Separation of Photons and Neutrons in BCAL

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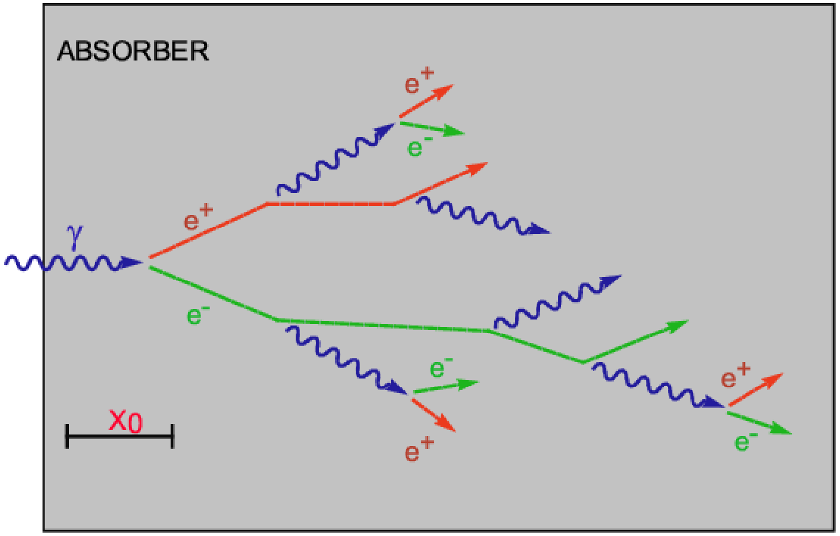
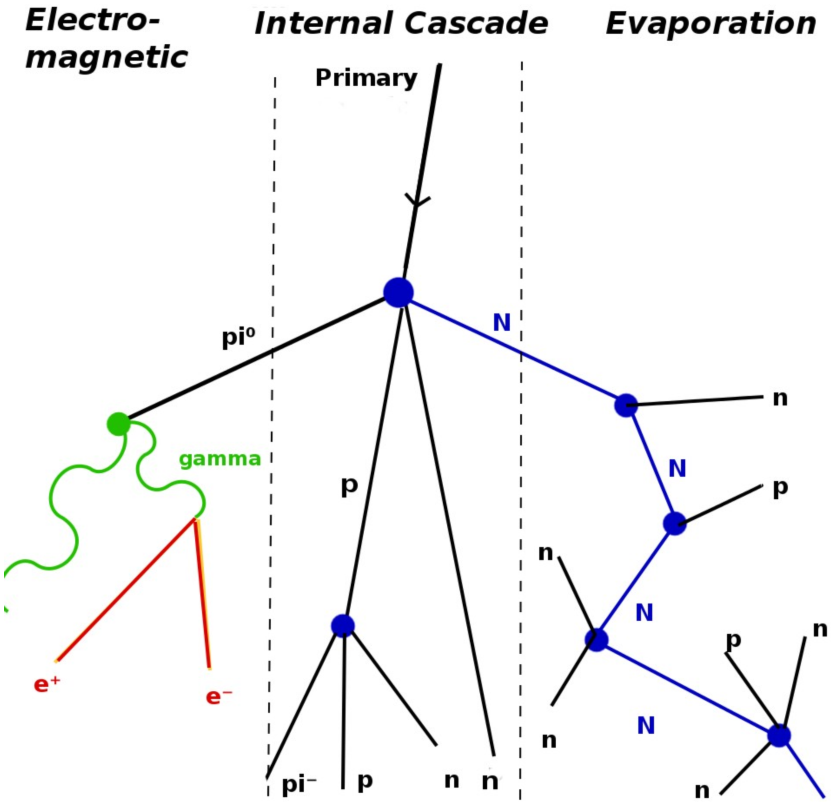
EM and Hadronic Showers

