SEMI-AUTOMATIC (A,Z) CALIBRATION OF FAST-SLOW HISTOGRAMS IN GARFIELD APPARATUS

L. Morelli

for the NUCL-EX collaboration.

1 Dipartimento di Fisica and INFN Bologna.

INTRODUCTION

The availability of 4π multi-detectors provides opportunities to study very complex nuclear phenomena and events associated to small cross sections. The price to be paid, however, comes in form of a vast amount of multidimensional data, which need to be calibrated in order to obtain useful correlations. The development of digital electronics, moreover, has increased the number of parameters characterizing the events. New semi-automatic methods are therefore required to perform a comprehensive data calibration and analysis [1]. A new procedure has been developed, in the ROOT framework [2] aimed at extracting, from Fast-Slow signals coming from CsI(Tl) scintillators, mass and charge of the detected Light Charged Particles (LCP). This ROOT powerful set of software tools uses object oriented programming and provides the user with numerous methods of displaying and analyzing data.

THE EXPERIMENT AND DATA ANALYSIS

The main detector of the GARFIELD apparatus consists of a gaseous microstrip chamber followed by CsI(Tl) scintillators. The measurement have been performed at LNL with a $^{32}$S beam from Tandem-Alpi complex onto a $^{56}$Fe target at 16.5 AMeV incident energy.

A new designed electronics [3] has been used for the signal coming from CsI(Tl) detectors [4].

It is well known that a shape analysis allows mass and charge identification of LCP with very low identification thresholds. A critical step in the analysis procedure is the calibration of the fast-slow 2d-histograms obtained from pulse shape discrimination in CsI(Tl) detector in order to obtain charge and mass of LCP.

The analysis of 2-dimensional fast-slow histograms is in general a relatively long and cumbersome procedure and must be repeated for each scintillator.

Most of the programs used to calibrate Fast-Slow plots imply an accurate sampling of each isotope branch and this results in a very time consuming procedure.

We started a new semi-automatic procedure in order to obtain the identification of all LCP lines, based on an automatic track of the ridge of the LCP branches; in this way the action of the researcher is devoted only to a check of the LCP mass spectra obtained, implying strong reduction of the calibration time. An example of 2-dimensional Fast-Slow histograms is shown in Fig 1.

![Fig. 1: Fast-Slow 2d-histogram.](image1)

The intense ridges visible in the histogram correspond to particles with different A and Z values; different isotopes form approximately parallel ridges. The task is to automatically identify the Z and the A of the detected particles.

The first step of the code is the determination of representative sampling points along the various ridges. This procedure is performed with ROOT functions and classes (Projection and T Spectrum fig 2); the result is shown in fig 3.

![Fig. 2: Fast-Slow with histogram created by projectionX function.](image2)

Significant time and effort have been devoted to develop a tracking method to automatically find the Z and A ridges.
The “tracking” is essentially a local method of pattern recognition. For more details see Ref [5]. Here the method is based on three phases: a parametric track model, which connects points of an isotopic ridge with a set of track parameters, a method to generate track seeds (figure 4a), a quality criterion, which allows to distinguish good track candidates from ghosts [5]. An example of a tracked histogram is shown in fig 4b.

After this step the points on each ridge are fitted by a power-law relation depending on the Z and A [6] (equation 1), with minuit package. This function is used to identify Z and A of individual particles.

\[ L_s(L_f, Z, A) = a_1(Z, A)L_f^{a_2(Z)} \]

\[ a_1(Z, A) = a_1(Z) [1 + k(Z - A/2)] \]  

In Fig. 5 the Fast-Slow bidimensional histogram is presented in a double logarithmic scale, thus showing the power low relation between the two signal. The fitting procedure is therefore easily performed in order to go to the last step of the indentification procedure i.e. the creation of mono-dimensional histograms representing LCP distributions in charge and mass (fig 6).

To each point in the Fast-Slow histogram is assigned a real mass value related to the distance from the closest analytic function, in order to quantitatively evaluate the good assignement of charge and mass to all LCP.

A refinement of the procedure is in progress, as well as the application to the same kind of detectors in other apparatuses.