Energy calibration of the gamma spectrometer at JET

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Within the Gamma-ray Spectrometer Upgrade (GSU) project at the JET experimental facility new detectors will be installed to replace the BGO scintillators with fast crystals, characterized by a decay time of ~20 ns. The 3"×3" $CeBr_3$ crystal from Scionix fulfils this condition. A CAEN Desktop Digitizer DT5720 with DPP-CI firmware was used for recording spectra.

This scintillator was tested under laboratory conditions at both NCBJ [1] and JET.

At JET, calibration sources were used, emitting gamma rays with energies up to 2734 keV, see Fig. 1.

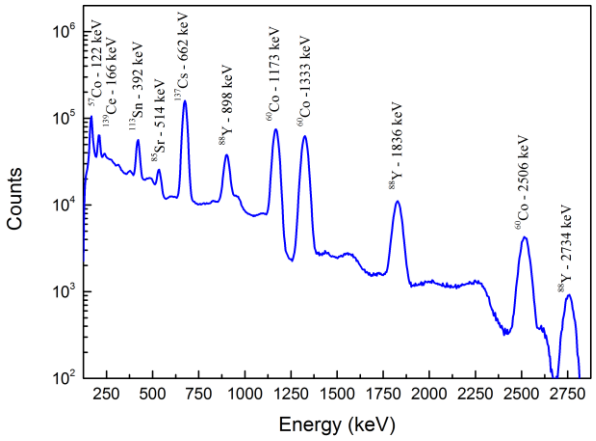

Fig. 1. Calibration spectrum recorded with a 3"×3" $CeBr_3$ scintillator at JET.

The spectrometer based on the $CeBr_3$ scintillator is characterized by very good linearity, see Fig. 2. The energy resolution at 662 keV was 4.5%.

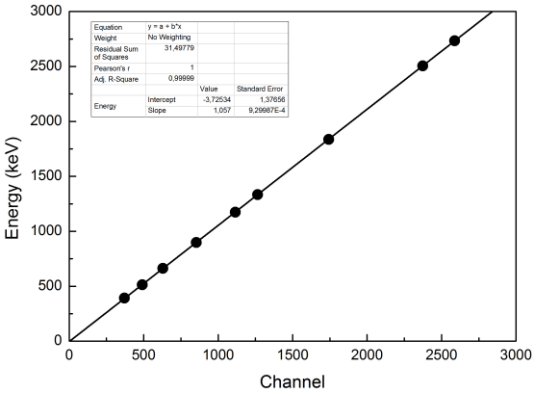

Fig. 2. Energy calibration of the spectrometer based on the $CeBr_3$ scintillator. Solid line is a linear fit to the experimental points.

In addition to measurements with radioactive sources, a natural background spectrum was recorded at JET and all peaks were identified, see Fig. 3. Such an unambiguous identification was possible due to the good linear performance of the detector and will later help to perform calibration at JET without radioactive sources but using only natural background gamma lines.

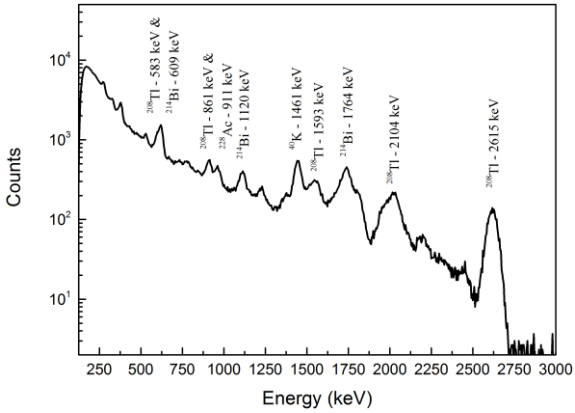

Fig. 3. Background spectrum measured at JET.

At JET both an AVD@NCBJ active [2] and a standard Scionix passive voltage divider were used in tests, see Fig. 4. We found that the detection efficiency as well as energy resolution determined during measurements with the low rates available at JET, corresponding to non-intensive gamma-ray fluxes, are independent of the divider used. Measurements at high counting rates were performed at NCBJ and details are presented in [1].

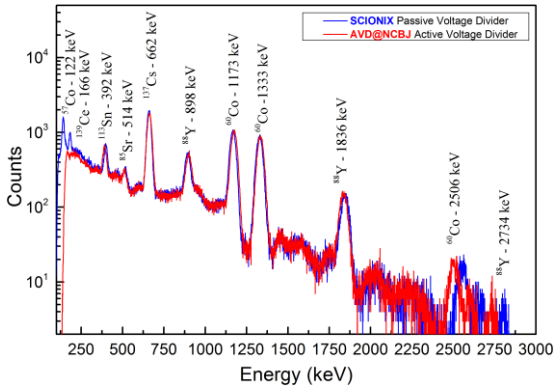

Fig. 4. Spectra recorded using AVD@NCBJ active and Scionix passive voltage dividers.

References

[1] R. Kwiatkowski et al., CeBr3 –based detector for Gamma-ray Spectrometer Upgrade at JET, sub. to Fusion Energy and Design (2017)
[2] S. Korolczuk, et al., Digital Acquisition in High Count Rate Gamma-Ray Spectrometry, IEEE Transactions on Nuclear Science 63 (2016)

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