Backward Hadronic Calorimeter update

Diffractive dijet study

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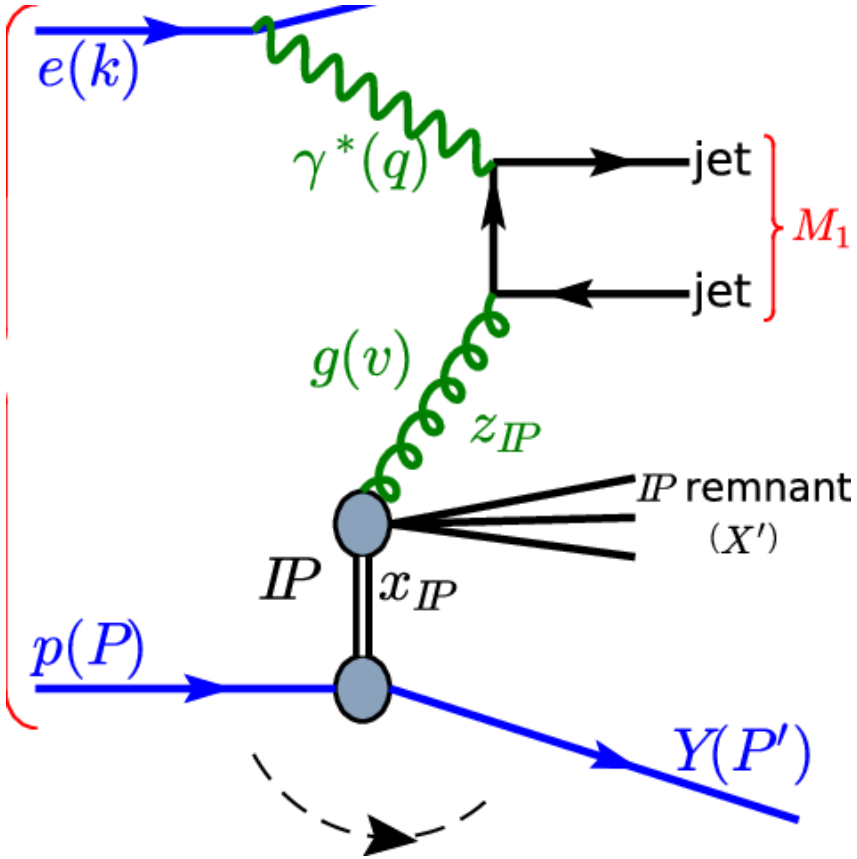
THE OHIO STATE UNIVERSITY

Outline

1. Diffractive dijets with nHCal
   - Process
   - Simulation setup
   - Events
   - Partons
   - Particles
   - Jet clustering
   - Acceptance
   - Particle distributions in nHCal
   - Jets
   - Jets measured
   - Jets measured vs. partons
2. Summary

Diffractive dijet - process



[Phys. Rev. D 107, 094038]

Diffractive dijet - simulation setup

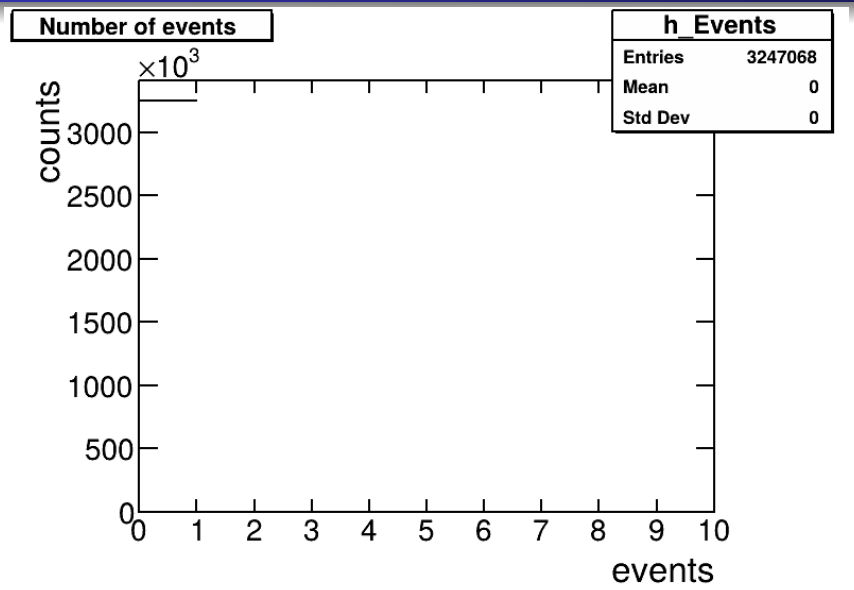
- Simulation setup for diffractive dijets
- PYTHIA version 8.311 simulation from EIC container:
  - $18 \times 275\ \mathrm{GeV}$ $e + p$ collisions, $0 < Q^2 < 1\ \mathrm{GeV}^2$
  - $3.1M$ events
- Run at Ohio Supercomputing Center (OSC) to use local computing resources
- Required Diffraction A or B or HardDiffraction A or B
  - All events are HardDiffraction on B - photon on proton

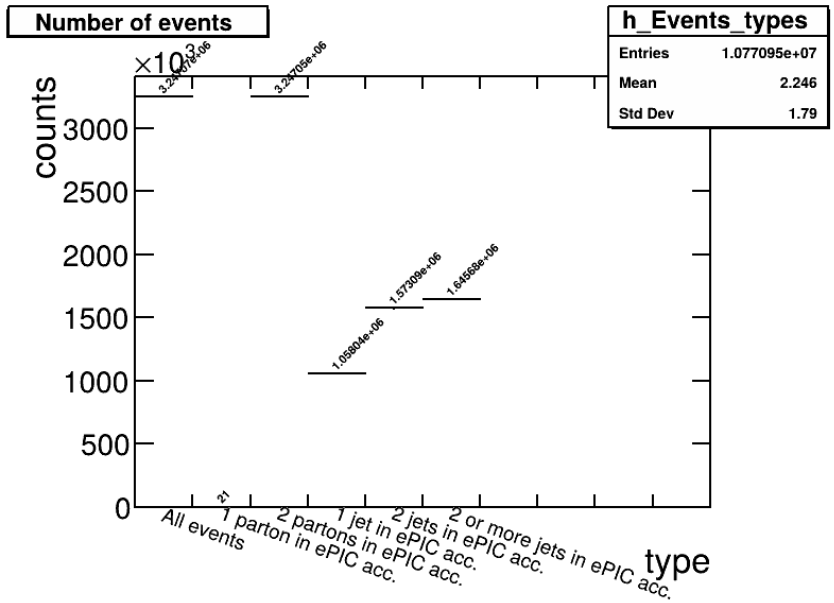
Listing: Simulation settings

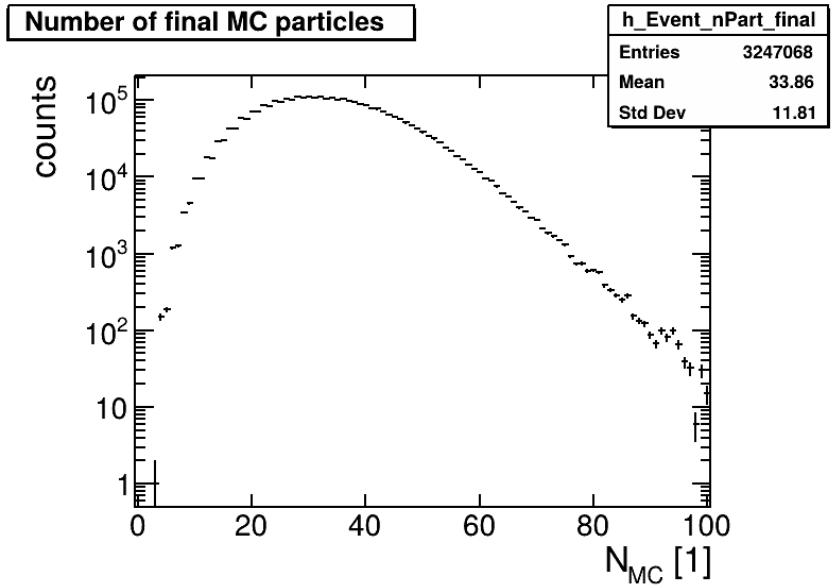
```
pythia8->ReadString("Beams:frameType=2");
pythia8->ReadString("Beams:idA=2212");
pythia8->ReadString("Beams:idB=11");
pythia8->ReadString("275.");
pythia8->ReadString("18.");
  //according to main342 for H1 dijets
pythia8->ReadString("PDF:lepton2gamma = on"); // Allow for photon-from lepton
pythia8->ReadString("Photon:ProcessType = 0"); // Allow all photon processes
pythia8->ReadString("Photon:Q2max = 1."); // Maximal Q2
pythia8->ReadString("HardQCD:all = on"); // All dijet MEs
pythia8->ReadString("PhotonParton:all = on"); // All dijet MEs with photons
pythia8->ReadString("PhaseSpace:pThatMin = 4."); // Minimal pT cut
pythia8->ReadString("MultipartonInteractions:pT0Ref = 3."); // Tuned ep value

// Setup of diffractive framework.
pythia8->ReadString("Diffraction:doHard = on");
pythia8->ReadString("Diffraction:sampleType = 1"); // 'PDF' sample
pythia8->ReadString("Diffraction:hardDiffSide = 2"); // Diff. on photon side
pythia8->ReadString("SigmaDiffractive:PomFlux = 7"); // H1 Fit B LO
pythia8->ReadString("PDF:PomSet = 6"); // H1 Fit B LO
```

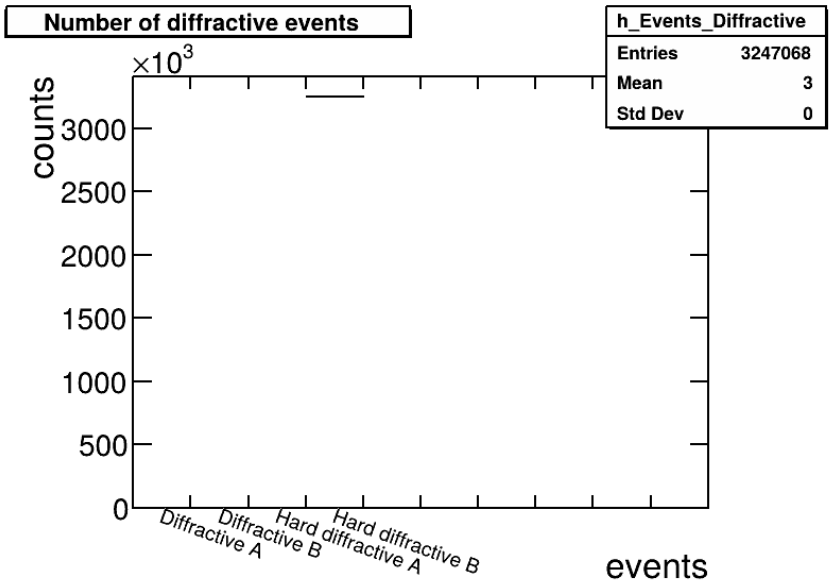
Events

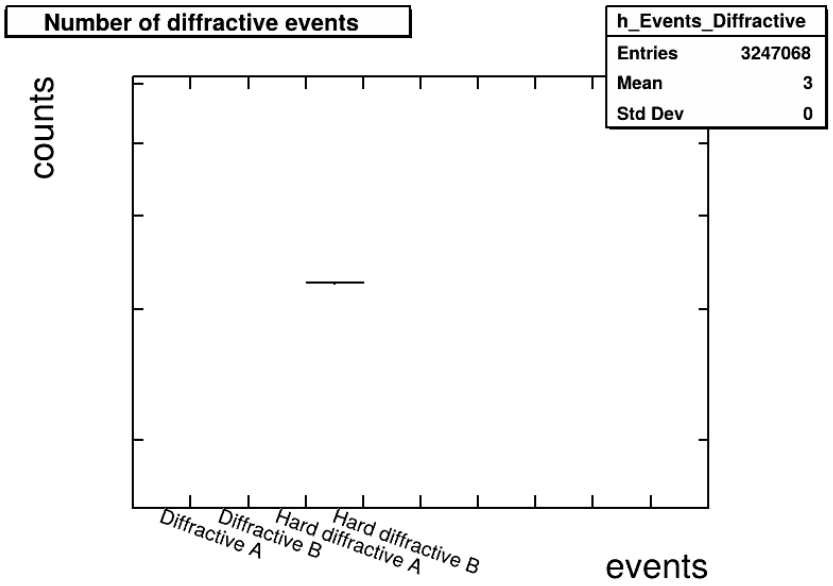






- First look at diffractive dijet events
- 33 final state particles on average

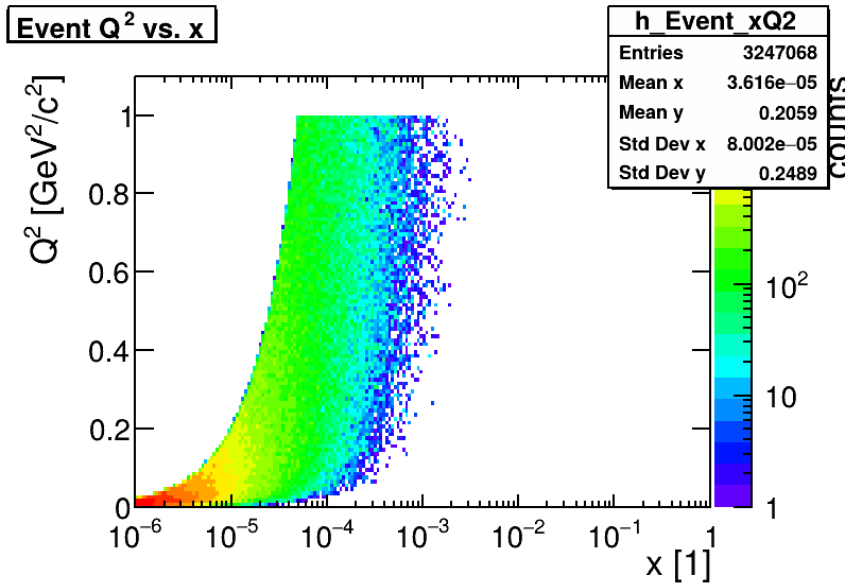




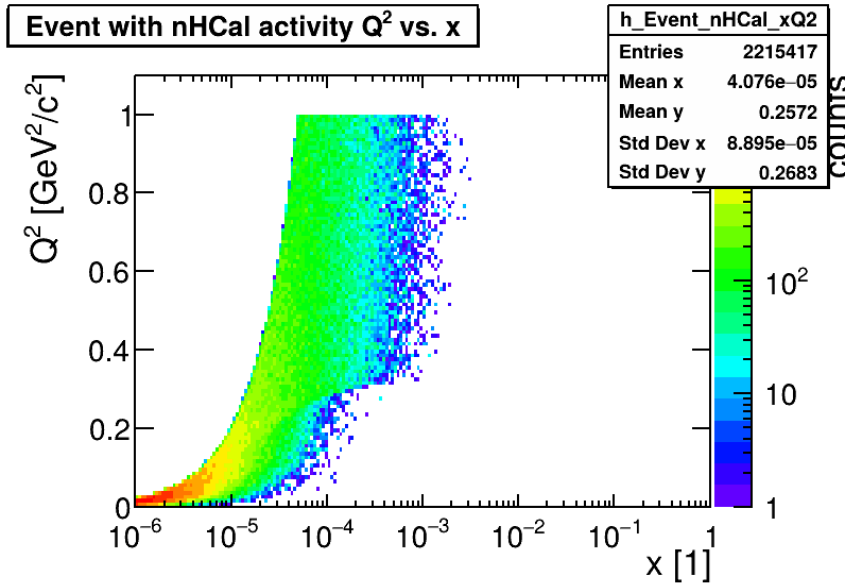
- All events are HardDiffraction on B - photon on proton

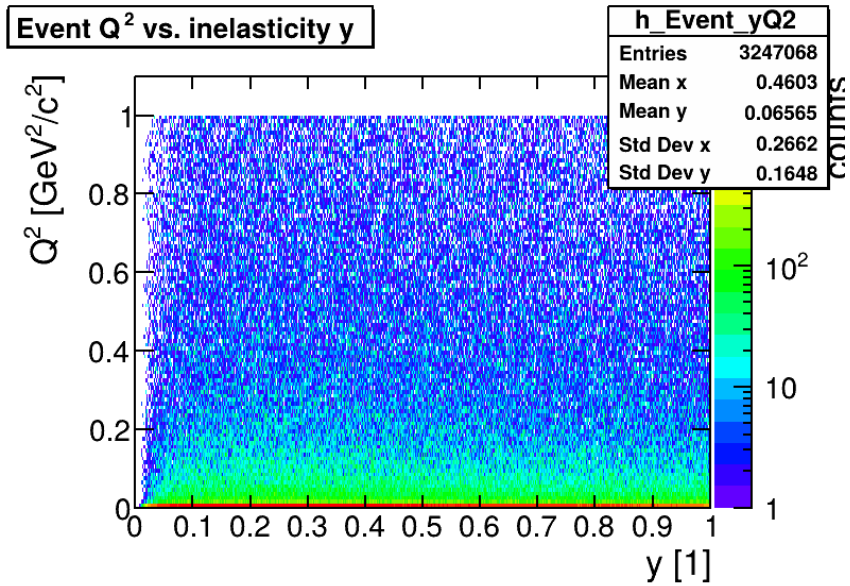
Event kinematics

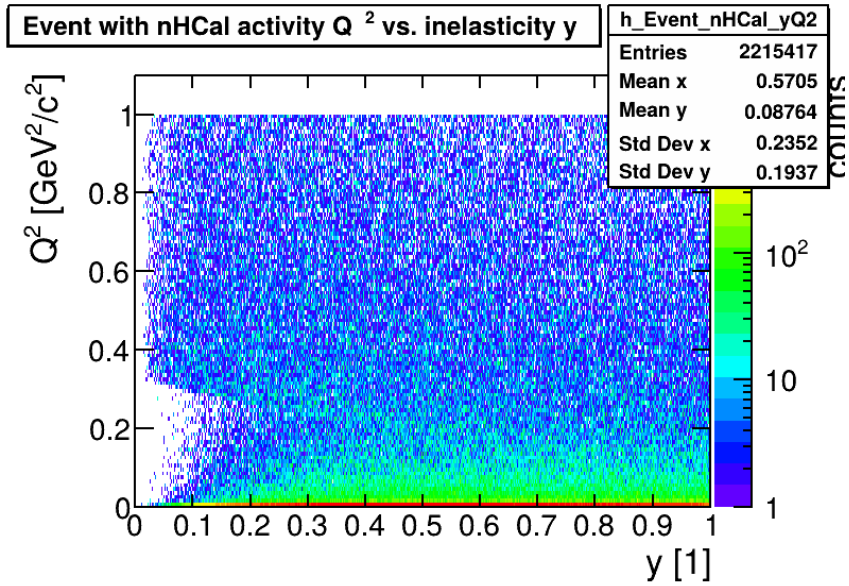
All events



With activity in nHCal



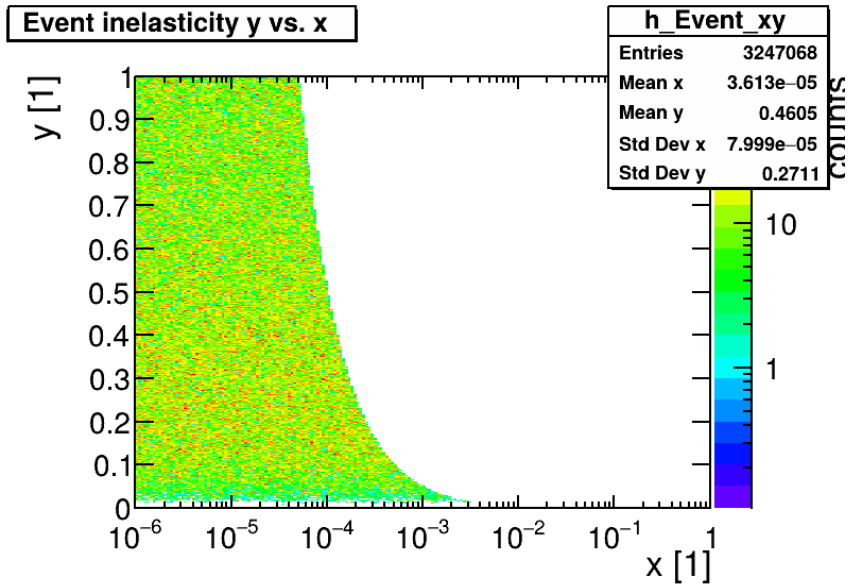




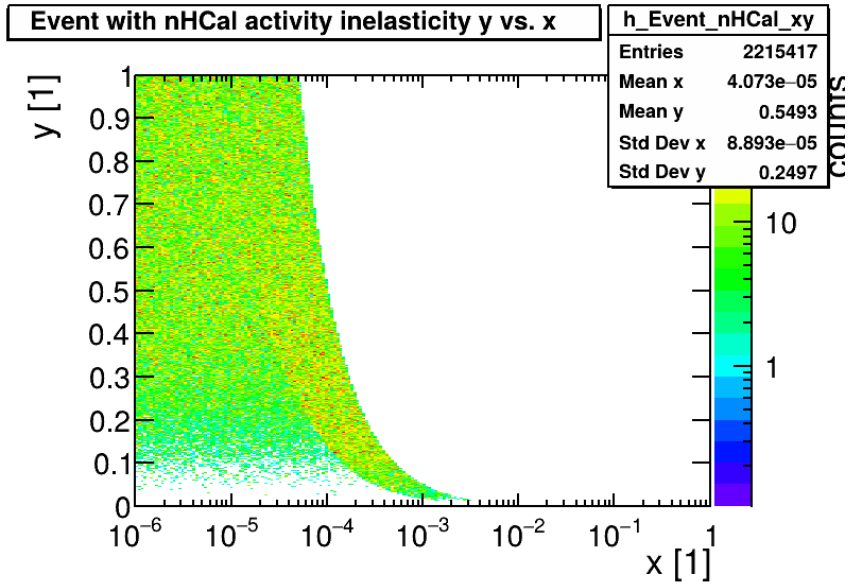
- 2.1M out of 3.1M (68%) events with activity in nHCal
- First look at diffractive dijet events

