Measurement of the Neutron Travel Time Distribution Inside a Neutron Monitor

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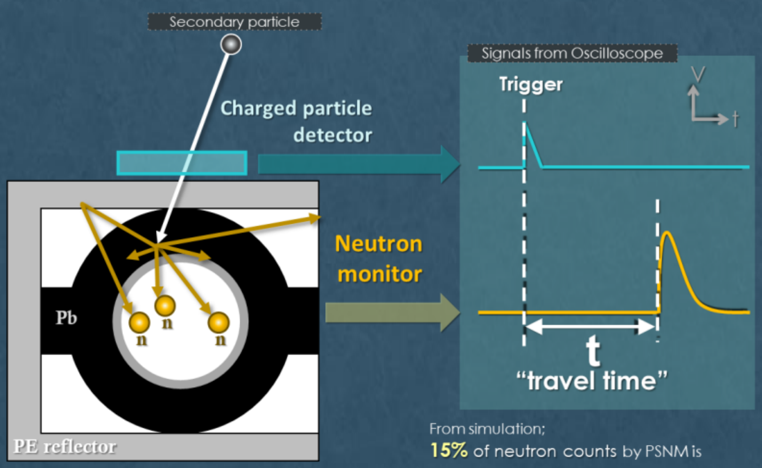
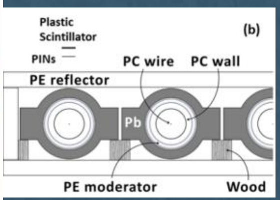
In a **neutron monitor**, atmospheric secondary particles from cosmic ray showers interact in lead to produce neutrons that are detected in proportional counters. We used **charged particle detectors** to provide a timing trigger for measurement of the **travel time distribution** of such neutrons, and compare with **Monte Carlo simulations**.

This travel time distribution underlies the time delay distribution between successive neutron counts, from which we can determine the leader fraction (inverse multiplicity),which has been used to monitor Galactic cosmic ray spectral variations over~1-40 GV.



From simulation;
15% of neutron counts by PSNM is
Proton

Experiment



Simulation

Fluka
(4-1.1)
&
EXPACS
(4.09)

- The travel time distribution from both the experimental setup and Monte Carlo simulations of atmospheric secondary particle detection was measured and characterized.
- We confirm a known travel time distribution with a peak (at ≈70 μs) and tail over a few ms, dominated by neutron counts.
- This distribution was fit using an analytic model of neutron diffusion and absorption, for both experimental and Monte Carlo results.
- We identify a group of prompt neutron monitor pulses that arrive within 20 μs of the charged-particle trigger, of which a substantial fraction can be attributed to charged-particle ionization in a proportional counter, according to both experimental and Monte Carlo results.
- The prompt pulses are associated with much higher mean multiplicity than typical pulses.
- These results validate and point the way to some improvements in Monte Carlo simulations and the resulting yield functions used to interpret the neutron monitor count rate and leader fraction.

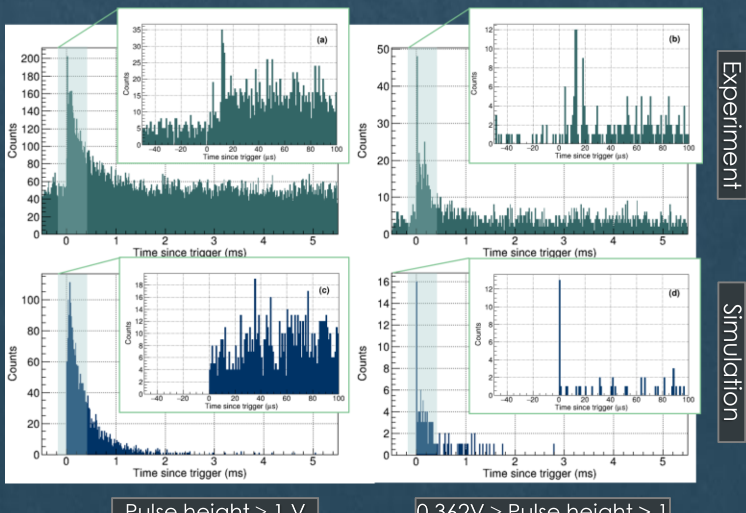


Figure :Distribution in time t(relative to a charged-particle trigger) of pulses in PSNM Tube 1 with−0.5≤ t <5.5ms and the insertion of the same distribution with−50≤ t <100μs for different pulse height range.

For detailed discussion, see QR code at the top