RIGA TECHNICAL UNIVERSITY

Institute of Particle Physics and Accelerator Technologies

Update from the CBG SPWG

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05.05.2023.

Doctoral Study Programme

- Recap of the programme:
  - DSP "Particle physics and accelerator technologies" is implemented jointly by RTU and UL;
  - The development, implementation and oversight is done with the support of the CBG partners;
  - The programme has a dedicated study programme council consisting of 8 council members:
    - 2 representing RTU;
    - 2 representing UL;
    - 2 representing the CBG;
    - 2 representing CERN;

      + 2 programme directors (1 from RTU, 1 from UL);

- Student attestation is performed yearly; for the academic year 2022/23 it is planned for the week of the 12th of June;

- The study direction (physics, materials science and mathematics) containing this DSP was undergoing accreditation during 2022;

Doctoral Study Programme

- The accreditation performed at RTU and UL separately:
  - Commission accrediting the UL study direction evaluated the programme as excellent (highest award);
  - Commission accrediting the RTU study direction evaluated the programme as good (second highest award);
  - Overall, the study directions were accredited as excellent at both universities;

- Main recommendations:
  - Improvement of the study course descriptions (on-going; will include some more substantial course changes as well);
  - Include *newer* literature (on-going, but we still note that some literature is from the 70s by design);
  - Ensure equal lecturer *vetting* for the guest lecturers (appropriate mechanisms will be developed);
  - Develop and implement a corresponding master's programme (on-going);

Doctoral students

- The programme has had only two intakes of doctoral students - autumn 2021 and autumn 2022;
- A 3rd year student started their PhD with us via an alternative programme and was transferred at the earliest possibility;

- Particle & atomic physics:
  - Andris Potrebko (Y3, RTU) Measurement of the top/anti-top mass difference at CMS;
  - Antra Gaile (Y2, RTU) Measurement of anomalous Higgs couplings in H→ZZ→4l channel at CMS;
  - Valts Krūmiņš (Y2, UL) Optical interferometry system for anti-beam positron measurements at AEgIS;
  - Normunds Ralfs Strautnieks (Y2, UL) Study of lepton universality in top decays at CMS;
  - Conrado Munoz Diaz (Y1, RTU) Measurement of the boosted top quark mass at CMS;
  - Dimitrios Sidiropoulos Kontos (Y, RTU) Study of the boosted top substructure at CMS;
  - Dace Osīte (Y1, RTU) Search for the dead-cone effect in b-decays from top quarks at CMS;

- Accelerator technologies & medical physics:
  - Lazar Nikitovic (Y2, RTU) Design of a high-frequency linear accelerator for injection into a therapy synchrotron;
  - Kristaps Paļskis (Y2, RTU) Optimization of ion beam parameters for very high dose rate (FLASH) radiotherapy;
  - Luca Piacentini (Y2, RTU) Integration of Systems, of a Carbon Ion Rotating Gantry for Medical Treatments;
  - Tobia Romano (Y1, RTU+PoliMi) Study of sintering behaviour of pure copper processed via binder jetting AM;

Development of the master's programme

- **Recap: Erasmus Mundus Design Measures (EMDM):**
  - Successful bid for EMDM funding in 2022;
    - 55 kEur (15 months until 31st of December 2023);
    - Deliverable: developed joint mechanisms for a new master's study programme;

- **Aims of the EMDM project:**
  - to develop joint mechanisms for admissions, evaluation, award of the degree, dissemination;
  - to develop the above mechanisms to be fully in line with the requirements for the Erasmus Mundus Joint Masters (EMJM) calls;
  - to develop a curriculum that would be highly competitive & desirable internationally (incl. to Western European students);

- **Aims of the planned master's programme:**
  - to develop the scientific capacity in modern fundamental physics and related technologies in the Baltic region;
  - to train and develop human resources with the skills and competencies desired by the local industry;
  - to increase the internationalisation of the higher education ecosystem in the Baltic region;

Development of the master's programme

- **Two-year <u>academic</u> master's** comprising **120 ECTS**, focused on topics relatable to:
  - Particle physics (experiment [primary], theory & phenomenology [secondary]);
  - Detector Technologies;
  - Accelerator Physics;
  - Accelerator Technologies;

- Programme to be implemented by a **consortium of Universities** from the three Baltic states (as of May 5th, 2023):
  - Riga Technical University (RTU, lead), Latvia (LV);
  - University of Latvia (UL), Latvia (LV);
  - University of Tartu (UT), Estonia (EE);
  - Vilnius University (VU), Lithuania (LT);
  - Kaunas University of Technology (KTU), Lithuania (LT);

