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Involvement and use of European Metrology Programme for Innovation and Research EMPIR in the Czech Metrology Institute – a positive example of the use of European cooperation

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Abstract

The Czech Metrology Institute (CMI) has been the national metrology institute of the Czech Republic since 1993. The significant development of the CMI's fundamental metrology departments and the gradual growth of the CMI's scientific and research capacities are linked to its successful participation in the European Metrology Research Programme (EMRP) and the European Metrology Programme for Innovation and Research (EMPIR). In total, 28 countries have participated in the EMPIR Programme, with Switzerland, Norway, Serbia, Bosnia and Herzegovina, Turkey and the UK in addition to the EU Member States. The necessary organisational and administrative background for the realisation of the EMPIR Programme was provided by EURAMET e.V., a European Regional Metrology Organisation operated as a non-profit association under German law. The most important benefit of the Programme for the CMI and the Czech Republic is the successful implementation of the research results of individual EMPIR projects. Within the framework of this implementation of the EMPIR results in the CMI, 6 new state measurement standards of the Czech Republic have already been established and another 4 are in the stage of preparation for announcement. Furthermore, 23 new or significantly modified measurement methods have been developed based on the results within the CMI and are now provided as a service by the CMI. Finally, participation in the EMPIR projects has been used to train 42 new CMI scientists in various fields of measurement. If to add to this the use of the results of the former EMRP Programme, it can be concluded that the development of metrology at the CMI over the last 10 years has been strongly conditioned by successful participation in European Metrology Programmes and the ability of the CMI to subsequently apply the results of individual projects to its laboratory practice.

Keywords: The Czech Metrology Institute; European Metrology Programme for Innovation and Research (EMPIR); National Metrology Institutes; modified measurement methods; EURAMET.

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A brief history of the establishment and development of the Czech Metrology Institute

The Czech Metrology Institute (CMI) was established after the division of the Czechoslovak Federation in 1993. Since 1968, Czechoslovakia intensively concentrated metrology within the federation in Bratislava where the new Czechoslovak Metrology Institute was established and the division of the federation was based on the principle of division of property according to the place of dislocation, so it was necessary to build the CMI practically from scratch. After its establishment, for a long time, the CMI's focus was on the area of legal metrology and on the requirements for verification and type approval of measuring instruments. At the same time, the CMI used all existing laboratory capacities throughout the Czech Republic, which ultimately led to the establishment of 14 internal organisational units of the CMI throughout the territory of the Czech Republic (CR). It was not until the late 1990s that the first germs of fundamental metrology departments were established within the CMI, which were gradually and slowly built according to the available financial resources and priorities of the Czech industry. At the start of the EMRP Programme in 2009, the CMI fundamental metrology facility was only less than half completed. The significant development of the CMI's fundamental metrology facilities and the gradual growth of the

CMI's scientific and research capacities are linked to the successful participation in the European Metrology Research Programme EMRP and the European Metrology Programme for Innovation and Research EMPIR. This successful use of European research projects can also be an inspiration for other National Metrology Institutes outside Central and Eastern Europe, including Ukraine.

EMPIR basic parameters

The European Metrology Programme for Innovation and Research (EMPIR) was approved by Decision No 555/2014/EU of the European Parliament and of the Council of 15 May 2014 on the participation of the Union in the European Metrology Programme for Innovation and Research jointly undertaken by several Member States [1], pursuant to Article 185 of the Treaty on the Functioning of the European Union. The EMPIR Programme was a follow-up to the highly successful European Metrology Coordinated Research Programme (EMPIR), which is described in detail in [2]. The budget of the EMPIR Programme was €600 million, of which €300 million was provided by the European Union and €300 million was co-funded by the Member States. The administrative and management costs of the Programme were less than 5% of the total budget. In total, 28 countries were involved in the Programme, with Switzerland, Norway, Serbia, Bosnia and Herzegovina, Turkey and the UK in addition to the EU Member States. The necessary organisational and administrative background for the realisation of the EMPIR Programme was provided by EURAMET e.V., a European Regional Metrology Organisation operated as a non-profit association under German law. The programme and its individual participants were regularly audited by the EU throughout the realisation of the EMPIR Programme. Based on Resolution No 901 of the Government of the Czech Republic of 7 December 2011, the Czech Metrology Institute (CMI) was entrusted with the preparation of the Czech Republic's participation in the EMPIR Programme. Significant support throughout the realisation of the Programme was provided by the Ministry of Education, Youth and Sport (MoEYS).