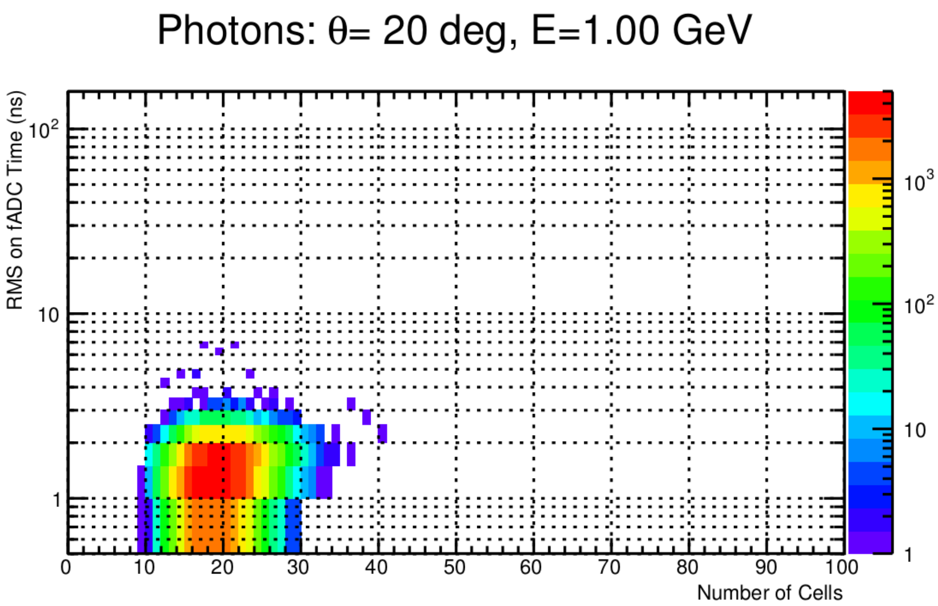


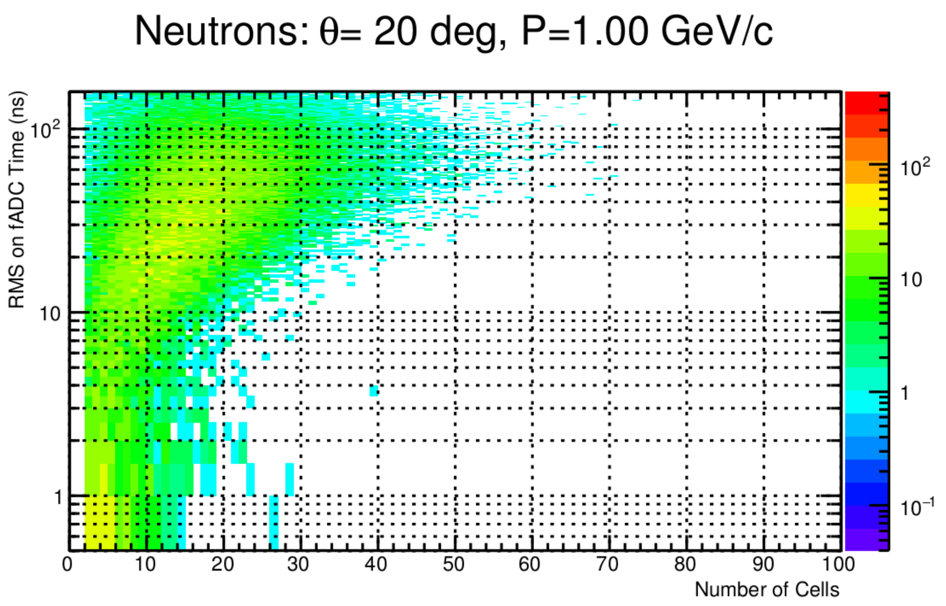


1. Energy is shared between light particles => shower is compact in time
2. EM shower is always “well-developed” in BCAL => many cells are fired

1. Energy is shared between heavy particles => big time difference between energy depositions in the early and late shower development stages
2. Hadronic shower might be “well-developed” or not “well-developed” in BCAL

Simulation





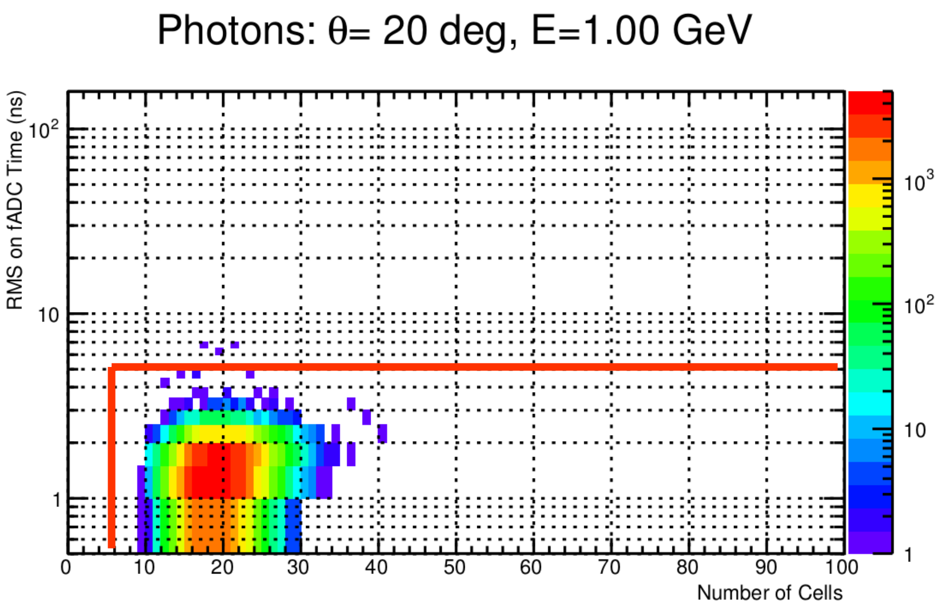
* Fine-structure model of BCAL in GEANT-3

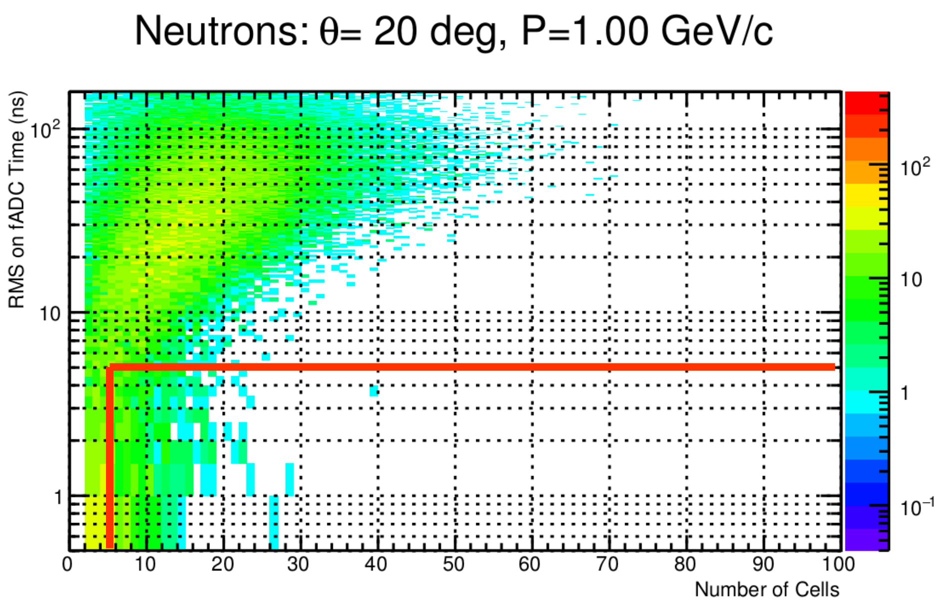
* Simulation of waveforms and production of “fADC” time

