WG5 - developing a sustainable LHeC and FCC-eh collider programme

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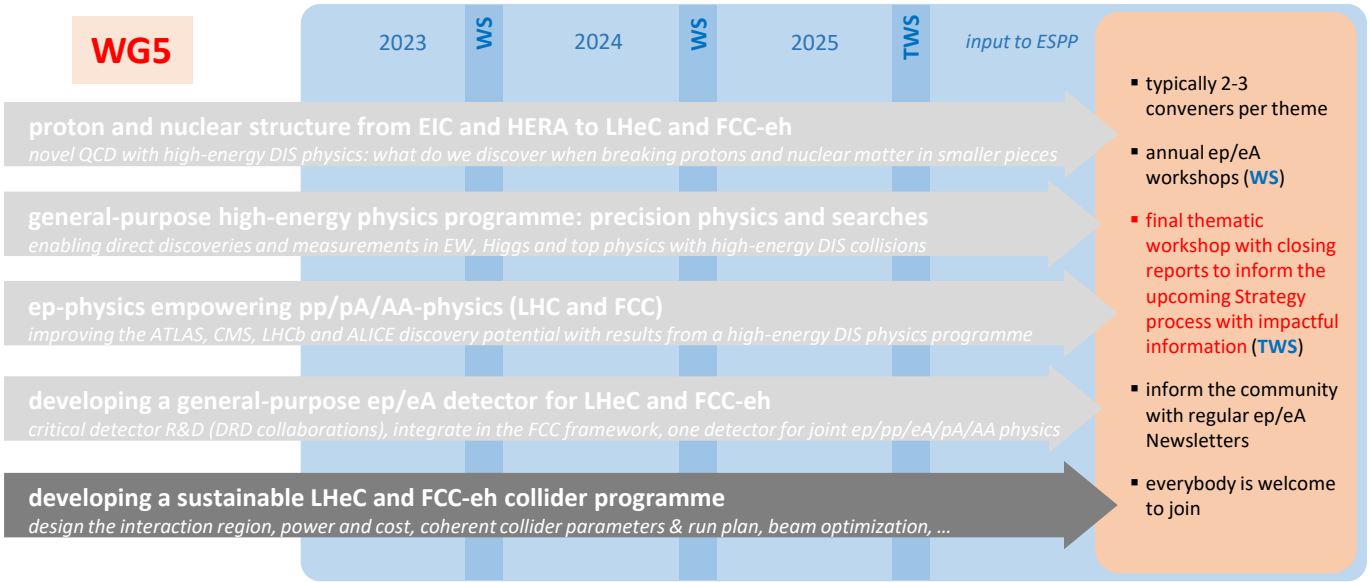
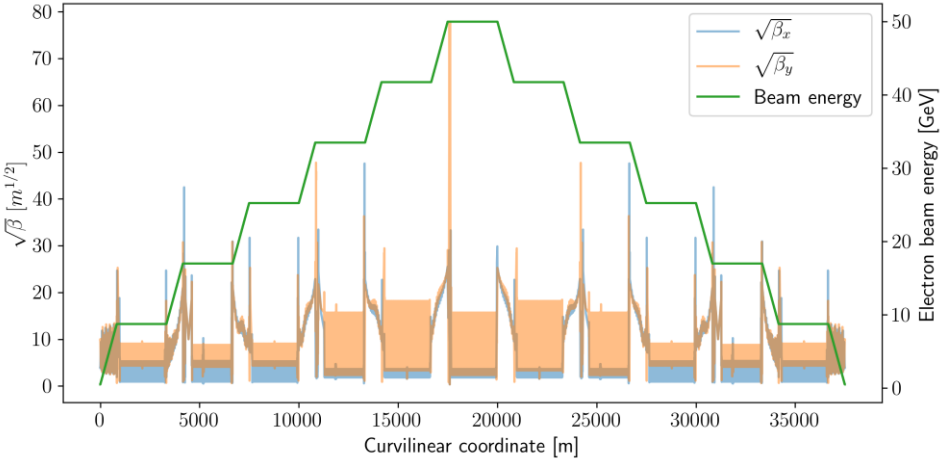
The ep/eA study at the LHC and FCC – new impactful goals for the community



Coordination Panel: N. Armesto, M. Boonekamp, O. Brüning, D. Britzger, J. D'Hondt (spokesperson), M. D'Onofrio, C. Gwenlan, U. Klein, P. Newman, Y. Papaphilippou, C. Schwanenberger, Y. Yamazaki

Energy Recovery Linac

- **ERL lattice design** and **dynamics**, PhD thesis of Kevin Andre (2022), supervised by **Bernard Holzer**



- **Design options** and **optimization**
  - Separate **FFAG arc design** and impact on **emittance preservation**
  - Lattice and robustness studies (imperfections) with **improved simulation framework (X-suite)**
  - Impact of **Coherent Synchrotron Radiation** and **micro-bunching instability** handling
- Building **ERL expertise**
  - Collaboration with Orsay PERLE and bERLinPRO
  - Operational experience

