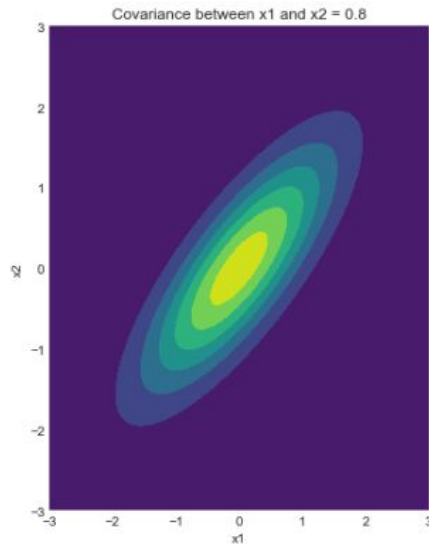# Cluster analysis of ^{55}Fe events

(Preliminary)

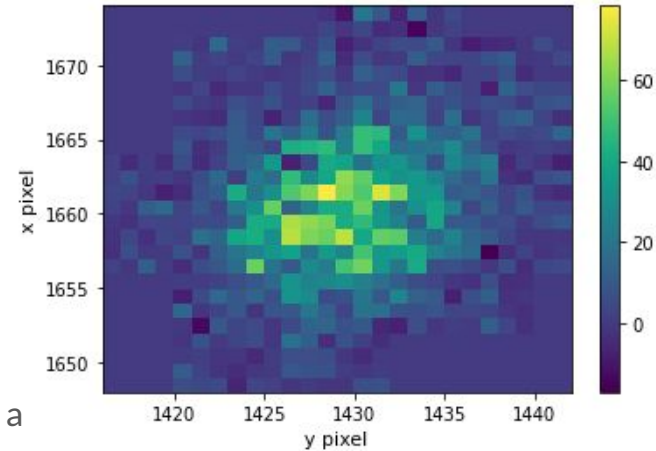Francesco Borra

Cluster analysis

^{55}Fe cluster

We want to determine if the clusters spots can be seen as a bivariate gaussian.

Contour of the density function of a bivariate gaussian

For a fast approach we can find the sample quantities σ_x, σ_y and ρ to evaluate clusters shapes.
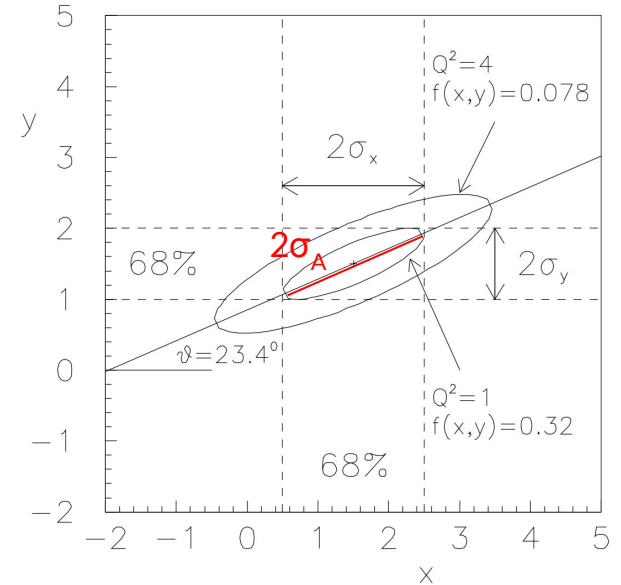
Cluster analysis

Tried to evaluate the directionality of the e^- recoil:

With the shape of the cluster it is possible to retrieve the e^- recoil; in fact using σ_x and σ_y of the bivariate gaussian we can find θ:

$$\tan 2\theta = \frac{2\rho\,\sigma_x\sigma_y}{\sigma_x^2 - \sigma_y^2}$$

We can then find σ_A and σ_B, that are width and height of the ellipse.
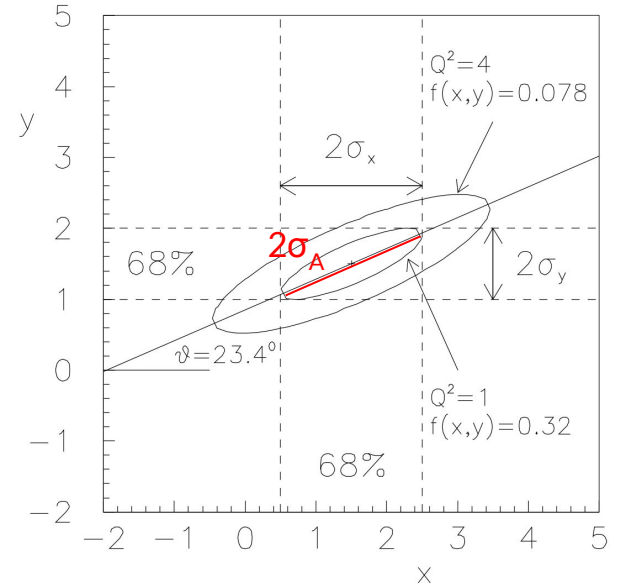
Cluster analysis

