Istituto Nazionale di Fisica Nucleare

GRAN SASSO SCIENCE INSTITUTE

Study of the “low gain” background campaign

Stefano Piacentini

10/05/2024

RUN 4 - The "low" vs "high" configurations

Low Gain

- GEMs Voltages: 420 V
- Drift field: 500 V/cm

- Run Considered:
  - ➡ 55174 - 56883
  - ➡ ~ 1700 runs of bkg data
  - ➡ One daily calibration available

I used ^{55}Fe data at step#3 [i.e. center of LIME in z] to cross-calibrate the two sets of data

High Gain

- GEMs Voltages: 440 V
- Drift field: 800 V/cm

- Run Considered:
  - ➡ 54505 - 55093
  - ➡ ~ 500 runs of bkg data
  - ➡ Chosen to be as **close** as possible **to low gain runs** to **reduce systematics** related to the detector conditions
  - ➡ Two daily calibrations available

RUN 4 - The “low” vs “high” configurations

Low Gain - ^{55}Fe calibration

- Cuts to select for spot-like tracks

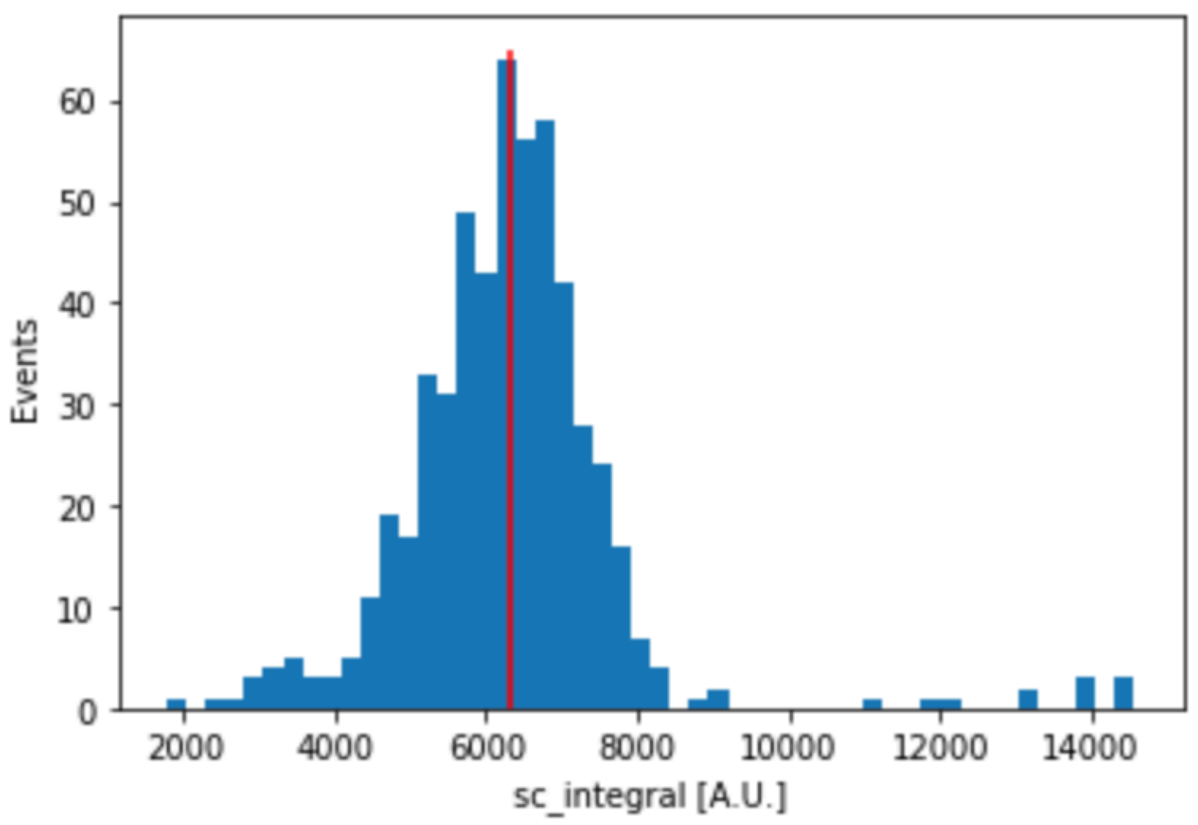
➡ **sc_rms > 6 [fake clusters]** *

➡ **sc_tgausssigma > 0.5 / 0.152 [events on the CMOS]**

➡ **R < 800 px [fiducialization]**

➡ sc_width/sc_length > 0.8 [round tracks]

➡ sc_integral < 15’000



LY (5.9 keV) = 6311 ± 63

High Gain - ^{55}Fe calibration

- Cuts to select for spot-like tracks

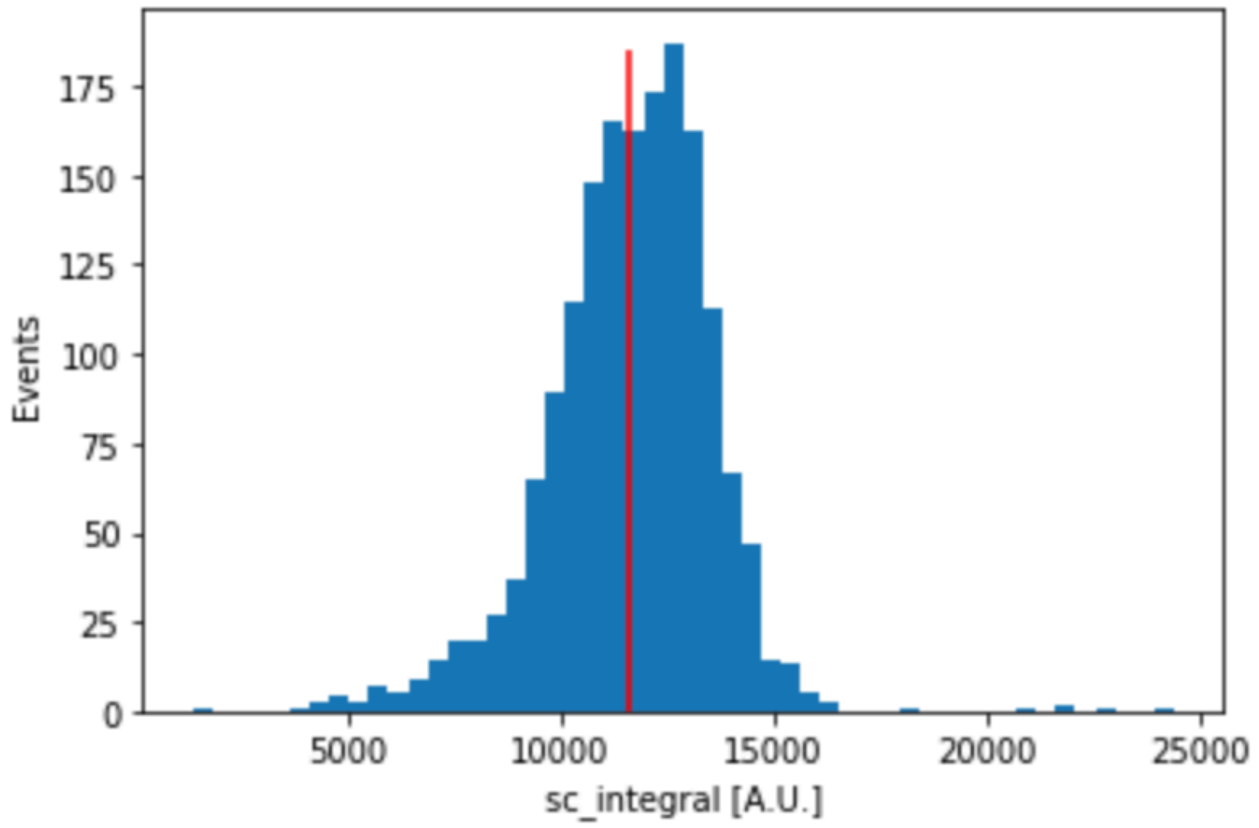
➡ **sc_rms > 6 [fake clusters]** *

➡ **sc_tgausssigma > 0.5 / 0.152 [events on the CMOS]**

➡ **R < 800 px [fiducialization]**

➡ sc_width/sc_length > 0.8 [round tracks]

➡ sc_integral < 25’000

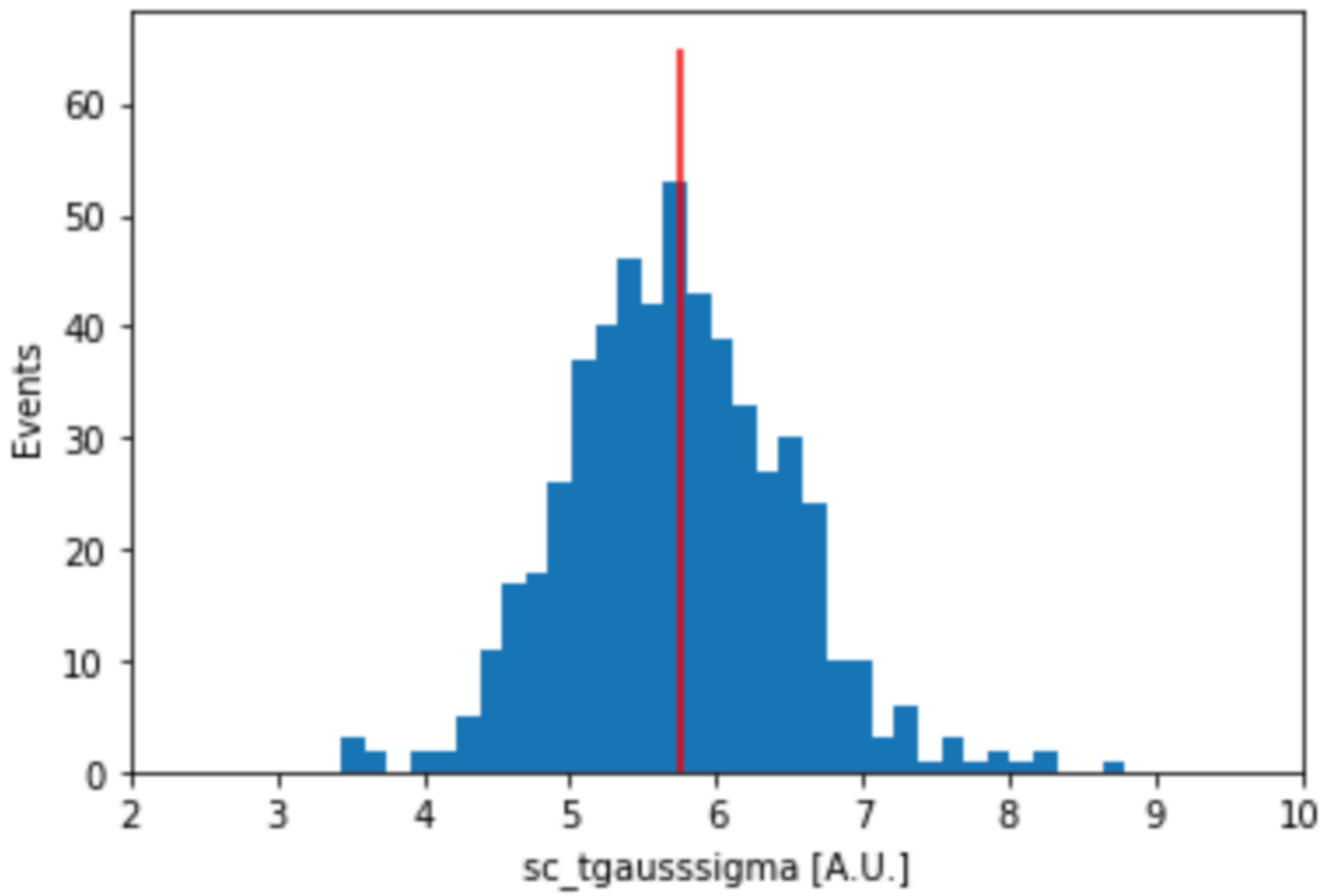


LY (5.9 keV) = 11641 ± 48

* Blue cuts are the ones applied to the data in the next slides

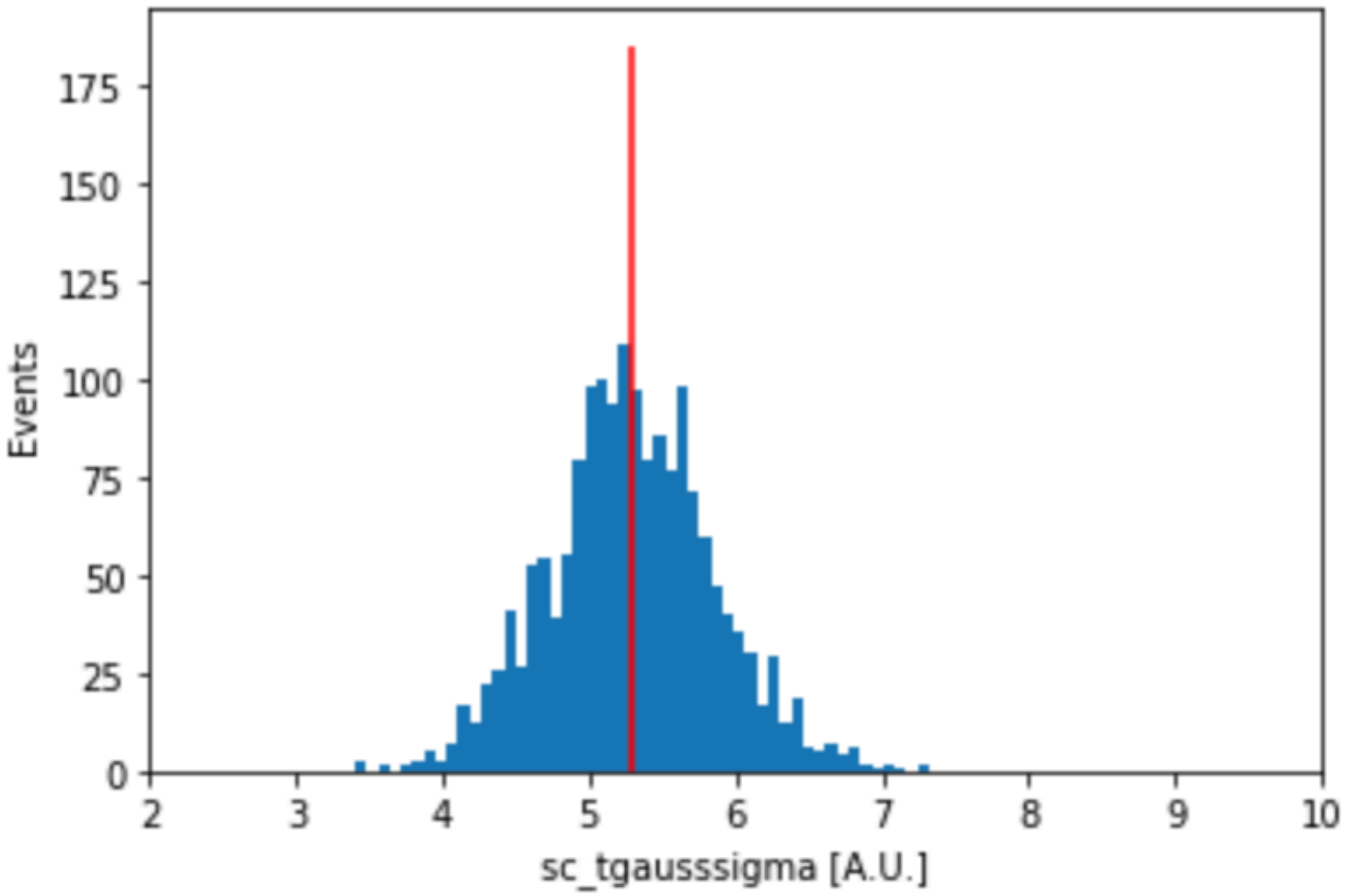
RUN 4 - The “low” vs “high” configurations

