Data production QA, 32b vs 64b QA, TPC alignment study with st_W Run 22

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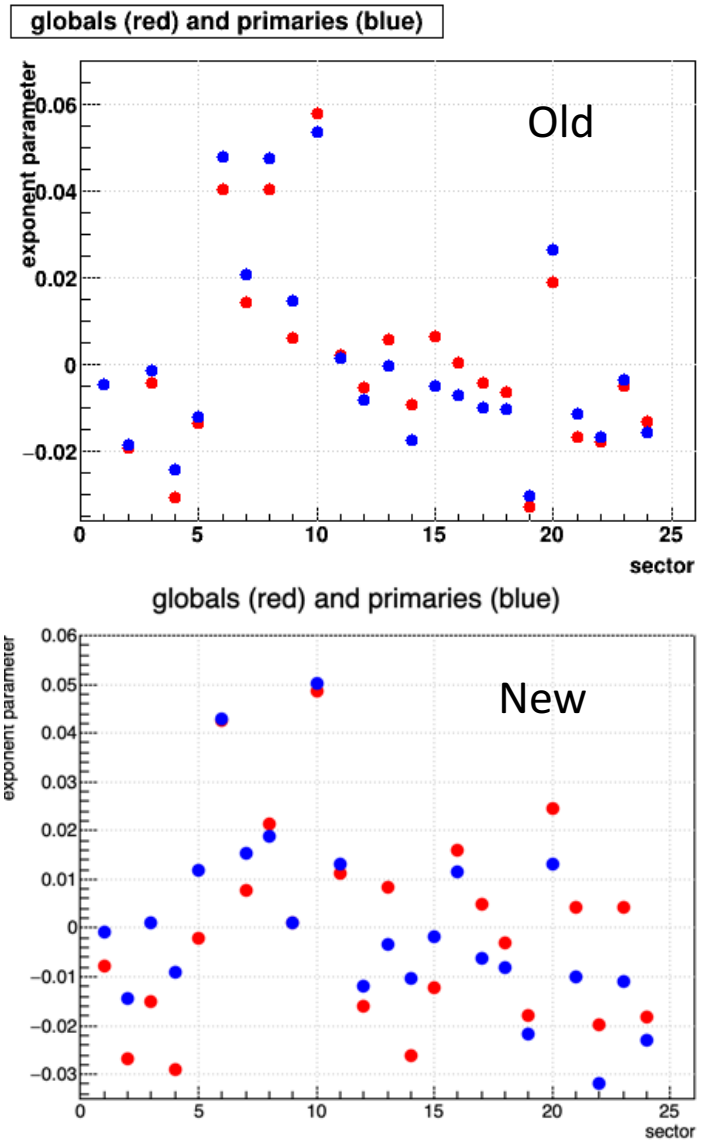
QA

- Management team is looking for volunteers for the following tasks:
  - Data production QA (Run 22-25)
    - Ongoing Run 25 data-taking
    - Large dataset production (Run 22 onward)
    - 2 volunteers from each PWG
  - 32b vs 64b QA
    - Software team is migrating from 32b infrastructure to 64b
    - 20% increase in production speed
      (Run 22 already being produced with 64b)
    - Expected effects: floating point precision + **software infrastructure**
    - Initially producing **Run 17, st_physics**, **BHT1**, **200M events** with 64b
    - Sample production ~1.5 month, can ask more data if needed
- Reach out to conveners if you would like to volunteer

