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Pulse Shape Discrimination for high pressure 3He counters

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The success of low counting rate experiments strongly depends on the accurate knowledge and reduction of the backgrounds present during the measurement campaigns. For this reason, dark matter search and low energy nuclear astrophysics experiments are performed in underground laboratories, shielded from the cosmic rays. Two important examples of low counting rate experiments for nuclear astrophysics are the measurement of 13C(alpha,n) and 22Ne(alpha,n) cross-sections at low energies, which are considered to be the main neutron sources for the astrophysical s-process.
These experiments require the use of high intrinsic efficiency detectors, such as the high pressure 3He counters, sensitive to thermal neutrons through the 3He(n,p) reactions. The intrinsic alpha-activity contained in the walls of these counters becomes a major source of background in low count rate scenarios.
Nevertheless, the neutron signal events can be masked by the internal alpha background present in the aluminium housing, complicating the uncertainty objectives for the experimental cross-section measurements.
To reduce this intrinsic background, over the years, many efforts were made in the pulse shape discrimination between the neutron and alpha event signature. Two recent examples are the use of current sensitive preamplifiers, taking advantage of the double peak structure formed by the triton and proton articles and low pressure 3He counters, for which the rise-time differences between alpha and 3He(n,p) events permit pulse shape discrimination.
However, most experiments are performed with charge sensitive preamplifiers in the electronic chain, thus losing the double peak structure of 3He(n,p) reactions, and the usage of higher-pressure (and thus higher-efficiency) counters limits the usefulness of discrimination by rise time neither benefited by the rise-time differences signals of the low pressure 3He detectors.
We will present an improved pulse shape discrimination methodology developed for high pressure 3He counters read out through charge sensitive preamplifiers electronics using standard digitizing methods, and a Monte Carlo simulation of the detector response to the different particle interactions.

Primary author: BALIBREA CORREA, Javier (INFN Napoli)

Co-authors: BEST, Andreas (NA); DI LEVA, Antonino (NA); IMBRIANI, Gianluca (NA)

Presenter: BALIBREA CORREA, Javier (INFN Napoli)

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