

Backward Hadronic Calorimeter update

Diffraction dijet study

Leszek Kosarzewski

The Ohio State University

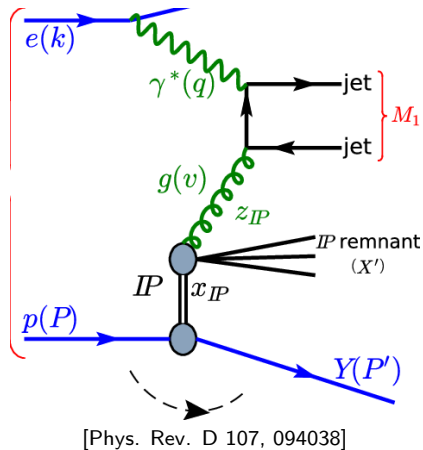
nHCal DSC meeting 11.10.2024



THE OHIO STATE UNIVERSITY

- 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



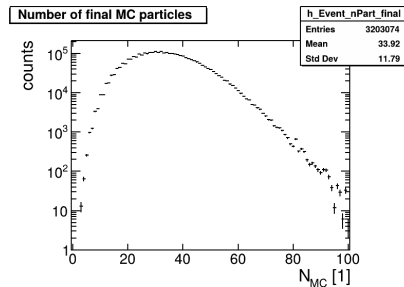
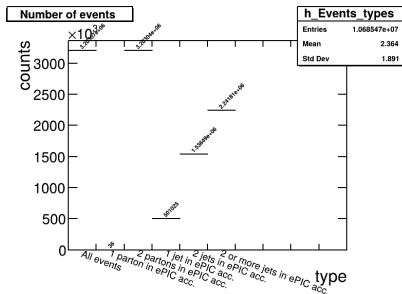
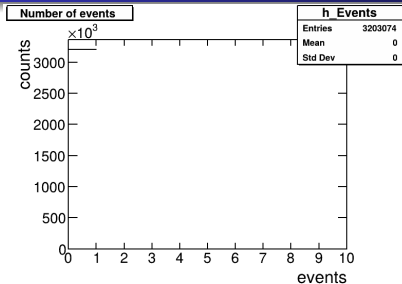
Diffractive dijet - simulation setup

- Simulation setup for diffractive dijets
- PYTHIA version 8.311 simulation from EIC container:
 - $18 \times 275 \text{ GeV } e + p$ collisions, $0 < Q^2 < 1 \text{ GeV}^2$
 - 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

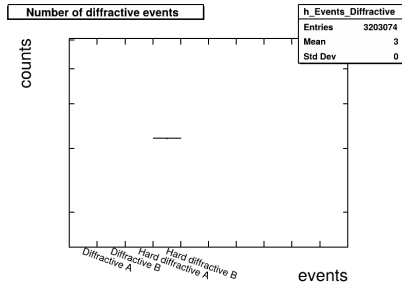
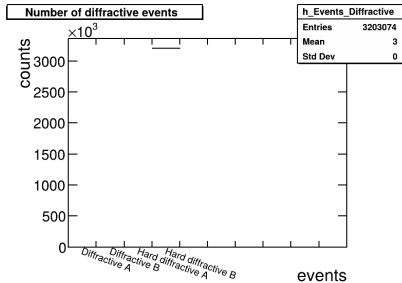
Listing: Simulation settings

```
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("SigmaDiffraction:PomFlux = 7"); // H1 Fit B LO
pythia8->ReadString("PDF:PomSet = 6"); // H1 Fit B LO
```



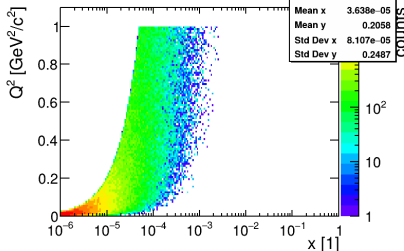
- First look at diffractive dijet events
- 33 final state particles on average



- All events are HardDiffraction on B - photon on proton

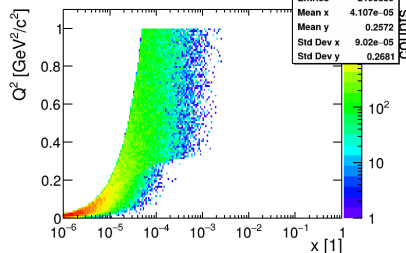
All events

Event Q^2 vs. x

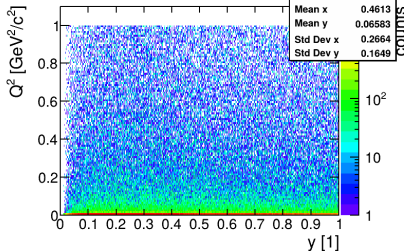


With activity in nHCal

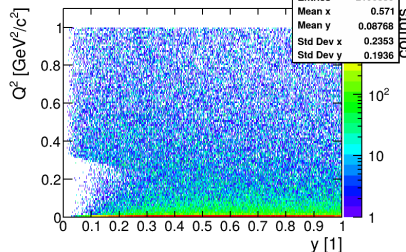
Event with nHCal activity Q^2 vs. x



Event Q^2 vs. inelasticity y



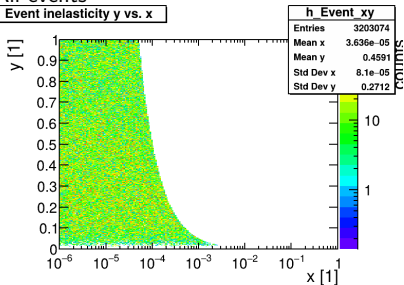
Event with nHCal activity Q^2 vs. inelasticity y



