

February 12, 2021

MEMO

From: Tiziano Camporesi,
Chair of the International Advisory Committee of the Center of Experimental Nuclear and Particle
Physics at Vilnius University

To: Whom it may concern

Following the meeting held **virtually in Vilnius** on November 17-18, 2020, please find attached
the conclusions and recommendation of the advisory committee.

Members of the International Advisory Committee:
Prof. Jonathan R. Ellis, King's College London, GB
Prof. Guenakh Mitselmakher, University of Florida, USA
Prof. Christoph Schaefer, CERN
Prof. Edita Suziedeliene, Vilnius University, LT
Dr. Danek Kotlinski, Paul Scherrer Institut, CH
Dr. Tiziano Camporesi, CERN, and Boston University, USA

Status Overview and Recommendations on Lithuania's Engagement in CERN Activities

1. Mandate

The International Advisory Committee (Committee) would like to recall that Associated Members of CERN are obliged to have a scientific, technical and industrial potential comparable to that required for CERN Member States as stipulated by CERN Council's decision in CERN/2918/Rev. In particular, *the following criteria must be fulfilled*:

- a. existence within the applicant State of a **solid basis in elementary particle physics**, both theoretical and experimental, adequately funded both for the support of the research within the country and also for payment of travel and living expenses to enable the scientists of that country to participate in CERN activities.
- b. existence of a sufficiently **developed industry** within the applicant State to enable it to tender for contracts with CERN with a reasonable chance of success.
- c. the will of the national authorities of the applicant State to **support basic research** and their awareness of the implications of participation in a **common endeavor** in the field of **particle physics**.

While point b. has been mostly addressed, points a. and c. still need attention.

On the road towards Associate Membership at CERN, more detailed negotiations between CERN and Lithuania took place. The findings and agreements were summarized by the CERN Task Force in the document CERN/3266/RA presented to the CERN Council for the voting on the Application for Associate Membership at CERN by the Government of the Republic of Lithuania. The report contains the following particular set of recommendations and agreements:

1. "However, no structures are in place today in order to **coordinate and steer** these resources in a physics-driven and coherent manner, such that they can be deployed to make a visible impact on **particle physics** research at CERN, e.g. in the framework of a major LHC experiment."

The physics-driven and coherent coordination and steering of resources has not been fully implemented yet.

2. "The Lithuanian political and academic authorities recognize this weakness and have committed to implement specific measures to address the problem, initially through the establishment of a **Chair of experimental particle physics** at Vilnius University that will serve as a nucleus for developing a competitive particle physics community ..."

The Chair of experimental particle physics has been established.

3. "Such a Chair will represent a significant investment ..."

The significant investment is ongoing via Lithuanian DNA programs (lt. Ateities ekonomikos DNR).

4. "... that will need to be part of fresh domestic resources, not to be taken from existing commitments to CERN-related activities such as, for example, contributions to experiment operations or upgrades. The position should be filled with an internationally recognized scientist trained at major particle physics laboratories and leading national collaborating institutions. The Task Force has recommended the establishment of an **International Advisory Committee** in order to assist ..."

The International Advisory Committee has been established.

5. "... with the search for appropriate candidates and **to oversee the further development** of nuclear physics and elementary **particle physics** research in Lithuania, to which Lithuania has committed (Annex 7)."

The International Advisory Committee is overseeing the further development of particle physics.

6. “The Task Force therefore welcomes the firm commitment of the Lithuanian authorities to establish a **Chair of experimental particle physics** at Vilnius University, ...”

The Chair has been established.

7. “ which will play a critical role: it is expected to be the **voice of Lithuanian science** in engaging with CERN, in order to help shaping its future program.”

The Lithuanian voice has been heard in the CERN Council and European Particle Physics Strategy Update process.

8. “At the same time the holder of this Chair would engage and **coordinate** the many technical and scientific contributions from Lithuania. This person, together with the available engineers and scientists, is expected to **build the solid basis** in elementary **particle physics**, which is the **most important requirement** to fully benefit from Associate Membership in CERN. ”

Implementation of this plan has met obstacles, mainly linked to the academic regulations and lack of flexibility of the academic structures: of the order of 10 people from various Institutes are in touch with the Center for Experimental Nuclear and Particle Physics (the Center), but it is hard to integrate them in the structure. It is expected that the Lithuanian DNA program will help consolidate the Center person-power and infrastructure. The International Advisory Committee re-affirms the following **mission** for the Center of Experimental Nuclear and Particle Physics: “to provide the critical scientific and Research and Development (R&D) core for a continued associate membership at CERN”, and, in particular, the mandates:

1. to **build up** the major particle physics efforts in Lithuania.
2. to be the **voice** of Lithuanian science in engaging with CERN.
3. to **coordinate** the many technical and scientific contributions from Lithuania.

