Hit-based track to MC particle association for DIS events

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Hit-based track to MC particle matching
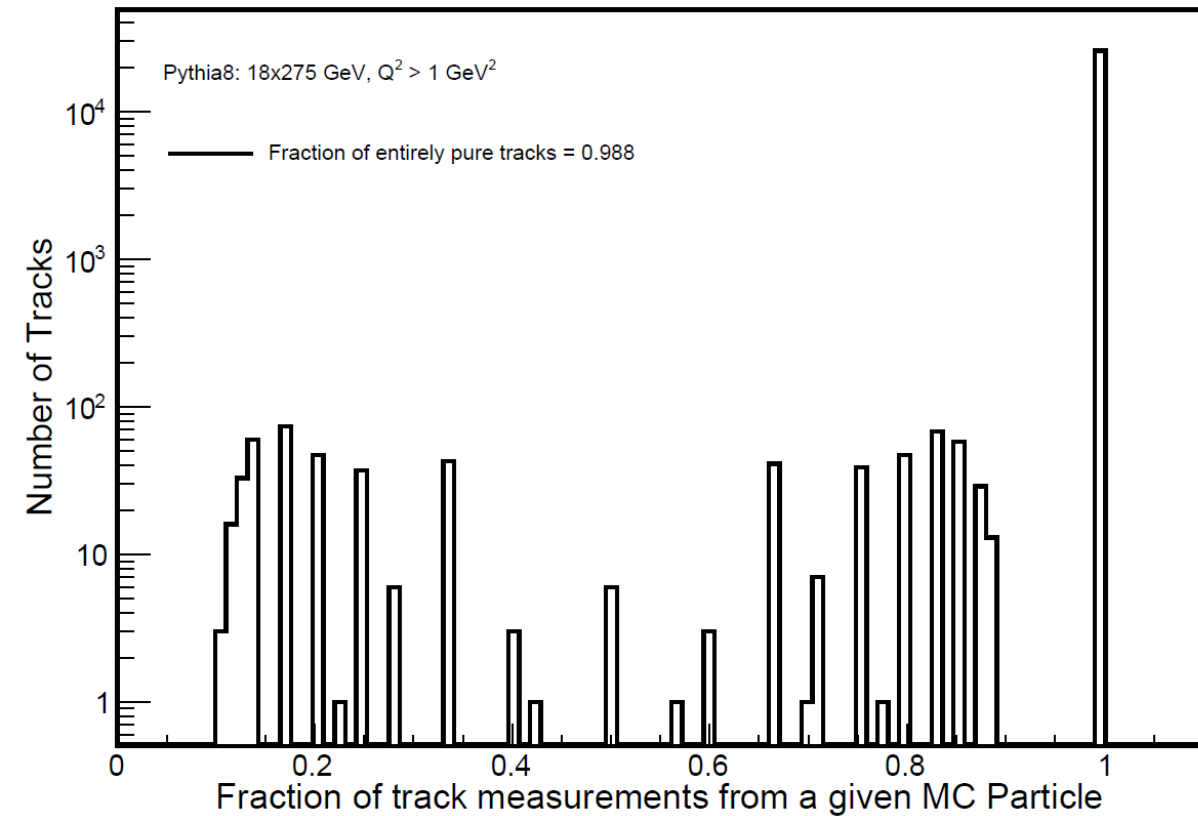
➢ Hit-based track to MC particle matching has been implemented into EICRecon (https://github.com/eic/EICrecon/pull/1564).

➢ For each measurement hit used in a track fit, we know which MC particle caused that hit (based on the Geant4 information). We use this to create hit-based associations between the tracks and the MC particles, with the association weight determined by the fraction of the hits caused by a given particle.

➢ Note that the association weights are based on the good measurement hits from the track fit, and do not consider outlier hits.