* No shower reconstruction (all cells above 2.5-MeV threshold are involved)

* “Particle gun” (neutrons and photons)

Universal Selection Cuts

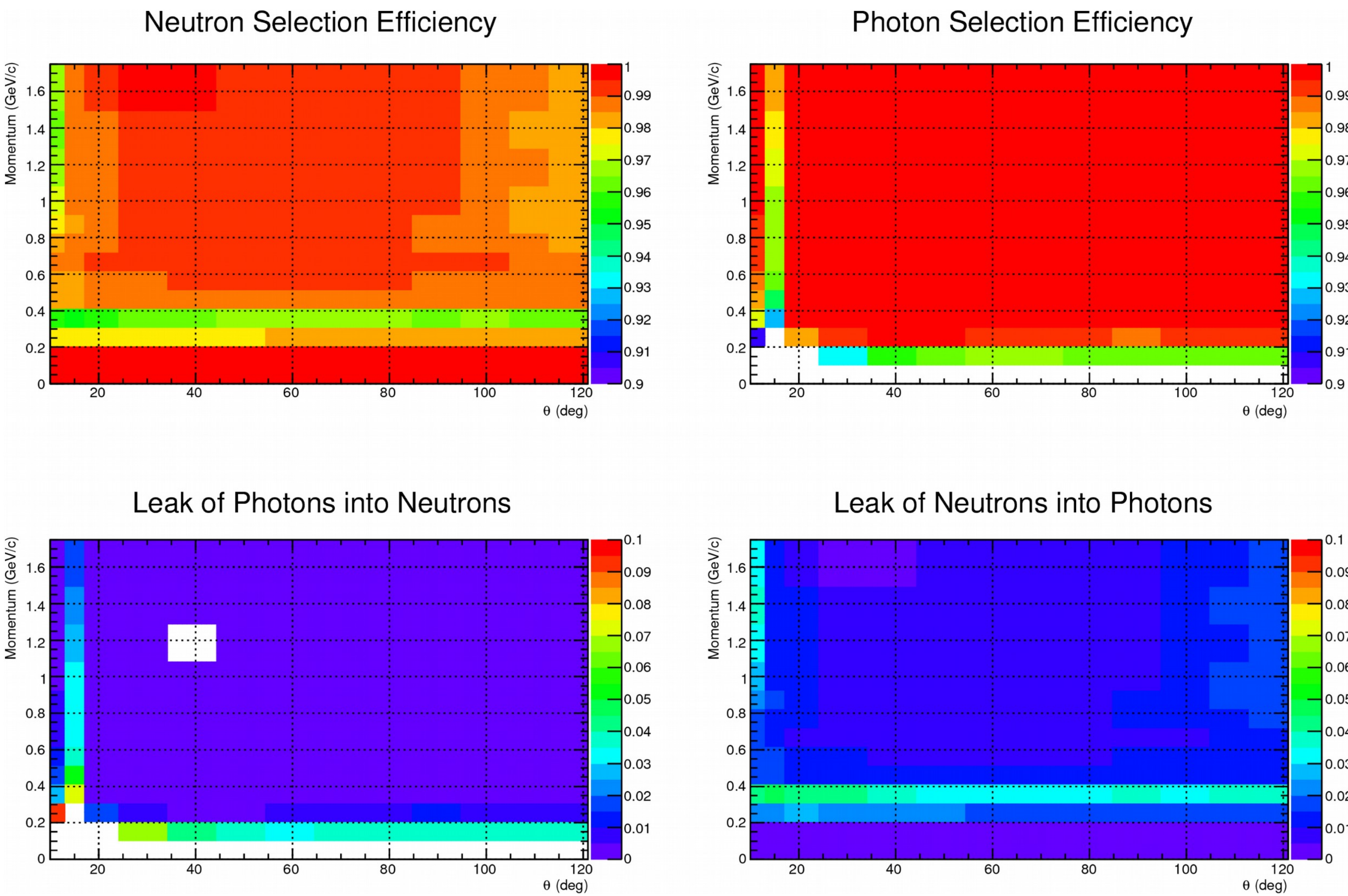




Cuts: Multiplicity > 5
.and. RMS <5 ns
.and. $\beta > 0.7$

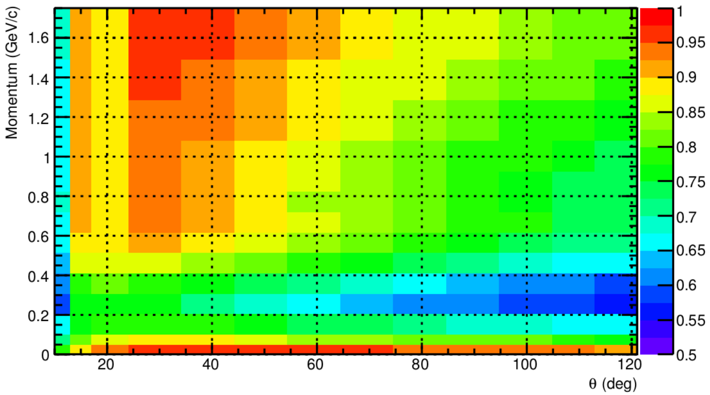
Cuts: Multiplicity <= 5
.or. RMS >=5 ns
.or. $\beta <= 0.7$

