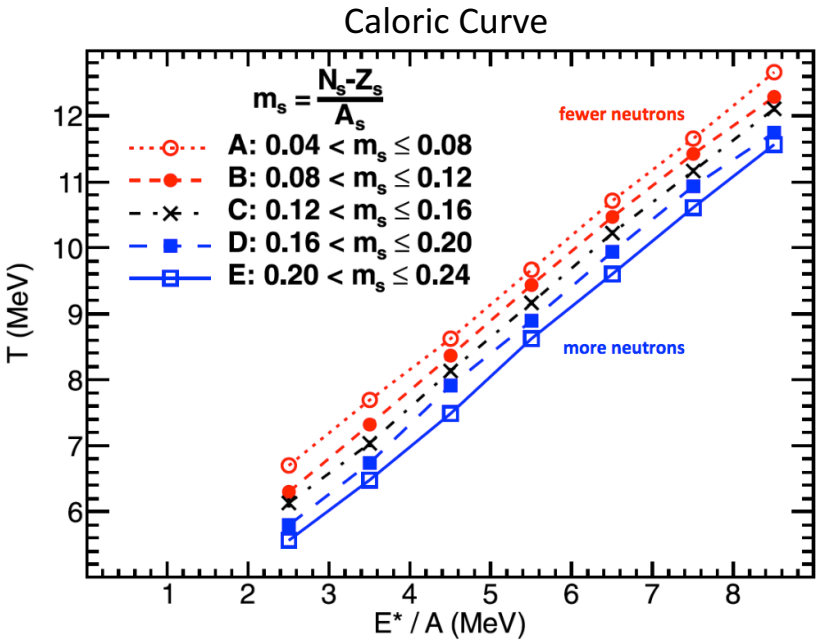
Calibration of a Fusion Experiment to Investigate the Nuclear Caloric Curve

Ashleigh Keeler

Background

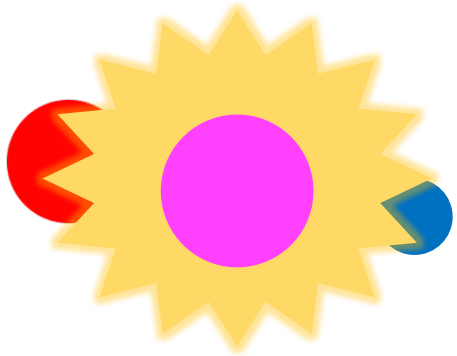
- Nuclear equation of state (EoS) importance:
  - Nucleosynthesis
  - Heavy-ion collisions
  - Supernovae dynamics
  - Neutron stars



A.B. McIntosh et al. Physics Letters B 719 (2013) 337–340

Introduction

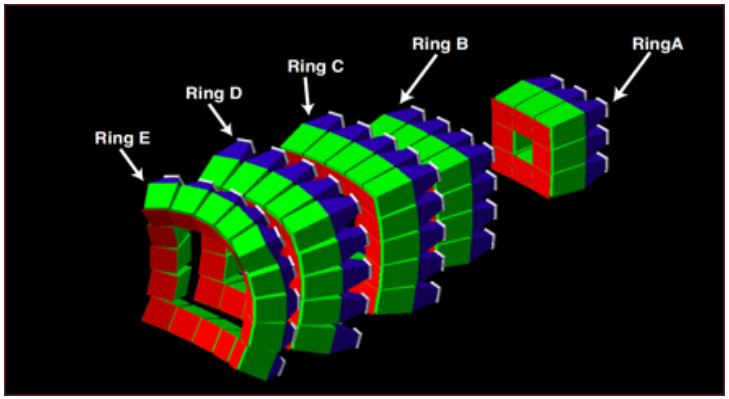
- To further investigate this result, fusion reactions (^{78}Kr + ^{12}C & ^{86}Kr + ^{12}C) were measured:
  - The beam energy was varied in the range 15-35 MeV/u in order to vary the excitation energy.

