

SIDIS-EIC Updates

EPIC(ECCE) vs. ATHENA vs. Delphes

- ◆ Analyzing the latest production (22.1)
- ◆ Comparisons to ATHENA and Delphes
- ◆ Software Updates

Christopher Dilks
SIDIS WG Meeting
4 October 2022



Available Simulation Files

ECCE Full Simulation (EPIC, but with ECCE Software Stack):

- Latest production, September 2022: "22.1" at [S3/eicctest/EPIC/Campaigns/22.1/SIDIS/pythia6](https://s3.amazonaws.com/eic-test/EPIC/Campaigns/22.1/SIDIS/pythia6)
 - (Semi-)Inclusive files From Pythia 6: [S3/eicctest/ECCE/ProductionInputFiles/SIDIS/pythia6](https://s3.amazonaws.com/eic-test/ECCE/ProductionInputFiles/SIDIS/pythia6)
 - $Q^2 > 1 \text{ GeV}^2$ (general Q^2)
 - $1 < Q^2 < 100 \text{ GeV}^2$ (low Q^2)
 - $Q^2 > 100 \text{ GeV}^2$ (high Q^2)
- Older productions: see https://wiki.bnl.gov/eicug/index.php/ECCE_Simulations_Working_Group#Productions

Fast Simulations:

- Delphes, with ATHENA card (https://github.com/eic/delphes_EIC)
- For example, use Pythia 8 HEPMC files from [S3/eicctest/ATHENA/EVGEN/DIS/NC/](https://s3.amazonaws.com/eic-test/ATHENA/EVGEN/DIS/NC/)

ATHENA Full Simulation:

- Latest production, December 2021: "DeathValley" at [S3/eicctest/ATHENA/RECO/deathvalley-v1.0/](https://s3.amazonaws.com/eic-test/ATHENA/RECO/deathvalley-v1.0/)
 - (Semi-)Inclusive files From Pythia 8 HEPMC: [S3/eicctest/ATHENA/EVGEN/DIS/NC/](https://s3.amazonaws.com/eic-test/ATHENA/EVGEN/DIS/NC/)
 - $Q^2 > 1 \text{ GeV}^2$
 - $Q^2 > 10 \text{ GeV}^2$
 - $Q^2 > 100 \text{ GeV}^2$
 - $Q^2 > 1000 \text{ GeV}^2$
- Older productions (Canyonlands, Acadia) found in other ATHENA/RECO directories

Cross Section Tables

- ◆ Stored in `datarec/xsec/xsec.dat`
- ◆ Used for Q^2 weighting
- ◆ Thanks to Ralf for providing the Pythia6 numbers!

<https://github.com/eic/sidis-eic/pull/182>

```
# Pythia 8, from ATHENA production HEPMC files: S3/eicctest/ATHENA/EVGEN/DIS/MC
#label      cross_section_[pb]  relative_uncertainty
pythia8:5x100/minQ2=1000  0.43023              0.00258
pythia8:5x100/minQ2=100   778.99               0.00223
pythia8:5x100/minQ2=10    30476                 0.00251
pythia8:5x100/minQ2=1     4.8573e+05           0.0027
pythia8:5x41/minQ2=100   287.28                0.00216
pythia8:5x41/minQ2=10    20365                 0.00242
pythia8:5x41/minQ2=1     4.0012e+05           0.00266
pythia8:10x100/minQ2=1000 6.8238                0.0023
pythia8:10x100/minQ2=100  1343                  0.0023
pythia8:10x100/minQ2=10   40026                 0.00258
pythia8:10x100/minQ2=1    5.5566e+05           0.00276
pythia8:10x275/minQ2=1000 42.031                0.00221
pythia8:10x275/minQ2=100  2489.4                0.0024
pythia8:10x275/minQ2=10   57053                 0.00266
pythia8:10x275/minQ2=1    6.6791e+05           0.00276
pythia8:18x275/minQ2=1000 79.451                0.00223
pythia8:18x275/minQ2=100  3370.2                0.00245
pythia8:18x275/minQ2=10   69275                 0.00266
pythia8:18x275/minQ2=1    7.4167e+05           0.00277

# Pythia 6, from ECCE production files:
# S3/eicctest/ECCE/ProductionInputFiles/SIDIS/pythia6
# Note: the following are values for noradcor files, radcor
#label      cross_section_[pb]  relative_uncertainty
pythia6:ep-5x41          3.189e+05            0.0011 # general Q2
pythia6:ep-5x41-q2-low  3.187e+05            0.0009 # 1 < Q2 < 100
pythia6:ep-5x41-q2-high 1.622e+02            0.0111 # 100 < Q2
pythia6:ep-10x100       5.797e+05            0.0011 # general Q2
pythia6:ep-10x100-q2-low 5.784e+05            0.0010 # 1 < Q2 < 100
pythia6:ep-10x100-q2-high 1.159e+03            0.0114 # 100 < Q2
pythia6:ep-18x275       8.830e+05            0.0011 # general Q2
pythia6:ep-18x275-q2-low 8.796e+05            0.0006 # 1 < Q2 < 100
pythia6:ep-18x275-q2-high 3.092e+03            0.0475 # 100 < Q2
```

Q² Weighting

Total Luminosity:

$$L_{\text{total}} = \frac{N_{\text{total}}}{\sigma_{\text{total}}}$$

Weight for Q² bin “i”:

$$W_i = \frac{L_{\text{total}}}{L_i}$$

For Q² bin “i”: $L_i = \frac{N_i}{\sigma_i}$

OR

Overlap corrected version: $L_i = \sum_j \frac{N_j}{\sigma_j}$

- sum *only* over bins “j” that *contain* bin “i”
- makes a small difference

Re-binning:

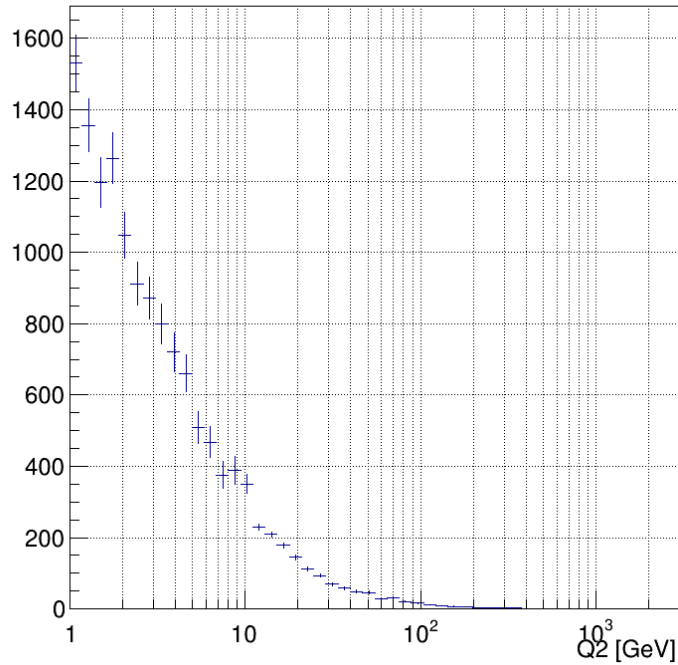
- ◆ Q² bin is automatically known from the ROOT file
- ◆ Seems better to use the true Q^{2*} to select the strictest Q² bin

* also depends on recon. method

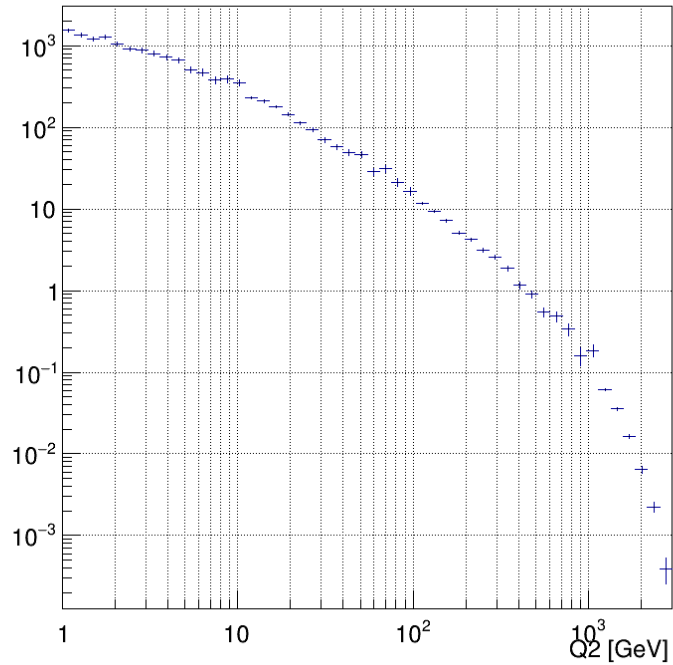
Q² Weighted Distributions

Pythia 8 → Delphes

Q² distribution, π^+ tracks, $p_T^{\text{lab}} > 0.10$, $W > 3.00$, $x_F > 0.00$, $0.01 < y < 0.95$, $0.20 < z < 0.90$



Q² distribution, π^+ tracks, $p_T^{\text{lab}} > 0.10$, $W > 3.00$, $x_F > 0.00$, $0.01 < y < 0.95$, $0.20 < z < 0.90$

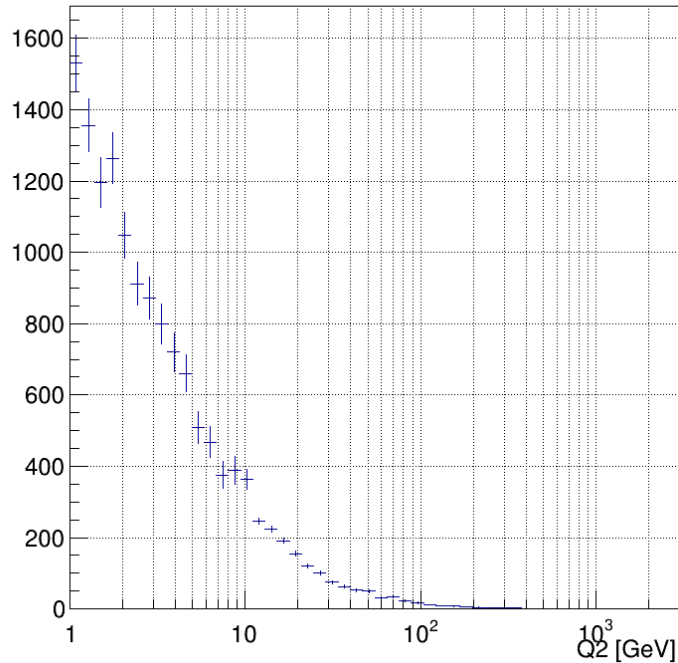


Q² Weighted Distributions

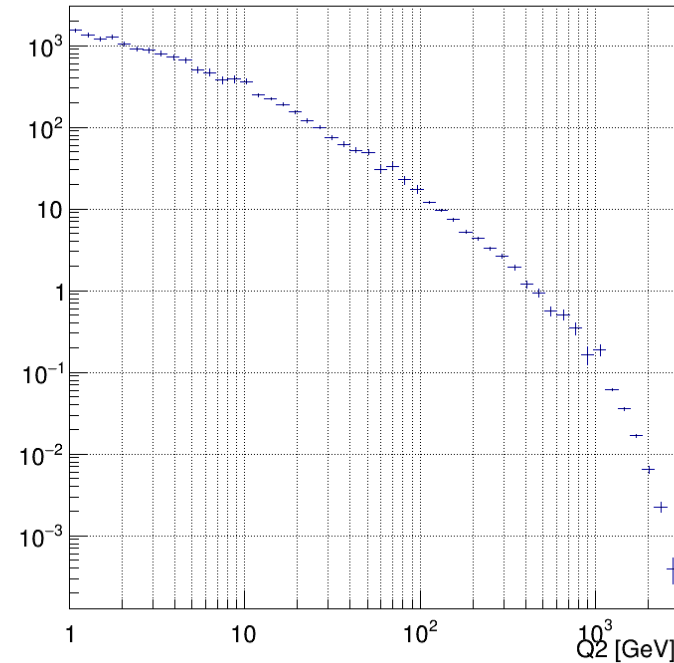
Overlap correction disabled

Pythia 8 → Delphes

Q² distribution, π^+ tracks, $p_T^{\text{lab}} > 0.10$, $W > 3.00$, $x_F > 0.00$, $0.01 < y < 0.95$, $0.20 < z < 0.90$



Q² distribution, π^+ tracks, $p_T^{\text{lab}} > 0.10$, $W > 3.00$, $x_F > 0.00$, $0.01 < y < 0.95$, $0.20 < z < 0.90$

