

Preliminary Figures Request: Measurement of W^+ / W^- cross ratio at RHIC

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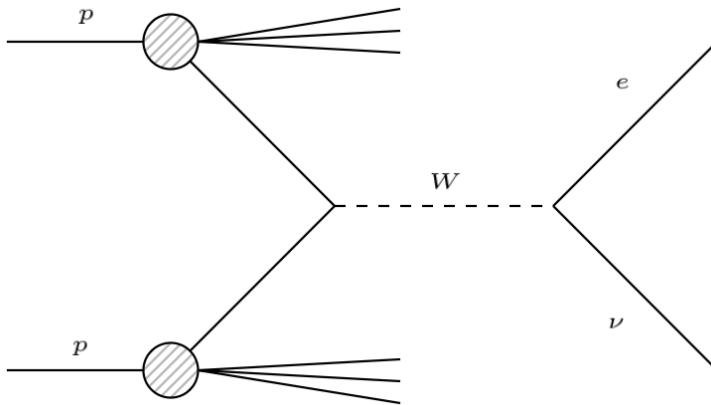
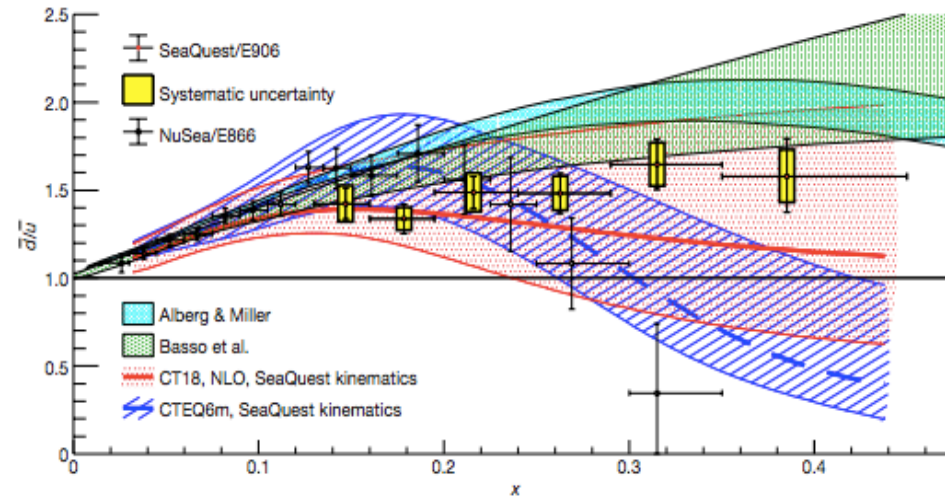


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Physics motivation



- Unpolarized sea quark ratio $\bar{d}/\bar{u}$
 - Predominantly measured via Drell-Yan
 - Conflict between measurements around the valence region.
 - STAR kinematics at the mid-rapidity ($|\eta| < 1$) is sensitive to the region $0.1 < x < 0.3$.
 - Can be further stretched to $0.06 < x < 0.4$ with EEMC.
- W production at STAR
 - Sensitive to $u\bar{d}$ (W^+) and $\bar{u}d$ (W^-) at leading order;
 - The cross section ratio $\sigma_{W^+}/\sigma_{W^-}$ can be used to probe $\bar{d}/\bar{u}$;

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

Dataset

- Dataset: st_W
- Year: 2017 (P20ic)
- Production tags:
 - pp500_production_2017
- Triggers used:
 - L2BW (570202)
 - L2EW (570206)
- Embedding request id: 20201502

Bad run list

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W candidate selection

- Kinematic selection
 - $25 < E_{T,cl}/GeV < 50$
 - $|\eta| < 1$
 - $p_{T,trk} > 10 GeV$
- Event selection
 - Large imbalance in p_T due to final state neutrino.
 - $\vec{p}_{T,bal} = -\sum \vec{p}_T$
 - $sp_{T,bal} = \vec{p}_{T,bal} \cdot \frac{\vec{p}_{T,cl}}{E_{T,cl}}$
- Electron isolation
 - Energy confined in a small space.
 - $E_{T,cl} = E_T^{2 \times 2}$
 - $E_T^{near} = E_{T,jet}^{\Delta R < 0.7}$

Vertex	Rank > 0
	$ z < 100 cm$
Track	$p_T > 10 GeV$
	$N_{hits} > 15$
	$N_{hits}/N_{pos} > 0.51$
Electron	$E_T^{2 \times 2}/E_T^{near} > 0.82$
	$E_T^{2 \times 2}/E_T^{4 \times 4} > 0.96$
W	$\left Q \times \frac{E_T}{p_T} \right < 3.0$
	$sp_{T,bal} > 16 GeV$
	$25 < E_{T,cl} < 50 GeV$
	$E_{T,away} < 11 GeV$
	TPC sector 20 masked out

Analysis procedure

- In the W cross section ratio measurement, the ratio reduces to:

$$\sigma_{W^+}/\sigma_{W^-} = \frac{\epsilon^-}{\epsilon^+} \cdot \frac{N_{obs}^+}{N_{obs}^-} = \frac{\epsilon^-}{\epsilon^+} \cdot \frac{N_{sig}^+ - N_{bg}^+}{N_{sig}^- - N_{bg}^-}$$

- where ϵ represents the sum of the efficiencies of our selection process.

