## Update on the upgrade of the Oxford detector

A. Spiridon, R. Chyzh, M. Dag, E. McCleskey, M. McCleskey, B.T. Roeder, A. Saastamoinen, R.E. Tribble, L. Trache,[1] E. Pollacco,[2] and G. Pascovici[1]

[1] *National Institute of Physics and Nuclear Engineering, Bucharest-Magurele, Romania*

[2] *IRFU, CEA Saclay, Gif-sur-Yvette, France*

The Oxford detector [1] is one of the two focal plane detectors of the Multipole-Dipole-Spectrometer (MDM). In the nuclear astrophysics group, this setup has been used primarily to study scattering and transfer reactions involving nuclei with A≤26. However at higher masses than that, we found that we are having significant difficulties in particle identification due to the insufficient resolution of both the dE and E signals. The upgrade was focused on improving the resolution of both of these signals. For details on the project see ref [2] and [3]. We proposed to improve the dE signal by introducing Micromegas [4], a new technology shown to provide gains of ~ $10^4$, as well as very good energy resolution.

Over the last year, we finished the modifications to the Oxford detector chamber to include 2 flanges with one D-Sub 25 feedthrough each. We received the Micromegas anode from the manufacturer and installed it in the Oxford. As seen in Fig. 1 the new anode consists of 28 pads, each 3.25 cm by 4.4 cm in size. The amplification gap is 256 µm thick. We collect the 28 energy signals through two D-Sub 25 connectors as seen in Fig. 2.

**FIG. 1.** The Micromegas Anode.

**FIG. 2.** Oxford detector with the new Anode mounted.

We first tested the upgraded detector with a 4-peak mix alpha source. Unfortunately, due to the design of the Oxford, the closest we could place the source was ~4 cm from the

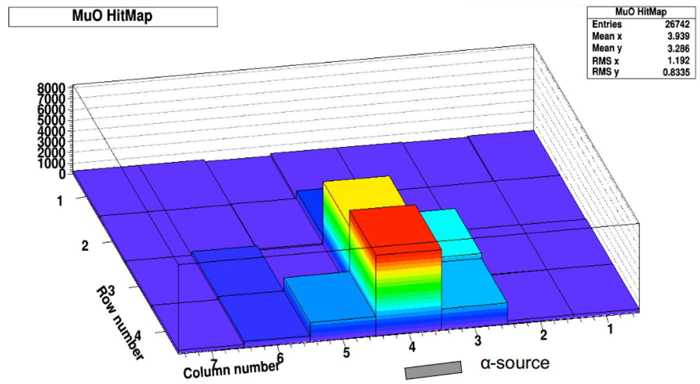


**FIG. 3.** Micromegas Pad Map showing the pads that detect alpha particles.

Micromegas anode. With an isobutane gas pressure of 100 Torr, we could only test a limited number of pads (Fig.3). However, it was enough as it showed that the new component works (Fig.4).

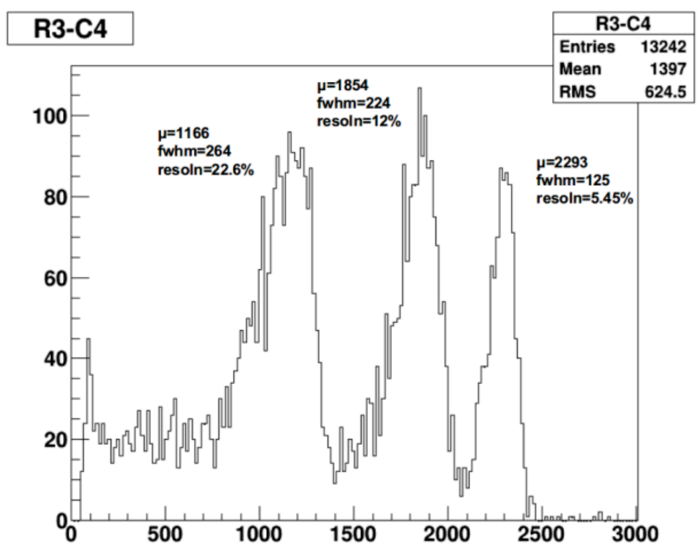


**FIG. 4.** Energy spectrum detected by pad R3-C4 (Row 3, Column 4).

Next, we tested the detector with beams in two separate experiments. In the first, we used $^{16}O$ at 12 MeV/u. In the second, we used $^{22}Ne$ and $^{28}Si$, each at 12 MeV/u. We focused on elastic scattering on gold foil (Fig. 5) in all measurements, and the reaction products were collimated with a narrow slit. We observed the detector response under these conditions for different bias voltages, gas pressures, and electronic gains.

