Exclusive Reactions Working Group Update

Daria, on behalf of the conveners

Conveners

Raphaël Dupré (Paris-Saclay) - Salvatore Fazio (BNL) - Tuomas Lappi (Jyväskylä) - Barbara Pasquini (Pavia) - Daria Sokhan (Glasgow)

1st EIC Yellow Report workshop - Temple University, Philadelphia
19th March 2020

Summary of activities: January - March

108 members currently signed up to the Google group: eicug-yr-physics-exclusive@eicug.org

Weekly meetings
(Fridays, nominally @ 9am or 10.30am but a new fixed time may be arranged after this workshop)
Usually attended by 20-30 people

Past three meetings with progress updates: https://indico.bnl.gov/category/291/

Topics reported on:

✳ Vector-meson production in e+A: impact of beam divergence and momentum spread (Thomas Ullrich)
✳ Double-tagging of deuteron in exclusive e+D reactions (Kong Tu, Alexander Jentsch)
✳ Backward angle pi0-production (Bernard Pire, Wenliang Li)
✳ Exclusive pi0 cross-section using PARTONS (Kemal Tezgin, Paweł Sznajder)
✳ DVCS and pi0-production (François-Xavier Girod)
✳ Reconstruction of Vector Mesons: electrons vs muons (Yulia Furletova)

Ideas / topics jotted down in a shared (among the whole WG) Overleaf document:
 https://www.overleaf.com/project/5e2df298b24ba1000124092b

Topics under consideration: DVCS

	Requires detection of:
Protons Cross-section and polarisation asymmetries	e, p, γ
π^0 **as DVCS background** In e+p	$e, p, (\gamma\gamma)$
Neutrons In e+d: require tagging of the spectator proton in addition to the recoil neutron	e, n, γ, p_s
Coherent on light ions In e+d and e+ He: tagging of the light nuclei	e, d, γ e, He, γ
Within heavy nuclei On the proton within heavy nuclei, with leading twist nuclear shadowing	e, p, γ

Topics under consideration: TCS / meson production

Many different physics motivations, different production mechanisms and generators.

Required additional detection of: (e^+e^-), $(\mu^+\mu^-)$, $(\pi^+\pi^-)$, etc..

TCS in e+p

J/Ψ on heavy ions

Test of t-resolution,
use of nuclear shadowing models,
suppression of incoherent part

Υ in e+p

Can one distinguish the Upsilon states from each other?

ϕ

2π states
For a number of mesons (rho, f_0, f_2, …)

Kaons

η

D-mesons
Via charged current production: is there a cross-section large enough?

Backward meson production
Is it kinematics sufficiently different from other meson-production?

General question:

How hermetic does the detector need to be to see a rapidity gap?

Not an exhaustive list!
Not prioritised, not everything needs to be a "benchmark" channel.

To be determined during this workshop!

Highlights from ER meetings: work in progress

DVCS and π^0 simulations

François-Xavier Girod

* Simulations for two kinematics (high low CoM energies): 10 x 100 GeV and 5 x 40 GeV

* For suppression of π^0 background, photon angular resolution is absolutely crucial.

See dedicated talks on new simulations by F.-X. Girod and on past work by S. Fazio this afternoon!