Low Gain - Fe diffusion



sc_tgausssigma = 5.747 ± 0.035

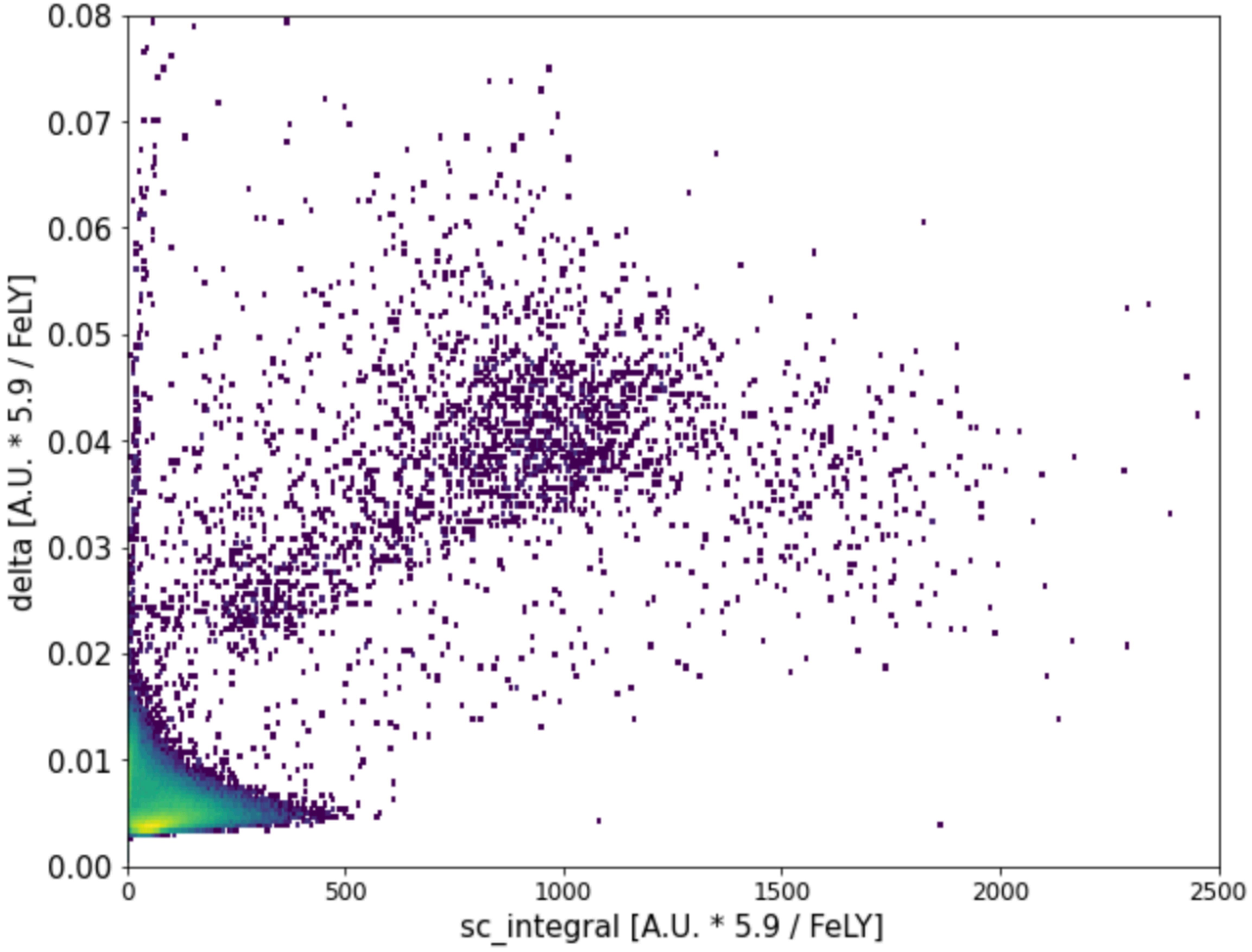
High Gain - Fe diffusion



sc_tgausssigma = 5.292 ± 0.014

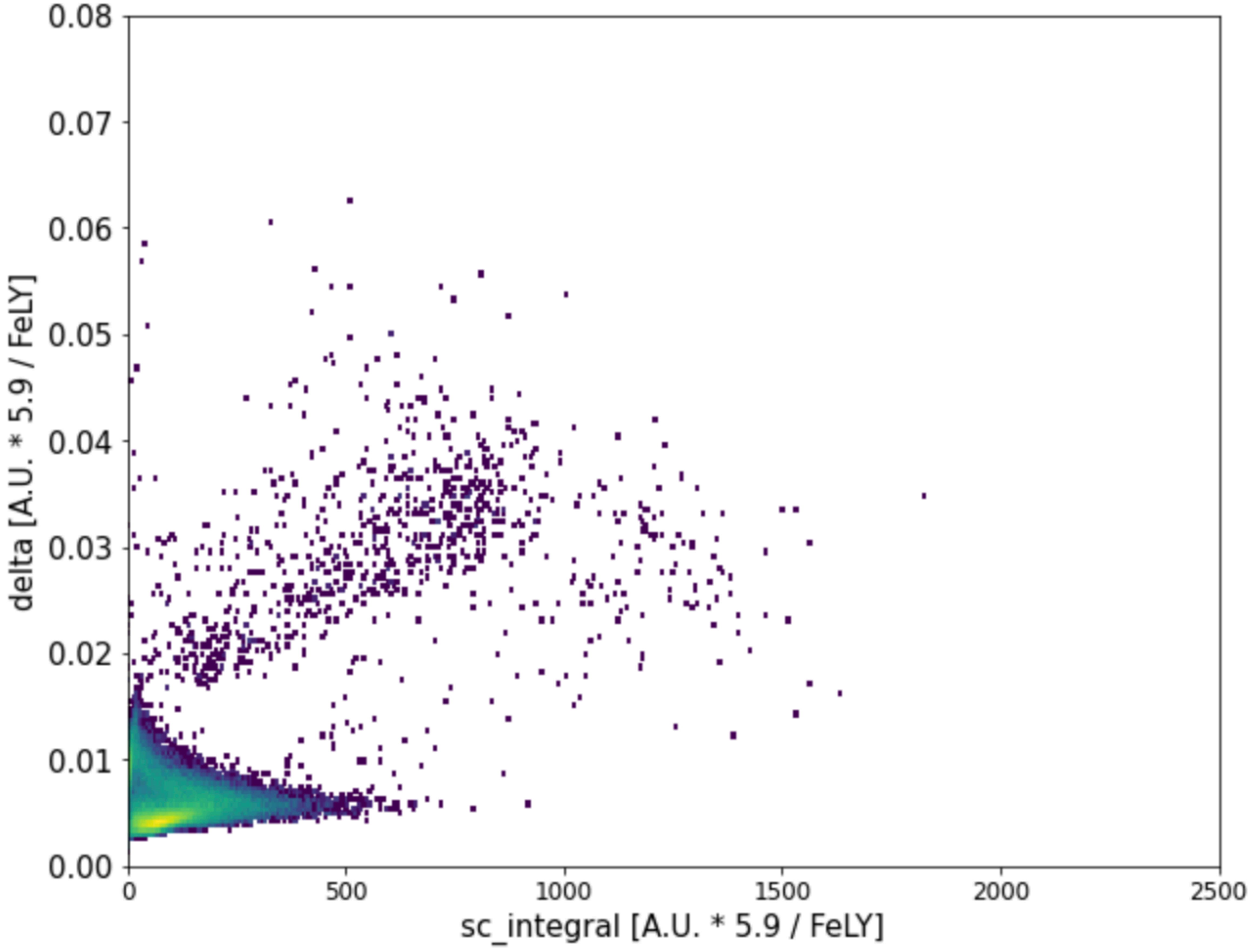
RUN 4 - The "low" vs "high" configurations

Low Gain - High Energy spectra



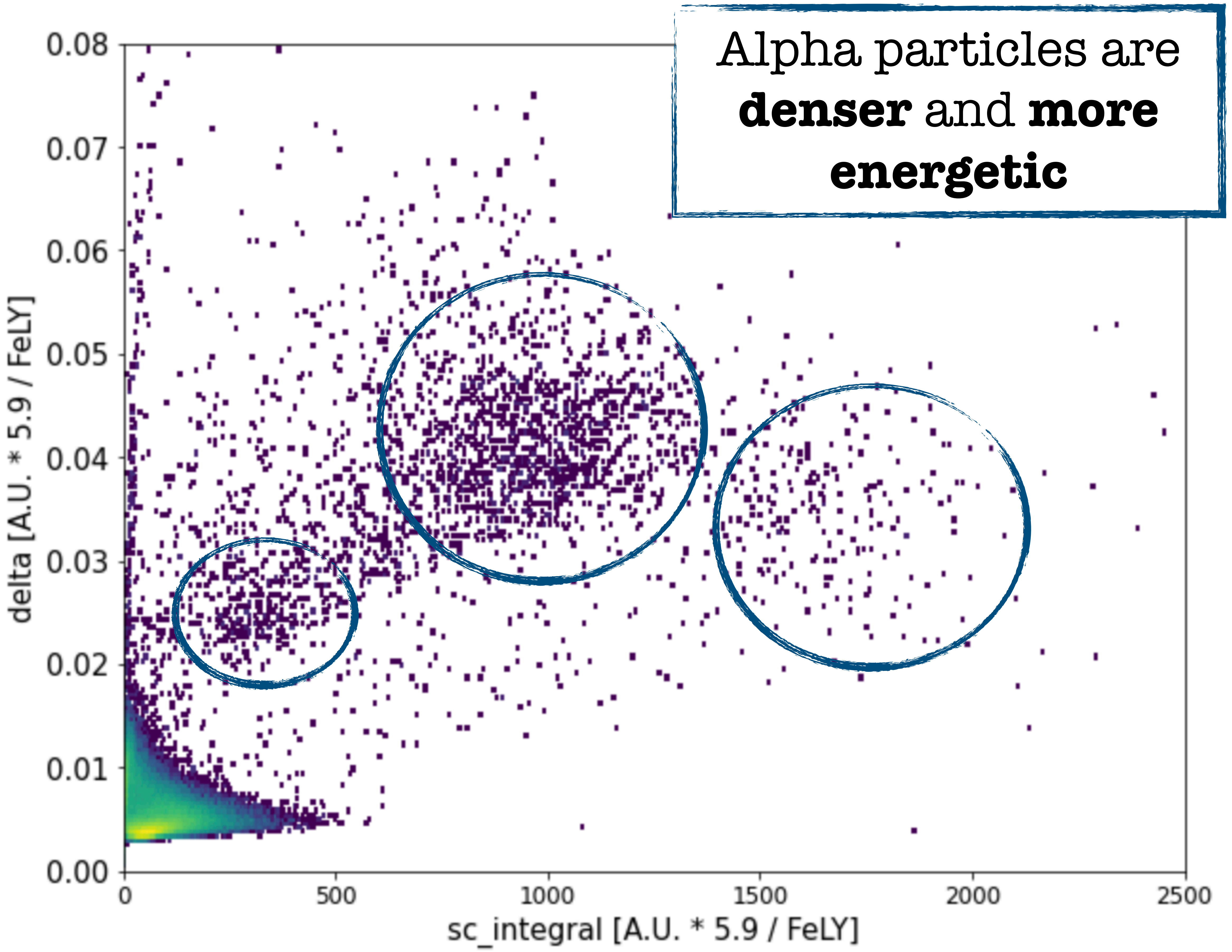
N.B. here there's a 3x in statistics

High Gain - High Energy spectra



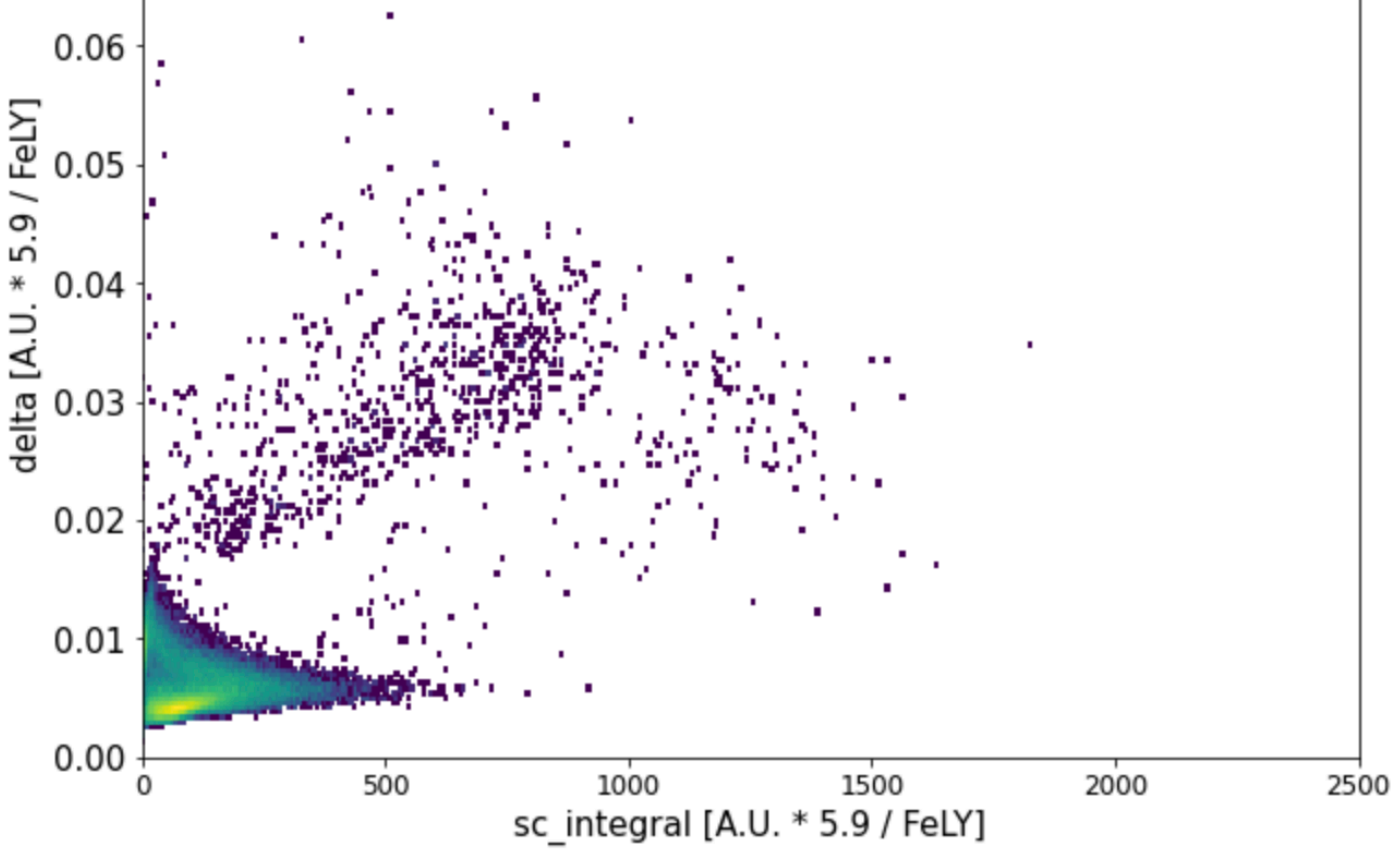
RUN 4 - The “low” vs “high” configurations

