Report of the CCM WG Force

14th CCM Meeting at BIPM in February 2013

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Meetings of CCM WG Force

Last Meeting of CCM WG Force at NIM (China) 2011

Most of the technical discussions in the meeting were related to force standards and focused on the improvement in the stability and reproducibility of force transducers, torque measurement standards. In the last few years, the plan for the torque measurement standard was successfully conducted and the first comparisons were completed.

Planned: Next CCM WG Force Meeting in 2014

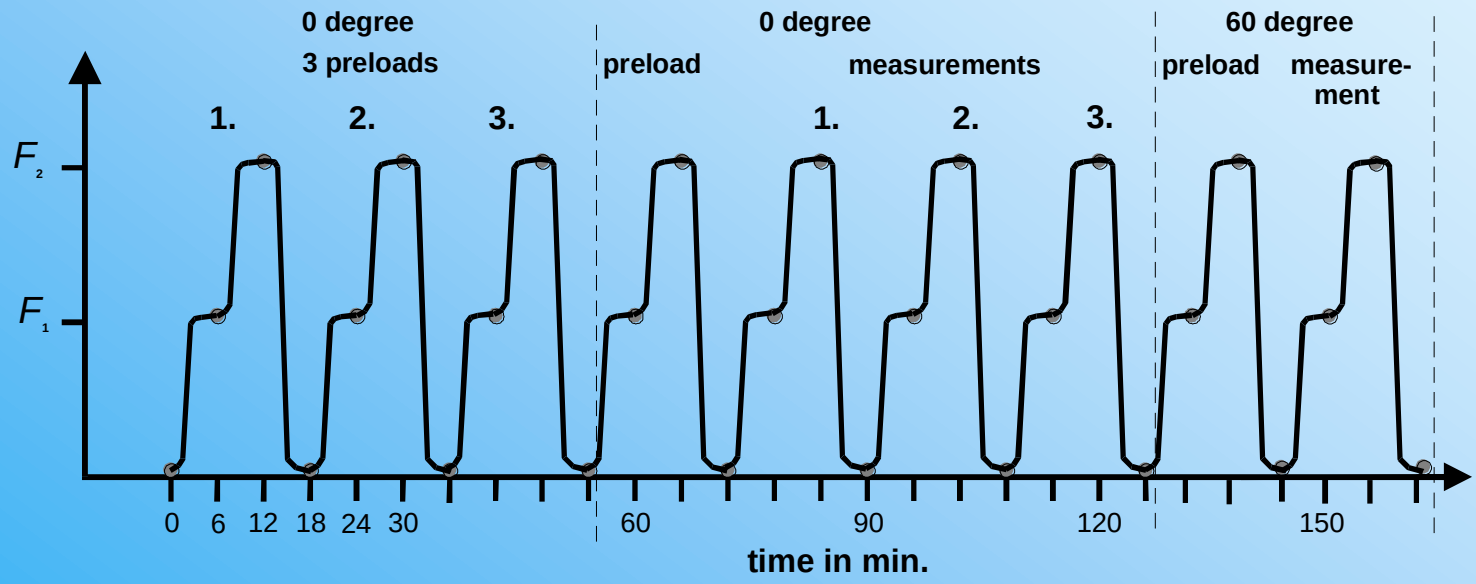
Terms of Reference of CCM WG Force (Draft)

- To improve techniques for realizing the SI unit of force and torque;
- To exchange information on the force and torque standard;
- To organize and perform CIPM key comparisons for supporting the CIPM MRA on force and torque;
- To coordinate RMO key and supplementary comparisons for accelerating the CIPM MRA in the field of force and torque;
- To provide guidance to accept CMCs on force and torque;
- To coordinate activities for force and torque measurements at NMIs; and
- To assess needs and seeds on metrology for force and torque.
- To advise the CCM on matters relating to force and torque;
- To improve harmonization of primary standards and organizing pilot studies;
- To maintain good links and interface with the force and torque community (IMEKO TC3); and
- To provide formal liaison among organizations involved in the standardisation (ISO TC164/SC 1 and SC 5).
- To collect the needs and the difficulties which may happen in drafting and validating the CMCs;
- To watch and anticipate for future needs of society; and
- To be a forum of exchanges between the force and torque experts of NIMs, through the RMOs.

CIPM + RMO Force and torque key comparison

Measurement sequence of laboratory group A :

Two force steps (50 % and 100%).



1 preload +
1 measurement
cycle in position

60°	60°
120°	120°
180°	180°
240°	240°
300°	300°
360°/0°	360°
1.rotation	2.rotation

Deflection = reading - zero signal

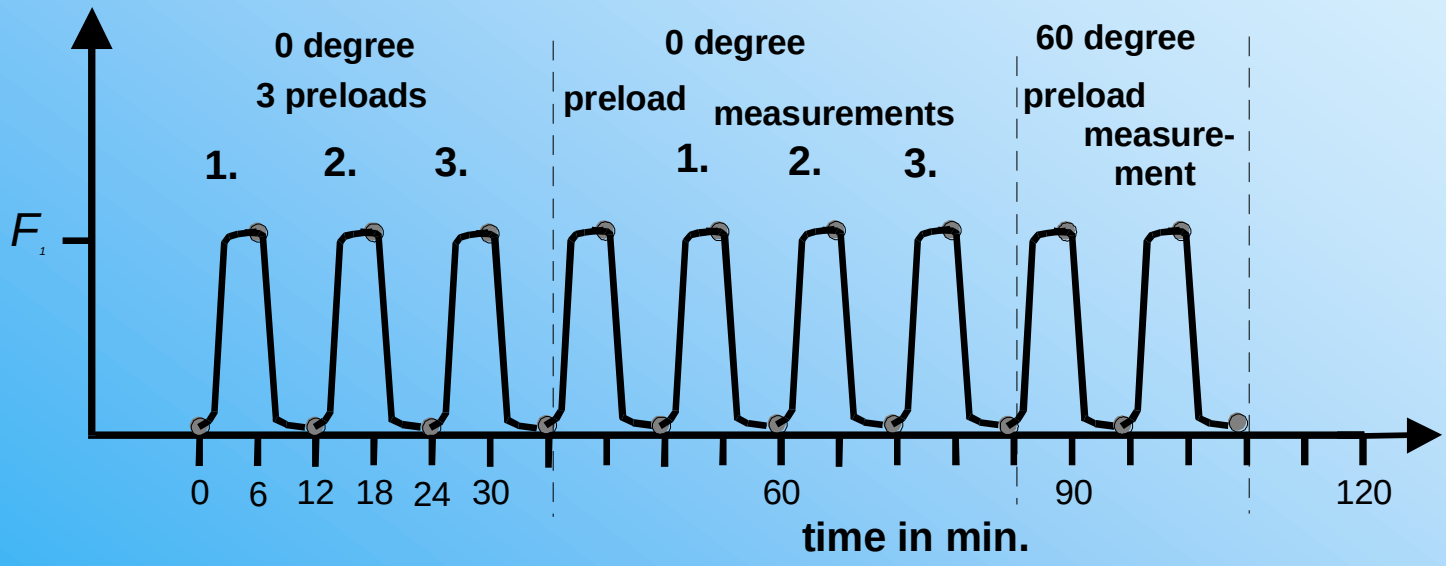
3 measurements in 0 degree positions => repeatability