2. Current Situation

While the mandate by the CERN Council is still being implemented in Lithuania, various Lithuanian scientific groups including the Center are continuing their closer integration to CERN. The Committee recognizes a **positive development** in Lithuanian Science, **whose groups are participating** in the following CERN activities: High-Energy Physics (HEP) and Material Science, and Data and Computer Science show great progress, which is highly appreciated. However, most of these activities are done by scientists outside of the Center, and the Committee is **particularly concerned that the Center lacks academic Research and Development (R&D) capabilities**. The main reason for this concern is the lack of allocation of R&D resources to the Center. It was brought to the Committee's attention that the DNA program (lt. Ateities ekonomikos DNR), if completed successfully, should improve the status.

On the other hand, other CERN-related R&D activities are generally progressing well in Lithuania. Currently, the most prominent activities in the country are (1) radiation-hard materials and radiation monitoring (within the RD50 collaboration); (2) scintillators for future detectors (involved with the CMS MIP Timing Detector and more widely with the Crystal Clear Collaboration); (3) new materials for beam-pipe coatings for future accelerators; (4) some initial activities related to the CMS pixel detectors and (5) material Radio Frequency (RF) measurements for accelerator cavities; (6) and lastly the medical studies in the field of nuclear medicine.

Looking at the new generation of scientists and students, the situation looks promising, though with some caveats. VU has a sufficient number of courses in particle physics at the Bachelor (undergraduate) level. A risk factor is the Master's (graduate) level: while there is an advanced one-semester "melange" course on particle physics, **a selection of more specialized courses in HEP theory and experiment is typically expected** of graduate schools with a particle physics curriculum. The **main obstacle** to enlarge such training capacity is the **limited number of academic personnel with specialized knowledge in particle physics**. One way to address this problem may be graduate courses conducted jointly with neighbouring countries. On the other hand, PhD-level studies focus on research as they should, and the currently available supervision is adequate. Generally, the student situation is unchanged since 2019. The **interest** in CERN-related research **is growing** in Lithuania,

which is very encouraging. A weak point is the low number of young researchers. The Committee notes the worrisome fact that there were no experimental HEP postdocs in Lithuania at all, but acknowledges the helpfulness of the special postdoc program for Marie Skłodowska Curie applicants by Lithuanian Research Council (LRC) that will serve as a one-time help. Other postdoc programs administered by LRC should be also exploited. The Committee notes with pleasure the incorporation of new HEP personnel via the DNA program. The short duration (1 year) for personnel is a limitation, which reduces the attractiveness of such a program, and the Committee recommends finding ways to extend the length of the grant to 3 years (which is a typical time span for successful post-doctoral engagements).

It is clear that CERN-related **funding should grow** in order to account for the growing interest. The current, limited, funding is oversubscribed. As a result, new funding programs are essential: in order to sustain the growth of the HEP community there should be national programs on top of the possible, and welcome, funds from the EU. The foreseen DNA program (lt. Ateities ekonomikos DNR) is acknowledged as a positive one-time boost in the correct direction, which is an encouraging development since 2019.

The Committee notes positively that CERN-related outreach activities to a broad public occur periodically in Lithuania. However, **participation in International Particle Physics Outreach Group (IPPOG) is still missing**, which could be helpful to spread the messages to wider audiences in an optimal way. The Committee welcomes the nomination of the Lithuanian coordinator for the CERN teacher program and encourages the coordinator to cooperate closely with both the Lithuanian teachers and CERN.

Since Lithuania's accession to CERN, the role of International Liaison Officer (ILO) has been instituted: this is a **positive development for relations with CERN** and is essential to promote the industrial return to Lithuania. **We encourage the ILO to be more proactive**, especially by his/her **presence at CERN** once the pandemic situation becomes safer. It seems that Lithuania's overall return is in good shape, while the current industrial return is at the limit for that of the Associate Member of CERN. The Committee also notes that several Lithuanians have joined CERN as laboratory personnel. However, it seems that Lithuania is not yet profiting from CERN studentships, which could be instrumental for new research and technological ideas to return to the country. A residency at CERN needs to be a recognized part of the curriculum. The Committee notes that the Business Incubator (BIC) has been established and has successfully started since then: this is a major step towards direct knowledge transfer to national industries.