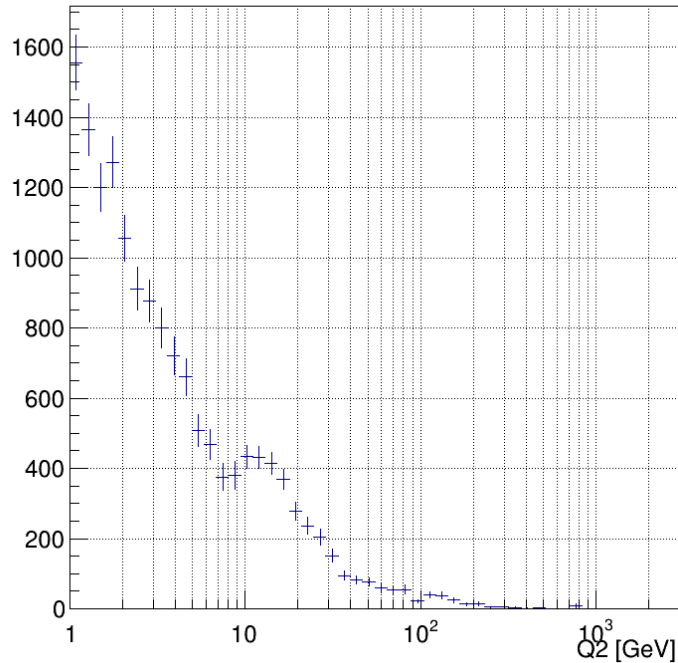


Q² Weighted Distributions

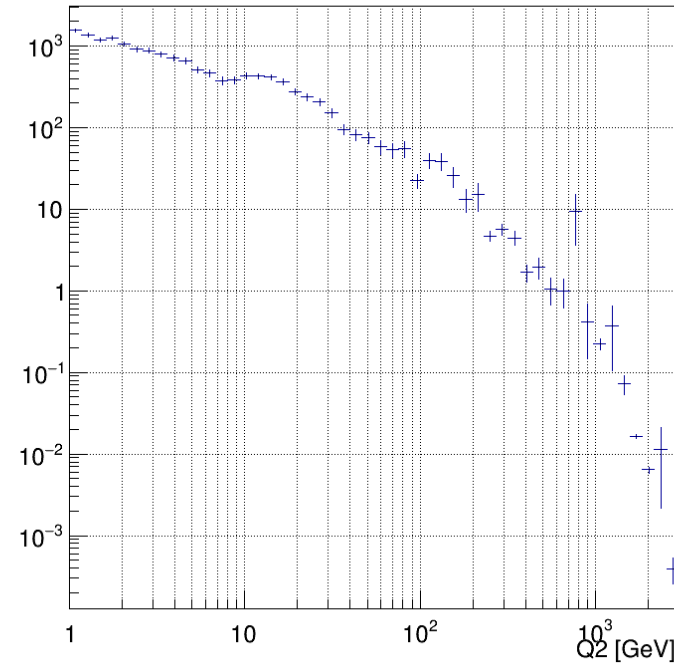
Re-binning disabled

Pythia 8 → Delphes

Q2 distribution, π^+ tracks, $p_T^{\text{lab}} > 0.10$, $W > 3.00$, $x_F > 0.00$, $0.01 < y < 0.95$, $0.20 < z < 0.90$

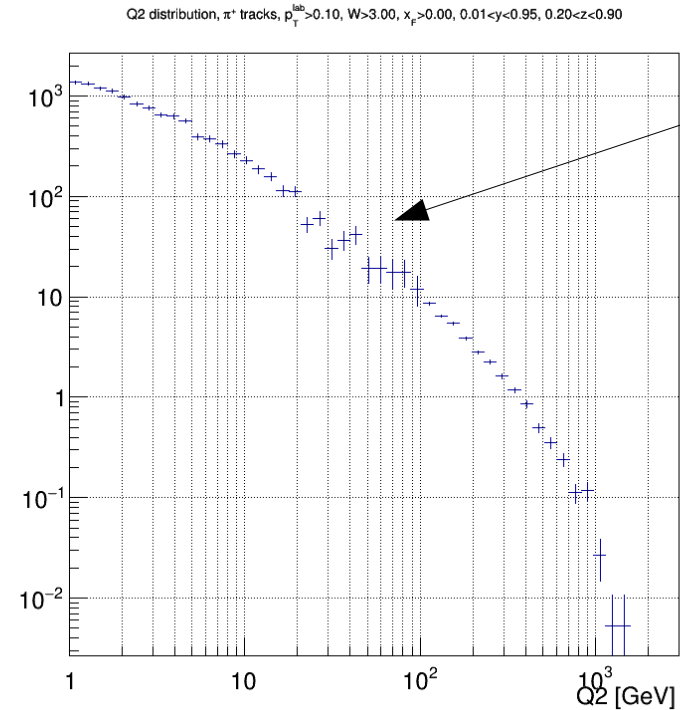
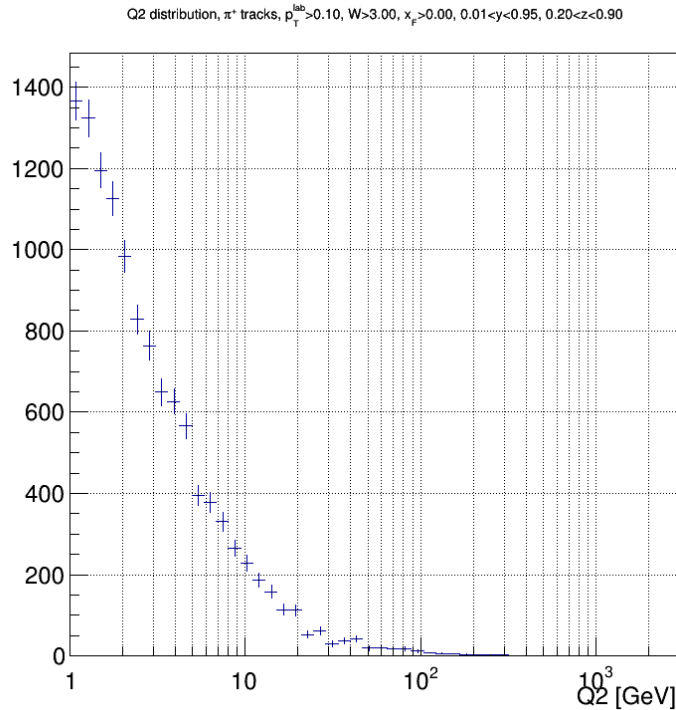


Q2 distribution, π^+ tracks, $p_T^{\text{lab}} > 0.10$, $W > 3.00$, $x_F > 0.00$, $0.01 < y < 0.95$, $0.20 < z < 0.90$



Q² Weighted Distributions

Pythia 6 → ECCE

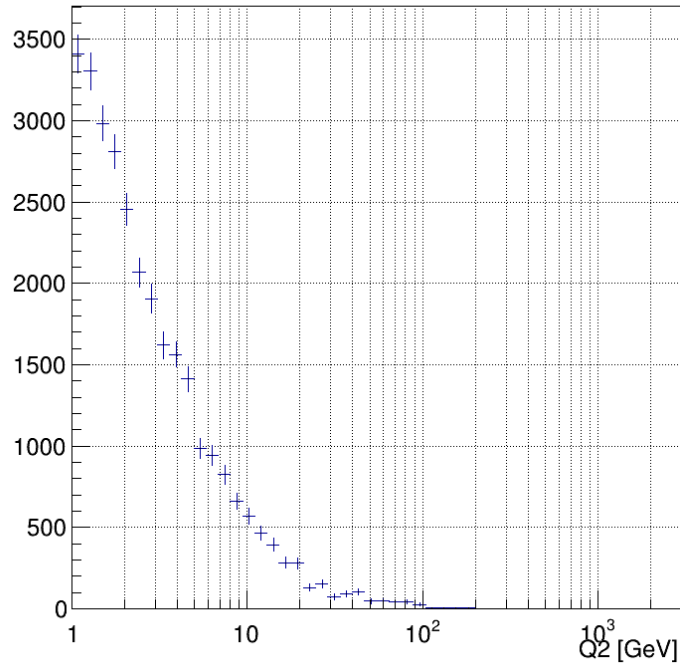


Q² Weighted Distributions

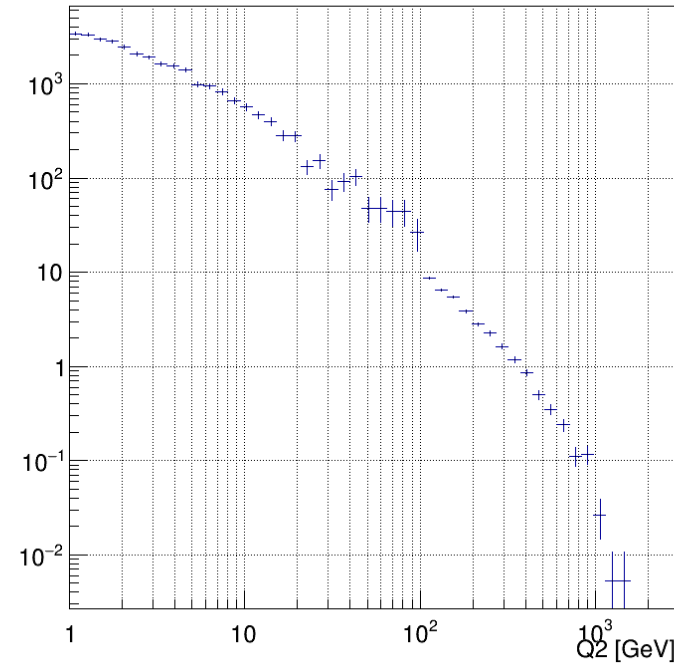
Overlap correction disabled

Pythia 6 → ECCE

Q2 distribution, π^+ tracks, $p_T^{\text{lab}} > 0.10$, $W > 3.00$, $x_F > 0.00$, $0.01 < y < 0.95$, $0.20 < z < 0.90$



Q2 distribution, π^+ tracks, $p_T^{\text{lab}} > 0.10$, $W > 3.00$, $x_F > 0.00$, $0.01 < y < 0.95$, $0.20 < z < 0.90$

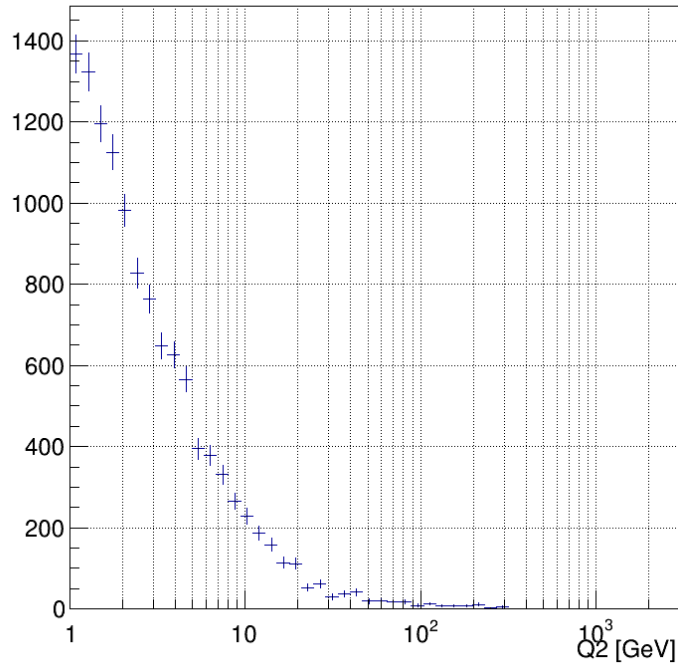


Q² Weighted Distributions

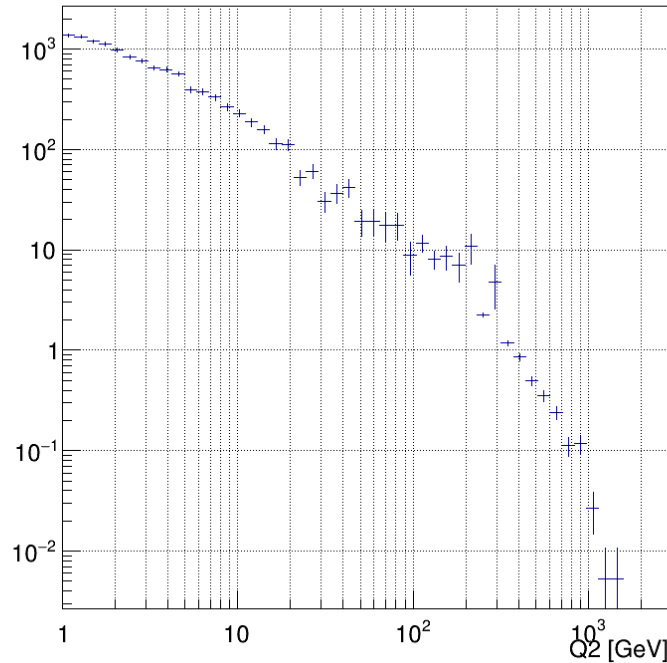
Re-binning disabled

Pythia 6 → ECCE

Q2 distribution, π^+ tracks, $p_T^{\text{lab}} > 0.10$, $W > 3.00$, $x_F > 0.00$, $0.01 < y < 0.95$, $0.20 < z < 0.90$



