RUN 13 W A_L ANALYSIS

Devika & Jinlong

2009	2012	2013
~500	~2500	~10000

STAR Collaboration Meeting - 06 /02-06/ 2015

OUTLINE

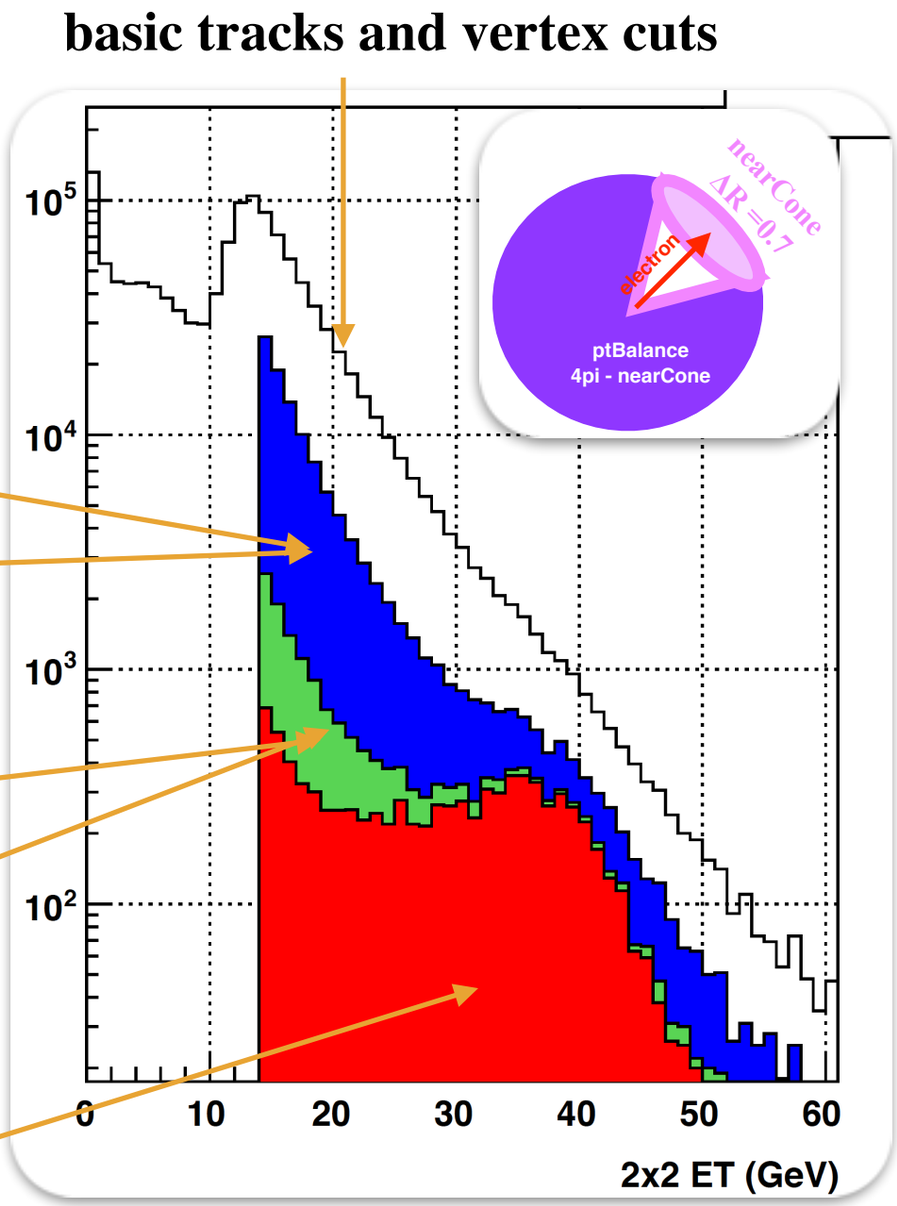
- Overview of Current Status
- Data Set
- Analysis Cuts
- Background Estimation
- BEMC Calibration
- Summary / Future Plans

CURRENT STATUS

- Issue with the discrepancy between data and MC.
- Optimization of various W selection cuts- Not really the answer.
- Discrepancy between data-MC was mainly caused by the use of out dated (Run 9 200 GeV) BEMC calibration.
- Calibration process of BEMC using run 13 500 GeV data is ongoing.
- Once the BEMC calibration is completed release of preliminary A_L results.

ANALYSIS CUTS

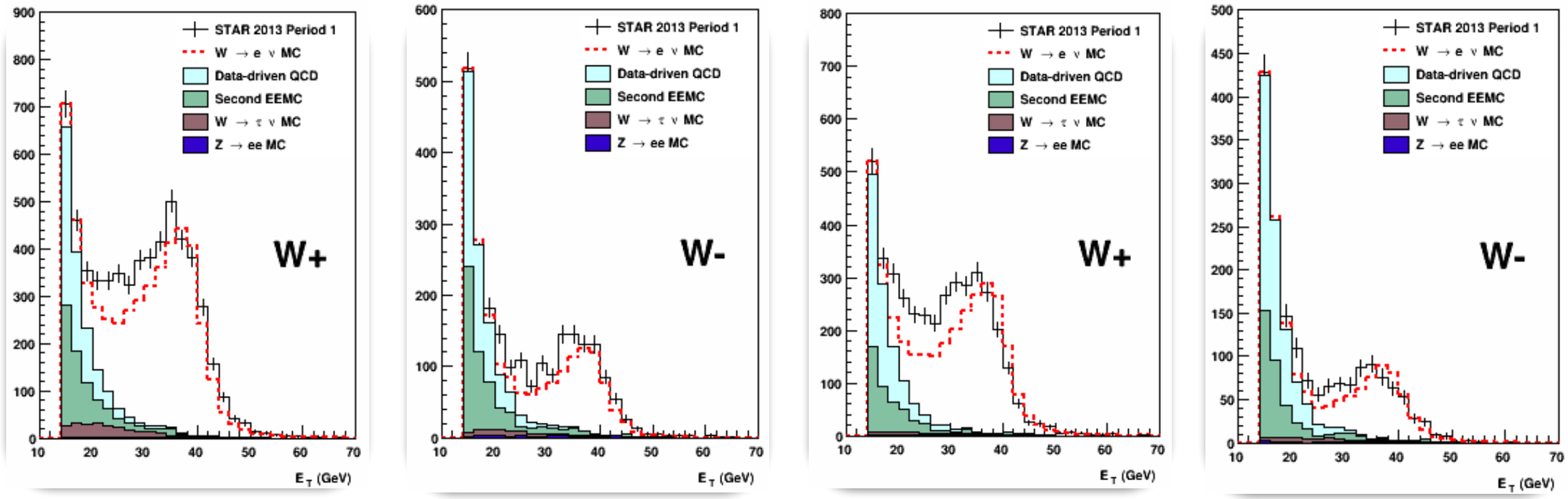
- $|Z_{vertex}| < 100$ cm
- track $P_T > 10$ GeV
- $E_{T\ (2x2)} > 14$ GeV
- $E_{T\ (2x2\ /\ 4x4)} > 95\ \%$
- $\Delta d_{\ (track\text{-}cluster)} > 7$ cm
- $E_{T\ (2x2\ /\ nearCone)} > 88\ \%$
- sign-pt balance > 14 GeV



BACKGROUND ESTIMATION

2x2 cluster E_T distribution of Events which pass all W selection cuts and various BG distribution

Period 1 **Period 2**

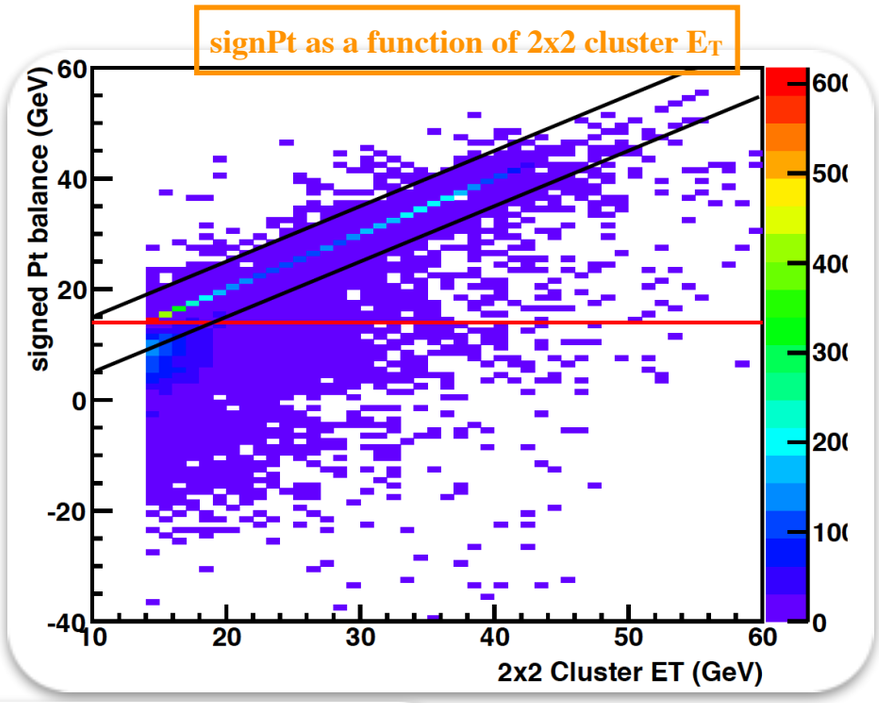


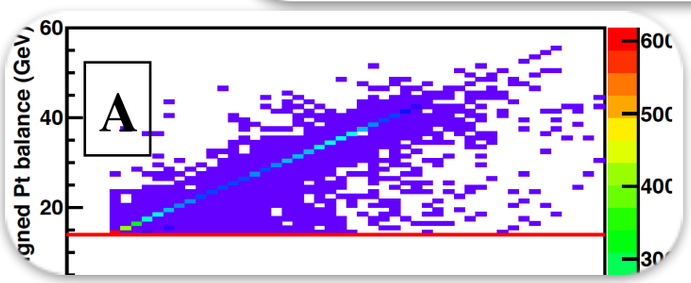
-1.1 < η < -1.1 **-1.1 < η < -1.1**

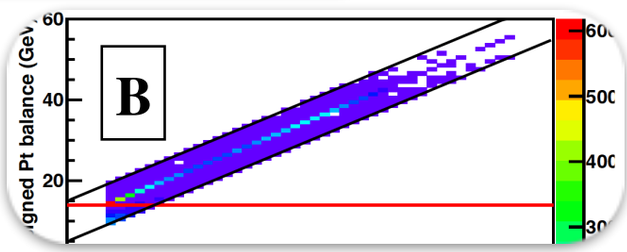
- **Large discrepancy between Data and MC.**
  - **Optimizing W-selection cuts.**
    - **Modified sign-pt balance cut.**
    - **New away E_T cut.**
  - **500 GeV BEMC calibration**

OPTIMIZING W SELECTION CUTS

Modified sing-pt balance cut

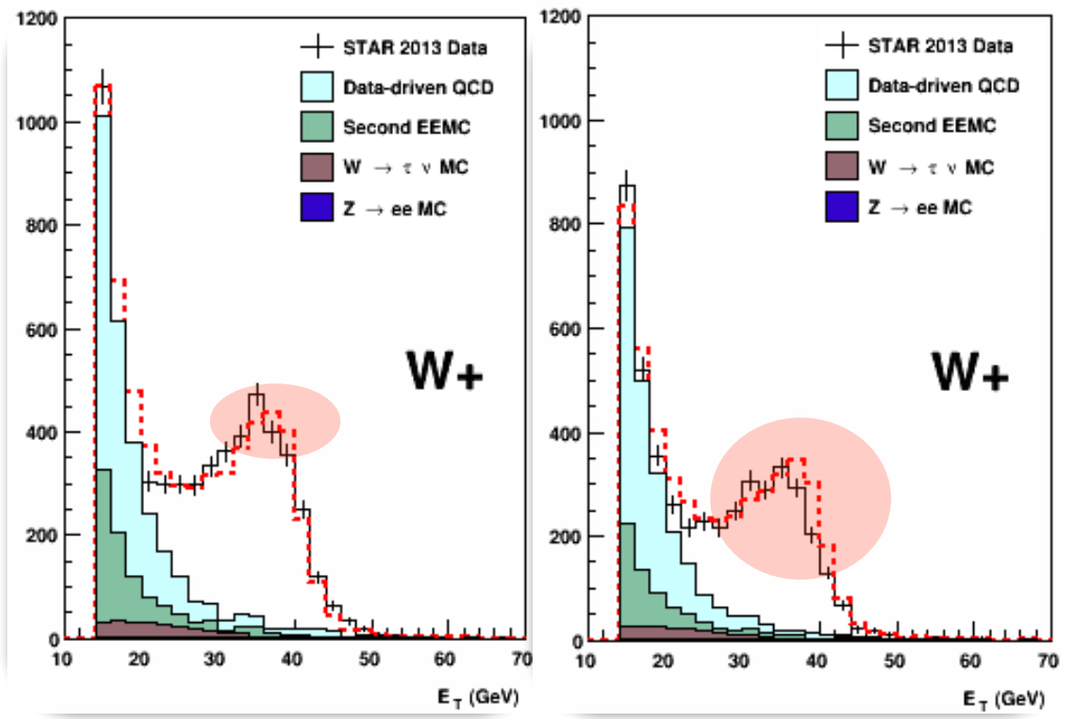


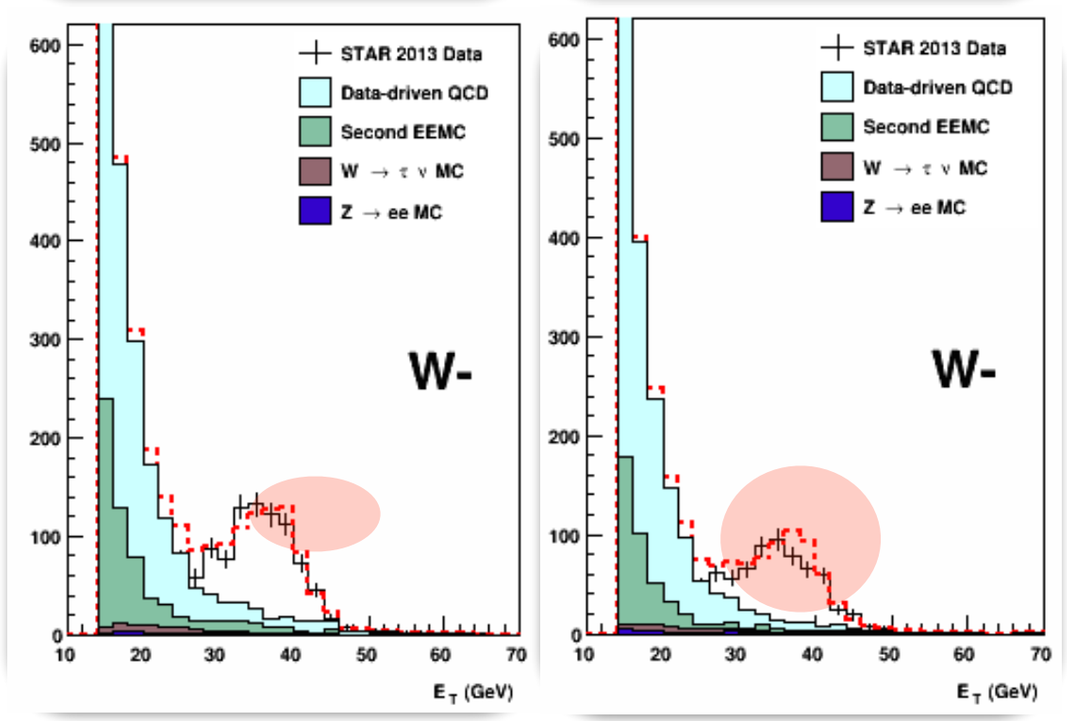




- **Significant reduction of data MC discrepancy.**
- **Not very well agree in low ET bins (below 20 GeV).**
- **Does not consist at the W-Jacobean peak position.**

