Measuring the W+/W- cross-section ratio at STAR

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For the CFNS Summer School

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Introduction

- First conclusive evidence of sea quark asymmetry observed by the New Muon Collaboration (NMC) at CERN in the early 1990s.
- Gottfried Sum rule

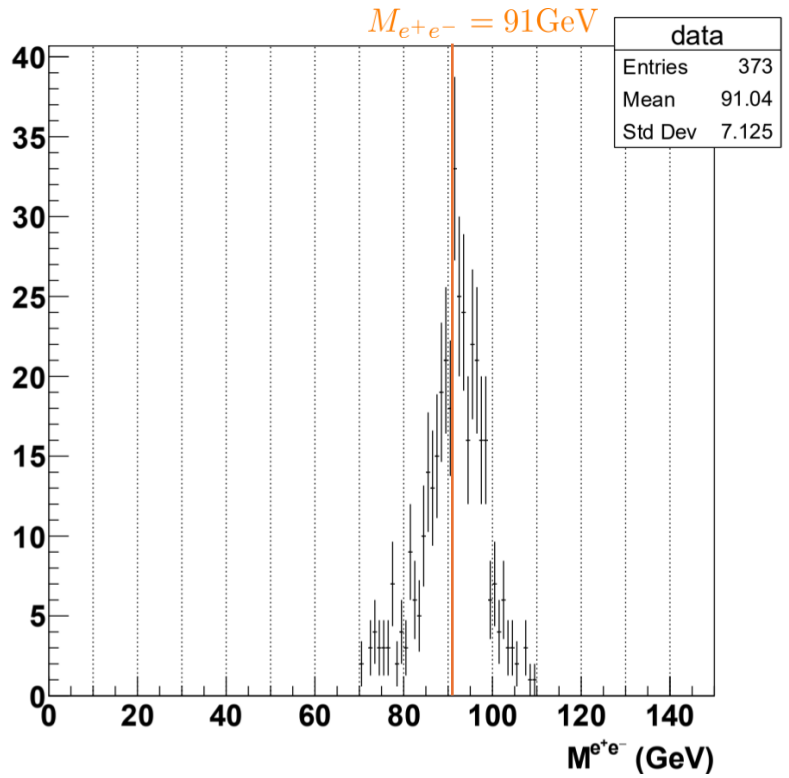
$$S_G = \int_0^1 \frac{dx}{x}[F_{2p}(x) - F_{2n}(x)] = \frac{1}{3} - \frac{2}{3}\int_0^1 dx[\bar{d}(x) - \bar{u}(x)]$$

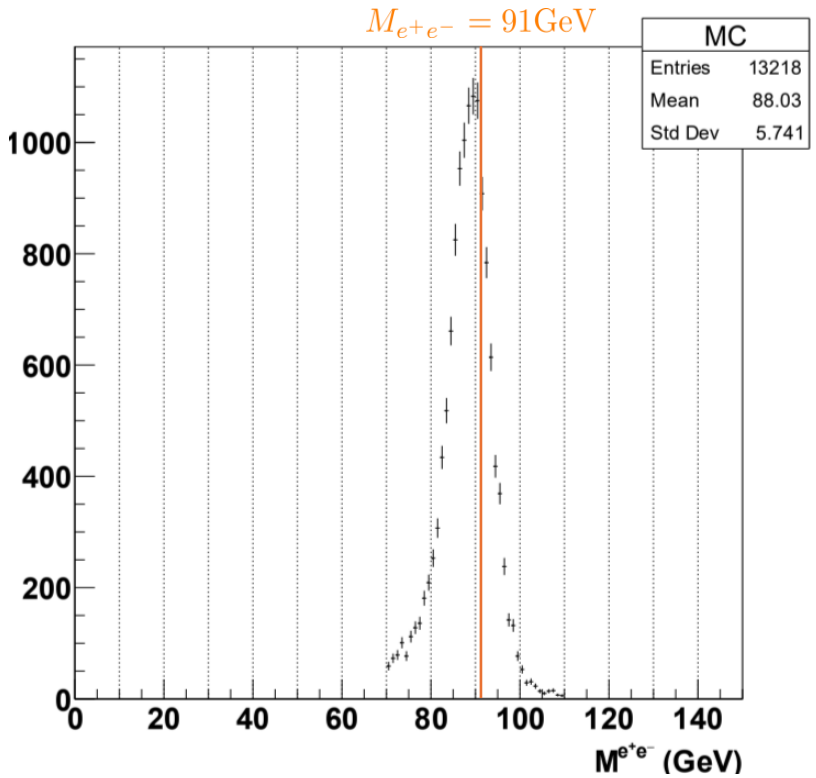
- For equal sea quark distributions, expected 0.33. Obtained $S_G = 0.235 \pm 0.026$.
- More down quarks than up quarks.
- Can be probed by W^+/W^- cross-section ratio.

