Commissioning of Texas CsI Array for Astrophysical Measurements (TexCAAM)

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Texas **C**sI **A**rray for **A**strophysical **M**easurements (TexCAAM) detector system was built to perform alpha-transfer reactions at sub- and near- Coulomb energies with rare isotope beams to establish the alpha ANCs of astrophysicaly important sub-threshold states. The development of the TexCAAM was discussed in Ref. [1]. The detector apparatus consists of 32 Scionix CsI(Tl) (5cmx5cmx4cm) detectors that surround a target that is backed by a single Micron MSD026 Si detector and an array of plastics scintillators coupled to an array of Si photomultipliers (Fig. 1). The target assembly suspends the target and the Si detector inside of the beam pipe and is conveniently connected via a single flange such that the

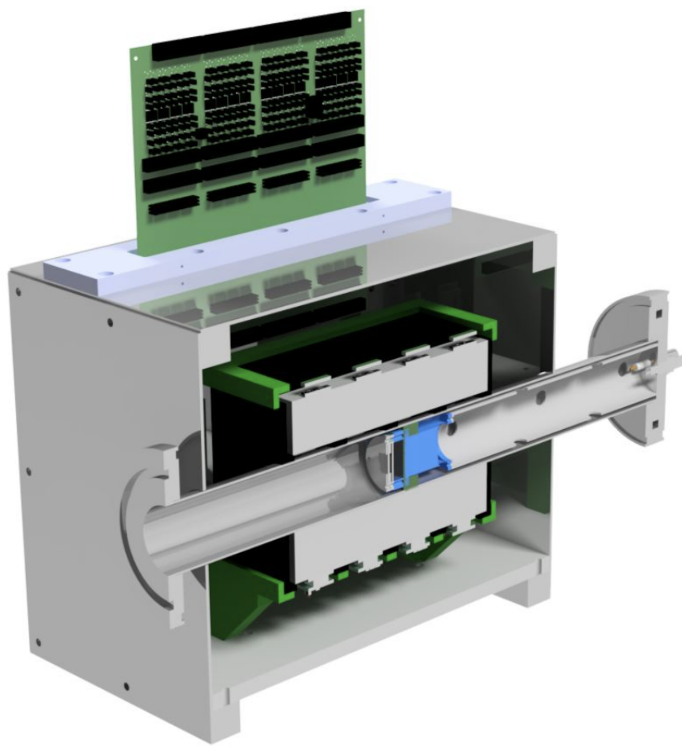

Fig. 1. Cutaway CAD drawing of TexCAAM. The target is inserted so that it is directly half way into the CsI array. The array of CsI is designed to maximize the solid angle covered while allowing the beampipe to go through the array. The black and green parts are a 3D printed skeleton that holds the CsI in place around the beampipe.

whole assembly can be removed and targets can quickly be changed (Fig. 2). The target consists of a rolled metal, such as ^{6}Li, that is designed to be thick enough to stop the incoming beam.

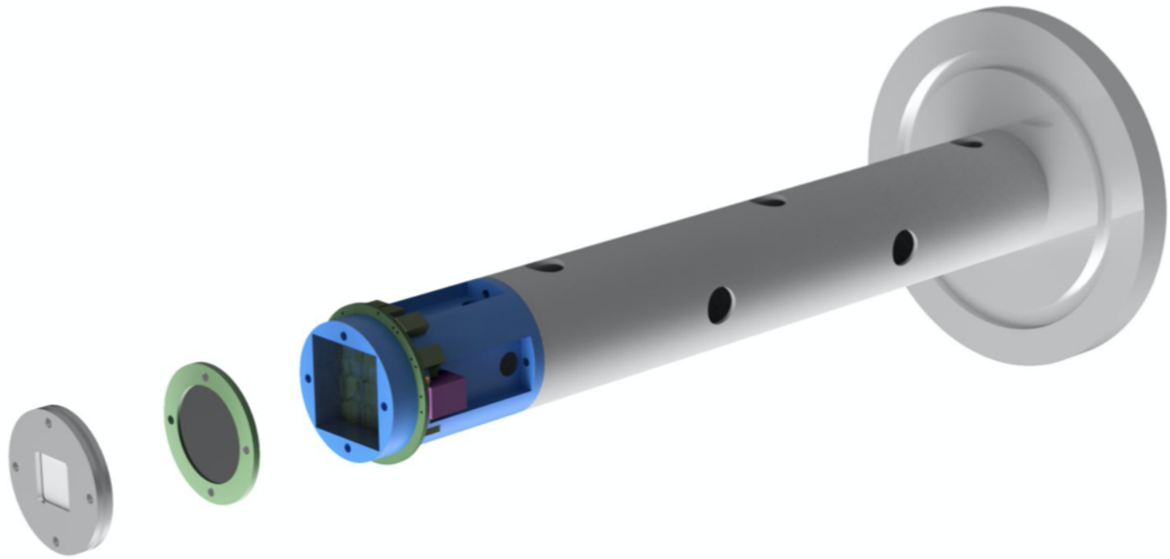

Fig. 2. CAD drawing of the target assembly where the right most object is a cutaway of the beampipe. The target assembly is blown out for ease of viewing and will slide into the beampipe being fixed via the flange. The frontmost component of the target assembly is the rolled target which is then backed by the Si detector and both are mounted to an array of plastic scintillators couple to an array of Si photomultipliers.

