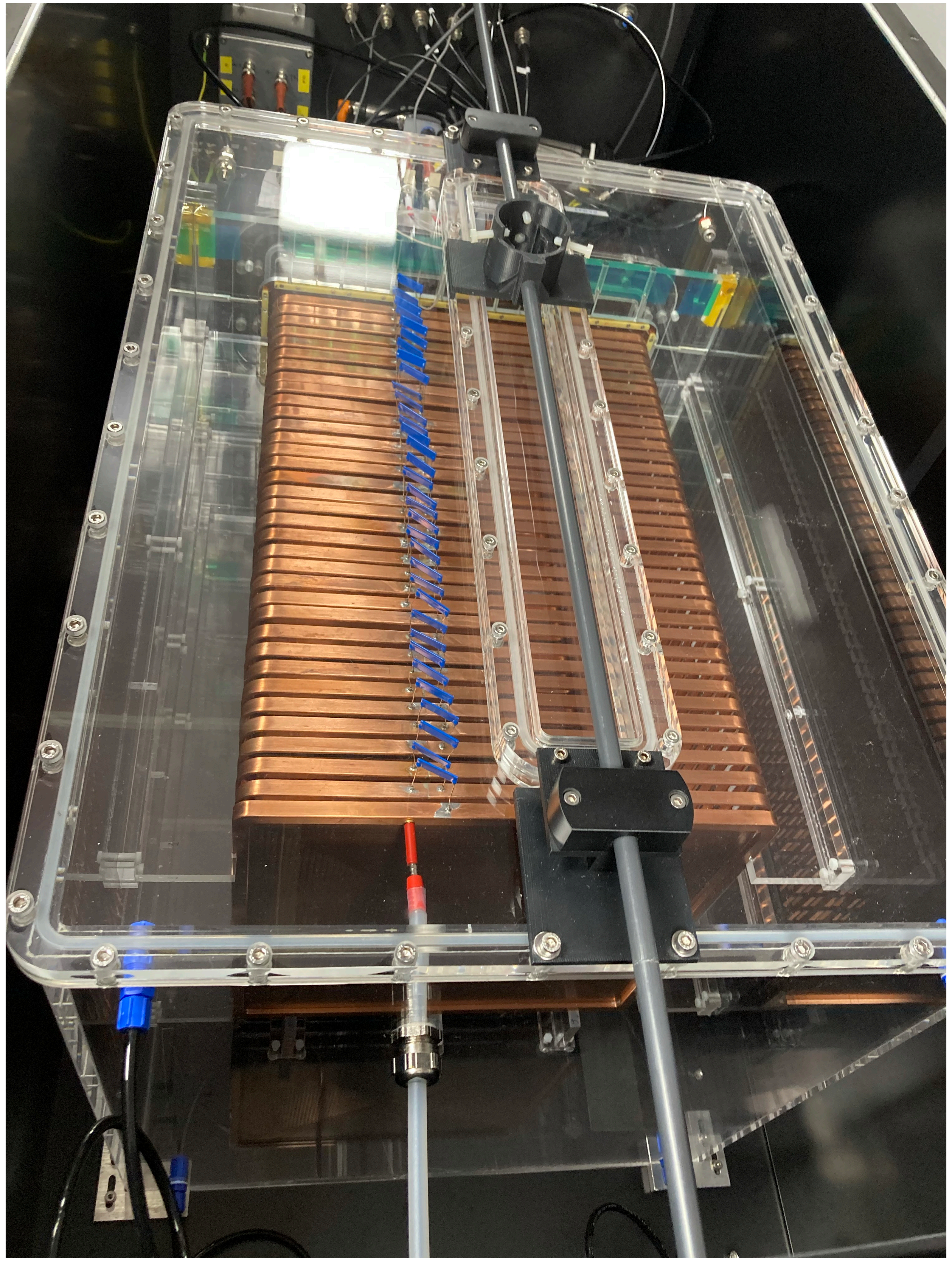
Founded from ERC in Horizon 2020 program (grant agreement 818744)

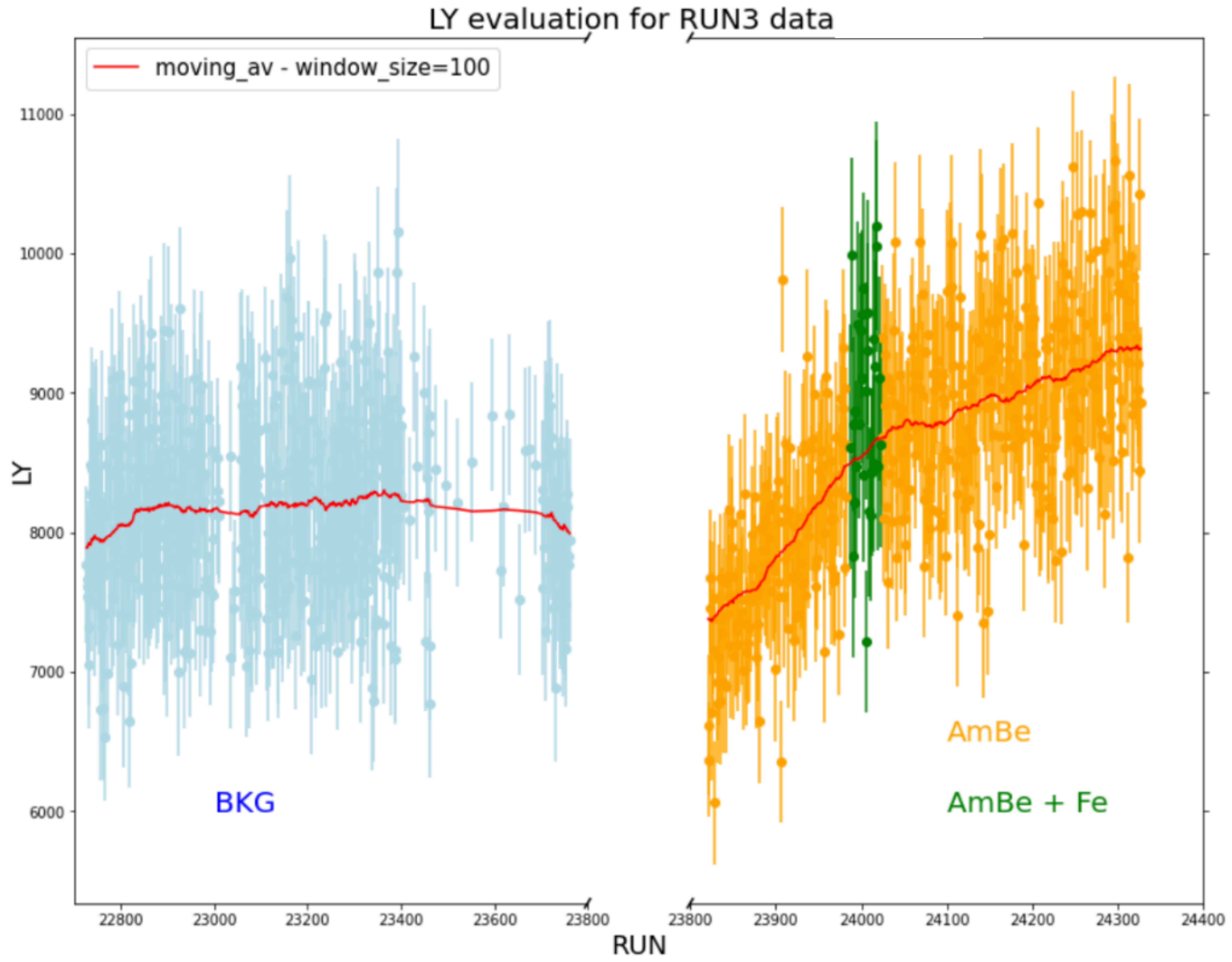
A first look at RUN3

F. Di Giambattista, M. Folcarelli, S. Piacentini, A. Prajapati



Analysis Meeting **22/09/2023**

Runs we will consider in the following



Start	Stop	Numbers			Description	Data runs	Data runs
Issue with the **pump**: it abruptly stopped working							
2023-07-25 12:15:46	2023-07-28 10:33:13	22570	-	22717	Stability	73	29432
2023-07-28 11:13:45	2023-07-28 11:51:10	22718	-	22724	Daily Calibration		
2023-07-28 11:55:49	2023-07-31 12:11:05	22725	-	23350	Bkg	567	227938
2023-07-31 12:13:08	2023-07-31 12:50:11	23351	-	23357	Daily Calibration		
2023-07-31 12:52:29	2023-08-01 14:42:19	23358	-	23579	Bkg	200	80382
2023-08-01 14:44:07	2023-08-01 15:27:10	23580	-	23586	Daily Calibration		
2023-08-01 15:33:15	2023-08-02 11:54:39	23587	-	23760	Bkg	157	63111
2023-08-02 11:56:49	2023-08-02 12:41:09	23761	-	23767	Daily Calibration		
2023-08-02 12:43:32	2023-08-02 14:50:34	23768	-	23800	Stability	29	11690
Installation of the AmBe source							
2023-08-02 15:56:54	2023-08-03 9:57:41	23819	-	23984	AmBe Campaign	150	60339
2023-08-03 10:07:42	2023-08-03 12:28:56	23987	-	24022	AmBe + Fe	31	12511
2023-08-03 12:31:49	2023-08-04 21:35:21	24023	-	24328	AmBe Campaign	277	111389
2023-08-04 21:39:20	2023-08-07 20:00:35	24329	-	25427	Pedestal Study [AmBe - GEMs OFF]	1013	411196
Issue with the **pump**: it died after run 24328							

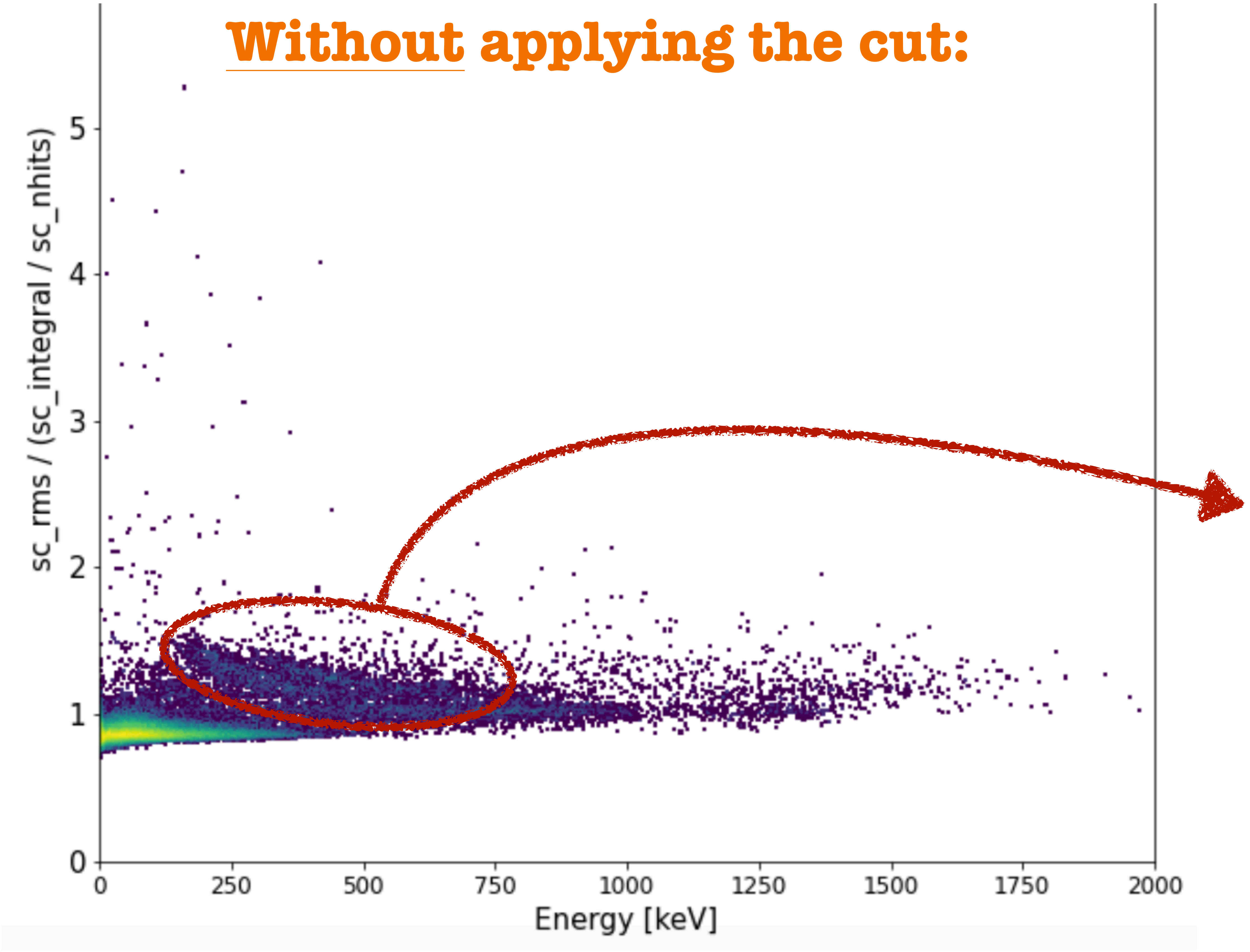
This sample is characterized by a **regular LY** condition, especially for the background part

Selection Cuts

- Quality cuts:
    - ➡ `sc_rms > 6` to remove the fake clusters identified by the reconstruction
    - ➡ `sc_tgausssigma * 0.152 > 0.5` to remove the events on the CMOS
- Fiducial cuts:
    - ➡ $(sc\_xmean - 1152)^2 + (sc\_ymean - 1152)^2 < 800^2$ to focus on events at the center of the image
    - ➡ `sc_xmin > 400 AND sc_xmax < 1900` to remove long tracks with an anomalous rms and size

Selection Cuts

➡ `sc_xmin > 400 AND sc_xmax < 1900`: Why?



A new variable: $\epsilon = \dfrac{\texttt{sc\_rms}}{\texttt{sc\_integral/sc\_nhits}}$

It has the interpretation of "**relative fluctuation**" of the intensity of the pixels of a cluster

What are these bands at high energy?

