TPC alignment study with st_W Run 22

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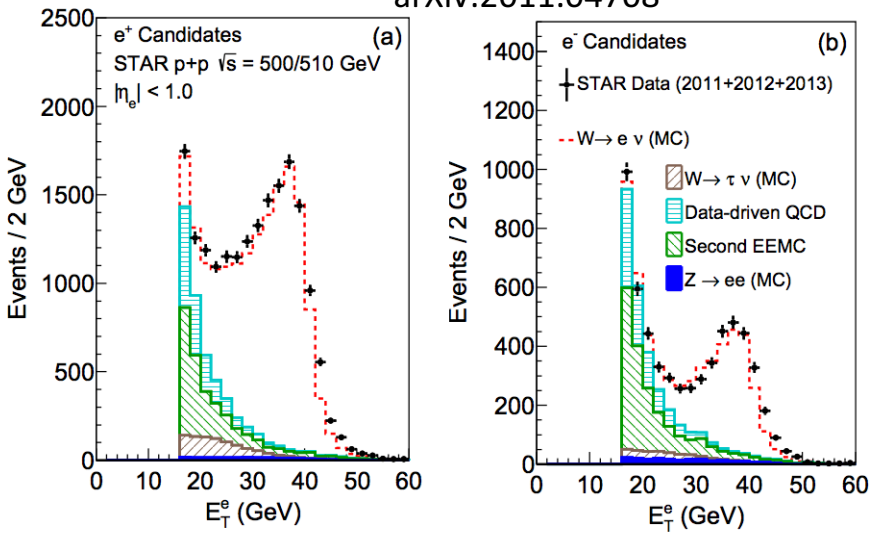
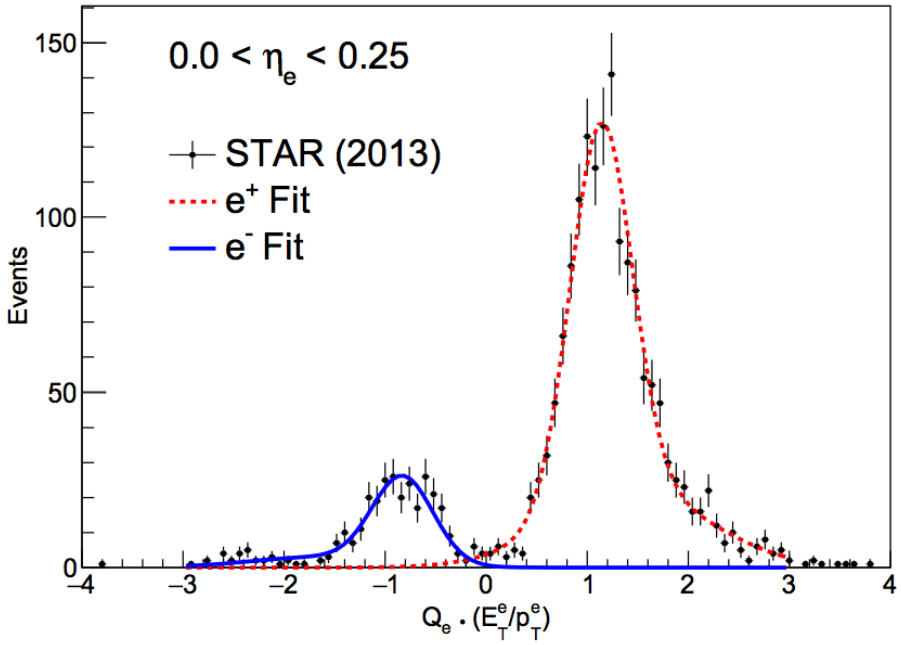
Strategy

