Photon-Neutron Separation with BCal

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The Problem

We'd like to separate photon-caused and neutron-caused showers of certain energy deposited in BCAL fibers.

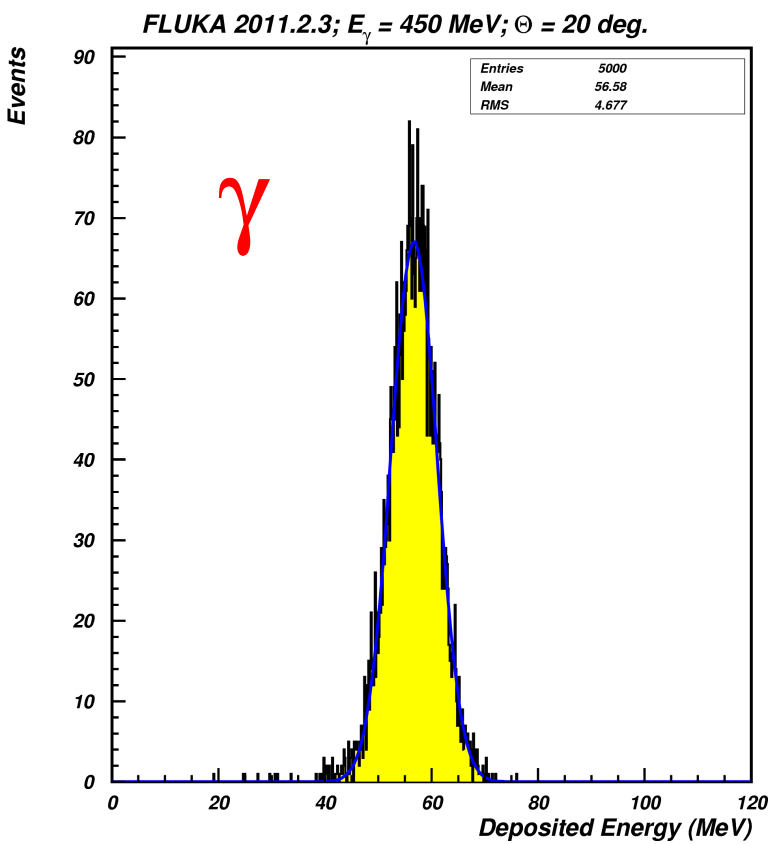
Solution

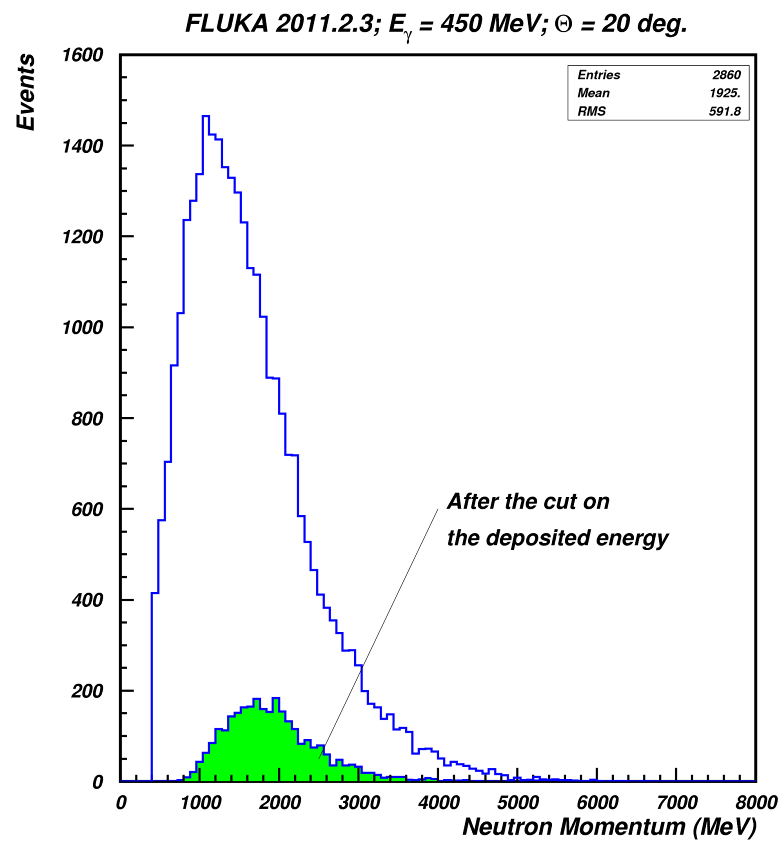
The photon-caused EM shower is developed “earlier” and located inside BCAL module with the maximum of deposited energy in the inner part of the calorimeter.

