

2019 Track-Finding Efficiency: WABs Redux

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HPS Analysis Meeting
June 8, 2021

Track-Finding Efficiency with Data

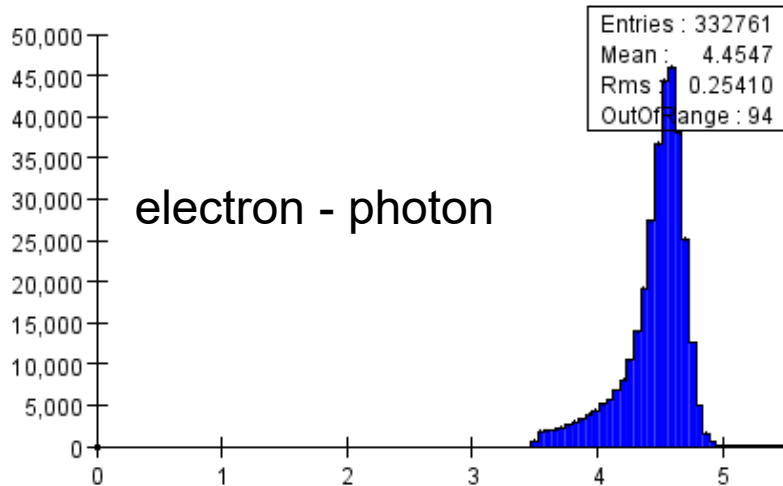
- Data Samples
 - Data run 31
- Reconstruction Version
 - hps-java 5.1 snapshot
- Detector
 - HPS_PhysicsRun2019-v2-FEE-Pass0
- Skim events containing two and only two clusters in the fiducial region of the calorimeter
- Clusters in diagonally opposite quadrants
- Cluster times within 2ns
- Cluster $E_{\text{sum}} > 3.5\text{GeV}$
- Provides 708542 WAB candidates

Event Classification

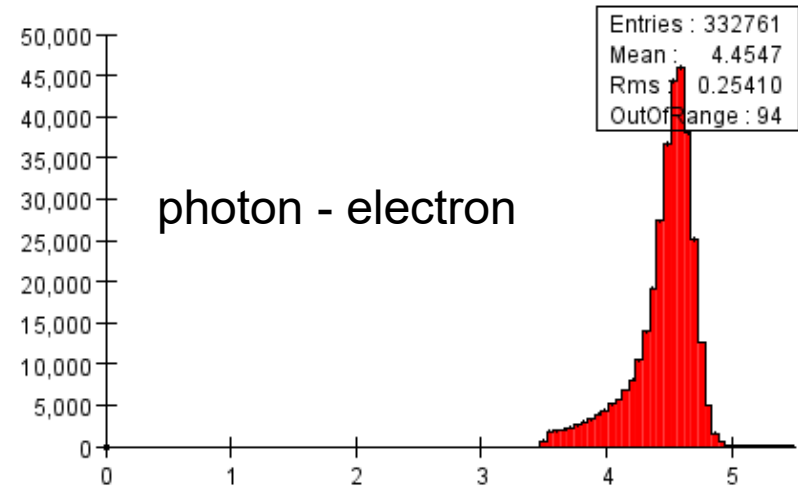
- Hypothesis is that these events are wide-angle bremsstrahlung (WAB) candidates where we have detected both the inelastically-scattered electron and the radiated photon, $e^- \gamma$.
- E_{sum} should equal beam energy
- One, or the other, of the clusters should have an associated track, the other should not.
- Discard events with a reconstructed positron, as these may be real trident events.
 - \rightarrow 642249 events
- Events reconstructed with two photons is a measure of the track inefficiency.