Probability to Recognize the Particle (if Shower Exists)

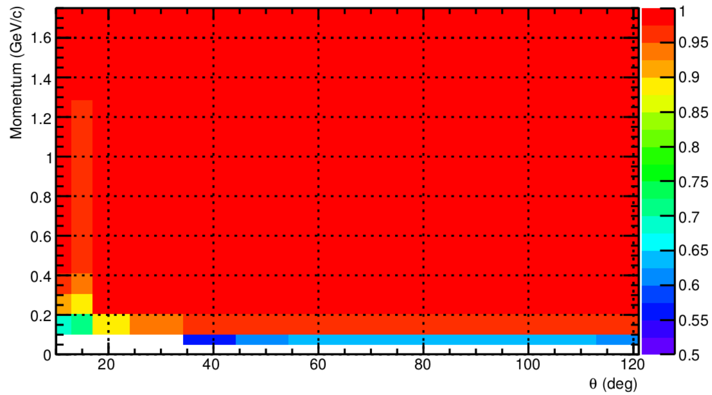


Probability to Detect and Recognize the Particle

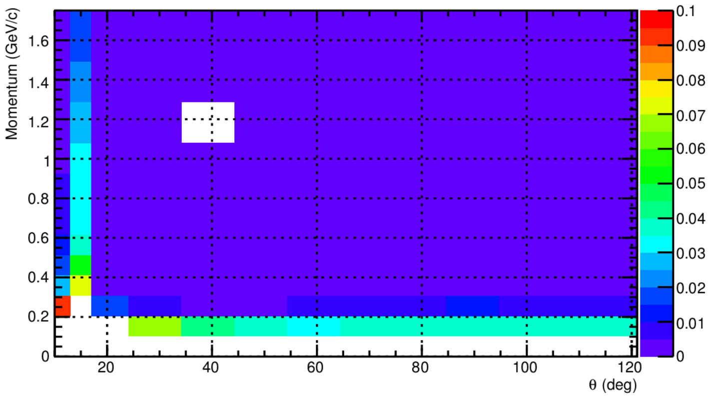
Neutron Detection Efficiency



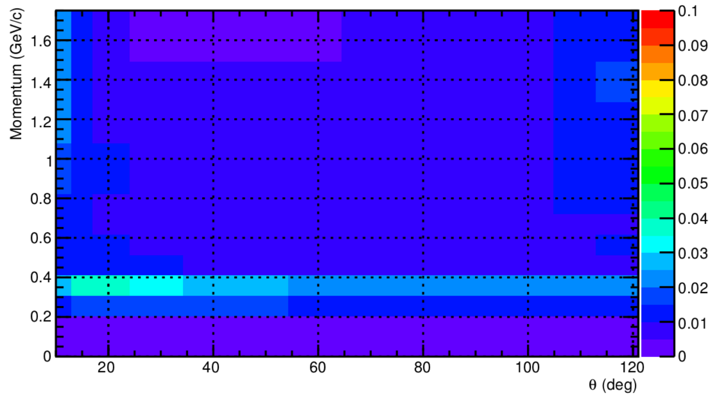
Photon Detection Efficiency



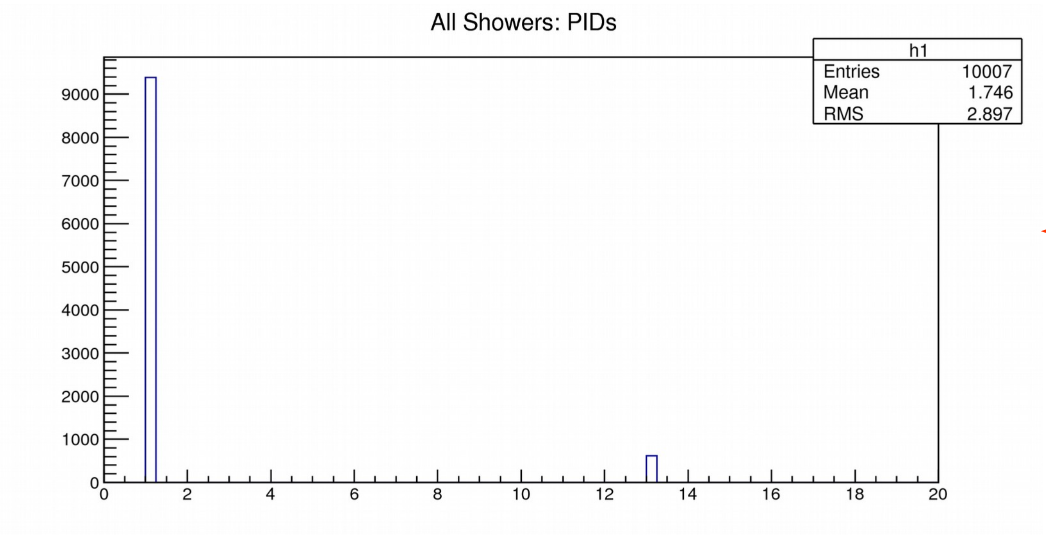
Leak of Photons into Neutrons



Leak of Neutrons into Photons



How It Works with *hd_geant* ?

