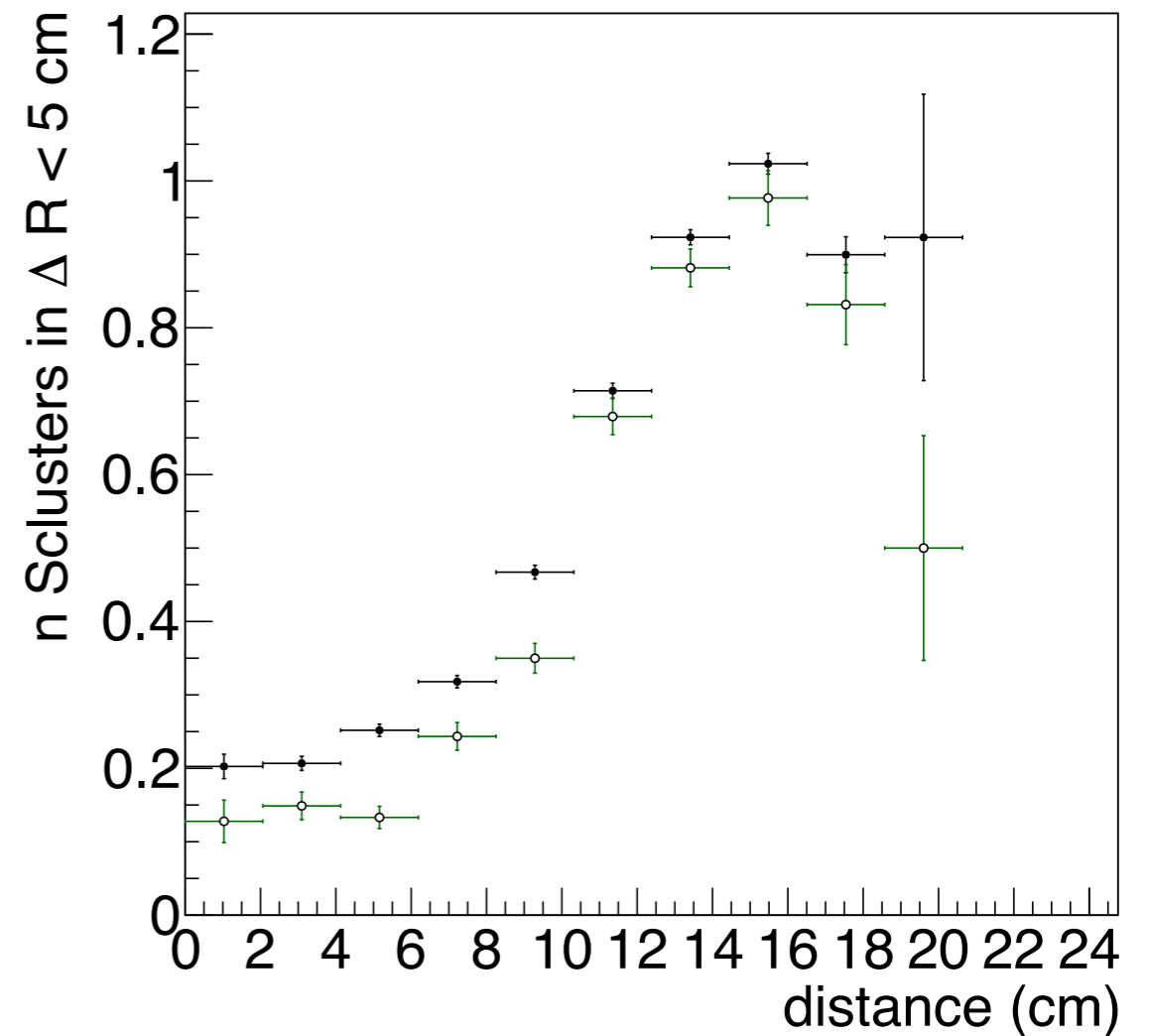
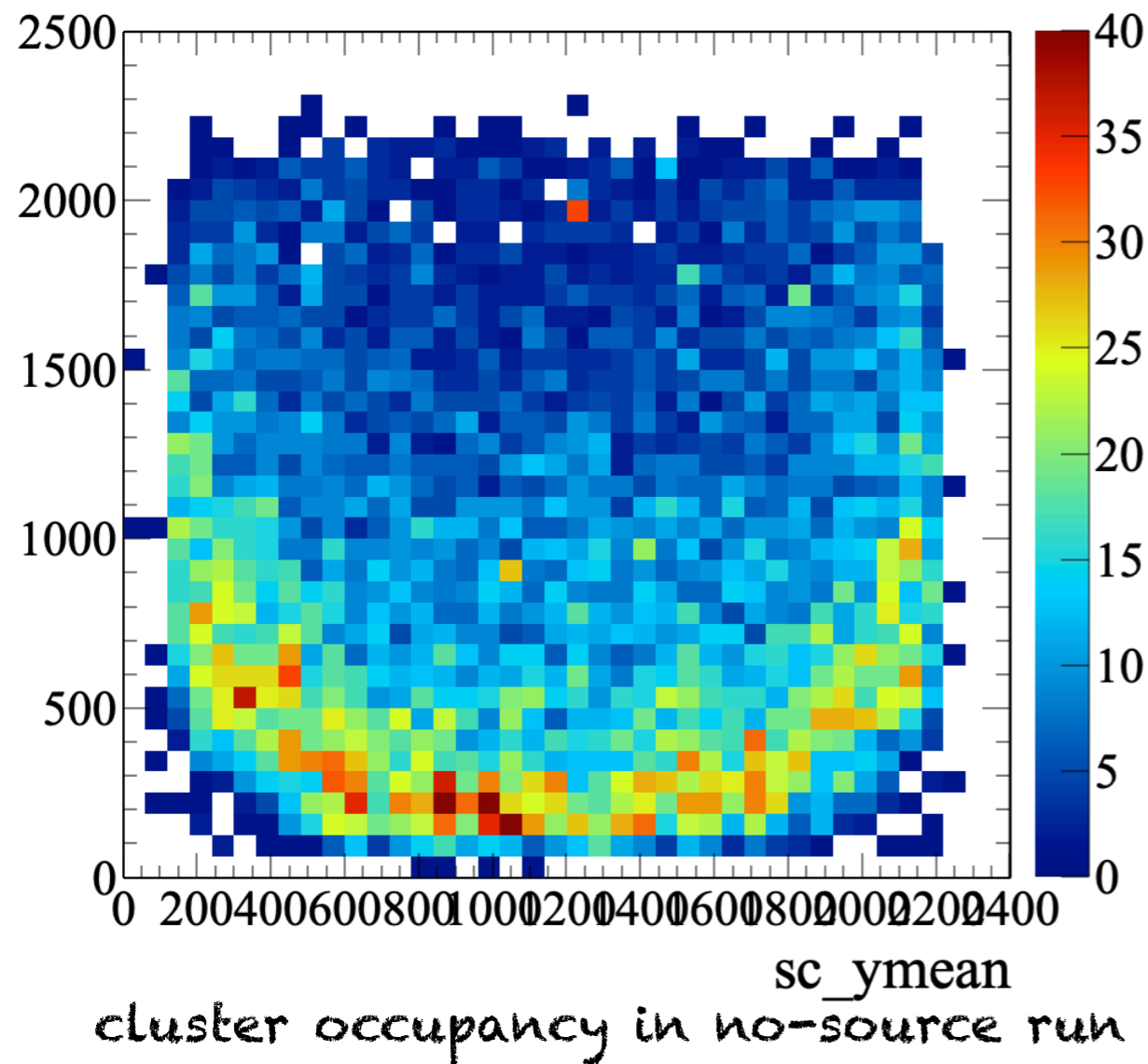


Update on reconstruction of LIME Summer data

G. Cavoto, E. Di Marco, D. Pinci
CYGNO reconstruction & analysis meeting,
03 December 2020

New findings

Found large occupancy of small/low-density clusters in both AmBe and cosmics data

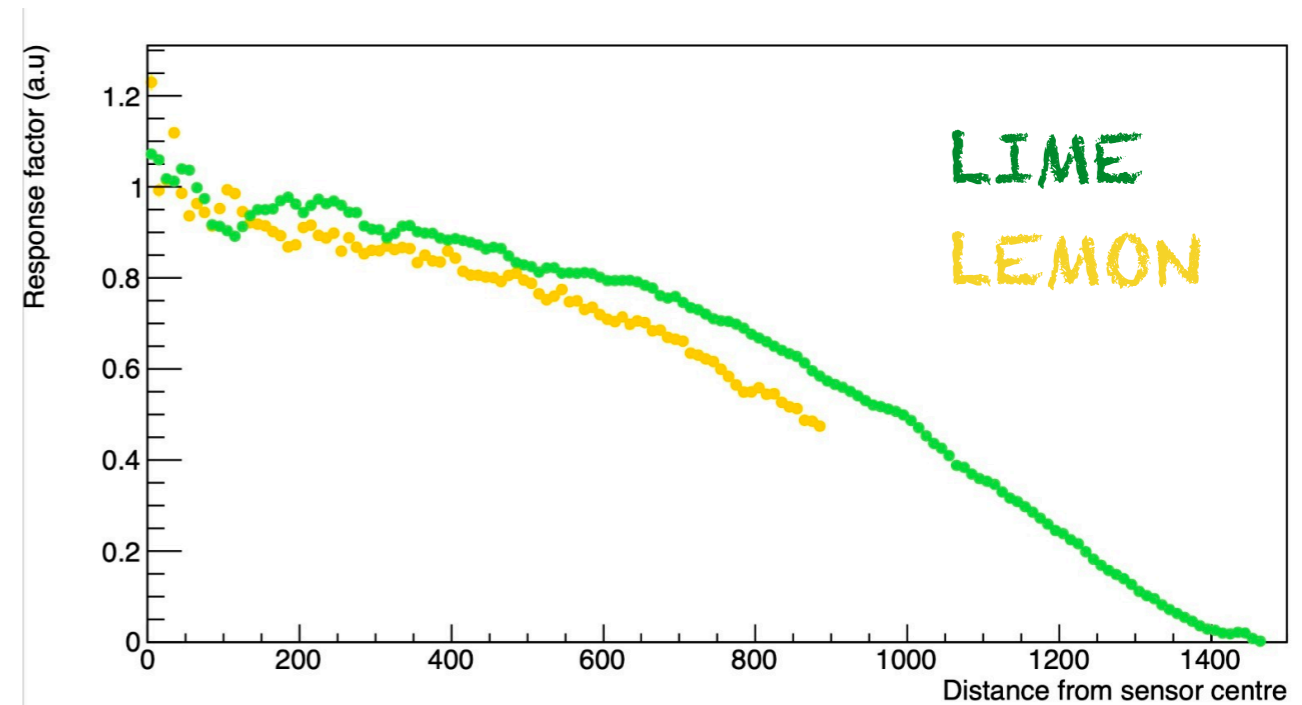
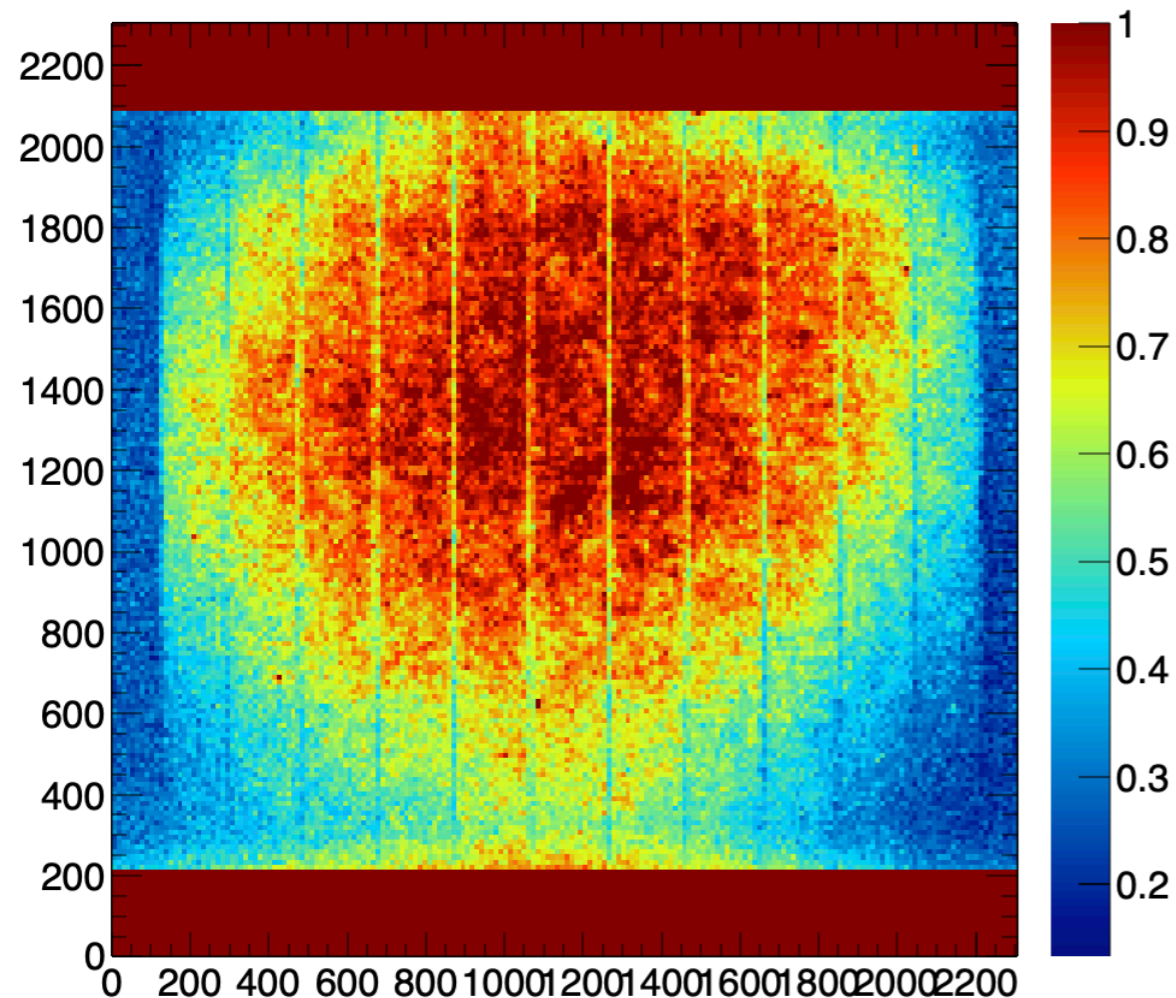