Tried to evaluate the directionality of the e^- recoil:

With the shape of the cluster it is possible to retrieve the e^- recoil; in fact using σ_x and σ_y of the bivariate gaussian we can find θ:

$$\tan 2\theta = \frac{2\rho\,\sigma_x\sigma_y}{\sigma_x^2 - \sigma_y^2}$$

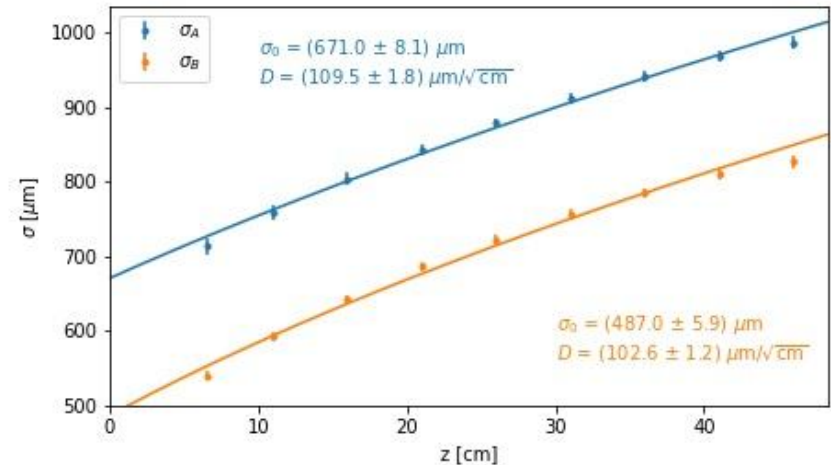We can then find σ_A and σ_B, that are width and height of the ellipse.

We expect an isotropic orientation of the clusters!

Cluster analysis

We expect that σ_A and σ_B will vary with respect to the z position of the source with:
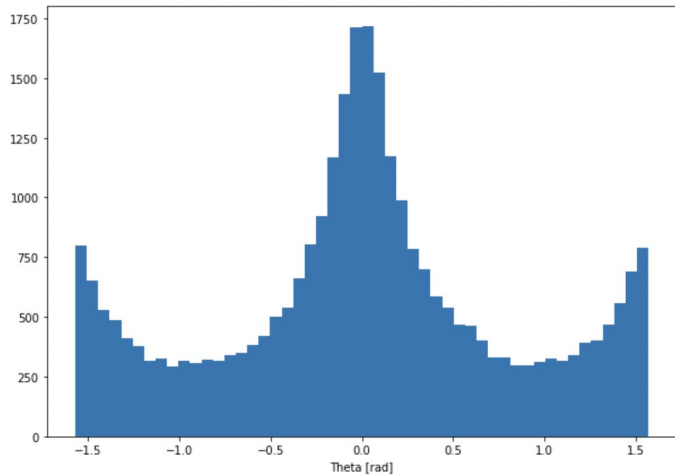
$$\sigma(z) = \sqrt{\sigma_0^2 + D^2 z}$$

- fits are not great but could be worse
- D are at 3 sigmas → to be understood

Cluster analysis

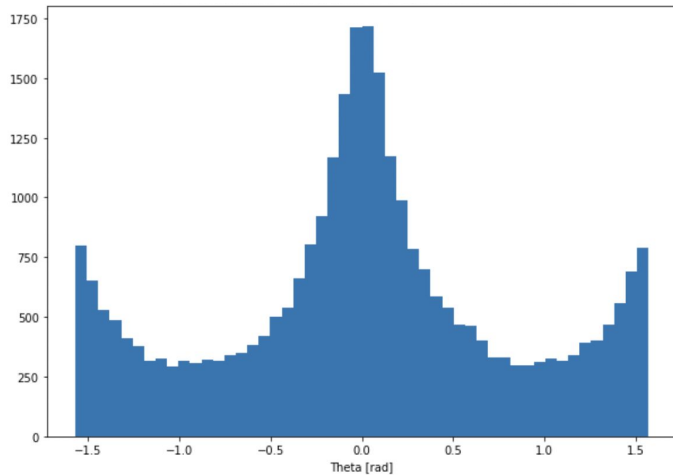**θ distribution:**

Expected uniform
distribution!!

But θ = 0 → cluster length
along x axis

Why do we have a
"preferred" direction?
Do we have a distortion of
some kind?