Management and realisation of the EMPIR Programme

The realisation of the whole Programme was managed by the EMPIR Committee, composed of the representatives of the EURAMET members from the participating States. However, the representatives of the participating States did not have an equal position in the EMPIR Committee, as the weight of their votes in the EMPIR Committee is calculated according to the national commitments of each country in accordance with the square root rule. The representative of Germany had the biggest number of votes, which was 10. The representative of the Czech Republic, who throughout the realisation period of the Programme was Assoc. RNDr. Jiří Tesař, Ph.D. had 4 votes. Participants with a small contribution to the solution had only one vote. The EMPIR Committee mainly took decisions on:

– the annual work plan (subject to the EC approval);

– the direction of strategic research and innovation in metrology;

– planned calls for project proposals;

– the procedure for evaluation of individual project proposals;

– the selection of projects to be funded;

– monitoring the progress and contribution of funded projects.

The EMPIR Committee has always invited the EC representatives to its meetings and sent relevant documents to the EC. The Commission formally had observer status at the EMPIR Committee meetings, with its representative regularly participated in the Committee discussions [3].

Breakdown of the EMPIR calls

The whole Programme was divided into 7 calls, which were launched annually from 2014 to 2020. The EMPIR calls for proposals were always published on the single participant portal of the EURAMET, as well as through other electronic means of dissemination of the Horizon 2020 information managed by the Commission. In addition, each annual call was typically structured into several specific thematic areas focusing on key metrology areas. The distribution of each of the main themes was as follows:

Call 1 2014: Metrology for industrial applications.

Call 2 2015: Metrology for Healthcare and Metrology for the Provision of the SI Units.

Call 3 2016: Metrology for Environmental Protection and Metrology Assurance for Energy.

Call 4 2017: Basic Research for Metrology and Metrology for Industrial Applications.

Call 5 2018: Metrology for Healthcare and Metrology for the Provision of the SI Units.

Call 6 2019: Metrology for Environmental Protection and Metrology Assurance for Energy.

Call 7 2020: Basic Research for Metrology and Metrology for Industrial Applications [4].

These key thematic areas have been complemented by a specific call "Metrology to support standardisation" every year since 2015, and a call "Research potential in metrology" every year between 2014 and 2019 to support the transfer of metrology knowledge between the Programme members. Complementary activities under the Programme were support grants to promote researcher mobility and to underpin the establishment of European Metrology Networks (EMNs) in the period 2019–2020, which should become an important element in the European Metrology Partnership Programme for the future [5].

Table 1

Statistics of individual calls and thematic areas, including the number of projects with the participation of the CMI

Thematic Area	Years of calls	No. of projects	No. of projects with the CMI participation
Metrology for industrial applications	2014, 2017, 2020	41	22
Metrology for Health	2015, 2018	19	4
Metrology for the provision of the SI units	2015, 2018	20	15
Metrology for environmental protection	2016, 2019	19	10
Metrology assurance for energy	2016, 2019	18	11
Basic research for metrology	2017, 2020	18	5
Research potential in metrology	2014 – 2019	21	15
European Metrology Networks	2019, 2020	7	5
Metrology supporting standardisation	2015 – 2020	37	12

Analysis of the Czech Republic's participation in the EMPIR Programme

In total, 200 EMPIR projects have been selected and subsequently implemented under 7 calls for proposals between 2014 and 2020. The implementation of Call 5 projects will be phased out in 2022. The last realised projects will not have been completed until the second half of 2024. The statistics for each call and thematic area are presented in Table 1.

Given the significant differences in the cost of the work between the participating countries, the simplest criterion for assessing the success of the participations is to compare the total number of projects involving the National Metrology Institutes and their affiliated laboratories of the country concerned, as shown in Fig. 1. In the case of the Czech Republic, it can be clearly stated that the involvement of the National Metrology Institute, the CMI, has been extremely successful and currently demonstrates an excellent position of the CMI in the field of science and research at least at the European level. This becomes even more evident when comparing the Czech Republic with, for example, Austria or Poland. Neither the position of the top European powers (Germany, Great Britain, France, and Italy), nor the excellent position of traditionally industrially developed medium-sized countries such as Switzerland, Finland, Sweden or the Netherlands, is surprising. It is with these countries of the similar size with advanced metrology that the CMI is currently seeking to compare and compete.

