SuperB:
Update on DCH FullSim Studies

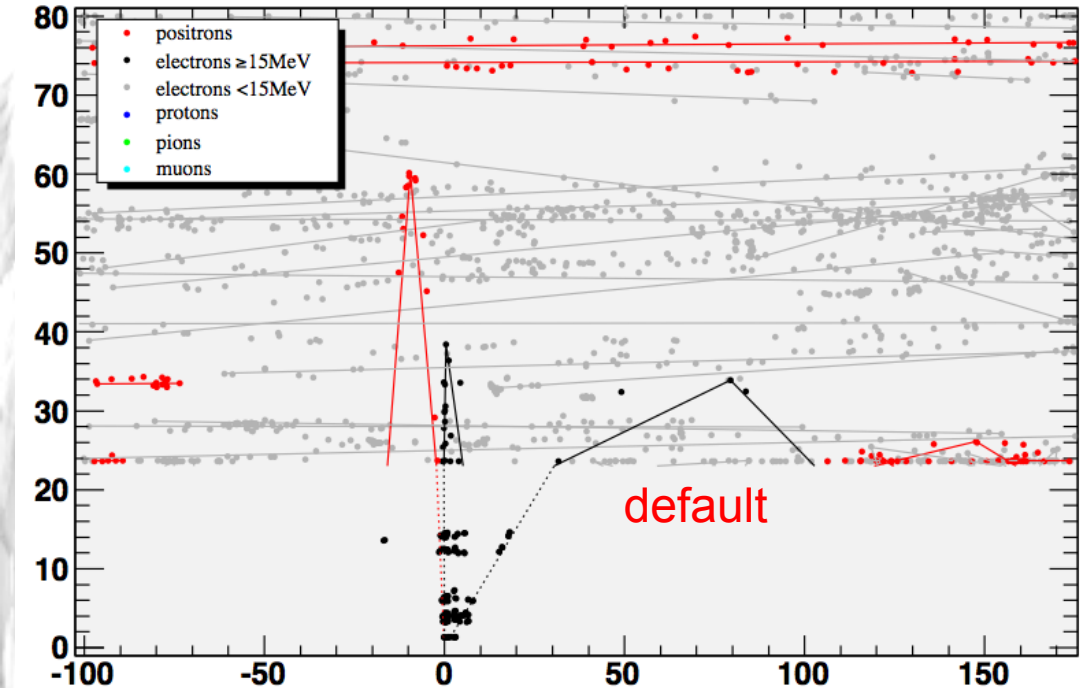
Dana Lindemann
McGill University

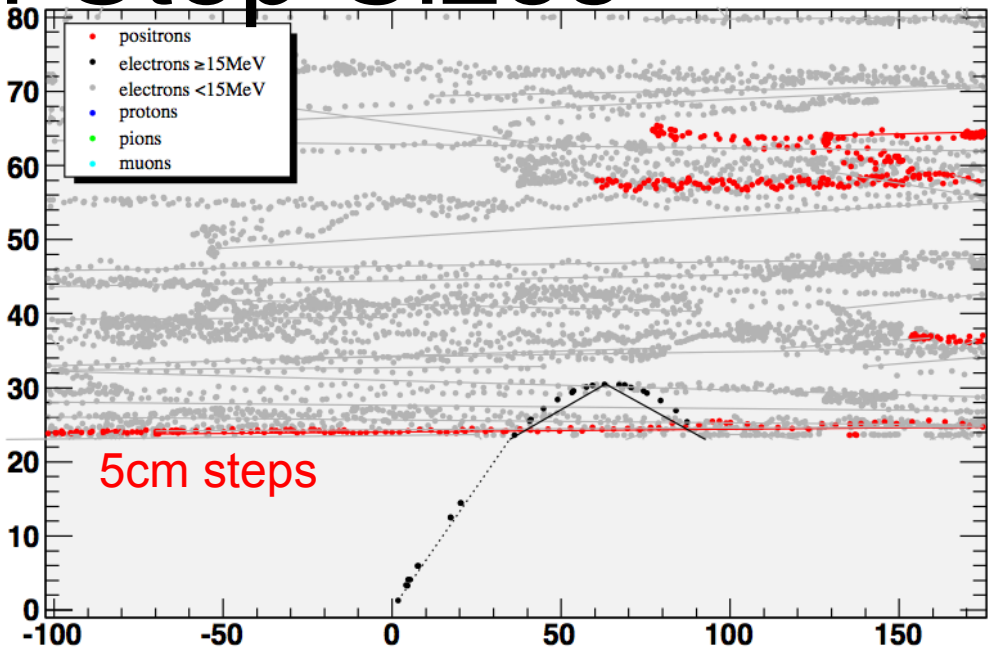
SuperB Collaboration Meeting – DCH session
Dec 14, 2010

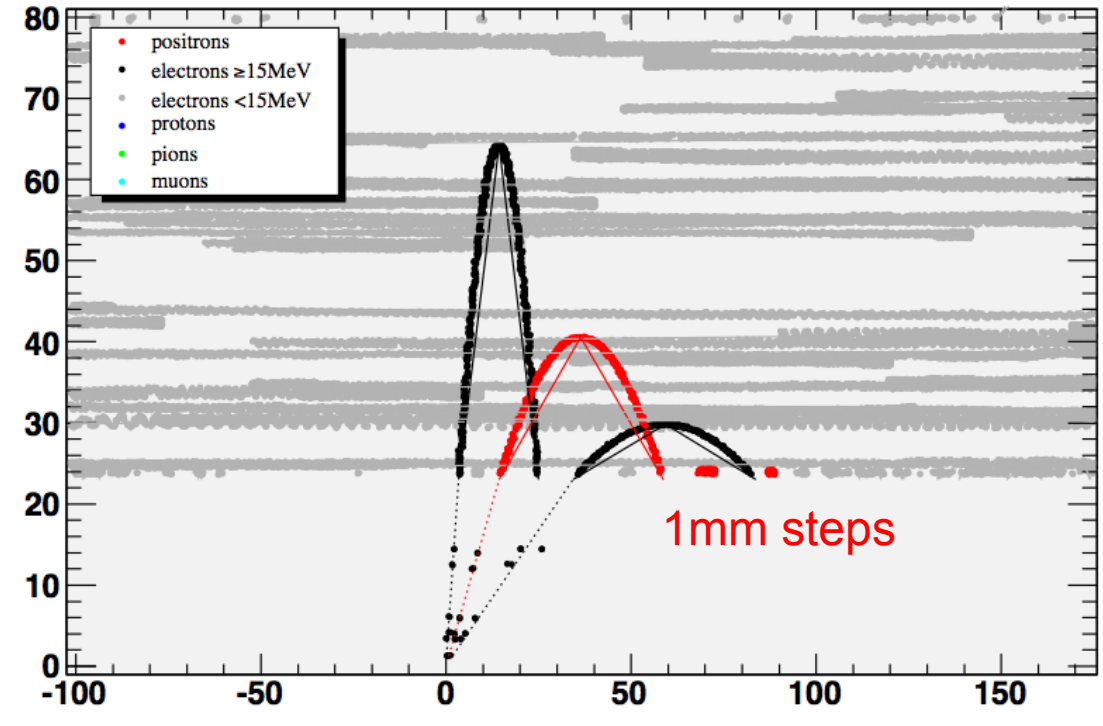
Outline

- Studies on deposited energy vs. Step Sizes
- Occupancy methods vs. Step Sizes
- Muon Gun