TPC Alignment Study

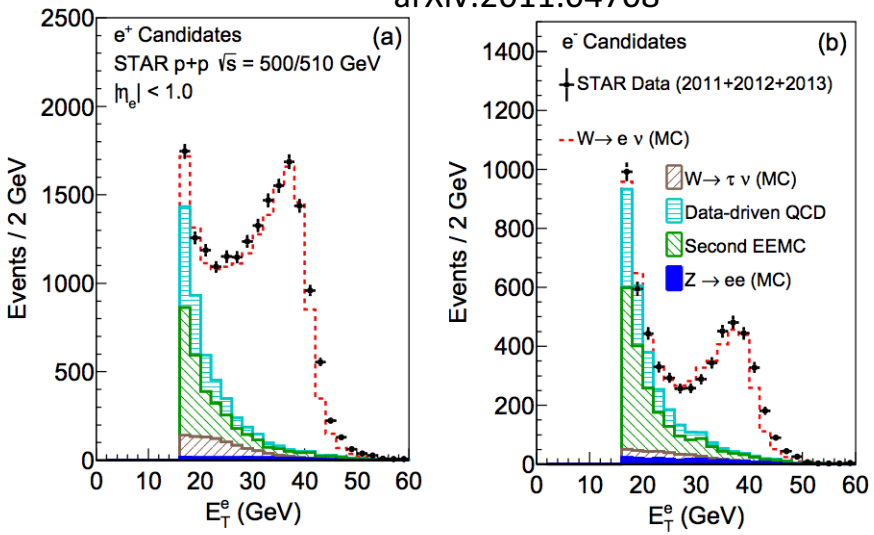


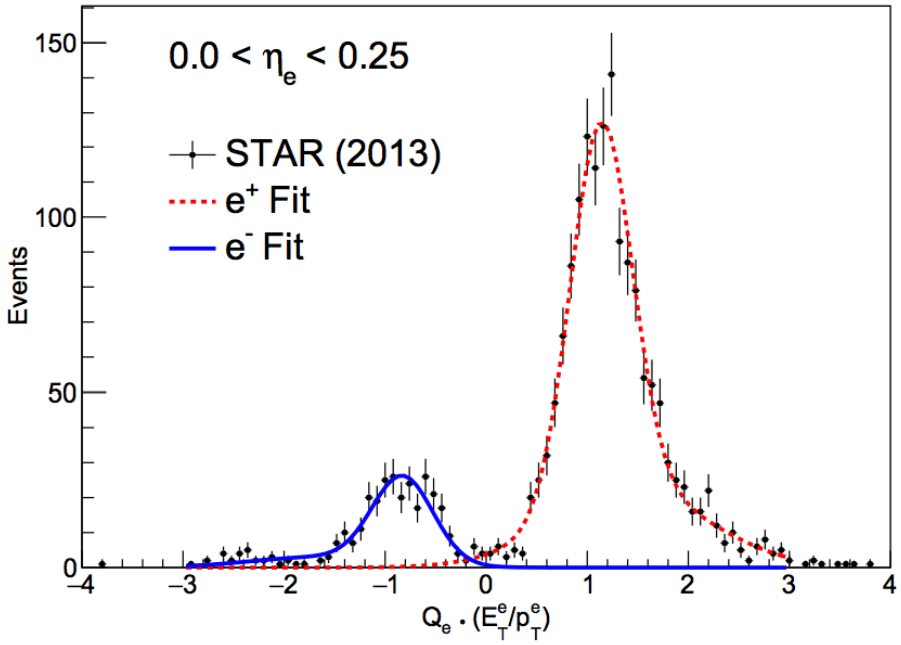
- Gene's TPC alignment study
  - https://drupal.star.bnl.gov/STAR/blog/genevb/h-h-Run-19-196-GeV-new-TPC-alignment
  - Run 19, AuAu, 19.6 GeV
  - Old vs new alignment software
  - Parametrization based on h+/h-
  - No significant improvement

- Run 22
  - How does the old TPC alignment perform with Run 22 (compared to previous)?
  - Input needed: expected impact on (spin/coldQCD) physics
  - For Run 22 st_physics/st_fwd production plan (needed fast)

Strategy

STAR Run 11-13 publication
arXiv:2011.04708

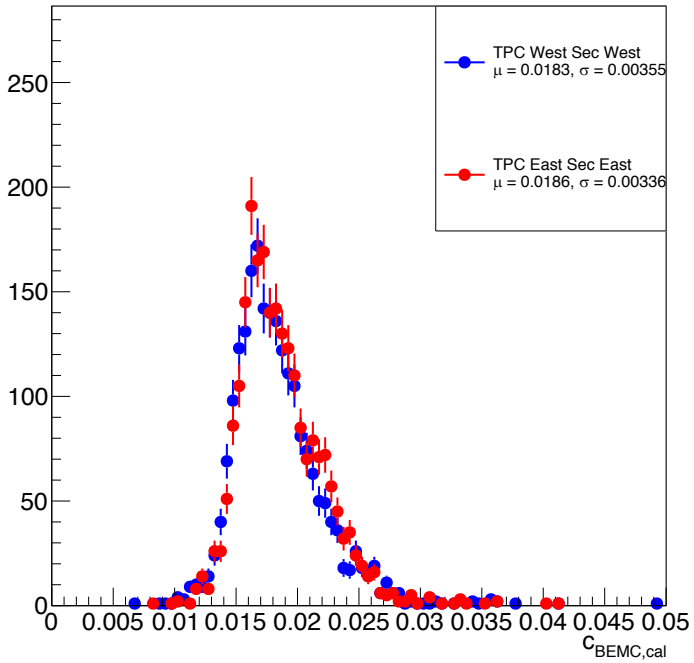




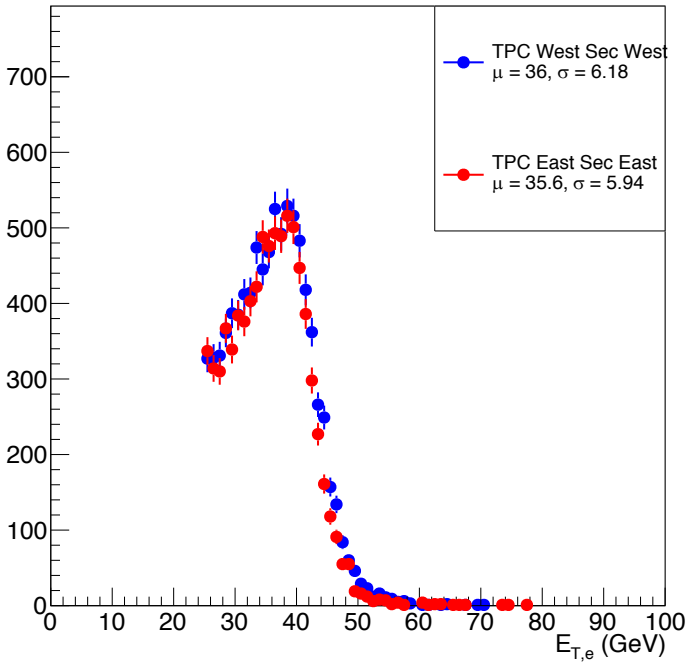
- Reconstructed $W \rightarrow e\nu$
  - EM final state ($p_T = E_T \sim 40\ GeV$)
  - "Mostly" free of TPC effect
    (Only used for charge discrimination, $q \times E_T/p_T$)
  - Clean identification
    ($B/S < 10\%$, at $E_T > 25\ GeV$)
- Strategy
  - Characterize each TPC sector
    (or West vs East) by fitting
    $q \times E_T/p_T$ with 4-Gaus (2 signal + 2 BG)
    or evaluating moments of distribution
- Dataset
  - All of st_W, Run 22, P23ia
    (3406 runs, No run QA performed)
  - Latest Run 22 BEMC (prel) calibration
    /star/u/charlespc99/run_22/BEMC_Cal/electrons/1014/electron.gains
  - TPC Sector 20 masked out
    (can be taken out)

