W^+/W^- ratio analysis Run 17

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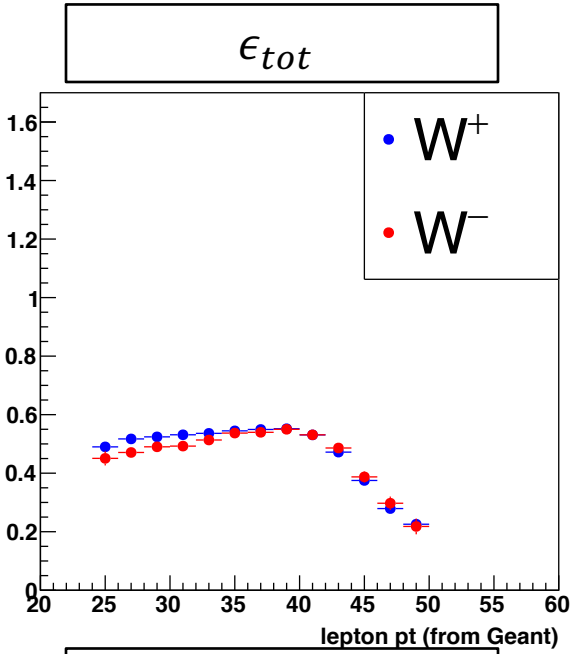
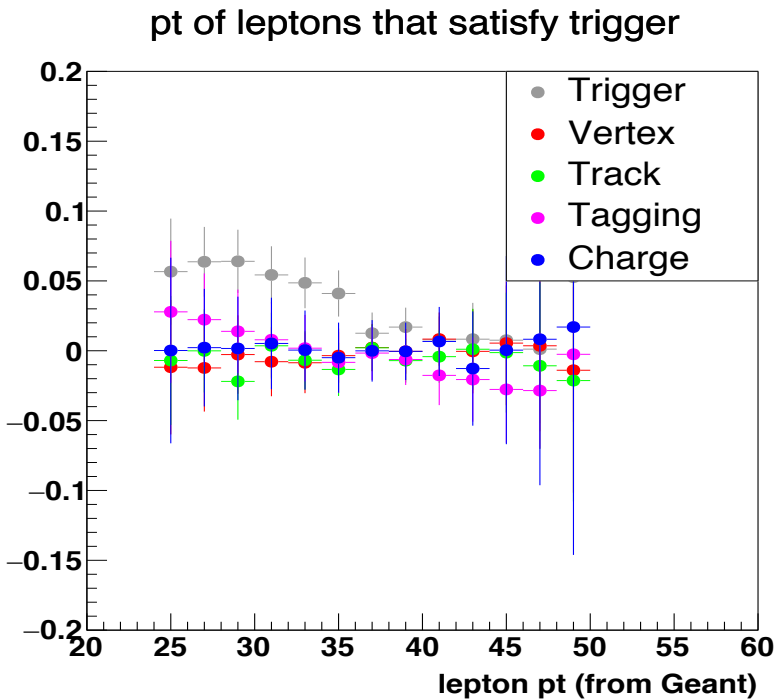
Recap

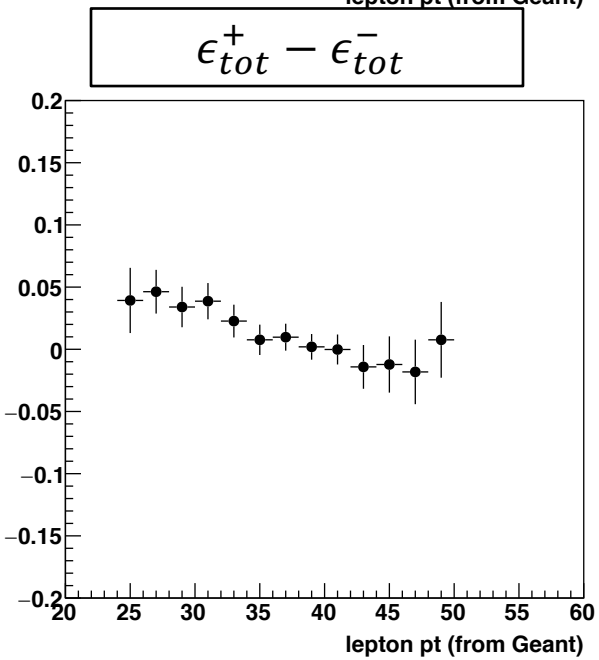
- Efficiency study
  - Good agreement between $\epsilon^{\pm}$ in η.
  - Anomaly when plotted against E_T^{clst}.
    - Majority of the non-zero slope came from trigger selection.

*** Much of this was found to be due to a bug.

    - $e^{W\pm}$ tagging quickly dives down after Jacobian peak (~40 GeV)







Efficiency (Recap)

- The total efficiency reflects the sum of five different contributions within the kinematic region ~~$E_T > 25GeV$~~ and $|\eta| <$ ~~1.1~~ **0.9**.

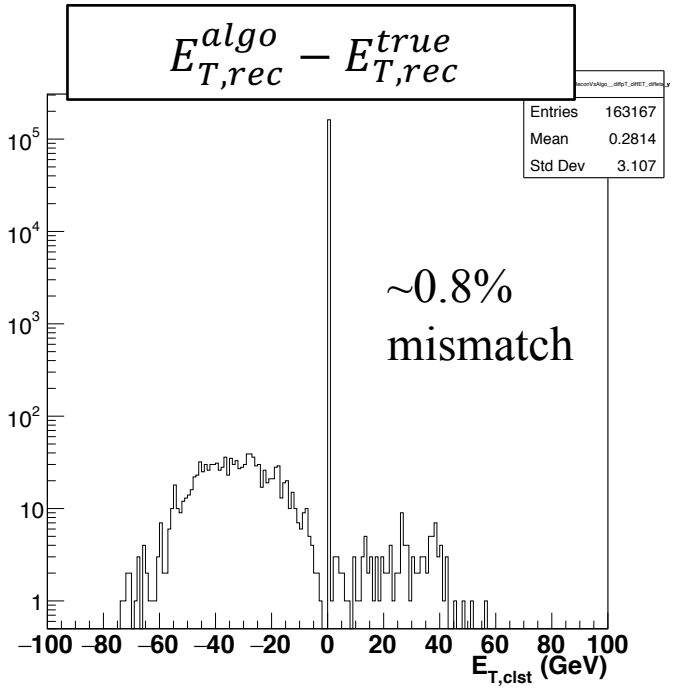
1. Trigger efficiency: $\epsilon_{trg} = N_{trg}/N_{gen}$
   - lbitET triggered

2. **Vertex efficiency**: $\epsilon_{vtx} = N_{vtx}/N_{trg}$
   - $Rank_{vtx} > 0$ &&
   - $|Z_{vtx}| < 100cm$ &&
   - $\left|Z_{vtx}^{rec} - Z_{vtx}^{gen}\right| < 2cm$

3. **Tracking efficiency**: $\epsilon_{trk} = N_{trk}/N_{vtx}$
   - Vertex with non-zero electron track &&
   - $p_T^{trk} > 10GeV$

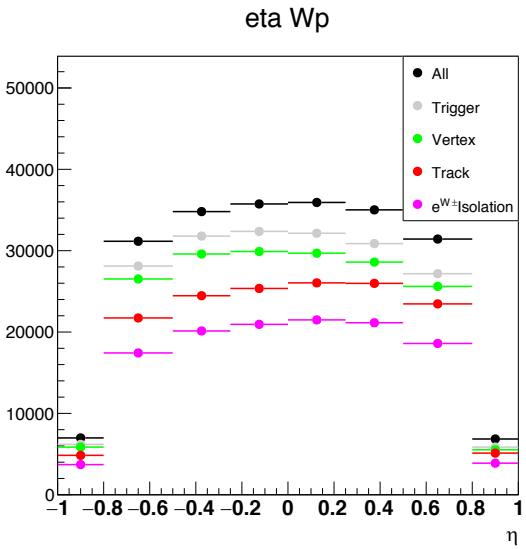
4. Tagging efficiency: $\epsilon_{tag} = N_{eW}/N_{trk}$
   - Track matched to a cluster (2x2/4x4 & E_T^{clst})
   - $E_T^{cluster}/E_T^{near} > 0.82$
   - $p_{T,balance} > 16\ GeV$

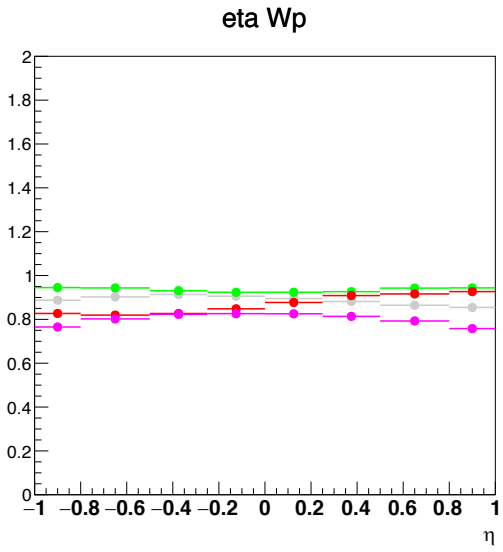
5. Charge efficiency: $\epsilon_{chg} = N_{eW}^{\pm}/N_{eW}$
   - $0.4 < |Q \times E_T/p_T| < 1.8$

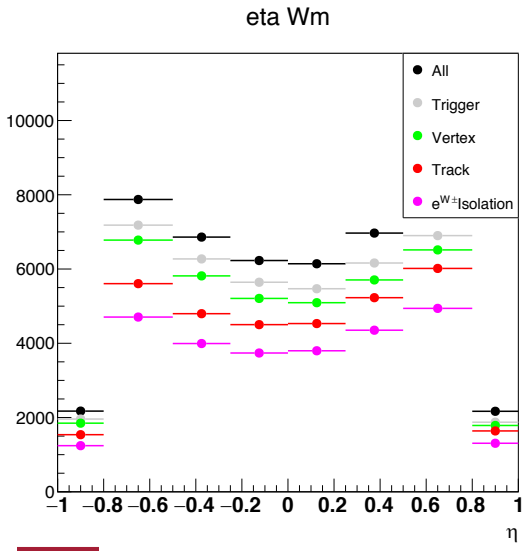


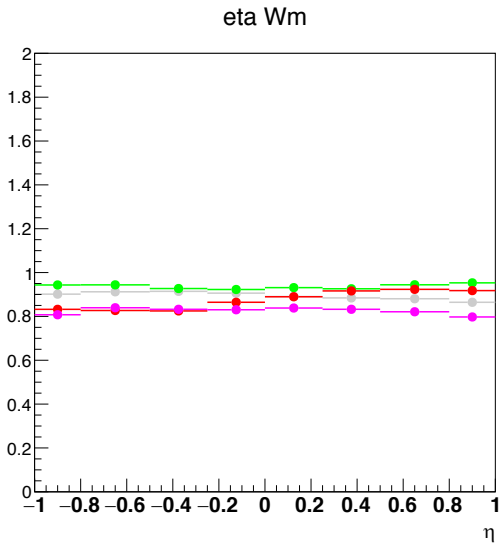
- Small fraction of the e^W tagged by the current algorithm found not to match the true e^W.
- This effect appears at the tracking selection stage as the code is set up at the moment.

Efficiency (η)

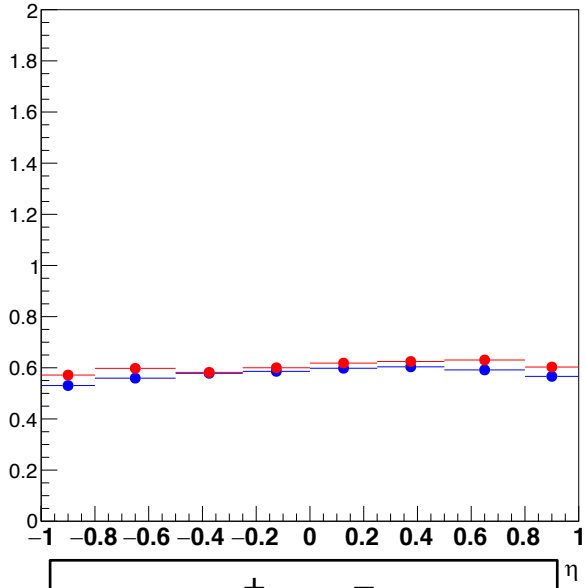




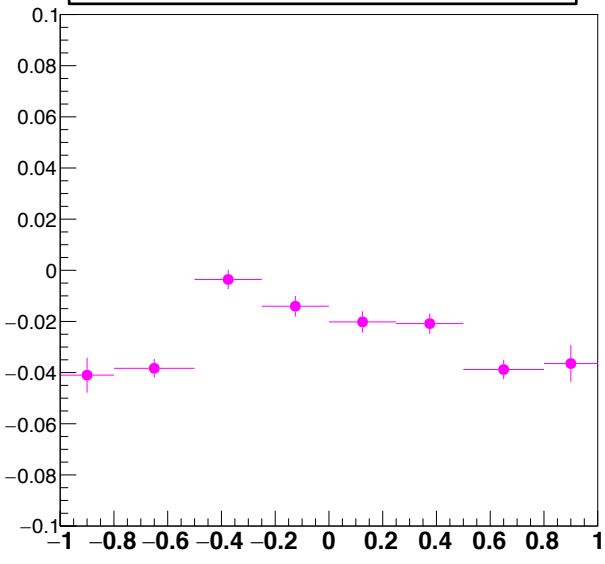




ϵ_{tot}

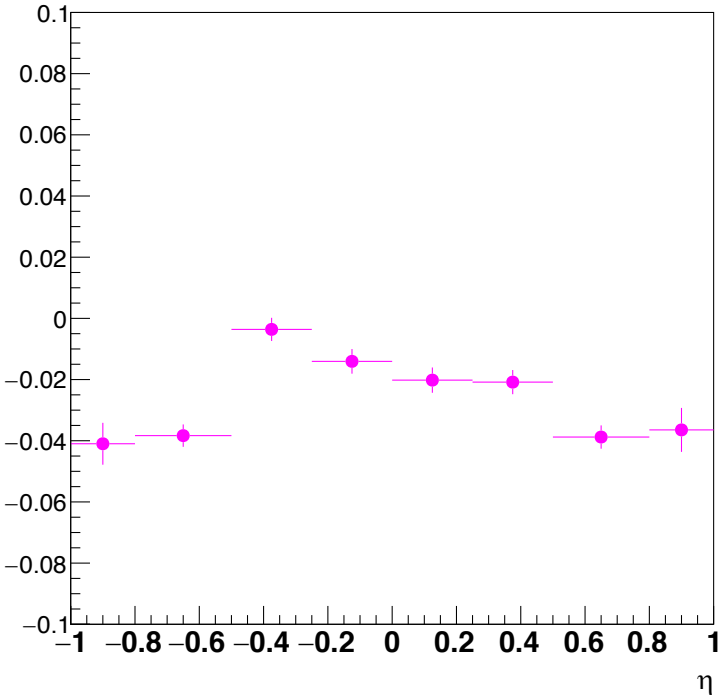


$\epsilon^{+} - \epsilon^{-}$

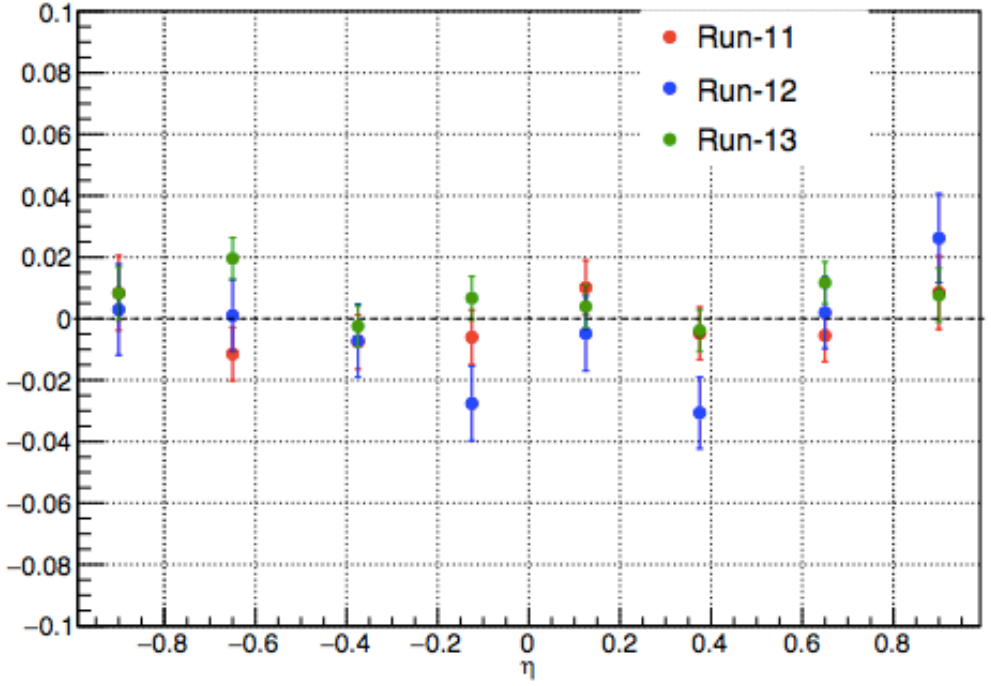


Comparison to Run 11+12+13

$\epsilon^+ - \epsilon^-$ (Run 17)

