Progress with testing automated particle identification

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In references [1] and [2], a new method to automatically identify particles in dE-E raw spectra has been described. In summary, the dataset for each spectrum is put to a square-root scale to equalize the distance between each atomic element group (Z) and a Fourier transform is applied to filter the frequency components. Then the program runs in three steps: it first searches for local maxima, then builds groups around those maxima (corresponding to the atomic elements) and finally fits the lines with a spline interpolation in order to linearize the data and separate the different isotopes.

In September 2017, the program was installed on a local Cyclotron computer and during the last few months several tests have been performed to evaluate the performance of the technique when confronted with different spectra from different detectors and experimental datasets. To test the program with a perfect-like spectrum, we simulated dE-E correlation data files using the CycSrim application as shown in Fig. 1. Fig. 2 shows the fit result at the end of the procedure. So, for generated data the program seems to work fine.

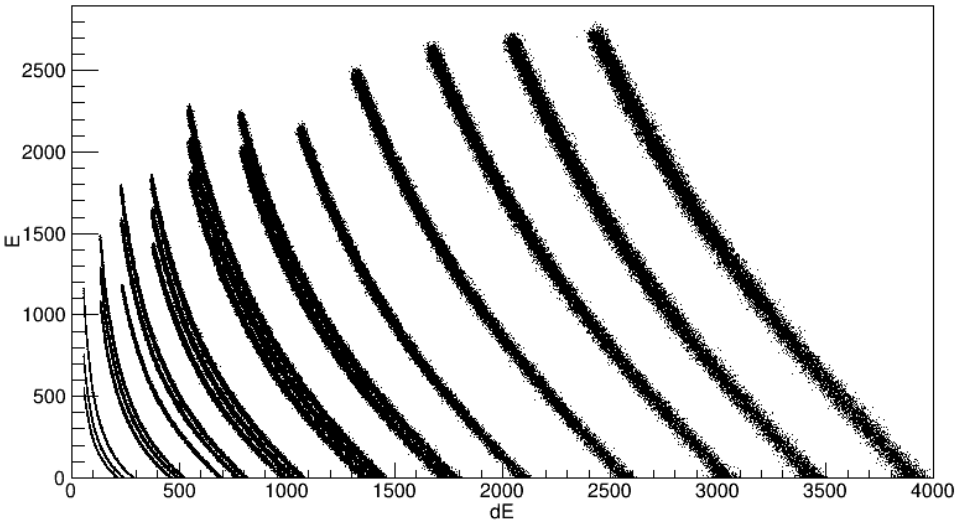

FIG. 1. CycSrim generated E vs dE spectra. Energy resolution is set to 2%.

For the initial program development and parameter tuning a real experimental dataset from a NIMROD Si-CsI(Tl) detector [3] was used. This spectrum has high statistic and very good charge and isotopic resolution. We can see in Fig. 3 that the procedure works well for this particular dataset. So we tested the program with several other detectors from different experiments and unfortunately, it seems that the program is not able to fit any other dataset than the one used for its development. In Fig. 4, we present an example of one of those failed attempts. As we can see, some fit lines are incomplete and some groups

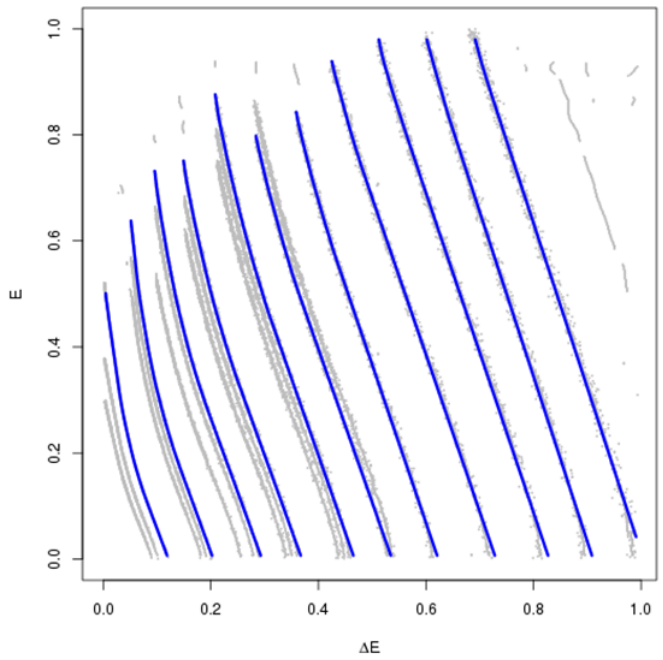

FIG. 2. Fit results from Figure 1 spectrum. Grey points are the square-root transformed data and the blue lines are the final fits for each Z.

are ignored. There are several possible explanations for these malfunctions. First, the program parameters have been tuned using the original dataset and might not be optimal for any others. Secondly, not enough statistics prevents the program to find enough maxima and thus leads to incapacity to create groups. Also, when the top of two Z lines in E vs dE spectra are too close to each other the program thinks it's a single group and merges them together.