Q2 distribution, π^+ tracks, $p_T^{\text{lab}} > 0.10$, $W > 3.00$, $x_F > 0.00$, $0.01 < y < 0.95$, $0.20 < z < 0.90$



Continuous Integration

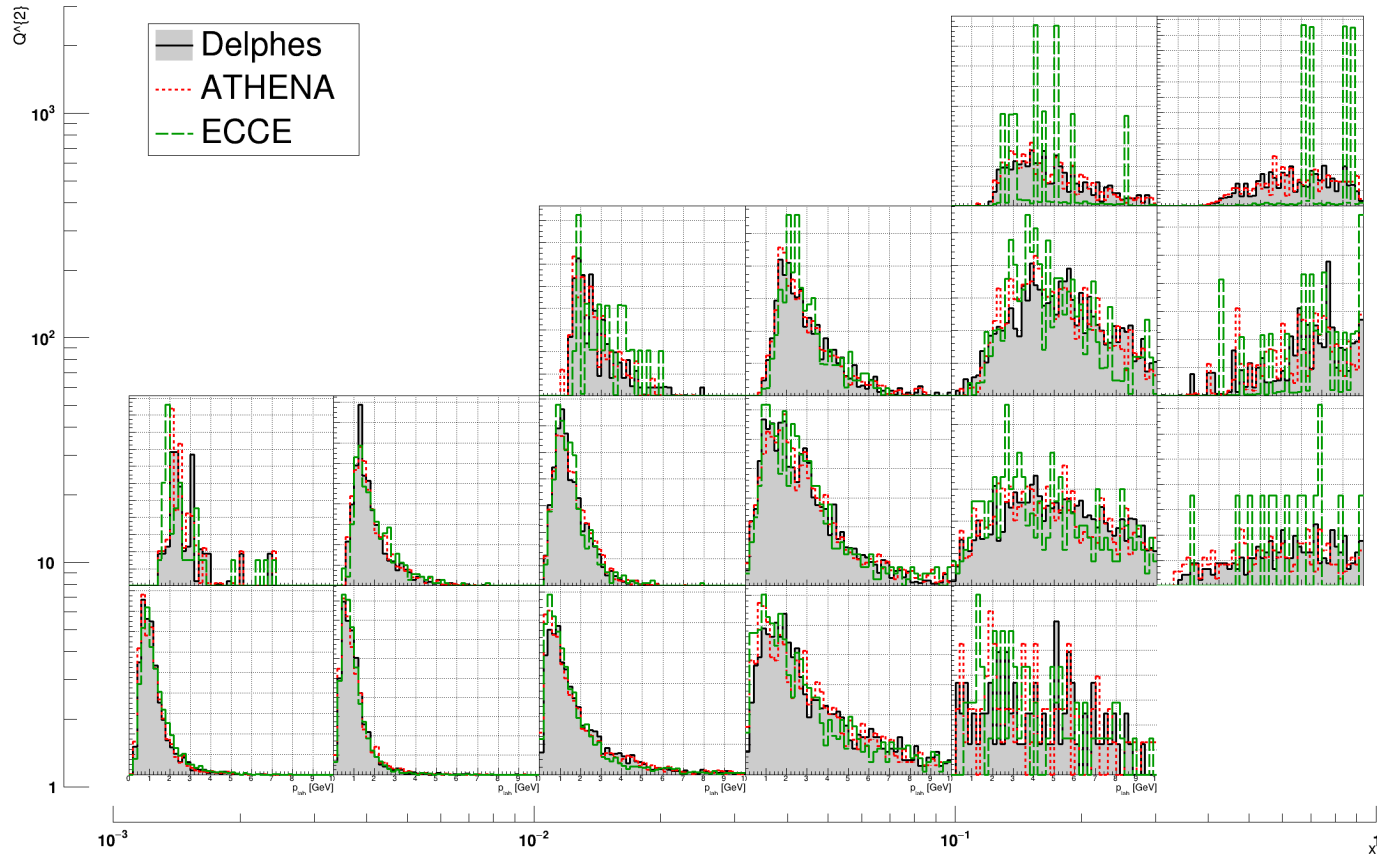


Cuts - Same as those from ATHENA

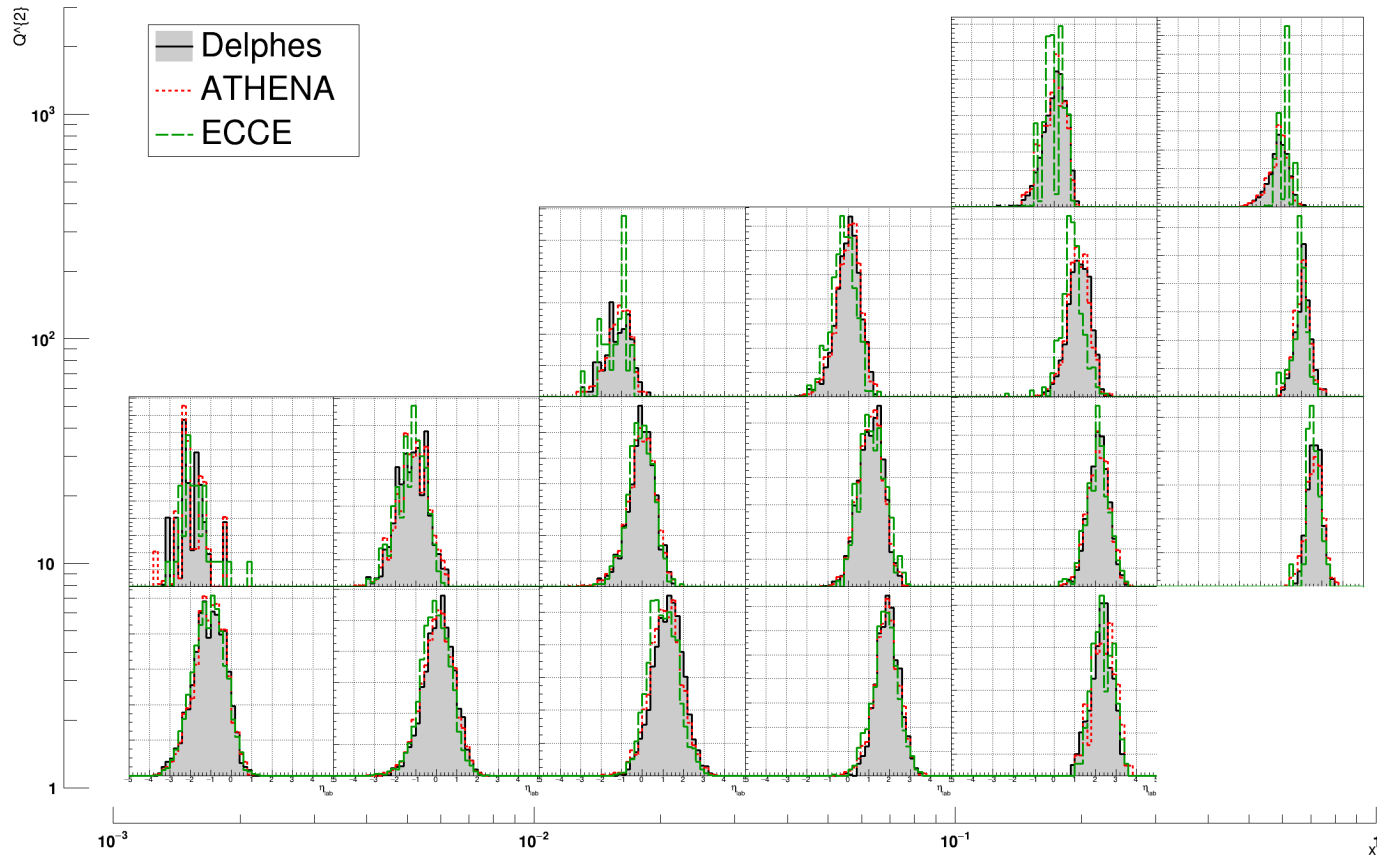
```
W > 3 GeV  
0.01 < y < 0.95  
0.2 < z < 0.9  
xF > 0  
pT_lab > 0.1 GeV (tracking limit)
```

- Showing electron method (all others available in CI)
- Energy: 10x100

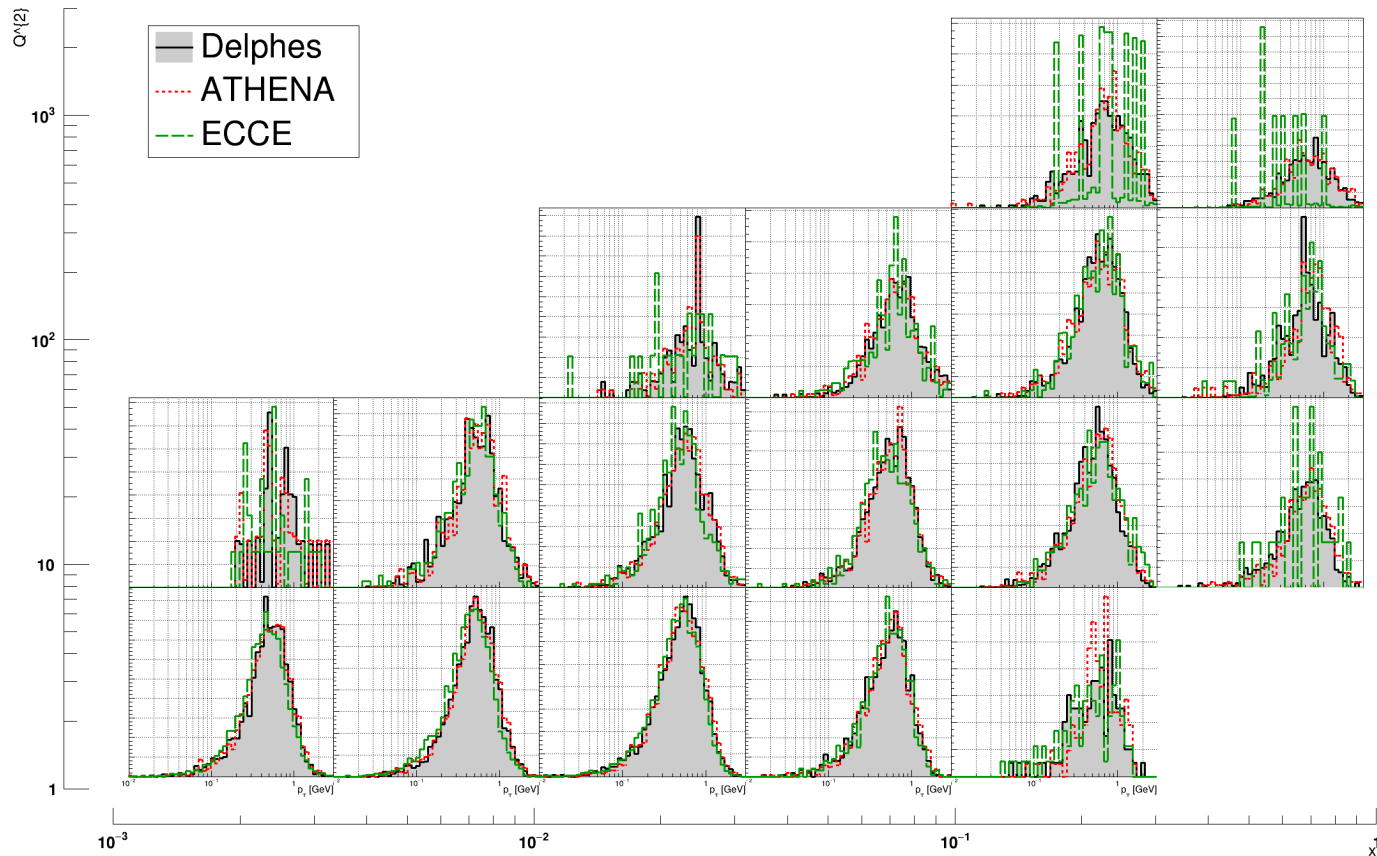
Comparison Plots: p , in bins of (x, Q^2)



