



# Analysis of public research institutes in Europe in selected S&T fields Historical evolution and future scenarios - Metrology

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# Analysis of public research institutes in Europe in selected S&T fields

Historical evolution and future scenarios - Metrology

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Kate Barker

Deborah Cox

Thordis Sveinsdottir

2009

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## Field: Metrology

This report reflects on the past and possible future of public metrology research institutes in the European Research Area (ERA). Metrology was one of six thematic areas, which were chosen as the focus of a European study to analyse the historical evolution and future scenarios for public research institutes in Europe in selected S&T fields. This report was presented as a part of the European Commission funded study to DG Research in 2009, contract number S106-12999 FORESIGHT-200702 Lot 2.

The overall aim of the project was to provide a basis for informing EU and national-level policies about the role of public research institutes in the development of the European Research Area<sup>1</sup> (ERA). It is clear that for the ERA to become a reality and a success, aspects of Europe's public research institute system will need to be tuned towards effectiveness and efficiency at the European level, in addition to the national level. The study looked at the past and potential future of research institutes in Europe. It focused on institutes in six fields, one of which is metrology, and aimed to provide a broad level of analysis that can improve understanding of the institutes and underpin policymaking in the institute sector.

## Research Questions

### 1.1 Mapping of the institutes by S&T field

- What are the public research institutes in the Member States in each field, and what are their missions, budgets etc.?

### 1.2 Main changes and the drivers of change

- What are the main changes that have occurred in these institutes in the last 20 years, and how do Member States differ in terms of the trajectories they have followed?
- Have there been important changes in terms of their objectives, rationale and research priorities?
- Has there been significant restructuring, modernisation or privatisation?
- What factors or drivers were behind these changes, and what was the impact of change?
- How have these public research institutes respond to EU research integration and globalisation?
- Do they cooperate more trans-nationally? In what ways has there been a closer integration of research activities of these institutes across national boundaries?

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<sup>1</sup> *Towards a European Research Area*, Communication from the Commission to the Council, COM(6), January 2006

- Is there a duplication of research effort across research institutes in different countries, and what are the advantages and disadvantages of this? To what extent is a diversity of research effort an asset or liability? How does this assessment differ according to the S&T field?
- What are the factors (socio-political, economic, research related..) explaining the healthy/unhealthy duplication of research efforts across member states?
- How have these public research institutes responded to EU research integration and globalisation?
- Do they cooperate more trans-nationally? In what ways has there been a closer integration of research activities of these institutes across national boundaries?
- Is there a duplication of research effort across research institutes in different countries, and what are the advantages and disadvantages of this? To what extent is a diversity of research effort an asset or liability? How does this assessment differ according to the S&T field?
- What are the factors (socio-political, economic, research related..) explaining the healthy/unhealthy duplication of research efforts across member states?

### 1.3 Scenarios for the future

- What are alternative future scenarios for the year 2030 for public research institutes in each field in terms of addressing the joint challenges of globalisation and moving towards a more integrated ERA?
- What are the constraints to further cooperation or integration?

## 2 Approach and Methods

### 2.1 Definition of the field

The mission of the metrology sector can be summarised as the development, maintenance and measurement of measurement standards. Metrology research centres in European countries all participate in the process of metrology policy formulation.

Metrology research is based upon expertise in various scientific fields and is used to underpin economic activity in diverse productive sectors and used by governments for regulation and standardisation essential for trade and functioning of goods and services. It is necessary for underpinning international standards and laws and for supporting national compliance. As technologies become more advanced, cross-cutting and novel technologies emerge (an obvious example here is the pervasive exploration of nanotechnology applications) new research and expertise is needed for standards and measurement systems.

Metrology research is organised in Europe through National Metrology Institutes (NMI) which conduct their research and provide their services on the basis of institutional funding from central government agencies or ministries. The organisation of the NMI varies, in

many countries the metrology structure is highly centralised, in others it is decentralised (such, for example, France). A result of this institutional arrangement is that metrology research institutions house specialists, which are not typically found in universities or private sector research. Many of the NMIs are fully nationally owned, some are semi-public and a range of smaller institutes are in fact private but dependent upon national public funding. The NMIs vary in the tasks they perform, some providing reference services, some providing the primary standards and some delivering commercial services, some being research intensive and others much less so. The metrology laboratory models operating throughout Europe are country dependent and highly diverse in terms of structure, ownership, funding models and operation. In recent years as can be seen from the profiles of eleven laboratories presented below the metrology infrastructure in Europe, throughout the member states, has been subject to significant restructuring and change.

The common denominator for the metrology sector is that all metrology laboratories are members of European and international metrology networks, in particular The European Association of National Metrology Institutes (EURAMET)<sup>2</sup> and WELMEC<sup>3</sup>. The objective of these networks is to establish a harmonised and consistent approach to European legal metrology. EURAMET is a Regional Metrology Organisation (RMO) of Europe. It coordinates the cooperation of National Metrology Institutes (NMI) of Europe in research in metrology, traceability of measurements to the SI units, international recognition of national measurement standards and of the Calibration and Measurement Capabilities (CMC) of its members. Among these tasks, EURAMET is responsible for the elaboration and execution of a European Metrology Research Programme (EMRP).