$$\frac{\sigma_{W^+}}{\sigma_{W^-}} \sim \frac{\bar{d}(x_2)u(x_1)}{\bar{u}(x_2)d(x_1)}$$

Z-mass measurements and calibration

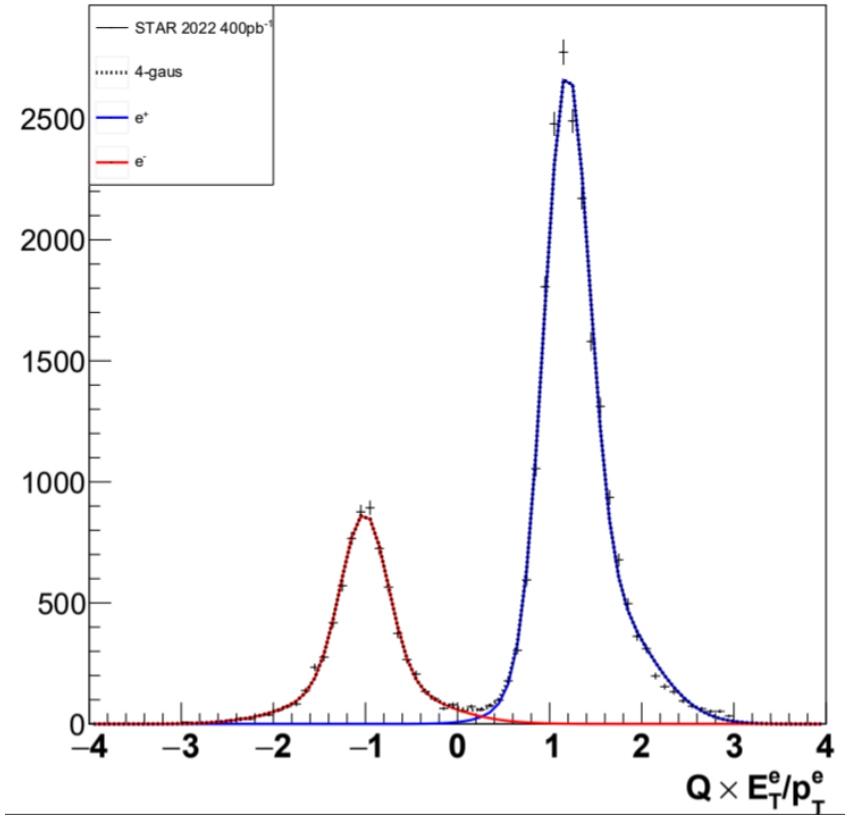
- Analysis performed using the STAR Run22 p+p data at $\sqrt{s} = 508$ GeV.
- Used own calibration obtained earlier to perform analysis.
- Final custom calibration was carried out using Z invariant mass plots for data vs MC embedding samples.