Event Cluster Types GBL

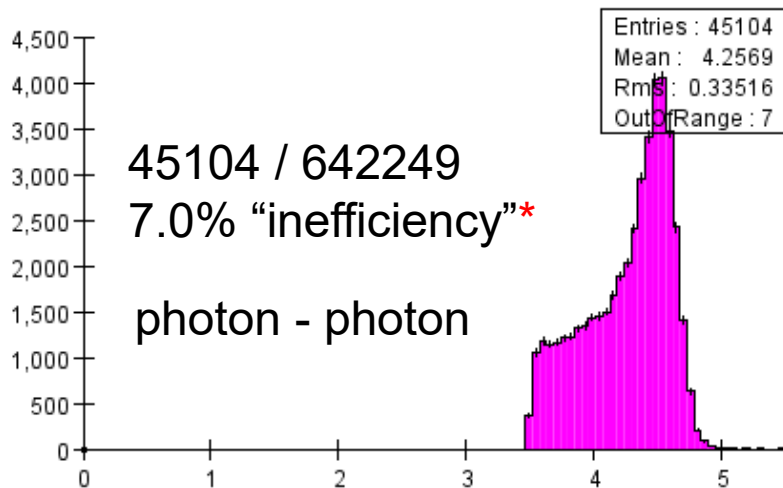
Cluster esum GBL ge



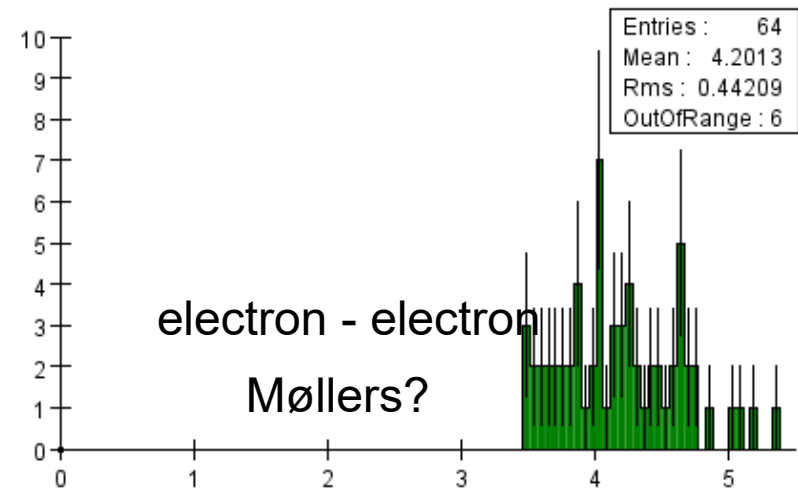
Cluster esum GBL ge



Cluster esum GBL gg

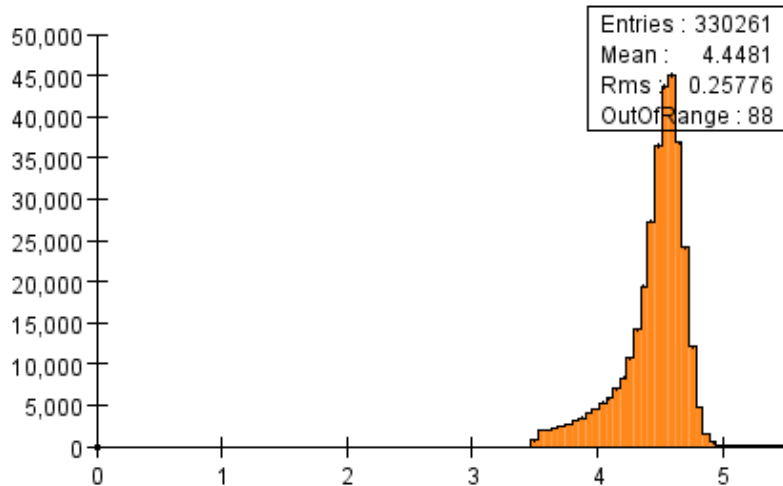


Cluster esum GBL ee

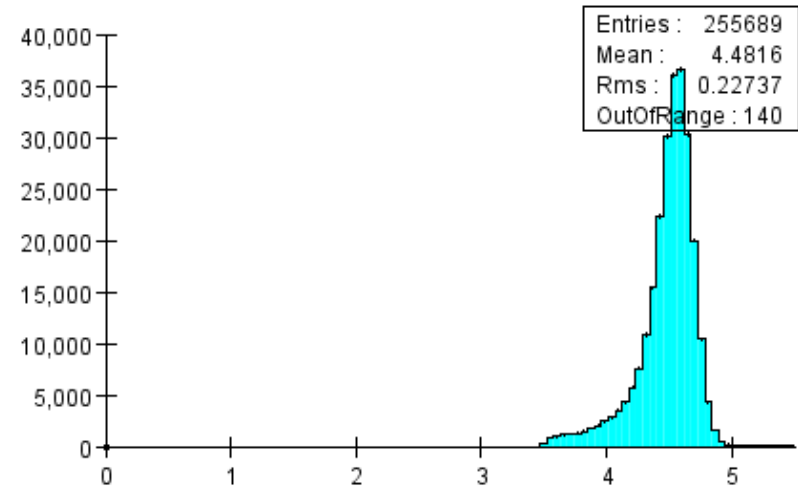


Event Cluster Types KF

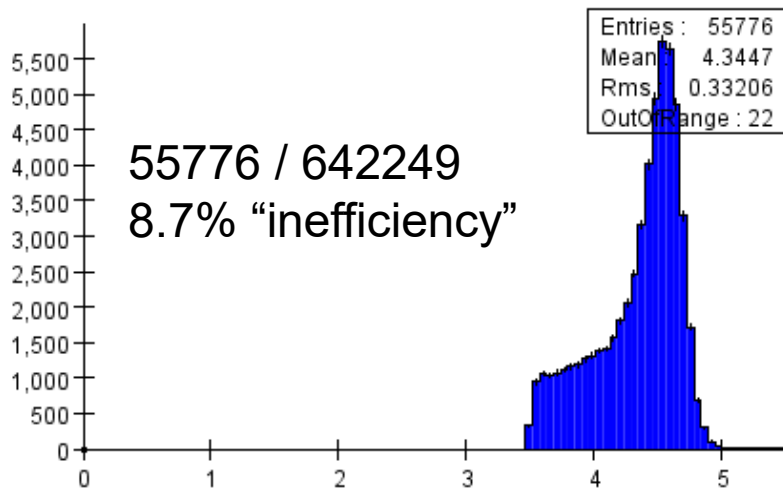
Cluster esum KF ge



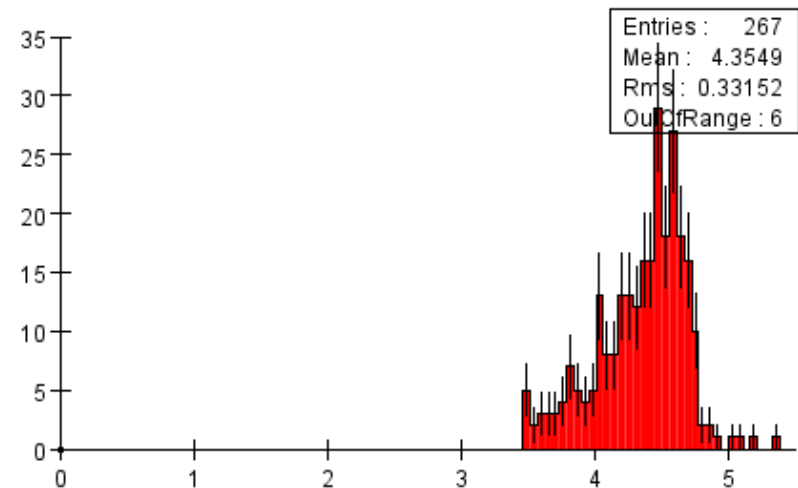
Cluster esum KF eg



Cluster esum KF gg

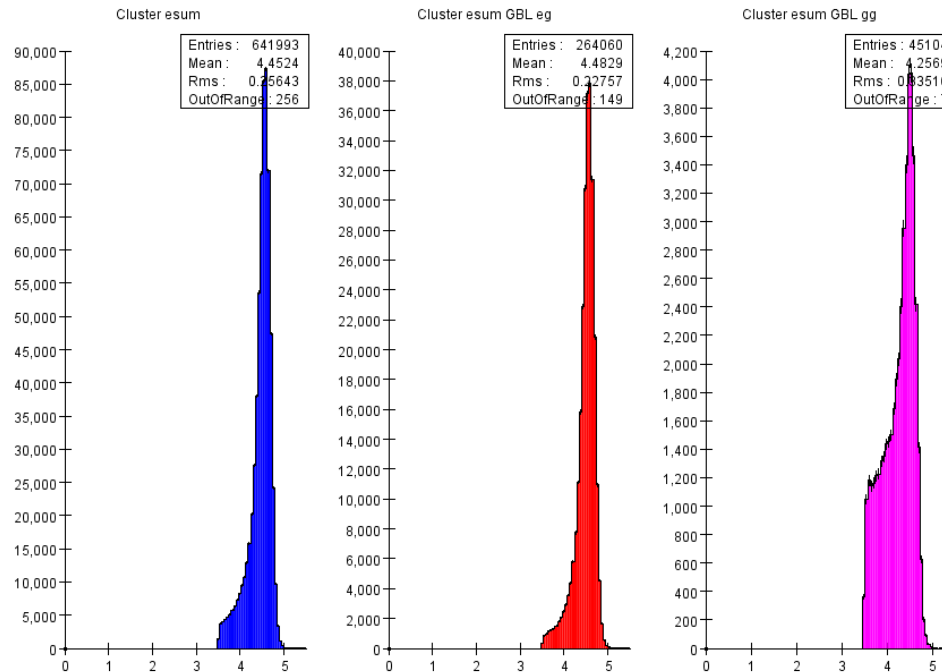


Cluster esum KF ee



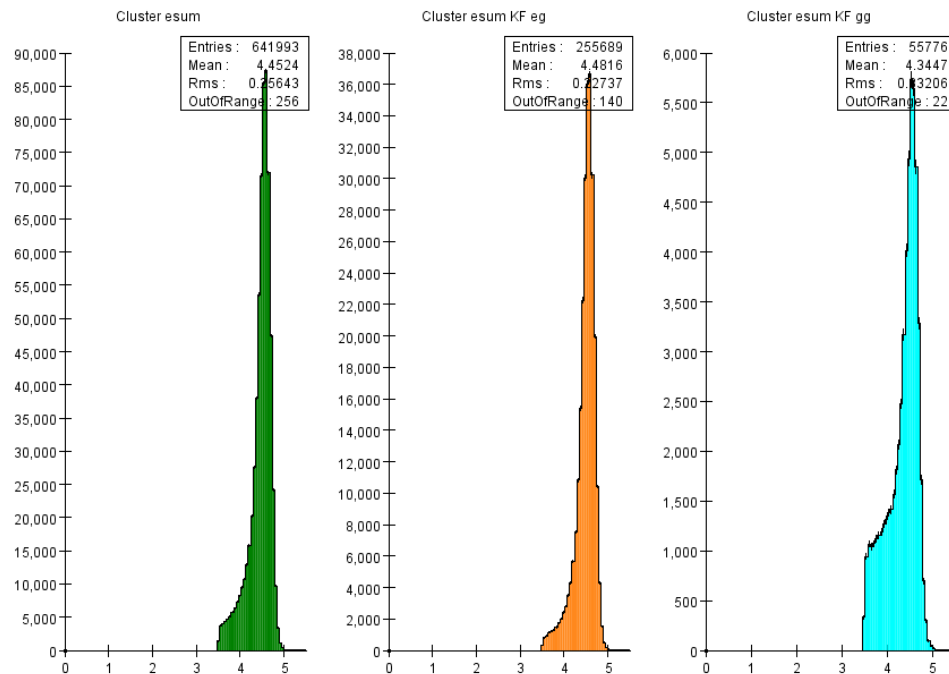
“Inefficiency” GBL

- Measured “inefficiency” is affected by the purity of the parent sample.
- Note that the gg Esum distribution has more of a “porch” at low Esum than the eg (or ge) sample



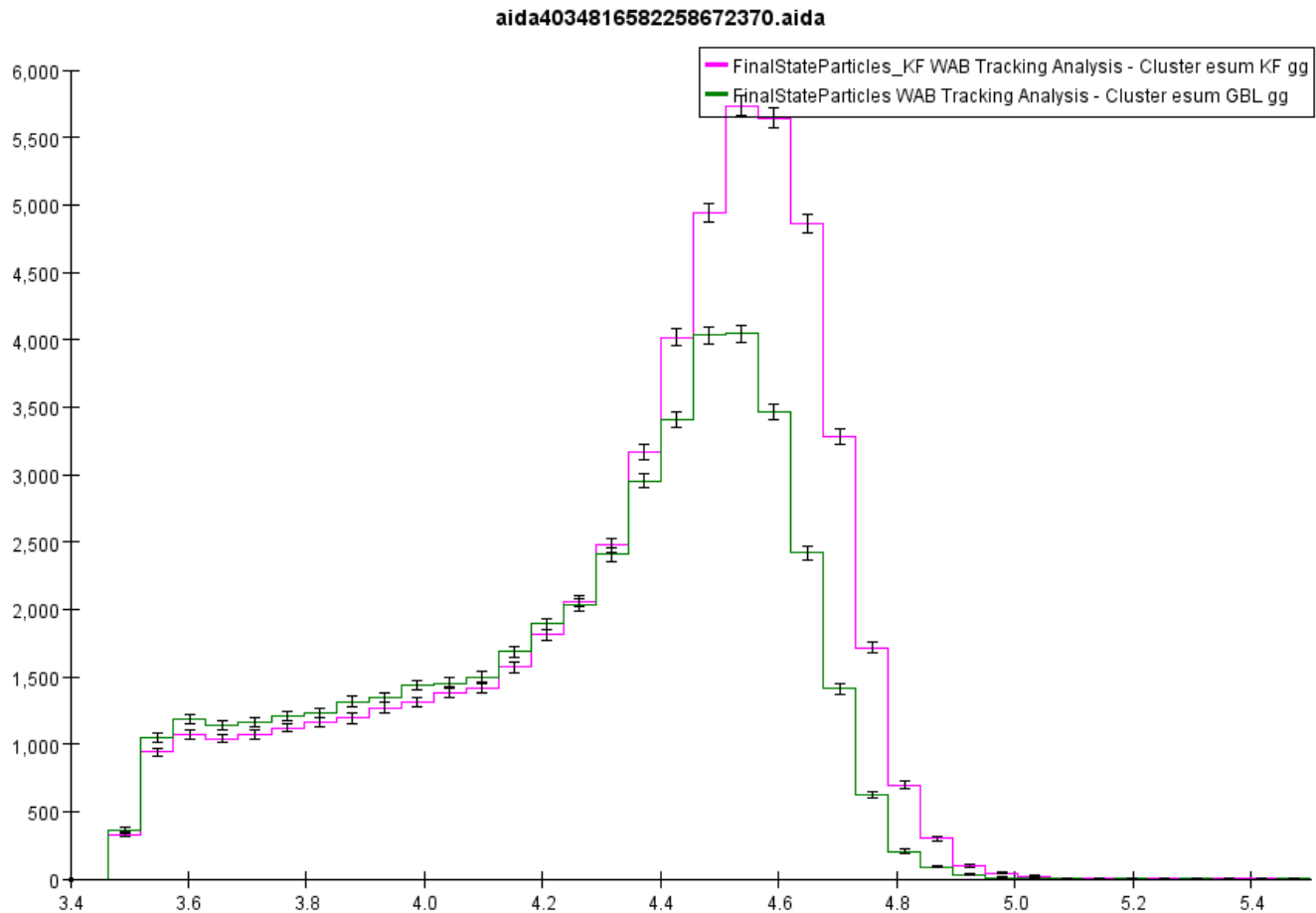
“Inefficiency” KF

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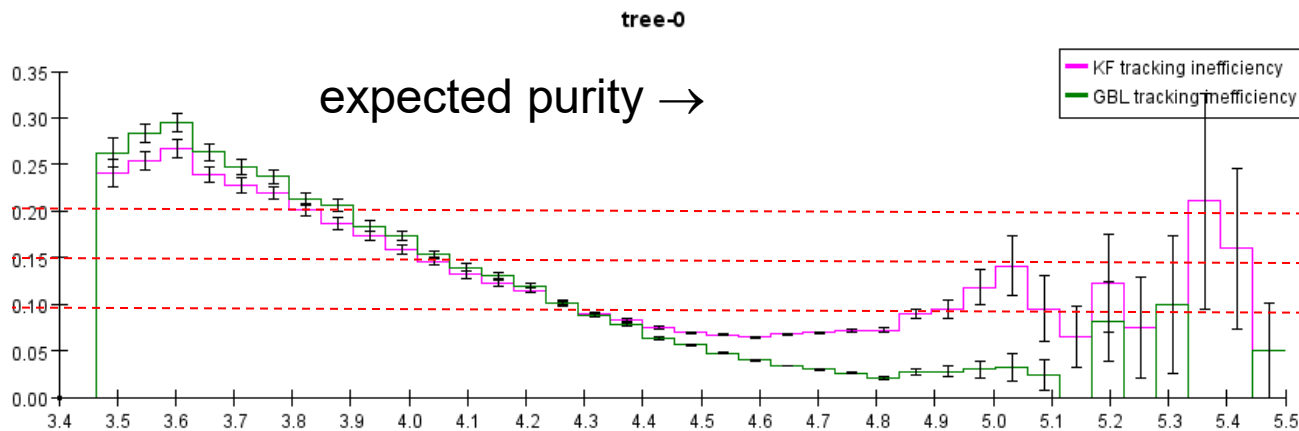
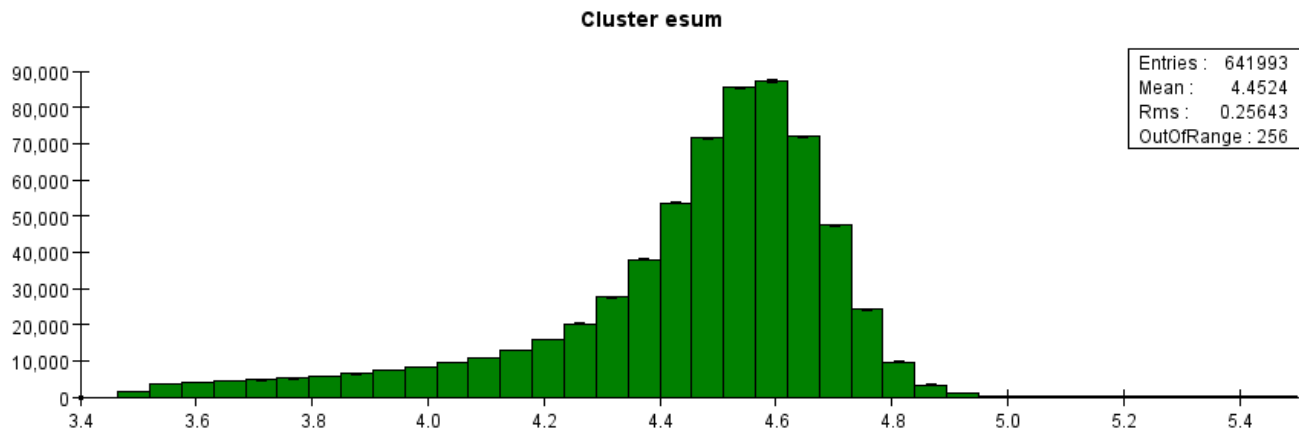
gg Esum

- Esum in events with no track matched to either cluster, “gg”



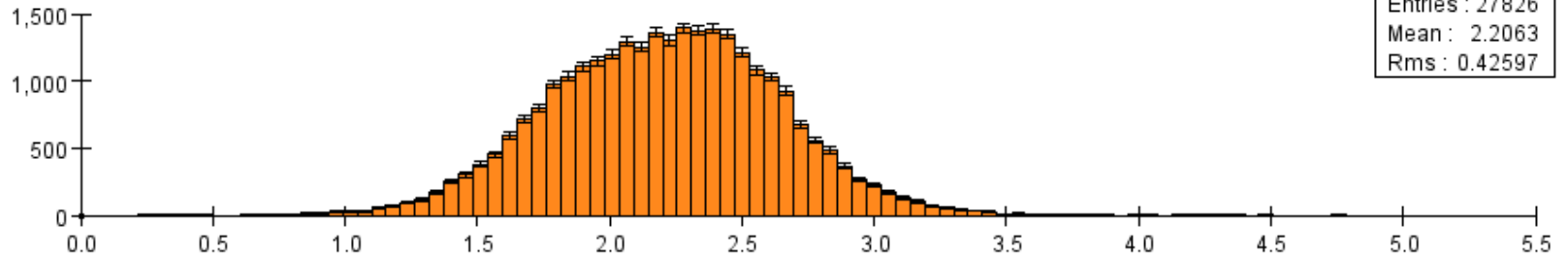
“Inefficiency” vs Esum

- Expect purity of the parent sample to increase as Esum nears beam energy.

