Update on GPDs efforts

S. Fazio

- Long time I do not update this group. This is meant to be a summary of work done in the last 6 months, mainly in the context of the EIC Y.R. initiative
  - If you followed the Y.R. exclusive PWG up close you may take a nap ;)
- External Collaborators: H. Moutarde (Saclay), P. Sznajder, and J. Wagner [Warsaw], H. Spiesberger [Mainz], K. Kumericki [Regensburg], J. Zhang [Shandong U.]
- We meet bi-weekly: https://indico.bnl.gov/category/267/

❑ Update on generators:

- MILOU updated with state of art GPD-based models (*see next slide*)
- ToyMC for exclusive pi0 and TCS developed and used for Y.R. studies
- New simulation used to test detector requirements

❑ Long term goals:

- Encode NLO GPD models for DVCS, TCS, HEMP into a novel generator (starting now)
- Calculate radiative effects at NLO and encode them in our generator
  - Hubert Spiesberger has currently no students. He needs support for this critical activity
- Perform impact studies, including the feasibility of extracting the D-term

Facilitating new studies: An updated DVCS generator (MILOU 3D)

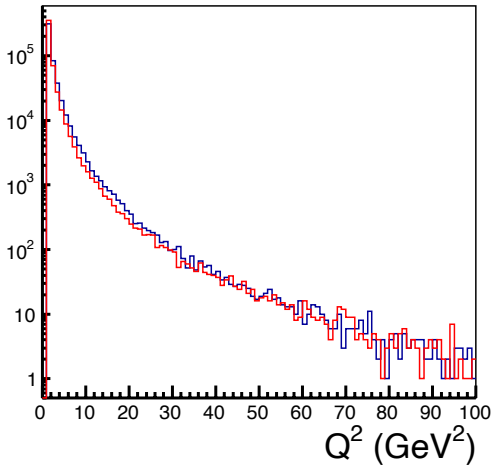
- **Model used by original MILOU code (A. Freund and M. McDermott), tuned on HERA, is by now obsolete**
- **In original MILOU CFFs were only tabled vs Q^2 and x_B.**
- **The t distribution of the original MILOU was parametrized**

The above considerations motivated a new effort to update the code in order to include novel state-of-art models

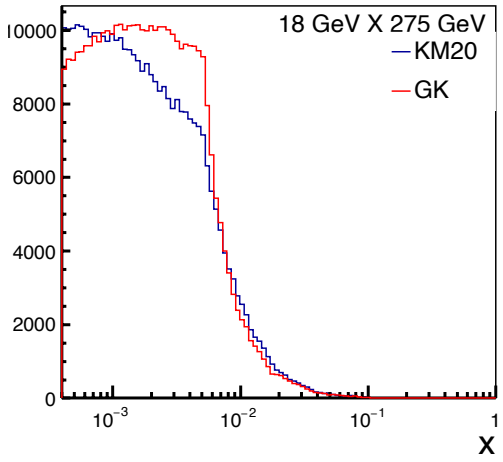
- **New beta version of MILOU with 3-dimensional (x_B, Q^2, t) CFFs tables now available**
  - Two set of 3d CFFs tables calculated using the GK model (by PARTONS) and KM20 model (provided by K. Kumericki), both are LO
  - The t distribution and slope, at different Q^2 ad x values, is now coming from the model, not parametrized!
  - Code can still run in the old mode (via option in the steering cards)
  - New CFFs tables by different models easy to add!
- **More information on the MILOU 3D code:** https://wiki.bnl.gov/eic/index.php/GPDs
- **A beta version of MILOU 3D can be obtained from:** https://drf-gitlab.cea.fr/milou/milou (account required)

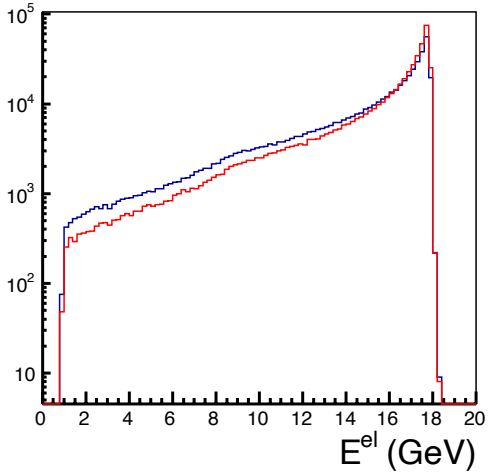
DVCS (18 x 275 GeV)