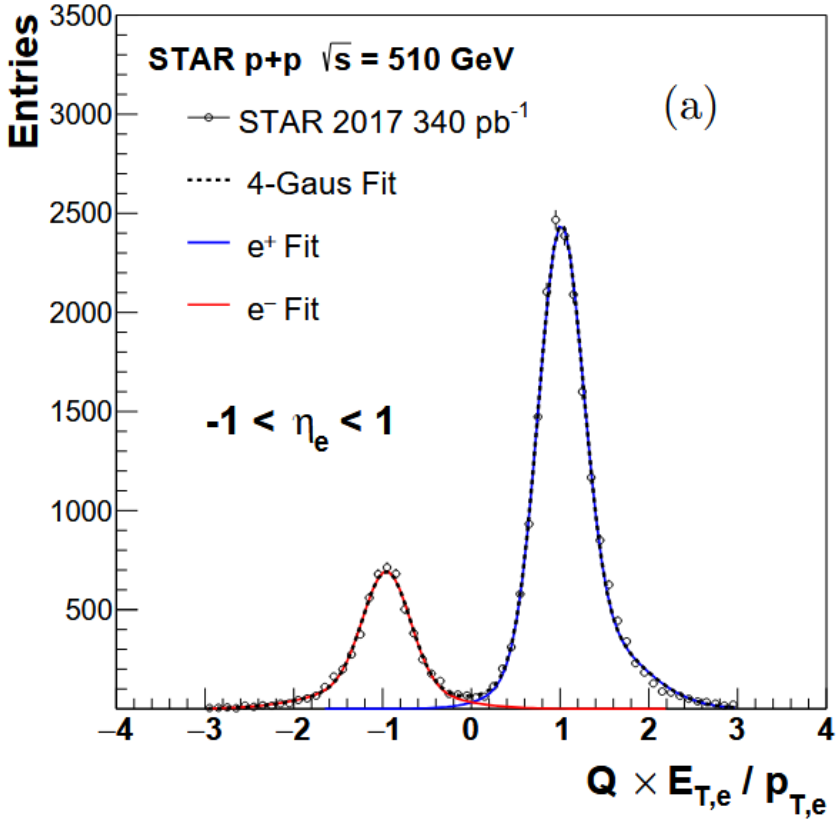




Charge Correction

- The qE_T/p_T distribution for W-candidates was obtained and fit to a 4-gaus fit.
- Accounts for charge misidentification by TPC.
- Number of signal events required for calculation of the charge correction factor r for the final ratio calculation.