Event kinematics

All events

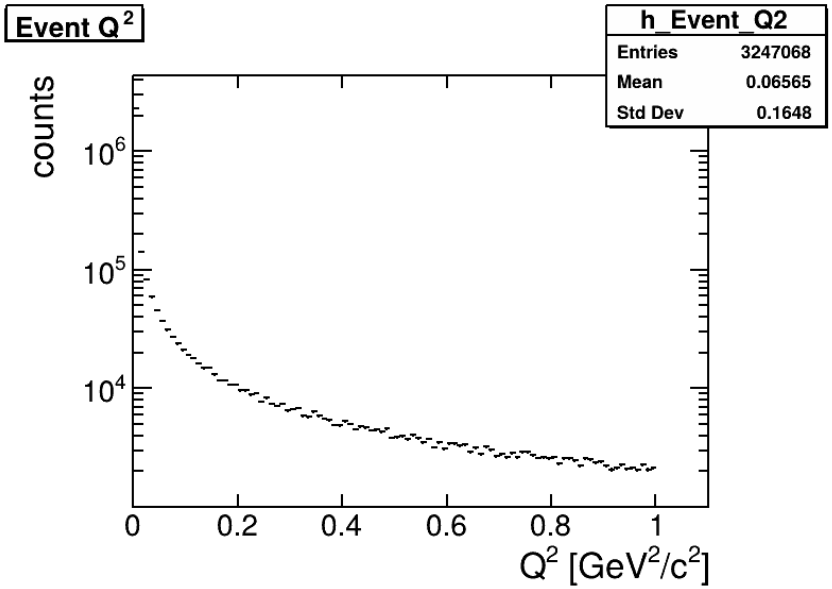


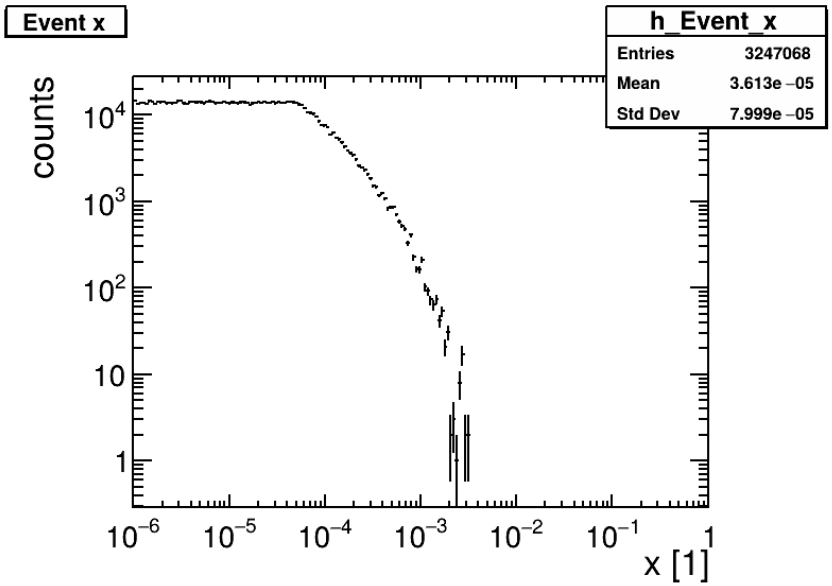
With activity in nHCal

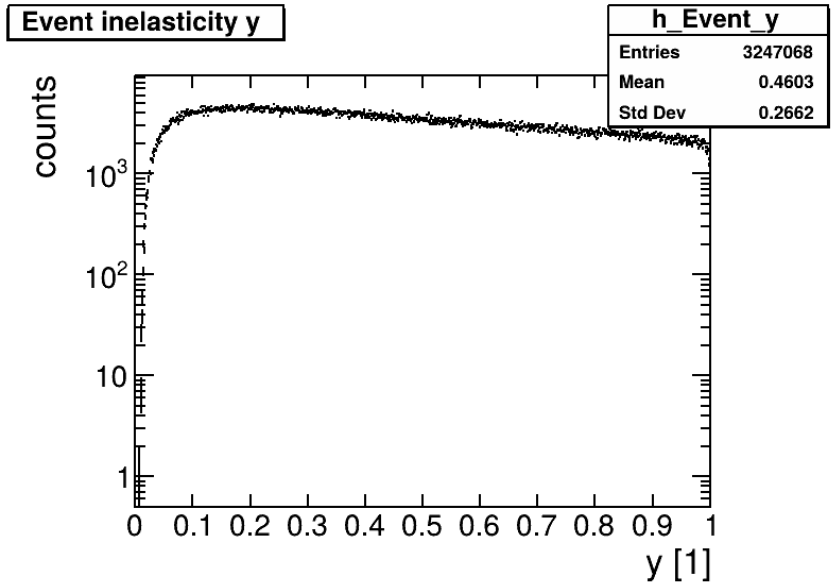


- $3.2M$ out of $4.7M$ (68%) events with activity in nHCal
- Includes scattered electron
- First look at diffractive dijet events

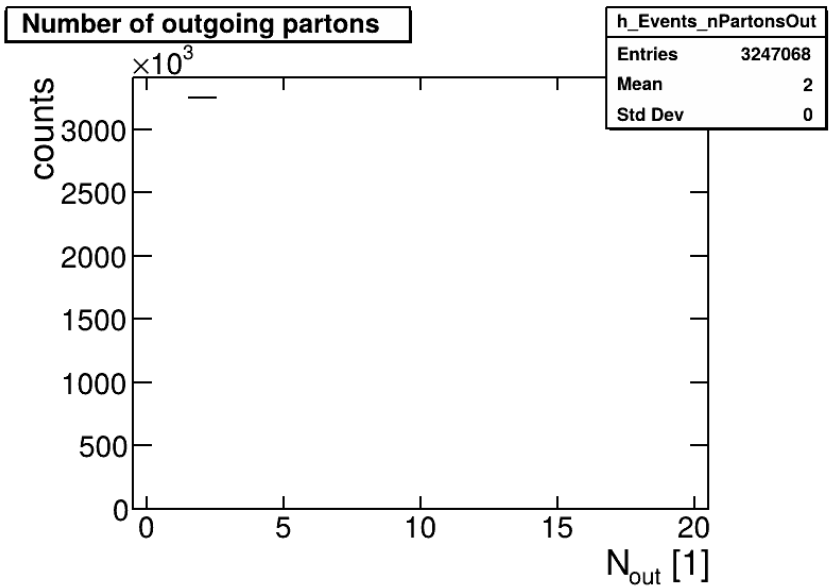
All events kinematics

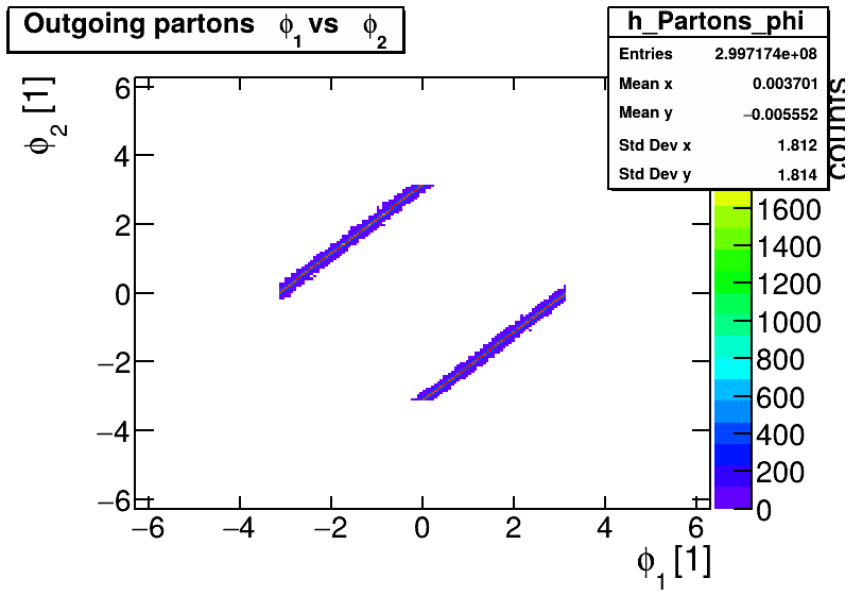






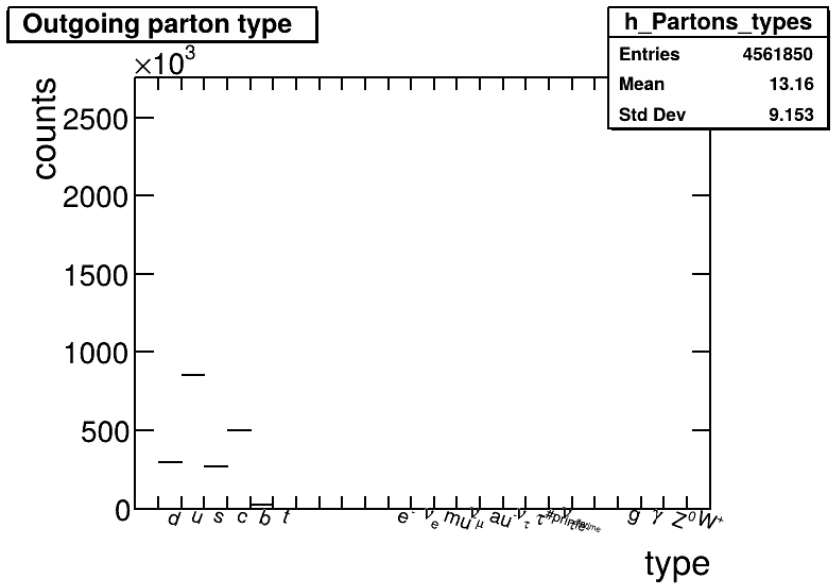
- All events



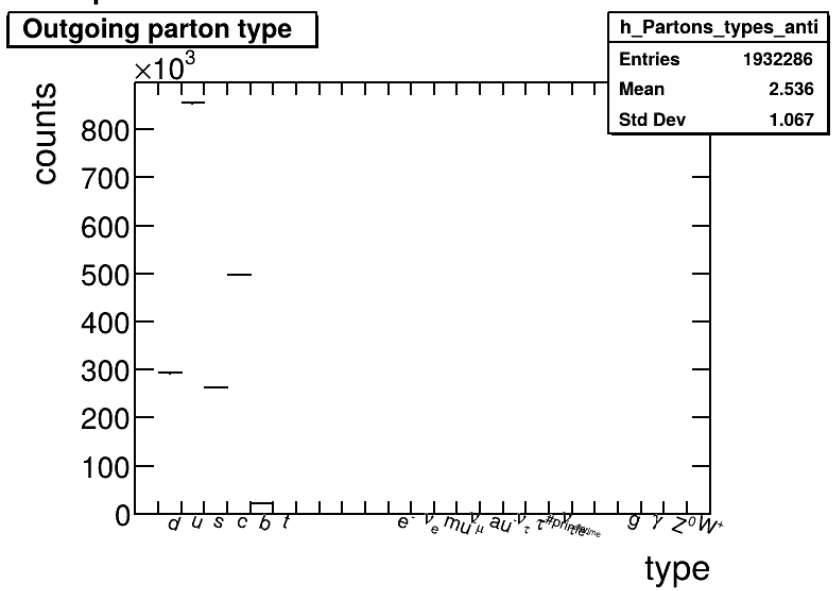


- First look at outgoing partons ($status = 23, 24$)

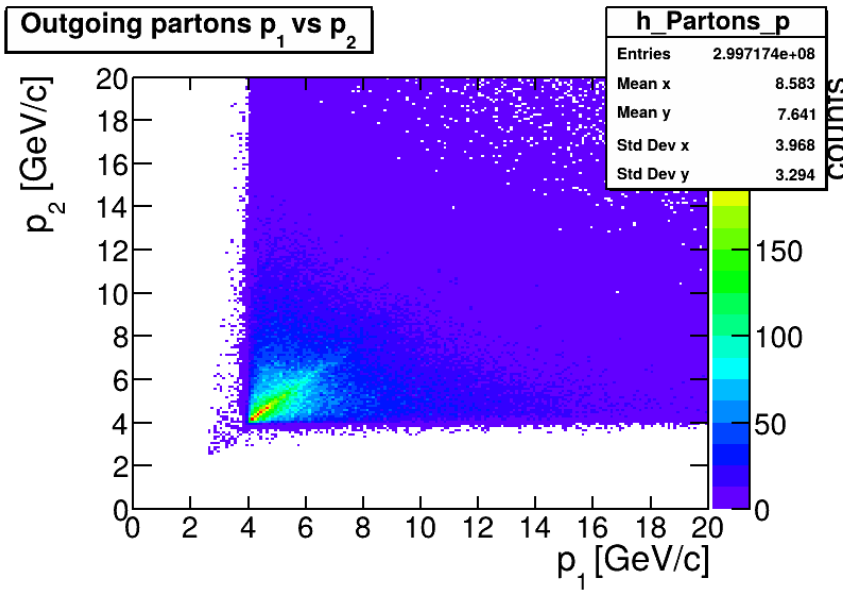
partons

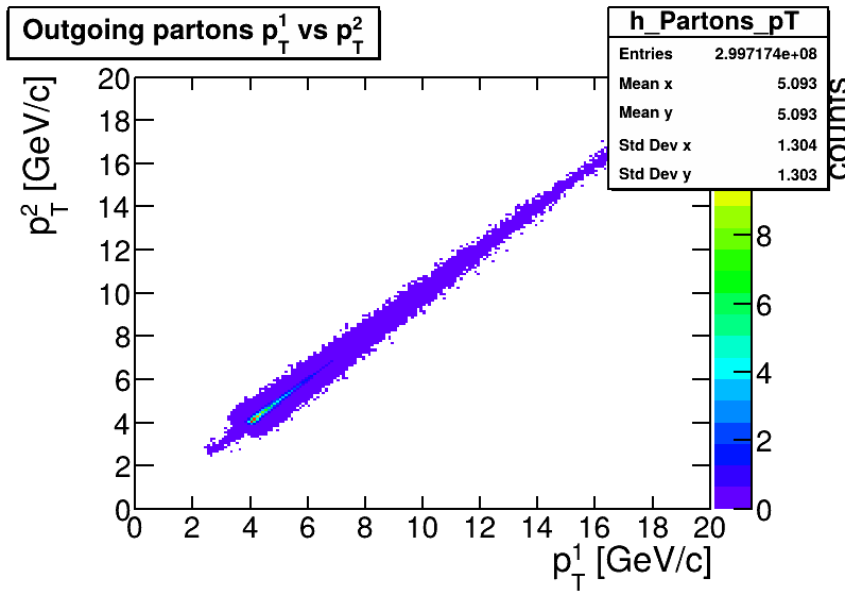


anti-partons



- First look at outgoing partons ($status = 23, 24$)





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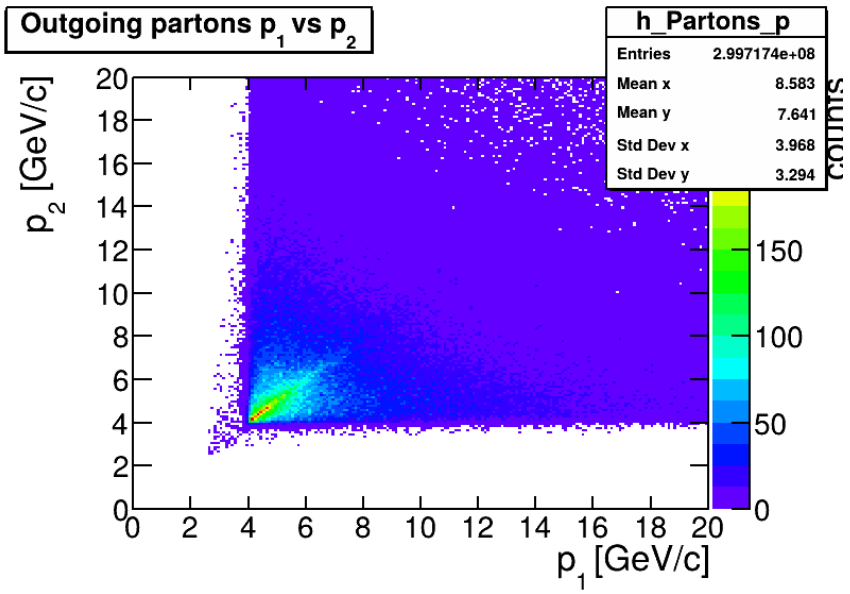

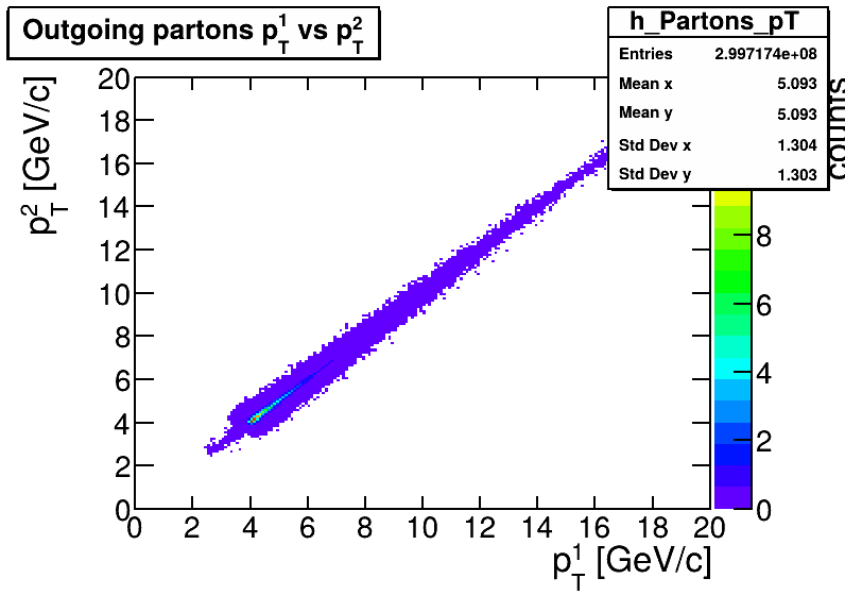

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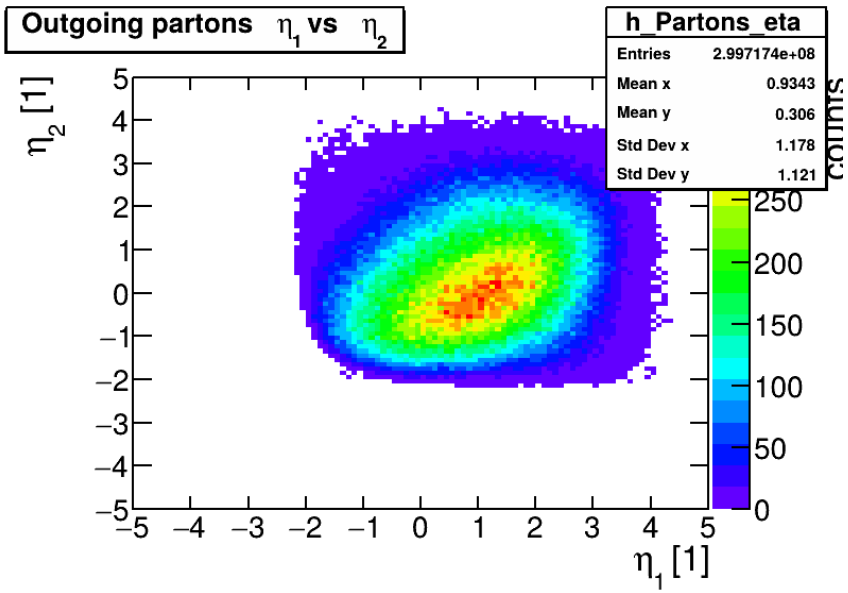

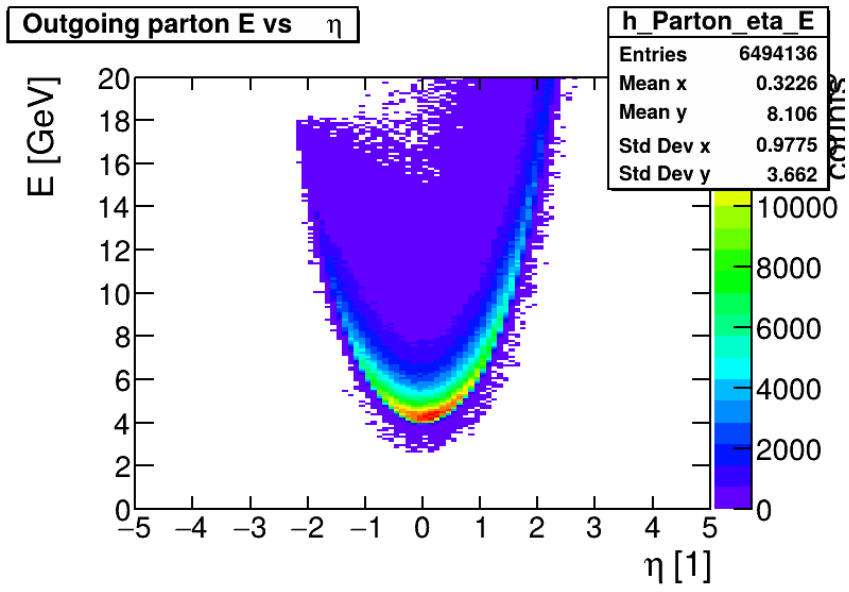

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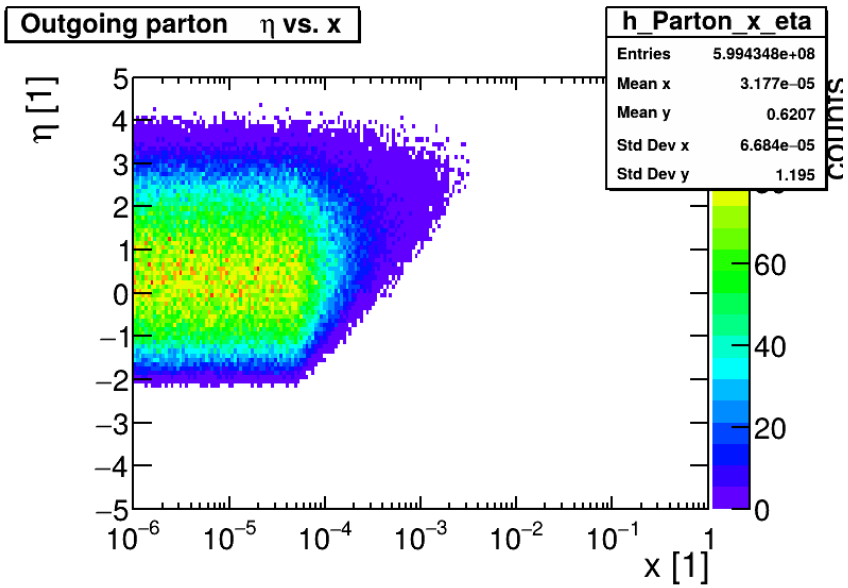