number of superclusters in $\Delta R < 5$ cm from a supercluster vs distance from center points towards split tracks in that region

vignetting effect

The high occupancy region suspiciously matches with low LY from vignetting effect

LY normalized to the center average



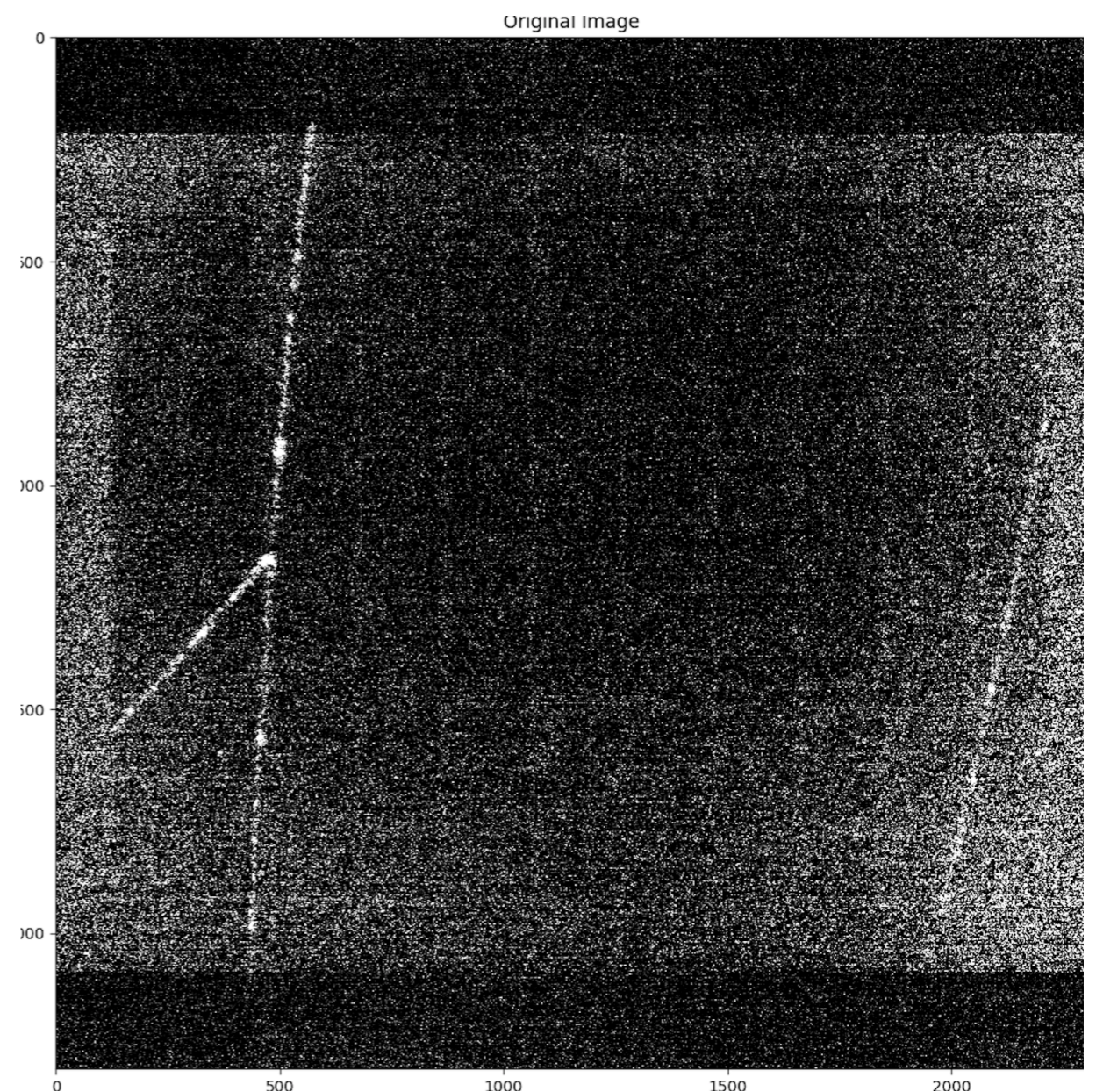
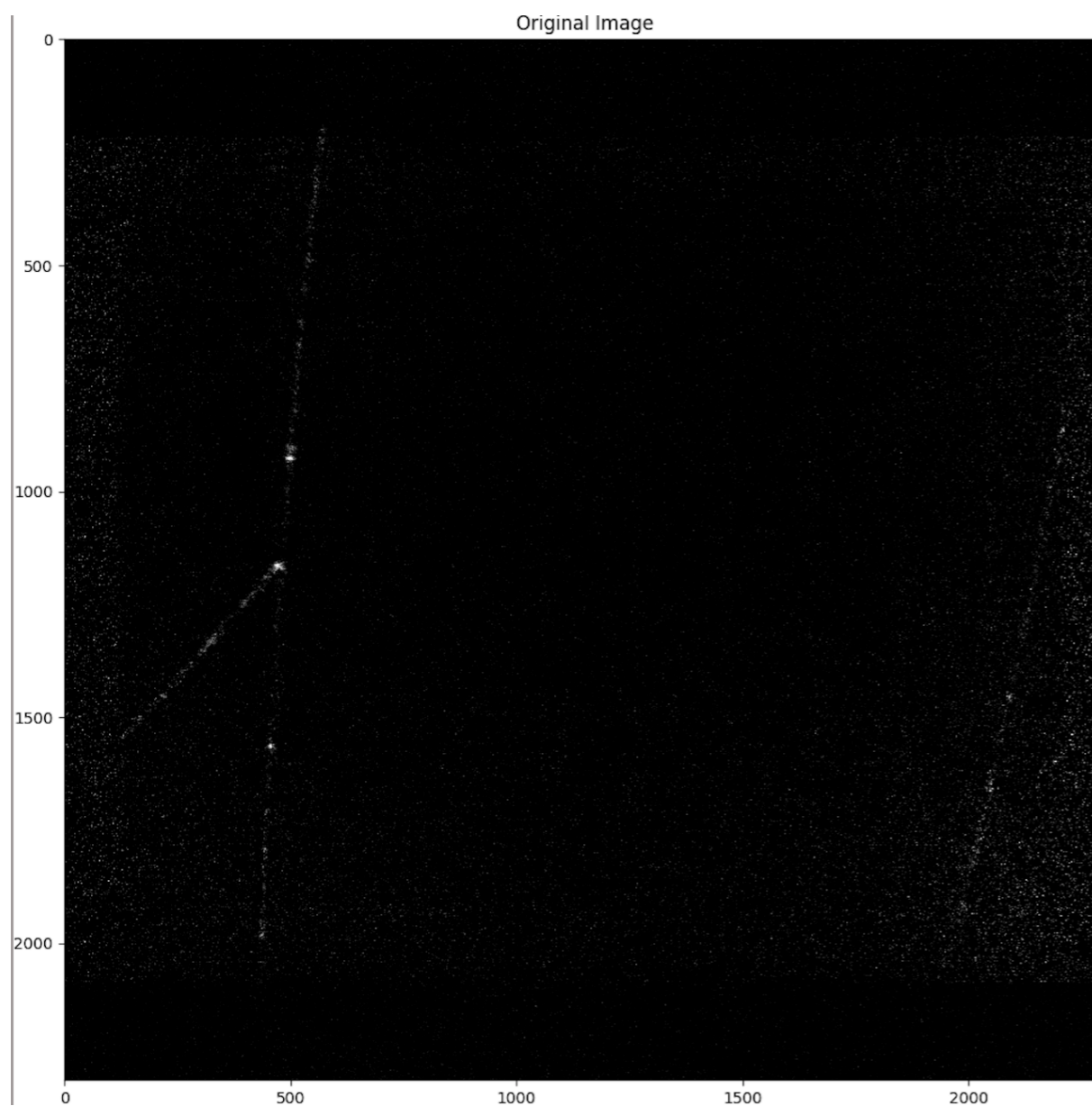
D. Pinci

Looking at images it seems indeed that the low LY induces faint pieces of cosmics to go under the zero-suppression thr.

Image after vignetting

But... this comes with price.

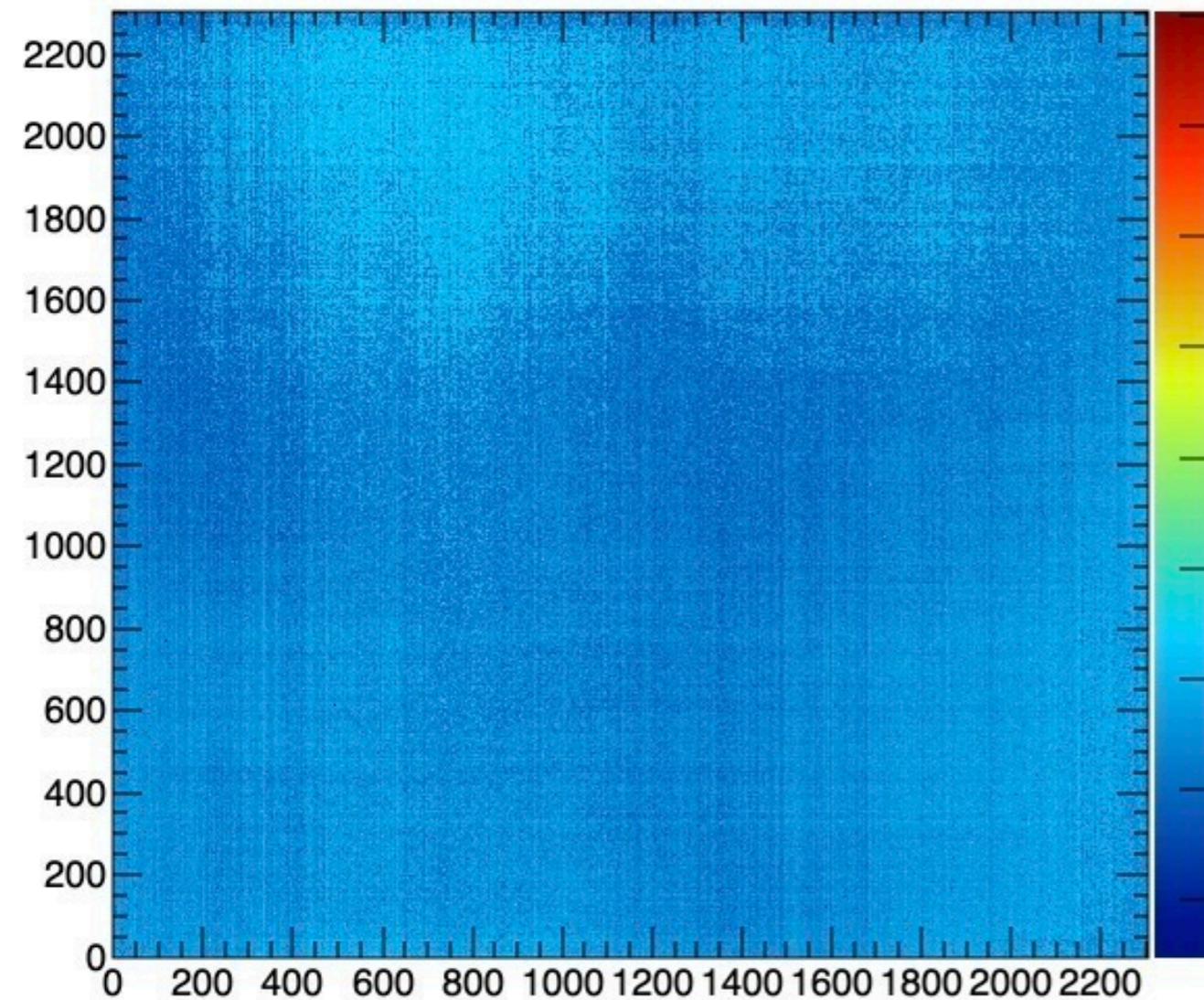
Even if the zero-suppression is done BEFORE the vignetting correction, it still amplifies the residual noise. A LOT.