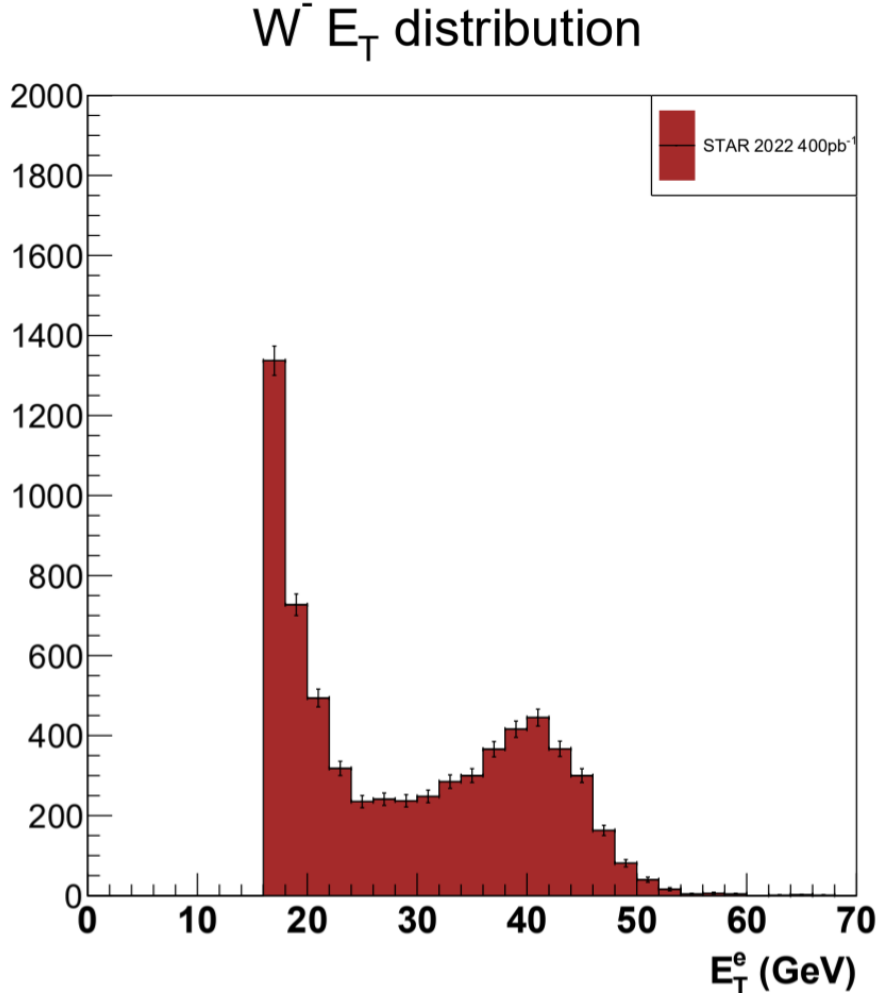


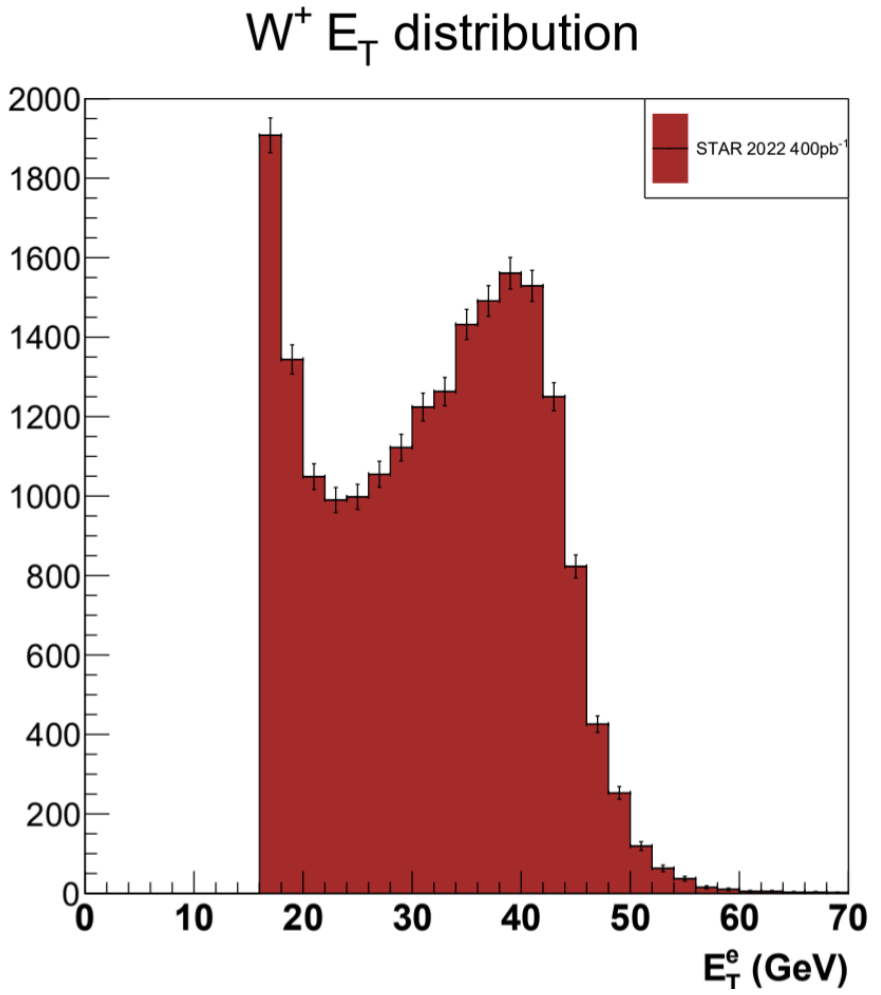
W Selection Cuts

- $E_T^{near,frac} > 0.82$
- $E_T^{away} > 11GeV$
- $p_{T,bal} > 16GeV$
- $-3 < q\frac{E_T}{p_T} < 3$