BEMC gain and W signal

BEMC gain West vs. East



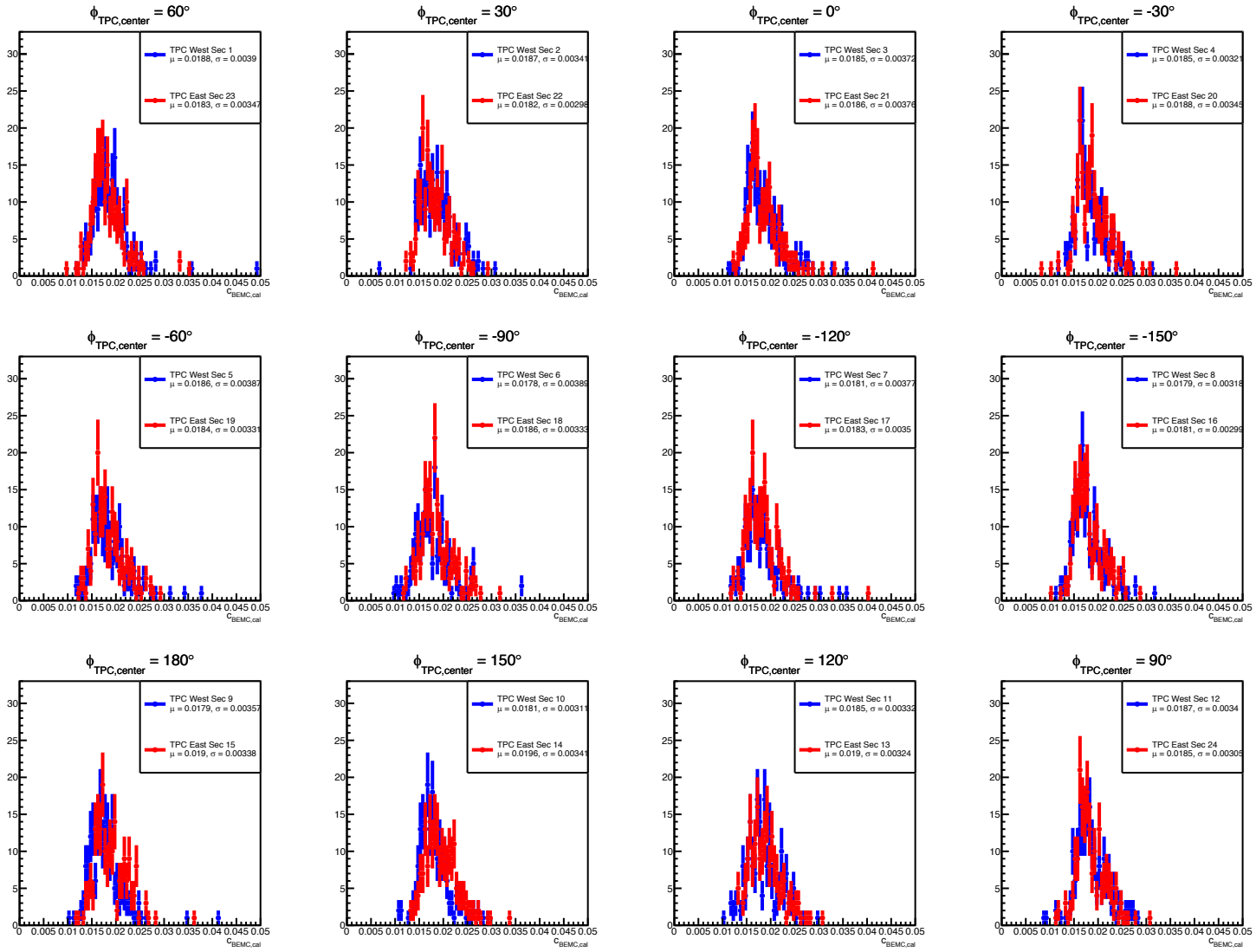
W signal (ET) West vs. East
No charge discrimination