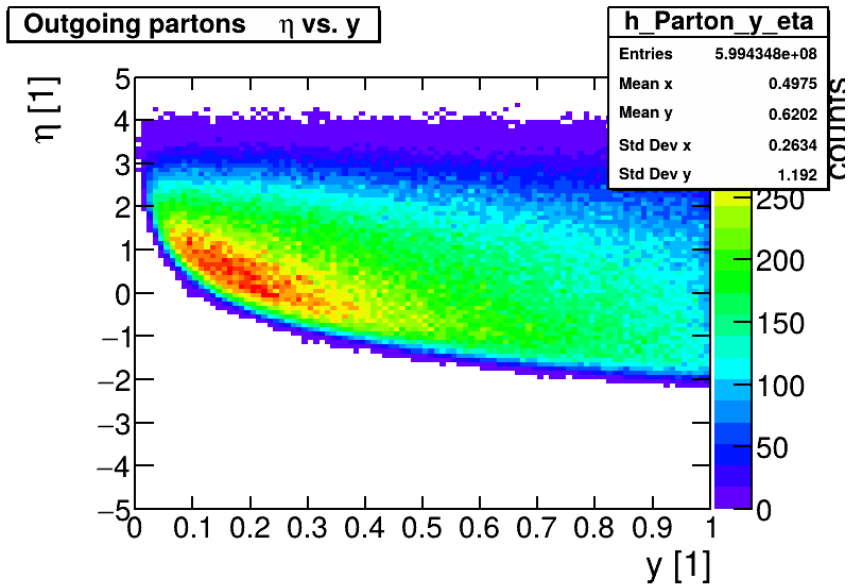

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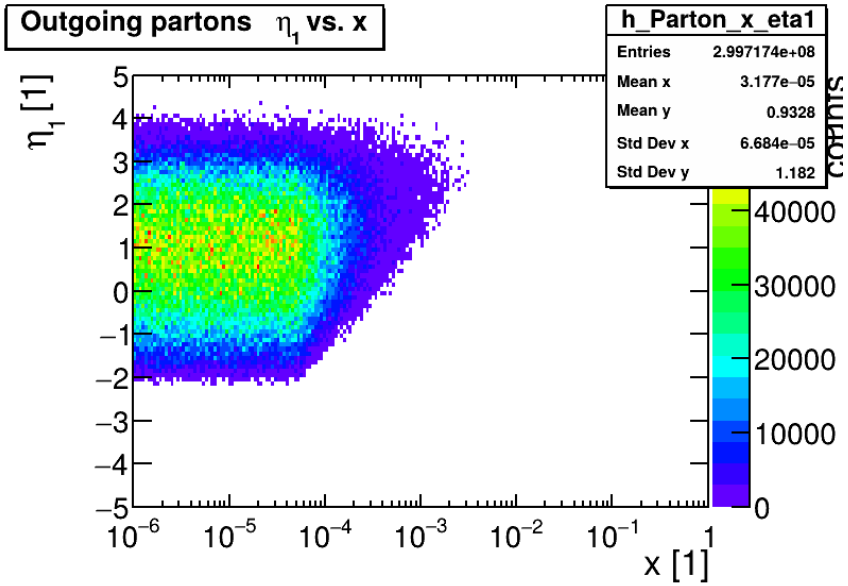
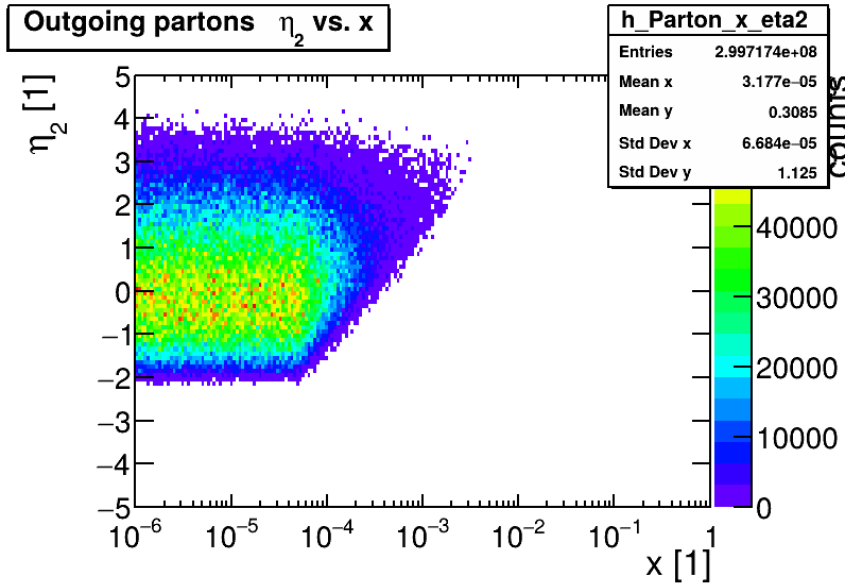
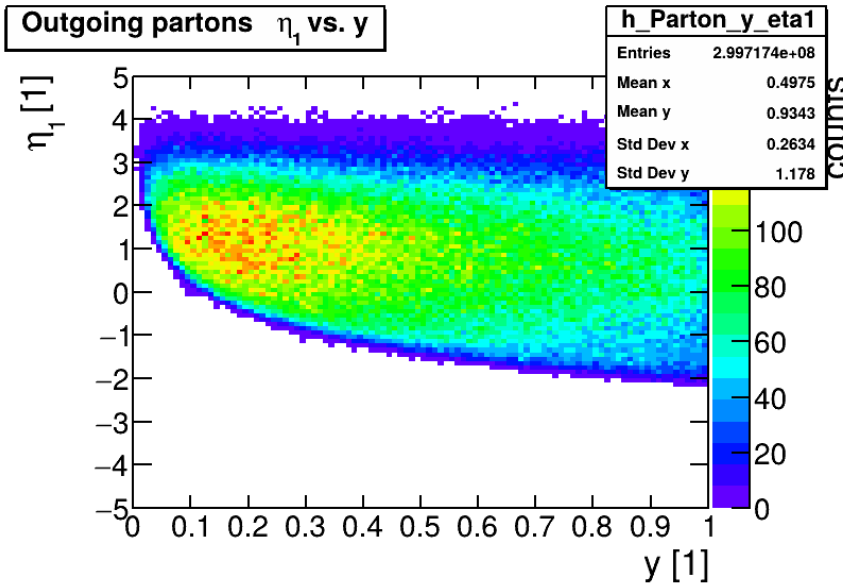
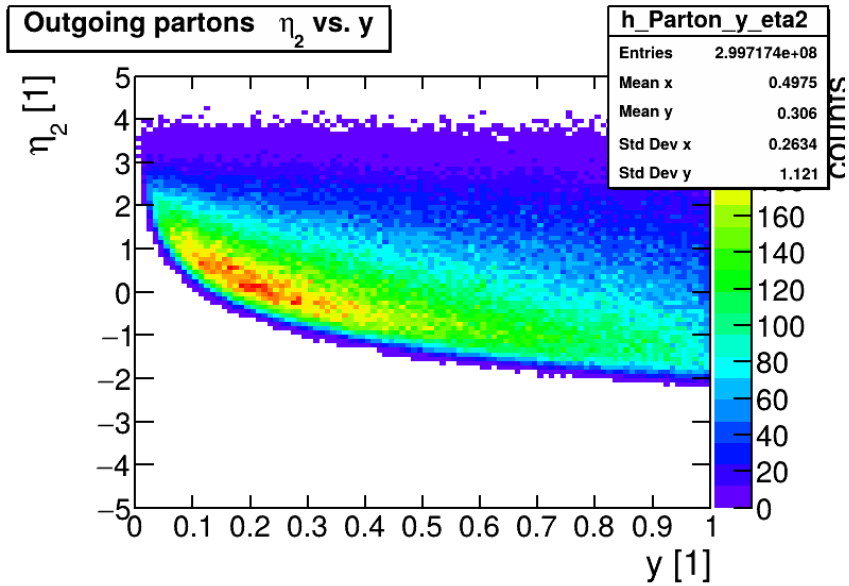
Partons



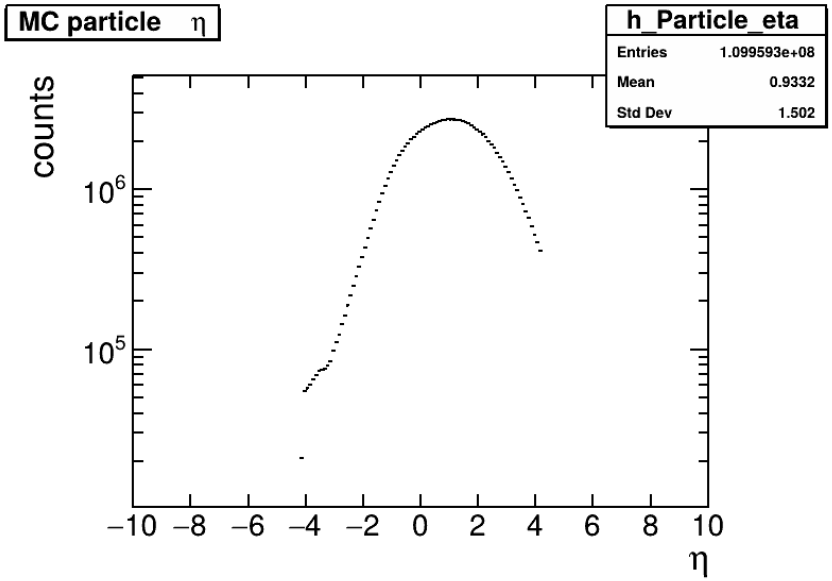


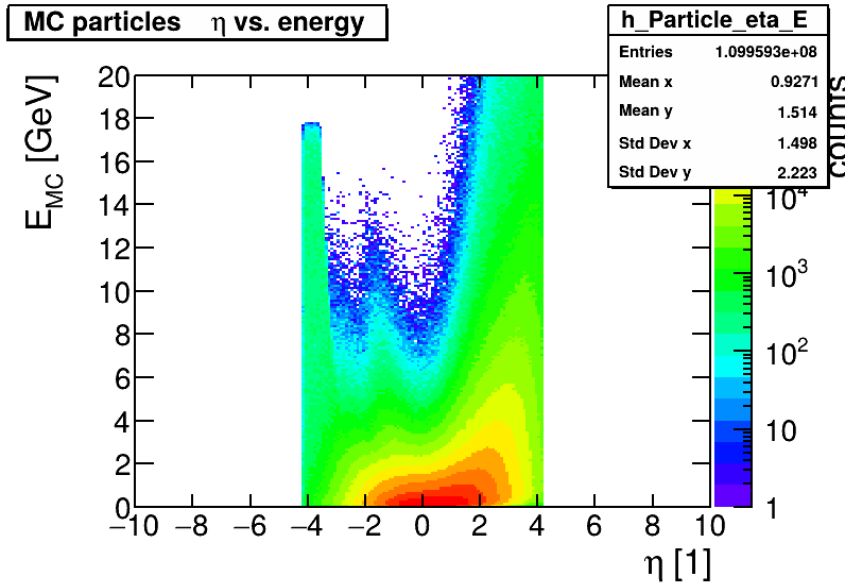


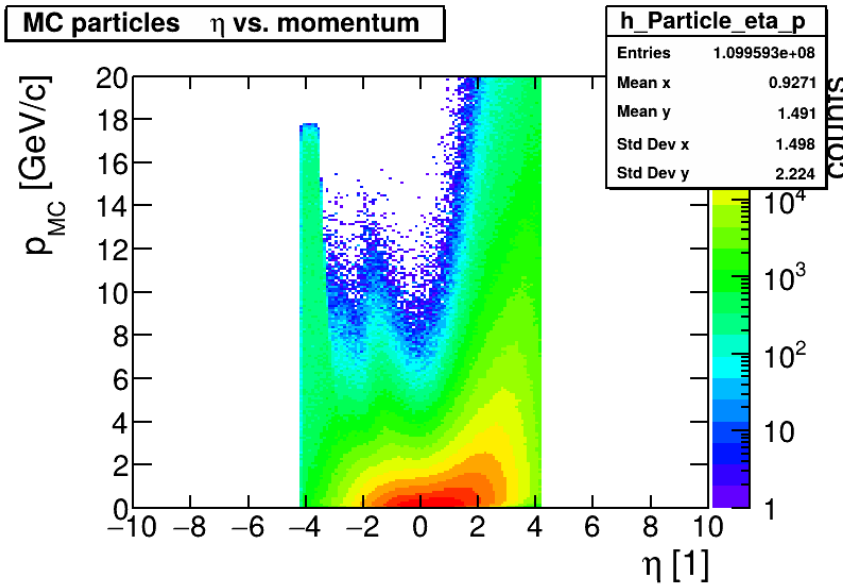


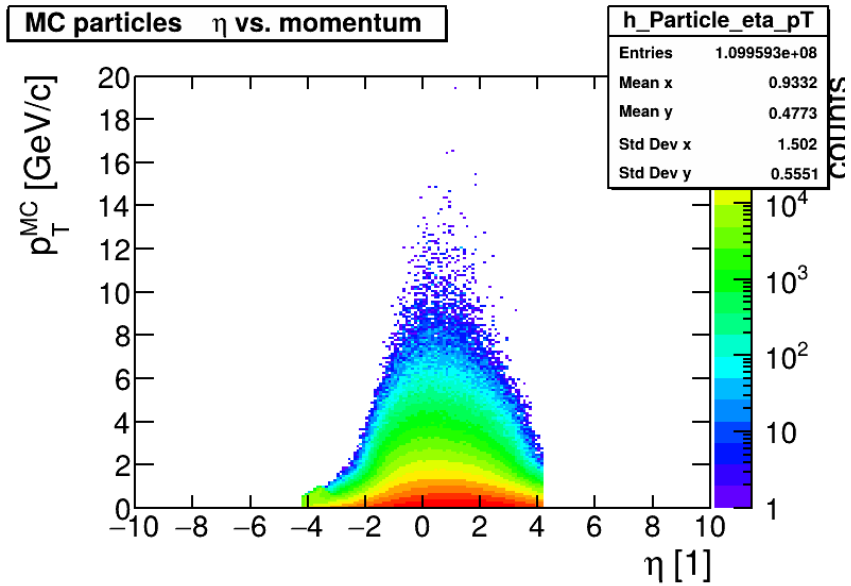
- First look at outgoing partons ($status = 23, 24$)

Particles


MC particle η
h_Particle_eta
Entries 1.099593e+08
Mean 0.9332
Std Dev 1.502
counts
η


MC particles η vs. energy
h_Particle_eta_E
Entries 1.099593e+08
Mean x 0.9271
Mean y 1.514
Std Dev x 1.498
Std Dev y 2.223
E_MC [GeV]
η [1]
counts

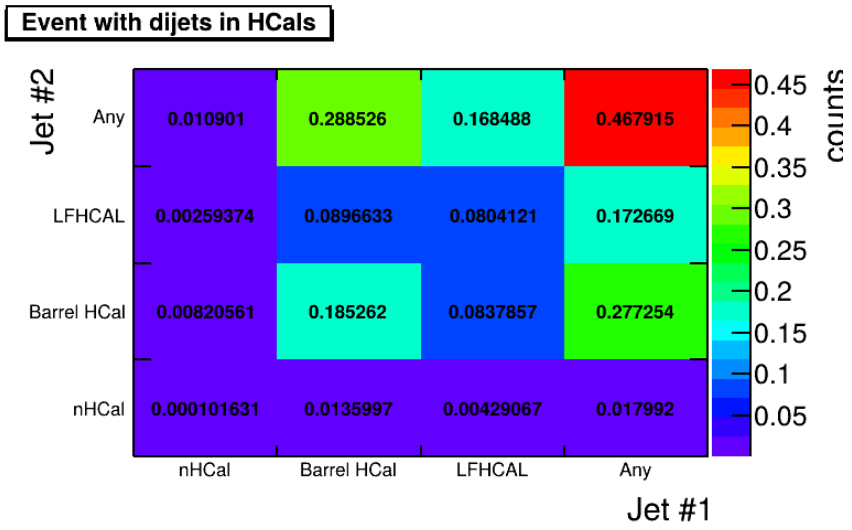

MC particles η vs. momentum
h_Particle_eta_p
Entries 1.099593e+08
Mean x 0.9271
Mean y 1.491
Std Dev x 1.498
Std Dev y 2.224
p_MC [GeV/c]
η [1]
counts

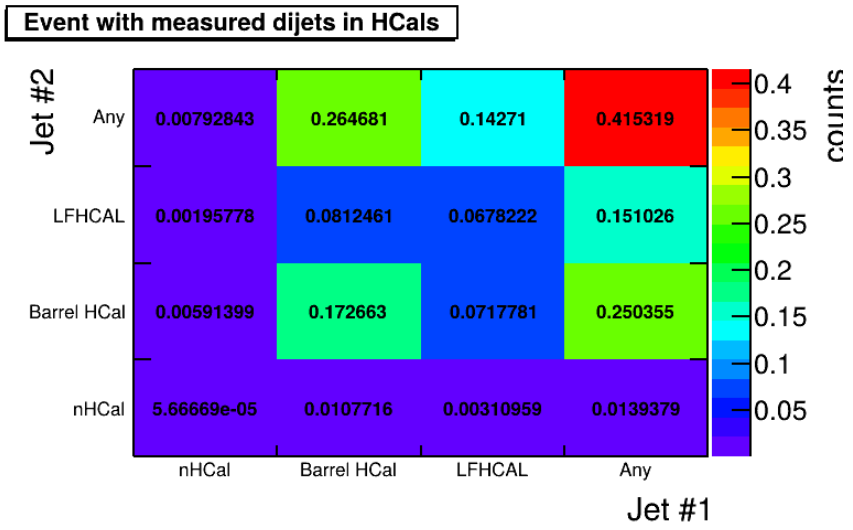

MC particles η vs. momentum
h_Particle_eta_pT
Entries 1.099593e+08
Mean x 0.9332
Mean y 0.4773
Std Dev x 1.502
Std Dev y 0.5551
p_T^MC [GeV/c]
η [1]
counts

Jet clustering

- Final state particles
- Beam particles excluded!
- Anti-k_T algorithm seems to work well, IR and collinear safe
  -
  - $d_{ij} = \min(\frac{1}{p_{Ti}^2}, \frac{1}{p_{Tj}^2}) \frac{\Delta R_{ij}^2}{R^2}$
  - $d_{iB} = \frac{1}{p_{Ti}^2}$
- $R = 1$
- Jet $p_T > 4\,\mathrm{GeV}$
- Sorted jets vs. p_T

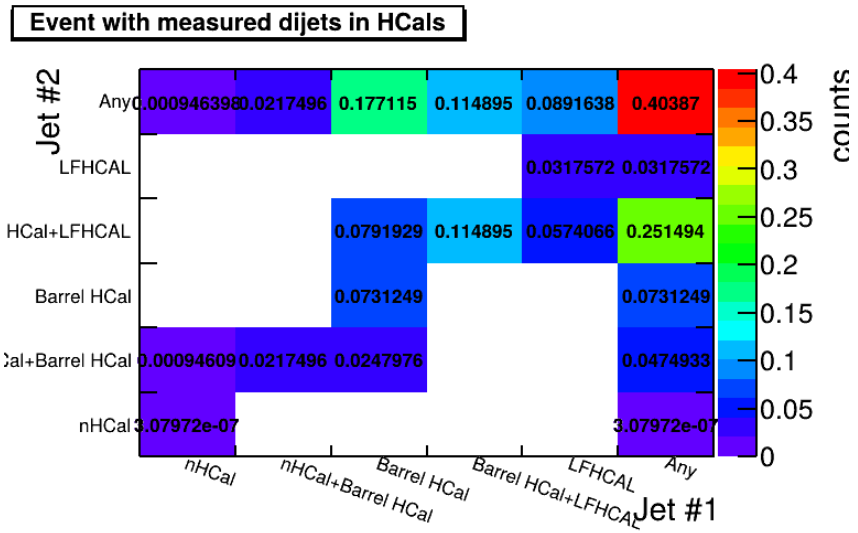
Acceptance

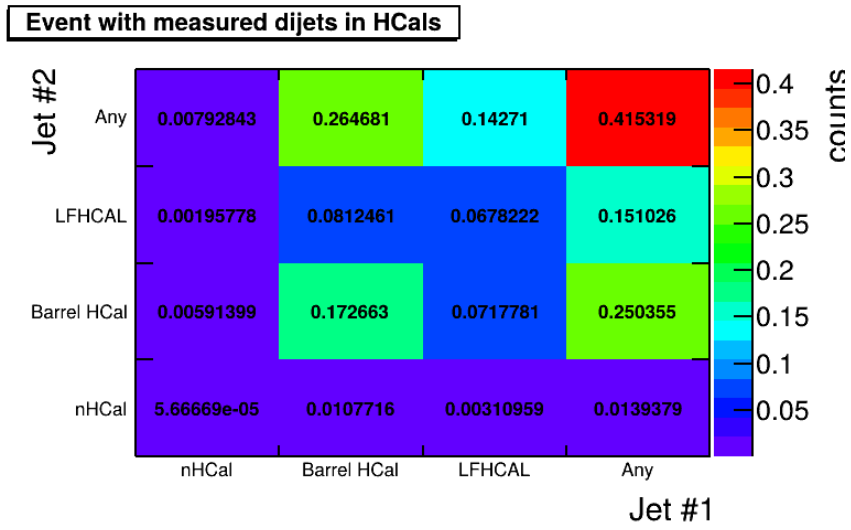




- Fractions of events with jets in HCals
- Fraction of events with 2 partons in ePIC acceptance

