Key comparison CCM.P-K1.c

MEASURAND : **Effective area $A'(p', 20\ °C)$ of two piston-cylinder units (Ruska 2465 pressure balance), unit C-415 from 79 kPa to 896 kPa and unit V-762 from 622 kPa to 6.8 MPa determined from pressure measurement comparisons against participants primary standards**

NOMINAL VALUE : **84 mm^2 for C-415 unit and 8.4 mm^2 for V-762 unit**

x_i : result of measurement, as $A'(p', 20\ °C)$ based on the arithmetic average of 10 experimental points, carried out by laboratory i

u_i : combined standard uncertainty of x_i

Piston-cylinder C-415

nominal p' / kPa	x_i / mm^2	u_i / x_i / 10^{-6}	x_i / mm^2	u_i / x_i / 10^{-6}	x_i / mm^2	u_i / x_i / 10^{-6}	x_i / mm^2	u_i / x_i / 10^{-6}	x_i / mm^2	u_i / x_i / 10^{-6}
79.4	**84.00527**	12.1	**84.00496**	3.4	**84.00511**	3.9	**84.00455**	8.6	**84.00494**	8.8
137.8	**84.00546**	10.3	**84.00485**	3.2	**84.00507**	4.9	**84.00480**	8.4	**84.00475**	9.0
196.0	**84.00477**	12.1	**84.00495**	3.0	**84.00498**	4.8	**84.00485**	8.4	**84.00505**	9.1
254.5	**84.00475**	11.8	**84.00493**	3.0	**84.00497**	4.7	**84.00467**	8.5	**84.00498**	9.3
312.8	**84.00494**	11.4	**84.00519**	2.9	**84.00506**	4.6	**84.00477**	8.6	**84.00509**	9.5
429.5	**84.00491**	11.0	**84.00525**	2.9	**84.00511**	4.6	**84.00484**	8.5	**84.00502**	9.8
546.2	**84.00483**	10.9	**84.00533**	2.9	**84.00521**	4.6	**84.00489**	8.5	**84.00493**	10.1
663.0	**84.00478**	10.7	**84.00540**	2.8	**84.00530**	4.6	**84.00494**	8.3	**84.00520**	10.5
779.7	**84.00481**	10.9	**84.00549**	2.8	**84.00530**	4.6	**84.00495**	8.2	**84.00513**	10.8
896.4	**84.00474**	10.7	**84.00555**	2.8	**84.00535**	4.6	**84.00500**	8.2	**84.00514**	11.1
	IMGC-CNR, Feb 1998		**BNM-LNE, Apr 1998**		**PTB, June 1998**		**NMIJ, Oct 1998**		**NIST, Apr 1999**	

Note:

The Italian laboratory IMGC-CNR is now INRIM (Istituto Nazionale di Ricerca Metrologica)

The French laboratory BNM-LNE is now LNE (Laboratoire National de Métrologie et d'Essais)

Key comparison CCM.P-K1.c (Cont.)

MEASURAND : **Effective area $A'(p', 20\ °C)$ of two piston-cylinder units (Ruska 2465 pressure balance), unit C-415 from 79 kPa to 896 kPa and unit V-762 from 622 kPa to 6.8 MPa determined from pressure measurement comparisons against participants primary standards**

NOMINAL VALUE : **84 mm^2 for C-415 unit and 8.4 mm^2 for V-762 unit**

x_i : result of measurement, as $A'(p', 20\ °C)$ based on the arithmetic average of 10 experimental points, carried out by laboratory *i*

u_i : combined standard uncertainty of x_i

Piston-cylinder V-762

nominal p' / kPa	x_i / mm^2	u_i / x_i / 10^{-6}	x_i / mm^2	u_i / x_i / 10^{-6}	x_i / mm^2	u_i / x_i / 10^{-6}	x_i / mm^2	u_i / x_i / 10^{-6}	x_i / mm^2	u_i / x_i / 10^{-6}
621.7	**8.388533**	10.9	**8.388535**	4.5	**8.388525**	4.8	**8.388500**	7.4	**8.388660**	8.7
738.5	**8.388499**	11.0	**8.388534**	3.6	**8.388539**	4.7	**8.388490**	7.4	**8.388610**	8.8
1077.5	**8.388512**	11.0	**8.388535**	3.3	**8.388562**	4.6	**8.388496**	7.4	**8.388620**	8.8
1767.0	**8.388538**	13.2	**8.388547**	3.3	**8.388610**	4.6	**8.388540**	7.5	**8.388690**	9.0
2935.7	**8.388619**	13.0	**8.388606**	3.2	**8.388694**	7.4	**8.388580**	7.6	**8.388740**	9.8
4104.4	**8.388668**	13.1	**8.388660**	3.1	**8.388738**	7.4	**8.388610**	7.8	**8.388780**	11.0
5273.1	**8.388683**	13.2	**8.388708**	3.1	**8.388768**	7.4	**8.388640**	8.1	**8.388830**	12.6
6441.8	**8.388746**	13.3	**8.388747**	3.1	**8.388801**	8.2	**8.388670**	8.4	**8.388880**	14.4
6792.4	**8.388751**	13.9	**8.388758**	3.2	**8.388811**	8.3	**8.388680**	8.5	**8.388870**	15.0
	IMGC-CNR, Feb 1998		**BNM-LNE, Apr 1998**		**PTB, June 1998**		**NMIJ, Oct 1998**		**NIST, Apr 1999**	

Key comparison EUROMET.M.P-K2

MEASURAND : **Effective area A (p_e, 20 °C) of an oil-lubricated gas-operated piston-cylinder assembly DH 4994, determined at four nominal gauge pressure p_e from pressure measurement comparisons against the laboratory standards of the participants**

NOMINAL VALUE : $x_{NOM} = 98.05\ mm^2$

$x_{i\text{-EUR}}$: result of measurements carried out by laboratory i at each nominal pressure:
A (p_e, 20 °C) as arithmetic average of 6 experimental points

$u_{i\text{-EUR}}$: combined standard uncertainty of $x_{i\text{-EUR}}$

Piston-cylinder DH 4994

nominal p_e / MPa	$x_{i\text{-EUR}}$ / mm²	$u_{i\text{-EUR}}$ / mm²	$x_{i\text{-EUR}}$ / mm²	$u_{i\text{-EUR}}$ / mm²	$x_{i\text{-EUR}}$ / mm²	$u_{i\text{-EUR}}$ / mm²	$x_{i\text{-EUR}}$ / mm²	$u_{i\text{-EUR}}$ / mm²	$x_{i\text{-EUR}}$ / mm²	$u_{i\text{-EUR}}$ / mm²	$x_{i\text{-EUR}}$ / mm²	$u_{i\text{-EUR}}$ / mm²
1.0	**98.0509**	0.0020	**98.0478**	0.0012	**98.0492**	0.0019	**98.0488**	0.0012	**98.0485**	0.0007	**98.0496**	0.0010
2.0	**98.0511**	0.0020	**98.0479**	0.0011	**98.0486**	0.0019	**98.0490**	0.0012	**98.0487**	0.0008	**98.0495**	0.0010
3.0	**98.0513**	0.0020	**98.0479**	0.0011	**98.0487**	0.0019	**98.0492**	0.0012	**98.0487**	0.0006	**98.0496**	0.0010
4.0	**98.0515**	0.0020	**98.0479**	0.0011	**98.0487**	0.0019	**98.0494**	0.0012	**98.0488**	0.0006	**98.0497**	0.0011
	BEV, June 1994		**MIKES, Sep/Oct 1994**		**CEM, July 1994**		**SP/FFA, Dec 1994**		**BNM-LNE, Oct 1995**		**PTB, May 1994**	

Key comparison EUROMET.M.P-K3.b

MEASURAND : **Effective area of two piston-cylinder units (Ruska 2465 pressure balance), unit C-71 from 80 kPa to 780 kPa and unit V-832 from 622 kPa to 6798 kPa determined from pressure measurement comparisons against participants primary standards**

NOMINAL VALUE : **84 mm^2 for C-71 unit and 8.4 mm^2 for V-832 unit**

The measurement results reported by the laboratories participant in EUROMET.M.P-K3.b for nine nominal pressures ranging from 80 kPa to 780 kPa for the transfer standard unit C-71, and from 622 kPa to 6798 kPa for the transfer standard unit V-832 are shown in Figure 3 and 4, respectively, in the EUROMET.M.P-K3.b Final Report.