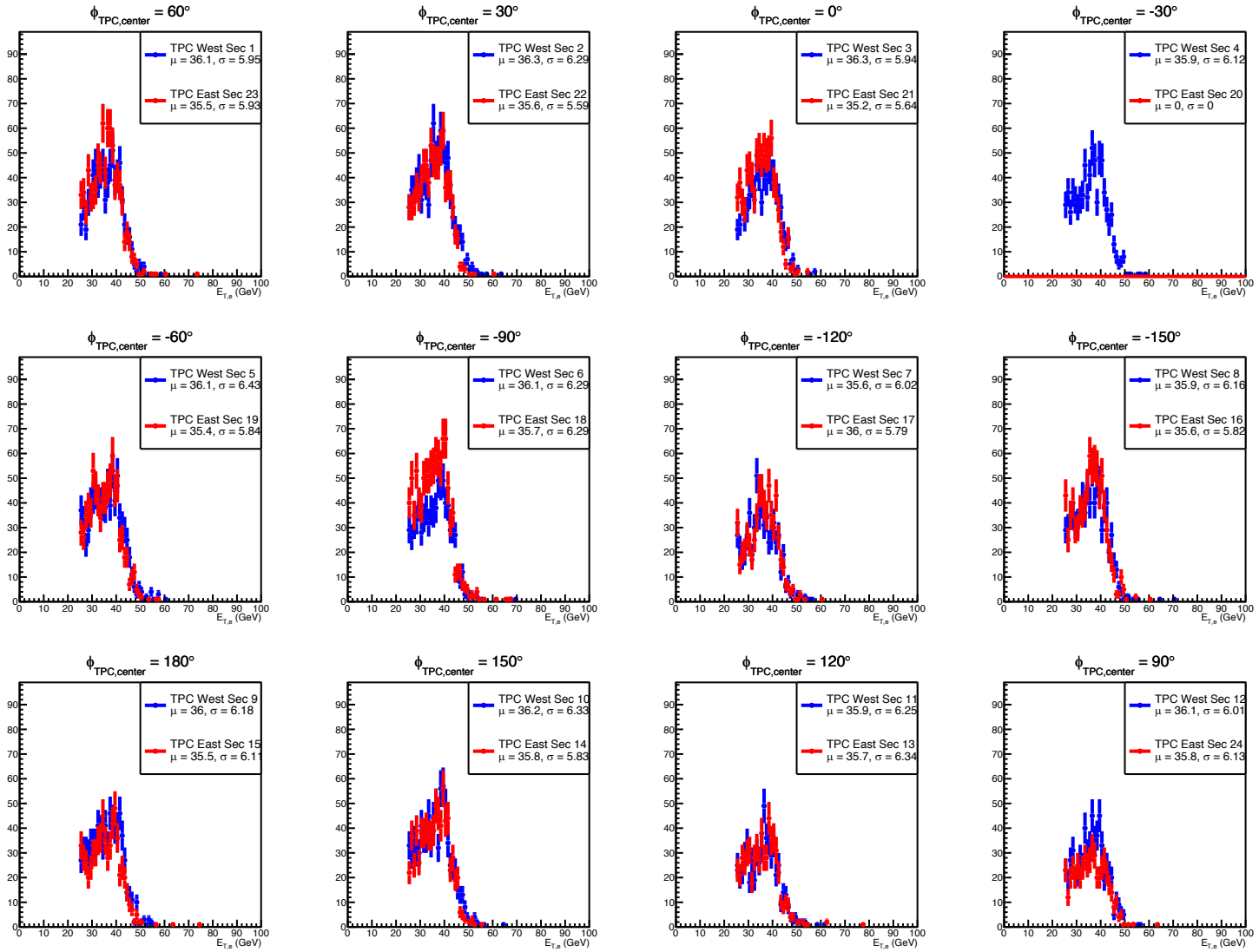
- $\sim 1.5\%$ lower BEMC gain in West
- $\sim 1.1\%$ higher $< E_{T,e} >$ in West
- $\sim 5.6\%$ wider gain width in West
- $\sim 4.0\%$ wider $E_{T,e}$ width in West

Physics signals do not converge; Shift/widening of BEMC gain and $E_{T,e}$ most likely coming from underlying detector effect

