CYCLOTRON INSTITUTE
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Profiling CsI detectors

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Goal

- Investigate the properties of two cesium iodide (CsI) detectors
- Measure the detector's resolution and whether it depends on the location on the detector's surface

Motivation

- These two CsI detectors will be used in the Texas Active Target (TexAT) detector currently being developed
  - Will be used for experiments with rare isotope beams to study structure of exotic nuclei and measure nuclear reactions relevant for nuclear astrophysics
- It is important to know whether these detectors have a good resolution and whether the location on the surface affects the data recorded

TexAT Detector

- An active-target time projection chamber (TPC) currently in development
  - TPC: A gas filled chamber with a uniformly applied electric field that allows 3D track reconstruction
    - Active target: The gas is both the detection medium and the target

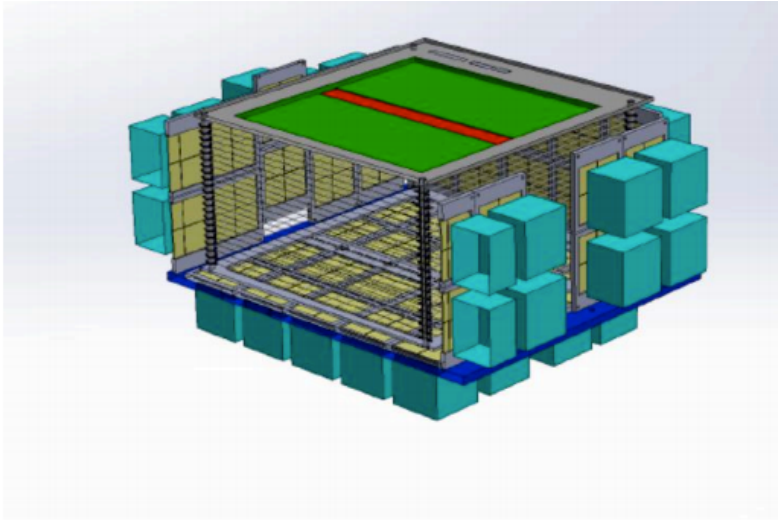


FIG. 1. TexAT assembly (one side of array is removed to show details).

From E. Koschivy et al.

TexAT Detector

- Incoming particles will ionize the atoms of the gas and create free electrons
  - Drift towards the readout plane (a MicroMegas board)
  - The detection location of the electrons and drift time allow for track reconstruction