Energy Recovery Linac

- Synergy with **FCCee injector design** option with recirculating LINAC (RLI) based on LHeC/FCCeh ERL
  - Coherent set of parameters for RLI to replace **LINAC pre-injectors + Booster**, including **positron** production
  - Synergy with **SRF pre-series production** while building CERN **SRF expertise** and **industrial validation**
  - Impact on **cryogenic system** towards reduced power and cost
  - Revive **TLEP option** based on **ERL** (Z, W, H-factory in the LHC tunnel)

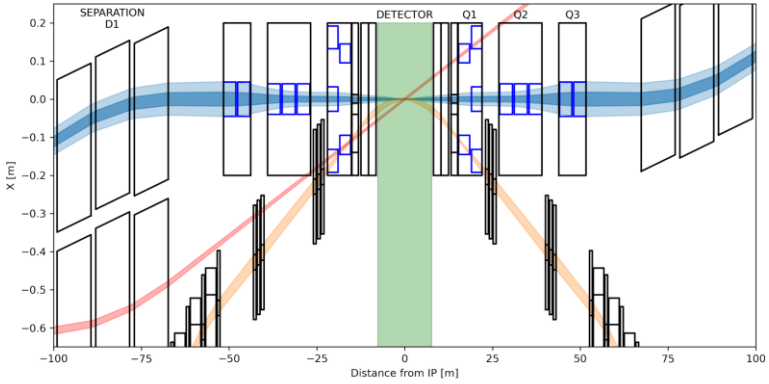
Tentative injector parameters with RLI @ 50 GeV (YP, FCC week 2021)

Accelerator	FCCee-Z		FCCee-W		FCCee-H		FCCee-tt	
Energy [GeV]	45.6		80		120		182.5	
Type of filling	Full	Top-up	Full	Top-up	Full	Top-up	Full	Top-up
RLI # bunches (800 GHz RF)	832		1000		328		48	
RLI bunch population [10^9]	3.0	0.15	1.3	0.04	1.9	0.06	2.8	0.08
RLI injections	1400		140		100		100	
#of BR cycles	-		1		1		1	
# of injections/collider bucket	70		1		1		1	
Total number of bunches	16640		2000		328		48	
Filling time (both species) [sec]	0.3	0.3	5.8	5.8	4.9	4.9	8.0	8.0

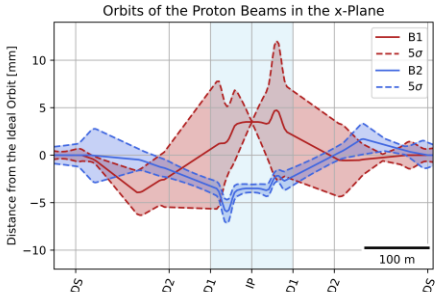
Interaction region design

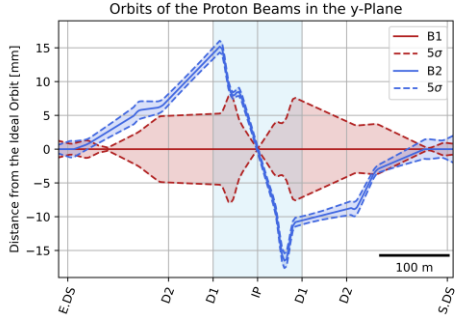
- Optimisation of **interaction region (optics** and **magnets)** for **LHeC** and FCCeh, PhD work of **Tiziana Von Witzleben** (to be finalised in 2025), supervised by **Bernard Holzer**
  - See IPAC 2023 paper on Concurrent Operation of the LHeC and the HL-LHC
  - See FCC week 2023 talk
  - Input for the design asymmetric magnets of the IR (magnets groups) using HL short model coils
- **Machine-detector interface, Laurent Forthomme** (Un of Krakow post-doc, hosted in BE-ABP @ CERN), supervised by **Bernard Holzer Krzysztof Piotrzkowski**
  - **SR radiation handling/shielding** in IR for machine and detector protection
  - **Optics** variants for **forward** and **backward detectors**

