Seeding in the Tracker Subsystem

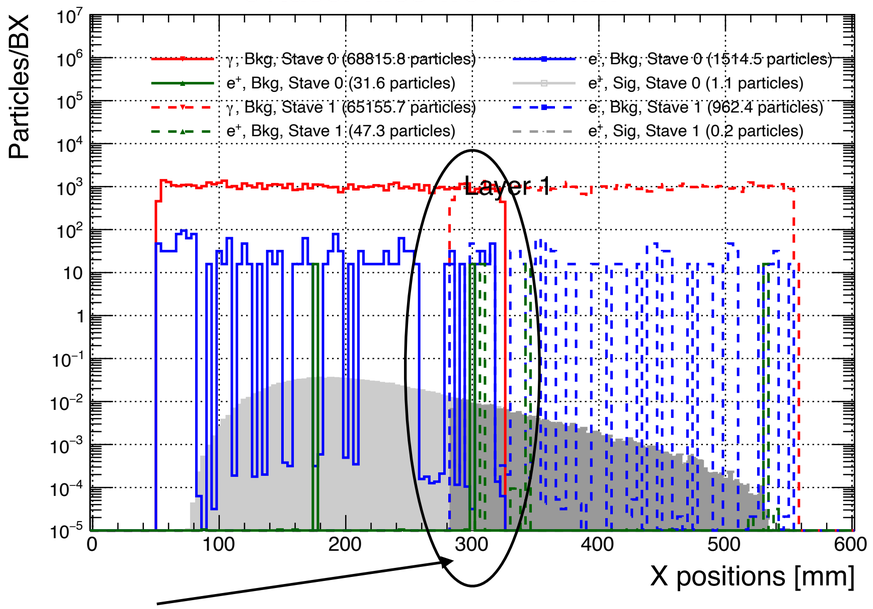
LUXE Simulation and Analysis Meeting

Arka Santra, November 24, 2020
Weizmann Institute of Science,
Rehovot, Israel

- e+laser hics setup
  - JETI 40 laser.
  - Spotsize w0 3000 nm.
  - Samples produced by Sasha.
  - Looked at the signal and background particles:
    - Created the seed from the seeding algorithm applied on the tracks (coming from “Tracks” trees).

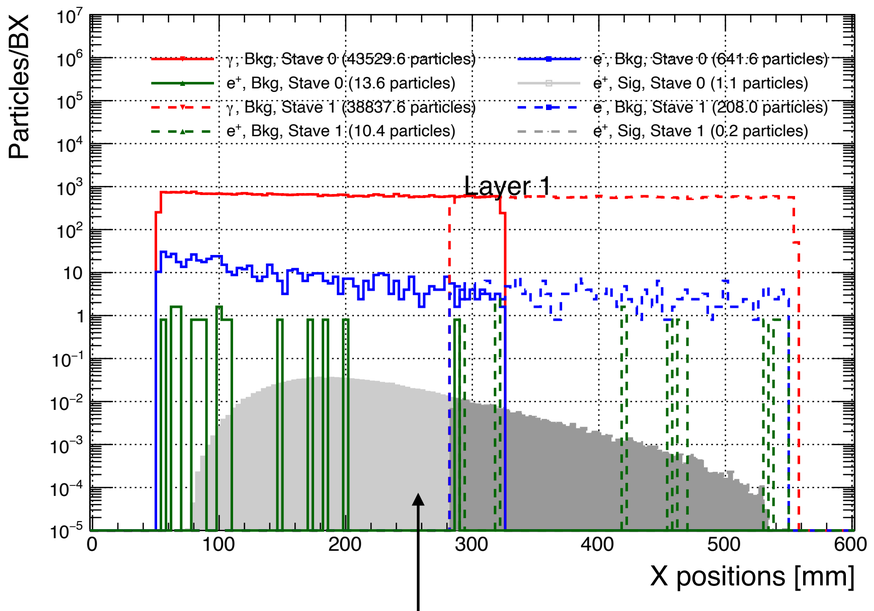
Number of particle tracks vs track x plots, first layer of tracker

