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ADVANCED DOSIMETRY DATA ANALYSIS USING TRACKING INFORMATION FROM PIXEL DETECTORS

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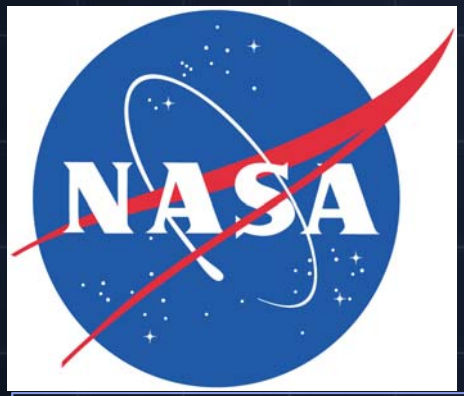

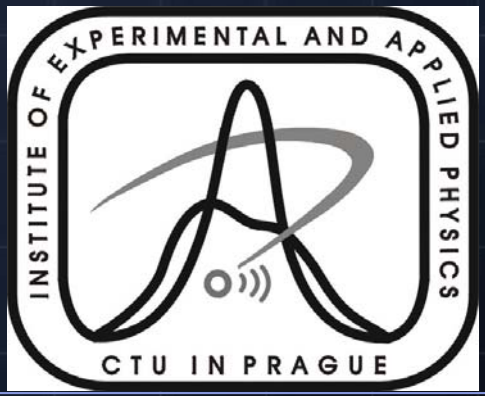

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OUTLINE

- Introduction
- Problem specification
- Angle & Delta-ray Analysis
- Conclusion and future work

Introduction

- Our goal is to provide as good as possible data which will be used for dosimetry calculations
- The ultimate goal would be to provide the energy spectra for different particle species which can be found in space radiation
- Two tasks – measure energy, identify particle

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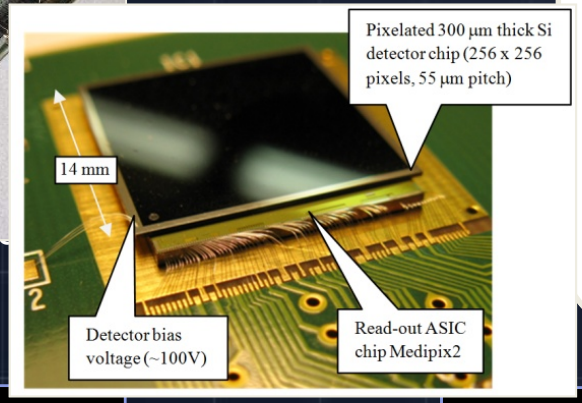
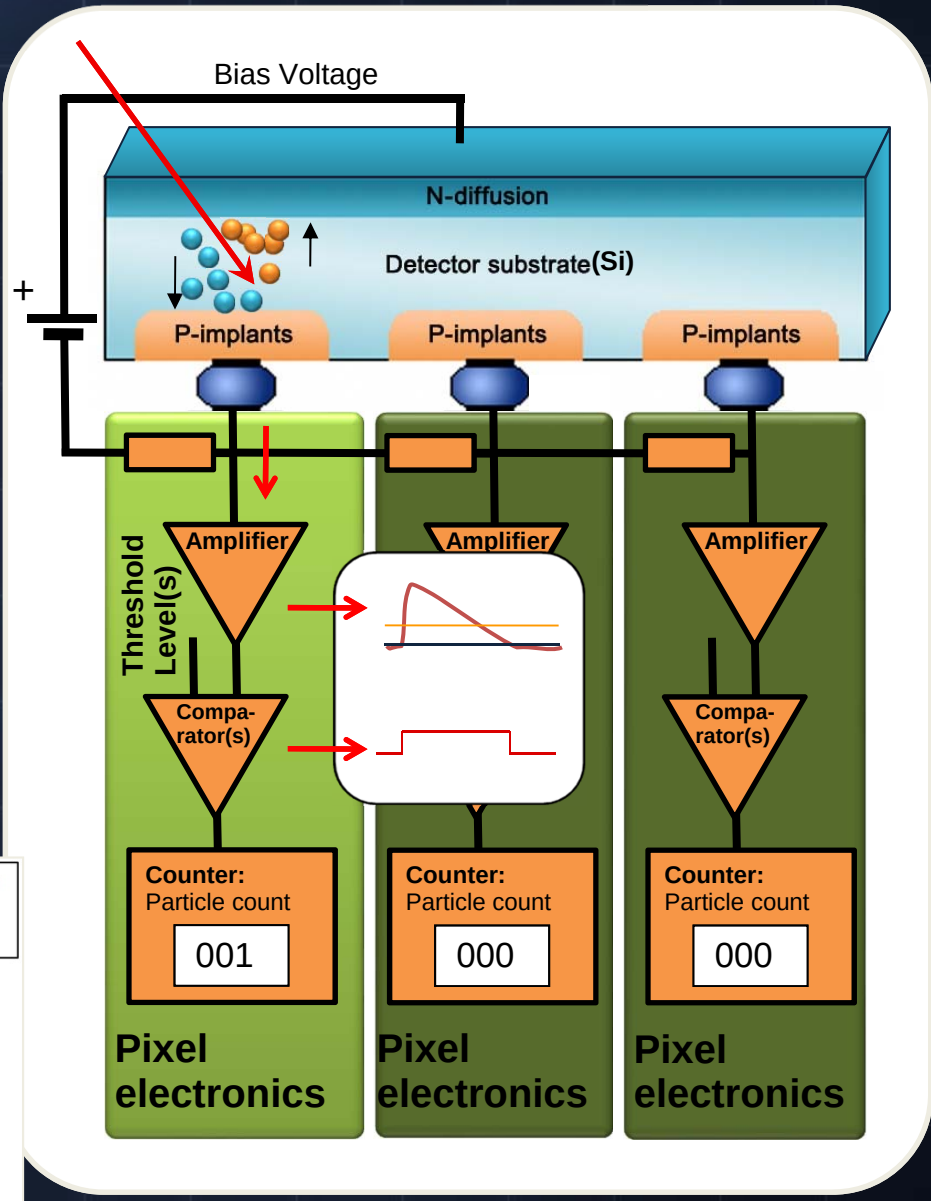
Medipix pixel detectors

