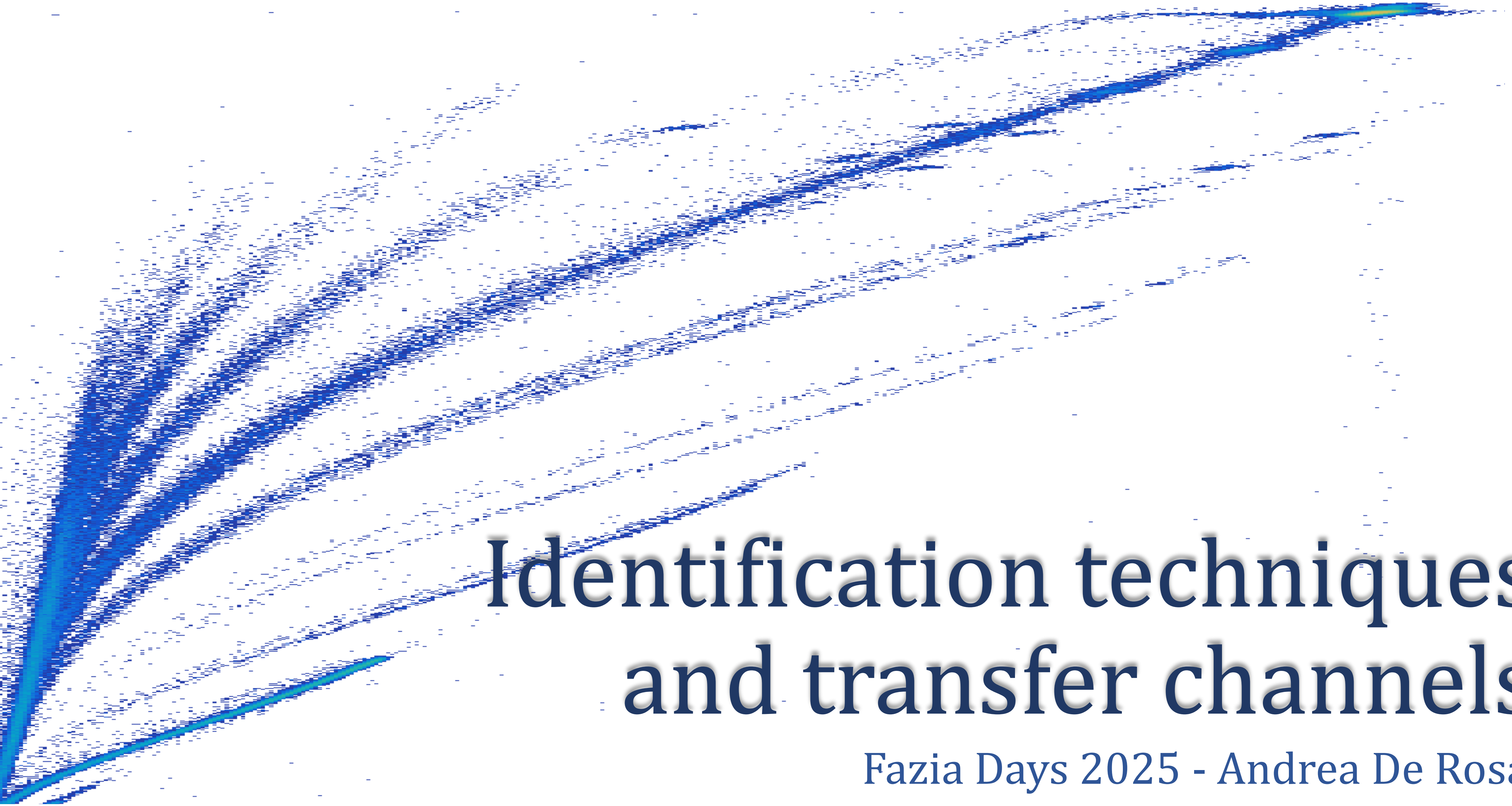
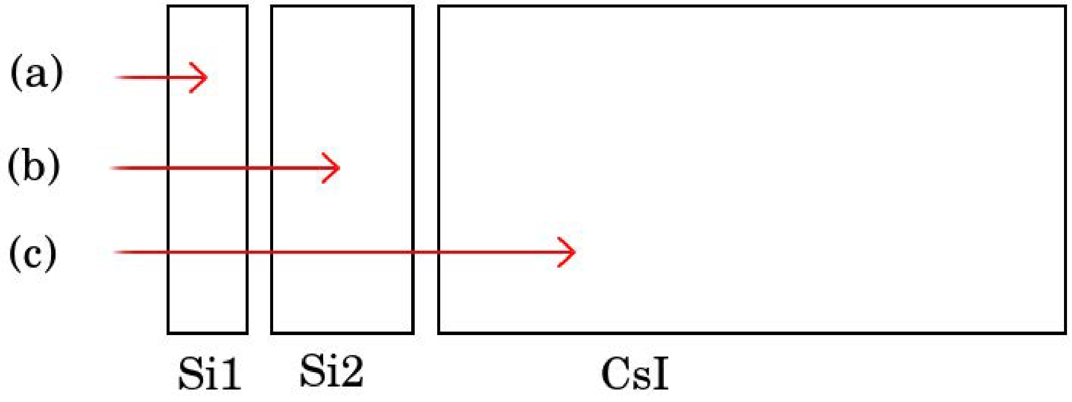


