CsI(Tl) array for Oxford detector at MDM spectrometer

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A new upgrade of a focal plane Oxford [1] detector of the MDM-2 [2] spectrometer has been made. A residual energy detector, which completely stops the particles and allows to measure total energy, was modified. In existing setup this detector is a plastic scintillator, read out by two photomultipliers from the sides. The energy resolution of this detector is good enough for high energy particles, but inadequate for the low energy particles. Moreover, the 50 mm thick Kapton exit window that is installed in front of the scintillator makes low energy ions invisible in the current setup. All of the above makes it impossible to use this setup for low energy experiments that are of interest for astrophysics.

We improved the existing detector by replacing the plastic scintillator with CsI(Tl) detectors, which were initially designed for TexAT project. This is a low cost upgrade, that turned out to be very effective.

Photodiode detector V50 PM 40/ 18-E2-Cs from SCIONIX [3] is CsI(Tl) 50 x 50 x 40 mm^3. It is readout by Si PIN photodiode S3204-08 (Hamamatsu). The crystal is wrapped in a reflective material and covered with a aluminized mylar film for protection. The thickness of the aluminized mylar on the entrance side is 2 mm, allowing to minimize energy losses of detected products. The SCIONIX supplies detectors with the custom low noise Charge Sensitive Preamplifiers (gain is about 4 V/pC). To reduce the noise level the preamplifiers are mounted directly on the photodetector body via silicon cooky.

The detectors were tested with standard radiation sources. The typical energy resolution of 13 - 15% is achieved for 661 keV g-rays from ^{137}Cs (Fig.1*)*, and about 5% from mixed (^{148}Gd, ^{239}Pu, ^{241}Am, and ^{244}Cm) α - source (Fig.2).

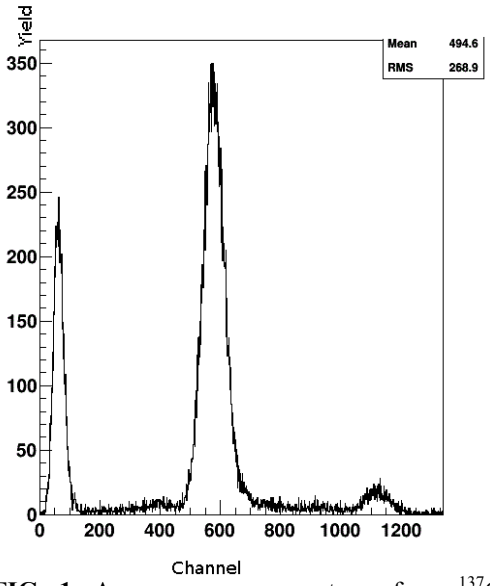

FIG. 1. A γ-ray energy spectrum from ^{137}Cs (E_γ=661 keV), measured by CsI(Tl) scintillator detector.

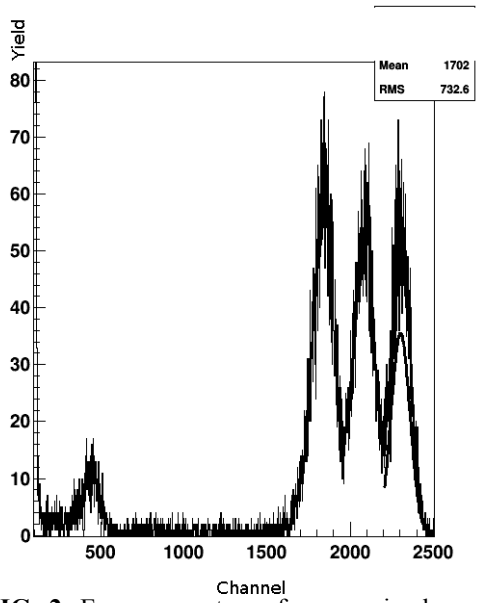

FIG. 2. Energy spectrum from a mixed *a*-source in CsI(Tl)- detector. E_a =3.178 MeV; 5.143 MeV; 5.474 MeV; 5.788 MeV.

A set of 7 CsI(Tl) scintillation detectors has been arranged in a line and mounted onto the modified back flange of the Oxford detector at MDM, as shown at Fig.3. Signals from the preamplifiers goes to the Mesytec shaper through the vacuum feedthrough. The preamplifier power (+12V, 50 mW/ channel) was taken from NIM bin, and the PIN detector bias (30V – 70V) was supplied by MPOD system from "W-IE-NE-R, Plein & Baus, Corp." [5].

