Pixel Calibration of Double-Sided Silicon Strip Detectors

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Introduction

Nuclear physics experiments involving rare isotope beams use large arrays of silicon strip detectors. These detectors are well-known for their very good energy and spatial resolutions. In this work, we discuss a detailed procedure and results of pixel-wise energy calibration of double-sided silicon strip detectors (DSSD) used in an experiment at HIE-ISOLDE, CERN [1, 2]. The results are compared to those obtained from the strip-wise calibration to get an idea of the accuracy and justification of the method [3].

Procedure

A $4\times1.15\,\mathrm{kBq}\ {}^{148}\mathrm{Gd}-{}^{239}\mathrm{Pu}-{}^{241}\mathrm{Am}-{}^{244}\mathrm{Cm}$ mixed α-source with energies between 3-6 MeV was used for energy calibraion of the detectors. The DSSD is comprised of 16 vertical strips on the front side and 16 horizontal strips on the back side, arranged orthogonally to each other. This setup results in a total segmentation of 256 pixels, allowing for precise spatial localization of incident particles. In strip calibration, each individual strip is calibrated, while in pixel calibration individual pixels are calibrated. Thus, the number of calibration parameters obtained in this process is $2\times\ 2\times256$ for a single 16×16 DSSD. A Monte Carlo simulation with experimental setup and the above alpha source as input is carried out to obtain the exact energy loss in each pixel. From the experimental data, the centroids of the α-peaks are initially obtained for each individual pixel. A ROOT [4] macro has been developed to account for the accuracy of the Gaussian fitting of the peaks. A linear regression is carried out for each pixel to obtain the linear transformation that converts the channel numbers into energy values. Finally, the energy loss corrections from Monte Carlo simulations are incorporated to the experimental data.

Results and Discussion

Using the above procedure, all the detectors used in the experiment have been calibrated. Fig 1 represents the comparison of FWHM of the α-peaks for one pentagon DSSD using strip and pixel calibrations. The energy

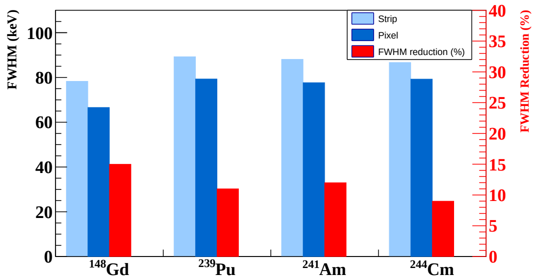

FIG. 1: Comparison of the FWHM of the α-energy peaks for one pentagon DSSD after strip and pixel calibration.

spread of the peaks is minimized for pixel calibration, with a maximum reduction of 15% in FWHM. It may be noted that when a charged particle deposits energy in the material of a DSSD, two signals are generated simultane-

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ously on each side. For a real event, the energy difference between two signals is nearby zero. The energy difference between the front and back side of the annular S3 detector is shown in Fig 2, where the difference is seen

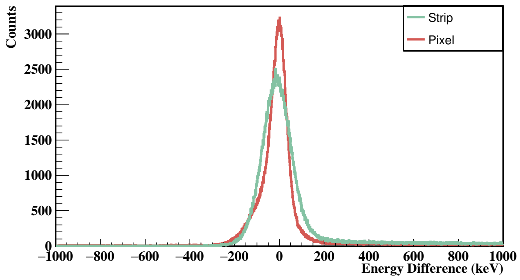

FIG. 2: Energy difference between the front and back strips of the annular S3 detector, with the smallest difference being observed for pixel calibration.

to be minimum for pixel calibration. It may

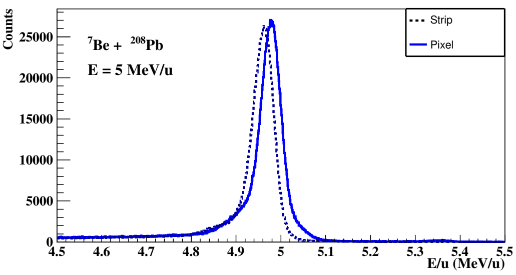

FIG. 3: Comparison between centroid value of the elastic peak in ^{7}Be + ^{208}Pb scattering after strip and pixel calibration.

thus be concluded that pixel calibration is a more accurate method for energy matching of the DSSDs. It helps to eliminate bad events from the experimental data in a better manner. The pixel calibration is applied to ^{7}Be + ^{208}Pb data at 5 MeV/u (Fig. 3) and it can be seen that pixel calibration improves the centroid value of the ^{7}Be elastic peak compared to strip calibration.

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