Neutron study
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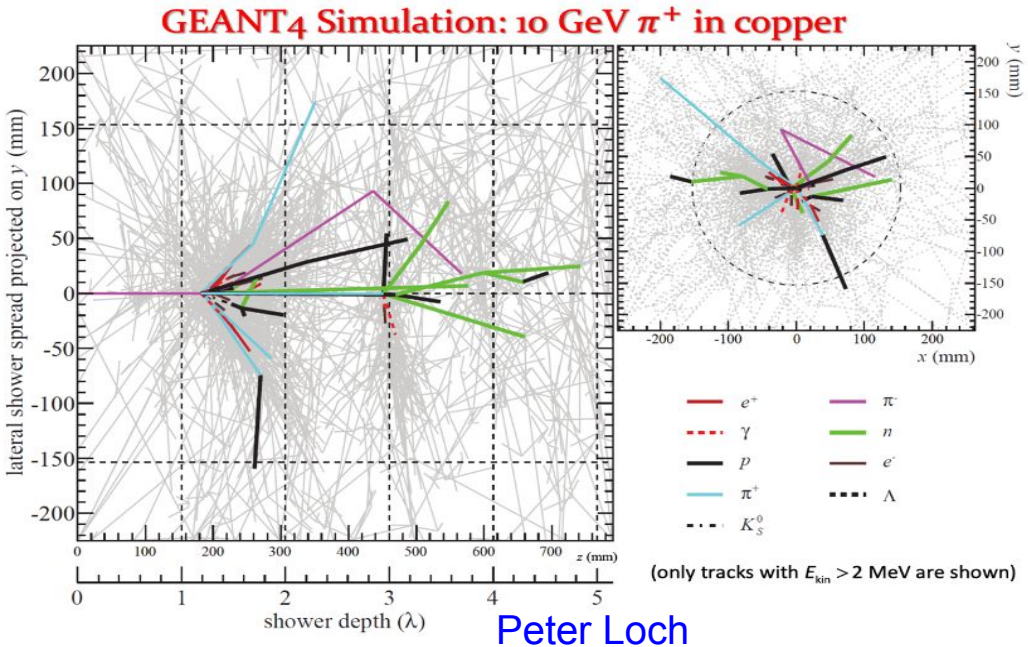
Objective

The main point of this study is to capture the neutrons produced as secondary particles in the hadronic cascade. These particles can be mistakenly counted as incident neutrons and mixed up with them.

We conducted timing studies for this purpose. We hypothesized that secondary neutrons should have longer mean time values since they reach the detector later than the incident particle.

Conceptual basis

Hadronic cascade



Peter Loch

Cascade energy distribution:

[Example: 5 GeV proton in lead-scintillator calorimeter]

Ionization energy of charged particles (p,π,μ)
1980 MeV [40%]