Medipix2

- 256 x 256 pixels
- Pitch of 55 um
- Based on hybrid technology
- Developed in CERN
- Control system (HW&SW) developed at IEAP
- Each pixel analogy of single channel analyzer in integral mode





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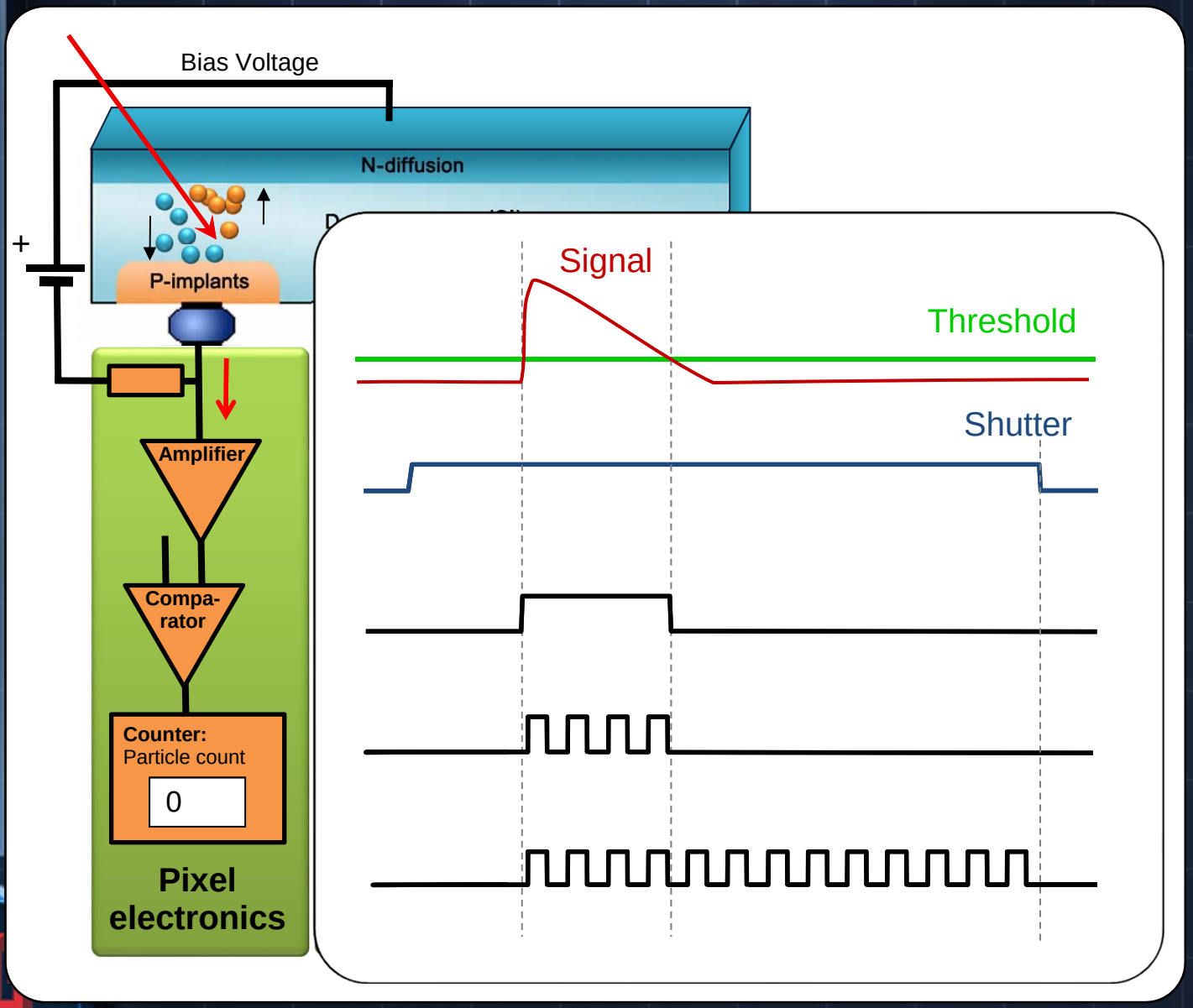
Operation modes of Timepix



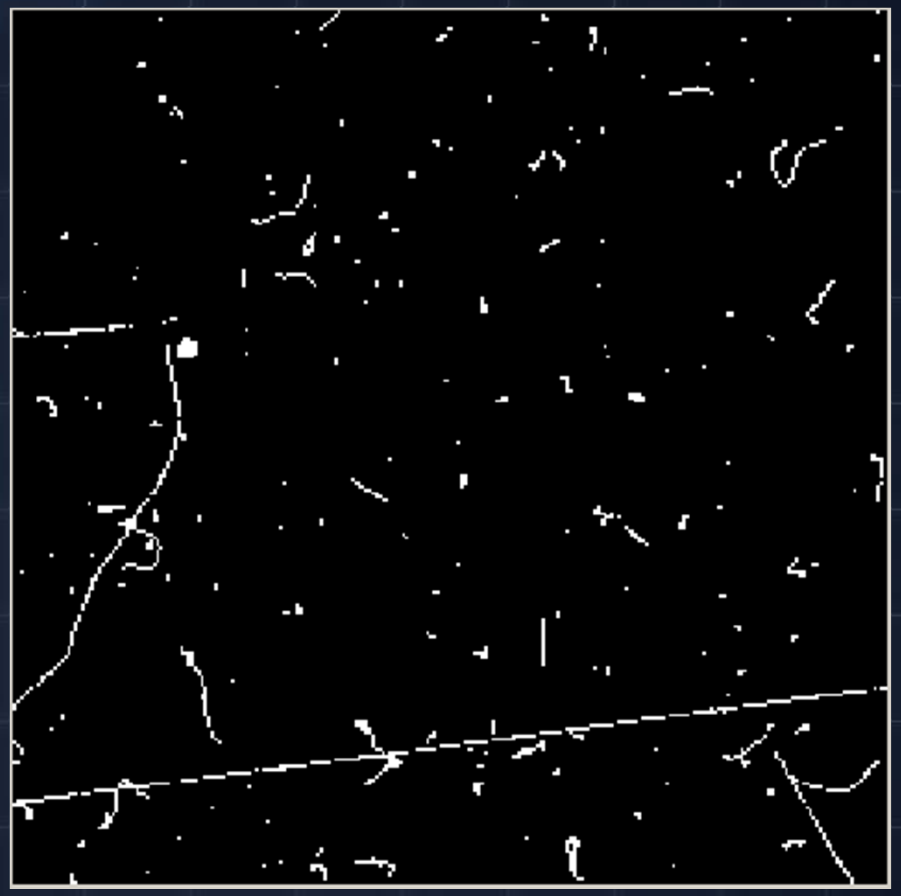
Medipix mode counting of incoming particles