The hadronic shower from neutron is developed “later” and significant part of the shower energy leaks out of back of the module; the maximum of the energy deposited in BCAL is shifted to the outer part of the calorimeter.

The ratio of the energies deposited in the most inner and the most outer readout layers can be used for photon-neutron separation.

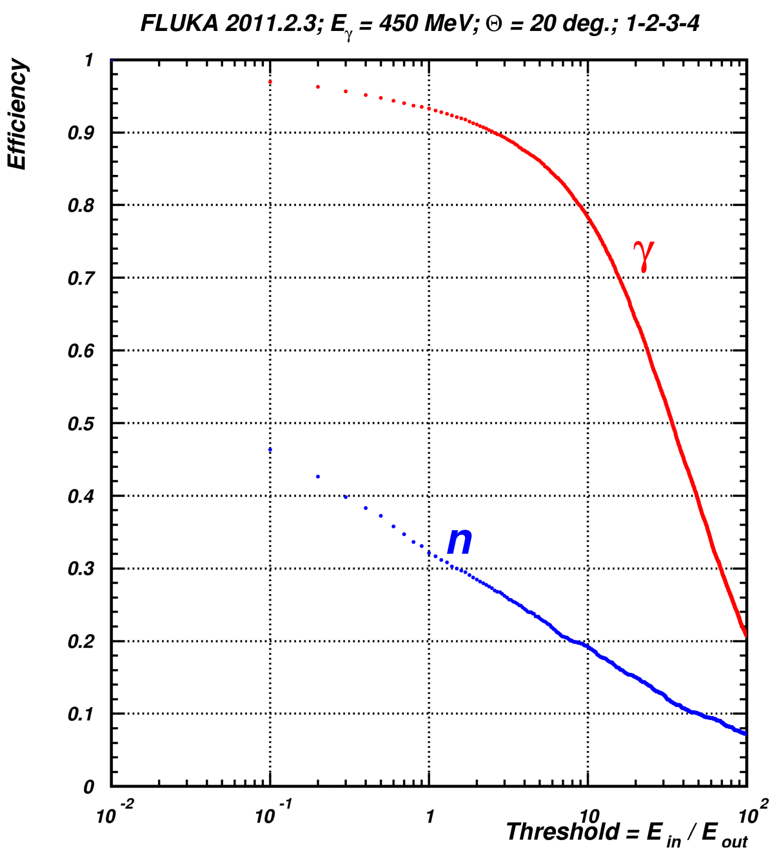
Selection of Neutron Events

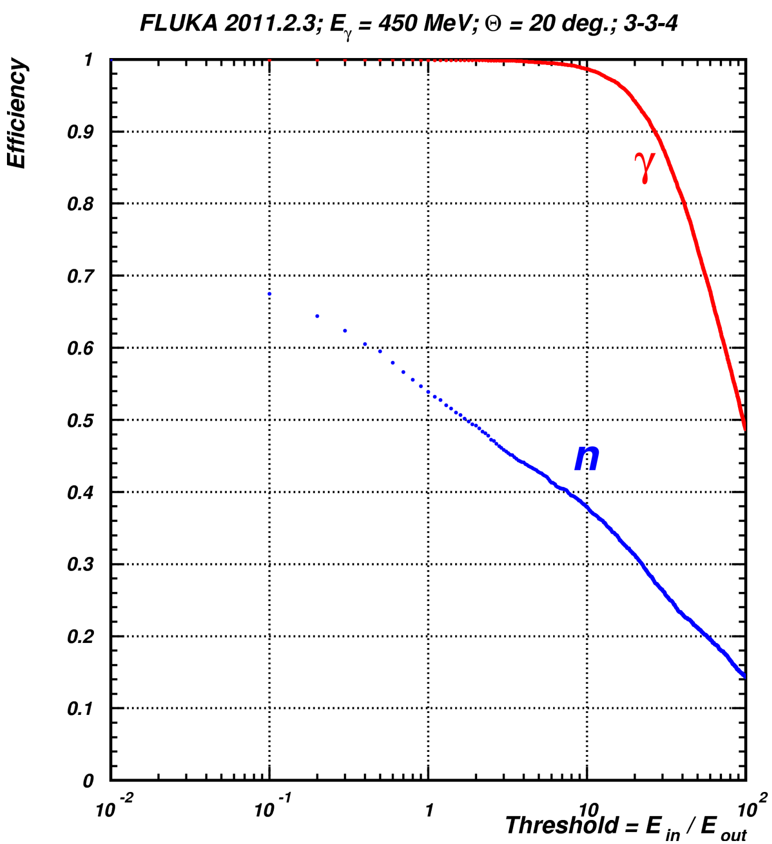




NOTE: Kinetic energy of selected neutrons (of about 1200 MeV) is significantly larger than the energy of correspondent photons.

