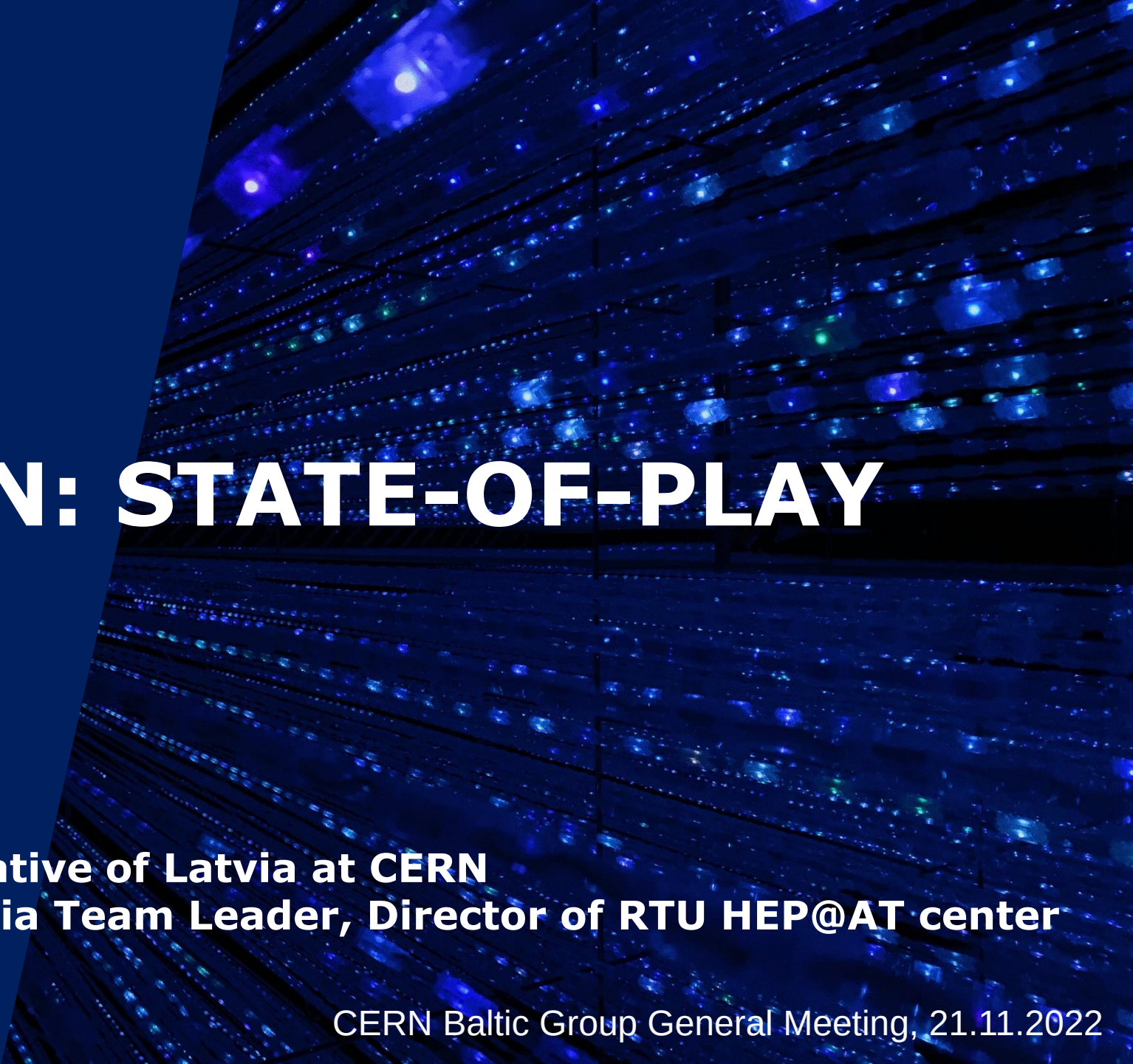
LATVIA - CERN: STATE-OF-PLAY



Prof. Toms Torims, Representative of Latvia at CERN
Dr. Kārlis Dreimanis, CMS Latvia Team Leader, Director of RTU HEP@AT center

CERN Baltic Group General Meeting, 21.11.2022

researchLatvia
Value Through Knowledge

Latvia is reliable and honest partner of CERN

Latvia – CERN Strategy

Latvia - CERN strategy

Government approved – consensus based - stakeholders and ministries

Overarching goals:

1. **Meaningful** and **coordinated** participation of Latvia at CERN in the **Associate Member** state status

2. To become **Full Member** state within **2-3 years**

Meaningful and coordinated participation of Latvia at CERN

Tasks for associate membership

1. To benefit from the **opportunities** at CERN – in the best possible way and at all levels
2. To provide sustainable contribution in attaining the **State priorities** in education, science, economic development and R&D
3. To foster environment of the **scientific excellence and industrial leadership**
4. To concentrate available and to attract new **human resources** / to use strategically available **financial instruments**
5. Within the next years to achieve "**well balanced country**" status and to ensure **60/40 proportion** for scientific HR / industrial return

Benefit from the opportunities at CERN

– in the best possible way and at all levels

Scientific/research portfolio

Based on the bottom-up initiatives / balance & diversity / strategic approach

CERN based experiments and collaborations

- **CMS** as a **HEP flagship** project (RTU+LU)
- **MEDICIS** (RTU+LU)
- AEgIS (LU)
- ISOLDE/LIEBE (LU)
- Crystal Clear Collaboration (LU)

Development of new projects and technologies at CERN

- Accelerator & Technology Sector /ATS-DO
- Engineering and Technology Departments
- FCC

EU funded projects CERN coordinated/associated

Riga Technical University (RTU)

- I.FAST
- HITRIplus
- HERTIS
- NIMMS

University of Latvia (UL)

