

# HL-LHC, HE-LHC, LHeC: the view from PDFs

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ATLAS PDF forum

Discussion of different channels  
Possible analysis strategies  
Format of the contribution

# PDFs at the times of future colliders

- Likely to be even more relevant as systematics
- Better theory (NNLO, scale, EW corrections), however are we measuring the same thing in DIS and pp?

(e.g. G.Altarelli June 2015):

The factorization “theorem” is essential. (only proven in DIS)

Not fully proved theoretically (beware of non pert. effects)

[nearly complete arguments only for Drell-Yan & similar]

Should finally be experimentally tested with precision

$$\sigma(s) = \sum_{A,B} \int \frac{dx_1}{x_1} \frac{dx_2}{x_2} p_A(x_1, Q^2) p_B(x_2, Q^2) \hat{\sigma}_{AB}(x_1 x_2 s, Q^2)$$

x times density of parton A

reduced X-section

- One way: precisely measure gluons and quarks at large x in DIS, evolve in  $Q^2$ , and predict the jet rates at large  $p_T$  at the LHC

# Also, can the measurements follow? (HL)

**W/Z production** Not statistically limited, systematics already sub-percent  
→ unlikely to profit from HL

**Jets** Need better control of systematics and correlations. Only highest pt bins can benefit from HL

**Boson + jets or boson pt.** Impact marginal so far, likely to remain so

**Direct photon production:** concerns with isolation requirements and systematics for HL

**Off-peak Drell-Yan** : improvement in statistics and kinematic reach needed.

**Top** : Look at double differential data and to use dilepton channel. Ideas like looking at  $t\bar{t}/Z$  ratios at different energies could also be pursued

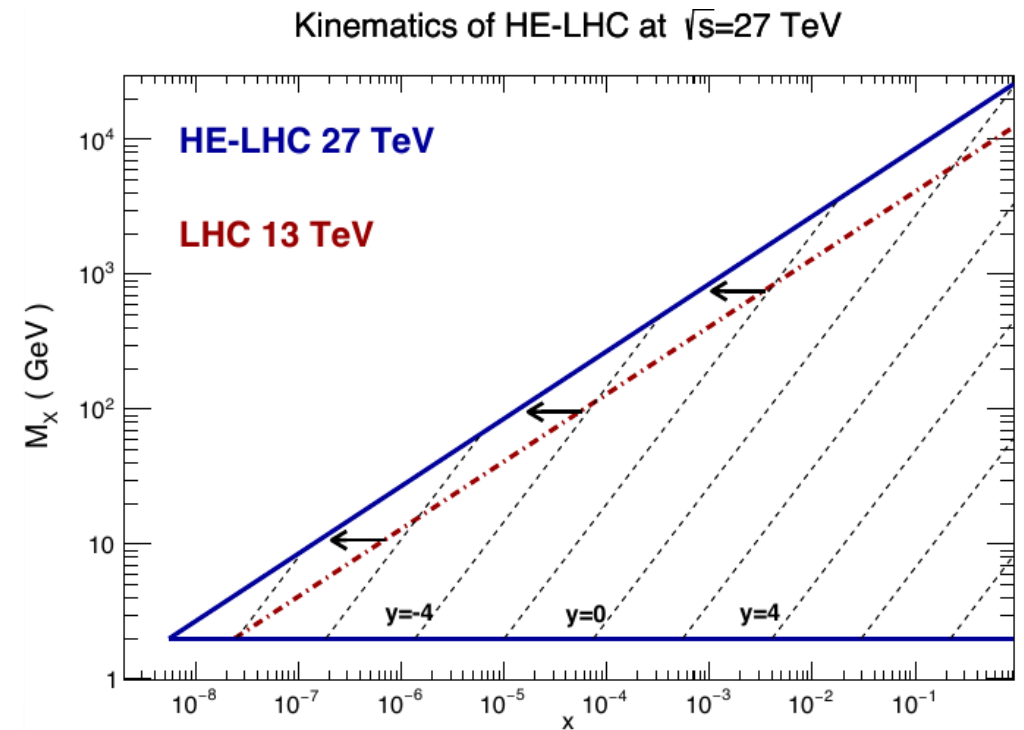
**Boson + heavy flavour** : Statistics can help. Current data on  $Z+c$  are not constraining on intrinsic charm: kinematic reach to higher- $x$  could help.