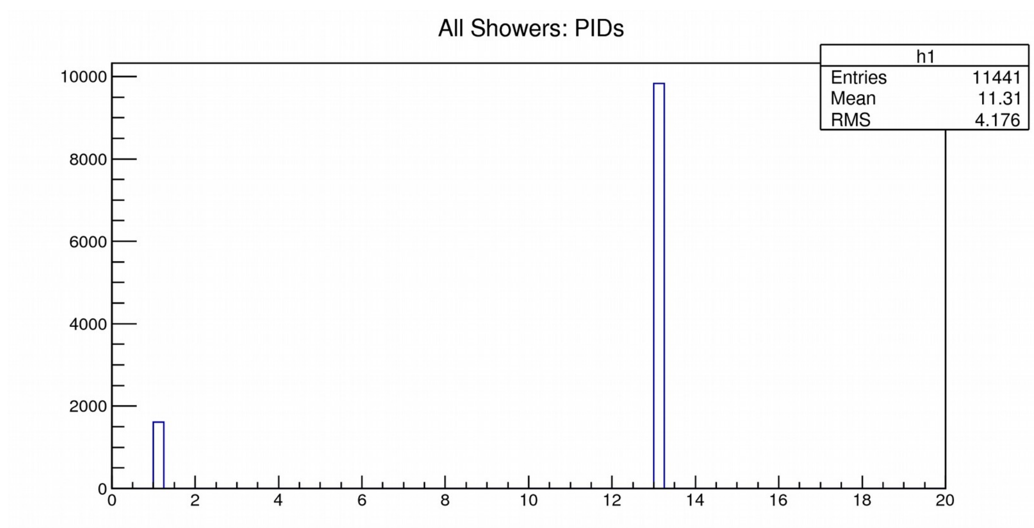


Photons: 1 GeV @ 20 deg.

Detection & PID probability is about 94%

Neutrons: 1 GeV/c @ 20 deg.

Detection & PID probability is about 85%



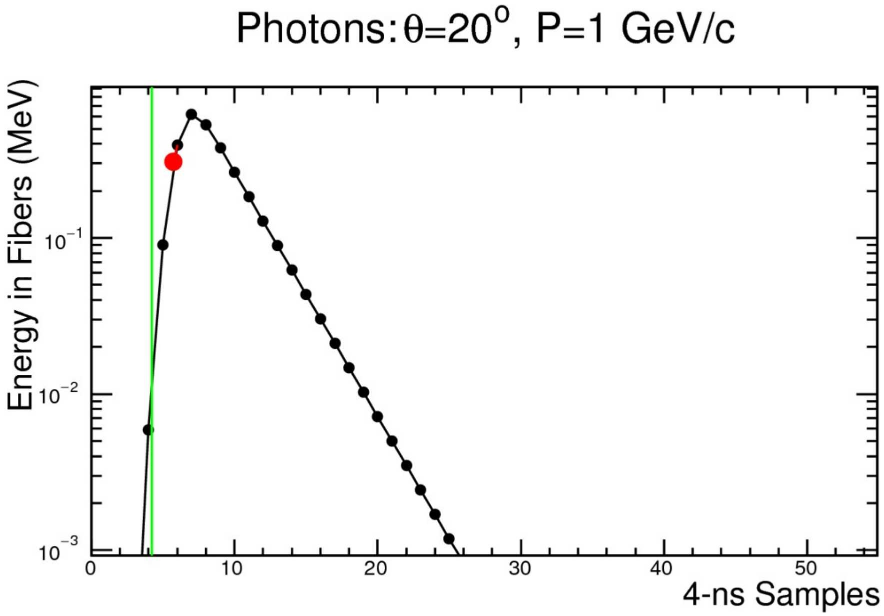
Timing in BCAL

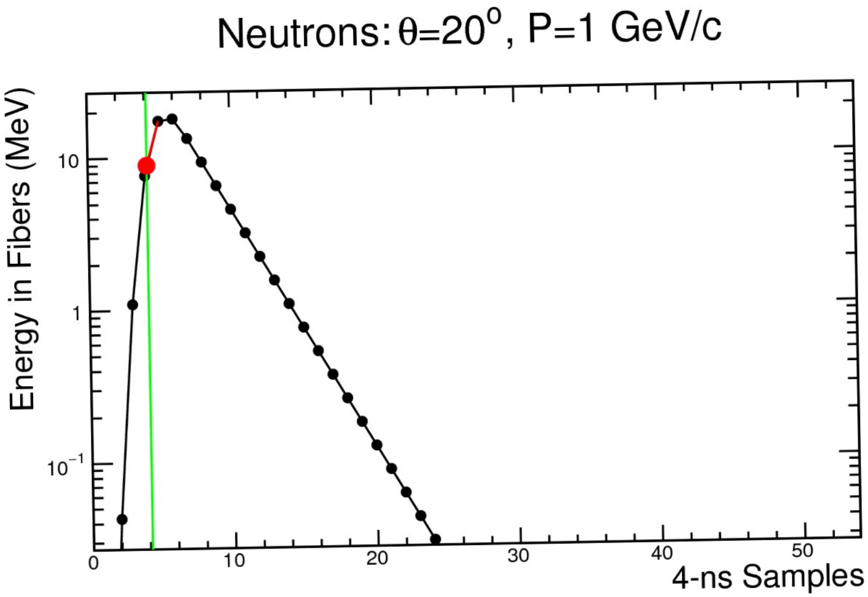
* fADC time: interpolation between 2 samples that are preceding the peak