Period 1 **Period 2**

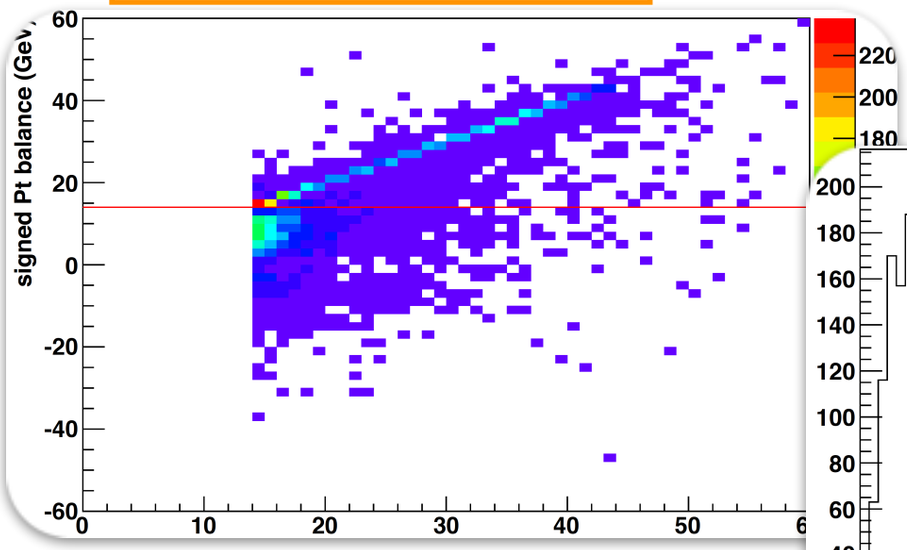




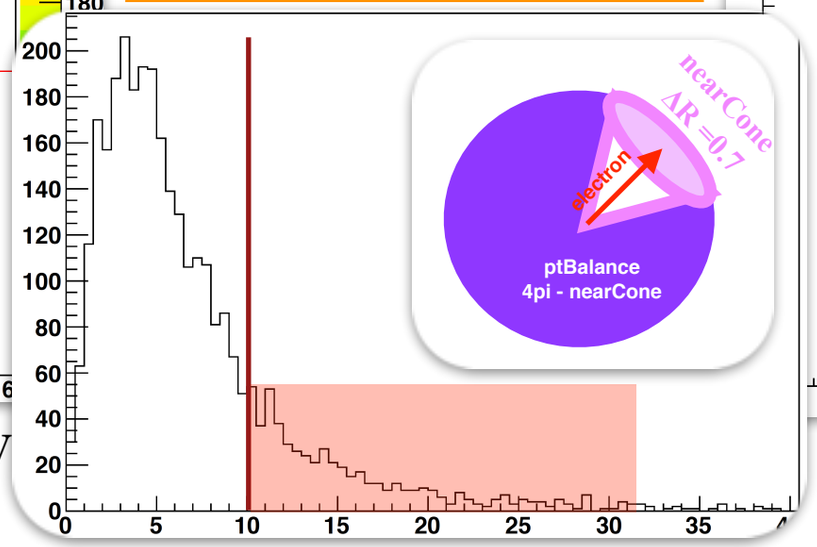
OPTIMIZING W SELECTION CUTS

New Away ET cut

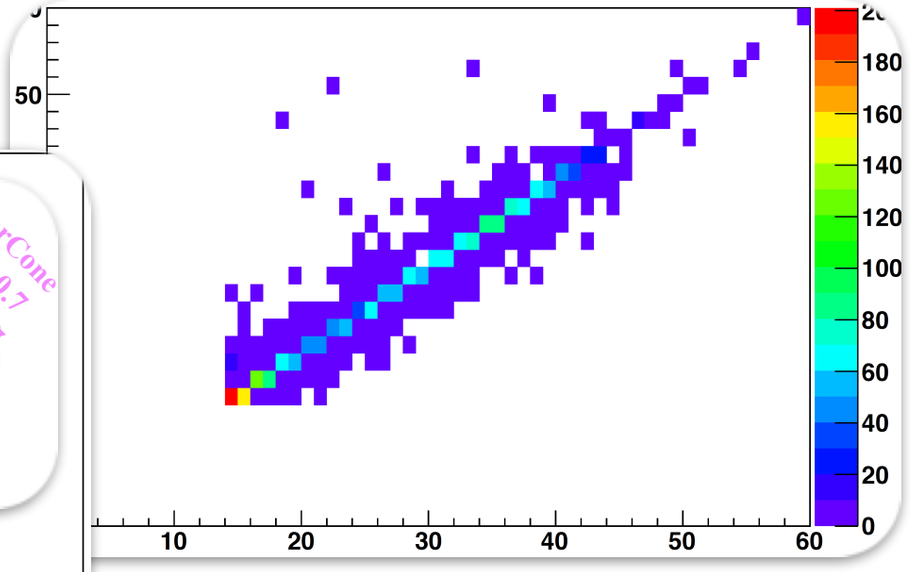
signPt as a function of 2x2 cluster E_T

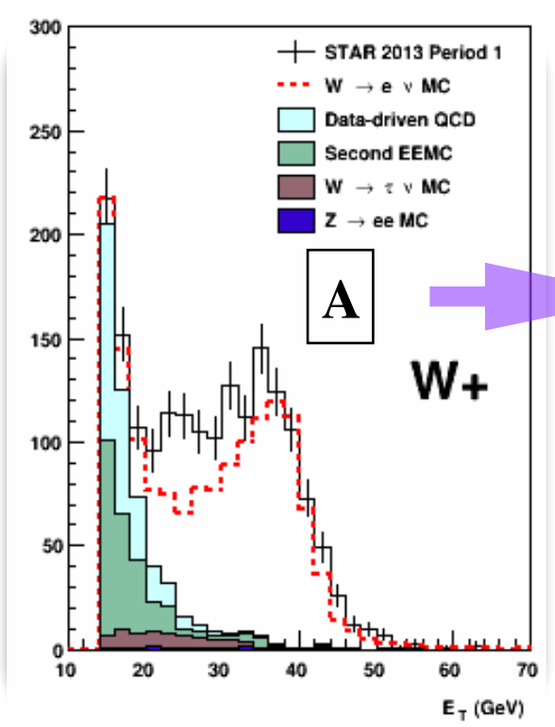


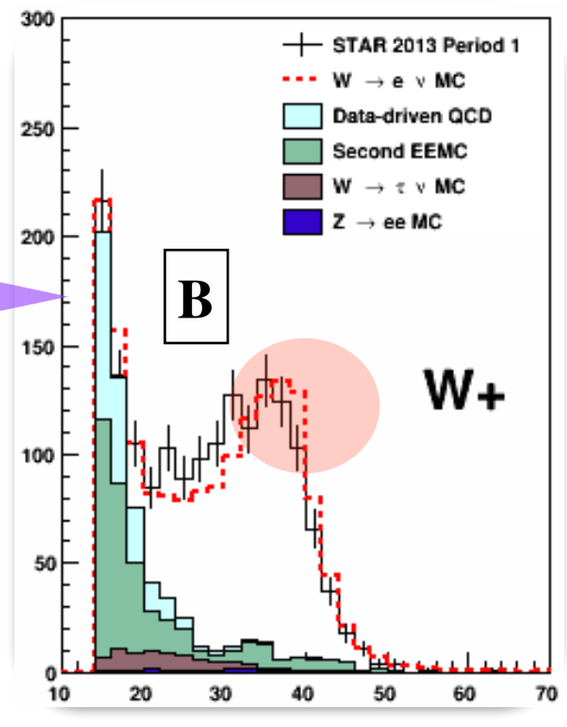
Away E_T of events which pass the sign pt balance cut



signPt as a function of 2x2 cluster E_T







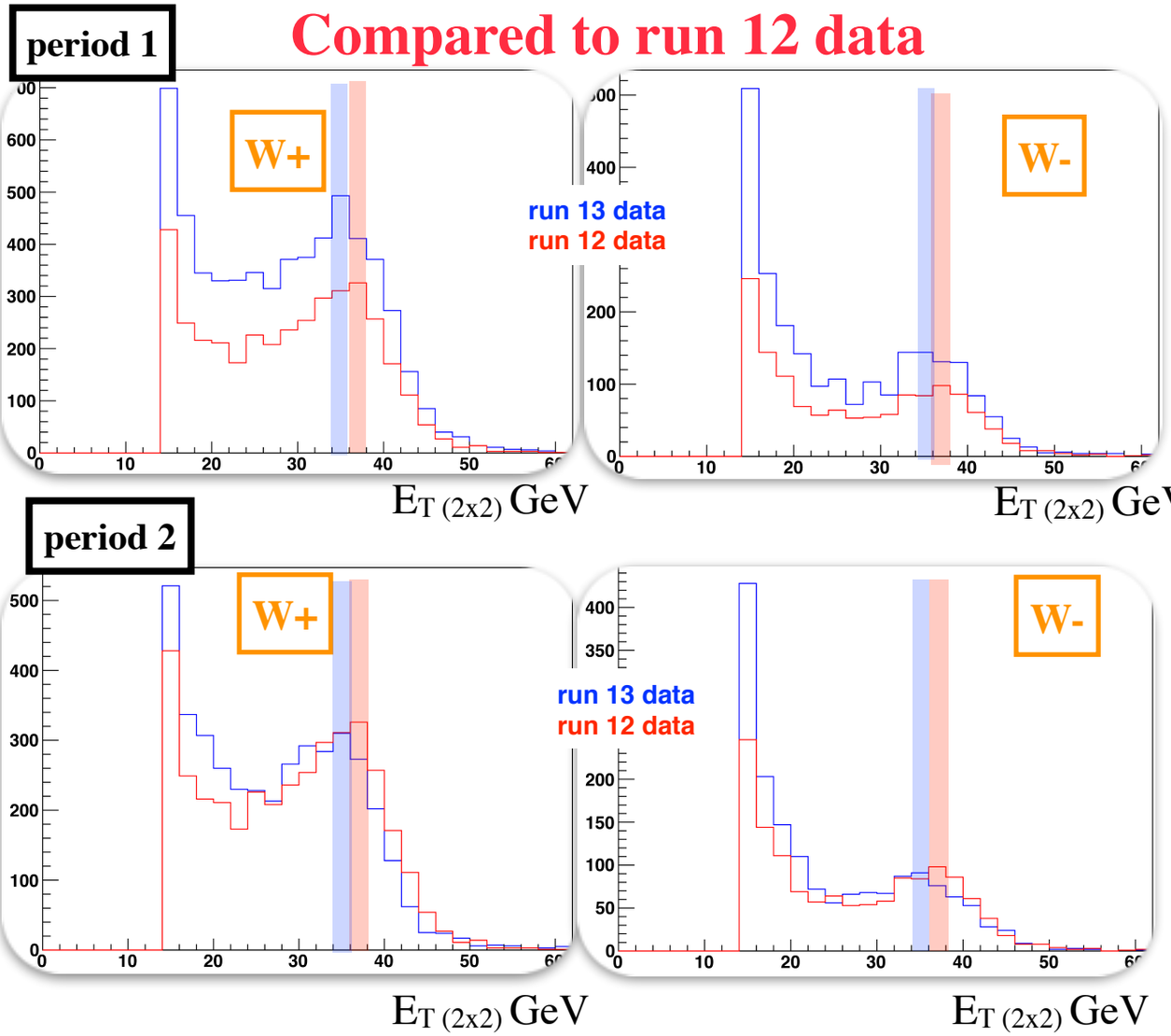
- Similar to modified sign-pt cut.
- Significant reduction of data MC discrepancy.
- Does not consist at the W-Jacobean peak position.