Time over threshold (TOT) mode allowing direct energy measurement in each pixel (analogy of 65 k multichannel analyzers with 1000 channels per pixel)

Timepix mode measurement of particle interaction/arrival time

Pixel detector advantage

- As with the cloud chamber, the particles interacting with the detector creates tracks which can be investigated
- We called the track originating from one particle CLUSTER



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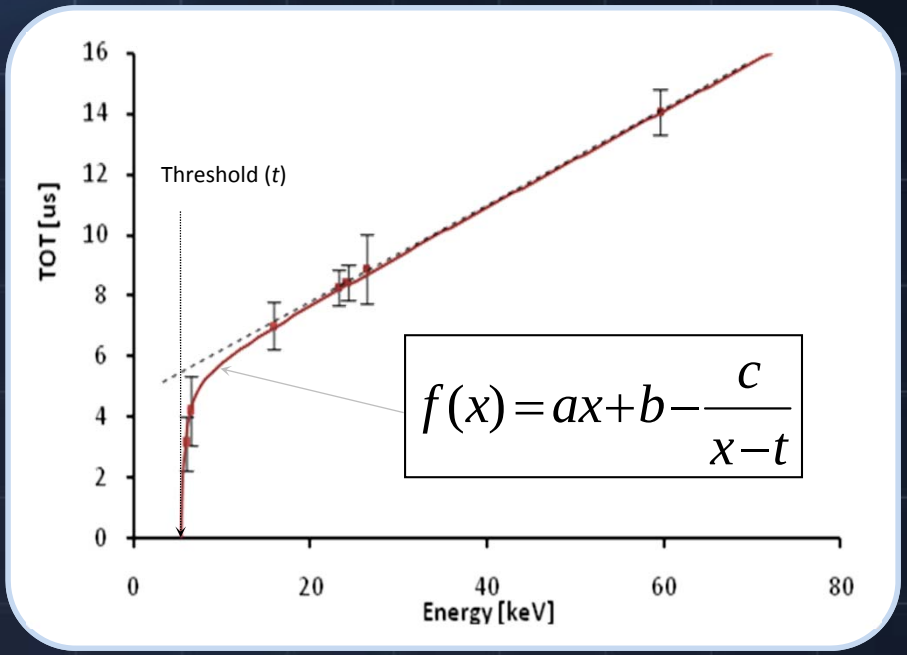
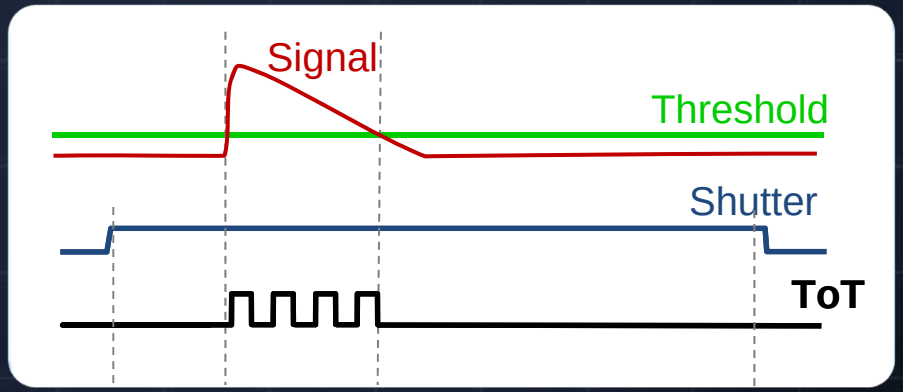
Energy measurement

- Opposite to cloud chamber we have also, directly dE information
- Typical value of threshold, i.e. the minimum detectable energy ~ 4 keV
- Typical resolution ~ 2 - 4 keV FWHM for energies 5 - 60 keV





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Measurement challenges

- Cluster variation (depends on types of ion and velocity)
- Azimuthal direction determination (path in detector)
- Delta-ray existance
- Detector effects
- Bias-voltage variation

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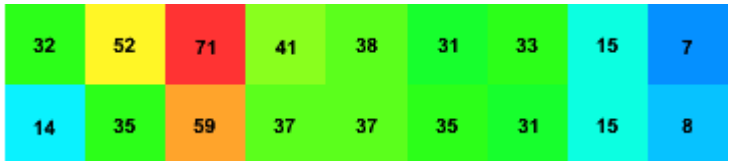
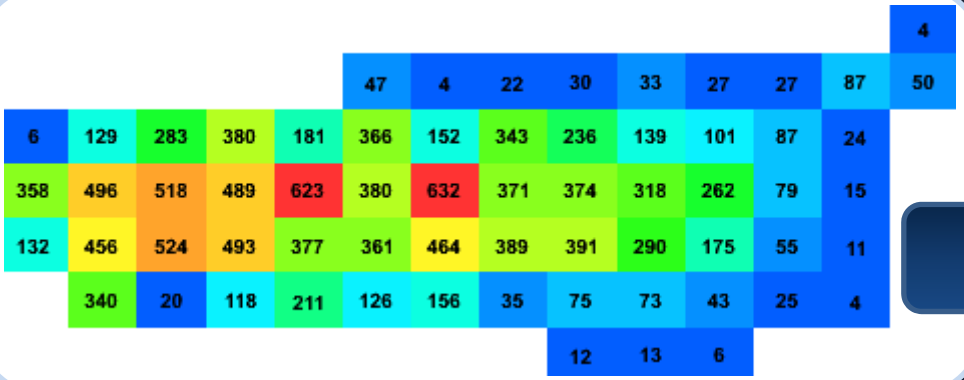
Cluster variation