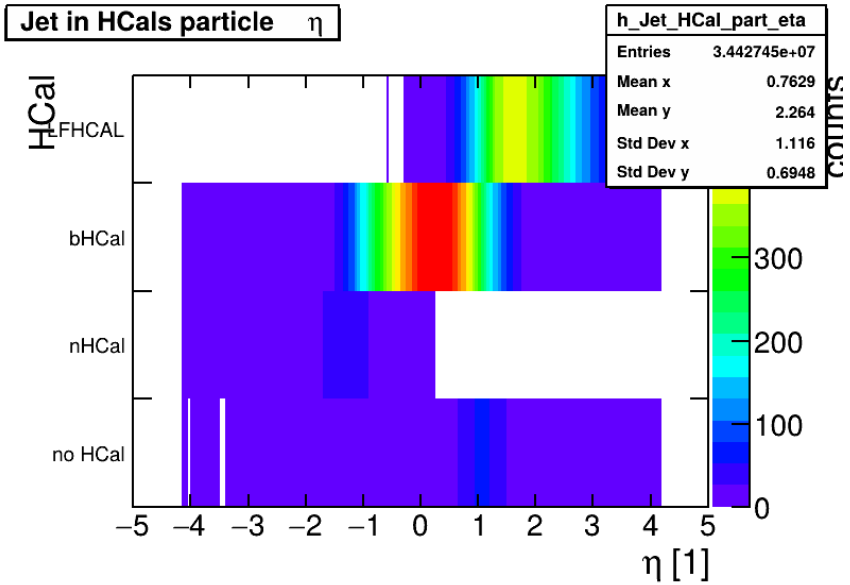
Acceptance

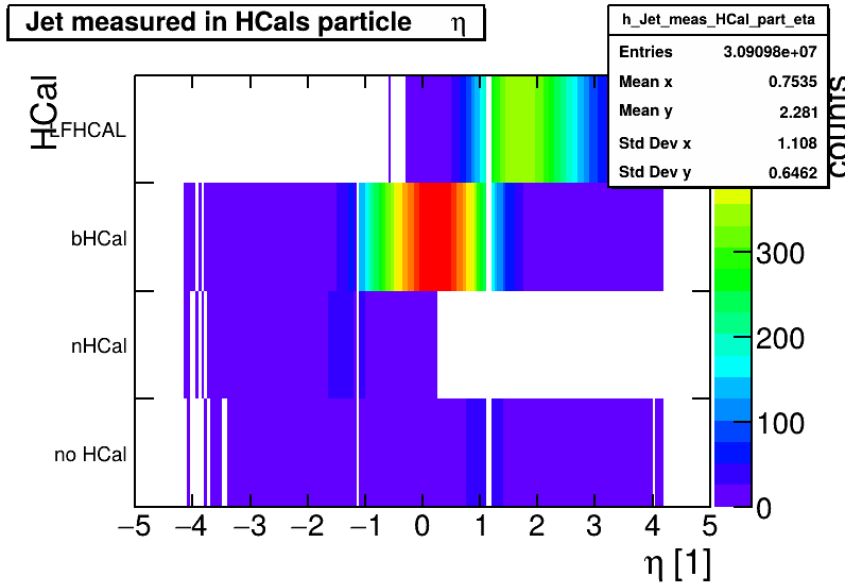


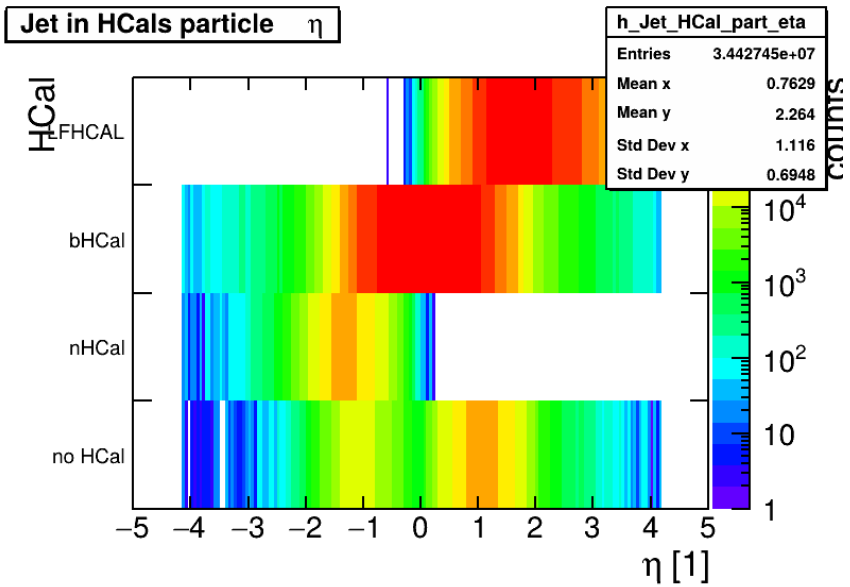


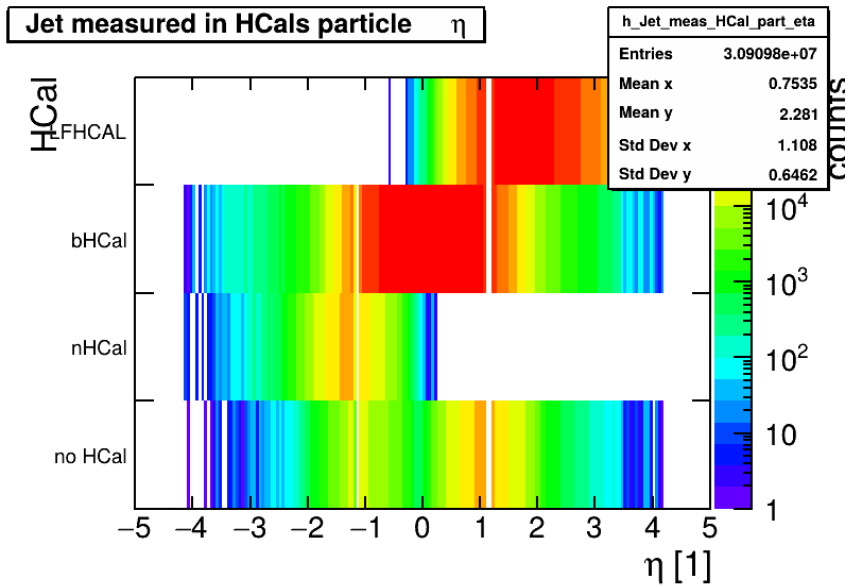
- Fractions of events with jets in HCals
- Fraction of events with 2 partons in ePIC acceptance

Jets in HCals vs. constituent η



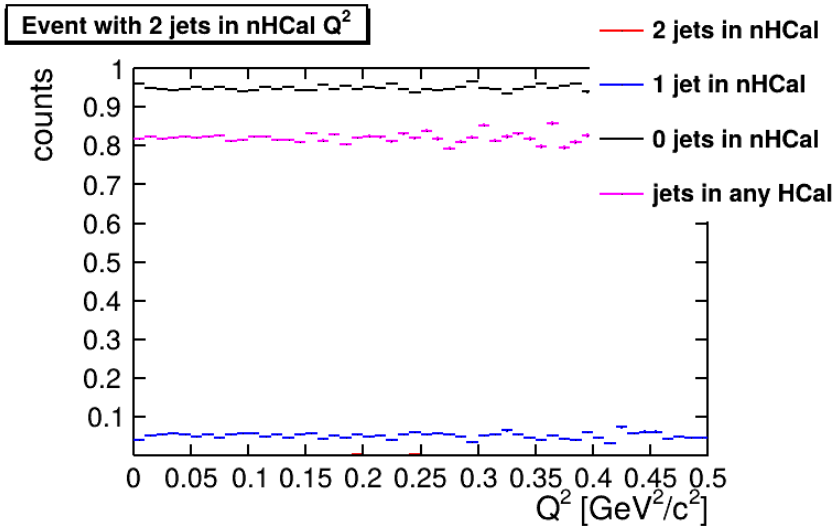


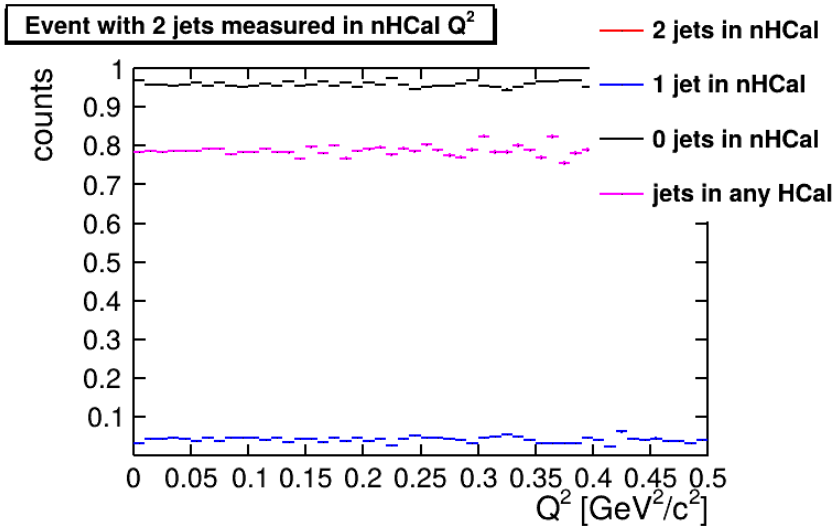


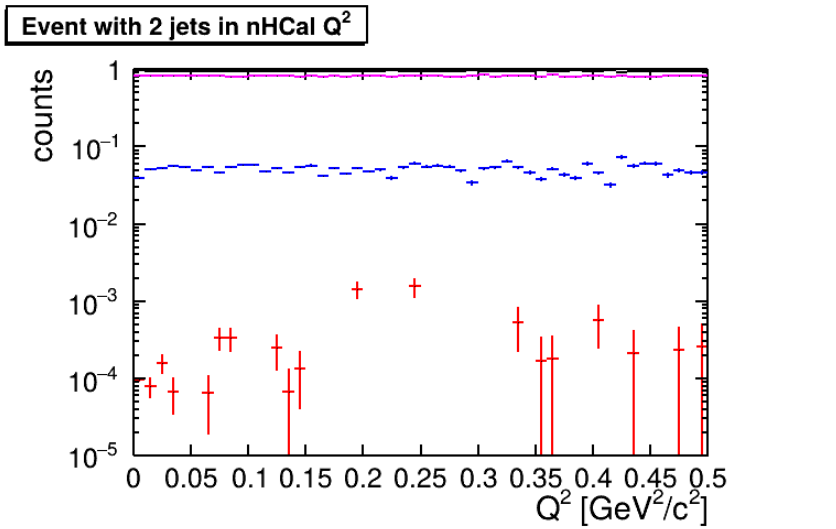


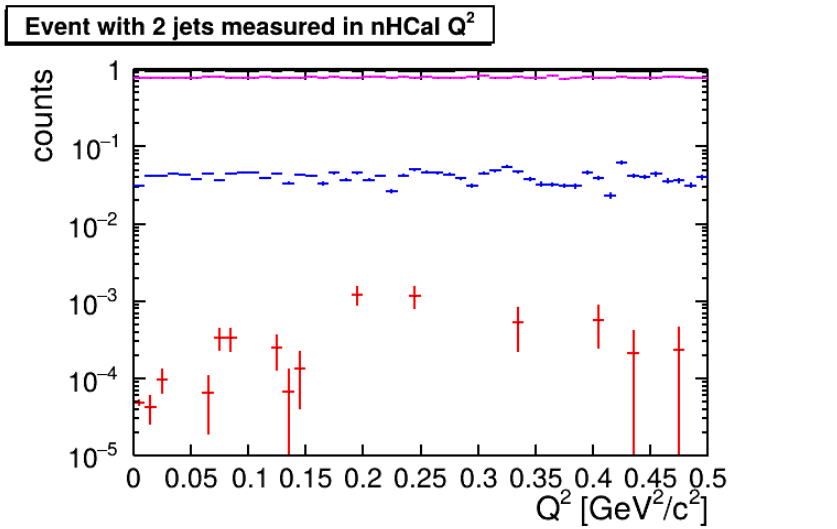
- η distributions for constituents of jets in HCals

Acceptance Q^2



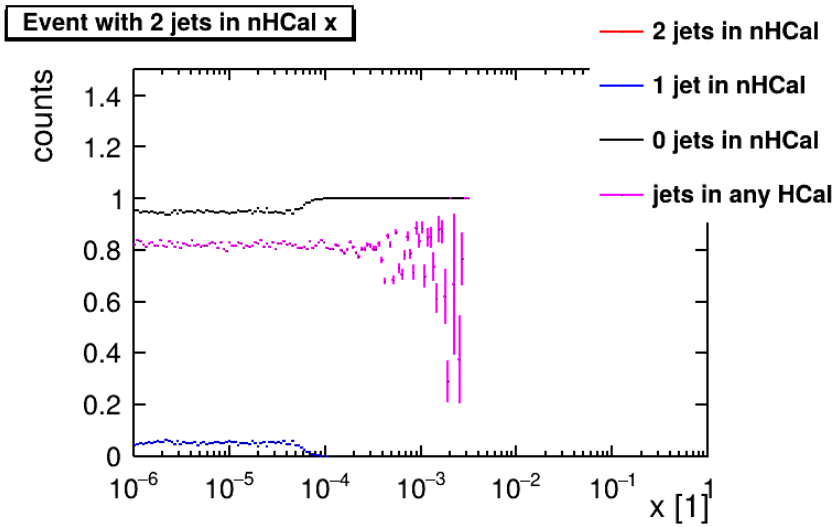


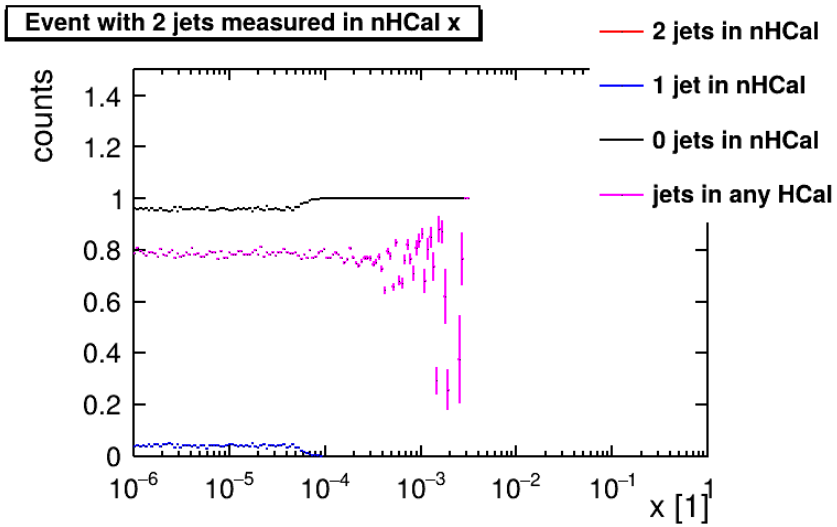


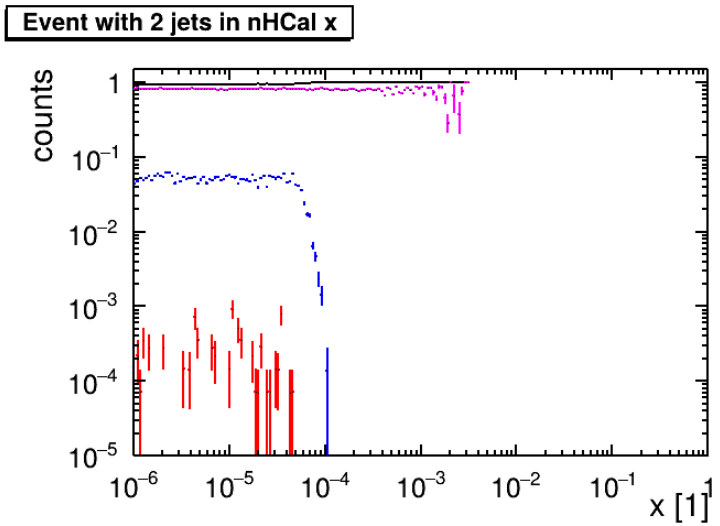


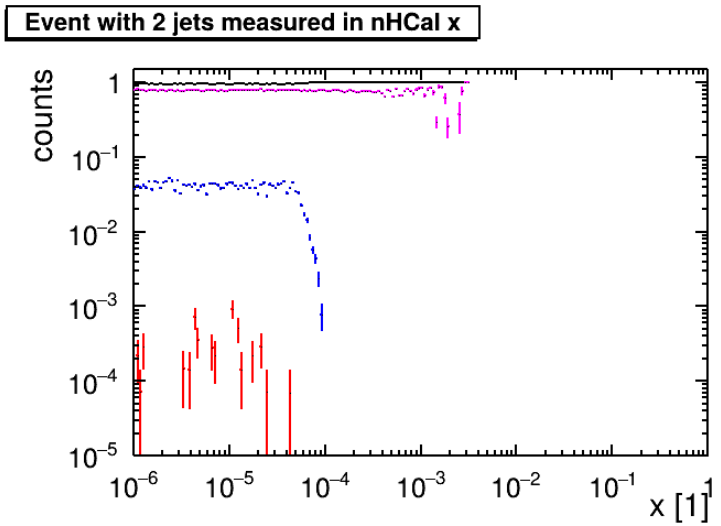
- Fractions of events with jets in HCals

Acceptance x



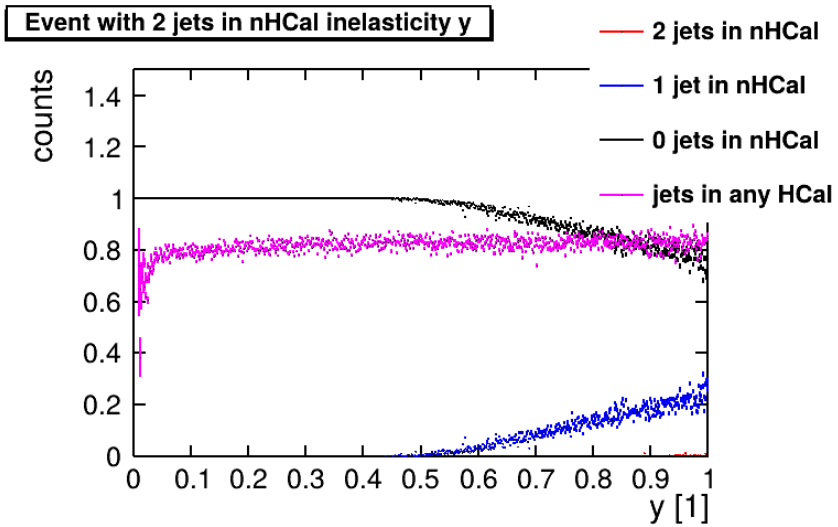


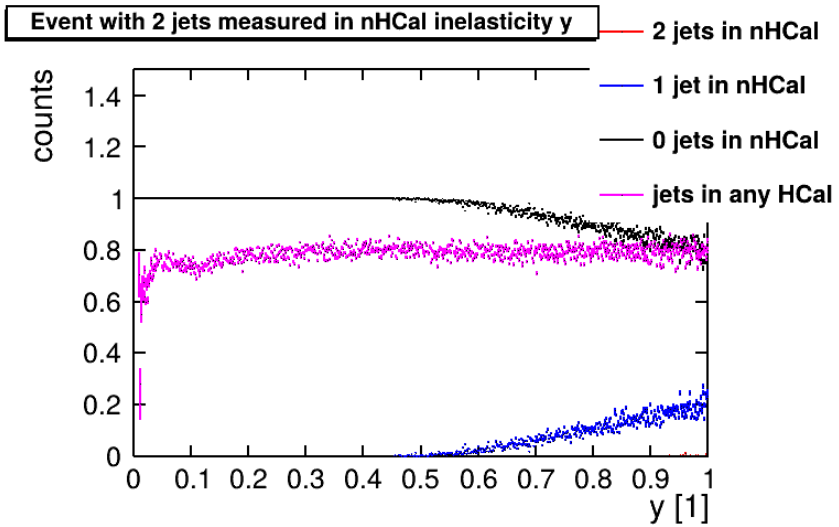


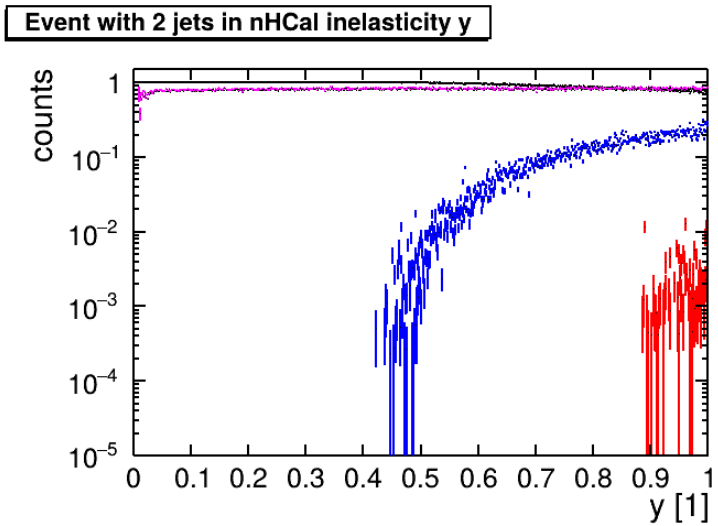


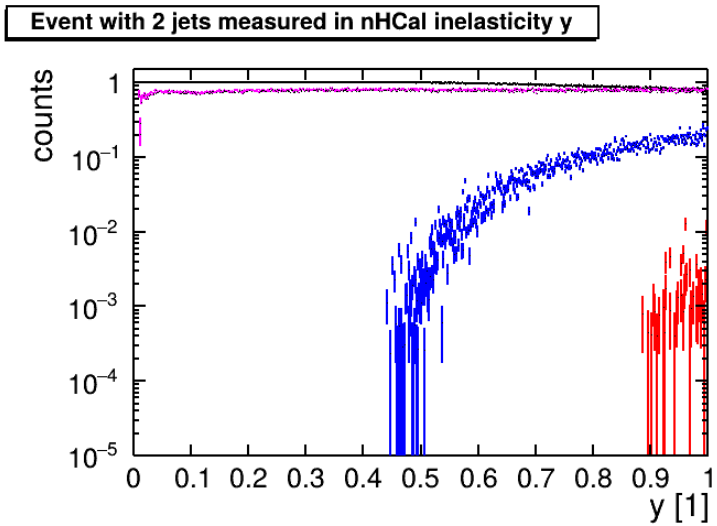
- Fractions of events with jets in HCals

