TCS simulations for EIC

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Recap

Toy MC for TCS developed by Pawel Sznajder.

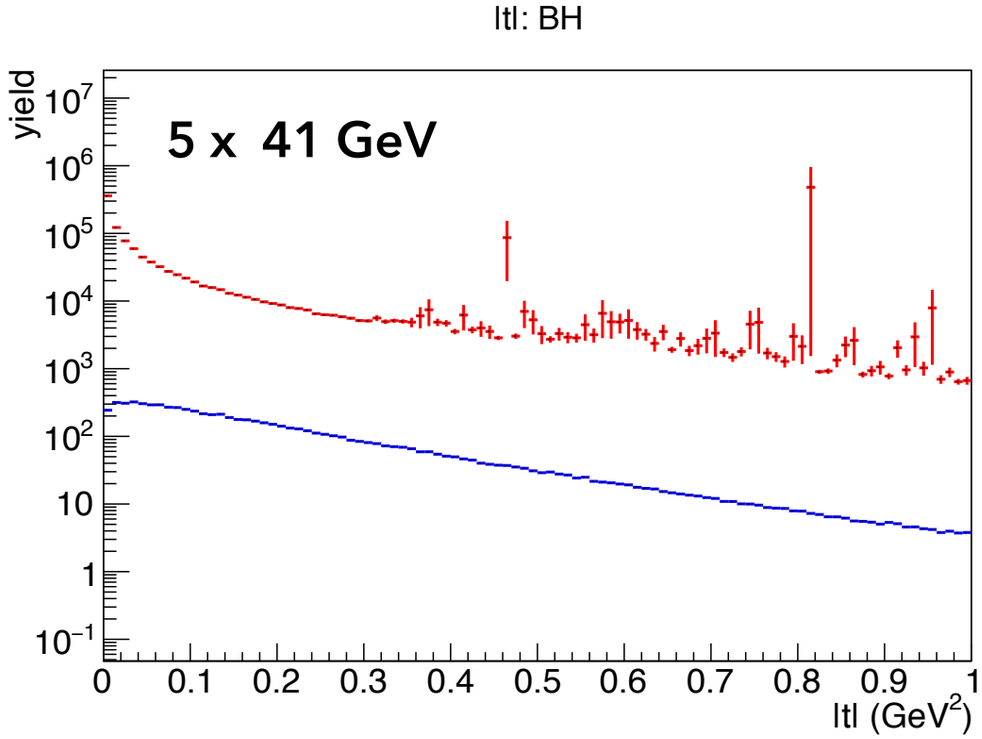
Generated variables:

$$Q^2,\ y,\ E_p,\ E_e,\ t,\ Q'^2,\ \theta,\ \phi,\ \phi_s$$

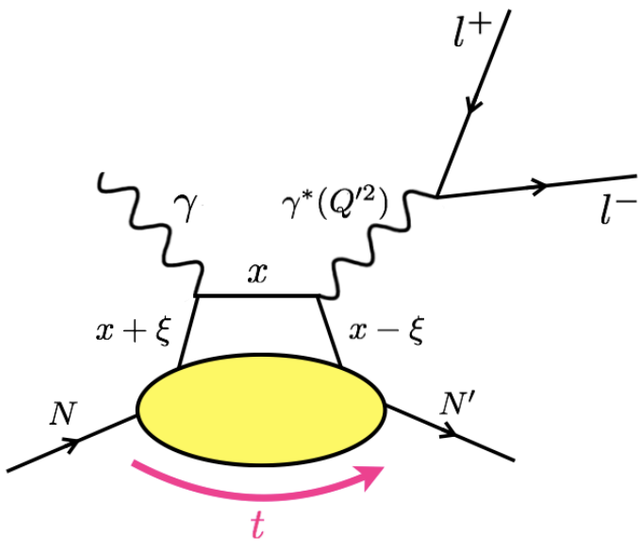
θ : angle between e+ and scattered proton in lepton CMS

ϕ: Trento-phi (angle between leptonic and hadronic plane)

ϕ_s : angle between leptonic plane and transverse component of target polarisation



Pure BH and pure TCS, no interference term yet.

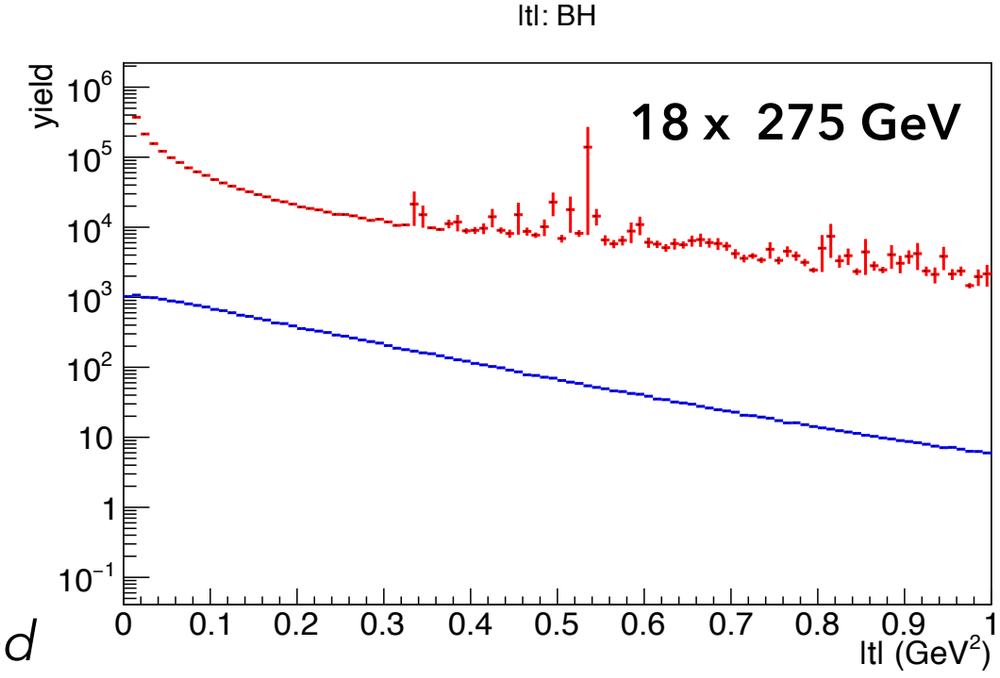


Cuts applied:

$$\frac{\pi}{4} < \theta < \frac{3\pi}{4}$$

$$2 < Q'^2 < M^2_{J/\Psi}$$

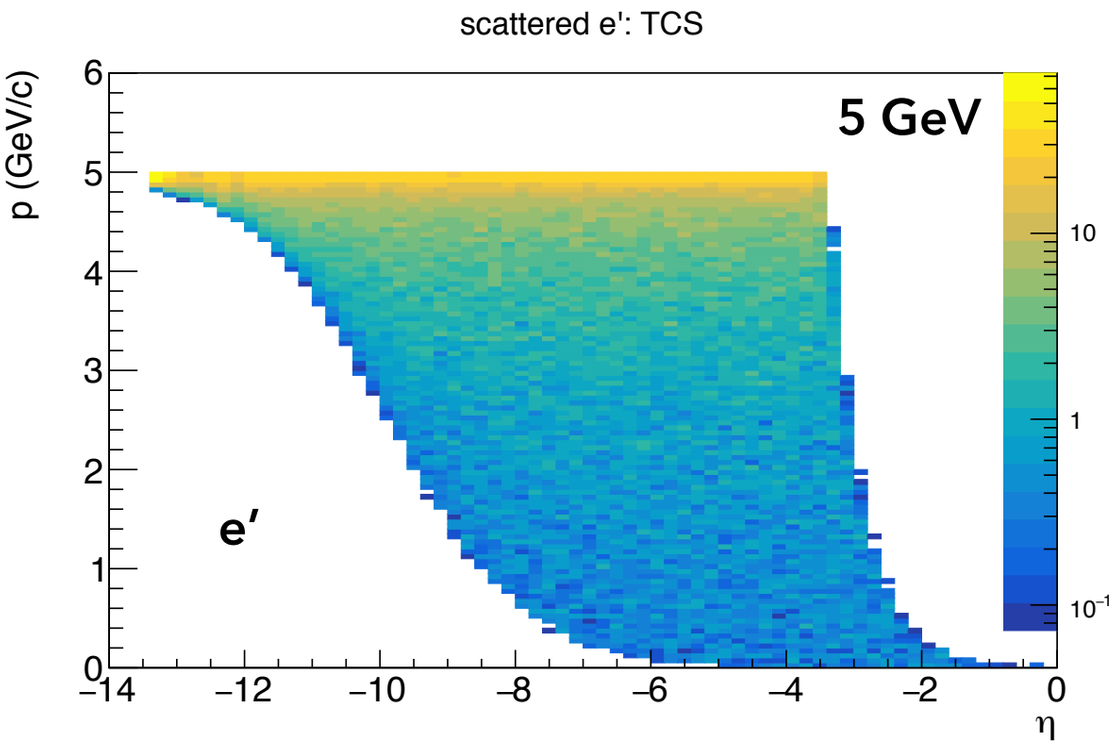
t-cut not yet implemented

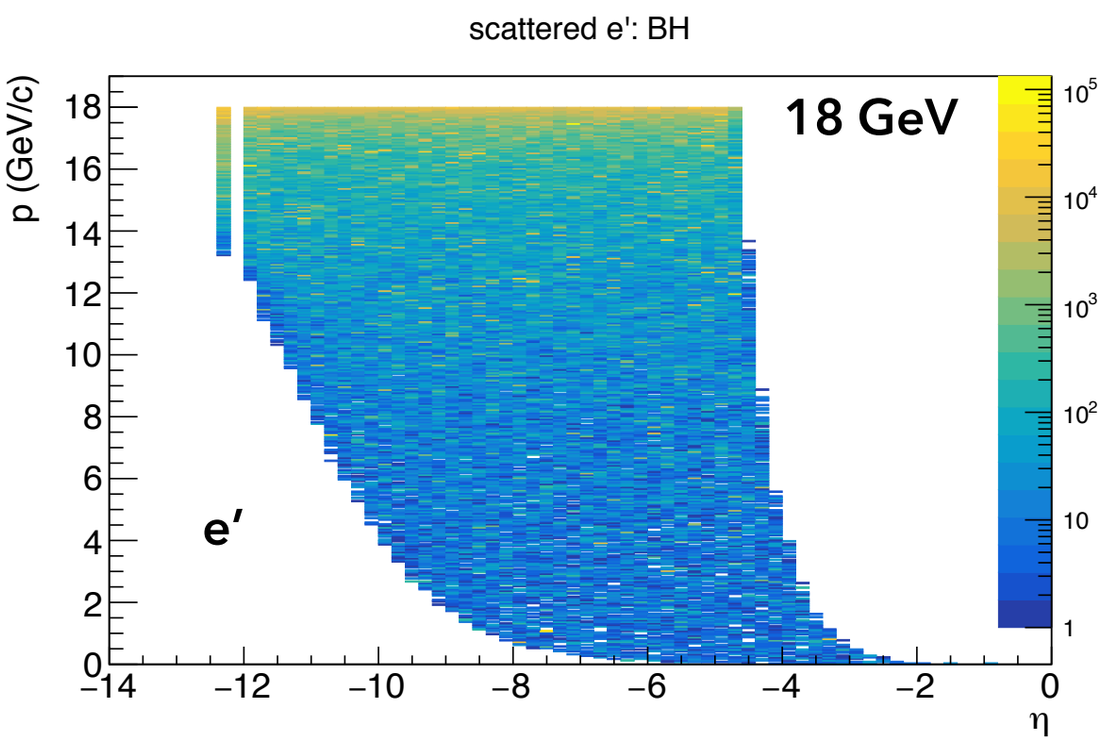


New: generated events passed through the eicsmear package (low-Q2 tagger excluded).

All yields are for 10 fm^{-1} integrated luminosity

Recap: scattered electron

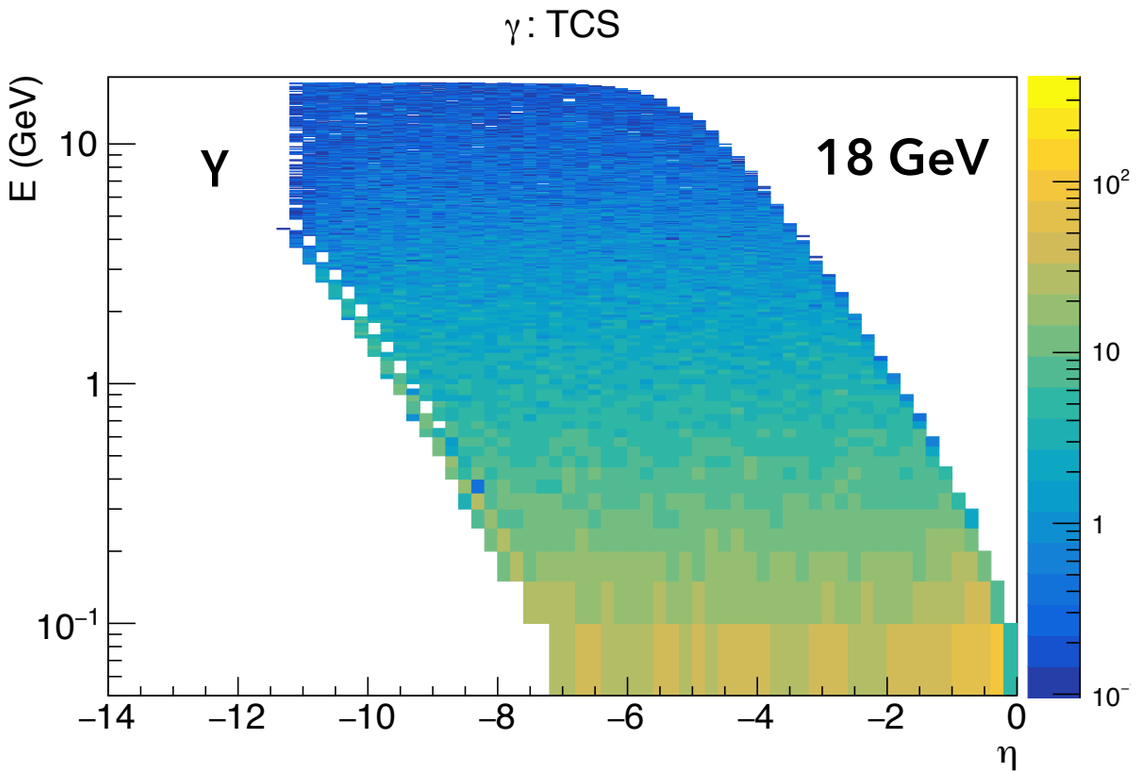




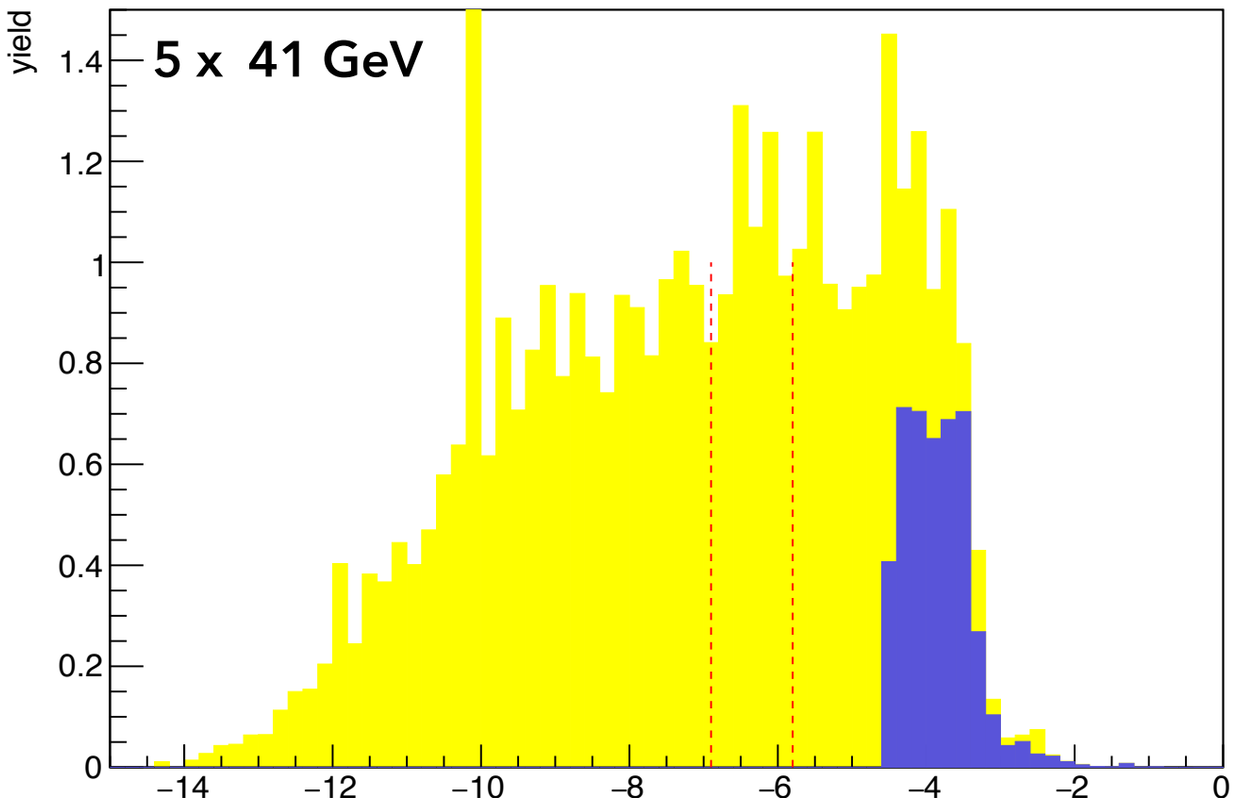
Scattered electron looks the same for both BH and TCS.
Ratio of TCS/BH hovers around ~1%

Scattered electron distribution (momenta, pseudo-rapidities) defined by the electron beam energy.