e+laser hics w0 3000 nm



Overlap of staves

Only electron beam, for electron background



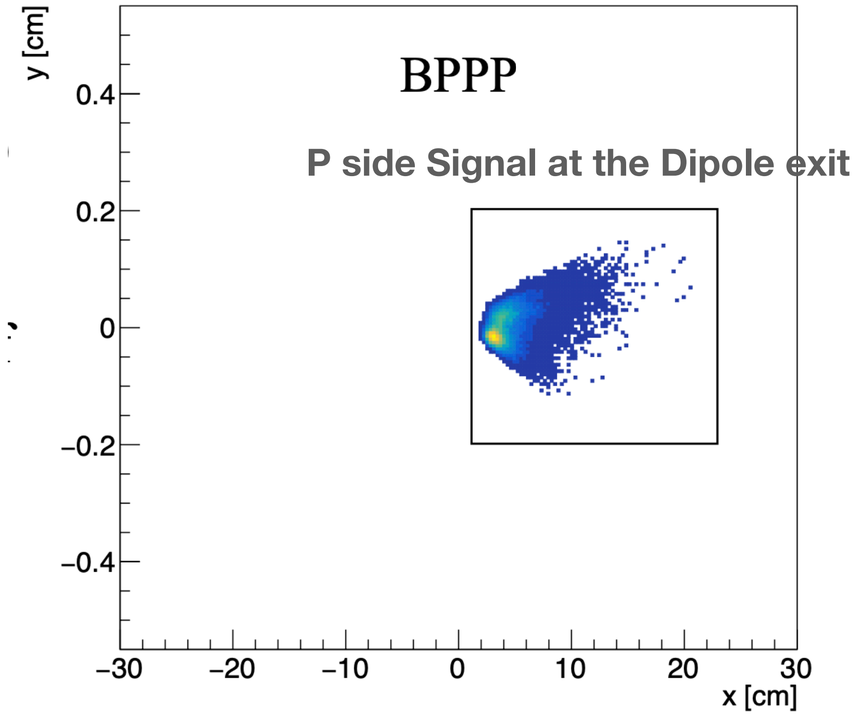
signal positron overlaid from the left plot

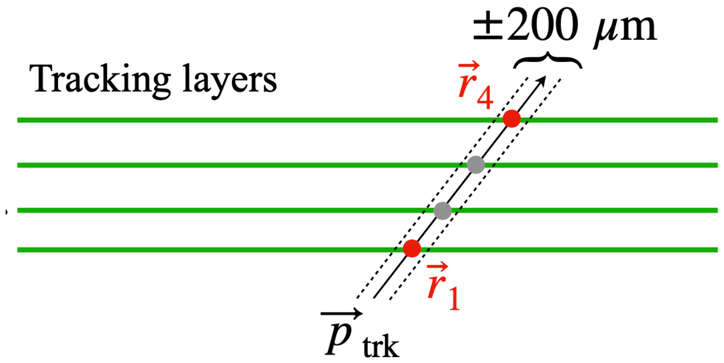
- **Showed these plots in previous meeting.**
  - Shows how many particle tracks we start with.
  - Can we reduce the tracks by seeding algorithm?

- The unwanted tracks from vtx_x < 0 and (vtx_z > 3600 && vtx_z < 4600) removed.
  - The end window of vacuum chamber, lanex planes etc.
- Solid lines are from inner stave (left side of plot), dotted lines from outer stave (right side of plot).
- For only electron beam, the signal positron is overlaid from the e+laser hics JETI 40 w0 3000 nm setup: for comparison.

