Final Report on the CIPM Key Comparison CCAUV.V-K5

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Abstract

The results of the fifth CIPM[1] key comparison (KC) in the area of vibration, here concerning sinusoidal acceleration, are presented. This comparison was intended to build the foundation for subsequent regional key comparisons over the extended frequency range from 10 Hz to 20 kHz. Measurement results reported by 14 participants for magnitude and phase shift of complex charge sensitivity of single ended and back to back accelerometers were compared. A key comparison reference value has been defined for each type of artifact, and the respective Degrees of Equivalence are reported. The final report has been peer-reviewed and approved for publication by the CCAUV[2], according to the provisions of the CIPM Mutual Recognition Arrangement (CIPM MRA).

[1]CIPM=International Committee for Weights and Measures

[2]CCAUV=Consultative Committee for Acoustics, Ultrasound and Vibration

Contents

1 — Introduction

This report presents the results of the fifth CIPM key comparison (KC) in the area of vibration, which in this case means sinusoidal acceleration. It has the status of a Final Report and was accepted by the participants as well as subsequently reviewed by the the CCAUV Key Comparison Working Group and finally approved by the CCAUV.

The comparison is supposed to build the foundation of subsequent regional key comparisons over the coming years, thus, providing strong support for the CIPM MRA in the field of vibration metrology.

This report defines a key comparison reference value (RV) in terms of magnitude and phase of the complex frequency response, and reports the Degrees of Equivalence (DoE) of the participants with respect to this reference value (see Section 8). Following the resolutions of CCAUV no bilateral DoE are calculated.

The Technical Protocol (TP) (see Appendix A) specifies in detail the aim and the task of the comparison, the conditions of measurement, the transfer standards used, measurement instructions and other items. A brief survey is given in the following sections.

The monitoring data documenting the stability of the transducers are reported in part in Section 6.

2 — Participants

Fourteen national metrology institutes or designated institutes from 5 regional metrology organizations (RMOs) took part in this comparison. They are listed in chronological order of measurement in Table 2.1.

Table 2.1: List of participants and actual schedule of CCAUV.V-K5.

Laboratory name	Acronym	Country	Country Code	RMO	Calibration week
Physikalisch-Technische Bundesanstalt	PTB	Germany	DE	EURAMET	week 7 2017 (week 0)
Danish Primary Lab for Acoustics	DPLA	Denmark	DK	EURAMET	7
Bundesamt für Metrologie	METAS	Switzerland	CH	EURAMET	13
Centro Español de Metrologa	CEM	Spain	ES	EURAMET	20
National Institute of Standards and Technology	NIST	United States	US	SIM	29
Centro Nacional de Metrologia	CENAM	Mexico	MX	SIM	40
National Metrology Institute of Japan	NMIJ	Japan	JP	APMP	51
National Institute of Metrology of China	NIM	China (PR)	CN	APMP	62
National Metrology Institute of Australia	NMIA	Australia	AU	APMP	72
National Institute of Metrology, Quality and Technology	INMETRO	Brazil	BR	SIM	82
National Metrology Institute of South Africa	NMISA	South Africa	ZA	AFRIMET	90
D.I. Mendelejev Institute for Metrology	VNIIM	Russia	RU	COOMET	100
National Metrology Center Singapore	NMC, A*Star	Singapore	SG	APMP	111
SE UKRMETRTEST-STANDART	UkrMet	Ukraine	UA	COOMET	124

3 — Task and Purpose of the Comparison

In the field of vibration and shock, this fifth global key comparison (CCAUV.V-K5) was organized in order to compare measurements of sinusoidal linear accelerations in the frequency range from 10 Hz to 20 kHz. The previous vibration key comparison CCAUV.V-K2 was finished in the year 2014 under difficult conditions and its results have presented sub-optimal conditions of measurement comparability. Therefore, it was decided during the meeting of CCAUV in November 2015 that a new KC repeating the scope of CCAUV.V-K2 was required. Later on, it was agreed by the participants to increase the upper frequency limit from 10 kHz to 20 kHz taking into account special precautions to improve the level of comparability at high frequencies. The technical protocol of CCAUV.V-K5 was then formatted with this goal in mind.

During the circulation period from March 2017 to July 2019, fourteen national metrology institutes (NMIs) from five regional metrology organizations (RMOs) calibrated two accelerometers as transfer standards by primary methods. It was the task of the comparison to measure the magnitude and the phase of the complex charge sensitivity of two accelerometer standards (one of single-ended design and one of back-to-back design) at different frequencies specified in the technical protocol (TP) (c.f. Appendix A). The magnitude of the complex charge sensitivity was calculated as the ratio of the amplitude of the accelerometer output charge to the amplitude of the acceleration at its reference surface. The reference surface was defined as the top surface of the mounting adapter (mounting surface) of the accelerometer of single-ended design (SE), and the top surface of the accelerometer of back-to-back design (BB). The charge sensitivity was given in picocoulombs per metre per second squared: pC/(m/s^2). A calibrated charge amplifier was used to measure the output charge of the accelerometer standards. This charge amplifier was not part of the set of traveling artifacts but part of the participants' laboratory inventory.

For the calibration of the two accelerometers, all NMIs applied laser interferometry in compliance with the international standards ISO 16063-1:1998 [1] and ISO 16063-11:1999 [2], in order to cover the entire frequency range chosen, within a specified range of the acceleration amplitudes with specified uncertainties. Although the TP left the option to apply different methods with similar known uncertainties, no other method (e.g. the reciprocity method) was applied.

Note: Originally it was planned to have a set of three accelerometers under calibration. However, the characteristics of one of the artifacts proved to be unsuited for a KC during the calibrations at the first three participants. It was therefore removed from the measuring program for the sake of more measuring time for the remaining two artifacts. The change is recorded in the technical protocol in the appendix.

The sensitivities and associated uncertainties reported by the participants were used for the calculation of the unilateral DoE between each NMI and the key comparison reference value. The results of this KC will form the new basis for DoE derived in subsequent RMO key comparisons, and therefore be the foundation for the registration of calibration and measurement capabilities (CMC) in the framework of the CIPM MRA. Moreover, under the perspective of defining how far the light shines, we can enumerate a set of calibration and measurement capabilities (CMCs) that can be supported by the results of this key comparison. Besides the direct support to primary calibration of accelerometer complex charge sensitivity, the results might also be used to support voltage sensitivity of accelerometers / acceleration measuring chains, under the assumption that charge sensitivity depends on the calibration of voltage sensitivity of an acceleration measuring chain and the sensitivity of the charge amplifier used. In addition, the uncertainty budgets provided by the participants give supporting evidence about the contribution of the charge conditioner used by each NMI. Therefore, this information can also be used to support future claims of CMCs related to electrical calibration of charge and voltage sensitivity of vibration signal conditioners.

4 — Transfer Standards as Artifacts

For the purpose of the comparison, the pilot laboratory monitored two accelerometers which were kindly provided by the manufacturer to the pilot laboratory for this KC for about one year prior to the start of the comparison measurements.

- One transfer standard accelerometer (single-ended), type 8305-001 SN 1610153 (manufacturer: Brüel & Kjaer) named SE-transducer subsequently.
- One reference standard accelerometer (back-to-back), type 8305 SN 1483350 (manufacturer: Brüel & Kjaer) named BB-transducer subsequently.

The SE type accelerometer was mounted on a mechanical adapter and this set was to be handled as a single mechanical unit for mounting, following the guidelines in the technical protocol.

5 — Circulation of the Artifacts

A star type circulation was used for this comparison, i.e. between the measurements at each participant's laboratory the pilot laboratory checked the artifacts for stability (see Section 6) and general condition.

The investigation of the long-term stability was continued throughout the circulation period, whenever the artifacts returned to the pilot laboratory. The results of the PTB stability measurements and other individual data of the transfer standards are given in Section 6.

6 — Results of the Monitoring Measurements

The artifacts were monitored by the pilot laboratory during the whole comparison. Due to the star-type circulation, a monitoring measurement was performed between each of the participant's measurements. The subsequent diagrams depict the stability of the artifacts over time for the duration of the comparison for some frequencies. The horizontal scale shows the participating institute which performed measurements right before the respective monitoring measurements. Hence, the horizontal axis represents time during the run of the key comparison (for details c.f. table 2.1). The first entry for PTB relates to the official submitted results of the pilot lab. The vertical axis gives the deviation from the mean of all monitoring measurements.

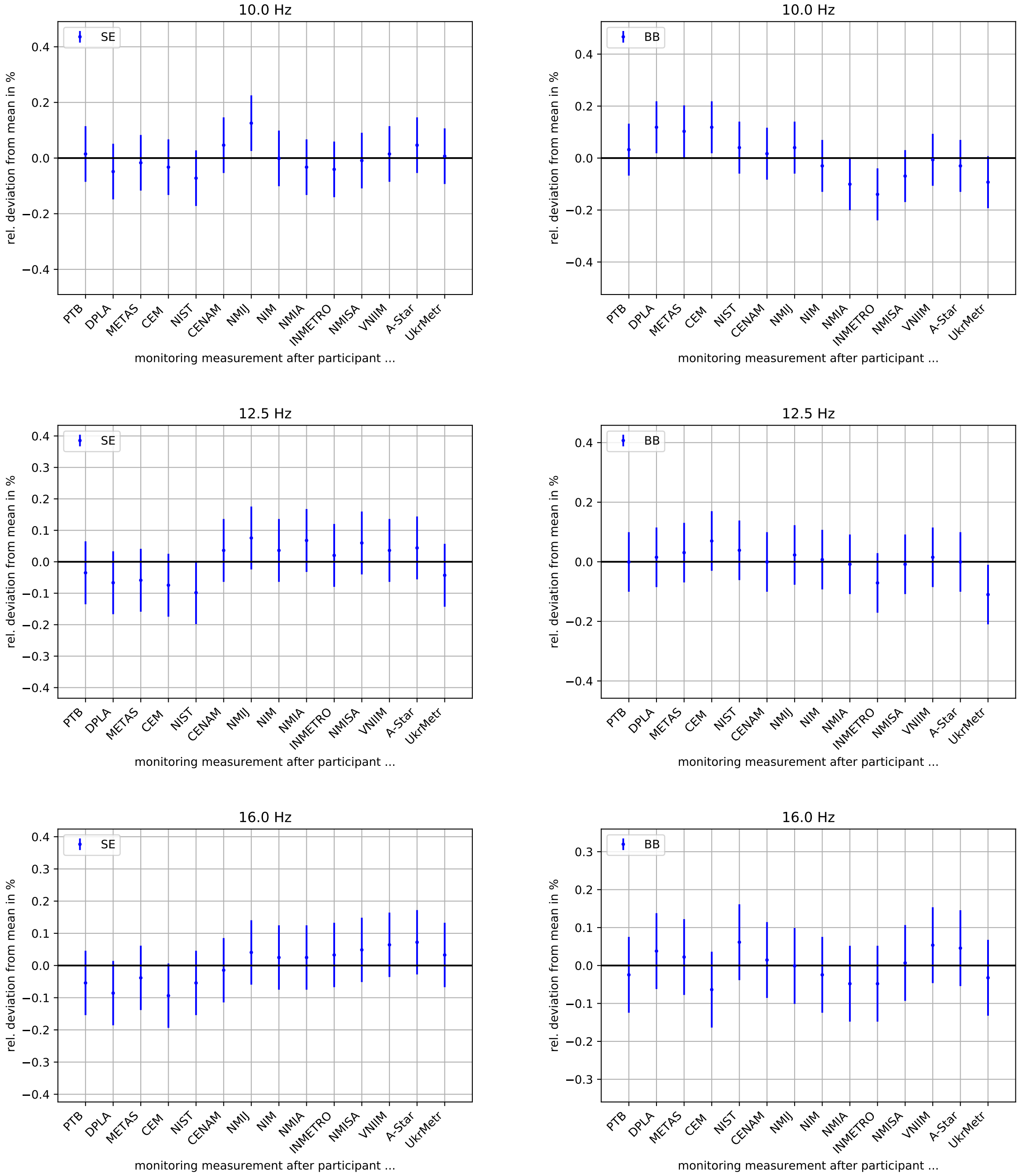

Figure 6.1: deviation of sensors sensitivity magnitude vs. time during monitoring (SE left column, BB right column)

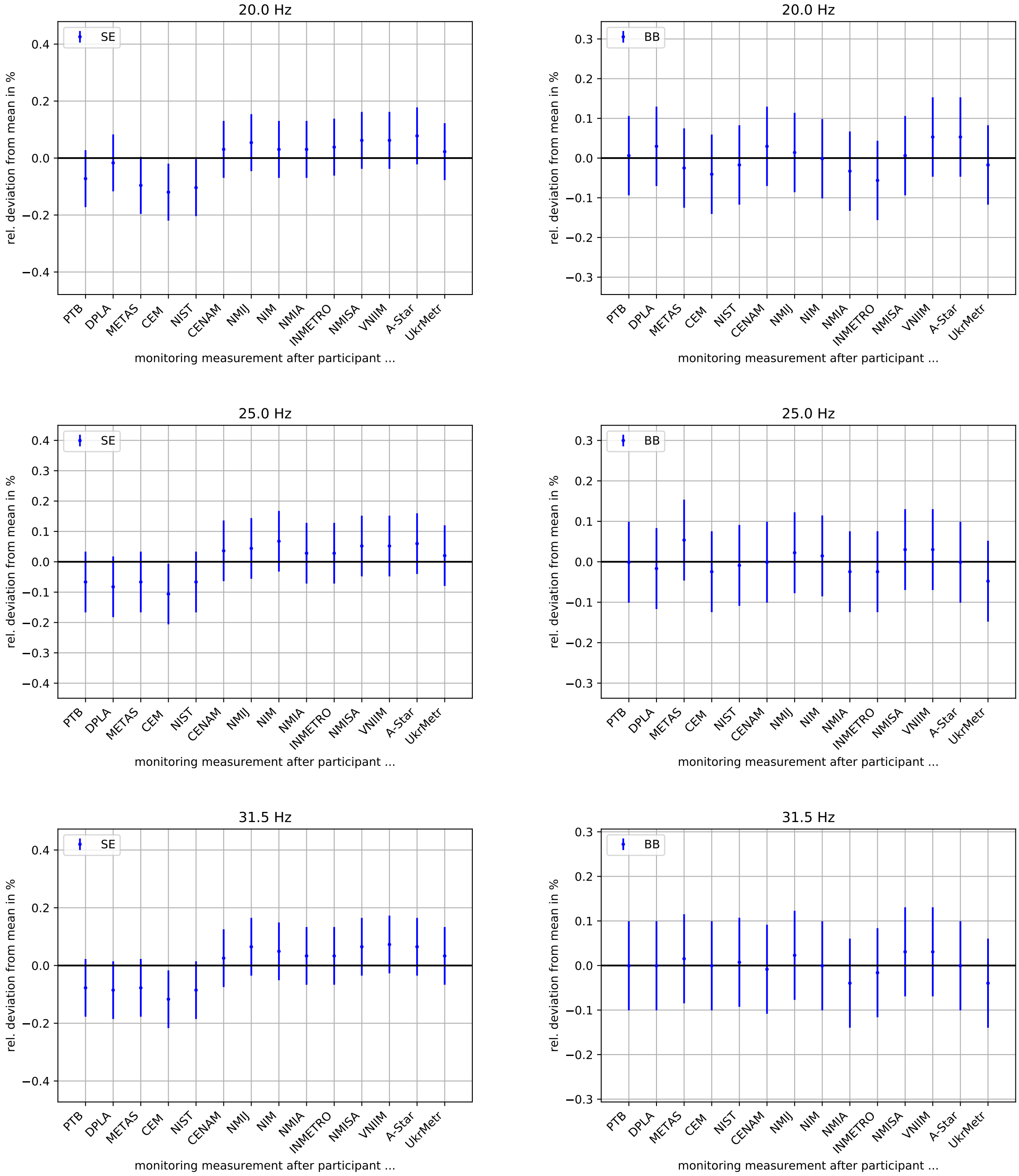

Figure 6.2: deviation of sensors sensitivity magnitude vs. time during monitoring (SE left column, BB right column)

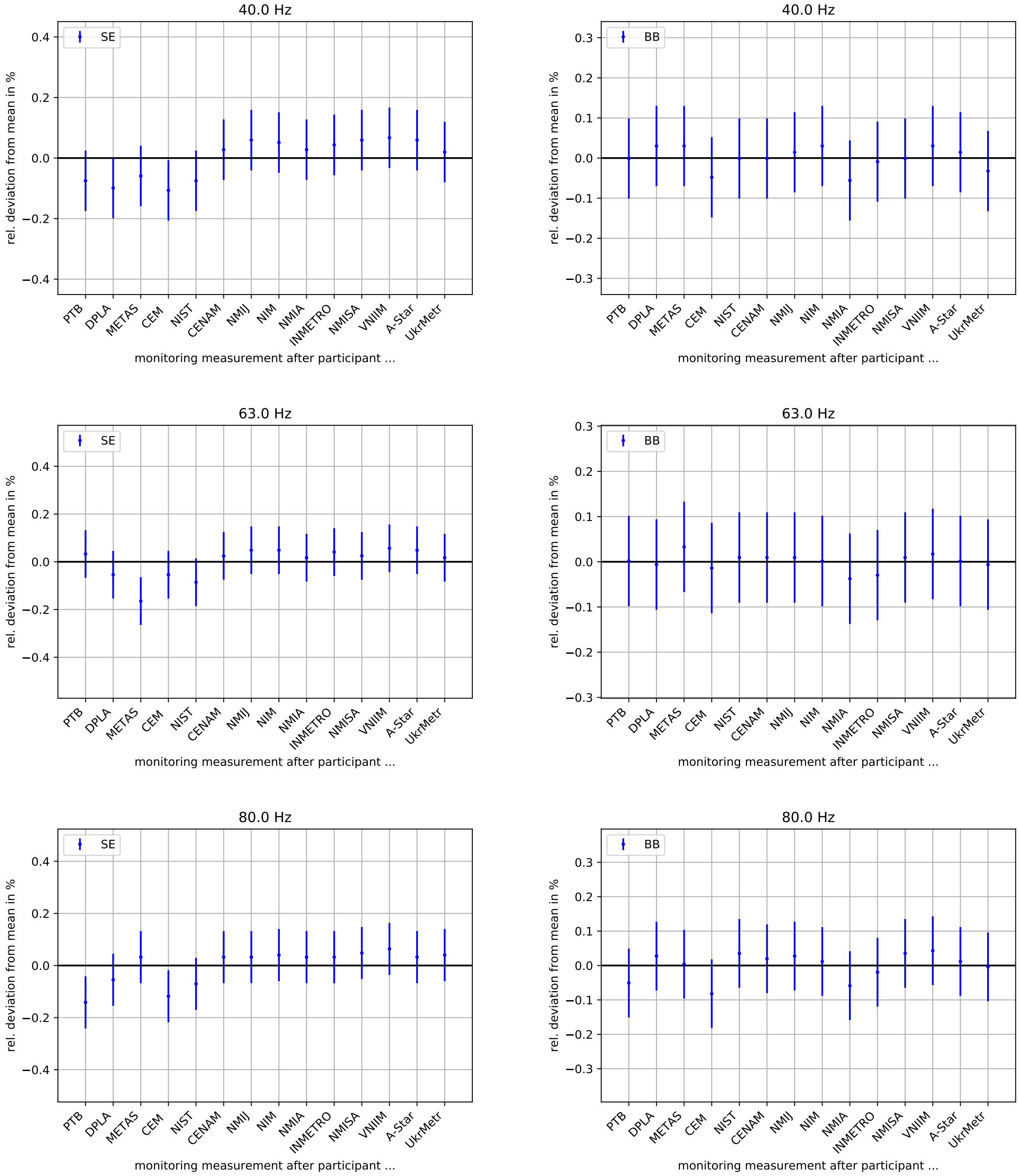

Figure 6.3: deviation of sensors sensitivity magnitude vs. time during monitoring (SE left column, BB right column)

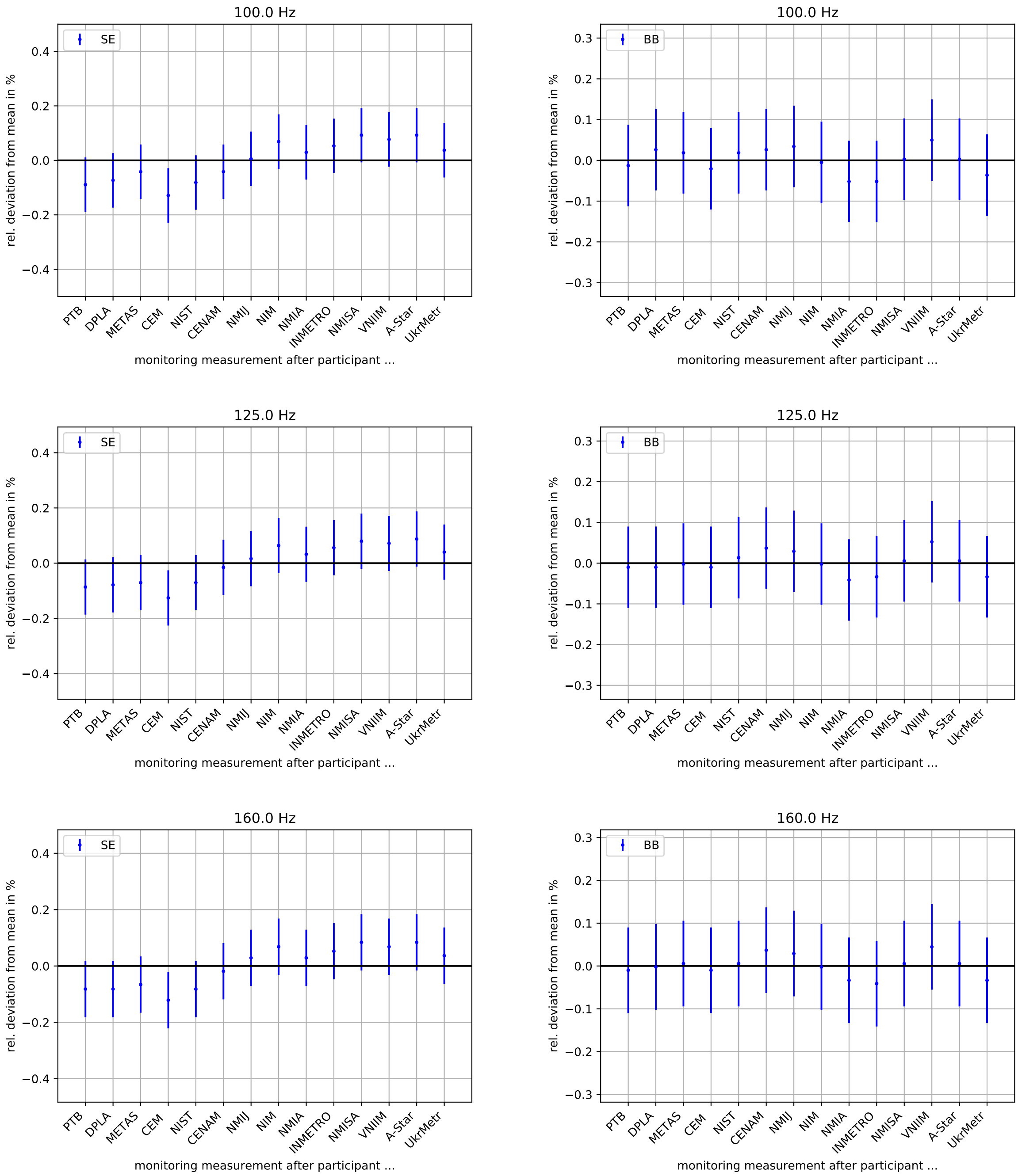

Figure 6.4: deviation of sensors sensitivity magnitude vs. time during monitoring (SE left column, BB right column)

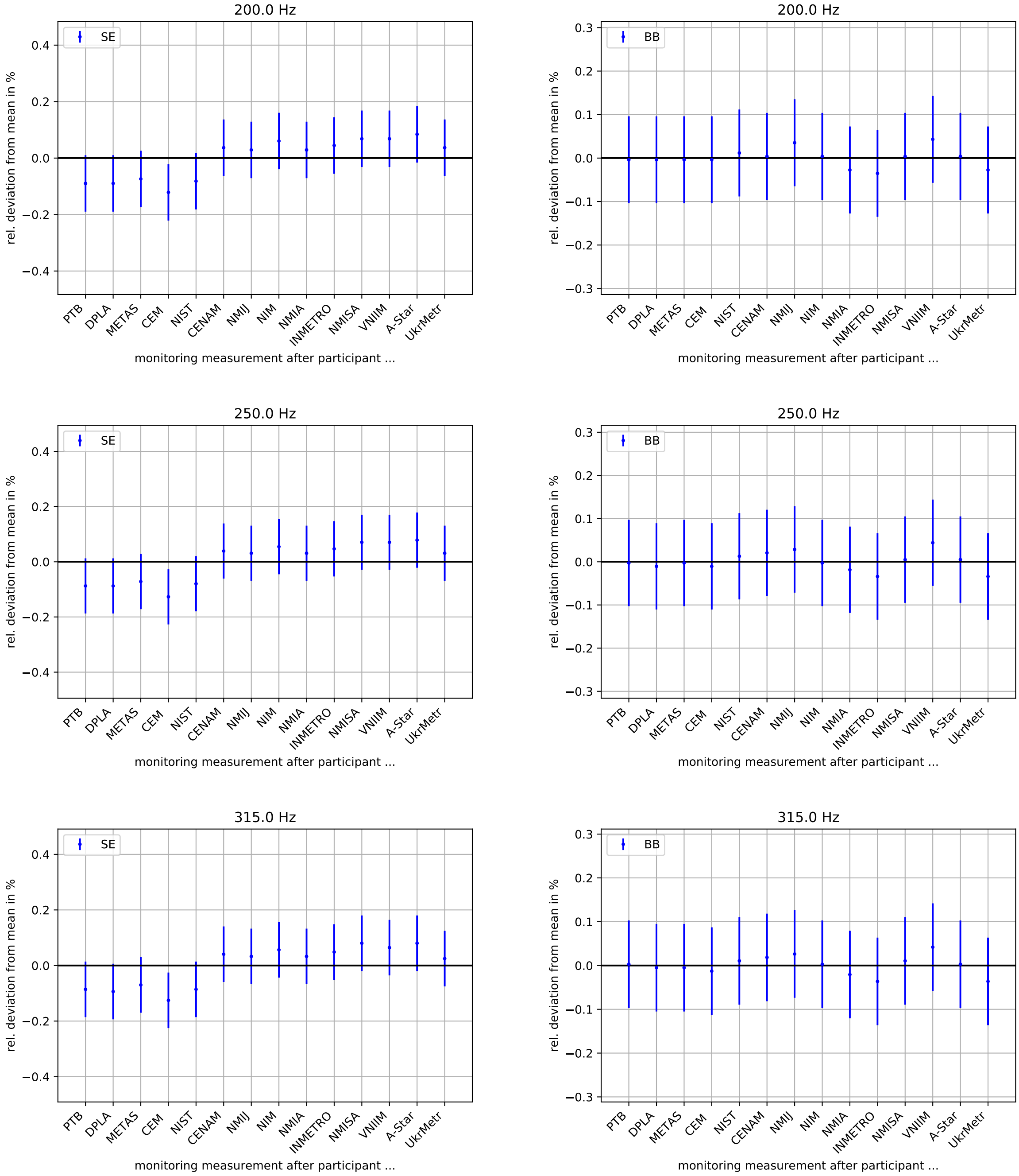

Figure 6.5: deviation of sensors sensitivity magnitude vs. time during monitoring (SE left column, BB right column)

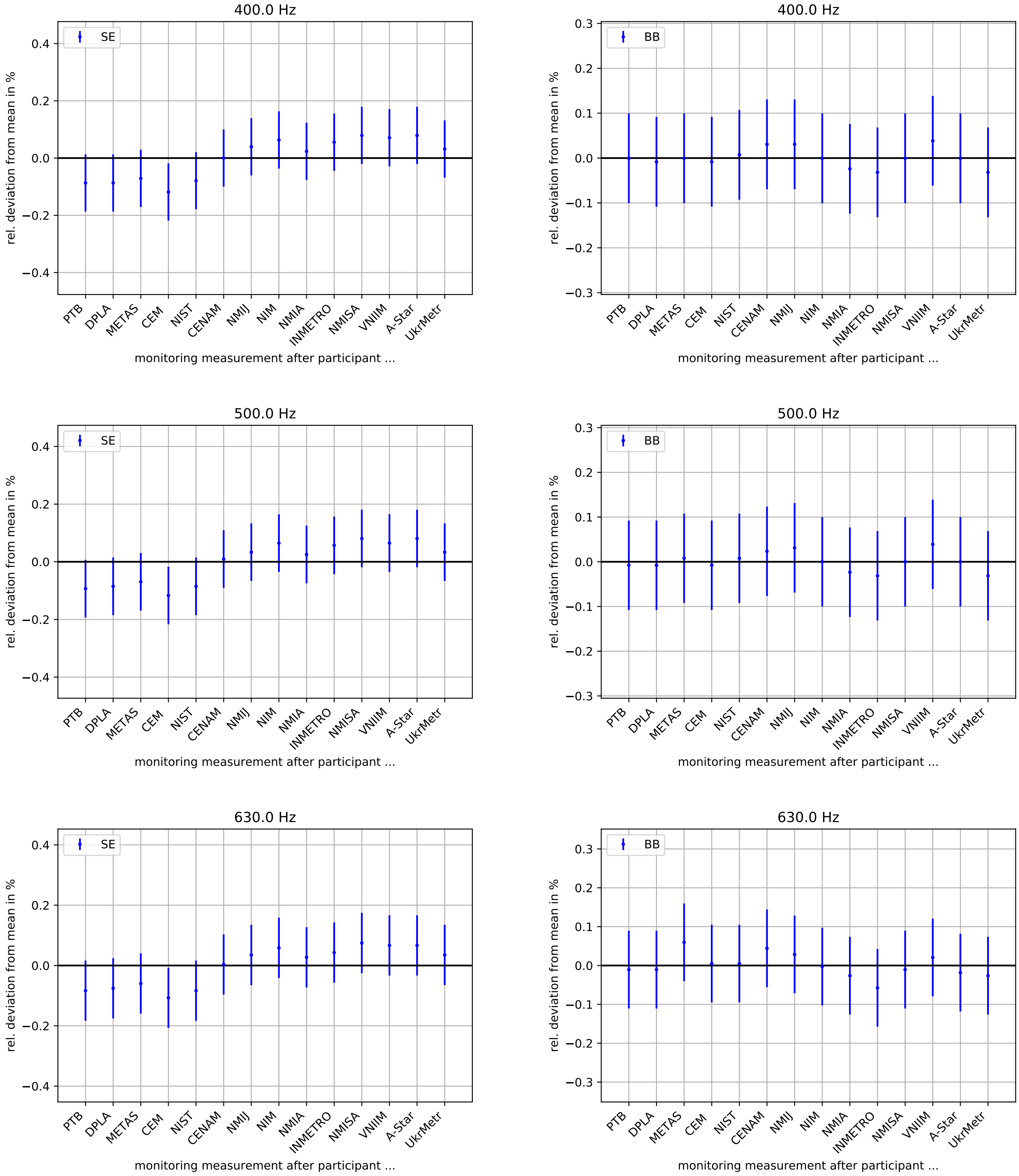

Figure 6.6: deviation of sensors sensitivity magnitude vs. time during monitoring (SE left column, BB right column)

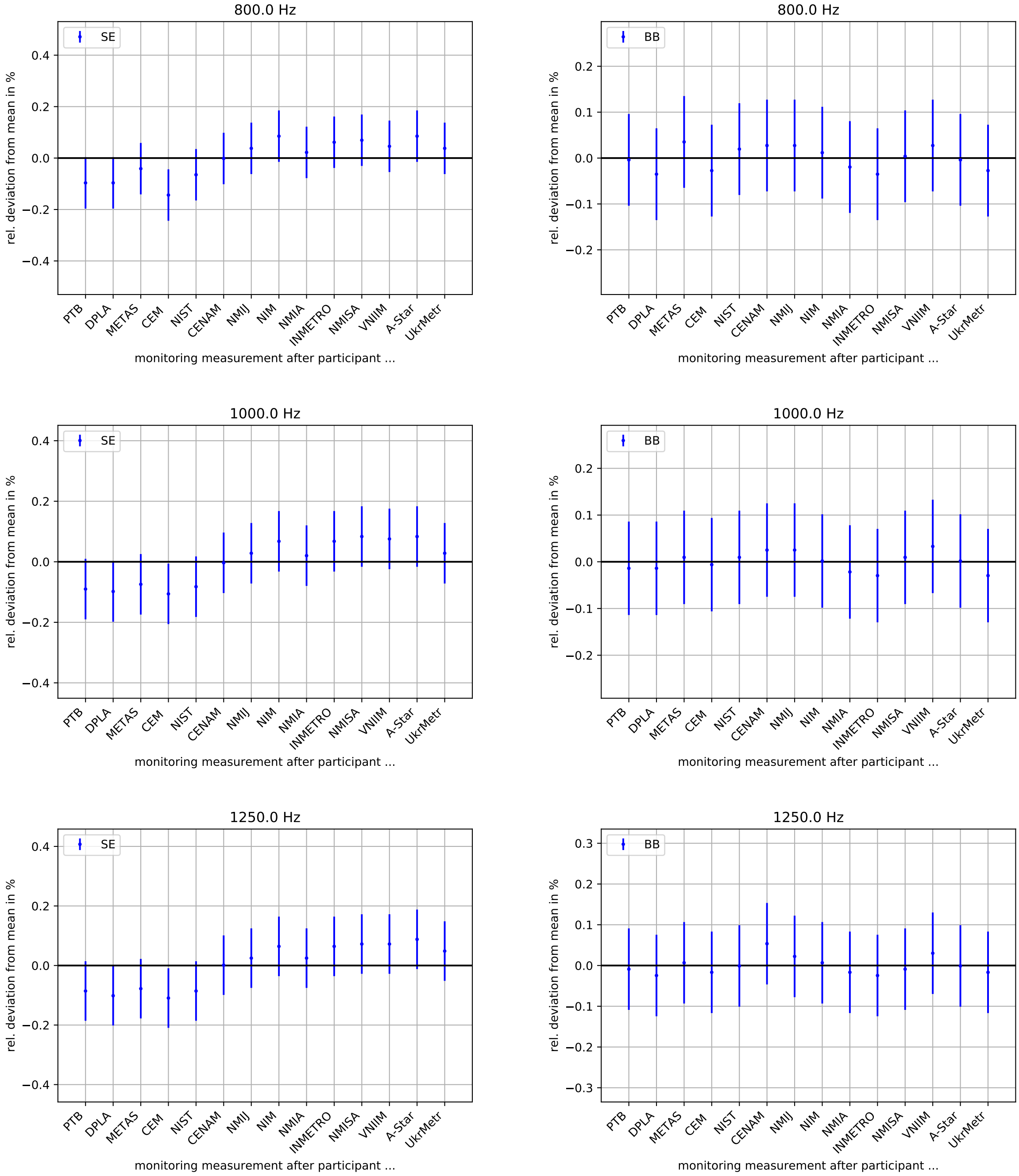

Figure 6.7: deviation of sensors sensitivity magnitude vs. time during monitoring (SE left column, BB right column)

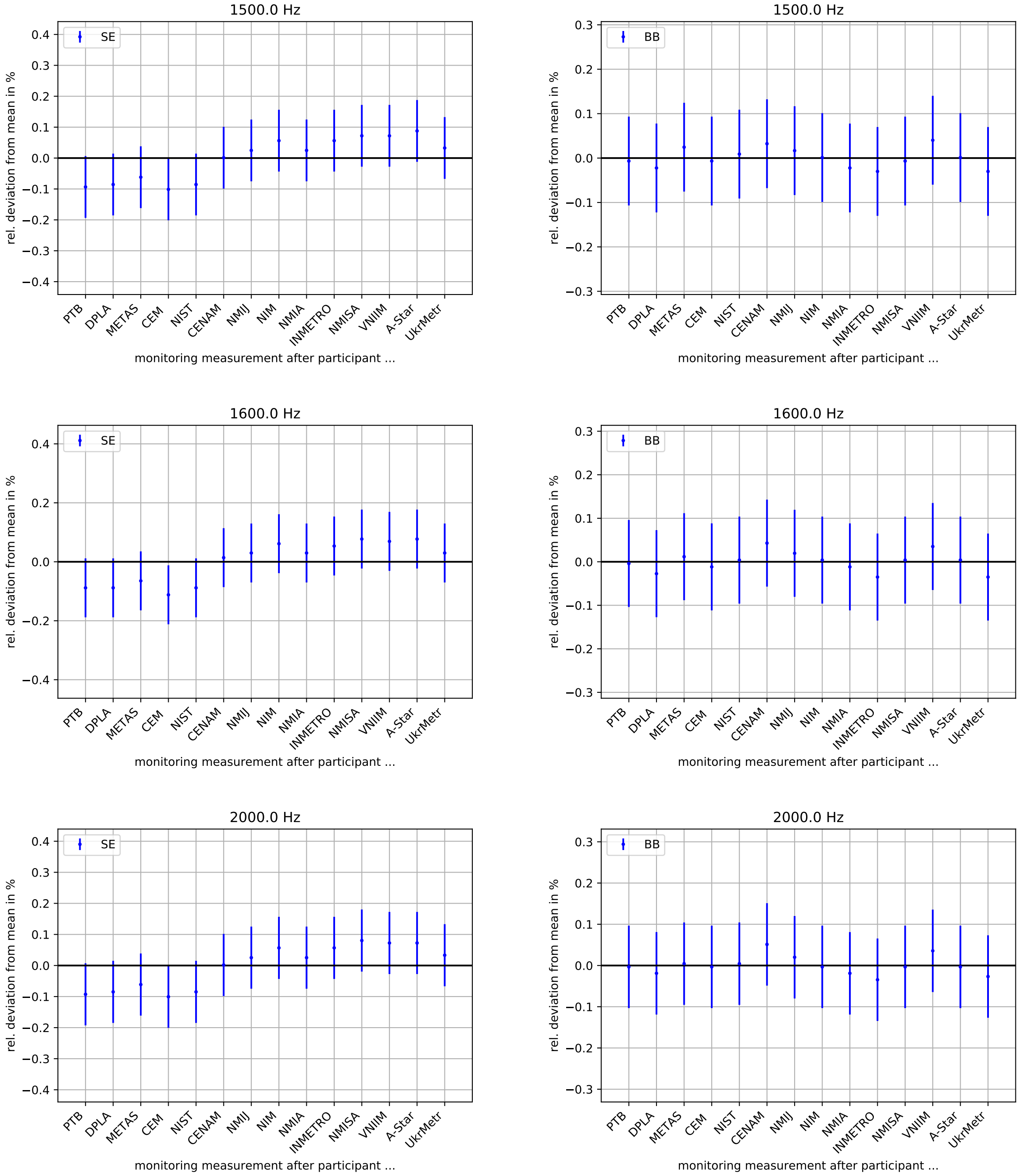

Figure 6.8: deviation of sensors sensitivity magnitude vs. time during monitoring (SE left column, BB right column)

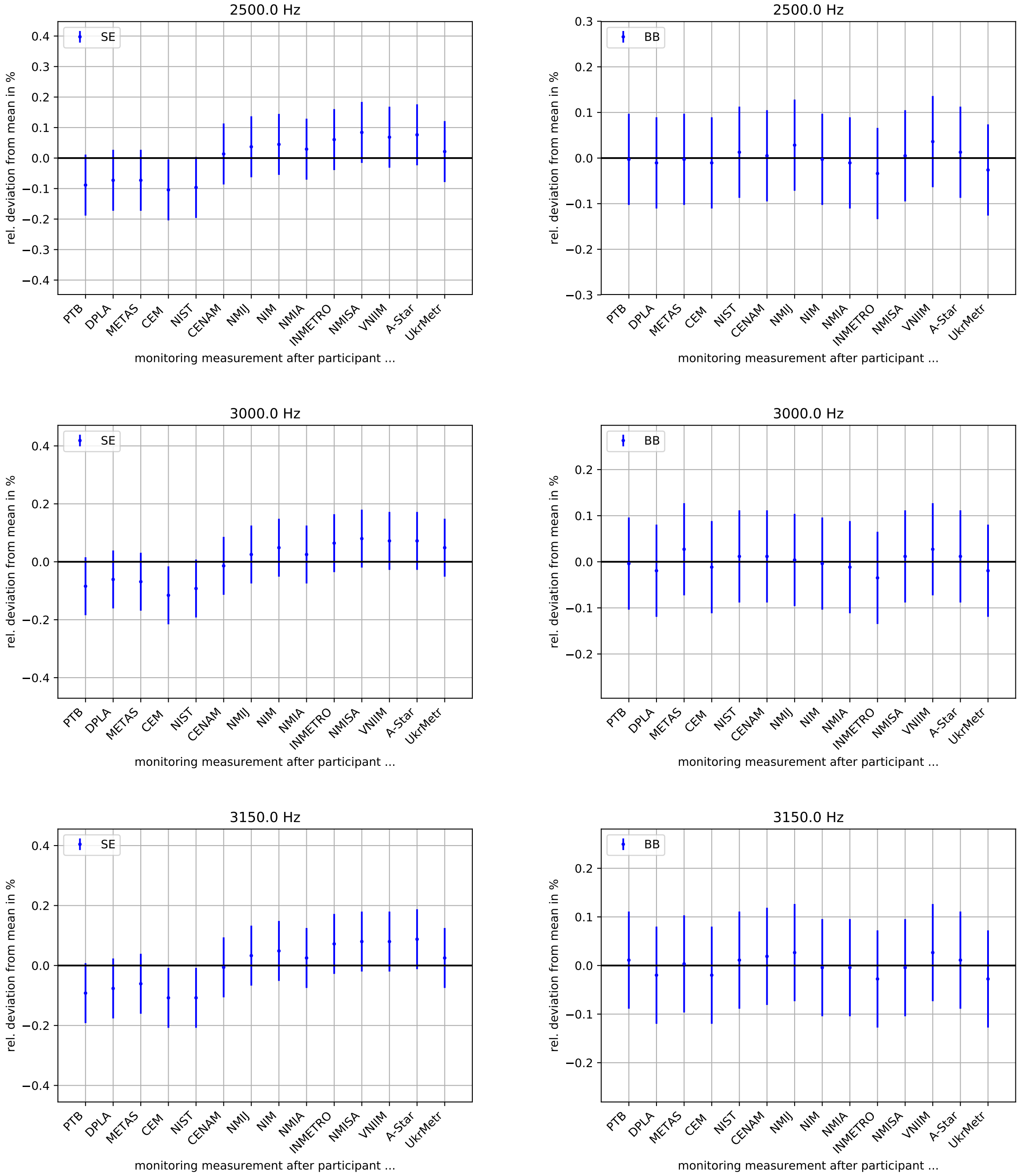

Figure 6.9: deviation of sensors sensitivity magnitude vs. time during monitoring (SE left column, BB right column)

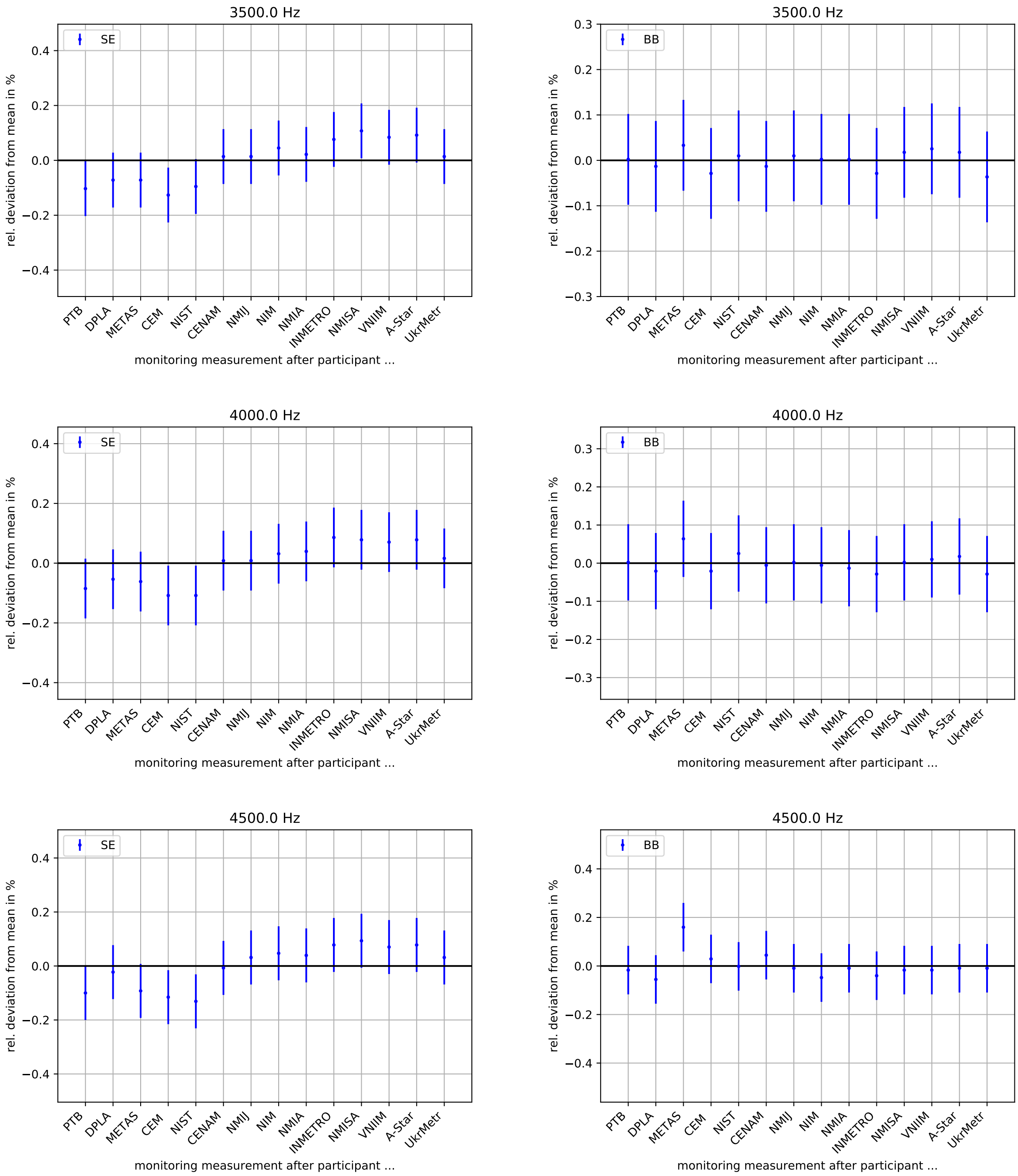

Figure 6.10: deviation of sensors sensitivity magnitude vs. time during monitoring (SE left column, BB right column)

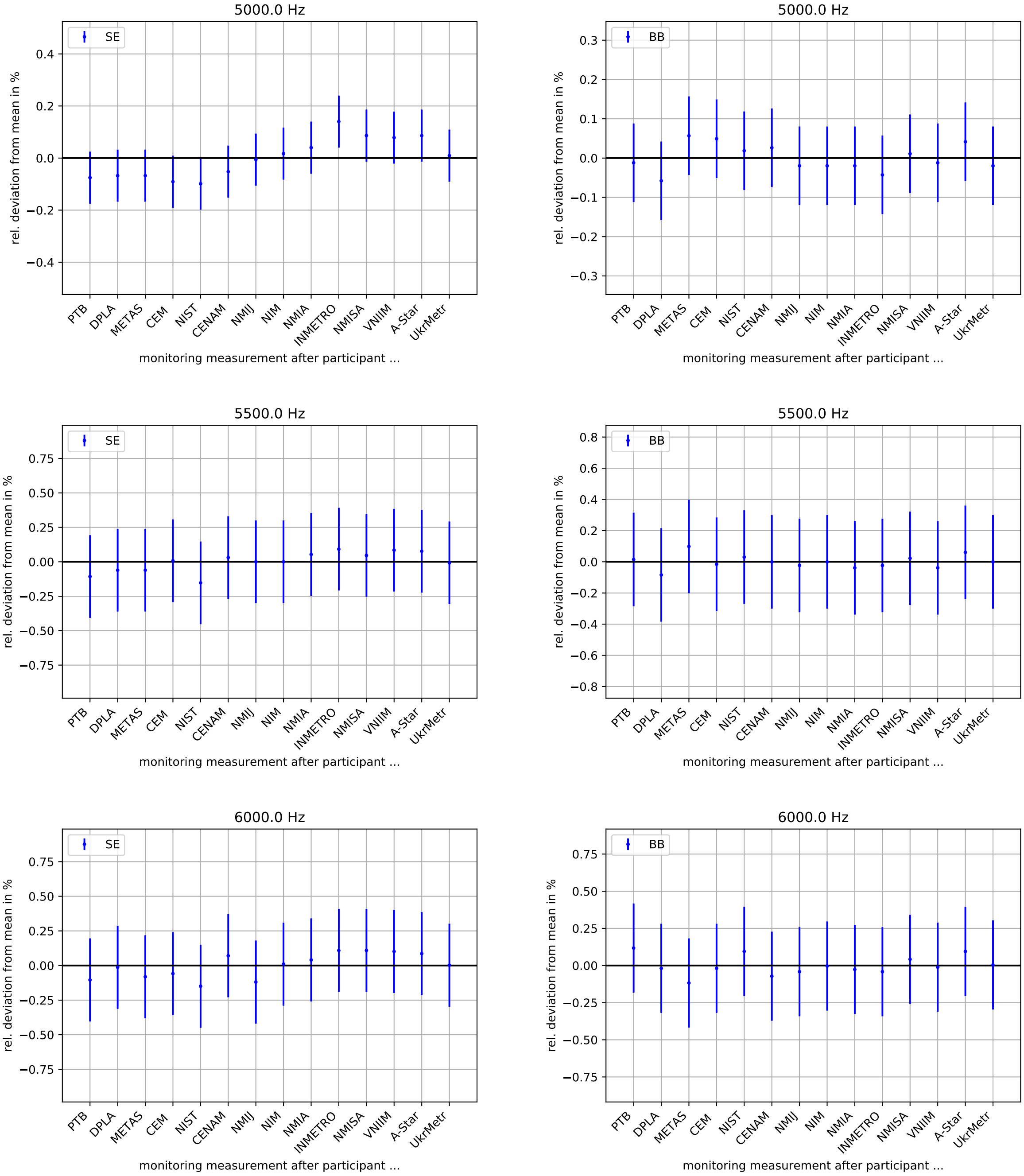

Figure 6.11: deviation of sensors sensitivity magnitude vs. time during monitoring (SE left column, BB right column)

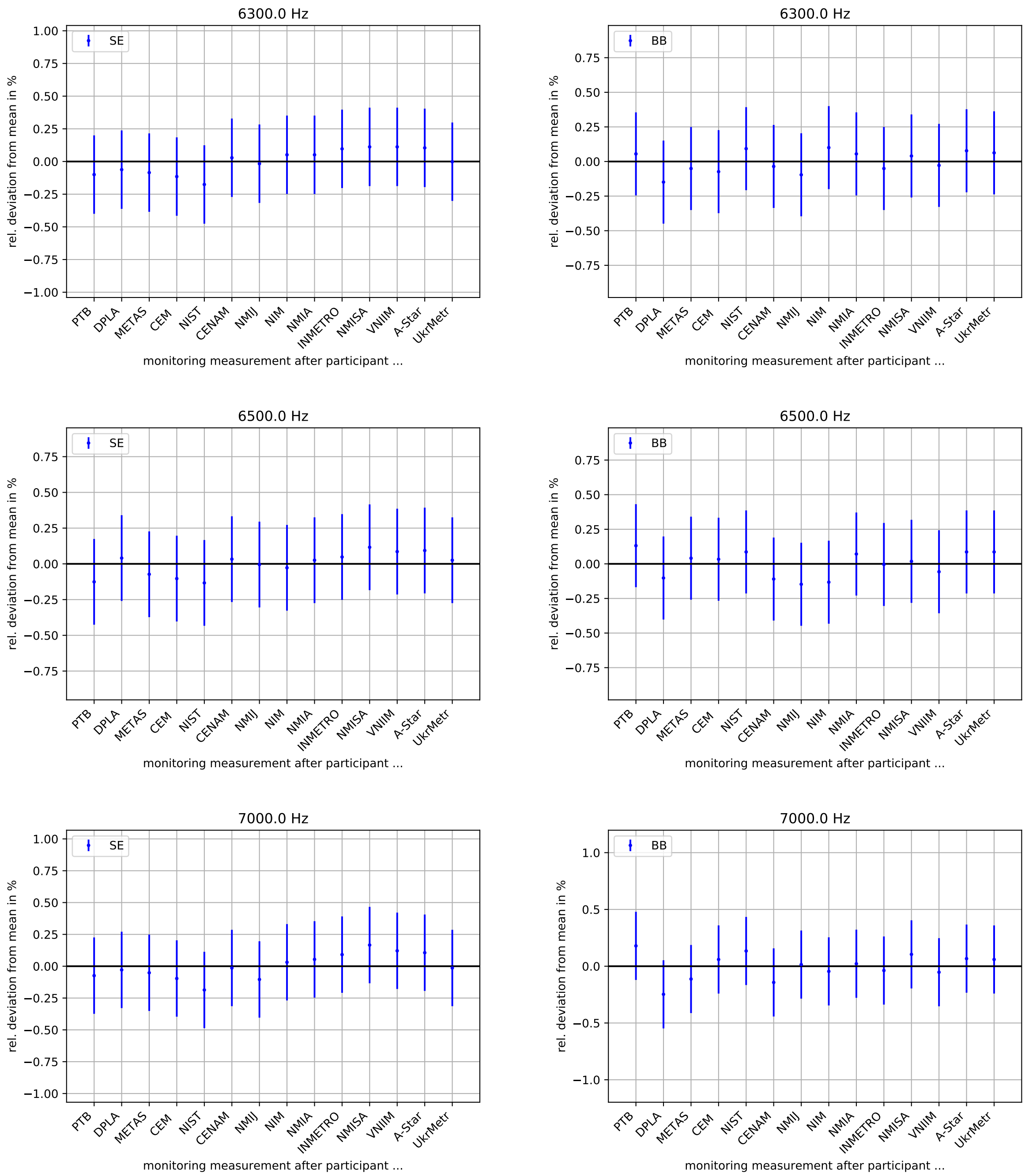

Figure 6.12: deviation of sensors sensitivity magnitude vs. time during monitoring (SE left column, BB right column)

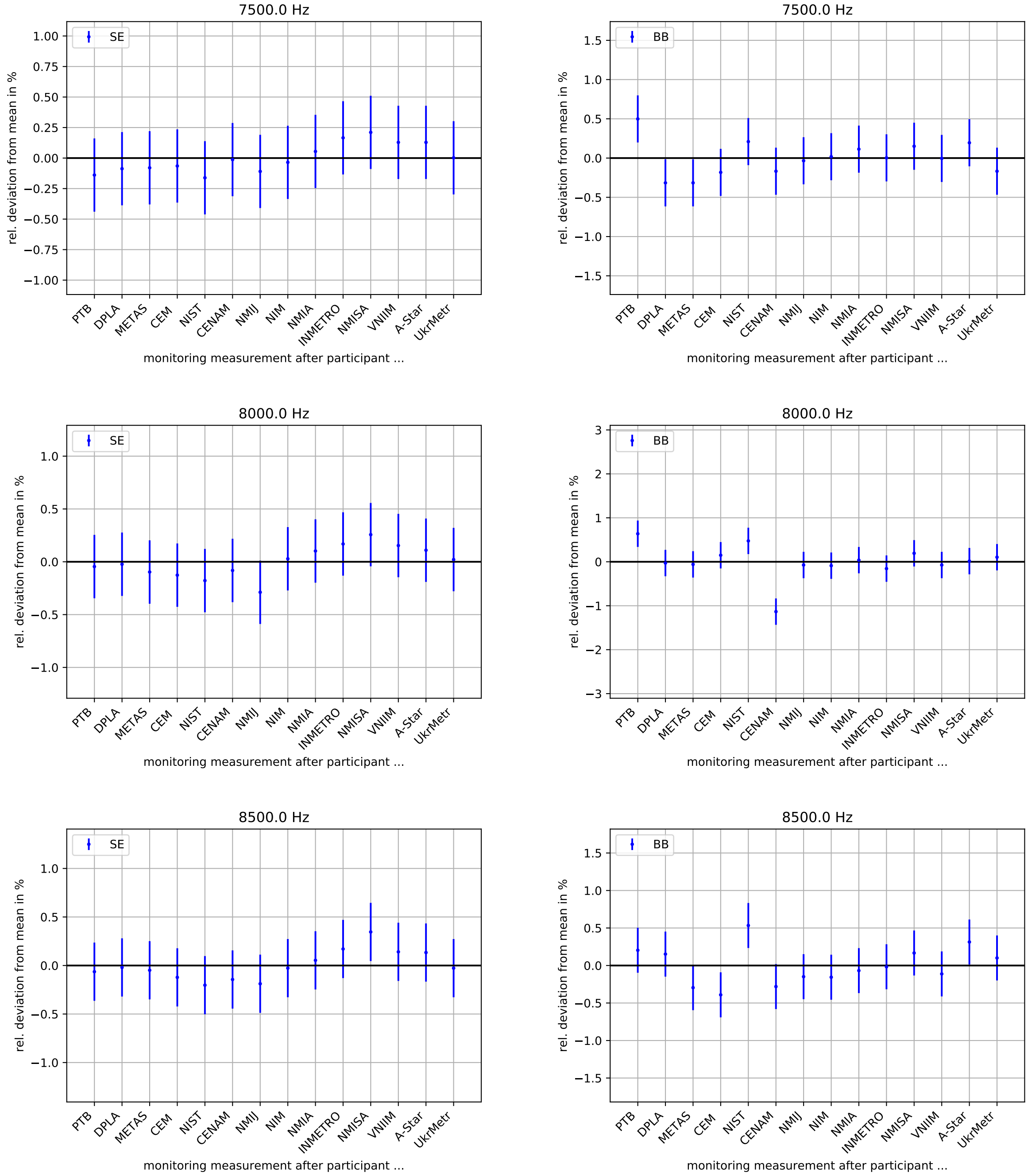

Figure 6.13: deviation of sensors sensitivity magnitude vs. time during monitoring (SE left column, BB right column)

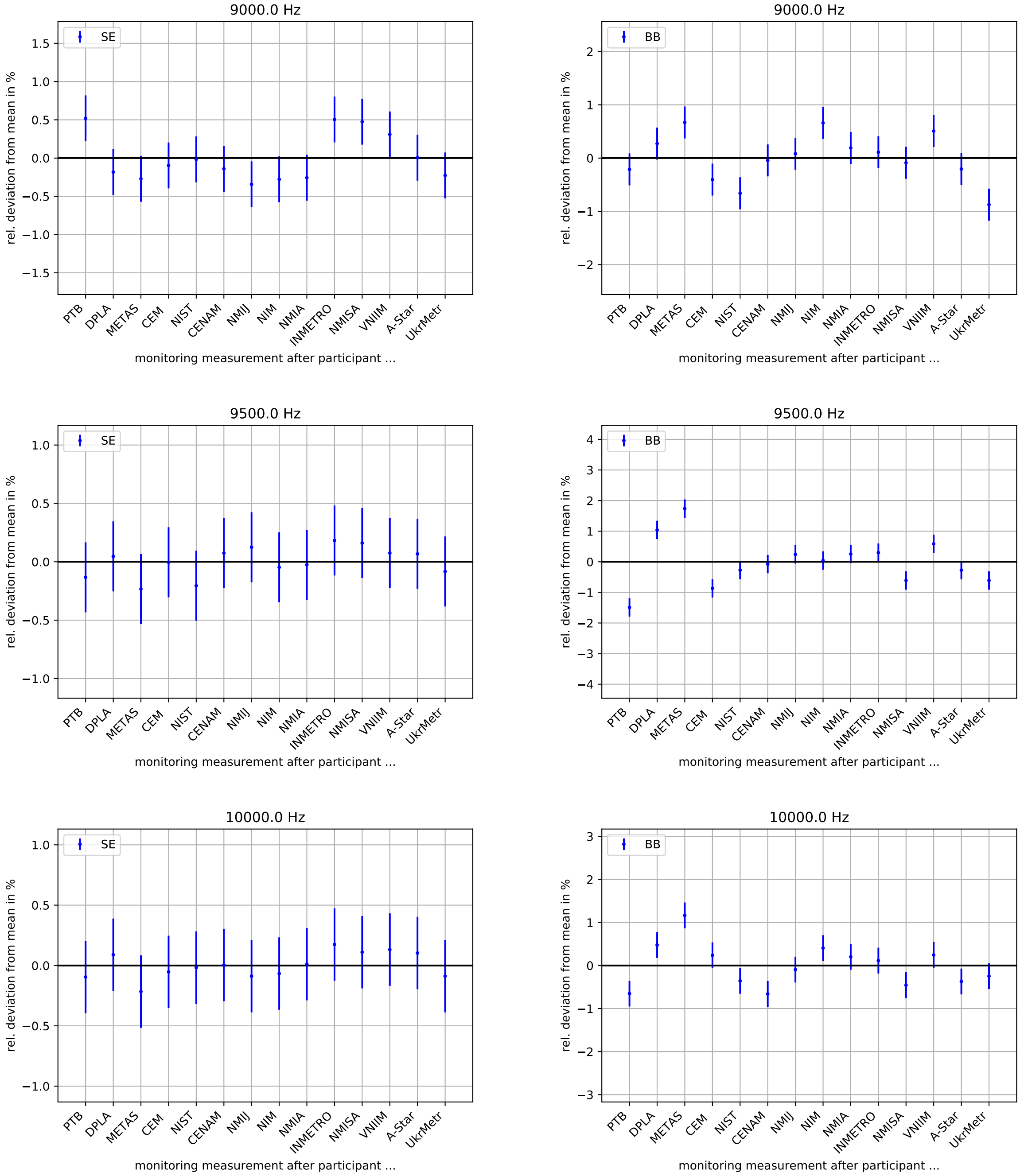

Figure 6.14: deviation of sensors sensitivity magnitude vs. time during monitoring (SE left column, BB right column)

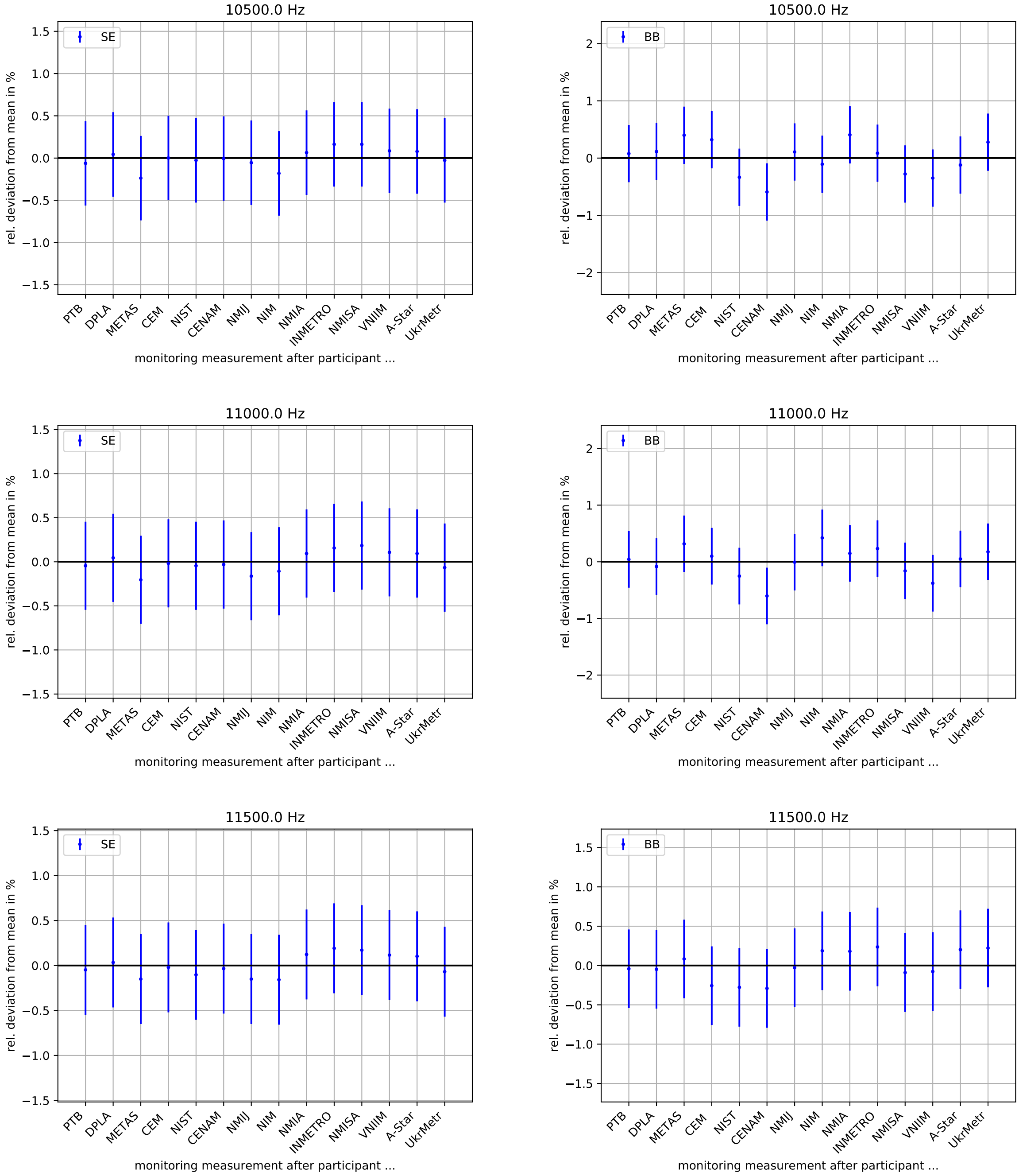

Figure 6.15: deviation of sensors sensitivity magnitude vs. time during monitoring (SE left column, BB right column)

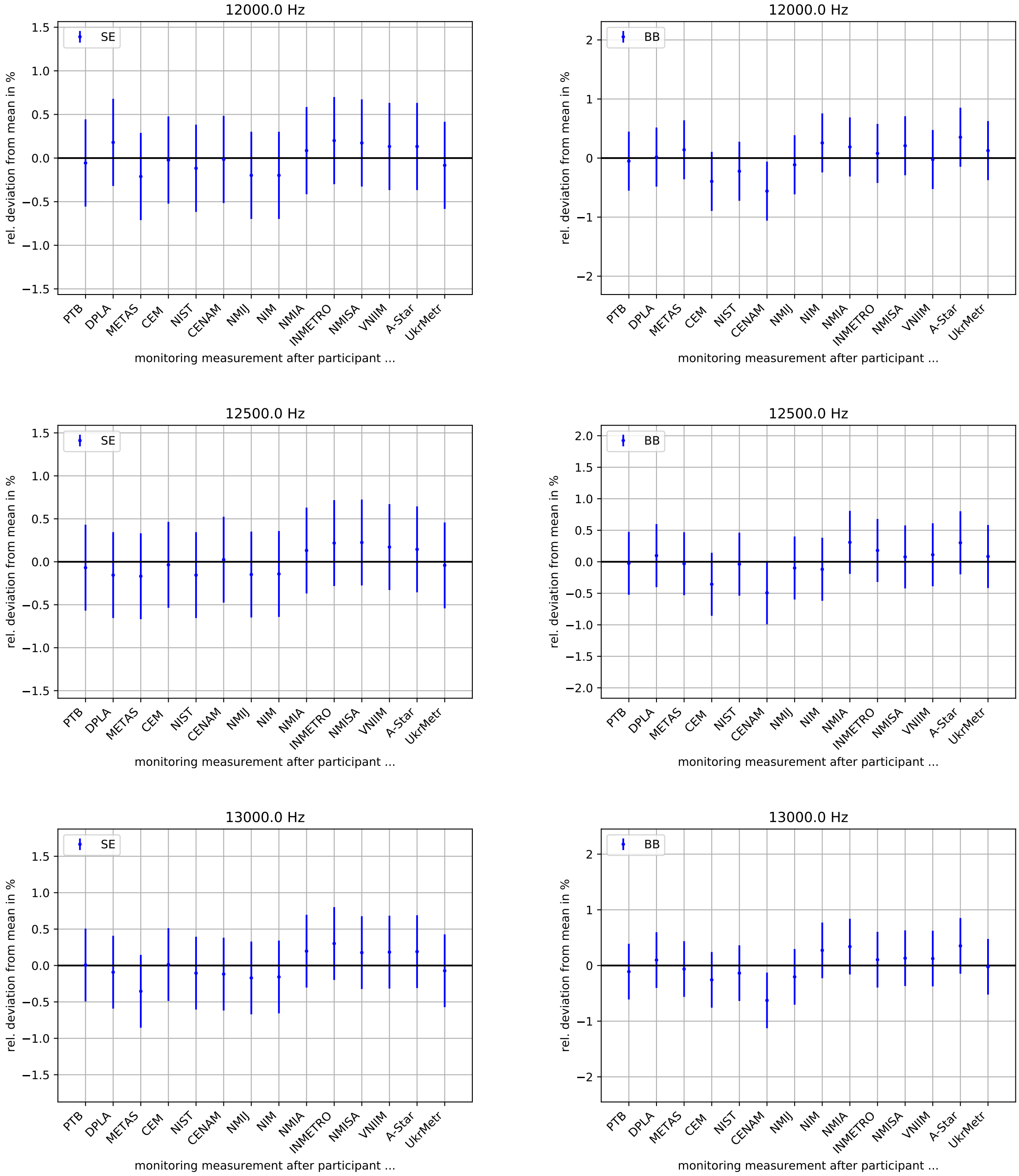

Figure 6.16: deviation of sensors sensitivity magnitude vs. time during monitoring (SE left column, BB right column)

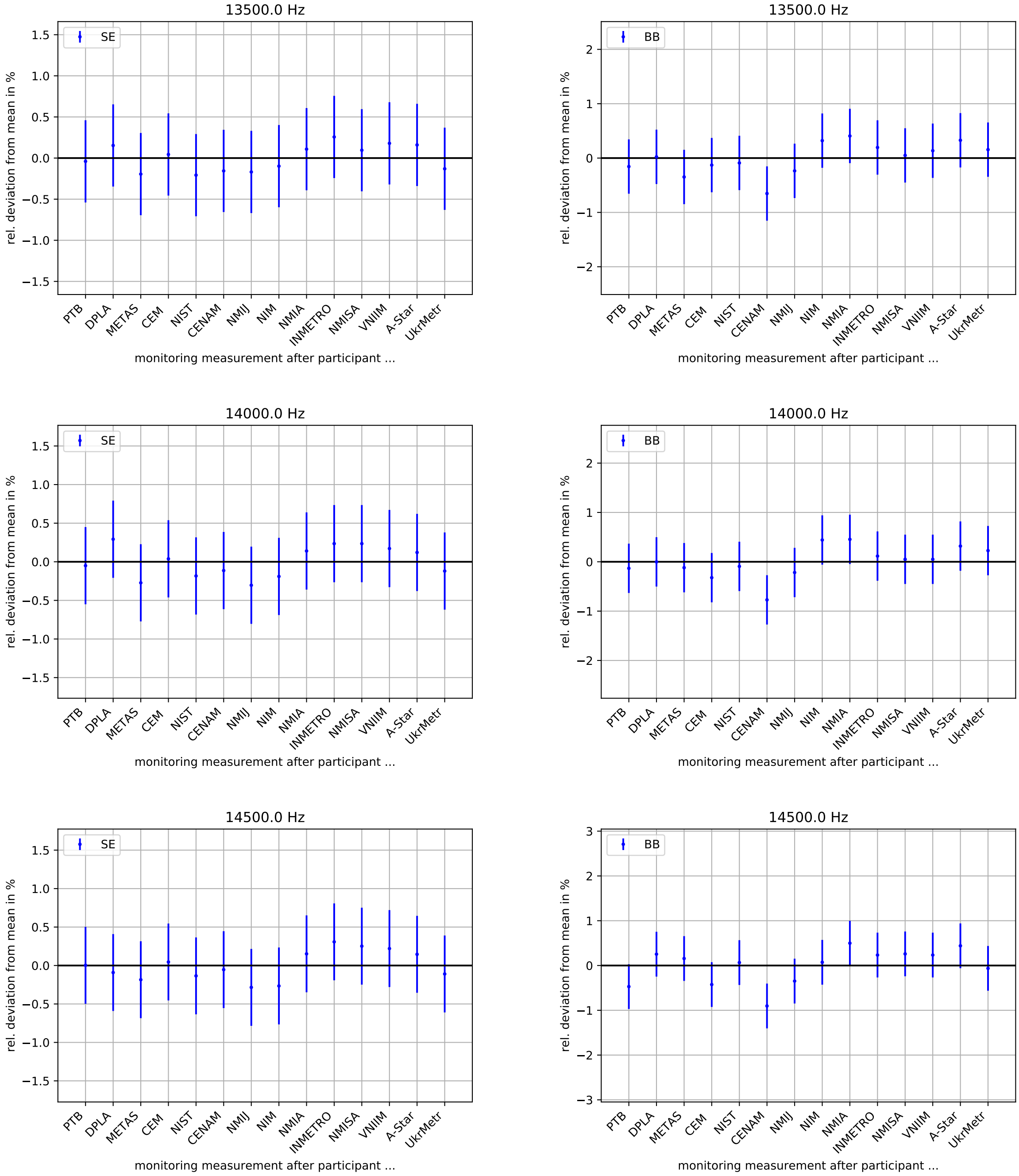

Figure 6.17: deviation of sensors sensitivity magnitude vs. time during monitoring (SE left column, BB right column)

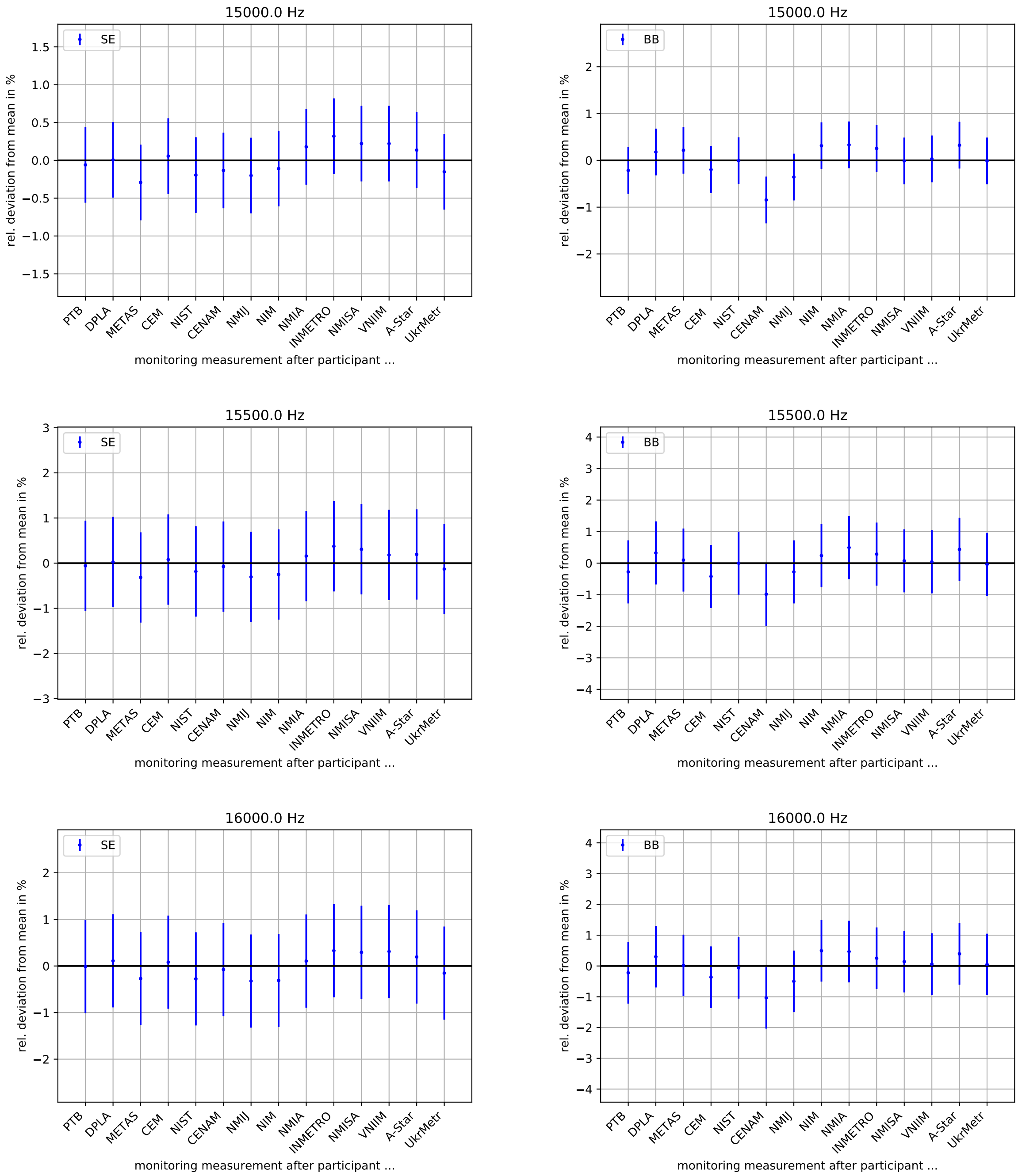

Figure 6.18: deviation of sensors sensitivity magnitude vs. time during monitoring (SE left column, BB right column)

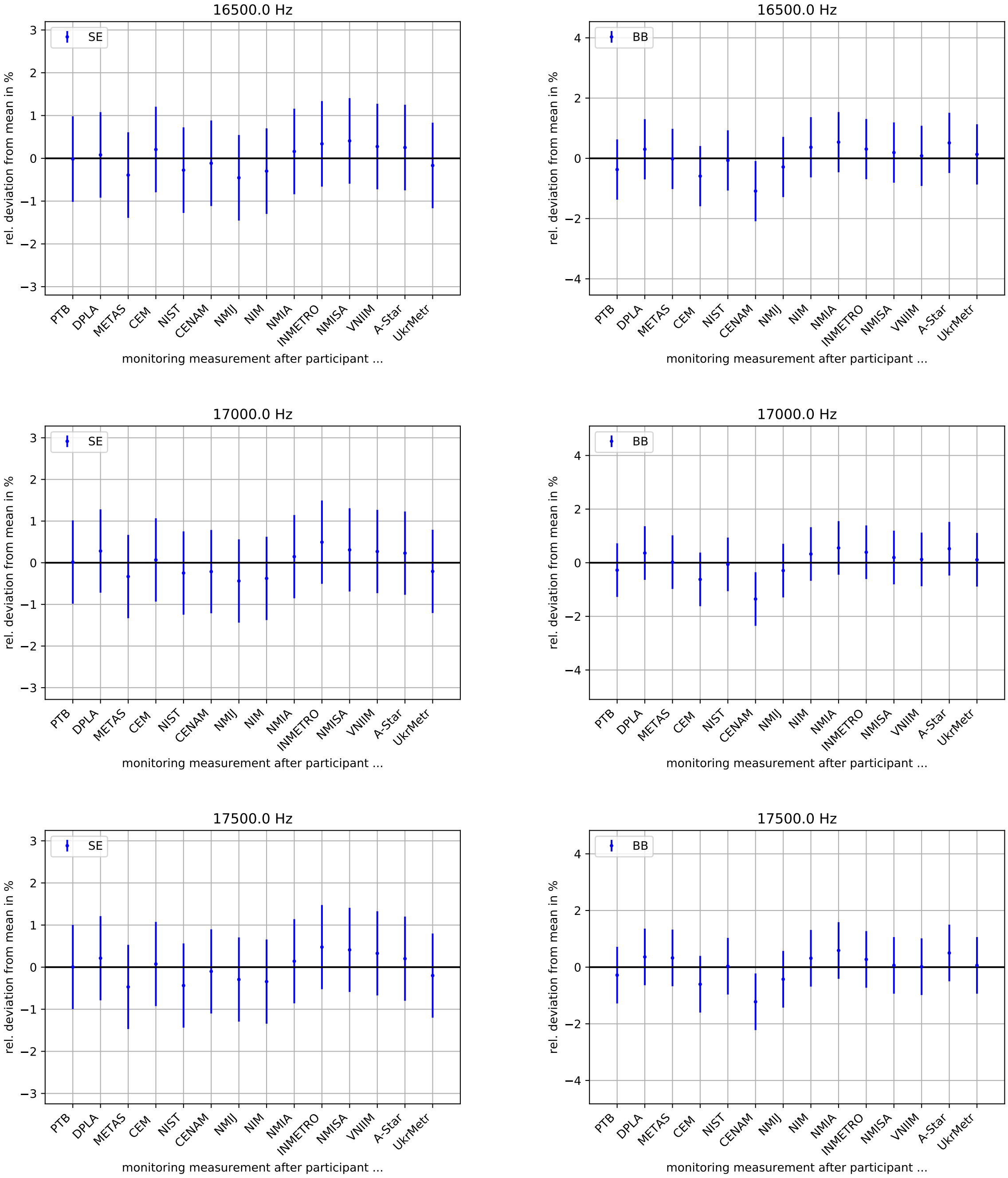

Figure 6.19: deviation of sensors sensitivity magnitude vs. time during monitoring (SE left column, BB right column)

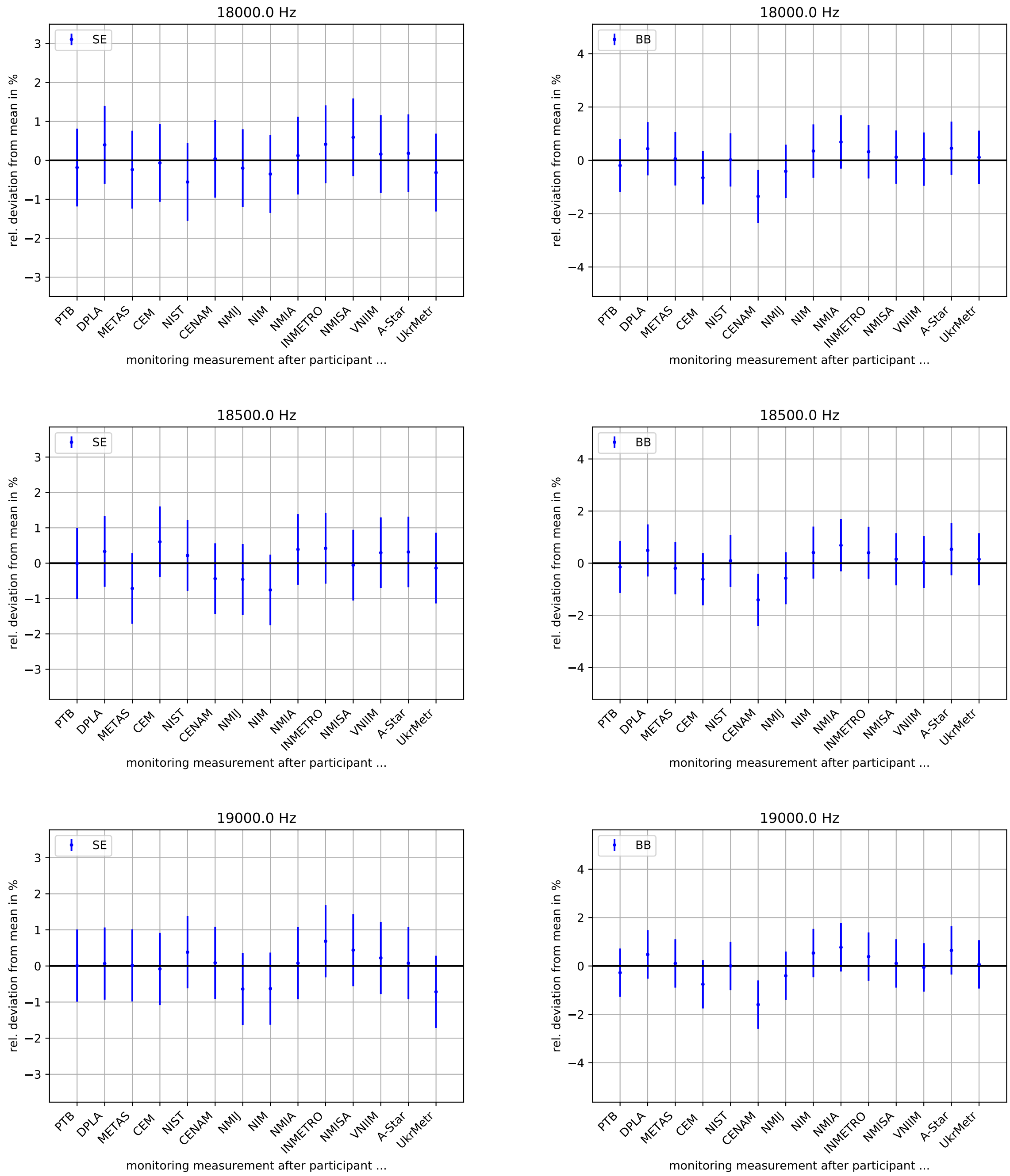

Figure 6.20: deviation of sensors sensitivity magnitude vs. time during monitoring (SE left column, BB right column)

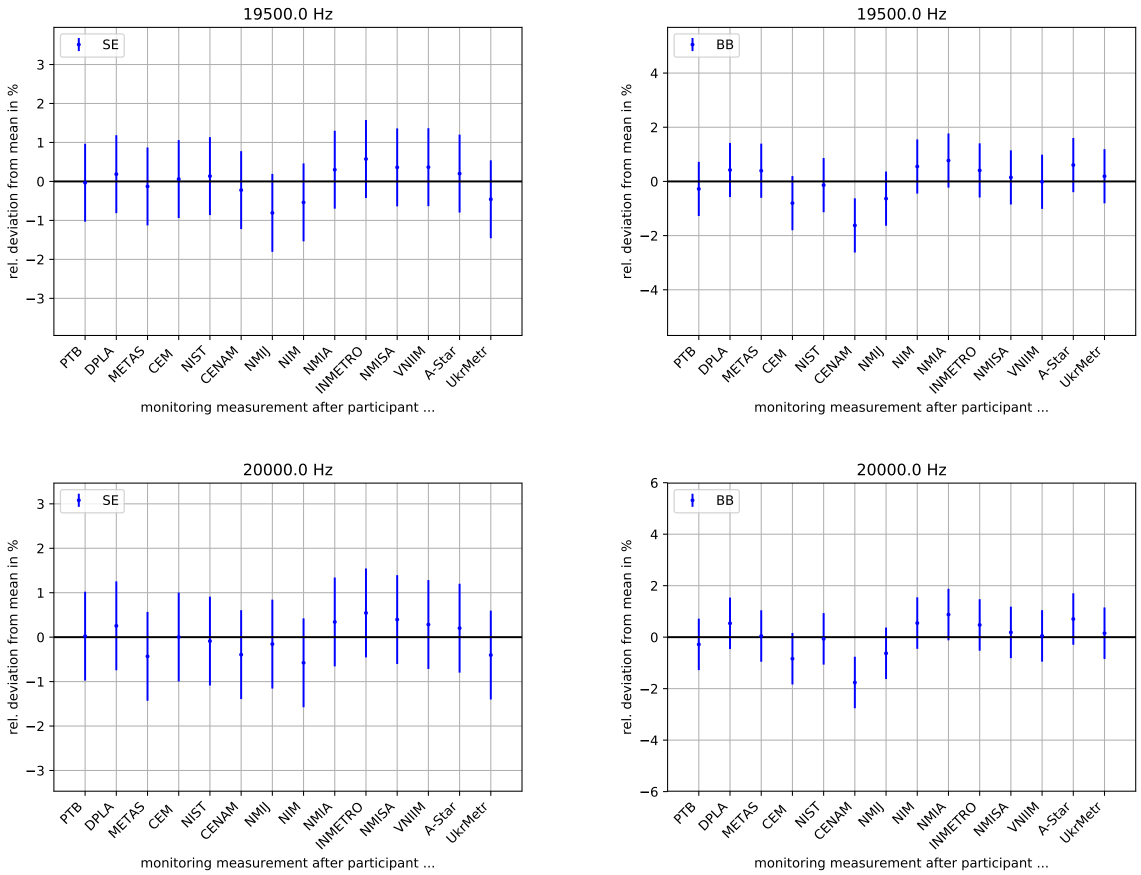

Figure 6.21: deviation of sensors sensitivity magnitude vs. time during monitoring (SE left column, BB right column)

The visual inspection of the graphed results indicates that both artifacts were quite stable within the resolution of the measurement uncertainty of the pilot lab. Between 8 kHz and 11 kHz the BB transducer exhibits a strong dispersion in the results which is attributed to an interaction of the cross-sensitivity with the cross-motion and a transverse resonance that is located in that frequency range. Similar dispersion can be observed in several of the participants' results.