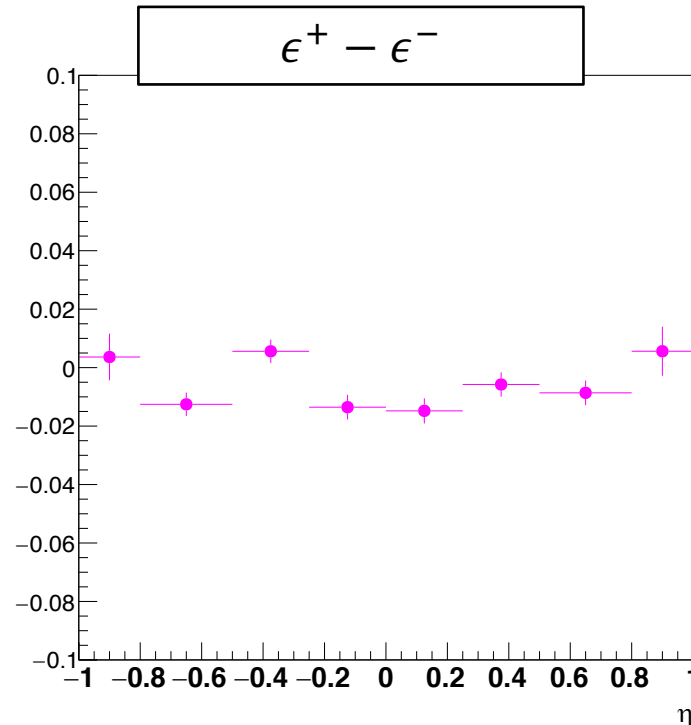
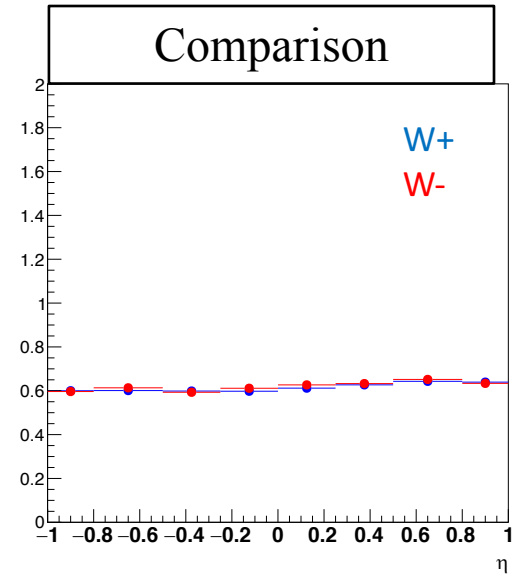
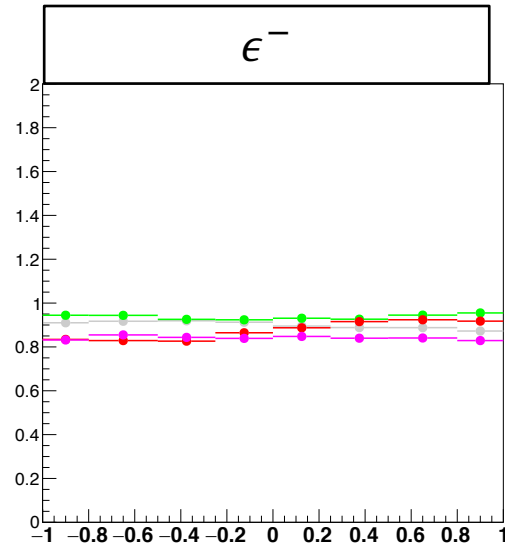
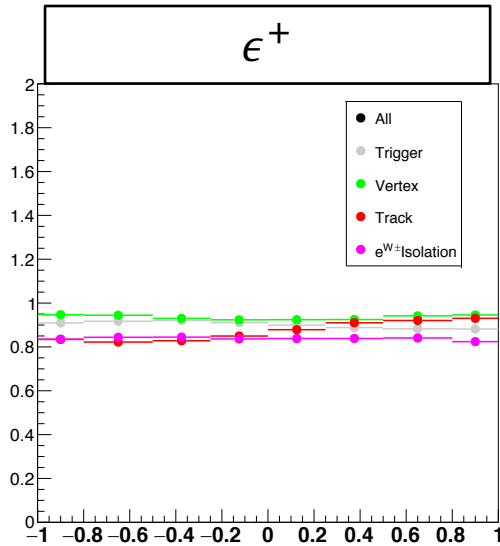
$$\epsilon = \epsilon_{trigger} \times \epsilon_{vertex} \times \epsilon_{tracking} \times \epsilon_{tagging}$$