Event number | Association index | Weight | MC Particle index | Track index

```
*          1 *          0 *             1 *         12 *          0 *
*          1 *          1 *             1 *         19 *          1 *
*          1 *          2 *             1 *         32 *          2 *
*          1 *          3 *             1 *         25 *          3 *
*          9 *          0 *             1 *         39 *          0 *
*          9 *          1 *             1 *         22 *          1 *
*          9 *          2 *             1 *         11 *          2 *
*          9 *          3 * 0.8571428 *         43 *          3 *
Type <CR> to continue or q to quit ==>
*          9 *          4 * 0.1428571 *        154 *          3 *
*          9 *          5 *             1 *         27 *          4 *
*          9 *          6 *             1 *         46 *          5 *
*          9 *          7 *             1 *         53 *          6 *
*          9 *          8 *             1 *         52 *          7 *
*          9 *          9 *             1 *          8 *          8 *
```
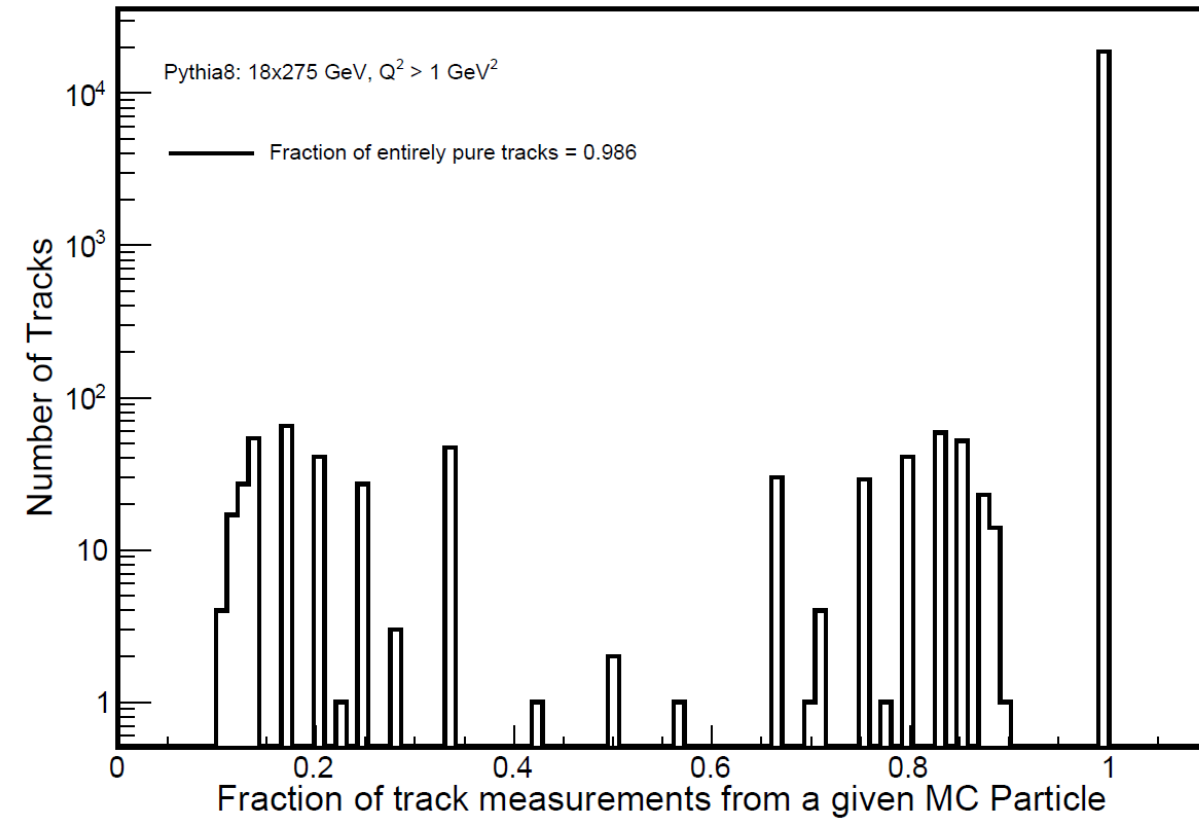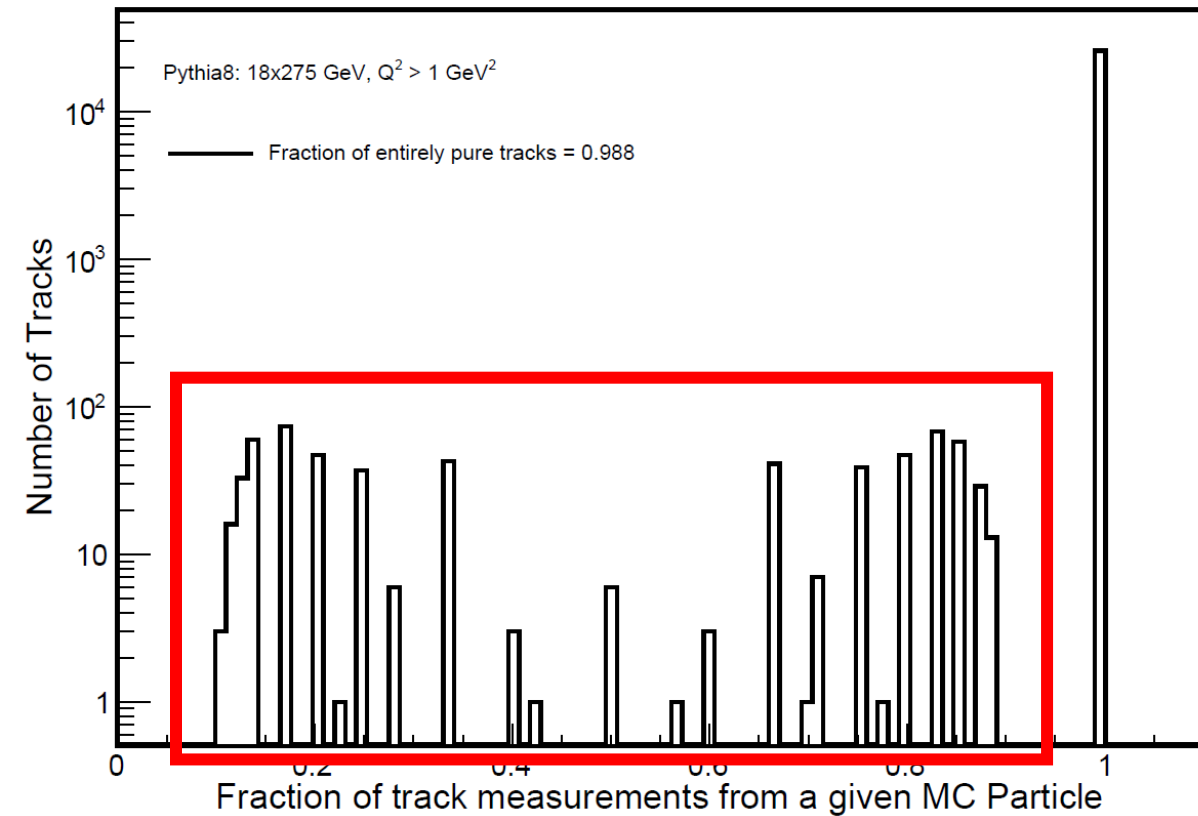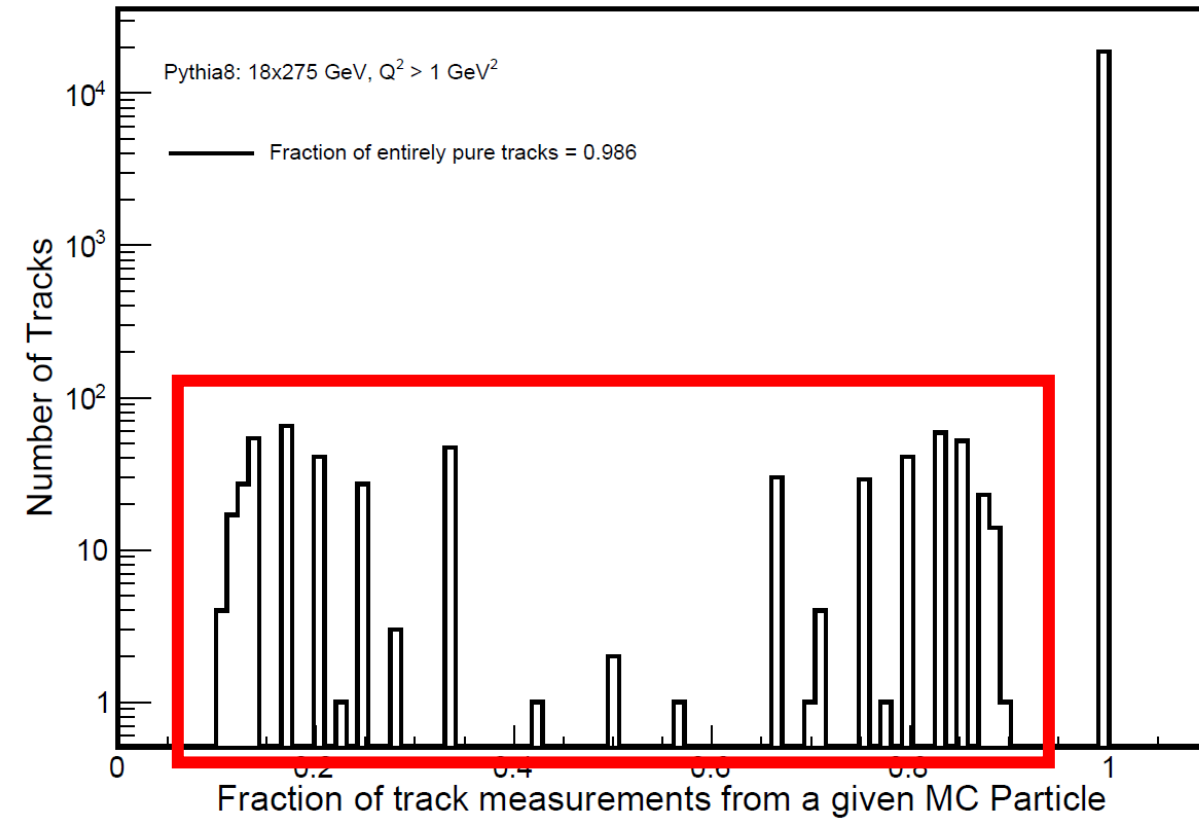
Track hit purity in DIS events