Key comparison APMP.M.P-K1.c

MEASURAND : **Effective area $A'(p', 23\ °C)$ of a piston-cylinder unit (Ruska 2465 pressure balance), unit V-407 from 0.4 MPa to 4.0 MPa determined from pressure measurement comparisons against participants secondary standards**

NOMINAL VALUE : **8.4 mm^2 for V-407 unit**

$x_{i\text{-APMP}}$: result of measurement, as $A'(p', 23\ °C)$ based on the arithmetic average of 10 experimental points, carried out by laboratory *i*
$u_{i\text{-APMP}}$: combined standard uncertainty of $x_{i\text{-APMP}}$

Laboratories maintaining primary standards

nominal p' / MPa	$x_{i\text{-APMP}}$ / mm^2	$u_{i\text{-APMP}}$ / $x_{i\text{-APMP}}$ / 10^{-6}	$x_{i\text{-APMP}}$ / mm^2	$u_{i\text{-APMP}}$ / $x_{i\text{-APMP}}$ / 10^{-6}	$x_{i\text{-APMP}}$ / mm^2	$u_{i\text{-APMP}}$ / $x_{i\text{-APMP}}$ / 10^{-6}	$x_{i\text{-APMP}}$ / mm^2	$u_{i\text{-APMP}}$ / $x_{i\text{-APMP}}$ / 10^{-6}	$x_{i\text{-APMP}}$ / mm^2	$u_{i\text{-APMP}}$ / $x_{i\text{-APMP}}$ / 10^{-6}
0.41	8.386087	21	8.386113	17	8.386061	12	8.386051	8.8	8.386103	5.9
0.81	8.386029	21	8.386037	17	8.386040	12	8.386046	8.9	8.386097	5.7
1.21	8.386054	21	8.386006	17	8.386002	12	8.386060	9.0	8.386086	5.6
1.61	8.386074	21	8.386021	17	8.386008	12	8.386080	9.1	8.386106	5.6
2.01	8.386044	21	8.386044	17	8.385993	12	8.386092	9.3	8.386125	8.1
2.41	8.386066	21	8.386071	17	8.386007	12	8.386109	9.5	8.386148	8.1
2.81	8.386092	21	8.386090	17	8.386018	12	8.386124	9.7	8.386160	8.2
3.21	8.386094	21	8.386098	17	8.386004	12	8.386128	10.0	8.386161	8.1
3.61	8.386115	21	8.386123	17	8.386016	12	8.386138	10.3	8.386176	8.3
4.01	8.386143	21	8.386140	17	8.386029	12	8.386150	10.6	8.386188	8.0
	NPLI, Oct.1998		KRISS, Apr. 1999		CSIRO-NML, Aug.1999		NMIJ, Sep. 1999		PTB, Mar. 2001	

Key comparison APMP.M.P-K1.c

MEASURAND : **Effective area $A'(p', 23\ °C)$ of a piston-cylinder unit (Ruska 2465 pressure balance), unit V-407 from 0.4 MPa to 4.0 MPa determined from pressure measurement comparisons against participants secondary standards**

NOMINAL VALUE : **8.4 mm^2 for V-407 unit**

$x_{i\text{-APMP}}$: result of measurement, as $A'(p', 23\ °C)$ based on the arithmetic average of 10 experimental points, carried out by laboratory i
$u_{i\text{-APMP}}$: combined standard uncertainty of $x_{i\text{-APMP}}$

Laboratories maintaining secondary standards

nominal p' / MPa	$x_{i\text{-APMP}}$ / mm^2	$u_{i\text{-APMP}}$ / $x_{i\text{-APMP}}$ / 10^{-6}	$x_{i\text{-APMP}}$ / mm^2	$u_{i\text{-APMP}}$ / $x_{i\text{-APMP}}$ / 10^{-6}	$x_{i\text{-APMP}}$ / mm^2	$u_{i\text{-APMP}}$ / $x_{i\text{-APMP}}$ / 10^{-6}	$x_{i\text{-APMP}}$ / mm^2	$u_{i\text{-APMP}}$ / $x_{i\text{-APMP}}$ / 10^{-6}	$x_{i\text{-APMP}}$ / mm^2	$u_{i\text{-APMP}}$ / $x_{i\text{-APMP}}$ / 10^{-6}	$x_{i\text{-APMP}}$ / mm^3	$u_{i\text{-APMP}}$ / $x_{i\text{-APMP}}$ / 10^{-6}
0.41	8.385780	30	8.386075	32	8.386067	23	8.385839	18	8.386342	31	8.385844	25
0.81	8.385780	30	8.386101	32	8.386085	23	8.385867	19	8.386499	31	8.385818	22
1.21	8.385710	30	8.386196	32	8.386026	23	8.385830	19	8.386387	20	8.385890	32
1.61	8.385730	30	8.386220	32	8.386071	23	8.385861	19	8.386338	18	8.385961	26
2.01	8.385710	30	8.386229	32	8.386039	23	8.385870	19	8.386377	18	8.385930	22
2.41	8.385730	30	8.386234	32	8.386066	23	8.385892	19	8.386355	18	8.385974	22
2.81	8.385740	30	8.386249	32	8.386074	23	8.385906	19	8.386354	17	8.385995	21
3.21	8.385730	30	8.386251	32	8.386055	23	8.385903	19	8.386363	17	8.386017	23
3.61	8.385750	30	8.386277	32	8.386050	23	8.385926	19	8.386364	17	8.386039	25
4.01	8.385770	30	8.386282	32	8.386063	23	8.385938	19	8.386386	17	8.386063	23
	MSL, May 1999		SPRING Singapore, Nov. 1998		NML-SIRIM, Jan.1999		SCL, June 1999		CSIR-NML, Oct.1999		NIS-Egypt, June 2000	

Note:
The CSIRO-NML is now NMIA (National Measurement Institute, Australia)
The SPRING Singapore is now A*STAR (Agency for Science, Technology and Research)
The CSIR-NML is now NMISA (National Metrology Institute of South Africa)

Key comparison APMP.M.P-K1.c.1

This is en extension of key comparison APMP.M.P-K1.c to CMS/ITRI and NMIT, using SPRING Singapore as the linking laboratory.
Detailed results are given in Table 4 on page 11 of the APMP.M.P-K1.c.1 Final Report.

Key comparison CCM.P-K1.c

MEASURAND : Effective area $A'(p', 20\ °C)$ of two piston-cylinder units, C-415 unit and V-762 unit

NOMINAL VALUE : 84 mm^2 for C-415 unit and 8.4 mm^2 for V-762 unit

The key comparison reference value, x_R, for each transfer standard is obtained as the linear fit $A'p'$ vs. pressure p' of the results from the five participants. The standard uncertainty of each reference value, u_R, is taken as the standard deviation of the linear fit.

Piston-cylinder C-415 $x_R / mm^2 = A'p'(p', 20\ °C) / mm^2 = 84.00489 + 2.962 \cdot 10^{-7} p'$ /kPa $\quad u_R / x_R = 2.5 \cdot 10^{-6}$

Piston-cylinder V-762 $x_R / mm^2 = A'p'(p', 20\ °C) / mm^2 = 8.3885165 + 3.947 \cdot 10^{-8} p'$ /kPa $\quad u_R / x_R = 7.2 \cdot 10^{-6}$

The degree of equivalence of each laboratory with respect to each reference value is given by a pair of terms:
$D_i = (x_i - x_R) / x_R$, the relative deviation from the reference value, and $U_i = 2 (u_i^2 + u_R^2)^{0.5} / x_R$, its expanded uncertainty ($k = 2$).

The degree of equivalence between two laboratories is given for each transfer standard by a pair of terms:
$D_{ij} = D_i - D_j = (x_i - x_j) / x_R$, the relative difference between their results, and $U_{ij} = 2 (u_i^2 + u_j^2 + u_{tr.std.}^2)^{0.5} / x_R$, its expanded uncertainty ($k = 2$). $u_{tr.std.}$ is the transfer standard stability (2.10^{-6} and 3.10^{-6} for C-415 and V-762 units respectively).
The degrees of equivalence by pairs are computed for the following pressures:
C-415 unit: pressures at 79.4 kPa, 429.5 kPa and 896.4 kPa; V-762 unit : pressures at 621.7 kPa, 1077.5 kPa, 4104.4 kPa and 6792.4 kPa.

Key comparison EUROMET.M.P-K2

MEASURAND : **Effective area A (p_e, 20 °C) of an oil-lubricated gas-operated piston-cylinder assembly DH 4994**

NOMINAL VALUE : $x_{NOM} = 98.05\ mm^2$

At nominal pressures 1 MPa and 4 MPa, reference values of the EUROMET comparison, $x_{R\text{-}EUR}$, were calculated as the weighted averages of the effective areas measured by the two primary laboratories, the BNM-LNE and the PTB. The standard uncertainty of each $x_{R\text{-}EUR}$, $u_{R\text{-}EUR}$, is calculated as: $u_{R\text{-}EUR} = (s_A^2 + s_B^2)^{1/2}$, with s_A calculated as the standard deviation of the weighted average of the results of the BNM-LNE and the PTB, and $s_B^2 = u_{LNE}^2 u_{PTB}^2 / (u_{LNE}^2 + u_{PTB}^2)$.

Piston-cylinder DH 4994

p_e = 1 MPa: $x_{R\text{-}EUR} = 98.04886\ mm^2$, $u_{R\text{-}EUR} = 0.00093\ mm^2$

p_e = 4 MPa: $x_{R\text{-}EUR} = 98.04901\ mm^2$, $u_{R\text{-}EUR} = 0.00074\ mm^2$

The degree of equivalence of each laboratory participant in EUROMET.M.P-K2 with respect to a reference value of the EUROMET comparison is given by a pair of terms: $D_{i\text{-}EUR} = (x_{i\text{-}EUR} - x_{R\text{-}EUR}) / x_{NOM}$, the relative deviation from $x_{R\text{-}EUR}$, and $U_{i\text{-}EUR} = 2\,(u_{i\text{-}EUR}^2 + u_{R\text{-}EUR}^2)^{0.5} / x_{NOM}$, its expanded uncertainty (k = 2).