7 — Results of the Participants

The following sections report the results submitted by the participants of the comparison to the pilot laboratory using the reporting spreadsheet. The results presented are given as

quantity	component	variable	unit
magnitude	value	X_i	fC/(m/s^2)
	exp. rel. uncertainty	U_{rel,X_i}	%
phase	value	φ_i	1°
	exp. uncertainty	U_{φ_i}	1°

where i is the index for the frequency.

7.1 Results for the Magnitude of the Complex Sensitivity

7.1.1 The Single-Ended Accelerometer (SN 1610153)

Table 7.1: Reported participant's results for the magnitude of the SE with relative expanded uncertainties ($k = 2$)

f	PTB		DPLA		METAS		CEM		NIST	
in Hz	X_i in $\frac{\mathrm{fC}}{\mathrm{m/s^2}}$	U_{rel,X_i} in %	X_i in $\frac{\mathrm{fC}}{\mathrm{m/s^2}}$	U_{rel,X_i} in %	X_i in $\frac{\mathrm{fC}}{\mathrm{m/s^2}}$	U_{rel,X_i} in %	X_i in $\frac{\mathrm{fC}}{\mathrm{m/s^2}}$	U_{rel,X_i} in %	X_i in $\frac{\mathrm{fC}}{\mathrm{m/s^2}}$	U_{rel,X_i} in %
10	126.50	0.10	126.40	0.40	126.55	0.23	126.46	0.40	126.51	0.30
12.5	126.51	0.10	126.40	0.40	126.54	0.23	126.51	0.40	126.54	0.30
16	126.51	0.10	126.40	0.40	126.56	0.23	126.54	0.40	126.55	0.30
20	126.50	0.10	126.40	0.40	126.58	0.19	126.53	0.40	126.53	0.30
25	126.49	0.10	126.40	0.40	126.58	0.19	126.53	0.40	126.52	0.30
31.5	126.49	0.10	126.40	0.40	126.59	0.19	126.53	0.40	126.57	0.30
40	126.48	0.10	126.40	0.40	126.57	0.19	126.54	0.40	126.56	0.30
63	126.46	0.10	126.40	0.40	126.59	0.19	126.53	0.40	126.56	0.30
80	126.50	0.10	126.40	0.40	126.58	0.19	126.51	0.40	126.58	0.30
100	126.44	0.10	126.40	0.40	126.55	0.20	126.48	0.40	126.56	0.30
125	126.45	0.10	126.40	0.40	126.54	0.20	126.51	0.40	126.56	0.30
160	126.45	0.10	126.40	0.40	126.55	0.21	126.49	0.40	126.40	0.30
200	126.46	0.10	126.40	0.40	126.56	0.22	126.50	0.40	126.55	0.30
250	126.46	0.10	126.40	0.40	126.62	0.36	126.50	0.40	126.55	0.30
315	126.49	0.10	126.40	0.40	126.57	0.27	126.51	0.40	126.57	0.30
400	126.48	0.10	126.50	0.40	126.57	0.28	126.53	0.40	126.59	0.30
500	126.50	0.10	126.50	0.40	126.57	0.23	126.54	0.40	126.61	0.30
630	126.52	0.10	126.50	0.40	126.59	0.25	126.56	0.40	126.62	0.30
800	126.55	0.10	126.50	0.40	126.59	0.23	126.58	0.40	126.61	0.30
1000	126.61	0.10	126.60	0.40	126.65	0.26	126.62	0.40	126.72	0.30
1250	126.66	0.10	126.70	0.40	126.73	0.26	126.73	0.40	126.73	0.40
1500	126.79	0.10	126.80	0.40	126.81	0.25	126.78	0.40	126.87	0.40
1600	126.85	0.10	126.70	0.40	126.83	0.25	126.89	0.40	126.87	0.40
2000	127.02	0.10	127.00	0.40	126.99	0.26	127.02	0.40	127.09	0.40
2500	127.34	0.10	127.30	0.40	127.25	0.25	127.37	0.40	127.41	0.40
3000	127.70	0.10	127.60	0.40	127.60	0.25	127.73	0.40	127.78	0.40
3150	127.82	0.10	127.80	0.40	127.80	0.25	127.89	0.40	127.91	0.40
3500	128.14	0.10	128.10	0.40	128.02	0.25	128.19	0.40	128.17	0.40
4000	128.66	0.10	128.60	0.40	128.47	0.25	128.70	0.40	128.74	0.40
4500	129.20	0.10	129.10	0.40	129.01	0.25	129.24	0.40	129.36	0.40
5000	129.89	0.10	129.80	0.60	129.72	0.24	129.91	0.40	130.01	0.40
5500	130.61	0.30	130.50	0.60	130.32	0.69	130.69	0.80	130.81	0.50
6000	131.42	0.30	131.30	0.60	131.02	0.69	131.48	0.80	131.57	0.50
6300	131.94	0.30	131.90	0.60	131.70	0.69	132.04	0.80	132.12	0.50
6500	132.29	0.30	132.10	0.60	131.96	0.70	132.36	0.80	132.49	0.50
7000	133.21	0.30	132.90	0.60	132.65	0.69	133.38	0.80	133.50	0.50
7500	134.43	0.30	134.10	0.60	133.68	0.70	134.61	0.80	134.71	0.50
8000	135.50	0.30	135.10	0.60	134.81	0.73	135.79	0.80	135.83	0.50
8500	136.66	0.30	136.40	0.60	135.90	0.70	136.91	0.80	137.09	0.50
9000	137.86	0.30	137.70	0.60	136.81	0.75	138.01	0.80	138.56	0.50
9500	139.47	0.30	138.90	0.60	138.37	0.74	139.52	0.80	140.01	0.50
10000	140.92	0.30	141.30	0.60	140.03	0.72	141.08	0.80	141.54	0.50
10500	142.52	0.50	141.50	1.00	141.26	1.69	142.81	1.50	143.25	1.50
11000	144.27	0.50	143.40	1.00	143.08	1.73	144.46	1.50	145.03	1.50
11500	146.13	0.50	145.20	1.00	144.60	1.68	146.33	1.50	146.95	1.50
12000	148.25	0.50	147.30	1.00	146.46	1.69	148.51	1.50	148.98	1.50
12500	150.29	0.50	149.30	1.20	148.41	1.71	150.65	1.50	151.24	1.50
13000	152.58	0.50	151.40	1.20	150.91	1.69	152.92	1.50	153.65	1.50
13500	155.18	0.50	154.00	1.20	152.99	1.72	155.49	1.50	156.14	1.50
14000	157.85	0.50	156.00	1.20	155.02	1.76	158.17	1.50	158.81	1.50
14500	160.62	0.50	158.10	1.20	158.07	1.71	161.05	1.50	161.80	1.50
15000	163.60	0.50	161.10	1.20	160.56	1.71	164.22	1.50	164.95	1.50
15500	166.85	1.00	164.30	1.20	163.99	1.70	167.61	2.00	168.13	2.00
16000	170.24	1.00	167.50	2.00	166.43	1.72	171.08	2.00	171.70	2.00
16500	174.20	1.00	171.10	2.00	169.86	1.74	174.58	2.00	175.71	2.00
17000	178.31	1.00	175.10	2.00	173.85	1.84	178.47	2.00	179.94	2.00
17500	182.11	1.00	179.00	2.00	177.17	1.76	182.85	2.00	184.00	2.00
18000	185.66	1.00	182.50	2.00	180.85	1.82	185.59	2.00	188.11	2.00
18500	190.45	1.00	186.50	2.00	184.43	2.00	192.11	2.00	193.41	2.00
19000	194.15	1.00	190.90	2.00	189.99	2.24	196.34	2.00	196.83	2.00
19500	200.50	1.00	195.90	2.00	194.21	1.76	201.73	2.00	202.84	2.00
20000	207.13	1.00	202.30	2.00	199.31	1.77	208.11	2.00	208.89	2.00

(continued) Reported participant's results for the magnitude of the SE with relative expanded uncertainties ($k = 2$)

f in Hz	CENAM X_i in $\frac{\text{fC}}{\text{m/s}^2}$	CENAM U_{rel,X_i} in %	NMIJ X_i in $\frac{\text{fC}}{\text{m/s}^2}$	NMIJ U_{rel,X_i} in %	NIM X_i in $\frac{\text{fC}}{\text{m/s}^2}$	NIM U_{rel,X_i} in %	NMIA X_i in $\frac{\text{fC}}{\text{m/s}^2}$	NMIA U_{rel,X_i} in %	INMETRO X_i in $\frac{\text{fC}}{\text{m/s}^2}$	INMETRO U_{rel,X_i} in %
10	127.00	0.30	126.76	0.70	126.84	0.40	126.64	0.30	126.67	0.20
12.5	127.24	0.30	126.70	0.70	126.84	0.40	126.65	0.30	126.67	0.20
16	127.04	0.30	126.66	0.50	126.90	0.40	126.67	0.30	126.67	0.20
20	126.75	0.30	126.64	0.40	126.89	0.40	126.67	0.30	126.67	0.20
25	126.73	0.30	126.64	0.40	126.90	0.40	126.67	0.30	126.67	0.20
31.5	126.67	0.30	126.63	0.40	126.89	0.40	126.66	0.30	126.67	0.20
40	126.61	0.30	126.62	0.40	126.90	0.40	126.66	0.30	126.67	0.20
63	126.45	0.30	126.62	0.40	126.88	0.40	126.65	0.30	126.67	0.20
80	126.54	0.30	126.62	0.40	126.85	0.40	126.65	0.30	126.68	0.20
100	126.53	0.30	126.60	0.40	126.89	0.40	126.65	0.30	126.68	0.20
125	126.56	0.30	126.61	0.40	126.89	0.40	126.65	0.30	126.68	0.20
160	126.53	0.30	126.67	0.40	126.88	0.40	126.63	0.30	126.68	0.20
200	126.54	0.30	126.64	0.40	126.89	0.40	126.66	0.30	126.69	0.20
250	126.66	0.30	126.62	0.30	126.85	0.40	126.68	0.30	126.69	0.20
315	126.64	0.30	126.64	0.30	126.90	0.40	126.68	0.30	126.70	0.20
400	126.67	0.30	126.65	0.30	126.92	0.40	126.67	0.30	126.71	0.20
500	126.64	0.30	126.67	0.30	126.94	0.40	126.69	0.30	126.73	0.20
630	126.65	0.30	126.65	0.30	126.95	0.40	126.73	0.30	126.76	0.20
800	126.67	0.30	126.71	0.30	127.00	0.40	126.75	0.30	126.79	0.20
1000	126.71	0.30	126.76	0.30	127.06	0.40	126.81	0.30	126.85	0.20
1250	126.78	0.30	126.80	0.30	127.14	0.40	126.84	0.30	126.92	0.20
1500	126.93	0.30	126.92	0.30	127.22	0.40	126.96	0.30	127.02	0.20
1600	127.03	0.30	127.02	0.30	127.28	0.40	127.05	0.30	127.06	0.20
2000	127.17	0.30	127.19	0.30	127.48	0.40	127.18	0.30	127.25	0.20
2500	127.87	0.30	127.50	0.30	127.78	0.40	127.51	0.30	127.54	0.24
3000	127.59	0.30	127.91	0.30	128.15	0.40	128.01	0.30	127.90	0.24
3150	127.73	0.30	128.01	0.30	128.29	0.40	128.04	0.30	128.02	0.34
3500	127.41	0.30	128.28	0.30	128.57	0.40	128.36	0.30	128.32	0.34
4000	128.09	0.30	128.83	0.30	129.13	0.40	128.88	0.30	128.81	0.34
4500	128.67	0.30	129.44	0.30	129.70	0.40	129.45	0.30	129.37	0.34
5000	129.37	0.30	130.12	0.50	130.38	0.40	130.21	0.30	130.01	0.60
5500	129.87	0.50	130.67	0.50	131.13	1.00	130.86	0.30	130.72	0.60
6000	130.15	0.50	131.63	0.50	131.99	1.00	131.77	0.30	131.51	0.60
6300	131.11	0.50	131.99	0.50	132.42	1.00	132.39	0.30	132.02	0.60
6500	131.65	0.50	132.47	0.50	132.82	1.00	132.69	0.30	132.38	0.60
7000	132.39	0.50	133.33	0.50	133.83	1.00	133.73	0.30	133.33	0.80
7500	133.00	0.50	134.58	0.50	134.99	1.00	134.98	0.30	134.37	0.80
8000	133.91	0.50	135.79	0.50	136.08	1.00	136.21	0.30	135.51	0.80
8500	135.89	0.50	136.94	0.50	137.21	1.00	137.39	0.40	136.73	0.80
9000	137.14	0.50	138.78	0.50	138.86	1.00	138.76	0.50	138.05	0.80
9500	137.96	0.50	139.48	0.60	139.94	1.00	139.95	0.40	139.48	0.80
10000	139.33	0.50	141.09	0.50	141.39	1.00	141.67	0.40	141.01	0.80
10500	141.46	0.80	142.73	0.80	142.95	1.50	143.26	0.60	142.65	1.00
11000	142.66	0.80	144.37	0.80	144.84	1.50	145.11	0.60	144.41	1.00
11500	144.08	0.80	146.41	0.80	146.61	1.50	146.95	0.60	146.29	1.00
12000	146.05	0.80	147.85	1.30	148.75	1.50	149.07	0.60	148.30	1.00
12500	148.54	0.80	150.77	2.20	150.88	1.50	151.26	0.60	150.45	1.00
13000	151.77	0.80	153.04	2.20	152.78	1.50	153.78	0.60	152.74	1.00
13500	153.31	0.80	156.03	2.20	155.34	1.50	156.19	0.60	155.18	1.00
14000	155.53	0.80	158.24	2.20	157.83	1.50	159.08	0.60	157.79	1.00
14500	158.78	0.80	161.17	2.20	160.94	1.50	162.16	1.00	160.57	1.00
15000	162.84	0.80	164.02	2.20	163.66	1.50	165.26	1.00	163.53	1.00
15500	166.91	0.80	167.19	2.20	167.06	1.50	168.71	1.00	166.69	1.20
16000	170.55	1.00	171.45	2.20	170.10	1.50	172.29	1.00	170.05	1.20
16500	171.87	1.00	174.18	2.20	174.50	1.50	176.23	1.00	173.63	1.20
17000	176.24	1.00	178.90	2.20	178.17	1.50	180.60	1.00	177.45	1.20
17500	180.08	1.00	183.86	3.00	182.73	1.50	184.58	1.00	181.51	1.20
18000	182.97	1.00	188.30	2.50	187.48	1.50	188.28	1.00	185.84	1.20
18500	186.12	1.00	192.36	2.50	190.79	1.50	194.05	1.50	190.45	1.20
19000	193.27	1.00	195.04	2.50	195.66	1.50	195.82	1.50	195.36	1.20
19500	202.53	1.00	200.13	2.50	201.35	1.50	204.03	1.50	200.58	1.20
20000	208.90	1.00	208.53	2.50	207.45	1.50	211.09	1.50	206.15	1.20

(continued) Reported participant's results for the magnitude of the SE with relative expanded uncertainties ($k = 2$)

f	NMISA		VNIIM		NMC,A*STAR		UkrMet	
in Hz	X_i in $\frac{\text{fC}}{\text{m/s}^2}$	U_{rel,X_i} in %	X_i in $\frac{\text{fC}}{\text{m/s}^2}$	U_{rel,X_i} in %	X_i in $\frac{\text{fC}}{\text{m/s}^2}$	U_{rel,X_i} in %	X_i in $\frac{\text{fC}}{\text{m/s}^2}$	U_{rel,X_i} in %
10	126.65	0.30	126.54	0.50	126.57	0.41	126.38	0.50
12.5	126.69	0.30	126.60	0.50	126.59	0.41	126.41	0.50
16	126.66	0.30	126.60	0.50	126.64	0.41	126.45	0.50
20	126.65	0.30	126.57	0.50	126.67	0.30	126.41	0.50
25	126.64	0.30	126.63	0.50	126.66	0.30	126.42	0.50
31.5	126.63	0.30	126.61	0.50	126.67	0.30	126.39	0.50
40	126.64	0.30	126.59	0.50	126.69	0.30	126.47	0.50
63	126.64	0.30	126.67	0.50	126.68	0.30	126.41	0.50
80	126.66	0.30	126.58	0.50	126.66	0.30	126.42	0.50
100	126.65	0.30	126.54	0.50	126.60	0.30	126.43	0.50
125	126.57	0.30	126.57	0.50	126.48	0.30	126.38	0.50
160	126.50	0.30	126.66	0.50	126.77	0.30	126.47	0.50
200	126.61	0.30	126.82	0.50	126.78	0.30	126.38	0.50
250	126.61	0.30	127.08	0.50	126.71	0.30	126.40	0.50
315	126.63	0.30	127.02	0.50	126.72	0.30	126.39	0.50
400	126.62	0.30	127.15	0.50	126.74	0.30	126.43	0.50
500	126.67	0.30	127.11	0.50	126.74	0.30	126.40	0.50
630	126.75	0.30	126.59	0.50	126.79	0.30	126.40	0.50
800	126.71	0.30	126.73	0.50	126.79	0.30	126.49	0.50
1000	126.79	0.30	126.94	0.50	126.80	0.41	126.52	0.50
1250	126.86	0.50	126.94	0.50	126.87	0.41	126.63	0.70
1500	126.91	0.50	127.06	0.50	127.03	0.41	126.67	0.70
1600	126.99	0.50	127.08	0.50	127.04	0.41	126.68	0.70
2000	127.15	0.50	127.39	0.50	127.21	0.41	126.86	0.70
2500	127.48	0.50	127.56	1.00	127.49	0.41	127.17	0.70
3000	127.74	0.50	127.88	1.00	127.81	0.41	127.62	0.70
3150	127.89	0.50	127.93	1.00	127.98	0.41	127.70	0.70
3500	128.24	0.50	128.17	1.00	128.26	0.41	128.09	0.70
4000	128.80	0.50	128.76	1.00	128.73	0.41	128.55	0.70
4500	129.42	0.50	129.24	1.00	129.36	0.41	129.20	0.70
5000	129.89	0.80	129.61	1.00	130.04	0.54	129.62	0.70
5500	130.64	0.80	130.61	1.50	130.79	0.54	130.31	1.50
6000	131.41	0.80	131.13	1.50	131.63	0.54	131.27	1.50
6300	132.03	0.80	131.29	1.50	132.07	0.54	131.51	1.50
6500	132.42	0.80	131.41	1.50	132.41	0.54	131.59	1.50
7000	133.20	0.80	132.60	1.50	133.45	0.54	132.65	1.50
7500	134.41	1.20	133.69	1.50	134.67	0.54	133.58	1.50
8000	135.62	1.20	134.71	1.50	135.80	0.54	135.24	1.50
8500	136.84	1.20	136.27	1.50	136.95	0.54	136.65	1.50
9000	137.85	1.20	137.53	1.50	138.25	0.54	137.18	1.50
9500	139.33	1.20	138.34	1.50	139.46	0.54	138.44	1.50
10000	140.81	1.20	139.28	1.50	141.03	1.19	139.96	1.50
10500	142.36	1.20	140.78	1.50	142.66	1.19	141.41	2.00
11000	144.05	1.20	141.65	1.50	144.29	1.19	142.94	2.00
11500	145.84	1.20	143.31	1.50	146.09	1.19	144.39	2.00
12000	147.81	1.20	145.02	1.50	148.08	1.19	145.54	2.00
12500	149.94	1.50	146.90	1.50	150.26	1.19	146.95	2.00
13000	152.16	1.50	147.83	1.50	152.51	1.19	147.81	2.00
13500	154.61	1.50	151.93	1.50	154.97	1.19	150.48	2.00
14000	157.25	1.50	154.46	1.50	157.64	1.19	153.51	2.00
14500	160.07	1.50	156.44	1.50	160.50	1.19	156.88	2.00
15000	163.04	1.50	160.56	1.50	163.50	1.42	158.88	2.00
15500	166.17	1.80	163.49	2.00	166.77	1.42	162.30	3.00
16000	169.63	1.80	165.15	2.00	170.29	1.42	165.20	3.00
16500	173.39	1.80	165.96	2.00	174.07	1.42	169.19	3.00
17000	177.34	1.80	167.36	2.00	178.08	1.42	173.34	3.00
17500	181.09	1.80	173.31	2.00	182.02	1.42	176.79	3.00
18000	184.78	1.80	176.30	2.00	185.78	1.42	180.12	3.00
18500	190.26	1.80	178.70	2.00	189.82	1.42	185.36	3.00
19000	194.24	1.80	191.17	2.00	194.36	1.42	190.11	3.00
19500	199.62	1.80	196.79	2.00	200.42	1.42	196.37	3.00
20000	205.62	1.80	202.97	2.00	206.66	1.42	201.51	3.00

7.1.2 The Back-to-Back Accelerometer (SN 1483350)

Table 7.2: Reported participant's results for the magnitude of the BB with relative expanded uncertainties ($k = 2$)

f	PTB		DPLA		METAS		CEM		NIST	
in Hz	X_i in $\frac{\mathrm{fC}}{\mathrm{m/s^2}}$	U_{rel,X_i} in %	X_i in $\frac{\mathrm{fC}}{\mathrm{m/s^2}}$	U_{rel,X_i} in %	X_i in $\frac{\mathrm{fC}}{\mathrm{m/s^2}}$	U_{rel,X_i} in %	X_i in $\frac{\mathrm{fC}}{\mathrm{m/s^2}}$	U_{rel,X_i} in %	X_i in $\frac{\mathrm{fC}}{\mathrm{m/s^2}}$	U_{rel,X_i} in %
10	127.99	0.10	127.90	0.40	127.79	0.23	128.15	0.40	127.96	0.30
12.5	127.99	0.10	128.00	0.40	127.88	0.23	128.15	0.40	128.03	0.30
16	127.99	0.10	127.90	0.40	127.90	0.23	128.13	0.40	128.05	0.30
20	127.95	0.10	127.90	0.40	127.96	0.19	128.14	0.40	128.02	0.30
25	127.99	0.10	127.90	0.40	128.06	0.19	128.04	0.40	128.03	0.30
31.5	128.00	0.10	128.00	0.40	128.10	0.19	128.04	0.40	128.08	0.30
40	127.97	0.10	128.00	0.40	128.08	0.19	128.06	0.40	128.08	0.30
63	127.96	0.10	127.90	0.40	128.11	0.19	128.06	0.40	128.06	0.30
80	127.93	0.10	127.90	0.40	128.07	0.19	128.03	0.40	128.09	0.30
100	127.91	0.10	127.90	0.40	128.03	0.19	127.98	0.40	128.05	0.30
125	127.92	0.10	127.90	0.40	128.03	0.19	128.00	0.40	128.07	0.30
160	127.93	0.10	127.90	0.40	128.03	0.20	128.03	0.40	128.06	0.30
200	127.93	0.10	127.90	0.40	128.05	0.20	127.97	0.40	127.89	0.30
250	127.94	0.10	127.90	0.40	128.10	0.23	127.98	0.40	127.98	0.30
315	127.96	0.10	128.00	0.40	128.09	0.20	127.98	0.40	128.05	0.30
400	127.96	0.10	127.90	0.40	128.10	0.20	127.99	0.40	128.04	0.30
500	127.97	0.10	128.00	0.40	128.05	0.20	127.99	0.40	128.04	0.30
630	127.99	0.10	128.00	0.40	128.07	0.20	128.01	0.40	128.06	0.30
800	128.01	0.10	128.00	0.40	128.07	0.20	128.02	0.40	128.08	0.30
1000	128.03	0.10	128.00	0.40	128.14	0.23	128.06	0.40	128.12	0.30
1250	128.06	0.10	128.10	0.40	128.20	0.24	128.13	0.40	128.10	0.40
1500	128.10	0.10	128.20	0.40	128.26	0.23	128.15	0.40	128.25	0.40
1600	128.21	0.10	128.00	0.40	128.24	0.24	128.25	0.40	128.25	0.40
2000	128.24	0.10	128.40	0.40	128.47	0.25	128.36	0.40	128.39	0.40
2500	128.41	0.10	128.60	0.40	128.69	0.26	128.63	0.40	128.64	0.40
3000	128.67	0.10	128.80	0.40	129.03	0.28	128.88	0.40	128.92	0.40
3150	128.96	0.10	129.00	0.40	129.12	0.28	129.01	0.40	129.03	0.40
3500	129.07	0.10	129.30	0.40	129.36	0.31	129.24	0.40	129.18	0.40
4000	129.33	0.10	129.70	0.40	129.81	0.34	129.64	0.40	129.62	0.40
4500	129.77	0.10	130.50	0.40	130.30	0.44	130.04	0.40	130.11	0.40
5000	130.20	0.10	130.60	0.60	130.92	0.46	130.53	0.40	130.61	0.40
5500	130.78	0.30	131.10	0.60	131.46	0.88	131.08	0.80	131.23	0.50
6000	131.42	0.30	131.70	0.60	132.08	1.07	131.66	0.80	131.83	0.50
6300	132.53	0.30	132.30	0.60	132.72	1.22	132.12	0.80	132.18	0.50
6500	132.77	0.30	132.40	0.60	132.74	1.35	132.37	0.80	132.43	0.50
7000	133.71	0.30	133.20	0.60	133.64	1.72	133.24	0.80	133.23	0.50
7500	134.91	0.30	134.20	0.60	136.15	2.20	134.21	0.80	134.42	0.50
8000	134.90	0.30	133.00	0.60	133.59	2.25	134.61	0.80	134.35	0.50
8500	136.19	0.30	135.20	0.60	135.99	2.44	135.00	0.80	135.50	0.50
9000	137.43	0.30	136.50	0.60	137.13	2.64	136.60	0.80	134.13	0.50
9500	138.80	0.30	137.60	0.60	139.15	2.14	138.01	0.80	136.59	0.50
10000	139.95	0.30	139.80	0.60	140.03	1.47	139.22	0.80	138.42	0.50
10500	141.22	0.50	139.80	1.00	141.47	2.02	140.88	1.50	140.16	1.50
11000	142.83	0.50	141.30	1.00	142.58	1.96	142.14	1.50	141.62	1.50
11500	144.44	0.50	142.80	1.00	144.53	1.80	143.85	1.50	143.06	1.50
12000	145.92	0.50	144.20	1.00	146.41	1.74	145.21	1.50	144.30	1.50
12500	147.59	0.50	145.70	1.20	148.33	1.75	146.90	1.50	146.21	1.50
13000	149.49	0.50	147.40	1.20	150.18	1.71	148.59	1.50	147.92	1.50
13500	151.39	0.50	149.20	1.20	152.03	1.72	150.47	1.50	149.80	1.50
14000	153.92	0.50	151.10	1.20	154.12	1.74	152.39	1.50	151.99	1.50
14500	155.40	0.50	153.20	1.20	156.66	1.75	154.11	1.50	153.32	1.50
15000	157.81	0.50	156.20	1.20	158.99	1.83	156.46	1.50	154.79	1.50
15500	160.37	1.00	158.30	1.20	161.88	1.87	158.84	2.00	157.43	2.00
16000	163.06	1.00	160.60	2.00	164.13	1.86	161.37	2.00	159.92	2.00
16500	165.83	1.00	163.00	2.00	167.85	1.93	164.18	2.00	162.59	2.00
17000	168.96	1.00	165.80	2.00	170.56	1.82	166.90	2.00	165.51	2.00
17500	172.25	1.00	168.70	2.00	174.12	1.93	169.98	2.00	168.62	2.00
18000	175.69	1.00	171.80	2.00	176.73	1.99	173.24	2.00	171.98	2.00
18500	179.51	1.00	174.90	2.00	181.55	1.95	176.79	2.00	175.55	2.00
19000	183.54	1.00	178.30	2.00	185.11	1.97	180.72	2.00	179.41	2.00
19500	187.89	1.00	182.40	2.00	189.50	2.00	184.66	2.00	183.46	2.00
20000	192.47	1.00	186.20	2.00	194.40	2.06	188.51	2.00	187.83	2.00

(continued) Reported participant's results for the magnitude of the BB with relative expanded uncertainties ($k = 2$)

f	CENAM		NMIJ		NIM		NMIA		INMETRO	
in Hz	X_i in $\frac{\mathrm{fC}}{\mathrm{m/s^2}}$	U_{rel,X_i} in %	X_i in $\frac{\mathrm{fC}}{\mathrm{m/s^2}}$	U_{rel,X_i} in %	X_i in $\frac{\mathrm{fC}}{\mathrm{m/s^2}}$	U_{rel,X_i} in %	X_i in $\frac{\mathrm{fC}}{\mathrm{m/s^2}}$	U_{rel,X_i} in %	X_i in $\frac{\mathrm{fC}}{\mathrm{m/s^2}}$	U_{rel,X_i} in %
10	128.20	0.30	128.01	0.40	128.26	0.40	127.90	0.30	128.12	0.20
12.5	128.20	0.30	127.97	0.40	128.28	0.40	127.94	0.30	128.10	0.20
16	128.17	0.30	127.98	0.40	128.31	0.40	128.01	0.30	128.07	0.20
20	128.16	0.30	127.92	0.40	128.25	0.40	128.04	0.30	128.03	0.20
25	128.09	0.30	128.09	0.40	128.28	0.40	128.04	0.30	128.02	0.20
31.5	128.07	0.30	128.03	0.40	128.23	0.40	128.03	0.30	128.00	0.20
40	128.06	0.30	127.97	0.40	128.23	0.40	128.03	0.30	127.98	0.20
63	128.08	0.30	127.98	0.40	128.21	0.40	127.98	0.30	127.97	0.20
80	128.03	0.30	127.92	0.40	128.18	0.40	127.98	0.30	127.96	0.20
100	128.19	0.30	127.99	0.40	128.35	0.40	127.99	0.30	127.95	0.20
125	127.99	0.30	127.94	0.40	128.17	0.40	127.99	0.30	127.92	0.20
160	128.00	0.30	127.96	0.40	128.17	0.40	128.00	0.30	127.93	0.20
200	128.02	0.30	127.90	0.40	128.14	0.40	127.93	0.30	127.94	0.20
250	127.86	0.30	127.89	0.30	128.26	0.40	127.98	0.30	127.93	0.20
315	127.91	0.30	127.91	0.30	128.24	0.40	127.98	0.30	127.95	0.20
400	127.92	0.30	127.91	0.30	128.22	0.40	127.96	0.30	127.96	0.20
500	127.95	0.30	127.93	0.30	128.25	0.40	127.99	0.30	127.96	0.20
630	128.24	0.30	127.96	0.30	128.39	0.40	128.03	0.30	128.00	0.20
800	127.99	0.30	127.97	0.30	128.26	0.40	128.04	0.30	128.02	0.20
1000	128.11	0.30	128.02	0.30	128.40	0.40	128.08	0.30	128.11	0.20
1250	128.32	0.30	128.09	0.30	128.42	0.40	128.14	0.30	128.14	0.20
1500	128.25	0.30	128.17	0.30	128.55	0.40	128.21	0.30	128.20	0.20
1600	128.28	0.30	128.18	0.30	128.58	0.40	128.28	0.30	128.24	0.20
2000	128.44	0.30	128.36	0.30	128.74	0.40	128.38	0.30	128.43	0.20
2500	128.91	0.30	128.63	0.30	128.94	0.40	128.60	0.30	128.65	0.24
3000	129.05	0.30	128.86	0.30	129.29	0.40	129.03	0.30	129.03	0.24
3150	128.99	0.30	128.93	0.30	129.36	0.40	129.07	0.30	129.04	0.34
3500	129.18	0.30	129.23	0.30	129.59	0.40	129.31	0.30	129.35	0.34
4000	129.70	0.30	129.66	0.30	130.07	0.40	129.71	0.30	129.78	0.34
4500	129.89	0.30	129.95	0.50	130.61	0.40	130.20	0.30	130.34	0.34
5000	130.12	0.30	130.70	0.50	131.19	0.40	130.75	0.30	130.68	0.60
5500	130.59	0.50			131.72	1.00	131.30	0.30	131.26	0.60
6000	130.68	0.50			132.50	1.00	132.02	0.30	131.91	0.60
6300	130.70	0.50			132.92	1.00	132.48	0.30	132.33	0.60
6500	130.85	0.50			133.15	1.00	132.82	0.30	132.62	0.60
7000	131.18	0.50			134.12	1.00	133.77	0.40	133.41	0.80
7500	132.02	0.50			135.11	1.00	135.28	0.90	134.27	0.80
8000	132.94	0.50			135.77	1.00	135.34	0.60	135.20	0.80
8500	134.00	0.50			136.56	1.00	135.58	1.00	136.21	0.80
9000	135.61	0.50			137.59	1.00	134.80	2.50	137.31	0.80
9500	136.56	0.50			138.75	1.00	137.14	1.60	138.48	0.80
10000	138.32	0.50			139.83	1.00	138.54	1.10	139.74	0.80
10500	139.08	0.80			141.07	1.50	139.70	1.20	141.20	1.00
11000	139.60	0.80			142.91	1.50	141.99	0.60	142.66	1.00
11500	141.21	0.80			144.77	1.50	143.97	0.60	144.27	1.00
12000	143.44	0.80			146.48	1.50	145.75	0.60	145.78	1.00
12500	144.82	0.80			148.11	1.50	147.70	0.60	147.42	1.00
13000	145.73	0.80			149.72	1.50	149.50	0.60	149.34	1.00
13500	147.85	0.80			151.77	1.50	151.37	0.60	151.37	1.00
14000	149.82	0.80			153.89	1.50	153.57	0.60	153.47	1.00
14500	153.15	0.80			155.70	1.50	155.42	1.00	155.49	1.00
15000	155.72	0.80			158.01	1.50	157.36	1.00	158.05	1.00
15500	158.49	0.80			160.49	1.50	160.02	1.00	160.72	1.20
16000	161.02	1.00			163.04	1.50	162.62	1.00	163.30	1.20
16500	165.29	1.00			165.89	1.50	165.45	1.00	166.66	1.20
17000	168.89	1.00			168.94	1.50	168.65	1.00	169.39	1.20
17500	170.85	1.00			172.00	1.50	171.87	1.00	172.53	1.20
18000	175.35	1.00			175.59	1.50	175.03	1.00	176.08	1.20
18500	181.69	1.00			179.05	1.50	179.10	1.50	179.73	1.20
19000	186.73	1.00			182.65	1.50	182.71	1.50	183.74	1.20
19500	190.77	1.00			186.95	1.50	187.05	1.50	188.33	1.20
20000	193.75	1.00			191.48	1.50	191.63	1.50	192.58	1.20

(continued) Reported participant's results for the magnitude of the BB with relative expanded uncertainties ($k = 2$)

f in Hz	NMISA X_i in $\frac{\text{fC}}{\text{m/s}^2}$	NMISA U_{rel,X_i} in %	VNIIM X_i in $\frac{\text{fC}}{\text{m/s}^2}$	VNIIM U_{rel,X_i} in %	NMC,A*STAR X_i in $\frac{\text{fC}}{\text{m/s}^2}$	NMC,A*STAR U_{rel,X_i} in %	UkrMet X_i in $\frac{\text{fC}}{\text{m/s}^2}$	UkrMet U_{rel,X_i} in %
10	128.04	0.30	128.29	0.50	127.82	0.41	127.75	0.50
12.5	128.13	0.30	128.26	0.50	127.90	0.41	127.76	0.50
16	128.00	0.30	128.24	0.50	127.94	0.41	127.76	0.50
20	127.99	0.30	128.24	0.50	127.96	0.30	127.74	0.50
25	128.00	0.30	128.23	0.50	127.96	0.30	127.74	0.50
31.5	127.99	0.30	128.23	0.50	127.97	0.30	127.75	0.50
40	127.98	0.30	128.21	0.50	128.00	0.30	127.72	0.50
63	127.97	0.30	128.10	0.50	127.96	0.30	127.74	0.50
80	127.98	0.30	128.13	0.50	127.93	0.30	127.73	0.50
100	127.99	0.30	128.10	0.50	127.89	0.30	127.73	0.50
125	127.88	0.30	128.10	0.50	127.93	0.30	127.72	0.50
160	127.82	0.30	128.12	0.50	127.95	0.30	127.73	0.50
200	127.85	0.30	128.14	0.50	127.89	0.30	127.74	0.50
250	127.87	0.30	128.16	0.50	127.96	0.30	127.74	0.50
315	127.87	0.30	128.24	0.50	127.96	0.30	127.73	0.50
400	127.89	0.30	128.28	0.50	127.98	0.30	127.72	0.50
500	127.90	0.30	128.33	0.50	127.96	0.30	127.76	0.50
630	127.94	0.30	128.42	0.50	127.98	0.30	127.79	0.50
800	127.99	0.30	128.41	0.50	128.02	0.30	127.80	0.50
1000	128.06	0.30	128.46	0.50	128.03	0.41	127.83	0.50
1250	128.09	0.50	128.49	0.50	128.08	0.41	127.95	0.70
1500	128.15	0.50	128.50	0.50	128.19	0.41	128.00	0.70
1600	128.20	0.50	128.53	0.50	128.20	0.41	128.06	0.70
2000	128.33	0.50	128.66	0.50	128.35	0.41	128.23	0.70
2500	128.62	0.50	128.77	1.00	128.63	0.41	128.52	0.70
3000	128.79	0.50	129.02	1.00	128.88	0.41	128.79	0.70
3150	128.97	0.50	129.21	1.00	129.02	0.41	128.85	0.70
3500	129.26	0.50	129.66	1.00	129.29	0.41	129.23	0.70
4000	129.74	0.50	130.02	1.00	129.62	0.41	129.57	0.70
4500	130.28	0.50	130.11	1.00	129.99	0.41	130.02	0.70
5000	130.67	0.80	130.59	1.00	130.45	0.54	130.40	0.70
5500	131.31	0.80	131.01	1.50	130.90	0.54	131.17	1.50
6000	131.98	0.80	131.79	1.50	131.41	0.54	131.83	1.50
6300	132.52	0.80	132.17	1.50	131.67	0.54	132.16	1.50
6500	132.91	0.80	132.57	1.50	131.86	0.54	132.41	1.50
7000	133.69	0.80	133.05	1.50	132.38	0.54	133.01	1.50
7500	135.52	1.20	133.90	1.50	133.05	0.54	133.68	1.50
8000	135.21	1.20	134.29	1.50	133.80	0.54	134.37	1.50
8500	137.05	1.20	134.84	1.50	134.66	0.54	135.24	1.50
9000	134.56	1.20	135.85	1.50	135.67	0.54	136.50	1.50
9500	141.42	1.20	137.64	1.50	136.92	0.54	137.73	1.50
10000	140.03	1.20	138.42	1.50	138.63	1.19	138.92	1.50
10500	140.51	1.20	139.31	1.50	140.11	1.19	140.36	2.00
11000	142.55	1.20	140.00	1.50	141.75	1.19	141.18	2.00
11500	144.58	1.20	141.43	1.50	143.61	1.19	142.92	2.00
12000	146.38	1.20	142.61	1.50	145.67	1.19	144.37	2.00
12500	148.29	1.50	144.28	1.50	147.51	1.19	146.78	2.00
13000	150.07	1.50	145.74	1.50	149.48	1.19	148.63	2.00
13500	151.92	1.50	147.19	1.50	151.55	1.19	150.71	2.00
14000	154.18	1.50	148.60	1.50	153.54	1.19	152.44	2.00
14500	156.32	1.50	150.55	1.50	155.55	1.19	155.01	2.00
15000	158.51	1.50	152.60	1.50	157.81	1.42	156.86	2.00
15500	161.12	1.80	154.52	2.00	160.33	1.42	159.05	3.00
16000	163.82	1.80	156.74	2.00	162.97	1.42	160.99	3.00
16500	166.72	1.80	159.16	2.00	165.86	1.42	164.00	3.00
17000	169.94	1.80	162.01	2.00	168.87	1.42	166.51	3.00
17500	173.20	1.80	165.08	2.00	172.12	1.42	169.91	3.00
18000	176.75	1.80	168.33	2.00	175.64	1.42	172.89	3.00
18500	180.61	1.80	171.23	2.00	179.34	1.42	176.49	3.00
19000	184.68	1.80	173.10	2.00	183.38	1.42	179.91	3.00
19500	189.22	1.80	178.70	2.00	187.70	1.42	183.55	3.00
20000	193.96	1.80	182.41	2.00	192.27	1.42	186.99	3.00

7.2 Results for the Phase of the Complex Sensitivity

7.2.1 The Single-Ended Accelerometer (SN 1610153)

Table 7.3: Reported participant's results for the phase of the SE with expanded uncertainties ($k = 2$)

f in Hz	PTB φ_i in °	PTB U_{φ_i} in °	DPLA φ_i in °	DPLA U_{φ_i} in °	METAS φ_i in °	METAS U_{φ_i} in °	CEM φ_i in °	CEM U_{φ_i} in °	NIST φ_i in °	NIST U_{φ_i} in °
10	0.00	0.20	0.01	0.30	-0.01	0.40	-0.03	0.50	-0.02	0.50
12.5	-0.05	0.20	0.01	0.30	-0.01	0.40	-0.02	0.50	-0.01	0.50
16	-0.02	0.20	0.01	0.30	-0.00	0.40	-0.01	0.50	-0.01	0.50
20	-0.03	0.20	0.00	0.30	0.00	0.38	-0.01	0.50	0.00	0.50
25	-0.02	0.20	-0.03	0.30	0.02	0.38	-0.00	0.50	0.01	0.50
31.5	-0.03	0.20	0.01	0.30	0.01	0.38	-0.00	0.50	0.02	0.50
40	-0.04	0.20	-0.02	0.30	0.02	0.38	0.00	0.50	0.02	0.50
63	-0.03	0.20	-0.01	0.30	-0.03	0.38	0.01	0.50	0.03	0.50
80	-0.04	0.20	0.00	0.30	-0.04	0.38	0.01	0.50	0.03	0.50
100	0.00	0.20	0.00	0.30	-0.05	0.38	-0.01	0.50	0.01	0.50
125	0.01	0.20	0.00	0.30	-0.07	0.38	-0.03	0.50	-0.00	0.50
160	0.00	0.20	0.00	0.30	-0.09	0.38	0.01	0.50	0.02	0.50
200	0.01	0.20	0.00	0.30	0.02	0.40	-0.00	0.50	0.02	0.50
250	0.01	0.20	-0.01	0.30	0.01	0.38	-0.01	0.50	0.02	0.50
315	0.01	0.20	0.01	0.30	-0.02	0.42	-0.02	0.50	0.02	0.50
400	0.01	0.20	-0.02	0.30	-0.01	0.38	-0.03	0.50	0.01	0.50
500	0.01	0.20	-0.04	0.30	-0.01	0.38	-0.04	0.50	0.01	0.50
630	0.01	0.20	-0.05	0.30	-0.01	0.38	0.02	0.50	-0.00	0.50
800	0.00	0.20	-0.06	0.30	-0.02	0.38	0.01	0.50	-0.03	0.50
1000	0.01	0.20	-0.09	0.30	0.02	0.48	0.01	0.50	-0.02	0.50
1250	0.00	0.50	-0.08	0.30	0.01	0.48	-0.01	1.00	-0.03	0.50
1500	0.00	0.50	-0.16	0.30	0.01	0.48	0.00	1.00	-0.04	0.50
1600	0.00	0.50	-0.15	0.30	0.01	0.48	0.02	1.00	-0.04	0.50
2000	0.00	0.50	-0.20	0.30	0.01	0.48	-0.00	1.00	-0.06	0.50
2500	0.00	0.50	-0.23	0.30	-0.01	0.48	-0.02	1.00	-0.08	0.50
3000	-0.01	0.50	-0.28	0.30	0.00	0.48	-0.02	1.00	-0.10	0.50
3150	0.00	0.50	-0.30	0.30	-0.01	0.48	-0.02	1.00	-0.10	0.50
3500	-0.01	0.50	-0.31	0.30	-0.00	0.48	-0.04	1.00	-0.11	0.50
4000	0.00	0.50	-0.40	0.30	0.01	0.48	-0.03	1.00	-0.15	0.50
4500	-0.01	0.50	-0.43	0.30	0.02	0.48	-0.02	1.00	-0.15	0.50
5000	-0.02	0.50	-0.47	0.50	-0.02	0.48	-0.05	1.00	-0.18	0.50
5500	-0.02	0.50	-0.59	0.50	-0.02	0.86	-0.07	1.00	-0.18	1.00
6000	-0.04	0.50	-0.59	0.50	-0.01	0.86	-0.09	1.00	-0.19	1.00
6300	-0.04	0.50	-0.49	0.50	-0.04	0.86	-0.08	1.00	-0.19	1.00
6500	-0.04	0.50	-0.63	0.50	-0.04	0.86	-0.09	1.00	-0.15	1.00
7000	-0.04	0.50	-0.68	0.50	-0.02	0.86	-0.08	1.00	-0.17	1.00
7500	-0.01	0.50	-0.71	0.50	-0.01	0.86	-0.07	1.00	-0.16	1.00
8000	-0.08	0.50	-0.77	1.00	-0.12	0.86	-0.19	1.00	-0.20	1.00
8500	-0.08	0.50	-0.85	1.00	-0.16	0.86	-0.23	1.00	-0.23	1.00
9000	-0.26	0.50	-0.87	1.00	-0.40	0.86	-0.68	1.00	-0.29	1.00
9500	-0.06	0.50	-0.92	1.00	-0.15	0.86	-0.16	1.00	-0.21	1.00
10000	-0.09	0.50	-0.81	1.00	-0.17	0.86	-0.22	1.00	-0.23	1.00
10500	-0.10	1.00	1.01	2.00	-0.21	1.72	-0.25	1.50	-0.25	1.50
11000	-0.10	1.00	-1.07	2.00	-0.23	1.72	-0.25	1.50	-0.24	1.50
11500	-0.08	1.00	-1.20	2.00	-0.23	1.72	-0.27	1.50	-0.24	1.50
12000	-0.07	1.00	-1.21	2.00	-0.21	1.72	-0.26	1.50	-0.22	1.50
12500	-0.08	1.00	-1.31	2.00	-0.27	1.72	-0.28	1.50	-0.22	1.50
13000	-0.08	1.00	-1.25	2.00	-0.23	1.72	-0.30	1.50	-0.23	1.50
13500	-0.07	1.00	-1.45	2.00	-0.29	1.72	-0.28	1.50	-0.23	1.50
14000	-0.11	1.00	-1.73	2.00	-0.36	1.72	-0.30	1.50	-0.21	1.50
14500	-0.11	1.00	-1.55	2.00	-0.20	1.72	-0.36	1.50	-0.22	1.50
15000	-0.15	1.00	-1.50	2.00	-0.34	1.72	-0.38	1.50	-0.29	1.50
15500	-0.16	2.00	-1.54	2.00	-0.59	1.72	-0.46	2.00	-0.27	1.50
16000	-0.17	2.00	-1.60	3.00	-0.57	1.72	-0.55	2.00	-0.30	1.50
16500	-0.22	2.00	-1.64	3.00	-0.53	1.74	-0.62	2.00	-0.36	1.50
17000	-0.37	2.00	-1.75	3.00	-0.63	1.72	-0.71	2.00	-0.53	1.50
17500	-0.64	2.00	-2.09	3.00	-0.88	1.74	-1.04	2.00	-0.81	1.50
18000	-0.29	2.00	-2.22	3.00	-0.93	1.82	-1.06	2.00	-0.87	1.50
18500	-0.86	2.00	-2.21	3.00	-1.10	1.94	-1.06	2.00	-1.04	1.50
19000	-0.29	2.00	-2.21	3.00	-0.96	1.74	-0.79	2.00	-0.54	1.50
19500	-0.19	2.00	-2.10	3.00	-0.75	1.74	-0.77	2.00	-0.50	1.50
20000	-0.19	2.00	-2.18	3.00	-0.76	1.72	-0.79	2.00	-0.51	1.50

(continued) Reported participant's results for the phase of the SE with expanded uncertainties ($k = 2$)

f in Hz	CENAM φ_i in °	CENAM U_{φ_i} in °	NMIJ φ_i in °	NMIJ U_{φ_i} in °	NIM φ_i in °	NIM U_{φ_i} in °	NMIA φ_i in °	NMIA U_{φ_i} in °	INMETRO φ_i in °	INMETRO U_{φ_i} in °
10	0.00	0.30	-0.01	0.50	0.06	0.50	-0.02	0.30	0.00	0.20
12.5	0.00	0.30	-0.04	0.50	0.05	0.50	-0.02	0.30	0.00	0.20
16	0.00	0.30	-0.02	0.40	0.05	0.50	-0.01	0.30	0.00	0.20
20	0.00	0.30	-0.02	0.30	0.04	0.50	-0.01	0.30	0.00	0.20
25	-0.01	0.30	-0.02	0.30	0.03	0.50	-0.01	0.30	0.00	0.20
31.5	0.00	0.30	-0.03	0.30	0.02	0.50	-0.01	0.30	0.00	0.20
40	-0.00	0.30	-0.02	0.30	0.02	0.50	-0.01	0.30	0.00	0.20
63	-0.05	0.30	-0.03	0.30	0.01	0.50	-0.01	0.30	0.00	0.20
80	0.00	0.30	-0.03	0.30	-0.00	0.50	-0.01	0.30	0.00	0.20
100	-0.03	0.30	-0.04	0.30	0.01	0.50	0.00	0.30	0.00	0.20
125	-0.02	0.30	-0.05	0.30	0.01	0.50	0.00	0.30	0.00	0.20
160	-0.02	0.30	-0.04	0.30	0.02	0.50	0.00	0.30	-0.01	0.20
200	-0.03	0.30	0.01	0.30	-0.04	0.50	0.01	0.30	-0.01	0.20
250	-0.05	0.30	0.01	0.30	0.00	0.50	0.01	0.30	-0.01	0.20
315	-0.04	0.30	0.01	0.30	0.01	0.50	0.01	0.30	-0.01	0.20
400	-0.02	0.30	0.01	0.30	0.00	0.50	0.03	0.30	-0.01	0.20
500	-0.01	0.30	0.00	0.30	-0.00	0.50	-0.01	0.30	-0.01	0.20
630	-0.02	0.30	-0.02	0.30	-0.00	0.50	0.02	0.30	-0.01	0.20
800	-0.03	0.30	0.02	0.30	0.02	0.50	0.02	0.30	-0.02	0.20
1000	-0.01	0.30	0.01	0.30	-0.02	0.50	0.03	0.50	-0.02	0.20
1250	-0.02	0.30	-0.01	0.30	-0.03	0.50	0.07	0.50	-0.02	0.20
1500	-0.10	0.30	-0.06	0.30	-0.04	0.50	0.04	0.50	-0.03	0.20
1600	-0.08	0.30	0.01	0.30	-0.05	0.50	0.00	0.50	-0.03	0.20
2000	-0.09	0.30	0.04	0.30	-0.05	0.50	0.03	0.50	-0.04	0.20
2500	-0.09	0.30	0.01	0.30	-0.08	0.50	0.04	0.50	-0.05	0.24
3000	-0.12	0.30	-0.01	0.30	-0.09	0.50	0.01	0.50	-0.06	0.24
3150	-0.20	0.30	0.03	0.30	-0.12	0.50	0.03	0.50	-0.06	0.34
3500	-0.16	0.30	0.01	0.30	-0.13	0.50	0.03	0.50	-0.07	0.34
4000	-0.20	0.30	-0.01	0.30	-0.15	0.50	0.06	0.50	-0.08	0.50
4500	-0.21	0.30	0.02	0.30	-0.17	0.50	0.05	0.60	-0.09	0.50
5000	-0.32	0.30	-0.03	0.40	-0.20	0.50	0.04	0.60	-0.10	0.50
5500	-0.30	0.50	0.01	0.40	-0.30	1.00	0.05	0.60	-0.11	0.80
6000	-0.39	0.50	0.01	0.40	-0.26	1.00	0.03	0.60	-0.12	0.80
6300	-0.45	0.50	-0.03	0.40	-0.27	1.00	0.03	0.60	-0.13	0.80
6500	-0.43	0.50	-0.02	0.40	-0.28	1.00	0.05	0.60	-0.14	0.80
7000	-0.47	0.50	0.02	0.40	-0.28	1.00	0.09	0.80	-0.15	0.80
7500	-0.45	0.50	0.03	0.40	-0.29	1.00	0.06	0.80	-0.16	1.00
8000	-0.44	0.50	0.00	0.40	-0.37	1.00	0.02	0.80	-0.17	1.00
8500	-0.45	0.50	-0.06	0.40	-0.46	1.00	-0.04	0.80	-0.19	1.00
9000	-0.53	0.50	-0.16	0.40	-0.53	1.00	-0.35	0.80	-0.20	1.00
9500	-0.50	0.50	-0.05	0.40	-0.41	1.00	0.03	0.80	-0.22	1.00
10000	-0.49	0.50	0.03	0.40	-0.48	1.00	0.02	0.80	-0.23	1.00
10500	-0.55	0.50	-0.08	0.40	-0.52	1.50	0.03	1.20	-0.25	1.20
11000	-0.54	0.50	0.04	0.50	-0.56	1.50	0.04	1.20	-0.26	1.20
11500	-0.58	0.50	-0.05	0.40	-0.56	1.50	0.05	1.20	-0.28	1.20
12000	-0.63	0.50	0.05	0.40	-0.53	1.50	0.07	1.20	-0.29	1.20
12500	-0.67	0.50	-0.04	0.40	-0.55	1.50	0.07	1.20	-0.31	1.20
13000	-0.64	0.50	0.02	0.50	-0.64	1.50	0.14	1.50	-0.33	1.20
13500	-0.64	0.50	-0.06	0.50	-0.59	1.50	0.13	1.50	-0.34	1.20
14000	-0.72	0.50	0.05	0.50	-0.60	1.50	0.12	1.50	-0.36	1.20
14500	-0.65	0.50	-0.10	0.50	-0.68	1.50	0.17	1.50	-0.38	1.20
15000	-0.65	0.50	-0.06	0.50	-0.77	1.50	0.09	1.50	-0.40	1.20
15500	-0.70	0.50	-0.03	0.50	-0.73	1.50	0.16	2.00	-0.42	1.20
16000	-0.70	0.50	-0.18	0.50	-0.71	1.50	0.05	2.00	-0.43	1.20
16500	-0.78	0.50	-0.08	0.60	-0.90	1.50	0.13	2.00	-0.45	1.20
17000	-0.72	0.50	-0.41	1.00	-0.98	1.50	-0.10	2.00	-0.47	1.20
17500	-0.72	0.50	-0.50	1.00	-1.16	1.50	-0.21	2.00	-0.49	1.20
18000	-0.79	0.50	-0.73	1.00	-1.07	1.50	-0.27	2.00	-0.51	1.20
18500	-0.93	0.50	-0.43	1.10	-1.08	1.50	0.03	2.00	-0.53	1.20
19000	-0.93	0.50	-0.66	1.00	-1.14	1.50	-0.20	2.00	-0.55	1.20
19500	-0.93	0.50	-0.16	0.60	-0.92	1.50	0.11	2.00	-0.58	1.20
20000	-1.04	0.50	-0.19	0.60	-0.98	1.50	0.19	2.00	-0.60	1.20

(continued) Reported participant's results for the phase of the SE with expanded uncertainties ($k = 2$)

f in Hz	NMISA φ_i in °	NMISA U_{φ_i} in °	VNIIM φ_i in °	VNIIM U_{φ_i} in °	NMC,A*STAR φ_i in °	NMC,A*STAR U_{φ_i} in °	UkrMet φ_i in °	UkrMet U_{φ_i} in °
10	0.04	0.20	0.04	1.00	-0.00	0.32	-0.01	0.50
12.5	0.02	0.20	0.02	1.00	0.01	0.32	0.00	0.50
16	0.02	0.20	0.04	1.00	0.01	0.32	-0.02	0.50
20	0.02	0.20	0.07	0.50	0.02	0.36	-0.03	0.50
25	0.01	0.20	-0.04	0.50	0.03	0.36	-0.05	0.50
31.5	0.01	0.20	-0.08	0.50	0.03	0.36	-0.06	0.50
40	0.01	0.20	-0.01	0.50	0.04	0.36	-0.03	0.50
63	0.00	0.20	-0.07	0.50	0.03	0.36	-0.04	0.50
80	0.00	0.20	-0.06	0.50	0.03	0.36	-0.02	0.50
100	0.00	0.20	-0.08	0.50	0.02	0.36	-0.01	0.50
125	0.00	0.30	-0.02	0.50	0.18	0.36	-0.06	0.50
160	-0.03	0.30	0.05	0.50	0.04	0.36	-0.05	0.50
200	-0.02	0.30	0.61	0.50	0.07	0.36	0.18	0.50
250	-0.02	0.30	1.27	0.50	0.03	0.36	0.19	0.50
315	-0.02	0.30	0.25	0.50	0.03	0.36	-0.02	0.50
400	-0.03	0.30	0.01	0.50	0.03	0.36	0.01	0.50
500	-0.04	0.30	0.04	0.50	0.03	0.36	0.09	0.50
630	-0.03	0.30	0.10	0.50	0.05	0.36	0.13	0.50
800	-0.07	0.30	0.09	0.50	0.02	0.36	0.15	0.50
1000	-0.08	0.30	0.10	0.50	0.06	0.62	0.17	0.50
1250	-0.09	0.50	0.05	0.50	0.03	0.62	-0.09	0.70
1500	-0.10	0.50	0.06	0.50	0.03	0.62	0.02	0.70
1600	-0.11	0.50	0.04	0.50	0.01	0.62	0.01	0.70
2000	-0.13	0.50	-0.02	0.50	0.03	0.62	0.01	0.70
2500	-0.14	0.50	-0.08	0.50	0.04	0.62	0.04	0.70
3000	-0.18	0.50	-0.10	0.50	0.02	0.62	-0.02	0.70
3150	-0.21	0.50	-0.19	0.50	0.04	0.62	-0.07	0.70
3500	-0.21	0.50	-0.26	0.50	0.05	0.62	-0.02	0.70
4000	-0.25	0.50	-0.41	0.50	0.08	0.62	-0.19	0.70
4500	-0.27	0.50	-0.56	0.50	0.04	0.62	-0.18	0.70
5000	-0.32	0.80	-0.68	0.50	0.03	0.66	-0.36	0.70
5500	-0.34	0.80	-0.74	1.00	0.06	0.66	-0.36	1.50
6000	-0.35	0.80	-0.79	1.00	0.02	0.66	-0.62	1.50
6300	-0.40	0.80	-0.96	1.00	0.05	0.66	-0.43	1.50
6500	-0.40	0.80	-0.94	1.00	-0.03	0.66	-0.54	1.50
7000	-0.48	0.80	-0.92	1.00	0.03	0.66	-0.51	1.50
7500	-0.53	0.80	-1.15	1.00	0.03	0.66	-0.47	1.50
8000	-0.51	0.80	-1.25	1.00	-0.03	0.66	-0.65	1.50
8500	-0.53	0.80	-1.38	1.00	-0.12	0.66	-0.68	1.50
9000	0.00	0.80	-1.30	1.00	-0.43	0.66	-0.69	1.50
9500	-0.64	0.80	-1.09	1.00	0.02	0.66	-0.69	1.50
10000	-0.63	0.80	-1.56	1.00	-0.05	1.22	-0.46	1.50
10500	-0.64	0.80	-1.12	1.50	-0.08	1.22	-0.71	2.00
11000	-0.69	0.80	-1.39	1.50	-0.09	1.22	-0.80	2.00
11500	-0.75	0.80	-1.46	1.50	-0.08	1.22	-0.82	2.00
12000	-0.79	0.80	-1.22	1.50	-0.06	1.22	-0.99	2.00
12500	-0.84	1.20	-1.34	1.50	-0.06	1.22	-0.81	2.00
13000	-0.89	1.20	-1.35	1.50	-0.09	1.22	-0.98	2.00
13500	-0.93	1.20	-1.02	1.50	-0.08	1.22	-0.81	2.00
14000	-0.94	1.20	-1.35	1.50	-0.06	1.22	-0.03	2.00
14500	-1.02	1.20	-1.31	1.50	-0.07	1.22	-0.12	2.00
15000	-1.01	1.20	-1.41	1.50	-0.13	1.66	-0.35	2.00
15500	-1.02	1.60	-2.07	1.50	-0.17	1.66	-0.82	3.00
16000	-1.03	1.60	-2.63	1.50	-0.18	1.66	-0.51	3.00
16500	-1.02	1.60	-2.50	1.50	-0.26	1.66	-0.22	3.00
17000	-0.92	1.60	-1.65	1.50	-0.46	1.66	-0.37	3.00
17500	-0.72	1.60	-1.48	1.50	-0.71	1.66	-1.01	3.00
18000	-0.63	1.60	-2.05	1.50	-0.94	1.66	-1.11	3.00
18500	-0.92	1.60	-1.98	1.50	-0.60	1.66	-0.77	3.00
19000	-1.32	1.60	-0.82	1.50	-0.57	1.66	-0.67	3.00
19500	-1.23	1.60	-1.33	1.50	-0.47	1.66	-0.21	3.00
20000	-1.27	1.60	-1.45	1.50	-0.35	1.66	-0.15	3.00

7.2.2 The Back-to-Back Accelerometer (SN 1483350)

Table 7.4: Reported participant's results for the phase of the BB with expanded uncertainties ($k = 2$)

f in Hz	PTB φ_i in °	PTB U_{φ_i} in °	DPLA φ_i in °	DPLA U_{φ_i} in °	METAS φ_i in °	METAS U_{φ_i} in °	CEM φ_i in °	CEM U_{φ_i} in °	NIST φ_i in °	NIST U_{φ_i} in °
10	179.96	0.20	179.97	0.30	179.95	0.40	179.96	0.50	179.99	0.50
12.5	179.93	0.20	179.97	0.30	180.10	0.40	179.96	0.50	179.99	0.50
16	179.97	0.20	179.98	0.30	179.98	0.40	179.96	0.50	179.98	0.50
20	179.97	0.20	179.97	0.30	180.02	0.38	179.96	0.50	179.99	0.50
25	179.98	0.20	179.95	0.30	180.04	0.38	179.96	0.50	180.00	0.50
31.5	179.96	0.20	179.99	0.30	180.01	0.38	179.98	0.50	180.00	0.50
40	179.95	0.20	179.96	0.30	180.00	0.38	179.98	0.50	180.01	0.50
63	179.96	0.20	179.98	0.30	179.95	0.38	179.99	0.50	180.01	0.50
80	179.95	0.20	179.98	0.30	179.94	0.38	179.98	0.50	180.02	0.50
100	179.98	0.20	179.99	0.30	179.93	0.38	179.97	0.50	180.01	0.50
125	179.99	0.20	179.98	0.30	179.91	0.38	179.96	0.50	179.99	0.50
160	179.99	0.20	179.99	0.30	179.89	0.38	179.98	0.50	179.99	0.50
200	179.99	0.20	179.99	0.30	180.03	0.38	179.98	0.50	180.02	0.50
250	179.99	0.20	179.99	0.30	180.00	0.38	179.97	0.50	180.02	0.50
315	179.99	0.20	179.99	0.30	179.99	0.38	179.96	0.50	180.03	0.50
400	179.99	0.20	179.97	0.30	179.97	0.38	179.96	0.50	180.01	0.50
500	180.00	0.20	179.96	0.30	179.98	0.38	179.95	0.50	180.00	0.50
630	179.99	0.20	179.95	0.30	179.97	0.38	180.01	0.50	180.02	0.50
800	179.99	0.20	179.92	0.30	179.97	0.38	180.01	0.50	179.98	0.50
1000	180.00	0.20	179.91	0.30	180.01	0.48	180.01	0.50	179.97	0.50
1250	179.98	0.50	179.89	0.30	180.00	0.48	179.98	1.00	179.99	0.50
1500	179.99	0.50	179.77	0.30	179.99	0.48	180.01	1.00	179.97	0.50
1600	179.99	0.50	179.71	0.30	180.00	0.48	180.00	1.00	179.96	0.50
2000	179.99	0.50	179.75	0.30	180.00	0.48	180.00	1.00	179.96	0.50
2500	179.98	0.50	179.74	0.30	179.98	0.48	179.98	1.00	179.94	0.50
3000	179.98	0.50	179.72	0.30	179.99	0.48	179.98	1.00	179.91	0.50
3150	179.98	0.50	179.67	0.30	179.98	0.48	179.97	1.00	179.90	0.50
3500	179.97	0.50	179.68	0.30	179.99	0.48	179.97	1.00	179.90	0.50
4000	179.98	0.50	179.68	0.30	180.00	0.48	179.97	1.00	179.87	0.50
4500	179.98	0.50	179.46	0.30	179.99	0.48	179.99	1.00	179.85	0.50
5000	179.97	0.50	179.58	0.50	179.97	0.48	179.96	1.00	179.80	0.50
5500	179.97	0.50	179.45	0.50	180.00	0.86	179.95	1.00	179.76	1.00
6000	179.96	0.50	179.44	0.50	179.99	0.86	179.93	1.00	179.70	1.00
6300	179.96	0.50	179.38	0.50	179.96	0.88	179.98	1.00	179.65	1.00
6500	179.96	0.50	179.35	0.50	179.96	0.90	179.97	1.00	179.72	1.00
7000	179.96	0.50	179.29	0.50	179.97	1.02	180.04	1.00	179.63	1.00
7500	179.88	0.50	179.20	0.50	179.64	1.26	179.75	1.00	179.54	1.00
8000	180.00	0.50	178.99	1.00	179.95	1.44	179.83	1.00	179.61	1.00
8500	179.87	0.50	179.09	1.00	180.33	1.78	180.28	1.00	179.38	1.00
9000	179.95	0.50	179.07	1.00	180.09	1.12	180.17	1.00	179.25	1.00
9500	180.10	0.50	179.11	1.00	180.16	1.06	179.89	1.00	179.48	1.00
10000	180.22	0.50	179.04	1.00	180.15	0.94	180.04	1.00	180.04	1.00
10500	180.24	1.00	178.84	2.00	180.07	1.74	179.98	1.50	179.85	1.50
11000	180.11	1.00	178.91	2.00	180.09	1.74	180.03	1.50	179.76	1.50
11500	180.00	1.00	178.81	2.00	180.12	1.74	179.91	1.50	179.60	1.50
12000	179.98	1.00	178.77	2.00	180.16	1.74	179.86	1.50	179.55	1.50
12500	179.96	1.00	178.78	2.00	180.05	1.72	179.88	1.50	179.52	1.50
13000	179.95	1.00	178.71	2.00	180.00	1.72	179.81	1.50	179.43	1.50
13500	179.94	1.00	178.73	2.00	179.89	1.72	179.78	1.50	179.39	1.50
14000	179.88	1.00	178.70	2.00	179.86	1.72	179.72	1.50	179.05	1.50
14500	179.76	1.00	178.89	2.00	179.92	1.72	179.64	1.50	179.28	1.50
15000	179.89	1.00	178.81	2.00	179.89	1.72	179.66	1.50	179.31	1.50
15500	179.89	2.00	178.55	2.00	179.80	1.72	179.67	2.00	179.29	1.50
16000	179.89	2.00	178.42	3.00	179.79	1.72	179.68	2.00	179.28	1.50
16500	179.90	2.00	178.35	3.00	179.72	1.72	179.64	2.00	179.28	1.50
17000	179.89	2.00	178.30	3.00	179.61	1.72	179.60	2.00	179.27	1.50
17500	179.91	2.00	178.24	3.00	179.60	1.72	179.61	2.00	179.25	1.50
18000	179.92	2.00	178.16	3.00	179.55	1.72	179.57	2.00	179.23	1.50
18500	179.94	2.00	178.14	3.00	179.52	1.72	179.55	2.00	179.24	1.50
19000	179.95	2.00	178.22	3.00	179.48	1.72	179.54	2.00	179.24	1.50
19500	179.95	2.00	178.27	3.00	179.43	1.72	179.53	2.00	179.22	1.50
20000	179.97	2.00	178.28	3.00	179.38	1.72	179.53	2.00	179.24	1.50

(continued) Reported participant's results for the phase of the BB with expanded uncertainties ($k = 2$)

f in Hz	CENAM φ_i in °	CENAM U_{φ_i} in °	NMIJ φ_i in °	NMIJ U_{φ_i} in °	NIM φ_i in °	NIM U_{φ_i} in °	NMIA φ_i in °	NMIA U_{φ_i} in °	INMETRO φ_i in °	INMETRO U_{φ_i} in °
10	180.00	0.30	180.01	0.30	180.08	0.50	179.95	0.30	179.97	0.20
12.5	180.00	0.30	179.98	0.30	180.05	0.50	179.96	0.30	179.97	0.20
16	180.00	0.30	179.98	0.30	180.04	0.50	179.97	0.30	179.97	0.20
20	180.00	0.30	180.01	0.30	180.00	0.50	179.96	0.30	179.97	0.20
25	180.00	0.30	179.98	0.30	180.02	0.50	179.96	0.30	179.97	0.20
31.5	180.00	0.30	179.99	0.30	179.97	0.50	179.96	0.30	179.97	0.20
40	180.00	0.30	179.96	0.30	180.01	0.50	179.96	0.30	179.97	0.20
63	179.96	0.30	180.02	0.40	180.01	0.50	179.97	0.30	179.97	0.20
80	179.91	0.30	179.97	0.30	179.99	0.50	179.97	0.30	179.97	0.20
100	179.95	0.30	179.95	0.30	179.99	0.50	179.98	0.30	179.97	0.20
125	179.99	0.30	179.95	0.30	180.00	0.50	179.98	0.30	179.97	0.20
160	179.98	0.30	179.95	0.30	180.00	0.50	179.98	0.30	179.97	0.20
200	179.97	0.30	179.99	0.30	180.03	0.50	179.97	0.30	179.97	0.20
250	180.00	0.30	180.02	0.30	179.99	0.50	179.99	0.30	179.97	0.20
315	179.98	0.30	180.02	0.30	179.99	0.50	180.00	0.30	179.96	0.20
400	179.94	0.30	180.02	0.30	180.00	0.50	180.03	0.30	179.96	0.20
500	179.92	0.30	179.99	0.30	179.99	0.50	179.98	0.30	179.96	0.20
630	179.93	0.30	179.99	0.30	179.97	0.50	180.01	0.30	179.96	0.20
800	179.89	0.30	179.99	0.30	179.97	0.50	180.01	0.30	179.96	0.20
1000	179.87	0.30	180.00	0.30	179.95	0.50	180.02	0.50	179.95	0.20
1250	179.76	0.30	180.00	0.30	179.96	0.50	180.06	0.50	179.95	0.20
1500	179.85	0.30	179.99	0.30	179.94	0.50	180.03	0.50	179.94	0.20
1600	179.80	0.30	180.00	0.30	179.90	0.50	179.98	0.50	179.94	0.20
2000	179.74	0.30	180.01	0.30	179.88	0.50	180.02	0.50	179.94	0.20
2500	179.76	0.30	179.99	0.30	179.86	0.50	180.02	0.50	179.93	0.24
3000	179.75	0.30	179.99	0.30	179.86	0.50	180.00	0.50	179.92	0.24
3150	179.68	0.30	179.98	0.30	179.81	0.50	180.00	0.50	179.92	0.34
3500	179.51	0.30	180.03	0.30	179.81	0.50	180.03	0.50	179.91	0.34
4000	179.42	0.30	180.01	0.30	179.80	0.50	180.05	0.50	179.90	0.50
4500	179.51	0.30	180.02	0.30	179.78	0.50	179.98	0.60	179.89	0.50
5000	179.31	0.30	179.95	0.40	179.68	0.50	180.03	0.60	179.89	0.50
5500	179.23	0.50			179.64	1.00	180.05	0.60	179.88	0.80
6000	179.32	0.50			179.60	1.00	180.03	0.60	179.87	0.80
6300	179.30	0.50			179.63	1.00	180.03	0.60	179.87	0.80
6500	179.12	0.50			179.62	1.00	180.06	0.60	179.86	0.80
7000	179.02	0.50			179.69	1.00	180.02	0.80	179.86	0.80
7500	179.02	0.50			179.52	1.00	180.03	0.80	179.85	1.00
8000	179.16	0.50			179.51	1.00	180.00	0.80	179.84	1.00
8500	179.07	0.50			179.49	1.00	179.65	0.80	179.84	1.00
9000	179.08	0.50			179.36	1.00	179.56	0.80	179.83	1.00
9500	178.79	0.50			179.51	1.00	180.45	0.80	179.82	1.00
10000	178.86	0.50			179.55	1.00	180.12	0.80	179.82	1.00
10500	178.75	0.50			179.56	1.50	180.33	1.20	179.81	1.20
11000	178.70	0.50			179.50	1.50	180.71	1.20	179.80	1.20
11500	178.60	0.50			179.55	1.50	180.57	1.20	179.80	1.20
12000	178.43	0.50			179.40	1.50	180.45	1.20	179.79	1.20
12500	178.37	0.50			179.34	1.50	180.31	1.20	179.79	1.20
13000	178.38	0.50			179.28	1.50	180.24	1.50	179.78	1.20
13500	178.25	0.50			179.26	1.50	180.19	1.50	179.77	1.20
14000	178.33	0.50			179.32	1.50	180.15	1.50	179.77	1.20
14500	178.36	0.50			179.10	1.50	179.90	1.50	179.76	1.20
15000	178.11	0.50			179.12	1.50	180.14	1.50	179.76	1.20
15500	178.22	0.50			179.13	1.50	180.14	2.00	179.75	1.20
16000	178.06	0.50			179.11	1.50	180.21	2.00	179.75	1.20
16500	178.20	0.50			179.21	1.50	180.14	2.00	179.74	1.20
17000	178.08	0.50			179.17	1.50	180.15	2.00	179.74	1.20
17500	178.10	0.50			179.08	1.50	180.15	2.00	179.73	1.20
18000	178.00	0.50			178.95	1.50	180.22	2.00	179.73	1.20
18500	177.80	0.50			179.04	1.50	180.27	2.00	179.72	1.20
19000	177.70	0.50			179.02	1.50	180.12	2.00	179.72	1.20
19500	177.70	0.50			178.95	1.50	180.28	2.00	179.71	1.20
20000	177.56	0.50			178.96	1.50	180.14	2.00	179.71	1.20

(continued) Reported participant's results for the phase of the BB with expanded uncertainties ($k = 2$)

f in Hz	NMISA φ_i in °	NMISA U_{φ_i} in °	VNIIM φ_i in °	VNIIM U_{φ_i} in °	NMC,A*STAR φ_i in °	NMC,A*STAR U_{φ_i} in °	UkrMet φ_i in °	UkrMet U_{φ_i} in °
10	180.05	0.20	179.91	1.00	179.99	0.32	179.93	0.50
12.5	180.05	0.20	179.88	1.00	179.99	0.32	179.99	0.50
16	180.09	0.20	179.90	1.00	179.98	0.32	179.91	0.50
20	180.04	0.20	179.91	0.50	180.00	0.36	179.95	0.50
25	180.03	0.20	179.89	0.50	180.01	0.36	179.94	0.50
31.5	180.03	0.20	179.89	0.50	180.01	0.36	179.95	0.50
40	180.04	0.20	179.92	0.50	180.01	0.36	179.95	0.50
63	180.03	0.20	179.92	0.50	180.00	0.36	179.95	0.50
80	180.02	0.20	179.92	0.50	180.01	0.36	179.94	0.50
100	180.02	0.20	179.93	0.50	180.02	0.36	179.93	0.50
125	180.02	0.30	179.97	0.50	180.04	0.36	179.97	0.50
160	180.04	0.30	180.02	0.50	180.01	0.36	180.01	0.50
200	180.01	0.30	180.06	0.50	180.02	0.36	180.09	0.50
250	180.00	0.30	180.09	0.50	180.02	0.36	180.10	0.50
315	179.99	0.30	180.00	0.50	180.02	0.36	179.95	0.50
400	179.99	0.30	180.11	0.50	180.02	0.36	179.96	0.50
500	179.98	0.30	180.10	0.50	180.01	0.36	179.98	0.50
630	179.97	0.30	180.08	0.50	180.04	0.36	179.95	0.50
800	179.96	0.30	180.09	0.50	180.02	0.36	180.08	0.50
1000	179.93	0.30	180.19	0.50	180.03	0.62	180.18	0.50
1250	179.92	0.50	180.13	0.50	180.02	0.62	179.78	0.70
1500	179.89	0.50	180.00	0.50	180.02	0.62	179.99	0.70
1600	179.90	0.50	180.16	0.50	180.02	0.62	179.98	0.70
2000	179.88	0.50	180.16	0.50	180.03	0.62	179.94	0.70
2500	179.86	0.50	180.17	0.50	180.03	0.62	179.80	0.70
3000	179.82	0.50	180.10	0.50	180.02	0.62	179.85	0.70
3150	179.80	0.50	180.08	0.50	180.03	0.62	179.97	0.70
3500	179.80	0.50	179.92	0.50	180.06	0.62	179.99	0.70
4000	179.76	0.50	179.85	0.50	180.07	0.62	179.76	0.70
4500	179.74	0.50	179.83	0.50	180.02	0.62	179.73	0.70
5000	179.69	0.80	179.74	0.50	180.02	0.66	179.72	0.70
5500	179.67	0.80	179.65	1.00	180.02	0.66	179.61	1.50
6000	179.64	0.80	179.69	1.00	179.99	0.66	179.55	1.50
6300	179.60	0.80	179.67	1.00	180.03	0.66	179.63	1.50
6500	179.60	0.80	179.49	1.00	179.96	0.66	179.64	1.50
7000	179.56	0.80	179.49	1.00	179.99	0.66	179.63	1.50
7500	179.58	0.80	179.45	1.00	179.90	0.66	179.39	1.50
8000	179.55	0.80	179.30	1.00	179.77	0.66	179.58	1.50
8500	179.99	0.80	179.46	1.00	179.46	0.66	179.33	1.50
9000	180.00	0.80	179.69	1.00	178.67	0.66	179.34	1.50
9500	178.92	0.80	179.83	1.00	180.15	0.66	179.55	1.50
10000	179.21	0.80	179.44	1.00	180.30	1.22	179.80	1.50
10500	178.90	0.80	179.53	1.50	180.42	1.22	179.52	2.00
11000	178.68	0.80	179.67	1.50	180.44	1.22	179.57	2.00
11500	178.72	0.80	179.69	1.50	180.43	1.22	179.92	2.00
12000	178.83	0.80	179.91	1.50	180.39	1.22	180.10	2.00
12500	178.91	1.20	179.80	1.50	180.21	1.22	180.08	2.00
13000	178.93	1.20	179.76	1.50	180.22	1.22	179.69	2.00
13500	178.97	1.20	179.97	1.50	180.07	1.22	179.66	2.00
14000	179.00	1.20	180.07	1.50	180.03	1.22	179.78	2.00
14500	179.06	1.20	180.34	1.50	179.89	1.22	179.73	2.00
15000	178.92	1.20	180.40	1.50	179.92	1.66	179.51	2.00
15500	178.89	1.60	180.55	1.50	179.94	1.66	179.63	3.00
16000	178.86	1.60	180.67	1.50	179.92	1.66	179.55	3.00
16500	178.84	1.60	180.83	1.50	179.89	1.66	179.69	3.00
17000	178.80	1.60	181.05	1.50	179.88	1.66	179.80	3.00
17500	178.78	1.60	181.21	1.50	179.87	1.66	179.73	3.00
18000	178.73	1.60	181.25	1.50	179.84	1.66	179.59	3.00
18500	178.70	1.60	181.25	1.50	179.83	1.66	179.74	3.00
19000	178.66	1.60	181.26	1.50	179.77	1.66	179.82	3.00
19500	178.64	1.60	182.28	1.50	179.77	1.66	179.68	3.00
20000	178.62	1.60	181.81	1.50	179.74	1.66	179.66	3.00

8 — Degree of Equivalence with Respect to the KC Reference Value

8.1 Analysis

The measurement results were reported by the participants using the mandatory report spreadsheet (Excel-file). For this file the displayed resolution of the data was limited, however, sometimes the resolution of the data stored in the file was representing many more significant digits. In order to comply with the resolution implied by the measurement uncertainty and to generate a consistent picture in this report, all input data were rounded before further calculation in the following way:

quantity	unit	representation
magnitude of complex sensitivity	$\frac{\mathrm{pC}}{\mathrm{m/s^2}}$	0.xxxxx
relative uncertainty	%	x.xx
phase of complex sensitivity	1°	x.xx
uncertainty of phase	1°	x.xx

The resulting reference values are represented with one more digit resolution in order to take the effect of weighing and averaging into account.