Quasi-real photon carries very low momentum



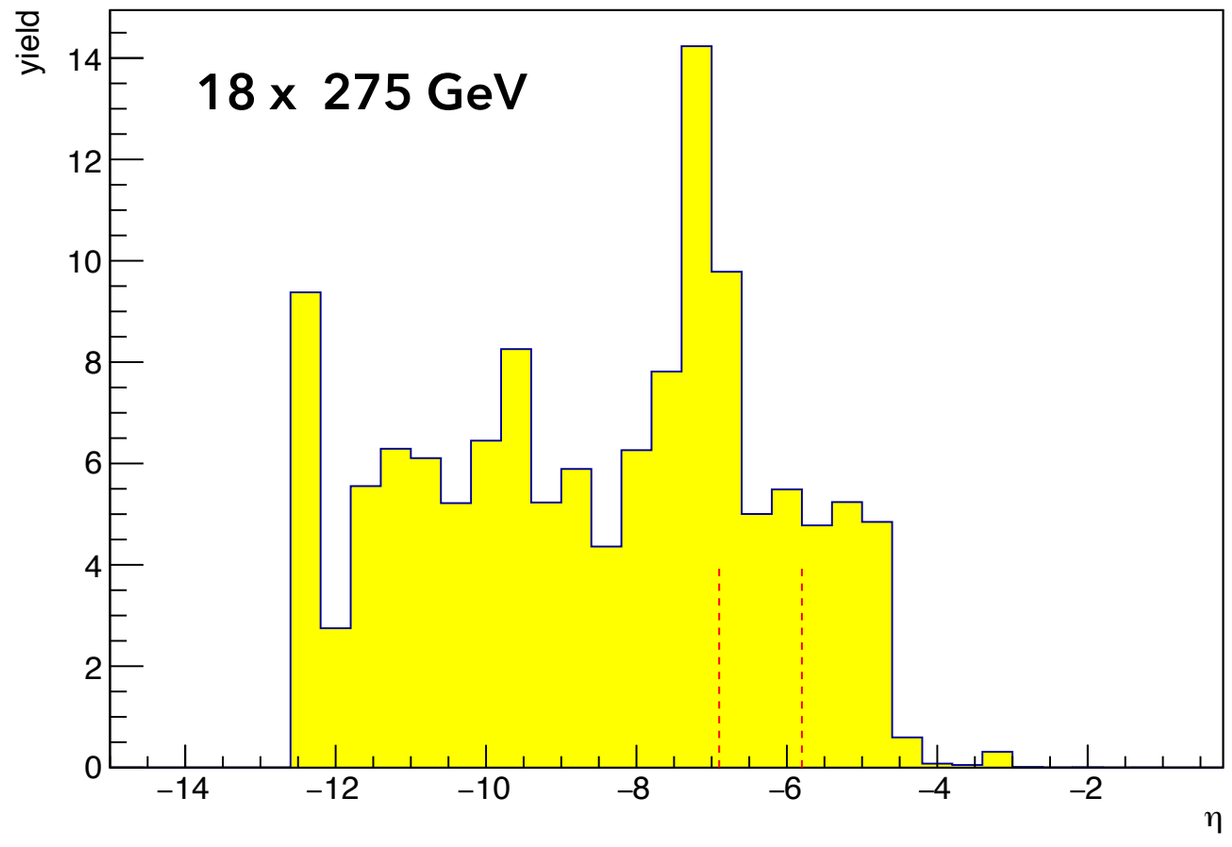
Scattered electron: acceptance and low-Q^2 tagger



Yellow: all generated

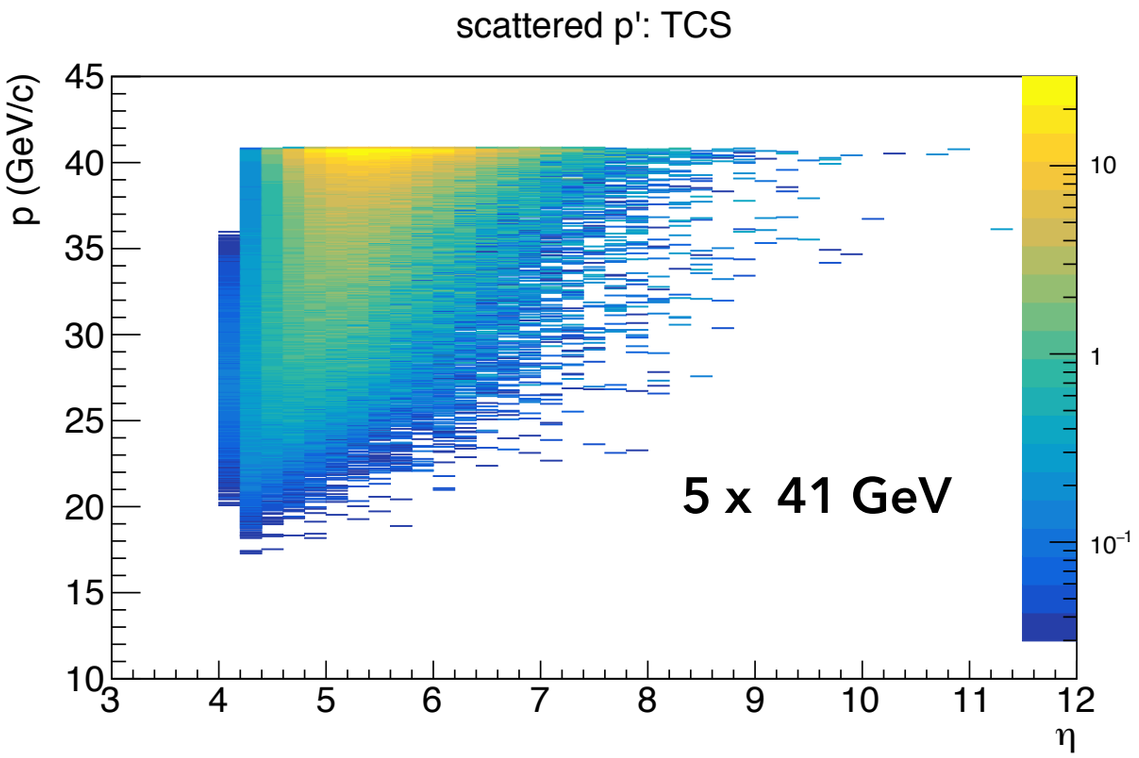
Purple: generated values for reconstructed events

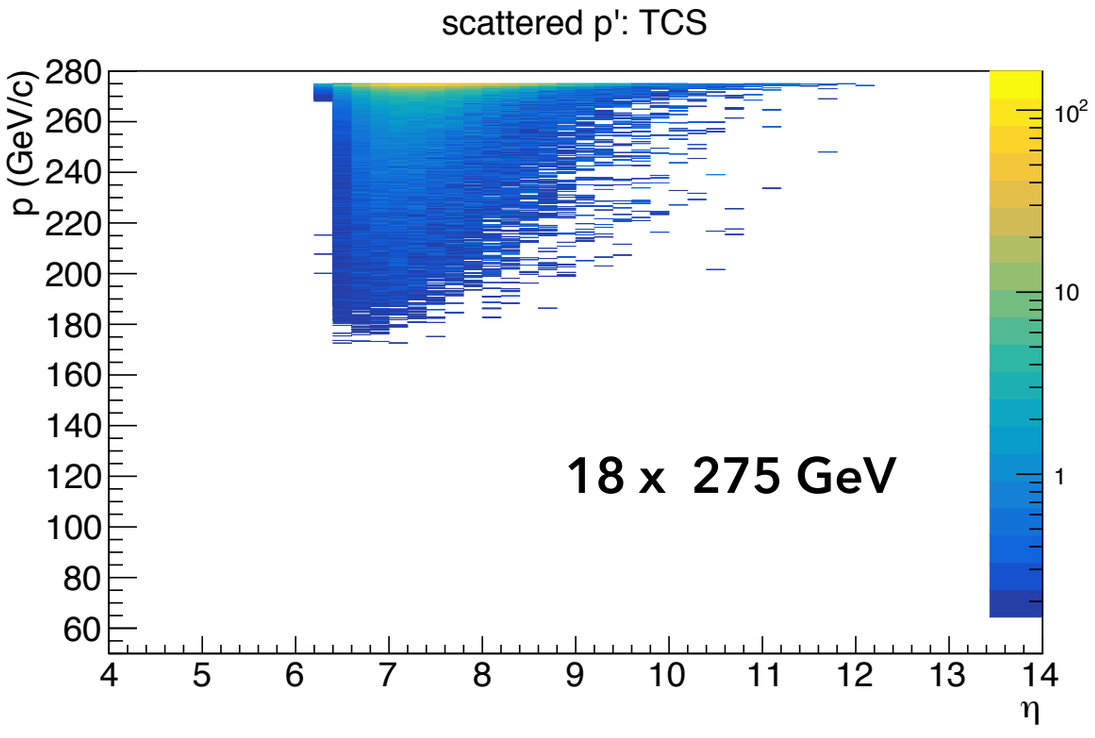
Red dashed lines: acceptance of low-Q^2 tagger.



- Detection of the scattered electron in the central detector is only possible for the lowest energy setting, and for a small fraction of events.
- Low-Q^2 tagger would increase stats by a small fraction.