The degree of equivalence between two laboratories participant in EUROMET.M.P-K2 is given by a pair of terms: $D_{ij\text{-}EUR} = (x_{i\text{-}EUR} - x_{j\text{-}EUR}) / x_{NOM}$, the relative difference between their results, and $U_{ij\text{-}EUR} = 2\,(u_{i\text{-}EUR}^2 + u_{j\text{-}EUR}^2)^{0.5} / x_{NOM}$, its expanded uncertainty (k = 2).

Linking key comparison EUROMET.M.P-K2 to key comparison CCM.P-K1.c

The linking laboratories between EUROMET.M.P-K2 and CCM.P-K1.c are the BNM-LNE and the PTB.

The degrees of equivalence of BNM-LNE and PTB obtained in both comparisons at similar nominal pressures are given in the following tables. We observe that they are comparable, and that the offsets are considerably smaller than the expanded uncertainties.

CCM.P-K1.c	BNM-LNE		PTB	
nominal p' / kPa	D_i / 10^{-6}	U_i / 10^{-6}	D_i / 10^{-6}	U_i / 10^{-6}
1077.5	-2.9	16	0.4	17
4104.4	-2.2	16	7.1	21

Piston-cylinder

V-762

EUROMET.M.P-K2	BNM-LNE		PTB	
nominal p_e / MPa	$D_{i\text{-EUR}}$ / 10^{-6}	$U_{i\text{-EUR}}$ / 10^{-6}	$D_{i\text{-EUR}}$ / 10^{-6}	$U_{i\text{-EUR}}$ / 10^{-6}
1.0	-3.7	14	7.5	20
4.0	-2.1	12	7.0	21

Piston-cylinder

DH 4994

The weighted average $x_{LNE+PTB} = (u_{PTB}^2 x_{LNE} + u_{LNE}^2 x_{PTB})/(u_{LNE}^2 + u_{PTB}^2)$ and the corresponding offset $D_{LNE+PTB} = (x_{LNE+PTB} - x_R)/x_R$ have been calculated:

$D_{LNE+PTB} = -1.8\ 10^{-6}$ for 1 MPa and $-0.8\ 10^{-6}$ for 4 MPa.

The degrees of equivalence of BEV, MIKES, CEM and SP/FFA obtained in the EUROMET comparison can thus be transferred to the key comparison CCM.P-K1.c as follows:

$D_i = D_{i\text{-EUR}} - 1.8$ (expressed in 10^{-6}) and $U_i = U_{i\text{-EUR}}$ at pressures close to 1 MPa,

$D_i = D_{i\text{-EUR}} - 0.8$ (expressed in 10^{-6}) and $U_i = U_{i\text{-EUR}}$ at pressures close to 4 MPa.

Since all EUROMET.M.P-K2 participants observed extremely small pressure dependencies of the measurand $x_{i\text{-EUR}}$ and reported almost constant uncertainties, it is sufficient to analyse the data obtained at minimum and maximum nominal pressures (1 MPa and 4 MPa). The result may be regarded as valid for the full pressure range covered.

Key comparison APMP.M.P-K1.c

MEASURAND : **Effective area $A'(p', 23\ °C)$ of a piston-cylinder assembly V-407**

NOMINAL VALUE : **8.4 mm^2**

The key comparison reference value, $x_{R\text{-}APMP}$, is obtained as the linear fit $A'p'$ vs. pressure p' of the results from the five participant laboratories which maintain primary pressure standard.
The standard uncertainty of each reference value, $u_{R\text{-}APMP}$, is taken as the standard deviation of the linear fit.

$$x_{R\text{-}APMP} / mm^2 = A'p'(p', 23\ °C) / mm^2 = 8.3860379 + 1.947 \cdot 10^{-5}\, p' / MPa \qquad u_{R\text{-}APMP} / x_{R\text{-}APMP} = 5.6 \cdot 10^{-6}$$

The degree of equivalence of each laboratory participant in APMP.M.P-K1.c with respect to each reference value of the APMP comparison is given by a pair of terms:
$D_{i\text{-}APMP} = (x_{i\text{-}APMP} - x_{R\text{-}APMP}) / x_{R\text{-}APMP}$, the relative deviation from the reference value, and
$U_{i\text{-}APMP} = 2\,(u_{i\text{-}APMP}^2 + u_{R\text{-}APMP}^2)^{0.5} / x_{R\text{-}APMP}$, its expanded uncertainty ($k = 2$).

The degree of equivalence between two laboratories is given for each transfer standard by a pair of terms:
$D_{ij\text{-}APMP} = D_{i\text{-}APMP} - D_{j\text{-}APMP} = (x_{i\text{-}APMP} - x_{j\text{-}APMP}) / x_{R\text{-}APMP}$, the relative difference between their results,
and $U_{ij\text{-}APMP} = 2\,(u_{i\text{-}APMP}^2 + u_{j\text{-}APMP}^2 + u_{tr.std.}^2)^{0.5} / x_R$, its expanded uncertainty (k = 2). utr.std.is the transfer standard stability uncertainty ($k = 2$). $u_{tr.std.}$ is the transfer standard stability (4.10^{-6} for V-407 unit).

Linking key comparison APMP.M.P-K1.c to key comparison CCM.P-K1.c

The linking laboratories between APMP.M.P-K1.c and CCM.P-K1.c are the NMIJ and the PTB. The degrees of equivalence of NMIJ and the PTB obtained in both comparisons at similar nominal pressures are given in the following tables.
We observe that they are comparable, and that the offsets are considerably smaller than the expanded uncertainties.

CCM.P-K1c	NMIJ		PTB	
p ' nom / MPa	$D_i \cdot 10^{-6}$	$U_i \cdot 10^{-6}$	$D_i \cdot 10^{-6}$	$U_i \cdot 10^{-6}$
1.07	-7.5	20.6	0.4	4.6
4.10	-8.2	21.2	7.1	20.6

APMP.M.P-K1c	NMIJ		PTB	
p' nom / MPa	$D_{i\text{- APMP}} \cdot 10^{-6}$	$U_{i\text{ -APMP}} \cdot 10^{-6}$	$D_{i\text{- APMP}} \cdot 10^{-6}$	$U_{i\text{ -APMP}} \cdot 10^{-6}$
1.21	-0.2	21	2.9	16
4.01	4.1	24	8.6	20

The combined differences were calculated as $D_{NMIJ+PTB} = (u_{NMIJ}^2 D_{PTB} + u_{PTB}^2 D_{NMIJ}) / (u_{NMIJ}^2 + u_{PTB}^2)$. It results from that equation the following numerical values (expressed in 10^{-6}):

$D_{NMIJ+PTB}$ = -1.8 and -0.15 at pressures close to respectively 1 MPa and 4 MPa for the comparison CCM.P-K1c

$D_{NMIJ+PTB}$ = 2.0 and 7.0 at pressures close to respectively 1 MPa and 4 MPa for the comparison APMP.M.P-K1c

The degrees of equivalence of NPLI, KRISS, CSIRO-NML, MSL, SPRINGSingapore, NML-SIRIM, SCL, CSIR-NML, and NIS obtained in in the APMP comparison can be transferred to the CCM.P-K1.c comparison as follows :

$D_i = D_{i\text{ -APMP}}$ - 3.8 (expressed in 10^{-6}) and $U_i = U_{i\text{ -APMP}}$ at pressures close to 1 MPa

$D_i = D_{i\text{ -APMP}}$ - 7.1 (expressed in 10^{-6}) and $U_i = U_{i\text{ -APMP}}$ at pressures close to 4 MPa

These statements make it possible to extend the CCM.P-K1.c matrices of equivalence computed for 1 MPa and 4 MPa to the full matrices of equivalence involving all participants in EUROMET.M.P-K2 and APMP.M.P-K1.c.

The pair-wise degrees of equivalence are generally given by two terms:

$D_{ij} = D_i - D_j$, and $U_{ij} = (U_i^2 + U_j^2)^{1/2}$ except in the case of two laboratories having participated in the same comparison.

Linking key comparison APMP.M.P-K1.c.1 to key comparison CCM.P-K1.c

The linkage is made through the common participation of SPRING Singapore in both APMP key comparisons, and is detailed in Section 4.4 of the APMP.M.P-K1.c Final Report.

Linking key comparison EUROMET.M.P-K3.b to key comparison CCM.P-K1.c

The linkage is made through the common participation of the PTB and INRIM in both comparisons, and is detailed in Section 7 of the EUROMET.M.P-K3.b Final Report. This makes it possible to extend the CCM.P-K1.c Matrices of equivalence to include the laboratories participant in EUROMET.M.P-K3.b only.