Low Gain - High Energy spectra



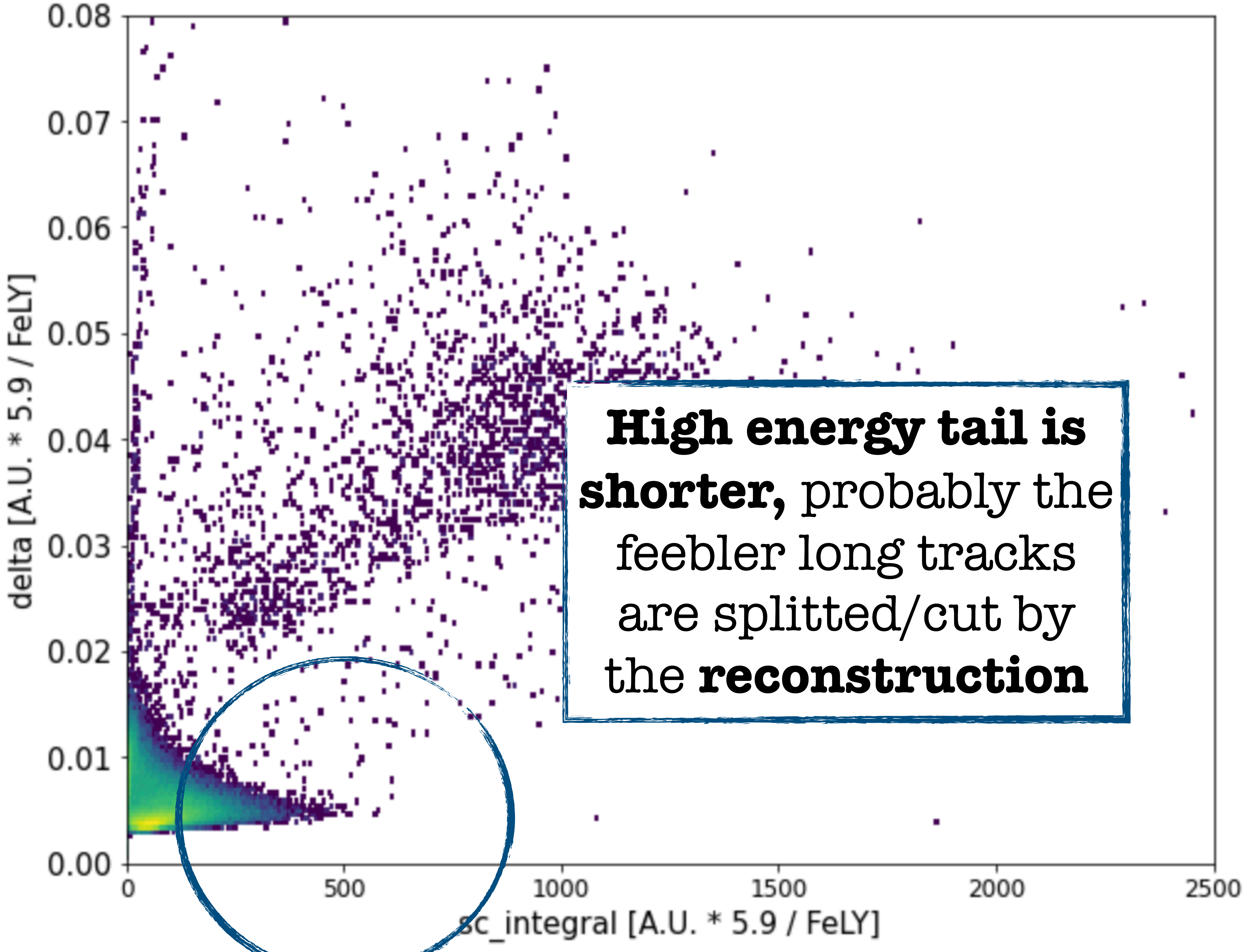
N.B. here there’s a 3x in statistics

High Gain - High Energy spectra



RUN 4 - The "low" vs "high" configurations

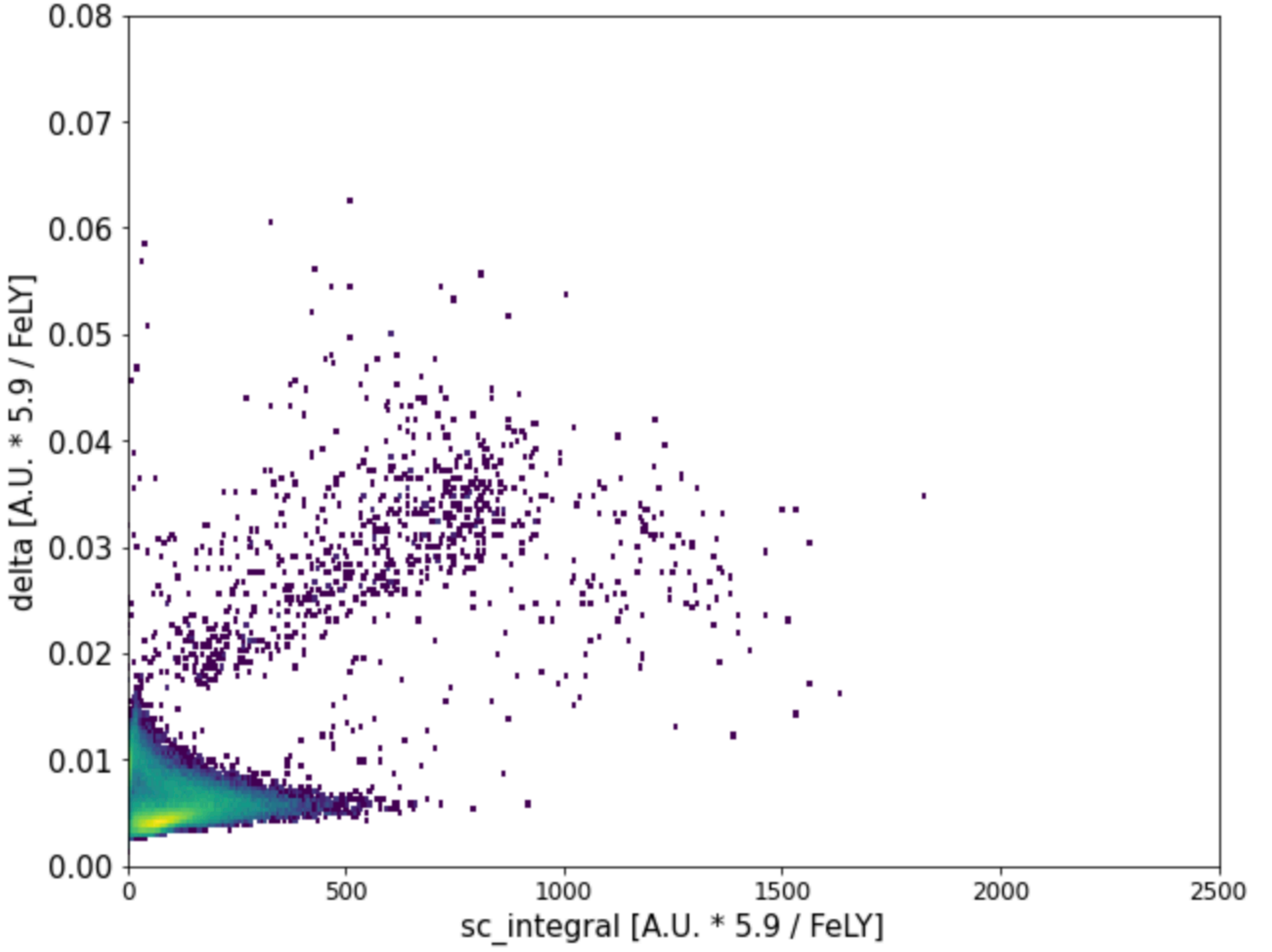
Low Gain - High Energy spectra



High energy tail is shorter, probably the feebler long tracks are splitted/cut by the **reconstruction**