STAR Run 11-13 publication
arXiv:2011.04708

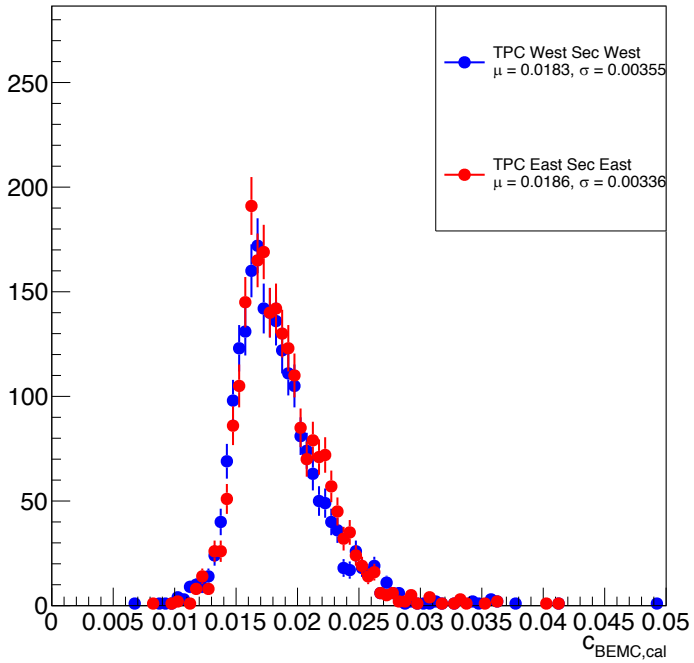




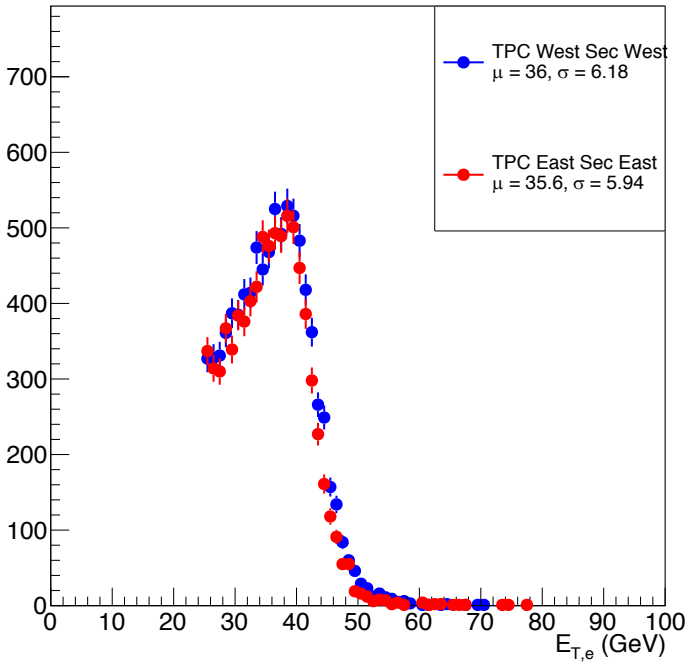
- Reconstructed $W \rightarrow e\nu$
  - EM final state ($p_T = E_T \sim 40\ GeV$)
  - "Mostly" free of TPC effect
    (Only used for charge discrimination, $q \times E_T/p_T$)
  - Clean identification ($B/S < 10\%$, at $E_T > 25\ GeV$)
- Strategy
  - Characterize each TPC sector (or West vs East) by
    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, P20ia
    (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