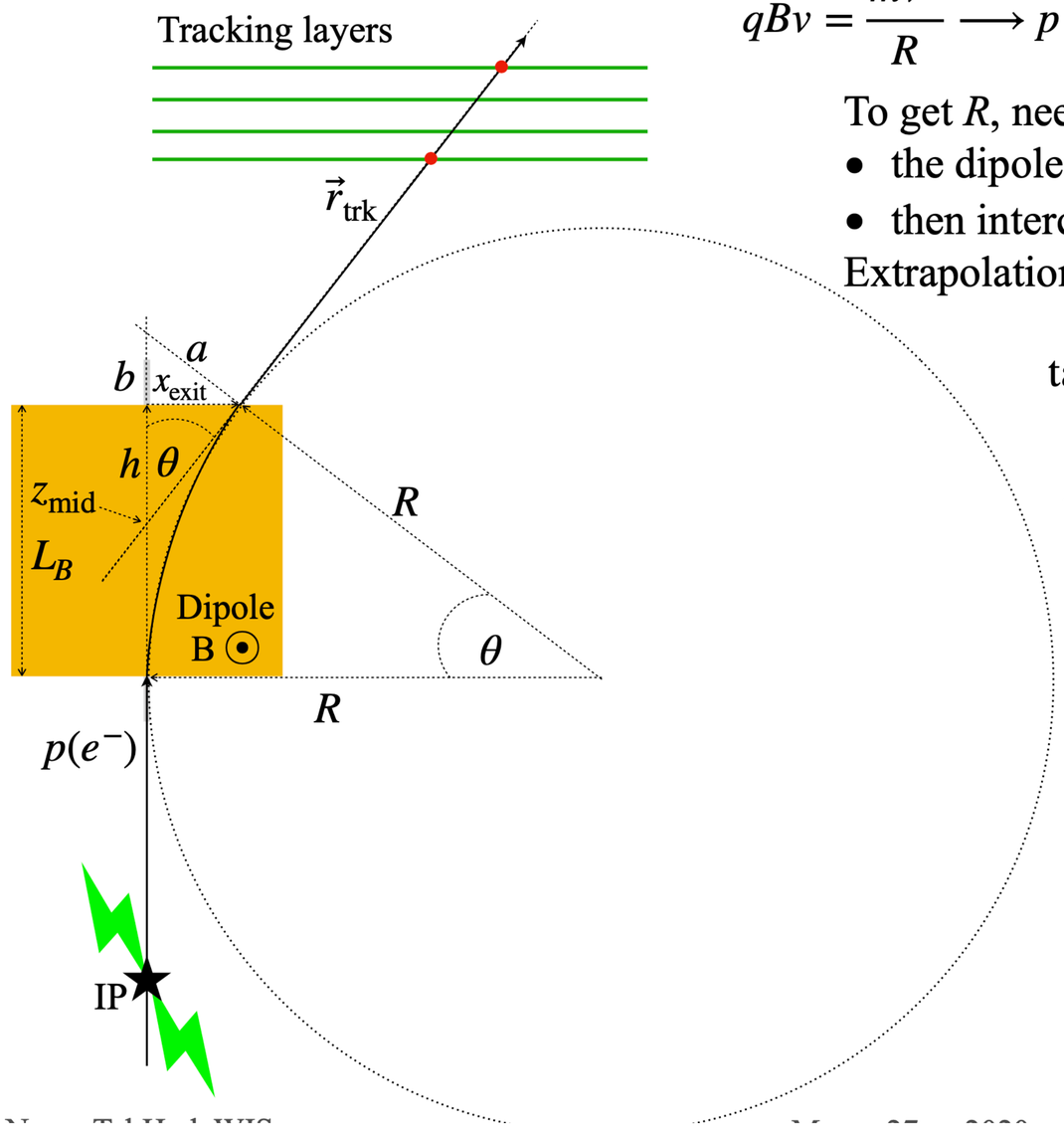
The seeding algorithm

- Keep unique set of tracks from first layer and last layer of tracker.
  - Overlap region is removed (by cutting on x value of the tracks) from the outer stave of first layer (innermost) and from the inner stave of the last layer (outermost).
- Loop over all pairs in layers 4 and 1, now only positron side (x>0).
- Reject pair of clusters if
  - |x1| > |x4| or they have different sign
  - |z1| == |z4|
  - |y_exit| > 20/2 mm
  - |x_exit| < 5 mm and |x_exit| > xDipoleWidth (330 mm) / 2
  - If not one cluster in the road of 200 um connecting vector r1 and r4 in both layer 2 and layer 3.
  - The seed energy is less than 1 GeV or 16.5 GeV.
    - The seed energy is calculated from the track.