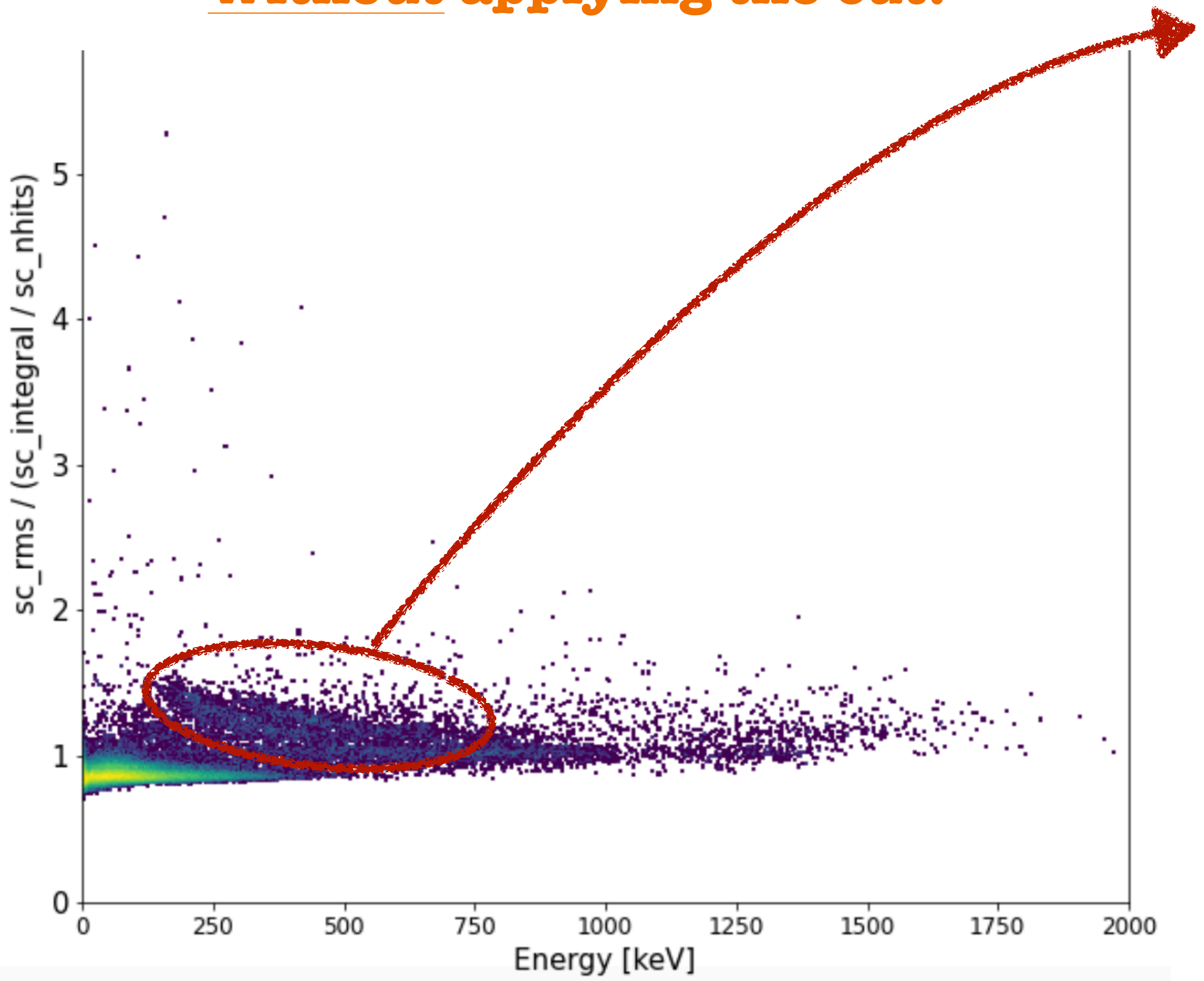
Two possibilities:

- high sc_rms
- high sc_nhits

Selection Cuts

➡ `sc_xmin > 400 AND sc_xmax < 1900`: Why?

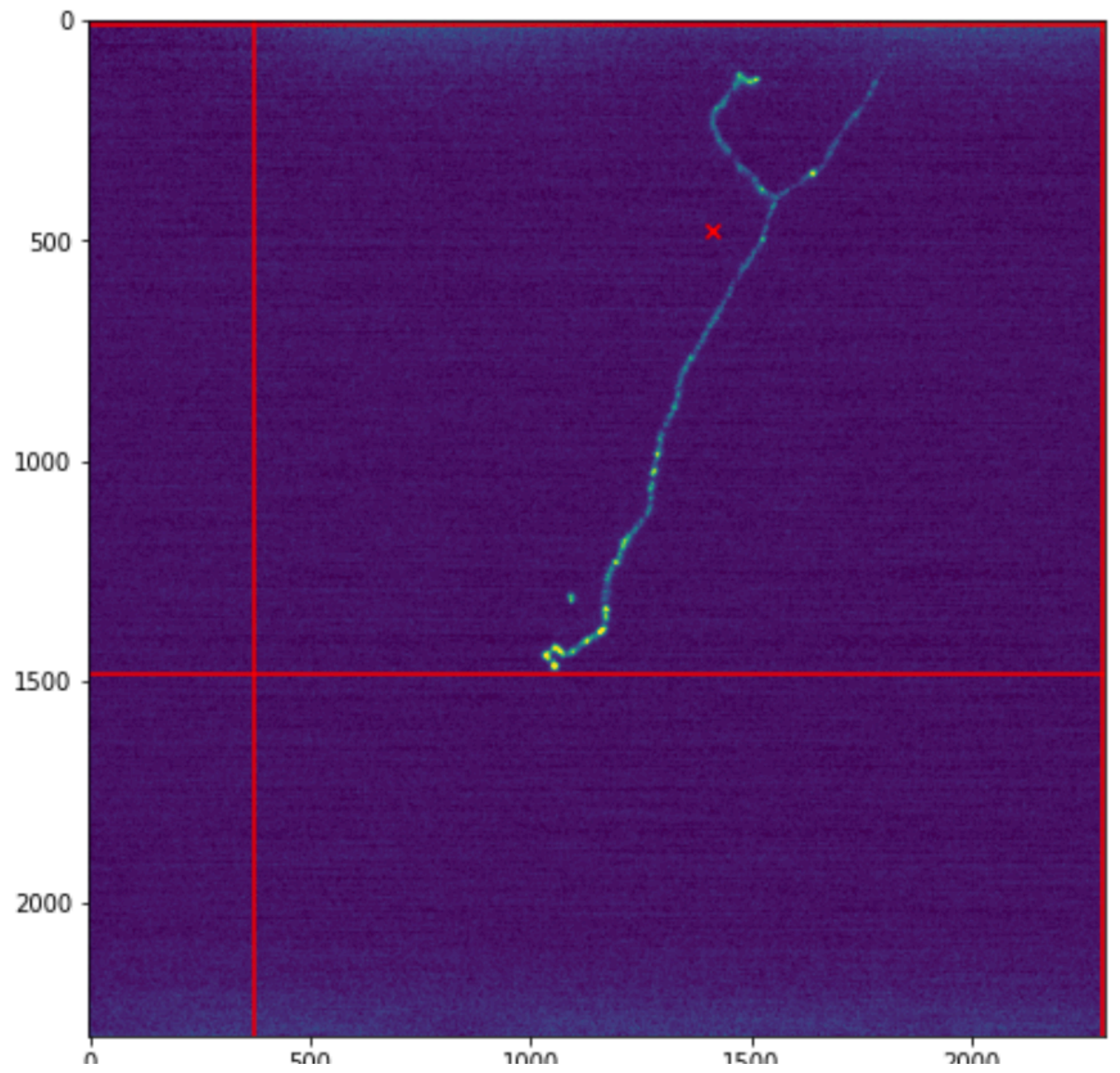
Without applying the cut:



We selected those events by requiring:

- energy above 120 keV
- $\epsilon > 1$

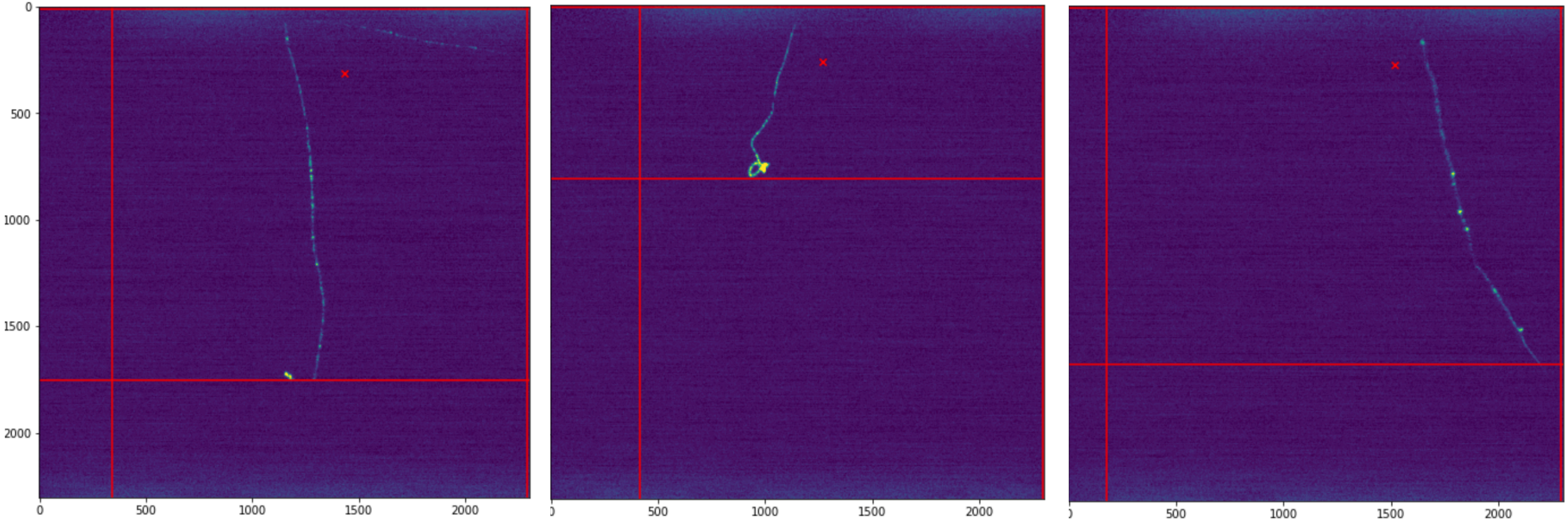
They all look like this (more examples in the next slide):



The red box is given by `sc_xmin`, `sc_xmax`, `sc_ymin`, and `sc_ymax`

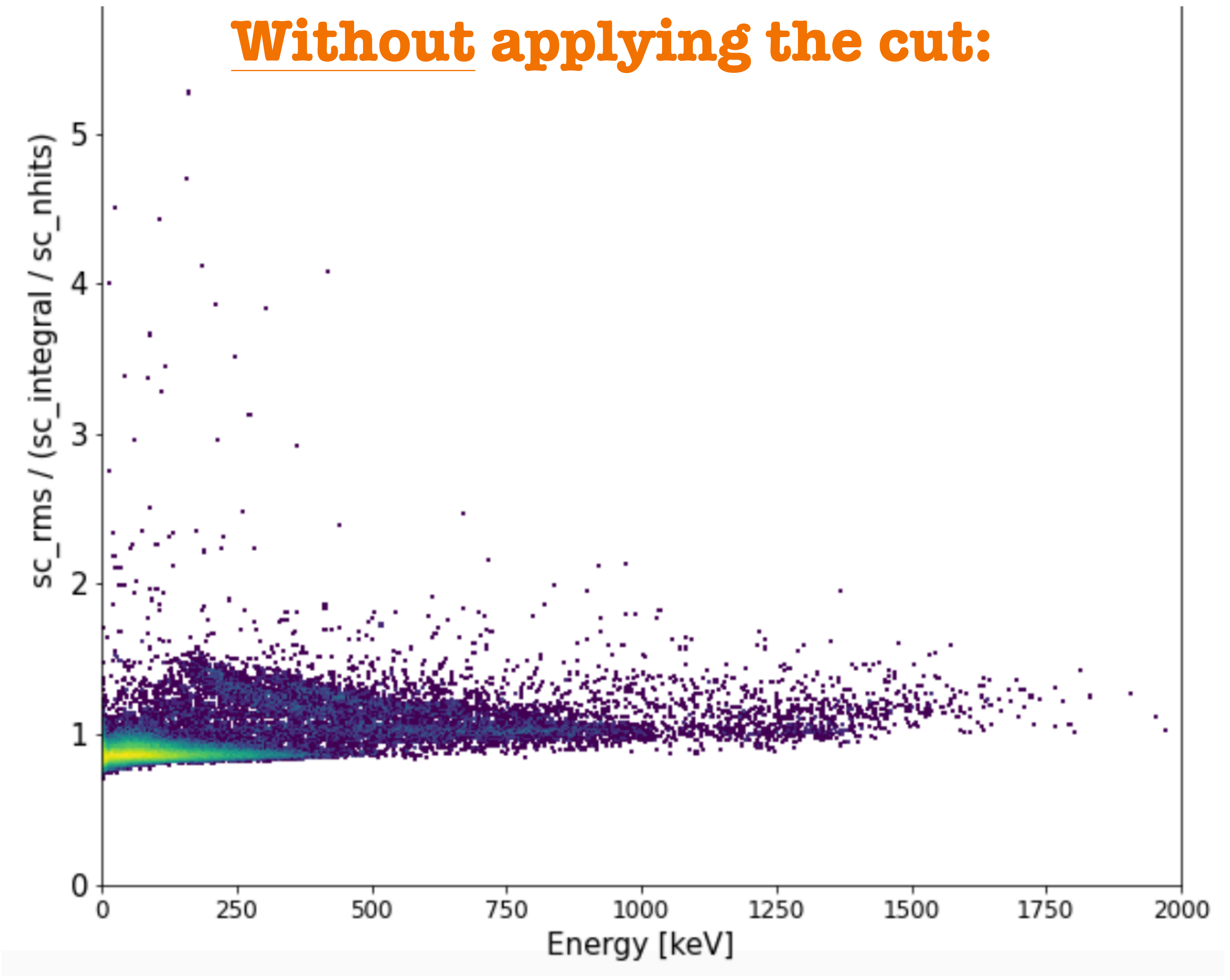
The bright halos are reconstructed as a single track!

