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MUST2: A new generation array for direct reaction studies

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Abstract. We have developed a new telescope array, dedicated to the study of direct reactions of exotic nuclei on light targets in inverse kinematics. This device, called MUST2, is briefly described, and the results of the first tests performed with an alpha source and Ni beams at 10 and 75 MeV/u on a CDH target are presented.

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1 Description of the array

A new and innovative array, MUST2, based on silicon strip technology and dedicated to the study of reactions induced by radioactive beams on light particles, is presently under construction. The detector will consist of 6 silicon strips-Si(Li)-CsI telescopes (see fig. 1). The thickness of these detectors is respectively 300 μm, 5mm and 4 cm, corresponding to a maximum energy deposition for protons of 6 MeV, 25 MeV and 150 MeV. Compared to the existing MUST array [1], the innovation comes from the new Si strip detectors (10×10 cm^2 instead of 6×6), the number of strips/side on each of them (128 instead of 60), the compactness of the array (volume divided by 6) and above all, the electronics which is based on ASIC chips. Each BiCMOS 36 mm^2 chip has 16 bipolar channels, with energy and time measurement [2]. Table 1 presents the ASIC characteristics and performances. The data are multiplexed and coded with VXI ADCs. When complete, the array will correspond to more than 3000 channels of electronics.

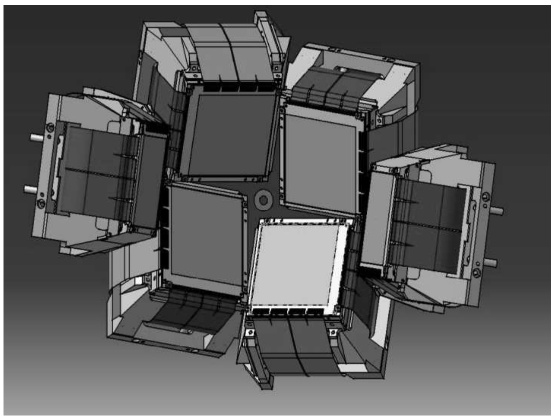

Fig. 1. Schematic drawing of the future MUST2 array.

Table 1. ASIC characteristics and performances.

Power consumption	28 mW/channel (+/ − 2.5 V)
Capacitance of detector	65 pF
Current of detector	20 nA
Energy range	+/ − 50 MeV
Contribution to energy resolution	16 keV FWHM
TAC range	300 ns and 600ns
Time resolution (FWHM)	240 ps (proton 6 MeV)
Threshold range	+/ − 1 MeV on 8 bits DAC
Readout	2 MHz serial

2 First results

The results of the first tests performed with one complete telescope show that the energy resolution is excellent. Figure 2 presents the spectrum measured with a 3-peak alpha

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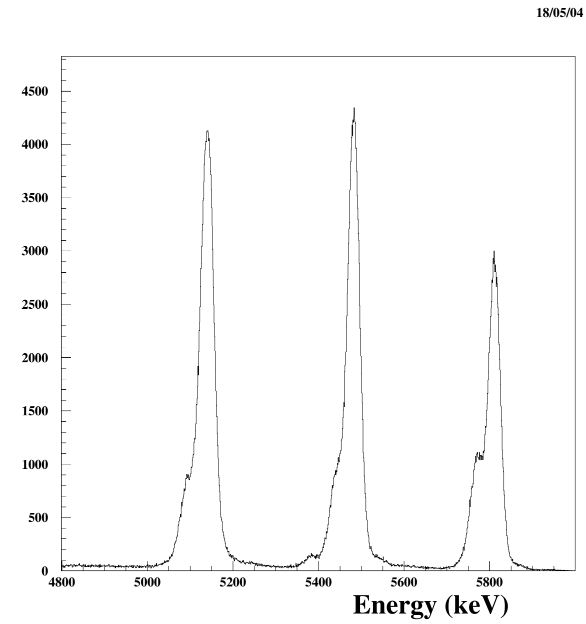

Fig. 2. Alpha souce spectrum measured with the Si strip detector of MUST2. The spectrum is obtained by superposition of the 128 horizontal strips, after calibration.