Selection:
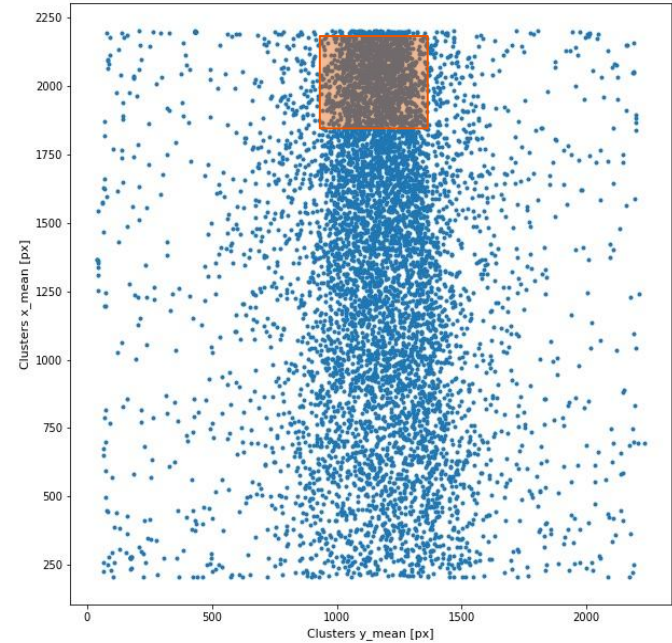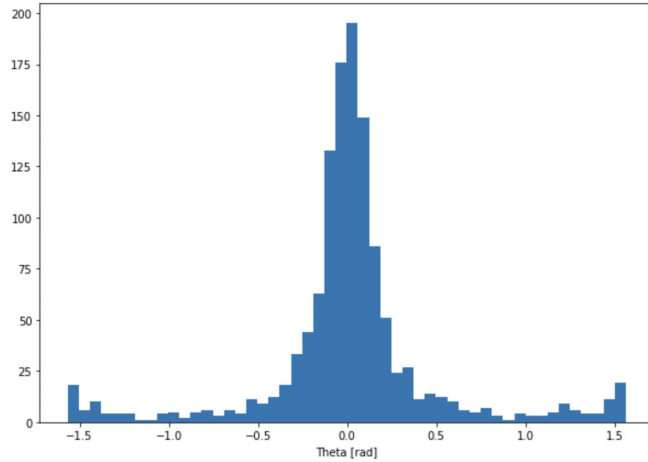+ len vs sc_integral custom cut
+ 1000 < sc_integral <15000

Cluster analysis

θ distribution:

Expected uniform distribution!!

But θ = 0 → cluster length along x axis

Why do we have a "preferred" direction?
Do we have a distortion of some kind?

Selection:
+ len vs sc_integral custom cut
+ 1000 < sc_integral <15000

- **wrong calculation of theta? (working on)**

- **not isotropic energy deposits?**

- **some kind of distortion in between deposit and revelation? (maybe lens distortion?)**

Cluster analysis

θ distribution in different TPC zones:

200x200 pixels
(1050<y<1250   1900<x<2100)

Selection:
+ len vs sc_integral custom cut
+ 1000 < sc_integral <15000

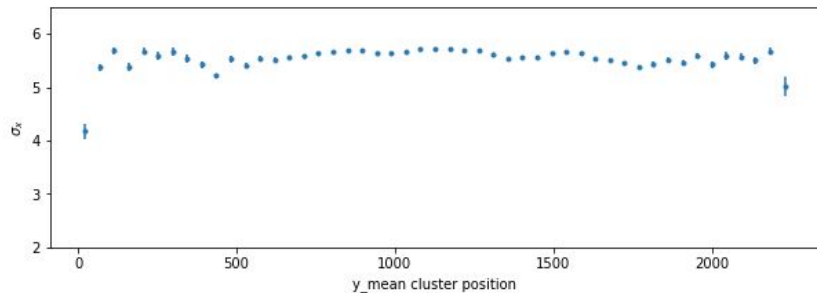# Cluster analysis

θ distribution in different TPC zones:

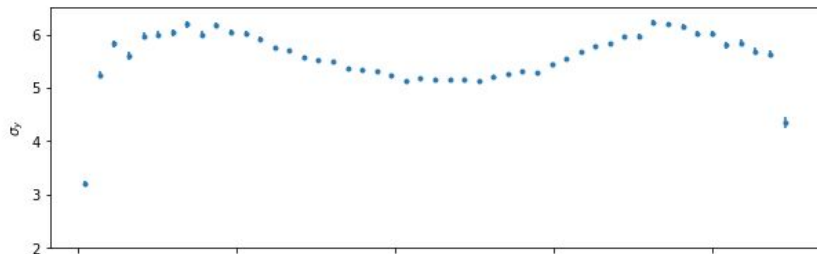

Theta distribuition central zone of TPC, source distance 6.5cm
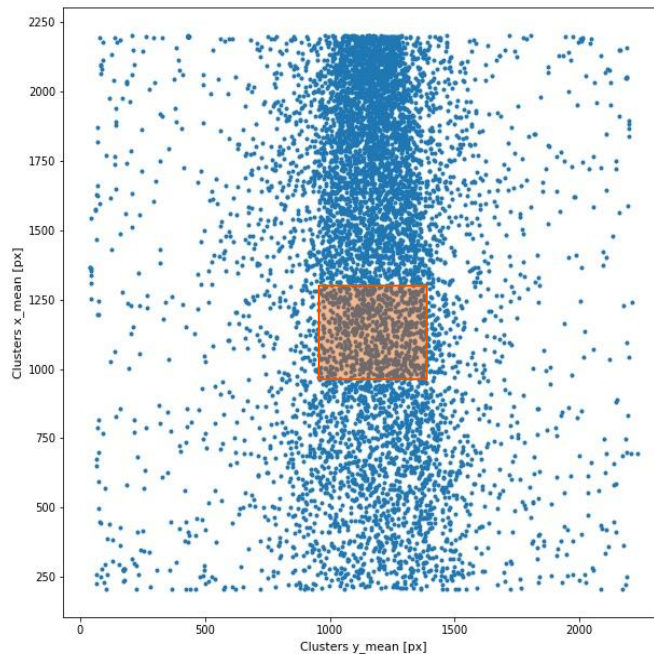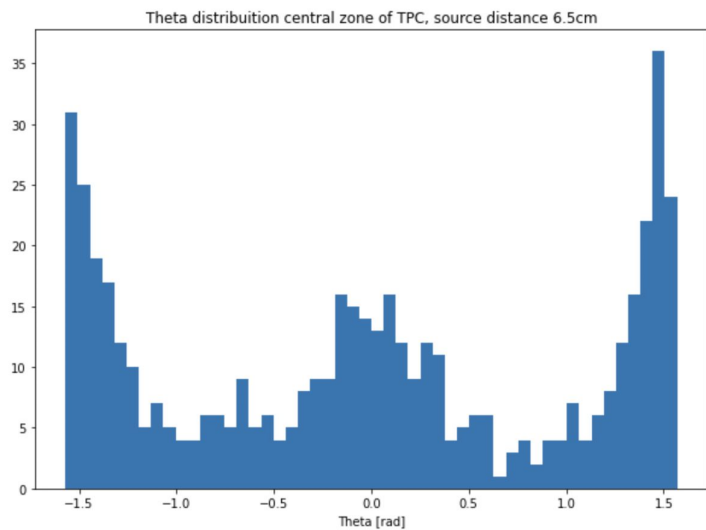
Selection:
+ len vs sc_integral custom cut
+ 1000 < sc_integral <15000

Peak on the opposite direction (π/2)!
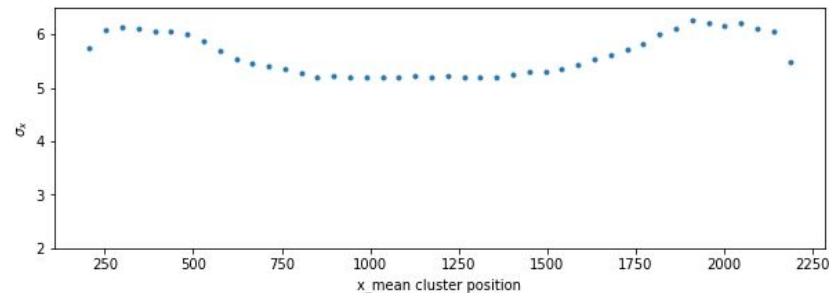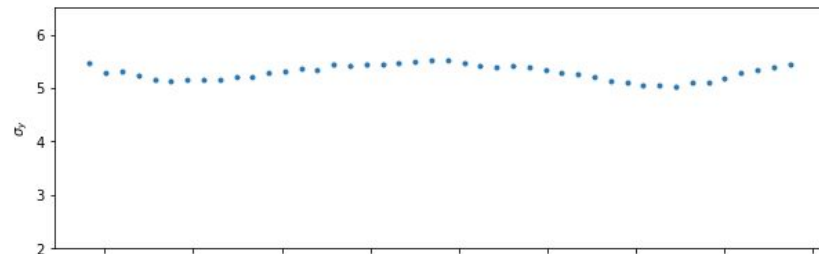(distortion stronger in the y direction?)

Cluster analysis

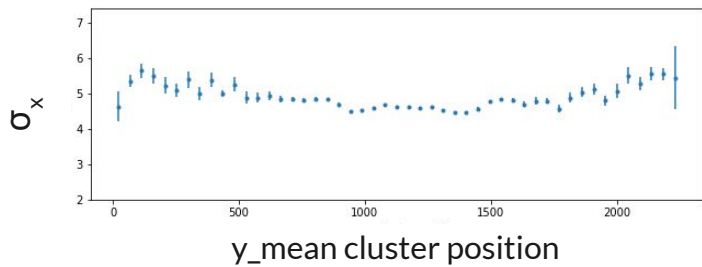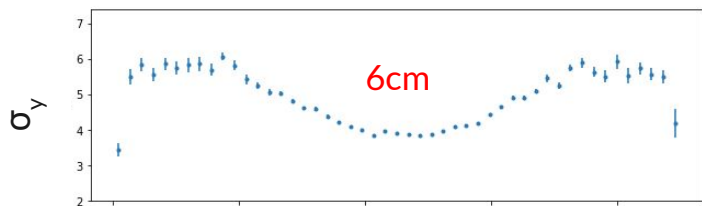**Analyzing sample σ_x and σ_y to evaluate effects of lens distortion:**

σ_y & σ_x vs y_mean cluster position (50 division)
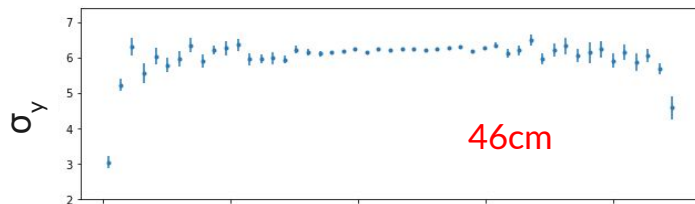

σ_y & σ_x vs x_mean cluster position (50 division)

6cm

6cm

Not constant!