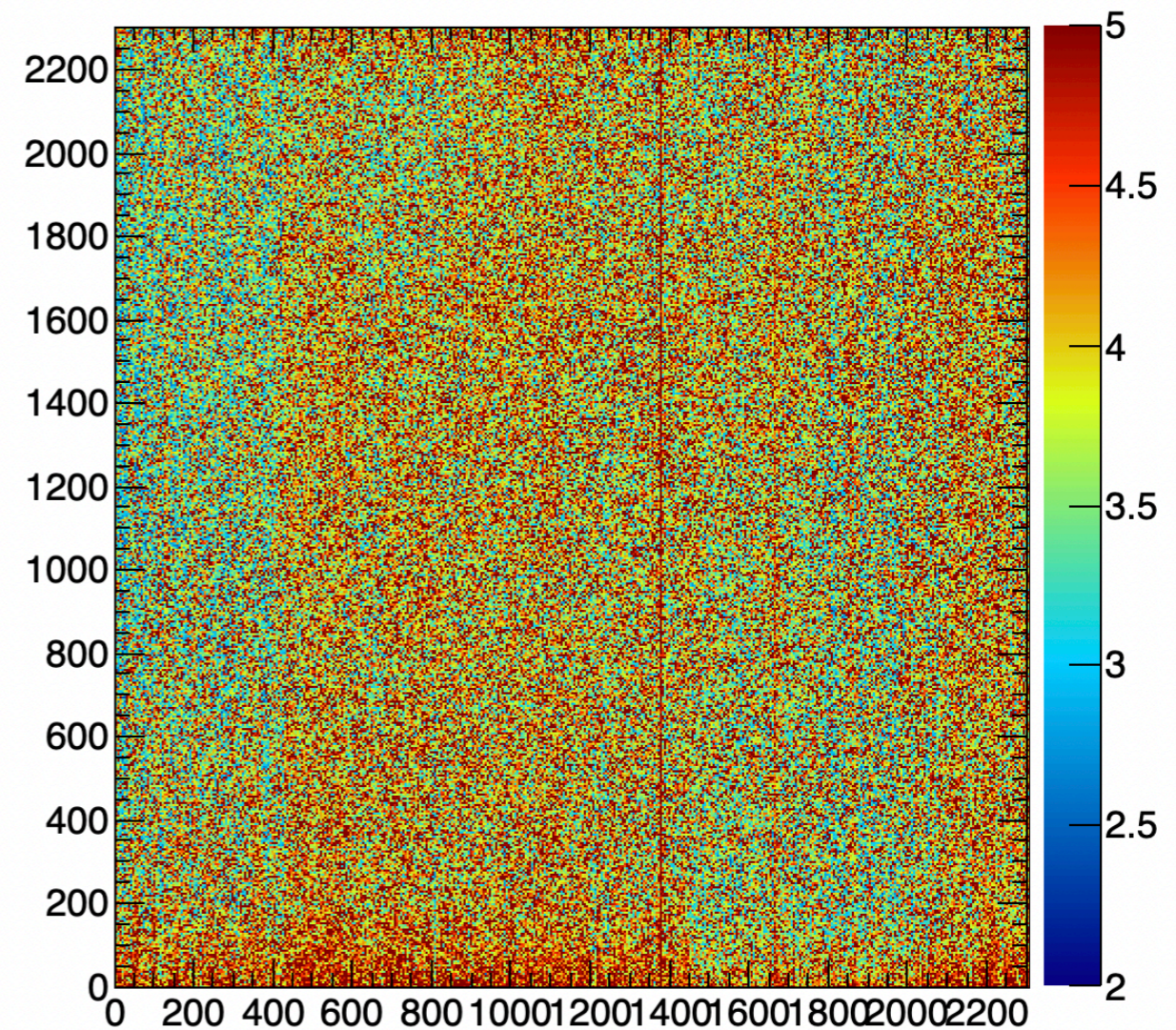
noise has other nefarious consequences

pattern sensor noise

Pedestal value, but also noise of the sensor is not random. It goes along strips and is different in 4 areas.



pedestal mean



pedestal RMS

noise filtering

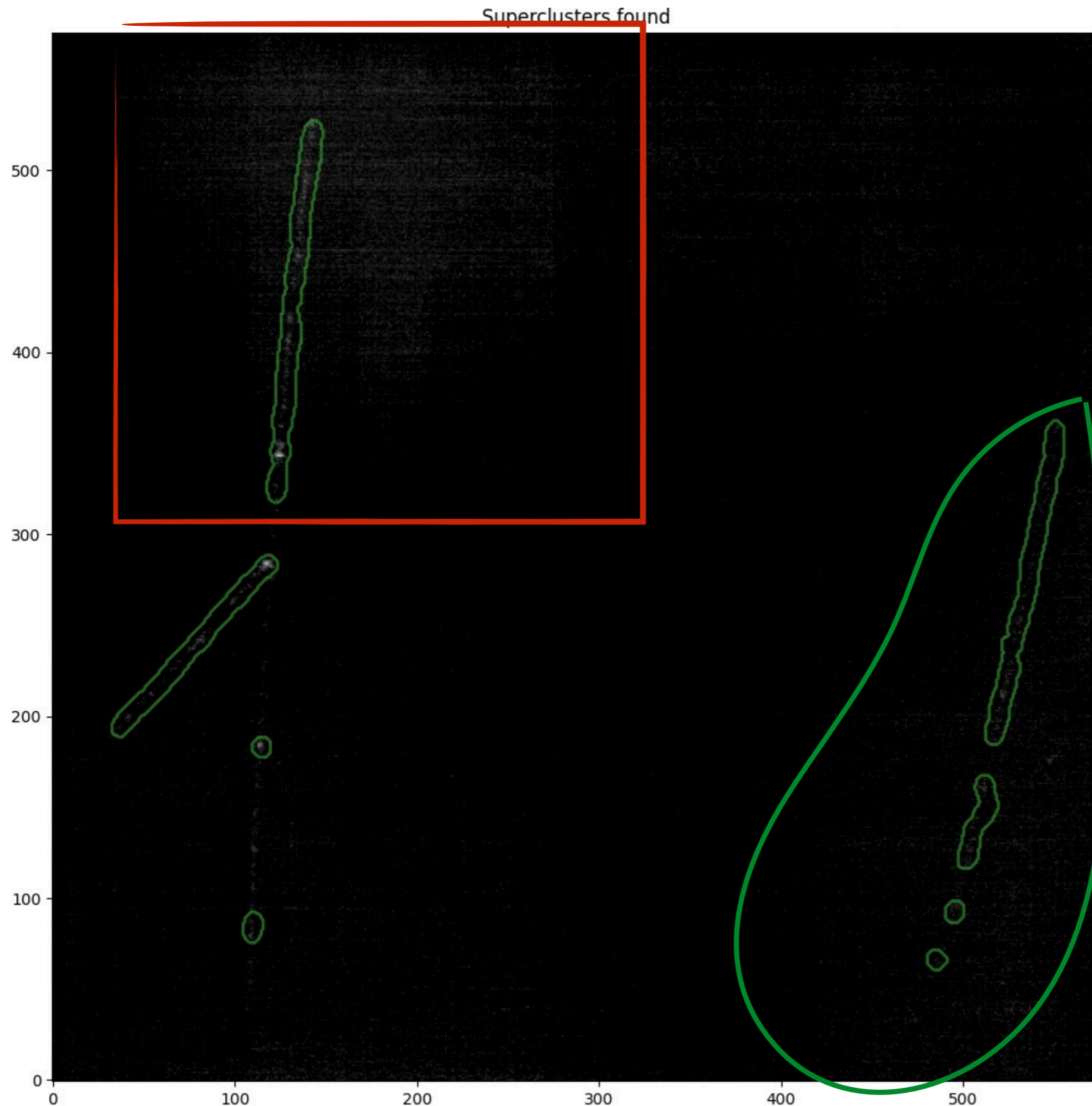
Before clustering we do few pre-processing of the image:

1. pedsub + zero-suppression
2. rebin the image by 4 (i.e. mean in 4x4 pixel matrix)
3. median filter applied to rebinned image (in 4x4 macro-pixel square)
4. thresholding at 1 filtered macro-pixel ≥ 1 count

(3) is very helpful in removing randomly scattered noise (a.k.a. "salt and pepper" noise).

!! But if there is a pattern in the matrices, it does not help. Especially after having rebinned the image by 4 !!

pattern noise in action



Still see the area with high pedestal value.

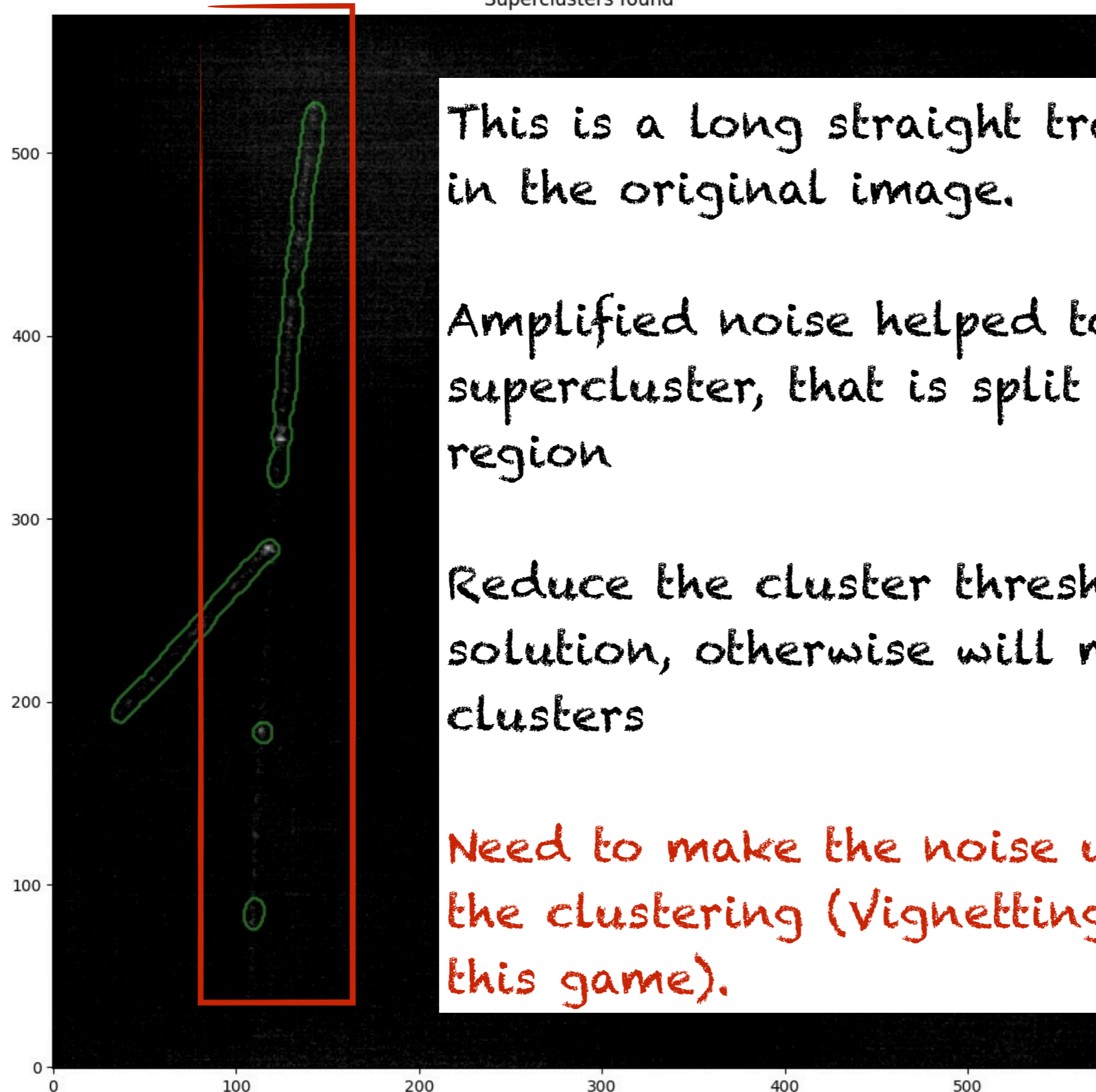
Imperfect pedestal subtraction could be amplified by rebinning + median filtering

Also biases the energy of long clusters

Vigetting amplified noise

pattern noise in action

Superclusters found



This is a long straight track that is uniform in the original image.