Development of the master's programme

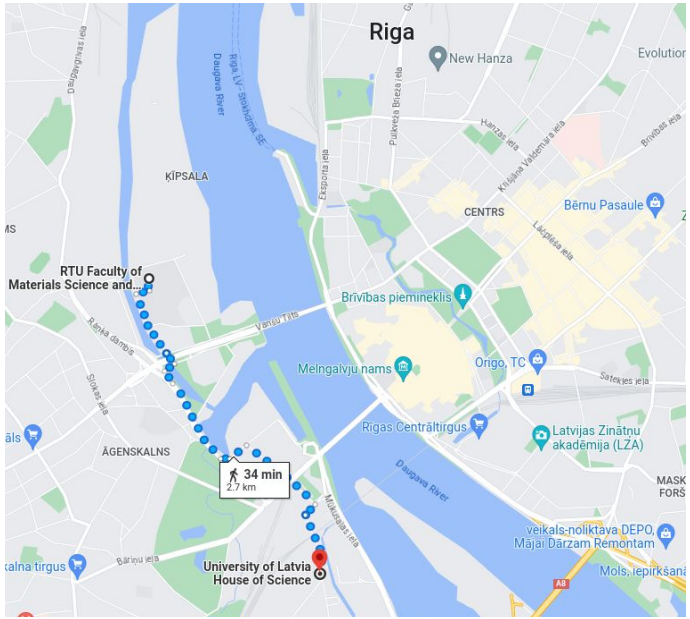
- Two year (120 ECTS) master's split into four semesters of equal weight (30 ECTS):
  - Semester 1: focused on laying down & strengthening the essential foundational knowledge, skills and competencies;
  - Semester 2: focused on deepening the skills and competencies, as well as providing initial specialisation;
  - Semester 3: focused on deepening specialisation and providing highly specific skills and competencies;
  - Semester 4: focused providing the research experience via the master's project/thesis.

- For the masters projects, we intent to cooperate with the relevant industry:
  - Baltic Scientific Instruments, … (LV);
  - GScan, … (EE);
  - Teltonika, … (LT);

- Important: a requirement for a EMJM master's programme – *"all students must spend at least a semester in a country that is not their home country at the commencement of their studies"*;

Semester outline

- **Semester 1, October - January (Y1) : Latvia;**
  - Physical proximity of UL and RTU campuses allows for Riga to be the best-placed city, where students can enjoy the broadest fundamental knowledge base; ie. modular courses that require little specialisation and longer duration;
- Semester 2, February - June (Y1) : Estonia;
  - Initial specialisation courses can be of shorter duration than fundamental courses, but travel during the semester would be sub-optimal;
  - Keeps all students *close* for longer;
- Semester 3, October - January (Y2) : Lithuania;
  - Highly specialised courses can be shorter & more intense;
  - Split between VU and KTU based on specialisation can be made;
  - Good public transport links still allow for travel between cities if-need-be;
- Semester 4, February - June (Y2) : all participating countries;
  - Aim for an approximately equal distribution of projects for all involved HEIs;
  - Encourage industry partners to provide projects & internship opportunities.



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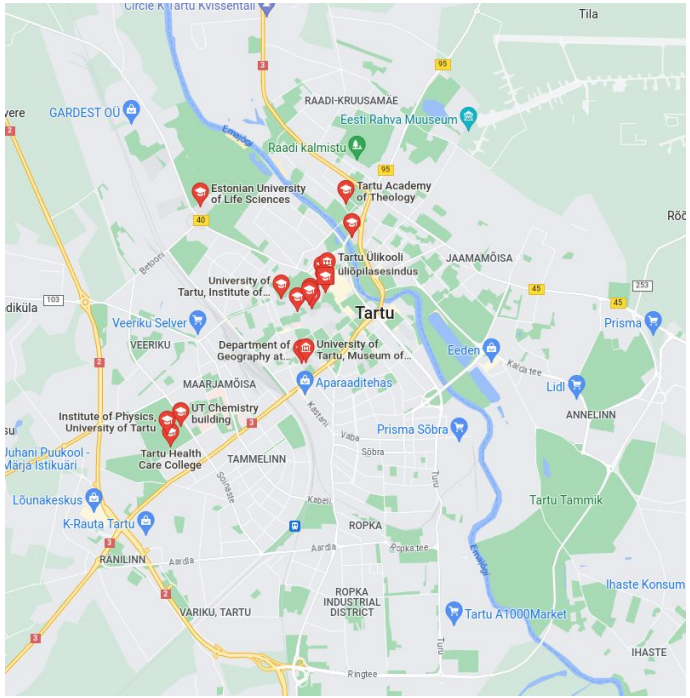