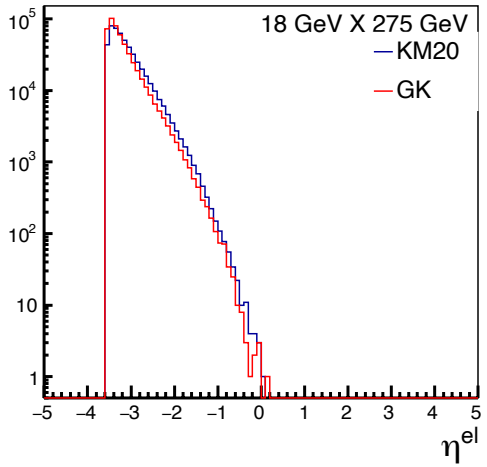
Photon virtuality



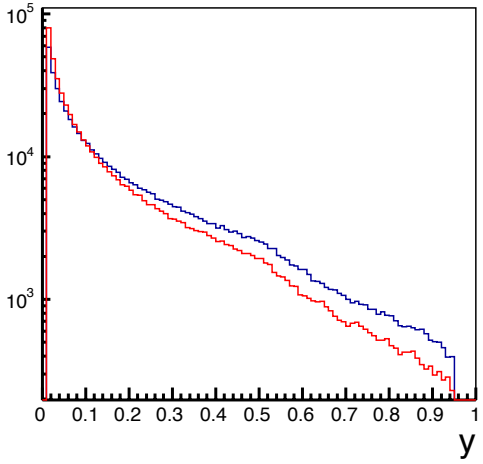
Bjorken's x

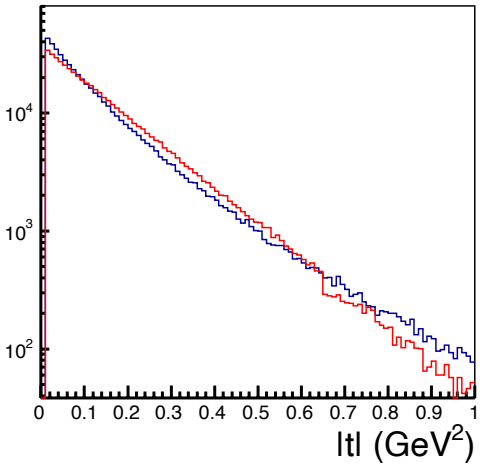


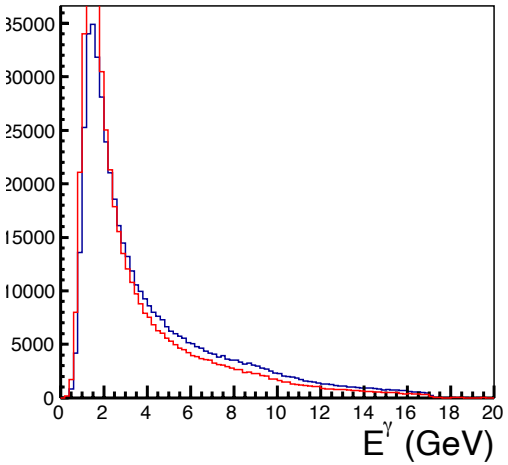


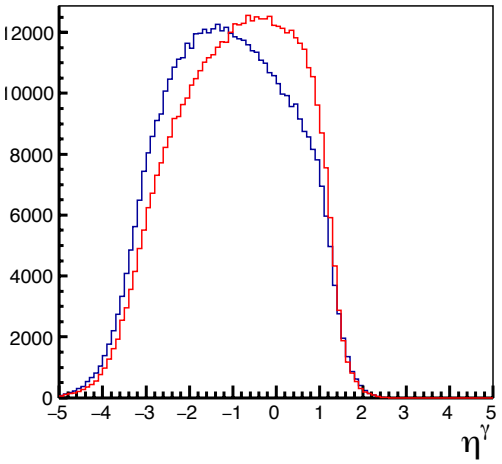


Inelasticity



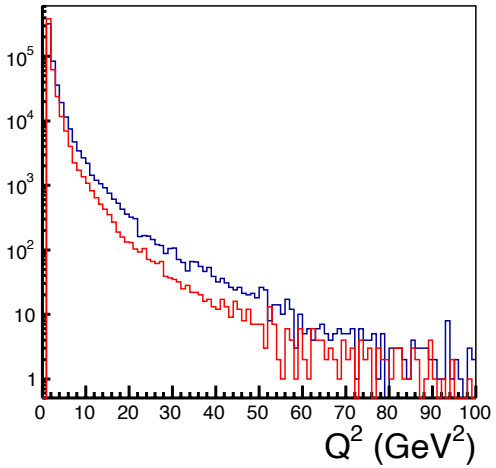




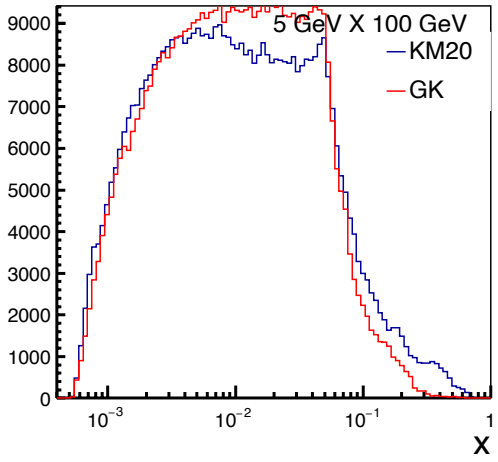


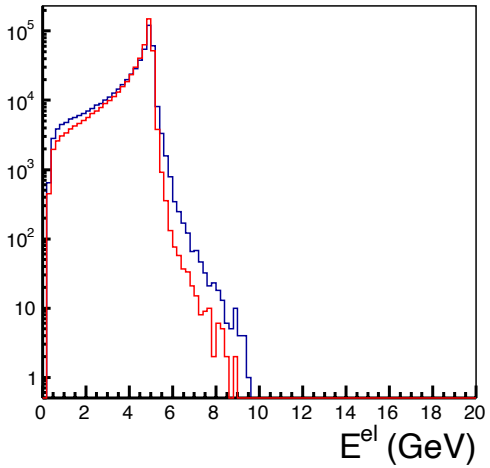
DVCS (5 x 100 GeV)

