

Is it possible to reduce costs and increase
benefits of key comparisons?

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What is the purpose of key comparisons?

Considering that

- the result of a measurement is expressed in an SI unit,
- the uncertainty claimed describes the possible deviation of the measured value from the SI unit according to its *definition* (not its *realisation*),

it should be agreed that

- the purpose of key comparisons is to test if results provided by NMIs are mutually consistent taking into account the claimed uncertainties.

How should key comparisons be analysed?

Considering that

- the median and the MAD (median of absolute deviations) works only in special cases [1],
- the weighted least squares method (LSQ) can be applied to all models, including drift models and can take into account covariances [2][4],
- discrepant results are easily identified and properly dealt with using LSQ [3],
- linking of key comparisons is easy with LSQ [2],

it is suggested that

- LSQ should be the agreed method for analysing KCs.

How should key comparisons be organised?

Considering that

- KCs involving 15-20 NMIs take years of measurement and have repetition periods of 10 years or longer,
- significant changes in staff or equipment are introduced continuously in NMIs,
- LSQ can provide strong links between comparisons,

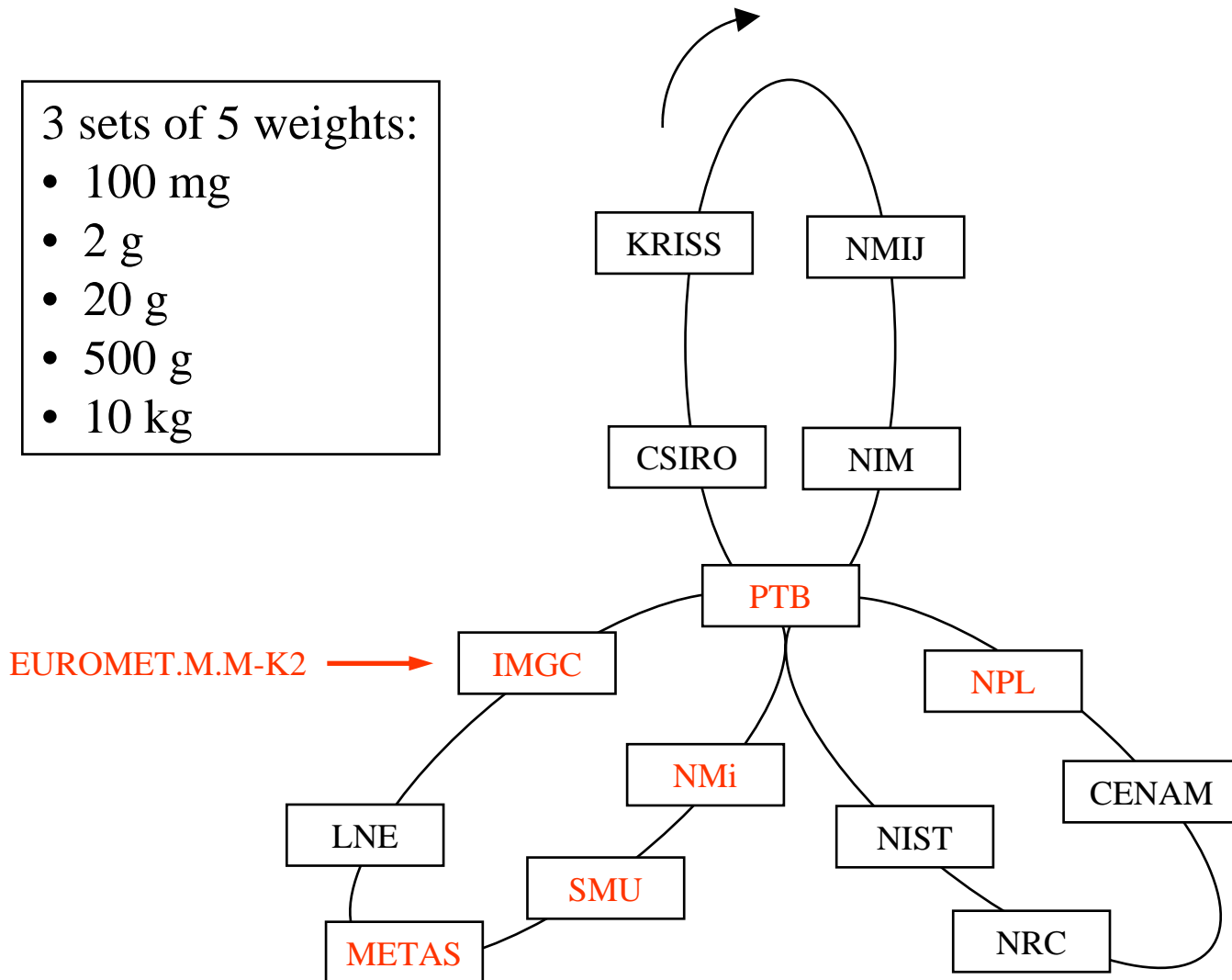
the benefits of key comparisons can be improved by