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

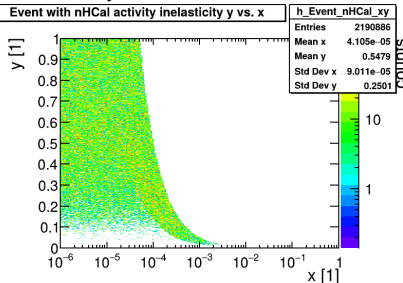
All events

Event inelasticity y vs. x



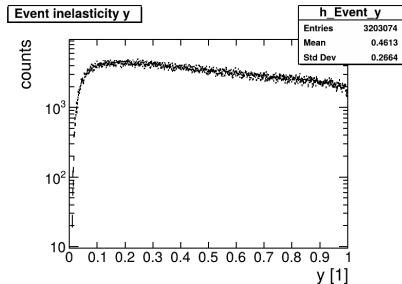
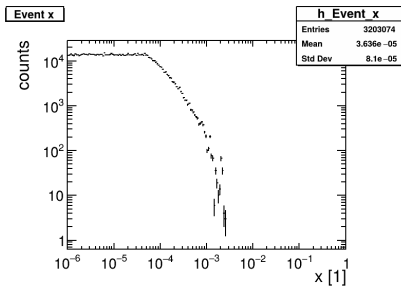
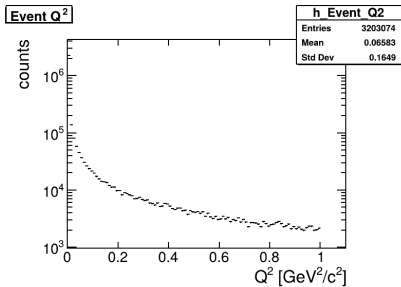
With activity in nHCal

Event with nHCal activity inelasticity y vs. x

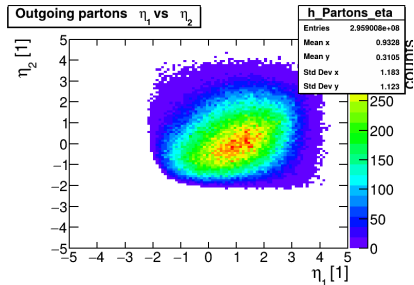
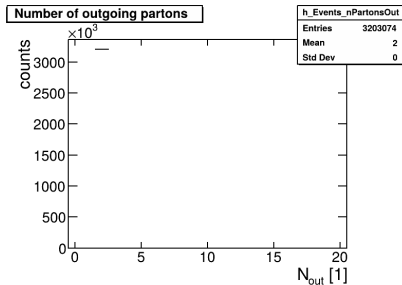


- 3.2M out of 4.7M (68%) events with activity in nHCal
- Includes scattered electron
- First look at diffractive dijet events

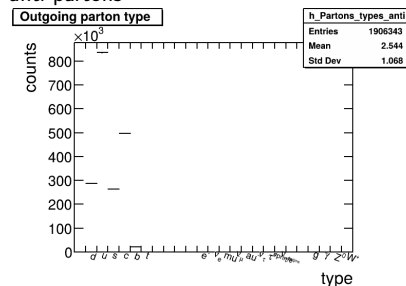
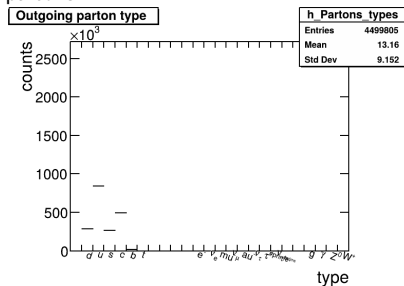
All events kinematics



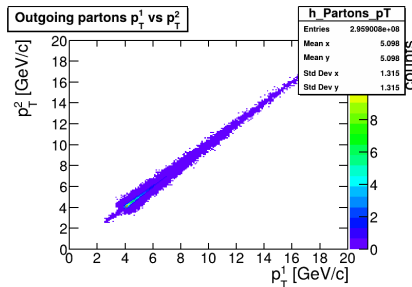
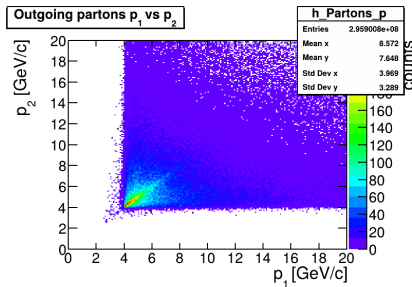
- All events



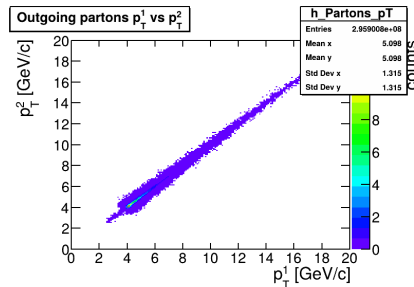
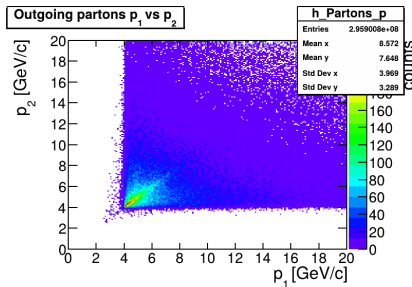
- First look at outgoing partons (*status* = 23, 24)



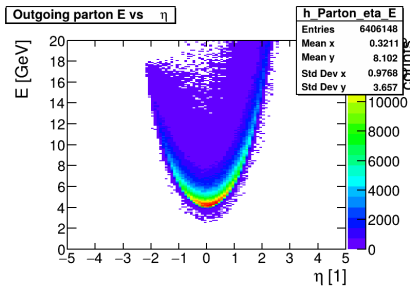
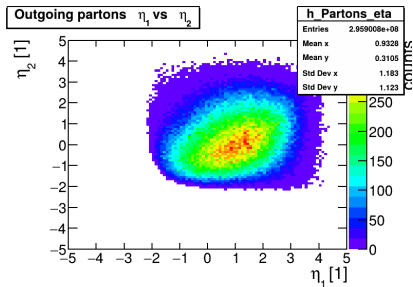
- First look at outgoing partons ($status = 23, 24$)



