A new linearization method for NIMROD super telescopes

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In order to study neutron-proton equilibration study, it is preferable to identify the isotope mass A and Z up to Z~ 20. Most Si-Si pairs in the NIMROD super telescopes can show a clear line for each isotope up to Z<=10. Only a few can resolve isotope above Z>10. Typical two examples are shown in Fig.1. In the upper panel, isotopes up to Z=8 appear as separate lines clearly. In the lower panel, isotopes with Z <=16 can be seen.

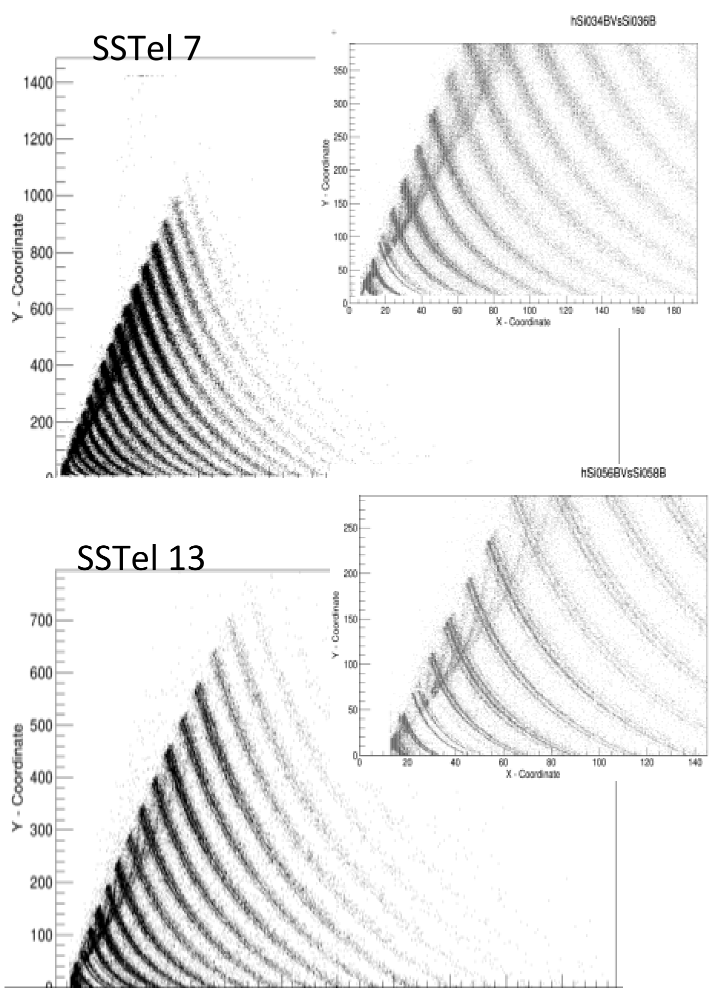

Fig. 1. Si1(dE) vs Si2(E) plot for particles stopped in Si2 detector in super telescopes #7 and #13. Inserts are plots in an expanded scale.

In order to identify the isotopes Z and A, a linearization package is used, in which Z as a real number is assigned for a give data point, using the distance from the nearby A=2Z lines. About 10-20 points are picked for each A=2Z isotopes, if they are identified by a separate line. Therefore in the lower case, A=2Z line can go up to Z=16, but the upper case, it only goes up to Z=10. In order to assign the A and Z values for all in the upper case, the range-energy table are used with the following steps.

1 Si1(dE) on the X axis and Si2 (E) on the Y axis are calibrated for Z=4-10 isotopes lines to match the lines calculated from the range energy tables.

2 Then for Z>10 isotopes, the lines calculated from the range energy tables are used for A=2Z lines for the linearization. (For Z<=10 picked points are used).

In this way, not only the isotopes, but also the Si energy on each axis can be calibrated at a time.

In Fig.2, linearized Z vs Esum (dE+E) are plotted for both cases. Even for isotopes with no distinctive lines, one can reasonably well identify the isotopes up to Z=20. In Fig.3, the extracted Z