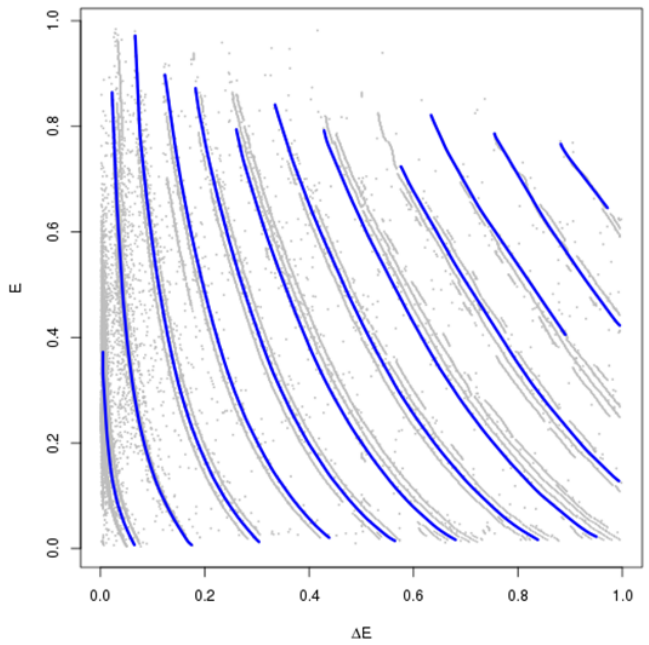

FIG. 3. Fit result for the program development experimental dataset.

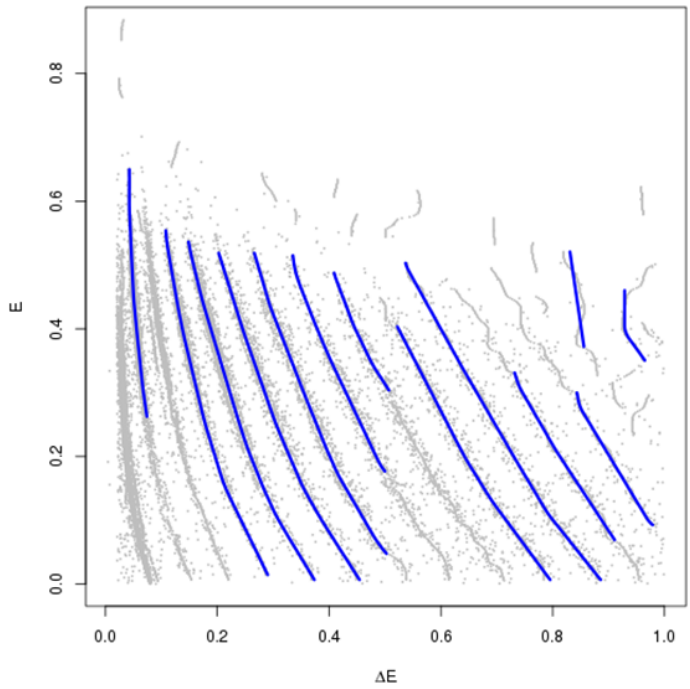

FIG. 4. Fit result for a random experimental dataset.

The technique has thus to be rethought and overhauled to work with imperfect and low statistic dataset, which are most of the real world experimental spectra. A solution could be to tell the program where the groups are by manually putting a single point on the top of each Z line. We are currently still working with the Department of Statistics to find a solution to make this program a suitable tool for our analysis.

[1] A.B. McIntosh *et al.*, *Progress* in Research, Cyclotron Institute, Texas A&M University (2015-2016), p. IV-65.

[2] A.B. McIntosh *et al.*, *Progress in Research*, Cyclotron Institute, Texas A&M University (2016-2017), p. IV-47.

[3] S. Wuenschel *et al.*, Nucl. Instrum. Methods Phys. Res. **A604**, 578 (2009).