Acceptance y





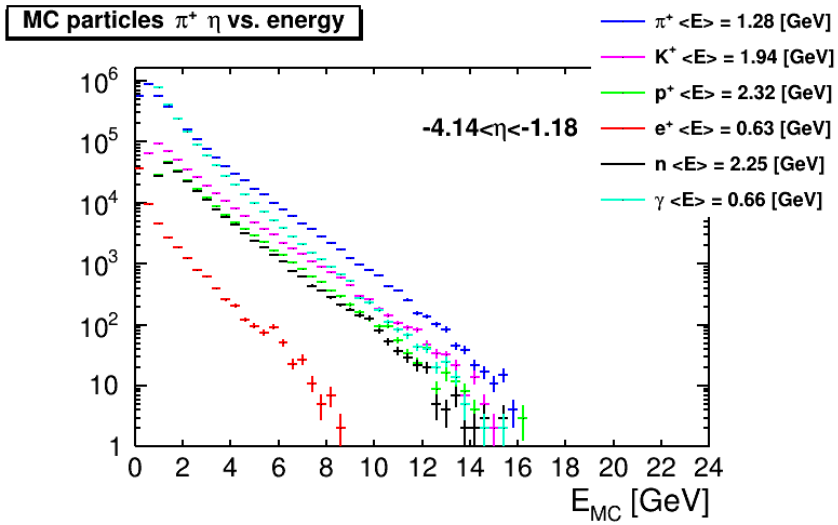




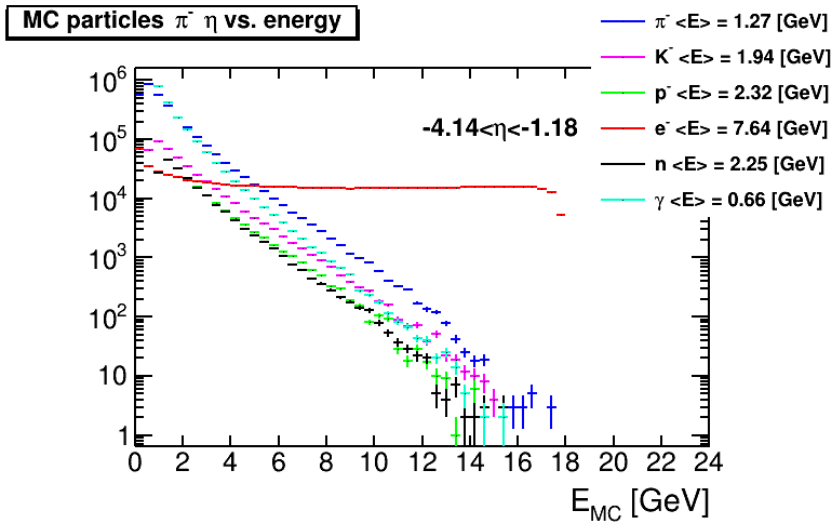
- Fractions of events with jets in HCals

Particle distributions in nHCal

positive charge

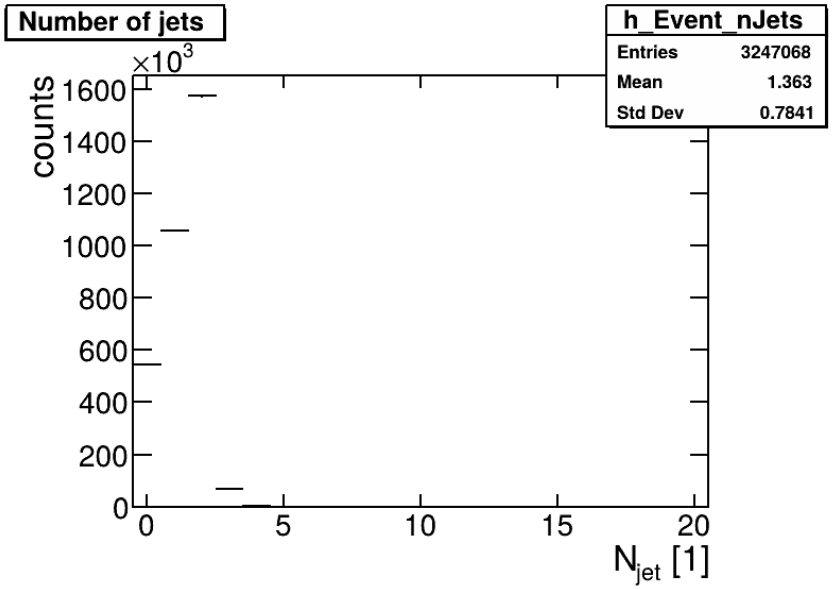


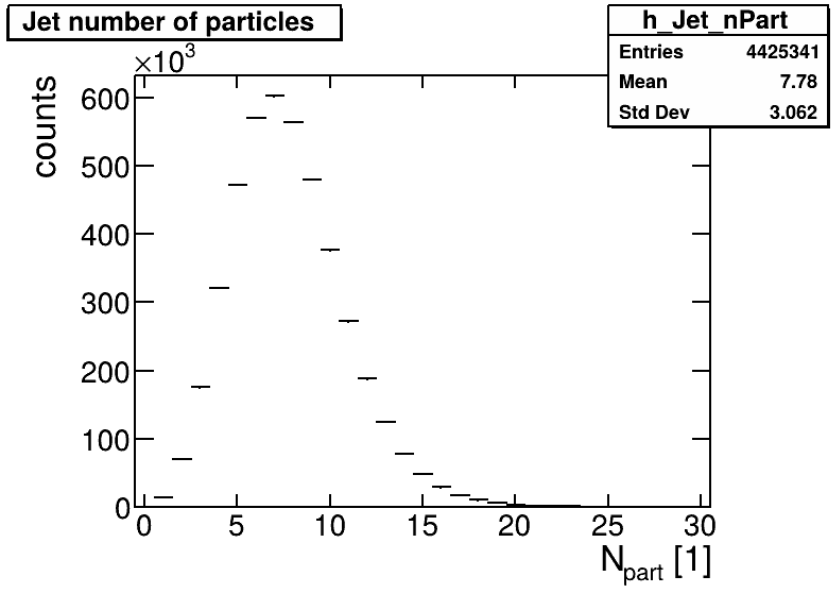
negative charge

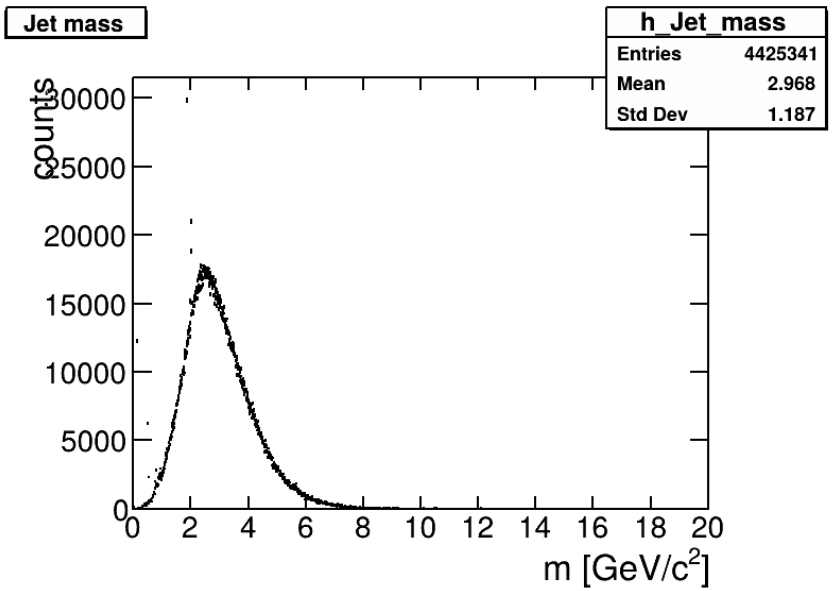


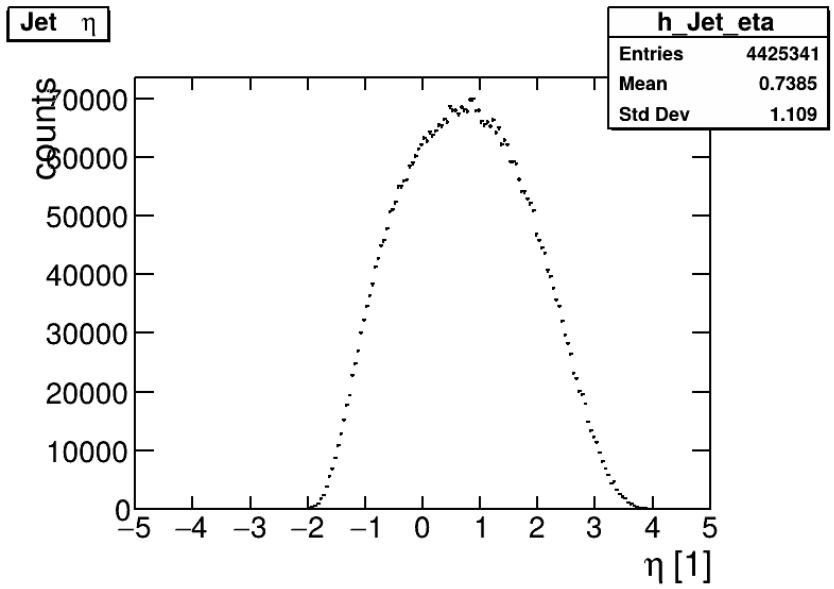
- Total energy distributions vs. η
  - Average neutron energy similar to inclusive events
- Kinetic energy is measured in nHCal

Jets

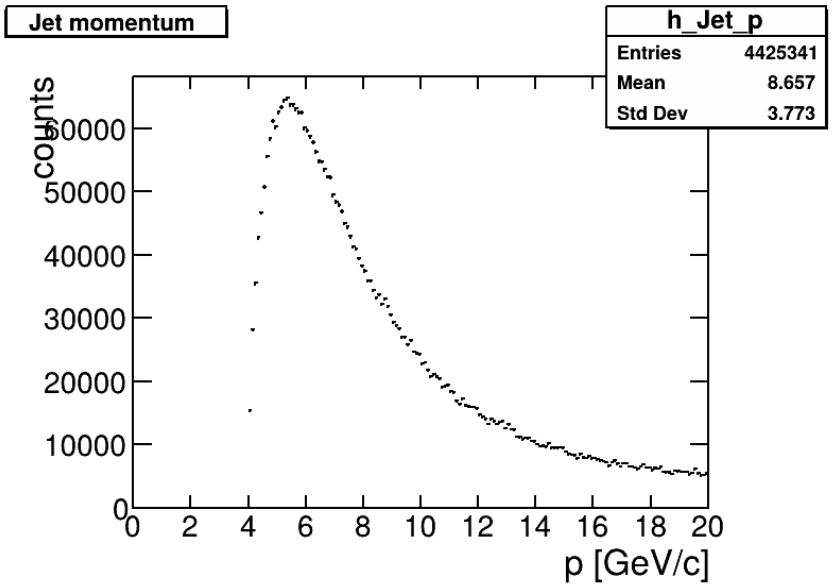


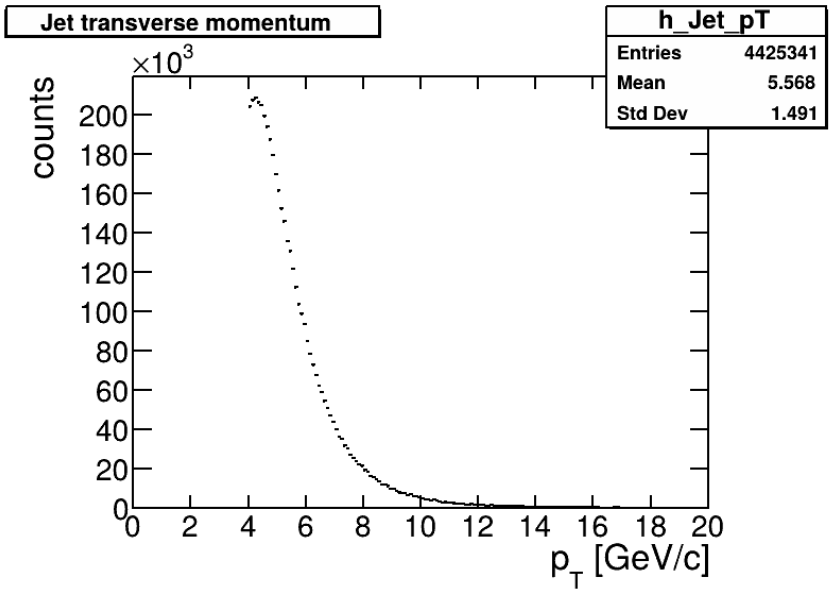




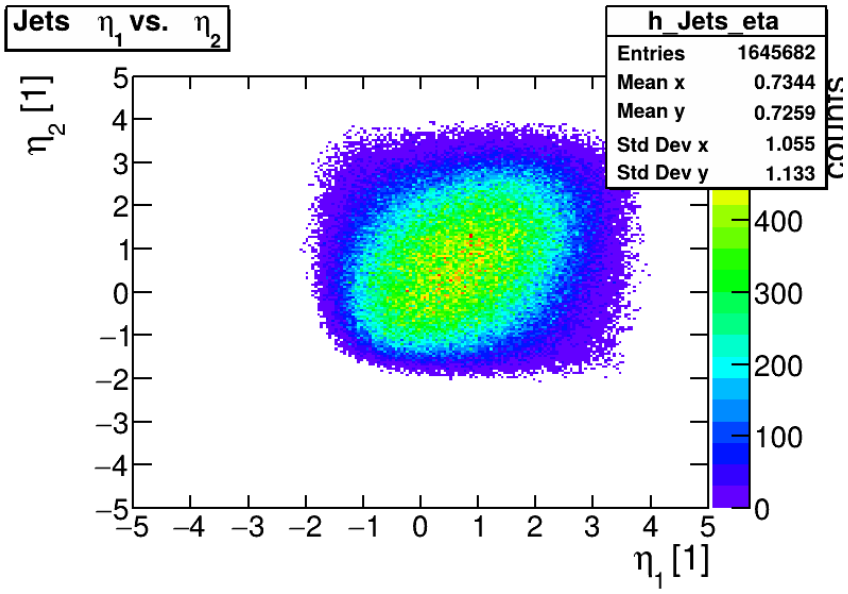


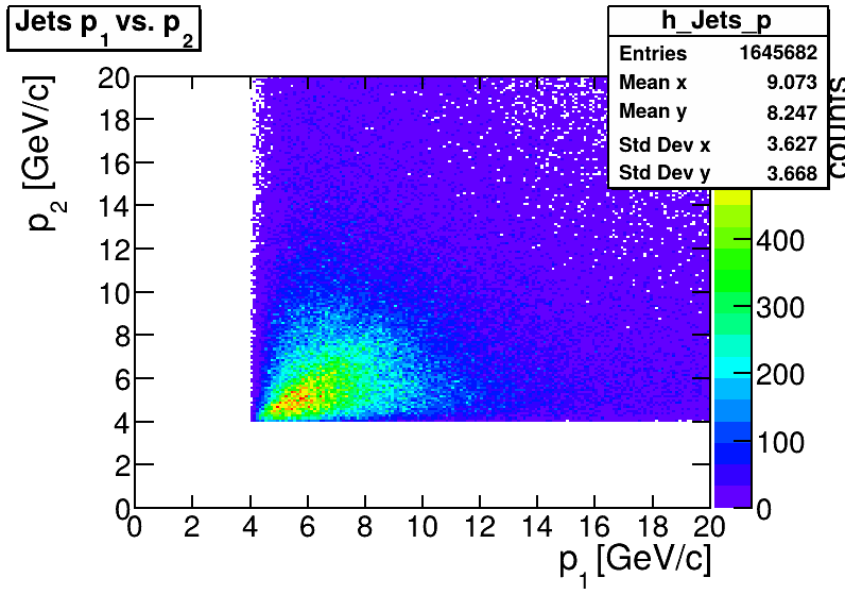
- All jets


Jet momentum
h_Jet_p
Entries 4425341
Mean 8.657
Std Dev 3.773
counts
p [GeV/c]

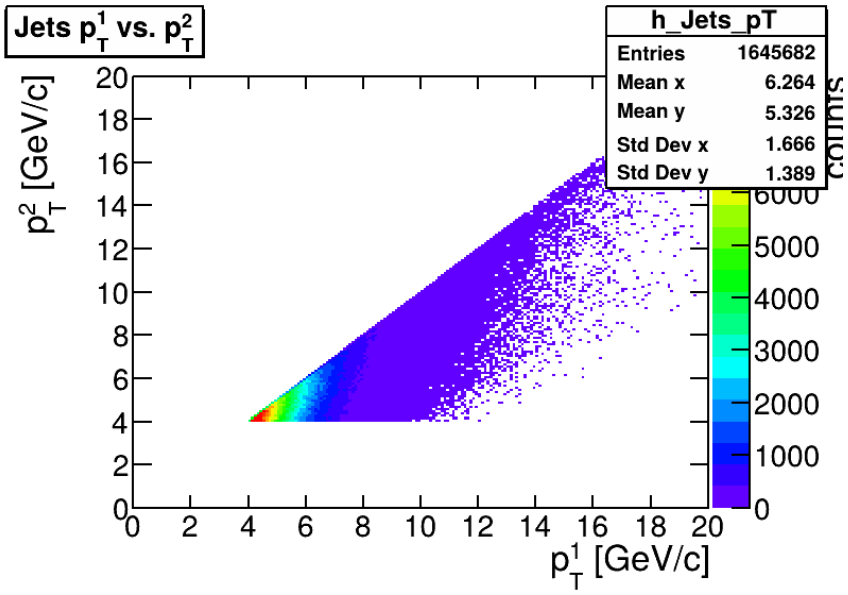

Jet transverse momentum
h_Jet_pT
Entries 4425341
Mean 5.568
Std Dev 1.491
×10^3
counts
p_T [GeV/c]

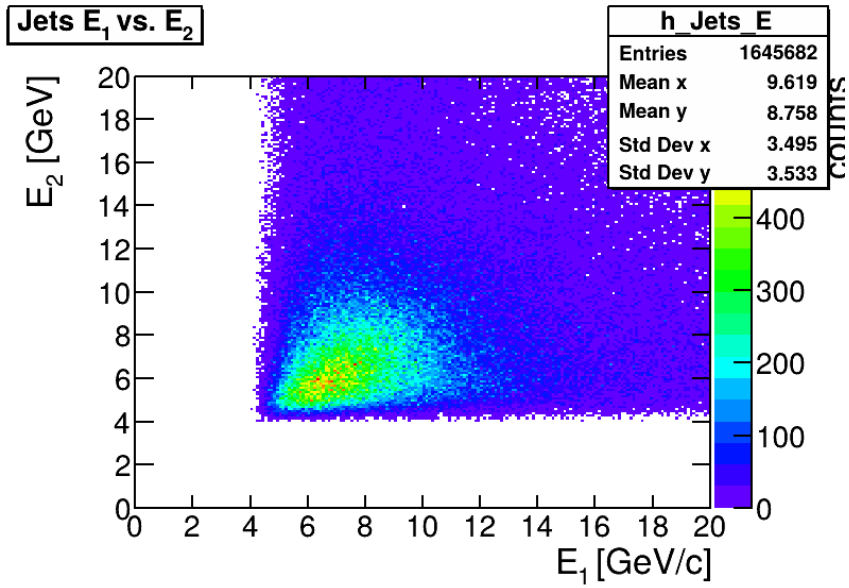
- All jets


Jets η_1 vs. η_2
h_Jets_eta
Entries 1645682
Mean x 0.7344
Mean y 0.7259
Std Dev x 1.055
Std Dev y 1.133
η_2 [1]
η_1 [1]
counts

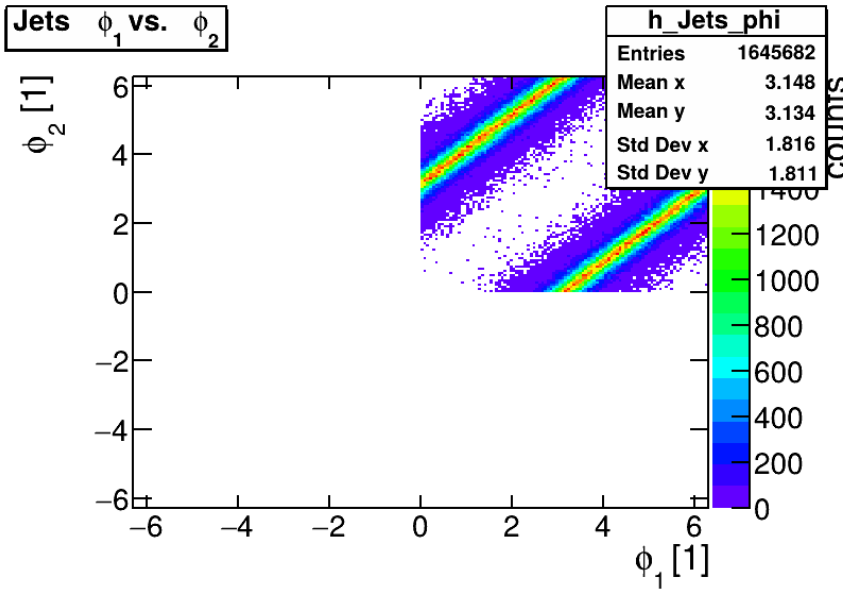

Jets p_1 vs. p_2
h_Jets_p
Entries 1645682
Mean x 9.073
Mean y 8.247
Std Dev x 3.627
Std Dev y 3.668
p_2 [GeV/c]
p_1 [GeV/c]
counts

- All jets


Jets p_T^1 vs. p_T^2
h_Jets_pT
Entries 1645682
Mean x 6.264
Mean y 5.326
Std Dev x 1.666
Std Dev y 1.389
p_T^2 [GeV/c]
p_T^1 [GeV/c]
counts

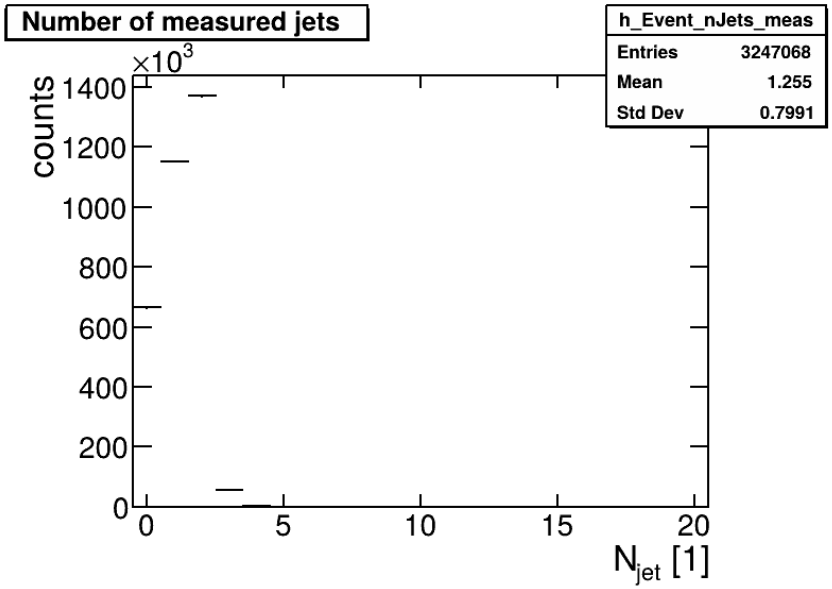

Jets E_1 vs. E_2
h_Jets_E
Entries 1645682
Mean x 9.619
Mean y 8.758
Std Dev x 3.495
Std Dev y 3.533
E_2 [GeV]
E_1 [GeV/c]
counts

