Test Beam Pixel Visualization

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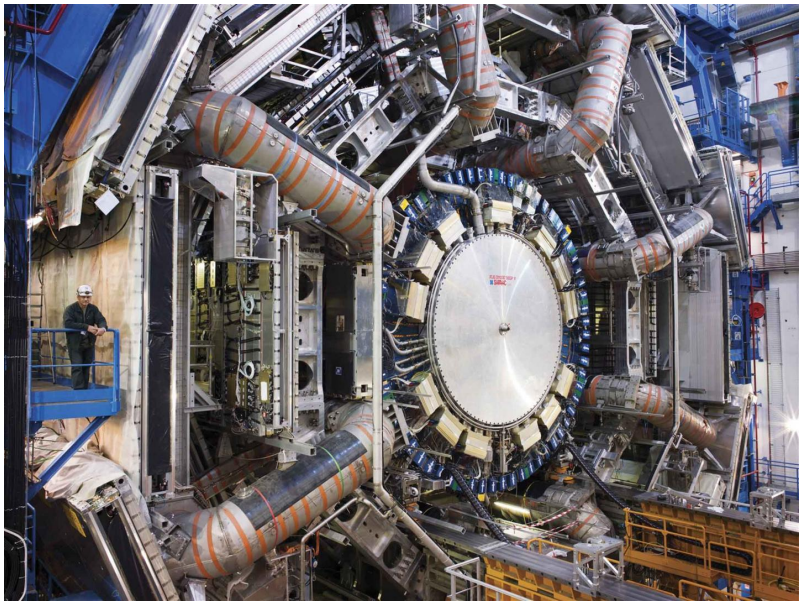
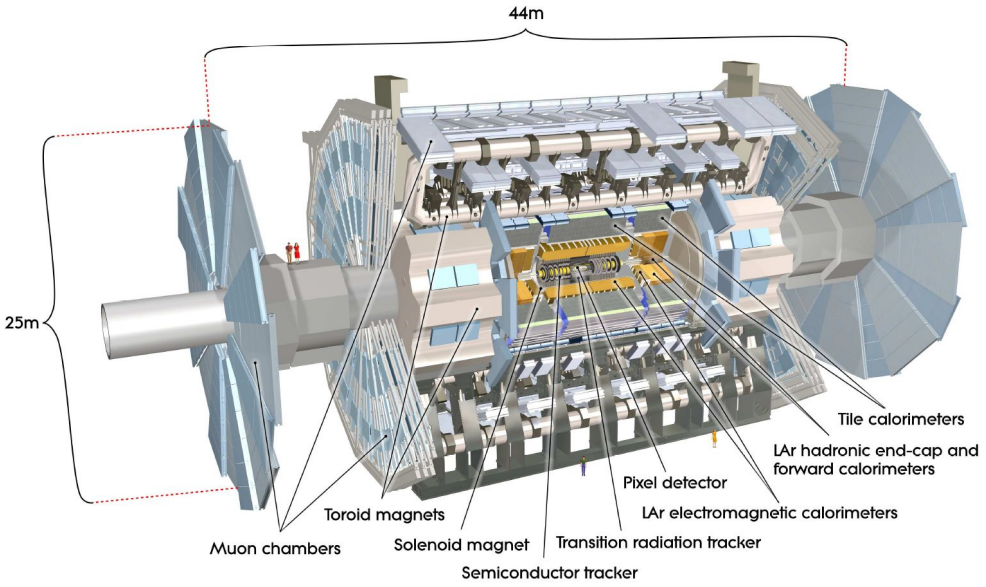
ATLAS Experiment