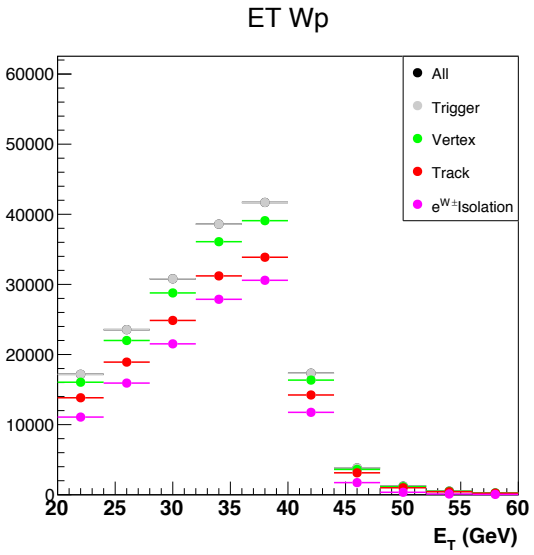


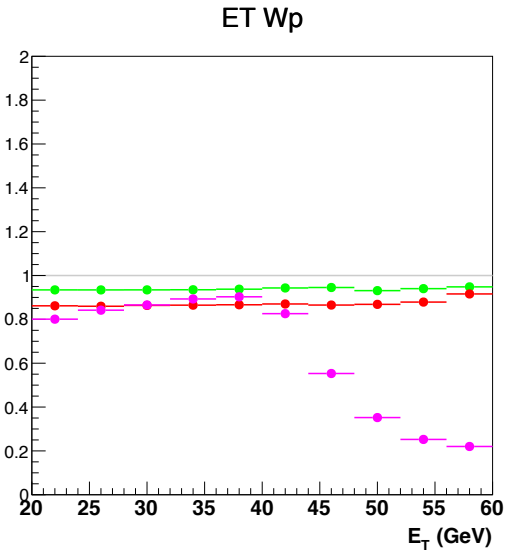
$\epsilon^+ - \epsilon^-$ (Run 11+12+13)

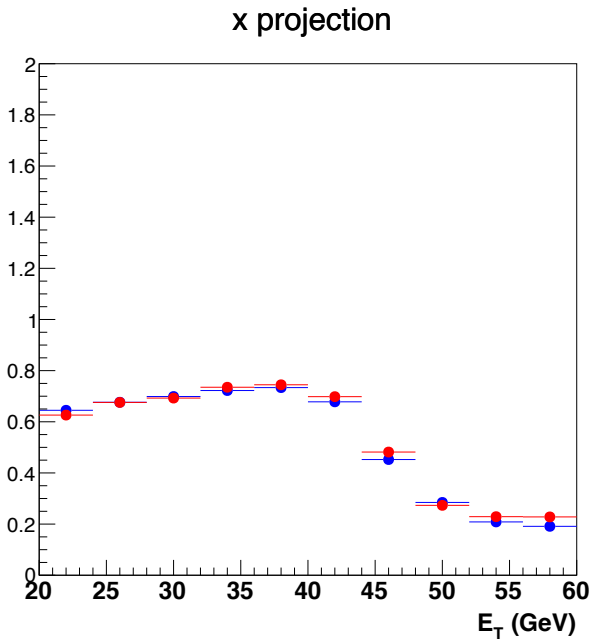


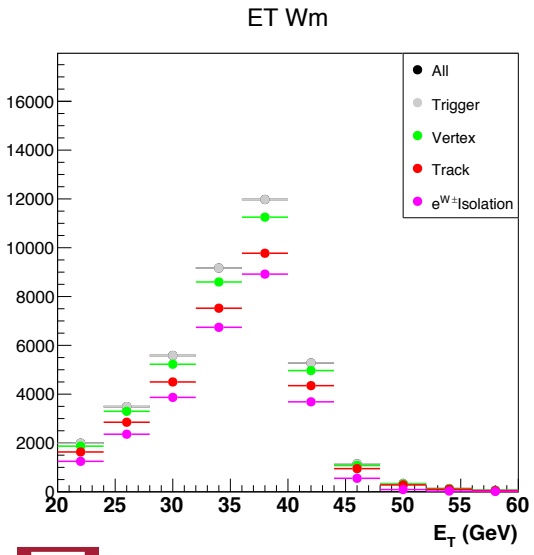
- Efficiency of e^{W+} in Run 17 seems to be systematically lower than e^{W-} by ~3% on average.
- Could be due to the kinematic cut ($E_T > 25GeV$) that was taken out for this study.

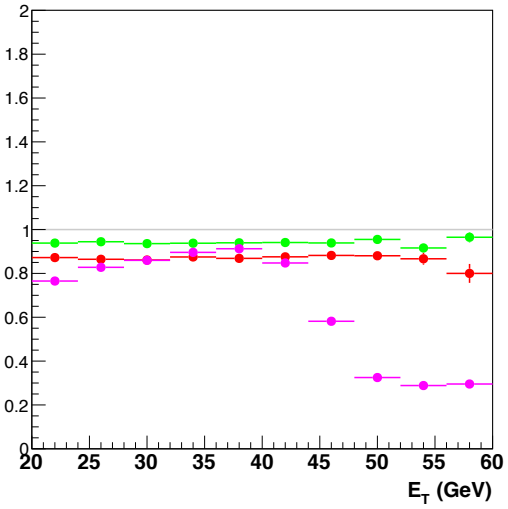
Efficiency (E_T)

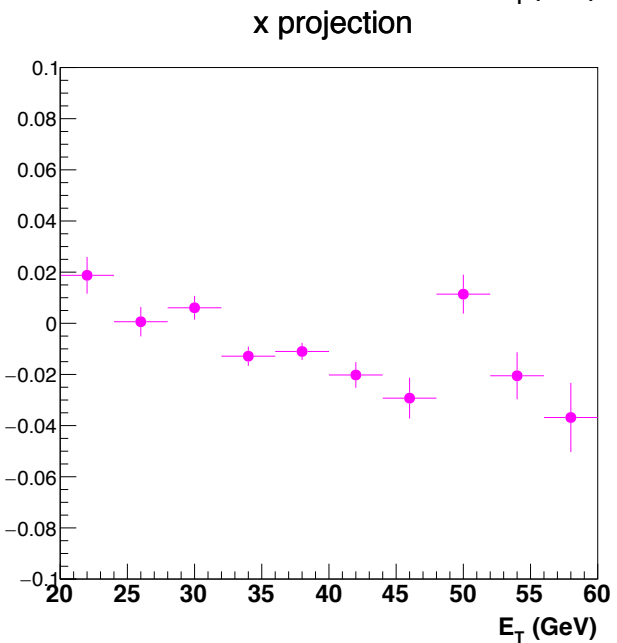






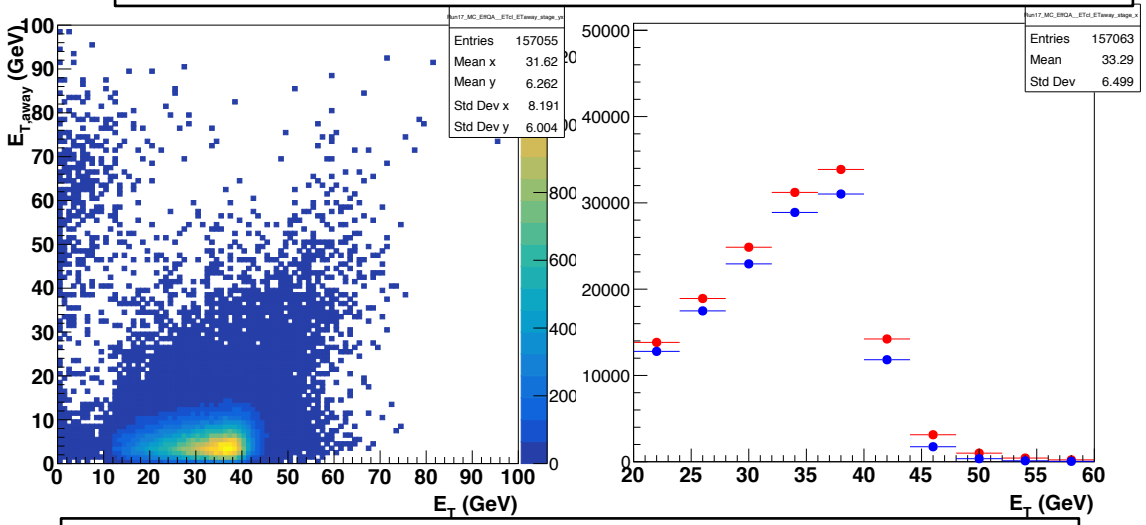


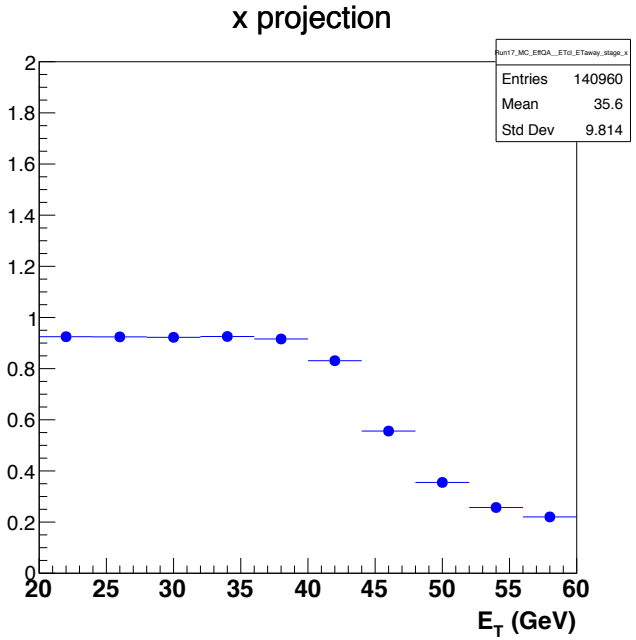




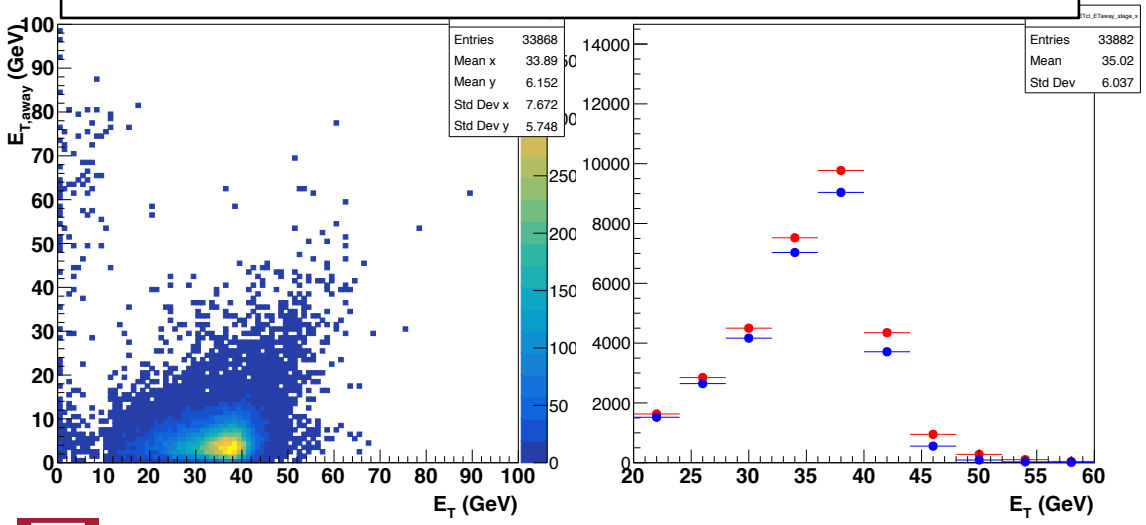
Efficiency of E_T^{away}

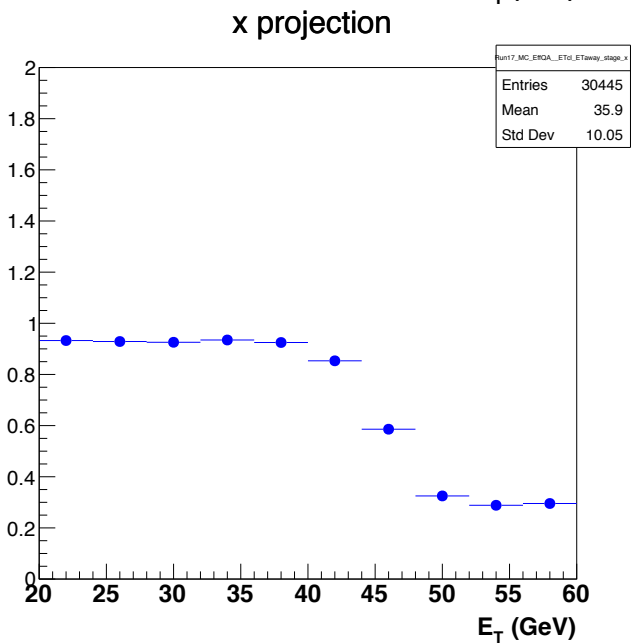
W^+



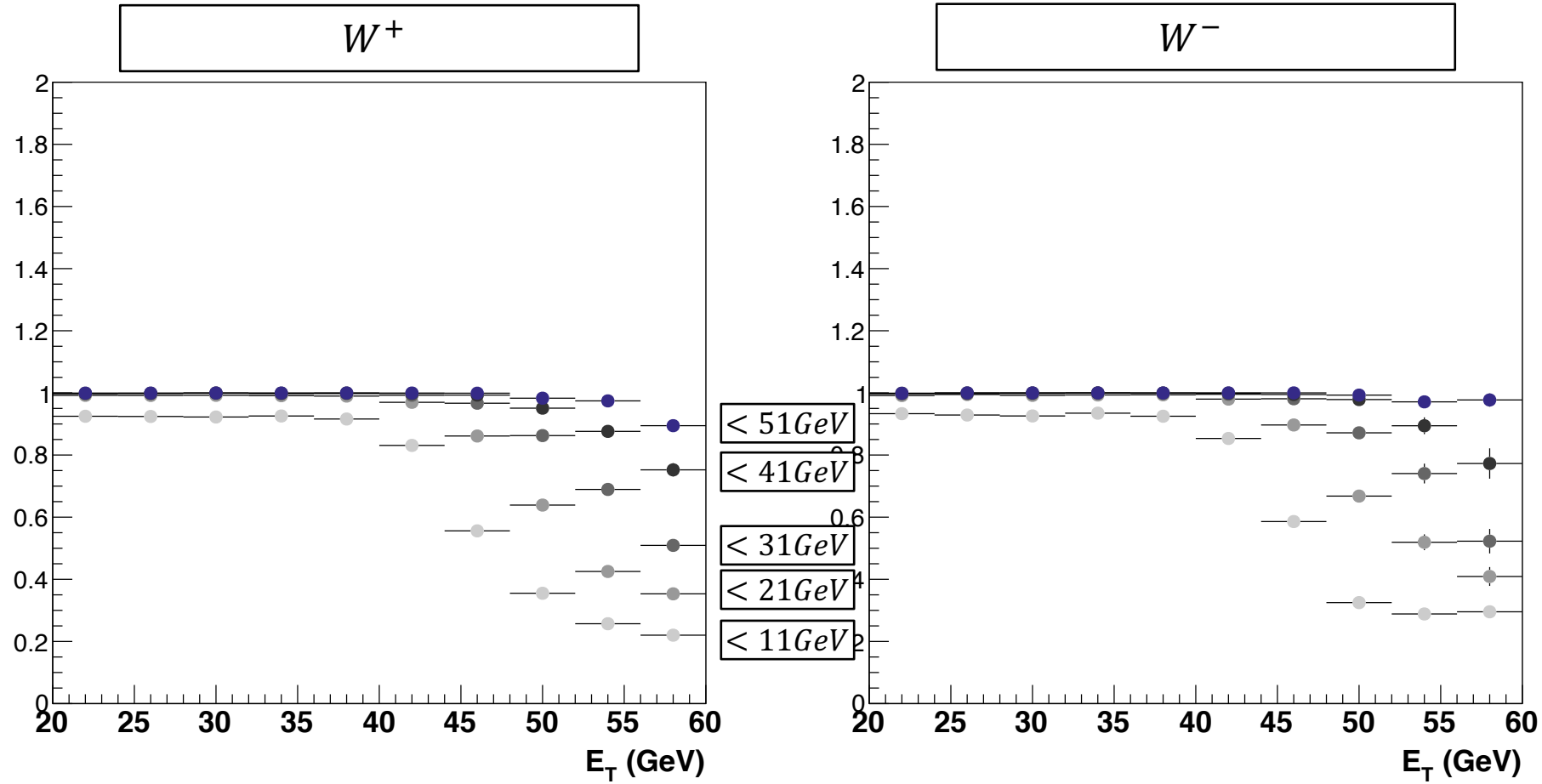


W^-



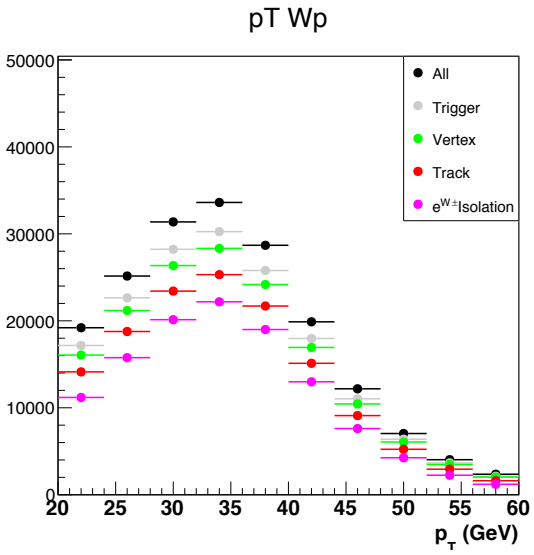


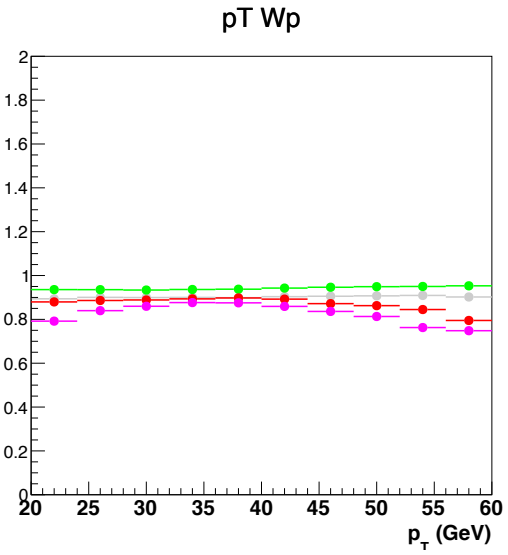
Efficiency of E_T^{away}

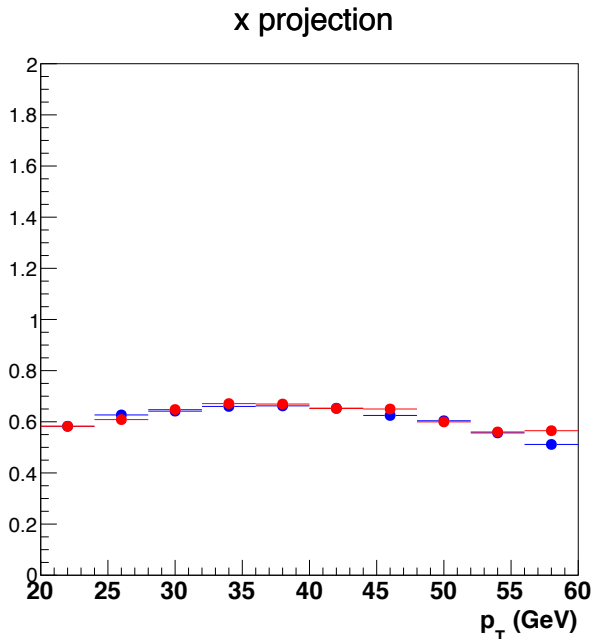


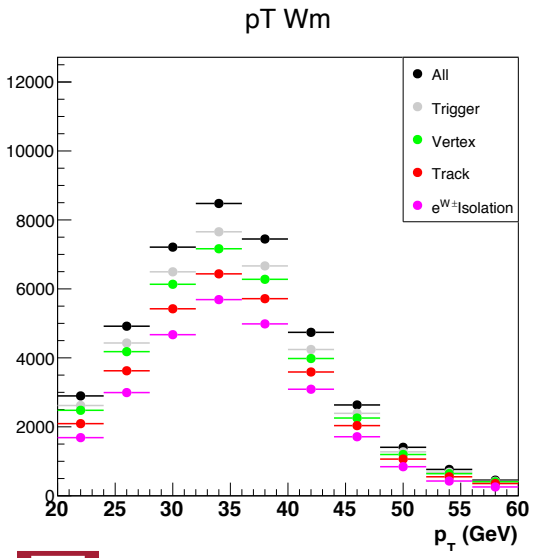
- E_T^{away} cut varied to identify "optimal" value.
  - Found to intrinsically discriminate high E_T $e^{W\pm}$.
  - Requires further study on background rejection performance.

