The FCC forward physics working group

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Future Circular Colliders - FCC

The FCCs

The Future Circular Colliders (FCCs) address some of the most fundamental open issues in particle physics

Following the discovery of the Higgs boson by ATLAS and CMS at the LHC in 2012, coupled with the absence of other phenomena, the particle physics panorama has become, surprisingly perhaps, very open. While the

- Many ongoing studies for FCCs in new 80-100 km circular tunnel, emphasis on new physics potential.
- However this also presents many new possibilities for studying forward physics in this higher energy regime.

$\longrightarrow$ FCC forward physics working group set up with the aim of exploring how this physics potential may be fully exploited.

Future Circular Colliders - FCC

http://fcc.web.cern.ch

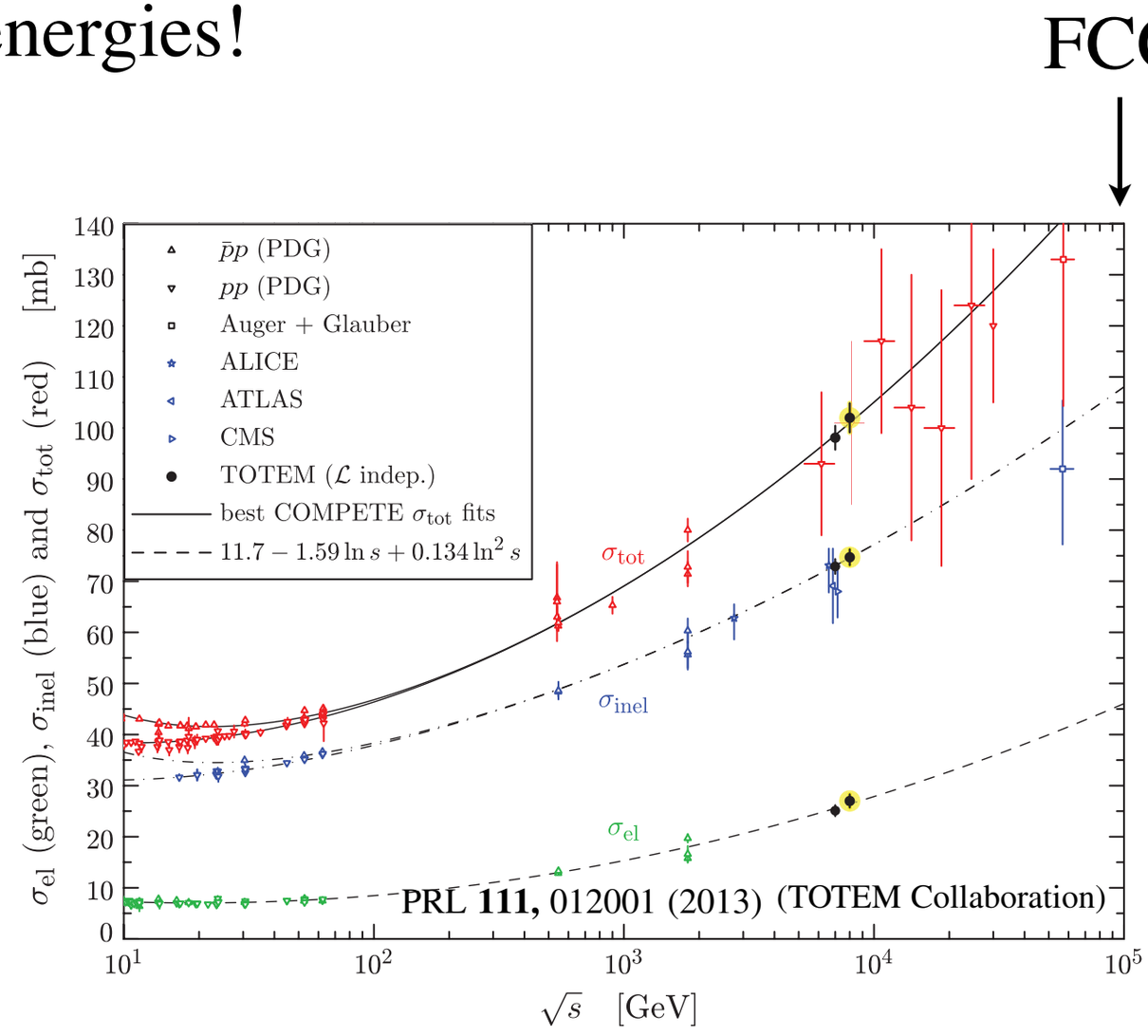
Two colliders in one

