Precision QCD with the LHeC and the FCC-eh

The LHeC Working Group: PDFs & Low-x

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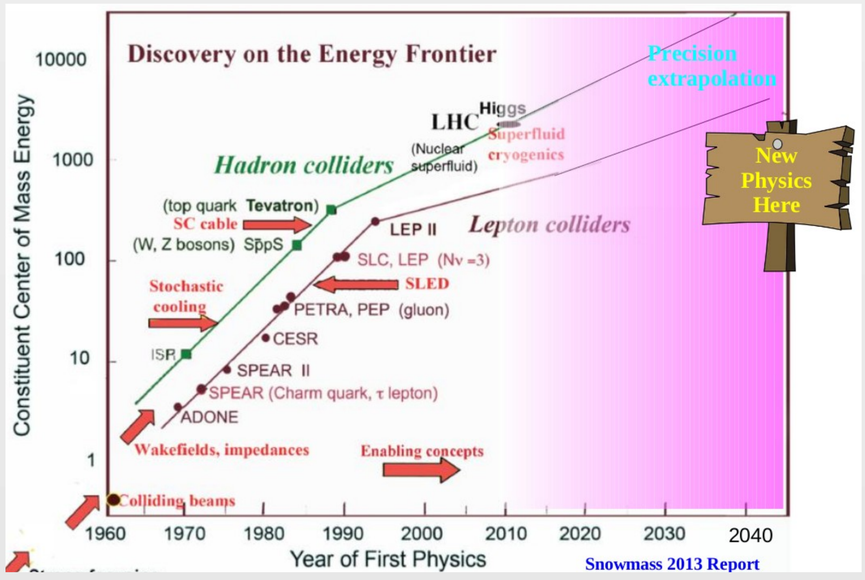
*Presenter

http://lhec.web.cern.ch

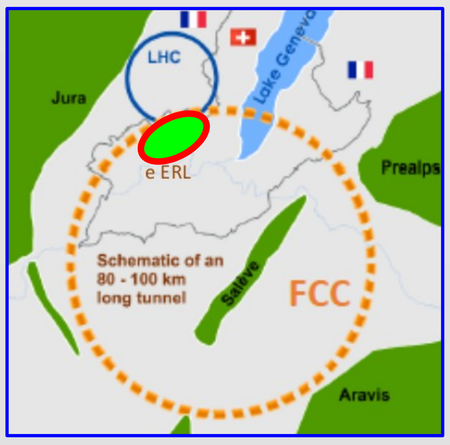
The path to future discoveries will be delineated with high-precision comparisons as we search for discrepancies between the data and the "Standard Model" predictions

Where is the "New Physics"



Precision indirect measurements can probe energy scales far larger than direct production channels, and thereby provide the most comprehensive characterization of the fundamental particles and forces