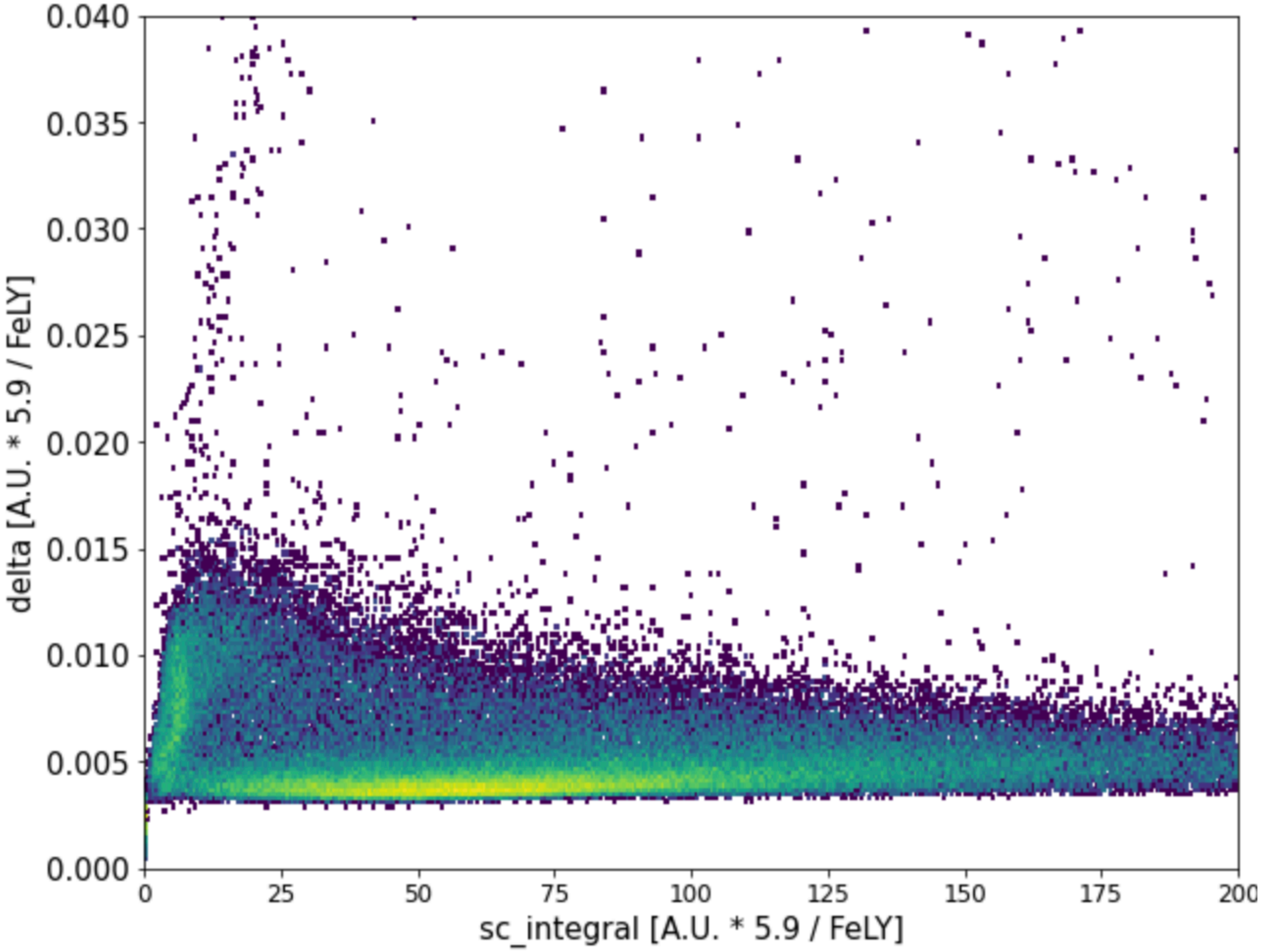
N.B. here there's a 3x in statistics

High Gain - High Energy spectra

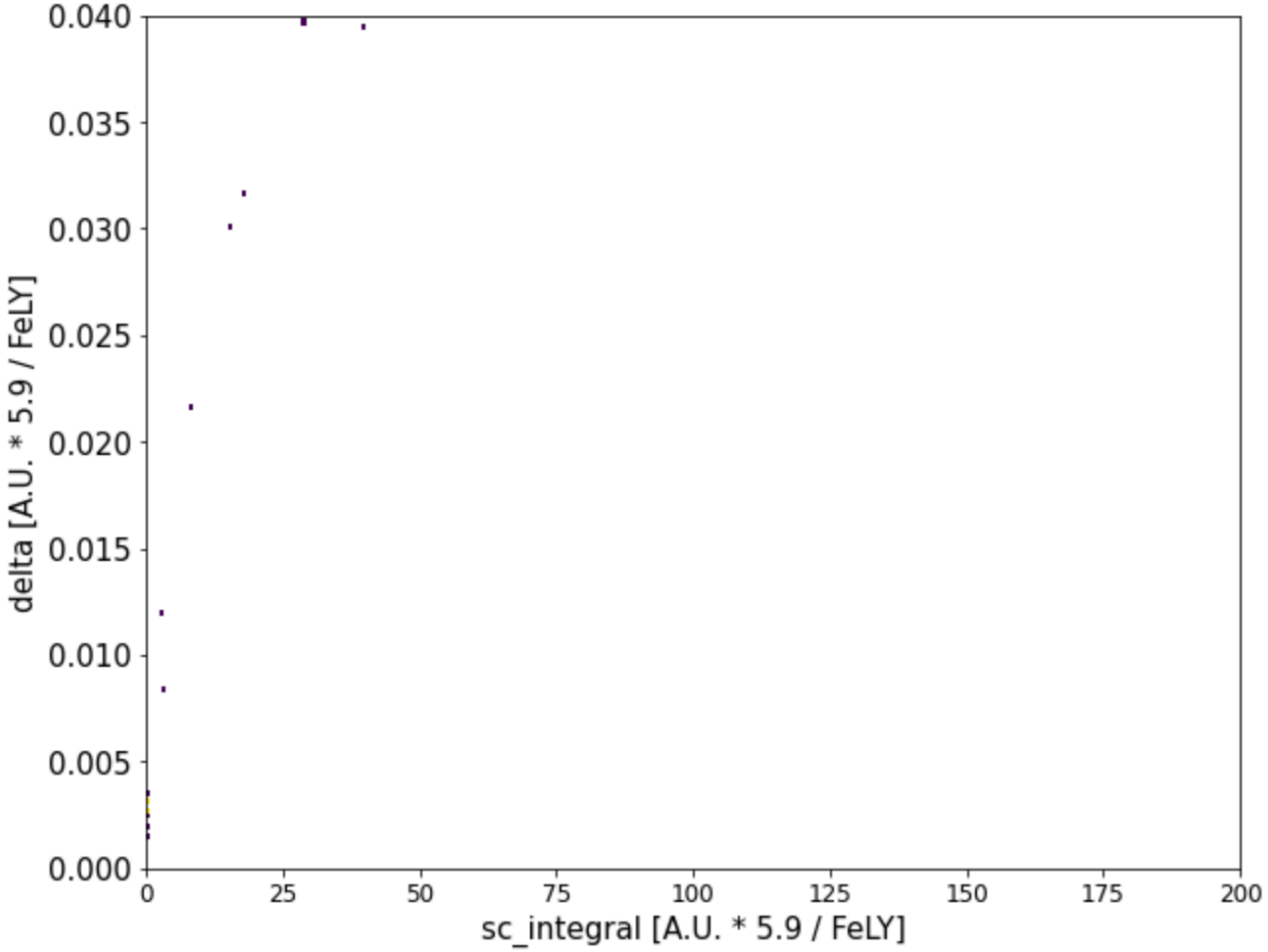


RUN 4 - The “low” vs “high” configurations

Low Gain - Low Energy spectra



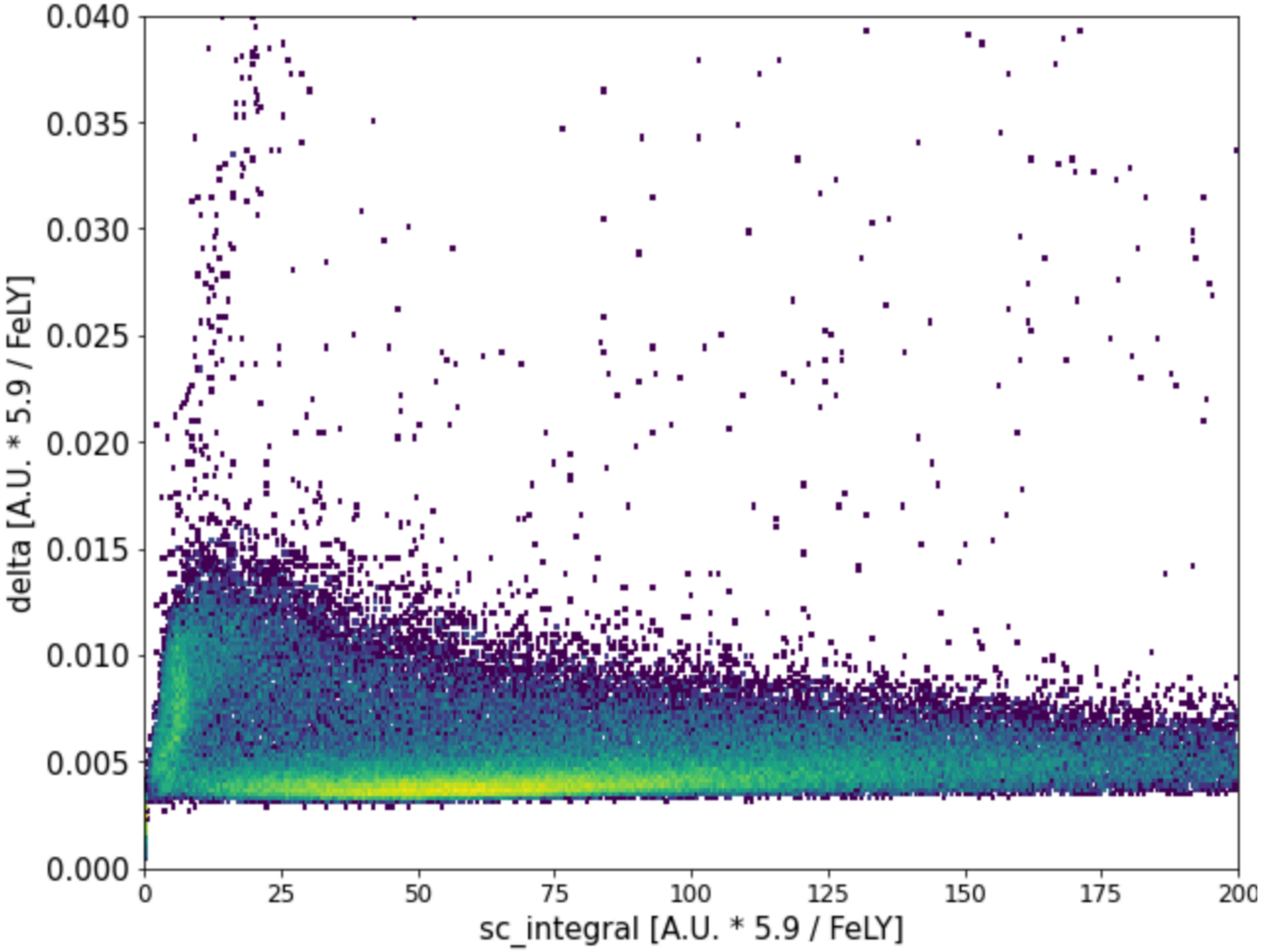
Low Gain - Low Energy spectra Pedestals



N.B. here statistics is much lower

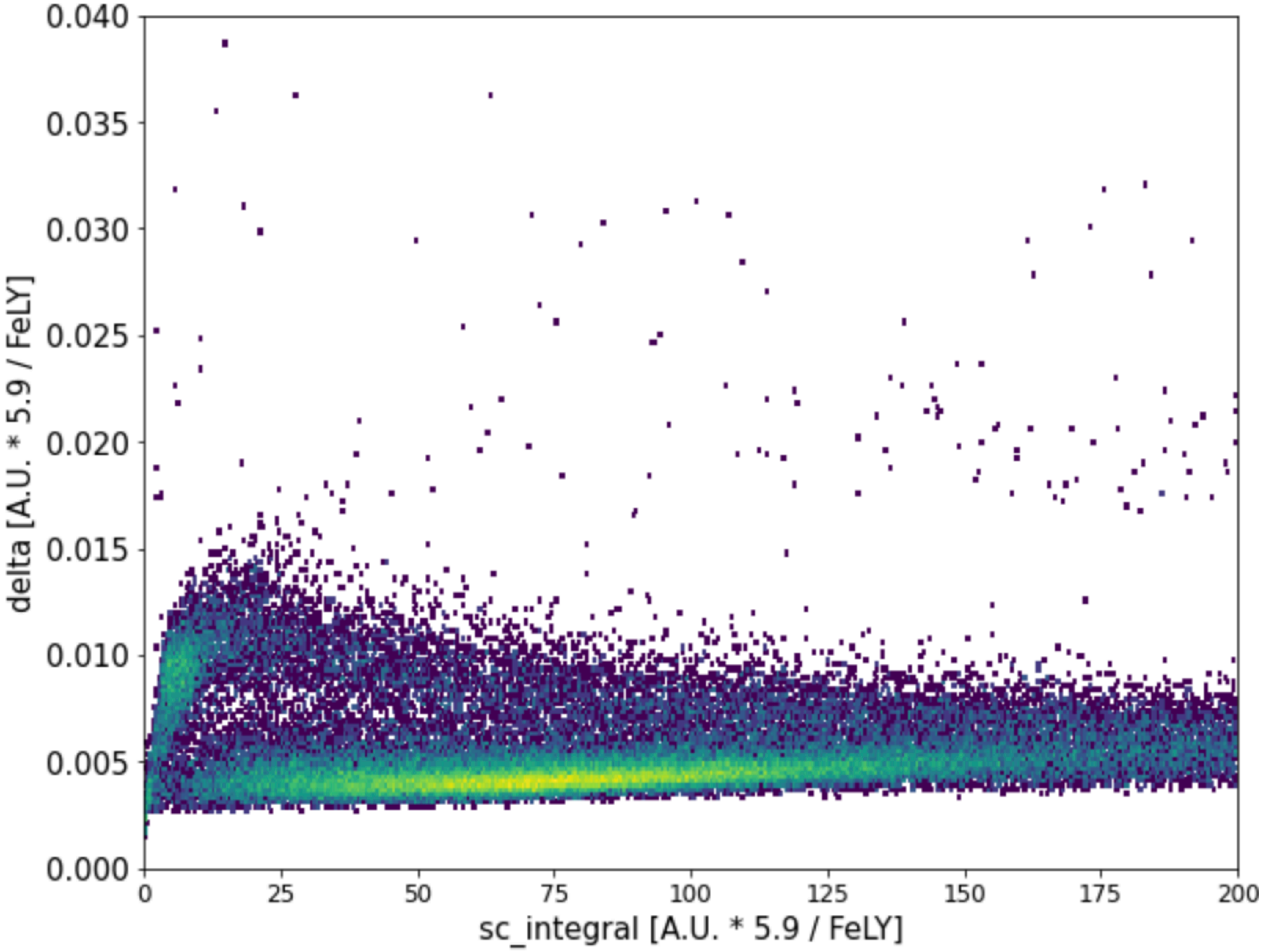
RUN 4 - The "low" vs "high" configurations

Low Gain - Low Energy spectra



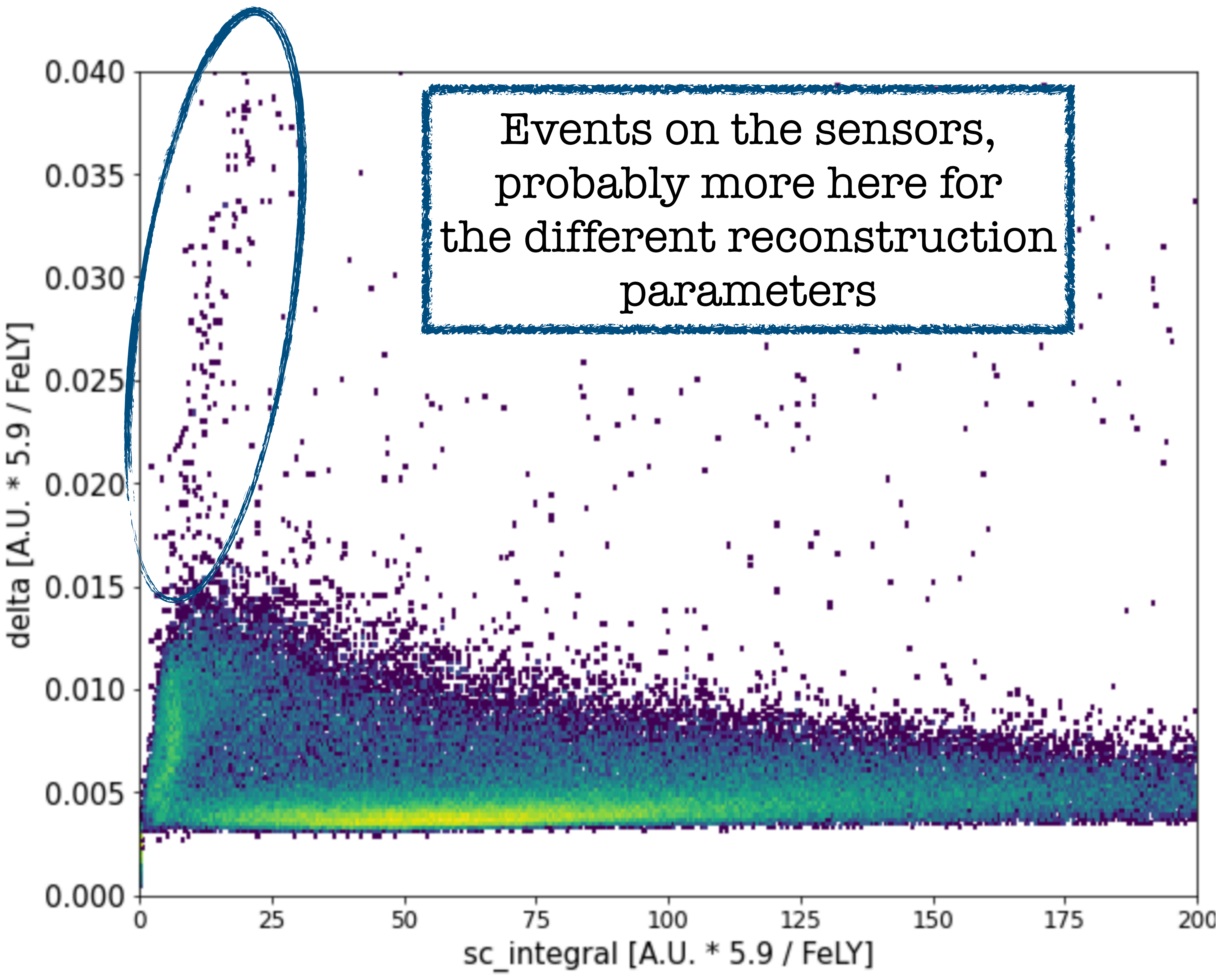
N.B. here there's a 3x in statistics

High Gain - Low Energy spectra



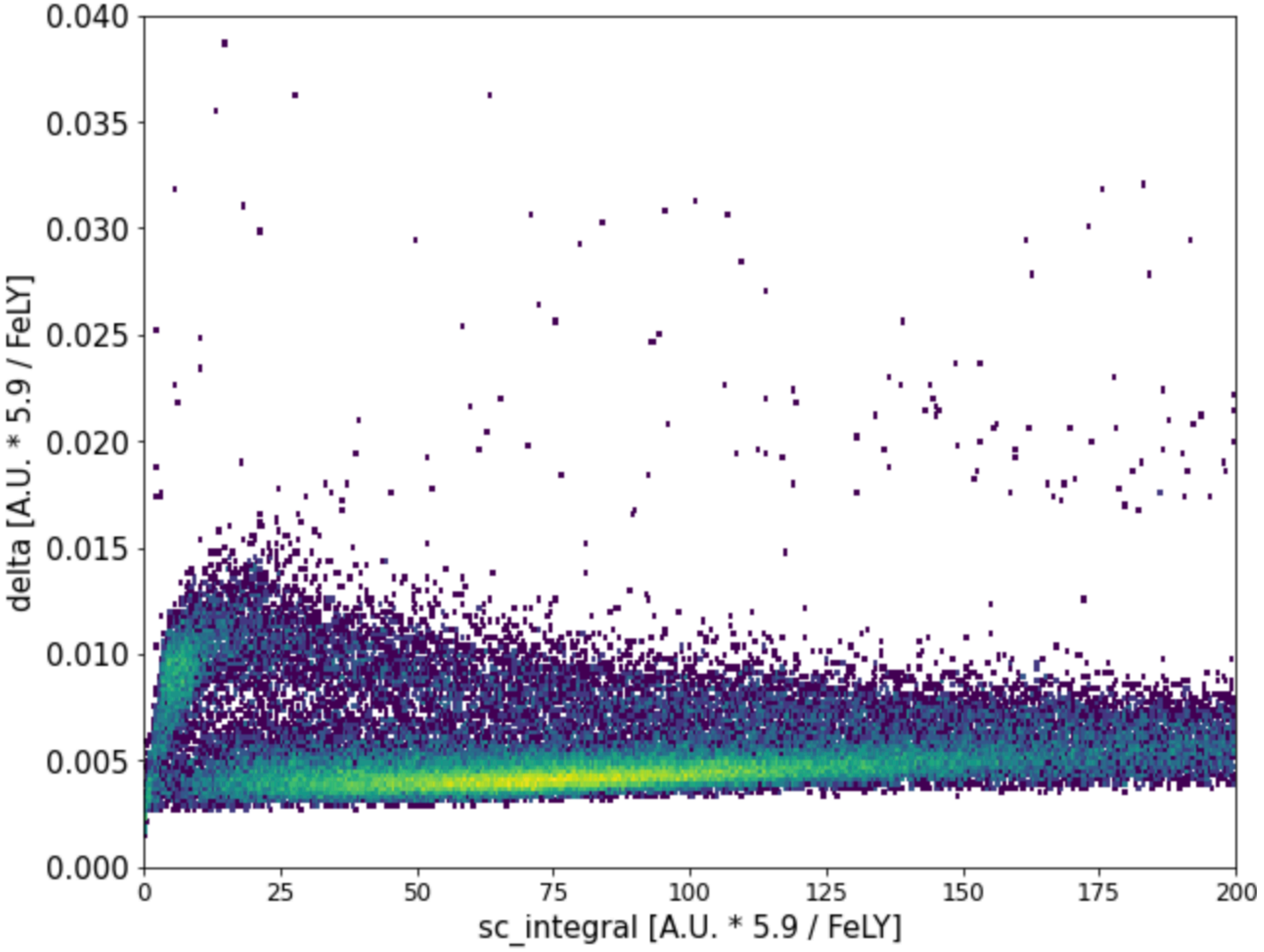
RUN 4 - The “low” vs “high” configurations