## 2.2 Development of the field over the past 20 years

### 2.2.1 Overview

Over the last 20 years the most commonly-seen and easily identifiable changes (based on review of annual reports and web sites) that have occurred in member states' metrology infrastructure are the institutional reconstructions, such as new EU regulations, new national laws, new organisational arrangements, joining international metrology organisations and the joint working together in EURAMET and the two successive ERA-Net actions for greater European collaboration and coordination. Entry into the European Union has been a significant change and triggered further change for the metrology institutes of the more recent member states.

Some member states have "privatised" their metrology services. However, no matter how "private" the new services are, the newly reorganised services are still mandated to enterprises fully or partially owned by the national governments (as shareholders).

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<sup>2</sup> <http://www.euramet.org/>

<sup>3</sup> <http://www.welmec.org/>

Each member state evolves its metrology infrastructure differently because each has its own historical experiences in participating international metrology conventions/organisations, national government structure, socio-economic-political circumstance, and science-technology-industry base.

### 2.2.2 Funding & Income

NMIs tend to have around 60% of their funding provided as core funding, around 25% income from commercial work for industry and government contracts and less than 7% of funding from the EU. This data comes from Williams 2002, p10 and was collected in 2002. Williams also revealed a large disparity in the budgets of NMIs and so as a consequence, in the R&D work that is carried out in the NMIs.<sup>4</sup> For Germany, for example, the total income for the NMI (in 2002) was €235 Million, while UK spent €139 Million. The third highest budget had Sweden with €45 Million, followed by France (€23 Million) and Italy (€21 Million). Smaller countries such as Belgium (€3.5 Million) or even Greece (€1 Million) have much more limited Metrology infrastructure. It is estimated that today Member States spend €120 Million on metrology research. Most investment in metrology is spent via the NMI and DI in Europe, less than 10% is subcontracted outside these institutes. Funding of metrology research is highly skewed across the EU 27 with Germany and the UK being major investors.

The metrology budget within EUROMET is shown below in graphical and tabular format. The data was compiled from an online survey which was conducted by DG Research between 7 May and 8 July 2008 and is published in the IMERA outputs.

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<sup>4</sup> Williams, Geoffrey, (2002): The assessment of the economic role of measurement and testing in modern society ("European Measurement Project"), Oxford and *Review of the ERA-NET iMERA and ERA-NET+ iMERA+ in view of the intention to prepare an Article 169 initiative*, 31.07.09

Figure 1 - Metrology R&D budget within Euromet

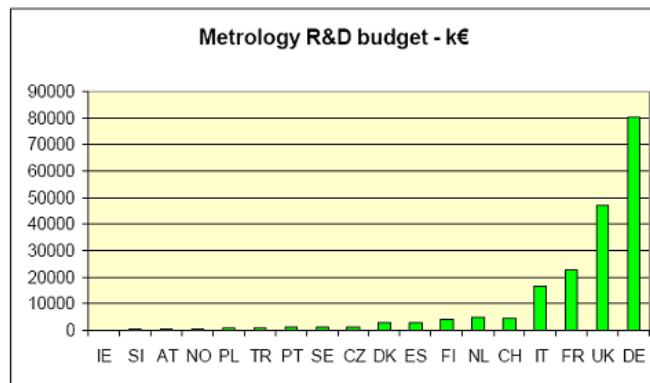
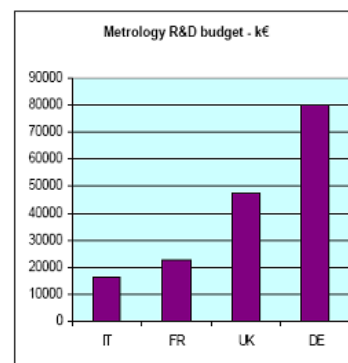
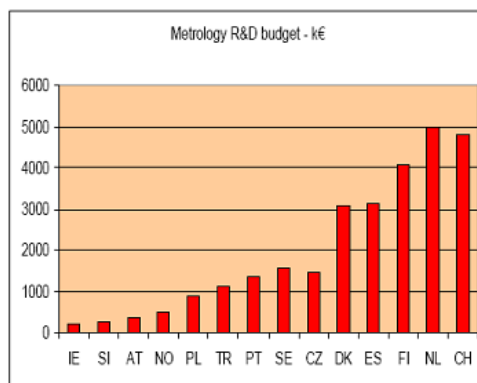


Fig.1. - Metrology R&D budget within Euromet - Country mentioned by ISO code.