Effectively, the FCCs would be two colliders in one: the study comprises a high energy proton-proton collider with a centre-of-mass energy of 100 TeV (FCC-hh), as well as a 90-400 GeV high luminosity e^+e^- machine (FCC-ee a.k.a. "TLEP"). This ambitious complex would also allow the use of heavy ions and e-p collisions. The 100 TeV proton machine constitutes the ultimate goal while the e^+e^- machine provides a possible intermediate step.

- Three collision possibilities under consideration:
  - Hadron-hadron (hh)
  - Electron-positron (ee)
  - Electron-proton (ep)
- 'Hadron' = proton and heavy ion.
- Aim of WG to consider all possibilities. Some selected examples follow…

Cross section measurements

- Possibility to precisely measure pp scattering cross sections at unprecedented energies!

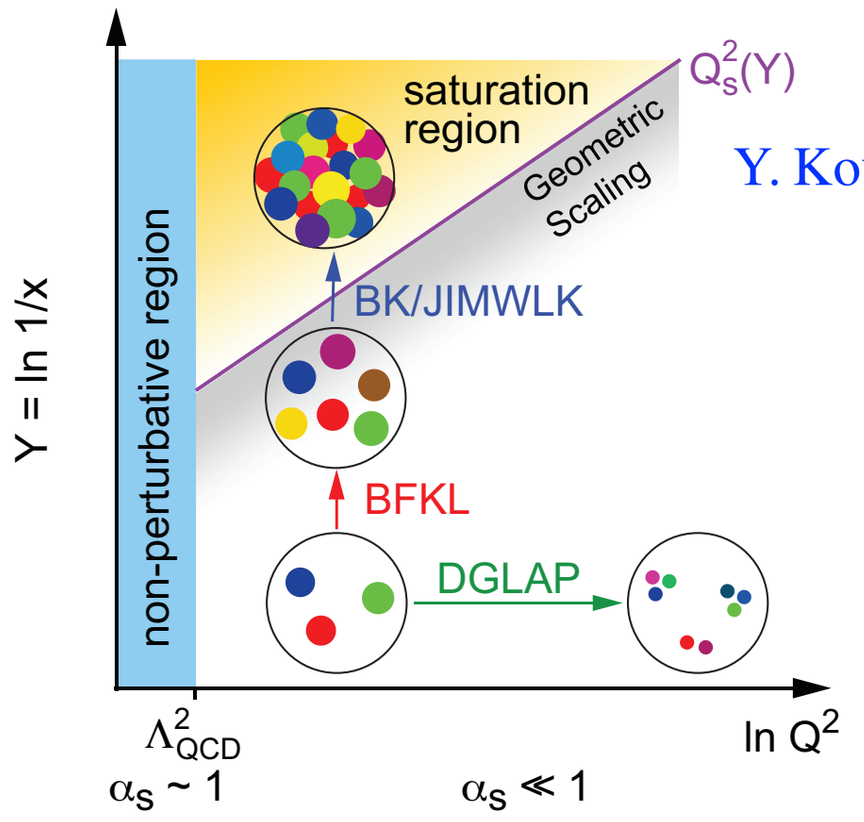


- (High) energy dependence of the diffractive dissociation cross sections, the shrinkage of the diffractive cone… ?

$$B_{el} = B_0 + b_1 \ln(s/s_0) + b_2 \ln^2(s/s_0)$$

Low x physics

• Higher $s \Rightarrow$ lower $x \Rightarrow$ increased sensitivity to saturation/BFKL effects.