- N_{bg} represents the sum of all remaining background contributions.

$$N_{bg} = N_{W \rightarrow \tau \nu} + N_{Z \rightarrow ee} + N_{QCD} + N_{EEMC}$$

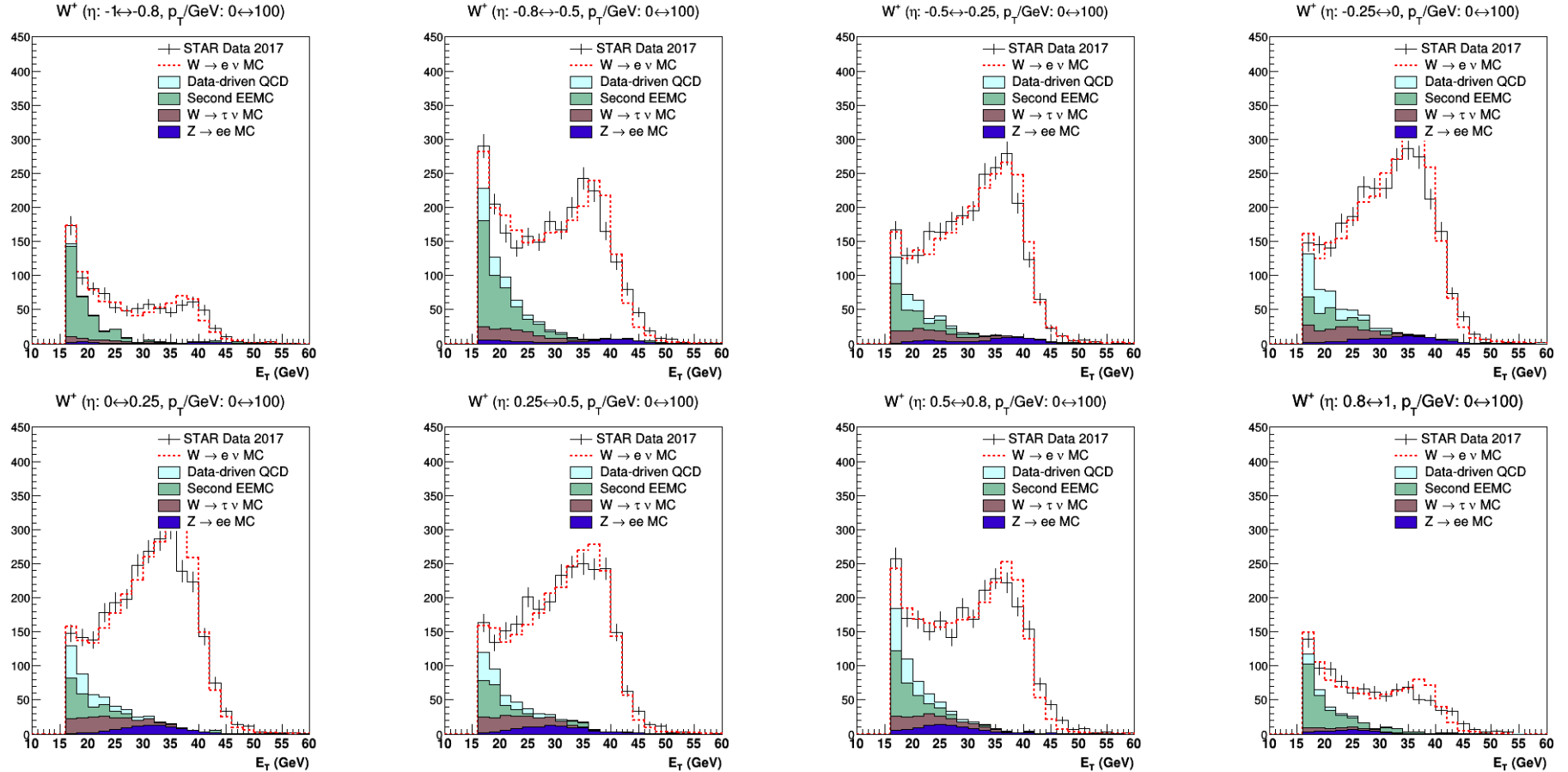
- $N_{W \rightarrow \tau \nu}$ and $N_{Z \rightarrow ee}$ are entirely determined from events from the embedding samples that pass the selection cuts.
- N_{EEMC} represents missing EEMC background and is estimated by first comparing the result with and without the EEMC information and taking the difference (mirrored in η).
- N_{QCD} represents the QCD background events that pass the selection cuts. Its shape is estimated by looking at the distribution that does not pass $sp_{T,bal}$ cut and normalize to match the discrepancy between data and simulation in E_T window $16 < E_T/GeV < 21$.
- The measurement has been performed over $-1 < \eta < 1$ divided into 8 bins.
 - Bin edges: [-1.0, -0.8, -0.5, -0.25, 0, 0.25, 0.5, 0.8, 1.0]

