

IMPLEMENTING METROLOGY IN THE EUROPEAN RESEARCH AREA – THE iMERA PROJECT

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Abstract: Advances in metrology underpin innovation, enable improvements in quality of life, and unlock potential from other areas of science. Increased demand for top-level metrology in traditional areas, allied with the need to support emerging areas of technology, requires a new approach from the European NMIs. Increasing levels of cooperation in R&D will enable the NMIs to significantly improve impact from funding that can not reasonably be expected to keep pace with demand growth. Within the iMERA project a coordinated European Metrology Research Programme will be prepared and the institutional and legal conditions for its implementation will be generated.

Keywords: research, metrology, EUROMET.

1. INTRODUCTION

Industry, trade, and increasingly quality of life depend on effective, consistent measurements. Therefore the demands on metrology are steadily growing, and can be expected to grow even more rapidly in the future [1]. The drivers behind this pressure may be considered threefold:

- traditional areas of industry are becoming more complex and are requiring broader measurement ranges and lower uncertainties,
- new areas of technology are emerging, e.g. nano-technology and biotechnology,
- areas which are not in themselves new, but in which the value of metrology is increasingly being recognised, e.g. chemistry, clinical medicine or food safety.

One of the roles of the National Metrology Institutes (NMIs) is to address these needs, although increasingly NMIs are facing the difficult situation that they need to free resources for the development and delivery of new metrology for new technologies and sectors whilst meeting demands of the existing “traditional” sectors [2] - a situation which is interpreted as the “metrology dilemma”. One key approach to address this dilemma is to increase impact through greater collaboration in metrology, both in the research and development effort and in the delivery of the resulting measurement services.

The vision of how this might be achieved in the field of research through the implementation of the European Research Area (ERA) in metrology will be discussed in this paper and ideas of how to accomplish this ambitious goal explored.

2. THE MERA PROJECT

Within the EU 5th Framework Programme EUROMET conducted a study “Metrology for the European Research Area” (MERA) [5] which analysed the metrological needs for Europe at the beginning of the 21st century. The aim of the project was to understand whether and how the “European metrology dilemma” might be addressed through closer collaboration. This involved developing the plans to optimise and increase significantly the impact of European metrology research.

National Measurement Systems, and the organisation of and within NMIs, varies from country to country. Whilst the smaller NMIs have always focussed their resources on the most pressing priorities of their country, relying on the capabilities of the larger NMI for the balance, in many larger countries the NMIs have historically provided a comprehensive range of services and research. The growth in demand on resources means that the assumption that all capability must be provided from within the country is being questioned even in the larger countries. Whilst smaller countries can identify and concentrate on their priority topics on a unilateral basis, if the larger countries adopt the same approach Europe risks losing vital capability and coherence [2].

Within the MERA project several scenarios for the future metrological infrastructure and their advantages and disadvantages were discussed. These included:

- a) **Comprehensive national provision**, where every country has an NMI, offering a comprehensive metrological service,
- b) **Selected standard holders**, where the NMI provides a service as comprehensive as possible, but maintains primary standards only in some selected (and agreed on the European level) areas, obtaining traceability in the other areas from another NMI,

c) **Specialised centres of excellence**, where selected NMIs maintain primary standards and offer traceability in one or several areas to all users in Europe,

d) **Single European Metrology Institute**, where the national NMIs are discontinued.

Whilst the current situation lies somewhat between scenarios (a) and (b), the European NMIs see the future solutions in scenario (b) or (c) or a mixture between (b) and (c). In this aspect, it should be noted that the optimum solution might vary between technical areas.

Concerning R&D in metrology, the MERA study identified, amongst other results, that:

- the aims of various national programmes have significant overlap,
- many of the research teams are sub-optimal in terms of critical mass,
- major/special metrological facilities are expensive to establish, and may not necessarily be fully utilised through national demand alone,
- many of the topics tackled by research would best be addressed collaboratively.

This indicates the potential for raising the effectiveness and impact through coordinated R&D activities in metrology realised at a European level. A pan European approach to metrological research would increase critical mass, share the burden and create a common scientific and technological perspective.

3. THE iMERA PROJECT

In October 2004, as a consequence of the outcome of the MERA project, EUROMET members submitted a proposal to the European Commission for a European Research Area Network under the 6th Framework Programme. This proposal - iMERA (“implementing MERA”) - was positively evaluated and the three-year contract between the partners and the European Commission commenced on 1 April 2005.

The aim of the proposal is twofold; firstly, to facilitate some ‘bottom-up’ but coordinated European research projects and secondly, to create the conditions and structures within EUROMET to enable the NMIs to conduct coordinated metrological research in identified areas of strategic importance.

Furthermore the project is investigating the prospects for collaboration on the basis of Article 169 of the European Treaty. This article enables the European Commission to give financial support to European research in areas where EU Member States are willing to pool part or all of their national resources. To facilitate this goal a number of ministries that fund national metrological research are also formal partners in the iMERA project. If the conditions are deemed appropriate, a proposal for a coordinated European metrology research programme (EMRP) will be prepared within the iMERA project with the aim of realising it

through Article 169 within the EU 7th Framework Programme in 2007/2008.

