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Developing an Active-Target detector for studying nuclear reactions of astrophysical significance

Active-Target technology enables a gas target also to act as the detection gas, eliminating the physical barrier between the target and the detection volumes. Detectors using this technology play a significant role in low energy nuclear physics. The ability to use radioactive beams and a flexible choice of target gas, enable these detectors to efficiently study various nuclear reactions with astrophysical importance.
TACTIC, an active-Target detector is being jointly developed by University of York, UK and TRIUMF, Canada. We will use helium as the detector gas to study alpha induced reactions at low centre of mass energies. In order to detect events with low energy deposition, a GEM (Gas Electron Multiplier) structure was previously used inside the detector, which provides electron multiplication inside the detector volume. This amplification stage enables the detection of events over a larger dynamic range. Currently we are modifying the existing prototype at University of York by using state of the art μ-RWELL GEM configuration. The new setup will provide a higher gas gain and better immunity from discharges in the detector at higher operating voltages, compared to the previously used GEM configuration. Moreover, the detector traps the ionization electrons generated by the un-reacted beam inside the central cathode cage by virtue of the cylindrical geometry and two concentric cathodes at different potentials. In comparison to other Active-Target detectors, this structure enables it to accommodate high beam intensities without pile-up. One of the benefits of the setup is, it allows detection of nuclear reactions taking place at different centre of mass energies at different positions along the beam-line inside the central cathode cage. The detector can efficiently measure the energy loss of reactions products and reconstruct their tracks inside the detection volume to give a precise location of the reaction vertex. This enables the measurement of excitation function using a single incident beam energy.
I will present the underlying physics, detailed mechanism and the astrophysical motivation behind the development of the detector.

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