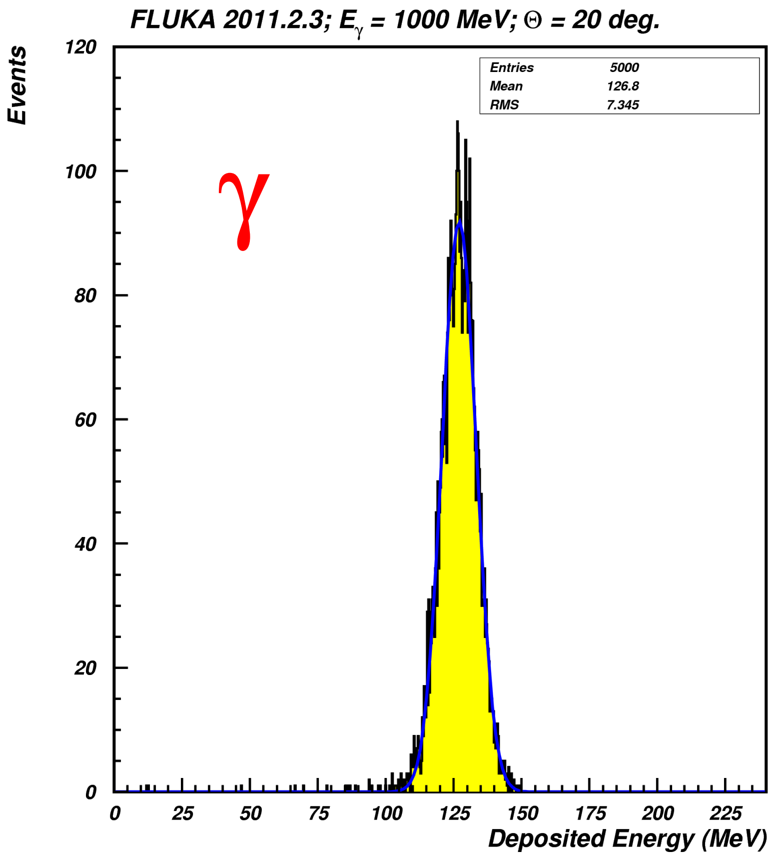
Neutron ID Efficiency

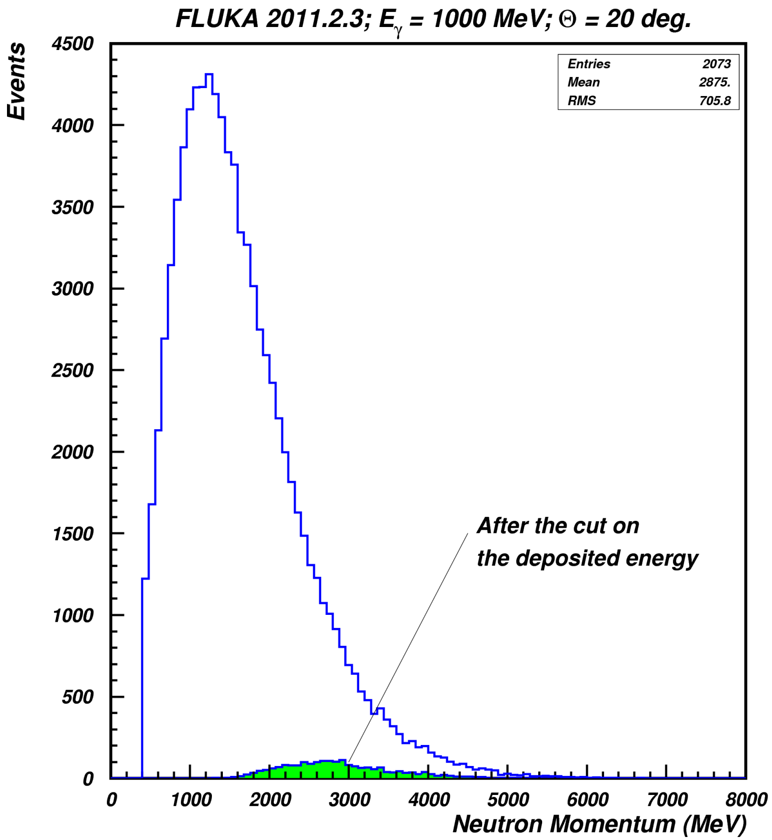