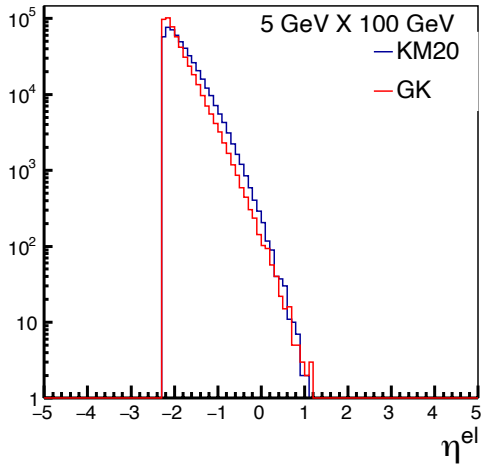
Photon virtuality



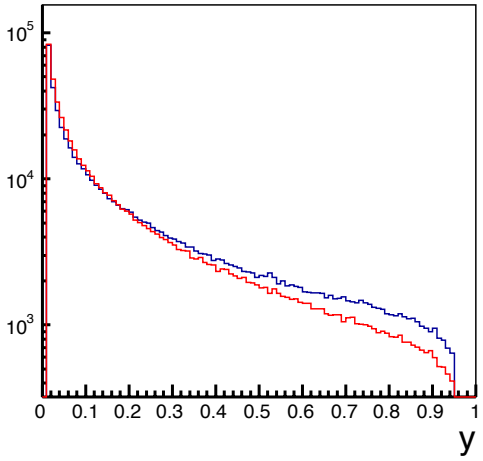
Bjorken's x

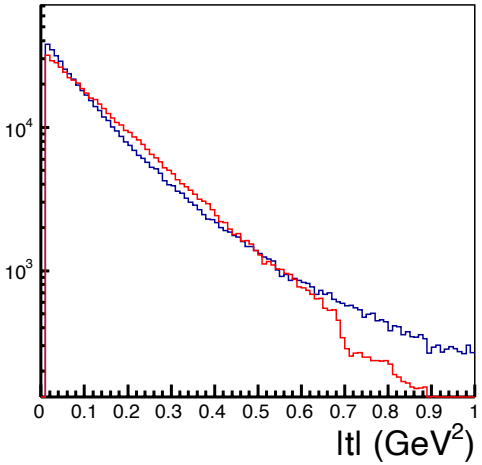


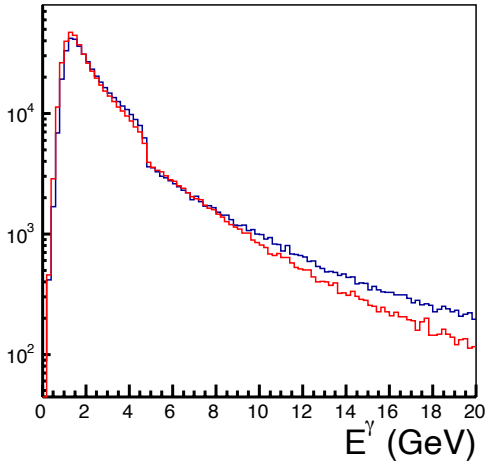


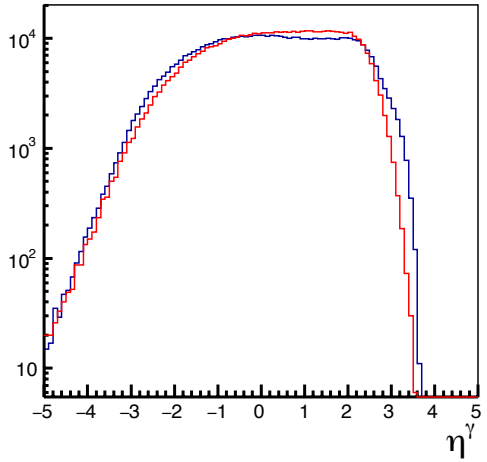


Inelasticity



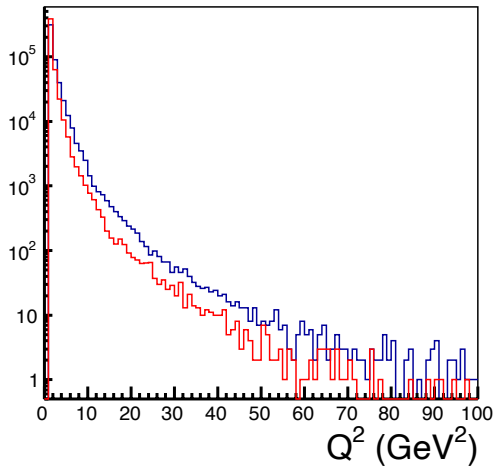




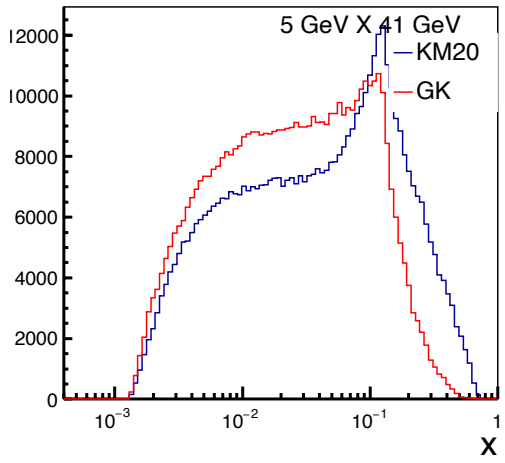


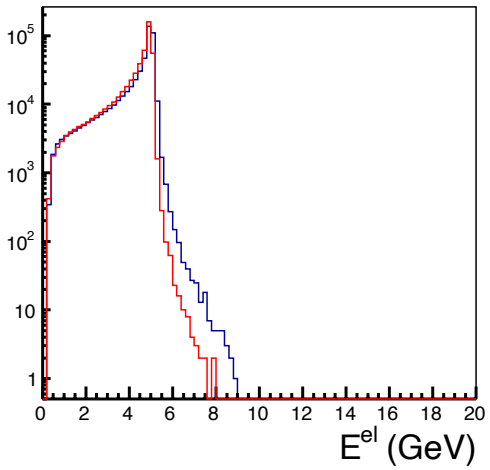
DVCS (5 x 41 GeV)