Amplified noise helped to make the supercluster, that is split in the no-noise region

Reduce the cluster thresholds is NOT a solution, otherwise will make many fake clusters

Need to make the noise uniform, THEN tune the clustering (Vignetting doesn't help in this game).

Filter the full resolution

A better solution is to median-filter the full resolution image with a short enough "radius". Used 2 pixel-size (real pixel=150 μ m)

Then rebin 4x4 (as before), then threshold >1 count/macropixel

=> This allows to reduce the noise ZS threshold (from 2.3x -> 1.5x σ_{noise})

And vignetting? Avoid applying it before the clustering, otherwise makes it crazy

1. do the clustering on the uncorrected image (flat S/B)

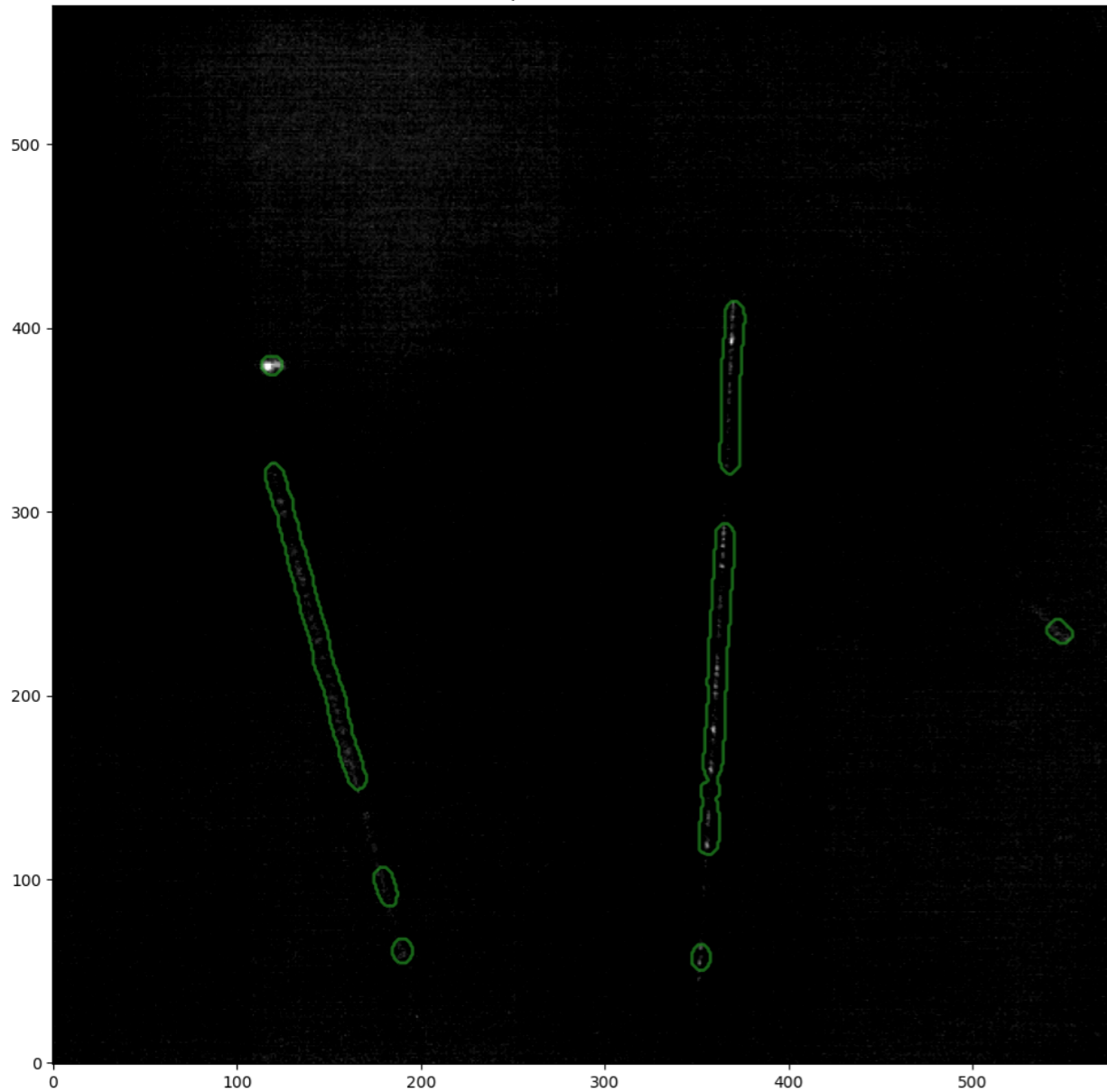
2. apply correction only for energy computation

i.e. have a position-dependent efficiency, but we already had with the dynamic cluster threshold, which can be now removed

