Neutral Current Detectors pulse simulation

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SNOMAN, the simulation framework for SNO, has been extended for SNO phase-III data-taking, to allow the simulation of physics events in the Neutral Current Detectors (NCD). Slow neutrons coming from neutral-current events are captured in the ^{3}He gas of the proportional counters, producing a proton-triton pair, traveling back-to-back and depositing their respective energy by ionizing the gas. Depending on the capture radius and production angle, the signature of such an event is different, with in some cases either the proton or the triton hitting the counter wall. As a result, the pulse energy distribution is a continuum comprised between 191 keV (when the proton hits the wall of the counter) and 764 keV (total energy deposited) with a shoulder at 573 keV (when the triton hits the wall of the counter).

Alpha particle emission from radioactive components present in the detector wall contribute as a background to the neutron-capture signal if its energy is in the neutron energy window.

In order to measure the neutral-current flux with the smallest uncertainties, a carefull simulation is carried out where contributions to the signal distortion from the electronics should be well-understood and simulation of the physics background under control.

In order to achieve this goal a set of calibration data has been taken. Alpha signals from counters sitting in the control room have been taken using a simple electronics, as well as data from an alpha beam sent in one of the NCD counters. They will help to understand the counter response on one hand.

On the other hand, the simulation is reproducing the electronics circuitry up-to our best of knowledge, allowing to switch on or off part of the electronics components in order to study the contribution of the NCD electronics to the neutron spectrum.

Detector properties of the NCDs such as the anode wire radius or the density of the components that is contained in the detector material are part of the simulation information. Physics properties of the gax mixture such as ion mobility, parametrization tables for the energy loss as a function of the path in the counters gaz are also handled by SNOMAN.

The simulated physics signal produced in the NCDs is transformed using an accurate description of the electronics chain from signal recording to digitization and the output pulse saved in the same format than data taken by the detector.

By comparing the output of the simulation to real data, a validation of the Monte Carlo simulation is performed. Small data sample using simple electronics will also help to validate the differents parts of the simulation framework by disentangling the electronics from the physics.

Figure 1 is the resulting simulated pulse as seen by the oscilloscope for a proton-triton pair emitted at 1 cm of the wire and with the proton traveling in the direction of the wire.

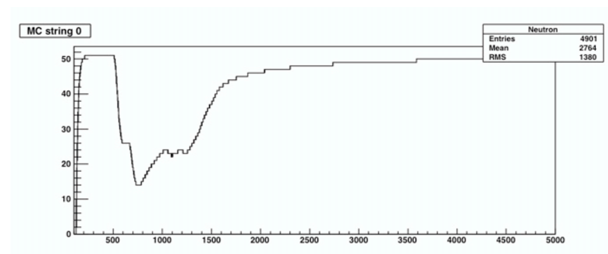

FIG. 1: Simulated output of the oscilloscope for a proton-triton pair created at 1 cm radius of the counter wire

In Figure 2 we have the simulated output of an 1 MeV alpha particle, produced at 1 cm radius of the counter wire and with the particle traveling in the direction of the wire.

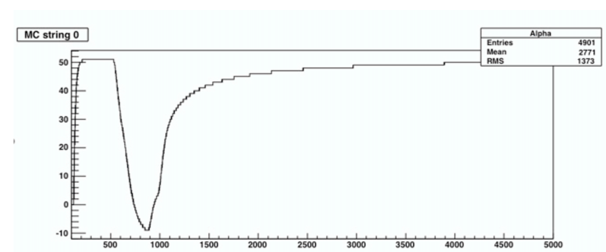

FIG. 2: Simulated output of the oscilloscope for 1 MeV alpha particle created at 1 cm radius of the counter wire