

Electroweak physics at LHeC

D. Britzger, N. Armesto, M. Klein, C. Schwanenberger, H. Spiesberger
for the LHeC and FCC-eh Study Group

Snowmass 2021
EF04 Topical Group Community Meeting
23.10.2020

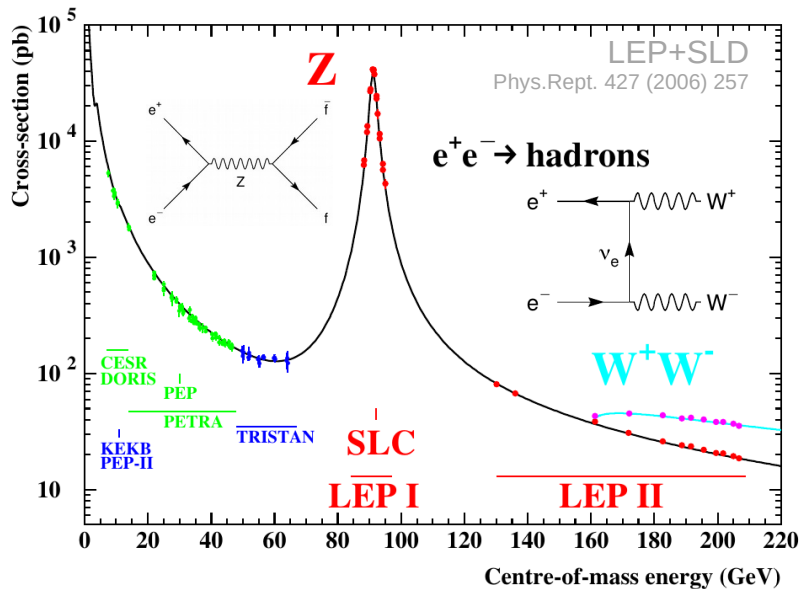


Max-Planck-Institut für Physik
(Werner-Heisenberg-Institut)

Electroweak physics at high scales

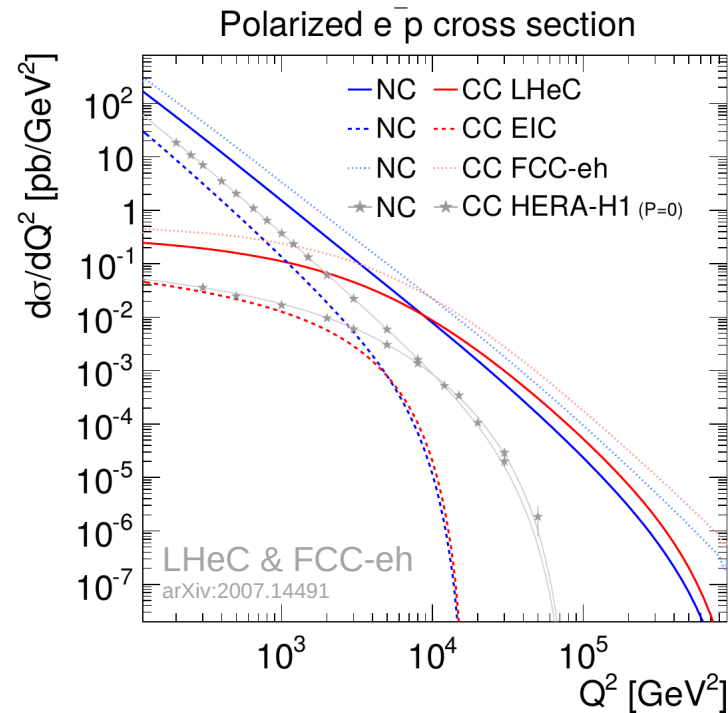
e^+e^- annihilation

- Foundation of precision EW physics
- Precision EW measurements at Z-pole

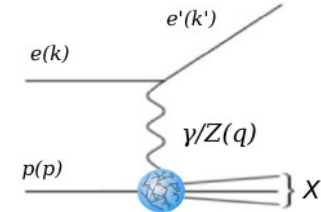


Future $e^\pm p$ DIS experiments (t-channel)

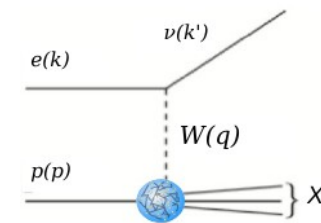
- neutral- and charged-current exchange
- precision measurements up to TeV scale



neutral-current (NC)



charged-current (CC)