- PRISMAP
- QuantHEP

+ Muon Collider Collaboration

Latvia @ CERN

Personal based long term @CERN: USER, COAS, PJAS, DOCT, FELL
- snapshot at 21/11/2022

CMS-Latvia HEP group

Users (rec. COLA) 100% at CERN

1. Senior researcher PhD in HEP – CMS Team leader
2. Senior researcher PhD in HEP – Top physics analysis group
3. PhD student – Technical Integration
4. PhD student – Higgs physics analysis group

Latvia Accelerator Technology group

PJAS and COAS 100% at CERN

5. Senior researcher – COAS / ATS-DO
6. Senior researcher – PJAS / ATS-DO
7. PhD Student AT – COAS / ATS-DO+CMS
8. PhD Student AT – DOCT /ATS-DO **paid by NIMMS**

AD-Antihydrogen Experiment

9. PhD Student Atomic physics - USER / AEgIS+CMS

CERN-Latvia doctoral programme

10. PhD Student AT – DOCT / ATS-DO+CMS
11. PhD Student MEDICIS – DOCT/SY-STI-RBS+CMS
12. **PhD Student Top physics – DOCT** / EP-CMG+CMS

CERN Doctoral Programme

13. **PhD Student Top physics – DOCT** / EP-CMD+CMS – **only DOCT paid by CERN**
14. PhD Student AT – DOCT / ATS-DO so far paid by Latvia

With no link to Latvia scientific community

15. CERN Fellow - FELL / EP-DT-EO - only FELL paid by CERN

+ numerous short (2-3 months) term stays @CERN paid from the Latvian budget

To continue capacity and competency building in HEP and AT

To maintain strong CERN related scientific institute with multidisciplinary research team and presence at CERN

Institute of Particle Physics and Accelerator Technologies

@Riga Technical University Faculty of Materials Science and Applied Chemistry

100% CERN related research

Elected academic staff - vision

1. Prof. Yuri Dokshitzer - **HEP**
2. Asoc.prof. Kārlis Dreimanis – **HEP**
3. Dr. Markus Seidel – **HEP** lecturer, PhD supervisor
4. Prof. Toms Torims - AT
5. Asoc.prof. Andris Ratkus - AT

Research staff

Elected HEP and AT Senior researchers / researchers / scientific assistants - **12 in total**

+ admin staff.

- Leading and running **CMS-Latvia HEP group**
- Executing **State Research Programme** in HEP and AT
- Running **Doctoral Programme** (jointly with University of Latvia) in HEP and AT
- Institutional partner of **CMS, FCC, Muon Collider**
- Collaborator and contributor to **I.FAST, HITRIplus** and **NIMMS** projects
- Leader of **HERTIS** project
- Leader of CMS **Tier2 center** project
- Representing RTU in **CERN Baltic Group**

+ Supervisory role of **HEP and AT students** at CERN

Dedicated doctoral programme

- In collaboration with CERN Baltic Group – **designed by CBG** Study Programme Working Group
- Students in programme: 3rd year – **1**; 2nd year **6**; 1st year **5**
- Students are **co-supervised by CERN** staff
- Strong presence of **international students**
- Executed in Latvia with mandatory **term at CERN**
- **World class** lecturers: Latvia, CBG, CERN, PSI
- Balance between **HEP** and **AT**
- International Study Program Council
- Relevant **master programme** is being developed

CERN research in Latvia

Other institutes carrying out CERN related research and projects

University of Latvia

1. Institute of Chemical Physics – Prof. Elina Pajuste group - **CMS** and **MEDICIS**
2. Faculty of Physics, Mathematics and Optometry - Prof. Mārcis Auziņš group – **AEgIS**
3. Faculty of Medicine – Prof. Maija Radziņa group – **MEDICIS/PRISMAP**
4. Institute of the Solid State Physics – Dr. Anatoli Popov group- **Crystal Clear Collaboration**
5. Institute of Physics – Dr. Kalvis Kravalis group – **ISOLDE / LIEBE**
6. Quantum Computing group of Prof. Andris Ambainis - **QuantHEP**

Riga Technical University

1. Department of artificial intelligence and systems engineering - Prof. Agris Ņikitenko group – **I.FAST** + Mechatronics, **Robotics** and Operations section **at CERN**
2. Institute of technical Physics – Prof. Arturs Medvids group – **I.FAST**
3. Institute of Industrial Electronics and Electrical Engineering – Prof. Pēteris Apse-Apsītis group - **ARIES**
4. Students of Institute of Mechanics and Mechanical Engineering - **I.FAST** and **HITRIplus**
5. High Performance Computing (HPC) Centre – **Tier2** project at **CMS**

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State Research Programme

Strengthening the development of the Latvian scientific community in the field of **high-energy physics** and **accelerator technology** in cooperation with the CERN

Programme call (2020-2022)
to be finalized 31.10.2022

900 000 EUR

Project leader: RIGA TECHNICAL UNIVERSITY

Project partners: UNIVERSITY OF LATVIA; INSTITUTE OF SOLID STATE PHYSICS, UNIVERSITY OF LATVIA

- Develop world-class knowledge
- Develop human capital & technologies
- Create products & services
- Involve scientific & academic staff, students, PhD applicants & young scientists

Programme call (2022-2026)
to begin implementation **Autumn 2022**

1 500 000 EUR

Eligible participants of the open call:

Research organizations, public organizations. Several partners must be involved

- Ensure the programme's continuity
- Foster research capacity

Outreach activities in Latvia

Integral part of the Latvia – CERN strategy / boosting interest in STEM

Latvian National Library

- permanent CERN exposition and classroom for children and general public – CERN as a centre of excellence for technology and innovation

Latvian Physics Teachers Association

- Participation in events, lectures of Latvian scientists @CERN and CERN staff / selection of teachers for the CERN visits