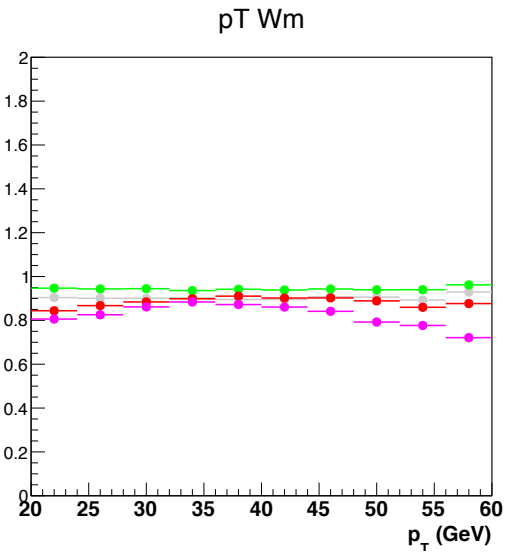
Efficiency (p_T)

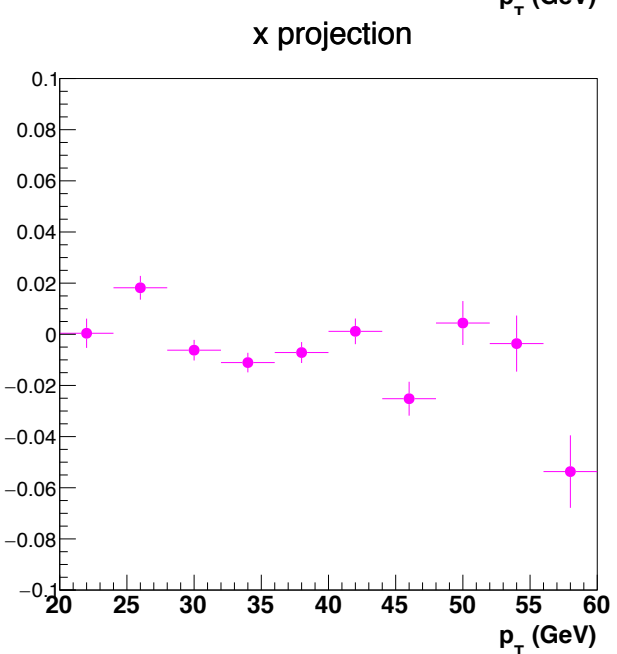






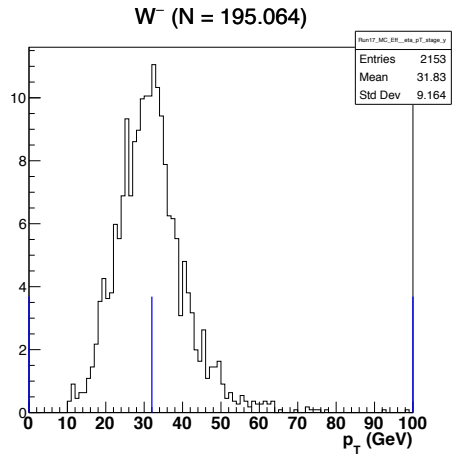


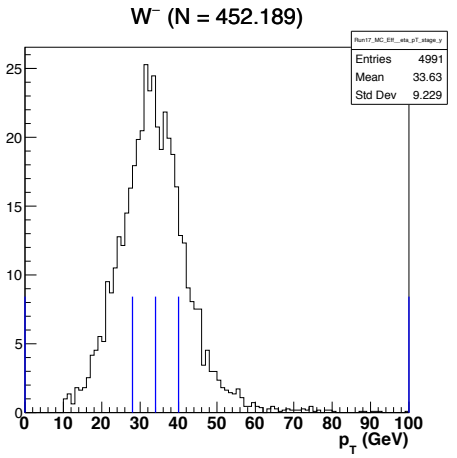


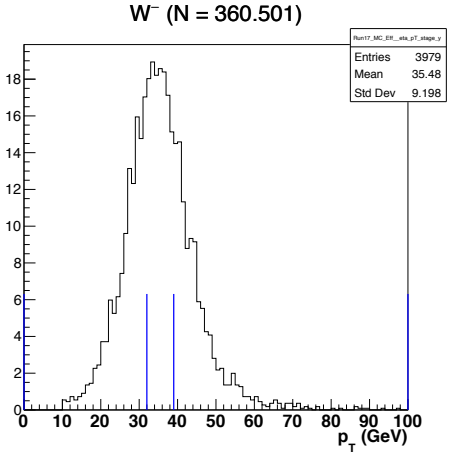


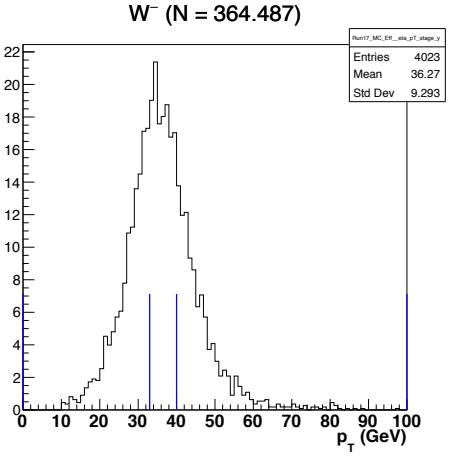
p_T distributions ($|\eta| < 1.0$, W^-)