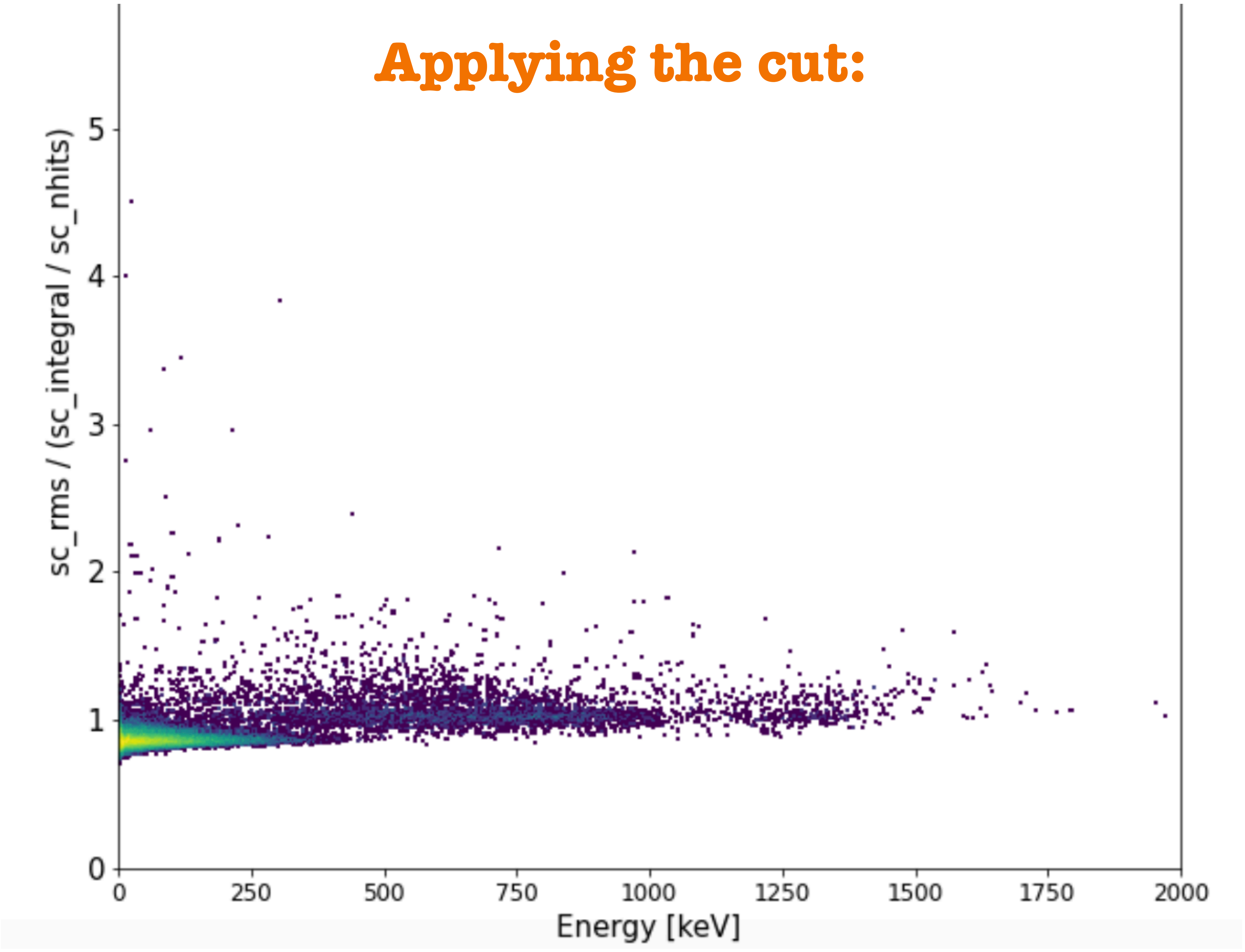
More examples



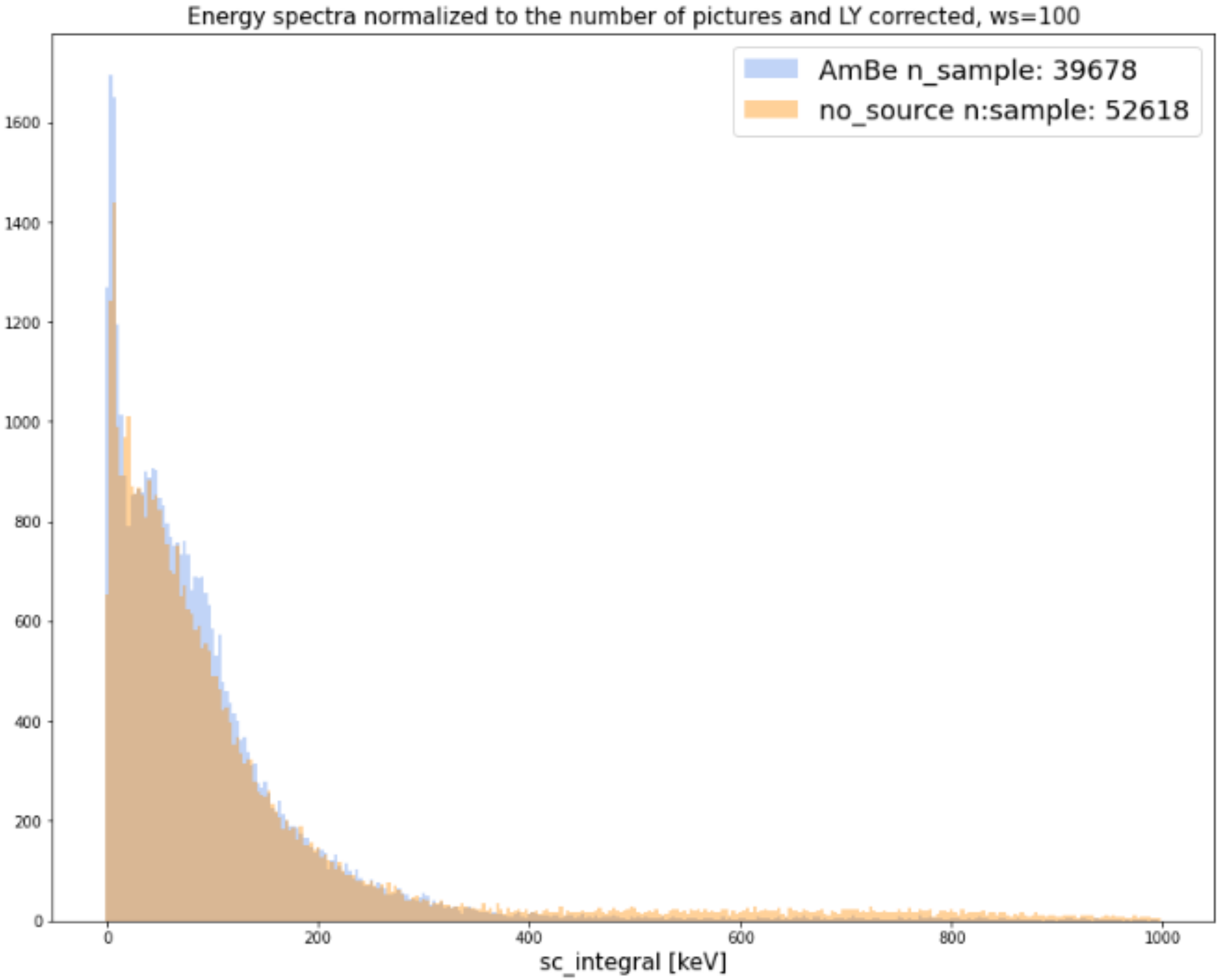
Selection Cuts

➡ sc_xmin > 400 AND sc_xmax < 1900: Why?

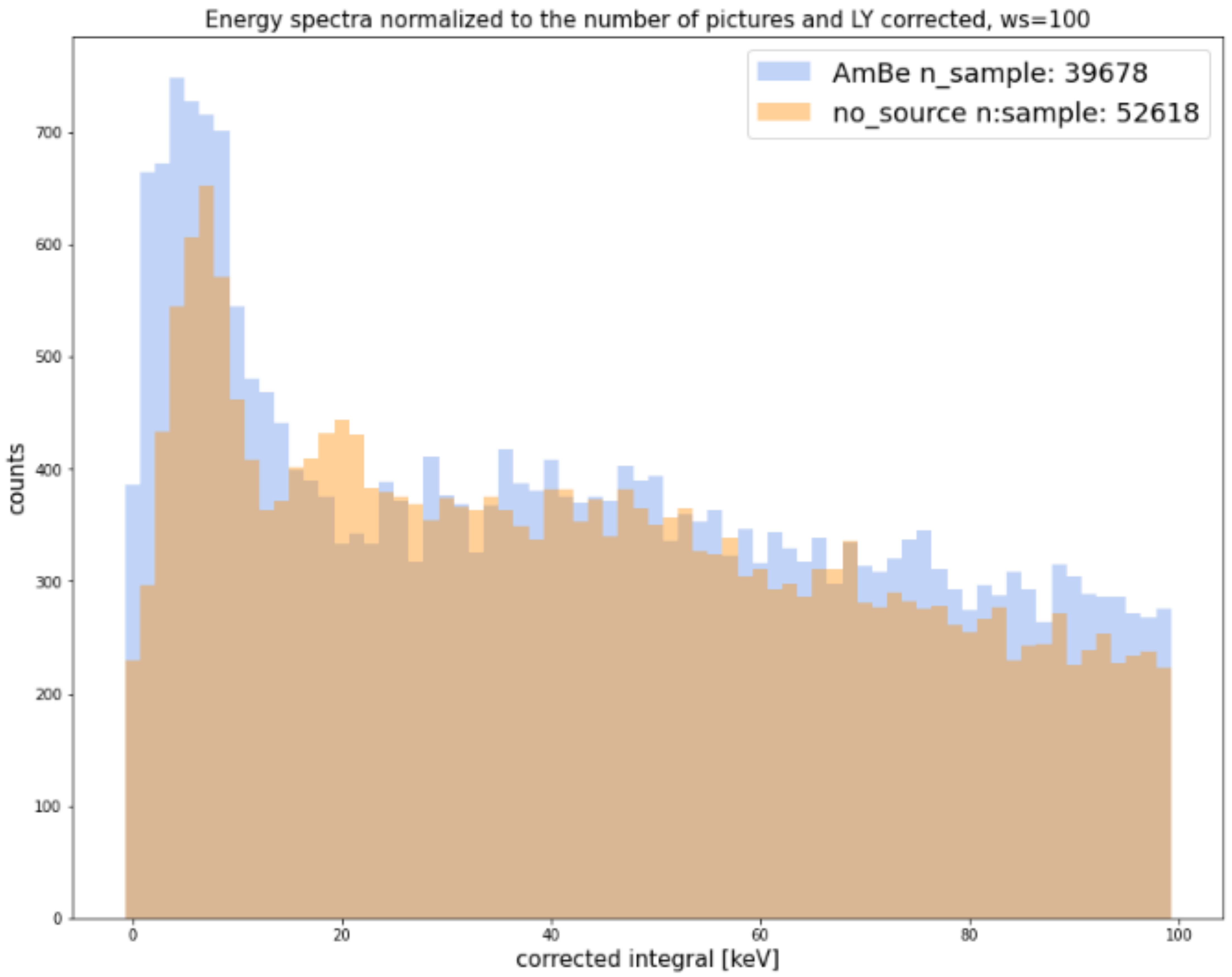




Energy spectrum

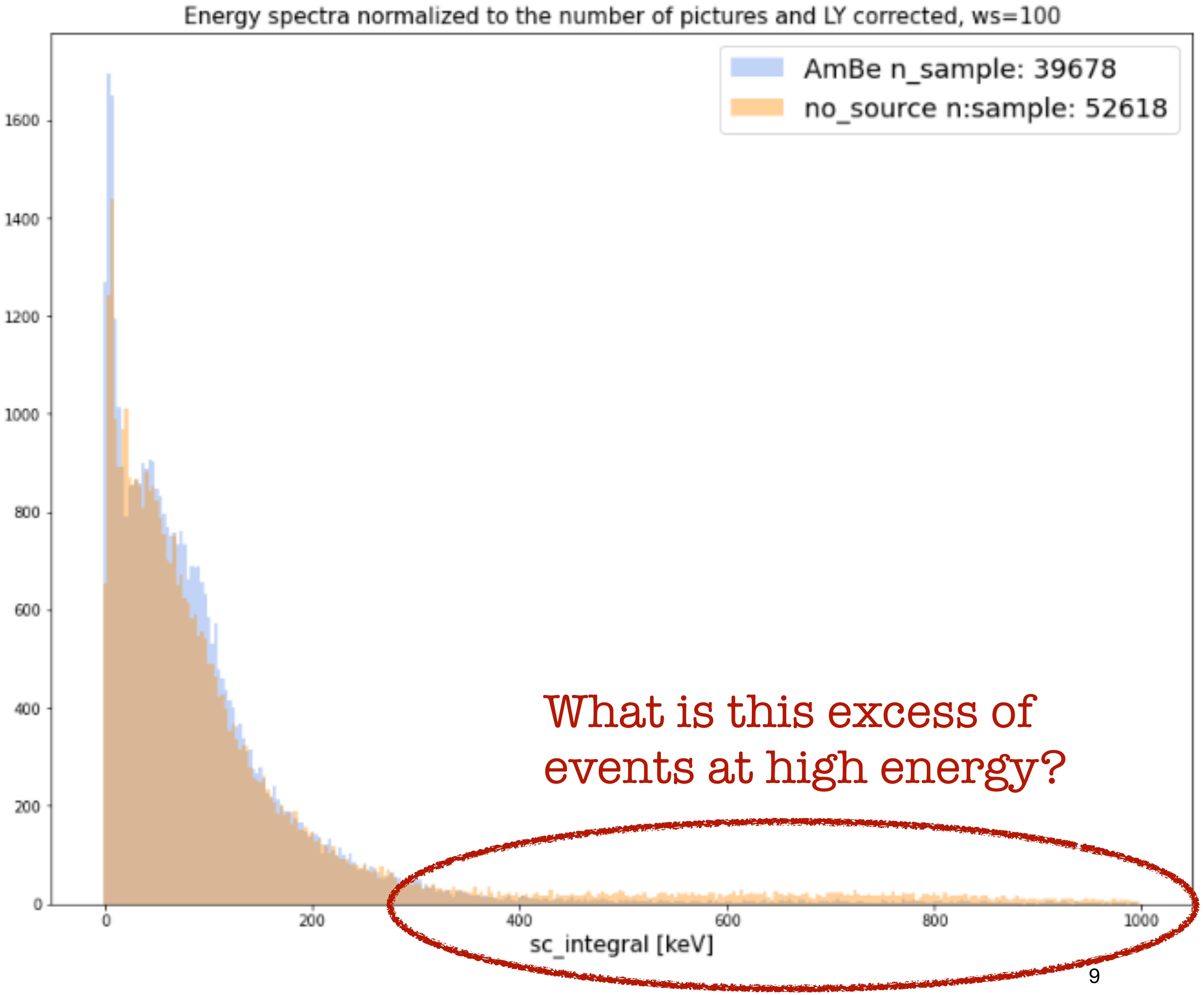


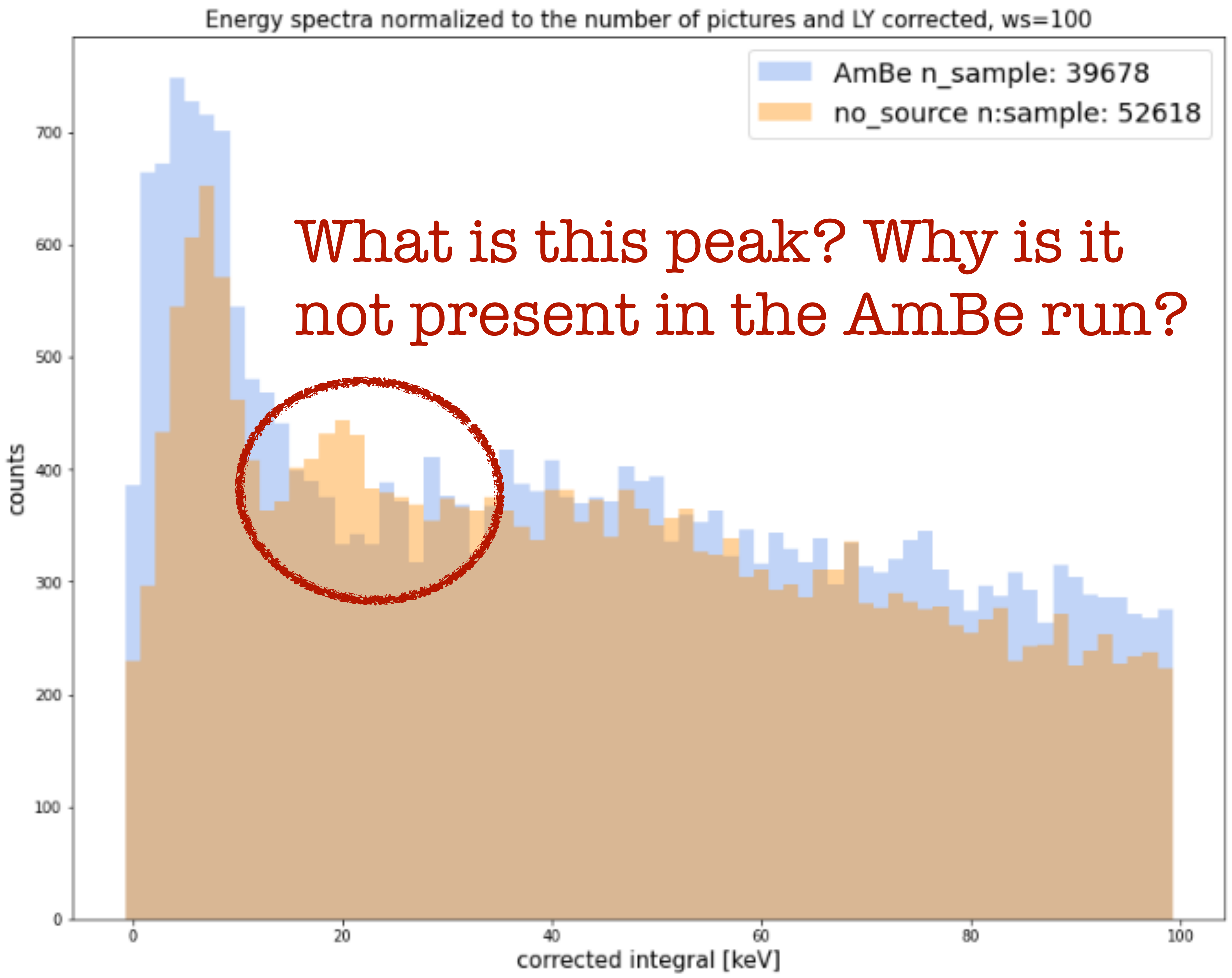
- **Normalization** of these histograms:
  - obtained dividing by the **number of runs**
  - it works because the **trigger rate** (and therefore the deadtime) **is the same**



