

Neutron spread on the transverse plane - follow-up on invisible scattering (3)

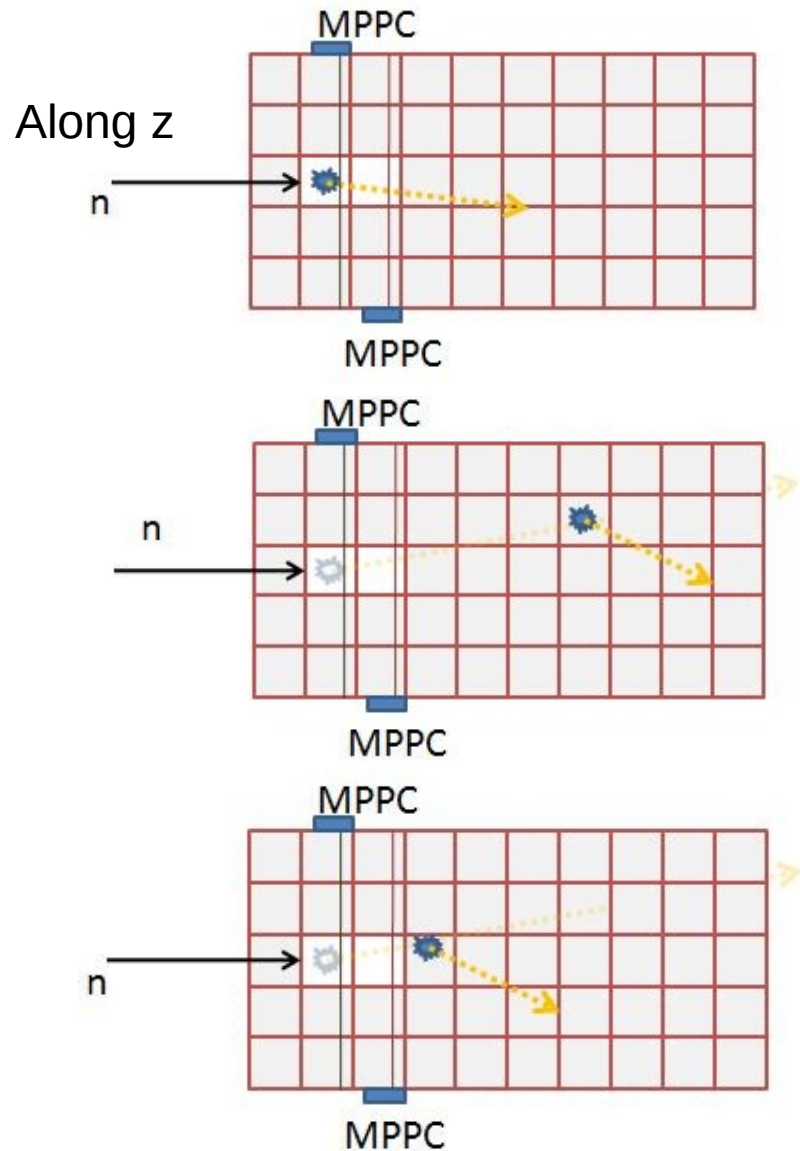
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Introduction

- Since the past weeks till next few weeks, a series of studies on the invisible scattering would happen.
- We need to understand the fraction of the neutron scattered off/in the fiducial volume, then determine some corrections and the systematics to that.