The production of a ^{6}Li target was a major hurdle to overcome. For the reaction of interest, a 50 um (2.67 mg/cm^{2}) thick ^{6}Li target was required. Since lithium oxidizes rapidly, target production had to be done carefully and procedurally. The lithium must be rolled in an inert gas environment while also being covered in diffusion oils. The lithium is pressed between two layers of thin, dense metals. The target must be frequently removed from the metal sandwich and the oils must be reapplied. If the lithium is left without checking, the lithium will stick to the metal and will be impossible to remove in a single piece. When ready for installation, the oils covering the lithium are removed using petroleum ether.

A commissioning run was performed using stable ^{12}C beam, but TexCAAM was attached to MARS rare isotope beamline, simulating an experiment with radioactive beam. The goal of the test run was to observe the ^{12}C(^{6}Li,dγ)^{16}O reaction by measuring deuterons and γ-rays in coincidence. We test the fundamental operations of TexCAAM. The main result of the commissioning run was an observation that TexCAAM performed as expected and that the γ background in coincidence with light charged particle is low. Given a data collection time of about 40 hours, we observed a background rate of 3-5 events per hour per MeV at all energies (see Fig. 3). Calculations for the ^{7}Be(^{6}Li,dγ)^{11}C reaction, the first one that will be performed using TexCAAM with radioactive beam, suggest a detection rate of ~10 events per hour for the state of interest, which surpasses the observed background rate. Various proof of principle conclusions were also made with this test run. For instance, confirmation of Si-γ coincidences, gating on events with light particles entering the Si detector, were used to remove significant noise from the γ-ray spectrum. The commissioning run provided the opportunity for troubleshooting of TexCAAM which was critical in order to move forward towards future experiments. We have not observed any γ-rays from ^{16}O in coincidence with deuterons. This is because the intensity of ^{12}C was limited due to pin-holes in the

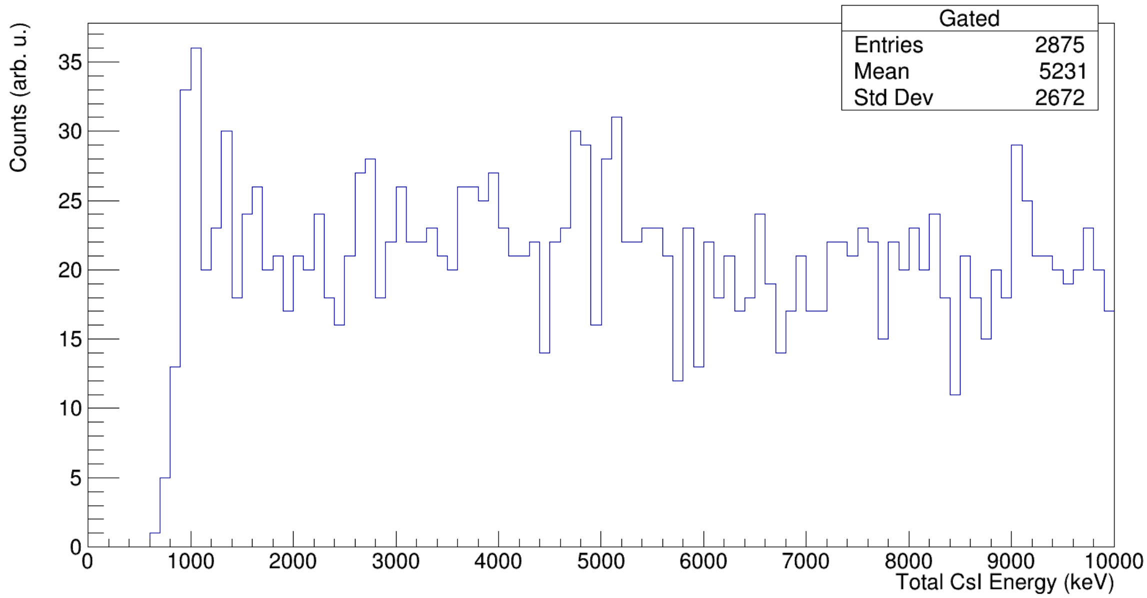

Fig. 3. Background measurement for the test run. This is a cumulative spectrum of the CsI detectors spanning over 40 hours. No statistically significant deviations from the background were observed.

lithium target and direct ^{12}C beam was overloading the detector. This issue will be fixed for the future runs. The TexCAAM setup was commissioned and is now ready for the first experiments.

[1] E. Aboud *et al.*, *Progress in Research*, Cyclotron Institute, Texas A&M University (2018-2019), p. IV-33.