However, we can also analyse the involvement of the CMI in more detail under individual thematic areas. The CMI's strongest position was in the areas of Metrology for Industrial Applications (Fig. 2), Metrology for the Provision of the SI Units (Fig. 3), Metrology for Energy (Fig. 4) and Research Potential in Metrology (Fig. 5), where it came second, third or fourth among other European countries, which could be considered quite exceptional.

On the other hand, the CMI's weakest results were in the areas of Metrology for Healthcare (Fig. 6) and Basic Research for Metrology (Fig. 7), but the sixth and seventh places could be still considered good and appropriate for the development of the metrology specialisations in the country. Moreover, given the current efforts of the CMI management to significantly increase its involvement in metrology activities in healthcare and the increased intensity of the CMI's collaboration with the country's leading universities in this field, a significant improvement in the CMI's position in this area can be expected in the future.

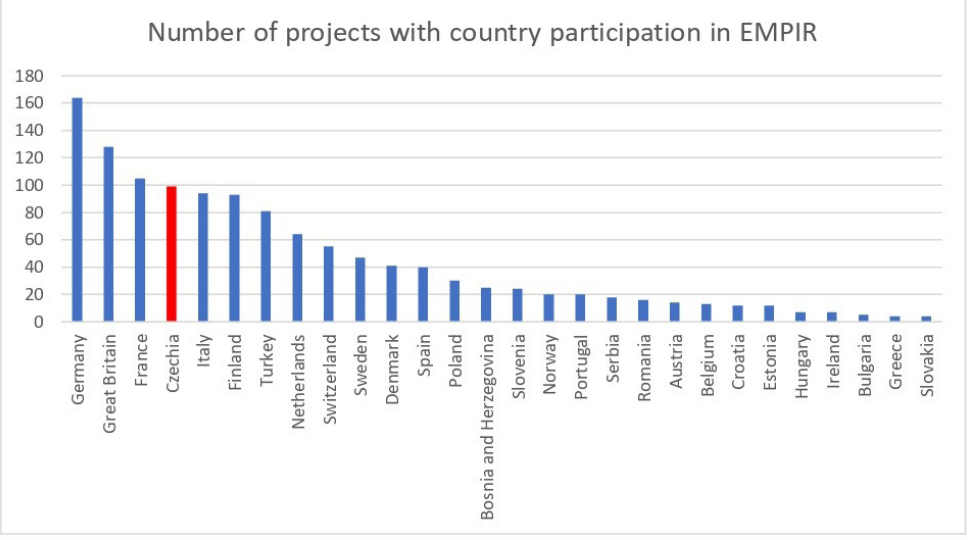

Fig. 1. Total number of projects involving National Metrology Institutes and their affiliated laboratories per country in the EMPIR Programme