The numerical values for the degrees of equivalence are given hereinafter for the two nominal pressures close to 1 MPa and 4 MPa, only, and those calculated for other nominal pressures as well as the pair-wise degrees of equivalence between participants in EUROMET.M.P-K3.b can be found from Table 12 to 27 in the EUROMET.M.P-K3.b Final Report.

CCM.P-K1.c, Piston-Cylinder C-415

nominal p' / kPa	D_i / 10^{-6}	U_i / 10^{-6}	D_i / 10^{-6}	U_i / 10^{-6}	D_i / 10^{-6}	U_i / 10^{-6}	D_i / 10^{-6}	U_i / 10^{-6}	D_i / 10^{-6}	U_i / 10^{-6}
79.4	**4.2**	24.8	**0.6**	8.4	**2.3**	9.2	**-4.3**	18.0	**0.3**	18.2
137.8	**6.3**	21.2	**-1.0**	8.2	**1.7**	11.0	**-1.6**	17.6	**-2.2**	18.6
196.0	**-2.1**	24.8	**0.0**	7.8	**0.4**	10.8	**-1.2**	17.6	**1.2**	18.8
254.5	**-2.6**	24.2	**-0.4**	7.8	**0.1**	10.6	**-3.5**	17.8	**0.2**	19.2
312.8	**-0.5**	23.4	**2.5**	7.6	**0.9**	10.4	**-2.5**	18.0	**1.3**	19.6
429.5	**-1.3**	22.6	**2.8**	7.6	**1.1**	10.4	**-2.1**	17.8	**0.0**	20.2
546.2	**-2.6**	22.4	**3.3**	7.6	**1.9**	10.4	**-1.9**	17.8	**-1.4**	20.8
663.0	**-3.6**	22.0	**3.7**	7.6	**2.5**	10.4	**-1.7**	17.4	**1.4**	21.6
779.7	**-3.7**	22.4	**4.4**	7.6	**2.1**	10.4	**-2.0**	17.2	**0.1**	22.2
896.4	**-4.9**	22.0	**4.7**	7.6	**2.3**	10.4	**-1.9**	17.2	**-0.2**	22.8
	IMGC-CNR		**BNM-LNE**		**PTB**		**NRLM**		**NIST**	

CCM.P-K1.c, Piston-Cylinder V-762

nominal p' / kPa	D_i / 10^{-6}	U_i / 10^{-6}	D_i / 10^{-6}	U_i / 10^{-6}	D_i / 10^{-6}	U_i / 10^{-6}	D_i / 10^{-6}	U_i / 10^{-6}	D_i / 10^{-6}	U_i / 10^{-6}
621.7	**-1.0**	26.2	**-0.7**	17.0	**-1.9**	17.4	**-4.9**	20.6	**14.2**	22.6
738.5	**-5.6**	26.2	**-1.4**	16.0	**-0.8**	17.2	**-6.6**	20.6	**7.7**	22.8
1077.5	**-5.6**	26.2	**-2.9**	15.8	**0.4**	17.0	**-7.5**	20.6	**7.3**	22.8
1767.0	**-5.8**	30.0	**-4.7**	15.8	**2.8**	17.0	**-5.5**	20.8	**12.4**	23.0
2935.7	**-1.6**	29.8	**-3.1**	15.8	**7.3**	20.6	**-6.2**	21.0	**12.8**	24.4
4104.4	**-1.3**	29.8	**-2.2**	15.6	**7.1**	20.6	**-8.2**	21.2	**12.1**	26.2
5273.1	**-5.0**	30.0	**-2.0**	15.6	**5.2**	20.6	**-10.1**	21.6	**12.6**	29.0
6441.8	**-3.0**	30.2	**-2.8**	15.6	**3.6**	21.8	**-12.0**	22.2	**13.0**	32.2
6792.4	**-4.0**	31.4	**-3.2**	15.8	**3.1**	22.0	**-12.5**	22.2	**10.2**	33.2
	IMGC-CNR		**BNM-LNE**		**PTB**		**NMIJ**		**NIST**	

EUROMET.M.P-K2, Piston-cylinder DH 4994

nominal p' / MPa	D_i / 10^{-6}	U_i / 10^{-6}	D_i / 10^{-6}	U_i / 10^{-6}	D_i / 10^{-6}	U_i / 10^{-6}	D_i / 10^{-6}	U_i / 10^{-6}
1.0	**19**	44	**-13**	31	**1**	42	**-3**	31
4.0	**24**	43	**-12**	27	**-4**	41	**3**	29
	BEV		MIKES		CEM		SP/FFA	

APMP.M.P-K1.c, Piston-Cylinder V-407

nominal p' / MPa	D_i / 10^{-6}	U_i / 10^{-6}	D_i / 10^{-6}	U_i / 10^{-6}	D_i / 10^{-6}	U_i / 10^{-6}	D_i / 10^{-6}	U_i / 10^{-6}	D_i / 10^{-6}	U_i / 10^{-6}	D_i / 10^{-6}	U_i / 10^{-6}	D_i / 10^{-6}	U_i / 10^{-6}	D_i / 10^{-6}	U_i / 10^{-6}	D_i / 10^{-6}	U_i / 10^{-6}
1.21	**-5**	43	**-10**	36	**-11**	26	**-46**	61	**12**	65	**-8**	46	**-31**	39	**35**	42	**-24**	64
4.01	**-4**	43	**-4**	36	**-17**	26	**-48**	61	**13**	65	**-13**	46	**-28**	39	**25**	36	**-13**	48
	NPLI		KRISS		CSIRO-NML		MSL		SPRING Singapore		NML-SIRIM		SCL		CSIR-NML		NIS	

APMP.M.P-K1.c.1

nominal p' / MPa	D_i / 10^{-6}	U_i / 10^{-6}	D_i / 10^{-6}	U_i / 10^{-6}
1.21	**0**	51	**20**	44
4.01	**-11**	51	**20**	41
	CMS/ITRI		NIMT	

EUROMET.M.P-K3.b, Piston-Cylinder V-832

nominal p' / kPa	D_i / 10^{-6}	U_i / 10^{-6}	D_i / 10^{-6}	U_i / 10^{-6}	D_i / 10^{-6}	U_i / 10^{-6}	D_i / 10^{-6}	U_i / 10^{-6}	D_i / 10^{-6}	U_i / 10^{-6}	D_i / 10^{-6}	U_i / 10^{-6}	D_i / 10^{-6}	U_i / 10^{-6}	D_i / 10^{-6}	U_i / 10^{-6}	D_i / 10^{-6}	U_i / 10^{-6}	D_i / 10^{-6}	U_i / 10^{-6}
1078	**30.1**	121.9	**7.1**	21.7	**-4.3**	21.9	**20.7**	22.3	**10.3**	39.5	**-7.7**	33.2	**5.3**	33.6	**2.8**	40.5	**7.7**	34.9	**56.8**	91.1
4107	**8.2**	61.1	**-2.4**	24.0	**-19.3**	25.7	**7.2**	26.5	**-9.7**	41.1	**-35.2**	34.9	**-6.6**	35.4	**-7.0**	42.0	**-16.4**	36.6	**40.0**	91.8
	FORCE		MIKES		NPL		UME		SMU		NSAI-NML		GUM		MKEH		NMISA		BIM	

DEGREES OF EQUIVALENCE BETWEEN PAIRS OF LABORATORIES

CCM.P-K1.c, C-415 unit $p' = 79.4$ kPa **Lab *j*** ⇨

Lab *i* ⇩

	IMGC-CNR		BNM-LNE		PTB		NMIJ		NIST	
	D_{ij} / 10^{-6}	U_{ij} / 10^{-6}	D_{ij} / 10^{-6}	U_{ij} / 10^{-6}	D_{ij} / 10^{-6}	U_{ij} / 10^{-6}	D_{ij} / 10^{-6}	U_{ij} / 10^{-6}	D_{ij} / 10^{-6}	U_{ij} / 10^{-6}
IMGC-CNR			**3.7**	25.4	**1.9**	25.6	**8.6**	29.8	**3.9**	30.2
BNM-LNE	**-3.7**	25.4			**-1.8**	11.2	**4.9**	18.8	**0.2**	19.2
PTB	**-1.9**	25.6	**1.8**	11.2			**6.7**	19.2	**2.0**	19.6
NMIJ	**-8.6**	29.8	**-4.9**	18.8	**-6.7**	19.2			**-4.6**	24.8
NIST	**-3.9**	30.2	**-0.2**	19.2	**-2.0**	19.6	**4.6**	24.8		

CCM.P-K1.c, C-415 unit $p' = 429.5$ kPa **Lab *j*** ⇨

Lab *i* ⇩

	IMGC-CNR		BNM-LNE		PTB		NMIJ		NIST	
	D_{ij} 10^{-6}	U_{ij} 10^{-6}	D_{ij} 10^{-6}	U_{ij} 10^{-6}	D_{ij} 10^{-6}	U_{ij} 10^{-6}	D_{ij} / 10^{-6}	U_{ij} / 10^{-6}	D_{ij} 10^{-6}	U_{ij} 10^{-6}
IMGC-CNR			**-4.0**	23.2	**-2.4**	24.0	**0.8**	28.0	**-1.3**	29.6
BNM-LNE	**4.0**	23.2			**1.7**	11.6	**4.9**	18.4	**2.7**	20.8
PTB	**2.4**	24.0	**-1.7**	11.6			**3.2**	19.8	**1.1**	22.0
NMIJ	**-0.8**	28.0	**-4.9**	18.4	**-3.2**	19.8			**-2.1**	26.4
NIST	**1.3**	29.6	**-2.7**	20.8	**-1.1**	22.0	**2.1**	26.4		