* TDC time: from crossing the threshold

* “Averaged” time: energy-averaged time for all energy depositions in the simulation (hd_geant)

“Normal” Waveforms



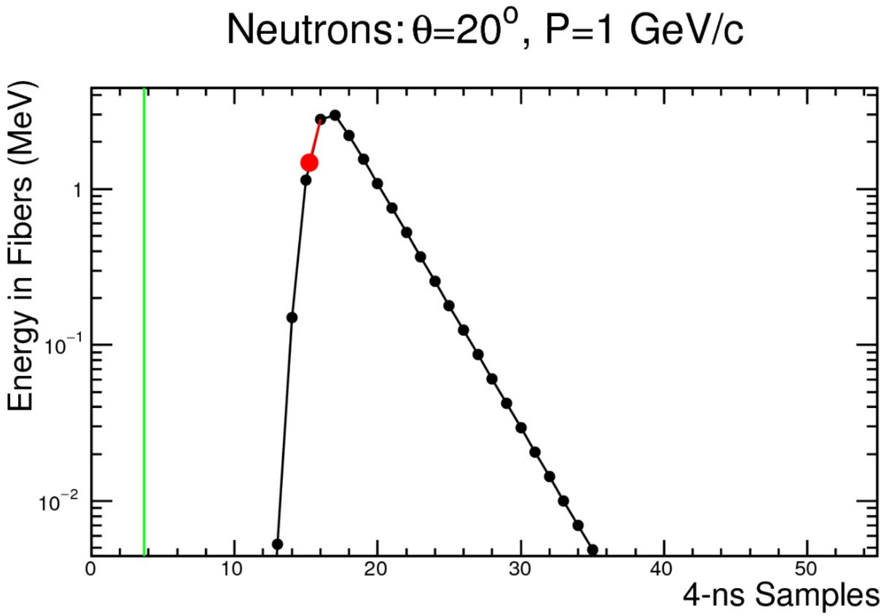


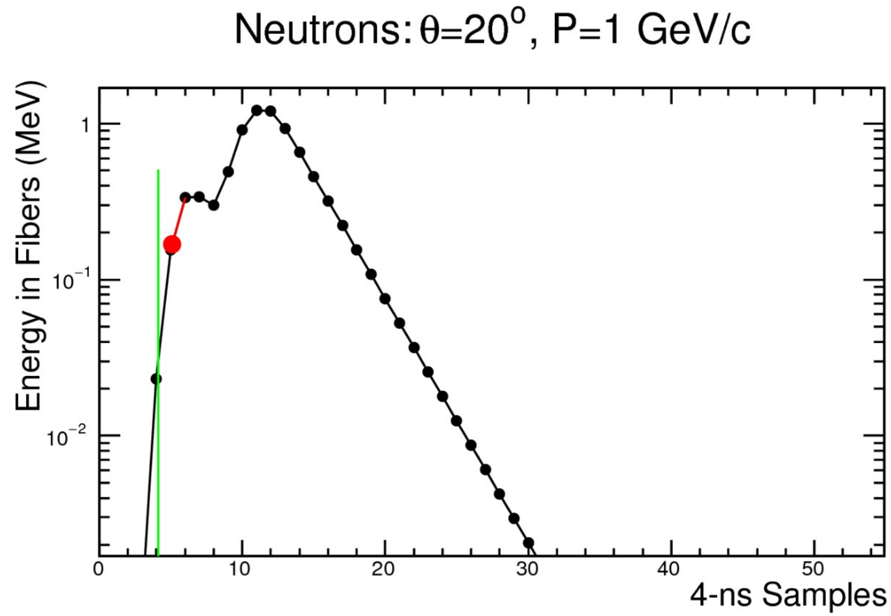
The cells with minimal times (in the showers) are presented