Visualization of Step Sizes

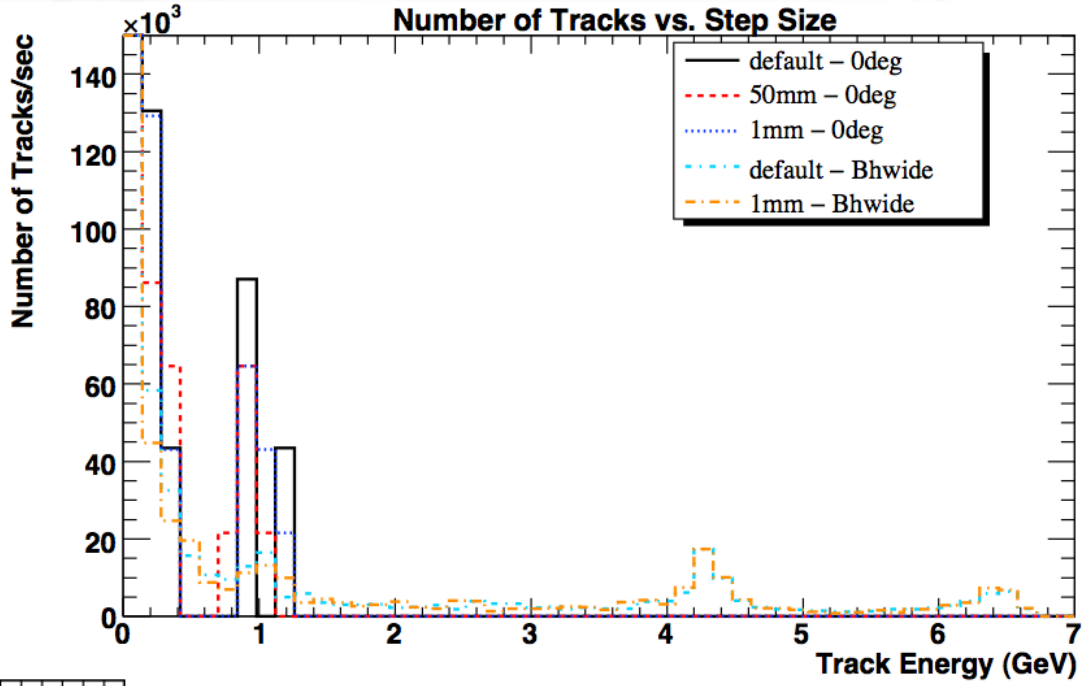


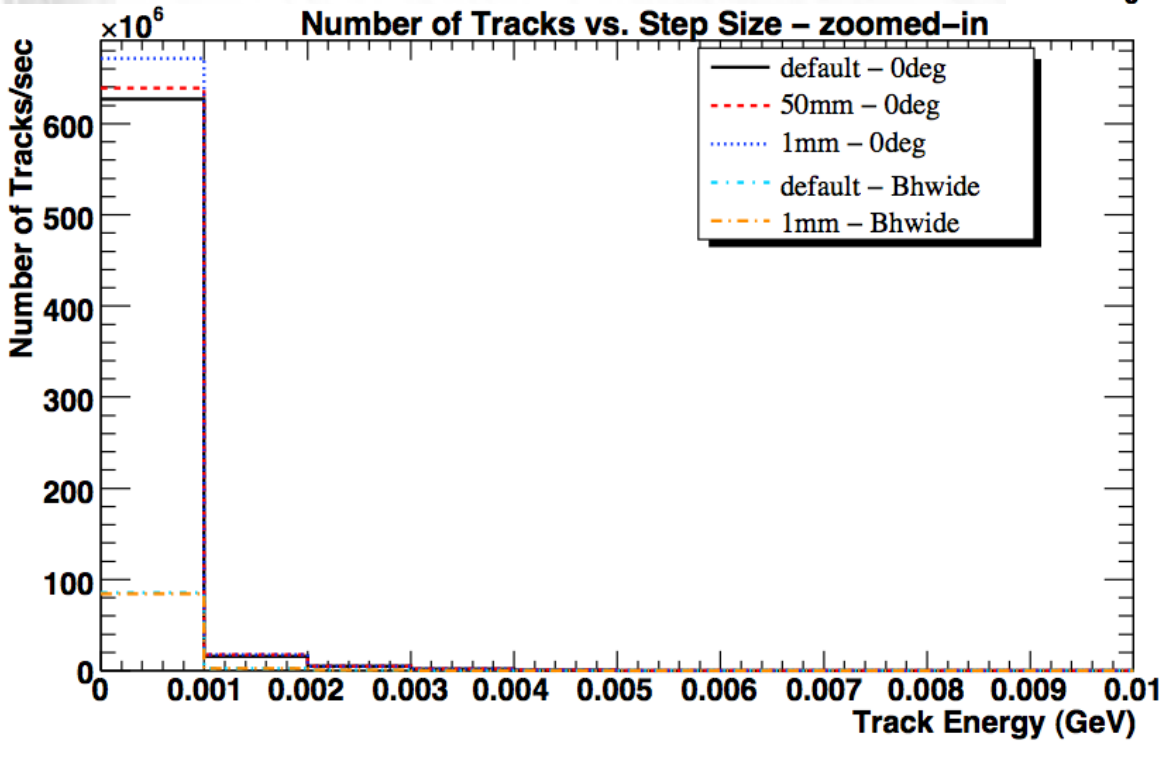




2000 events with tracks
1.5MeV < E < 150MeV,
hits with depE > 0 only

Number of Tracks vs. Step Size

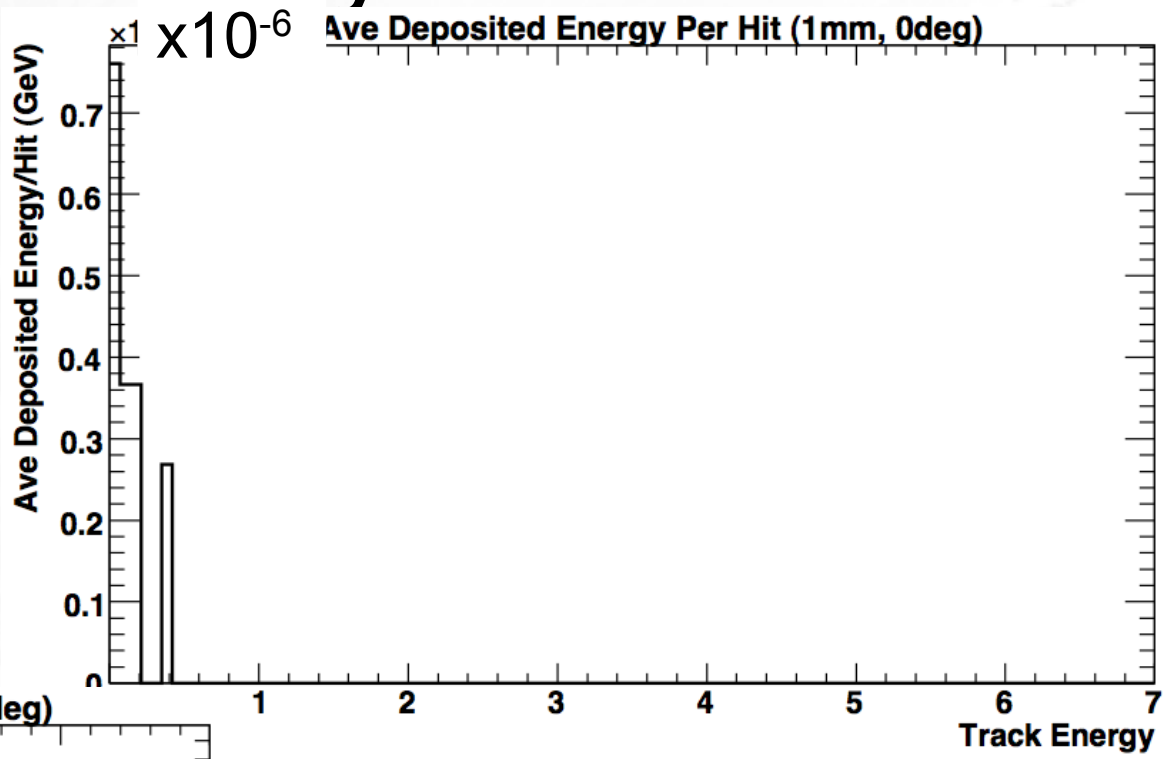


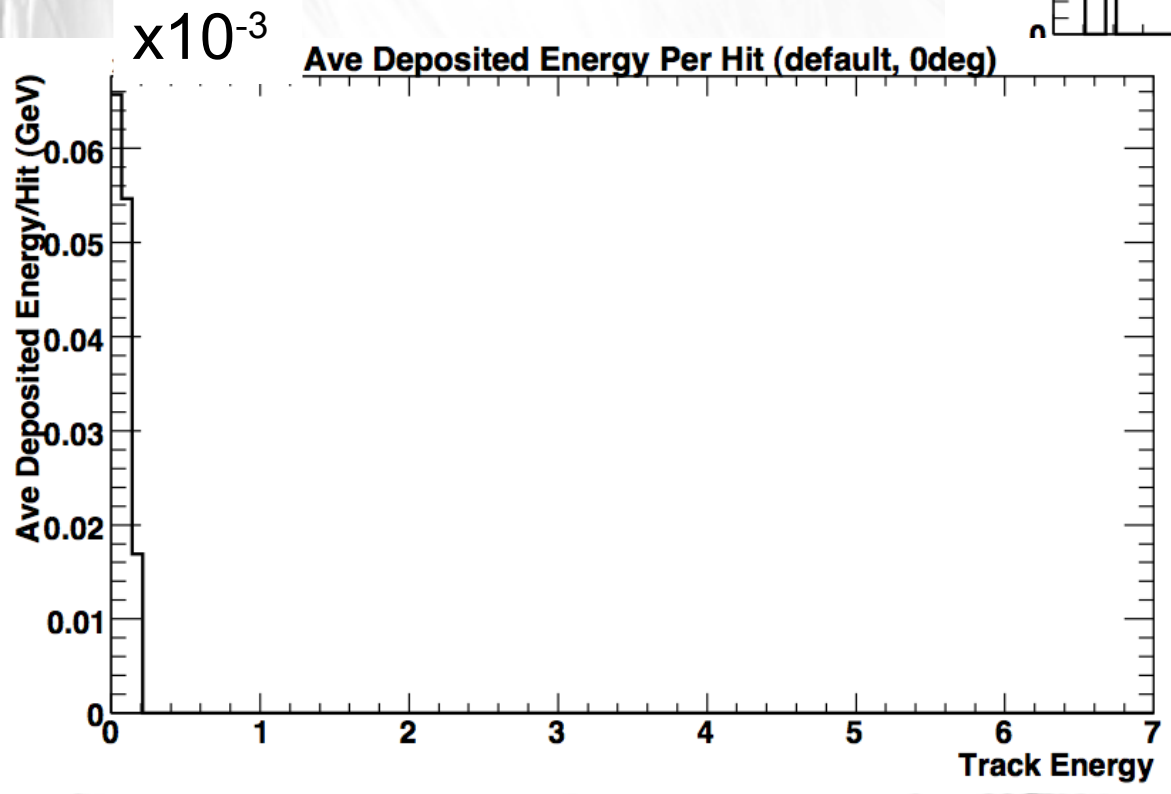


Conclusions:
Same number of tracks of various energies, regardless of step size

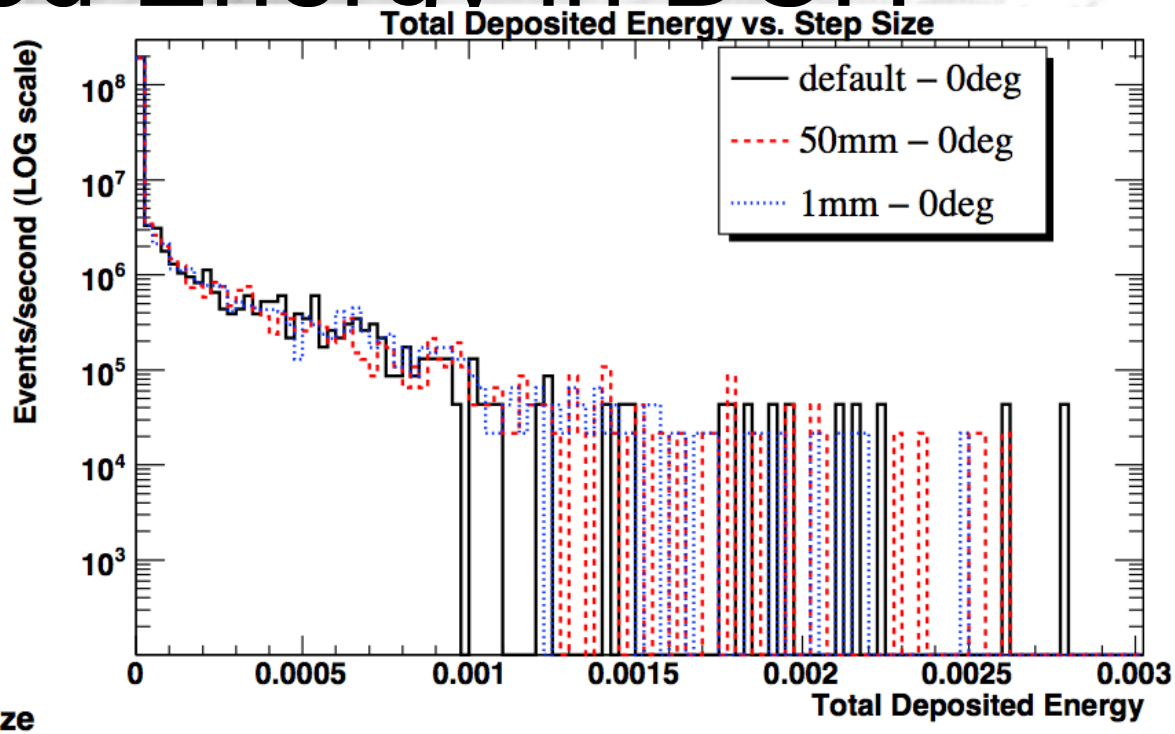
Deposted Energy Per Hit

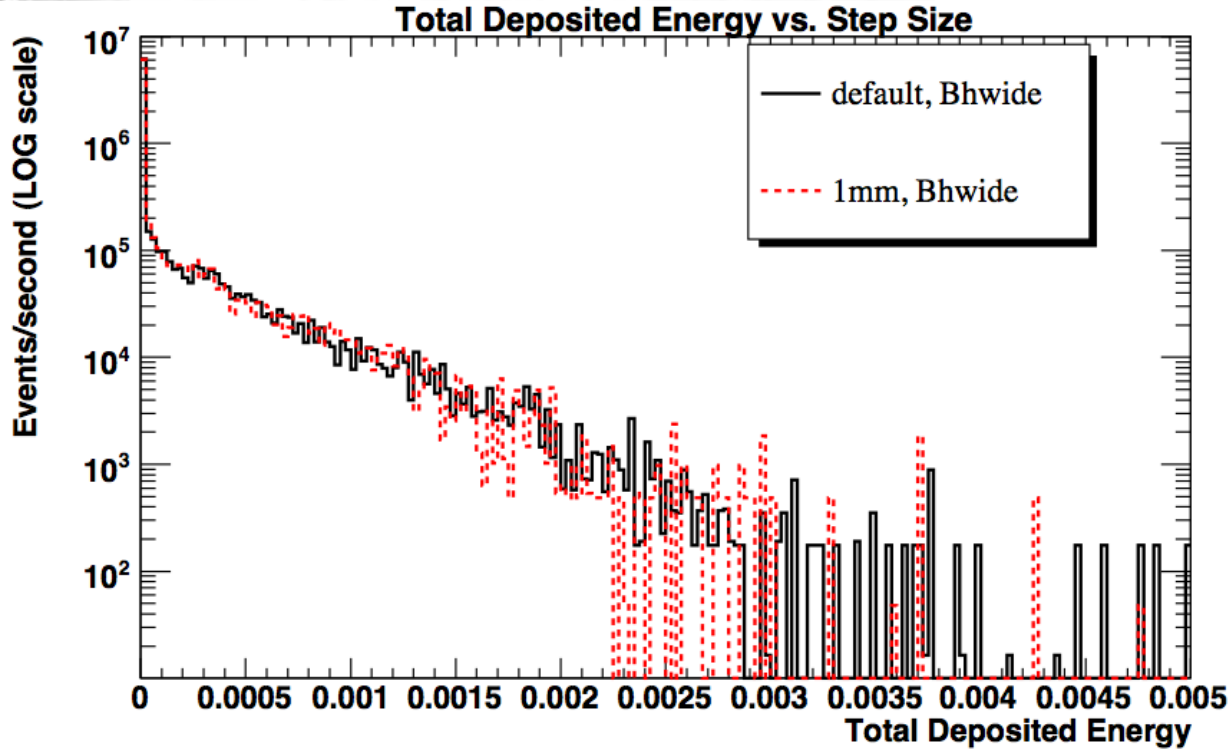
Conclusions: Each hit has 2 orders of mag more deposited energy in the default sample, but less hits.





Total Deposited Energy in DCH



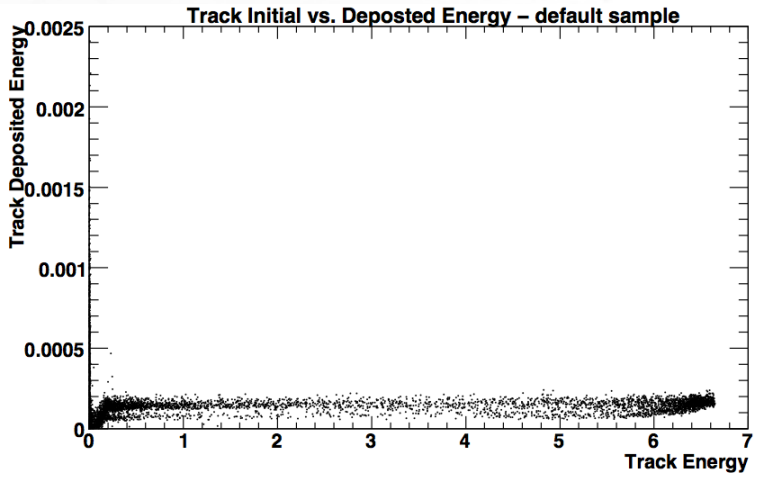


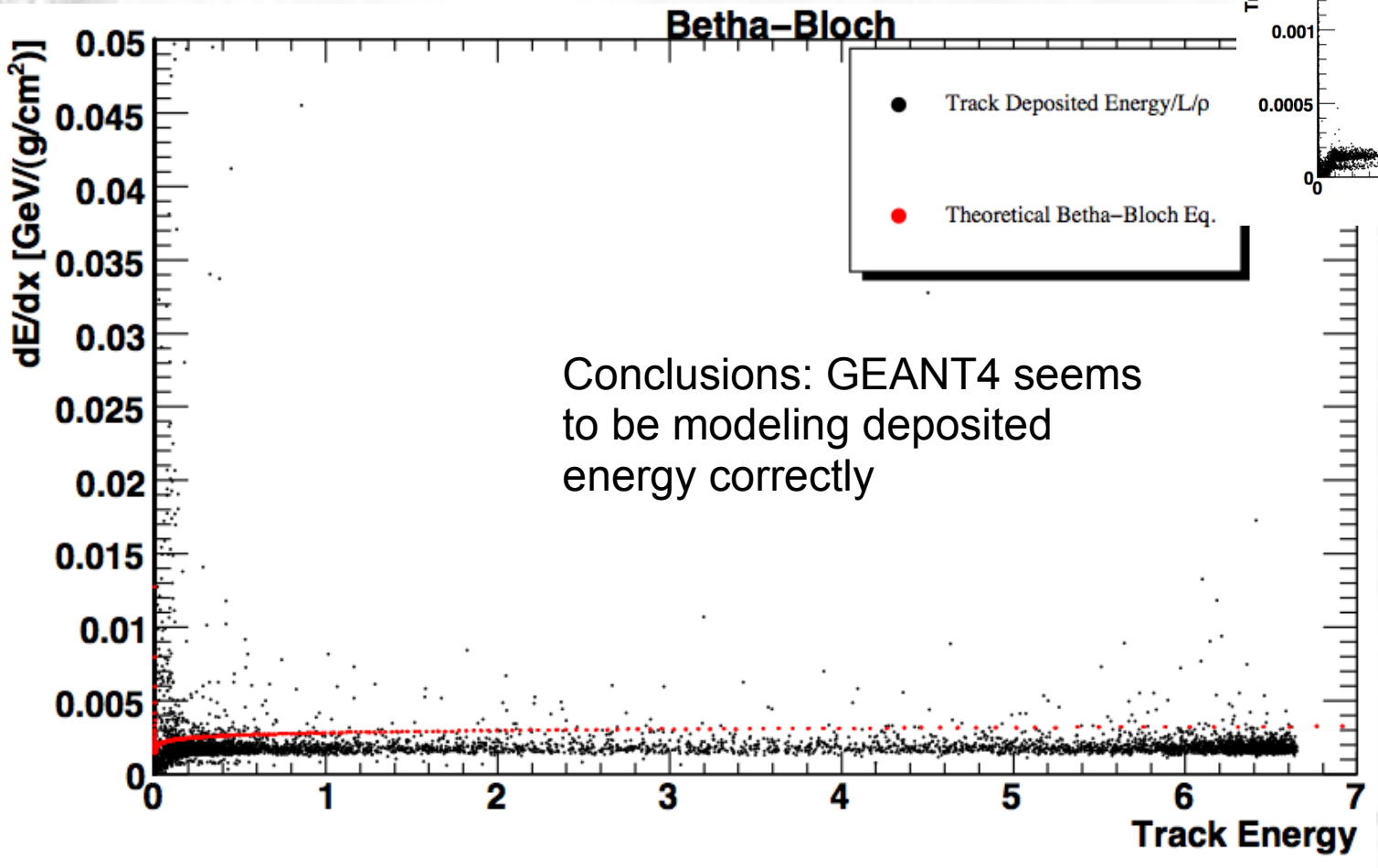
Conclusions:
Same amount of integrated deposited energy within DCH, regardless of track size.

Betha-Bloch plots

$$\left(\frac{dE}{dx}\right)_{elec} = (4\pi r_e^2 m_e c^2)\left(\frac{N_A Z}{A}\right)\left(\frac{1}{\beta^2}\right)\left[\ln\left(\frac{\gamma m_e c^2 \beta\sqrt{\gamma-1}}{\sqrt{2}I}\right) + \frac{1}{2}(1-\beta^2) - \left(\frac{2\gamma-1}{2\gamma^2}\right)\ln 2 + \frac{1}{16}\left(\frac{\gamma-1}{\gamma}\right)^2\right]$$

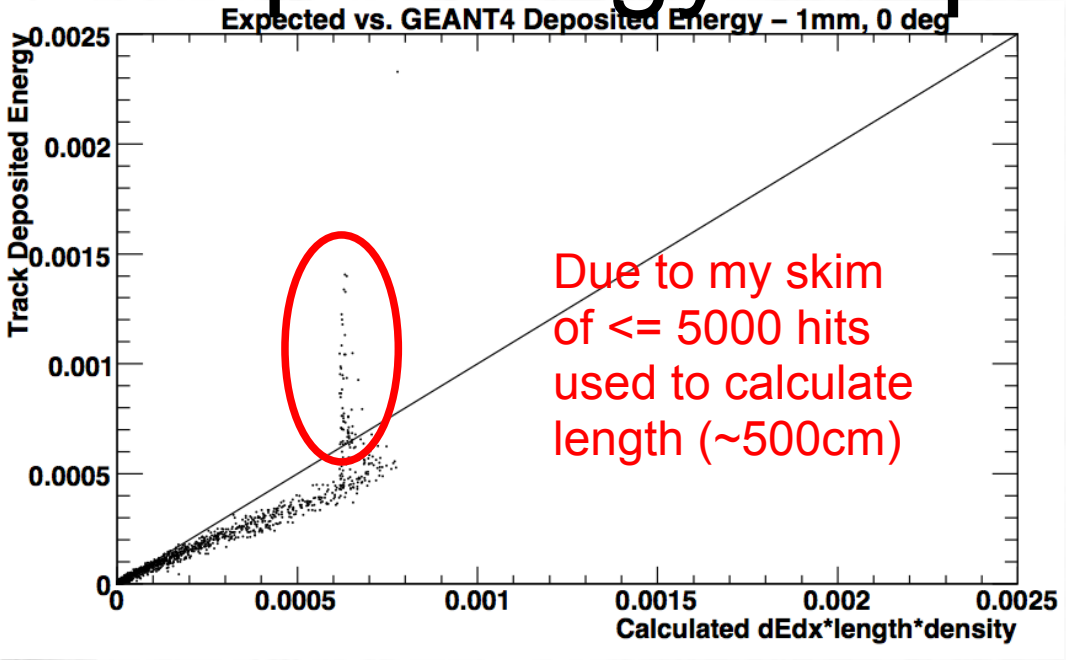
A=31, Z=15
(density = 0.00084 cm^3/g





Conclusions: GEANT4 seems to be modeling deposited energy correctly

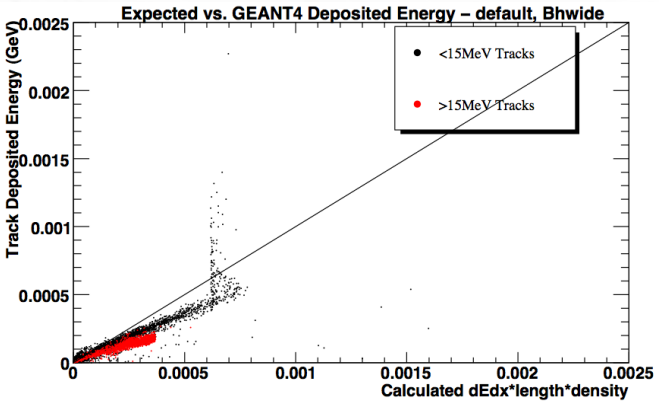
Dep Energy -Expected vs. GEANT4

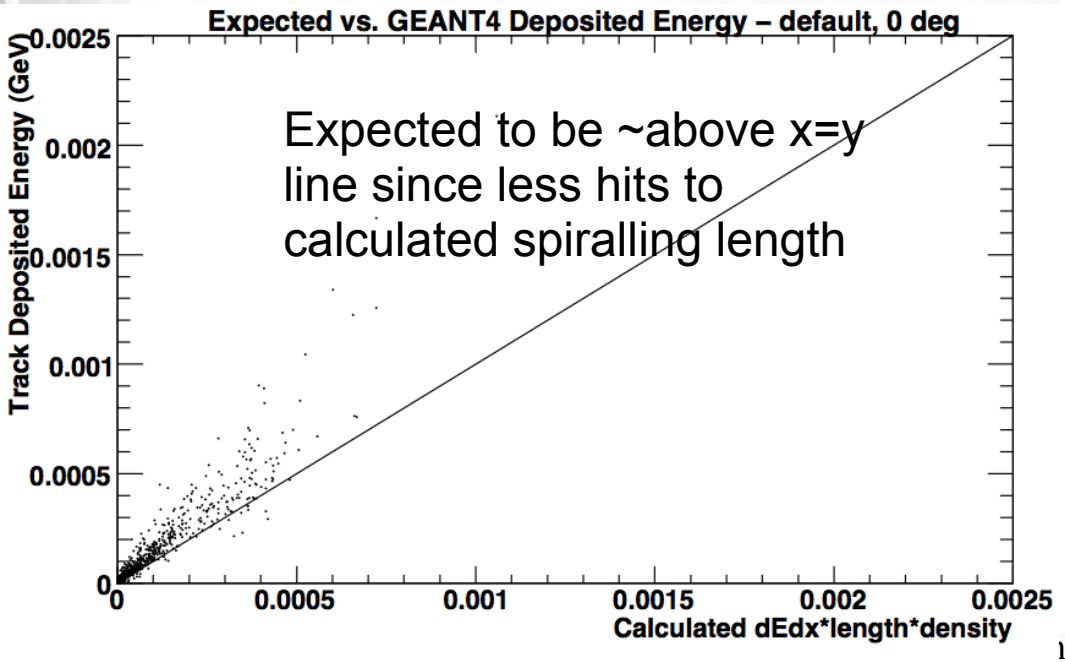


Due to my skim of <= 5000 hits used to calculate length (~500cm)