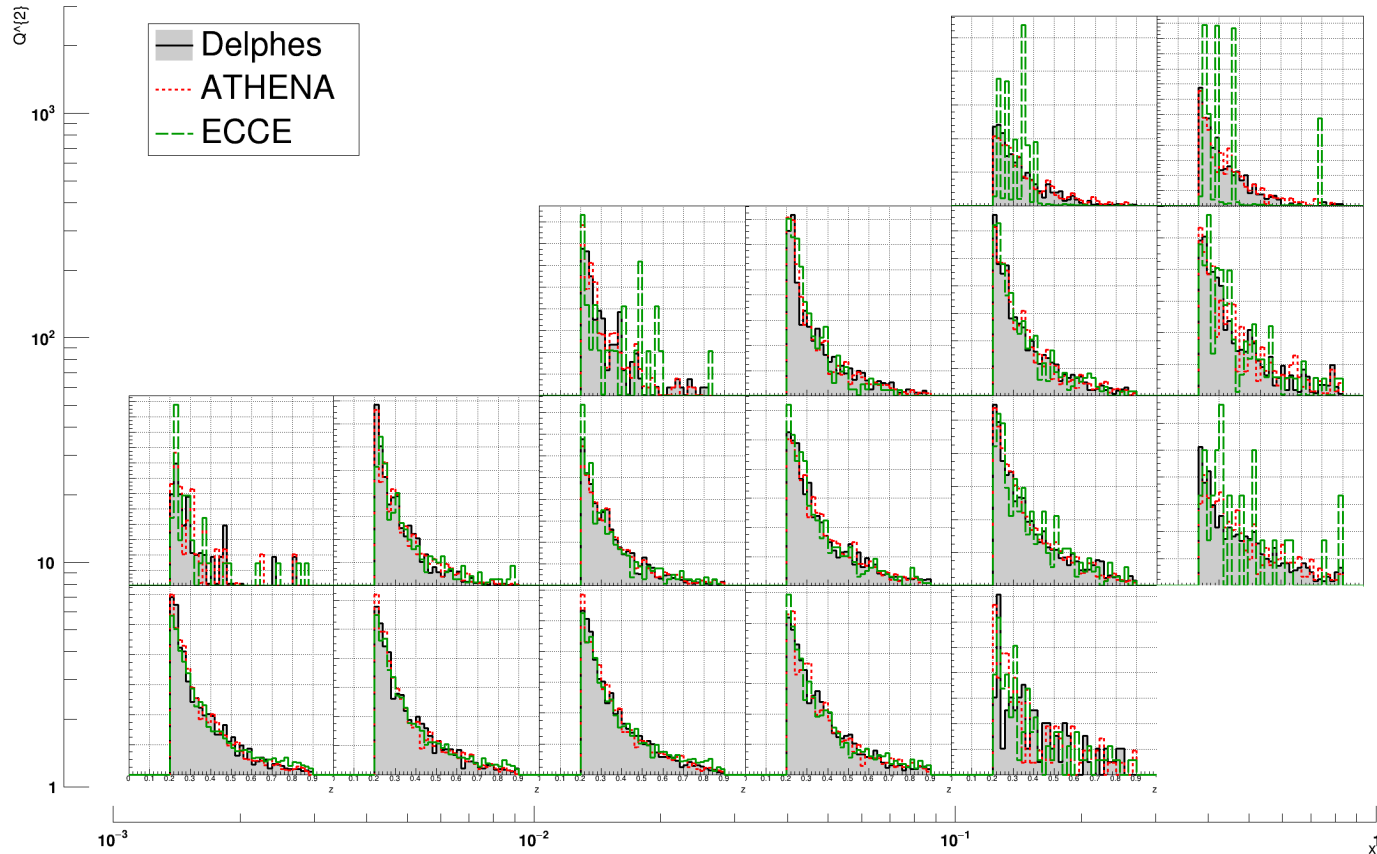
Comparison Plots: η



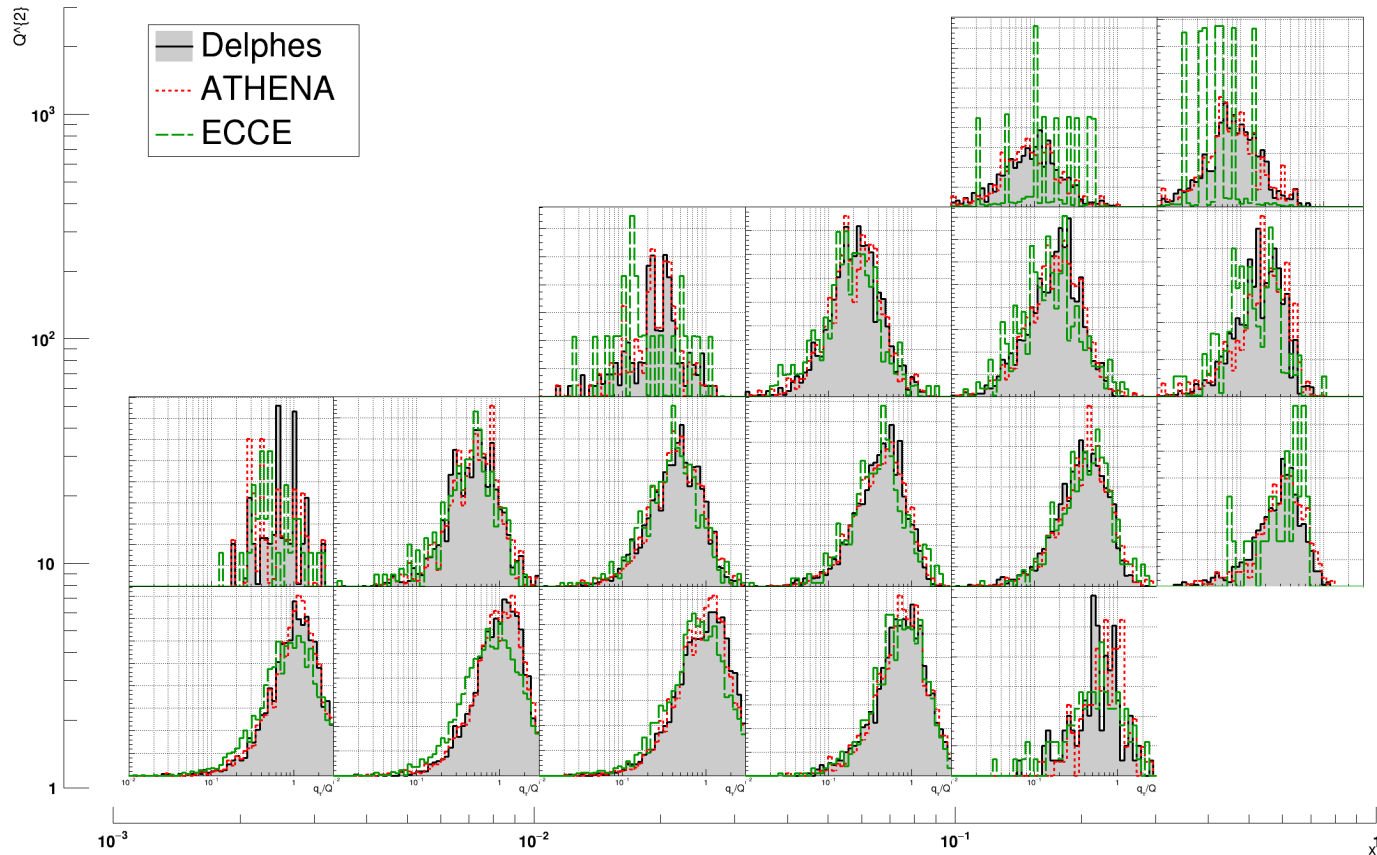
Comparison Plots: p_T



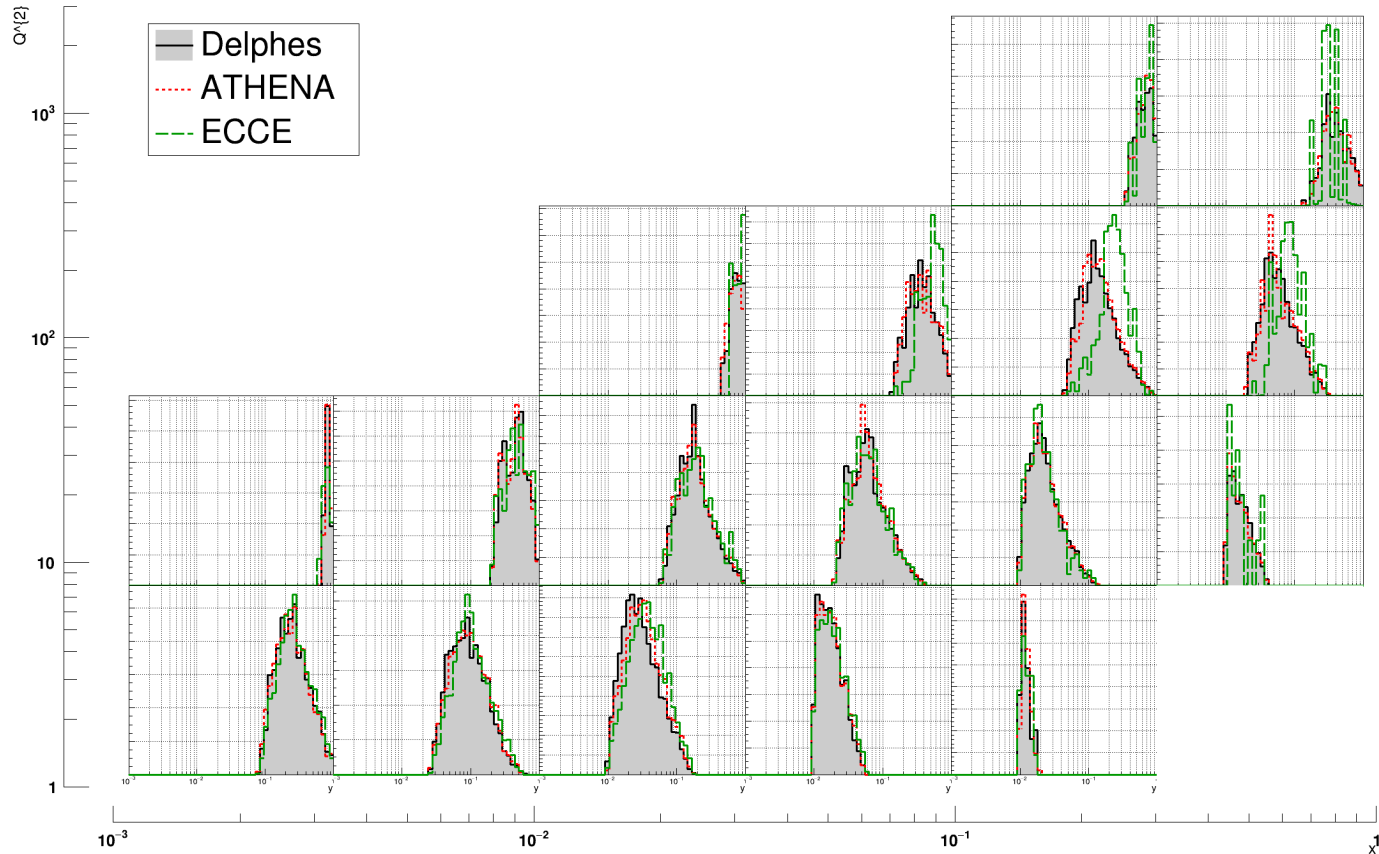
Comparison Plots: z



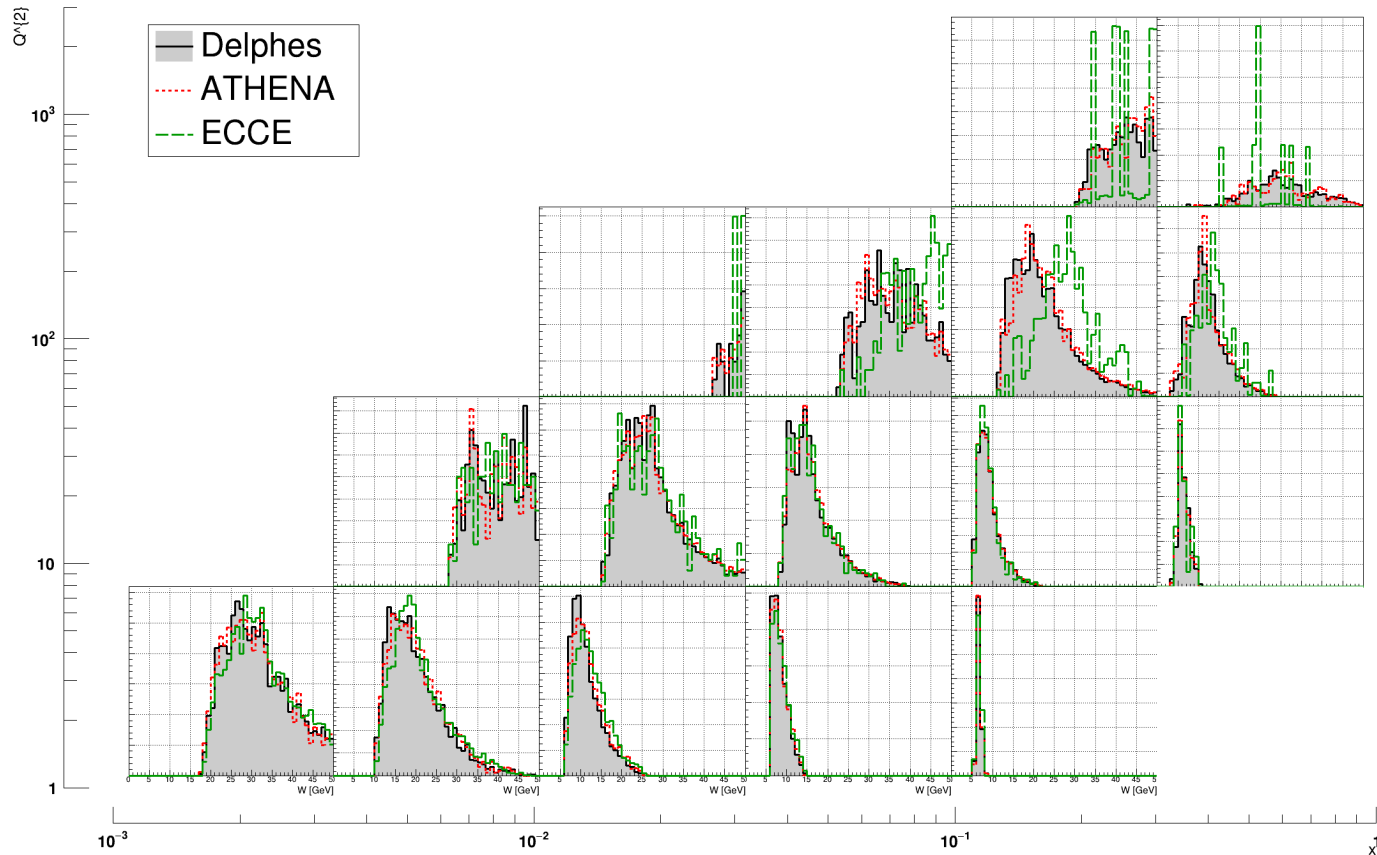
Comparison Plots: q_T/Q