3.1 The Consortium

The iMERA consortium comprises 20 partners from 14 countries including the IRMM-JRC. They may have the status of a “programme manager” (NMI) or “programme owner” (Ministry or their representative), or both.

3.2 The Project management

Day to day management of the project is via the Network Management Committee (NMC), comprising the leaders of each of the various different task groups that make up the project, which will be chaired by the Project Coordinator. Oversight and guidance is ensured through a separate Network Steering Committee (NSC). Composed of senior representatives of 8 countries and, once again, chaired by the Project Coordinator to ensure continuity, the NSC monitors the progress of the project, and, if necessary, suggests corrective actions. Furthermore the NSC has responsibility for the key recommendation related to the Go/No-Go decision regarding the continuation towards Article 169. Work is organised in 6 Work Packages (WPs) each comprising a number of tasks. The first 5 WPs are “operational” and address incrementally increasing levels of collaboration, whilst the 6th WP contains the horizontal project management and associated activities. Thus, unusually for an EC project, the WP structure is not thematic, and topics such as foresight are addressed in more than one Work Package.

A dedicated web portal facilitates the project management for the consortium and also provides more general access to information disseminating the project outputs.

3.3 The Work Packages

Considering the rather ambitious aim of the project, a significant number of issues in widely diverse areas have to be addressed. The project comprises 37 “tasks” identified by Work Package and task number and corralled into 12 task groups [4], described briefly below.

3.3.1 Systematic exchange of information and best practice

In this first work package the information needed for joint actions are collected by the partners and collated by the task group. The work is divided in several tasks such as: National programme landscaping, overview of national processes for foresight and prioritisation, knowledge transfer and training opportunities...

3.3.2 Strategic activities

This work package is built on the preceding one and prepared the ground for joint activities between the national programmes in the following work package. It also consists in several tasks of which the more important are: assessment

of the existing foresight information, identification of opportunities and quantification of the benefits of collaborative R&D, intellectual property issues, special needs of emerging EUROMET members...

3.3.3 Joint activities

The three tasks in this work package identify the strategic European metrology research activities based on the collected foresight information: Joint foresight studies, Joint training and mobility and Joint research projects.

3.3.4 Transnational activities

Following the joint activities relating to foresight, training and mobility in the third work package, this work package establishes the structures and processes for joint activities and launches joint European research projects. It consists of four tasks: identification of strategic European metrology research activities to support innovation and quality of life, adaptation of the EUROMET structures to facilitate and optimizes joint ERA-NET activities, opening special facilities to other European metrologists and launching a quick start projects with central fundings.

With the achievements of the above tasks, a new level of coordinated metrological research will be reached in Europe. A coherent level of European research in metrology will help to achieve the aim of establishing Europe as the most competitive and dynamic knowledge-based transfer economy until 2010.

3.3.5 Realization of the ERA in Metrology through Article 169

The 5th operational Work package focuses solely on the prospects for launching an Article 169 action, and is over and above the expected commitment from this type of EC project. Workshops are planned at various stages of the project in order to enable input from the practitioners and stakeholders.

4. ACHIEVEMENTS

Some tasks have been already completed and recommendations issued.

4.1 National programme landscaping

The landscaping questionnaire gave the opportunity to share a large amount of information on the metrology R&D activities performed by European NMIs (including Designated Institutes): the manpower available in each metrology field, new areas in development, an idea of available financial support per field, etc.

The analysis of this landscape should give some ideas and inputs for identifying the R&D programme priorities in individual countries. It will provide background for the programme owners and programme managers forum, Task 2.2. Combined with personnel mobility opportunities

(output from Task 1.7), and the recommendations of Task 2.3 (Identifying opportunities and quantifying the benefits of collaborative R&D and shared facilities to aid national funding decisions), this sharing of information will provide a sound basis for future choices on collaborative metrology R&D in Europe.

The landscape:

- gives a snapshot of R&D activities in each country, in each field;
- gives a global view of R&D in Europe per domain;
- gives a better idea of manpower in each metrology sector and globally;
- points out new areas of development;
- provides a view on mobility opportunities;
- is a vital step to enabling a trans-national research programme.

The report will also be useful to EUROMET TC chairs and technical experts to get a better idea of R&D performed in their fields across countries, in particular the chapter § 3.2.4 on “the analysis of R&D developed subjects in metrology” and the detailed annexes.

To summarise and for the continued efficiency of the project:

- the roadmaps elaborated in Task 4.1 and this Task 1.1 report will be pillars to support the work of Task 5.1 - Preparation of the European Metrology Research Programme;
- the detailed annexes and other parts of the report give information of R&D activities per field and per country useful to Euromet TC chairs
- we encourage each EUROMET TC to make use of this information by collating a summary of the existing R&D programmes/activities in relevant technical areas, to complement this report and the roadmaps, to support the elaboration of the EMRP;
- EUROMET should consider mechanisms for maintaining the information in this report – an up to date resource of this nature will be vital for making informed choices throughout the lifetime of the EMRP and beyond.