$-1.0 < \eta < 0$

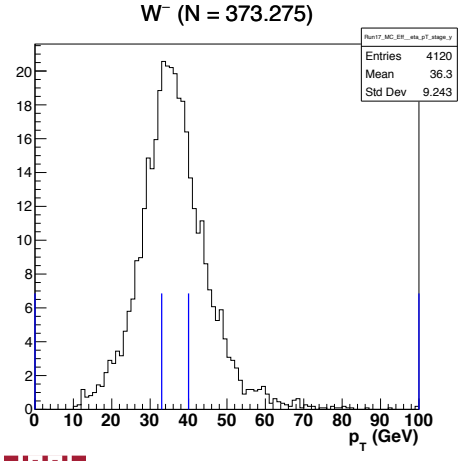


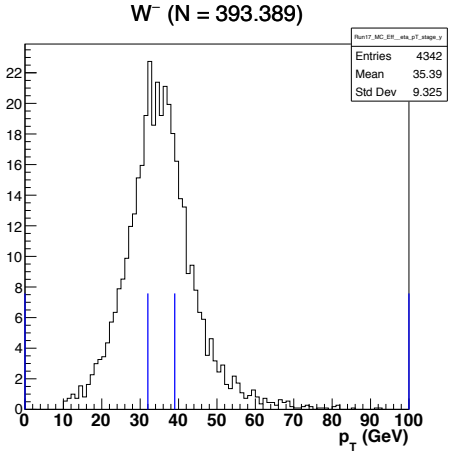


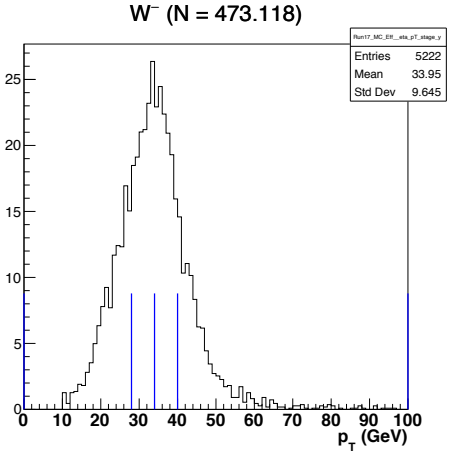


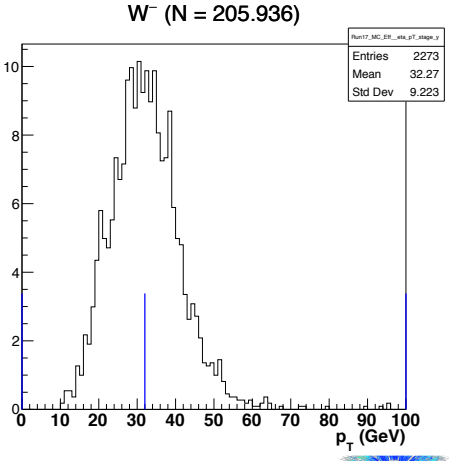


$0 < \eta < +1.0$

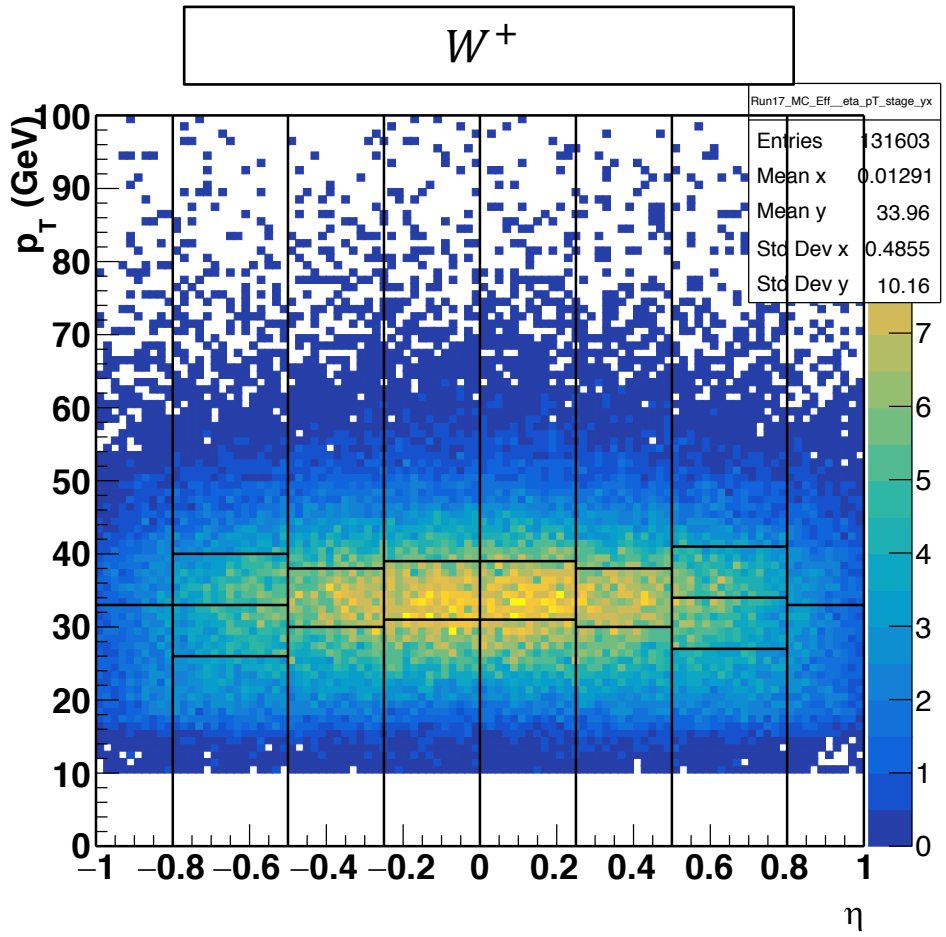


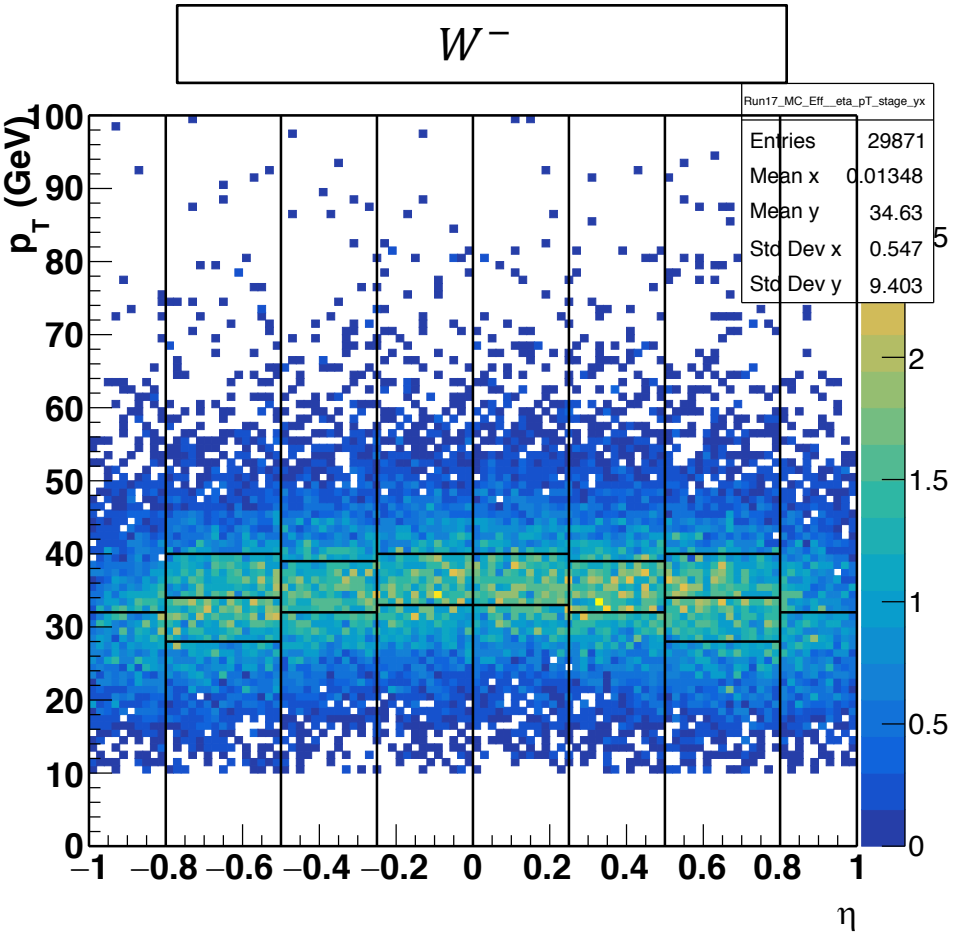




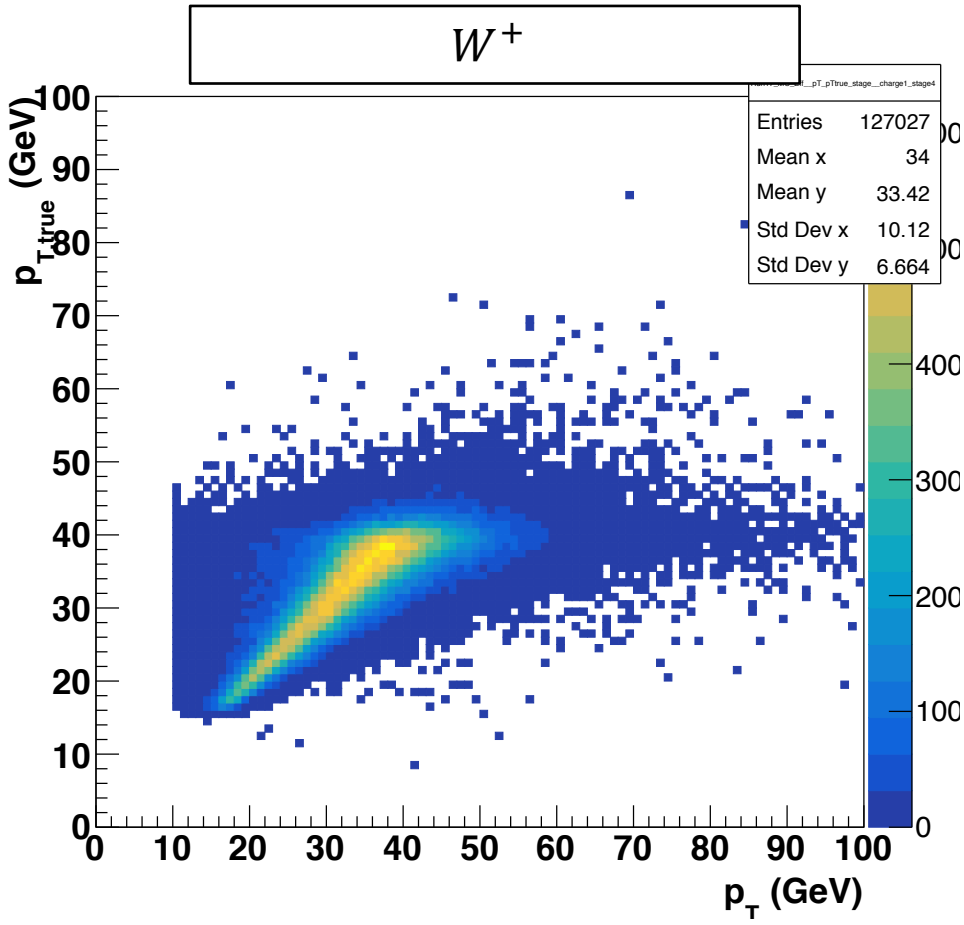


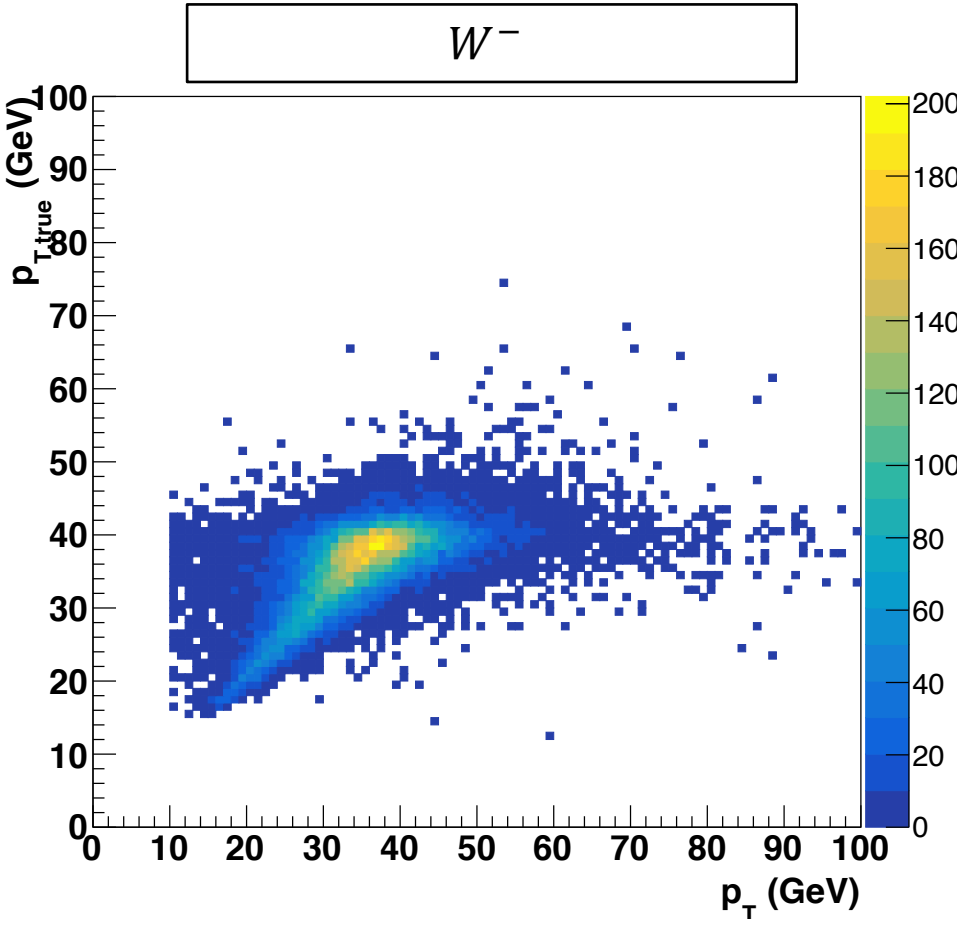
$p_T - \eta$ distribution





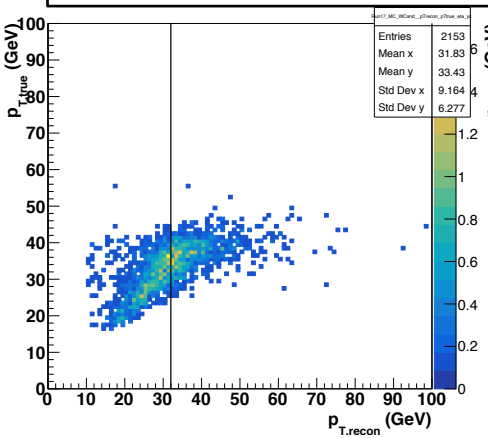
Non-linerity in $p_{T,true}/p_T$

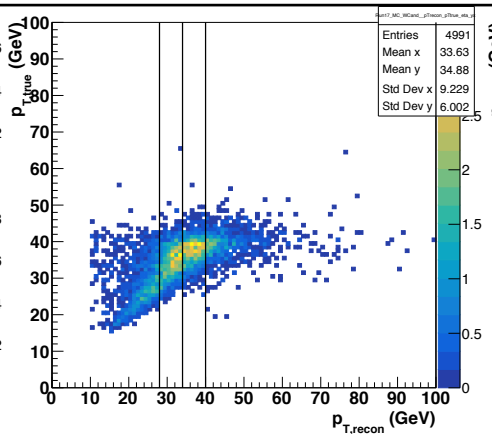


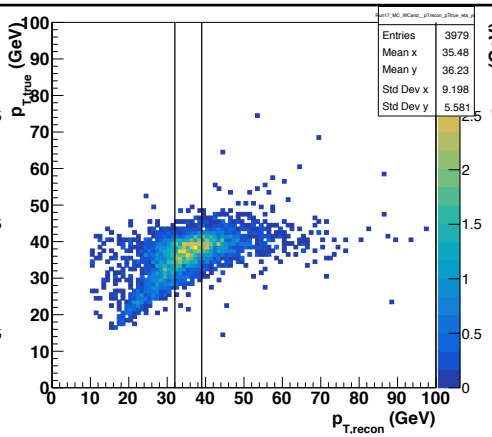


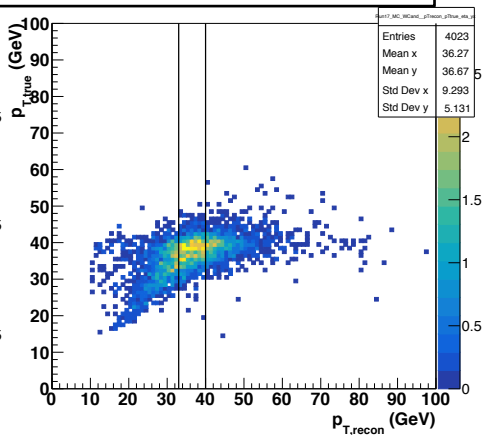
Determining $p_{T,true}$ binning

$-1.0 < \eta < 0$

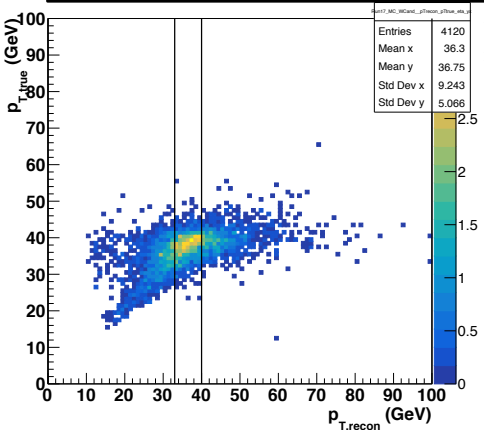


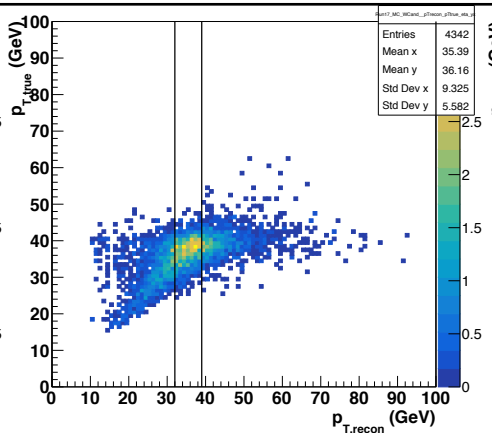


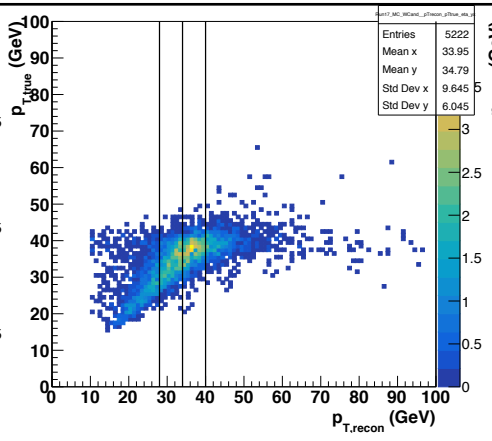


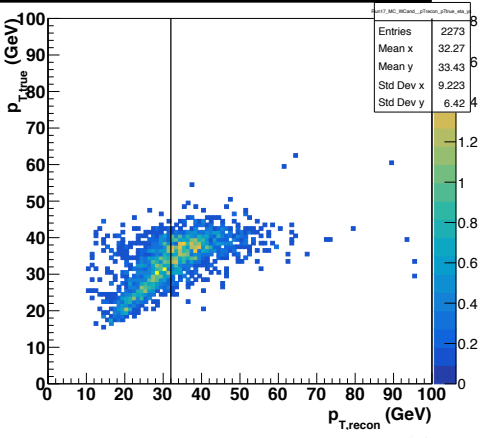


$0 < \eta < +1.0$



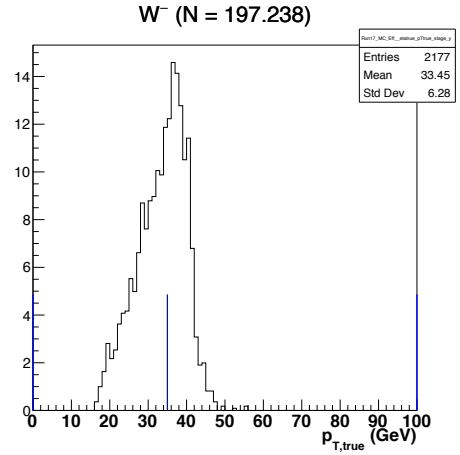


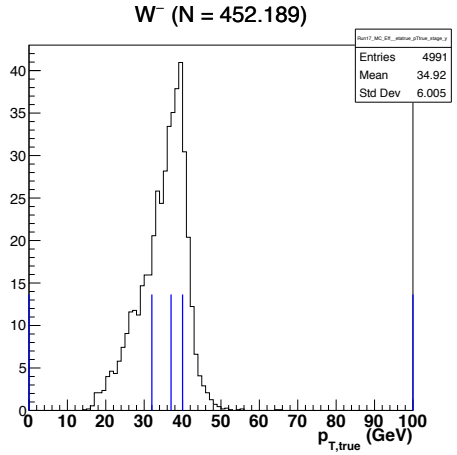


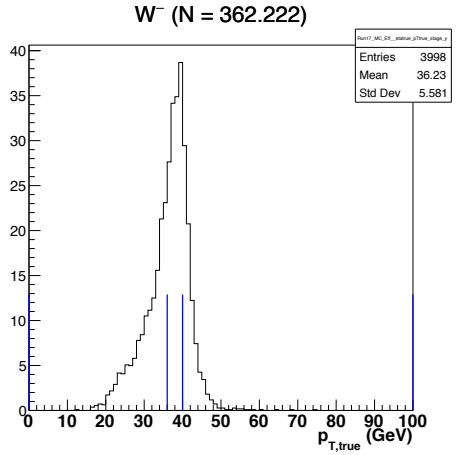


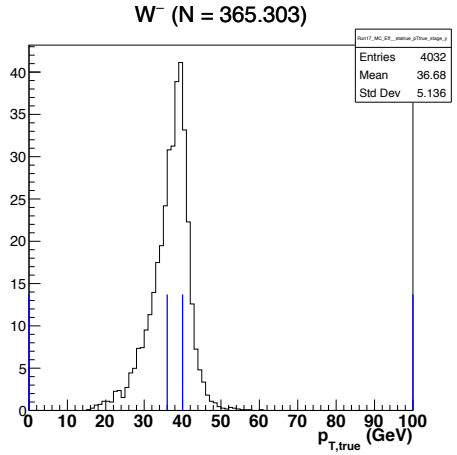
Determining $p_{T,true}$ binning

$-1.0 < \eta < 0$









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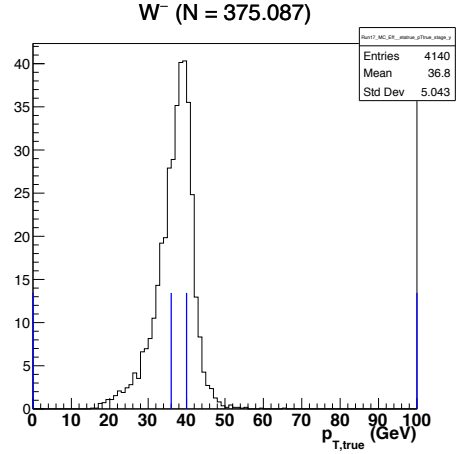
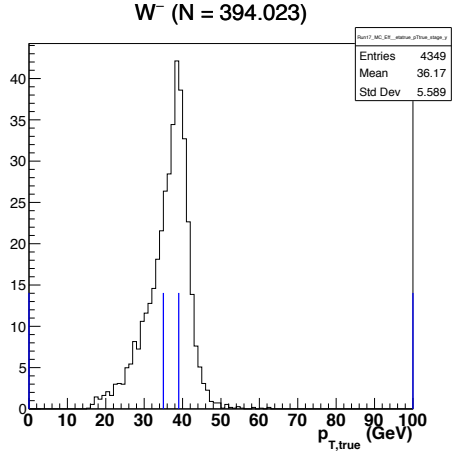
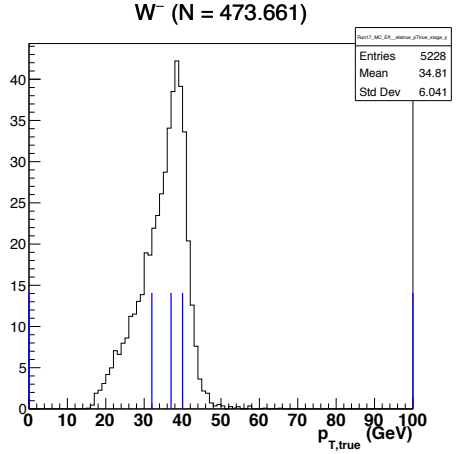
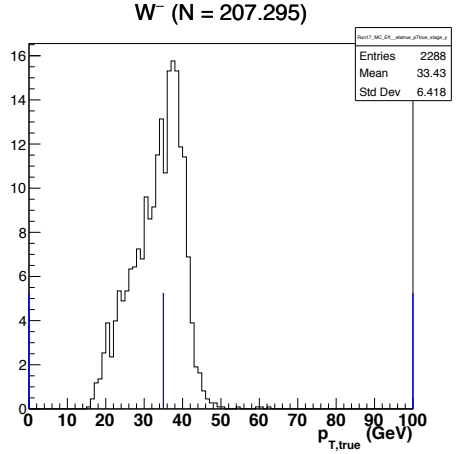








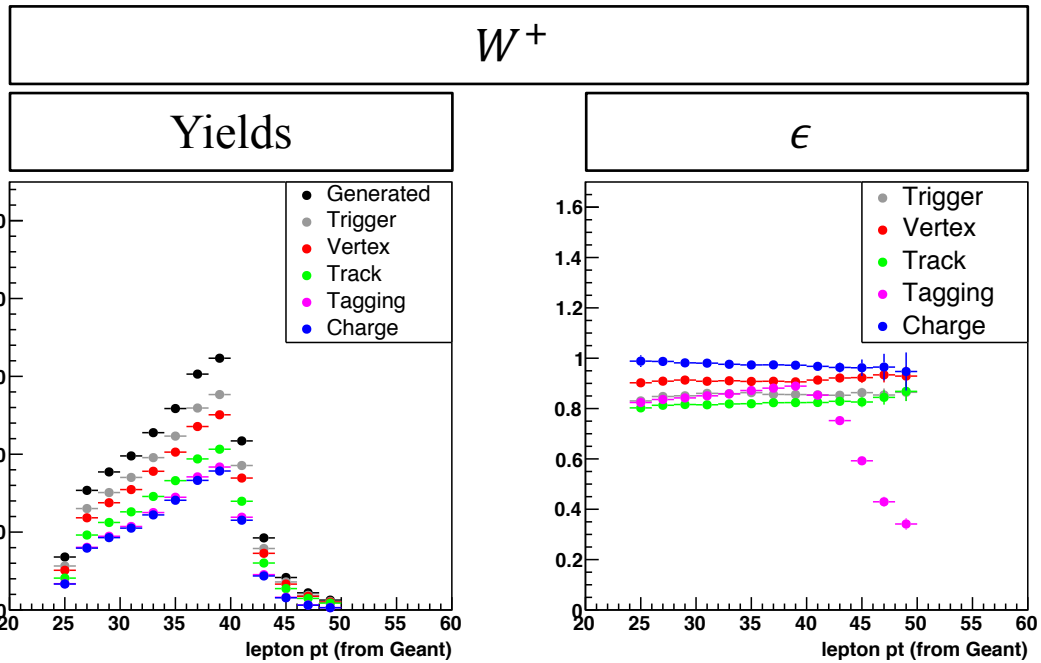
Summary

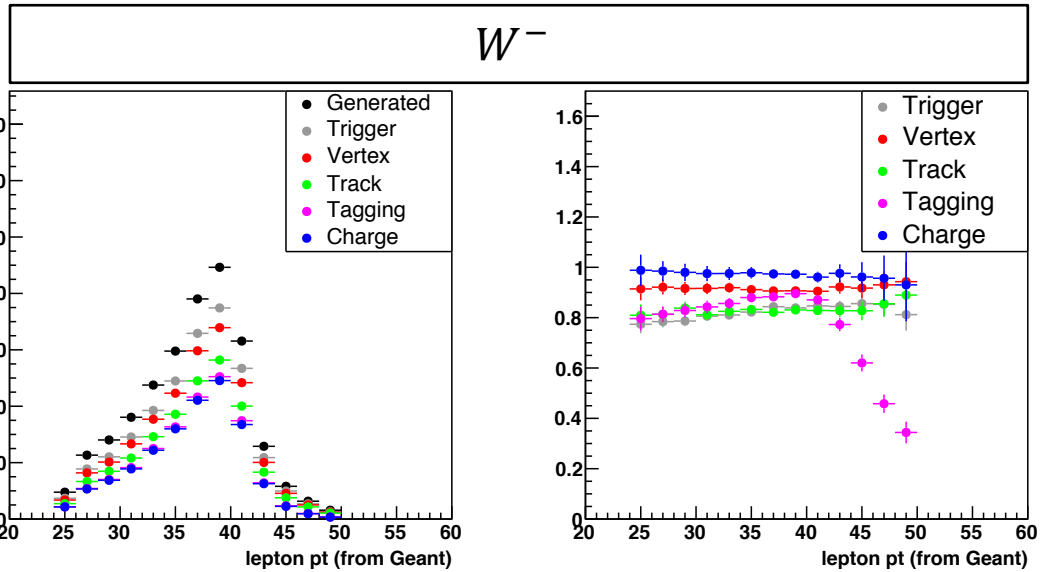
- Efficiency study
  - Much of the issues are resolved after bug-fixing.
  - Discrepancies with previous results (Run11+12+13, η).
    - First test will be to include the E_T cut back in.
  - The higher E_T behavior in $e^{W\pm}$ tagging was found to originate from E_T^{away} selection cut.
    - Further study required to determine "optimal" value.
  - Reasonable results when plotted against p_T.