effect on the raw images

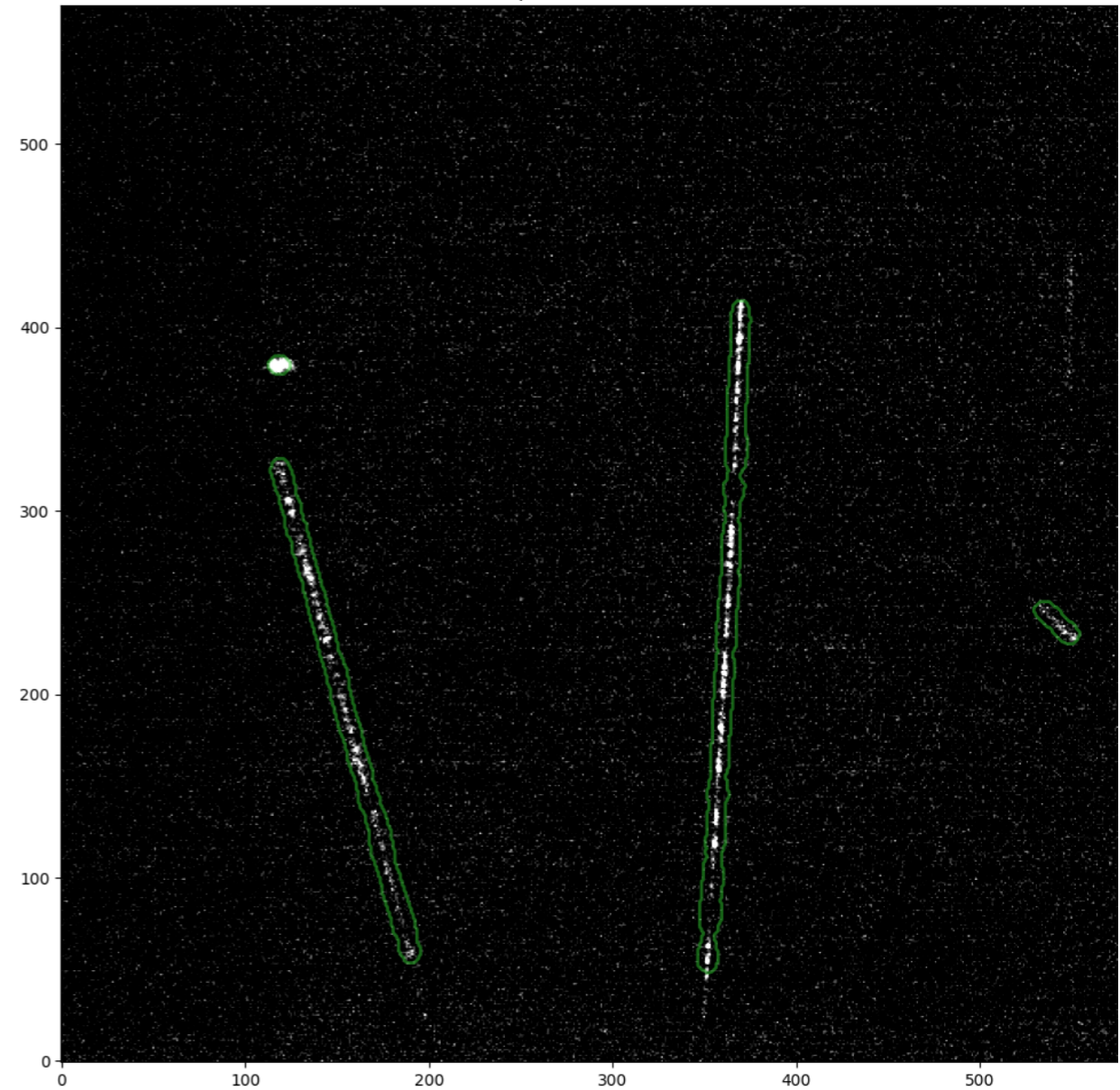


Superclusters found



old noise filtering

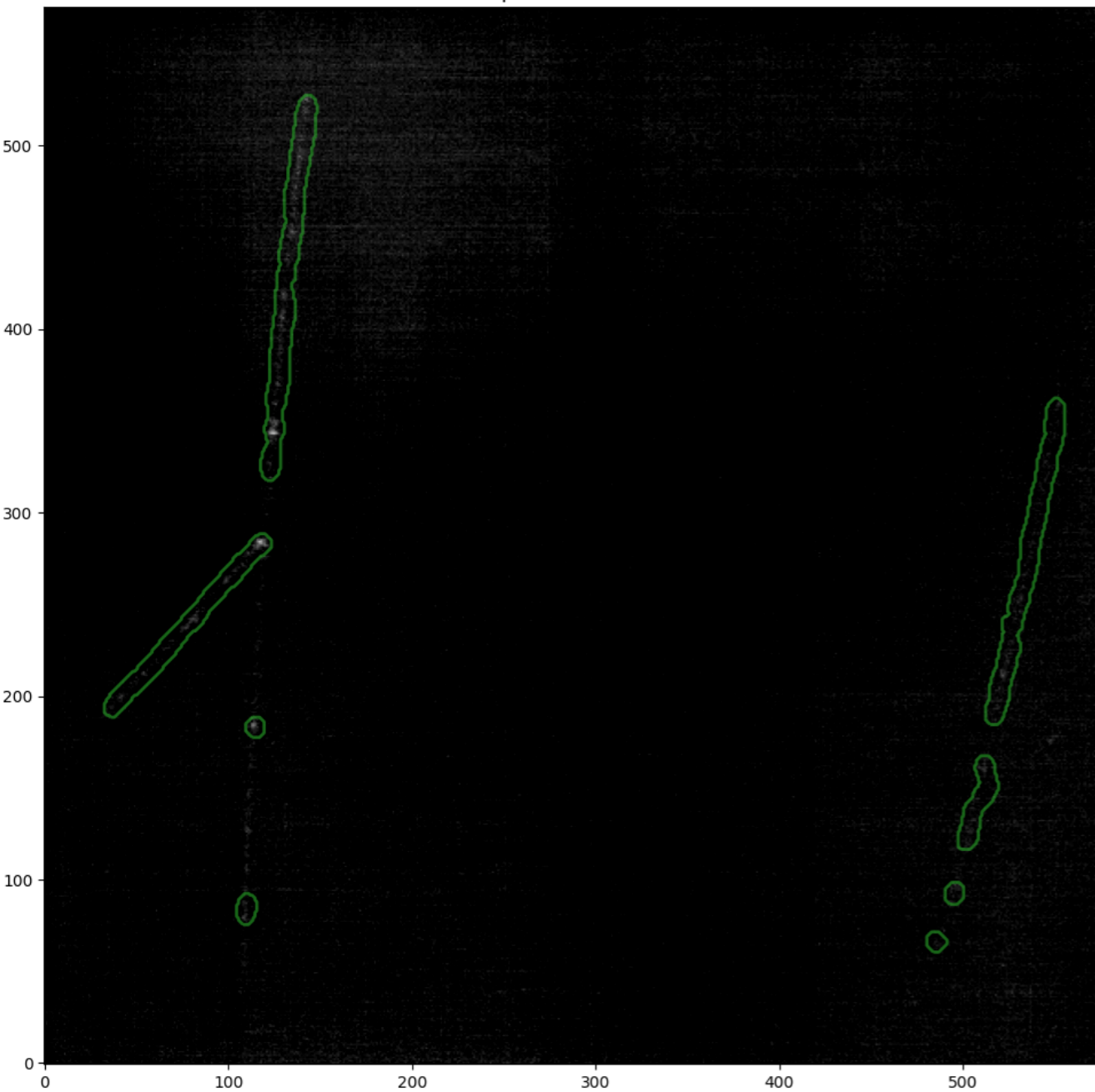
Superclusters found



new noise filtering

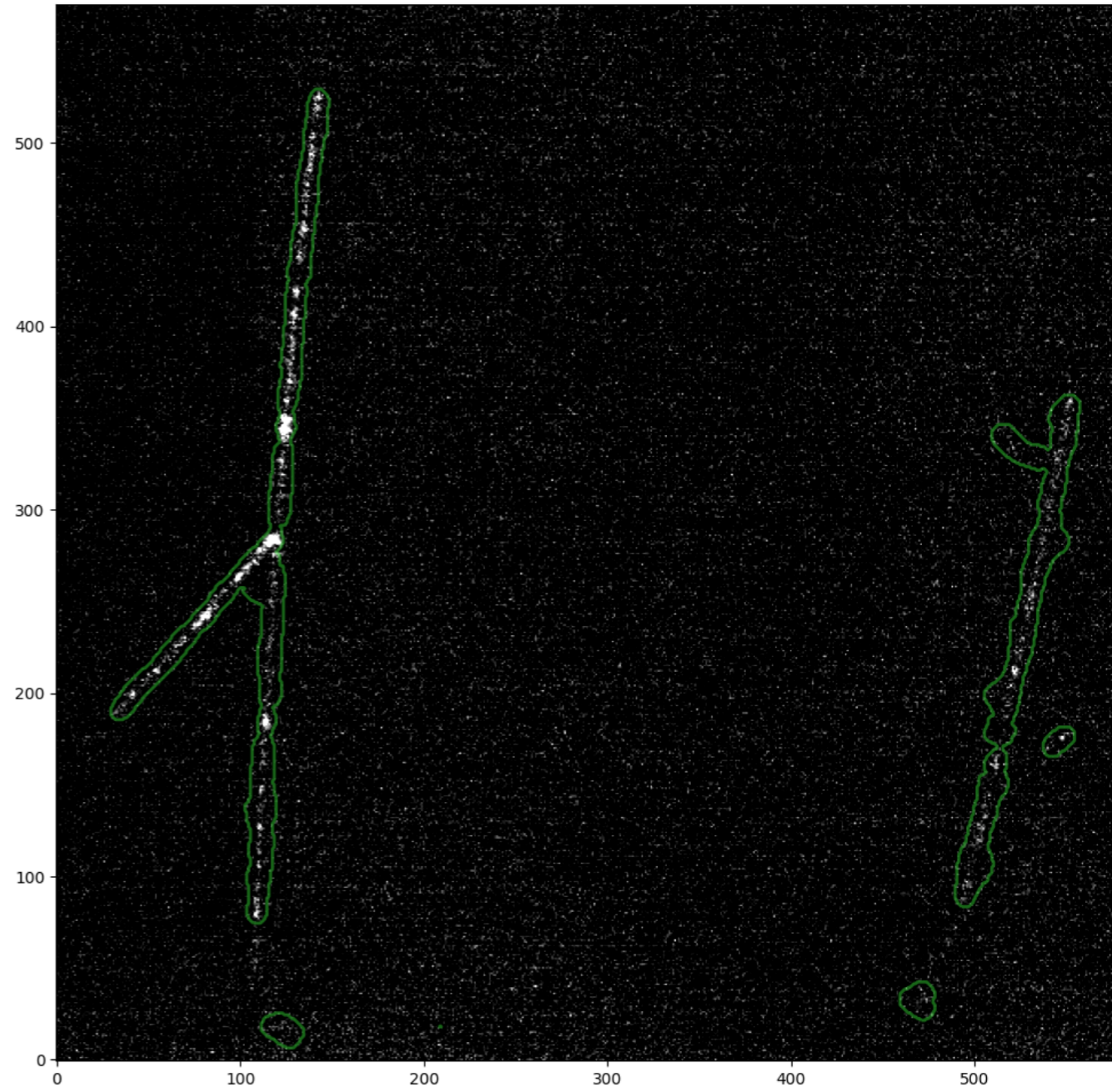
effect on the raw images

Superclusters found



old noise filtering

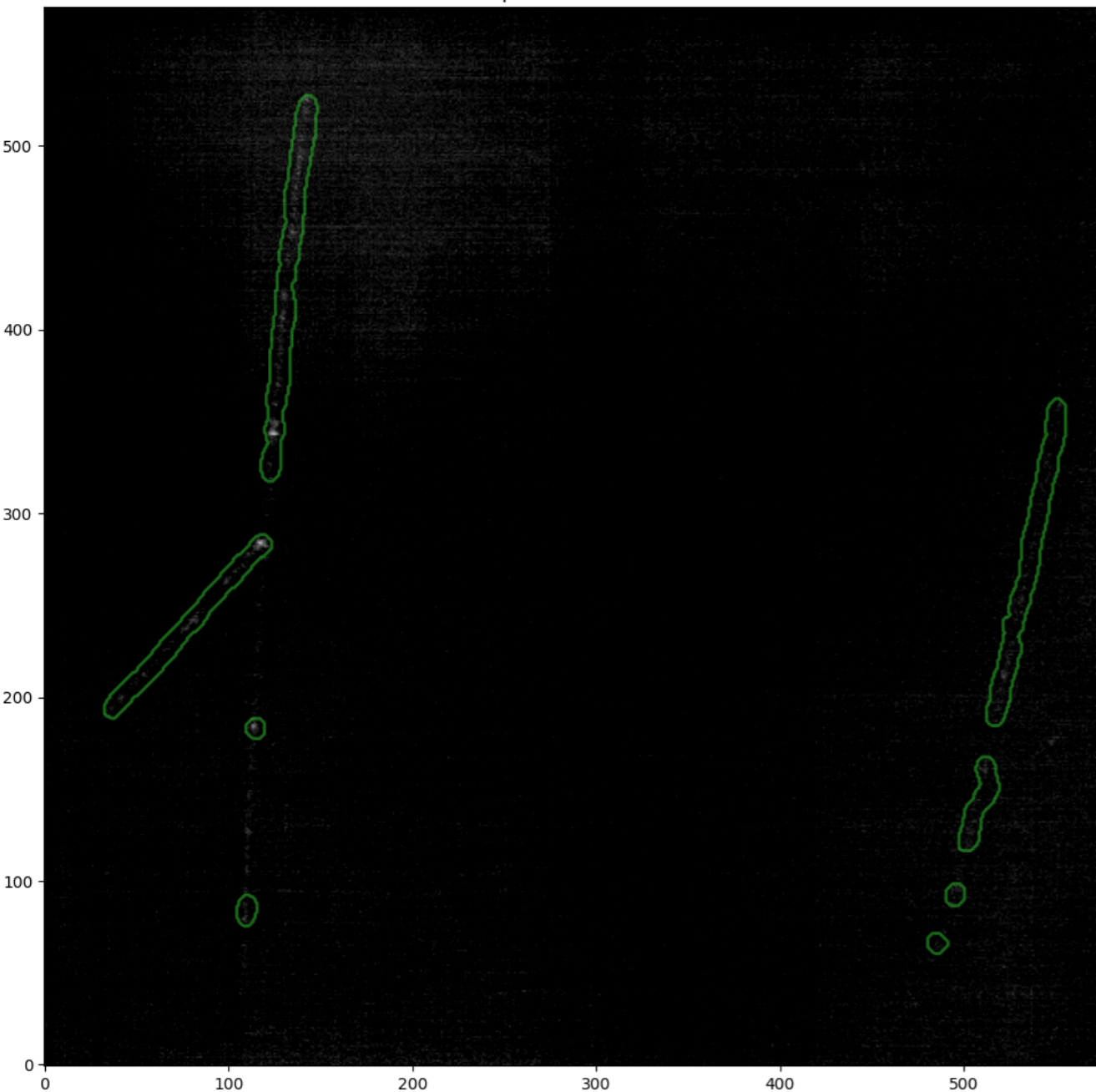
Superclusters found



new noise filtering

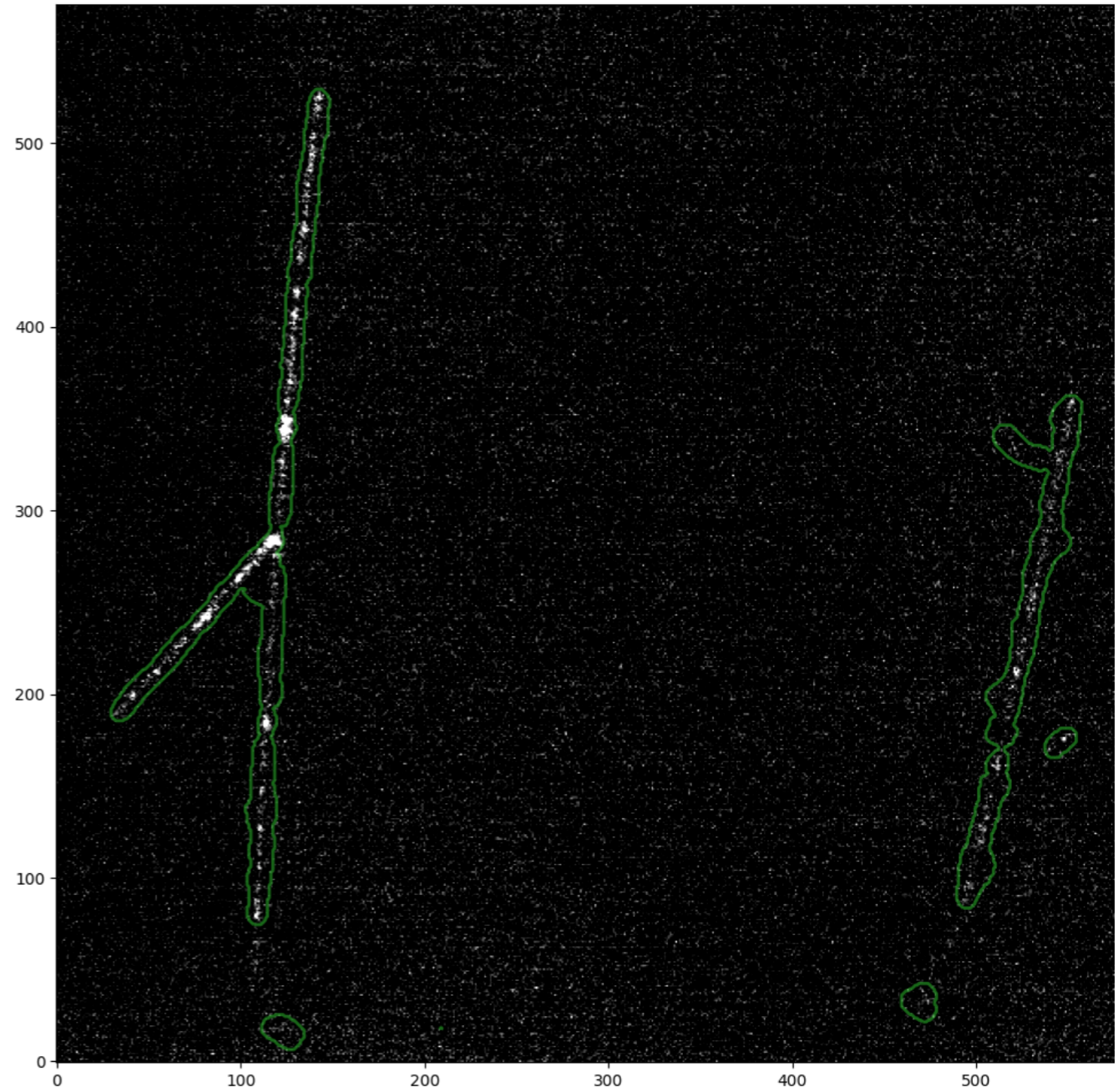
