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Measurements of angular distributions of light particles at energies of astrophysical interest with GASTLY apparatus

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The GASTLY (GAs Silicon Two-Layer sYstem) apparatus has been designed and developed in the recent past to perform cross section measurements of light particles emitted in nuclear reactions at energies as close as possible to the Gamow peak. In particular, the alpha and proton channels of the 12C+12C fusion reaction have been studied at E c.m. down to about 2.5 MeV, in a first measurement campaign, obtaining interesting results from an astrophysical point of view, as reported in [Ref.1]. The modular detection system, based on Ionization Chambers (IC) followed by large-area Silicon Strip Detectors (SSD), has been described in detail in [Ref.2] and here we report the improvements made to allow measurements of angular distributions with good energy and angular resolution.
A new electronics has been designed to perform a single strip readout for the Silicon detectors, using 16 home-made low-noise charge preamplifiers (one for each strip), placed directly inside the aluminum box containing the SSD and the IC electrodes and gas (CF4). Due to the high density of electronic lines, issues such as crosstalk between the signals of different strips and power dissipation were addressed and solved.
Furthermore, a simulation code based on Geant4 routines has been written to evaluate the geometric efficiency of the detection system and the angular uncertainty for each strip. The simulation results have been successfully compared with the results of laboratory tests.
Finally, in view of a possible future use of the GASTLY apparatus in underground experiments, where restrictions in the use of CF4 gas might be present, we have successfully tested the functionality of the modules using different filling gases (e.g., Argon). We will also report the measured reduction of the background obtained by performing underground tests at the Laboratori Nazionali del Gran Sasso (LNGS), in Italy.

[Ref.1] L. Morales-Gallegos et al., “Direct measurements of the 12 C+ 12 C reactions cross-sections towards astrophysical energies”, Eur. Phys. J. A (2024) 60:11, DOI: 10.1140/epja/s10050-024-01233-6

[Ref.2] M. Romoli et al., “Development of a two-stage detection array for low-energy light charged particles in nuclear astrophysics applications”, Eur.Phys.J.A 54 (2018), 142, DOI:10.1140/epja/i2018-12575-5

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