Comments

Hi Florencia,

It would be good to schedule a presentation at our next upgrade physics meeting. A few comments:

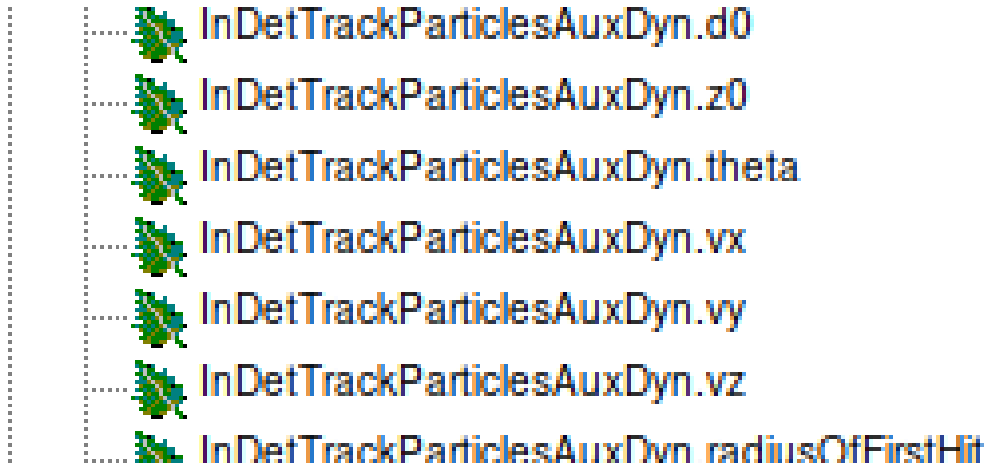
- Pflow has not been validated in Run 4 samples yet, so using pflow inputs is too premature without further studies. My suggestion for now is to use EMTopo jets, fully calibrated, and use tracks as inputs to compute substructure variables.

- A key element of any Run 4 study is track selection. In fact I see you use pt>0.5 GeV as in Run 2/3 but we only store tracks above 1 GeV in Run 4 in the central region. For the forward region you will need a cut on track time to reduce pileup contamination. Track impact parameter significance cuts are extremely important. My suggestion is that you require track z0 significance < 3 with respect to the primary vertex, and depending on what sample you are looking at, require that the reco vertex z is within 2mm of the truth z vertex.

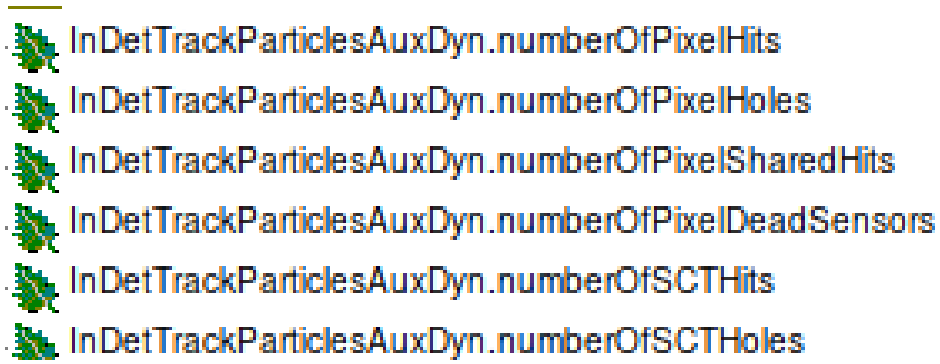
- Please quantify the average of each input variable (as well as the tagger rejection at fixed efficiency) as a function of the vertex z density.

Best,
Ariel

New variables



Added for a Track definition



Not added, but we can think to integrate them

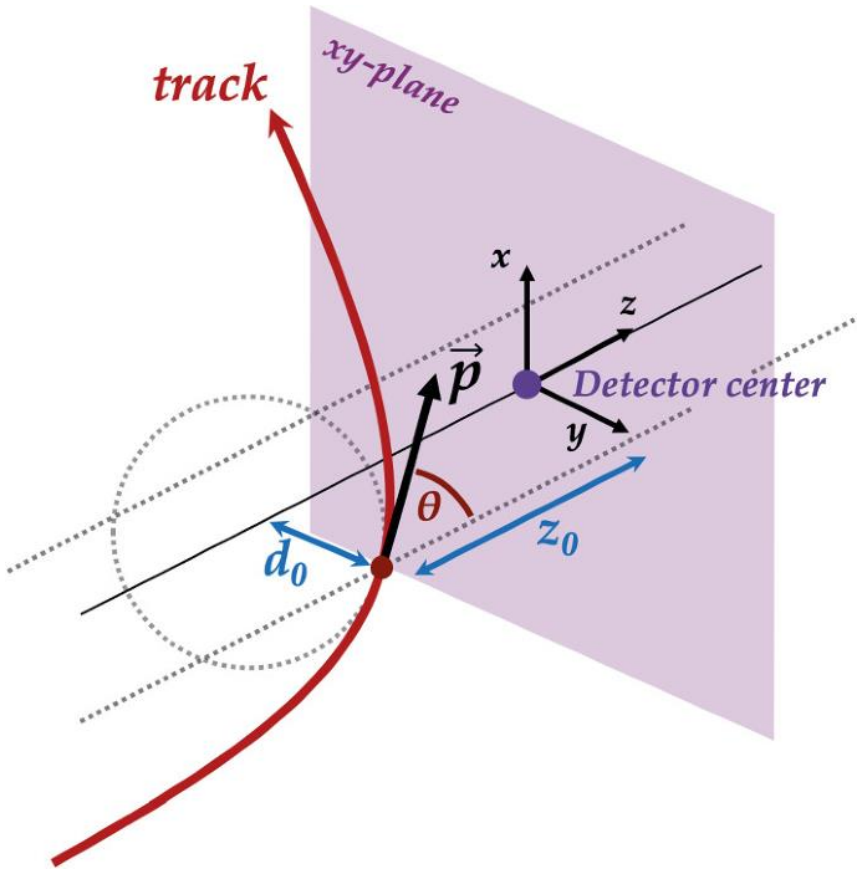
New track variables

- Primary vertex: The primary vertex is reconstructed from the tracks of the particles that originate from the collision point.