Electron in a B-field of a dipole



$$qBv = \frac{mv^2}{R} \longrightarrow p = qBR \longrightarrow p[\text{GeV}] = 0.3 \cdot B[\text{T}] \cdot R[m]$$

To get R, need to extrapolate the track backwards to

- the dipole exit plane and obtain the x_{exit} coordinate
- then intercept with the $x = 0$ line to find $z_{\text{mid}} \rightarrow h$

Extrapolation is done using 2 points at layer 4 and 1

$$\tan\theta = \frac{x_{\text{exit}}}{h} = \frac{L_B + b}{R} \longrightarrow R = h\frac{L_B + b}{x_{\text{exit}}}$$

$$\tan\theta = \frac{b}{x_{\text{exit}}} \longrightarrow R = h\frac{L_B + x_{\text{exit}}\tan\theta}{x_{\text{exit}}}$$

$$R = h\frac{L_B + x_{\text{exit}}^2/h}{x_{\text{exit}}} = \frac{hL_B}{x_{\text{exit}}} + x_{\text{exit}}$$

$$p_{\text{seed}} = 0.3B \cdot \left(\frac{hL_B}{x_{\text{exit}}} + x_{\text{exit}}\right)$$

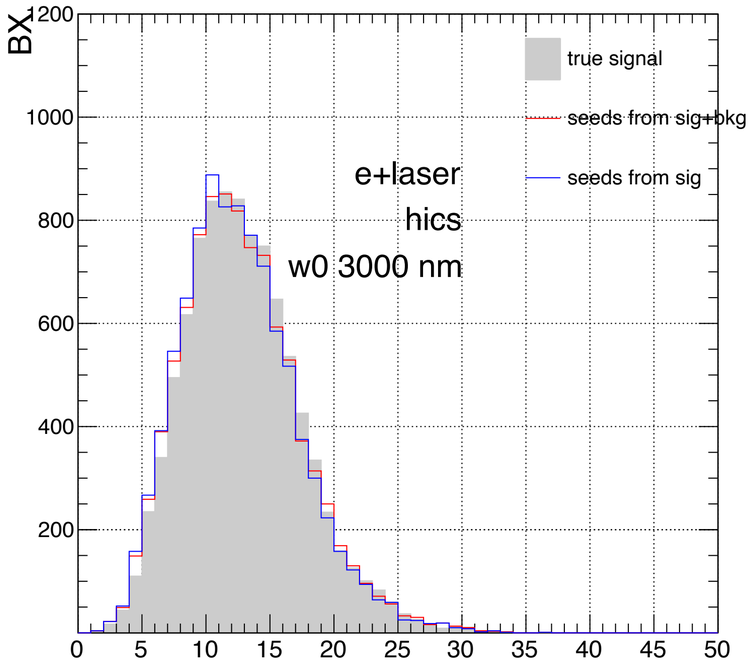
$$\vec{p}_{\text{seed}} = \left(\sim 0,\ p_{\text{seed}}\frac{y_{\text{trk}}}{r_{\text{trk}}},\ p_{\text{seed}}\frac{z_{\text{trk}}}{r_{\text{trk}}}\right)$$

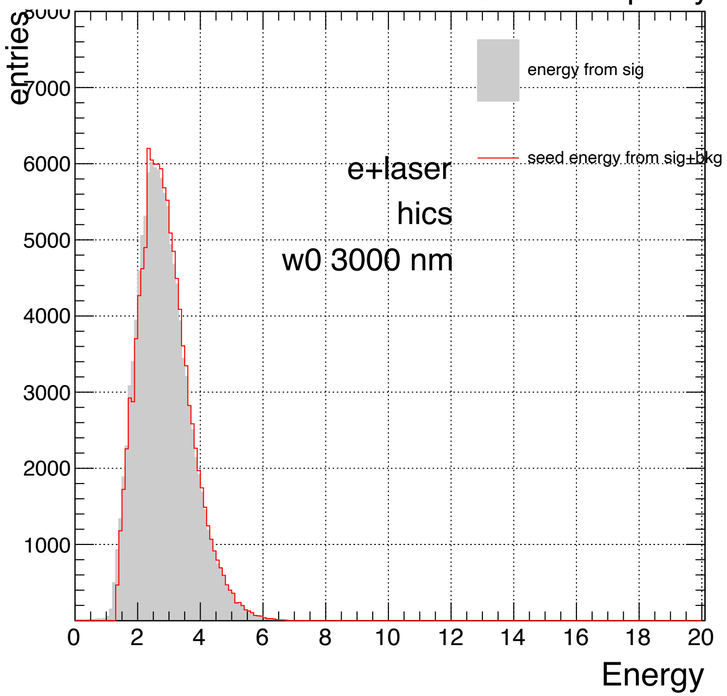
Random number drawn from the truth p_x distribution at the vertex