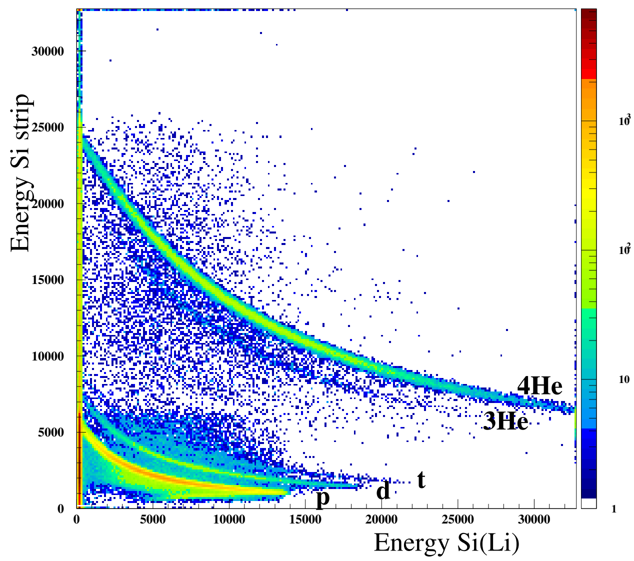

Fig. 3. Identification plot measured for the Si strip and Si(Li) detectors. The energy for Si strip is given in keV. The calibration for Si(Li) is 2 keV/channel.

source, composed of ^{239}Pu,^{241}Am, ^{244}Cm. The resolution obtained was 35 keV, when the 128 horizontal or 128 vertical strips were superposed. The telescope was also tested at GANIL by measuring the elastic scattering of ^{58}Ni at

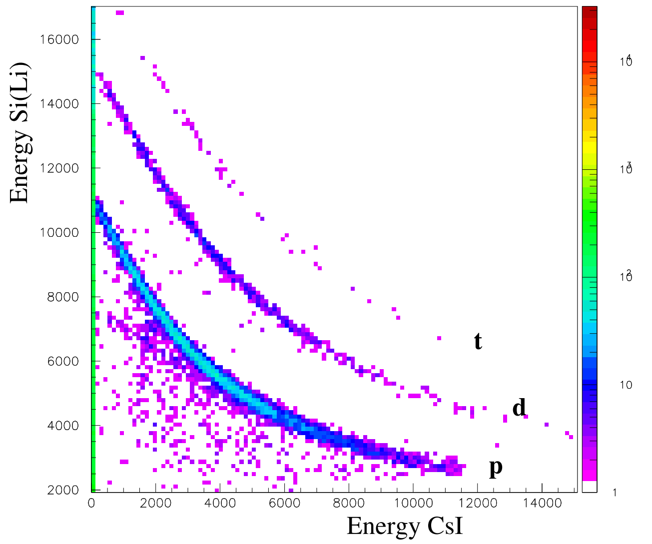

Fig. 4. Identification plot measured for the Si(Li) and CsI detectors. The axis scale is 2 keV/channel for Si(Li) and 10 keV/channel for CsI detectors.

10 and 74.5 MeV/nucleon on a CDH target. Figures 3 and 4 present ΔE-E identification plots for the Si-strip *versus* the Si(Li) detectors measured at 10 MeV/nucleon and for the Si(Li) *versus* CsI detectors at 74.5 MeV/nucleon, when the MUST2 telescope was located at 70 degrees from the beam axis in the laboratory. In both plots the identification is straightforward: $Z = 1$ (proton, deuton and triton) and $Z = 2$ (^{3,4}He) in fig. 3 and $Z = 1$ hyperbolas in fig. 4 are clearly distinguished.

The present set-up of MUST2, as shown in fig. 1 has a large angular coverage with efficiencies of approximately 70% up to angles of 45 deg. This along with the additional measurement of time per channel and a large energy dynamic range makes the study of reactions leading to unbound states with several particles in the exit channel possible. The compactness of the array allows it to be installed inside a Ge multi-detector such as EXOGAM, allowing the γ-particles coincidences to be measured in the case of bound excited states. The first experiment with a large fraction of the final array is scheduled in the second half of 2005.

References

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