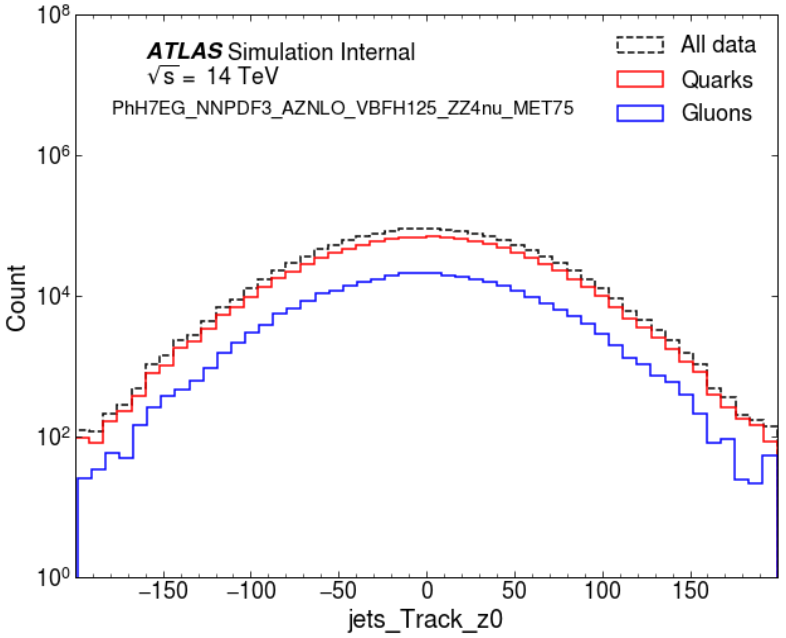
- d0: Transverse impact parameter of the track. The distance of closest approach of the track to the primary vertex in the transverse (xy) plane. This parameter is crucial for identifying displaced vertices, which can be indicative of secondary vertices from decays of particles like B-hadrons

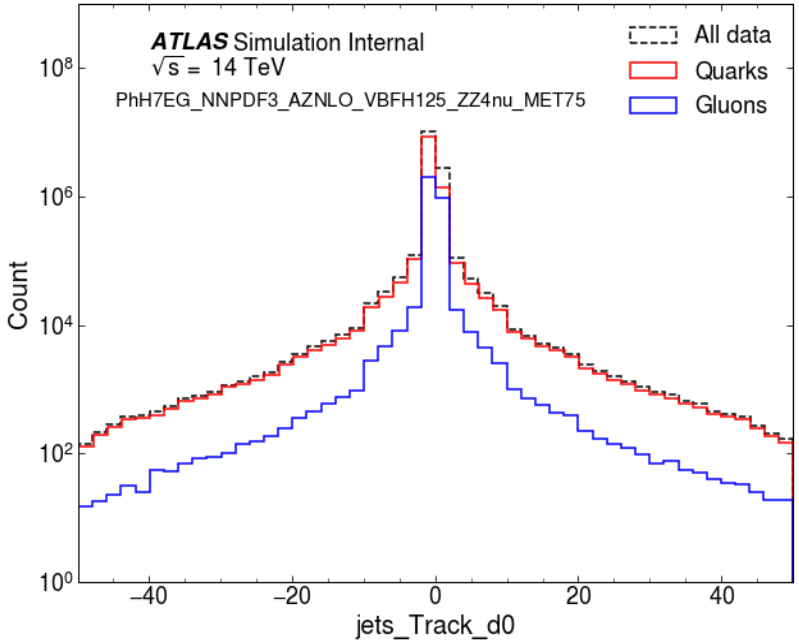
- z0: Longitudinal impact parameter of the track. The distance along the z-axis (beamline) between the primary vertex and the point where the track is closest to the z-axis. This parameter helps in assessing the alignment of the track with the primary vertex along the beamline direction

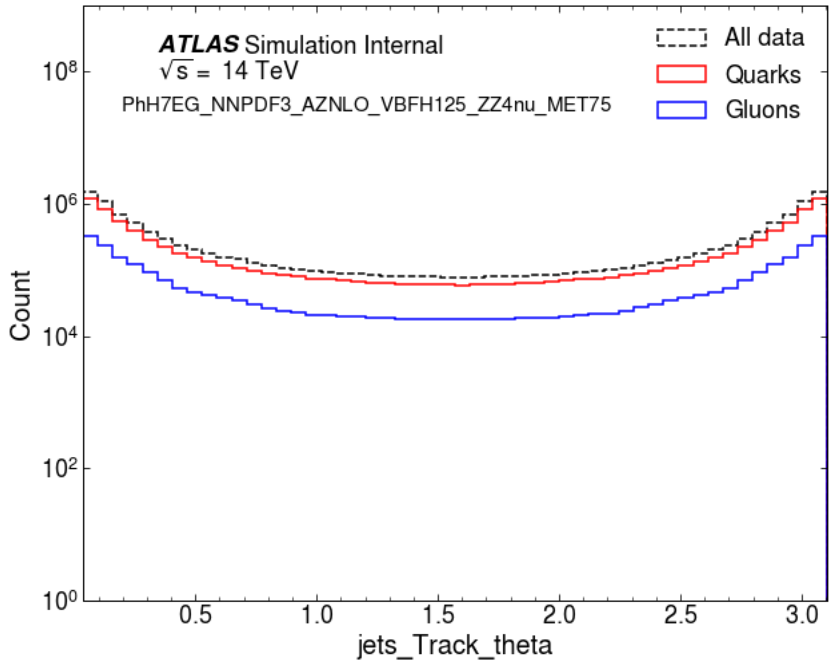
- theta: Polar angle of the track. The angle between the track and the z-axis (beamline). In spherical coordinates, it defines the direction of the track with respect to the beamline. This angle is important for understanding the track's orientation in the detector