only e-h collisions



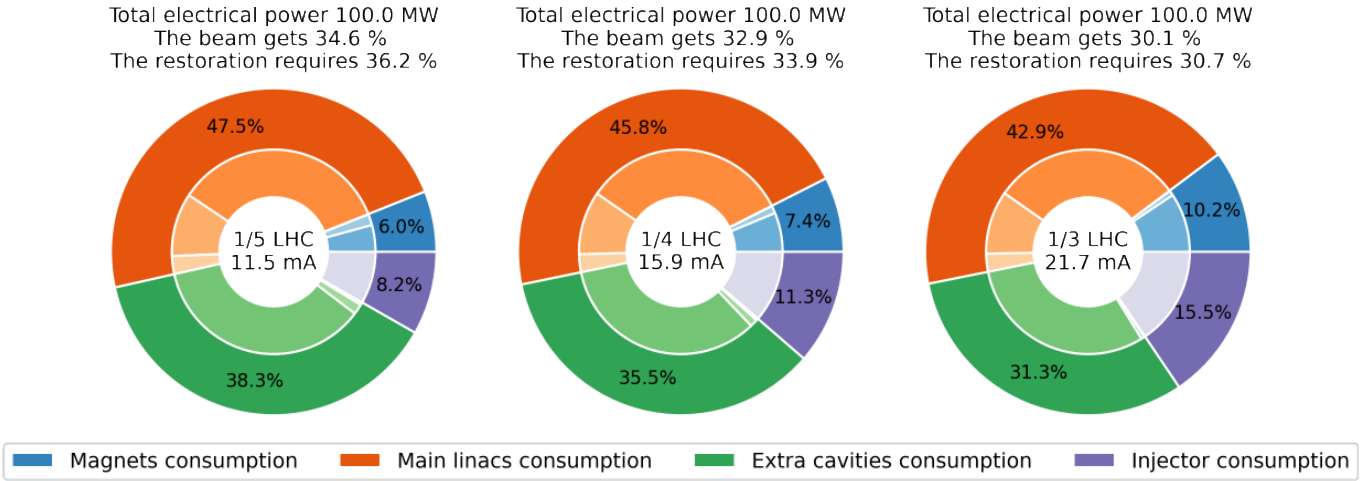
e-h and h-h collisions





Collider parameters

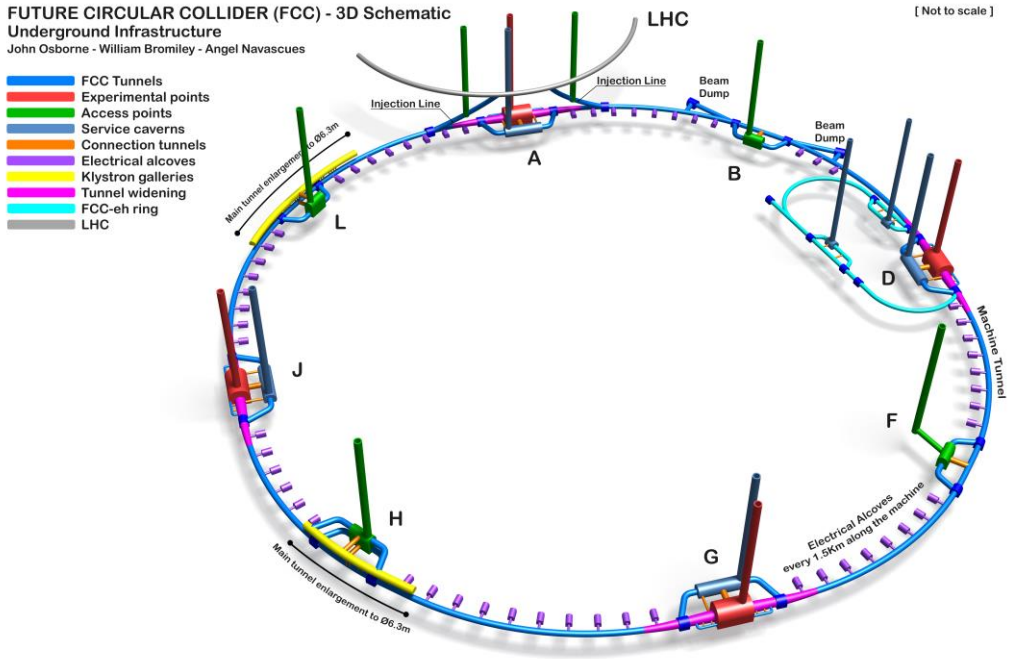
- **Coherent collider parameters** and **operational scenario,** Oliver Brüning, Bernhard Holzer and Yannis Papaphilippou, together with Massimo Giovannozzi (FCChh study coordinator)
  - **Power** and **cost - ERL power estimates** in Kevin Andre's PhD thesis appendix for **50 GeV** energy and **100 MW power** and **various circumferences**



  - Parameter optimization for **140MW wall-plague** power limit (**magnets**, **RF design**), **injection/dump energy choice**
  - **Dedicated** vs **parasitic running** (increased **e-current**, **BBU limit** in ERL)

Sustainability and life-cycle analysis

- **CE optimization** based on CO2 emission (J. Osborne)
- **High-Temperature SRF** @ 4.5 K (R. Calaga et al.)
- Fast **re-active tuners**



LHeC and FCC-eh collider programme – Organisation and Practical aspects

WG convenors: Oliver Brüning, Yannis Papaphilippou

WG indico page: https://indico.cern.ch/category/17311/

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