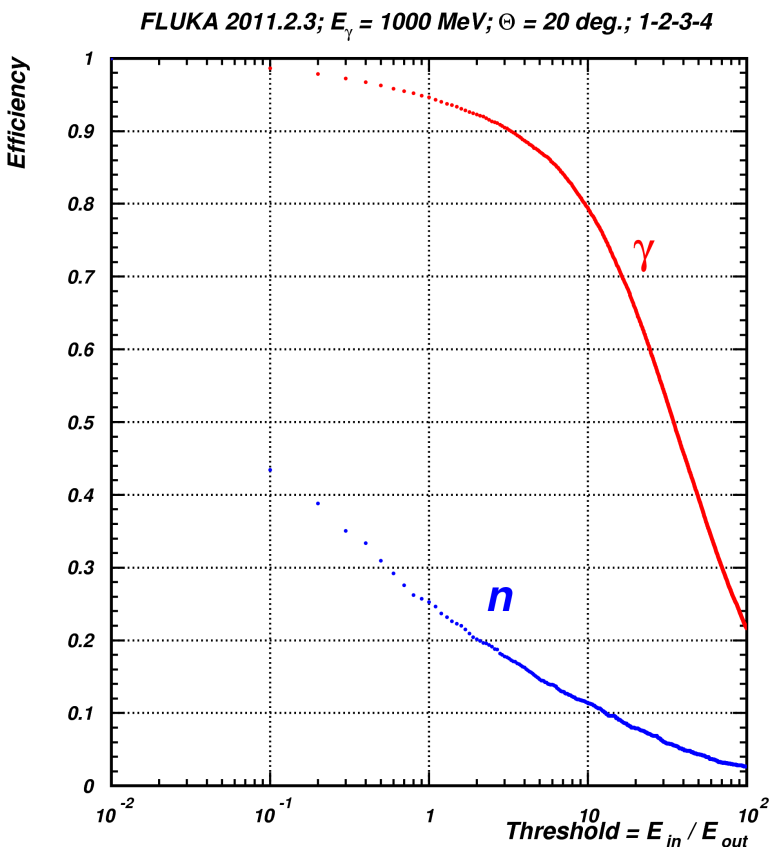
Suppression of neutrons by factor of about 2.5 is achievable without reducing the photon efficiency

