# Golden physics channels from Inclusive Working Group

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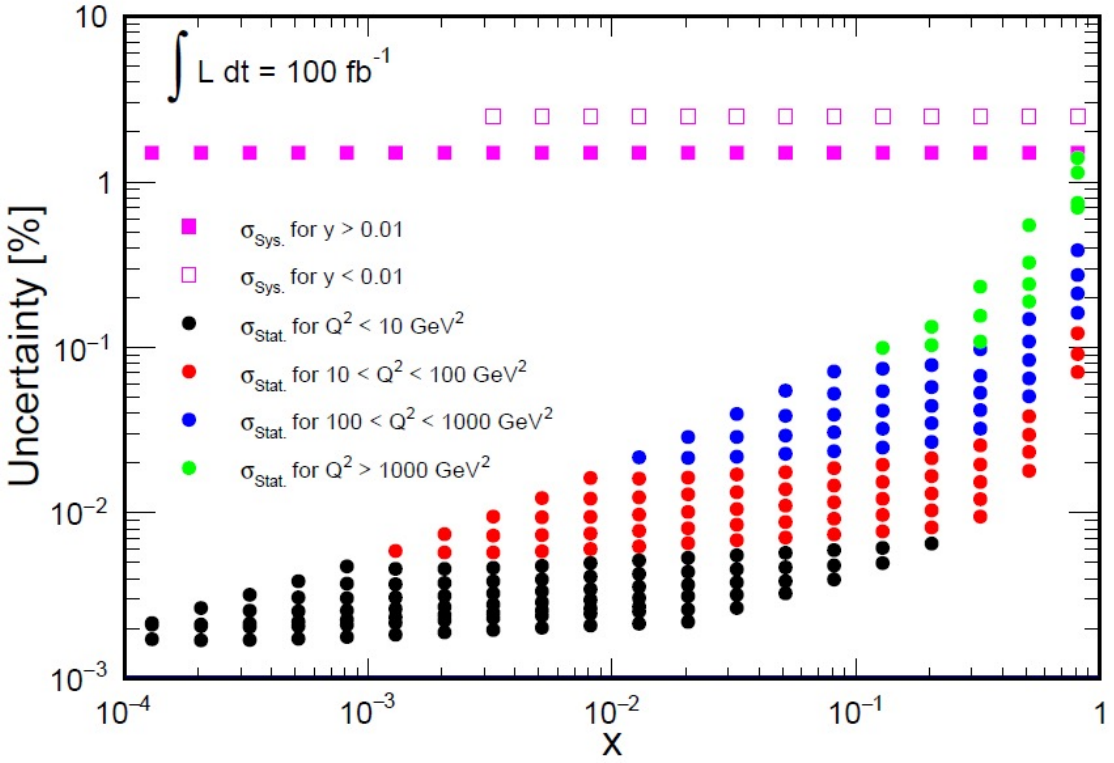
| Golden channels | Physics Topic/goal |
|---|---|
| Unpolarized inclusive ep/d:<br>$\boldsymbol{\sigma}(x,Q^2) \rightarrow F_2, F_L$ | Proton PDFs<br>$q(x,Q^2)$ , $g(x, Q^2)$ |
| Unpolarized inclusive eA:<br>$\boldsymbol{\sigma}(x,Q^2) \rightarrow F_2, F_L$ | Nuclear PDFs<br>$q(x,Q^2)$ , $g(x, Q^2)$ |
| Polarized inclusive ep/d,<br>$A_{LL} \rightarrow A_1(x,Q^2) \rightarrow g_1$ | Proton spin structure<br>Gluon & Quark Helicity<br>$\Delta g(x,Q^2)$, $\Delta u^+$, $\Delta d^+$ |
| Parity-violating DIS | Polarized/unpolarized PDF (strange) |

# Unpolarized nucleon PDFs

Simulated statistical and systematic uncertainties for electron-proton NC DIS at √s = 140.7 GeV.




e-p NC at $\sqrt{s}$ = 140.7 GeV (18x275 GeV)

- EIC pseudo-data was generated during the yellow report to study nucleon PDFs.
- For proton beams we used L = 100 fb$^{-1}$ with $\sqrt{s}$ = 28.6, 44.7, 63.3, 140.7 GeV for NC, and 140.7 GeV for CC. For deuteron beams we use L = 10 fb$^{-1}$ and consider only NC at $\sqrt{s}$ = 28.6, 66.3, 89.0 GeV.
- For the e-p NC data, the uncorrelated (point-to-point) systematic uncertainty was set at 1.5% (with an additional 2% for 0.005<y<0.01). A normalization uncertainty of 2.5% was also included.
- For the e-p CC data, an uncorrelated uncertainty of 2.5% and a normalization uncertainty of 2.3%.