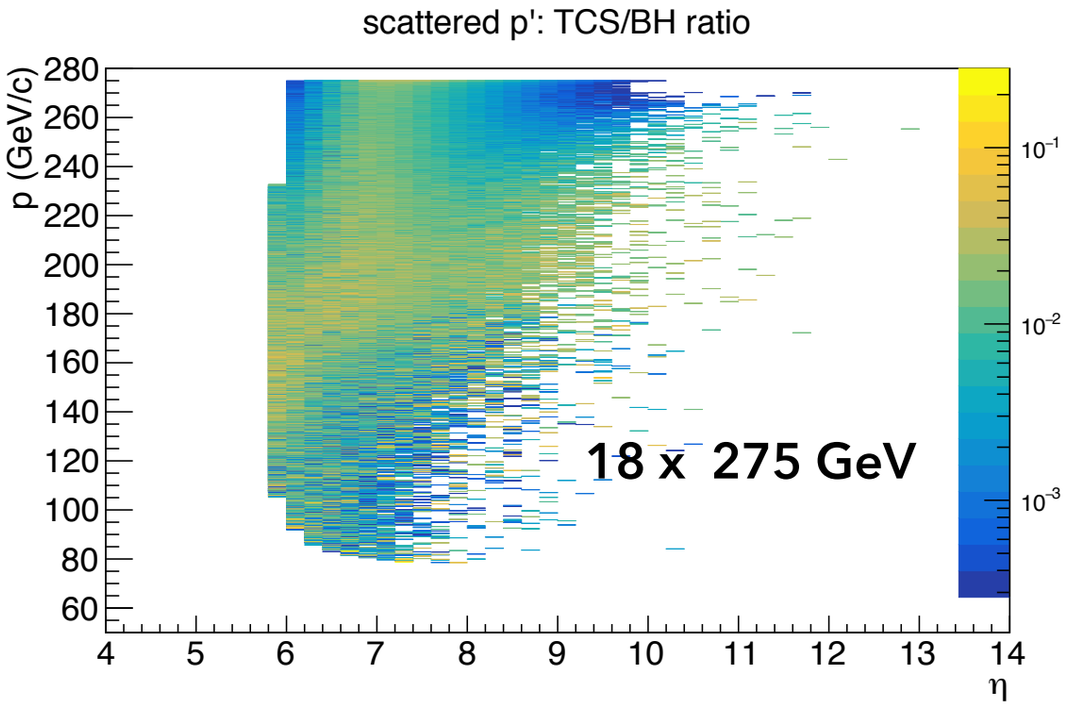
Recap: scattered proton



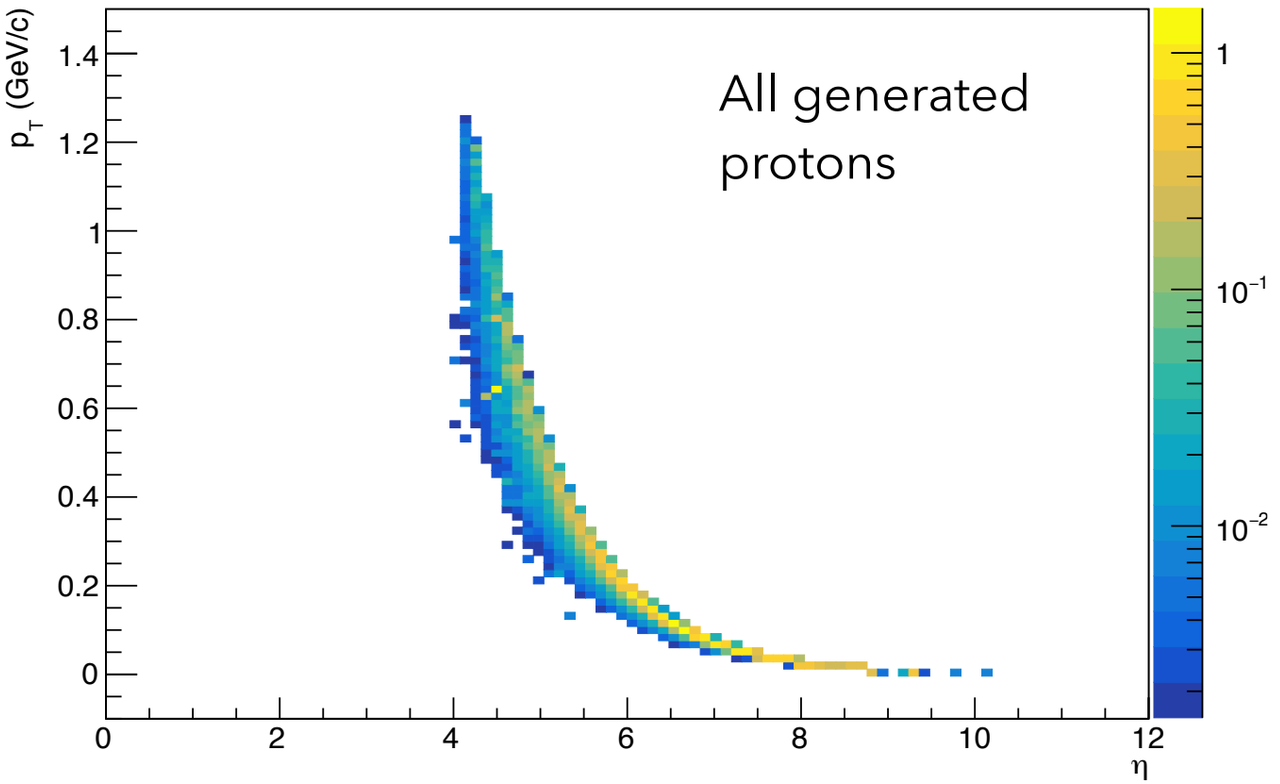


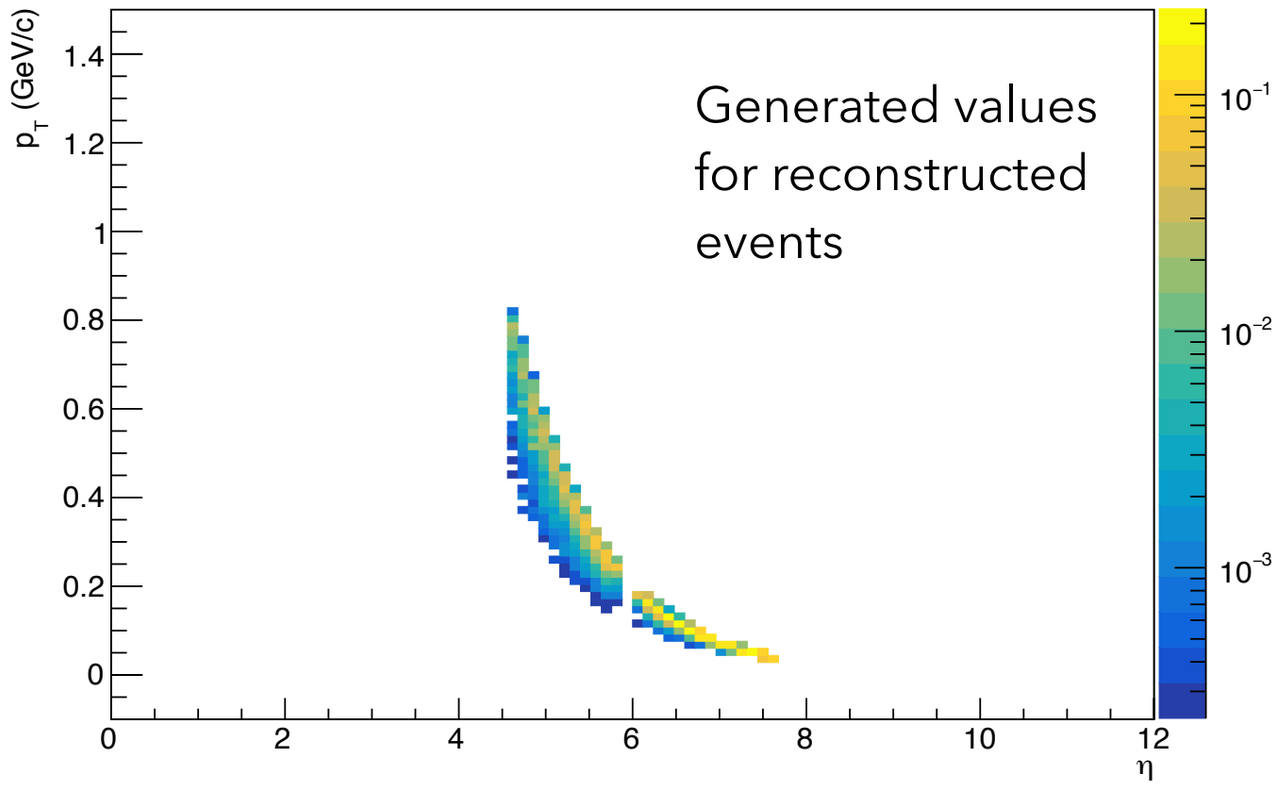
Distribution (pseudorapidity, momenta) defined by proton-beam energy.

TCS/BH ratio shows a Y-shaped non-uniform distribution for all energy settings.