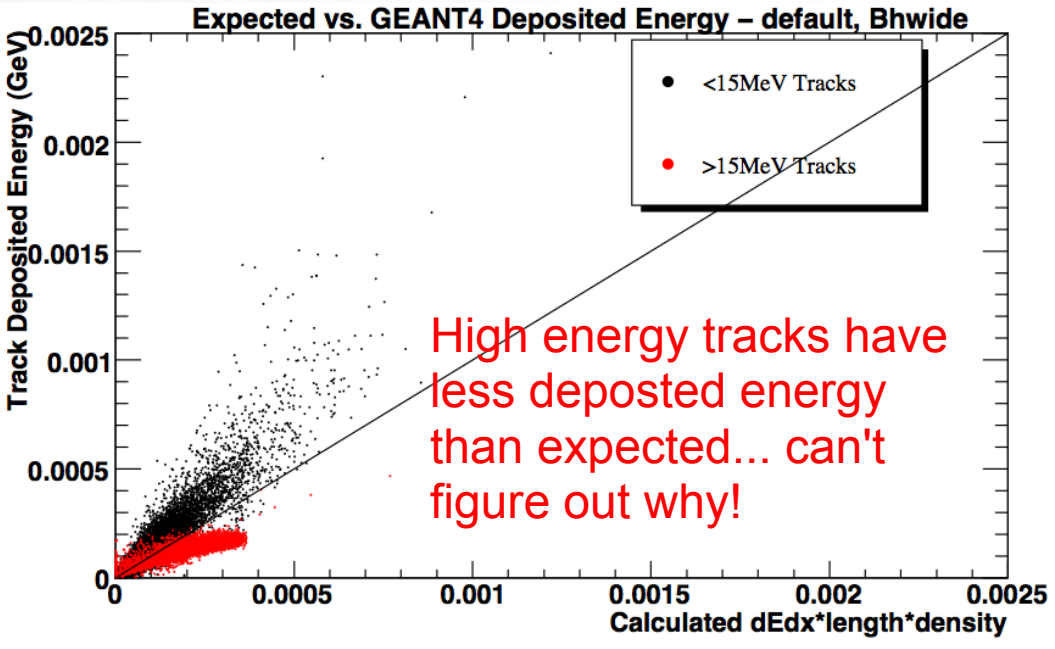
Length: sum of straight-line distances btw hits

Conclusion: GEANT4 seems to be modeling the deposted energy fine (although maybe not for higher energy tracks?)



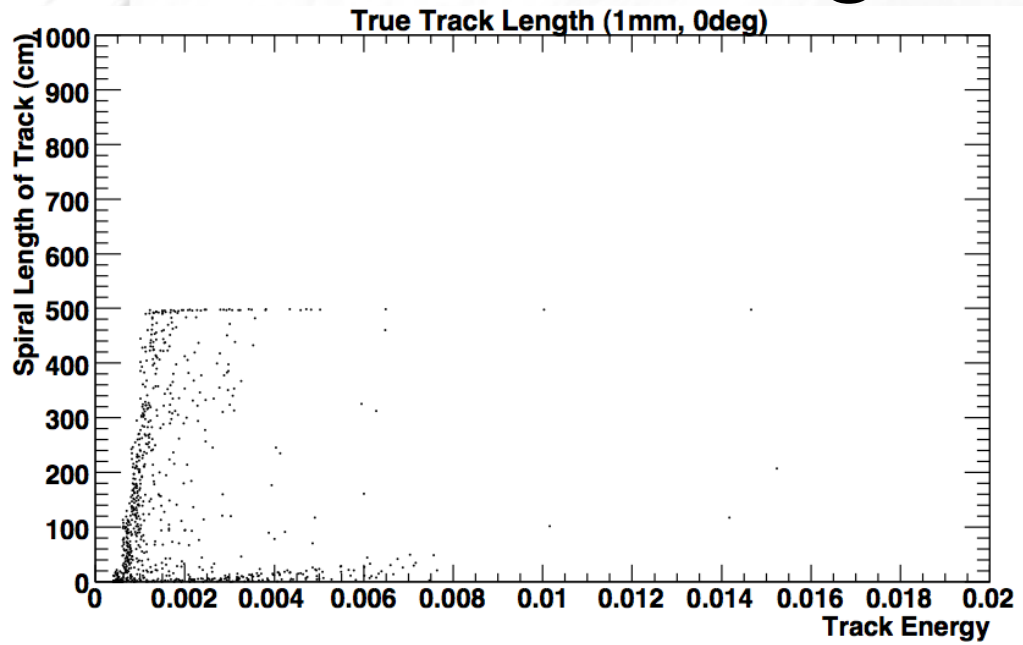


Expected to be ~above x=y line since less hits to calculated spiralling length

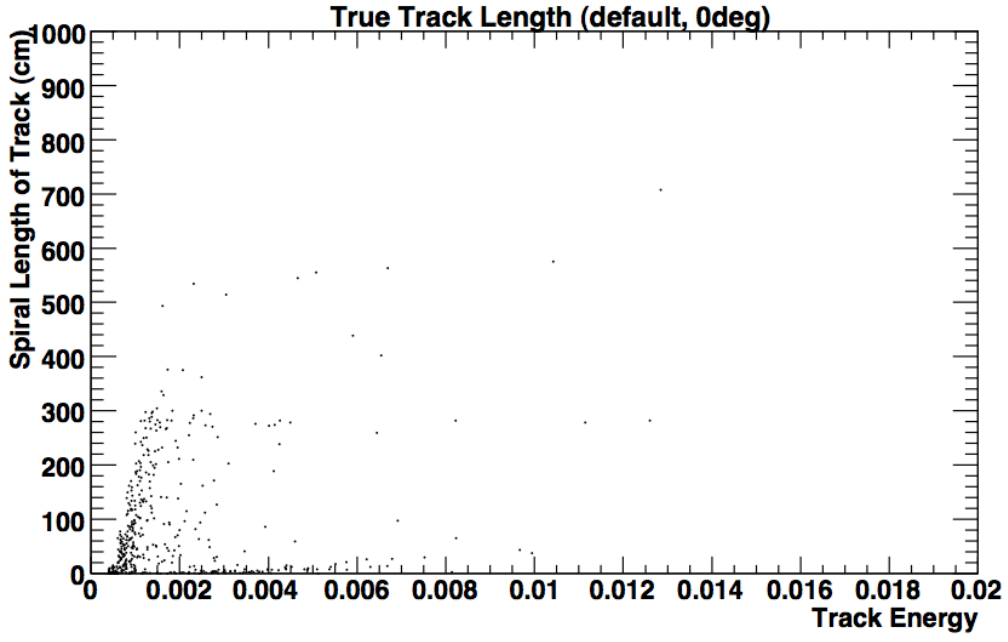


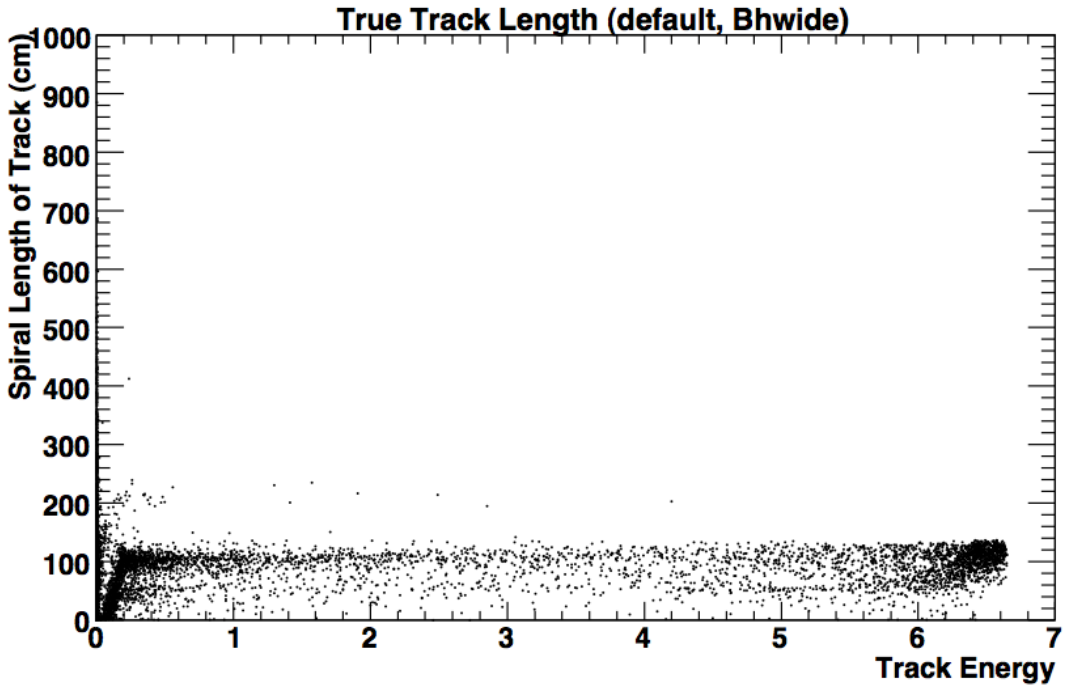
High energy tracks have less deposted energy than expected... can't figure out why!

Track Length using hit-by-hit



Conclusions: Lengths look about the same for low energy tracks (also same conclusion for length between 1st and last hits only)

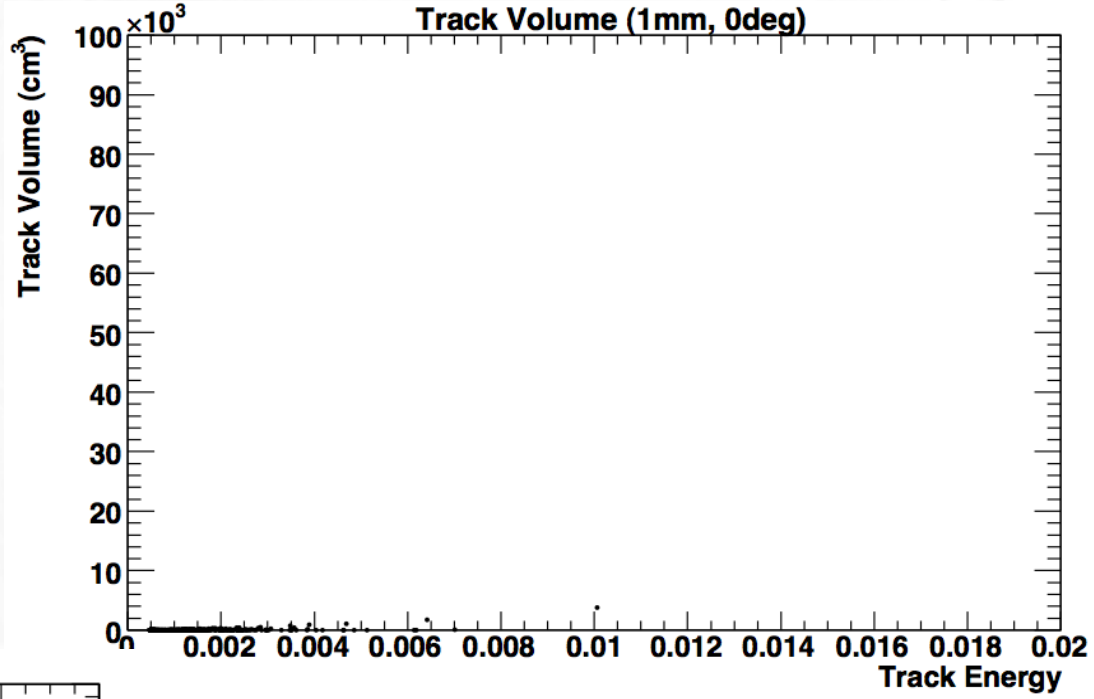


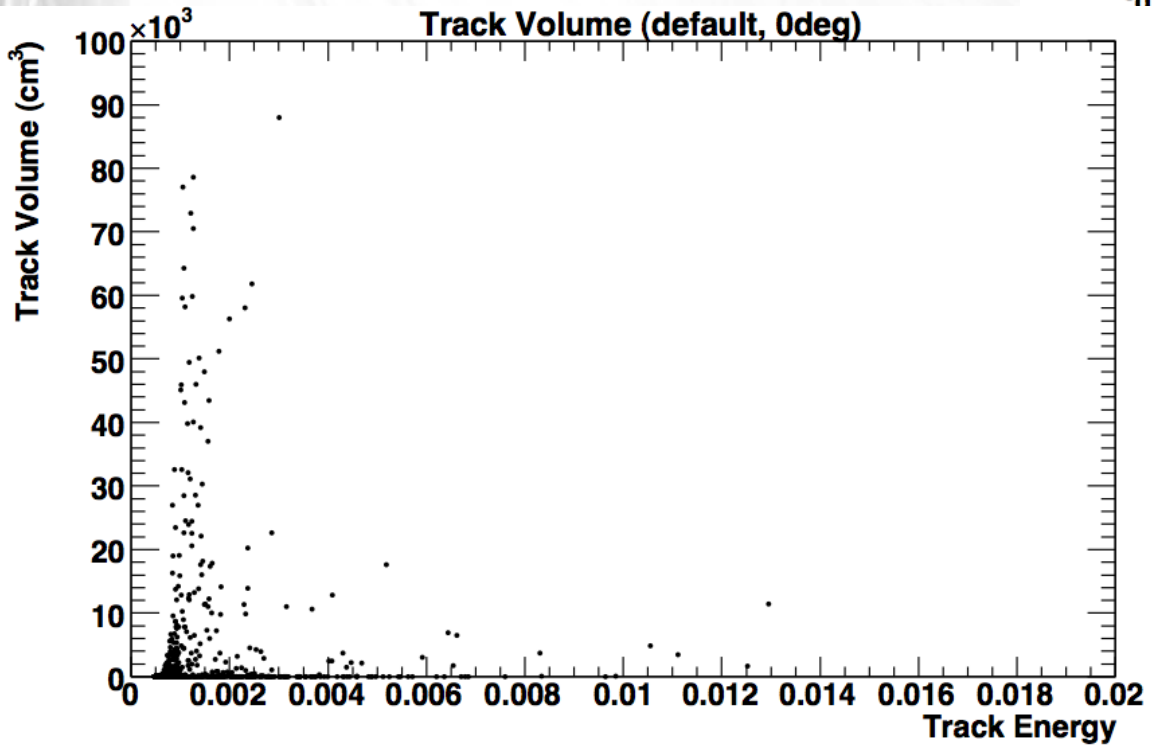


Track "Volume"

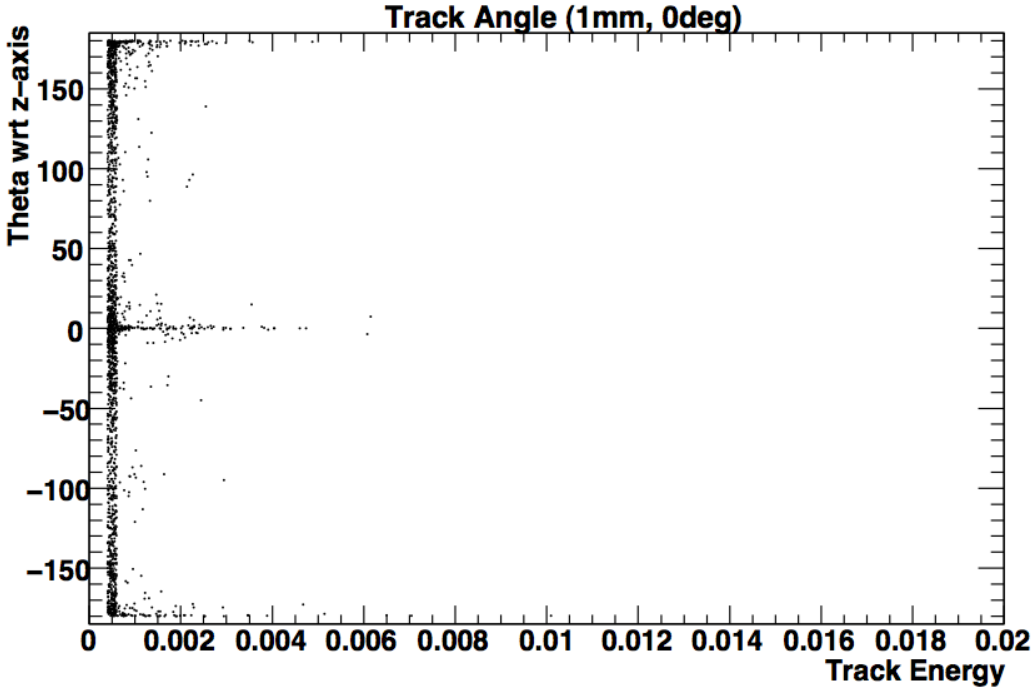
Volume of cm^3 needed to contain full track