W-Jacobean Peak Position

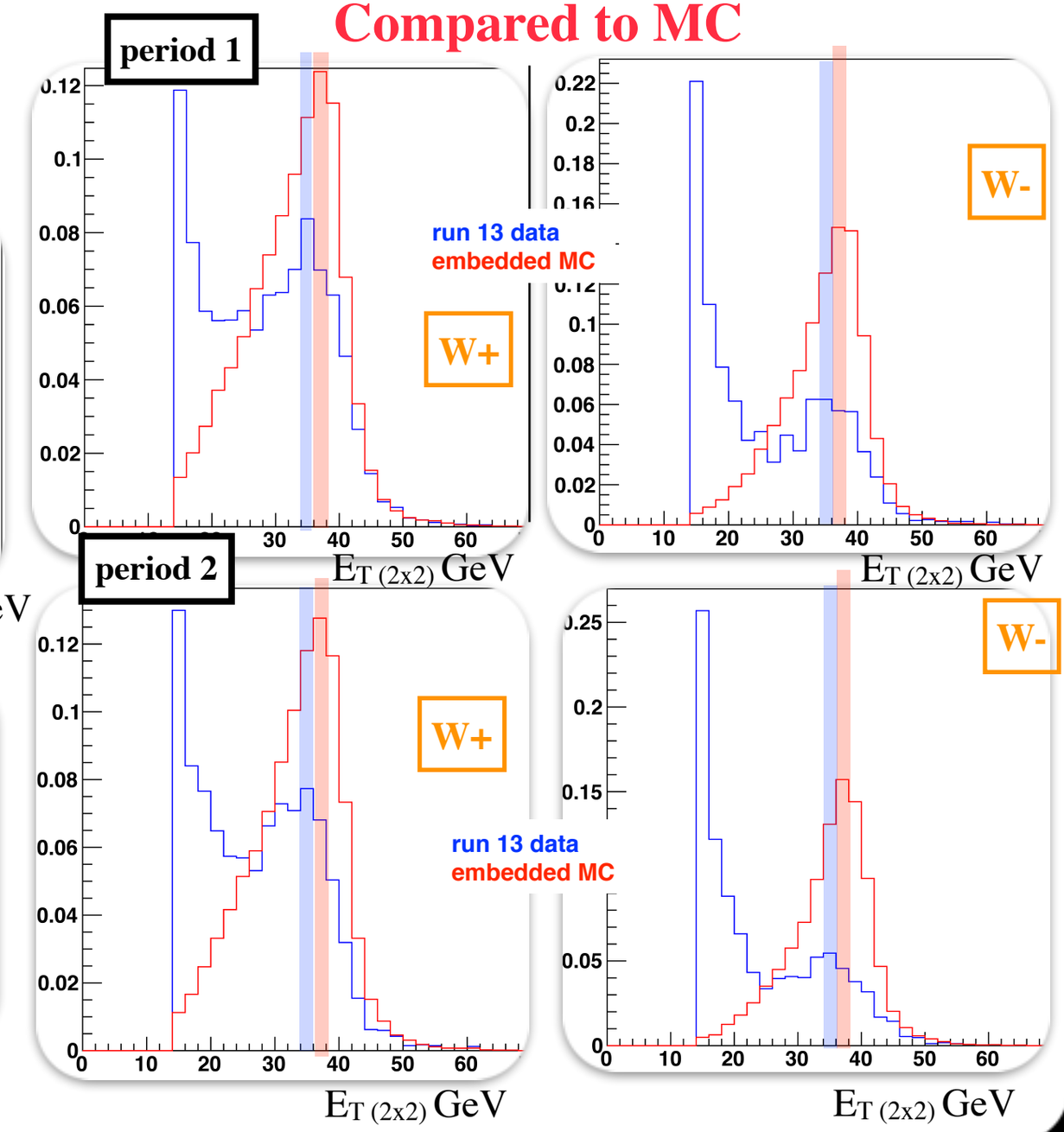
- **W-Jacobean peak position of run 13 data is shifted towards lower ET compared to Embedded MC and run12 data.**
- **This indicated the low gains in the BEMC tower calibration.**

2x2 cluster E_T distribution of Events which pass all W selection cuts

Compared to run 12 data



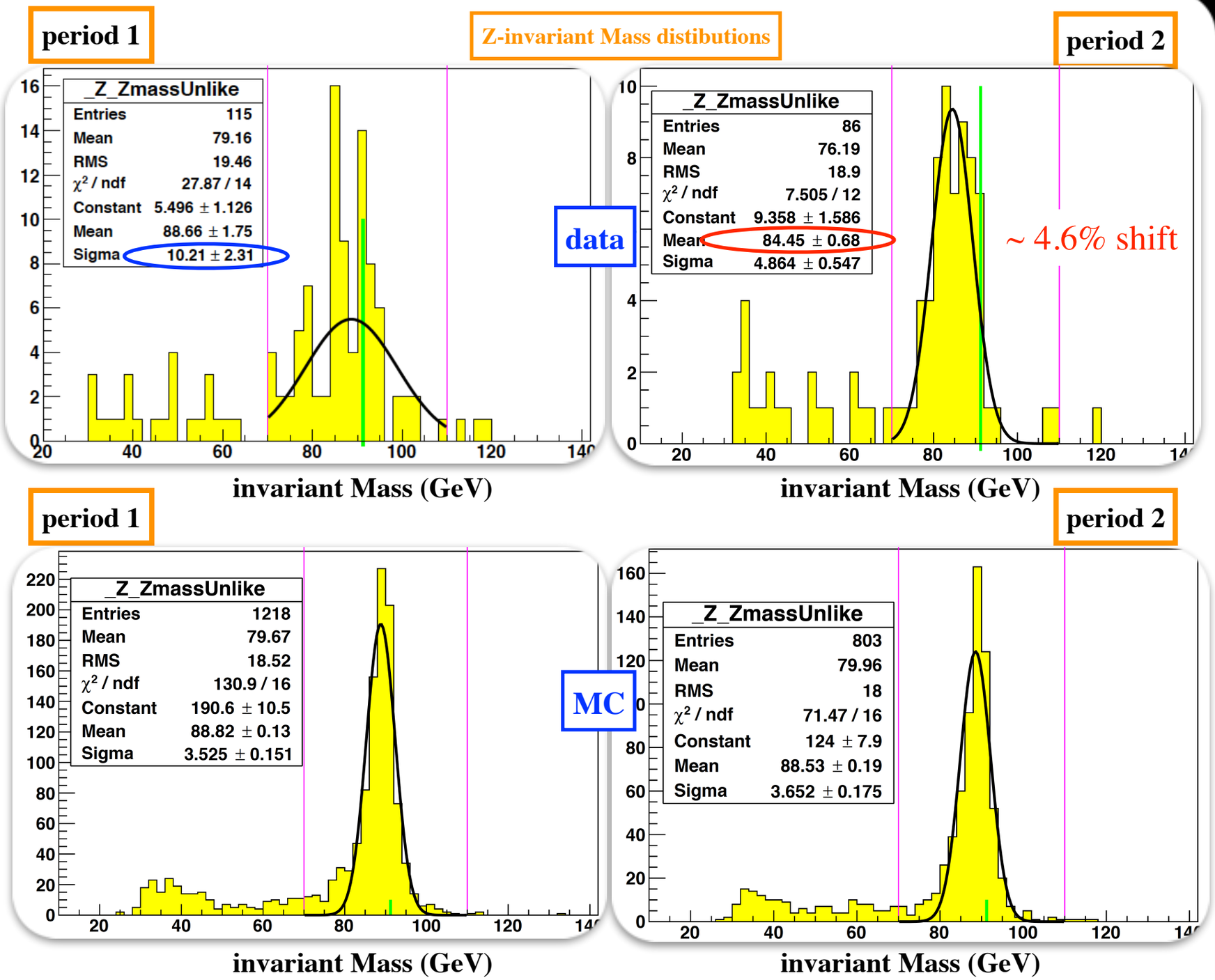
Compared to MC



Z-invariant Mass Peak Position

PDG : 91.1876 GeV

- **Run 13 data shows overall ~2% shift in Z invariant mass Peak.**
- **Another indication of low gains in BEMC tower calibration.**



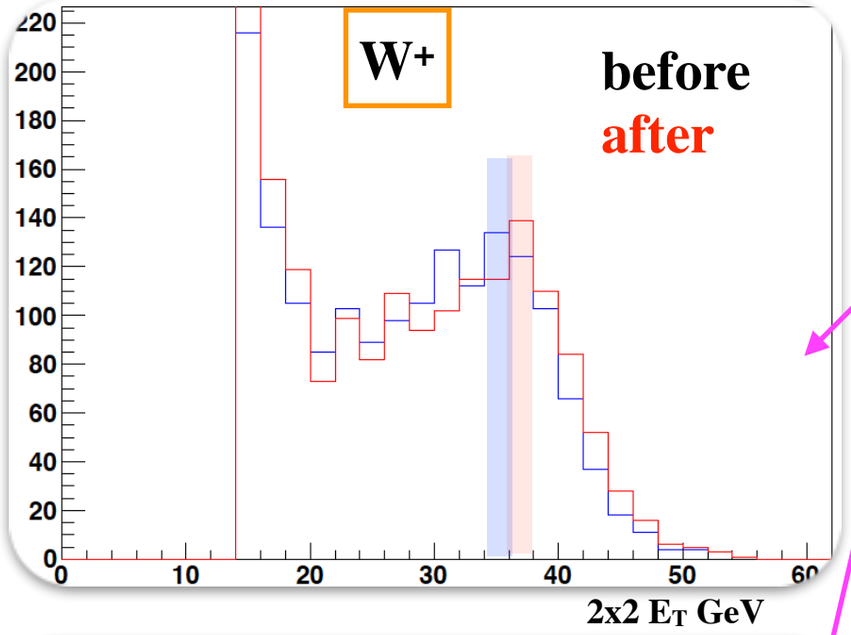
WHY WE NEED Run 13 BEMC Calibration??

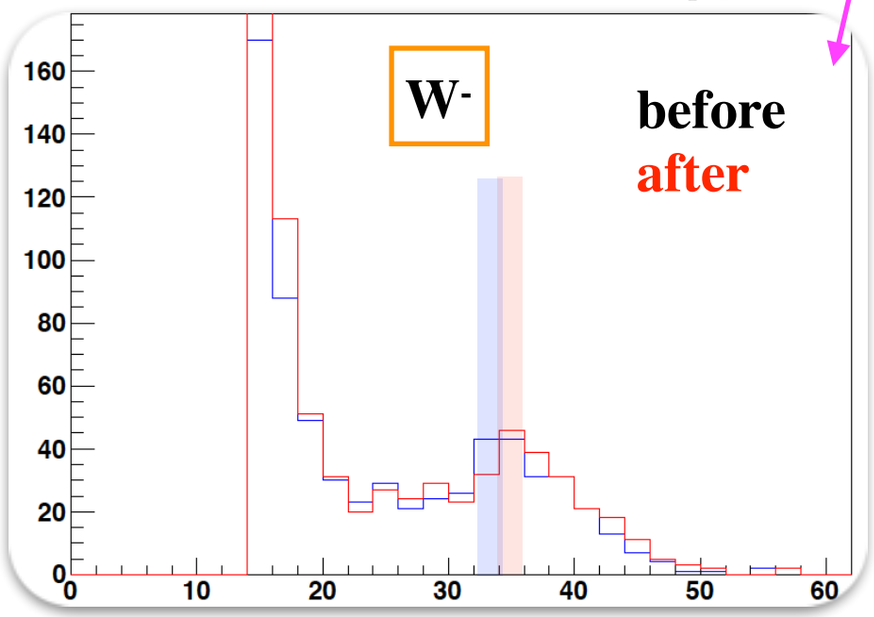
- So far there has been **NO pp500 GeV BEMC calibration** done at STAR.
- Run 12 W analysis used run 9 pp200 GeV calibration done by Matt Walker and others.
- The total integrated luminosity is increased from run 9 to run 12 by factor of **6** and to run 13 by factor of **19.**
- An **updated calorimeter calibration** is clearly needed several years after the last calibration was done for the release of preliminary and in particular published results.
- Run 12 pp200 GeV calibration recently completed by Kevin and they indicate that significant gain change from 200 to 500 GeV is expected.
- In run 13 we observe that the reconstructed invariant Z mass peak is shifted by ~ 4.6% towards low mass compare to embedded MC.
- Reconstructed W Jacobean Peak position in run 13 data sample (both period 1 and 2) is shifted compared to embedded MC and run 12 data.

Fudge-Factor

- **We applied a fudge factor [=1.03] (estimated based on the W-Jacobean Peak position shift in run 13 compared to MC and run 12) at tower level and reanalyze run 13 data.**

2x2 cluster E_T distribution of Events which pass all W selection cuts

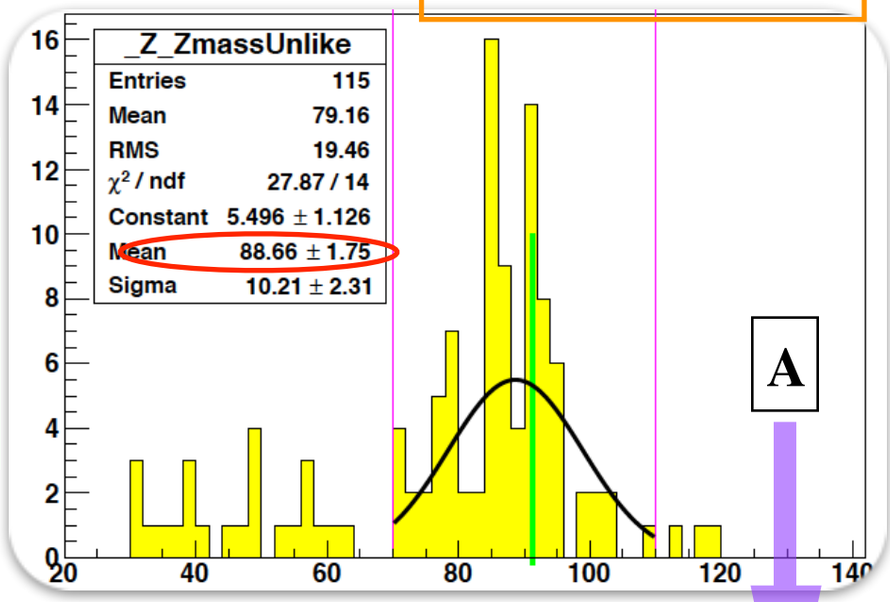


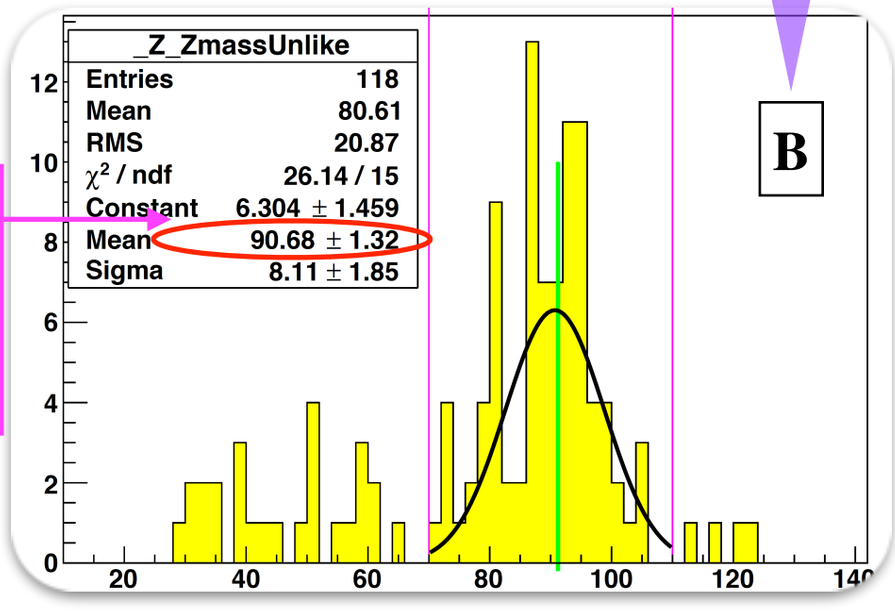


jacobean peaks shifted towards large ET after applying fudge factor.