d0, z0, theta

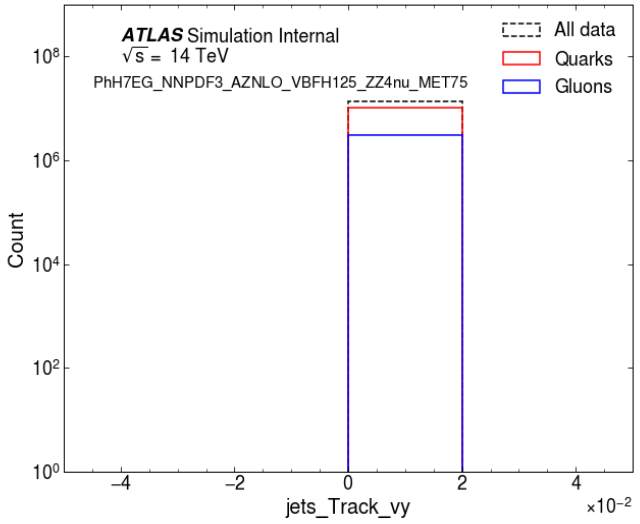

ATLAS Simulation Internal
√s = 14 TeV
PhH7EG_NNPDF3_AZNLO_VBFH125_ZZ4nu_MET75
All data
Quarks
Gluons
Count
jets_Track_z0

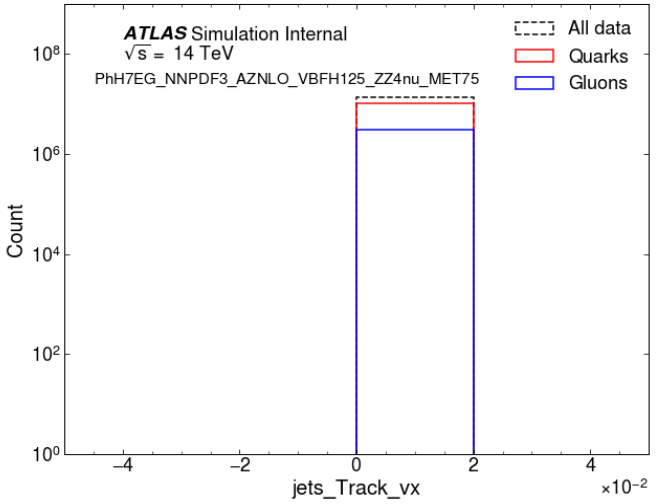

ATLAS Simulation Internal
√s = 14 TeV
PhH7EG_NNPDF3_AZNLO_VBFH125_ZZ4nu_MET75
All data
Quarks
Gluons
Count
jets_Track_d0

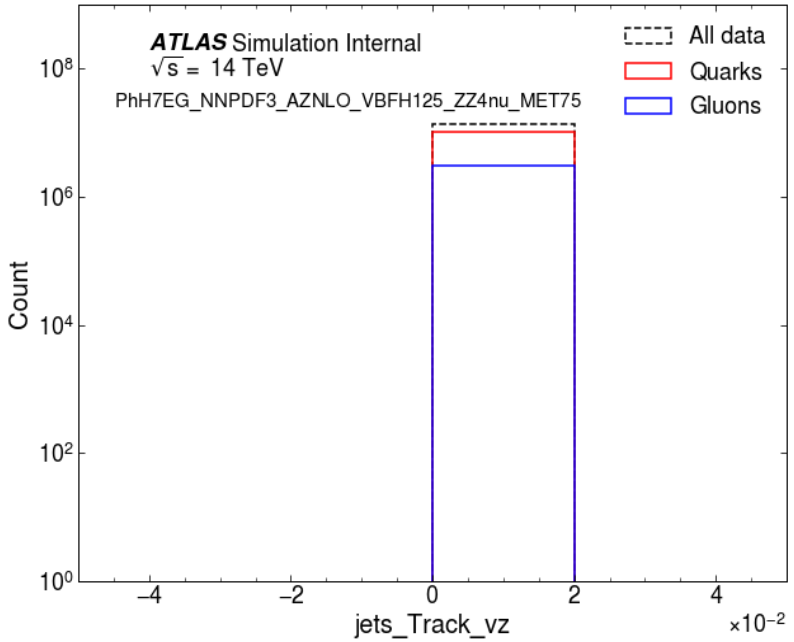

ATLAS Simulation Internal
√s = 14 TeV
PhH7EG_NNPDF3_AZNLO_VBFH125_ZZ4nu_MET75
All data
Quarks
Gluons
Count
jets_Track_theta

Track vertex positions

- Vx: x-coordinate of the track's vertex. The x-coordinate of the position where the track originates, typically corresponding to the point where the track was produced.
- Vy: y-coordinate of the track's vertex. y-coordinate of the track's vertex
- Vz: z-coordinate of the track's vertex. The z-coordinate of the position where the track originates. This coordinate is particularly important for understanding the longitudinal position of the track origin along the beamline