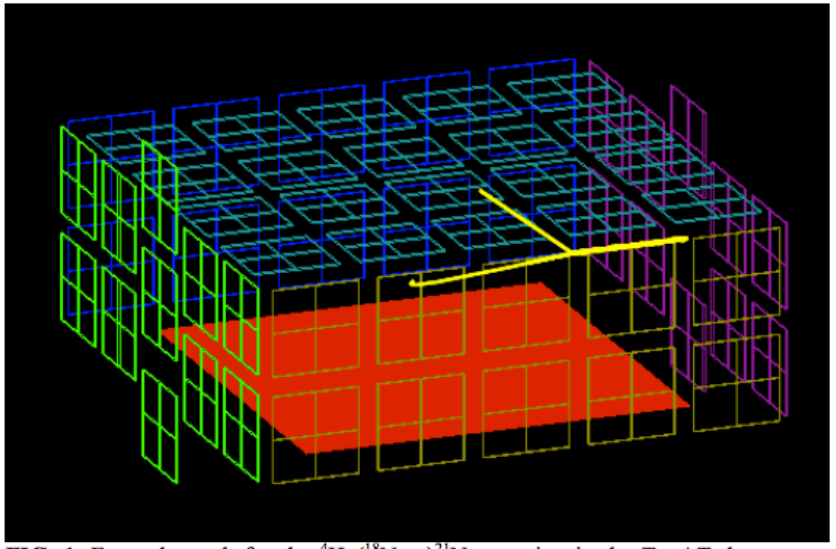


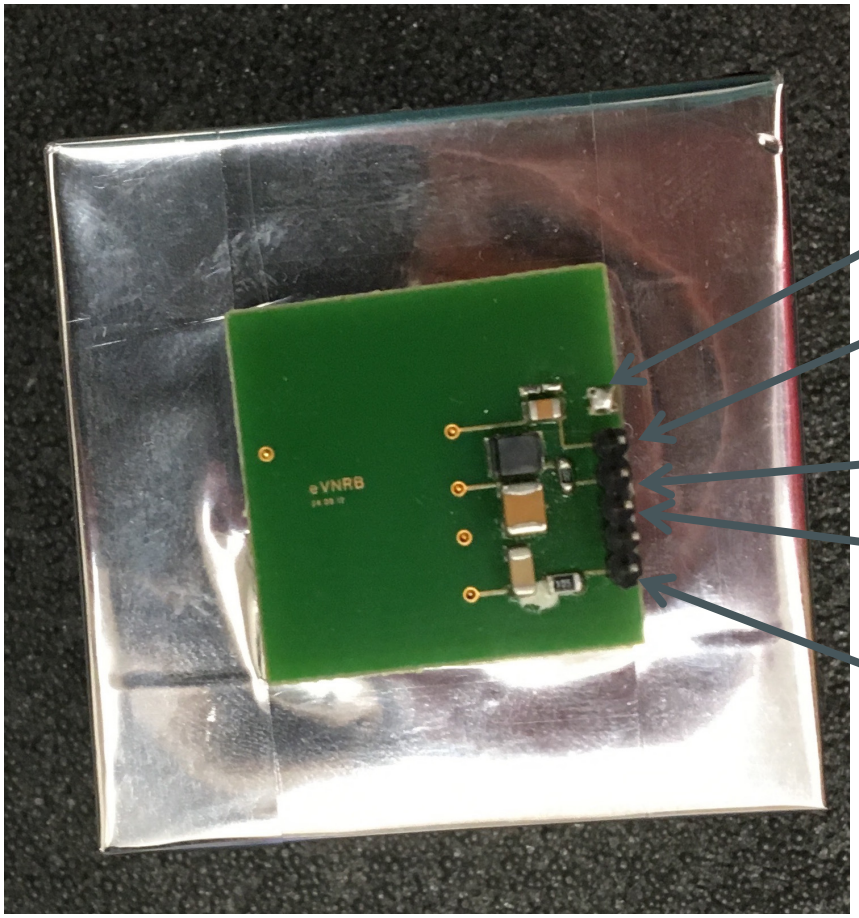
FIG. 1. Example track for the $^{4}He(^{18}Ne,p)^{21}Na$ reaction in the TexAT detector as visualized in Geant4. The light recoil (proton) hits the Si detector on the top plate and the heavy recoil (^{21}Na) stops in the gas volume.

From E. Koschivy et al.

About CsI detectors

- CsI is a type of scintillation detector (or scintillator)
- Converts the energy of the incoming charged particles into light
- Silicon PIN diodes convert the light to free electrons
  - A photon knocks out an electron in the p-n junction
- CsI is a slow scintillation detector

The CsI detector



Ground

Out

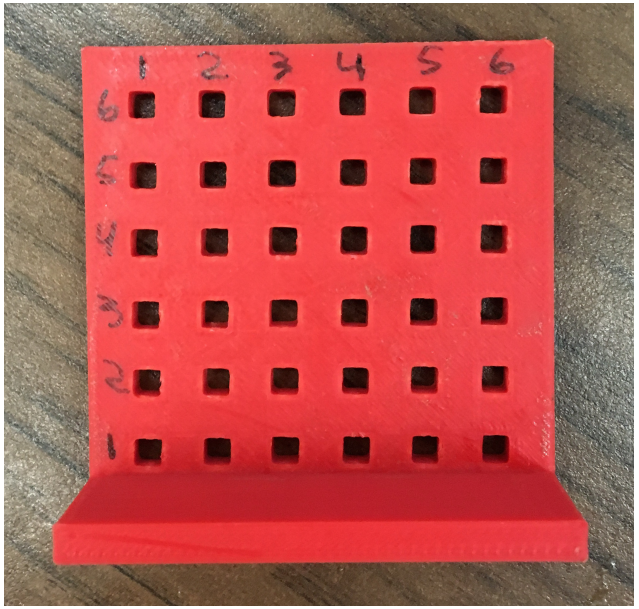
+12 V

Ground

+70 V

Profiling the CsI detector

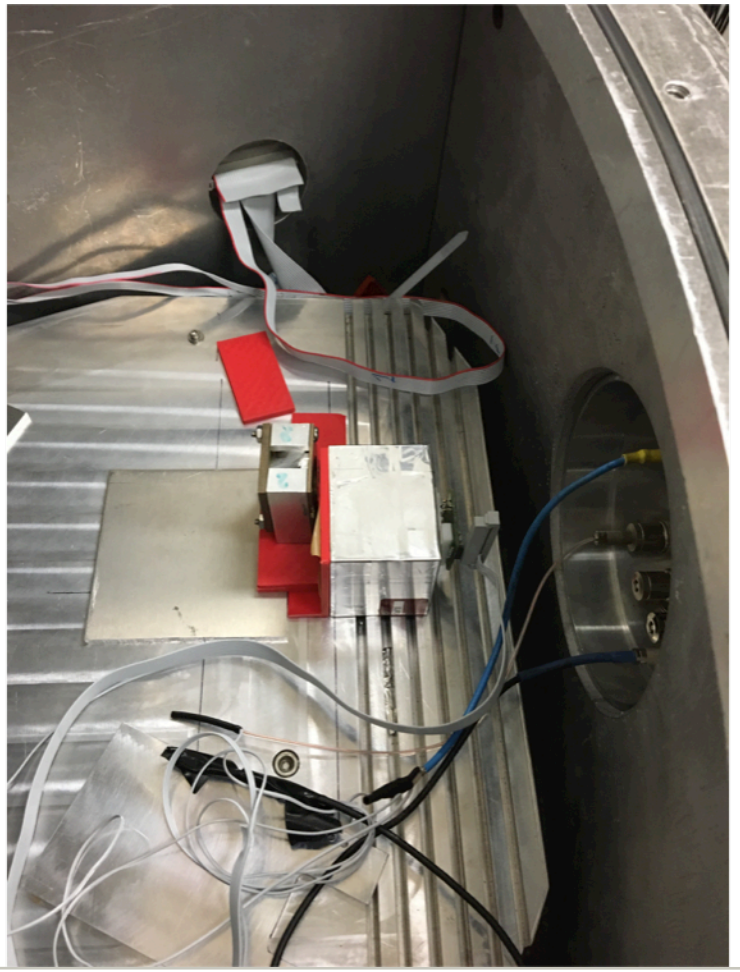
- Profiled a cesium iodide detector by placing a mask in front of the detector and measuring the frequency and energies of the alpha particles that pass through each hole