Current Results

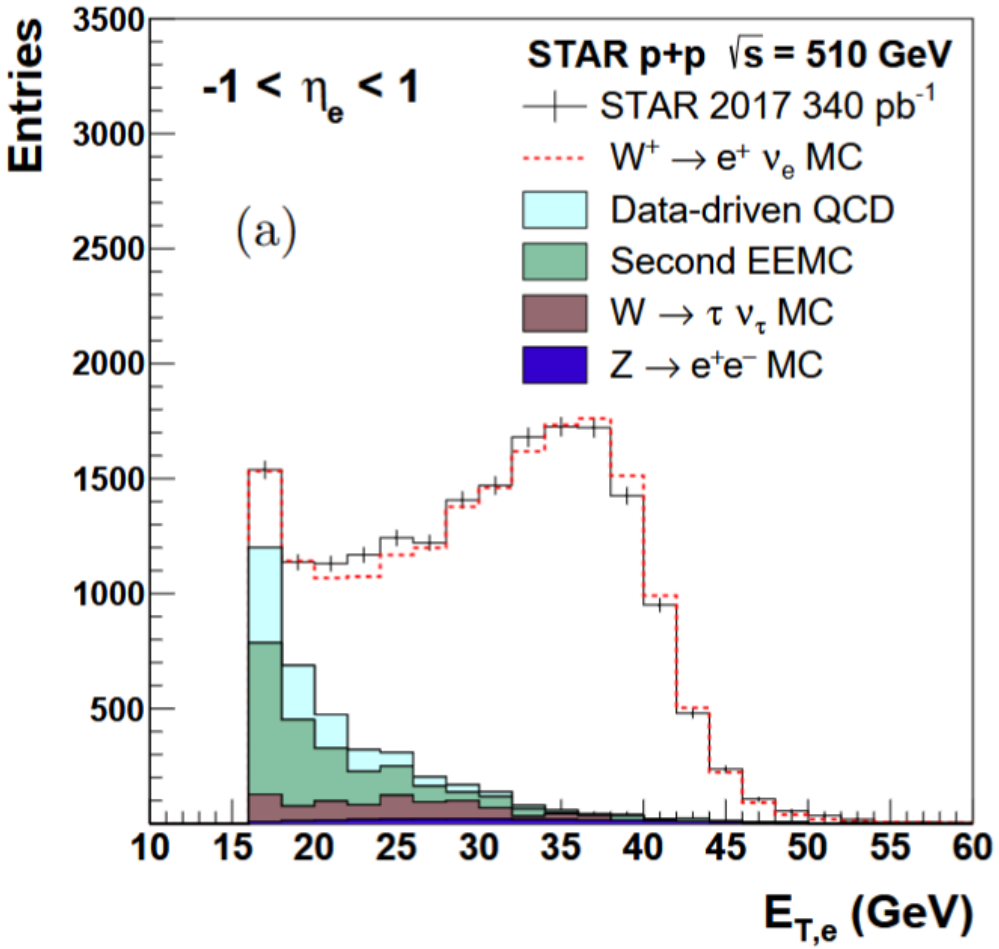
- E_T distributions for $W^{\pm}$ obtained.
- Background analysis still in progress.