Y. Kovchegov, arXiv:1410.7722

$$Q_s^2 \sim A^{1/3} \left(\frac{1}{x}\right)^{\lambda}$$

• eh: DIS (geometric scaling…), photoproduction…

• hh: photoproduction, particle production in heavy ion collisions, jet studies (BFKL)….

• ee: BFKL effects in $\sigma(\gamma\gamma)$…

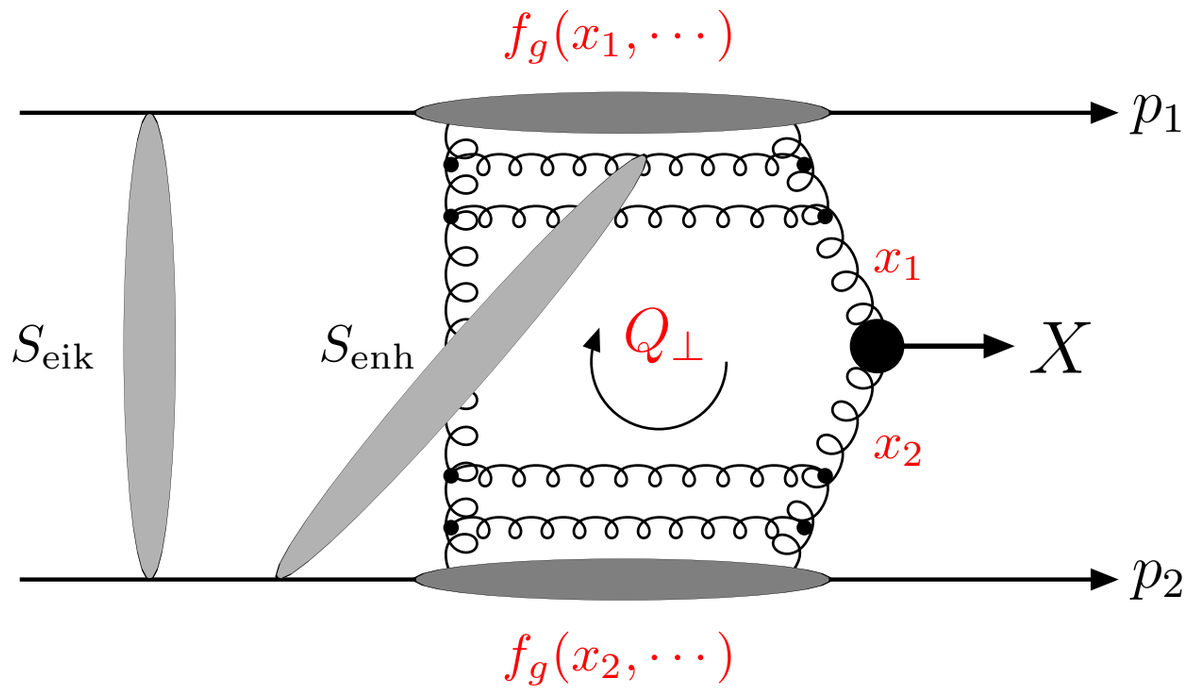
Central Exclusive Production

• Lower gluon $x \Rightarrow$ larger σ . Caveat: survival factor will be significantly smaller at this higher $\sqrt{s}$.