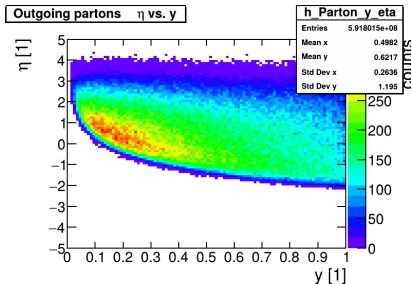
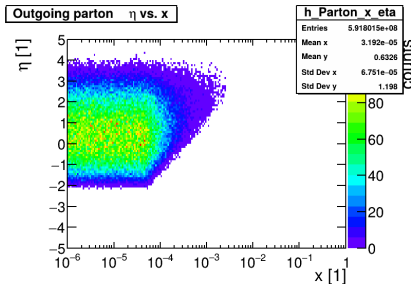
- First look at outgoing partons ($status = 23, 24$)



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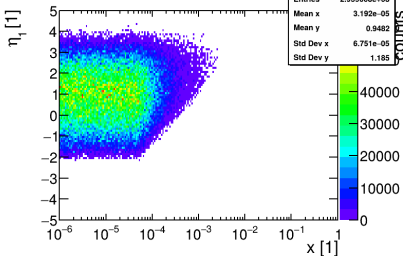


- First look at outgoing partons (*status* = 23, 24)

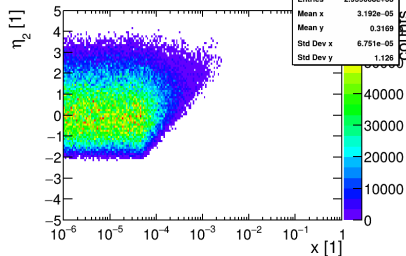


- First look at outgoing partons ($status = 23, 24$)

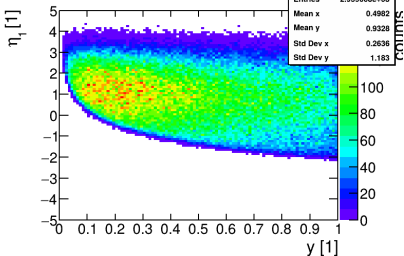
Outgoing partons η_1 vs. x



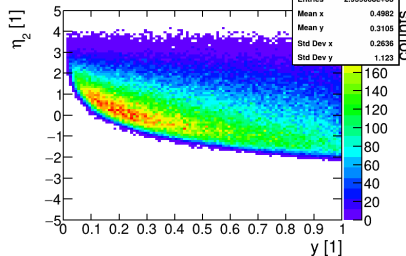
Outgoing partons η_2 vs. x



Outgoing partons η_1 vs. y

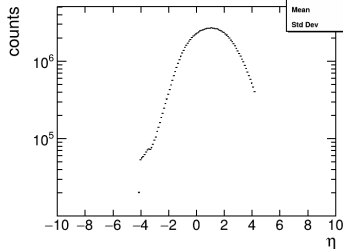


Outgoing partons η_2 vs. y



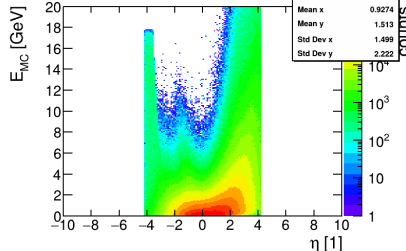
- First look at outgoing partons ($status = 23, 24$)

MC particle η



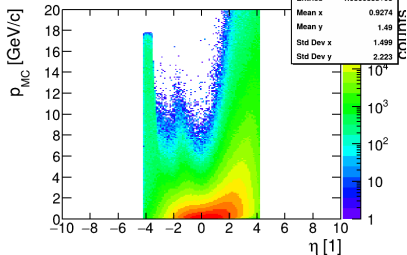
h Particle eta	
Entries	1.086683e+08
Mean	0.9336
Std Dev	1.502

MC particles η vs. energy



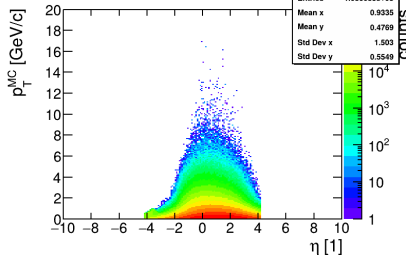
h Particle eta E	
Entries	1.086683e+08
Mean x	0.9274
Mean y	1.513
Std Dev x	1.499
Std Dev y	2.222

MC particles η vs. momentum



h Particle eta p	
Entries	1.086683e+08
Mean x	0.9274
Mean y	1.49
Std Dev x	1.499
Std Dev y	2.223

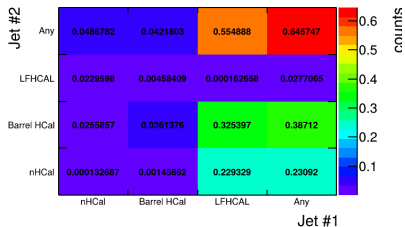
MC particles η vs. momentum



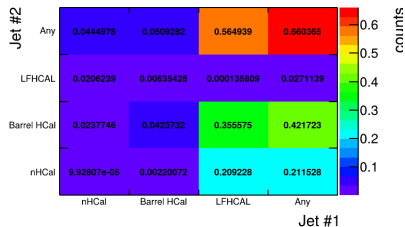
h Particle eta pT	
Entries	1.086683e+08
Mean x	0.9335
Mean y	0.4769
Std Dev x	1.503
Std Dev y	0.5549