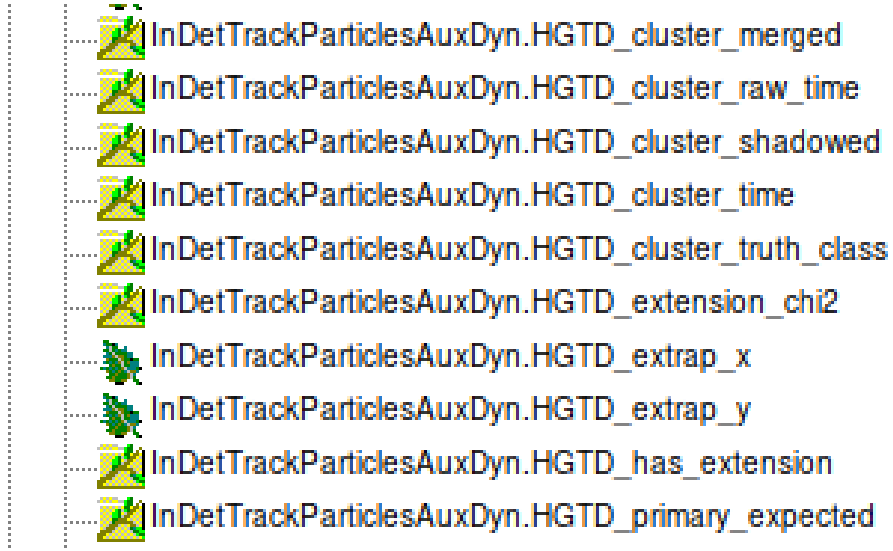




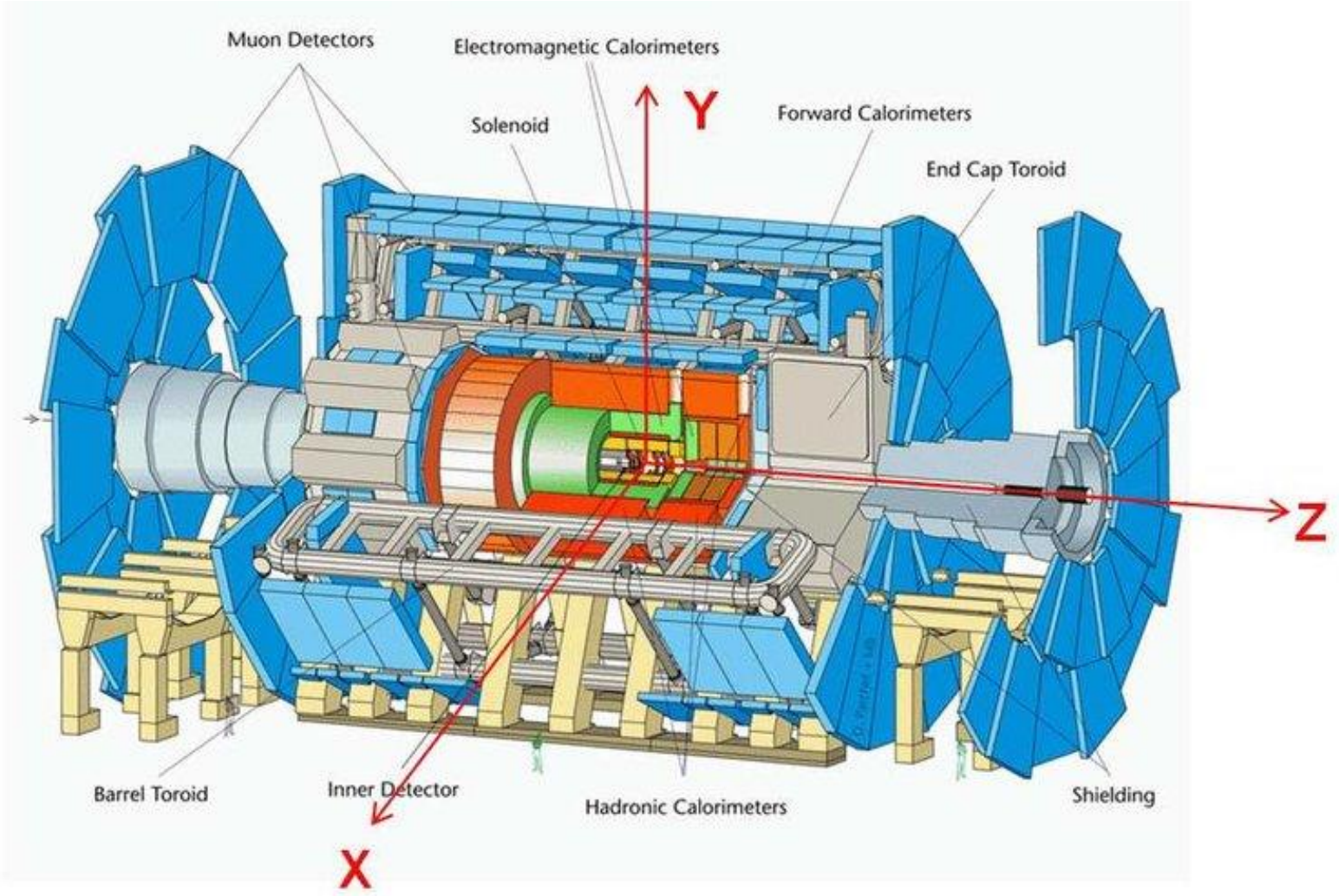


HGTD

```
Track properties
vector<int>     *InDetTrackParticlesAuxDyn_truthOrigin;
vector<int>     *InDetTrackParticlesAuxDyn_truthType;
Int_t           InDetTrackParticlesAuxDyn_truthParticleLink_;
vector<float>   *InDetTrackParticlesAuxDyn_truthMatchProbability;
vector<vector<bool> > *InDetTrackParticlesAuxDyn_HGTD_cluster_merged;
vector<vector<float> > *InDetTrackParticlesAuxDyn_HGTD_cluster_raw_time;
vector<vector<bool> > *InDetTrackParticlesAuxDyn_HGTD_cluster_shadowed;
vector<vector<float> > *InDetTrackParticlesAuxDyn_HGTD_cluster_time;
vector<vector<int> > *InDetTrackParticlesAuxDyn_HGTD_cluster_truth_class;
vector<vector<float> > *InDetTrackParticlesAuxDyn_HGTD_extension_chi2;
vector<float>   *InDetTrackParticlesAuxDyn_HGTD_extrap_x;
vector<float>   *InDetTrackParticlesAuxDyn_HGTD_extrap_y;
vector<vector<bool> > *InDetTrackParticlesAuxDyn_HGTD_has_extension;
vector<vector<bool> > *InDetTrackParticlesAuxDyn_HGTD_primary_expected;
vector<unsigned int> *InDetTrackParticlesAuxDyn_HGTD_summaryinfo;
vector<int>     *InDetTrackParticlesAuxDyn_nBC_meas;
vector<float>   *InDetTrackParticlesAuxDyn_time;
vector<float>   *InDetTrackParticlesAuxDyn_timeres;
```