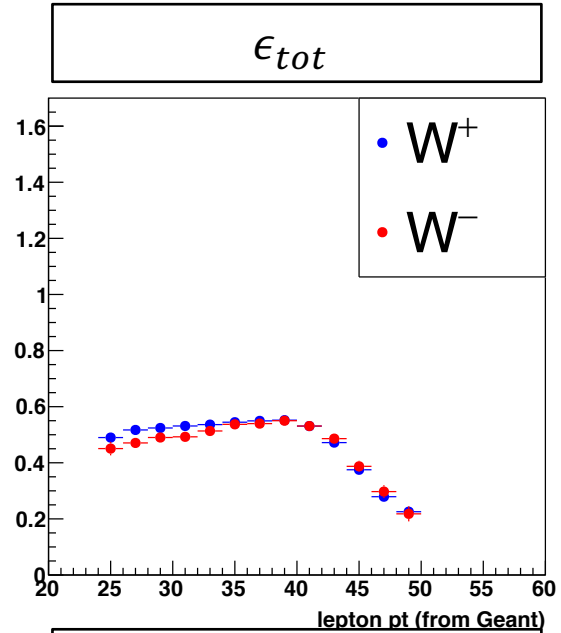
- $W^{\pm}$ ratio in p_T bins.
  - Current binning scheme aims to distribute statistics so that each p_T/η bin would have about the same statistics.
  - ~10% statistical uncertainty in W^- in each bin expected, using the proposed binning.

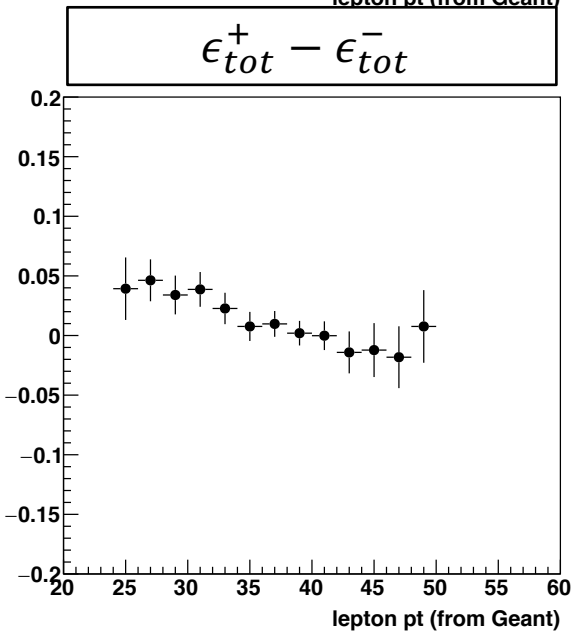
- Next step
  - Determine $p_{T,true}$ binning scheme → response matrix.
    - Same binning throughout all η?
    - Number of bins?
  - Suggestions from the community will always be much appreciated.

Efficiency (p_T)



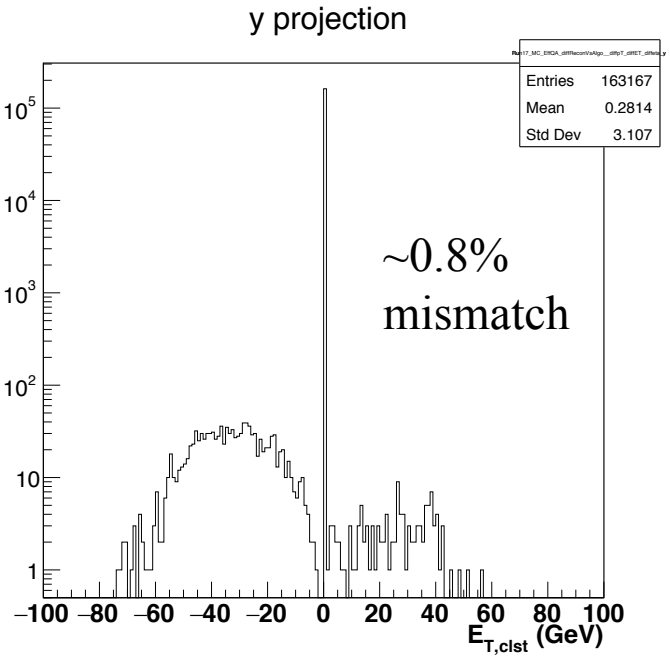




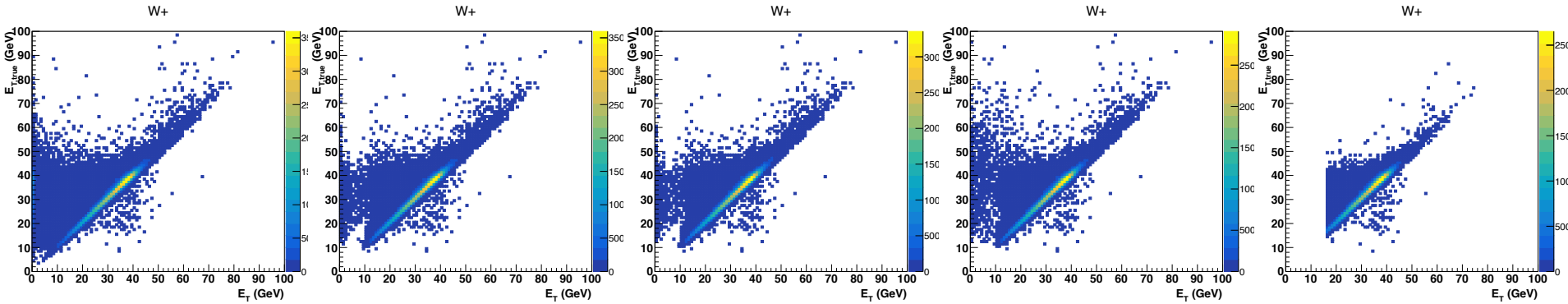


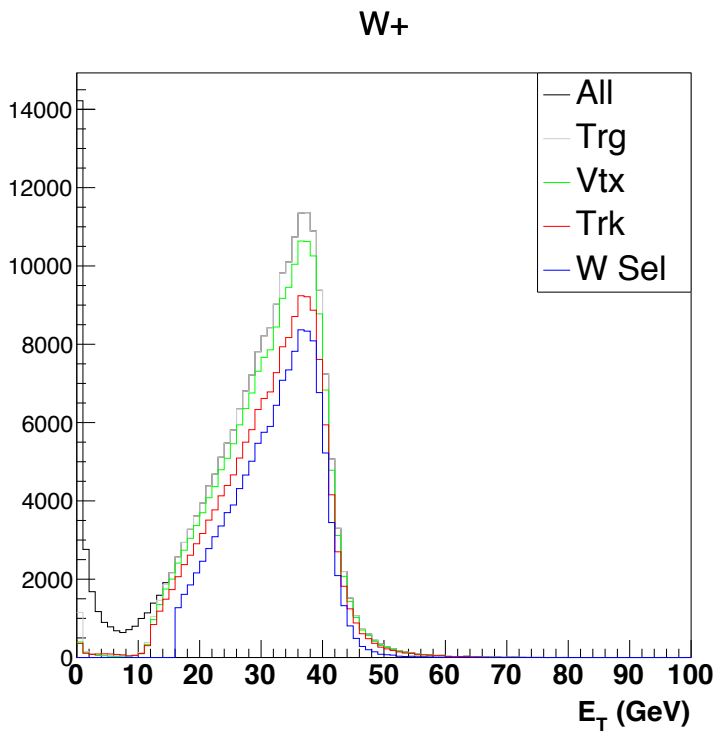
Efficiency

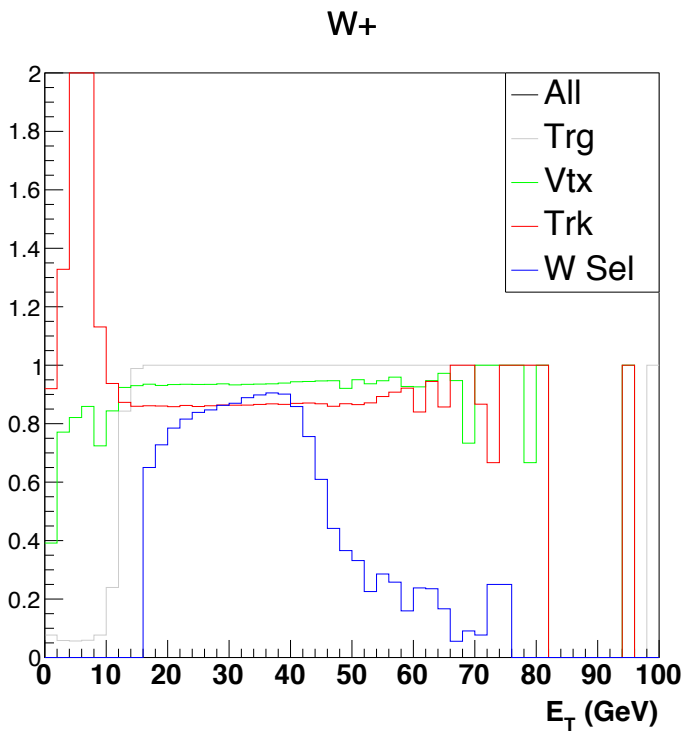
- The total efficiency reflects the sum of five different contributions within the kinematic region $E_T > 25GeV$ and $|\eta| < 1.1$.
  1. Trigger efficiency: $\epsilon_{trg} = N_{trg}/N_{gen}$
     - lbitET triggered
  2. **Vertex efficiency**: $\epsilon_{vtx} = N_{vtx}/N_{trg}$
     - $Rank_{vtx} > 0$ &&
     - $|Z_{vtx}| < 100cm$ &&
     - $\left|Z_{vtx}^{rec} - Z_{vtx}^{gen}\right| < 2cm$
  3. **Tracking efficiency**: $\epsilon_{trk} = N_{trk}/N_{vtx}$
     - Vertex with non-zero electron track &&
     - $p_T^{trk} > 10GeV$
  4. Tagging efficiency: $\epsilon_{tag} = N_{eW}/N_{trk}$
     - Track matched to a cluster
     - $E_T^{cluster}/E_T^{near} > 0.82$
     - $p_{T,balance} > 16\ GeV$
  5. Charge efficiency: $\epsilon_{chg} = N_{eW}^{\pm}/N_{eW}$
     - $0.4 < |Q \times E_T/p_T| < 1.8$



