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Improved measurements of (α, p) reactions with a new ANASEN design

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Several (α, p) reactions on proton-rich nuclei are among the most important nuclear reactions occurring during Type I X-ray bursts. However, large uncertainties remain in these reaction rates due to the lack of direct measurements. The Array for Nuclear Astrophysics and Structure with Exotic Nuclei (ANASEN) is a gas target and charged particle detector designed for studying (α, p) reactions. A previous $^{18}\text{Ne}(\alpha, p)^{21}\text{Na}$ measurement with ANASEN used a position-sensitive proportional counter along the beam axis with a barrel of thick silicon detectors far from the beam axis to track protons from these reactions [1]. Due to the poor tracking resolution of the proportional counter, this measurement achieved a center-of-mass energy resolution of only 1.4 MeV. We have developed a new approach, replacing the proportional counter with a hexagonal barrel of thin ($\sim 80 \mu\text{m}$) silicon detectors. This allows pure helium gas to be used and improves the tracking resolution, though at a cost of overall efficiency. The new setup was used in stable beam tests at the Fox Laboratory at Florida State University, and in both stable and radioactive beam measurements at TRIUMF-ISAC. Results from stable beam tests and from a measurement of the $^{18}\text{F}(\alpha, p)^{21}\text{Ne}$ excitation function, which may impact asymptotic giant branch nucleosynthesis [2] and helium burning on accreting white dwarfs [3], will be presented. Plans for future measurements at TRIUMF-ISAC and FRIB will be discussed.

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