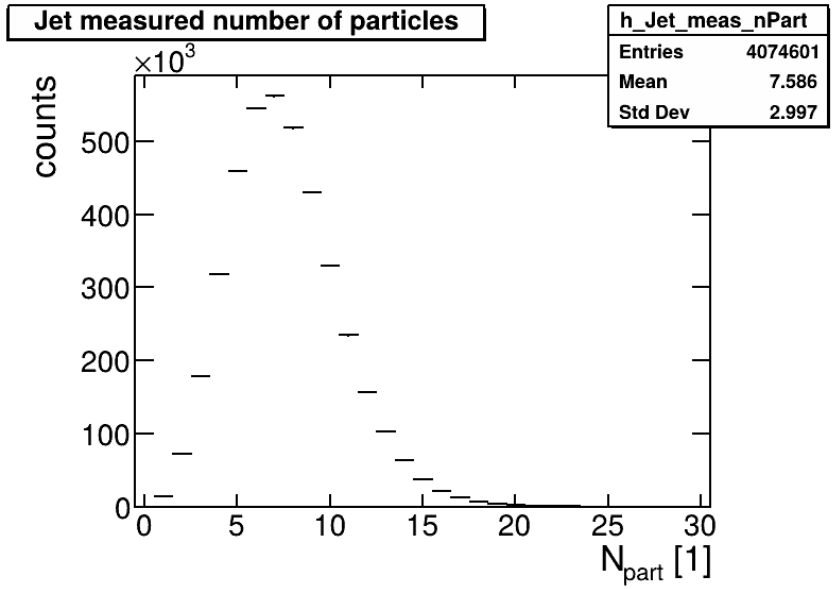
- All jets

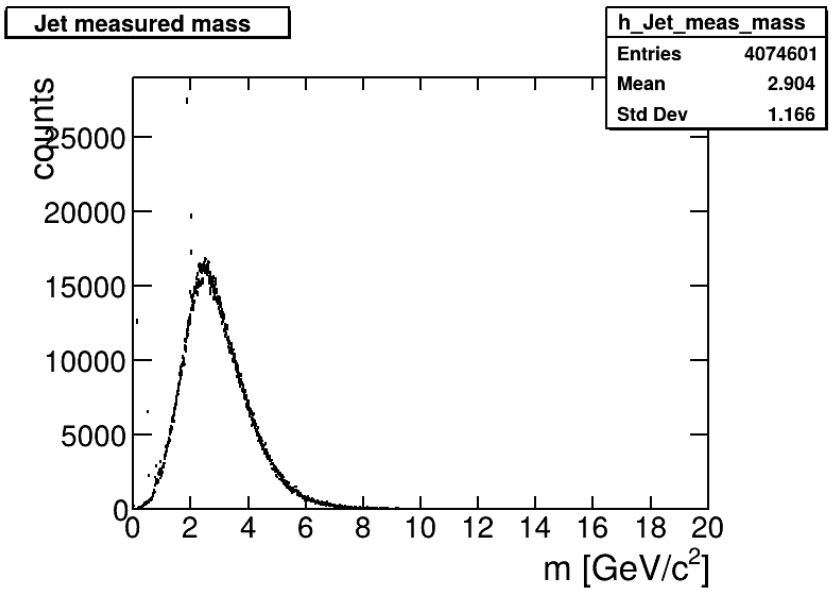

Jets ϕ_1 vs. ϕ_2
h_Jets_phi
Entries 1645682
Mean x 3.148
Mean y 3.134
Std Dev x 1.816
Std Dev y 1.811
ϕ_2 [1]
ϕ_1 [1]
counts