σ_y

σ_x

y_mean cluster position

σ_y

σ_x

x_mean cluster position

46cm

46cm

σ_y

σ_x

σ_y

σ_x

Heatmaps of σ_x and σ_y
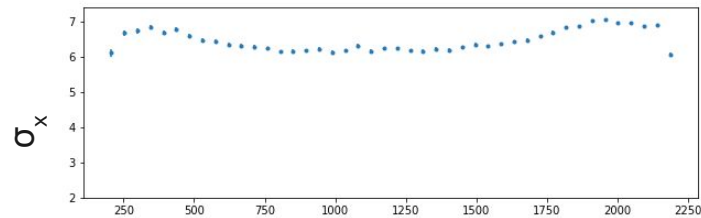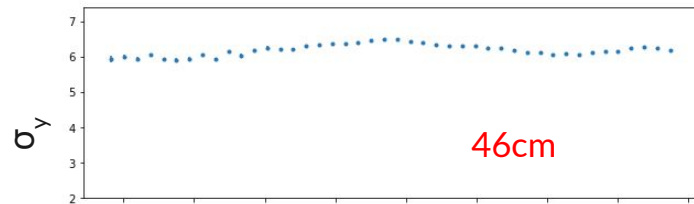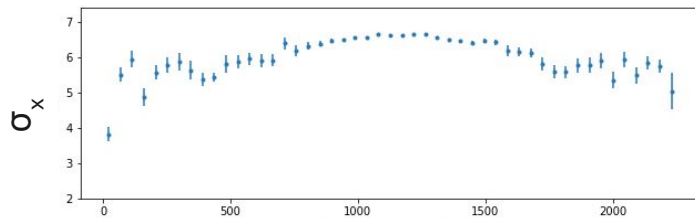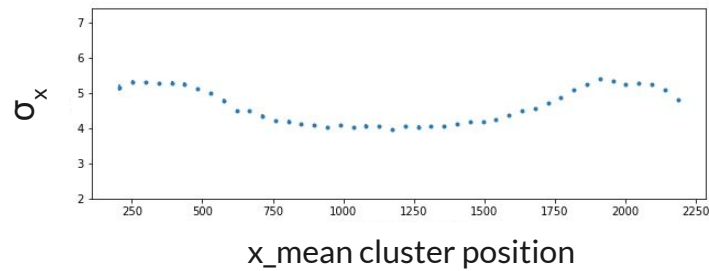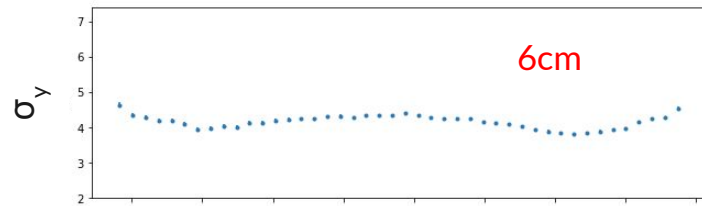
Expected distortion along x axis (averaged to zero along y axis)
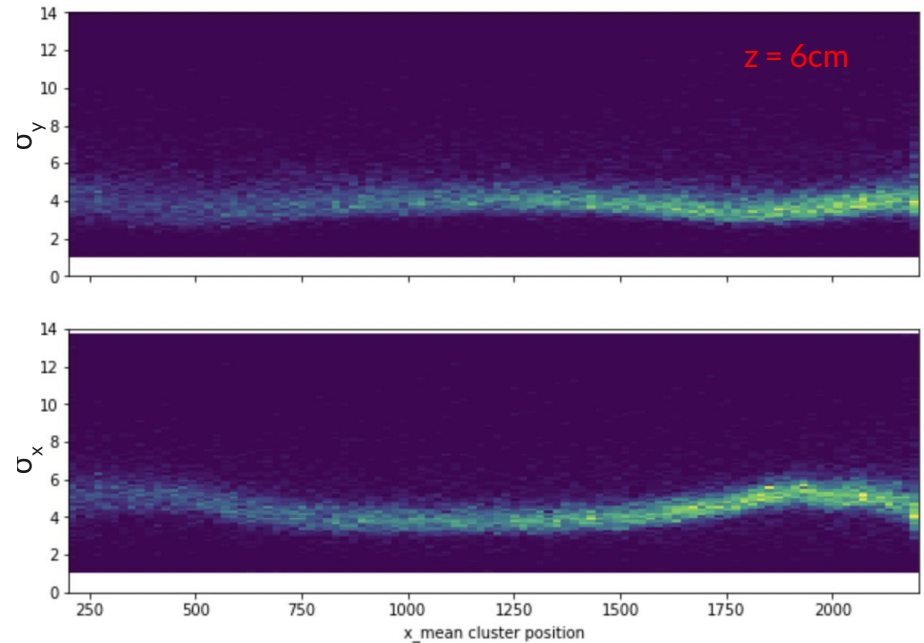
σ_y & σ_x vs x_mean cluster position, 46cm