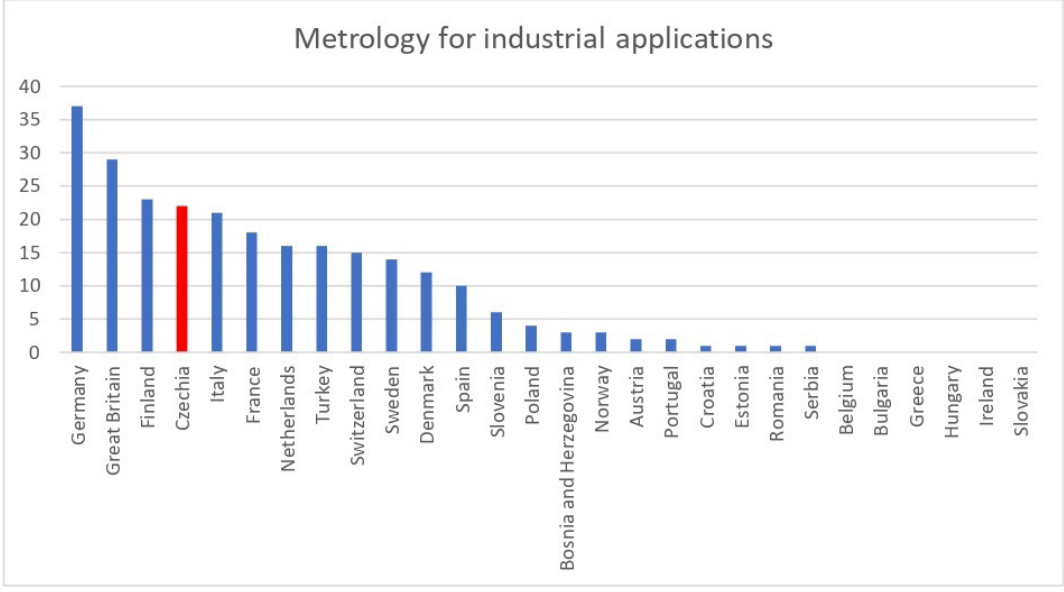

Fig. 2. Total number of projects involving National Metrology Institutes and their affiliated laboratories per country in the Metrology for Industrial Applications theme of the EMPIR

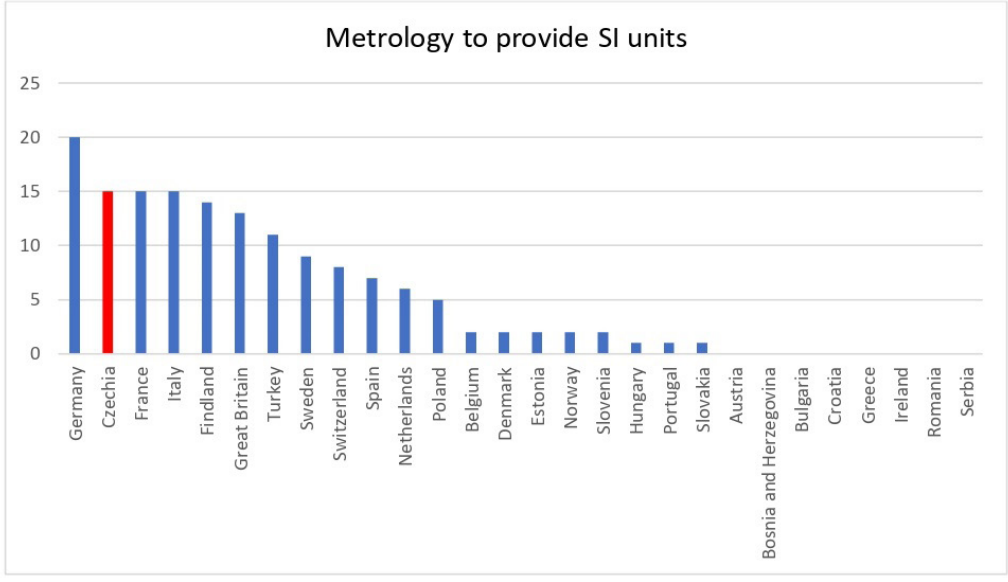

Fig. 3. Total number of projects involving National Metrology Institutes and their affiliated laboratories per country in the Metrology for the provision of the SI units theme of the EMPIR