- Final state particles
- Beam particles excluded!
- Generalized ee k_T algorithm seems to work well, IR and collinear safe
 - $d_{ij} = \min(E_i^{2p}, E_j^{2p}) \frac{1 - \cos(\theta_{ij})}{1 - \cos(R)}$
 - $d_{iB} = E_i^{2p}$
- $R = 1$
- $p = -1$
- Jet $E > 4$ GeV
- Sorted jets vs. E

Event with dijets in HCals

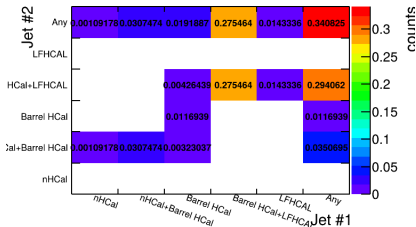


Event with measured dijets in HCals

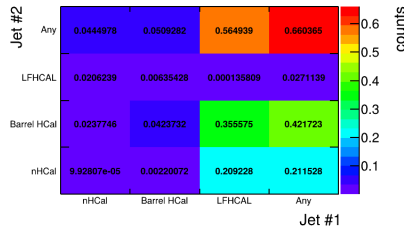


- Fractions of events with jets in HCals
- Fraction of events with 2 partons in ePIC acceptance

Event with measured dijets in HCals

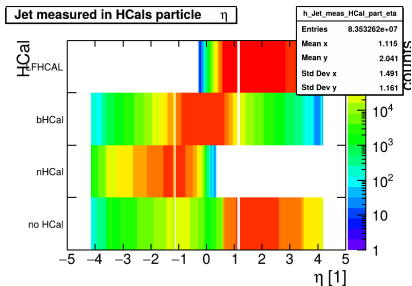
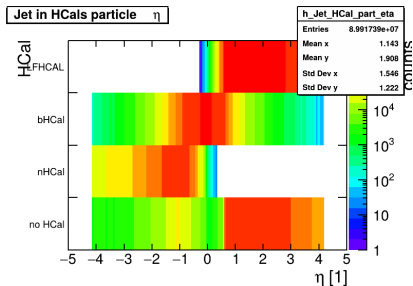
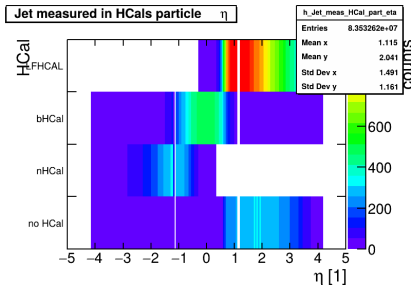
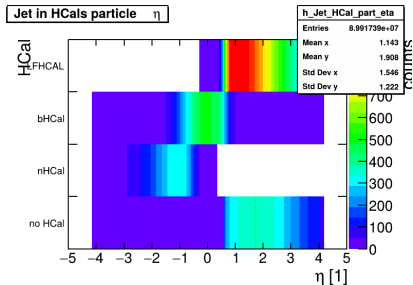


Event with measured dijets in HCals

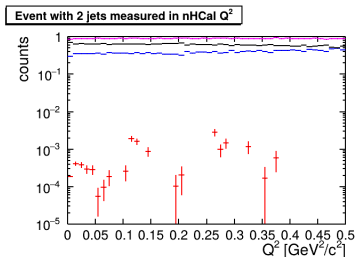
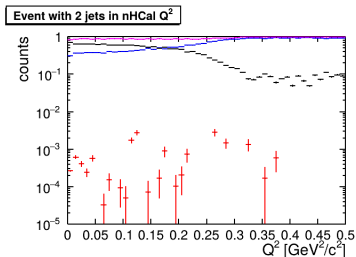
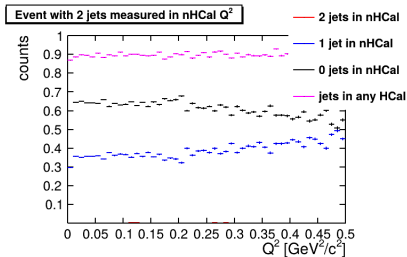
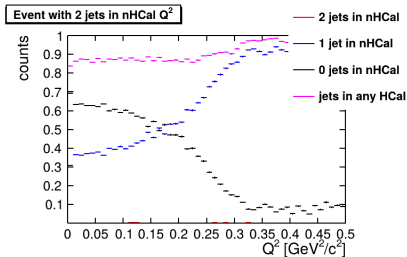


- Fractions of events with jets in HCals
- Fraction of events with 2 partons in ePIC acceptance

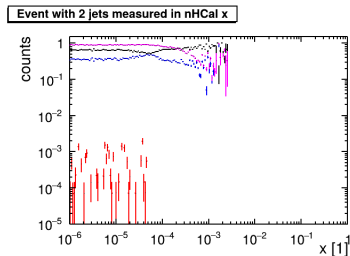
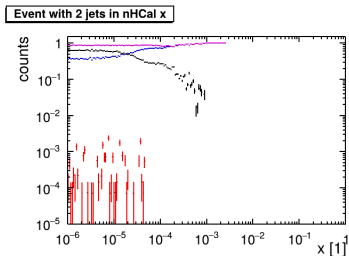
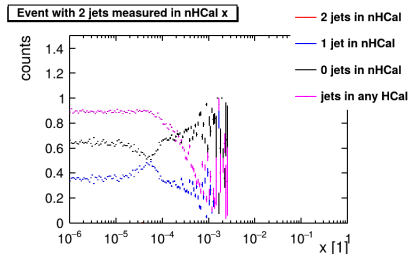
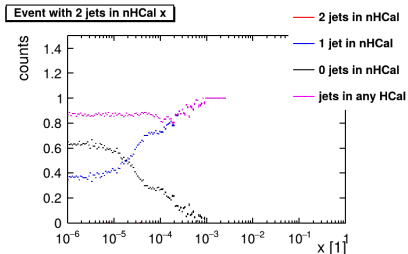
Jets in HCals vs. constituent η