12 measurements from 60 to 360 degree positions => mean value + reproducibility

CIPM + RMO Force and torque key comparison

Measurement sequence of laboratory group B :

Measurement sequence as for laboratory group A, but only one force step (50 %).



1 preload + 1 measurement cycle in position	
60°	60°
120°	120°
180°	180°
240°	240°
300°	300°
360°/0°	360°
1.rotation	2.rotation

Deflection = reading - zero signal

3 measurements in 0 degree positions => repeatability

12 measurements from 60 to 360 degree positions => mean value + reproducibility

KCs in the field of force:

Final agreement and publication of the following KCs:

- **CCM.F-K1.a (load cell up to 10 kN) and .b (up to 5 kN),**
- **CCM.F-K2.a (load cell up to 100 kN) and .b (up to 50 kN),**
- **CCM.F-K4.a (load cell up to 4 MN) and .b (up to 2 MN)**

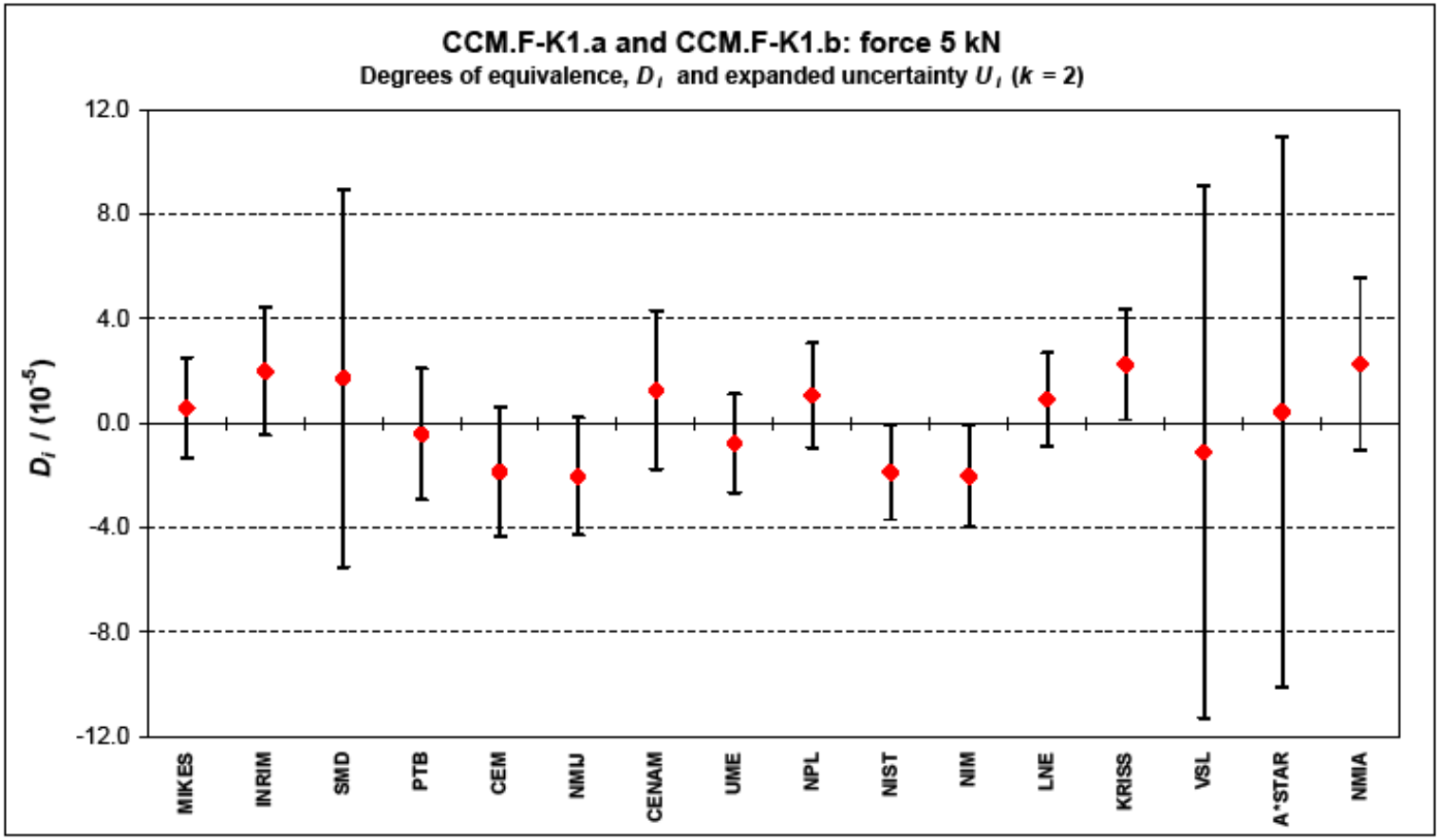
- **CCM.F-K5 to CCM.F-K22, which had been conducted in the past, were all approved for provisional equivalence as key comparisons.**

The following KCs are underway and should be finished and

agreed next CCM WG Force meeting in 2014:

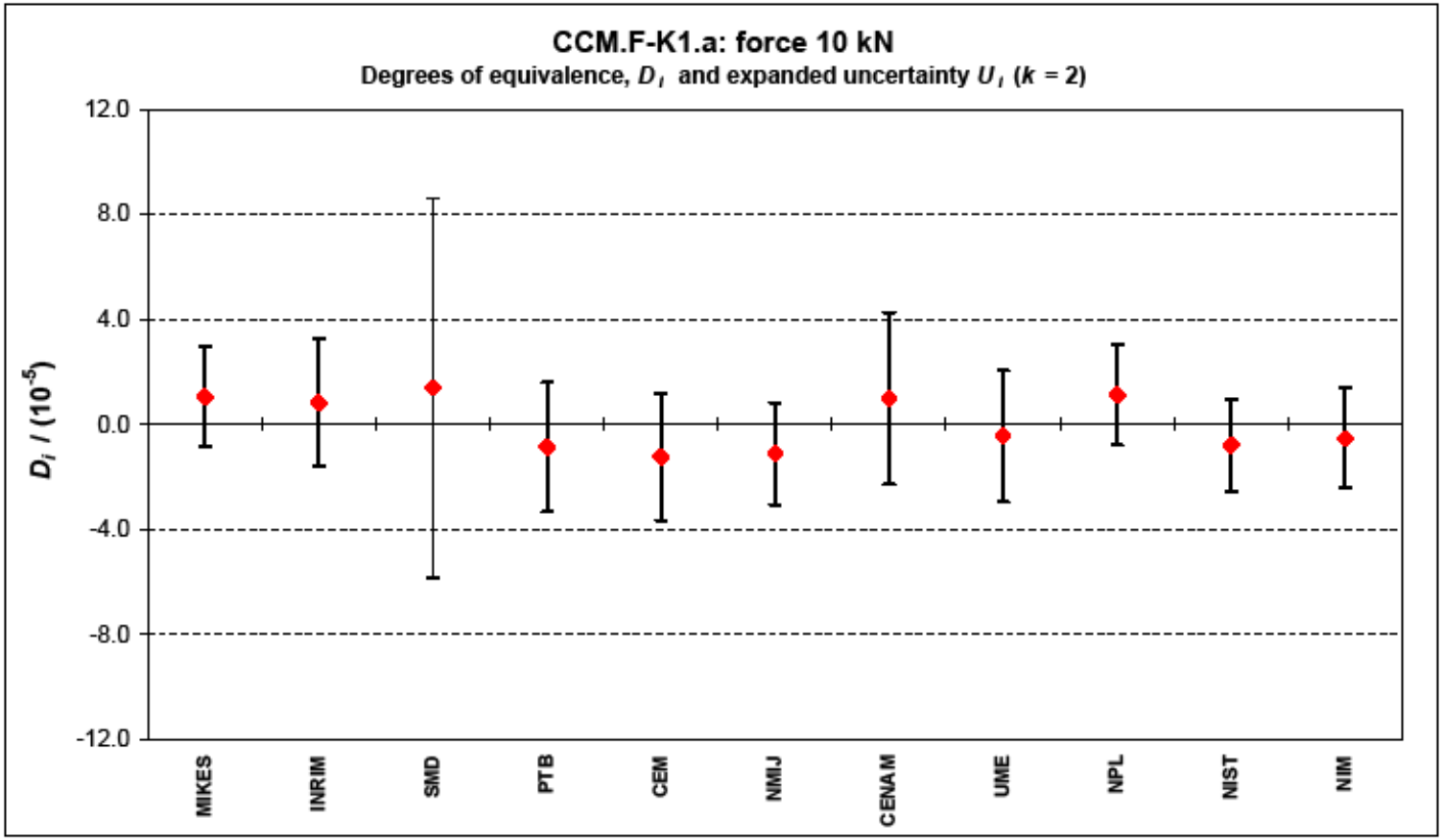
- **CCM.F-K3.a (force transducer up to 1 MN) and .b (up to 500 kN)**

CCM.F-K1.a and CCM.F-K1.b (force 5 kN)