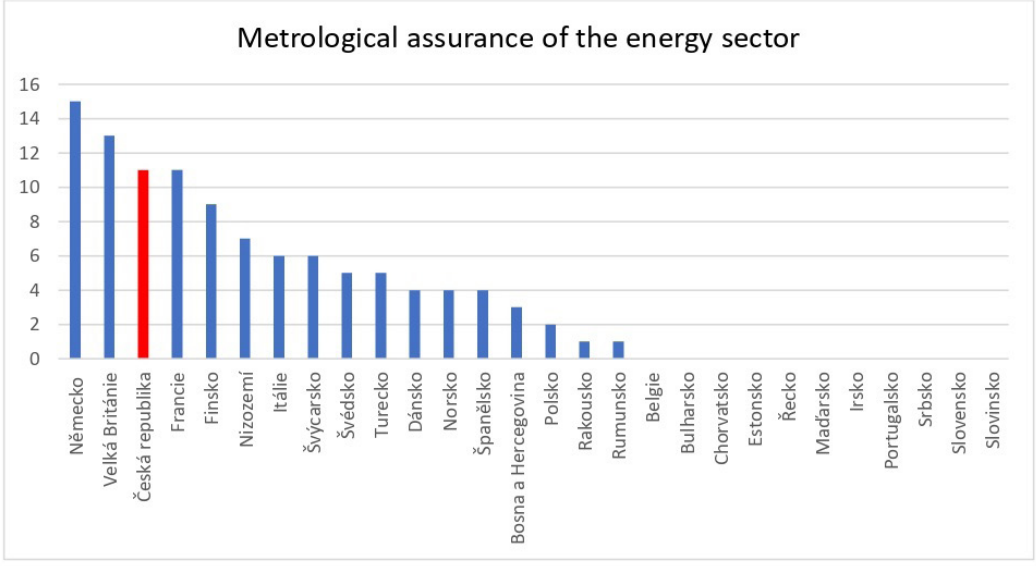

Fig. 4. Total number of projects involving National Metrology Institutes and their affiliated laboratories per country in the Energy Metrology Assurance thematic area of the EMPIR Programme

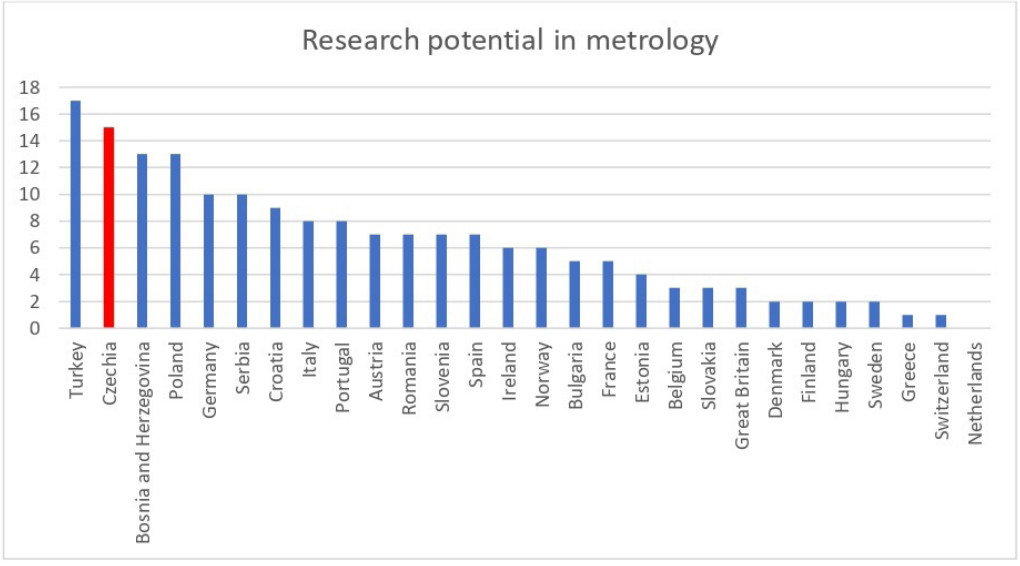

Fig. 5. Total number of projects involving National Metrology Institutes and their affiliated laboratories per country in the EMPIR Research Potential in Metrology thematic area