LHeC – a future DIS experiment at CERN

New energy-recovery linac at LHC

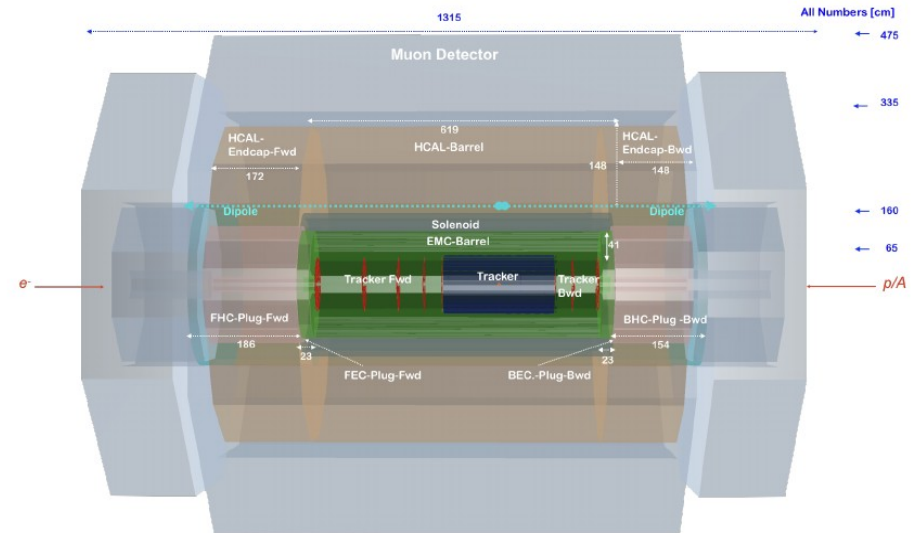
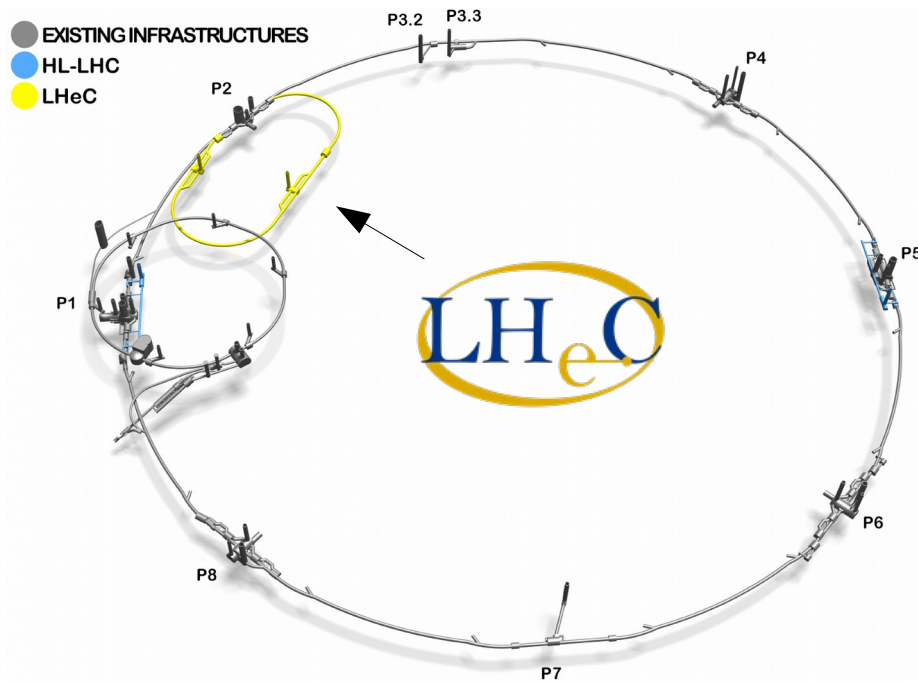
$$E_e = 60 \text{ GeV} \quad \sqrt{s} \sim 1.3 \text{ TeV}$$

