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(G*) Development of Segmented Ionization Chamber Technologies for High Precision Low-Rate Experiments

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Ionization chambers are widely used for detecting radiation emitted as a result of nuclear decay, and offer potential for high-resolution energy measurement, particle track reconstruction, and for long-lived isotope lifetime measurements. Presently, they are commonly used for measuring the energy of alpha particles emitted during radioactive decay processes and are also used for fission fragment experiments. When built with a conventional Frisch grid design and waveform digitizing data acquisition system (DAQ), these detectors can recover one of the two spherical angles of emission of a particle via the relationship between signal rise time and the polar angle of emission.
In order to fully characterize the particle track however, the azimuthal angle must also be known. To recover this, it is necessary to build a chamber with a segmented electrode where each segment is connected to an independent amplification system and DAQ channel. When this is done, complete reconstruction in 3D space of the particle track is possible in addition to high-resolution measurement of its energy.
The SCI-CASTER project being developed at the Simon Fraser University Nuclear Science Laboratory aims to achieve full 3D track reconstruction and high-resolution energy measurement of low-rate alpha decay experiments by segmentation of the chamber anode. In principle, this design will also allow for the rejection of events originating from outside the detector volume by analysis of segment signal timing, thereby improving background rejection.
Preliminary experiments using a non-segmented design have been carried out to evaluate the performance of the DAQ and accompanying amplification circuitry. Further, data from a simulated segmented detector has been analyzed to characterize the signals induced on the anode electrodes.
This presentation will outline the design process of the current SCI-CASTER prototype detector system and will discuss results from the non-segmented design, ongoing simulations, and the prototype segmented detector currently under construction.

Keyword-1

Ionization Chamber

Keyword-2

Tracking Detectors

Keyword-3

Segmented Detectors

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