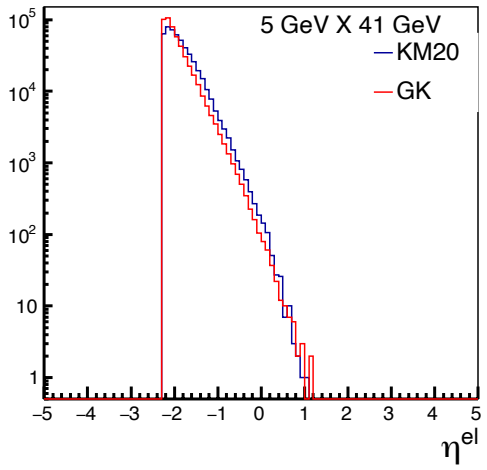
Photon virtuality



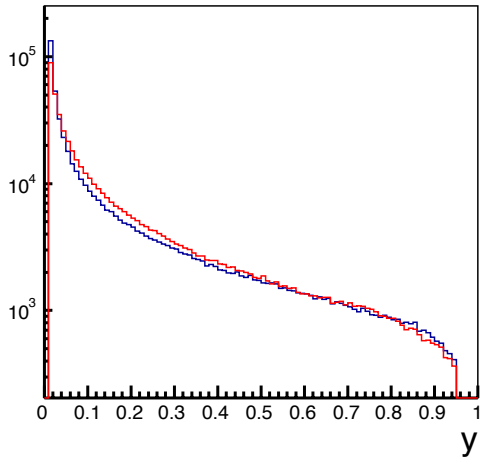
Bjorken's x

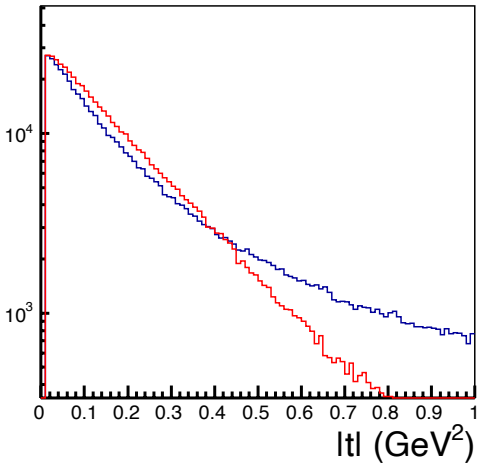


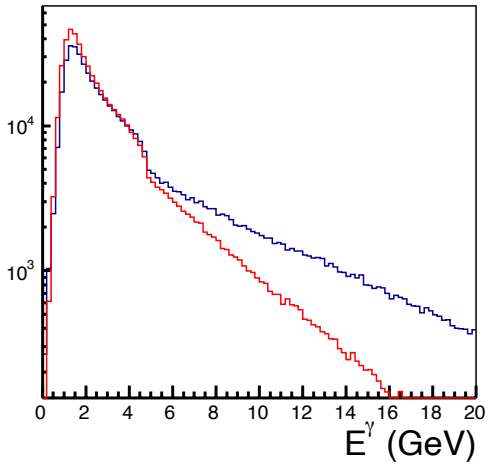


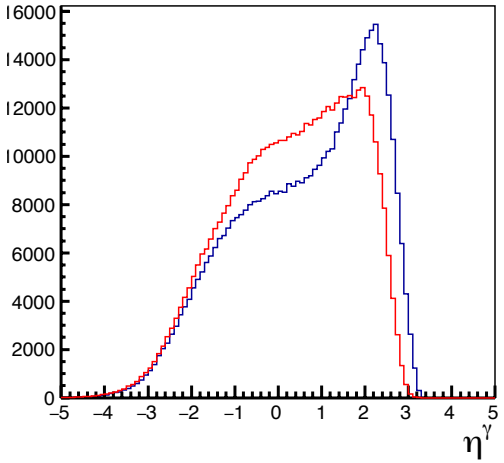


Inelasticity

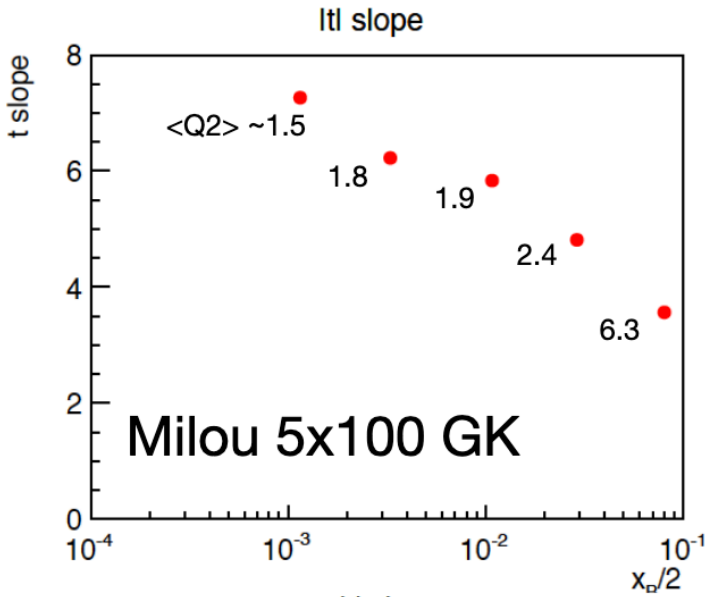


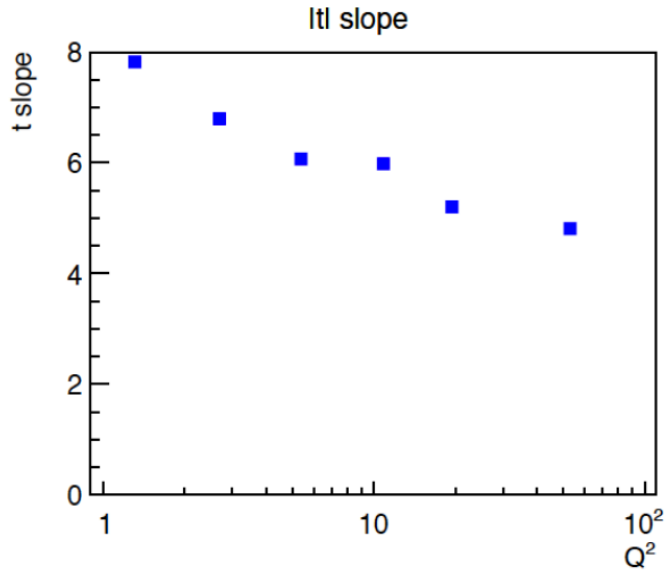


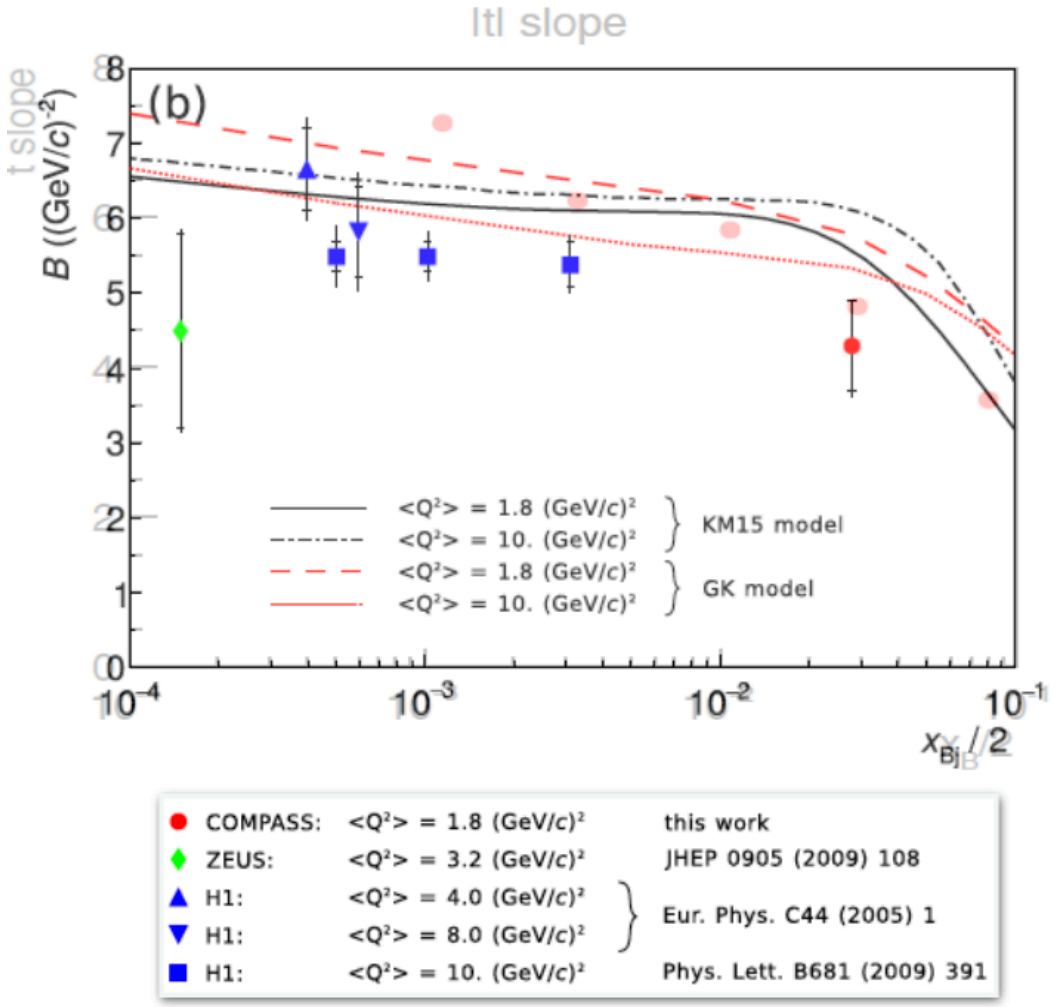




Comparison to Compass and HERA







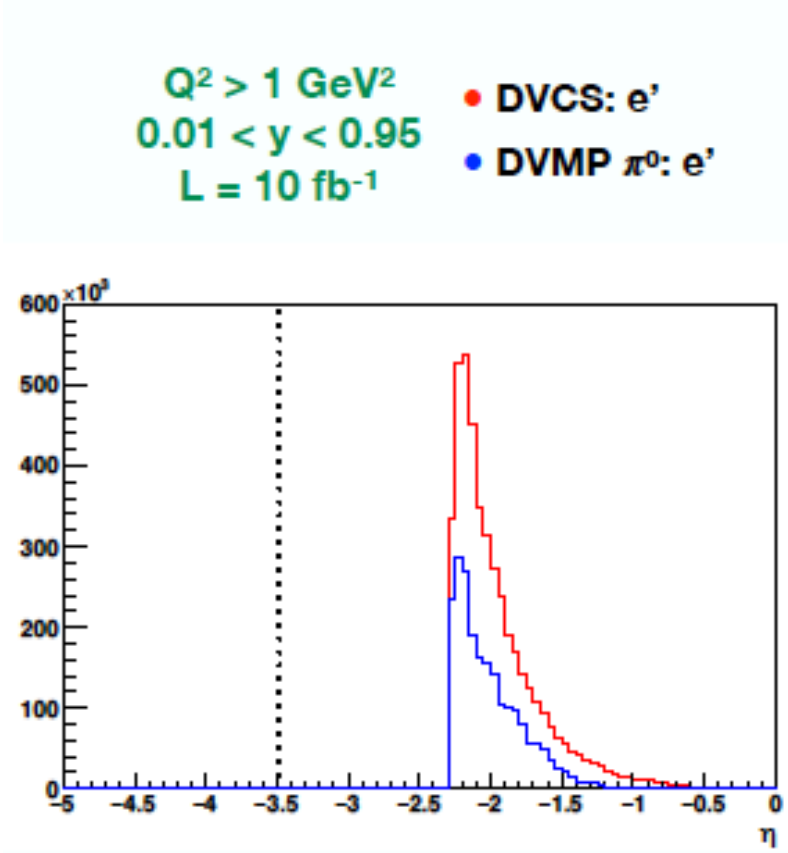
Take away message:

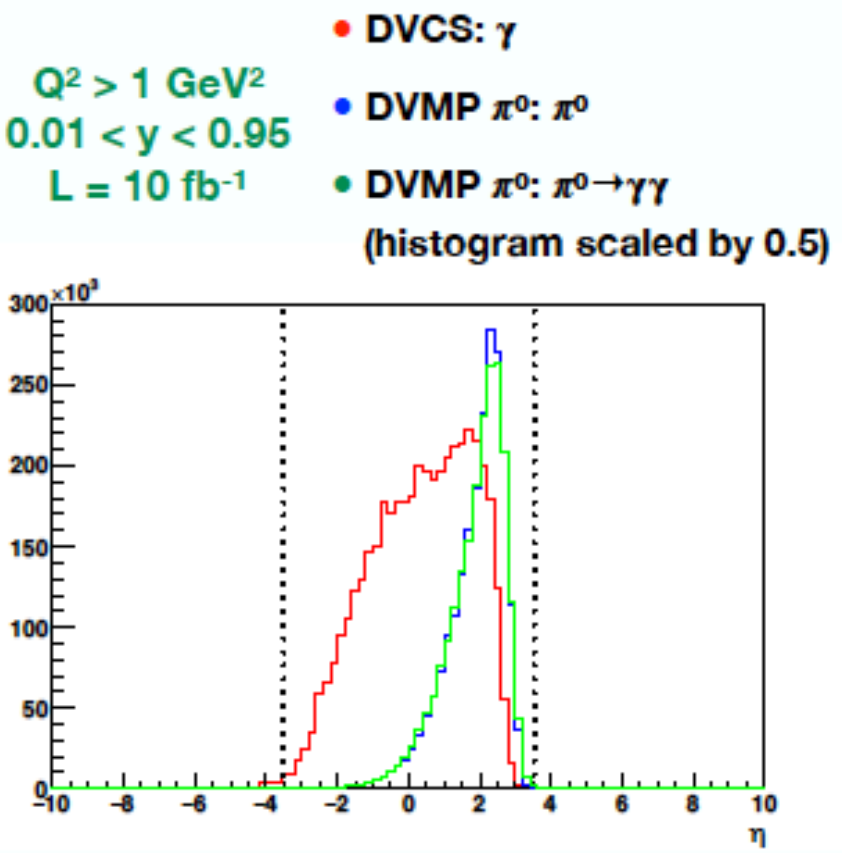
MILOU 3D is an excellent tool, readily available to facilitate current and near future studies

