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Exploring nuclear structure and stellar helium burning with the HIgS Optical Time Projection Chamber

Stellar helium burning results in the formation of carbon and oxygen [1]. However, the carbon-to-oxygen ratio at the end of helium burning is not well known, despite its importance in stellar evolution theory. Furthermore, alpha particle clustering in ^{12}C remains somewhat mysterious, with the structure of the first excited 0^+ Hoyle state still under question [2].

The gamma-ray beam facility at HIgS (Duke University, USA) coupled with active target detectors, present an ideal opportunity for solving these problems, by allowing precise measurements of the $^{16}\text{O}(\gamma, \alpha)$ and $^{12}\text{C}(\gamma, \alpha)$ cross sections.

This talk will discuss the Optical Readout Time Projection Chamber (O-TPC) at HIgS [3] and the experiments that were performed to measure the photo-disassociation of ^{16}O and ^{12}C . The experimental analyses so far will be discussed with a focus on the unique opportunity that this detector provides to precisely measure detailed angular distributions.

[1] W. A. Fowler, Rev. Mod. Phys. 56, (1984)

[2] M. Freer and H. O. U. Fynbo, Prog. Part. Nucl. Phys. 78, (2014)

[3] M. Gai, et al., JINST 5 (2010)

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