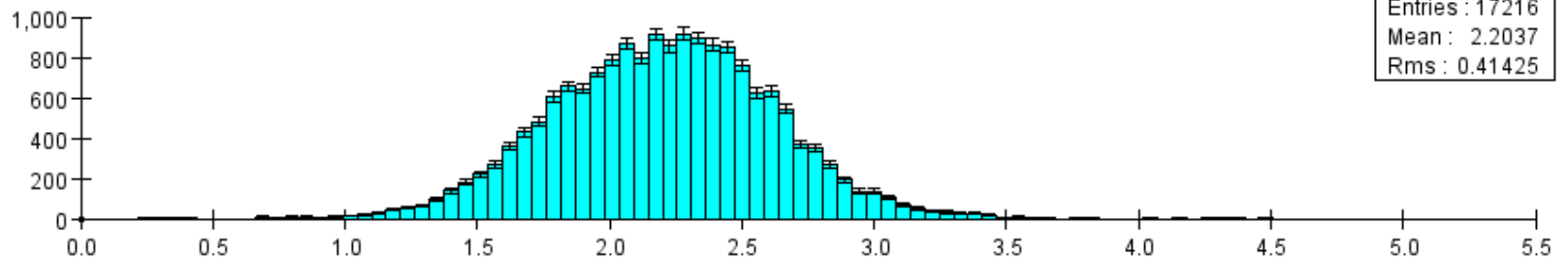


Events with GBL but no KF track

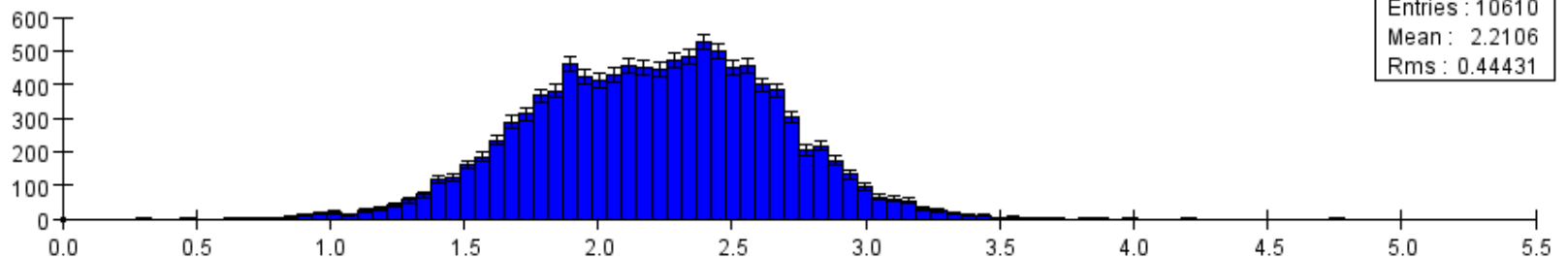
Cluster with GBL Track missing KF Track energy