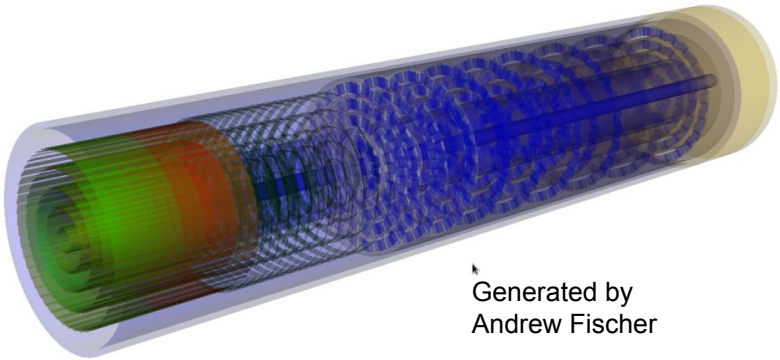
- Experiment being done at the Large Hadron Collider at CERN
- Studies involve the standard model, fundamental particles



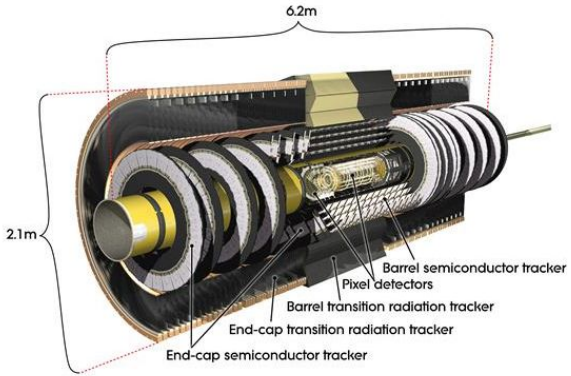


Purpose

- Inner detector at CERN will be replaced in 2024
  - Old detector was made with pixels, strips, gaseous tracker
  - Will be replaced with all silicon tracker
  - The pixel detector hardware must be tested
    - New technologies like CMOS pixels