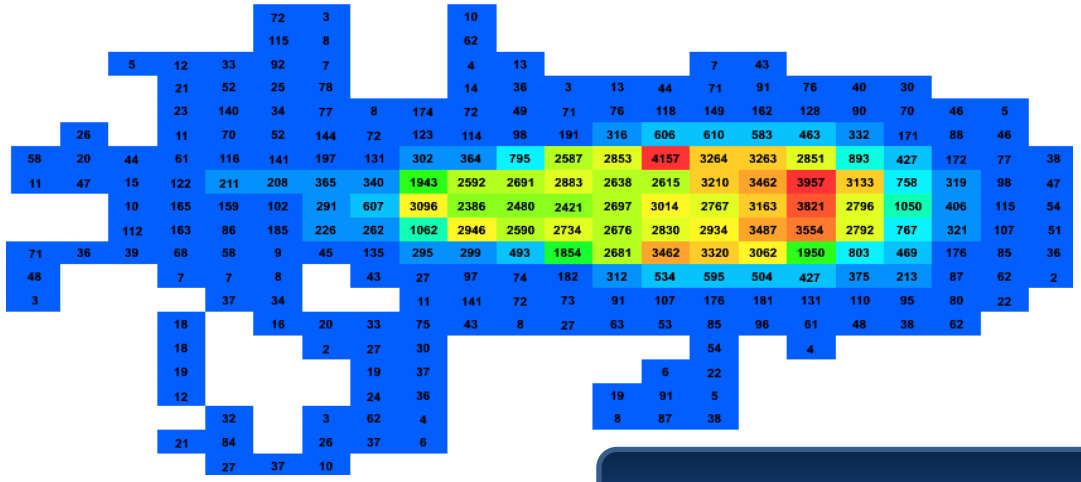
H-100MeV-15V-60degree



C-400MeV-15V-60degree



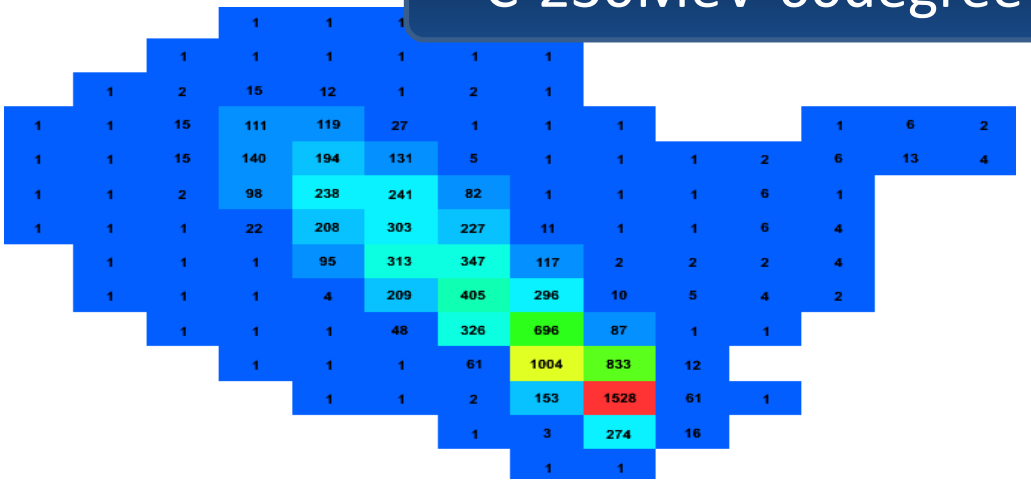
Fe-400MeV-15V-60degree



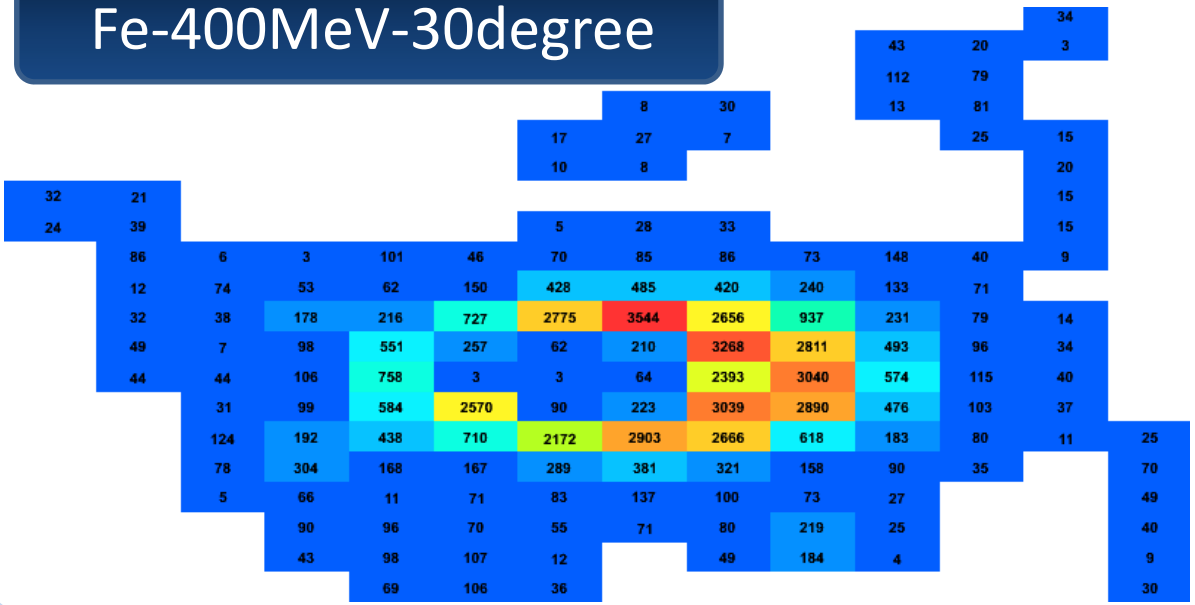
Azimuthal, Delta-ray and Detector effects