4.2 Overview of national foresight process

In terms of future perspectives, it is clear that the foresight should set the grounds for the foundation and the operation of the post-iMERA institutions. To achieve this goal a preliminary requirement is a common template for the European foresight, in order to harmonise the procedures and get homogenous results. Of course, national foresights can still survive but may have a different approach and, perhaps, a different template.

Open issues which need further discussion are: how to harmonise the two levels (European and national) and what to do when they are diverging in scope and priority.

In order to be effective, foresight must at the same time combine the needs set by FP7 and formulated by people outside the metrology community and the metrology solutions provided by EUROMET TCs. It should also go

beyond the linear extrapolation model or, in other words, be visionary.

There is an initial strategy problem which concerns the way the target is defined; it should be

- broad enough to cover as much of metrology system as possible;
- focused enough to trigger changes;
- simple enough to be understood, and supported, by all stakeholders.

To promote a foresight study aiming at the EMRP formulation implies an involvement of several hundreds of people (some estimates are for 300 to 3000 people to be involved). An interesting proposal to manage such EMRP Foresight was the establishment (e.g. within the TC-IntMet) of a European Metrology Foresight Panel (EMFP) which could consist of about 15-20 metrology experts from European NMIs and EUROMET. It should meet at least once a year and it should be responsible for compilation and update of a European Metrology Foresight Study (EMFS). It could include advice from external experts, stakeholders, interest groups. It should be free to choose appropriate foresight tools, including how to consult external experts and it should be independent from EMRP program formulators in order to avoid any automatism from foresight to EMRP.

To fully exploit the research opportunities, the EMRP formulation and consequently the EMFS has to take into account the new elements which FP7 envisaged. Among other, they include an emphasis on research themes rather than on “instruments”; a significant simplification of the program operation; a focus on developing research that meets the needs of European industry, through the work of Technology Platforms and the new Joint Technology Initiatives; an establishment of a European Research Council, funding the best of European science; an integration of international co-operation in all four programmes; a development of regions of knowledge; and a Risk-Sharing Finance Facility aimed at fostering private investment in research.

4.3 Joint research projects

A few of them started since April 2005 and are on going. The list is given hereafter along with the country code of the pilot country:

Toward more accurate temperature fixed points (FR)
Determination of an accurate T_{tp} vs x (isotopic) relationship for neon (IT)
Advanced Mathematical and Computational Tools in Metrology: a European collaboration in research (IT)
Recommendations for the calibration and evaluation of pH on site measuring instruments (FR)
Use of the Temperature Amplifier as a new temperature standard for contact thermometry (IT)
Measurement of acoustical impedance of artificial ears (GB)

Tip and sample interactions in scanning probe microscopy (GB)

New Determinations of the Boltzmann Constant (DE)

Binary Josephson Array Power Standard (DE)

A common protocol has been issued for these projects defining work programme with stated objectives, defined responsibilities, timescales and resources. They are monitored in detail to quantify benefit/cost of conducting R&D on a collaborative basis.

4.4 Quick start projects

Two projects were started and are almost completed:

- Study of a real-time control unit for JDAC arrays: application to watt balance experiments

The project will produce a prototype control unit for the bias source, based on readily available (commodity) hardware and open source software, to provide a reliable, versatile, platform for a variety of JDAC array measurements requiring real-time control.

The software for the control unit would be published as free software under the General Public License (GPL) making the results of the work freely available across the EU and the world.

- High temperature fixed points for contact thermometry

The project corresponds to the key starting step of Euromet project N°857 (4 years duration), the general objective of which is to develop robust high temperature fixed points for thermocouple calibration above the freezing point of copper / 1084 °C.

This project will produce a set of six robust cobalt-carbon eutectic cells. Local assessment of the developed cells will be performed, the final aim being to qualify the Co-C point as a new fixed point for thermocouple calibration with ultra-low level of uncertainty.

5. CONCLUSION

An opportunity to increase impact from European funding in metrology through the enhanced coordination of the R&D activities in metrology between the European NMIs has been identified. The iMERA project has the ambitious aim to generate the conditions for the execution of a coordinated – that is both strategically led “top-down” and innovation led “bottom-up” – metrology R&D projects. Furthermore the project will undertake the groundwork with the prospect of launching, should conditions prove favourable, a formal European Metrology Research Programme utilizing Article 169 of the Treaty within the 7th Framework Programme. The EMRP would be supported through a mix of national contributions and support of the European Union and could be launched within the next 2 or 3 years.

The coordinated R&D activities will increase the benefit-cost-ratio significantly by avoiding unnecessary redundancy and by looking for the most appropriate approach and institution or consortium for the realisation of

a specific research project. This efficient use of the resources will open the possibility to address new fields in metrology, such as nano-metrology, biotechnology, etc., thus responding to the future metrological needs of European industry and society. Additionally, the ability to pool together the technical and human capacity of all participating European NMIs, particularly in the case of the most ambitious research projects, will enable the required “critical mass” to be achieved - a scenario probably not possible within an individual NMI.

In this way iMERA will enable the participating countries to increase significantly the national and European impact of their investment in R&D in metrology.

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