- organising smaller comparisons timed at the need of the participating NMIs,
- updating the analysis as results are available,
- feeding back quickly information to participants.

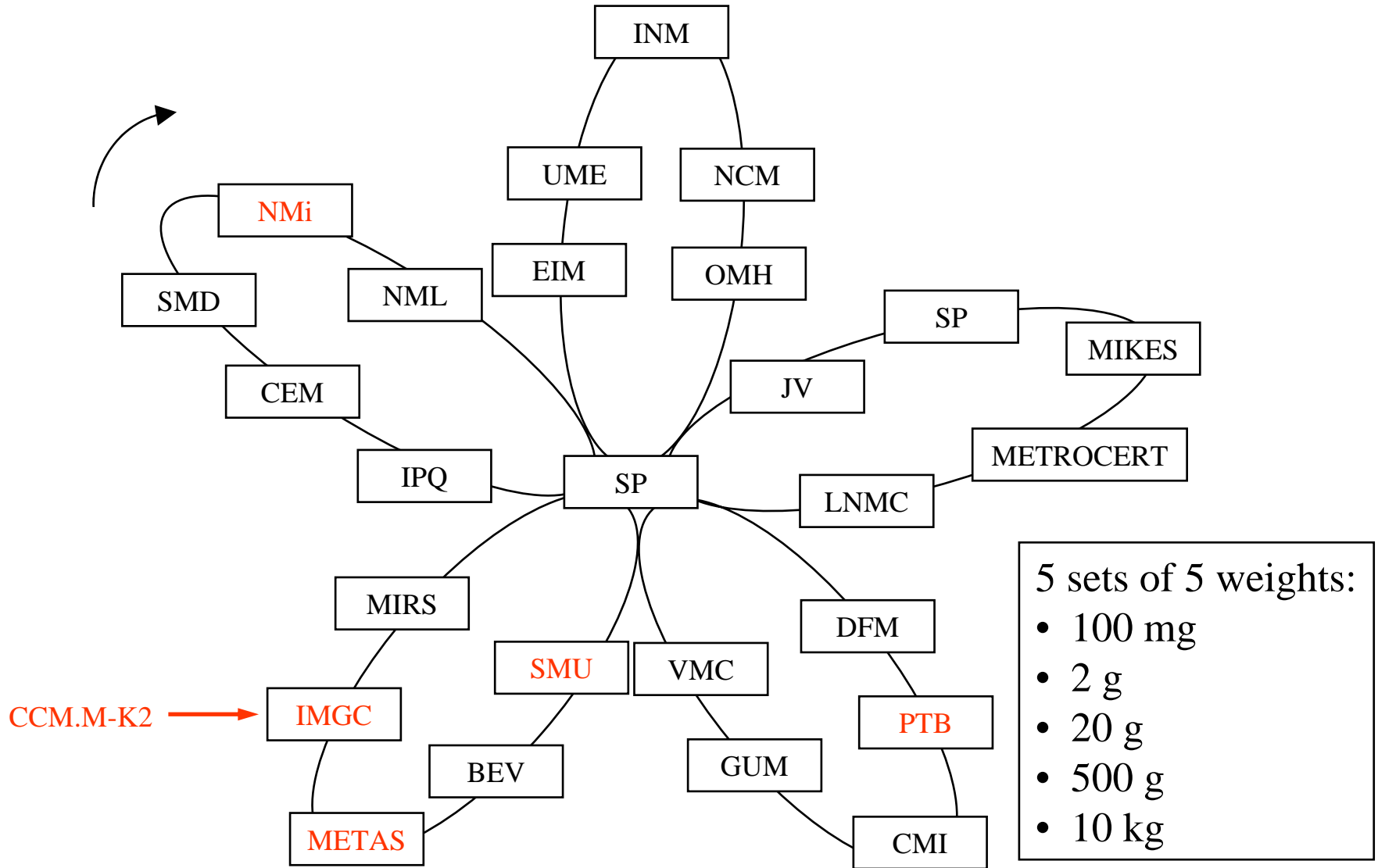
CCM.M-K2 (1998-1999)