Identification techniques and transfer channels

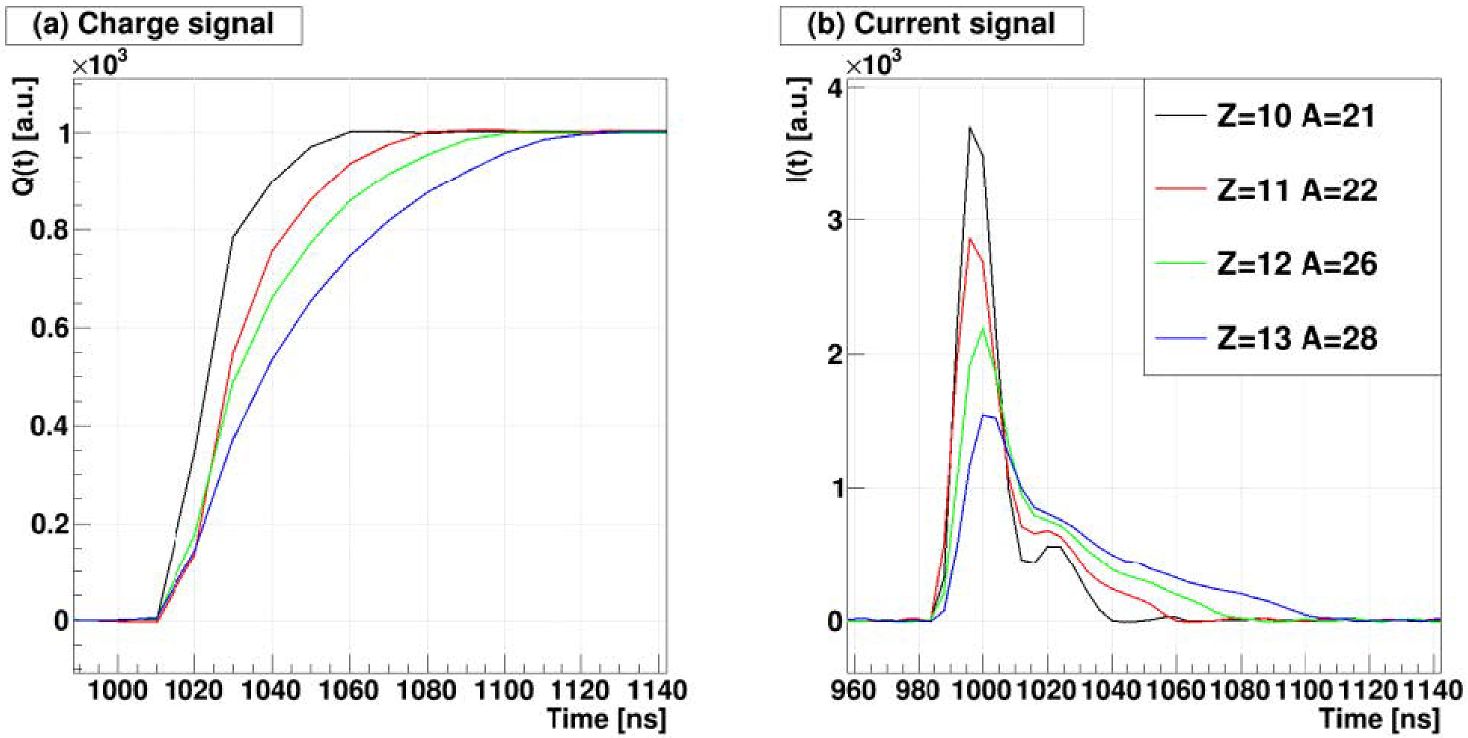
Fazia Days 2025 - Andrea De Rosa

Telescope stages and stopped particles

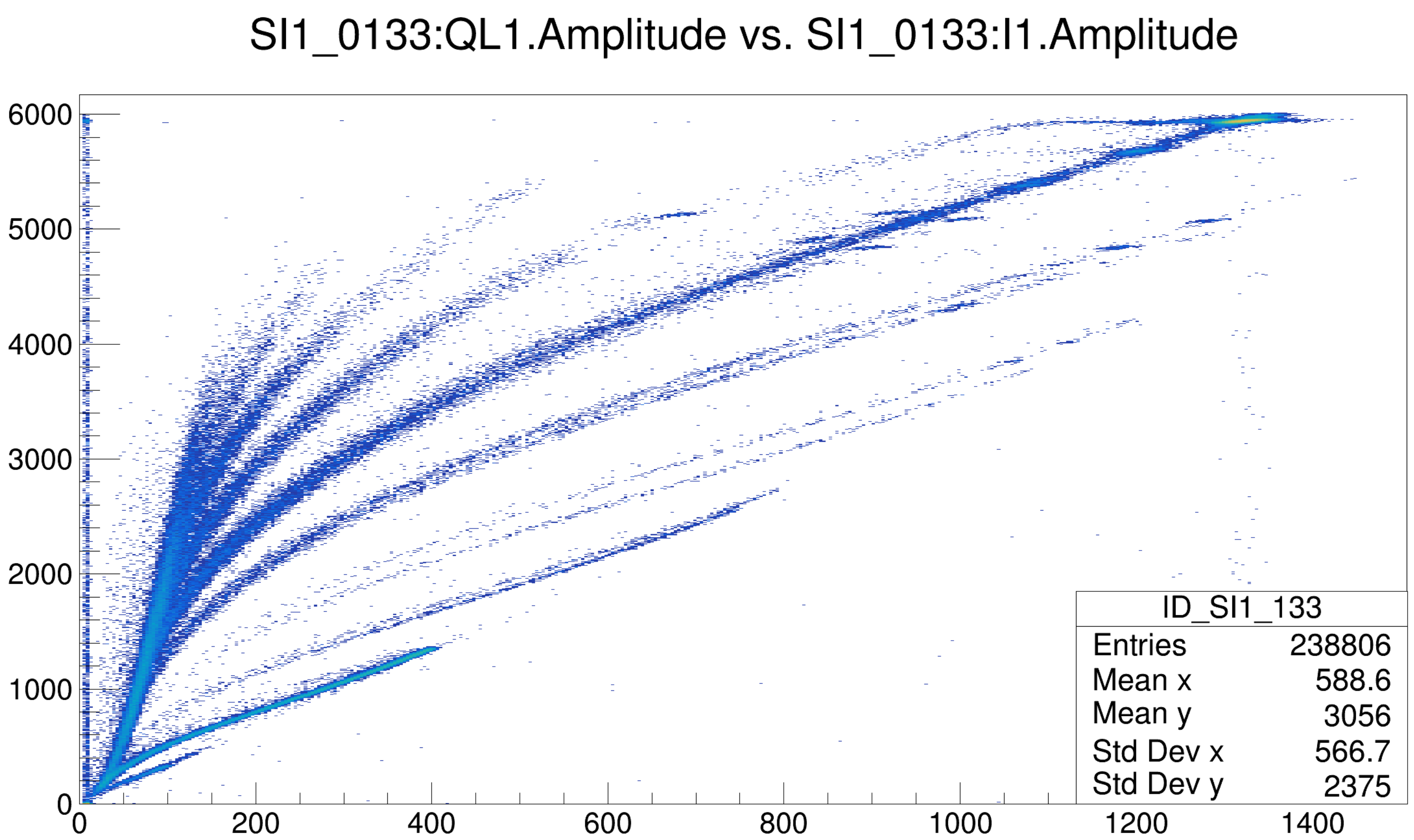


a) Heavy or slow ions identified via PSA
b) Ions up to Li id via ΔE-E
c) Light ions and gammas id via PSA in CsI or ΔE-E

Pulse Shape Analysis

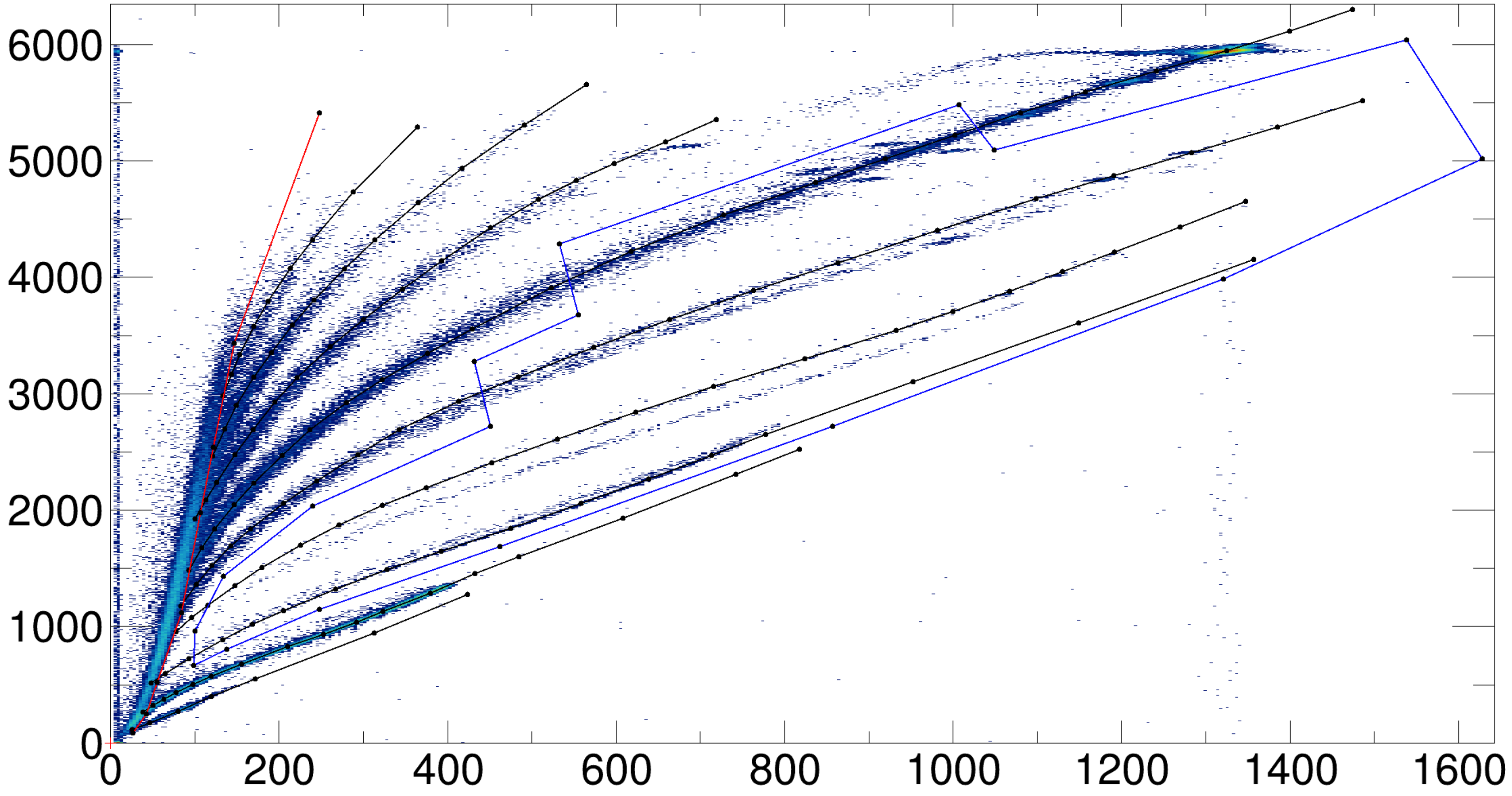


- E loss profile depends on Z and A
- Heavier particles have smaller range
- Energy released in a smaller volume
- Slower signals because of collection time
- Reverse-mounted detectors