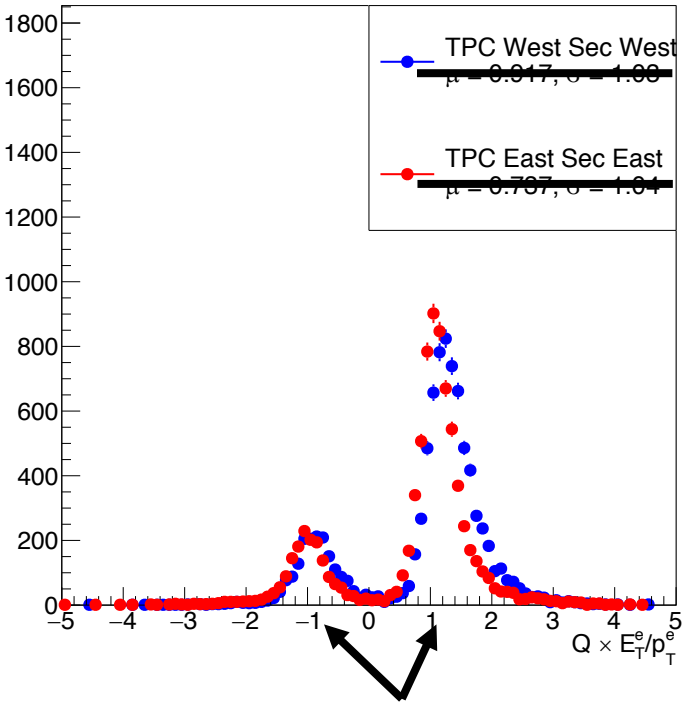
BEMC Gain per TPC sector



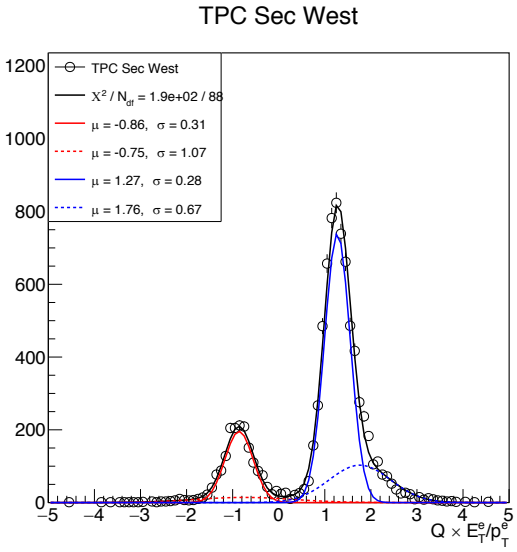
$E_{T,e}$ $(W \rightarrow e\nu)$ Signal per TPC sector

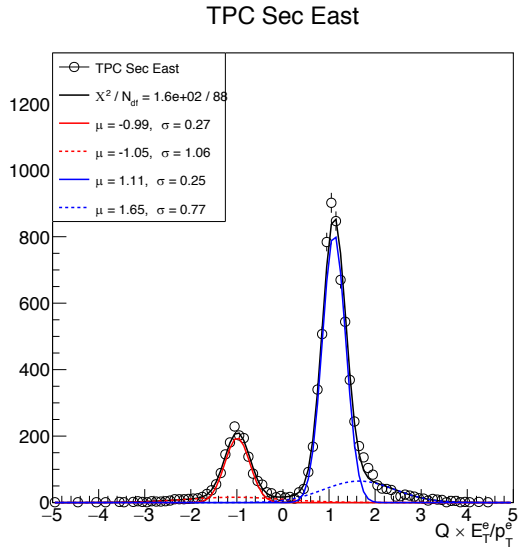


Charge Discrimination



Shift in $q \times E_T/p_T$ observed





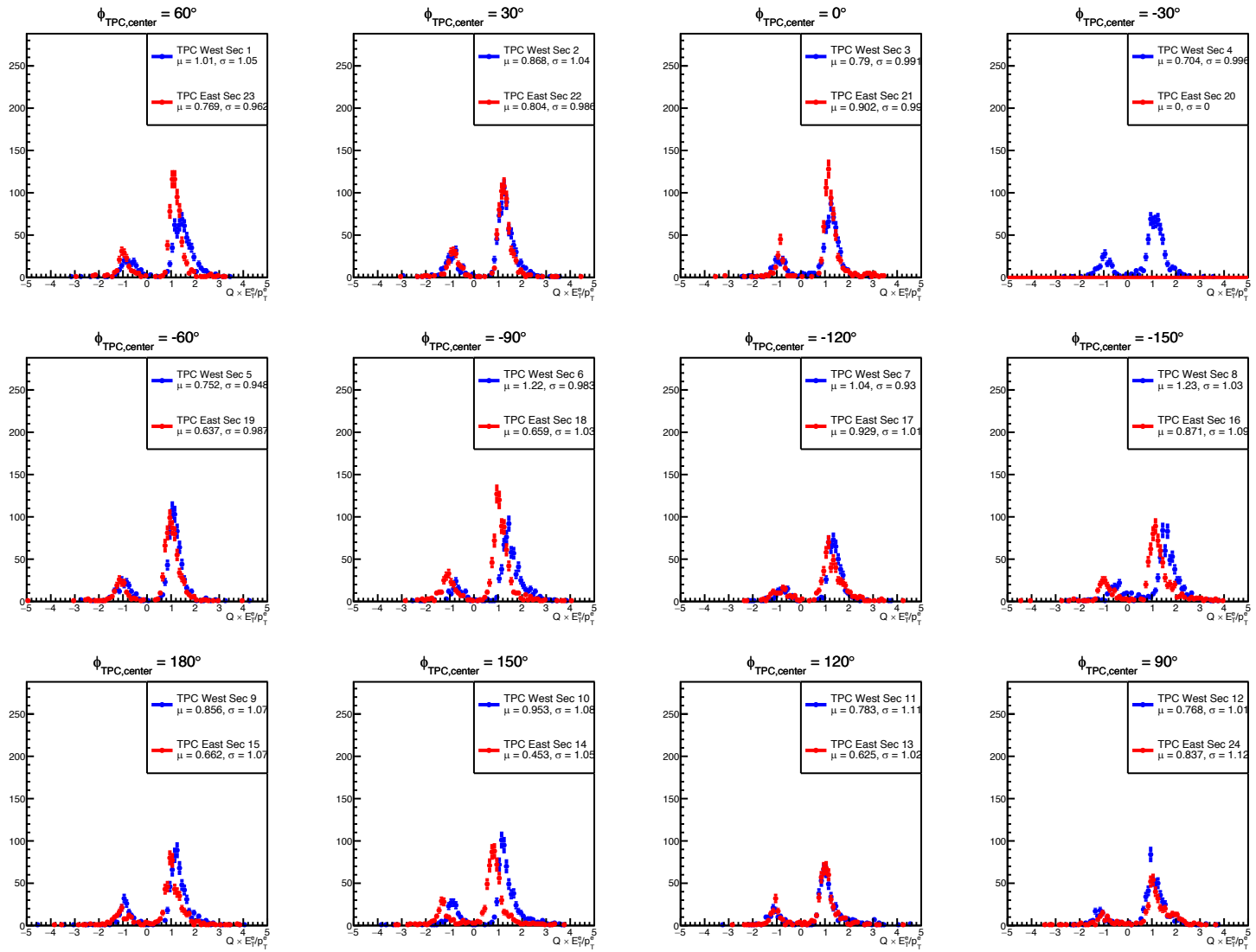
Fitting performed with

- 4 Gaussian, Log-likely, Range = $-5 < x < 5$
- Width < 0.5 for signal, > 0.5 for BG
- Centroid > 0.75 (< -0.75) to avoid one Gaussian fitting to $\mu \sim 0$
- No (signal) centroid fixing, final BEMC calib based on MC