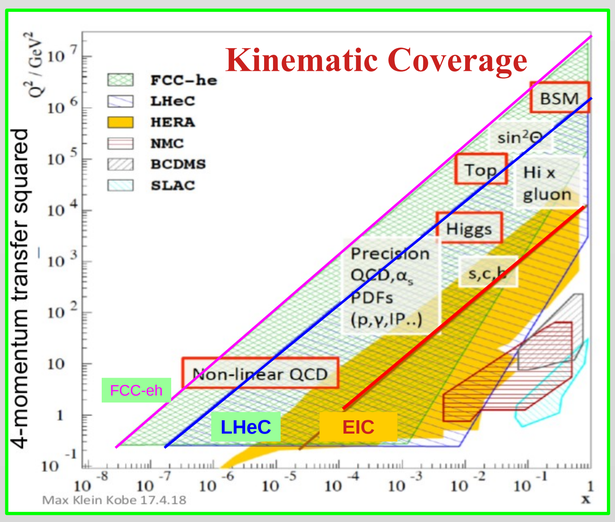
The Machines: LHeC & FCC-eh

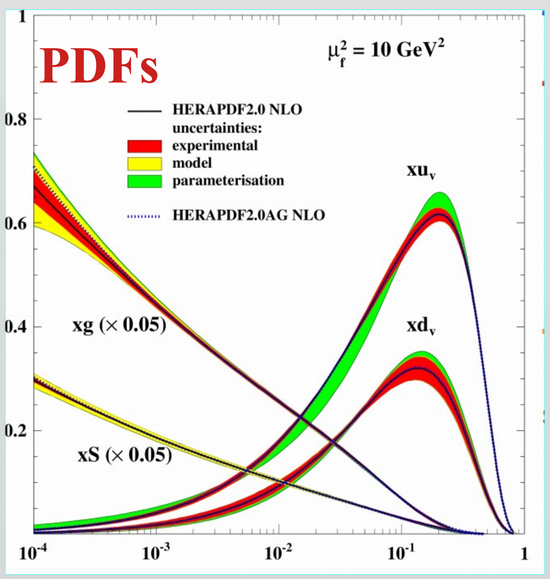


LHeC: Energy Recovery Linac (**ERL**)
e beam: up to 60 GeV
L_{int}~1.0 ab^{-1} *(1000× HERA per 10 yrs)*

Operates Synchronously with:
HL-LHC: *ep* √s=1.3 TeV (7 TeV proton)
HE-LHC: *ep* √s=1.8 TeV (14 TeV proton)
FCC-eh: *ep* √s=3.5 TeV (50 TeV proton)

Kinematic Reach with Precision



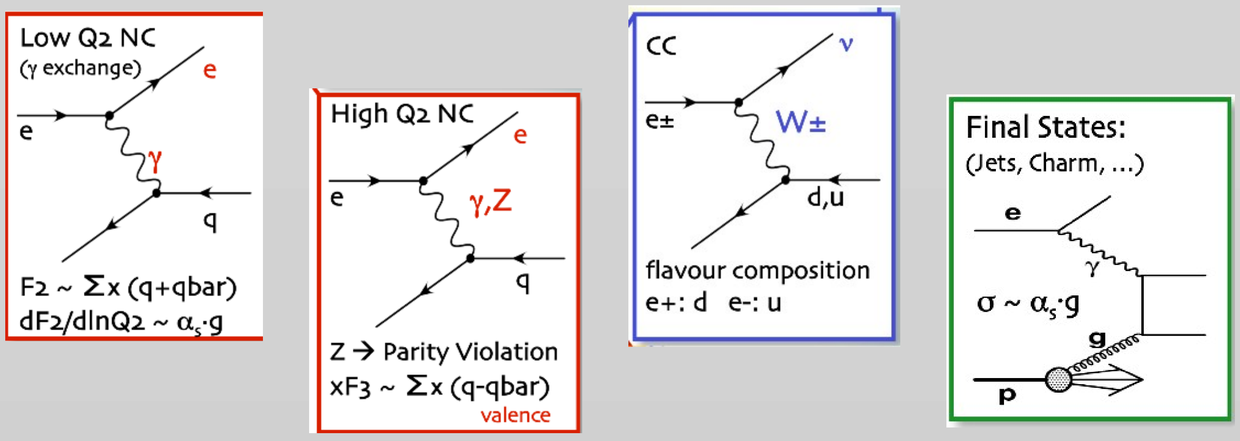


Limiting Factor: Parton Distribution Functions (PDFs)

ATLAS analysis of W boson mass: "the fixed-order PDF uncertainty and the parton shower PDF uncertainty give the largest contributions." *Eur.Phys.J. C78 (2018) no.2, 110*

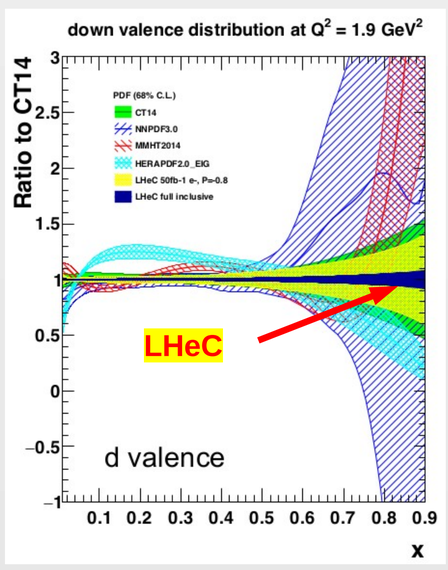
PDF uncertainties: "a limitation that cannot be overcome using only *pp* data."