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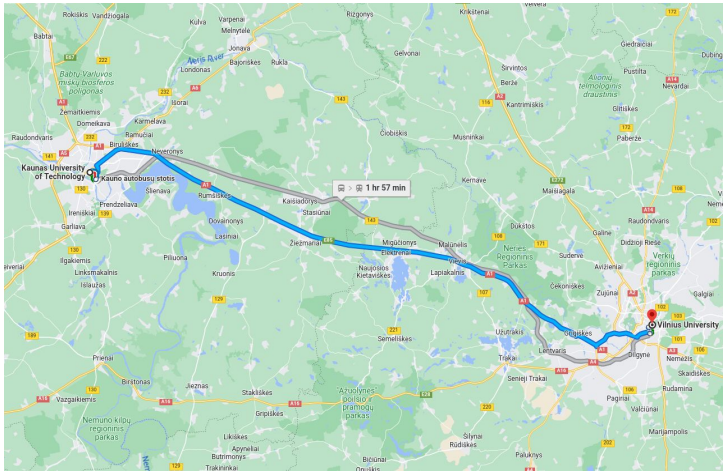

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News from the CERN council

- Encouraging (for us) discussion in the ECFA* report at the CERN Council:
  [the Taskforce] *"calls for the creation of a dedicated panel in this area under the auspices of ECFA, in consultation with organisations or communities representing neighbouring disciplines and ICFA"*;

  "The role of this coordination panel would primarily be to enhance the synergies between existing training programmes and stimulate the creation of complementary ones where relevant, in particular multidisciplinary schools or academia-industry-joined training programmes. The second equally important DCT sets out as a goal the creation of a European master's degree programme in HEP instrumentation [read:accelerator and detector physics and technologies]*, to also be a potential responsibility of this proposed panel to help coordinate."* [from the R&D roadmap document: https://cds.cern.ch/record/2784893];

  additionally,

  "ECFA recognizes the need for the experimental and theoretical communities involved in physics studies, experiment designs and detector technologies at future Higgs factories to gather."

- There is great interest in our planned activities from CERN and the accelerator-based research facilities!
- With our planned programme we are literally ahead of the curve and ahead of CERN!
- Potentially, we could receive significant aid from CERN and ECFA in our pursuit!

* European Committee for Future Accelerators

Workshop

- The project group held a workshop at RTU on the 27th of April;
- Great breakthroughs achieved via face-to-face discussions;
- A second workshop planned in June;

Curriculum outline

- Initially hoped to retain many existing courses, in order to minimise the workload on the consortium members;
  This idea has been mostly scrapped and the current plan is to introduce new, tailor-made study courses;
- Work on course development initiated *from the ground up*, ie. from the desired learning outcomes at the end of each semester towards the topics;

- **Semester 1:** students must have an overall understanding & skills in the scientific topics covered by the study programme:
  - Broad understanding of modem [particle] physics:
    - Standard Model (overview, mechanics and kinematics);
    - Material - radiation interaction (overview and introduction to detector systems);
  - Strong skills in applied mathematics for research (statistics);
  - High-level programming language skills (python, C++);
  - Accelerator physics topics:
    - Electrodynamics;
    - Superconductivity;
    - Instrumentation (types of systems, design overviews, engineering & design concepts);

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- **Semester 2:** students must obtain deeper knowledge in all of the fundamental scientific aspects of the programme and begin initial specialisation:
  - General understanding of field theories;
    - Group theory, free fields, interacting fields and connection to the Standard Model;
  - Finite element analysis and computer-aided design;
  - Specialisation topics (non-exhaustive):
    - Quantum field theory;
    - General relativity;
    - Robotics and firmware;
    - Plasma physics for accelerators;

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- Work on course development initiated *from the ground up*, ie. from the desired learning outcomes at the end of each semester towards the topics;

- **Semester 3**: students must obtain speciaslised knowledge of the fundamental scientific aspects within their chosen pathway of expertise:
  - Data analysis methods in high-energy physics (possibly with a particular focus on CMS);
  - Quantum field theory (incl. QED and QCD);
  - Medical physics (use of particle and radiation therapy, use of accelerators);
  - Advanced materials:
    - HEP instrumentation (accelerators, magnets);
    - Advanced material-radiation interaction and particle detectors;
  - Quantum field theory (incl. QED and QCD);
  - Medical physics (use of particle and radiation therapy, use of accelerators);

Mantra of the programme

- We aim to create a highly competitive and unique-in-Europe master's programme aimed at HEP and HEP instrumentation;
- We must strive to create a curriculum and a study experience that is attractive to everyone interested in the field!
- We are small Baltic countries without highly-recognised HE sector in the West; we must seek to change that!
- Mantra:
  - *Where other programmes offer 5 lecture-hours per ECTS, we must offer 6;*
  - *Where other programmes offer 1 tutorial hour per ECTS, we must offer 2;*
  - *Where other programmes are localised on the campuses of their respective Universities, we offer a chance to spend a semester in three different countries!*
- We will also aim to offer, in collaboration with our industrial partners and CERN, internships in the inter-year summer.