Efficiency

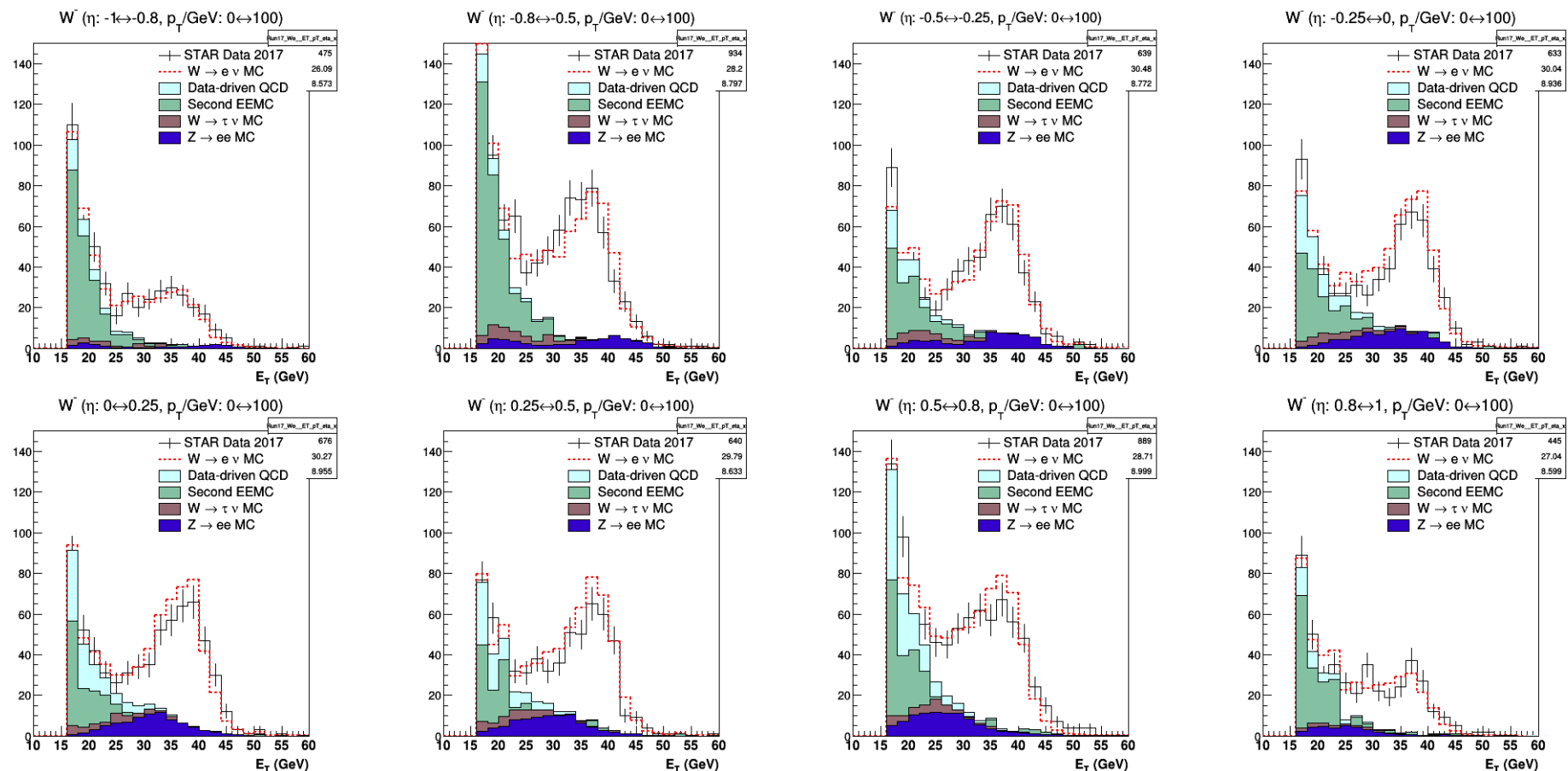


- Efficiency ratio ϵ^-/ϵ^+ is consistent with 1 (0.99~1.02).

Background (W^+)



Background (W^-)



Systematic uncertainties

- Systematic uncertainties
 - Charge dependence $\delta_{\Delta\epsilon}$:
 - Remaining charge dependence obtained by taking the difference between $\epsilon^{\pm}$.
 - BEMC calibration δ_{BEMC} :
 - Due to imperfect BEMC calibration, obtained by taking the variation in the efficiency ratio while varying BEMC gain by $\pm 3\%$.
 - Background description δ_{QCD}^{bg} :
 - The uncertainty associated with the QCD background description in terms of its shape and normalization has been tested by varying $sp_{T,bal}$ cut from 5 *GeV* to 25 *GeV* (nominal = 16 *GeV*) and the upper limit of $E_{T,cl}$ window from 18 *GeV* to 25 *GeV*.
 - Missing dijet δ_{QCD}^{dijet} :
 - Dijet events are neglected when one of the two jets is outside the detector acceptance region.
 - A Pythia study was done to estimate the effect.
 - BEMC gain correction $\delta_{BEMC,cor}$
 - The effect of applying BEMC gain correction of -4.3% has been estimated by taking the difference between the nominal sample and a test sample without the correction.