# Unpolarized nucleon PDFs

Potential impact on pdf from NC and CC pseudo EIC data - relative uncertainties after EIC normalized to pre-EIC relative uncertainties.

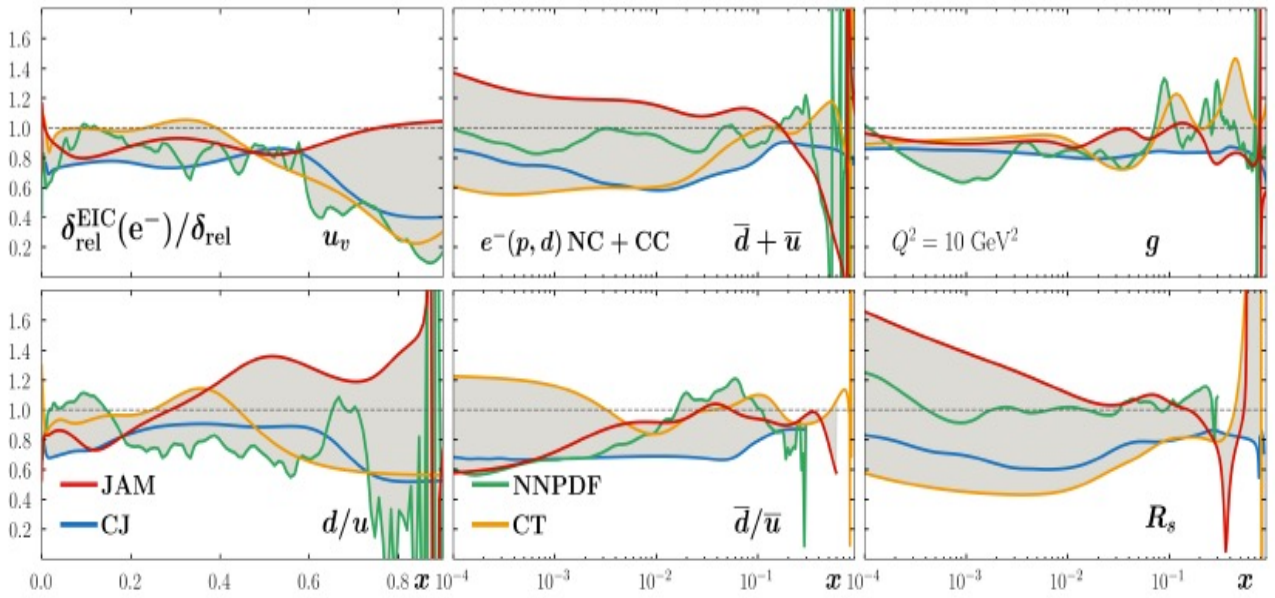
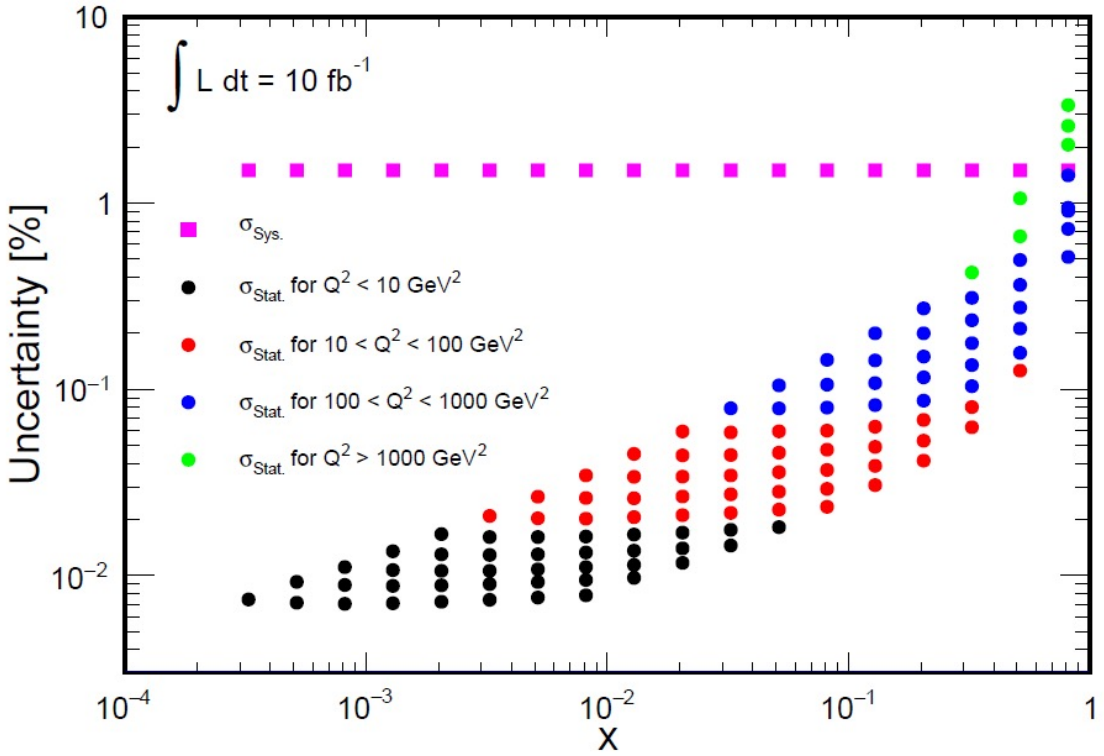