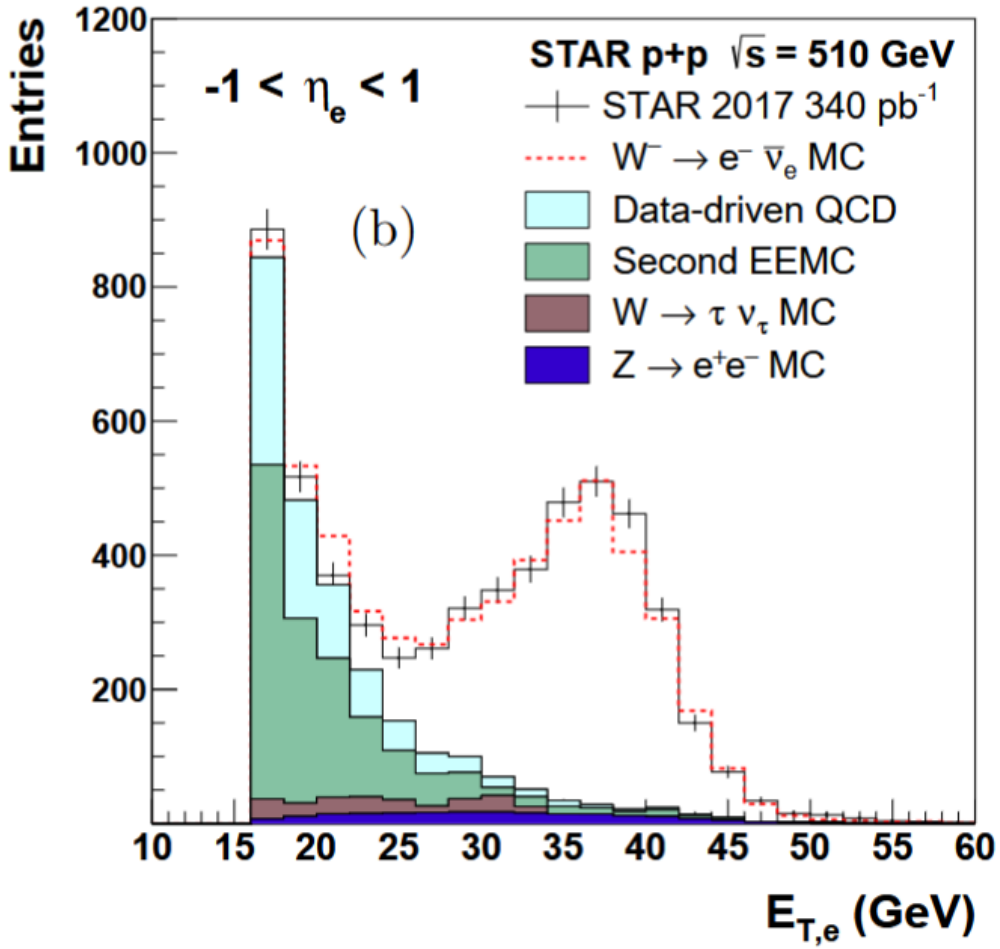




2017 Results

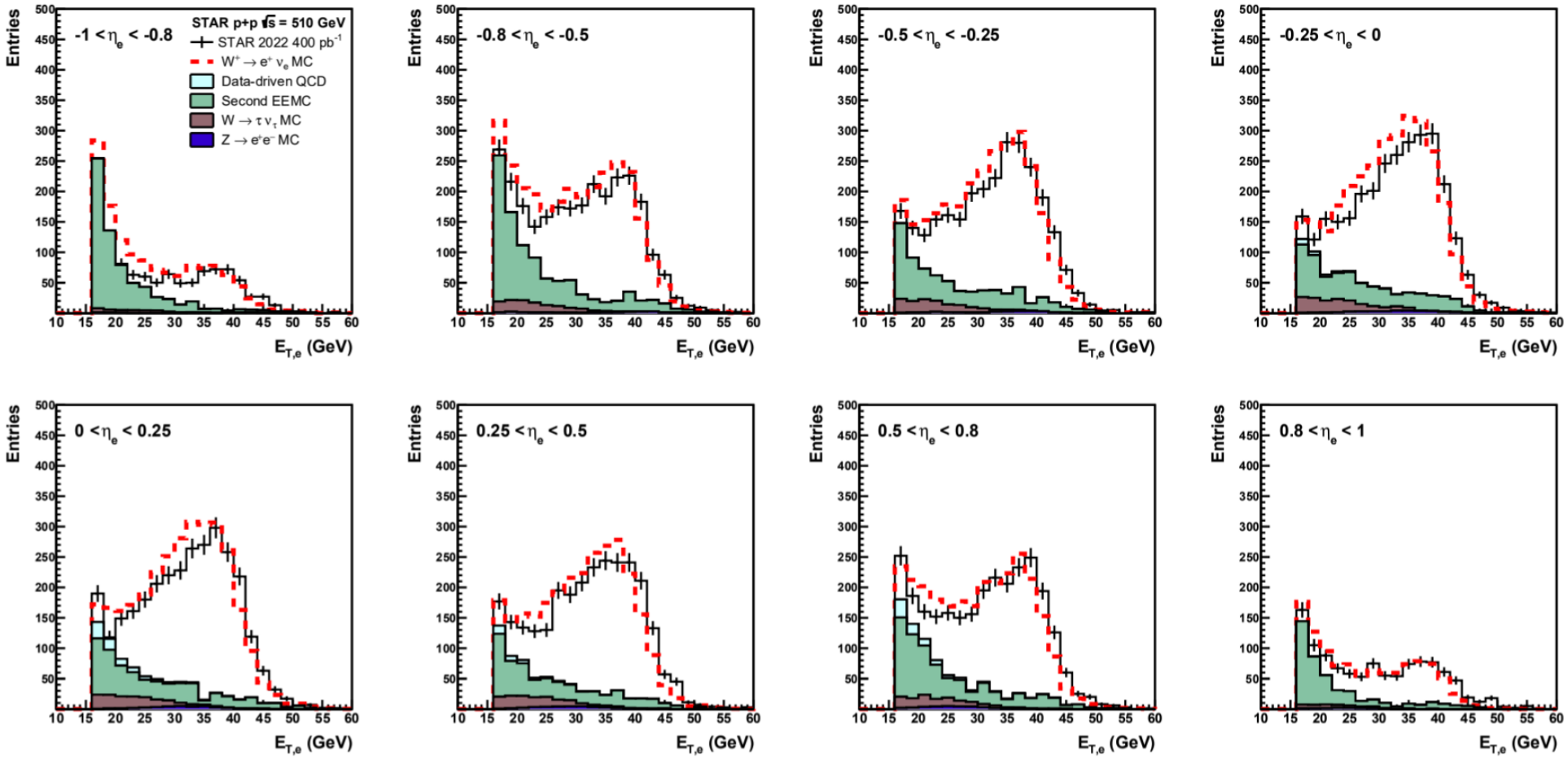
- Can see that initial peak is due to qcd backgrounds.





My Results….?

- Too much second EEMC background. – no EEMC calibration, bad towers leading to false background



Future Work

- Perform background analysis and get transverse energy distribution including all backgrounds.
- Correct for TPC Alignment.
- Produce MC Embeddings for Run22 data, currently using Run17 embeddings.
- Calculate cross-section ratio with all corrections.
- Calculate systematic uncertainties.
- Publish result along with 2017 result for the ratio analysis. This will be the final paper on the W cross-section ratio analysis by STAR since this is the last 500 GeV dataset produced.

Thank You

Recent theory paper exploring the effects of the 2017 result on the sea quark asymmetry

Probing SU(2) Quark Flavor Asymmetry with W Bosons at RHIC
Maximiliano Ponce-Chavez (Michigan State U.)
e-Print: 2606.06383 [hep-ph]

Backup

Current issues and Future Plans

- TPC alignment issue currently, causing misalignment of particle momenta within different TPC sectors
- Leads to high systematic uncertainties in calibration based on particle charge and particle momentum measurement.
- Fix is currently in progress.