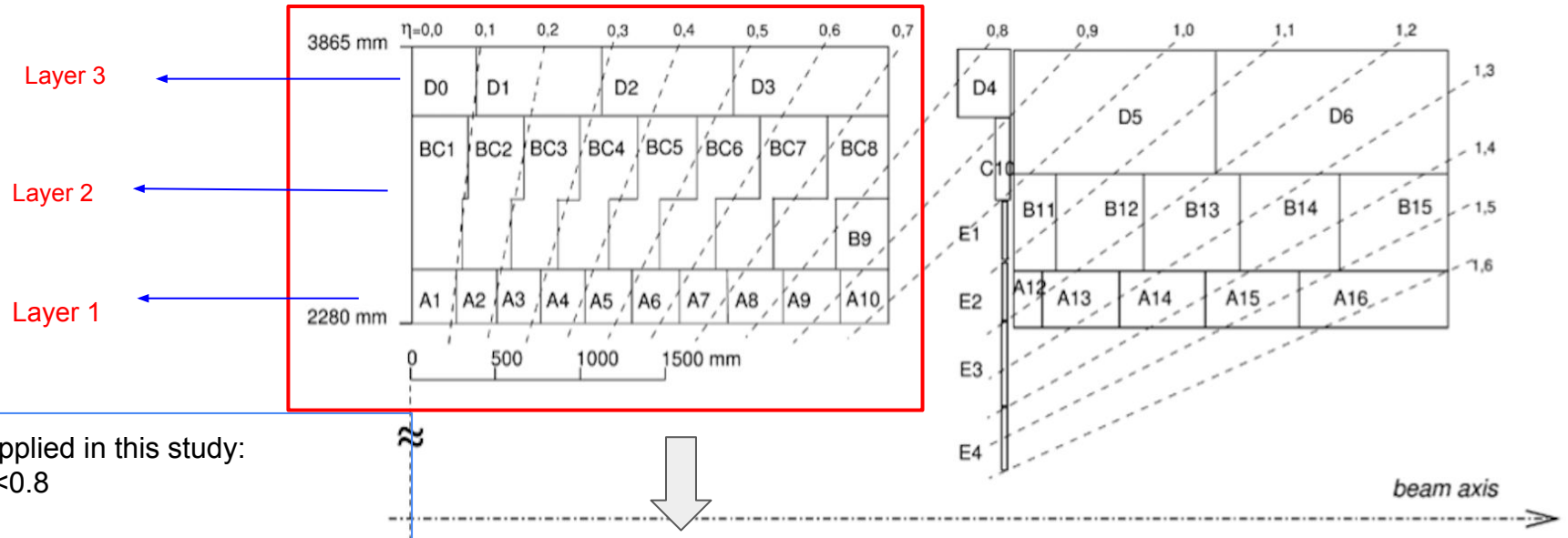
Electromagnetic shower (π^0,η^0,e) 760 MeV [15%]

Neutrons [10%] 520 MeV

Photons from nuclear de-excitation 310 MeV [6%]

Non-detectable energy (nuclear binding, neutrinos)
1430 MeV [29%]

TileCal cell layout



Cut applied in this study:
|eta| <0.8

3 longitudinal layer (A, BC, D)

Region of interest

Data selection

3 different single particles has been studied

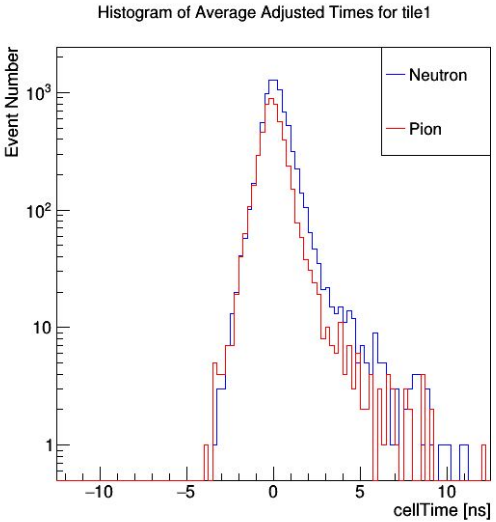
- Single Pi- without pileup
- Single Neutrons without pileup
- Single Antineutrons without pileup

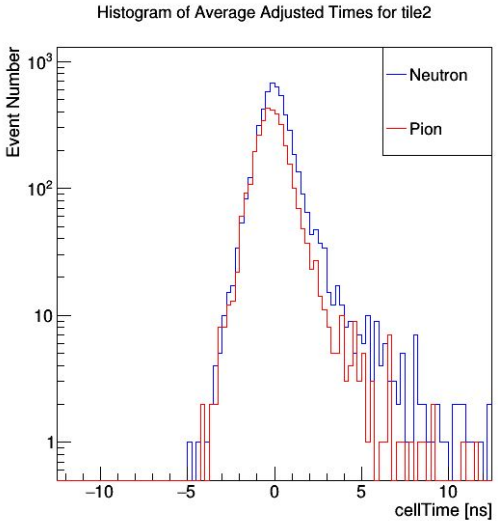
The cut applied to all the (MC) is consistent.