σ_y & σ_x vs x_mean cluster position, 6cm

z = 46 cm

z = 6cm

Heatmaps of σ_x and σ_y

Expected distortion along y axis (averaged to zero along x axis)

σ_y & σ_x vs y_mean cluster position, 46cm
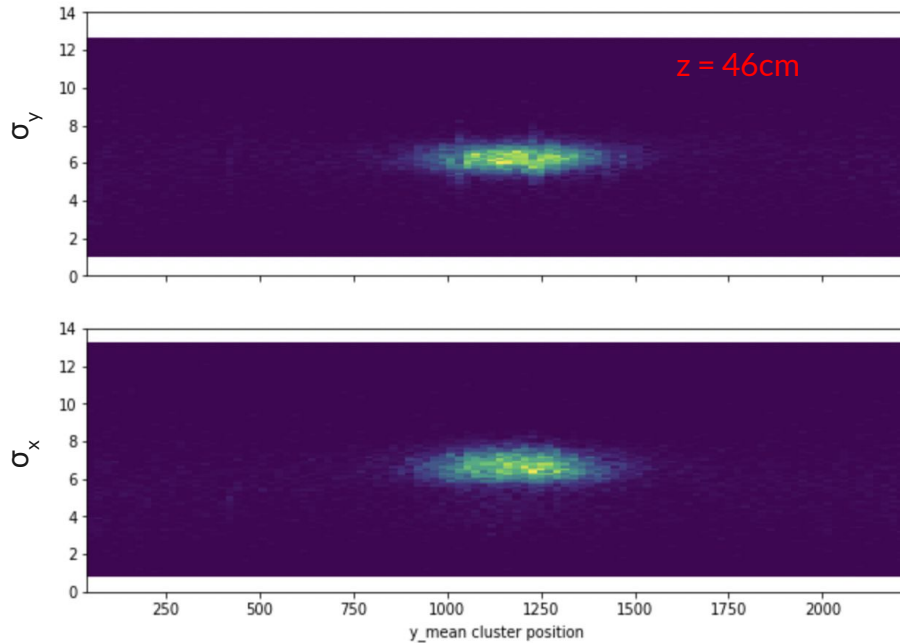
σ_y & σ_x vs y_mean cluster position, 6cm

Heatmaps of σ_x and σ_y

Expected distortion along y axis (averaged to zero along x axis)