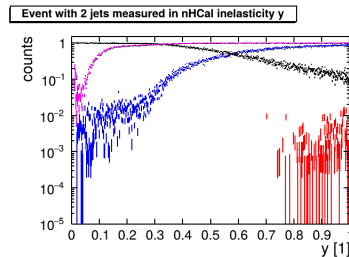
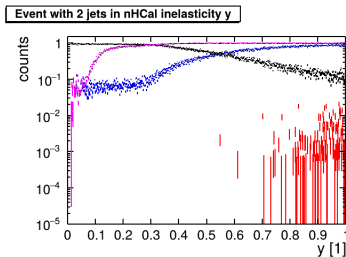
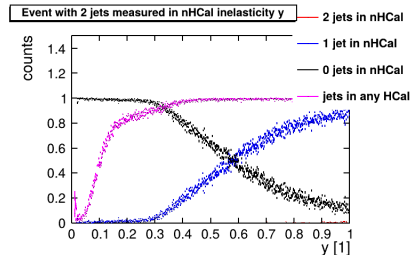
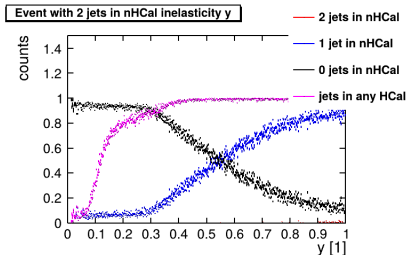
- η distributions for constituents of jets in HCals



- Fractions of events with jets in HCal



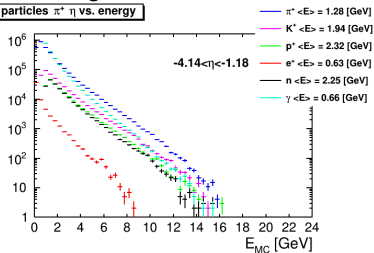
- Fractions of events with jets in HCals



- Fractions of events with jets in HCals

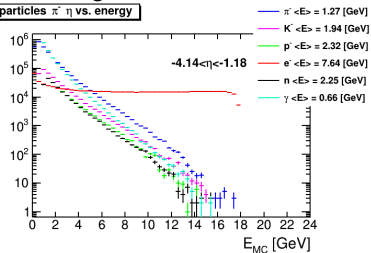
positive charge

MC particles π^+ η vs. energy

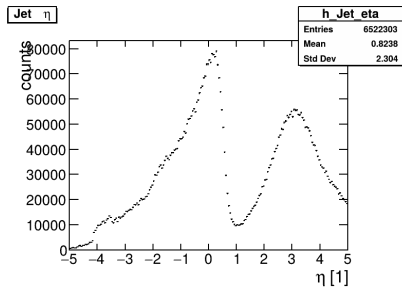
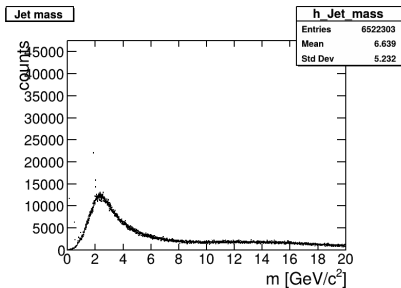
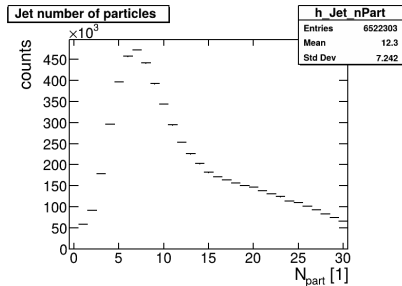
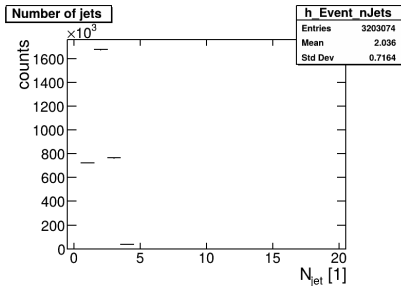


negative charge

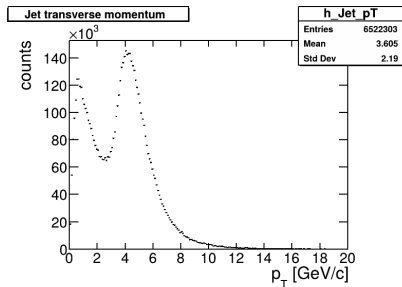
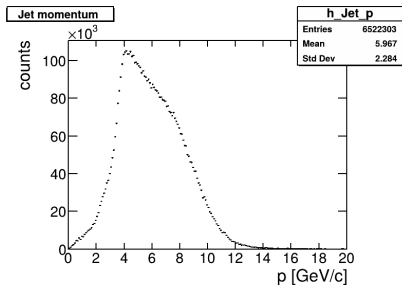
MC particles π^- η vs. energy