IMERA Contract - 016220

Summary table of the metrology R&D budget elaboration

EUROMET NMIs		Budget metrology k€				
		Total metrology euromet	R&D only per activity in % FTE	R&D only per activity detailed	Total per activity detailed	Total per field
NML	IE	225	202,5	210	230	230
MIRS	SI	361,95	289,56	259,45	361,95	361,85
BEV	AT	640	344,64	0	0	0
JV	NO	1300	693,29	480	900	900
GUM	PL	1623,8	726,33	884,3	1474,4	337,2
UME	TR	2750	1104,4	1100	2750	2050
IPQ-INETI-DPRSN	PT	1843	1357,37	0	0	0
SP	SE	3040	1660,45	1570	3040	3030
CMI	CZ	2270	1702,05	1470,7	2270	2266,7
DFM	DK	3100	3100	3090	3090	2470
CEM	ES	4550	3107,2	5090	6890	4100
MIKES	FI	4600	4065,02	0	0	0
NMI-VSL	NL	5777	4773,54	4970	5778	5778
METAS	CH	6312	5848,93	4500	4800	4800
INRIM & ENEA	IT	20670	15703	16020	20670	20680
LNE	FR	28385	21195,08	22857	30016	28410
NPL	UK	50870	46810,57	47270	51260	50890
PTB	DE	84200	79779,5	80200	84200	84930
<b>Total</b>		<b>222518</b>	<b>192463</b>	<b>189971,45</b>	<b>217730</b>	<b>211234</b>

■ figures not available



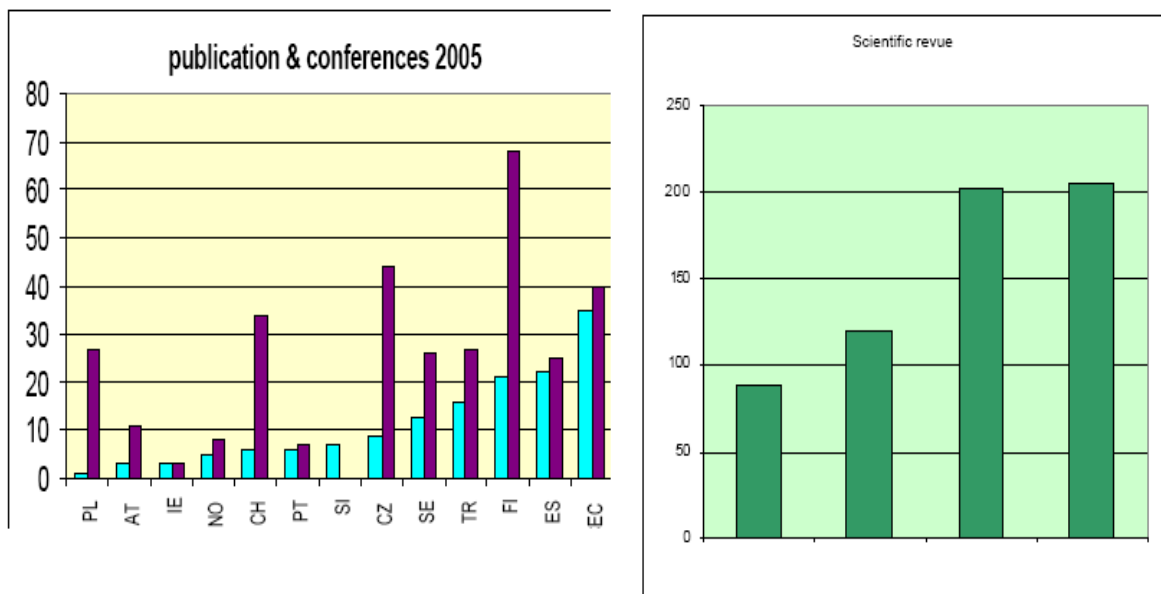
### 2.2.3 International Collaboration

The main locus of collaboration has been through EURAMET and the successive ERA-NET actions in the Sixth and Seventh Framework Programmes. The ERA-NET Plus was devoted to the preparation of an Article 169 action for much fuller European coordination of metrology research. All member states are participating in international organisations, e.g. EURAMET and WELMEC, but it seems not all member states actively participating in European research programmes. Except that, only bigger and richer member states can afford more independent, diversified or fundamental R&D activities.

### 2.2.4 Publication trends

Publication trends for EUROMET NMIs are shown below for 2005. This data is drawn from the iMERA project<sup>5</sup>. The graph below on the left shows the distribution of the publication to scientific reviews and participation to conferences for countries other than the UK, Germany, Italy and France. The image on the right shows distribution to scientific reviews for UK, DE, IT and FR.

The combined figures for the countries on the left show some 1700 scientific presentations in the year and 800 articles.



### 2.2.5 University Links

We have not been able to find data on this so far, but it appears likely to be low in this field.

<sup>5</sup> iMERA contract 016220, Task 1.1 Final Report (PU) V2.0

### 2.2.6 Horizontal questions

New developments in ICT and increasing concerns about environmental impact and measurement are opening further requirements for standards and regulation support.

### 2.3 Drivers of change

If we state that one main change seen in this sector in Europe is the move towards European collaboration and integration, as evidenced by the ERA-NET actions and moves towards an Article 169, then it is relevant to examine the drivers for this. They appear to be strongly about European being disadvantaged in **international trade and competition**:

- Developments in the US, with a single standards research agency (NIST) running a decentralised and responsive national measurement system and a concentrated R&D programme, making the US more competitive and contributing to enhanced economic growth
- Developments in Asia, driven by the economic growth in this region and the recognition in Asia that measurement and in particular international measurement will be key to economic growth, the presence of the APMP – the Asia-Pacific Metrology Program, with regional collaboration and enhancement of metrology and measurement systems in mind, again to promote economic growth.
- Increasing role of metrology in society in areas such as health, environment and related policy needs, many of which transcend national boundaries.
- New types of measurement needed for international trade in new and emerging technologies.