effect on the raw images

Superclusters found



old noise filtering

Superclusters found

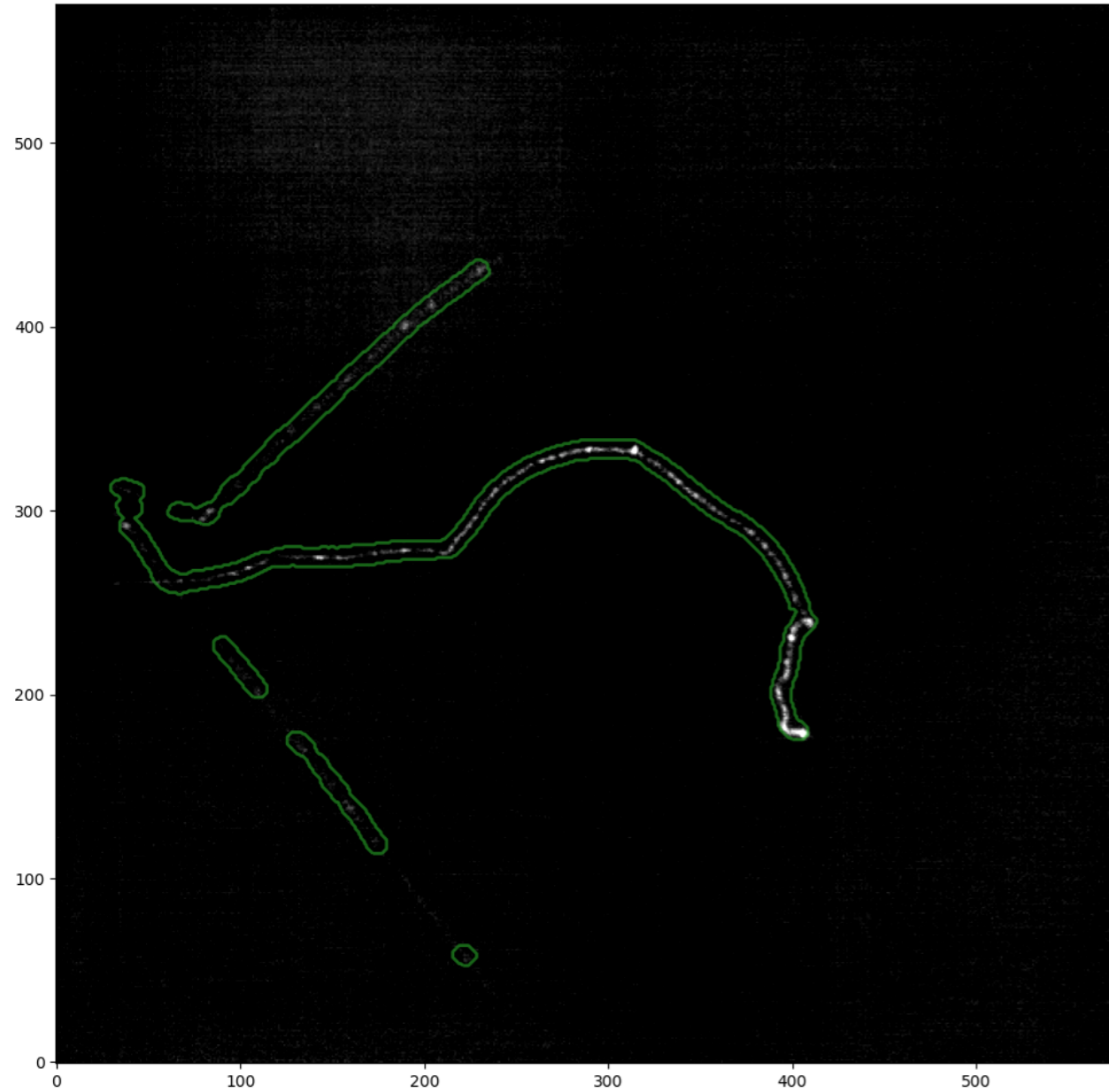


new noise filtering

effect on the raw images

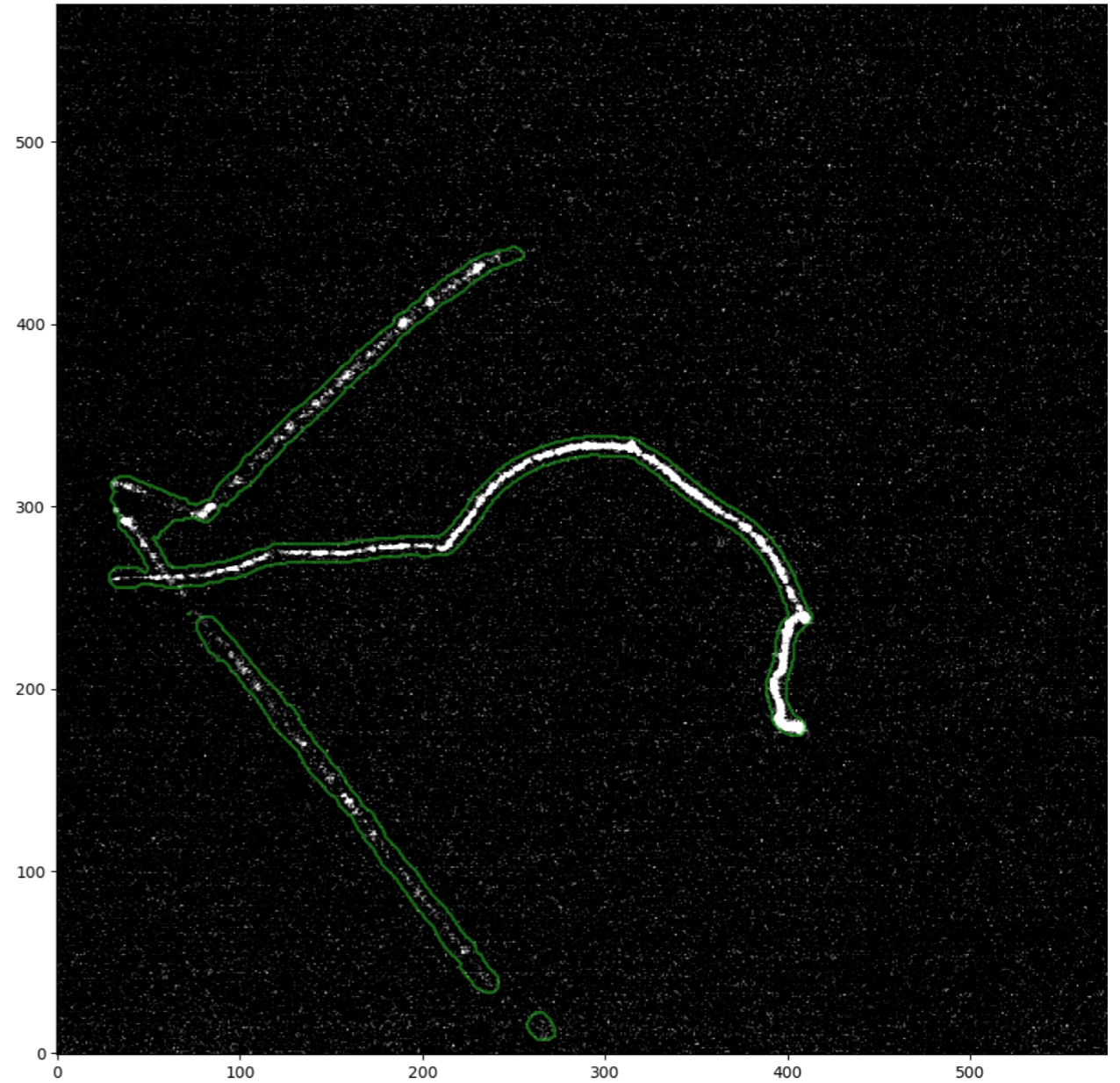


Superclusters found



old noise filtering

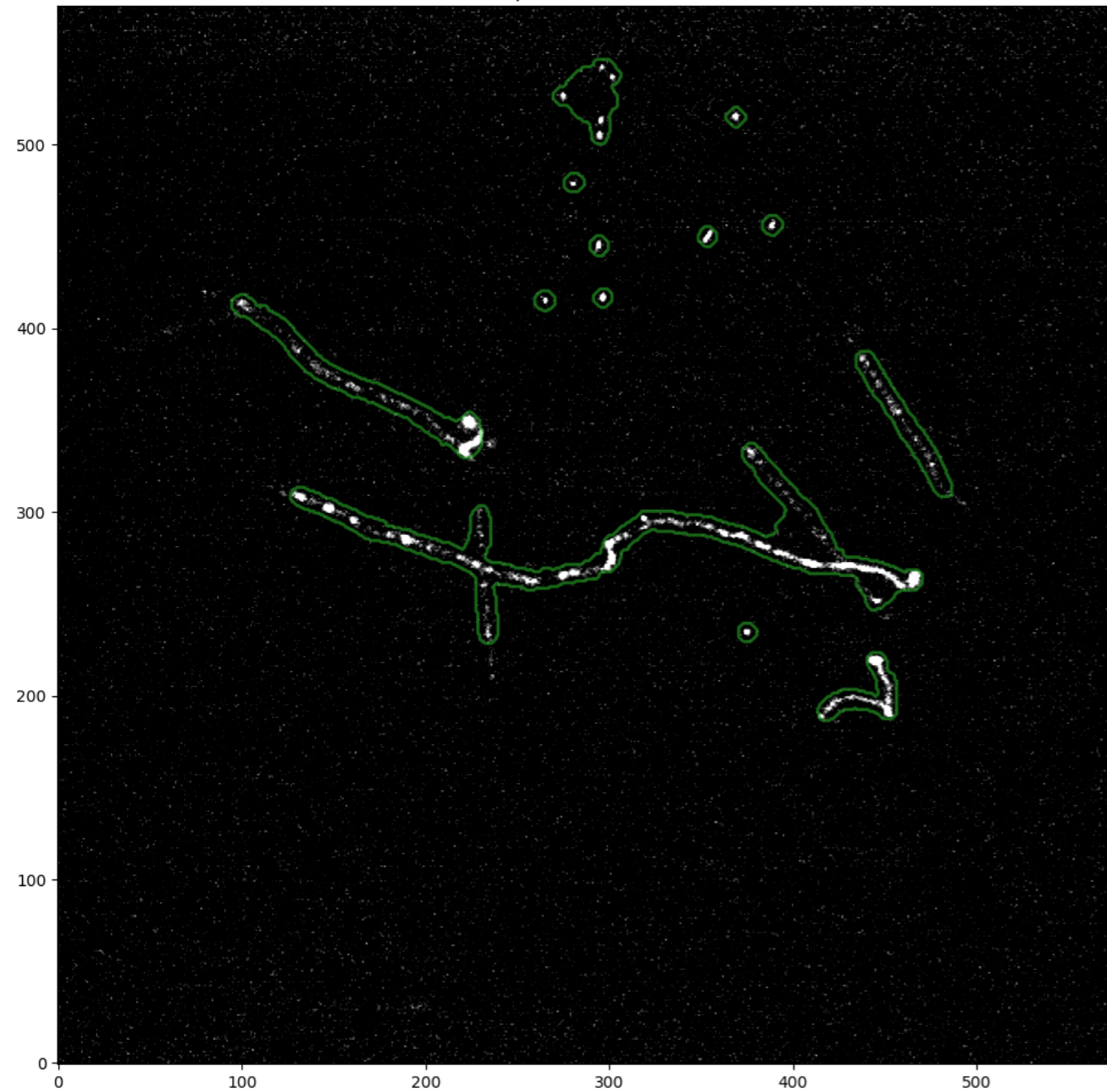
Superclusters found



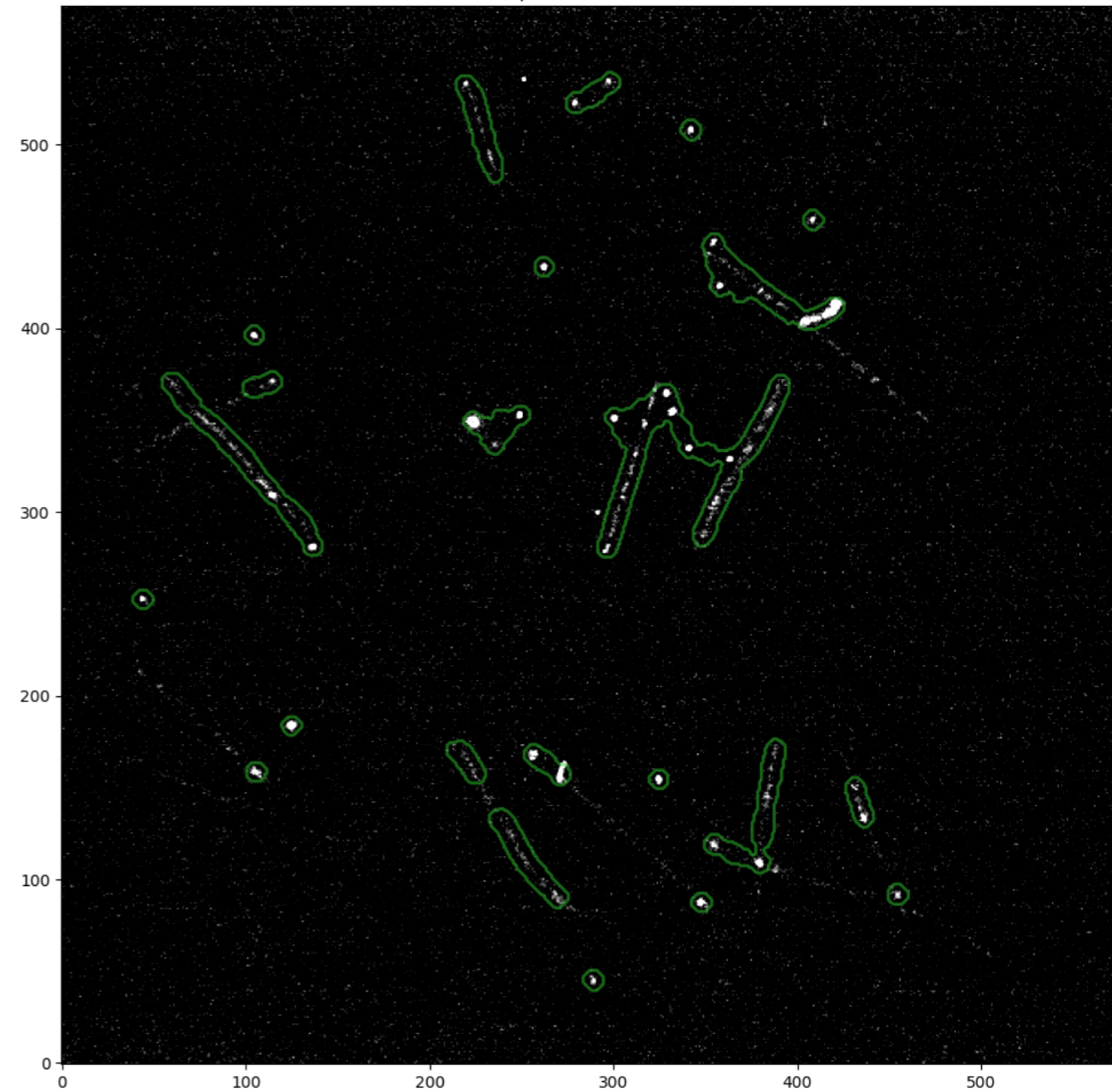
new noise filtering

Iron (multi-spots)