The mask for the CsI detector.

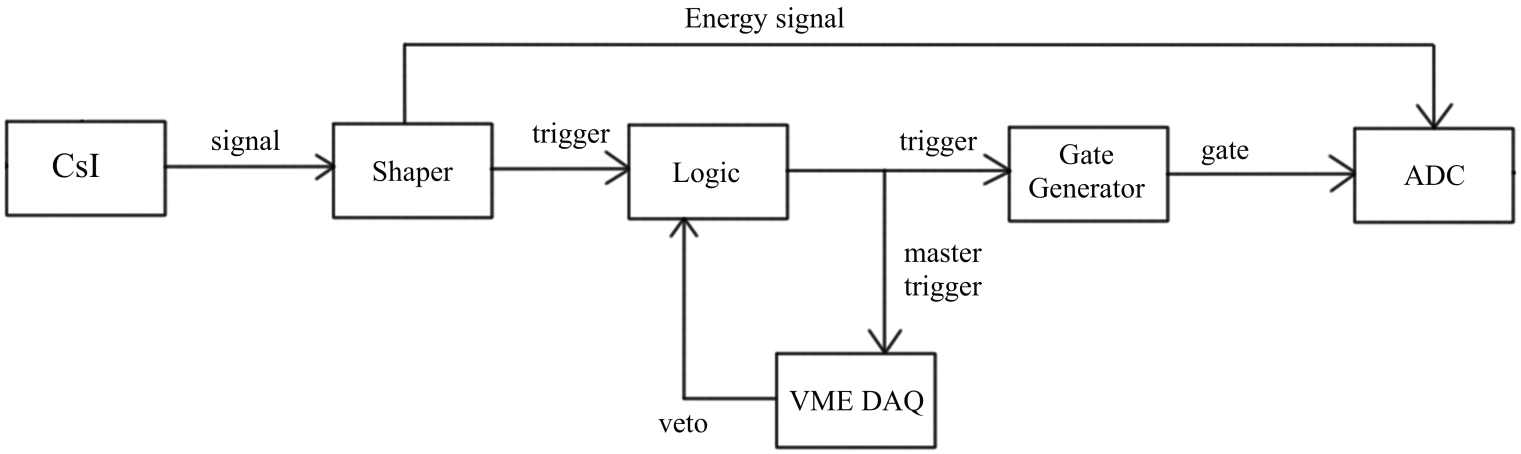
Profiling the CsI detector

- Recorded the means and sigmas of each energy peaks
- Calculated the FWHMs and resolutions for each hole (FWHM= sigma*2.3548, resolution=FWHM/mean)



Setup of the cesium iodide experiment.

