Latvijas Zinātņu padome

Noslēguma posma konsolidētais vērtējums

Projekta nosaukums: VPP-IZM-CERN-/1-0002 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

Zinātniskā izcilība

The project has been organized in four work packages: management, dissemination, outreach (WP1); fundamental HEP research at the CMS experiment (WP2); sensory material development for HEP applications at the CMS experiment (WP3); state-of-the-art accelerator technology research had development (R&D) within CERN-related projects, such as Innovation Fostering in Accelerator Science and Technology (I.FAST) and Heavy-Ion Therapy Research Integration plus (HITRIplus) (WP4). The goals of WP2 were to build up the research capacity in HEP in Latvia; to create a pipeline of students that will naturally amplify this endeavor and ensure its long-term impact; to contribute at a high scientific level to the physics program of CMS; and to take on a central role in detector-related work, in order to bolster the scientific impact of the Latvian group. In the two years of the program, these goals have been to a large extent achieved. The group working on two analyses (top-related and H-related physics) has been consolidated (particularly through the addition of a new, experienced, postdoc) and strengthened (master and doctoral students), and the participating Latvian institutes have consequently achieved co-authorship status for CMS publications. The two analyses, and the color reconnection work, offer the potential to become involved in a wider range of physics topics, given the broad range of covered physics signatures. Also, the choice of the type of detector that forms part of WP3 (a MIP Timing Detector that will play a central role at the higher collisions rates of the HL-LHC) ensures that the Latvian community will be well placed. WP3 focuses on the required crystal detector R&D and has the goal of establishing the Latvian institutes as able to take on the responsibility of building a major sub-detector of the CMS experiment. Both of these areas have been successfully engaged, and furthermore, fruitful connections to other Latvian science activities have built. Strong (and for some sub-projects, leading) involvement in the I.FAST (but also in the societally relevant HITRIplus and HERTIS projects) accelerator technology projects constitutes WP4. Also here, the achieved results match very well the project goals, and allowed synergies with, e.g., mechanical and cooling issues in the CMS Barrel Timing Detector that forms a major part of WP3, as well as networking (with e.g., the CERN MME group). All goals set out in the original proposal were met. In particular it is to be appreciated that, in the course of the project, flexibility was shown to use cross disciplinary benefits of the analysis and the instrumental oriented projects to combine their strengths. On the analysis side, 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. From the evaluation it appears that the two PhD students, Mr Potrebko and Ms Gaile are performing well. The lesson to be learned from the apparent problems of the predecessor of Dr Seidel is that it is rather risky to build such an analysis effort based on a single junior researcher. 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. The group working on detector materials (WP3) is performing very well and has shown a constant development and growth. The research conducted has been overall of very good quality. As for future activities, the PI and team may want to enhance their leadership capabilities in Higgs research by defining more clearly the objectives of their work within the very large CMS group on Higgs analyses. In a first stage the PI and team plan to join existing Higgs groups and ongoing analyses, which is fine in order to familiarize the students with the subject. However, as in the case of top physics the team has identified two subjects (the study of the colour flow and colour reconnection in top quark decays and the measurement of the top/anti-top quark mass difference), in which they specialize and can lead the advancement and the progress, so it would be good to do the same for the Higgs research, by finding some specific subjects that the group could specialize on and thus become the leader of the analysis on that subject.

The advantage of such an approach is that the team gets recognized within the collaboration and has a certain independence in the choice of the analysis strategy, leading to opportunities for creative and novel solutions and innovation in the data analysis, benefiting both the team's reputation as developing the creative and innovative skills of the students. Overall, there is no doubt that the chosen subjects of research, the physics analyses, as well as those related to the detector and the accelerator development, together with the achieved results, show high dynamism of the PI as well as of the team. The results are of great importance that will lead to some genuine advances in the fields of interest.

Ietekme

The project has met all its goals regarding publications and increasing the group size. It is good to read that a new doctoral study program was started as a result of this project and that this is supported by an Erasmus fund. The impact of work packages WP2, WP3, and WP4 is strengthened through several collaborations with foreign experts in the form of co-supervision of master and doctoral students. There was an important increase in the scientific manpower and a total of five PhD students are now involved with this program, which is a very healthy number. The number of master students is somewhat smaller in WP2. This could be due to the fact that this package had a turbulent start. The group was engaged in a large number of public outreach events. It would be good if an idea of the impact of these events could be given, maybe by the size of the audience or (for radio interviews) the number of reactions/questions that were received as a result. The number of publications and conference contributions is well beyond expectation. The increase in manpower, international collaborations as well as many publications have greatly contributed to their international competitiveness of all work programs. Perhaps one area where future efforts can expand on could be, e.g. outreach through involvement in master classes, direct communication with high school-level students, or attempts to reach wider audiences; successful MSc and PhD defences. Four master thesis successfully completed and six PhD theses under way are a very positive outcome, but more importantly, the retention factor between MSc and PhD indicates that indeed, a Latvian HEP and AT community is being developed in a sustainable manner; creation of networks: within CMS, the Baltic states, Europe and internationally, the project has resulted in enhanced integration and stronger ties and has established an identity in all three WP's, a solid basis for future developments 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 in a long-term manner, and developing a wide international network for common activities in the future. For the future, it may also be useful to develop the creativity and originality of the students and early career researcher, to encourage team members to participate in relatively small but impactful projects where they can individually contribute and developed e.g., novel algorithms for the data analysis

Īstenošana

The PI and his team have shown remarkable dynamism in contrasting the adverse effects of unexpected events such as the sanitary crisis, by joining the effort for the High Energy Ventilator project at CERN, leading to fruitful collaboration with the CERN group in charge as well to the publication of which the PI is a co-author. On a less positive note, a senior postdoctoral scientist in the team seems to have under-performed, thus leading to delays in the publication of the results of the colour flow and colour reconnection analysis. Apparently, the situation has degraded over a year. No details are given in the report on the reason why this happened. It would be opportune in the future to manage the crisis rapidly, identifying the possible causes as well as the solutions to implement in the short term, before the situation degrades and more damage is induced on the cohesion of the team and the individuals. On the other hand, the PI has been very efficient in managing the students, who are substantially involved in the implementation of the project, as well as in advancing and completing the whole project. Overall, considering the short time frame of 2 years, which furthermore coincided with the main impact of the Covid-19 crisis, the project can be considered to have succeeded very well. Several potential problems were identified and dealt with in a timely and efficient manner (e.g. the replacement of a postdoc with central responsibility for the success of WP2) and the three strands (physics

analysis, detector development and accelerator-related R&D) brought together in such a manner that an identifiable and broad Latvian HEP community has resulted, with multiple individual researchers involved in partly separate, partly overlapping areas, and embedded in a wider Latvian scientific community.

Projekta mērķis sasniegts