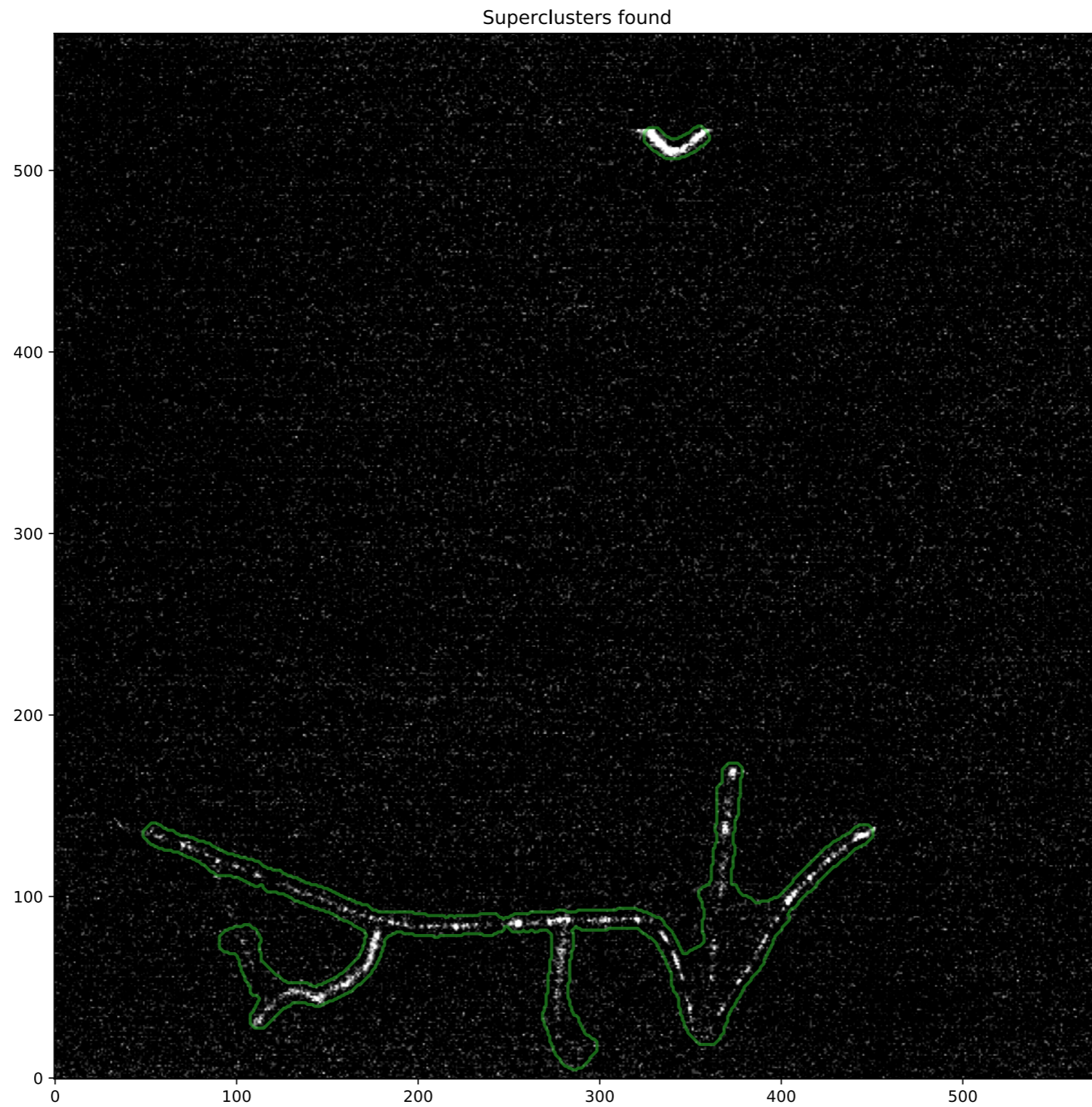
Superclusters found



Superclusters found

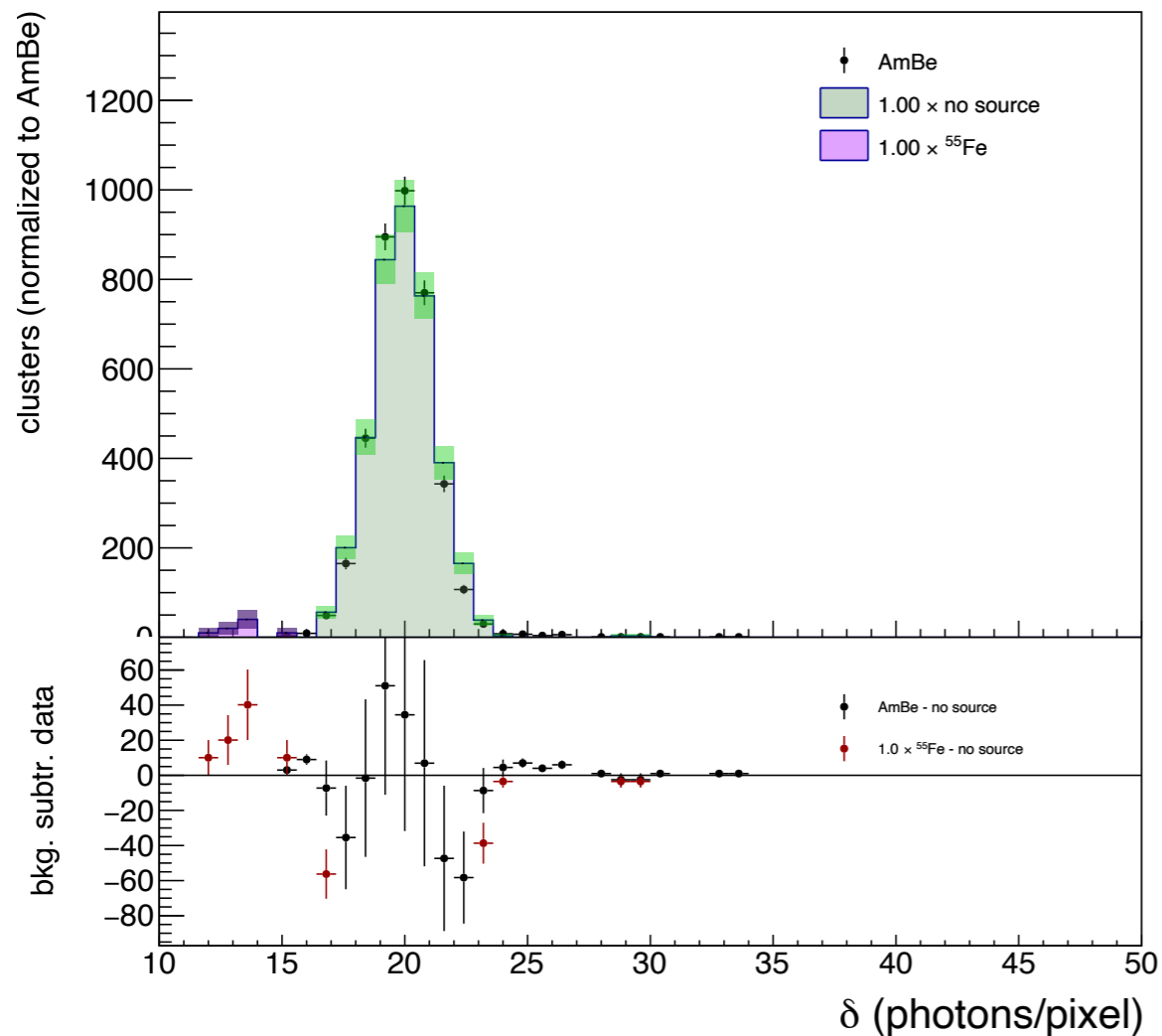


Sliced frames with this DAQ configuration so not many long tracks. **But is the noise is lower?**

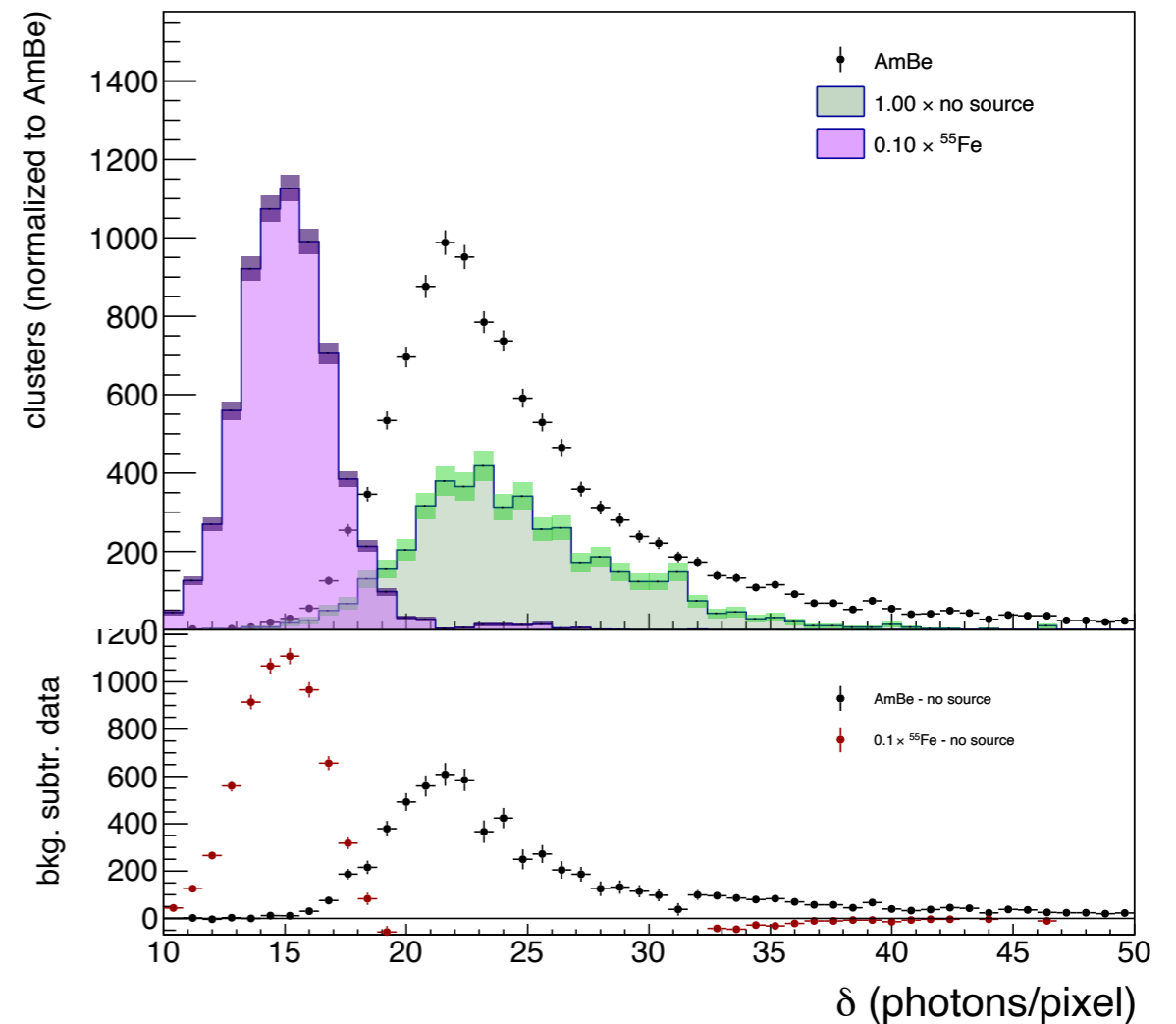


"V3" reco smoking gun

The smoking gun has been the density of long tracks, being similar to the Fe spots