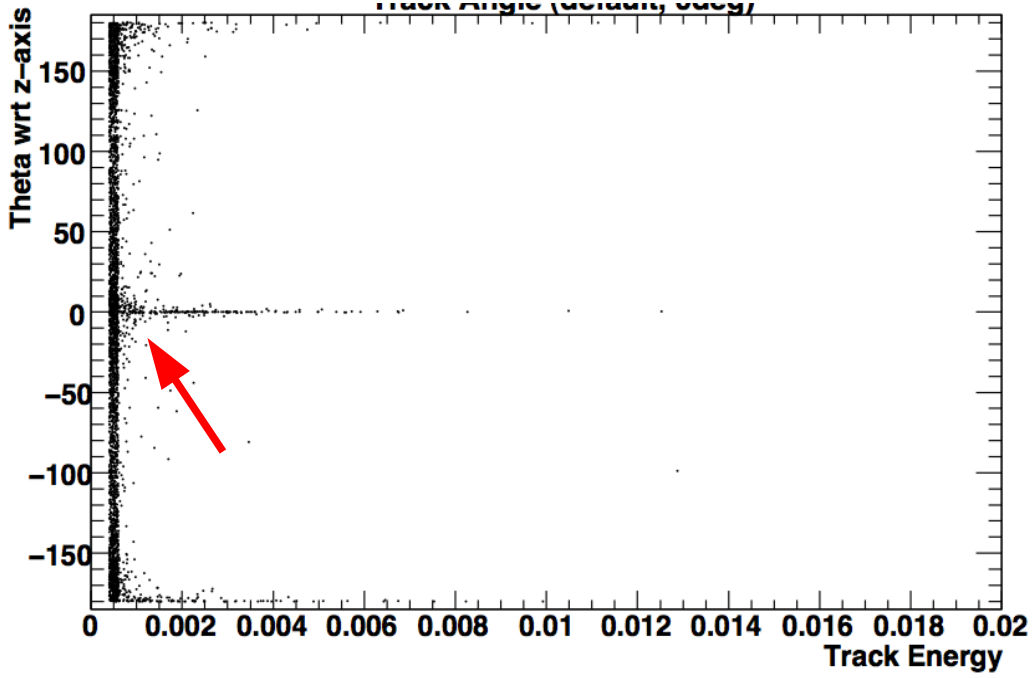
Conclusions: This tends to be larger for default than 1mm., as expected from the visualization pics



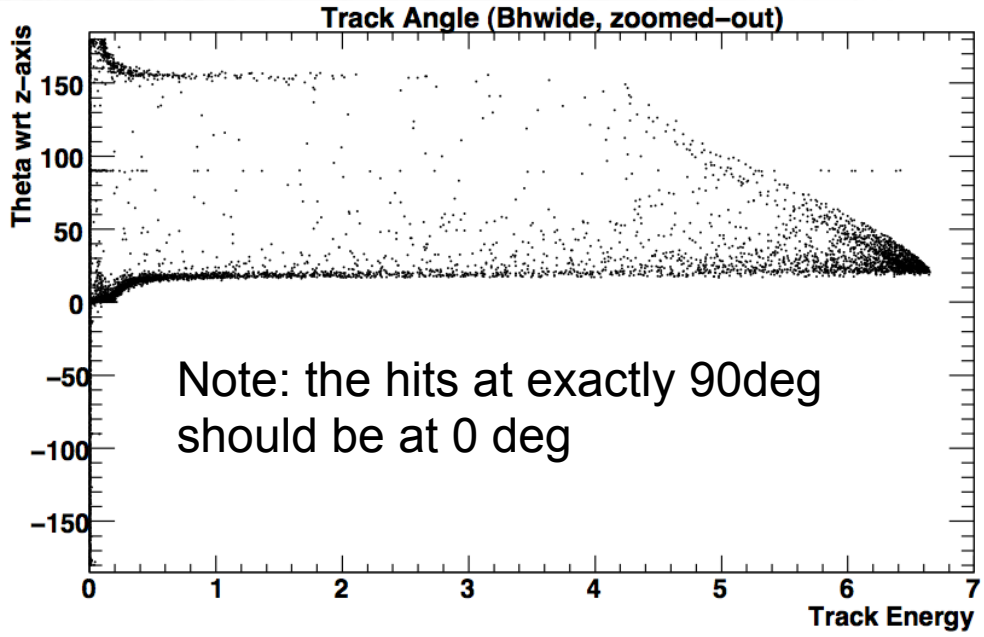


Track Angle





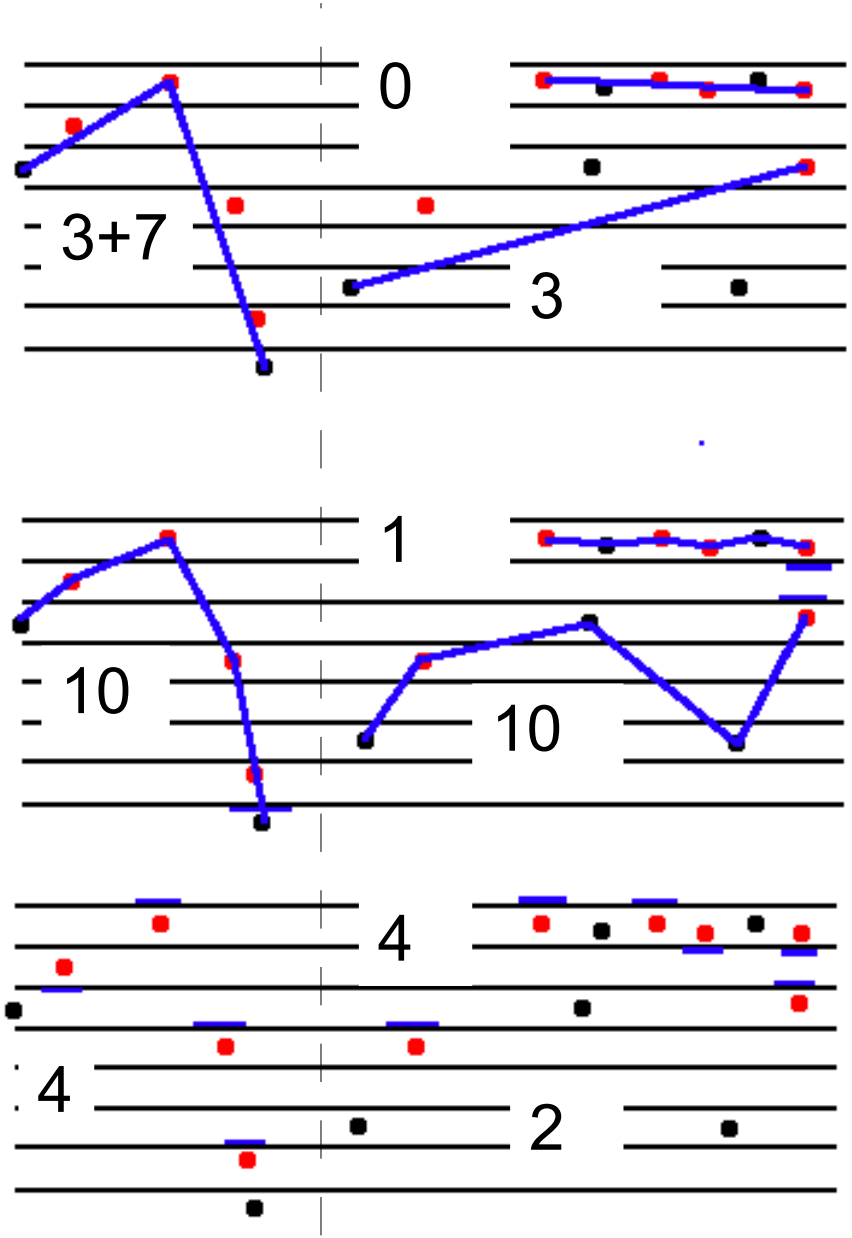
Calculated using the theta between the first and last hits, wrt z-axis



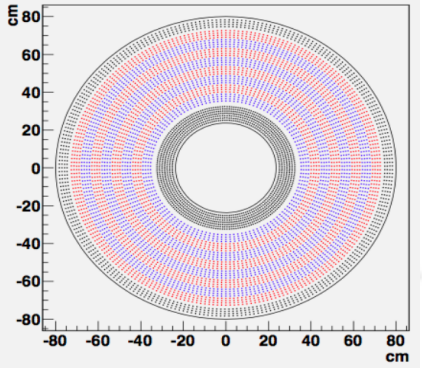
Note: the hits at exactly 90deg should be at 0 deg

Conclusions:
The smaller step-size tends to have more very low energy tracks (<1.5MeV) that are parallel to the beam-axis than the default samples, but the difference is small.

Occupancy Methods



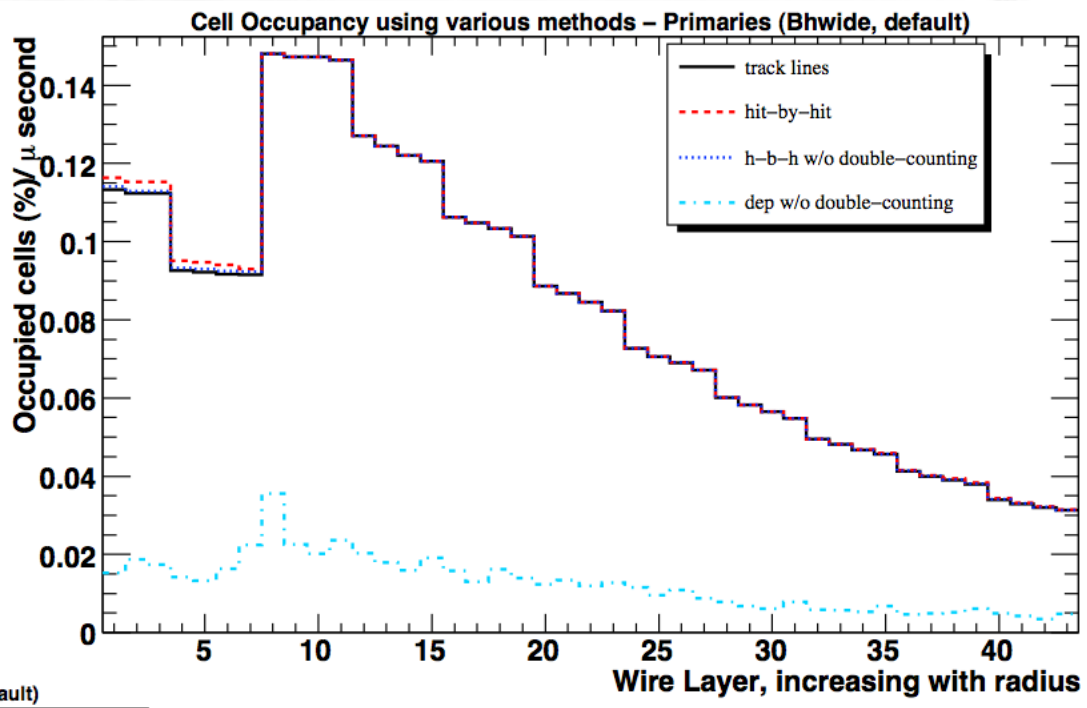
Track Lines:
Tracks entering/exiting: 2 straight lines
Low E tracks: 1 straight line
1 wire-hit per crossed wire radii.
Just uses wire-radii and allows
double-counting (no phi arrangment check)

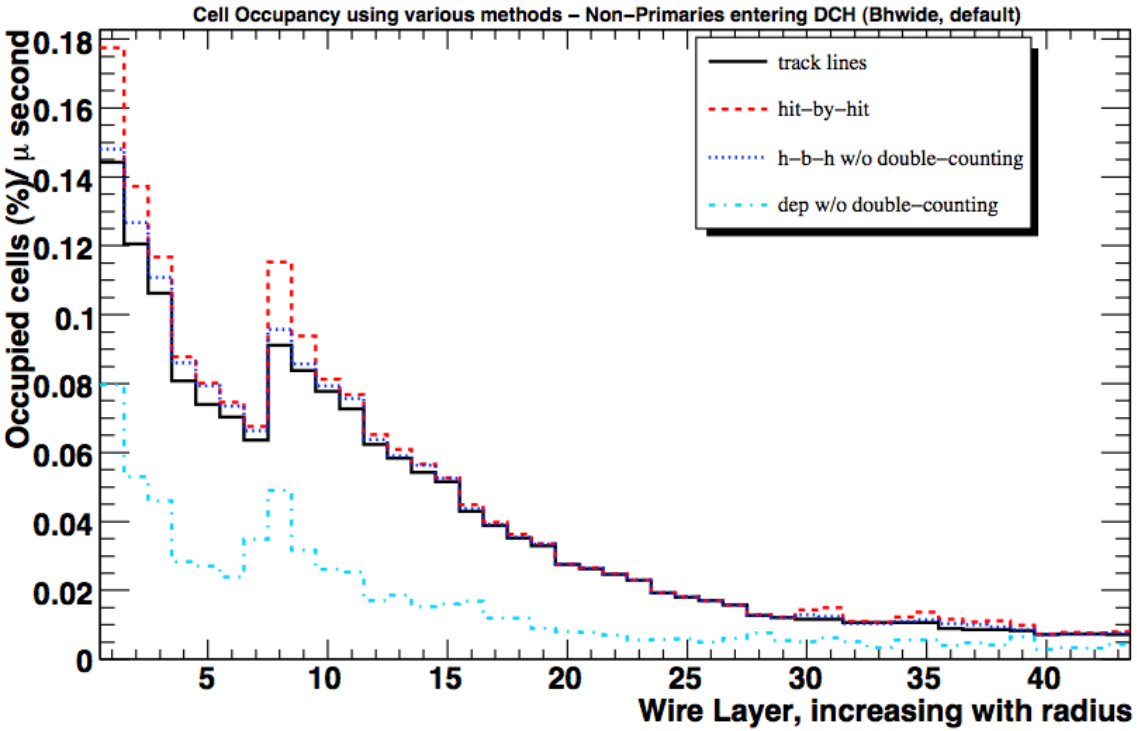


Hit-by-Hit w/o double-counting:
Straight lines between ALL hits.
1 wire-hit per crossed wire
(accounting for phi arrangement)
If no crossed wires, wire closest to first hit.
Allows only 1 wire-hit per wire per event.

Deposited Energy w/o double-counting:
1 wire-hit for each hit with deposited E >0
Uses whichever wire is closest to hit
(accounting for phi arrangement)
Allows only 1 wire-hit per wire per event.