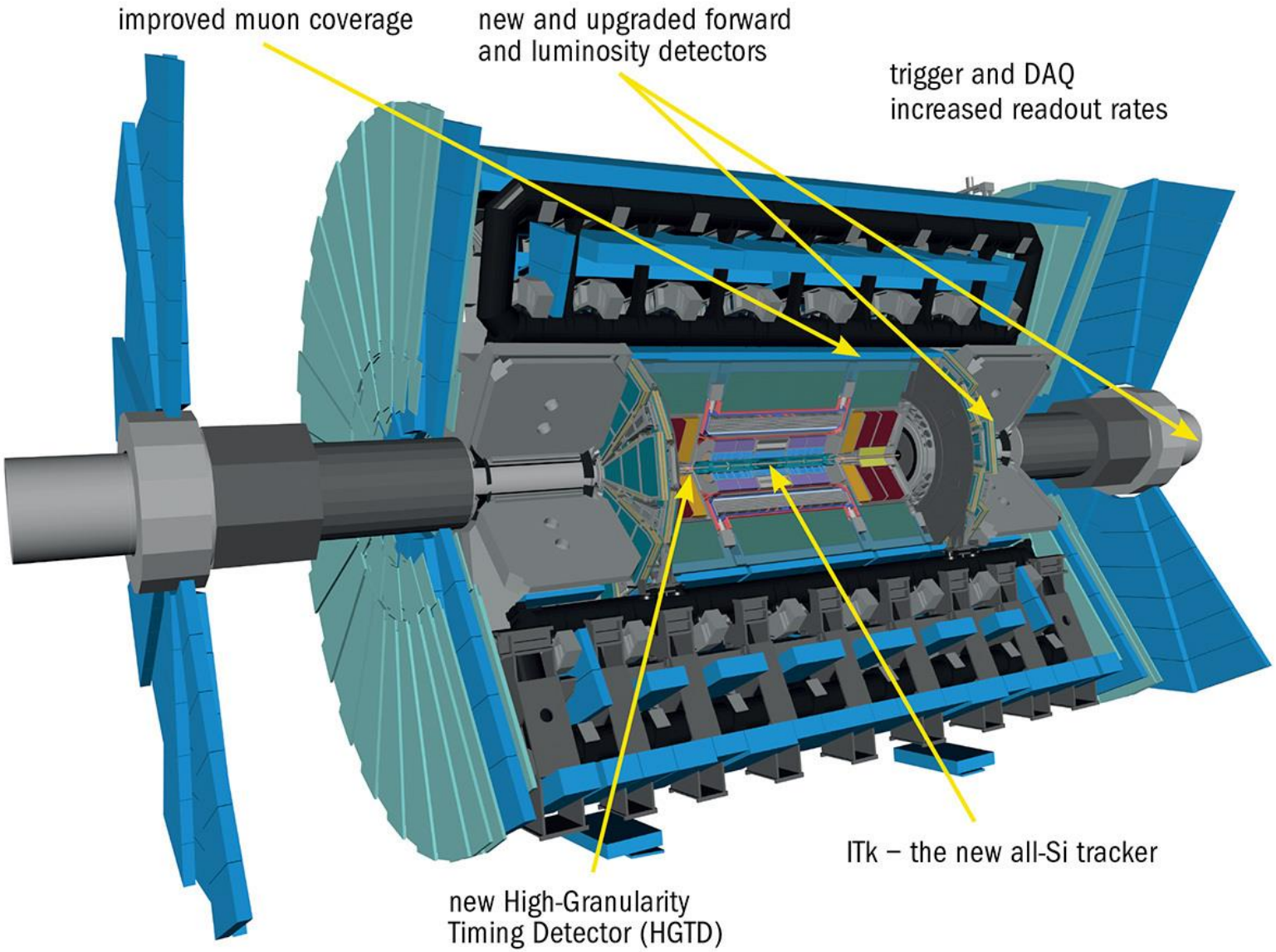


HGTD

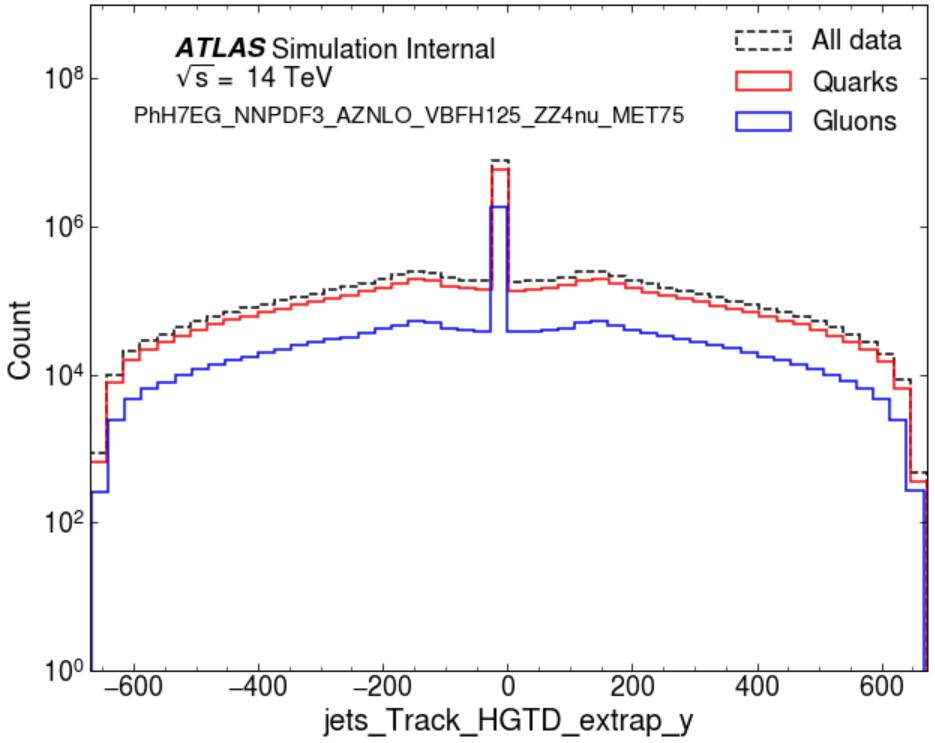

Muon Detectors
Electromagnetic Calorimeters
Y
Solenoid
Forward Calorimeters
End Cap Toroid
Z
Barrel Toroid
Inner Detector
Hadronic Calorimeters
Shielding
X