Low Gain - Low Energy spectra



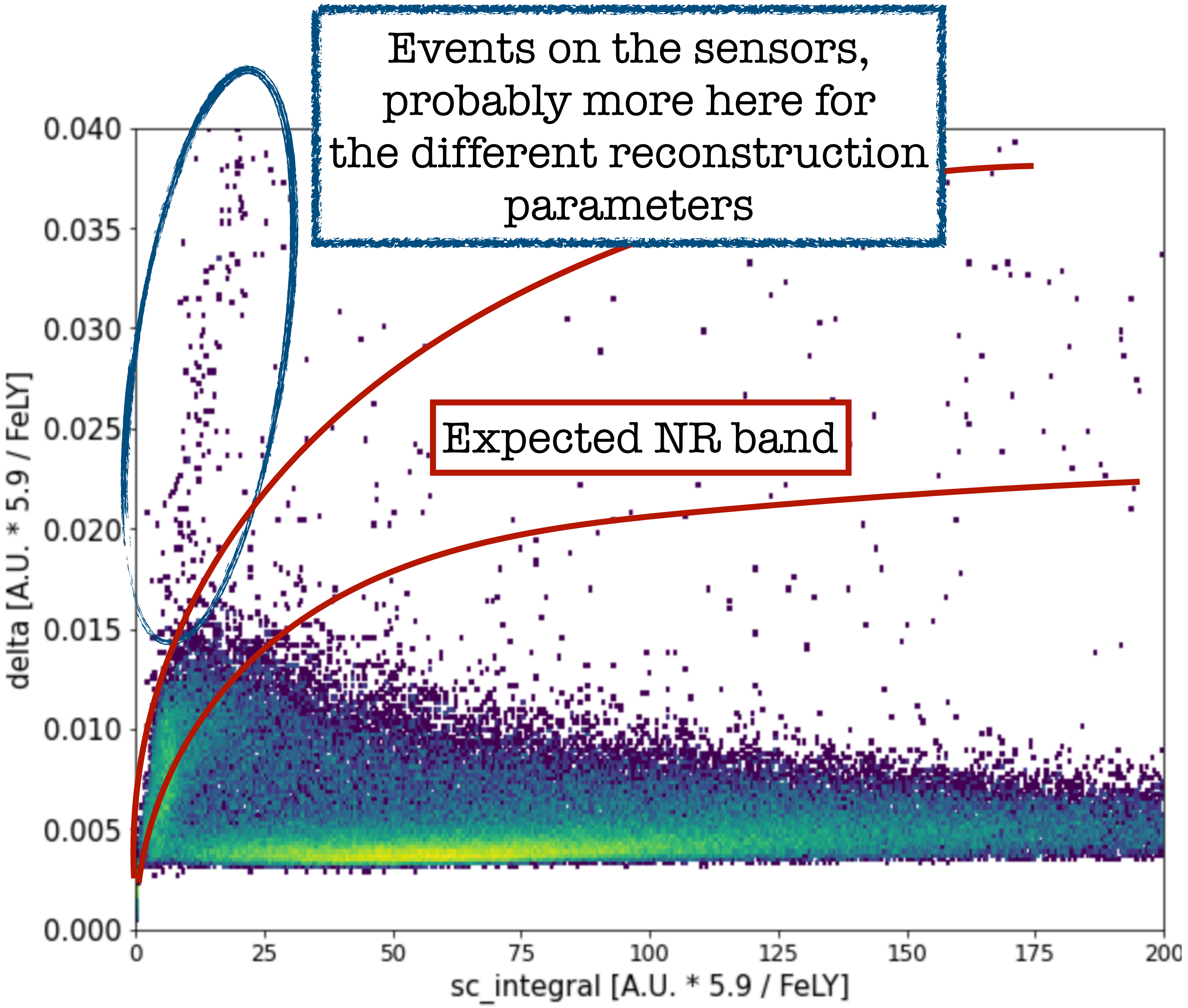
N.B. here there’s a 3x in statistics

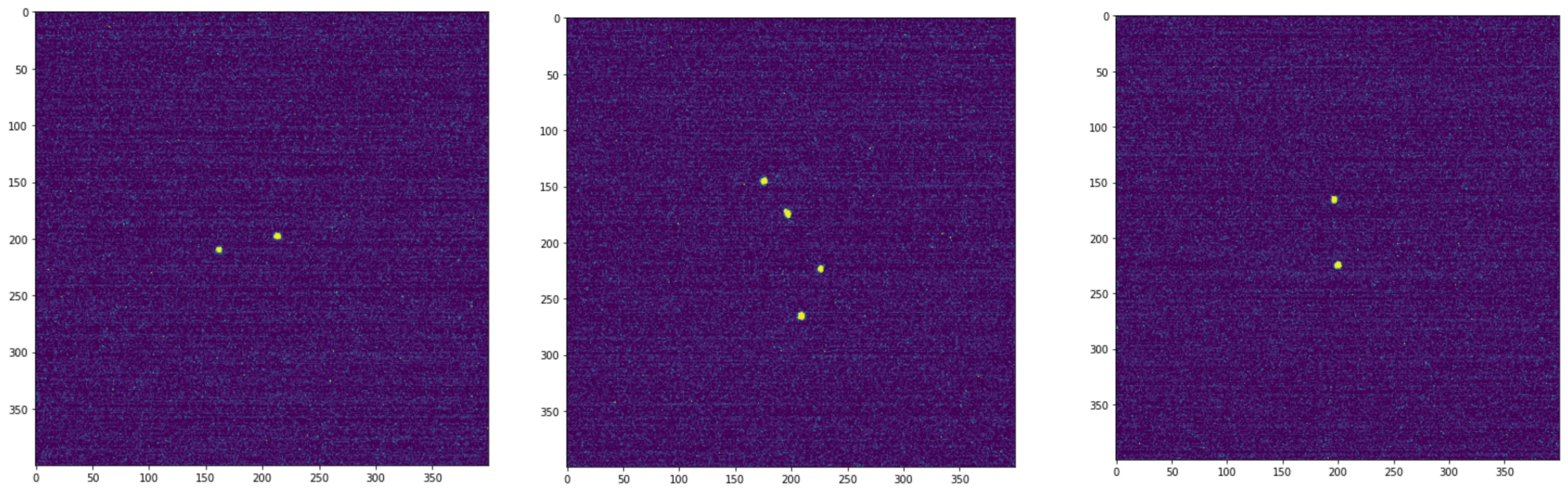
High Gain - Low Energy spectra



RUN 4 - The “low” vs “high” configurations

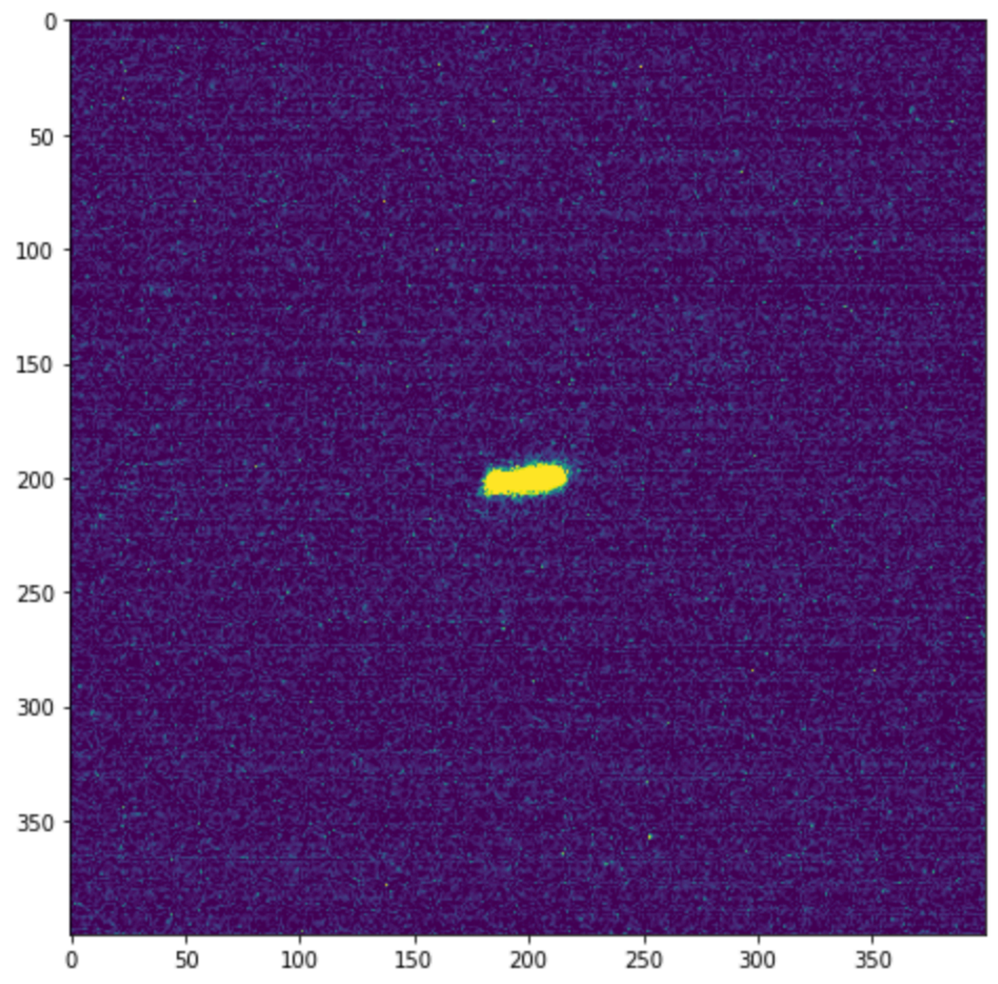
Low Gain - Low Energy spectra





Mostly multiple hits on the CMOS clustered as a single track. How to remove them without removing interesting NR events?

Just for comparison,
how a NR deposit looks like:
[same pixel range]