Energy spectrum

- **Normalization** of these histograms:
  - obtained dividing by the **number of runs**
  - it works because the **trigger rate** (and therefore the deadtime) **is the same**





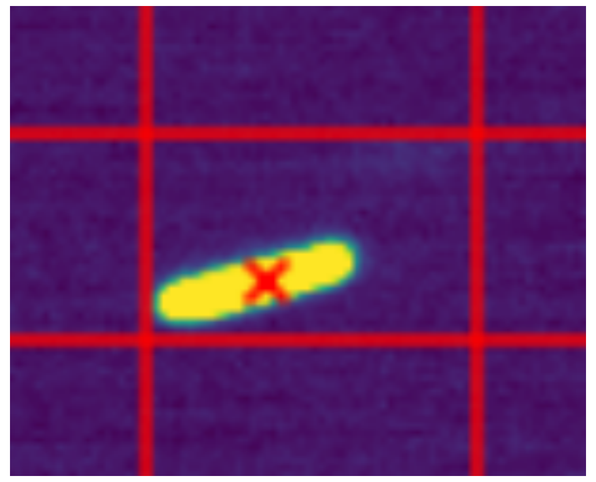
High energy excess

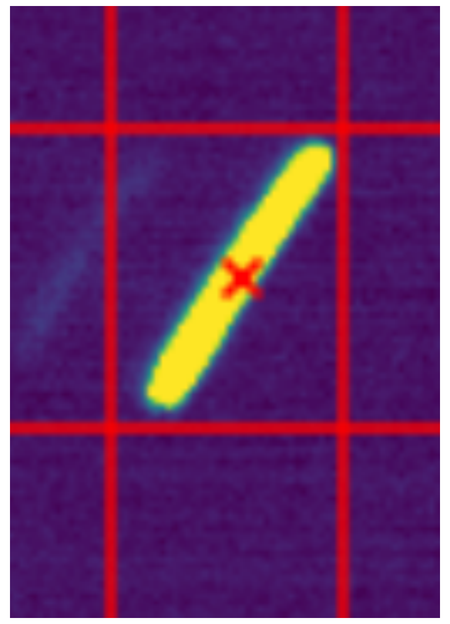
Let's define: $\delta = \dfrac{\text{corrected integral}}{\texttt{sc\_nhits}}$

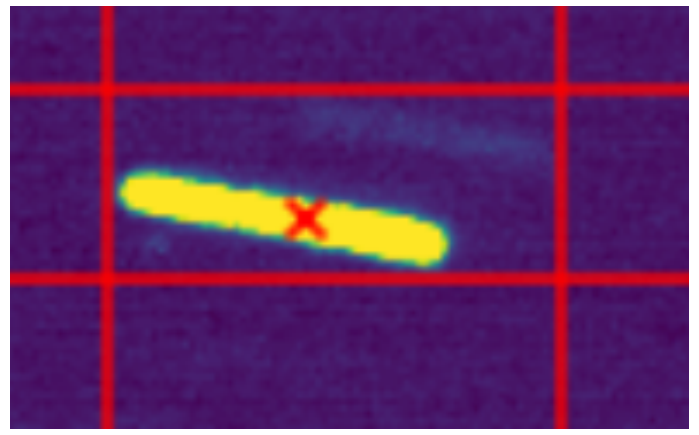
The **high energy excess** corresponds to an **high density excess**

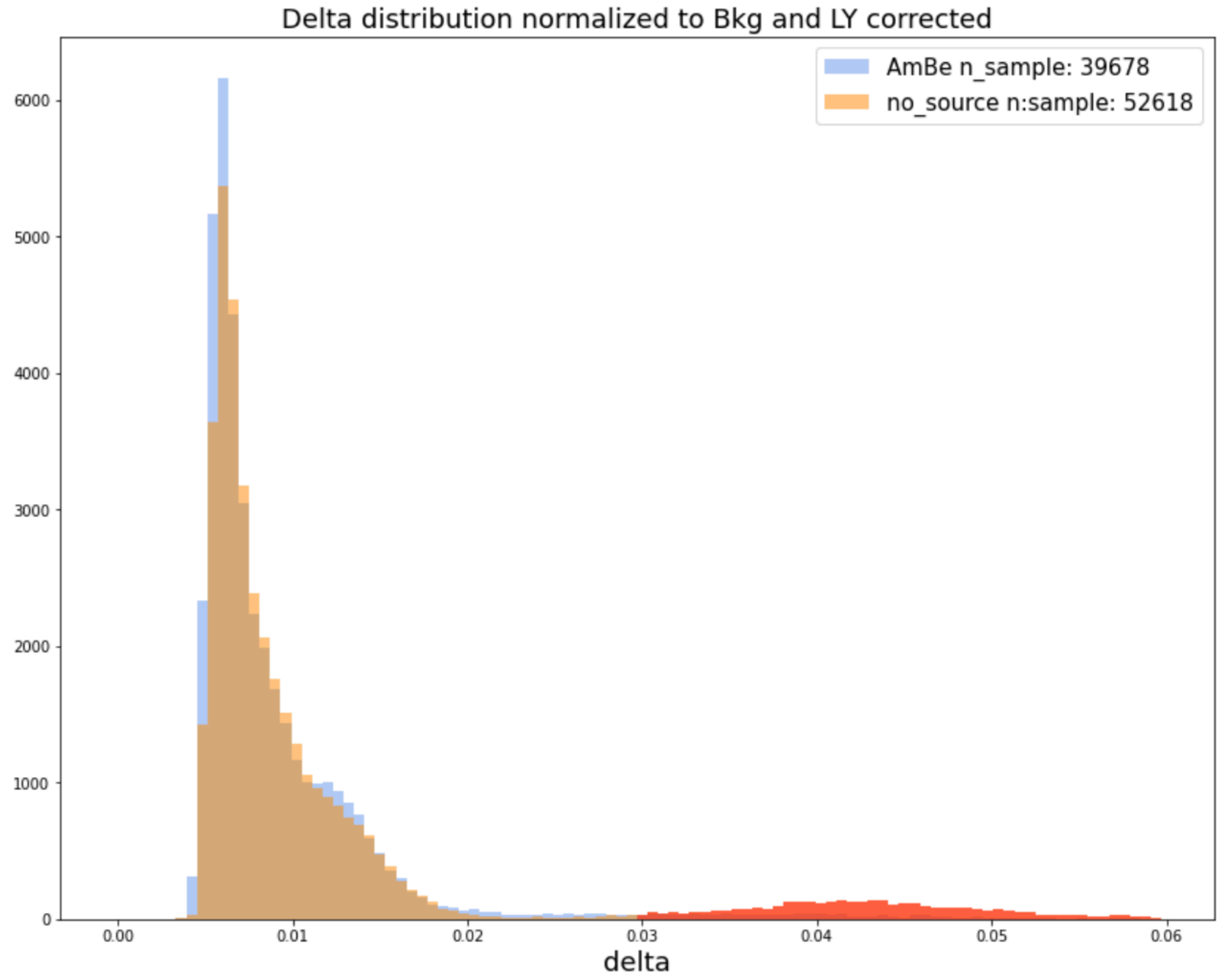
We can **select them by requiring** $\delta > 0.03$

How they look like:



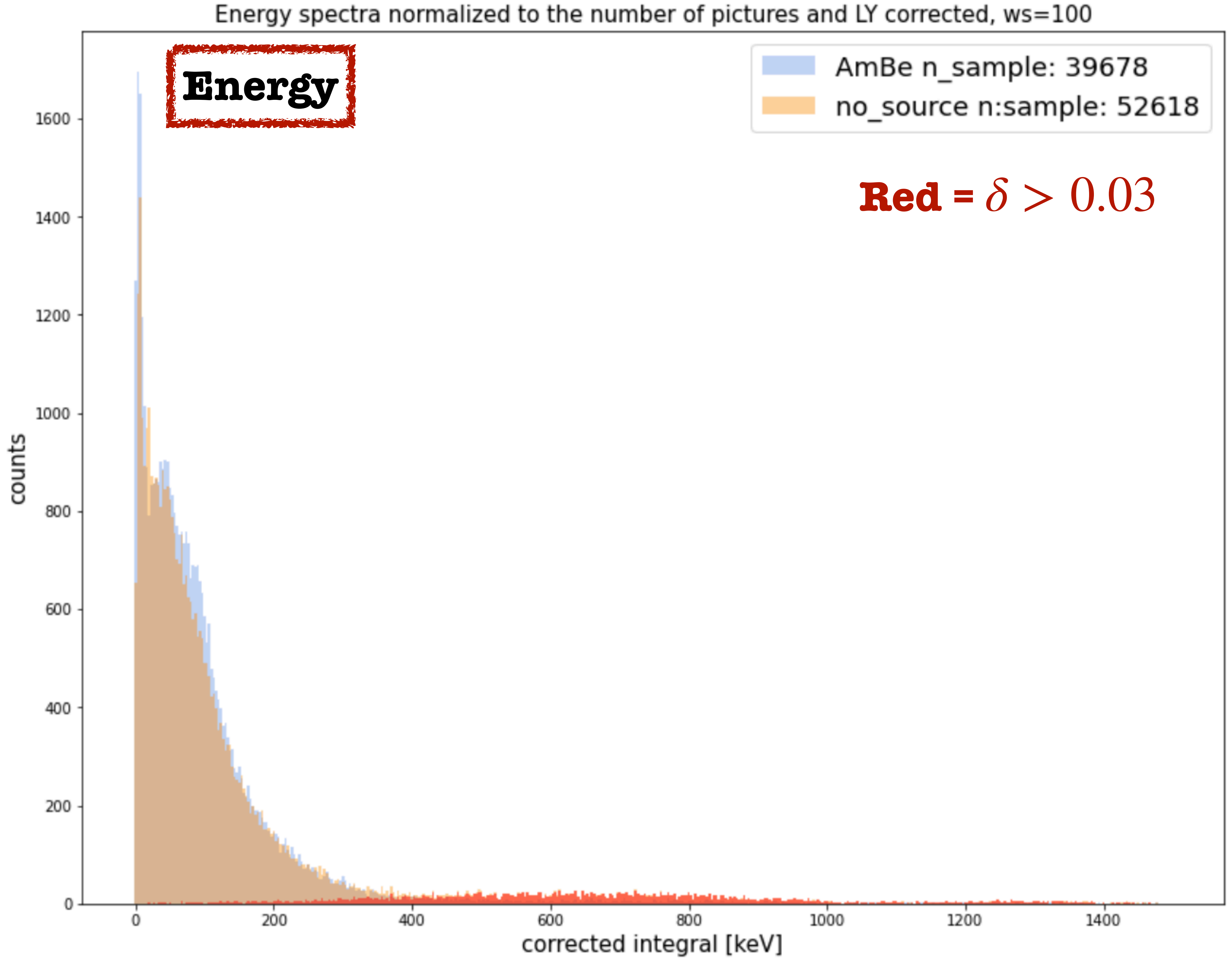


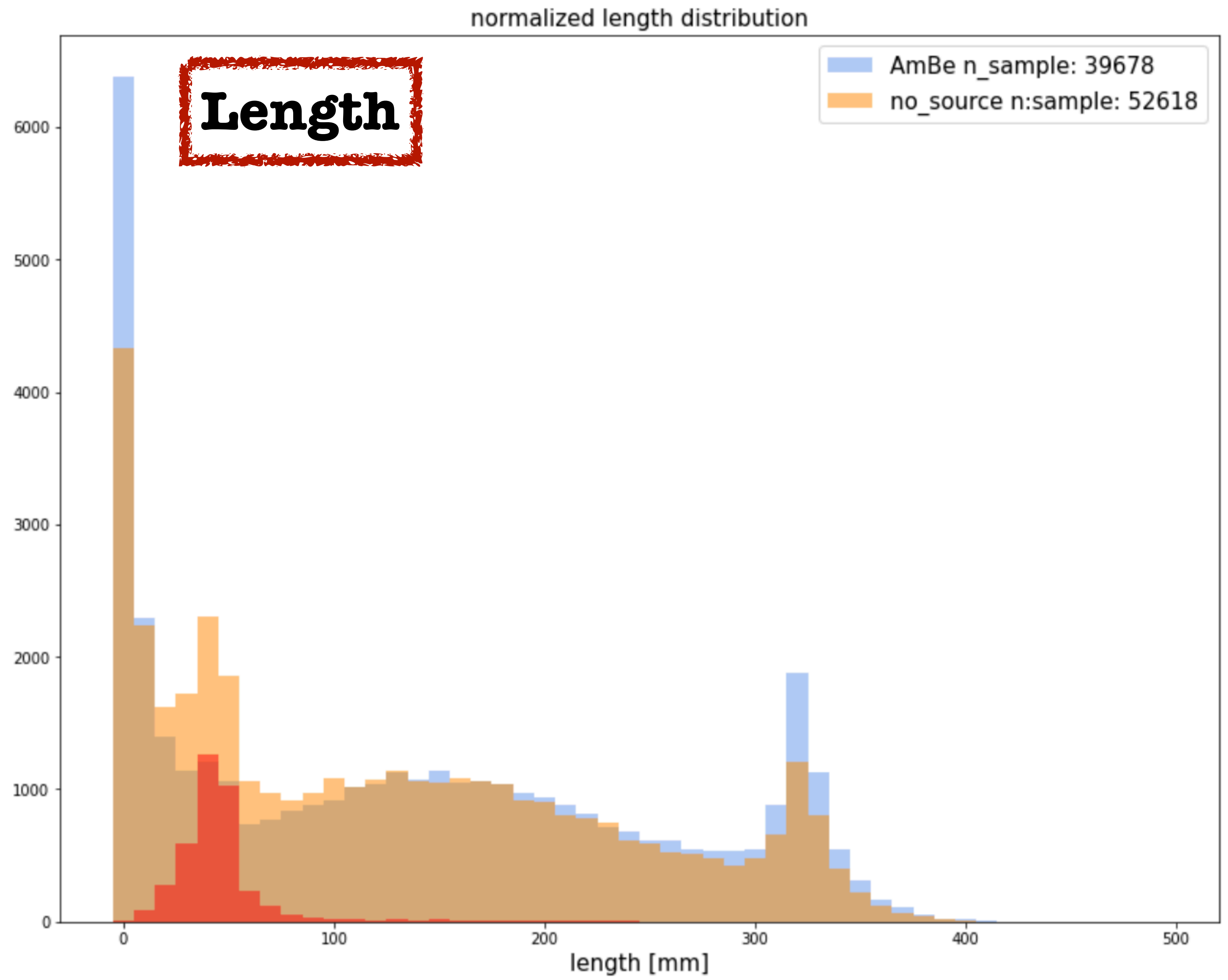


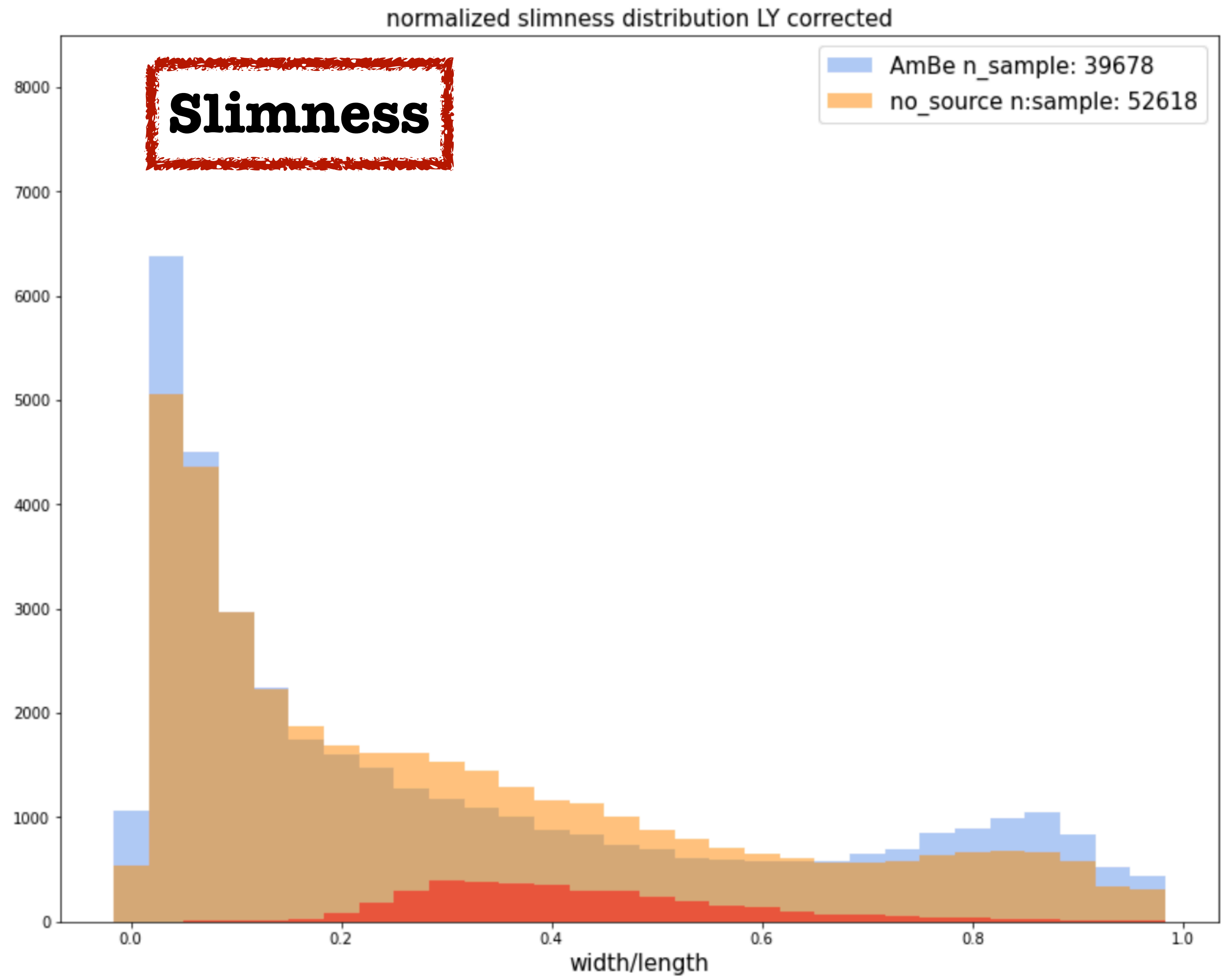


High energy excess

Looking into the other variables:

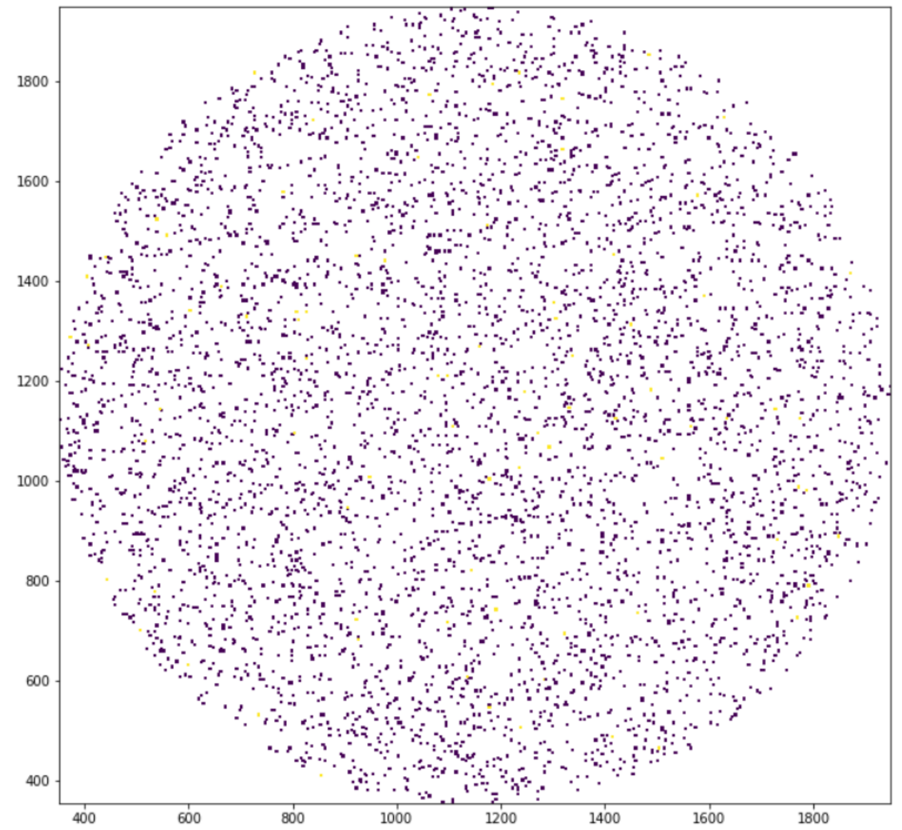


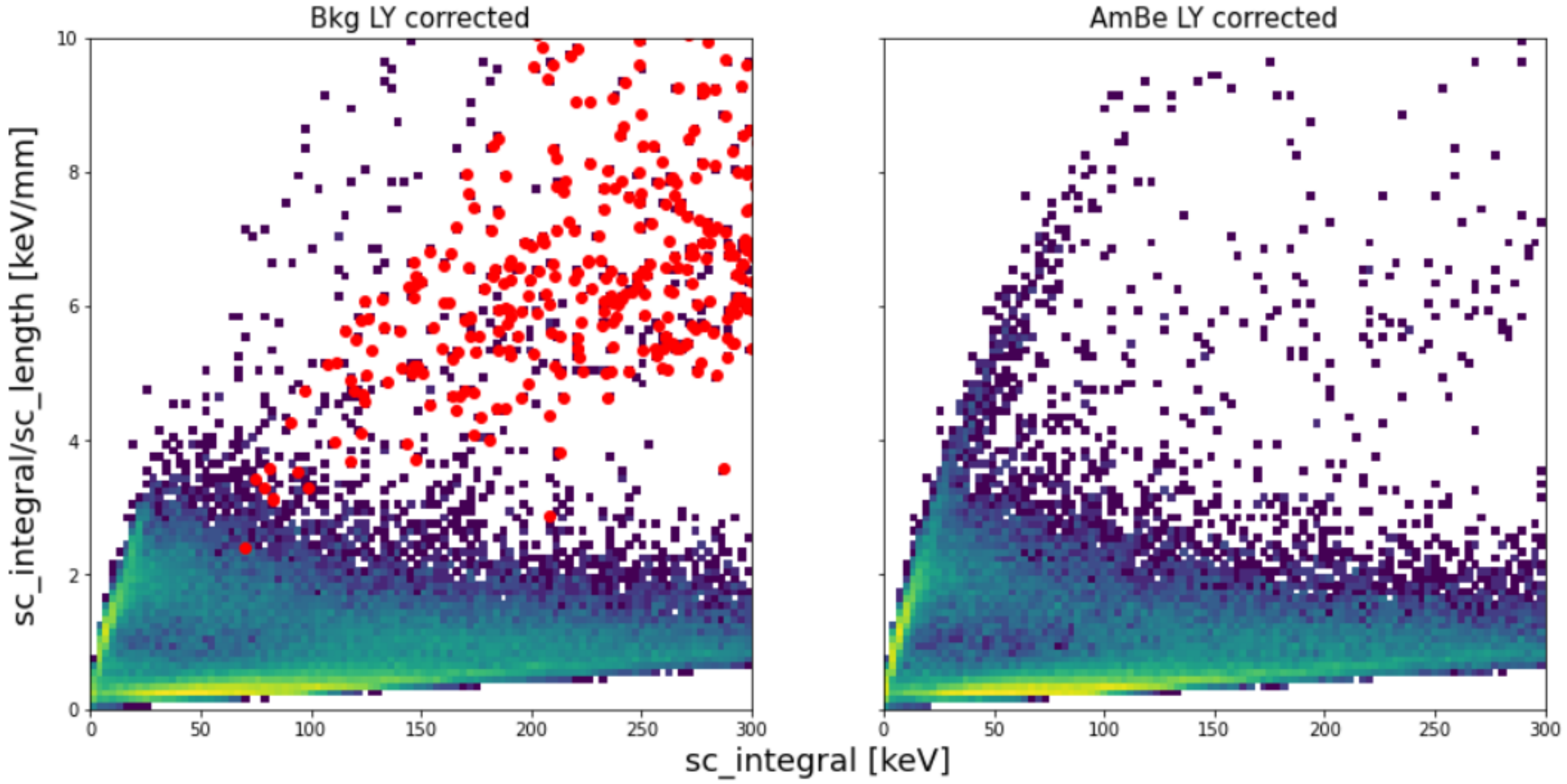


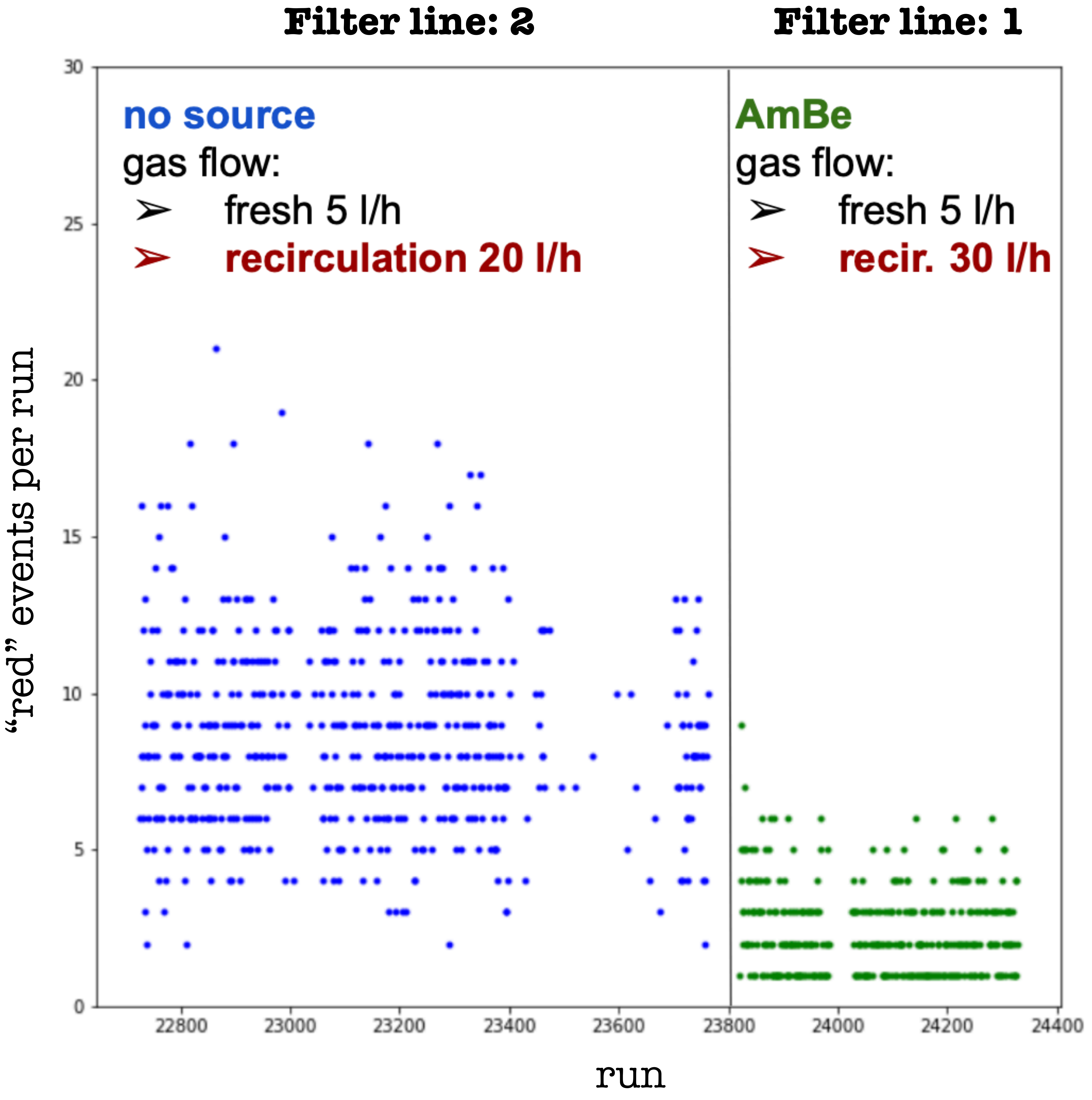


High energy excess

Spatial distribution



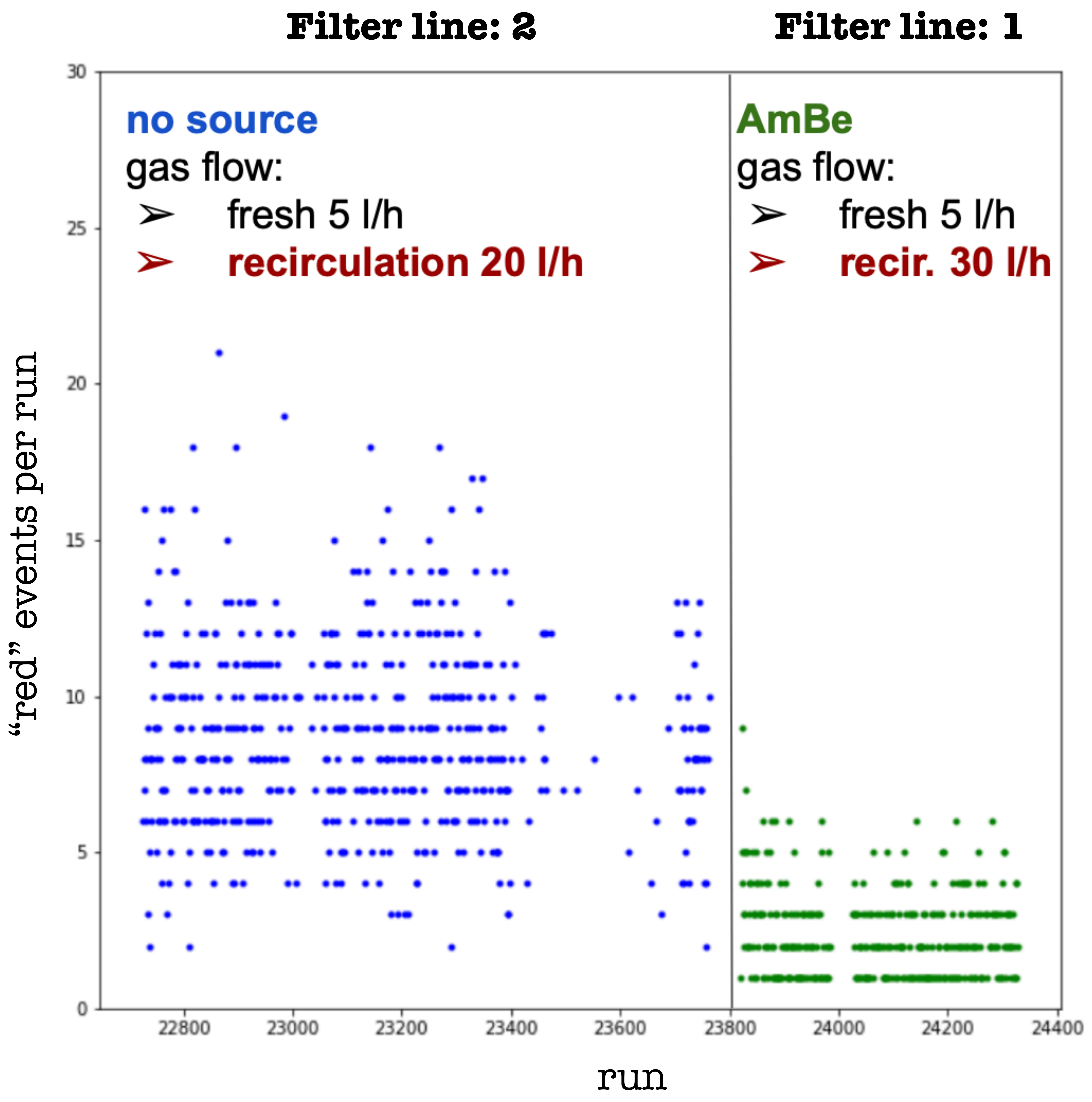




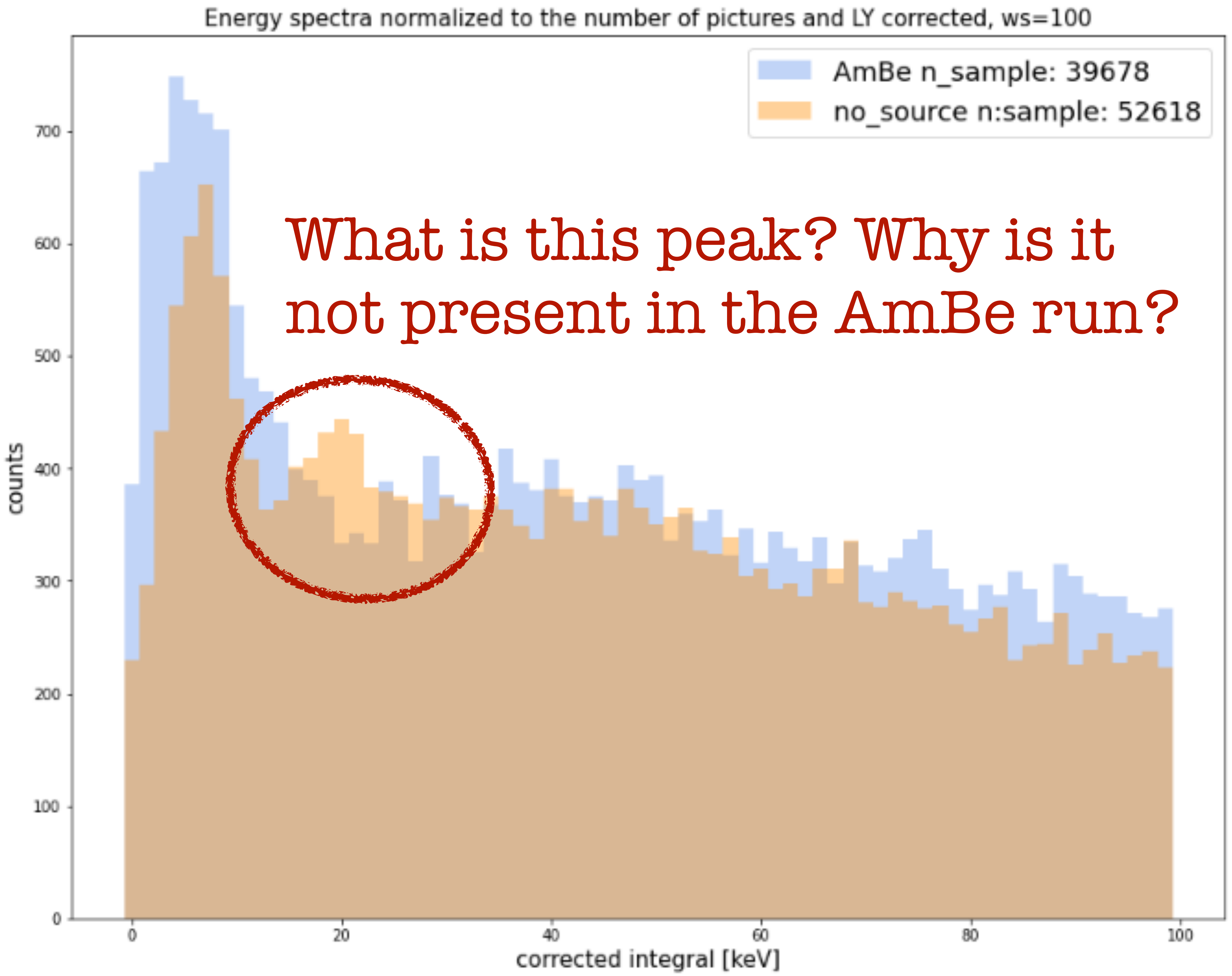
High energy excess

Conclusions:

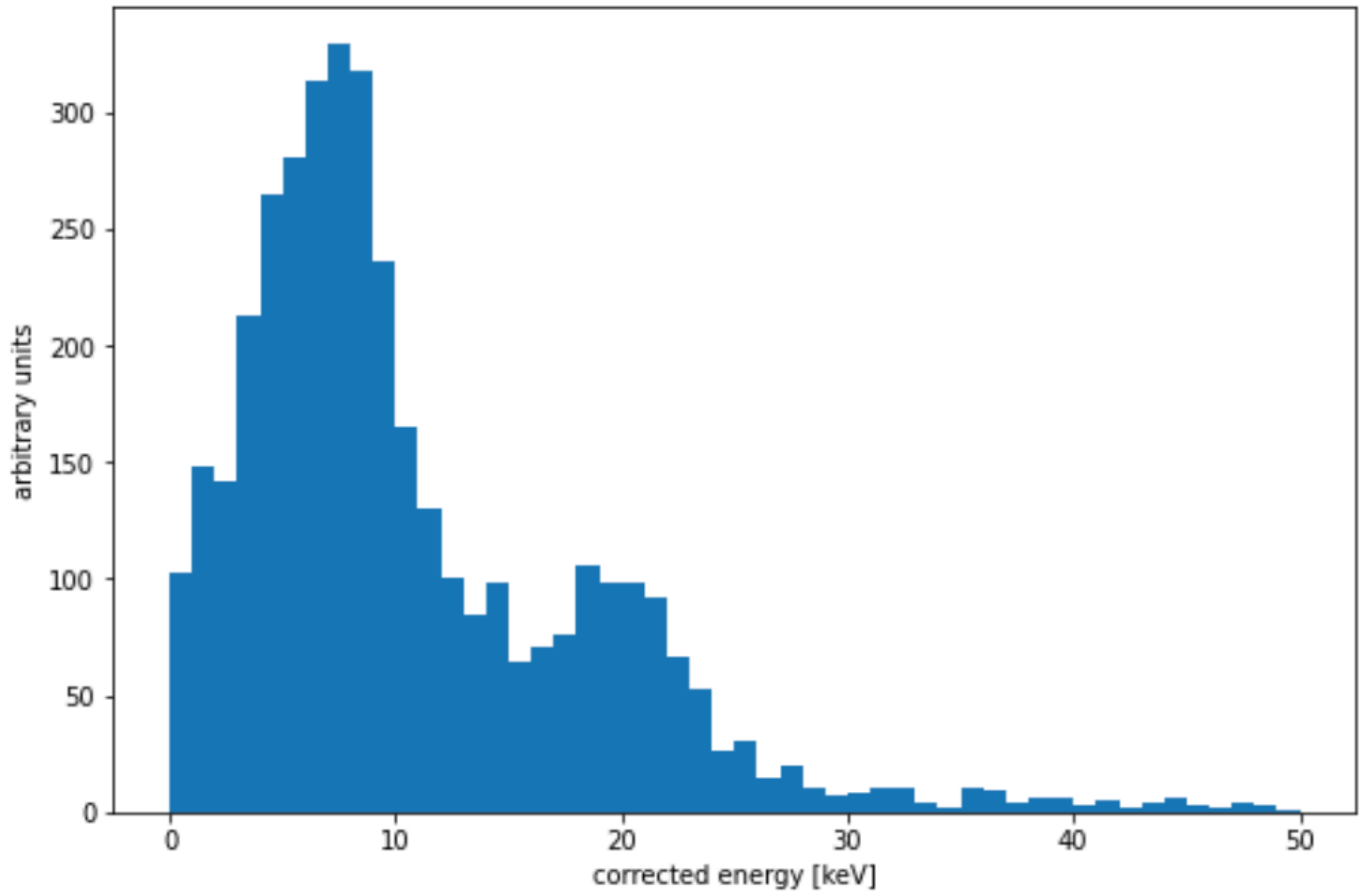
- They are uniformly distributed:
  - ➡ Inside the gas?
  - ➡ From the GEMs / cathode?
- Strong correlation with:
  - ➡ Gas flow?
  - ➡ **Filter line?**
    - **This hypothesis is favored** by the fact that **^{55}Fe data taken previously using line 1** (runs 20817 - 21041) showed a rate of "red" events equal to 3.2 events/run, **consistent with AmBe data**



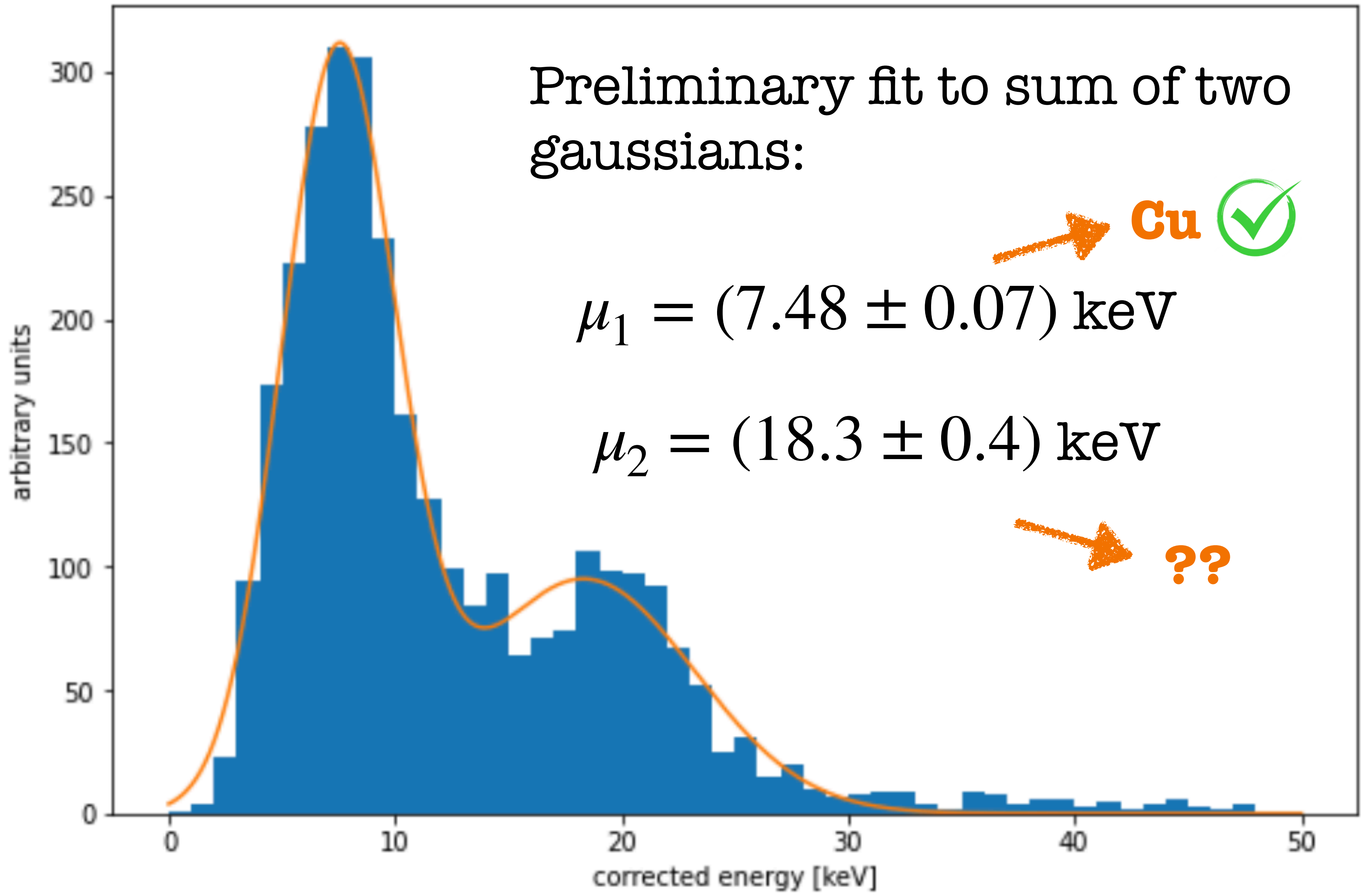
Low energy excess



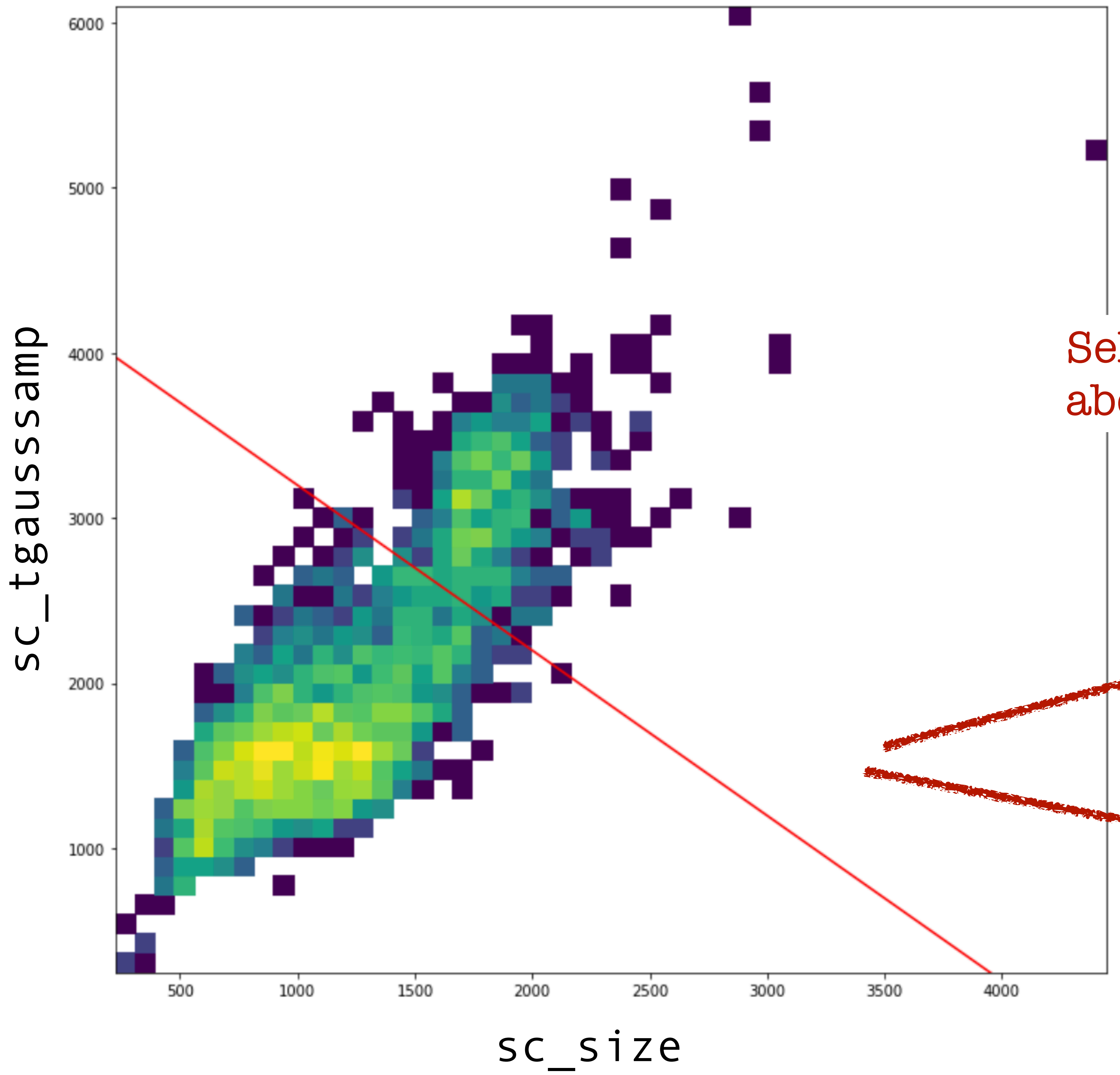
Adding sc_width/sc_length > 0.8 to the standard selection