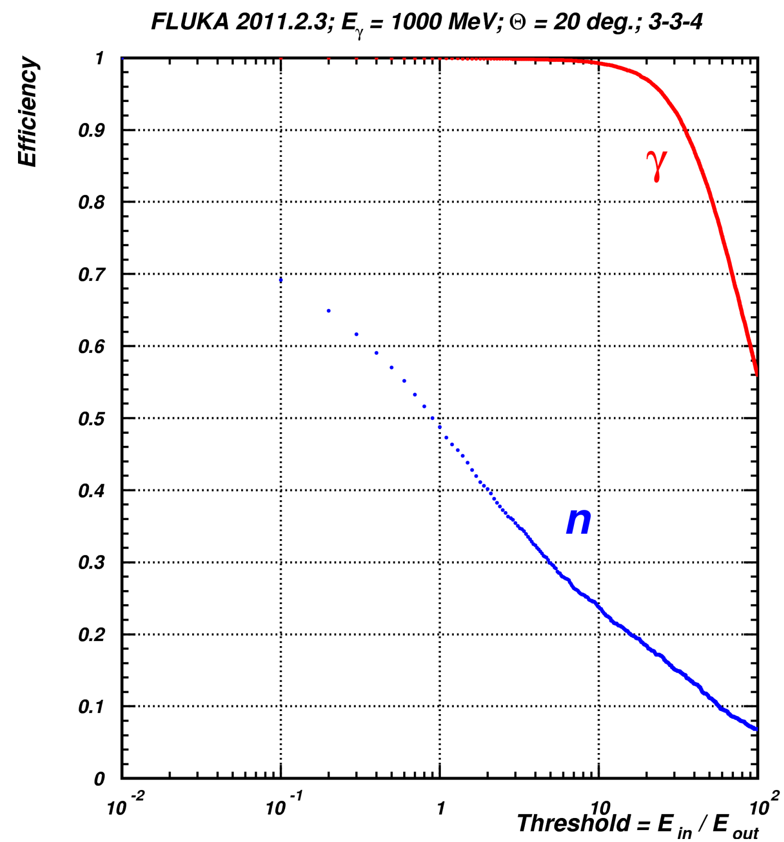
Selection of Neutron Events





Neutron ID Efficiency





Suppression of neutrons by factor of about 4 is achievable without reducing the photon efficiency

NOTE: the higher neutron energy (viz., the more difficult the use of TOF), the better the suggested separation method works

Neutron ID via Time-of-Flight

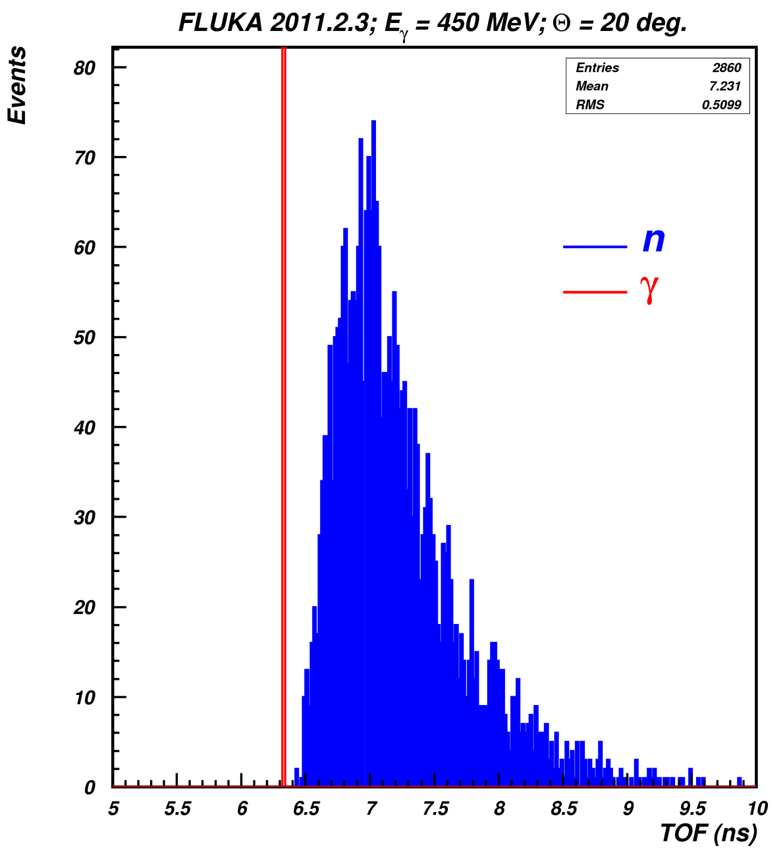
- To have no photon loss, the window of 3σ window on photon shower TOF (viz., about ± 300-450 ps) is required; it comparable with the gap in between photon and correspondent neutron TOF.

