

State Research Programme: High-energy physics and  
accelerator technologies



VPP-IZM-CERN-2022/1-0001

**Kārlis Dreimanis**  
project leader

**01.03.2023.**

# Reminder: summary of the aims of the State Research Programme:

- **Overarching goal:** *“to strengthen the scientific community in Latvia in the fields of high-energy particle physics and accelerator technologies in collaboration with CERN”*
- **Goal:** *“to carry out scientific research in natural and engineering sciences in the fields of high-energy physics and accelerator technologies in order to develop world class scientific excellence, human capital and technologies, involving the academic personnel, as well as students and early-careers scientists”*
- Overall objectives:
  - To establish a research community in high-energy physics (HEP) and accelerator technologies (AT) in Latvia;
  - To increase the scientific capacity in the fields of HEP and AT in Latvia by establishing and solidifying new research groups focused on particle physics, particle detectors and accelerator research & technologies;
  - To maximize the involvement of early-careers researchers and students;
  - To establish research avenues for the prospective students of the new doctoral study programme in “Particle physics and accelerator technologies”<sup>[1]</sup>;

# Summary of the previous project (2020-2022):

Title: “Top quark and Higgs physics at the CMS experiment, development of crystal scintillator detectors and sub-detectors of the CMS detector, and the development of particle accelerator technology for societal applications in collaboration with CERN”

- The project was split into four work packages:
  - **WP1:** Management;
  - **WP2:** CMS physics;
  - **WP3:** CMS detector & crystal scintillator research;
  - **WP4:** Accelerator technologies;

- The consortium of the project:
  - Riga Technical University (RTU) [lead];
  - University of Latvia (UL);
  - UL Institute of Solid-State Physics (UL ISSP);

- Budget:

Total budget:	836'460	Euros
Annual Budget:	418'230	Euros

- Budget split:

	RTU	UL	UL ISSP
€	583'570	126'446	126'446
%	69.77%	15.12%	15.12%

# Feedback of the previous project (2020-2022):

- Scientific excellence:
  - *“All goals set out in the original proposal were met.”;*
  - *“The hiring of Dr Seidel has proven to give this part of the project the boost it needed. This is of utmost importance for the continuation of this aspect of the program.”;*
  - *“For the continuity of the analysis effort, it will be essential that a senior and permanent staff member are hands-on involved in this work.”.*
- Impact:
  - *“The project has met all its goals regarding publications and increasing the group size.”;*
  - *“The number of publications and conference contributions is well beyond expectation.”;*
  - *“Overall, the project has well met the expected impact objectives, particularly in the core areas of growing a local and regional HEP and AT community.”*
- Implementation:
  - *“The PI and his team have shown remarkable dynamism in contrasting the adverse effects of unexpected events such as the sanitary crisis.”* (e.g. the HEV project).

# Summary of the new project (2022-2026):

Title: "High-energy particle physics research at the CMS experiment and the development of advanced accelerator technologies in collaboration with CERN"

- Consortium of the project remains unchanged:

- Riga Technical University (RTU) [lead];
- University of Latvia (UL);
- UL Institute of Solid-State Physics (UL ISSP);

- Consolidated work packages:

- **WP1:** Management;
- **WP2:** CMS physics & detector, incl. scintillator research;
- **WP3:** Development of advanced AT;

- Overall budget:

	Total (€)	Annual (€)
SRP1 (2020-2022)	836'460	418'230
SRP2 (2022-2026)	1'395'000	348'750
	Δ	↓69'480 (↓16.6%)

- Total budget split:

	SRP1 (2020-2022)		SRP2 (2022-2026)	
<b>RTU</b>	€583'570	69.77%	€959'000	68.75% (↓1.0%)
<b>UL</b>	€126'446	15.12%	€218'000	15.63% (↑0.5%)
<b>UL ISSP</b>	€126'446	15.12%	€218'000	15.63% (↑0.5%)

# Recommendations for the new project call

## Recommendations:

- Work towards establishing leading/expert roles in the Higgs physics programme at CMS, similarly to the Top physics contributions;
- Limit the possibility of 'single point of failure' in the physics programme; ie. recommendation of acquiring more senior researchers;
- Monitor the outreach more closely (the numbers of people reached), where practicable.

