Key comparison EUROMET.L-K4.2005

MEASURAND : Internal diameter
GAUGE : 3.5/5 mm ring

The comparison was carried out in two groups: Group 1 and Group 2

x_i : deviation from nominal length measured by laboratory *i*

u_i : standard uncertainty of x_i

Group 1	x_i / µm	u_i / µm	Date of measurement
MKEH	**20.600**	0.130	Sep 2005
SMD	**19.930**	0.071	Oct 2005
SP	**20.400**	0.120	Nov 2005
PTB	**20.580**	0.037	Dec 2005
VSL	**20.560**	0.047	Jan 2006
MIKES	**20.600**	0.095	Mar 2006
LNE	**20.620**	0.050	Apr 2006
NMISA	**20.430**	0.210	Jul - Aug 2006
INMETRO	**20.650**	0.110	Nov - Dec 2006
NPL	**20.550**	0.039	Feb 2006
INRIM	**20.640**	0.050	*
METAS	**20.630**	0.040	Jul 2005

* Jun 2005, Jan & Nov - Dec 2007

Group 2	x_i / µm	u_i / µm	Date of measurement
METAS	**0.340**	0.040	Feb 2009
INRIM	**0.310**	0.050	Jul 2006
NPL	**0.280**	0.042	**
BEV	**-0.340**	0.250	Jul 2005
CMI	**0.000**	0.300	Sep 2005
GUM	**0.650**	0.250	Oct 2005
NSAI NML	**-0.120**	0.475	Nov 2005
DTI	**0.300**	0.450	Dec 2005
MIRS/UM-FS/LTM	**-**	-	Feb 2006
EIM	**0.200**	0.250	Mar 2006
AS METROSERT	**-0.320**	0.341	Apr 2006
LATMB	**0.230**	0.500	May 2006
MKEH	**-0.030**	0.130	***
HMI/FSB-LPMD	**-**	-	Aug 2006
INM(RO)	**-0.300**	0.390	Sep 2006
UME	**0.280**	0.115	Oct 2006
NRC	**0.250**	0.100	Nov 2006
CEM	**0.380**	0.140	Dec 2006

** Jan 2006 & Mar - Apr 2009
*** May - Jun 2005, Jun 2006, Jan 2007 & Sep 2008

Key comparison EUROMET.L-K4.2005

MEASURAND : Internal diameter
GAUGE : 40 mm ring

The comparison was carried out in two groups: Group 1 and Group 2

x_i : deviation from nominal length measured by laboratory *i*

u_i : standard uncertainty of x_i

Group 1	x_i / µm	u_i / µm	Date of measurement
MKEH	**-0.080**	0.140	Sep 2005
SMD	**-0.129**	0.070	Oct 2005
SP	**-0.100**	0.130	Nov 2005
PTB	**-0.277**	0.030	Dec 2005
VSL	**-0.150**	0.050	Jan 2006
MIKES	**-0.180**	0.095	Mar 2006
LNE	**-0.140**	0.050	Apr 2006
NMISA	**-0.180**	0.082	Jul - Aug 2006
INMETRO	**-0.150**	0.110	Nov - Dec 2006
NPL	**-0.130**	0.043	Feb 2006
INRIM	**-0.180**	0.050	*
METAS	**-0.150**	0.040	Jul 2005

* Jun 2005, Jan & Nov - Dec 2007

Group 2	x_i / µm	u_i / µm	Date of measurement
METAS	**-0.290**	0.040	Feb 2009
INRIM	**-0.320**	0.055	Jul 2006
NPL	**-0.280**	0.041	**
BEV	**-0.230**	0.250	Jul 2005
CMI	**-0.300**	0.400	Sep 2005
GUM	**-0.230**	0.130	Oct 2005
NSAI NML	**0.100**	0.332	Nov 2005
DTI	**0.300**	0.550	Dec 2005
MIRS/UM-FS/LTM	**-0.400**	0.310	Feb 2006
EIM	**-0.300**	0.250	Mar 2006
AS METROSERT	**-0.090**	0.344	Apr 2006
LATMB	**-0.680**	0.500	May 2006
MKEH	**-0.230**	0.150	***
HMI/FSB-LPMD	**-0.470**	0.260	Aug 2006
INM(RO)	**-0.600**	0.400	Sep 2006
UME	**-0.100**	0.143	Oct 2006
NRC	**-0.390**	0.100	Nov 2006
CEM	**-0.370**	0.140	Dec 2006

** Jan 2006 & Mar - Apr 2009
*** May - Jun 2005, Jun 2006, Jan 2007 & Sep 2008

Key comparison EUROMET.L-K4.2005

MEASURAND : External diameter
GAUGE : 4/5 mm plug

The comparison was carried out in two groups: Group 1 and Group 2

x $_i$ **: deviation from nominal length measured by laboratory *i***

u $_i$ **: standard uncertainty of *x*** $_i$

Group 1	x_i / µm	u_i / µm	Date of measurement
MKEH	**0.360**	0.120	Sep 2005
SMD	**0.197**	0.096	Oct 2005
SP	**0.300**	0.080	Nov 2005
PTB	**0.182**	0.017	Dec 2005
VSL	**-0.270**	0.103	Jan 2006
MIKES	**0.160**	0.095	Mar 2006
LNE	**0.270**	0.050	Apr 2006
NMISA	**0.000**	0.240	Jul - Aug 2006
INMETRO	**-0.240**	0.110	Nov - Dec 2006
NPL	**-0.080**	0.043	Feb 2006
INRIM	**0.260**	0.060	*
METAS	**0.290**	0.050	Jul 2005

* Jun 2005, Jan & Nov - Dec 2007

Group 2	x_i / µm	u_i / µm	Date of measurement
METAS	**-0.080**	0.040	Feb 2009
INRIM	**-0.040**	0.050	Jul 2006
NPL	**-0.190**	0.047	**
BEV	**-0.030**	0.150	Jul 2005
CMI	**-0.400**	0.300	Sep 2005
GUM	**-0.181**	0.090	Oct 2005
NSAI NML	**-0.170**	0.075	Nov 2005
DTI	**-0.100**	0.450	Dec 2005
MIRS/UM-FS/LTM	**-0.300**	0.150	Feb 2006
EIM	**-0.030**	0.170	Mar 2006
AS METROSERT	**-0.160**	0.156	Apr 2006
LATMB	**-0.540**	0.700	May 2006
MKEH	**-0.120**	0.120	***
HMI/FSB-LPMD	**-0.250**	0.300	Aug 2006
INM(RO)	**-0.900**	0.390	Sep 2006
UME	**-0.220**	0.150	Oct 2006
NRC	**-0.160**	0.100	Nov 2006
CEM	**0.110**	0.140	Dec 2006

** Jan 2006 & Mar - Apr 2009
*** May - Jun 2005, Jun 2006, Jan 2007 & Sep 2008

Key comparison EUROMET.L-K4.2005

MEASURAND : External diameter
GAUGE : 50 mm plug

The comparison was carried out in two groups: Group 1 and Group 2

x_i : deviation from nominal length measured by laboratory *i*

u_i : standard uncertainty of x_i

Group 1	x_i / µm	u_i / µm	Date of measurement
MKEH	**-0.740**	0.140	Sep 2005
SMD	**-0.756**	0.068	Oct 2005
SP	**-0.300**	0.100	Nov 2005
PTB	**-0.258**	0.037	Dec 2005
VSL	**-0.640**	0.107	Jan 2006
MIKES	**-0.260**	0.095	Mar 2006
LNE	**-0.350**	0.050	Apr 2006
NMISA	**-0.260**	0.078	Jul - Aug 2006
INMETRO	**-0.060**	0.110	Nov - Dec 2006
NPL	**-0.500**	0.068	Feb 2006
INRIM	**-0.250**	0.055	*
METAS	**-0.270**	0.045	Jul 2005

* Jun 2005, Jan & Nov - Dec 2007

Group 2	x_i / µm	u_i / µm	Date of measurement
METAS	**-0.750**	0.070	Feb 2009
INRIM	**-0.680**	0.075	Jul 2006
NPL	**-0.890**	0.058	**
BEV	**-0.640**	0.150	Jul 2005
CMI	**-0.800**	0.400	Sep 2005
GUM	**-0.820**	0.120	Oct 2005
NSAI NML	**-0.780**	0.100	Nov 2005
DTI	**-1.500**	0.550	Dec 2005
MIRS/UM-FS/LTM	**-1.500**	0.260	Feb 2006
EIM	**-0.610**	0.180	Mar 2006
AS METROSERT	**-0.790**	0.239	Apr 2006
LATMB	**-1.040**	1.000	May 2006
MKEH	**-0.640**	0.140	***
HMI/FSB-LPMD	**-0.830**	0.300	Aug 2006
INM(RO)	**-1.400**	0.410	Sep 2006
UME	**-0.860**	0.156	Oct 2006
NRC	**-0.570**	0.100	Nov 2006
CEM	**-0.670**	0.140	Dec 2006

** Jan 2006 & Mar - Apr 2009
*** May - Jun 2005, Jun 2006, Jan 2007 & Sep 2008

Key comparison EUROMET.L-K4.2005

MEASURAND : External diameter
GAUGE : 30 mm sphere

The comparison was carried out in two groups: Group 1 and Group 2

x_i : deviation from nominal length measured by laboratory *i*

u_i : standard uncertainty of x_i

Group 1	x_i / µm	u_i / µm	Date of measurement
MKEH	**-11.980**	0.140	Sep 2005
SMD	**-12.391**	0.081	Oct 2005
SP	**-12.200**	0.160	Nov 2005
PTB	**-11.894**	0.009	Dec 2005
VSL	**-11.860**	0.047	Jan 2006
MIKES	**-12.000**	0.059	Mar 2006
LNE	**-11.850**	0.100	Apr 2006
NMISA	**-11.980**	0.076	Jul - Aug 2006
INMETRO	**-11.850**	0.110	Nov - Dec 2006
NPL	**-11.880**	0.057	Feb 2006
INRIM	**-11.890**	0.065	*
METAS	**-11.870**	0.070	Jul 2005

* Jun 2005, Jan & Nov - Dec 2007

Group 2	x_i / µm	u_i / µm	Date of measurement
METAS	**-13.770**	0.070	Feb 2009
INRIM	**-13.690**	0.065	Jul 2006
NPL	**-13.640**	0.054	**
BEV	**-13.890**	0.150	Jul 2005
CMI	**-14.200**	0.400	Sep 2005
GUM	**-13.944**	0.090	Oct 2005
NSAI NML	**-14.000**	0.090	Nov 2005
DTI	**-14.500**	0.550	Dec 2005
MIRS/UM-FS/LTM	**-14.900**	0.150	Feb 2006
EIM	**-13.660**	0.180	Mar 2006
AS METROSERT	**-13.680**	0.196	Apr 2006
LATMB	**-**	-	May 2006
MKEH	**-13.830**	0.140	***
HMI/FSB-LPMD	**-13.970**	0.300	Aug 2006
INM(RO)	**-14.700**	0.400	Sep 2006
UME	**-13.840**	0.100	Oct 2006
NRC	**-13.710**	0.100	Nov 2006
CEM	**-13.910**	0.080	Dec 2006

** Jan 2006 & Mar - Apr 2009
*** May - Jun 2005, Jun 2006, Jan 2007 & Sep 2008

Key comparison EUROMET.L-K4.2005

MEASURAND : Internal or external diameter
GAUGES : 3.5/5 mm ring, 40 mm ring, 4/5 mm plug, 50 mm plug and 30 mm sphere

The key comparison reference values, x_R, were calculated in each group separately, based on the weighted mean, after excluding iteratively laboratories having a poor degree of equivalence until results were consistent.

The combined standard uncertainty of x_R is designated as u_R.

		3.5/5 mm ring	40 mm ring	4/5 mm plug	50 mm plug	30 mm sphere
		Internal diameter	Internal diameter	External diameter	External diameter	External diameter
Group 1	x_R / µm	20.590	-0.183	0.207	-0.270	-11.896
	u_R / µm	0.017	0.016	0.015	0.021	0.009
Group 2	x_R / µm	0.290	-0.290	-0.120	-0.730	-13.830
	u_R / µm	0.023	0.023	0.021	0.033	0.029

For each group and each gauge, the degrees of equivalence of laboratory *i* relative to the key comparison reference value is given by a pair of terms: $D_i = x_i - x_R$ and U_i its expanded uncertainty ($k = 2$).

Linking of the two groups has been done by simply representing the results on a common graph, i.e. by setting the deviation from nominal value of the respective reference values of the two groups arbitrarily to zero. The consistency of the two linked groups with each other is demonstrated by the consistency of the linking laboratories (METAS, INRIM and partly NPL) with each of the reference values.
The linking laboratories are shown in the middle of the tables and graphs of equivalence.

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

Key comparison EUROMET.L-K4.2005

MEASURAND : Internal diameter
GAUGES : 3.5/5 mm ring and 40 mm ring

Lab *i* ⇩	3.5/5 mm ring	
	D_i / µm	U_i / µm
MKEH	0.010	0.258
SMD	-0.660	0.146
SP	-0.190	0.238
PTB	-0.010	0.066
VSL	-0.030	0.088
MIKES	0.010	0.187
LNE	0.030	0.094
NMISA	-0.160	0.419
INMETRO	0.060	0.217
NPL	-0.040	0.070
INRIM	0.050	0.094
METAS	0.040	0.072
METAS	0.050	0.065
INRIM	0.020	0.089
NPL	-0.010	0.070
BEV	-0.630	0.498
CMI	-0.290	0.598
GUM	0.360	0.498
NSAI NML	-0.410	0.949
DTI	0.010	0.899
MIRS/UM-FS/LTM	-	-
EIM	-0.090	0.498
AS METROSERT	-0.610	0.680
LATMB	-0.060	0.999
MKEH	-0.320	0.256
HMI/FSB-LPMD	-	-
INM(RO)	-0.590	0.779
UME	-0.010	0.225
NRC	-0.040	0.195
CEM	0.090	0.276

Lab *i* ⇩	40 mm ring	
	D_i / µm	U_i / µm
MKEH	0.103	0.278
SMD	0.054	0.136
SP	0.083	0.258
PTB	-0.094	0.051
VSL	0.033	0.095
MIKES	0.003	0.187
LNE	0.043	0.095
NMISA	0.003	0.161
INMETRO	0.033	0.218
NPL	0.053	0.080
INRIM	0.003	0.095
METAS	0.033	0.073
METAS	0.000	0.065
INRIM	-0.030	0.100
NPL	0.010	0.068
BEV	0.060	0.498
CMI	-0.010	0.799
GUM	0.060	0.256
NSAI NML	0.390	0.662
DTI	0.590	1.099
MIRS/UM-FS/LTM	-0.110	0.618
EIM	-0.010	0.498
AS METROSERT	0.200	0.686
LATMB	-0.390	0.999
MKEH	0.060	0.296
HMI/FSB-LPMD	-0.180	0.518
INM(RO)	-0.310	0.799
UME	0.190	0.282
NRC	-0.100	0.195
CEM	-0.080	0.276

Group 1 laboratories

Linking laboratories between Group 1 and Group 2

Group 2 laboratories

Key comparison EUROMET.L-K4.2005

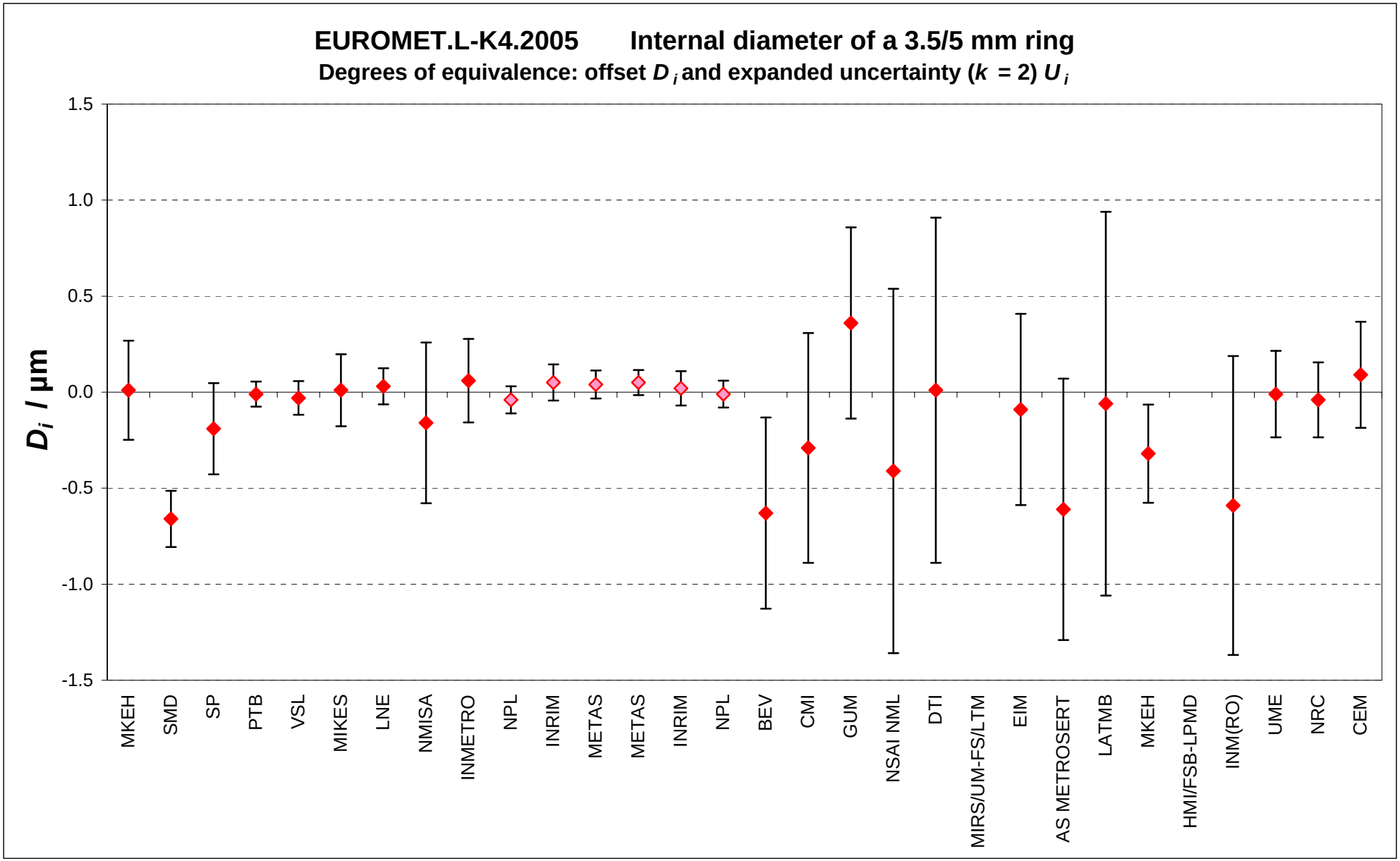
MEASURAND : External diameter
GAUGES : 4/5 mm plug, 50 mm plug and 30 mm sphere

Linking laboratories between Group 1 and Group 2

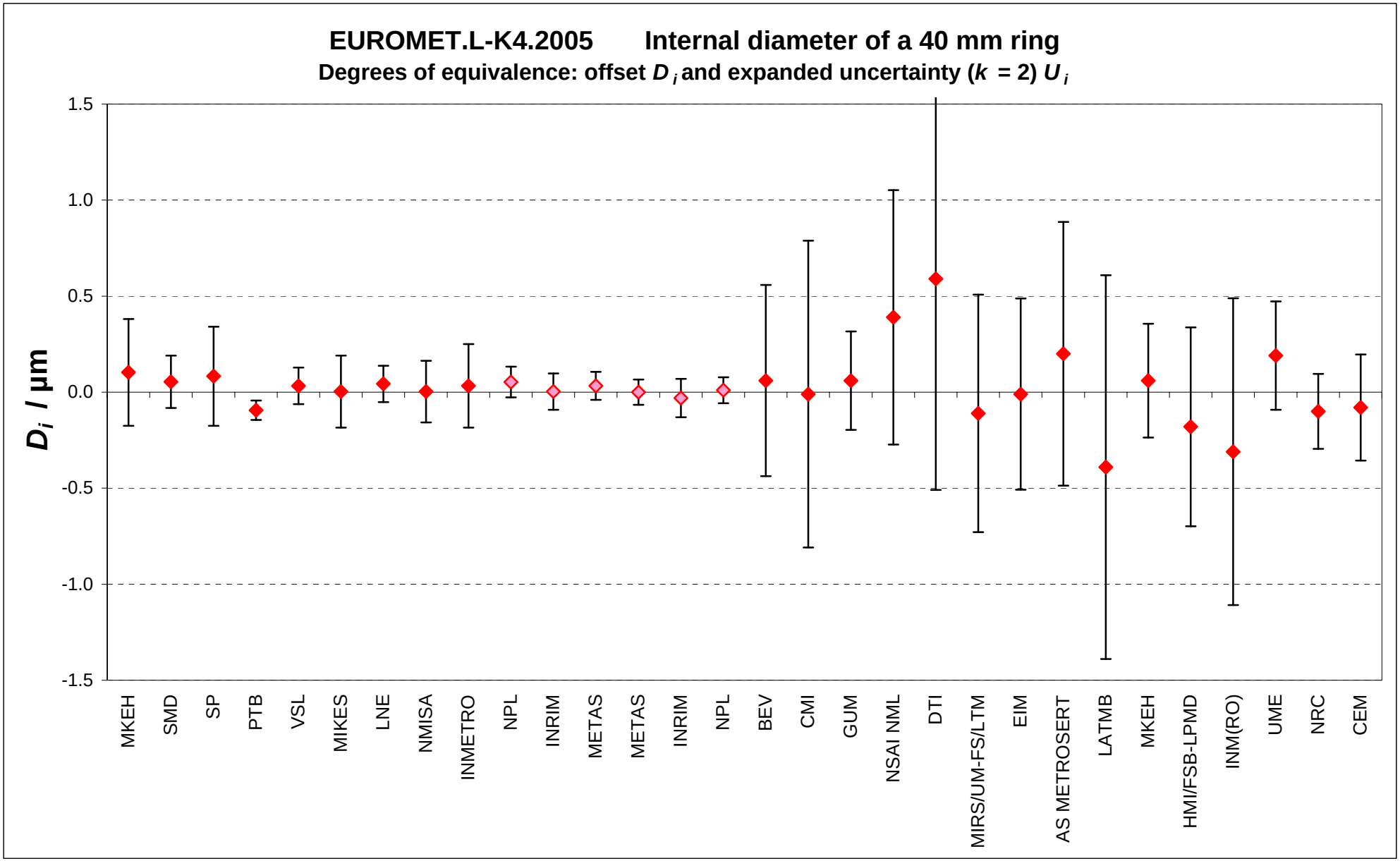
Lab *i* ⇩	4/5 mm plug	
	D_i / µm	U_i / µm
MKEH	0.153	0.238
SMD	-0.010	0.190
SP	0.093	0.157
PTB	-0.025	0.016
VSL	-0.477	0.208
MIKES	-0.047	0.188
LNE	0.063	0.095
NMISA	-0.207	0.479
INMETRO	-0.447	0.222
NPL	-0.287	0.091
INRIM	0.053	0.116
METAS	0.083	0.095
METAS	0.040	0.068
INRIM	0.080	0.091
NPL	-0.070	0.084
BEV	0.090	0.297
CMI	-0.280	0.599
GUM	-0.061	0.175
NSAI NML	-0.050	0.144
DTI	0.020	0.899
MIRS/UM-FS/LTM	-0.180	0.297
EIM	0.090	0.337
AS METROSERT	-0.040	0.309
LATMB	-0.420	1.399
MKEH	0.000	0.236
HMI/FSB-LPMD	-0.130	0.599
INM(RO)	-0.780	0.779
UME	-0.100	0.297
NRC	-0.040	0.196
CEM	0.230	0.277

Lab *i* ⇩	50 mm plug	
	D_i / µm	U_i / µm
MKEH	-0.470	0.283
SMD	-0.486	0.142
SP	-0.030	0.196
PTB	0.012	0.061
VSL	-0.370	0.218
MIKES	0.010	0.185
LNE	-0.080	0.091
NMISA	0.010	0.150
INMETRO	0.210	0.216
NPL	-0.230	0.142
INRIM	0.020	0.102
METAS	0.000	0.080
METAS	-0.020	0.123
INRIM	0.050	0.135
NPL	-0.160	0.134
BEV	0.090	0.293
CMI	-0.070	0.797
GUM	-0.090	0.231
NSAI NML	-0.050	0.189
DTI	-0.770	1.098
MIRS/UM-FS/LTM	-0.770	0.516
EIM	0.120	0.354
AS METROSERT	-0.060	0.473
LATMB	-0.310	1.999
MKEH	0.090	0.272
HMI/FSB-LPMD	-0.100	0.596
INM(RO)	-0.670	0.817
UME	-0.130	0.305
NRC	0.160	0.189
CEM	0.060	0.272

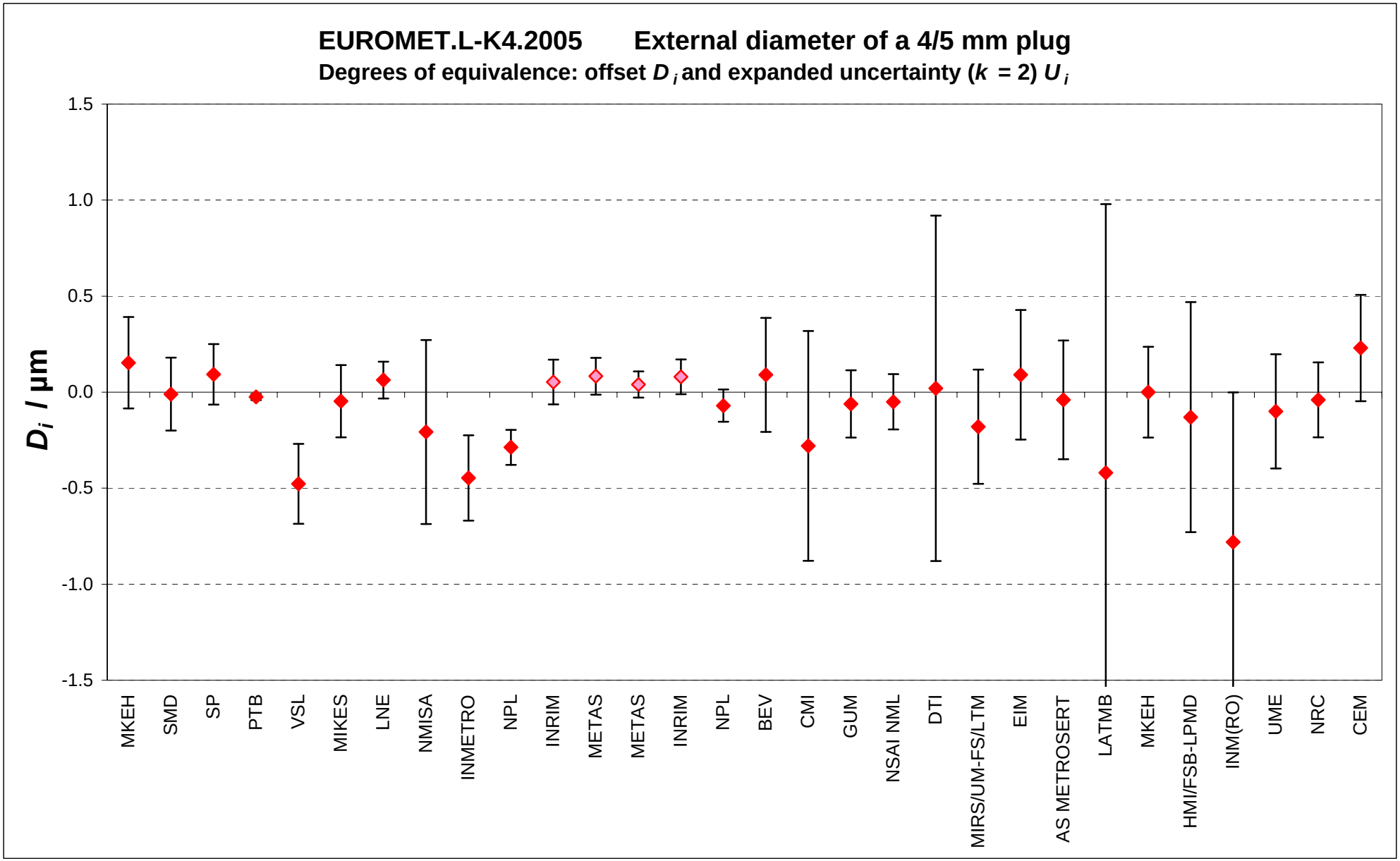
Lab *i* ⇩	30 mm sphere	
	D_i / µm	U_i / µm
MKEH	-0.084	0.279
SMD	-0.495	0.163
SP	-0.304	0.319
PTB	0.002	0.000
VSL	0.036	0.092
MIKES	-0.104	0.117
LNE	0.046	0.199
NMISA	-0.084	0.151
INMETRO	0.046	0.219
NPL	0.016	0.113
INRIM	0.006	0.129
METAS	0.026	0.139
METAS	0.060	0.127
INRIM	0.140	0.116
NPL	0.190	0.122
BEV	-0.060	0.294
CMI	-0.370	0.798
GUM	-0.114	0.170
NSAI NML	-0.170	0.170
DTI	-0.670	1.098
MIRS/UM-FS/LTM	-1.070	0.306
EIM	0.170	0.355
AS METROSERT	0.150	0.388
LATMB	-	-
MKEH	0.000	0.274
HMI/FSB-LPMD	-0.140	0.597
INM(RO)	-0.870	0.798
UME	-0.010	0.191
NRC	0.120	0.191
CEM	-0.080	0.149



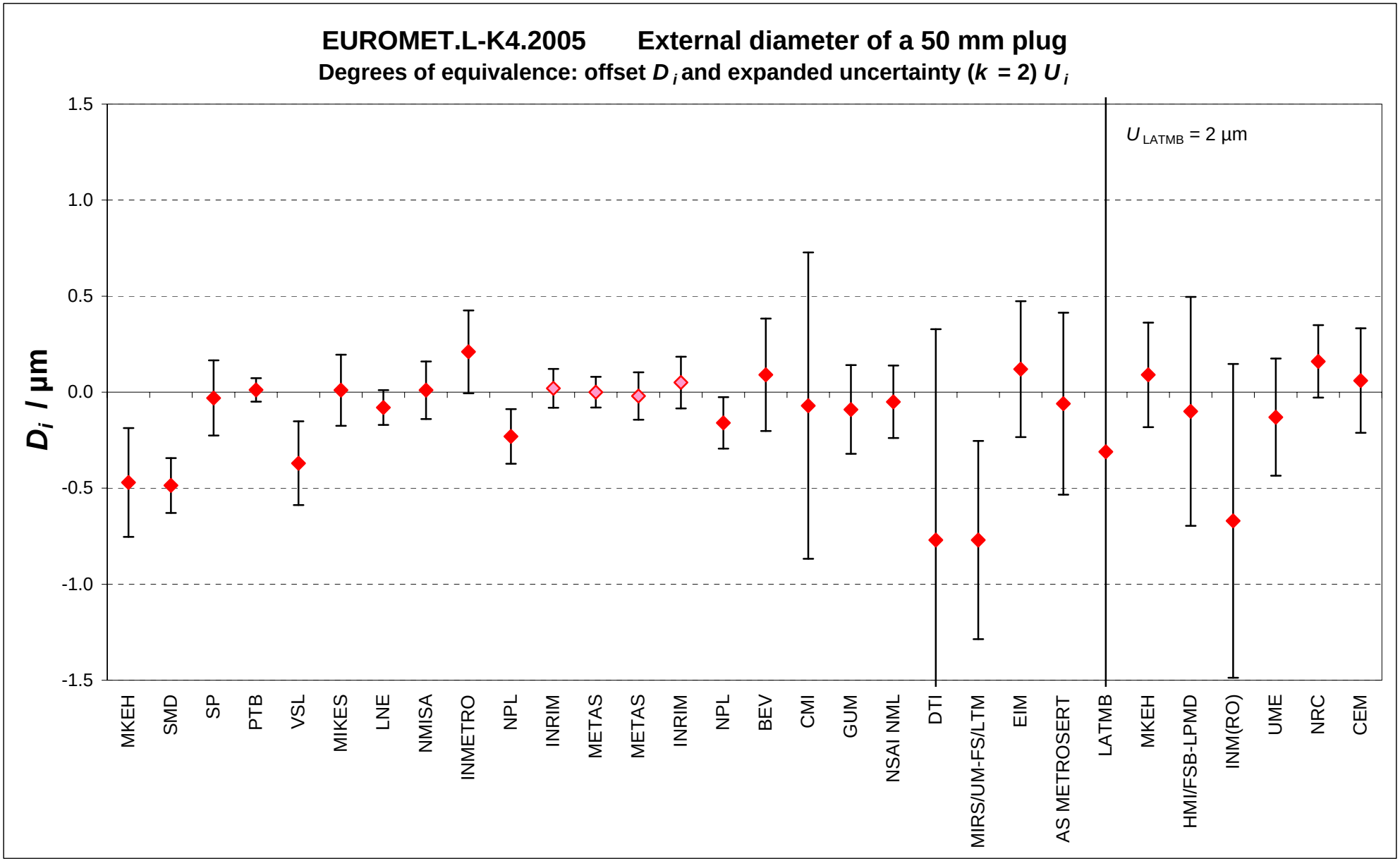
Group 1 and Group 2 laboratories (red diamonds) shown on the left and on the right, respectively, with linking laboratories (pink diamonds) in the middle of the graph



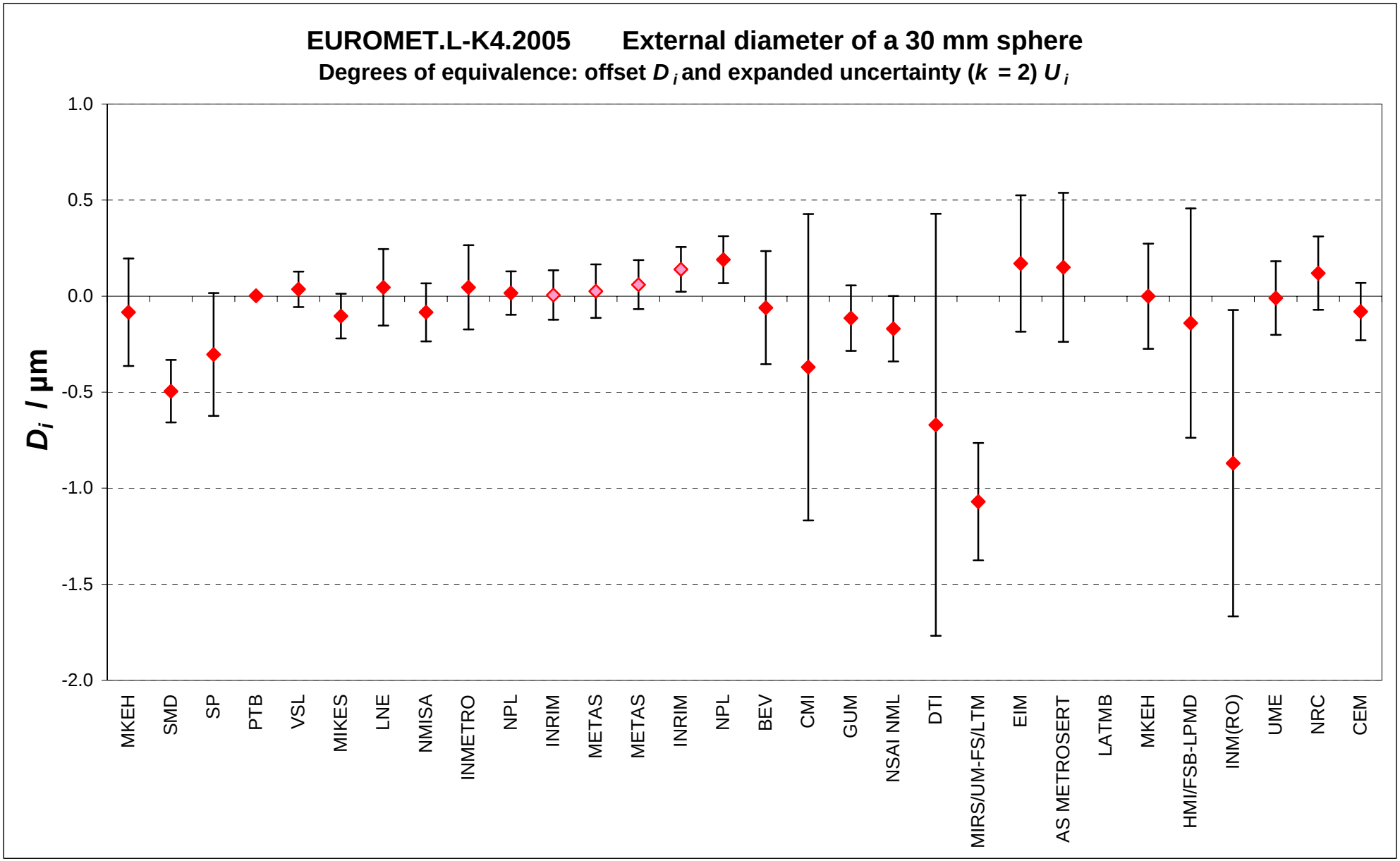
Group 1 and Group 2 laboratories (red diamonds) shown on the left and on the right, respectively, with linking laboratories (pink diamonds) in the middle of the graph



Group 1 and Group 2 laboratories (red diamonds) shown on the left and on the right, respectively, with linking laboratories (pink diamonds) in the middle of the graph



Group 1 and Group 2 laboratories (red diamonds) shown on the left and on the right, respectively, with linking laboratories (pink diamonds) in the middle of the graph



Group 1 and Group 2 laboratories (red diamonds) shown on the left and on the right, respectively, with linking laboratories (pink diamonds) in the middle of the graph