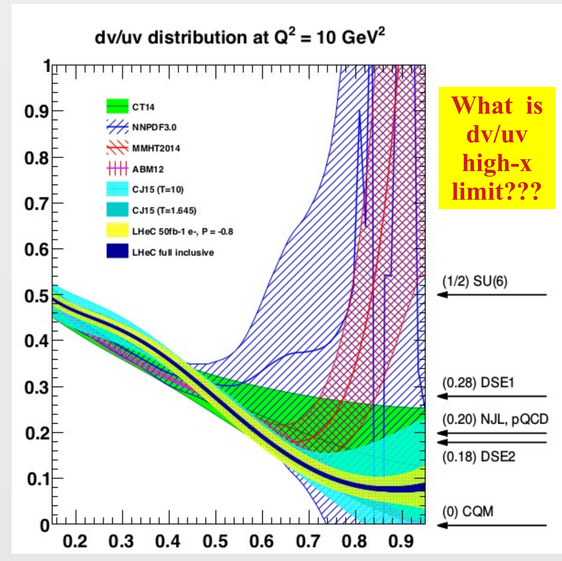
Sample Processes



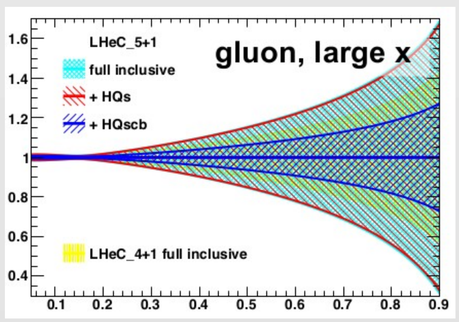
Able to study a wide variety of processes with precision across {x,Q^2} range for above processes, … and also
e.g. … Diffractive DIS on nuclear targets, Transversity GPDs …

Precision QCD ⇒ Precision PDFs





C. Gwenlan: DIS2019 Workshop

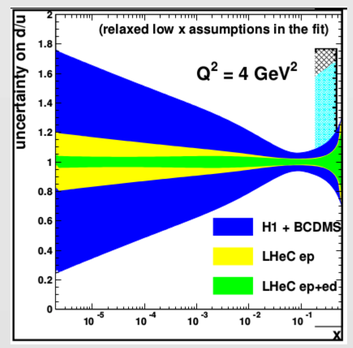


Impact of HQ data on LHeC PDFs with more flexible parameterization

Significant improvement in PDF precision from LHeC!!!

High Stats
Large Q^2 lever arm

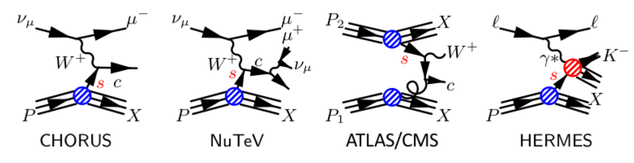
"e-d" option ⇒ d/u



LHeC CDR 2012

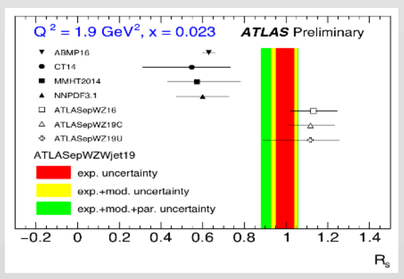
The "Strange" Strange PDF

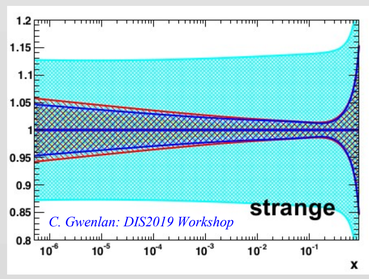
strange pdf poorly known; suppressed cf. other light quarks? strange valence?