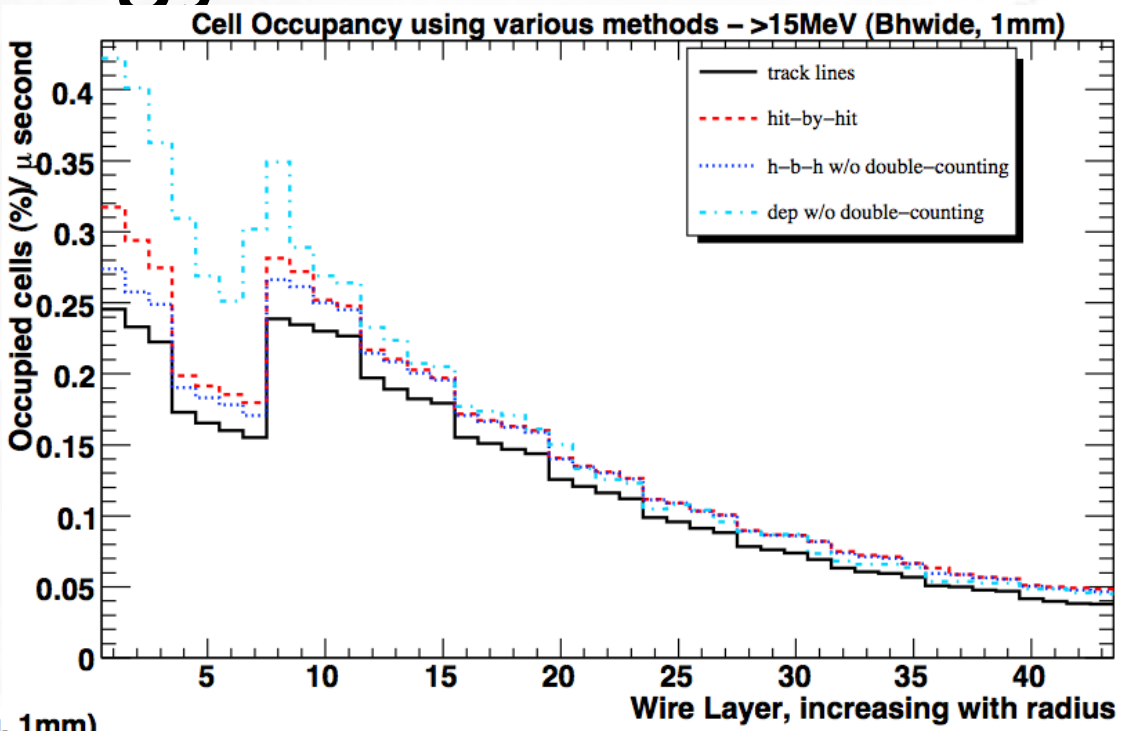
Occ Methods for High Energy Tracks

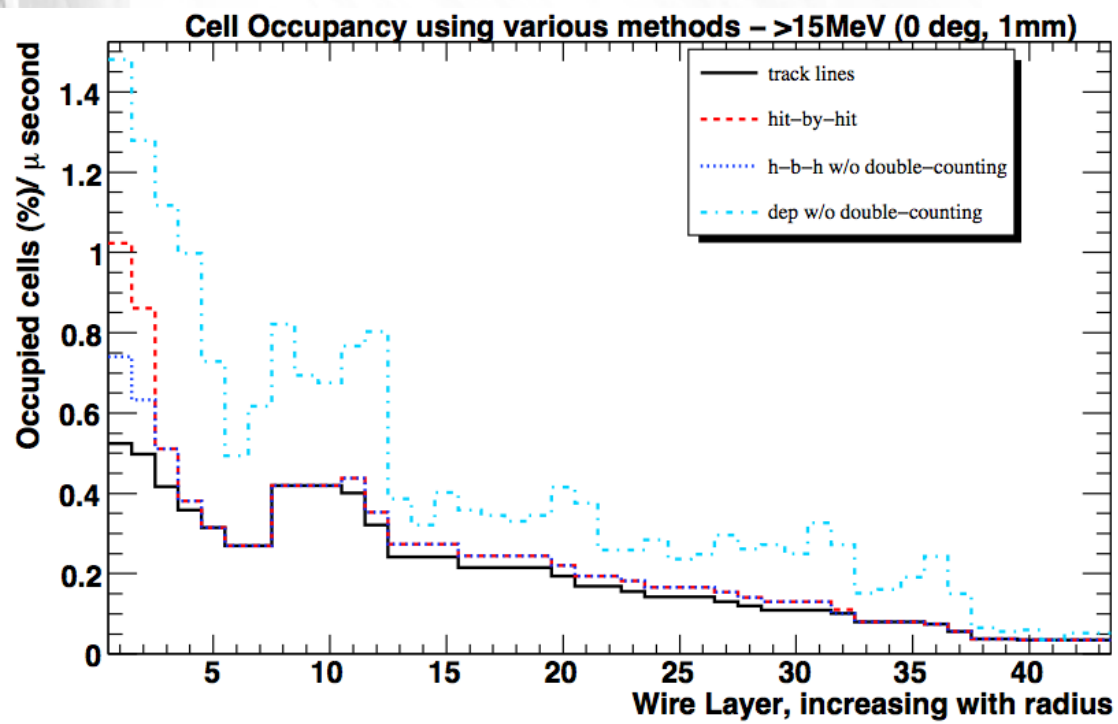




Conclusions: Little difference b/w methods for default sample & high energy tracks.
Deposited energy method is low b/c the tracks only have a few hits, which is unrealistic

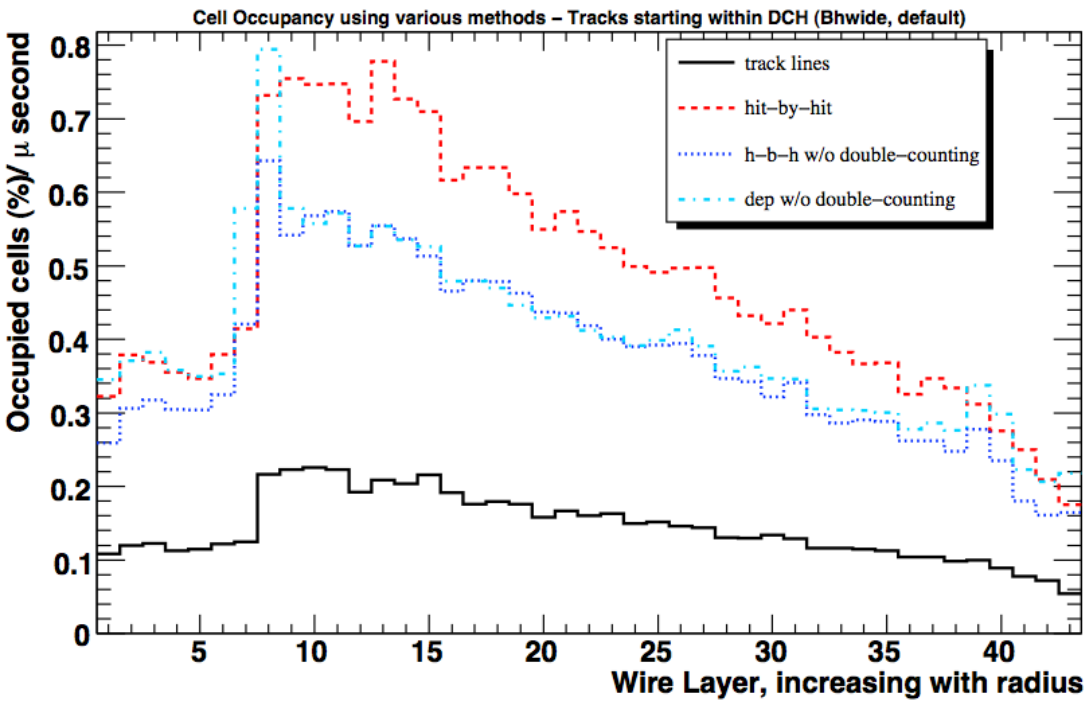
Occ for High Energy Tracks - 1mm

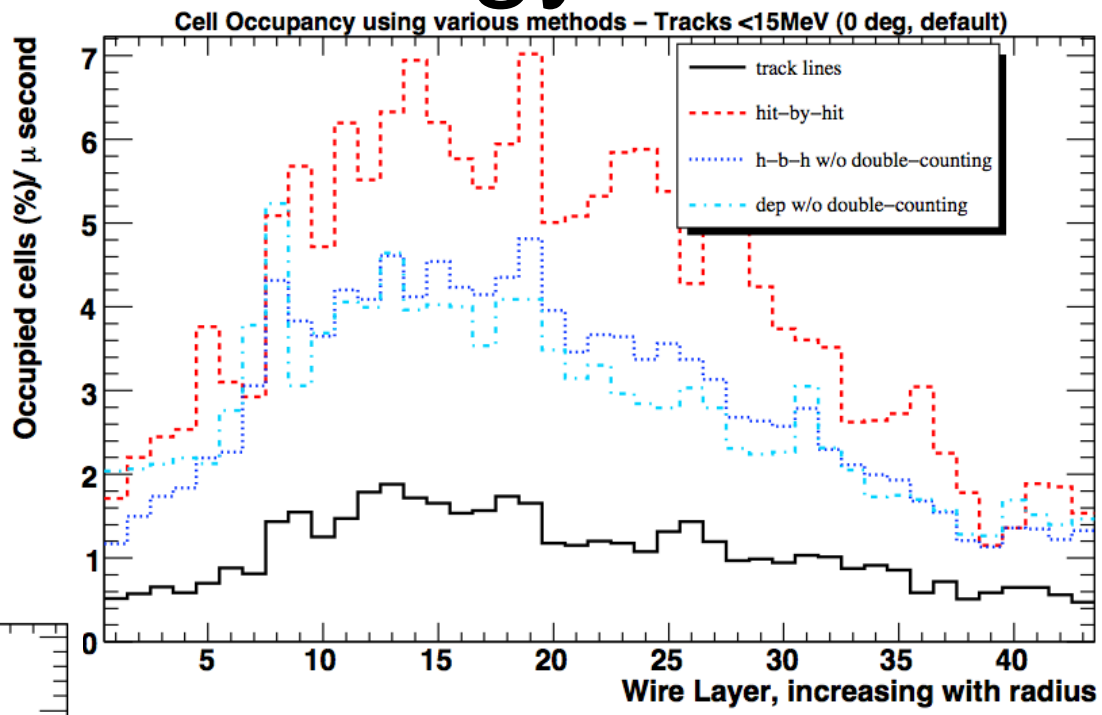




Conclusions: For the 1mm steps, high E tracks have MORE deposited hits than expected b/c hits are “spread out” a bit from the track line.

Occ Methods for Low Energy Tracks

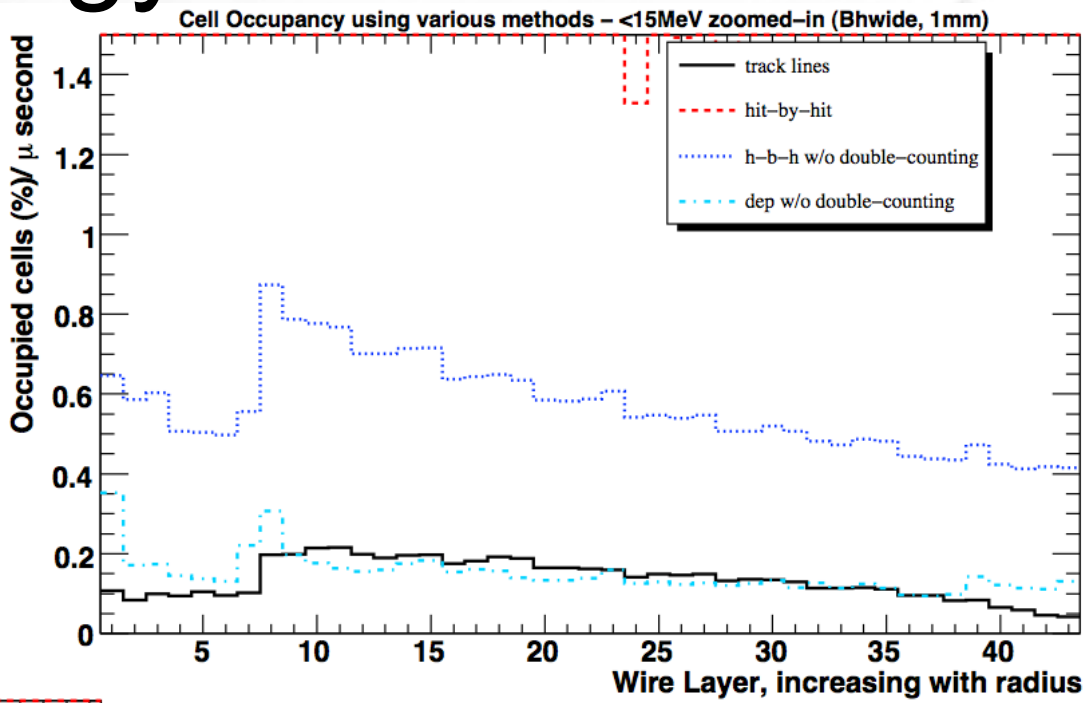


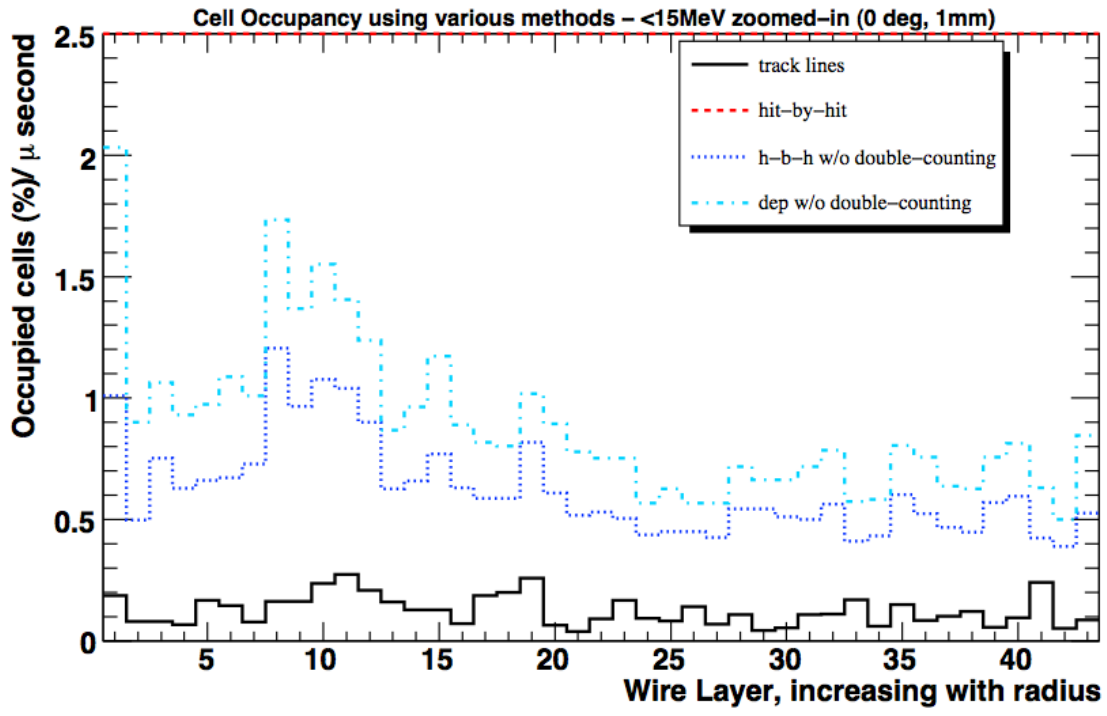


Conclusion: hit-by-hit method is most similar to deposited energy method for low energy tracks for default sample.

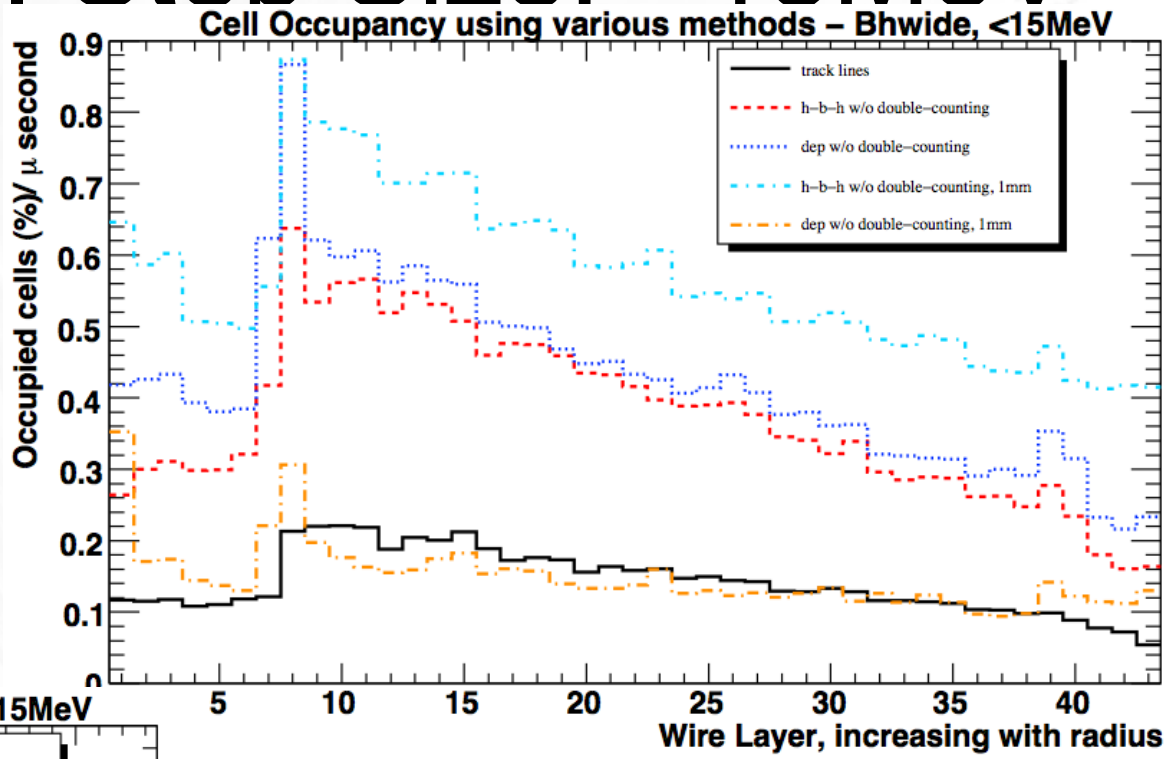
Occ for Low Energy Tracks - 1mm

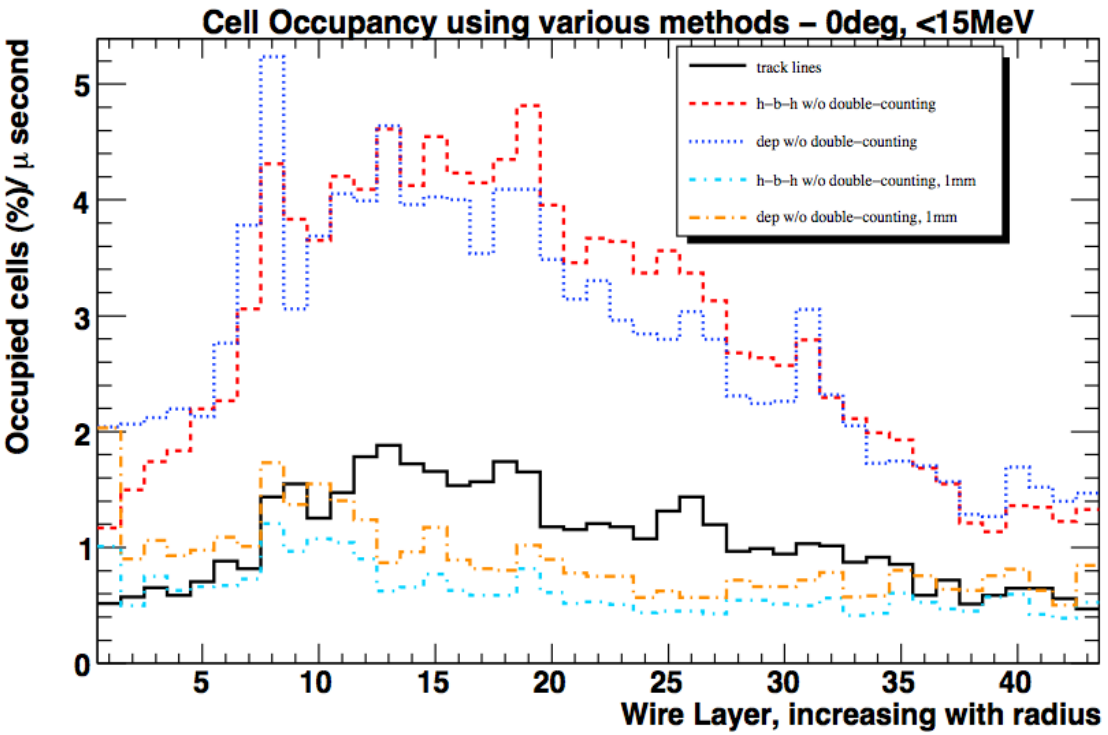
Conclusions: For 1mm steps, hit-by-hit method is a fine approximation for deposited energy for low-energy, 0 deg tracks, but is an over approximation for Bhwide tracks. Haven't figured this out, yet...