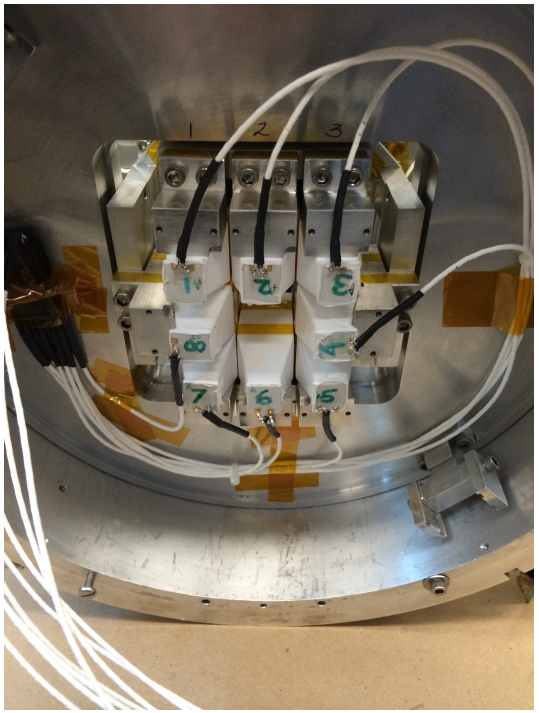


- The light charged particles (LCP's) that are evaporated from the nucleus carry information about the temperature.

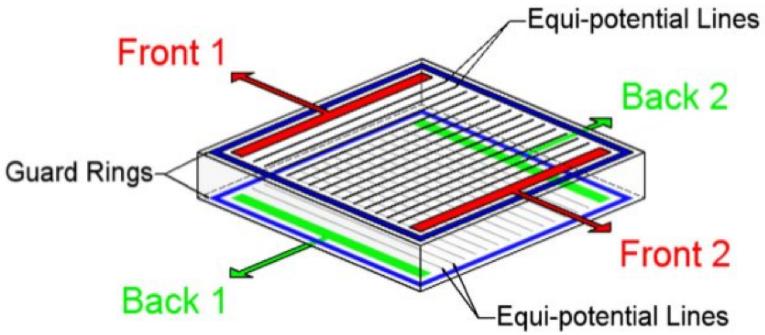
FAUST

- Si-CsI(TI)/PD detector array FAUST (Forward Array Using Silicon Technology)
- 68 ΔE-E telescopes
- Measures LCP's
- $1.6° \leq \theta \leq 45°$