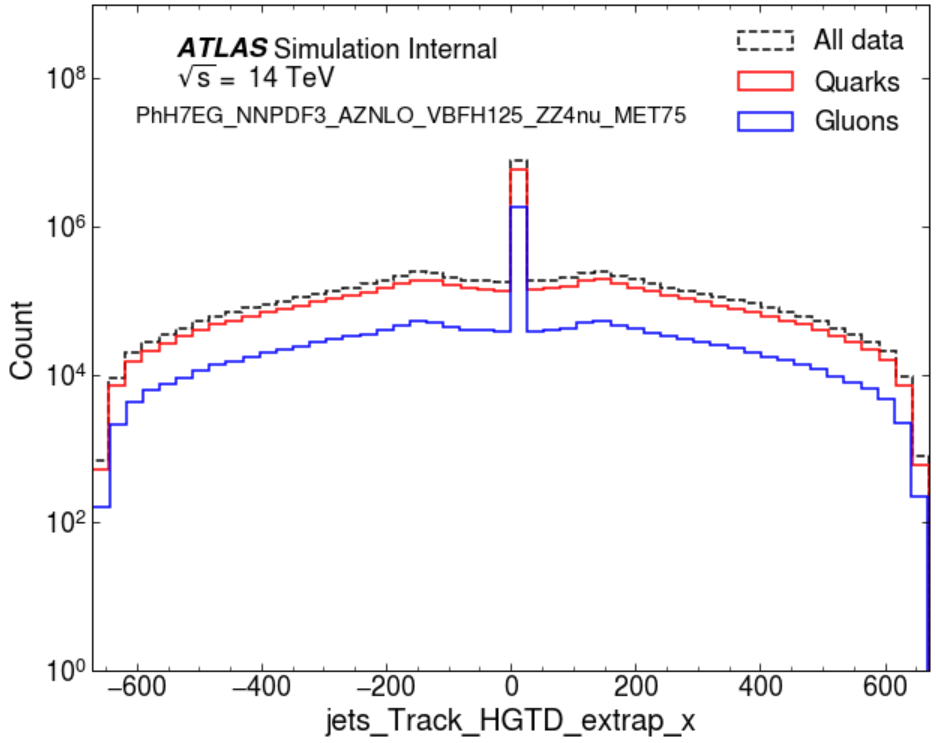
HGTD

- **Coverage Range**: The HGTD is planned to cover the pseudorapidity range from approximately $2.4 < |\eta| < 4.0$.