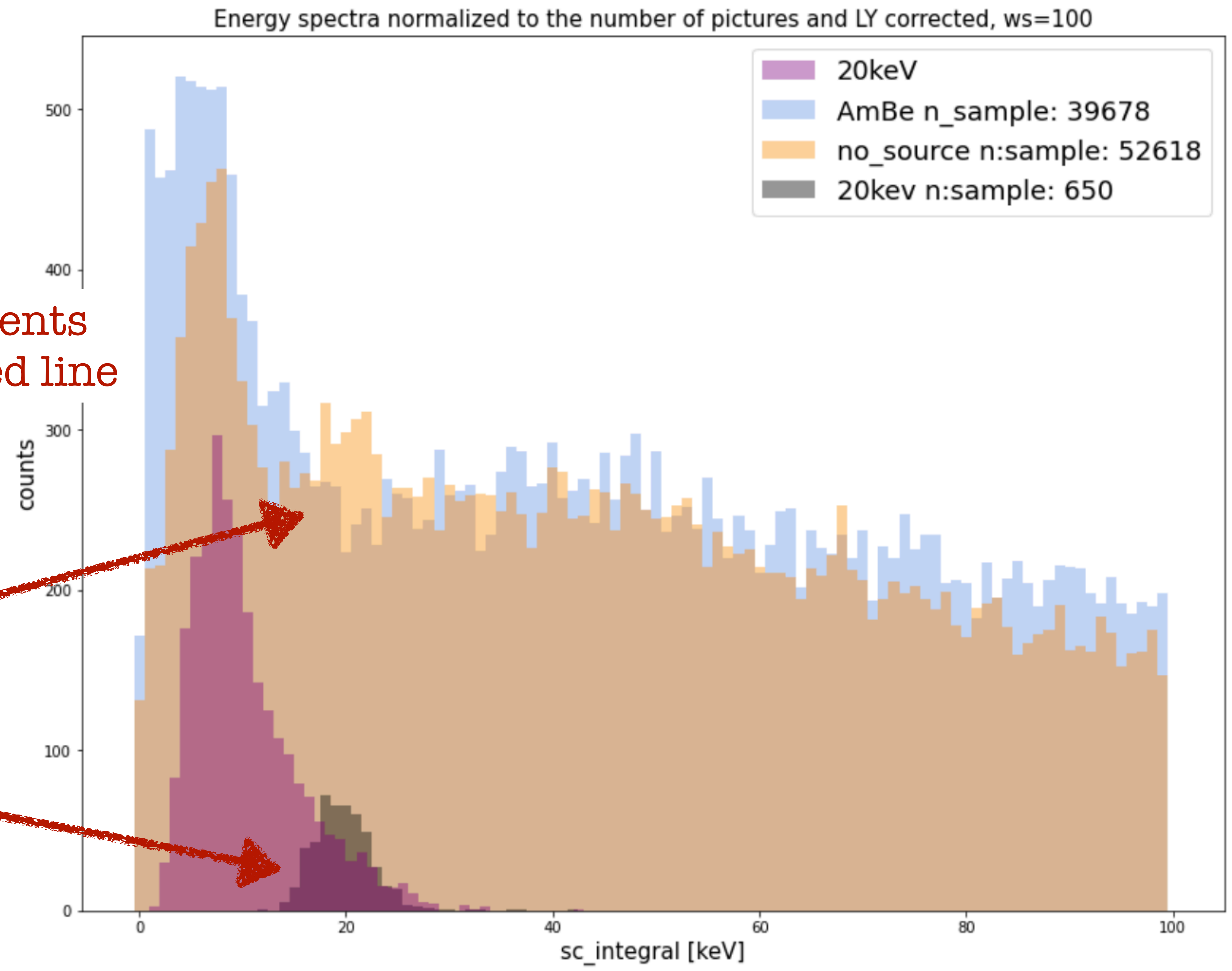
Adding $\delta > 0.1$ to remove residual MIP tracks



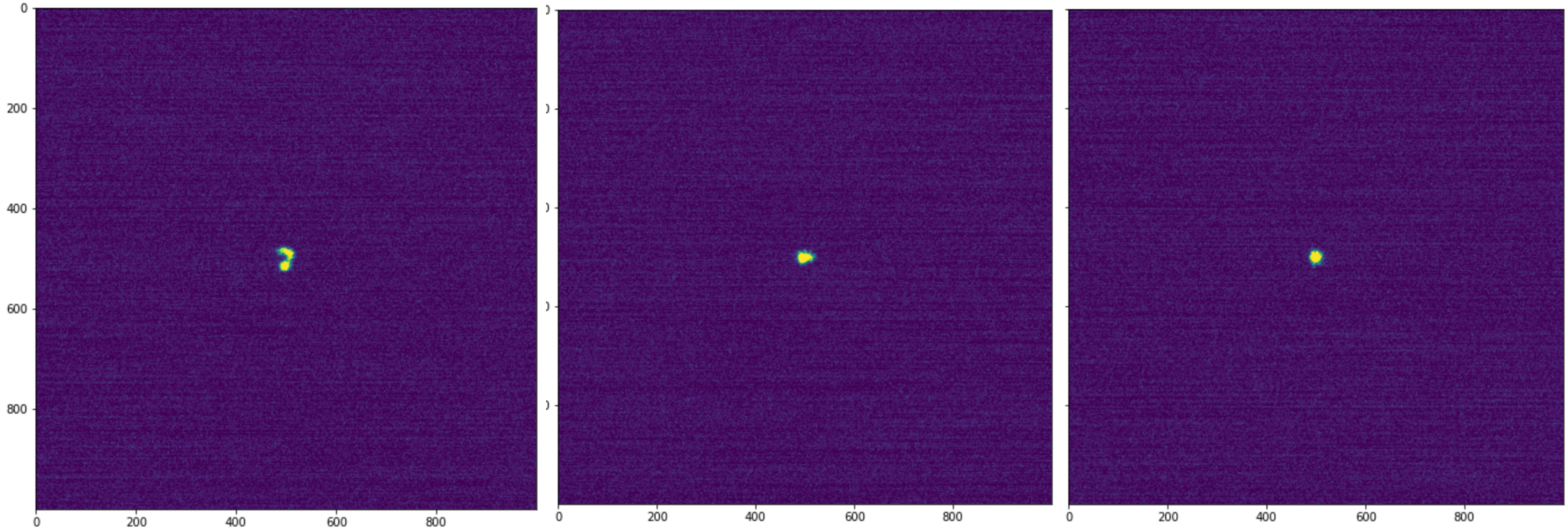
Low energy excess: separate the two peaks



Selecting events above the red line



Low energy excess

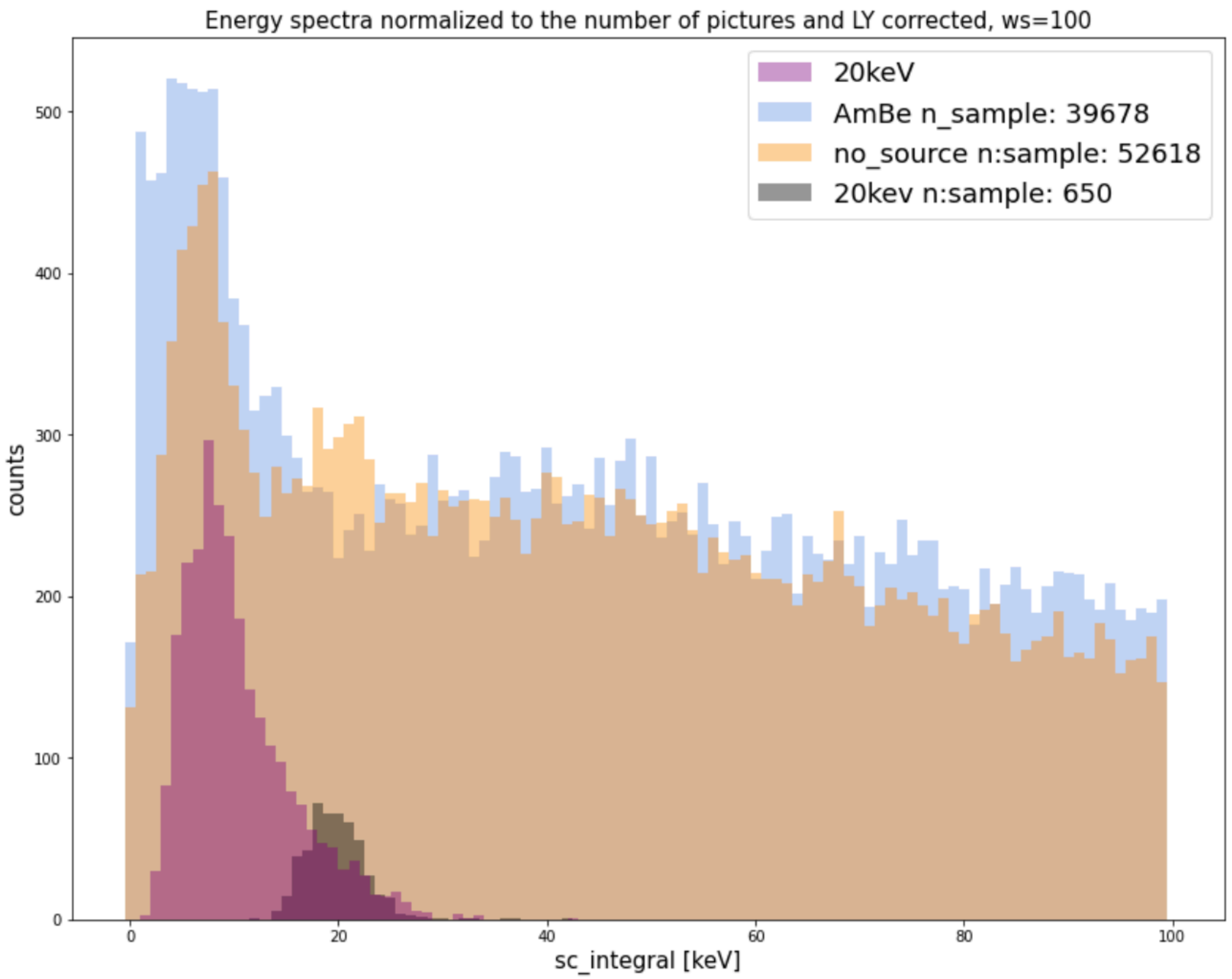


Low energy excess

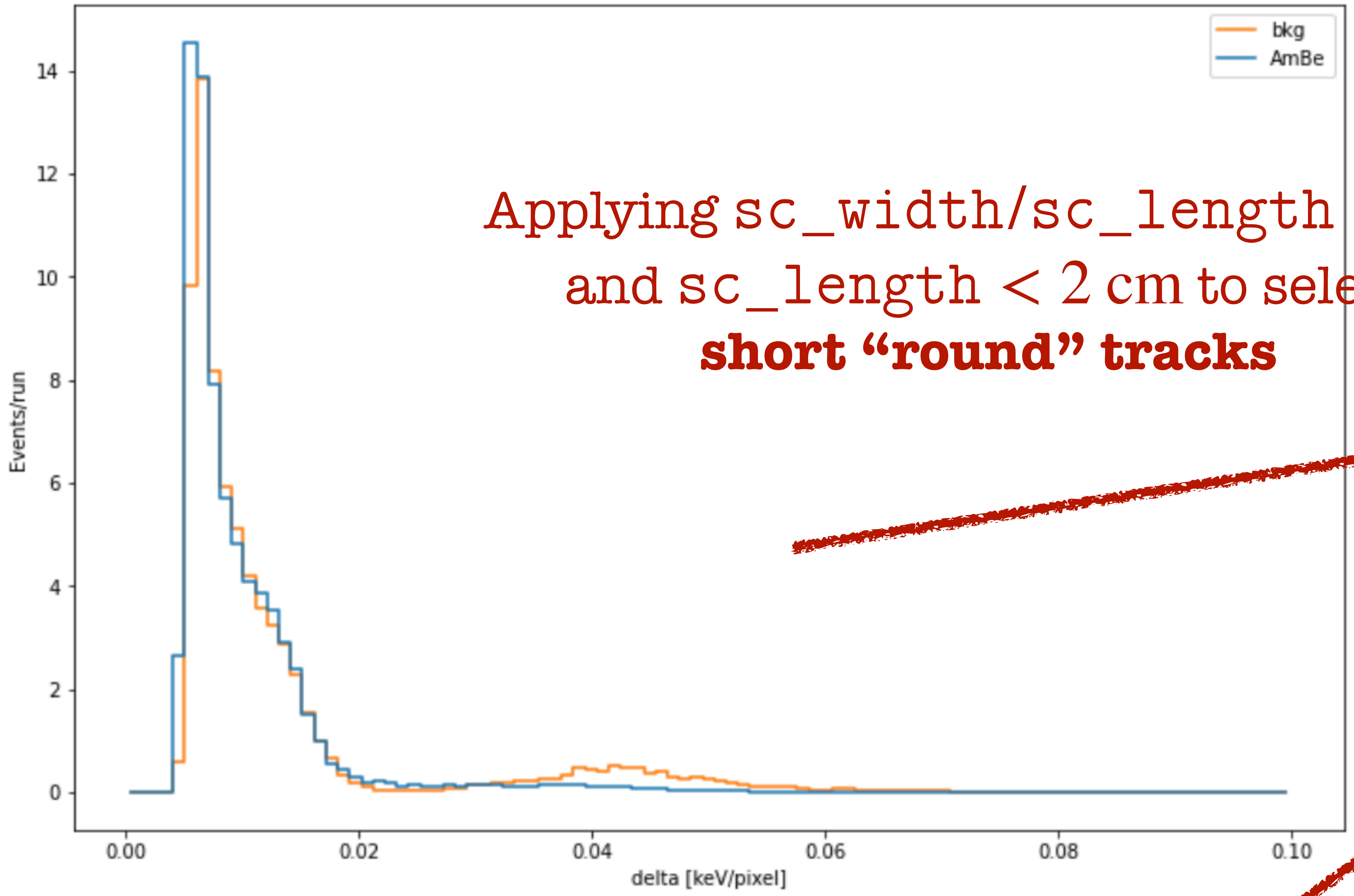
Conclusions:

- They are uniformly distributed:
  - ➡ Inside the gas?
  - ➡ From the GEMs / cathode?