3. Future

In June 2020, the European Strategy for Particle Physics has been approved that sets the main priorities for at least the next seven years for all European efforts as well as CERN. In particular, the following two are of high importance to Lithuania, in the Committee's opinion:

1. **full exploitation of the LHC physics potential**, which depends on the successful completion of the high-luminosity upgrade of accelerators and experiments.
2. Continued developments in **theory, detector R&D, software, and computing**.

Other priorities are more focused towards the longer-term future and depend much more on the country's own long-term ambitions.

High-Energy Physics (HEP) research is an important component of the reasons why Lithuania has joined CERN: in order to exploit this, potential adequate investments are required. The main advantages can be summarized as:

- HEP is a very international field.
- HEP helps to maximize the return invested to CERN.
- within physics, HEP is the leading discipline in Data Science, i.e., Artificial Intelligence (AI), Big Data, Cloud Computing, Machine Learning, etc.
- HEP is a multidisciplinary field that fosters innovation and the development of new technologies.

- disruptive technologies can only come from fundamental research.
- HEP students¹ are desired in industry upon graduation, and often create start-ups.

CERN is a large international organization, and it is a unique laboratory. It is worth stressing that by Lithuania's accession to CERN, CERN has effectively become a **national laboratory** of Lithuania. As with any laboratory, it has a lot of value and potential, thus it is important to **use CERN's** infrastructure at its fullest. At the moment Lithuania is leading the way for Baltic neighbours, but the picture might change as Latvia is applying for associate membership and Estonia has been accepted for associate membership on the path towards full membership. Lithuania may wish to maintain the leadership in the region.

A strong **voice in the Baltic region** could be achieved if the role of the Center is strengthened. More precisely, Lithuania could potentially lead the Baltic effort: for this to happen the growth of the Center is imperative. In addition, vigorous R&D programs are important for the growth of local industry. Validating the potential of local industry, will, in turn, bring investment/resources from outside Lithuania. R&D and deeper integration with CERN can be instrumental in bringing large EU research infrastructure to the Baltics, such as medical centers based on accelerators.

In order to maximize the impact and returns from the membership of CERN, it is important to strengthen both the detector activities and industrial engagement, where the latter is reaching the maximum for an Associate Member of CERN. Some of the goals could be reached by establishing **targeted funding** for the relevant research of Lithuanian teams, which should not be aimed at boosting salaries. The Center should play a leading role in this process, in particular by contributing to the development of the national physics strategy (especially the HEP part) and by coordinating CERN-related academic Research and Development (R&D) in Lithuania, especially by being involved in setting local responsibilities.

A target for R&D activities should include **detector building** (the DNA program is in the right direction). For example, within CMS, the current main experiment with Lithuanian participation, the MIP Timing Detector and the Pixel detector are examples of state-of-the-art detector technology developments of interest to Lithuania.

Detector development is important for future technologies, a deeper integration into the experimental community, forming highly skilled new generations of researchers, and in general the future of fundamental research. In addition, such R&D efforts foster applications, with knowledge and people being transferred into industry, start-ups, medical applications, etc. Detectors are an integral part of **any smart technology**, together with computing and algorithms (data analysis): they are absolute musts for future high-tech industries and companies.

The Center is an example of opening Lithuanian science towards Europe and incorporating global trends in general. Careful and adequate **planning must be continued** as it is vital to Lithuania's success. The Lithuanian CERN activities are governed by the Plan as outlined by the Ministry of Education, Science and Sport of the Republic of Lithuania. Once matured, the planning process could become a model for other scientific fields.

4. Conclusions

The International Advisory Committee is pleased to see that the Center for Experimental Nuclear and Particle Physics (Center) is representing Lithuania in the venues where the High Energy Physics European scientific policy is being defined, namely the CERN Council and the European Strategy Group for Particle Physics.

The next deadline in the process, which ultimately should aim for full CERN membership, is the review to happen 5 years after association to CERN, in 2022.

In order for this review to be successful and to fully attain the role advocated in the original request of the CERN Council, the Committee recommends:

¹ In the CMS experiment alone, there are 1050 PhD students. Lithuanian nationals have major engagements in CMS.

- extending and expanding the funding for programs, such as the DNA program, which are in line with 2019 recommendations.
- CERN-related national funding programs should be coordinated by the Center.
- the Center's staff should be increased.
- the Center is on the way to become an academic R&D hub for European collaboration, and such developments should be continued.