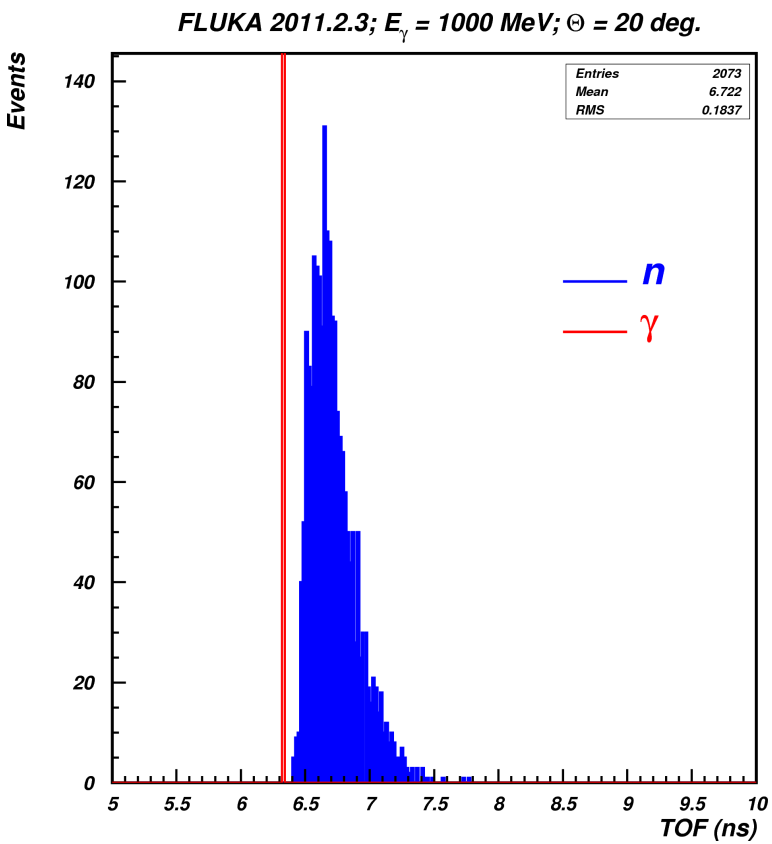
- Because the most of energy deposition from neutrons is located in the outer layers of BCAL while the time measurements are planning for the inner layers only, the accuracy of TOF measurements for neutrons will be significantly worse than for photons.

- Taking into account the mentioned above, the TOF for significant fraction of neutrons (up to 50% => "neutron suppression factor" of about 2) will overlap with the selection cut for photons. (Simulation is required to establish the exact value.)

- The proposed neutron selection method (that is independent of TOF) will improve significantly the overall identification of neutrons.

Neutron ID via Time-of-Flight





NOTE: No resolution on time measurements is shown here.

Conclusions:

The ratio of the energies deposited in the most inner and the most outer readout layers can be used for photon-neutron separation; suppression of neutrons by factor of 2.5-4 is achievable without loss of photon efficiency

The higher neutron energy (viz., the more difficult the use of TOF), the better the suggested separation method works

The proposed neutron selection method (that is independent of TOF) will improve significantly the overall identification of neutrons

Photon-neutron separation can NOT be an argument in the choice in between 1-2-3-4 and 3-3-4 readout segmentations

Readout segmentation with less thickness of outer readout layer might lead to a better photon-neutron separation