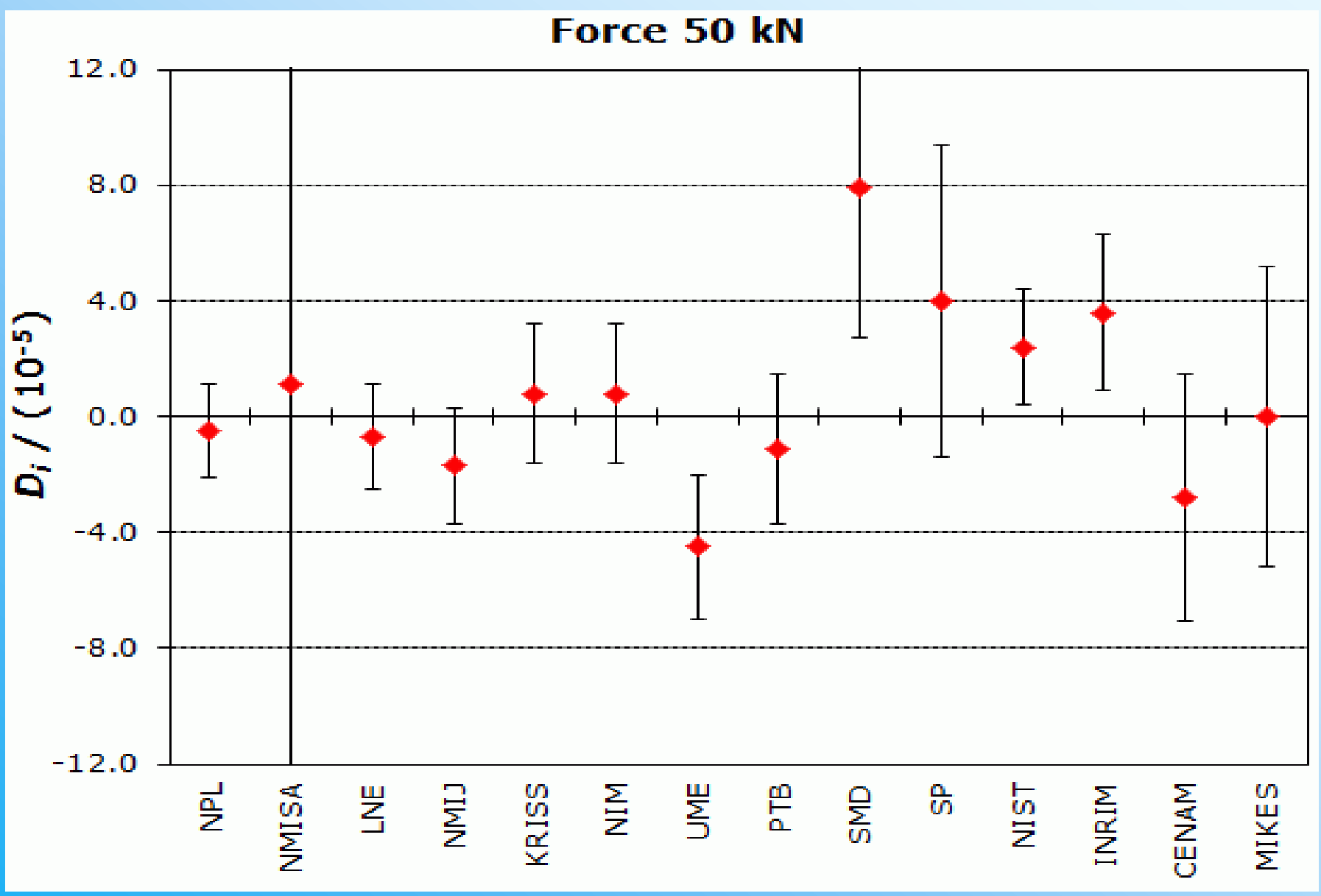


The BIPM key comparison database, May 2009

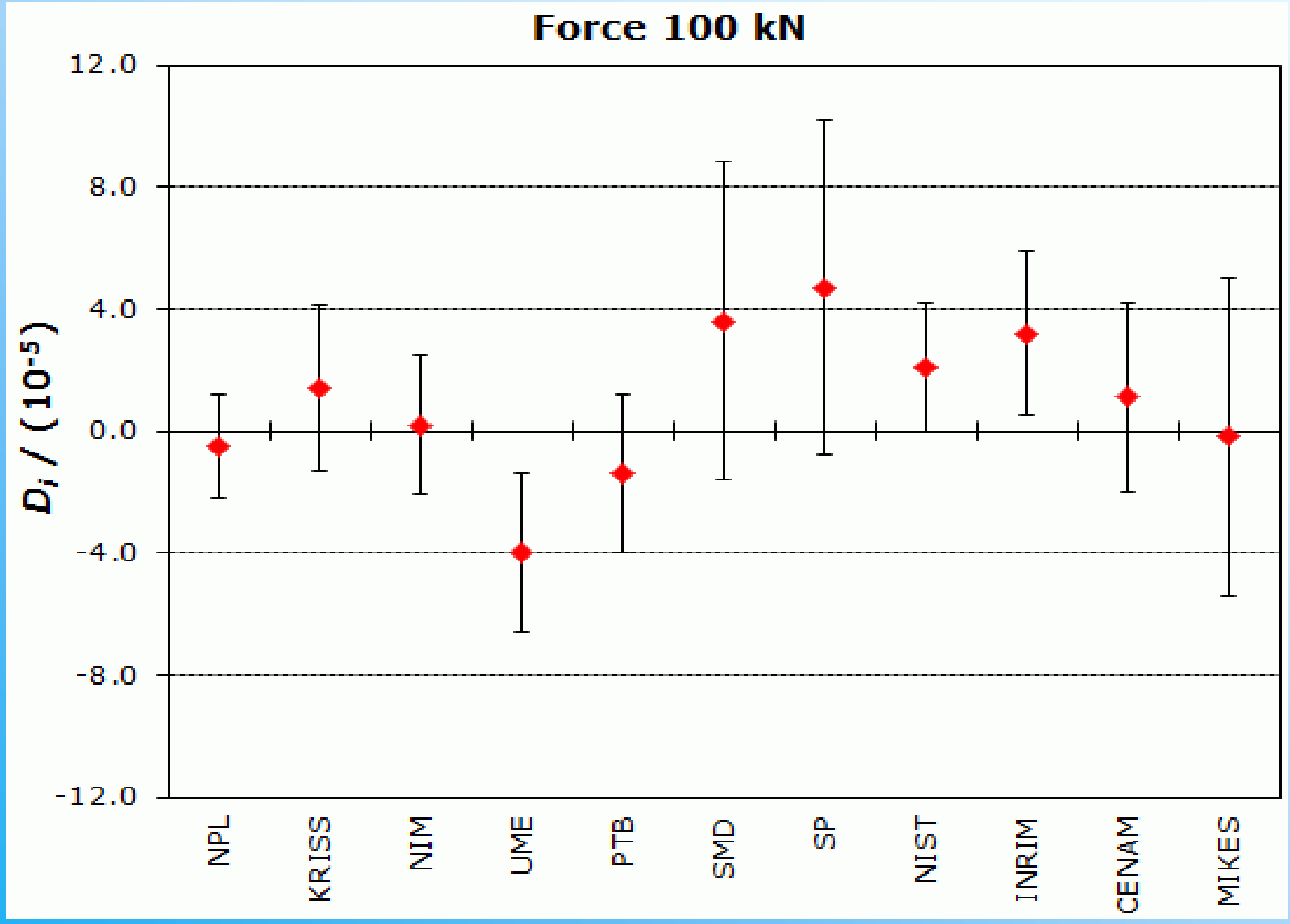
CCM.F-K1.a (force 10 kN)