**Figure 7.4:** Comparison of relative uncertainties for unpolarized PDFs $xf(x)$ for different partons, before and after the inclusion of EIC data, evaluated at $Q^2 = 10$ GeV$^2$. We include the analysis of different collaborations, limited to $e^-$ datasets.

- EIC pseudo-data was generated during the yellow report to study nucleon PDFs.
- For proton beams we used L = 100 fb$^{-1}$ with $\sqrt{s}$ = 28.6, 44.7, 63.3, 140.7 GeV for NC, and 140.7 GeV for CC. For deuteron beams we use L = 10 fb$^{-1}$ and consider only NC at $\sqrt{s}$ = 28.6, 66.3, 89.0 GeV.
- For the e-p NC data, the uncorrelated (point-to-point) systematic uncertainty was set at 1.5% (with an additional 2% for 0.005<y<0.01). A normalization uncertainty of 2.5% was also included.
- For the e-p CC data, an uncorrelated uncertainty of 2.5% and a normalization uncertainty of 2.3%.

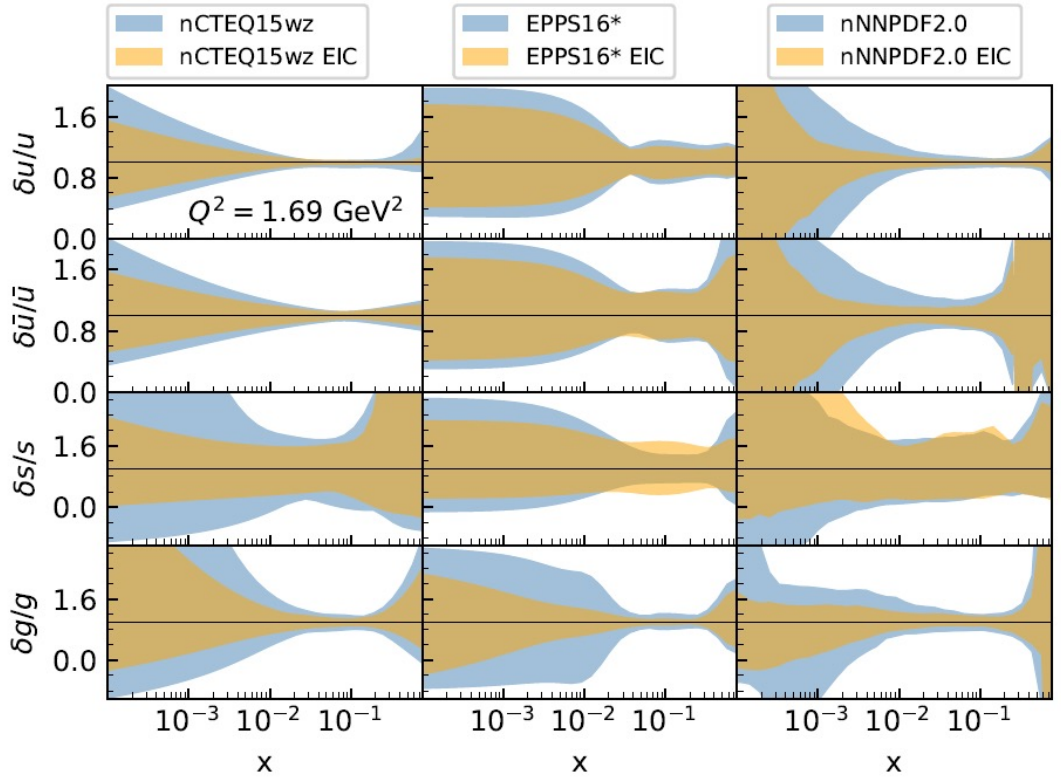
# Unpolarized nuclear PDFs

Simulated statistical and systematic uncertainties for eA NC DIS at √s = 89 GeV (Fig. 7.67)




e-Au NC at $\sqrt{s}$ = 89 GeV (18x110 GeV)

Potential impact on nuclear PDF (Fig.7.68)
- relative uncertainties after EIC normalized to pre-EIC relative uncertainties.



