**Advantages and requirements of an active target TPC for DAPPER**

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The Detector Array for Photons, Protons, and Exotic Residues has been developed and commissioned. DAPPER was commissioned with a stable beam and used to measure 57Fe(d,pg) reactions. The calibration is well in hand, and analysis is underway. This experiment will result in a determination of the photon strength function via the Forward Method, and a determination of the photon strength function via the Oslo Method. Nonetheless, improvements can be made to DAPPER to improve its capabilities. In particular, an active target time projection chamber (TPC) could offer several advantages to DAPPER.

A TPC filled with pure deuterium gas provides a target largely free from impurities, so background reactions on target contaminants would no longer be a significant concern; currently, fusion evaporation on the carbon in the CD2 target is a background which can't be removed event by event.

An active target provides a significantly higher areal density of deuterium than even the relatively thick (~500ug/cm2, which is ~125ug/cm2 deuterium) deuterated plastic targets used previously. Assuming a pressure of 500 Torr, we obtain 1100ug/cm2 of deuterium, a ten-fold increase.

Currently, the uncertainty in the measurement of the excitation energy is dominated by two things: the energy loss of the ejectile proton, and the angle of the ejectile proton. These contribute roughly equally to the uncertainty. Currently, we can only assume the reaction takes place at halfway through the solid target, and correct on average for the proton's energy loss. With an active target, we can accurately correct event by event for the energy loss. The finite size of the beam spot and the granularity of the S3 silicon detector used to measure the proton limit the accuracy of the deduced angle of the proton. With a time projection chamber, the endpoint of the track can still be measured with the S3 inside the gas, and angle of the track can be additionally be measured with TPC.

The TPC needs to be as small as possible to accommodate the gamma ray detectors; the current gamma detectors fit around an ISO-160 Tee. The larger the TPC, the farther the gamma detectors will be and thus the lower the efficiency will be. The TPC needs to use low-Z material and as little material as possible to minimize photon scattering.

The TPC needs to be able to handle a reaction rate of 500 protons per second, which is easily achievable. However, to attain that rate, we anticipate a rate of at least 3e5 iron nuclei per second. There may well need to be a central region of the TPC blind to the ionization. The ionization in this region needs to not distort the electric field.

To maintain current ejectile angle knowledge, the angle should be measured with an accuracy of 1.5 degrees. Angular accuracy in the TPC will depend on the angle of the track, and resolution of the reaction vertex in all dimensions. Vertex accuracy on the order of 1.5mm should be achievable and in much of phase space is sufficient. Even if the vertex is not known to this accuracy, the track angle relative to the beam axis should be measured with 1.5 degree accuracy of better.

The gas gain should be high enough, and the preamp gain appropriate, that the tracks from protons between 200 keV and 10 MeV can be measured. These tracks deposit 13.1 keV/mm and 0.57 keV/mm respectively.

For the protons that stop in the gas, the track length should be used to deduce the proton energy; this should be possible to benchmark at a variety of energies (from a variety of initial positions) at which they punch through the gas and into the silicon detector.

A cylindrical TPC with axis parallel (or perhaps nearly parallel) to the beam axis, and with electric field along the cylinder's axis, seems more attractive than other geometries. For example, a rectangular TPC with field perpendicular to the beam results in the high ionization of the beam tracks creating a large background over a larger region in which protons should be measured. With cylindrical design, the S3 silicon for residual proton energy would cover backward angles in the lab, and the electron multipliers and pad plane would be on the downstream end of the TPC.