Calibration Method for Two-Dimensional Spectra Acquired on 4B Array NIMROD

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An important step in the off-line analysis of data from the 4B multidetector array NIMROD is the calibration of spectra. We present here a method for the calibrations of two-dimensional spectra using a minimization procedure. In the experimental spectra, the lines for 3 selected isotopes are assigned and fitted. Using the assigned mass and charge, corresponding lines in the two-dimensional)E-E plot are calculated. Finally, the calibrations are obtained by minimization of a function where calibration coefficients are the variable parameters. In the present analysis the minimization function is defined simply as a sum of squares of absolute deviations. The minimization package MINUIT [1] has been used in the present work. Two-dimensional scatter-plots can be used instead of full two-dimensional histograms and thus the necessary disk and memory space is reduced. The data from Si-Si-CsI(TI) telescopes have been used in the analysis.

For Si-Si calibration, the calibration formula

$$E = a_0 + a_1 X + a_2 \sqrt{X} \qquad (1)$$

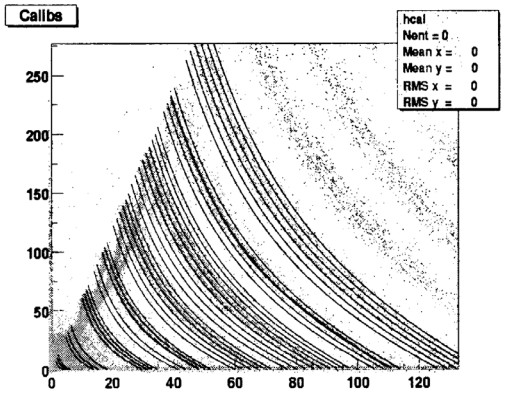

Figure 1: An example of the calibrated Si-Si spectra using the proton, ^{9}Be and ^{15}N line. The data used originate from reaction ^{124}Sn+^{124}Sn at 28 MeV/u. The data were collected in ring 8 of NIMROD.

was used for both Si detectors. Additional constraints were applied in the minimization functional in order to position correctly the punch-through points. Figure 1 shows an example of the calibrated spectra using the proton, ^{9}Be and ^{15}N line. The data used originate from reaction ^{124}Sn+^{124}Sn at 28 MeV/u. The data were collected in ring 8 of NIMROD. One can see that the overall agreement in the shape of calculated and calibrated experimental lines is very good and allows for the possibility to set the gates for

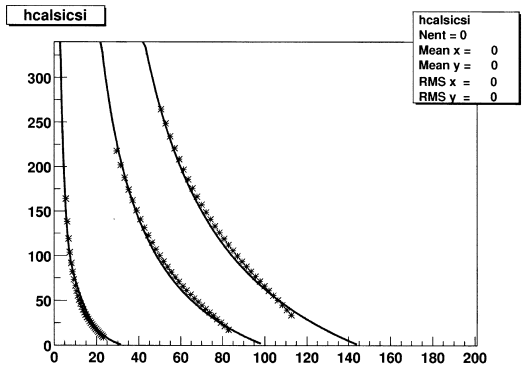

Figure 2: An example of experimental and calculated isotope lines (^{4}He, ^{9}Be, ^{11}B) for Si-CsI(TI) spectrum in the ring 8 of NIMROD.

identification of different isotopes using calculated lines.

For Si-CsI(TI) calibration a similar procedure is carried out. The calibration of Si detector is known from Si-Si analysis. For the energy calibration of Csl(TI) detector a formula of Tassan-Got [2] is used

$$E = L^2 + 2\rho L\sqrt{1+\ln(1+\frac{L}{\rho})} \qquad (2)$$

where L is the light output (in our case in the slow gate) and $\Delta = 0AZ^2$ where 0 is a calibration parameter. Another parameter of calibration is the pedestal which should be subtracted from the raw light output signal. An example of obtained agreement of experimental and calculated lines (^{4}He, ^{9}Be, ^{11}B) is given in Figure 2. The overall agreement is quite good, the uncertainty in the low energy part being caused mainly by uncertainty in the position of the pedestal. The examples of spectra calibrated using this method are given in our other contribution to this report discussing our results for reaction ^{124}Sn+^{28}Si at 28 MeV/u. The Si-CsI(TI) calibration also offers the possibility to set identification gates for different isotopes. For this purpose the light output obtained in the fast gate offers more promise since the isotope lines are resolved much better than in the Si-Csl(TI) spectra using slow gate. An open question is to what extent the signal in the fast gate reflects the total light output. Also, saturation effects take place in the fast gate.

In summary, the calibration methods presented here appear to be useful for the analysis of data from 4B multidetector with high granularity like NIMROD. Further improvement should be looked for in more sophisticated minimization functions allowing more precise agreement of calibrated experimental and calculated isotopic lines.

References

[1] F. James and M. Roos, MINUIT - Users Guide, Program Library D506, CERN, 1981.

[2] L. Tassan-Got, nucl-ex/0103004.