Cluster with GBL Track missing KF Track energy top

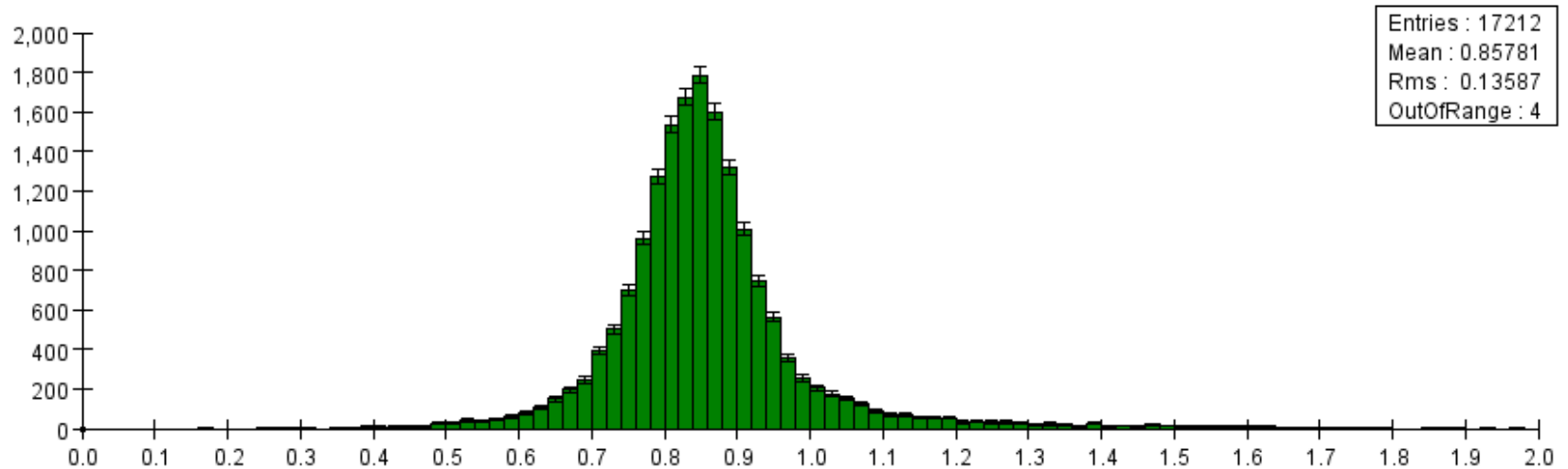


Cluster with GBL Track missing KF Track energy bottom

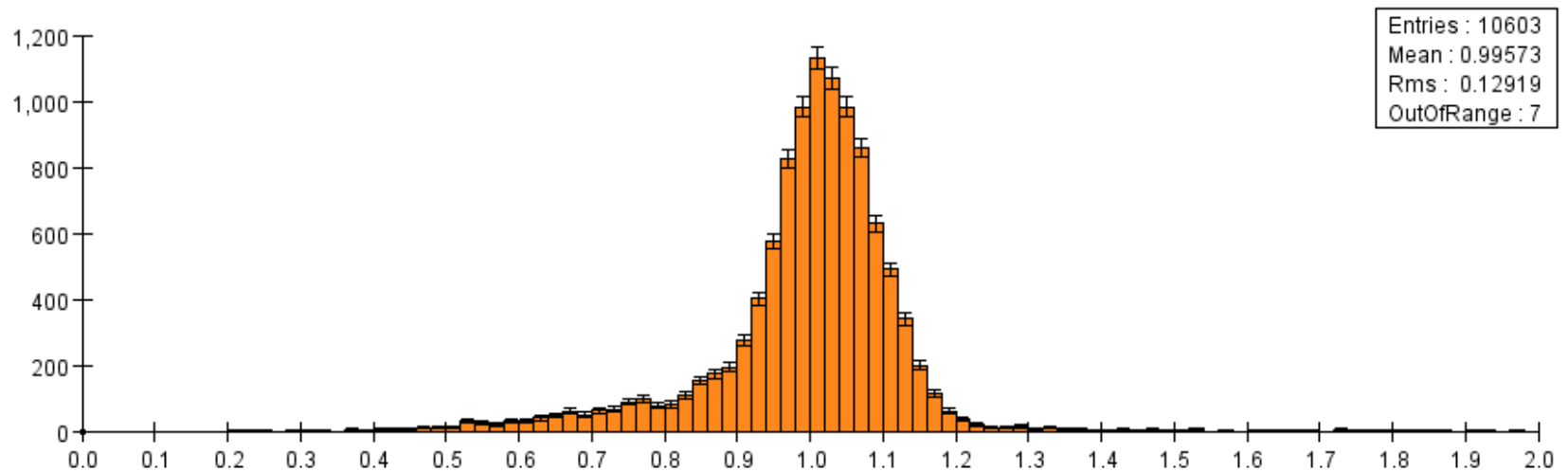


Events with GBL but no KF track

Cluster with GBL Track missing KF Track EoverP top

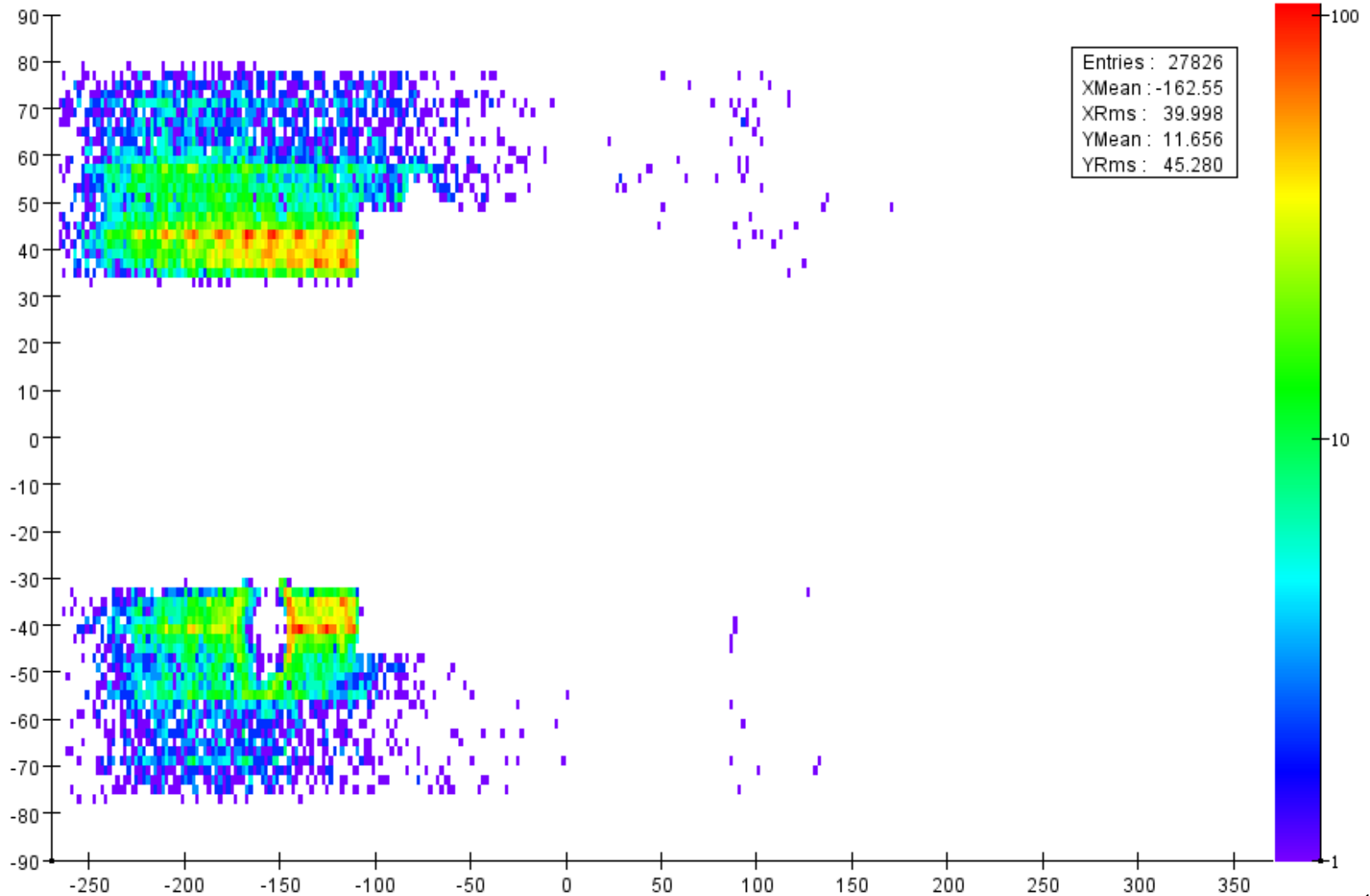


Cluster with GBL Track missing KF Track EoverP bottom



Events with GBL but no KF track

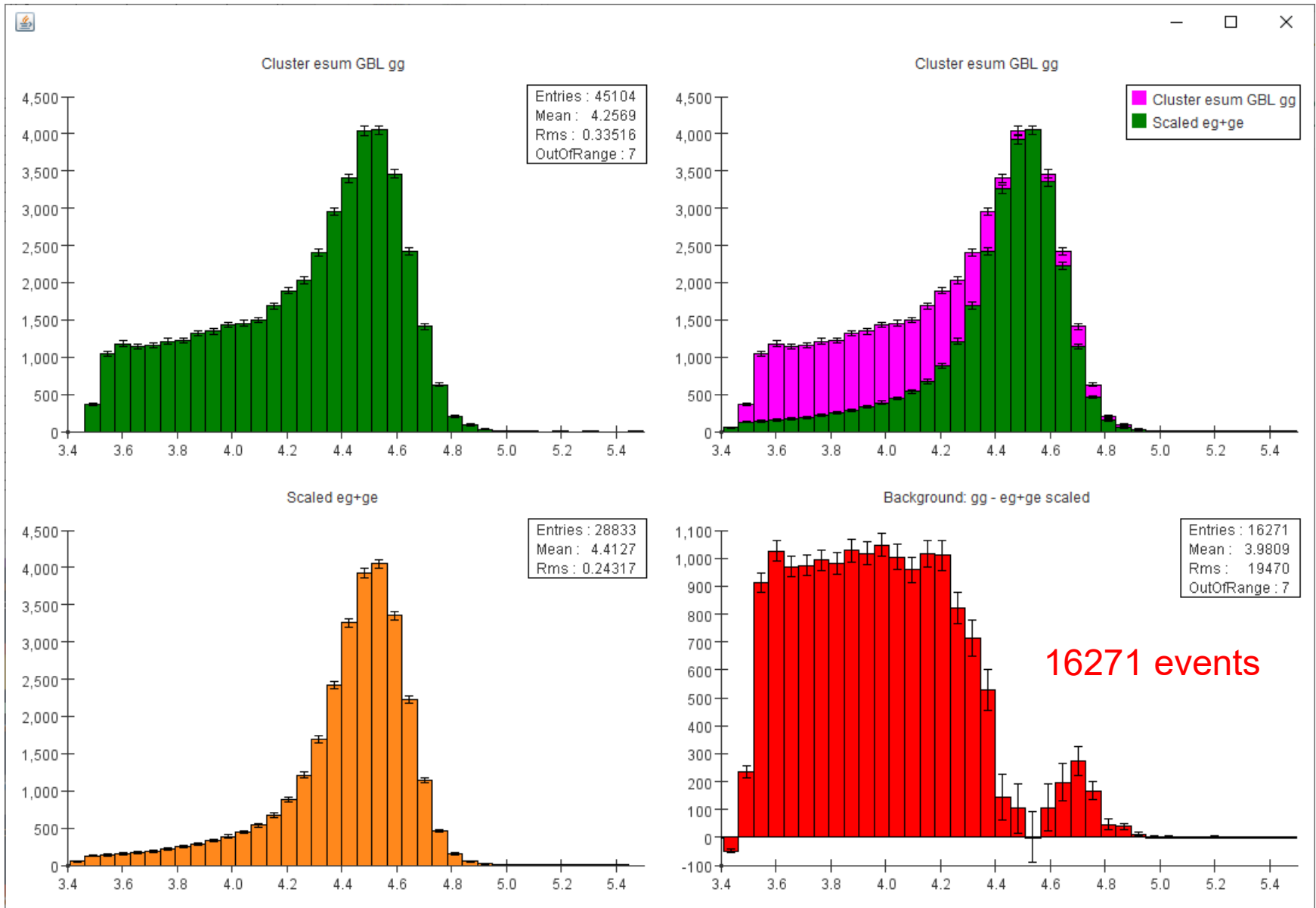
Cluster with GBL Track missing KF Track x vs y



Track-Finding Efficiency Using Data

- Difference in shape of $e^- \gamma$ and $\gamma \gamma$ e sum distribution points to evidence for non-WAB background.
- Sum $e^- \gamma$ and γe^- histograms.
- Subtract this WAB distribution from the $\gamma \gamma$ histogram after scaling to match the peak height.
- Provides estimate of non-WAB background contribution.

Track-Finding Efficiency Using Data



Track-Finding Efficiency Using Data

- Subtracting a scaled WAB esum distribution from the $\gamma\gamma$ esum distribution results in a flat background “porch” distribution.
- Can cut tighter on esum to get better purity, but want to study background as a function of esum
- Better estimate of the tracking efficiency for WABs in run 31 is now:

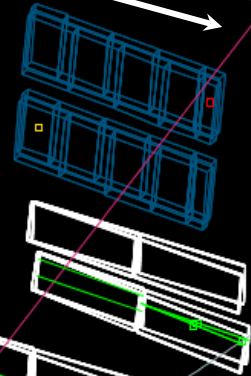
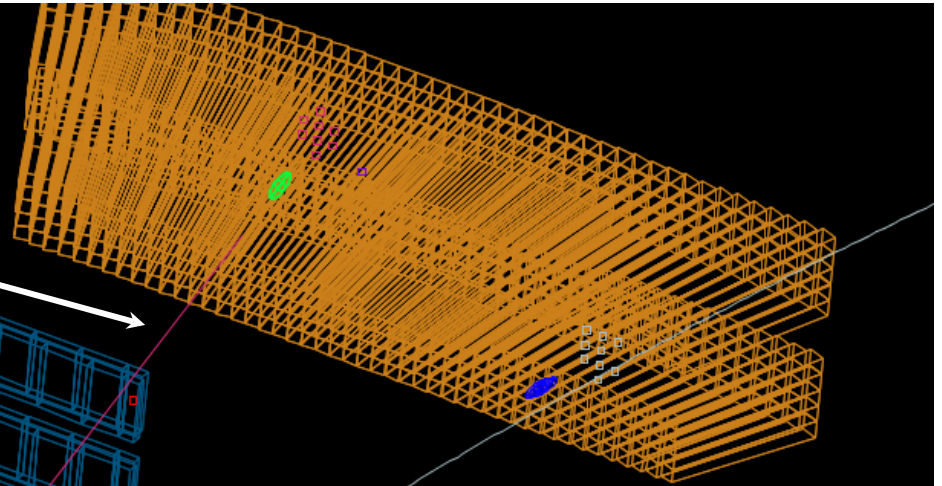
$$1 - (45104 - 16271) / 642249 = 95.5\%$$

Track-Finding Efficiency Using Data

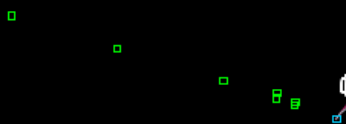
- Preliminary study of the track-finding efficiency using WABS indicates an efficiency of finding Seed Tracker / GBL tracks in the momentum range between 1 and 3.5 GeV of $\sim 95.5\%$ for run 31.
- Seed Tracker appears to have a slightly higher efficiency of finding tracks than the Kalman Filter.
- 27826 events having one GBL track matched to an Ecal cluster but no KF track have been skimmed.
- These events fall into at least three categories:
 - Events with a nearby KF track, but the track was not matched to the cluster
 - may have to tweak some settings in track-cluster matcher
 - Events with KF tracks, but have picked up wrong hits in the earlier layers and have very low momentum
 - Events with no KF tracks at all
- Quite often there are essentially duplicate GBL tracks
 - MergeTrackCollections needs to be revisited.

FinalStateParticles

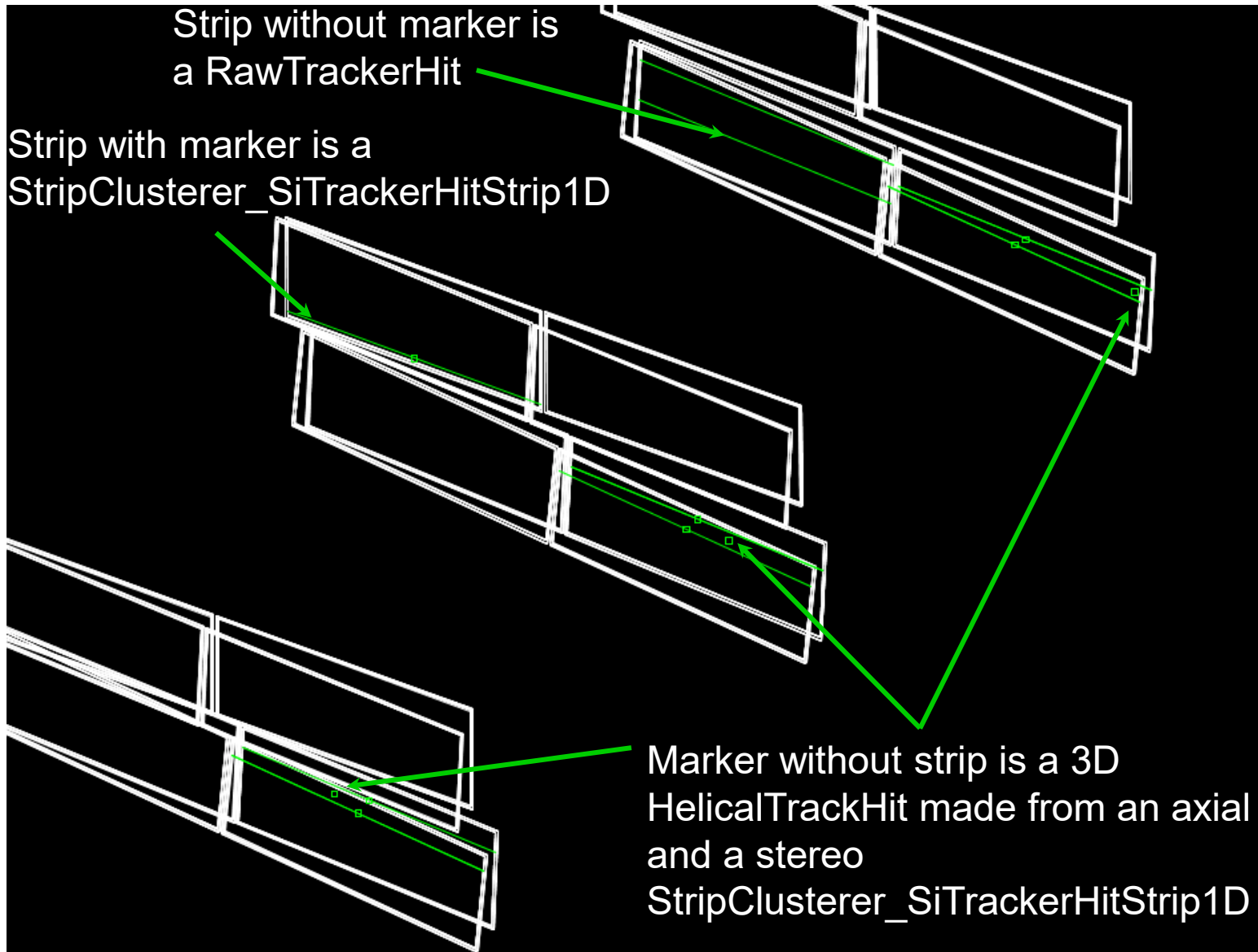
Photons drawn as
straight lines along with
cluster and Ecal cells