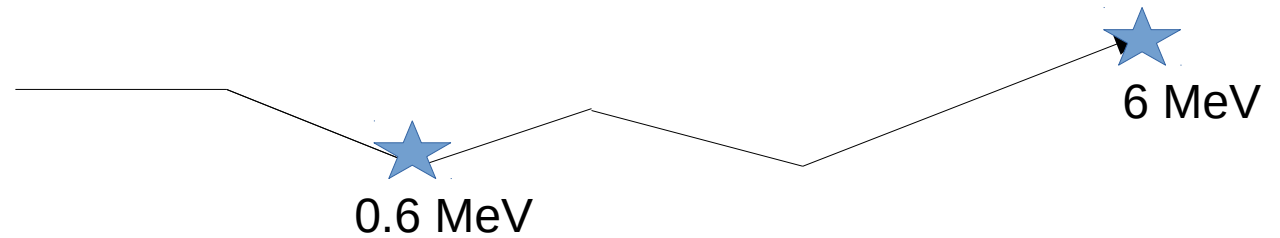
Invisible scattering impact



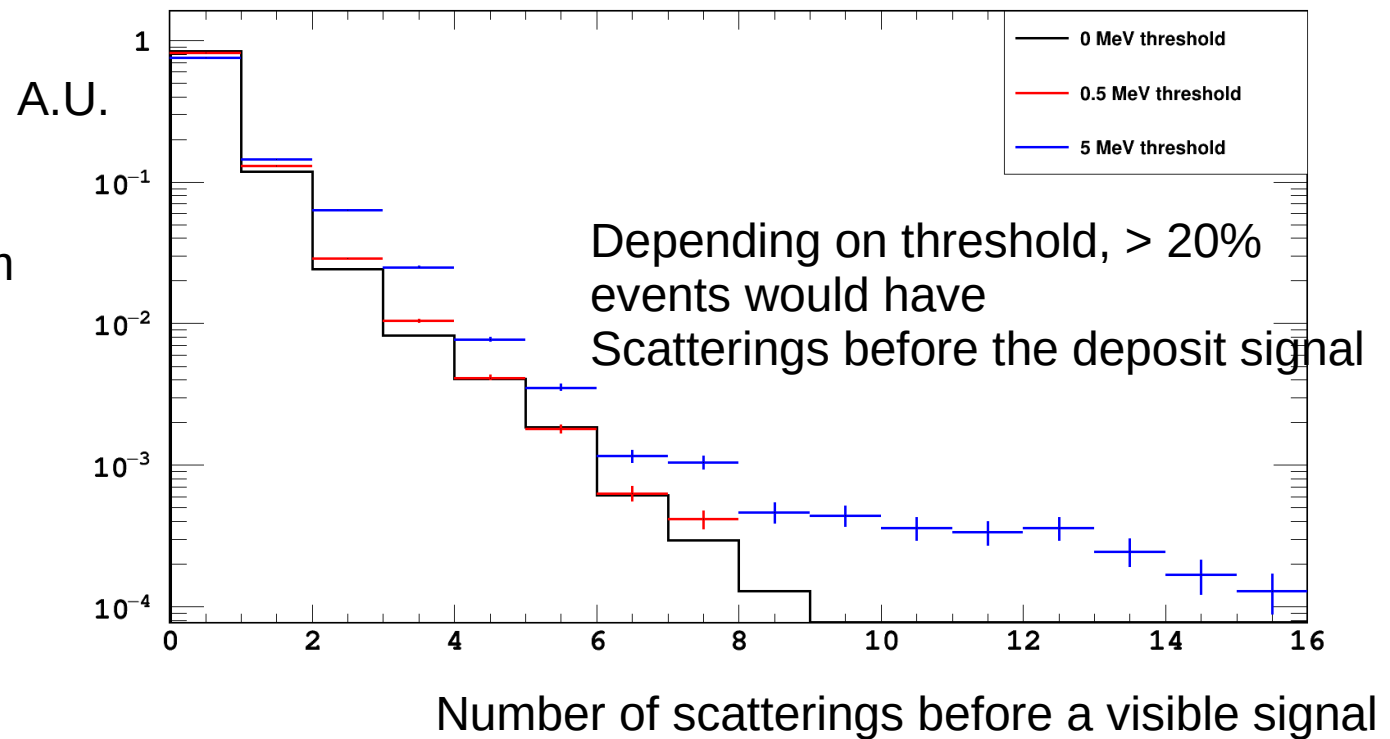
- Extinction may be biased with different flux at different layers due to invisible scattering.
- A useful check is to look at the neutron vertices spread on the transverse plane.

What neutron looks like in the prototype?