Electronics setup



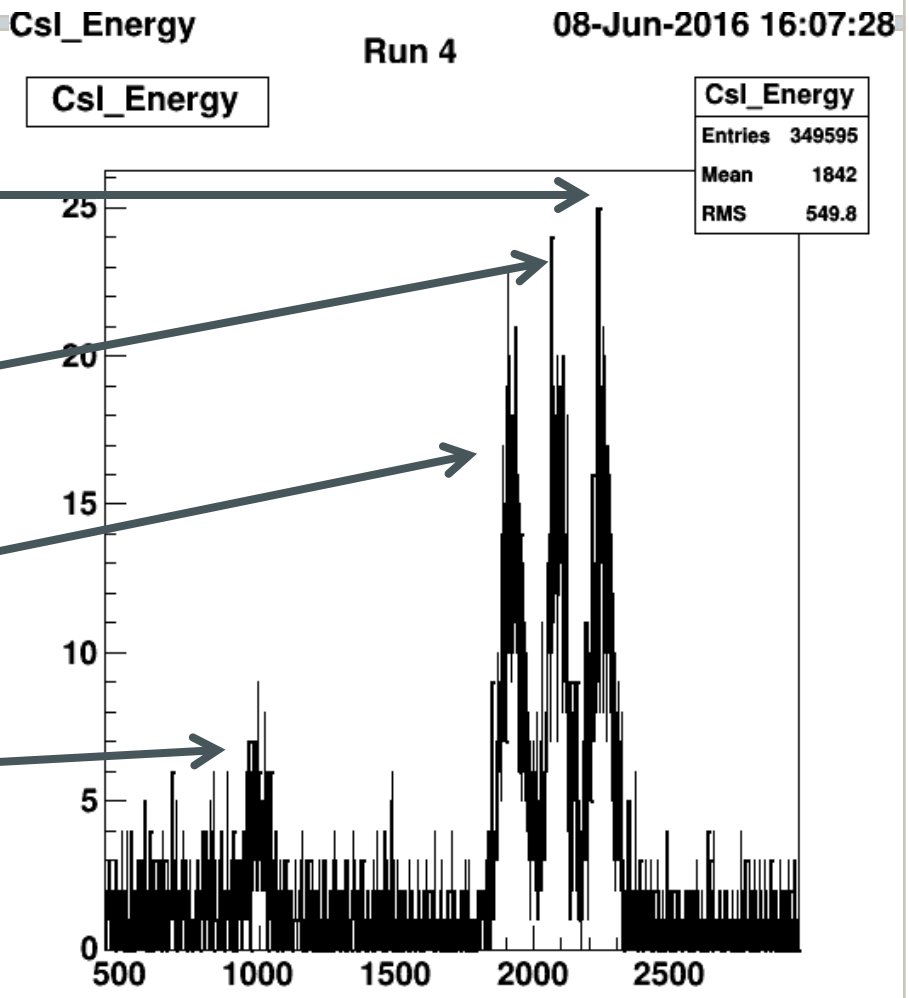
Example data

Cm-244 at 5787.68 keV

Am-241 at 5474.12 keV

Pu-239 at 5142.60 keV

Gd-148 at 3177.75 keV

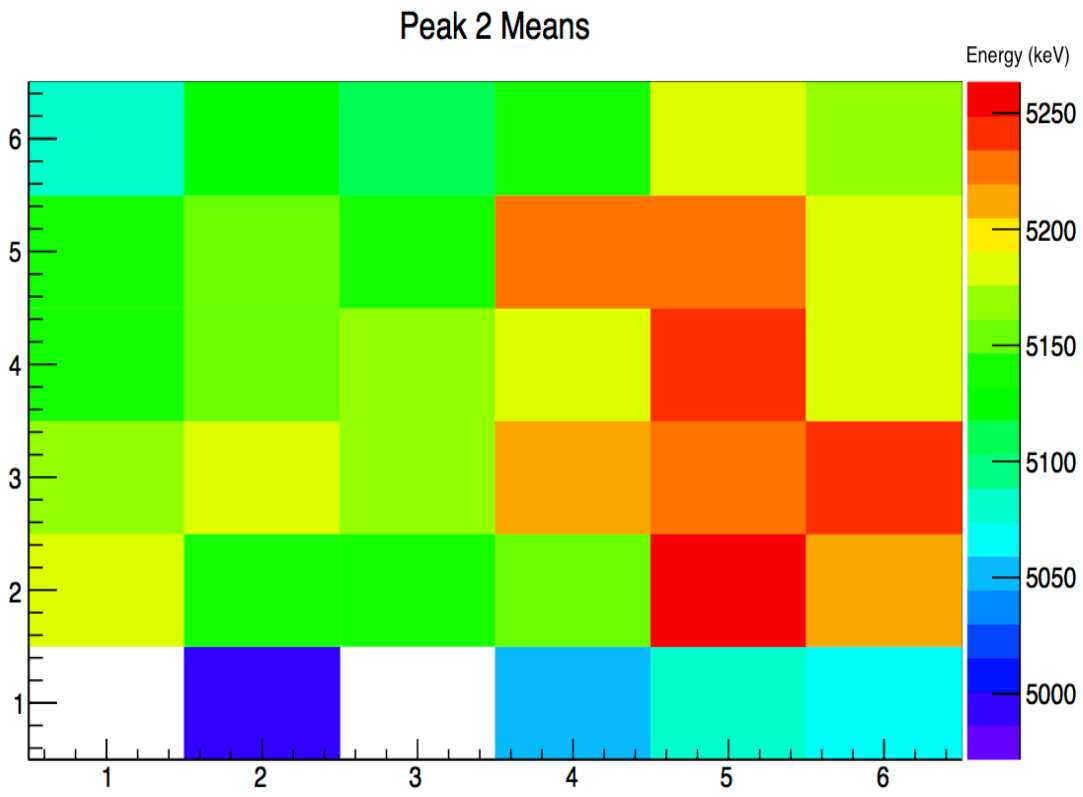


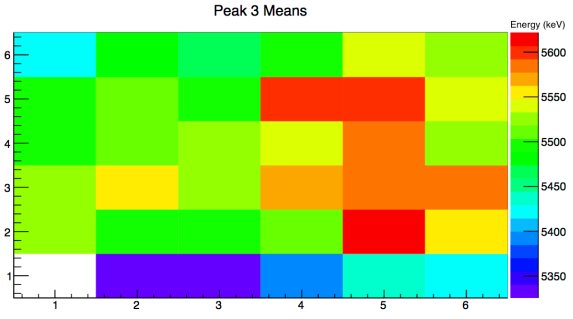
My CsI Detector

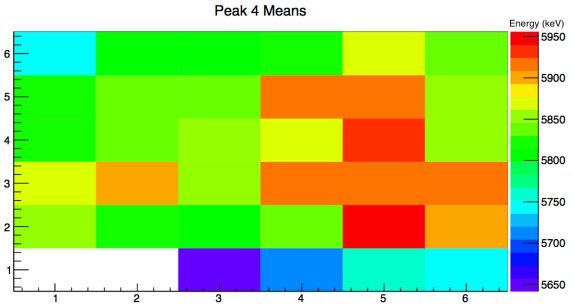
Results

- The lowest peak (Peak 1) frequently didn't show up in the measurements, so the results for it are not shown here.
- Here are the mean and resolution plots for the other three peaks.