Occ Methods vs. Step Size. <15MeV

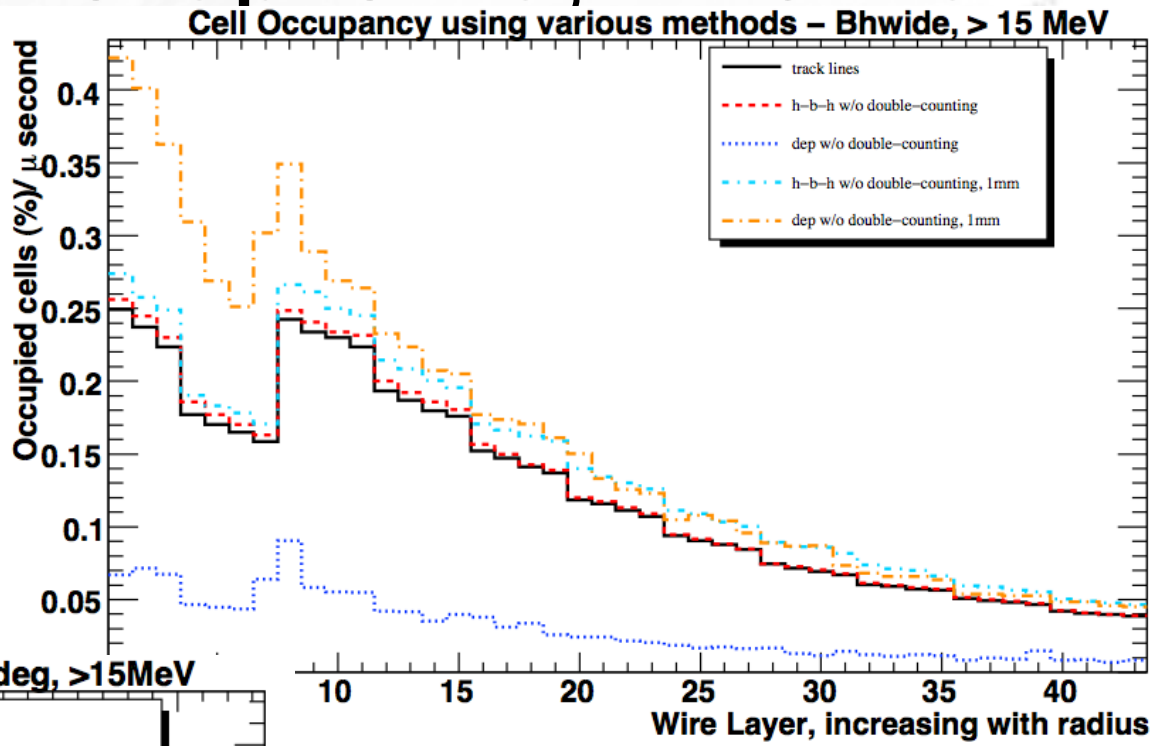


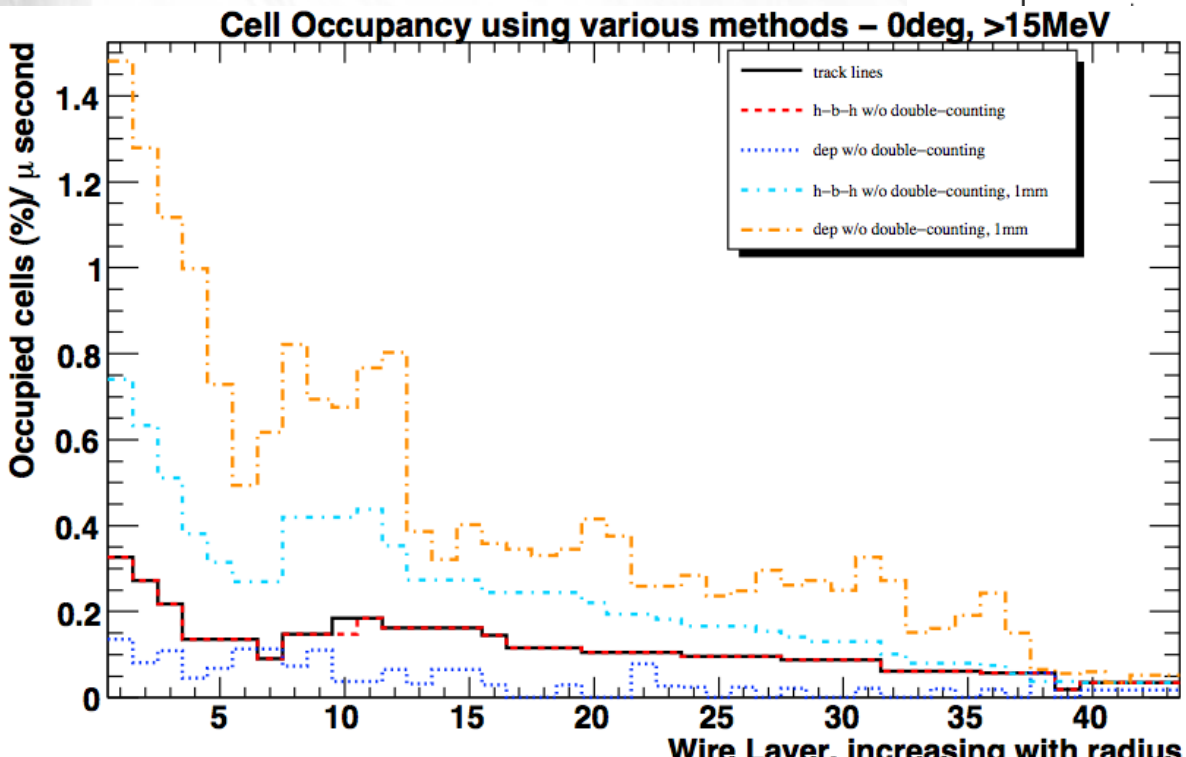


Conclusions: The yellow line is likely the best approximate of what's really happening...

So, if we are to use the default samples instead of the 1mm step-sizes, the track-line method (black) might be the best approximation for low energy tracks, except for the first few tracks.

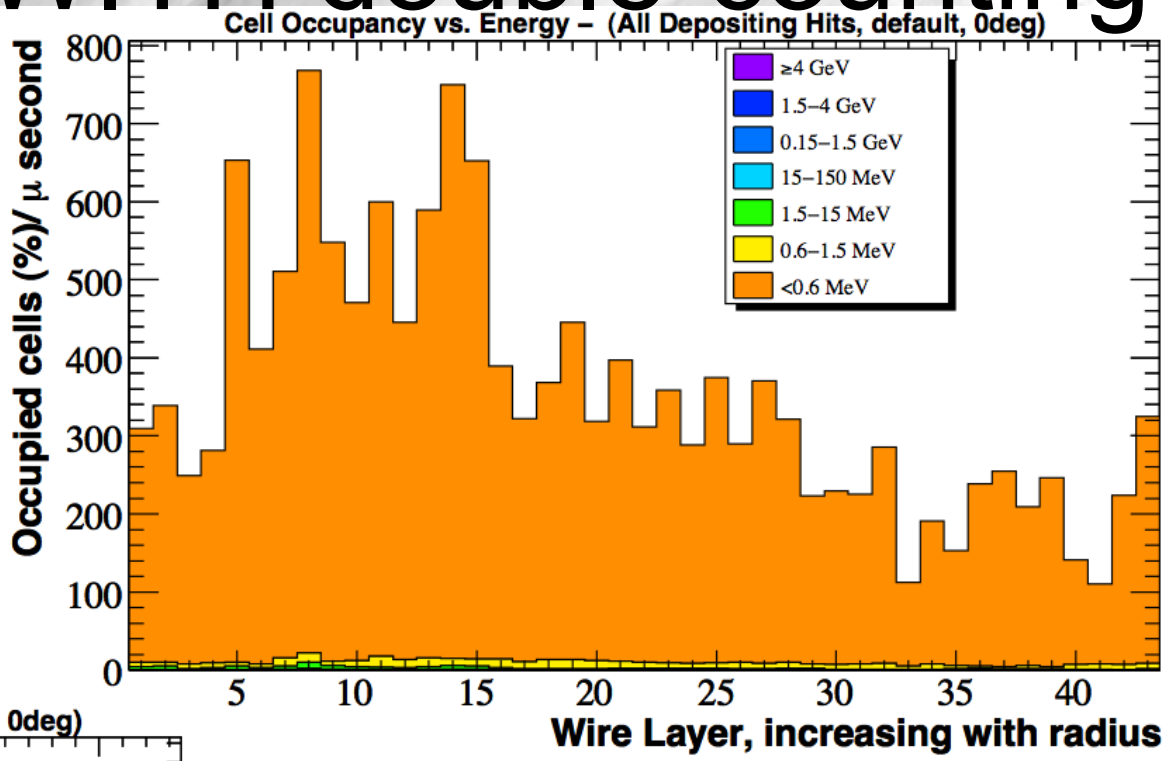
Occ Methods vs. Step Size, >15MeV

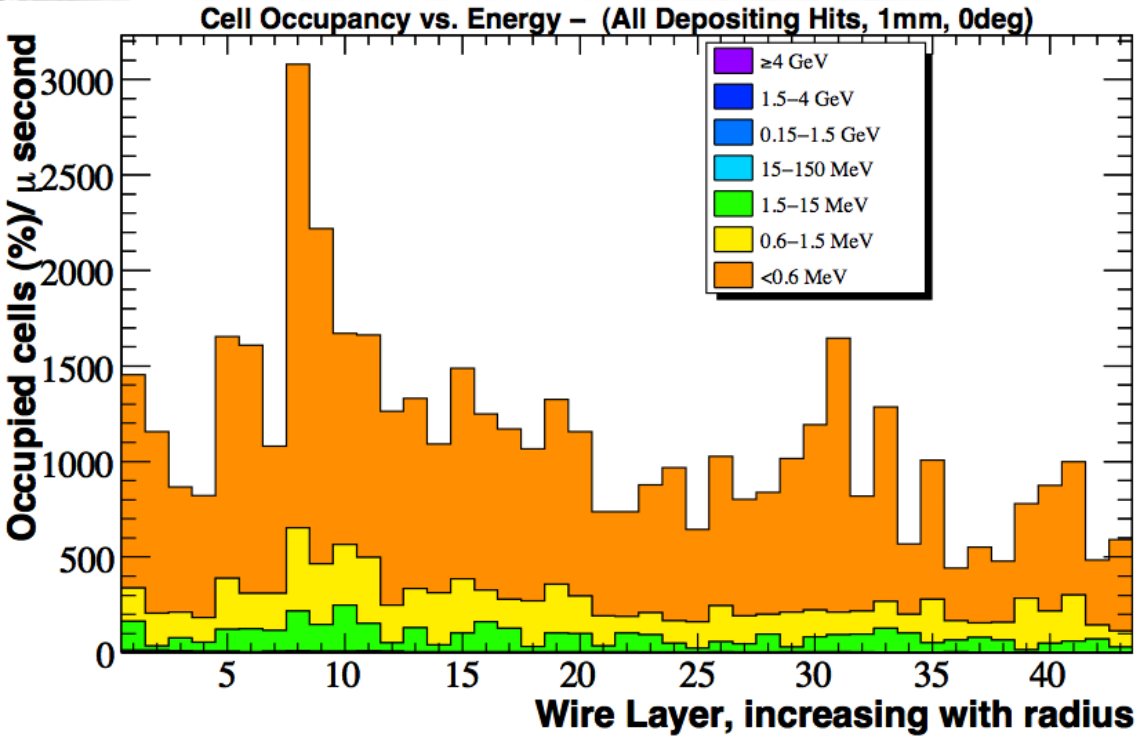




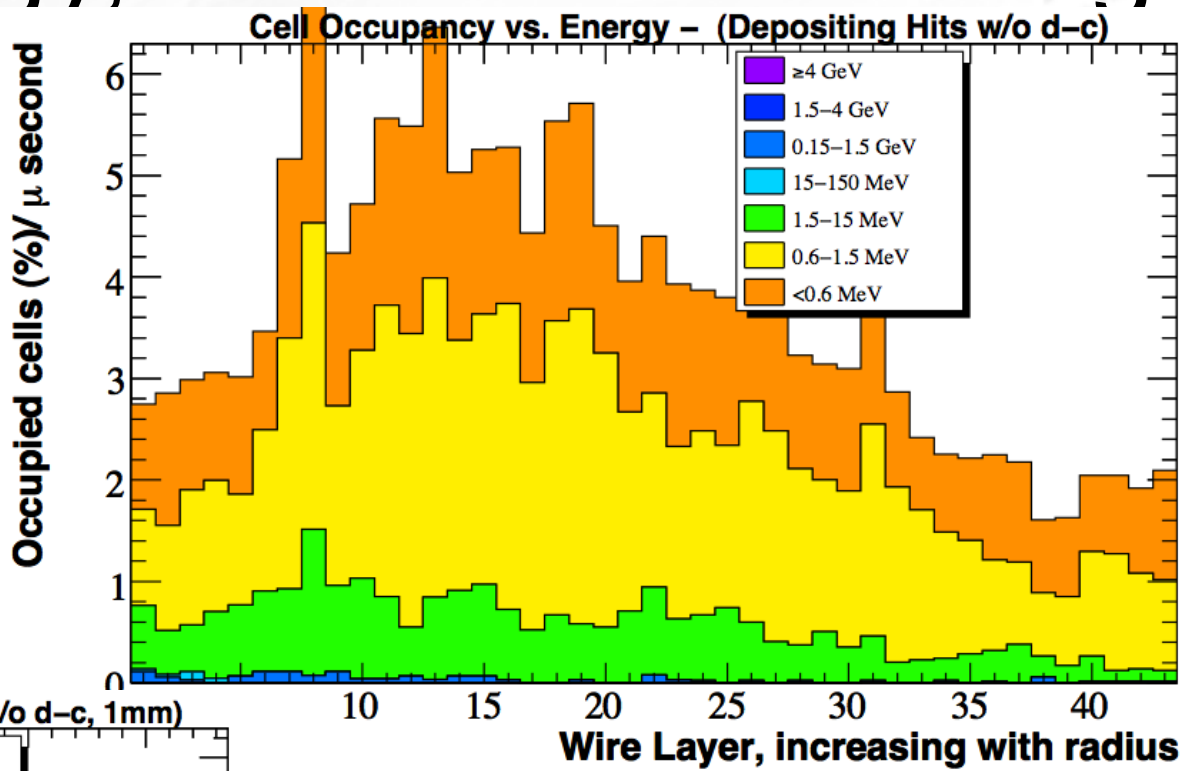
Conclusions: Either the track-line method (black) or the hit-by-hit method (cyan) with the default sample might be the best approximation of the 1mm deposited energy (yellow), but with “smudging” applied.