- Azimuthal direction
- Delta-ray existance
- Detector effects

C-230MeV-60degree



Fe-400MeV-30degree



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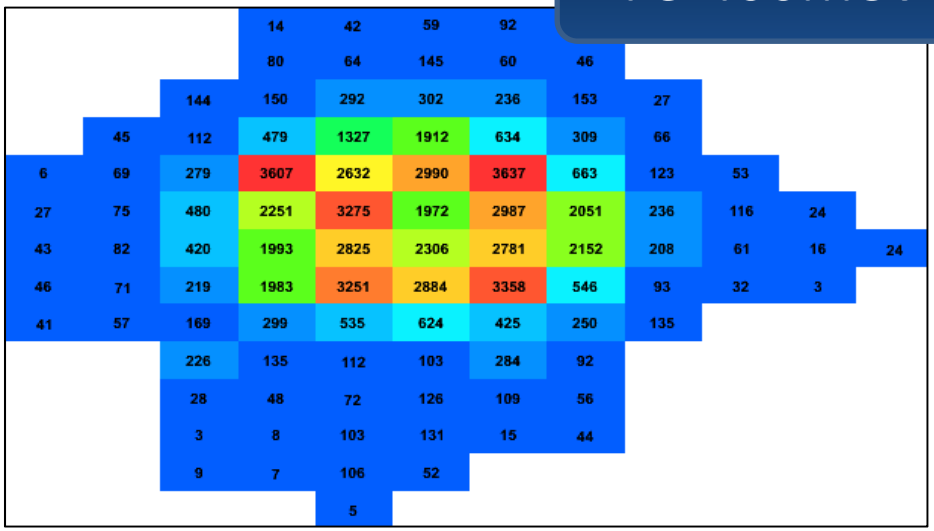
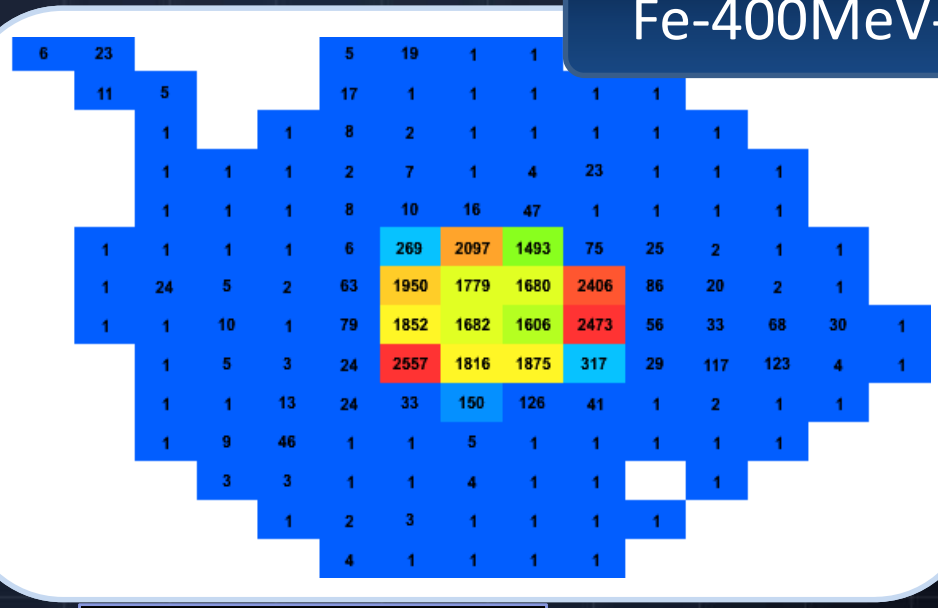
Bias-voltage variation

- The cluster shape depends on the applied bias voltage
- We need to optimize the bias voltage for given sensor thickness

Fe-400MeV-15V

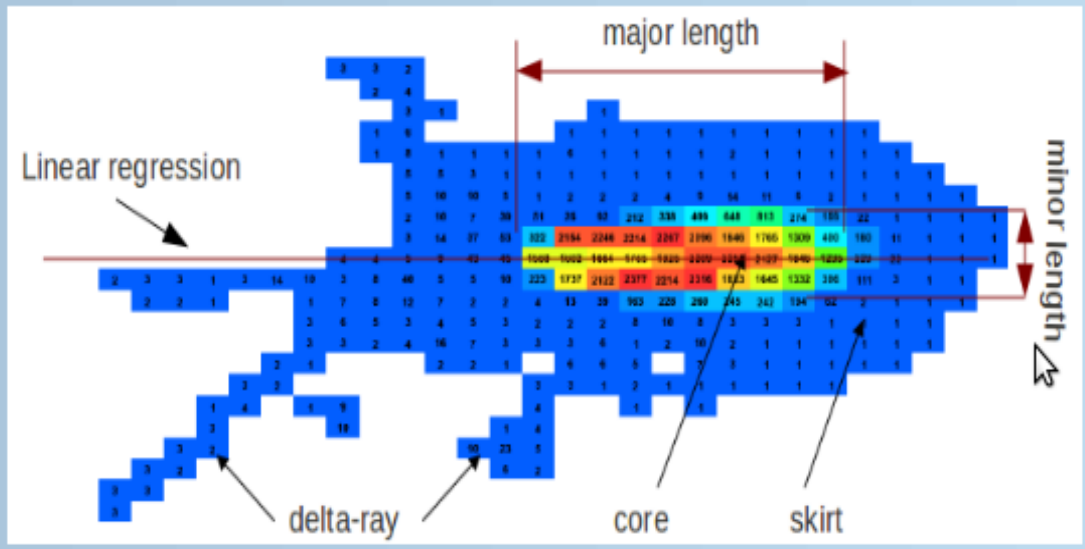


Fe-400MeV-100V



Angle calculation

- Algorithm using selective removal of external pixels to identify the actual core region, which is used to calculate the projected track length estimate



$$\tan(\alpha) = \frac{55}{300}\left(major - \frac{minor - 1.5}{major + 1} minor\right)$$