An example of > 10 scattering
Of a neutron

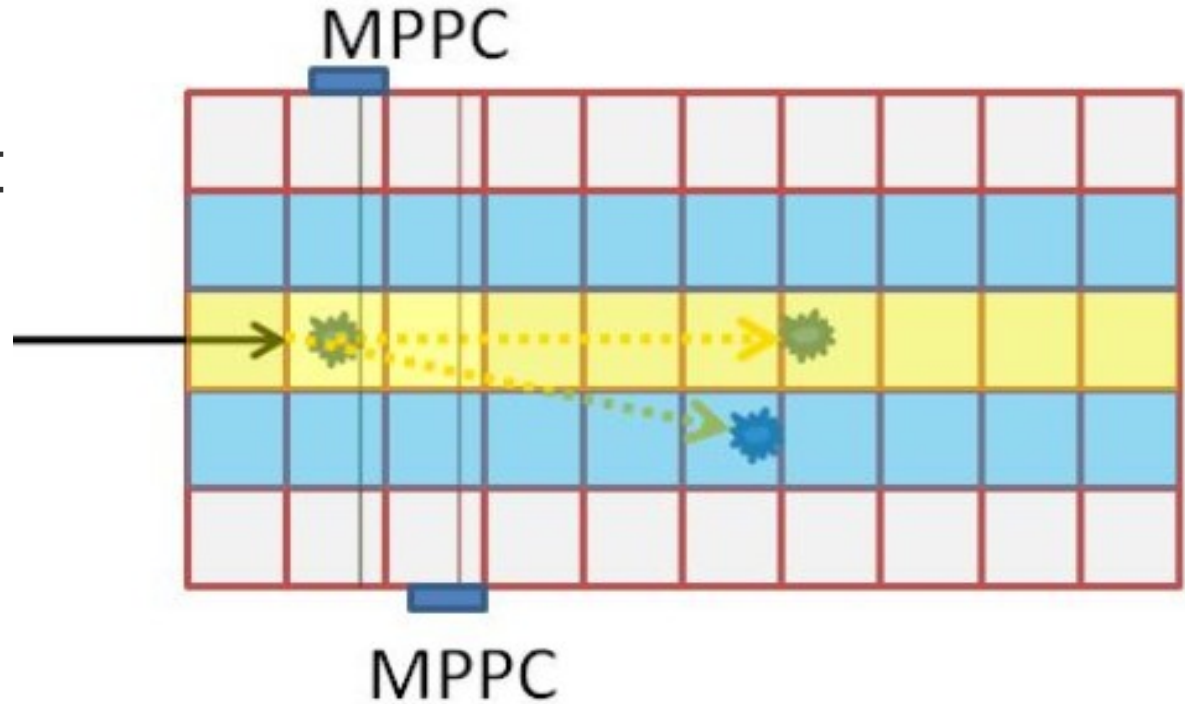


Higher threshold induces higher scattering numbers

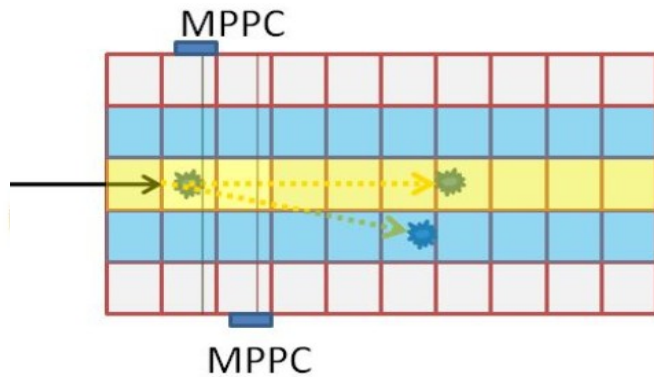


True level study setup

- Simulate a 24x8x48 detector without dead materials
- No rotation; beam enters from the center
- Beam origin is a 0.45 radius circle
- Record the true hit information; no reconstruction used; 0.5 MeV threshold assumed