Results

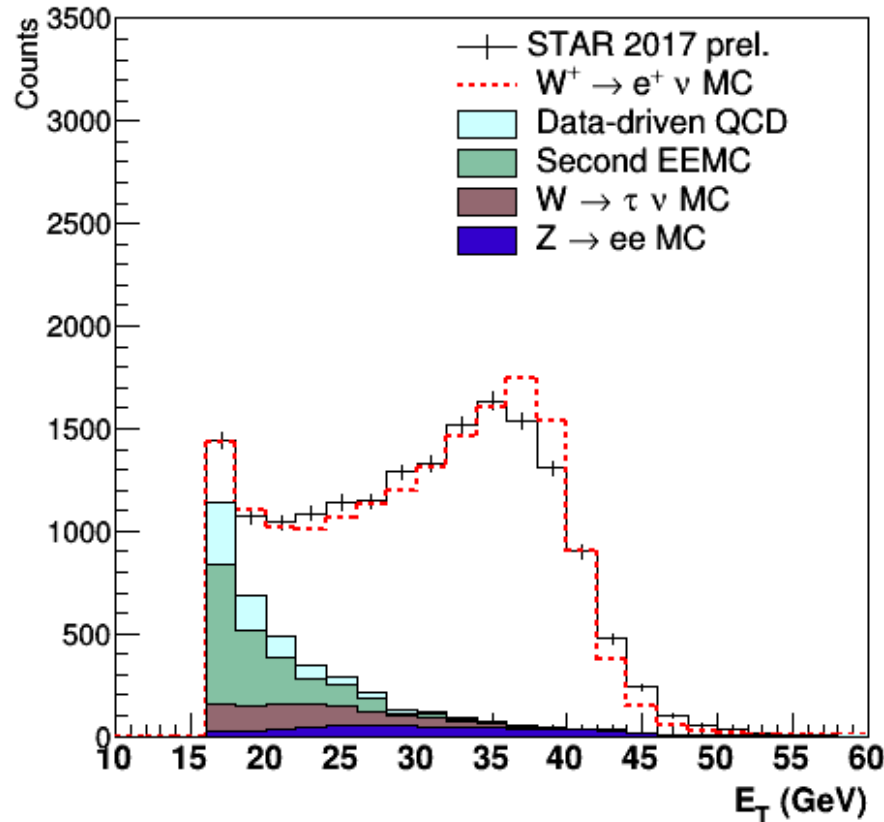
- The numeric values of systematic uncertainties are summarized in the table below.

η bin	1	2	3	4	5	6	7	8
$\delta_{\Delta\epsilon}(\%)$	0.3	1.0	0.5	1.0	1.0	0.4	0.7	0.4
$\delta_{BEMC}^{high}(\%)$	0.2	0.0	0.0	0.0	-0.1	0.0	-0.4	0.3
$\delta_{BEMC}^{low}(\%)$	0.2	0.3	-0.3	-0.2	-0.2	-0.3	0.0	0.5
$\delta_{QCD}^{bg}(\%)$	0.3	0.3	0.6	0.7	0.5	0.6	0.6	0.5
δ_{QCD}^{dijet}	44% of N_{bg}^{QCD}							
$\delta_{BEMC,cor}(\%)$	6.7	3.7	2.6	4.5	3.9	0.0	1.9	1.2

- The result is summarized in the table below.