From Noam

Plots from seeds

- True signal is when required positron using pdg=-11 and track id=1
  - Energy from Geant4 from first tracker layer.
- Seeds from sig+bkg applies the seeding algorithm on all available electron and positron tracks.
  - Energy from the seeds
- Seeds from signal applies the seeding algorithm on signal tracks (selected by trackid=1 and pdgid=-11).

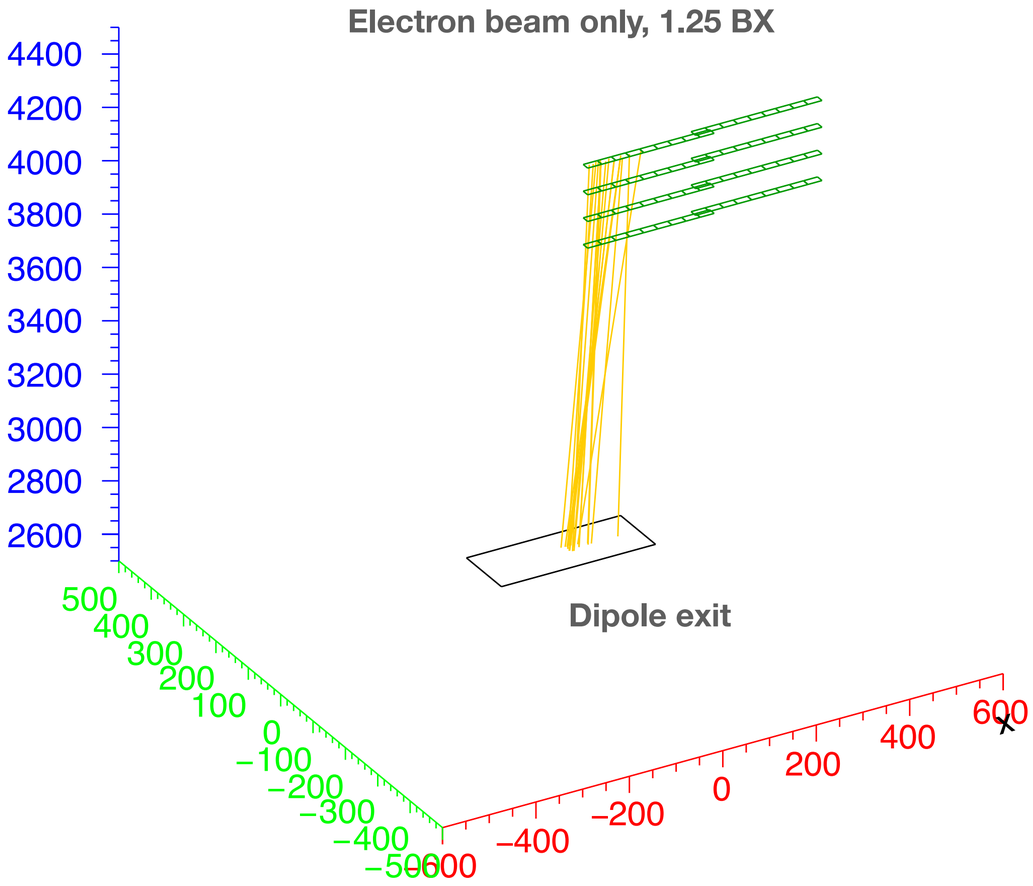




Electron Beam only file, no signal

