First Operation of the GADAST, GAmma-ray Detector around a Secondary Target at the Middle FRS: Measurements of Inelastic Scattering of ^{17}Ne*

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A pilot experiment with the GADAST demonstrator, an array of 16 γ-ray scintillation detectors with CsI(Tl) crystals installed near the secondary target position F2 of the fragment separator FRS has been performed (see Fig.1). Such array allows the detection of γ-rays emitted from the exited fragments produced in nuclear reactions with radioactive beams and will be used in addition to the other standard detectors of the Super-FRS [1].

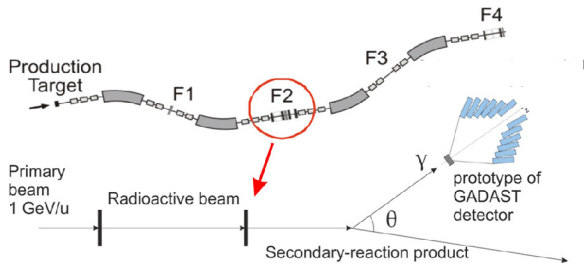

Figure 1. Position of the new gamma detector GADAST at the mid-focus F2 of the fragment separator FRS.

Each 3x6x15 cm^3 CsI(Tl) scintillating crystal produced by Amcrys (www.amcrys-h.com) was coupled to a 7 stage photo-multiplier tube ET-9106SB with green-light sensitive photocathode. The 8-crystal cluster is shown in Fig. 2 together with the corresponding optical guides, PMT and front-end electronics. The inset shows an in-board high-voltage generator coupled to the PMT socket and a board with the pre-amplifier of the anode signals.

Figure 2. A cluster of 8 CsI(Tl) scintillating crystals, constituting one half of the tested GADAST demonstrator.

The signals from the pre-amplifiers of all detectors were processed by a 16-channel board with electric filters, discriminators and shaper amplifiers. The board was developed at JINR. The produced timing logic and analog spectroscopic signals were directed to a standard VME digital electronics. The detectors can be operated in a broad energy range from ~0.04 to 40 MeV and have a low sensitivity to magnetic fields.

The γ-ray de-excitations of the ^{17}Ne isotopes produced at FRS at energy of 450 A·MeV were studied with the GADAST demonstrator during the S388 experiment "Two-proton decay of ^{30}Ar". In particular, an 1.288(7) MeV γ-ray emitted from the first excited state 1/2$^-$ of the ^{17}Ne in a inelastic scattering reaction has been measured in coincidence with ^{17}Ne ions identified by the standard FRS method. The measured Doppler-corrected γ-ray spectrum is shown in Fig. 3. The peak width of 0.10(2) MeV slightly exceeds the known 0.094 MeV width of this state, which provides an estimate of the GADAST energy resolution of 5(2)% .

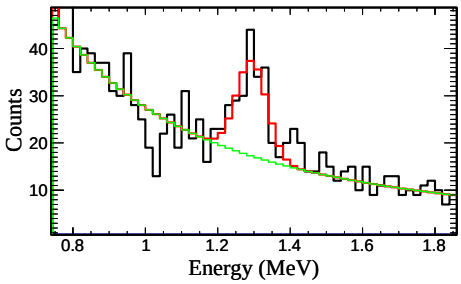

Figure 3. The Doppler-corrected γ-ray spectrum measured in the inelastic scattering of ^{17}Ne isotopes (the black histogram). The peak is fitted by a Gauss distribution. The continuum spectrum is approximated by a polynomial; their sum is the red-color curve. The measured energy of the ^{17}Ne excited state is 1.294(8) MeV matching the literature value of 1.288(7) MeV [2].

In conclusion, the performance of the GADAST demonstrator paves a way for a full-scale GADAST detector which will consist of 64 modules based on the tested CsI(Tl) crystals. Some planned experiments combine the use of GADAST with the unique features of the fragment separator Super-FRS: an identification of the heavy secondary fragments at energies up to 1.5 GeV/u, high transmissions of exotic nuclei produced via fission of U projectiles, and precise measurements of the ion momentum distributions by applying a dispersion-matched mode of the Super-FRS.

References

[1] I. Mukha *et al.,* Letter of Intent 49 to G-PAC GSI (2010), unpublished.

[2] Brookhaven National Nuclear Data Center, http://www.nndc.bnl.gov .

* This work is supported by the BMBF grant GSI-JINR N 4.8 NuSTAR.

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