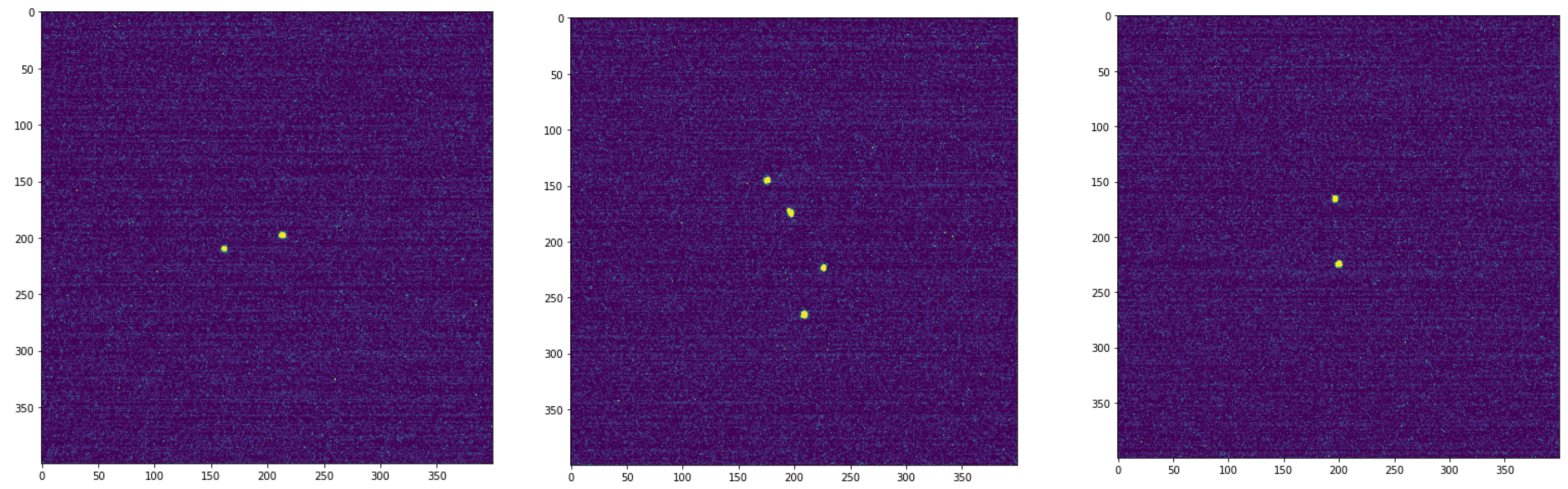


RUN 4 - The “low” vs “high” configurations

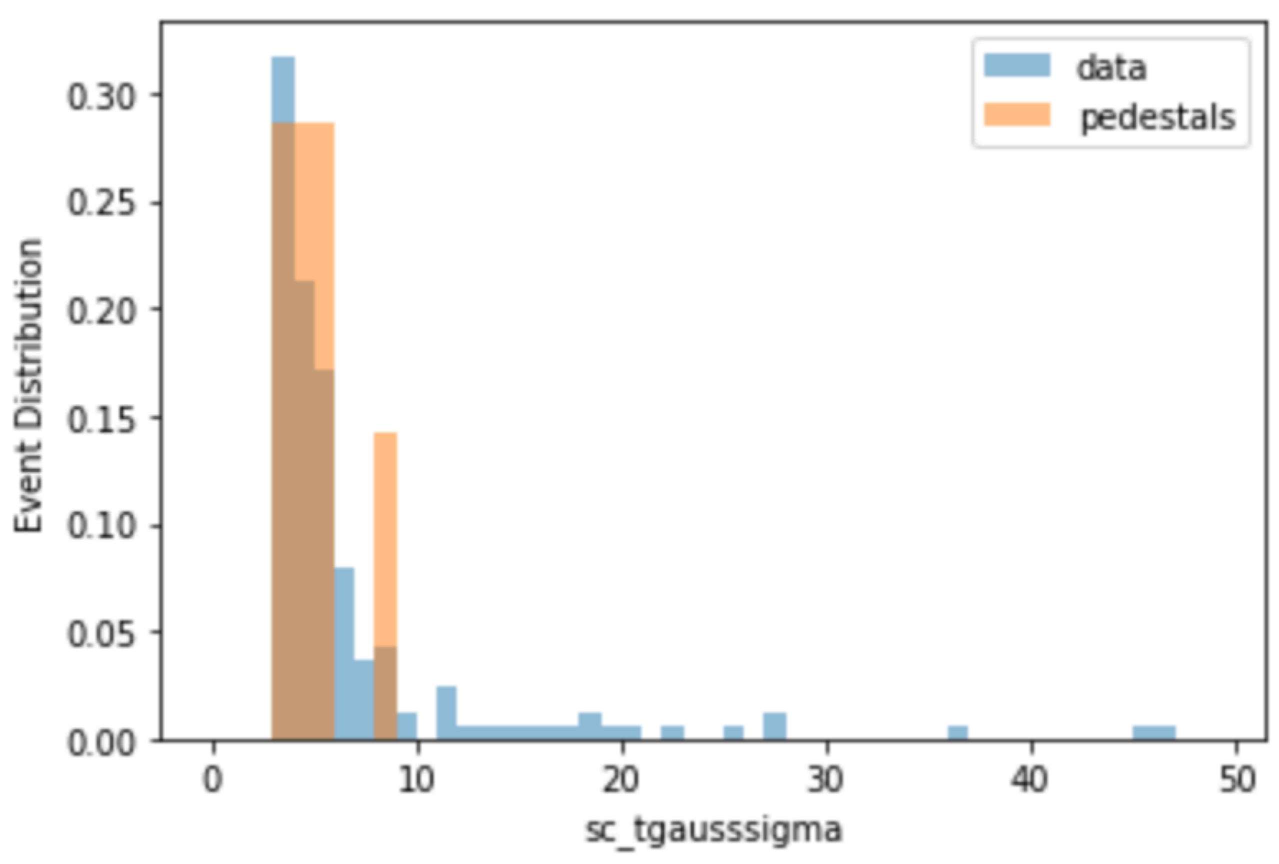
Low Gain - Low Energy spectra

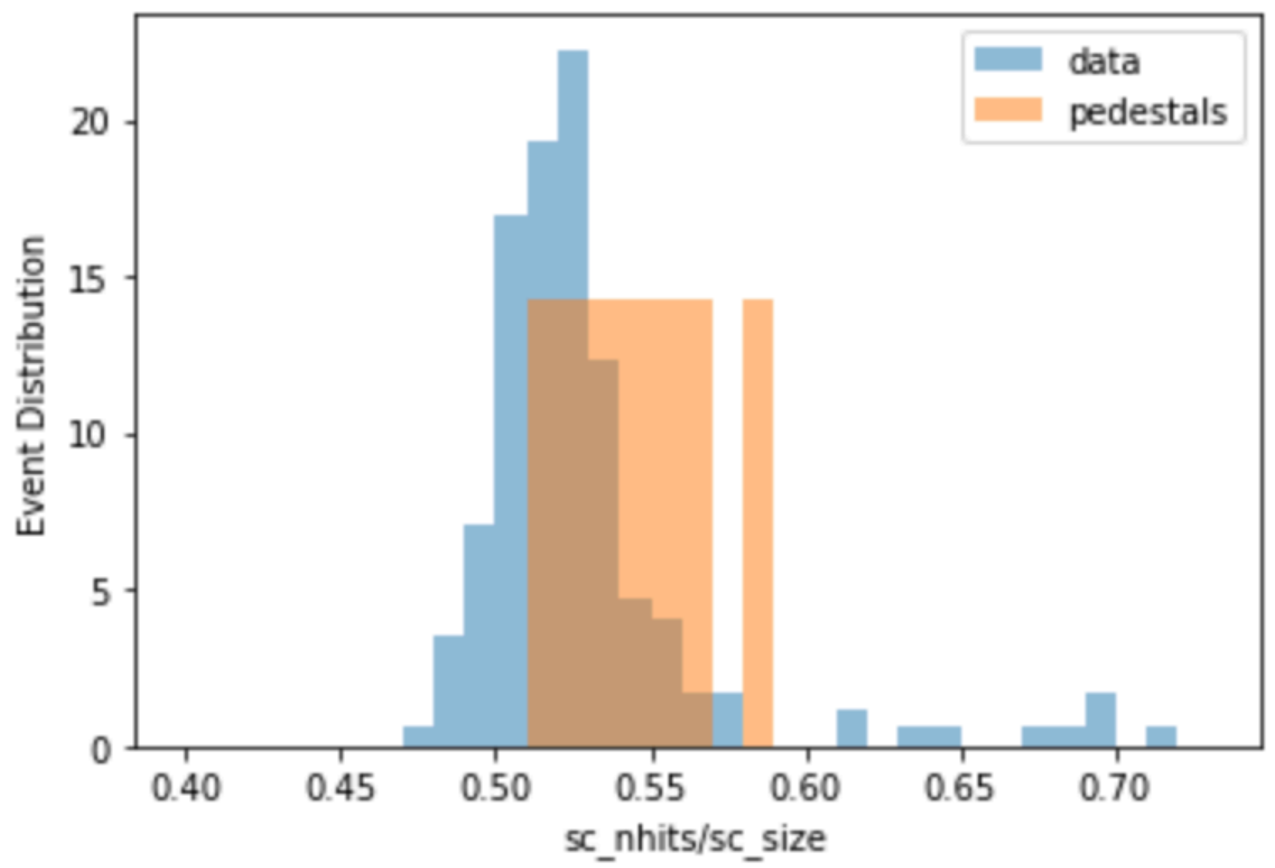
Following selection:

- ➡ sc_rms > 6 [fake clusters]
- ➡ sc_tgausssigma > 0.5 / 0.152 [events on the CMOS]
- ➡ R < 800 px [fiducialization]
- ➡ sc_integral < 50 keVeq
- ➡ delta > 0.023 keVeq/pixel^2

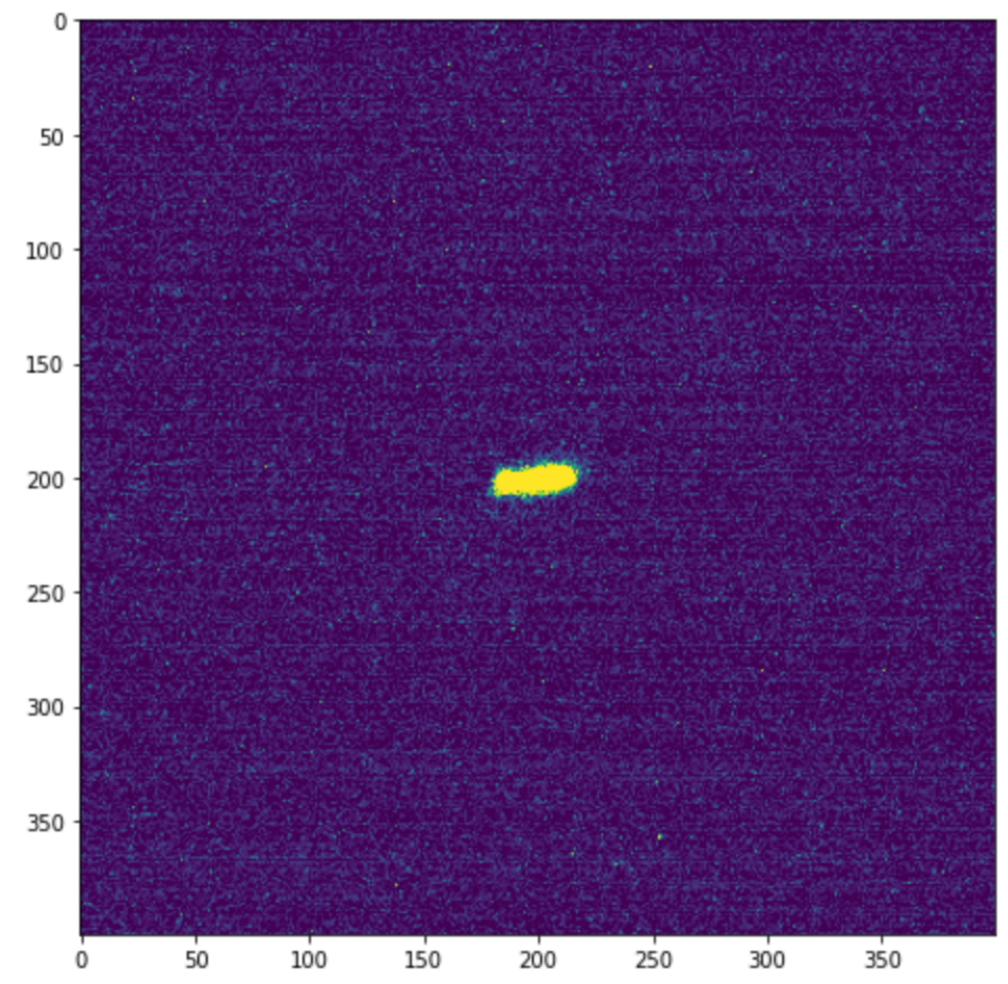


Mostly multiple hits on the CMOS clustered as a single track. How to remove them without removing interesting NR events?





Just for comparison,
how a NR deposit looks like:
[same pixel range]

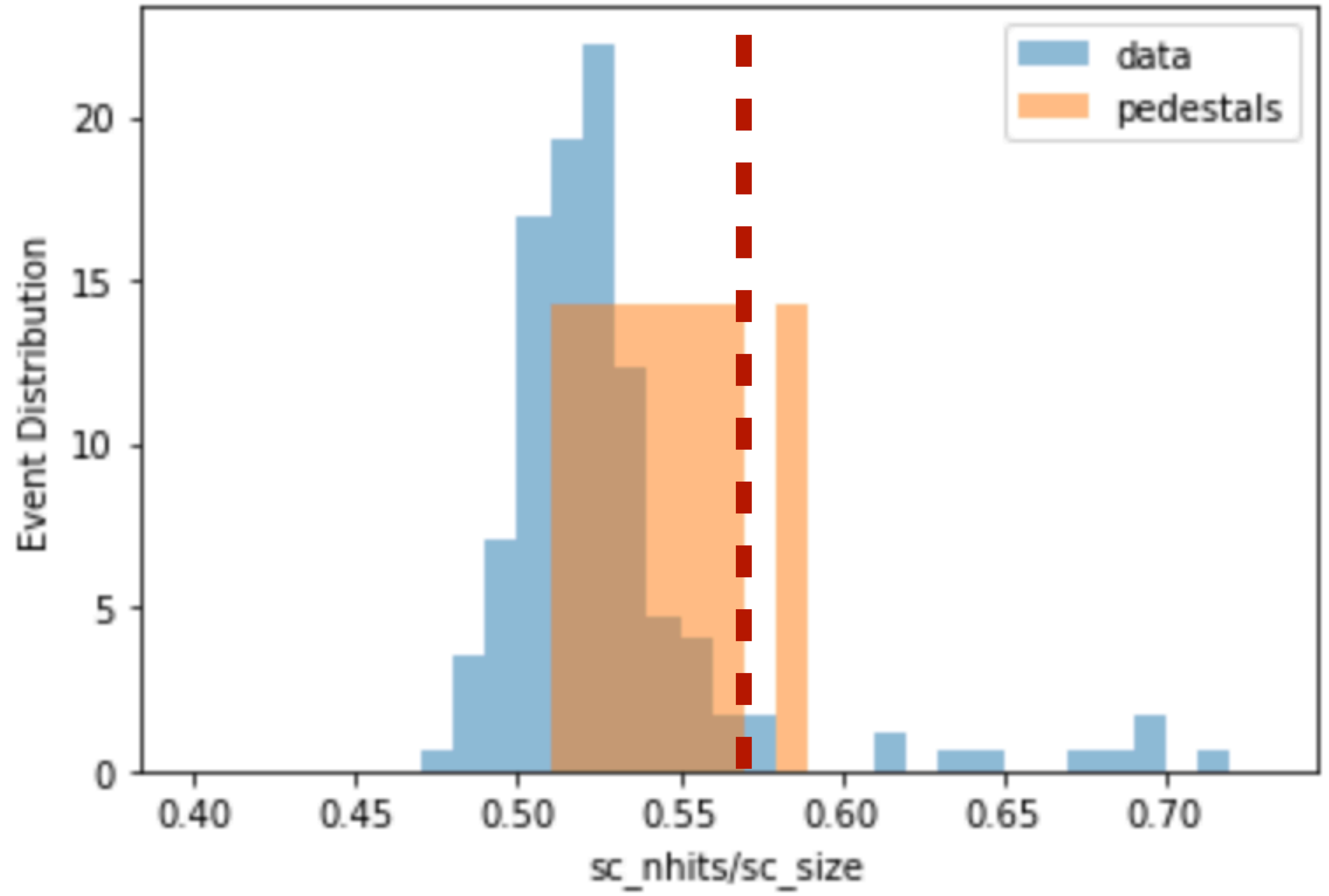


RUN 4 - The "low" vs "high" configurations

Low Gain - Low Energy spectra

Following selection:

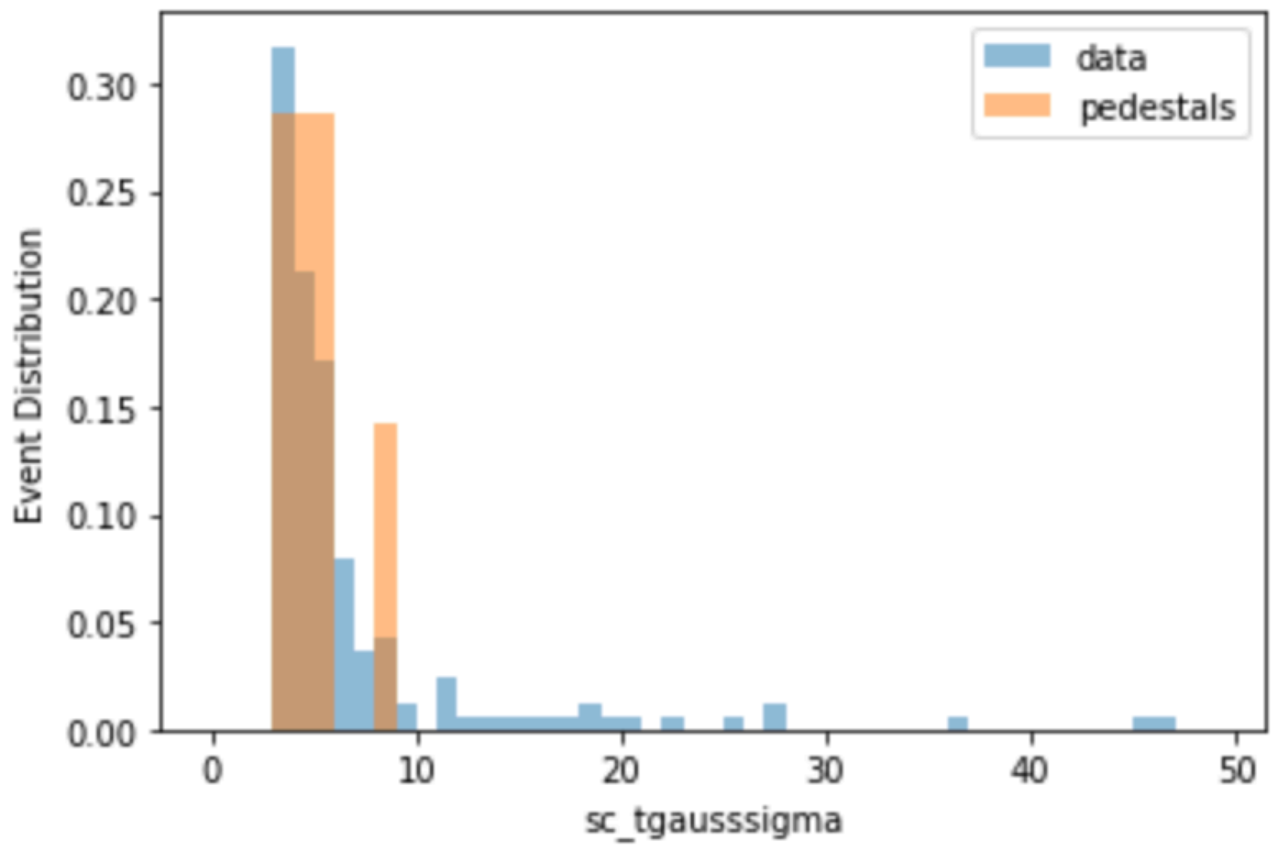
- ➡ sc_rms > 6 [fake clusters]
- ➡ sc_tgausssigma > 0.5 / 0.152 [events on the CMOS]
- ➡ R < 800 px [fiducialization]
- ➡ sc_integral < 50 keVeq
- ➡ delta > 0.023 keVeq/pixel^2

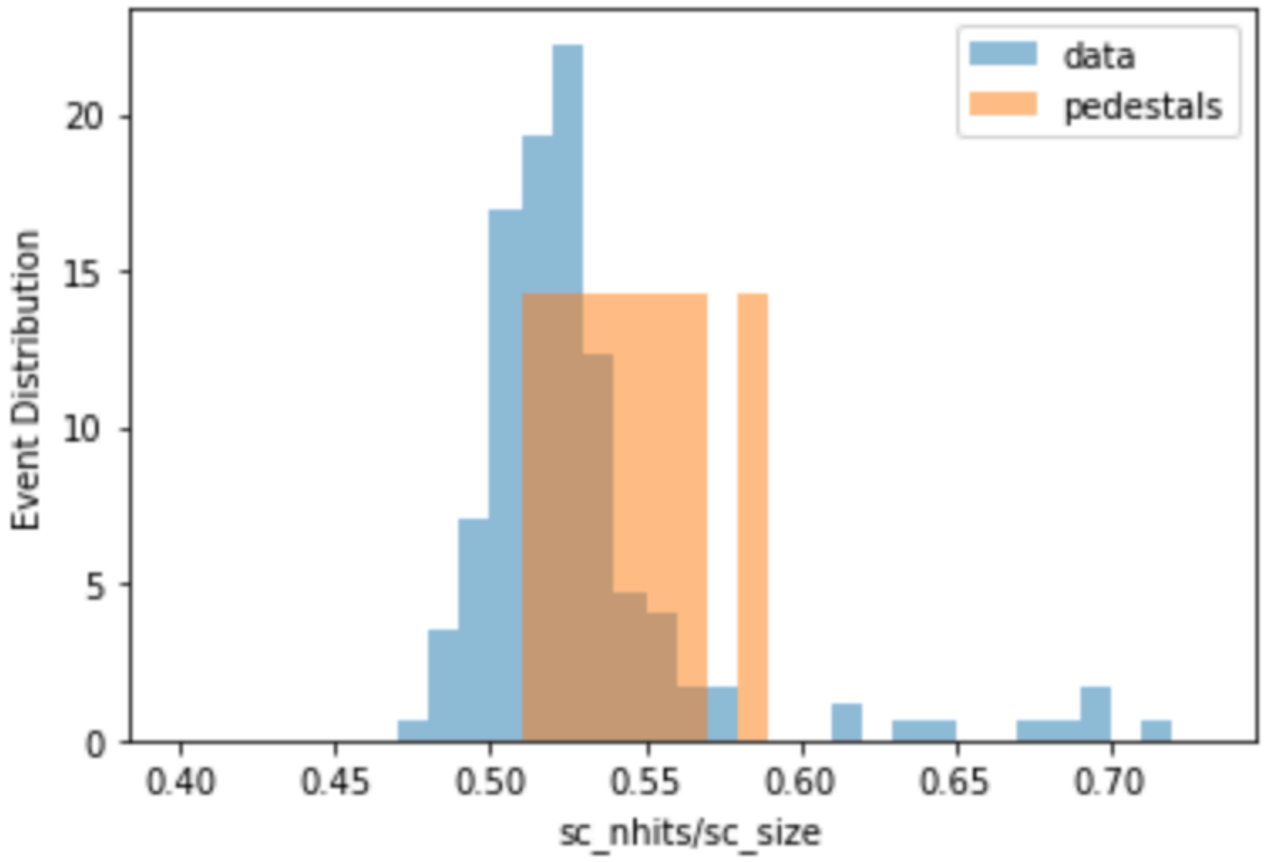


Proposed **new cut:**

- ➡ sc_nhits/sc_size > 0.57

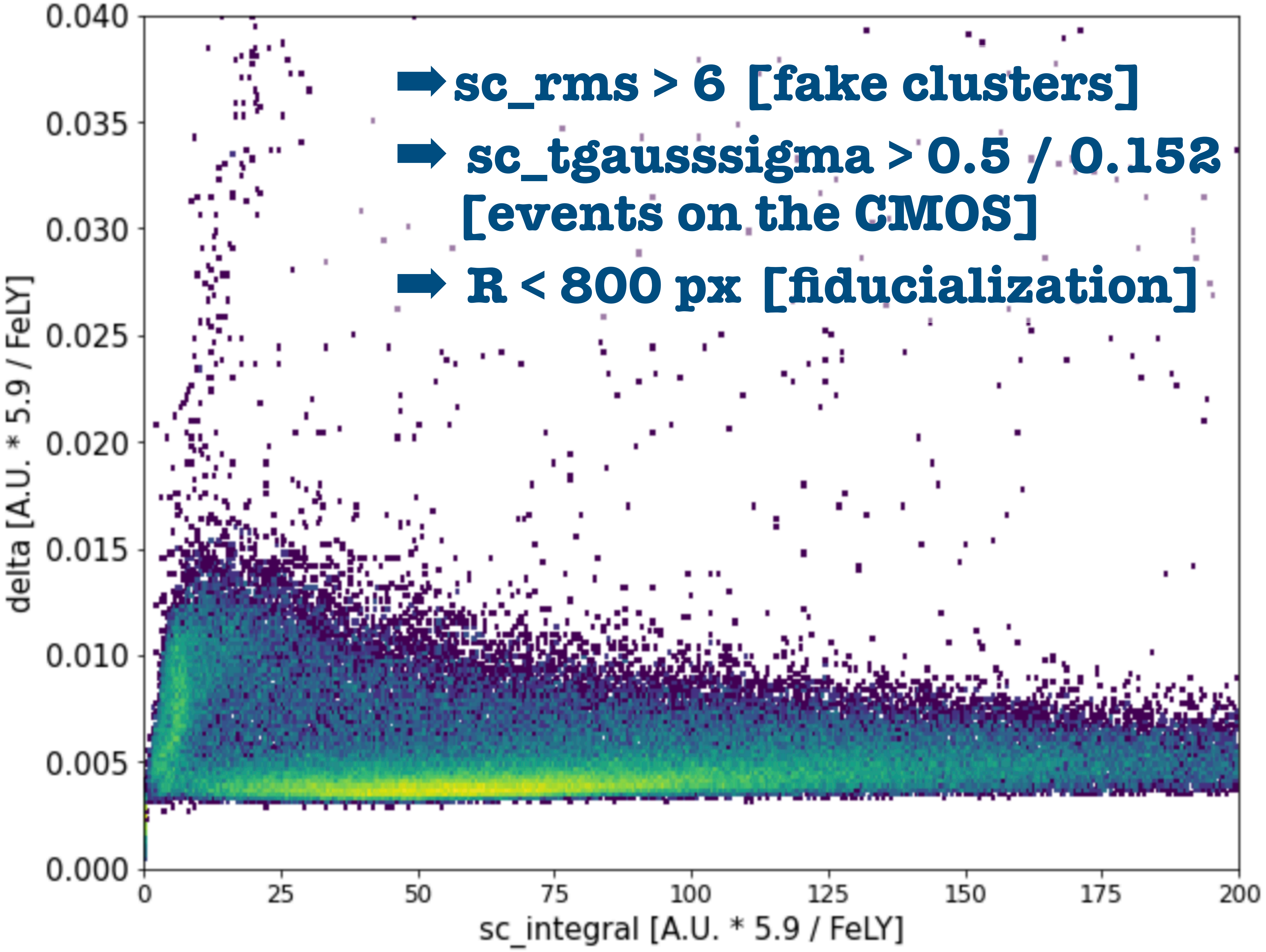
Equivalent to requiring 57% of pixels of the cluster above threshold. Reasonable?