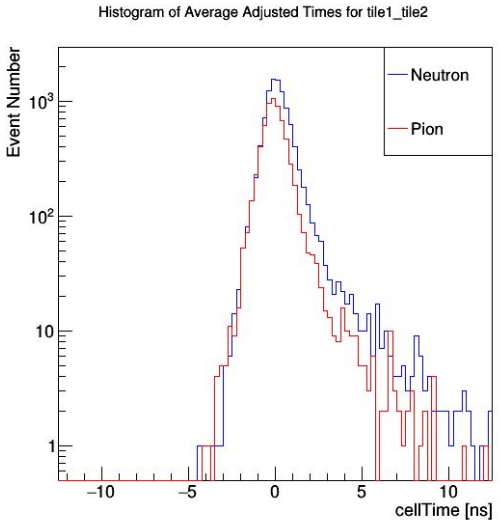
cellE> 0.5 GeV,cellTime != 0, 1 GeV <particle Energey < 20 GeV, |eta| <0.8

Cell time distribution (pi- vs Neutrons)

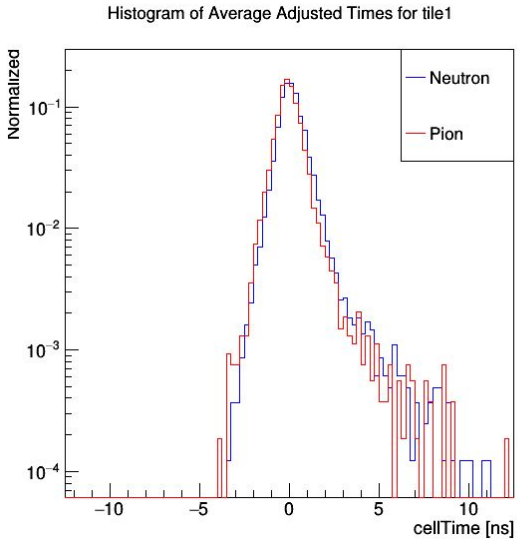
The cellTime has been corrected for detector effects. The average cell time for each event has been plotted.