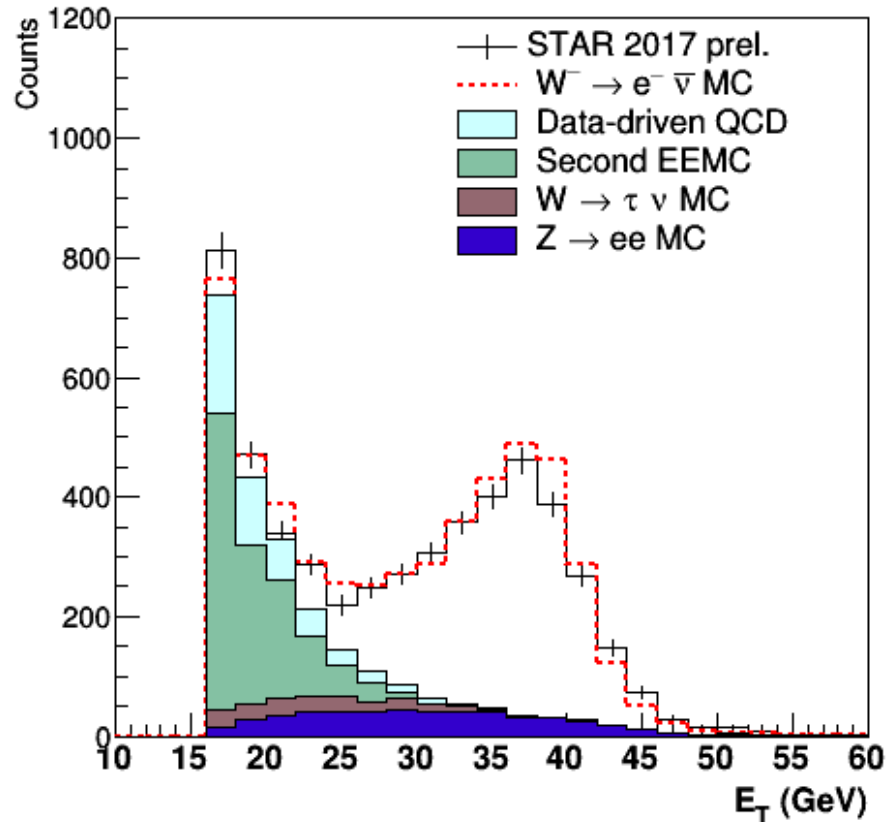
η -bin	σ^+/σ^-	δ_{stat}	δ_{syst}
$-1.0 < \eta < -0.8$	2.42	0.24	0.17
$-0.8 < \eta < -0.5$	3.63	0.23	0.14
$-0.5 < \eta < -0.25$	5.06	0.36	0.17
$-0.25 < \eta < -0.0$	6.73	0.54	0.36
$0 < \eta < 0.25$	6.01	0.43	0.30
$0.25 < \eta < 0.5$	5.75	0.43	0.17
$0.5 < \eta < 0.8$	3.84	0.25	0.14
$0.8 < \eta < 1.0$	2.40	0.23	0.05

Preliminary figure 1



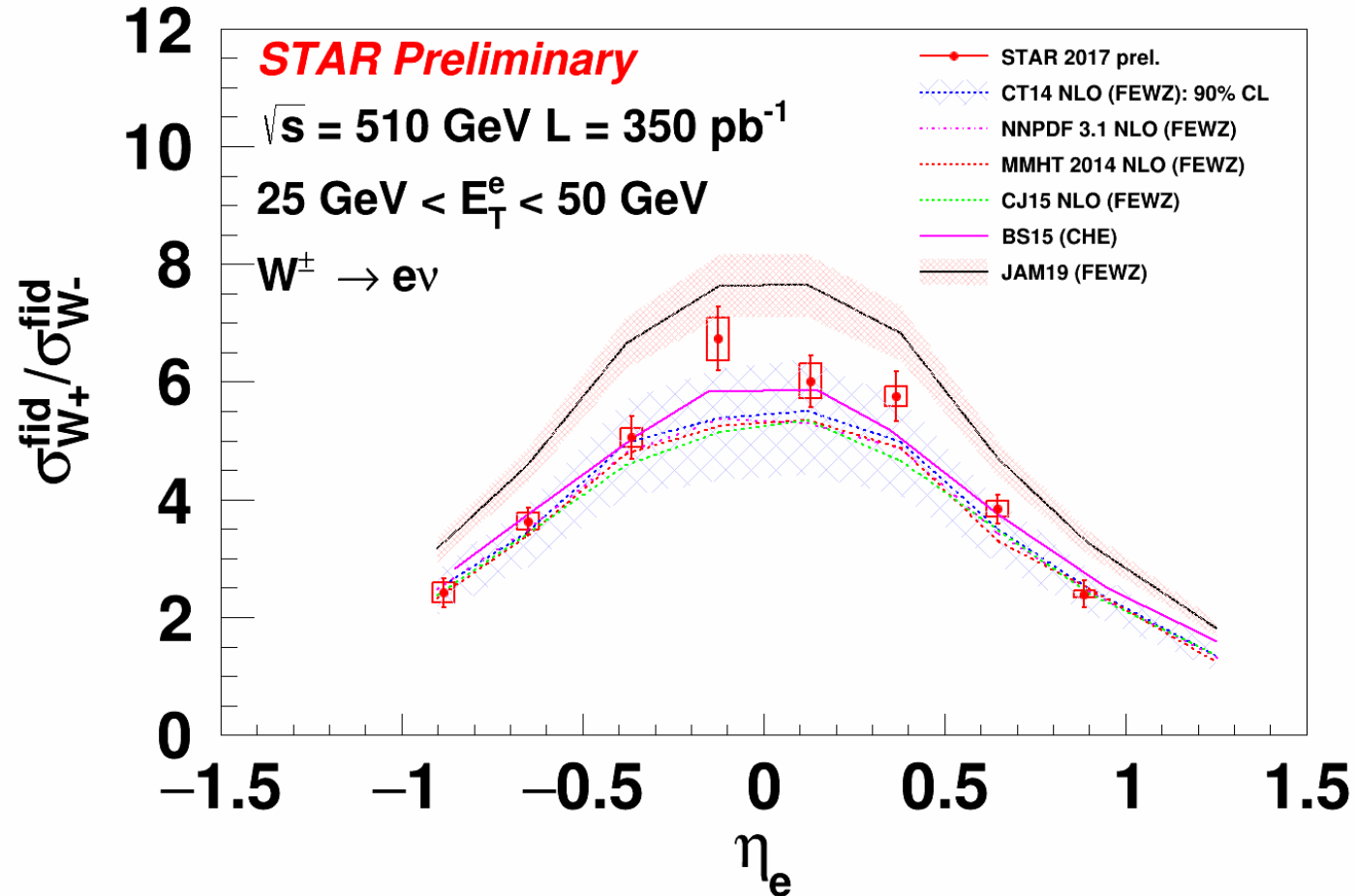
- Caption: Signal and background E_T^e distribution for positron candidates in the BEMC.

