Measurement of the ^{7}Be(p,γ)^{8}B Cross Section at the HRIBF *

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There have been many measurements of the ^{7}Be(p,γ)^{8}B reaction due to its importance in the solar neutrino problem [1]. The ^{8}B decays produce the majority of the high energy neutrinos emitted from the solar core. Those high energy neutrinos provide most or all of the solar neutrino flux detected in many solar neutrino experiments[2,3]. Persistent discrepancies between the measured flux of solar neutrinos and the predicted flux have been observed in those experiments. The solution requires either radical alterations to the theory of stellar structure or new neutrino properties [1]. Neutrino oscillations have been proposed as one possible solution.

The current generation of solar neutrino experiments will measure the flux of ^{8}B neutrinos from the sun with an uncertainty approaching 1%. A quantitative comparison of the measured neutrino flux with the standard solar model provides a rigorous contraint on neutino mixing parameters. The dominant uncertainty in the determination of these mixing parameters arises from the uncertainty in the ^{7}Be(p,γ)^{8}B reaction rate. Numerous measurements of the ^{7}Be(p,γ)^{8}B cross section have been performed using radioactive targets. However, the dominant uncertainties in the determination of the astrophysical reaction rate result from systematic uncertainties. Measurements using independent techniques are thus desired to better constrain the systematic uncertaintes. Measurements of the Coulomb dissociation of ^{8}B and the Asymptotic Normalization Coefficient for ^{7}Be+p are examples of successful approaches that have recently been applied to this problem. By combining the results obtained from numerous techniques, it may be possible to achieve the desired overall uncertainty of better than 5% in the ^{7}Be(p,γ)^{8}B astrophysical S-factor.

We plan a direct measurement of the ^{7}Be(p,γ)^{8}B cross section at the Holifield Radioactive Ion Beam Facility using a different experimental technique. The ^{7}Li(p,n)^{7}Be reaction will be used to produce ^{7}Be at the Triangle Universities Nuclear Laboratory, and the ^{7}Be particles in a metal matrix will be shipped to ORNL. After a series of chemical processes[4], a pellet containing ^{7}Be will then be mounted in a Cs sputter ion source to produce a beam of ^{7}BeO$^-$. The ^{7}BeO$^-$ will be accelerated in the 25 MV tandem accelerator and dissociated at the terminal to produce a ^{7}Be beam. The ^{7}Be beam will bombard a windowless hydrogen gas target. The windowless gas target has been constructed and is being tested. Areal densities of 3×10^{18} /cm ^{2} of helium have been achieved in the central target region. A detailed description of the ^{7}Be beam production and the gas target will be given. The DRS will be used to separate the unreacted beam particles from ^{8}B recoils. Due to the forward focusing of the inverse kinematics and the large acceptance of the DRS, the ^{8}B recoils can be detected with high efficiency. The DRS utilizes two crossed-field velocity filters and a 50° dipole magnet to separate primary beam particles from the recoils of interest. A rejection of 2×10^{-11} of scattered beam particles has been achieved in a test run[5]. The ^{8}B recoils are finally detected at the focal plan in a ionization counter which can give a further suppression of scattered beam particles. A detailed description of the experimental setup will be given.

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