School of the Young Physicists of Latvia

- Virtual and in-person lectures + events

Job shadowing at CERN

- Every year 4-5 school children come to CERN to shadow Latvian scientists and engineers with preparatory and post-events in Latvia

+ many other events and activities

Latvia - CERN Stakeholders Group

Encompassing all relevant stakeholders - platform for engagement and exchange
https://indico.cern.ch/category/11669/

- 10 **regular meetings** since Nov 2019
- Organised by CERN **National Contact point**
- All **relevant** research institutions, business entities and associations, related ministries and agencies, CERN Council Delegates and ILO
- **Informing** the stakeholders about the relevant CERN-based and CERN-related activities
- Directly supporting the stakeholders' **engagement** with CERN
- Managing the information **exchange** and **collaboration** vis-à-vis CERN and the stakeholders

Geneva/CERN based ILO

To ensure meaningful Latvian business participation @CERN

CERN as priority

- ILO KPI's are directly based on industry engagement

Knowledge Transfer

- Technological and knowledge return to Latvia by engaging R&D capable companies

Well-balanced industrial return

- To ensure fulfilment of the current 'quota' ~ 400 000 CHF
- To prepare industrial portfolio for the full-membership @CERN
- To closely collaborate with Latvian scientific and engineering community at CERN

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Latvia – CERN Strategy

Full membership at CERN

Full membership at CERN

Tasks - liaison with decisionmakers and stakeholders

1. To **ensure support** of the CERN Management and Member states
2. To actively **participate** in the work of the CERN Council and its committees – *inter alia* to cultivate **positive attitude** towards Latvia's full membership
3. To **coordinate** Latvia's position at Council meetings and its committees
4. To facilitate coordination among the **Baltic States**: at CERN Baltic Group and Baltic Assembly level – to foster **joint position** vis-à-vis CERN
5. To ensure **continuous support** from the Government, Parliament, scientific community, entrepreneurs, other partners and society at large

Full membership at CERN

Tasks – scientific and technical measures

1. To ensure stable **financial framework** for CERN activities in Latvia – ensuring **50/50 principle** – where proportion of the national funding is gradually exceeding CERN membership
2. To continue **capacity and competency** building in HEP and AT: to maintain strong CERN related **scientific institute** with interdisciplinary research team and presence at CERN; to run master level programme in HEP and AT
3. To facilitate **industrial return** and engagement with CERN; including ILO organised dedicated events in Latvia
4. To cultivate **positive image** of Latvia – CERN cooperation *#LatvijaCERN*

Proposed timeline for full membership

2023 1st half

March Council

Government letter of intent to become associate member in pre-stage to the full membership - to the President of CERN Council and DG

2023 1st half

June Council

Favourable CERN Council decision and invitation to apply for the associate membership in pre-stage to full membership

- subsequently application is submitted

2023 2nd half

Sept Council

CERN Council Decision to form the Task Force

Task Force visit to Latvia

December Council

CERN Task Force report is evaluated and DG is mandated to negotiate agreement

2024

Agreement negotiations

Cabinet of Ministers decision

Signature of pre-stage Agreement

Ratification procedure

2025

prospective time when Latvia becomes associate member in pre-stage to the full membership at CERN

To ensure stable financial framework for CERN activities in Latvia

Membership payments

Currency	2023	2024	2025	2026	2027
	Associate Member	Associate member in pre-stage to full membership	Associate member in pre-stage to full membership	Full member	Full member
CHF	**1 024 850**	**1 281 250**	**1 793 750**	**2 494 000**	**2 494 000**
EUR	**1 019 553**	**1 274 588**	**1 784 423**	**2 481 032**	**2 481 032**

CERN experiments and programmes

Activity	2023	2024	2025	2026	2027
CMS*	222 084	350 000	360 000	450 000	450 000
MEDICIS	40 000	50 000	80 000	100 000	100 000
Teacher programme	12 000	12 000	12 000	12 000	12 000
Student programmes	6 000	6 000	9 000	9 000	9 000
Total EUR	**280 084**	**418 000**	**461 000**	**571 000**	**571 000**

* 3->4 authors; 2->3 students at CERN; 3->4 senor scientists

+ Phase II upgrade

CERN National Contact Point @ Science Council of Latvia

Activity	2023	2024	2025	2026	2027
Staff and admin costs	88 435	88 800	112 800	112 800	50 400
Communication & PR	8 000	8 000	8 000	8 000	8 000
Outreach – visits to CERN	20 000	20 000	20 000	20 000	20 000
Network events with CERN	5 000	5 000	5 000	5 000	5 000
Total EUR	**128 935**	**139 300**	**163 300**	**163 300**	**100 900**

+ 99 000 EUR/per annum to cover living costs Latvia's Representative at CERN

National CERN activities

	2023	2024	2025	2026	2027
State Research Prog. in HEP and AT	300 000	700 000	1 000 000	1 000 000	1 200 000
Tier 2 Center	260 000	100 000	100 000	100 000	100 000
Total EUR	**560 000**	**800 000**	**1 100 000**	**1 100 000**	**1 300 000**