Truth-seeded tracks

Pythia8: 18x275 GeV, $Q^2 > 1$ GeV^2

Fraction of entirely pure tracks = 0.988

Number of Tracks

Fraction of track measurements from a given MC Particle

Real-seeded tracks

Pythia8: 18x275 GeV, $Q^2 > 1$ GeV^2

Fraction of entirely pure tracks = 0.986

Number of Tracks

Fraction of track measurements from a given MC Particle

Track hit purity in DIS events

Same reconstructed track gets filled into histogram multiple times when associated with multiple MC particles.
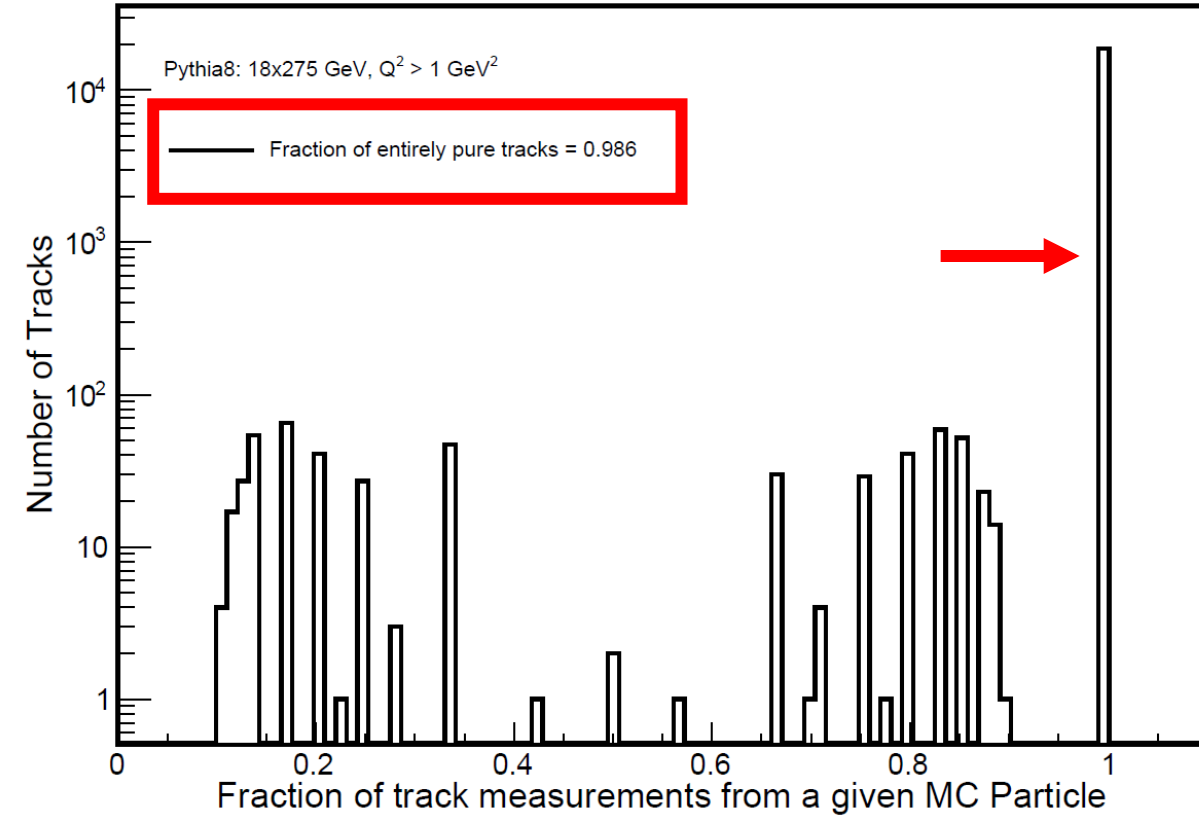

Truth-seeded tracks

Real-seeded tracks

Track hit purity in DIS events

For this setting, >98.5% of the reconstructed tracks have measurement hits associated with only one MC particle.
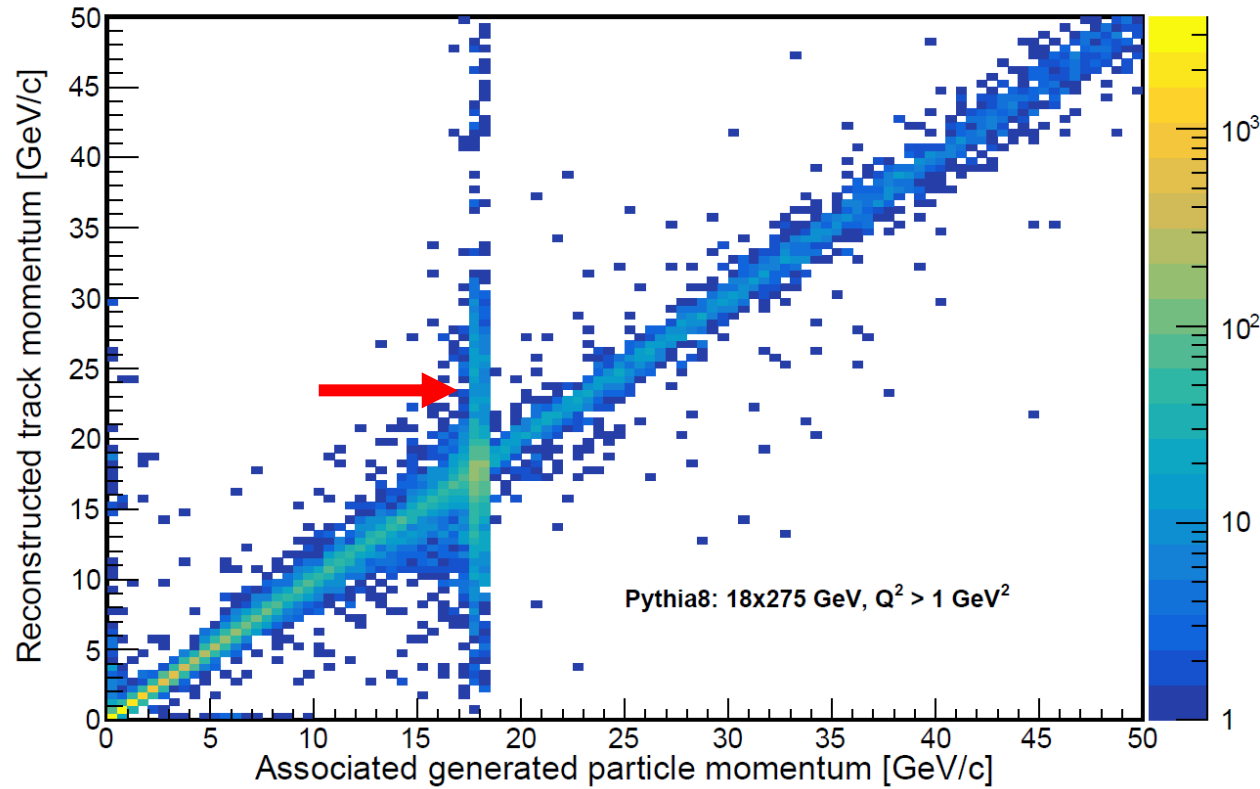