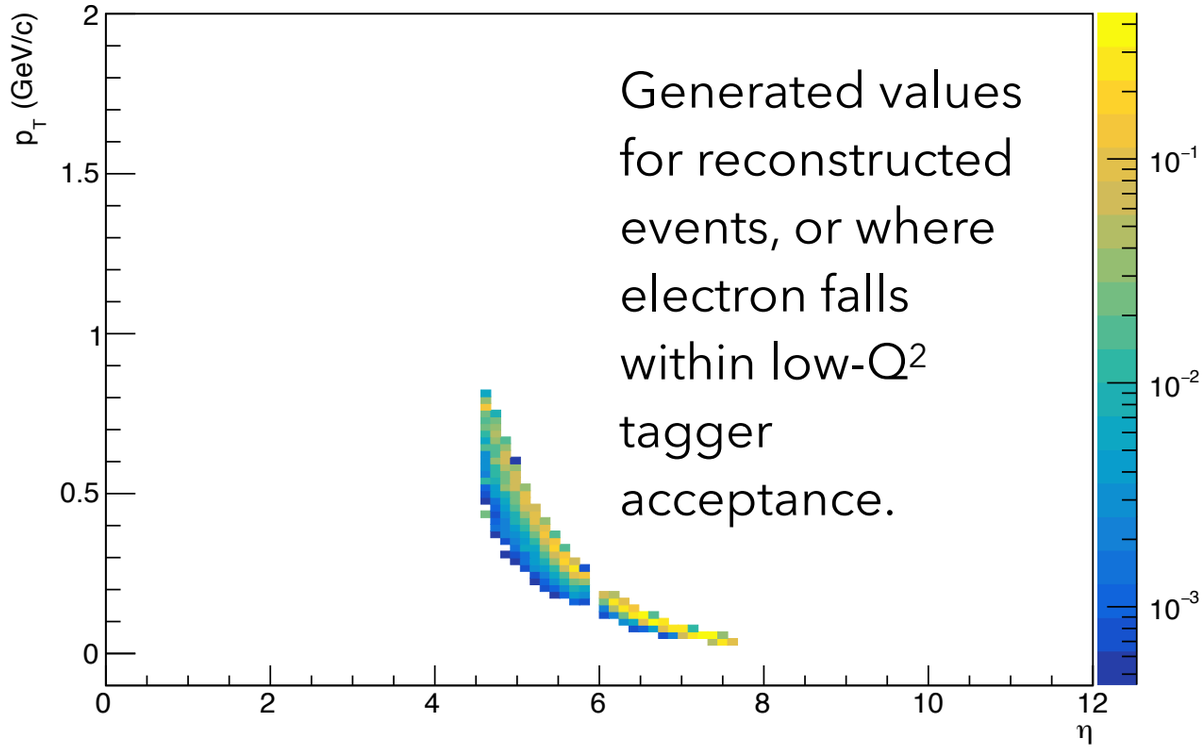
Scattered proton transverse momentum: 5 GeV x 41 GeV



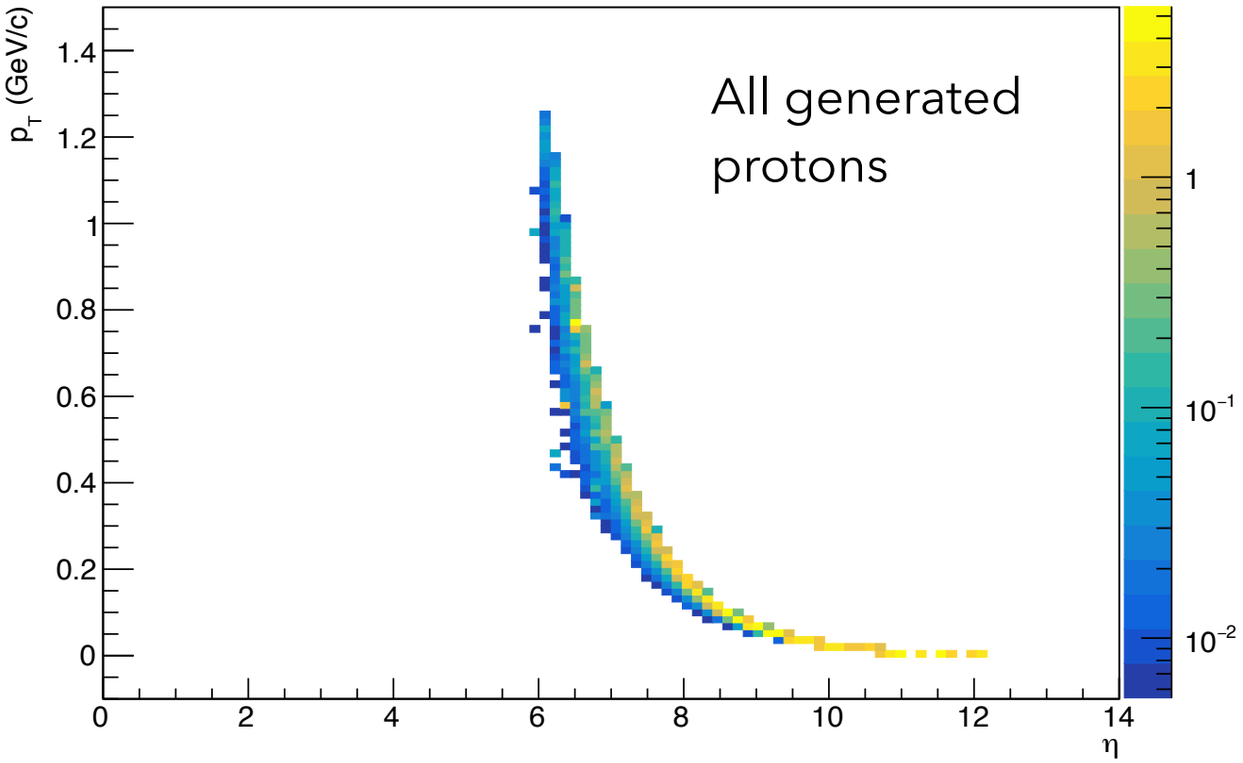


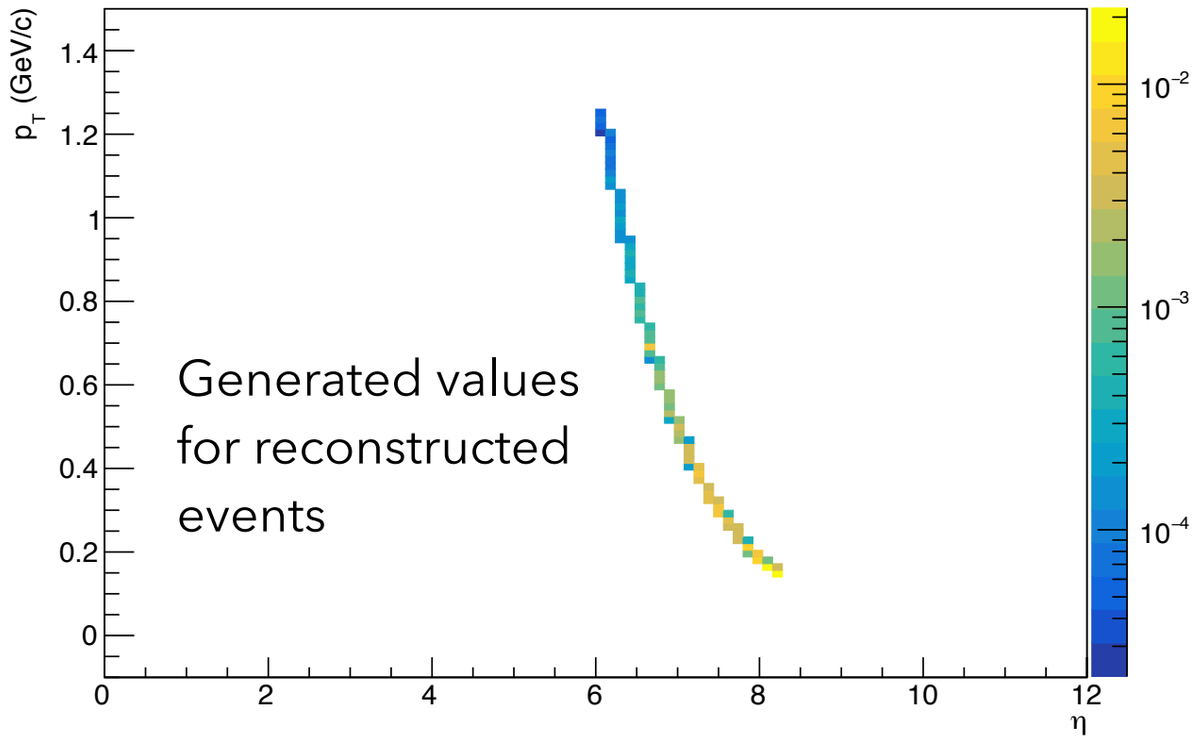
Loss of small number of events between central endcap and far-forward detectors, small gap just below eta = 6, loss of stats at eta > 7.7 (due to min p_T).

Addition of low-Q^2 tagger doesn't seem to change much.