σ_y & σ_x vs y_mean cluster position, 46cm

z = 46cm

σ_y & σ_x vs y_mean cluster position, 6cm

Stronger effect in y direction?
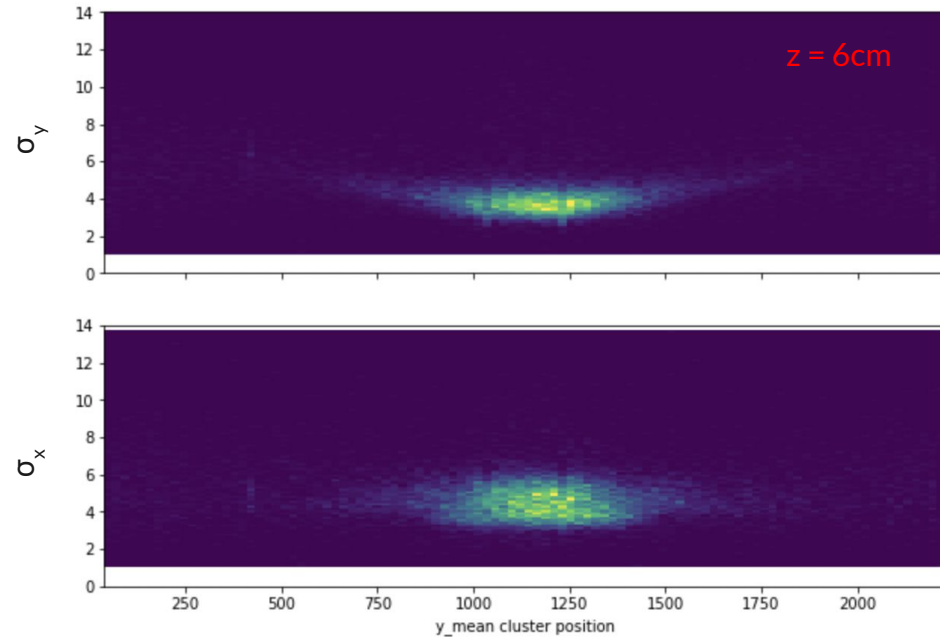
z = 6cm
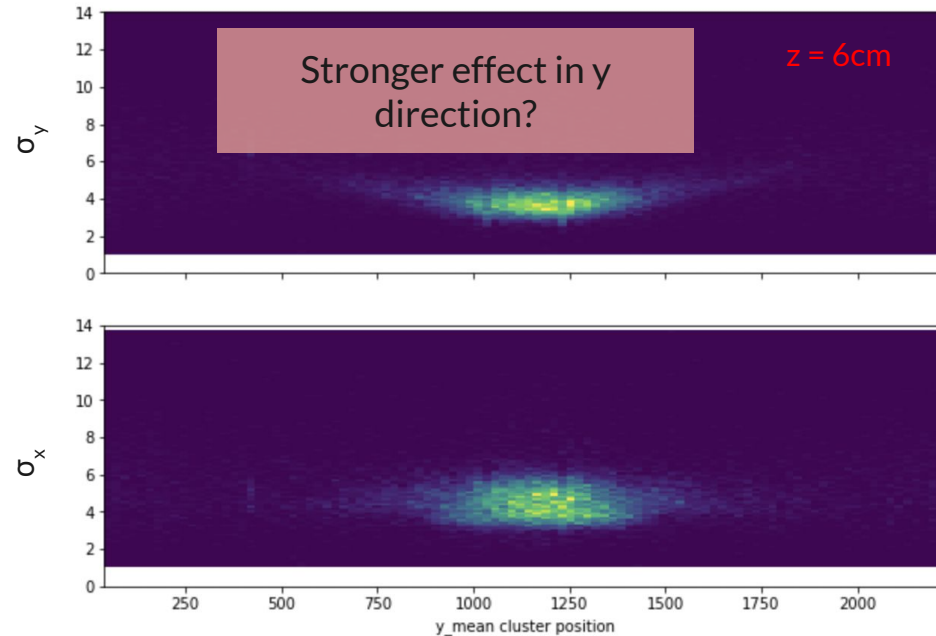
Further heatmaps to evaluate distortion
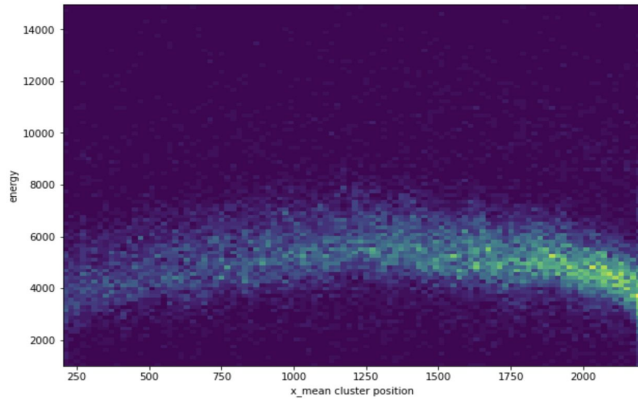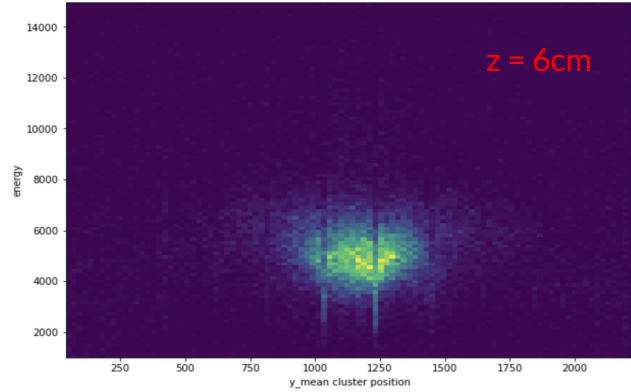
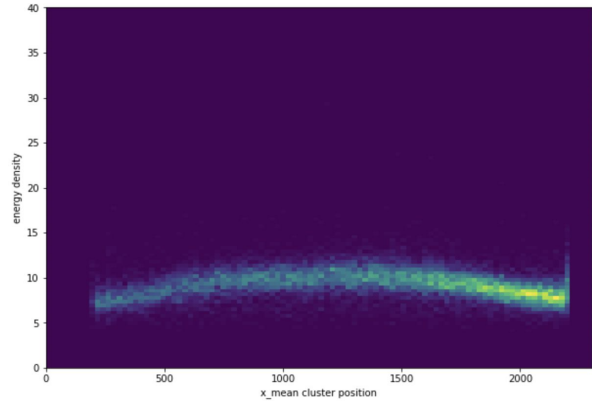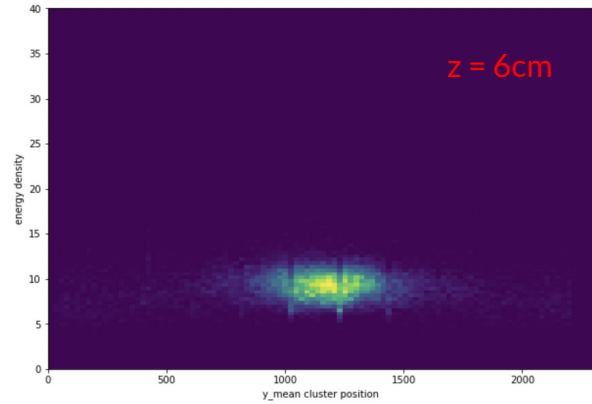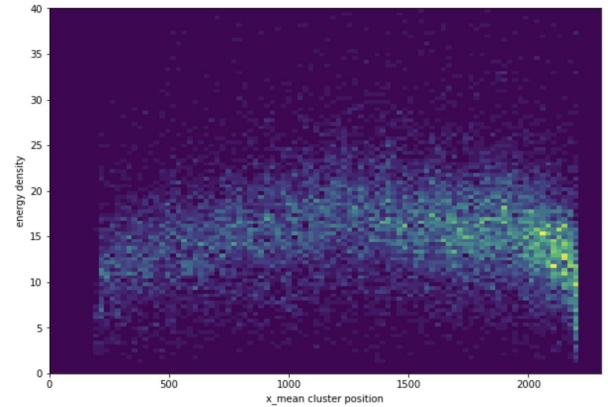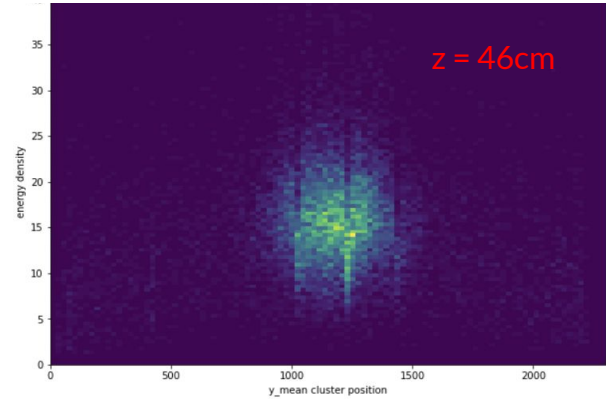*sc_integral* vs *x/y* cluster position
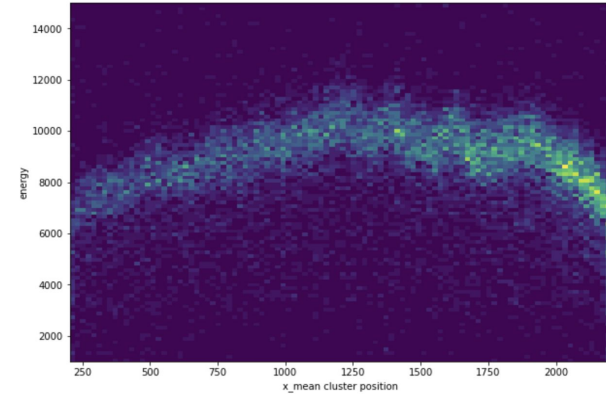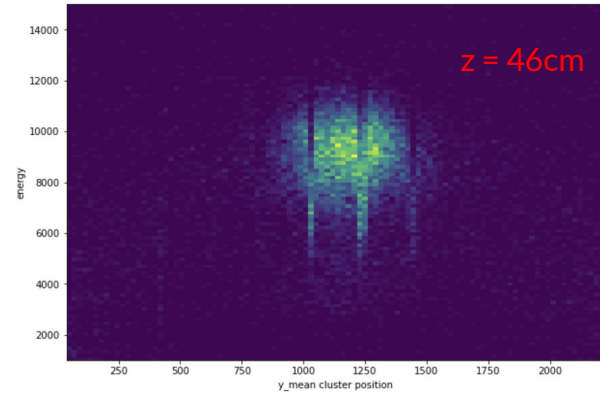
Further heatmaps to evaluate distortion