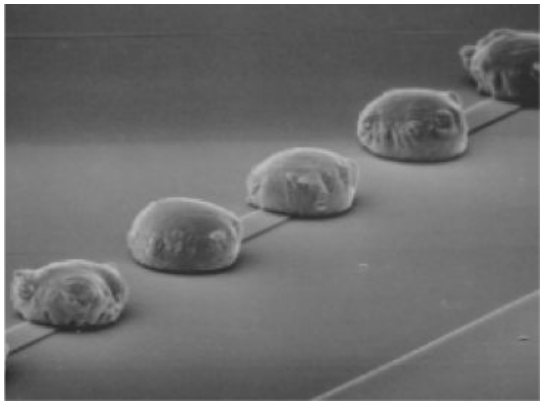


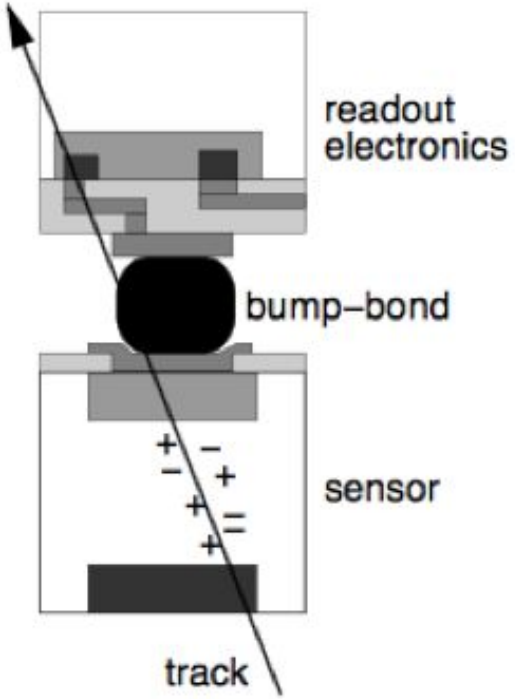
Generated by
Andrew Fischer



Pixel Detectors

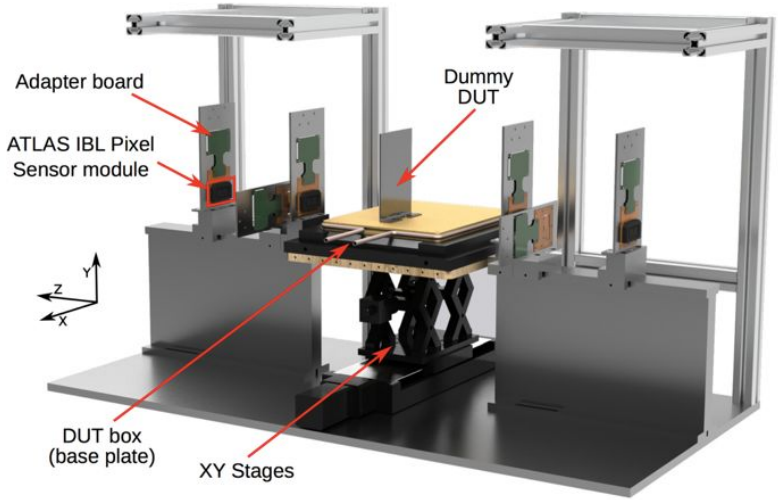
- How they work
  - Electric field in place within sensor
  - Particle comes through and scatters electrons
  - Electrons get picked up by one side of sensor
  - Signal gets sent across bump-bond and turned into electronic signal
    - CMOS pixels don’t require a bump bond





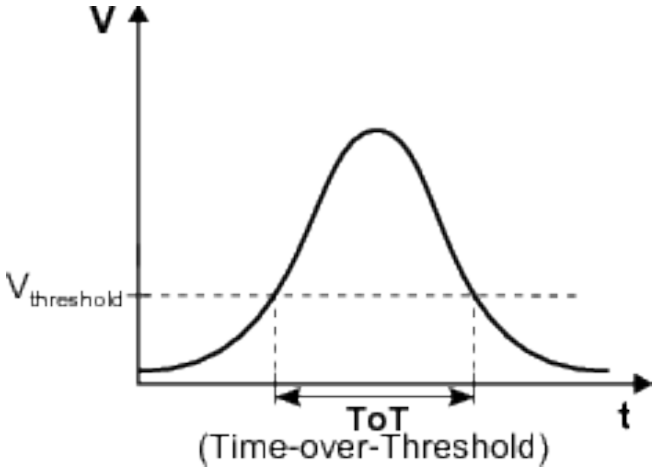
Test Beam

- We need to test the performance of the CMOS detectors
- Set up several sensors in a line to create a pixel telescope
  - Sent protons along track
  - Generated tracks from the hits



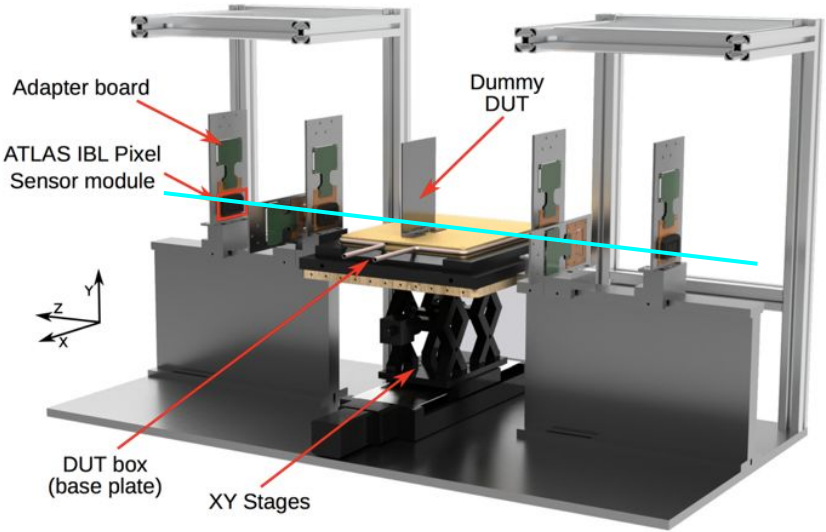
What is a hit?