3 sets of 5 weights:

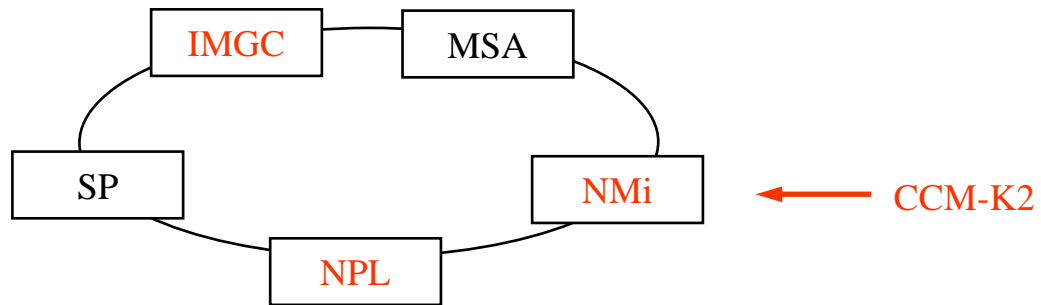
- 100 mg
- 2 g
- 20 g
- 500 g
- 10 kg



EUROMET.M.M-K2 (2002-2003)



EUROMET.M.M-K2.1 (planned)



1 set of 5 weights:

- 100 mg
- 2 g
- 20 g
- 500 g
- 10 kg

How much reporting is needed?

Assuming that

- it is agreed that the purpose of a key comparison is to test consistency between results provided by NMIs,
- the use of weighted least squares for analysing key comparison has been agreed upon,

each participant needs to report

- measurement results including uncertainties and covariances (correlation coefficients),
- covariances between results of this and similar key comparison (to strengthen linking),
- covariances with other participants due to traceability.

How much reporting is needed?

