

Key comparison EUROMET.M.P-K1.b

MEASURAND: Pressure

NOMINAL VALUE: 0.3 mPa

p_i pressure measurement carried out at laboratory i

u_i standard uncertainty of laboratory i

(values taken from Table 13 of the EUROMET.M.P-K1.b Final Report)

Lab i	p_i / Pa	u_i / Pa	Date of measurement
NPL	3.004E-04	1.3E-06	May 2000
BNM-LNE	3.000E-04	5.5E-06	Jun 2000
MIRS/IMT	3.012E-04	1.8E-06	Sep 2000
CNR-IMGC	-	-	-
CEM	2.971E-04	1.2E-05	Apr 2001
UME	-	-	-
PTB	2.997E-04	1.1E-06	Apr 2000 - Jul 2000 - Mar 2001 - Nov 2001 - Feb 2002

Key comparison EUROMET.M.P-K1.b

MEASURAND: Pressure

NOMINAL VALUE: 0.9 mPa

p_i pressure measurement carried out at laboratory i

u_i standard uncertainty of laboratory i

(values taken from Table 13 of the EUROMET.M.P-K1.b Final Report)

Lab i	p_i / Pa	u_i / Pa	Date of measurement
NPL	9.002E-04	3.4E-06	May 2000
BNM-LNE	9.008E-04	8.9E-06	Jun 2000
MIRS/IMT	9.058E-04	3.3E-06	Sep 2000
CNR-IMGC	-	-	-
CEM	8.981E-04	2.2E-05	Apr 2001
UME	8.915E-04	4.1E-06	Dec 2001 to Jan 2002
PTB	8.998E-04	2.5E-06	Apr 2000 - Jul 2000 - Mar 2001 - Nov 2001 - Feb 2002

Key comparison EUROMET.M.P-K1.b

MEASURAND: Pressure

NOMINAL VALUE: 3 mPa

p_i pressure measurement carried out at laboratory i

u_i standard uncertainty of laboratory i

(values taken from Table 13 of the EUROMET.M.P-K1.b Final Report)

Lab i	p_i / Pa	u_i / Pa	Date of measurement
NPL	3.003E-03	1.1E-05	May 2000
BNM-LNE	2.998E-03	2.3E-05	Jun 2000
MIRS/IMT	3.025E-03	9.0E-06	Sep 2000
CNR-IMGC	-	-	-
CEM	3.004E-03	5.8E-05	Apr 2001
UME	2.990E-03	1.0E-05	Dec 2001 to Jan 2002
PTB	3.004E-03	7.8E-06	Apr 2000 - Jul 2000 - Mar 2001 - Nov 2001 - Feb 2002

Key comparison EUROMET.M.P-K1.b

MEASURAND: Pressure

NOMINAL VALUE: 9 mPa

p_i pressure measurement carried out at laboratory i

u_i standard uncertainty of laboratory i

(values taken from Table 13 of the EUROMET.M.P-K1.b Final Report)

Lab i	p_i / Pa	u_i / Pa	Date of measurement
NPL	9.000E-03	3.2E-05	May 2000
BNM-LNE	8.992E-03	5.5E-05	Jun 2000
MIRS/IMT	9.075E-03	2.6E-05	Sep 2000
CNR-IMGC	9.224E-03	3.0E-05	Oct 2000 to Nov 2000
CEM	9.008E-03	1.6E-04	Apr 2001
UME	8.981E-03	2.9E-05	Dec 2001 to Jan 2002
PTB	9.021E-03	2.9E-05	Apr 2000 - Jul 2000 - Mar 2001 - Nov 2001 - Feb 2002

Key comparison EUROMET.M.P-K1.b

MEASURAND: Pressure

NOMINAL VALUE: 30 mPa

p_i pressure measurement carried out at laboratory i

u_i standard uncertainty of laboratory i

(values taken from Table 13 of the EUROMET.M.P-K1.b Final Report)

Lab i	p_i / Pa	u_i / Pa	Date of measurement
NPL	3.002E-02	1.1E-04	May 2000
BNM-LNE	3.000E-02	1.8E-04	Jun 2000
MIRS/IMT	3.025E-02	8.8E-05	Sep 2000
CNR-IMGC	3.066E-02	7.5E-05	Oct 2000 to Nov 2000
CEM	3.005E-02	5.4E-04	Apr 2001
UME	2.993E-02	9.6E-05	Dec 2001 to Jan 2002
PTB	3.005E-02	9.8E-05	Apr 2000 - Jul 2000 - Mar 2001 - Nov 2001 - Feb 2002

Key comparison EUROMET.M.P-K1.b

MEASURAND: Pressure

NOMINAL VALUE: 90 mPa

p_i pressure measurement carried out at laboratory i

u_i standard uncertainty of laboratory i

(values taken from Table 13 of the EUROMET.M.P-K1.b Final Report)

Lab i	p_i / Pa	u_i / Pa	Date of measurement
NPL	9.010E-02	2.6E-04	May 2000
BNM-LNE	9.003E-02	5.2E-04	Jun 2000
MIRS/IMT	9.071E-02	2.7E-04	Sep 2000
CNR-IMGC	9.112E-02	2.4E-04	Oct 2000 to Nov 2000
CEM	9.022E-02	1.6E-03	Apr 2001
UME	8.978E-02	2.9E-04	Dec 2001 to Jan 2002
PTB	9.009E-02	2.9E-04	Apr 2000 - Jul 2000 - Mar 2001 - Nov 2001 - Feb 2002

Key comparison EUROMET.M.P-K1.b

MEASURAND: Pressure

NOMINAL VALUE: 0.3 Pa

p_i pressure measurement carried out at laboratory i

u_i standard uncertainty of laboratory i

(values taken from Table 13 of the EUROMET.M.P-K1.b Final Report)

Lab i	p_i / Pa	u_i / Pa	Date of measurement
NPL	3.003E-01	8.4E-04	May 2000
BNM-LNE	2.998E-01	1.7E-03	Jun 2000
MIRS/IMT	3.019E-01	9.1E-04	Sep 2000
CNR-IMGC	3.006E-01	7.9E-04	Oct 2000 to Nov 2000
CEM	3.004E-01	2.2E-03	Apr 2001
UME	2.994E-01	8.7E-04	Dec 2001 to Jan 2002
PTB	2.998E-01	5.6E-04	Apr 2000 - Jul 2000 - Mar 2001 - Nov 2001 - Feb 2002