# High-Energy

- Project is more far away and uncertain than HL
- From the Pdf point of view, ratio between same measurement at different energies can lead to interesting systematic cancellations

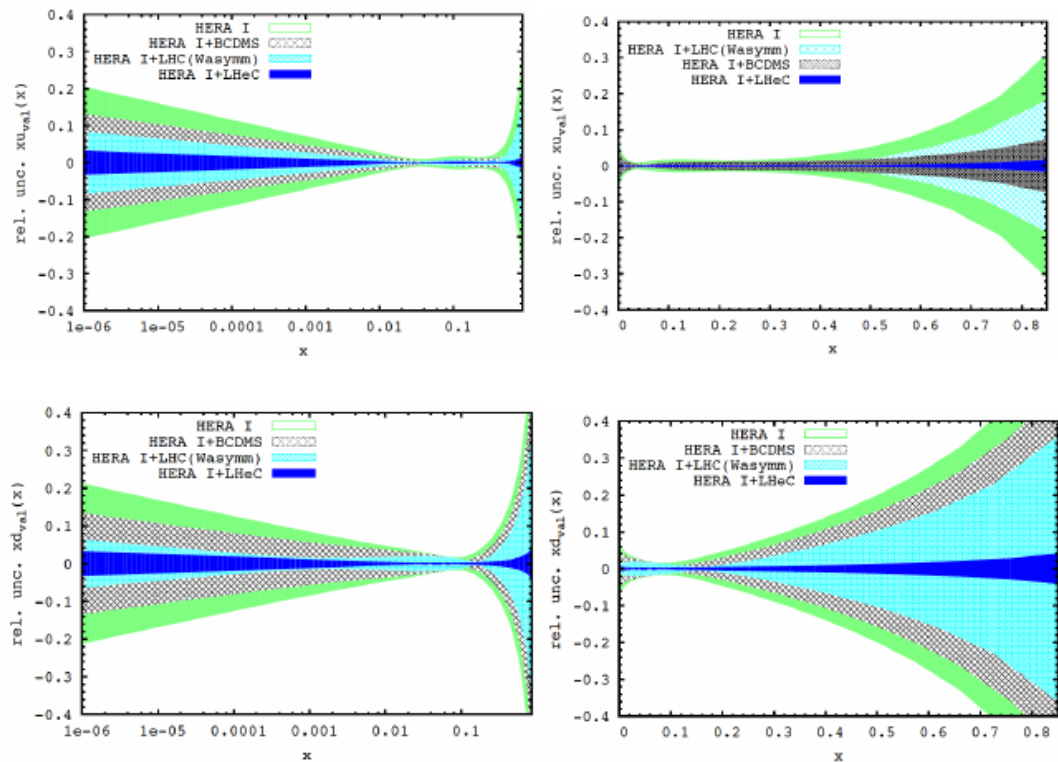
(jets, photons, DY, V + jets)

- However, detectors will be different. How will the cancellations be ?



# LHeC

- “Ultimate” tool for Pdf determination, impact studies on PDF precision already performed (e.g. CDR arXiv : 1206.2913)



- Impact of these improvements on HL and HE systematics?
- Can key measurements be performed with the required precision without it?

# Organisation of work

- The PDF fitting group cannot embark in a full analysis on a new accelerator
  - Make educated guesses on pileup systematics, and increase in statistics, then redo the fit- only works for HL
  - To add e.g. double differential distributions, need help from analysers
  - Sample generation: will it be centralised?
  - Finally, we need a chapter on the LHeC PDFs and their impact on physics. Does it belong to the PDF part or to individual physics chapters?

# Working summary

- Plan to concentrate on the most promising channels, possibly just redoing the fit without the full analysis
- Need to liaise with analysers for anything more ambitious, and just perform the fit
- It is important to stress the impact of LHeC on PDFs and their influence on the other measurements (or even searches, like non-resonant dijets/dileptons)