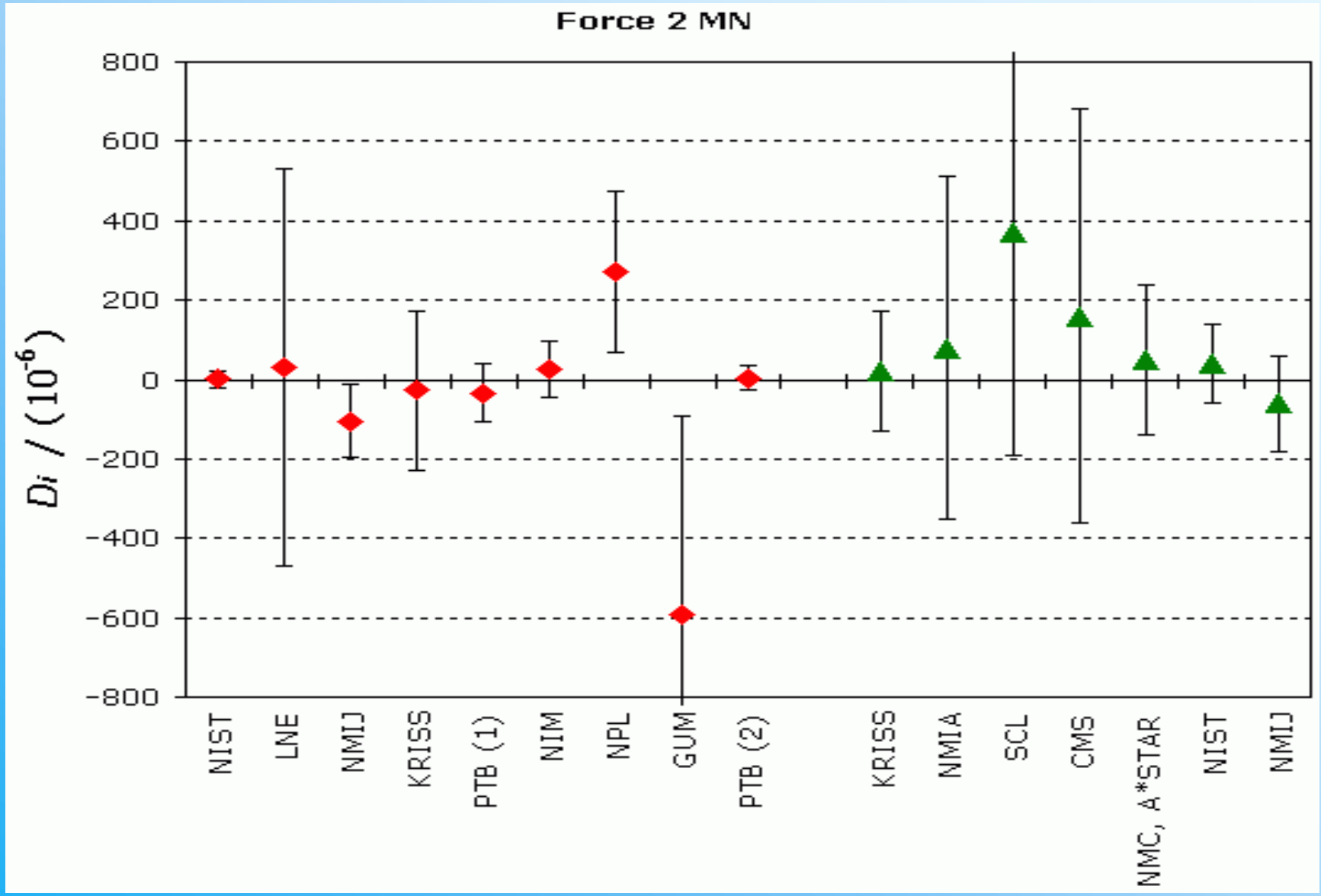
CCM.F-K2.a and CCM.F-K2.b (force 50 kN)



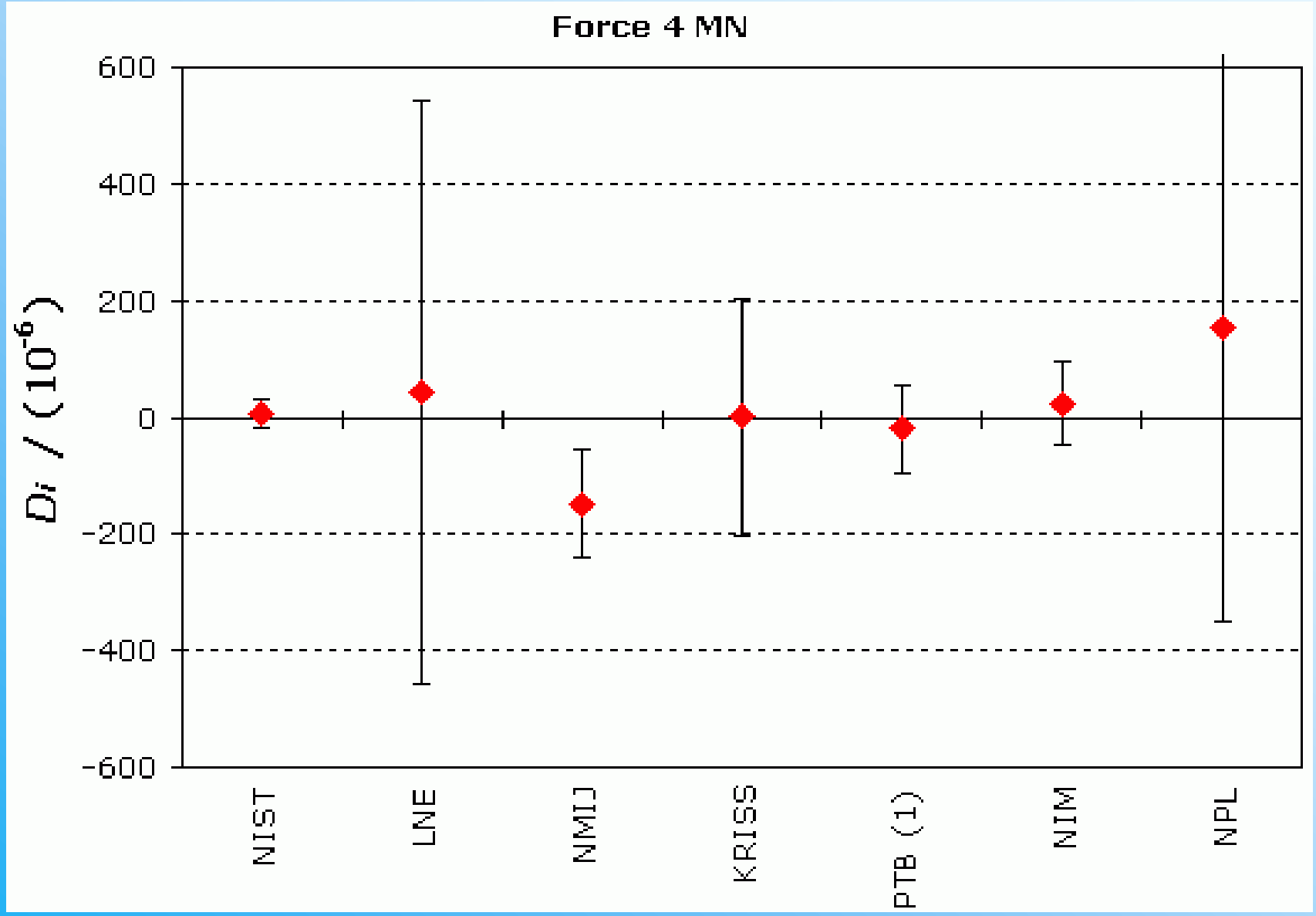
CCM.F-K2.a (force 100 kN)



CCM.F-K4.a and CCM.F-K4.b (force 2 MN) and APMP.M.F-K4.b



CCM.F-K4.a (force 4 MN)