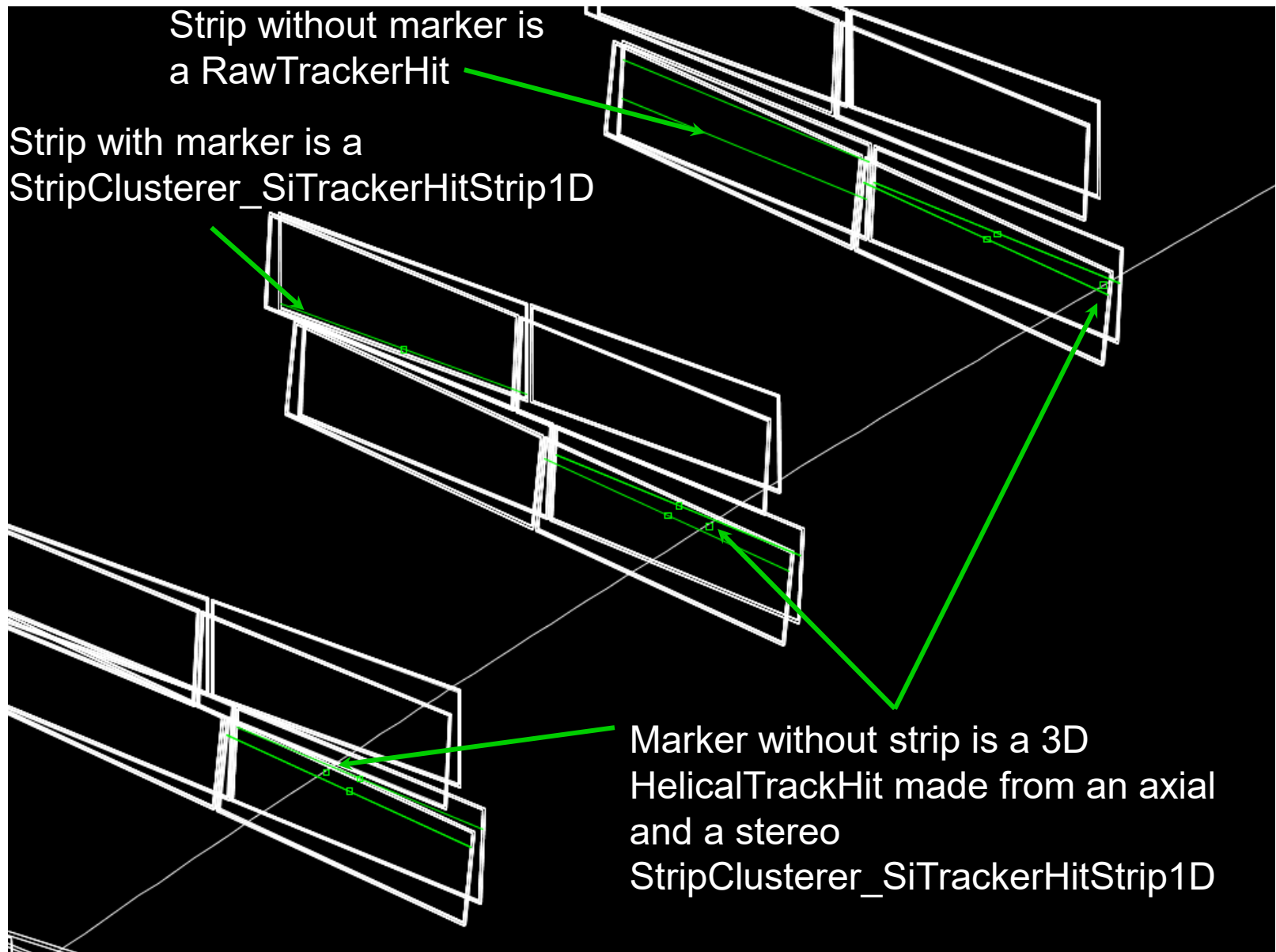
Electrons drawn as
curved lines along with
cluster and Ecal cells



