Negative HCal Discussion

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Detector-1 Calorimetry WG Meeting

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Negative HCal Discussion Points

- Particle / Jet energy in the negative endcap region will be low
  - Standard HCal used to find energy would be prohibitively expensive / not needed
  - What would be the benefits of having a system to tag neutral particles?

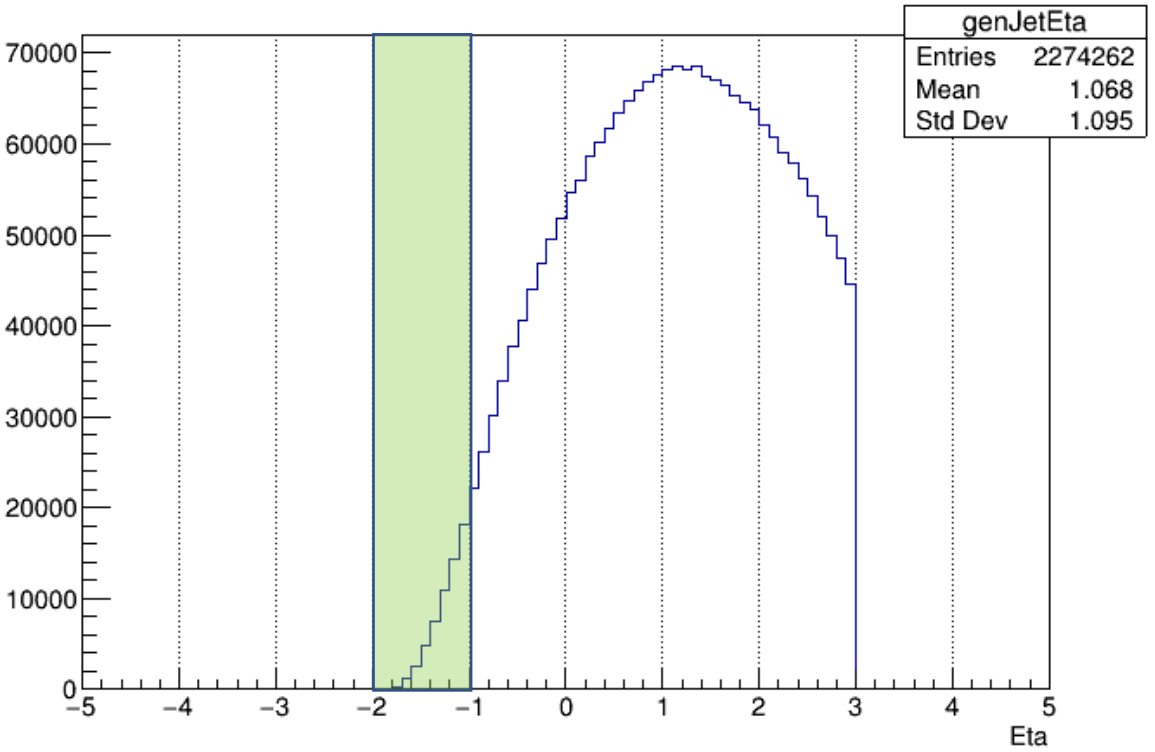
- Yield of jets in this region is comparatively low
  - Collecting ~10 fb^-1 / year will still allow precise jet measurements – want to make sure we can take advantage of all of our phase space
  - Want as much uniformity in acceptance as possible

- Even if NHCal may not drive any particular measurement, if we think we may want one at any point in the future, we should plan for / integrate it into the design from the start