$$LET = \frac{E.\cos\alpha}{300}$$

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Angle determination

		angle of entrance							
ion	Energy MeV/A	0	20	30	40	45	60	75	85
1H	100	18.64±2.88		30.14±3.37			58.74±1.57	73.93±0.66	
1H	160	18.06±2.67		28.76±3.88		42.56±3.03	57.19±3.28		
4He	100	21.92±2.92		33.48±1.86			59.97±1.28	74.1±0.91	
4He	180			32.66±2.87		46.42±1.85	46.43±1.86		
12C	230	21.7±1.30		25.68±3.77		43.67±1.94	60.91±1.11		86
12C	400	9.29±7.68		25.76±2.62			60.68±0.82		85
16O	230								
20Ne	600	23.09±1.75	25.61±2.46		40.12±2.09		60.29±1.05		85
20Ne	600	15.55±4.98							
40Ar	290	25.69±2.11		30.79±3.00			59.51±0.84		85
40Ar	650	23.05±0.97		30.22±2.33			59.46±0.88		85
56Fe	400	24.52±1.09		28.34±2.37			59.6±0.88	75.86±0.35	

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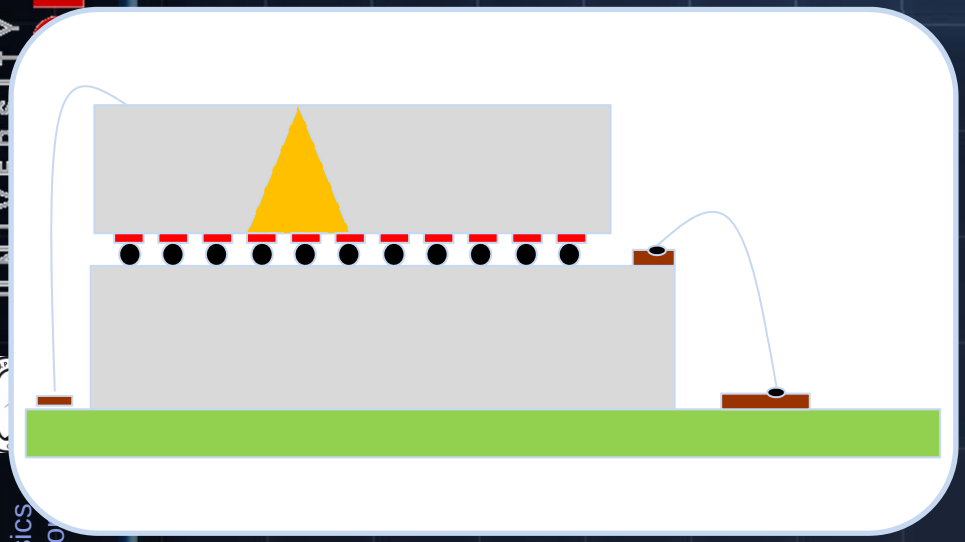
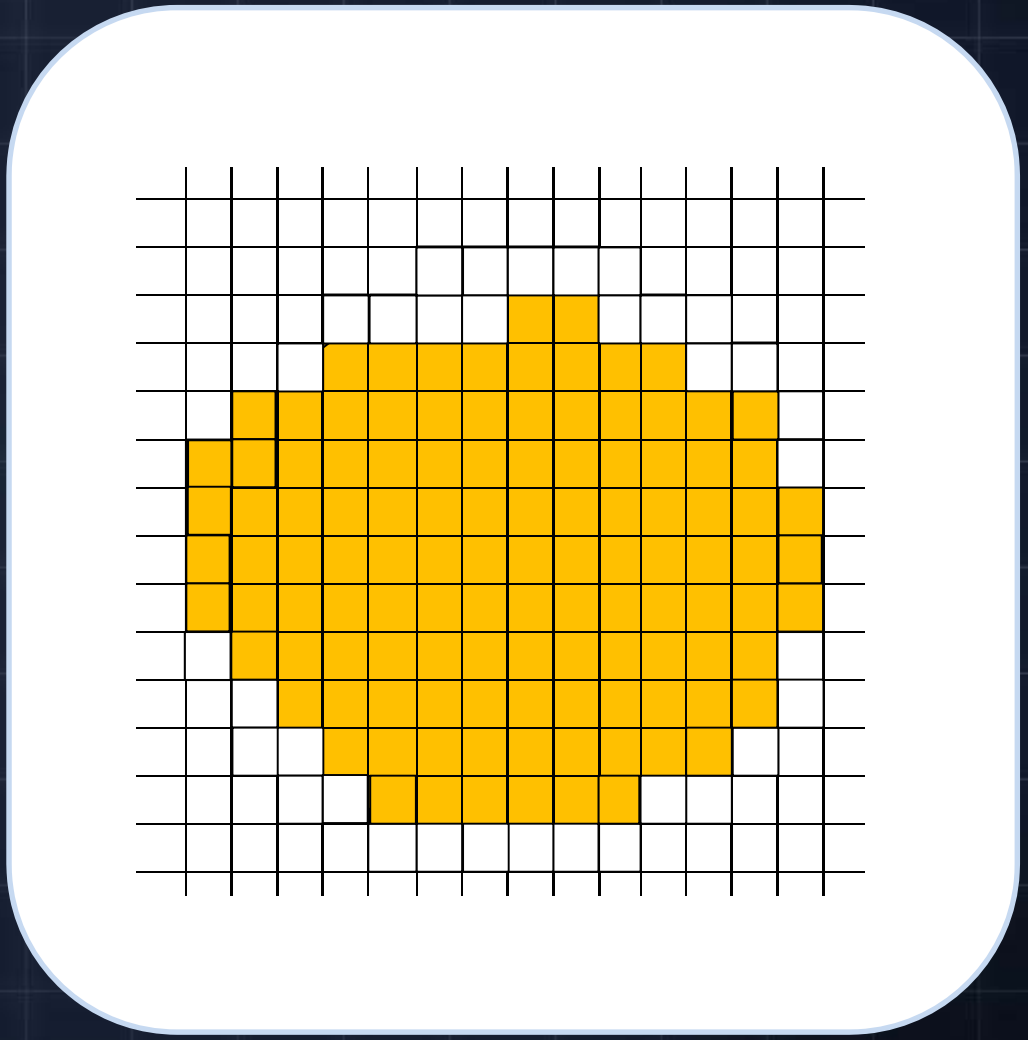
Explaining small angle error