Key comparison EUROMET.M.P-K1.b

MEASURAND: Pressure

NOMINAL VALUE: 0.9 Pa

p_i pressure measurement carried out at laboratory i

u_i standard uncertainty of laboratory i

(values taken from Table 13 of the EUROMET.M.P-K1.b Final Report)

Lab i	p_i / Pa	u_i / Pa	Date of measurement
NPL	9.004E-01	2.6E-03	May 2000
BNM-LNE	9.000E-01	5.1E-03	Jun 2000
MIRS/IMT	9.059E-01	2.7E-03	Sep 2000
CNR-IMGC	9.016E-01	2.3E-03	Oct 2000 to Nov 2000
CEM	9.021E-01	6.4E-03	Apr 2001
UME	8.988E-01	2.5E-03	Dec 2001 to Jan 2002
PTB	8.994E-01	1.7E-03	Apr 2000 - Jul 2000 - Mar 2001 - Nov 2001 - Feb 2002

Key comparison SIM-EUROMET.M.P-BK3

MEASURAND: Pressure

d relative difference between the pressures p_{CENAM} and p_{PTB} : $d = [p_{\text{CENAM}} / p_{\text{PTB}}] - 1$

U expanded uncertainty $k = 2$ of d

(values taken from Table 11 of the SIM-EUROMET.M.P-BK3 Final Report)

Date of measurement: April 2002 to June 2002

Nominal pressure	d	U
0.3 mPa	-0.0036	0.0295
0.9 mPa	-0.0026	0.0120
3 mPa	-0.0028	0.0070
9 mPa	-0.0042	0.0077
30 mPa	-0.0048	0.0076
90 mPa	-0.0033	0.0074
0.3 Pa	-0.0024	0.0048
0.9 Pa	-0.0018	0.0041

Key comparison EUROMET.M.P-K1.b

MEASURAND: Pressure

EQUIVALENCE STATEMENTS

For each of the nominal pressures measured in the comparison EUROMET.M.P-K1.b, a reference value, p_{R-EUR} is computed as the weighted average of the results from some of the participants (see Table below).

The weights are inversely proportional to the square of the individual uncertainties u_i .

The standard uncertainty, u_{R-EUR} , of p_{R-EUR} is the standard uncertainty of the weighted average.

(see pages 27 and 28 of the EUROMET.M.P-K1.b Final report)

Nominal pressure	Laboratories included in the computation of p_{R-EUR}	p_{R-EUR} / Pa	u_{R-EUR} / Pa
0.3 mPa	BNM-LNE, NPL, PTB	3.000E-04	8.1E-07
0.9 mPa	BNM-LNE, NPL, PTB, UME	9.000E-04	1.8E-06
3 mPa	BNM-LNE, NPL, PTB, UME	3.000E-03	5.2E-06
9 mPa	BNM-LNE, NPL, PTB, UME	9.000E-03	1.6E-05
30 mPa	BNM-LNE, NPL, PTB, UME	3.000E-02	5.5E-05
90 mPa	BNM-LNE, NPL, PTB, UME	9.000E-02	1.5E-04
0.3 Pa	BNM-LNE, CNR-IMGC, NPL, PTB, UME	3.000E-01	3.6E-04
0.9 Pa	BNM-LNE, CNR-IMGC, NPL, PTB, UME	9.000E-01	1.1E-03

The EUROMET degree of equivalence of each laboratory with respect to the reference value is given by a pair of terms: $D_{i-EUR} = [(p_i / p_{R-EUR}) - 1]$ and U_{i-EUR} , its expanded uncertainty ($k = 2$) computed according to Equations 29 and 30 on page 29 of the Final report. D_{i-EUR} and U_{i-EUR} are dimensionless.

No pair-wise degrees of equivalence are computed for this comparison.

Key comparison EUROMET.M.P-K1.b

MEASURAND: Pressure

DEGREES OF EQUIVALENCE relative to the EUROMET reference values (in relative terms)

Nominal pressure	NPL		BNM-LNE		MIRS/IMT		CNR-IMGC		CEM		UME		PTB	
	D_{i-EUR}	U_{i-EUR}	D_{i-EUR}	U_{i-EUR}	D_{i-EUR}	U_{i-EUR}	D_{i-EUR}	U_{i-EUR}	D_{i-EUR}	U_{i-EUR}	D_{i-EUR}	U_{i-EUR}	D_{i-EUR}	U_{i-EUR}
0.3 mPa	0.0013	0.0065	-0.0001	0.036	0.0039	0.013	-	-	-0.0096	0.078	-	-	-0.0010	0.0047
0.9 mPa	0.0002	0.0064	0.0008	0.019	0.0065	0.0082	-	-	-0.0021	0.048	-0.0094	0.0082	-0.0002	0.0039
3 mPa	0.0011	0.0062	-0.0006	0.015	0.0084	0.0069	-	-	0.0014	0.039	-0.0032	0.0058	0.0014	0.0039
9 mPa	0.0000	0.0060	-0.0009	0.012	0.0083	0.0069	0.0249	0.0074	0.0008	0.036	-0.0021	0.0053	0.0023	0.0052
30 mPa	0.0006	0.0060	0.0000	0.011	0.0085	0.0069	0.0219	0.0061	0.0016	0.036	-0.0022	0.0053	0.0018	0.0054
90 mPa	0.0011	0.0047	0.0004	0.011	0.0079	0.0070	0.0125	0.0064	0.0024	0.036	-0.0025	0.0055	0.0010	0.0054
0.3 Pa	0.0010	0.0050	-0.0008	0.011	0.0064	0.0065	0.0021	0.0047	0.0015	0.015	-0.0018	0.0053	-0.0007	0.0029
0.9 Pa	0.0005	0.0052	0.0000	0.011	0.0065	0.0063	0.0018	0.0044	0.0023	0.014	-0.0013	0.0051	-0.0006	0.0029

Linking key comparison EUROMET.M.P-K1.b to key comparison CCM.P-K4

Taking into account the nominal pressure ranges involved in the key comparisons CCM.P-K4 and EUROMET.M.P-K1.b, the linkage between both can be computed only for a pressure close to 1 Pa.

For a nominal pressure close to 1 Pa, three laboratories, CNR-IMGC, NPL and PTB, are common participants to both comparisons. Examination of their performance in both comparisons leads to the conclusions (see Section 12 of the EUROMET.M.P-K1.b Final Report) that the CCM.P-K4 key comparison reference value and the EUROMET reference value are in agreement. The EUROMET degrees of equivalence relative to the reference value may thus be transferred to CCM.P-K4.

The CCM.P-K4 degrees of equivalence, D_i and U_i , are expressed in Pa, while the EUROMET.M.P-K1.b ones, D_{i-EUR} and U_{i-EUR} , are expressed in relative terms. The transfer to CCM.P-K4 is thus obtained by multiplying by p_{R-EUR} the D_{i-EUR} and U_{i-EUR} values. It follows that at a nominal pressure of 1 Pa, $D_i = (D_{i-EUR} \times p_{R-EUR})$ and $U_i = (U_{i-EUR} \times p_{R-EUR})$ for participants taking part only in EUROMET.M.P-K1.b.

The CCM.P-K4 graph of equivalence can thus be extended to include the BNM-LNE, MIRS/IMT, CEM and UME results.

Linking key comparison SIM-EUROMET.M.P-BK3 to key comparison EUROMET.M.P-K1.b

The stability of the PTB primary standard between both comparisons was substantiated by the same check standard. It follows that, at all nominal values of the pressure, it is possible to link the CENAM values to the EUROMET.M.P-K1.b reference value p_{R-EUR} via the PTB primary standard.

By multiplying the ratio $r = (d + 1)$ with the pressure p_{PTB} obtained during EUROMET.M.P-K1.b, one obtains a fictive value for the pressure p_{CENAM} which can be compared with the EUROMET reference value p_{R-EUR} :
 $p_{CENAM} = r p_{PTB}$ with the uncertainty u_{CENAM} given in Equation 27 of the SIM-EUROMET.M.P-BK3 Final Report.

For all nominal values of the pressure, the degrees of equivalence of CENAM relative to the EUROMET.M.P-K1.b reference value is then computed from p_{CENAM} and u_{CENAM} , as if CENAM had participated in EUROMET.M.P-K1.b.

No pair-wise degrees of equivalence involving CENAM are computed.

Nominal pressure	p_{CENAM} / Pa	u_{CENAM} / Pa	$D_{CENAM-EUR}$	$U_{CENAM-EUR}$
0.3 mPa	2.986E-04	4.348E-06	-0.0047	0.030
0.9 mPa	8.975E-04	4.917E-06	-0.0028	0.012
3 mPa	2.996E-03	7.712E-06	-0.0013	0.006
9 mPa	8.983E-03	1.983E-05	-0.0019	0.006
30 mPa	2.991E-02	6.450E-05	-0.0030	0.006
90 mPa	8.979E-02	1.940E-04	-0.0023	0.005
0.3 Pa	2.991E-01	5.120E-04	-0.0030	0.004
0.9 Pa	8.978E-01	1.063E-03	-0.0024	0.003

Linking key comparison SIM-EUROMET.M.P-BK3 to key comparison CCM.P-K4

The conclusions of the linkage between EUROMET.M.P-K1.b and CCM.P-K4 for a nominal pressure of 1 Pa apply to the results of CENAM.

It follows that at a nominal pressure of 1 Pa, $D_{CENAM} = (D_{CENAM-EUR} \times p_{R-EUR})$ and $U_{CENAM} = (U_{CENAM-EUR} \times p_{R-EUR})$. The CCM.P-K4 graph of equivalence can thus be extended to include the CENAM results.

Key comparisons CCM.P-K4, EUROMET.M.P-K1.b, and SIM-EUROMET.M.P-BK3 are linked at a nominal pressure of 1 Pa. Additional degrees of equivalence are available from the linking of key comparison EUROMET.M.P-K1.a to CCM.P-K4 for a nominal pressure value of 1 Pa (details are available by clicking [here](#))

DEGREES OF EQUIVALENCE relative to the CCM.P-K4 reference value, NOMINAL PRESSURE: 1 Pa

Participants in CCM.P-K4

	D_i	U_i
	/ Pa	
CSIRO-NML	0.211	0.046
CNR-IMGC	0.0023	0.0054
NIST	0.0003	0.0015
NPLI	-0.0048	0.0023
NPL	0.0013	0.0054
PTB	0.0002	0.0029

No pair-wise degrees of equivalence are deduced from the measurements carried out in the framework of either key comparisons EUROMET.M.P-K1.a, EUROMET.M.P-K1.b, or SIM-EUROMET.M.P-BK3.

Participants in EUROMET.M.P-K1.b and not in CCM.P-K4

BNM-LNE	0.0000	0.010
MIRS/IMT	0.0059	0.0057
CEM	0.0021	0.013
UME	-0.0012	0.0046

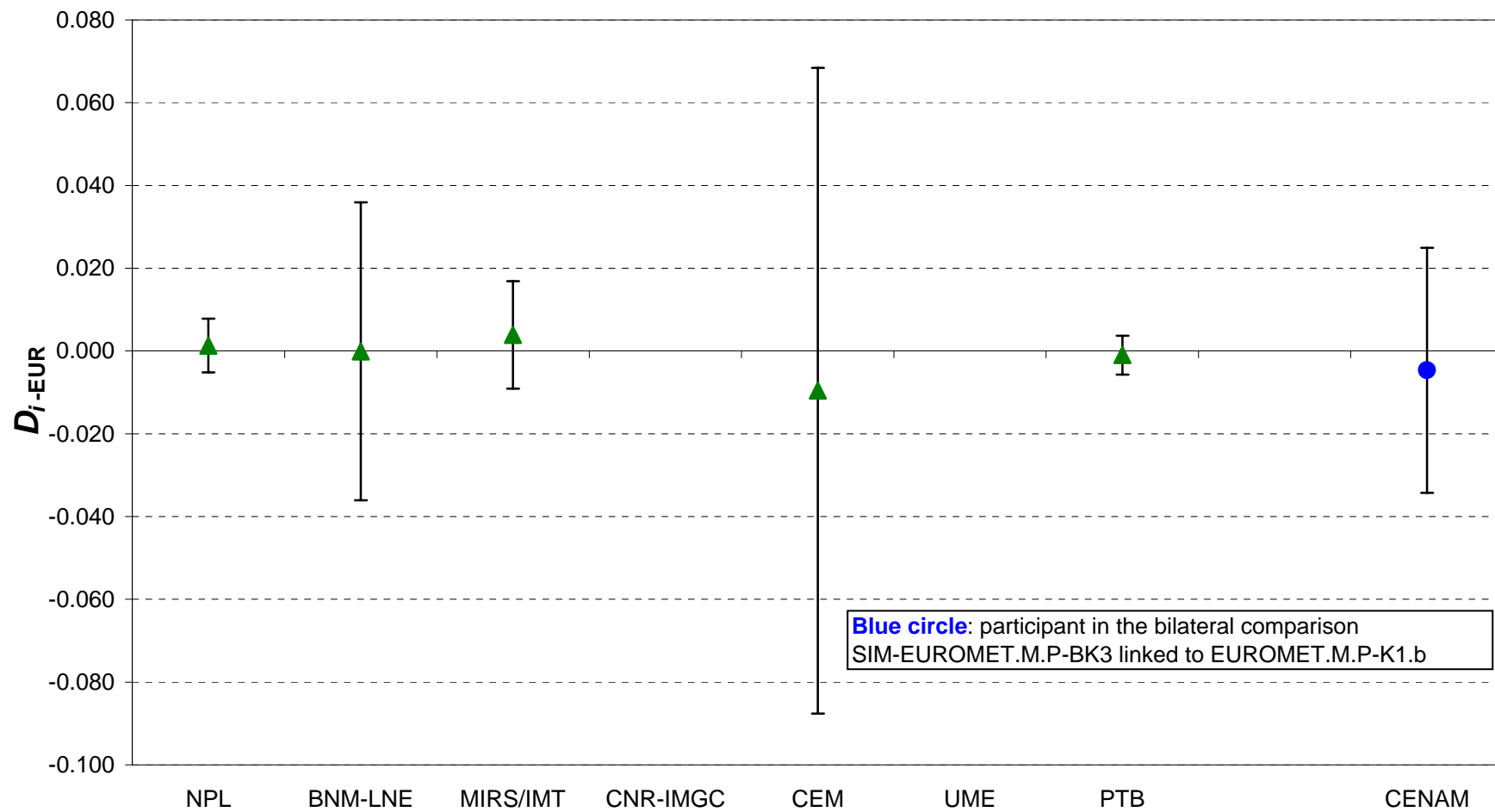
Participant in SIM-EUROMET.M.P-BK3 and not in CCM.P-K4

CENAM	-0.0022	0.003
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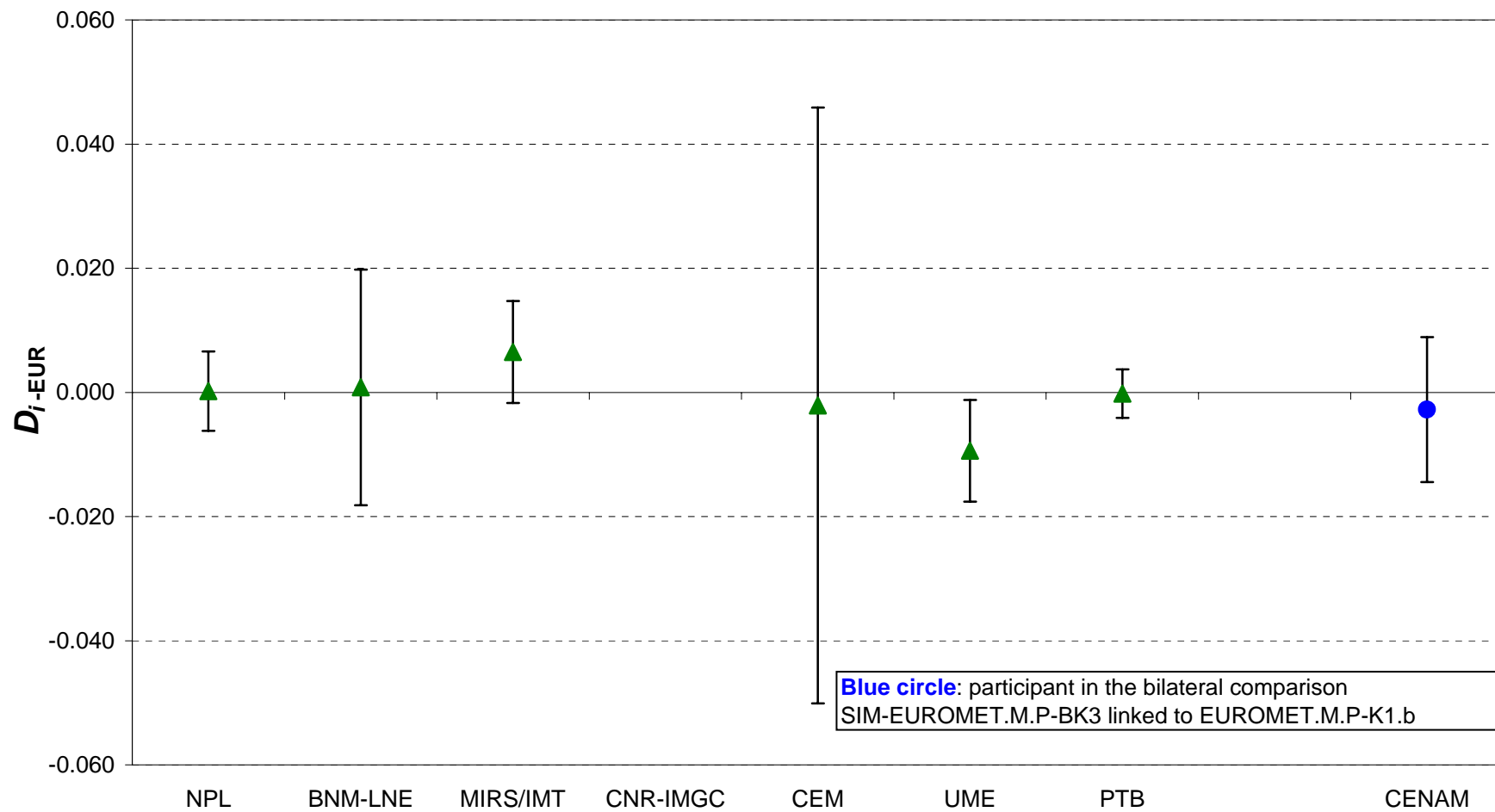
Participants in EUROMET.M.P-K1.a and not in CCM.P-K4