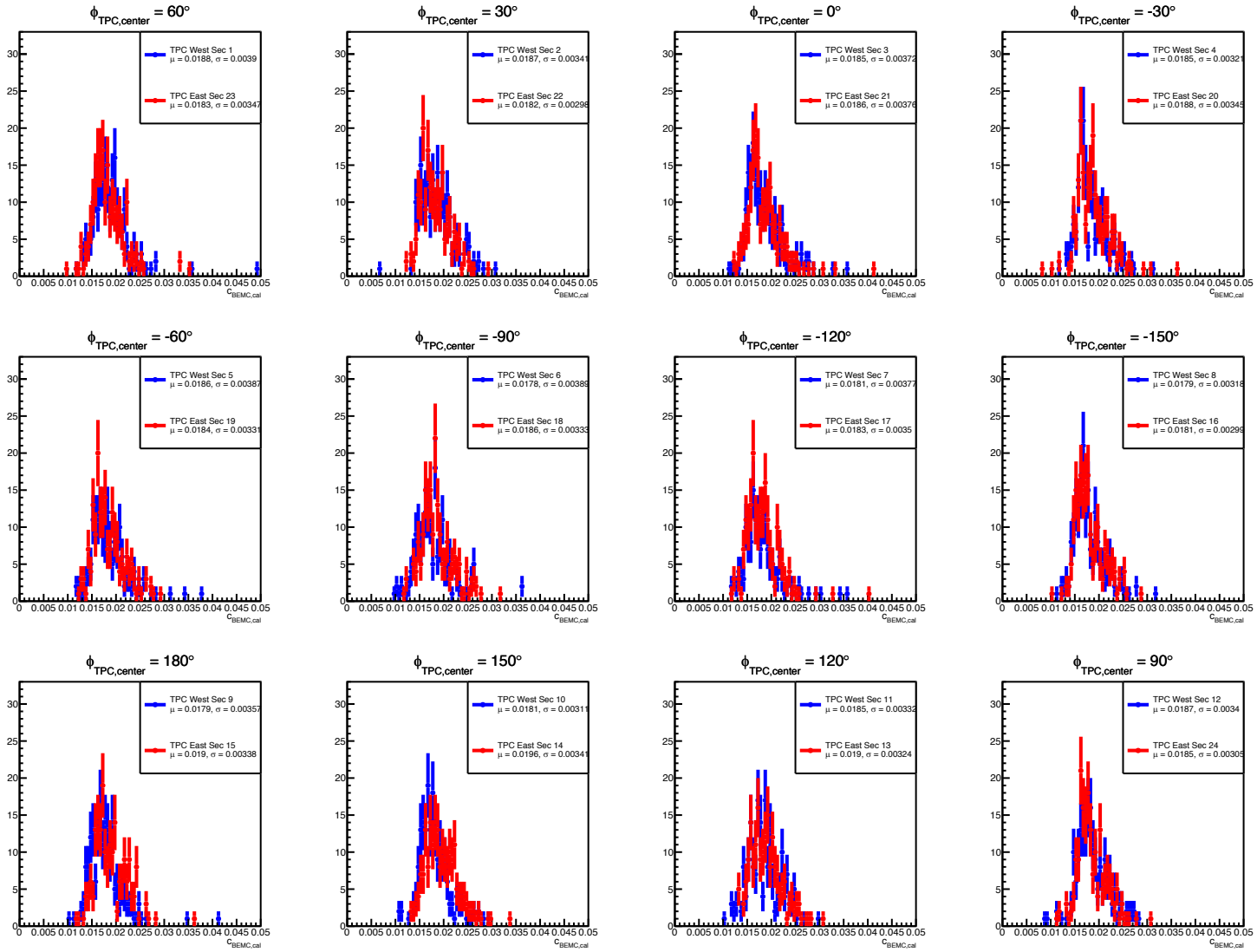


- ~1.5% lower BEMC gain in West
- ~1.1% higher $< E_{T,e} >$ in West
- ~5.6% wider gain width in West
- ~4.0% wider $E_{T,e}$ width in West