Proposed Latvia - CERN budget until 2027

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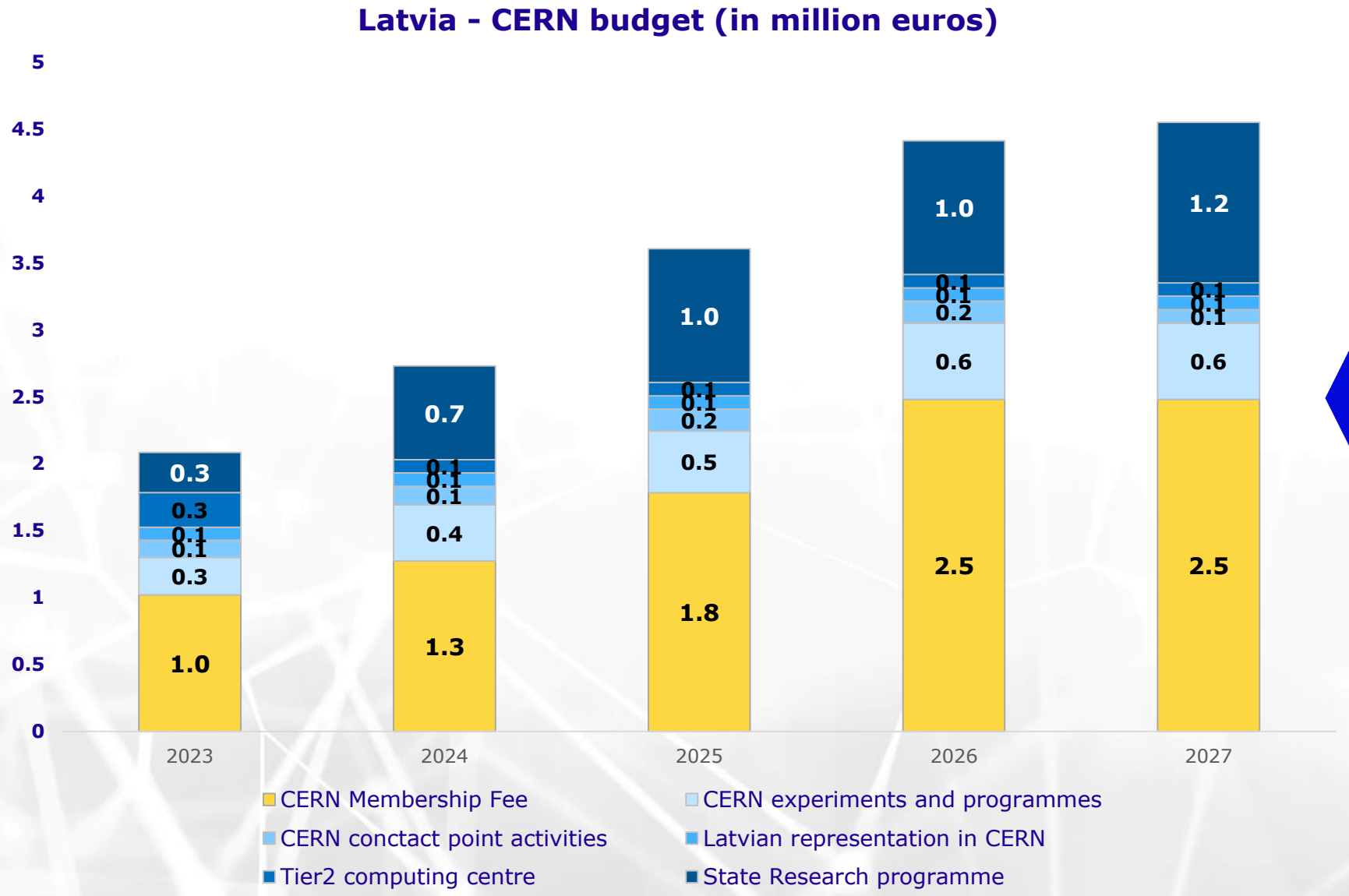

Ensuring 50/50 principle – where proportion of the national funding is gradually exceeding CERN membership

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Participation in Accelerator Projects

By Latvia Accelerator Technology Group at CERN
Leader Dr. Andris Ratkus

Research directions

- Innovation and development of accelerator technologies
- Accelerator medical applications
- Accelerator environmental applications

Accelerator Technology Group in Latvia and at CERN

Accelerator Technology Team

- **Before Latvia's Associate Member State at CERN**
  - Toms Torims
  - Guntis Pikurs PhD student
  - Andris Ratkus



Accelerator Technology Team

- **After Latvia's Associate Member State status**
  - Jānis Vilcāns PhD student
  - Luca Piacentini PhD student*

  2021 Oct – Dec

  - Lazar Nikitovics PhD student*
  - Dagnija Kroģere MSc student
  - Kristaps Paļskis PhD student*

  2022 Feb – Mar

  - *Viesturs Lācis MSc student* — *2022 CERN summer school student*

* Particle Physics and Accelerator Technologies study programme

Accelerator projects and Student thesis

Accelerator research and Innovation for European Science and Society

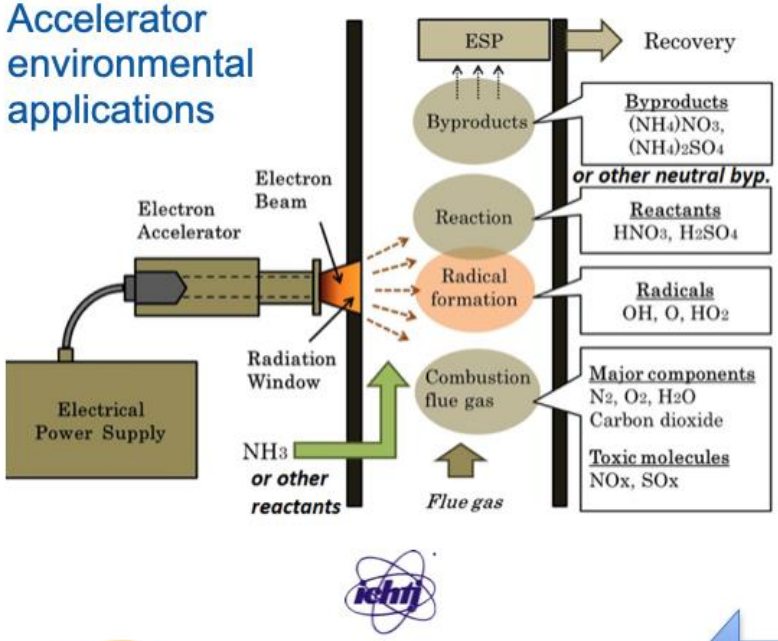
- Development of hybrid electron accelerator system for the treatment of marine diesel exhaust gases