DVCS & pi0

- Why we worry about a background from "$\pi^0 \to \gamma\gamma$" ?
  1) The two decay photons could merge into one
  2) One of the photons could go out of the acceptance
- Measuring exclusive $\pi^0 \to \gamma\gamma$ is interesting on its own

Pseudo-rapidity distributions: 5 GeV x 41 GeV



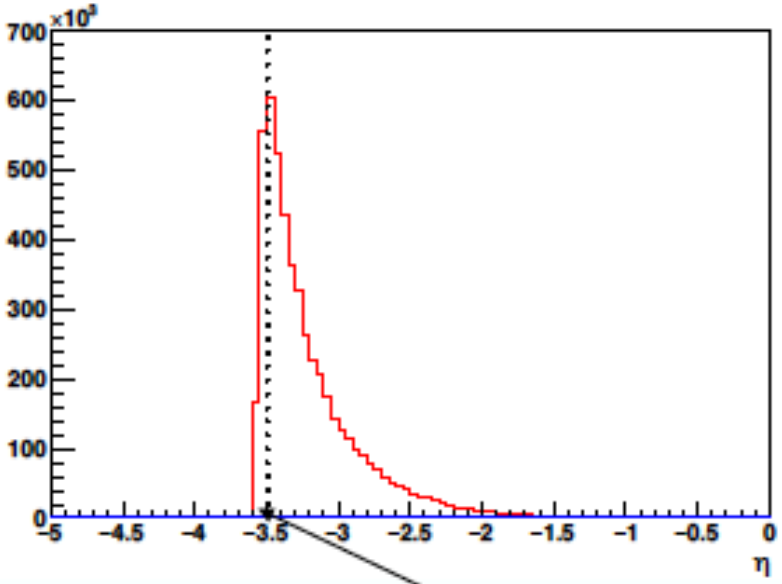


DVCS & pi0

Pseudo-rapidity distributions: 8 GeV x 275 GeV

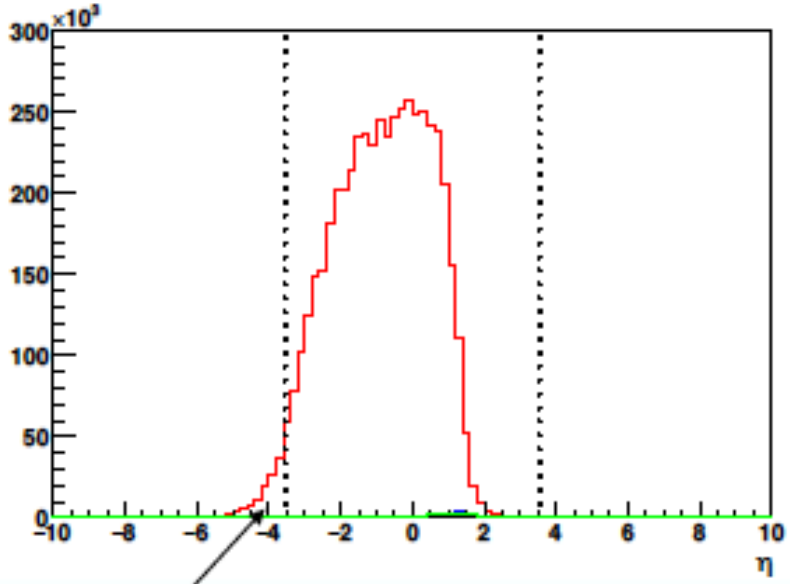
$Q^2 > 1$ GeV^2
$0.01 < y < 0.95$
$L = 10$ fb^{-1}

- DVCS: e'
- DVMP π^0: e'



$Q^2 > 1$ GeV^2
$0.01 < y < 0.95$
$L = 10$ fb^{-1}

- DVCS: γ
- DVMP π^0: π^0
- DVMP π^0: $\pi^0 \rightarrow \gamma\gamma$ (histogram scaled by 0.5)



this will be lost
with |eta| < 3.5 acceptance

DVMP π^0 is totally suppressed at these beam energies

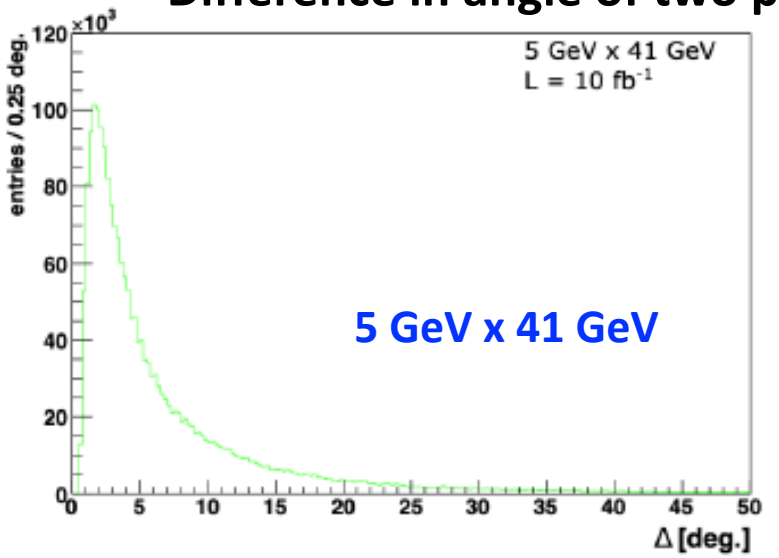
DVMP π^0 measurement only possible at low energies

DVCS & pi0

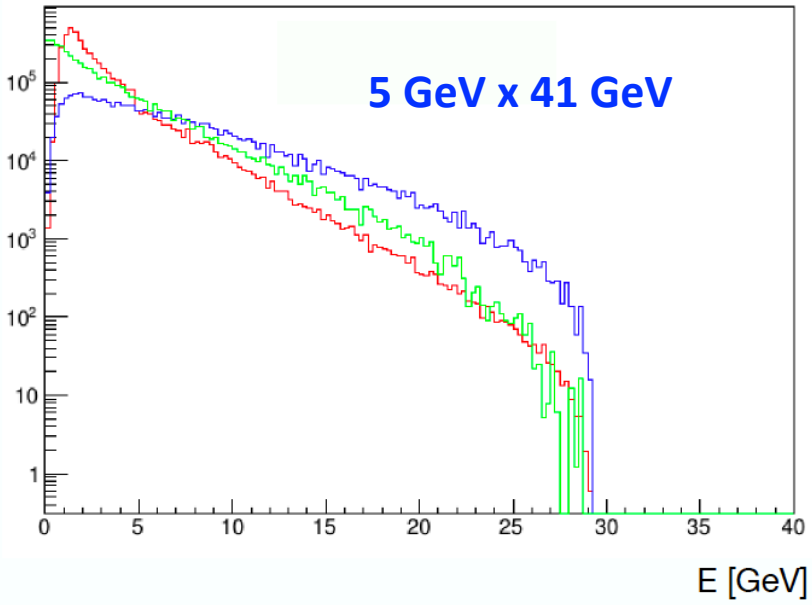
$Q^2 > 1$ GeV^2
$0.01 < y < 0.95$
$|eta| < 3.5$
$L = 10$ fb^{-1}