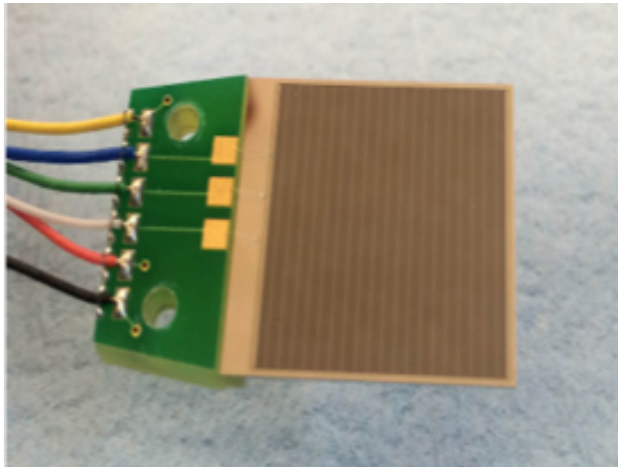




Charge Splitting

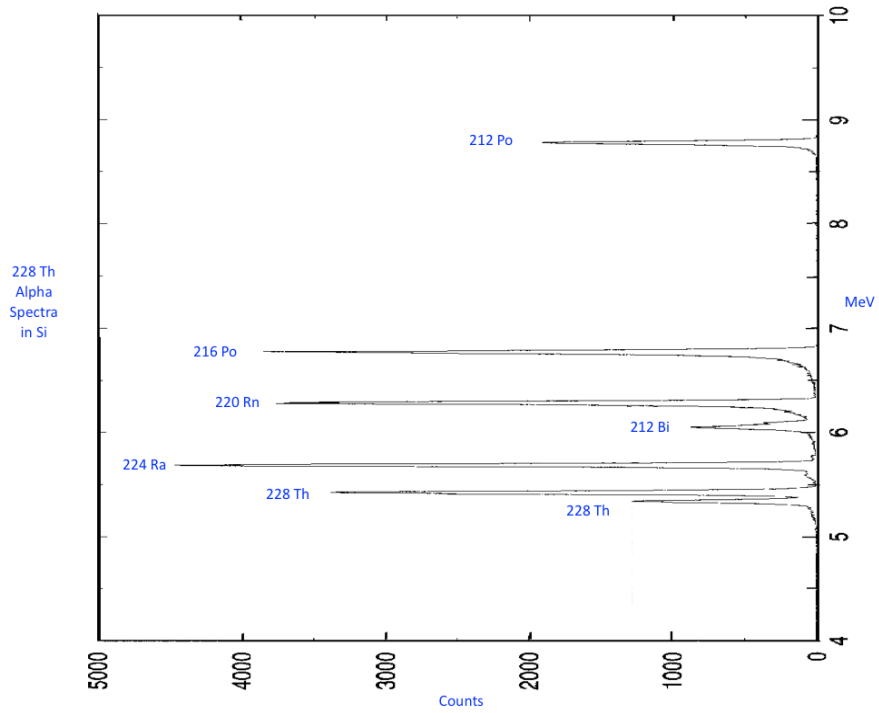


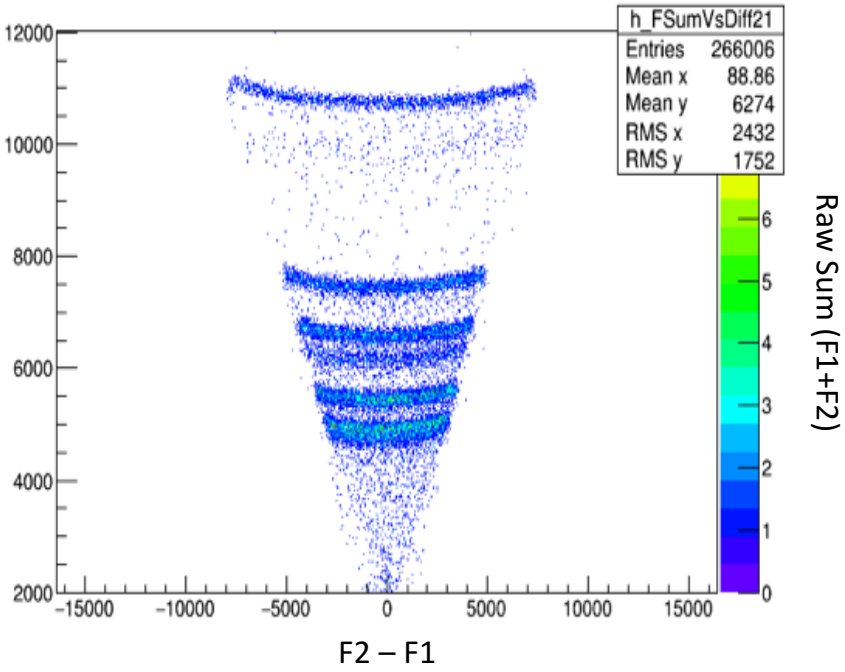
Schematic of DADL, showing the equipotential lines on the uniformly resistive surface, which allows the position to be determined by charge splitting