Torque Key Comparisons

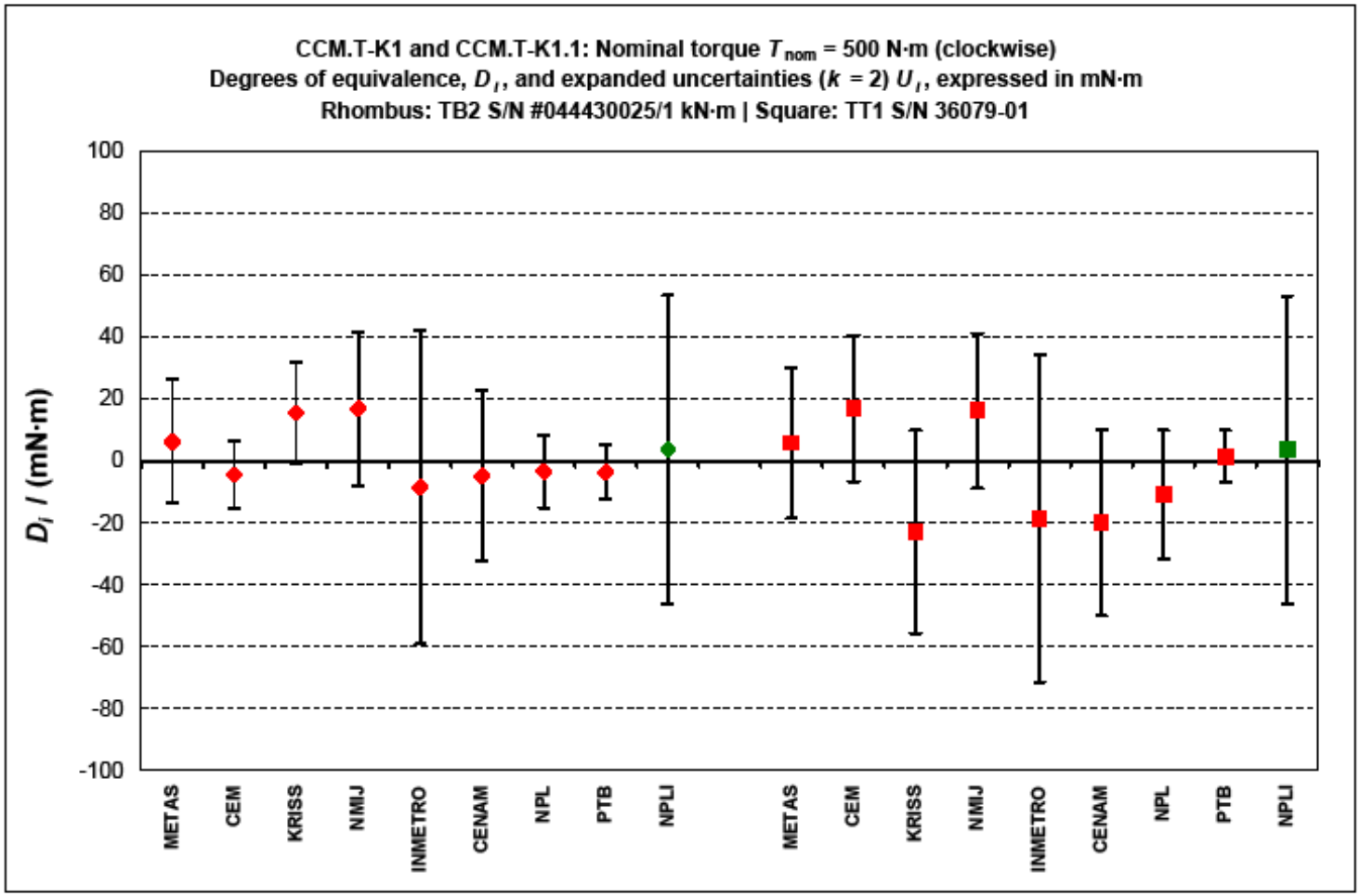
The WG manages the following key comparisons for torque standards:

- **CCM.T-K1 (torque transducer, 1 kN•m, piloted by the PTB) is at the status “results published in BIPM Database”;**
- **CCM.T-K1.1 (bilateral, pilot: PTB, participant: NPL India) the final report was published**

The following KCs are underway and should be finished and agreed until next CCM WG Force meeting in 2014:

CCM.T-K2 (torque transducer, 20 kN·m)

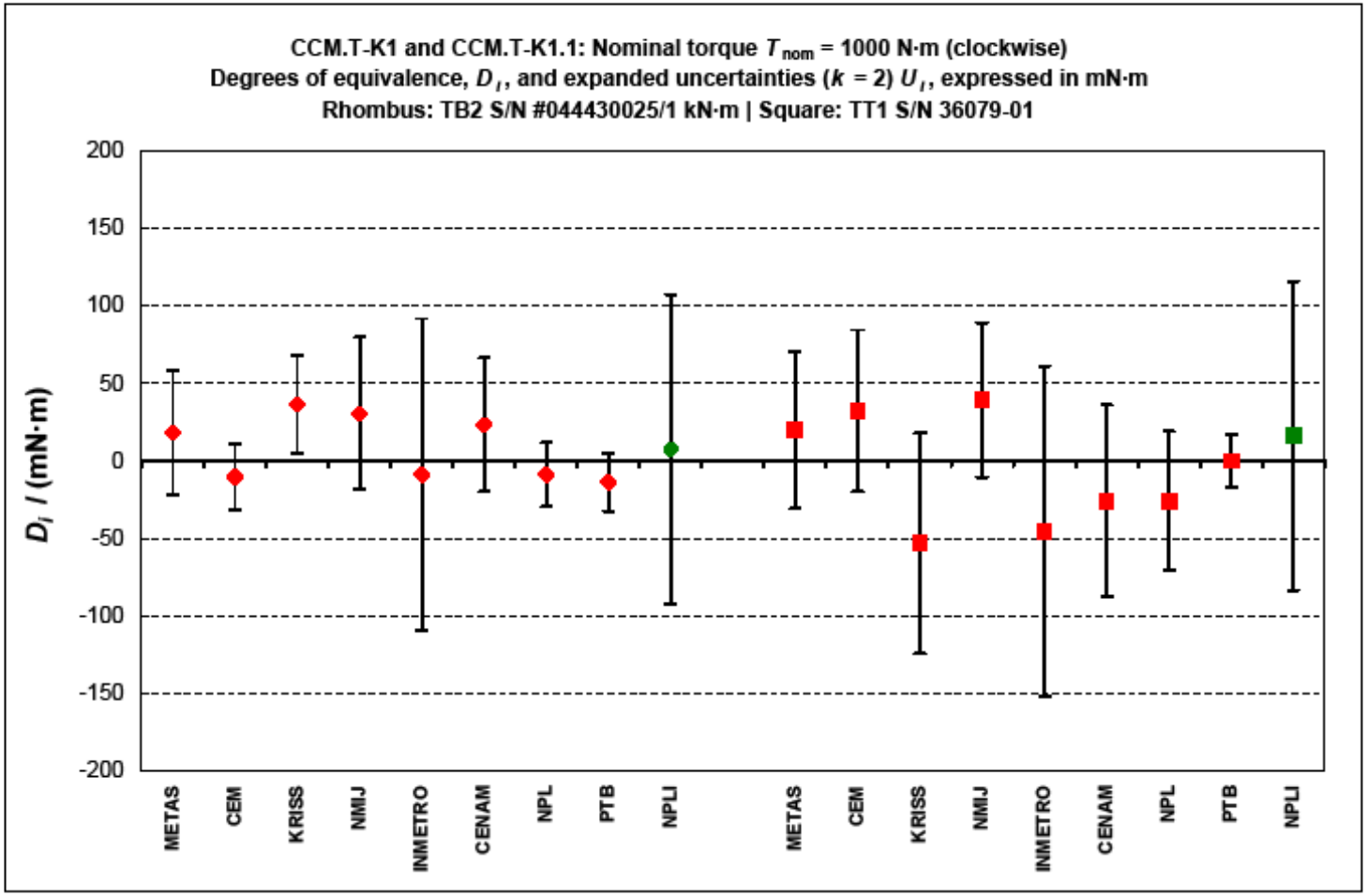
CCM.T-K1 and CCM.T-K1.1, 500 Nm clockwise