Preliminary figure 2



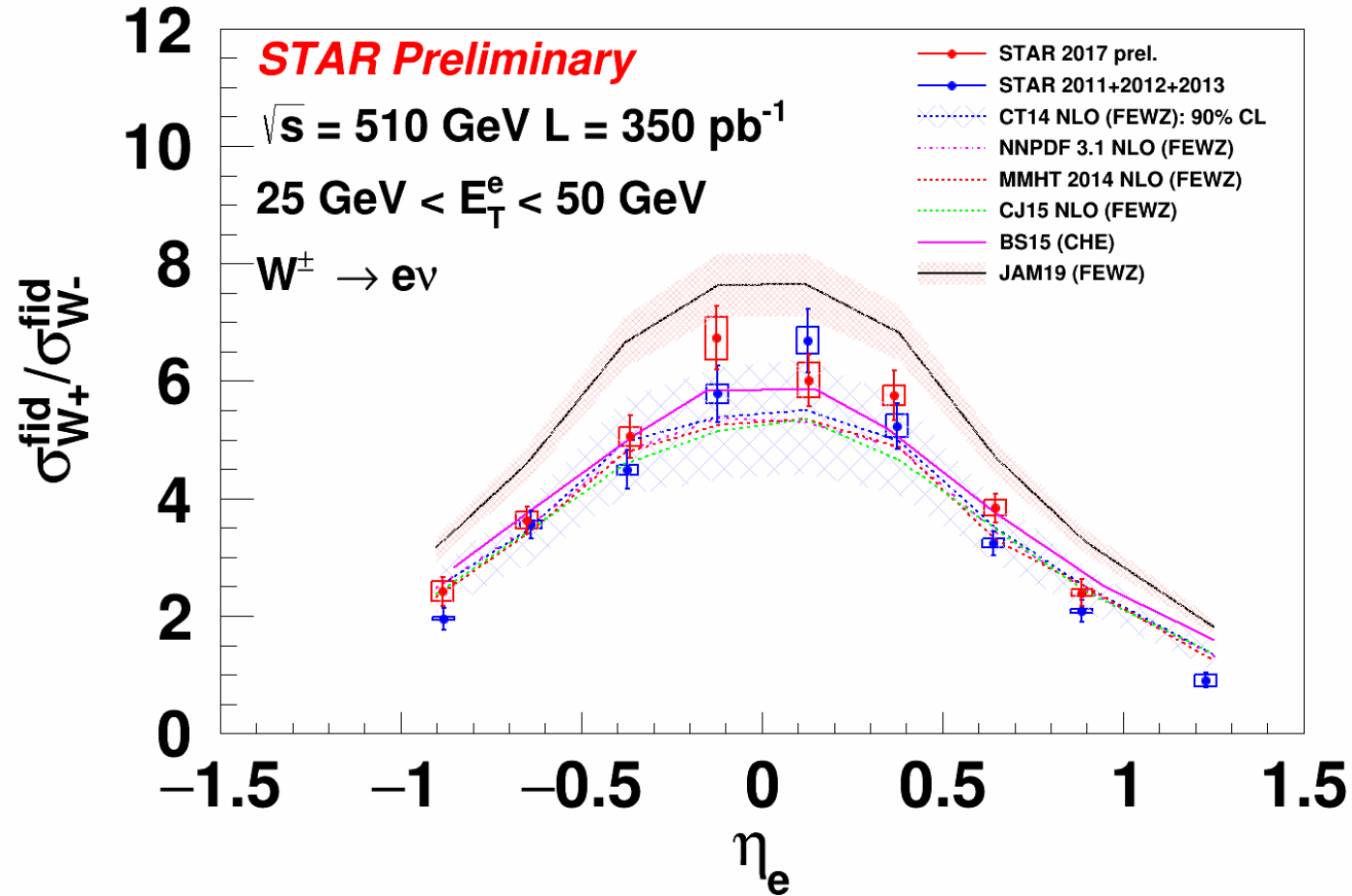
- Caption: Signal and background E_T^e distribution for electron candidates in the BEMC.