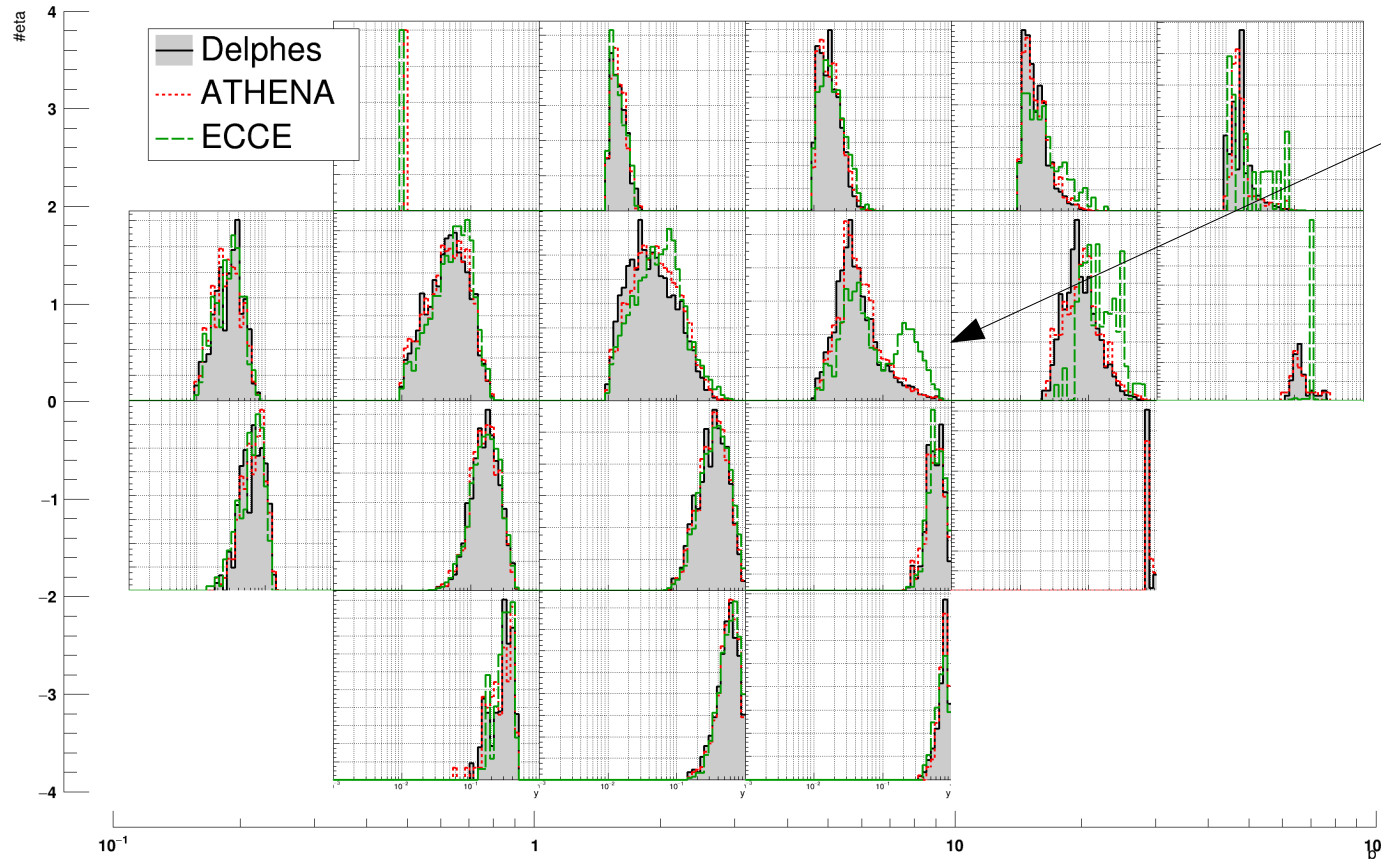
Comparison Plots: y



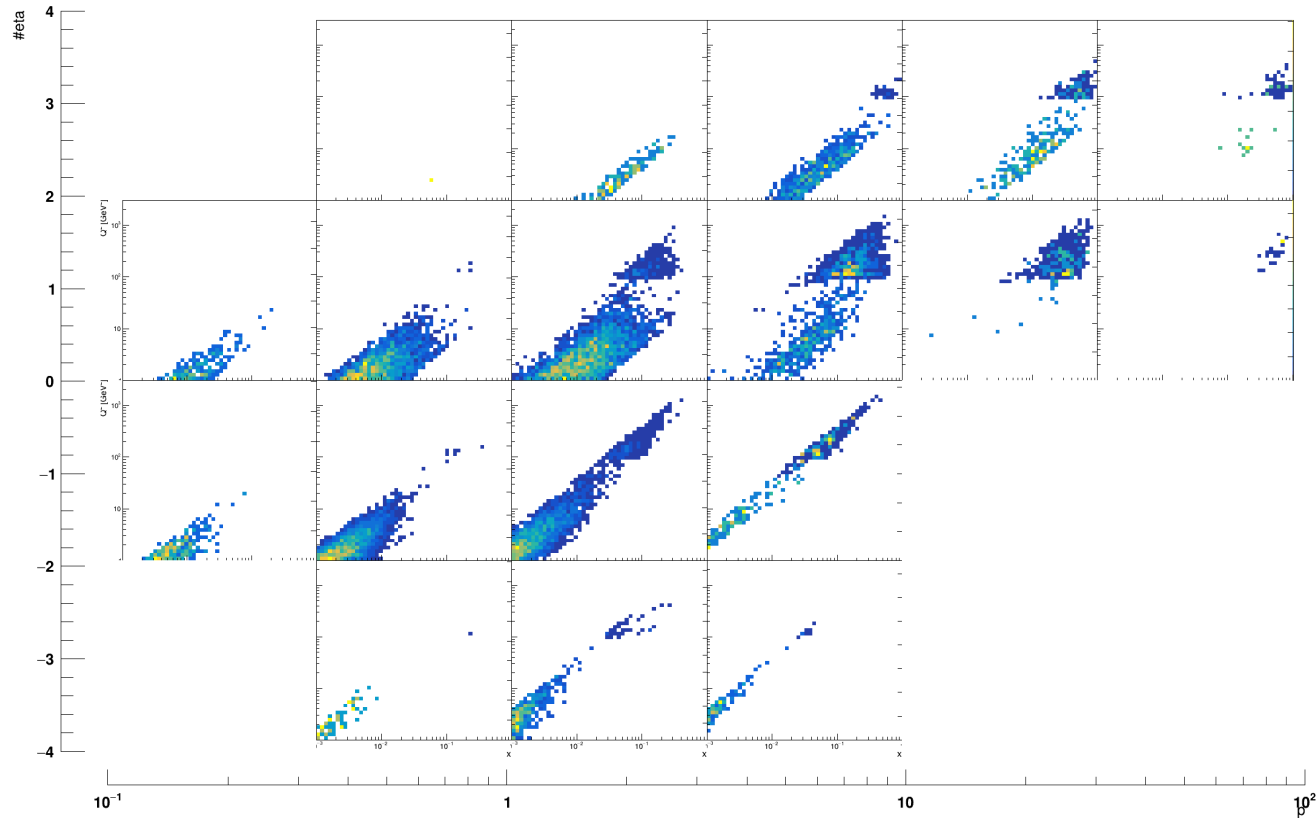
Comparison Plots: W



Comparison Plots: y , in bins of (η, p)



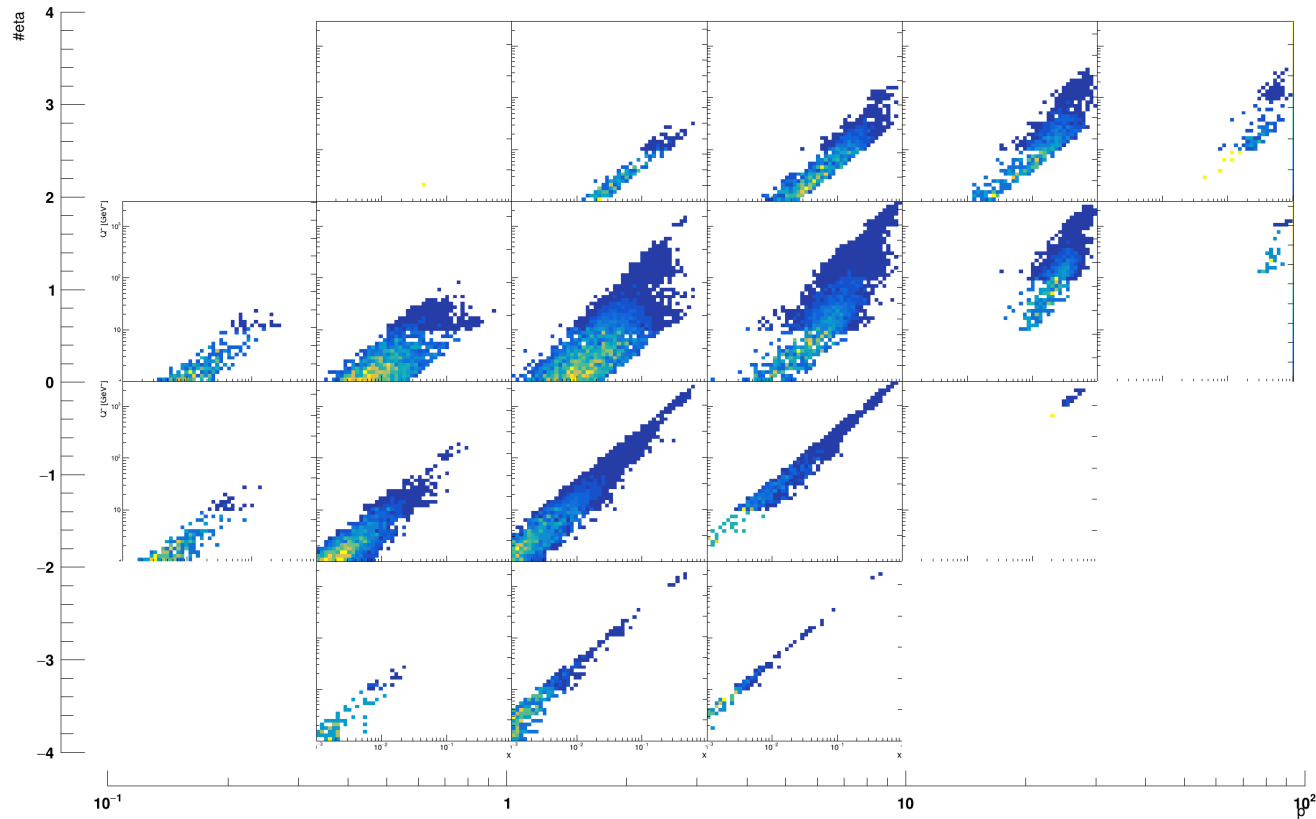
(x, Q^2) in bins of (η, p)



