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Understanding the P-Process Using Gamma-Induced Reactions

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The astrophysical source of the p nuclei –a series of rare, proton-rich stable isotopes with abnormally high natural abundances –remains an open question. The p nuclei cannot be produced through the known neutron capture processes, but instead are thought to be synthesized in astrophysical environments via a series of photodisintegration reactions on s-process seeds. A major source of uncertainty in understanding the production of p nuclei is the necessity to use cross sections and reaction rates derived from theoretical models, in particular the statistical Hauser-Feshbach approach. With very little experimental nuclear structure constraint, these cross section predictions can vary by orders of magnitude, preventing a careful assessment of the conditions needed to produce p nuclei in the abundances observed.

To address the need for experimental constraint of the predicted cross sections, the HIgS P- Process Collaboration has undertaken several measurements of gamma-induced charged-particle reactions on p-process nuclei across the range of astrophysical energies using monoenergetic beams of gamma rays at HIgS. Utilizing the SIDAR array of highly-segmented, high resolution silicon detectors coupled to the ORRUBA/GODDESS data acquisition system, the various photodisintegration reaction products can be measured, and the total and partial cross sections derived and compared to predictions. Here, the experimental setup, preliminary analysis, and future plans will be discussed.

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