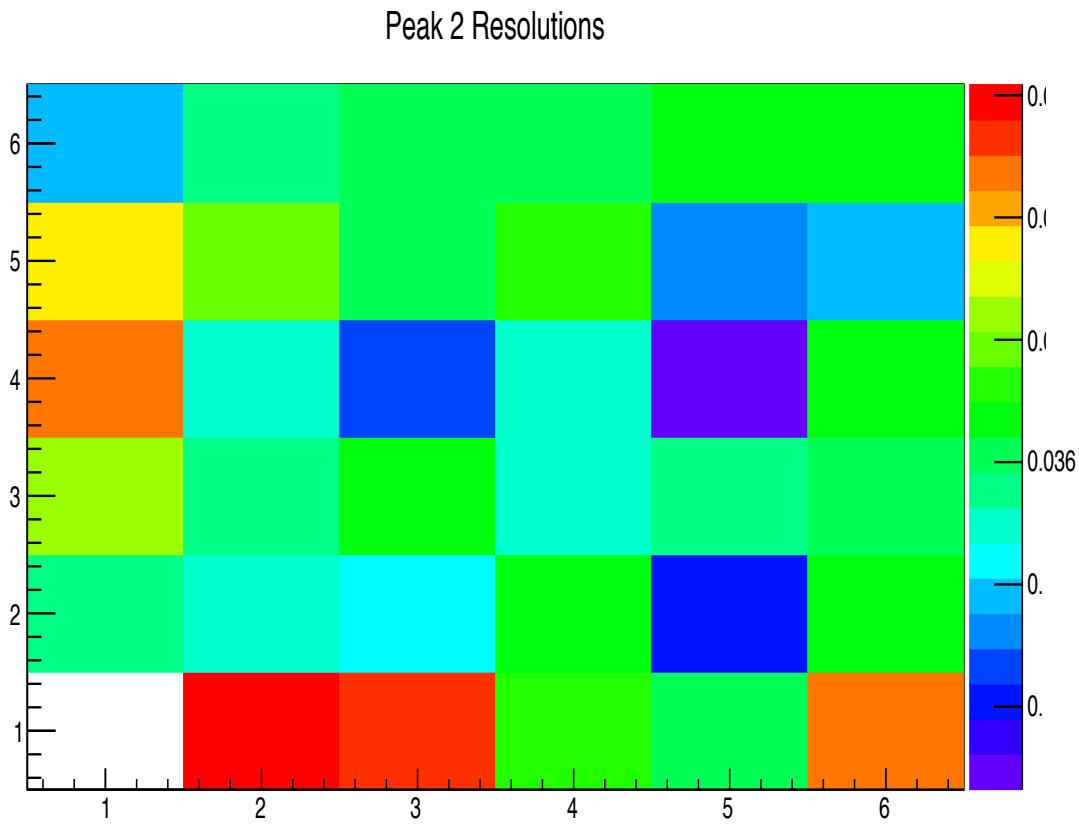
Peak means

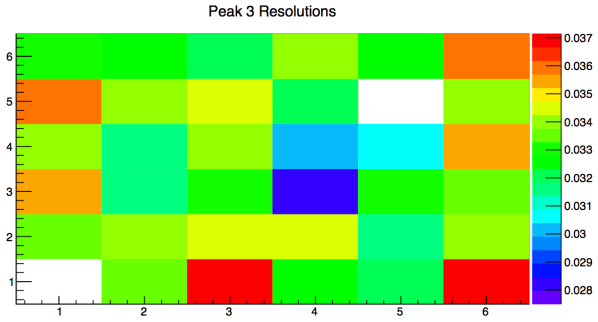

Peak 2 Means
Energy (keV)
5250
5200
5150
5100
5050
5000
1
2
3
4
5
6

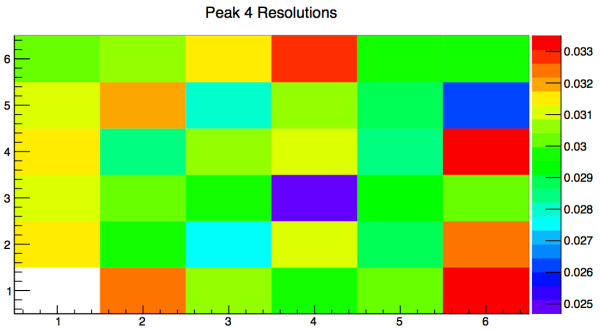

Peak 3 Means
Energy (keV)
5600
5550
5500
5450
5400
5350


Peak 4 Means
Energy (keV)
5950
5900
5850
5800
5750
5700
5650

Peak 2 Resolutions

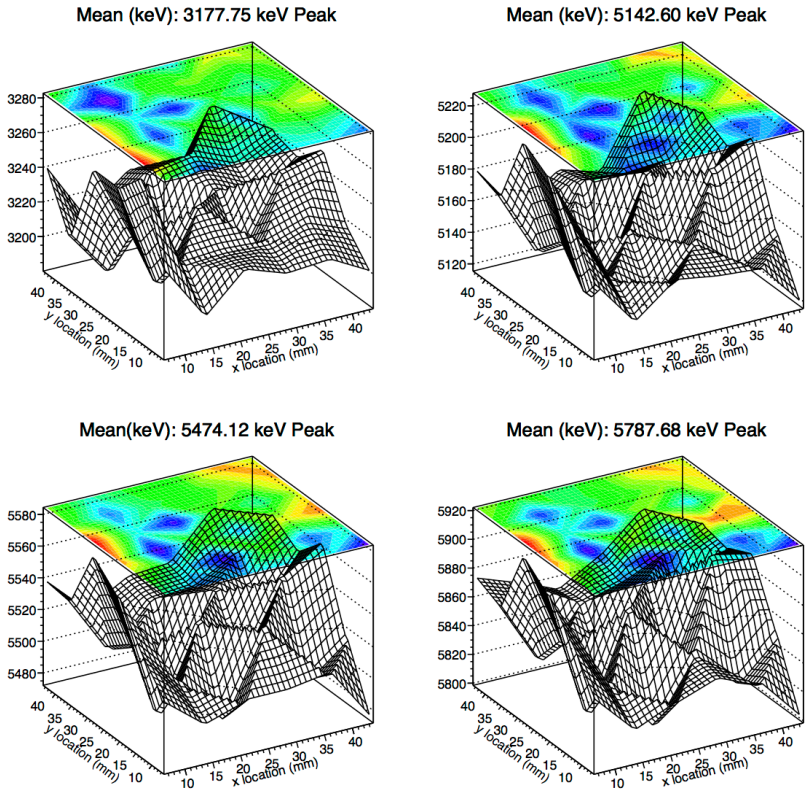