Metrology is seen as a crucial factor in enabling economic growth. The lack of an efficient and effective European metrology system, in comparison to perceived strengths in the United States and moves in Asia towards being effective and efficient, is providing the impetus for increasing the Europeanisation of metrology research and services.

The promotion of European coordination in research funding through joint programming is another driver here, i.e. financial support in the Sixth and Seventh Framework programmes for coordination of metrology research has acted as a driver to promote it. The debate about the ERA and its revitalisation are bringing up issues such as research training and mobility, and the ERA debates may also be driving the interest in increasing cooperation between the metrology laboratories and also increasing cooperation (from a low level) between metrology laboratories and other research performers.

At a broader level, the European project as a whole, of bringing in all states in Europe to the Union to create a level economic area, drives the more recent member states and those states waiting to join the EU to come into line with respect to measurement and regulation.

Technological drivers relate in particular to developments in ICTs and nanoscale research and technologies.

Against these drivers for more collaboration in Europe are the national funding systems for metrology and NMIs and the need for national and in particular SMEs in national settings to relate to a national or local provider of measurement services.

The organisational changes in metrology laboratories (see below in the sketches) seem to have been driven by general programmes of government reform and reorganisation. This driver for efficiency in the public sector is still present.

### 2.3.1 Sketches of the 11 selected institutes

As highlighted in our original proposal, we selected 11 institutes that collectively provide a spread of geography and experience to further our understanding of the drivers of change in the area of Metrology. Below is a list of the selected institutes and the rationale behind their selection.

Figure 2 Selected institutes

Institute	Acronym	Country	Reason for selection
Bulgarian Institute of Metrology	BIM	Bulgaria	Significant restructuring in the last decade to harmonise with the EU
Czech Metrology Institute	CMI	Czech Republic	Disintegration of the Czech-Slovak Federation resulted in the move of the laboratory from Government ownership to independent organisation
Danish National Metrology Institute	DFM	Denmark	Recently privatised and decentralised
Laboratoire National d'Essais	LNE	France	Large organisation, Significant restructuring, R&D activities
Physikalisch Technische Bundesanstalt	PTB	Germany	Large organisation, R&D activities
Istituto Nazionale di Ricerca Metrologica	INRIM	Italy	Significant restructuring, R&D activities
National Metrology Laboratory	NML	Ireland	Significant restructuring
Holland Metrology Group <sup>6</sup>	HM	Netherlands	Significant restructuring, R&D activities
Central Office of Measures	GUM	Poland	R&D activities

<sup>6</sup> The parent organisation of the Van Swinden Laboratory (VSL).

Institute	Acronym	Country	Reason for selection
SP Technical Research Institute of Sweden	SP	Sweden	Large organisation, R&D activities
National Physical Laboratory	NPL	UK	Significant restructuring, Large organisation, R&D activities

### 2.3.2 Bulgarian Institute of Metrology, Bulgaria

In Bulgaria, the public metrology authority, formally established in 1948, has experienced a series of organisational changes over the past few decades. In 1998, it was called the State Agency for Standardisation and Metrology (SASM). Within the period 1999 – 2005 as a part of the process on harmonisation of Bulgarian legislation with the European Union and the establishment of economical infrastructure adequate to the needs of Bulgarian market, the (SASM) was restructured and different legal entities were segregated from it (“Bulgarian Accreditation Service”, Bulgarian Institute for Standardisation, “Certification and Testing” and **Bulgarian Institute of Metrology**). After the legislative and normative changes in 2005 the restructuring process has been finalised and the SASM has been transformed and renamed the **State Agency for Metrological and Technical Surveillance (SAMTS)**. In 2006, the Bulgarian Institute Metrology (BIM) was established, acting as Bulgaria’s NMI. It is an independent public organisation accountable to the Council of Ministers. BIM has two main directorates: “the National Centre of Metrology”, and “Measures and Measuring Instruments”. BIM’s headquarter is in Sofia along with 5 regional offices. BIM has 353 employees, of which 54 are directly involved in activities related to research, comparing, maintaining and developing national standards and 249 carry out the activities in the legal field; 39 are directly involved in administrative services.

### 2.3.3 Czech Metrology Institute, Czech Republic

The Czech Metrology Institute was established by the Czech Department of Trade and industry in 1966. In 1990, the Ministry of Industry and Trade mandated CMI as a state administration body on national metrology. In 1993 as a result of the disintegration of the Czech-Slovak Federation CMI became an independent public organisation, reporting to the Ministry and representing the Czech Republic’s NMI in international organisations. The institute has 300+ staff members of whom some 30% have postgraduate degrees. Within CMI, there are three major divisions: National Standard Laboratories, Calibration Services and Legal Metrology Services. CMI has 12 regional branches and its headquarter is in Brno. CMI’s primary metrology laboratories are mainly situated in Prague. CMI conducts R&D activities and is involved in a wide range of projects. CMI also closely works with various higher education institutes and “associated laboratories” in specific areas.