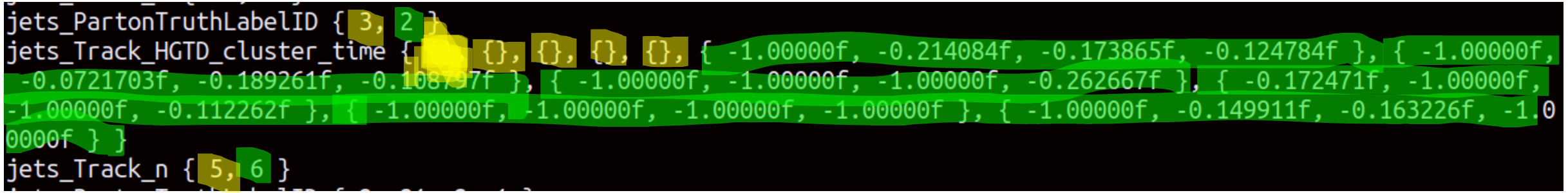


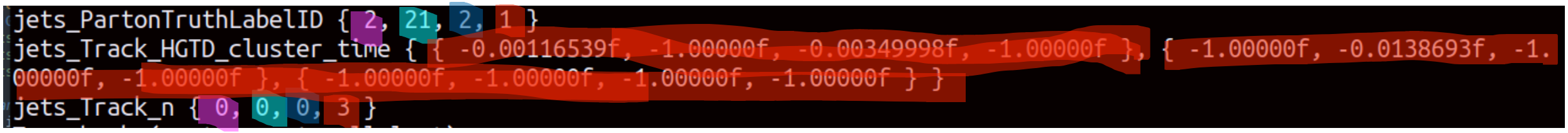
HGTD Extrapolated x and y coordinates





HGTD cluster time



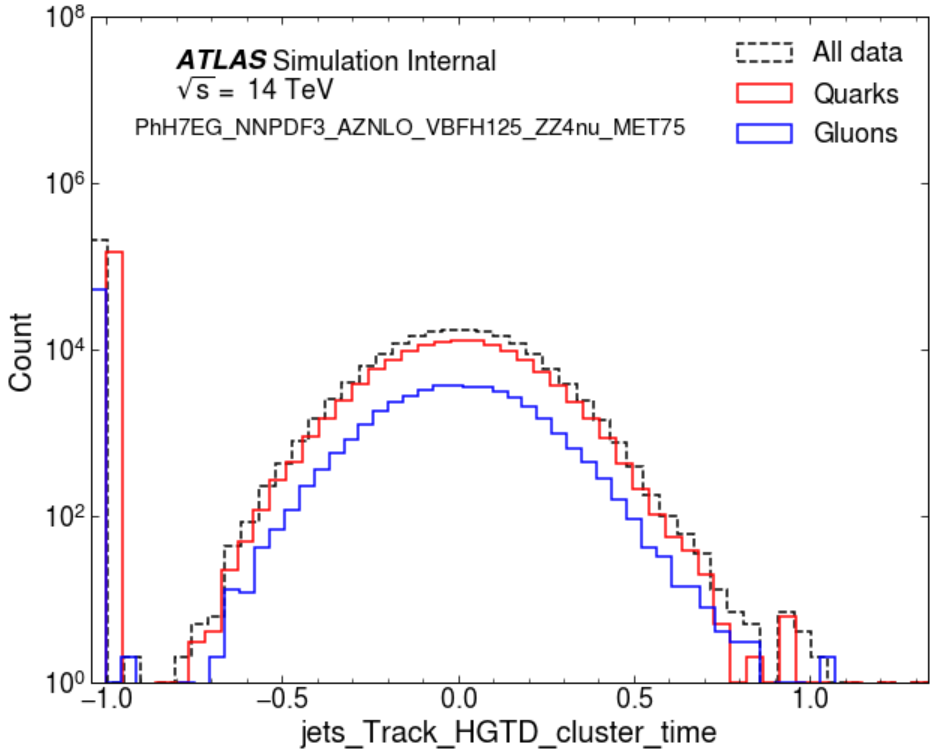


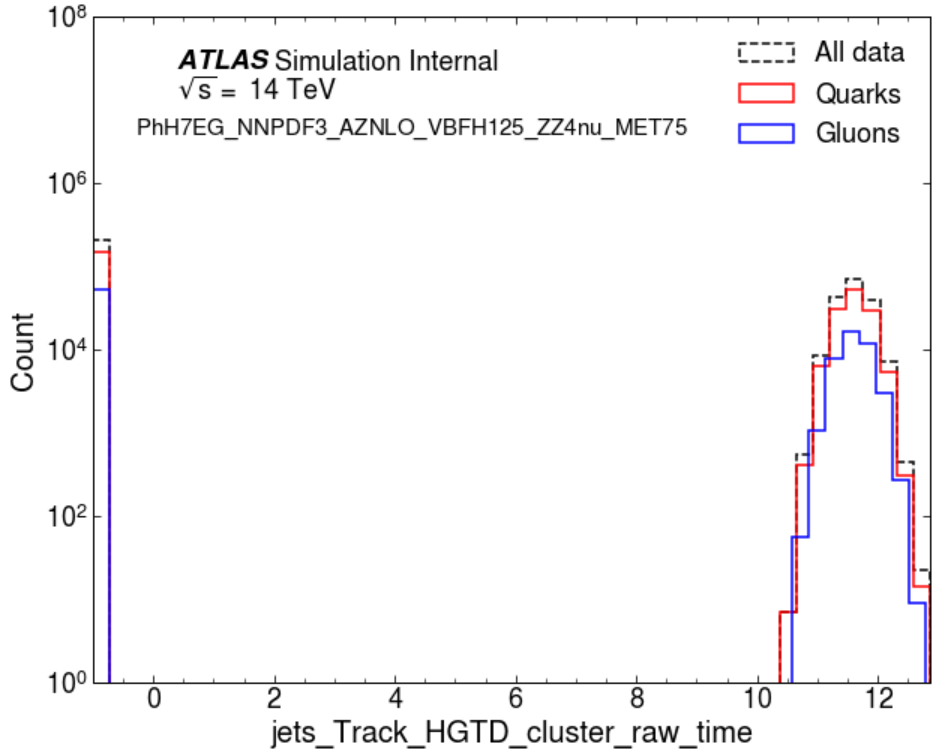
record the time information associated with clusters from the HGTD.

HGTD cluster time

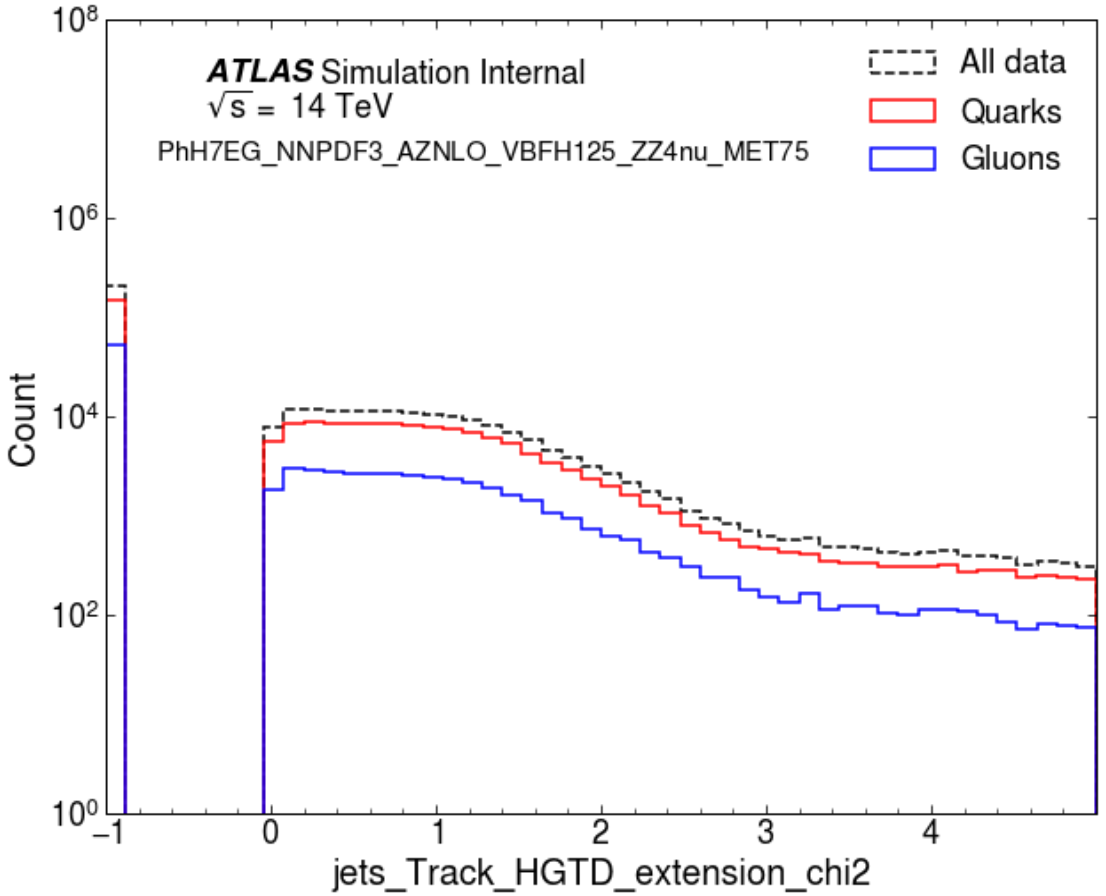
HGTD cluster raw time refers to the unprocessed timing information directly measured by the HGTD detector. It represents the raw signal arrival time at the detector without any corrections or calibrations applied.