Red diamonds: TB2
Green diamond: TB2, participant in CCM.T-K1.1

Red squares: TT1
Green square: TT1, participant in CCM.T-K1.1

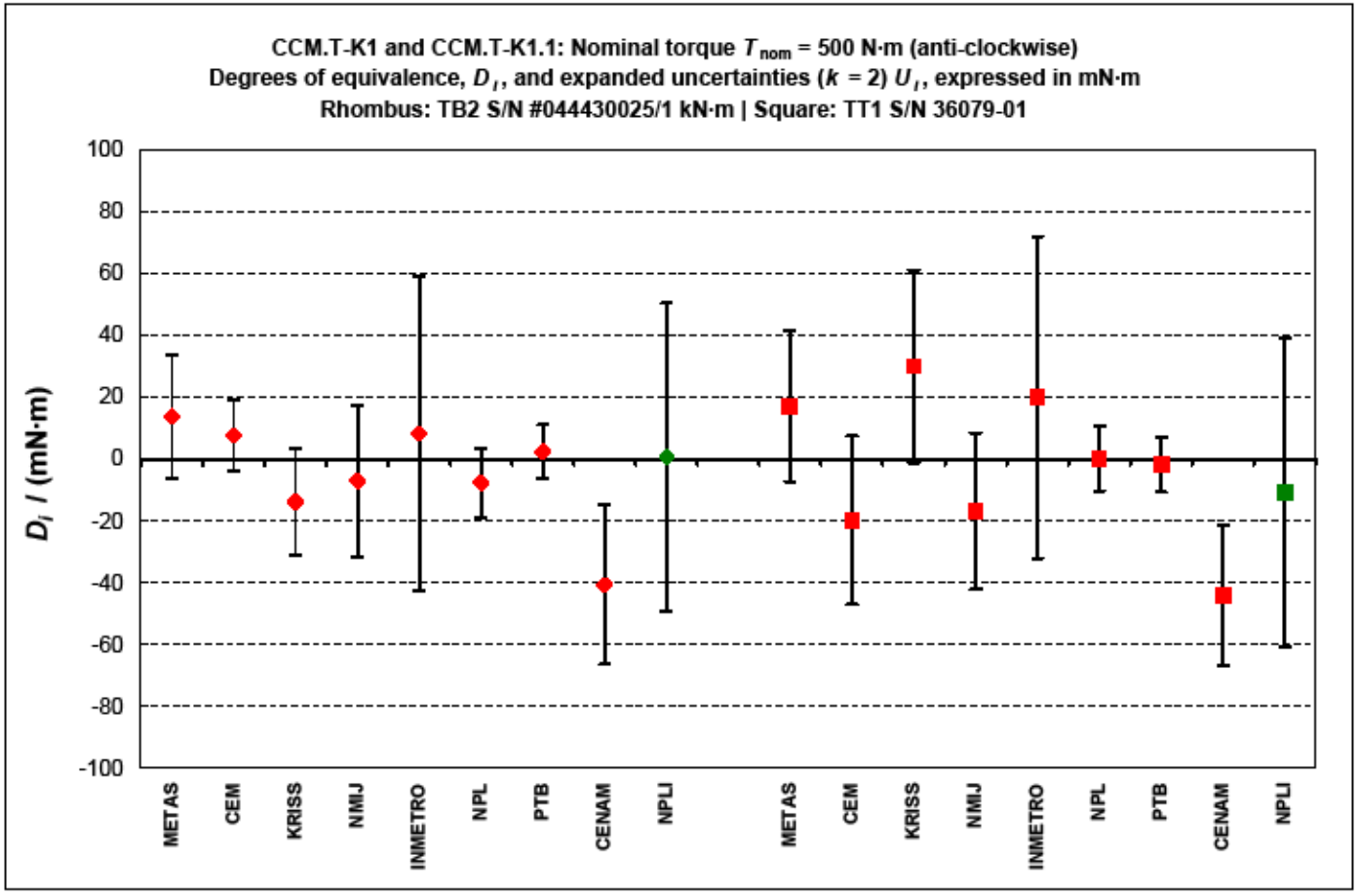
CCM.T-K1 and CCM.T-K1.1, 1000 Nm, clockwise