As in previous key comparisons in the area of vibration calibration, the evaluation of the results was performed using a weighted mean of the form

$$X_{\mathrm{KC}}(f) = \sum \frac{X_i(f)}{u_i^2(f)} \cdot \left(\sum \frac{1}{u_i^2(f)} \right)^{-1} \tag{8.1}$$

Contributing to the weighted mean were all participants' results who were not identified as outliers according to [3]. In the subsequent charts these are labeled as member of consistent subset (MoCS). Outliers (non MoCS) were not included in the calculation of the weighted mean.

The variance of the weighted mean takes the following form

$$u_{\mathrm{KC}}^2(f) = \left(\sum \frac{1}{u_i^2(f)} \right)^{-1} \tag{8.2}$$

In the equations the following shortcuts were used:

$X_i(f)$	Result of participant i of the largest consistent subset at frequency f
$u_i(f)$	absolute standard uncertainty of participant i of the largest consistent subset at frequency f
$X_{\mathrm{KC}}(f)$	best estimate of the key comparison reference value (KCRV) at frequency f
$u_{\mathrm{KC}}(f)$	estimated absolute standard uncertainty of the KCRV at frequency f

For the further evaluation of the KC the degrees of equivalence with respect to the KCRV are calculated as:

$$D_i(f) = X_i(f) - X_{\mathrm{KC}}(f) \tag{8.3}$$

$$u_{D_i}^2(f) = \begin{cases} u_i^2(f) - u_{\mathrm{KC}}^2(f) & \text{for MoCS} \\ u_i^2(f) + u_{\mathrm{KC}}^2(f) & \text{for non MoCS} \end{cases} \tag{8.4}$$

The formulas are applicable to the magnitude as well as to the phase measurement results.

8.2 The Mode of Presentation of the Results

In the subsequently presented tables results with $|D_i(f)| > U_{D_i}(f)$ where $U_{D_i}(f) = 2 \cdot u_{D_i}(f)$ are marked by a yellow background.

Results which were excluded from the largest consistent subset (non-MoCS results) according to the result of the consistency check, and which therefore did not contribute to the KCRV are (in addition) marked with an asterisk (*). In the subsequently presented diagrams the points for the participant results are color coded to express whether the result is MoCS or non-MoCS.

For details of the calculations concerning consistency and the related reasoning the reader is referred to the original publication [3].

8.3 Magnitude of the Complex Sensitivity of the SE

Table 8.1: Unilateral degrees of equivalence for the magnitude of the SE

f in Hz	KCRV X_{KC} in $\frac{\mathrm{fC}}{\mathrm{m/s^2}}$	KCRV U_{KC} in $\frac{\mathrm{fC}}{\mathrm{m/s^2}}$	PTB D_i in $\frac{\mathrm{fC}}{\mathrm{m/s^2}}$	PTB U_{D_i} in $\frac{\mathrm{fC}}{\mathrm{m/s^2}}$	DPLA D_i in $\frac{\mathrm{fC}}{\mathrm{m/s^2}}$	DPLA U_{D_i} in $\frac{\mathrm{fC}}{\mathrm{m/s^2}}$	METAS D_i in $\frac{\mathrm{fC}}{\mathrm{m/s^2}}$	METAS U_{D_i} in $\frac{\mathrm{fC}}{\mathrm{m/s^2}}$	CEM D_i in $\frac{\mathrm{fC}}{\mathrm{m/s^2}}$	CEM U_{D_i} in $\frac{\mathrm{fC}}{\mathrm{m/s^2}}$	NIST D_i in $\frac{\mathrm{fC}}{\mathrm{m/s^2}}$	NIST U_{D_i} in $\frac{\mathrm{fC}}{\mathrm{m/s^2}}$
10	126.571	0.085	-0.07	0.09	-0.17	0.50	-0.02	0.28	-0.11	0.50	-0.06	0.37
12.5	126.594	0.085	-0.08	0.09	-0.19	0.50	-0.05	0.28	-0.08	0.50	-0.05	0.37
16	126.590	0.084	-0.08	0.09	-0.19	0.50	-0.03	0.28	-0.05	0.50	-0.04	0.37
20	126.574	0.081	-0.07	0.10	-0.17	0.50	0.01	0.23	-0.04	0.50	-0.04	0.37
25	126.569	0.081	-0.08	0.10	-0.17	0.50	0.01	0.23	-0.04	0.50	-0.05	0.37
31.5	126.568	0.081	-0.08	0.10	-0.17	0.50	0.02	0.23	-0.04	0.50	0.00	0.37
40	126.561	0.081	-0.08	0.10	-0.16	0.50	0.01	0.23	-0.02	0.50	-0.00	0.37
63	126.546	0.081	-0.09	0.10	-0.15	0.50	0.04	0.23	-0.02	0.50	0.01	0.37
80	126.565	0.081	-0.06	0.10	-0.16	0.50	0.02	0.23	-0.05	0.50	0.02	0.37
100	126.531	0.082	-0.09	0.10	-0.13	0.50	0.02	0.24	-0.05	0.50	0.03	0.37
125	126.527	0.082	-0.08	0.10	-0.13	0.50	0.01	0.24	-0.02	0.50	0.03	0.37
160	126.532	0.082	-0.08	0.10	-0.13	0.50	0.02	0.25	-0.04	0.50	-0.13	0.37
200	126.554	0.083	-0.09	0.10	-0.15	0.50	0.01	0.27	-0.05	0.50	-0.00	0.37
250	126.563	0.084	-0.10	0.09	-0.16	0.50	0.06	0.45	-0.06	0.50	-0.01	0.37
315	126.579	0.083	-0.09	0.10	-0.18	0.50	-0.01	0.33	-0.07	0.50	-0.01	0.37
400	126.585	0.083	-0.11	0.10	-0.09	0.50	-0.02	0.34	-0.06	0.50	0.00	0.37
500	126.599	0.082	-0.10	0.10	-0.10	0.50	-0.03	0.28	-0.06	0.50	0.01	0.37
630	126.612	0.083	-0.09	0.10	-0.11	0.50	-0.02	0.31	-0.05	0.50	0.01	0.37
800	126.636	0.082	-0.09	0.10	-0.14	0.50	-0.05	0.28	-0.06	0.50	-0.03	0.37
1000	126.696	0.084	-0.09	0.09	-0.10	0.50	-0.05	0.32	-0.08	0.50	0.02	0.37
1250	126.752	0.087	-0.09	0.09	-0.05	0.50	-0.02	0.32	-0.02	0.50	-0.02	0.50
1500	126.868	0.086	-0.08	0.09	-0.07	0.50	-0.06	0.31	-0.09	0.50	0.00	0.50
1600	126.921	0.086	-0.07	0.09	-0.22	0.50	-0.09	0.31	-0.03	0.50	-0.05	0.50
2000	127.097	0.087	-0.08	0.09	-0.10	0.50	-0.11	0.32	-0.08	0.50	-0.01	0.50
2500	127.418	0.089	-0.08	0.09	-0.12	0.50	-0.17	0.31	-0.05	0.50	-0.01	0.50
3000	127.749	0.089	-0.05	0.09	-0.15	0.50	-0.15	0.31	-0.02	0.50	0.03	0.50
3150	127.870	0.091	-0.05	0.09	-0.07	0.50	-0.07	0.31	0.02	0.50	0.04	0.50
3500	128.137	0.092	0.00	0.09	-0.04	0.50	-0.12	0.31	0.05	0.50	0.03	0.50
4000	128.662	0.092	-0.00	0.09	-0.06	0.51	-0.19	0.31	0.04	0.51	0.08	0.51
4500	129.218	0.092	-0.02	0.09	-0.12	0.51	-0.21	0.31	0.02	0.51	0.14	0.51
5000	129.886	0.098	0.00	0.09	-0.09	0.77	-0.17	0.30	0.02	0.51	0.12	0.51
5500	130.637	0.184	-0.03	0.35	-0.14	0.76	-0.32	0.88	0.05	1.03	0.17	0.63
6000	131.427	0.185	-0.01	0.35	-0.13	0.77	-0.41	0.88	0.05	1.04	0.14	0.63
6300	131.997	0.186	-0.06	0.35	-0.10	0.77	-0.30	0.89	0.04	1.04	0.12	0.63
6500	132.348	0.187	-0.06	0.35	-0.25	0.77	-0.39	0.90	0.01	1.04	0.14	0.64
7000	133.278	0.190	-0.07	0.35	-0.38	0.77	-0.63	0.90	0.10	1.05	0.22	0.64
7500	134.569	0.202	-0.14	0.35	-0.47	0.78	-0.89	0.91	0.04	1.06	0.14	0.64
8000	135.717	0.205	-0.22	0.35	-0.62	0.78	-0.91	0.96	0.07	1.07	0.11	0.65
8500	136.750	0.208	-0.09	0.35	-0.35	0.79	-0.85	0.93	0.16	1.08	0.34	0.65
9000	138.133	0.228	-0.27	0.35	-0.43	0.79	-1.32	1.00	-0.12	1.08	0.43	0.65
9500	139.496	0.227	-0.03	0.35	-0.60	0.80	-1.13	1.00	0.02	1.09	0.51	0.66
10000	141.106	0.234	-0.19	0.35	0.19	0.81	-1.08	0.98	-0.03	1.10	0.43	0.67
10500	142.449	0.360	0.07	0.62	-0.95	1.37	-1.19	2.36	0.36	2.11	0.80	2.12
11000	144.125	0.364	0.14	0.62	-0.73	1.39	-1.05	2.45	0.33	2.14	0.90	2.14
11500	146.132	0.389	-0.00	0.62	-0.93	1.40	-1.53	2.40	0.20	2.16	0.82	2.17
12000	148.135	0.409	0.11	0.62	-0.84	1.42	-1.68	2.44	0.37	2.19	0.84	2.20
12500	150.405	0.439	-0.11	0.61	-1.10	1.74	-1.99	2.50	0.25	2.22	0.84	2.23
13000	152.679	0.422	-0.10	0.64	-1.28	1.77	-1.77	2.52	0.24	2.25	0.97	2.27
13500	154.653	0.472	0.53	0.62	-0.65	1.79	-1.66	2.59	0.84	2.28	1.49	2.29
14000	157.489	0.526	0.36	0.59	-1.49	1.80	-2.47	2.68	0.68	2.31	1.32	2.32
14500	160.643	0.527	-0.02	0.61	-2.54*	1.97*	-2.57	2.65	0.41	2.36	1.16	2.37
15000	163.140	0.503	0.46	0.65	-2.04	1.87	-2.58	2.70	1.08	2.41	1.81	2.42
15500	166.270	0.647	0.58	1.54	-1.97	1.86	-2.28	2.71	1.34	3.29	1.86	3.30
16000	170.484	0.695	-0.24	1.55	-2.98	3.28	-4.05*	2.95*	0.60	3.35	1.22	3.36
16500	173.198	0.749	1.00	1.57	-2.10	3.34	-3.34	2.86	1.38	3.41	2.51	3.43
17000	177.296	0.770	1.01	1.61	-2.20	3.42	-3.45	3.10	1.17	3.49	2.64	3.52
17500	181.191	0.792	0.92	1.64	-2.19	3.49	-4.02	3.02	1.66	3.57	2.81	3.59
18000	186.221	0.836	-0.56	1.66	-3.72	3.55	-5.37*	3.40*	-0.63	3.62	1.89	3.67
18500	190.704	0.908	-0.25	1.67	-4.20	3.62	-6.27*	3.80*	1.41	3.73	2.71	3.76
19000	194.124	0.802	0.03	1.77	-3.22	3.73	-4.13	4.18	2.22	3.84	2.71	3.85
19500	201.057	0.865	-0.56	1.81	-5.16*	4.01*	-6.85*	3.53*	0.67	3.94	1.78	3.96
20000	206.819	0.906	0.31	1.86	-4.52	3.94	-7.51*	3.64*	1.29	4.06	2.07	4.08

(continued) Unilateral degrees of equivalence for the magnitude of the SE

f in Hz	KCRV X_{KC} in $\frac{fC}{m/s^2}$	KCRV U_{KC}	CENAM D_i in $\frac{fC}{m/s^2}$	CENAM U_{D_i}	NMIJ D_i in $\frac{fC}{m/s^2}$	NMIJ U_{D_i}	NIM D_i in $\frac{fC}{m/s^2}$	NIM U_{D_i}	NMIA D_i in $\frac{fC}{m/s^2}$	NMIA U_{D_i}	INMETRO D_i in $\frac{fC}{m/s^2}$	INMETRO U_{D_i}
10	126.571	0.085	0.43	0.37	0.19	0.88	0.27	0.50	0.07	0.37	0.10	0.24
12.5	126.594	0.085	0.65	0.37	0.11	0.88	0.25	0.50	0.06	0.37	0.08	0.24
16	126.590	0.084	0.45	0.37	0.07	0.63	0.31	0.50	0.08	0.37	0.08	0.24
20	126.574	0.081	0.18	0.37	0.07	0.50	0.32	0.50	0.10	0.37	0.10	0.24
25	126.569	0.081	0.16	0.37	0.07	0.50	0.33	0.50	0.10	0.37	0.10	0.24
31.5	126.568	0.081	0.10	0.37	0.06	0.50	0.32	0.50	0.09	0.37	0.10	0.24
40	126.561	0.081	0.05	0.37	0.06	0.50	0.34	0.50	0.10	0.37	0.11	0.24
63	126.546	0.081	-0.10	0.37	0.07	0.50	0.33	0.50	0.10	0.37	0.12	0.24
80	126.565	0.081	-0.02	0.37	0.06	0.50	0.29	0.50	0.09	0.37	0.12	0.24
100	126.531	0.082	-0.00	0.37	0.07	0.50	0.36	0.50	0.12	0.37	0.15	0.24
125	126.527	0.082	0.03	0.37	0.08	0.50	0.36	0.50	0.12	0.37	0.15	0.24
160	126.532	0.082	-0.00	0.37	0.14	0.50	0.35	0.50	0.10	0.37	0.15	0.24
200	126.554	0.083	-0.01	0.37	0.09	0.50	0.34	0.50	0.11	0.37	0.14	0.24
250	126.563	0.084	0.10	0.37	0.06	0.37	0.29	0.50	0.12	0.37	0.13	0.24
315	126.579	0.083	0.06	0.37	0.06	0.37	0.32	0.50	0.10	0.37	0.12	0.24
400	126.585	0.083	0.08	0.37	0.06	0.37	0.33	0.50	0.08	0.37	0.12	0.24
500	126.599	0.082	0.04	0.37	0.07	0.37	0.34	0.50	0.09	0.37	0.13	0.24
630	126.612	0.083	0.04	0.37	0.04	0.37	0.34	0.50	0.12	0.37	0.15	0.24
800	126.636	0.082	0.03	0.37	0.07	0.37	0.36	0.50	0.11	0.37	0.15	0.24
1000	126.696	0.084	0.01	0.37	0.06	0.37	0.36	0.50	0.11	0.37	0.15	0.24
1250	126.752	0.087	0.03	0.37	0.05	0.37	0.39	0.50	0.09	0.37	0.17	0.24
1500	126.868	0.086	0.06	0.37	0.05	0.37	0.35	0.50	0.09	0.37	0.15	0.24
1600	126.921	0.086	0.11	0.37	0.10	0.37	0.36	0.50	0.13	0.37	0.14	0.24
2000	127.097	0.087	0.07	0.37	0.09	0.37	0.38	0.50	0.08	0.37	0.15	0.24
2500	127.418	0.089	0.45	0.37	0.08	0.37	0.36	0.50	0.09	0.37	0.12	0.29
3000	127.749	0.089	-0.16	0.37	0.16	0.37	0.40	0.50	0.26	0.37	0.15	0.29
3150	127.870	0.091	-0.14	0.37	0.14	0.37	0.42	0.50	0.17	0.37	0.15	0.43
3500	128.137	0.092	-0.73	0.37	0.14	0.37	0.43	0.51	0.22	0.37	0.18	0.43
4000	128.662	0.092	-0.57	0.37	0.17	0.38	0.47	0.51	0.22	0.38	0.15	0.43
4500	129.218	0.092	-0.55	0.37	0.22	0.38	0.48	0.51	0.23	0.38	0.15	0.43
5000	129.886	0.098	-0.52	0.38	0.23	0.64	0.49	0.51	0.32	0.38	0.12	0.77
5500	130.637	0.184	-0.77	0.62	0.03	0.63	0.49	1.30	0.22	0.35	0.08	0.76
6000	131.427	0.185	-1.28	0.62	0.20	0.63	0.56	1.31	0.34	0.35	0.08	0.77
6300	131.997	0.186	-0.89	0.63	-0.01	0.63	0.42	1.31	0.39	0.35	0.02	0.77
6500	132.348	0.187	-0.70	0.63	0.12	0.64	0.47	1.32	0.34	0.35	0.03	0.77
7000	133.278	0.190	-0.89	0.63	0.05	0.64	0.55	1.32	0.45	0.35	0.05	1.05
7500	134.569	0.202	-1.57*	0.70*	0.01	0.64	0.42	1.33	0.41	0.35	-0.20	1.06
8000	135.717	0.205	-1.81*	0.70*	0.07	0.65	0.36	1.35	0.49	0.35	-0.21	1.06
8500	136.750	0.208	-0.86	0.65	0.19	0.65	0.46	1.36	0.64	0.51	-0.02	1.07
9000	138.133	0.228	-0.99*	0.72*	0.65	0.66	0.73	1.37	0.63	0.66	-0.08	1.08
9500	139.496	0.227	-1.54*	0.73*	-0.02	0.81	0.44	1.38	0.45	0.51	-0.02	1.09
10000	141.106	0.234	-1.78*	0.73*	-0.02	0.67	0.28	1.39	0.56	0.52	-0.10	1.10
10500	142.449	0.360	-0.99	1.07	0.28	1.08	0.50	2.11	0.81	0.78	0.20	1.38
11000	144.125	0.364	-1.47	1.08	0.24	1.10	0.71	2.14	0.98	0.79	0.28	1.40
11500	146.132	0.389	-2.05*	1.22*	0.28	1.10	0.48	2.16	0.82	0.79	0.16	1.41
12000	148.135	0.409	-2.09*	1.24*	-0.29	1.88	0.61	2.19	0.93	0.80	0.16	1.43
12500	150.405	0.439	-1.86*	1.27*	0.37	3.29	0.48	2.22	0.86	0.79	0.05	1.44
13000	152.679	0.422	-0.91	1.14	0.36	3.34	0.10	2.25	1.10	0.82	0.06	1.47
13500	154.653	0.472	-1.34	1.13	1.38	3.40	0.69	2.28	1.54*	1.05*	0.53	1.48
14000	157.489	0.526	-1.96*	1.35*	0.75	3.44	0.34	2.31	1.59*	1.09*	0.30	1.49
14500	160.643	0.527	-1.86*	1.38*	0.53	3.51	0.30	2.36	1.52	1.53	-0.07	1.52
15000	163.140	0.503	-0.30	1.20	0.88	3.57	0.52	2.40	2.12*	1.73*	0.39	1.56
15500	166.270	0.647	0.64	1.17	0.92	3.62	0.79	2.42	2.44*	1.81*	0.42	1.89
16000	170.484	0.695	0.07	1.56	0.97	3.71	-0.38	2.45	1.81	1.58	-0.43	1.92
16500	173.198	0.749	-1.33	1.55	0.98	3.76	1.30	2.51	3.03*	1.92*	0.43	1.94
17000	177.296	0.770	-1.06	1.59	1.60	3.86	0.87	2.56	3.30*	1.96*	0.15	1.99
17500	181.191	0.792	-1.11	1.62	2.67	5.46	1.54	2.62	3.39*	2.01*	0.32	2.03
18000	186.221	0.836	-3.25*	2.01*	2.08	4.63	1.26	2.69	2.06	1.69	-0.38	2.07
18500	190.704	0.908	-4.58*	2.07*	1.66	4.72	0.09	2.71	3.35	2.77	-0.25	2.10
19000	194.124	0.802	-0.85	1.76	0.92	4.81	1.54	2.82	1.70	2.83	1.24	2.20
19500	201.057	0.865	1.47	1.83	-0.93	4.93	0.29	2.89	2.97	2.94	-0.48	2.25
20000	206.819	0.906	2.08	1.88	1.71	5.13	0.63	2.98	4.27*	3.29*	-0.67	2.30

(continued) Unilateral degrees of equivalence for the magnitude of the SE

f in Hz	KCRV X_{KC}	U_{KC} in $\frac{\mathrm{fC}}{\mathrm{m/s^2}}$	NMISA D_i	U_{D_i} in $\frac{\mathrm{fC}}{\mathrm{m/s^2}}$	VNIIM D_i	U_{D_i} in $\frac{\mathrm{fC}}{\mathrm{m/s^2}}$	NMC,A*STAR D_i	U_{D_i} in $\frac{\mathrm{fC}}{\mathrm{m/s^2}}$	UkrMet D_i	U_{D_i} in $\frac{\mathrm{fC}}{\mathrm{m/s^2}}$
10	126.571	0.085	0.08	0.37	-0.03	0.63	-0.00	0.51	-0.19	0.63
12.5	126.594	0.085	0.10	0.37	0.01	0.63	-0.00	0.51	-0.18	0.63
16	126.590	0.084	0.07	0.37	0.01	0.63	0.05	0.51	-0.14	0.63
20	126.574	0.081	0.08	0.37	-0.00	0.63	0.10	0.37	-0.16	0.63
25	126.569	0.081	0.07	0.37	0.06	0.63	0.09	0.37	-0.15	0.63
31.5	126.568	0.081	0.06	0.37	0.04	0.63	0.10	0.37	-0.18	0.63
40	126.561	0.081	0.08	0.37	0.03	0.63	0.13	0.37	-0.09	0.63
63	126.546	0.081	0.09	0.37	0.12	0.63	0.13	0.37	-0.14	0.63
80	126.565	0.081	0.10	0.37	0.02	0.63	0.10	0.37	-0.14	0.63
100	126.531	0.082	0.12	0.37	0.01	0.63	0.07	0.37	-0.10	0.63
125	126.527	0.082	0.04	0.37	0.04	0.63	-0.05	0.37	-0.15	0.63
160	126.532	0.082	-0.03	0.37	0.13	0.63	0.24	0.37	-0.06	0.63
200	126.554	0.083	0.06	0.37	0.27	0.63	0.23	0.37	-0.17	0.63
250	126.563	0.084	0.05	0.37	0.52	0.63	0.15	0.37	-0.16	0.63
315	126.579	0.083	0.05	0.37	0.44	0.63	0.14	0.37	-0.19	0.63
400	126.585	0.083	0.03	0.37	0.56	0.63	0.15	0.37	-0.16	0.63
500	126.599	0.082	0.07	0.37	0.51	0.63	0.14	0.37	-0.20	0.63
630	126.612	0.083	0.14	0.37	-0.02	0.63	0.18	0.37	-0.21	0.63
800	126.636	0.082	0.07	0.37	0.09	0.63	0.15	0.37	-0.15	0.63
1000	126.696	0.084	0.09	0.37	0.24	0.63	0.10	0.51	-0.18	0.63
1250	126.752	0.087	0.11	0.63	0.19	0.63	0.12	0.51	-0.12	0.88
1500	126.868	0.086	0.04	0.63	0.19	0.63	0.16	0.51	-0.20	0.88
1600	126.921	0.086	0.07	0.63	0.16	0.63	0.12	0.51	-0.24	0.88
2000	127.097	0.087	0.05	0.63	0.29	0.63	0.11	0.51	-0.24	0.88
2500	127.418	0.089	0.06	0.63	0.14	1.27	0.07	0.52	-0.25	0.89
3000	127.749	0.089	-0.01	0.63	0.13	1.28	0.06	0.52	-0.13	0.89
3150	127.870	0.091	0.02	0.63	0.06	1.28	0.11	0.52	-0.17	0.89
3500	128.137	0.092	0.10	0.63	0.03	1.28	0.12	0.52	-0.05	0.89
4000	128.662	0.092	0.14	0.64	0.10	1.28	0.07	0.52	-0.11	0.90
4500	129.218	0.092	0.20	0.64	0.02	1.29	0.14	0.52	-0.02	0.90
5000	129.886	0.098	0.00	1.03	-0.28	1.29	0.15	0.70	-0.27	0.90
5500	130.637	0.184	0.00	1.03	-0.03	1.95	0.15	0.68	-0.33	1.95
6000	131.427	0.185	-0.02	1.03	-0.30	1.96	0.20	0.69	-0.16	1.96
6300	131.997	0.186	0.03	1.04	-0.71	1.96	0.07	0.69	-0.49	1.96
6500	132.348	0.187	0.07	1.04	-0.94	1.96	0.06	0.69	-0.76	1.97
7000	133.278	0.190	-0.08	1.05	-0.68	1.98	0.17	0.70	-0.63	1.98
7500	134.569	0.202	-0.16	1.60	-0.88	2.00	0.10	0.70	-0.99	1.99
8000	135.717	0.205	-0.10	1.61	-1.01	2.01	0.08	0.70	-0.48	2.02
8500	136.750	0.208	0.09	1.63	-0.48	2.03	0.20	0.71	-0.10	2.04
9000	138.133	0.228	-0.28	1.64	-0.60	2.05	0.12	0.71	-0.95	2.05
9500	139.496	0.227	-0.17	1.66	-1.16	2.06	-0.04	0.72	-1.06	2.06
10000	141.106	0.234	-0.30	1.67	-1.83	2.08	-0.08	1.66	-1.15	2.09
10500	142.449	0.360	-0.09	1.67	-1.67	2.08	0.21	1.66	-1.04	2.81
11000	144.125	0.364	-0.08	1.69	-2.48	2.09	0.16	1.68	-1.19	2.84
11500	146.132	0.389	-0.29	1.71	-2.82	2.11	-0.04	1.69	-1.74	2.86
12000	148.135	0.409	-0.33	1.73	-3.12	2.14	-0.06	1.71	-2.60	2.88
12500	150.405	0.439	-0.46	2.21	-3.50*	2.25*	-0.14	1.73	-3.45	2.91
13000	152.679	0.422	-0.52	2.24	-4.85*	2.26*	-0.17	1.77	-4.87*	2.99*
13500	154.653	0.472	-0.04	2.27	-2.72	2.23	0.32	1.78	-4.17*	3.05*
14000	157.489	0.526	-0.24	2.30	-3.03*	2.38*	0.15	1.80	-3.98	3.02
14500	160.643	0.527	-0.57	2.34	-4.20*	2.41*	-0.14	1.84	-3.76	3.09
15000	163.140	0.503	-0.10	2.39	-2.58	2.36	0.36	2.27	-4.26*	3.22*
15500	166.270	0.647	-0.10	2.92	-2.78	3.21	0.50	2.28	-3.97	4.83
16000	170.484	0.695	-0.85	2.97	-5.33*	3.38*	-0.19	2.32	-5.28	4.91
16500	173.198	0.749	0.19	3.03	-7.24*	3.40*	0.87	2.36	-4.01	5.02
17000	177.296	0.770	0.04	3.10	-9.94*	3.43*	0.78	2.41	-3.96	5.14
17500	181.191	0.792	-0.10	3.16	-7.88*	3.56*	0.83	2.46	-4.40	5.24
18000	186.221	0.836	-1.44	3.22	-9.92*	3.62*	-0.44	2.50	-6.10	5.34
18500	190.704	0.908	-0.44	3.30	-12.00*	3.69*	-0.88	2.54	-5.34	5.49
19000	194.124	0.802	0.12	3.40	-2.95	3.74	0.24	2.64	-4.01	5.65
19500	201.057	0.865	-1.44	3.49	-4.27	3.84	-0.64	2.71	-4.69	5.83
20000	206.819	0.906	-1.20	3.59	-3.85	3.96	-0.16	2.79	-5.31	5.98

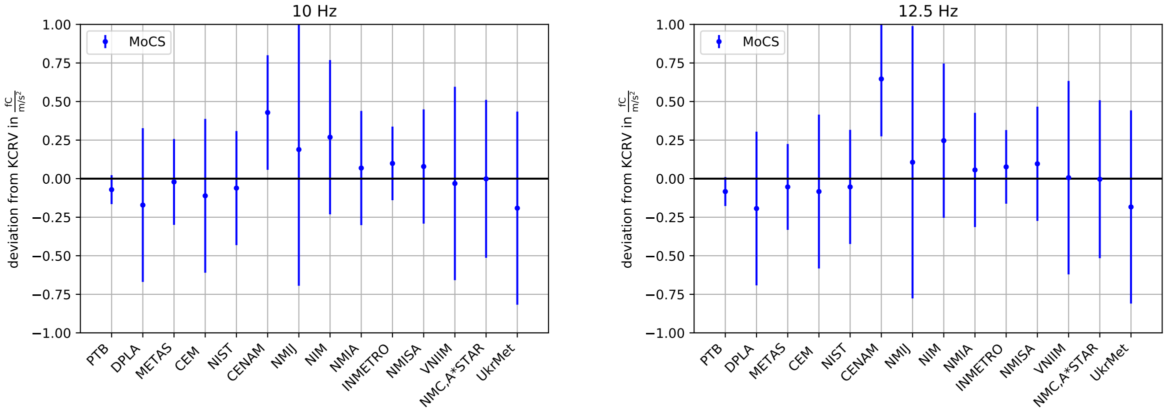

Figure 8.1: deviation of the magnitude for the frequencies 10 Hz and 12.5 Hz for the SE

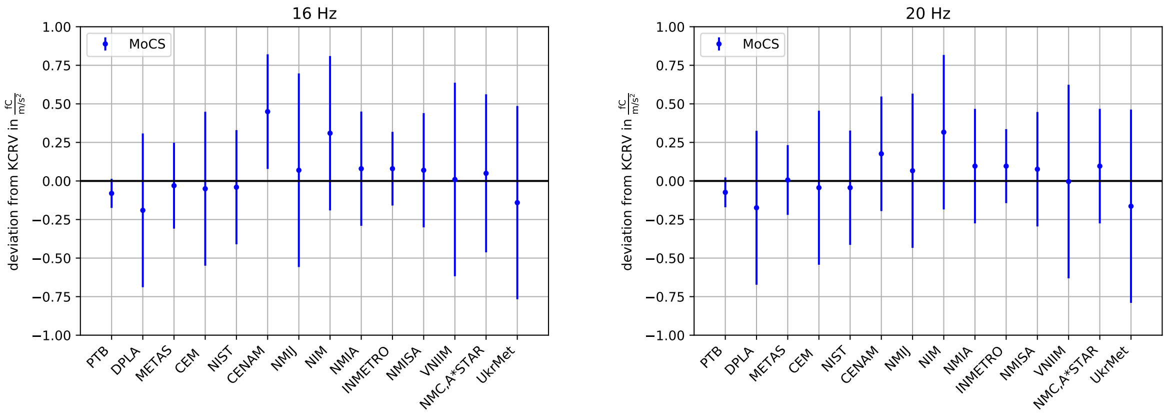

Figure 8.2: deviation of the magnitude for the frequencies 16 Hz and 20 Hz for the SE

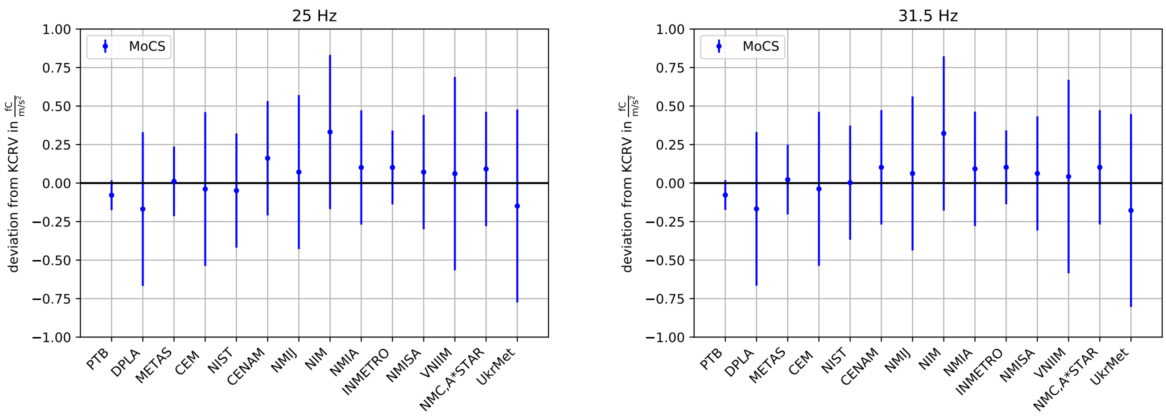

Figure 8.3: deviation of the magnitude for the frequencies 25 Hz and 31.5 Hz for the SE

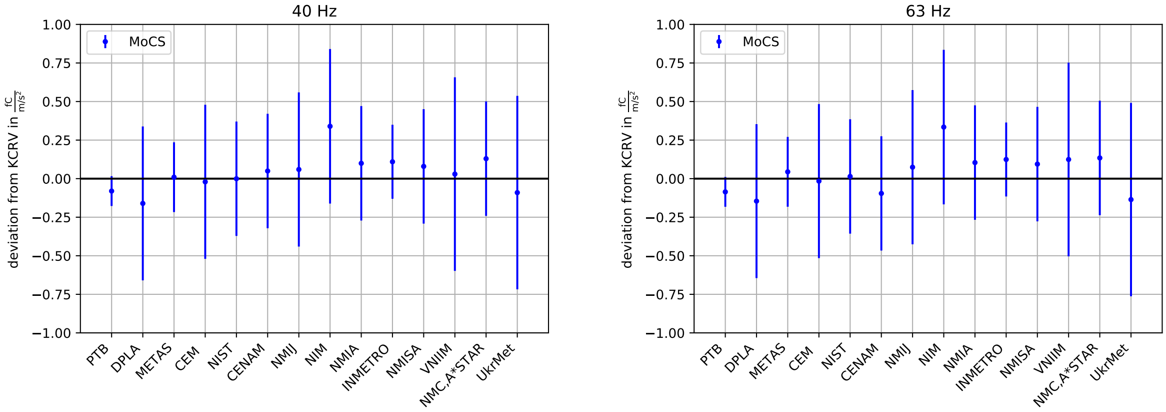

Figure 8.4: deviation of the magnitude for the frequencies 40 Hz and 63 Hz for the SE

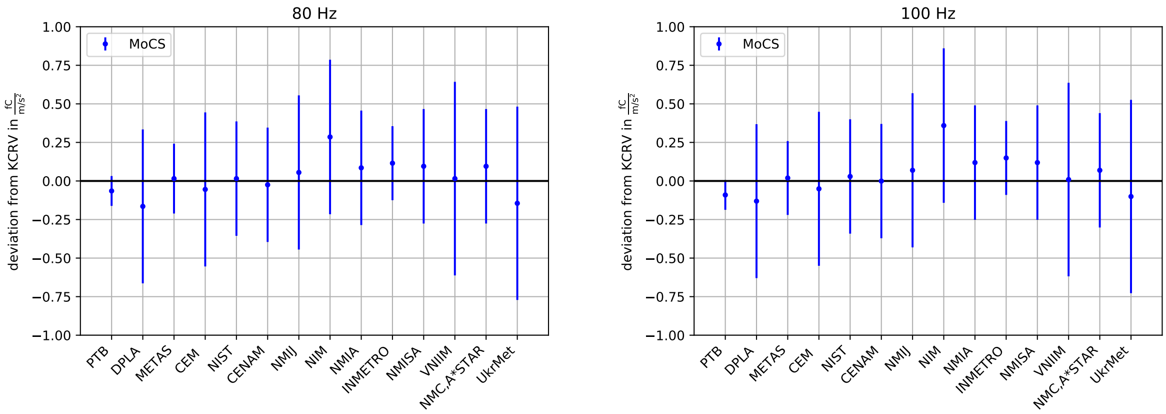

Figure 8.5: deviation of the magnitude for the frequencies 80 Hz and 100 Hz for the SE

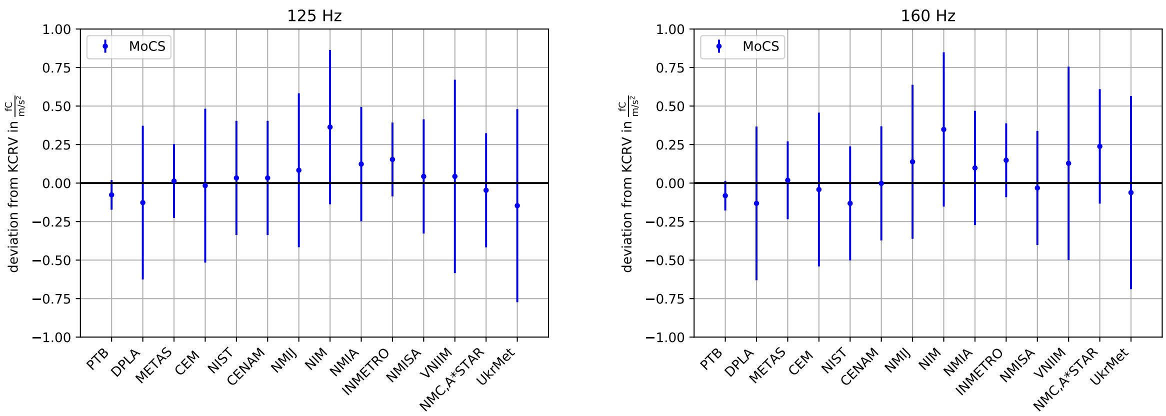

Figure 8.6: deviation of the magnitude for the frequencies 125 Hz and 160 Hz for the SE

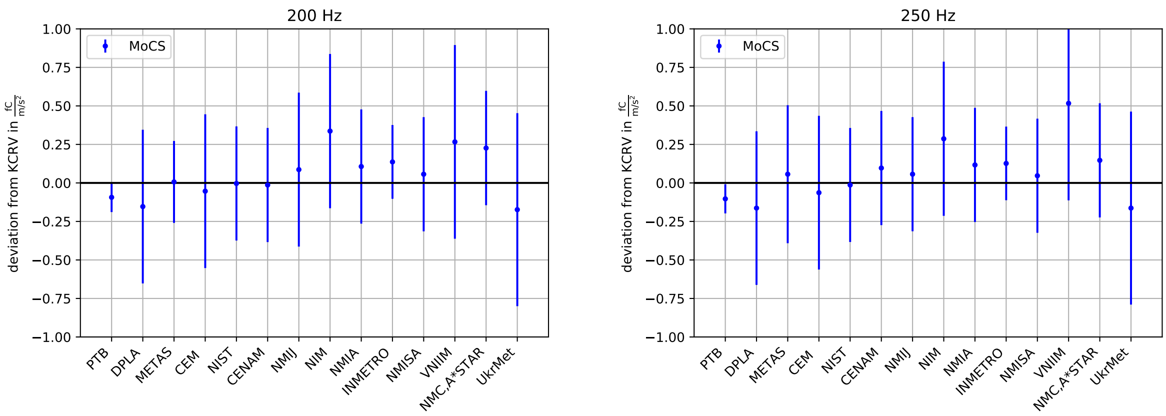

Figure 8.7: deviation of the magnitude for the frequencies 200 Hz and 250 Hz for the SE

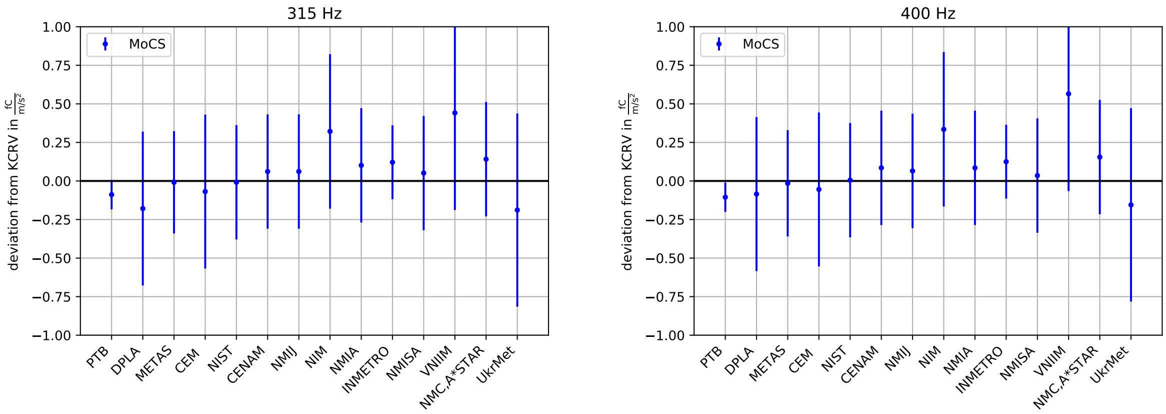

Figure 8.8: deviation of the magnitude for the frequencies 315 Hz and 400 Hz for the SE

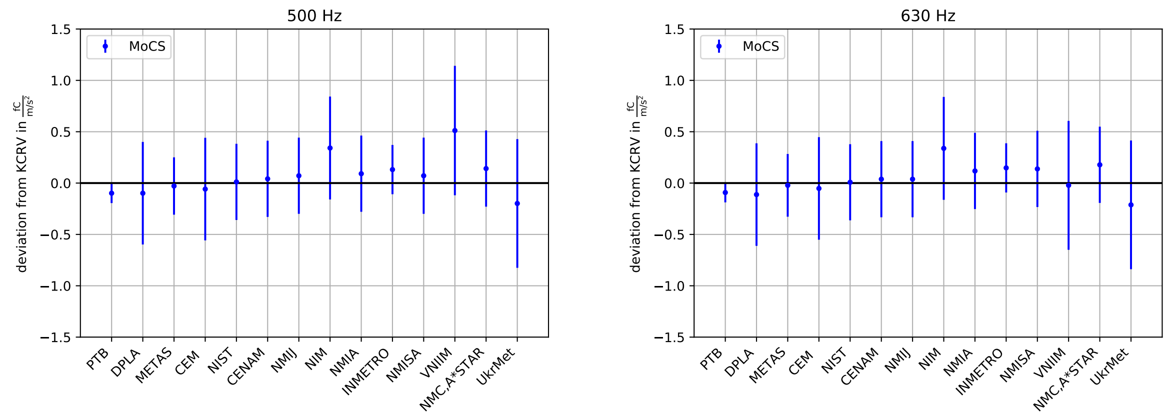

Figure 8.9: deviation of the magnitude for the frequencies 500 Hz and 630 Hz for the SE

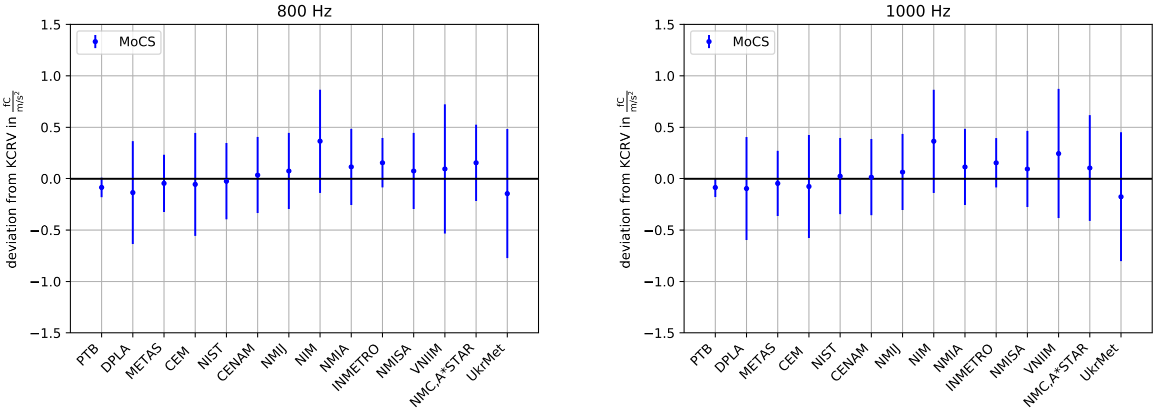

Figure 8.10: deviation of the magnitude for the frequencies 800 Hz and 1000 Hz for the SE

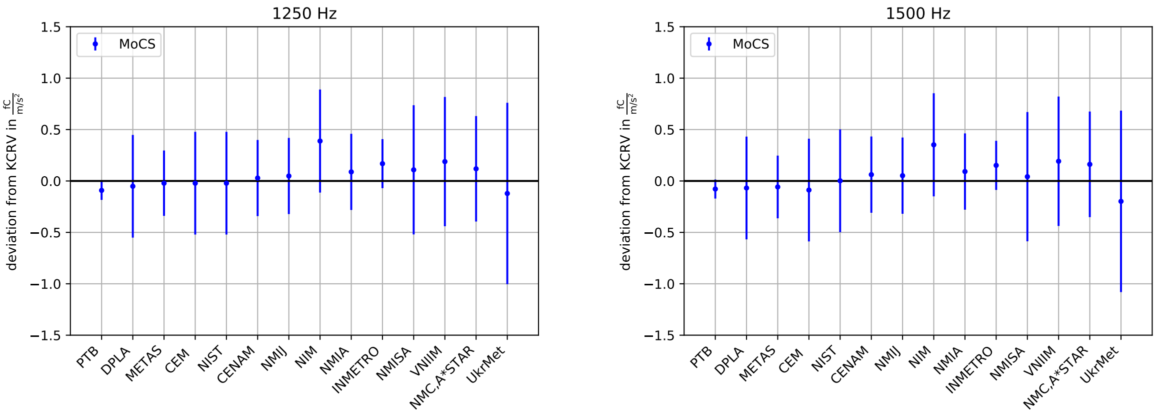

Figure 8.11: deviation of the magnitude for the frequencies 1250 Hz and 1500 Hz for the SE

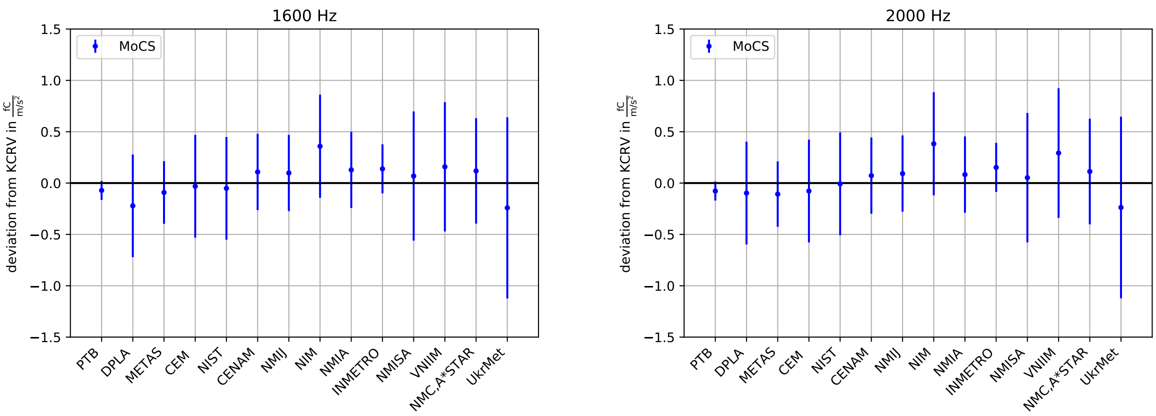

Figure 8.12: deviation of the magnitude for the frequencies 1600 Hz and 2000 Hz for the SE

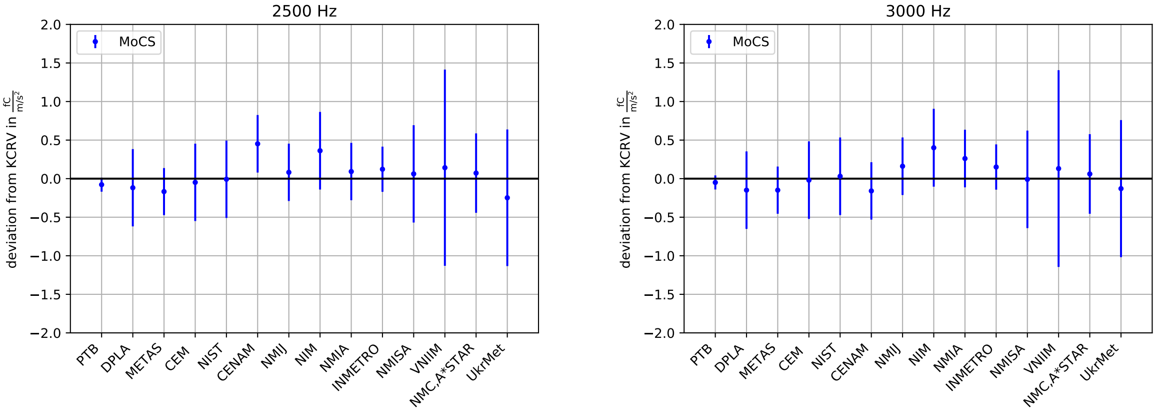

Figure 8.13: deviation of the magnitude for the frequencies 2500 Hz and 3000 Hz for the SE

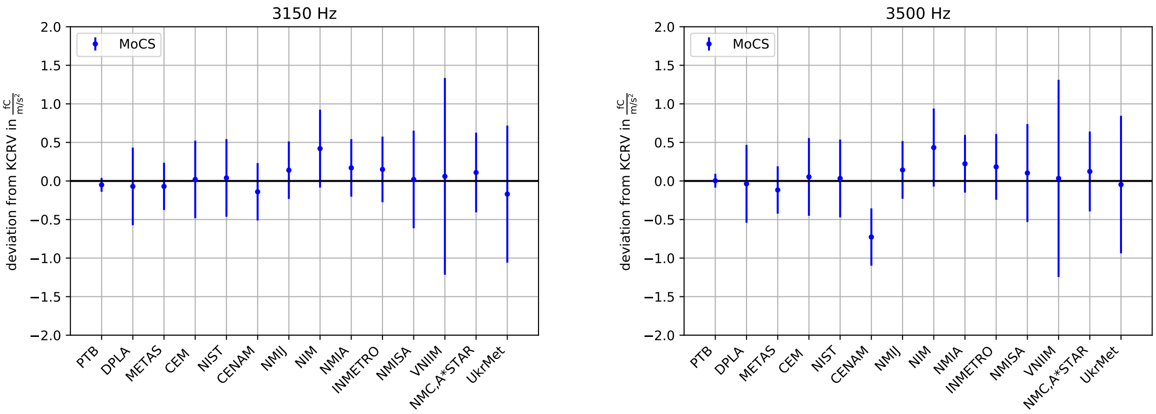

Figure 8.14: deviation of the magnitude for the frequencies 3150 Hz and 3500 Hz for the SE

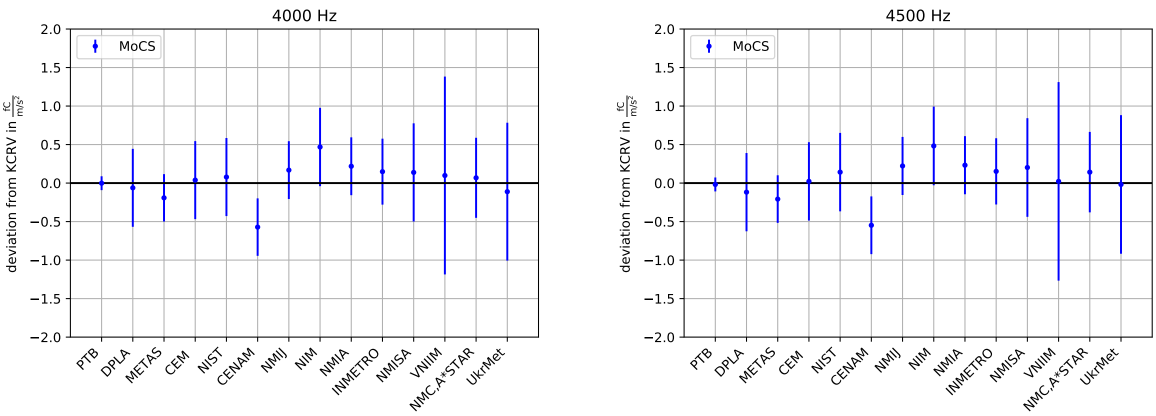

Figure 8.15: deviation of the magnitude for the frequencies 4000 Hz and 4500 Hz for the SE

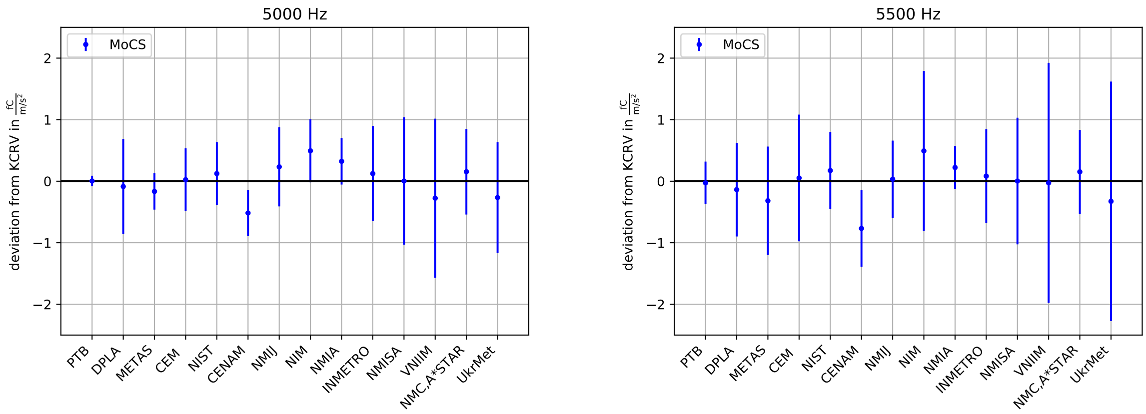

Figure 8.16: deviation of the magnitude for the frequencies 5000 Hz and 5500 Hz for the SE

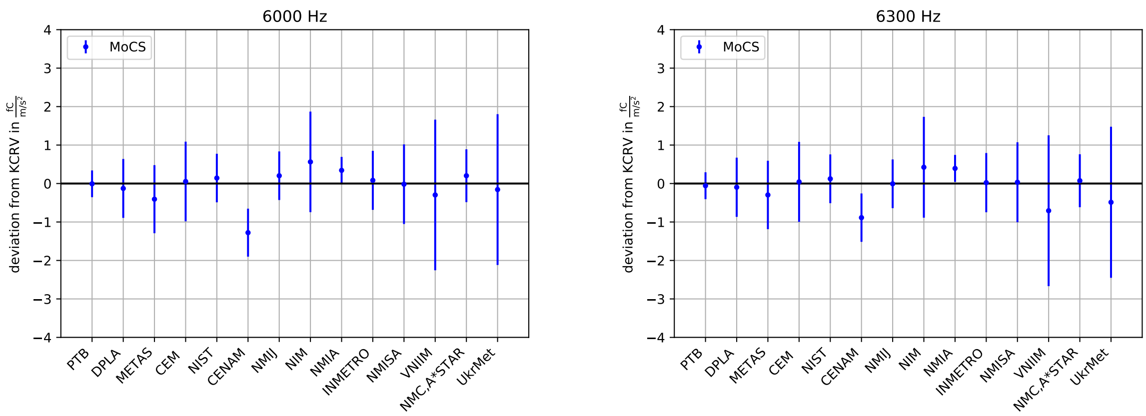

Figure 8.17: deviation of the magnitude for the frequencies 6000 Hz and 6300 Hz for the SE

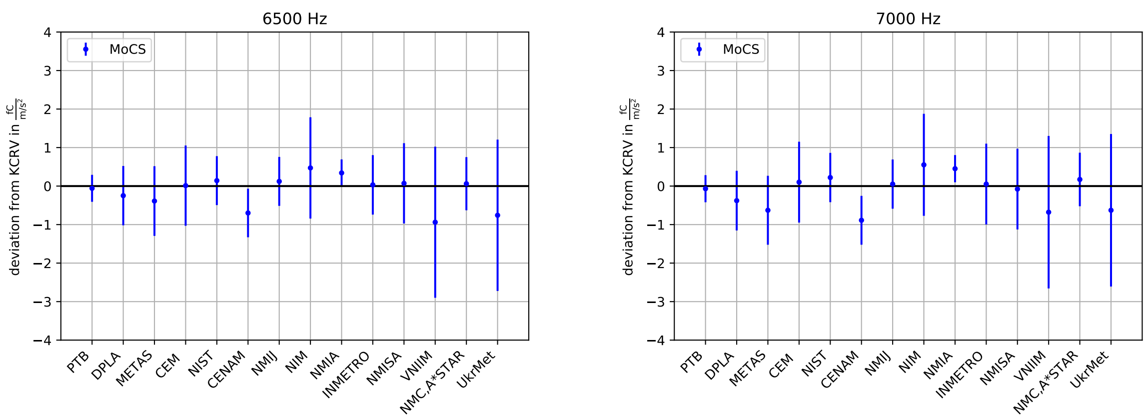

Figure 8.18: deviation of the magnitude for the frequencies 6500 Hz and 7000 Hz for the SE

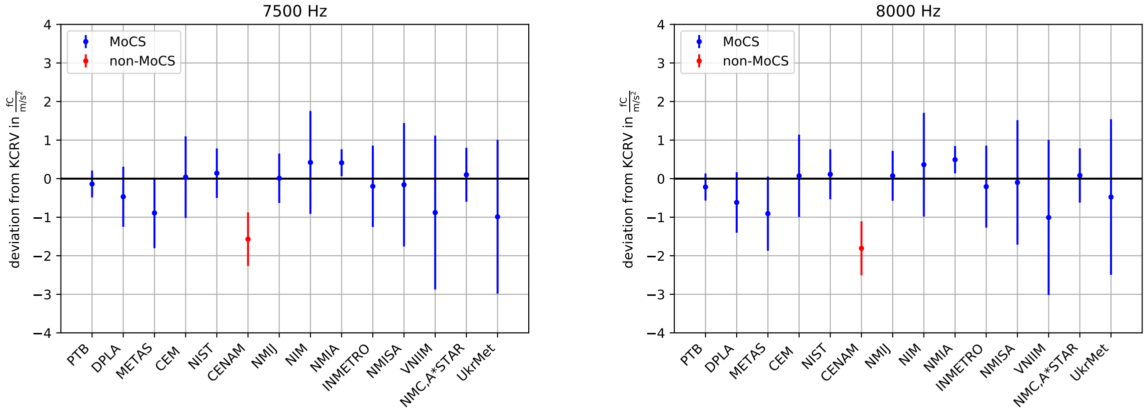

Figure 8.19: deviation of the magnitude for the frequencies 7500 Hz and 8000 Hz for the SE

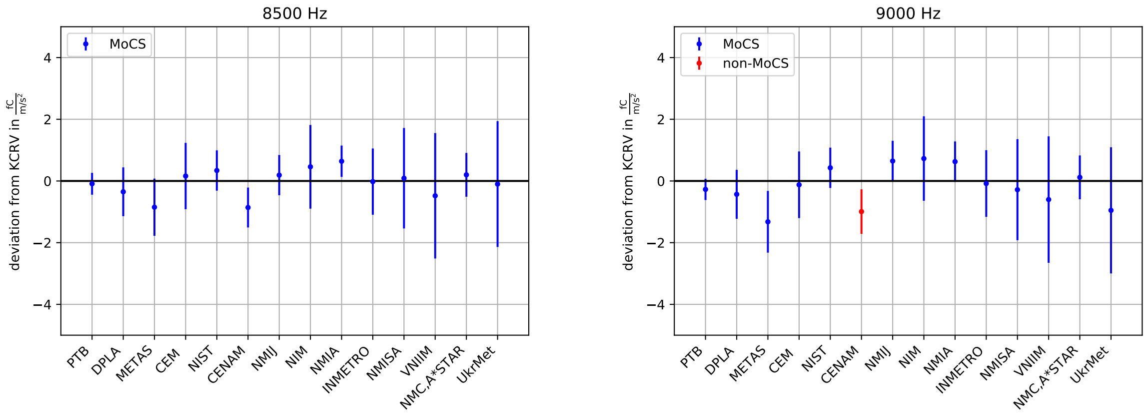

Figure 8.20: deviation of the magnitude for the frequencies 8500 Hz and 9000 Hz for the SE

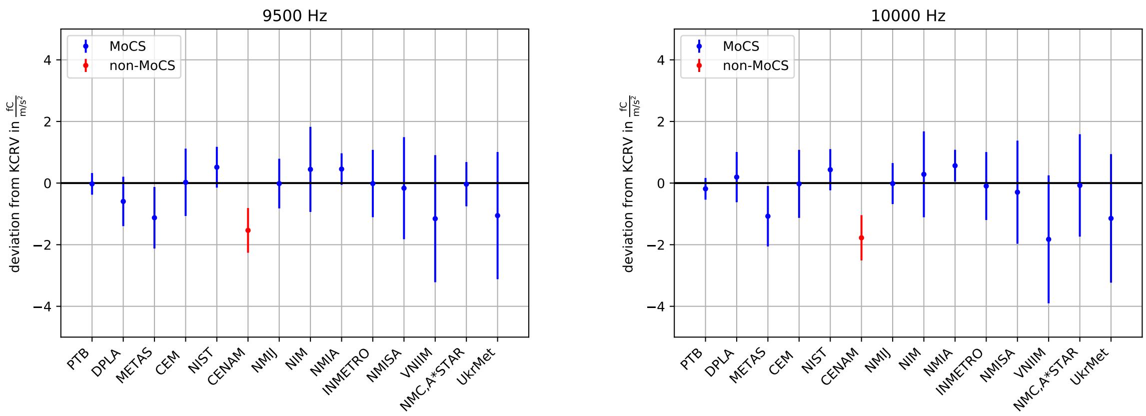

Figure 8.21: deviation of the magnitude for the frequencies 9500 Hz and 10000 Hz for the SE

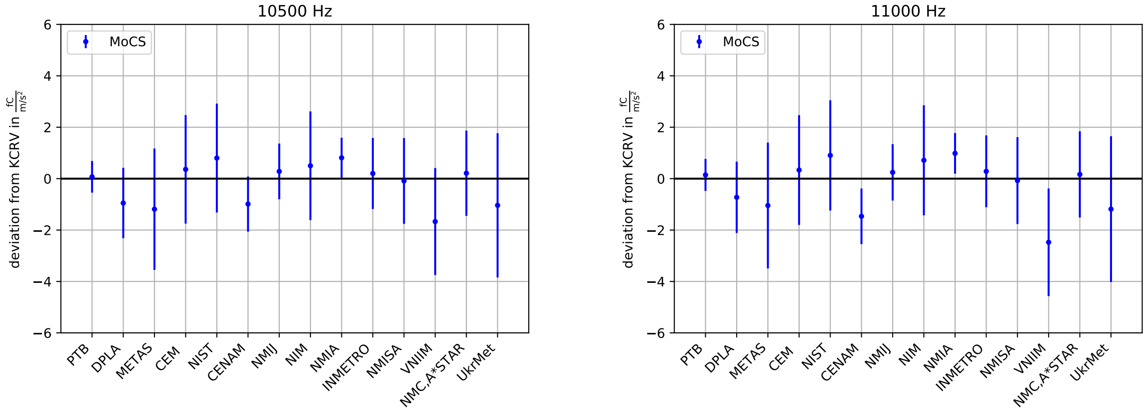

Figure 8.22: deviation of the magnitude for the frequencies 10500 Hz and 11000 Hz for the SE

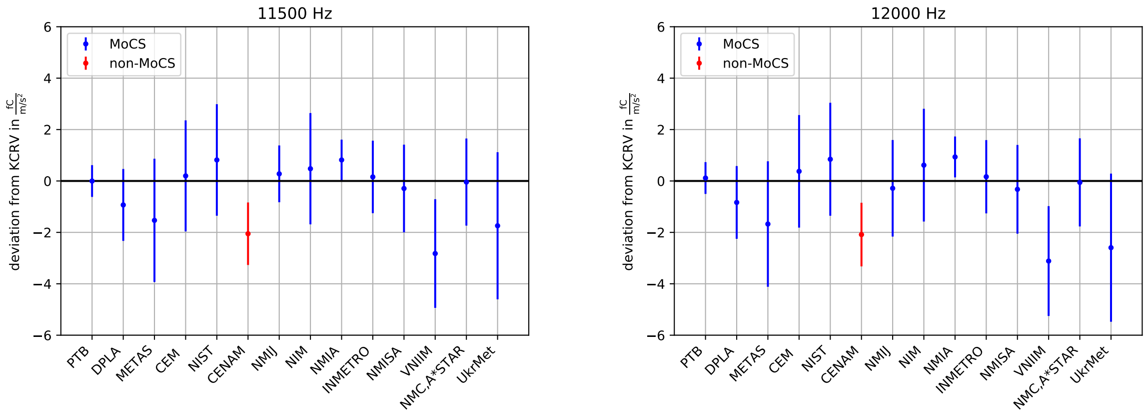

Figure 8.23: deviation of the magnitude for the frequencies 11500 Hz and 12000 Hz for the SE

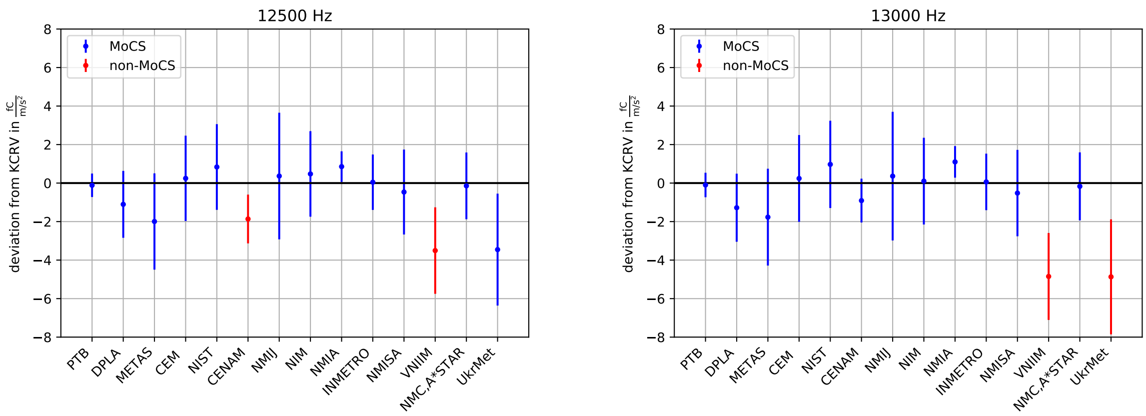

Figure 8.24: deviation of the magnitude for the frequencies 12500 Hz and 13000 Hz for the SE

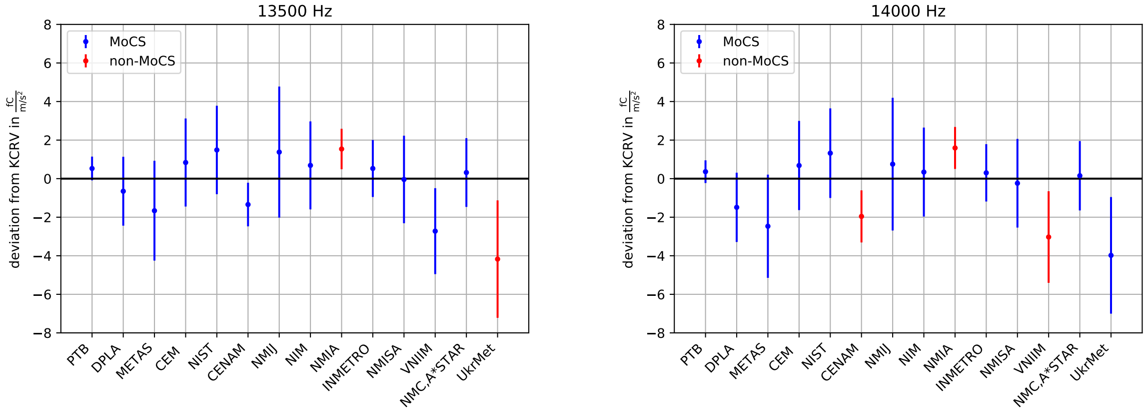

Figure 8.25: deviation of the magnitude for the frequencies 13500 Hz and 14000 Hz for the SE

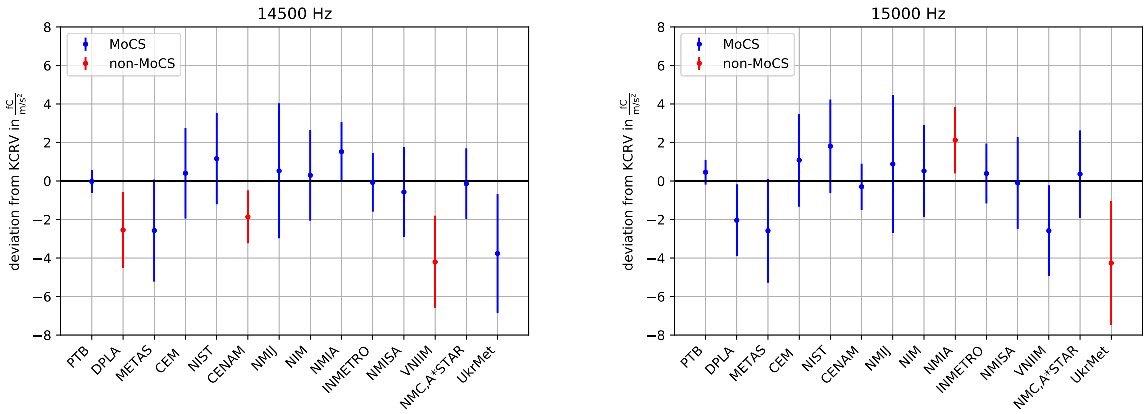

Figure 8.26: deviation of the magnitude for the frequencies 14500 Hz and 15000 Hz for the SE

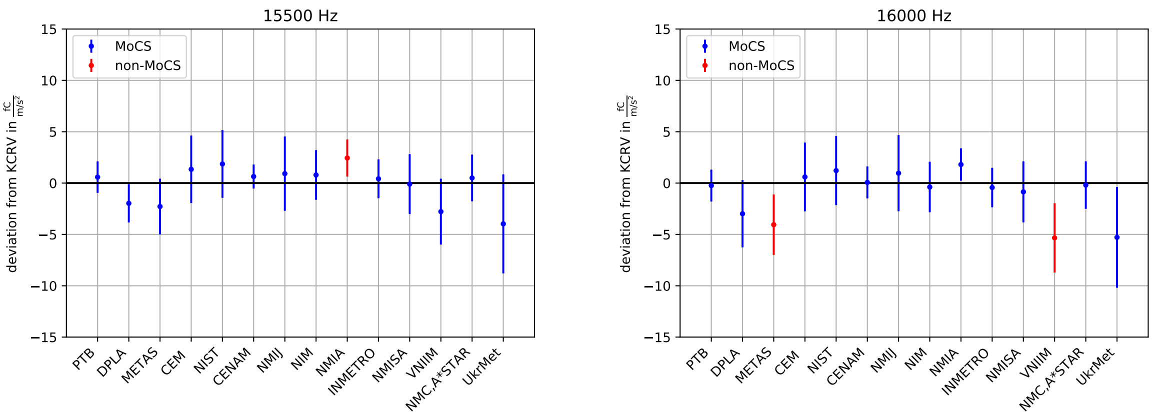

Figure 8.27: deviation of the magnitude for the frequencies 15500 Hz and 16000 Hz for the SE