Photograph of DADL

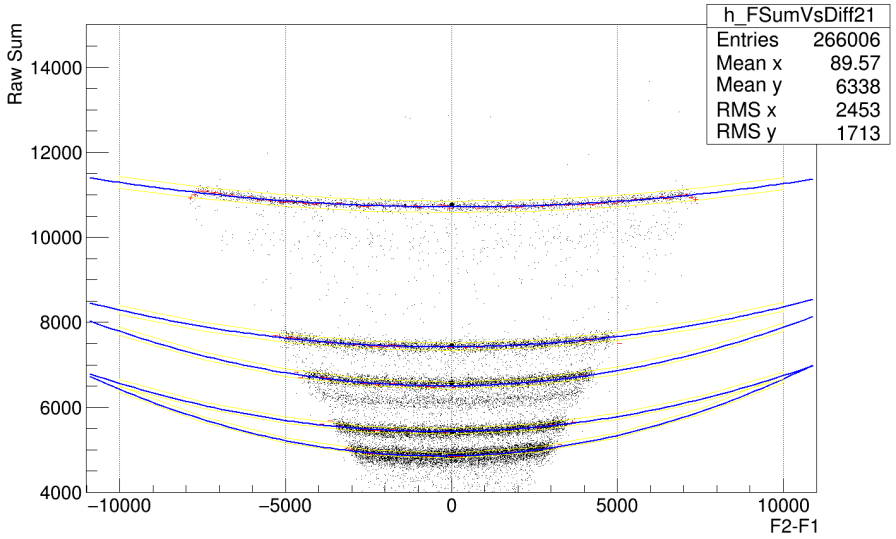
Position Correction



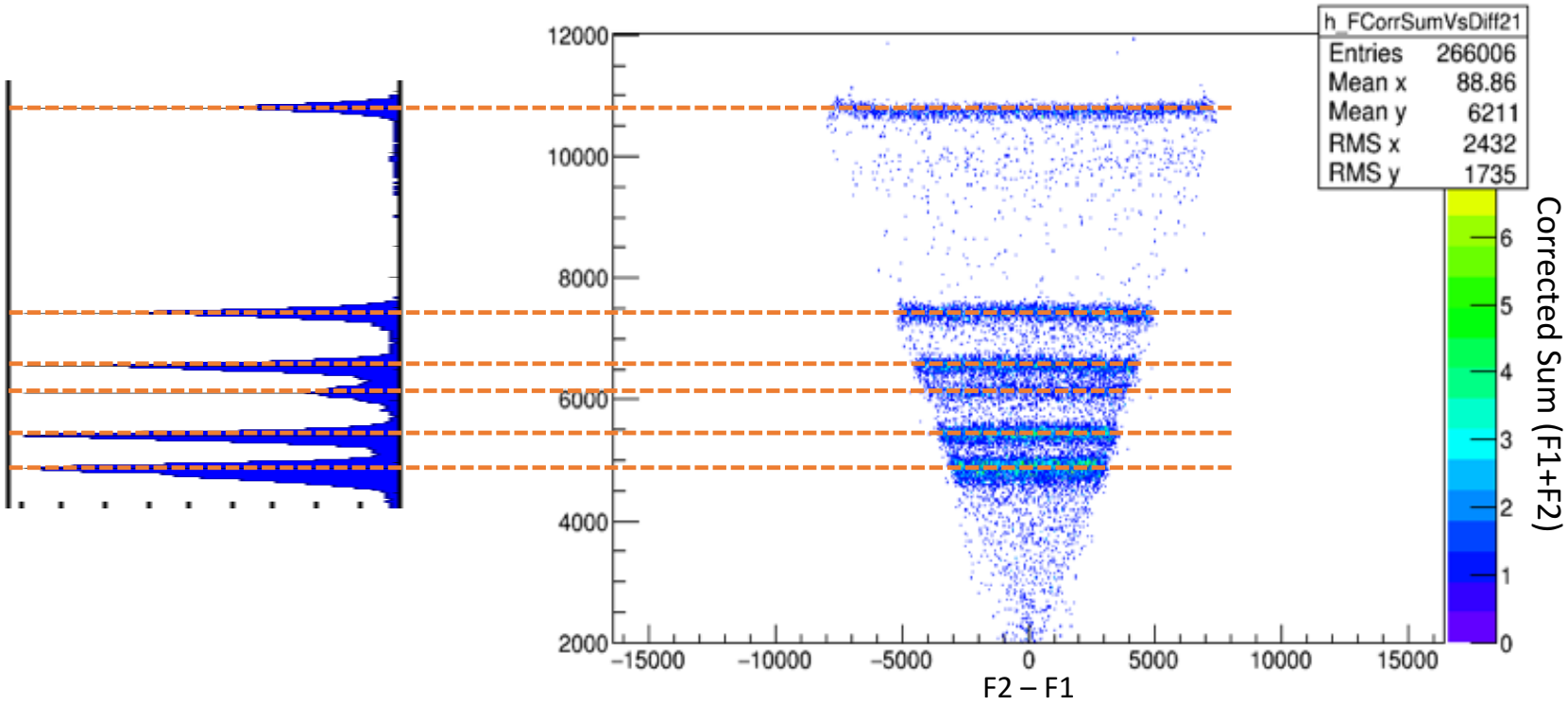


Position Correction

- Parametrization of the curvature of these bands as a function of the total energy was necessary in order to take full advantage of the resolution of the silicon detectors.