#### 2.3.4 Danish National Metrology Institute, Denmark

In Denmark, the metrology infrastructure has been privatised and decentralised in recent years. Until 2008 there were three major organisations (along with many private and educational members) practicing metrology. In 2009 these three organisations formed [DANIAmet](#). DANIAmet is a “decentralised” metrology network coordinated by Danish Fundamental Metrology (DFM). DFM *per se* is a private company owned fully by the Technical University of Denmark ([DTU](#)). DFM is also a member of the GTS - Advanced Technology Group. It is a network of nine independent Danish research and technology organisations helping companies and authorities with technological and measurement problems. DFM performs research in specific areas of fundamental metrology that are of special importance to the Danish society. DFM acts as the Danish NMI in international organisations. Since the Danish metrology infrastructure is highly decentralised and metrology is becoming more diversified, other members (public or private) of DANIAmet can also act as the Danish NMI in different international occasions. Both DFM and DANIAmet conduct and participate in “R&D”, nationally and internationally.

#### 2.3.5 Laboratoire National D’Essai, France

The Laboratoire National d'Essais was established in 1901 as part of the Conservatoire National des Arts et Métiers (CNAM). It was set up to meet industrial testing and measurement requirements, especially in the fields of materials, machinery and physics. LNE began focusing on consumer product safety in 1930, and in 1976 set up a consumer products department. Between 1978 and 2000, under the new law LNE became a state-owned enterprise attached to the French Ministry of Industry. In the last 10 years LNE has been diversifying into new research areas and expanding its international operation. In 2001 LNE launched its international operations by setting up LNE-Asia. Based in Hong Kong, LNE-Asia is a joint venture between LNE and CMA Testing and Certification Laboratories (51% owned by LNE). In 2005 LNE opened an office in Shanghai.

In 2003 the Laboratory consolidated two of its main activities. In the certification field it took over the electromedical device certification activity performed by G-MED/LCIE, and in the metrology field it acquired LCIE's electrical metrology calibration centre. In 2004 LNE opened a centre for R&D in electrical metrology and nanometrology at its Trappes site. Firstly, LNE reinforced its international activity by opening a G-MED subsidiary in the United States. Secondly, the French government entrusted LNE (it seems a process of “privatisation”) with overall responsibility for French metrology, in replacement of the former organization called Bureau National de Métrologie (BNM), which had been in charge of this function since 1969. Now LNE is a state-owned enterprise coordinating the work of France's other three national metrology laboratories (CNAM, CEA and Observatoire de Paris) and acts as the French NMI in international organisations. In LNE, the studies and research projects in scientific and industrial metrology are carried out by several laboratories of different public or private bodies. Two categories should be considered: the National Metrology Laboratories (NMLs), main French metrology laboratories, and the associate

laboratories with the LNE (ALs) for specific fields and which skills are complementary of the LNE's (see the full list of [LNE's labs](#)). All the scientific activities (involving all laboratories, NMLs and ALs) bring together some 220 researchers in metrology.

LNE has 773 employees in total and 5 "lines of business": R&D, calibration/metrology consultancy, testing/analysis, certification and training. LNE has 55,000 sqm of labs and 10 locations in France and abroad:

- 2 locations in Paris Region(HQ in Paris and Trappes Lab)
- 3 regional offices and 1 branch (LNE Nîmes, LNE Poitiers, LNE Poitiers, LNE Toulouse and LNE / G-MED Saint Etienne)
- In Asia (LNE-ASIA Hong Kong and LNE-ASIA Shanghai)
- In US (G-MED North America Washington DC).

LNE had €69.6 million revenue in 2008 and €14.5 million Research Budget for 2008. The State's financial contribution takes the form of annual subsidies.

According to the available information, LNE is actively participating in a wide range of fundamental and applied R&D projects (e.g. medical and nano), nationally and internationally.

### 2.3.6 PTB, Germany

In 1887 the Physikalisch-Technische Reichsanstalt (PTR) was funded as the national metrology institute providing scientific and technical services. In 1950 the Physikalisch-Technische Bundesanstalt (PTB) was established in Braunschweig. In 1953 the PTR in Berlin-Charlottenburg was affiliated to PTB and formed the "Berlin Institute". In 1990 by taking over some of the tasks of the metrology department of the former German Democratic Republic, a new PTB was re-established.

Now the PTB is the highest public metrology authority under the auspices of the Federal Ministry of Economics and Technology (BMWI) and represent Germany in international metrology organisation. The PTB has approx. 1800 employees, divided into 9 divisions (2 of them in Berlin; consisting of approximately 60 departments and about 200 project groups in total) (see [Figures and Facts](#)). Within the departments, the project groups are the smallest organizational units. The PTB's annual budget is about € 130 million.

The PTB has 3 sites:

- The PTB premises in Braunschweig: Since 1947, the PTB has been located in Braunschweig. Some 1200 employees in eight divisions work here.
- Berlin-Charlottenburg: The traditional site of the PTB since 1887. The Divisions "Temperature and Synchrotron Radiation" and "Medical Physics and Metrological

Information Technology" can be found here.