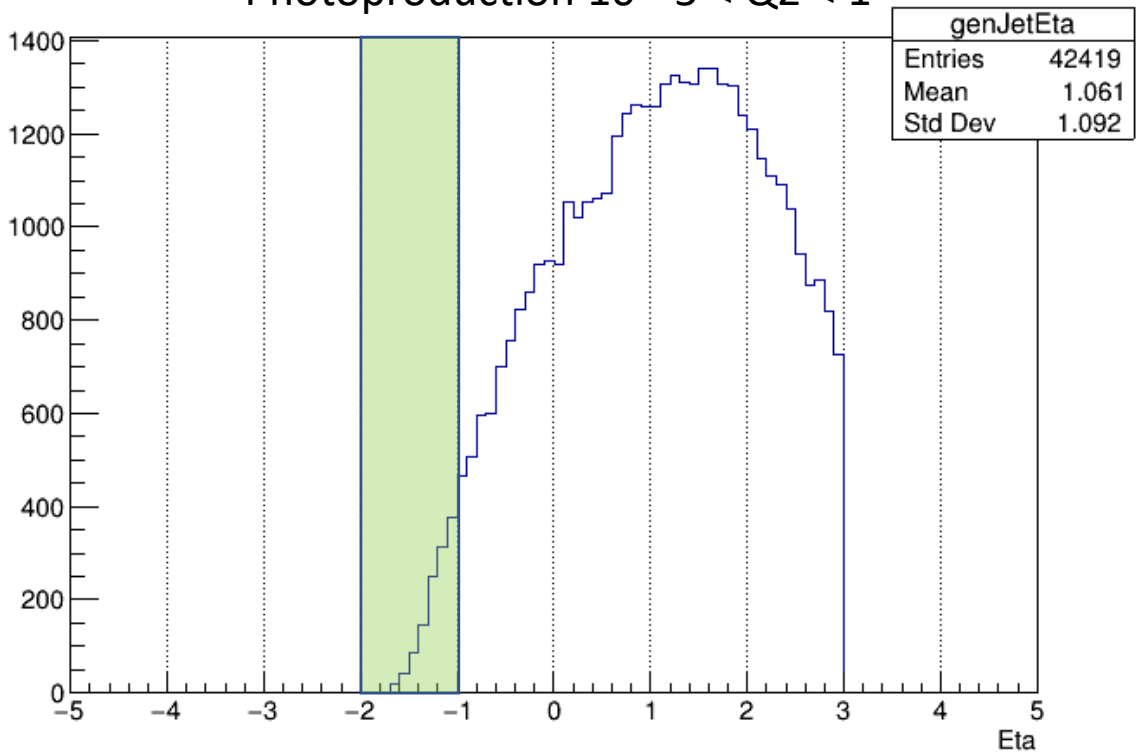
Jet Yield in the Negative Endcap

- Yield for eta < -1 (jet pT > 5 GeV) is roughly 3% of the total yield for |eta| < 3
- For 1 fb^-1 integrated luminosity, expect a little over 400K events in this region

NC DIS Q2 > 10 GeV2



Photoproduction 10^-5 < Q2 < 1



- The photoproduction jet yield in the negative endcap also represents about 3% of the total yield
- Expect about 1.4M endcap jets per 1 fb^-1

Calculating JER & JES

- Perform studies using ATHENA parametrization in DELPHES fast simulation framework
  - Assume NHCal $\Delta E/E = 70\%/\sqrt{[E]} + 5\%$

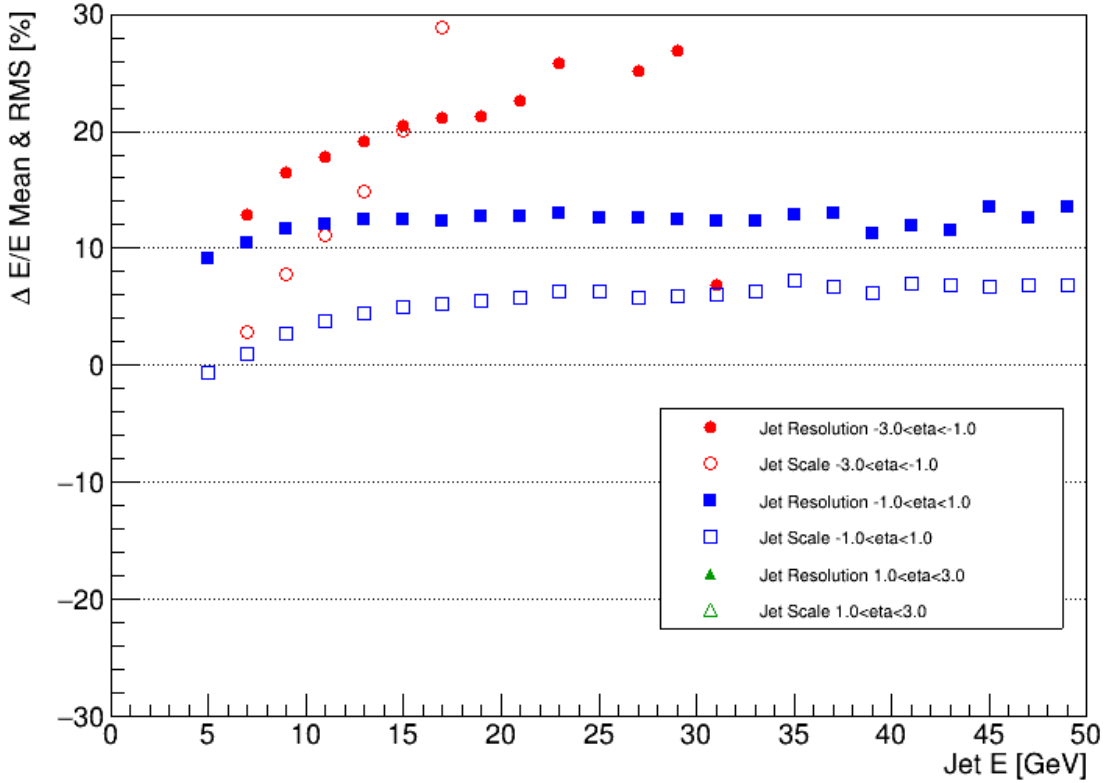
- Simulation is PYTHIA8 NC DIS 18x275 with $Q2 > 10$ GeV2

- DELPHES constructs energy flow objects (tracks, photons, and neutral hadrons) – build jets (Anti-kT, R = 1.0) from these components. Also look at case where neutral hadron EFlow objects for eta < -1 are not used – simulate lack of NHCal