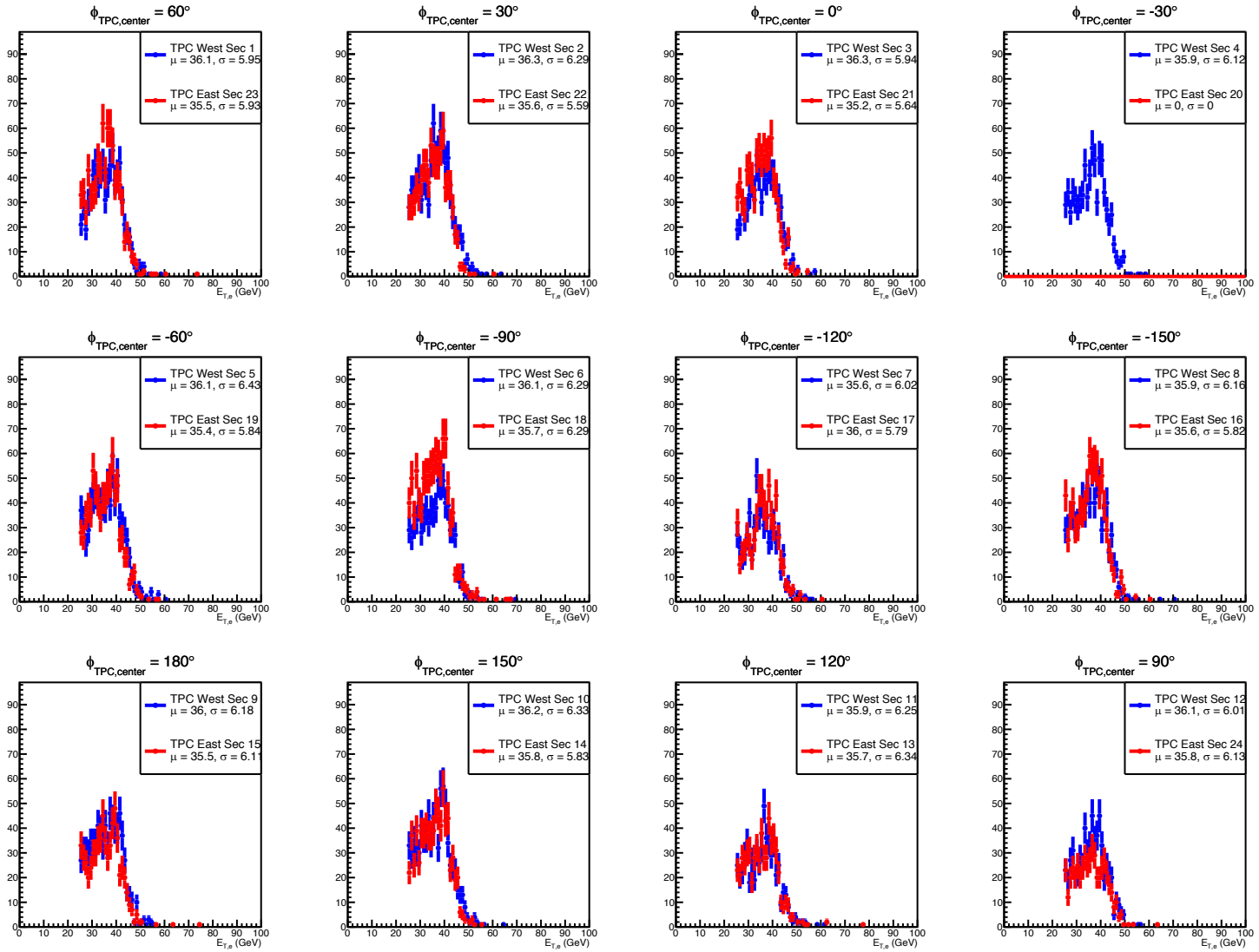
Physics signals do not converge

Shift/widening of BEMC gain and $E_{T,e}$ most likely coming from underlying detector effect (TPC?)