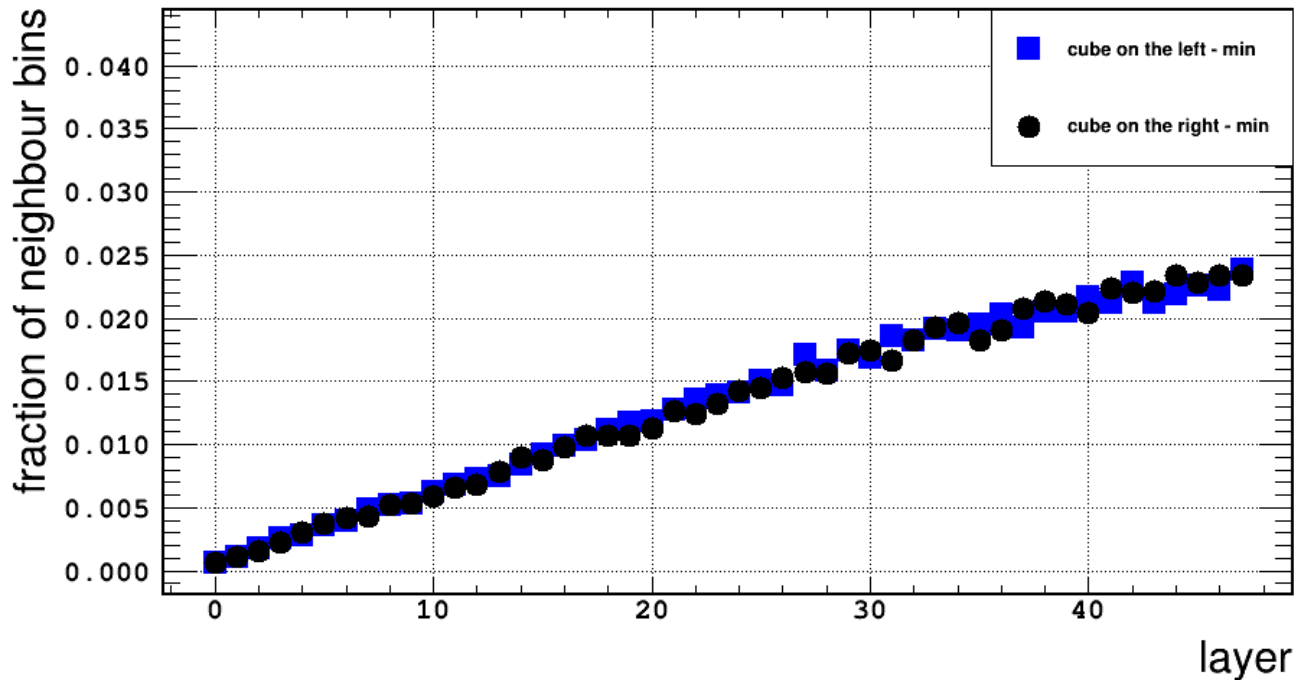


True scattering spread along the beam



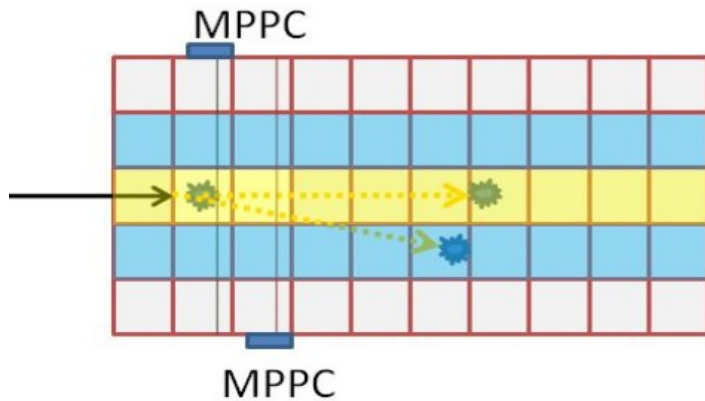
- Neutron beam pointing to the center of the detector
- No rotation
- Spread is purely due to invisible scattering