Red diamonds: TB2
Green diamond: TB2, participant in CCM.T-K1.1

Red squares: TT1
Green square: TT1, participant in CCM.T-K1.1

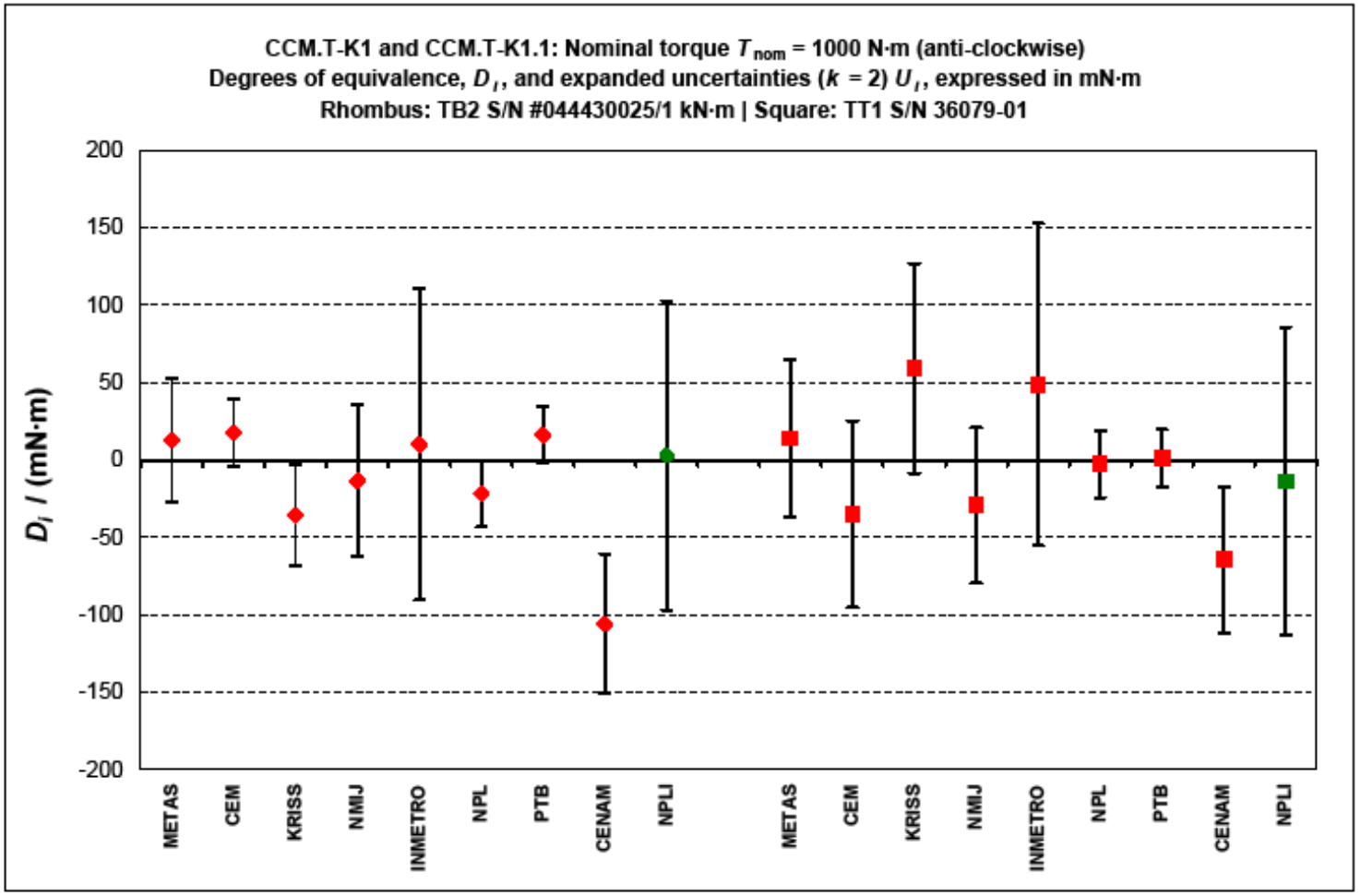
CCM.T-K1 and CCM.T-K1.1, 500 Nm, anti-clockwise



Red diamonds: TB2
Green diamond: TB2, participant in CCM.T-K1.1

Red squares: TT1
Green square: TT1, participant in CCM.T-K1.1

CCM.T-K1 and CCM.T-K1.1, 1000 Nm, anti-clockwise



Red diamonds: TB2
Green diamond: TB2, participant in CCM.T-K1.1

Red squares: TT1
Green square: TT1, participant in CCM.T-K1.1

Discussion on the frequency of KCs

The discussion on the frequency of KCs in the field of force and torque has shown, that KCs are needed to support CMC claims but they will never cover all ranges. But many of the CMC entries are supported by other measurements or results of special investigations or knowledge and by supplementary comparisons.

The WG should decide about the frequency of KCs on the basis of the knowledge about the machines and the experience in the laboratories. Many participants agreed that a period of 15 years should be considered to be a good interval for dead-weight machines.

RMO Comparisons in the field of force

APMP.M.F-K2.a and b (force transducer 50 kN, 100 kN)

APMP.M.F-K3.a (force transducer 500 kN, 1000 kN)

APMP.M.F-K3.b (force transducer 500 kN)

APMP.M.F-K4.b (force transducer 2000 kN)

COOMET.M.F-S1 (Force: 20 kN, 50 kN, 100 kN, 250 kN, 500 kN, 1000 kN and 2000 kN)

COOMET.M.F-S2 (Force: 10 kN, 14 kN, 16 kN, 20 kN, 50 kN, 60 kN, 80 kN and 100 kN)

EUROMET.M.F-K1 (force transducer 5 kN, 10 kN)

EUROMET.M.F-K2 (force transducer 50 kN, 100 kN)

EUROMET.M.F-K3 (force transducer 500 kN, 1 MN, 2 MN, 4 MN)

RMO Comparisons in the field of torque

EURAMET.M.T-S1
(Torque, clockwise and anti-clockwise: 500 N·m and 1000 N·m, 50 N·m and 200 N·m, 5 N·m and 10 N·m, 1 N·m and 5 N·m)

EURAMET.M.T-S2
(Torque, clockwise and anti-clockwise: 100 N·m)

EURAMET.M.T-S3
(Torque: 10 N·m to 1 kN·m,
Transfer device(s): Standard torque wrenches)

COOMET.M.T-S1
(Torque, clockwise and anti-clockwise:
100 N·m, 500 N·m, 1500 N·m and 2500 N·m)

Other RMO Comparisons related to force

SIM.M.F-S1 (Calibration of a force testing machine in compression, Force: 10 kN to 100 kN)

SIM.M.F-S2 (Calibration of a force testing machine in compression, Force: 10 000 N to 100 000 N)

SIM.M.F-S3 (Charpy V-notch reference specimen: 20 J and 100 J)

SIM.M.F-S4 (force transducer 50 kN, 100 kN)

Future Work of the CCM WG Force

New planned KCs are not yet agreed.

As future subjects, the working group will consider:

- small force measurement,

- multi-component force measurement,

- comparisons under consideration of parasitical components

- dynamic force metrology.

In the field of torque it is planned to continue the torque KCs in the range below 500 N•m, especially for the torque steps of 20 N•m and 50 N•m.

Planned: Next CCM WG Force Meeting in 2014