

CERN Doctoral Student Program

PhD Thesis Proposal

“Layout of the Interaction region for e-p collisions in the FCC-eh Collider”

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In the context of the FCC project, scenarios are discussed to provide – in parallel to the proton-proton collisions as standard operation mode - electron-proton collisions in one of the straight sections of the FCC. The interest to investigate the inner structure of the proton in deep inelastic scattering experiments, initiated already a study for electron-proton collisions at CERN’s LHC and directed to design the Large Hadron Electron Collider, LHeC. A similar approach will be followed for the FCC-eh layout.

A 60 GeV electron beam is foreseen to collide with the FCC proton beam in Interaction Point “L”. The electrons will be accelerated in an recirculating electron linac, that will operate in energy recovery mode for highest power efficiency. The design concept of this ERL is described in detail in the CDR of the LHeC.

At the same time, however, a detailed analysis of the proton lattice of the FCC is needed which is the main focus of the proposed PhD thesis. It will include an overall optimisation of the present machine optics and - as major challenge – the design of geometry and focusing structure of the second, non-colliding proton beam. Similar problems arise and will be investigated for LHeC as the concurrent ep and pp operation is foreseen in order not to cut into the pp luminosity through the ep collisions.

The transformation of the hadron colliders LHC and FCC into twin ep and pp colliders represents a unique challenge for understanding lattice, optics, beam-beam effects and the interaction regions, which will be investigated in the context of this thesis.

In summary, the thesis will concentrate on the design of the interaction region between electron and proton beams, focusing mainly on layout and optimization of the proton beam optics, the integration of its mini beta insertions and eventual chromaticity control, and the layout of the three beam separation scheme. After a careful re-optimisation of the proposed

Required parameters are missing or incorrect.

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proton beam optics -- matched to the existing FCC or LHC lattice -- the work will concentrate on aspects of the mini-beta (or final focus) scheme, building on the present design considerations of the mini-beta quadrupoles. Special emphasis will be put on the fact that geometry, orbit and lattice of three beams have to be optimized at the same time, including the cross-over of the two proton beams to preserve the overall geometry of the storage ring. The optics calculations might be extended towards a tracking simulation of the complete FCC-eh accelerator complex to determine the influence of the e-p collisions onto the dynamic aperture of the proton beams.

The thesis will be embedded in the CERN accelerator physics group and the international FCC-eh, LHeC and PERLE design teams.



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