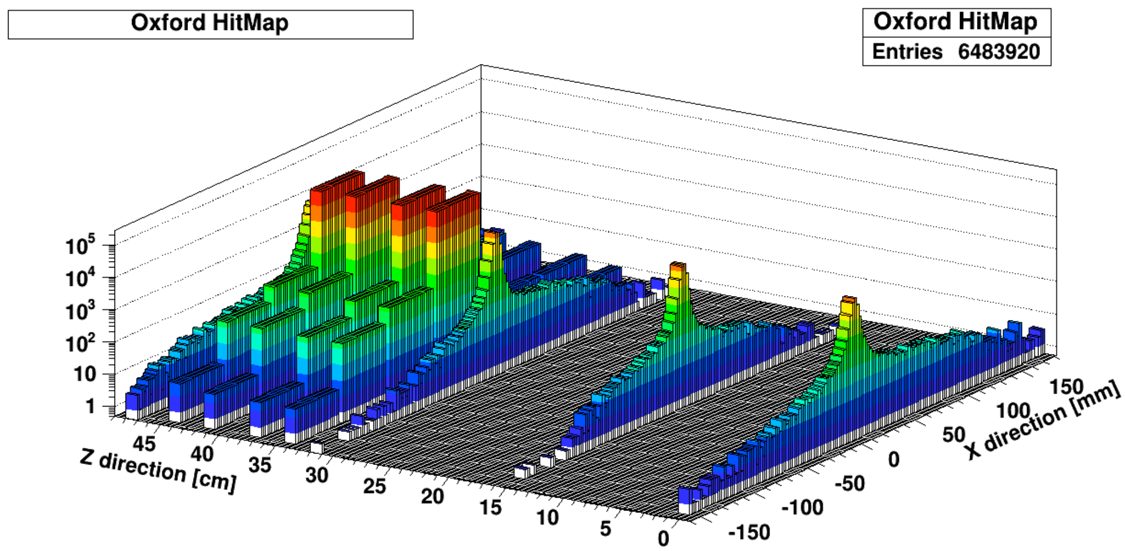


**FIG. 5.** A map of the Oxford detector showing the 4 position-sensitive avalanche counters and the Micromegas pads. The peaks show that the beam is passing through the center of the detector highlighting predominantly column 4 (central) of the Micromegas anode.

We obtained energy resolutions for the individual pads in the range of 5.5-6.5% for 100 Torr and 85 Torr, 5.5-6% for 70 Torr, 6.5-7% For 50 Torr and 8-9% for 30 Torr. Averaging the energy over all the pads gave us significantly better resolution (Fig. 6).