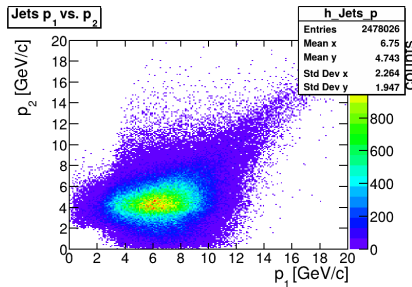
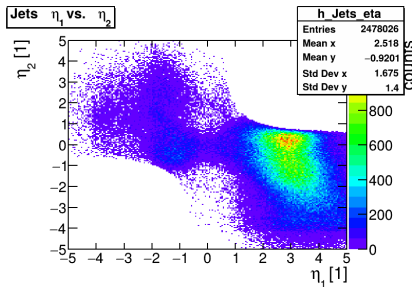
- Total energy distributions vs. η
 - Average neutron energy similar to inclusive events
- Kinetic energy is measured in nHCal



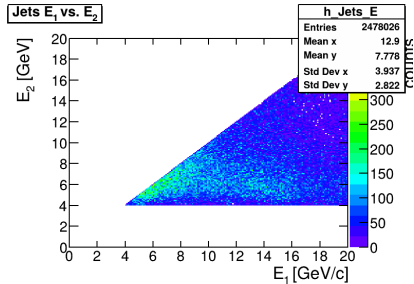
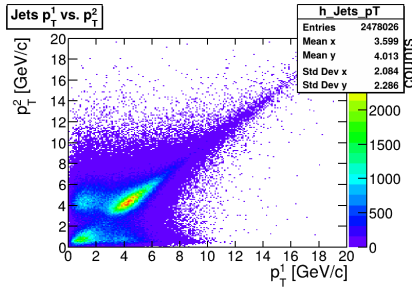
- All jets



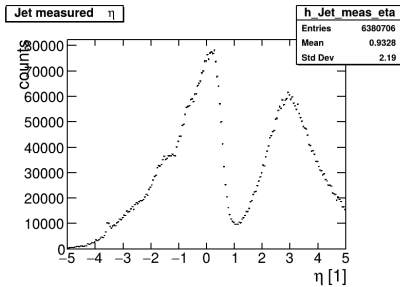
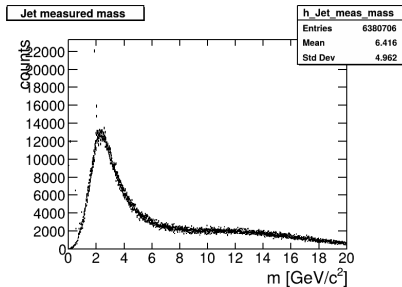
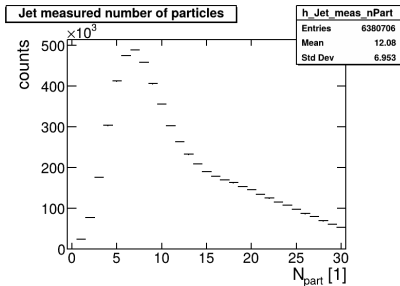
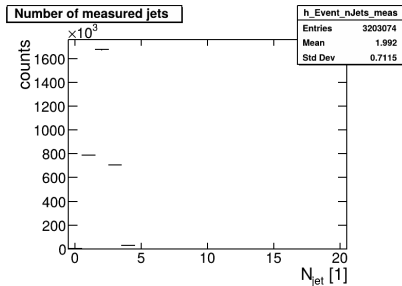
- All jets



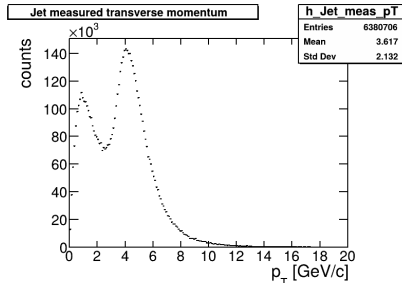
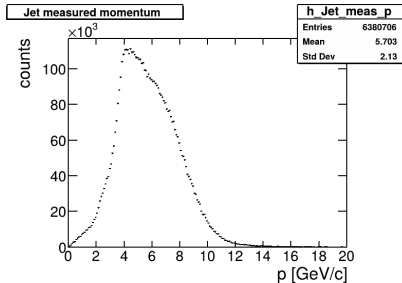
- All jets



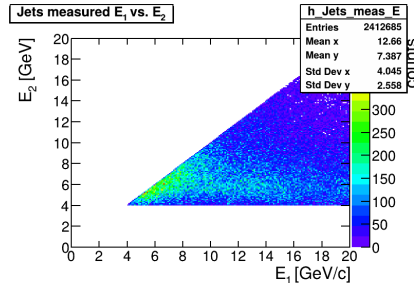
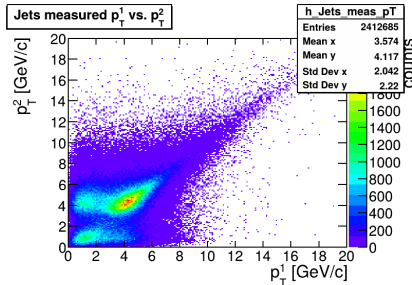
- All jets



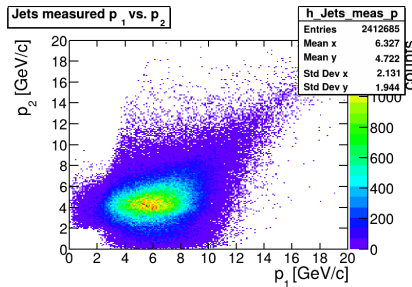
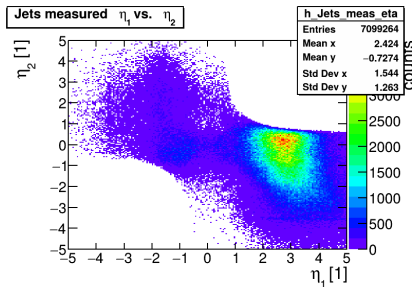
- Measured jets