- Error caused by pixel size and different threshold at pixels

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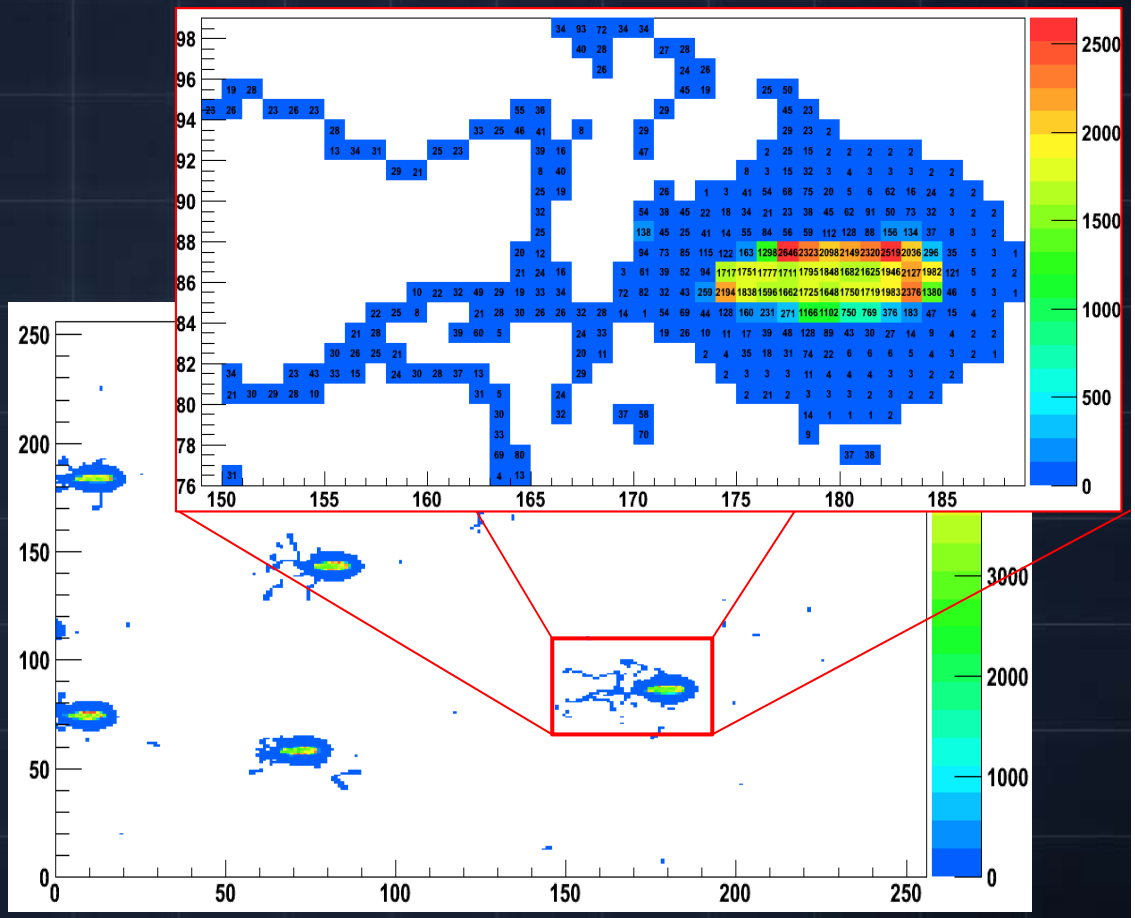
Delta-ray Analysis

- Purpose: particle identification→ getting velocity information
- Two methods - skeletonization (image reconstruction based)
- Contour analysis - looking for the cluster core properties