1.25 BX available

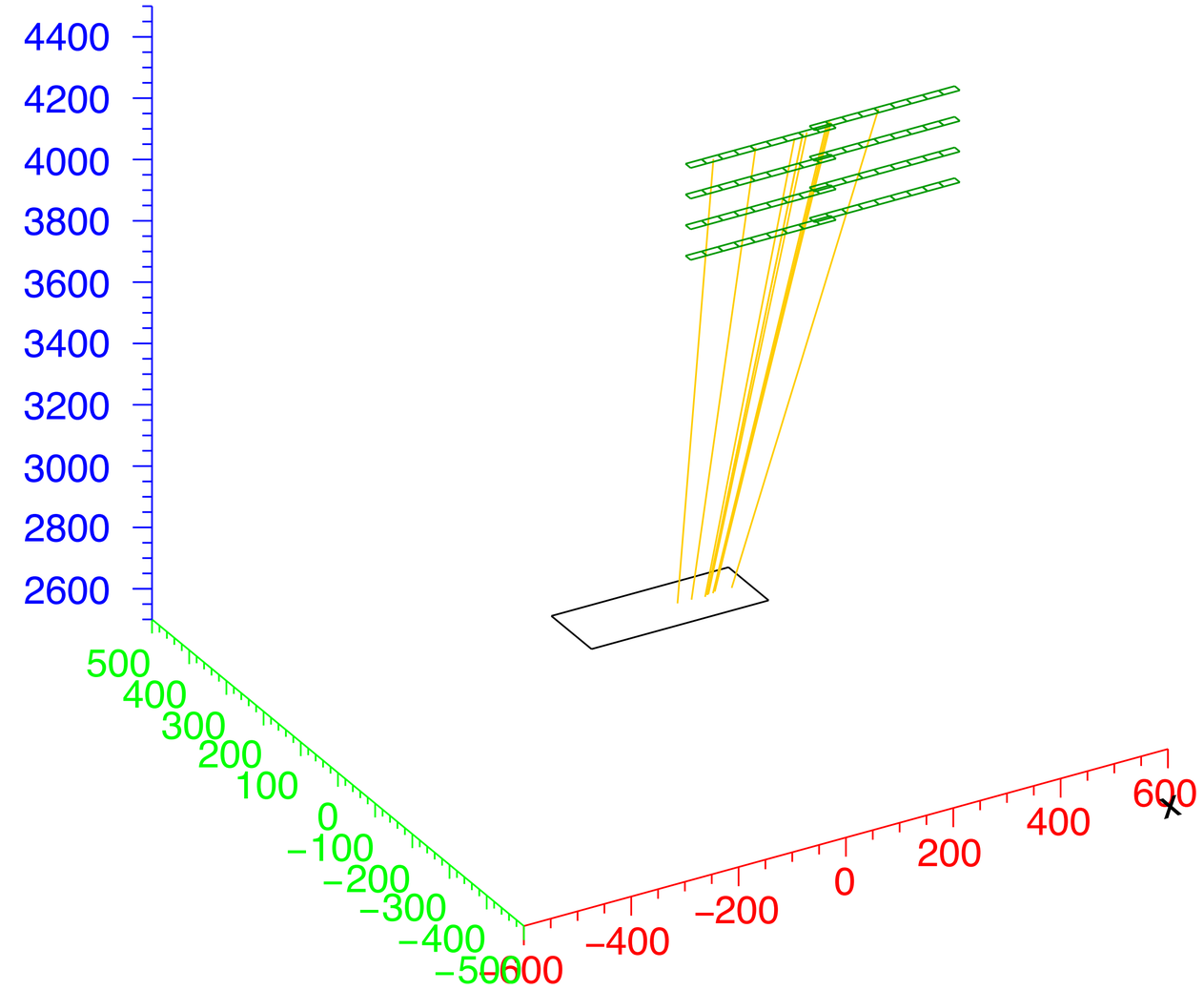
- The track energy did not consider the FPC layer before the pixel, so applying an energy cut of 50 KeV on all clusters.
- The seeding algorithm reduces the possible track pairs from 667964 to 18 (for 1.25 BX).
  - Acceptance rate of 2.69e-3 %
  - Some of the tracks will not survive the Kalman Filter fit as they are too straight.
    - The acceptance will even go down further.



