



Particle visualization and identification with Timepix detectors

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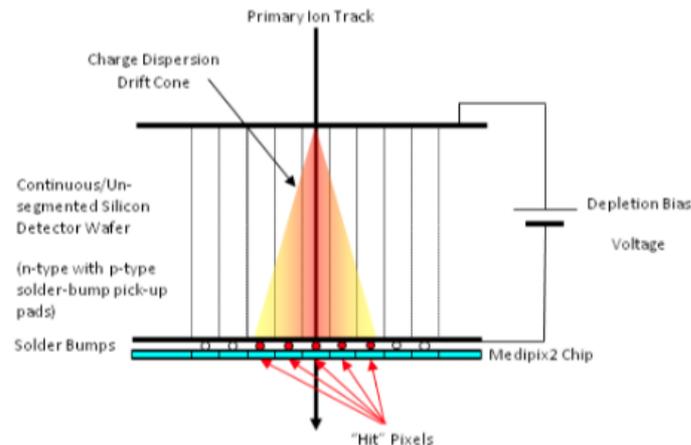
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Tom Whyntie

Project #1 goals

- To use information from Timepix detectors to analyze patterns of charge. This will aid in the identification of different particle species.

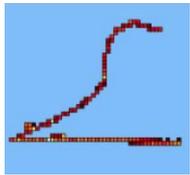
Timepix detector

- The Medipix2 device was originally used to count single X-ray photons for medical applications.
- With the development of the Timepix mode, the Timepix detector was used as a charged particle detector as this mode offered the time-of-arrival info about incident photons.
- The reverse bias p-n junction of the silicon-based detector creates a charge-sensitive volume of space-time that generates a signal in the presence of ionizing radiation.
- The pixelated nature of the patterns formed by charge deposited in the depletion zone readily facilitates the visualization of incident radiation.



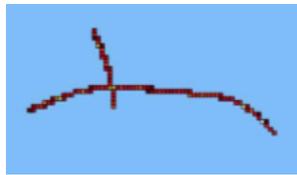
Previously on the last episode...

- First algorithm : had difficulties in differentiating SW, brancher and crossover clusters.
- Wanted to come up with additional cluster properties to better differentiate between cluster types



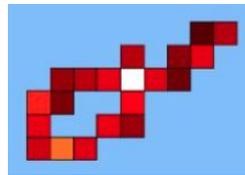
Brancher

Process:
Could be a
Decay



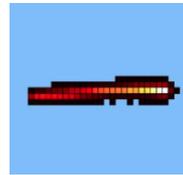
Crossover

Detector could
Be reading the
Tracks left by
2+ particles as
A single particle.



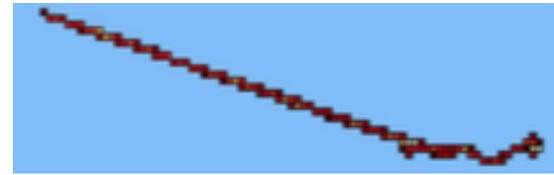
Looper

Beta
Radiation.



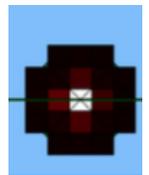
Slug

Heavy
Ions and/
Or nuclear
Fragments.



Straight Wiggly (SW)

Fast particles losing KE
To Coulomb interactions
With the lattice.