ECCE production

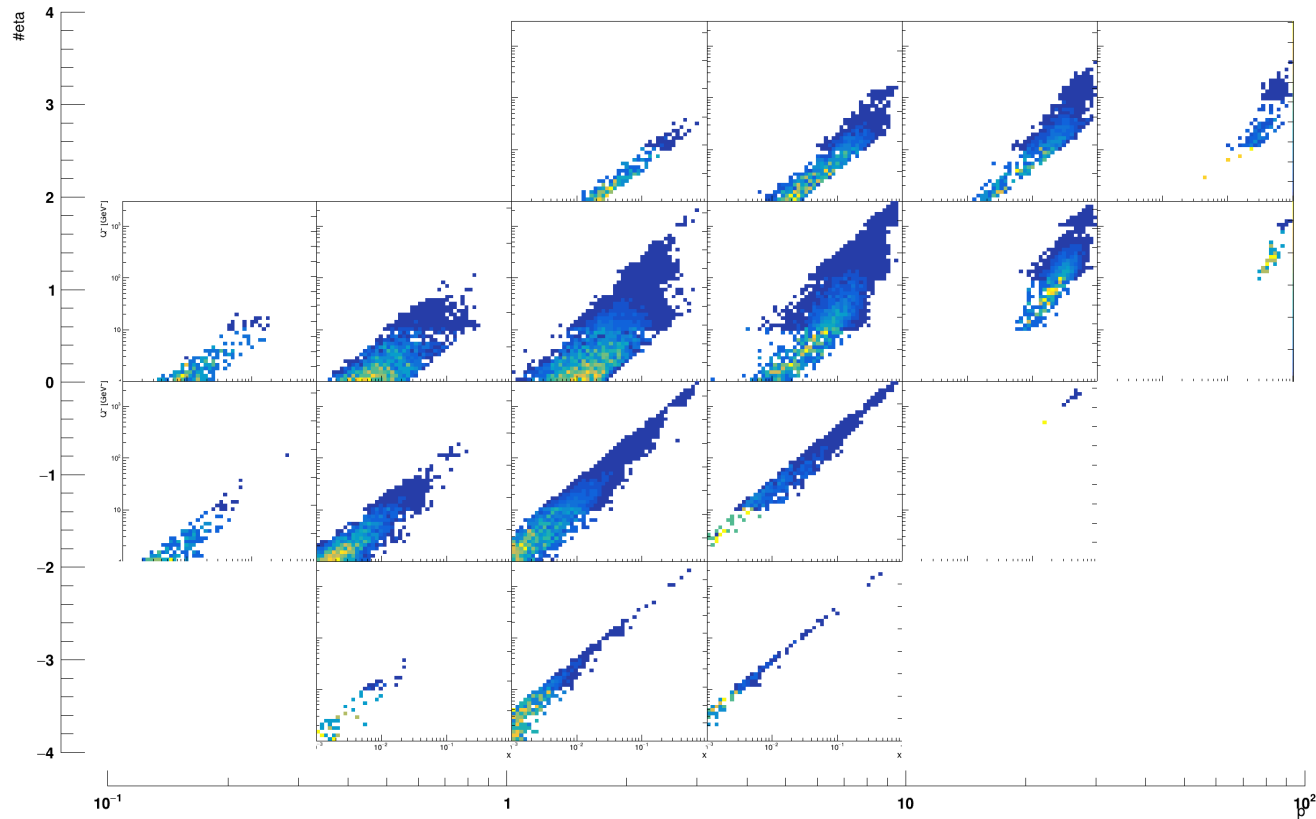
Seems like we need more statistics in the CI

(x, Q^2) in bins of (η, p)



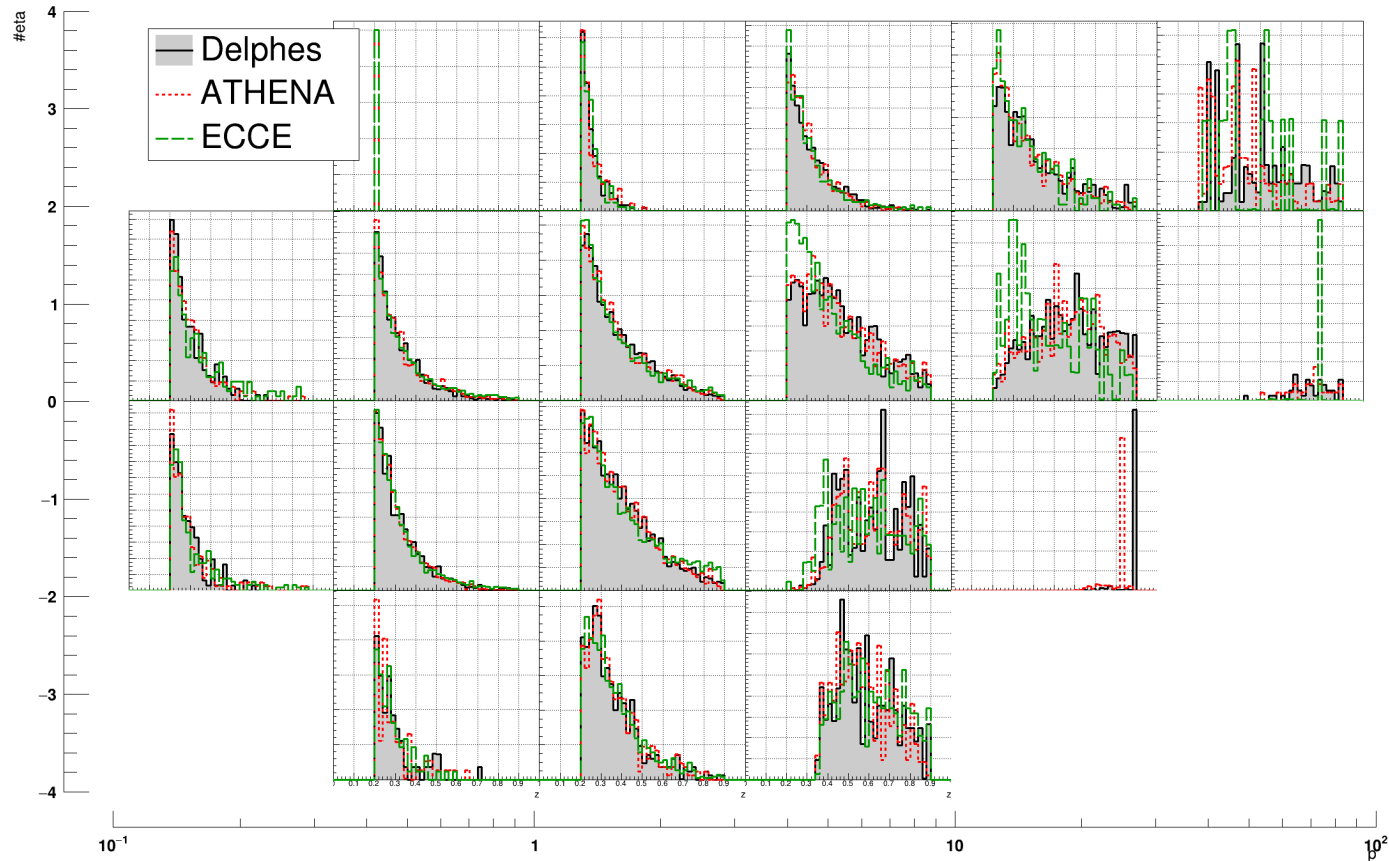
ATHENA
production

(x, Q^2) in bins of (η, p)