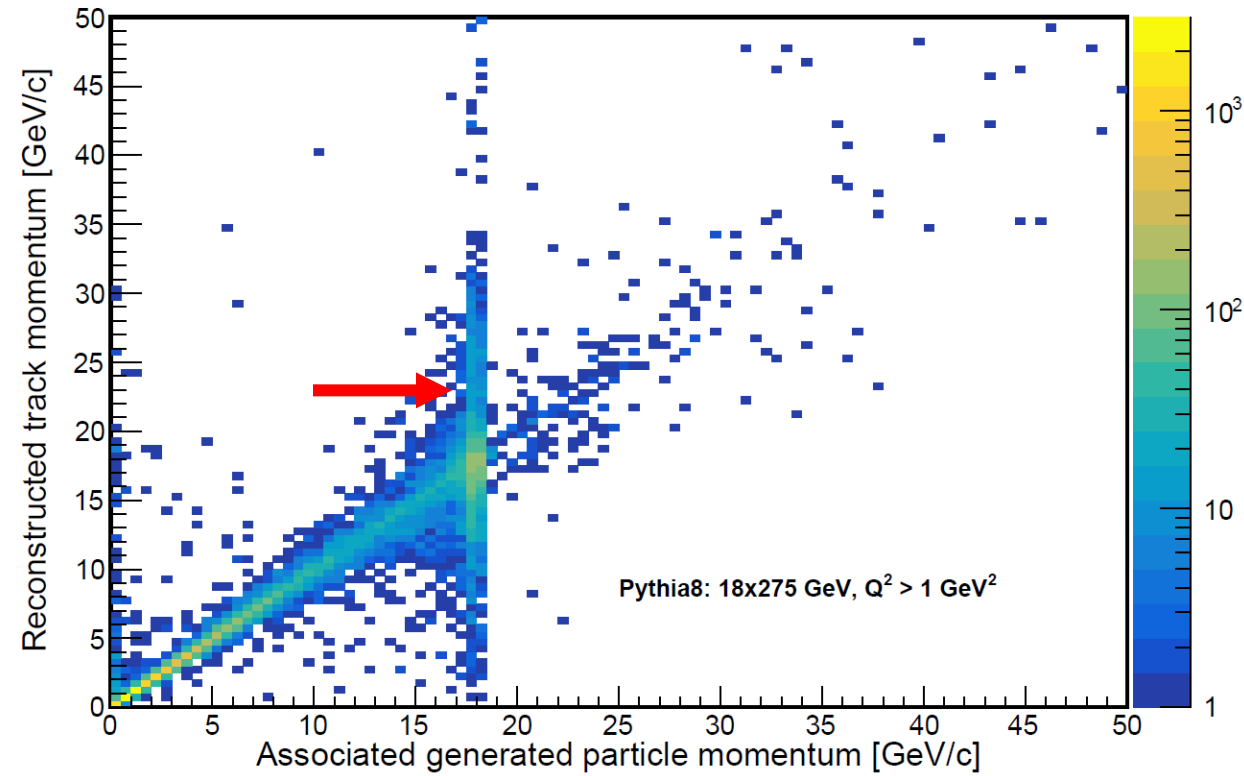Truth-seeded tracks
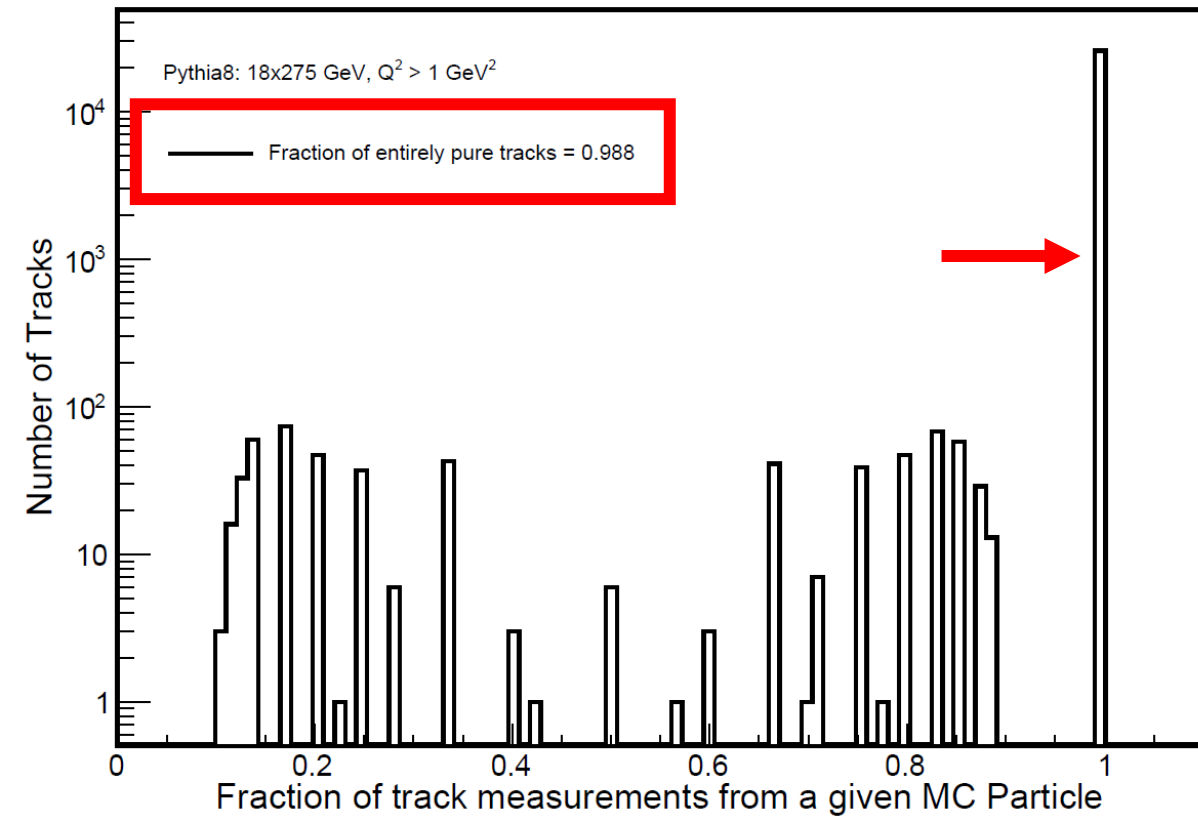
Real-seeded tracks