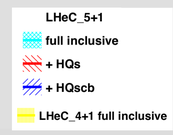


Strange PDF poses a significant challenge!

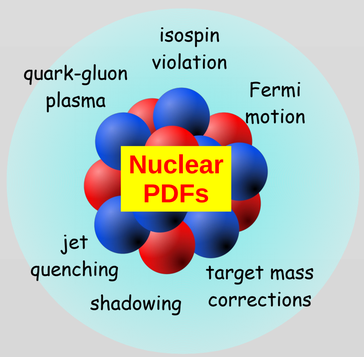
Can approach from multiple fronts to yield improved uncertainties

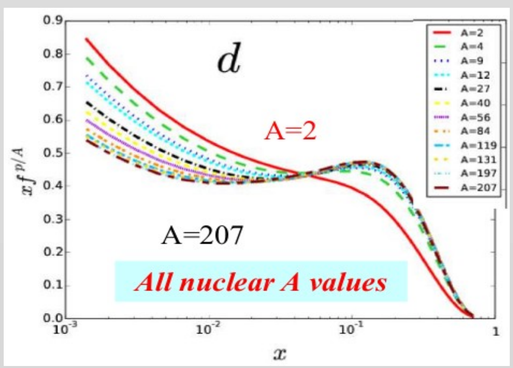


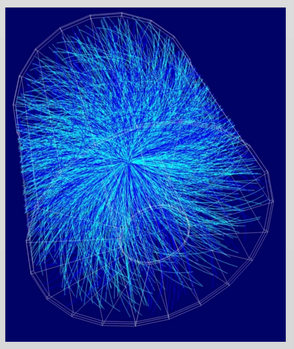




Nuclear PDFs



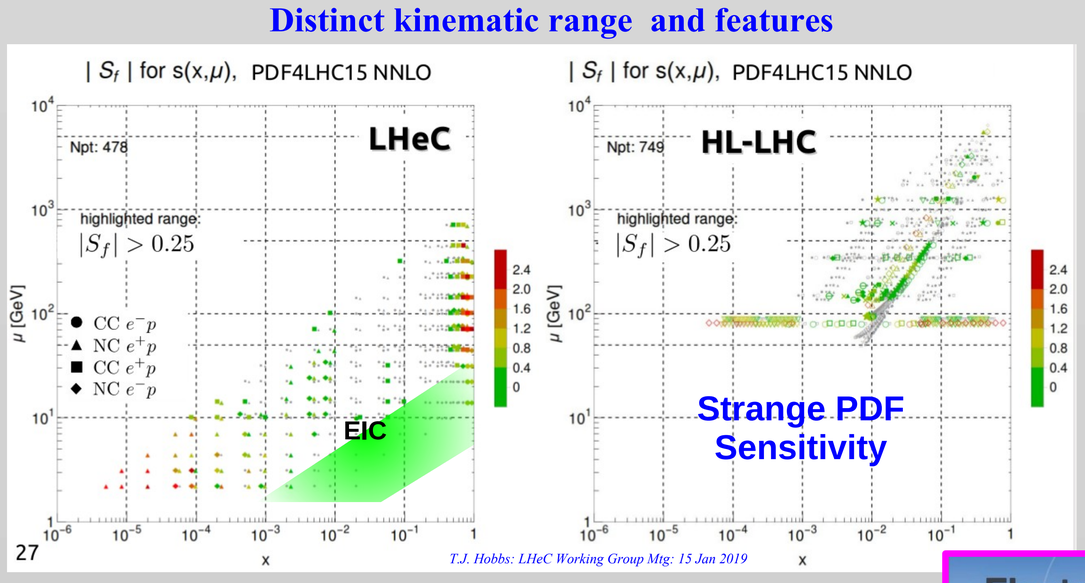




Nuclear Beams: Key for flavor differentiation, … including s(x) puzzle

PDF Sensitivity

Distinct kinematic range and features



These developments are crucial in advancing our searches for "new physics" signatures.

Electrons for the LHC
LHeC/FCCeh and PERLE Workshop
24-25 October 2019
… near CERN