- JER & JES Calculation:
  1. Find all detector level jets with pT > 5 GeV and more than 1 constituent in our acceptance
  2. For each detector jet, find closest particle level jet in ΔR while requiring $\Delta R < 0.5$
  3. Calculate ratio (Detector – Particle)/Particle Jet Energy plotted vs particle jet energy
  4. JES = Mean of distribution calculated from values within +/- 2*RMS of the raw mean
  5. JER = RMS of values within raw mean +/- 2*RMS

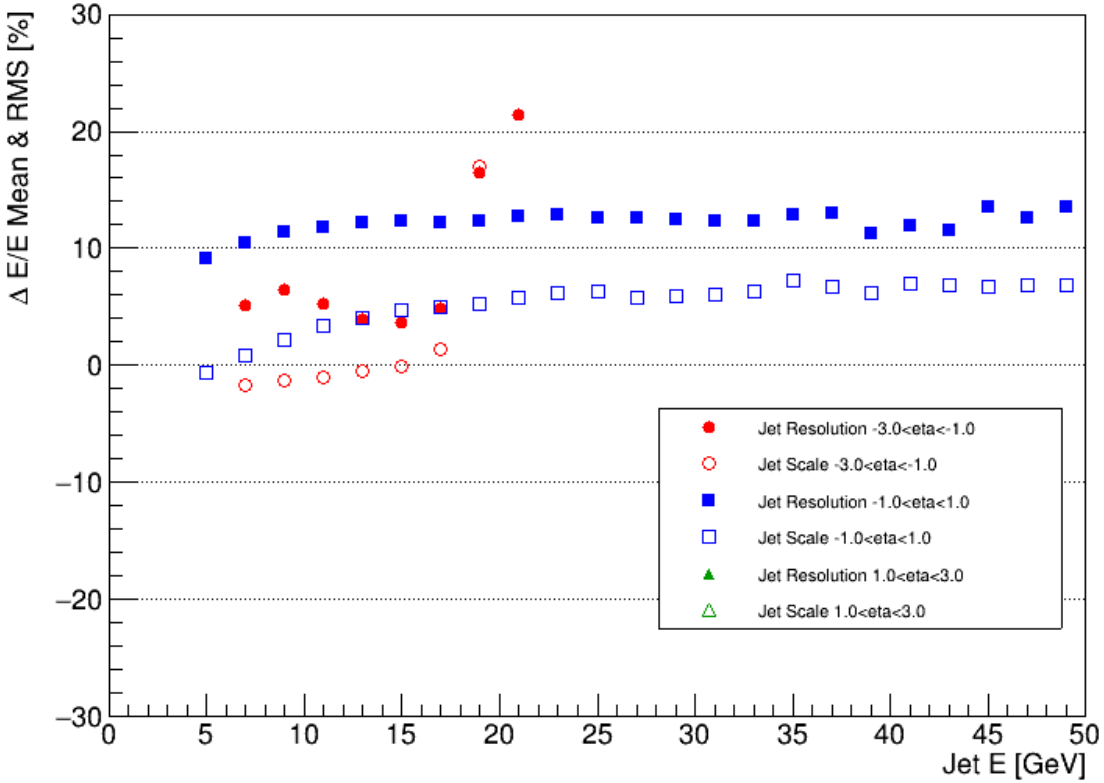
Jet Energy Resolution

Neutral Hadron EFlow for all Eta



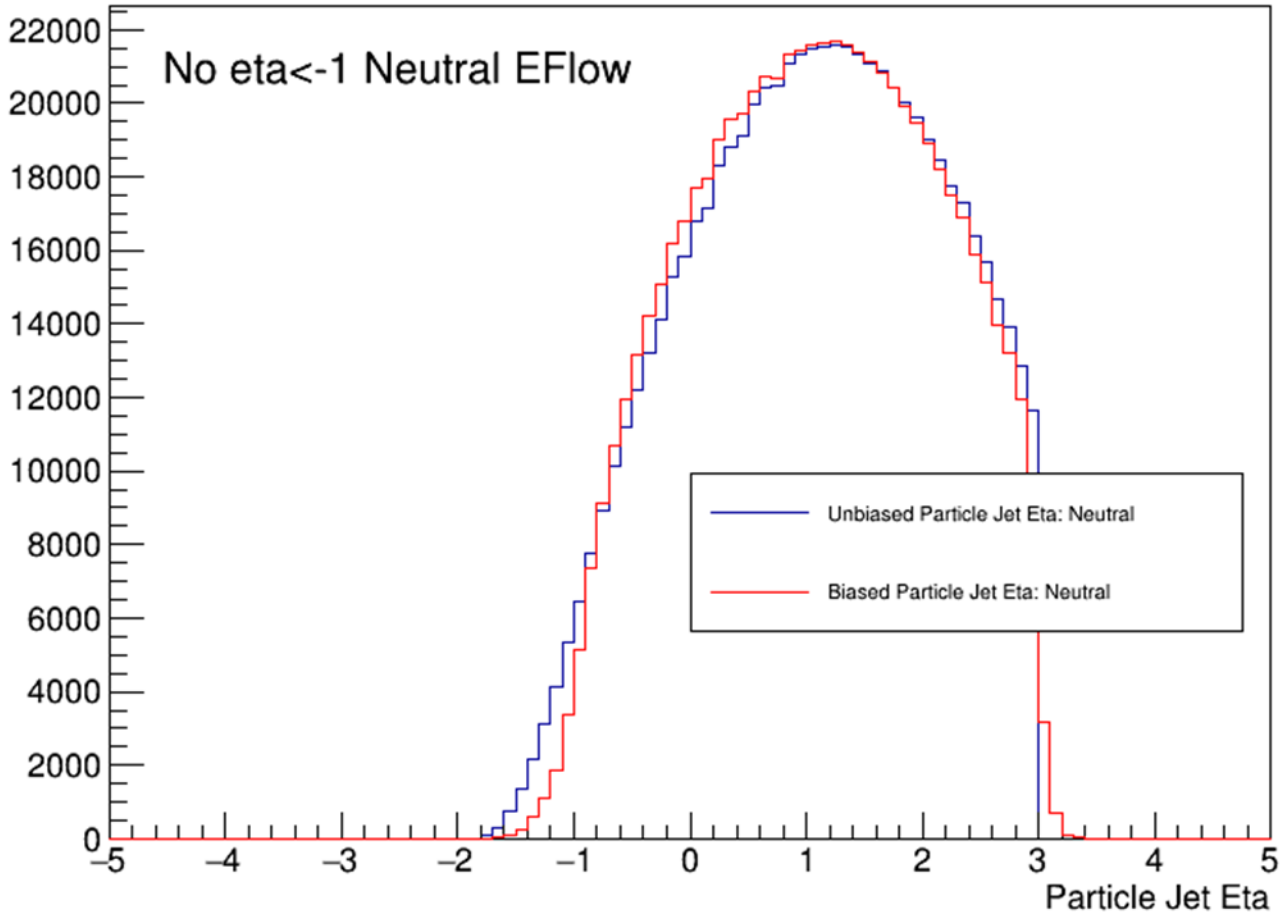
- When using neutral hadron objects in the negative endcap region, large energy fluctuations drive poor resolution and inflate JES

Neutral Hadron EFlow for Eta > -1