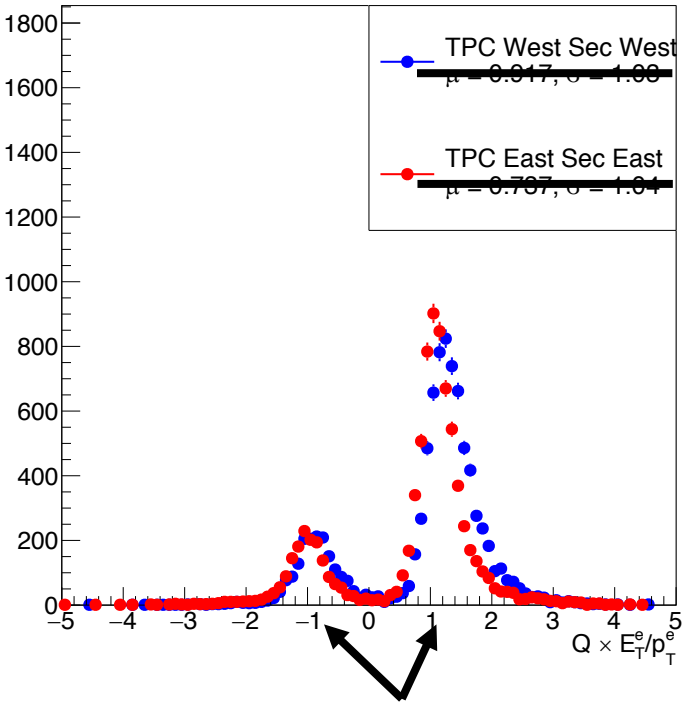
BEMC Gain per TPC sector



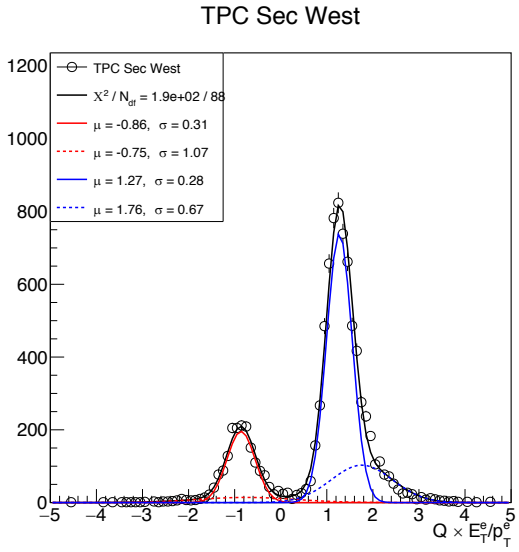
$E_{T,e}$ $(W \rightarrow e\nu)$ Signal per TPC sector