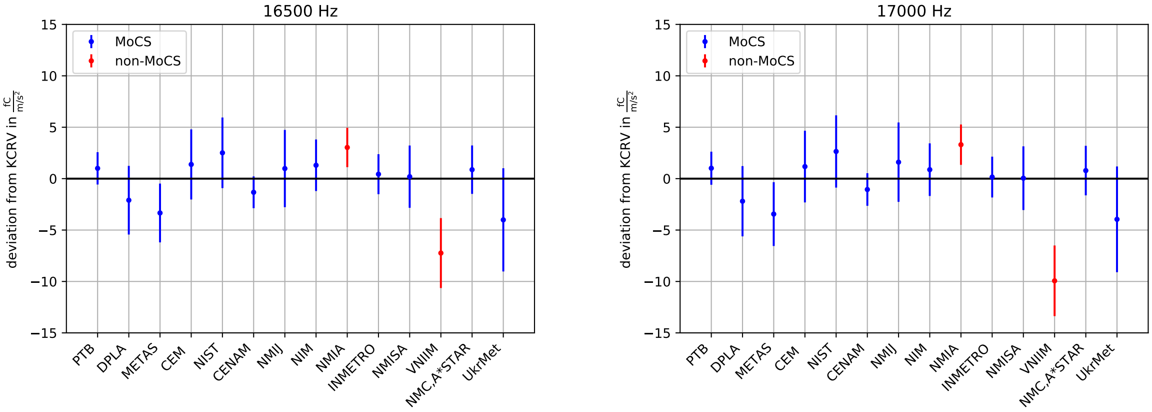

Figure 8.28: deviation of the magnitude for the frequencies 16500 Hz and 17000 Hz for the SE

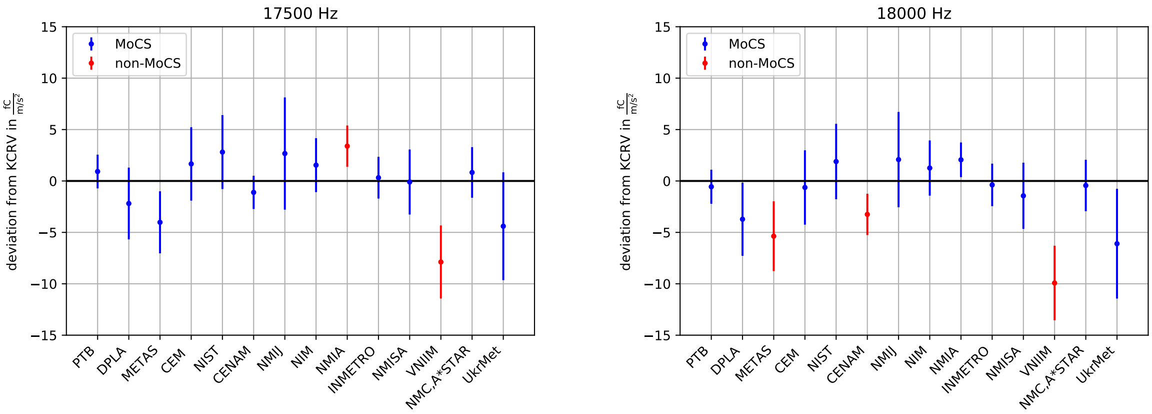

Figure 8.29: deviation of the magnitude for the frequencies 17500 Hz and 18000 Hz for the SE

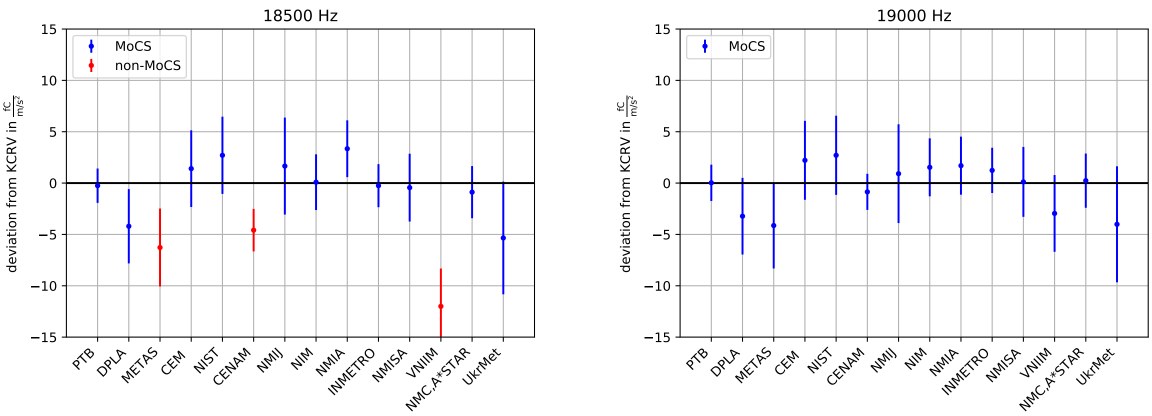

Figure 8.30: deviation of the magnitude for the frequencies 18500 Hz and 19000 Hz for the SE

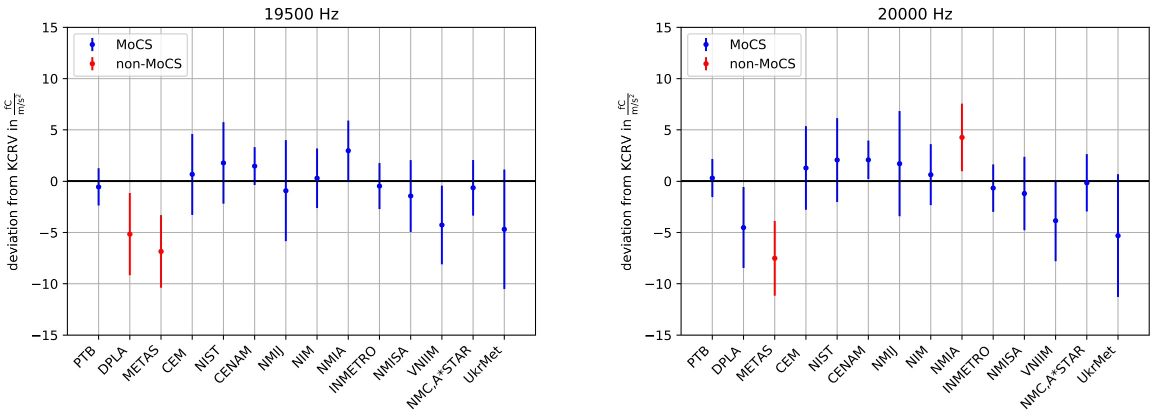

Figure 8.31: deviation of the magnitude for the frequencies 19500 Hz and 20000 Hz for the SE

8.4 Magnitude of the Complex Sensitivity of the BB

Table 8.2: Unilateral degrees of equivalence for the magnitude of the BB

f in Hz	KCRV		PTB		DPLA		METAS		CEM		NIST	
	X_{KC} in $\frac{\mathrm{fC}}{\mathrm{m/s^2}}$	U_{KC}	D_i in $\frac{\mathrm{fC}}{\mathrm{m/s^2}}$	U_{D_i}	D_i in $\frac{\mathrm{fC}}{\mathrm{m/s^2}}$	U_{D_i}	D_i in $\frac{\mathrm{fC}}{\mathrm{m/s^2}}$	U_{D_i}	D_i in $\frac{\mathrm{fC}}{\mathrm{m/s^2}}$	U_{D_i}	D_i in $\frac{\mathrm{fC}}{\mathrm{m/s^2}}$	U_{D_i}
10	128.001	0.085	-0.01	0.10	-0.10	0.50	-0.21	0.28	0.15	0.51	-0.04	0.37
12.5	128.020	0.085	-0.03	0.10	-0.02	0.50	-0.14	0.28	0.13	0.51	0.01	0.37
16	128.013	0.085	-0.02	0.10	-0.11	0.50	-0.11	0.28	0.12	0.51	0.04	0.37
20	127.991	0.082	-0.04	0.10	-0.09	0.50	-0.03	0.23	0.15	0.51	0.03	0.38
25	128.018	0.082	-0.03	0.10	-0.12	0.50	0.04	0.23	0.02	0.51	0.01	0.38
31.5	128.025	0.082	-0.03	0.10	-0.03	0.51	0.07	0.23	0.01	0.51	0.05	0.38
40	128.007	0.082	-0.04	0.10	-0.01	0.51	0.07	0.23	0.05	0.51	0.07	0.38
63	127.996	0.082	-0.04	0.10	-0.10	0.50	0.11	0.23	0.06	0.51	0.06	0.38
80	127.974	0.082	-0.04	0.10	-0.07	0.50	0.10	0.23	0.06	0.51	0.12	0.38
100	127.969	0.082	-0.06	0.10	-0.07	0.50	0.06	0.23	0.01	0.51	0.08	0.38
125	127.953	0.082	-0.03	0.10	-0.05	0.50	0.08	0.23	0.05	0.51	0.12	0.38
160	127.958	0.083	-0.03	0.10	-0.06	0.50	0.07	0.24	0.07	0.51	0.10	0.38
200	127.946	0.083	-0.02	0.10	-0.05	0.50	0.10	0.24	0.02	0.51	-0.06	0.37
250	127.956	0.083	-0.02	0.10	-0.06	0.50	0.14	0.28	0.02	0.51	0.02	0.37
315	127.978	0.082	-0.02	0.10	0.02	0.51	0.11	0.24	0.00	0.51	0.07	0.38
400	127.979	0.082	-0.02	0.10	-0.08	0.50	0.12	0.24	0.01	0.51	0.06	0.38
500	127.986	0.082	-0.02	0.10	0.01	0.51	0.06	0.24	0.00	0.51	0.05	0.38
630	128.026	0.082	-0.04	0.10	-0.03	0.51	0.04	0.24	-0.02	0.51	0.03	0.38
800	128.028	0.082	-0.02	0.10	-0.03	0.51	0.04	0.24	-0.01	0.51	0.05	0.38
1000	128.073	0.084	-0.04	0.10	-0.07	0.51	0.07	0.28	-0.01	0.51	0.05	0.38
1250	128.122	0.087	-0.06	0.09	-0.02	0.50	0.08	0.30	0.01	0.51	-0.02	0.50
1500	128.173	0.087	-0.07	0.09	0.03	0.51	0.09	0.28	-0.02	0.51	0.08	0.51
1600	128.232	0.087	-0.02	0.09	-0.23	0.50	0.01	0.30	0.02	0.51	0.02	0.51
2000	128.342	0.087	-0.10	0.09	0.06	0.51	0.13	0.31	0.02	0.51	0.05	0.51
2500	128.550	0.090	-0.14	0.09	0.05	0.51	0.14	0.32	0.08	0.51	0.09	0.51
3000	128.824	0.091	-0.15	0.09	-0.02	0.51	0.21	0.35	0.06	0.51	0.10	0.51
3150	129.001	0.093	-0.04	0.09	-0.00	0.51	0.12	0.35	0.01	0.51	0.03	0.51
3500	129.178	0.094	-0.11	0.09	0.12	0.51	0.18	0.39	0.06	0.51	0.00	0.51
4000	129.516	0.094	-0.19	0.09	0.18	0.51	0.29	0.43	0.12	0.51	0.10	0.51
4500	130.184	0.147	-0.41*	0.20*	0.32	0.50	0.12	0.55	-0.14	0.50	-0.07	0.50
5000	130.614	0.164	-0.41*	0.21*	-0.01	0.77	0.31	0.58	-0.08	0.50	-0.00	0.50
5500	131.061	0.194	-0.28	0.34	0.04	0.76	0.40	1.14	0.02	1.03	0.17	0.63
6000	131.655	0.196	-0.23	0.34	0.05	0.77	0.43	1.40	0.01	1.03	0.18	0.63
6300	132.368	0.207	0.16	0.34	-0.07	0.77	0.35	1.61	-0.25	1.04	-0.19	0.63
6500	132.630	0.208	0.14	0.34	-0.23	0.77	0.11	1.78	-0.26	1.04	-0.20	0.63
7000	133.447	0.227	0.26	0.33	-0.25	0.77	0.19	2.29	-0.21	1.04	-0.22	0.63
7500	134.680	0.269	0.23	0.30	-0.48	0.76	1.47	2.98	-0.47	1.04	-0.26	0.62
8000	134.734	0.258	0.17	0.31	-1.73*	0.84*	-1.14	2.99	-0.12	1.05	-0.38	0.62
8500	135.862	0.273	0.33	0.30	-0.66	0.76	0.13	3.31	-0.86	1.04	-0.36	0.62
9000	136.017	0.355	1.41*	0.54*	0.48	0.74	1.11	3.60	0.58	1.03	-1.89*	0.76*
9500	137.684	0.400	1.12*	0.58*	-0.08	0.72	1.47	2.95	0.33	1.03	-1.09*	0.79*
10000	138.981	0.323	0.97*	0.53*	0.82	0.77	1.05	2.03	0.24	1.07	-0.56	0.61
10500	140.472	0.407	0.75	0.58	-0.67	1.34	1.00	2.83	0.41	2.07	-0.31	2.06
11000	142.219	0.403	0.61	0.59	-0.92	1.35	0.36	2.77	-0.08	2.09	-0.60	2.09
11500	143.951	0.407	0.49	0.60	-1.15	1.37	0.58	2.57	-0.10	2.12	-0.89	2.11
12000	145.538	0.411	0.38	0.60	-1.34	1.38	0.87	2.51	-0.33	2.14	-1.24	2.13
12500	147.326	0.426	0.26	0.60	-1.63	1.70	1.00	2.56	-0.43	2.16	-1.12	2.15
13000	149.148	0.431	0.34	0.61	-1.75	1.72	1.03	2.53	-0.56	2.19	-1.23	2.18
13500	151.198	0.445	0.19	0.61	-2.00	1.73	0.83	2.58	-0.73	2.21	-1.40	2.20
14000	153.445	0.452	0.48	0.62	-2.34	1.76	0.68	2.64	-1.05	2.24	-1.45	2.23
14500	155.191	0.497	0.21	0.60	-1.99	1.77	1.47	2.70	-1.08	2.26	-1.87	2.25
15000	157.253	0.472	0.56	0.63	-1.05	1.81	1.74	2.87	-0.79	2.30	-2.46	2.27
15500	159.643	0.599	0.73	1.49	-1.34	1.80	2.24	2.97	-0.80	3.12	-2.21	3.09
16000	162.409	0.658	0.65	1.49	-1.81	3.14	1.72	2.98	-1.04	3.16	-2.49	3.13
16500	165.548	0.672	0.28	1.52	-2.55	3.19	2.30	3.17	-1.37	3.21	-2.96	3.18
17000	168.651	0.683	0.31	1.55	-2.85	3.25	1.91	3.03	-1.75	3.27	-3.14	3.24
17500	171.640	0.697	0.61	1.58	-2.94	3.30	2.48	3.29	-1.66	3.33	-3.02	3.30
18000	175.171	0.712	0.52	1.61	-3.37	3.36	1.56	3.44	-1.93	3.39	-3.19	3.37
18500	178.903	0.842	0.61	1.59	-4.00	3.40	2.65	3.44	-2.11	3.43	-3.35	3.41
19000	182.752	0.861	0.79	1.62	-4.45	3.46	2.36	3.54	-2.03	3.51	-3.34	3.48
19500	187.354	0.909	0.54	1.64	-4.95*	3.76*	2.15	3.68	-2.69	3.58	-3.89	3.55
20000	192.170	0.840	0.30	1.73	-5.97*	3.82*	2.23	3.92	-3.66	3.68	-4.34	3.66

(continued) Unilateral degrees of equivalence for the magnitude of the BB

f in Hz	KCRV X_{KC} in $\frac{\mathrm{fC}}{\mathrm{m/s^2}}$	KCRV U_{KC} in $\frac{\mathrm{fC}}{\mathrm{m/s^2}}$	CENAM D_i in $\frac{\mathrm{fC}}{\mathrm{m/s^2}}$	CENAM U_{D_i}	NMIJ D_i in $\frac{\mathrm{fC}}{\mathrm{m/s^2}}$	NMIJ U_{D_i}	NIM D_i in $\frac{\mathrm{fC}}{\mathrm{m/s^2}}$	NIM U_{D_i}	NMIA D_i in $\frac{\mathrm{fC}}{\mathrm{m/s^2}}$	NMIA U_{D_i}	INMETRO D_i in $\frac{\mathrm{fC}}{\mathrm{m/s^2}}$	INMETRO U_{D_i}
10	128.001	0.085	0.20	0.38	0.01	0.50	0.26	0.51	-0.10	0.37	0.12	0.24
12.5	128.020	0.085	0.18	0.38	-0.05	0.50	0.26	0.51	-0.08	0.37	0.08	0.24
16	128.013	0.085	0.16	0.38	-0.03	0.50	0.30	0.51	-0.00	0.37	0.06	0.24
20	127.991	0.082	0.17	0.38	-0.07	0.51	0.26	0.51	0.05	0.38	0.04	0.24
25	128.018	0.082	0.07	0.38	0.07	0.51	0.26	0.51	0.02	0.38	0.00	0.24
31.5	128.025	0.082	0.04	0.38	0.00	0.51	0.20	0.51	0.00	0.38	-0.03	0.24
40	128.007	0.082	0.05	0.38	-0.04	0.51	0.22	0.51	0.02	0.38	-0.03	0.24
63	127.996	0.082	0.08	0.38	-0.02	0.51	0.21	0.51	-0.02	0.37	-0.03	0.24
80	127.974	0.082	0.06	0.38	-0.05	0.51	0.21	0.51	0.01	0.37	-0.01	0.24
100	127.969	0.082	0.22	0.38	0.02	0.51	0.38	0.51	0.02	0.38	-0.02	0.24
125	127.953	0.082	0.04	0.38	-0.01	0.51	0.22	0.51	0.04	0.38	-0.03	0.24
160	127.958	0.083	0.04	0.37	0.00	0.51	0.21	0.51	0.04	0.37	-0.03	0.24
200	127.946	0.083	0.07	0.38	-0.05	0.50	0.19	0.51	-0.02	0.37	-0.01	0.24
250	127.956	0.083	-0.10	0.37	-0.07	0.37	0.30	0.51	0.02	0.37	-0.03	0.24
315	127.978	0.082	-0.07	0.37	-0.07	0.37	0.26	0.51	0.00	0.38	-0.03	0.24
400	127.979	0.082	-0.06	0.37	-0.07	0.37	0.24	0.51	-0.02	0.38	-0.02	0.24
500	127.986	0.082	-0.04	0.37	-0.06	0.37	0.26	0.51	0.00	0.38	-0.03	0.24
630	128.026	0.082	0.21	0.38	-0.07	0.38	0.36	0.51	0.00	0.38	-0.03	0.24
800	128.028	0.082	-0.04	0.38	-0.06	0.38	0.23	0.51	0.01	0.38	-0.01	0.24
1000	128.073	0.084	0.04	0.38	-0.05	0.37	0.33	0.51	0.01	0.37	0.04	0.24
1250	128.122	0.087	0.20	0.37	-0.03	0.37	0.30	0.51	0.02	0.37	0.02	0.24
1500	128.173	0.087	0.08	0.37	-0.00	0.37	0.38	0.51	0.04	0.37	0.03	0.24
1600	128.232	0.087	0.05	0.37	-0.05	0.37	0.35	0.51	0.05	0.37	0.01	0.24
2000	128.342	0.087	0.10	0.38	0.02	0.38	0.40	0.51	0.04	0.38	0.09	0.24
2500	128.550	0.090	0.36	0.38	0.08	0.38	0.39	0.51	0.05	0.38	0.10	0.30
3000	128.824	0.091	0.23	0.38	0.04	0.38	0.47	0.51	0.21	0.38	0.21	0.30
3150	129.001	0.093	-0.01	0.38	-0.07	0.38	0.36	0.51	0.07	0.38	0.04	0.43
3500	129.178	0.094	0.00	0.38	0.05	0.38	0.41	0.51	0.13	0.38	0.17	0.43
4000	129.516	0.094	0.18	0.38	0.14	0.38	0.55	0.51	0.19	0.38	0.26	0.43
4500	130.184	0.147	-0.29	0.36	-0.23	0.63	0.43	0.50	0.02	0.36	0.16	0.42
5000	130.614	0.164	-0.49	0.35	0.09	0.63	0.58	0.50	0.14	0.36	0.07	0.77
5500	131.061	0.194	-0.47	0.62			0.66	1.30	0.24	0.34	0.20	0.76
6000	131.655	0.196	-0.97	0.62			0.85	1.31	0.37	0.34	0.26	0.77
6300	132.368	0.207	-1.67*	0.69*			0.55	1.31	0.11	0.34	-0.04	0.77
6500	132.630	0.208	-1.78*	0.69*			0.52	1.32	0.19	0.34	-0.01	0.77
7000	133.447	0.227	-2.27*	0.69*			0.67	1.32	0.32	0.48	-0.04	1.04
7500	134.680	0.269	-2.66*	0.71*			0.43	1.32	0.60	1.19	-0.41	1.04
8000	134.734	0.258	-1.79*	0.71*			1.04	1.33	0.61	0.77	0.47	1.05
8500	135.862	0.273	-1.86*	0.72*			0.70	1.34	-0.28	1.33	0.35	1.05
9000	136.017	0.355	-0.41	0.58			1.57	1.33	-1.22	3.35	1.29*	1.15*
9500	137.684	0.400	-1.12*	0.79*			1.07	1.33	-0.54	2.16	0.80	1.03
10000	138.981	0.323	-0.66	0.61			0.85	1.36	-0.44	1.49	0.76	1.07
10500	140.472	0.407	-1.39	1.04			0.60	2.08	-0.77	1.63	0.73	1.35
11000	142.219	0.403	-2.62*	1.19*			0.69	2.11	-0.23	0.75	0.44	1.37
11500	143.951	0.407	-2.74*	1.20*			0.82	2.13	0.02	0.76	0.32	1.38
12000	145.538	0.411	-2.10*	1.22*			0.94	2.16	0.21	0.77	0.24	1.40
12500	147.326	0.426	-2.51*	1.23*			0.78	2.18	0.37	0.78	0.09	1.41
13000	149.148	0.431	-3.42*	1.24*			0.57	2.20	0.35	0.79	0.19	1.43
13500	151.198	0.445	-3.35*	1.26*			0.57	2.23	0.17	0.79	0.17	1.45
14000	153.445	0.452	-3.62*	1.28*			0.45	2.26	0.13	0.80	0.03	1.47
14500	155.191	0.497	-2.04*	1.32*			0.51	2.28	0.23	1.47	0.30	1.47
15000	157.253	0.472	-1.53	1.15			0.76	2.32	0.11	1.50	0.80	1.51
15500	159.643	0.599	-1.15	1.12			0.85	2.33	0.38	1.48	1.08	1.83
16000	162.409	0.658	-1.39	1.47			0.63	2.36	0.21	1.49	0.89	1.85
16500	165.548	0.672	-0.26	1.51			0.34	2.40	-0.10	1.51	1.11	1.88
17000	168.651	0.683	0.24	1.54			0.29	2.44	-0.00	1.54	0.74	1.91
17500	171.640	0.697	-0.79	1.56			0.36	2.48	0.23	1.57	0.89	1.95
18000	175.171	0.712	0.18	1.60			0.42	2.54	-0.14	1.60	0.91	1.99
18500	178.903	0.842	2.79*	2.00*			0.15	2.55	0.20	2.55	0.83	1.99
19000	182.752	0.861	3.98*	2.06*			-0.10	2.60	-0.04	2.60	0.99	2.03
19500	187.354	0.909	3.42*	2.11*			-0.40	2.65	-0.30	2.65	0.98	2.07
20000	192.170	0.840	1.58	1.75			-0.69	2.75	-0.54	2.75	0.41	2.15

(continued) Unilateral degrees of equivalence for the magnitude of the BB

f in Hz	KCRV X_{KC} in $\frac{fC}{m/s^2}$	KCRV U_{KC} in $\frac{fC}{m/s^2}$	NMISA D_i in $\frac{fC}{m/s^2}$	NMISA U_{D_i} in $\frac{fC}{m/s^2}$	VNIIM D_i in $\frac{fC}{m/s^2}$	VNIIM U_{D_i} in $\frac{fC}{m/s^2}$	NMC,A*STAR D_i in $\frac{fC}{m/s^2}$	NMC,A*STAR U_{D_i} in $\frac{fC}{m/s^2}$	UkrMet D_i in $\frac{fC}{m/s^2}$	UkrMet U_{D_i} in $\frac{fC}{m/s^2}$
10	128.001	0.085	0.04	0.37	0.29	0.64	-0.18	0.52	-0.25	0.63
12.5	128.020	0.085	0.11	0.37	0.24	0.64	-0.12	0.52	-0.26	0.63
16	128.013	0.085	-0.01	0.37	0.23	0.64	-0.07	0.52	-0.25	0.63
20	127.991	0.082	-0.00	0.38	0.25	0.64	-0.03	0.37	-0.25	0.63
25	128.018	0.082	-0.02	0.38	0.21	0.64	-0.06	0.37	-0.28	0.63
31.5	128.025	0.082	-0.04	0.38	0.20	0.64	-0.06	0.37	-0.28	0.63
40	128.007	0.082	-0.03	0.37	0.20	0.64	-0.01	0.38	-0.29	0.63
63	127.996	0.082	-0.03	0.37	0.10	0.64	-0.04	0.37	-0.26	0.63
80	127.974	0.082	0.01	0.37	0.16	0.64	-0.04	0.37	-0.24	0.63
100	127.969	0.082	0.02	0.38	0.13	0.64	-0.08	0.37	-0.24	0.63
125	127.953	0.082	-0.07	0.37	0.15	0.64	-0.02	0.37	-0.23	0.63
160	127.958	0.083	-0.14	0.37	0.16	0.64	-0.01	0.37	-0.23	0.63
200	127.946	0.083	-0.10	0.37	0.19	0.64	-0.06	0.37	-0.21	0.63
250	127.956	0.083	-0.09	0.37	0.20	0.64	0.00	0.37	-0.22	0.63
315	127.978	0.082	-0.11	0.37	0.26	0.64	-0.02	0.38	-0.25	0.63
400	127.979	0.082	-0.09	0.37	0.30	0.64	0.00	0.38	-0.26	0.63
500	127.986	0.082	-0.09	0.37	0.34	0.64	-0.03	0.38	-0.23	0.63
630	128.026	0.082	-0.09	0.37	0.39	0.64	-0.05	0.38	-0.24	0.63
800	128.028	0.082	-0.04	0.38	0.38	0.64	-0.01	0.38	-0.23	0.63
1000	128.073	0.084	-0.01	0.37	0.39	0.64	-0.04	0.52	-0.24	0.63
1250	128.122	0.087	-0.03	0.63	0.37	0.64	-0.04	0.52	-0.17	0.89
1500	128.173	0.087	-0.02	0.63	0.33	0.64	0.02	0.52	-0.17	0.89
1600	128.232	0.087	-0.03	0.64	0.30	0.64	-0.03	0.52	-0.17	0.89
2000	128.342	0.087	-0.01	0.64	0.32	0.64	0.01	0.52	-0.11	0.89
2500	128.550	0.090	0.07	0.64	0.22	1.28	0.08	0.52	-0.03	0.90
3000	128.824	0.091	-0.03	0.64	0.20	1.29	0.06	0.52	-0.03	0.90
3150	129.001	0.093	-0.03	0.64	0.21	1.29	0.02	0.52	-0.15	0.90
3500	129.178	0.094	0.08	0.64	0.48	1.29	0.11	0.52	0.05	0.90
4000	129.516	0.094	0.22	0.64	0.50	1.30	0.10	0.52	0.05	0.90
4500	130.184	0.147	0.10	0.63	-0.07	1.29	-0.19	0.51	-0.16	0.90
5000	130.614	0.164	0.06	1.03	-0.02	1.30	-0.16	0.69	-0.21	0.90
5500	131.061	0.194	0.25	1.03	-0.05	1.96	-0.16	0.68	0.11	1.96
6000	131.655	0.196	0.33	1.04	0.14	1.97	-0.24	0.68	0.18	1.97
6300	132.368	0.207	0.15	1.04	-0.20	1.97	-0.70	0.68	-0.21	1.97
6500	132.630	0.208	0.28	1.04	-0.06	1.98	-0.77	0.68	-0.22	1.98
7000	133.447	0.227	0.24	1.05	-0.40	1.98	-1.07	0.68	-0.44	1.98
7500	134.680	0.269	0.84	1.60	-0.78	1.99	-1.63*	0.77*	-1.00	1.99
8000	134.734	0.258	0.48	1.60	-0.44	2.00	-0.93	0.67	-0.36	2.00
8500	135.862	0.273	1.19	1.62	-1.02	2.00	-1.20*	0.78*	-0.62	2.01
9000	136.017	0.355	-1.46	1.58	-0.17	2.01	-0.35	0.64	0.48	2.02
9500	137.684	0.400	3.74*	1.74*	-0.04	2.03	-0.76	0.62	0.05	2.03
10000	138.981	0.323	1.05	1.65	-0.56	2.05	-0.35	1.62	-0.06	2.06
10500	140.472	0.407	0.04	1.64	-1.16	2.05	-0.36	1.62	-0.11	2.78
11000	142.219	0.403	0.33	1.66	-2.22	2.06	-0.47	1.64	-1.04	2.79
11500	143.951	0.407	0.63	1.69	-2.52	2.08	-0.34	1.66	-1.03	2.83
12000	145.538	0.411	0.84	1.71	-2.93	2.10	0.13	1.68	-1.17	2.86
12500	147.326	0.426	0.96	2.18	-3.05	2.12	0.18	1.70	-0.55	2.90
13000	149.148	0.431	0.92	2.21	-3.41	2.14	0.33	1.73	-0.52	2.94
13500	151.198	0.445	0.72	2.23	-4.01*	2.25*	0.35	1.75	-0.49	2.98
14000	153.445	0.452	0.74	2.27	-4.84*	2.27*	0.10	1.77	-1.00	3.02
14500	155.191	0.497	1.13	2.29	-4.64*	2.31*	0.36	1.78	-0.18	3.06
15000	157.253	0.472	1.26	2.33	-4.65*	2.34*	0.56	2.19	-0.39	3.10
15500	159.643	0.599	1.48	2.84	-5.12*	3.15*	0.69	2.20	-0.59	4.73
16000	162.409	0.658	1.41	2.87	-5.67*	3.20*	0.56	2.22	-1.42	4.78
16500	165.548	0.672	1.17	2.92	-6.39*	3.25*	0.31	2.26	-1.55	4.87
17000	168.651	0.683	1.29	2.98	-6.64*	3.31*	0.22	2.30	-2.14	4.95
17500	171.640	0.697	1.56	3.04	-6.56*	3.37*	0.48	2.34	-1.73	5.05
18000	175.171	0.712	1.58	3.10	-6.84*	3.44*	0.47	2.39	-2.28	5.14
18500	178.903	0.842	1.71	3.14	-7.67*	3.53*	0.44	2.40	-2.41	5.23
19000	182.752	0.861	1.93	3.21	-9.65*	3.57*	0.63	2.46	-2.84	5.33
19500	187.354	0.909	1.87	3.28	-8.65*	3.69*	0.35	2.51	-3.80	5.43
20000	192.170	0.840	1.79	3.39	-9.76*	3.74*	0.10	2.60	-5.18	5.55

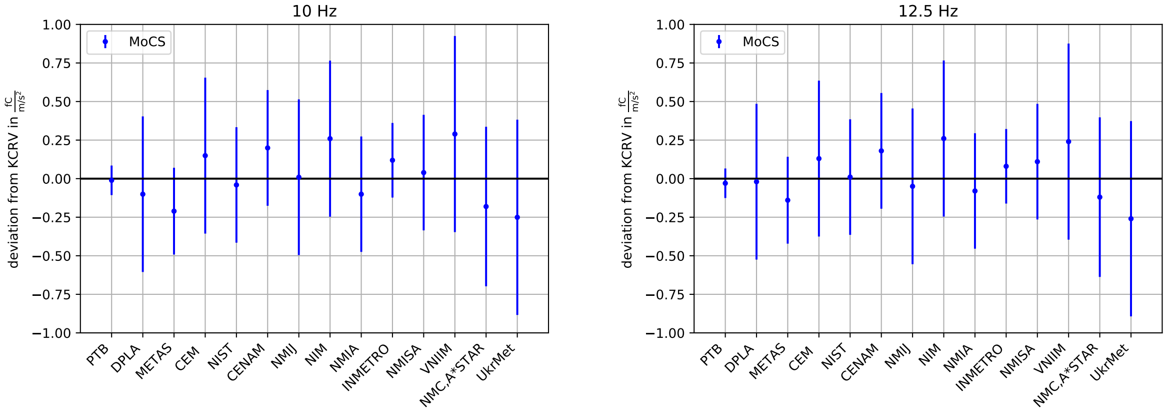

Figure 8.32: deviation of the magnitude for the frequencies 10 Hz and 12.5 Hz for the BB

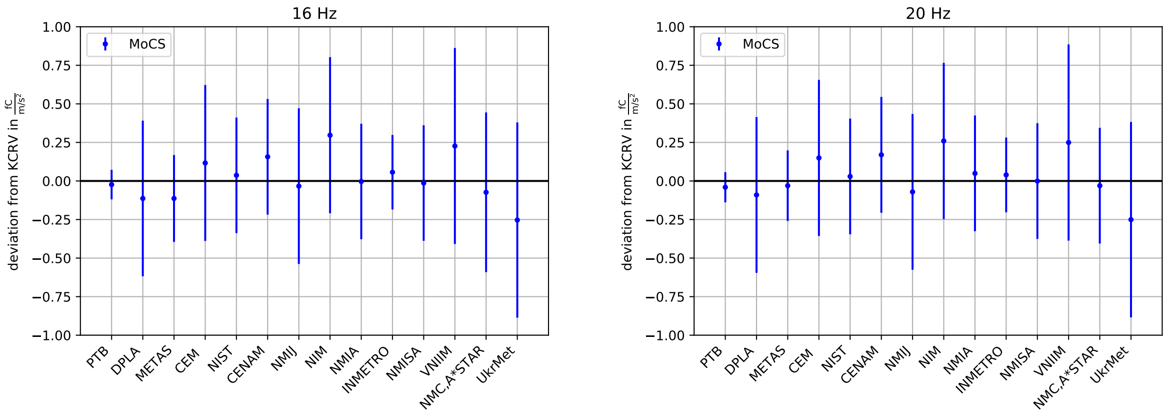

Figure 8.33: deviation of the magnitude for the frequencies 16 Hz and 20 Hz for the BB

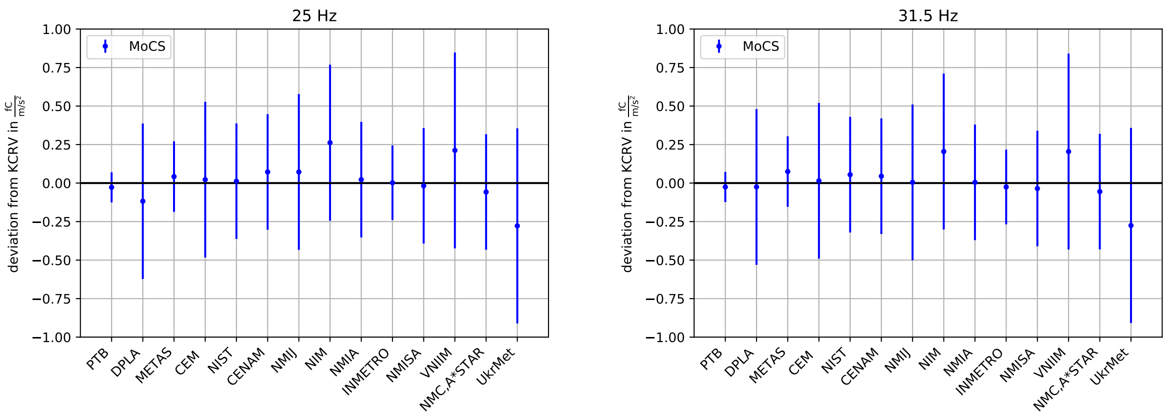

Figure 8.34: deviation of the magnitude for the frequencies 25 Hz and 31.5 Hz for the BB

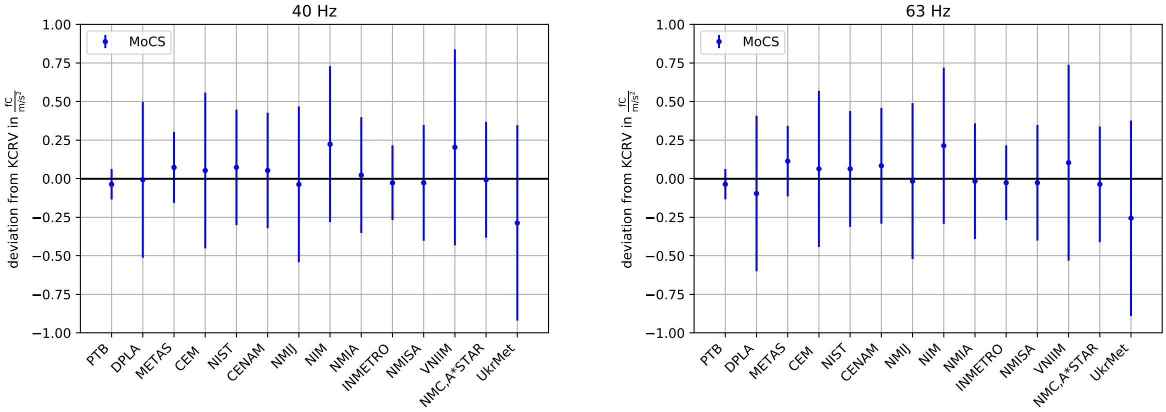

Figure 8.35: deviation of the magnitude for the frequencies 40 Hz and 63 Hz for the BB

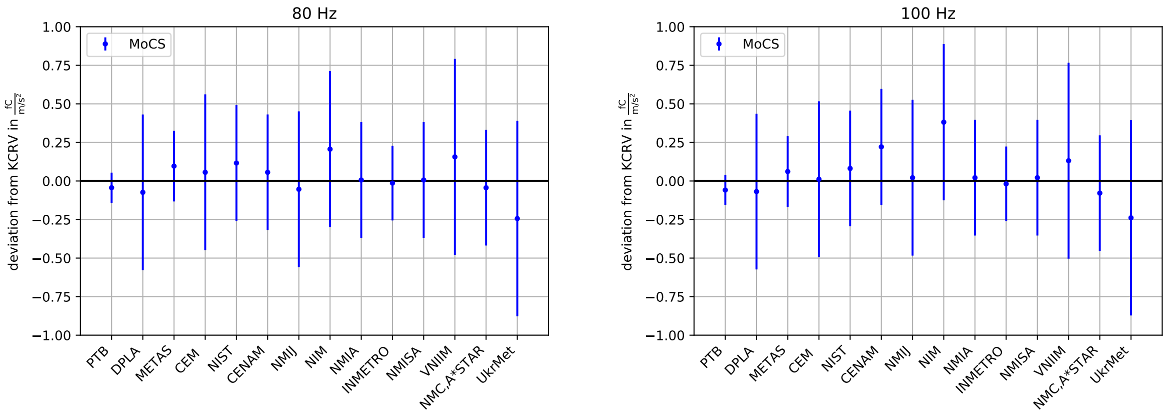

Figure 8.36: deviation of the magnitude for the frequencies 80 Hz and 100 Hz for the BB

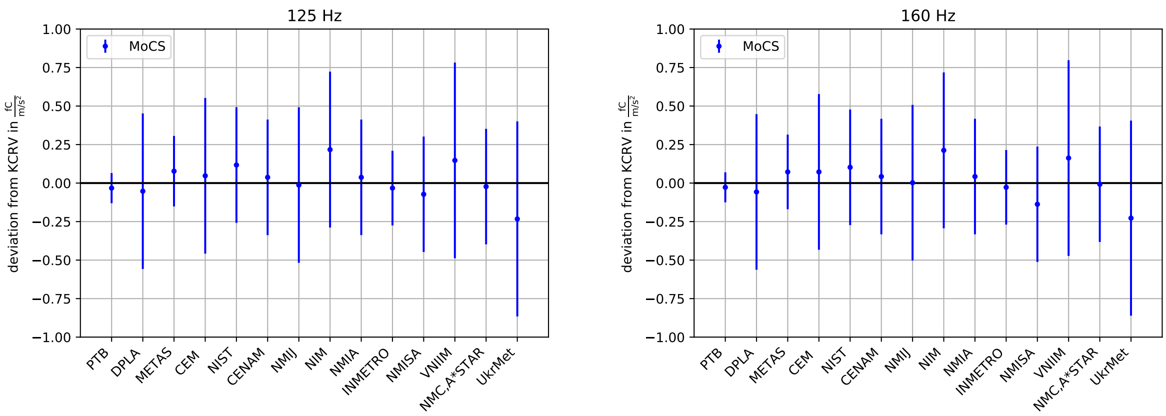

Figure 8.37: deviation of the magnitude for the frequencies 125 Hz and 160 Hz for the BB

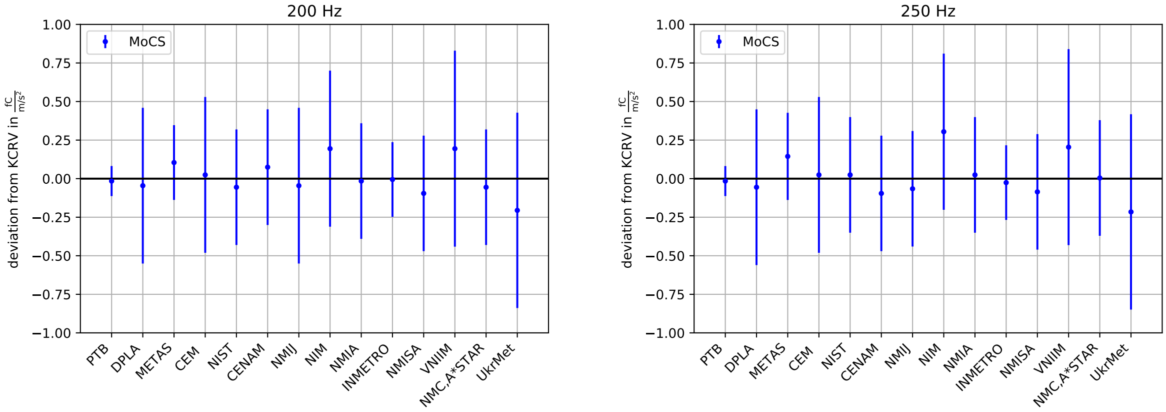

Figure 8.38: deviation of the magnitude for the frequencies 200 Hz and 250 Hz for the BB

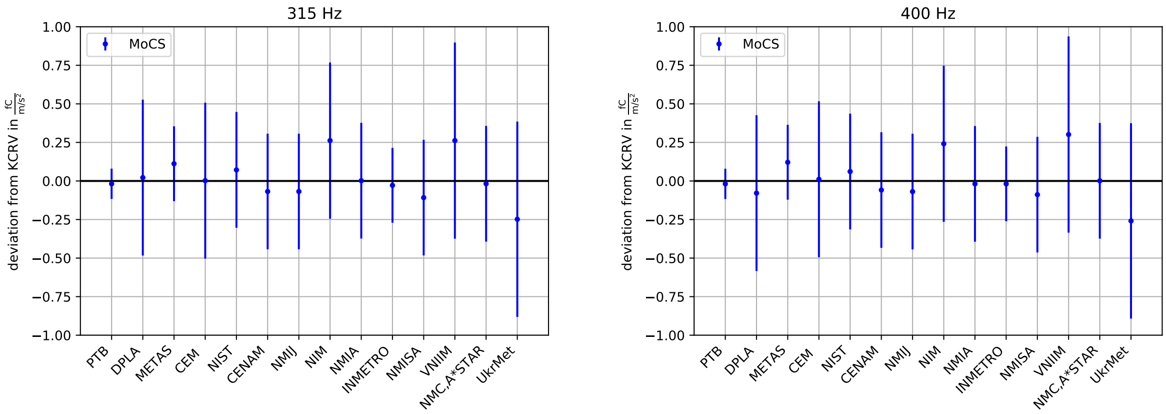

Figure 8.39: deviation of the magnitude for the frequencies 315 Hz and 400 Hz for the BB

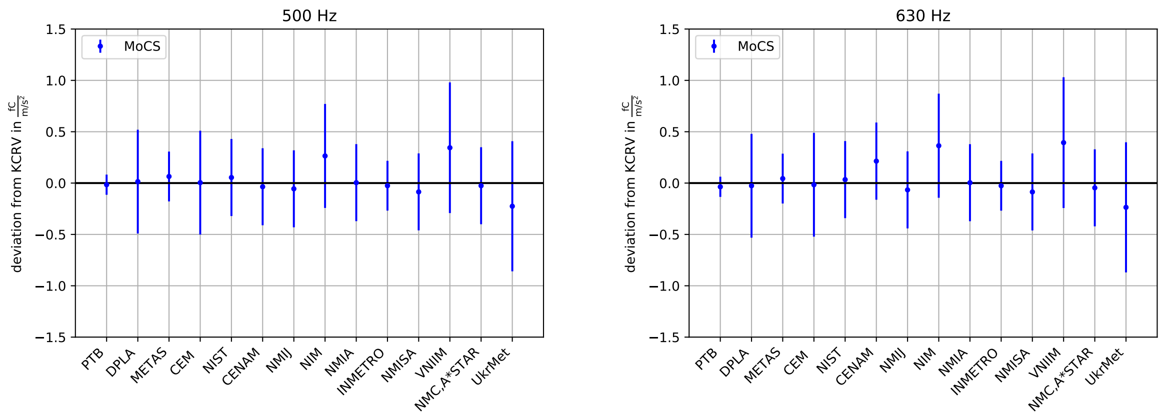

Figure 8.40: deviation of the magnitude for the frequencies 500 Hz and 630 Hz for the BB

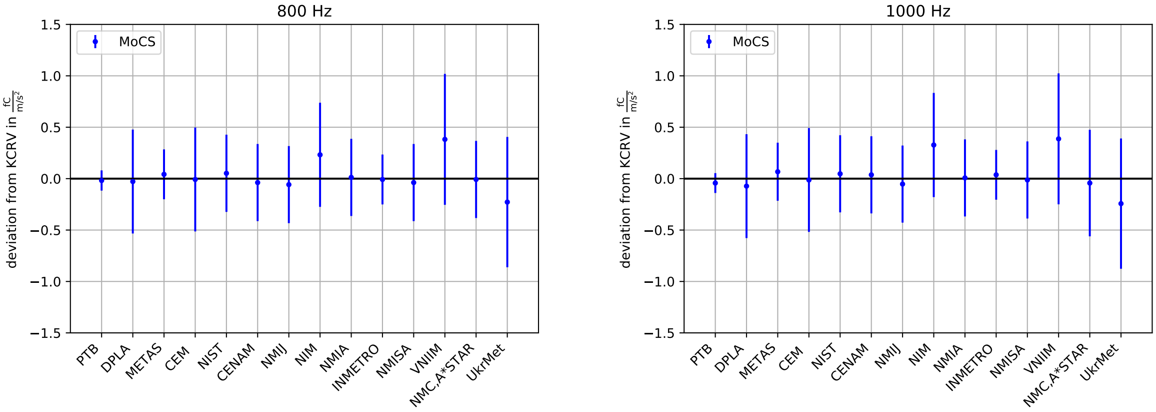

Figure 8.41: deviation of the magnitude for the frequencies 800 Hz and 1000 Hz for the BB

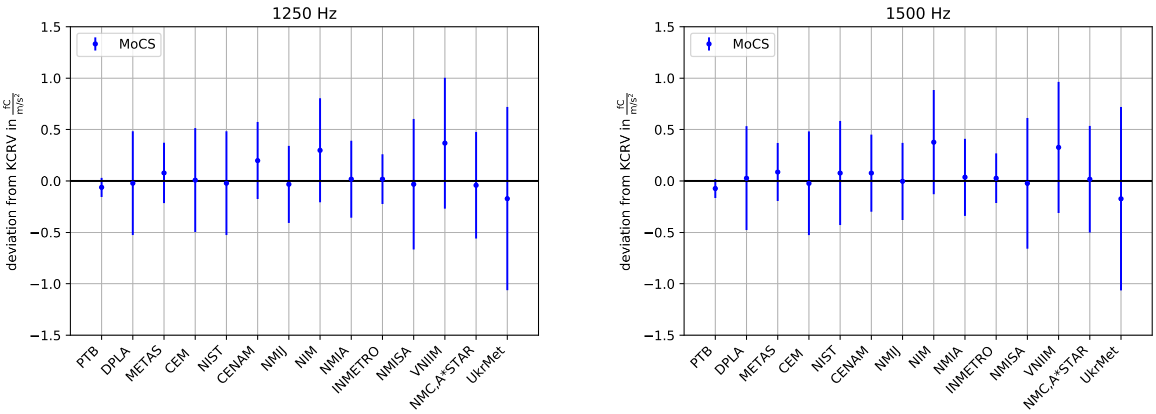

Figure 8.42: deviation of the magnitude for the frequencies 1250 Hz and 1500 Hz for the BB

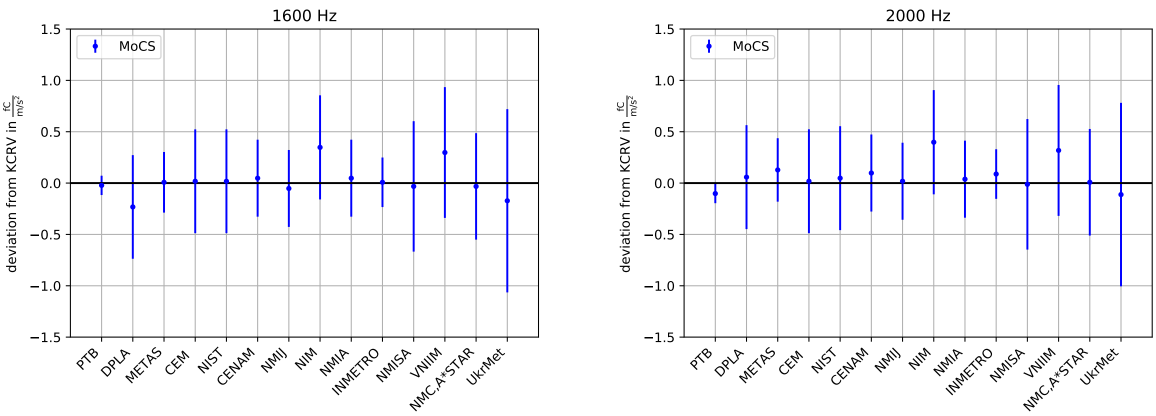

Figure 8.43: deviation of the magnitude for the frequencies 1600 Hz and 2000 Hz for the BB

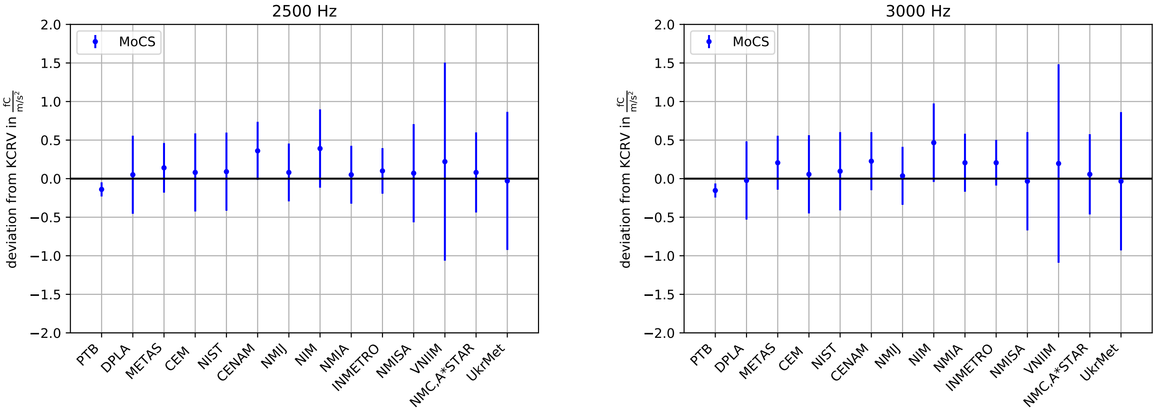

Figure 8.44: deviation of the magnitude for the frequencies 2500 Hz and 3000 Hz for the BB

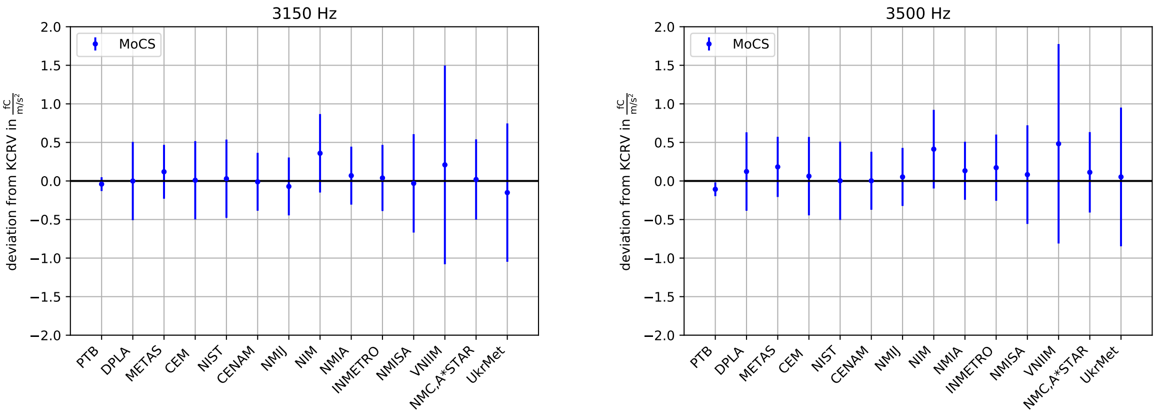

Figure 8.45: deviation of the magnitude for the frequencies 3150 Hz and 3500 Hz for the BB

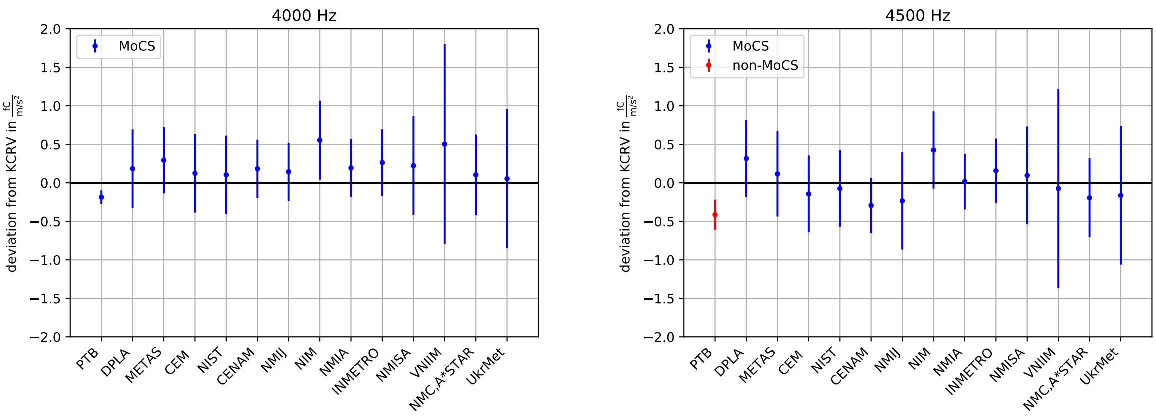

Figure 8.46: deviation of the magnitude for the frequencies 4000 Hz and 4500 Hz for the BB

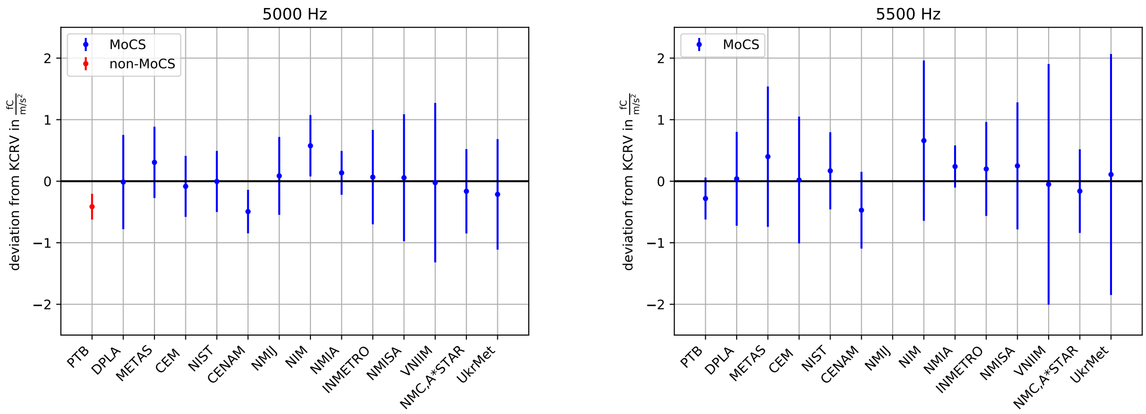

Figure 8.47: deviation of the magnitude for the frequencies 5000 Hz and 5500 Hz for the BB

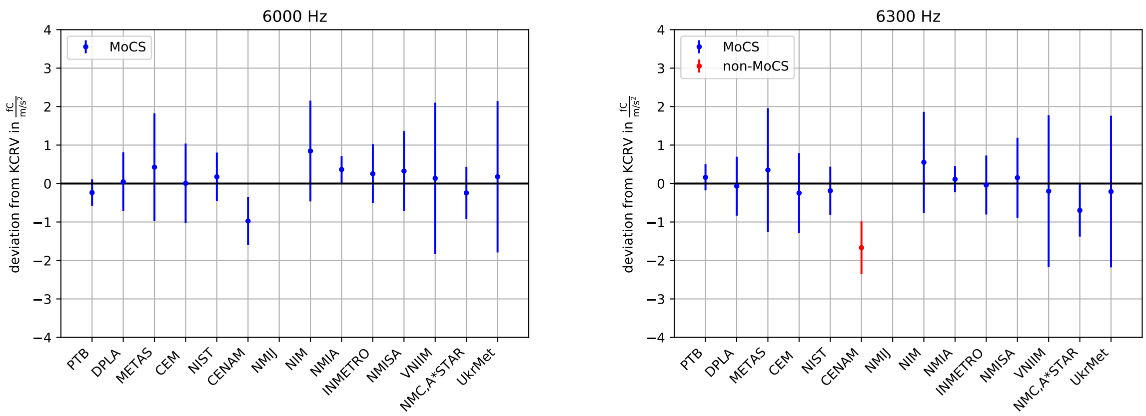

Figure 8.48: deviation of the magnitude for the frequencies 6000 Hz and 6300 Hz for the BB

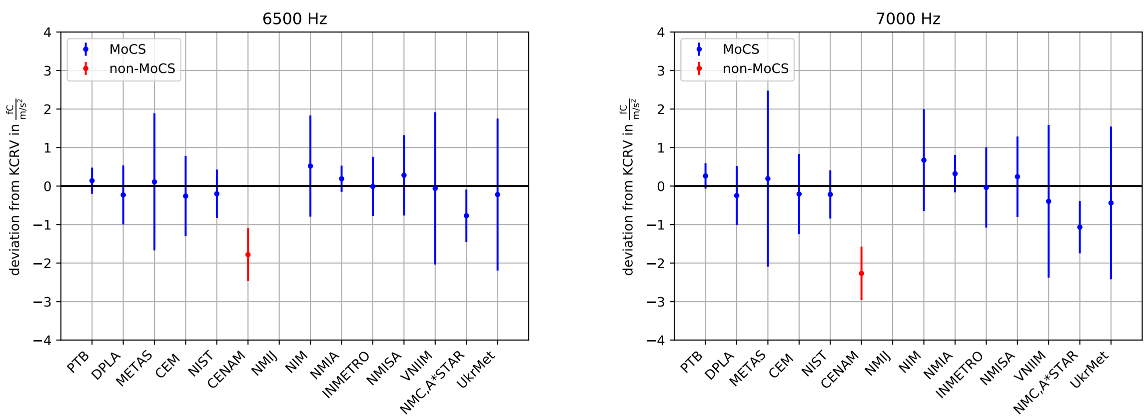

Figure 8.49: deviation of the magnitude for the frequencies 6500 Hz and 7000 Hz for the BB

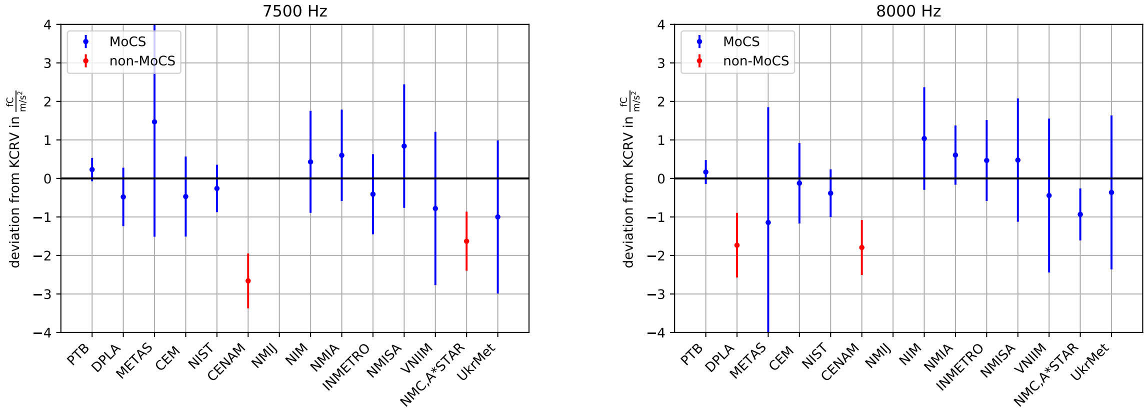

Figure 8.50: deviation of the magnitude for the frequencies 7500 Hz and 8000 Hz for the BB

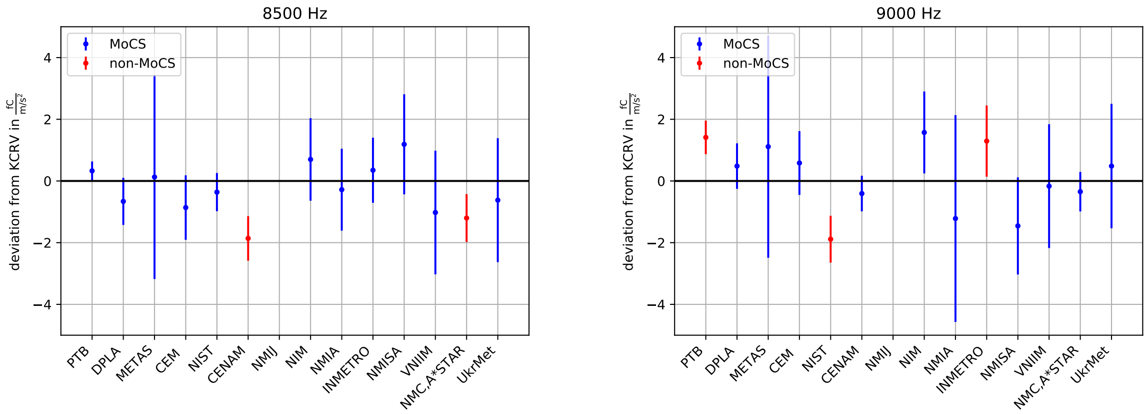

Figure 8.51: deviation of the magnitude for the frequencies 8500 Hz and 9000 Hz for the BB

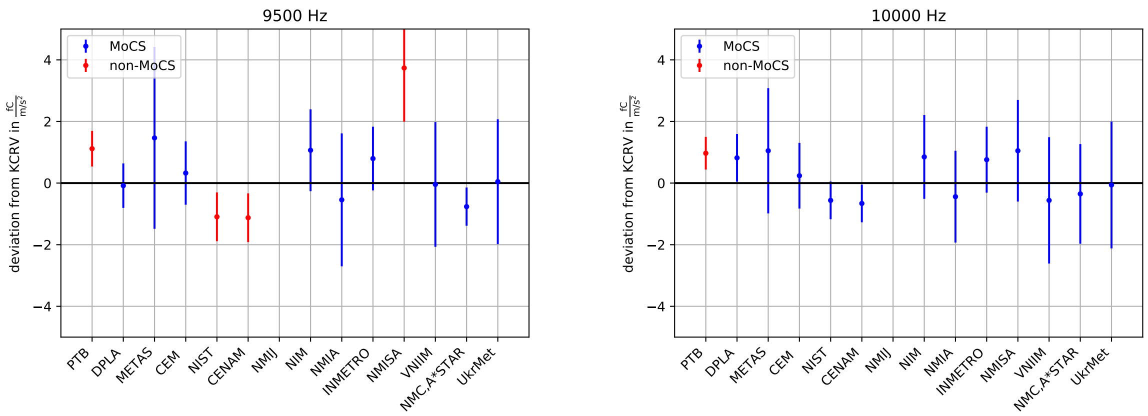

Figure 8.52: deviation of the magnitude for the frequencies 9500 Hz and 10000 Hz for the BB

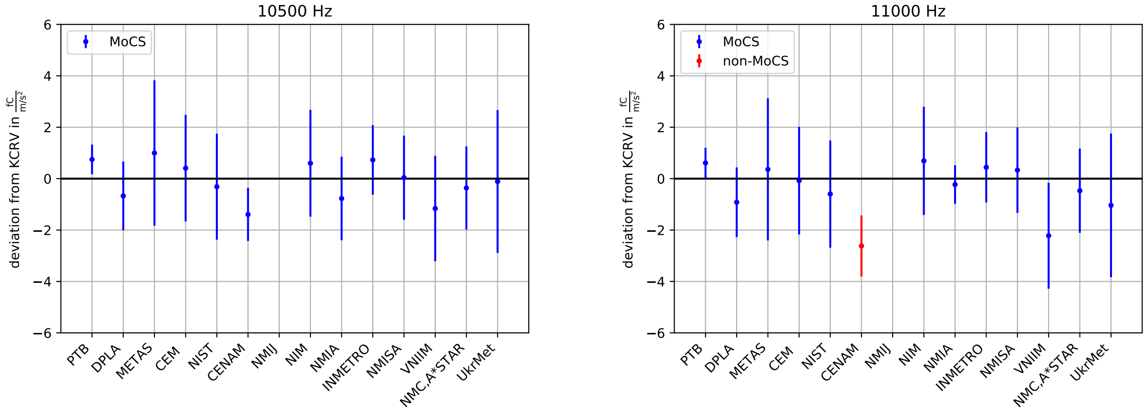

Figure 8.53: deviation of the magnitude for the frequencies 10500 Hz and 11000 Hz for the BB

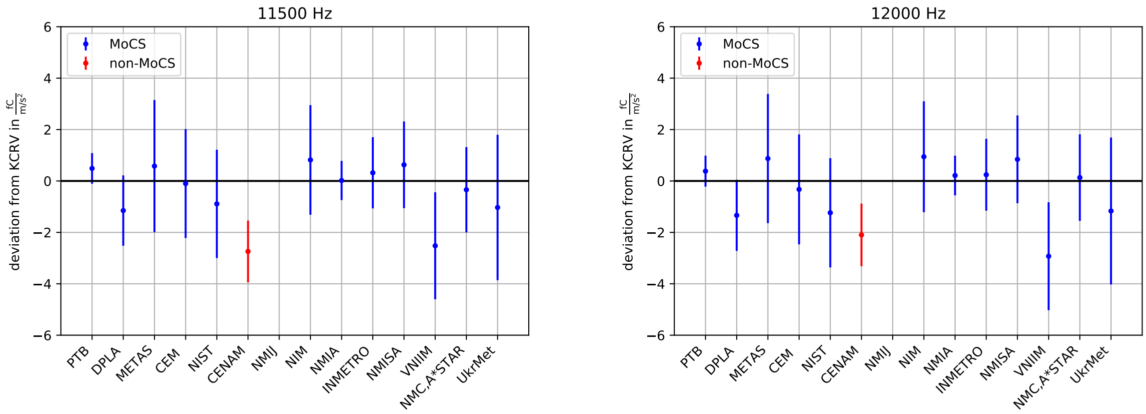

Figure 8.54: deviation of the magnitude for the frequencies 11500 Hz and 12000 Hz for the BB

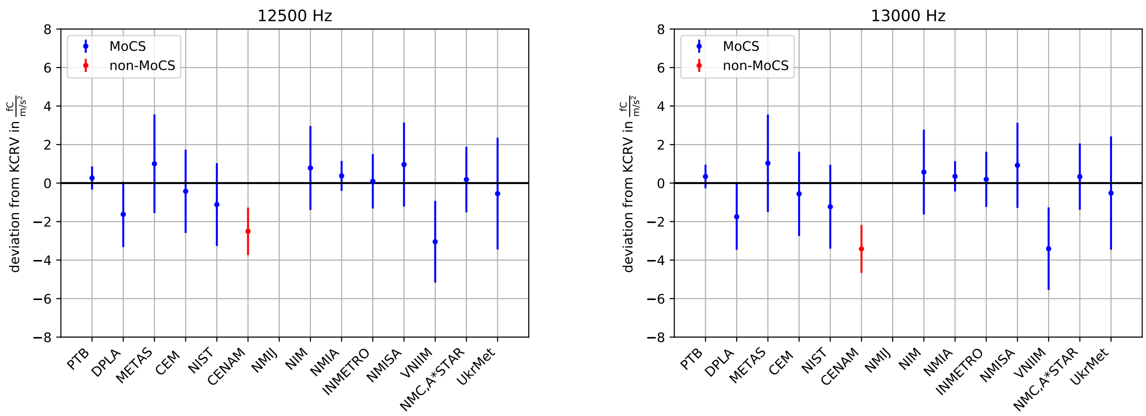

Figure 8.55: deviation of the magnitude for the frequencies 12500 Hz and 13000 Hz for the BB

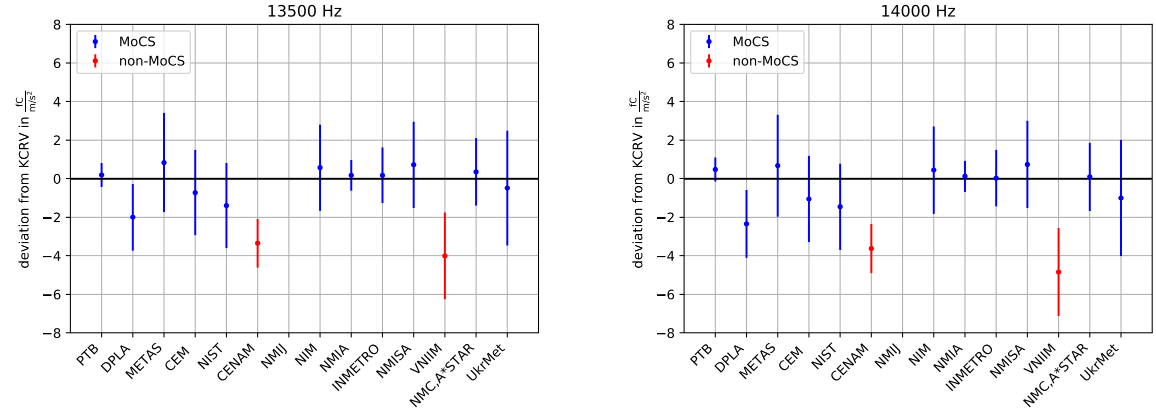

Figure 8.56: deviation of the magnitude for the frequencies 13500 Hz and 14000 Hz for the BB

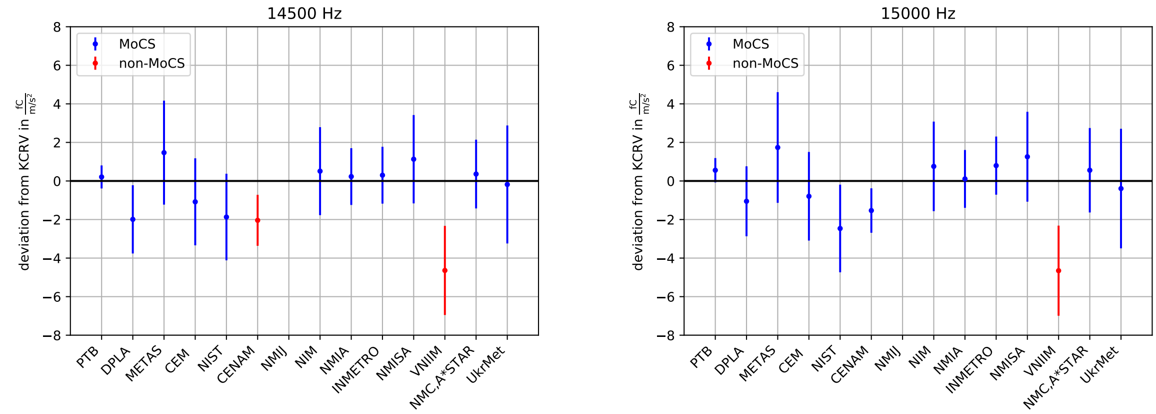

Figure 8.57: deviation of the magnitude for the frequencies 14500 Hz and 15000 Hz for the BB

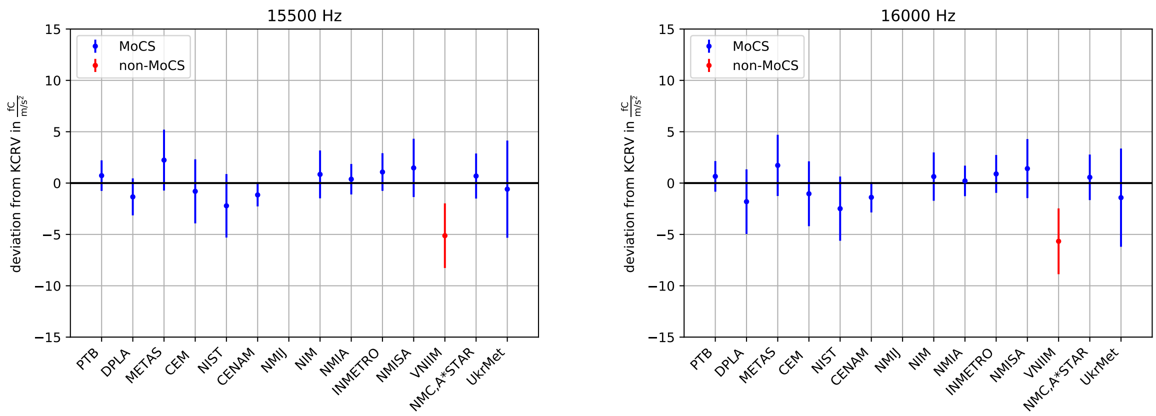

Figure 8.58: deviation of the magnitude for the frequencies 15500 Hz and 16000 Hz for the BB

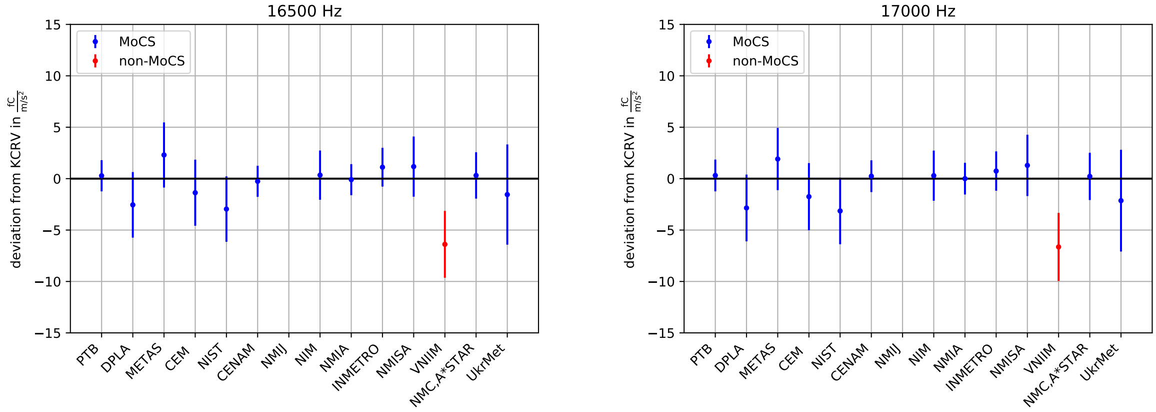

Figure 8.59: deviation of the magnitude for the frequencies 16500 Hz and 17000 Hz for the BB

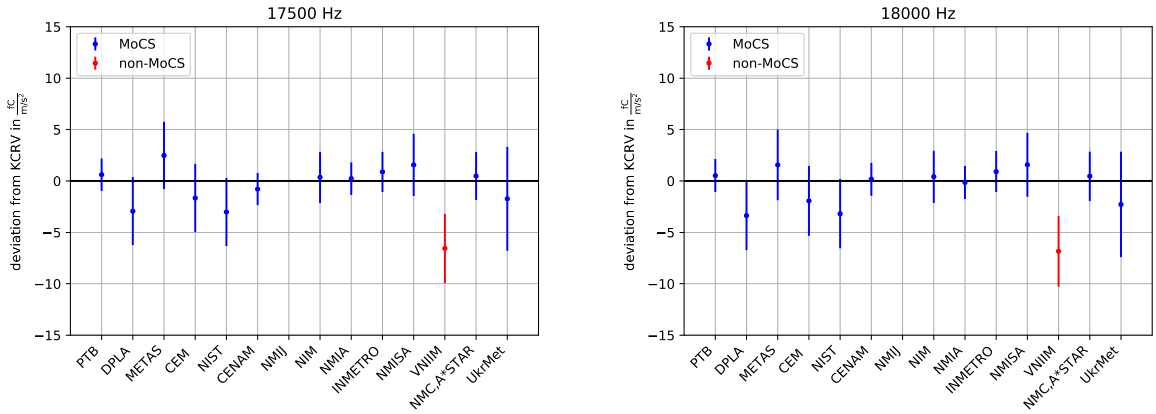

Figure 8.60: deviation of the magnitude for the frequencies 17500 Hz and 18000 Hz for the BB

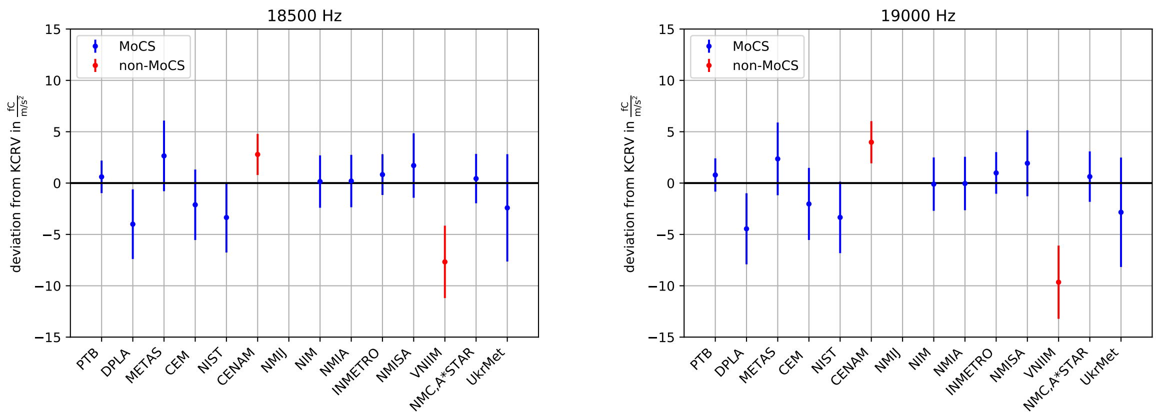

Figure 8.61: deviation of the magnitude for the frequencies 18500 Hz and 19000 Hz for the BB

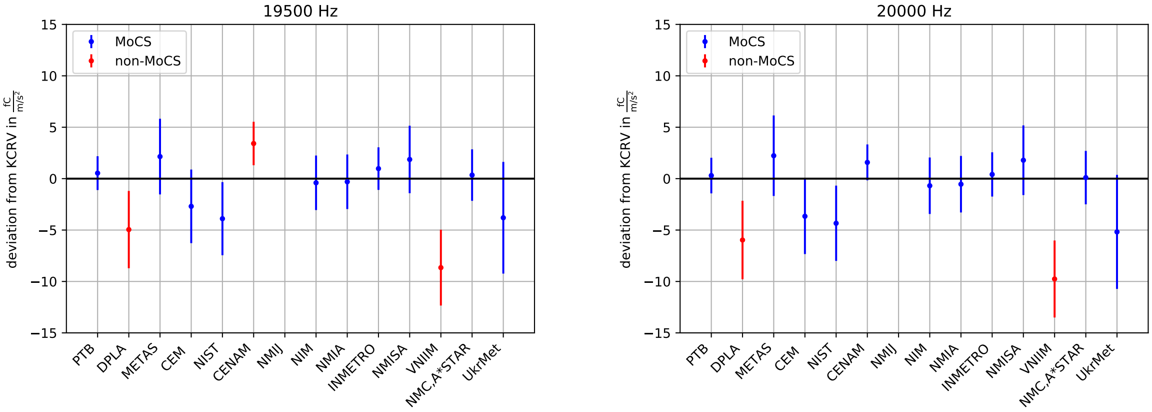

Figure 8.62: deviation of the magnitude for the frequencies 19500 Hz and 20000 Hz for the BB