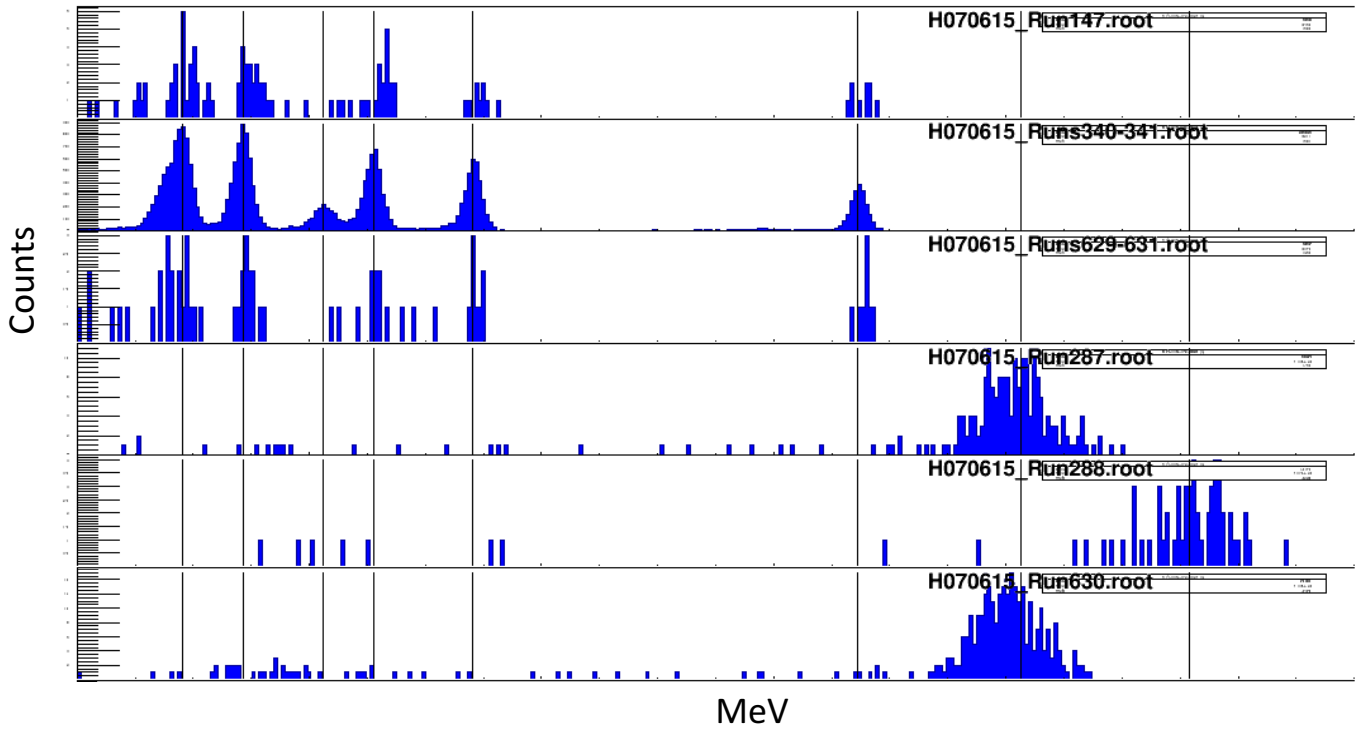


Position Correction



Energy Calibration

- Plotting several runs allowed us to determine that the location of these energy peaks did not change significantly with time.



