Slovenian input to the European Strategy for Particle Physics Update 2018–2020

The Slovenian Particle Physics Community[1]

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Abstract

This document reflects the view of the Slovenian HEP community on its engagement in current and future particle physics projects. It represents the input of a relatively small particle physics community to the European Strategy for Particle Physics.

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Introduction

The Slovenian high energy physics community is small in absolute terms, nevertheless already historically strongly involved in the global experimental and theoretical efforts in the field. The community consists of around 50 active researchers and around five groups at various institutions, mainly concentrated at the Jožef Stefan Institute in Ljubljana.

Our community is actively participating, according to its potentials, in endeavours at the energy (CERN), the intensity (KEK), as well as the cosmology (PAO, CTA) frontiers. We do believe that it is only through complementarity of different approaches that physics beyond the Standard Model (New Physics, NP) may be revealed, let alone interpreted.

Running Projects

Slovenian HEP researches are strongly involved in LHC physics, both experimentally in the ATLAS collaboration, as well as theoretically, with a specific inclination of the latter to the intersection / correlation of high transverse momenta and flavour physics phenomena. The next big milestone in the LHC contributions to NP searches is no doubt the High Luminosity upgrade of the LHC (HL-LHC).

In ATLAS, the focus in R&D and construction has traditionally been in tracking and beam conditions detectors. Following up on these, the contributions to the construction of the Phase II upgrade are directed to the ITk (end-cap strips, beam protection/monitoring) and the add-on timing detector (HGTD) where the group has been playing a leading role in the development of LGAD sensors.

It is the construction, commissioning and the subsequent ten-year exploitation of the full HL-LHC potential up to its limits that are given absolute priority in our resources. On top of this, also the Run3 LHC period starting in 2021, with 300/fb of 14 TeV collisions possesses a promising potential to provide hints of NP signatures. Run3 operations running in parallel with Phase II construction should not be played down in the Strategy. It is representing a formidable task in our management how to survive this resource-intense period.

The Slovenian contribution to ATLAS computing has always been at the level of the most developed countries; also the highest management positions were (and are) held by members of our group. Our plan is to actively continue this effort, both supplying the adequate hardware resources, as well as participating in the common effort of adapting the physics algorithms to more efficient hardware platforms. We have no doubts that LHC and its experiments are going to be one of the cornerstones of the respective strategy to be prepared.

At the intensity frontier a relatively strong involvement of Slovenian physicists is present at the Belle II experiment at SuperKEKB. After a preparation of the physics program (in which both experimentalists and theorists from Slovenia took a major role), and after a successful detector development and commissioning (with a special role of our colleagues in the particle identification devices), Belle II took first collision data in 2018. It should be noticed that the Belle II experiment and collaboration, despite taking place in Japan, represent a significant involvement of European HEP researchers in general.

Belle II will - exploiting a planned 50-time larger sample of detected B pairs than currently available from previous generation B-factories - hopefully provide answers to some intriguing puzzles in flavour physics. Perhaps the most actual one is the question of lepton flavour universality, tested in a clean environment of e^+e^- collisions by measuring ratio of decay rates of $B \to D^* l \nu$ and $B \to D^* \tau \nu$ ($l=e,\mu$). The current world average precision does not allow for a solid conclusion on possible lepton flavour universality violation. We believe that because of this and several other hints of possible NP contributions that need to be tested to

higher precision it is necessary to include the high intensity and relatively low energy e^+e^- collider experiments into the European Strategy.

Furthermore, within the intensity frontier there is a strong complementarity among processes measured by the LHCb and Belle II experiments. Our intention is to contribute to the next upgrade of LHCb in coping with requirements of HL-LHC. Here again the Slovenian team is involved in the R&D for the upgraded RICH counter.

The Pierre Auger Observatory and the Cherenkov Telescope Array are the leading endeavours at the cosmological frontier, researching the origin of the Universe and its evolution. Slovenian researchers contribute to the detector development (photosensitive semiconductor detectors), atmospheric monitoring (LIDAR) and to the research of the origin and identity of the cosmic rays.

High-energy physics experience of Slovenian researchers in detector development, research and analysis techniques as well as in massively distributed computing technologies has been successfully ported to the cosmology frontier, enabling the experiments to shortcut their development cycle.

We believe that the cosmic frontier of NP search should fully feature in the Strategy.

Future Collider Projects

The Slovenian particle physics community is relatively small and with the limited resources available, it has to remain fully committed to the currently running projects, including R&D for the foreseen upgrades. While we are clearly interested in the outcome of the discussion on the future projects, we will not be able to significantly contribute to preparatory studies of these, beyond existing mostly theoretical and phenomenological inputs. Nevertheless, given our expertise in developing, designing, and running novel detectors for particle physics experiments, mainly tracking and PID detectors, we can expect a generic Slovenian contribution to detector R&D for these new collider projects. Here we can exploit our reactor facility for the radiation QA of the upgrade programme as well as to provide generic tracking detector research for high fluence environments.

We share the opinion that it is certainly necessary to limit as much as possible the time gap between the end of the HL-LHC and SuperKEKB/Belle II programmes and any of the upcoming facilities. An extensive gap would have detrimental effects on the recruitment of new generations of young physicists, as well as on securing continuous national funding for high-energy physics programmes.