(Finished)

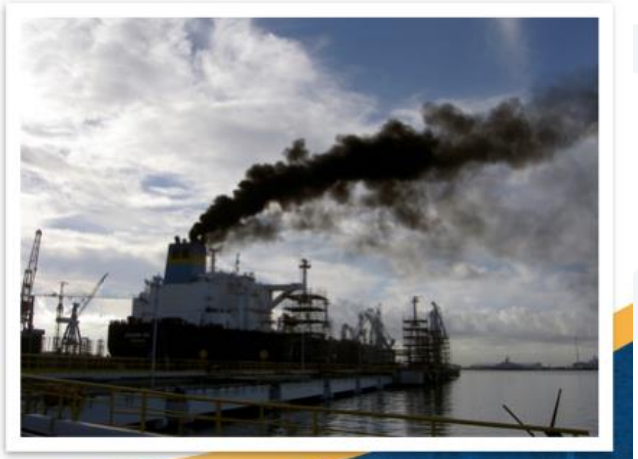
Accelerator community-
promising technology

Maritime industry-
demand for better solution

Accelerator environmental applications



- MARPOL Annex VI - sulphur content shall be reduced to 0.50%
- Economically viable solution is still not there
- No technology can remove simultaneously SOx and NOx



ARIES PoC

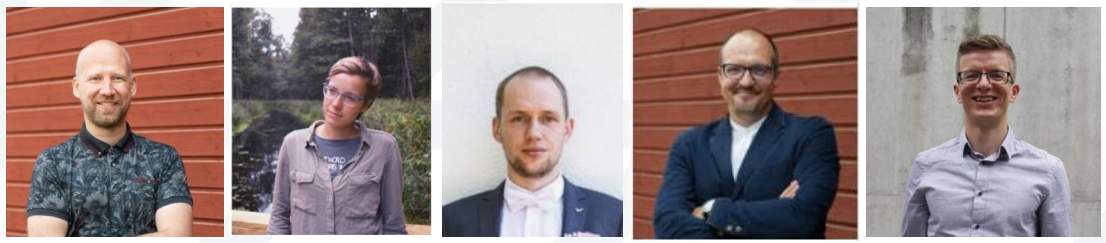
Courtesy of T.Torims

Innovation Fostering in Accelerator Science and Technology

- WP1: Management, coordination and dissemination
  - Task 1.2: Information Flow Management and Cross-coordination (Task Leader RTU)

- WP10: Advanced Accelerator Technologies (Coordinator RTU)
  - Task 10.1: Coordination and Communication (Task Leader RTU)
  - Task 10.2: Additive Manufacturing - Survey of applications and potential developments
  - Task 10.3: Refurbishment of accelerator components by AM technologies (Task Leader RTU)

- WP12: Societal Applications
  - Task 12.1 sub task 3: Environmental applications of electron beam



Student thesis

- **Guntis Pikurs PhD thesis**:

Research on performance improvement of accelerator and detector components by additive manufacturing

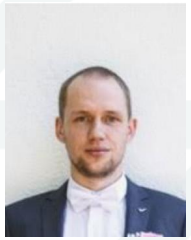
- **Dagnija Krogere MSc thesis (Defended)** :

Research of additive manufacturing applications and strategies for repairing particle accelerator components

- **Viesturs Lācis MSc thesis**:

Laser Polishing of Additively Manufactured RFQ Prototype





Formnext Frankfurt 2022

Hybrid Exhaust-gas-cleaning and Accelerator Technology for International Shipping

HERTIS

Based on promising results of the ARIES PoC

HERTIS Collaboration was established between multiple partners

objectives:

- To foster multidisciplinary cooperation between Accelerator and Maritime Communities
- To develop and maintain joint Strategy
- To prepare and submit the Projects on behalf of the Collaboration.

RIGA TECHNICAL UNIVERSITY

Fraunhofer FEP

ichtj

UNIVERSITY OF TARTU

CERN

WESTERN NORWAY RESEARCH INSTITUTE VESTLANDSFORSKING

KPMG

ECOSPRAY TECHNOLOGIES

GRIMALDI LINES

REMONTOWA

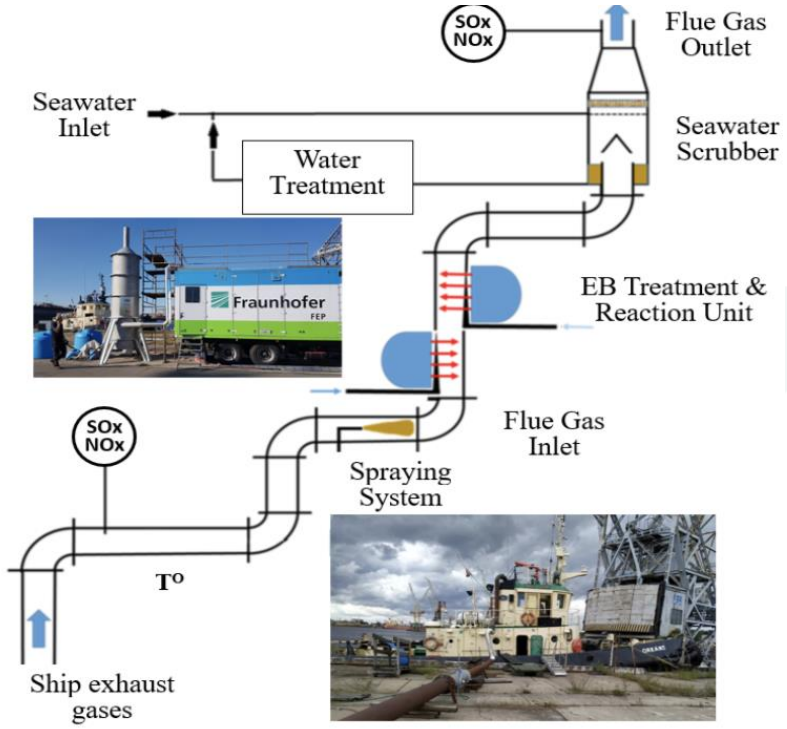
BIO POLINEX

ABS

Student thesis

- **Ekaterina Tskhay MSc thesis (Defended)**:

Qualitative and quantitative analysis of the hybrid electron accelerator exhaust gas abatement technology impact to the selected maritime logistics aspects



Source: Aries Proof of concept

Heavy Ion Therapy Research Integration

HITRI plus
Heavy Ion Therapy Research Integration

- WP 7: Advanced accelerator and gantry design
  - Task 7.4: Injector Linac Design
  - Task 7.5: Integration of an innovative superconducting gantry: optics, mechanics, beam delivery

PhD Student thesis

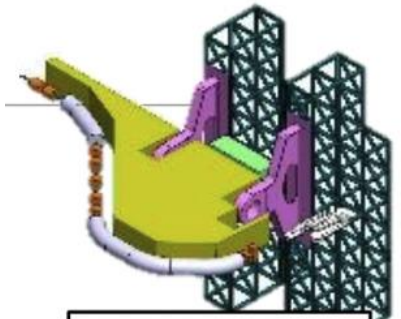
- **Lazar Nikitovics thesis**:

Design study of a high-frequency linear accelerator for the purposes of injection into a therapy synchrotron and parallel production radioisotopes

HITRI plus
Heavy Ion Therapy Research Integration

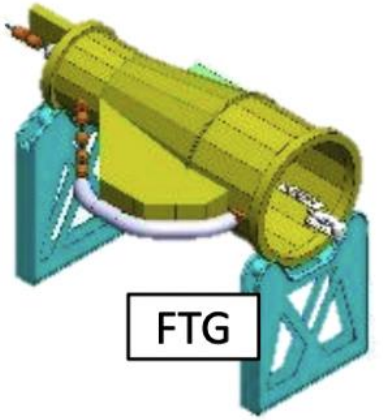
- **Janis Vilcans thesis:**

Development of the rotational (mobile) cryostat system for the superconducting magnets in the hadron therapy installations



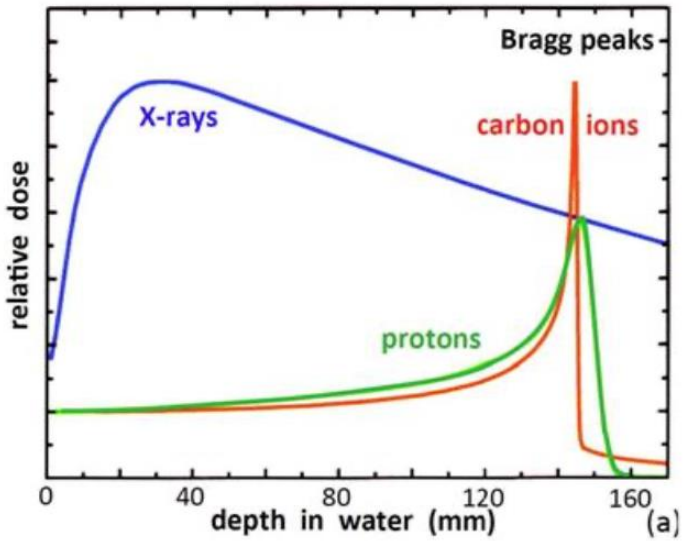
- **Luca Piacentini thesis:**

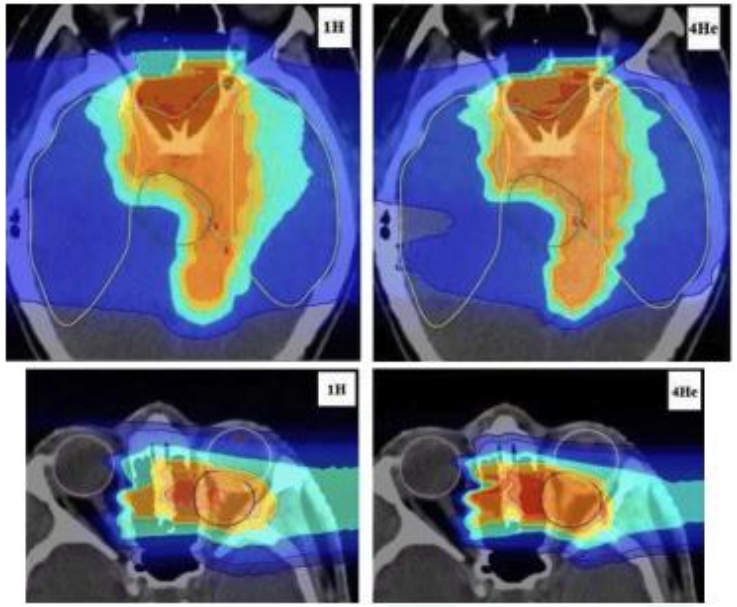
Mechanical integration of systems, instruments and components of a carbon ion rotating gantry for medical treatments



Next Ion Medical Machine Study

- Developing new technologies for the future generation of accelerators for cancer therapy



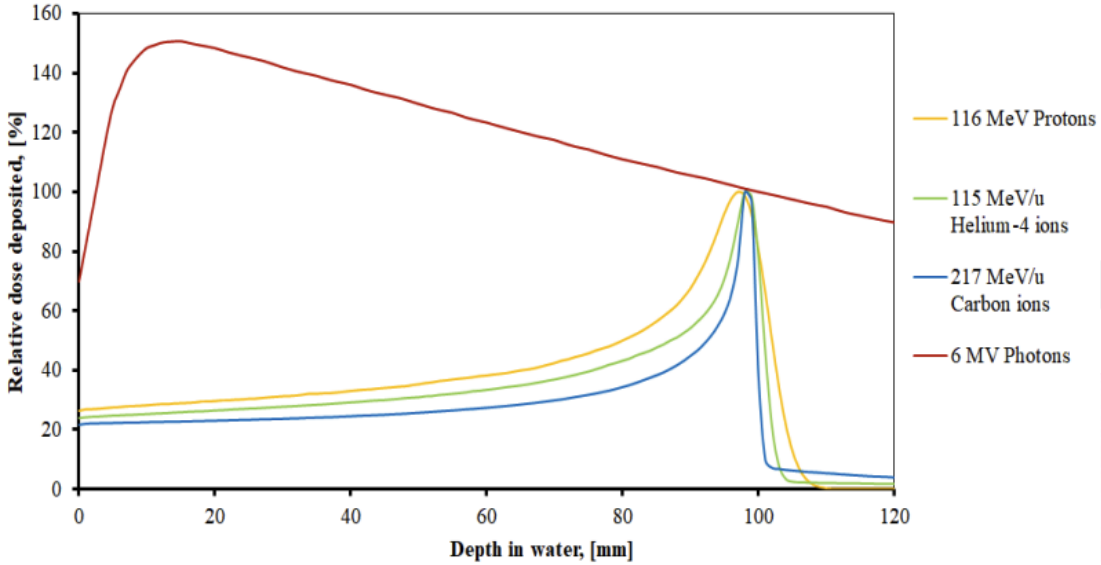


Courtesy: M. Vretenar and K. Palskis

Student thesis

- **Kristaps Palskis PhD thesis**:

Studies of different ion types and their use for radiation therapy, *FLASH* therapy aspects.
Optimization of ion beam parameters for very high dose rate (FLASH) radiotherapy



Courtesy: K. Palskis

Accelerator medical applications

Particle therapy centre geography in Europe, ENLIGHT 2020

Courtesy: K. Palskis

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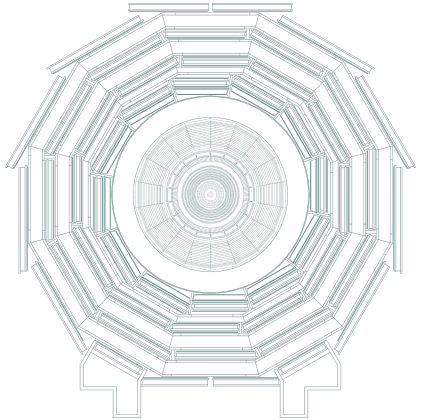
Centre of High-Energy Physics and Accelerator Technologies

HEP in Latvia: the CMS-Latvia group

Dr Kārlis Dreimanis

Director of the Centre of High-Energy Physics and Accelerator Technologies

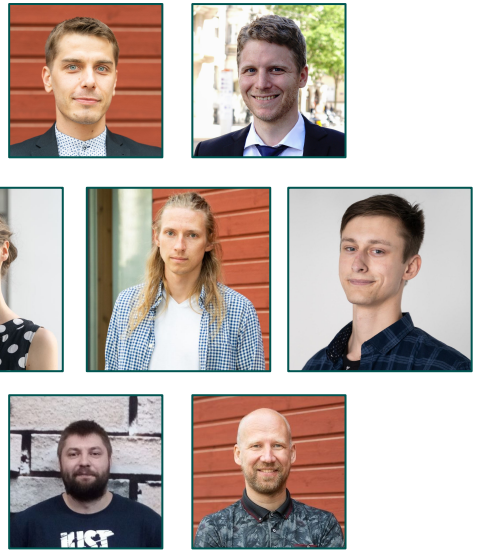


Overview of the group

- **CMS-Latvia HEP group** at present consists of **8 <u>core</u> personnel** ...
  - Two senior researchers;
  - Three PhD students (2 RTU, 1 UL);
  - Two engineers [part-time];

  ... involved in **5 groups at the CMS experiment**:

  - **Top physics analysis group;** **[primary activity]**
  - **MIP Timing Detector (MTD) project;** **[primary activity]**
  - SM Physics - Vector Boson group; *[secondary activity]*
  - Higgs physics analysis group; *[secondary activity]*
  - Technical Integration team; *[secondary activity]*



- 4 more personnel at UL and Institute of Solid-State Physics working on studying the LYSO crystals to be used in the barrel layer of the MTD;
- **<u>Main goals</u>**:
  - To continuously **produce high-quality scientific output** in experimental HEP at CMS;
  - To **grow the scientific capacity** of the group and to expand the breadth of the topics covered;
  - To **become a truly self-sufficient** research cluster, highly attractive to talent from abroad;
  - To **start *producing* world-class** early-careers **researchers** through our doctoral program;

Doctoral study program

- During 2019-21 developed a **doctoral study program** in "High-energy physics and accelerator technologies":
  - Invaluable tool towards capacity building in HEP;
  - Allows us to train local talent and to attract international talent at the graduate studies level;
  - Demonstrably highlights the pathway to world-leading research institutions, such as CERN, for students/pupils;

- First intake of students, academic year **2021/22**:
  - **6 students enrolled** [2 students in HEP at CMS];
  - **1 CMS student transferred** from a different study program into the 2nd year;
  - Currently **3 full-time PhD students** working at the CMS experiment;
  - About to intake **3 more full-time CMS PhD** students for the academic year **2022/23**:
    - One local student;
    - Two foreign students (Spain and Greece);
      (they will begin their studies on the 3rd of October);
  - 2 AT students also to be enrolled in *cotutelle* with cooperating institutes in Estonia and Italy;

- We provide the option for students to go on a **long-term attachment to CERN** (up to 24 months) in Y2&Y3 [**Invaluable!** Speaking from my own experience.]

Master's study program

- Working towards developing a program where students could work on HEP already at the **master's level**:
  - Erasmus Mundus Design Measures project proposal submitted:
    - Potential lump sum grant of 55 kEur to develop the program contents and structure;
    - Plan to apply for Erasmus Mundus Joint Measures for the implementation of the program;
  - Aim for an **international program involving student mobility** between Latvia, Estonia, Lithuania and, possibly, Croatia;
  - Extremely important in order to grow the field of HEP in Latvia!
  - We aim to have a master's level studies in HEP to be available in Latvia starting the academic year of 2025/26! (hope for the year prior);

Current CMS physics program

- **Top physics**: the group is working on or is about to undertake 6 physics analyses in the Top PAG:





  - **Colour flow in top-quark decays**, (previously unfinished; efforts to publish will restart shortly); M.Seidel, K.Dreimanis [pub. projected in 2023];
  - **Top anti-top quark mass difference measurement** **A.Potrebko [PhD]**, M.Seidel, K.Dreimanis; [pub. projected in 2024];
  - **Lepton-universality in top decays via electron impact parameter** **N.Strautnieks(UL) [PhD]**, M.Seidel, E.Pajuste (UL), K.Dreimanis; [pub. projected in 2024/25];
  - **Study of the dead-cone effect in b-jets in top quark decays*** **D.Osīte [PhD]**, M.Seidel, K.Dreimanis; [pub. projected in 2025/26];
  - **Measurement of the boosted Top quark mass** **C.Muñoz Díaz [PhD]**, M.Seidel, K.Dreimanis; [pub. projected in 2025/26];
  - **Study of the substructure of boosted Top quark decays CMS** **D.Sidiropoulos Kontos [PhD]**, M.Seidel, K.Dreimanis; [pub. projected in 2025/26];

- A.Potrebko developing and validating the first tt{bar} sample for CMS using Sherpa MC generator;

* - Y. Dokshitzer is one of the original proponents of this effect and we aim to use his expertise to improve our experimental understanding of jets and jet-like structures at CMS;

Current CMS physics program

- **Three new students enrolled:** all will work on Top Physics*:

Ms Dace Osīte : Dead-cone studies in top decays;

Mr Dimitrios Sidiropoulos Kontos : Boosted top substructure;

Mr Conrado Muñoz Diaz : Boosted top mass measurement;

* - currently the topics are quite preliminary;

Current CMS physics program

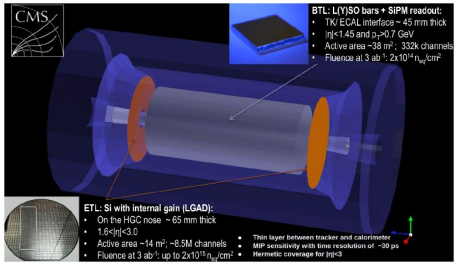
- **Higgs physics**: the group is performing or is about to perform 2 studies in the Higgs PAG:
  - **Study of the low-pT electron reconstruction efficiency**, **A. Gaile [PhD]**, **N. Strautnieks(UL) [PhD]** , E. Pajuste (UL), T. Šćulac (Split, HR), [CMS int. note in progress];
  - **Search for a high-mass Higgs resonance in the Golden Channel**, **A. Gaile [PhD]**, K. Dreimanis, T. Šćulac (Split, HR), [pub. Projected in 2024/25];




- **Other topics**:
  - M. Seidel has legacy involvement and a major role in the long-awaited W mass measurement at CMS;
  - M. Seidel has been selected to be the *Standard Model Physics - Vector Boson Group (SMP-V)* co-convenor (next 2 years);

Current CMS detector program

- Our group joined the MIP Timing Detector (MTD) project at CMS in 2020:
  - Made up of the end-cap timing layer (ETL) and the barrel timing layer (BTL);
  - MTD is a timing layer to be inserted between the tracker and the ECAL for Runs 4 and 5;
  - Aim to provide CMS with charged track timing information with ~35 ps resolution;



- Strategically involving group members to become core experts on specific aspects of the sub-system;

- CMS-Latvia in MTD:
  - Initial involvement in the design of cooling manifolds, **G.Pikurs [eng]**;
  - Leadership position: *MTD BTL Mechanics, Assembly and Interfaces (MAI)* coordinator - **K. Dreimanis**;
  - Currently responsible for the BTL cooling tests at the Tracker Integration Facility (TIF), b.186;
  - **A. Gaile [PhD]** is to be the main developer of the MTD detector control and safety systems (DCS & DSS);
  - **N.Strautnieks (UL) [PhD]** and **D.Osīte [PhD]** will be trained to become leading members of the MTD Detector Performance group (DPG), developing the MTD software for integration into the CMS code-base (CMSSW);
  - **C.Diaz [PhD]** will be tasked to continue the construction database development for MTD BTL;
  - UL and UL-ISSP researchers studying LYSO crystals used in the BTL (as a part of the Crystal Clear Collaboration);

Current CMS detector program

- G.Pikurs and J.Vilcāns are involved in the CMS Technical Integration (TI) team:
  - Core engineering team part-responsible for the operation of the CMS experiment;
- Various tasks:
  - Development of the cushioning system to suppress the vibration from the dual-phase CO2 cooling plants t CMS (G.Pikurs);
  - Development of the automation of the doors for the *garage* of the forward calorimeter (HF), (G.Pikurs);
  - Development of the support gantry for the installation of the High-Granularity Calorimeter (HGCal) for Run 4 (J.Vilcāns);
- The TI activities are not *directly* HEP-developing, however:
  - These provide us with a readily available access to our own engineers for the detector development work on the MTD and elsewhere;
  - Shows us as being a willing and trustworthy collaborating institute within CMS;
  - **Increases our visibility within CMS**: key to attracting more talent from abroad for engineering **and** physics!

Take away message

Latvia is reliable and honest partner of CERN

CERN – Latvia collaboration is yielding many mutual benefits

Latvia is ready to take the next step – to become full member of CERN

Thank you!

Research Latvia