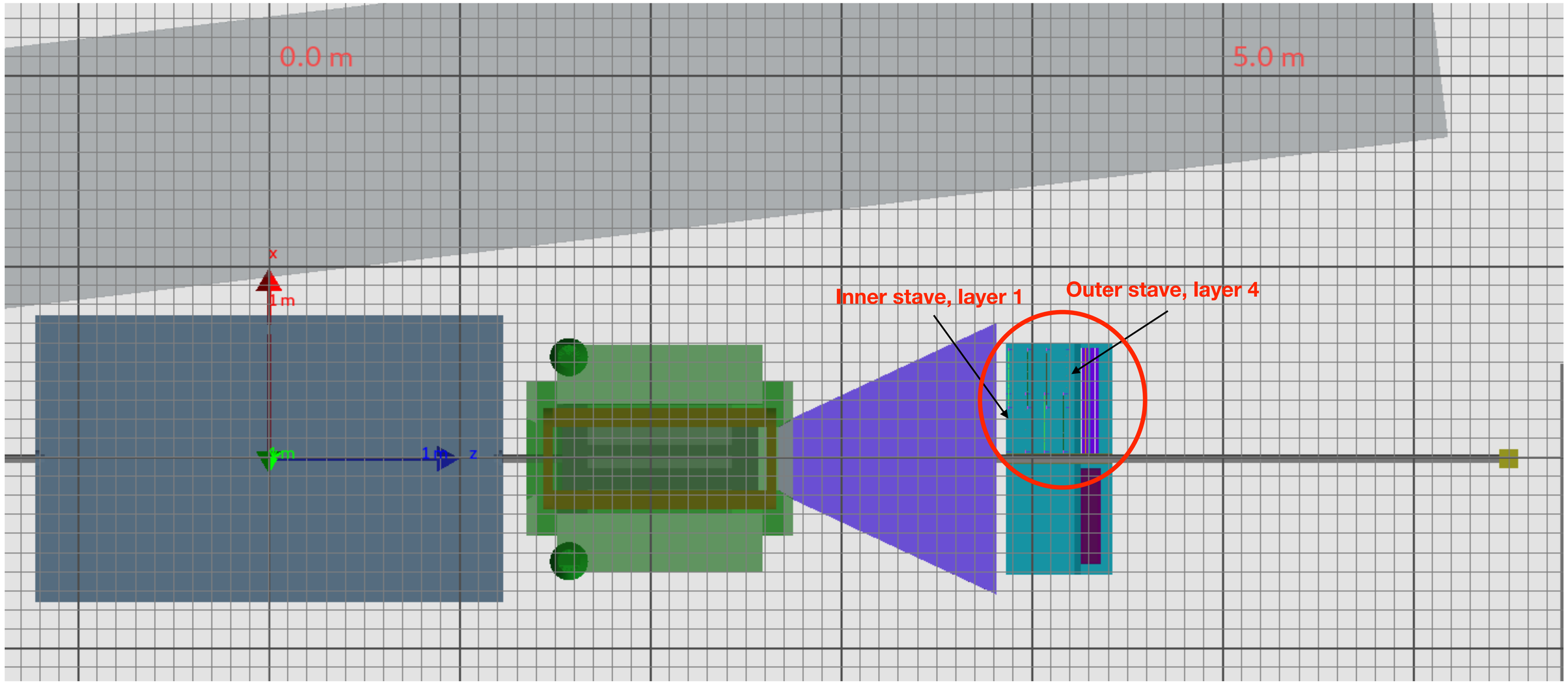
Summary and To Do

- Successfully applied the seeding algorithm
  - Noam prepared an event display setup to view the tracks in the tracker setup.
- May need to tweak some of the rejection criteria more carefully and come up with the optimum set of cuts.

Seed track diagrams for 1 BX, e+laser hics, signal and background



The subsystems near the IP



Plots from Sasha