- Raw data is given in timestamps, time-over-threshold, and pixels
- Events are determined by setting threshold gating and hit plane parameters
  - Gating is determined by the time-over-threshold
  - Number of planes that must register a hit



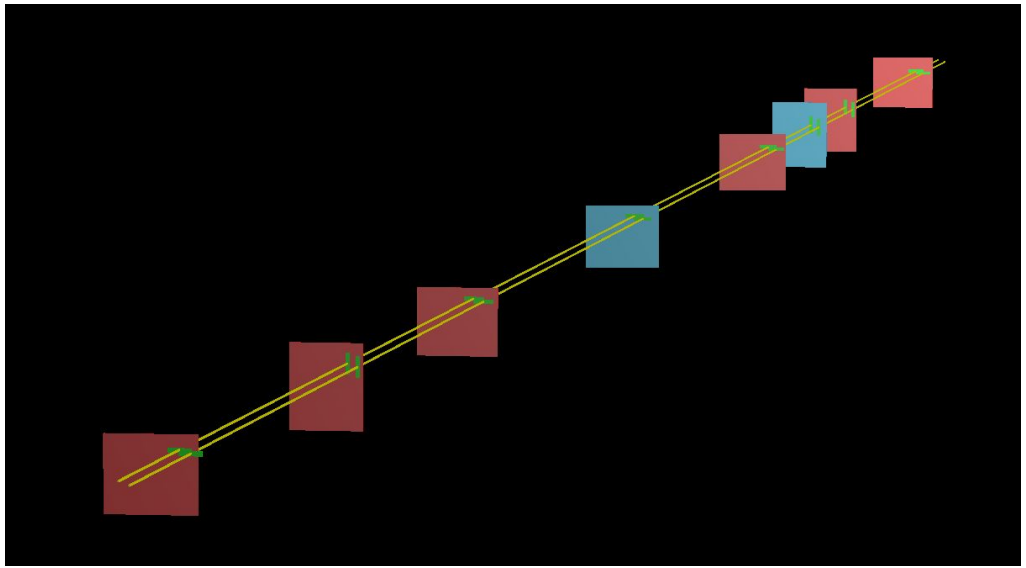
What is a track?

- The track is a representation of the proton's path through the telescope planes
  - Since beams are straight lines, track is determined by Chi^2
  - Track is given by x_0, y_0, and slope (x/z, y/z)
- Must have 2 trigger hits
  - First and last plane must record a hit
- Chi^2 must be lower than 5
  - This ensures that we aren't just looking at noise
- All 6 telescope planes must be hit