'energy density' vs *x/y* cluster position

Conclusions

- we observe a non-uniform angular distribution of the ^{55}Fe clusters
- in average the difference between the horizontal and the vertical dimensions of the clusters is ~2 pixels
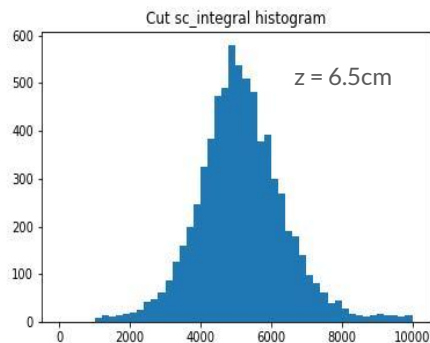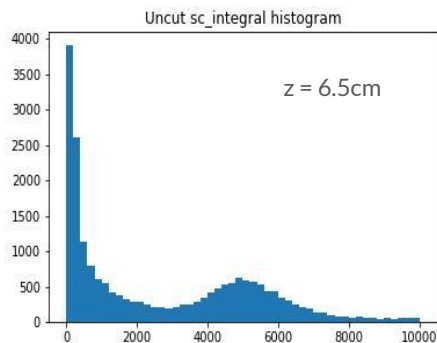- different zones of the pictures with different behaviour: optical distortion effect?

Suggestions?

Backup slides

Cluster selection

The first approach was discarding all clusters with:

- taken only clusters in *redpix_* variables (reduced pixels)
- *sc_integral* < 1000 && *sc_integral* > 15000
- outside of a chosen zone in *sc_length* vs *sc_integral*

Photon ppx vs Cluster lenght, run 5868 46cm

Photon ppx vs Cluster lenght, run 5911 6.5cm

Uncut sc_integral histogram

z = 6.5cm

Cut sc_integral histogram

z = 6.5cm

19