- Poor description of background without help from MC
  - Expectation = Remaining background mostly charge symmetric (QCD-dijet + $Z \rightarrow e^+e^-$ (80%) vs $W \rightarrow \tau \rightarrow e$ (20%))

  → Evaluate different moments of distribution for now

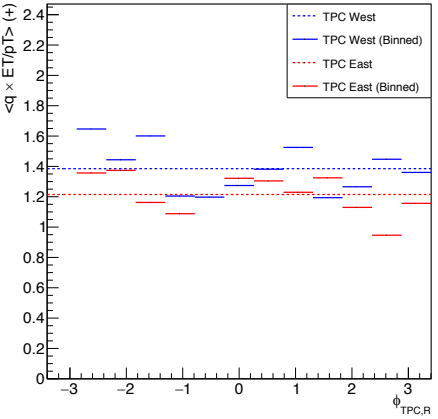
Charge distributions



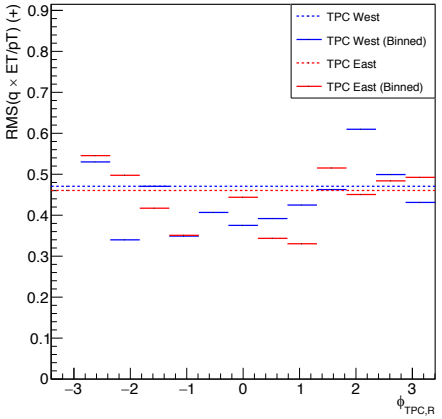
- Large mismatches seen in some sectors/phi regions
- Shifts in West sectors

Moments of $q \times E_T/p_T$ Dist.

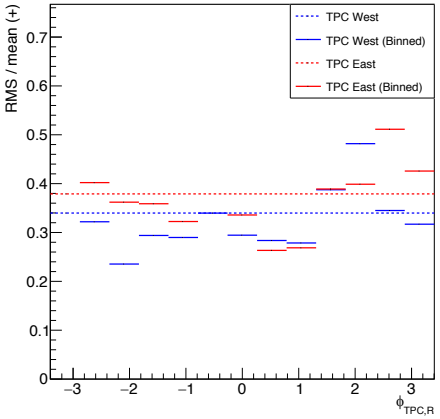
Mean E_T/p_T (e^+-side)



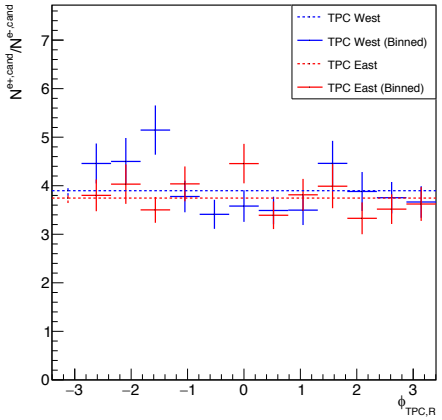
RMS (+)



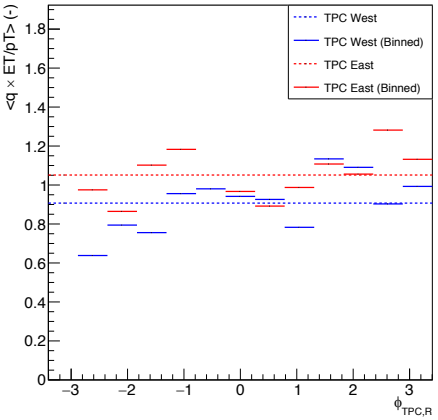
RMS / mean (+)



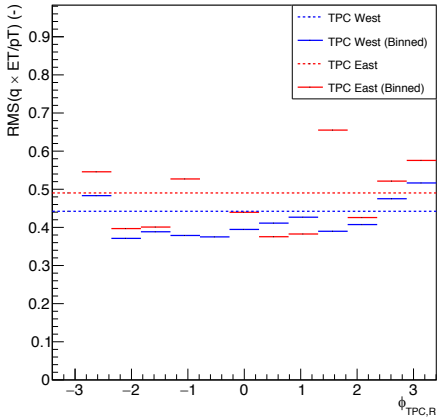
N^{e+}/N^{e-}



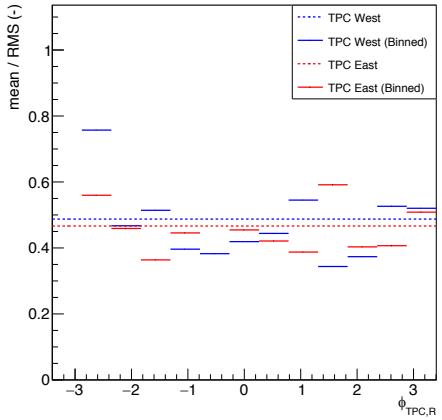
Mean E_T/p_T (-)