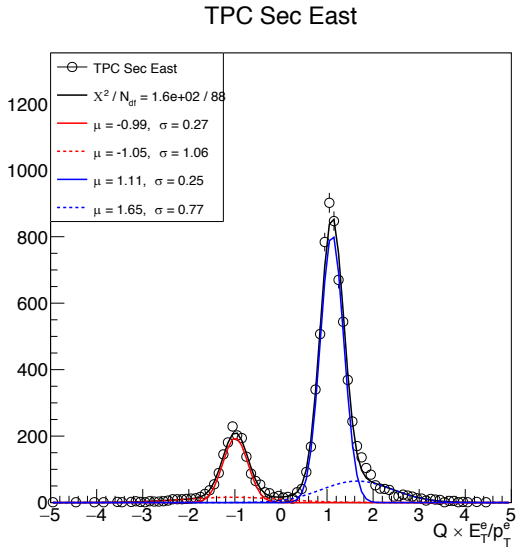


Charge Discrimination



Shift + widening observed





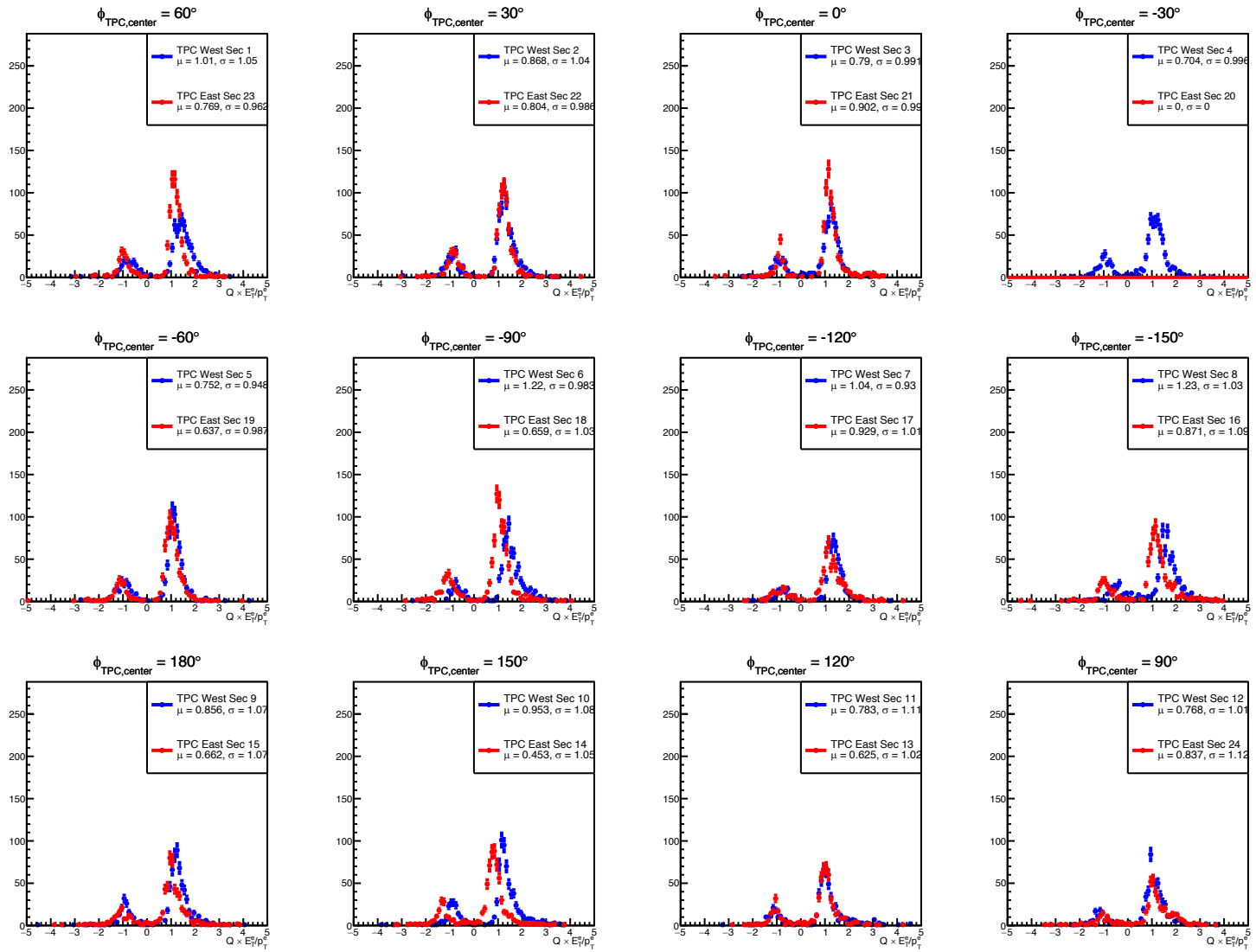
Fitting performed with

- 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

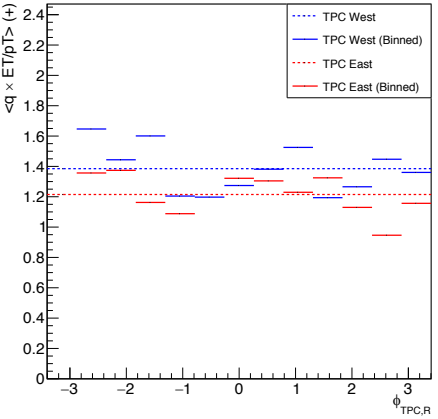
Charge distributions



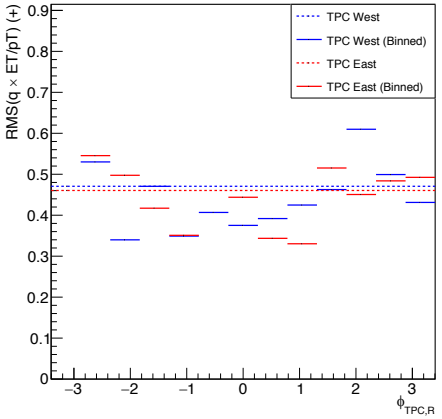
- Large mismatches seen in some sectors/phi regions
- Shifts in West sectors

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

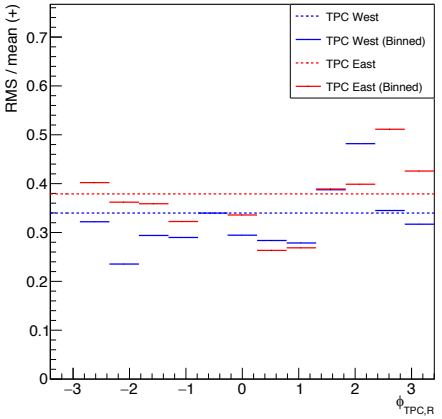
Mean E_T/p_T (e^+-side)