High luminosity: $\sim 1 \text{ ab}^{-1}$ in 2030s

Exploit full physics potential of HL-LHC

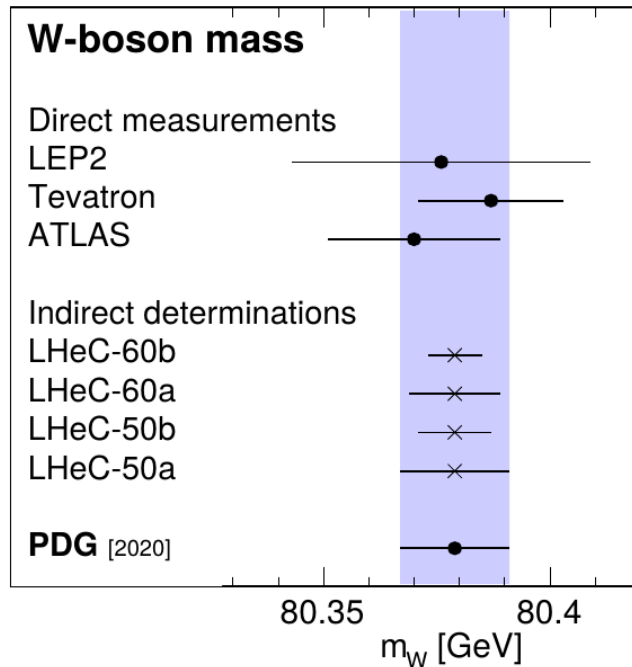
LHeC experimentation

- 'Multi-purpose' detector at LHC-Point 2
- Huge physics potential beyond EW-physics
- Similar concept for FCC-eh proposal

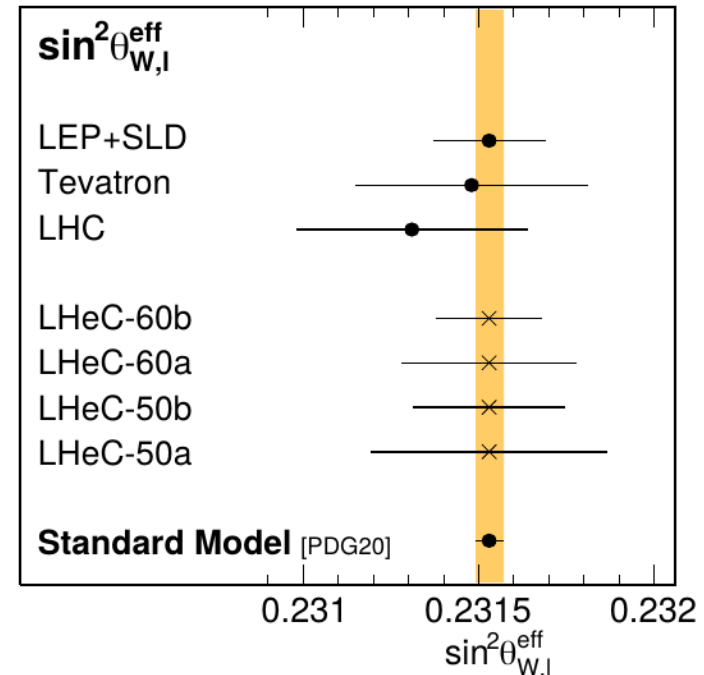


Electroweak physics with NC & CC DIS

Prospects for EW precision measurements using **inclusive NC & CC DIS cross sections at LHeC**
Results based on a study using simulated NC & CC DIS cross sections in a simultaneous determination of the EW parameter together with the proton-PDF → PDFs are not a limitation!