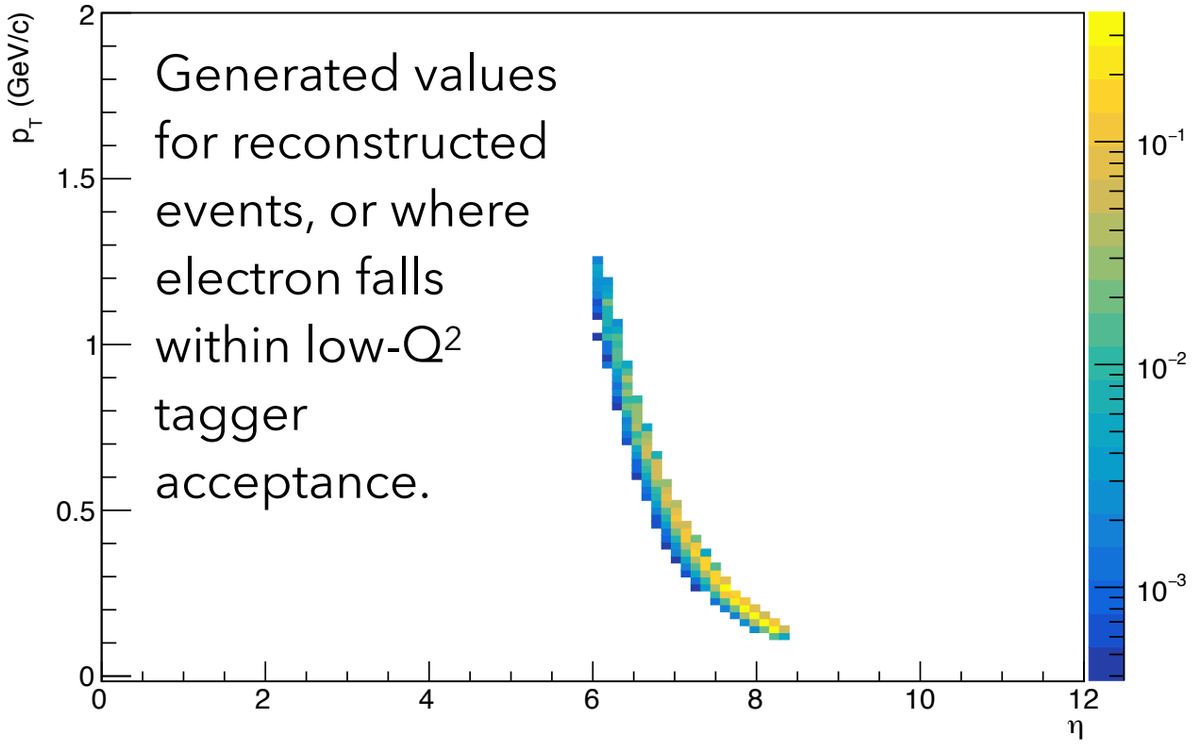
Scattered proton transverse momentum: 18 GeV x 275 GeV



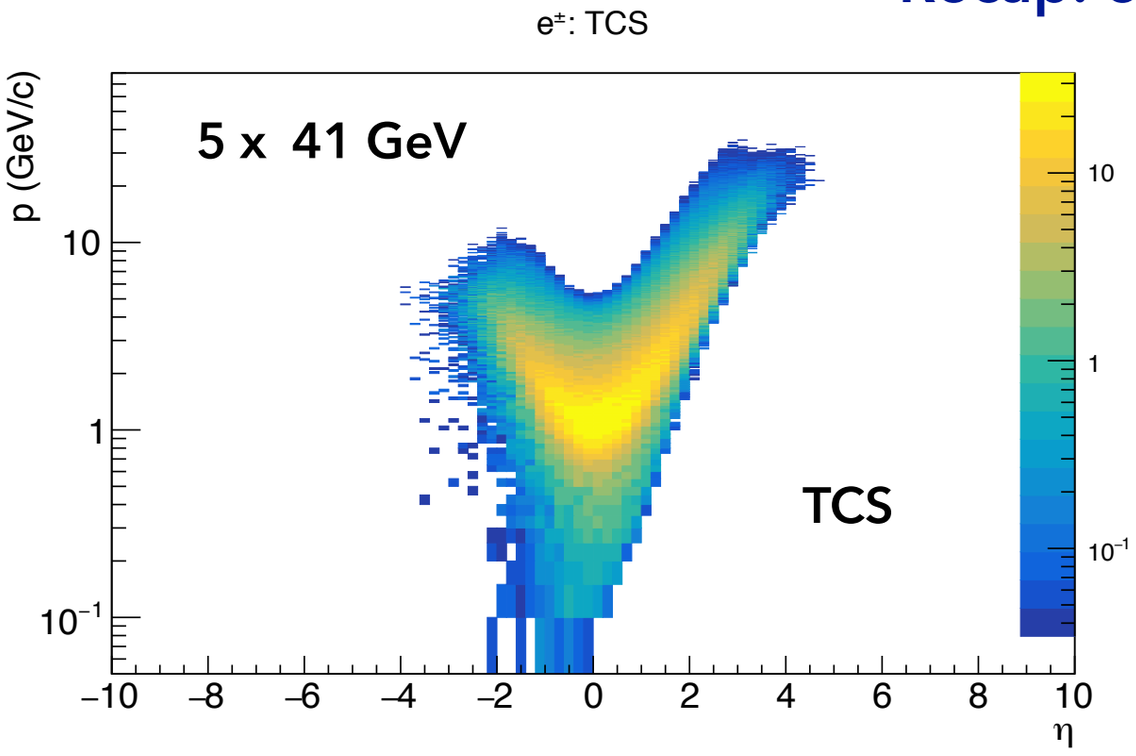


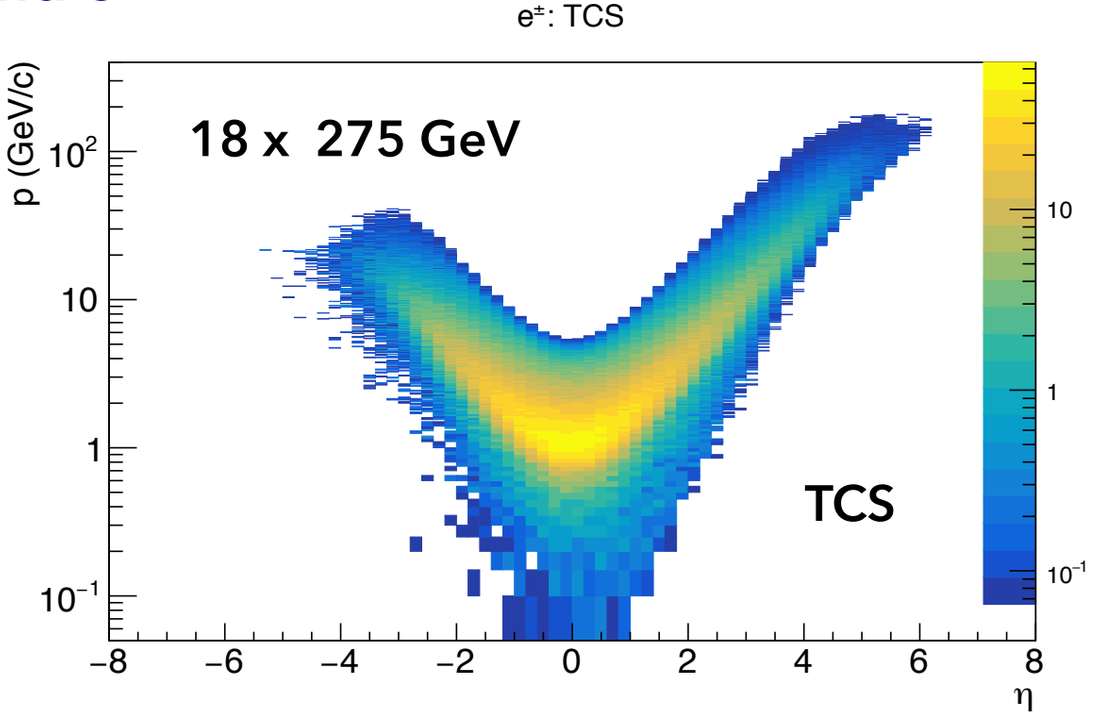
Loss of stats at eta > 8.4 (due to angular acceptance).