# Comments for the new project call

*[...] While the proposed project promises to have high impact in terms of generating opportunities in academic research and applications for industries, the expert panel would have appreciated some discussion of plans on how to foster contacts with commercial parties, and generally more detailed discussion of the expected research impact. [...]*

- The main industrial component of this SRP is the possibility to engage industry in additive manufacturing of accelerator components, based on the research performed as a part of this project; industrial partners in Europe have been engaged; potential partners in Latvia, regarding additive manufacturing, AT and HEP detector development, will be sought through collaboration with the CERN Latvia group and the Latvian ILO at CERN.

# Comments for the new project call

*[...] Data management and dissemination plans are appropriate and exist in the framework of those of the CMS experiment, although the degree to which the general public will access the thus provided detailed data can be subject to debate. [...]*

- It is agreed that the direct impact of such data being available does not particularly high. However, during the current project the HEP group will aim to make the access to the CMS open data more visible in Latvia as well as will aim to undertake various outreach activities, targeting younger audiences, such as high-school pupils, using these data.



# Comments for the new project call

*[...]. The research plan is very ambitious, with some risk that it cannot be fully completed within the allocated time of this proposal.[...]*

- The research plan is indeed very ambitious. Provided the growth of the HEP group can be maintained, we are confident that all the goals put forward will be achieved. Additionally, the *ideal goals* and the *mandatory set goals* are relatively distinct; the mandatory set goals and deliverables will be achieved in full.

## Consolidation of the WP2

- It was noticed early on during the previous project, that there is a considerable overlap between the two HEP and CMS-related WPs working on physics analyses (previously WP2) and detector development (previously WP3);
- Only direct scintillator material research was performed by a distinctly separate group of personnel (UL & UL ISSP);
- For this call it was decided to consolidate the HEP and CMS-related activities into one single WP (WP2);
- Although direct scintillator material research is still included in this WP, focus must be aimed at detector development for HEP:
  - Direct scintillator material research, although valuable in and of itself, has a very limited impact on the development of HEP in Latvia;
  - The PL will work even harder to integrate the UL ISSP team more into the CMS detector group (namely, MTD BTL);
  - The need for deeper integration was communicated to and agreed upon by the UL ISSP team prior to commencement of this project.

# Project personnel (currently recruited)

- WP1 (management):
  - Kārlis Dreimanis (RTU);
  - Elīna Pajuste (UL);
  - Anatoli Popov (UL ISSP);
- WP2 (HEP):
  - Kārlis Dreimanis (RTU);
  - Elīna Pajuste (UL);
  - Anatoli Popov (UL ISSP);
  - Markus Seidel (RTU);
  - [PhD] Andris Potrebko (RTU);
  - [PhD] Antra Gaile (RTU);
  - [PhD] Conrado Munoz Diaz (RTU);
  - [PhD] Normunds Ralfs Strautnieks (UL);
  - [PhD] Anastasiia Chekhovska (UL ISSP);
  - [PhD] Tamara Tsebrienko (UL ISSP);
  - [MSc] Alise Podelinska (UL ISSP);
- WP3 (AT):
  - Andris Ratkus (RTU);
  - [PhD] Guntis Pikurs (RTU);
  - [PhD] Luca Piacentini (RTU);
  - [PhD] Kristaps Paļskis (RTU);
  - *[PhD] Lazar Nikitovic\** (RTU);
  - [MSc] Viesturs Lācis (RTU);
- Only four (!) of the current group are employed full-time within this SRP:
  - Andris Ratkus (RTU) [direct SRP contract and SRP-supported project associate (PJAS) contract at CERN];
  - Andris Potrebko (RTU)\*;
  - Normunds Ralfs Strautnieks (UL);
  - Conrado Munoz Diaz (RTU);

# Main aims of the new project

- WP1:
  - To achieve in full the overarching goals and objectives of the SRP call, as well as the required thematic and horizontal tasks.
- WP2:
  - To continue the excellent physics programme within the Top quark physics analysis group (PAG);
  - To develop expertise and leading roles within the Higgs boson PAG;
  - To retain the leadership roles within the CMS collaboration, such as:
    - *Standard Model Physics Vector Boson (SMP-V) co-convenorship (M.Seidel);*
    - *MTD BTL Mechanics, Assembly and Integration (BTL MAI) co-convenorship (K.Dreimanis);*
    - *Significant institutional leadership in the MTD sub-detector project;*
  - To attain the award of the first HEP PhDs funded by this SRP (on track for 1 in 2024 and 2 in 2025);
  - To integrate the UL ISSP group in the HEP activities at CMS, namely the MTD BTL group.
- WP3:
  - To continue the high-profile AT research within the current projects (I.FAST, NIMMS, HITRlplus);
  - To pursue involvement in the upcoming AT projects at CERN;
  - To achieve the award first AT PhDs funded by this SRP (on track for 1 in 2023 and 3 in 2025);