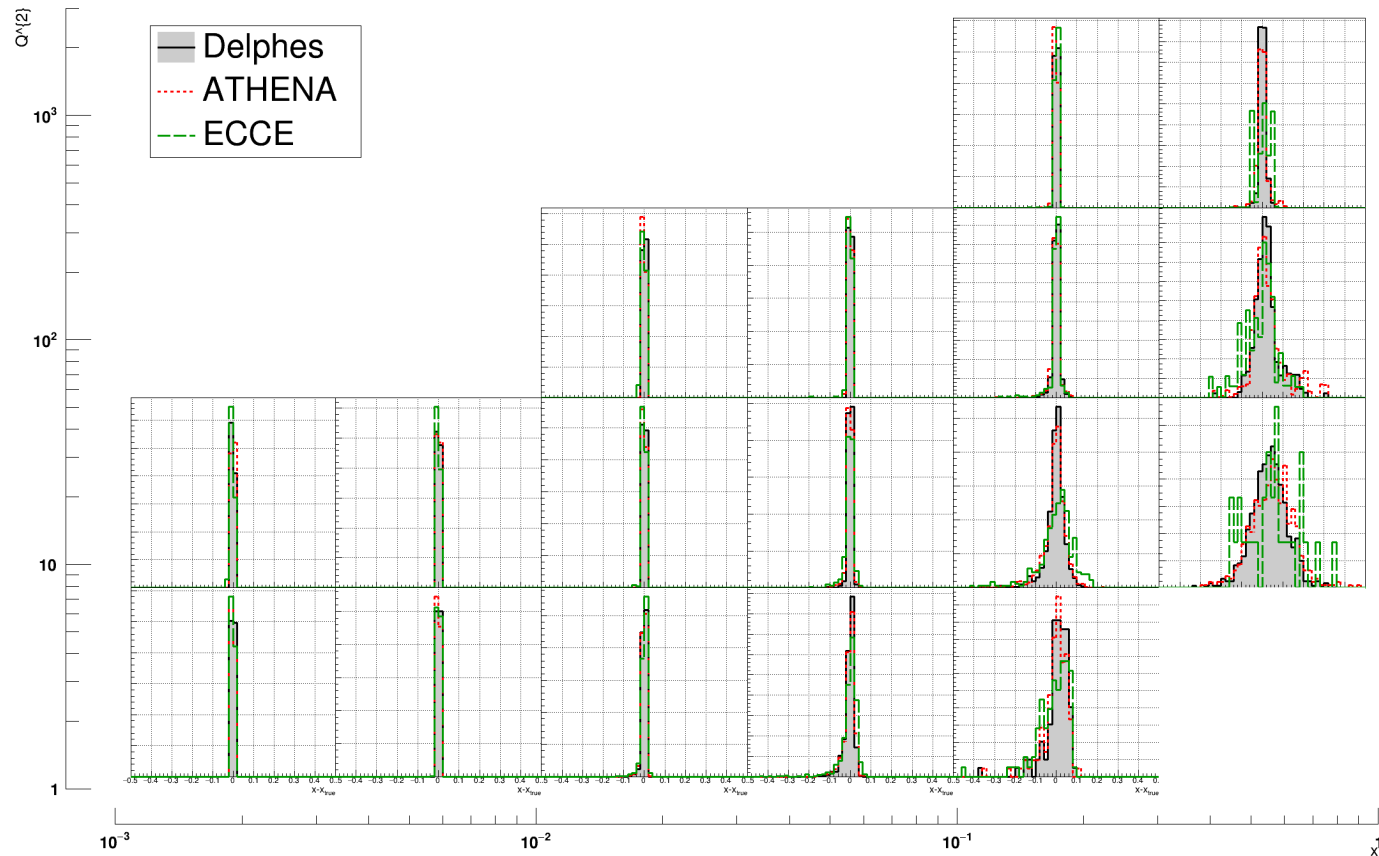


Fastsim
production

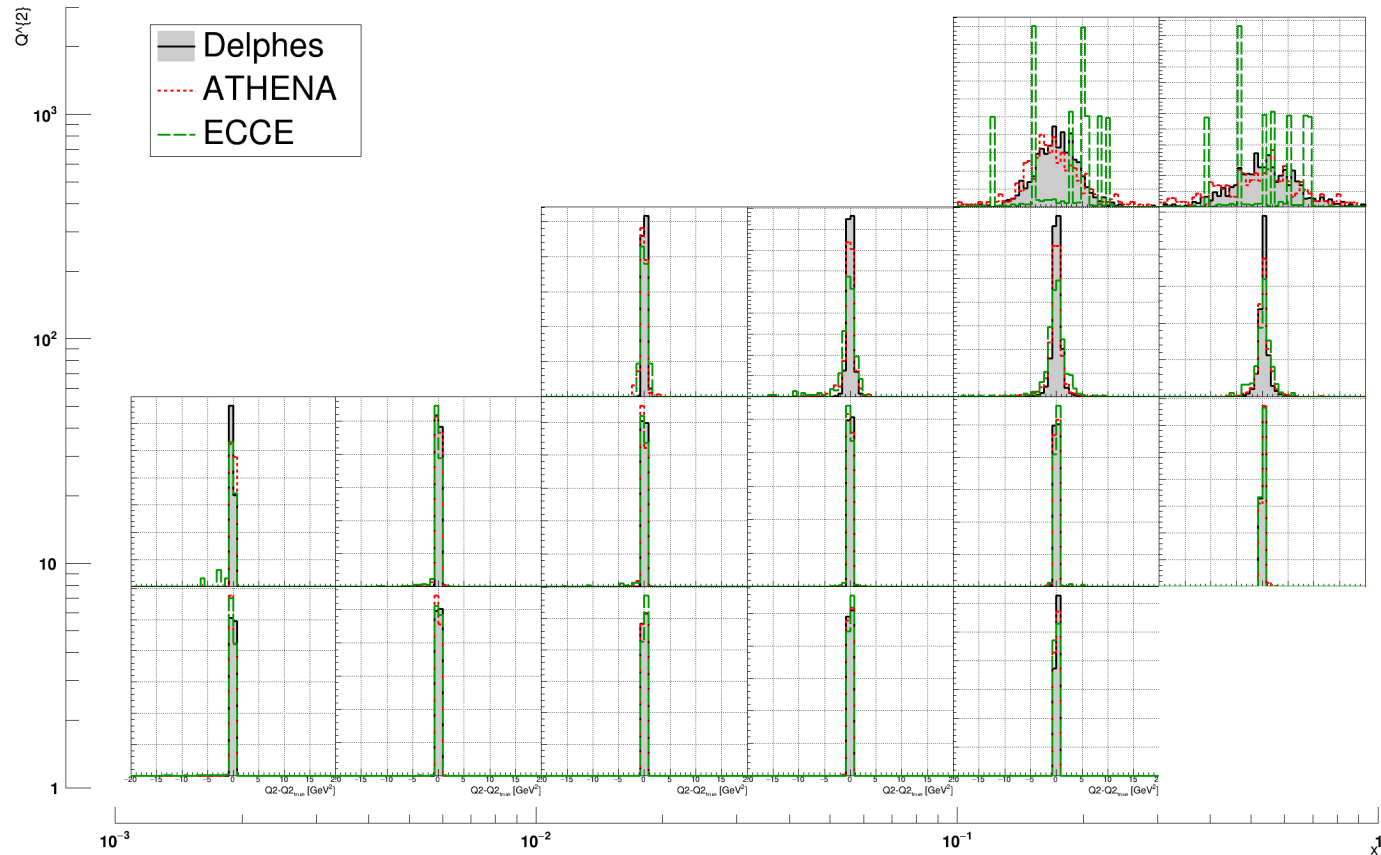
Comparison Plots: z , in bins of (η, p)