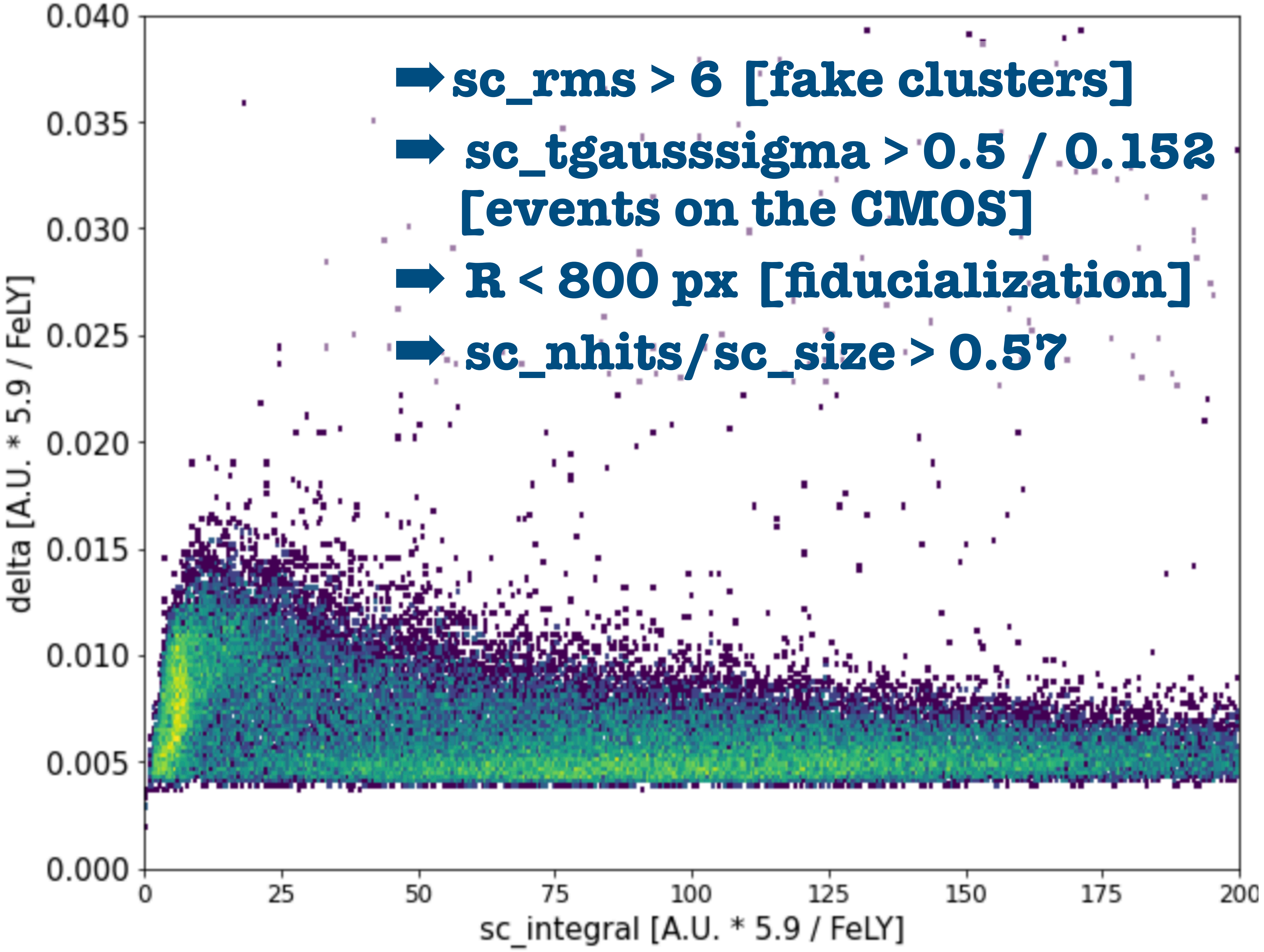




RUN 4 - The "low" vs "high" configurations

Low Gain - Low Energy spectra

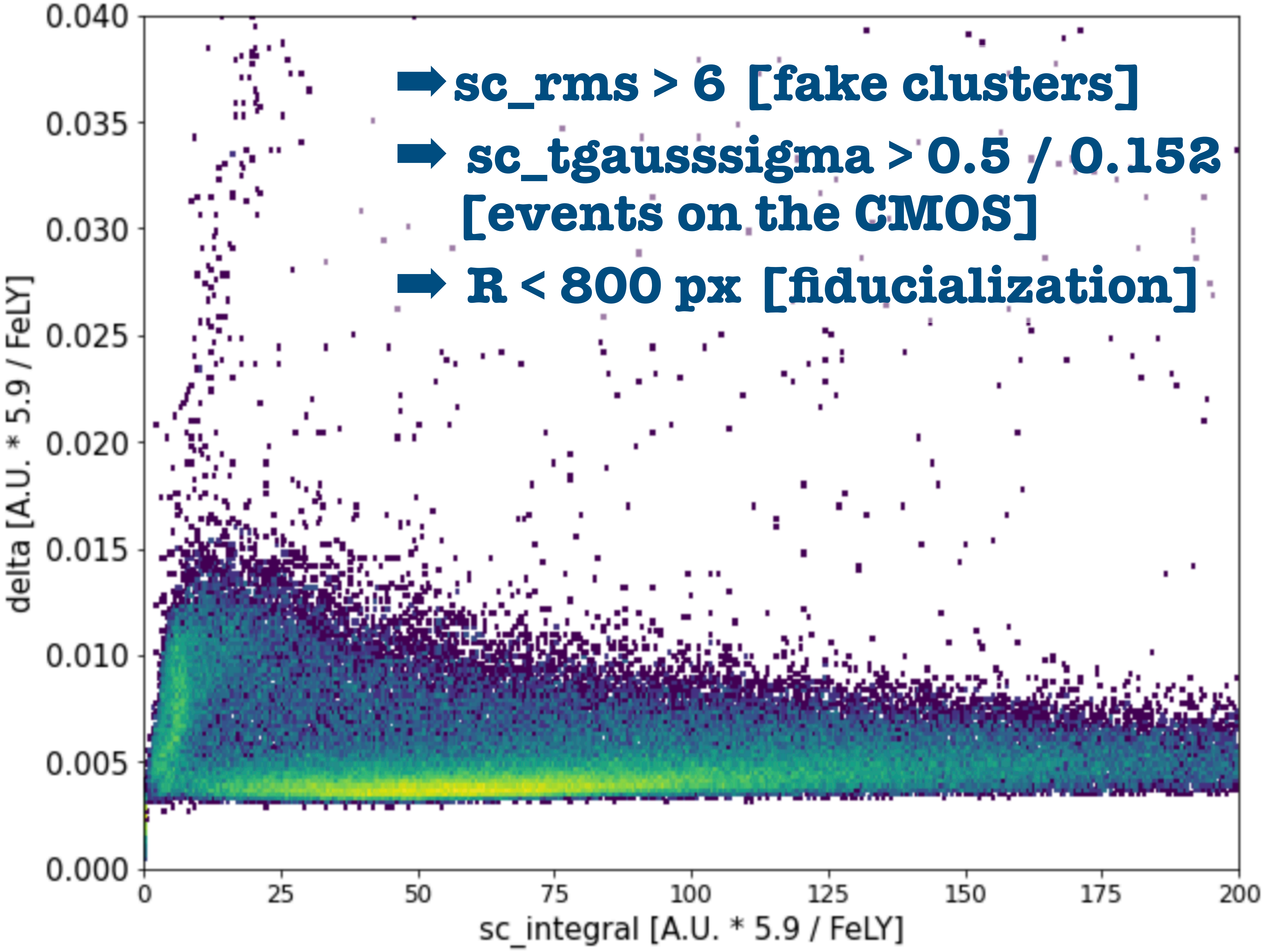


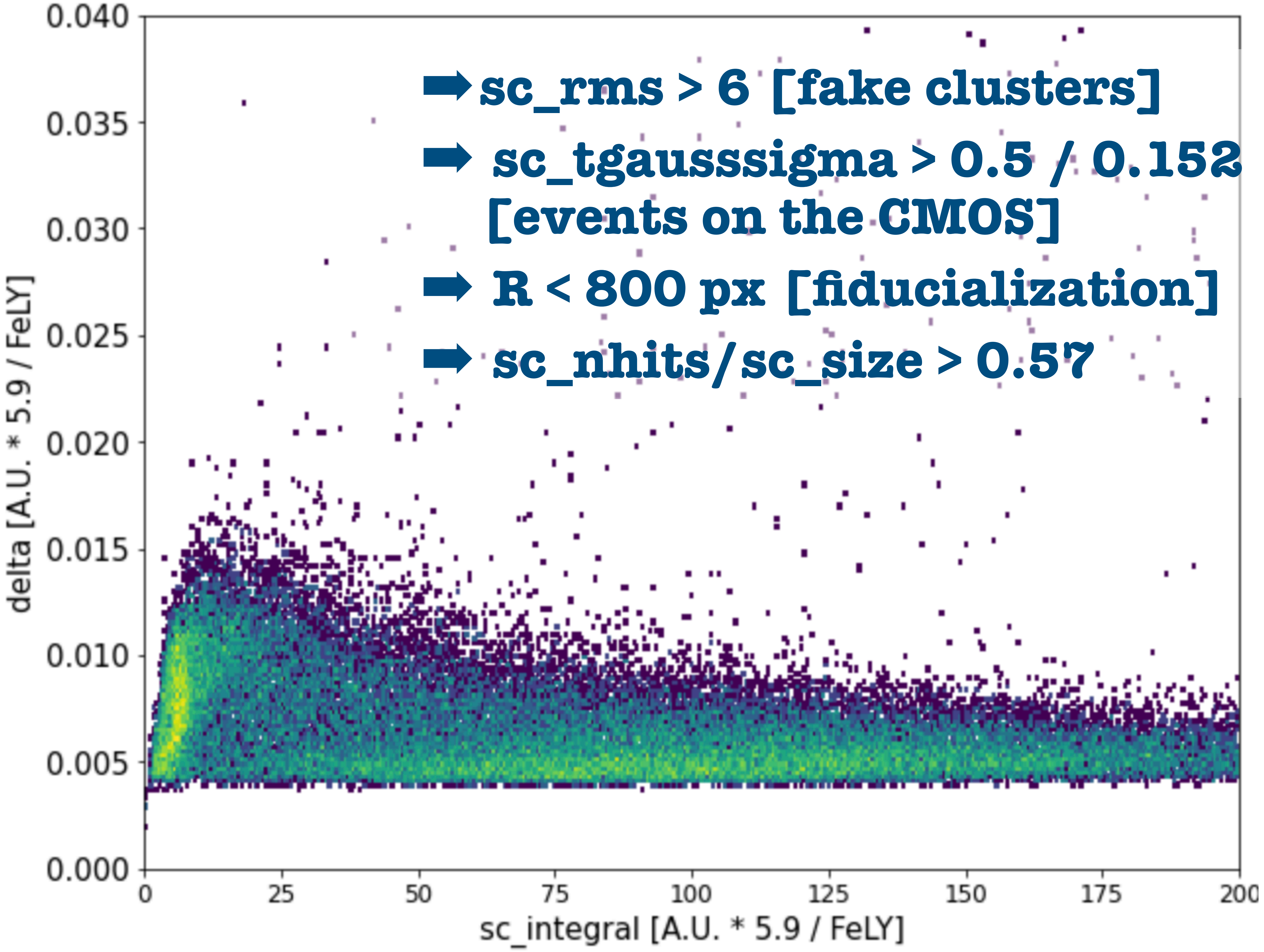


RUN 4 - The “low” vs “high” configurations

Low Gain - Low Energy spectra

1. The **EoS events disappear**
2. The **high density events** at **low energy** are **not influenced** by the cut
3. The **ER band** is **not influenced** by the cut
4. The **MIP band changes**, as expected (as it cointains cut/splitted feeble tracks with a lot of sub-threshold pixels)

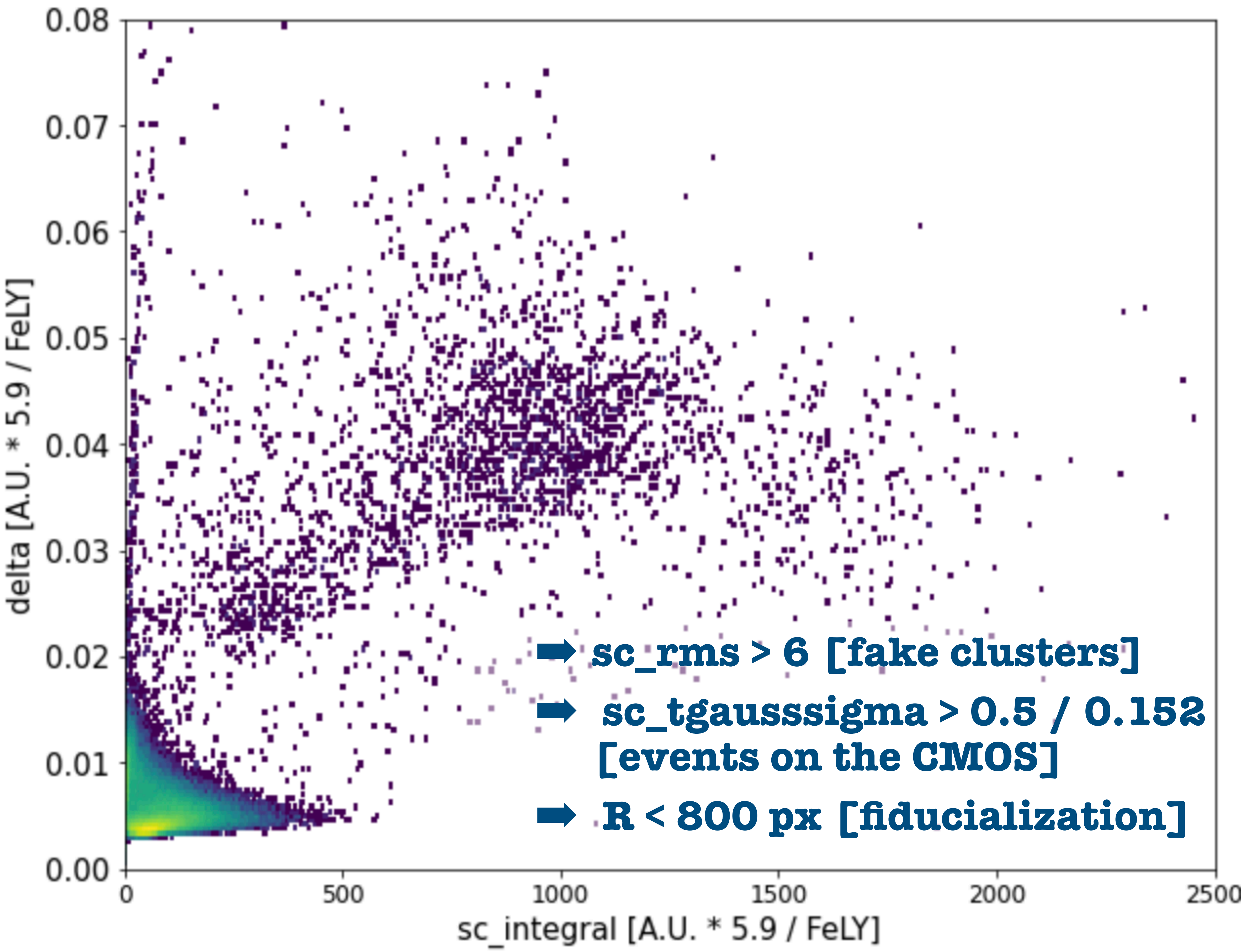


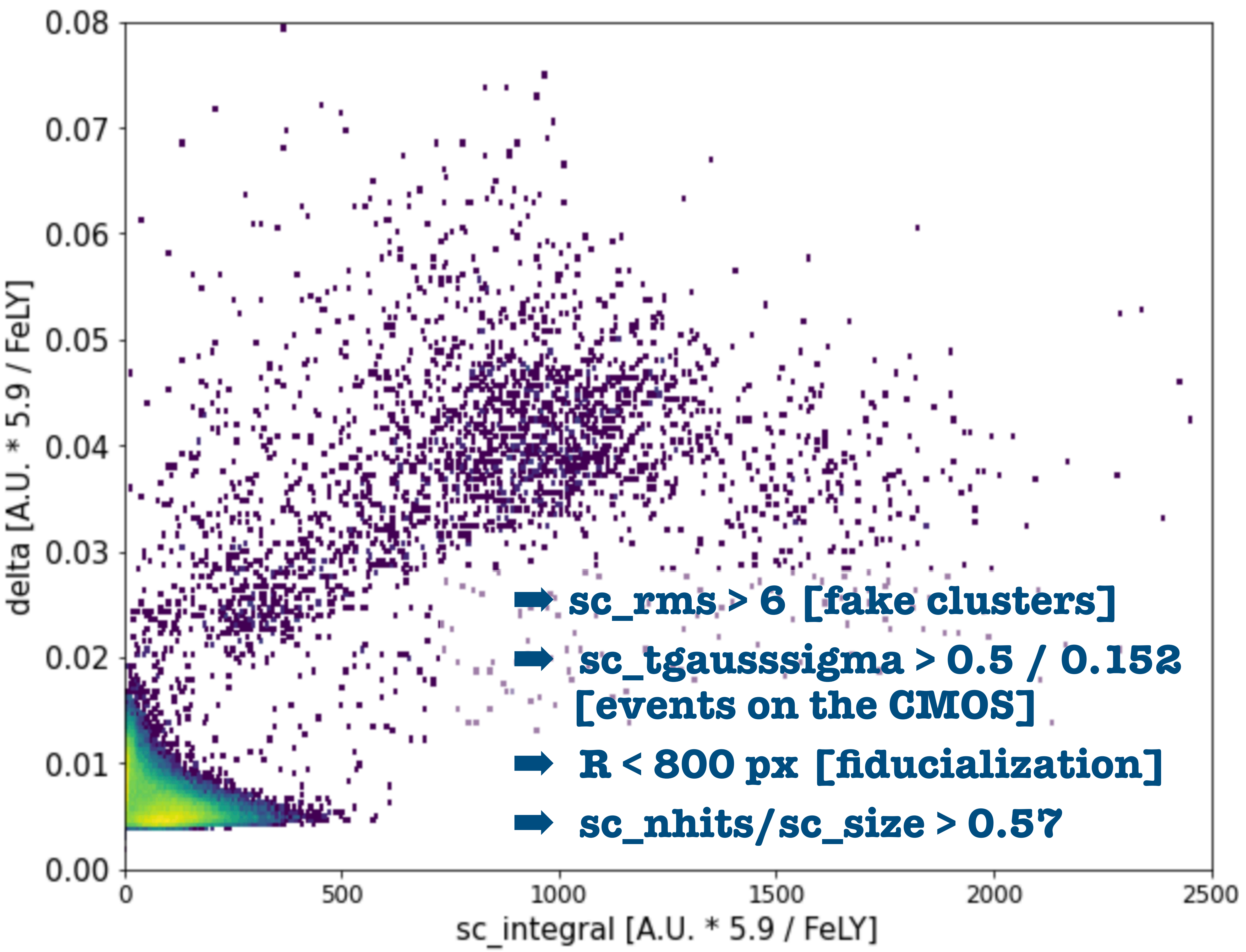


RUN 4 - The "low" vs "high" configurations

1. The **alphas seem to not be influenced**, but imho more statistics is needed to say something about the efficiency of this cut

Low Gain - High Energy spectra





Conclusions

- From the point of view of the background studies, the 420 V - 500 V/cm configuration does not seem too bad wrt to the nominal configuration tested so far:
    - >0.5x in LY of the Fe spot (but not saturated)
    - +10% in the dimension of the Fe spots
- The looser reconstruction needed to deal with a lower LY introduces some issue with multiple hits on the sensor:
    - with a cut on sc_nhits / sc_size it seems possible to cut them out
    - this new cut seems not to affect the interesting physics (NR/alpha band and the ER band)
    - more statistics is needed for a complete study