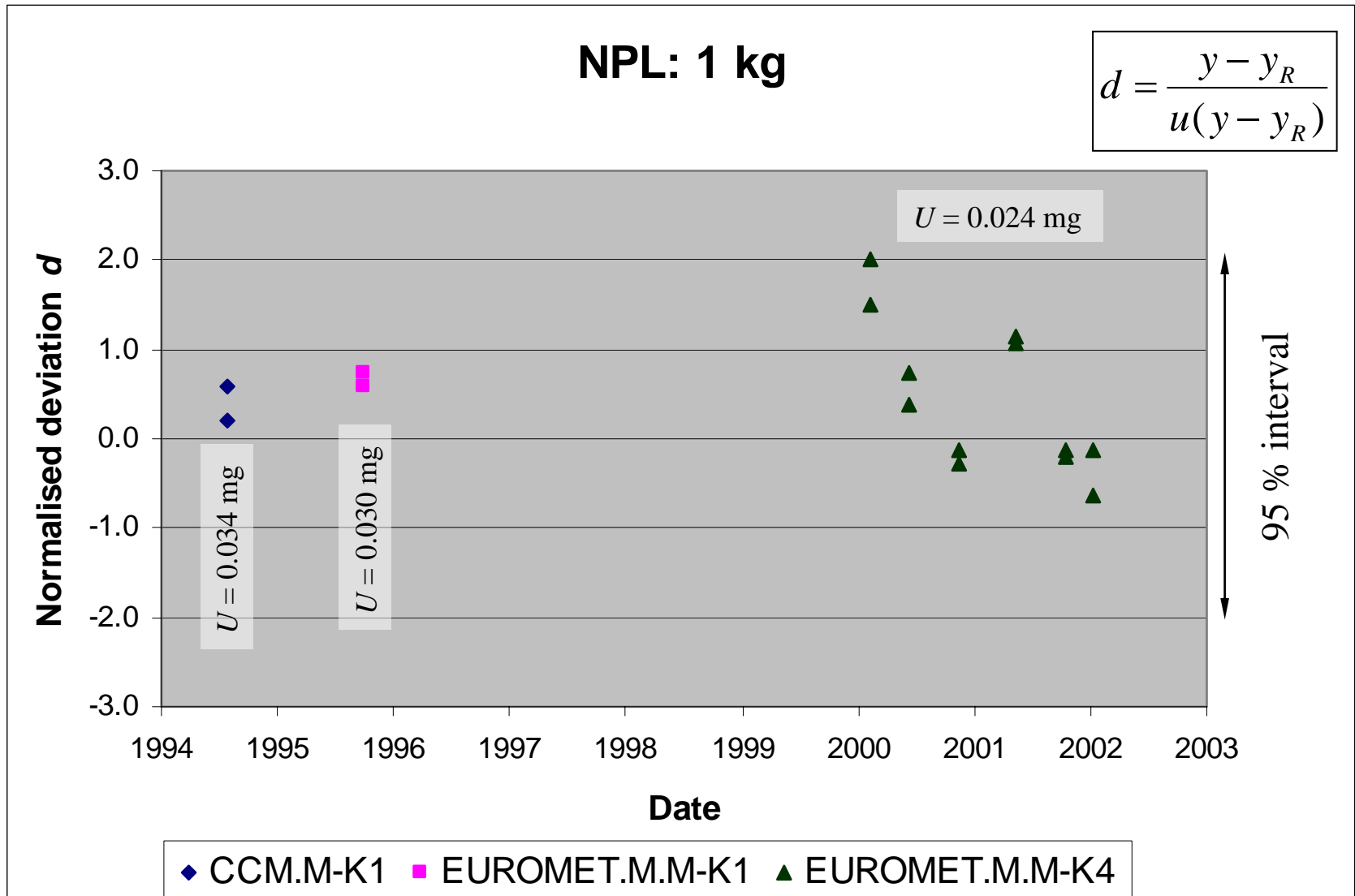
Assuming further that

- BIPM is provided with the necessary tools for the least squares analysis,
- it is agreed to restructure the KCDB,