228Th

228Th

228Th

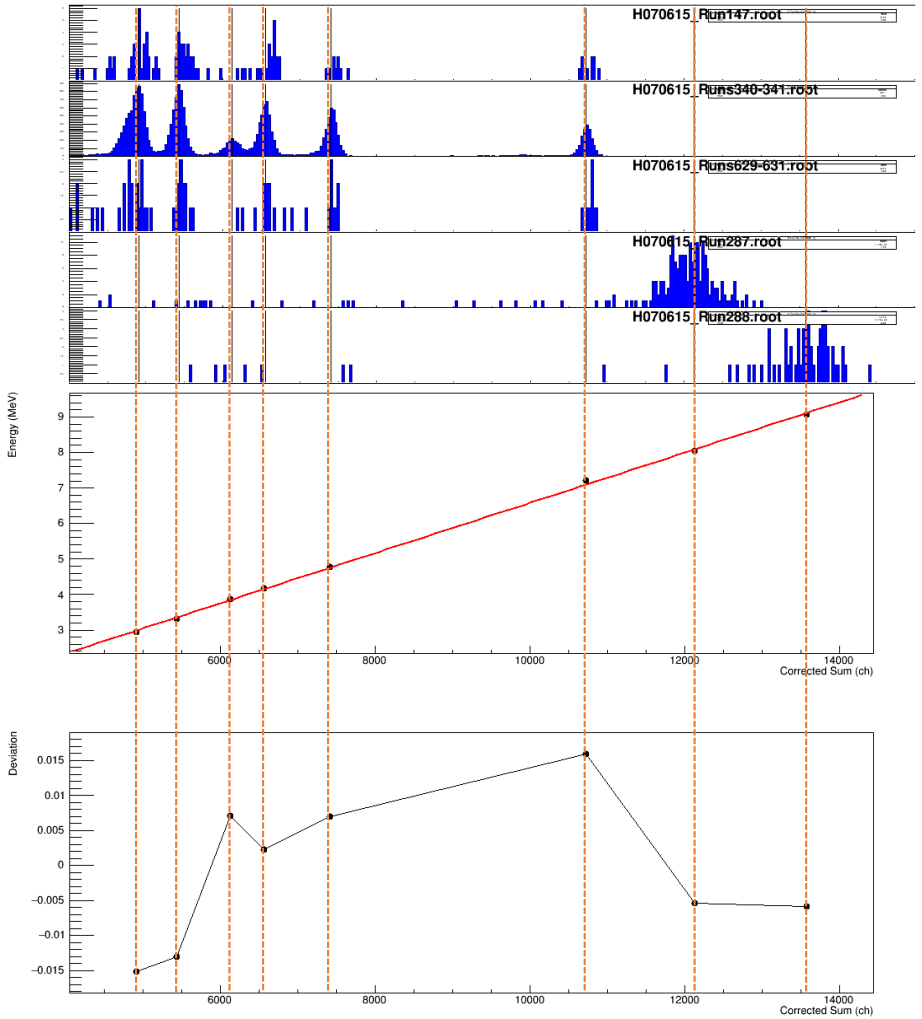
Alpha @ 15

Degraded Alpha @ 15

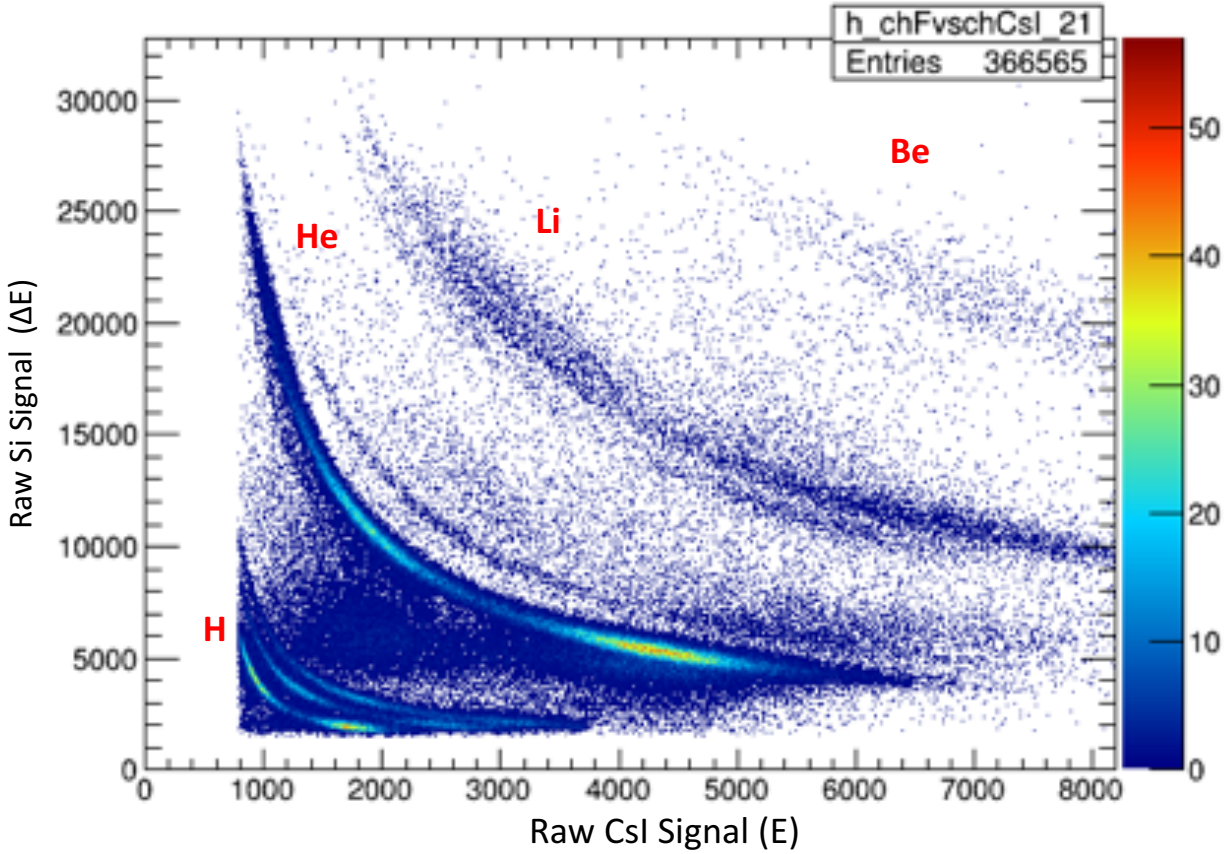
Alpha @ 15

Energy Calibration

- For detector 21 front, a linear fit is an accurate representation of the data to within 1.5%



Particle Identification (PID)