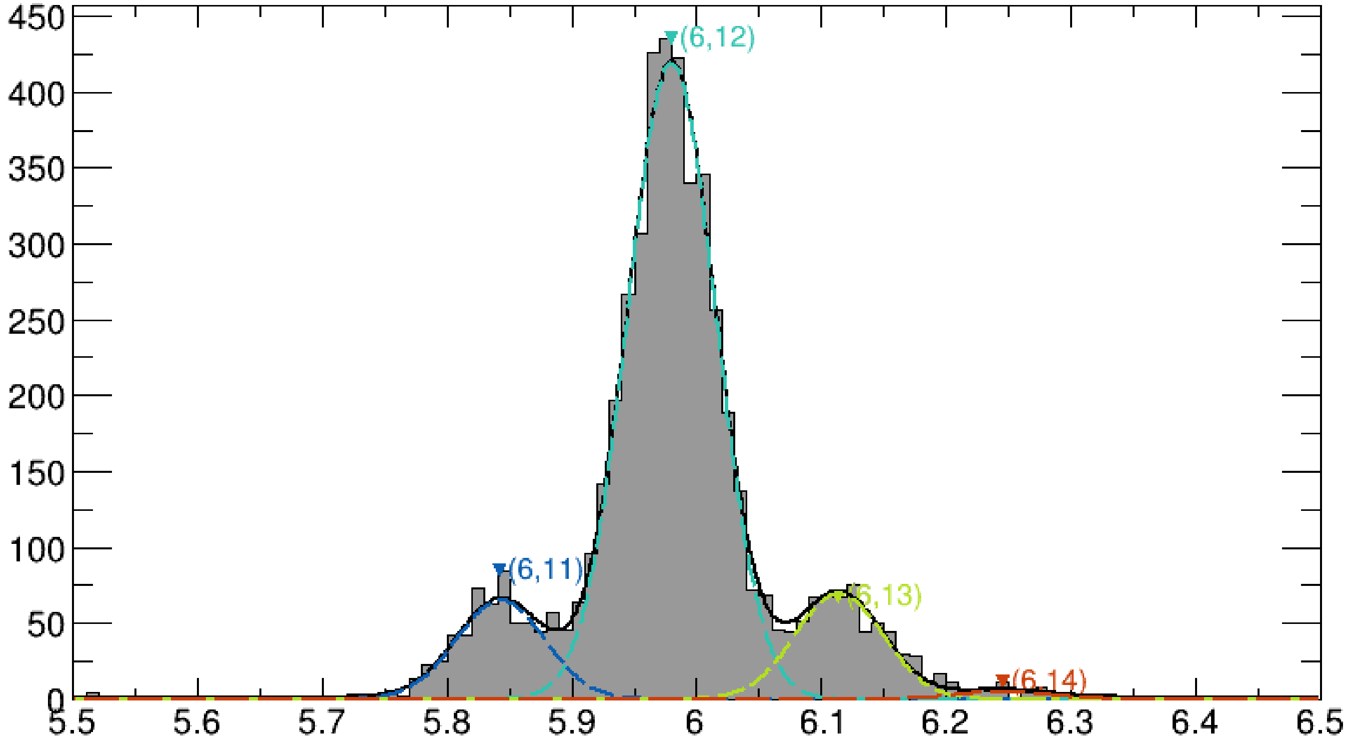
In the FAZIA apparatus the best choice is to plot the Energy of the particle vs its maximum current

Identification procedure



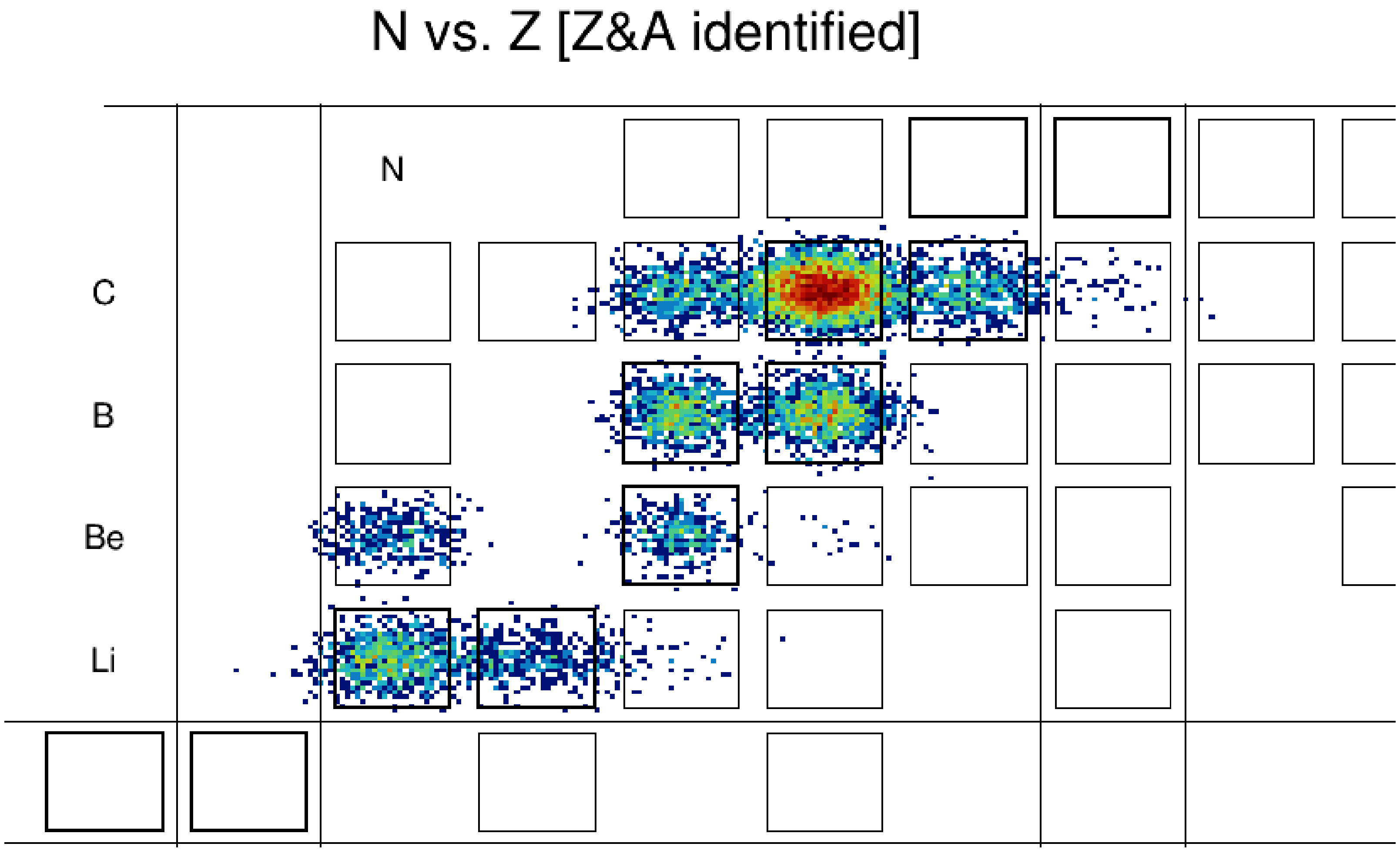
- Cutline for slow particles
- One line for each Z
- PID value is assigned to each particle $PID = Z + \delta Z$
- Info region for mass ID

PID distribution and Mass ID



- With a multi-gaussian fit in the PID distribution we can identify the particles
- One gaussian for each isotope
- Each particle is assigned to a certain isotope with a probability given by the fit