# Deliverables

WP	Deliverable	# at midpoint	# at close
WP1	D.1.1: Successful management of the project, including the delivery of all of its deliverables	n/a	n/a
	D.1.2: Project's mid-point report submitted to the Latvian Council of Sciences	1	0
	D.1.3: Project's final report submitted to the Latvian Council of Sciences	0	1
WP2	D.2.1: Involvement in the CMS physics programme with no less than six research personnel	n/a	n/a
	D.2.2: Additional co-authors of all CMS publications	1	2
	D.2.3: At least two successfully defended PhD theses in HEP	0	2
	D.2.4: CMS <i>OpenAccess</i> data, made available for the relevant target audiences	0	1
	D.2.5: Leadership role in the MTD sub-detector project	1	1
	D.2.6: Prototype MTD DCS and DSS system for the CMS collaboration	1	1
	D.2.7: Co-authored publications in crystal research in journals listed on Web of Science or SCOPUS	2	4
WP3	D.3.1: Involvement in CERN-based AT projects with no less than four research personnel	n/a	n/a
	D.3.2: At least one successfully defended master's thesis in AT	1	1
	D.3.3: At least one successfully defended doctoral thesis in AT	0	1
	D.3.4: Above-threshold application to a European funding call, such as <i>Horizon Europe</i>	0	1
	D.3.5: At least three publications in journals listed on Web of Science or SCOPUS	1	3
Shared	D.S.1: Individual participation in international conferences with a presentation or poster	4	8
	D.S.2: Public engagement & dissemination activities, such as public interviews and lectures	4	8
	D.S.3: Significant involvement of students in the research activities of the project	8	8

# Main challenges of the new project

- The aim of the SRP is to grow the HEP & AT community in Latvia; with the per-annum reduction in funding combined with both the current and projected/needed increase of PhD students in the future years, further growth is at risk of stagnation or even contraction;
- It is paramount to recruit further PhD students to work on HEP physics at UL in the coming years:
  - at risk due to the lack of funds;
  - recruitment of HEP PhD students still challenging in Latvia (even if successful so far).
- Need to increase the number of senior/permanent staff on HEP and AT in Latvia:
  - extremely challenging with the current funding;
  - “permanent” research staff models essentially non-existent in Latvia.
- Ideally, all\* recruited personnel should be involved in this SRP at a minimum of 0.7 FTE (current average around 0.25 FTE);
- Deeper integration of the UL ISSP group into HEP detector research at CMS will be a challenge:
  - personnel non-experts in the field of HEP;
  - all involved personnel employed on low FTEs within this project.

\* it can be foreseen how senior personnel from UL or UL ISSP could choose to have a lower FTE due to other on-going projects, however, this would absolutely be advisable for all students.

# Current status of SRP-2:

- The new project is *only* two months old, but significant initial progress has already been achieved:
  - The consortium has been re-established (all of the legal documentation has been prepared and signed);
  - The planned personnel for the first year of implementation has been recruited;
  - All recruited personnel are actively performing their research activities within their respective WPs;
  - The first outreach event already has taken place, a lecture on Dark Matter for pupils from Liepāja ([in Latvian](#));
  - We have joined a CMS-internal consortium of Universities (CJLST group) working jointly on physics analyses, with a focus on Higgs physics.
- First SRP-funded student (Andris Potrebko) returning to be based in Latvia following his LTA;
- Major milestone:
  - **Two new CMS co-authorships** achieved at the end of 2022, with the support of this SRP, including the first CMS physics co-author from the University of Latvia!