BNM-LNE	-0.0056	0.0051
MIKES	0.039	0.044
SP	0.0028	0.038
CEM	0.0031	0.0090
OMH	0.00082	0.082
UME	0.0062	0.0060
NMi-VSL	0.0036	0.035

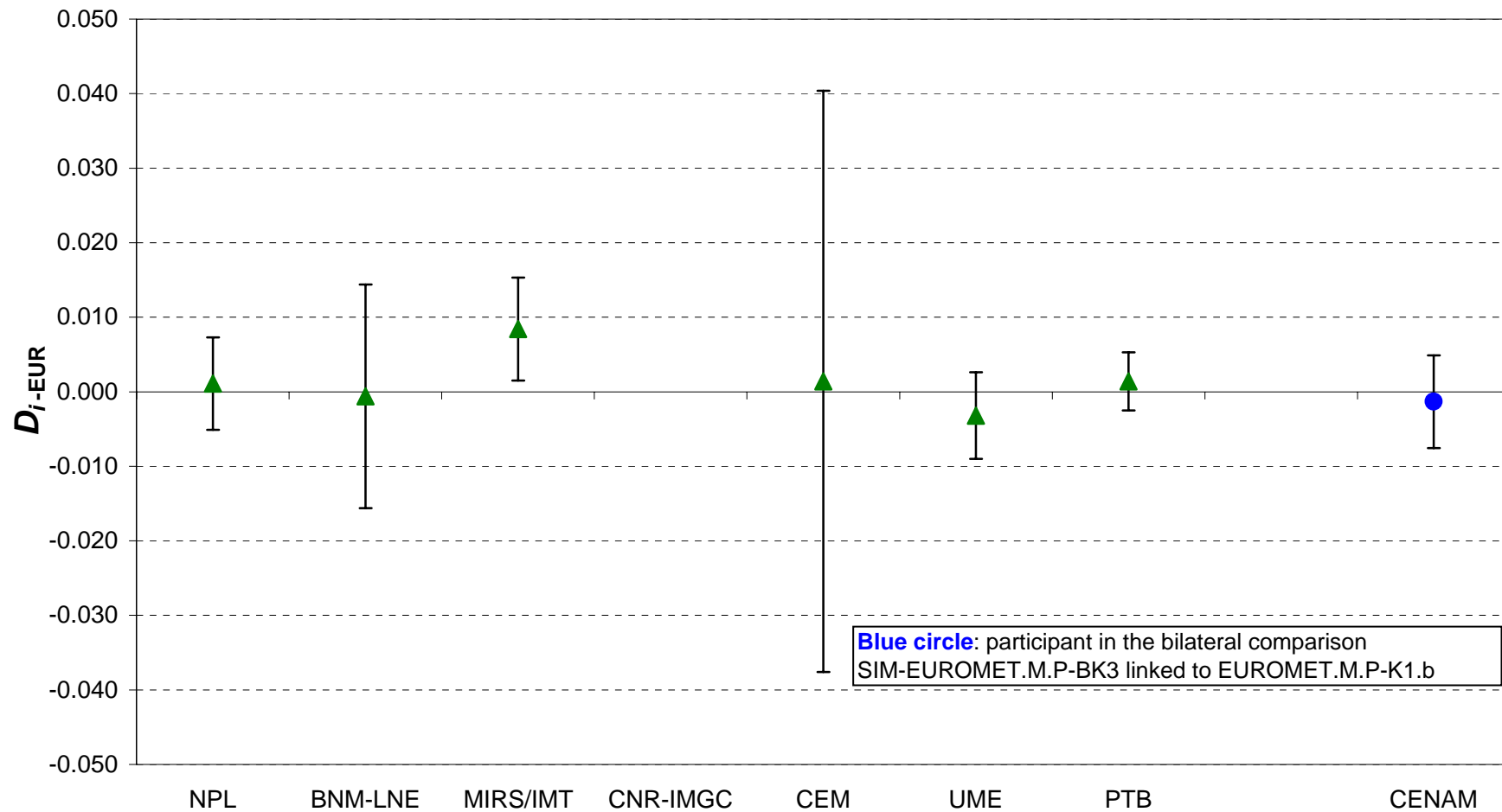
EUROMET.M.P-K1.b **nominal pressure 0.3 mPa**
EUROMET degrees of equivalence D_{i-EUR} and expanded uncertainty ($k = 2$) U_{i-EUR}



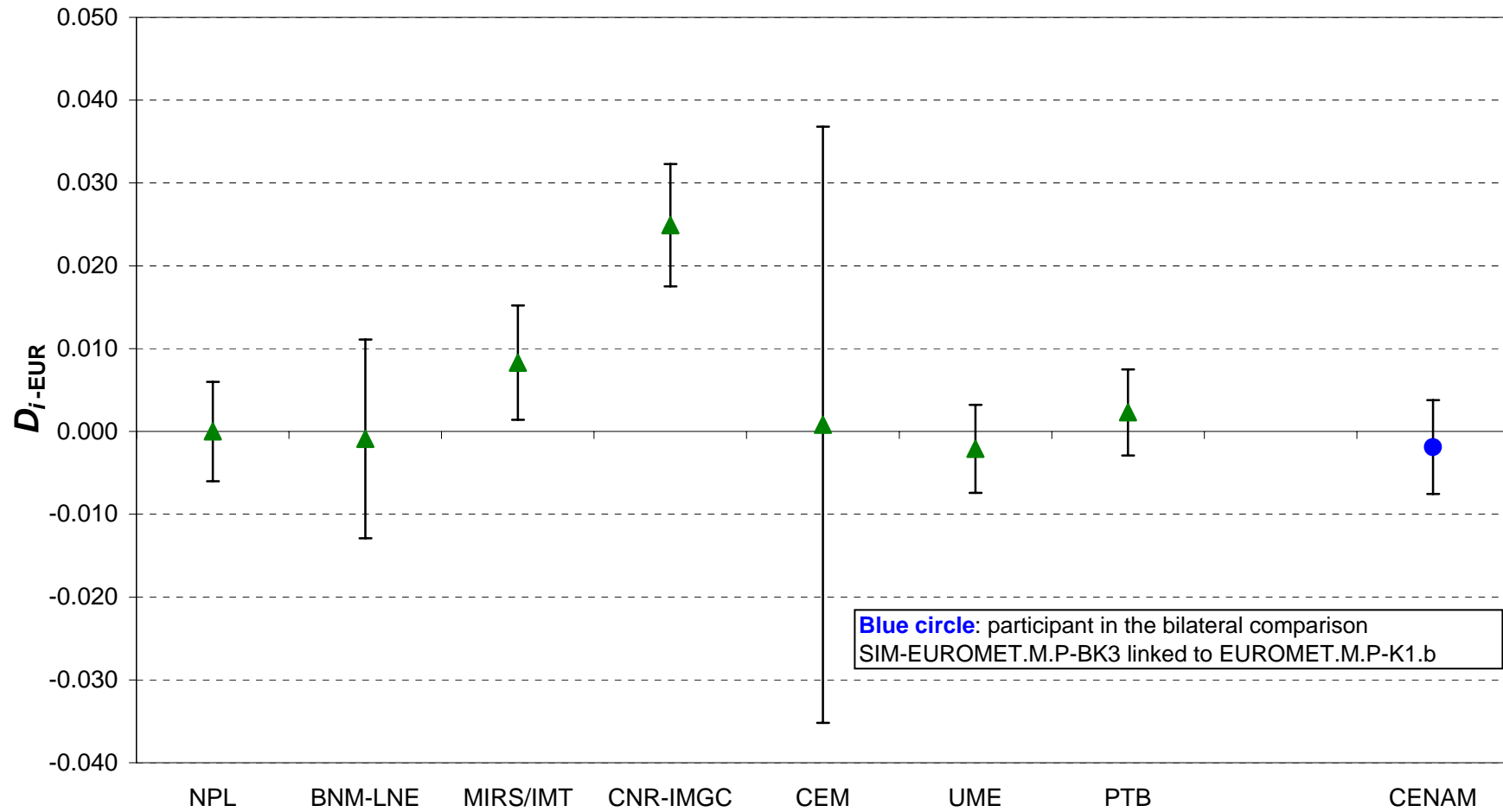
EUROMET.M.P-K1.b **nominal pressure 0.9 mPa**
EUROMET degrees of equivalence D_{i-EUR} and expanded uncertainty ($k = 2$) U_{i-EUR}