# Nucleon spin structure-Helicity pdf

Impact on the helicity distributions with DSSV14 analysis

- uncertainties improvement after inclusion of √s~45 GeV and 140GeV with 10 $fb^{-1}$
- uncorrelated uncertainty 2%, norm. uncertainty 2.3%

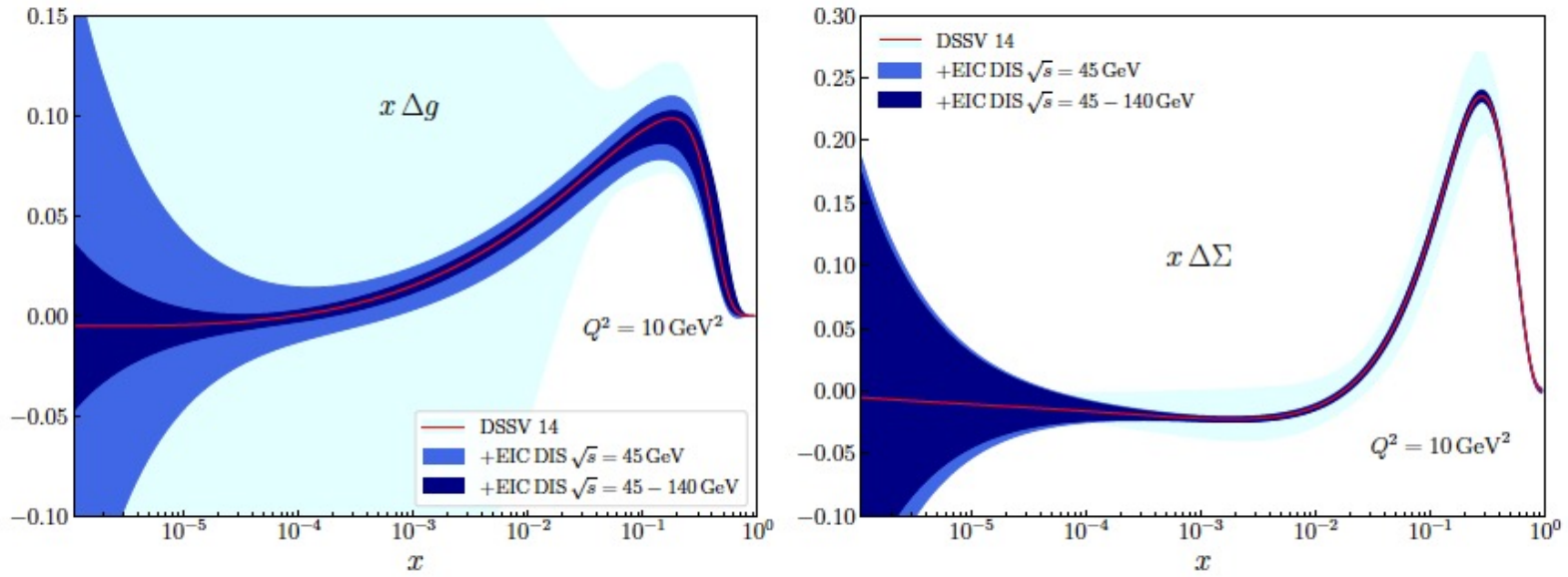



**Figure 7.12:** Impact of the projected EIC $A_{LL}$ pseudoda on the gluon helicity (left panel) and quark singlet helicity (right panel) distributions as a function of $x$ for $Q^2 = 10\,\mathrm{GeV}^2$. In addition to the DSSV14 estimate (light-blue), the uncertainty bands resulting from the fit including the $\sqrt{s} = 45$ GeV DIS pseudodata (blue) and, subsequently, the reweighting with $\sqrt{s} = 140$ GeV pseudodata (dark blue), are also shown.