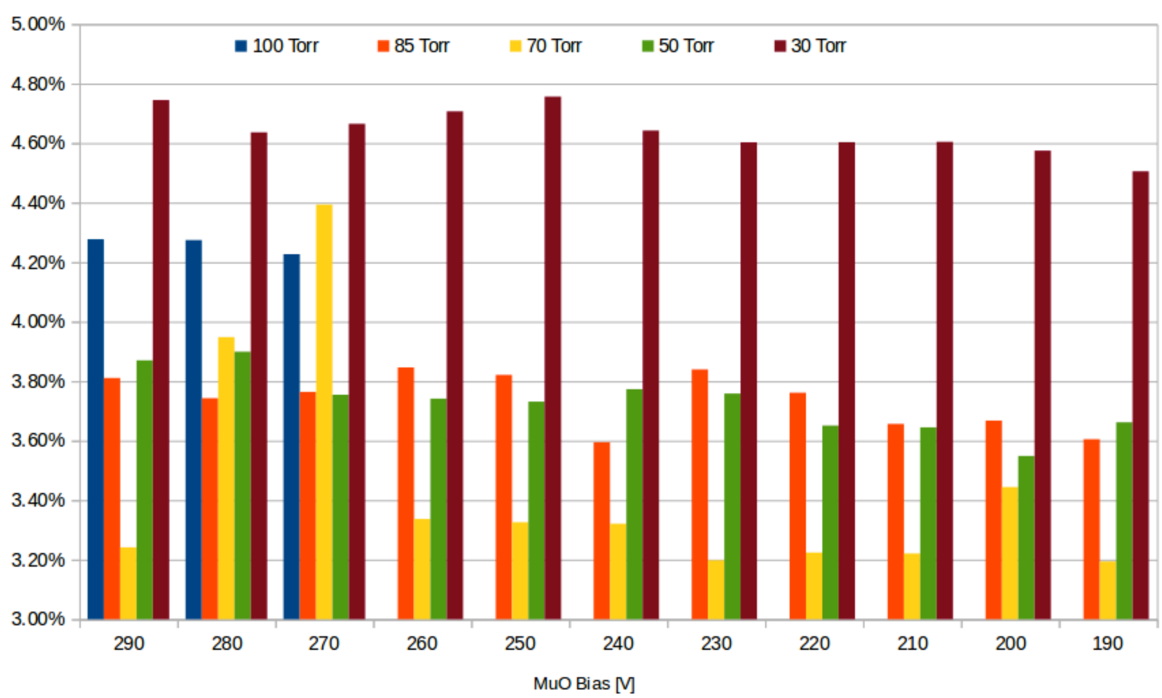


**FIG. 6.** Plot showing the energy loss resolution for the Micromegas anode (averaged over the 28 pads) for different bias voltages of the Micromegas and different gas pressures.

Last but not least, we analyzed reaction products of the beam ions interaction with a 13C target at different MDM angles. We compared the new PID spectra with the spectra obtained with the original design. Fig. 7 shows one such comparison for $^{22}$Ne at 5 deg and 30 Torr.

It can be easily seen in this figure that the resolution is much better with the Micromegas than the ionization chamber. The upgrade was considered successful so the modified detector is going to be used in nuclear physics experiments. As suggested by our collaborators, when the beam schedule allows for it, there will be further tests done with beams at much higher energies.

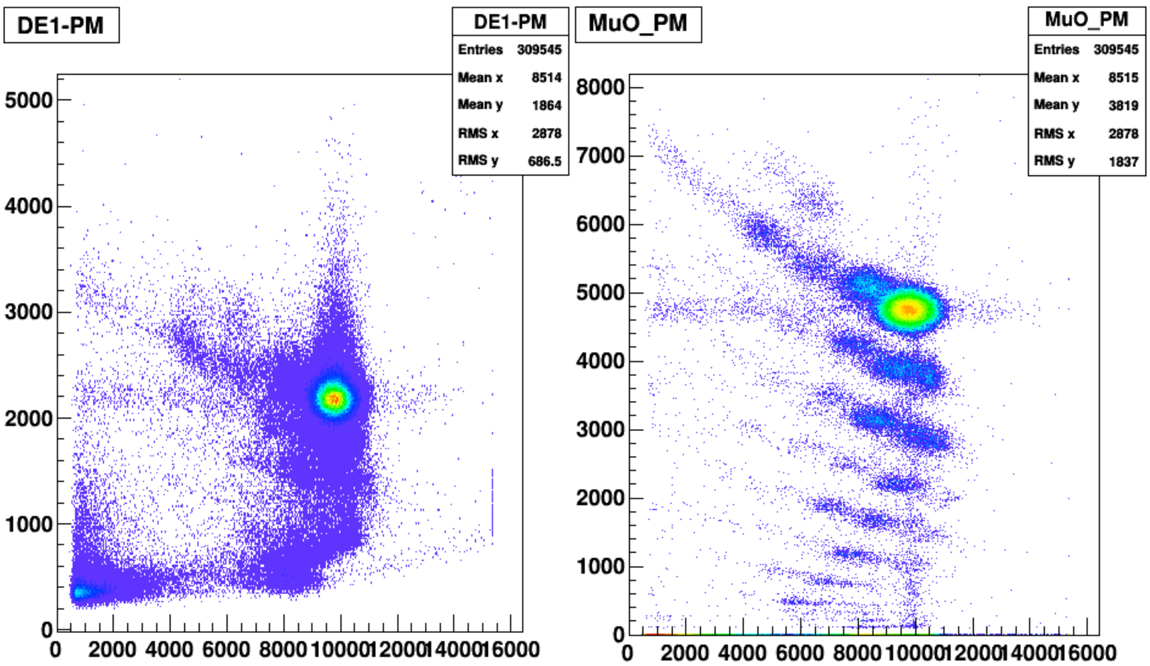


**FIG. 7.** Spectrum on left shows energy detected by the ionization chamber, dE1, versus residual energy detected by the scintillator. Spectrum on right shows energy detected by the Micromegas versus same residual energy.

For information on improving the residual energy signal, see part 2 of this paper in the same annual report.

[1] D.H. Youngblood *et al.*, Nucl. Instrum. Methods Phys. Res. **A361**, 359 (1995); M. McCleskey, Ph.D Thesis, Texas A&M University (2011)

[2] A. Spiridon *et al.*, *Progress in Research*, Cyclotron Institute, Texas A&M University (2012-2013), p. IV-50

[3] A. Spiridon *et al.*, *Progress in Research*, Cyclotron Institute, Texas A&M University (2013-2014), p. IV-45.

[4] Y. Giomataris *et al.*, Nucl. Instrum. Methods Phys. Res. **A376**, 29 (1996).