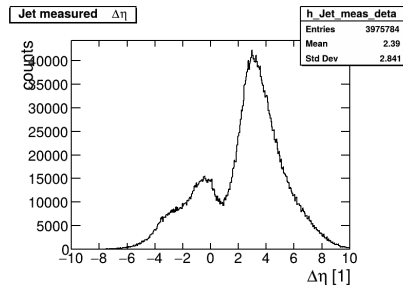
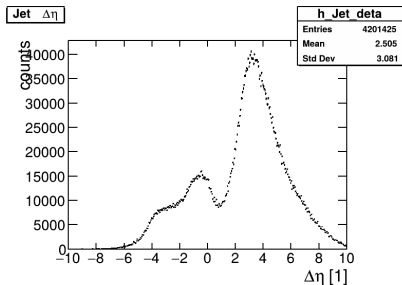
- Measured jets



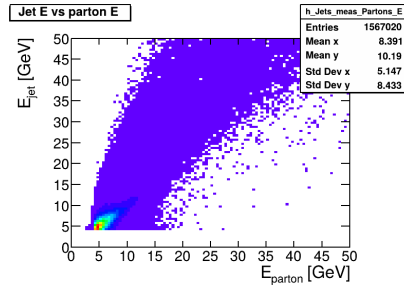
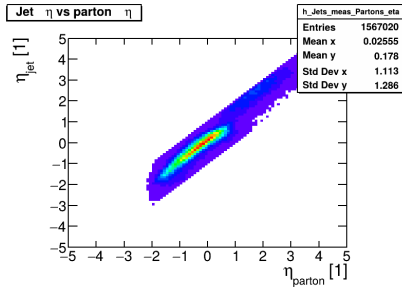
- Measured jets



- Measured jets



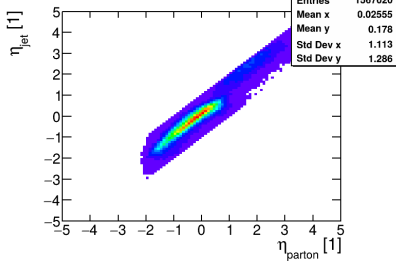
- All jets vs. measured



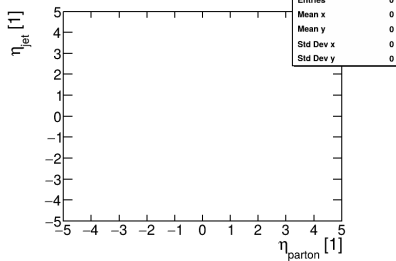
- Jets measured vs. partons

Jets measured vs. partons

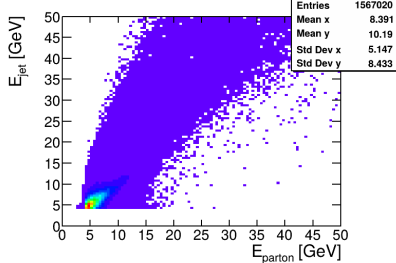
Jet η vs parton 1 η



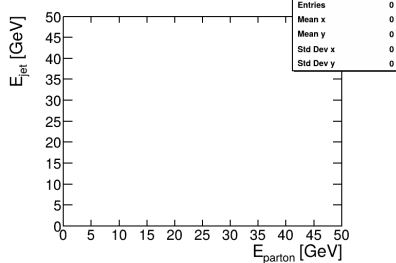
Jet η vs parton 2 η



Jet E vs parton 1 E



Jet E vs parton 2 E

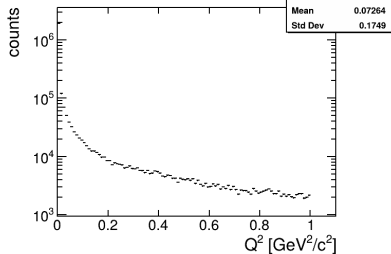


Conclusions

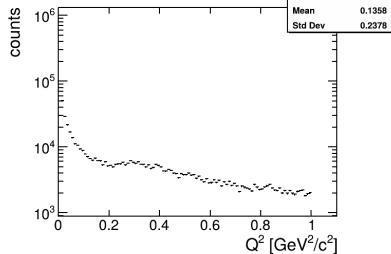
- Implemented FastJet
- First look at jets