- Ignoring neutral hadron EFlow objects in the NHCal greatly improves JES & JER
- How does this bias our jet sample?

Neutral Fragmentation Bias



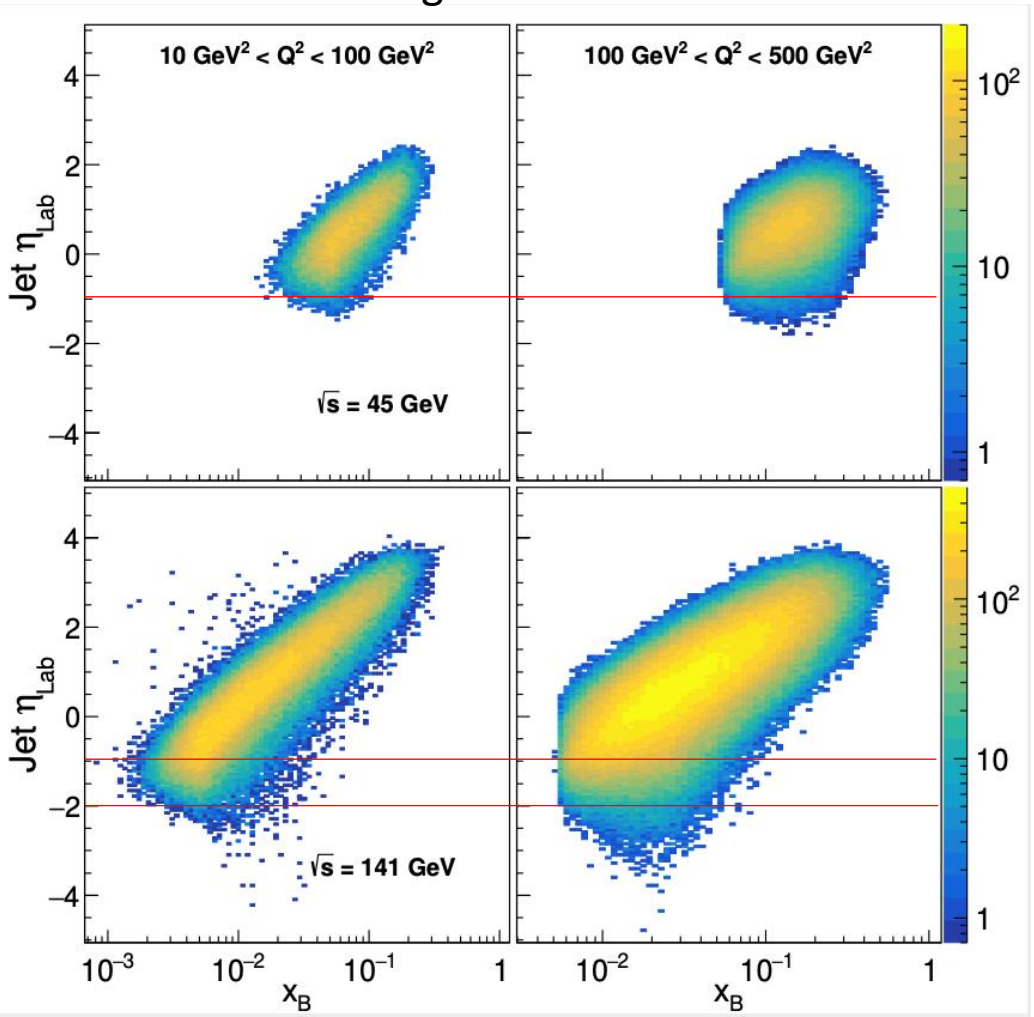
- The sample of particle level jets matched to selected detector level jets will be biased w.r.t. the raw particle level distribution
- Blue curve is unbiased particle level eta distribution for all jets containing a neutral hadron
- Red curve is distribution of particle level jets containing a neutral hadron matched to selected detector level jets when omitting neutral hadron EFlow objects in the negative endcap
- See that this detector configuration significantly biases against jets containing a neutral hadron in the negative endcap region