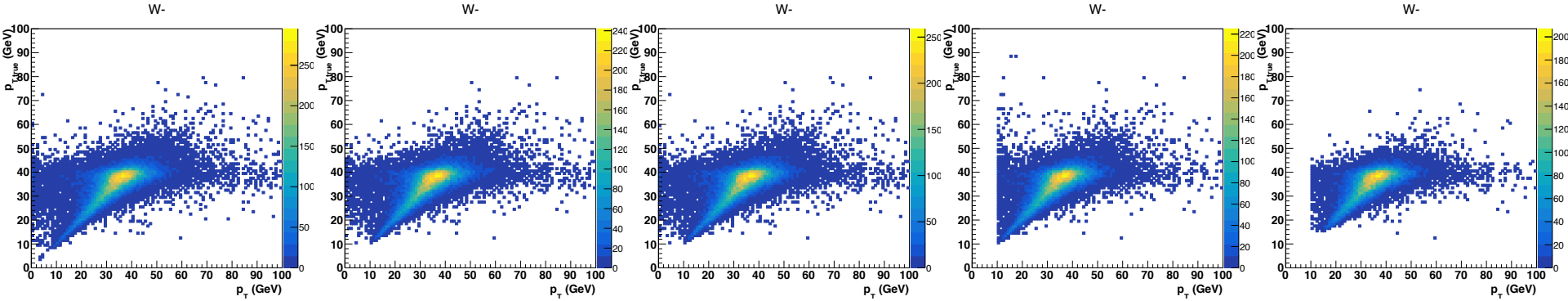
Efficiency in E_T

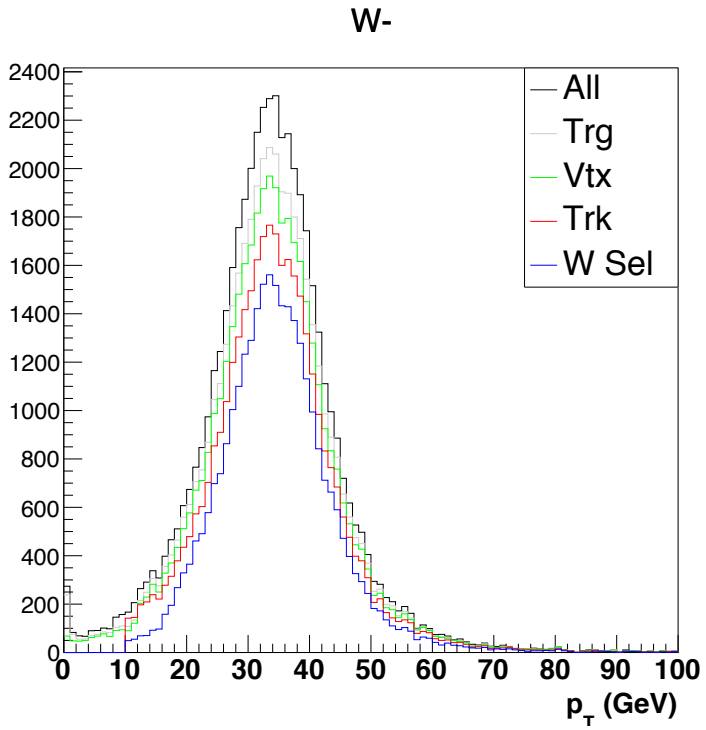


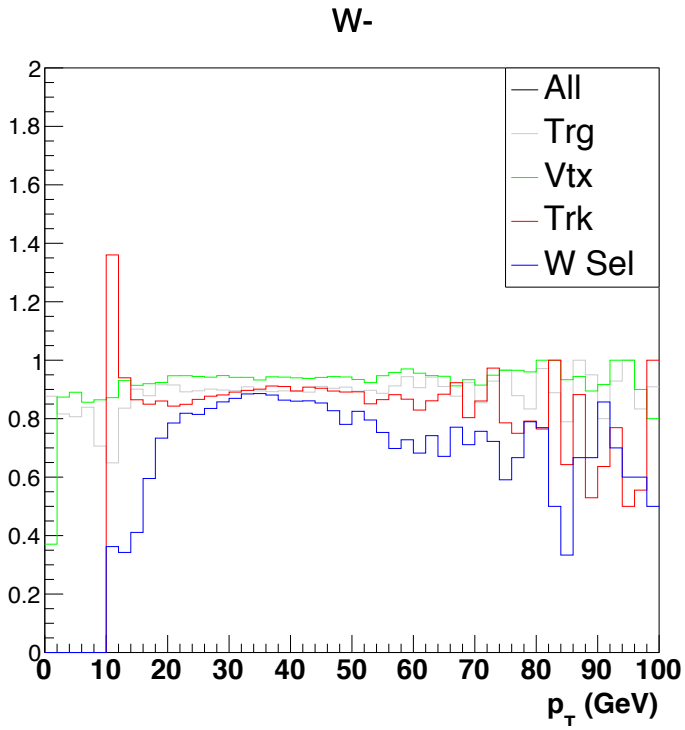




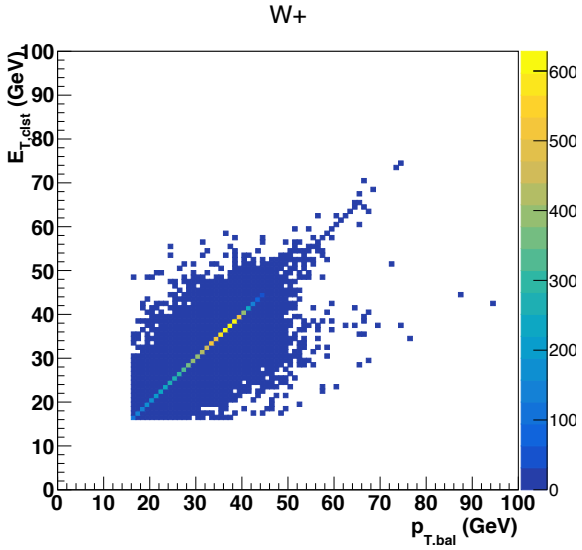
Efficiency p_T

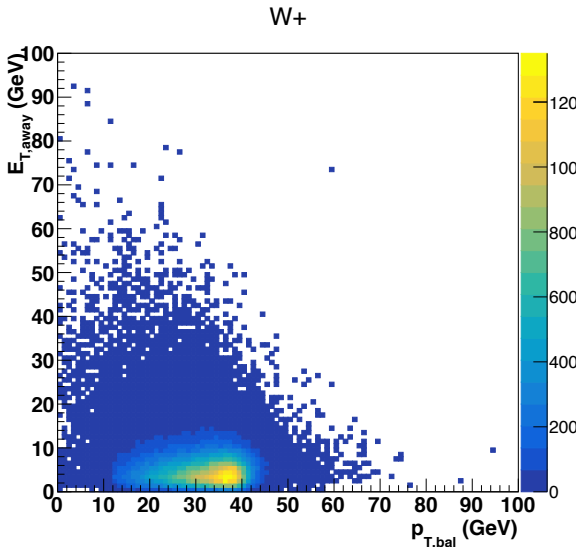


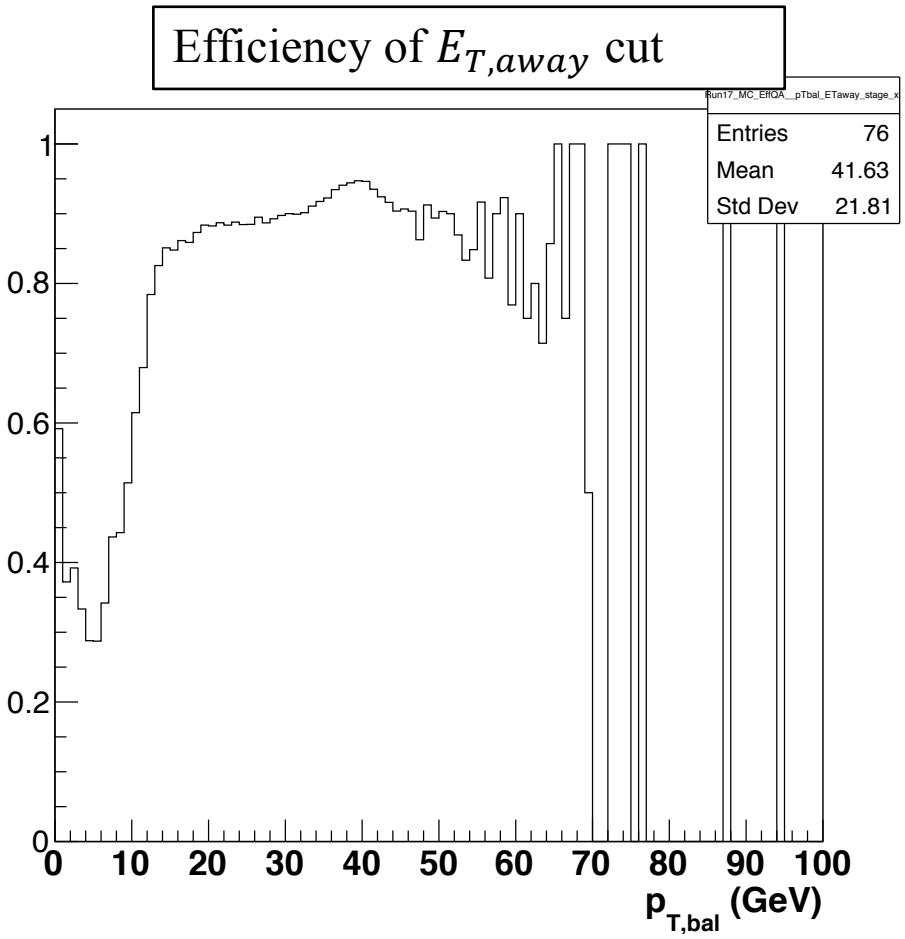




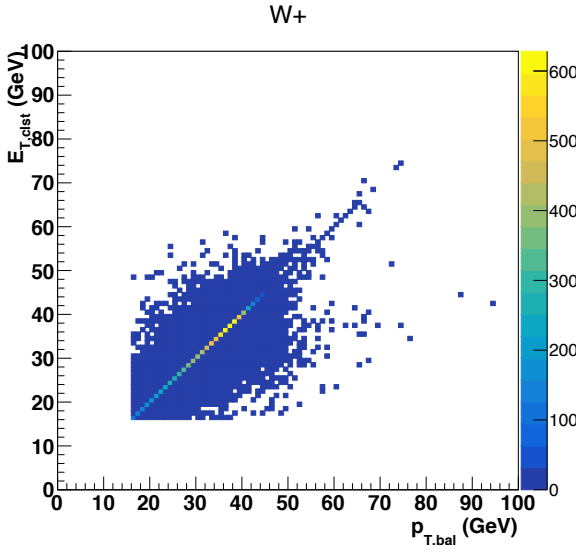
Efficiency of E_T^{away} cut

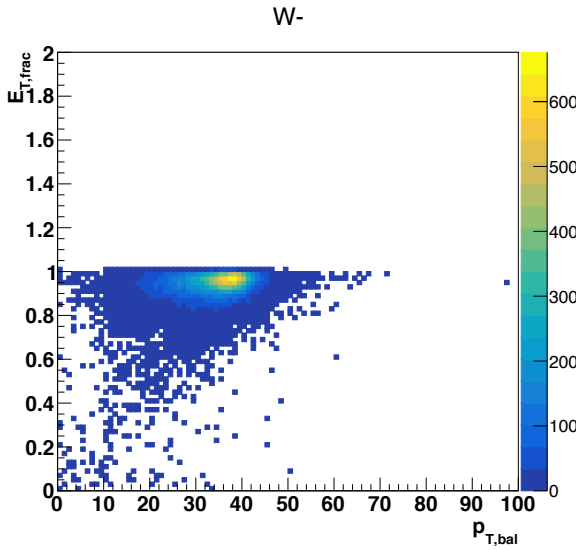


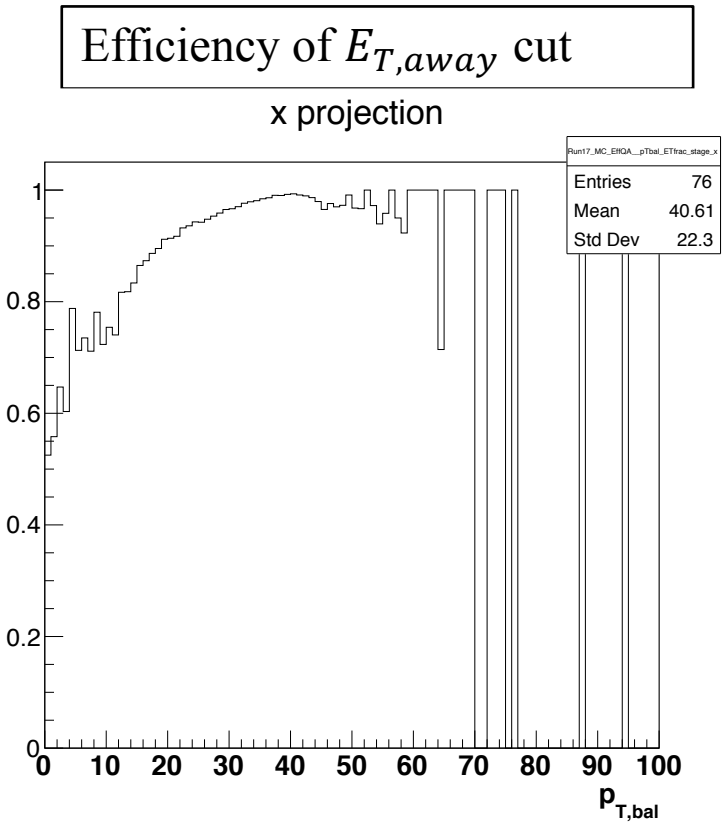




Efficiency of E_T^{away} cut

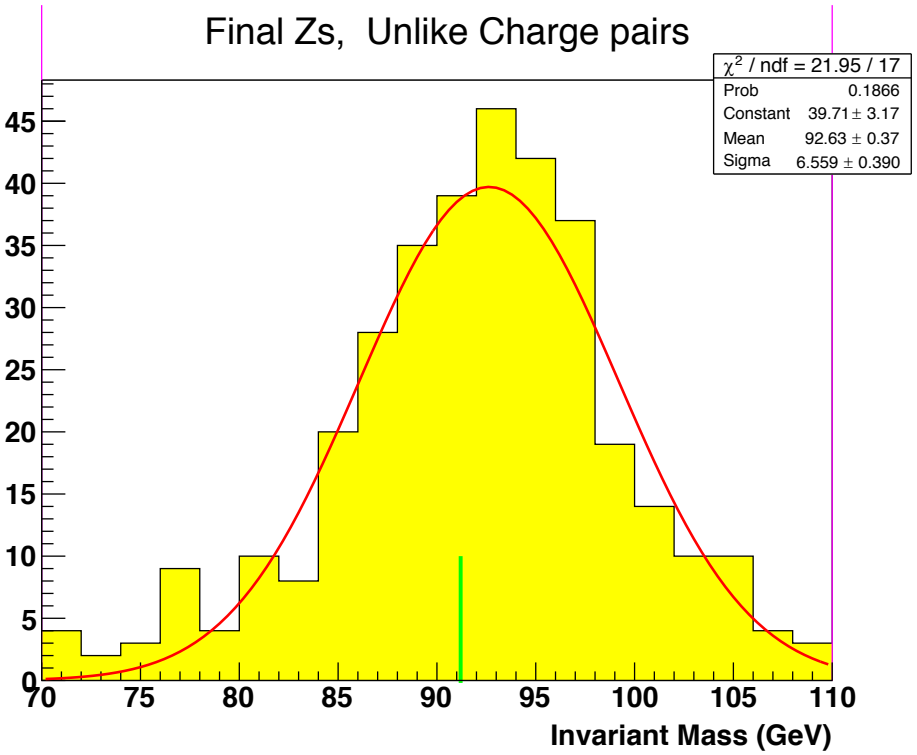


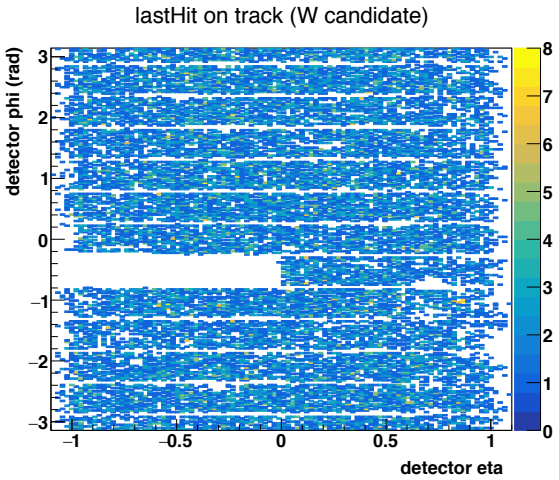


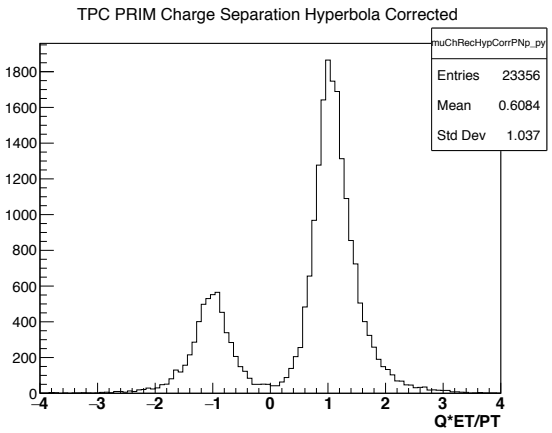


Overview

- Full production of st_W and embedding
  - ~332 pb^{-1} (2542 / 2691 runs) analyzed at the moment.
  - Uses final EMC calibration (P20ic).
  - EMC gain correction estimated with Z mass peak has **not** been included.
  - TPC sector 20 excluded.

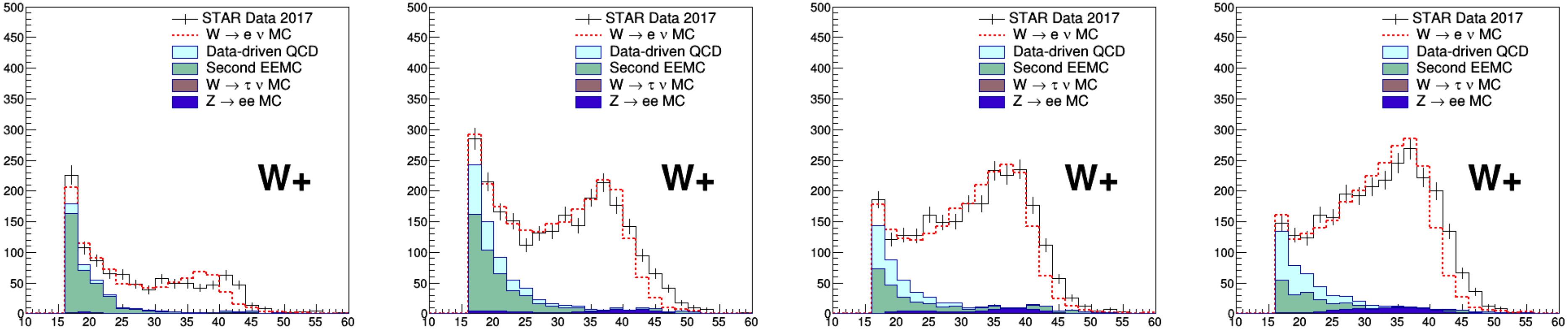




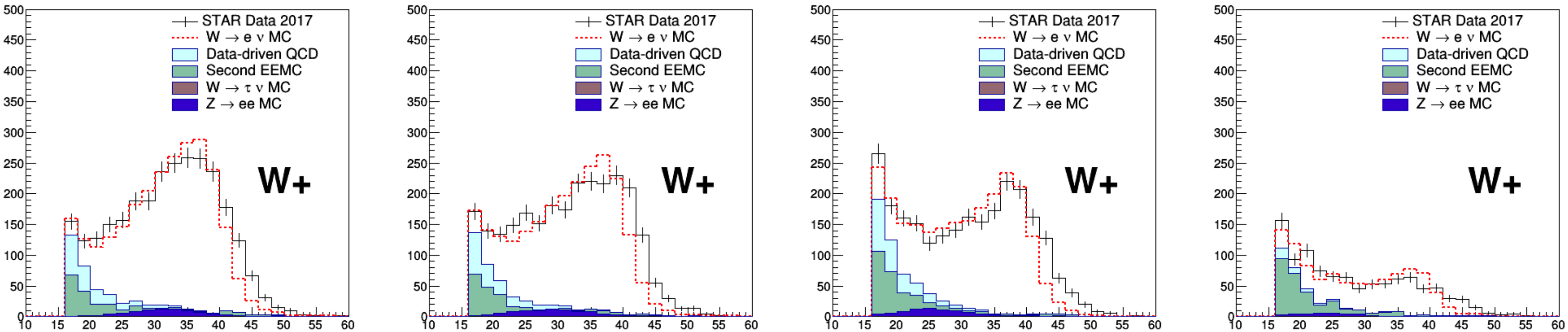


$E_T\,(W^+)$

$-1.0 < \eta < 0$

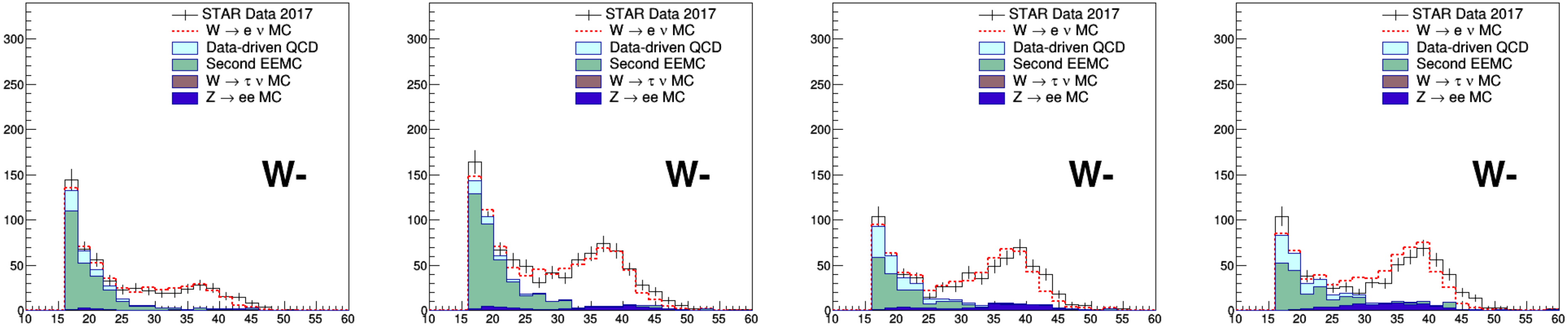


$0 < \eta < +1.0$

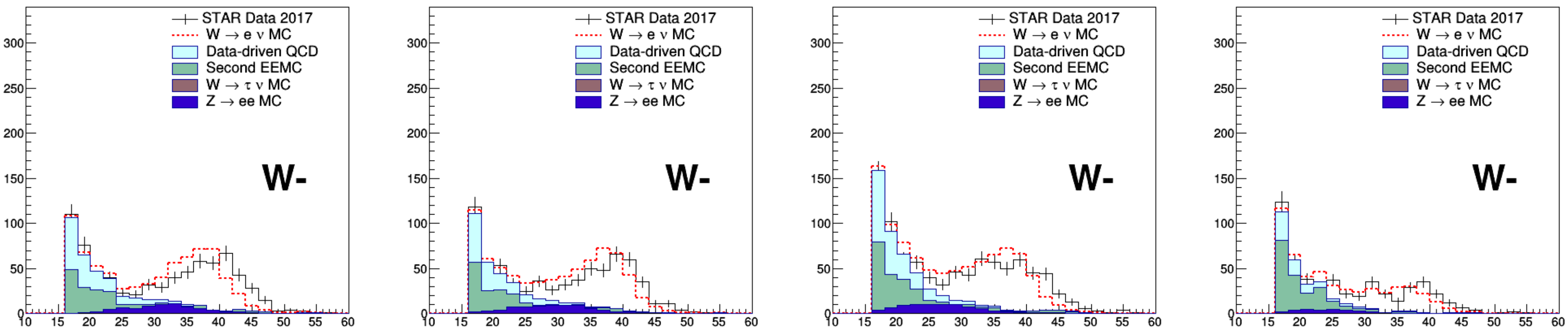


$E_T\ (W^-)$

$-1.0 < \eta < 0$

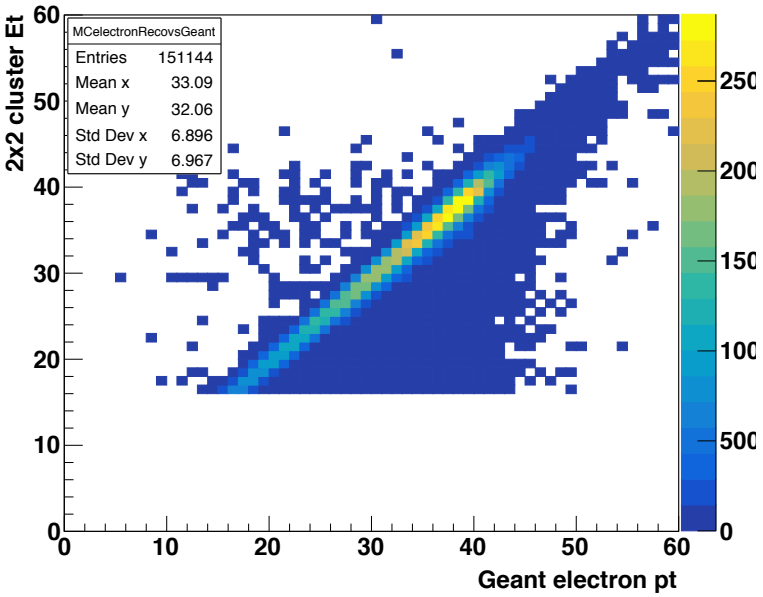


$0 < \eta < +1.0$

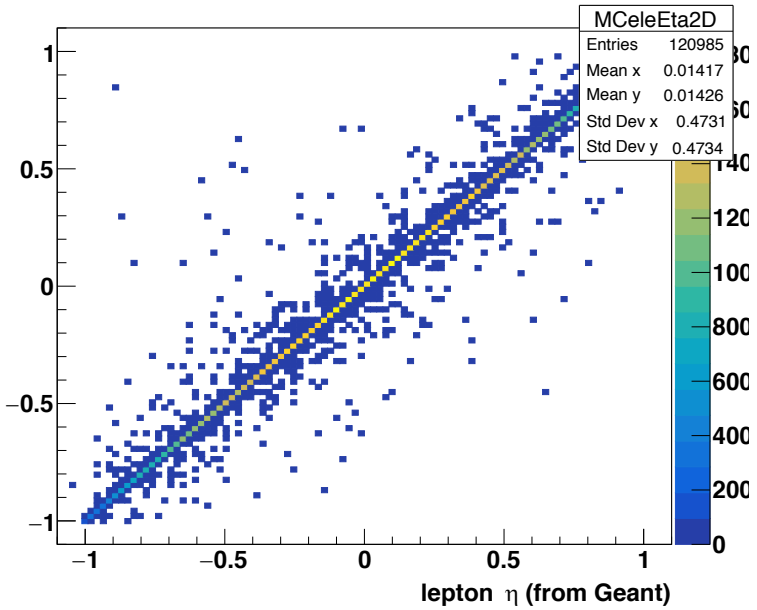


MC quantities (W^+)