RMS (-)

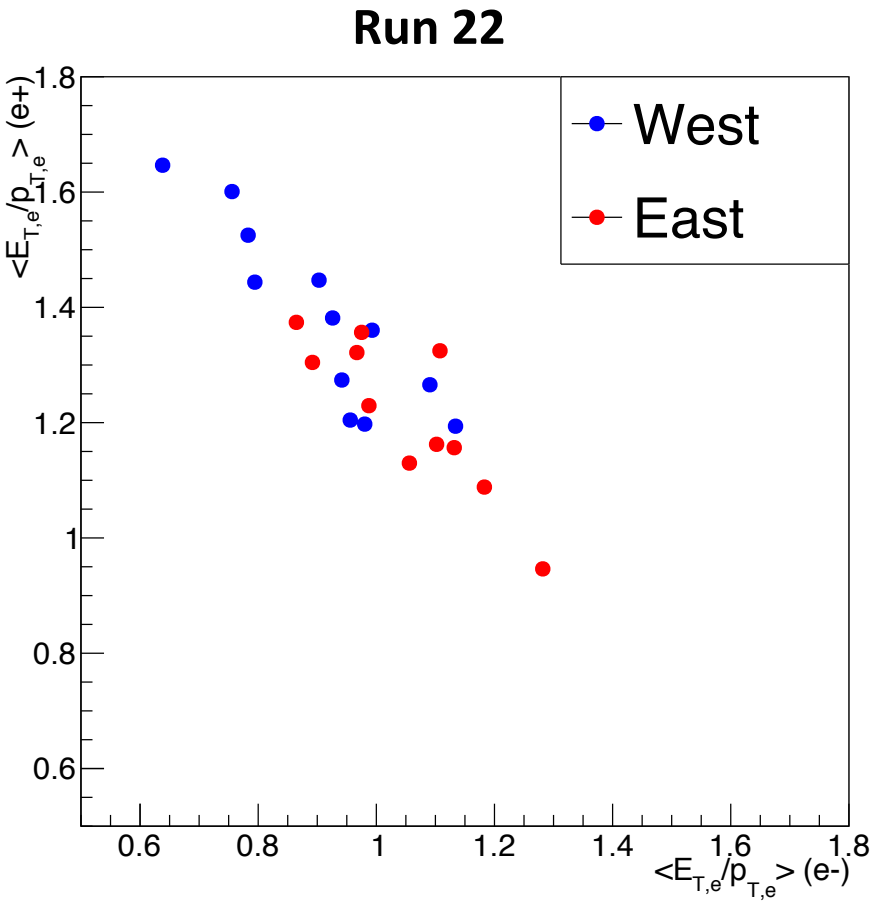


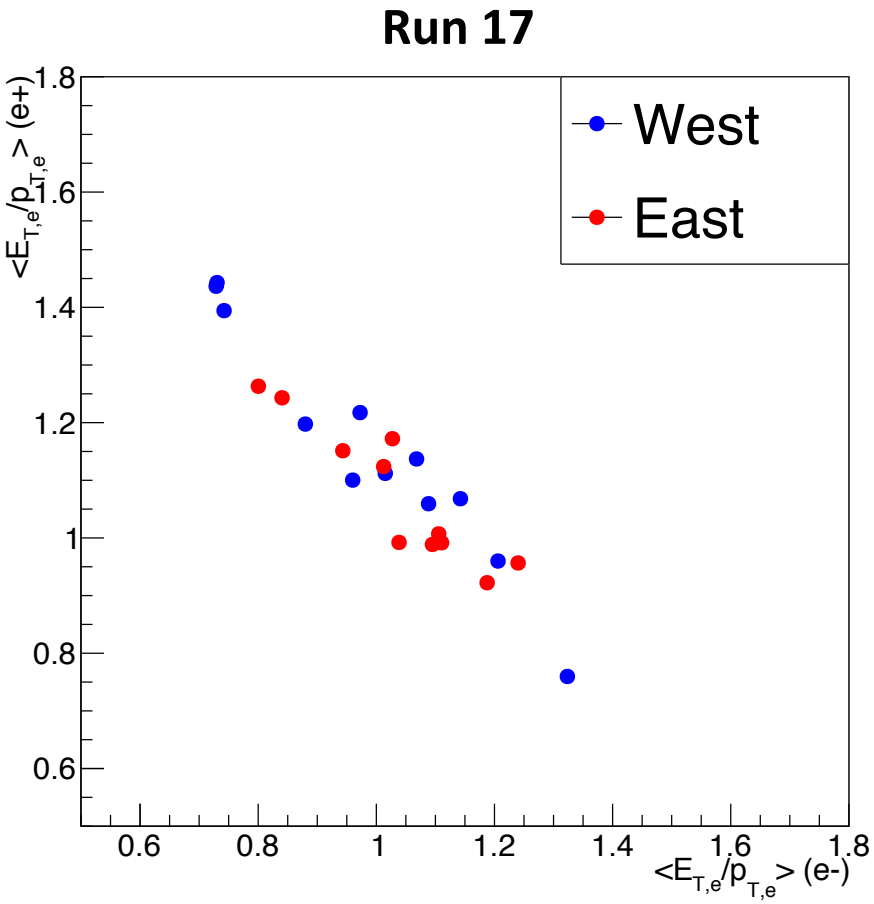
RMS / mean (-)