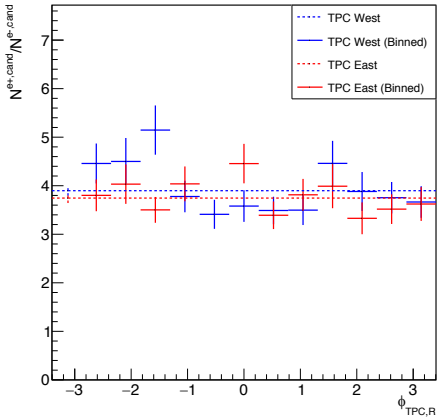
RMS (+)



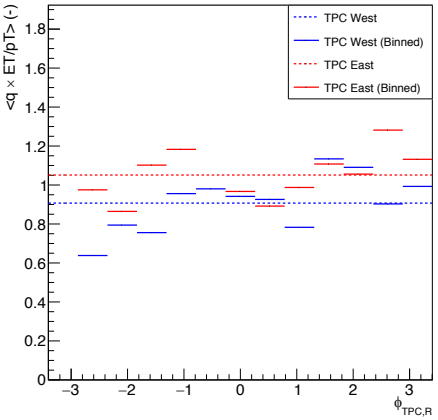
RMS / mean (+)



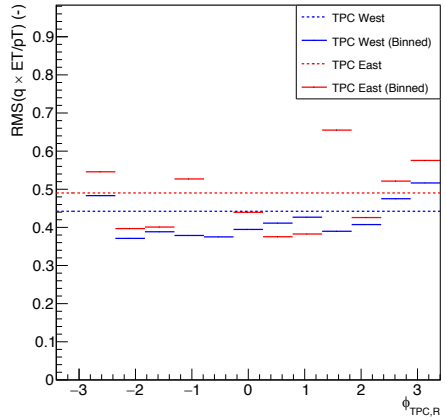
N^{e+}/N^{e-}



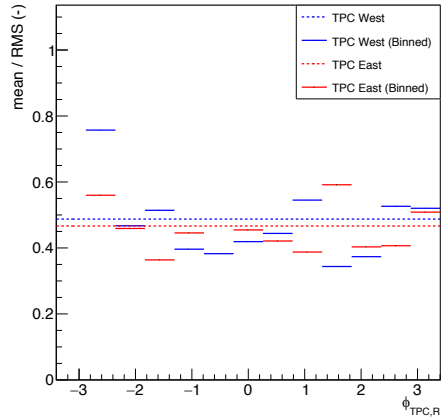
Abs-Mean E_T/p_T (-)



RMS (-)