CCM.P-K1.c, C-415 unit $p' = 896.4$ kPa **Lab *j*** ⇨

Lab *i* ⇩

	IMGC-CNR		BNM-LNE		PTB		NMIJ		NIST	
	D_{ij} / 10^{-6}	U_{ij} / 10^{-6}	D_{ij} / 10^{-6}	U_{ij} / 10^{-6}	D_{ij} / 10^{-6}	U_{ij} / 10^{-6}	D_{ij} / 10^{-6}	U_{ij} / 10^{-6}	D_{ij} / 10^{-6}	U_{ij} / 10^{-6}
IMGC-CNR			**-9.6**	22.6	**-7.3**	23.6	**-3.1**	27.2	**-4.8**	31.0
BNM-LNE	**9.6**	22.6			**2.4**	11.6	**6.5**	17.8	**4.9**	23.2
PTB	**7.3**	23.6	**-2.4**	11.6			**4.2**	19.2	**2.5**	24.4
NMIJ	**3.1**	27.2	**-6.5**	17.8	**-4.2**	19.2			**-1.7**	27.8
NIST	**4.8**	31.0	**-4.9**	23.2	**-2.5**	24.4	**1.7**	27.8		

CCM.P-K1.c, V-762 unit p' = 621.7 kPa Lab *j* ⇨

Lab *i* ⇩

	IMGC-CNR		BNM-LNE		PTB		NMIJ		NIST	
	D_{ij} 10^{-6}	U_{ij} 10^{-6}	D_{ij} 10^{-6}	U_{ij} 10^{-6}	D_{ij} 10^{-6}	U_{ij} 10^{-6}	D_{ij} / 10^{-6}	U_{ij} / 10^{-6}	D_{ij} 10^{-6}	U_{ij} 10^{-6}
IMGC-CNR			**-0.2**	24.4	**0.95**	24.6	**3.9**	27.0	**-15.1**	28.4
BNM-LNE	**0.2**	24.4			**1.2**	14.4	**4.2**	18.4	**-14.9**	20.4
PTB	**-0.95**	24.6	**-1.2**	14.4			**3.0**	18.6	**-16.0**	20.6
NMIJ	**-3.9**	27.0	**-4.2**	18.4	**-3.0**	18.6			**-19.0**	23.6
NIST	**15.1**	28.4	**14.9**	20.4	**16.0**	20.6	**19.0**	23.6		

CCM.P-K1.c, V-762 unit p' = 6792.4 kPa Lab *j* ⇨

Lab *i* ⇩

	IMGC-CNR		BNM-LNE		PTB		NMIJ		NIST	
	D_{ij} 10^{-6}	U_{ij} 10^{-6}	D_{ij} 10^{-6}	U_{ij} 10^{-6}	D_{ij} 10^{-6}	U_{ij} 10^{-6}	D_{ij} / 10^{-6}	U_{ij} / 10^{-6}	D_{ij} 10^{-6}	U_{ij} 10^{-6}
IMGC-CNR			**-0.8**	29.2	**-7.2**	33.0	**8.5**	33.2	**-14.2**	41.2
BNM-LNE	**0.8**	29.2			**-6.3**	18.8	**9.3**	19.2	**-13.4**	31.2
PTB	**7.2**	33.0	**6.3**	18.8			**15.6**	24.6	**-7.0**	34.8
NMIJ	**-8.5**	33.2	**-9.3**	19.2	**-15.6**	24.6			**-22.6**	35.0
NIST	**14.2**	41.2	**13.4**	31.2	**7.0**	34.8	**22.6**	35.0		

DEGREES OF EQUIVALENCE BETWEEN PAIRS OF LABORATORIES

CCM.P-K1.c, V-762 unit, p' = 1077.5 kPa — **EUROMET.M.P-K1.c, DH-4994 unit, p_e = 1.0 MPa** — **APMP.M.P-K1.c, V-407 unit, p' = 1.21 MPa**

Lab i (rows) ⇩, Lab j (columns) ⇨

Lab i	IMGC-CNR		BNM-LNE		PTB		NMIJ		NIST	
	D_{ij} / 10^{-6}	U_{ij} / 10^{-6}	D_{ij} / 10^{-6}	U_{ij} / 10^{-6}	D_{ij} / 10^{-6}	U_{ij} / 10^{-6}	D_{ij} / 10^{-6}	U_{ij} / 10^{-6}	D_{ij} / 10^{-6}	U_{ij} / 10^{-6}
IMGC-CNR			**-3**	24	**-6**	25	**2**	27	**-13**	29
BNM-LNE	**3**	24			**-3**	13	**5**	17	**-10**	20
PTB	**6**	25	**3**	13			**8**	18	**-7**	21
NMIJ	**-2**	27	**-5**	17	**-8**	18			**15**	24
NIST	**13**	29	**10**	20	**7**	21	**-15**	24		
BEV	**25**	51	**22**	47	**19**	47	**27**	49	**12**	50
MIKES	**-7**	41	**-10**	35	**-13**	35	**-6**	37	**-20**	38
CEM	**7**	50	**4**	45	**1**	45	**9**	47	**-6**	48
SP/FFA	**3**	41	**0**	35	**-3**	35	**5**	37	**-10**	38
NPLI	**1**	50	**-2**	46	**-5**	46	**3**	48	**-12**	49
KRISS	**-4**	44	**-7**	39	**-10**	40	**-2**	41	**-17**	42
CSIRO-NML	**-5**	37	**-8**	31	**-11**	31	**-3**	33	**-18**	35
MSL	**-40**	67	**-43**	63	**-46**	64	**-38**	65	**-53**	65
SPRING*	**18**	70	**15**	67	**12**	67	**20**	68	**5**	69
NML-SIRIM	**-2**	53	**-5**	49	**-8**	49	**0**	51	**-15**	52
SCL	**-25**	47	**-28**	42	**-31**	42	**-23**	44	**-38**	45
CSIR-NML	**41**	49	**38**	45	**35**	45	**43**	47	**28**	48
NIS	**-18**	69	**-21**	66	**-24**	66	**-16**	67	**-31**	68

Lab i	BEV		MIKES		CEM		SP/FFA	
	D_{ij} / 10^{-6}	U_{ij} / 10^{-6}	D_{ij} / 10^{-6}	U_{ij} / 10^{-6}	D_{ij} / 10^{-6}	U_{ij} / 10^{-6}	D_{ij} / 10^{-6}	U_{ij} / 10^{-6}
IMGC-CNR	**-25**	51	**7**	41	**-7**	50	**-3**	41
BNM-LNE	**-22**	47	**10**	35	**-4**	45	**0**	35
PTB	**-19**	47	**13**	35	**-1**	45	**3**	35
NMIJ	**-27**	49	**6**	37	**-9**	47	**-5**	37
NIST	**-12**	50	**20**	38	**6**	48	**10**	38
BEV			**32**	47	**18**	55	**22**	47
MIKES	**-32**	47			**-14**	45	**-10**	35
CEM	**-18**	55	**14**	45			**4**	45
SP/FFA	**-22**	47	**10**	35	**-4**	45		
NPLI	**-24**	61	**8**	53	**-6**	60	**-2**	53
KRISS	**-29**	57	**3**	47	**-11**	55	**-7**	47
CSIRO-NML	**-30**	51	**2**	41	**-12**	50	**-8**	41
MSL	**-65**	75	**-33**	69	**-47**	74	**-43**	69
SPRING*	**-7**	78	**25**	72	**11**	77	**15**	72
NML-SIRIM	**-27**	64	**5**	56	**-9**	63	**-5**	56
SCL	**-50**	59	**-18**	50	**-32**	57	**-28**	50
CSIR-NML	**16**	61	**48**	52	**34**	59	**38**	52
NIS	**-43**	78	**-11**	71	**-25**	77	**-21**	71