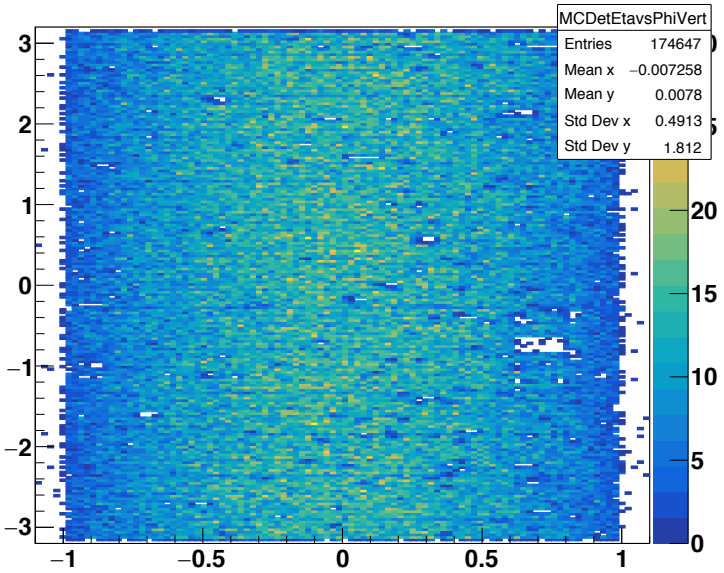
Electron Reco pt vs Geant pt



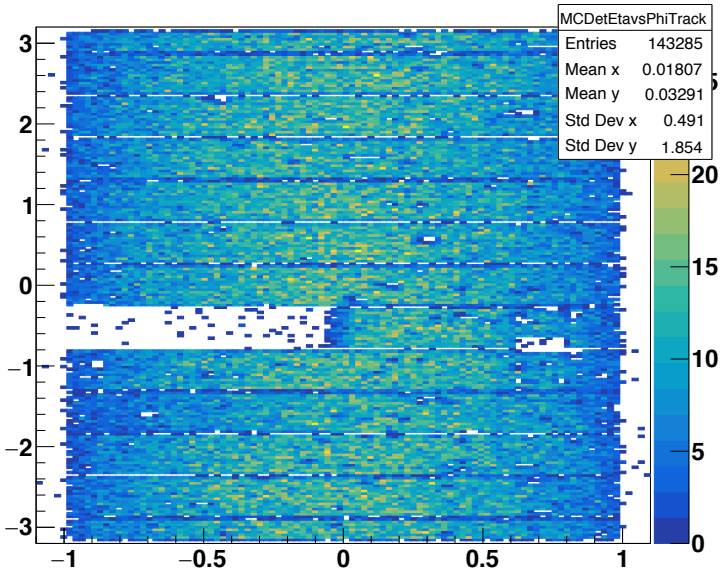
reconstructed MC η vs True MC η of all leptons that pass W cuts



Lepton Detector Eta vs. Phi (Pass Trig+Vertex+Track Cut)

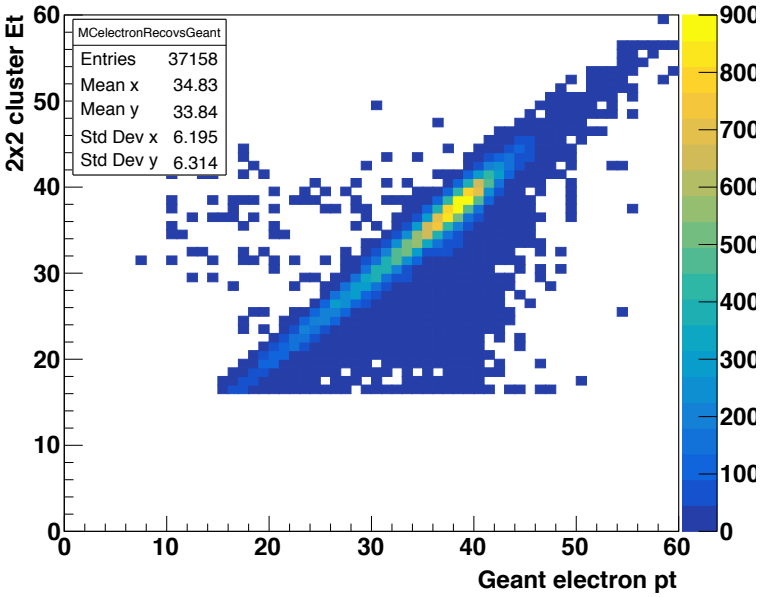


Lepton Detector Eta vs. Phi (Pass Trig+Track Cut)

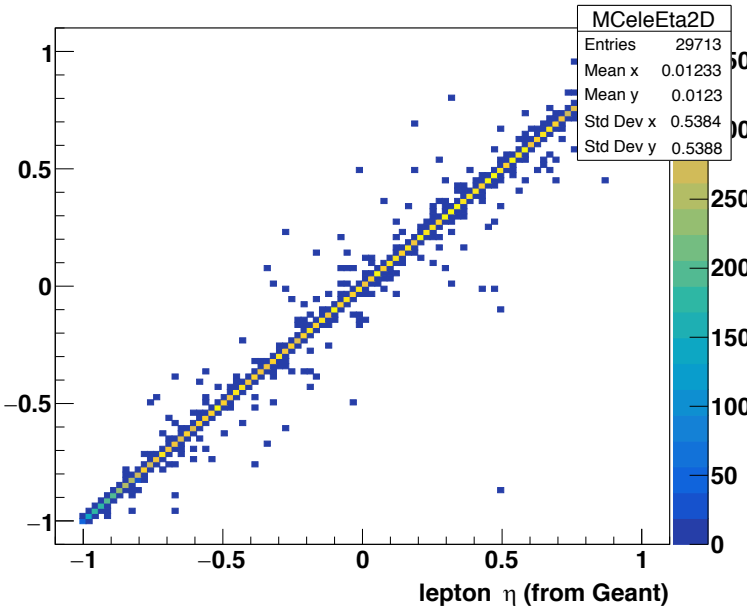


MC quantities (W^-)

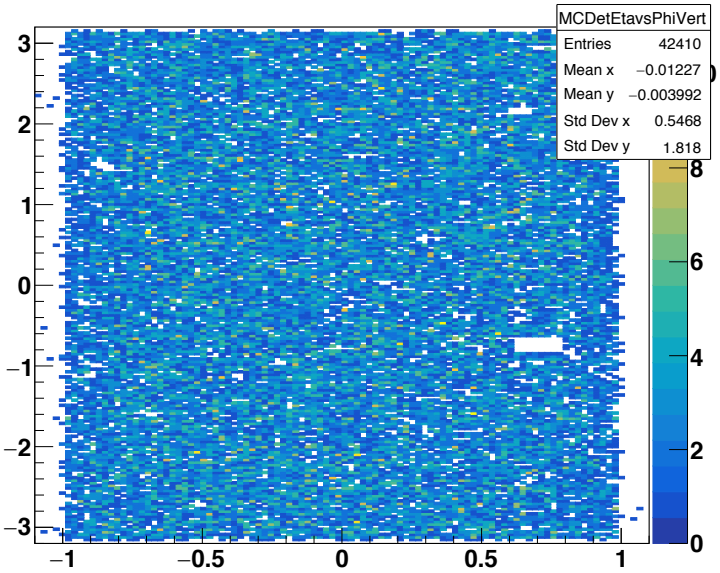
Electron Reco pt vs Geant pt



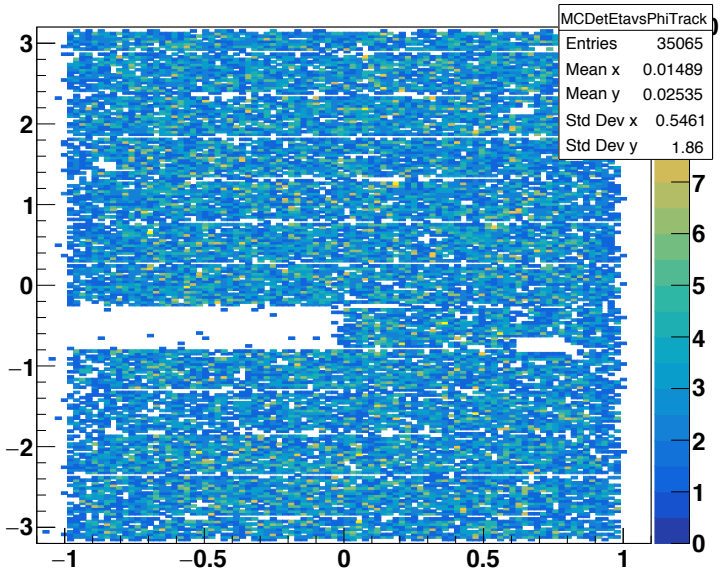
reconstructed MC η vs True MC η of all leptons that pass W cuts



Lepton Detector Eta vs. Phi (Pass Trig+Vertex+Track Cut)



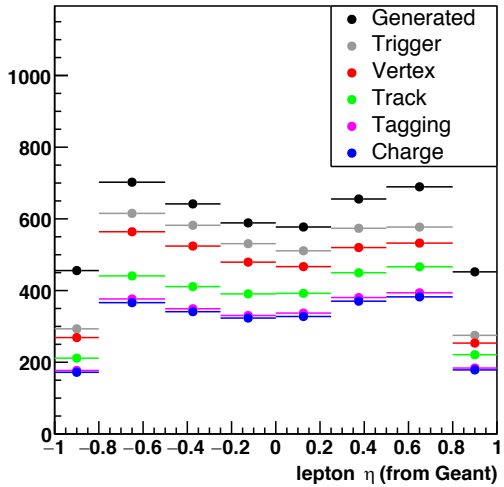
Lepton Detector Eta vs. Phi (Pass Trig+Track Cut)



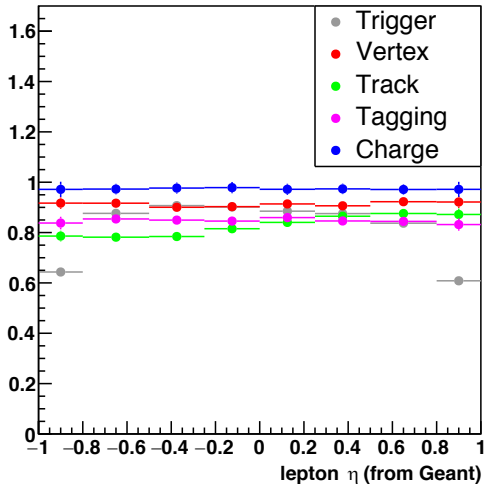
Efficiency (η)