8.5 Phase of the Complex Sensitivity of the SE

Table 8.3: Unilateral degrees of equivalence for the phase of the SE

f	KCRV		PTB		DPLA		METAS		CEM		NIST	
in	X_{KC}	U_{KC}	D_i	U_{D_i}	D_i	U_{D_i}	D_i	U_{D_i}	D_i	U_{D_i}	D_i	U_{D_i}
Hz	in °		in °		in °		in °		in °		in °	
10	0.006	0.083	-0.01	0.18	0.00	0.29	-0.02	0.39	-0.04	0.49	-0.03	0.49
12.5	-0.006	0.083	-0.04	0.18	0.02	0.29	-0.00	0.39	-0.01	0.49	-0.00	0.49
16	0.000	0.082	-0.02	0.18	0.01	0.29	-0.00	0.39	-0.01	0.49	-0.01	0.49
20	-0.001	0.081	-0.03	0.18	0.00	0.29	0.00	0.37	-0.01	0.49	0.00	0.49
25	-0.006	0.081	-0.01	0.18	-0.02	0.29	0.03	0.37	0.01	0.49	0.02	0.49
31.5	-0.006	0.081	-0.02	0.18	0.02	0.29	0.02	0.37	0.01	0.49	0.03	0.49
40	-0.006	0.081	-0.03	0.18	-0.01	0.29	0.03	0.37	0.01	0.49	0.03	0.49
63	-0.013	0.081	-0.02	0.18	0.00	0.29	-0.02	0.37	0.02	0.49	0.04	0.49
80	-0.011	0.081	-0.03	0.18	0.01	0.29	-0.03	0.37	0.02	0.49	0.04	0.49
100	-0.008	0.081	0.01	0.18	0.01	0.29	-0.04	0.37	-0.00	0.49	0.02	0.49
125	-0.000	0.084	0.01	0.18	0.00	0.29	-0.07	0.37	-0.03	0.49	0.00	0.49
160	-0.010	0.084	0.01	0.18	0.01	0.29	-0.08	0.37	0.02	0.49	0.03	0.49
200	0.024	0.085	-0.01	0.18	-0.02	0.29	-0.00	0.39	-0.02	0.49	-0.00	0.49
250	0.003	0.086	0.01	0.18	-0.01	0.29	0.01	0.37	-0.01	0.49	0.02	0.49
315	0.005	0.085	0.00	0.18	0.00	0.29	-0.03	0.41	-0.03	0.49	0.01	0.49
400	-0.001	0.084	0.01	0.18	-0.02	0.29	-0.01	0.37	-0.03	0.49	0.01	0.49
500	-0.004	0.084	0.01	0.18	-0.04	0.29	-0.01	0.37	-0.04	0.49	0.01	0.49
630	0.001	0.084	0.01	0.18	-0.05	0.29	-0.01	0.37	0.02	0.49	-0.00	0.49
800	-0.006	0.084	0.01	0.18	-0.05	0.29	-0.01	0.37	0.02	0.49	-0.02	0.49
1000	-0.007	0.089	0.02	0.18	-0.08	0.29	0.03	0.47	0.02	0.49	-0.01	0.49
1250	-0.021	0.104	0.02	0.49	-0.06	0.28	0.03	0.47	0.01	0.99	-0.01	0.49
1500	-0.048	0.104	0.05	0.49	-0.11	0.28	0.06	0.47	0.05	0.99	0.01	0.49
1600	-0.040	0.104	0.04	0.49	-0.11	0.28	0.05	0.47	0.06	0.99	0.00	0.49
2000	-0.049	0.104	0.05	0.49	-0.15	0.28	0.06	0.47	0.05	0.99	-0.01	0.49
2500	-0.066	0.109	0.07	0.49	-0.16	0.28	0.06	0.47	0.05	0.99	-0.01	0.49
3000	-0.088	0.109	0.08	0.49	-0.19	0.28	0.09	0.47	0.07	0.99	-0.01	0.49
3150	-0.108	0.115	0.11	0.49	-0.19	0.28	0.10	0.47	0.09	0.99	0.01	0.49
3500	-0.111	0.115	0.10	0.49	-0.20	0.28	0.11	0.47	0.07	0.99	0.00	0.49
4000	-0.152	0.118	0.15	0.49	-0.25	0.28	0.16	0.47	0.12	0.99	0.00	0.49
4500	-0.170	0.119	0.16	0.49	-0.26	0.28	0.19	0.46	0.15	0.99	0.02	0.49
5000	-0.208	0.134	0.19	0.48	-0.26	0.48	0.19	0.46	0.16	0.99	0.03	0.48
5500	-0.170	0.176	0.15	0.47	-0.42	0.47	0.15	0.84	0.10	0.98	-0.01	0.98
6000	-0.194	0.176	0.15	0.47	-0.40	0.47	0.18	0.84	0.10	0.98	0.00	0.98
6300	-0.201	0.176	0.16	0.47	-0.29	0.47	0.16	0.84	0.12	0.98	0.01	0.98
6500	-0.219	0.176	0.18	0.47	-0.41	0.47	0.18	0.84	0.13	0.98	0.07	0.98
7000	-0.229	0.180	0.19	0.47	-0.45	0.47	0.21	0.84	0.15	0.98	0.06	0.98
7500	-0.237	0.181	0.23	0.47	-0.47	0.47	0.23	0.84	0.17	0.98	0.08	0.98
8000	-0.230	0.191	0.15	0.46	-0.54	0.98	0.11	0.84	0.04	0.98	0.03	0.98
8500	-0.274	0.191	0.19	0.46	-0.58	0.98	0.11	0.84	0.04	0.98	0.04	0.98
9000	-0.379	0.191	0.12	0.46	-0.49	0.98	-0.02	0.84	-0.30	0.98	0.09	0.98
9500	-0.254	0.191	0.19	0.46	-0.67	0.98	0.10	0.84	0.09	0.98	0.04	0.98
10000	-0.274	0.197	0.18	0.46	-0.54	0.98	0.10	0.84	0.05	0.98	0.04	0.98
10500	-0.283	0.239	0.18	0.97	1.29	1.99	0.07	1.70	0.03	1.48	0.03	1.48
11000	-0.329	0.256	0.23	0.97	-0.74	1.98	0.10	1.70	0.08	1.48	0.09	1.48
11500	-0.332	0.239	0.25	0.97	-0.87	1.99	0.10	1.70	0.06	1.48	0.09	1.48
12000	-0.304	0.239	0.23	0.97	-0.91	1.99	0.09	1.70	0.04	1.48	0.08	1.48
12500	-0.330	0.245	0.25	0.97	-0.98	1.98	0.06	1.70	0.05	1.48	0.11	1.48
13000	-0.365	0.266	0.29	0.96	-0.88	1.98	0.14	1.70	0.07	1.48	0.14	1.48
13500	-0.379	0.266	0.31	0.96	-1.07	1.98	0.09	1.70	0.10	1.48	0.15	1.48
14000	-0.378	0.266	0.27	0.96	-1.35	1.98	0.02	1.70	0.08	1.48	0.17	1.48
14500	-0.402	0.266	0.29	0.96	-1.15	1.98	0.20	1.70	0.04	1.48	0.18	1.48
15000	-0.421	0.269	0.27	0.96	-1.08	1.98	0.08	1.70	0.04	1.48	0.13	1.48
15500	-0.476	0.286	0.32	1.98	-1.06	1.98	-0.11	1.70	0.02	1.98	0.21	1.47
16000	-0.537	0.288	0.37	1.98	-1.06	2.99	-0.03	1.70	-0.01	1.98	0.24	1.47
16500	-0.587	0.303	0.37	1.98	-1.05	2.98	0.06	1.71	-0.03	1.98	0.23	1.47
17000	-0.692	0.332	0.32	1.97	-1.06	2.98	0.06	1.69	-0.02	1.97	0.16	1.46
17500	-0.760	0.332	0.12	1.97	-1.33	2.98	-0.12	1.71	-0.28	1.97	-0.05	1.46
18000	-0.846	0.332	0.56	1.97	-1.37	2.98	-0.08	1.79	-0.21	1.97	-0.02	1.46
18500	-0.897	0.336	0.04	1.97	-1.31	2.98	-0.20	1.91	-0.16	1.97	-0.14	1.46
19000	-0.831	0.332	0.54	1.97	-1.38	2.98	-0.13	1.71	0.04	1.97	0.29	1.46
19500	-0.659	0.303	0.47	1.98	-1.44	2.98	-0.09	1.71	-0.11	1.98	0.16	1.47
20000	-0.713	0.303	0.52	1.98	-1.47	2.98	-0.05	1.69	-0.08	1.98	0.20	1.47

(continued) Unilateral degrees of equivalence for the phase of the SE

f in Hz	KCRV X_{KC} in °	KCRV U_{KC} in °	CENAM D_i in °	CENAM U_{D_i} in °	NMIJ D_i in °	NMIJ U_{D_i} in °	NIM D_i in °	NIM U_{D_i} in °	NMIA D_i in °	NMIA U_{D_i} in °	INMETRO D_i in °	INMETRO U_{D_i} in °
10	0.006	0.083	-0.01	0.29	-0.02	0.49	0.05	0.49	-0.03	0.29	-0.01	0.18
12.5	-0.006	0.083	0.01	0.29	-0.03	0.49	0.06	0.49	-0.01	0.29	0.01	0.18
16	0.000	0.082	-0.00	0.29	-0.02	0.39	0.05	0.49	-0.01	0.29	-0.00	0.18
20	-0.001	0.081	0.00	0.29	-0.02	0.29	0.04	0.49	-0.01	0.29	0.00	0.18
25	-0.006	0.081	-0.00	0.29	-0.01	0.29	0.04	0.49	-0.00	0.29	0.01	0.18
31.5	-0.006	0.081	0.01	0.29	-0.02	0.29	0.03	0.49	-0.00	0.29	0.01	0.18
40	-0.006	0.081	0.01	0.29	-0.01	0.29	0.03	0.49	-0.00	0.29	0.01	0.18
63	-0.013	0.081	-0.04	0.29	-0.02	0.29	0.02	0.49	0.00	0.29	0.01	0.18
80	-0.011	0.081	0.01	0.29	-0.02	0.29	0.01	0.49	0.00	0.29	0.01	0.18
100	-0.008	0.081	-0.02	0.29	-0.03	0.29	0.02	0.49	0.01	0.29	0.01	0.18
125	-0.000	0.084	-0.02	0.29	-0.05	0.29	0.01	0.49	0.00	0.29	0.00	0.18
160	-0.010	0.084	-0.01	0.29	-0.03	0.29	0.03	0.49	0.01	0.29	-0.00	0.18
200	0.024	0.085	-0.05	0.29	-0.01	0.29	-0.06	0.49	-0.01	0.29	-0.03	0.18
250	0.003	0.086	-0.05	0.29	0.01	0.29	-0.00	0.49	0.01	0.29	-0.01	0.18
315	0.005	0.085	-0.05	0.29	0.00	0.29	0.00	0.49	0.00	0.29	-0.02	0.18
400	-0.001	0.084	-0.02	0.29	0.01	0.29	0.00	0.49	0.03	0.29	-0.01	0.18
500	-0.004	0.084	-0.01	0.29	0.00	0.29	0.00	0.49	-0.01	0.29	-0.01	0.18
630	0.001	0.084	-0.02	0.29	-0.02	0.29	-0.00	0.49	0.02	0.29	-0.01	0.18
800	-0.006	0.084	-0.02	0.29	0.03	0.29	0.03	0.49	0.03	0.29	-0.01	0.18
1000	-0.007	0.089	-0.00	0.29	0.02	0.29	-0.01	0.49	0.04	0.49	-0.01	0.18
1250	-0.021	0.104	0.00	0.28	0.01	0.28	-0.01	0.49	0.09	0.49	0.00	0.17
1500	-0.048	0.104	-0.05	0.28	-0.01	0.28	0.01	0.49	0.09	0.49	0.02	0.17
1600	-0.040	0.104	-0.04	0.28	0.05	0.28	-0.01	0.49	0.04	0.49	0.01	0.17
2000	-0.049	0.104	-0.04	0.28	0.09	0.28	-0.00	0.49	0.08	0.49	0.01	0.17
2500	-0.066	0.109	-0.02	0.28	0.08	0.28	-0.01	0.49	0.11	0.49	0.02	0.21
3000	-0.088	0.109	-0.03	0.28	0.08	0.28	-0.00	0.49	0.10	0.49	0.03	0.21
3150	-0.108	0.115	-0.09	0.28	0.14	0.28	-0.01	0.49	0.14	0.49	0.05	0.32
3500	-0.111	0.115	-0.05	0.28	0.12	0.28	-0.02	0.49	0.14	0.49	0.04	0.32
4000	-0.152	0.118	-0.05	0.28	0.14	0.28	0.00	0.49	0.21	0.49	0.07	0.49
4500	-0.170	0.119	-0.04	0.28	0.19	0.28	0.00	0.49	0.22	0.59	0.08	0.49
5000	-0.208	0.134	-0.11	0.27	0.18	0.38	0.01	0.48	0.25	0.58	0.11	0.48
5500	-0.170	0.176	-0.13	0.47	0.18	0.36	-0.13	0.98	0.22	0.57	0.06	0.78
6000	-0.194	0.176	-0.20	0.47	0.20	0.36	-0.07	0.98	0.22	0.57	0.07	0.78
6300	-0.201	0.176	-0.25	0.47	0.17	0.36	-0.07	0.98	0.23	0.57	0.07	0.78
6500	-0.219	0.176	-0.21	0.47	0.20	0.36	-0.06	0.98	0.27	0.57	0.08	0.78
7000	-0.229	0.180	-0.24	0.47	0.25	0.36	-0.05	0.98	0.32	0.78	0.08	0.78
7500	-0.237	0.181	-0.21	0.47	0.27	0.36	-0.05	0.98	0.30	0.78	0.08	0.98
8000	-0.230	0.191	-0.21	0.46	0.23	0.35	-0.14	0.98	0.25	0.78	0.06	0.98
8500	-0.274	0.191	-0.18	0.46	0.21	0.35	-0.19	0.98	0.23	0.78	0.08	0.98
9000	-0.379	0.191	-0.15	0.46	0.22	0.35	-0.15	0.98	0.03	0.78	0.18	0.98
9500	-0.254	0.191	-0.25	0.46	0.20	0.35	-0.16	0.98	0.28	0.78	0.03	0.98
10000	-0.274	0.197	-0.22	0.46	0.30	0.35	-0.21	0.98	0.29	0.78	0.04	0.98
10500	-0.283	0.239	-0.27	0.44	0.20	0.32	-0.24	1.48	0.31	1.18	0.03	1.18
11000	-0.329	0.256	-0.21	0.43	0.37	0.43	-0.23	1.48	0.37	1.17	0.07	1.17
11500	-0.332	0.239	-0.25	0.44	0.28	0.32	-0.23	1.48	0.38	1.18	0.05	1.18
12000	-0.304	0.239	-0.33	0.44	0.35	0.32	-0.23	1.48	0.37	1.18	0.01	1.18
12500	-0.330	0.245	-0.34	0.44	0.29	0.32	-0.22	1.48	0.40	1.17	0.02	1.17
13000	-0.365	0.266	-0.27	0.42	0.39	0.42	-0.27	1.48	0.51	1.48	0.04	1.17
13500	-0.379	0.266	-0.26	0.42	0.32	0.42	-0.21	1.48	0.51	1.48	0.04	1.17
14000	-0.378	0.266	-0.34	0.42	0.43	0.42	-0.22	1.48	0.50	1.48	0.02	1.17
14500	-0.402	0.266	-0.25	0.42	0.30	0.42	-0.28	1.48	0.57	1.48	0.02	1.17
15000	-0.421	0.269	-0.23	0.42	0.36	0.42	-0.35	1.48	0.51	1.48	0.02	1.17
15500	-0.476	0.286	-0.22	0.41	0.45	0.41	-0.25	1.47	0.64	1.98	0.06	1.17
16000	-0.537	0.288	-0.16	0.41	0.36	0.41	-0.17	1.47	0.59	1.98	0.11	1.17
16500	-0.587	0.303	-0.19	0.40	0.51	0.52	-0.31	1.47	0.72	1.98	0.14	1.16
17000	-0.692	0.332	-0.03	0.37	0.28	0.94	-0.29	1.46	0.59	1.97	0.22	1.15
17500	-0.760	0.332	0.04	0.37	0.26	0.94	-0.40	1.46	0.55	1.97	0.27	1.15
18000	-0.846	0.332	0.06	0.37	0.12	0.94	-0.22	1.46	0.58	1.97	0.34	1.15
18500	-0.897	0.336	-0.03	0.37	0.47	1.05	-0.18	1.46	0.93	1.97	0.37	1.15
19000	-0.831	0.332	-0.10	0.37	0.17	0.94	-0.31	1.46	0.63	1.97	0.28	1.15
19500	-0.659	0.303	-0.27	0.40	0.50	0.52	-0.26	1.47	0.77	1.98	0.08	1.16
20000	-0.713	0.303	-0.33	0.40	0.52	0.52	-0.27	1.47	0.90	1.98	0.11	1.16

(continued) Unilateral degrees of equivalence for the phase of the SE

f in Hz	KCRV X_{KC} in °	KCRV U_{KC} in °	NMISA D_i in °	NMISA U_{D_i} in °	VNIIM D_i in °	VNIIM U_{D_i} in °	NMC,A*STAR D_i in °	NMC,A*STAR U_{D_i} in °	UkrMet D_i in °	UkrMet U_{D_i} in °
10	0.006	0.083	0.03	0.18	0.03	1.00	-0.01	0.31	-0.02	0.49
12.5	-0.006	0.083	0.03	0.18	0.03	1.00	0.02	0.31	0.01	0.49
16	0.000	0.082	0.02	0.18	0.04	1.00	0.01	0.31	-0.02	0.49
20	-0.001	0.081	0.02	0.18	0.07	0.49	0.02	0.35	-0.03	0.49
25	-0.006	0.081	0.02	0.18	-0.03	0.49	0.04	0.35	-0.04	0.49
31.5	-0.006	0.081	0.02	0.18	-0.07	0.49	0.04	0.35	-0.05	0.49
40	-0.006	0.081	0.02	0.18	-0.00	0.49	0.05	0.35	-0.02	0.49
63	-0.013	0.081	0.01	0.18	-0.06	0.49	0.04	0.35	-0.03	0.49
80	-0.011	0.081	0.01	0.18	-0.05	0.49	0.04	0.35	-0.01	0.49
100	-0.008	0.081	0.01	0.18	-0.07	0.49	0.03	0.35	-0.00	0.49
125	-0.000	0.084	0.00	0.29	-0.02	0.49	0.18	0.35	-0.06	0.49
160	-0.010	0.084	-0.02	0.29	0.06	0.49	0.05	0.35	-0.04	0.49
200	0.024	0.085	-0.04	0.29	0.59	0.49	0.05	0.35	0.16	0.49
250	0.003	0.086	-0.02	0.29	1.27*	0.51*	0.03	0.35	0.19	0.49
315	0.005	0.085	-0.03	0.29	0.24	0.49	0.02	0.35	-0.03	0.49
400	-0.001	0.084	-0.03	0.29	0.01	0.49	0.03	0.35	0.01	0.49
500	-0.004	0.084	-0.04	0.29	0.04	0.49	0.03	0.35	0.09	0.49
630	0.001	0.084	-0.03	0.29	0.10	0.49	0.05	0.35	0.13	0.49
800	-0.006	0.084	-0.06	0.29	0.10	0.49	0.03	0.35	0.16	0.49
1000	-0.007	0.089	-0.07	0.29	0.11	0.49	0.07	0.61	0.18	0.49
1250	-0.021	0.104	-0.07	0.49	0.07	0.49	0.05	0.61	-0.07	0.69
1500	-0.048	0.104	-0.05	0.49	0.11	0.49	0.08	0.61	0.07	0.69
1600	-0.040	0.104	-0.07	0.49	0.08	0.49	0.05	0.61	0.05	0.69
2000	-0.049	0.104	-0.08	0.49	0.03	0.49	0.08	0.61	0.06	0.69
2500	-0.066	0.109	-0.07	0.49	-0.01	0.49	0.11	0.61	0.11	0.69
3000	-0.088	0.109	-0.09	0.49	-0.01	0.49	0.11	0.61	0.07	0.69
3150	-0.108	0.115	-0.10	0.49	-0.08	0.49	0.15	0.61	0.04	0.69
3500	-0.111	0.115	-0.10	0.49	-0.15	0.49	0.16	0.61	0.09	0.69
4000	-0.152	0.118	-0.10	0.49	-0.26	0.49	0.23	0.61	-0.04	0.69
4500	-0.170	0.119	-0.10	0.49	-0.39	0.49	0.21	0.61	-0.01	0.69
5000	-0.208	0.134	-0.11	0.79	-0.47	0.48	0.24	0.65	-0.15	0.69
5500	-0.170	0.176	-0.17	0.78	-0.57	0.98	0.23	0.64	-0.19	1.49
6000	-0.194	0.176	-0.16	0.78	-0.60	0.98	0.21	0.64	-0.43	1.49
6300	-0.201	0.176	-0.20	0.78	-0.76	0.98	0.25	0.64	-0.23	1.49
6500	-0.219	0.176	-0.18	0.78	-0.72	0.98	0.19	0.64	-0.32	1.49
7000	-0.229	0.180	-0.25	0.78	-0.69	0.98	0.26	0.64	-0.28	1.49
7500	-0.237	0.181	-0.29	0.78	-0.91	0.98	0.27	0.63	-0.23	1.49
8000	-0.230	0.191	-0.28	0.78	-1.02	0.98	0.20	0.63	-0.42	1.49
8500	-0.274	0.191	-0.26	0.78	-1.11	0.98	0.15	0.63	-0.41	1.49
9000	-0.379	0.191	0.38	0.78	-0.92	0.98	-0.05	0.63	-0.31	1.49
9500	-0.254	0.191	-0.39	0.78	-0.84	0.98	0.27	0.63	-0.44	1.49
10000	-0.274	0.197	-0.36	0.78	-1.29	0.98	0.22	1.20	-0.19	1.49
10500	-0.283	0.239	-0.36	0.76	-0.84	1.48	0.20	1.20	-0.43	1.99
11000	-0.329	0.256	-0.36	0.76	-1.06	1.48	0.24	1.19	-0.47	1.98
11500	-0.332	0.239	-0.42	0.76	-1.13	1.48	0.25	1.20	-0.49	1.99
12000	-0.304	0.239	-0.49	0.76	-0.92	1.48	0.24	1.20	-0.69	1.99
12500	-0.330	0.245	-0.51	1.17	-1.01	1.48	0.27	1.20	-0.48	1.98
13000	-0.365	0.266	-0.52	1.17	-0.98	1.48	0.28	1.19	-0.61	1.98
13500	-0.379	0.266	-0.55	1.17	-0.64	1.48	0.30	1.19	-0.43	1.98
14000	-0.378	0.266	-0.56	1.17	-0.97	1.48	0.32	1.19	0.35	1.98
14500	-0.402	0.266	-0.62	1.17	-0.91	1.48	0.33	1.19	0.28	1.98
15000	-0.421	0.269	-0.59	1.17	-0.99	1.48	0.29	1.64	0.07	1.98
15500	-0.476	0.286	-0.54	1.57	-1.59	1.47	0.31	1.64	-0.34	2.99
16000	-0.537	0.288	-0.49	1.57	-2.09	1.47	0.36	1.63	0.03	2.99
16500	-0.587	0.303	-0.43	1.57	-1.91	1.47	0.33	1.63	0.37	2.98
17000	-0.692	0.332	-0.23	1.57	-0.96	1.46	0.23	1.63	0.32	2.98
17500	-0.760	0.332	0.04	1.57	-0.72	1.46	0.05	1.63	-0.25	2.98
18000	-0.846	0.332	0.22	1.57	-1.20	1.46	-0.09	1.63	-0.26	2.98
18500	-0.897	0.336	-0.02	1.56	-1.08	1.46	0.30	1.63	0.13	2.98
19000	-0.831	0.332	-0.49	1.57	0.01	1.46	0.26	1.63	0.16	2.98
19500	-0.659	0.303	-0.57	1.57	-0.67	1.47	0.19	1.63	0.45	2.98
20000	-0.713	0.303	-0.56	1.57	-0.74	1.47	0.36	1.63	0.56	2.98

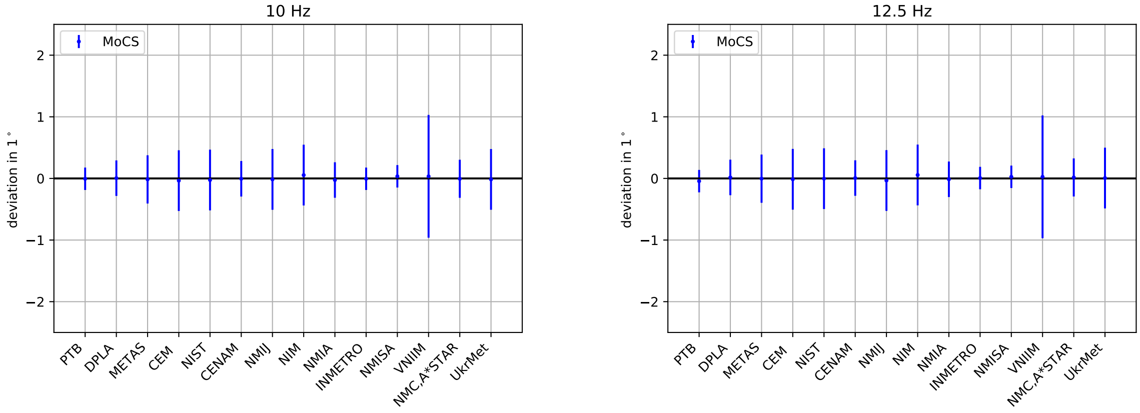

Figure 8.63: deviation of the phase for the frequencies 10 Hz and 12.5 Hz for the SE

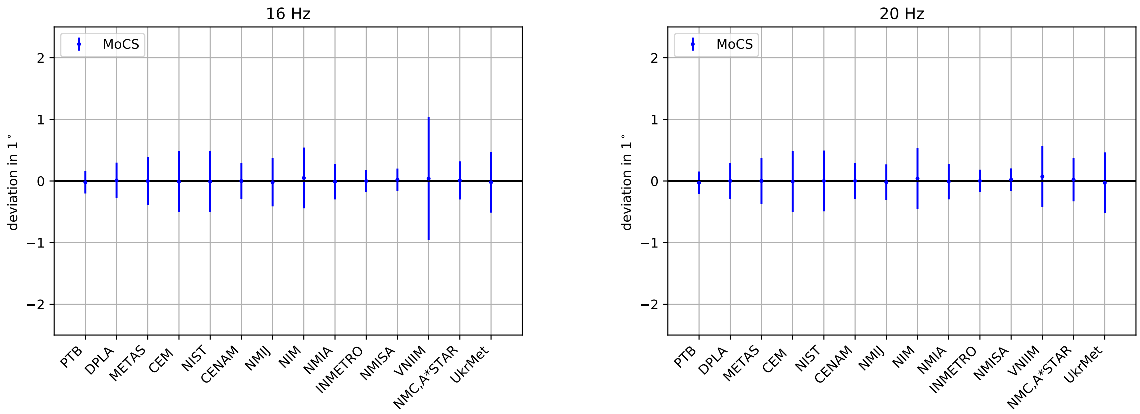

Figure 8.64: deviation of the phase for the frequencies 16 Hz and 20 Hz for the SE

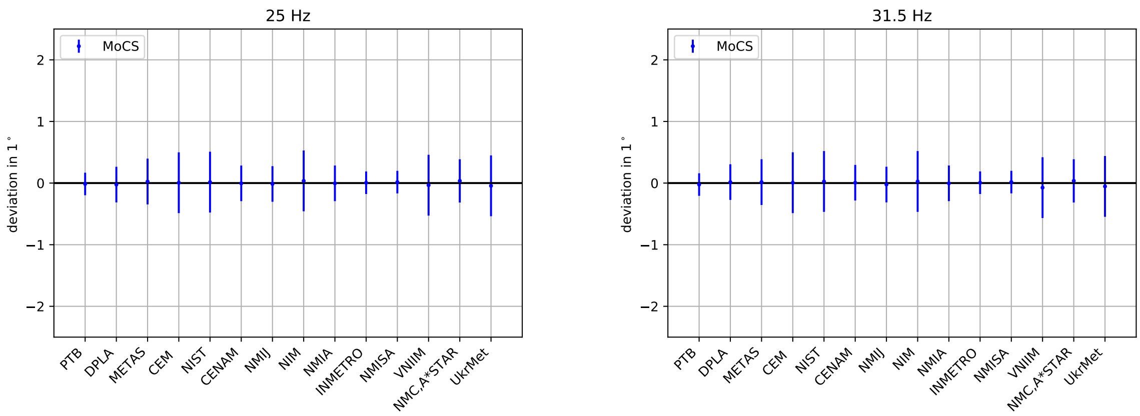

Figure 8.65: deviation of the phase for the frequencies 25 Hz and 31.5 Hz for the SE

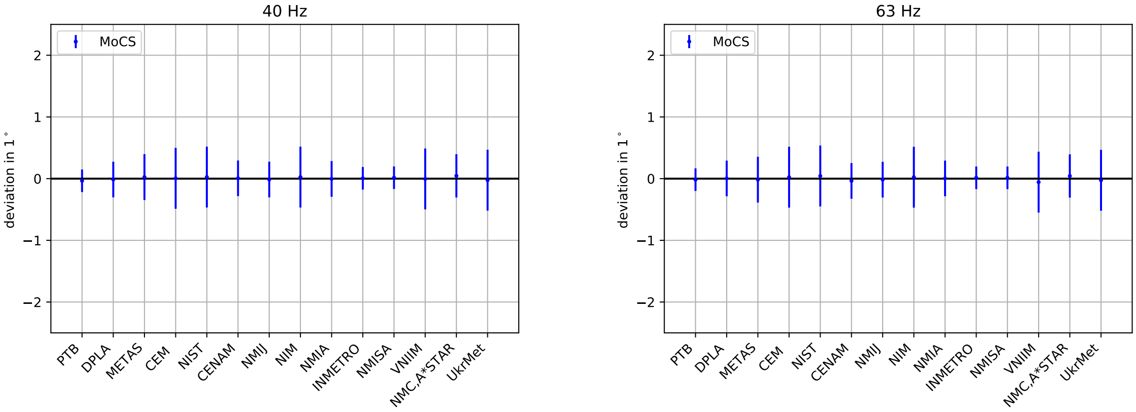

Figure 8.66: deviation of the phase for the frequencies 40 Hz and 63 Hz for the SE

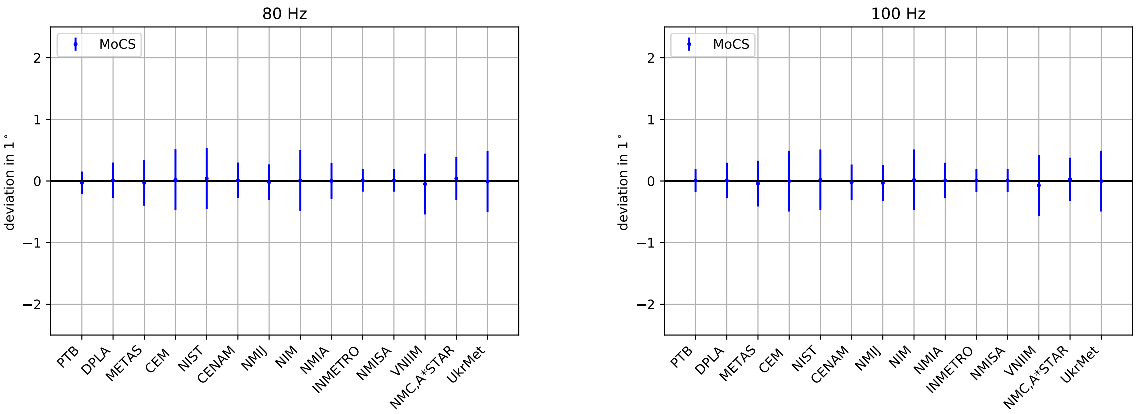

Figure 8.67: deviation of the phase for the frequencies 80 Hz and 100 Hz for the SE

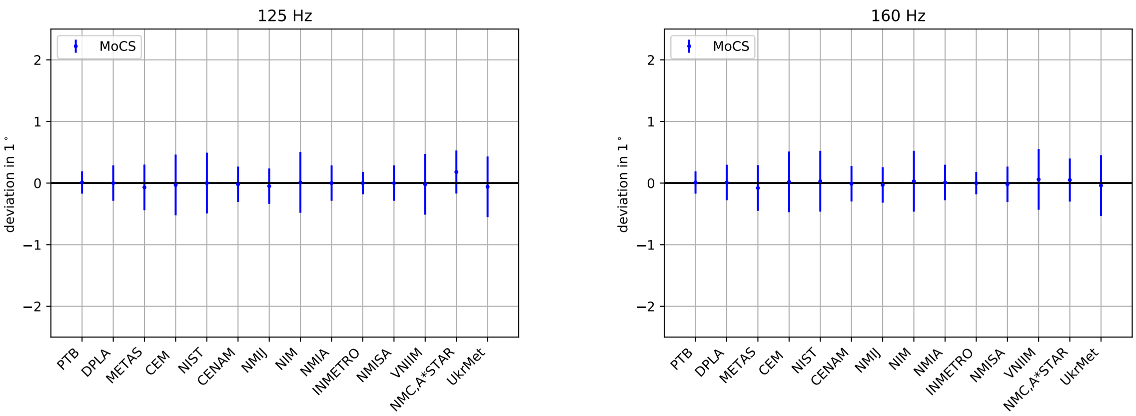

Figure 8.68: deviation of the phase for the frequencies 125 Hz and 160 Hz for the SE

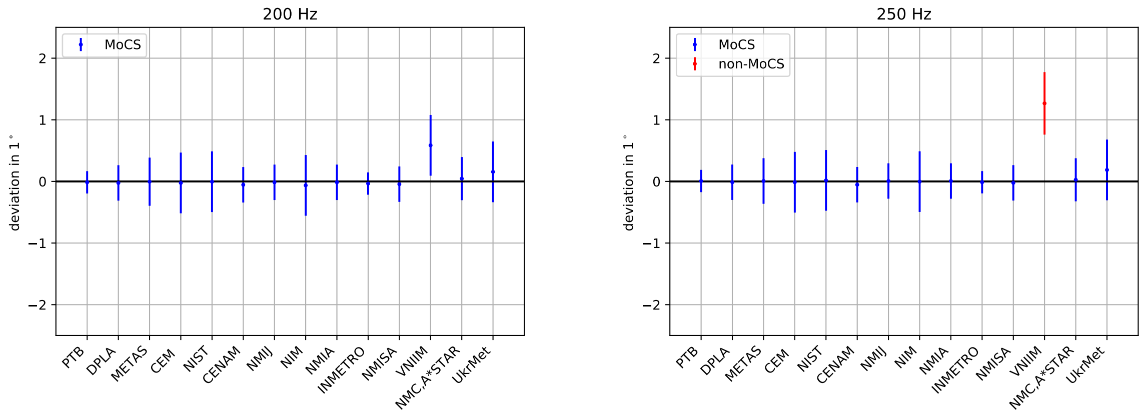

Figure 8.69: deviation of the phase for the frequencies 200 Hz and 250 Hz for the SE

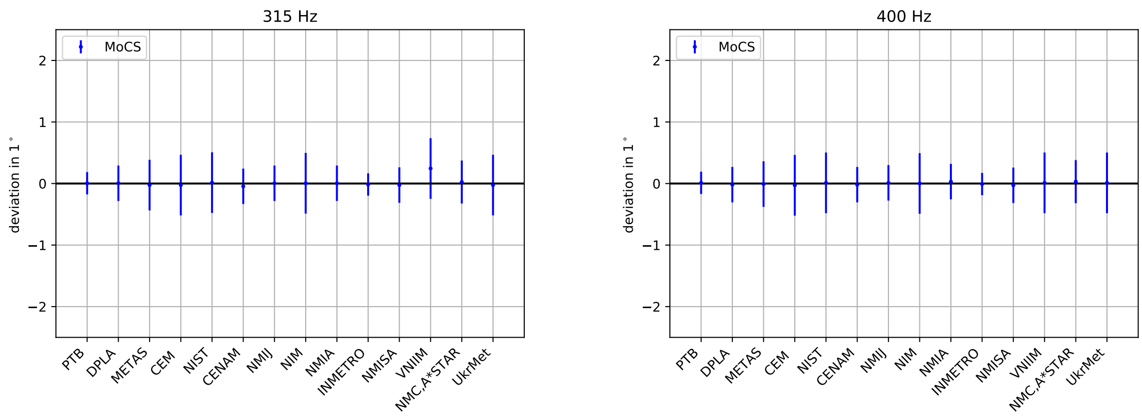

Figure 8.70: deviation of the phase for the frequencies 315 Hz and 400 Hz for the SE

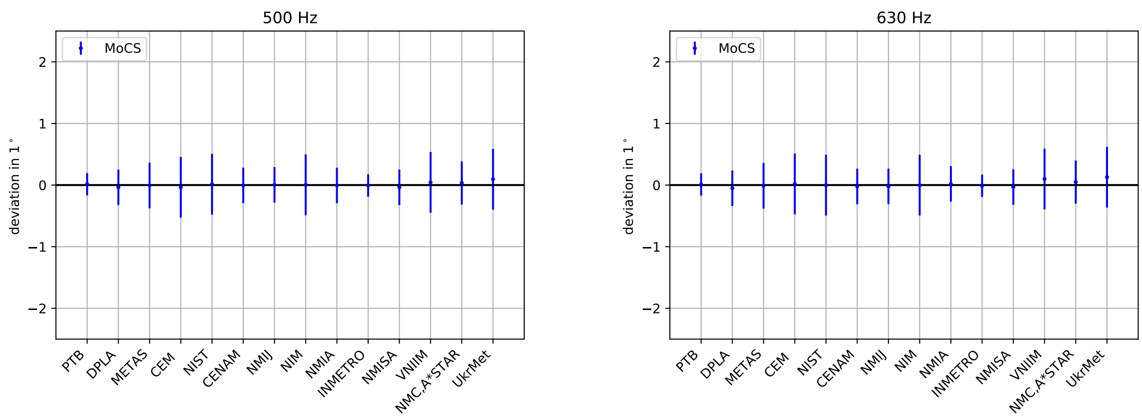

Figure 8.71: deviation of the phase for the frequencies 500 Hz and 630 Hz for the SE

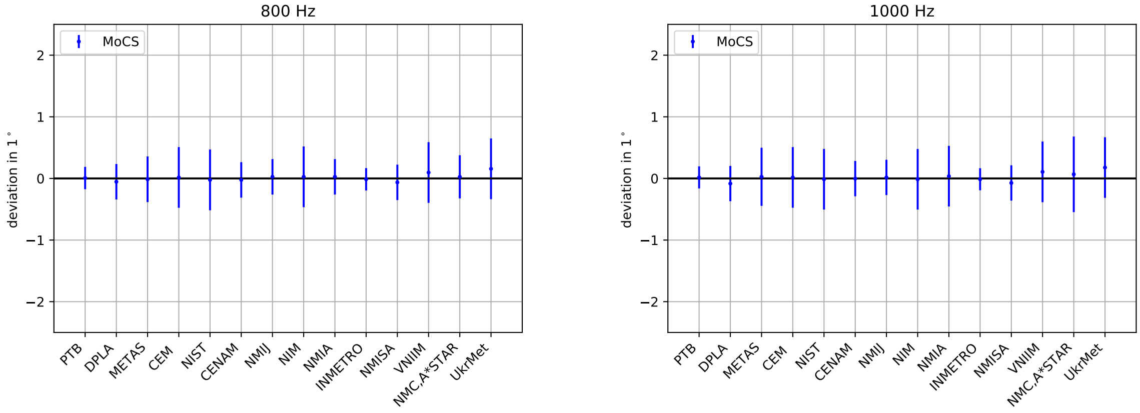

Figure 8.72: deviation of the phase for the frequencies 800 Hz and 1000 Hz for the SE

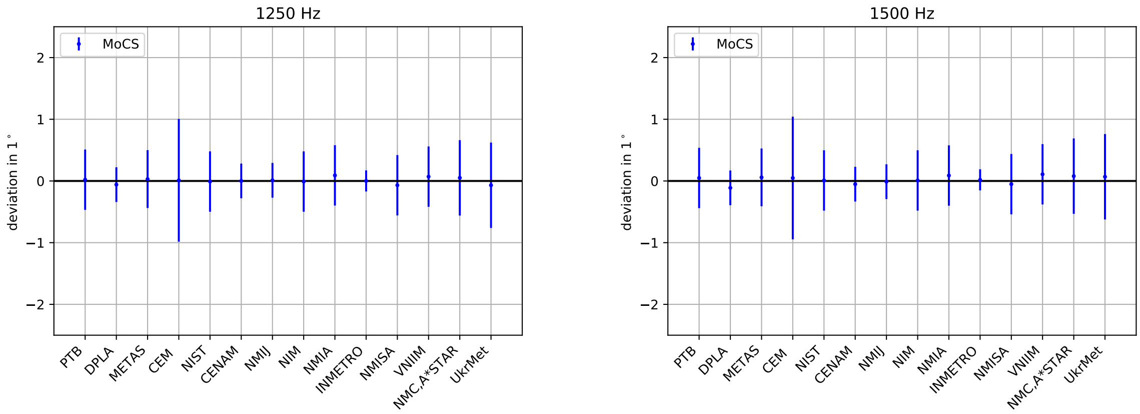

Figure 8.73: deviation of the phase for the frequencies 1250 Hz and 1500 Hz for the SE

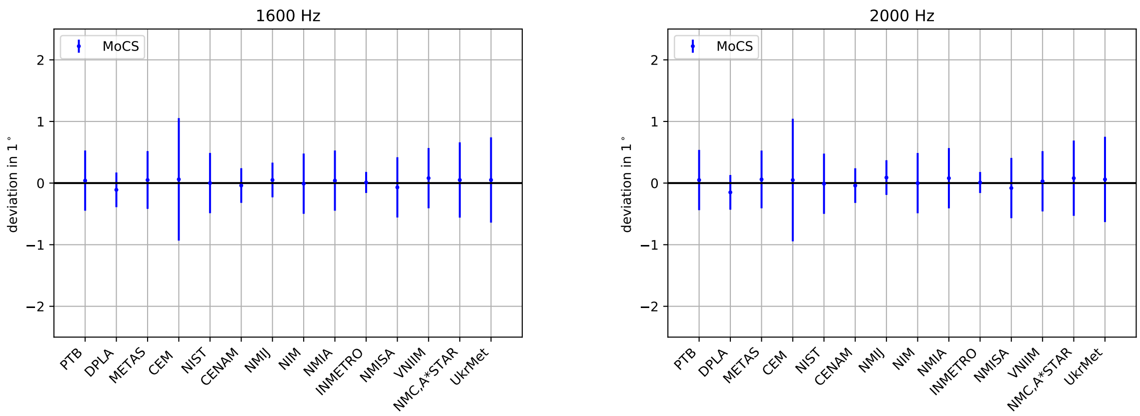

Figure 8.74: deviation of the phase for the frequencies 1600 Hz and 2000 Hz for the SE

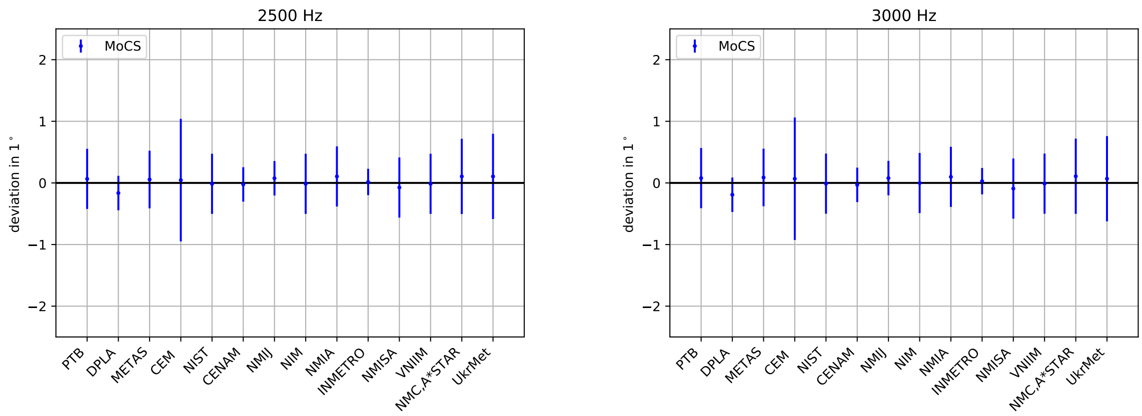

Figure 8.75: deviation of the phase for the frequencies 2500 Hz and 3000 Hz for the SE

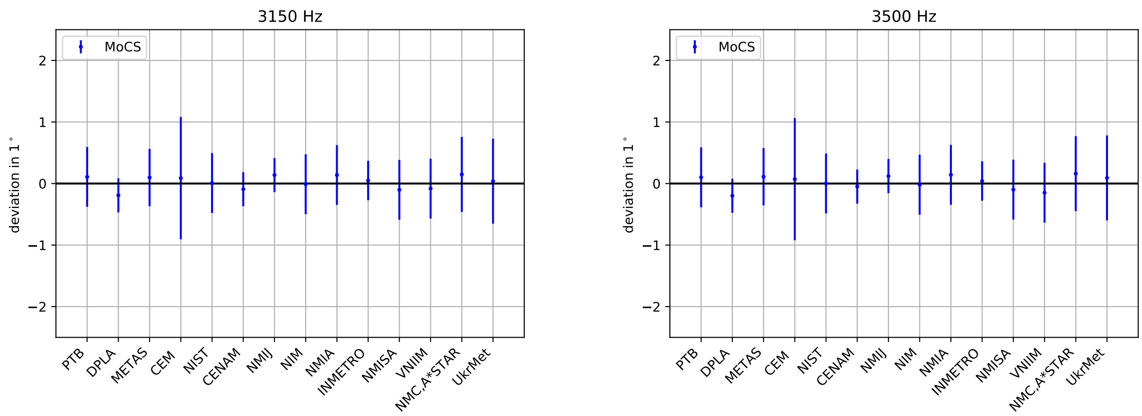

Figure 8.76: deviation of the phase for the frequencies 3150 Hz and 3500 Hz for the SE

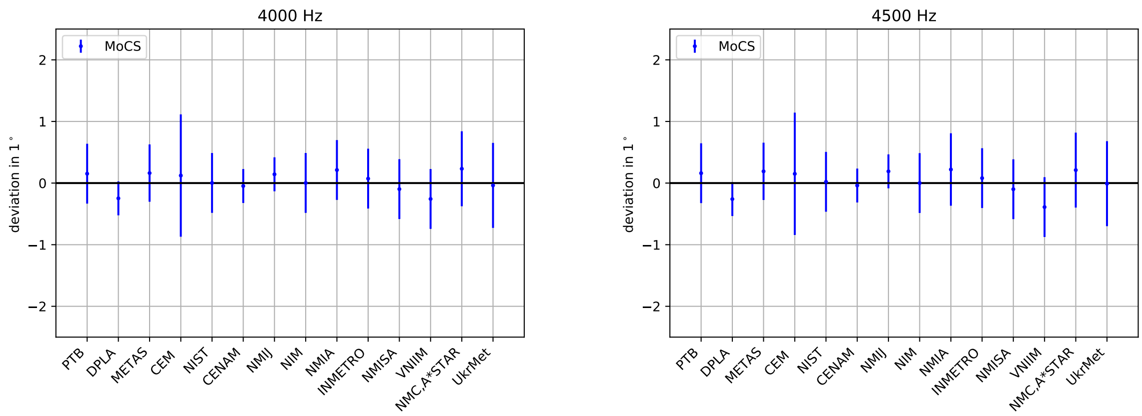

Figure 8.77: deviation of the phase for the frequencies 4000 Hz and 4500 Hz for the SE

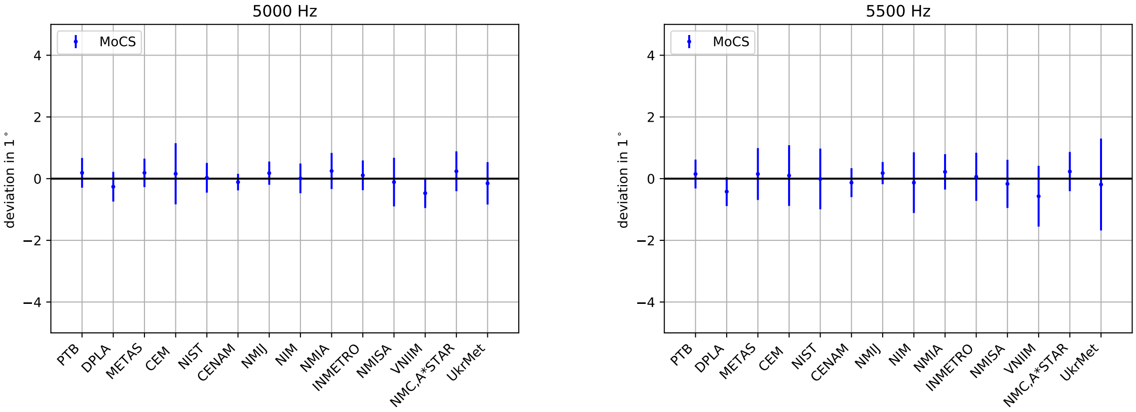

Figure 8.78: deviation of the phase for the frequencies 5000 Hz and 5500 Hz for the SE

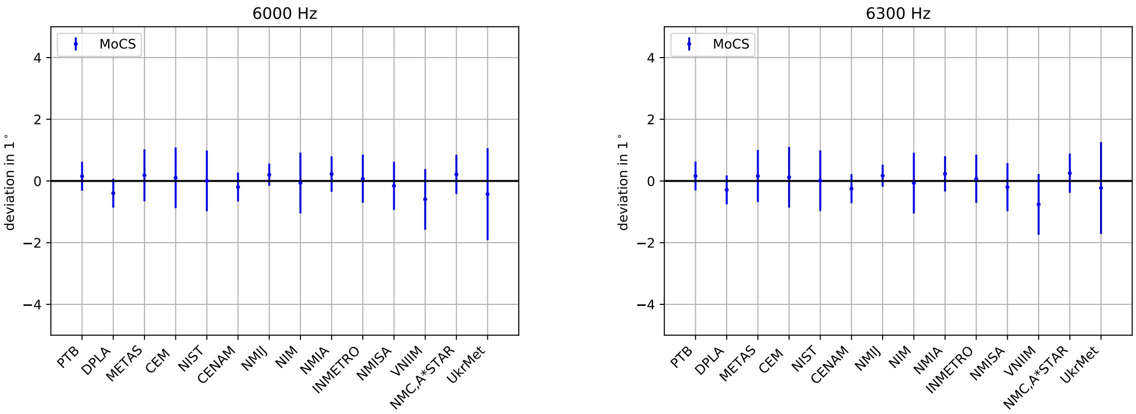

Figure 8.79: deviation of the phase for the frequencies 6000 Hz and 6300 Hz for the SE

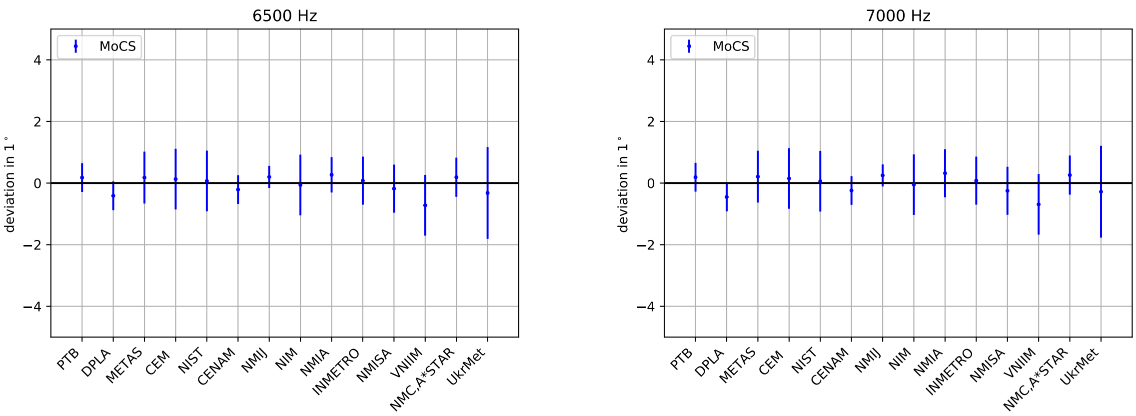

Figure 8.80: deviation of the phase for the frequencies 6500 Hz and 7000 Hz for the SE

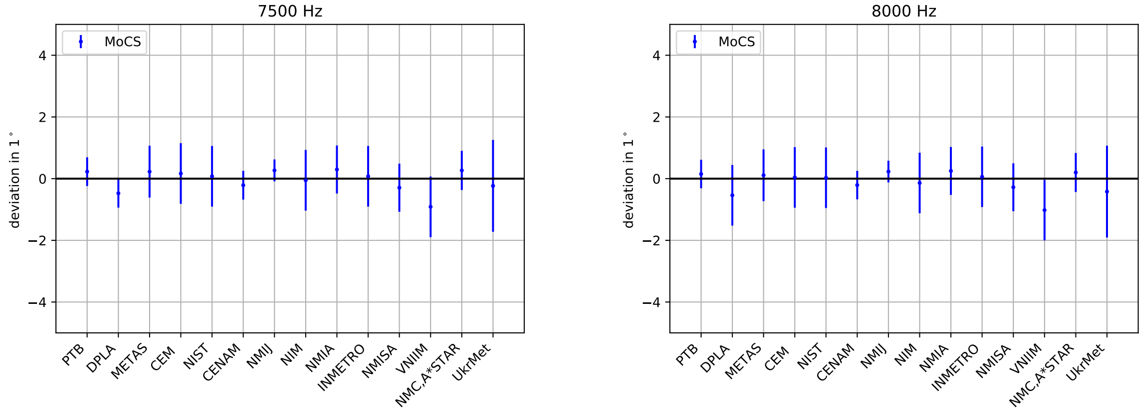

Figure 8.81: deviation of the phase for the frequencies 7500 Hz and 8000 Hz for the SE

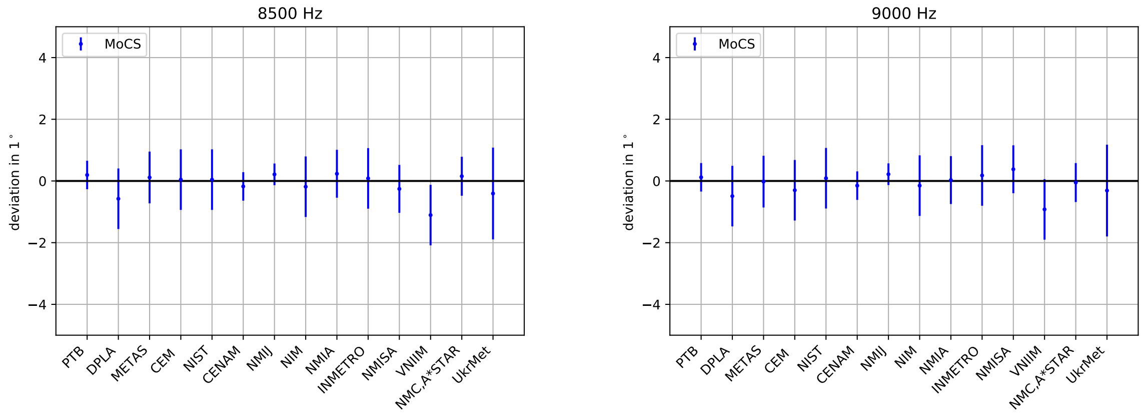

Figure 8.82: deviation of the phase for the frequencies 8500 Hz and 9000 Hz for the SE

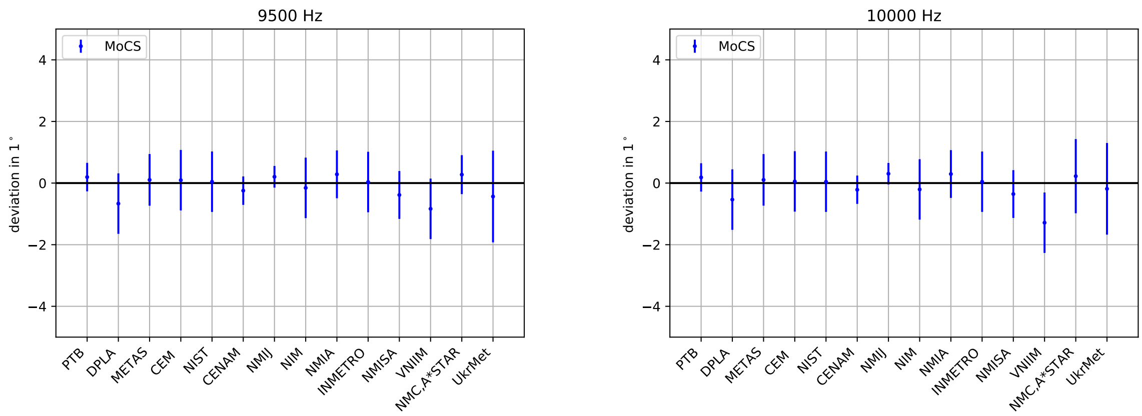

Figure 8.83: deviation of the phase for the frequencies 9500 Hz and 10000 Hz for the SE

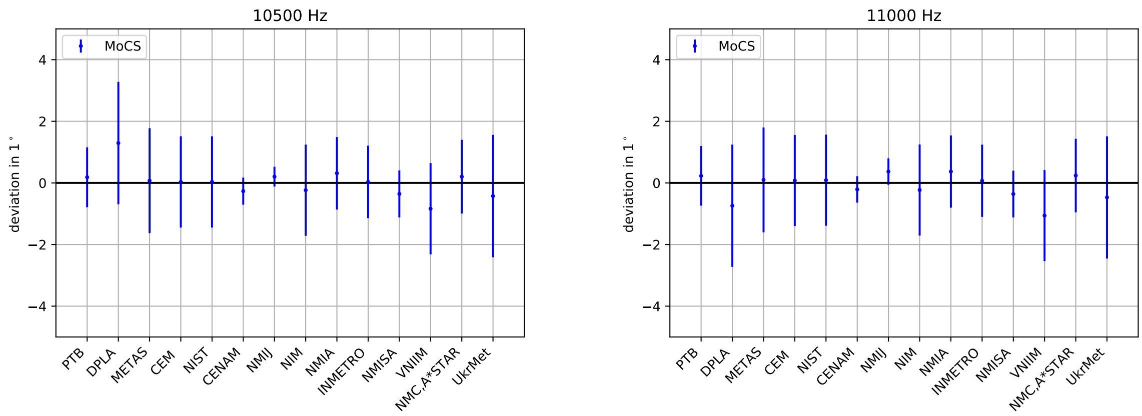

Figure 8.84: deviation of the phase for the frequencies 10500 Hz and 11000 Hz for the SE

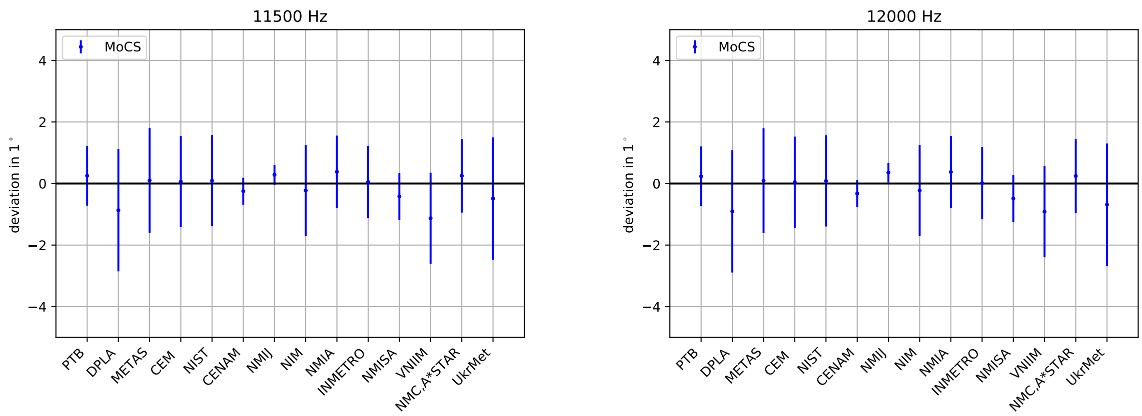

Figure 8.85: deviation of the phase for the frequencies 11500 Hz and 12000 Hz for the SE

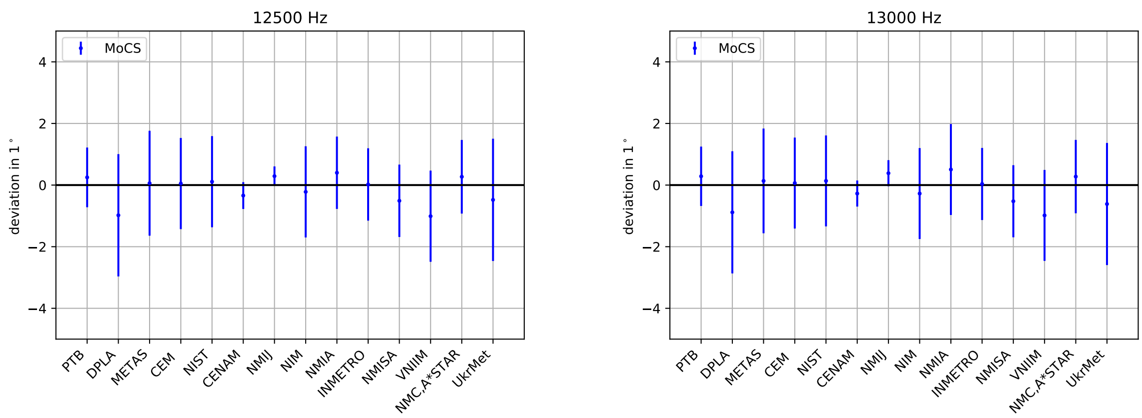

Figure 8.86: deviation of the phase for the frequencies 12500 Hz and 13000 Hz for the SE

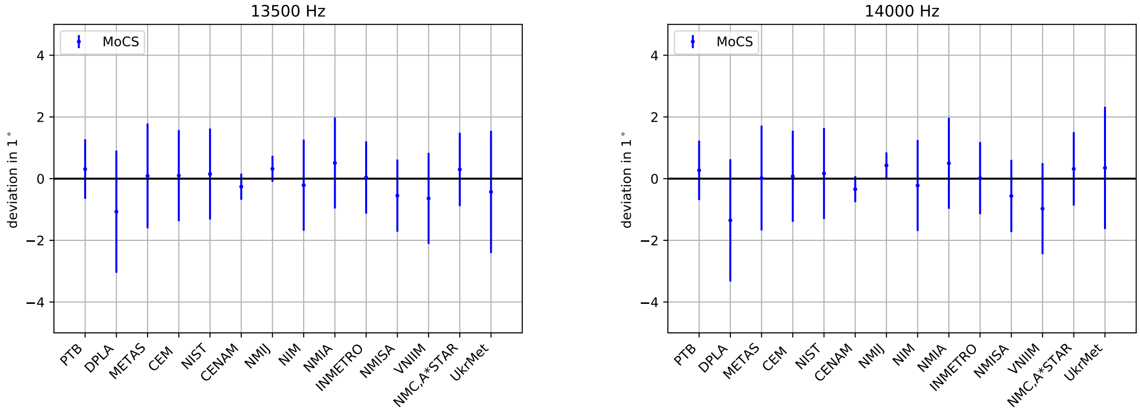

Figure 8.87: deviation of the phase for the frequencies 13500 Hz and 14000 Hz for the SE

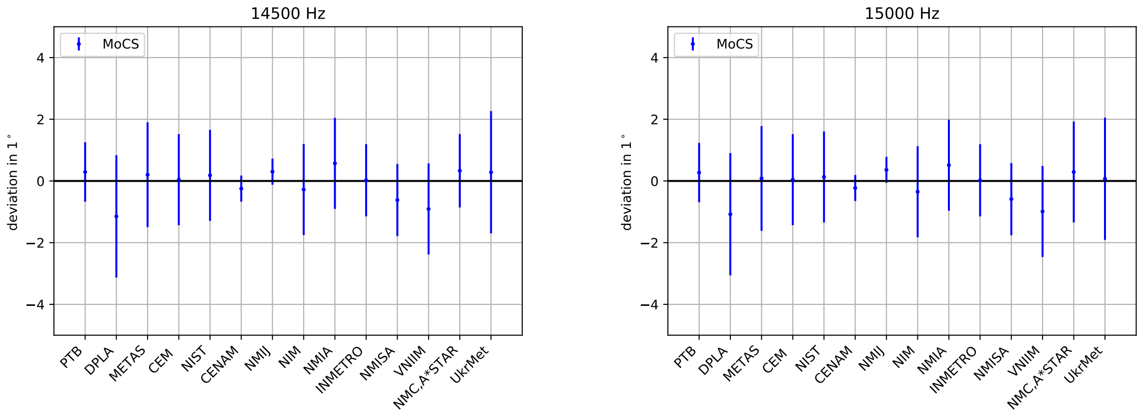

Figure 8.88: deviation of the phase for the frequencies 14500 Hz and 15000 Hz for the SE

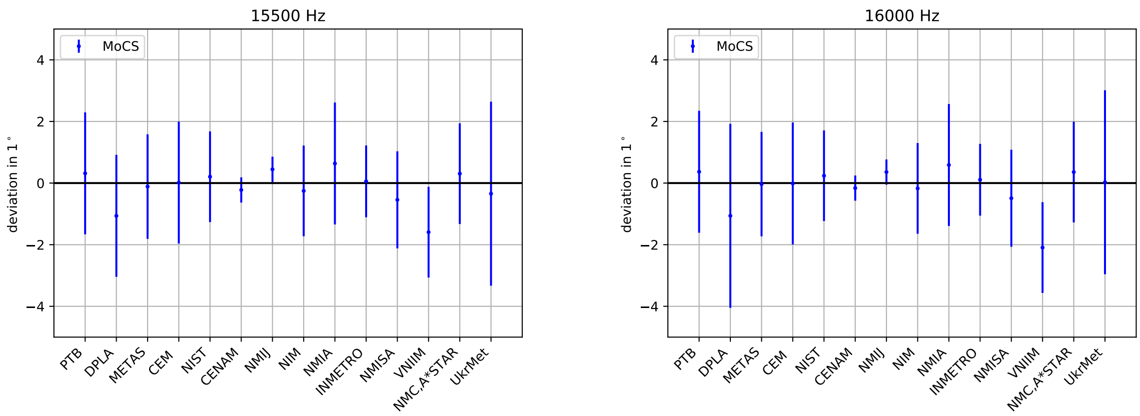

Figure 8.89: deviation of the phase for the frequencies 15500 Hz and 16000 Hz for the SE

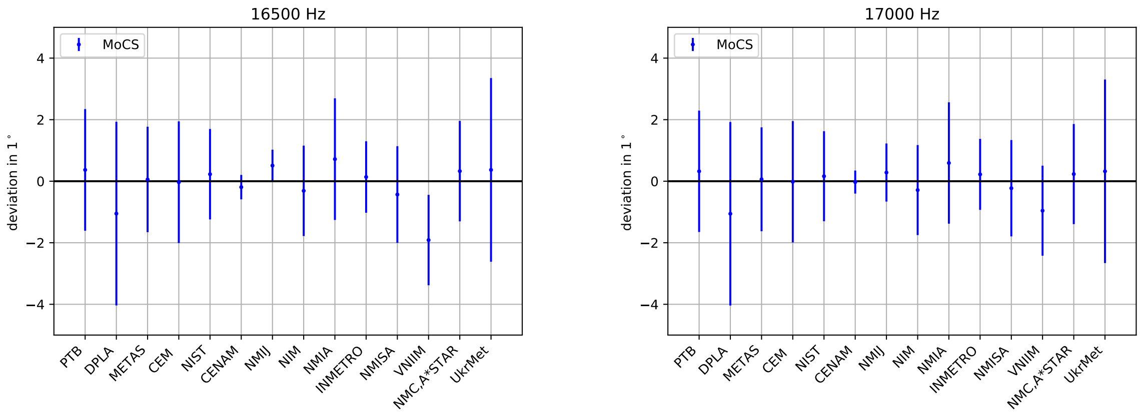

Figure 8.90: deviation of the phase for the frequencies 16500 Hz and 17000 Hz for the SE

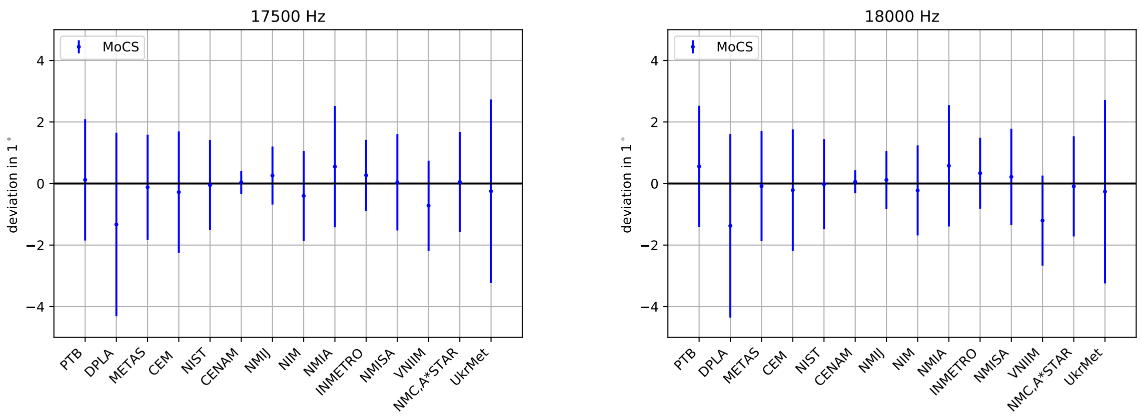

Figure 8.91: deviation of the phase for the frequencies 17500 Hz and 18000 Hz for the SE

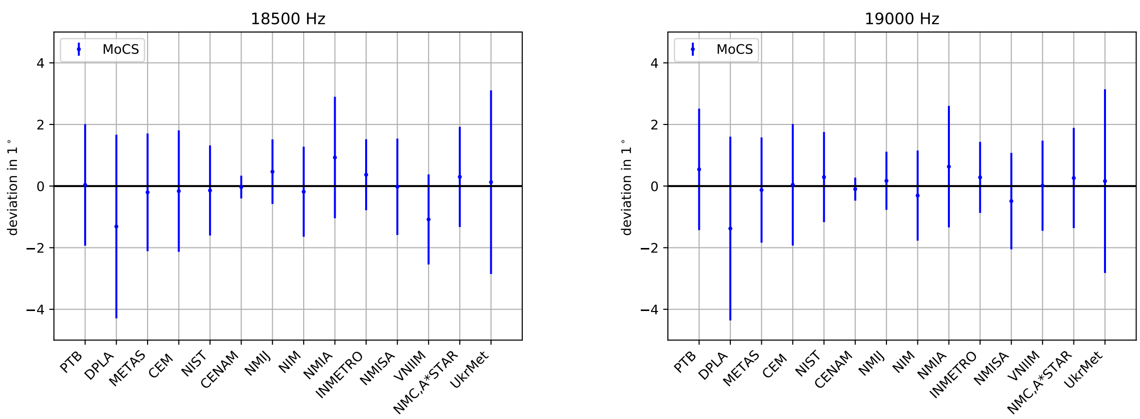

Figure 8.92: deviation of the phase for the frequencies 18500 Hz and 19000 Hz for the SE

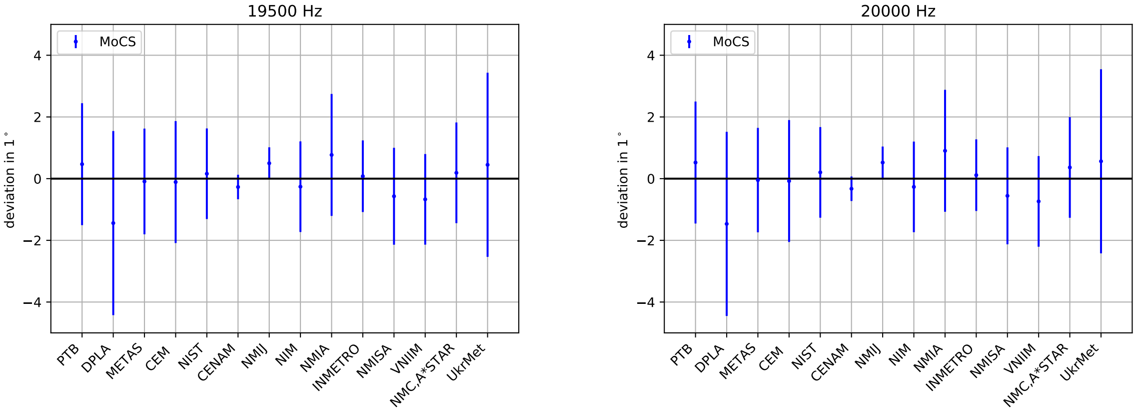

Figure 8.93: deviation of the phase for the frequencies 19500 Hz and 20000 Hz for the SE

8.6 Phase of the Complex Sensitivity of the BB

Table 8.4: Unilateral degrees of equivalence for the phase of the BB

f in Hz	KCRV X_{KC} in °	KCRV U_{KC} in °	PTB D_i in °	PTB U_{D_i} in °	DPLA D_i in °	DPLA U_{D_i} in °	METAS D_i in °	METAS U_{D_i} in °	CEM D_i in °	CEM U_{D_i} in °	NIST D_i in °	NIST U_{D_i} in °
10	179.987	0.081	-0.03	0.18	-0.02	0.29	-0.04	0.39	-0.03	0.49	0.00	0.49
12.5	179.988	0.081	-0.06	0.18	-0.02	0.29	0.11	0.39	-0.03	0.49	0.00	0.49
16	179.994	0.081	-0.02	0.18	-0.01	0.29	-0.01	0.39	-0.03	0.49	-0.01	0.49
20	179.988	0.081	-0.02	0.18	-0.02	0.29	0.03	0.37	-0.03	0.49	0.00	0.49
25	179.986	0.081	-0.01	0.18	-0.04	0.29	0.05	0.37	-0.03	0.49	0.01	0.49
31.5	179.985	0.081	-0.02	0.18	0.01	0.29	0.03	0.37	-0.00	0.49	0.02	0.49
40	179.982	0.081	-0.03	0.18	-0.02	0.29	0.02	0.37	-0.00	0.49	0.03	0.49
63	179.982	0.082	-0.02	0.18	-0.00	0.29	-0.03	0.37	0.01	0.49	0.03	0.49
80	179.972	0.081	-0.02	0.18	0.01	0.29	-0.03	0.37	0.01	0.49	0.05	0.49
100	179.979	0.081	0.00	0.18	0.01	0.29	-0.05	0.37	-0.01	0.49	0.03	0.49
125	179.981	0.084	0.01	0.18	-0.00	0.29	-0.07	0.37	-0.02	0.49	0.01	0.49
160	179.983	0.084	0.01	0.18	0.01	0.29	-0.09	0.37	-0.00	0.49	0.01	0.49
200	179.995	0.084	-0.01	0.18	-0.01	0.29	0.03	0.37	-0.02	0.49	0.02	0.49
250	179.999	0.084	-0.01	0.18	-0.01	0.29	0.00	0.37	-0.03	0.49	0.02	0.49
315	179.988	0.084	0.00	0.18	0.00	0.29	0.00	0.37	-0.03	0.49	0.04	0.49
400	179.988	0.084	0.00	0.18	-0.02	0.29	-0.02	0.37	-0.03	0.49	0.02	0.49
500	179.980	0.084	0.02	0.18	-0.02	0.29	0.00	0.37	-0.03	0.49	0.02	0.49
630	179.981	0.084	0.01	0.18	-0.03	0.29	-0.01	0.37	0.03	0.49	0.04	0.49
800	179.976	0.084	0.01	0.18	-0.06	0.29	-0.01	0.37	0.03	0.49	0.00	0.49
1000	179.976	0.089	0.02	0.18	-0.07	0.29	0.03	0.47	0.03	0.49	-0.01	0.49
1250	179.942	0.104	0.04	0.49	-0.05	0.28	0.06	0.47	0.04	0.99	0.05	0.49
1500	179.929	0.104	0.06	0.49	-0.16	0.28	0.06	0.47	0.08	0.99	0.04	0.49
1600	179.920	0.104	0.07	0.49	-0.21	0.28	0.08	0.47	0.08	0.99	0.04	0.49
2000	179.918	0.104	0.07	0.49	-0.17	0.28	0.08	0.47	0.08	0.99	0.04	0.49
2500	179.906	0.109	0.07	0.49	-0.17	0.28	0.07	0.47	0.07	0.99	0.03	0.49
3000	179.893	0.109	0.09	0.49	-0.17	0.28	0.10	0.47	0.09	0.99	0.02	0.49
3150	179.869	0.115	0.11	0.49	-0.20	0.28	0.11	0.47	0.10	0.99	0.03	0.49
3500	179.846	0.115	0.12	0.49	-0.17	0.28	0.14	0.47	0.12	0.99	0.05	0.49
4000	179.812	0.118	0.17	0.49	-0.13	0.28	0.19	0.47	0.16	0.99	0.06	0.49
4500	179.778	0.119	0.20	0.49	-0.32	0.28	0.21	0.46	0.21	0.99	0.07	0.49
5000	179.739	0.134	0.23	0.48	-0.16	0.48	0.23	0.46	0.22	0.99	0.06	0.48
5500	179.727	0.196	0.24	0.46	-0.28	0.46	0.27	0.84	0.22	0.98	0.03	0.98
6000	179.726	0.196	0.23	0.46	-0.29	0.46	0.26	0.84	0.20	0.98	-0.03	0.98
6300	179.715	0.196	0.25	0.46	-0.33	0.46	0.25	0.86	0.27	0.98	-0.06	0.98
6500	179.673	0.197	0.29	0.46	-0.32	0.46	0.29	0.88	0.30	0.98	0.05	0.98
7000	179.624	0.202	0.34	0.46	-0.33	0.46	0.35	1.00	0.42	0.98	0.01	0.98
7500	179.539	0.206	0.34	0.46	-0.34	0.46	0.10	1.24	0.21	0.98	0.00	0.98
8000	179.620	0.222	0.38	0.45	-0.63	0.98	0.33	1.42	0.21	0.98	-0.01	0.98
8500	179.569	0.223	0.30	0.45	-0.48	0.97	0.76	1.77	0.71	0.97	-0.19	0.97
9000	179.493	0.220	0.46	0.45	-0.42	0.98	0.60	1.10	0.68	0.98	-0.24	0.98
9500	179.841	0.244	0.26	0.44	-0.73	0.97	0.32	1.03	0.05	0.97	-0.36	0.97
10000	179.873	0.255	0.35	0.43	-0.83	0.97	0.28	0.90	0.17	0.97	0.17	0.97
10500	179.380	0.298	0.86	0.95	-0.54	1.98	0.69	1.71	0.60	1.47	0.47	1.47
11000	179.707	0.372	0.40	0.93	-0.80	1.97	0.38	1.70	0.32	1.45	0.05	1.45
11500	179.684	0.372	0.32	0.93	-0.87	1.97	0.44	1.70	0.23	1.45	-0.08	1.45
12000	179.693	0.372	0.29	0.93	-0.92	1.97	0.47	1.70	0.17	1.45	-0.14	1.45
12500	179.764	0.396	0.20	0.92	-0.98	1.96	0.29	1.67	0.12	1.45	-0.24	1.45
13000	179.697	0.404	0.25	0.91	-0.99	1.96	0.30	1.67	0.11	1.44	-0.27	1.44
13500	179.681	0.404	0.26	0.91	-0.95	1.96	0.21	1.67	0.10	1.44	-0.29	1.44
14000	179.652	0.404	0.23	0.91	-0.95	1.96	0.21	1.67	0.07	1.44	-0.60	1.44
14500	179.127	0.314	0.63	0.95	-0.24	1.98	0.79	1.69	0.51	1.47	0.15	1.47
15000	179.635	0.415	0.26	0.91	-0.82	1.96	0.26	1.67	0.03	1.44	-0.32	1.44
15500	178.937	0.349	0.95	1.97	-0.39	1.97	0.86	1.68	0.73	1.97	0.35	1.46
16000	179.654	0.494	0.24	1.94	-1.23	2.96	0.14	1.65	0.03	1.94	-0.37	1.42
16500	179.666	0.494	0.23	1.94	-1.32	2.96	0.05	1.65	-0.03	1.94	-0.39	1.42
17000	179.669	0.494	0.22	1.94	-1.37	2.96	-0.06	1.65	-0.07	1.94	-0.40	1.42
17500	179.668	0.494	0.24	1.94	-1.43	2.96	-0.07	1.65	-0.06	1.94	-0.42	1.42
18000	179.641	0.494	0.28	1.94	-1.48	2.96	-0.09	1.65	-0.07	1.94	-0.41	1.42
18500	179.650	0.494	0.29	1.94	-1.51	2.96	-0.13	1.65	-0.10	1.94	-0.41	1.42
19000	179.632	0.494	0.32	1.94	-1.41	2.96	-0.15	1.65	-0.09	1.94	-0.39	1.42
19500	179.732	0.494	0.22	1.94	-1.46	2.96	-0.30	1.65	-0.20	1.94	-0.51	1.42
20000	179.668	0.494	0.30	1.94	-1.39	2.96	-0.29	1.65	-0.14	1.94	-0.43	1.42