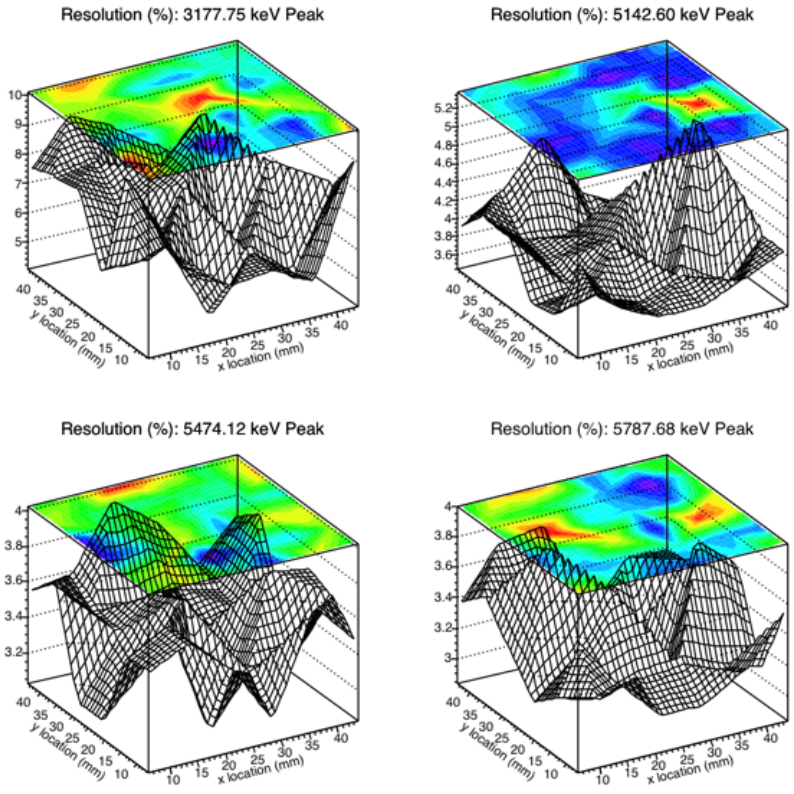


Kaitlin's CsI Detector

Kaitlin's Results



Kaitlin's Results



Conclusions

- The setup to test resolution and surface nonuniformity worked
- The two detectors behaved similarly
  - Resolution is better in the middle than at the edges, like was expected
- Nonuniformity contributes less than the instrinsic resolution of the detector