Decisions reached at the Workshop

- The degree to be awarded was discussed at length in terms of both the area and the award of the diploma;
  - It was concluded that **only the award of a uniform degree is viable** for the consortium - master of physics;
  - Naming of a further specialisation of the degree (eg. particle physics, accelerator physics, medical physics) is not planned at this time, but the student's specialisation should be inferred from the diploma supplement;
  - It was concluded that **only a joint-diploma is viable long-term** (afterwards also emphasised by the rector of Vilnius University);

- The admission of students would proceed as a stepped-process, with them being admitted in Latvia in semester 1, in Estonia in semester 2 and Lithuania in semester 3, followed by graduating with the aforementioned joint-diploma;

- We are still aiming to submit an EMJM project proposal in February 2024:
  - Consortium is in agreement that the implementation in the current form can only proceed with a successful bid;
  - If successful, the first intake of students would be September 2025;

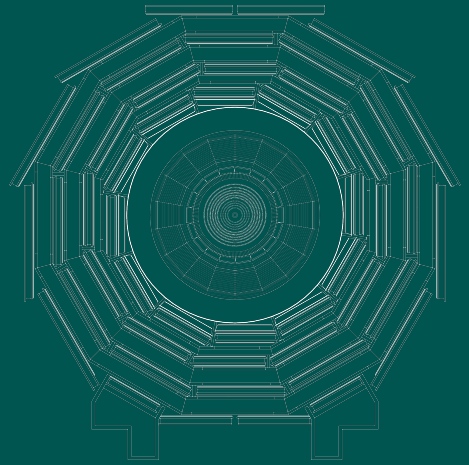
- Joint-diploma requirement might be *a bridge too far* for this project call:
  - Support from the policy makers will be paramount;
  - In case it is not viable to submit the project ot the 2024 call, the 2025 call will be utilised;
  - If successful, the first intake of students would be September 2026;

Summary

- DSP is progressing well; a major deficiency, as identified by the commission of experts, lack of a master's programme;
- We have successfully bid for EMDM project funding, allowing to kick-start the development of such a master's programme;
- EMDM project on-going with a consortium of 5 Universities of the CBG (RTU, UL, UT, VU, KTU);
- Multiple meetings and a workshop held - reasonable progress;

- Aim to create a project proposal for the implementation of a new master's programme in HEP instrumentation:
  - Clear need as identified by ECFA and CERN (we are literally a year ahead of them!);
  - A semester of study in each of the three Baltic states followed by the fourth semester in the country of choice;
  - Single joint-diploma in physics awarded;

- Aim for the 2024 EMJM call!



Thank you

EMJM - the target grant

- We explicitly aim to develop a program eligible to be submitted to the Erasmus Mundus Joint Masters (EMJM) call;
- EMJM calls typically close in mid-February → aim to have a project proposal ready for February 2024;
- EMJM:
  - Supports the implementation of Joint-Masters programs for up to 74 months (renewable);
  - Allows for the support of up to 4-5 full editions of a 2-year master's cohorts;
  - Financial support:
    - Institutionally: 750 Eur/month per student for up to 100 students;
    - Stipends: 1'400 Eur/month stipend for up to 60 students;
      max. 10% of stipends to students of the same nationality;
- At least 1 semester in 2 partner-HEIs other than in the country of residence of the student;
- For our program, at least 1 semester in each of the three Baltic countries;

EMDM Project budget

- Reminder, this project was awarded a lump sum grant of 55 kEur;
  - Original plan was to fund travel for meetings using these funds directly from the RTU accounts;
  - Given the current status, plan to split these funds among partners based on a consortium agreement;
  - The consortium agreement for **this** project must be developed **ASAP**;
  - Propose to split of **40 kEur** among the 5 partners to fund the day-to-day work on the programme development in 2023;
  - This results in **8 kEur per partner** for the next 7 months (May-December);

- **15 kEur** to be retained by RTU at this stage for other related near-term activities:
  - Creation of the visual identity and promotional material, including a dedicated web-page;
  - Licensing costs in Latvia and in partner countries, if required;
  - Other miscellaneous costs arising;