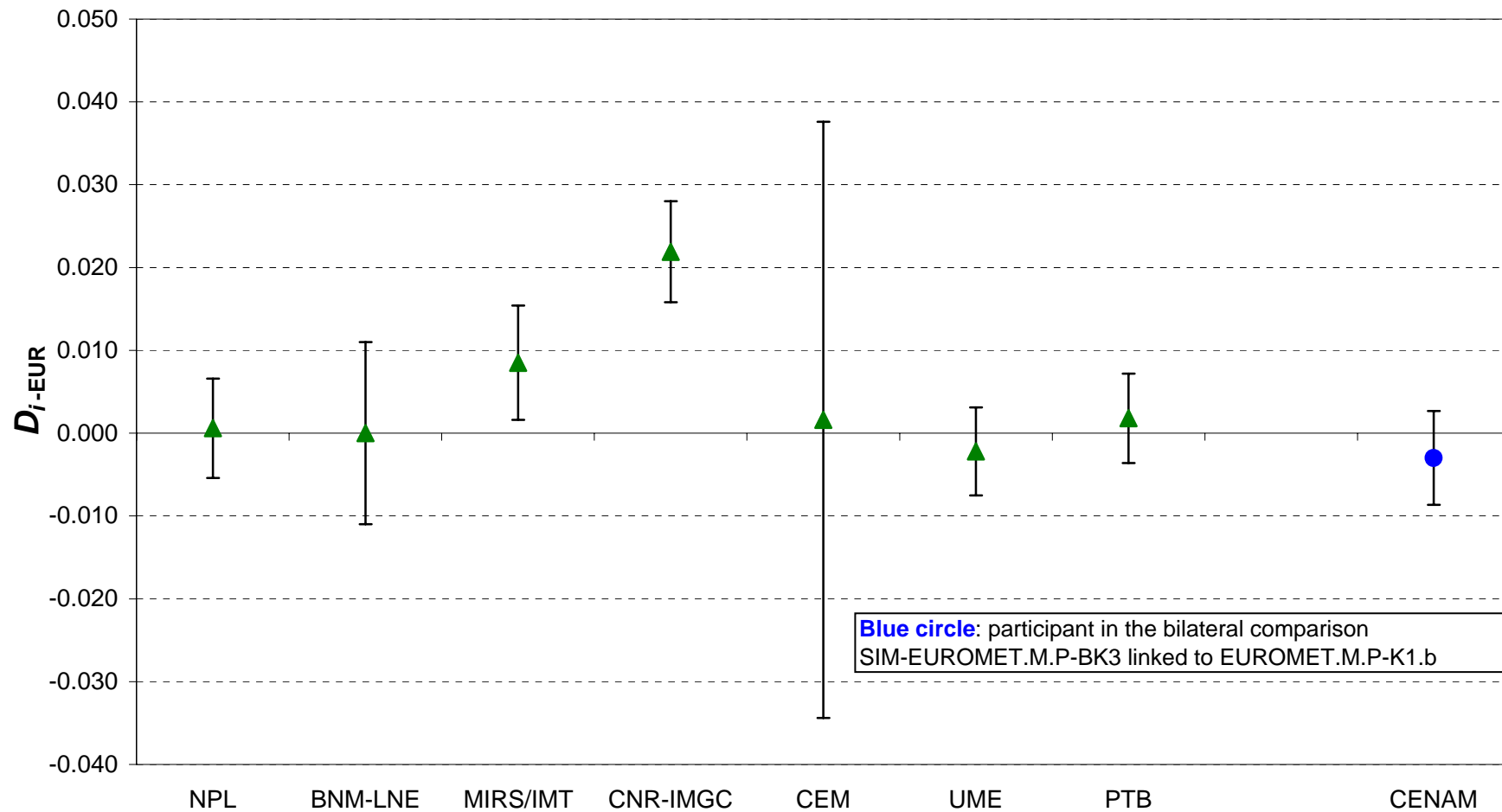
EUROMET.M.P-K1.b **nominal pressure 3 mPa**
EUROMET degrees of equivalence D_{i-EUR} and expanded uncertainty ($k = 2$) U_{i-EUR}