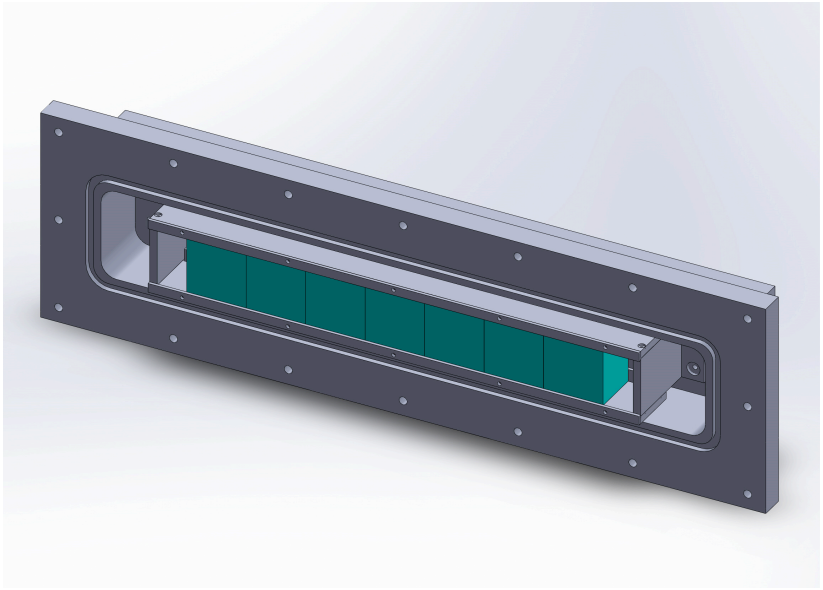

FIG. 3. A general view of the CsI(Tl) array, installed on the back flange of the Oxford detector.

The array was beam tested in April, 2016. A spectrum of deuterons, scattered on the Gold target at 5 degrees at the deuteron beam energy of 8 MeV, is shown in Fig.4. The energy resolution for the

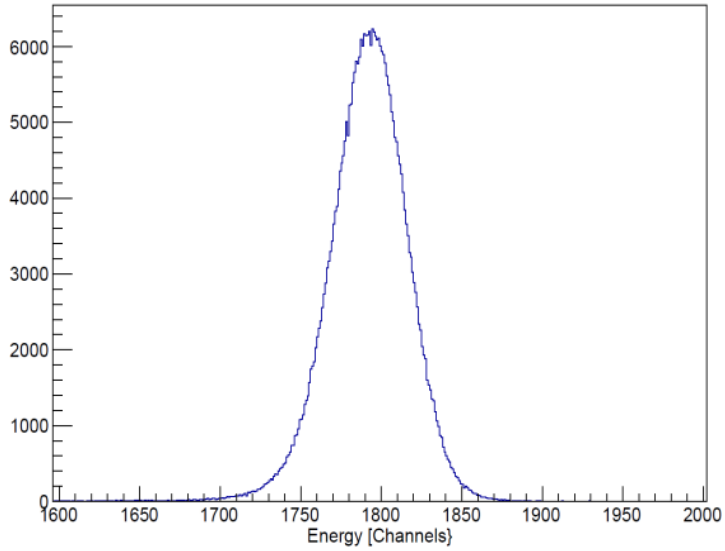

FIG. 4. Energy spectrum of deuterons (E=8 MeV), scattered from a Gold target (MDM spectrometer, q = 5^o), as measured by CsI(Tl) scintillator detectors.

deuterons, stopped in the central CsI(Tl) detector of the array proved to be surprisingly good: at the level of 3%. The CsI(Tl) array has already been used in recent low energy a-transfer experiment experiment ^{6}Li(^{22}Ne,d)^{26}Mg, performed at 1 MeV/u of ^{22}Ne beam [4].

The latest upgrades of the Oxford detector with the CsI(Tl) array and the MicroMegas detector [6] substantially improve the performance of the detector and most importantly allow for low energy measurements to be performed.

[1] J.S. Winfield *et al.*, Nucl. Instrum. Methods Phys. Res. **A251**, 297 (1986).

[2] D.M. Pringle, W.N. Catford *et al*., Nucl. Instrum. Methods Phys. Res. **A245**, 230 (1986).

[3] http://www.scionix.nl

[4] H. Jayatissa, G.V. Rogachev, V.Z.Goldberg *et al*. *Progress in Research*, Cyclotron Institute, Texas A&M University (2015-2016) p. I-49.

[5] http://www.wiener-d.com/sc/power-supplies/mpod--lvhv/mpod-crate.html

[6] A. Spiridon, R. Chyzh, M. Dag *et al. Progress in Research*, Cyclotron Institute, Texas A&M University (2014-2015), p. IV-29.