- East seems okay (no significant shift in mean between e+ and e-)
- Large shift in mean E_T/p_T in West

Comparisons with Run 17





- Run 17: Some broadening in West, but both East and West symmetric about mean(e-, e+) = (1, 1)
- Run 22: East behaves like Run 17, West is skewed towards low e- and high e+

Summary

- Potential TPC effects in Run 22 BEMC calibration identified
- $q \times E_T / p_T$ seems to be systematically shifted in the west side, which is not observed in Run 17
- Suggestions? Other observables? Physics implications?
- Key points
  - Using new alignment increases production time by $\sim 50\%$
  - New alignment also is imperfect; improvement not clear
  - Producing a test sample will take > 1 month
  - Post-reconstruction momentum correction by Emmy Duckworth
    https://drupal.star.bnl.gov/STAR/subsys/tpc/tpc-group-meetings
    https://drupal.star.bnl.gov/STAR/system/files/presentation_2024-12-18.pptx

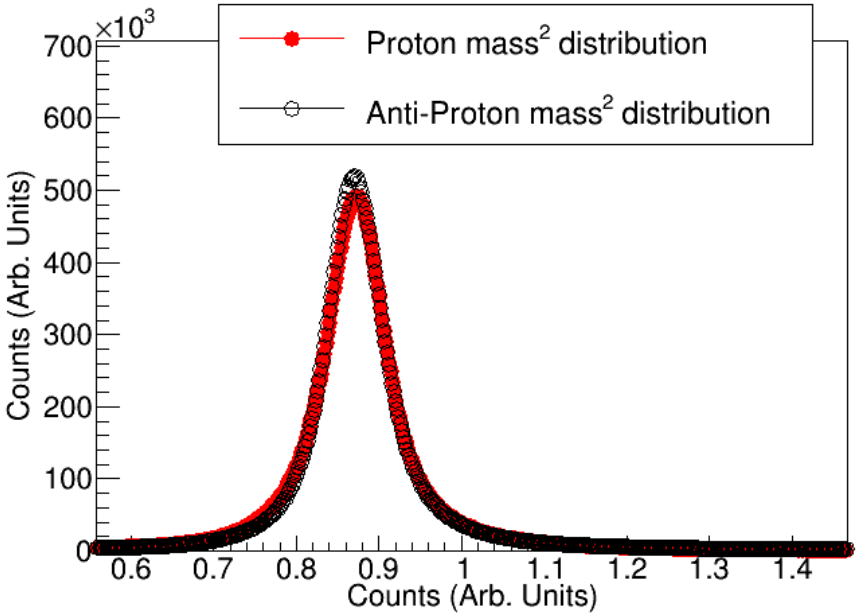
Post-recon Momentum Correction

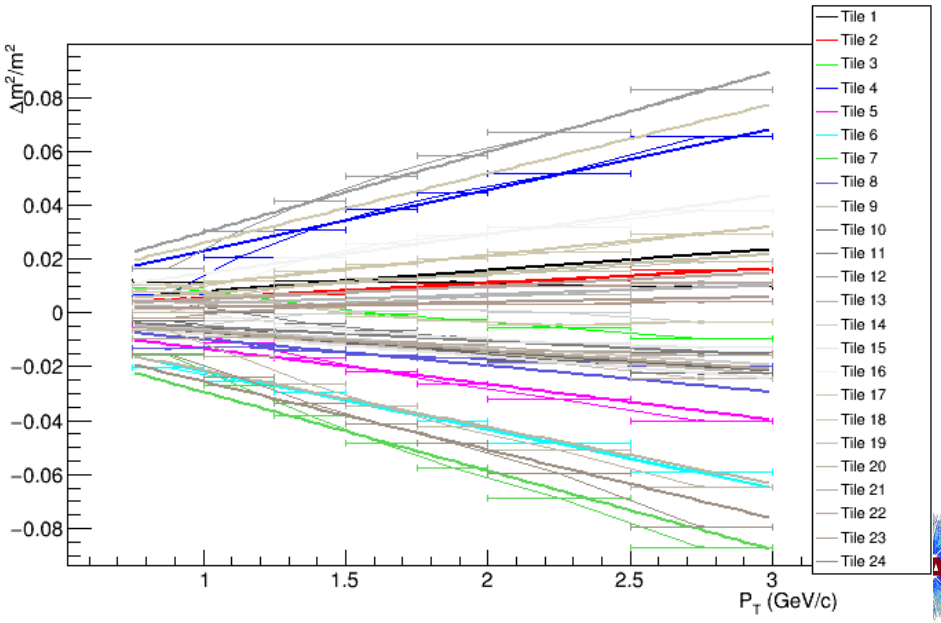
- Study performed with Run 18 Heavy Ion collisions
- Using ToF mass to correct TPC tracking

$$P_{orig} \rightarrow P_{corrected} = bP_{orig}$$

$$\left(P_{orig}\right)^2\left(1+\frac{\delta m^2}{m^2}\right) = \left(bP_{orig}\right)^2$$

- Can be performed with tracks traversing in only one or multiple TPC sectors
- Clearer correlation with Gene's parametrization (based on h+/h-) than this (W) study





TPC Geometry