Lab i	NPLI		KRISS		CSIRO-NML		MSL		SPRING*		NML-SIRIM		SCL		CSIR-NML		NIS	
	D_{ij} / 10^{-6}	U_{ij} / 10^{-6}	D_{ij} / 10^{-6}	U_{ij} / 10^{-6}	D_{ij} / 10^{-6}	U_{ij} / 10^{-6}	D_{ij} / 10^{-6}	U_{ij} / 10^{-6}	D_{ij} / 10^{-6}	U_{ij} / 10^{-6}	D_{ij} / 10^{-6}	U_{ij} / 10^{-6}	D_{ij} / 10^{-6}	U_{ij} / 10^{-6}	D_{ij} / 10^{-6}	U_{ij} / 10^{-6}	D_{ij} / 10^{-6}	U_{ij} / 10^{-6}
IMGC-CNR	**-1**	50	**4**	44	**5**	37	**40**	67	**-18**	70	**2**	53	**25**	47	**-41**	49	**18**	69
BNM-LNE	**2**	46	**7**	39	**8**	31	**43**	63	**-15**	67	**5**	49	**28**	42	**-38**	45	**21**	66
PTB	**5**	46	**10**	40	**11**	31	**46**	64	**-12**	67	**8**	49	**31**	42	**-35**	45	**24**	66
NMIJ	**-3**	48	**2**	41	**3**	33	**38**	65	**-20**	68	**0**	51	**23**	44	**-43**	47	**16**	67
NIST	**12**	49	**17**	42	**18**	35	**53**	65	**-5**	69	**15**	52	**38**	45	**-28**	48	**31**	68
BEV	**24**	61	**29**	57	**30**	51	**65**	75	**7**	78	**27**	64	**50**	59	**-16**	61	**43**	78
MIKES	**-8**	53	**-3**	47	**-2**	41	**33**	69	**-25**	72	**-5**	56	**18**	50	**-48**	52	**11**	71
CEM	**6**	60	**11**	55	**12**	50	**47**	74	**-11**	77	**9**	63	**32**	57	**-34**	59	**25**	77
SP/FFA	**2**	53	**7**	47	**8**	41	**43**	69	**-15**	72	**5**	56	**28**	50	**-38**	52	**21**	71
NPLI			**6**	54	**6**	48	**41**	73	**-17**	76	**3**	61	**27**	55	**-40**	58	**20**	75
KRISS	**-6**	54			**1**	42	**35**	69	**-23**	72	**-2**	57	**21**	50	**-45**	53	**14**	72
CSIRO-NML	**-6**	48	**-1**	42			**35**	65	**-23**	68	**-3**	51	**20**	44	**-46**	47	**-21**	67
MSL	**-41**	73	**-35**	69	**-35**	65			**-58**	88	**-38**	75	**-14**	71	**-81**	73	**-21**	87
SPRING*	**17**	76	**23**	72	**23**	68	**58**	88			**20**	78	**44**	74	**-23**	76	**36**	90
NML-SIRIM	**-3**	61	**2**	57	**3**	51	**38**	75	**-20**	78			**23**	58	**-43**	61	**16**	78
SCL	**-27**	55	**-21**	50	**-20**	44	**14**	71	**-44**	74	**-23**	58			**-66**	55	**-7**	73
CSIR-NML	**40**	58	**45**	53	**46**	47	**81**	73	**23**	76	**43**	61	**66**	55			**59**	90
NIS	**-20**	75	**-14**	72	**21**	67	**21**	87	**-36**	90	**-16**	78	**7**	73	**-59**	90		

***SPRING stands for SPRING Singapore**

DEGREES OF EQUIVALENCE BETWEEN PAIRS OF LABORATORIES

CCM.P-K1.c, V-762 unit, p' = 4104.4 kPa **EUROMET.M.P-K2, DH 4994 unit, p_e = 4.0 MPa** **APMP.M.P-K1.c, V-407 unit, p' = 4.01 MPa**

Lab j ⇒

Lab i ⇓

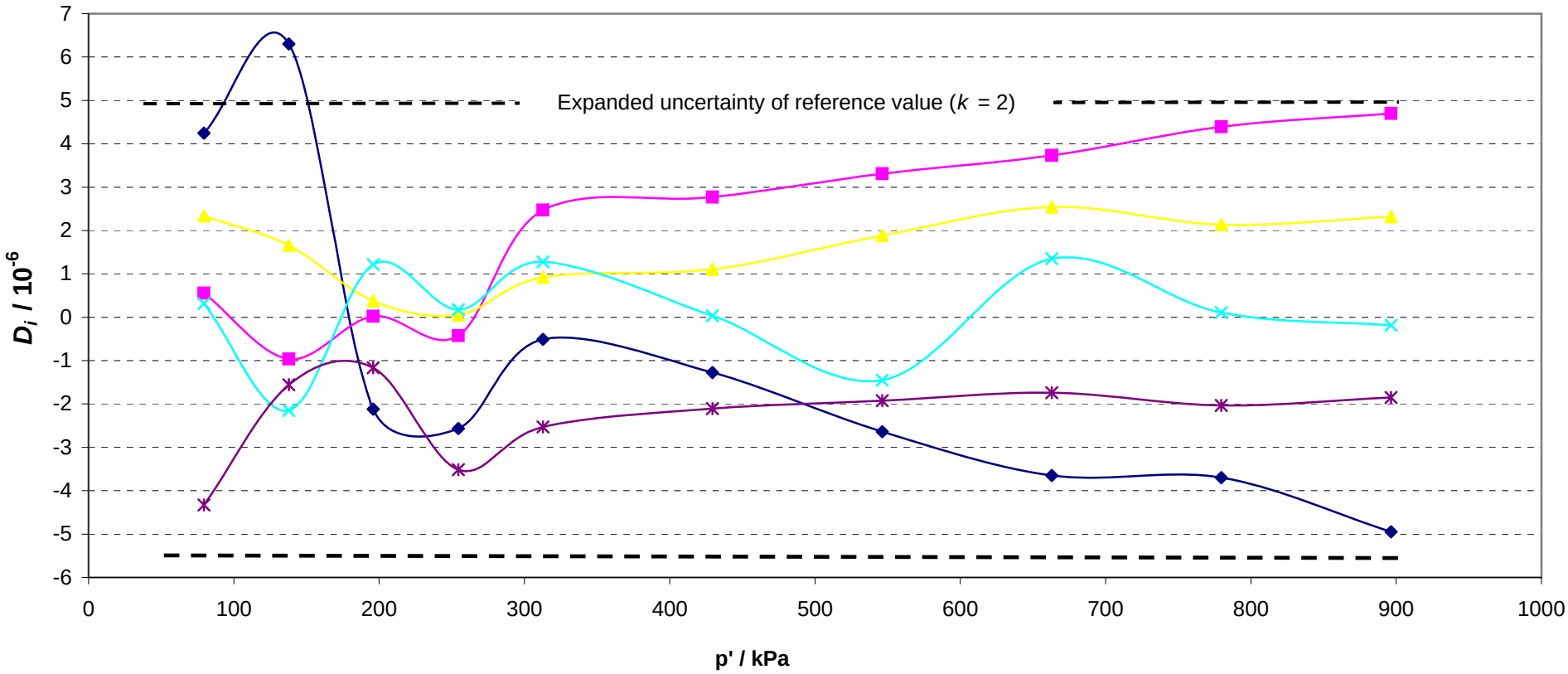
Lab i	IMGC-CNR D_{ij} / 10^{-6}	IMGC-CNR U_{ij} / 10^{-6}	BNM-LNE D_{ij} / 10^{-6}	BNM-LNE U_{ij} / 10^{-6}	PTB D_{ij} / 10^{-6}	PTB U_{ij} / 10^{-6}	NMIJ D_{ij} / 10^{-6}	NMIJ U_{ij} / 10^{-6}	NIST D_{ij} / 10^{-6}	NIST U_{ij} / 10^{-6}
IMGC-CNR			**0.95**	27.6	**-8.3**	30.6	**6.9**	31.0	**-13.4**	35.8
BNM-LNE	**-0.95**	27.6			**-9.3**	17.0	**6.0**	17.8	**-14.3**	23.6
PTB	**8.3**	30.6	**9.3**	17.0			**15.3**	22.4	**-5.0**	27.2
NMIJ	**-6.9**	31.0	**-6.0**	17.8	**-15.3**	22.4			**-20.3**	27.6
NIST	**13.4**	35.8	**14.3**	23.6	**5.0**	27.2	**20.3**	27.6		
BEV	**25**	52	**26**	46	**17**	48	**32**	48	**12**	50
MIKES	**-11**	40	**-10**	31	**-19**	34	**-4**	34	**-24**	38
CEM	**-3**	51	**-2**	44	**-11**	46	**4**	46	**-16**	49
SP/FFA	**4**	42	**5**	33	**-4**	36	**11**	36	**-9**	39
NPLI	**-3**	52	**-2**	46	**-11**	47	**4**	48	**-16**	50
KRISS	**-3**	47	**-2**	39	**-11**	41	**4**	42	**-16**	44
CSIRO-NML	**-16**	40	**-15**	31	**-25**	33	**-9**	34	**-30**	37
MSL	**-47**	68	**-46**	63	**-55**	65	**-40**	65	**-60**	67
SPRING*	**14**	71	**15**	67	**6**	68	**21**	68	**1**	70
NML-SIRIM	**-12**	55	**-11**	49	**-21**	51	**-5**	51	**-26**	53
SCL	**-27**	49	**-26**	42	**-35**	44	**-20**	44	**-40**	47
CSIR-NML	**26**	47	**27**	39	**18**	42	**33**	42	**13**	45
NIS	**-12**	57	**-11**	51	**-21**	52	**-5**	53	**-26**	55