Conclusions and Next Steps

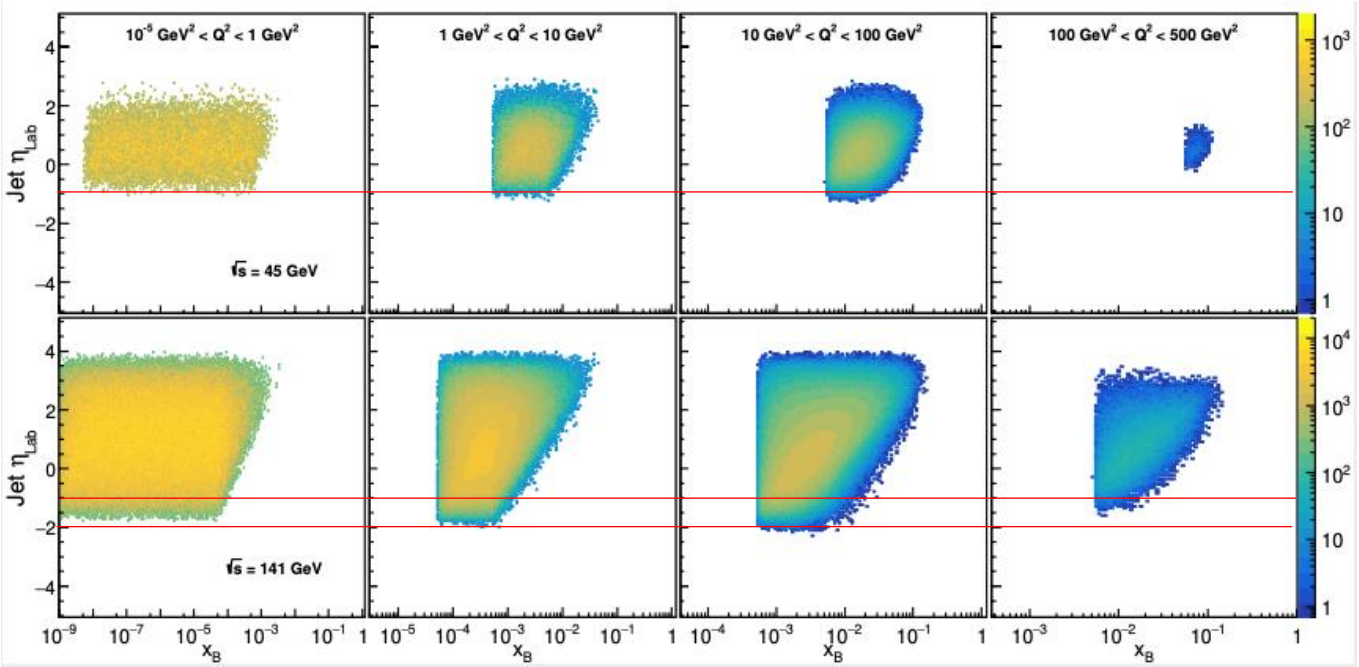
- Omission of neutral hadron EFlow objects in negative endcap region (~equivalent to not having a NHCal) leads to greatly improved JES & JER on a sample of jets biased against neutral fragmentation
- Having a means of tagging jets containing neutral hadrons would allow to quantify this bias in a data-driven way and allow separate unfolding of jets with and without neutral hadrons
- Need to repeat these studies using full simulation and confirm that neutral hadron tagging is feasible
- Can we identify physics observables for which such a bias in the jets sample would significantly impact our conclusions?
- So far only thought about jets, could an NHCal have benefits for other measurements? – Hadronic final state for kinematics determination?

