Inclusive Group Report

ATHENA Bi-weekly meeting
22 July 2021

Paul Newman (Birmingham)
Barak Schmookler (Stonybrook)
Qinghua Xu (Shandong)

Two tasks:

- Detector configuration benchmarking
- Producing ‘golden’ plots for proposal

Benchmarking Detector Configurations

- **NC DIS cross section**
  - → Underlying observable for much of EIC physics
  - → Good quality, well understood, generators exist
  - → Sensitive to systematics on electron ID / reconstruction, response to overall hadronic final state, QED radiation …

- **Total cross section in photoproduction ($Q^2 \to 0$) limit**
  - → Benchmarking beamline / low angle instrumentation in the outgoing electron direction

- **CC DIS cross section?**
  - → Dedicated studies of hadronic response at large Q^2? [can also be done with NC samples]

Readiness to study ATHENA Full-detector Simulations?

- Person-power exists (Stony Brook, Birmingham, BNL, UC Riverside …)

- Tools being developed using samples from Yellow Report studies and simple smearing tools.

Minimum bias simulation data available from the yellow report effort

Data Set	Generator	Beam Energies	Run Information	Number of Events	Int. Luminosity
1	Pythia6	5x41 GeV e-p	$Q^2 > 0.5$ GeV^2; NC unpolarized; QED Radiation OFF	100 million	0.14 fb^{-1}
2	Pythia6	5x41 GeV e-p	$Q^2 > 3.0$ GeV^2; NC unpolarized; QED Radiation OFF	100 million	0.96 fb^{-1}
3	Pythia6	5x100 GeV e-p	$Q^2 > 0.5$ GeV^2; NC unpolarized; QED Radiation OFF	15 million	0.016 fb^{-1}
4	Pythia6	10x100 GeV e-p	$Q^2 > 0.5$ GeV^2; NC unpolarized; QED Radiation OFF	11 million	9.9e-3 fb^{-1}
5	Pythia6	10x110 GeV e-p	$Q^2 > 0.5$ GeV^2; NC unpolarized; QED Radiation OFF	15 million	0.013 fb^{-1}
6	Pythia6	18x110 GeV e-p	$Q^2 > 0.5$ GeV^2; NC unpolarized; QED Radiation OFF	15 million	0.011 fb^{-1}
7	Pythia6	18x275 GeV e-p	$Q^2 > 0.5$ GeV^2; NC unpolarized; QED Radiation OFF	15 million	9.0e-3 fb^{-1}
8	Pythia6	27.5x920 GeV e+p	$Q^2 > 1.5$ GeV^2; NC unpolarized; QED Radiation OFF	10 million	0.011 fb^{-1}
9	Djangoh	5x41 GeV e-p	$Q^2 > 0.5$ GeV^2; NC unpolarized; QED Radiation OFF	~10 million	0.014 fb^{-1}
10	Djangoh	5x100 GeV e-p	$Q^2 > 0.5$ GeV^2; NC unpolarized; QED Radiation OFF	~10 million	0.011 fb^{-1}
11	Djangoh	10x100 GeV e-p	$Q^2 > 0.5$ GeV^2; NC unpolarized; QED Radiation OFF	~10 million	9.1e-3 fb^{-1}
12	Djangoh	18x275 GeV e-p	$Q^2 > 0.5$ GeV^2; NC unpolarized; QED Radiation OFF	~10 million	6.6e-3 fb^{-1}
13	Djangoh	27.6x920 GeV e+p	$Q^2 > 1.5$ GeV^2; NC unpolarized; QED Radiation OFF	~2.5 million	3.5e-3 fb^{-1}
14	Pythia6	5x41 GeV e-p	Q^2 down to photo-production limit; NC unpolarized; QED Radiation OFF	500 million	6.3e-3 fb^{-1}
15	Pythia6	10x100 GeV e-p	Q^2 down to photo-production limit; NC unpolarized; QED Radiation OFF	300 million	2.3e-3 fb^{-1}
16	Pythia6	18x275 GeV e-p	Q^2 down to photo-production limit; NC unpolarized; QED Radiation OFF	300 million	1.7e-3 fb^{-1}
17	Djangoh	10x100 GeV e-p	$Q^2 > 0.5$ GeV^2; NC unpolarized; QED Radiation ON	~15 million	0.013 fb^{-1}

- Still need more detailed evaluation of overall Full-Sim sample sizes required … meeting between physics working group conveners needed soon (many overlaps!)

Readiness to study ATHENA Full-detector Simulations?

- Reviewing systematic sources and evaluation methods starting from Yellow Report