min loc. flux weight



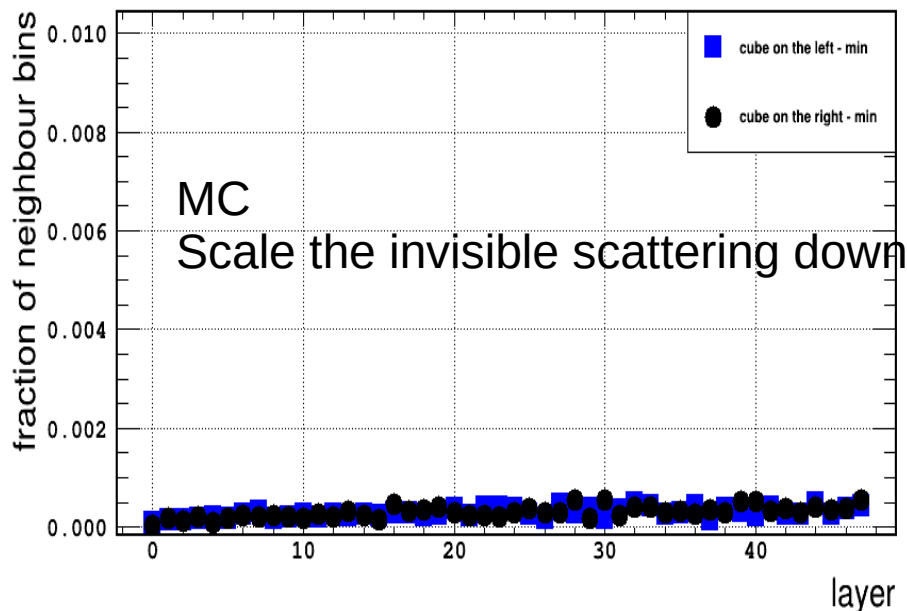
Across the entire detector along z , a 2.5% spread seen from the invisible scattering

True scattering spread along the beam

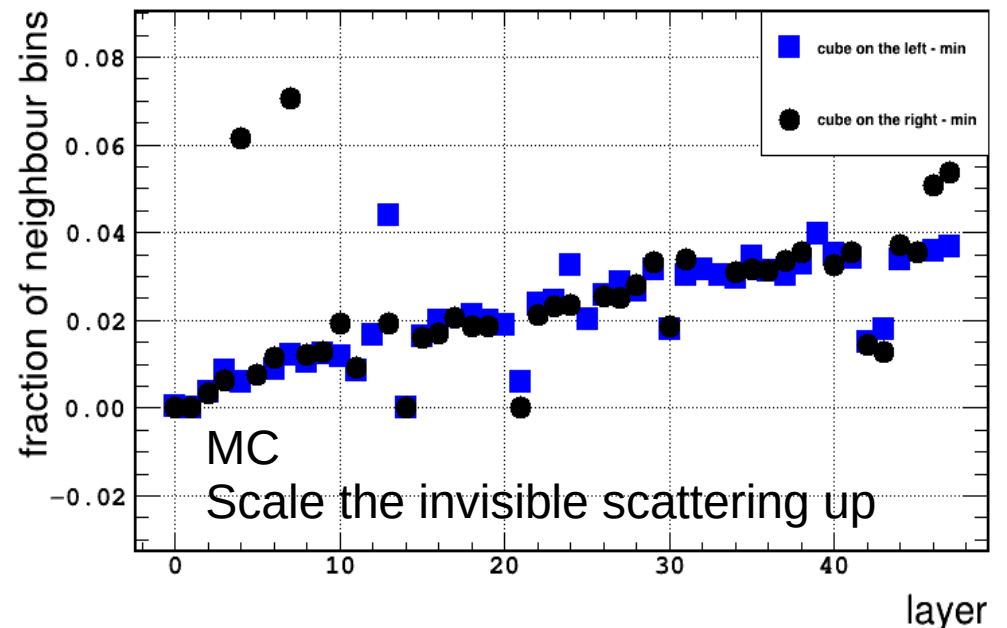


- Scaling invisible scatterings up and down can result in a higher and lower spread
- A selection of the same thing in data can be used as side band and fit with MC