Z - invariant mass peak value is closer to PDG value. (91.1876 GeV)

Z-invariant Mass distibutions





BEMC CALIBRATION

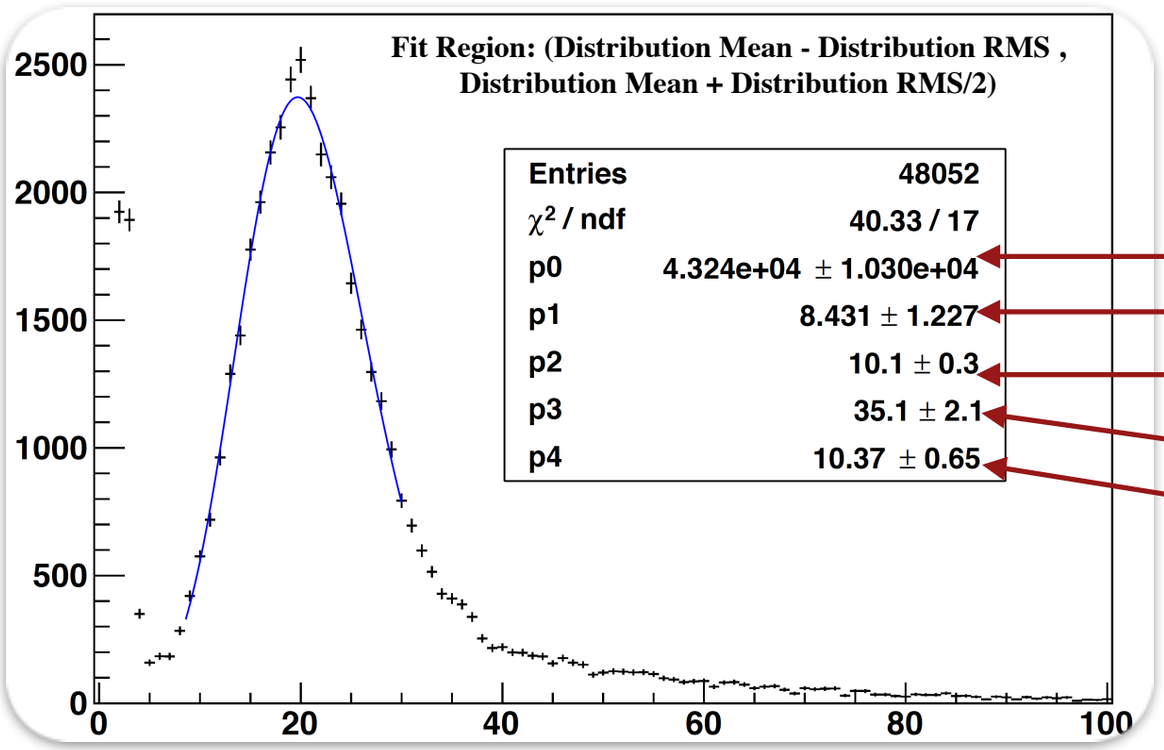
Introduction

- Calibration constants (gain) need to estimate in order to obtain the energy of calorimeter towers. **E = (ADC-ped) * gain**
- Best way to calibrate calorimeter towers is to use abundant electrons tracks pointing to each tower. [since e's deposit all of their energy in to the towers with E/P ~1]
- But we do not have that many e's tower by tower.
- Obtain relative calibration using plenty of MIPs which are available tower by tower.
- Use E/P from electrons to adjust the relative constant and obtain the absolute gain. **gain = C_{abs} = C_{rel} / <E/P>**

BEMC CALIBRATION

Relative Calibration : MIPS

- **Obtain MIP ADC distribution of each tower.**
- **Fit it with a function [“gaus*Landau”] which best describe the signal and background regions.**
- **Obtain the mean of the fit as the MIP ADC value.**
- **Use the formula to calculate relative calibration constant for each tower.**



- **Signal region fit with the Gaussian function**
- **BG is well fit with the landau function**

Constant
Gauss Mean
Gauss Sigma
Landau MP value
Landau sigma

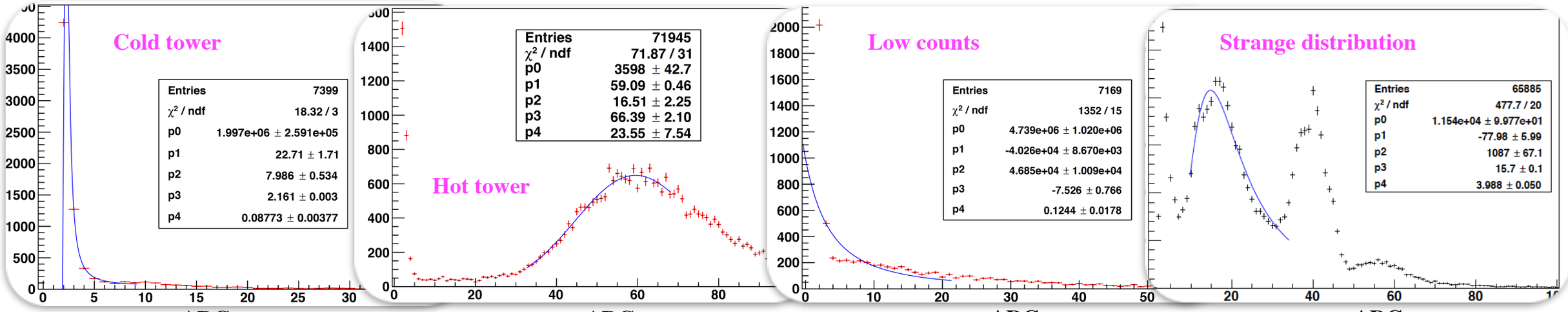
$$C_{relative} = \frac{0.264\left(1+0.056\eta^2\right)}{ADC_{MIP}\sin(\theta)}$$

MIP-ADC = Mean of the Fit function

([p0]*gaus(x,[p1],[p2]*Landau(x,[p3],[p4])

BEMC CALIBRATION

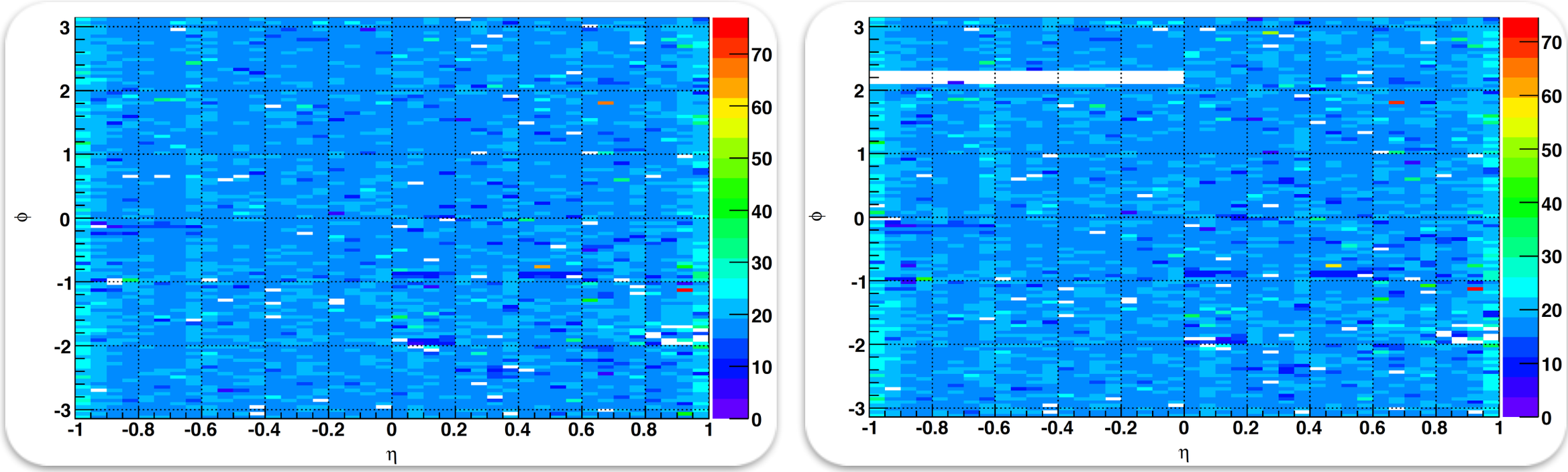
Relative Calibration : Tower QA



Period 1

Eta-Phi map of Good tower MIP-ADCs

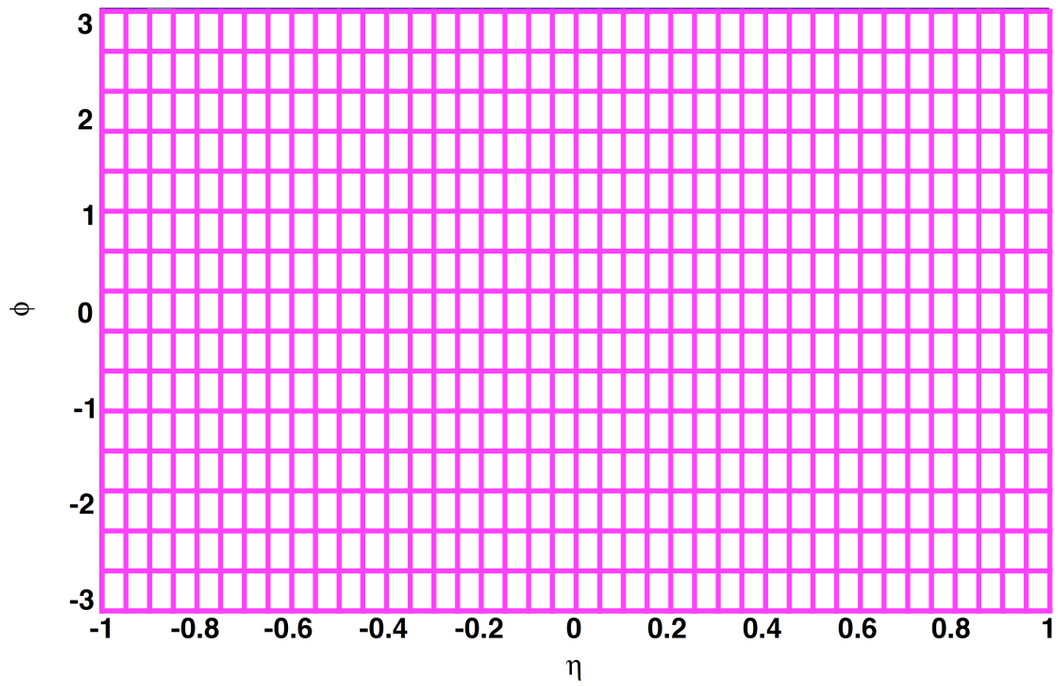
Period 2



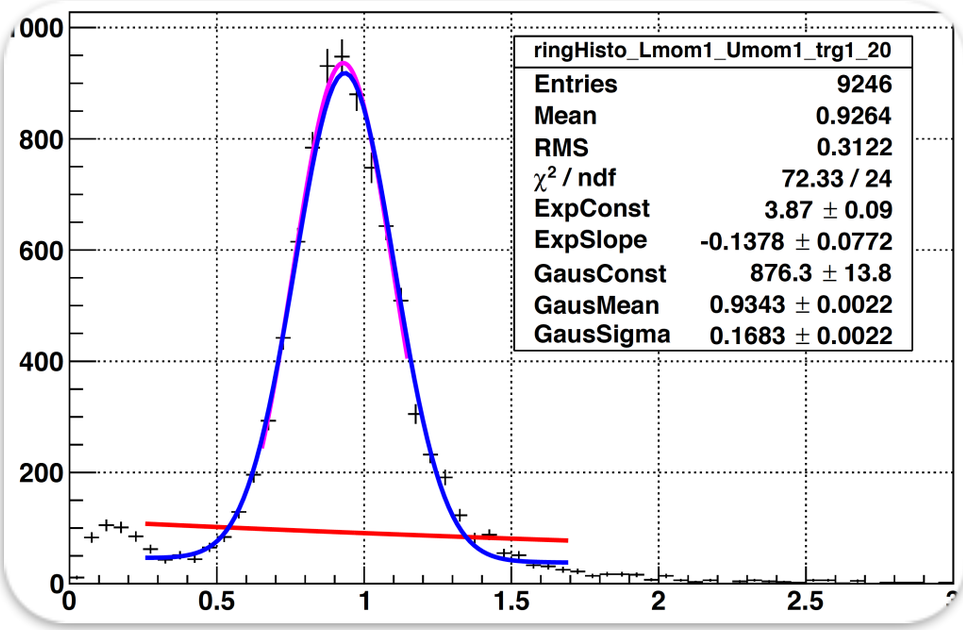
BEMC CALIBRATION

Absolute Calibration : Electrons

- We use e's tracks that pointed to calorimeter towers to obtain E/P value.
- Group e's by eta rings (120 towers at same eta) and crate slices. (8 towers in each crate in same eta).
- Use HT trigger options to get E/P distribution in each eta ring and Fit with appropriate fitting function.
- Extract mean E/P value from the fit function.