Momentum reconstruction

Scattered electron with $Q^2 \sim$ 1 GeV^2 in negative endcap
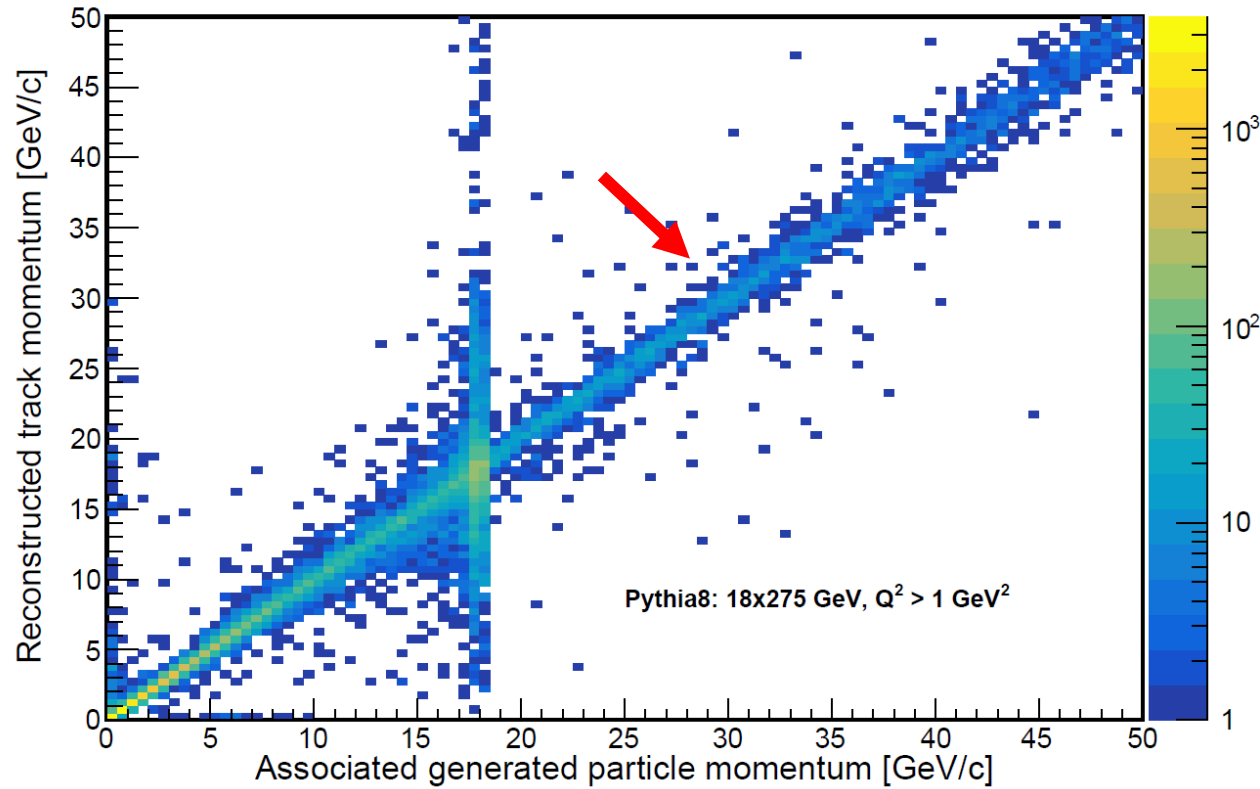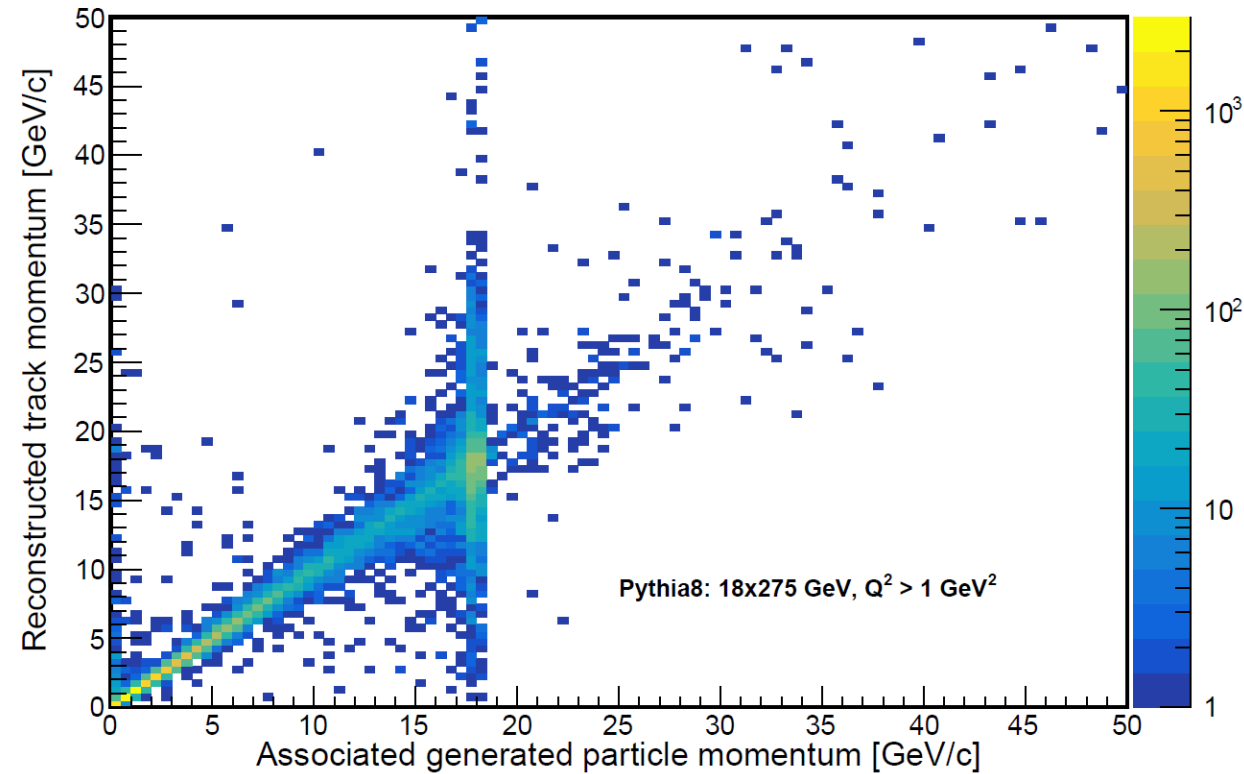
Momentum reconstruction

