^{35}K experiments

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One the most important questions that nuclear physics is trying to address is the origin and abundance of the elements in the universe. Proton-gamma capture reactions, X(p, γ)Y, play an important role in the creation of elements in processes like X-ray bursts or novae explosions [1-3]. The main focus of this work is one of these reactions, ^{34g,m}Cl(p,γ)^{35}Ar. In novae, production of ^{34}S depends on the amount of ^{34}Cl, which β-decays into ^{34}S with $T_{1/2}$=1.5266 s. Sulfur isotopic ratios can be used for classification of presolar grains, which can be found in the meteorites. One way to destroy ^{34}Cl is the reaction ^{34g,m}Cl(p,γ)^{35}Ar. The rate of this reaction will eventually determine how much ^{34}Cl will be left for the creation of ^{34}S. To be able to accurately predict the reaction rate of ^{34}Cl(p,γ)^{35}Ar, one needs to know the resonances in ^{35}Ar, including their energy, spin-parity, and proton width. We chose to study this reaction by means of an indirect method where we populate states in ^{35}Ar just above the proton threshold, S_p, and observe them decaying into the ground state of ^{34}Cl + proton. The detection of low energy protons becomes the major challenge for the experiment. The AstroBoxII was built to address this problem [4] [6]. To test our system we had an experiment in March, 2017. A beam of ^{36}Ar at 36 MeV/u impinged on an H_2 cryogenic gas target in the target chamber of MARS [5]. Through the reaction ^{1}H(^{36}Ar,^{35}K)2n we created a secondary beam of ^{35}K and then implanted it into the AstroBoxII. After gain-matching the AstroBoxII anode pads, we calibrated two HPGe detectors with ^{137}Cs and ^{152}Eu sources. The estimated production rate for ^{35}K was 2.77 event/nC. An Al degrader (13 mil) on a rotary mechanism was used to control the position for the implantation of ^{35}K in the AstroBoxII. Due to a number of technical issues the beam time was very limited with only about 6 hours of data available. This was sufficient to determine that the system was working as expected.

In July, 2017, we had a second experiment with a ^{35}K secondary beam produced through MARS. After initial calibration of the AstroBoxII by the beam of ^{25}Si we switched to a ^{35}K beam. The production rate for ^{35}K was 2.9 event/nC. Along with the AstroBoxII, we used four HpGe Clover detectors that allowed us to measure the coincidences between protons and gamma rays. It was necessary for the setup to be sure that the excited states in ^{35}Ar that were populated by β-decay of ^{35}K were decaying directly to the ground state of ^{34}Cl after emission of a proton. Due to relatively low intensity of the ^{35}K beam it was decided to have a third experiment in October, 2017 to improve our results. The setup was identical to the one we had in July, but with more time and higher beam current we significantly improved the statistics for the low energy proton spectrum, which was the main goal of the experiment.

The analysis of the data from the July and October runs is underway and expected to be finished within next few months as a part of the Ph.D. thesis work for the first author.

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