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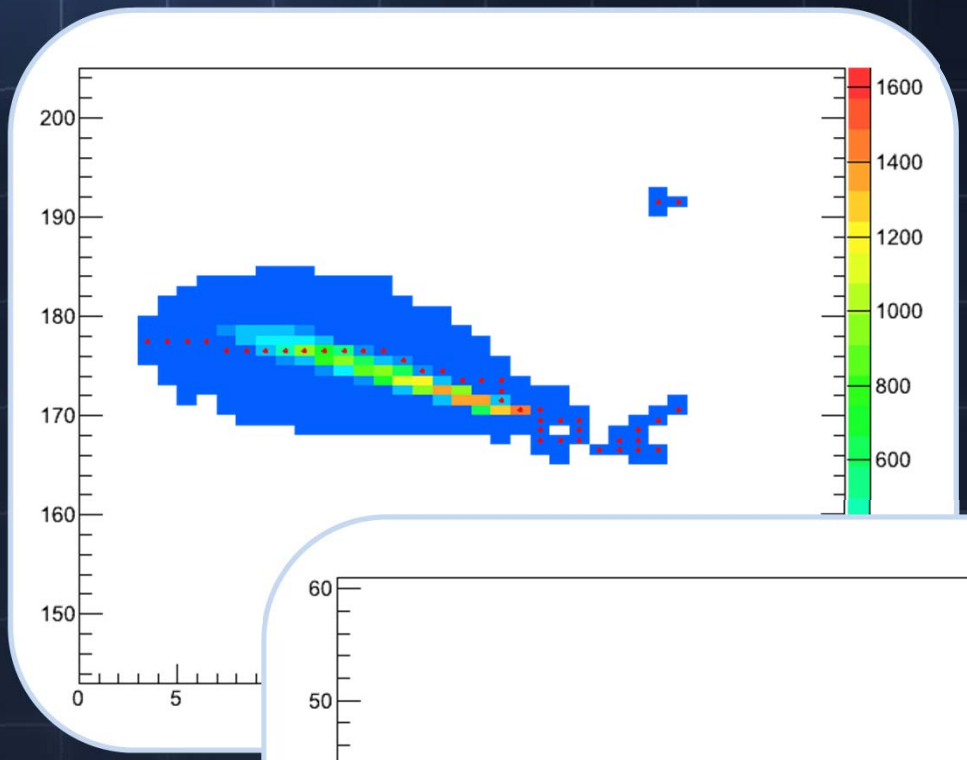
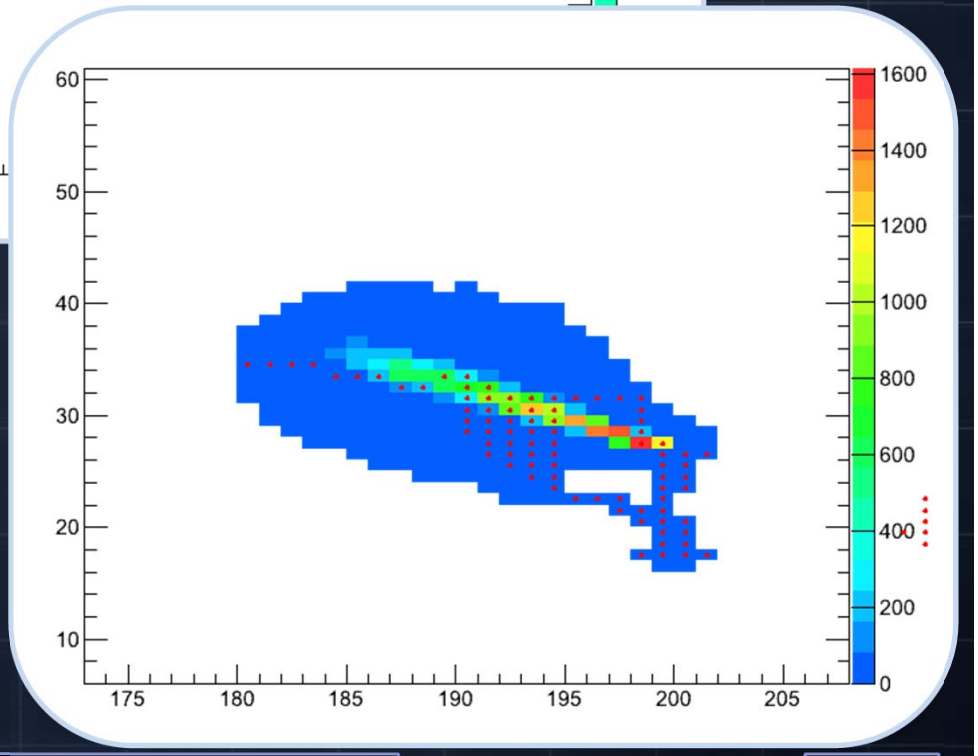
Delta-ray Analysis

- Because of the complex properties of the clusters, simple methods such as erosion will not work properly





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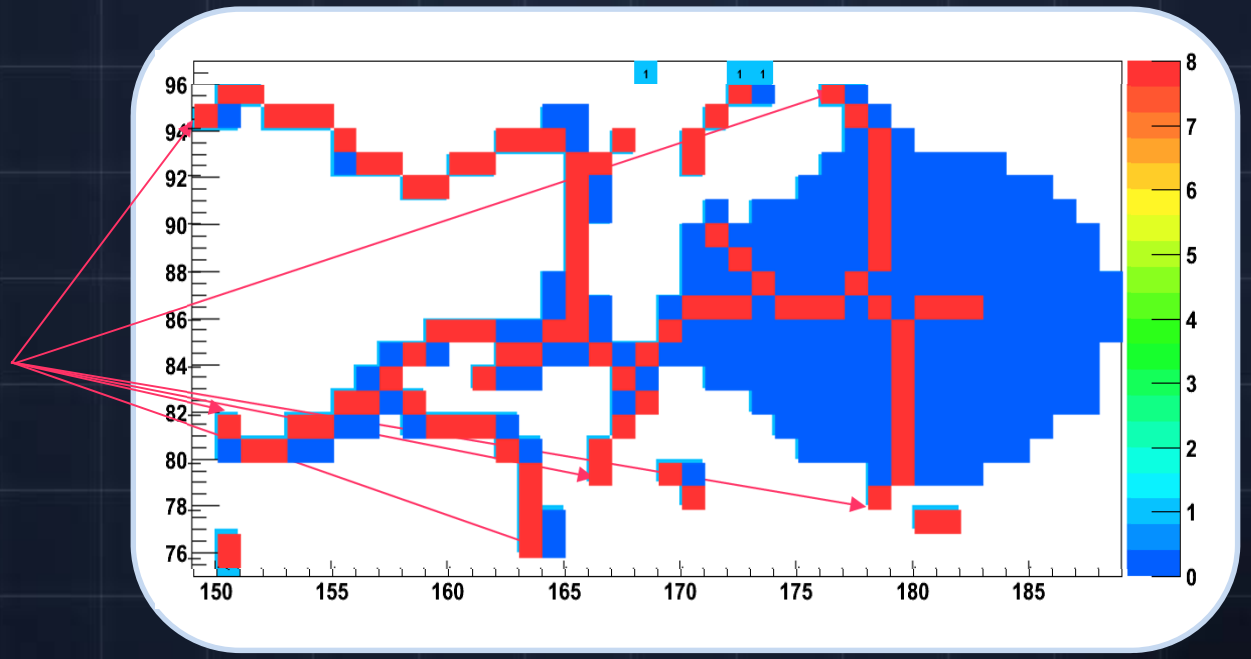
Delta-ray analysis

- We implemented more sophisticated methods
- Pixel level discrimination – boundary pixels level 1, neigbours lvl 2 etc.
- Delta-rays begin at endpoints and end at user defined level



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Conclusion and future work

- We are able to precisely identify the entrance angle of the particle and so the path of the particle from the angles > 20 degree
- We are able to identify the delta electrons in the cluster
- The energy measurement is affected by detector effects, this will be suppresed with newer generation of the chip
- We are working on the interpolation algorithm for improving the dE
- We are working on the separation algortihm which will separate two connected clusters
- We are working on the cluster shape algorithms

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Thank you for your attention!