Far-forward particles reconstructed in truth-seeded tracking
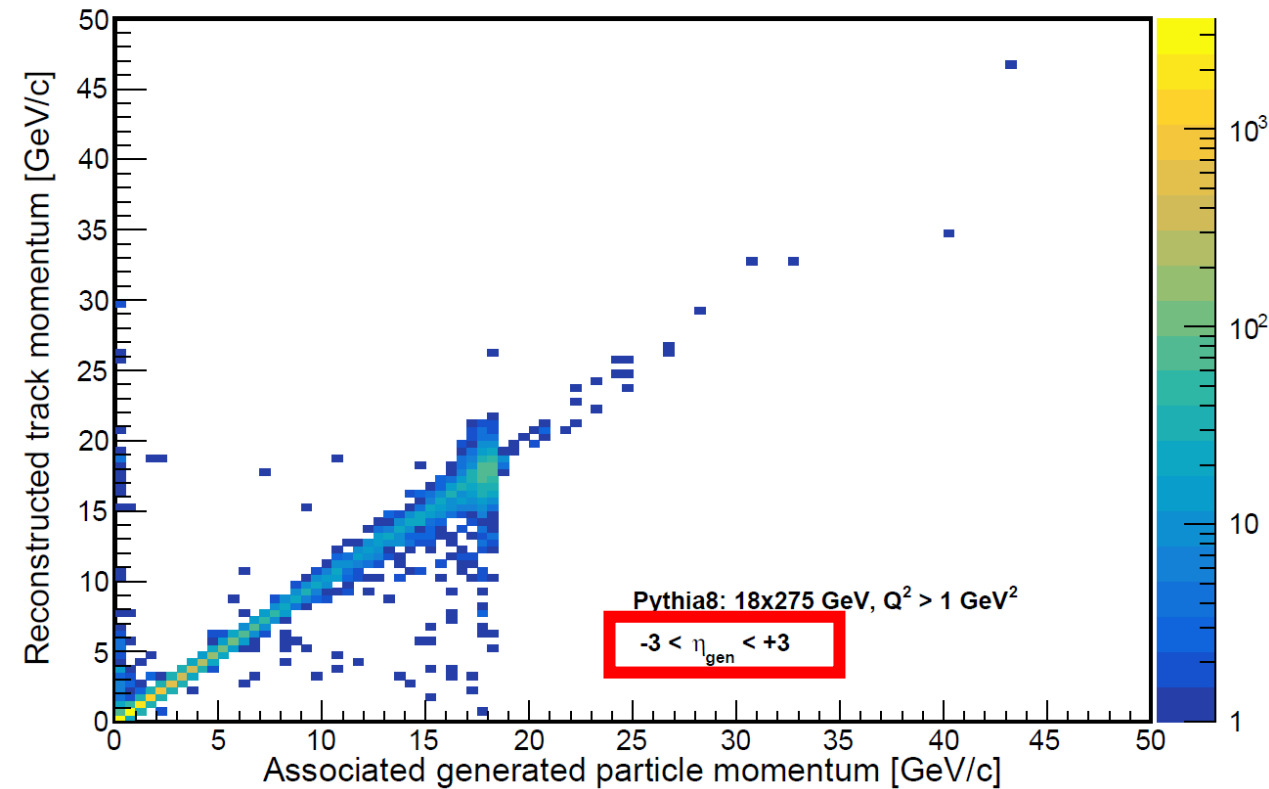