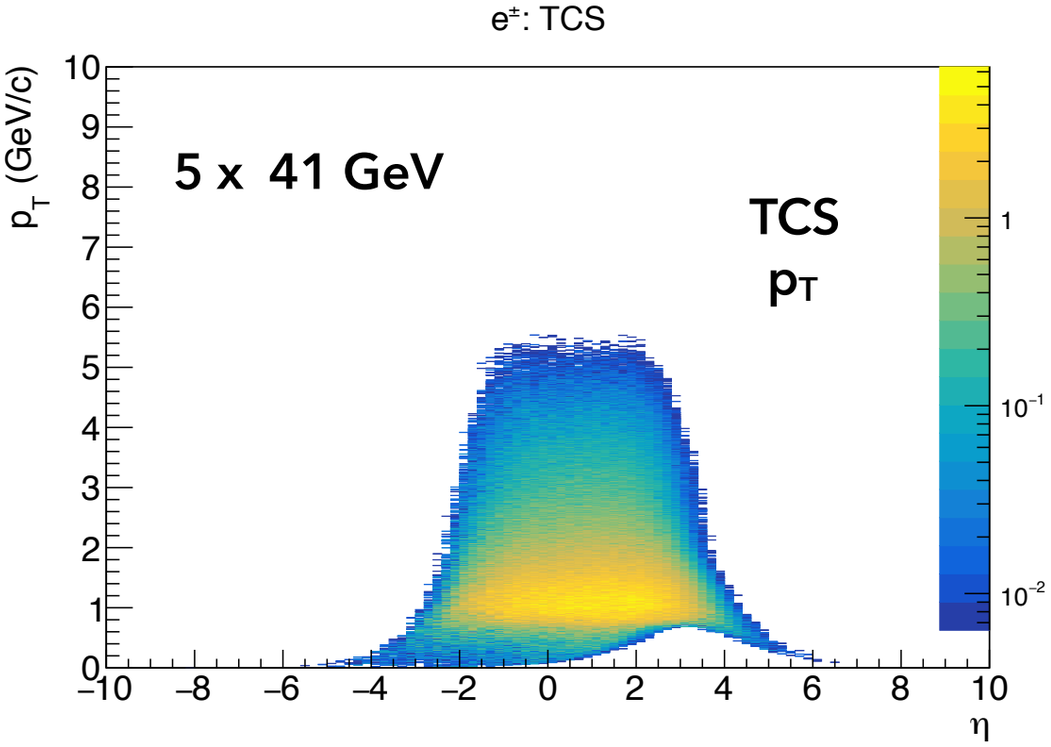
Addition of low-Q^2 tagger increases the statistics somewhat.

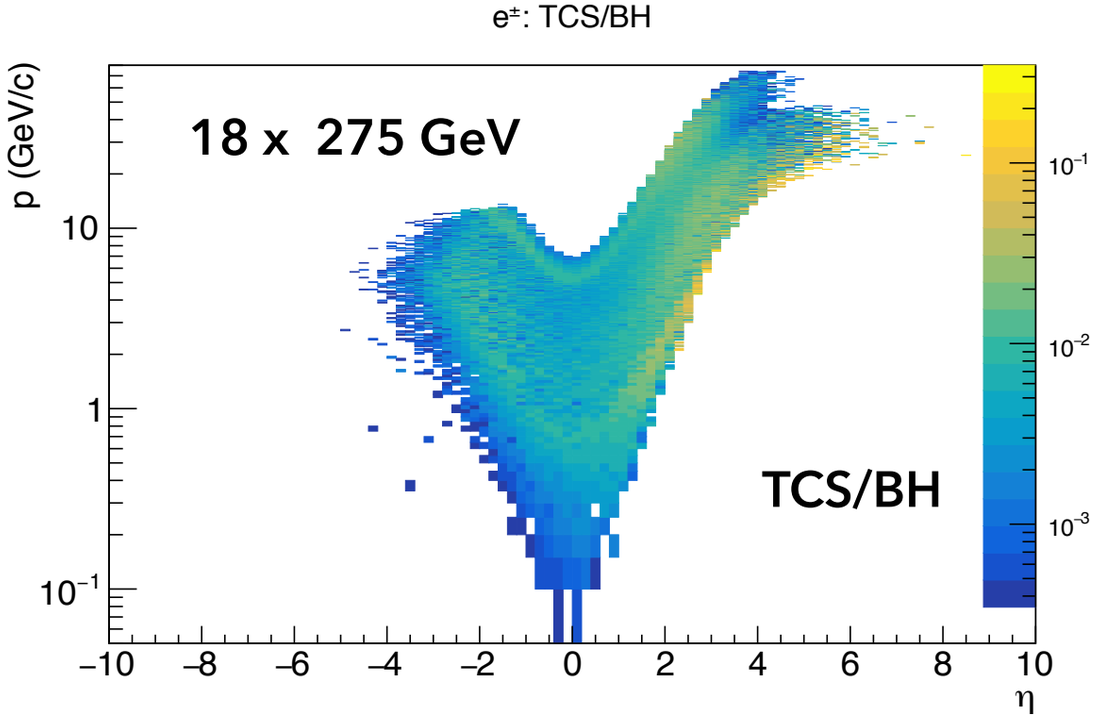


Recap: e+ and e-



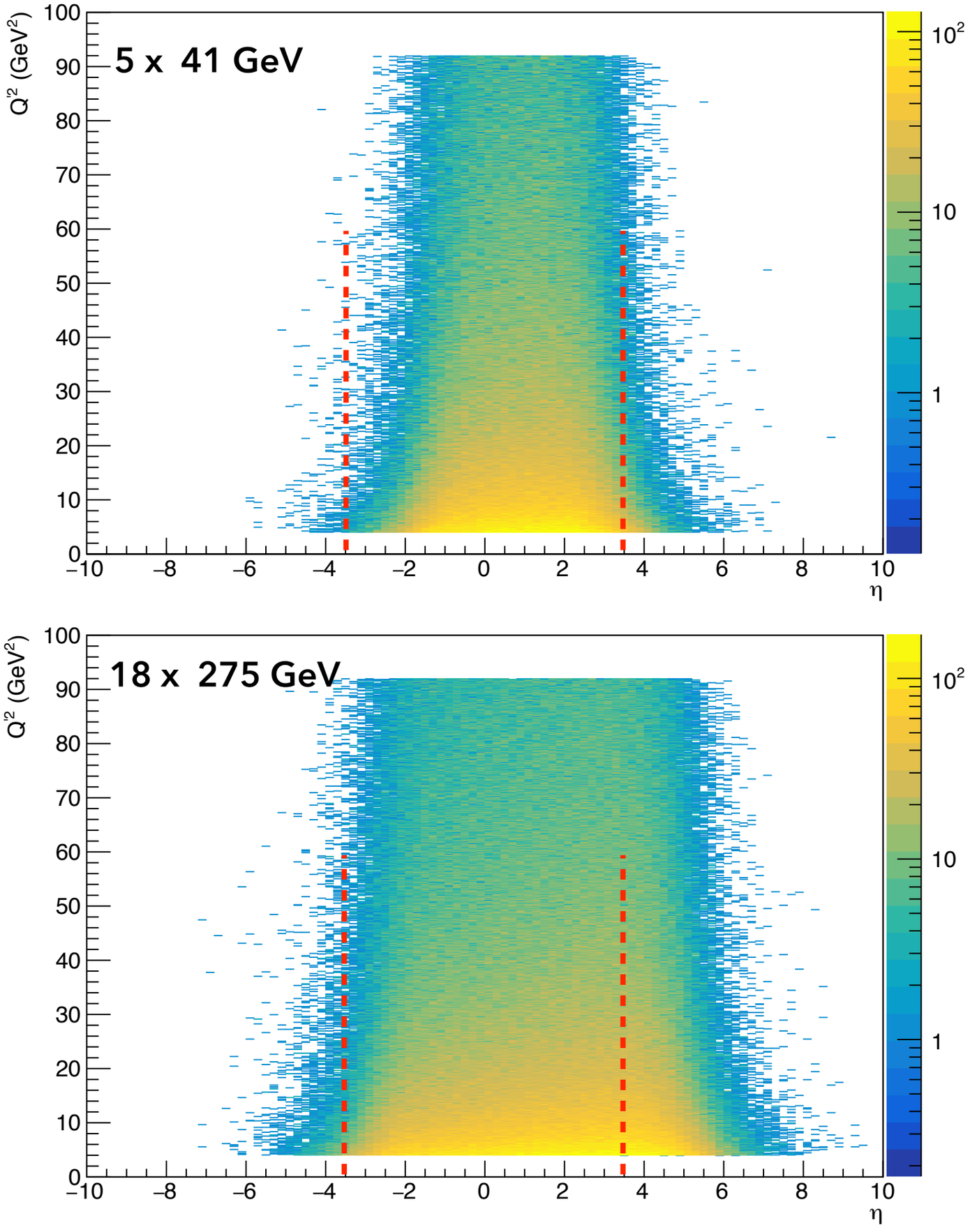






- Max forward / backward momenta defined by beam energies.
- Transverse momenta peak at 0.8 - 2 GeV/c
- Ratio of TCS/BH fairly uniform, edge effects possibly due to binning.
- Muon distributions: same