Lab i	BEV D_{ij} / 10^{-6}	BEV U_{ij} / 10^{-6}	MIKES D_{ij} / 10^{-6}	MIKES U_{ij} / 10^{-6}	CEM D_{ij} / 10^{-6}	CEM U_{ij} / 10^{-6}	SP/FFA D_{ij} / 10^{-6}	SP/FFA U_{ij} / 10^{-6}
IMGC-CNR	**-25**	52	**11**	40	**3**	51	**-4**	42
BNM-LNE	**-26**	46	**10**	31	**2**	44	**-5**	33
PTB	**-17**	48	**19**	34	**11**	46	**4**	36
NMIJ	**-32**	48	**4**	34	**-4**	46	**-11**	36
NIST	**-12**	50	**24**	38	**16**	49	**9**	39
BEV			**36**	46	**28**	55	**21**	47
MIKES	**-36**	46			**-8**	44	**-15**	33
CEM	**-28**	55	**8**	44			**-7**	45
SP/FFA	**-21**	47	**15**	33	**7**	45		
NPLI	**-28**	61	**8**	51	**0**	59	**-7**	52
KRISS	**-28**	56	**8**	45	**0**	54	**-7**	46
CSIRO-NML	**-41**	50	**-5**	38	**-13**	49	**-20**	39
MSL	**-72**	75	**-36**	67	**-44**	74	**-51**	68
SPRING*	**-11**	78	**25**	70	**17**	77	**10**	71
NML-SIRIM	**-37**	63	**-1**	54	**-9**	62	**-16**	55
SCL	**-52**	58	**-16**	47	**-24**	56	**-31**	48
CSIR-NML	**1**	56	**37**	45	**29**	55	**22**	46
NIS	**-37**	65	**-1**	55	**-9**	63	**-16**	56

Lab i	NPLI D_{ij} / 10^{-6}	NPLI U_{ij} / 10^{-6}	KRISS D_{ij} / 10^{-6}	KRISS U_{ij} / 10^{-6}	CSIRO-NML D_{ij} / 10^{-6}	CSIRO-NML U_{ij} / 10^{-6}	MSL D_{ij} / 10^{-6}	MSL U_{ij} / 10^{-6}	SPRING D_{ij} / 10^{-6}	SPRING U_{ij} / 10^{-6}	NML-SIRIM D_{ij} / 10^{-6}	NML-SIRIM U_{ij} / 10^{-6}	SCL D_{ij} / 10^{-6}	SCL U_{ij} / 10^{-6}	CSIR-NML D_{ij} / 10^{-6}	CSIR-NML U_{ij} / 10^{-6}	NIS D_{ij} / 10^{-6}	NIS U_{ij} / 10^{-6}
IMGC-CNR	**3**	52	**3**	47	**16**	40	**47**	68	**-14**	71	**12**	55	**27**	49	**-26**	47	**12**	57
BNM-LNE	**2**	46	**2**	39	**15**	31	**46**	63	**-15**	67	**11**	49	**26**	42	**-27**	39	**11**	51
PTB	**11**	47	**11**	41	**25**	33	**55**	65	**-6**	68	**21**	51	**35**	44	**-18**	42	**21**	52
NMIJ	**-4**	48	**-4**	42	**9**	34	**40**	65	**-21**	68	**5**	51	**20**	44	**-33**	42	**5**	53
NIST	**16**	50	**16**	44	**30**	37	**60**	67	**-1**	70	**26**	53	**40**	47	**-13**	45	**26**	55
BEV	**28**	61	**28**	56	**41**	50	**72**	75	**11**	78	**37**	63	**52**	58	**-1**	56	**37**	65
MIKES	**-8**	51	**-8**	45	**5**	38	**36**	67	**-25**	70	**1**	54	**16**	47	**-37**	45	**1**	55
CEM	**0**	59	**0**	54	**13**	49	**44**	74	**-17**	77	**9**	62	**24**	56	**-29**	55	**9**	63
SP/FFA	**7**	52	**7**	46	**20**	39	**51**	68	**-10**	71	**16**	55	**31**	48	**-22**	46	**16**	56
NPLI			**0**	54	**14**	48	**44**	73	**-17**	76	**10**	61	**24**	55	**-29**	54	**10**	63
KRISS	**0**	54			**13**	42	**44**	69	**-17**	72	**9**	57	**24**	50	**-29**	48	**9**	58
CSIRO-NML	**-14**	48	**-13**	42			**31**	65	**-30**	68	**-4**	51	**11**	44	**-43**	42	**-35**	53
MSL	**-44**	73	**-44**	69	**-31**	65			**-61**	88	**-35**	75	**-20**	71	**-73**	69	**-35**	76
SPRING*	**17**	76	**17**	72	**30**	68	**61**	88			**26**	78	**41**	74	**-12**	73	**26**	79
NML-SIRIM	**-10**	61	**-9**	57	**4**	51	**35**	75	**-26**	78			**15**	58	**-39**	57	**0**	65
SCL	**-24**	55	**-24**	50	**-11**	44	**20**	71	**-41**	74	**-15**	58			**-53**	51	**-15**	60
CSIR-NML	**29**	54	**29**	48	**43**	42	**73**	69	**12**	73	**39**	57	**53**	51			**39**	79
NIS	**-10**	63	**-9**	58	**35**	53	**35**	76	**-26**	79	**0**	65	**15**	60	**-39**	79		

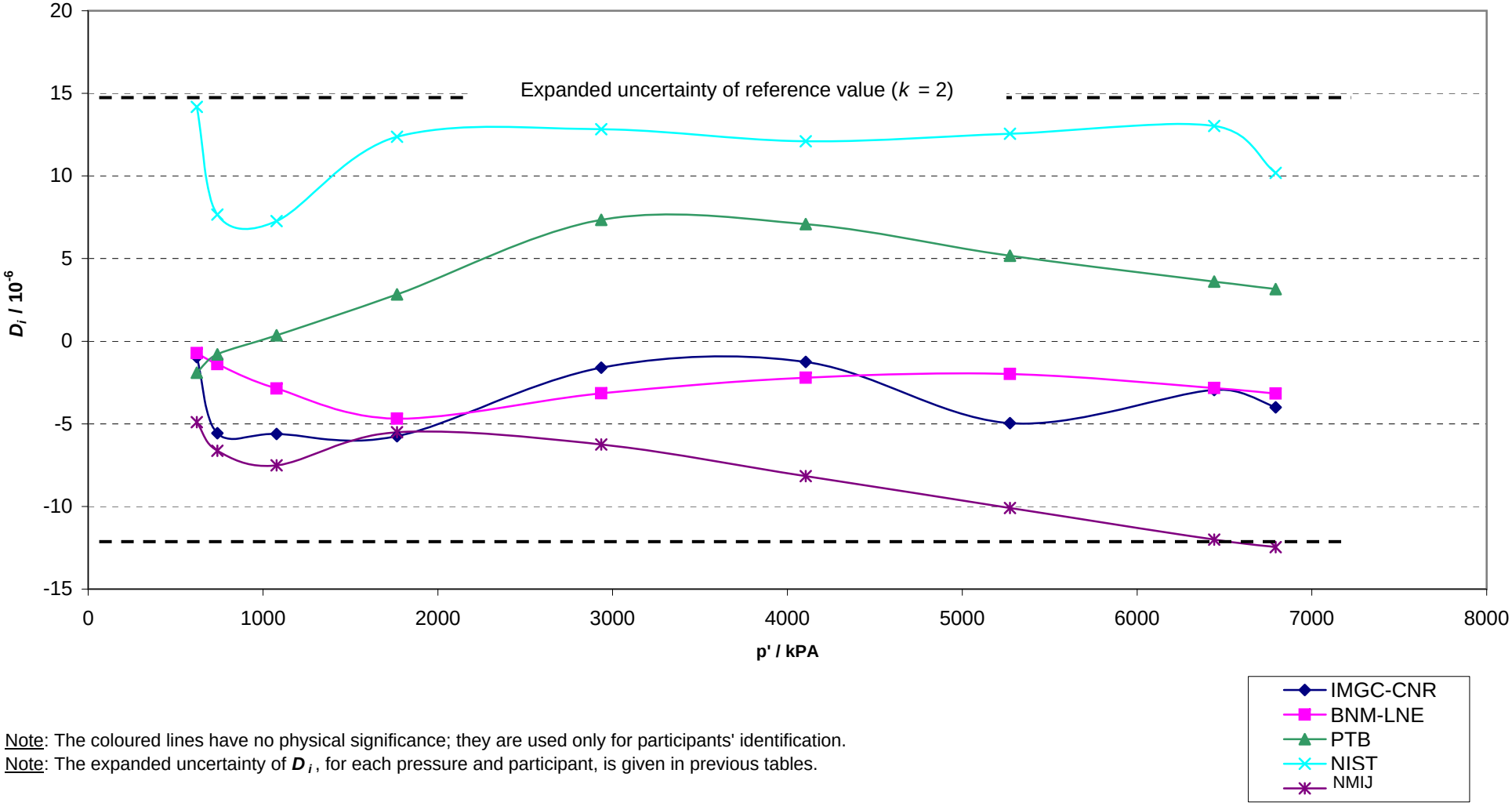
***SPRING stands for SPRING Singapore**

CCM.P-K1.c, C-415 piston-cylinder
Degrees of equivalence
$D_i = (x_i - x_R) / x_R$ versus p'