W^+

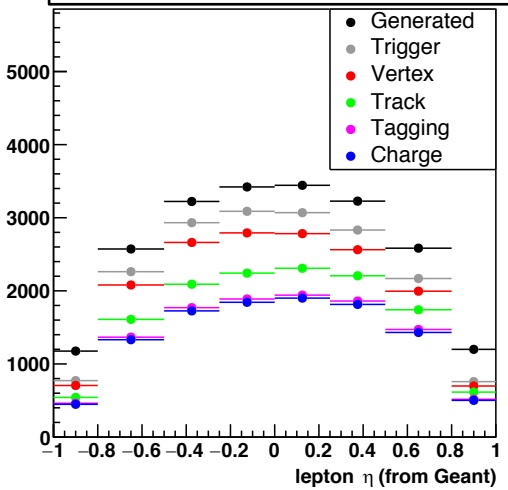
Yields

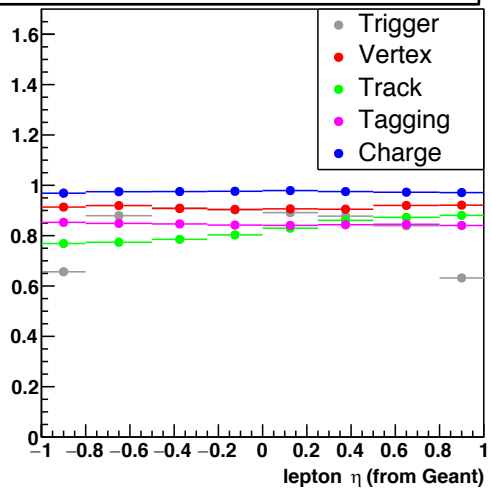


ϵ

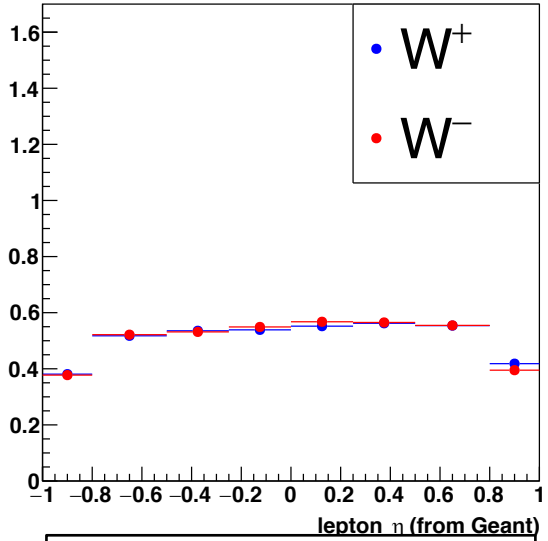


W^-

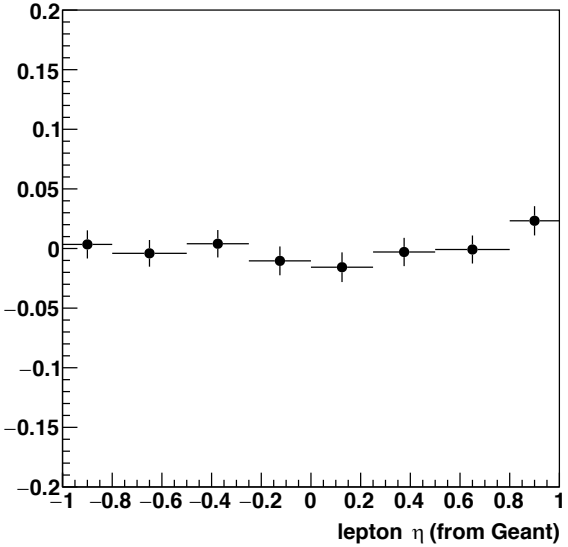




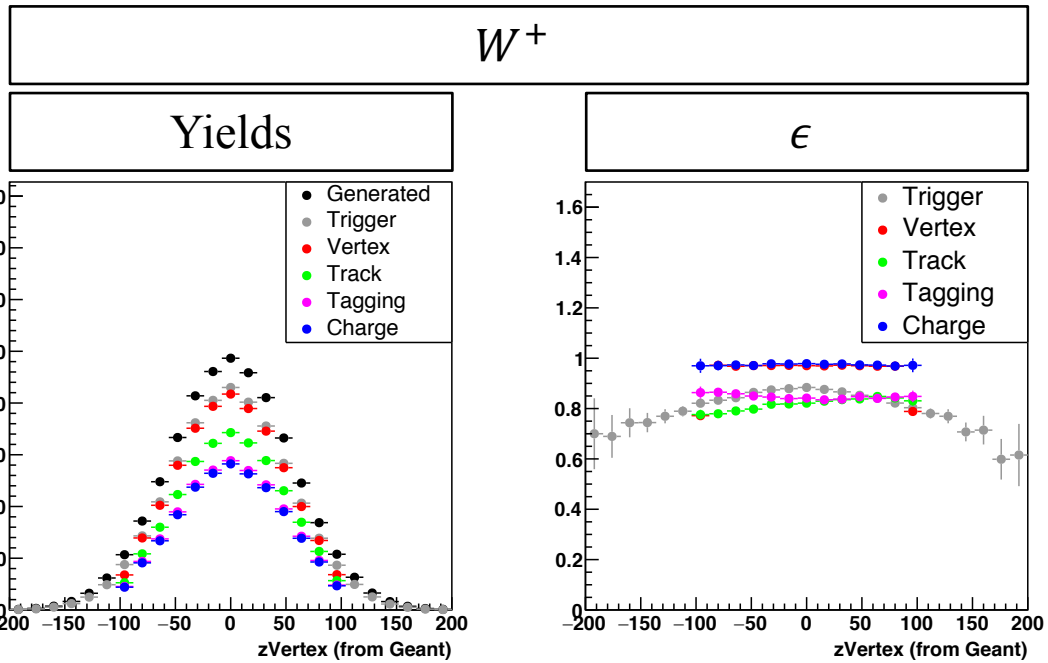
ϵ_{tot}

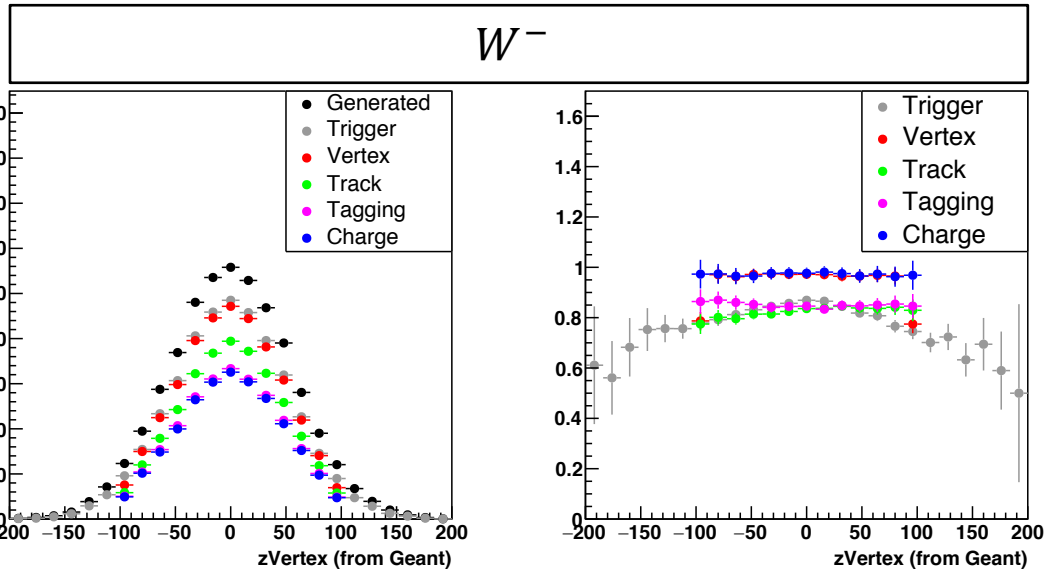


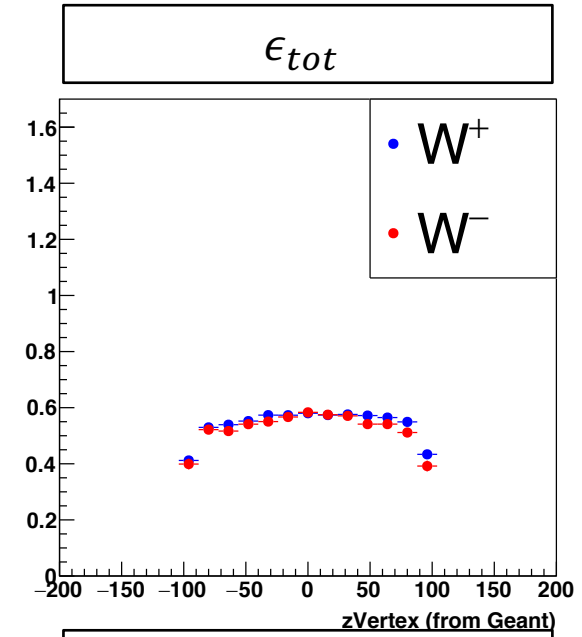
$\epsilon^+_{tot} - \epsilon^-_{tot}$

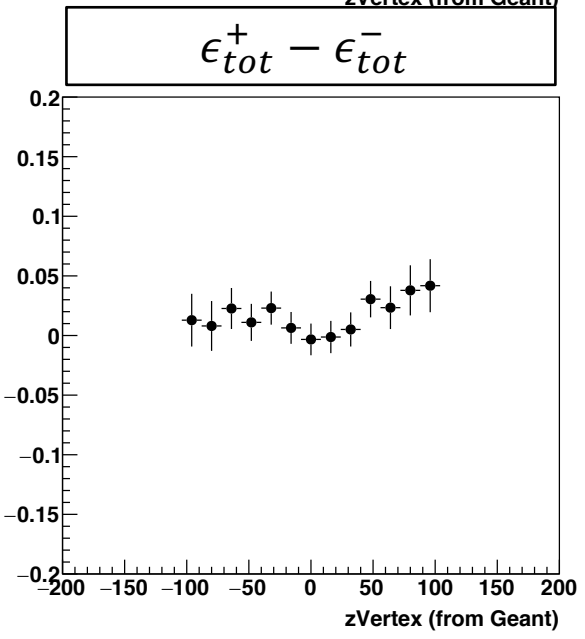


Efficiency (Z_{vtx})

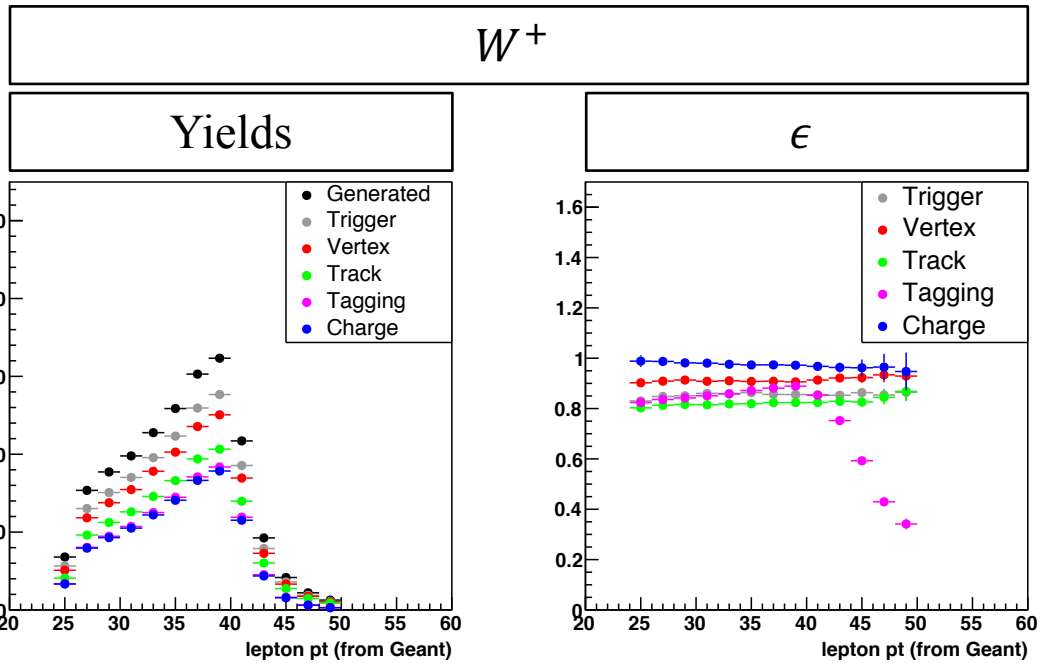


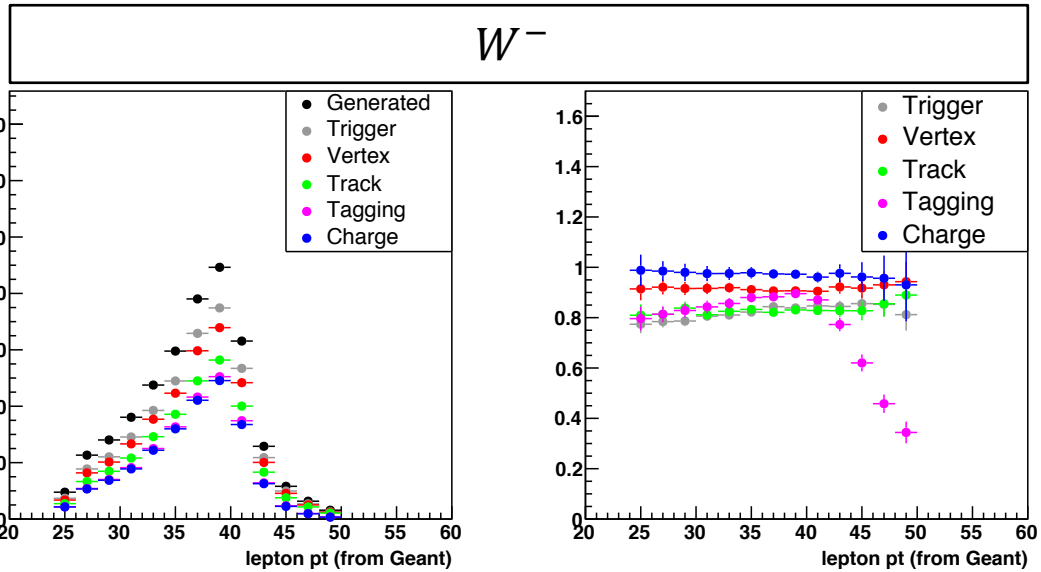


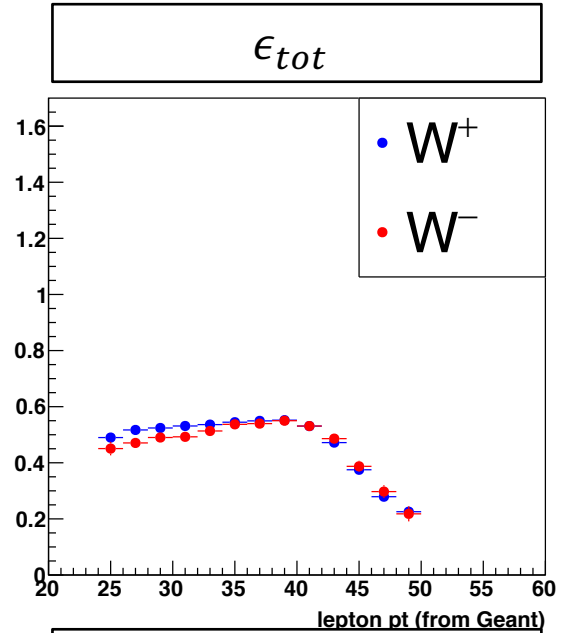


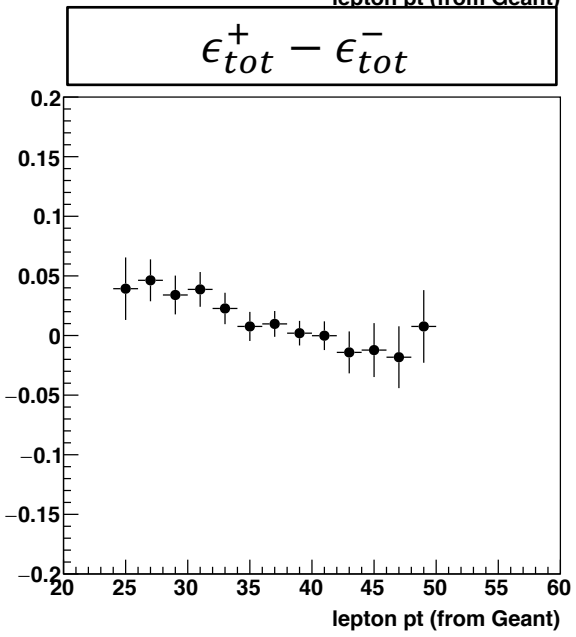


Efficiency (p_T)

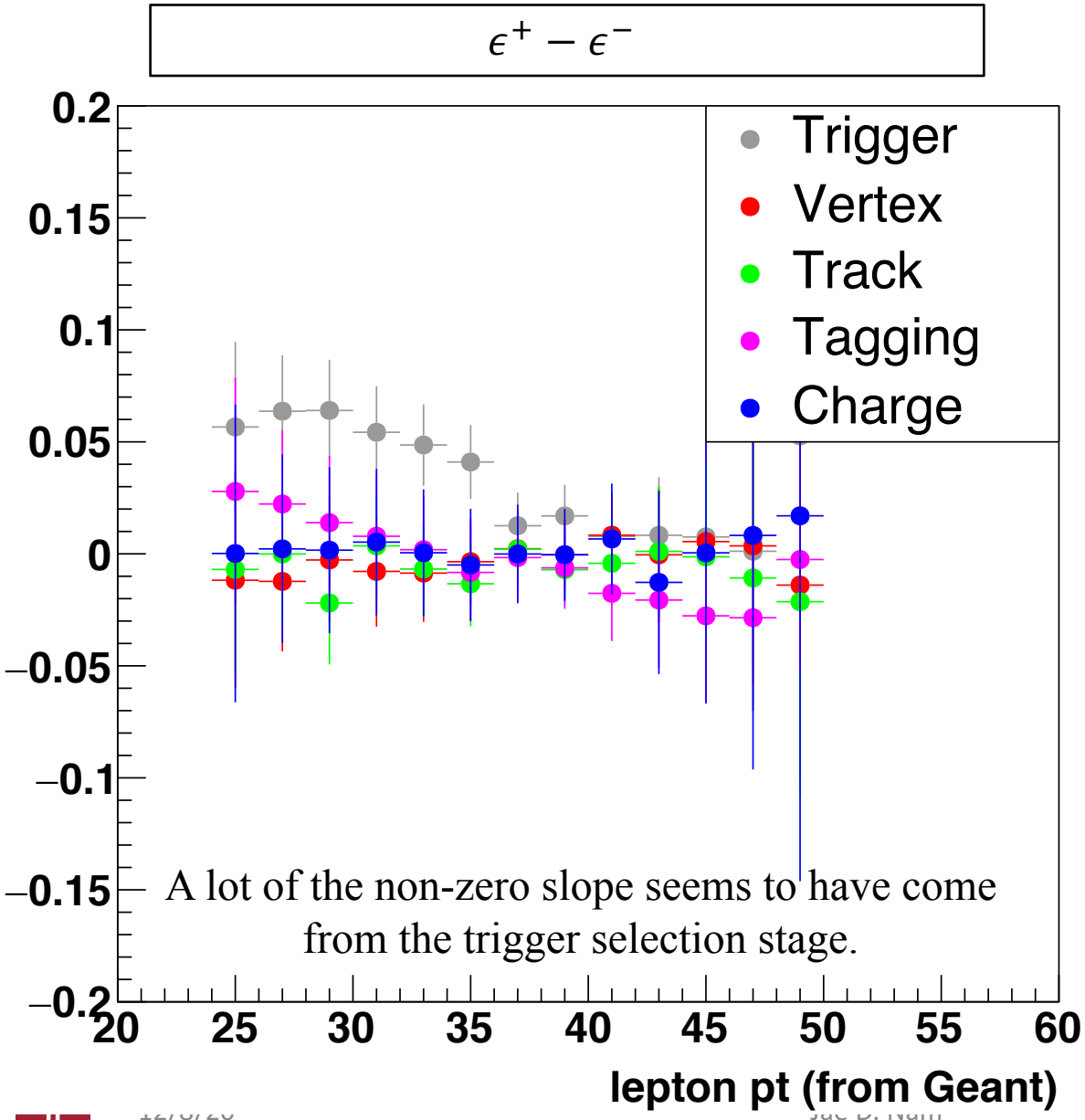


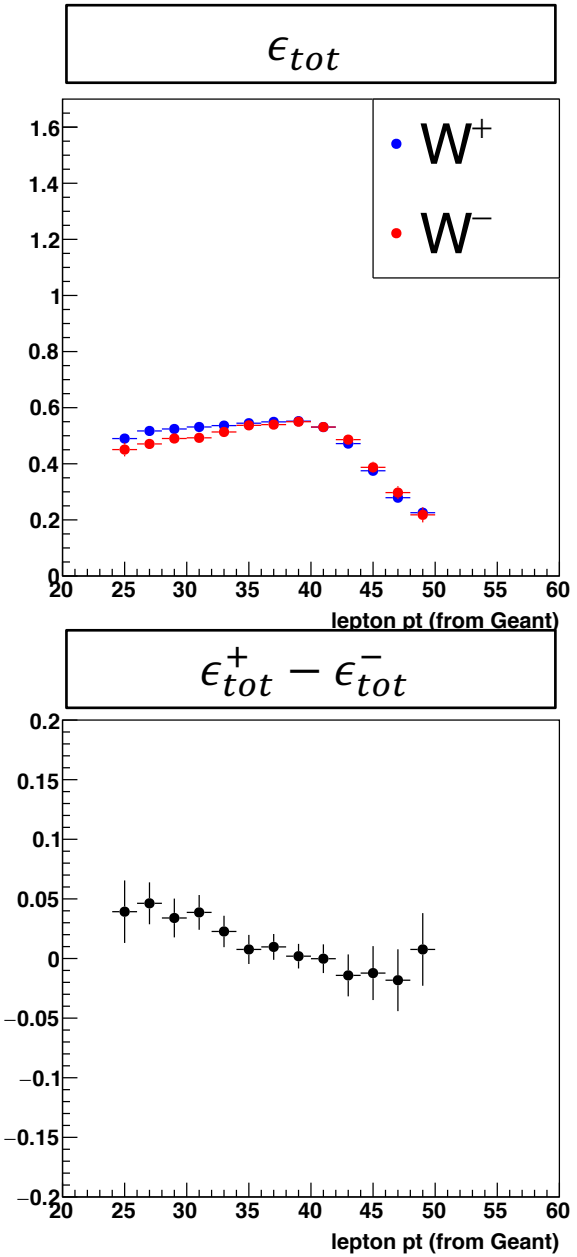






Efficiency (p_T)





Summary

- Production P20ic is complete.
  - Relatively good agreement between MC and data.
    - Wider Jacobian peak in data.
  - Good matching between true and reconstructed quantities.

- Efficiency study
  - Expected small efficiency correction in the barrel η bins.
  - Systematic efficiency difference between $W^{\pm}$ with non-zero slope in lepton-p_T.
    - Seems to come at the trigger selection stage.

- To-do list
  - Endcap measurement
  - Systematic uncertainties