Boxy

Possibly
Caused by
Neutron-
Detector
interactions

Cuts based on cluster properties

- Cluster properties: linearity, radius, density, inner pixel fraction, etc

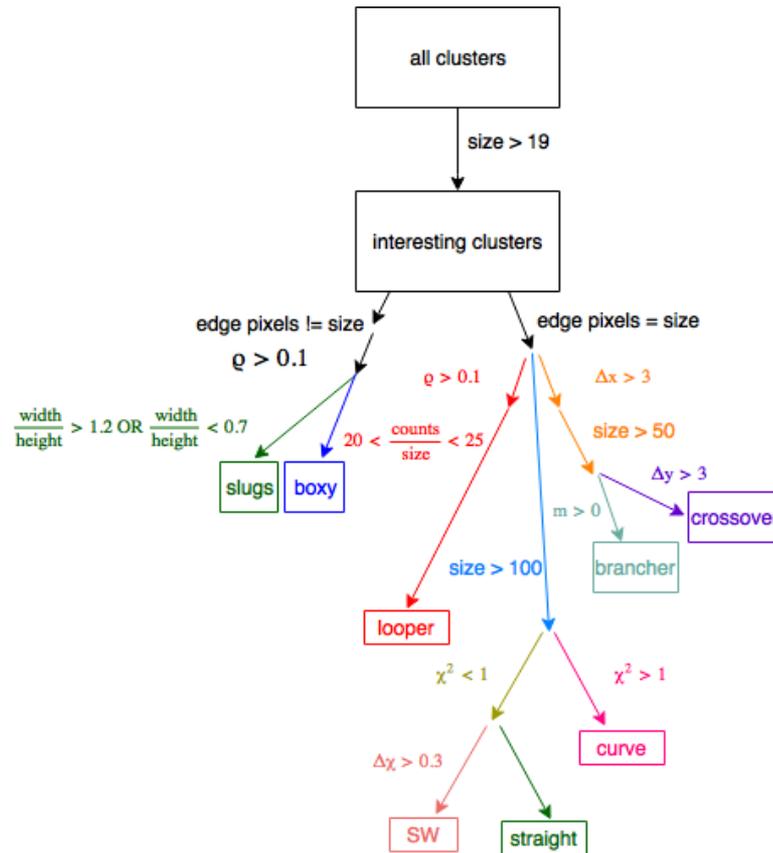
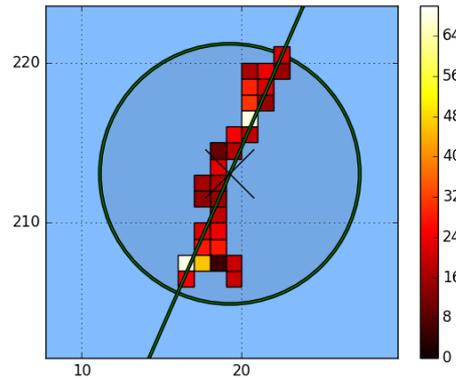
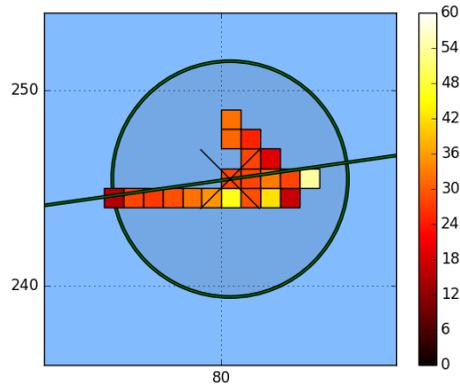
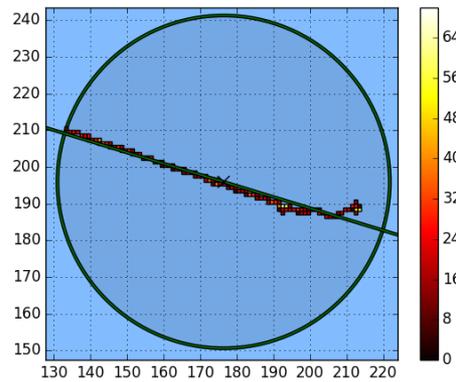
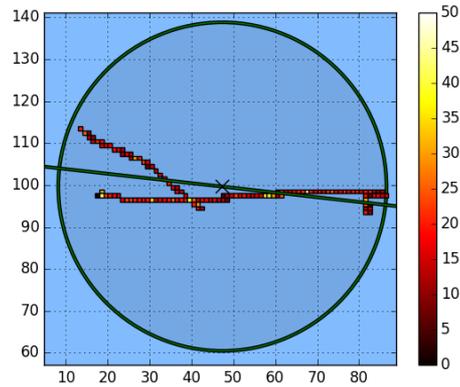


Figure: Cuts to classify clusters.