Backward angle π^0 production

Bernard Pire and Bill Lee

* Baryon-to-meson transition distribution amplitude (TDA): new window into 3D structure.
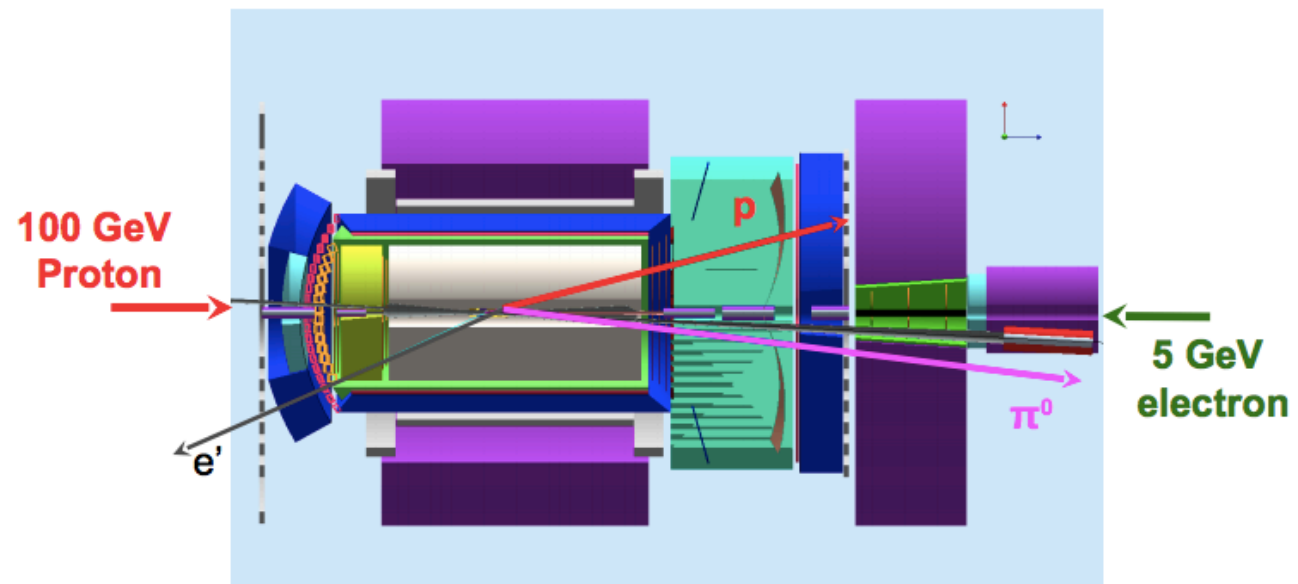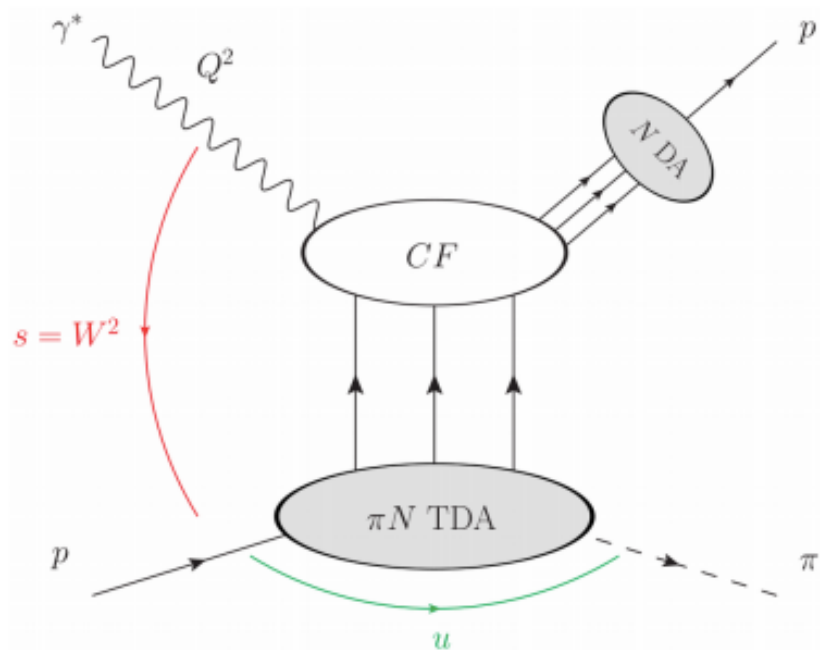
* Generator developed, simulations under way to determine whether any new constraints on detectors.

Highlights from ER meetings: work in progress

Hard exclusive π^0 production in PARTONS

Kemal Tezgin (UConn) and the PARTONS team

✳ In some kinematics, transverse photon polarisation contributes substantially: access to chiral-odd transversity GPDs.

✳ Can be computed as a twist-3 effect in the pion distribution amplitude (Goloskokov-Kroll model).

✳ Kinematics: low ξ and -t, high Q^2 and W.