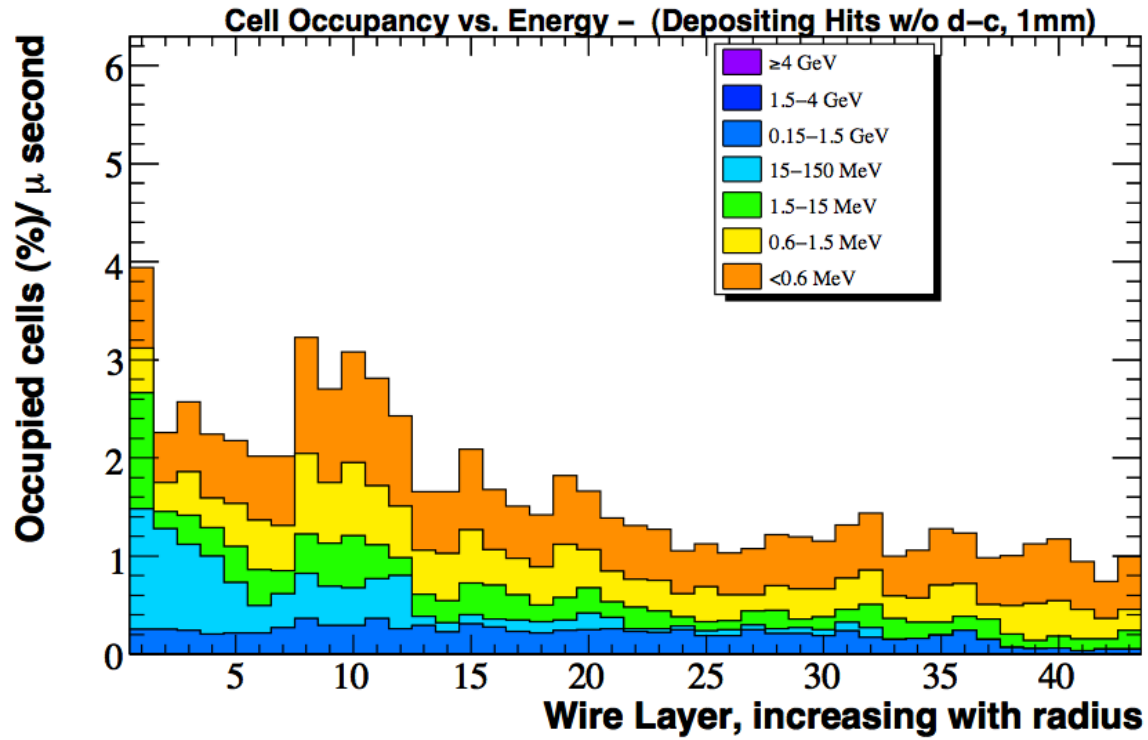
Deposted E Hits WITH double-counting





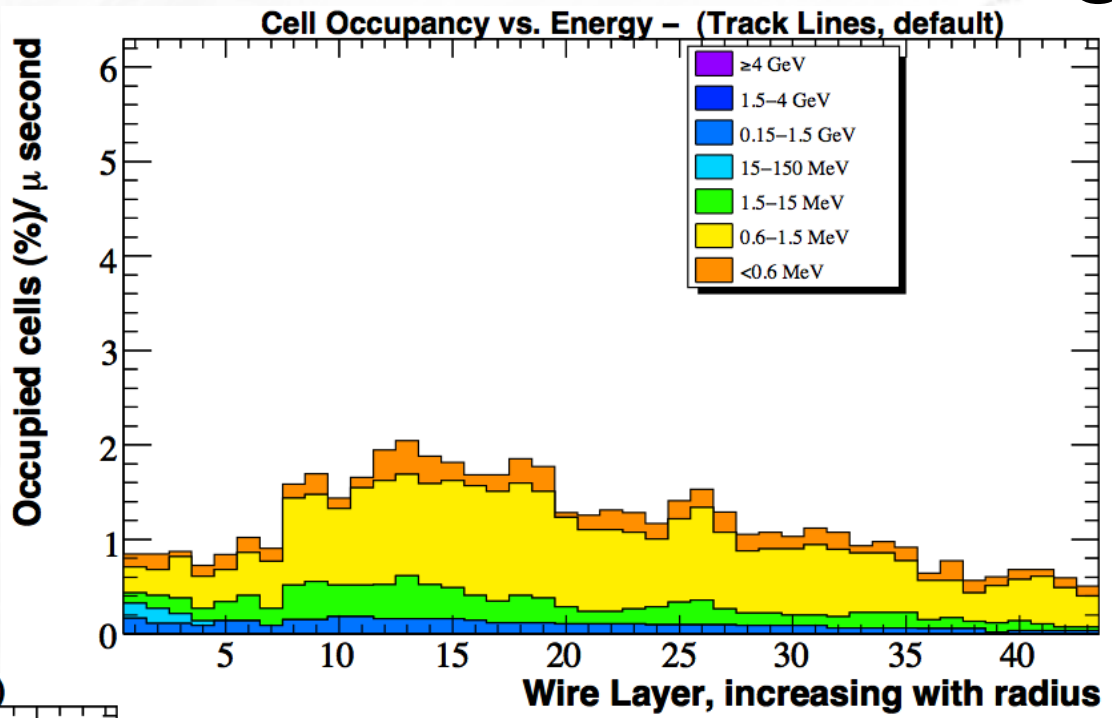
Deposited Energy, no double counting

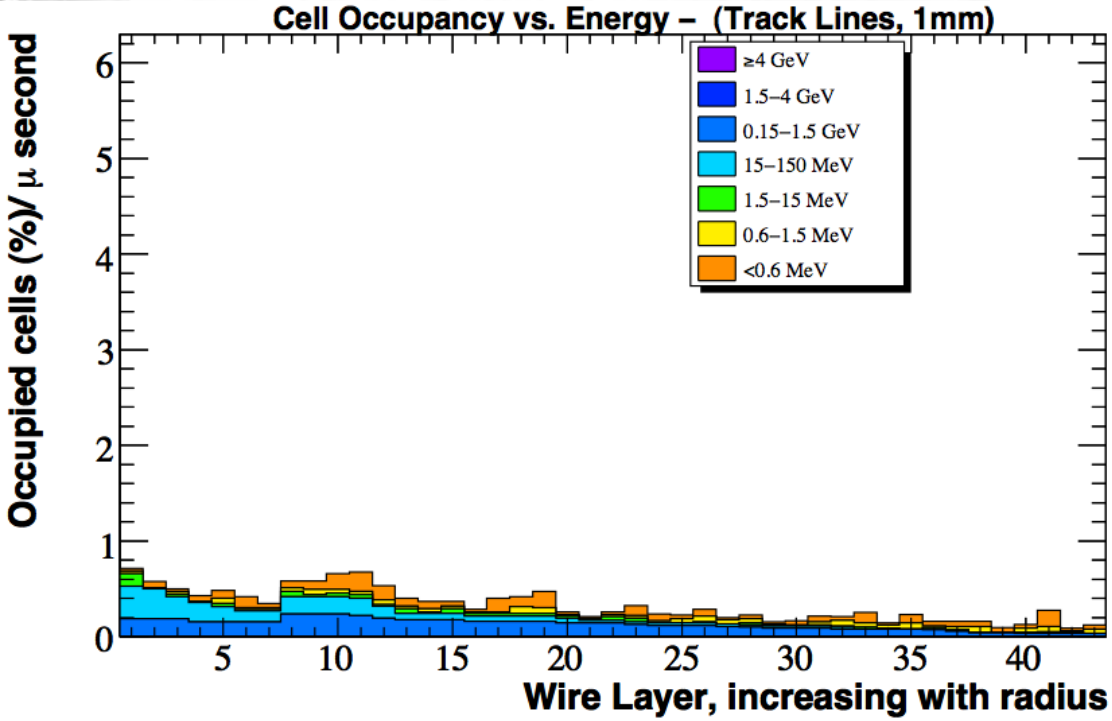


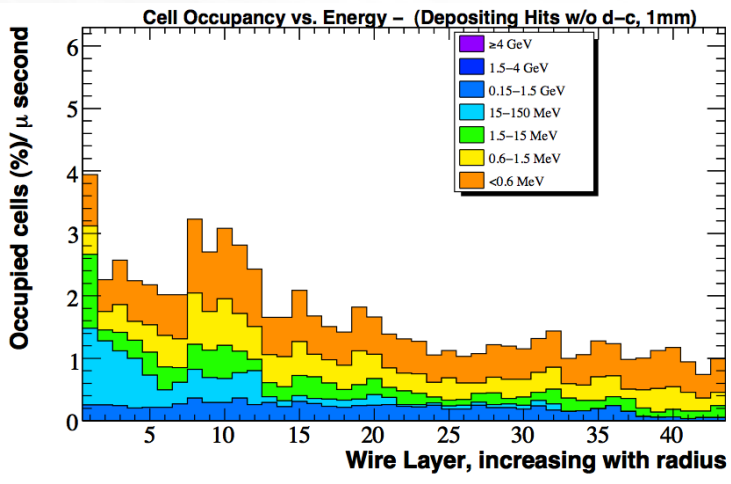


Note the excess of 15-150 MeV events!!