Preliminary figure 3.a



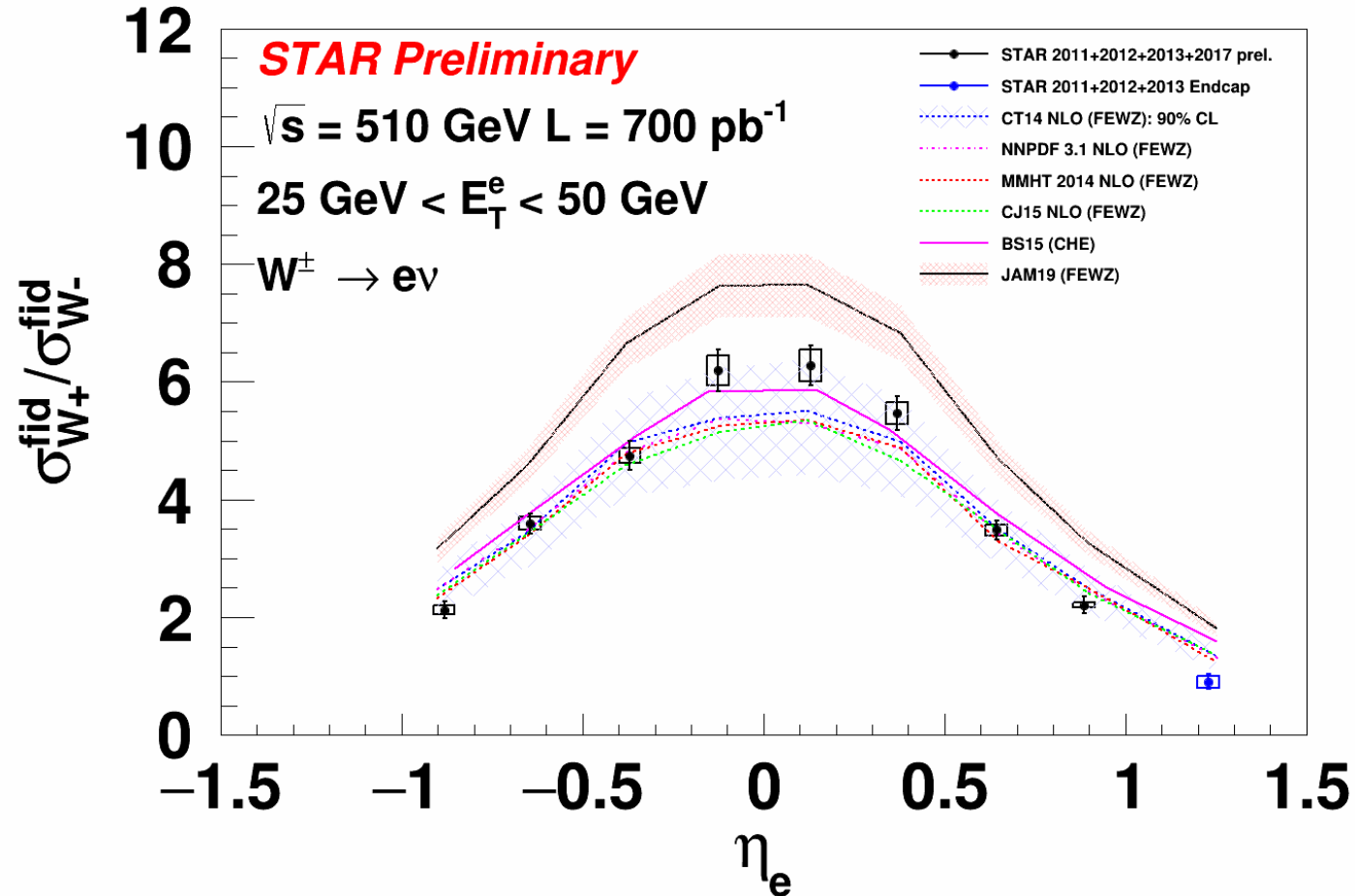
- Caption: W^+/W^- for STAR 2017 dataset against pseudorapidity. The central values correspond to the mean value of η^e for that bin. The vertical bars represent the statistical uncertainty, whereas the height of the rectangles represents the systematic uncertainty for the respective data point. The measurement is compared to various theory frameworks with several PDF inputs.

Preliminary figure 3.b



- Caption: W^+/W^- for STAR 2017 dataset and against pseudorapidity in comparison to the published measurement using combined STAR 2011, 2012, and 2013 datasets. The central values correspond to the mean value of η_e for that bin. The vertical bars represent the statistical uncertainty, whereas the height of the rectangles represents the systematic uncertainty for the respective data point. The measurement is compared to various theory frameworks with several PDF inputs.

Preliminary figure 3.c



- Caption: W^+/W^- for combined STAR 2011, 2012, 2013 and 2017 datasets against pseudorapidity. The central values correspond to the mean value of η^e for that bin. The vertical bars represent the statistical uncertainty, whereas the height of the rectangles represents the systematic uncertainty for the respective data point. The measurement is compared to various theory frameworks with several PDF inputs.