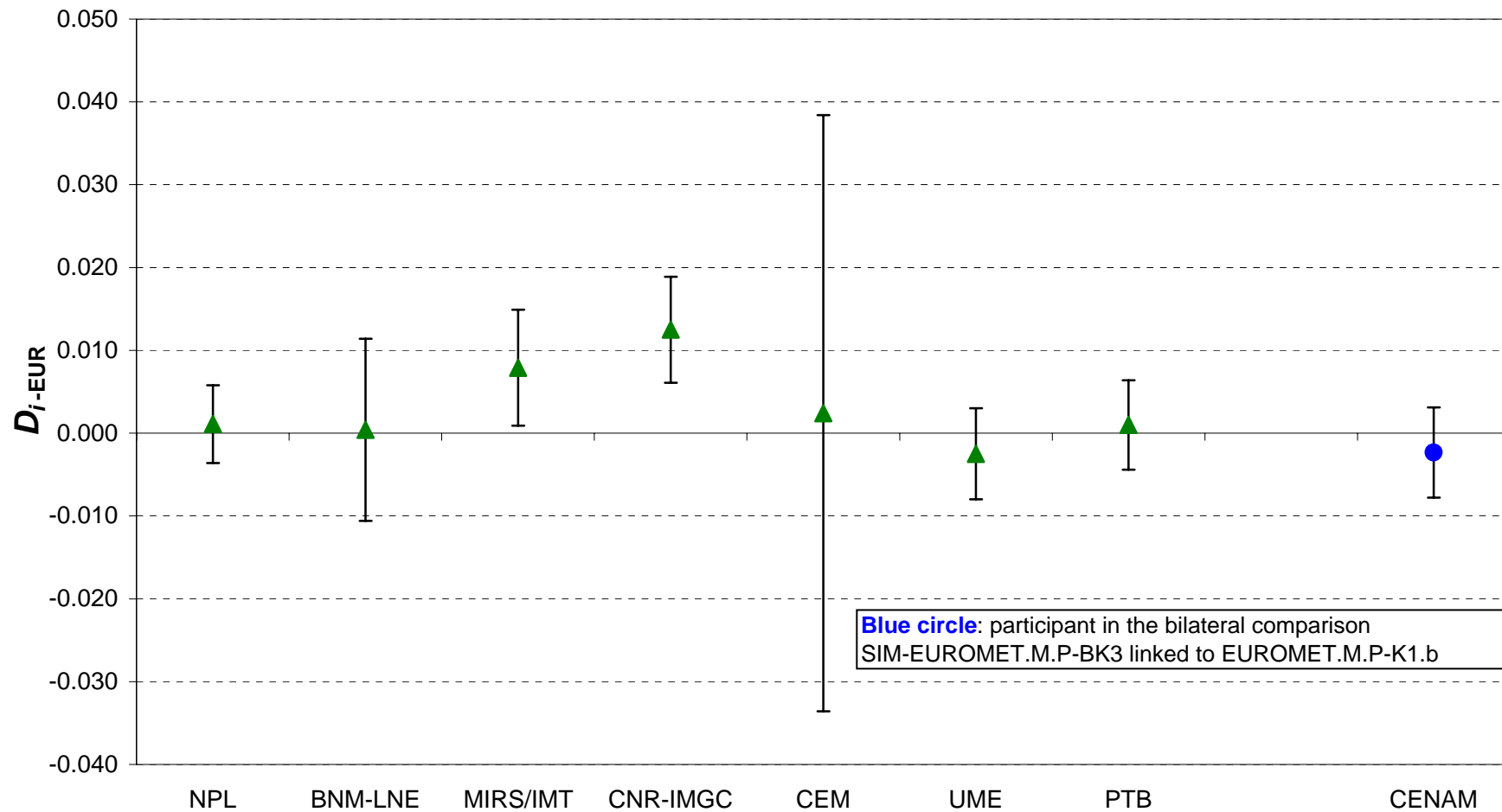
EUROMET.M.P-K1.b **nominal pressure 9 mPa**
EUROMET degrees of equivalence D_{i-EUR} and expanded uncertainty ($k = 2$) U_{i-EUR}



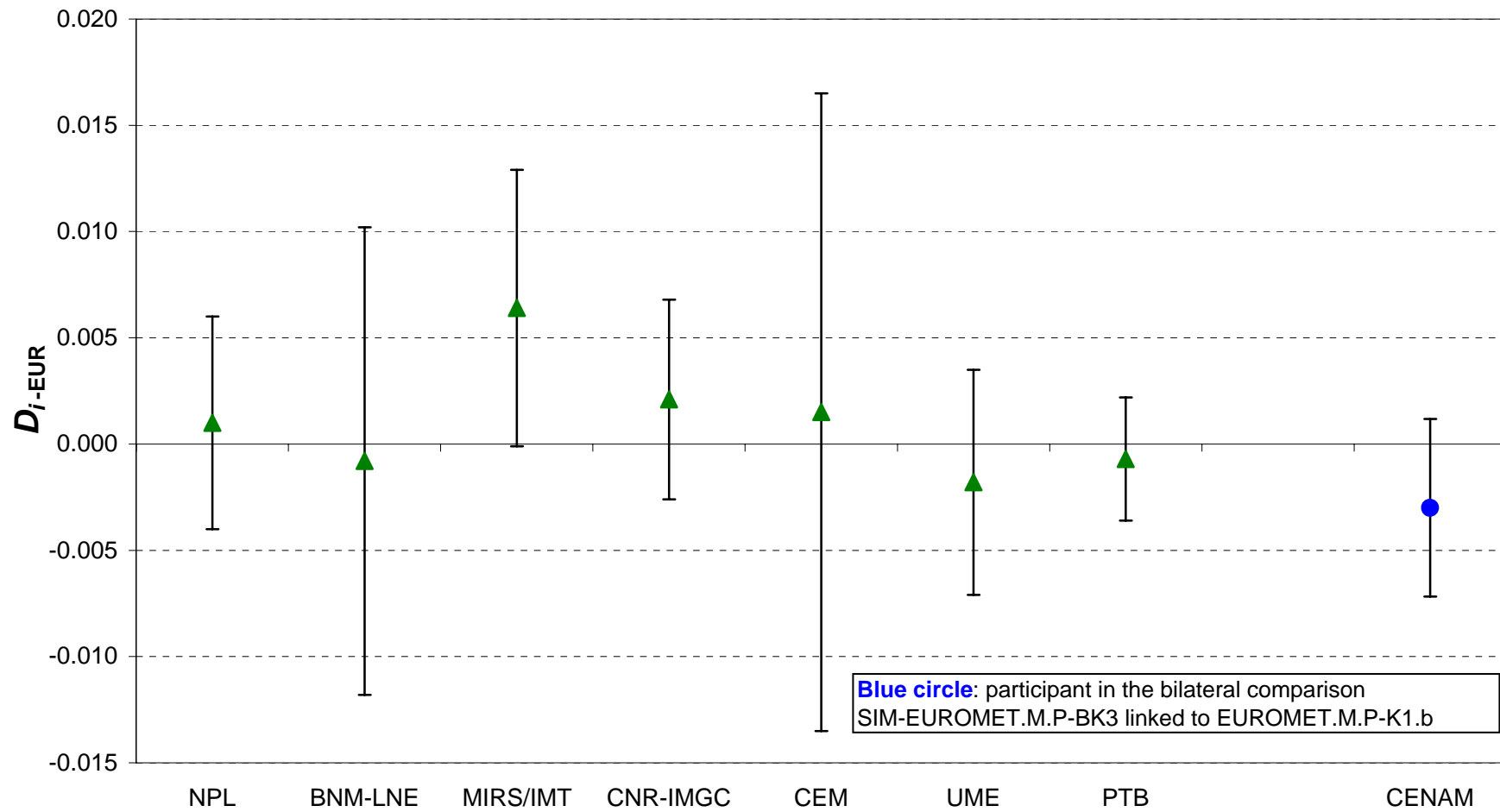
EUROMET.M.P-K1.b **nominal pressure 30 mPa**
EUROMET degrees of equivalence D_{i-EUR} and expanded uncertainty ($k = 2$) U_{i-EUR}