(continued) Unilateral degrees of equivalence for the phase of the BB

f	KCRV		CENAM		NMIJ		NIM		NMIA		INMETRO	
in	X_{KC}	U_{KC}	D_i	U_{D_i}	D_i	U_{D_i}	D_i	U_{D_i}	D_i	U_{D_i}	D_i	U_{D_i}
Hz	in °		in °		in °		in °		in °		in °	
10	179.987	0.081	0.01	0.29	0.02	0.29	0.09	0.49	-0.04	0.29	-0.02	0.18
12.5	179.988	0.081	0.01	0.29	-0.01	0.29	0.06	0.49	-0.03	0.29	-0.02	0.18
16	179.994	0.081	0.01	0.29	-0.01	0.29	0.05	0.49	-0.02	0.29	-0.02	0.18
20	179.988	0.081	0.01	0.29	0.02	0.29	0.01	0.49	-0.03	0.29	-0.02	0.18
25	179.986	0.081	0.01	0.29	-0.01	0.29	0.03	0.49	-0.03	0.29	-0.02	0.18
31.5	179.985	0.081	0.02	0.29	0.01	0.29	-0.01	0.49	-0.02	0.29	-0.01	0.18
40	179.982	0.081	0.02	0.29	-0.02	0.29	0.03	0.49	-0.02	0.29	-0.01	0.18
63	179.982	0.082	-0.02	0.29	0.04	0.39	0.03	0.49	-0.01	0.29	-0.01	0.18
80	179.972	0.081	-0.06	0.29	-0.00	0.29	0.02	0.49	-0.00	0.29	-0.00	0.18
100	179.979	0.081	-0.03	0.29	-0.03	0.29	0.01	0.49	0.00	0.29	-0.01	0.18
125	179.981	0.084	0.01	0.29	-0.03	0.29	0.02	0.49	-0.00	0.29	-0.01	0.18
160	179.983	0.084	-0.00	0.29	-0.03	0.29	0.02	0.49	-0.00	0.29	-0.01	0.18
200	179.995	0.084	-0.03	0.29	-0.01	0.29	0.03	0.49	-0.03	0.29	-0.03	0.18
250	179.999	0.084	0.00	0.29	0.02	0.29	-0.01	0.49	-0.01	0.29	-0.03	0.18
315	179.988	0.084	-0.01	0.29	0.03	0.29	0.00	0.49	0.01	0.29	-0.03	0.18
400	179.988	0.084	-0.05	0.29	0.03	0.29	0.01	0.49	0.04	0.29	-0.03	0.18
500	179.980	0.084	-0.06	0.29	0.01	0.29	0.01	0.49	0.00	0.29	-0.02	0.18
630	179.981	0.084	-0.05	0.29	0.01	0.29	-0.01	0.49	0.03	0.29	-0.02	0.18
800	179.976	0.084	-0.09	0.29	0.01	0.29	-0.01	0.49	0.03	0.29	-0.02	0.18
1000	179.976	0.089	-0.11	0.29	0.02	0.29	-0.03	0.49	0.04	0.49	-0.03	0.18
1250	179.942	0.104	-0.18	0.28	0.06	0.28	0.02	0.49	0.12	0.49	0.01	0.17
1500	179.929	0.104	-0.08	0.28	0.06	0.28	0.01	0.49	0.10	0.49	0.01	0.17
1600	179.920	0.104	-0.12	0.28	0.08	0.28	-0.02	0.49	0.06	0.49	0.02	0.17
2000	179.918	0.104	-0.18	0.28	0.09	0.28	-0.04	0.49	0.10	0.49	0.02	0.17
2500	179.906	0.109	-0.15	0.28	0.08	0.28	-0.05	0.49	0.11	0.49	0.02	0.21
3000	179.893	0.109	-0.14	0.28	0.10	0.28	-0.03	0.49	0.11	0.49	0.03	0.21
3150	179.869	0.115	-0.19	0.28	0.11	0.28	-0.06	0.49	0.13	0.49	0.05	0.32
3500	179.846	0.115	-0.34	0.28	0.18	0.28	-0.04	0.49	0.18	0.49	0.06	0.32
4000	179.812	0.118	-0.39	0.28	0.20	0.28	-0.01	0.49	0.24	0.49	0.09	0.49
4500	179.778	0.119	-0.27	0.28	0.24	0.28	0.00	0.49	0.20	0.59	0.11	0.49
5000	179.739	0.134	-0.43	0.27	0.21	0.38	-0.06	0.48	0.29	0.58	0.15	0.48
5500	179.727	0.196	-0.50	0.46			-0.09	0.98	0.32	0.57	0.15	0.78
6000	179.726	0.196	-0.41	0.46			-0.13	0.98	0.30	0.57	0.14	0.78
6300	179.715	0.196	-0.41	0.46			-0.08	0.98	0.32	0.57	0.16	0.78
6500	179.673	0.197	-0.55	0.46			-0.05	0.98	0.39	0.57	0.19	0.78
7000	179.624	0.202	-0.60	0.46			0.07	0.98	0.40	0.77	0.24	0.77
7500	179.539	0.206	-0.52	0.46			-0.02	0.98	0.49	0.77	0.31	0.98
8000	179.620	0.222	-0.46	0.45			-0.11	0.98	0.38	0.77	0.22	0.98
8500	179.569	0.223	-0.50	0.45			-0.08	0.97	0.08	0.77	0.27	0.97
9000	179.493	0.220	-0.41	0.45			-0.13	0.98	0.07	0.77	0.34	0.98
9500	179.841	0.244	-1.05*	0.56*			-0.33	0.97	0.61	0.76	-0.02	0.97
10000	179.873	0.255	-1.01*	0.56*			-0.32	0.97	0.25	0.76	-0.05	0.97
10500	179.380	0.298	-0.63	0.40			0.18	1.47	0.95	1.16	0.43	1.16
11000	179.707	0.372	-1.01*	0.62*			-0.21	1.45	1.00	1.14	0.09	1.14
11500	179.684	0.372	-1.08*	0.62*			-0.13	1.45	0.89	1.14	0.12	1.14
12000	179.693	0.372	-1.26*	0.62*			-0.29	1.45	0.76	1.14	0.10	1.14
12500	179.764	0.396	-1.39*	0.64*			-0.42	1.45	0.55	1.13	0.03	1.13
13000	179.697	0.404	-1.32*	0.64*			-0.42	1.44	0.54	1.44	0.08	1.13
13500	179.681	0.404	-1.43*	0.64*			-0.42	1.44	0.51	1.44	0.09	1.13
14000	179.652	0.404	-1.32*	0.64*			-0.33	1.44	0.50	1.44	0.12	1.13
14500	179.127	0.314	-0.77	0.39			-0.03	1.47	0.77	1.47	0.63	1.16
15000	179.635	0.415	-1.52*	0.65*			-0.51	1.44	0.51	1.44	0.13	1.13
15500	178.937	0.349	-0.72	0.36			0.19	1.46	1.20	1.97	0.81	1.15
16000	179.654	0.494	-1.59*	0.70*			-0.54	1.42	0.56	1.94	0.10	1.09
16500	179.666	0.494	-1.47*	0.70*			-0.46	1.42	0.47	1.94	0.07	1.09
17000	179.669	0.494	-1.59*	0.70*			-0.50	1.42	0.48	1.94	0.07	1.09
17500	179.668	0.494	-1.57*	0.70*			-0.59	1.42	0.48	1.94	0.06	1.09
18000	179.641	0.494	-1.64*	0.70*			-0.69	1.42	0.58	1.94	0.09	1.09
18500	179.650	0.494	-1.85*	0.70*			-0.61	1.42	0.62	1.94	0.07	1.09
19000	179.632	0.494	-1.93*	0.70*			-0.61	1.42	0.49	1.94	0.09	1.09
19500	179.732	0.494	-2.03*	0.70*			-0.78	1.42	0.55	1.94	-0.02	1.09
20000	179.668	0.494	-2.11*	0.70*			-0.71	1.42	0.47	1.94	0.04	1.09

(continued) Unilateral degrees of equivalence for the phase of the BB

f	KCRV		NMISA		VNIIM		NMC,A*STAR		UkrMet	
in Hz	X_{KC} in °	U_{KC} in °	D_i in °	U_{D_i} in °	D_i in °	U_{D_i} in °	D_i in °	U_{D_i} in °	D_i in °	U_{D_i} in °
10	179.987	0.081	0.06	0.18	-0.08	1.00	0.00	0.31	-0.06	0.49
12.5	179.988	0.081	0.06	0.18	-0.11	1.00	0.00	0.31	0.00	0.49
16	179.994	0.081	0.10	0.18	-0.09	1.00	-0.01	0.31	-0.08	0.49
20	179.988	0.081	0.05	0.18	-0.08	0.49	0.01	0.35	-0.04	0.49
25	179.986	0.081	0.04	0.18	-0.10	0.49	0.02	0.35	-0.05	0.49
31.5	179.985	0.081	0.05	0.18	-0.09	0.49	0.03	0.35	-0.03	0.49
40	179.982	0.081	0.06	0.18	-0.06	0.49	0.03	0.35	-0.03	0.49
63	179.982	0.082	0.05	0.18	-0.06	0.49	0.02	0.35	-0.03	0.49
80	179.972	0.081	0.05	0.18	-0.05	0.49	0.04	0.35	-0.03	0.49
100	179.979	0.081	0.04	0.18	-0.05	0.49	0.04	0.35	-0.05	0.49
125	179.981	0.084	0.04	0.29	-0.01	0.49	0.06	0.35	-0.01	0.49
160	179.983	0.084	0.06	0.29	0.04	0.49	0.03	0.35	0.03	0.49
200	179.995	0.084	0.01	0.29	0.06	0.49	0.02	0.35	0.09	0.49
250	179.999	0.084	0.00	0.29	0.09	0.49	0.02	0.35	0.10	0.49
315	179.988	0.084	0.00	0.29	0.01	0.49	0.03	0.35	-0.04	0.49
400	179.988	0.084	0.00	0.29	0.12	0.49	0.03	0.35	-0.03	0.49
500	179.980	0.084	0.00	0.29	0.12	0.49	0.03	0.35	0.00	0.49
630	179.981	0.084	-0.01	0.29	0.10	0.49	0.06	0.35	-0.03	0.49
800	179.976	0.084	-0.02	0.29	0.11	0.49	0.04	0.35	0.10	0.49
1000	179.976	0.089	-0.05	0.29	0.21	0.49	0.05	0.61	0.20	0.49
1250	179.942	0.104	-0.02	0.49	0.19	0.49	0.08	0.61	-0.16	0.69
1500	179.929	0.104	-0.04	0.49	0.07	0.49	0.09	0.61	0.06	0.69
1600	179.920	0.104	-0.02	0.49	0.24	0.49	0.10	0.61	0.06	0.69
2000	179.918	0.104	-0.04	0.49	0.24	0.49	0.11	0.61	0.02	0.69
2500	179.906	0.109	-0.05	0.49	0.26	0.49	0.12	0.61	-0.11	0.69
3000	179.893	0.109	-0.07	0.49	0.21	0.49	0.13	0.61	-0.04	0.69
3150	179.869	0.115	-0.07	0.49	0.21	0.49	0.16	0.61	0.10	0.69
3500	179.846	0.115	-0.05	0.49	0.07	0.49	0.21	0.61	0.14	0.69
4000	179.812	0.118	-0.05	0.49	0.04	0.49	0.26	0.61	-0.05	0.69
4500	179.778	0.119	-0.04	0.49	0.05	0.49	0.24	0.61	-0.05	0.69
5000	179.739	0.134	-0.05	0.79	0.00	0.48	0.28	0.65	-0.02	0.69
5500	179.727	0.196	-0.06	0.78	-0.08	0.98	0.29	0.63	-0.12	1.49
6000	179.726	0.196	-0.09	0.78	-0.04	0.98	0.26	0.63	-0.18	1.49
6300	179.715	0.196	-0.11	0.78	-0.04	0.98	0.32	0.63	-0.08	1.49
6500	179.673	0.197	-0.07	0.78	-0.18	0.98	0.29	0.63	-0.03	1.49
7000	179.624	0.202	-0.06	0.77	-0.13	0.98	0.37	0.63	0.01	1.49
7500	179.539	0.206	0.04	0.77	-0.09	0.98	0.36	0.63	-0.15	1.49
8000	179.620	0.222	-0.07	0.77	-0.32	0.98	0.15	0.62	-0.04	1.48
8500	179.569	0.223	0.42	0.77	-0.11	0.97	-0.11	0.62	-0.24	1.48
9000	179.493	0.220	0.51	0.77	0.20	0.98	-0.82	0.62	-0.15	1.48
9500	179.841	0.244	-0.92	0.76	-0.01	0.97	0.31	0.61	-0.29	1.48
10000	179.873	0.255	-0.66	0.76	-0.43	0.97	0.43	1.19	-0.07	1.48
10500	179.380	0.298	-0.48	0.74	0.15	1.47	1.04	1.18	0.14	1.98
11000	179.707	0.372	-1.03	0.71	-0.04	1.45	0.73	1.16	-0.14	1.97
11500	179.684	0.372	-0.96	0.71	0.01	1.45	0.75	1.16	0.24	1.97
12000	179.693	0.372	-0.86	0.71	0.22	1.45	0.70	1.16	0.41	1.97
12500	179.764	0.396	-0.85	1.13	0.04	1.45	0.45	1.15	0.32	1.96
13000	179.697	0.404	-0.77	1.13	0.06	1.44	0.52	1.15	-0.01	1.96
13500	179.681	0.404	-0.71	1.13	0.29	1.44	0.39	1.15	-0.02	1.96
14000	179.652	0.404	-0.65	1.13	0.42	1.44	0.38	1.15	0.13	1.96
14500	179.127	0.314	-0.07	1.16	1.21	1.47	0.76	1.18	0.60	1.98
15000	179.635	0.415	-0.71	1.13	0.77	1.44	0.29	1.61	-0.12	1.96
15500	178.937	0.349	-0.05	1.56	1.61	1.46	1.00	1.62	0.69	2.98
16000	179.654	0.494	-0.79	1.52	1.02	1.42	0.27	1.58	-0.10	2.96
16500	179.666	0.494	-0.83	1.52	1.16	1.42	0.22	1.58	0.02	2.96
17000	179.669	0.494	-0.87	1.52	1.38	1.42	0.21	1.58	0.13	2.96
17500	179.668	0.494	-0.89	1.52	1.54	1.42	0.20	1.58	0.06	2.96
18000	179.641	0.494	-0.91	1.52	1.61	1.42	0.20	1.58	-0.05	2.96
18500	179.650	0.494	-0.95	1.52	1.60	1.42	0.18	1.58	0.09	2.96
19000	179.632	0.494	-0.97	1.52	1.63	1.42	0.14	1.58	0.19	2.96
19500	179.732	0.494	-1.09	1.52	2.55	1.42	0.04	1.58	-0.05	2.96
20000	179.668	0.494	-1.05	1.52	2.14	1.42	0.07	1.58	-0.01	2.96

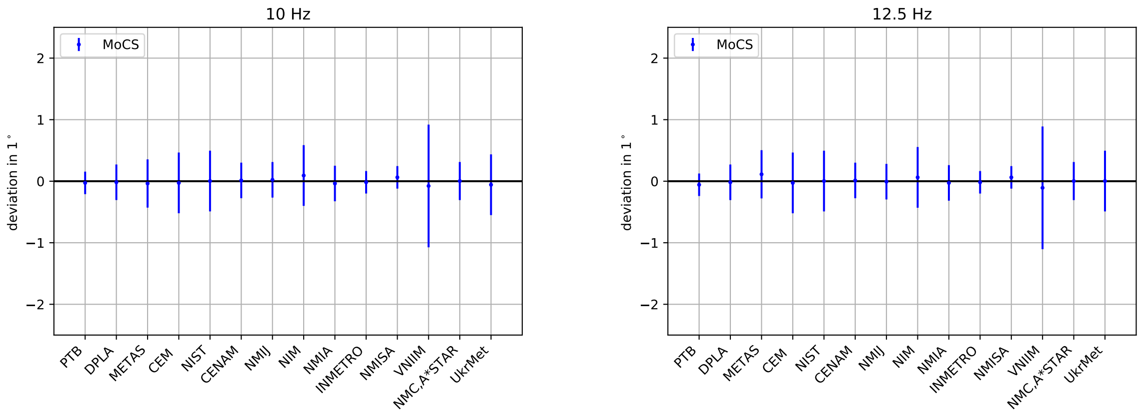

Figure 8.94: deviation of the phase for the frequencies 10 Hz and 12.5 Hz for the BB

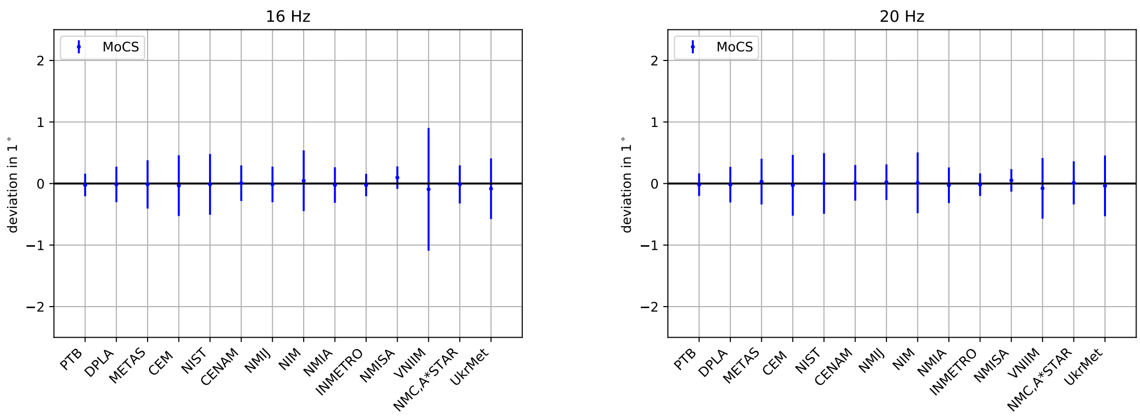

Figure 8.95: deviation of the phase for the frequencies 16 Hz and 20 Hz for the BB

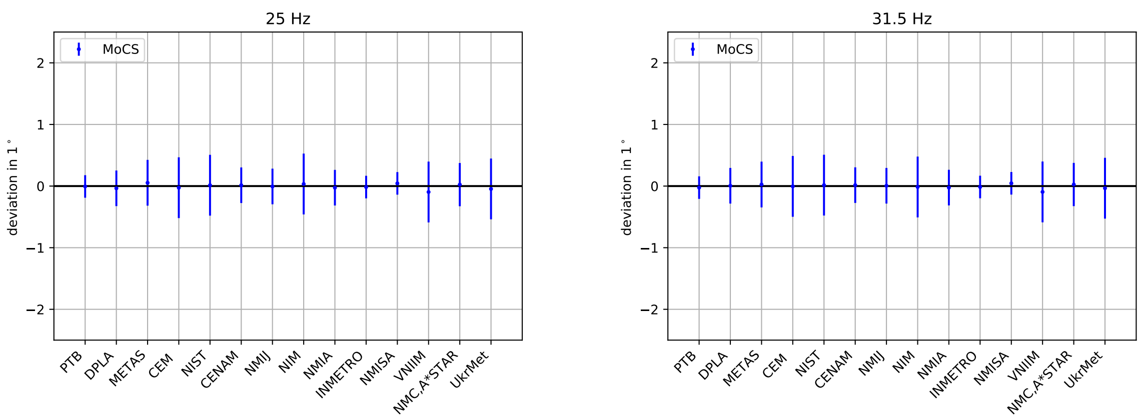

Figure 8.96: deviation of the phase for the frequencies 25 Hz and 31.5 Hz for the BB

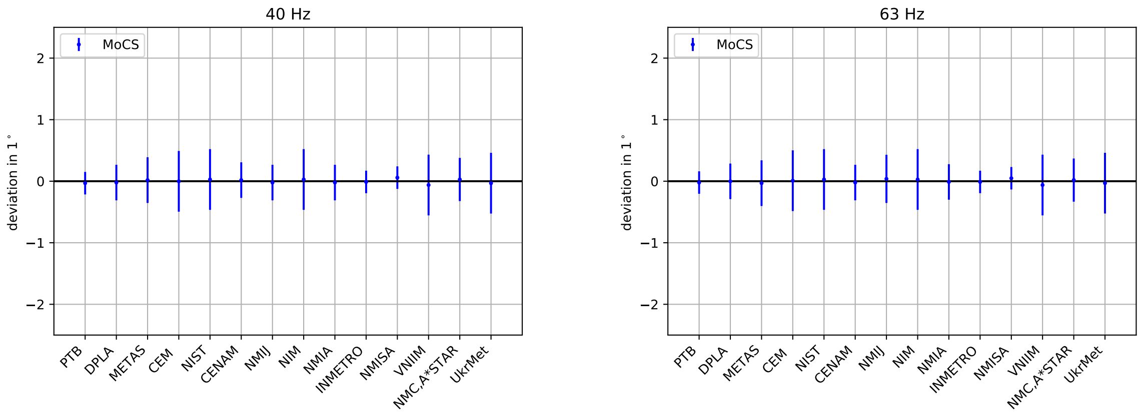

Figure 8.97: deviation of the phase for the frequencies 40 Hz and 63 Hz for the BB

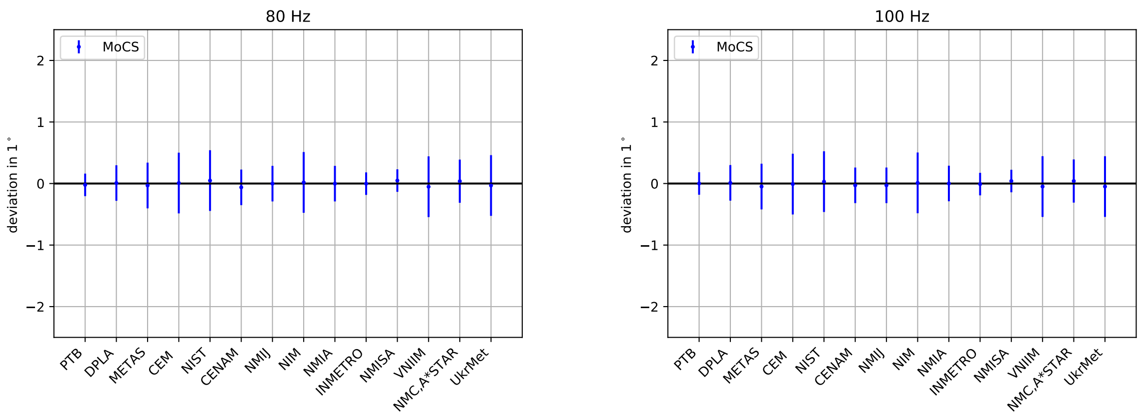

Figure 8.98: deviation of the phase for the frequencies 80 Hz and 100 Hz for the BB

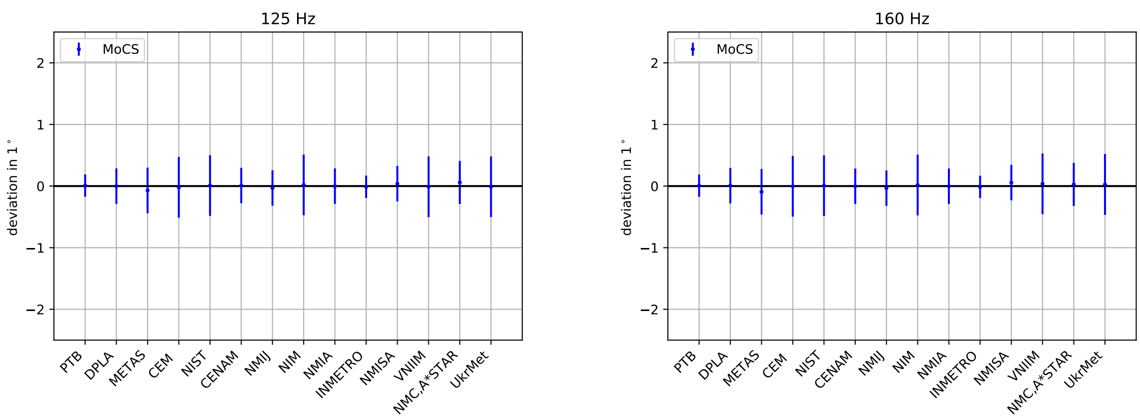

Figure 8.99: deviation of the phase for the frequencies 125 Hz and 160 Hz for the BB

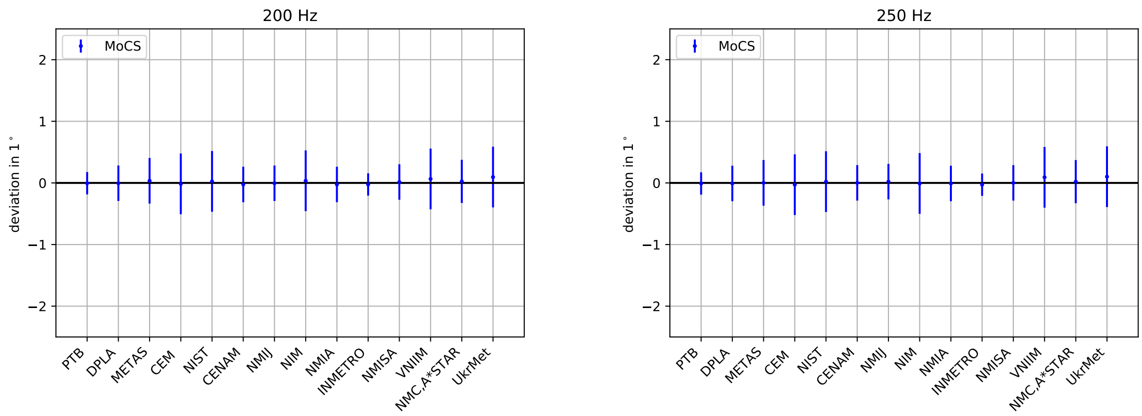

Figure 8.100: deviation of the phase for the frequencies 200 Hz and 250 Hz for the BB

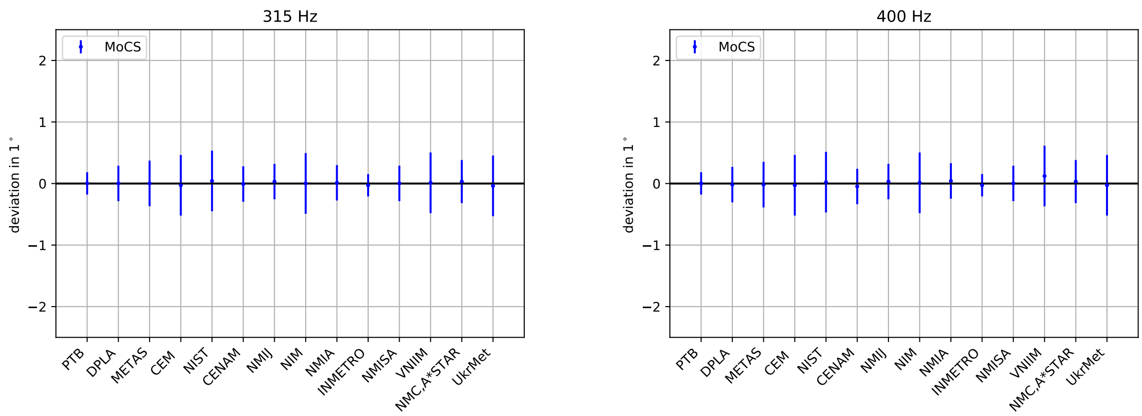

Figure 8.101: deviation of the phase for the frequencies 315 Hz and 400 Hz for the BB

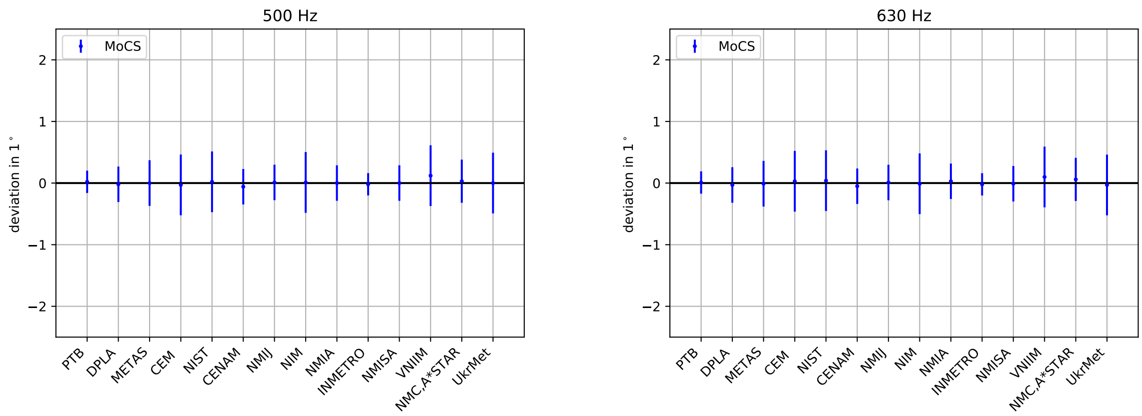

Figure 8.102: deviation of the phase for the frequencies 500 Hz and 630 Hz for the BB

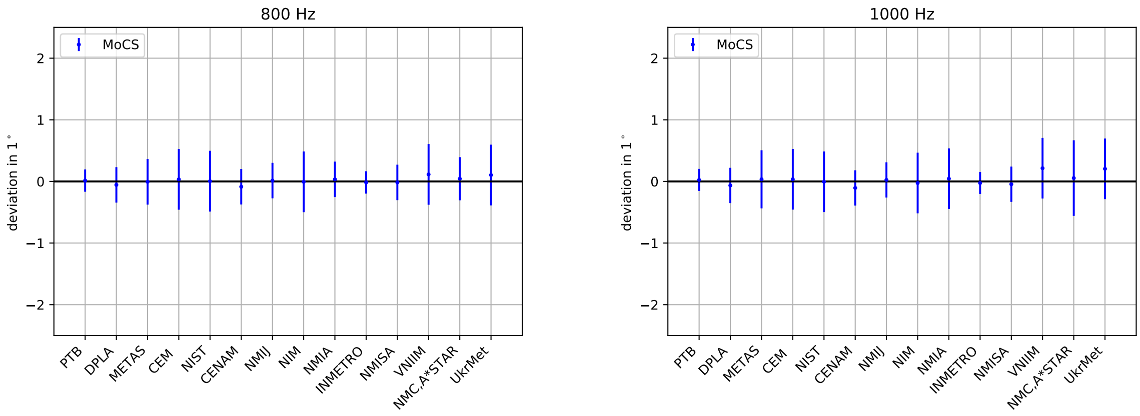

Figure 8.103: deviation of the phase for the frequencies 800 Hz and 1000 Hz for the BB

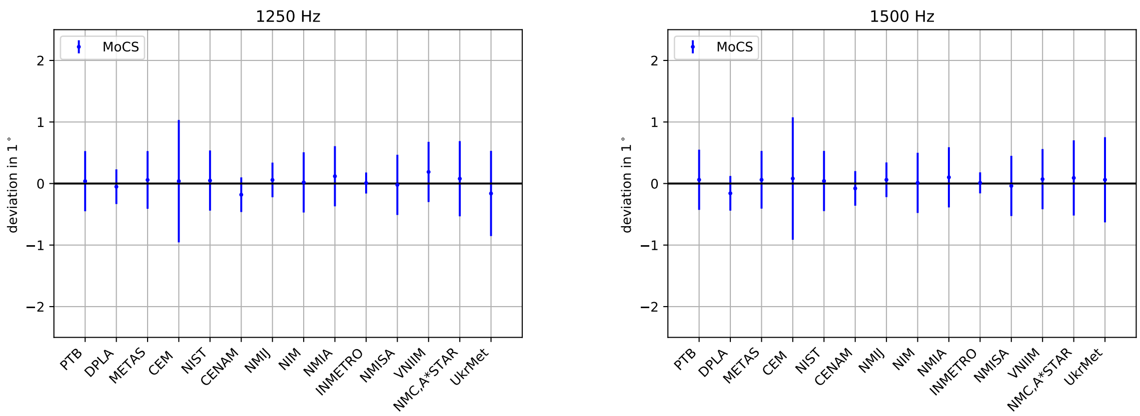

Figure 8.104: deviation of the phase for the frequencies 1250 Hz and 1500 Hz for the BB

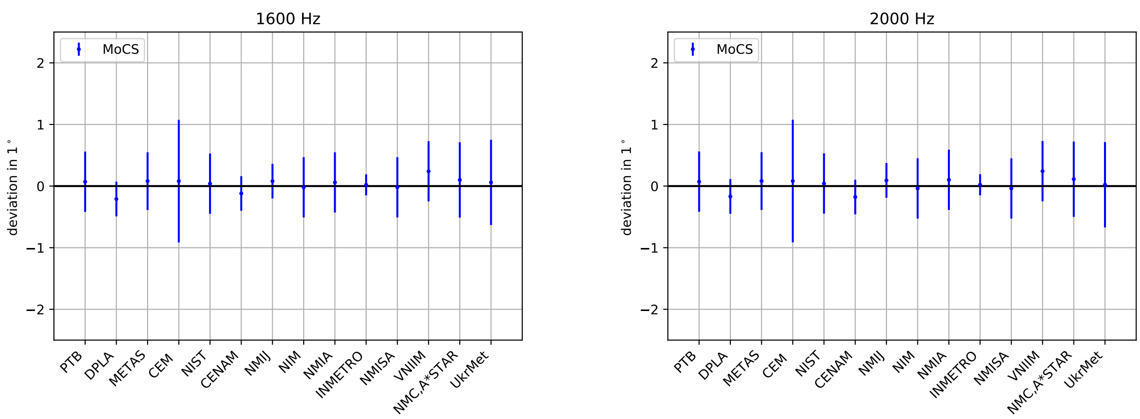

Figure 8.105: deviation of the phase for the frequencies 1600 Hz and 2000 Hz for the BB

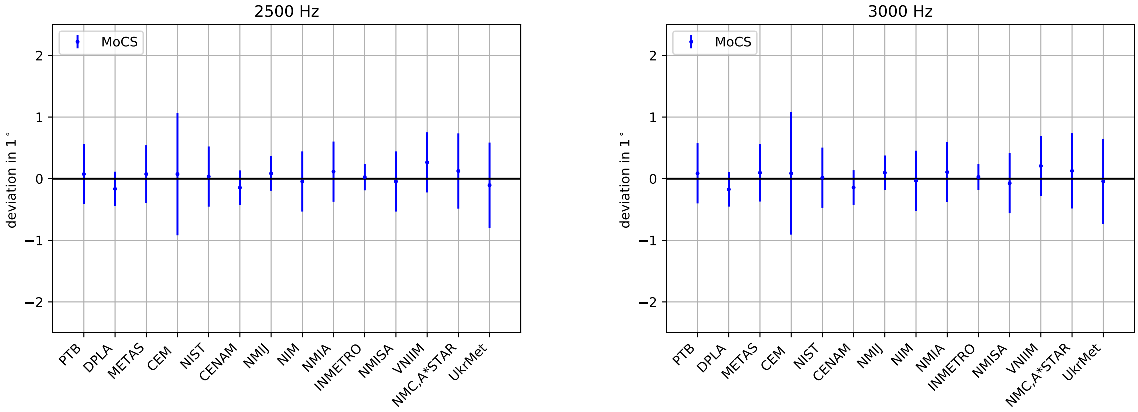

Figure 8.106: deviation of the phase for the frequencies 2500 Hz and 3000 Hz for the BB

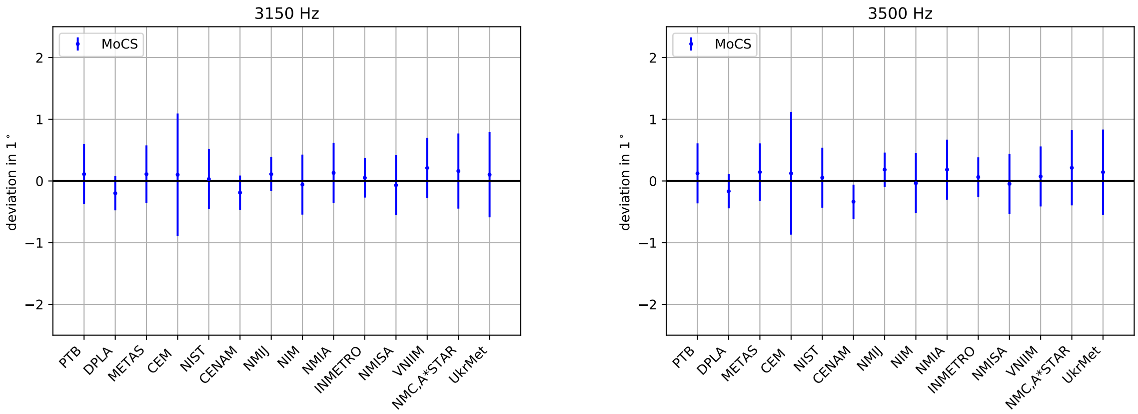

Figure 8.107: deviation of the phase for the frequencies 3150 Hz and 3500 Hz for the BB

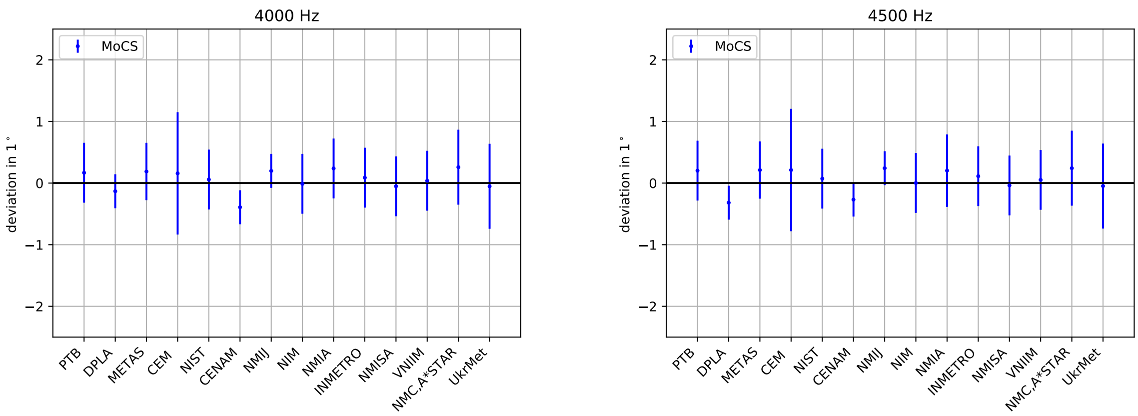

Figure 8.108: deviation of the phase for the frequencies 4000 Hz and 4500 Hz for the BB

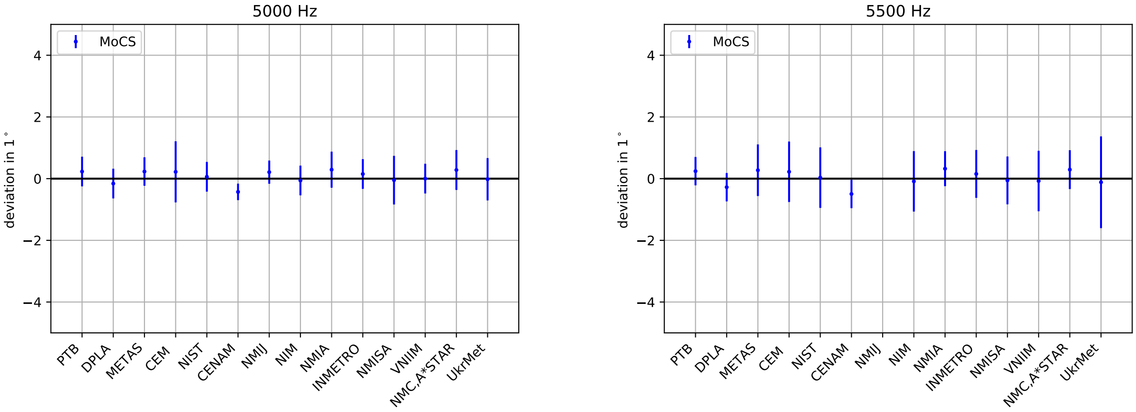

Figure 8.109: deviation of the phase for the frequencies 5000 Hz and 5500 Hz for the BB

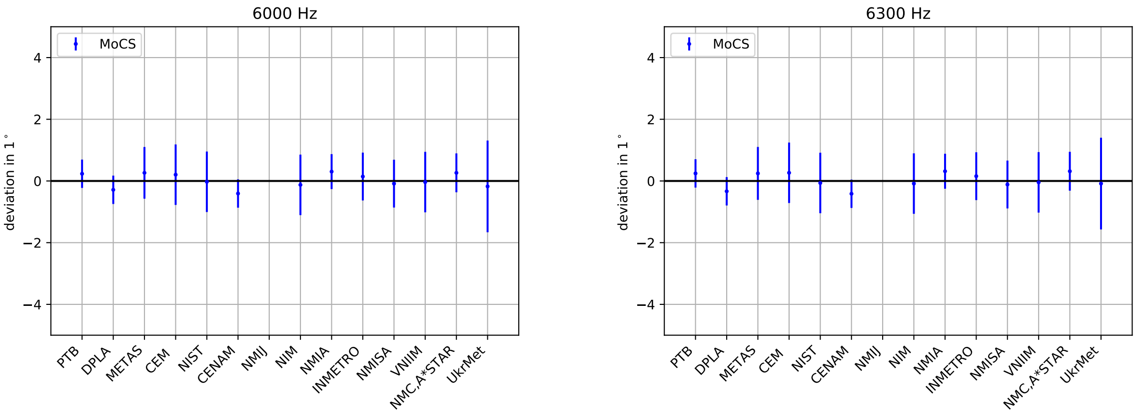

Figure 8.110: deviation of the phase for the frequencies 6000 Hz and 6300 Hz for the BB

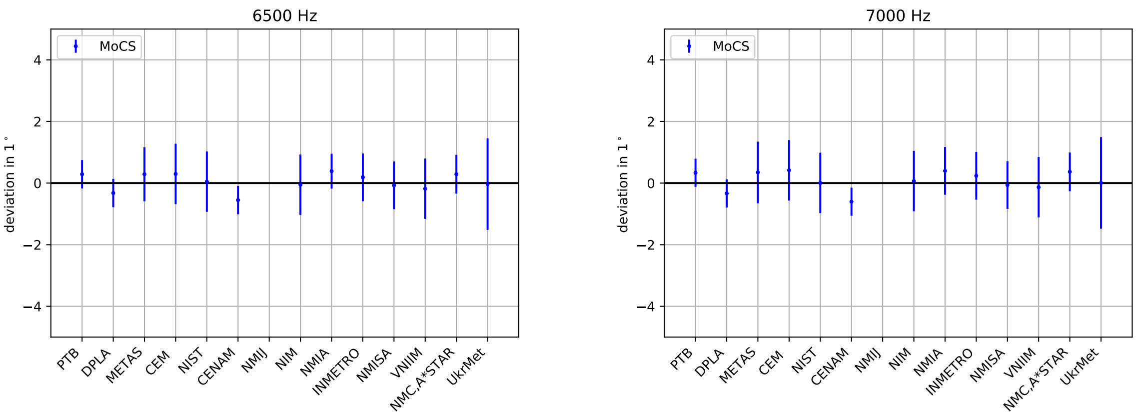

Figure 8.111: deviation of the phase for the frequencies 6500 Hz and 7000 Hz for the BB

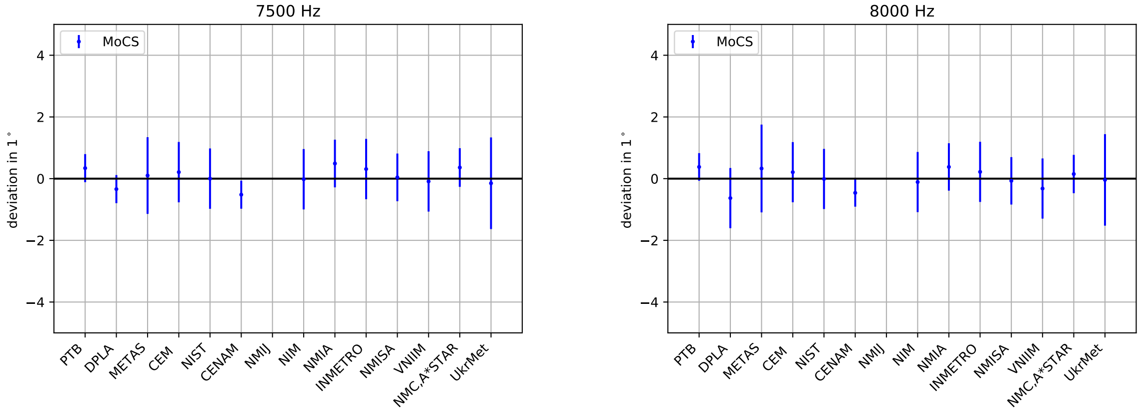

Figure 8.112: deviation of the phase for the frequencies 7500 Hz and 8000 Hz for the BB

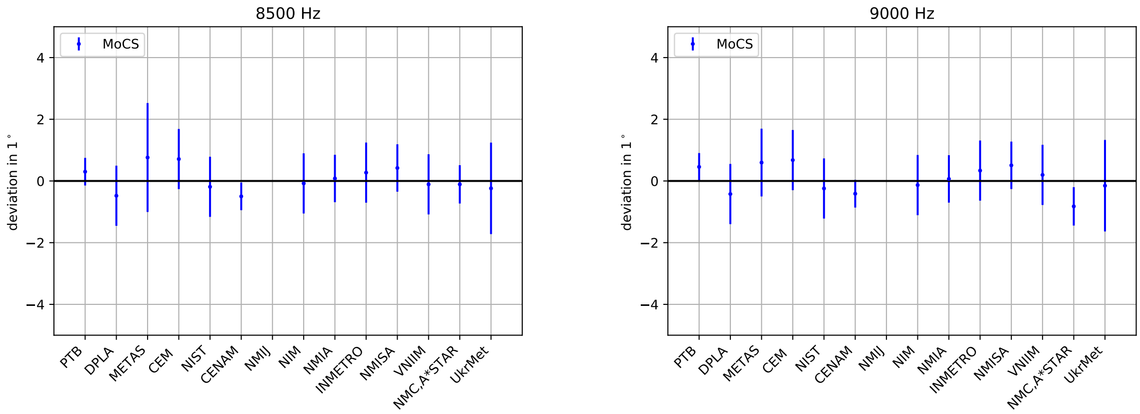

Figure 8.113: deviation of the phase for the frequencies 8500 Hz and 9000 Hz for the BB

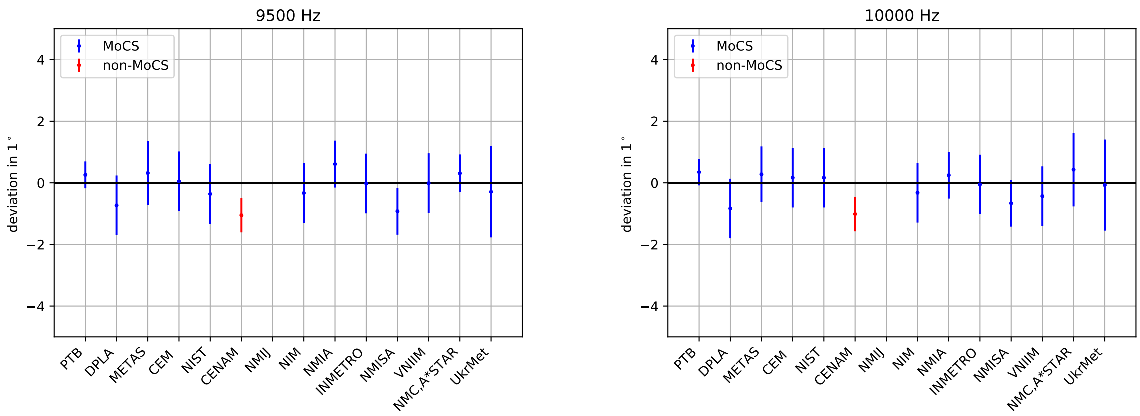

Figure 8.114: deviation of the phase for the frequencies 9500 Hz and 10000 Hz for the BB

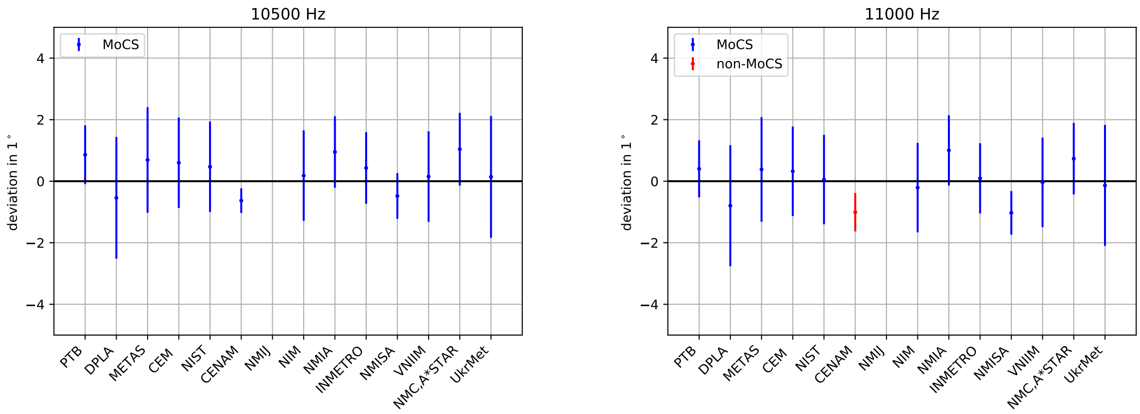

Figure 8.115: deviation of the phase for the frequencies 10500 Hz and 11000 Hz for the BB

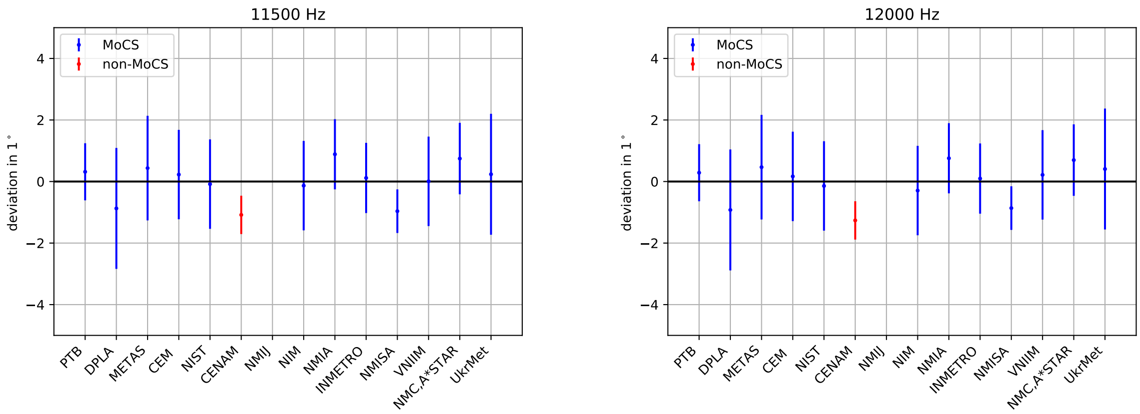

Figure 8.116: deviation of the phase for the frequencies 11500 Hz and 12000 Hz for the BB

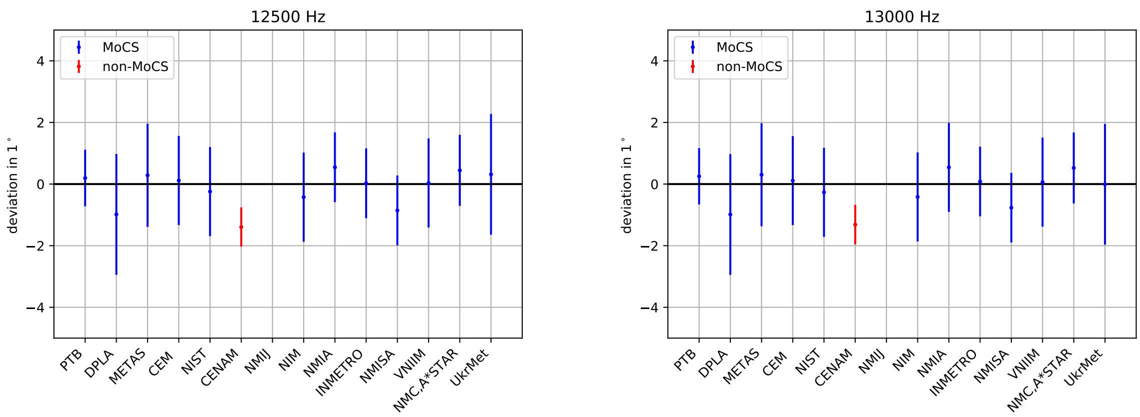

Figure 8.117: deviation of the phase for the frequencies 12500 Hz and 13000 Hz for the BB

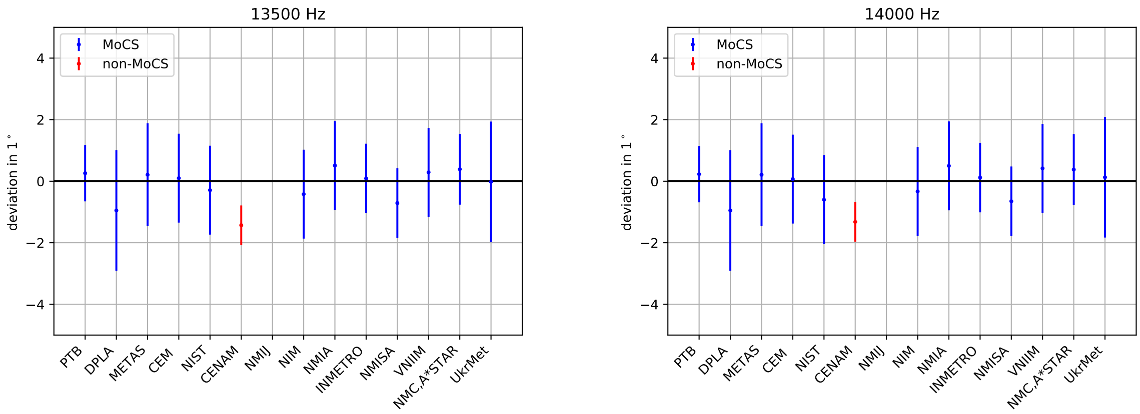

Figure 8.118: deviation of the phase for the frequencies 13500 Hz and 14000 Hz for the BB

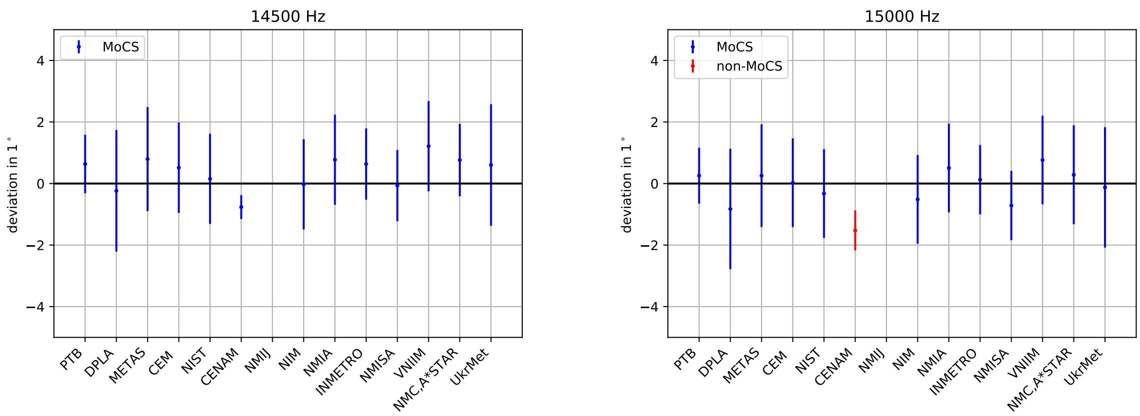

Figure 8.119: deviation of the phase for the frequencies 14500 Hz and 15000 Hz for the BB

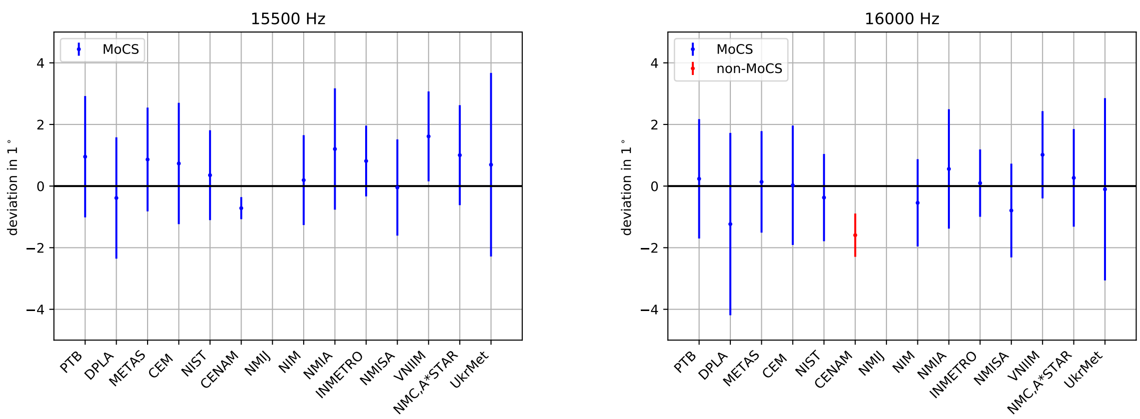

Figure 8.120: deviation of the phase for the frequencies 15500 Hz and 16000 Hz for the BB

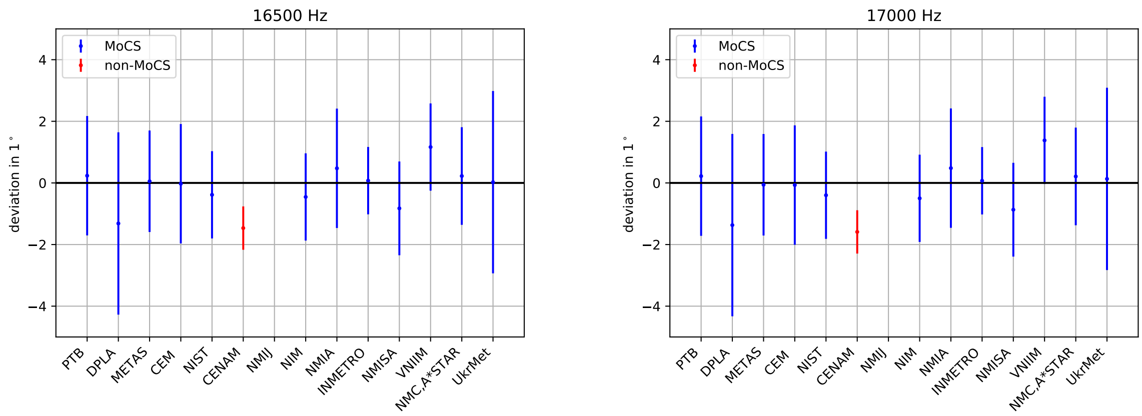

Figure 8.121: deviation of the phase for the frequencies 16500 Hz and 17000 Hz for the BB

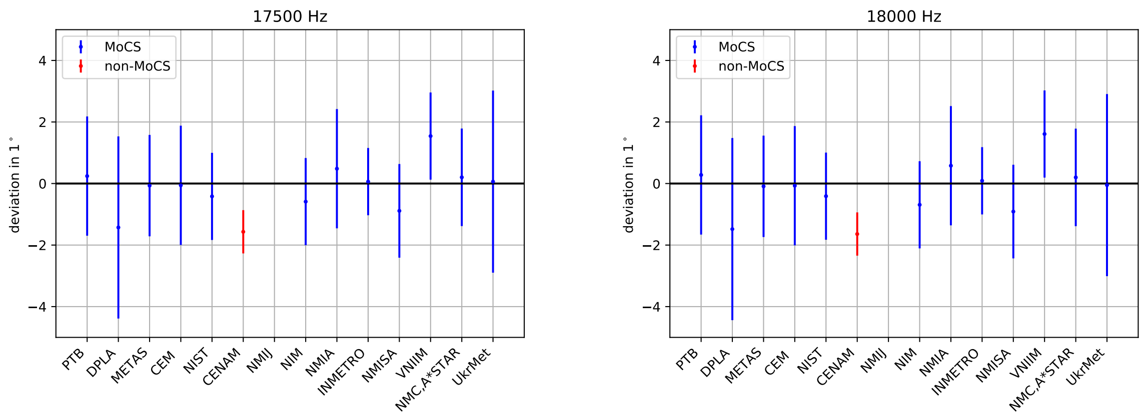

Figure 8.122: deviation of the phase for the frequencies 17500 Hz and 18000 Hz for the BB

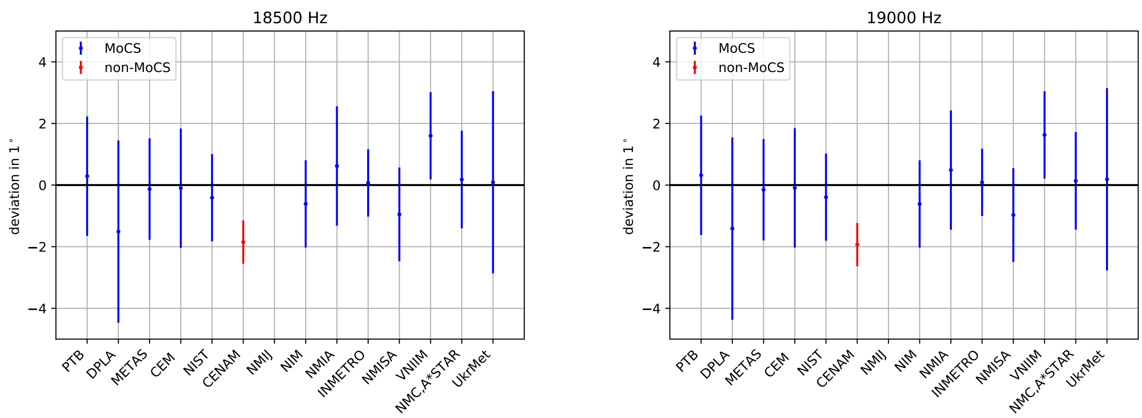

Figure 8.123: deviation of the phase for the frequencies 18500 Hz and 19000 Hz for the BB

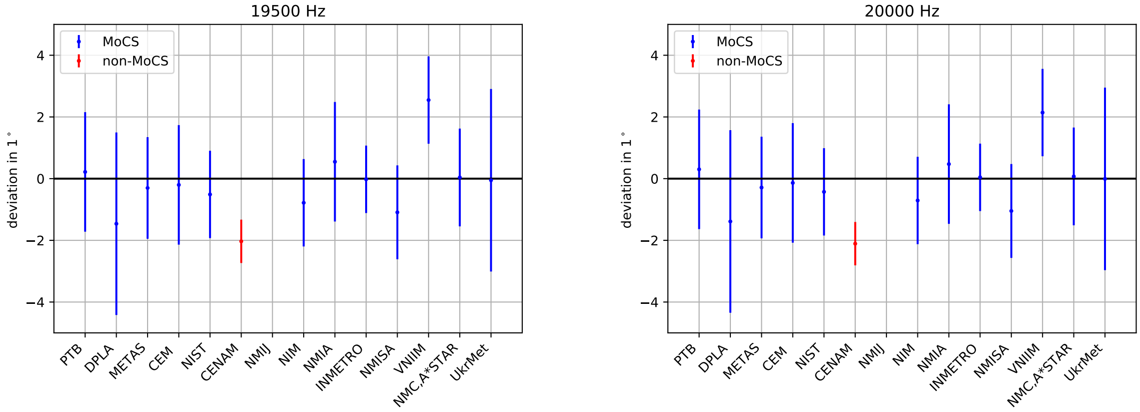

Figure 8.124: deviation of the phase for the frequencies 19500 Hz and 20000 Hz for the BB

9 — Conclusion

In the field of vibration and shock, this fifth global key comparison (CCAUV.V-K5) was organized in order to compare measurement capabilities of national metrology laboratories for primary calibration of accelerometers by laser-interferometry. With its scope of calibration of magnitude and phase response in the frequency range from 10 Hz to 20 kHz, it challenged the technical boundaries of the field. During the analysis and comparison of results, it turned out that both artifacts circulated for the task had their individual problems.

With the experience and lessons understood from the former comparison CCAUV.V-K2 the CCAUV had decided to mount and fix the single-ended artifact onto a steel-adapter for the calibration measurements in order to ensure identical mounting conditions for all participants. The goal behind this was to avoid effects as variation on mounting torque, inappropriate reflective surface of shaker mounting surface and different conditions caused by stiffness, roughness and modal behavior of shaker armatures or by any adapter usually used by the NMIs. Even if the adapter circulated with the SE accelerometer did not present infinite stiffness, it was very probably stiffer than most shaker armatures available and consequently provided a more homogeneous and controlled measurement condition among participants. Therefore, it was expected that it would ultimately help to improve the level of comparability between results at high frequencies.

It turned out however, that owing to the geometry of the adapter, the measurement results showed a strong position dependence related to the target point of the Laser interferometer. Deviations could be observed as large as 12 % at 20 kHz and 6 % at 16 kHz between individual Laser target points, which is evidence for a strong dynamic deformation of the adapter. Unfortunately, the TP did not include strict guidance on the selection and number of target points but left this to be decided by the participating lab according to the lab's procedures. The problem of the position dependence was mitigated to a large extent by averaging of multiple positions as requested by the TP. Due to this effect the results of most laboratories became consistent. However, this was not always the case and the larger spread of the SE results at high frequencies gives evidence of this systemic problem. It is clear, that the question of relative motion and how to calibrate SE accelerometers beyond 10 kHz is still open for investigation and discussion.

The back-to-back transducer revealed a strong transverse resonance between approximately 8 kHz to 11 kHz, which led to an increased spread of the results for different Laser positions and deteriorated repeatability in this sub-range of frequencies. In addition, the optical quality of the reference surface was refurbished in February 2017 with the (unintended) consequence of an slightly oblique and uneven target for the Laser afterwards. This also challenged the optical adjustment for the calibration.

The above mentioned complications were to the largest extent related to the magnitude results for the complex sensitivity. In contrast the phase results exhibited a large amount of consistency between the participants over the whole scope. This demonstrates that phase calibration has reached the state of being a well established standard service on the level of national metrology institutes.

One aspect of the comparison task was the complementation of the measurement chain with a local charge amplifier calibrated by the participant. Due to this requirement the consistency of the KC results demonstrate the participants' associated capability of calibration of magnitude and/or phase of the complex transfer function of charge amplifiers. In addition, and in terms of how far the light shines this capabilitiy could then be expected to be valid for other kinds of measuring amplifiers as well, including voltage amplifiers.

Despite these challenges the Key Comparison CCAUV.V-K5 can be considered successful for most participants, the represented RMOs and the CCAUV as a whole. It establishes many new consistent degrees of equivalence. It will in any case help to improve the quality of vibration and shock metrology on the global scale, in part by highlighting areas where additional action is needed in order to support global equivalency.

We must highlight that this was the first CIPM key comparison capable to determine KCRVs and DoEs for both SE and BB accelerometers in the extended frequency range from 10 Hz to 20 kHz. It is important to note that this scope includes some challenging frequencies, which refer to transverse and case resonances of the artifacts circulated. Further improvements can be implemented, and the outcome of this KC and the gain in knowledge provided by it will certainly help to achieve even better results in the future. The design of the mechanical adaptor might need to be reviewed in order to have radial symmetry and/or the requirement to perform laser measurements on some specific points can be added in technical protocols of future comparisons. Some new requirements might need to be considered in order to improve comparability at frequencies higher than 20 kHz. It should be noted that normal calibrations carried out by the participants use different shakers, and adaptors, which are prone to larger effects of mounting differences. The mounting conditions used at the calibration laboratories and by customers' applications might present even larger measurement differences. Therefore, estimated uncertainties at high frequencies shall consider the effect of mounting conditions with care. The results of this comparison can provide the basis for the comparability currently achievable by NMIs under very well controlled conditions.

10 — References

[1] ISO 16063-1:1998 Methods for the calibration of vibration and shock transducers – Part 1: Basic concepts

[2] ISO 16063-11:1999 Methods for the calibration of vibration and shock transducers – Part 11: Primary vibration calibration by laser interferometry

[3] M. G. Cox, The evaluation of key comparison data: determining the largest consistent subset, Metrologia 44, 2007, 187, http://iopscience.iop.org/0026-1394/44/3/005

Appendix A: — Technical Protocol

Technical Protocol of the CIPM Key Comparison

CCAUV.V-K5

2017-03-06

revised 2018-02-13 (changed schedule)

Task and Purpose of the Comparison

According to the rules set up by the CIPM MRA the consultative committees of the CIPM have the responsibility to establish “degrees of equivalence” (DoE) between the different measurement standards operated by the national NMIs. This is done by conducting key comparisons (KC) on different levels of the international metrological infrastructure. The previous top level KC in the field of Vibration metrology, CCAUV.V-K2 was finished in the year 2014 under difficult conditions and its results have since been then the foundation of many established DoE in the field.

Due to the fact, that the conditions of measurement comparability were sub-optimal during CCAUV.V-K2 the meeting of CCAUV in November 2015 took the decision to start to prepare the next KC with a scope covering that of CCAUV.V-K2 and more.

The results of this KC will, after approval for equivalence, form the new basis for DoE derived in subsequent RMO key comparisons, and therefore be the foundation for the registration of “calibration and measurement capabilities” (CMC) in the framework of the CIPM MRA.

The specific task of the KC is to measure the complex charge sensitivity of three different accelerometers at specified frequencies with primary means *I.e.* according to ISO 16063-11 “Methods for the calibration of vibration and shock transducers -- Part 11: Primary vibration calibration by laser interferometry”.

The reported sensitivities and associated uncertainties are then supposed to be used for the calculation of the DoE between the participating NMI and the key comparison reference value.

Pilot Laboratory

Pilot laboratory for this Key Comparison is

Physikalisch-Technische Bundesanstalt (PTB)
Working Group 1.71 “Acceleration”
Bundesallee 100
38116 Braunschweig
Germany

This is the delivery address for the set of artefacts and the written and signed reports. Contact Persons are

Dr. Thomas Bruns	Denis Nordmann
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Terms of participation

According to the recently published “Recommendations from the Working Group on the Implementation and Operation of the CIPM MRA” [1] the number of participant in a KC like this “*should typically be limited to the minimum number of institutes necessary to provide effective linkage in each region, (typically no more than three institutes per RMO)*.”

This is a recommendation to keep the consumed time for the KC from start of measurement to final publication within reasonable limits.

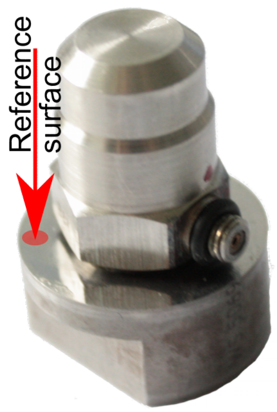
Following this recommendation, this technical protocol is distributed to the chairman of the technical committees of Acoustics, Ultra sound and Vibration (AUV) of all regional metrology organizations with the request to nominate up to three participating institutes of the respective RMO.

Beyond the obvious necessity to cover the scope of the KC (see below) with a sufficiently low measurement uncertainty, the willingness to coordinate a subsequent RMO-comparison is required from the nominated participants.

Devices under Test and Measurement Conditions

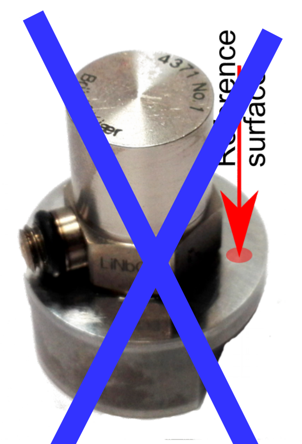
For the calibration task of this KC a set of ~~three~~ two piezoelectric accelerometers will be circulated among the participating laboratories. The individual transducers being

- a Brüel & Kjær 8305-001 (SN: 1610153) “single ended” (SE) type
- a Brüel & Kjær 8305 S (SN: ...) “back to back” (BB) type.
- ~~a Brüel & Kjaer 4371 (SN: 1) “single ended” (SE) type~~



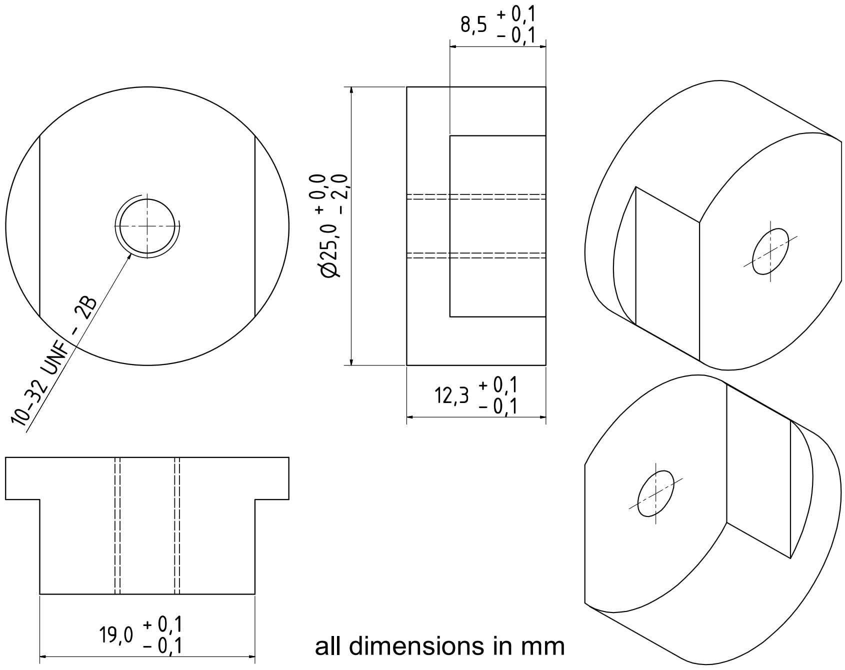
Brüel & Kjær 8305-001
(with adapter)

Brüel & Kjær 8305 S



Brüel & Kjaer 4371
(with adapter)

The ~~two~~ SE type accelerometer~~s are each~~ is mounted on a mechanical adapter, which was designed and manufactured according to the drawing below:



The adapter is made of stainless steel 1.4404 (AISI 316L) and has a weight (calculated) of 41 g. Its top surface is polished in order to provide mirror-like reflectivity for the Laser.

The accelerometers are to be calibrated for magnitude and phase of their complex charge sensitivity according to those procedures and conditions implemented by the NMI in conformance with ISO 16063-11 which provide magnitude and phase information of the artefact. The sensitivities reported shall be for the accelerometers alone, excluding any effects from the charge amplifier.

The frequency range of the measurements was agreed to be from 10 Hz to 20 kHz. Specifically the laboratories are supposed to measure at the following frequencies (all values in Hz).

10, 12.5, 16, 20, 25, 31.5, 40, 63, 80, 100, 125, 160, 200, 250, 315, 400, 500, 630, 800, 1 000, 1 250, 1 500, 1 600, 2 000, 2 500, 3 000, 3 150, 3 500, 4 000, 4 500, 5 000, 5 500, 6 000, 6 300, 6 500, 7 000, 7 500, 8 000, 8 500, 9 000, 9 500, 10 000, 10 500 11 000, 11 500, 12 000, 12 500, 13 000. 13 500, 14 000, 14 500, 15 000, 15 500, 16 000, 16 500, 17 000, 17 500, 18 000, 18 500, 19 000, 19 500, 20 000.

Note: *this set does deviate from the standard frequencies of ISO 266.*

The participating laboratories should be able to provide magnitude results over the whole frequency range with their systems and to provide phase results at least for the range from 10 Hz to 10 kHz.

The charge amplifier (CA) used for the calibration is not provided within the set of the artefacts, it must therefore be provided by the individual participant. By this measure, the capability of the participating laboratory to calibrate charge amplifiers is implicitly verified.

The measurement condition should be kept according to the laboratory's standard conditions for calibration of customer accelerometers for claiming their best measurement capability or CMC where applicable. This presumes that these conditions comply with those defined by the applicable ISO documentary standards [2,3,4], simultaneously.

Specific conditions for the measurements of this KC are:

- acceleration amplitudes: preferably 50 m/s² to 100 m/s²
  a range of 2 m/s² to 200 m/s² is admissible.

- ambient temperature and accelerometer temperature during the calibration: (23 ± 2) ºC (actual values to be stated within tolerances of ± 0.3 ºC). The accelerometer temperature should be measured and reported.
- relative humidity: max. 75 %RH
- mounting torque of the accelerometer: (2.0 ± 0.1) N·m

Circulation Type, Schedule and Transportation

The transducers are circulated in a star type fashion with a measurement period of three weeks provided for each participant. In between two subsequent measurements at any participants laboratory the transducers are measured at the pilot lab in order to monitor the long term stability.The schedule is planned as follows:

Participant	Country ISO-Code	Transportation to Participant week from	Measurement from	Measurement to	Transportation to Pilot week from	Monitoring measurements from	Monitoring measurements to
PTB	DE		13.02.2017	05.03.2017	06.03.2017	13.02.2017	26.03.2017
DPLA	DK	27.03.2017	03.04.2017	23.04.2017	24.04.2017	01.05.2017	04.06.2017
METAS	CH	08.05.2017	15.05.2017	04.06.2017	05.06.2017	12.06.2017	16.07.2017
CEM	ES	26.06.2017	03.07.2017	23.07.2017	24.07.2017	31.07.2017	03.09.2017
NIST	US	28.08.2017	04.09.2017	24.09.2017	25.09.2017	02.10.2017	05.11.2017
CENAM	MX	13.11.2017	20.11.2017	10.12.2017	11.12.2017	18.12.2017	21.01.2018
NMIJ	JP	29.01.2018	05.02.2018	25.02.2018	26.02.2018	05.03.2018	18.03.2018
NIM	CN	19.03.2018	26.03.2018	08.04.2018	09.04.2018	16.04.2018	29.04.2018
INMETRO	BR	30.04.2018	07.05.2018	20.05.2018	21.05.2018	28.05.2018	10.06.2018
NMIA	AU	11.06.2018	18.06.2018	01.07.2018	02.07.2018	09.07.2018	22.07.2018
NMC/A*Star	SG	23.07.2018	30.07.2018	12.08.2018	13.08.2018	20.08.2018	02.09.2018
NMISA	ZA	03.09.2018	10.09.2018	23.09.2018	24.09.2018	01.10.2018	14.10.2018
VNIIM	RU	15.10.2018	22.10.2018	04.11.2018	05.11.2018	12.11.2018	25.11.2018
UkrMet	UA	26.11.2018	03.12.2018	16.12.2018	17.12.2018	24.12.2018	06.01.2019

The cost of transportation to and from a participating laboratory shall be covered by the participating laboratory.
For transportation, the artefacts are packed in a protective aluminium box, which in turn is put into a card-board container. The dimensions are 35 cm x 40 cm x 29 cm, the weight is approximately 3 kg.
The accelerometers have to be send by an international logistic service providing a tracking system. The transportation has to include an insurance covering a total value of 12 000,- € in case the set of accelerometers gets damaged or lost during transportation.
As an alternative the artefact may be hand carried by a member of the participating laboratory.