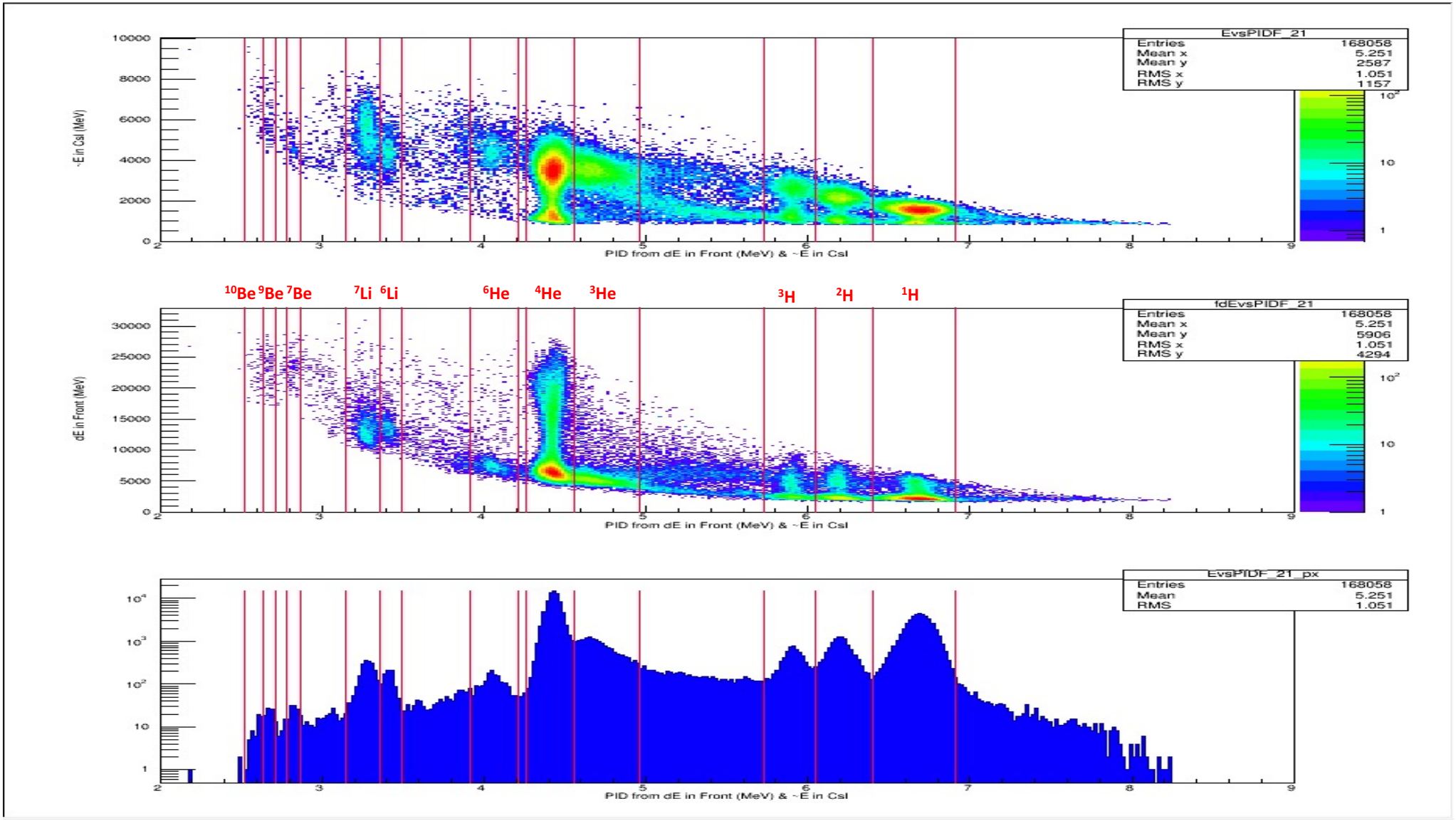


Particle Identification (PID)

- A parameterized formula, based on the Bethe-Bloch equation, was used to straighten the PID lines measured with the ΔE-E technique.

$$PID = b * \log(x_0) - \log(b * \Delta E) - (b-1)\log(E + x_1 * \Delta E)$$

Where b is defined as: $b = x_2 - x_3 * \frac{\Delta E}{x_4}$


EvsPIDF_21
Entries 168058
Mean x 5.251
Mean y 2587
RMS x 1.051
RMS y 1157
~E in CsI (MeV)
PID from dE in Front (MeV) & ~E in CsI
10Be 9Be 7Be 7Li 6Li 6He 4He 3He 3H 2H 1H
fdEvsPIDF_21
Entries 168058
Mean x 5.251
Mean y 5906
RMS x 1.051
RMS y 4294
dE in Front (MeV)
PID from dE in Front (MeV) & ~E in CsI
EvsPIDF_21_px
Entries 168058
Mean 5.251
RMS 1.051
PID from dE in Front (MeV) & ~E in CsI

Future

- The particle identification (PID) and PID cuts described in this presentation are being finalized.
- Once the PID is completed, the next step is the energy calibration of the CsI detectors (based on the silicon energy calibration and the PID).
- Position Calibration
- This calibration of FAUST will allow further study of the asymmetry energy in the EoS to be investigated via the nuclear caloric curve.