- Berlin-Adlershof: For the handling of fundamental and applied metrology tasks focussed on "radiometry", the PTB laboratory at the electron storage ring BESSY II makes use of synchrotron radiation from the UV to the X-ray range. Immediately adjacent to BESSY II, PTB is establishing an additional synchrotron radiation source for the spectral range from the terahertz to the extreme ultraviolet with special development potential for the future semiconductor technology, the Metrology Light Source. It is designed especially for metrological purposes but may, however, also be used by other interested parties. The PTB operates R&D in the field of metrology. In addition, the PTB has also application-and user-oriented R&D - in cooperation with industry, including small and medium enterprises, research institutions and universities. R&D takes place in all areas of the PTB.

### 2.3.7 Istituto Nazionale di Ricerca Metrologica, Italy

The Italian metrology infrastructure has been reorganised recently. In 2006 the [Istituto Elettrotecnico Nazionale "Galileo Ferraris" \(IEN\)](#) and the [Istituto di Metrologia "Gustavo Colonnetti" \(IMGC\)](#) merged to establish the Istituto Nazionale di Ricerca Metrologica (INRIM). INRIM is the national public body (also as the NMI, accountable to the Ministry of University and Research) with the task of carrying out and promoting scientific research in metrology. After the handover of the primary metrology tasks previously assigned to IMGC and the IEN, INRIM plays the pivotal role in most scientific metrology activities in Italy (except for the field of ionising radiation, where ENEA-INMRI maintains its role). INRIM has 4 divisions: electronics, mechanics, optics and thermodynamics, and has its main premises in Torino and operational centres in Politecnico of Torino and University of Pavia. INRIM's main R&D areas are in fundamental physical constants, materials, metrology for chemistry, nanotechnology, innovation, quantum information and artificial vision. INRIM actively participates in research projects, both through resources of its own and through programs of collaboration with universities and other national or international public and private organizations. INRIM also offers scholarships and supports PhD thesis. In addition, it provides technical and consultancy services to other scientific bodies, public administrations, companies or other private organisations, and provides high level calibration services to third parties under private law.

### 2.3.8 National Metrology Laboratory, Ireland

The National Metrology Laboratory (NML) is the national metrology institute for Ireland and is responsible for the maintenance and development of the national standards for physical units and their dissemination to Irish users. It has a staff of about 30 persons and is located in a purpose-built laboratory with the entrance located at Claremont Avenue, Glasnevin.

Before 2009 the NML exercised its functions within Enterprise Ireland (EI), now it is a division of the National Standards Authority of Ireland (NSAI). NML will continue to operate as the national metrology institute for Ireland. The purpose of transferring the NML from EI

to the NSAI is to enhance the services delivered by the NML and to facilitate its continual development within the NSAI. The transfer is also to rationalize the Irish metrology infrastructure. The NSAI exercises national certification, standardization and legal metrology functions.

### **2.3.9 Holland Metrology, The Netherlands**

In 1989, the Dutch Office of Weights and Measures was privatised under the name Holland Metrology (HM). The reason was firstly, to enable the authorities to concentrate on governmental tasks and, secondly, to utilise the existing knowledge in the calibration task group and to offer this knowledge and experience to companies. In 2001, HM was acquired by the TNO organisation (TNO Bedrijven BV). In 2008, the HM group became an enterprise with €35.3 m in gross revenue (€32.1m net revenue). The core activities of HM are as follows:

- Calibration, verification, type approval and system certification
- National measurement standards, research and development, and consulting
- Market surveillance and enforcement.

The HM has its head office in Delft. Its core activities are provided from various locations in The Netherlands, Belgium (via BMi in Kasterlee) and Italy (Padua). The HM Group also provides these products and services worldwide. The HM has 3 business units: VSL, Nmi and Verispect BV. The VSL (the Van Swinden Laboratory) was established in 1875. Now it is one part the HM and also called the Dutch Metrology Institute, as it functions as the NMI for the Netherlands. The VSL employs 85 people, divided into three sections:

- Calibration and Reference Materials
- Customized Applied Metrology
- Research and Development.

The VSL also offers contract research and consultancy services. The VSL is located in the new Delft Technopolis business park. The VSL is a private company with a public mission.

NMi is the independent expert for testing, certification, calibration and training in the fields of metrology and gaming. Verispect is commissioned by the national government to enforce metrological legislation.

### **2.3.10 GUM, Poland**

In Poland, the national metrology tasks are mandated to the Central Office of Measures (GUM). GUM was established in 1919. After 1993 and until 2008, GUM has experienced a series of reorganisations. Now the GUM is a public organisation and the NMI under the supervision of the Ministry of Economic Affairs. The GUM's head office is in Warsaw. It has



9 regional offices, 62 peripheral metrology authorities and 9 peripheral assay offices. The GUM is currently participating in the European Metrology Research Programme with in particular on energy ([EMRP](#)).