N.C. systematic uncertainties

	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 (2.5-3 for y<0.01)	2.5-4.3

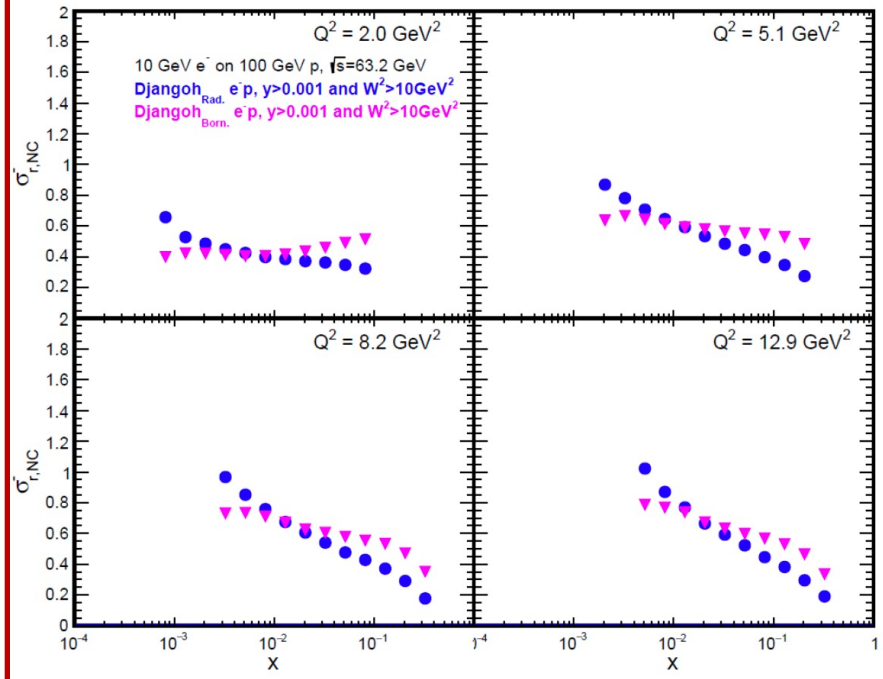
- Developing plans for small set of key quantities / systematics to be used in benchmarking e.g. calo energy scales, charged pion rejection-power …
  - → (x, Q^2) resolution with electron, hadron, mixed methods
  - → Electron ID purity
  - → Sensitivity to QED radiative effects
  - → dependence on beam parameters (crossing angle etc)?

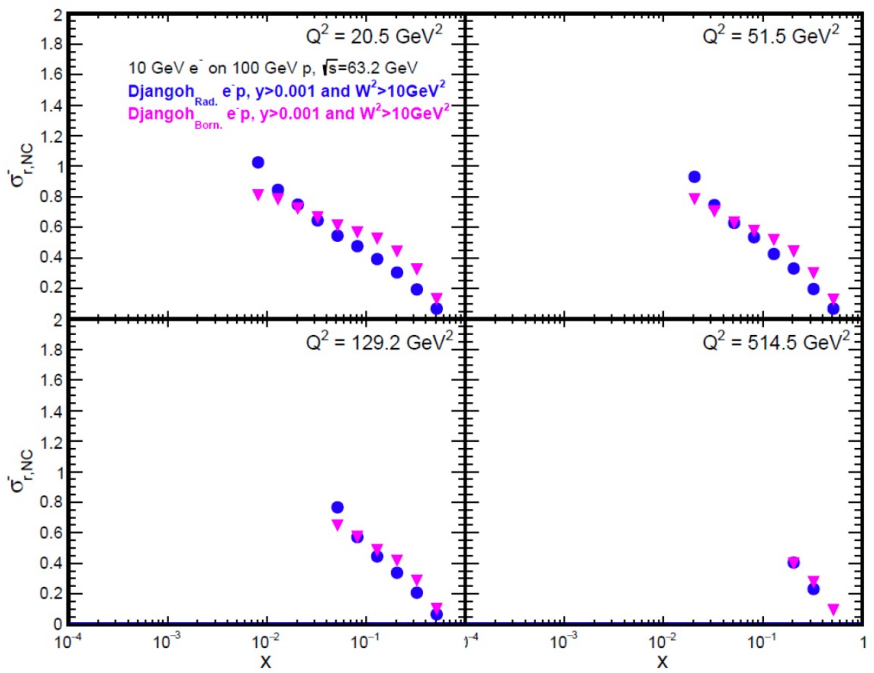
- Ideas to demonstrate advantages of ATHENA?
  - → what happens to benchmarking quantities with lower B field?

- More detailed person-power assessments and task allocations planned around next Working Group meeting (Mon 26 July)

Studies of QED Radiation Effects

Radiative correction factor – scattered electron method





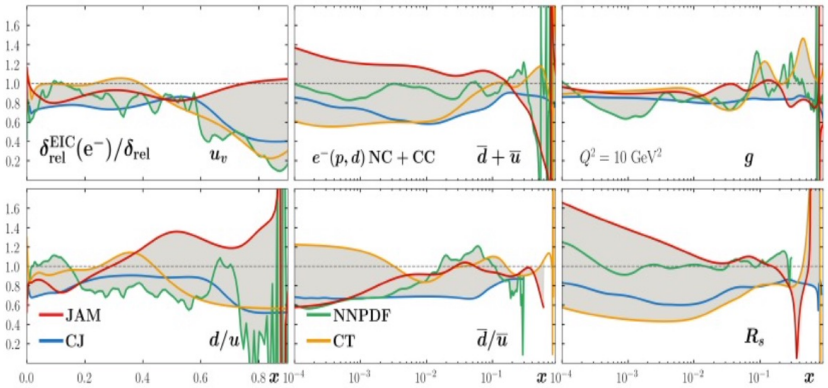
- Studies with PYTHIA6 and DJANGO, turning on/off interfaces to QED-radiation simulations

- Large corrections as y→1 when using electron method

- Work ongoing to understand generators.

Possible `Golden' Plots (all based on NC DIS)

- Derived from fits to NC cross sections
  - Inclusive proton PDFs
  - Inclusive nuclear PDFs
  - Proton spin PDFs



- Statements on sensitivity to e.g. new low-x dynamics follow from precision on these quantities

- Rekindling interactions with theory / fitting colleagues from Yellow Report