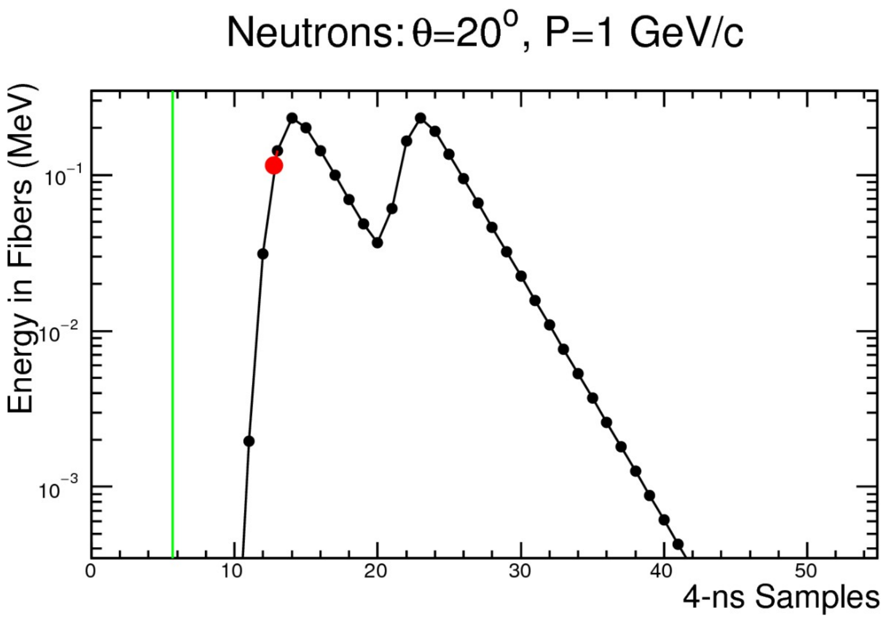
Green line: expected time to the cell

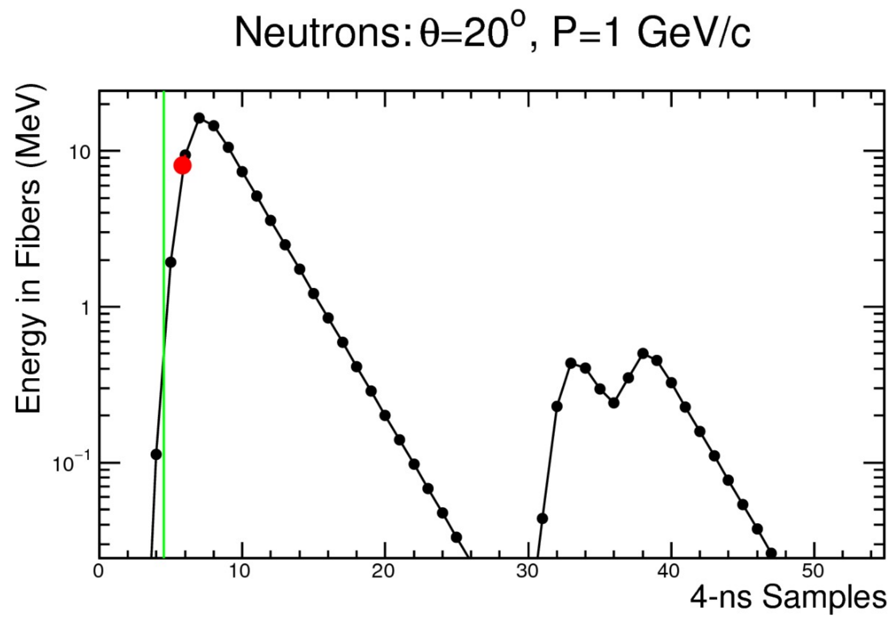
Red dot: extracted fADC time

“Delayed” and Multi-Peaked Waveforms for Neutrons

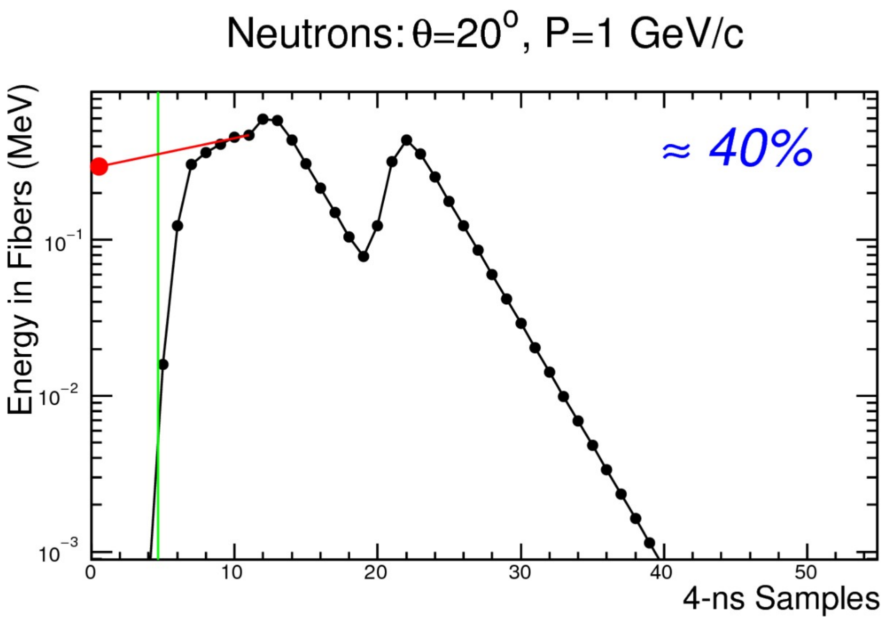


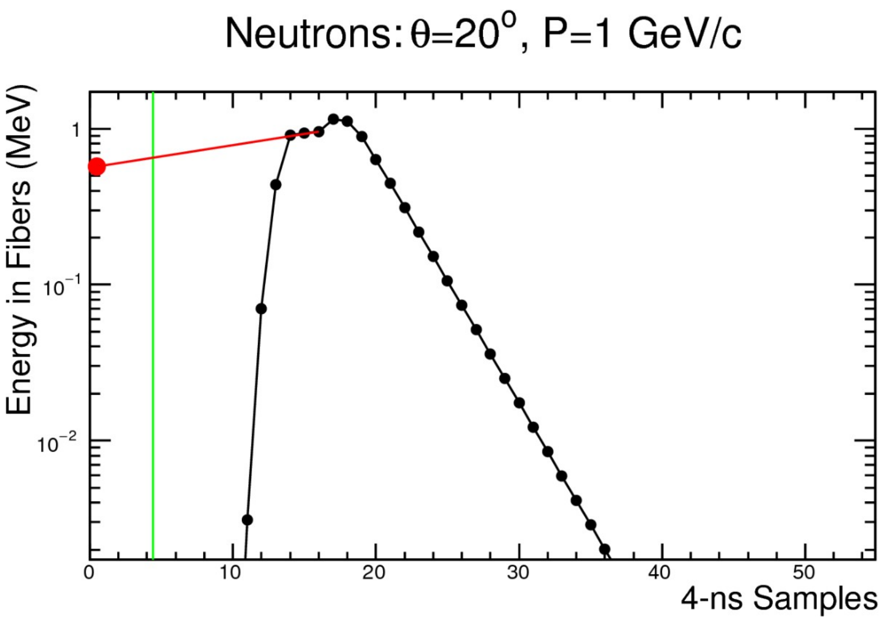






“Tachyons”



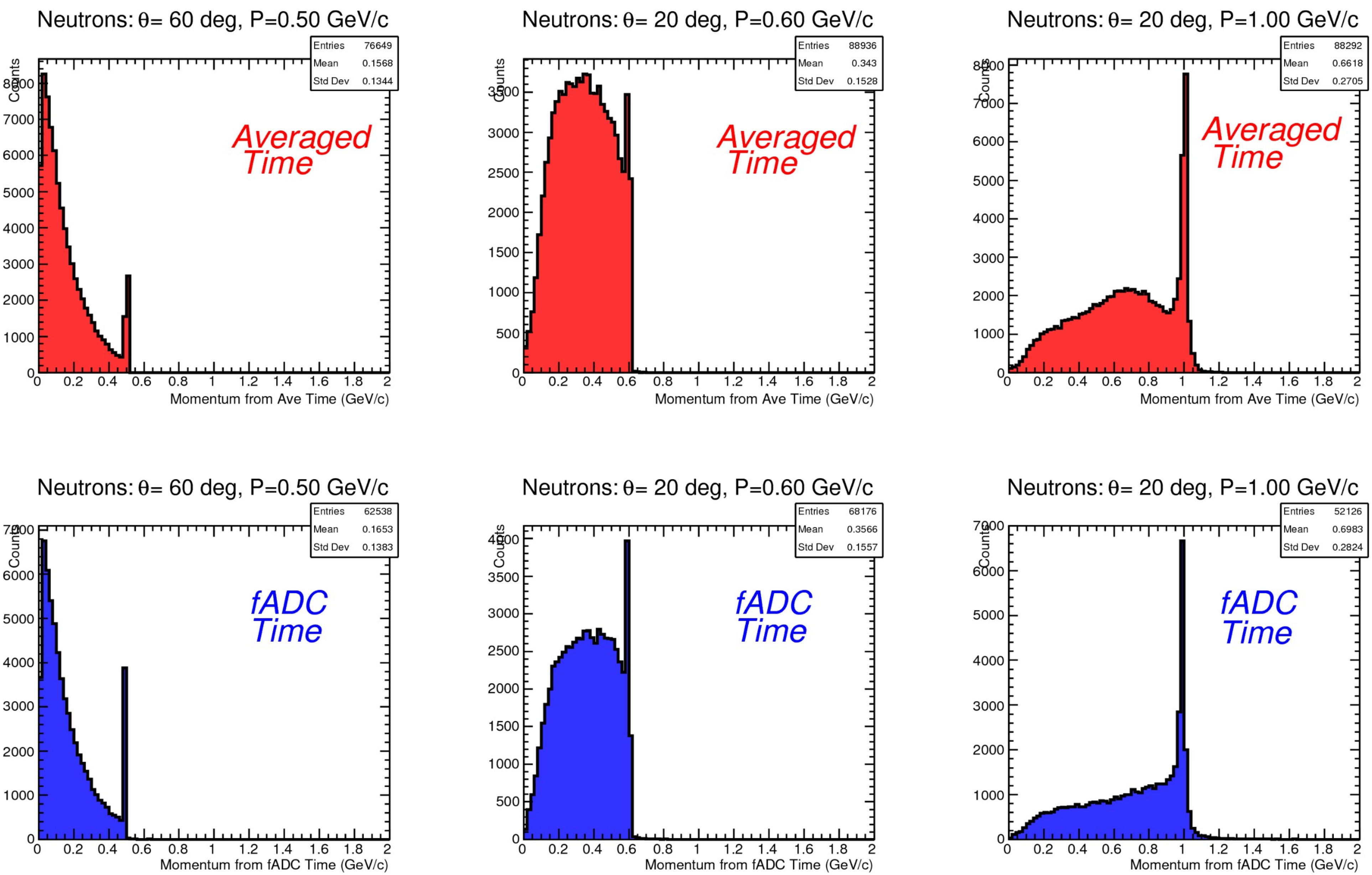


Superimposed waveforms => Extremely small fADC time as an artifact of the “flat” peak

Relatively big probability

“Threshold-crossed” (TDC) time partly improve the situation

Reconstructed Momenta



Conclusions

1. We found an effective way to separate neutrons and photons in BCAL

2. Reconstruction of the neutron momentum from time-of-flight is difficult

3. As much as possible, the TDC timing should be used for neutrons

4. *hd_geant* might introduce distortions in neutron time (compared to the data)