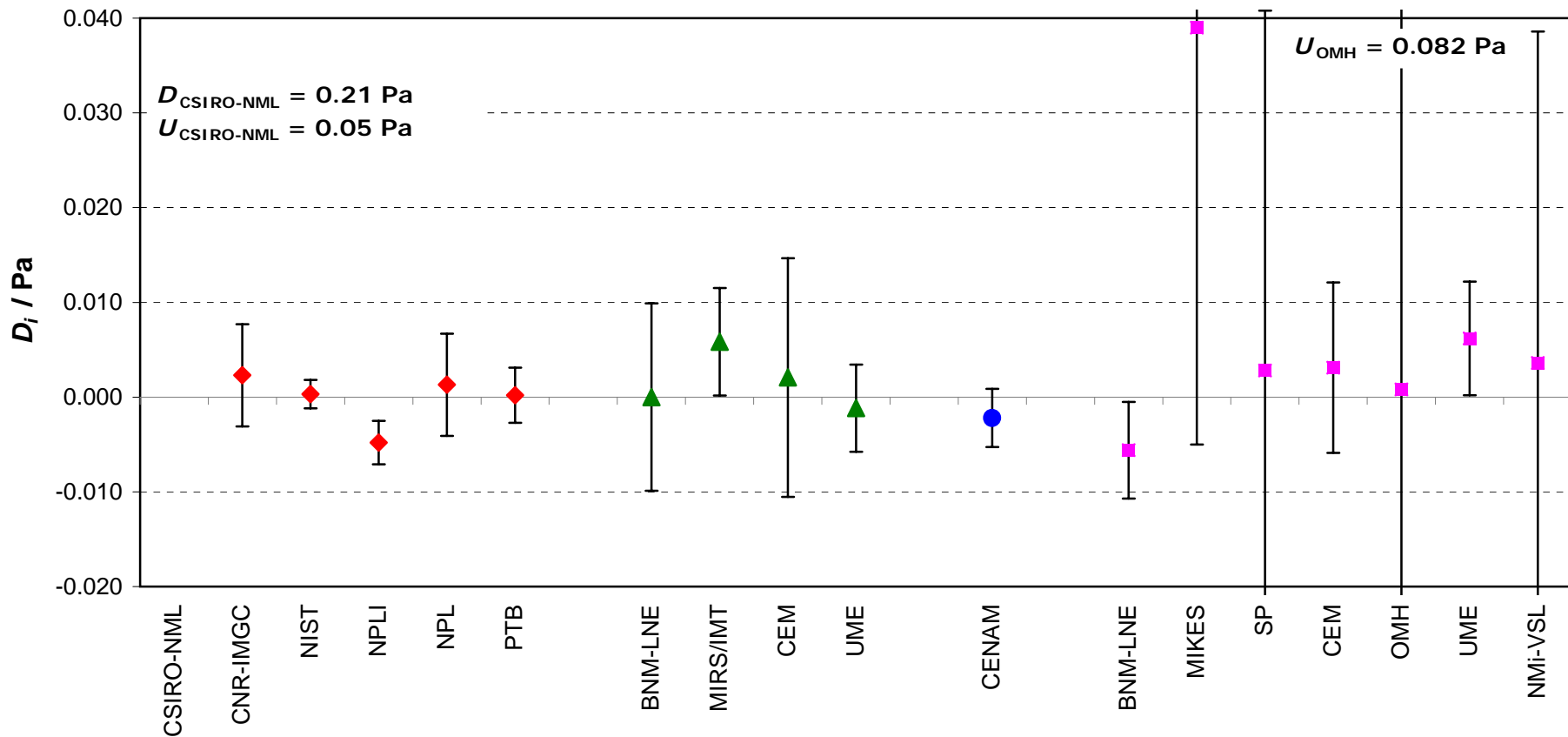
EUROMET.M.P-K1.b **nominal pressure 90 mPa**
EUROMET degrees of equivalence D_{i-EUR} and expanded uncertainty ($k = 2$) U_{i-EUR}



EUROMET.M.P-K1.b **nominal pressure 0.3 Pa**
EUROMET degrees of equivalence D_{i-EUR} and expanded uncertainty ($k = 2$) U_{i-EUR}



**CCM.P-K4, EUROMET.M.P-K1.b, SIM-EUROMET.M.P.BK3, and EUROMET.M.P-K1.a pressure ~
1 Pa Degrees of equivalence [D_i and U_i ($k = 2$)]**



Red diamonds: participants in CCM.P-K4
Green triangles: participants in EUROMET.M.P-K1.b and not in CCM.P-K4
Blue circle: participant in SIM-EUROMET.M.P-BK3 and not in CCM.P-K4
Pink squares: participants in EUROMET.M.P-K1.a and not in CCM.P-K4