Acknowledgements

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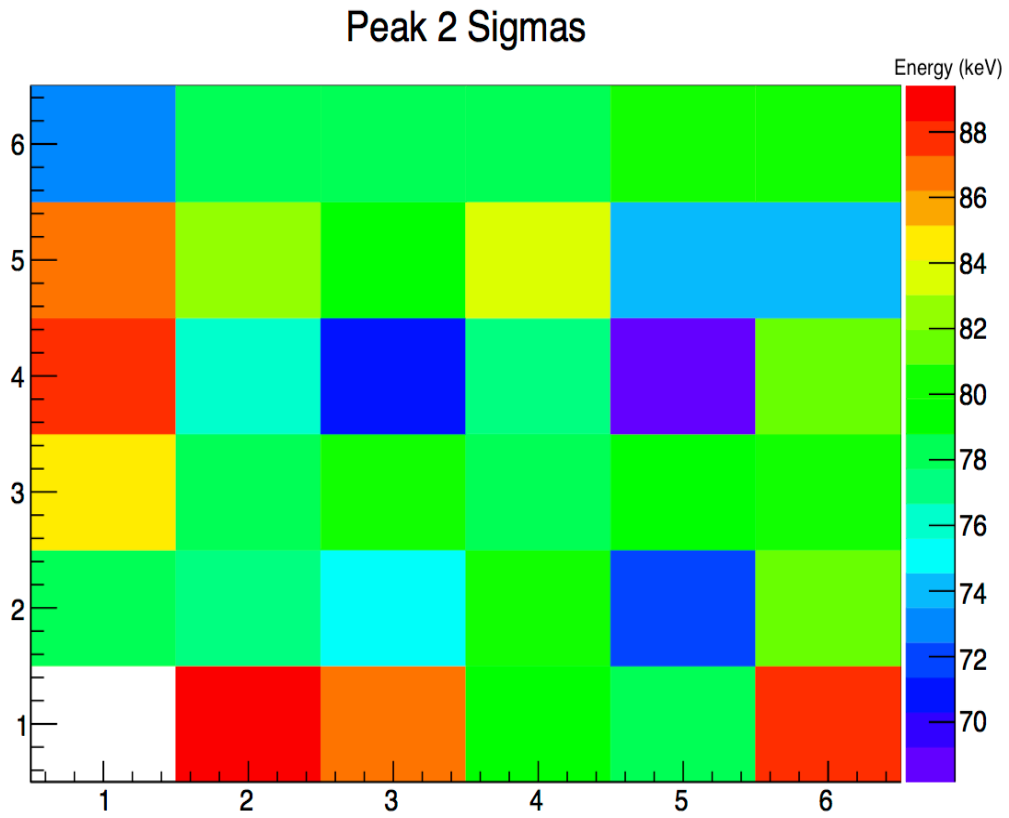
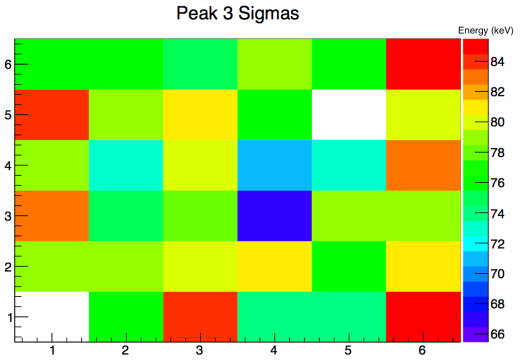
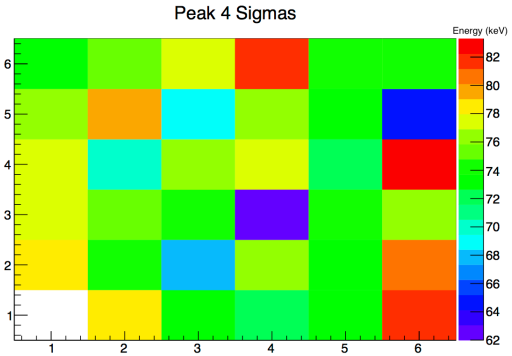
References

- E. Koschivy, G. V. Rogachev, E.Uberseder, and E. Pollaco. Texas A&M and IRFU, CEA Saclay, Gif-Sur-Ivette, France. *Texas Active Target (TexAT) Detector- part I: Design and construction progress*.
- E. Koschivy, G. V. Rogachev, E.Uberseder, and E. Pollaco. Texas A&M and IRFU, CEA Saclay, Gif-Sur-Ivette, France. *Texas Active Target (TexAT) Detector- part 2: Monte Carlo Simulations*.

