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ACTAR TPC: An active target and time projection chamber for nuclear physics

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One of the main challenges facing experiments with rare-isotope beams is the need to extract high quality data of key physical observables from extremely limited numbers of incident ions and ever decreasing production cross sections for nuclei furthest from stability. Experiments are performed in inverse kinematics and must rely on thick reaction targets but this is often with the cost of a significant reduction in the efficiency for detection of low-energy particles, energy resolution, and overall sensitivity.

We have adopted an alternative approach and are presently developing a high-luminosity gas-filled active target and time projection chamber (ACTAR TPC) for experiments at GANIL, ISOLDE, and worldwide. In an active target, the filling gas is used as both a sensitive detection medium for charged particles and as a thick reaction target with relatively low energy loss per-unit-length compared to conventional solid-targets. Another main advantage of these detectors is their ability to track the individual trajectories of reaction or decay products through its volume to provide a complete 3-dimensional reconstruction on an event-by-event basis.

The core detection system will consist of micro pattern gaseous detectors (MPGDs) coupled to a highly pixelated 2x2 mm^2 pad plane for a total of 16k electronic channels. Technical challenges associated with mechanics and readout of such a high-density front end have required several parallel developments including the design and construction of a comprehensive ASIC-based electronics system called General Electronics for TPCs (GET). A detailed overview of the ACTAR TPC project, whose aim is to perform first experiments in 2017, and first results obtained with a 2048-channel prototype version of the final design will be presented.

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