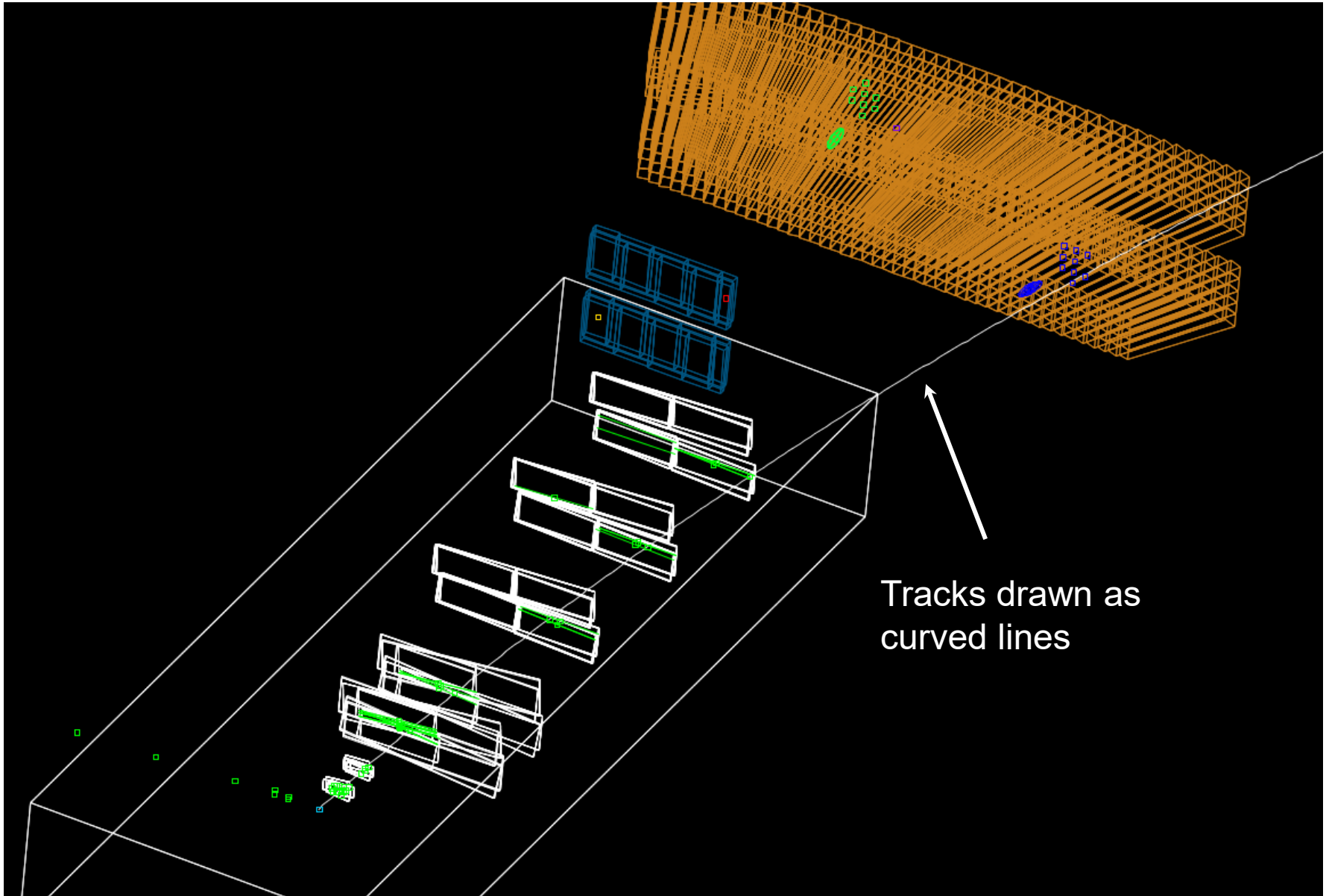
Hits



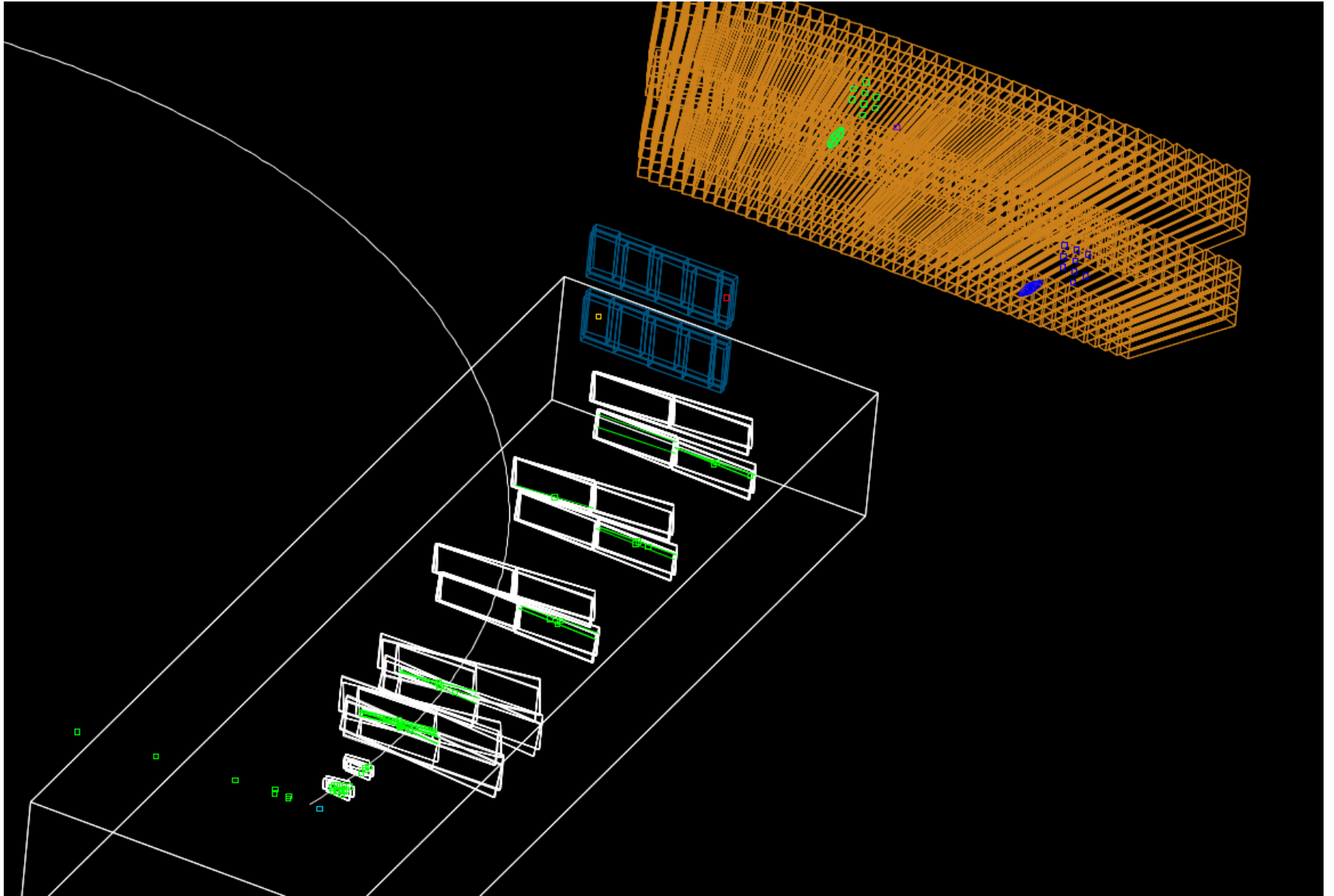
Hits and Tracks



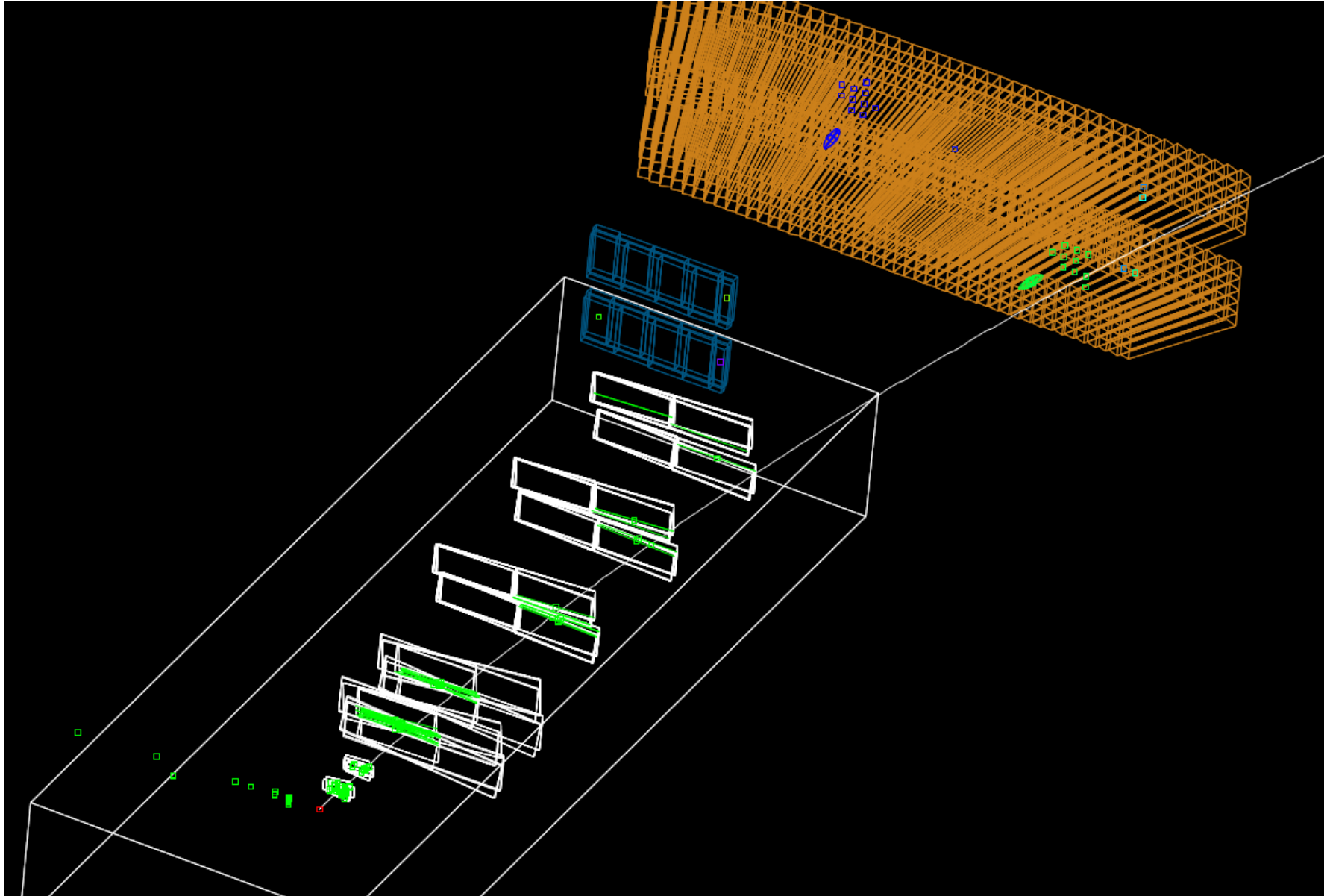
GBL



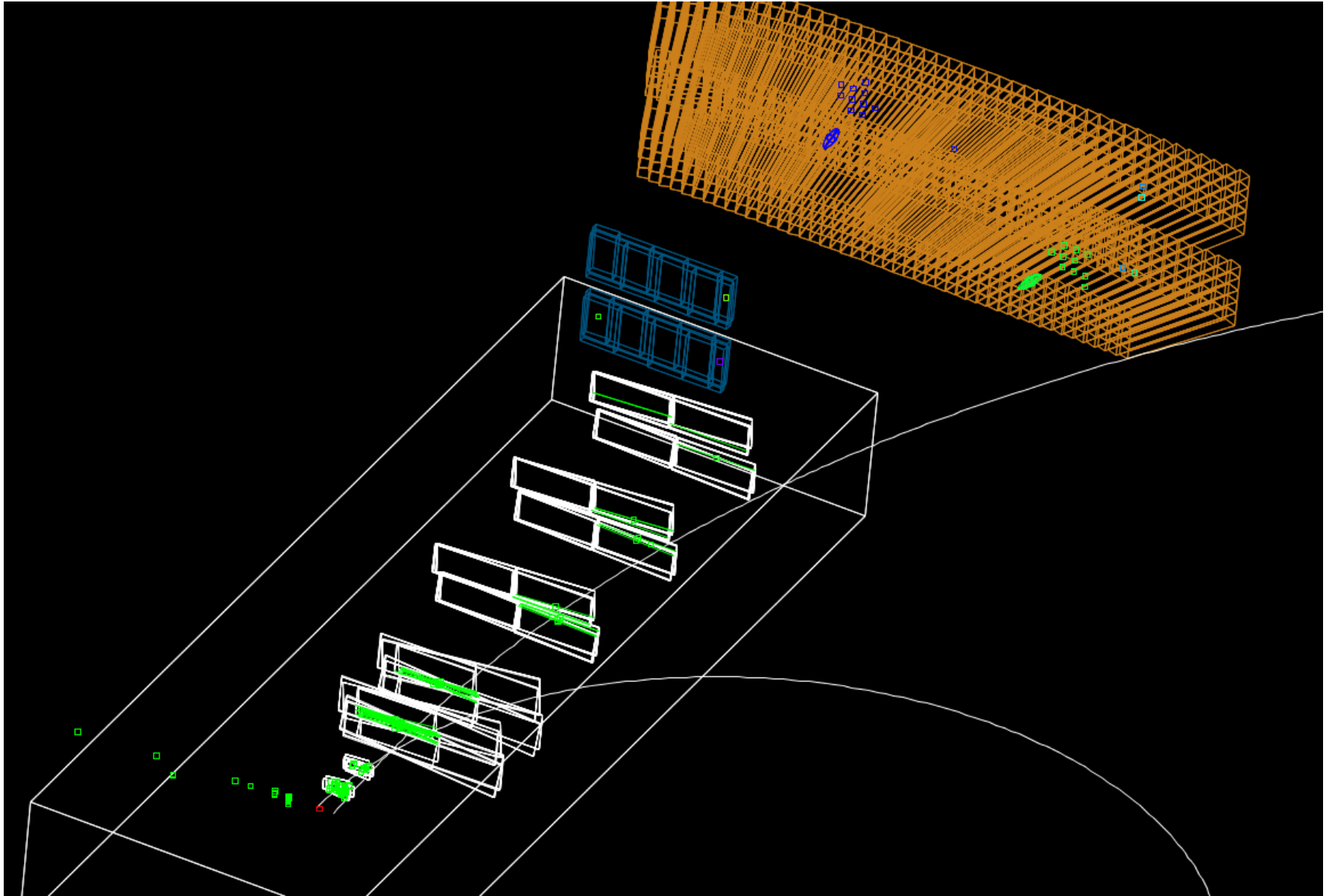
KF



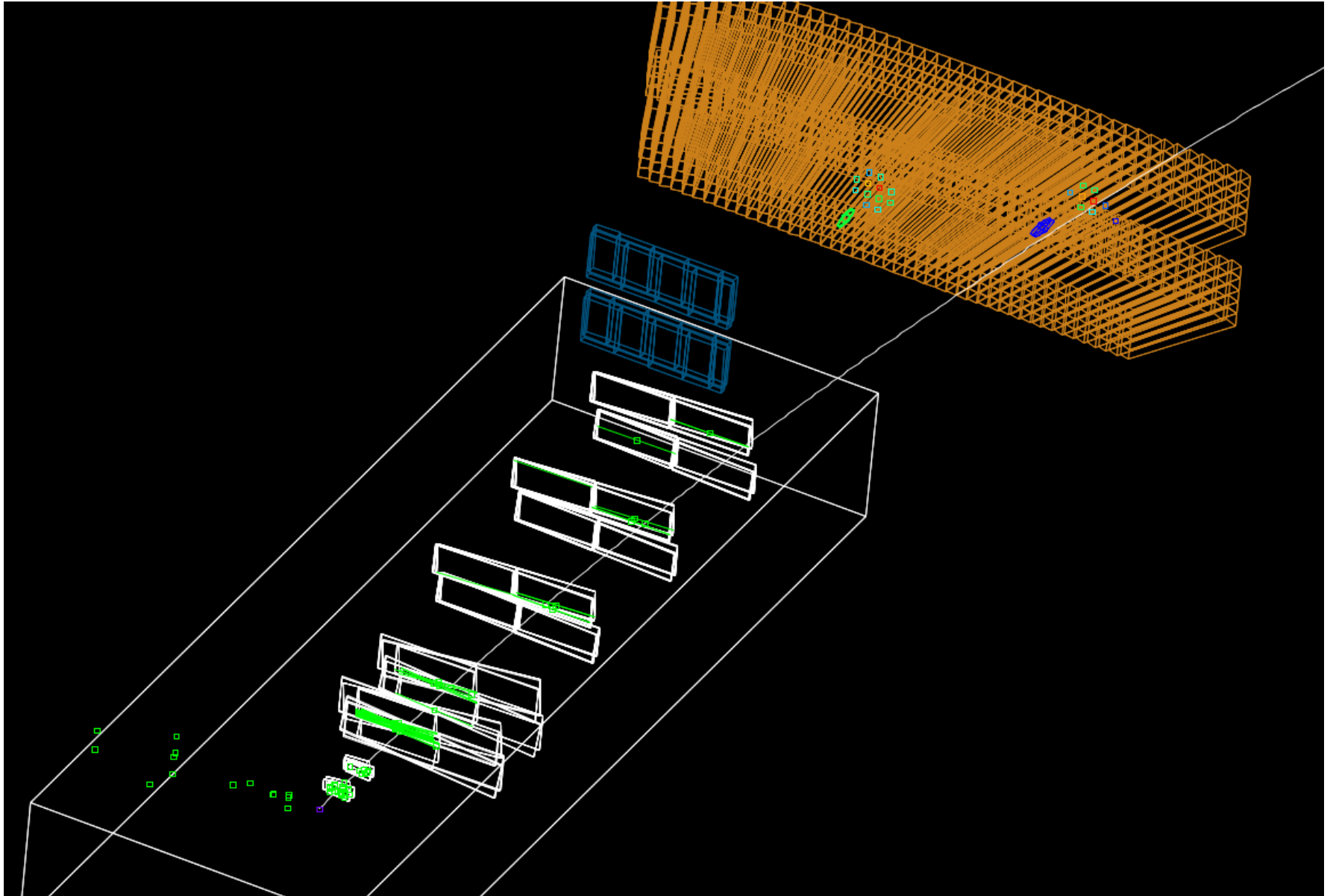
GBL



