# NUCLEAR REACTIONS AT ASTROPHYSICAL ENERGIES WITH GAMMA-RAY BEAMS: A NOVEL EXPERIMENTAL APPROACH

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A new methodology to measure cross-sections for thermonuclear reactions that power the stars is being developed at the University of Warsaw. These reactions take place at different energies according to the respective stellar environment. Such energies are well below the Coulomb barrier and the respective cross-sections are incredibly small, often below the experimental reach. There is a lack of experimental data on cross-sections for low-energies, information that is indispensable for modelling energy production in stars. As a consequence, extrapolations are made, with their unavoidable large uncertainty. Of particular interest are (p,γ) and (α,γ) reactions, in particular those, within the CNO cycle that regulate the ratio of C and O and those that burn $^{18}$O and, therefore, regulate the ratio between $^{16}$O and $^{18}$O in the Universe. Among these, the most important are: $^{12}C(\alpha,\gamma)^{16}O$, $^{18}O(p,\gamma)^{19}F$ and $^{18}O(\alpha,\gamma)^{22}Ne$.

We propose to use a gaseous active target detector to study (α,γ) and (p,γ) nuclear reactions of current astrophysical interest by means of studying time-inverse processes induced by high energy photons. The advantage of such an approach stems from the fact that photons are not subject to the nuclear Coulomb barrier. The Extreme Light Infrastructure-Nuclear Physics (ELI-NP) – currently being built near Bucharest, Romania – will deliver monochromatic, brilliant and polarized gamma-ray beams. The charged products of photodisintegration reactions will be measured by means of a Time Projection Chamber (eTPC) with innovative 3-coordinate (u-v-w) planar electronic readout acting as virtual pixels. The detector will be equipped with triple-GEM structure for gas amplification and will work at lower-than-atmospheric pressure. The concept of the detector and preliminary results from a demonstrator detector will be presented.