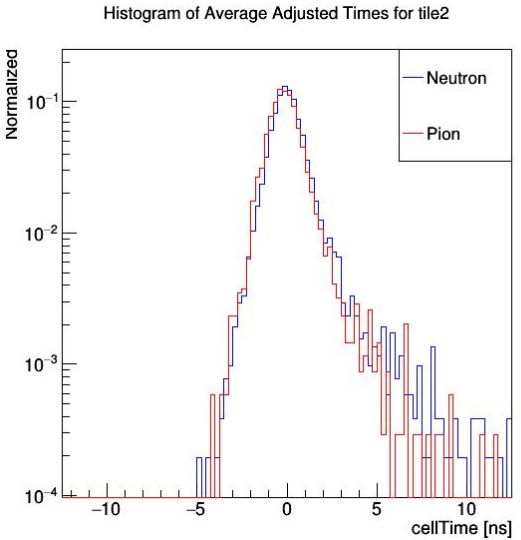


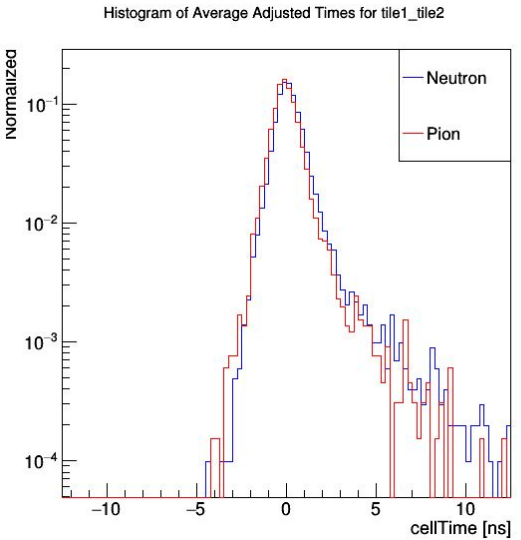




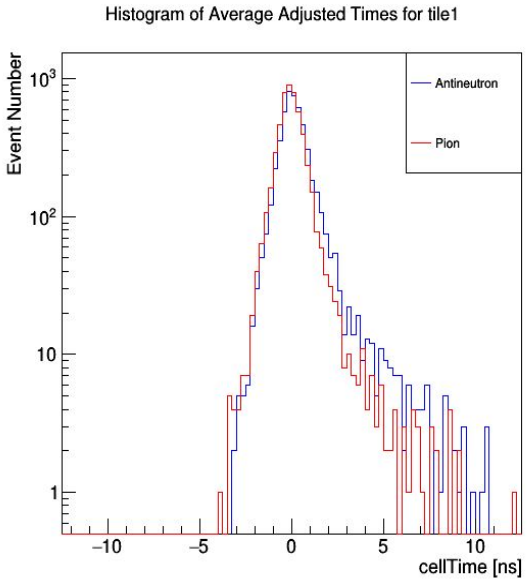
Normalized cell time distribution(Pi- vs Neutrons)

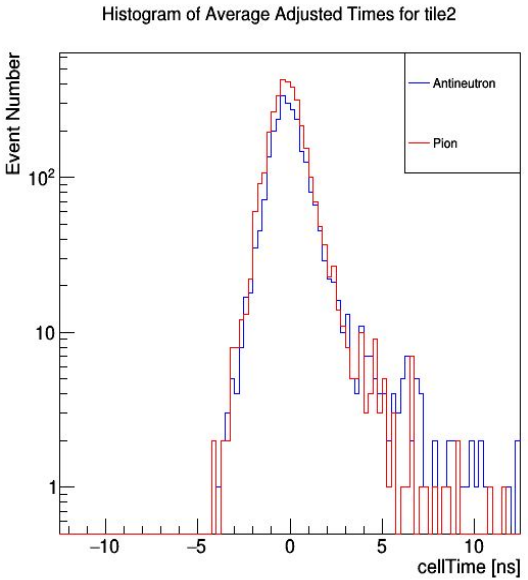


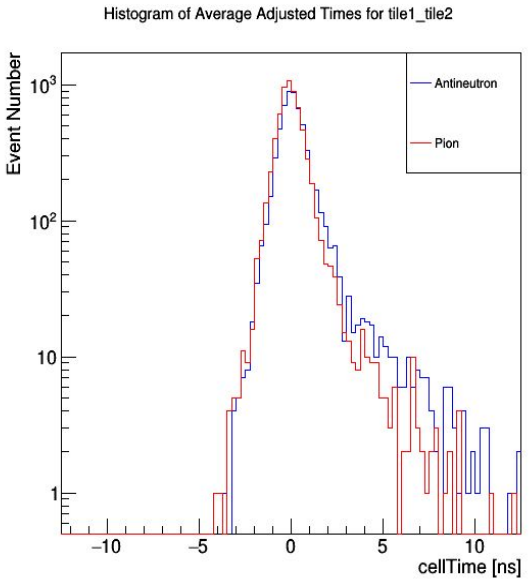




Cell Time distribution (pi- vs antineutron)







Conclusions

- There is no significant difference among all data sets with respect of cellTime distribution in this study.

- I would not expect the simulation to collect all the secondary neutrons produced in other events and add them to the single neutron sample. However, I think that some secondary neutrons might be counted as other particles in the proton events or pion events or some other events.

- Adding hit information could be helpful in this regard, as it would enable us to distinguish between the incident particles and those produced later in the cascade.