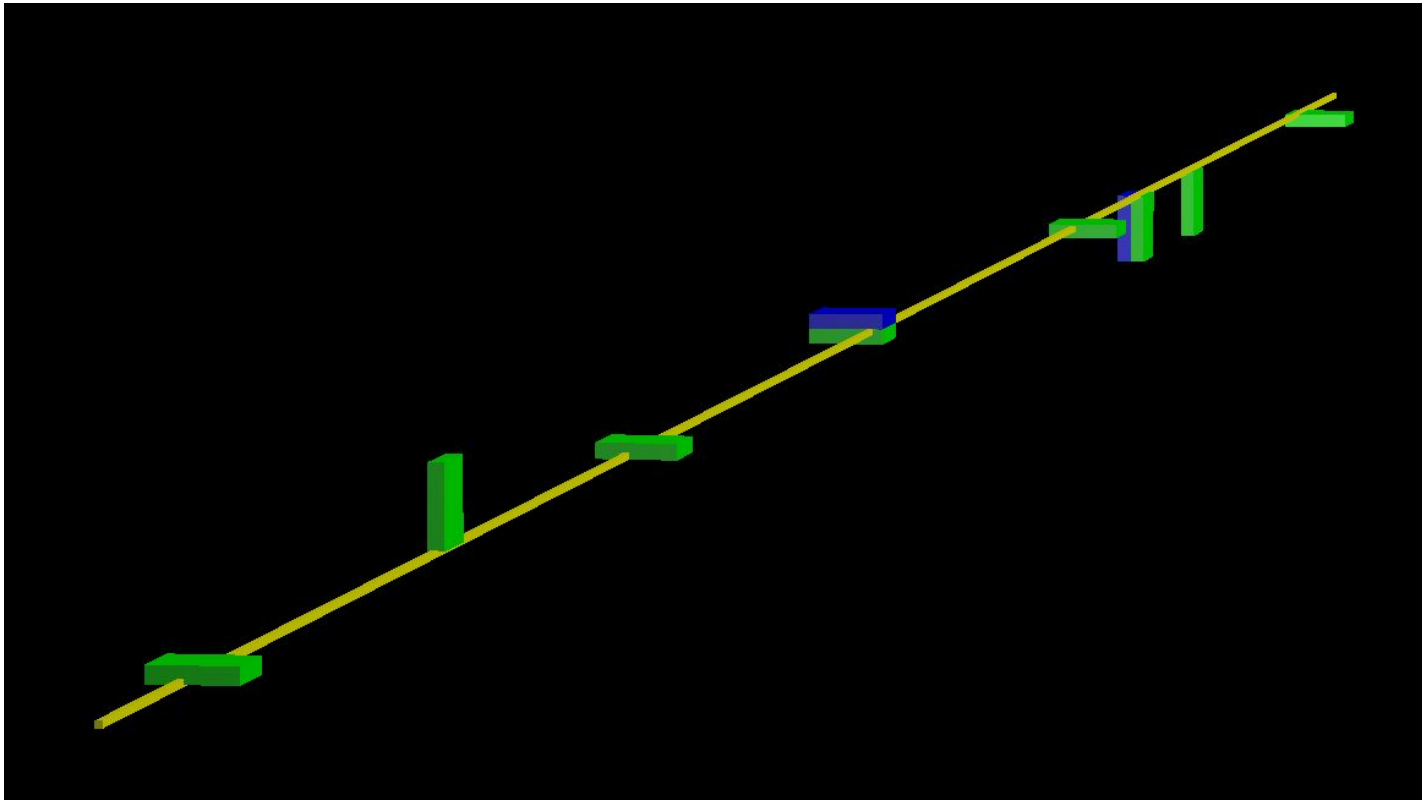


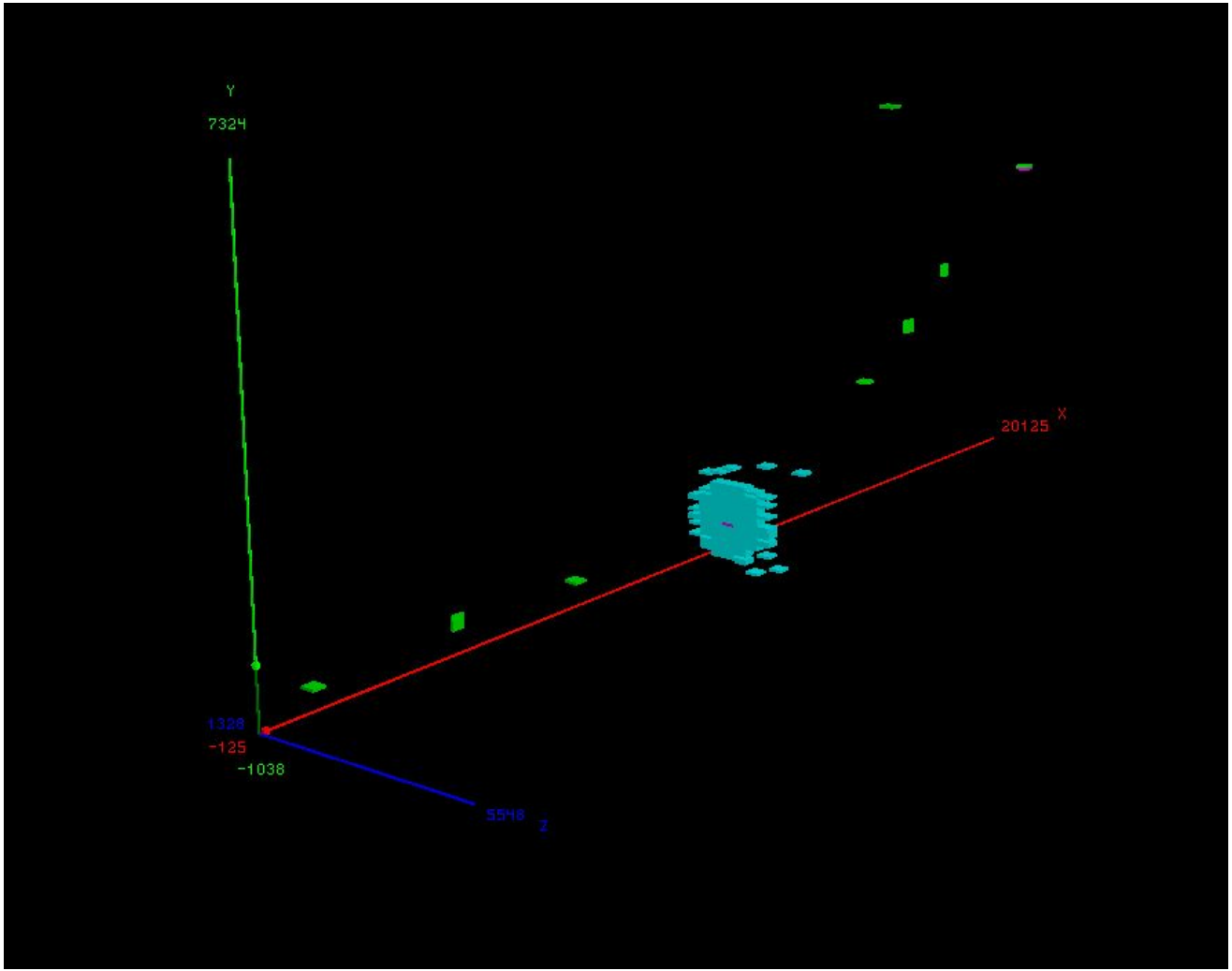
Visualization Program Developed

- Takes the sensor geometry and pixel data to create a 3D representation of an event
  - Can display entire event to scale or only the hit pixels, to get a better view
  - Aids in analysis