Inclusive Jet Eta Coverage

Leading Order Process



Higher Order Processes: Photoproduction, PGF, QCDC



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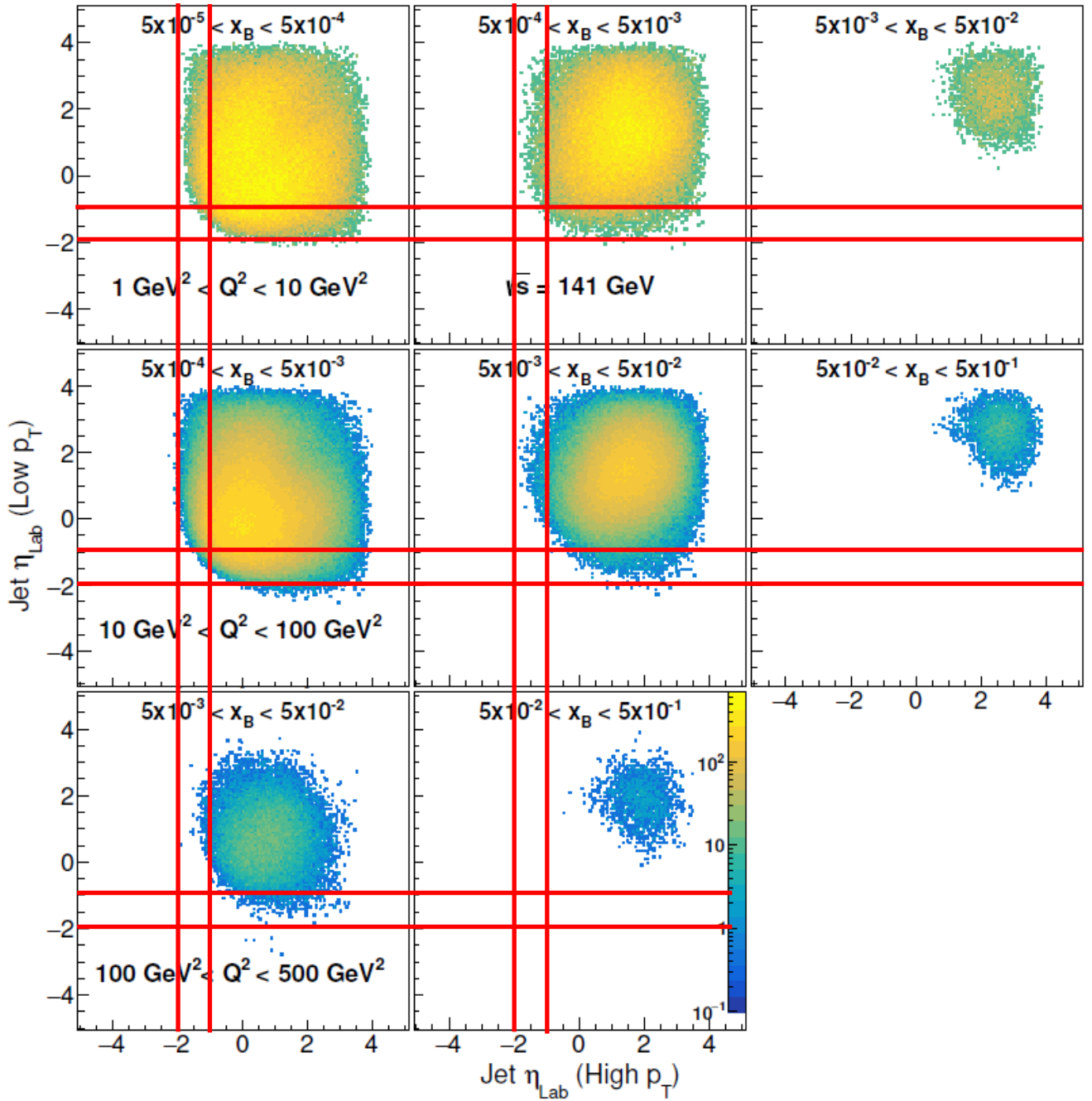
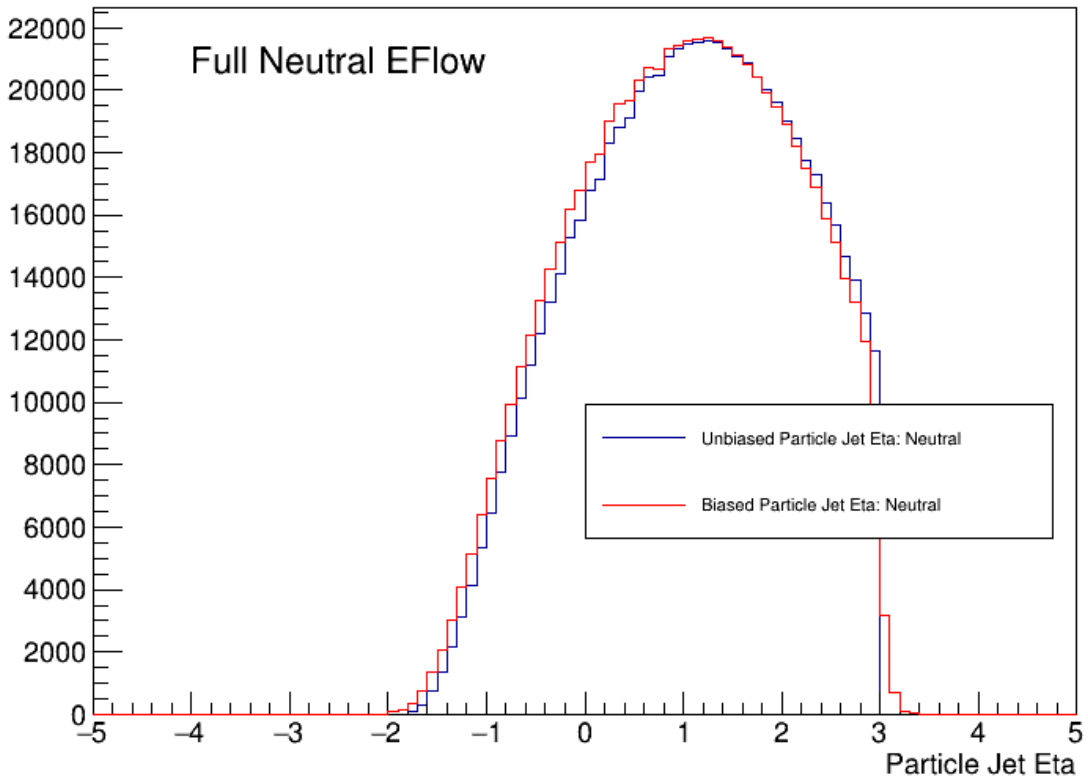
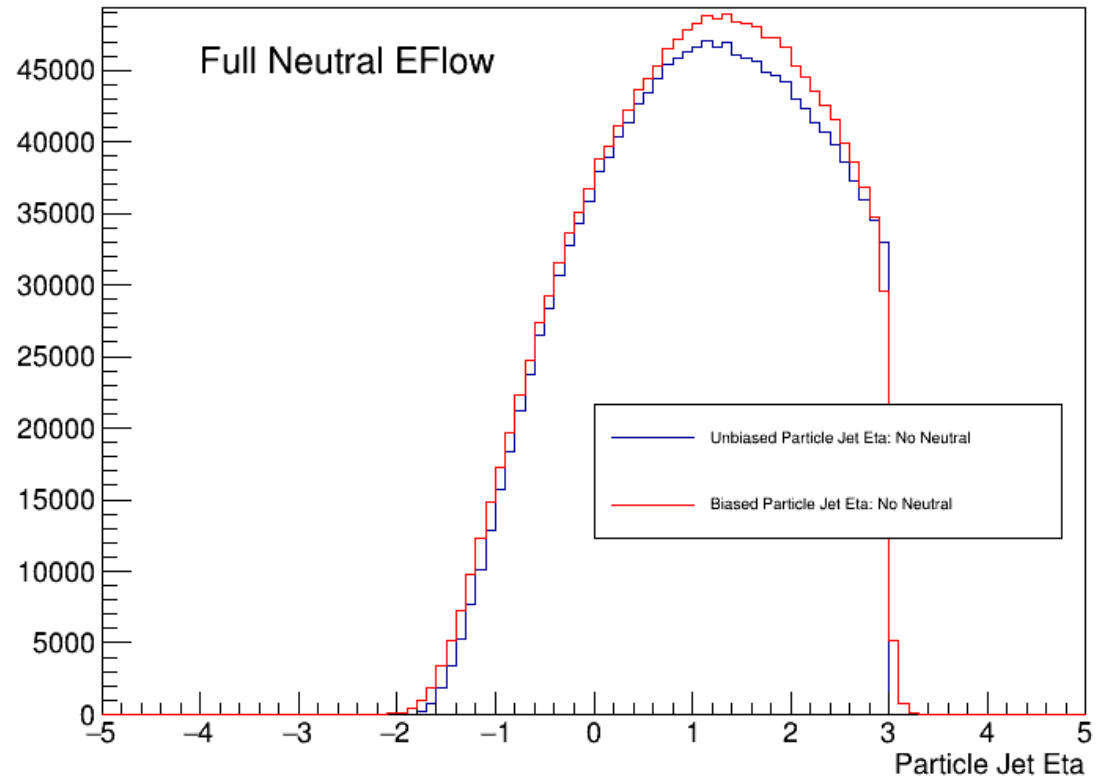