### 2.3.11 Sweden - SP

In Sweden, the SWEDAC (Board for Accreditation and Conformity Assessment) is the central government agency (under the supervision of the Ministry of Foreign Affairs and the Ministry of Industry) operating as a national accreditation and metrology body in various sectors. Most of SWEDAC's personnel, in total about 115 employees, work at the headquarters in Borås. In Stockholm, about 40 persons work at SWEDAC's office in the Old Town (Gamla Stan). In addition to its own personnel, SWEDAC uses the services of over 200 external technical experts as assessors for its accreditation work. Public authority duties make up about 25 per cent of the total annual turnover of about SEK 150 million (2008), with the remaining 75 per cent coming from commercial work. Under the SWEDAC, there are 2 independent NMIs: the Swedish National Testing and Research Institute (the SP, established in 1920) and the National Radiation Protection Institute (SSI). The SP is a large enterprise in metrology. The SP (SP Technical Research Institute of Sweden) is the parent company of a group consisting of 6 subsidiary companies. The Swedish state is the sole shareholder of the company:

- Staff (2008): About 574 (SP Group 843)
- Turnover (2008): About SEK 589 Million (SP Group 845)
- Share capital: SEK 36 Million.
- SP operates from about 30 sites all over Sweden. Its headquarters and main facilities are in Borås.

The work within the parent company is organised into 8 technical departments: Building Technology and Mechanics, Certification, Chemistry and Materials Technology, Electronics, Energy Technology, Fire Technology, Measurement Technology, Weights and Measures. The SP's [R&D activities](#) cover a wide technical range, with about 30 technology areas. More than half of its staff are graduate engineers or scientists, and 90 are trained research scientists. The SP's cooperation with universities and institutes of technology, not only in connection with projects and training, but also through teaching and facilities cooperation (covering more than 70 institutions, of which about a dozen are in other countries). The SP participates continuously in about 30 EU projects, in cooperation with partners from its extensive international network.

### 2.3.12 National Physical Laboratory, UK

In the UK, measurement issues are looked after by the National Measurement System (NMS), which encompasses:

- The National Measurement Office (renamed from the National Weights and Measures Laboratory to NMO in 2009): NMO is an Executive Agency of the Department for Business, Innovation and Skills (the new ministry BIS was created by merging [BERR](#) and [DIUS](#) in 2009)
- The National Physical Laboratory (NPL)
- LGC Ltd (the former Laboratory of the Government Chemist)
- TUV NEL Ltd (the National Engineering Laboratory).

NPL, established in 1900, sits at the heart of the National Measurement System. It is the main provider of the measurement and materials research programmes and infrastructure for BIS, working with business to ensure the measurement accuracy vital to the UK economy. NPL is a Government Owned-Contractor Operated (GOCO) organisation. The UK Government own the assets and intellect but the organisation is run on a day-to-day basis, on behalf of the [National Measurement Office](#) of the BIS, by NPL Management Limited, which is a wholly-owned subsidiary of the [Serco Group plc](#).

NPL provides the scientific support for the UK national measurement system. It also provides significant commercial services (technical and R&D) to industry. Its research areas are acoustics, biotechnology, analytical sciences, electromagnetics, advanced materials, engineering measurements, environmental measurement, ionising radiation, optical radiation and photonics, mathematics and scientific computing, nanoscience, quantum phenomena and time and frequency.

NPL employs around 500 scientists and does have collaborations with universities and industry, taking part in Knowledge Transfer Partnerships, a scheme of the UK Technology Strategy Board to promote joint projects and fellowships between the research base and firms. The NPL received considerable investment with the opening of new laboratories in 2008. It has been playing a leading role in European and international collaborations.

## 2.4 Scenarios for the future - Common scenarios for metrology research institutes

### 2.4.1 Alpha Scenario – Business as Usual

In this scenario, we can see that the national laboratories remain in each member state. This is driven by the need to support statutory and regulatory functions and to support firms in measurements and calibration. The large and strong laboratories, which have a significant research effort compared to the small laboratories which are primarily fulfilling the requirements of their national measurement systems and reacting to international changes, continue to develop their networks with other national laboratories and to drive more collaborative research within Europe. However, with present levels of funding this is

mainly about exchange of views and meetings and joint communications, but with limited joint research and joint research programming. Some intergovernmental initiatives are built with variable geometry. Countries with limited metrology capacity and little or no research remain small players, yet still exist due to national requirements to operate the measurement system. Metrology research is only weakly directed to challenges and needs for European industry, society and policy. It is only weakly engaged in thinking about anticipatory work for future challenges. There is duplication and non-optimal use of research infrastructures, and in many countries there is little renewal of infrastructures. Metrology does not increase in attractiveness as a research area.

#### **2.4.2 Beta Scenario – Negative**

Here we can construct a scenario born from recession and low growth, where metrology research, in common with some other areas of public research, is subject to cuts. More reorganisations and quasi privatisations take place with the aim of increasing efficiency, but there is little or no pay-off in terms of effectiveness. The disparity between the labs across the EU increases, and cooperation between the research institutions fades away due to lack of financial support and the need to keep core national functions. Cooperation with business and government also reduces, making metrology research less relevant. Contract research declines as industry investment in R&D and technical services declines. However it does not fade away completely due to national and local needs. European industry is less well supported in terms of international trading and the US and Asia increase their comparative advantage as trading blocks as their metrology underpinning becomes more effective and efficient than the European services. US and Asian metrology research institutes become the contractors of choice for research and technical services.