✳ Good agreement with deep exclusive π^0-production from COMPASS.
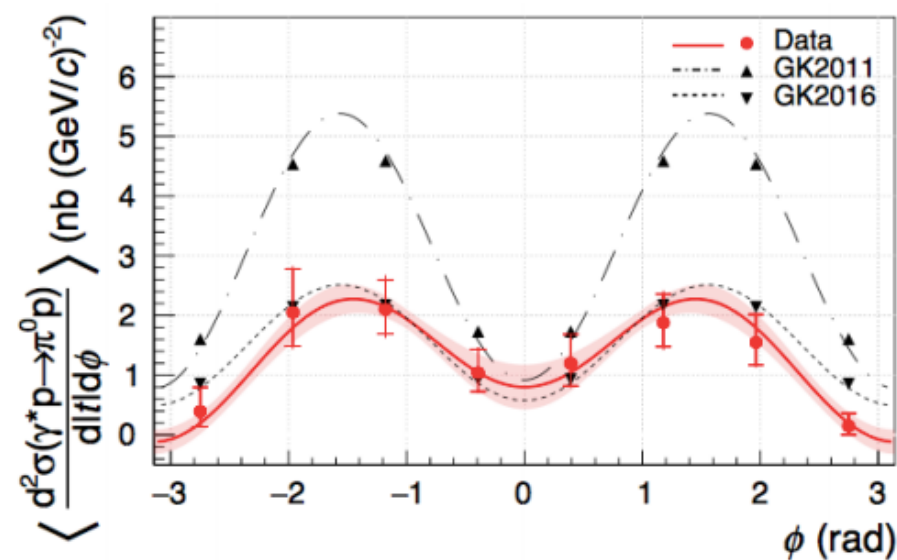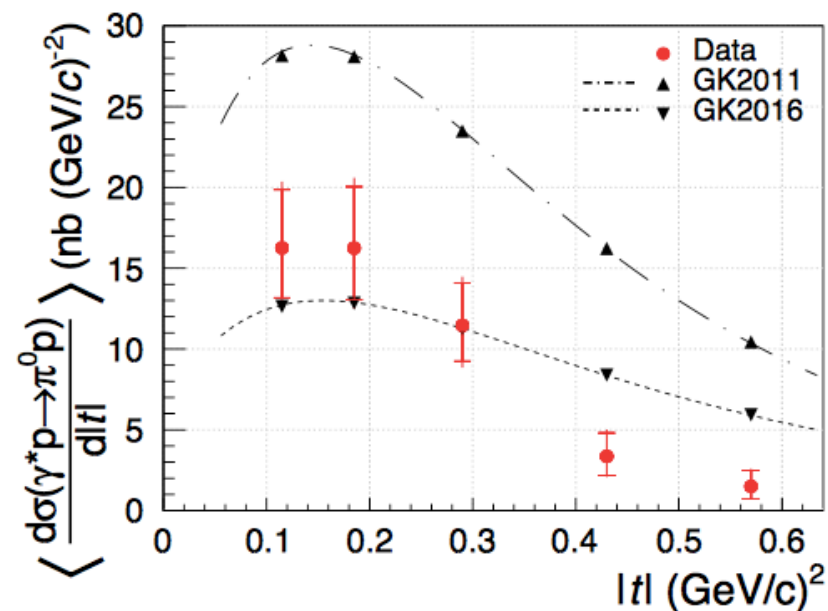
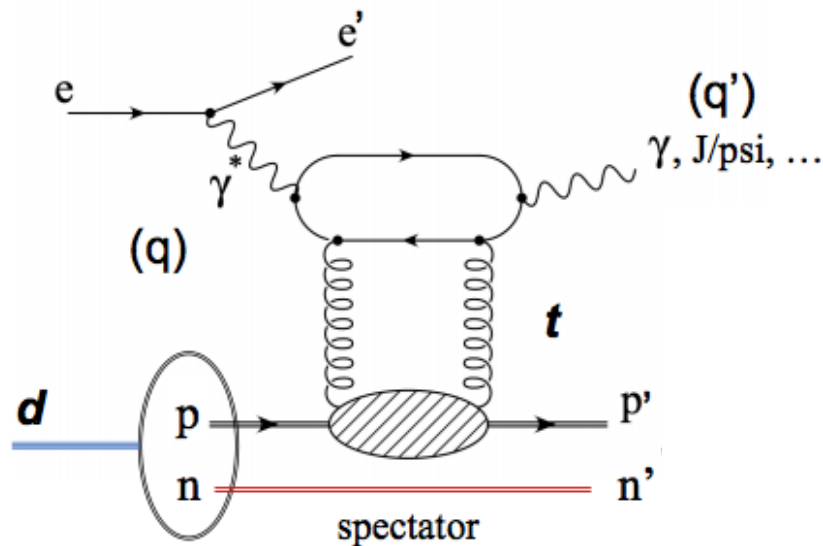$$< Q^2 > = 2\,GeV^2,\ < x_{Bj} > = 0.093.$$ COMPASS Collaboration arXiv:1903.12030

✳ Implementation of GK model into PARTONS framework: link between GPDs and experimental observables. To be used for simulations.