Fit Function : "gaus+expo"

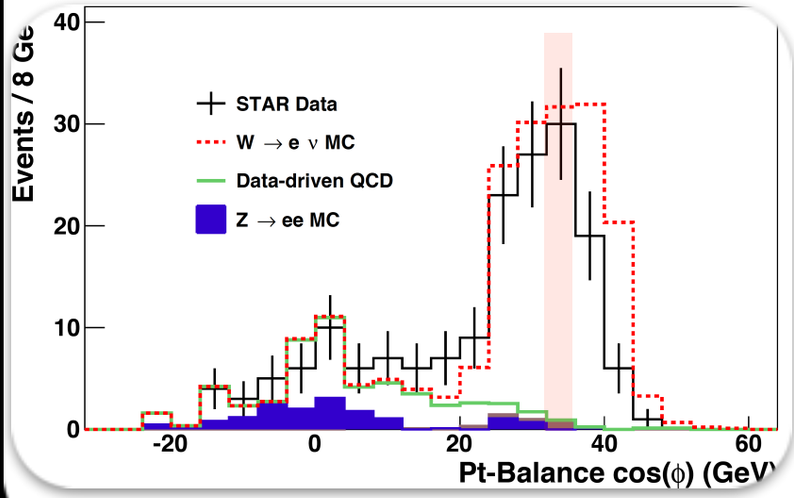


FORWARD RAPIDITY W A_L ANALYSIS

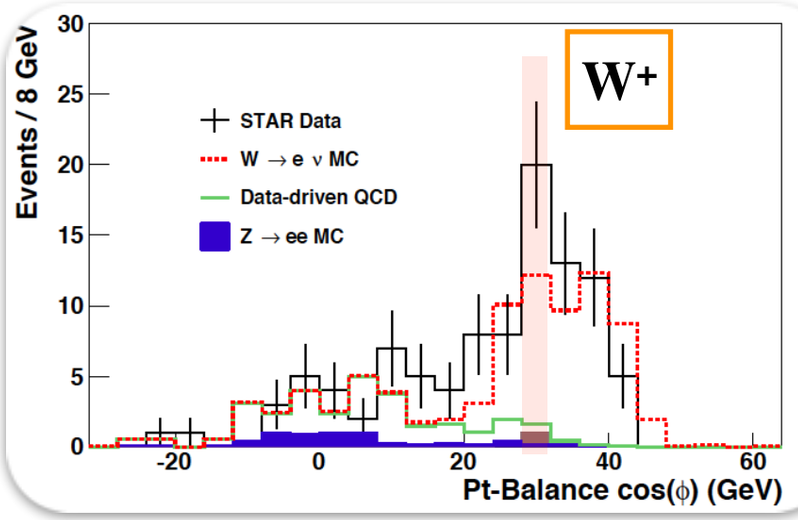
REQUIREMENT

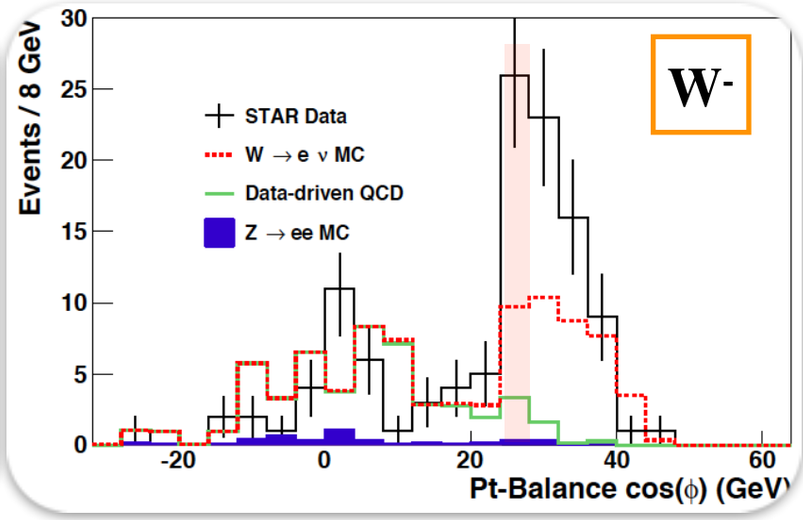
- In run 12 analysis W A_L results is extended to 2 bins in forward eta using EEMC.
- In run 13 we observe a peak towards low E_T in e+/e- ET distribution in forward analysis similar to Jacobean peak position in mid-rapidity.
- We believe this was caused by the outdated EEMC calibration and hence require an updated calibration of EEMC in order to extend run 13 analysis in to forward regions.
- We have a dataset with completed QA for the forward analysis.

Run 12



Run 13- Period 1





FURTURE PLANS

- We plan to release run 13 preliminary W-A_L results using run13 pp 500 GeV BEMC calibration only in mid-rapidity region ($|\eta| < 1.0$).
- Final results will include ,
  - run 13 A_L extended up to η=1.4 in forward region requiring updated calibration of EEMC.
  - run 12 A_L results with updated run 12 500 GeV calibration [run 12 500 GeV calibration is in progress].
- Very forward rapidity ($1.0 < |\eta| < 2.0$) analysis using FGT is ongoing separate preliminary results will be released.

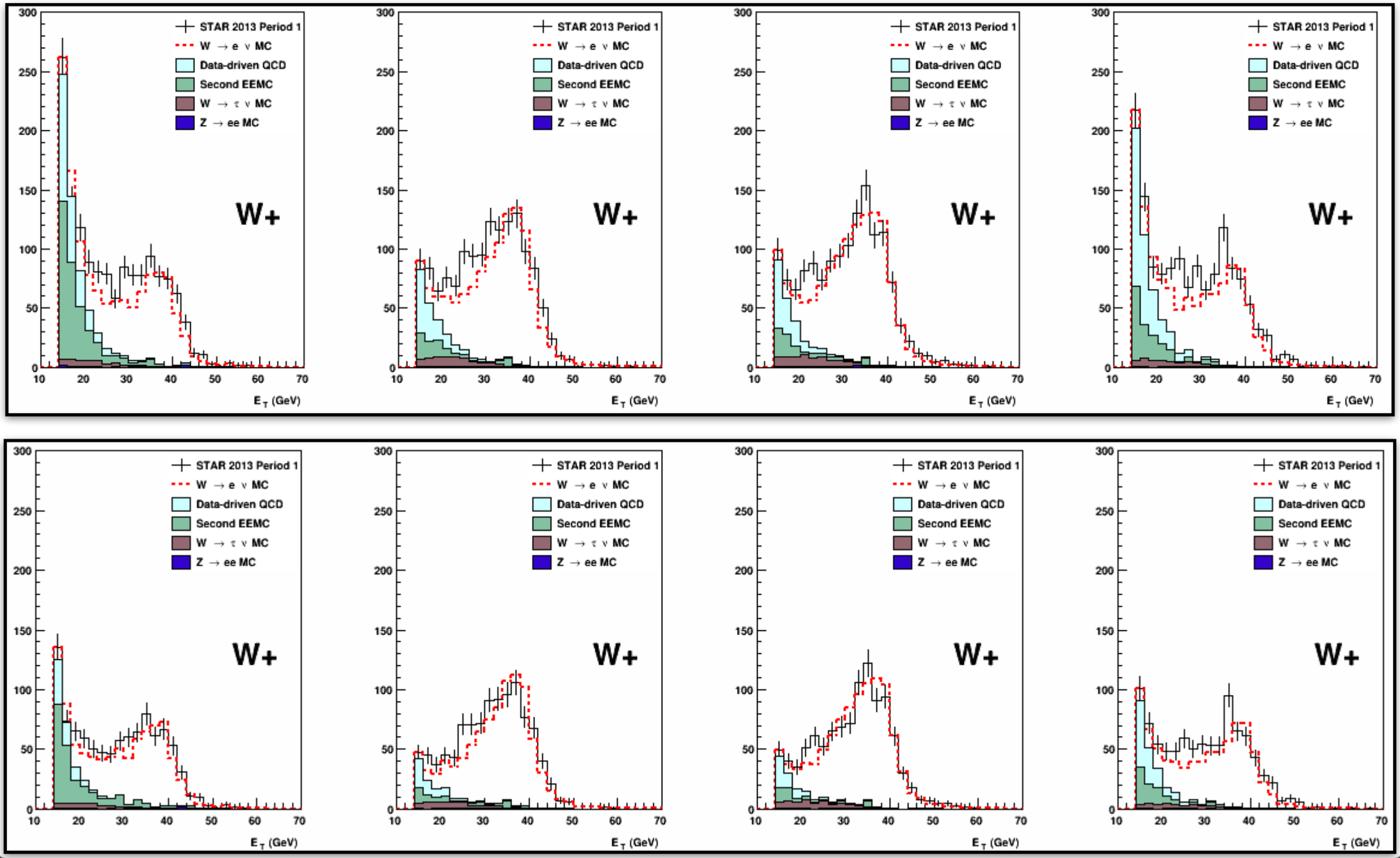
SUMMARY

BACK UP

DATA SET

- Data : QA completed.
  - Period 1 : 126.17 pb-1 [938 runs]
  - Period 2: 121.7 pb-1 [716 runs]
- Embedding : QA completed.
  - Period 1:
  - Period 2:

BG 4 ETA BINS- PERIOD 1

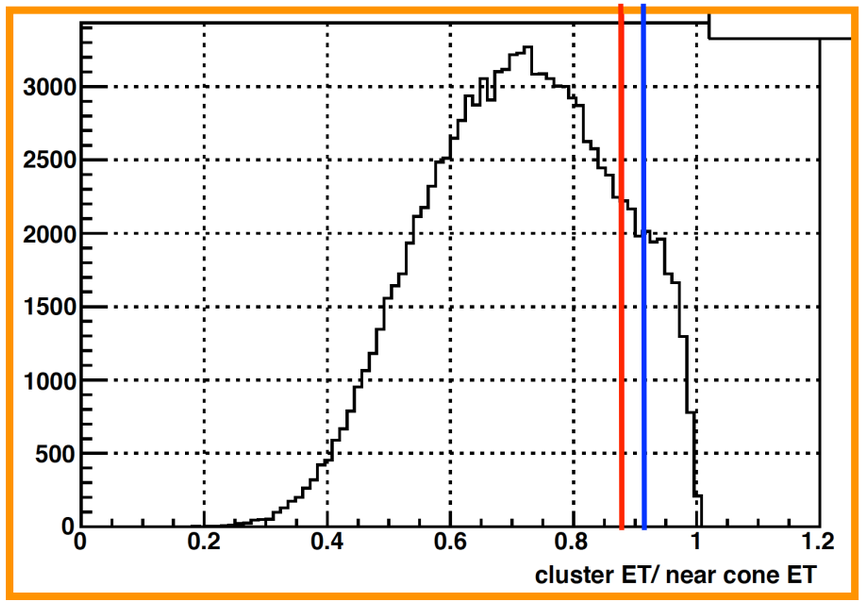


BG 4 ETA BINS- PERIOD 1

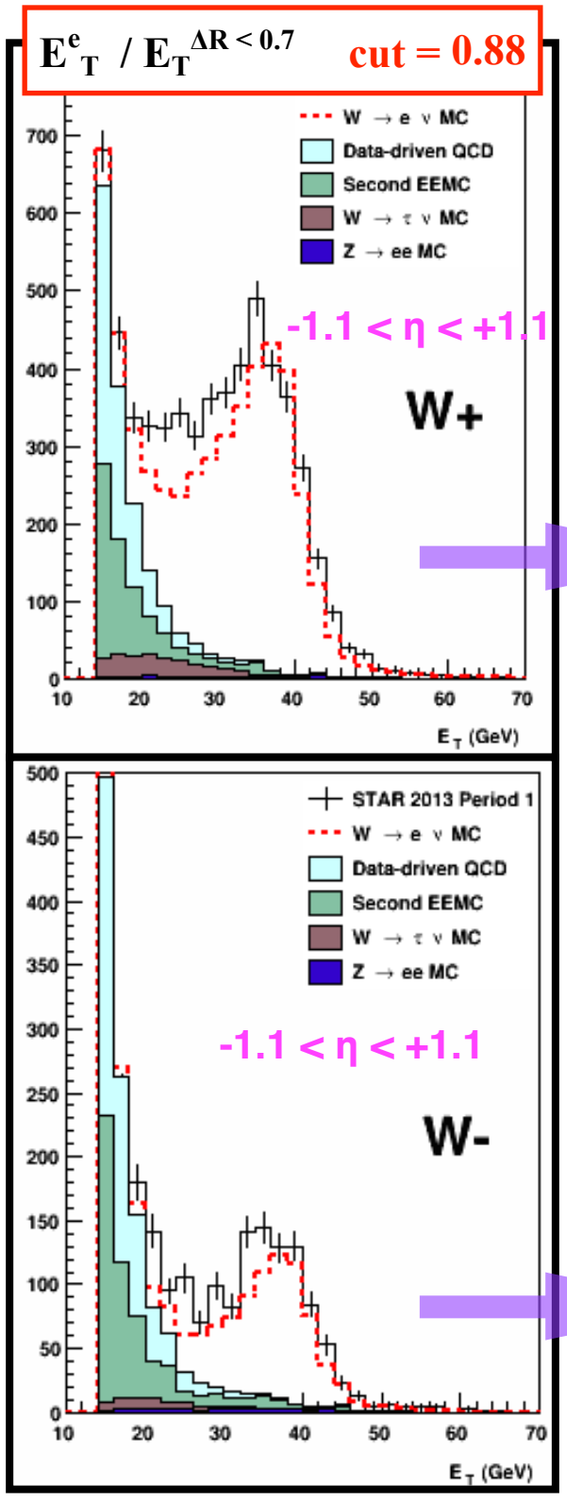
OPTIMIZING W SELECTION CUTS

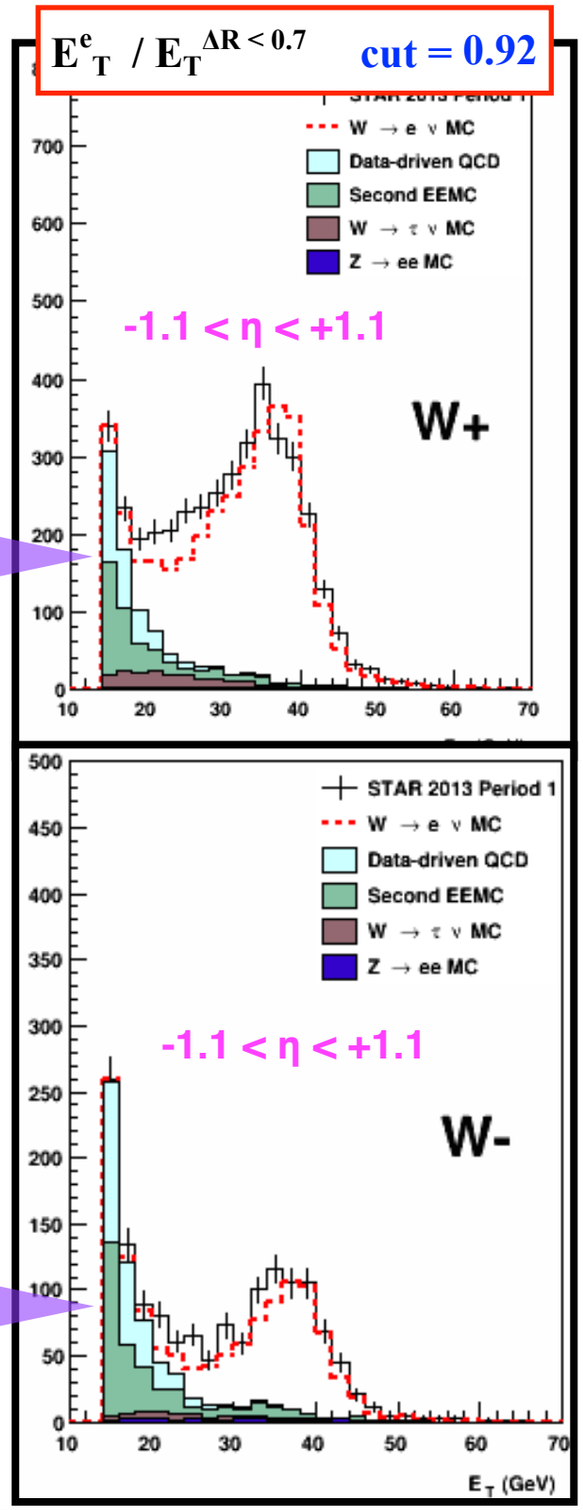
nearCone Isolation cut

candidate e+/e- events $E_{T(2x2)}$ distribution after matching tracks requirement.