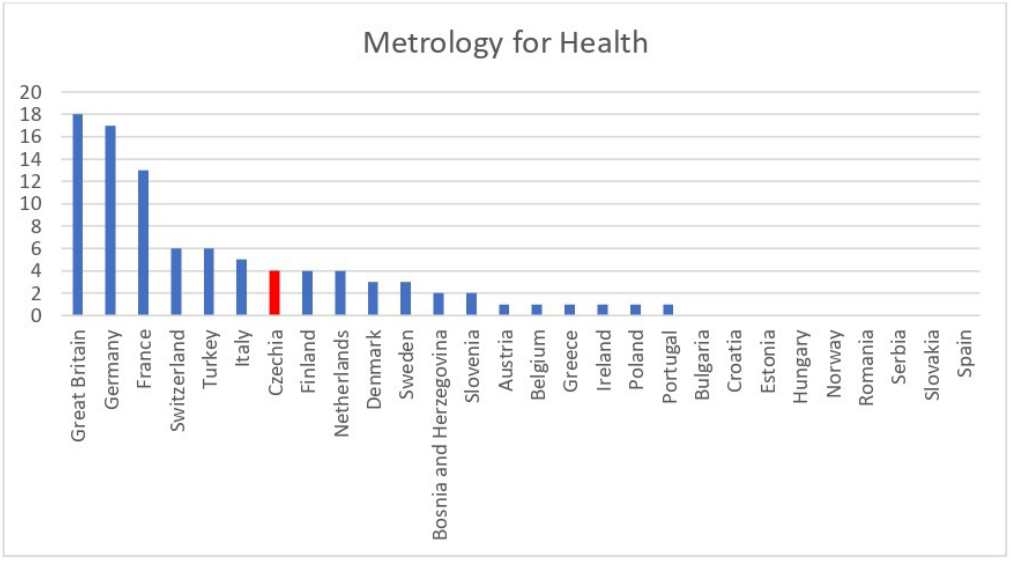

Fig. 6. Total number of projects involving National Metrology Institutes and their affiliated laboratories per country in the EMPIR Health Metrology thematic area

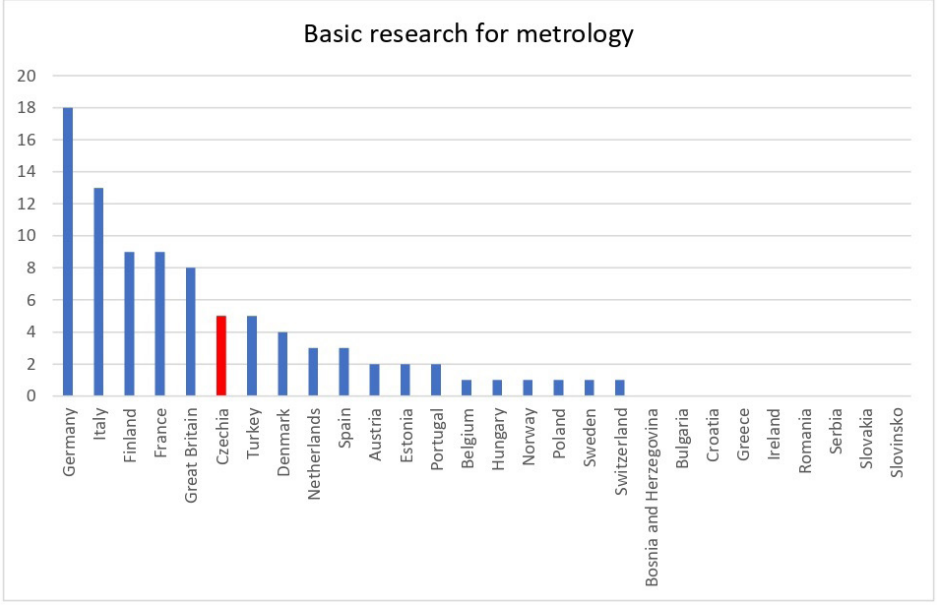

Fig. 7. Total number of projects involving National Metrology Institutes and their affiliated laboratories per country in the EMPIR Basic Research for Metrology thematic area

As far as regards the CMI, it is significant that the involvement in the EMPIR Programme has been spread among the individual CMI departments both geographically and accounting for the professional focus on individual metrological disciplines. Currently, 194 CMI staff members have already been involved in the Programme, and it can be expected that this number will exceed 200 staff members by the completion of the realisation in 2024. Significantly, for the future, the involvement of the CMI's young researchers is also much broader than in the previous EMRP Programme.

The most important benefit for the CMI and the Czech Republic is the successful implementation of the research results of individual EMPIR projects. As part of this implementation of the EMPIR results in the CMI, 6 new Czech national measurement standards have already been established and 4 more in the stage of preparation for announcement. Furthermore, 23 new or significantly modified measurement methods have been developed based on the results within the CMI and are now provided as a service by the CMI. Finally, participation in the EMPIR projects has been used to train 42 new CMI scientists in various fields of measurement. If to add to this the use of the results of the former EMRP Programme, it can be concluded that the development of metrology at the CMI over the last 10 years has been strongly conditioned by successful participation in European Metrology Programmes and the ability of the CMI to subsequently apply the results of individual projects to its laboratory practice.