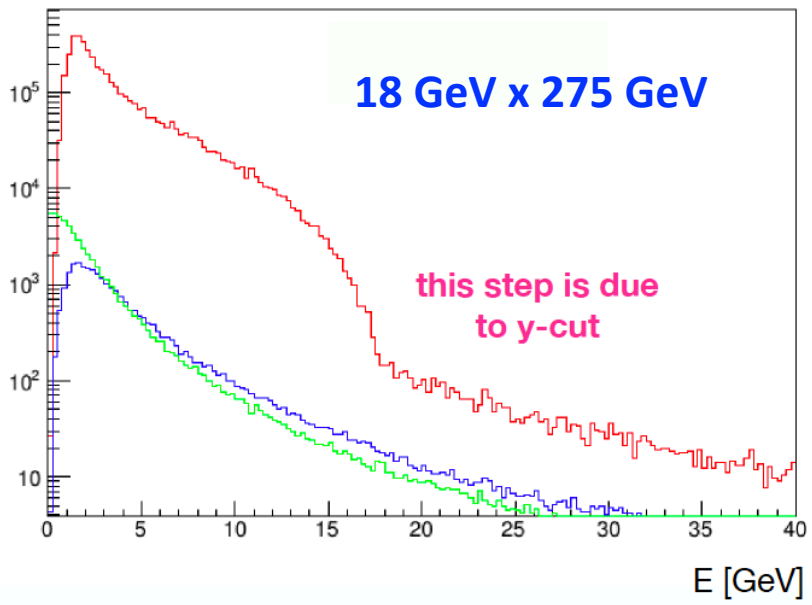
- DVCS: γ
- DVMP π^0: π^0
- DVMP π^0: $\pi^0 \rightarrow \gamma\gamma$

Difference in angle of two photons



Energy distributions

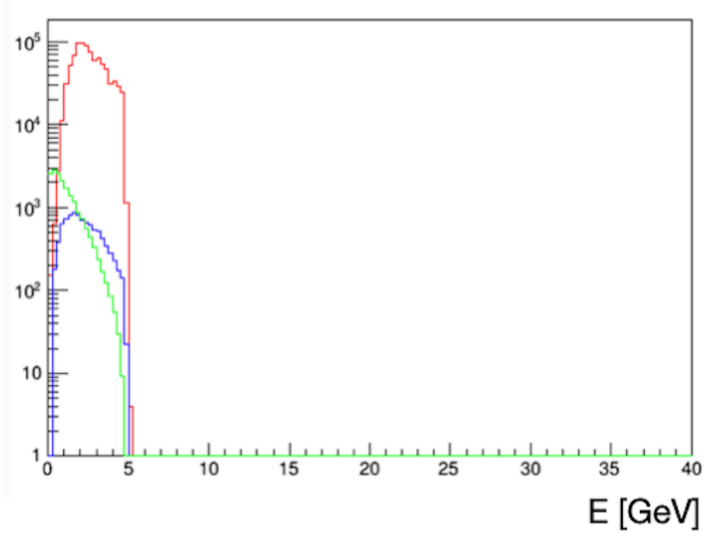


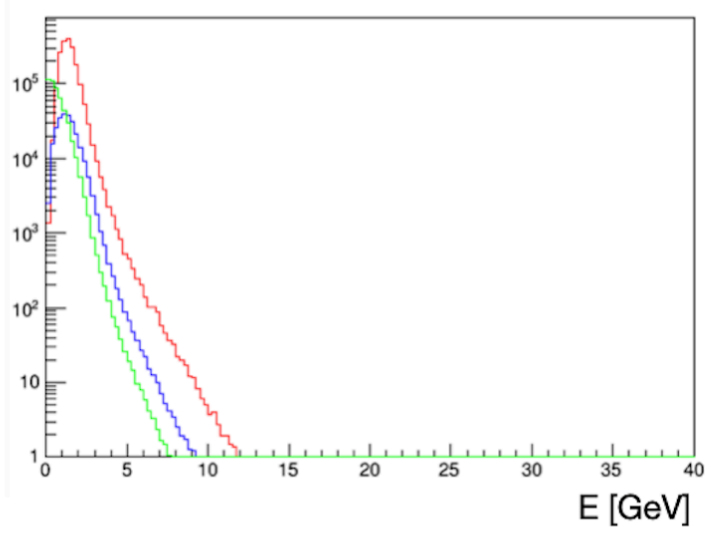


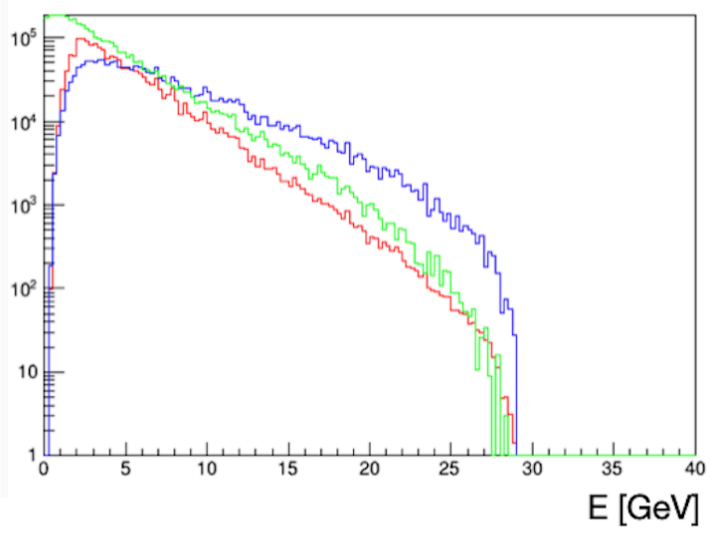
Energy distributions at various ranges of eta