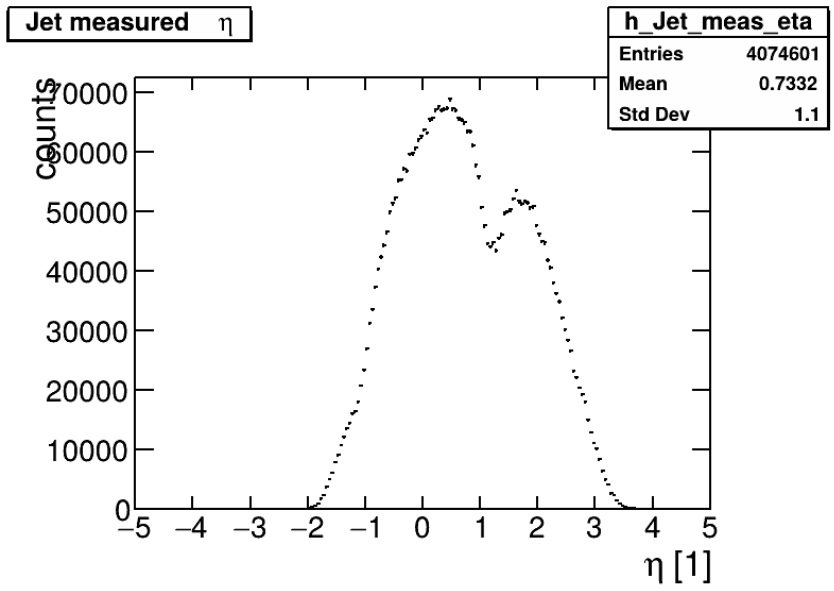
- All jets

Jets measured



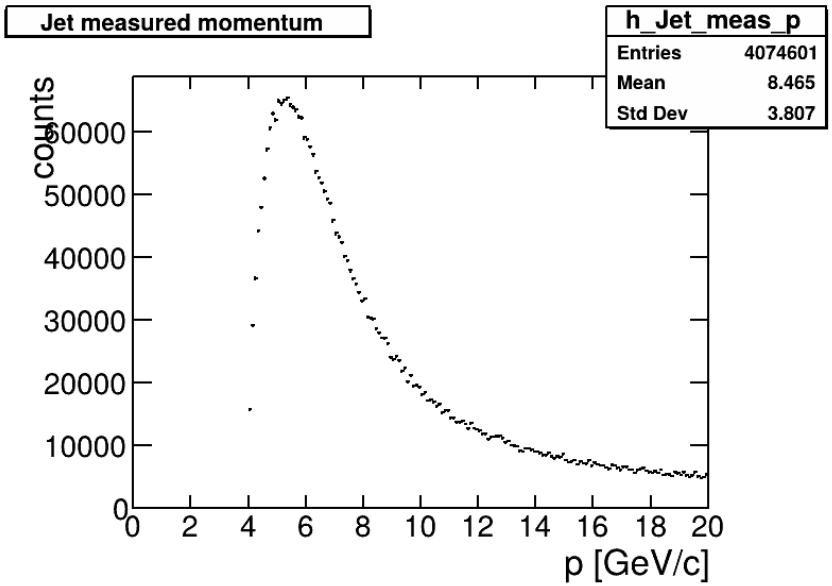


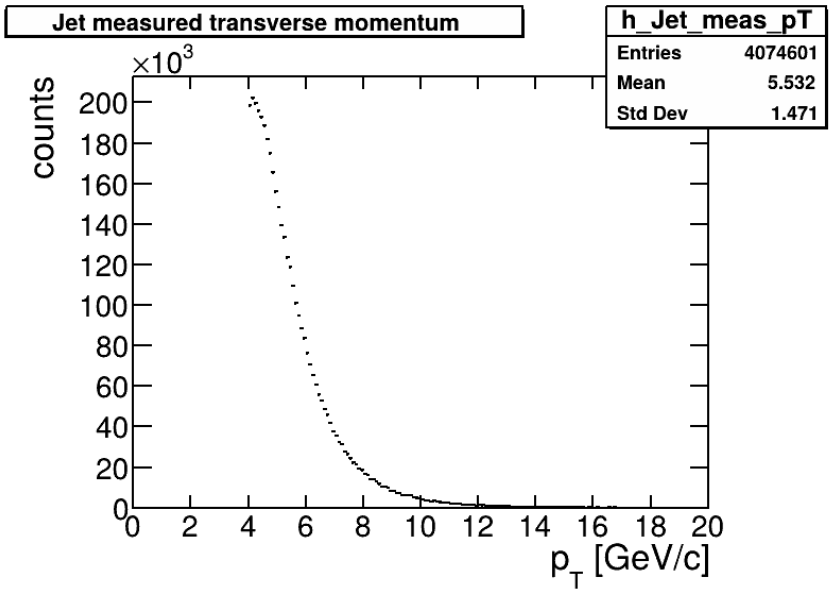




- Measured jets

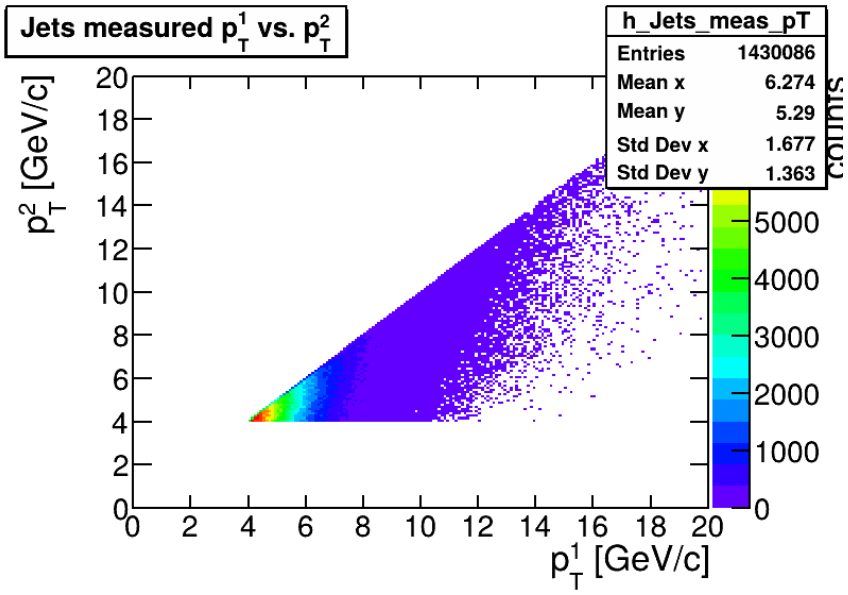
Jets measured

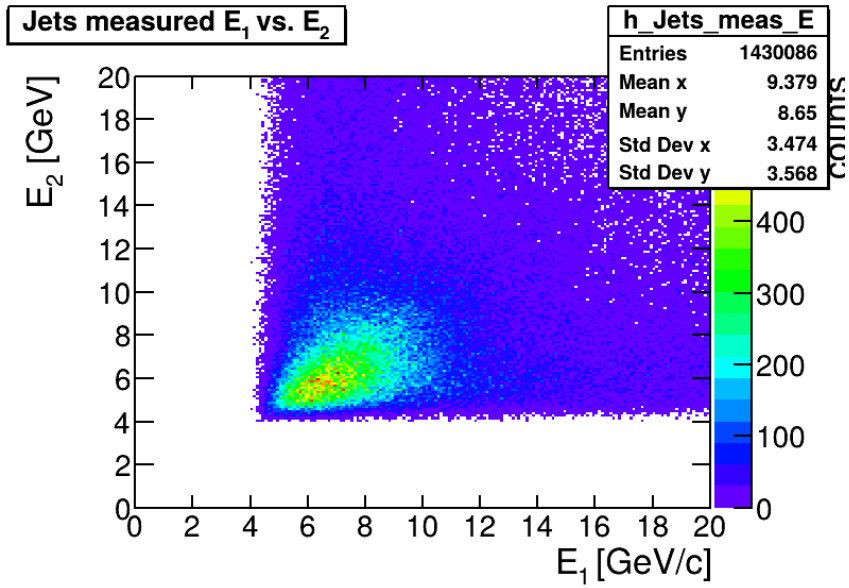




- Measured jets

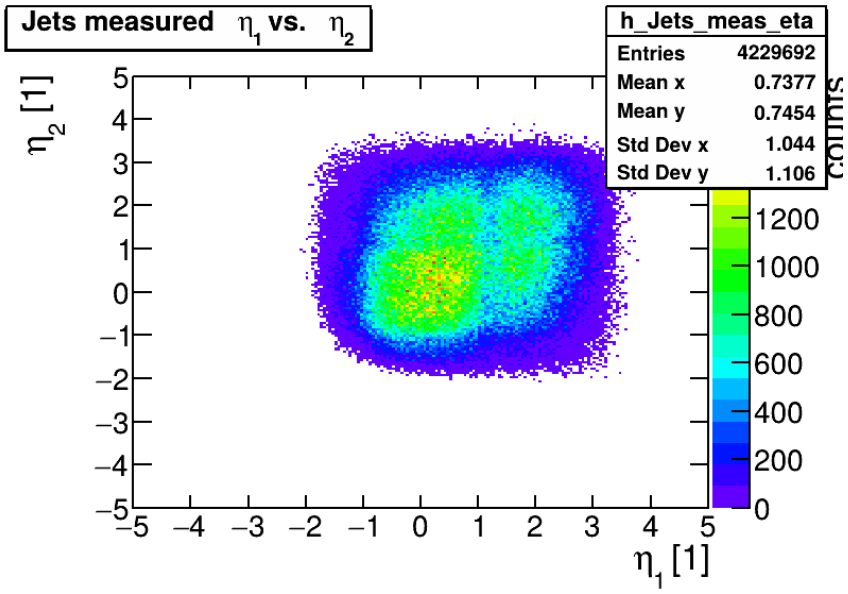
Jets measured

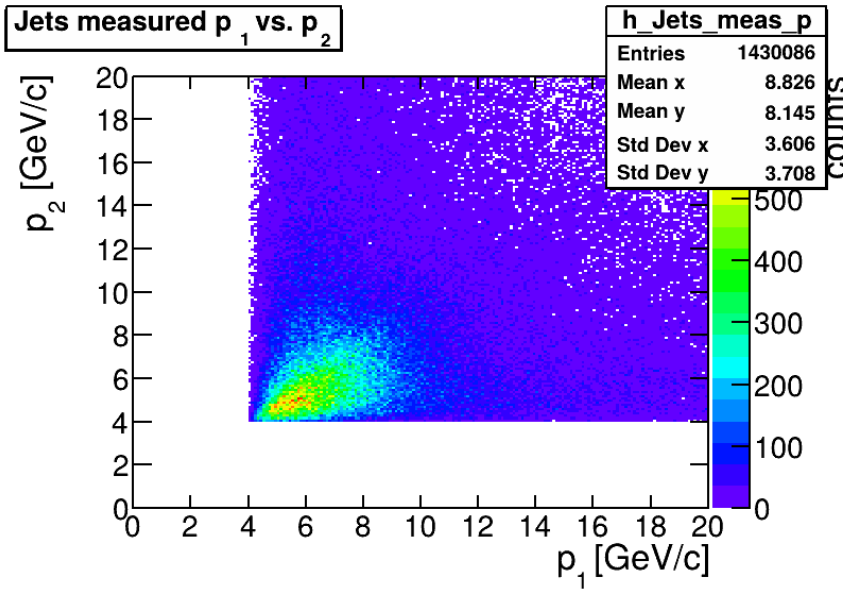




- Measured jets

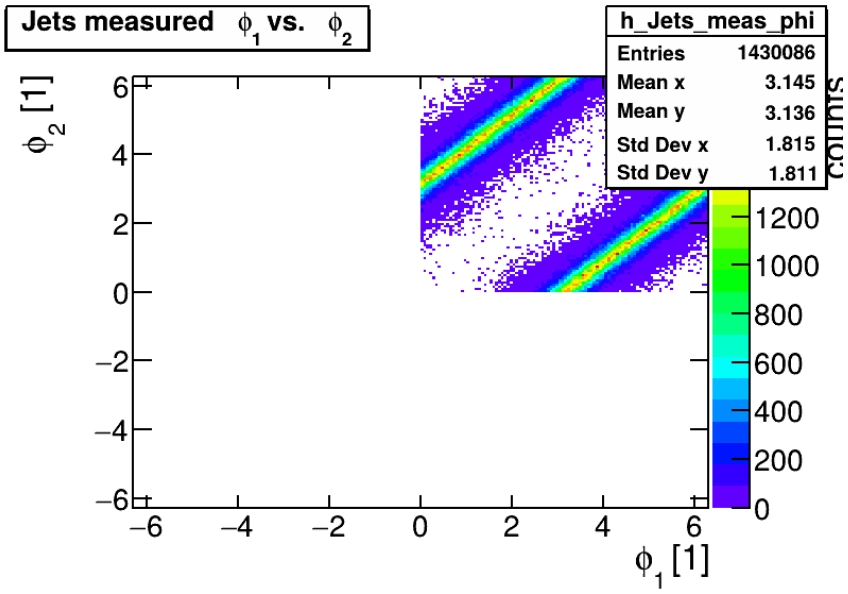
Jets measured



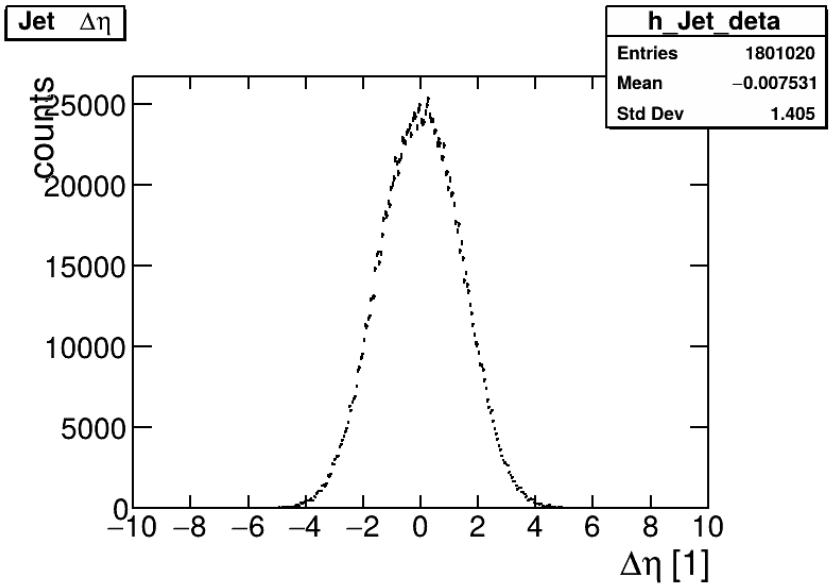


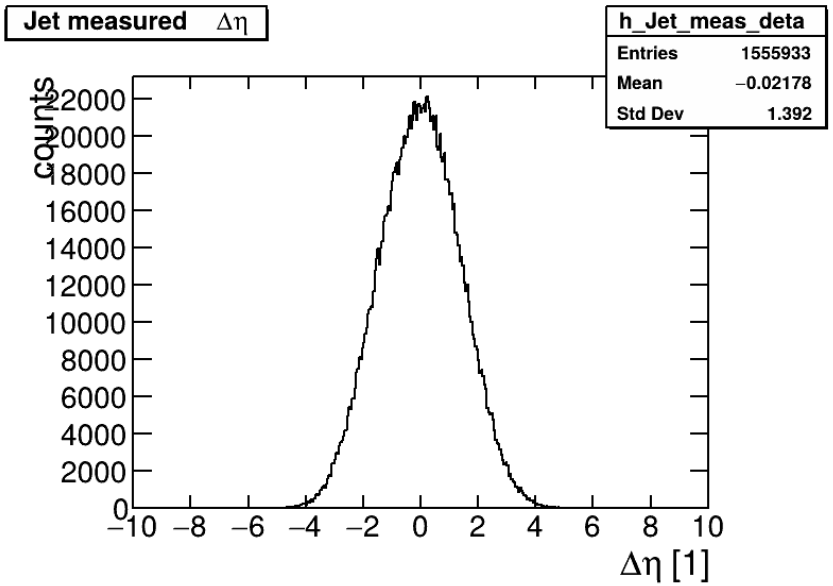
- Measured jets

Jets measured



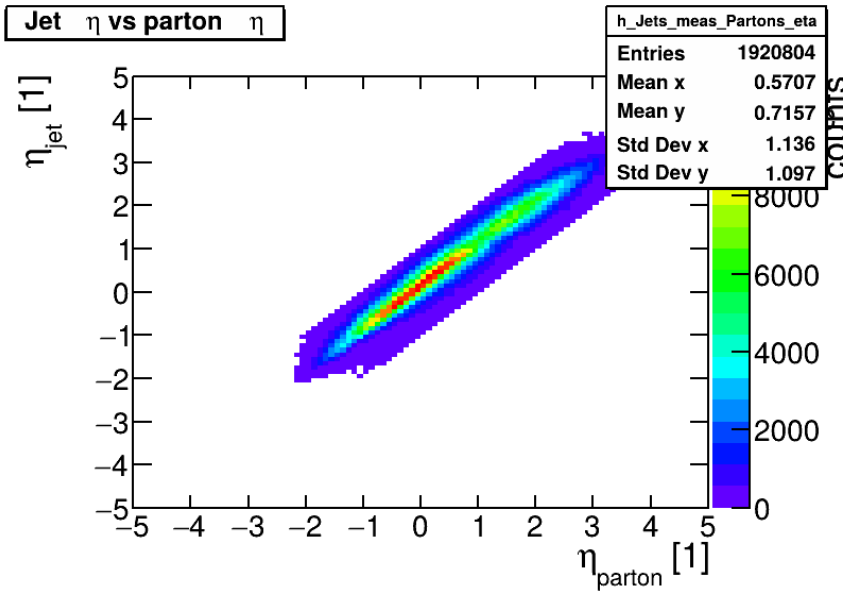
- Measured jets

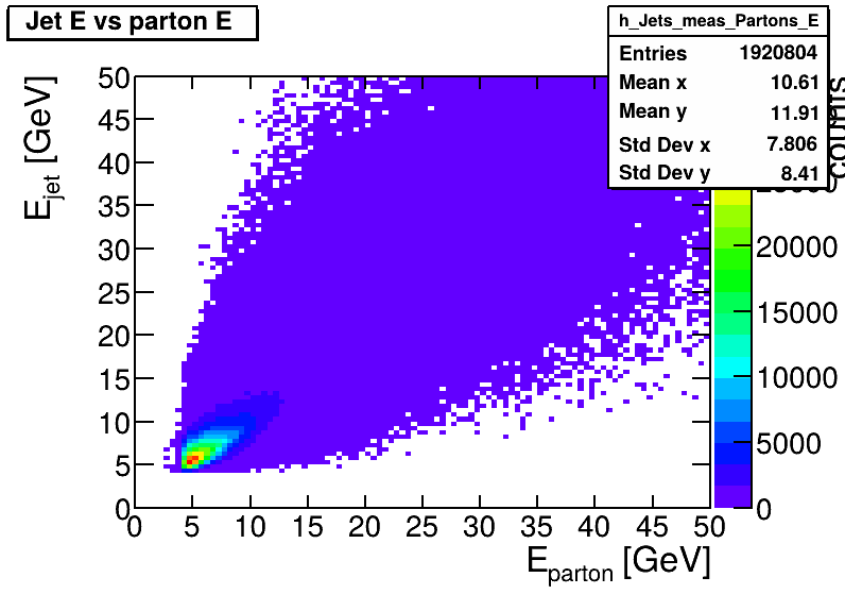




- All jets vs. measured

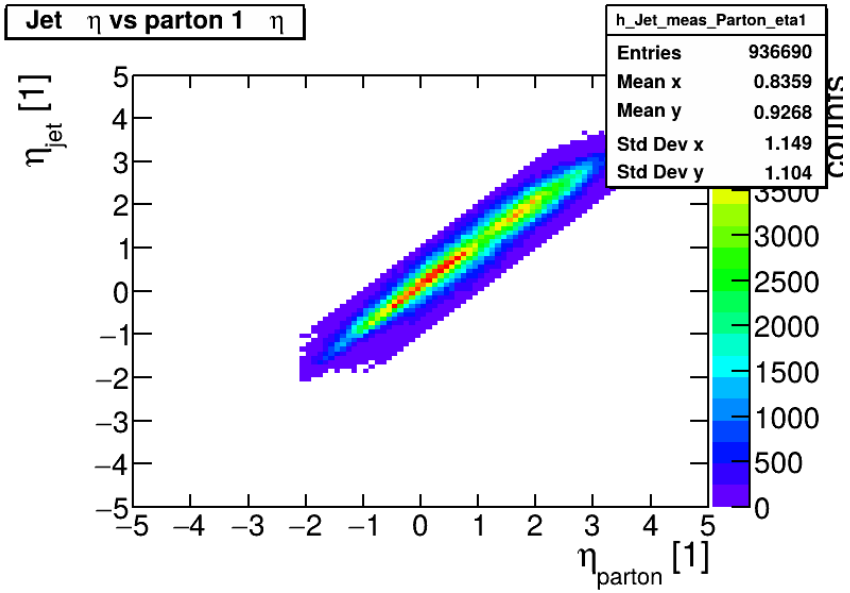
Jets measured vs. partons

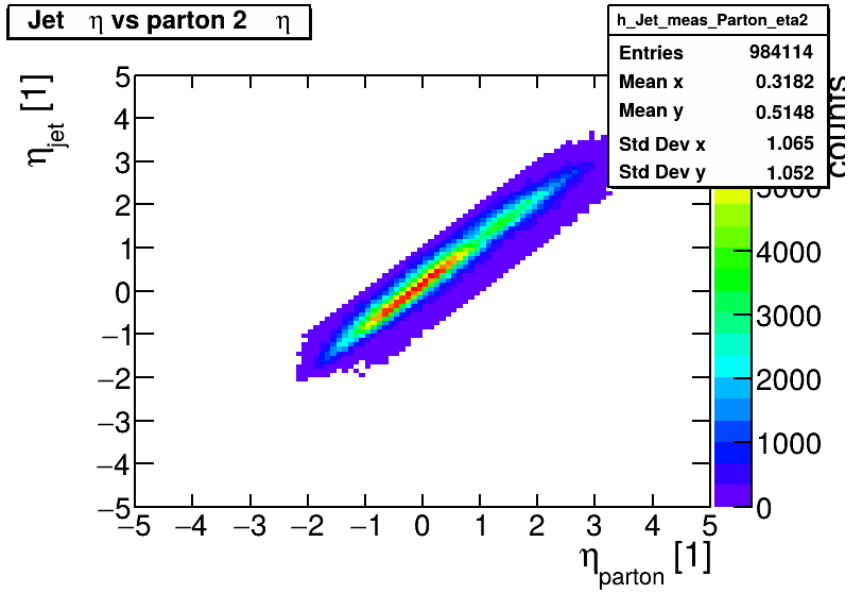


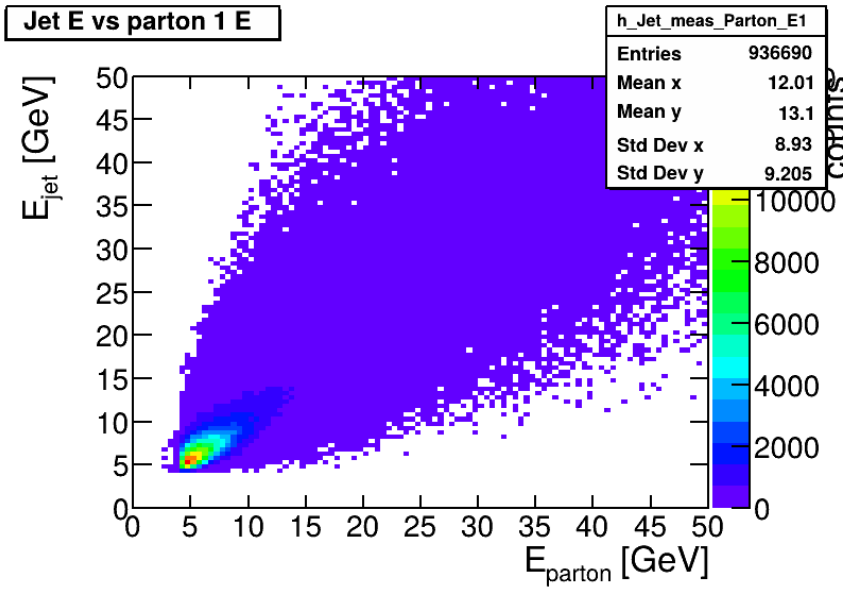


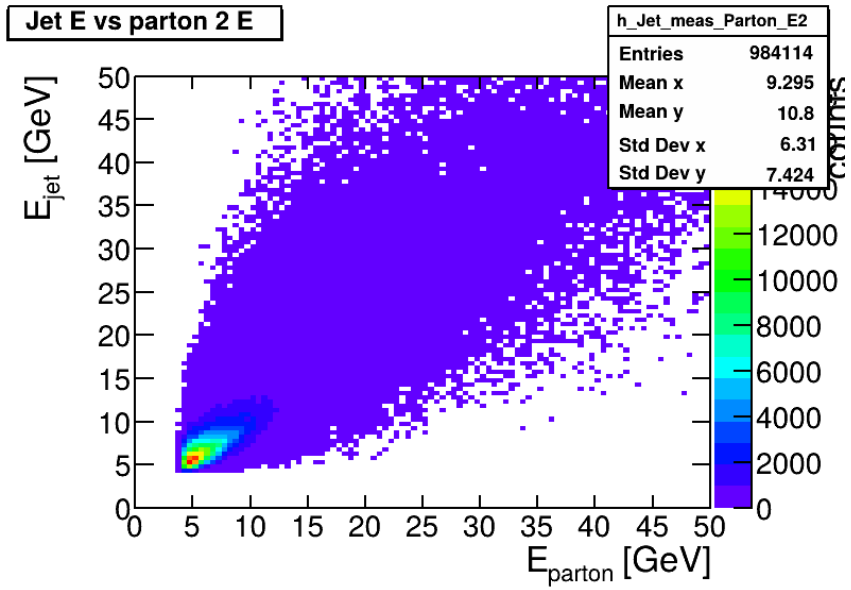
- Jets measured vs. partons

Jets measured vs. partons

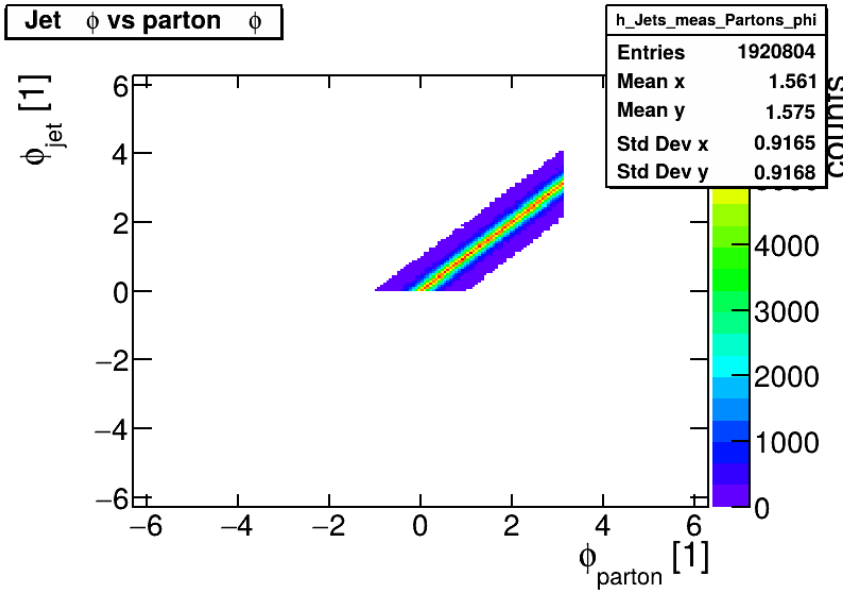


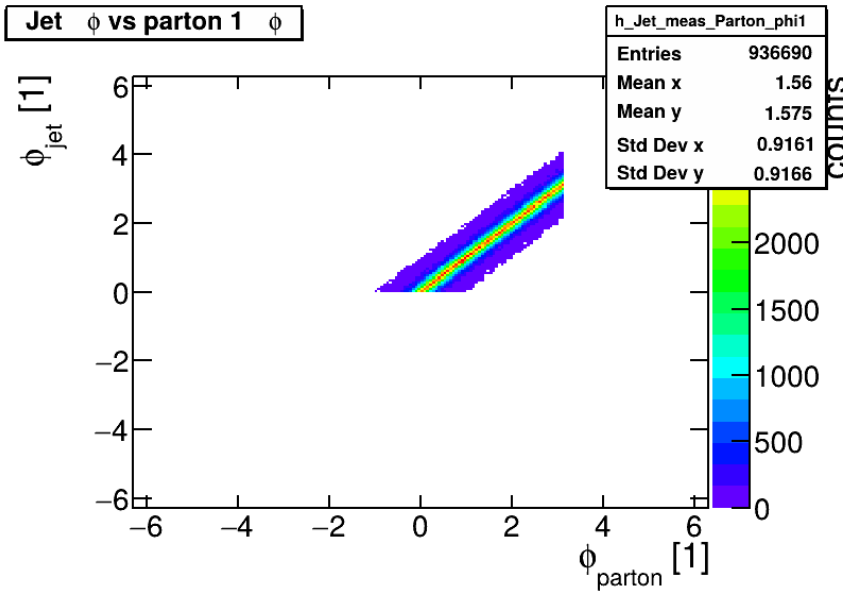


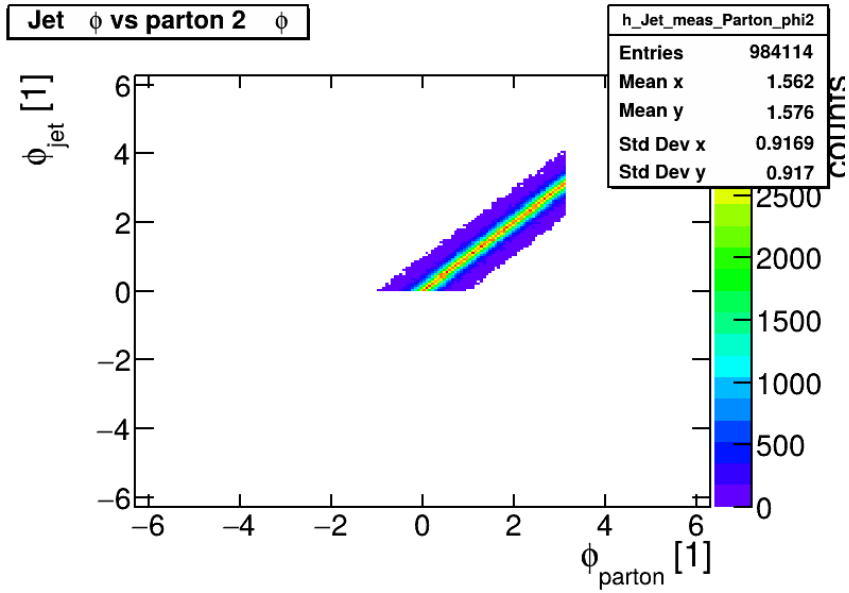




Jets measured vs. partons







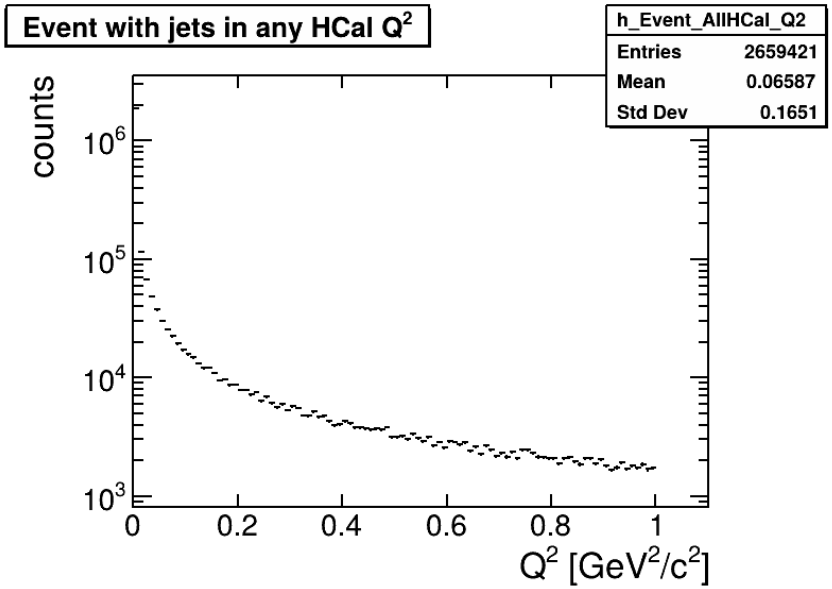
Summary

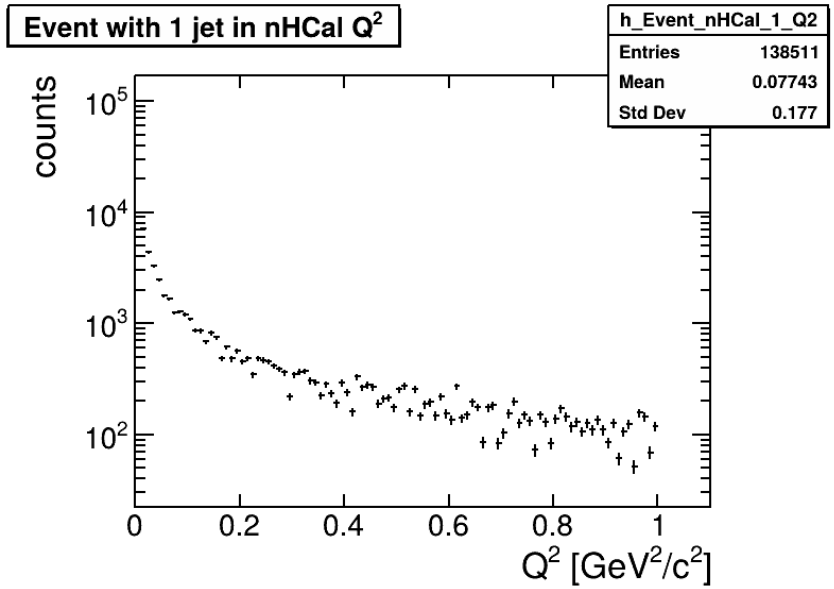
Conclusions

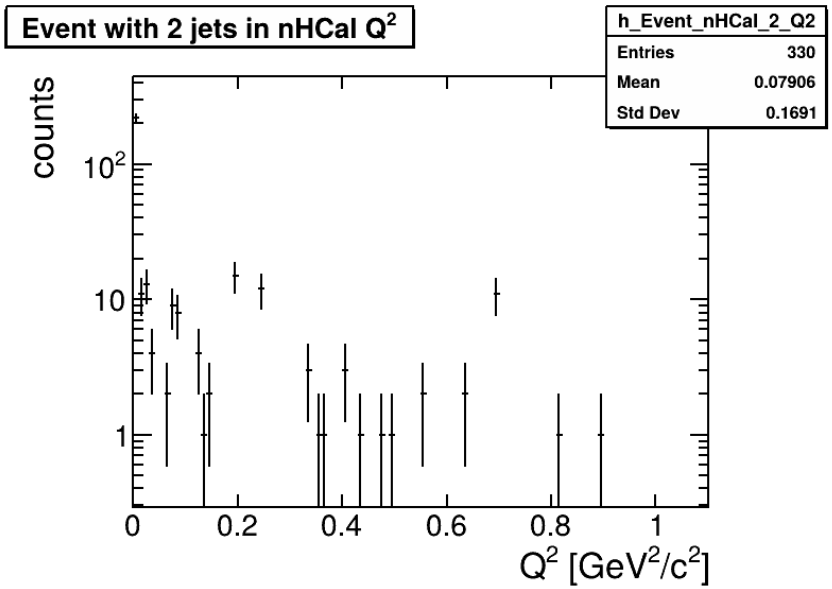
- Implemented FastJet
- First look at jets