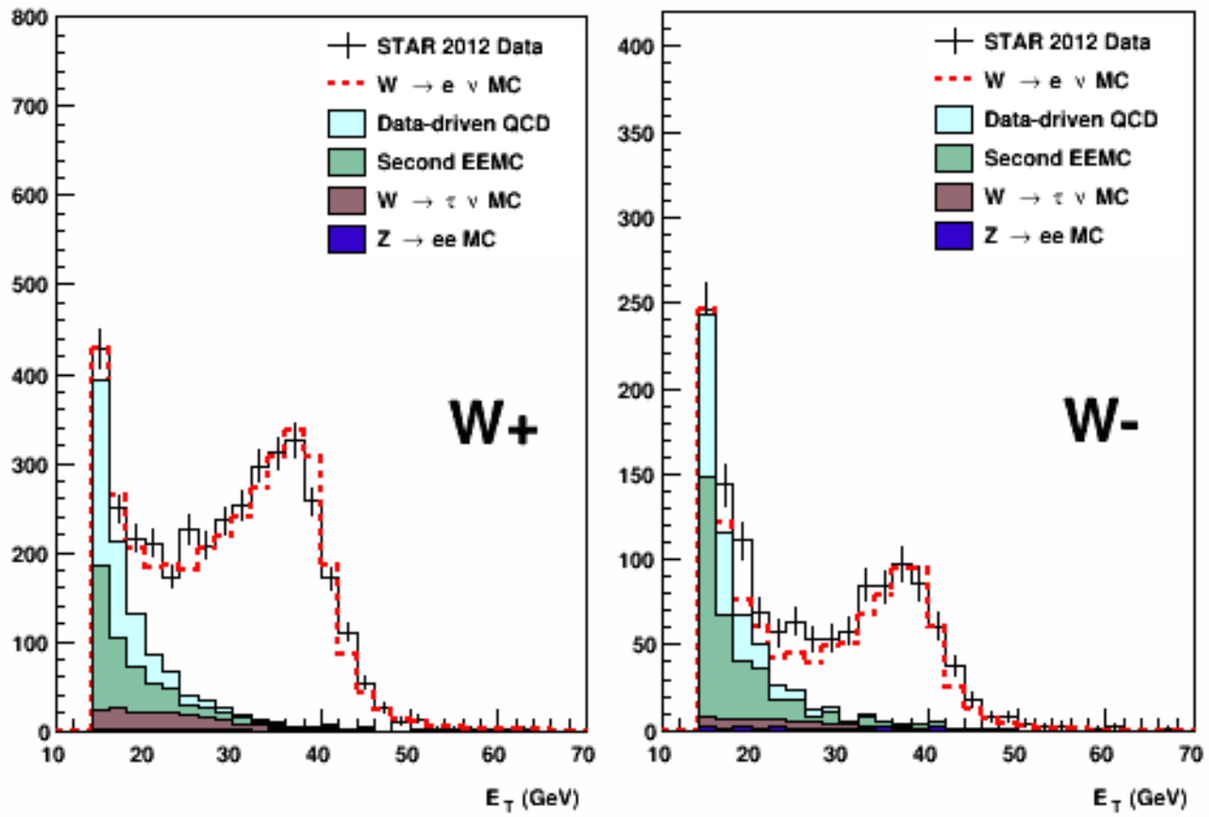


- **Visible reduction of the discrepancy.**
- **Not much change in Signal / Background.**
- **Does Not resolve the issue.**

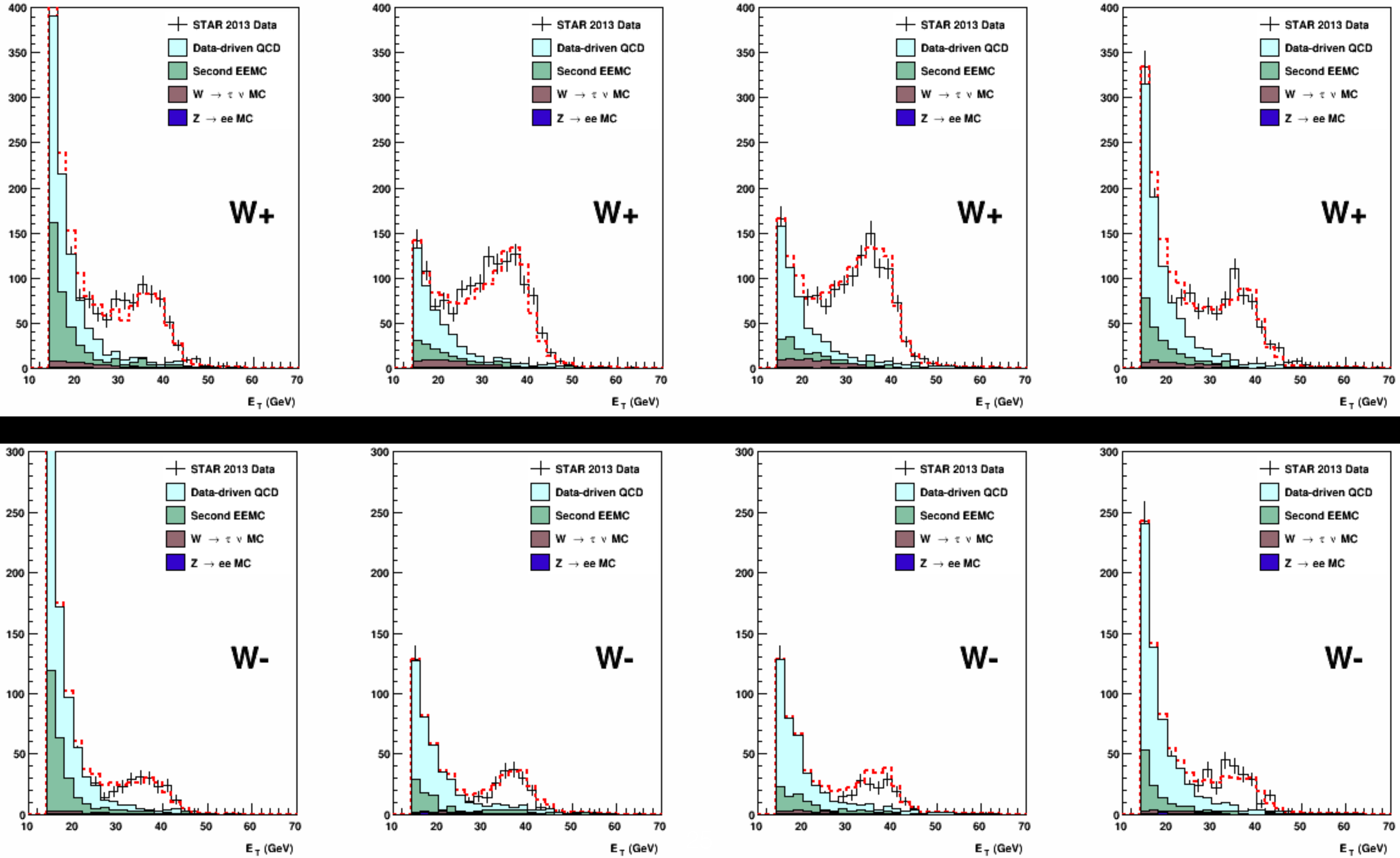




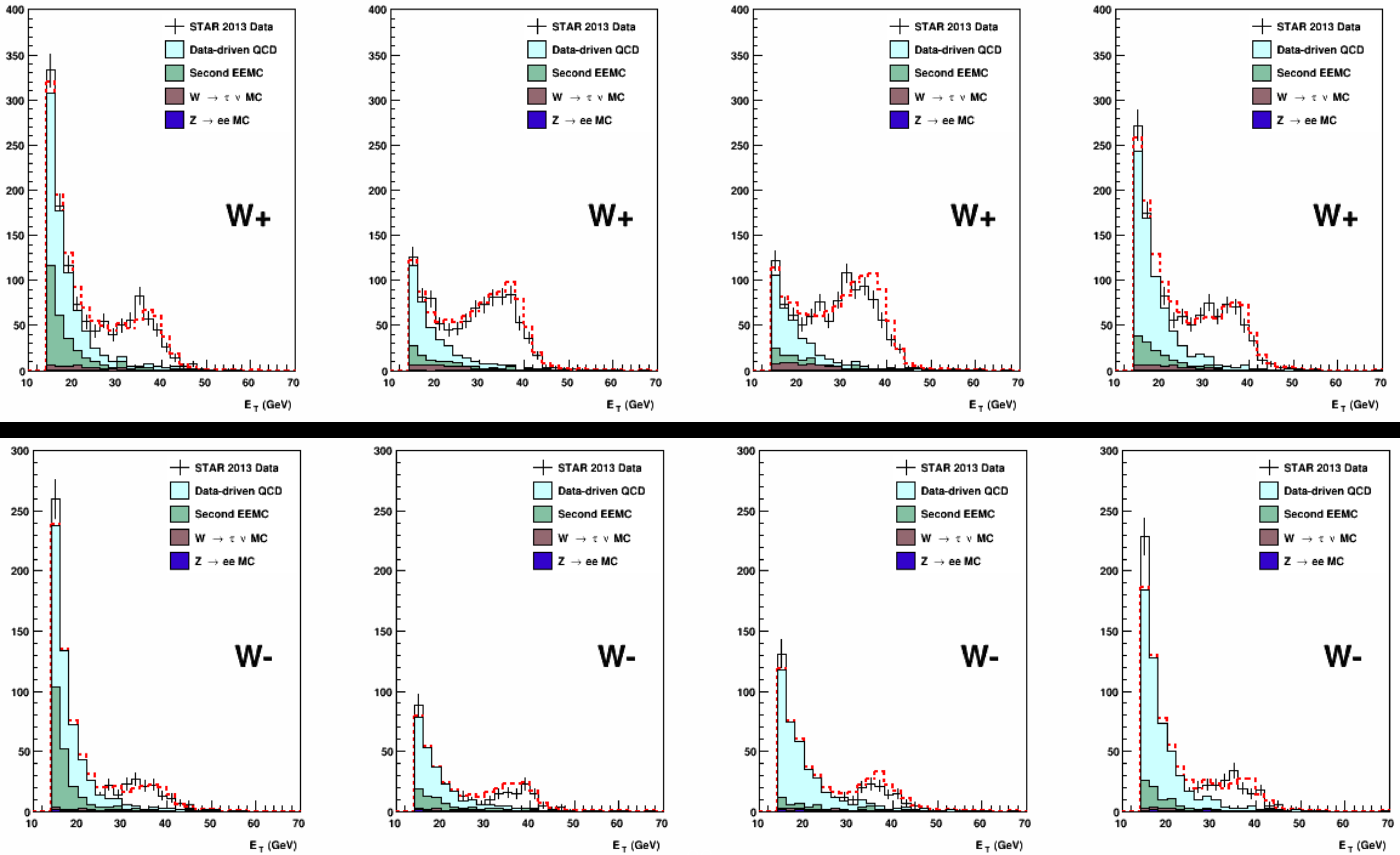
RUN 12 BG


STAR 2012 Data
W → e ν MC
Data-driven QCD
Second EEMC
W → τ ν MC
Z → ee MC
W+
W-
E_T (GeV)

