New Setup for Dead Layer Determination in HPGe Planar Detectors

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INTRODUCTION

The dead layers induced by the passivation treatments of the intrinsic surface of a High Purity Germanium (HPGe) detector can have very detrimental effects on the final detector performance in high resolution gamma-ray spectroscopy \cite{1,2}. The study of the properties of the dead layers is then particularly important and for this study we have prepared at LNL a new experimental set-up that will be described in the following section.

NEW EXPERIMENTAL SETUP

The new experimental set-up has been constructed for studying of the charge collection phenomena in HPGe detector prototypes realized at LNL. With this new set-up it is possible to estimate the thickness of dead layer near the passivated surface \cite{3-7}.

As can be seen in Fig. 1, the HPGe crystal is mounted in between a PTFE disk and an Aluminum support. The first one isolates the crystal, allowing the contact between the high-voltage and the n+ surface (red line) through an 11 mm diameter hole in the center of the disk. The second one touches the p+ surface (blue line) via a 0.5 mm thick Indium foil, to improve the electric contact.

The upper face of the Aluminium HPGe support is 1 mm thick to reduce the gamma absorption.

This mounting cap is fixed to the cryostat and has a reduced lateral thickness of 1 mm alongside the crystal, to perform lateral scans with low energy gamma rays.

Taking into account the Aluminum end cap that covers all the system to pump down the crystal to a pressure around $10^{-5}\div10^{-6}$ mbar, the total absorbing thickness of the Aluminum layers is 3.1 mm.

To produce a thin gamma beam for the lateral scans, a lead collimator 25 mm thick with 1.5 mm diameter drilled hole was realized. This collimator was mounted on a micrometrical motion device and positioned as close as possible to the Aluminum end cap. In this way an actual distance of 9.6 mm between the crystal and the collimator has been obtained.

Different measurements have been performed irradiating from the bottom of the end cap of the cryostat, using different calibration sources or varying the distance from the detector. The crystal efficiency, determined as a function of the energy of the radiation source, has allowed verifying the nominal thicknesses of the absorbing layers. Acquiring the counting rate trends of a $^{241}$Am source with and without the collimator, as a function of the distance, it was found that the collimator introduces an attenuation coefficient of 0.002 with respect to the initial activity.

Moreover we have seen that the counting rate with the collimated source remains constant in a 12 cm range of distance from the end cap: a very thin “pencil-like beam” has been obtained, whose dimension is given by the spot diameter.

CONCLUSIONS

This new set-up has allowed the effects of several passivations on a planar HPGe detector to be studied, besides having guaranteed with a good precision the calculation of the number of gamma rays coming out from the collimator.

The set-up has been used to characterize different passivations as described in another report of this volume \cite{8}.