Highlights from ER meetings: work in progress

J/Ψ production on the deuteron with double-tagging
Kong Tu and Alexander Jentsch (BNL)

✳ BeAGLE generator: J/Ψ production in e+d with deuteron break-up. Can be modified for DVCS.

✳ Some observables are very sensitive to energy/momentum resolution, others to acceptance (K. Tu).

✳ Full simulation studied in EicROOT with GEANT4 (A. Jentsch).

✳ Comparison of proton and neutron tagging for different detector acceptances and resolutions:

• Neutron detector

Neutron Det.	Default	V1	V2
Acceptance	5 mrad	6 mrad	7 mrad
Energy reso.	$\frac{50\%}{\sqrt{E}} + 5\%$	$\frac{30\%}{\sqrt{E}} + 5\%$	$\frac{100\%}{\sqrt{E}} + 5\%$

• Proton detector
  • Acceptance: (0,5) + (7-22) mrad (default)

Proton Det.	Default	V1	V2
Momentum reso.	$\frac{dp_T}{p_T} = 3\%$	$\frac{dp_T}{p_T} = 5\%$	$\frac{dp_T}{p_T} = 10\%$

• Energy configurations:
  • 18 x 135 GeV (default)
  • 10 x 50 GeV
  • 5 x 20 GeV

Highlights from ER meetings: work in progress

## Impact of beam divergence and beam momentum spread

Thomas Ullrich (BNL)

✳ Resolution in t crucial for many processes.

✳ Comparison of two methods of reconstructing t in e+A:

$$t = (p_A - p_{A'})^2 = (p_V + p_{e'} - p_e)^2 \quad \text{("exact" method)}$$

$$t = [\vec{p}_T(e') + \vec{p}_T(V)]^2 \quad \text{("approximate" method, as used in HERA)}$$

✳ Beam momentum smear makes the "exact" method unusable in e+A. Approximate method is viable, but t-resolution is affected by beam divergence.


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See Thomas' talk @ 8.50am on Friday on this and more and joint-session discussion on Fri PM!
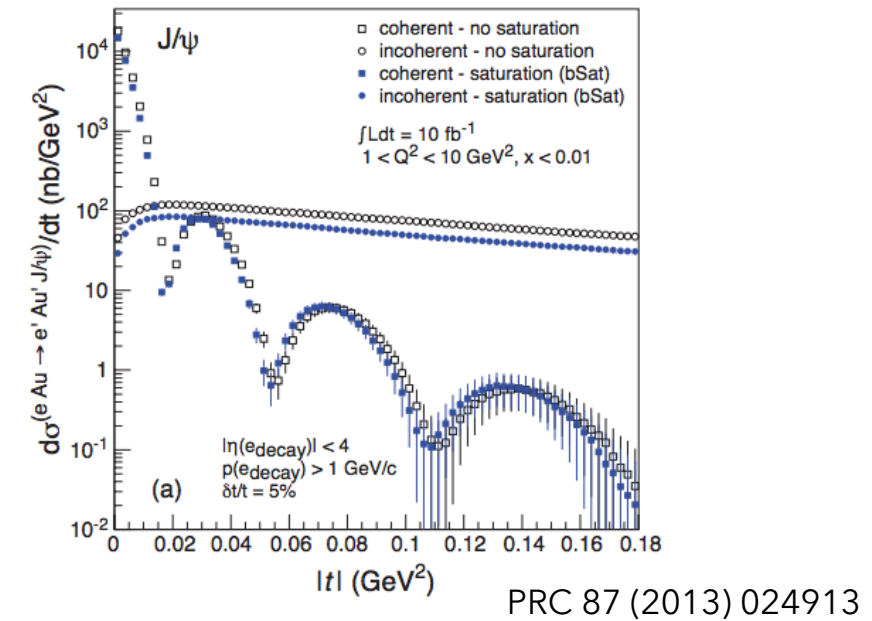
Reconstruction of VM: electrons vs muons

Yulia Furletova (JLab)

✳ Study of resolutions and background suppression in VM decays at HERA.

✳ Reconstruction through invariant mass: need for PID and momentum resolution below a few %.

✳ Electrons: need hadron suppression by 10^4 due to the huge backgrounds & additional tools for e ID.

