Improvement of the realisation of the mass scale

as involvement of robotic mass comparators, dimensional limitations of the inner chambers or weighing pans of the mass comparators or different composition of the weighing set, the methods shall be reshaped to the actual laboratory needs. Some available publications are covering parts of the task [7 - 14].

Despite the very recent new SI, usually the 1 kg mass standard is still used as starting point of the dissemination process, as it was at the time when the definition of the kilogram was based on the international prototype.

One of the outcomes of the new definition is that the uncertainty of the calibration of the one kilogram mass standards is increased. It forces a lot of national metrology institutes to enlarge their calibration measurement capabilities [15]. The most important scientific result of the proposed improvement in subdivision and multiplication techniques is that it could play an important role in preventing many National Metrology Institutes (NMIs) from being forced to increase their Calibration and Measurement Capabilities [15].

The specific objectives of the project are:

a) to analyse the methods for realisation and dissemination of the mass scale including the impact from the recent redefinition of the kilogram; to create an appropriate methodology in order to optimise for different technical requirements and parameters (e.g. robustness, effectiveness, small uncertainty, properties of different weighing instruments, different types of weight sets, number of control weights or standards).

b) to develop and implement calibration methods to realise, improve and maintain the mass scale.

c) to develop advanced mathematical and statistical tools and software solutions to calculate the results from mass measurements and to evaluate the associated uncertainties (including correlations between standards and measurements and handling of outliers).

d) to draft a EURAMET guideline for the realisation of the mass scale.

e) for each participant, to develop an individual long-term strategy.

3. AIMED SCIENTIFIC RESULTS

Improved designs of the measurements with guidance for choosing an appropriate design will be produced. It includes optimisation for robustness, effectiveness, uncertainty, taking into account the properties of different weighing instruments, different types of set of weights, the number of control weights and mass standards.

Second scientific results would be a reduction of the uncertainties via better mathematical methods. Currently used mathematical solutions are usually limited to ordinary or weighted least squares methods. Generally, these methods do not allow the use of multiple mass standards as input to the disseminations. This is probably the biggest opportunity to improve the realisation of the mass scale, because the different realisation of mass unit delivers calibration of different nominal values. Recalling that in the past the one kilogram was the solely the starting point of the realisation of the mass scale. Nowadays with Kibble balances, the mass of weights with a wider range of nominal values can be determined (e.g. 50 g to 1 kg) while using other techniques (e.g. capacitive, electrostatic) small mass standards (e.g. 10 mg to 1 g) can be realised. All these calibrated mass standards shall be included as input into the calculation of the mass scale in order to reduce the uncertainties.

4. SUMMARY

This article is to bring into attention the scientific potential of the EMPIR project “Realmass”, which is aiming the improvement of one of the most important techniques in mass metrology, the realisation of the mass scale.

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