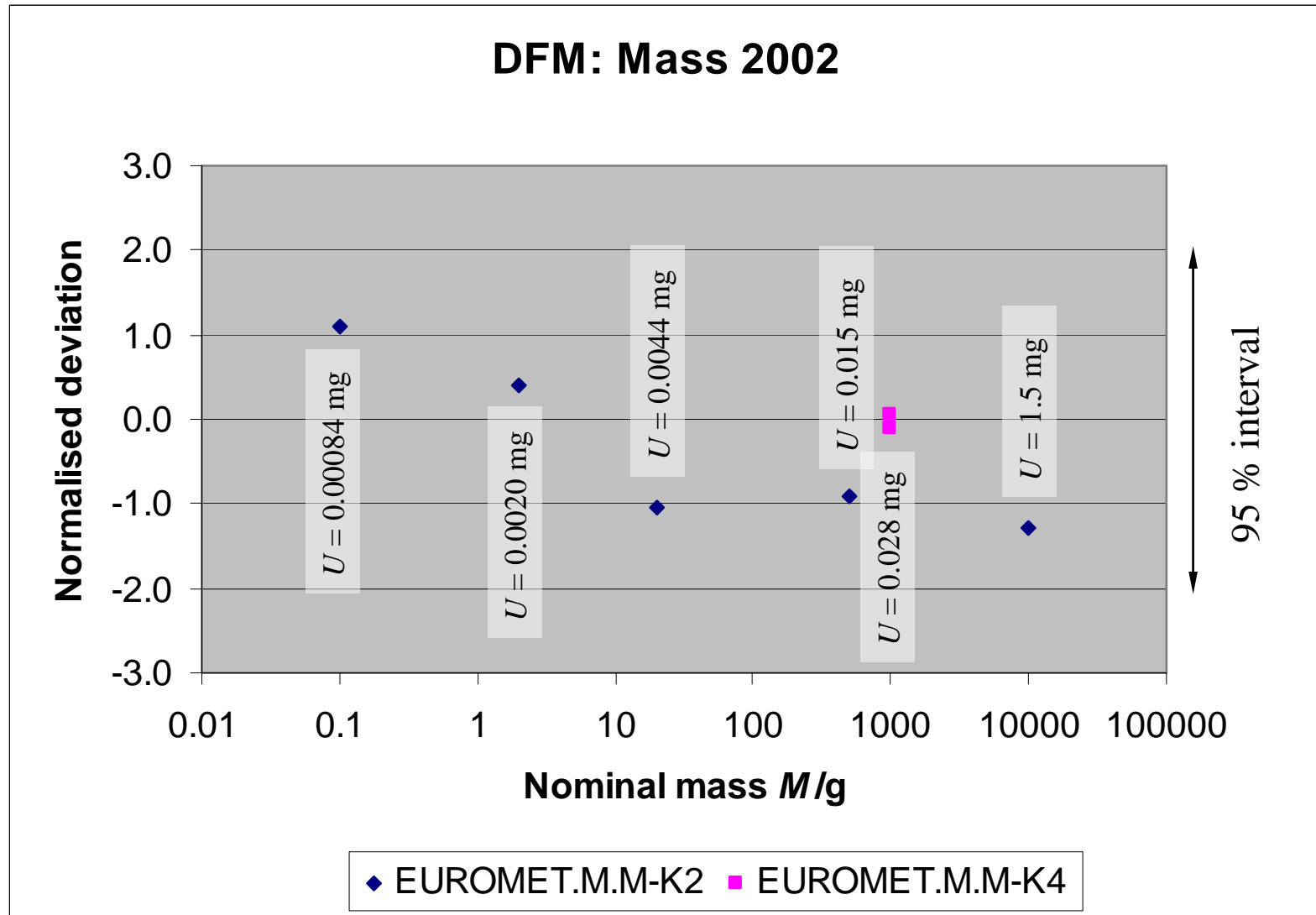
a search facility of the KCDB could provide

- for a specified NMI, the claimed measurement uncertainties and the degrees of equivalence with the key comparison reference values as a function of time or nominal quantity value,
- for a the specified pair of NMIs, the degrees of equivalence between their results in specified KCs (if needed).

Degrees of equivalence versus time



Degree of equivalence versus quantity value



Conclusion

Increase in benefits is possible by

- organising smaller but linked comparisons timed at the needs of participating NMIs,
- reducing the feed-back time to the participants,
- providing the information essential for the MRA.

Reduction in cost is possible by

- having an agreed method for the analysis of KCs,
- integrating the analysis tools with the KCDB,
- skipping traditional KC reports.

References

1. J.W. Müller, *Possible Advantages of a Robust Evaluation of Comparisons*, J. Res. Natl. Stand. Technol. **105**, 551 (2000)
2. L. Nielsen, *Evaluation of measurement intercomparisons by the method of least squares*, DFM-99-R39 (2000)
3. L. Nielsen, *Identification and handling of discrepant measurements in key comparisons*, DFM-02-R28 (2002)
4. L. Nielsen: *Evaluation of the calibration history of a measurement standard*, DFM-01-25 (2001)