However, it was not only the CMI that participated in the EMPIR Programme, but also many other entities. According to the rules, the EMPIR Programme allowed for the participation of other research organisations in addition to the direct participation of National Metrology Institutes and their affiliated laboratories. Specifically, according to Annex II, paragraph 4 of the Decision of the European Parliament and the Council, 15% of the Programme budget was reserved for these other organisations. Practice has shown that it was administratively much simpler and easier for the Czech entities to participate in the EMPIR Programme through other research organisations than through the affiliated laboratory system. The overall involvement of other organisations in the EMPIR Programme was successful, and the use of European funding was successful for certain universities (Charles University in Prague, Palacký University in Olomouc, ČVÚT in Prague) and the institutes of the Academy of Sciences (Institute of Physics of the CAS, Institute of Nuclear Physics of the CAS, Institute of Instrumentation of the CAS, Institute of Plasma Physics of the CAS), as well as some state institutions (State Institute of Nuclear, Chemical and Biological Protection, Military Technical Institute, CESNET), and industrial companies (ADVACAM, MECAS ESI s. r.o., NUVIA a.s.). Many entities from the Czech Republic have been involved repeatedly during the EMPIR Programme and have been successful in multiple projects [6].

Evaluation of the EMPIR Programme from the CMI perspective

Overall, the EMPIR Programme has been a very relevant, efficient and socially beneficial European instrument to support the development of metrology and its application in industrial, health and environmental innovation. The involvement of Czech entities in this Programme, not only the CMI, but also many other entities, was also very successful. As it has been shown, the development of metrology at the CMI over the last 10 years has been strongly conditioned by successful participation in European metrology programmes and the ability of the CMI to subsequently apply the results of individual projects to its laboratory practice. In the authors' opinion, this is a successful example for other countries in the CEE region, including Ukraine. The positive contribution of the European EMRP and EMPIR Programmes is also being demonstrated by the CMI metrologists to their Ukrainian colleagues in the framework of the ongoing European twinning project in Ukraine coordinated by the CMI.

Considering the success of the EMPIR Programme from an overall European perspective and the success of the CMI and other entities from the Czech Republic, one can only welcome the fact that although the Programme has come to its end, the coordinated European research in metrology will continue, as the European Metrology Partnership, which is a larger successor to the EMPIR, was finally approved by the European Parliament and Council in November 2021 [7].

Залучення та використання Європейської метрологічної програми інновацій та наукових досліджень (EMPIR) у Чеському метрологічному інституті – позитивний приклад застосування європейської співпраці

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Анотація

Чеський метрологічний інститут (ЧМІ) є національним метрологічним інститутом Чеської Республіки з 1993 року. Значний розвиток підрозділів з фундаментальної метрології та поступове зростання наукового й дослідницького потенціалу ЧМІ пов'язані з його успішною участю в Європейській програмі досліджень у сфері метрології (EMRP) та Європейській метрологічній програмі інновацій та наукових досліджень (EMPIR). Таке успішне використання європейських дослідницьких проєктів може стати джерелом натхнення також і для інших національних метрологічних інститутів за межами Центральної та Східної Європи, включаючи Україну. Загалом у програмі EMPIR взяли участь 28 країн, а також Швейцарія, Норвегія, Сербія, Боснія та Герцеговина, Туреччина й Велика Британія на додаток до країн-членів ЄС. Необхідну організаційну та адміністративну базу для реалізації програми EMPIR надала EURAMET, європейська Регіональна метрологічна організація, яка діє як некомерційна асоціація відповідно до законодавства Німеччини. Найважливішою перевагою для ЧМІ та Чеської Республіки стало успішне впровадження результатів досліджень окремих проєктів EMPIR, у рамках чого в ЧМІ вже створено 6 нових державних еталонів вимірювання Чехії та ще 4 еталони перебувають на стадії розробки. Крім того, на основі результатів ЧМІ було розроблено 23 нові або значно модифіковані методи вимірювання, які сьогодні пропонуються як послуги ЧМІ. Зрештою, участь у проєктах EMPIR було використано для підготовки 42 нових науковців ЧМІ у різних галузях вимірювання. Якщо до цього додати використання результатів попередньої програми EMRP, можна зробити висновок, що розвиток метрології в ЧМІ протягом останніх 10 років значною мірою зумовлювався успішною участю ЧМІ в європейських програмах з метрології та його здатністю застосовувати результати окремих проєктів у своїй лабораторній практиці.

Ключові слова: Чеський метрологічний інститут; Європейська метрологічна програма інновацій та наукових досліджень (EMPIR); національні метрологічні інститути; модифіковані методи вимірювання; EURAMET.

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