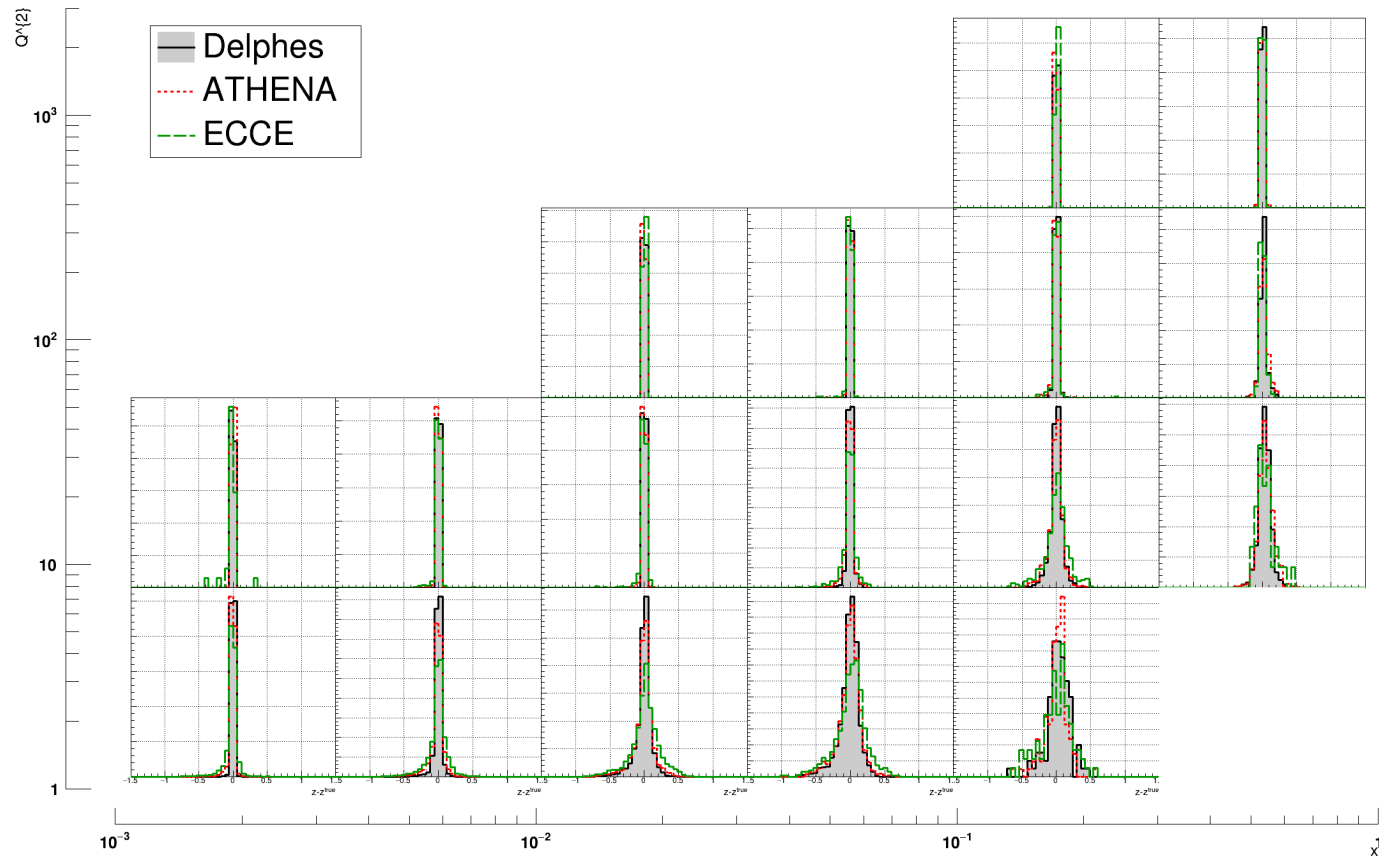
Resolution: x



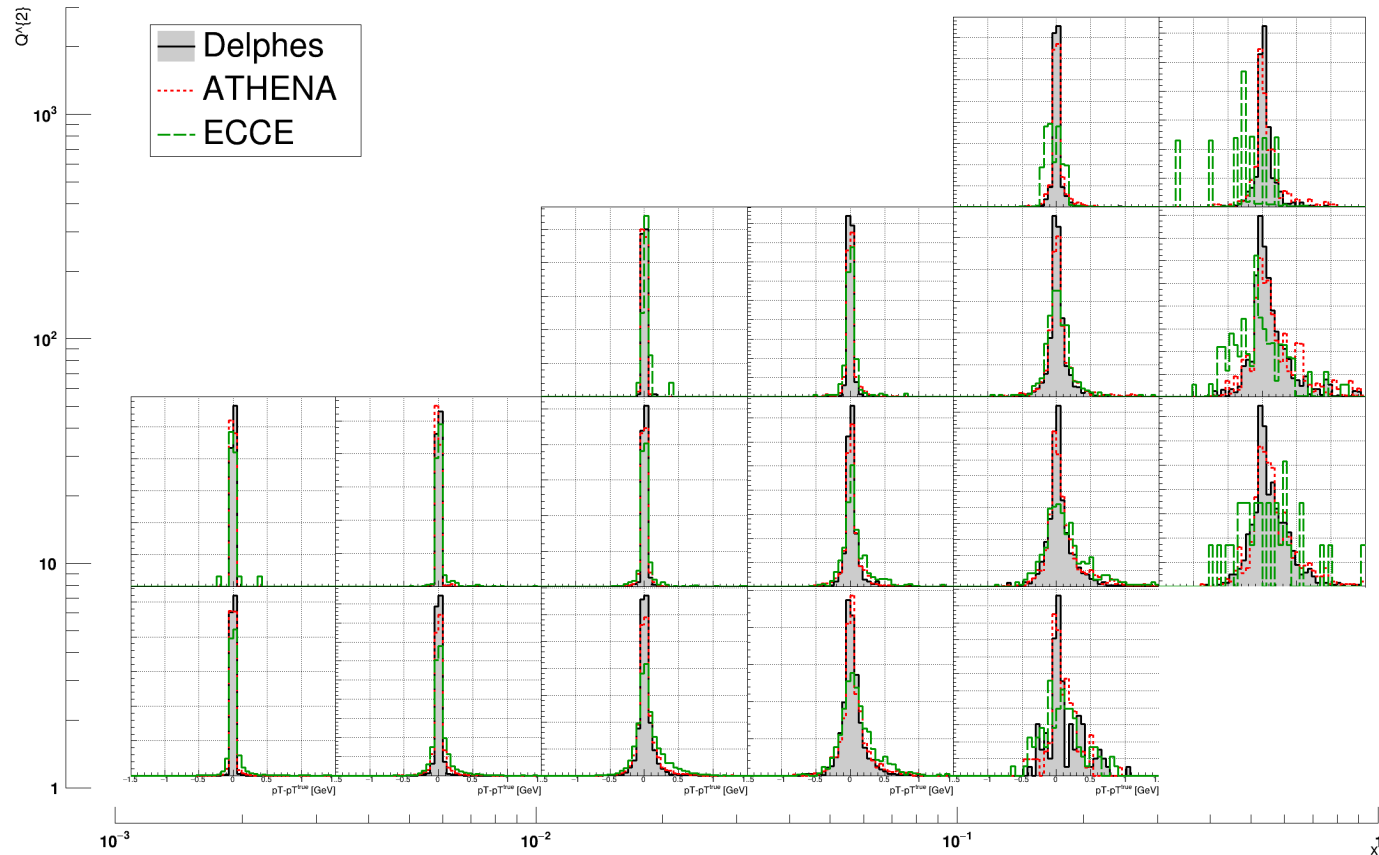
Resolution: Q^2



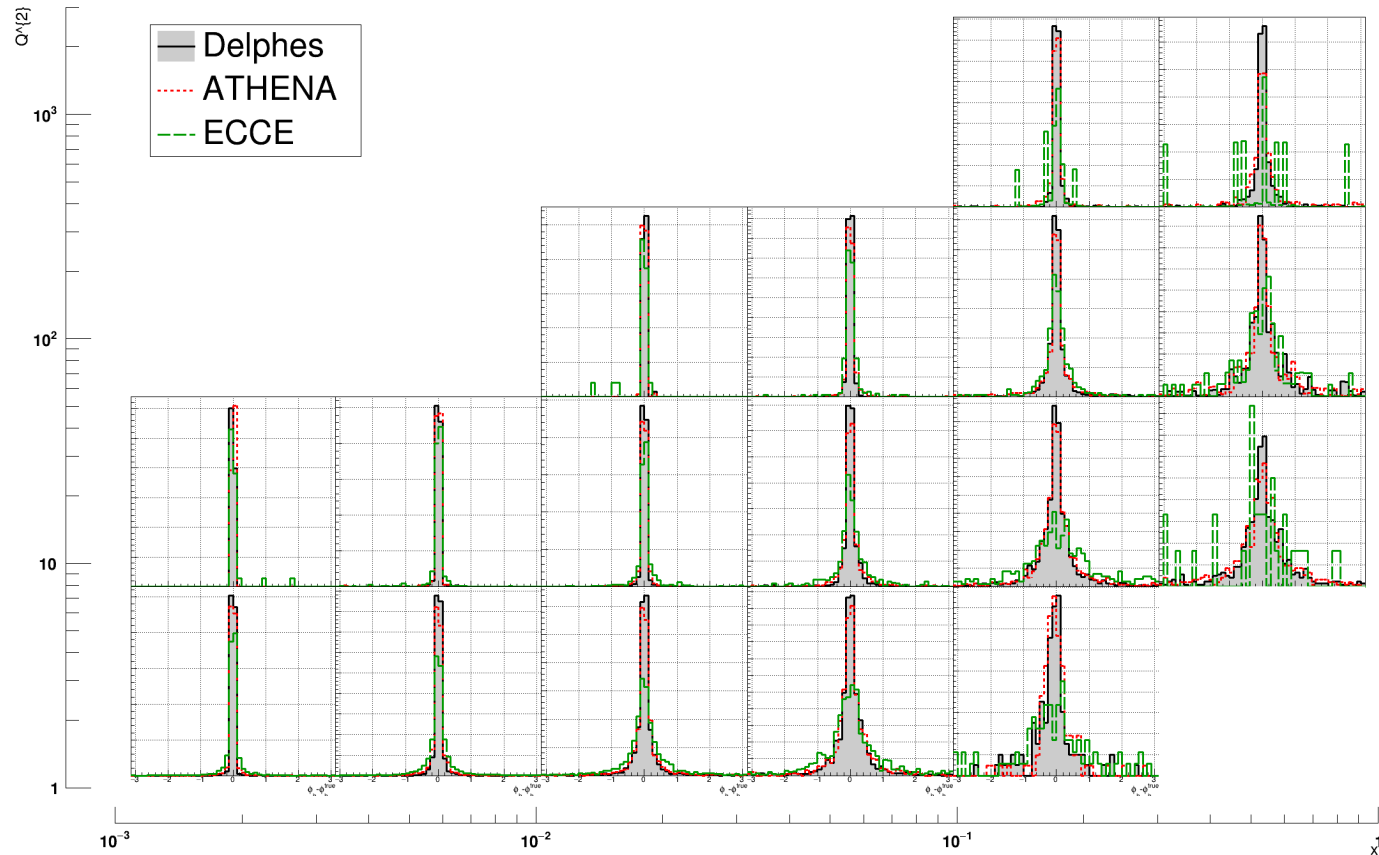
Resolution: z



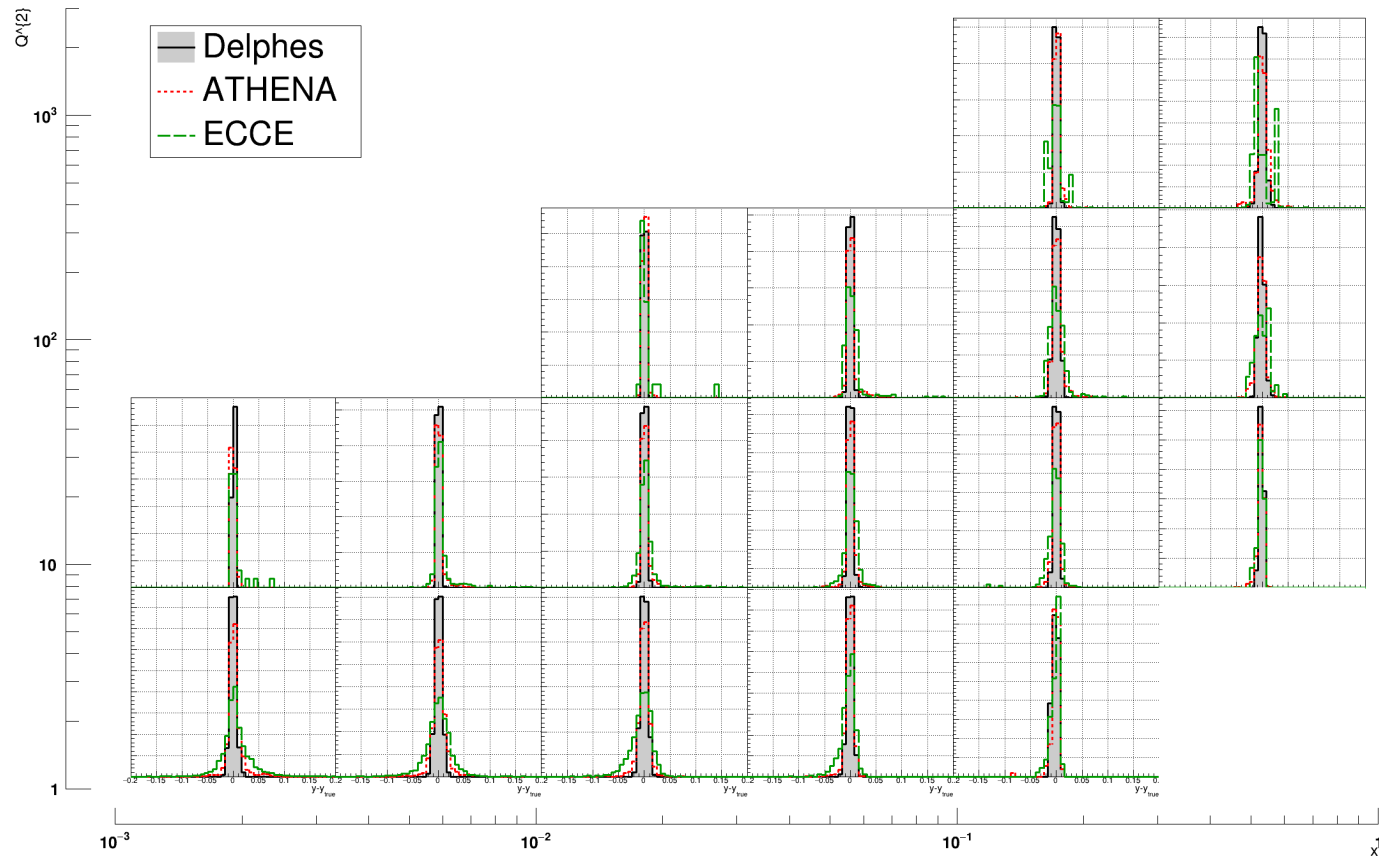
Resolution: p_T



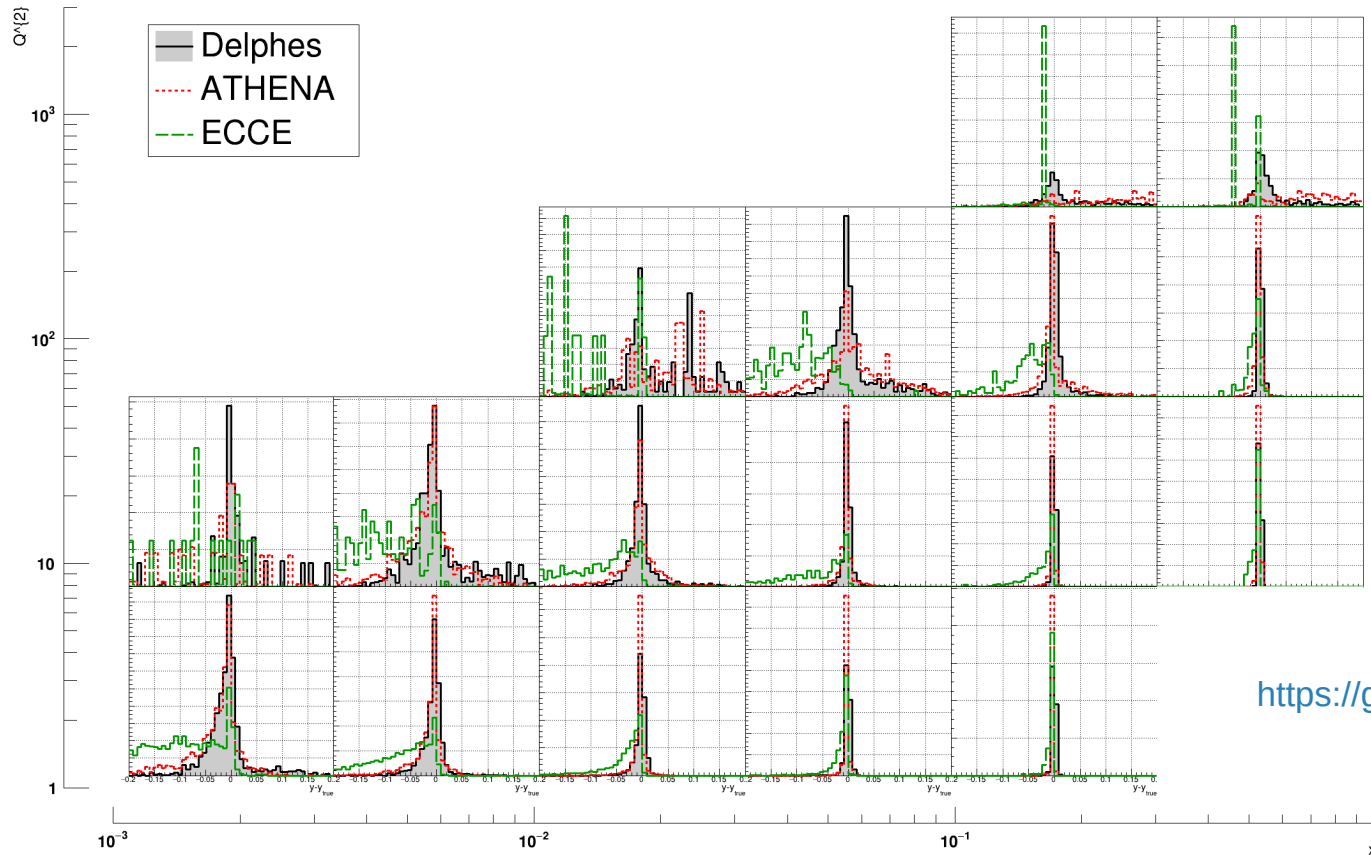
Resolution: ϕ_h



Resolution: y



Issue with hadronic recon. methods



e.g., y-resolution
from JB

<https://github.com/eic/sidis-eic/issues/187>

New Configuration File Format

```
1 #####
2 # EXAMPLE CONFIGURATION FILE
3 #####
4 # Global Settings:
5 # =====
6 :eleBeamEn 10 # beam energies, in GeV
7 :ionBeamEn 100
8 :crossingAngle -25 # crossing angle, in mrad
9 :totalCrossSection 555660.0 # total cross section, needed for Q2 weights; this may be the same
10 # cross section as your least-strict Q2 range (e.g., Q2>1)
11
12 # Group Settings: these settings are specific for each Q2 range
13 # =====
14 # NOTE: they must be sorted by increasing strictness
15 # of Q2 cuts, or at least by decreasing cross section
16
17 # Q2 range 1
18 :q2min 1.0
19 #:q2max 100.0 # specify a Q2 maximum, if you need one
20 :crossSection 555660.0 # cross section
21 datarec/10x100/minQ2=1/file1.root # list of local files
22 datarec/10x100/minQ2=1/file2.root
23 datarec/10x100/minQ2=1/file3.root
24
25 # Q2 range 2
26 :q2min 10.0
27 :crossSection 40026.0
28 datarec/10x100/minQ2=10/file1.root
29 datarec/10x100/minQ2=10/file2.root
30
31 # Q2 range 3 # note: to stream from S3, use s3https URLs
32 :q2min 100.0
33 :crossSection 1343.0
34 s3https://dtn01.sdcc.bnl.gov:9000/eicctest/EPIC/____/____/10x100/minQ2=100/file1.root
35 s3https://dtn01.sdcc.bnl.gov:9000/eicctest/EPIC/____/____/10x100/minQ2=100/file2.root
36 s3https://dtn01.sdcc.bnl.gov:9000/eicctest/EPIC/____/____/10x100/minQ2=100/file3.root
```


New Configuration File Format

- ◆ *Significantly* more user friendly than the previous version
- ◆ Comment out parts you don't need
- ◆ No more boilerplate beam energies and crossing angle in every. single. macro.
- ◆ Automated generation is very similar to before, for example:

```
s3tools/make-ecce-config.sh 10x100 ecce d 10
```

generation script:

- **make-ecce-config.sh:** ECCE, and latest EPIC production
- **make-athena-config.sh:** ATHENA
- **make-fastsim-S3-config.sh:** Pythia8 (S3) → Delphes

beam energies

subdirectory (for
downloaded files)

s: stream from S3
d: download from S3
c: just make the config file

Number of files
per Q2 range

SIDIS-EIC Name Change

- ◆ Open to ideas
- ◆ Make it unique and/or easy to find

epic-analysis

common
analysis
epic
framework
inclusive
semi-inclusive
jets
heavy-flavor

- ◆ Straightforward to do, done it before (and many times upstream...)
- ◆ Old URLs will auto-redirect, but good practice to update them
 - For EPIC Devs, change remote:

```
git remote set-url origin git@github.com:eic/NEW_NAME.git
```