Identified particles

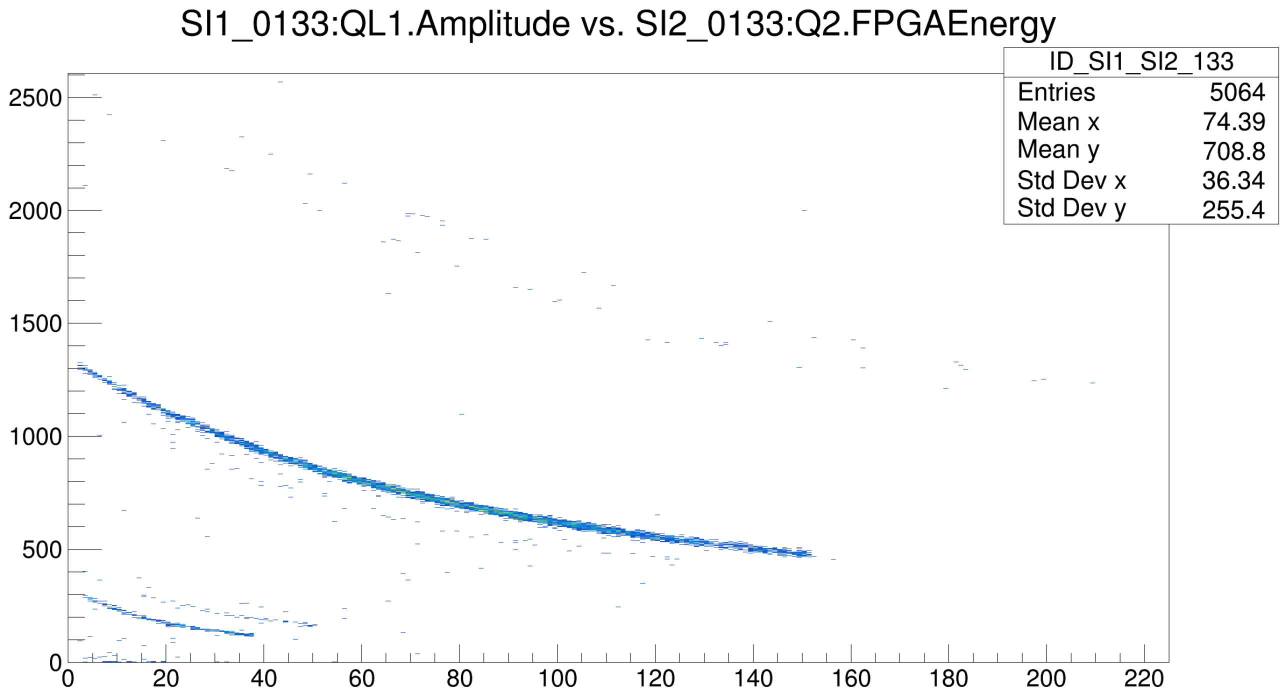


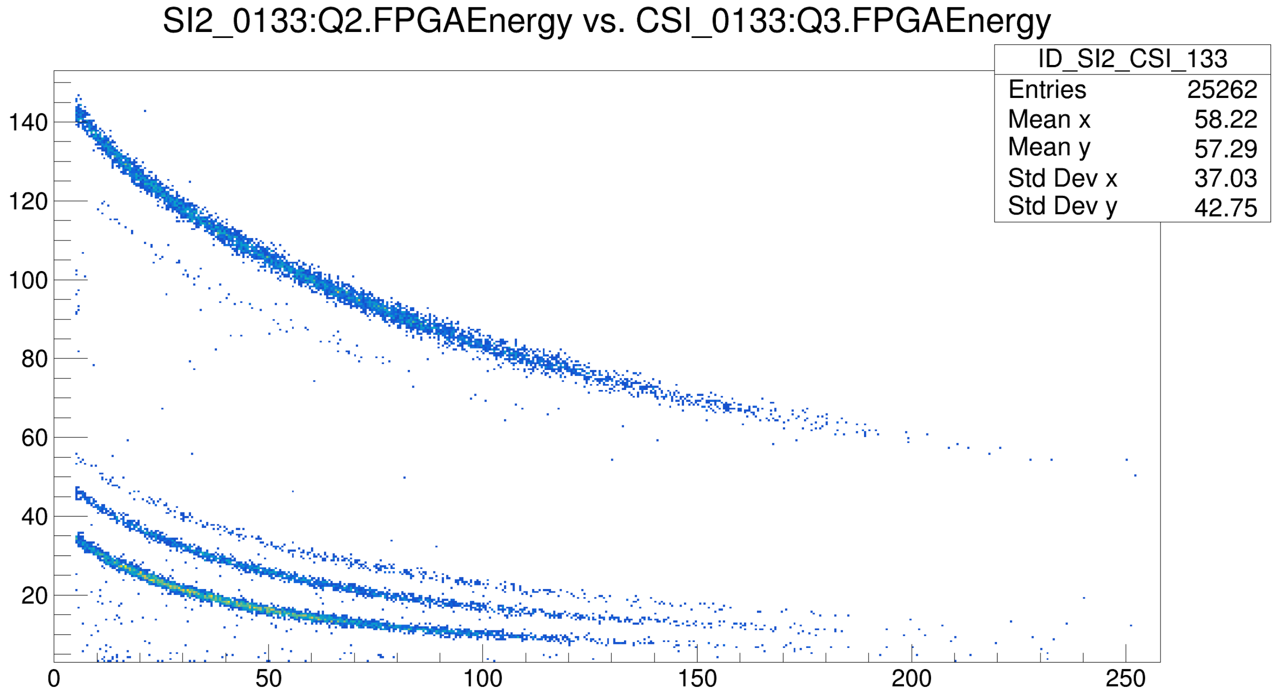
We can check the position of each particle in the Segrè Chart

After this procedure we can analyse the events in which we have only the particles of interest