Handling, Measurement and Analysis Instructions

The participating laboratories have to observe the following instructions:

- The charge amplifier used for the measurement of the accelerometer's response has to be calibrated with equipment traceable to national measurement standards.
- The motion of the BB accelerometer should be measured with the laser directly on the (polished) reference surface of the transducer without any additional reflector or dummy mass (c.f. picture on page 2).
- The SE accelerometers ***shall be mounted together with the mounting adapter***, that comes attached to them. The combined SE accelerometer with adapter should be handled as a single mechanical unit for mounting. ***The mounting adapter must not be adjusted, loosened or removed.*** The mounting or dismounting torque

between the adapter and the shaker shall be applied to the unit via the mounting adapter. An appropriate crowfoot wrench with 3/8” square drive adaptation and 19 mm span is provided within the set.

- The motion of the SE accelerometers shall be measured on the top surface of the polished mounting adapter that comes attached to each, close to the accelerometer's housing (c.f. picture on page 2).
- The mounting surface of the BB accelerometer or the adapters in case of the SE accelerometers and the moving part of the exciter must be slightly lubricated before mounting.
- The cable between accelerometer and charge amplifier should be taken from the set of DUT delivered to the laboratory. It is a B&K super low-noise, 10-32 UNF (M) to 10-32 UNF (M), 1,2 m cable.
- In order to reduce the influence of non-rectilinear motion, the measurements should be performed for at least three different laser positions which are symmetrically distributed over the respective measurement surface.
- It is advised that the measurement results should be compiled from complete measurement series carried out at different days under nominally the same conditions, except that the BB accelerometer or adapter in case of an SE accelerometer is remounted and the cable reattached. The standard deviation of the subsequent measurements should be included in the report.
- For acceleration signals $a(t)$ of the form
  $$a(t)=\hat{a}\cdot\cos(\omega t+\varphi_a) \qquad (1)$$
  and the respective charge output signal of the transducer $q(t)$ of the form
  $$q(t)=\hat{q}\cdot\cos(\omega t+\varphi_q) \qquad (2)$$
  the phase is defined according to ISO 16063-1 as
  $$\Delta\varphi = \varphi_q-\varphi_a\,. \qquad (3)$$
- For the measurement of the phase of the sensitivity the delay or phase characteristics of the interferometer channel(s) has to be taken into account, since the photo-diode-amplifier-system typically has a non-negligible influence on the result.

Communication of the Results to the Pilot Laboratory

Each participating laboratory will submit one printed and signed calibration report for each accelerometer to the pilot laboratory[1] including the following:

- a description of the calibration systems used and the mounting techniques for the accelerometer,
- a description of the calibration methods used, including information about the demodulation scheme,
- a documented record of the ambient conditions during measurements,
- the calibration results, including the relative expanded measurement uncertainty, and the applied coverage factor for each value,
- a detailed uncertainty budget for the system covering all components of measurement uncertainty (calculated according to GUM, [5, 6]). Including among others information on the type of uncertainty (A or B), assumed distribution function

1 A scanned copy sent by Email should suffice.

and repeatability component. (These information are necessary for the evaluation and linking of subsequent RMO KC).

In addition each participating laboratory will receive three electronic spreadsheets prepared by the pilot laboratory, where the calibration results have to be filled in following the structure given in the files. The use of the electronic spreadsheets for reporting is mandatory. The consistency between the results in electronic form and the printed and signed calibration report is the responsibility of the participating laboratory. The data submitted in the electronic spreadsheet shall be deemed the official results submitted for the comparison.

The results have to be submitted to the pilot laboratory within six weeks after the measurements.

The pilot laboratory will submit it's set of results to the executive secretary of CCAUV in advance to the first measurement of a participating laboratory.

Remarks on the Post Processing

- Presuming consistency of the results, the key comparison reference values and the degrees of equivalence will be calculated according to the established methods as a weighted mean as agreed upon already for CCAUV.V-K1.
- In case of damage or loss of any of the artefacts the KC will be evaluated as far in the schedule as possible, all further action concerning continuation will be decided in coordination with the participants.

References

[1] BIPM, “Recommendations from the Working Group on the Implementation and Operation of the CIPM MRA”, 23rd August 2016 http://www.bipm.org/utils/common/documents/CIPM-MRA-review/Recommendations-from-the-WG.pdf

[2] ISO 16063-1:1998 “Methods for the calibration of vibration and shock transducers -- Part 1: Basic concepts

[3] ISO 16063-11:1999 “Methods for the calibration of vibration and shock transducers -- Part 11: Primary vibration calibration by laser interferometry”

[4] ISO/IEC 17025:2005 “General requirements for the competence of testing and calibration laboratories”

[5] ISO/IEC Guide 98-3:2008 “Uncertainty of measurement -- Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)

[6] ISO/IEC Guide 98-3:2008/Suppl 1:2008 “Propagation of distributions using a Monte Carlo method”

Acknowledgement

The Artefacts were kindly committed by Brüel & Kjær to the pilot lab for the purpose of this comparison. They are especially selected from a larger production sample intended to provide the quality of “best measurement standards” in terms of the CIPM MRA.

Appendix B: — Measurement Uncertainty Budgets of the Participants

B.1 PTB

B.1.1 magnitude

					combined frequency ranges			
Disturbing Component	**comment**	**95% value**	**distribution**	**factor**	**10 Hz to 5 kHz**	**to 10 kHz**	**to 15 kHz**	**to 20 kHz**
frequency of SAM	deviation of sample clock from generator clock		rectangular	1,73205081	5,77E-05	5,77E-05	5,77E-05	5,77E-05
Accelerometer Voltage	sampling of HP3458A	5,00E-04	rectangular	1,73205081	2,89E-04	2,89E-04	2,89E-04	2,89E-04
Velocity amplitude	wave length, optical adjustment, deviation between the two beams	1,16E-05	normal	2	5,80E-06	5,80E-06	5,80E-06	5,80E-06
harmon. Distortion	mainly 1st harmonic		Steiner	1	7,84E-06	7,84E-06	7,84E-06	7,84E-06
Humm on Voltage	typical 1mV	5,00E-07	Steiner	1,00	5,00E-07	5,00E-07	5,00E-07	5,00E-07
Noise on Voltage	MC on influence to SAM duration 20ms, Un=1,0mV		normal	1	3,30E-06	3,30E-06	3,30E-06	3,30E-06
Transverse Motion	S(transv) = 0,7% a(transv) < 4%		u-type	1,41421356	1,98E-04	1,98E-04	1,98E-04	1,98E-04
Base strain sensitivity	S = 0,005m/s² / µ€ € < 0,1 µm/m	0,000005	rectangular	1,73	2,89E-06	2,89E-06	2,89E-06	2,89E-06
mounting	S = 6e-4/Nm; dM = 0,2 Nm	0,00012	rectangular	1,73205081	6,93E-05	6,93E-05	6,93E-05	6,93E-05
Temperature	S=2,5e-4 /K dT = 0,3 K	0,000075	rectangular	1,73	4,33E-05	4,33E-05	4,33E-05	4,33E-05
Magnetic field	S=1/a *(m/s²)/T B < 0,03mT	0,0000003	rectangular	1,73	1,73E-07	1,73E-07	1,73E-07	1,73E-07
Airborne acoustics	S=0,008 m/s² at 154 dB max sound level 88 dB	8,00E-08	rectangular	1,73	4,62E-08	4,62E-08	4,62E-08	4,62E-08
Noise on Interferom.	noise level equiv. of 2 nm after demodulation, Monte Carlo		normal	1	1,10E-04	3,00E-04	6,20E-04	1,10E-03
a-synchronous Measurement	voltage/acceleration/voltage	1,00E-04	rectangular	1,73	5,77E-05	5,77E-05	5,77E-05	5,77E-05
charge ampl. calibration					2,12E-04	2,12E-04	2,12E-04	2,12E-04
resid. influences		1,00E-04	normal	1,41421356	7,07E-05	7,07E-05	7,07E-05	7,07E-05
exp. std. dev					2,30E-04	1,60E-04	4,40E-04	6,60E-04
rel. std. uncertainty	**in %**				**0,0501**	**0,0549**	**0,0874**	**0,1353**
rel. comb. exp. Uncertainty (k=2)	**in %**				**0,1002**	**0,1098**	**0,1748**	**0,2707**
stated rel. comb. exp. Uncertainty	**in %**				**0,1000**	**0,3000**	**0,5000**	**1,0000**

B.1.2 phase

					combined frequency ranges		
Disturbing Component	**comment**	**95% value**	**distribution**	**factor**	**10 Hz to 1 kHz**	**to 10 kHz**	**to 20 kHz**
Channel a-synchronisity	all frequencies	< 10 ns	normal	2	1,80E-03	1,80E-02	3,60E-02
Humm (50 Hz)	Monte Carlo, multiples of 20ms are evaluated	equivalent displacement amp. 4 μm	normal	1	8,00E-03	1,00E-03	1,00E-03
Noise on accelerometer Voltage output	Monte Carlo, SNR=500	< 2mV @ 1V	normal	1	4,00E-04	4,00E-04	4,00E-04
Transverse/Rocking motion	1 % transv. Sensitivity @ 10% transv. Excitation	rel. Phase 0 … 2pi	U-type (by MC)	1	7,00E-04	7,00E-04	7,00E-04
delay of Laser Vibrom. + Mixer + Filter	absolut correction 1,54μs applied	uncert. of correction 60 ns	rectang.	1,73	1,25E-02	1,25E-01	2,49E-01
Calibration Charge Amplifier B&K 2650	including Stability, reproducibility, methode (black box)	<0,02°	normal	2	2,00E-02	2,00E-02	2,00E-02
Noise on heterodyne interferometer channel	noise level equiv. of 2 nm after demodulation, Monte Carlo	< 2nm	normal	1	1,43E-04	1,43E-02	5,73E-02
Motion disturbance	drift, relative motion evaluation as velocity and period by period	estimated < 0,02°	normal	2	1,00E-02	1,00E-02	1,00E-02
exp. Std. deviation		typical < 0,02°	normal	2	1,00E-02	1,50E-02	2,00E-02
std. uncertainty	**in 1°**				**0,029**	**0,130**	**0,260**
exp. Uncertainty (k=2)	**in 1°**				**0,057**	**0,259**	**0,520**
stated exp. Uncertainty	**in 1°**				**0,200**	**0,500**	**1,000**

B.2 DPLA

Uncertainty budget for magnitude

Budget of Uncertainties — **Quadrature system with WQ-2914---**

Notes:

All values except the last line are 1sigma values
Budget of uncertainty for a piezoelectric accelerometer at 50-100 m/s(^2) at the higher frequencies.
Temperature influence on accelerometer not included.

i	Quantity	Description	Unc. Contribution	Relative expanded uncertainty or bounds of estimated error components	Probability distribution model	Factor	f	160	10 Hz to 20 Hz	> 20 Hz to 2 kHz	> 2 kHz to 4 kHz	> 4 kHz to 5 kHz	> 5 kHz to 10 kHz	> 10 kHz to 12 kHz	> 12 kHz to 15.5 kHz	> 15.5 kHz to 20 kHz
								Relative contribution $u_{rel,i}(y)$								
				[%]		x_i		%	%	%						
1	$u(\hat{u}_V)$	Output voltage Measurement	$u_1(S)$	0,124	Normal (k = 2)	0,5		0,062	0,062	0,062	0,062	0,062	0,062	0,062	0,062	0,062
2	$u(\hat{u}_F)$	Voltage filtering effect on accelerometer output amplitude measurement (frequency band limitati	$u_2(S)$	0,010	Rectangular	0,577		0,006	0,006	0,006	0,006	0,006	0,006	0,006	0,006	0,006
3	$u(\hat{u}_D)$	Effect of voltage disturbance on accelerometer output voltage measurement (e.g. hum and nois	$u_3(S)$	0,010	Rectangular	0,577		0,006	0,006	0,006	0,006	0,006	0,006	0,006	0,006	0,006
4	$u(\hat{u}_T)$	Effect of transverse, rocking and bending acceleration on accelerometer output voltage measur	$u_4(S)$	0,100	Special	0,2357		0,024	0,024	0,024	0,024	0,047	0,071	0,118	0,118	0,118
4a	$u(S_Q)$	Calibration factor for Reference charge amplifier	$u_{4a}(S)$	0,176	Normal (k = 2)	0,5		0,088	0,089	0,088	0,088	0,088	0,088	0,088	0,088	0,088
5	$u(\hat{\varphi}_{M,Q})$	Effect of interferometer quadrature output signal disturbance on phase amplitude measurement	$u_5(S)$	0,050	Rectangular	0,577		0,029	0,029	0,029	0,058	0,058	0,058	0,058	0,058	0,058
6	$u(\hat{\varphi}_{M,F})$	Interferometer signal filtering effect on phase amplitude measurement (frequency band limitation	$u_6(S)$	**Included in 5**												
7	$u(\hat{\varphi}_{M,VD})$	Effect of voltage disturbance on phase amplitude measurement (e.g. random noise in the photo(	$u_7(S)$	**Included in 5**												
8	$u(\hat{\varphi}_{M,MD})$	Effect of motion disturbance on phase amplitude measurement (e.g. drift; relative motion betwee	$u_8(S)$	0,100	Rectangular	0,236		0,024	0,024	0,024	0,025	0,037	0,059	0,047	0,071	0,094
9	$u(\hat{\varphi}_{M,PD})$	Effect of phase disturbance on phase amplitude measurement (e.g. phase noise of the interferor	$u_9(S)$	**Included in 5**												
10	$u(\hat{\varphi}_{M,RE})$	Residual interferometric effects on phase amplitude measurement (interferometer function)	$u_{10}(S)$	**Included in 5**												
11	$u(f_{FG})$	Vibration frequency measurement (frequency generator and indicator)	$u_{11}(S)$	0,0025	Rectangular	1,1547		0,003	0,003	0,003	0,003	0,003	0,003	0,003	0,003	0,003
12	$u(S_{RE})$	Residual effects on sensitivity measurement (e.g. random effect in repeat measurements; experi	$u_{12}(S)$	0,089	Rectangular	0,577		0,047	0,052	0,052	0,074	0,074	0,124	0,236	0,349	0,579
	$u_{rel}(S_2)$	**Uncertainty for accelerometer sensitivity S_2**		**Standard uncertainty (k = 1)**				**0,147**	**0,150**	**0,149**	**0,171**	**0,188**	**0,248**	**0,338**	**0,459**	**0,698**
		Uncertainty for accelerometer sensitivity S_2		**95% conf.level uncertainty (k = 2)**				**0,294**	**0,300**	**0,299**	**0,341**	**0,375**	**0,495**	**0,675**	**0,919**	**1,396**

Uncertainty budget for phase

Budget of Uncertainties **Quadrature system with air-bearing shaker**

Phase

Notes:

All values are 1sigma values
Budget of uncertainty for a piezoelectric accelerometer at 30-100 m/s(^2) at the higher frequencies.
Temperature influence on accelerometer not included.

i	Quantity Numbering following ISO 16063-11 Table A.4 φ_u	Description	Unc. Contribution	Relative expanded uncertainty or bounds of estimated error components [degrees]	Probability distribution model	Factor xi	f 160 Relative contribution $u_{rel,i}(y)$ [degrees]	> 10 Hz to 20 Hz [degrees]	> 20 Hz to 40 Hz [degrees]	> 40 Hz to 500 Hz [degrees]	> 500 Hz to 1,25 kHz [degrees]	> 1,25 kHz to 2 kHz [degrees]	> 2 kHz to 4 kHz [degrees]	> 4 kHz to 5 kHz [degrees]	> 5 kHz to 6.4 kHz [degrees]	> 6.4 kHz to 7.5 kHz [degrees]	> 7.5 kHz to 10 kHz [degrees]	> 10 kHz to 15.5 [degrees]	> 15.5 kHz to 20 kHz [degrees]
			Charge																
1	$u(\varphi_u, V)$	Accelerometer output phase measurement (waveform recorder; e.g. ADCresolution)	u_1 (S)	0,200	Rectangular	0,577	0,115	0,115	0,115	0,115	0,115	0,115	0,115	0,115	0,173	0,173	0,404	0,866	1,097
2	$u(\varphi_u, F)$	Voltage filtering effect on accelerometer output phase measurement (frequency band limitation)	u_2 (S)	**Included in 1**	Rectangular	0,577													
3	$u(\varphi_u, D)$	Effect of voltage disturbance on accelerometer output voltage phase measurement (e.g. hum ar	u_3 (S)	0,010	Rectangular	0,577	0,006	0,006	0,006	0,006	0,006	0,006	0,006	0,006	0,006	0,006	0,006	0,006	0,006
4	$u(\varphi_u, T)$	Effect of transverse, rocking and bending acceleration on accelerometer output voltage phase n	u_4 (S)	0,060	Special	0,2357	0,014	0,014	0,014	0,014	0,014	0,014	0,014	0,028	0,028	0,028	0,042	0,071	0,071
4a	$u(\varphi_u, Q)$	Calibration factor for Reference charge amplifier phase response	u_{4a} (S)	0,020	Rectangular	0,577	0,012	0,012	0,012	0,012	0,012	0,012	0,012	0,012	0,012	0,014	0,040	0,110	0,110
5	$u(\varphi_s, Q)$	Effect of interferometer quadrature output signal disturbance on displacement phase amplitude r	u_5 (S)	0,010	Rectangular	0,577	0,006	0,006	0,006	0,006	0,006	0,006	0,006	0,006	0,006	0,006	0,006	0,006	0,006
6	$u(\varphi_s, F)$	Interferometer signal filtering effect on displacement phase amplitude measurement (frequency b	u_6 (S)	**Included in 5**															
7	$u(\varphi_s, VD)$	Effect of voltage disturbance on displacement phase amplitude measurement (e.g. random nois	u_7 (S)	**Included in 5**															
8	$u(\varphi_s, MD)$	Effect of motion disturbance on displacement phase amplitude measurement (e.g. drift; relative r	u_8 (S)	0,057	Rectangular	0,577	0,033	0,033	0,033	0,033	0,033	0,033	0,033	0,033	0,033	0,033	0,033	0,033	0,033
9	$u(\varphi_s, PD)$	Effect of phase disturbance on displacement phase amplitude measurement (e.g. phase noise o	u_9 (S)	**Included in 5**															
10	$u(\varphi_s, RE)$	Residual interferometric effects on displacement phase amplitude measurement (interferometer	u_{10} (S)	0,010	Rectangular	0,577	0,006	0,006	0,006	0,006	0,006	0,006	0,023	0,023	0,052	0,052	0,115	0,173	0,231
11	$u(\Delta\varphi, RE)$	Residual effects on phase shift measurement (e.g. random effect in repeat measurements; exper	u_{12} (S)	0,050	Rectangular	0,577	0,029	0,029	0,029	0,029	0,029	0,029	0,029	0,029	0,115	0,115	0,115	0,231	0,231
	$u(\Delta\varphi)$	**Uncertainty for accelerometer sensitivity $\Delta\varphi$**		**Standard uncertainty (k = 1)**			**0,125**	**0,125**	**0,125**	**0,125**	**0,125**	**0,125**	**0,127**	**0,130**	**0,219**	**0,220**	**0,441**	**0,923**	**1,152**
		Uncertainty for accelerometer sensitivity $\Delta\varphi$		**95% conf.level uncertainty (k = 2)**			**0,250**	**0,250**	**0,250**	**0,250**	**0,250**	**0,250**	**0,254**	**0,259**	**0,439**	**0,439**	**0,882**	**1,846**	**2,305**

B.3 METAS

Measurement uncertainty budget for the primary calibration of accelerometers, type B&K 8305, single ended, (amplitude)

uncertainty contribution					frequency range / Hz						
					5 - < 20	20 - < 63	63 - < 1 k	1 k - < 5 k	5 k - 10 k	>10 k - 15 k	>15 k - 10 k
Component		Distribution	Factor	Evaluation Type	contribution	contribution	contribution	contribution	contribution	contribution	contribution
electrical measurement	including charge amplifier calibration	normal	2,00	Type B	3,00E-04	3,00E-04	3,00E-04	3,00E-04	3,00E-04	5,00E-04	5,00E-04
frequency	including the influence of speed to acceleration conversion	rectangular	1,73	Type B	1,00E-05	1,00E-05	1,00E-05	1,00E-05	1,00E-05	1,00E-05	1,00E-05
signal conditioner gain	including level non-linearity	normal	2,00	Type B	2,00E-04	2,00E-04	2,00E-04	2,00E-04	2,00E-04	2,00E-04	2,00E-04
signal conditioner frequency response	including frequency non-linearity	normal	2,00	Type B	5,00E-04	5,00E-04	5,00E-04	5,00E-04	2,00E-03	4,00E-03	4,00E-03
transverse motion	typical values for 8305-type of transducer	rectangular	1,73	Type B	1,40E-04	1,40E-04	1,40E-04	7,00E-04	2,50E-03	7,00E-03	7,00E-03
contribution of harmonics	nonlinearities affecting mechanical excitation	rectangular	1,73	Type B	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
hum	max. tolerated contribution of powerline hum	rectangular	1,73	Type B	1,00E-04	1,00E-04	1,00E-04	1,00E-04	1,00E-04	1,00E-04	1,00E-04
noise	broadband noise (including DUT, mechanical, electrical contributions)	normal	2,00	Type B	1,00E-05	1,00E-05	1,00E-05	1,00E-05	1,00E-05	1,00E-05	1,00E-05
position dependence	reproducibility and averaging from different measurement positions * (determined for each calibration)	rectangular	1,73	Type A*	2,10E-05	2,94E-05	5,22E-04	2,70E-04	4,30E-04	4,65E-04	1,96E-03
transducer mounting	including reproducibility of mounting torque	rectangular	1,73	Type A	7,00E-05	7,00E-05	1,40E-04	5,00E-04	1,00E-03	2,00E-03	2,00E-03
cable fixture	including connector strain and triboelectric effects	rectangular	1,73	Type B	9,00E-04	7,00E-04	7,00E-04	3,50E-04	0,00E+00	0,00E+00	0,00E+00
relative motion	including imperfections of the laser vibration isolation	rectangular	1,73	Type B	1,00E-04	1,00E-05	1,00E-05	1,00E-05	1,00E-05	1,00E-05	1,00E-05
thermal stability	combinde effect on laser reference, signal acquisition and DUT	rectangular	1,73	Type B	1,50E-05	1,50E-05	1,50E-05	1,50E-05	1,50E-05	1,50E-05	1,50E-05
linearity	additional effects of non-linearity	rectangular	1,73	Type B	1,00E-05	1,00E-05	1,00E-05	1,00E-05	1,00E-05	1,00E-05	1,00E-05
reference signal	instabilities affecting the velocity signal after demodulation	rectangular	1,73	Type B	1,00E-05	1,00E-05	1,00E-05	1,00E-05	1,00E-05	1,00E-05	1,00E-05
residual components		rectangular	1,73	Type B	1,00E-04	1,00E-04	1,00E-04	1,00E-04	1,00E-04	1,00E-04	1,00E-04
relative standard uncertainty					1,12E-03	9,57E-04	1,10E-03	1,16E-03	3,40E-03	8,34E-03	8,55E-03
expanded uncertainty					2,23E-03	1,91E-03	2,19E-03	2,31E-03	6,81E-03	1,67E-02	1,71E-02
expanded uncertainty (%)					**0,22**	**0,19**	**0,22**	**0,23**	**0,7**	**1,7**	**1,7**

Measurement uncertainty budget for the primary calibration of accelerometers, type B&K 8305, single ended, (phase)

uncertainty contribution					frequency range / Hz						
					5 - < 20	20 - < 63	63 - < 1 k	1 k - 5 k	5 k - 10 k	>10 k - 15 k	>15 k - 10 k
Component		Distribution	Factor	Evaluation Type	contribution	contribution	contribution	contribution	contribution	contribution	contribution
electrical measurement	including charge amplifier calibration	normal	2,00	Type B	5,00E-02	5,00E-02	5,00E-02	5,00E-02	5,00E-02	1,00E-01	1,00E-01
frequency	including the influence of speed to acceleration conversion	rectangular	1,73	Type B	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
signal conditioner gain	including level non-linearity	normal	2,00	Type B	1,00E-01	1,00E-01	1,00E-01	1,00E-01	1,00E-01	2,00E-01	2,00E-01
signal conditioner frequency response	including frequency non-linearity	normal	2,00	Type B	1,00E-01	1,00E-01	1,00E-01	1,00E-01	2,00E-01	4,00E-01	4,00E-01
transverse motion	typical values for 8305-type of transducer	rectangular	1,73	Type B	7,00E-02	7,00E-02	7,00E-02	1,40E-01	3,00E-01	6,00E-01	6,00E-01
contribution of harmonics	nonlinearities affecting mechanical excitation	rectangular	1,73	Type B	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
hum	max. tolerated contribution of powerline hum	rectangular	1,73	Type B	1,00E-02	1,00E-02	1,00E-02	1,00E-02	1,00E-02	2,00E-02	2,00E-02
noise	broadband noise (including DUT, mechanical, electrical contributions)	normal	2,00	Type B	1,00E-02	1,00E-02	1,00E-02	1,00E-02	1,00E-02	2,00E-02	2,00E-02
position dependence	reproducibility and averaging from different measurement positions * (determined for each calibration)	rectangular	1,73	Type A*	1,04E-03	4,96E-04	4,71E-02	3,67E-03	6,22E-03	4,19E-02	8,64E-02
transducer mounting	including reproducibility of mounting torque	rectangular	1,73	Type A	5,00E-02	5,00E-02	5,00E-02	1,00E-01	2,00E-01	4,00E-01	4,00E-01
cable fixture	including connector strain and triboelectric effects	rectangular	1,73	Type B	7,00E-02	5,00E-02	5,00E-02	0,00E+00	0,00E+00	0,00E+00	0,00E+00
relative motion	including imperfections of the laser vibration isolation	rectangular	1,73	Type B	5,00E-02	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
thermal stability	combinde effect on laser reference, signal acquisition and DUT	rectangular	1,73	Type B	1,00E-02	1,00E-02	1,00E-02	1,00E-02	1,00E-02	2,00E-02	2,00E-02
linearity	additional effects of non-linearity	rectangular	1,73	Type B	1,00E-02	1,00E-02	1,00E-02	1,00E-02	1,00E-02	2,00E-02	2,00E-02
reference signal	instabilities affecting the velocity signal after demodulation	rectangular	1,73	Type B	1,00E-02	1,00E-02	1,00E-02	1,00E-02	1,00E-02	2,00E-02	2,00E-02
residual components		rectangular	1,73	Type B	5,00E-02	5,00E-02	5,00E-02	5,00E-02	5,00E-02	1,00E-01	1,00E-01
relative standard uncertainty					2,01E-01	1,88E-01	1,94E-01	2,35E-01	4,31E-01	8,62E-01	8,66E-01
expanded uncertainty (°)					**0,40**	**0,38**	**0,39**	**0,47**	**0,9**	**1,7**	**1,7**

B.4 CEM

Uncertainty budget

Magnitude

Description	Frequency range (Hz)	Relative expanded uncertainty (%)	Probability distribution	Factor	Uncertainty type	Uncertainty contribution
Laser	0.4 - 20 000	0.26	normal	2	B	0.130
Voltage	0.4 - 20 000	0.06	normal	1	B	0.060
Hum and noise	0.4 - 20 000	0.02	rectangular	1.732	B	0.012
Mounting	0.4 - 20 000	0.1	rectangular	1.732	B	0.058
Transverse motion	0.4 - 20 000	0.12	special	1	B	0.120
Reproducibility and repeatibility	0.4-< 10	0.1	normal	1	B	0.10
	10 - 5 000	0.05				0.05
	>5 000 - 10 000	0.35				0.35
	>10 000 - 15 000	0.5				0.70
	>15 000 - 20 000	1				1.00
Temperature response	0.4 - 20 000	0.1	rectangular	1.732	B	0.058
Relative motion, instability, geometric location of the laser beam	0.4 - 20 000	0.1	rectangular	1.732	B	0.058
Influence on voltage from magnetic field from exciter	0.4 - 20 000	0.05	rectangular	1.732	B	0.029
Temperature influence on sensor	0.4 - 20 000	0.04	rectangular	1.732	B	0.023
		Expanded uncertainty (0.4 Hz - < 10 Hz)				0.5
		Expanded uncertainty (10 Hz - 5 kHz)				0.4
		Expanded uncertainty (>5 kHz -10 kHz)				0.8
		Expanded uncertainty (>10 kHz -15 kHz)				1.5
		Expanded uncertainty (>15 kHz -20 kHz)				2.0

Phase

Description	Frequency range (Hz)	Expanded uncertainty (1°)	Probability distribution	Factor	Uncertainty type	Uncertainty contribution
Laser	0.4 - 20 000	0.1	normal	2	B	0.05
Voltage	0.4 - 20 000	0.5	normal	2	B	0.25
Hum and noise	0.4 - 20 000	0.02	rectangular	1.732	B	0.012
Mounting	0.4 - 20 000	0.1	rectangular	1.732	B	0.058
Reproducibility and repeatibility	0.4 - 1 000	0.05	rectangular	1.732	B	0.03
	>1 000 - 10 000	0.5				0.29
	>10 000 - 15 000	1.1				0.64
	>15 000 - 20 000	1.6				0.92
Temperature response	0.4 - 20 000	0.01	rectangular	1.732	B	0.006
Influence on voltage from magnetic field from exciter	0.4 - 20 000	0.02	rectangular	1.732	B	0.012
Relative motion, instability, geometric location of the laser beam	0.4 - 1 000	0.05	rectangular	1.732	B	0.03
	>1 000 - 10 000	0.5				0.29
		Expanded uncertainty (0.4 Hz - 1 kHz)				0.5
		Expanded uncertainty (>1 kHz -10 kHz)				1.0
		Expanded uncertainty (>10 kHz -15 kHz)				1.5
		Expanded uncertainty (>15 kHz -20 kHz)				2.0

B.5 NIST

NIST Measurement Uncertainty Budget : Magnitude

				Frequency, Hz (contribution in parts per million (ppm)					
Element		Distrbution	Type	10 - < 20	20 - 1,000	> 1,000 - 5,000	> 5,000 - 10,000	> 10,000 - 15,000	> 15,000 - 20,000
1	Accelerometer Output Voltage	Normal	B	200	200	200	200	500	500
2	Vibration Velocity	Normal	B	10	10	10	10	10	10
3	Frequency of Vibration Signal	Normal	B	10	10	10	10	10	10
4	Amplifier Gain	Normal	B	200	200	200	200	200	200
5	Voltage disturbance (hum and noise)	Normal	B	100	100	100	100	100	100
6	Transverse, rocking, and bending	Rectangular	B	400	1000	1000	1000	1000	1000
7	Harmonic Distortion	Rectangular	B	100	100	100	100	100	100
8	Voltage filtering effect	Normal	B	500	500	500	800	2500	5000
9	Spot location	Rectangular	B	200	400	1000	1000	3000	5000
10	Interferometer motion	Rectangular	B	100	10	10	10	10	10
11	Temperature change	Rectangular	B	15	15	15	15	15	15
12	Linearity	Rectangular	B	10	10	10	10	10	10
13	Temporal instability of vibration signal	Rectangular	B	10	10	10	10	10	10
15	Environmental effects	Rectangular	B	1000	400	600	500	1000	3000
16	Residual effects	Normal	A	700	500	1000	2000	5000	5000
			Uncertainty	1,43E-03	1,39E-03	1,93E-03	2,64E-03	6,52E-03	9,24E-03
		Expanded uncertainty (k=2), %		**0,3**	**0,3**	**0,4**	**0,5**	**1,5**	**2,0**

NIST Measurement Uncertainty Budget : Phase

Element			Type	Frequency, Hz 10 - < 20	20 - 1,000	> 1,000 - 5,000	> 5,000 - 10,000	> 10,000 - 15,000	> 15,000 - 20,000
1	Accelerometer Output Voltage	Normal	B	0,050	0,050	0,050	0,050	0,050	0,050
2	Vibration Velocity	Normal	B	0,050	0,050	0,050	0,150	0,150	0,150
3	Frequency of Vibration Signal	Normal	B	0,000	0,000	0,000	0,000	0,000	0,000
4	Amplifier Gain	Normal	B	0,100	0,100	0,100	0,100	0,100	0,100
5	Voltage disturbance (hum and noise)	Normal	B	0,015	0,015	0,015	0,015	0,015	0,015
6	Transverse, rocking, and bending	Rectangular	B	0,070	0,070	0,125	0,200	0,200	0,200
7	Harmonic Distortion	Rectangular	B	0,000	0,000	0,000	0,000	0,000	0,000
8	Voltage filtering effect	Normal	B	0,050	0,050	0,050	0,100	0,200	0,200
9	Spot location	Rectangular	B	0,010	0,100	0,100	0,150	0,150	0,150
10	Interferometer motion	Rectangular	B	0,050	0,050	0,050	0,050	0,050	0,050
11	Temperature change	Rectangular	B	0,010	0,010	0,010	0,010	0,010	0,010
12	Linearity	Rectangular	B	0,010	0,010	0,010	0,010	0,010	0,010
13	Temporal instability of vibration signal	Rectangular	B	0,000	0,000	0,050	0,100	0,100	0,100
15	Environmental effects	Rectangular	B	0,150	0,050	0,100	0,200	0,200	0,200
16	Residual effects	Normal	A	0,050	0,050	0,050	0,050	0,200	0,200
			Uncertainty	0,225	0,201	0,247	0,404	0,480	0,480
		Expanded uncertainty (k=2), °		**0,5**	**0,5**	**0,5**	**1,0**	**1,5**	**1,5**

B.6 CENAM

Accelerometer B&K 8305, SN: 1483350
Sensitivity Magnitude

	Frequency (Hz)	10	12,5	16	20	25		40	63	80	100	125	160	200	250	315	400	500	630	800
voltage measurement	u1	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,07	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05
distortion voltage	u2	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,10	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07
transverse sensitivity	u3	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10
displacement quantization	u4	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15
trigger hysteresis	u5	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
frequency band limitation	u6	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12
photoelectric noise	u7	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
relative motion, tot dist	u8	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01
phase disturbance	u9	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05
interferometric effects	u10	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02
frequency generator	u11	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
reproducibility	u12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12
charge sensitivity	u13	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10
correlation	r(1,10)	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01
correlation	r(1,11)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
correlation	r(10,11)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Expanded relative uncert	Urel(S)	0,29	0,29	0,29	0,29	0,29	0,29	0,29	0,30	0,29	0,29	0,29	0,29	0,29	0,29	0,29	0,29	0,29	0,29	0,29

	Frequency (Hz)	1000	1250	1500	1600	2000	2500	3000	3150	3500	4000	4500	5000	5500	6000	6300	6500	7000	7500	8000	8500	9000	9500
voltage measurement	u1	0,05	0,05	0,05	0,05	0,05	0,05	0,07	0,07	0,07	0,05	0,05	0,05	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12
total distortion voltage	u2	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12
transverse sensitivity	u3	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07
min-point resolution	u4	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,20	0,20	0,20	0,20	0,20	0,20	0,20	0,20	0,20	0,20
voltage disturbance	u5	0,12	0,12	0,12	0,12	0,12	0,12	0,15	0,15	0,15	0,12	0,12	0,12	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25
relative motion	u6	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15
interferometric effects	u7	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,22	0,22	0,22	0,22	0,22	0,22	0,22	0,22	0,22	0,22
frequency generator	u8	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
reproducibility	u9	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12
charge amplifier	u10	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08
Expanded relative uncert	Urel(S)	0,29	0,29	0,29	0,29	0,29	0,29	0,31	0,31	0,31	0,29	0,29	0,29	0,48	0,48	0,48	0,48	0,48	0,48	0,48	0,48	0,48	0,48

	Frequency (Hz)	10000	10500	11000	11500	12000	12500	13000	13500	14000	14500	15000	15500	16000	16500	17000	17500	18000	18500	19000	19500	20000
voltage measurement	u1	0,12	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08
total distortion voltage	u2	0,12	0,20	0,20	0,20	0,20	0,20	0,20	0,20	0,20	0,20	0,20	0,20	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25
transverse sensitivity	u3	0,07	0,14	0,14	0,14	0,14	0,14	0,14	0,14	0,14	0,14	0,14	0,14	0,26	0,26	0,26	0,26	0,26	0,26	0,26	0,26	0,26
min-point resolution	u4	0,20	0,37	0,37	0,37	0,37	0,37	0,37	0,37	0,37	0,37	0,37	0,37	0,47	0,47	0,47	0,47	0,47	0,47	0,47	0,47	0,47
voltage disturbance	u5	0,25	0,23	0,23	0,23	0,23	0,23	0,23	0,23	0,23	0,23	0,23	0,23	0,26	0,26	0,26	0,26	0,26	0,26	0,26	0,26	0,26
relative motion	u6	0,15	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,28	0,28	0,28	0,28	0,28	0,28	0,28	0,28	0,28
interferometric effects	u7	0,22	0,28	0,28	0,28	0,28	0,28	0,28	0,28	0,28	0,28	0,28	0,28	0,30	0,30	0,30	0,30	0,30	0,30	0,30	0,30	0,30
frequency generator	u8	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
reproducibility	u9	0,12	0,48	0,48	0,48	0,48	0,48	0,48	0,48	0,48	0,48	0,48	0,48	0,53	0,53	0,53	0,53	0,53	0,53	0,53	0,53	0,53
charge amplifier	u10	0,08	0,20	0,20	0,20	0,20	0,20	0,20	0,20	0,20	0,20	0,20	0,20	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25
Expanded relative uncert	Urel(S)	0,48	0,81	0,81	0,81	0,81	0,81	0,81	0,81	0,81	0,81	0,81	0,81	0,97	0,97	0,97	0,97	0,97	0,97	0,97	0,97	0,97

Accelerometer B&K 8305, SN: 1483350
Sensitivity Phase

Frequency	(Hz)	10	12,5	16	20	25	31,5	40	63	80	100	125	160	200	250	315	400	500	630	800
Accelerometer output phase measurement (ADC resolution)	u1	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02
Voltage filtering (frequency band limitation) on accelerometer output phase	u2	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05
Voltage disturbance (hum and noise) on accelerometer output phase	u3	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12
Transverse, rocking and bending on accelerometer output phase	u4	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15
Interferometer quadrature signal on displacement phase measurement	u5	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08
Interferometer filtering on displacement phase measurement (frequency band limitation)	u6	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16
Motion disturbance on displacement phase measurement	u7	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,09
Residual interferometric effects on displacement phase measurement	u8	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07
Expanded relative uncert	Urel(ϕ)	0,29	0,29	0,29	0,29	0,29	0,29	0,29	0,29	0,29	0,29	0,29	0,29	0,29	0,29	0,29	0,29	0,29	0,29	0,29

Frequency	(Hz)	1000	1250	1500	1600	2000	2500	3000	3150	3500	4000	4500	5000	5500	6000	6300	6500	7000	7500	8000	8500	9000	9500
Accelerometer output phase measurement (ADC resolution)	u1	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08
Voltage filtering (frequency band limitation) on accelerometer output phase	u2	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12
Voltage disturbance (hum and noise) on accelerometer output phase	u3	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,28	0,28	0,28	0,28	0,28	0,28	0,28	0,28	0,28	0,28
Transverse, rocking and bending on accelerometer output phase	u4	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,26	0,26	0,26	0,26	0,26	0,26	0,26	0,26	0,26	0,26
Interferometer quadrature signal on displacement phase measurement	u5	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13
Interferometer filtering on displacement phase measurement (frequency band limitation)	u6	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16
Motion disturbance on displacement phase measurement	u7	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13
Residual interferometric effects on displacement phase measurement	u8	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15
Expanded relative uncert	Urel(ϕ)	0,29	0,29	0,29	0,29	0,29	0,29	0,29	0,29	0,29	0,29	0,29	0,29	0,50	0,50	0,50	0,50	0,50	0,50	0,50	0,50	0,50	0,50

Frequency	(Hz)	10000	10500	11000	11500	12000	12500	13000	13500	14000	14500	15000	15500	16000	16500	17000	17500	18000	18500	19000	19500	20000
Accelerometer output phase measurement (ADC resolution)	u1	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08
Voltage filtering (frequency band limitation) on accelerometer output phase	u2	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12
Voltage disturbance (hum and noise) on accelerometer output phase	u3	0,28	0,28	0,28	0,28	0,28	0,28	0,28	0,28	0,28	0,28	0,28	0,28	0,28	0,28	0,28	0,28	0,28	0,28	0,28	0,28	0,28
Transverse, rocking and bending on accelerometer output phase	u4	0,26	0,26	0,26	0,26	0,26	0,26	0,26	0,26	0,26	0,26	0,26	0,26	0,26	0,26	0,26	0,26	0,26	0,26	0,26	0,26	0,26
Interferometer quadrature signal on displacement phase measurement	u5	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13
Interferometer filtering on displacement phase measurement (frequency band limitation)	u6	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16
Motion disturbance on displacement phase measurement	u7	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13
Residual interferometric effects on displacement phase measurement	u8	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15
Expanded relative uncert	Urel(ϕ)	0,50	0,50	0,50	0,50	0,50	0,50	0,50	0,50	0,50	0,50	0,50	0,50	0,50	0,50	0,50	0,50	0,50	0,50	0,50	0,50	0,50

Accelerometer B&K8305 WH 2335, SN: 1610153
Sensitivity Magnitude

Frequency	(Hz)	10	12,5	16	20	25		40	63	80	100	125	160	200	250	315	400	500	630	800
voltage measurement	u1	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,07	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05
distortion voltage	u2	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,10	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07
transverse sensitivity	u3	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10
displacement quantization	u4	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15
trigger hysteresis	u5	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
frequency band limitation	u6	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12
photoelectric noise	u7	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
relative motion, tot dist	u8	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01
phase disturbance	u9	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05
interferometric effects	u10	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02
frequency generator	u11	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
reproducibility	u12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12
charge sensitivity	u13	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10
correlation	r(1,10)	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01
correlation	r(1,11)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
correlation	r(10,11)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Expanded relative uncert	Urel(S)	0,29	0,29	0,29	0,29	0,29	0,29	0,29	0,30	0,29	0,29	0,29	0,29	0,29	0,29	0,29	0,29	0,29	0,29	0,29

Frequency	(Hz)	1000	1250	1500	1600	2000	2500	3000	3150	3500	4000	5000	5000	5500	6000	6300	6500	7000	7500	8000	8500	9000	9500
voltage measurement	u1	0,05	0,05	0,05	0,05	0,05	0,05	0,07	0,07	0,07	0,05	0,05	0,05	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12
total distortion voltage	u2	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12
transverse sensitivity	u3	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07
min-point resolution	u4	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,20	0,20	0,20	0,20	0,20	0,20	0,20	0,20	0,20	0,20
voltage disturbance	u5	0,12	0,12	0,12	0,12	0,12	0,12	0,15	0,15	0,15	0,12	0,12	0,12	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25
relative motion	u6	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15
interferometric effects	u7	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,22	0,22	0,22	0,22	0,22	0,22	0,22	0,22	0,22	0,22
frequency generator	u8	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
reproducibility	u9	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12
charge amplifier	u10	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08
Expanded relative uncert	Urel(S)	0,29	0,29	0,29	0,29	0,29	0,29	0,31	0,31	0,31	0,29	0,29	0,29	0,48	0,48	0,48	0,48	0,48	0,48	0,48	0,48	0,48	0,48

Frequency	(Hz)	10000	10500	11000	11500	12000	12500	13000	13500	14000	14500	15000	15500	16000	16500	17000	17500	18000	18500	19000	19500	20000
voltage measurement	u1	0,12	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08
total distortion voltage	u2	0,12	0,20	0,20	0,20	0,20	0,20	0,20	0,20	0,20	0,20	0,20	0,20	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25
transverse sensitivity	u3	0,07	0,14	0,14	0,14	0,14	0,14	0,14	0,14	0,14	0,14	0,14	0,14	0,26	0,26	0,26	0,26	0,26	0,26	0,26	0,26	0,26
min-point resolution	u4	0,20	0,37	0,37	0,37	0,37	0,37	0,37	0,37	0,37	0,37	0,37	0,37	0,47	0,47	0,47	0,47	0,47	0,47	0,47	0,47	0,47
voltage disturbance	u5	0,25	0,23	0,23	0,23	0,23	0,23	0,23	0,23	0,23	0,23	0,23	0,23	0,26	0,26	0,26	0,26	0,26	0,26	0,26	0,26	0,26
relative motion	u6	0,15	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,28	0,28	0,28	0,28	0,28	0,28	0,28	0,28	0,28
interferometric effects	u7	0,22	0,28	0,28	0,28	0,28	0,28	0,28	0,28	0,28	0,28	0,28	0,28	0,30	0,30	0,30	0,30	0,30	0,30	0,30	0,30	0,30
frequency generator	u8	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
reproducibility	u9	0,12	0,48	0,48	0,48	0,48	0,48	0,48	0,48	0,48	0,48	0,48	0,48	0,53	0,53	0,53	0,53	0,53	0,53	0,53	0,53	0,53
charge amplifier	u10	0,08	0,20	0,20	0,20	0,20	0,20	0,20	0,20	0,20	0,20	0,20	0,20	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25
Expanded relative uncert	Urel(S)	0,48	0,81	0,81	0,81	0,81	0,81	0,81	0,81	0,81	0,81	0,81	0,81	0,97	0,97	0,97	0,97	0,97	0,97	0,97	0,97	0,97

Accelerometer B&K8305 WH 2335, SN: 1610153
Sensitivity Phase

Frequency	(Hz)	10	12,5	16	20	25	31,5	40	63	80	100	125	160	200	250	315	400	500	630	800
Accelerometer output phase measurement (ADC resolution)	u1	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02
Voltage filtering (frequency band limitation) on accelerometer output phase	u2	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05
Voltage disturbance (hum and noise) on accelerometer output phase	u3	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12
Transverse, rocking and bending on accelerometer output phase	u4	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15
Interferometer quadrature signal on displacement phase measurement	u5	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08
Interferometer filtering on displacement phase measurement (frequency band limitation)	u6	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16
Motion disturbance on displacement phase measurement	u7	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,09
Residual interferometric effects on displacement phase measurement	u8	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07
Expanded relative uncert	Urel(φ)	0,29	0,29	0,29	0,29	0,29	0,29	0,29	0,29	0,29	0,29	0,29	0,29	0,29	0,29	0,29	0,29	0,29	0,29	0,29

Frequency	(Hz)	1000	1250	1500	1600	2000	2500	3000	3150	3500	4000	4500	5000	5500	6000	6300	6500	7000	7500	8000	8500	9000	9500
Accelerometer output phase measurement (ADC resolution)	u1	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08
Voltage filtering (frequency band limitation) on accelerometer output phase	u2	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12
Voltage disturbance (hum and noise) on accelerometer output phase	u3	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,28	0,28	0,28	0,28	0,28	0,28	0,28	0,28	0,28	0,28
Transverse, rocking and bending on accelerometer output phase	u4	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,26	0,26	0,26	0,26	0,26	0,26	0,26	0,26	0,26	0,26
Interferometer quadrature signal on displacement phase measurement	u5	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13
Interferometer filtering on displacement phase measurement (frequency band limitation)	u6	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16
Motion disturbance on displacement phase measurement	u7	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13
Residual interferometric effects on displacement phase measurement	u8	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15
Expanded relative uncert	Urel(φ)	0,29	0,29	0,29	0,29	0,29	0,29	0,29	0,29	0,29	0,29	0,29	0,29	0,50	0,50	0,50	0,50	0,50	0,50	0,50	0,50	0,50	0,50

Frequency	(Hz)	10000	10500	11000	11500	12000	12500	13000	13500	14000	14500	15000	15500	16000	16500	17000	17500	18000	18500	19000	19500	20000
Accelerometer output phase measurement (ADC resolution)	u1	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08
Voltage filtering (frequency band limitation) on accelerometer output phase	u2	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12
Voltage disturbance (hum and noise) on accelerometer output phase	u3	0,28	0,28	0,28	0,28	0,28	0,28	0,28	0,28	0,28	0,28	0,28	0,28	0,28	0,28	0,28	0,28	0,28	0,28	0,28	0,28	0,28
Transverse, rocking and bending on accelerometer output phase	u4	0,26	0,26	0,26	0,26	0,26	0,26	0,26	0,26	0,26	0,26	0,26	0,26	0,26	0,26	0,26	0,26	0,26	0,26	0,26	0,26	0,26
Interferometer quadrature signal on displacement phase measurement	u5	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13
Interferometer filtering on displacement phase measurement (frequency band limitation)	u6	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16
Motion disturbance on displacement phase measurement	u7	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13	0,13
Residual interferometric effects on displacement phase measurement	u8	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15	0,15
Expanded relative uncert	Urel(φ)	0,50	0,50	0,50	0,50	0,50	0,50	0,50	0,50	0,50	0,50	0,50	0,50	0,50	0,50	0,50	0,50	0,50	0,50	0,50	0,50	0,50

B.7 NMIJ

8305-001(SE) Magnitude

Frequency	System	Method	Sensitivity	Conbined uncertainty	Expanded uncertainty (k=2)	Stated uncertainty (k=2)	Charge amplifier calibration	Voltage standard uncertainty	Digitizer calibration	Laser wavelength	Alignnment of laser (Abbe error)	Alignment of transducer (cosine error)	Timebase uncertainty	Amplitude measurement of displacement	Amplitude measurement of accelerometer output	Transverse motion	Temperature coefficient of transducer	Repeatability
[Hz]			[V·s^2/m]	[%]	[%]	[%]	Conbined [%]	B [%]	B [%]	B [%]	B [%]	B [%]	B [%]	A [%]	A [%]	B [%]	B [%]	A [%]
10	VD	SAM	0,12676	0,32	0,64	0,7	1,1,E-01	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	2,8E-01	2,0E-05	1,0E-01	3,5E-02	1,3E-02
12,5	VD	SAM	0,12670	0,32	0,65	0,7	1,1,E-01	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	2,8E-01	1,6E-05	1,0E-01	3,5E-02	6,7E-03
16	VD	SAM	0,12666	0,24	0,48	0,5	1,1,E-01	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	1,8E-01	1,5E-05	1,0E-01	3,5E-02	2,2E-02
20	VD	SAM	0,12664	0,16	0,32	0,4	1,1,E-01	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	4,0E-02	9,3E-06	1,0E-01	3,5E-02	1,2E-02
25	VD	SAM	0,12664	0,17	0,34	0,4	1,1,E-01	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	7,5E-02	1,3E-05	1,0E-01	3,5E-02	9,6E-03
31,5	VD	SAM	0,12663	0,15	0,31	0,4	1,1,E-01	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	1,3E-02	6,4E-06	1,0E-01	3,5E-02	7,6E-03
40	VD	SAM	0,12662	0,15	0,31	0,4	1,1,E-01	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	1,9E-03	5,0E-06	1,0E-01	3,5E-02	3,2E-03
63	VD	SAM	0,12662	0,15	0,31	0,4	1,1,E-01	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	9,4E-05	5,4E-06	1,0E-01	3,5E-02	6,3E-03
80	VD	SAM	0,12662	0,15	0,31	0,4	1,1,E-01	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	7,3E-05	6,3E-06	1,0E-01	3,5E-02	7,7E-03
100	VD	SAM	0,12660	0,15	0,31	0,4	1,1,E-01	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	7,9E-05	6,9E-06	1,0E-01	3,5E-02	1,1E-02
125	VD	SAM	0,12661	0,15	0,31	0,4	1,1,E-01	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	7,0E-05	7,4E-06	1,0E-01	3,5E-02	1,8E-02
160	VD	SAM	0,12667	0,16	0,31	0,4	1,1,E-01	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	7,3E-05	8,8E-06	1,0E-01	3,5E-02	2,8E-02
200	VD	SAM	0,12664	0,15	0,31	0,4	1,1,E-01	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	2,3E-05	3,2E-06	1,0E-01	3,5E-02	9,3E-03
250	VD	SAM	0,12662	0,11	0,22	0,3	2,2,E-02	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	2,7E-05	1,0E-06	1,0E-01	3,5E-02	5,5E-03
315	VD	SAM	0,12664	0,11	0,22	0,3	2,2,E-02	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	1,5E-05	9,9E-07	1,0E-01	3,5E-02	7,8E-03
400	VD	SAM	0,12665	0,11	0,22	0,3	2,2,E-02	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	8,4E-06	1,0E-06	1,0E-01	3,5E-02	6,2E-03
500	VD	SAM	0,12667	0,11	0,22	0,3	2,2,E-02	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	5,3E-06	1,0E-06	1,0E-01	3,5E-02	6,1E-03
630	VD	SAM	0,12665	0,11	0,22	0,3	2,2,E-02	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	3,4E-06	1,3E-06	1,0E-01	3,5E-02	7,4E-03
800	VD	SAM	0,12671	0,11	0,22	0,3	2,2,E-02	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	2,3E-06	1,3E-06	1,0E-01	3,5E-02	1,7E-02
1000	VD	SAM	0,12676	0,11	0,21	0,3	1,2,E-02	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	4,3E-06	3,6E-06	1,0E-01	3,5E-02	7,6E-03
1250	VD	SAM	0,12680	0,11	0,21	0,3	1,2,E-02	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	4,0E-05	3,9E-06	1,0E-01	3,5E-02	8,8E-03
1500	VD	SAM	0,12692	0,11	0,22	0,3	1,2,E-02	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	3,7E-06	3,8E-06	1,0E-01	3,5E-02	1,8E-02
1600	VD	SAM	0,12702	0,11	0,22	0,3	1,2,E-02	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	4,1E-06	3,6E-06	1,0E-01	3,5E-02	1,5E-02
2000	VD	SAM	0,12719	0,11	0,21	0,3	1,2,E-02	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	8,0E-06	4,0E-06	1,0E-01	3,5E-02	9,7E-03
2500	VD	SAM	0,12750	0,11	0,21	0,3	1,2,E-02	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	9,2E-06	4,0E-06	1,0E-01	3,5E-02	8,4E-03
3000	VD	SAM	0,12791	0,11	0,22	0,3	1,2,E-02	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	1,3E-05	5,3E-06	1,0E-01	3,5E-02	3,3E-02
3150	VD	SAM	0,12801	0,11	0,21	0,3	1,2,E-02	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	1,4E-05	4,2E-06	1,0E-01	3,5E-02	1,2E-02
3500	VD	SAM	0,12828	0,11	0,21	0,3	1,2,E-02	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	2,1E-05	6,5E-06	1,0E-01	3,5E-02	9,8E-03
4000	VD	SAM	0,12883	0,11	0,22	0,3	1,2,E-02	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	2,9E-05	5,1E-06	1,0E-01	3,5E-02	1,5E-02
4500	VD	SAM	0,12944	0,11	0,22	0,3	1,2,E-02	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	3,9E-05	6,6E-06	1,0E-01	3,5E-02	1,7E-02
5000	VD	SAM	0,13012	0,21	0,41	0,5	1,2,E-02	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	5,1E-05	6,1E-06	2,0E-01	3,5E-02	4,0E-02
5500	VD	SAM	0,13067	0,21	0,42	0,5	1,2,E-02	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	7,5E-05	1,2E-05	2,0E-01	3,5E-02	4,9E-02
6000	VD	SAM	0,13163	0,21	0,43	0,5	1,2,E-02	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	7,2E-05	6,4E-06	2,0E-01	3,5E-02	6,5E-02
6300	VD	SAM	0,13199	0,21	0,41	0,5	1,2,E-02	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	8,0E-05	1,2E-05	2,0E-01	3,5E-02	3,3E-02
6500	VD	SAM	0,13247	0,21	0,42	0,5	1,2,E-02	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	8,8E-05	4,0E-05	2,0E-01	3,5E-02	5,5E-02
7000	VD	SAM	0,13333	0,22	0,45	0,5	1,2,E-02	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	1,1E-04	1,4E-05	2,0E-01	3,5E-02	9,6E-02
7500	VD	SAM	0,13458	0,21	0,41	0,5	8,2,E-03	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	9,4E-05	6,7E-05	2,0E-01	3,5E-02	3,9E-02
8000	VD	SAM	0,13579	0,21	0,41	0,5	8,2,E-03	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	1,1E-04	4,1E-05	2,0E-01	3,5E-02	3,8E-02
8500	VD	SAM	0,13694	0,22	0,44	0,5	8,2,E-03	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	1,0E-04	6,2E-05	2,0E-01	3,5E-02	8,8E-02
9000	VD	SAM	0,13878	0,21	0,42	0,5	8,2,E-03	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	1,3E-04	1,1E-04	2,0E-01	3,5E-02	5,2E-02
9500	VD	SAM	0,13948	0,29	0,58	0,6	8,2,E-03	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	1,5E-04	2,3E-04	2,0E-01	3,5E-02	2,1E-01
10000	VD	SAM	0,14109	0,22	0,45	0,5	8,2,E-03	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	1,8E-04	5,1E-04	2,0E-01	3,5E-02	9,6E-02
10500	VD	SAM	0,14273	0,26	0,52	0,8	8,2,E-03	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	1,8E-04	2,5E-03	2,0E-01	3,5E-02	1,6E-01
11000	VD	SAM	0,14437	0,31	0,63	0,8	8,2,E-03	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	2,1E-04	1,5E-01	2,0E-01	3,5E-02	1,8E-01
11500	VD	SAM	0,14641	0,25	0,49	0,8	8,2,E-03	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	2,4E-04	4,5E-03	2,0E-01	3,5E-02	1,4E-01
12000	VD	SAM	0,14785	0,54	1,09	1,3	8,2,E-03	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	3,0E-04	1,4E-03	4,0E-01	3,5E-02	3,7E-01
12500	VD	SAM	0,15077	0,96	1,91	2,2	8,2,E-03	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	2,7E-04	8,7E-04	9,0E-01	3,5E-02	3,2E-01
13000	VD	SAM	0,15304	0,96	1,92	2,2	8,2,E-03	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	3,1E-04	7,1E-04	9,0E-01	3,5E-02	3,3E-01
13500	VD	SAM	0,15603	0,93	1,85	2,2	8,2,E-03	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	3,9E-04	7,6E-04	9,0E-01	3,5E-02	2,1E-01
14000	VD	SAM	0,15824	1,03	2,06	2,2	8,2,E-03	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	3,5E-04	8,2E-04	9,0E-01	3,5E-02	5,0E-01
14500	VD	SAM	0,16117	0,98	1,95	2,2	8,2,E-03	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	4,1E-04	1,2E-03	9,0E-01	3,5E-02	3,7E-01
15000	VD	SAM	0,16402	0,95	1,90	2,2	8,2,E-03	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	4,1E-04	4,0E-03	9,0E-01	3,5E-02	3,1E-01
15500	VD	SAM	0,16719	0,92	1,84	2,2	8,2,E-03	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	4,2E-04	1,8E-03	9,0E-01	3,5E-02	1,9E-01
16000	VD	SAM	0,17145	0,98	1,96	2,2	8,2,E-03	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	5,7E-04	6,1E-03	9,0E-01	3,5E-02	3,8E-01
16500	VD	SAM	0,17418	1,00	2,00	2,2	8,2,E-03	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	5,4E-04	1,8E-01	9,0E-01	3,5E-02	4,0E-01
17000	VD	SAM	0,17890	0,95	1,90	2,2	8,2,E-03	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	5,7E-04	1,0E-02	9,0E-01	3,5E-02	3,0E-01
17500	VD	SAM	0,18386	1,31	2,63	3,0	8,2,E-03	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	9,4E-04	1,1E-01	9,0E-01	3,5E-02	9,5E-01
18000	VD	SAM	0,18830	1,18	2,35	2,5	6,6,E-03	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	7,6E-04	1,8E-02	9,0E-01	3,5E-02	7,6E-01
18500	VD	SAM	0,19236	0,96	1,91	2,5	6,6,E-03	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	7,8E-04	3,7E-03	9,0E-01	3,5E-02	3,2E-01
19000	VD	SAM	0,19504	1,02	2,04	2,5	6,6,E-03	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	8,5E-04	1,5E-03	9,0E-01	3,5E-02	4,8E-01
19500	VD	SAM	0,20013	0,96	1,93	2,5	6,6,E-03	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	9,3E-04	1,2E-03	9,0E-01	3,5E-02	3,5E-01
20000	VD	SAM	0,20853	1,15	2,31	2,5	6,6,E-03	3,0E-04	6,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	8,4E-04	9,9E-04	9,0E-01	3,5E-02	7,2E-01

8305-001(SE) Phase

Frequency	System	Method	Phase shift	Conbined uncertainty	Expanded uncertainty (k=2)	Stated uncertainty (k=2)	Charge amplifier calibration	Initial phase of interferometer signal	Initial phase of accelerometer output	Repeatability	Relative motion	Harmonic distortion	Difference in sampling timing	Frequency uncertainty	Delay in interferometer
[Hz]			[deg]	[deg]	[deg]	[deg]	Combined [rad]	A [rad]	A [rad]	A [rad]	B [rad]	B [rad]	B [rad]	B [rad]	B [rad]
10	VD	SAM	-0,01	0,21	0,43	0,5	1,8E-04	2,8E-03	2,0E-07	7,4E-05	1,6E-06	2,4E-03	1,8E-06	1,8E-04	3,6E-07
12,5	VD	SAM	-0,04	0,22	0,43	0,5	1,8E-04	2,8E-03	1,6E-07	1,9E-04	1,6E-06	2,4E-03	2,3E-06	1,8E-04	4,5E-07
16	VD	SAM	-0,02	0,18	0,35	0,4	1,8E-04	1,8E-03	1,5E-07	1,5E-04	1,6E-06	2,4E-03	2,9E-06	1,8E-04	5,8E-07
20	VD	SAM	-0,02	0,14	0,29	0,3	1,8E-04	4,0E-04	9,3E-08	5,9E-05	1,6E-06	2,4E-03	3,6E-06	1,8E-04	7,3E-07
25	VD	SAM	-0,02	0,15	0,29	0,3	1,8E-04	7,5E-04	1,3E-07	3,1E-05	1,6E-06	2,4E-03	4,5E-06	1,8E-04	9,1E-07
31,5	VD	SAM	-0,03	0,14	0,28	0,3	1,8E-04	1,3E-04	6,4E-08	5,0E-05	1,6E-06	2,4E-03	5,7E-06	1,8E-04	1,1E-06
40	VD	SAM	-0,02	0,14	0,28	0,3	1,8E-04	1,9E-05	5,0E-08	6,9E-05	1,6E-06	2,4E-03	7,3E-06	1,8E-04	1,5E-06
50	VD	SAM	-0,02	0,14	0,28	0,3	1,8E-04	3,2E-06	5,1E-08	2,3E-05	1,6E-06	2,4E-03	9,1E-06	1,8E-04	1,8E-06
63	VD	SAM	-0,03	0,14	0,28	0,3	1,8E-04	9,4E-07	5,4E-08	1,5E-05	1,6E-06	2,4E-03	1,1E-05	1,8E-04	2,3E-06
80	VD	SAM	-0,03	0,14	0,28	0,3	1,8E-04	7,3E-07	6,3E-08	2,5E-05	1,6E-06	2,4E-03	1,5E-05	1,8E-04	2,9E-06
100	VD	SAM	-0,04	0,14	0,28	0,3	1,8E-04	7,9E-07	6,9E-08	4,6E-05	1,6E-06	2,4E-03	1,8E-05	1,8E-04	3,6E-06
125	VD	SAM	-0,05	0,14	0,28	0,3	1,8E-04	7,0E-07	7,4E-08	1,2E-04	1,6E-06	2,4E-03	2,3E-05	1,8E-04	4,5E-06
160	VD	SAM	-0,04	0,15	0,29	0,3	1,8E-04	7,3E-07	8,8E-08	6,6E-04	1,6E-06	2,4E-03	2,9E-05	1,8E-04	5,8E-06
200	VD	SAM	0,01	0,14	0,28	0,3	1,8E-04	2,3E-07	3,2E-08	9,6E-05	1,6E-06	2,4E-03	3,6E-05	1,8E-04	7,3E-06
250	VD	SAM	0,01	0,14	0,28	0,3	1,8E-04	2,7E-07	1,0E-08	2,5E-05	1,6E-06	2,4E-03	4,5E-05	1,8E-04	9,1E-06
315	VD	SAM	0,01	0,14	0,28	0,3	1,8E-04	1,5E-07	9,9E-09	1,5E-05	1,6E-06	2,4E-03	5,7E-05	1,8E-04	1,1E-05
400	VD	SAM	0,01	0,14	0,28	0,3	1,8E-04	8,4E-08	1,0E-08	2,8E-05	1,6E-06	2,4E-03	7,3E-05	1,8E-04	1,5E-05
500	VD	SAM	0,00	0,14	0,28	0,3	1,8E-04	5,3E-08	1,0E-08	1,3E-05	1,6E-06	2,4E-03	9,1E-05	1,8E-04	1,8E-05
630	VD	SAM	-0,02	0,14	0,28	0,3	1,8E-04	3,4E-08	1,3E-08	7,6E-05	1,6E-06	2,4E-03	1,1E-04	1,8E-04	2,3E-05
800	VD	SAM	0,02	0,14	0,28	0,3	1,8E-04	2,3E-08	1,3E-08	5,1E-05	1,6E-06	2,4E-03	1,5E-04	1,8E-04	2,9E-05
1000	VD	SAM	0,01	0,14	0,28	0,3	1,8E-04	4,3E-08	3,6E-08	6,2E-05	1,6E-06	2,4E-03	1,8E-04	1,8E-04	3,6E-05
1250	VD	SAM	-0,01	0,14	0,28	0,3	1,8E-04	4,0E-07	3,9E-08	1,5E-04	1,6E-06	2,4E-03	2,3E-04	1,8E-04	4,5E-05
1500	VD	SAM	-0,06	0,14	0,28	0,3	1,8E-04	3,7E-08	3,8E-08	2,2E-04	1,6E-06	2,4E-03	2,7E-04	1,8E-04	5,4E-05
1600	VD	SAM	0,01	0,14	0,28	0,3	1,8E-04	4,1E-08	3,6E-08	9,6E-05	1,6E-06	2,4E-03	2,9E-04	1,8E-04	5,8E-05
2000	VD	SAM	0,04	0,14	0,29	0,3	1,8E-04	8,0E-08	4,0E-08	1,0E-04	1,6E-06	2,4E-03	3,6E-04	1,8E-04	7,3E-05
2500	VD	SAM	0,01	0,14	0,29	0,3	1,8E-04	9,2E-08	4,0E-08	1,0E-04	1,6E-06	2,4E-03	4,5E-04	1,8E-04	9,1E-05
3000	VD	SAM	-0,01	0,14	0,29	0,3	1,8E-04	1,3E-07	5,3E-08	4,3E-05	1,6E-06	2,4E-03	5,4E-04	1,8E-04	1,1E-04
3150	VD	SAM	0,03	0,15	0,29	0,3	1,8E-04	1,4E-07	4,2E-08	1,1E-04	1,6E-06	2,4E-03	5,7E-04	1,8E-04	1,1E-04
3500	VD	SAM	0,01	0,15	0,29	0,3	1,8E-04	2,1E-07	6,5E-08	6,3E-05	1,6E-06	2,4E-03	6,3E-04	1,8E-04	1,3E-04
4000	VD	SAM	-0,01	0,15	0,30	0,3	1,8E-04	2,9E-07	5,1E-08	4,0E-04	1,6E-06	2,4E-03	7,3E-04	1,8E-04	1,5E-04
4500	VD	SAM	0,02	0,15	0,30	0,3	1,8E-04	3,9E-07	6,6E-08	1,2E-04	1,6E-06	2,4E-03	8,2E-04	1,8E-04	1,6E-04
5000	VD	SAM	-0,03	0,15	0,30	0,4	1,8E-04	5,1E-07	6,1E-08	3,9E-04	1,6E-06	2,4E-03	9,1E-04	1,8E-04	1,8E-04
5500	VD	SAM	0,01	0,15	0,31	0,4	1,8E-04	7,5E-07	1,2E-07	2,1E-04	1,6E-06	2,4E-03	1,0E-03	1,8E-04	2,0E-04
6000	VD	SAM	0,01	0,16	0,31	0,4	1,8E-04	7,2E-07	6,4E-08	3,5E-04	1,6E-06	2,4E-03	1,1E-03	1,8E-04	2,2E-04
6300	VD	SAM	-0,03	0,16	0,31	0,4	1,8E-04	8,0E-07	1,2E-07	1,6E-04	1,6E-06	2,4E-03	1,1E-03	1,8E-04	2,3E-04
6500	VD	SAM	-0,02	0,16	0,32	0,4	1,8E-04	8,8E-07	4,0E-07	2,6E-04	1,6E-06	2,4E-03	1,2E-03	1,8E-04	2,4E-04
7000	VD	SAM	0,02	0,16	0,32	0,4	1,8E-04	1,1E-06	1,4E-07	2,1E-04	1,6E-06	2,4E-03	1,3E-03	1,8E-04	2,5E-04
7500	VD	SAM	0,03	0,16	0,32	0,4	1,8E-04	9,4E-07	6,7E-07	1,9E-04	1,6E-06	2,4E-03	1,4E-03	1,8E-04	2,7E-04
8000	VD	SAM	0,00	0,16	0,33	0,4	1,8E-04	1,1E-06	4,1E-07	2,1E-04	1,6E-06	2,4E-03	1,5E-03	1,8E-04	2,9E-04
8500	VD	SAM	-0,06	0,17	0,34	0,4	1,8E-04	1,0E-06	6,2E-07	2,4E-04	1,6E-06	2,4E-03	1,5E-03	1,8E-04	3,1E-04
9000	VD	SAM	-0,16	0,18	0,36	0,4	1,8E-04	1,3E-06	1,1E-06	9,2E-04	1,6E-06	2,4E-03	1,6E-03	1,8E-04	3,3E-04
9500	VD	SAM	-0,05	0,17	0,35	0,4	1,8E-04	1,5E-06	2,3E-06	2,1E-04	1,6E-06	2,4E-03	1,7E-03	1,8E-04	3,4E-04
10000	VD	SAM	0,03	0,18	0,36	0,4	1,8E-04	1,8E-06	5,1E-06	5,8E-04	1,6E-06	2,4E-03	1,8E-03	1,8E-04	3,6E-04
10500	VD	SAM	-0,08	0,18	0,37	0,4	1,8E-04	1,8E-06	2,5E-05	5,7E-04	1,6E-06	2,4E-03	1,9E-03	1,8E-04	3,8E-04
11000	VD	SAM	0,04	0,21	0,41	0,5	1,8E-04	2,1E-06	1,5E-03	6,5E-04	1,6E-06	2,4E-03	2,0E-03	1,8E-04	4,0E-04
11500	VD	SAM	-0,05	0,19	0,38	0,4	1,8E-04	2,4E-06	4,5E-05	7,1E-04	1,6E-06	2,4E-03	2,1E-03	1,8E-04	4,2E-04
12000	VD	SAM	0,05	0,20	0,39	0,4	1,8E-04	3,0E-06	1,4E-05	9,2E-04	1,6E-06	2,4E-03	2,2E-03	1,8E-04	4,4E-04
12500	VD	SAM	-0,04	0,19	0,39	0,4	1,8E-04	2,7E-06	8,7E-06	3,9E-04	1,6E-06	2,4E-03	2,3E-03	1,8E-04	4,5E-04
13000	VD	SAM	0,02	0,20	0,40	0,5	1,8E-04	3,1E-06	7,1E-06	7,7E-04	1,6E-06	2,4E-03	2,4E-03	1,8E-04	4,7E-04
13500	VD	SAM	-0,06	0,21	0,41	0,5	1,8E-04	3,9E-06	7,6E-06	7,8E-04	1,6E-06	2,4E-03	2,4E-03	1,8E-04	4,9E-04
14000	VD	SAM	0,05	0,22	0,43	0,5	1,8E-04	3,5E-06	8,2E-06	1,2E-03	1,6E-06	2,4E-03	2,5E-03	1,8E-04	5,1E-04
14500	VD	SAM	-0,10	0,21	0,43	0,5	1,8E-04	4,1E-06	1,2E-05	7,3E-04	1,6E-06	2,4E-03	2,6E-03	1,8E-04	5,3E-04
15000	VD	SAM	-0,06	0,23	0,46	0,5	1,8E-04	4,1E-06	4,0E-05	1,4E-03	1,6E-06	2,4E-03	2,7E-03	1,8E-04	5,4E-04
15500	VD	SAM	-0,03	0,22	0,44	0,5	1,8E-04	4,2E-06	1,8E-05	8,0E-04	1,6E-06	2,4E-03	2,8E-03	1,8E-04	5,6E-04
16000	VD	SAM	-0,18	0,23	0,46	0,5	1,8E-04	5,7E-06	6,1E-05	1,3E-03	1,6E-06	2,4E-03	2,9E-03	1,8E-04	5,8E-04
16500	VD	SAM	-0,08	0,27	0,55	0,6	1,8E-04	5,4E-06	1,8E-03	2,0E-03	1,6E-06	2,4E-03	3,0E-03	1,8E-04	6,0E-04
17000	VD	SAM	-0,41	0,46	0,91	1,0	1,8E-04	5,7E-06	1,0E-04	1,3E-03	1,6E-06	7,2E-03	3,1E-03	1,8E-04	6,2E-04
17500	VD	SAM	-0,50	0,46	0,93	1,0	1,8E-04	9,4E-06	1,1E-03	1,4E-03	1,6E-06	7,2E-03	3,2E-03	1,8E-04	6,3E-04
18000	VD	SAM	-0,73	0,49	0,97	1,0	1,8E-04	7,6E-06	1,8E-04	3,0E-03	1,6E-06	7,2E-03	3,3E-03	1,8E-04	6,5E-04
18500	VD	SAM	-0,43	0,52	1,04	1,1	1,8E-04	7,8E-06	3,7E-05	4,4E-03	1,6E-06	7,2E-03	3,4E-03	1,8E-04	6,7E-04
19000	VD	SAM	-0,66	0,49	0,97	1,0	1,8E-04	8,5E-06	1,5E-05	2,7E-03	1,6E-06	7,2E-03	3,4E-03	1,8E-04	6,9E-04
19500	VD	SAM	-0,16	0,26	0,51	0,6	1,8E-04	9,3E-06	1,2E-05	8,6E-04	1,6E-06	2,4E-03	3,5E-03	1,8E-04	7,1E-04
20000	VD	SAM	-0,19	0,26	0,51	0,6	1,8E-04	8,4E-06	9,9E-06	2,8E-04	1,6E-06	2,4E-03	3,6E-03	1,8E-04	7,3E-04

8305S(BB) Magnitude

Frequency	System	Method	Sensitivity	Conbined uncertainty	Expanded uncertainty (k=2)	Stated uncertainty (k=2)	Charge amplifier calibration	Voltage standard uncertainty	Digitizer calibration	Laser wavelength	Alignnment of laser (Abbe error)	Alignment of transducer (cosine error)	Timebase uncertainty	Amplitude measurement of displacement	Amplitude measurement of accelerometer output	Transverse motion	Temperature coefficient of transducer	Repeatability
[Hz]			[V·s²/m]	[%]	[%]	[%]	Conbined [%]	B [%]	B [%]	B [%]	B [%]	B [%]	B [%]	A [%]	A [%]	B [%]	B [%]	A [%]
10	VA-1	SAM	0,12801	0,16	0,31	0,4	1,1,E-01	3,0E-04	4,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	7,2E-03	4,6E-06	1,0E-01	3,5E-02	1,7E-02
12,5	VA-1	SAM	0,12797	0,15	0,31	0,4	1,1,E-01	3,0E-04	4,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	2,4E-03	4,1E-06	1,0E-01	3,5E-02	1,9E-02
16	VA-1	SAM	0,12798	0,16	0,31	0,4	1,1,E-01	3,0E-04	4,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	1,2E-03	3,8E-06	1,0E-01	3,5E-02	2,2E-02
20	VA-1	SAM	0,12792	0,15	0,31	0,4	1,1,E-01	3,0E-04	4,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	3,2E-03	1,9E-06	1,0E-01	3,5E-02	2,8E-03
25	VA-1	SAM	0,12809	0,15	0,31	0,4	1,1,E-01	3,0E-04	4,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	2,5E-03	2,1E-06	1,0E-01	3,5E-02	1,2E-02
31,5	VA-1	SAM	0,12803	0,15	0,31	0,4	1,1,E-01	3,0E-04	4,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	1,3E-03	2,1E-06	1,0E-01	3,5E-02	1,4E-02
40	VA-1	SAM	0,12797	0,15	0,31	0,4	1,1,E-01	3,0E-04	4,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	5,4E-04	2,2E-06	1,0E-01	3,5E-02	2,0E-02
63	VA-1	SAM	0,12798	0,16	0,31	0,4	1,1,E-01	3,0E-04	4,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	3,4E-04	2,3E-06	1,0E-01	3,5E-02	1,9E-02
80	VA-1	SAM	0,12792	0,15	0,31	0,4	1,1,E-01	3,0E-04	4,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	3,4E-04	2,6E-06	1,0E-01	3,5E-02	1,6E-04
100	VA-1	SAM	0,12799	0,15	0,31	0,4	1,1,E-01	3,0E-04	4,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	1,5E-04	3,0E-06	1,0E-01	3,5E-02	3,7E-03
125	VA-1	SAM	0,12794	0,15	0,31	0,4	1,1,E-01	3,0E-04	4,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	9,7E-05	3,3E-06	1,0E-01	3,5E-02	7,1E-03
160	VA-1	SAM	0,12796	0,16	0,32	0,4	1,1,E-01	3,0E-04	4,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	8,3E-05	3,6E-06	1,0E-01	3,5E-02	3,7E-02
200	VA-1	SAM	0,12790	0,15	0,31	0,4	1,1,E-01	3,0E-04	4,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	3,7E-05	1,5E-06	1,0E-01	3,5E-02	1,3E-02
250	VA-1	SAM	0,12789	0,11	0,22	0,3	2,3,E-02	3,0E-04	4,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	5,2E-05	1,6E-06	1,0E-01	3,5E-02	1,6E-02
315	VA-1	SAM	0,12791	0,11	0,22	0,3	2,3,E-02	3,0E-04	4,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	5,4E-05	2,6E-06	1,0E-01	3,5E-02	9,5E-03
400	VA-1	SAM	0,12791	0,11	0,22	0,3	2,3,E-02	3,0E-04	4,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	5,5E-05	3,1E-06	1,0E-01	3,5E-02	9,1E-03
500	VA-2	SAM	0,12793	0,11	0,22	0,3	2,3,E-02	3,0E-04	4,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	3,2E-03	2,7E-05	1,0E-01	3,5E-02	4,7E-03
630	VA-2	SAM	0,12796	0,11	0,22	0,3	2,3,E-02	3,0E-04	4,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	1,6E-03	1,9E-03	1,0E-01	3,5E-02	1,0E-03
800	VA-2	SAM	0,12797	0,11	0,22	0,3	2,2,E-02	3,0E-04	4,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	4,6E-04	1,3E-05	1,0E-01	3,5E-02	5,6E-03
1000	VA-2	SAM	0,12802	0,11	0,21	0,3	1,2,E-02	3,0E-04	4,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	2,2E-05	8,9E-06	1,0E-01	3,5E-02	2,8E-04
1250	VA-2	SAM	0,12809	0,11	0,21	0,3	1,2,E-02	3,0E-04	4,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	1,1E-05	2,3E-05	1,0E-01	3,5E-02	5,0E-03
1500	VA-2	SAM	0,12817	0,11	0,21	0,3	1,2,E-02	3,0E-04	4,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	6,5E-06	4,9E-06	1,0E-01	3,5E-02	5,9E-03
1600	VA-2	SAM	0,12818	0,11	0,21	0,3	1,2,E-02	3,0E-04	4,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	5,8E-06	4,7E-06	1,0E-01	3,5E-02	2,1E-03
2000	VA-2	SAM	0,12836	0,11	0,21	0,3	1,2,E-02	3,0E-04	4,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	4,6E-06	3,6E-06	1,0E-01	3,5E-02	4,0E-03
2500	VA-2	SAM	0,12863	0,11	0,21	0,3	1,2,E-02	3,0E-04	4,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	4,9E-06	2,9E-06	1,0E-01	3,5E-02	6,6E-03
3000	VA-2	SAM	0,12886	0,12	0,23	0,3	1,2,E-02	3,0E-04	4,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	1,8E-05	5,7E-06	1,0E-01	3,5E-02	4,3E-02
3150	VA-2	SAM	0,12893	0,11	0,22	0,3	1,2,E-02	3,0E-04	4,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	1,4E-05	4,7E-06	1,0E-01	3,5E-02	3,3E-02
3500	VA-2	SAM	0,12923	0,11	0,22	0,3	1,2,E-02	3,0E-04	4,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	9,8E-06	2,7E-06	1,0E-01	3,5E-02	2,5E-02
4000	VA-2	SAM	0,12966	0,11	0,23	0,3	1,2,E-02	3,0E-04	4,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	6,1E-05	2,0E-06	1,0E-01	3,5E-02	3,8E-02
4500	VA-2	SAM	0,12995	0,24	0,47	0,5	1,2,E-02	3,0E-04	4,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	1,2E-04	2,3E-06	2,0E-01	3,5E-02	1,2E-01
5000	VA-2	SAM	0,13070	0,22	0,44	0,5	1,2,E-02	3,0E-04	4,6E-04	1,5E-04	5,6E-07	4,2E-04	1,8E-10	1,7E-04	2,0E-06	2,0E-01	3,5E-02	8,6E-02
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20000																		

We do not submit our results over 5000 Hz.