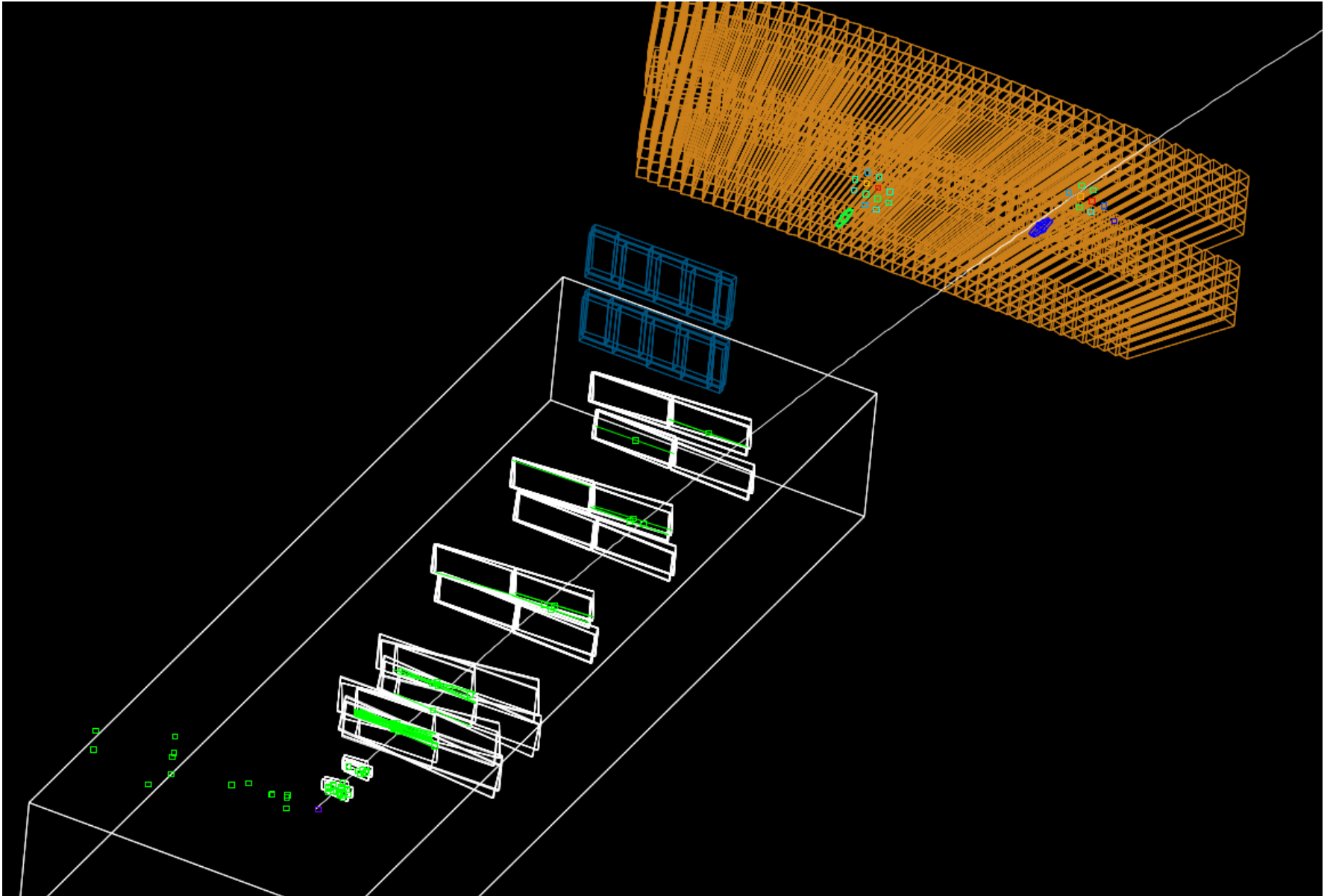
KF



GBL

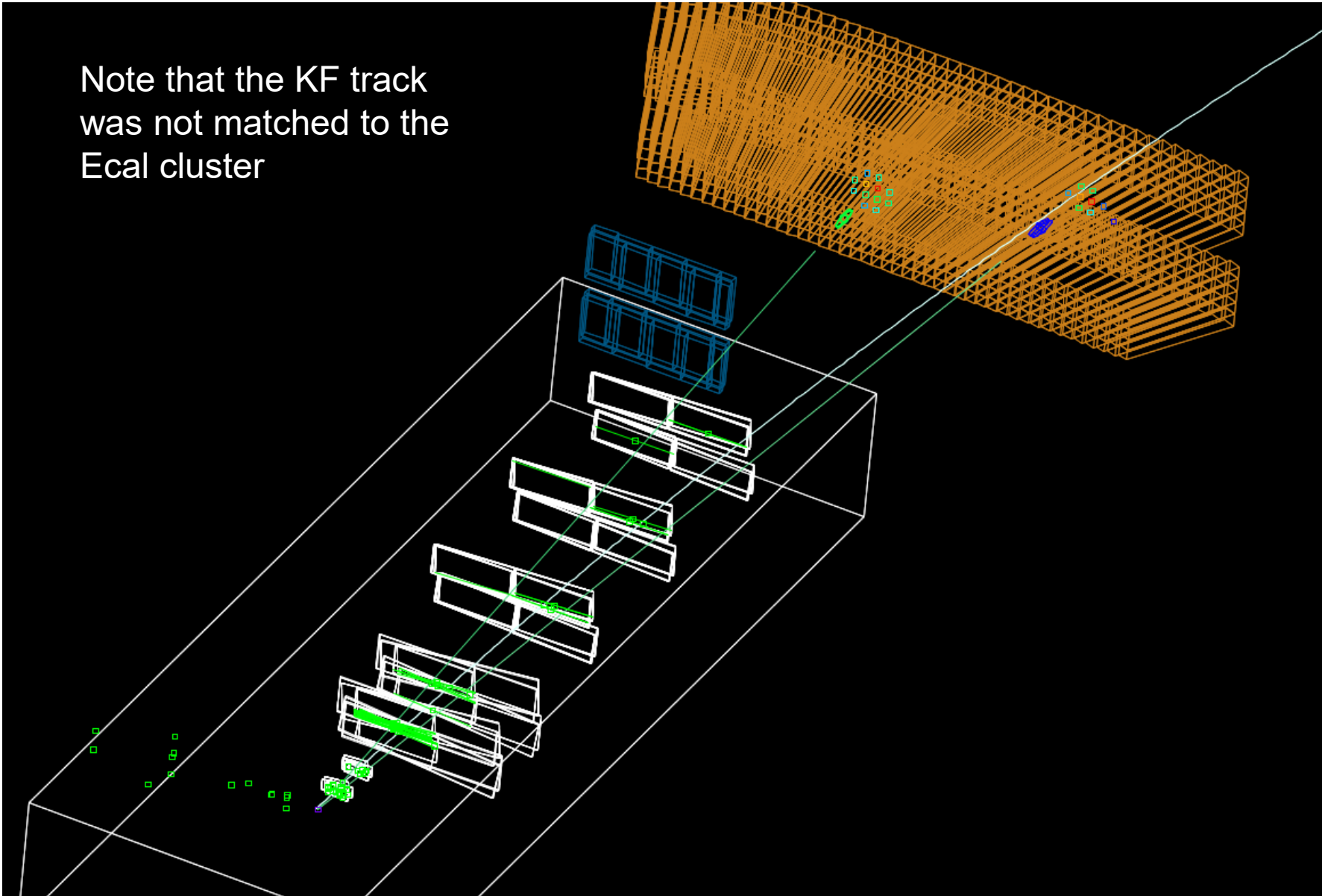


KF

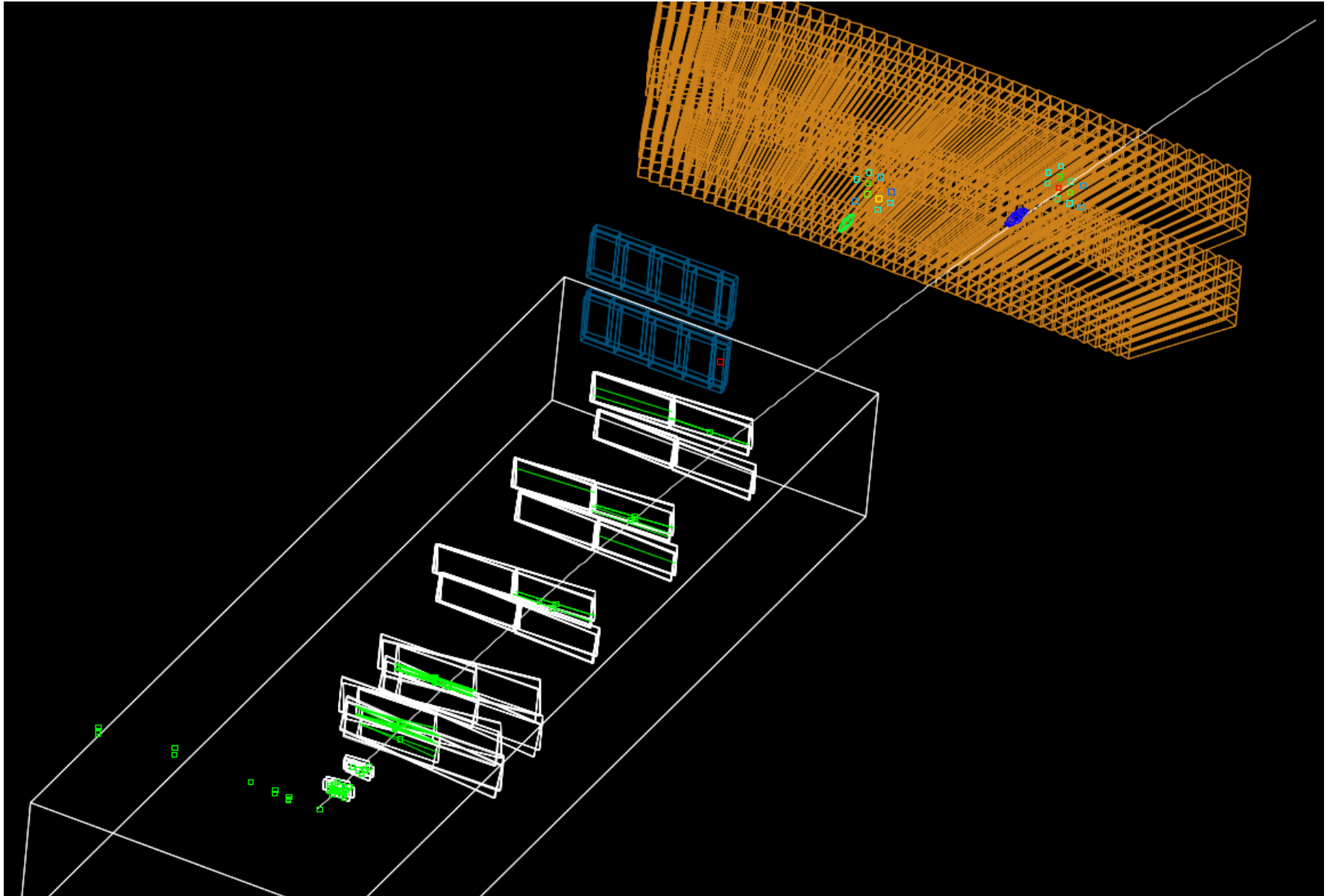


KF

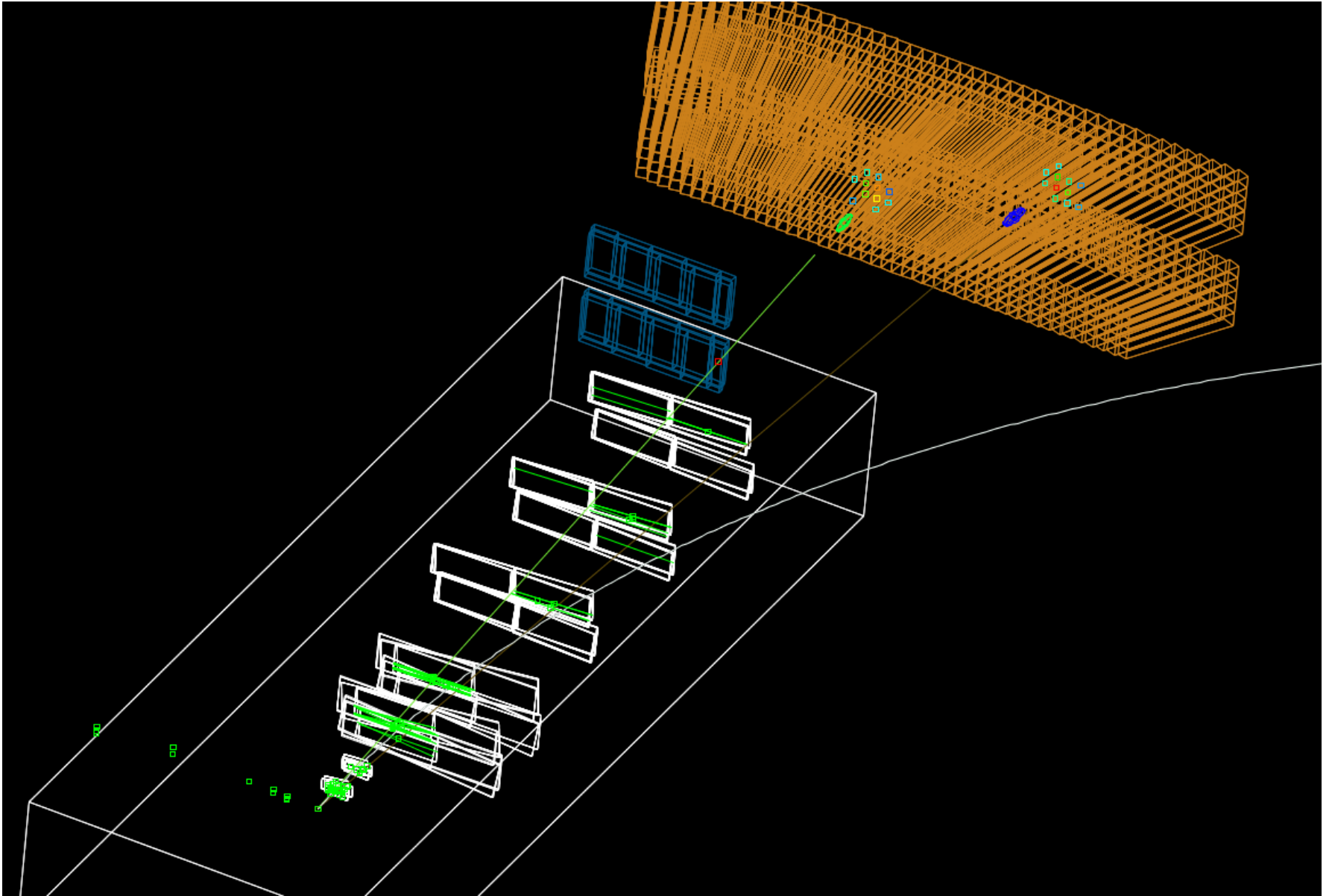
Note that the KF track
was not matched to the
Ecal cluster