ΔE-E Identification

From Bethe-Bloch formula $\Delta E \propto \frac{Z^2 A}{E}$





Identified particles in FAZIA

General performances

ΔE-E

Charge id for every Z

Mass id up to Z=25

PSA

Charge id for every Z

Mass id up to Z=20

Particles observed in E881

ΔE-E

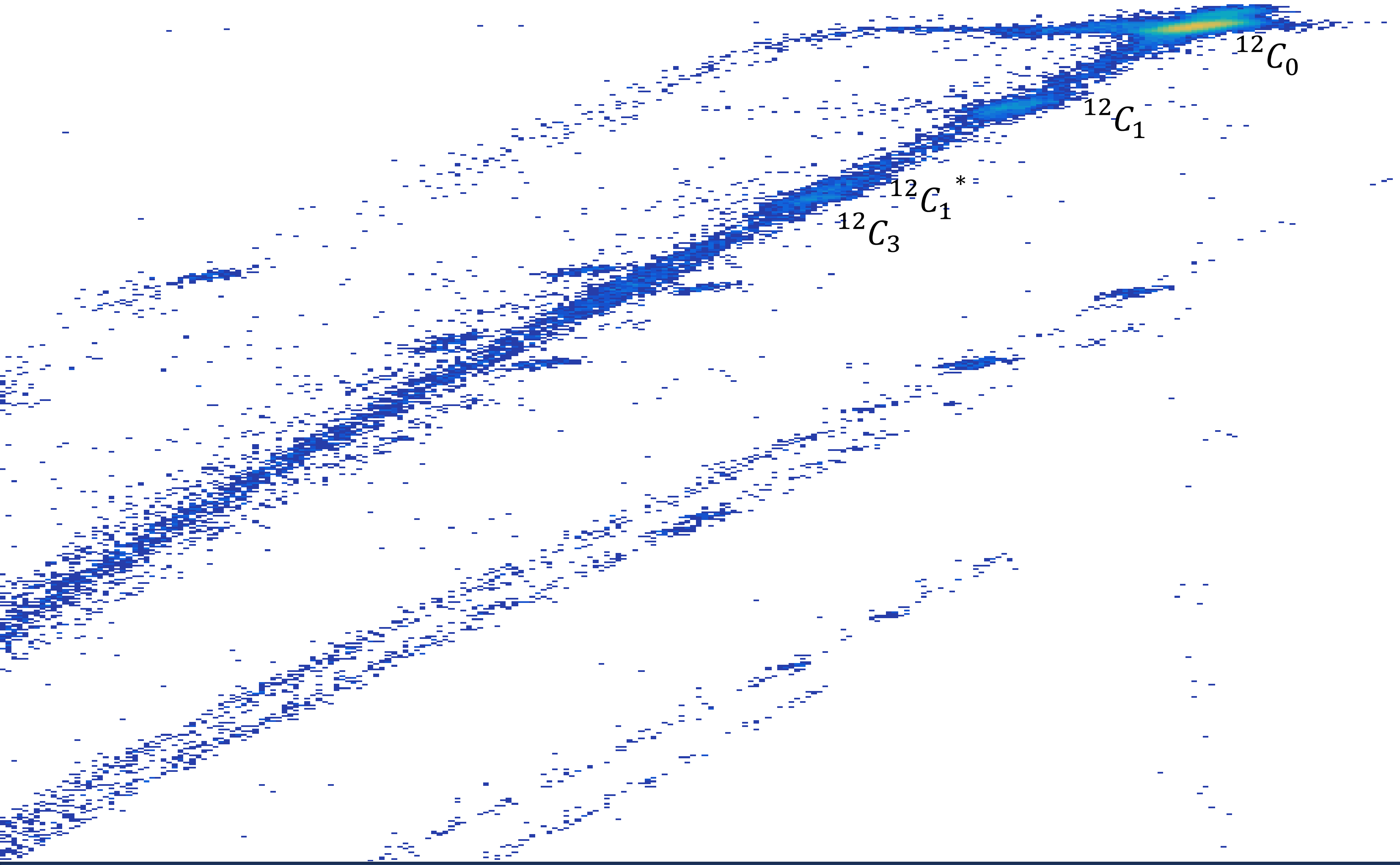
Charge and Mass id up to Z=3

PSA

Charge id up to Z=9

Mass id up to Z=6

Elastic and inelastic peaks

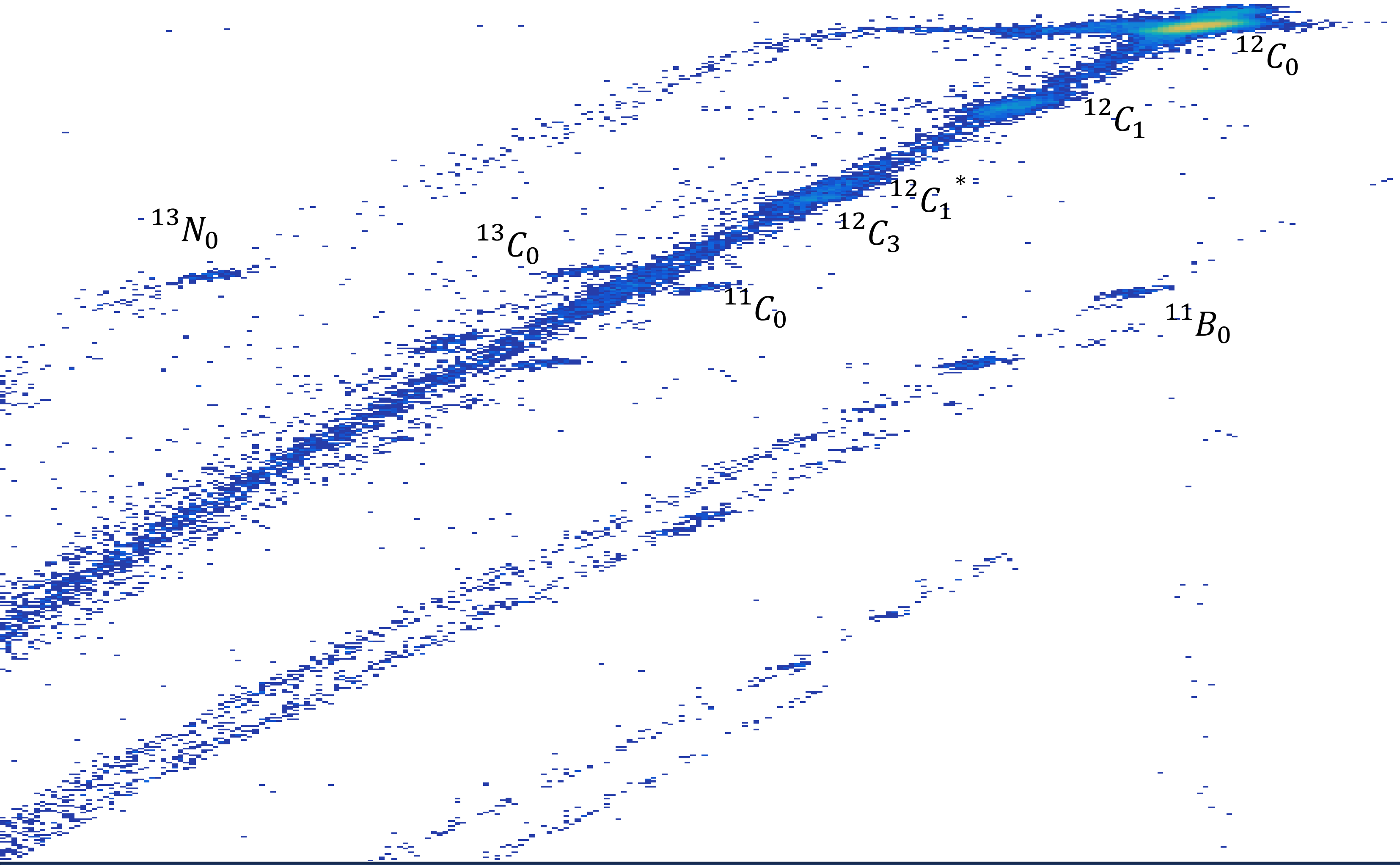


When the target or/and the projectile is excited, the detected particle has a lower TKE

We get different peaks:

- $^{12}C_0$ Elastic peak
- $^{12}C_1$ Inelastic peak to 4.4MeV state
- $^{12}C_1^*$ Double inelastic to 4.4MeV
- $^{12}C_3$ Inelastic to 9.6 MeV

One nucleon transfer

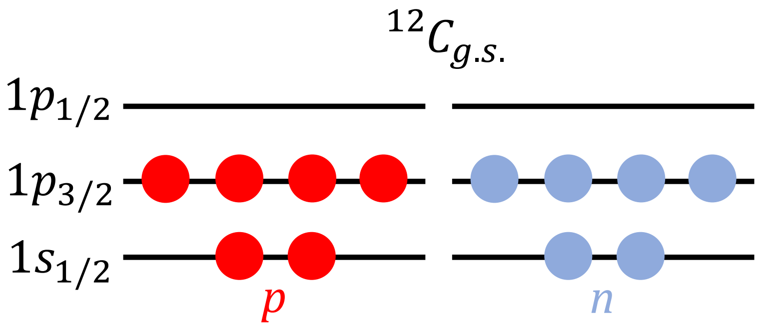


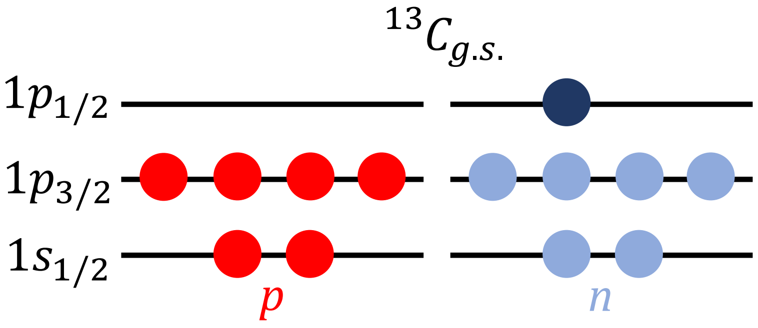
We analyse the transfer peaks in pairs for simmetry reasons

Peaks with no excitations:

- $^{11}C_0$
- $^{13}C_0$
- $^{11}B_0$
- $^{13}N_0$

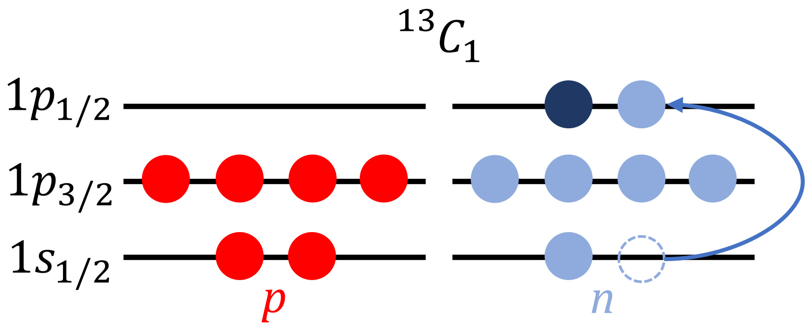
Excited states in transfer channels

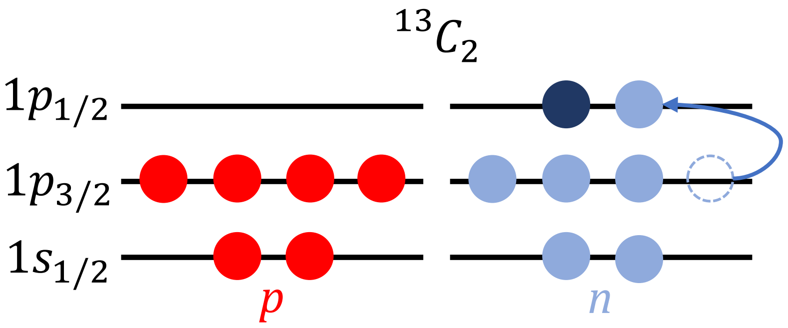


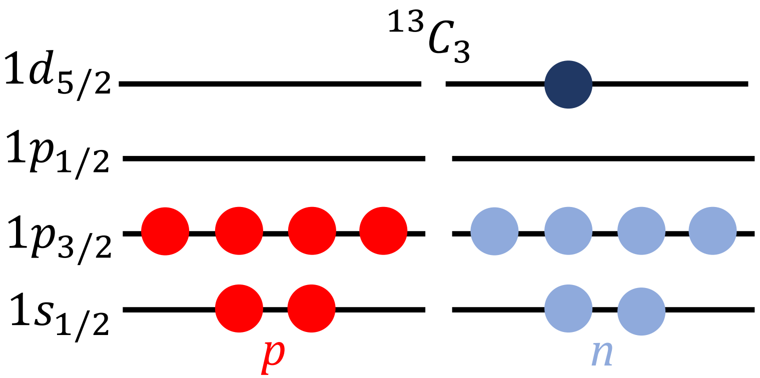


Transfer reaction are peripherical

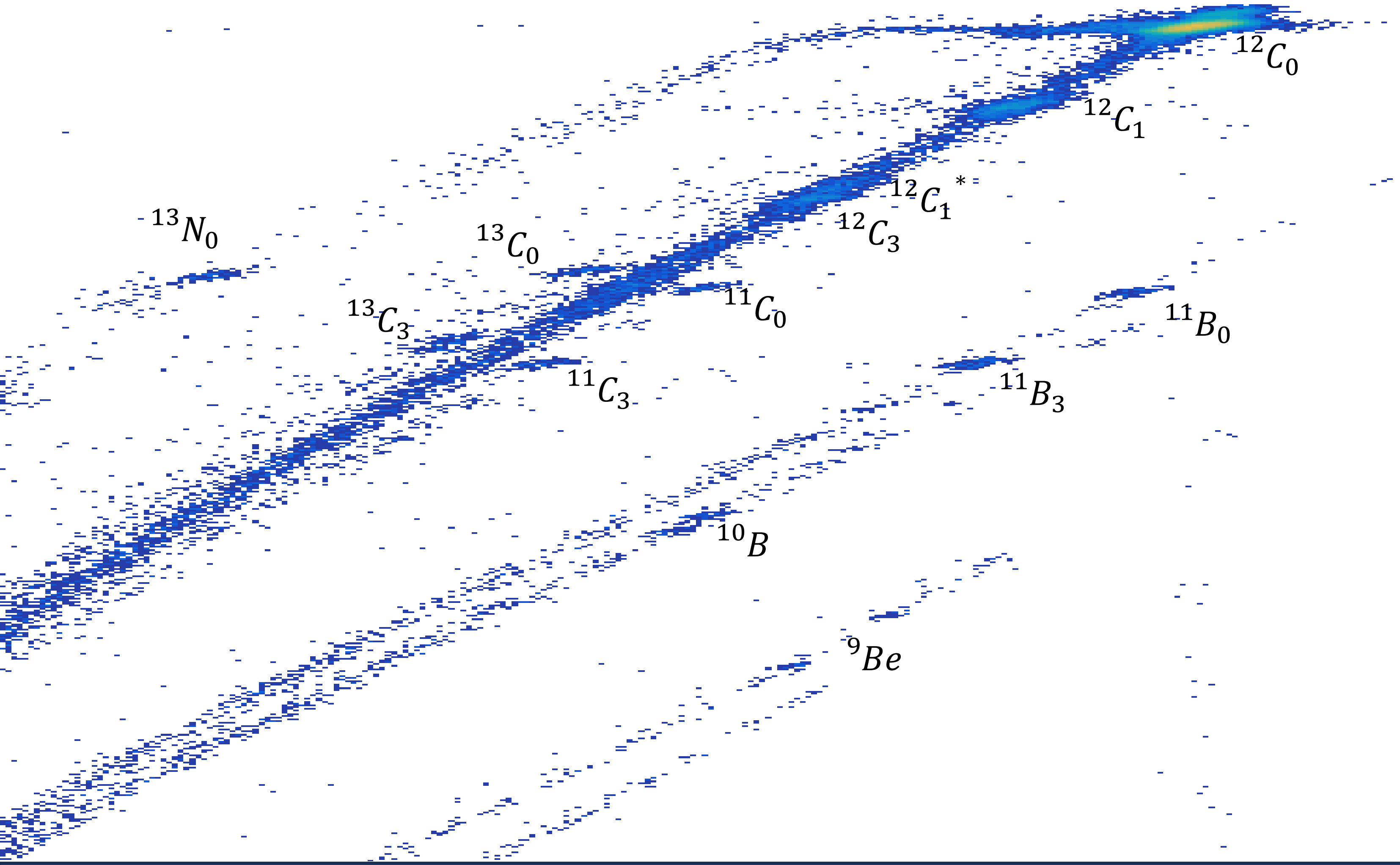
The third excited state is the most probable







One nucleon transfer



Peaks with excitation to the third excited state:

- $^{11}C_3$
- $^{13}C_3$
- $^{11}B_3$

There is no $^{13}N_3$ peak because the excited nitrogen decays via proton emission