8305S(BB) Phase

Frequency	System	Method	Phase shift	Conbined uncertainty	Expanded uncertainty (k=2)	Stated uncertainty (k=2)	Charge amplifier calibration	Initial phase of interferometer signal	Initial phase of accelerometer output	Repeatability	Relative motion	Harmonic distortion	Difference in sampling timing	Frequency uncertainty	Delay in interferometer
[Hz]			[deg]	[deg]	[deg]	[deg]	Combined [rad]	A [rad]	A [rad]	A [rad]	B [rad]	B [rad]	B [rad]	B [rad]	B [rad]
10	VA-1	SAM	-0,01	0,14	0,28	0,3	2,2E-04	3,9E-05	4,6E-08	4,5E-06	1,6E-06	2,4E-03	1,8E-06	1,8E-04	3,6E-07
12,5	VA-1	SAM	-0,04	0,14	0,28	0,3	1,9E-04	1,7E-05	4,1E-08	2,8E-05	1,6E-06	2,4E-03	2,3E-06	1,8E-04	4,5E-07
16	VA-1	SAM	-0,02	0,14	0,28	0,3	2,0E-04	8,3E-06	3,8E-08	3,9E-05	1,6E-06	2,4E-03	2,9E-06	1,8E-04	5,8E-07
20	VA-1	SAM	-0,02	0,14	0,29	0,3	1,9E-04	2,7E-05	1,9E-08	4,0E-04	1,6E-06	2,4E-03	3,6E-06	1,8E-04	7,3E-07
25	VA-1	SAM	-0,02	0,14	0,29	0,3	1,9E-04	2,0E-05	2,1E-08	4,7E-04	1,6E-06	2,4E-03	4,5E-06	1,8E-04	9,1E-07
31,5	VA-1	SAM	-0,03	0,14	0,28	0,3	1,9E-04	1,0E-05	2,1E-08	3,0E-04	1,6E-06	2,4E-03	5,7E-06	1,8E-04	1,1E-06
40	VA-1	SAM	-0,02	0,14	0,29	0,3	2,0E-04	3,6E-06	2,2E-08	3,6E-04	1,6E-06	2,4E-03	7,3E-06	1,8E-04	1,5E-06
63	VA-1	SAM	-0,03	0,15	0,30	0,4	2,3E-04	7,8E-07	2,3E-08	9,5E-04	1,6E-06	2,4E-03	1,1E-05	1,8E-04	2,3E-06
80	VA-1	SAM	-0,03	0,14	0,28	0,3	1,9E-04	3,0E-06	2,6E-08	1,7E-04	1,6E-06	2,4E-03	1,5E-05	1,8E-04	2,9E-06
100	VA-1	SAM	-0,04	0,14	0,28	0,3	1,9E-04	1,4E-06	3,0E-08	1,9E-04	1,6E-06	2,4E-03	1,8E-05	1,8E-04	3,6E-06
125	VA-1	SAM	-0,05	0,14	0,28	0,3	1,9E-04	5,8E-07	3,3E-08	1,4E-04	1,6E-06	2,4E-03	2,3E-05	1,8E-04	4,5E-06
160	VA-1	SAM	-0,04	0,14	0,29	0,3	1,8E-04	5,7E-07	3,6E-08	4,2E-04	1,6E-06	2,4E-03	2,9E-05	1,8E-04	5,8E-06
200	VA-1	SAM	0,01	0,14	0,28	0,3	1,8E-04	2,2E-07	1,5E-08	1,5E-05	1,6E-06	2,4E-03	3,6E-05	1,8E-04	7,3E-06
250	VA-1	SAM	0,01	0,14	0,28	0,3	1,8E-04	3,8E-07	1,6E-08	2,0E-04	1,6E-06	2,4E-03	4,5E-05	1,8E-04	9,1E-06
315	VA-1	SAM	0,01	0,14	0,28	0,3	1,8E-04	3,7E-07	2,6E-08	1,1E-05	1,6E-06	2,4E-03	5,7E-05	1,8E-04	1,1E-05
400	VA-1	SAM	0,01	0,14	0,28	0,3	1,8E-04	3,6E-07	3,1E-08	2,3E-04	1,6E-06	2,4E-03	7,3E-05	1,8E-04	1,5E-05
500	VA-2	SAM	0,00	0,14	0,28	0,3	1,8E-04	1,7E-05	2,7E-07	5,1E-06	1,6E-06	2,4E-03	9,1E-05	1,8E-04	1,8E-05
630	VA-2	SAM	-0,02	0,14	0,28	0,3	1,8E-04	1,5E-05	1,9E-05	3,6E-05	1,6E-06	2,4E-03	1,1E-04	1,8E-04	2,3E-05
800	VA-2	SAM	0,02	0,14	0,28	0,3	1,8E-04	3,1E-06	1,3E-07	4,6E-05	1,6E-06	2,4E-03	1,5E-04	1,8E-04	2,9E-05
1000	VA-2	SAM	0,01	0,14	0,28	0,3	1,8E-04	1,6E-07	8,9E-08	3,7E-06	1,6E-06	2,4E-03	1,8E-04	1,8E-04	3,6E-05
1250	VA-2	SAM	-0,01	0,14	0,28	0,3	1,8E-04	1,0E-07	2,3E-07	5,9E-05	1,6E-06	2,4E-03	2,3E-04	1,8E-04	4,5E-05
1500	VA-2	SAM	-0,06	0,14	0,28	0,3	1,8E-04	4,8E-08	4,9E-08	5,7E-05	1,6E-06	2,4E-03	2,7E-04	1,8E-04	5,4E-05
1600	VA-2	SAM	0,01	0,14	0,28	0,3	1,8E-04	4,3E-08	4,7E-08	3,9E-05	1,6E-06	2,4E-03	2,9E-04	1,8E-04	5,8E-05
2000	VA-2	SAM	0,04	0,14	0,29	0,3	1,8E-04	2,5E-08	3,6E-08	8,5E-05	1,6E-06	2,4E-03	3,6E-04	1,8E-04	7,3E-05
2500	VA-2	SAM	0,01	0,14	0,29	0,3	1,8E-04	4,4E-08	2,9E-08	3,3E-05	1,6E-06	2,4E-03	4,5E-04	1,8E-04	9,1E-05
3000	VA-2	SAM	-0,01	0,14	0,29	0,3	1,8E-04	1,5E-07	5,7E-08	6,7E-06	1,6E-06	2,4E-03	5,4E-04	1,8E-04	1,1E-04
3150	VA-2	SAM	0,03	0,14	0,29	0,3	1,8E-04	9,9E-08	4,7E-08	7,1E-07	1,6E-06	2,4E-03	5,7E-04	1,8E-04	1,1E-04
3500	VA-2	SAM	0,01	0,15	0,29	0,3	1,8E-04	8,3E-08	2,7E-08	2,0E-04	1,6E-06	2,4E-03	6,3E-04	1,8E-04	1,3E-04
4000	VA-2	SAM	-0,01	0,15	0,30	0,3	1,8E-04	4,9E-07	2,0E-08	2,2E-04	1,6E-06	2,4E-03	7,3E-04	1,8E-04	1,5E-04
4500	VA-2	SAM	0,02	0,15	0,30	0,3	1,8E-04	1,2E-06	2,3E-08	2,1E-04	1,6E-06	2,4E-03	8,2E-04	1,8E-04	1,6E-04
5000	VA-2	SAM	-0,03	0,15	0,30	0,4	1,8E-04	1,4E-06	2,0E-08	2,5E-04	1,6E-06	2,4E-03	9,1E-04	1,8E-04	1,8E-04
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We do not submit our results over 5000 Hz.

B.8 NIM

NIM- Uncertainty Budget for Magnitude of Complex Sensitivity

Disturbing Component	Probability distribution	Factor	Estimated uncertainty,in %			Uncertainty contribution ui,(k =1)		
			10Hz～5kHz	>5kHz～10kHz	>10kHz～20kHz	10Hz～5kHz	>5kHz～10kHz	>10kHz～20kHz
Interferometer output signal disturbance on phase amplitude	retangular	1,732	0,05	0,15	0,20	2,89E-02	8,66E-02	1,15E-01
Effect of voltage disturbance on phase amplitude measurement	retangular	1,732	0,01	0,10	0,10	5,77E-03	5,77E-02	5,77E-02
Effect of motion disturbance on phase amplitude measurement	retangular	1,732	0,10	0,25	0,40	5,77E-02	1,44E-01	2,31E-01
Effect of phase disturbance on phase amplitude measurement	retangular	1,732	0,01	0,10	0,20	5,77E-03	5,77E-02	1,15E-01
Residual interferometric effects on phase amplitude measurement	retangular	1,732	0,05	0,15	0,20	2,89E-02	8,66E-02	1,15E-01
Vibration frequency measurement accuracy	retangular	1,732	0,05	0,20	0,30	2,89E-02	1,15E-01	1,73E-01
Accelerometer output voltage measurement (ADC resolution+DAQ range linearity)	retangular	1,732	0,02	0,10	0,20	1,15E-02	5,77E-02	1,15E-01
Filtering effect on sensitivity measurement	retangular	1,732	0,10	0,10	0,30	5,77E-02	5,77E-02	1,73E-01
Charge amplifier gain accuracy	normal(k =2)	2,000	0,10	0,30	0,40	5,00E-02	1,50E-01	2,00E-01
Effect of voltage disturbance on accelerometer output voltage measurement	retangular	1,732	0,05	0,10	0,15	2,89E-02	5,77E-02	8,66E-02
Effect of transverse motion on accelerometer output voltage measurement	retangular	1,732	0,10	0,10	0,20	5,77E-02	5,77E-02	1,15E-01
Residual effects on accelerometer output voltage measurement	normal(k =2)	2,000	0,10	0,15	0,20	5,00E-02	7,50E-02	1,00E-01
Effect of Mounting torque	retangular	1,732	0,01	0,01	0,01	5,77E-03	5,77E-03	5,77E-03
Effect of Hum(50Hz)	retangular	1,732	0,01	0,01	0,01	5,77E-03	5,77E-03	5,77E-03
Effect of Noise	retangular	1,732	0,01	0,01	0,01	5,77E-03	5,77E-03	5,77E-03
Effect of Temperature change	retangular	1,732	0,01	0,01	0,01	5,77E-03	5,77E-03	5,77E-03
repeatability measurementon accelerometer output voltage measurement	retangular	1,732	0,01	0,15	0,40	5,77E-03	8,66E-02	2,31E-01
Standard deviation on accelerometer output voltage measurement	normal(k =2)	2,000	0,20	0,40	0,60	1,00E-01	2,00E-01	3,00E-01
Relative Combained Uncertainty, in %						0,169	0,381	0,620
Relative Expanded Uncertainty (k =2), in %						0,34	0,76	1,24
Stated Expanded Uncertainty (k =2),in %						0,4	1,0	1,5

NIM- Uncertainty Budget for Phase of Complex Sensitivity

Disturbing Component	Probability distribution	Factor	Estimated uncertainty,in 1°			Uncertainty contribution ui,(k =1)		
			10Hz～5kHz	>5kHz～10kHz	>10kHz～20kHz	10Hz～5kHz	>5kHz～10kHz	>10kHz～20kHz
Interferometer output signal disturbance on displacement phase measurement	retangular	1,732	0,10	0,15	0,20	5,77E-02	8,66E-02	1,15E-01
Effect of voltage disturbance on displacement phase measurement	retangular	1,732	0,05	0,10	0,20	2,89E-02	5,77E-02	1,15E-01
Effect of motion disturbance on displacement phase measurement	retangular	1,732	0,05	0,15	0,20	2,89E-02	8,66E-02	1,15E-01
Effect of phase disturbance on displacement phase measurement	retangular	1,732	0,10	0,20	0,25	5,77E-02	1,15E-01	1,44E-01
Residual interferometric effects on displacement phase measurement	retangular	1,732	0,05	0,10	0,15	2,89E-02	5,77E-02	8,66E-02
Environmental effects on phase shift measurement	retangular	1,732	0,05	0,10	0,20	2,89E-02	5,77E-02	1,15E-01
Accelerometer output phase measurement(ADC)	normal(k =2)	2,000	0,08	0,10	0,15	4,00E-02	5,00E-02	7,50E-02
Filtering effect on accelerometer output phase measurement	retangular	1,732	0,10	0,05	0,20	5,77E-02	2,89E-02	1,15E-01
Charge amplifier phase accuracy	normal(k =2)	2,000	0,10	0,20	0,40	5,00E-02	1,00E-01	2,00E-01
Filtering effect on Interferometer output phase measurement	retangular	1,732	0,10	0,20	0,30	5,77E-02	1,15E-01	1,73E-01
Effect of voltage disturbance on accelerometer output phase measurement	retangular	1,732	0,05	0,15	0,20	2,89E-02	8,66E-02	1,15E-01
Effect of transverse motion on accelerometer output phase measurement	retangular	1,732	0,10	0,10	0,20	5,77E-02	5,77E-02	1,15E-01
Effect of Mounting torque	retangular	1,732	0,01	0,01	0,01	5,77E-03	5,77E-03	5,77E-03
Effect of Hum(50Hz)	retangular	1,732	0,01	0,01	0,01	5,77E-03	5,77E-03	5,77E-03
Effect of Noise	retangular	1,732	0,01	0,01	0,01	5,77E-03	5,77E-03	5,77E-03
Effect of Temperature change	retangular	1,732	0,01	0,01	0,01	5,77E-03	5,77E-03	5,77E-03
repeatability measurement on accelerometer phase shift measurement	retangular	1,732	0,01	0,20	0,40	5,77E-03	1,15E-01	2,31E-01
Standard deviation on accelerometer phase shift measurement	normal(k =2)	2,000	0,15	0,40	0,70	7,50E-02	2,00E-01	3,50E-01
Relative Combained Uncertainty, in 1°						0,175	0,360	0,611
Relative Expanded Uncertainty (k =2), in 1°						0,35	0,72	1,22
Stated Expanded Uncertainty (k =2),in 1°						0,5	1,0	1,5

B.9 NMIA

B.9.1 single-ended

Magnitude uncertainty components for determining accelerometer calibration by interferometry.

Description	Symbol	Probability	DoF	10 Hz to 500 Hz	630 Hz to 8 kHz	8.5 kHz to 10 kHz	10.5 kHz to 14 kHz	14.5 kHz to 18 kHz	18.5 kHz to 20 kHz
				Drive frequency. Drive amplitude 100 m·s^{-2} for 80 Hz and higher.					
Acceleration Magnitude Sensitivity (AUVVP03 Uncertainty)				%	%	%	%	%	%
Digitiser voltage resolution of interferometer signal	$u_1(S_a)$	Rect	30	0.010	0.020	0.031	0.061	0.101	0.125
Digitiser voltage resolution of accelerometer signal	$u_2(S_a)$	Rect	30	0.022	0.022	0.022	0.022	0.022	0.022
Digitiser voltage accuracy of accelerometer signal	$u_3(S_a)$	Rect	30	0.058	0.058	0.058	0.058	0.058	0.058
Effect of interferometer quadrature output signal disturbance on displacement phase measurement	$u_4(S_a)$	Rect	30	0.017	0.017	0.017	0.017	0.017	0.017
Residual uncertainty associated FFT Tone Detect method used for sine approx., determining reference acceleration from displacement data, frequency accuracy and stability of drive motion.	$u_5(S_a)$	Rect	30	0.029	0.029	0.029	0.029	0.029	0.029
Voltage filtering effect on accelerometer output phase measurement (frequency band limitation)	$u_6(S_a)$	Rect	30	0.006	0.006	0.006	0.006	0.006	0.006
Effect of voltage disturbance on accelerometer voltage measurement (e.g. hum and noise)	$u_7(S_a)$	Norm	30	0.015	0.015	0.015	0.015	0.015	0.015
Effect of transverse, rocking, and bending acceleration on accelerometer output voltage measurement (transverse sensitivity)	$u_8(S_a)$	Norm	30	0.052	0.052	0.052	0.052	0.052	0.052
Effect on voltage disturbance on displacement measurement (e.g. random noise in photoelectric measuring chain)	$u_9(S_a)$	Rect	30	0.006	0.006	0.006	0.006	0.006	0.006
Effect of motion disturbance on displacement phase measurement	$u_{10}(S_a)$	Rect	30	0.001	0.001	0.001	0.001	0.001	0.001
Errors relating to relative motion between reference surface and spot sensed by interferometer.	$u_{11}(S_a)$	Rect	30	0.006	0.006	0.006	0.006	0.006	0.006
Effect of phase disturbance on displacement phase measurements (interferometer function)	$u_{12}(S_a)$	Rect	30	0.001	0.001	0.001	0.001	0.001	0.001
Residual interferometric effects on displacement phase measurement (interferometer function)	$u_{13}(S_a)$	Rect	30	0.030	0.030	0.030	0.030	0.030	0.030
Residual error between Heterodyne and Homodyne comparisons	$u_{14}(S_a)$	Norm	30	0.000	0.000	0.000	0.100	0.200	0.500
Combined TYPE B uncertainty Acceleration sensitivity, uc %	$u_C(S_a)$			0.09	0.10	0.10	0.15	0.24	0.52
Effective degrees of freedom TYPE B				120	127	138	114	61	36
Rounding error	$u(Sr)$	Rect	30	0.029	0.029	0.029	0.029	0.029	0.029
Residual effects on magnitude measurements -Typical expected TYPE A	$u_A(S)$	Norm	30	0.010	0.050	0.100	0.100	0.300	0.400
Combined TYPE B uncertainty for Voltage acceleration sensitivity, uc %	$u_{c(S)}$			0.10	0.11	0.14	0.18	0.39	0.66
Effective degrees of freedom TYPE B				141	175	105	143	69	64
Coverage or k factor				2.0	2.0	2.0	2.0	2.0	2.0
Expanded uncertainty for voltage acceleration sensitivity (%), Uc for k=2	$U_{c(S)}$			0.20	0.22	0.28	0.36	0.77	1.31
Charge Amplifier Magnitude Sensitivity (AUVVP04 Uncertainty)									
Digitiser voltage resolution	$u_1(S_q)$	Rect	30	0.002	0.002	0.002	0.002	0.002	0.002
Digitiser voltage accuracy	$u_2(S_q)$	Rect	30	0.012	0.012	0.012	0.012	0.012	0.012

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Description	Symbol	Probability	DoF	10 Hz to 500 Hz	630 Hz to 8 kHz	8.5 kHz to 10 kHz	10.5 kHz to 14 kHz	14.5 kHz to 18 kHz	18.5 kHz to 20 kHz
				Drive frequency. Drive amplitude 100 m·s^{-2} for 80 Hz and higher.					
Residual uncertainty associated FFT Tone Detect method used for sine approx., frequency accuracy and stability of drive voltage.	$u_3(S_q)$	Rect	30	0.029	0.029	0.029	0.029	0.029	0.029
Effect of voltage disturbance on voltage measurement (e.g. hum and noise)	$u_4(S_q)$	Norm	30	0.005	0.005	0.005	0.005	0.005	0.005
Calibration and stability of reference capacitor	$u_5(S_q)$	Rect	30	0.006	0.006	0.006	0.006	0.006	0.006
Frequency stability of reference capacitor	$u_6(S_q)$	Norm	30	0.000	0.001	0.001	0.001	0.001	0.001
Effect of cabling on reference capacitor	$u_7(S_q)$	Norm	30	0.011	0.086	0.086	0.122	0.158	0.176
Combined TYPE B uncertainty for Charge amplifier uc %	$u_C(S_q)$			0.03	0.09	0.09	0.13	0.16	0.18
Effective degrees of freedom TYPE B				54	38	38	34	32	32

Combined TYPE B uncertainty for Charge acceleration sensitivity, uc %	$u_{c(Sa.q)}$			0.11	0.15	0.17	0.22	0.42	0.68
Effective degrees of freedom TYPE B				169	160	143	160	89	73
Coverage or k factor				2.0	2.0	2.0	2.0	2.0	2.0
Expanded uncertainty for charge acceleration sensitivity (%), Uc for k=2	$U_{c(Sa.q)}$			0.21	0.29	0.34	0.44	0.83	1.36
Minimum expanded uncertainty for charge acceleration sensitivity quoted in report, %	$U_{c(Sa.q)}$			**0.3**	**0.3**	**0.4**	**0.6**	**1.0**	**1.5**

Phase uncertainty components for determining accelerometer calibration by interferometry.

Description	Symbol	Probability	DoF	Drive frequency. Drive amplitude 100 m·s⁻² for 80 Hz and higher. 10 Hz to 800 Hz	1 kHz to 4 kHz	4.5 kHz to 6.5 kHz	7 kHz to 10 kHz	10.5 kHz to 12.5 kHz	13 kHz to 15 kHz	15.5 kHz to 18 kHz	18.5 kHz to 20 kHz
Acceleration Phase Sensitivity (AUVVP03 Uncertainty)											
Digitiser voltage resolution for interferometer quadrature angle	$u_1(\varphi_a)$	Rect	30	0.036	0.036	0.047	0.112	0.175	0.252	0.363	0.448
Digitiser voltage resolution for accelerometer signal	$u_2(\varphi_a)$	Rect	30	0.079	0.079	0.079	0.079	0.079	0.079	0.079	0.079
Digitiser Phase Resolution (Degrees)	$u_3(\varphi_a)$	Rect	30	0.017	0.094	0.135	0.208	0.260	0.312	0.374	0.416
Digitiser pre-trigger resolution	$u_4(\varphi_a)$	Rect	30	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Uncertainty associated with pre-digitisation phase delay (interferometer head / homodyne)	$u_5(\varphi_a)$	Rect	30	0.009	0.049	0.070	0.108	0.135	0.162	0.194	0.216
Uncertainty associated with pre-digitisation phase delay (Heterodyne LDV processor)	$u_6(\varphi_a)$	Rect	30	0.017	0.094	0.135	0.208	0.260	0.312	0.374	0.416
Effect of interferometer quadrature output signal disturbance on displacement phase measurement	$u_7(\varphi_a)$	Rect	30	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
Sine-Approximation using FFT residual uncertainty	$u_8(\varphi_a)$	Rect	30	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
Voltage filtering effect on accelerometer output phase measurement	$u_9(\varphi_a)$	Rect	30	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006
Effect of voltage disturbance on accelerometer output phase measurement	$u_{10}(\varphi_a)$	Norm	30	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034
Effect of transverse, rocking, and bending acceleration on accelerometer output phase measurement	$u_{11}(\varphi_a)$	Rect	30	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017
Effect on voltage disturbance on displacement phase measurement	$u_{12}(\varphi_a)$	Rect	30	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
Effect of motion disturbance on displacement phase measurement	$u_{13}(\varphi_a)$	Rect	30	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Effect of phase disturbance on displacement phase measurements	$u_{14}(\varphi_a)$	Rect	30	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Residual interferometric effects on displacement phase measurement	$u_{15}(\varphi_a)$	Rect	30	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Combined TYPE B uncertainty (acceleration sensitivity), uc deg	$u_C(\varphi_a)$			0.10	0.17	0.23	0.34	0.44	0.54	0.68	0.78
Effective degrees of freedom TYPE B				68	126	108	104	106	108	108	106
Rounding error	$u(\varphi r)$	Rect	30	0.029	0.029	0.029	0.029	0.029	0.029	0.029	0.029
Residual effects on phase shift measurements -Typical expected TYPE A repeat uncert	$u_A(\varphi)$	Norm	30	0.100	0.100	0.100	0.100	0.200	0.200	0.200	0.200
Combined TYPE B uncertainty for voltage acceleration sensitivity, uc deg	$u_C(\varphi_a)$			0.14	0.20	0.25	0.36	0.48	0.58	0.71	0.80
Effective degrees of freedom TYPE B				108	172	144	121	140	134	126	119
Coverage or k factor				2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Expanded uncertainty for voltage acceleration sensitivity (deg), Uc for k=2	$U_C(\varphi_a)$			0.28	0.39	0.49	0.71	0.95	1.14	1.39	1.58
Charge Amplifier Phase Sensitivity (AUVVP04 Uncertainty)											
Digitiser voltage resolution	$u_1(\varphi_q)$	Rect	30	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011
Digitiser Phase Resolution (Deg)	$u_2(\varphi_q)$	Rect	30	0.017	0.062	0.090	0.139	0.173	0.208	0.249	0.277
Digitiser channel synchronization, and master clock accuracy	$u_3(\varphi_q)$	Rect	30	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006

Continuation of Measurement Report

				Drive frequency. Drive amplitude 100 m·s^{-2} for 80 Hz and higher.							
Description	**Symbol**	**Probability**	**DoF**	**10 Hz to 800 Hz**	**1 kHz to 4 kHz**	**4.5 kHz to 6.5 kHz**	**7 kHz to 10 kHz**	**10.5 kHz to 12.5 kHz**	**13 kHz to 15 kHz**	**15.5 kHz to 18 kHz**	**18.5 kHz to 20 kHz**
Reference Capacitor frequency response	$u_4(\varphi_q)$		30	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.001
Effect of varying capacitance on charge amplifier phase response	$u_5(\varphi_q)$		30	0.003	0.037	0.055	0.086	0.109	0.131	0.158	0.176
Sine-Approximation using FFT residual uncertainty	$u_6(\varphi_q)$	Rect	30	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
Voltage filtering effect on phase measurement	$u_7(\varphi_q)$	Rect	30	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006
Effect of voltage disturbance on output phase (noise and hum)	$u_8(\varphi_q)$	Norm	30	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034
Combined TYPE B uncertainty for charge amplifier, uc deg	$u_C(\varphi_q)$			0.04	0.08	0.11	0.17	0.21	0.25	0.30	0.33
Effective degrees of freedom TYPE B				56	72	61	55	54	53	52	52
Combined TYPE B uncertainty for charge acceleration sensitivity, uc deg	$u_{c(\varphi a.q)}$			0.15	0.22	0.27	0.40	0.53	0.63	0.77	0.87
Effective degrees of freedom TYPE B				125	220	189	163	180	173	162	153
Coverage or k factor				2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Expanded uncertainty for charge acceleration sensitivity (deg), Uc for k=2	$U_{c(\varphi a.q)}$			0.30	0.43	0.54	0.78	1.04	1.24	1.51	1.71
Minimum expanded uncertainty for charge acceleration sensitivity quoted in report, Degrees	$U_{c(\varphi a.q)}$			**0.3**	**0.5**	**0.6**	**0.8**	**1.2**	**1.5**	**2.0**	**2.0**

B.9.2 back-to-back

Magnitude uncertainty components for determining accelerometer calibration by interferometry.

				Drive frequency. Drive amplitude 100 m·s^{-2} for 80 Hz and higher.					
Description	**Symbol**	**Probability**	**DoF**	**10 Hz to 500 Hz**	**630 Hz to 8 kHz**	**8.5 kHz to 10 kHz**	**10.5 kHz to 14 kHz**	**14.5 kHz to 18 kHz**	**18.5 kHz to 20 kHz**
Acceleration Magnitude Sensitivity (AUVVP03 Uncertainty)				%	%	%	%	%	%
Digitiser voltage resolution of interferometer signal	$u_1(S_a)$	Rect	30	0.010	0.020	0.031	0.061	0.101	0.125
Digitiser voltage resolution of accelerometer signal	$u_2(S_a)$	Rect	30	0.022	0.022	0.022	0.022	0.022	0.022
Digitiser voltage accuracy of accelerometer signal	$u_3(S_a)$	Rect	30	0.058	0.058	0.058	0.058	0.058	0.058
Effect of interferometer quadrature output signal disturbance on displacement phase measurement	$u_4(S_a)$	Rect	30	0.017	0.017	0.017	0.017	0.017	0.017
Residual uncertainty associated FFT Tone Detect method used for sine approx., determining reference acceleration from displacement data, frequency accuracy and stability of drive motion.	$u_5(S_a)$	Rect	30	0.029	0.029	0.029	0.029	0.029	0.029
Voltage filtering effect on accelerometer output phase measurement (frequency band limitation)	$u_6(S_a)$	Rect	30	0.006	0.006	0.006	0.006	0.006	0.006
Effect of voltage disturbance on accelerometer voltage measurement (e.g. hum and noise)	$u_7(S_a)$	Norm	30	0.015	0.015	0.015	0.015	0.015	0.015
Effect of transverse, rocking, and bending acceleration on accelerometer output voltage measurement (transverse sensitivity)	$u_8(S_a)$	Norm	30	0.052	0.052	0.052	0.052	0.052	0.052
Effect on voltage disturbance on displacement measurement (e.g. random noise in photoelectric measuring chain)	$u_9(S_a)$	Rect	30	0.006	0.006	0.006	0.006	0.006	0.006
Effect of motion disturbance on displacement phase measurement	$u_{10}(S_a)$	Rect	30	0.001	0.001	0.001	0.001	0.001	0.001
Errors relating to relative motion between reference surface and spot sensed by interferometer.	$u_{11}(S_a)$	Rect	30	0.006	0.006	0.006	0.006	0.006	0.006
Effect of phase disturbance on displacement phase measurements (interferometer function)	$u_{12}(S_a)$	Rect	30	0.001	0.001	0.001	0.001	0.001	0.001
Residual interferometric effects on displacement phase measurement (interferometer function)	$u_{13}(S_a)$	Rect	30	0.030	0.030	0.030	0.030	0.030	0.030
Residual error between Heterodyne and Homodyne comparisons	$u_{14}(S_a)$	Norm	30	0.000	0.000	0.000	0.100	0.200	0.500
Combined TYPE B uncertainty Acceleration sensitivity, uc %	$u_C(S_a)$			0.09	0.10	0.10	0.15	0.24	0.52
Effective degrees of freedom TYPE B				120	127	138	114	61	36
Rounding error	$u(Sr)$	Rect	30	0.029	0.029	0.029	0.029	0.029	0.029
Residual effects on magnitude measurements -Typical expected TYPE A	$u_A(S)$	Norm	30	0.010	0.050	0.100	0.100	0.300	0.400
Combined TYPE B uncertainty for Voltage acceleration sensitivity, uc %	$u_{c(S)}$			0.10	0.11	0.14	0.18	0.39	0.66
Effective degrees of freedom TYPE B				141	175	105	143	69	64
Coverage or k factor				2.0	2.0	2.0	2.0	2.0	2.0
Expanded uncertainty for voltage acceleration sensitivity (%), Uc for k=2	$U_{c(S)}$			0.20	0.22	0.28	0.36	0.77	1.31
Charge Amplifier Magnitude Sensitivity (AUVVP04 Uncertainty)									
Digitiser voltage resolution	$u_1(S_q)$	Rect	30	0.002	0.002	0.002	0.002	0.002	0.002
Digitiser voltage accuracy	$u_2(S_q)$	Rect	30	0.012	0.012	0.012	0.012	0.012	0.012

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Continuation of Measurement Report

Description	Symbol	Probability	DoF	Drive frequency. Drive amplitude 100 m·s^{-2} for 80 Hz and higher. 10 Hz to 500 Hz	630 Hz to 8 kHz	8.5 kHz to 10 kHz	10.5 kHz to 14 kHz	14.5 kHz to 18 kHz	18.5 kHz to 20 kHz
Residual uncertainty associated FFT Tone Detect method used for sine approx., frequency accuracy and stability of drive voltage.	$u_3(S_q)$	Rect	30	0.029	0.029	0.029	0.029	0.029	0.029
Effect of voltage disturbance on voltage measurement (e.g. hum and noise)	$u_4(S_q)$	Norm	30	0.005	0.005	0.005	0.005	0.005	0.005
Calibration and stability of reference capacitor	$u_5(S_q)$	Rect	30	0.006	0.006	0.006	0.006	0.006	0.006
Frequency stability of reference capacitor	$u_6(S_q)$	Norm	30	0.000	0.001	0.001	0.001	0.001	0.001
Effect of cabling on reference capacitor	$u_7(S_q)$	Norm	30	0.011	0.086	0.086	0.122	0.158	0.176
Combined TYPE B uncertainty for Charge amplifier uc %	$u_C(S_q)$			0.03	0.09	0.09	0.13	0.16	0.18
Effective degrees of freedom TYPE B				54	38	38	34	32	32

Combined TYPE B uncertainty for Charge acceleration sensitivity, uc %	$u_{c(Sa.q)}$			0.11	0.15	0.17	0.22	0.42	0.68
Effective degrees of freedom TYPE B				169	160	143	160	89	73
Coverage or k factor				2.0	2.0	2.0	2.0	2.0	2.0
Expanded uncertainty for charge acceleration sensitivity (%), Uc for k=2	$U_{c(Sa.q)}$			0.21	0.29	0.34	0.44	0.83	1.36
Minimum expanded uncertainty for charge acceleration sensitivity quoted in report, %	$U_{c(Sa.q)}$			**0.3**	**0.3**	**0.4**	**0.6**	**1.0**	**1.5**

Continuation of Measurement Report

Phase uncertainty components for determining accelerometer calibration by interferometry.

				Drive frequency. Drive amplitude 100 m·s^{-2} for 80 Hz and higher.							
Description	**Symbol**	**Probability**	**DoF**	**10 Hz to 800 Hz**	**1 kHz to 4 kHz**	**4.5 kHz to 6.5 kHz**	**7 kHz to 10 kHz**	**10.5 kHz to 12.5 kHz**	**13 kHz to 15 kHz**	**15.5 kHz to 18 kHz**	**18.5 kHz to 20 kHz**
Acceleration Phase Sensitivity (AUVVP03 Uncertainty)											
Digitiser voltage resolution for interferometer quadrature angle	$u_1(\varphi_a)$	Rect	30	0.036	0.036	0.047	0.112	0.175	0.252	0.363	0.448
Digitiser voltage resolution for accelerometer signal	$u_2(\varphi_a)$	Rect	30	0.079	0.079	0.079	0.079	0.079	0.079	0.079	0.079
Digitiser Phase Resolution (Degrees)	$u_3(\varphi_a)$	Rect	30	0.017	0.094	0.135	0.208	0.260	0.312	0.374	0.416
Digitiser pre-trigger resolution	$u_4(\varphi_a)$	Rect	30	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Uncertainty associated with pre-digitisation phase delay (interferometer head / homodyne)	$u_5(\varphi_a)$	Rect	30	0.009	0.049	0.070	0.108	0.135	0.162	0.194	0.216
Uncertainty associated with pre-digitisation phase delay (Heterodyne LDV processor)	$u_6(\varphi_a)$	Rect	30	0.017	0.094	0.135	0.208	0.260	0.312	0.374	0.416
Effect of interferometer quadrature output signal disturbance on displacement phase measurement	$u_7(\varphi_a)$	Rect	30	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
Sine-Approximation using FFT residual uncertainty	$u_8(\varphi_a)$	Rect	30	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
Voltage filtering effect on accelerometer output phase measurement	$u_9(\varphi_a)$	Rect	30	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006
Effect of voltage disturbance on accelerometer output phase measurement	$u_{10}(\varphi_a)$	Norm	30	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034
Effect of transverse, rocking, and bending acceleration on accelerometer output phase measurement	$u_{11}(\varphi_a)$	Rect	30	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017
Effect on voltage disturbance on displacement phase measurement	$u_{12}(\varphi_a)$	Rect	30	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
Effect of motion disturbance on displacement phase measurement	$u_{13}(\varphi_a)$	Rect	30	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Effect of phase disturbance on displacement phase measurements	$u_{14}(\varphi_a)$	Rect	30	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Residual interferometric effects on displacement phase measurement	$u_{15}(\varphi_a)$	Rect	30	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Combined TYPE B uncertainty (acceleration sensitivity), uc deg	$u_C(\varphi_a)$			0.10	0.17	0.23	0.34	0.44	0.54	0.68	0.78
Effective degrees of freedom TYPE B				68	126	108	104	106	108	108	106
Rounding error	$u(\varphi r)$	Rect	30	0.029	0.029	0.029	0.029	0.029	0.029	0.029	0.029
Residual effects on phase shift measurements -Typical expected TYPE A repeat uncert	$u_A(\varphi)$	Norm	30	0.100	0.100	0.100	0.100	0.200	0.200	0.200	0.200
Combined TYPE B uncertainty for voltage acceleration sensitivity, uc deg	$u_C(\varphi_a)$			0.14	0.20	0.25	0.36	0.48	0.58	0.71	0.80
Effective degrees of freedom TYPE B				108	172	144	121	140	134	126	119
Coverage or k factor				2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Expanded uncertainty for voltage acceleration sensitivity (deg), Uc for k=2	$U_C(\varphi_a)$			0.28	0.39	0.49	0.71	0.95	1.14	1.39	1.58
Charge Amplifier Phase Sensitivity (AUVVP04 Uncertainty)											
Digitiser voltage resolution	$u_1(\varphi_q)$	Rect	30	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011
Digitiser Phase Resolution (Deg)	$u_2(\varphi_q)$	Rect	30	0.017	0.062	0.090	0.139	0.173	0.208	0.249	0.277
Digitiser channel synchronization, and master clock accuracy	$u_3(\varphi_q)$	Rect	30	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006

Ref: RN181376 File: MC/18/1005 Checked: *[illegible]* Date: 16 August 2018

Continuation of Measurement Report

				Drive frequency. Drive amplitude 100 m·s⁻² for 80 Hz and higher.							
Description	**Symbol**	**Probability**	**DoF**	**10 Hz to 800 Hz**	**1 kHz to 4 kHz**	**4.5 kHz to 6.5 kHz**	**7 kHz to 10 kHz**	**10.5 kHz to 12.5 kHz**	**13 kHz to 15 kHz**	**15.5 kHz to 18 kHz**	**18.5 kHz to 20 kHz**
Reference Capacitor frequency response	$u_4(\varphi_q)$		30	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.001
Effect of varying capacitance on charge amplifier phase response	$u_5(\varphi_q)$		30	0.003	0.037	0.055	0.086	0.109	0.131	0.158	0.176
Sine-Approximation using FFT residual uncertainty	$u_6(\varphi_q)$	Rect	30	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
Voltage filtering effect on phase measurement	$u_7(\varphi_q)$	Rect	30	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006
Effect of voltage disturbance on output phase (noise and hum)	$u_8(\varphi_q)$	Norm	30	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034
Combined TYPE B uncertainty for charge amplifier, uc deg	$u_C(\varphi_q)$			0.04	0.08	0.11	0.17	0.21	0.25	0.30	0.33
Effective degrees of freedom TYPE B				56	72	61	55	54	53	52	52
Combined TYPE B uncertainty for charge acceleration sensitivity, uc deg	$u_{c(\varphi a.q)}$			0.15	0.22	0.27	0.40	0.53	0.63	0.77	0.87
Effective degrees of freedom TYPE B				125	220	189	163	180	173	162	153
Coverage or k factor				2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Expanded uncertainty for charge acceleration sensitivity (deg), Uc for k=2	$U_{c(\varphi a.q)}$			0.30	0.43	0.54	0.78	1.04	1.24	1.51	1.71
Minimum expanded uncertainty for charge acceleration sensitivity quoted in report, Degrees	$U_{c(\varphi a.q)}$			**0.3**	**0.5**	**0.6**	**0.8**	**1.2**	**1.5**	**2.0**	**2.0**

B.10 INMETRO

Table 3 – Uncertainty budget for magnitude of the BTB and SE accelerometers' complex charge sensitivity

i	Standard uncertainty component $u(x_i)$	Source of uncertainty	description	Probability distribution model	Factor x_i	Relative uncertainty contribution $u_{rel,i}(y)$ (%) frequency (Hz) 10 to 2000	>2000 to 3000	>3000 to 4500	>4500 to <7000	7000 to 10000	>10000 to 15000	>15000 to 20000
1	$u(\hat{u}_V)$	accelerometer output voltage measurement (ADC resolution + DAQ range linearity)	results of different calibrations measured against Fluke 5720A	normal (k=2)	0,5	0,05	0,05	0,05	0,05	0,05	0,08	0,08
2	$u(\hat{u}_F)$	voltage filtering effect on accelerometer output amplitude measurement	No analog filtering applied	rectangular	0,58	0,01	0,01	0,01	0,01	0,01	0,01	0,01
3	$u(\hat{u}_D)$	effect of voltage disturbance on accelerometer output voltage measurement	effect on sensitivity by simulated noise on interferometer and accel channels	normal (k=1)	1	0,05	0,05	0,05	0,05	0,06	0,06	0,06
4	$u(\hat{u}_T)$	effect of transverse, rocking and bending acceleration on accelerometer voltage measurement (transverse sensitivity)	The residual effect on sensitivity is estimated by the error to a LS fit, which is to be less than	rectangular	0,58	0,00	0,00	0,06	0,12	0,12	0,12	0,09
5	$u(\Phi_{M,Q})$	effect of interferometer quadrature output signal disturbance on phase amplitude measurement (e.g. offsets, voltage amplitude deviation, deviation from 90° nominal angle difference)	Ellipse fit correction implemented. Residual effect already included in i = 3			0,00	0,00	0,00	0,00	0,00	0,00	0,00
6	$u(\Phi_{M,F})$	interferometer signal filtering effect on phase amplitude measurement (frequency band limitation)	No analog filtering applied.	rectangular	0,58	0,01	0,01	0,01	0,01	0,01	0,01	0,01

7	$u(\Phi_{M, VD})$	effect of voltage disturbance on phase amplitude measurement	Estimated to be less than	rectangular	0,58	0,02	0,02	0,02	0,02	0,02	0,02	0,02
8	$u(\Phi_{M, MD})$	effect of motion disturbance on phase amplitude measurement	Estimated to be less than	rectangular	0,58	0,03	0,03	0,03	0,03	0,03	0,03	0,03
9	$u(\Phi_{M, PD})$	effect of phase disturbance on phase amplitude measurement	Estimated to be less than	rectangular	0,58	0,03	0,03	0,03	0,03	0,03	0,03	0,03
10	$u(\Phi_{M, RE})$	residual interferometric effects on phase amplitude measurement	Estimated to be less than	normal (sqrt(N))	0,30	0,02	0,02	0,02	0,02	0,02	0,02	0,02
11	$u(f_{FG})$	vibration frequency measurement (frequency generator and indicator)	Estimated to be less than (standard limit)	normal (k=2)	0,5	0,00	0,00	0,00	0,00	0,00	0,00	0,00
12	$u(S_{RE})$	residual effects on sensitivity measurement (e.g. random effect in repeat measurements; experimental standard deviation of arithmetic mean)	measured (for N=6, std dev of the mean)	normal (sqrt(N))	0,41	0,01	0,01	0,01	0,05	0,06	0,06	0,06
13	$u(\lambda \mathrm{cal})$	laser wavelength calibration	calibration of laser + bandwidth (1200 MHz)	normal (k=2)	0,5	0,00	0,00	0,00	0,00	0,00	0,00	0,00
14	$u(\lambda_E)$	environmental effects on laser wavelength . Estimated to be less than (dT =+/- 3 C, dP = +/- 70 hPa, dU = +/- 20 %)	Estimated to be less than (Temp range from 21 to 25 degrees)	rectangular	0,58	0,00	0,00	0,00	0,00	0,00	0,00	0,00
15	$u(A \mathrm{\ cal})$	amplifier gain calibration	calibration of amplifier BK 2650 with constant charge input	normal (k=2)	0,5	0,03	0,03	0,03	0,03	0,03	0,03	0,03
16	$u(e_{T, A})$	reference amplifiers tracking (deviations in gain for different amplification settings)	Not applicable. Amplifier used at a fixed gain setting			0,00	0,00	0,00	0,00	0,00	0,00	0,00
17	$u(e_{L, f, A})$	deviation from constant amplitude-frequency characteristic of reference amplifier	Not applicable. Amplifier calibrated at all frequencies			0,00	0,00	0,00	0,00	0,00	0,00	0,00
18	$u(e_{L, f, P})$	deviation from constant amplitude-frequency characteristic of reference accelerometer	Not applicable. Results reported with the input acceleration			0,00	0,00	0,00	0,00	0,00	0,00	0,00
19	$u(e_{L, a, A})$	amplitude effect on gain of reference amplifier	Estimated to be less than (amplitude range up to 100 m/s^2)	rectangular	0,58	0,01	0,01	0,01	0,01	0,01	0,01	0,01

20	$u(e_{L,a,P})$	amplitude effect on sensitivity (magnitude) of reference accelerometer	Estimated to be less than (amplitude range up to 100 m/s²)	rectangular	0,58	0,01	0,01	0,01	0,01	0,01	0,01	0,01
21	$u(e_{I,A})$	instability of reference amplifier gain, and effect of source impedance on gain	Estimated to be less than	rectangular	0,58	0,02	0,02	0,02	0,02	0,02	0,02	0,02
22	$u(e_{I,P})$	instability of sensitivity (magnitude) of reference accelerometer	Estimated to be less than	rectangular	0,58	0,01	0,01	0,01	0,01	0,01	0,01	0,01
23	$u(e_{E,A})$	environmental effects on gain of reference amplifier	Estimated to be less than (dT =+/- 1 oC during one complete calibration)	rectangular	0,58	0,04	0,04	0,01	0,01	0,01	0,01	0,01
24	$u(e_{E,P})$	environmental effects on sensitivity (magnitude) of reference accelerometer	Estimated to be less than (dT =+/- 1 °C during calibration, St = 0.02%/°C)	rectangular	0,58	0,01	0,01	0,01	0,01	0,01	0,01	0,01
25	$u(S_{SF})$	safety factor (reproducibility)	Estimated to be less than	rectangular	0,58	0,00	0,00	0,00	0,12	0,29	0,46	0,58

$u_c(S_2)/S_2$ %	Estimated relative combined standard uncertainty (%) for accelerometer sensitivity (k=1)	0,09	0,09	0,10	0,19	0,33	0,49	0,60
$U(S_2)/S_2$ %	Estimated relative expanded uncertainty (%) for accelerometer sensitivity (k=2)	0,19	0,19	0,21	0,38	0,66	0,98	1,20

	frequency (Hz)						
	10 to 2000	>2000 to 3000	>3000 to 4500	>4500 to <7000	7000 to 10000	>10000 to 15000	>15000 to 20000
Reported relative expanded Uncertainty for accelerometer sensitivity (k=2)	0,20	0,24	0,34	0,60	0,80	1,0	1,2

Table 4 – Uncertainty budget for phase shift of the BTB and SE accelerometers' complex charge sensitivity

i	Standard uncertainty component $u(x_i)$	Source of uncertainty	description	Probability distribution model	Factor x_i	Uncertainty contribution $u_{\mathrm{rel,i}}(y)$ (°) frequency (Hz) 10 to 2000	>2000 to 3000	>3000 to <4000	4000 to 5000	>5000 to 7000	>7000 to 10000	>10000 to 20000
1	$u(\Phi_{u,V})$	accelerometer output phase measurement	results of different calibrations measured against a reference signal	normal (k=1)	1	0,03	0,03	0,03	0,03	0,03	0,03	0,10
2	$u(\Phi_{u,F})$	voltage filtering effect on accelerometer output phase measurement	No analog filtering applied. Special digital filter has negligible effect.	rectangular	0,58	0,00	0,00	0,00	0,00	0,00	0,00	0,00
3	$u(\Phi_{u,D})$	effect of voltage disturbance on output phase measurement (e.g hum and noise)	effect on sensitivity by simulated noise on interferometer and accel channels	normal (k=1)	1	0,05	0,05	0,10	0,10	0,20	0,20	0,20
4	$u(\Phi_{u,T})$	effect of transverse, rocking and bending acceleration on accelerometer output phase measurement (transverse sensitivity)	The residual effect on sensitivity is estimated by the error to a LS fit, which is to be less than	rectangular	0,58	0,02	0,05	0,07	0,17	0,30	0,30	0,30
5	$u(\Phi_{S,Q})$	effect of interferometer quadrature output signal disturbance on displacement phase measurement (e.g. offsets, voltage amplitude deviation, deviation from 90 degrees nominal angle difference)	Ellipse fit correction implemented. Residual effect already included in i = 3			0,00	0,00	0,00	0,00	0,00	0,00	0,00
6	$u(\Phi_{S,F})$	interferometer signal filtering effect on displacement phase measurement (frequency band limitation)	No analog filtering applied.	rectangular	0,58	0,01	0,01	0,01	0,01	0,01	0,01	0,01

7	$u(\Phi_{s,VD})$	effect of voltage disturbance on displacement phase measurement (e.g. random noise in the photoelectric measuring chains)	Estimated to be less than	rectangular	0,58	0,02	0,02	0,02	0,02	0,02	0,02	0,02
8	$u(\Phi_{s,MD})$	effect of motion disturbance on displacement phase measurement (e.g. drift; relative motion between accelerometer reference surface and the spot sensed by the interferometer)	Estimated to be less than	rectangular	0,58	0,03	0,03	0,03	0,03	0,03	0,03	0,03
9	$u(\Phi_{s,PD})$	effect of phase disturbance on displacement phase measurement (e.g. phase noise of the interferometer signals)	Estimated to be less than	rectangular	0,58	0,03	0,03	0,03	0,03	0,03	0,03	0,03
10	$u(\Phi_{s,RE})$	residual interferometric effects on displacement phase measurement	Estimated to be less than	normal (sqrt(N))	0,30	0,02	0,02	0,02	0,02	0,02	0,02	0,02
11	$u(\Delta\Phi_{RE})$	residual effects on phase shift measurement (e.g. random effect in repeat measurements; experimental standard deviation of arithmetic mean)	Measured (for N=6, std dev of the mean)	normal (sqrt(N))	0,45	0,02	0,02	0,02	0,04	0,04	0,09	0,09
12	$u(\Delta\Phi_{A,cal})$	amplifier phase shift calibration	calibration of amplifier BK 2650 with constant charge input	normal (k=2)	0,5	0,03	0,03	0,03	0,03	0,03	0,03	0,03
13	$u(e_{\mathrm{T,\,A}})$	reference amplifier tracking (deviations in phase for different amplification settings)	Not applicable. A single calibrated setting is used.	rectangular	0,58	0,00	0,00	0,00	0,00	0,00	0,00	0,00
14	$u(e_{\mathrm{T,\,f,\,A}})$	deviations from linear phase-frequency characteristic of reference amplifier	Not applicable. A single calibrated setting is used.	rectangular	0,58	0,00	0,00	0,00	0,00	0,00	0,00	0,00
15	$u(\lambda\mathrm{cal})$	deviations from linear phase-frequency characteristic of reference accelerometer	Effect included in the standard deviation of the mean	normal (k=2)	0,5	0,03	0,03	0,03	0,03	0,03	0,03	0,03
16	$u(e_{\mathrm{L},\,a,\,\mathrm{A}})$	amplitude effect on phase shift of reference amplifier	Estimated to be less than	rectangular	0,58	0,01	0,01	0,01	0,01	0,01	0,01	0,01

17	$u(e_{L,a,P})$	amplitude effect on phase shift of reference accelerometer	Estimated to be less than (amplitude range up to 100 m/s²)	rectangular	0,58	0,01	0,01	0,01	0,01	0,01	0,01	0,01
18	$u(e_{I,A})$	instability of reference amplifier phase shift, and effect of source impedance on phase shift	Estimated to be less than	rectangular	0,58	0,02	0,02	0,02	0,02	0,02	0,02	0,02
19	$u(e_{I,P})$	instability of reference accelerometer phase shift	Estimated to be less than	rectangular	0,58	0,01	0,01	0,01	0,01	0,01	0,01	0,01
20	$u(e_{E,A})$	environmental effects on phase shift of reference amplifier	Estimated to be less than (dT =+/- 1 oC during one complete calibration)	rectangular	0,58	0,04	0,01	0,01	0,01	0,01	0,01	0,01
21	$u(e_{E,P})$	environmental effects on phase shift of reference accelerometer	Estimated to be less than (dT =+/- 1 ºC during calibration, St = 0.02%/ºC)	rectangular	0,58	0,01	0,01	0,01	0,01	0,01	0,01	0,01
22	$u(\Delta\Phi_{SF})$	safety factor (reproducibility)	Estimated to be less than	rectangular	0,58	0,00	0,03	0,06	0,12	0,12	0,17	0,35

$u_c(\Delta\Phi)$	Estimated combined standard uncertainty (°) for accelerometer phase shift (k=1)	0,10	0,11	0,15	0,25	0,39	0,42	0,52
$U(\Delta\Phi)$	Estimated expanded uncertainty (°) for accelerometer phase shift (k=2)	0,20	0,22	0,31	0,49	0,78	0,83	1,04

	frequency (Hz)						
	10 to 2000	>2000 to 3000	>3000 to <4000	4000 to 5000	>5000 to 7000	>7000 to 10000	>10000 to 20000
Reported expanded uncertainty (°) for accelerometer phase shift (k=2)	0,20	0,24	0,34	0,50	0,80	1,0	1,2

B.11 NMISA

UNCERTAINTY BUDGET MATRIX (UBM)										Certificate No		AV\VS-3732/3
										Procedure No		AV\VS-0001
Reference: Guide to the Expression of Uncertainty in Measurement, issued by BIPM, IEC, IFCC, ISO, IUPAC, IUPAP, OIML - ISO 1995 (ISBN 92-67-10188-9)												
Description:	Sensitivty calibration (modulus) as per ISO 16063-11 method 3	**Make & model:**	Brüel & Kjær Endevco		**Range:**	0,1 Hz to 20 kHz						**Metrologist**
		Serial number:										Ian Veldman
Mathematical Model:		$S = \hat{u}/\hat{a} = \hat{u}/(2\pi f)^2 d$										
Symbol	**Input Quantity (Source of Uncertainty)**	**Standard Uncertainty Contribution $U_i(y)$**								**Reliability**	**Degrees of Freedom**	**Remarks**
		0,1 Hz 0,2 Hz	**> 0,2 Hz < 1 Hz**	**1 Hz to 1 kHz**	**> 1 kHz < 5 kHz**	**5 kHz to 7 kHz**	**> 7 kHz to 12 kHz**	**> 12 kHz to 15 kHz**	**>15 kHz to 20 kHz**		infinite	
u	**▼ Standards and Reference Equipment (Uncorrelated) ▼**	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**	***v***	
φ_Q	Interferometer output signal disturbance on phase amplitude	0,006	0,006	0,006	0,058	0,115	0,115	0,173	0,289	100	infinite	e.g. offsets, voltage amplitude deviations, <> 90° Corrected with Heydemant procedure
φ_{VD}	Effect of voltage disturbance on phase amplitude measurement	0,000	0,000	0,000	0,000	0,001	0,001	0,001	0,002	100	infinite	Additive uncorrelated noise is reduced by $1/\sqrt{n}$. Where n=number of samples pes vibration cycle. Worse case =10%/1000
φ_{MD}	Effect of motion disturbance on phase amplitude measurement	0,012	0,006	0,009	0,115	0,231	0,404	0,462	0,462	100	infinite	Relative motion between sensing spot, exiter and accelerometer. Worse case calculated for 16mm double ended accelerometer.
φ_{PD}	Effect of phase disturbance on phase amplitude measurement	0,006	0,006	0,006	0,029	0,058	0,058	0,115	0,289	100	infinite	Corrected for using Heydemann correction procedure
φ_{RE}	Residual interferometric effects on phase amplitude measurement	0,012	0,012	0,006	0,006	0,058	0,029	0,058	0,115	100	infinite	Not aware of any
f_{FG}	Vibration frequency measurement accuracy	0,006	0,006	0,029	0,040	0,087	0,115	0,144	0,173	100	infinite	ISO 16063-11 requirement: ≤ 0,05 % of reading
λ_U	Uncertainty on laser wavelength measurement	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	100	infinite	Uncertainty quoted on certificate
$\hat{u}_V$	Accelerometer output voltage measurement (ADC resolution/accuracy)	0,087	0,035	0,058	0,035	0,035	0,035	0,035	0,035	100	infinite	Manufacturer's specification worse case on 1 V range
S_F	Filtering effect on sensitivity measurement	0,046	0,046	0,058	0,058	0,115	0,115	0,115	0,231	100	infinite	$e=(f/f_{Hp})^2$
G_{CA}	Charge amplifier gain accuracy	0,100	0,100	0,050	0,100	0,100	0,100	0,100	0,100	100	infinite	Conditiong amplifier uncertainty
	▼ Unit Under Test / Calibration (Uncorrelated) ▼											
$\hat{u}_D$	Effect of voltage disturbance on accelerometer output voltage measurement	0,035	0,025	0,015	0,030	0,025	0,025	0,100	0,150	100	infinite	$U_{THD} = ½(d/100)^2$; Maximum allowed by ISO 16063
$\hat{u}_T$	Effect of transverse motion on accelerometer output voltage measurement	0,025	0,015	0,025	0,025	0,040	0,050	0,125	0,125	100	infinite	Transeverse error for a transverse sensitivity of 1%
$\hat{u}_{RES}$	Residual effects on accelerometer output voltage measurement	0,025	0,025	0,025	0,035	0,025	0,050	0,050	0,050	100	infinite	Tribo-electric effect
$\hat{u}_\sigma$	Standard deviation on accelerometer output voltage measurement	0,300	0,200	0,100	0,150	0,200	0,350	0,450	0,500		7	ESDM for sensitivity calulation using 4 points
About UBM	**TOTAL COMBINED UNCERTAINTY**											
Best Measurement Capability (Excluding UUT contribution)	Combined Uncertainty (Normal) ▼Confidence Level▼	0,14	0,117	0,101	0,184	0,325	0,468	0,553	0,698	V_{eff}	infinite	Checked and Approved By:
	Expanded Uncertainty $k = 2$ 95,45 %	0,28	0,23	0,20	0,37	0,65	0,94	1,11	1,40	$k =$	**2,00**	
Uncertainty of Measurement (Including UUT contribution)	Combined Uncertainty (Normal) ▼Confidence Level▼	0,34	0,235	0,147	0,243	0,385	0,589	0,732	0,882	V_{eff}	infinite	
	Expanded Uncertainty $k = 2$ 95,45 %	0,8	0,5	0,3	0,5	0,8	1,2	1,5	1,8	$k =$	**2,00**	

UNCERTAINTY BUDGET MATRIX (UBM)										
								Certificate No		AV\VS-3732 & 3
								Procedure No		AV\VS-0001
Reference: Guide to the Expression of Uncertainty in Measurement, issued by BIPM, IEC, IFCC, ISO, IUPAC, IUPAP, OIML - ISO 1995 (ISBN 92-67-10188-9)										
Description:	Complex Sensitivity Calibration (Phase) as per ISO 16063-11 method 3	Make & model:	Brüel & Kjær Endevco		Range:	0,1 Hz to 20 kHz				Metrologist
		Serial number:	123							Ian Veldman
Mathematical Model:		$S_{phase} = UUT_{Phase} - Ref_{Phase} - Ref_{Delay} - AtoD_{Phase} - DSP_{Delay}$								
Symbol	Input Quantity (Source of Uncertainty)	Standard Uncertainty Contribution $Ui(y)$						Reliability	Degrees of Freedom	Remarks
		0,1 Hz to 100 Hz	> 100 Hz to 1 kHz	> 1 kHz < 5 kHz	5 kHz to 12 kHz	> 12 kHz to 15 kHz	> 15 kHz to 20 kHz		infinite	
u	▼ Standards and Reference Equipment (Uncorrelated) ▼	(°)	(°)	(°)	(°)	(°)	(°)	%	v	
$\varphi_{s,Q}$	Interferometer output signal disturbance on displacement phase measurement	0,035	0,046	0,075	0,115	0,231	0,202	100	infinite	e.g. offsets, voltage amplitude deviations, <> 90° Corrected with Heydemant procedure
$\varphi_{s,VD}$	Effect of voltage disturbance on displacement phase measurement	0,029	0,040	0,058	0,069	0,144	0,202	100	infinite	Additive uncorrelated noise is reduced by 1/√n. Where n=number of samples pes vibration cycle. Worse case =10%/1000
$\varphi_{s,MD}$	Effect of motion disturbance on displacement phase measurement	0,029	0,029	0,058	0,069	0,115	0,231	100	infinite	Relative motion between sensing spot, exiter and accelerometer. Worse case calculated for 16mm double ended accelerometer.
$\varphi_{s,PD}$	Effect of phase disturbance on displacement phase measurement	0,040	0,040	0,115	0,087	0,144	0,173	100	infinite	Corrected for using Heydemann correction procedure
$\varphi_{s,RE}$	Residual interferometric effects on displacement phase measurement	0,012	0,012	0,046	0,058	0,173	0,173	100	infinite	Not aware of any
$\Delta_{\varphi E}$	Environmental effects on phase shift measurement	0,017	0,017	0,029	0,058	0,115	0,087	100	infinite	ISO 16063-11 requirement: ≤ 0,05 % of reading
$\varphi_{u,V}$	Accelerometer output phase measurement (ADC resolution/accuracy)	0,025	0,025	0,100	0,150	0,200	0,175	100	infinite	SAM phase calculation accuracy
$\varphi_{u,F}$	Filtering effect on accelerometer output phase measurement	0,029	0,029	0,087	0,231	0,289	0,289	100	infinite	e=(f/fHp)2
$\varphi_{C,A}$	Charge amplifier phase accuracy	0,035	0,040	0,050	0,127	0,127	0,127	100	infinite	Certified value
	▼ Unit Under Test / Calibration (Uncorrelated) ▼									
$\hat{u}_D$	Effect of voltage disturbance on accelerometer output phase measurement	0,012	0,023	0,069	0,144	0,231	0,289	100	infinite	U_{THD} = ½(d/100)2; Maximum allowed by ISO 16063
$\hat{u}_T$	Effect of transverse motion on accelerometer output phase measurement	0,012	0,017	0,029	0,058	0,058	0,058	100	infinite	Transeverse error for a transverse sensitivity of 1%
$\hat{u}_{RES}$	Residual effects on accelerometer output voltage measurement	0,005	0,010	0,025	0,025	0,025	0,058	100	infinite	Tribo-electric effect
$\hat{u}_{RES}$	Standard deviation on accelerometer phase shift measurement	0,050	0,090	0,100	0,150	0,250	0,550	100	infinite	ESDM for sensitivity calulation using 5 cycles minimum
About UBM	TOTAL COMBINED UNCERTAINTY									
Best Measurement Capability (**Excluding** UUT contribution)	Combined Uncertainty (Normal) ▼Confidence Level▼	0,09	0,10	0,22	0,36	0,54	0,58	V_{eff}	infinite	Checked and Approved By:
	Expanded Uncertainty k = 2 95,45 %	0,2	0,20	0,4	0,7	1,1	1,15	k =	2,00	
Uncertainty of Measurement (Including UUT contribution)	Combined Uncertainty (Normal) ▼Confidence Level▼	0,10	0,13	0,24	0,39	0,60	0,80	V_{eff}	infinite	
	Expanded Uncertainty k = 2 95,45 %	0,2	0,3	0,5	0,8	1,2	1,6	k =	2,00	

B.12 VNIIM

i	Standard uncertainty component	Source of uncertainty	Probability distribution	Factor	Type of uncertainty	Relative standard uncertainty, %			
						10Hz<u≤2kHz	2kHz<u≤5kHz	5kHz<u≤15kHz	15kHz<u≤20kHz
1	u(u,V)	Measurement of the output voltage of the accelerometer (accuracy of the analog-digital conversion)	rectangular	1,732	B	0,070	0,070	0,070	0,070
2	u(u,F)	Effect of filtering on the measurement of the amplitude of the output voltage of the accelerometer (flatness of the analog-digital conversion)	rectangular	1,732	B	0,070	0,070	0,070	0,070
3	u(u,D)	Effect of voltage distortion on the measurement of the output voltage of the accelerometer (interference and electrical noise in the circuit)	rectangular	1,732	B	0,100	0,084	0,054	0,040
4	u(u,T)	Effect of transverse and angular accelerations on the measurement of the output voltage of the accelerometer (transverse sensitivity)	Normal	2,000	A	0,100	0,200	0,400	0,500
5	u(ϕM,Q)	Effect of distortion of the quadrature output signals of the interferometer on the measurement of the phase demodulation (zero shift, deviation of the voltage amplitude, deviation from 90 ° of the nominal phase difference of the quadrature signals)	rectangular	1,732	B	0,030	0,030	0,030	0,030
6	u(φM,F)	Effect of filtering the interferometer signal on the measurement of the amplitude of the phase demodulation (band limitation)	rectangular	1,732	B	0,010	0,010	0,010	0,010
7	u(φM,VD)	Effect of voltage distortion on the measurement of the amplitude of phase demodulation (random noise in photoelectric measuring circuits)	rectangular	1,732	B	0,050	0,050	0,050	0,050
8	u(φM,MD)	Effect of motion distortion on the measurement of the amplitude of phase demodulation (the relative motion between the accelerometer reference surface and the laser spot of the interferometer)	rectangular	1,732	B	0,025	0,025	0,025	0,025
9	u(φM,PD)	Effect of phase distortion on the measurement of the amplitude of the phase demodulation (the phase noise of the interferometer signal)	rectangular	1,732	B	0,100	0,300	0,500	0,700
10	u(φM,RE)	Residual interference effects on the measurement of the amplitude of phase modulation (interferometer function)	Normal	2,000	A	0,010	0,010	0,010	0,010
11	u(f,FG)	Vibration frequency measurement (frequency generator and indicating device)	rectangular	1,732	B	0,007	0,007	0,007	0,007
12	u(S,RE)	Residual effects on the measurement of the charge amplifier calibration	Normal	2,000	A	0,050	0,050	0,050	0,050
		Standard uncertainty				**0,22**	**0,39**	**0,66**	**0,87**
		The relative expanded uncertainty of measurement of the sensitivity				**0,43**	**0,78**	**1,31**	**1,74**

i	Standard uncertainty component	Source of uncertainty	Probability distribution	Factor	Type of uncertainty	Relative standard uncertainty, degree			
						10Hz<u≤16Hz	16Hz<u≤5kHz	5kHz<u≤10kHz	10kHz<u≤20kHz
1	u(φu,V)	Accelerometer output phase measurement	Normal	2,000	B	0,100	0,100	0,100	0,100
2	u(φu,F)	Voltage filtering effect on accelerometer output phase measurement	Normal	2,000	B	0,050	0,050	0,050	0,050
3	u(φu,D)	Effect of voltage disturbance on accelerometer output phase measurement	Normal	2,000	B	0,200	0,050	0,050	0,050
4	u(φu,T)	Effect of transverse, rocking and bending acceleration on accelerometer output phase measurement	Normal	2,000	A	0,100	0,050	0,050	0,200
5	u(ϕs,Q)	Effect of interferometer quadrature output signal disturbance on displacement phase measurement	rectangular	1,732	B	0,100	0,100	0,200	0,300
6	u(φs,F)	Interferometer signal filtering effect on displacement phase measurement	rectangular	1,732	B	0,050	0,050	0,100	0,200
7	u(φs,VD)	Effect of voltage disturbance on displacement phase measurement	rectangular	1,732	B	0,050	0,030	0,050	0,050
8	u(φs,MD)	Effect of motion disturbance on displacement phase measurement (drift, relative motion between the accelerometer reference surface and the spot sensed by the interferometer)	rectangular	1,732	B	0,050	0,050	0,050	0,050
9	u(φs,PD)	Effect of phase disturbance on displacement phase measurement (phase noise of the interferometer signals)	rectangular	1,732	B	0,200	0,100	0,200	0,400
10	u(φs,RE)	Residual interferometric effects on displacement phase measurement	Normal	2,000	A	0,100	0,100	0,200	0,300
11	u(Δφ,RE)	Residual effects on phase shift measurement (random effect in repeat measurements, experimental standard deviation of arithmetic mean)	Normal	2,000	A	0,200	0,100	0,300	0,300
		Standard uncertainty				**0,41**	**0,25**	**0,49**	**0,73**
		The relative expanded uncertainty of measurement of the sensitivity				**0,82**	**0,50**	**0,98**	**1,46**

B.13 NMC, A*STAR

NMC's Measurement Uncertainty Budget for Magnitude

Uncertainty components	Probability distribution model	10 Hz to < 20 Hz	20 Hz to < 1 kHz	1 kHz to < 5 kHz	5 kHz to < 10 kHz	10 kHz to < 15 kHz	15 kHz to 20 kHz
Reference Laser	Normal	5.00E-04	5.00E-04	5.00E-04	5.00E-04	1.00E-03	1.00E-03
Electrical measurement (Voltage, amplifier gain & frequency response)	Rectangular	6.00E-04	6.00E-04	6.00E-04	6.00E-04	1.60E-03	2.05E-03
Transverse motion	Rectangular	1.00E-04	5.00E-04	1.00E-03	1.00E-03	1.00E-03	1.00E-03
Harmonics	Rectangular	1.00E-04	1.00E-04	1.00E-04	1.00E-04	1.00E-04	1.00E-04
Hum	Rectangular	1.00E-04	1.00E-04	1.00E-04	1.00E-04	1.00E-04	1.00E-04
Noise	Rectangular	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05
Geometrical location of laser	Rectangular	1.00E-04	2.00E-04	5.00E-04	5.00E-04	2.00E-03	3.00E-03
Accelerometer mounting	Rectangular	2.00E-05	2.00E-05	5.00E-04	5.00E-04	1.00E-03	3.00E-03
Cable layout	Rectangular	1.00E-03	3.00E-04	2.00E-04	0.00E+00	0.00E+00	0.00E+00
Relative motion between laser & exciter	Rectangular	1.00E-03	1.00E-03	1.00E-03	1.00E-03	1.00E-03	1.00E-03
Temperature variation	Rectangular	1.50E-05	1.50E-05	1.50E-05	1.50E-05	1.50E-05	1.50E-05
Non-linearity	Rectangular	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05	1.00E-05
Long term stability of control unit	Rectangular	2.89E-04	1.73E-04	1.73E-04	2.31E-04	2.31E-04	4.04E-04
Influence of magnetic fields	Rectangular	1.00E-03	1.00E-04	1.00E-04	1.00E-04	1.00E-04	1.00E-04
Residual effects	Rectangular	7.00E-04	5.00E-04	1.00E-03	2.00E-03	5.00E-03	5.00E-03
	Type A	1.37E-04	9.27E-05	6.24E-05	1.46E-04	2.16E-04	3.35E-04
Combined relative standard measurement uncertainty		2.06E-03	1.52E-03	2.05E-03	2.69E-03	5.97E-03	7.11E-03
Effective degree of freedom		2.04E+05	2.89E+05	4.68E+06	4.61E+05	2.32E+06	8.10E+05
Coverage factor		2.00	2.00	2.00	2.00	2.00	2.00
Expanded uncertainty [%]		0.41	0.30	0.41	0.54	1.19	1.42

NMC's Measurement Uncertainty Budget for Phase shift

Uncertainty components	Probability distribution model	10 Hz to < 20 Hz °	20 Hz to < 1 kHz °	1 kHz to < 5 kHz °	5 kHz to < 10 kHz °	10 kHz to < 15 kHz °	15 kHz to 20 kHz °
Reference standard	Normal	0.100	0.100	0.250	0.250	0.500	0.750
Angular frequency	Rectangular	0.000	0.000	0.000	0.000	0.000	0.000
Voltage measurement	Rectangular	0.050	0.050	0.050	0.050	0.050	0.050
Amplifier gain	Rectangular	0.100	0.100	0.100	0.100	0.100	0.100
Frequency response	Rectangular	0.050	0.050	0.050	0.100	0.200	0.200
Harmonics	Rectangular	0.000	0.000	0.000	0.000	0.000	0.000
Hum	Rectangular	0.010	0.010	0.010	0.010	0.010	0.010
Noise	Rectangular	0.010	0.010	0.010	0.010	0.010	0.010
Geometrical location	Rectangular	0.010	0.080	0.080	0.100	0.100	0.100
Relative motion	Rectangular	0.020	0.020	0.100	0.100	0.100	0.100
Temperature variation	Rectangular	0.010	0.010	0.010	0.010	0.010	0.010
Non-linearity	Rectangular	0.010	0.010	0.010	0.010	0.010	0.010
Long term stability of control unit	Rectangular	0.006	0.012	0.035	0.040	0.069	0.081
Residual effects	Rectangular	0.000	0.000	0.000	0.000	0.200	0.200
	Type A	0.009	0.005	0.004	0.002	0.002	0.005
	Combined standard measurement uncertainty [°]	0.161	0.180	0.309	0.327	0.606	0.826
	Effective degree of freedom	4.95E+05	9.43E+06	1.58E+08	1.65E+09	1.85E+10	4.24E+09
	Coverage factor	2.00	2.00	2.00	2.00	2.00	2.00
	Expanded uncertainty [°]	0.32	0.36	0.62	0.65	1.21	1.65

B.14 UkrMet

CHARGE SENSITIVITY - MAGNITUDE **UKRMETRTESTSTANDART**

i	Standard uncertainty component	Source of uncertainty	Probability distribution	Factor	Type of uncertainty	Relative standard uncertainty, %				
						10 ≤F≤ 1000 Hz	1001 ≤F≤ 5000 Hz	5001 ≤F≤ 10000 Hz	10001 ≤F≤ 15000 Hz	15001 ≤F≤ 20000 Hz
1	u(u,V)	Measurement of the output voltage of the accelerometer (accuracy of the analog-digital conversion)	rectangular	1,732	B	0,07	0,07	0,07	0,07	0,07
2	u(u,F)	Effect of filtering on the measurement of the amplitude of the output voltage of the accelerometer (flatness of the analog-digital conversion)	rectangular	1,732	B	0,07	0,07	0,07	0,07	0,07
3	u(u,D)	Effect of voltage distortion on the measurement of the output voltage of the accelerometer (interference and electrical noise in the circuit)	rectangular	1,732	B	0,07	0,07	0,07	0,07	0,07
4	u(u,T)	Effect of transverse and angular accelerations on the measurement of the output voltage of the accelerometer (transverse sensitivity)	rectangular	1,732	B	0,15	0,2	0,3	0,4	0,5
5	u(ϕM,Q)	Effect of distortion of the quadrature output signals of the interferometer on the measurement of the phase demodulation (zero shift, deviation of the voltage amplitude, deviation from 90 ° of the nominal phase difference of the quadrature signals)	rectangular	1,732	B	0,04	0,04	0,04	0,04	0,04
6	u(φM,F)	Effect of filtering the interferometer signal on the measurement of the amplitude of the phase demodulation (band limitation)	rectangular	1,732	B	0,03	0,03	0,03	0,03	0,03
7	u(φM,VD)	Effect of voltage distortion on the measurement of the amplitude of phase demodulation (random noise in photoelectric measuring circuits)	rectangular	1,732	B	0,03	0,03	0,03	0,03	0,03
8	u(φM,MD)	Effect of motion distortion on the measurement of the amplitude of phase demodulation (the relative motion between the accelerometer reference surface and the laser spot of the interferometer)	rectangular	1,732	B	0,04	0,04	0,04	0,04	0,04
9	u(φM,PD)	Effect of phase distortion on the measurement of the amplitude of the phase demodulation (the phase noise of the interferometer signal)	rectangular	1,732	B	0,1	0,2	0,4	0,5	0,7
10	u(φM,RE)	Residual interference effects on the measurement of the amplitude of phase modulation (interferometer function)	rectangular	1,732	B	0,05	0,1	0,2	0,2	0,2
11	u(f,FG)	Vibration frequency measurement (frequency generator and indicating device)	rectangular	1,732	B	0,007	0,007	0,007	0,007	0,007
12	u(S,RE)	Random effect in repeat measurements (standard deviation)	Normal	2,000	A	0,05	0,1	0,3	0,4	0,7
		Estimated relative combined standard uncertainty, %, for accelerpmeter sensitivity				**0,24**	**0,35**	**0,63**	**0,79**	**1,14**
		Estimated relative expanded uncertainty, %, for accelerometer sensitivity (k=2)				**0,48**	**0,69**	**1,26**	**1,59**	**2,27**
		Reported relative expandad uncertainty, %, for accelerometer sensitivity (k=2)				**0,5**	**0,7**	**1,5**	**2,0**	**3,0**

CHARGE SENSITIVITY - PHASE SHIFT **UKRMETRTESTSTANDART**

i	Standard uncertainty component	Source of uncertainty	Probability distribution	Factor	Type of uncertainty	Relative standard uncertainty, degrees				
						10 ≤F≤ 1000 Hz	1001 ≤F≤ 5000 Hz	5001 ≤F≤ 10000 Hz	10001 ≤F≤ 15000 Hz	15001 ≤F≤ 20000 Hz
1	u(φu,V)	Accelerometer output phase measurement	rectangular	1,732	B	0,1	0,1	0,2	0,3	0,5
2	u(φu,F)	Voltage filtering effect on accelerometer output phase measurement	rectangular	1,732	B	0,05	0,05	0,07	0,1	0,15
3	u(φu,D)	Effect of voltage disturbance on accelerometer output phase measurement	rectangular	1,732	B	0,1	0,1	0,1	0,15	0,2
4	u(φu,T)	Effect of transverse, rocking and bending acceleration on accelerometer output phase measurement	rectangular	1,732	B	0,1	0,1	0,3	0,2	0,2
5	u(ϕs,Q)	Effect of interferometer quadrature output signal disturbance on displacement phase measurement	rectangular	1,732	B	0,05	0,05	0,1	0,2	0,3
6	u(φs,F)	Interferometer signal filtering effect on displacement phase measurement	rectangular	1,732	B	0,05	0,05	0,1	0,2	0,3
7	u(φs,VD)	Effect of voltage disturbance on displacement phase measurement	rectangular	1,732	B	0,05	0,05	0,05	0,1	0,1
8	u(φs,MD)	Effect of motion disturbance on displacement phase measurement (drift, relative motion between the accelerometer reference surface and the spot sensed by the interferometer)	rectangular	1,732	B	0,05	0,05	0,05	0,05	0,1
9	u(φs,PD)	Effect of phase disturbance on displacement phase measurement (phase noise of the interferometer signals)	rectangular	1,732	B	0,05	0,1	0,2	0,3	0,4
10	u(φs,RE)	Residual interferometric effects on displacement phase measurement	rectangular	1,732	B	0,05	0,1	0,2	0,3	0,4
11	u(Δφ,RE)	Residual effects on phase shift measurement (random effect in repeat measurements, experimental standard deviation of arithmetic mean)	Normal	2,000	A	0,08	0,11	0,22	0,38	0,47
		Estimated relative combined standard uncertainty, degrees, for accelerpmeter phase shift				**0,23**	**0,27**	**0,55**	**0,76**	**1,05**
		Estimated relative expanded uncertainty, degrees, for accelerometer phase shift (k=2)				**0,46**	**0,55**	**1,09**	**1,52**	**2,09**
		Reported relative expandad uncertainty, degrees, for accelerometer phase shift (k=2)				**0,5**	**0,7**	**1,5**	**2,0**	**3,0**