HGTD cluster time refers to the processed and calibrated timing information that has been corrected for various factors such as detector response, calibration constants, and timing offsets. This is the timing information used for final analysis and comparison with other measurements.





HGTD extension chi2

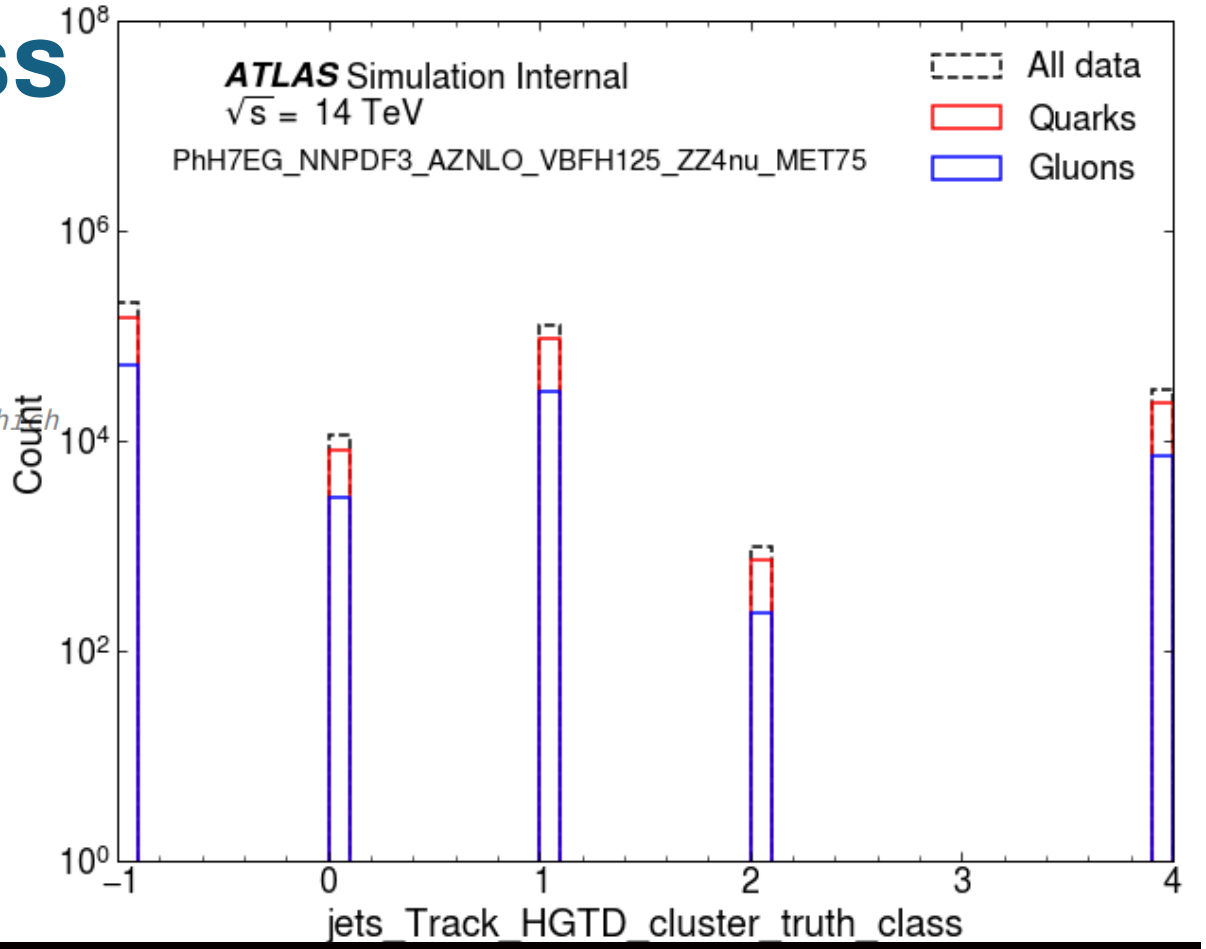


- Measures the discrepancy between the expected position of a track (based on its parameters) and the actual position where the track intersects the HGTD.
- This helps quantify the goodness-of-fit for the track's extrapolation to the HGTD.
- A lower chi-squared value indicates a better fit between the predicted and observed positions, whereas a higher value suggests a poorer fit.

HGTD cluster truth class

```
namespace HGTD {
enum class ClusterTruthOrigin {
  UNIDENTIFIED = 0,
  TRUTH_PARTICLE = 1, // originates from the tested truth particle
  HARD_SCATTER = 2,   // originates from a HS particle, but unclear which
  PILEUP = 3,         // originates from a pileup interaction
  SECONDARY = 4       // originates from some secondary interaction
};
```

https://acode-browser1.usatlas.bnl.gov/lxr/source/athena/HighGranularityTimingDetector/HGTD_Reconstruction/HGTD_RecToolInterfaces/HGTD_RecToolInterfaces/IHGTD_ClusterTruthTool.h#0051




```
jets_PartonTruthLabelID { 3, 1 }
jets_Track_HGTD_cluster_time { {}, {}, {}, {}, {}, {}, {}, {}, {}, {}, {}, {}, {}, {}, {}, { -0.0868788f, -1.00000f, -1.00000f, -1.00000f }, { -0.0626068f, -0.133852f, -1.00000f, -1.00000f }, { -0.0399399f, -0.131161f, -0.0712185f, -0.201877f }, { -1.00000f, -1.00000f, -1.00000f, -1.00000f }, { -1.00000f, -0.0767756f, -0.0902195f, -1.00000f }, { -0.104699f, -1.00000f, -0.0932989f, -0.0751143f } }
jets_Track_HGTD_cluster_truth_class { {}, {}, {}, {}, {}, {}, {}, {}, {}, {}, {}, {}, {}, {}, {}, { 4, -1, -1, -1 }, { 1, 1, -1, -1 }, { 1, 1, 1, 1 }, { -1, -1, -1, -1 }, { -1, 1, 1, -1 }, { 1, -1, 1, 1 } }
jets_Track_n { 16, 6 }
```

Extrapolated x and y. Only leading and sub-leading jets