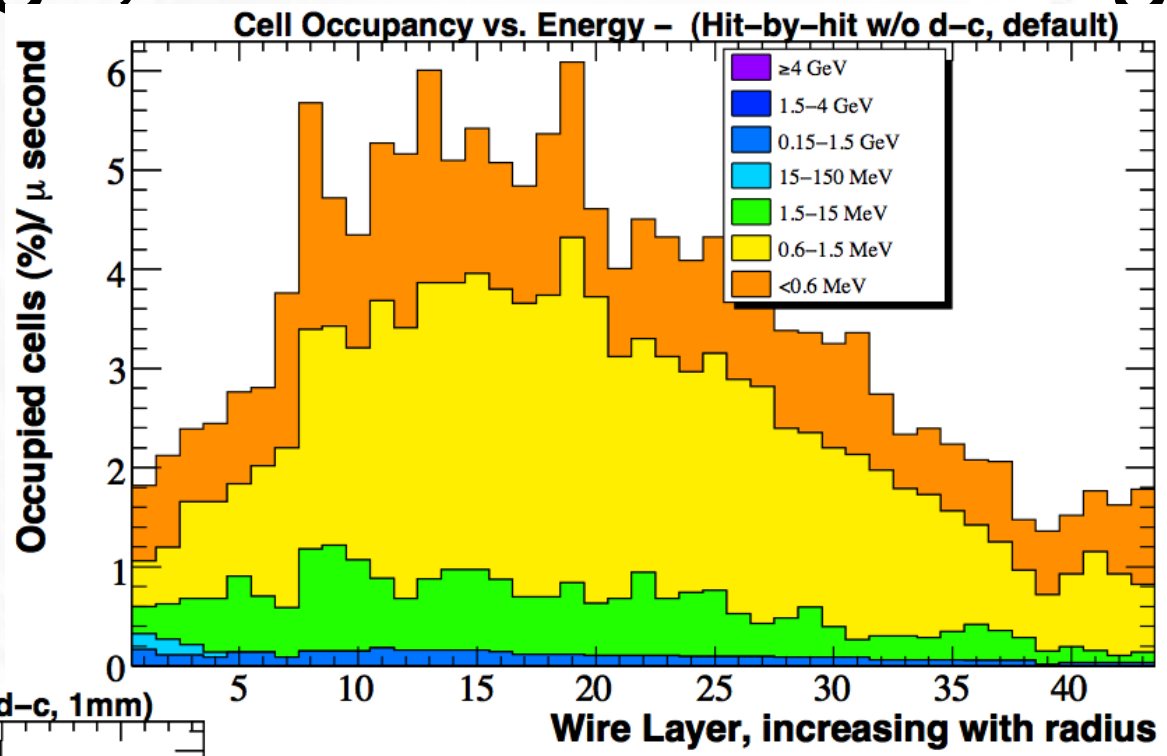
Track-Lines method, no double counting

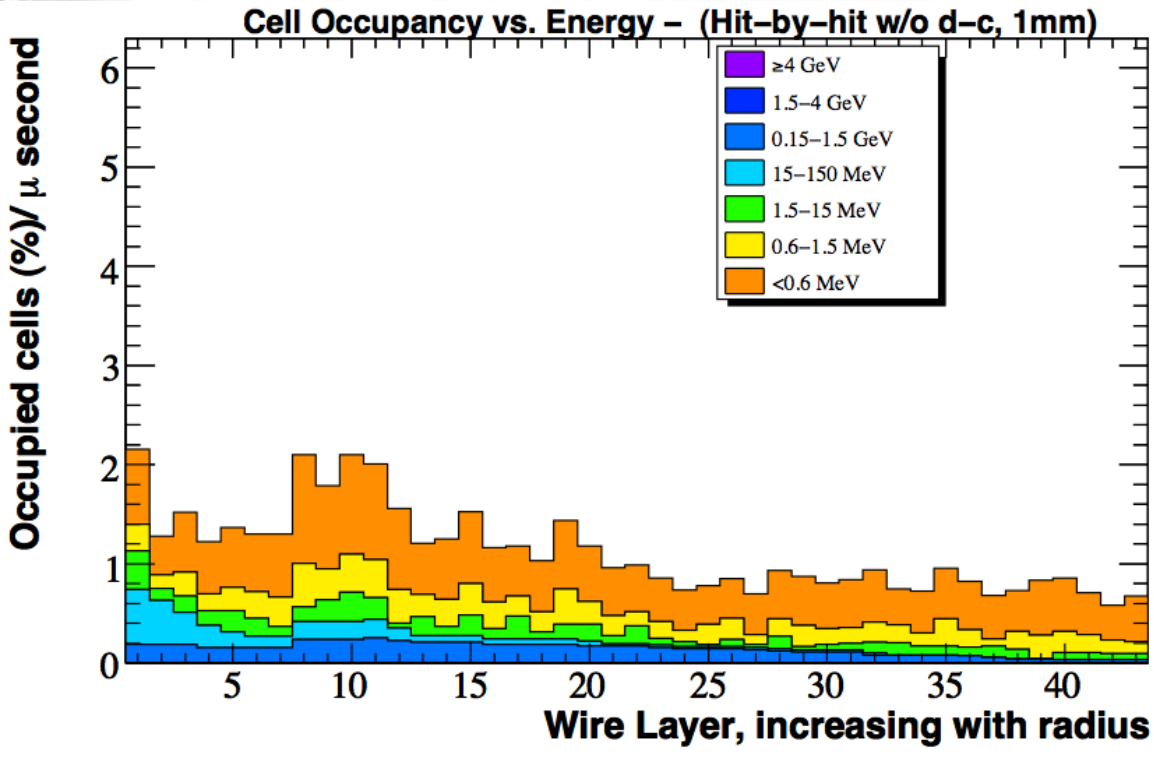


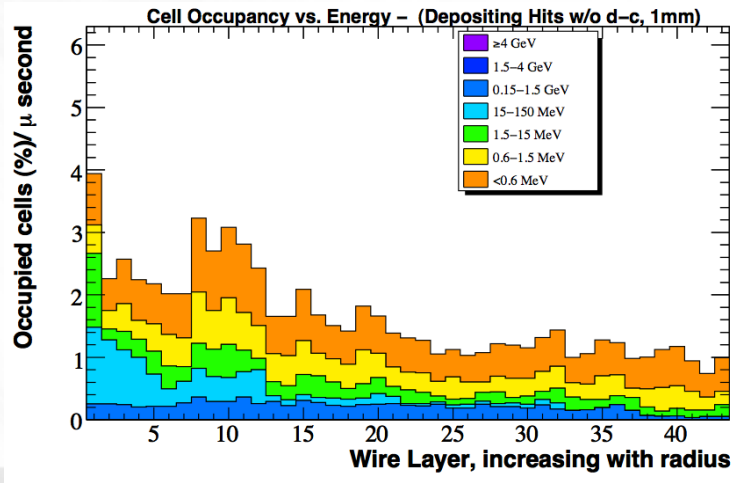




Hit-by-Hit crossings, no double-counting





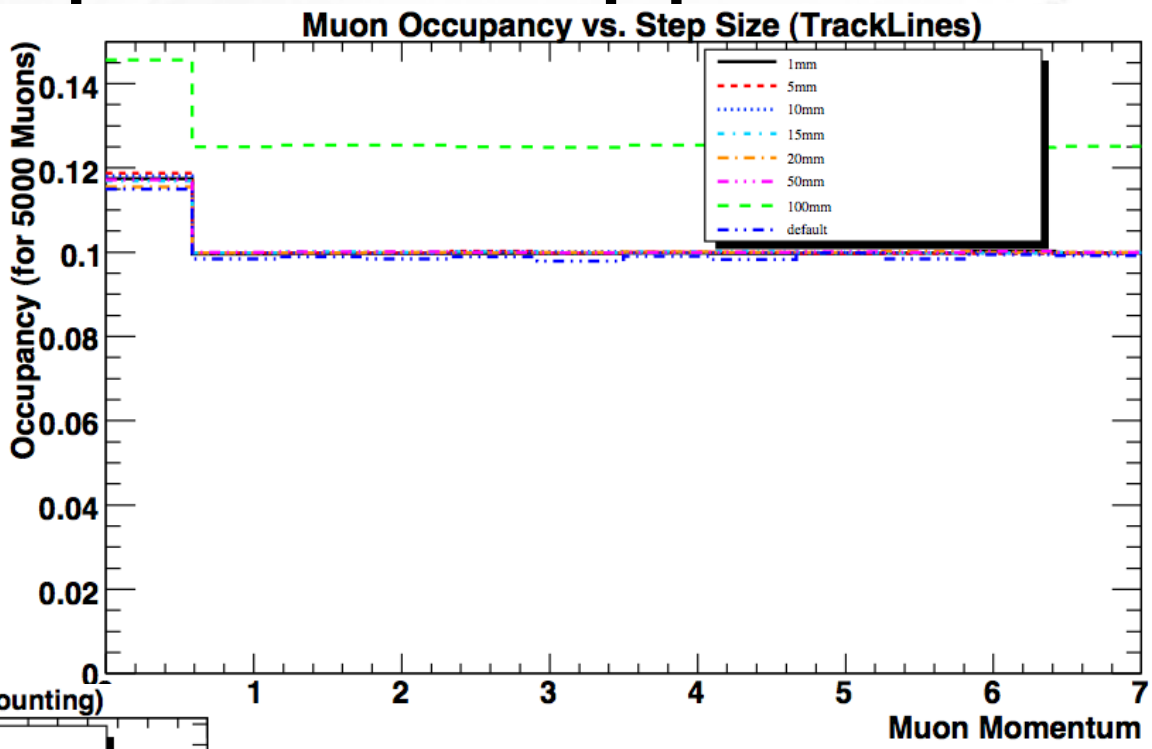


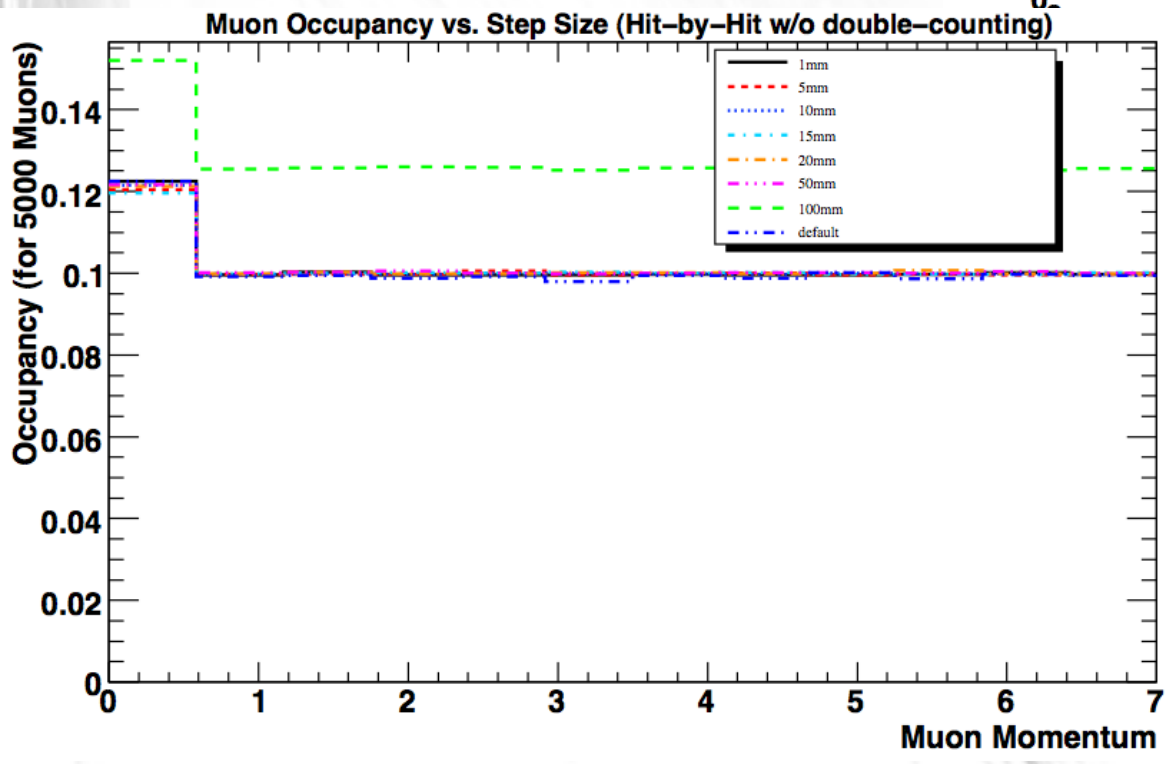
Muon Gun

Muon Gun vs. Step Size – Approx Occ

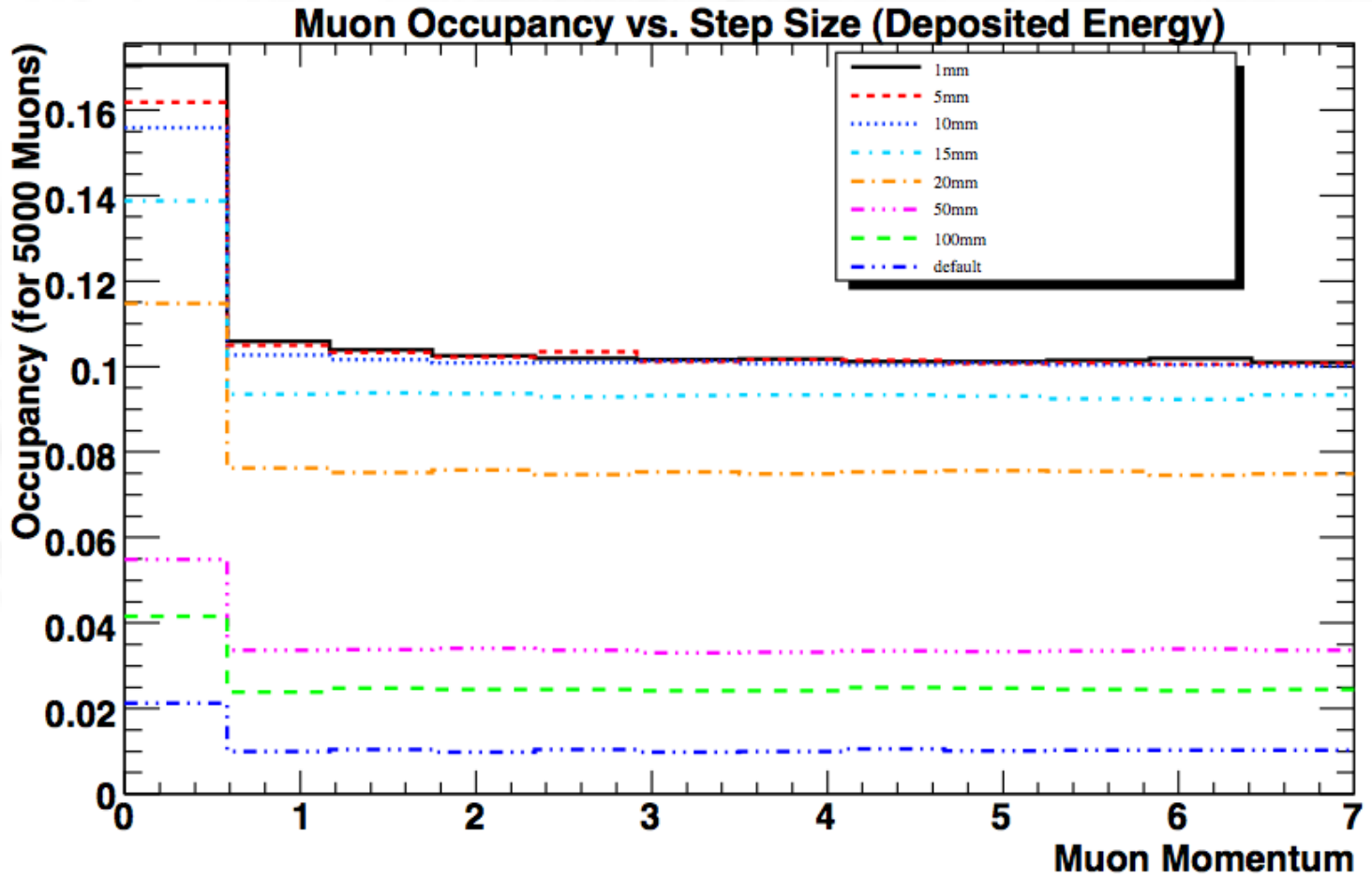
Conclusions:

The TrackLines and hit-by-hit methods of occupancy are constant vs. Step size.





Muon Gun vs. Step Size – Dep. Occ

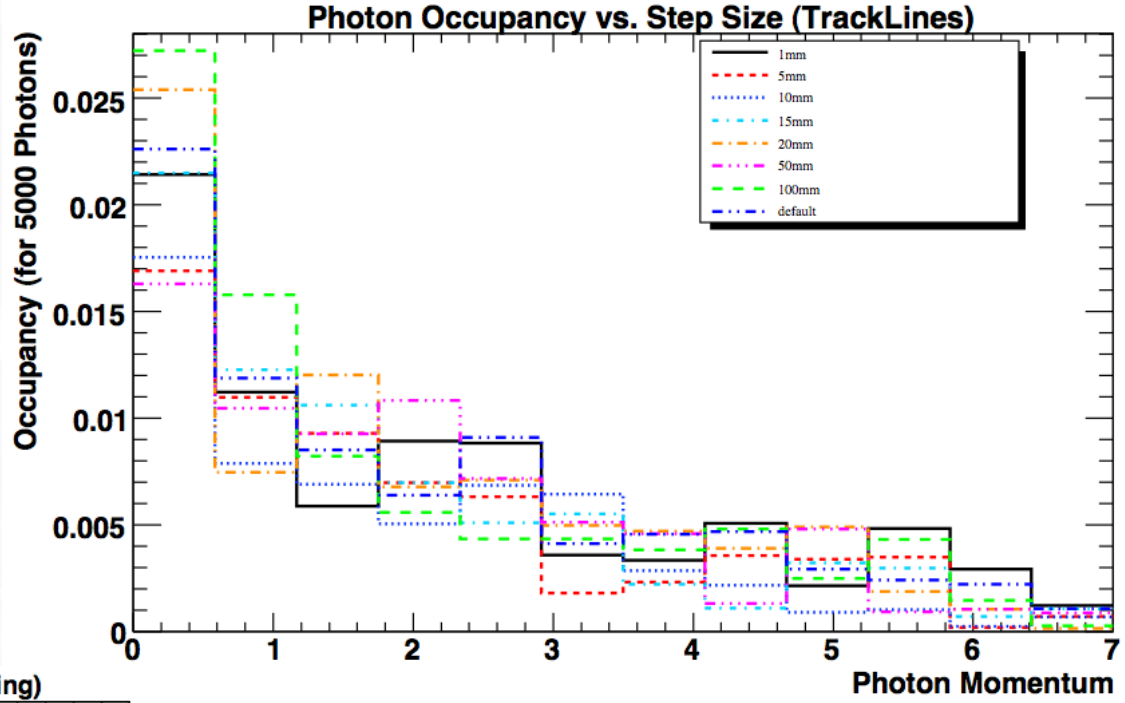


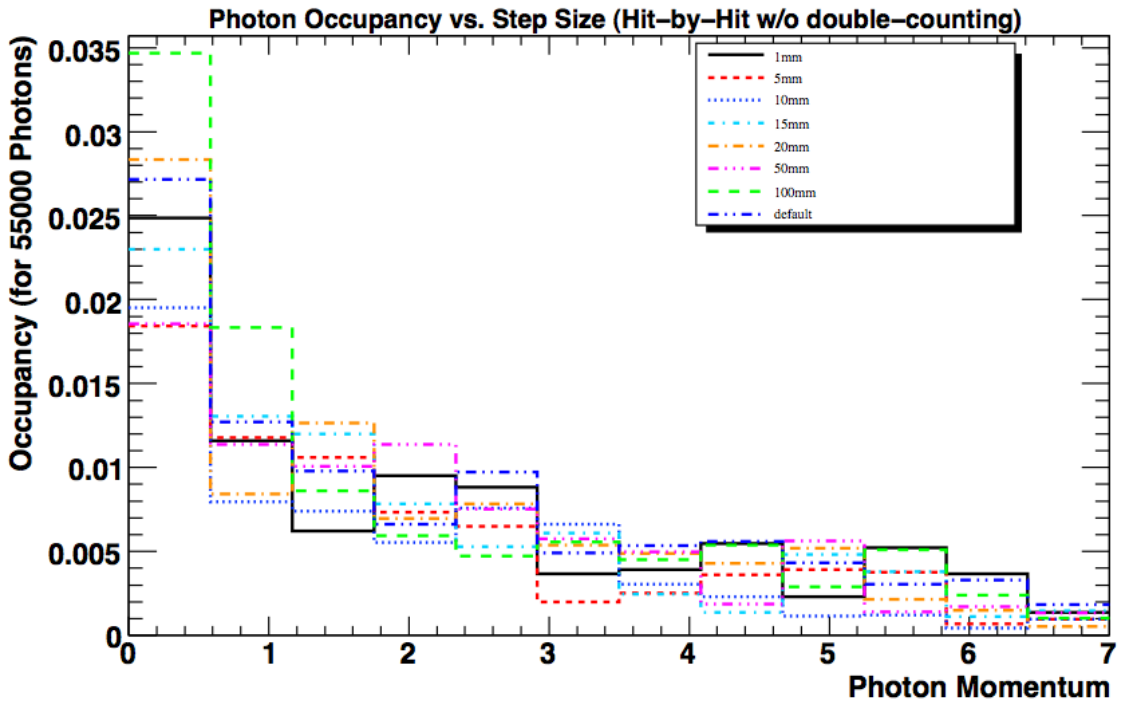
Conclusions: Smaller step sizes show larger amounts of deposted energy.
~10 or 15mm seems to be the cut-off.
Similar results for electron gun. .

Photon Gun vs. StepSize – Approx Occ

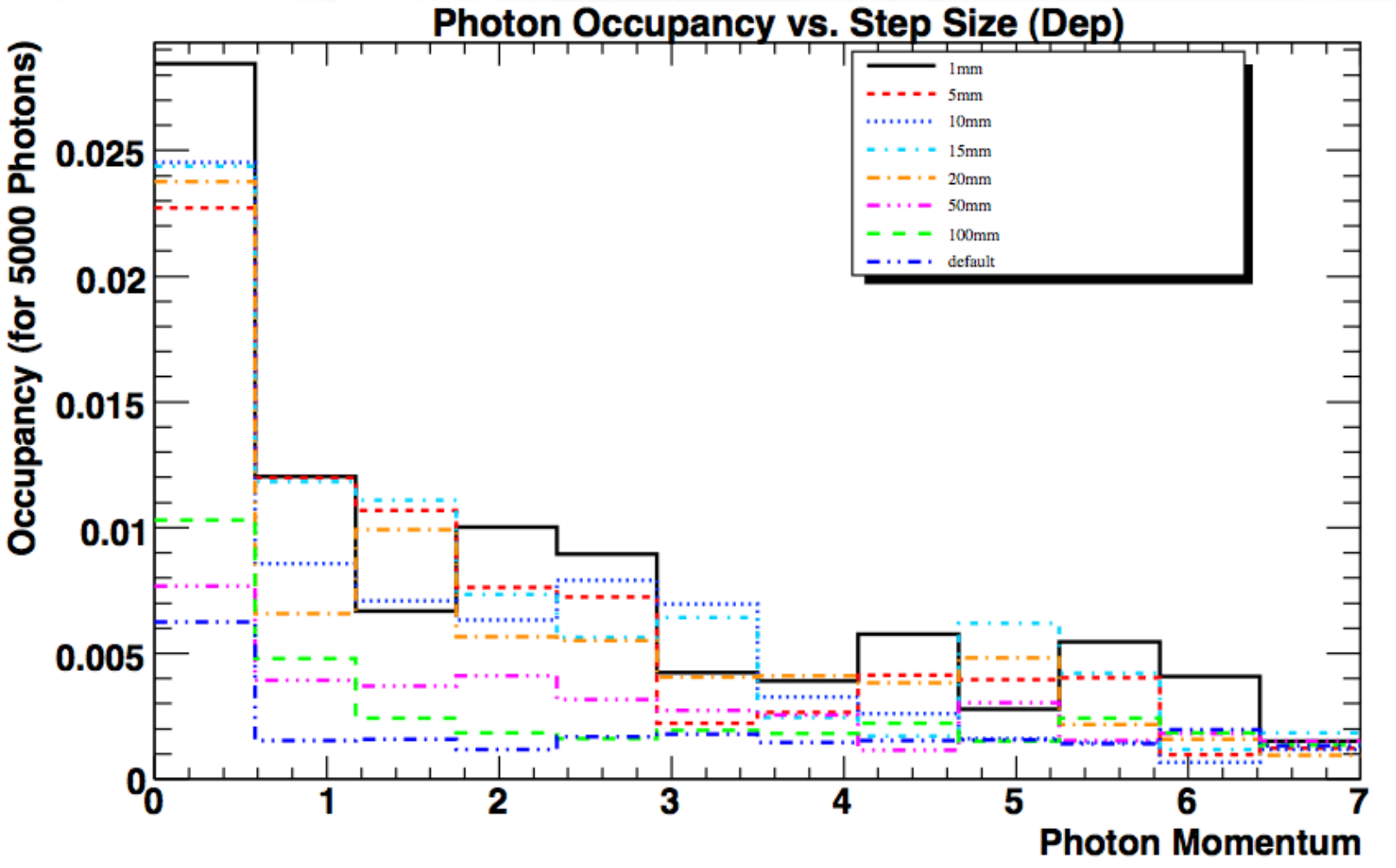
Conclusions:

The TrackLines and hit-by-hit methods of occupancy are constant vs. Step size.





Photon Gun vs. Step Size – Dep. Occ



Conclusions: 10-15mm might still be a fine step-size to use.

Conclusions

- GEANT4 seems to be modeling the amount of deposited energy OK, but maybe not the location of these deposits
- I have not decided on an occupancy method that works for the default sample – maybe track lines is OK, but still not ideal
- The low step-size samples show additional occupancies from high energy tracks and additional occupancies in the low radii region, but MUCH lower occupancies from low E tracks.
- Perhaps using step sizes of 10 or 15mm would be better, but would result in larger files!