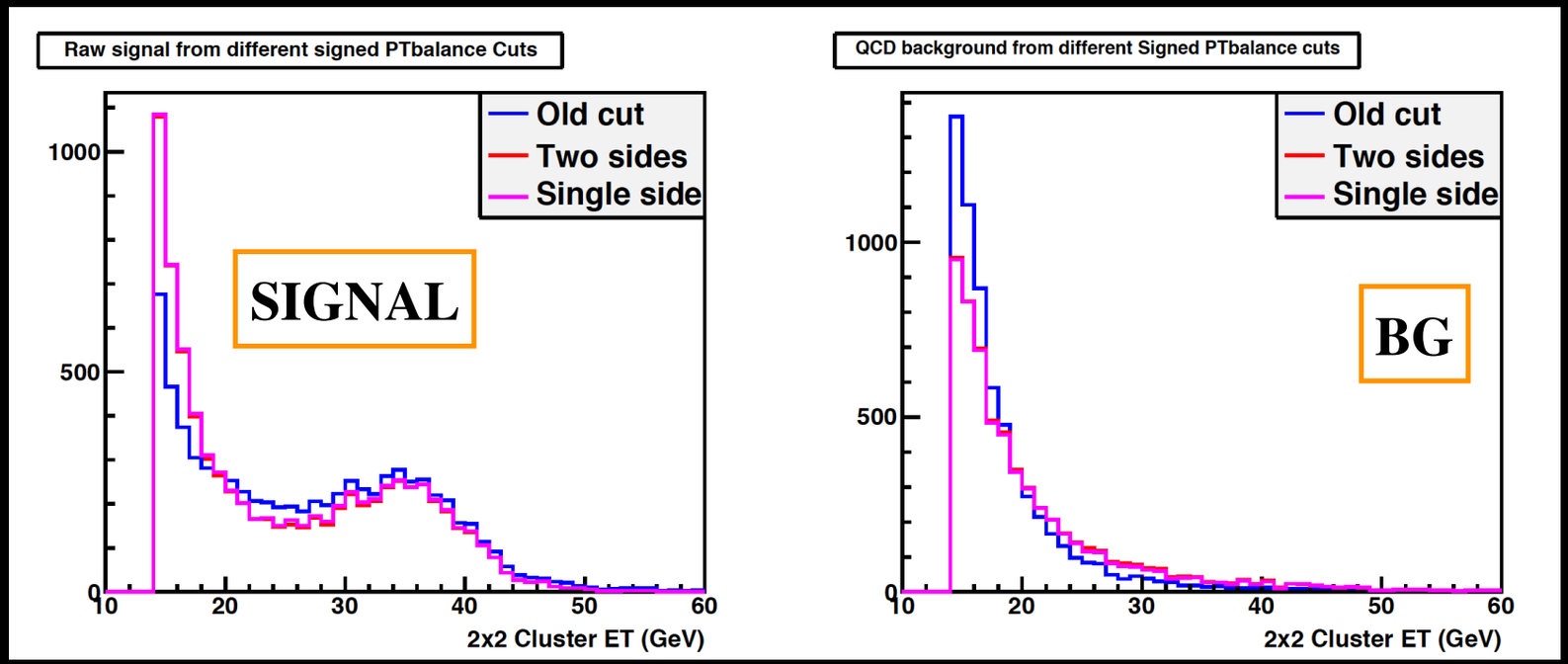
Sign-pt cut - P1

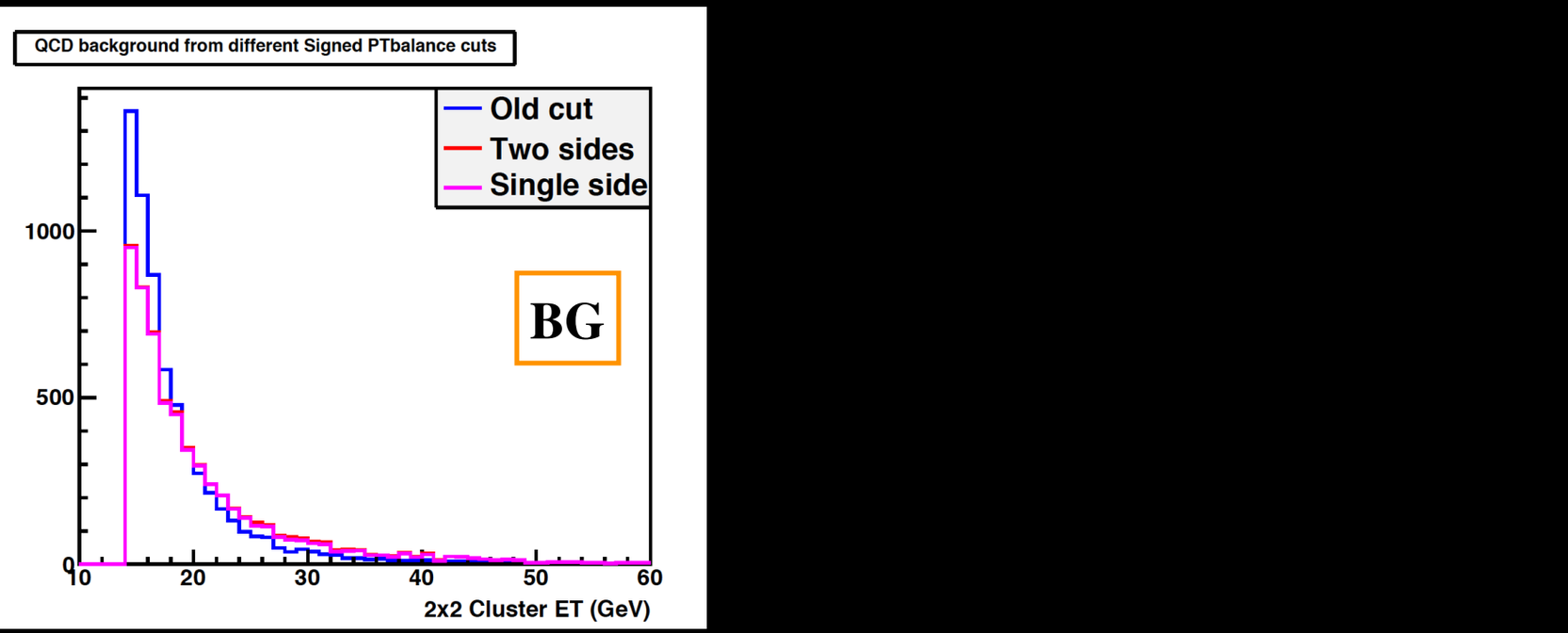


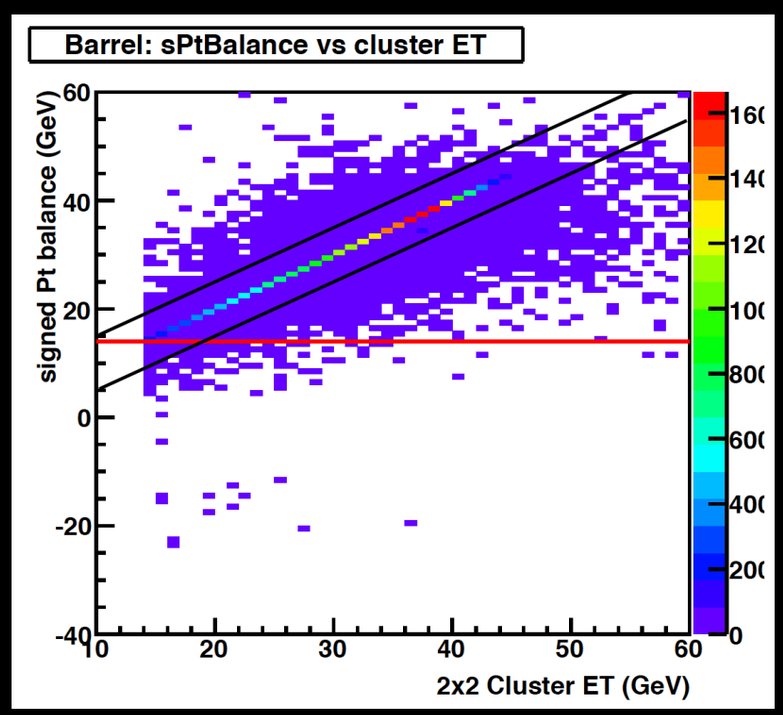
Sign-pt cut - P2

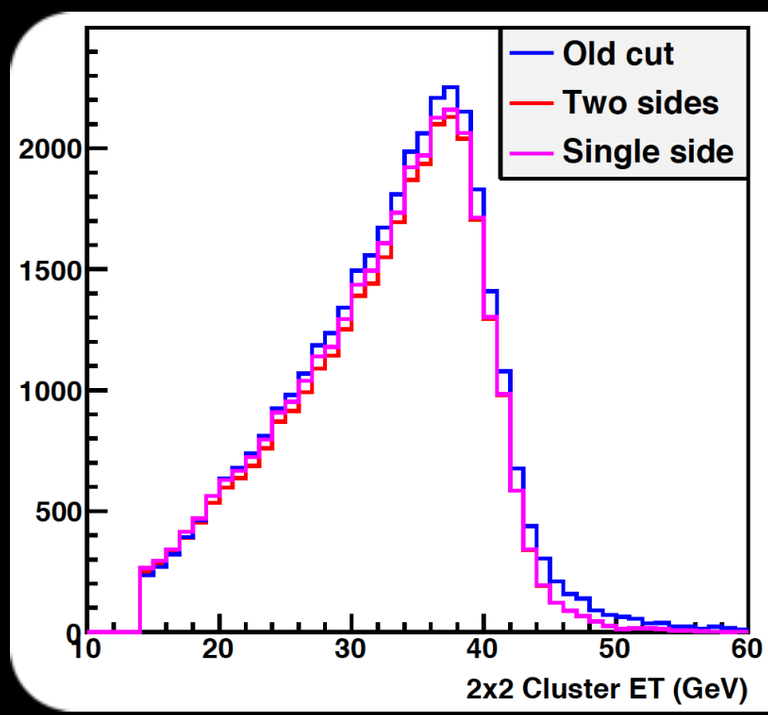


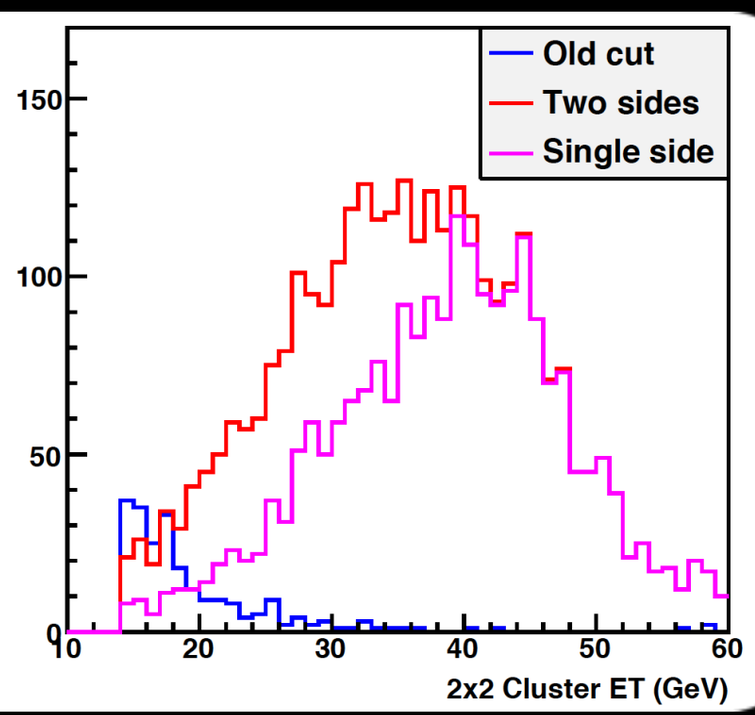
Modified-signPT cut

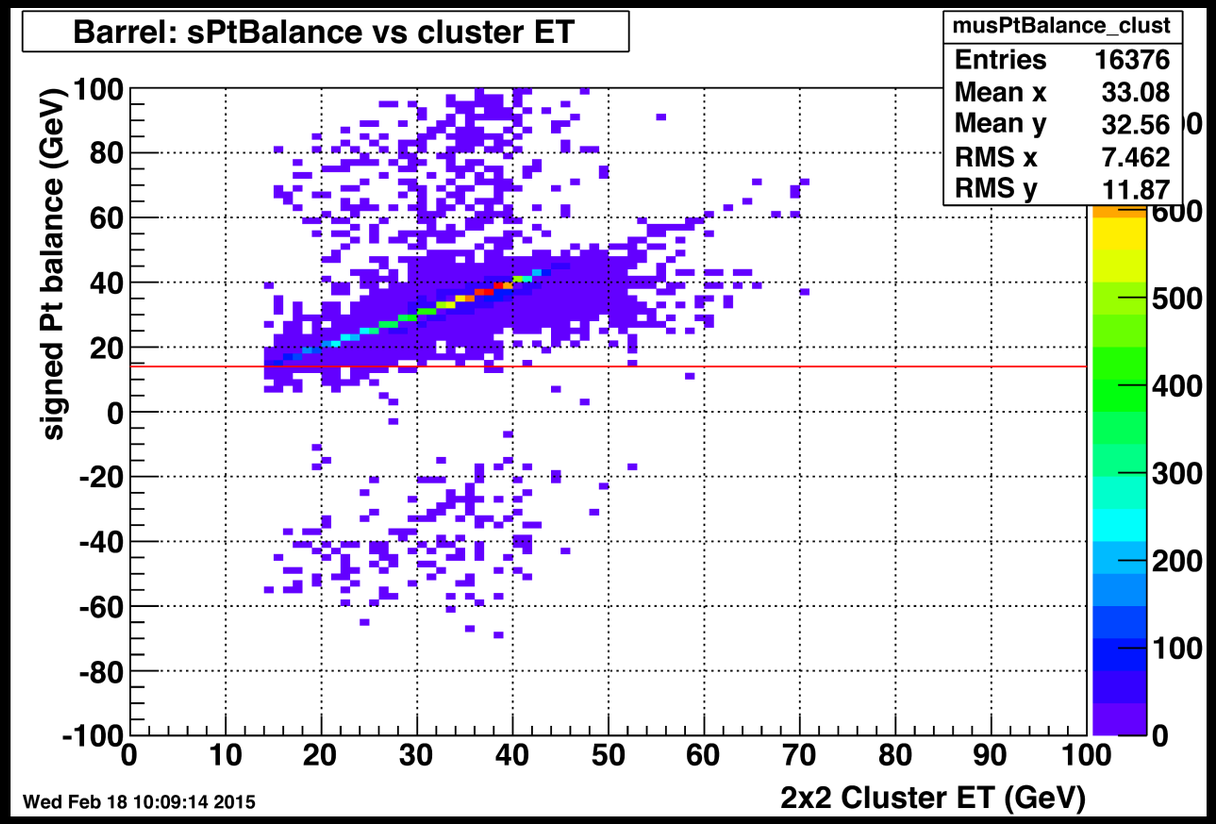




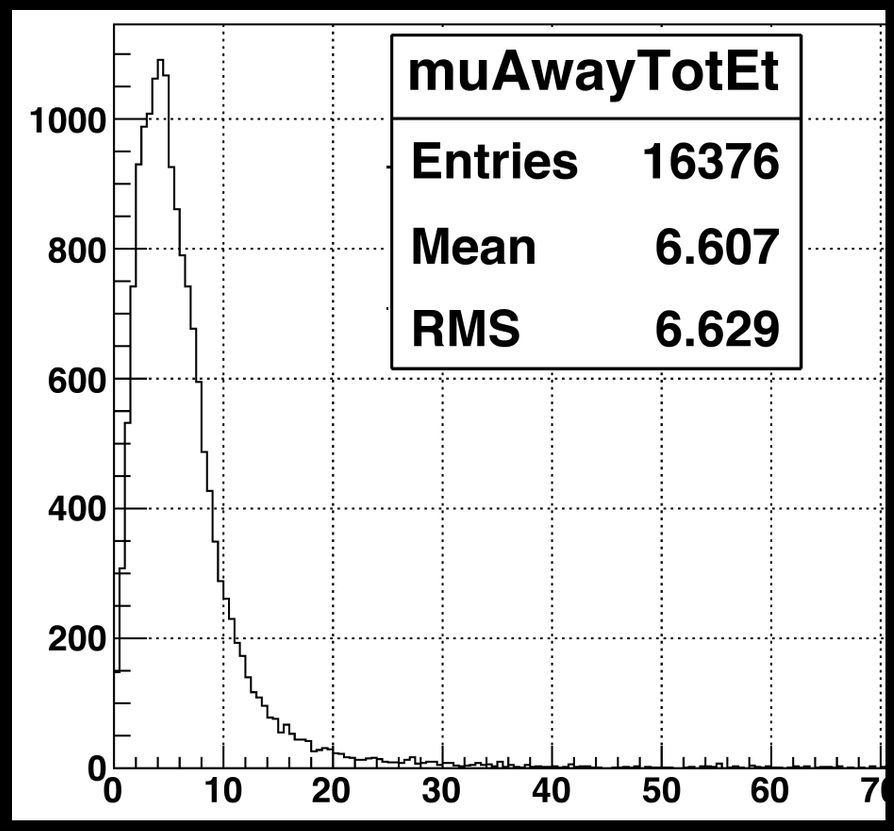


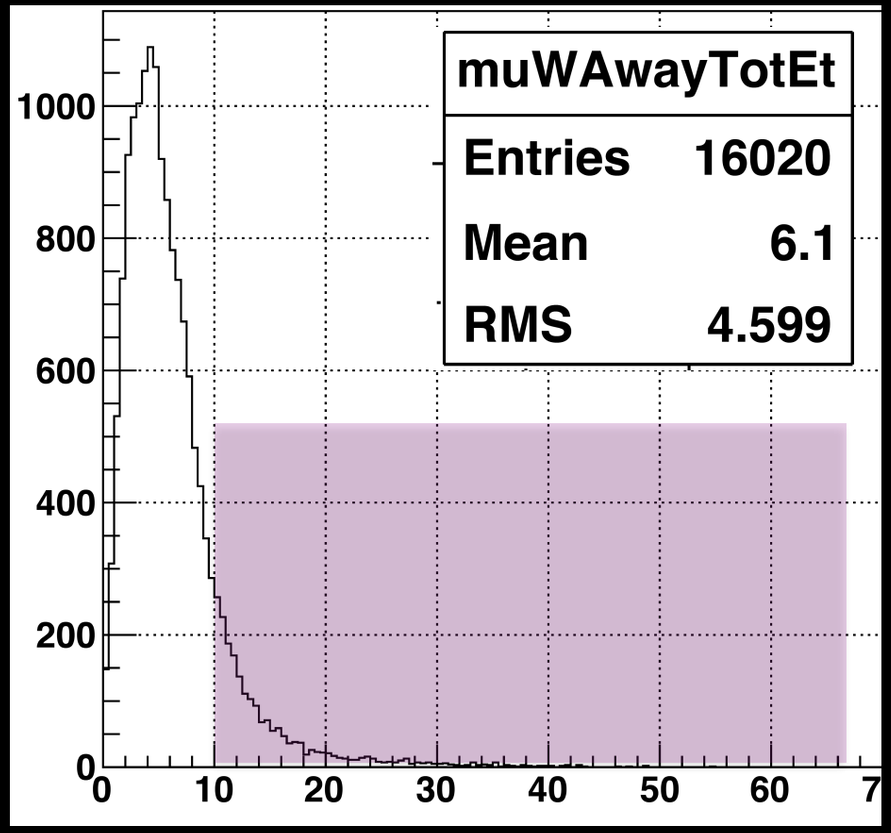






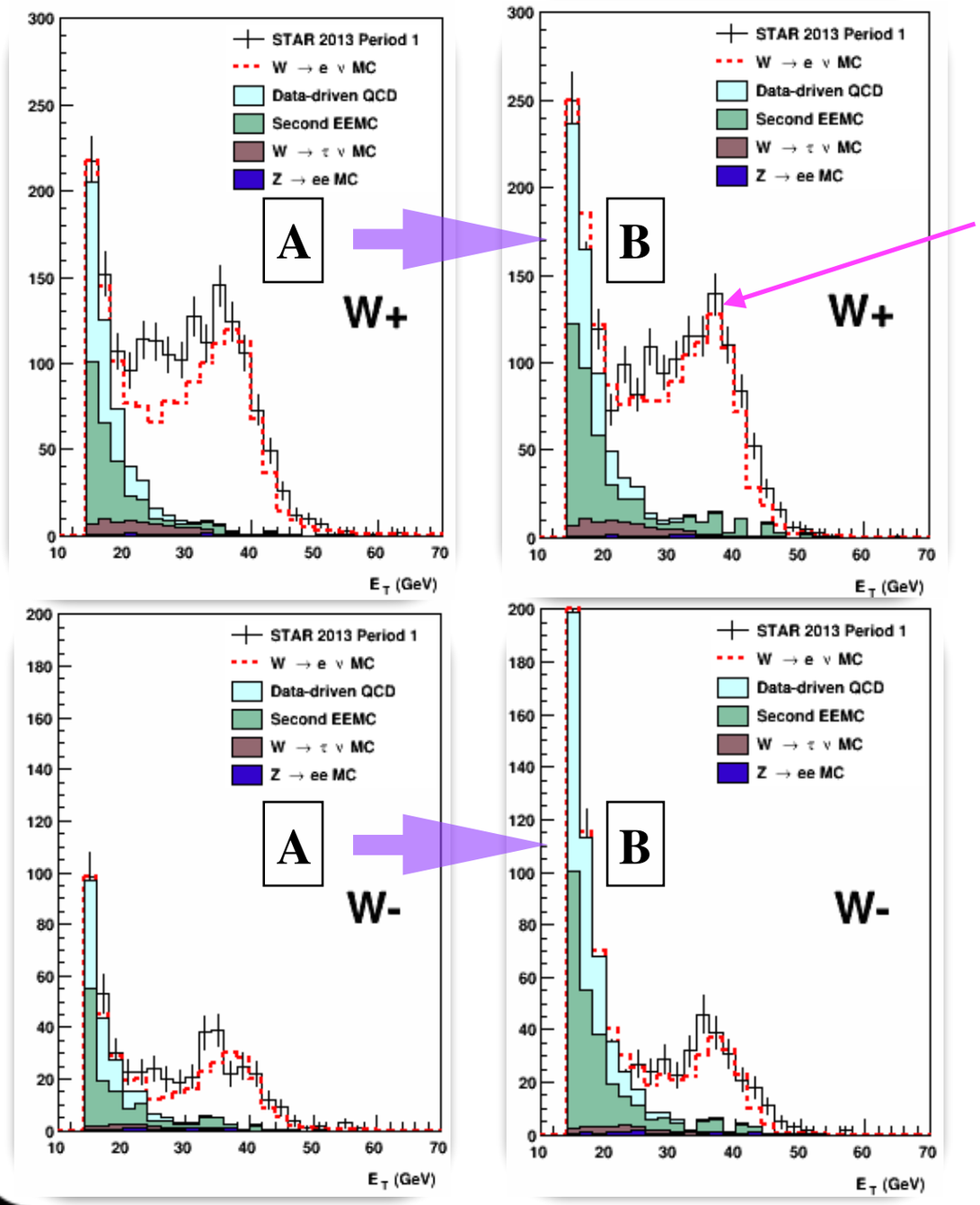
awayET cut - MC



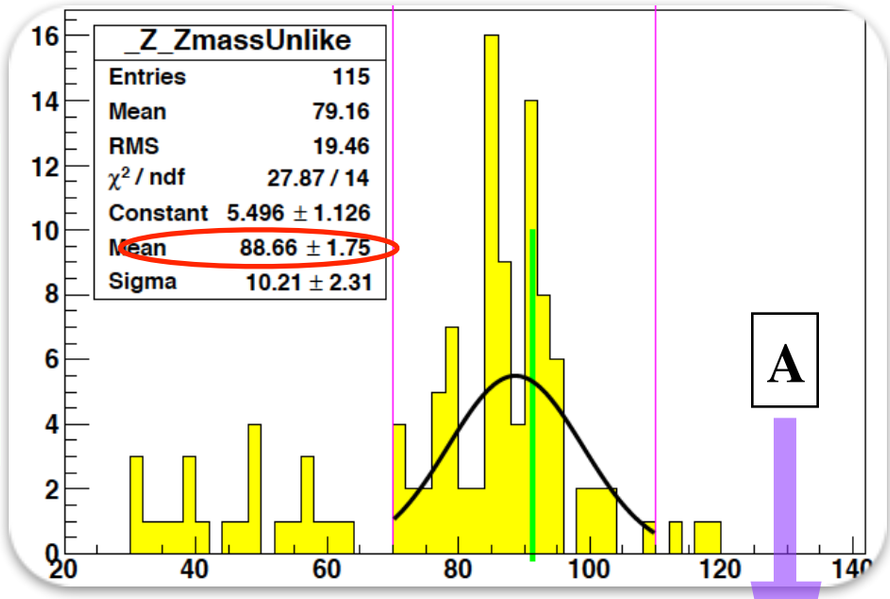


Fudge-Factor

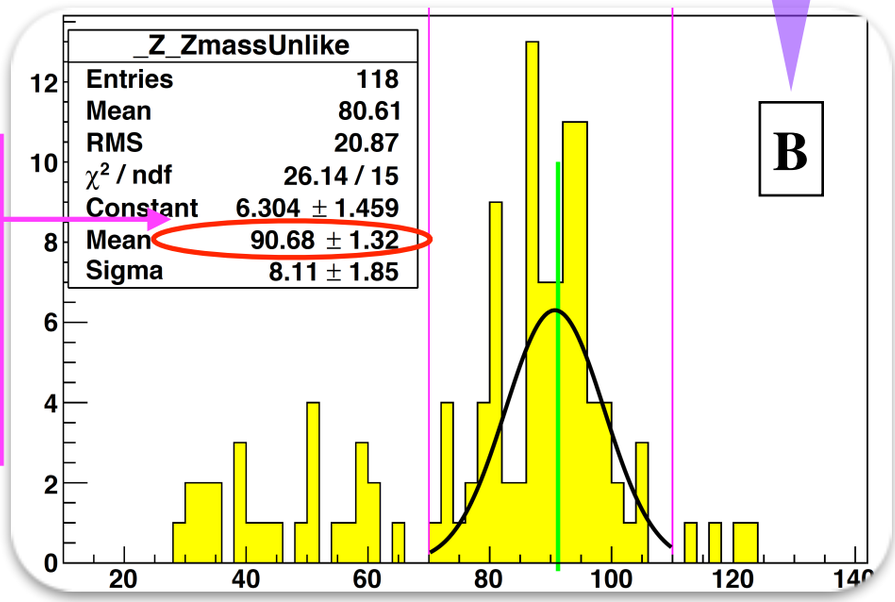
- **We applied a fudge factor [=1.03] (estimated based on the W-Jacobean Peak position shift in run 13 compared to MC and run 12) at tower level and reanalyze run 13 data.**