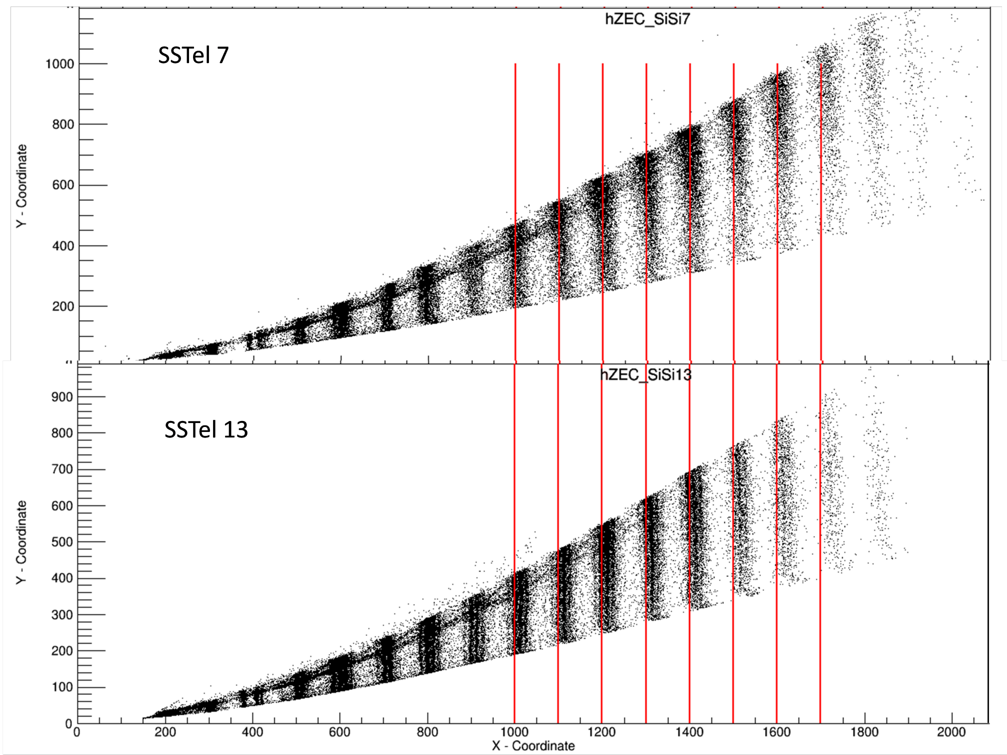

Fig. 2. Linearized Z vs Esum. On the X axis the number correspond Z*100. In the Y axis the energy is given in MeV.

numbers are compared between these two telescopes for Z=0-10 in the upper and Z=10-20 in the lower. Even for those in which no clear lines are observed for individual isotopes like telescope #7, the Z numbers are not only reasonable, though their absolute number is slightly shifted. They can be easily corrected later. For the n/p equilibration study, the widths of the isotope distribution are crucial and they are more or less same as those of telescope #13. When each isotope is fit by a Gaussian in a given Z for telescope #13, the mean and sigma can be extracted. Using these means and widths, one can reasonably well evaluate the isotope yield when no isotope lines are observed like telescope#7. Further study is now underway.

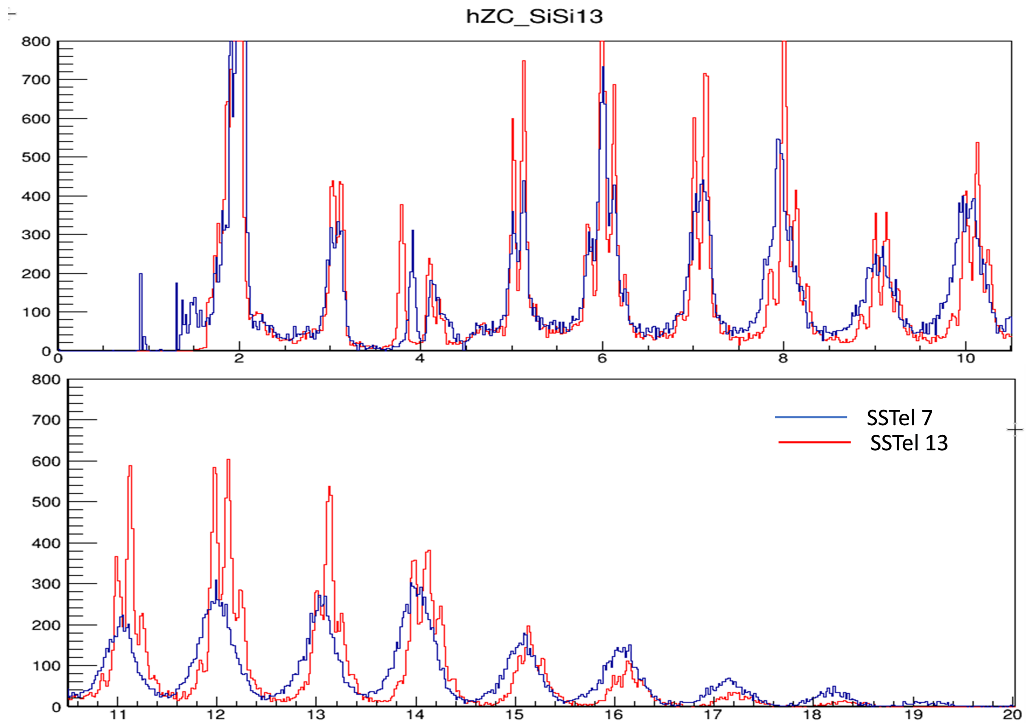

Fig. 3. The projected Linearized Z value on the X axis from Fig.2. Red histogram is from the telescope #13 and the blue represent the Z from the telescope # 7. Z=int(Z) corresponds to isotopes with A=2Z. The fraction indicates the mass difference from the A=2Z isotope.