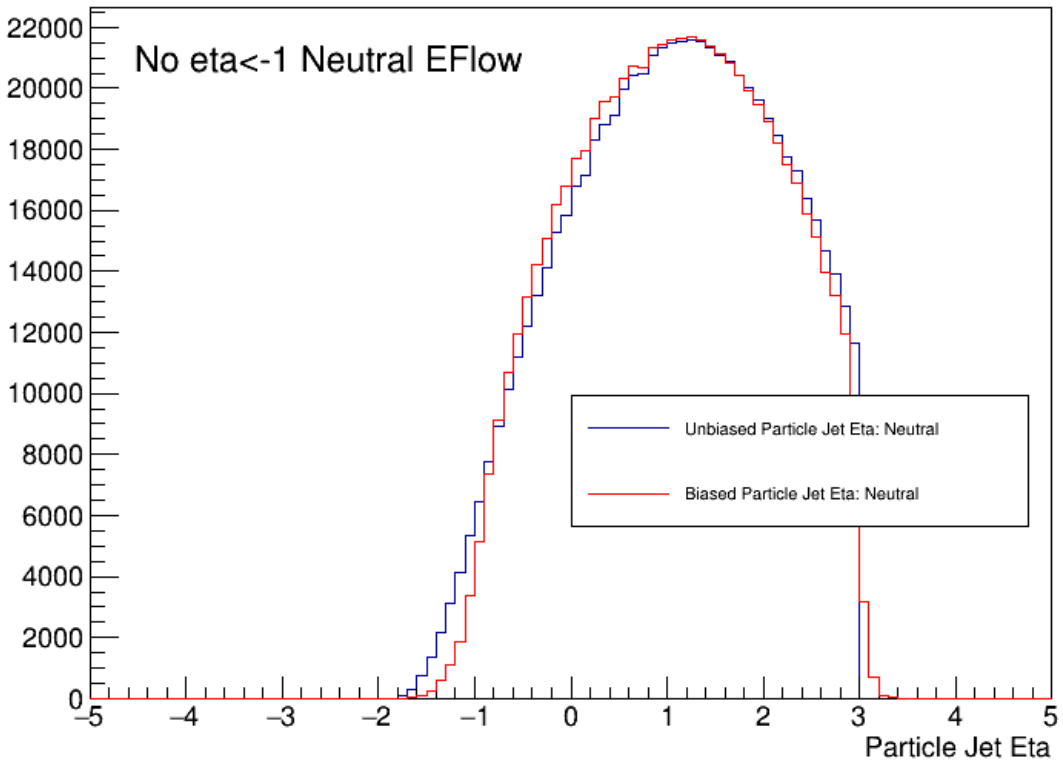
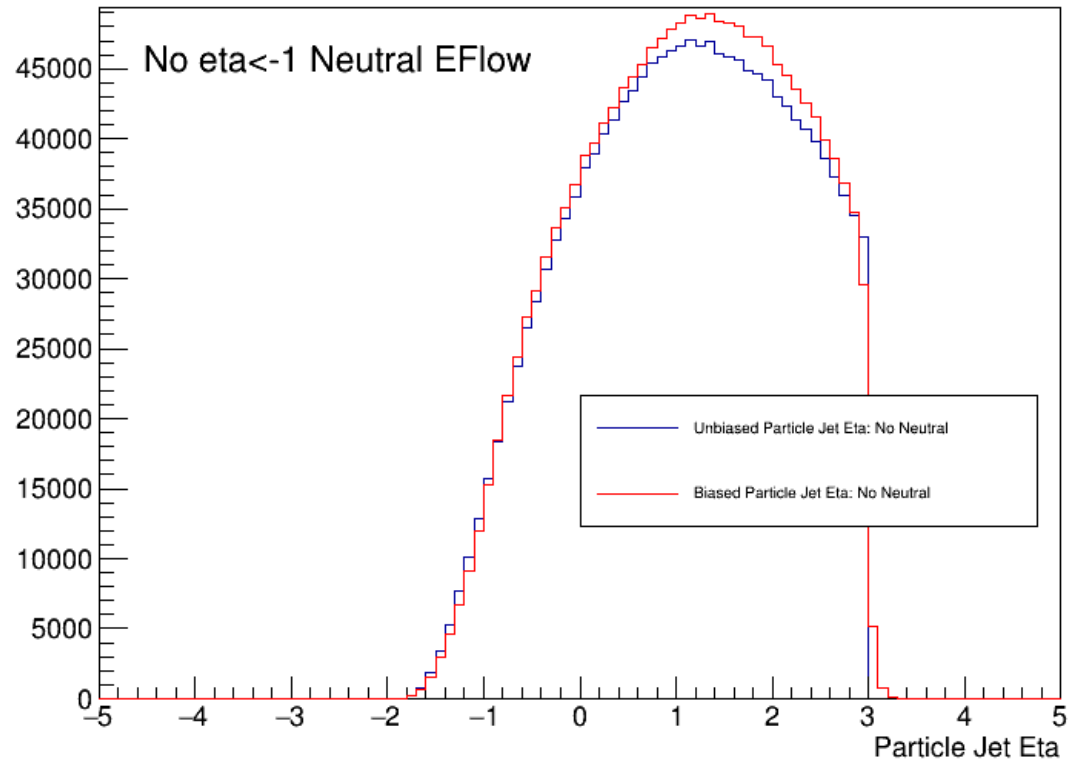
Dijet Eta Coverage




Full Neutral EFlow
Unbiased Particle Jet Eta: Neutral
Biased Particle Jet Eta: Neutral
Particle Jet Eta


Full Neutral EFlow
Unbiased Particle Jet Eta: No Neutral
Biased Particle Jet Eta: No Neutral
Particle Jet Eta


No eta<-1 Neutral EFlow
Unbiased Particle Jet Eta: Neutral
Biased Particle Jet Eta: Neutral
Particle Jet Eta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Unbiased Particle Jet Eta: No Neutral
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