

LHeC and FCC-he: Model specific explorations EF08 Lol Summary

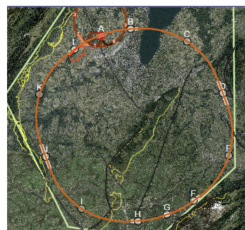
Oliver Fischer

for the LHeC study group



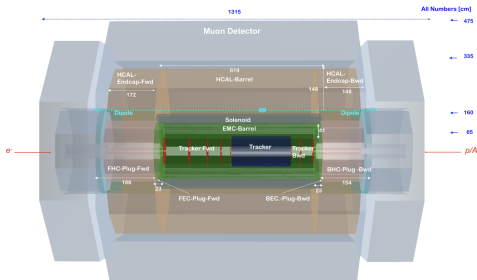
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The Large Hadron electron Collider



- ▶ Official CERN project, <http://lhec.web.cern.ch/>
- ▶ CDR [1206.2913], very recent update [2007.14491]
- ▶ Part of the **F**uture **C**ircular **C**ollider: FCC-he (hadron electron)
- ▶ Working groups: PDF, Higgs, Top, Electroweak, **BSM**, ...
- ▶ Motivation:
 - High-resolution microscope: test **QCD** at smallest distances.
 - **PDF**: improve precision of LHC results.
 - Important **Higgs** measurements.
 - Affordable: ~ 1.4 BCHF.

Phenomenology at ep



► Important differences to **ee** and **pp**:

- Asymmetric beam setup.
- Delphes detector card: protons going forward.
- Processes that 'prefer' specific momentum transfer 'fix' x .
⇒ kinematics fixed (typical forward boosts of final states).

► Available and working Tools:

- MadGraph5 + PYTHIA6 (patched)
- Herwig7.2.1
- WHIZARD 3.0.0.beta
- Delphes card

► Work in progress to enable PYTHIA8 support.

Extensions of the Higgs sector

Existing studies:

- ▶ CP violating top-Higgs interactions;
- ▶ Flavor changing neutral currents;
- ▶ Charged scalars: THDM Type III, NMSSM, Georgi-Machacek model;
- ▶ Neutral scalars: flavor violation in THDM, scalar singlet discovery prospects, exotic Higgs decays to $4b$;
- ▶ Higgs couplings: HWW, HZZ, self couplings.

See chapter 8, section 2 of [\[arXiv:2007.14491 \[hep-ex\]\]](#)

Further studies:

- ▶ Improve: top-Higgs interaction, Higgs self-couplings;
- ▶ New: survey of exotic Higgs decays, connection to Dark Matter models.

Searches for SUSY

Existing studies:

- ▶ Prompt signatures in compressed scenarios with Bino-like/Wino-like LSP
- ▶ Prompt signatures in compressed slepton scenario;
- ▶ Prompt and displaced searches for Higgsinos.

See chapter 8, section 3 of [\[arXiv:2007.14491 \[hep-ex\]\]](#)

Further studies:

- ▶ Improve searches for sparticle resonances in RPV scenarios;
- ▶ Include other sleptons in the searches.

Further topics

Anomalous gauge couplings:

- ▶ Top quark: ttZ , $tt\gamma$, tbW , and FCNC tuZ , $tu\gamma$, tuH ;
- ▶ Triple gauge bosons: WWZ , $WW\gamma$

See chapter 8, section 5 of [arXiv:2007.14491 [hep-ex]]

Heavy resonances and contact interactions:

- ▶ Leptoquarks;
- ▶ Heavy Z' bosons with flavor violation;
- ▶ Vector-like quarks;
- ▶ Excited fermions.

See chapter 8, section 6 of [arXiv:2007.14491 [hep-ex]]

Most of the above can be improved by considering more processes/final states and up-to-date analysis techniques.

Summary

- ▶ Electron-proton are well motivated (PDF, Higgs, ...)

Europe's affordable track to precision Higgs measurements and the full exploitation of the LHC

- ▶ A lot of **complementary** to other colliders.
- ▶ A variety of **opportunities** for BSM searches:
 - VBF produced particles with compressed spectra;
 - Long lived particles;
 - Signals that look like hadronic noise;
 - Anything that connects to electron or light quark flavors.
- ▶ Plenty of room for **new** ideas!