$-3.5 < \eta_\gamma < -1$ | $-1 < \eta_\gamma < 1$ | $1 < \eta_\gamma < 3.5$

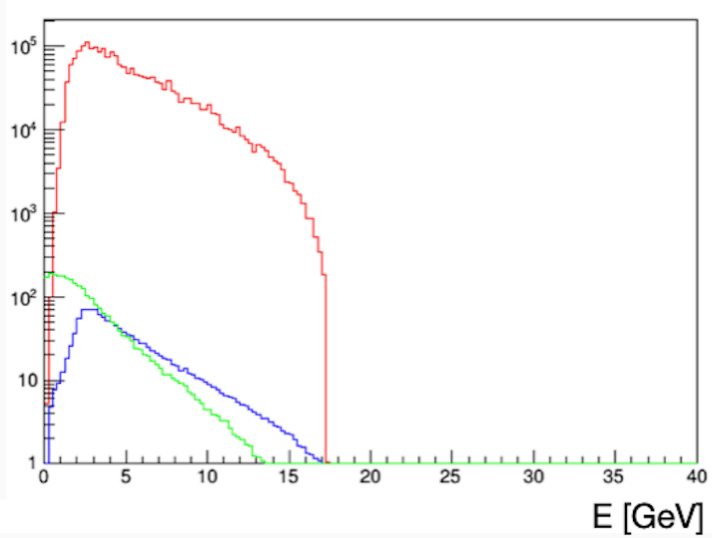
5 GeV x 41 GeV

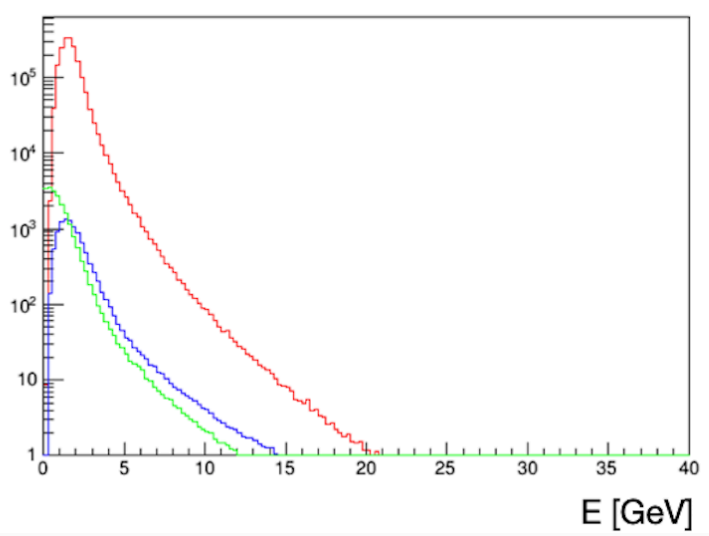


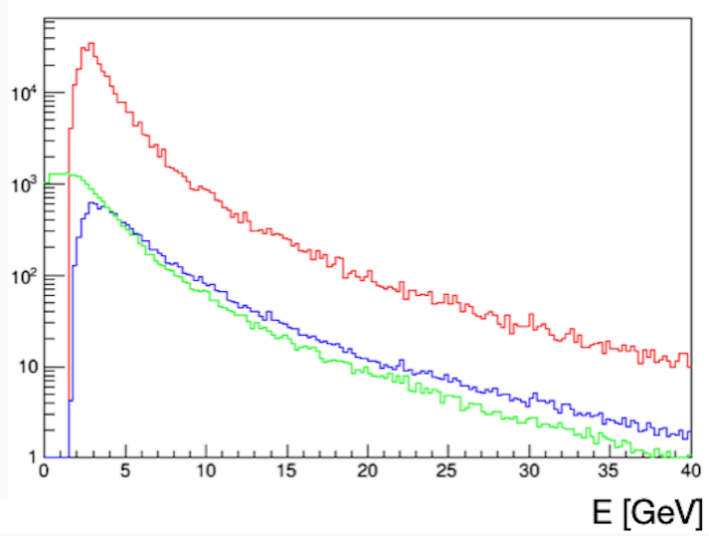




18 GeV x 275 GeV





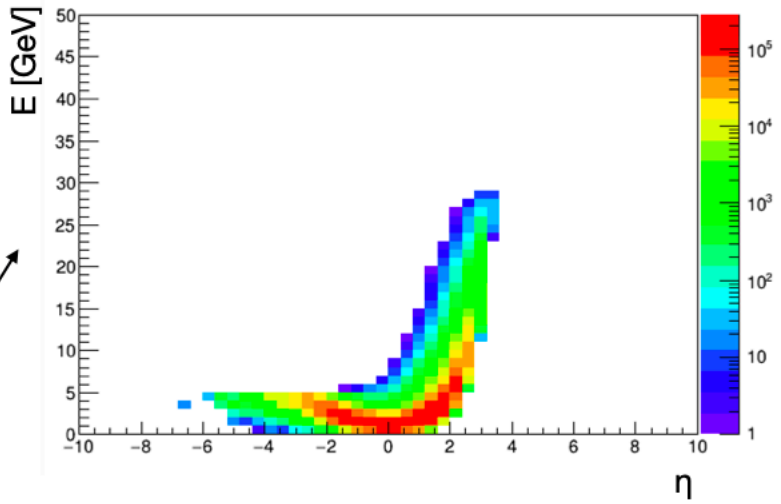


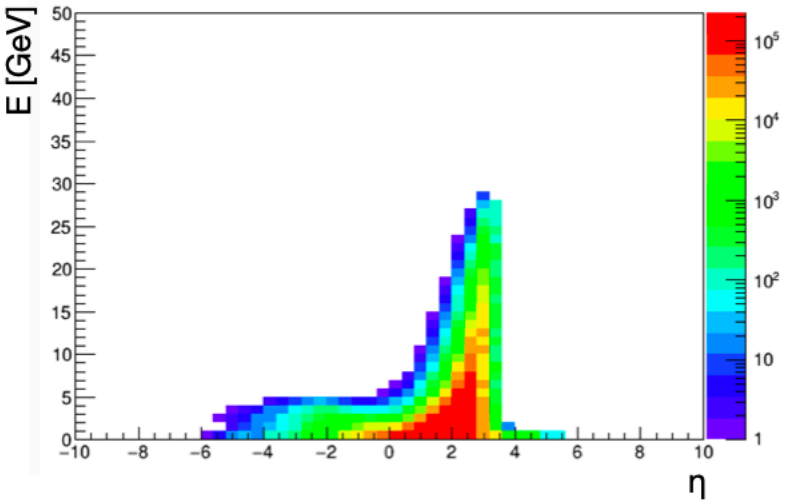
Pseudo-rapidity vs. Energy

DVCS

DVMP π^0: $\pi^0 \rightarrow \gamma\gamma$

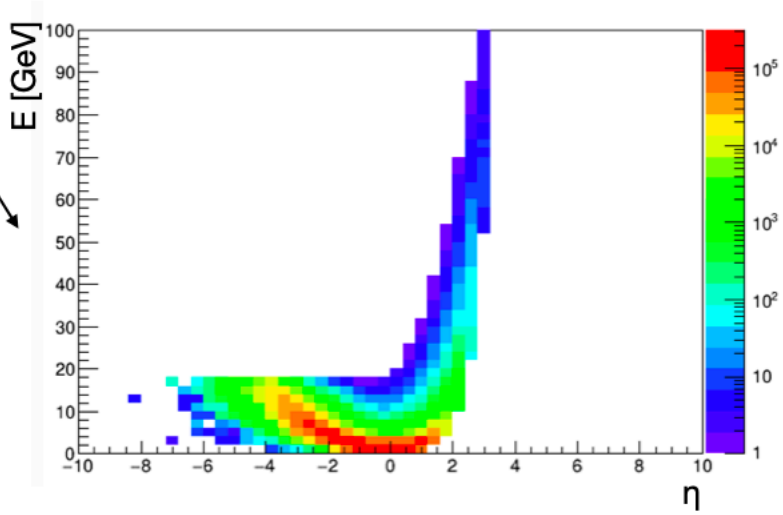
5 GeV x 41 GeV

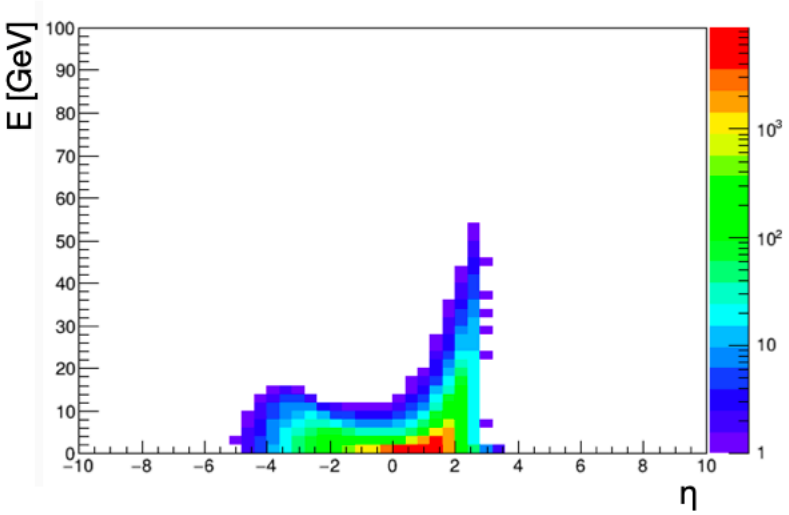




mind different scales

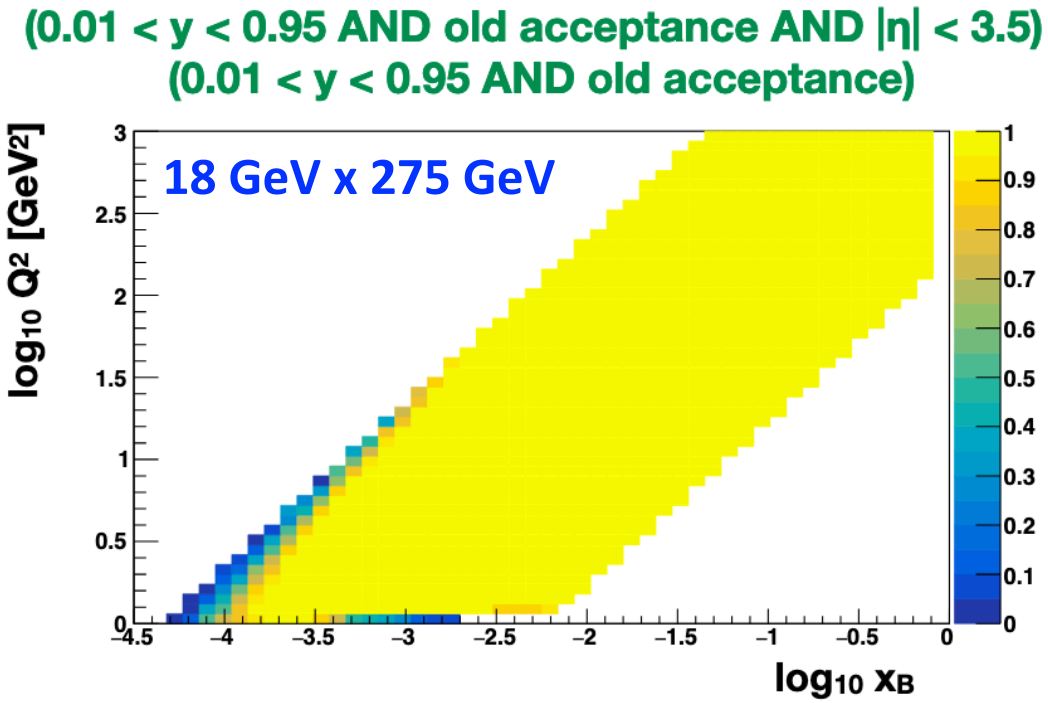
18 GeV x 275 GeV





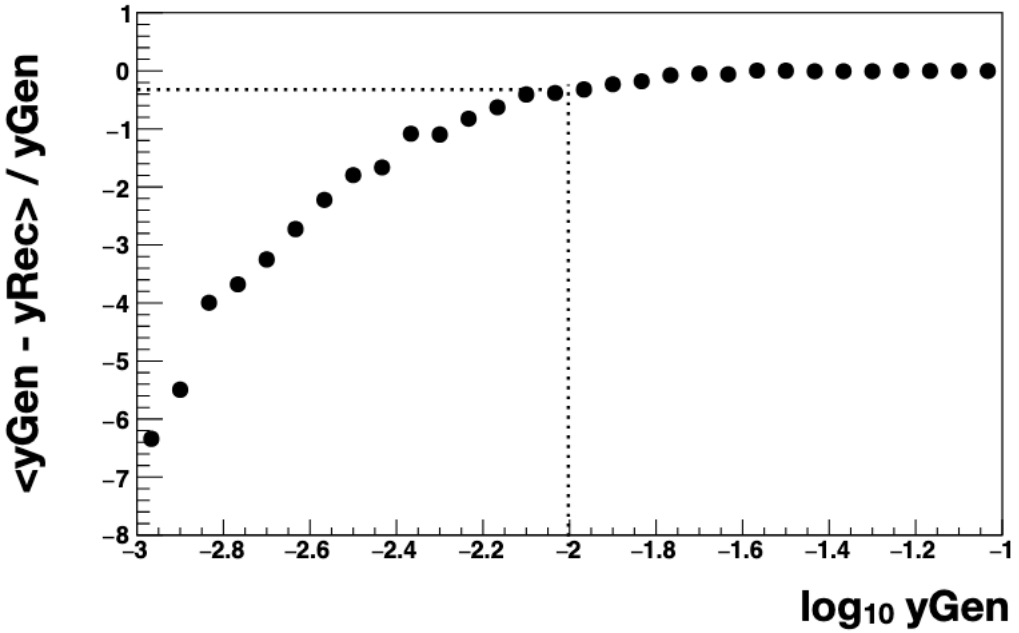
DVCS - |eta| effect

Effect only sizable at top beam energies

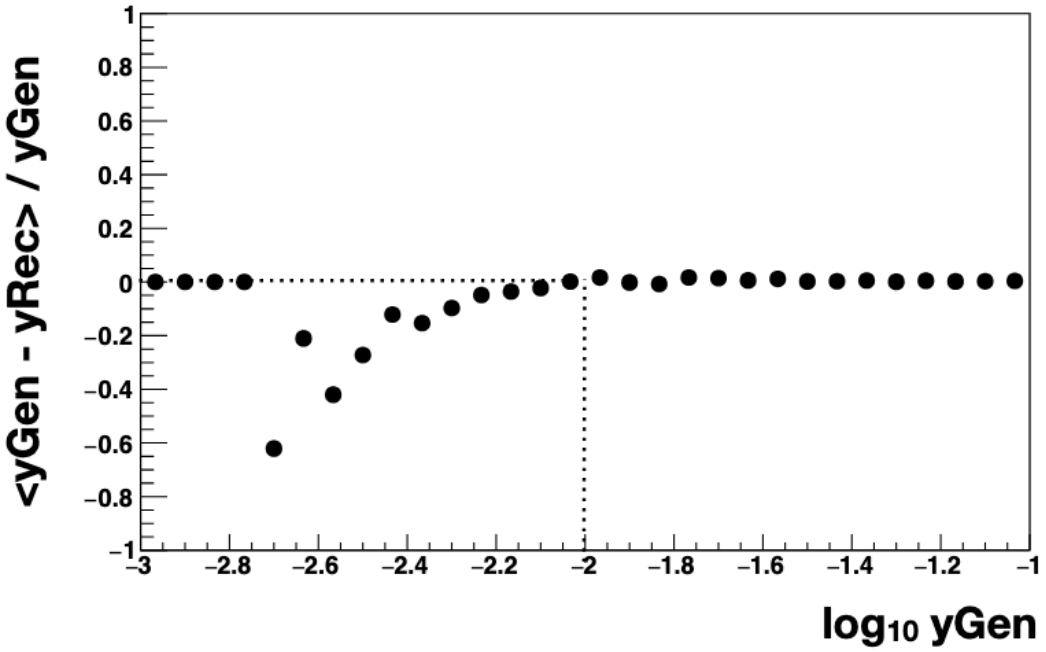


DVCS
validation of y < 0.01 acceptance cut

18 GeV x 275 GeV



5 GeV x 41 GeV



Default y < 0.01 cut is reasonable

Summarizing…

- We have updated MILOU with state of art GPD-based models of DVCS (GK and KM20)
  - The generator is available, some groups have requested access (e.g. Nicole d'Hose, CNF at JLAB …)
  - We have plans for a novel generator (currently mainly based on P. Sznajder's work)
    - Includes exclusive pi0 and TCS, HEMP
    - Includes radiative corrections (H. Spiesperger)
    - Based on ToyMC (P. Sznajder) already used for the Y.R.
- New MILOU 3D and Pawel's ToyMC allowed us to give key contributions to the Y.R. studies (DVCS, pi0, TCS)
- New postdoc dedicated to help with these efforts and carry on first impact studies on
  - D-term extraction
  - HEMP and flavor separation
  - Feasibility of DVCS measurements to give Q^2 lever arm at large x