min loc. flux+sct weight



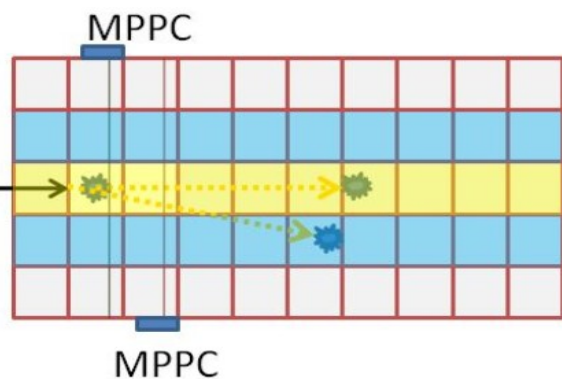
min loc. flux+sct (larger) weight



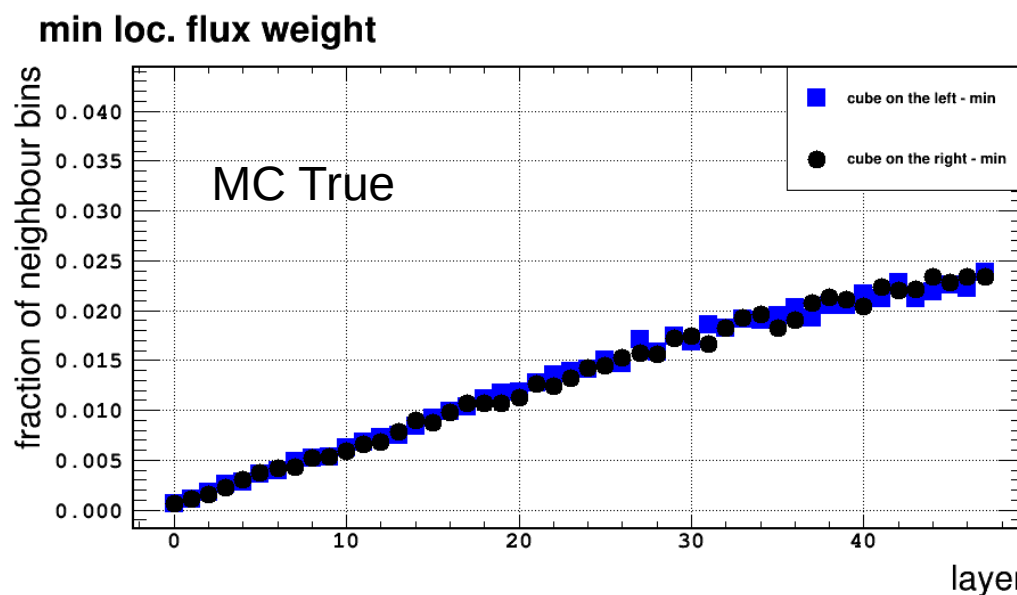
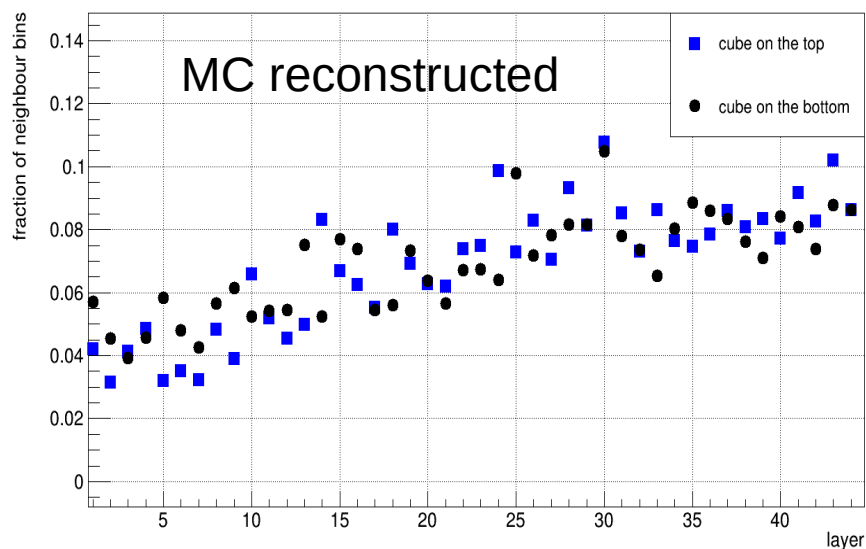
Go through the reconstruction

- > 10 PE for each MPPC hit
- Single cluster in time
- Single cluster in space
- > 3 cubes fired
- Linearity with PCA 0.9 (needs an update)
- No outer layer activity (all dimension)
- Vertex: first cube along z
- No neutron energy selection for now