$$\delta m_W = \pm 6 \text{ MeV}$$

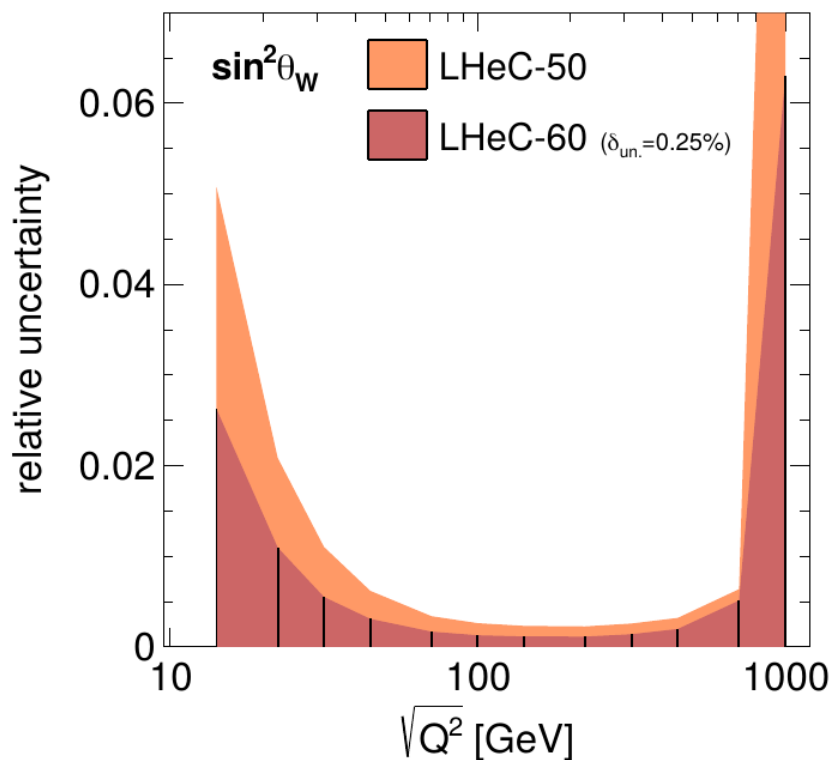


$$\delta \sin^2 \theta_W = \pm 0.00015$$

Electroweak physics with NC & CC DIS

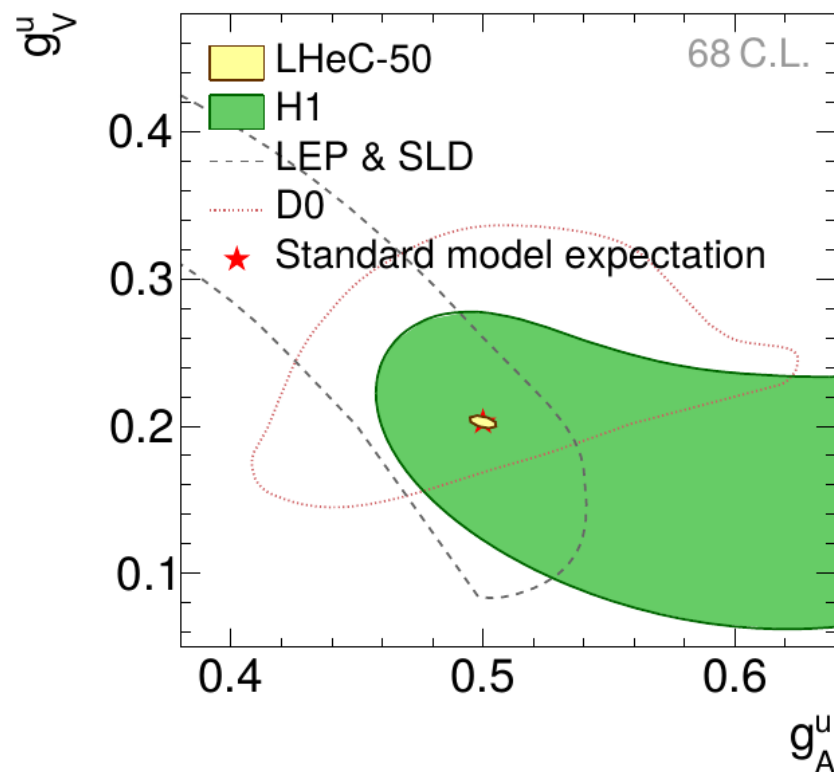
Running of $\sin^2\theta_W$ (unique!)

expected experimental uncertainties
in range $20 < Q < 1000$ GeV



Light-quark weak NC couplings g_V, g_A

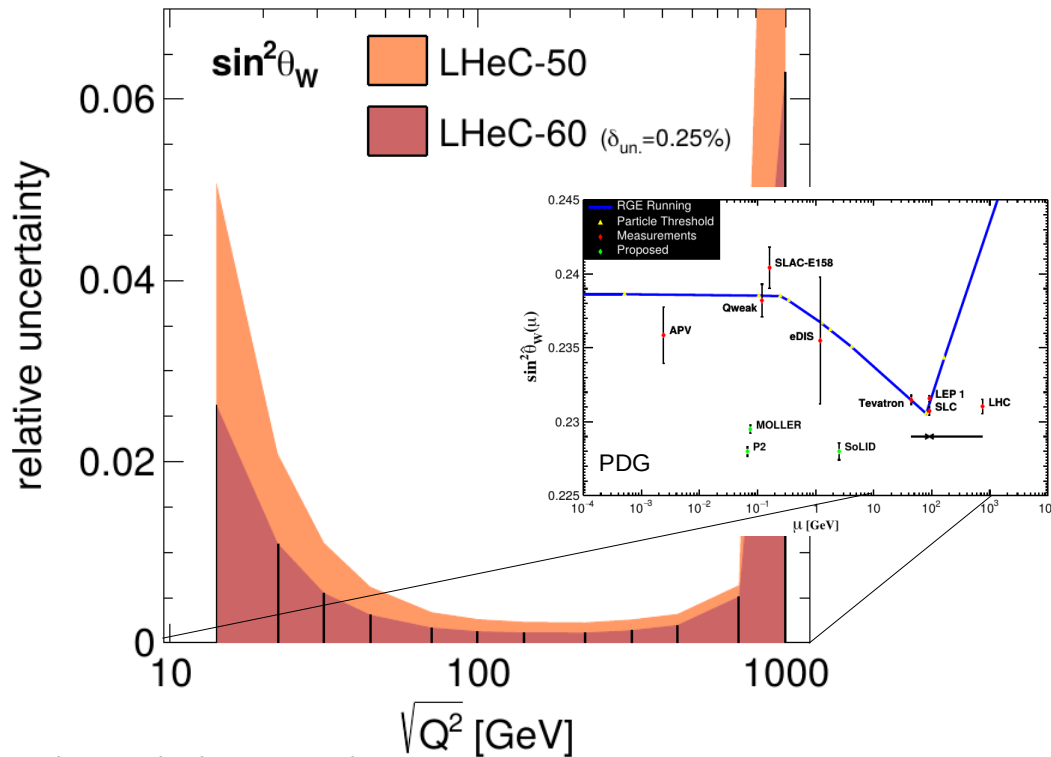
Determination of up- and down-type
couplings at permille precision



