

Slovak Particle Physics Community Input to Update of the European Strategy for Particle Physics

The Slovak particle physics community's participation at CERN involves two big LHC projects: ATLAS (mostly top quark physics) and ALICE (light-flavour physics) and two smaller projects: NA62 (precision measurements in Standard Model) and ISOLDE (nuclei shape engineering). The non-CERN projects involves mostly neutrino experiments.

For the strategy update we would like to keep our focus on CERN-based projects. We believe CERN should maintain its world-leading position in particle physics. The Higgs boson discovery at the LHC in 2012 has completed the Standard Model (SM). At the time, this epochal discovery led many physicists to develop ideas that new discoveries would soon follow and allow us to explain deep unsolved mysteries like nature of dark matter or the observed baryon asymmetry. However, at accelerators we have not yet observed any manifestations of physics beyond the SM, e.g. Supersymmetry, Extra Dimensions, etc. As a result, Higgs boson physics has become a major area for new physics. Measurements of the Higgs boson couplings to other fundamental particles, as well as its self-couplings are of fundamental importance for determining if the Higgs sector opens up to reveal signals of new physics. Therefore, after the HL-LHC reaches its potential, we strongly recommend the most preferred flagship project for CERN to be FCC-ee electron-positron collider machine FCC-ee as a Higgs Boson (and W/Z boson and $t\bar{t}$) factory with subsequent construction of the FCC-hh in the last quarter of the century. We found the FCC-ee project as a project with a huge physics potential simultaneously providing a long-term perspective for young experts and the particle physics in general. The start of the FCC-ee should follow soon after the HL-LHC decommissioning to preserve human and financial resources.

We think there might be two risk areas for the FCC-ee project:

1. a parallel (and presumably quicker) construction of another e^+e^- Higgs boson factory machine in China (CepC)
2. unexpected breakthrough results from the proton-proton collisions at the HL-LHC

If any of them materializes or becomes a serious matter we propose to skip the FCC-ee construction and jump directly to a new energy frontier facility LHC-hh. Since the FCC-hh construction takes more years (at least a decade) than the FCC-ee, we suggest for the 1st case, in order to fill the gap in delivering physics data and prevent the brain drain, to build LHeC (an electron accelerator added to the LHC to provide electron-proton collisions) which could be financially and physics-wise an interesting midterm option. In the 2nd case we recommend a full exploitation of the HL-LHC results with extension of the HL-LHC to Run 7 and 8 in order to maintain the human resources and also to secure a continuous funding.

From our view point, the e^+e^- accelerator projects, such as the ILC or CLIC projects, do not provide as much versatility as the FCC project.

The R&D topics, which should be pursued in parallel, should involve new accelerator techniques (like plasma wake-field) to reduce sizes of the future colliders (after the FCC era) and should also focus on new high field magnets needed for the FCC-hh.

It should also be added that a muon accelerator would represent a major advance if the necessary technologies were successfully developed.

For non-collider projects, the most perspective are the neutrino experiments like KM3NeT which have an interesting physics potential, long-term perspective and do not demand huge financial and human resources.

There is a significant fraction of particle physics community in Slovakia working in heavy-ion physics mostly grouped in ALICE experiment. We believe that to keep the momentum the ALICE 3 for HL-LHC should be also a priority since it is still not approved for Run 5 and 6.

Slovakia has a very rich history and expertise in outreach. CERN is highly recognized in Slovak public as a successful scientific hub. We think the CERN outreach program is important for keeping the recognition and promote CERN and its future projects to general public, funding agencies and potential future experts among young people.

Draft V.1