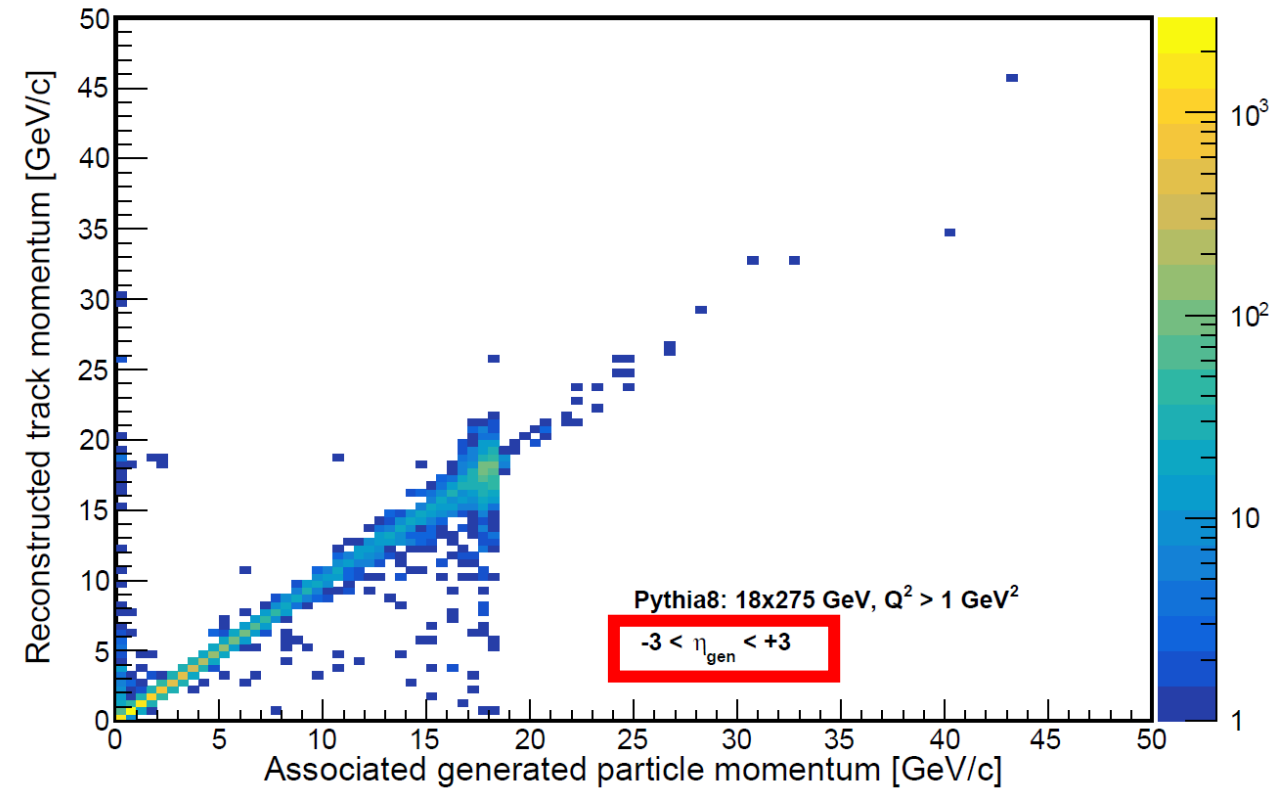Truth-seeded tracks

Real-seeded tracks

Momentum reconstruction

When limiting the angular rang of the associated MC particle, we see that the scattered electron peak and the far-forward particles are removed.

Truth-seeded tracks

Real-seeded tracks

Summary

➢ Hit-based track to MC particle associations have been implemented into the standard reconstructed output. Thanks to Wouter!

➢ The results look good for DIS events with 18x275 GeV and $Q^2 > 1$ GeV^2.

➢ We can use these associations to study, for example, momentum resolutions in DIS events and compare to the single-particle results. Since most tracks are associated with a single particle in these DIS events, we should see the same performance, I think.

➢ The next step is to repeat the purity study with background mixed in. It will be interesting to see to what extend the synchrotron photons hits, for example, cause a decrease the track purities. (Ben started some of these studies.)