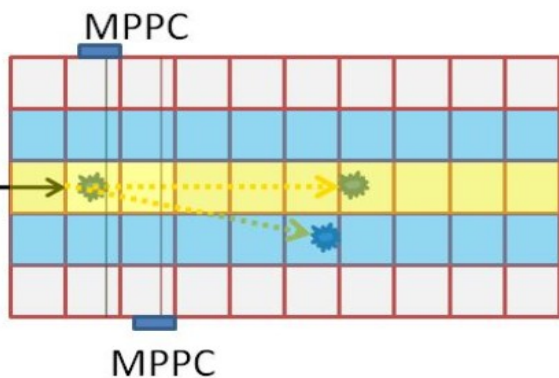
Reconstructed vs. true



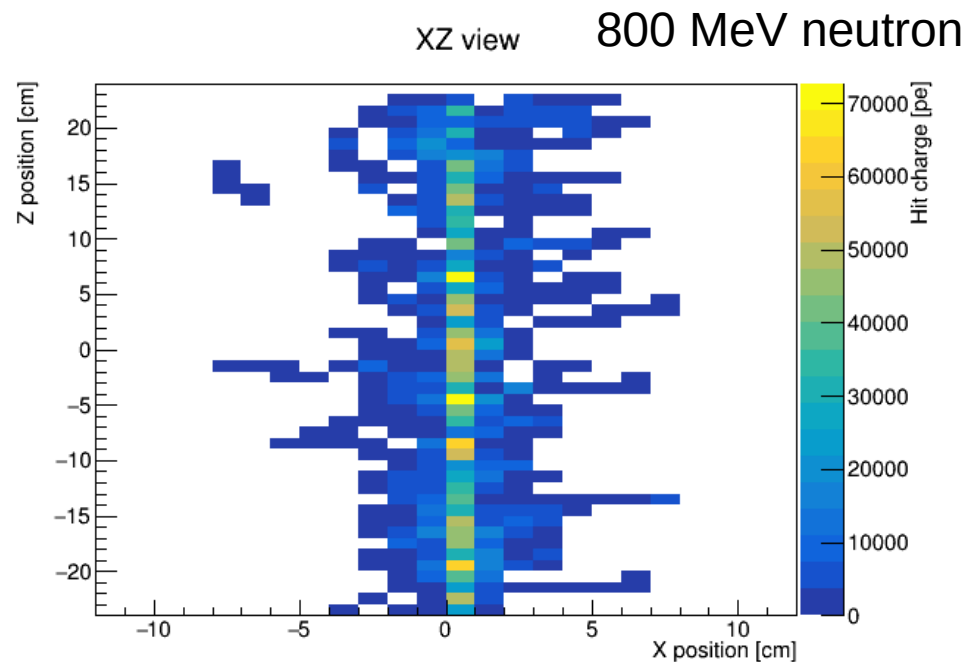
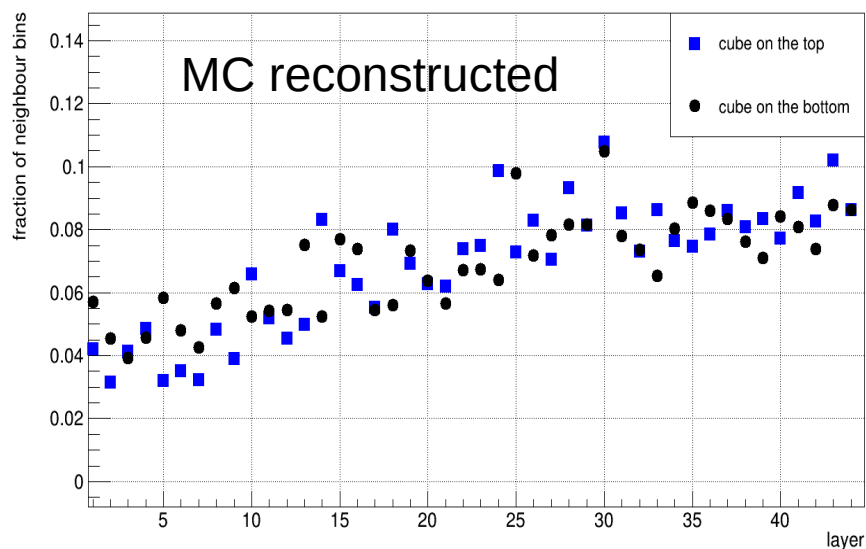
- The first layer does not give a 0 on the spread.
- The spread on the spread is larger due to the additional uncertainty induced by the reconstruction
- Reconstruction uncertainty seems to be more crucial than invisible scattering