BACKUP

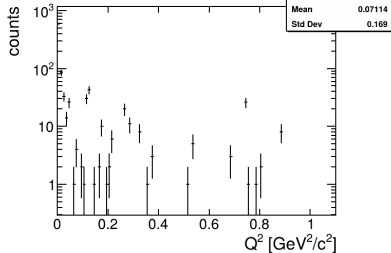
Event with jets in any HCal Q^2



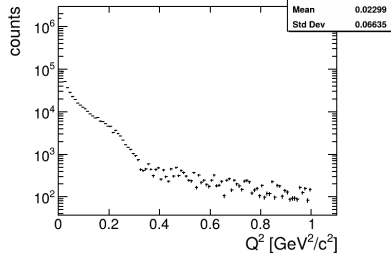
Event with 1 jet in nHCal Q^2



Event with 2 jets in nHCal Q^2

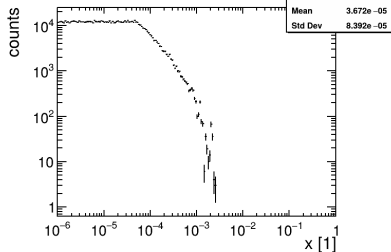


Event with 0 jets in nHCal Q^2

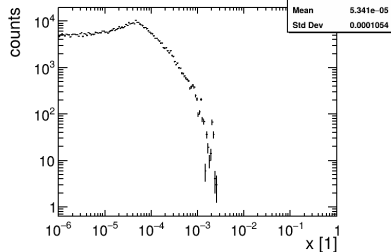


- All events

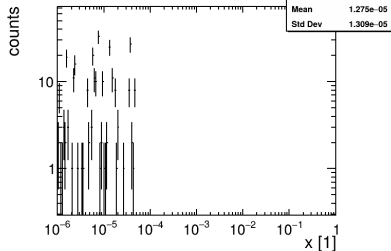
Event with jets in any HCal x



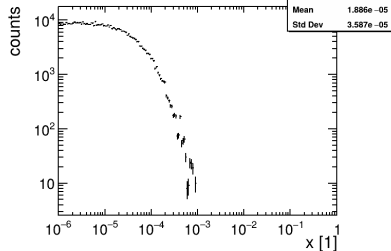
Event with 1 jet in nHCal x



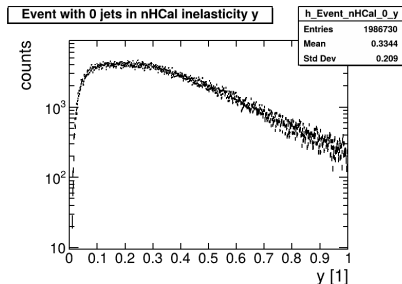
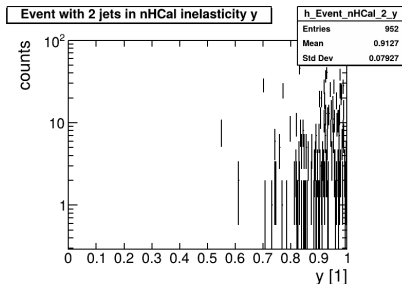
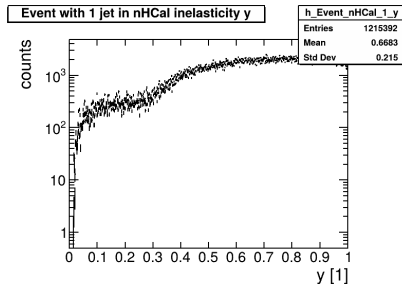
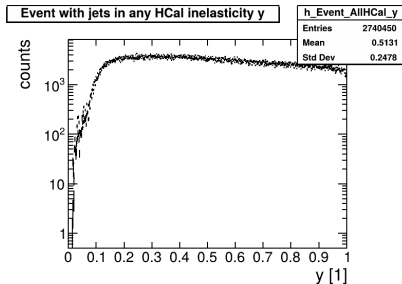
Event with 2 jets in nHCal x



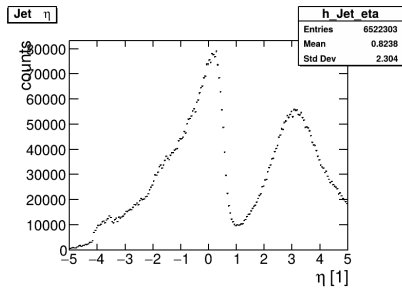
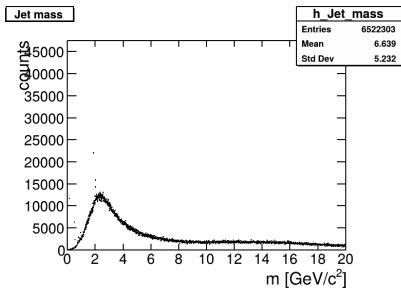
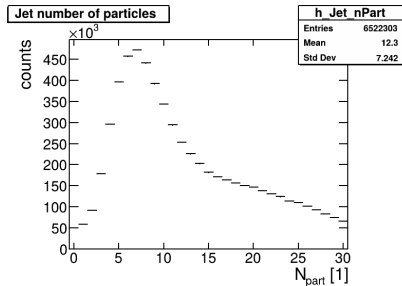
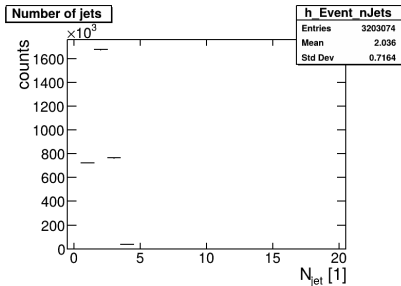
Event with 0 jets in nHCal x



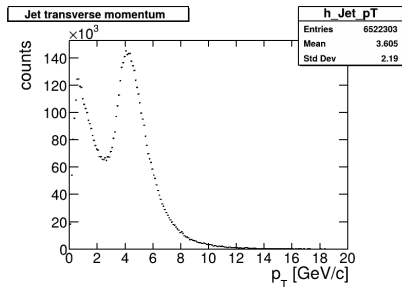
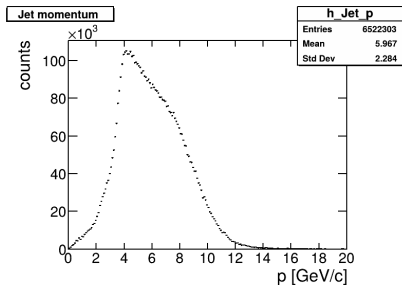
- All events



- All events

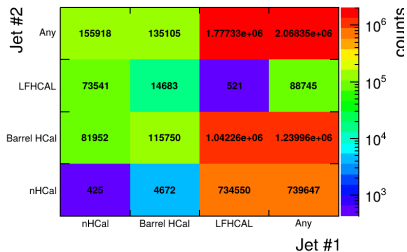


- All jets

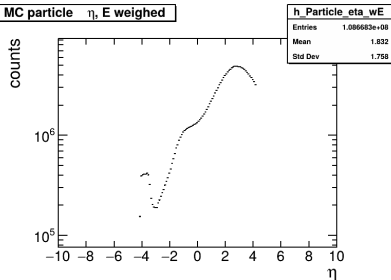


- All jets

Event with dijets in HCals



MC particle η , E weighed



- Calculated average energy in acceptance of HCals