• (Very) first estimate for SM Higgs: $\sigma^{\rm FCC}/\sigma^{\rm LHC} \sim 10$

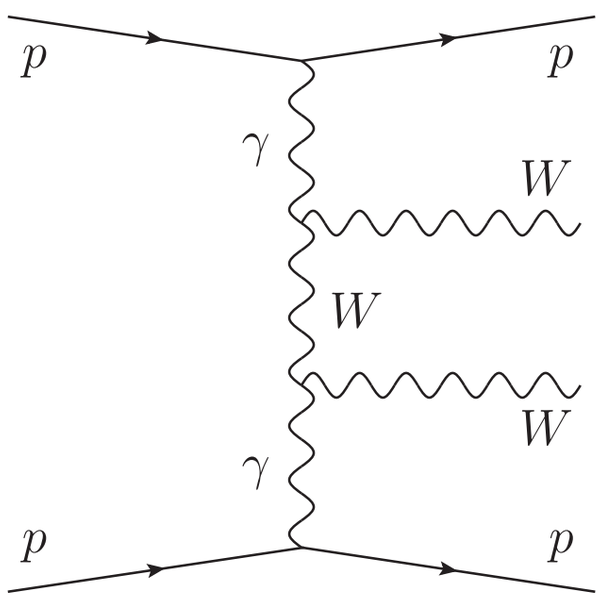
$\longrightarrow$ Potentially huge gain in rate. But relies on gluon PDF and S^2 in unprobed regions. Important uncertainties.

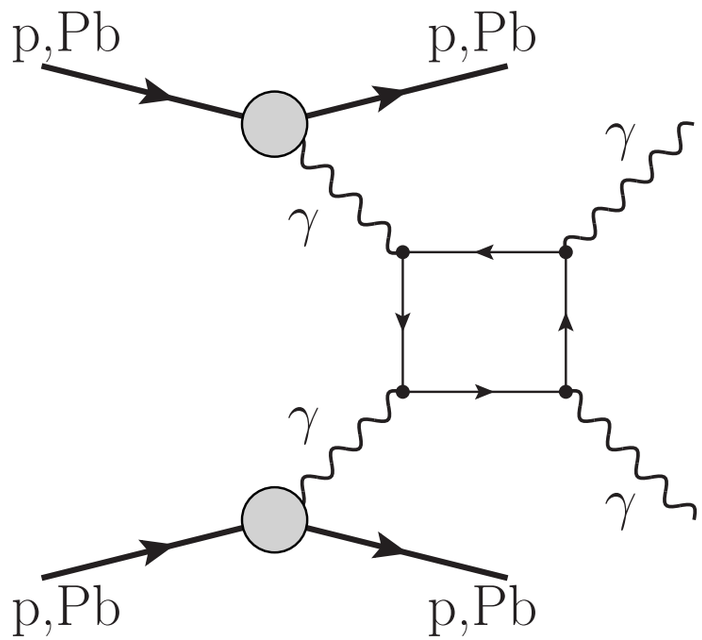
• Jet production: expect similar gain in rate, also for non-exclusive diffractive jets.



"Exploratory" physics

- Higher $s \Rightarrow$ larger mass reach, for e.g. anomalous coupling studies.
- Light-by-light scattering: study by d'Enterria and Silveira (arXiv: 1602.08088): $O(5-35)$ event increase from LHC to FCC ($pp - PbPb$).
- Study of d'Enterria and Telles (arXiv:1510.0814): 5σ observations of the $\gamma\gamma \to H \to b\bar{b}$ and $\gamma\gamma \to W^+W^-$ processes anticipated in ee.
- 750 GeV resonance studies in $\gamma\gamma$ fusion (hh/ee).





Summary and outlook

- FCC Forward physics working group:
  - Explore full physics potential of FCCs for forward physics and diffractive measurements in ee, hh and eh modes.
  - Motivate additional detectors/IPs: very forward detectors for low and roman pots to detect intact protons.
- Aim to provide contribution to FCC design study outlining physics case and presenting necessary detectors/running scenarios.
- The higher energy and the possibility for ee and eh (as well as hh) collisions offered by the FCCs provides a very strong physics case.
- While some studies performed, still a lot of concrete work to be done.
- Contributions strongly encouraged!