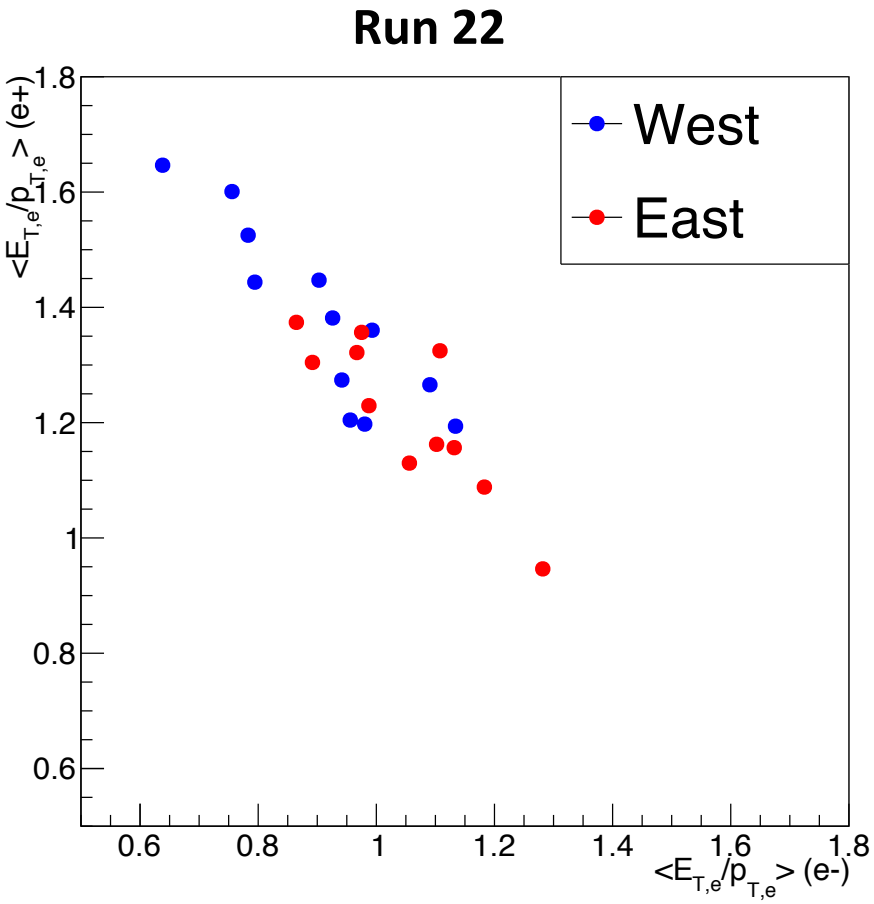


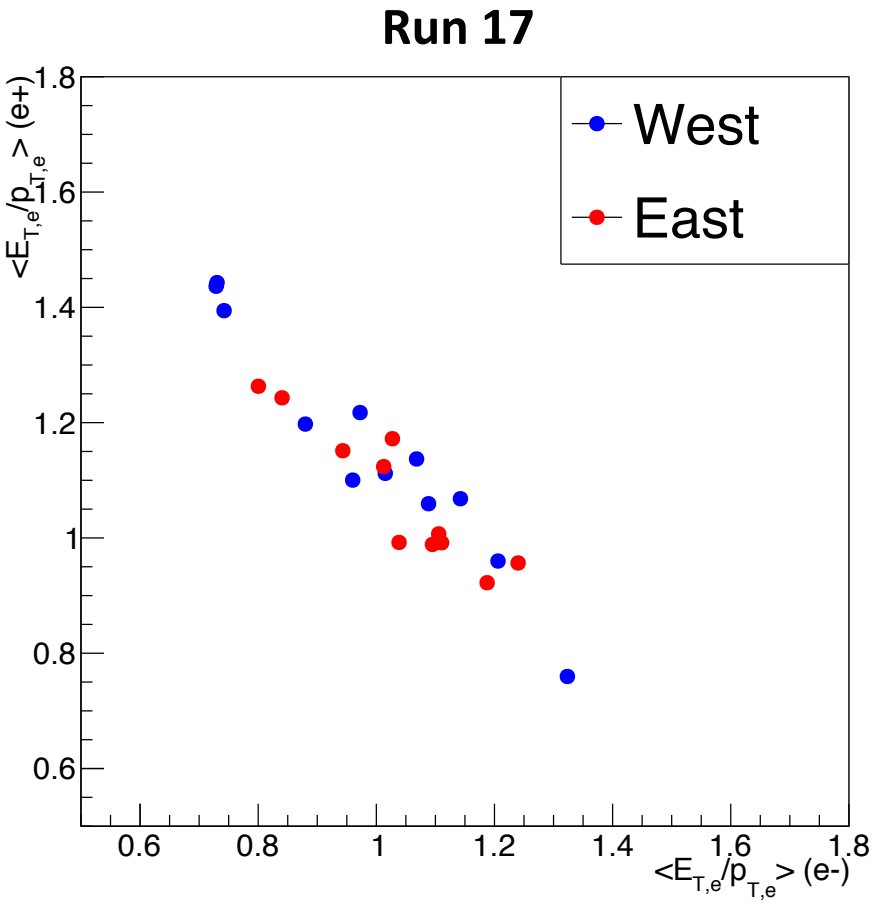
RMS / mean (-)



- 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 symmetrical about mean(e-, e+) = (1, 1)
- Run 22: East behaves like Run 17 (perhaps more broadening?), 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?

TPC Geometry