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Toward studying photonuclear reactions with active-target TPC

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Stellar evolution modeling requires knowledge of the mechanism and cross-section of nuclear reactions. Given the conditions in the stellar interior, the stellar reactions occur predominantly within relatively narrow energy ranges well below the Coulomb barrier.
For many (α,γ), (p,γ) reactions important for stellar nucleosynthesis the measurement of their cross-sections at the relevant energies is impossible with present experimental conditions. Among these reactions is the ^{12}C(α,γ)^{16}O reaction, which determines the carbon to oxygen ratio at the end of stellar helium burning — a paramount importance problem in nuclear astrophysics.
Thanks to the availability of intense, monochromatic γ-ray beams, to obtain accurate cross-sections at relevant energies, the time-reversal photodisintegration reactions can be investigated instead. Given the time-invariance of the strong and electromagnetic interactions, the cross-sections of (α,γ), (p,γ) reactions can be calculated according to the detailed balance principle from the cross-section of the corresponding time-reversal photodisintegration. The photodisintegration approach has the advantage of larger cross-section, lower background, and different systematic uncertainties.
A detector capable of measuring the low energy products of such photonuclear reactions — an active-target Time Projection Chamber with electronic readout (ELITPC) — is being developed at the University of Warsaw. Full kinematic reconstruction of the charged reaction products will be possible. The flagship experiment of the detector is the measurement of the cross-section of ^{16}O(γ,α)^{12}C photodisintegration reaction down to the energy of 1 MeV using γ-ray beams of HIγS, USA and ELI-NP, Romania.
In my talk, I will present the design of the ELITPC detector and describe its experimental program.
Within the ELITPC collaboration, my main contribution is the development of event reconstruction software using classic computer vision algorithms and dedicated detector control system.

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