This poster is about the development, physics and realisation of the LHeC: a 50-60 GeV electron energy recovery linac (ERL) scattered concurrently off the LHC p/A

**The Basic Concept**

An intense electron beam (20mA current) is accelerated in three passes through two 11m linacs. In an energy recovery linac racetrack configuration, which is positioned tangentially to the LHC (at IP2, or 1 for FCC). The electron-proton interaction does not disturb the proton beams in a noticeable manner. Thus the LHeC may operate synchronously with the LHC. The installation of the ERL is in a separate tunnel, while the detector installation requires a typical LHC shutdown length of two years. The whole project concept therefore is that of adding instrumentation and providing crucial new physics, i.e. of making the LHC physics richer and thus sustaining its HL phase.

**LHeC: Partons and Beyond**

For the first time it will enable the precise separation of the proton and weak nuclear structure, i.e. determine the quark, s, d, u, c, t, b, the top and gluon resonance distributions through various (C) and charged current (CC) cross sections and direct heavy quark (c, b) PDF measurements in two-hard (k_t) limited range, from x = 10^{-4} to 0.9 and from Q^2 = 1 to 10^4 GeV^2.

**High Luminosity Electron-Hadron Physics at TeV energy**

The LHeC represents a new laboratory for high energy physics, for its programme comprises five major themes:

- **Microscope of structure:** By virtue of the ultrahigh intensity and intensity of the LHC, the LHeC is the cleanest high resolution microscope of matter, the Hubble telescope of sub-nuclear physics.
- **Empowerment of LHC physics:** The LHeC books crucial input into the proton structure and QCD dynamics. The measured, internal input on partons will clarify the mass precision, and thus extend the reliability and range for BSM searches, and provide input required for precision QCD, electroweak and Higgs physics. This way, it empowers the LHC physics and utilizes the LHC infrastructure. It is the near detector for the GDRs.
- **Novel Higgs Physics Facility:** The clear separation, the large Higgs production cross section and novel detection and analysis techniques enable precision input in all large decay channels, including H→cc, which, combined with pp, lead to percent level LHC-Higgs coupling results, comparable to ee.
- **Discovery of new physics:** The LHeC is a TeV energy scale new configuration, it has large discovery potential in QCD (substructure), electroweak (Higgses, RH resonances), top and substructure physics.
- **Revolution of nuclear particle physics:** The unique structure of nuclei is of an infant status like that of LHeC. The LHeC provides an independent determination of the Higgs couplings, for the more abundant decays (brown, left plot). Reaching the LHeC programme, all relevant structures have been re-evaluated (dark, blue, lower plot). A combined analysis (light blue, lower plot) lead to percent level results, expressed as parameters scaling the SM couplings.

**LHC Physics: Partons and Beyond**

The high energy, high luminosity accesses the weak neutral current DIS region down to small x. This enables high precision electroweak measurements, supported by the high electron beam polarisation.

**Higgs Physics with LHeC and LHC**

The LHeC provides an independent determination of the Higgs couplings, for the more abundant decays (brown, left plot). Reaching the LHeC programme, all relevant structures have been re-evaluated (dark, blue, lower plot). A combined analysis (light blue, lower plot) lead to percent level results, expressed as parameters scaling the SM couplings.

**PERLE: powerful energy recovery linac for experiments**

PERLE is the first of the two revolutionary concepts for accelerator design. A high energy collider application for the LHeC (and possible successors with FCC). For stable, cost and CDS' benefit, the frequency was chosen to be 202 MHz. A first step simulation study, built around a 0.3 GeV, with a large gradient stability margin (see right). The PERLE Collaboration was built to realize a 500 MeV energy facility at CERN for the development of LHeC detectors and LHeC conditions: high current and 3 passes. In a second phase it provides unique opportunities for intense low energy physics and industrial use.

**Conclusions: Statement of the IAC to DG**

- The LHeC detector (left below) is a large acceptance, precision detection. Its design is determined by kinematics and high precision demands. It is a large acceptance, precision detection. It is determined by kinematics and high precision demands.
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