# Nucleon spin structure-Helicity pdf

Impact on the helicity distributions from JAM analysis

- uncertainties improvement with 100 fb$^{-1}$ pseudo data – reduced by ~80% for **ΔG**, **ΔΣ**
- the assumption of SU(3) symmetry has a big impact

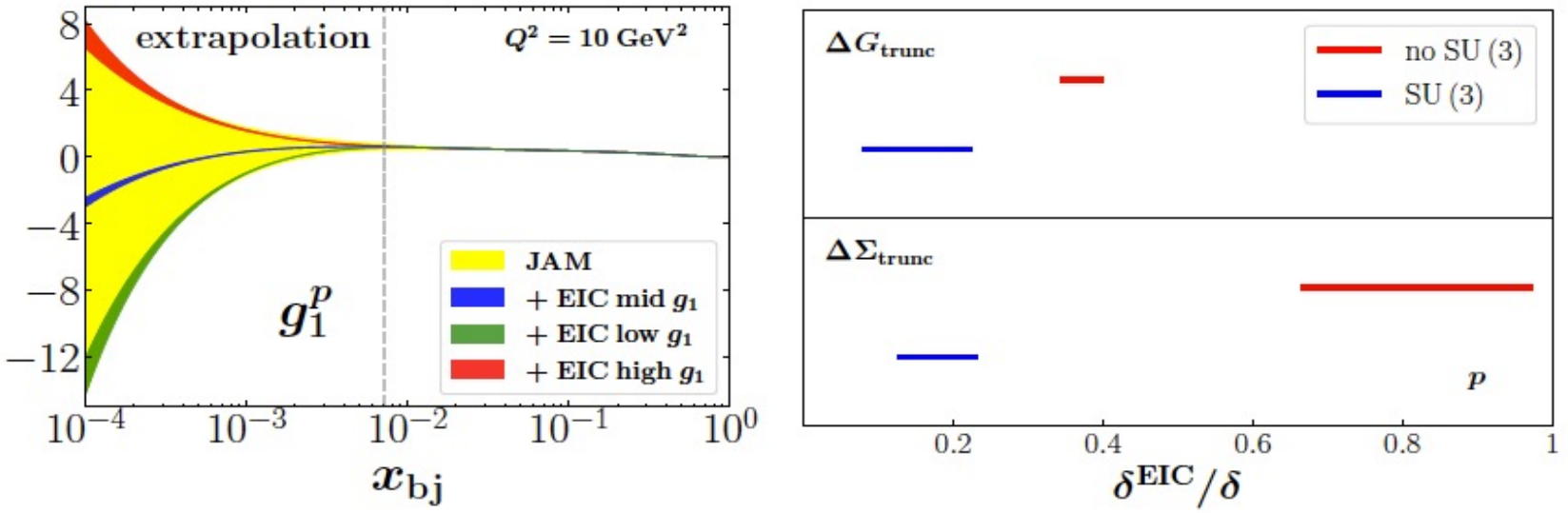



**Figure 7.13:** Left: Impact of projected $A_{LL}^p$ data at EIC kinematics on $g_1^p$, relative to the JAM global QCD analysis [89, 90] (yellow band), taking $+1\sigma$ ("high $g_1$", red band), $-1\sigma$ ("low $g_1$", green band) and central ("mid $g_1$", blue band) uncertainties of $A_{LL}^p$. Right: Uncertainty on the gluon ($\Delta G_{\text{trunc}}$) and quark-singlet ($\Delta\Sigma_{\text{trunc}}$) truncated moments from $x_{\text{min}} = 10^{-4}$ to 1 with EIC data ($\delta^{\text{EIC}}$) normalized to the baseline PDFs uncertainties ($\delta$) [89, 90], covering the "low", "mid" and "high" scenarios, for the case of no SU(3) symmetry (red lines) and with SU(3) symmetry (blue lines).

# N.C. systematic uncertainties (YR)

| | **Point-to-Point (%)** | **Normalization (%)** |
|---|---|---|
| Statistics (10 $fb^{-1}$) | 0.01-0.35 | - |
| Luminosity | - | ~1 |
| Electron Purity | - | ~1 (for 90% purity) |
| Bin-Centering | <0.5 | <0.5 |
| Radiative Corrections (*HERA*) | 1 | - |
| Acceptance / Bin-Migration + Trigger & Tracking Eff. + Charge-Symmetric Background | 1-2 | 2-4 |
| Additional uncertainty for y<0.01 bins | 2 | - |
| Total | 1.5-2.3<br>(2.5-3 for y<0.01) | 2.5-4.3 |

# Plan for next step:

- We mostly will not redo the PDF fits, but focus on the precision that we can obtain on these observables with full event simulation including detector effects, crossing angle, beam effects, electron PID/background.