✳ Muons: in principle a cleaner sample, ID via passage through absorbers but needs good separation from showers produced by hadrons in the absorber.

✳ For t reconstruction need far-forward proton detection.

(Sylvester Joosten)
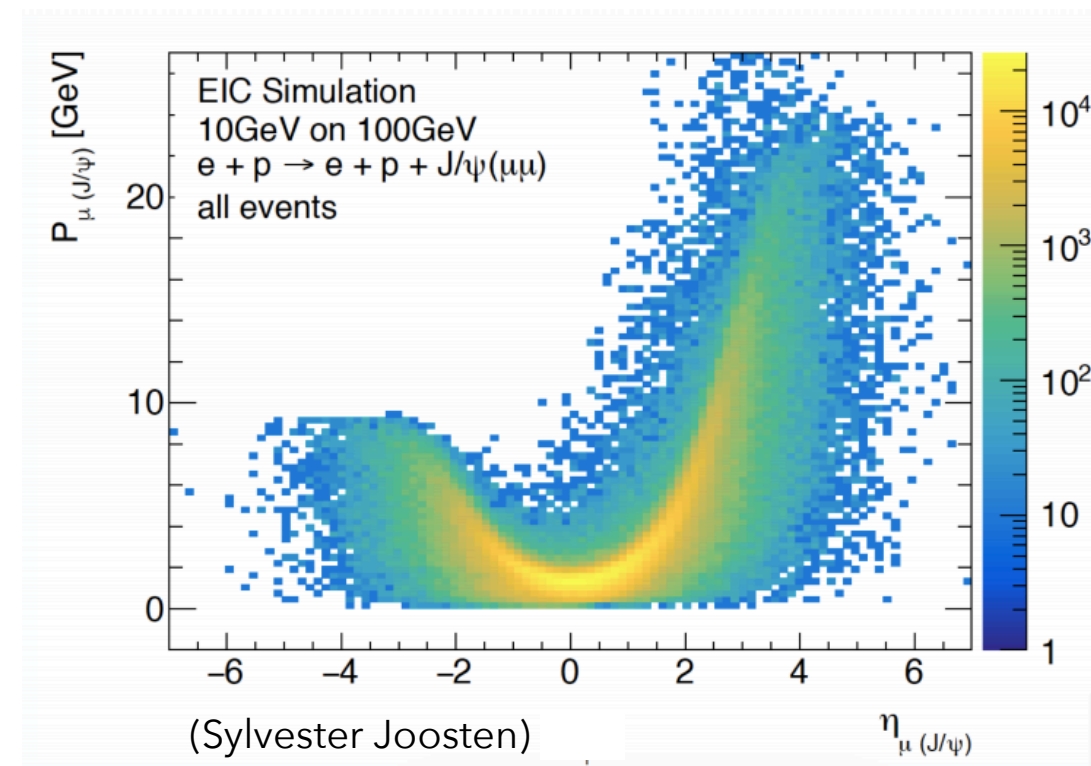
See talk on past VM at EIC studies by S. Joosten at 8.30am on Friday!

Parallel sessions agenda @ Temple

Thursday (DVCS / pi0):

16.30: Summary of available DVCS and GPDs impact studies in e+p at EIC (Salvatore Fazio)
16.50: DVCS and pi0 (François-Xaview Girod)
17.10: DVCS analysis framework (Simonetta Liuti)
17.30 - 18.00: Discussion: "What now and where to next?"

Friday early (Vector mesons / TCS):

8.30: Summary of available studies on VMP in e+p collisions at EIC (Sylvester Joosten)
8.50: Summary of studies and challenges for VMP in e+A collisions at EIC (Thomas Ullrich)
9.10: Exclusive di-jet production as an access to the gluon Wigner function (Heikki Mantysaari)
9.30: TCS with PARTONS (Jakub Wagner)
9.50 - 10.30: Discussion: "What now and where to next?"

Friday after coffee (Constraints from theory and extended discussion):

11.00: Accessing the transverse force in a nucleon (Matthias Burkardt)
11.20: N -> N* transition GPDs (Asli Tandogan)
11.40: Extended discussion (chaired by Christian Weiss):
        What is the needed kinematic reach (x_B and Q^2)?
        What is the lowest CoM energy needed?

Friday afternoon: joint session with Diffractive/Tagging and Forward Detectors / IR groups

Updates and discussions towards a summary document of what has been studied (and resulting constraints) aimed for the Pavia meeting.