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Circular Higgs Factories & Possible Long-Term Strategy

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In 2012 two LHC experiments have discovered a new particle with a mass around 125 GeV, which appears to be the scalar Higgs boson of the Standard Model. To further examine this remarkable particle it could be produced in large numbers for precision studies by an e+e− collider operating near the ZH threshold at beam energies of 120 GeV, or, in the s-channel by a gamma-gamma collider with primary electron beam energies of 80 GeV, or by a high-energy electron-proton collider.
In this talk I will discuss tentative design parameters, novel concepts and accelerator-physics challenges (1) for a high-luminosity lepton-hadron collider, bringing into collision a 60-GeV electron beam from an energy-recovery electron linac with one of the LHC hadron beams –LHeC –, (2) for a gamma-gamma Higgs-factory collider based on the reconfigured recirculating SC electron linac –SAPPHiRE –and (3) for a circular e+e− Higgs-factory collider in a new tunnel with a circumference of 80-100 km –TLEP. I will also discuss future paths to pp and eA collisions at even higher energies (VHE-LHC, TLHeC and VHE-TLHeC), and sketch a possible long-term strategy for accelerator-based high-energy physics.
For the LHeC a conceptual design was completed in 2012. Recently parameters are being modified to further increase the LHeC luminosity, which implies higher lepton-beam current and smaller proton-beam spot size. It is planned to validate key components of the LHeC in a CERN ERL test facility, which is presently being designed.
An important challenge for SAPPHiRE is the layout of the interaction region and the generation of high-power photon pulses needed for Compton back scattering. These photon pulses, which collide with the electron beams about 1 mm from the interaction point proper, could be produced either by a conventional laser together with an optical stacking cavity or by a Free Electron Laser.
TLEP has the potential to deliver some 500 times the LEP luminosity simultaneously to each of four experiments at 240 GeV c.m. More specifically, the proposed TLEP machine covers the full energy range from the Z pole up to above the top quark pair threshold, with luminosities ranging from close to 1036 cm-2s-1 per IP at the Z ("Tera-Z factory") to 1034 cm-2s-1 at the top threshold. Beam polarization at energies up to the W pair threshold should be possible, allowing exquisite energy calibration by resonant depolarization. Many of TLEP's novel design ingredients –such as an insertion with beta* equal to or less than 1 mm, and operation with beam lifetimes of a few minutes –will soon be demonstrated at SuperKEKB in Japan.
Importantly, TLEP provides a path towards a later Very High Energy LHC ("VHE-LHC"), with a centre-of-mass energy approaching 100 TeV in pp collisions: VHE-LHC and TLEP would be housed in the same tunnel and could share a large part of the infrastructure including experimental caverns, magnets, and major detector components. Such a complex could also deliver highest-energy highest-luminosity ep and eA collisions.
Only preliminary rough concepts exist for going to energies beyond VHE-LHC. E.g. 1000-TeV pp collisions could be realized with the help of crystals in the TLEP/VHE-LHC tunnel.

Presenter: Dr ZIMMERMANN, Frank (CERN)