But why friend zone some clusters?

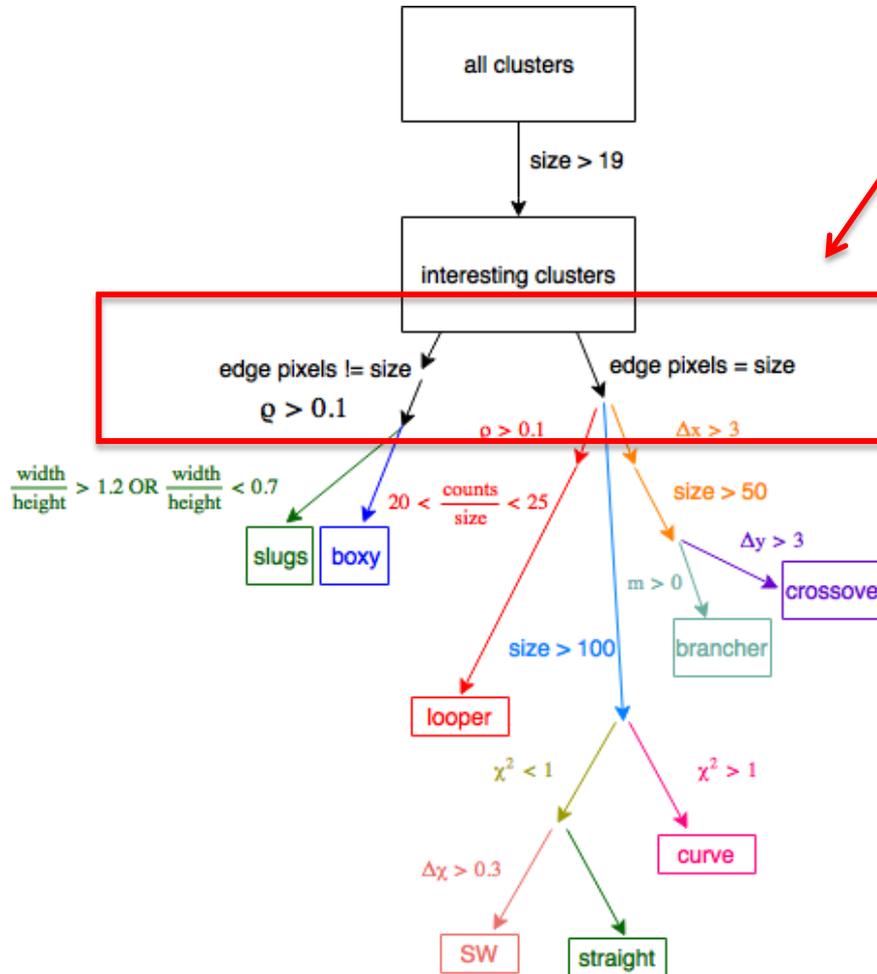


Size < 20
Just noise
Not interesting



Size > 20

Cuts based on cluster properties



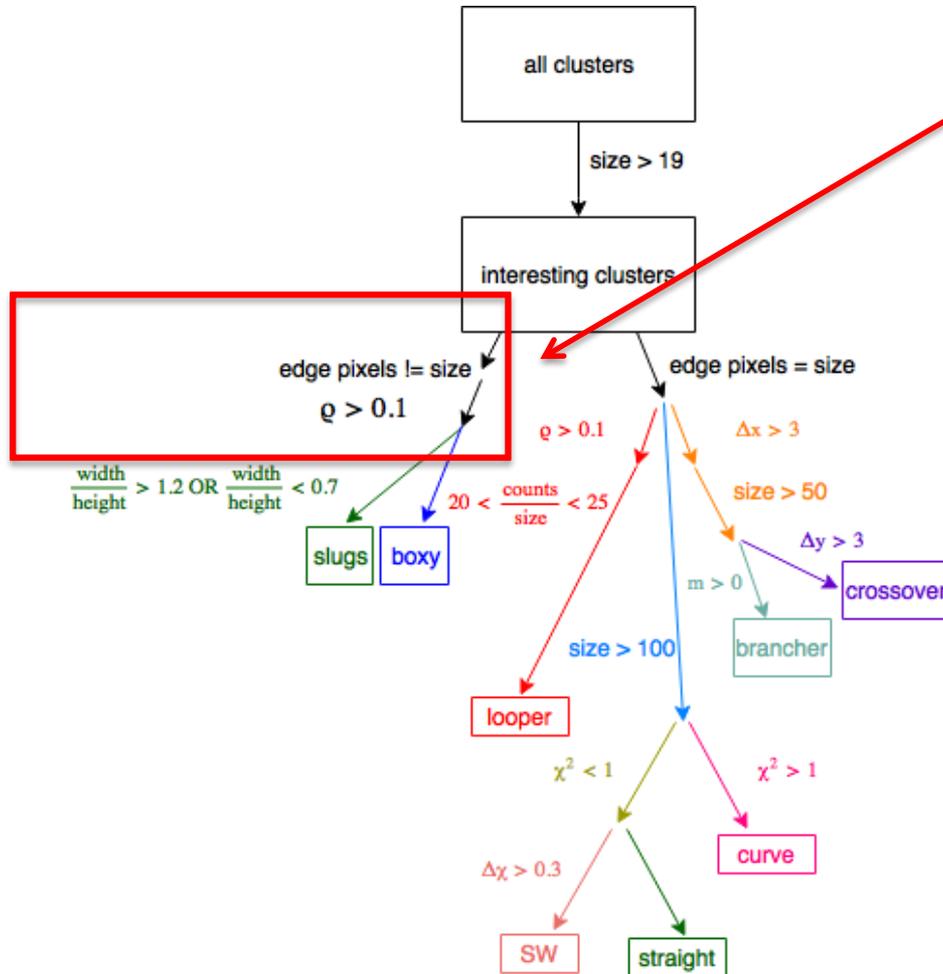
Does it contain bulk pixels or not?

Compact/linear pixel distributions expected to contain at least one pixel entirely surrounded by other pixels.

The shorter more compact boxys and slugs were isolated from the longer and thinner, or looping clusters. Boxys and slugs contain such bulk pixels, but loopers do not.

Figure: Cuts to classify clusters.

Cuts based on cluster properties



How to tell boxys and slugs apart?