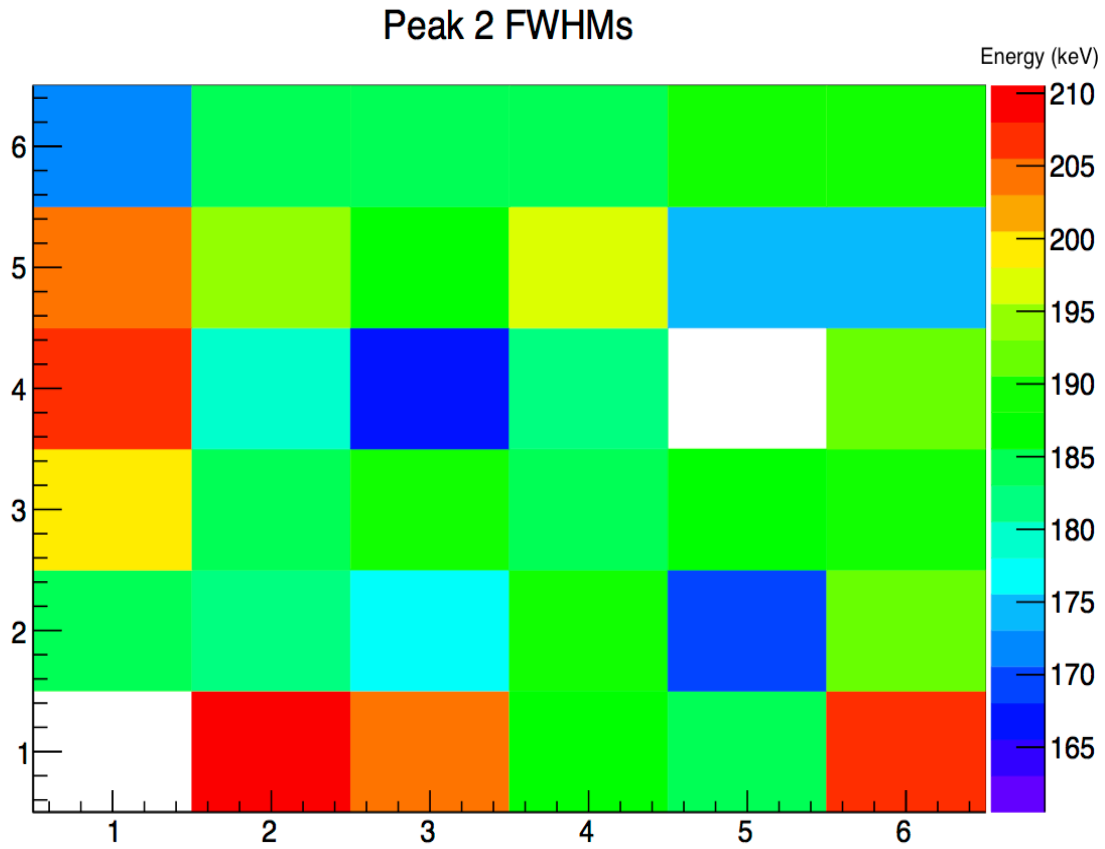
Peak 2 Sigmas

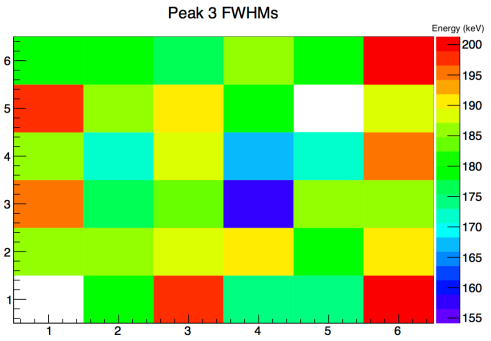


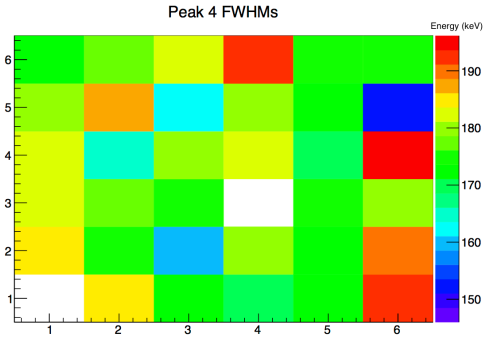




Peak 2 FWHM


Peak 2 FWHMs
Energy (keV)
210
205
200
195
190
185
180
175
170
165
1
2
3
4
5
6


Peak 3 FWHMs
Energy (keV)
200
195
190
185
180
175
170
165
160
155
1
2
3
4
5
6


Peak 4 FWHMs
Energy (keV)
190
180
170
160
150
1
2
3
4
5
6

Kaitlin's Results