RIGA-RTU author list:

K. Dreimanis, **A. Galle**, G. Pikurs, A. Potrebko, M. Seidel, V. Veckains<sup>1</sup>

<sup>1</sup>: Also at Riga Technical University, Riga, Latvia

LATVIA-UNIV author list:

**N.R. Strautnieks**

# Summary:

- The previous project concluded in October of 2022, having achieved all the goals and deliverables, and with an excellent evaluation!
- New project proposal, retaining the previous institutional consortium, successfully undertaken: official start date of the 48-month project, 15.12.2022;
- Despite the increase in the total funding, the per-annum funding for the second project has decreased by 70 kEur (~16.6%);
- WP2 and WP3 from the previous project consolidated into a single WP2;
- The still-young project already yielding results (new CMS co-authorships; outreach events);
- New doctoral students already involved in this SRP;
- We stand ready and able to deepen our HEP and AT programme, including the recruitment of further PhD students (funding permitting).



**Thank you.**

**Back-up.**

# Current PhD topics (HEP)

Name, Surname	Year of study	Affiliation	Title
Andris Potrebko	Year 3	RTU	“Top/anti-top quark mass difference measurement using Run 2 data collected by the CMS experiment”
Antra Gaile	Year 2	RTU	“Measurement of the Higgs anomalous couplings in Run 2 data of the LHC and the development of the detector control systems at the CMS experiment”
Normunds Strautnieks	Year 2	UL	“Test of lepton universality via the measurement of the electron impact parameter using the Run 2 data collected by the CMS experiment”
Dace Osīte*	Year 1	RTU	“Study of the dead-cone effect in b-jets in top quark decays”
Conrado Munoz Diaz	Year 1	RTU	“Measurement of the boosted Top quark mass”
Dimitrios Sidiropoulos Kontos*	Year 1	RTU	“Study of the substructure of boosted Top quark decays CMS”

\* currently, not funded by the SRP, due to the lack of funds available.

# Current PhD topics (AT)

Name, Surname	Year of study	Affiliation	Title
Guntis Pikurs	Year 4	RTU	“Research on design improvement of accelerator components by additive manufacturing”
Luca Piacentini	Year 2	RTU	“Mechanical Integration of Systems, Instruments and Components of a Carbon Ion Rotating Gantry for Medical Treatments”
Kristaps Paļskis	Year 2	RTU	“Optimization of ion beam parameters for very high dose rate (FLASH) radiotherapy”
Lazar Nikitovič	Year 2	RTU	“Design of a high-frequency linear accelerator for injection into a therapy synchrotron”
Tobia Romano*	Year 1	RTU	“Investigation on the sintering behaviour of pure copper processed via binder jetting additive manufacturing”

\* *cotutelle* student with PoliMi; currently, not funded by the SRP, due to the lack of funds available.

# SRP1: Expected Deliverables

**D.1.1:** Cooperation and partnership agreements between partners and with CERN;  
**D.1.2:** Annual and final report to the Scientific Council;  
**D.1.3:** At least 4 *OpenAccess* public engagement/outreach activities;  
**D.1.4:** An above threshold project application to a European research body;  
**D.1.5:** Biannual staff & students seminars

**WP1**

**D.2.1:** Involvement in the CMS physics programme with 4 registered researchers in CMS physics analysis working groups;  
**D.2.2:** Doubling of the HEP research community in Latvia;  
**D.2.3:** Co-authorship of CMS publications made publicly available on arXiv; 2 publications with a significant role;

**WP2**

**D.3.1:** Strong involvement in the CMS sub-detector upgrade with 2 registered researchers in CMS upgrade projects, e.g. MTD, HGCal;  
**D.3.2:** New data and results regarding the properties of various crystal scintillator and *classic* scintillator materials;  
**D.3.3:** Co-authorship of CMS publications made publicly available on arXiv;

**WP3**

**WP4**

**D.4.1:** Doubling of the AT research community in Latvia;  
**D.4.2:** Participation in CERN-based AT projects with 2 registered researchers in at least 1 group at CERN, e.g. MSC, MME  
**D.4.3:** 2 scientific publications resulting from the on-going research, published in journals listed in databases like *Web of Science* and *SCOPUS* and made publicly available;

**Shared deliverables**

**D.S.1:** Participation of the researchers and students in international conferences with an oral or a poster presentation;  
**D.S.2:** Completion of at least two master's thesis;  
**D.S.3:** Strong involvement of 4 doctoral students in the research activities of the project;  
**D.S.4:** Provision of access to data, such as the CMS *OpenAccess data*, for the relevant target audiences.