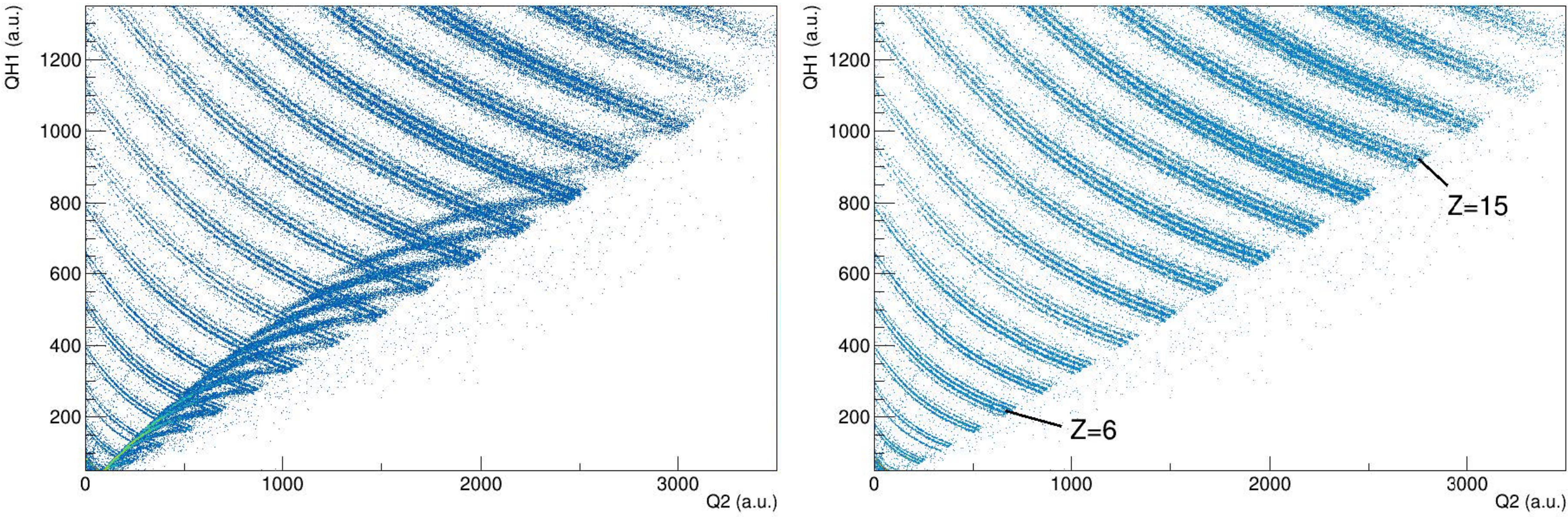
Peaks in ^{10}B and ^{9}Be

Further analysis for transfer reactions

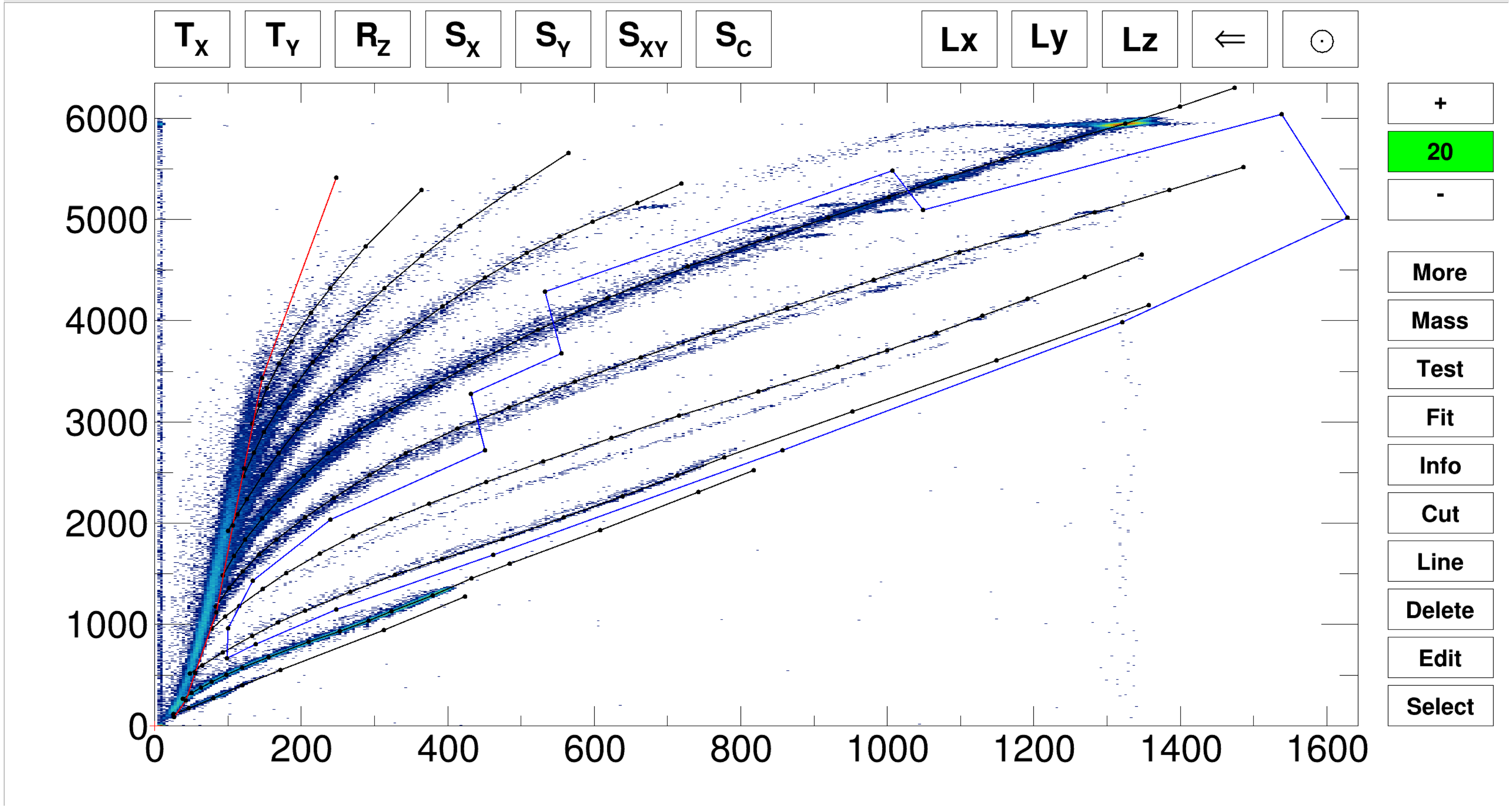
- Calibration needed for computing the excitation energies
- Coincidences to analyse unstable products (example 12C and p coincidences for excited 13N)
- Further investigations into additional peaks (9Be and 10B)