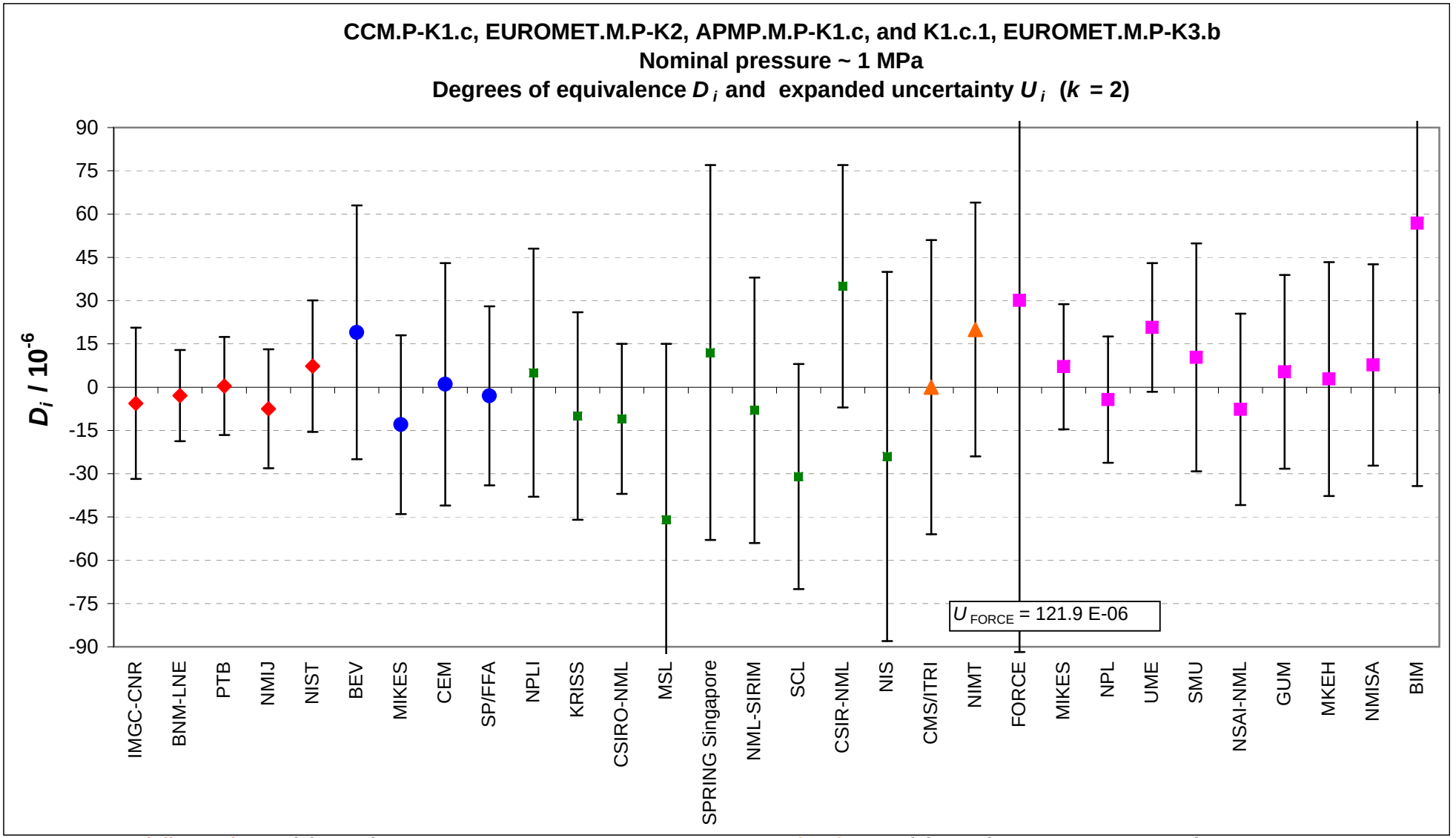


Note: The coloured lines have no physical significance; they are used only for participants' identification.
Note: The expanded uncertainty of D_i, for each pressure and participant, is given in previous tables.

CCM.P-K1.c, V-762 piston-cylinder
Degrees of equivalence
$D_i = (x_i - x_R) / x_R$ versus p'



Note: The coloured lines have no physical significance; they are used only for participants' identification.
Note: The expanded uncertainty of D_i, for each pressure and participant, is given in previous tables.



Red diamonds: participants in CCM.P-K1.c

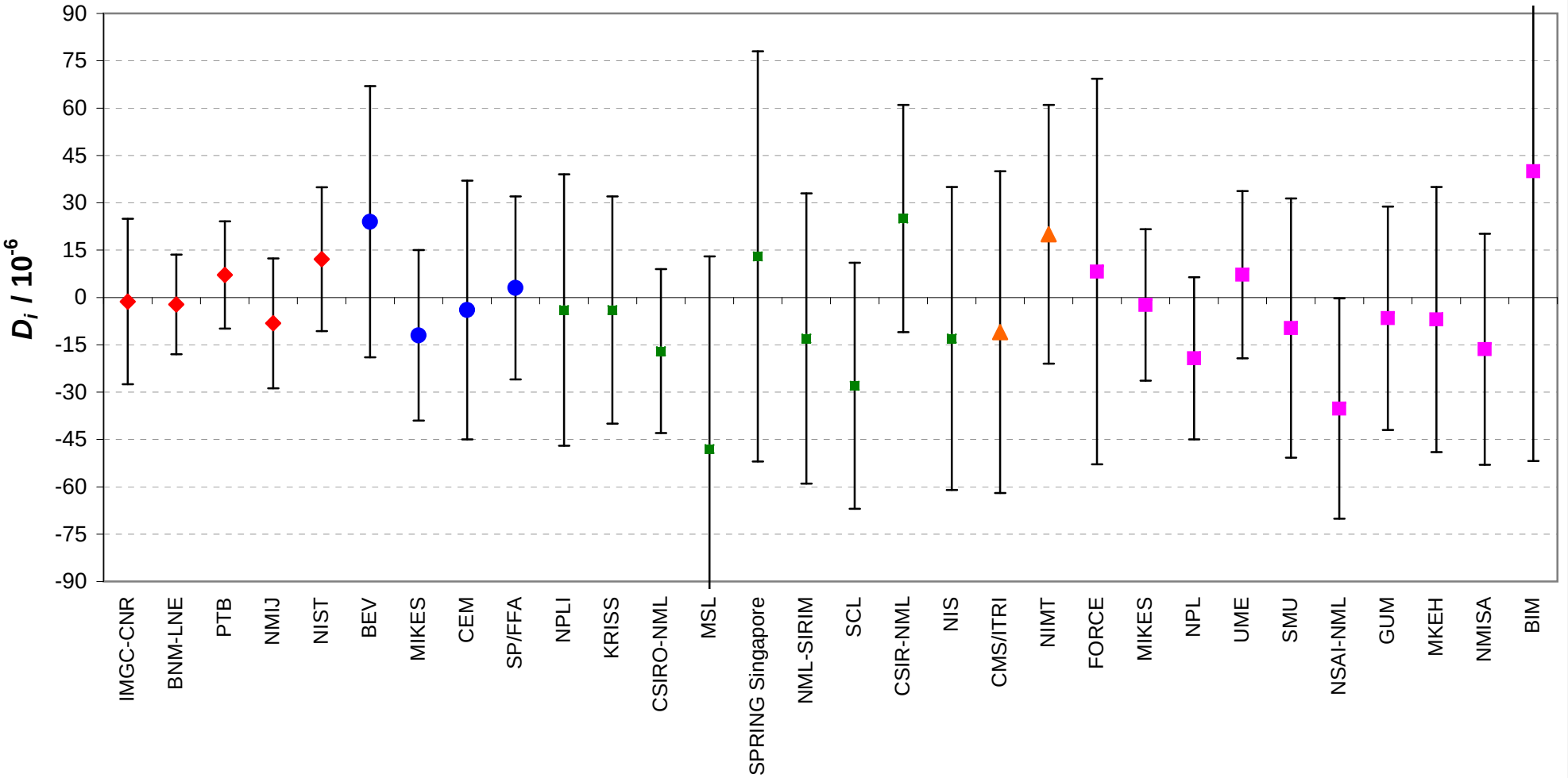
Blue circles: participants in EUROMET.M.P-K2 only

Green squares: participants in APMP.M.P-K1.c only

Orange triangles: participants in APMP.M.P-K1.c.1 only

Pink squares: participants in EUROMET.M.P-K3.b only

CCM.P-K1.c, EUROMET.M.P-K2, APMP.M.P-K1.c, and K1.c.1, EUROMET.M.P-K3.b
Nominal pressure ~ 4 MPa
Degrees of equivalence D_i and expanded uncertainty U_i (k = 2)



Red diamonds: participants in CCM.P-K1.c
Blue circles: participants in EUROMET.M.P-K2 only
Green squares: participants in APMP.M.P-K1.c only
Orange triangles: participants in APMP.M.P-K1.c.1 only
Pink squares: participants in EUROMET.M.P-K3.b only