#### **2.4.3 Delta Scenario - Transforming**

Here we could imagine an extreme – a single networked organisation in effect performing metrology research and development across Europe and supporting local firms through quasi-national measurement systems. There is some rationalisation of research in particular and in supporting metrology services as well throughout the member states. Research is planned and executed at a European level but with attention to diverse needs within regions of Europe. This leads to a critical mass of research effort, sharing of infrastructures such as expensive or large scale equipment and more mobility of scientists, increasing the attractiveness of metrology as a science area. In policy terms, there is greater effectiveness of Europe in negotiating with WTO. Research is aligned to European policy needs and to growing and emerging industries in Europe. The organisation is also active in global markets for R&D and technical services concerning metrology. The organisation is active in building links with university research and industry, in order to keep at the cutting edge of science and industrial innovation. It is active in ensuring metrology expertise is available in member states where it has been less well supported and consequently is less well developed.

## Appendix - List of European Metrology Laboratories

Below is a list of the European Metrology laboratories we have considered for this study. It includes 27 European countries of which three are EFTA countries.

**Figure 3 List of European Metrology Laboratories**

Metrology Laboratories (EC 27)		
Name of Organisation	Acronym	Country
Bundesamt für Eich- und Vermessungswesen (Federal Office of Metrology and Surveying)	BEV	Austria
Metrology Division		Belgium
Bulgarian Institute for Metrology	BIM	Bulgaria
Weights and Measures Section	WMS	Cyprus
Czech Metrology Institute	CMI	Czech Republic
the Danish National Metrology Institute	DFM	Denmark
Central Office of Metrology	METROS ERT	Estonia
The Centre for Metrology and Accreditation	MIKES	Finland
LNE	LNE	France
Physikalisch-Technische Bundesanstalt (PTB) federal institute for metrology	PTB	Germany
Hellenic Institute of Metrology	EIM	Greece
Division of Metrology of MKEH	MKEH	Hungary
National Metrology Laboratory	NML	Ireland
Istituto Nazionale di Ricerca Metrologica	INRIM	Italy
Latvian National Metrology Centre	LNMC	Latvia
State metrology service	VMT	Lithuania
L'Institut Luxembourgeois de la Normalisation, de l'Accréditation, de la Sécurité	ILNAS	Luxembourg
Malta Standard Authority National Metrology Service	MSA- NMS	Malta
Central Office of Measures	GUM	Poland
Instituto Portuguese de Qualities - Portuguese Institute for Quality	IPQ	Portugal
National Institute of Metrology	BRML- INM	Romania
Slovak Institute of Metrology	SMU	Slovakia
National Metrology Institute of the Republic of Slovenia	MIRS	Slovenia
Centro Español de Metrología - CEM (Metrology Spanish Centre)	CEM	Spain
SP Technical Research Institute of Sweden	SP	Sweden
Swedish Radiation Safety Authority	SSM	Sweden

<b>Metrology Laboratories (EC 27)</b>		
<b>Name of Organisation</b>	<b>Acronym</b>	<b>Country</b>
Van Swinden Laboratory / Dutch Metrology Institute	VSL	The Netherlands
Nederlands Meetinstituut B.V.	Nmi	The Netherlands
National Physical Laboratory	NPL	UK
National Measurement Office	NMO	UK

Further details of the project

The complete and final report from the project can be found at

<http://ec.europa.eu/research/era/docs/en/research-institutes-in-the-era.pdf>

Academic journal articles arising from the work undertaken on this research project are printed in the journal *foresight* and *R&D Management* and are available from links below.

Barker, K., Cox, D., Sveinsdottir, T. (2011) Foresight on the future of public research metrology in Europe. *foresight*, 13(1), 5-18 [Foresight on the future of public research metrology in Europe](#)

Barker, K., Cox, D., Sveinsdottir, T. (2012) Re-shaping European Metrology Research – the Role of National Research Managers. *R&D Management*, March.

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## Manchester Institute of Innovation Research

The Manchester Institute of Innovation Research (MIOIR) is the research centre of excellence in the Manchester Business School (MBS) and The University of Manchester in the field of innovation and science studies. With more than 50 full members and a range of associated academics from across the University, MIOIR is Europe's largest and one of the World's leading research centres in this field.

The Institute's key strengths lie in the linkage and cross-fertilisation of economics, management and policy around innovation and science. Building on forty years of tradition in innovation and science studies, the Institute's philosophy is to combine academic rigour with concrete practical relevance for policy and management. This includes broad engagement with and research for policy makers and societal and industrial stakeholders in the Manchester City Region, across the UK and internationally. MIOIR is also firmly committed to a range of teaching activities within and beyond MBS and integrates a strong and successful PhD programme into its research activities. The Institute has a visitor programme for academics and management and policy practitioners and provides a range of popular and high level executive education courses on evaluation, foresight and S&T Policy.

For more information please visit [www.mbs.ac.uk/research/portals/innovation/](http://www.mbs.ac.uk/research/portals/innovation/)