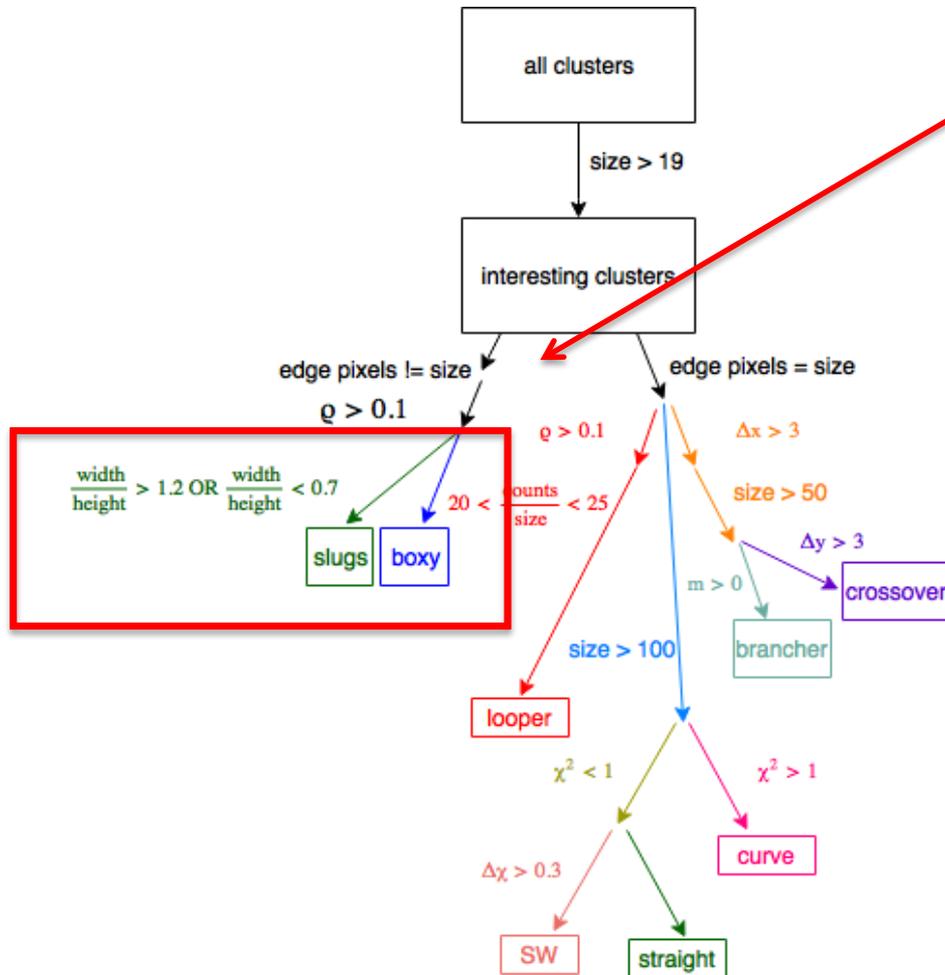
The unweighted radius of a cluster was defined as the distance from the unweighted cluster centre to the furthest pixel.

The density of a cluster was defined as the ratio of the area occupied by pixels contained within this radius and the total area of the circle with an equivalent radius.

A cluster was considered slug- or boxy-like if the density $\rho > 0.1$.

Figure: Cuts to classify clusters.

Cuts based on cluster properties

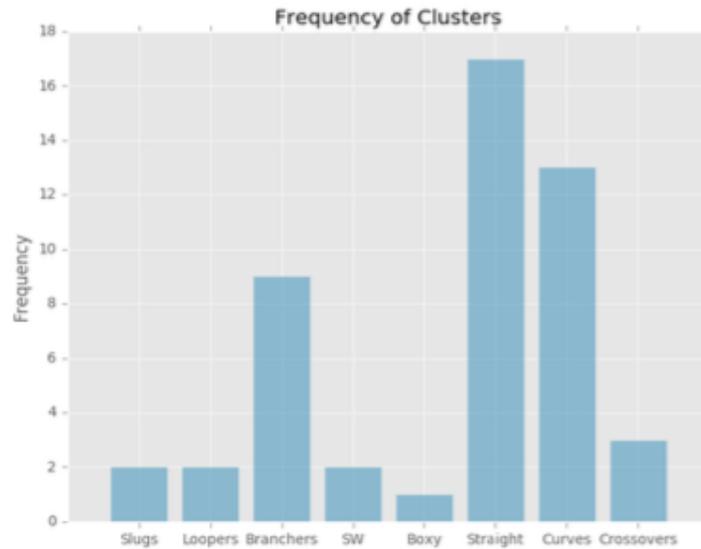


How to tell boxys and slugs apart?

Aspect ratios of slugs was significantly different from 1 while that of boxys approached unity.

Figure: Cuts to classify clusters.

Results



87% efficient!

A lot better than the 35% efficiency from last time.

Figure 3: Frequency of clusters identified by our algorithm.

Type	Number Identified (by eye)	Identified Correctly (by algorithm)
Brancher	7	6
Crossover	4	2
Loopers	2	2
Slugs	2	2
Straight-Wiggly	1	1

Figure 4: Results comparison between manual and algorithm results for cluster classification.

Trip pics