Electroweak physics with NC & CC DIS

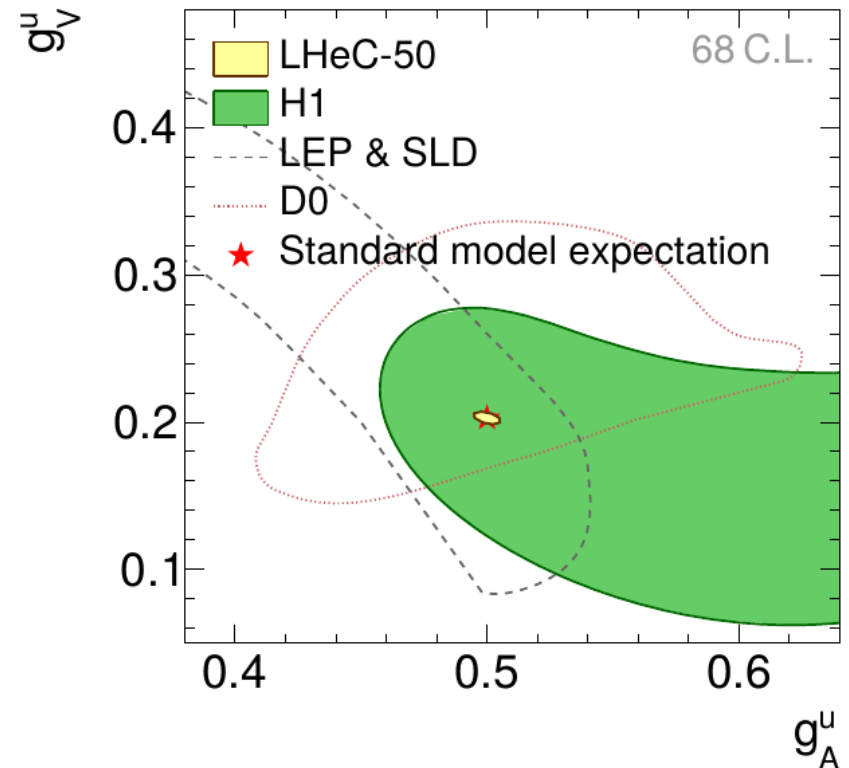
Running of $\sin^2\theta_W$ (unique!)

expected experimental uncertainties
in range $20 < Q < 1000$ GeV



Light-quark weak NC couplings g_V, g_A

Determination of up- and down-type
couplings at permille precision



Summary

LHeC provides unique opportunities for precision EW measurements in the 2030s

Many measurements feasible (a few examples shown today. More: EPJ C80 (2020) 831 & arXiv:2007.14491)

→ these are often complementary to e^+e^- or pp and test different aspects of GSW theory

An updated CDR for the LHeC was submitted in July 2020 (arXiv:2007.14491)

Need strong support from HEP community to realize LHeC (~6% of annual CERN budget over 20 years)

Not discussed today

- LHeC has very strong impact on precision physics at the HL-LHC (LHeC: proton-PDFs, α_s at ± 0.0002 , MC optimizations,...) → (LHC: EW, Higgs, top, SM, BSM-physics)
- Direct Z and W production in DIS at LHeC/FCC-eh (aTGC's)
- EW physics in eA-collisions at LHeC/FCC-eh
- Higgs-, Top-, QCD-, proton-structure-, heavy-ion-, BSM, low-E, diffractive-physics at LHeC
→ see other working groups