Only displaying the pixels




Y
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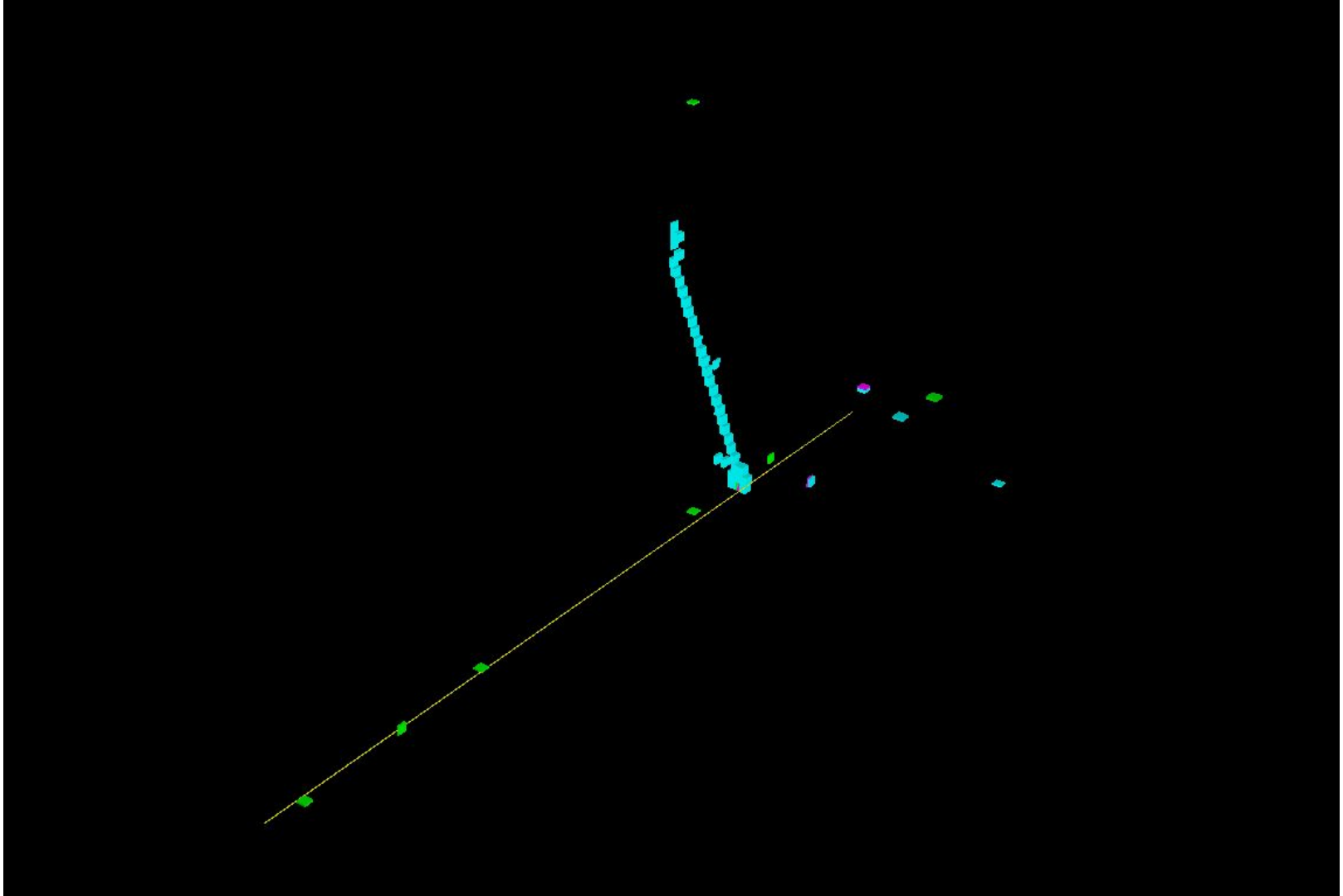
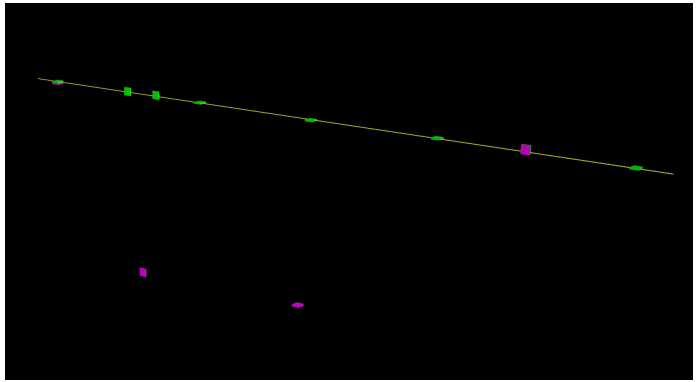
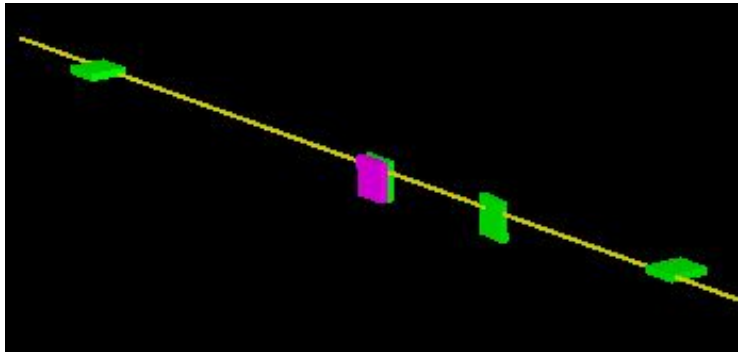
X
1328
-125
-1038
5548
Z



Errors Discovered

- Found a boolean that should’ve been a double
  - Not all distances should be 1
  - Easy to visually see that distances were not being calculated properly
- Track algorithm was biased
  - Putting tracks in a larger grid than expected
- Clustering algorithm was biased
  - Absolute value was missing from cluster-track distances
  - Clusters would be placed inaccurately on one side of the track





Questions