Acknowledgements

I would like to thank the SJY research group, and the staff of the Cyclotron.

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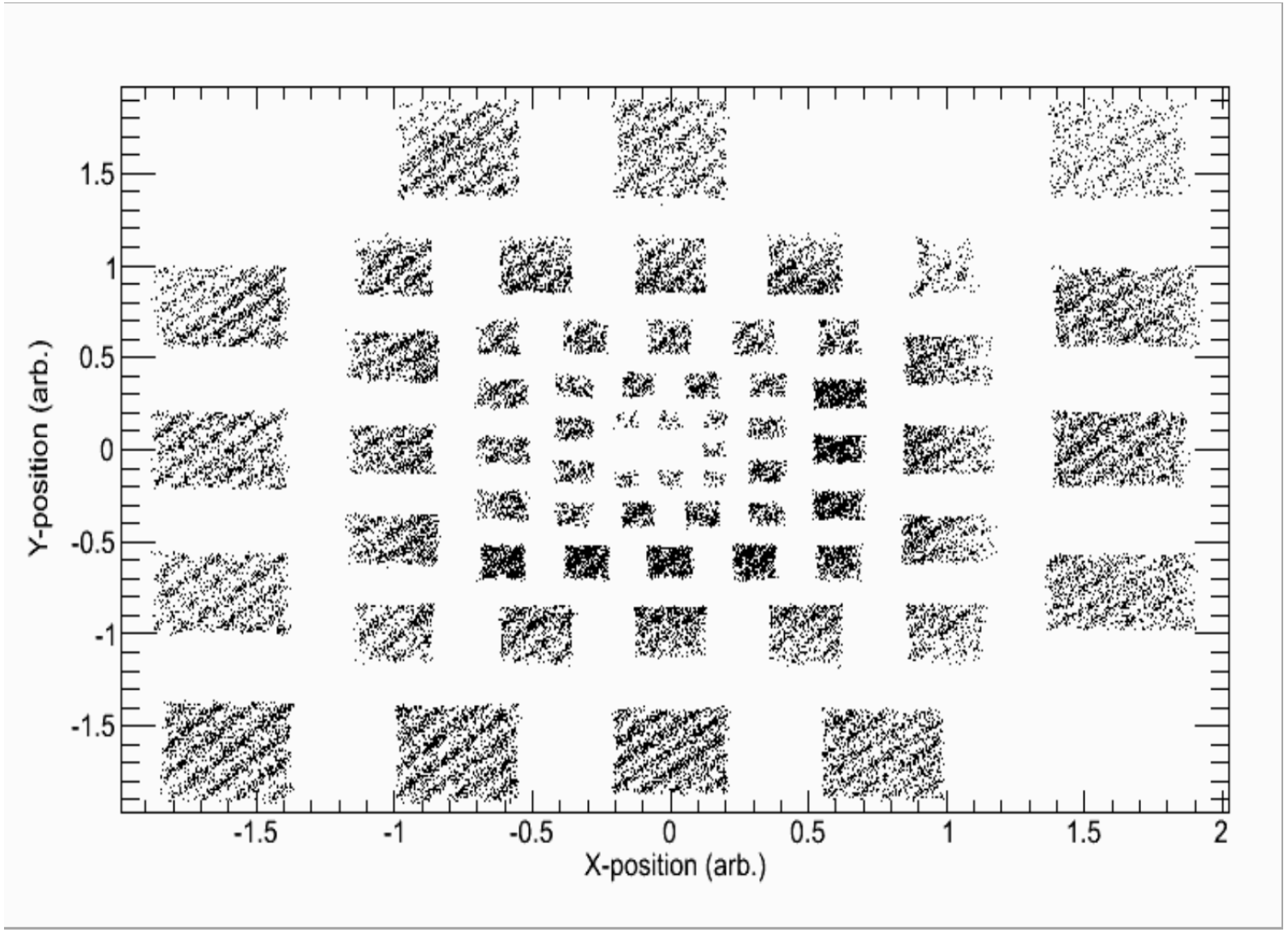
Y-position (arb.)
1.5
1
0.5
0
-0.5
-1
-1.5
-1.5
-1
-0.5
0
0.5
1
1.5
2
X-position (arb.)