Progress of Lithuania in Particle Physics

Aurelijus Rinkevicius
Experimental Nuclear and Particle Physics Center

2022-11-24

Timeline of Particle Physics in Lithuania

1992 Nuclear theorists and applied physicists co-sign CMS LoI.

1993–16 Applied physicists join CERN RD programs.

2005 First particle physicist in Lithuania: assoc. prof. T. Gajdosik (phenomenology).

2007 Signed CMS MoU.

2008 Senior scientist A. Juodagalvis moves from Nuclear theory to Exp. HEP.

2009 First undergraduate students with HEP-themed theses (advisor: T. Gajdosik).

2015 Lithuanians@CERN starts.

2017 Signature of the CERN agreement.

2018 Lithuania becomes an Associate Member of CERN.

2018 CERN Baltic Group starts.

2019 First PhD in HEP theory (V. Dudenas, advisor: T. Gajdosik).

2019 First new HEP (theory) staff at Vilnius (V. Dudenas).

2019 Elected Chair of Particle Physics (Center) starts (A. Rinkevicius).

About the Center

Some highlights:

- Established as a criterion for CERN associated membership.
- Chair started in 2019 April.
- Involved in all new HEP developments in Lithuania since 2019.
- Currently, all staff is project-based (no VU baseline funds).

Main Activities 2021–2022 (1/2) at the Center

Drafting:

- Drafting earlier versions of Lithuanian CERN Action Plan 2022–2027.
  - Misc. commenting of recent versions
  - Was in making since mid-2020
- Preparing a pixel lab proposal (HW only).
- Co-prepared a COST Action (on EWK/VBS and Higgs topics)
  - 2nd resubmission in 2022 Oct.

CMS research:

- Engaged in
  - $t\bar{t}H$ analysis (A. Rinkevicius, N. Chychkalo)
  - CMS online tools (D. Simelevicius, V. Rapsevicius)
  - DiHiggs analysis (A. Carvalho*, N. Chychkalo)
- CMS “extended internships” (Cat A personnel)

Overall research:

- Projects with CERN, industry, and Lithuanian Research Council.

Main Activities 2021–2022 (2/2) at the Center

Studies and students:

- Reworking (and teaching) HEP courses.
- Student (undergraduate and graduate) supervision.

Knowledge transfer:

- Co-starting DeepTech Entrepreneurship program with VU Business School, CERN Lithuanian BIC, CERN KT.

Baltics:

- Keeping ties with Baltics via CERN Baltic Group.
- Co-organization of 1st CERN Baltic Conference (2021), organized 2nd (2022)

Outreach:

- A couple of masterclass events with KTU, LSMU, ...
- Various solo events

Main Activities 2021–2022 at Vilnius U.

CMS research:

- Drell–Yan analysis (A. Juodagalvis, M. Ambrozas)
- CMS Tracker (A. Juodagalvis, M. Ambrozas)

Theory:

- DiHiggs (A. Juodagalvis, D. Jurciukonis, V. Dudenas)
- Grimus–Neufeld Model (T. Gajdosik, V. Dudenas, S. Drauksas)
- Seesaw Mechanism (T. Gajdosik, V. Dudenas, S. Drauksas, A. Vitkus)
  - Nuclear theory (A. Deltuva, D. Jurciukonis)

In the past:

- 1 theory PhD dissertations defended

A Closer Look

Financial resources (Center):

Bruto income:

- 2019–2021: 790 k€ (380 ITC CERN, 280 Ministry, 130 LRC)
  - Projects: 6 orders, 1 LRC. Applied: 3 EU Horizon, 1 EU SF.
- 2022: 62+ k€
- 2023 onwards: 200 k€
- Via Consortium (estimation) 2022+: 30 k€/year.

Financial resources (ITPA/TFAI):

Project income:

- 2019–2022: 280 k€ (via Lithuanian Academy of Sciences)
- Via Consortium (estimation) 2022+: 60 k€/year.

Human resources (Center):

- Management: Chair and admin. specialist
- Scientific personnel (4[1] FTE): 2 Sen. Sc., 1 Sc., 1 junior Sc.
- Students (PhD): 1; (BSc/MSc): 2
- Outside: 1 postdoc* (CERN), 2 PhD stud. (Cornell U.), 1 intern

Human resources (all):

- 3–4 undergraduate students
- $\sim$2 graduate (master) students
- 4 graduate (PhD) students
- 5 HEP staff

In the past (2019–2021):

- deputy, 5 CERN interns, 2 junior Sc., 3 internat. students (2 U. of Cambridge)

[1] Including chair

Activities at the Center (2019–2022)

Activities with partners (esp. VU FF TFAI/ITPA, VU MIF).

- R&D: HEP, Computer and Data Science
  - 150+ CMS pubs. (esp. top and Higgs), 5 confs.
- CERN supporting activities: DBs, monitoring, DAQ SW, shifts
- Renewed BSc and MSc (6 new courses)
- Coestablished DeepTech Entrepreneurship program
- Outreach and events: $\sim$27 events for school pupils and teachers
- CERN Baltic Group (CBG) activities; HEPCOST/COMETA consorcium
  - CBG summer schools and conferences
- Dedicated stipends: 11 students

Future

Main Objectives

Prelude to the new era of HEP in Lithuania:

- New long-term planning and resources
- New Particle Physics infrastructure

Objectives:

1. **Build up** major HEP community to meet Full Membership reqs.
2. **Connect** and integrate into international and leading HEP projects
3. **Accelerate** industrial engagement and knowledge transfer
4. **Follow** European HEP planning via EPPSU

Pixel Detector Lab

- Allows better exploitation of HL-LHC upgrade and scientific program
- Follows EPPSU detector R&D goals
- Lies foundations for future-collider detector-development basis
- Enables interdisciplinary technologies for scientific diversity

(Past) Technicalities:

- Agreed with CMS Tracker project in 2019.
  - Invitation letter from Tracker management in Nov 2020.
  - Tracker experts participated in setting up plans.
- In 2022–2027 Action Plan, Ministry alocated 1.5 M€ (to the Center).

New Type of R&D in Lithuania

- Laser-based particle accelerators
  $\Rightarrow$ new R&D on accelerator technologies for future colliders
- R&D in particle therapy
  $\Rightarrow$ interdisciplinary research and diversity
- New and sustained R&D in detectors and smart technologies
  $\Rightarrow$ technological and societal gains

$\Rightarrow$ New people and resources to accompany

$\Rightarrow$ To brain gain and novel R&D!

Backup

Planned Activities

Pixel detector lab (2023–2027):

- Agreed with CMS Tracker project in 2019.
  - Invitation letter from Tracker management in Nov 2020.
  - Tracker experts participated in setting up plans.
- Some difficulties in Lithuania were met.
- In 2022–2027 Action Plan, Ministry alocated 1.5 M€ (to the Center).
- Envisioned for Makerspace/Hackerspace Entrepreneurship activities
  - Important for national development of startups.
  - Could aid to CERN DRD and ASIC strategy.

Envisioned Activities

- Accelerator technologies (2023++)
  - Exotic accelerators (laser based).
  - Early steps towards particle therapy.
- Tier-2 cluster (?) and smart systems lab (2027+)
- Baltic region hadron therapy center (2027++)