data and MC jacobean peaks aline and data-MC discrepancy reduced.



Z - invariant mass peak value is closer to PDG value. (91.1876 GeV)



MIP Cuts

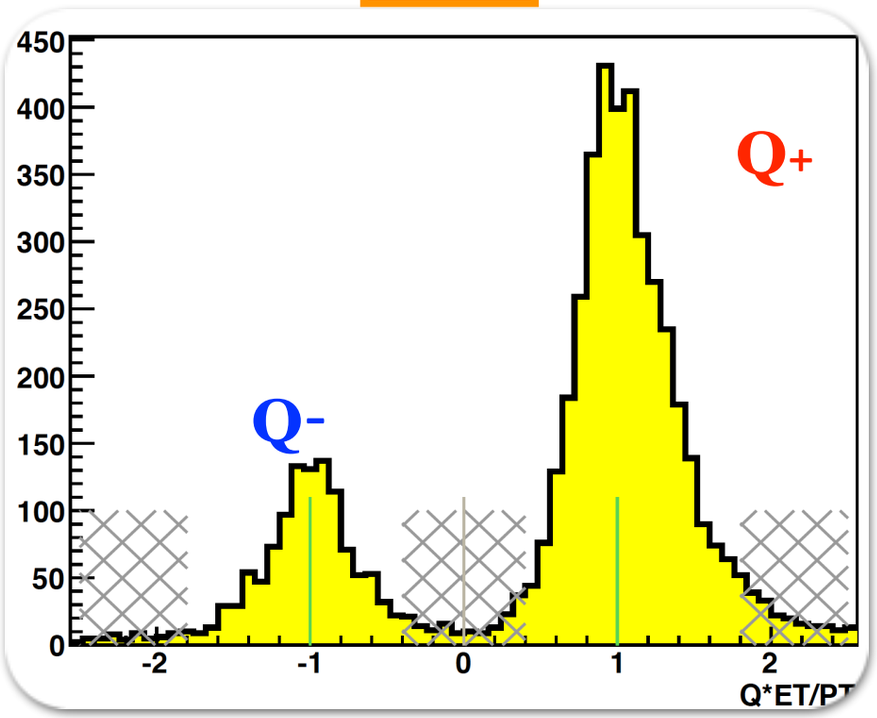
- Vertex Rank > 1e6
- |vertex-Z| < 30 cm
- only one track per tower per event
- Track momentum > 1 GeV/c
- (ADC-ped) > 1.5 ped RMS
- Track must enter and exit the same tower
- Highest E neighboring tower in 3x3 cluster < 2 GeV

CALIBRATION OF TPC

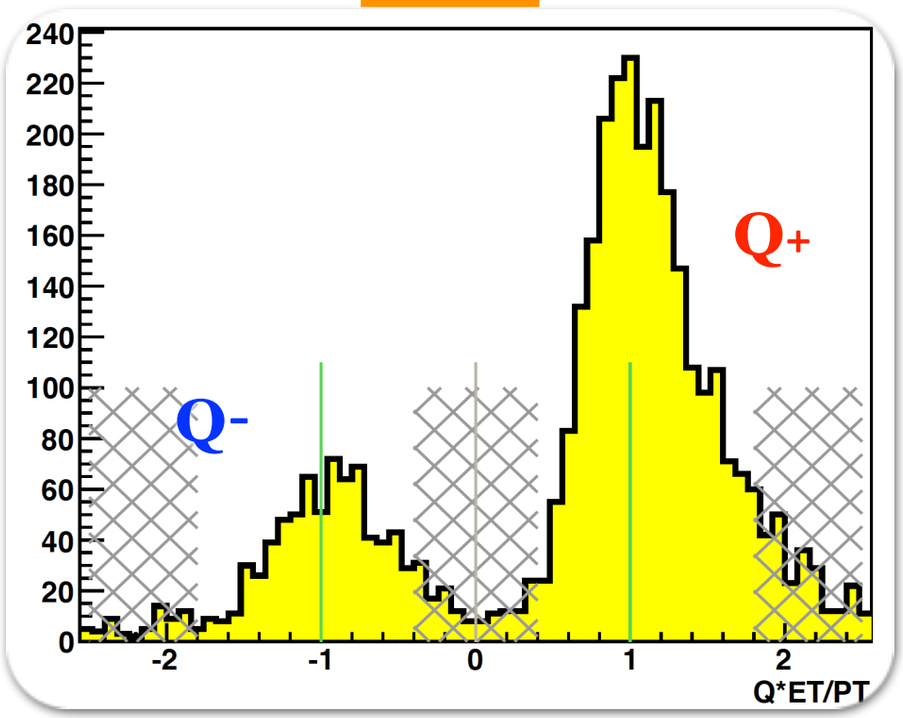
TPC

- **TPC calibration is completed for both period 1 and period 2.**

period 1



period 2



PERIOD 2 ENDCAP BG