Reconstructed vs. true

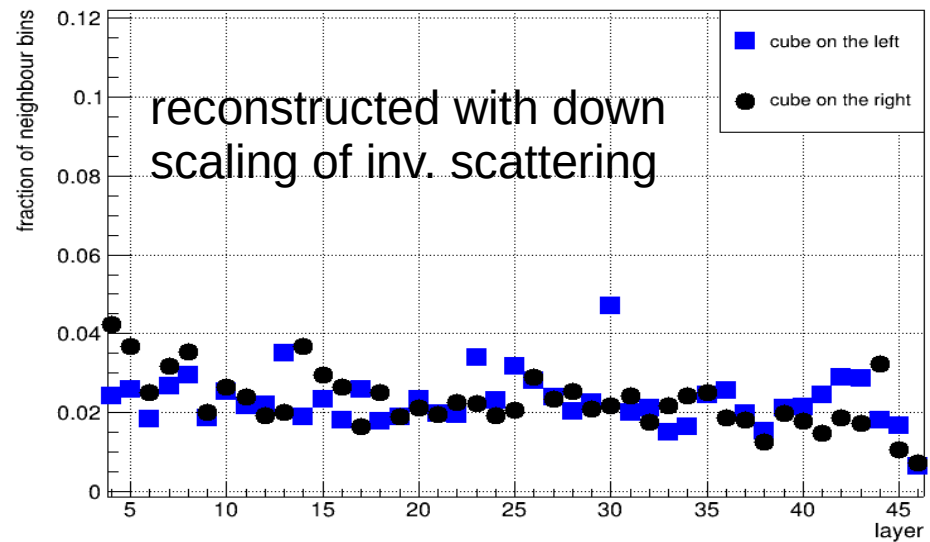
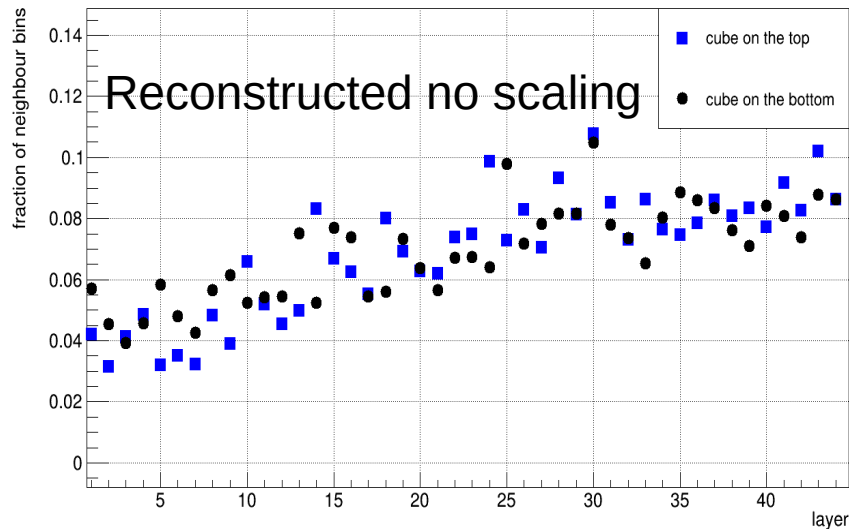


- The first layer does not give a 0 on the spread due to:
 - at the starting layer, more than one voxels reconstructed
 - backward scattering tracks



Reconstruction

- We can scale up/down invisible scattering in the reconstructed scenario.
- However, it seems that tuning the reconstruction itself to find a more precise vertex is more important.



Conclusion

- The vertex spread on the transverse dimension across the entire detector is at 2.5% level.
- A side-band can be selected and a MC-data fit with that can be built.
- However, the spread introduced by reconstruction itself is larger than that by invisible scattering.
- An optimized reconstruction might be prioritized and comparison can be performed again with optimized reconstruction.