Lepton pair: acceptance effect on kinematics



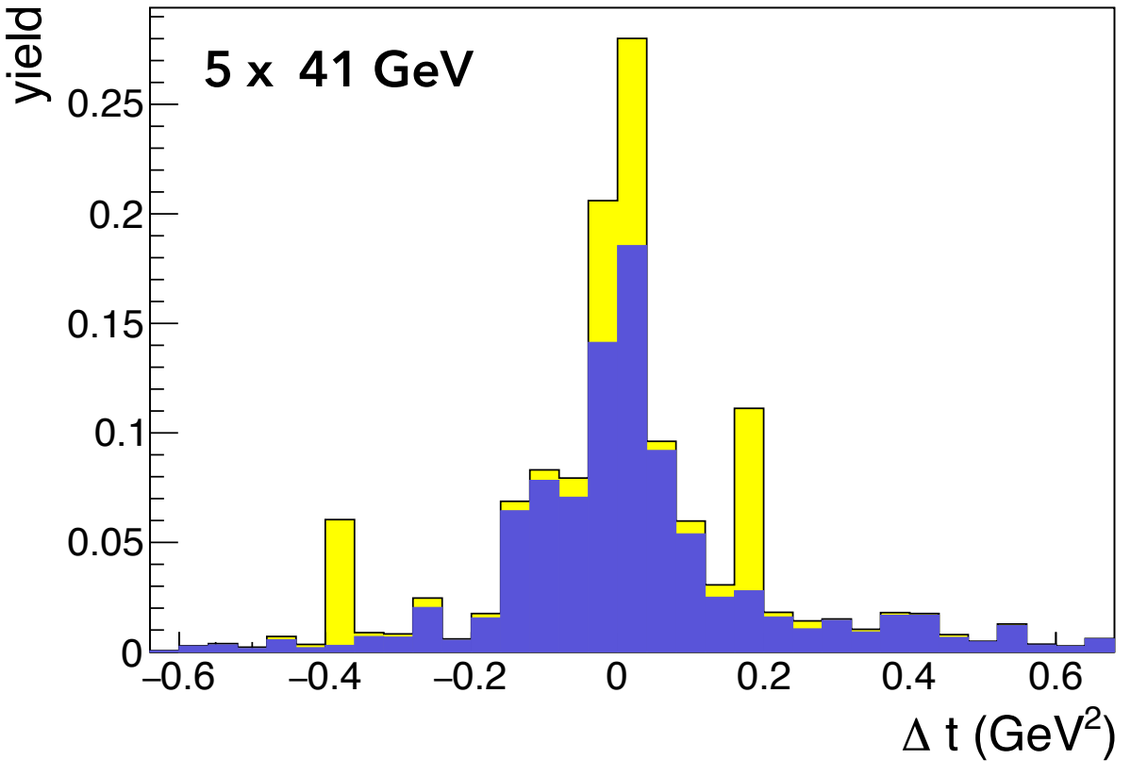
Note: eta shown is of the leptons (e^+e^-)

Red dashed lines: acceptance of central detector

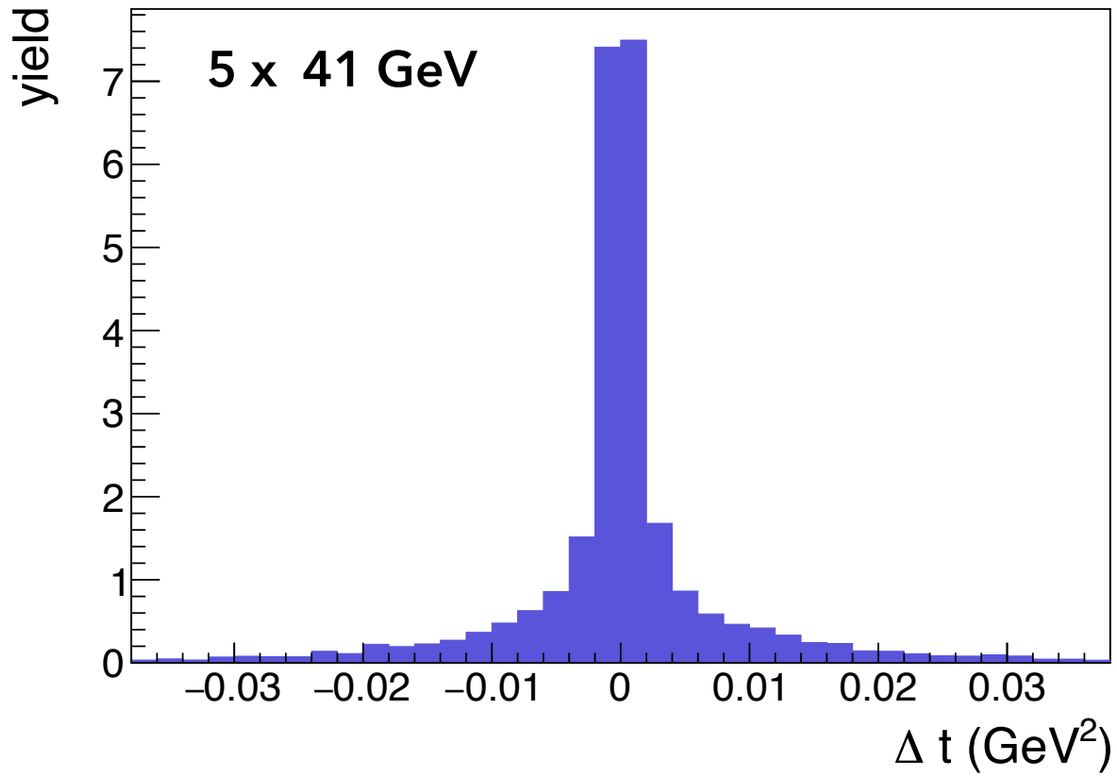
- At lowest collision energies, some very small loss of events with lowest Q'^2
- At highest collision energies, very forward leptons are missed – loss of events at all Q'^2

Resolution on t

$t = (q' - q)^2$



$t = (p' - p)^2$

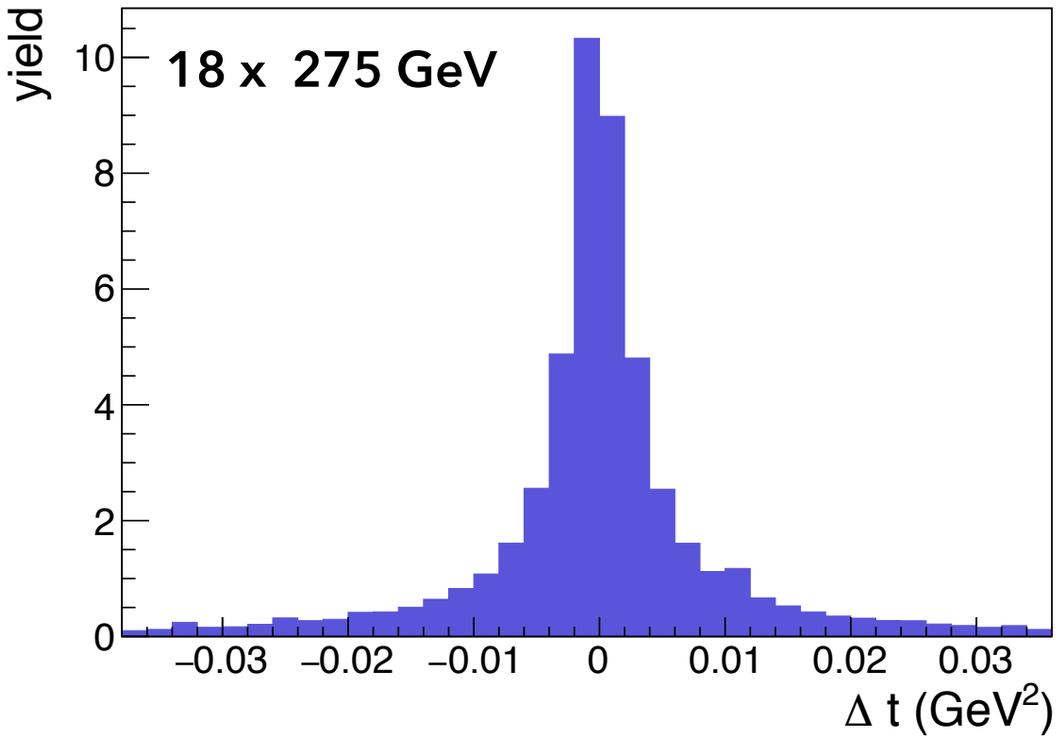


Plots show generated t - reconstructed t, where t is calculated either using q and q′ or p and p′

Yellow: events with a reconstructed electron

Purple: events where a proton was also reconstructed

Resolution **much** better when using proton information. Unless low-Q^2 tagger can have phenomenal resolution, it's not needed for t.



Summary

- BH dominates over TCS by ~ a factor of 100.
- For all produced particles, TCS and BH distributions are practically identical.
- Defining quasi-real photo production as $Q^2 < 0.1$, except for a small fraction of the statistics at the lowest electron beam energy, scattered electron falls outside of the central detector acceptance. Would need to be reconstructed from e^+e^- and p'.
- Low-Q2 tagger would enable a small fraction of scattered electrons to be detected at all collision energies.
- Resolution on t is, however, >10 times better if t is calculated using incoming and scattered proton instead of scattered electron and the produced lepton pair – this does not, however, include uncertainty on the beam momentum! Needs to be checked…
- Scattered electron and produced lepton pairs well-separated in scattering angle: minimal background.
- No strong motivation for low-Q^2 tagger, except as additional background suppression and systematic checks.
- At lowest collision energies, missing high-angle protons. Lowest-angle protons missing at all collision energies. Need to estimate fraction lost… Pushing acceptance of Roman Pots to the lowest p_T values possible is crucial.
- Produced lepton pair fare well – they're easily detectable in the central detector and only the very forward leptons are lost at the highest collision energies. This cuts into the Q'^2 distribution uniformly.
- Next steps: full detector simulation…