Backup slides

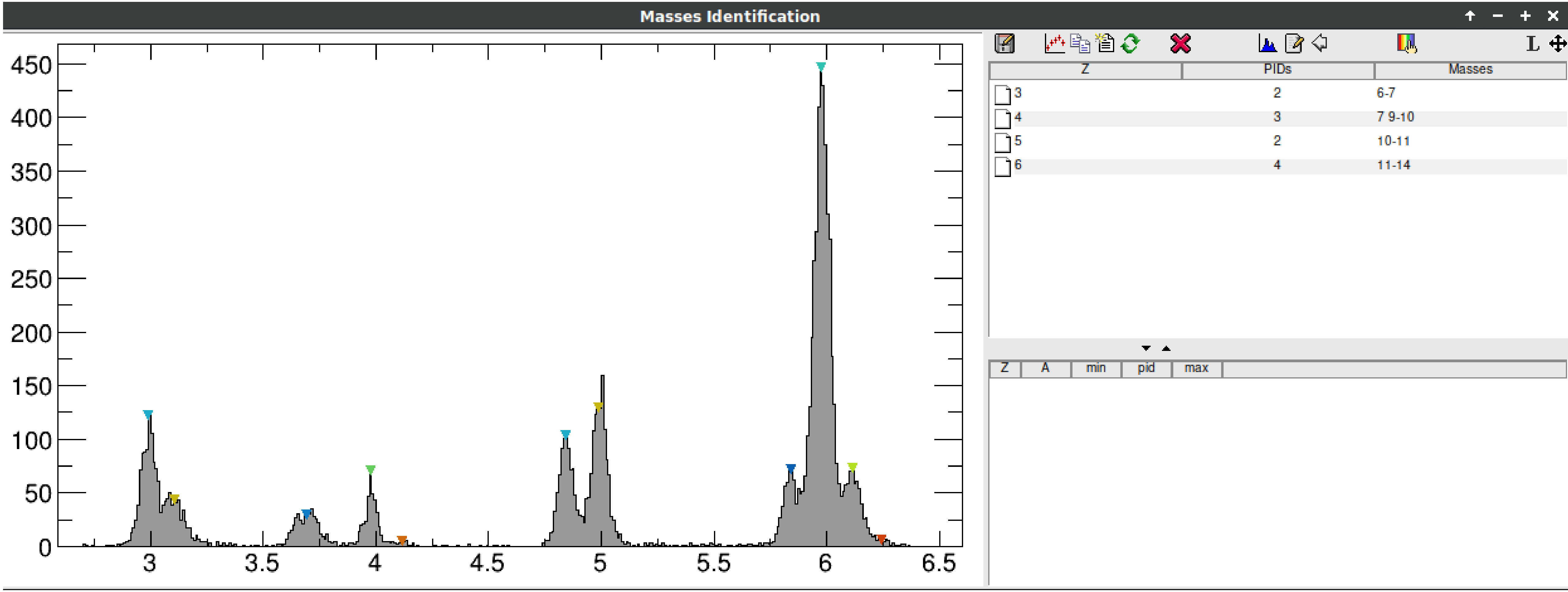
Punch through



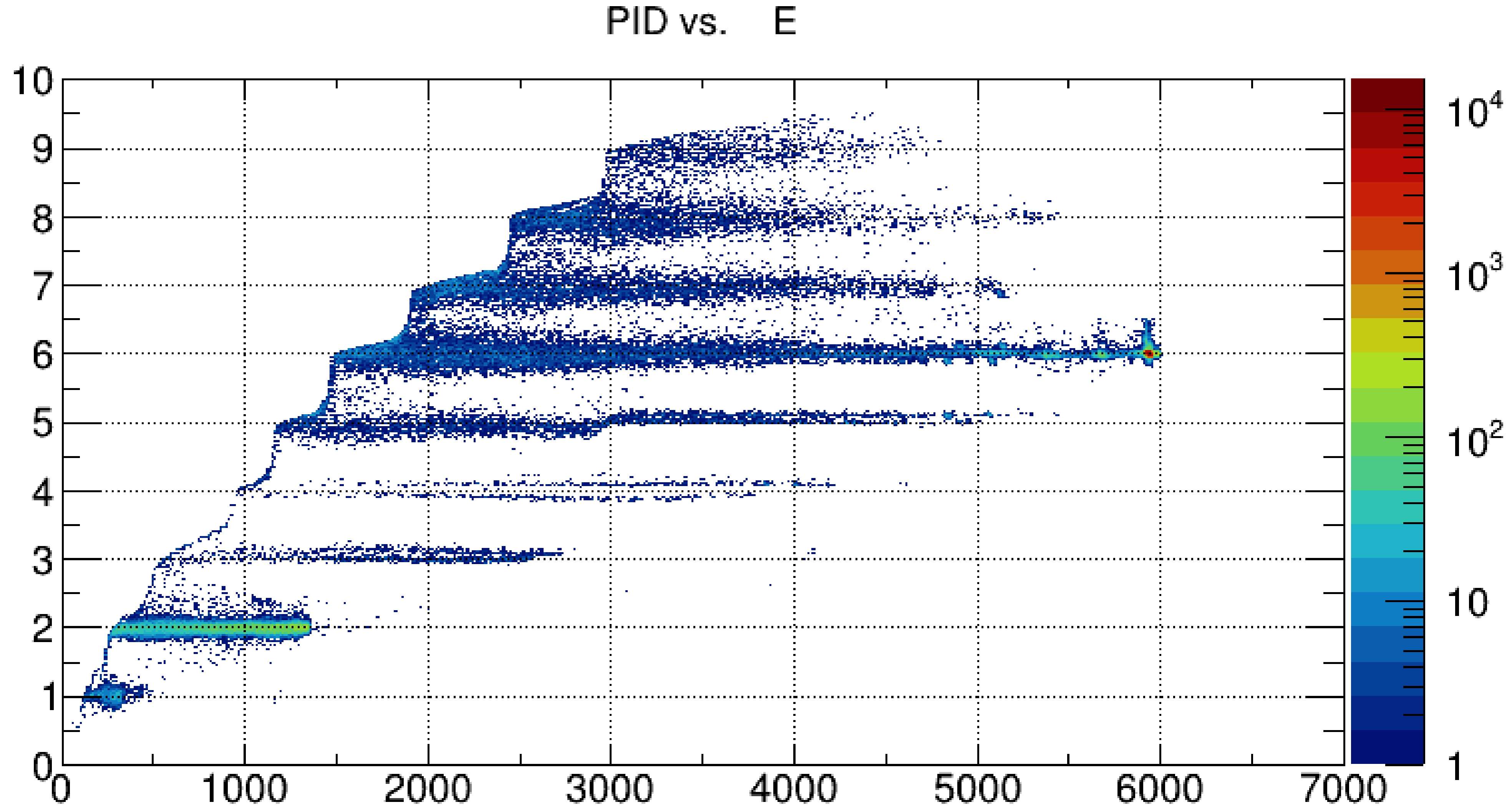
Tools for ID matrix



PID distribution and Mass ID

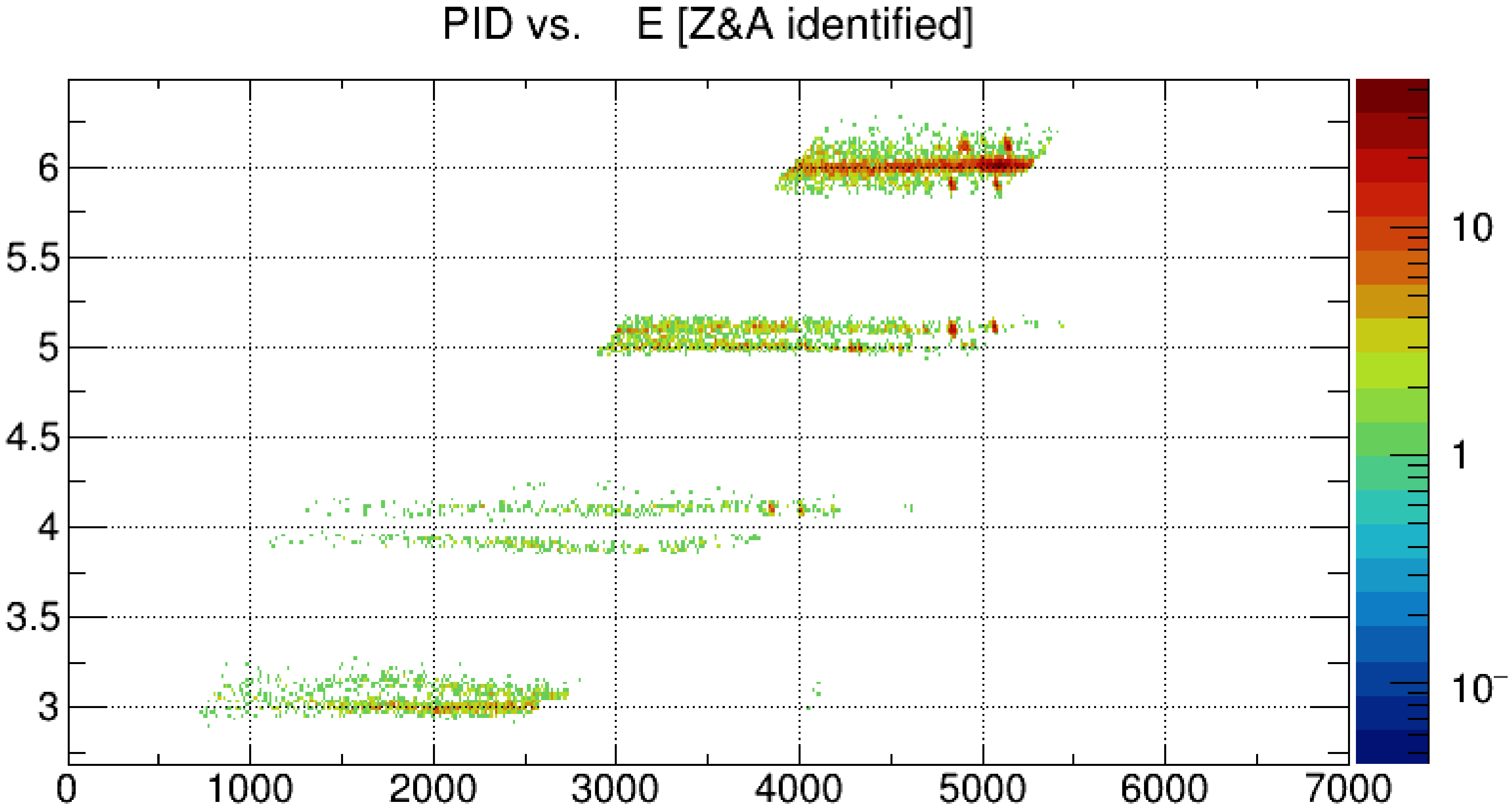


PID vs E

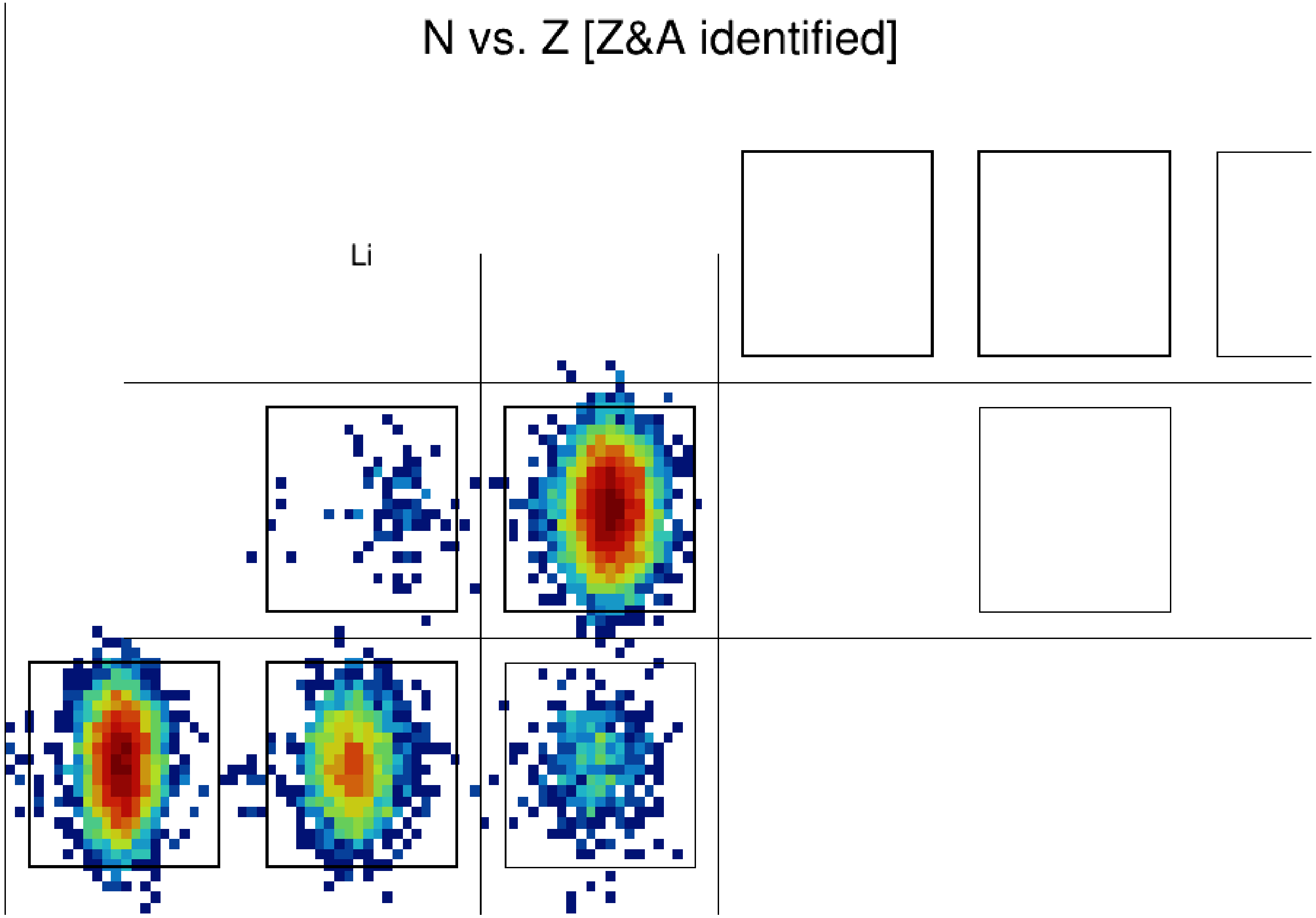


PID vs. E
10
9
8
7
6
5
4
3
2
1
0
0
1000
2000
3000
4000
5000
6000
7000
10^4
10^3
10^2
10
1

PID vs E in Mass ID region



Segrè chart for ΔE-E



Levels of 13C and 13N