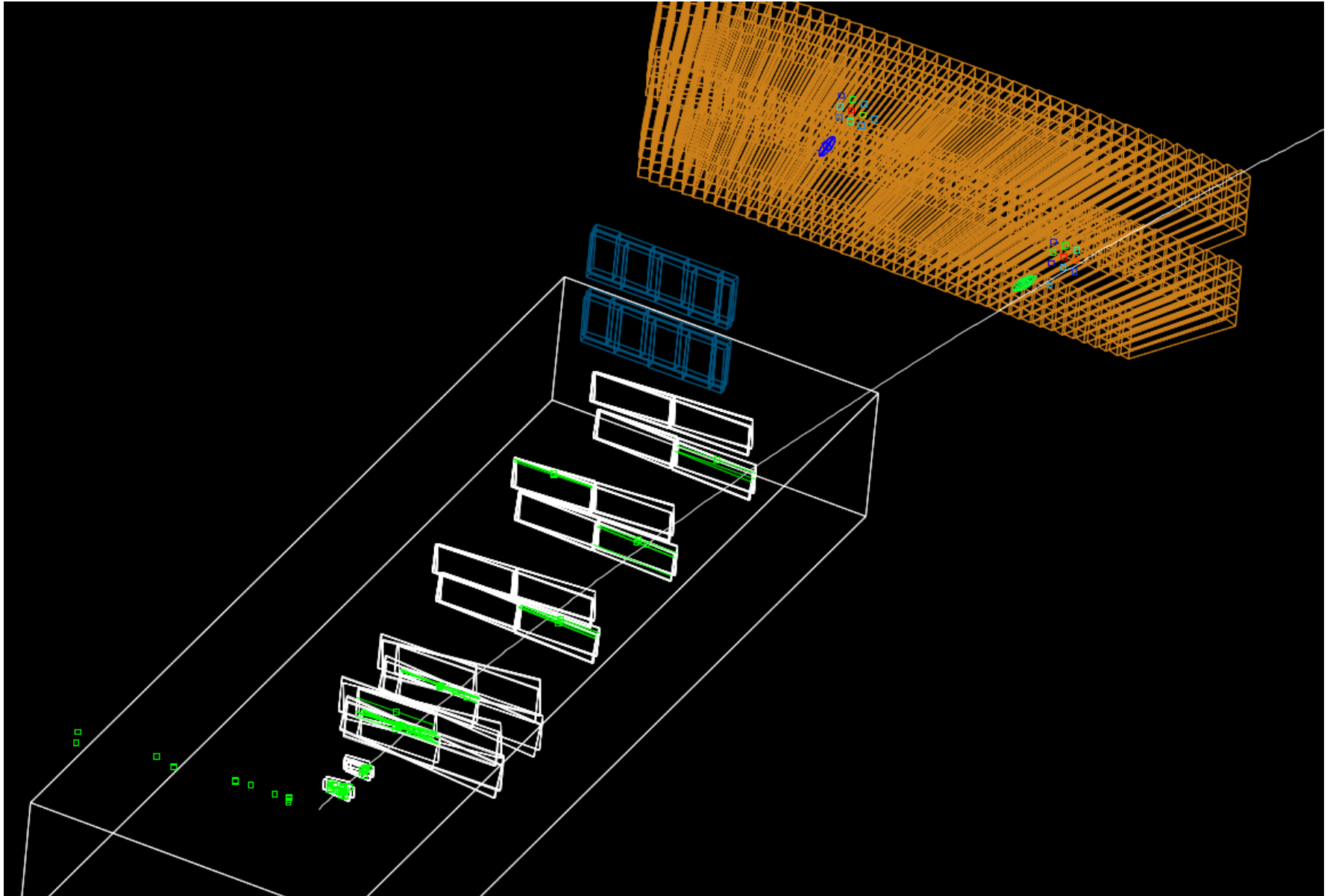
GBL



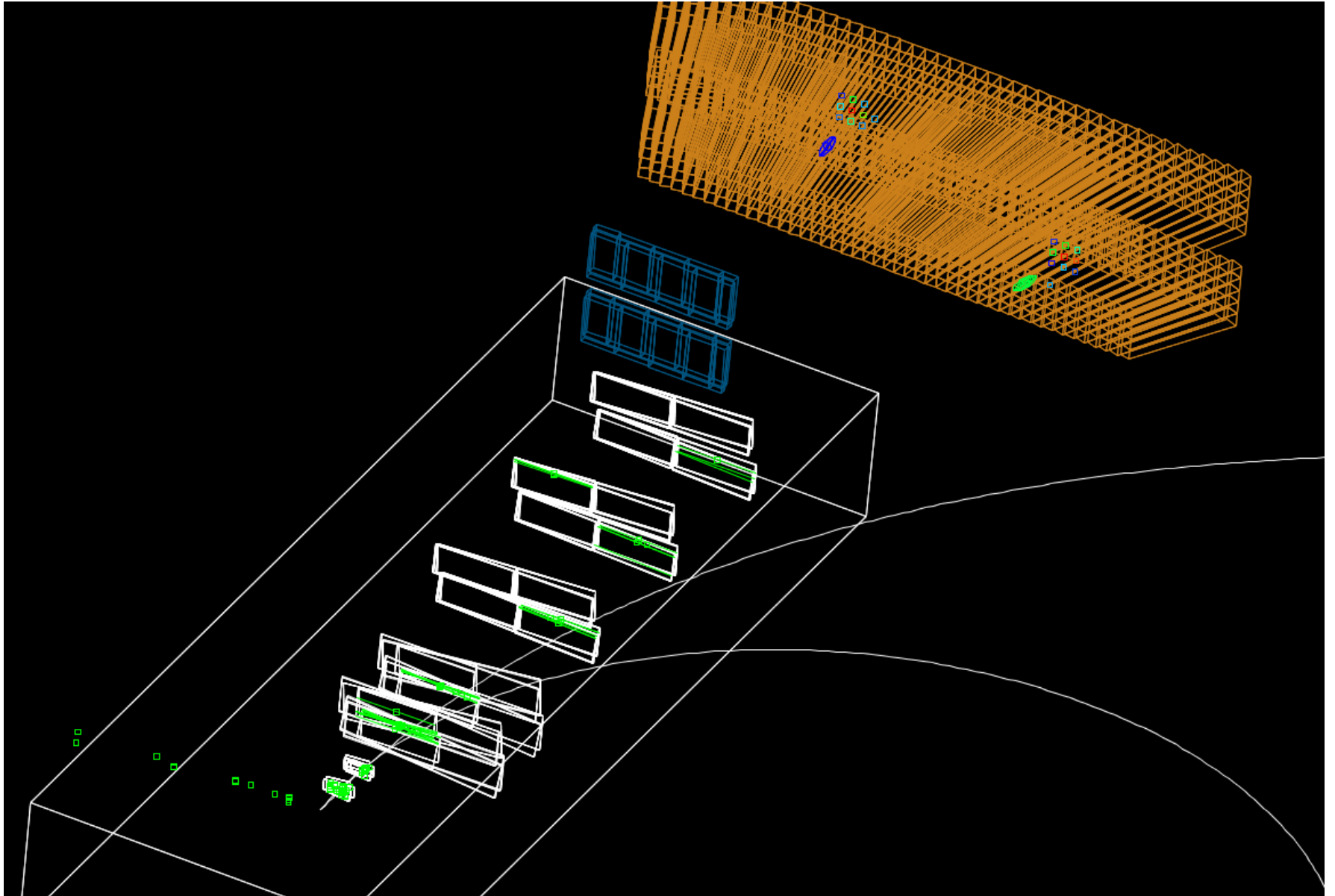
KF



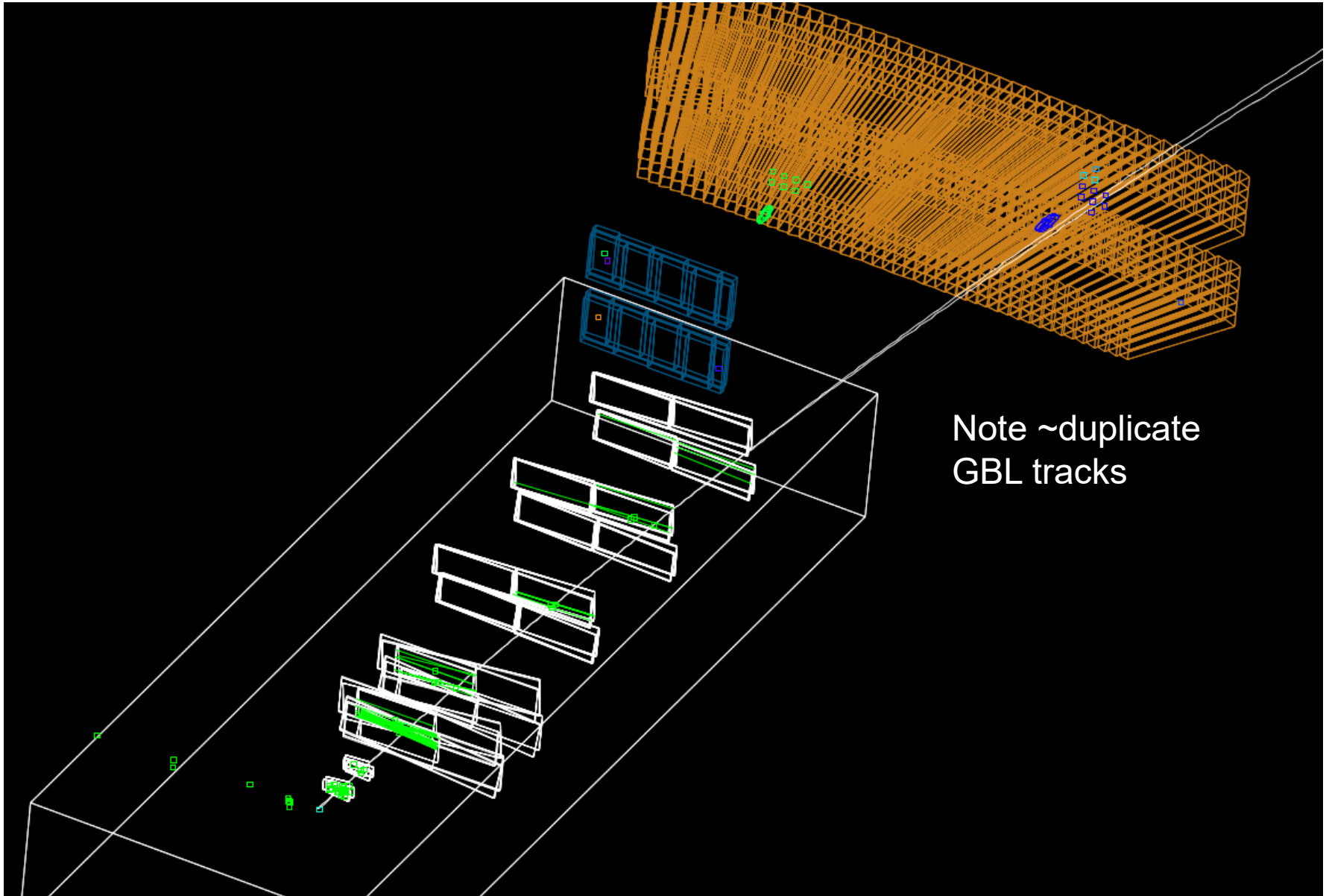
GBL



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