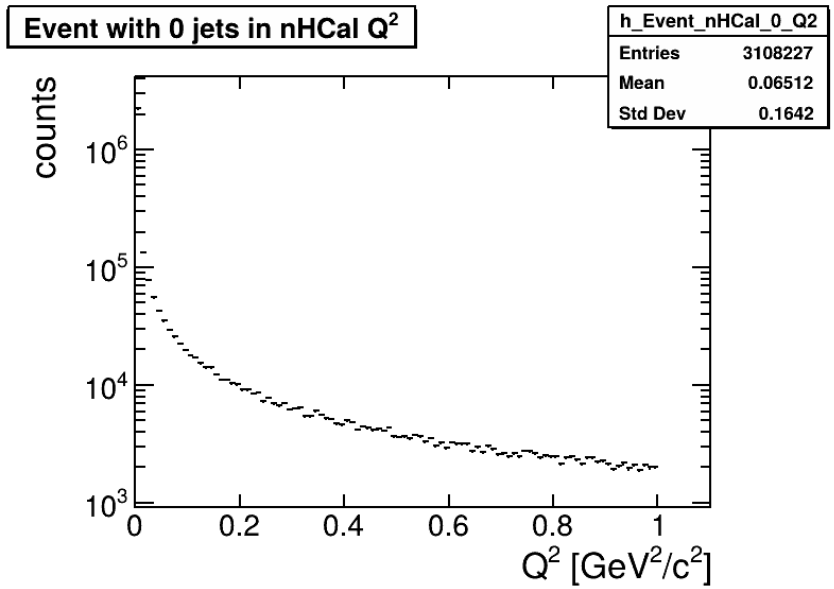
BACKUP

Event kinematics - Q^2



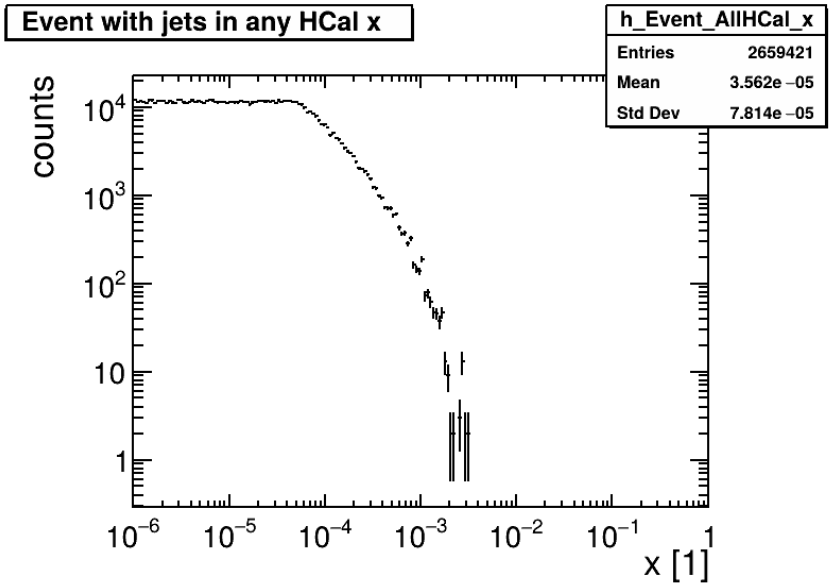


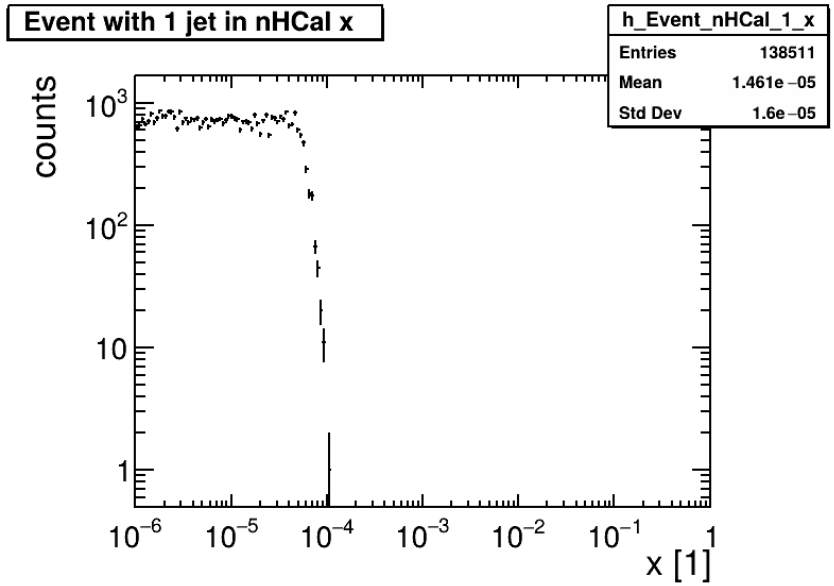


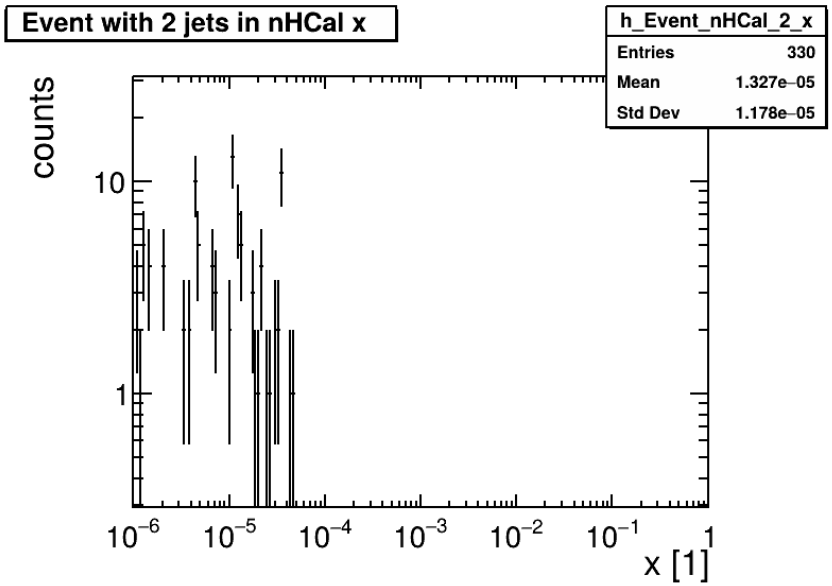


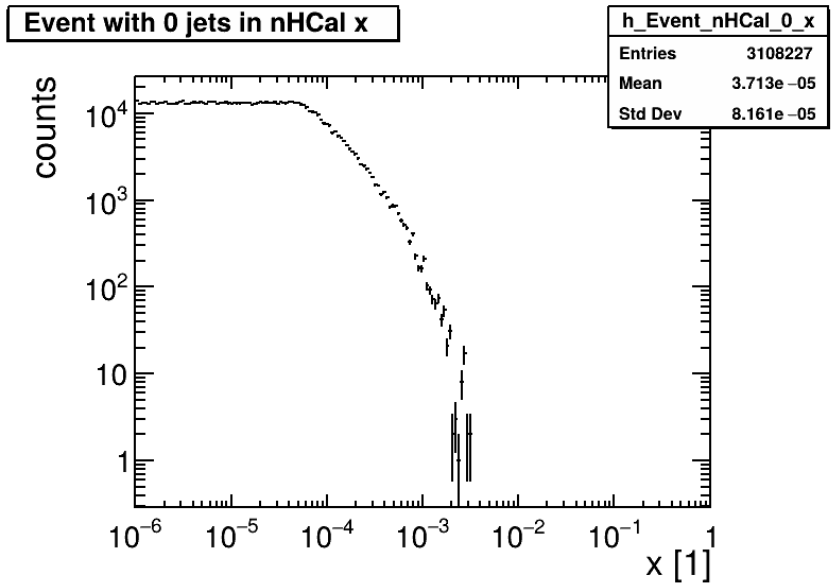
- All events

Event kinematics - Q^2



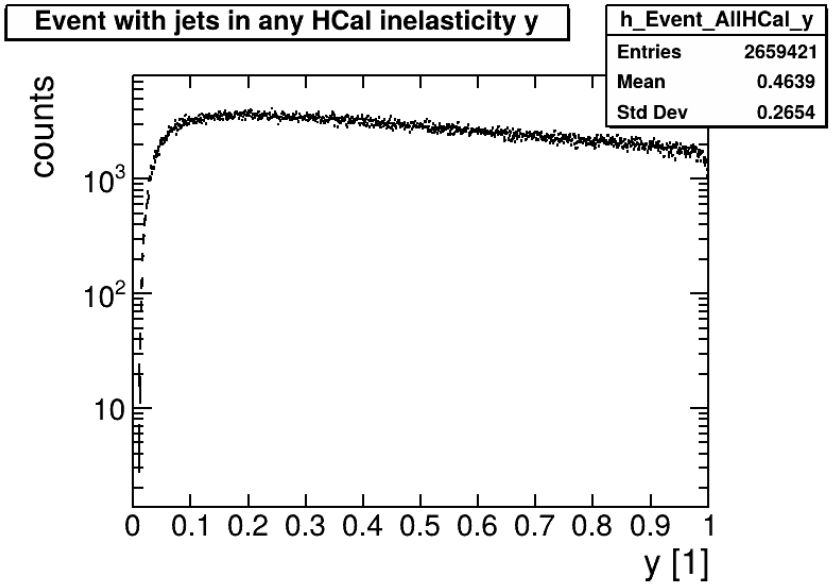


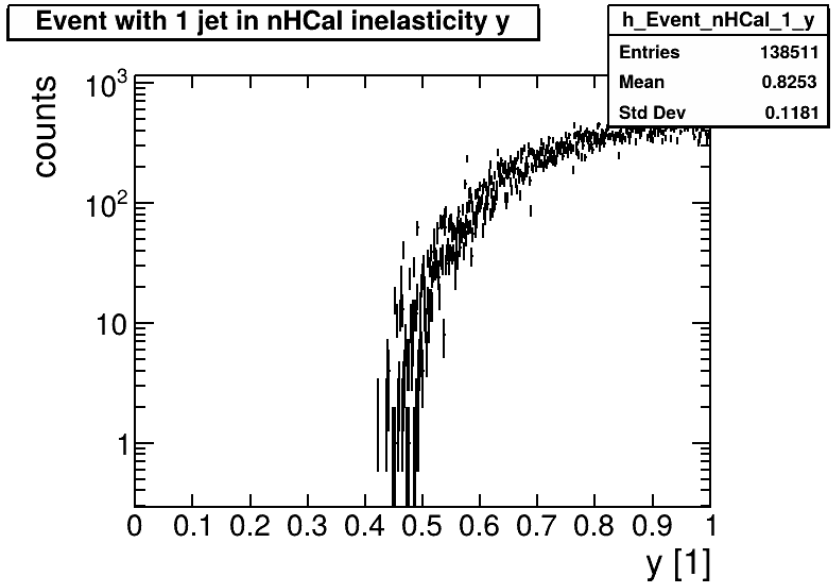


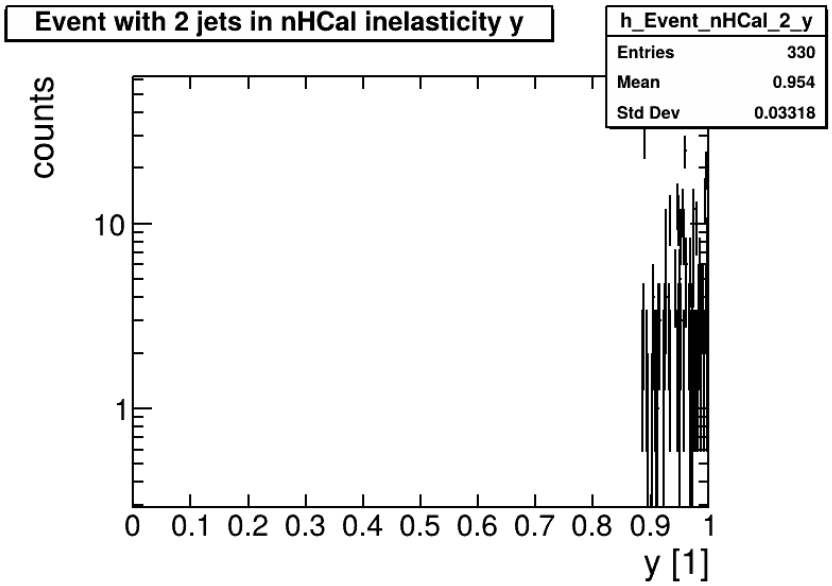


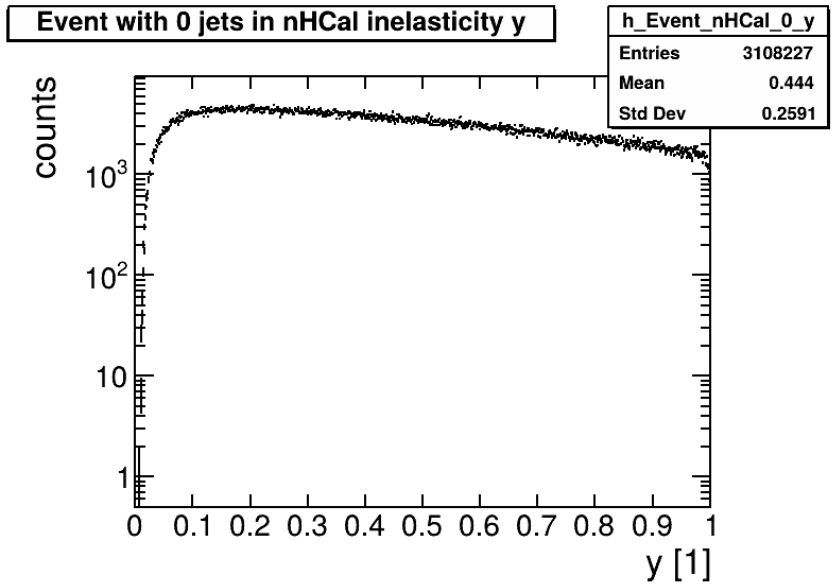
- All events

Event kinematics - Q^2



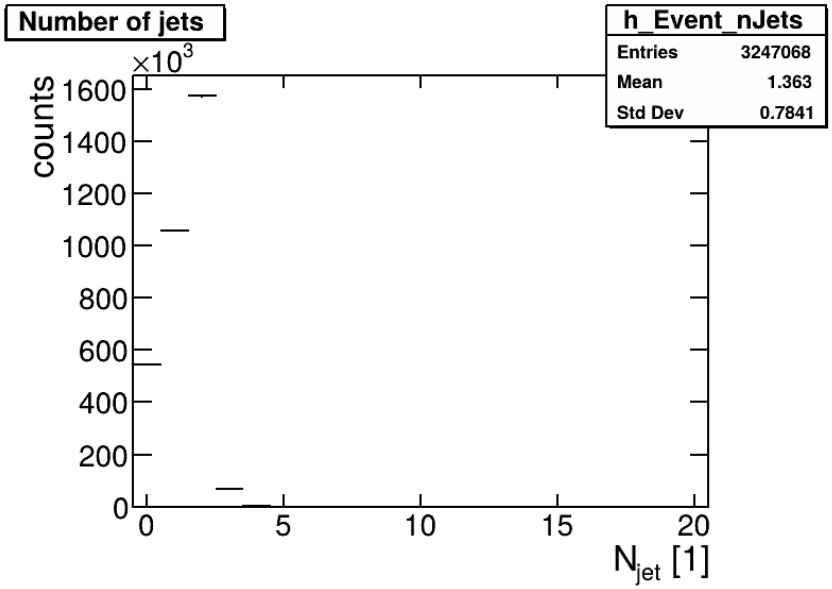


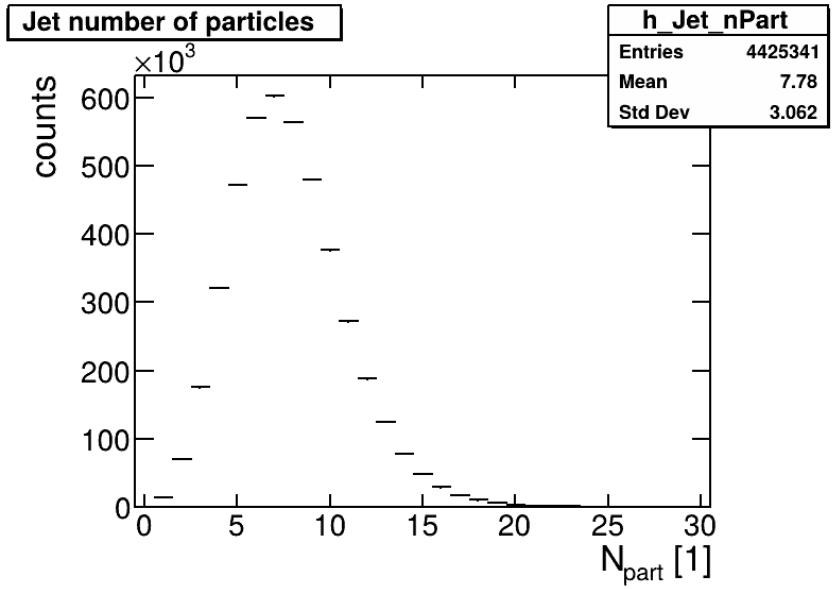


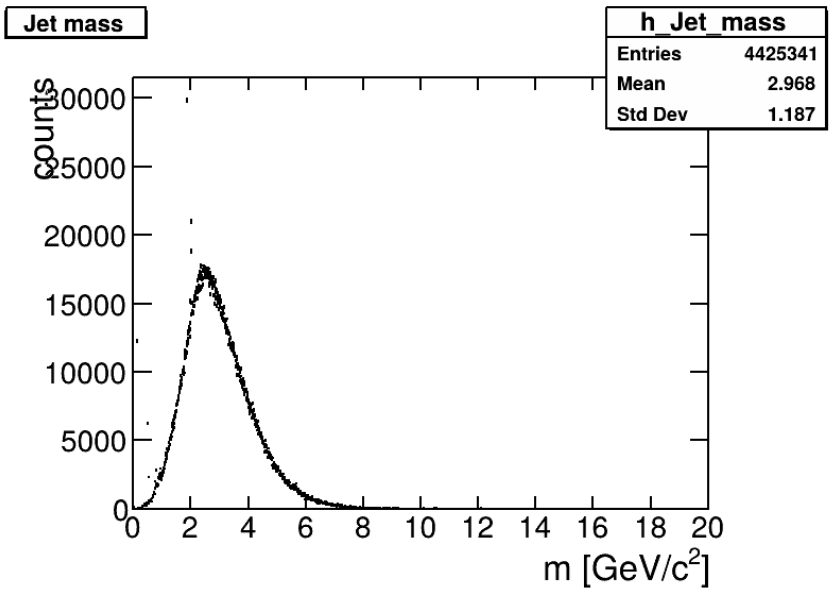


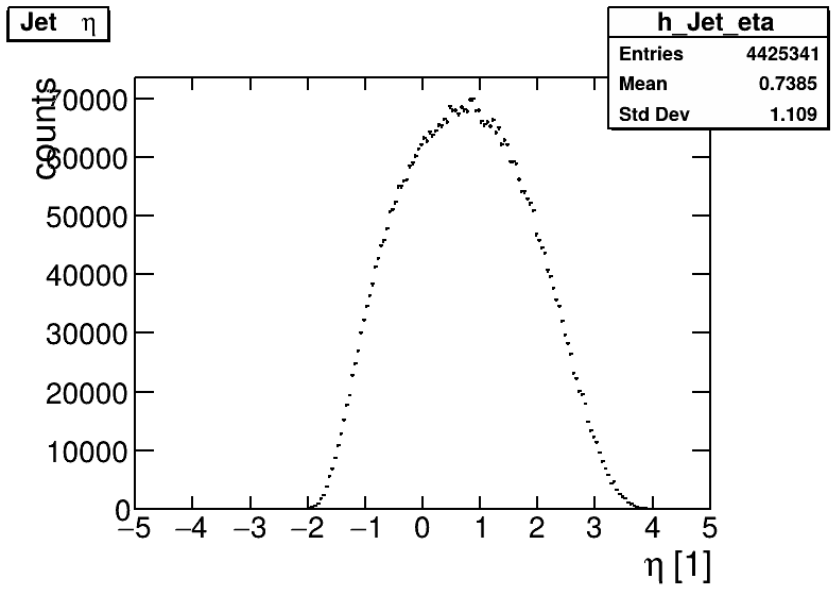
- All events

Jets

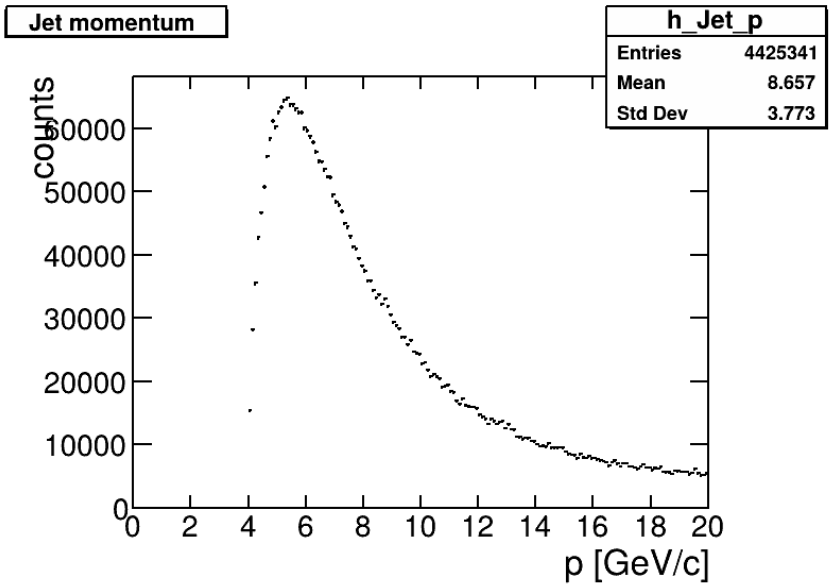


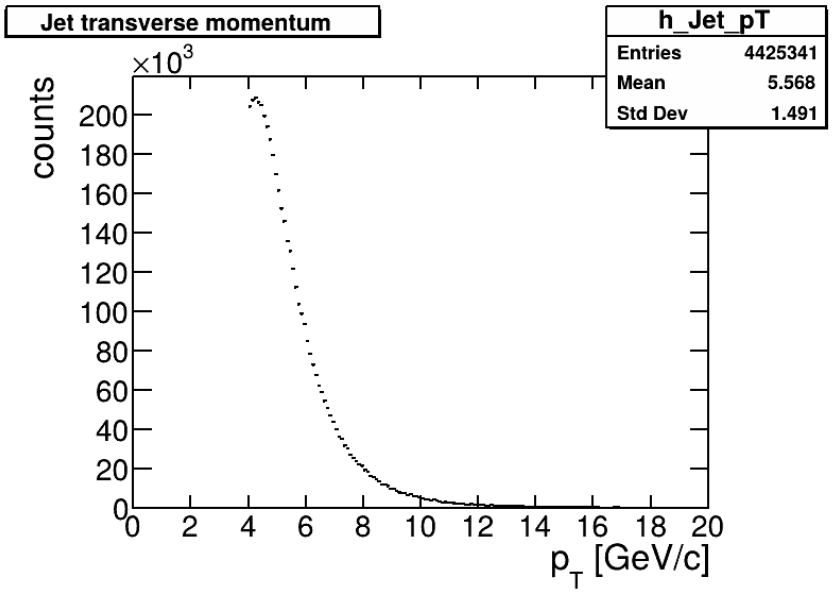






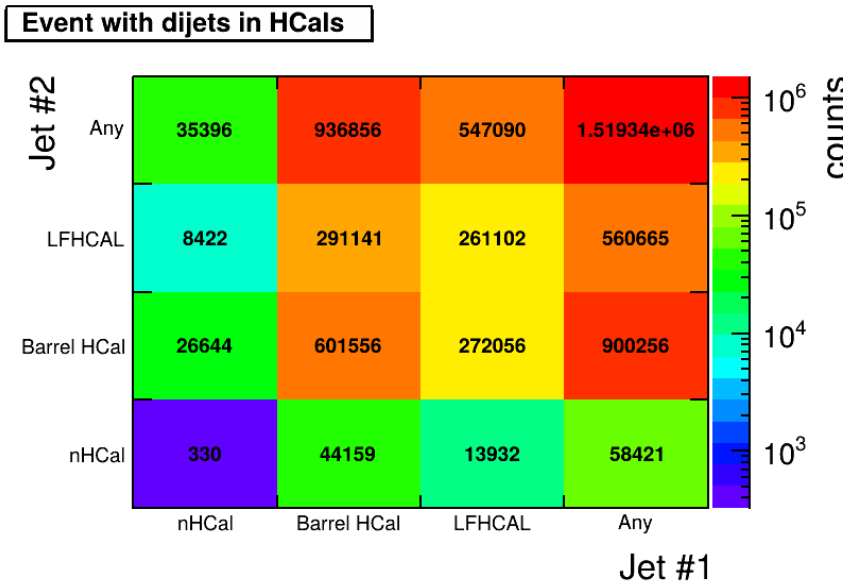
- All jets

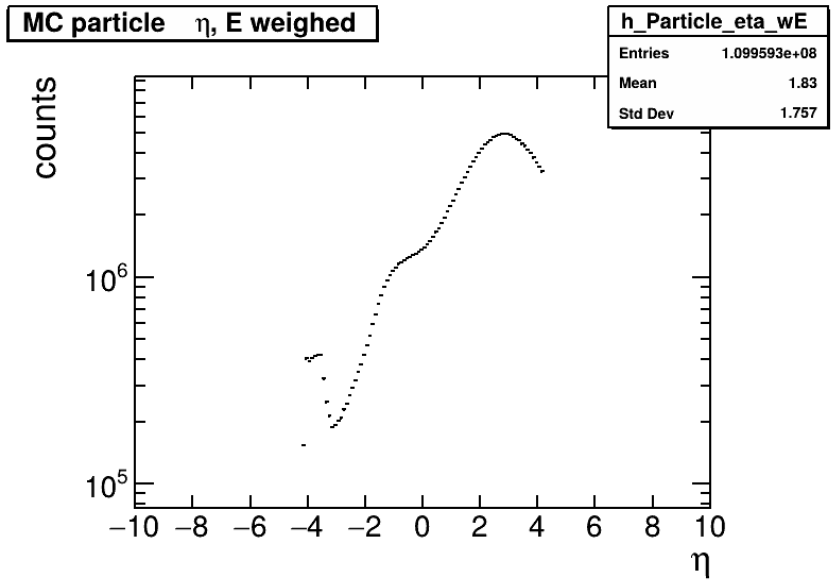

Jet momentum
h_Jet_p
Entries 4425341
Mean 8.657
Std Dev 3.773
counts
60000
50000
40000
30000
20000
10000
0
0 2 4 6 8 10 12 14 16 18 20
p [GeV/c]


Jet transverse momentum
h_Jet_pT
Entries 4425341
Mean 5.568
Std Dev 1.491
counts
×10^3
200
180
160
140
120
100
80
60
40
20
0
0 2 4 6 8 10 12 14 16 18 20
p_T [GeV/c]

- All jets

Events with jets in HCals





- Calculated average energy in acceptance of HCals