long (>12 cm) slim tracks

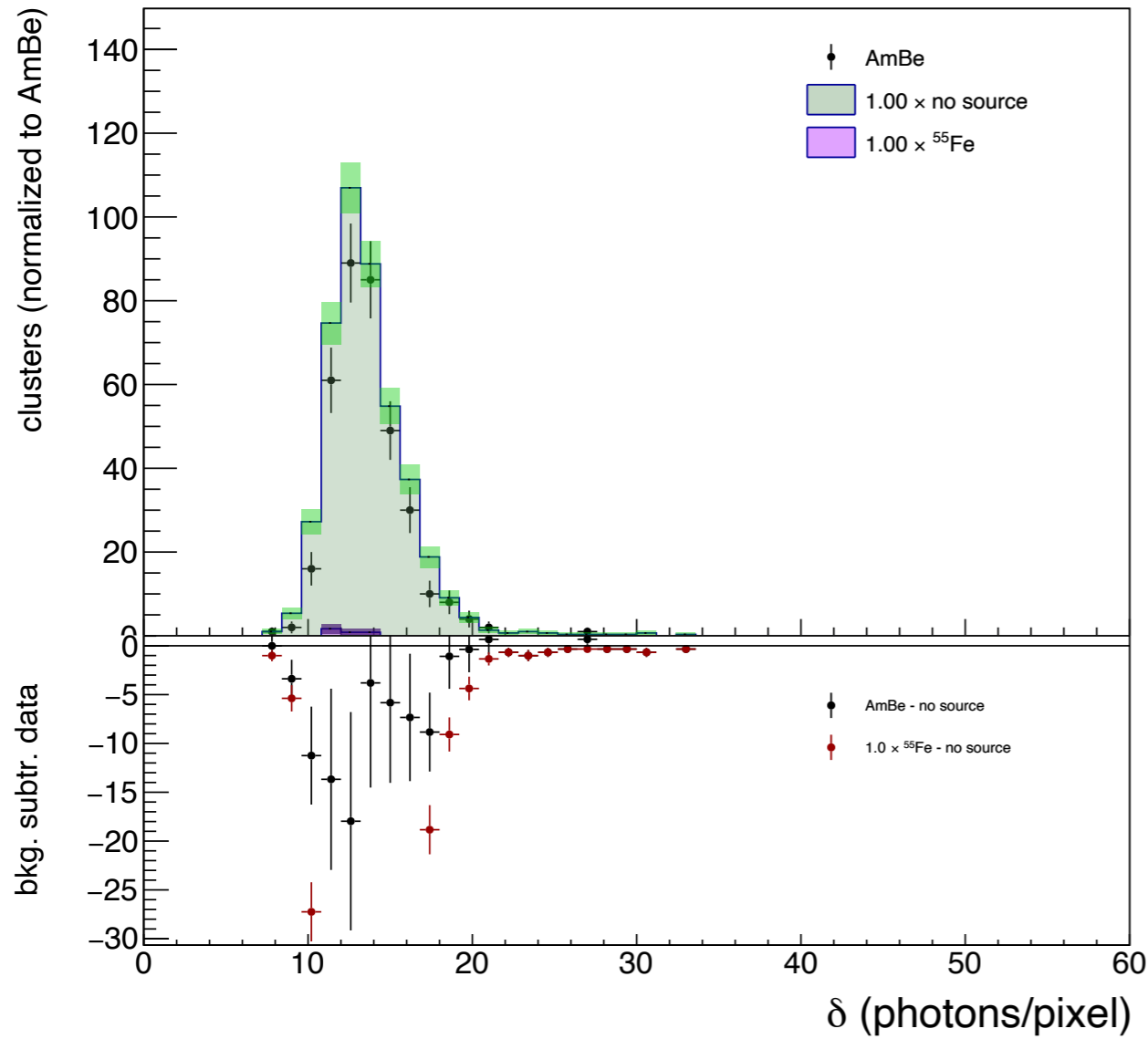


short tracks (<1cm)

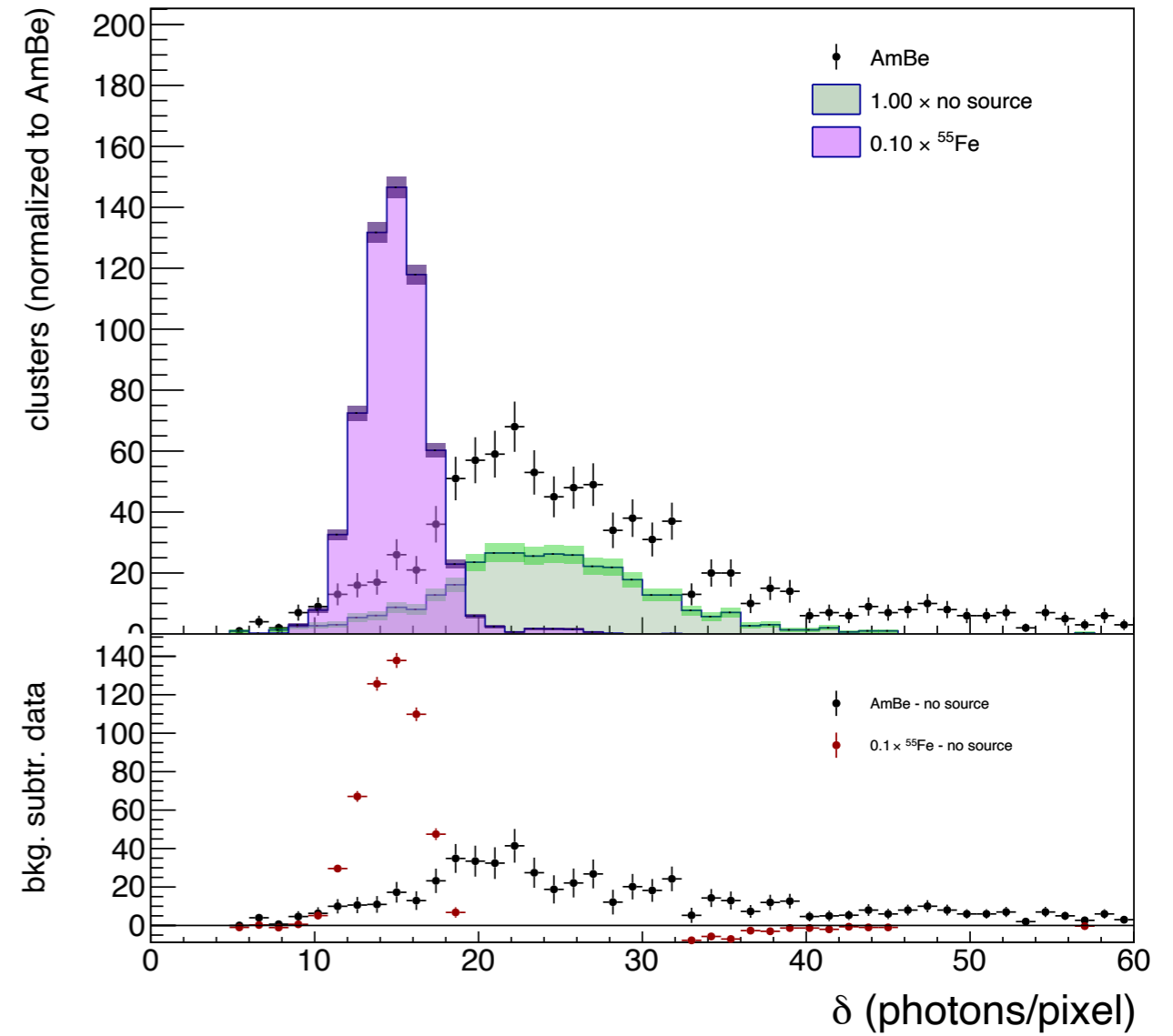
δ of cosmic (20 ph/pix) > Fe (14 ph/pix) ???

"V4" on the right direction

hot off the queues



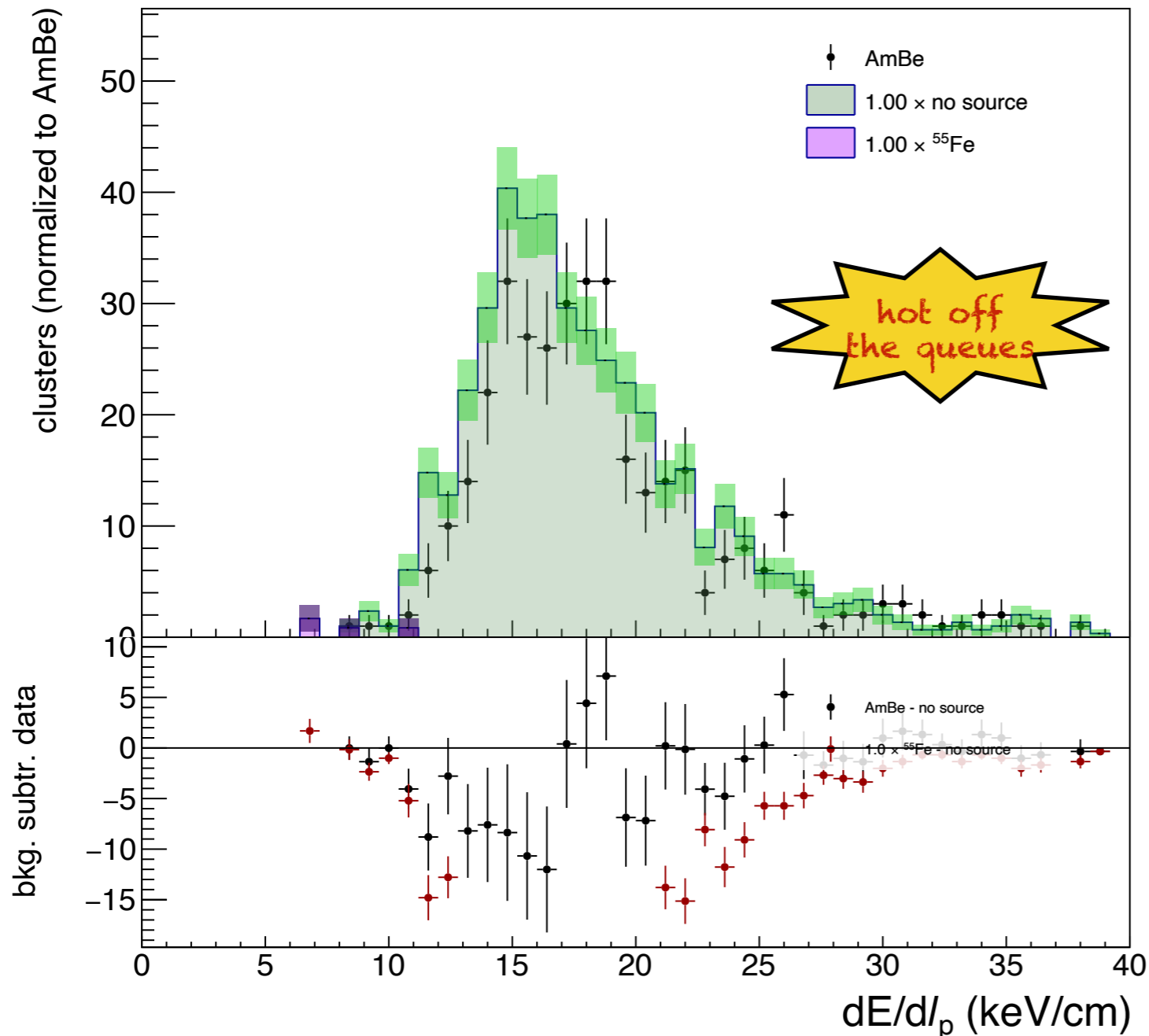
long (>12 cm) slim tracks



short tracks (<1cm)

δ of cosmics now < Fe. Still high...

Calibrating very roughly with Fe spots



Still very high (peak should be around 2 keV/cm)

Longer path along z wrt LEMON, but the angle cannot do so much

But... this is not a clean sample of cosmics:
pileup (2, 3 tracks overlap)
radioactivity
need to select a very pure sample (straight / no branches...)

Conclusions

A couple of major aspects understood:

1. Fe strange scale: it is mostly ok. What we called cosmic in Fe sample were mostly multiple overlapped spots to a piece of track changing energy, dE/dx , etc.

=> Spots can be used to calibrate the absolute scale

2. High dE/dx of long tracks: due to bad noise subtraction along a faint track.

=> Partially recovered with reco "V4", but dE/dx seems still too large wrt expected. Investigations ongoing...