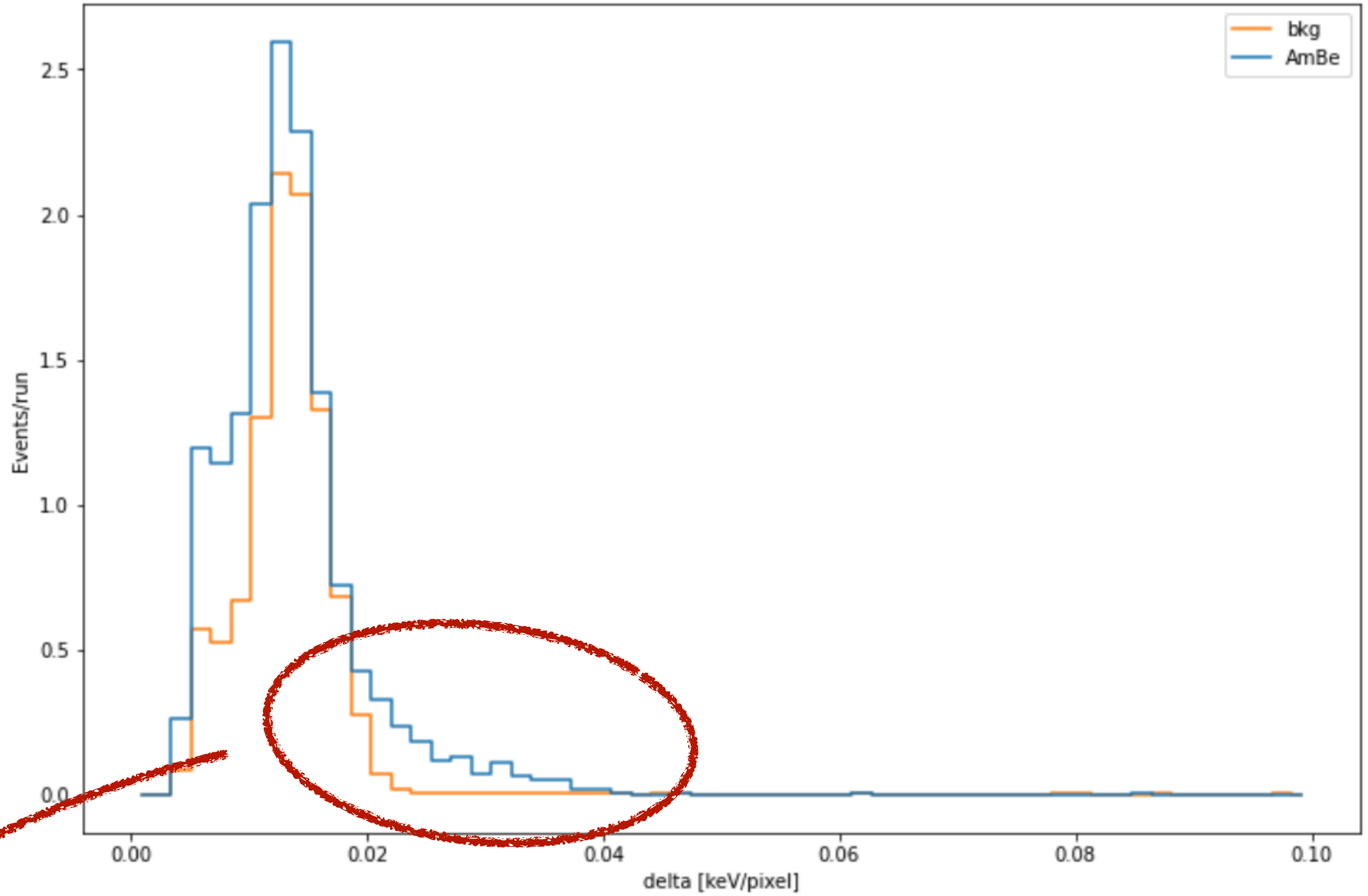
- **They are not present neither in the simulation or the AmBe campaign data:**
  - ➡ Gas flow?
  - ➡ **Filter line?**
    - **This hypothesis is favored** by the fact that ^{55}**Fe data taken previously using line 1** (runs 20817 - 21041) showed a rate of "red" events equal to 3.2 events/run, **consistent with AmBe data**

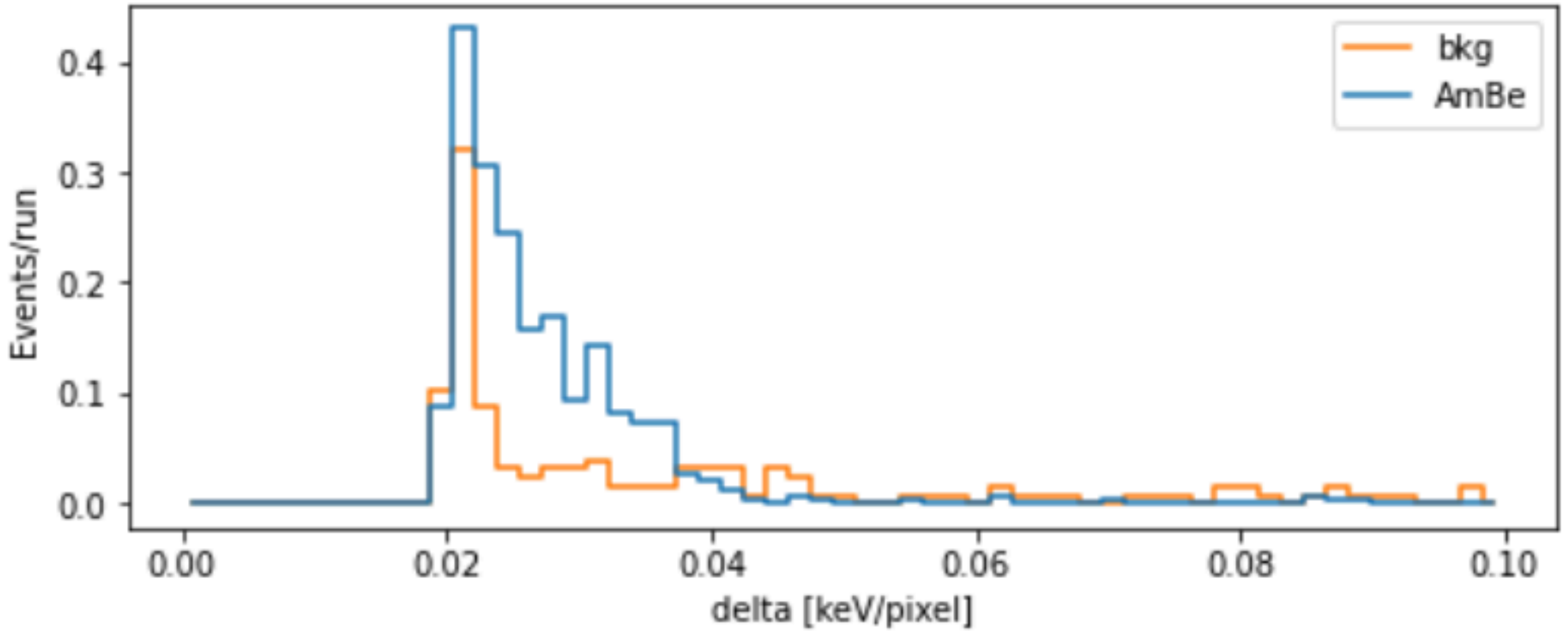


Looking for NRs



Applying sc_width/sc_length > 0.7 and sc_length < 2 cm to select **short "round" tracks**



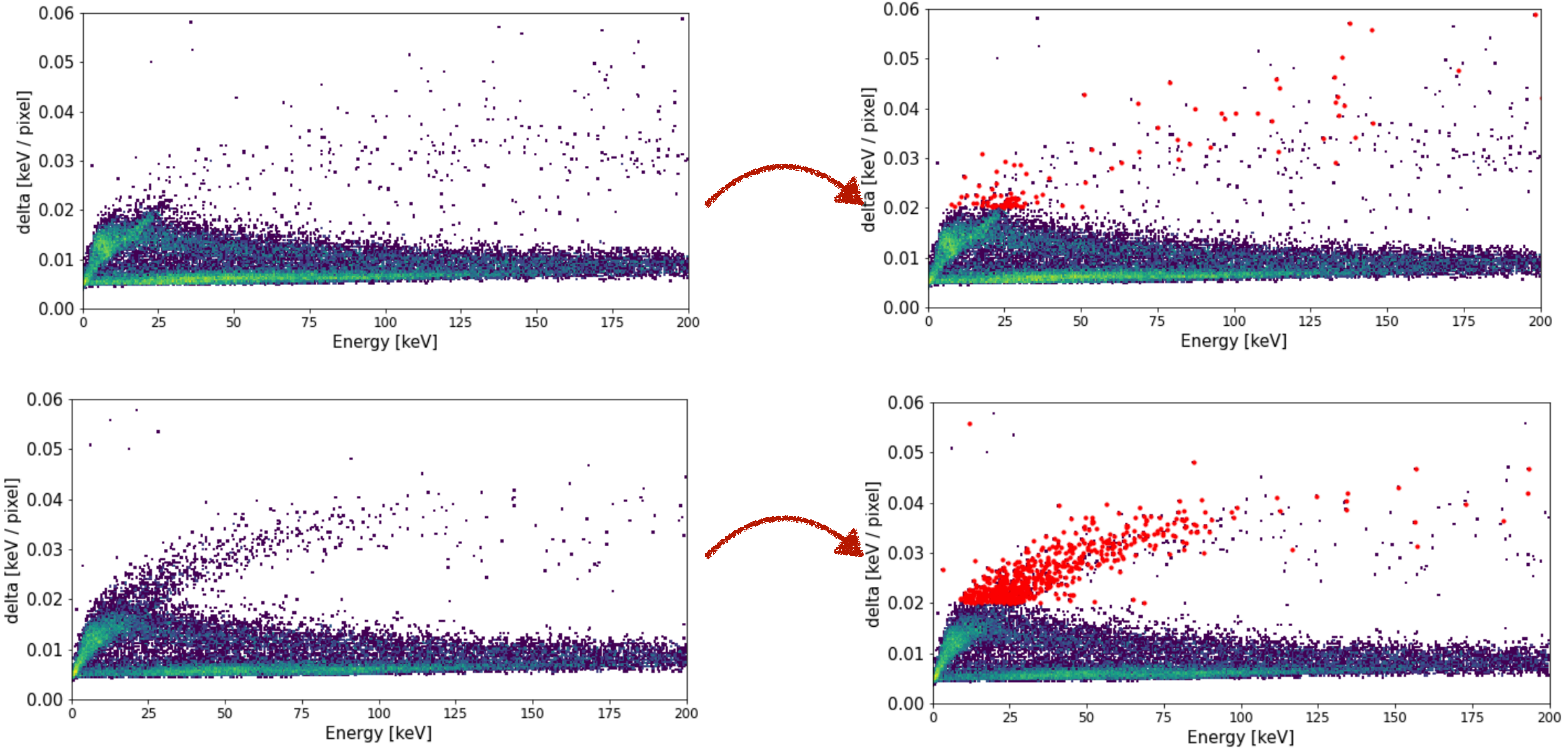


The $\delta > 0.02$ region:

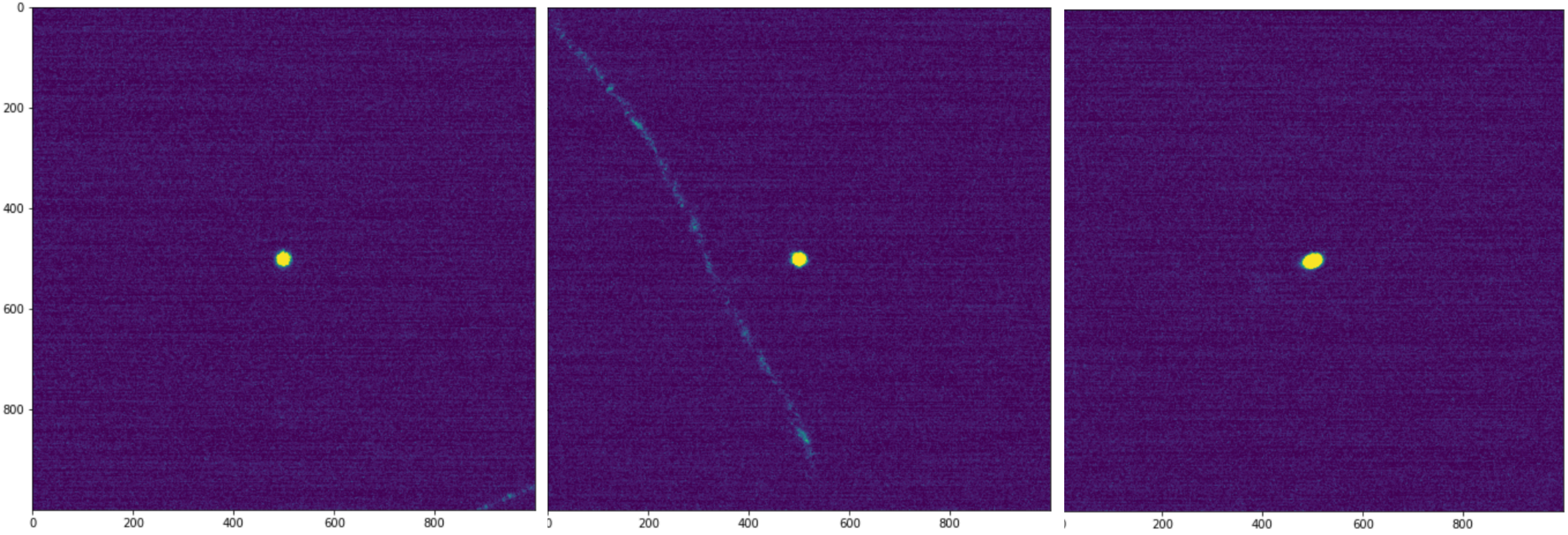
- is interesting because compatible with the NR density in LEMON
- has a big ""SNR""

Looking for NRs

Red points:
$\texttt{sc\_width/sc\_length} > 0.7$
$\texttt{sc\_length} < 2\,\mathrm{cm}$



Some examples



Conclusions

- We found an **excess of alphas in the bkg runs**
- **In the same dataset**, we found a **peak of ERs with an energy around 20 keV** which is **not** present in the **simulation or the AmBe data**
- **Both** can be explained by the **use of two different filter lines**, but the causes are still unknown
- Finally, even if still preliminary, we clearly are able to identify “high” energy **NRs in the AmBe data**:
  - We still have to work on a reliable estimate of their rate to compare with our MC simulation
  - The efficiency of our cuts drops significantly below ~25 keV, and we are still working on the optimal section

Backup

NRs: slimness and length

Histograms obtained subtracting the “alpha” excess in the bkg runs: