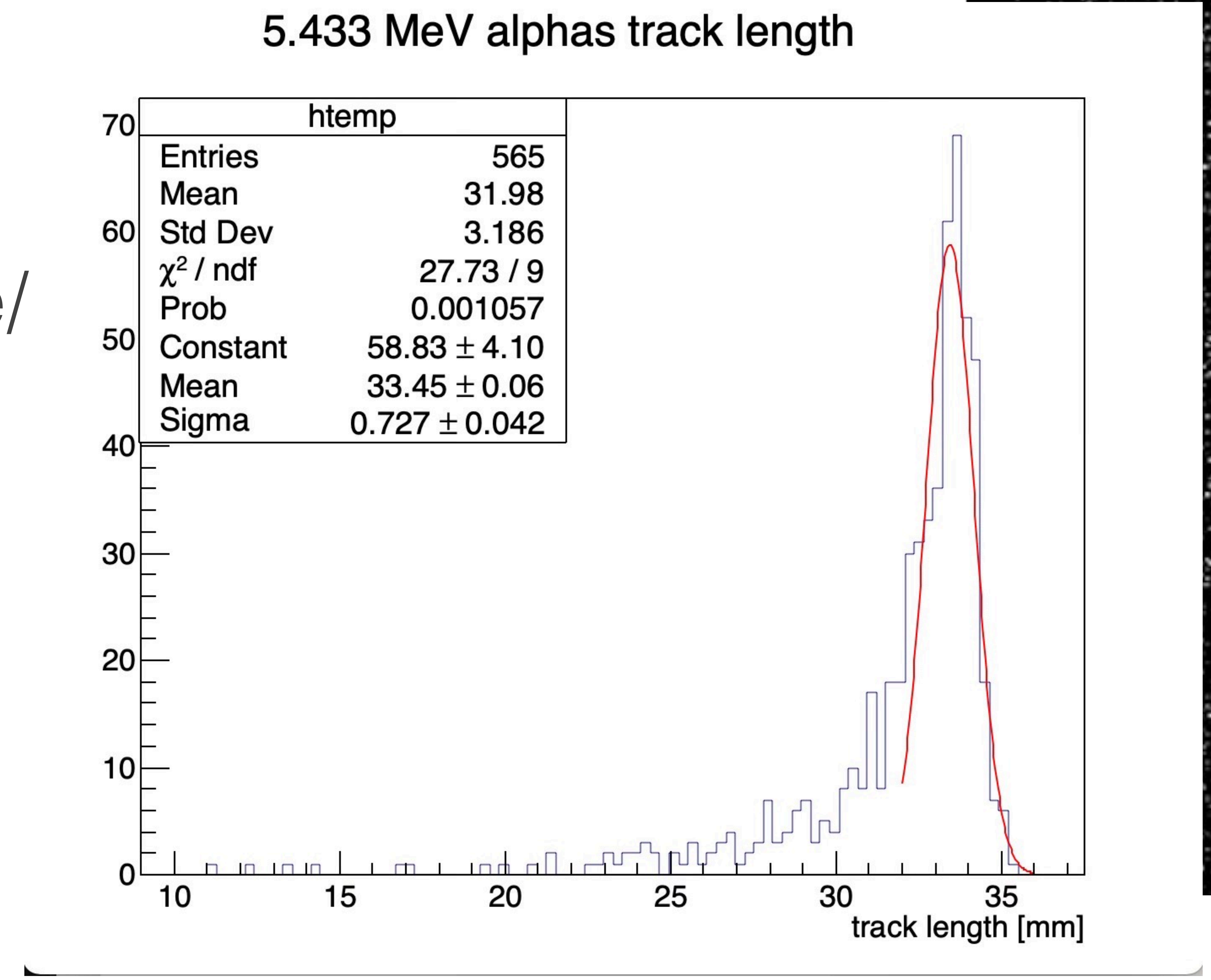
Studies on alphas

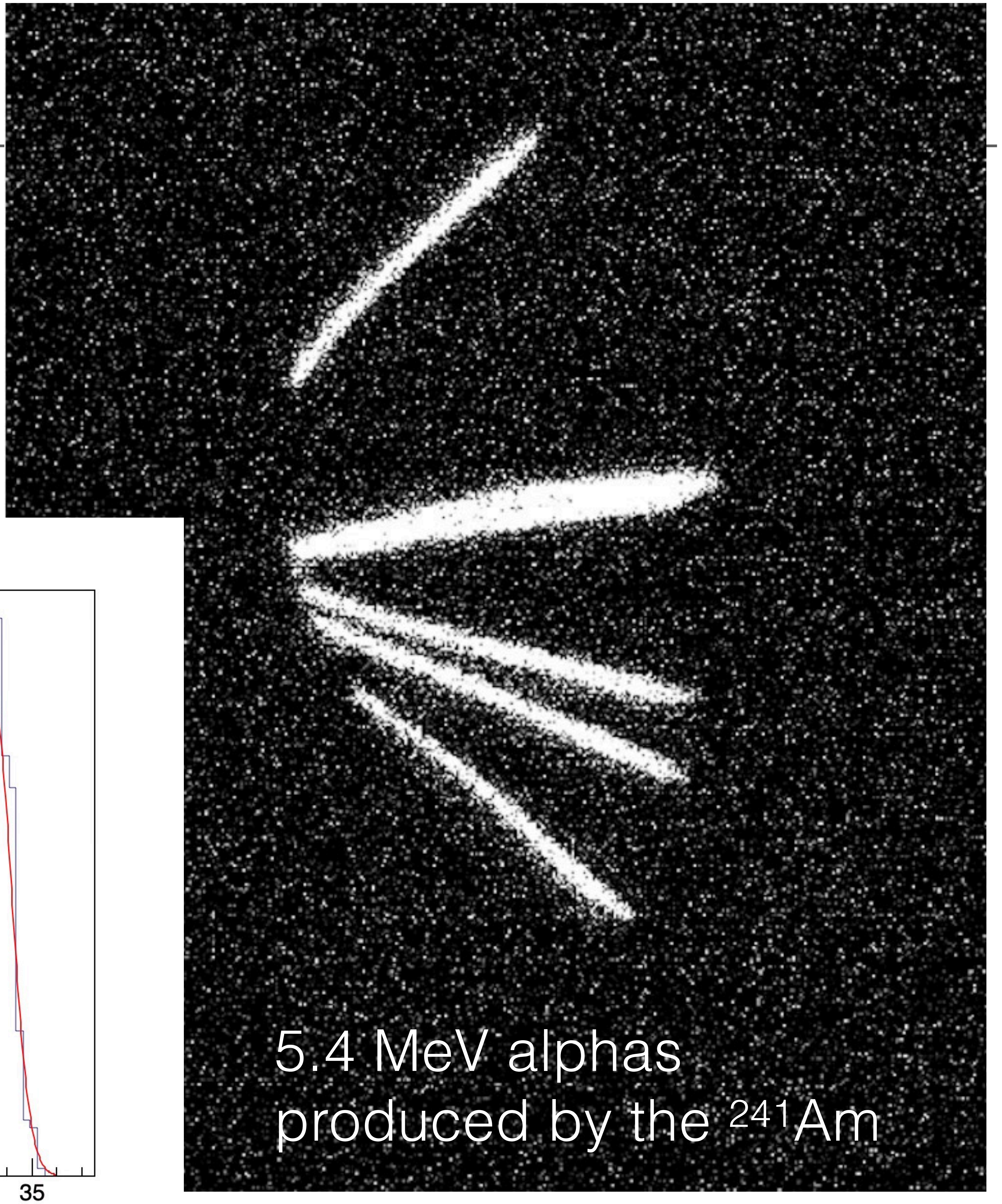
The alpha tracks

- Alpha tracks can be easily identified in our detectors because of their brightness and length (few cm);

- for example the 5.4 MeV alphas produced by the ^{241}Am are expected to travel about 35 mm in He/ CF_4 40/60

- confirmed by the test in MANGO and ORANGE

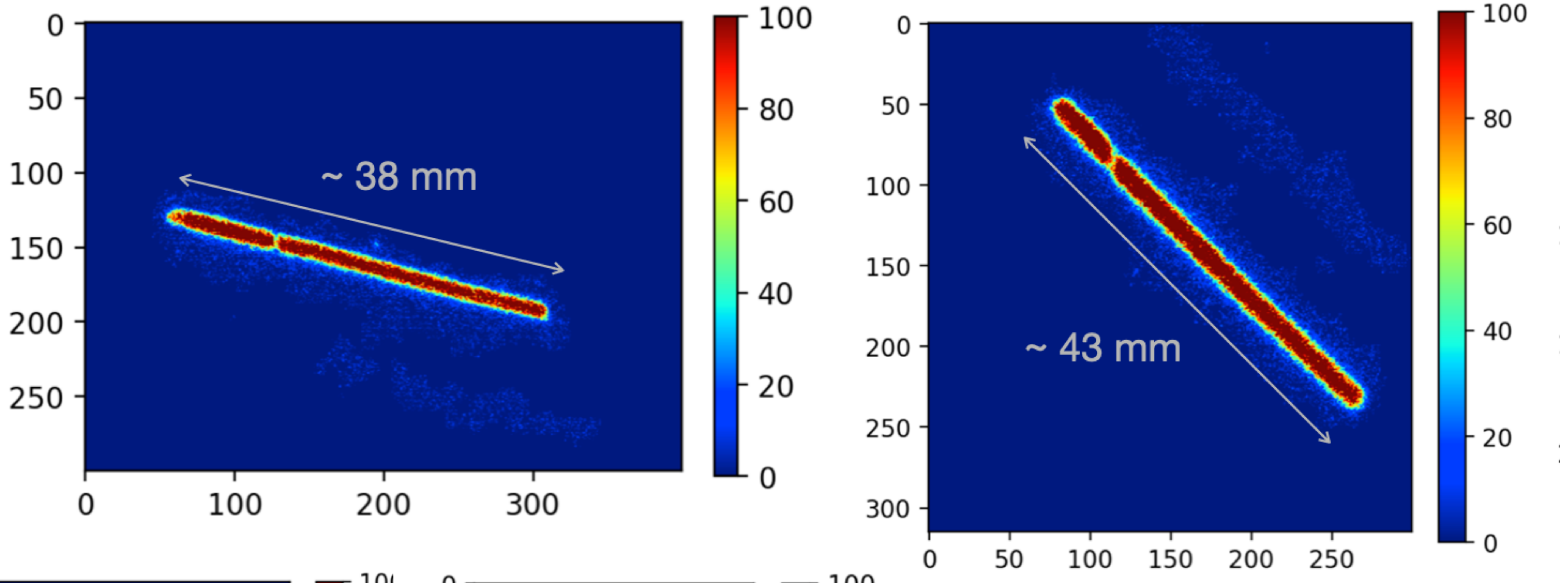


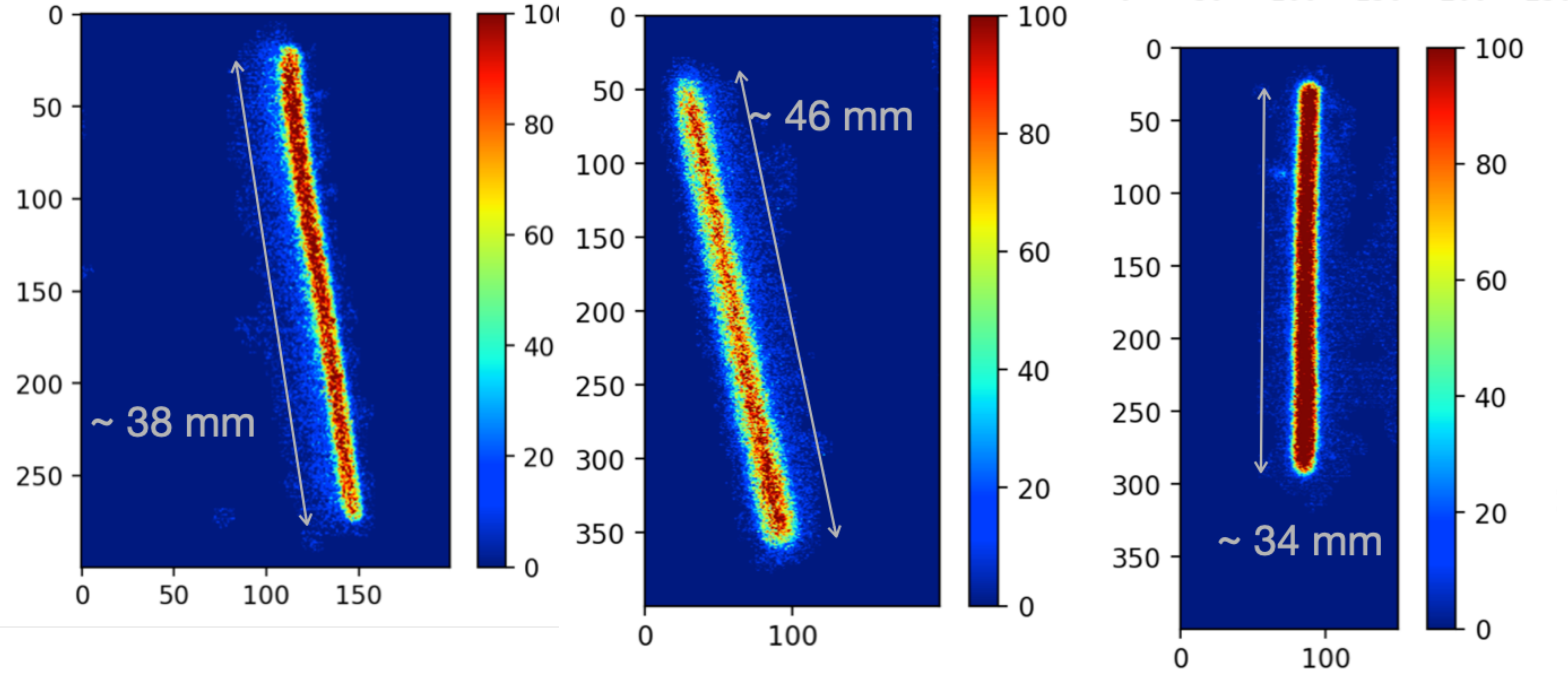


The alpha tracks

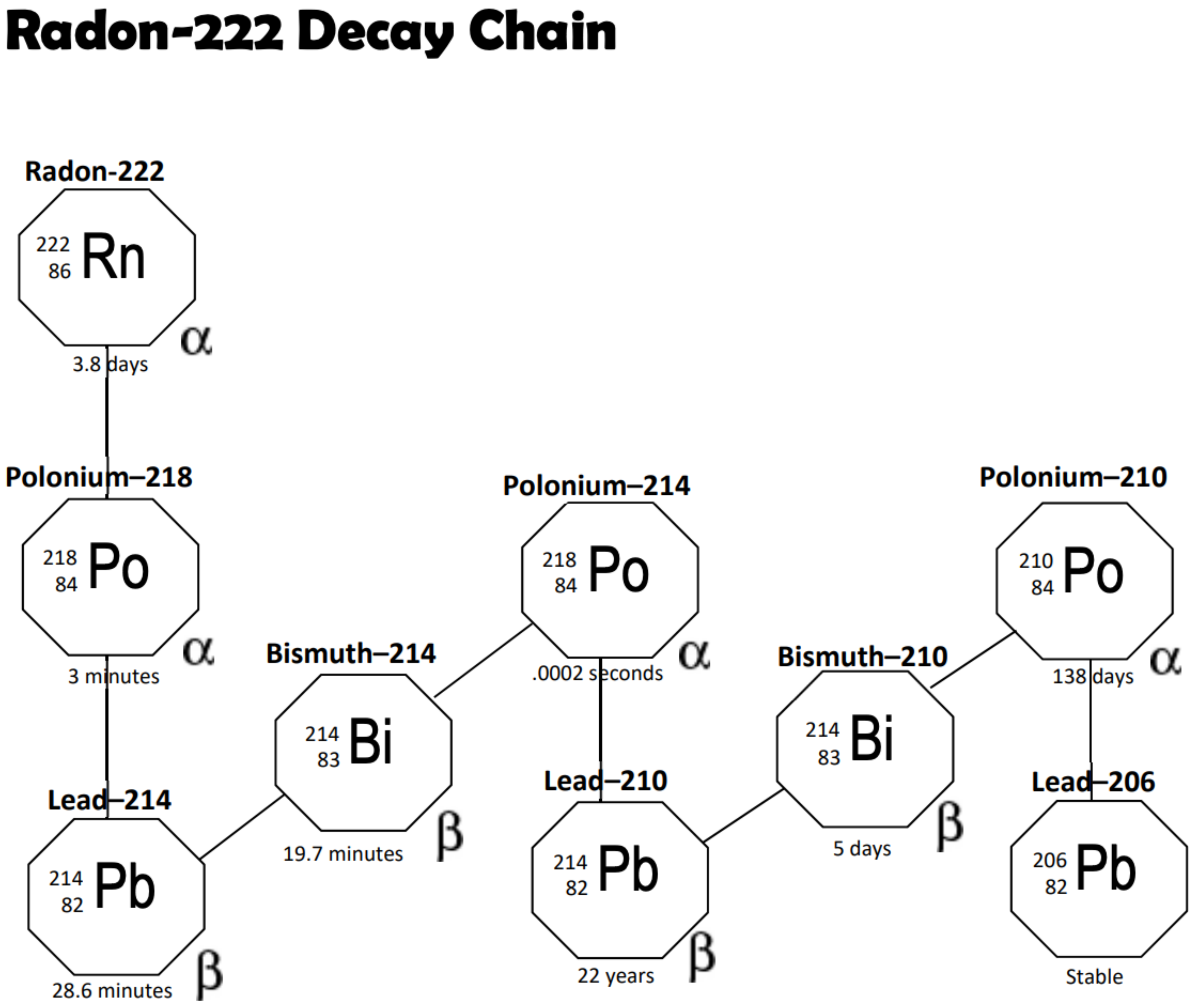
- Similar tracks were found in the excess of produced by the AmBe interactions

- Most of them were found to have lengths of few centimeters





The Radon Contamination



- So, a Rn contamination would produce:
  - 3 alphas:
    - ^{222}Rn -> 5.590 MeV (about 43 mm?)
    - ^{218}Po -> 6.115 MeV (about 50 mm?)
    - ^{214}Po -> 7.833 MeV (about 73 mm?)
  - 2 betas
  - a lot of gammas from 50 keV to 2200 keV

arXiv:1501.07757v1

The Radon Contamination

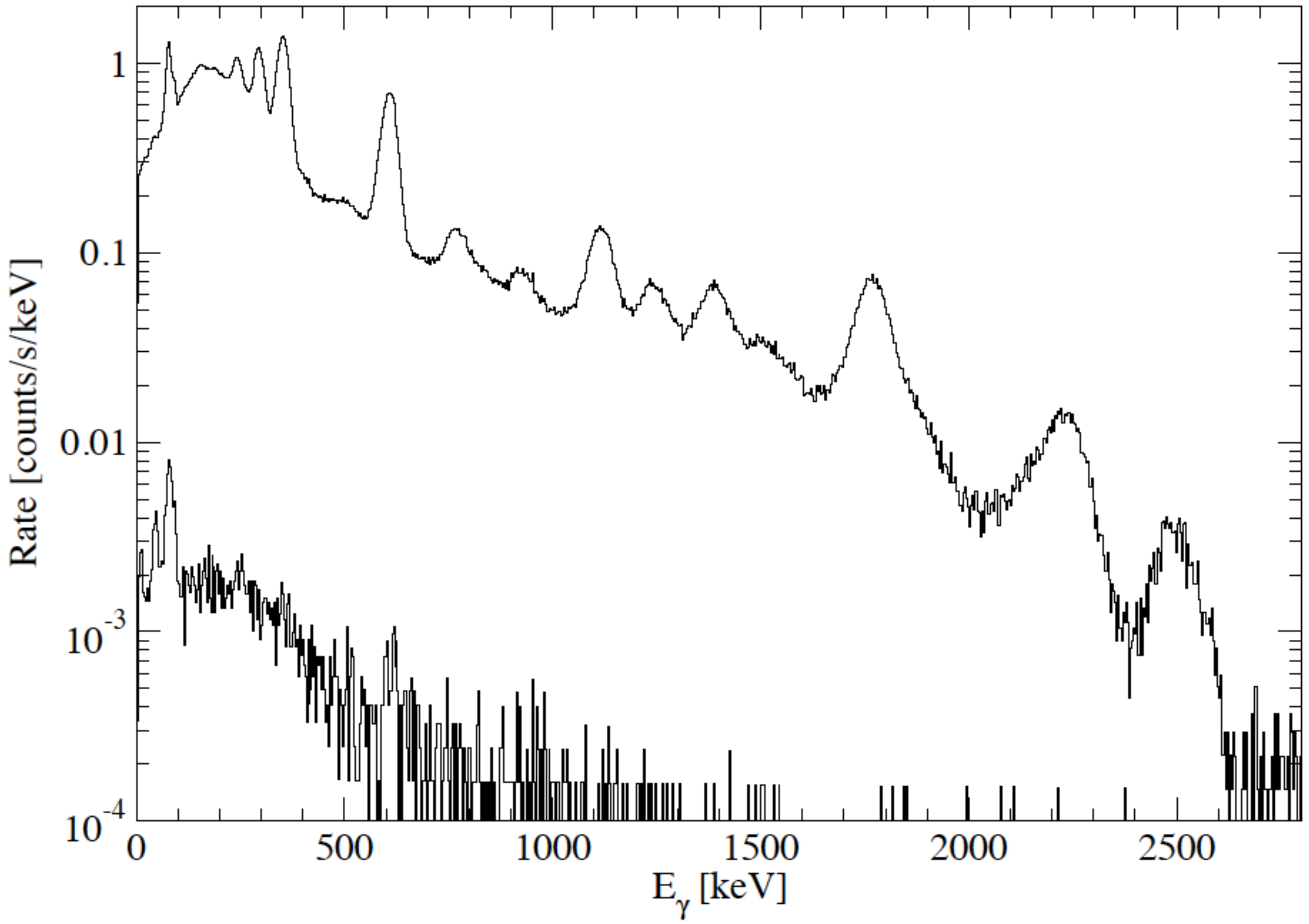


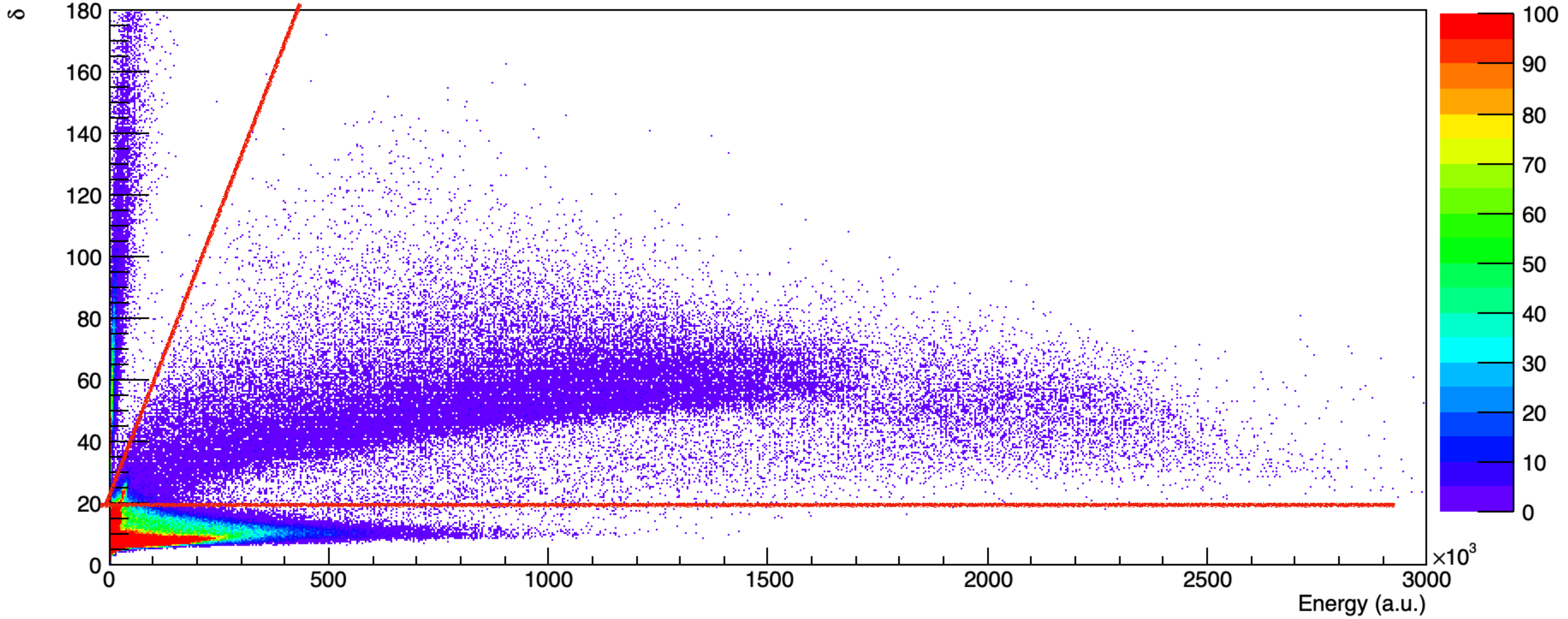
Figure 3: Spectra collected underground before charging the oil with radon (lower graph) and during a radon run (upper graph).

Isotope	Decay type	half-life	Gamma energy [keV]	Relative probability
^{222}Rn	α	3.8 d		
^{218}Po	α	3.1 m		
^{214}Pb	β	26.8 m	242	7%
			295	18%
			352	36%
^{214}Bi	β	19.9 m	609	45%
			768	5%
			934	3%
			1120	15%
			1238	6%
			1378	4%
			1764	15%
			2204	5%
^{214}Po	α	164 μs		
^{210}Pb	β	22.3 y	46.5	4%
^{210}Po	α	138 d		
^{206}Pb				

- Therefore we should expect a increase allso of the low energy part of the spectrum

The Radon Contamination

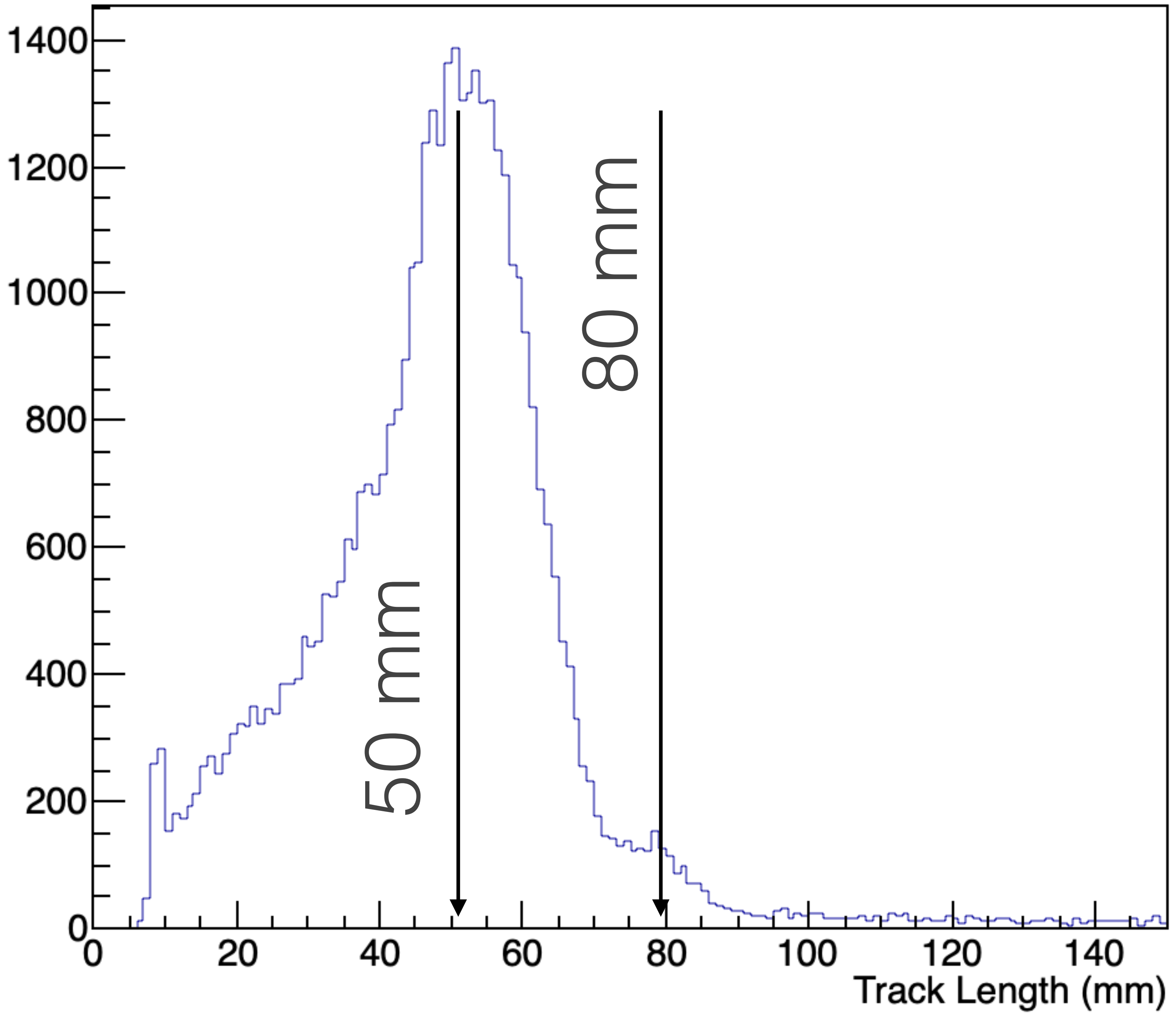
- To select alpha we use their large energy density (δ = sc_integral/sc_nhits) > 25;

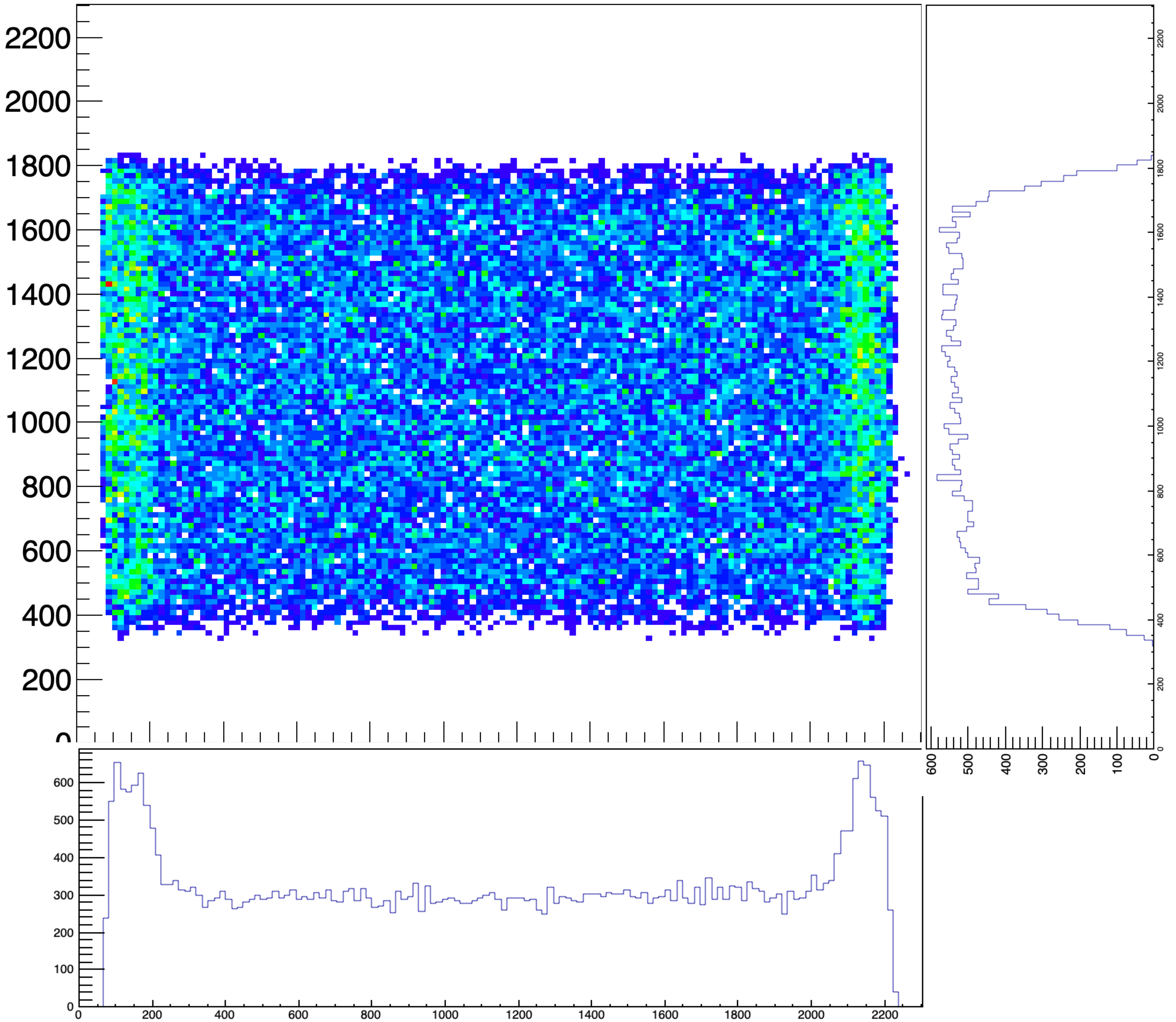


The Radon Contamination

- Mainly on the sides and almost flat in the gas volume

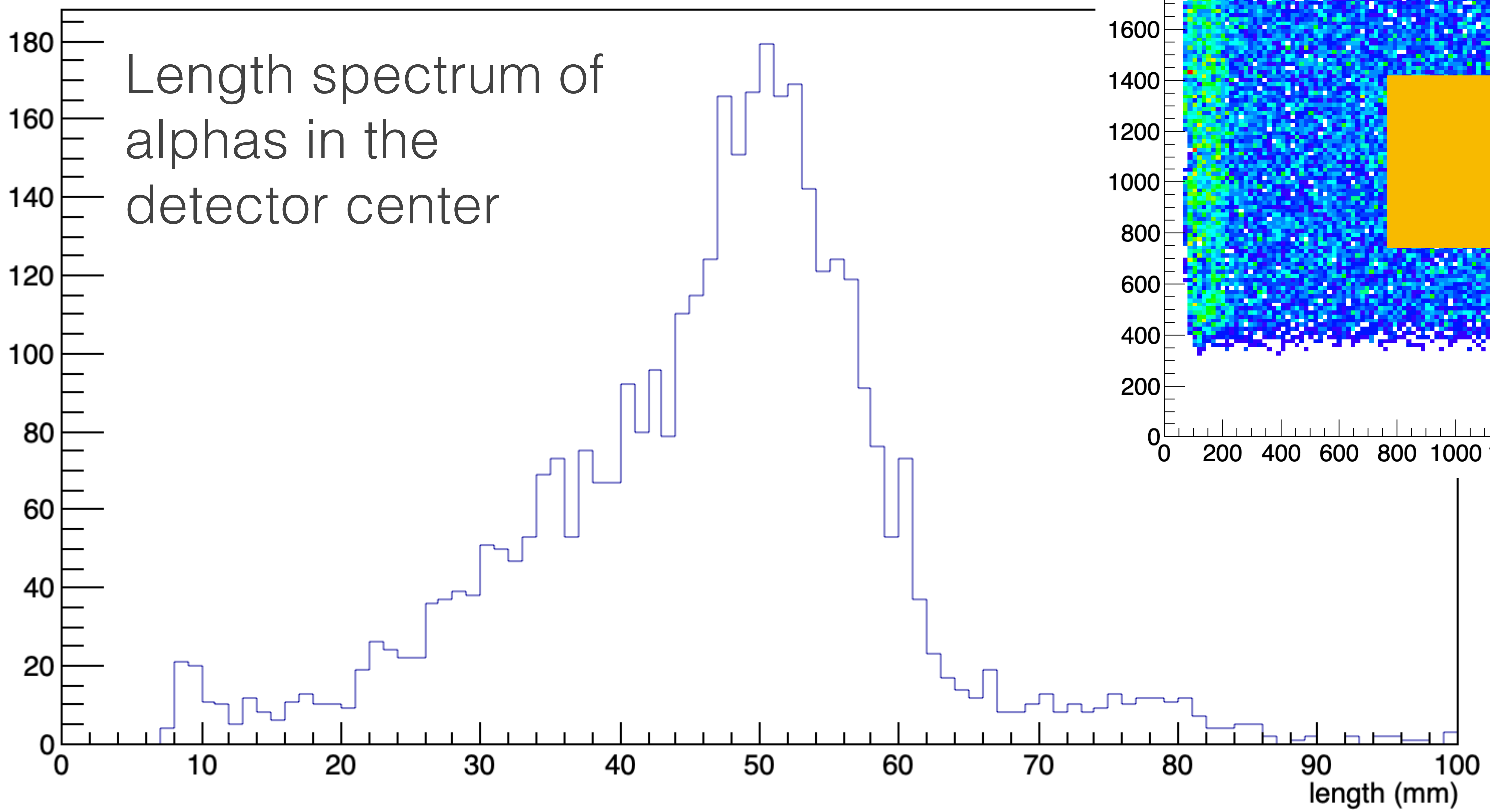
- Length spectrum shows 2 peaks

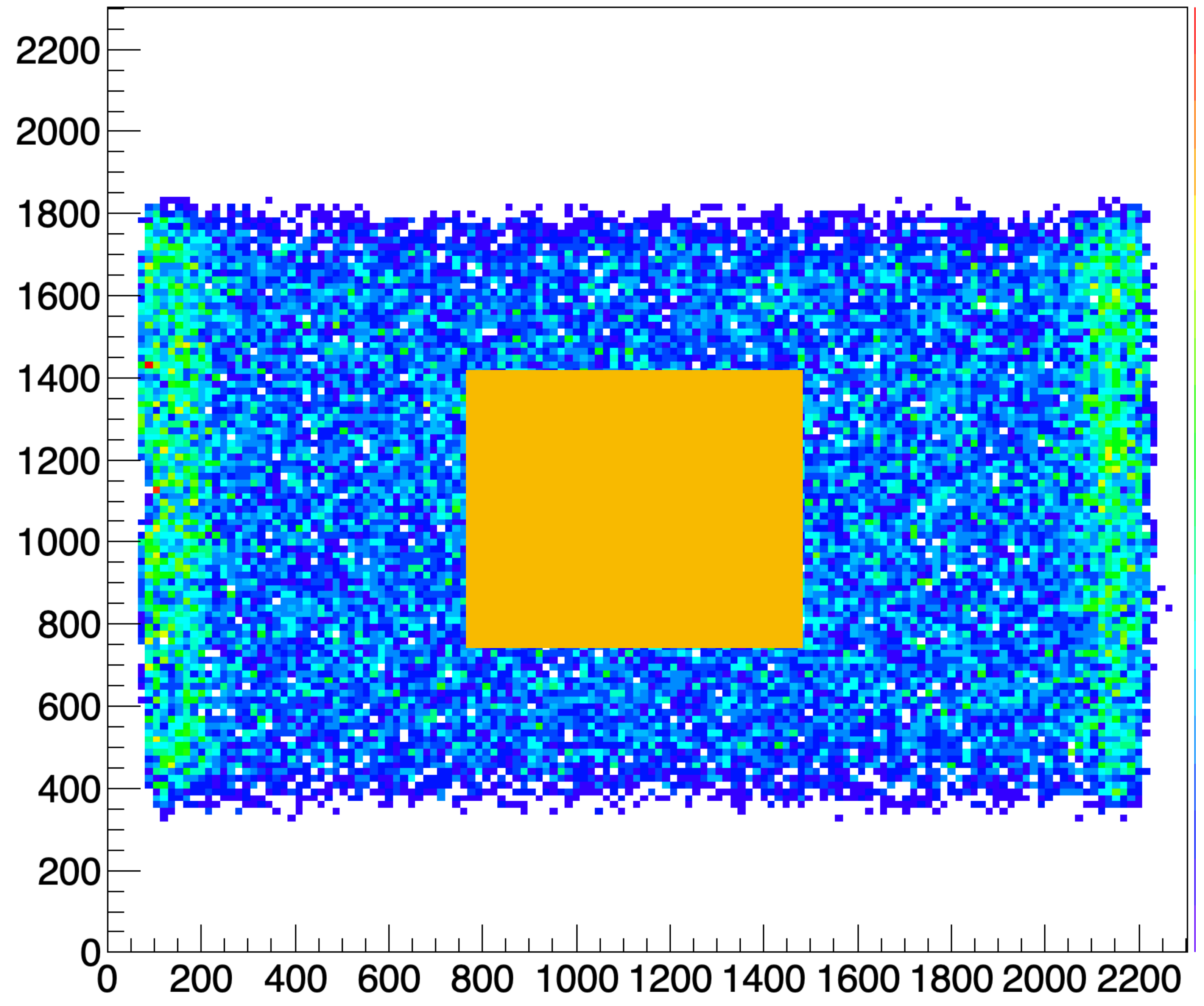




The Radon Contamination

- Length spectrum in the detector center: it seems that the low alpha background is concentrated on the detector side;





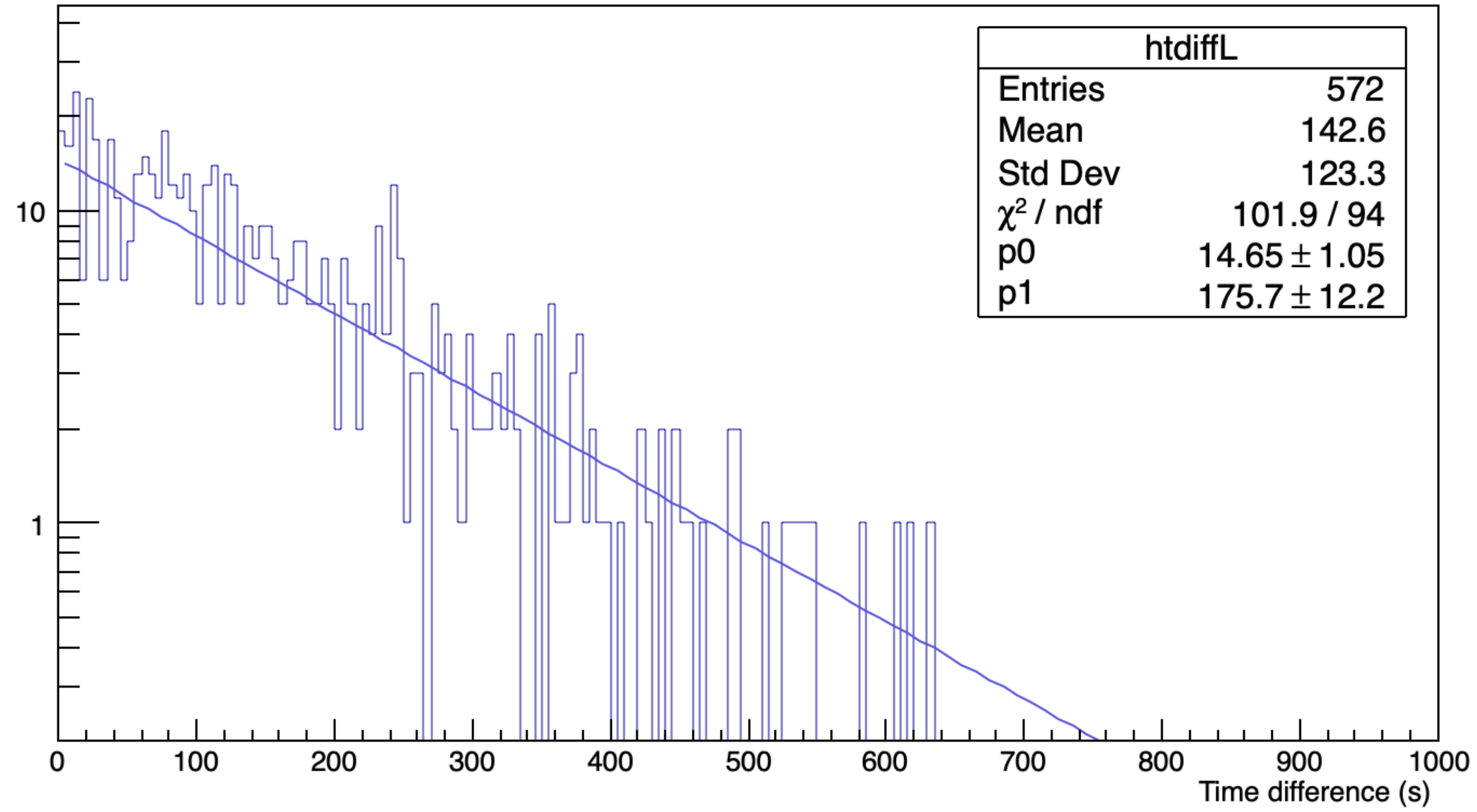
The Radon Contamination

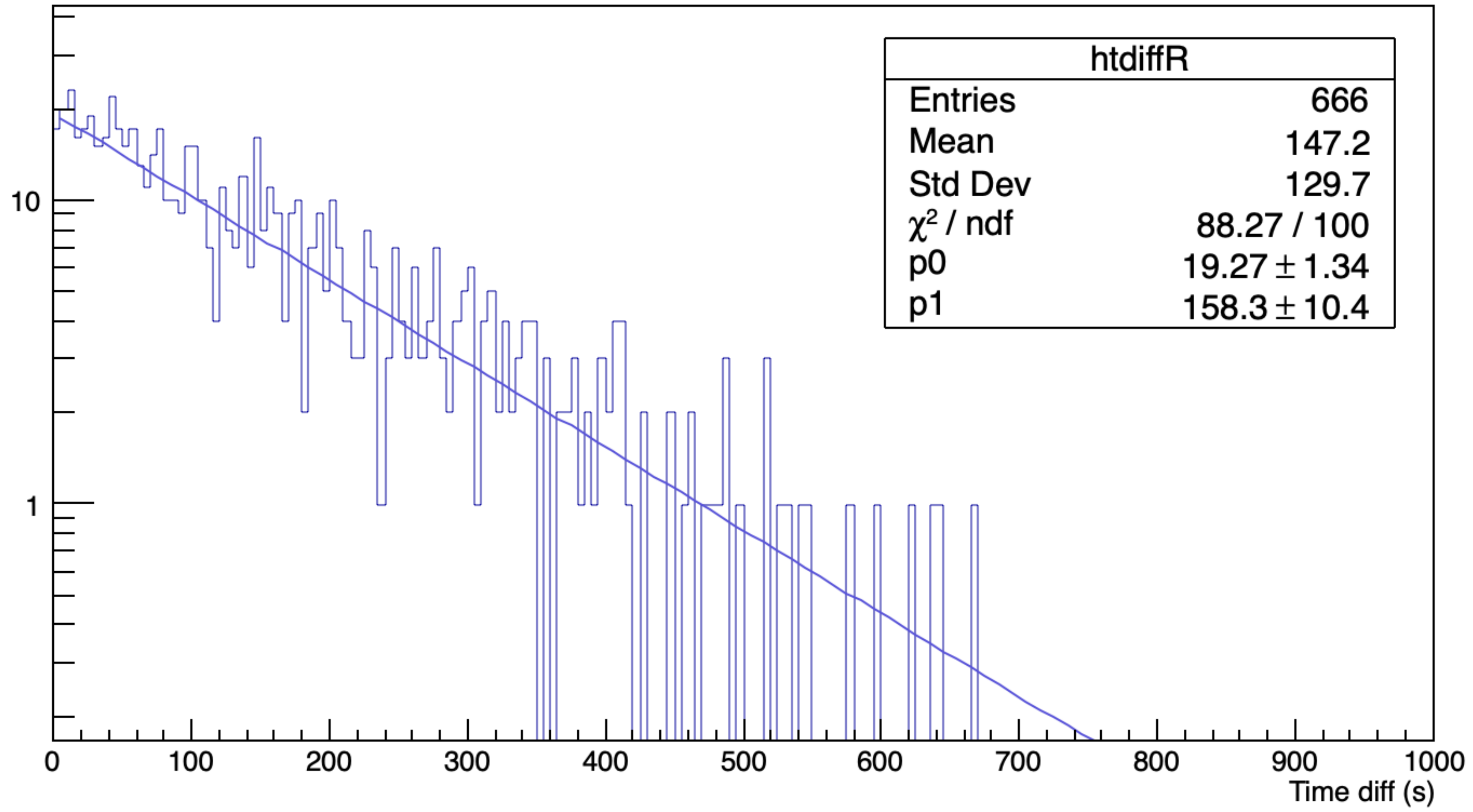
Since we cannot identify the parent ^{222}Rn decaying and its secondary alpha (^{218}Po decay), we are using the method also described in

Background identification in cryogenic calorimeters through $\alpha - \alpha$ delayed coincidences

Given a frequency f of random alphas, their time difference would anyway have an exponential decay with a time constant of 1/f;

If 1/f is very different from the ^{218}Po life-time, the first effect becomes less important



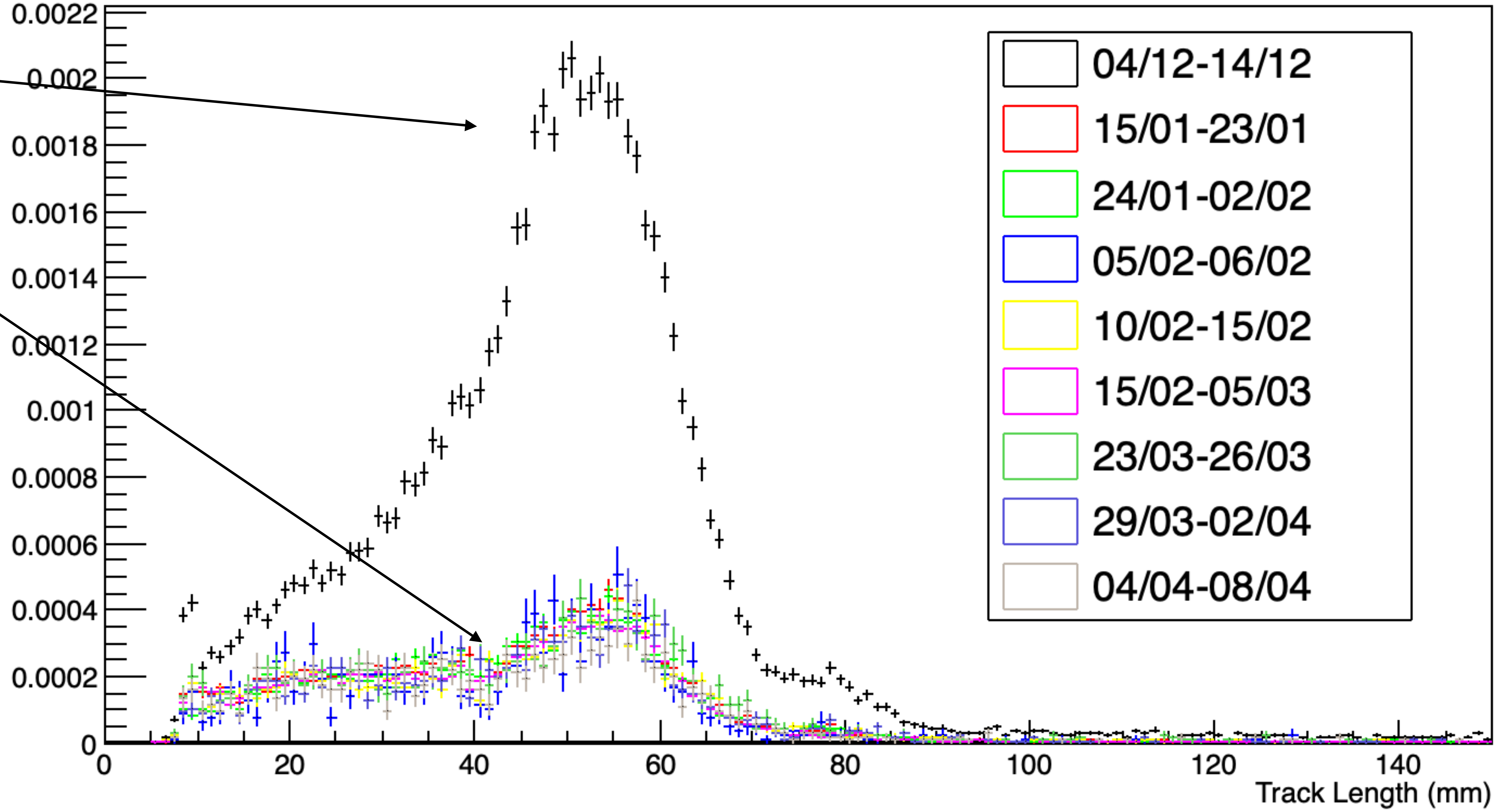


The Radon Contamination

Before the winter break

All after the winter break

A large decrease is visible after the insertion of a complete filter system.



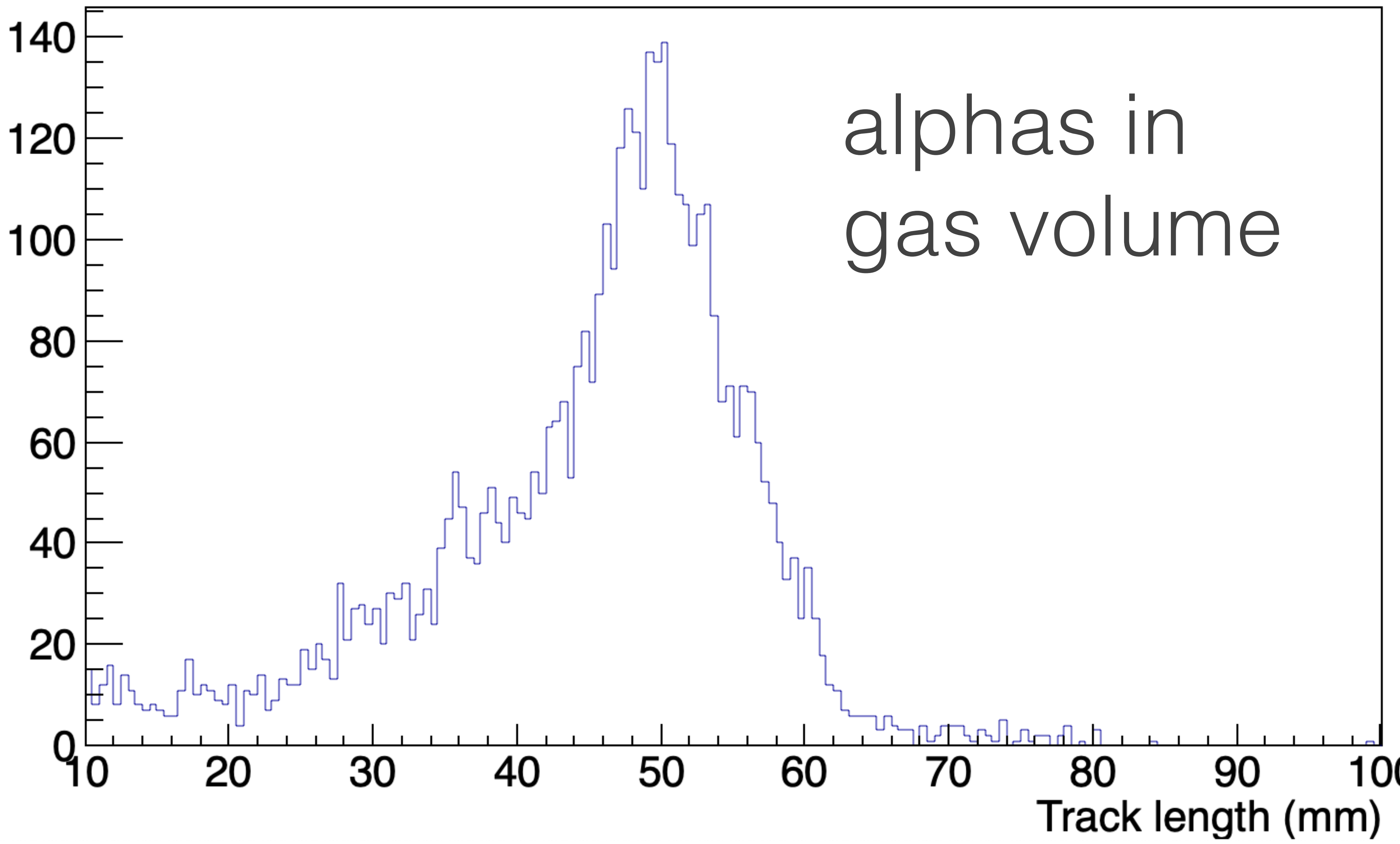
The combined operation of them is properly reducing humidity and also alpha particles

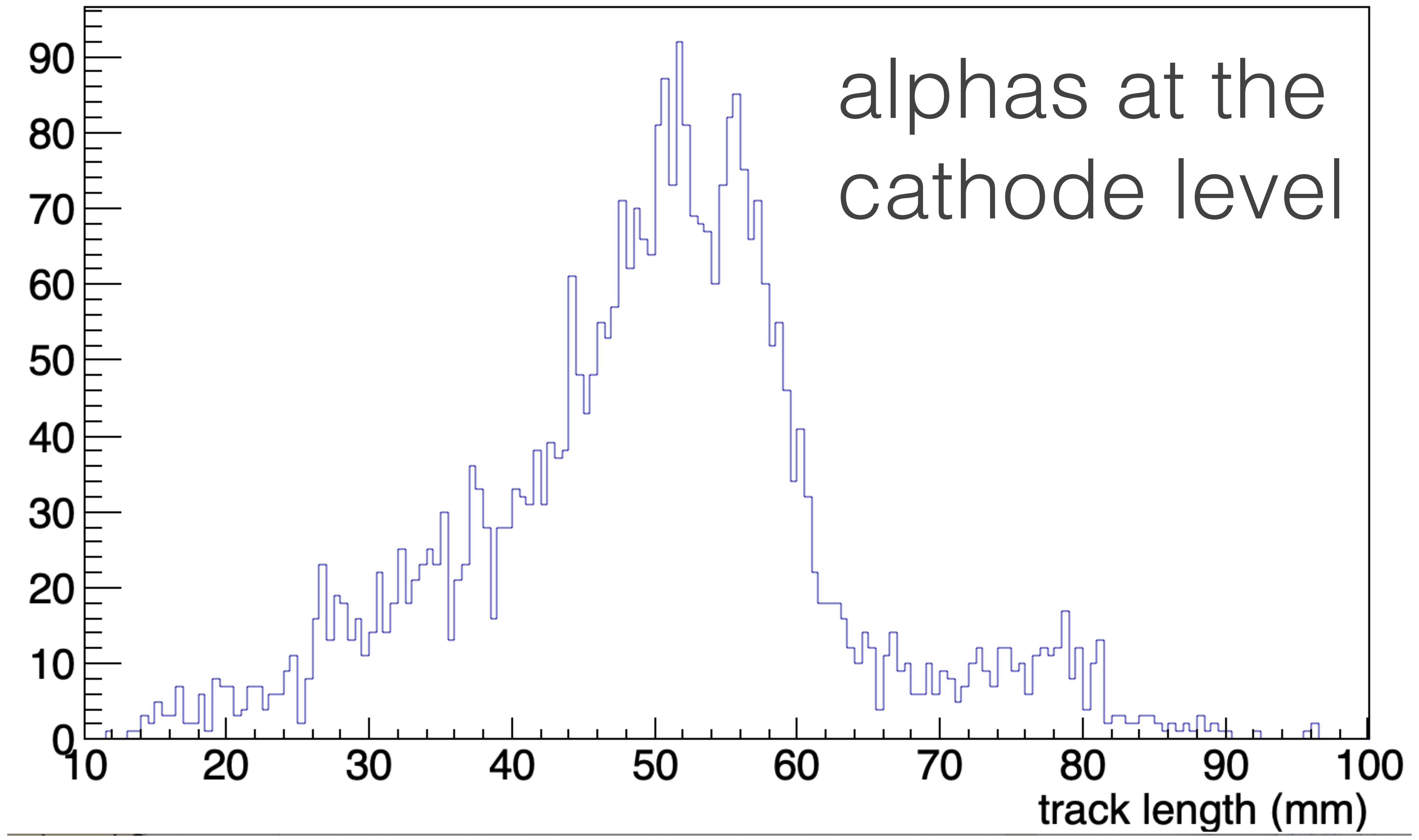
The Radon Contamination

We have shape variables that are a good indicator of the cluster distance from the GEMs

It seems to confirm that the 50 mm component has a large spread in Z while the 80 mm one is concentrated at high Z;

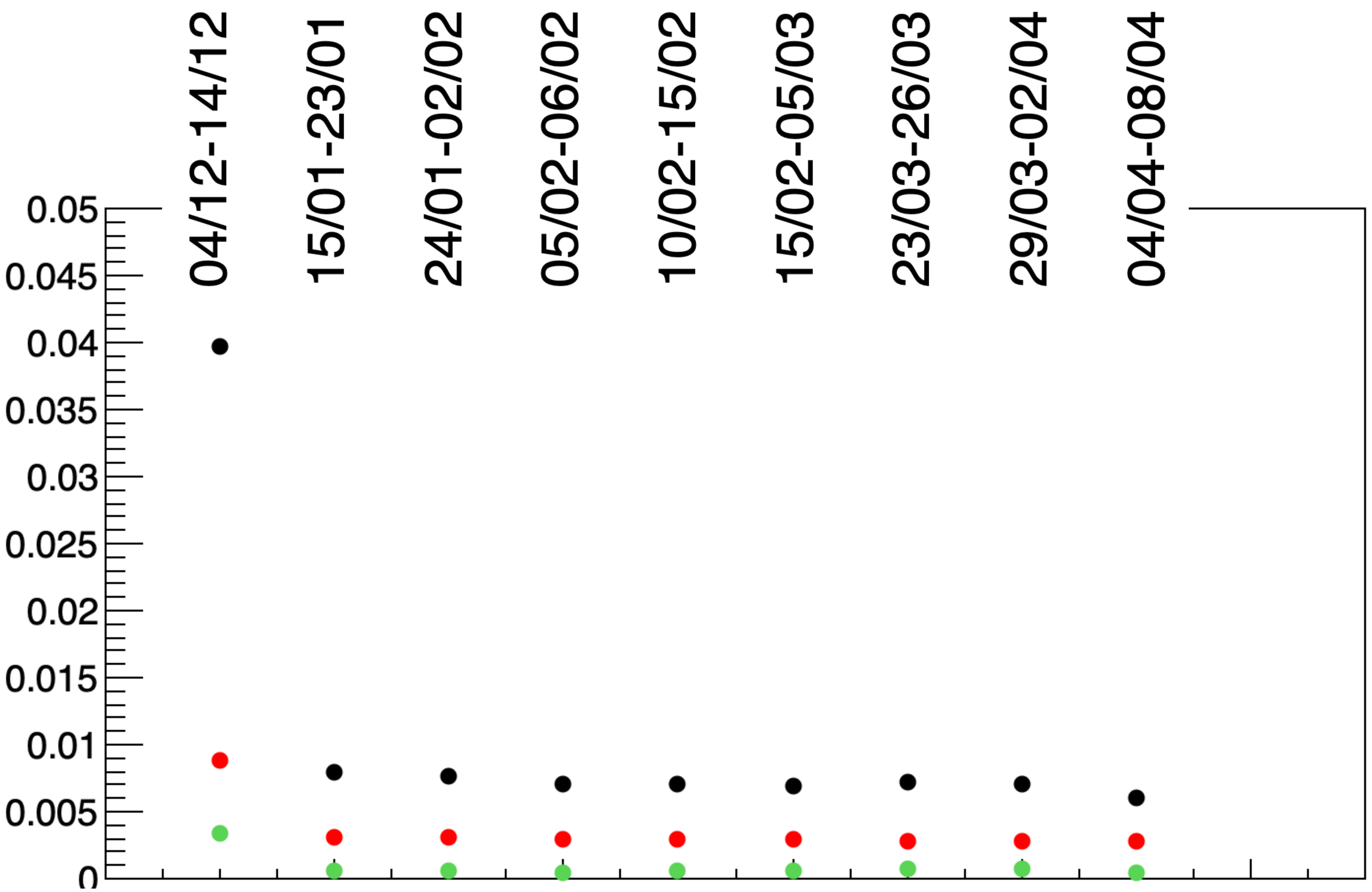
As if it is produced at the cathode level. This is compatible with the production of a positive ion after to beta decays, that do not neutralise and lives enough to reach the cathode

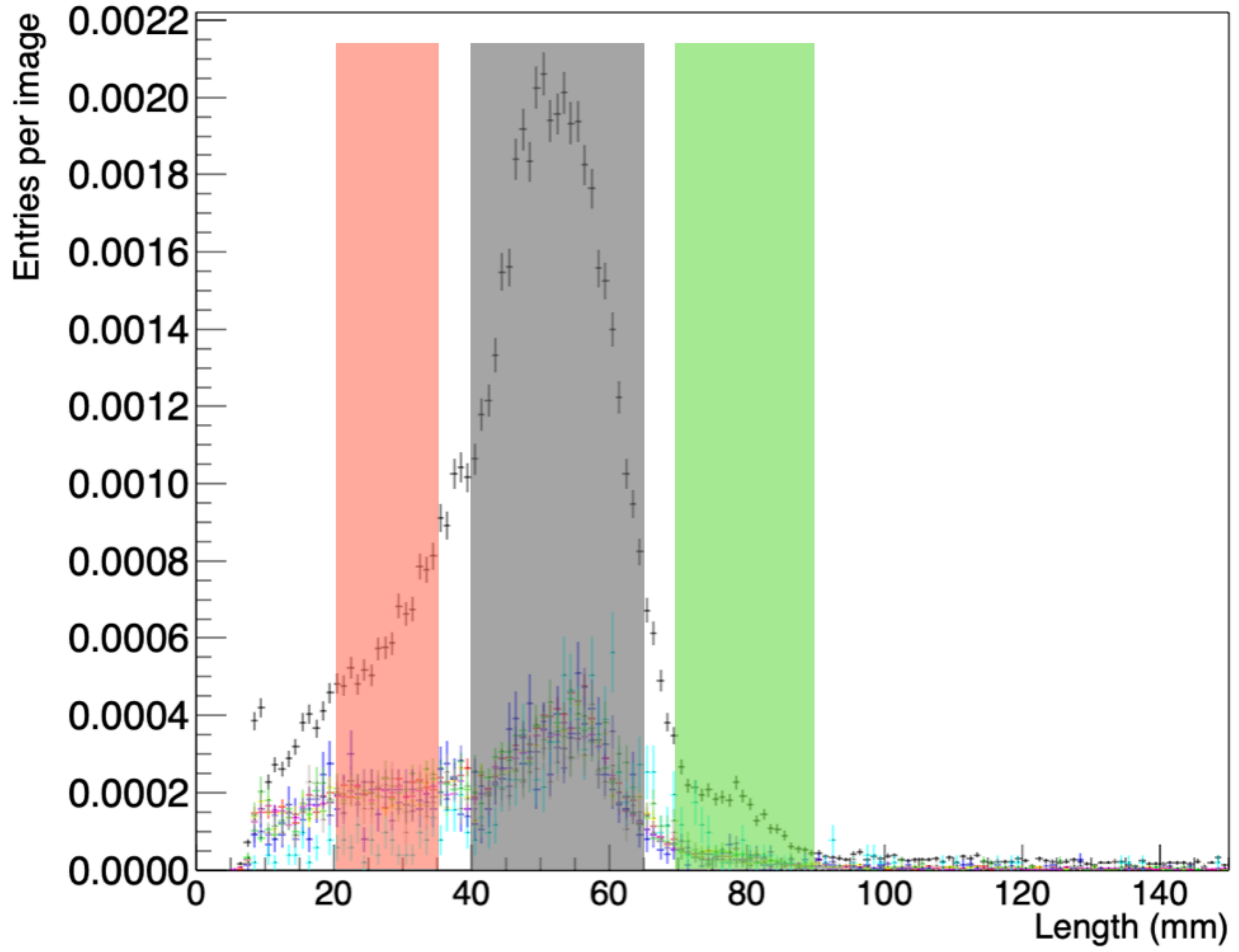


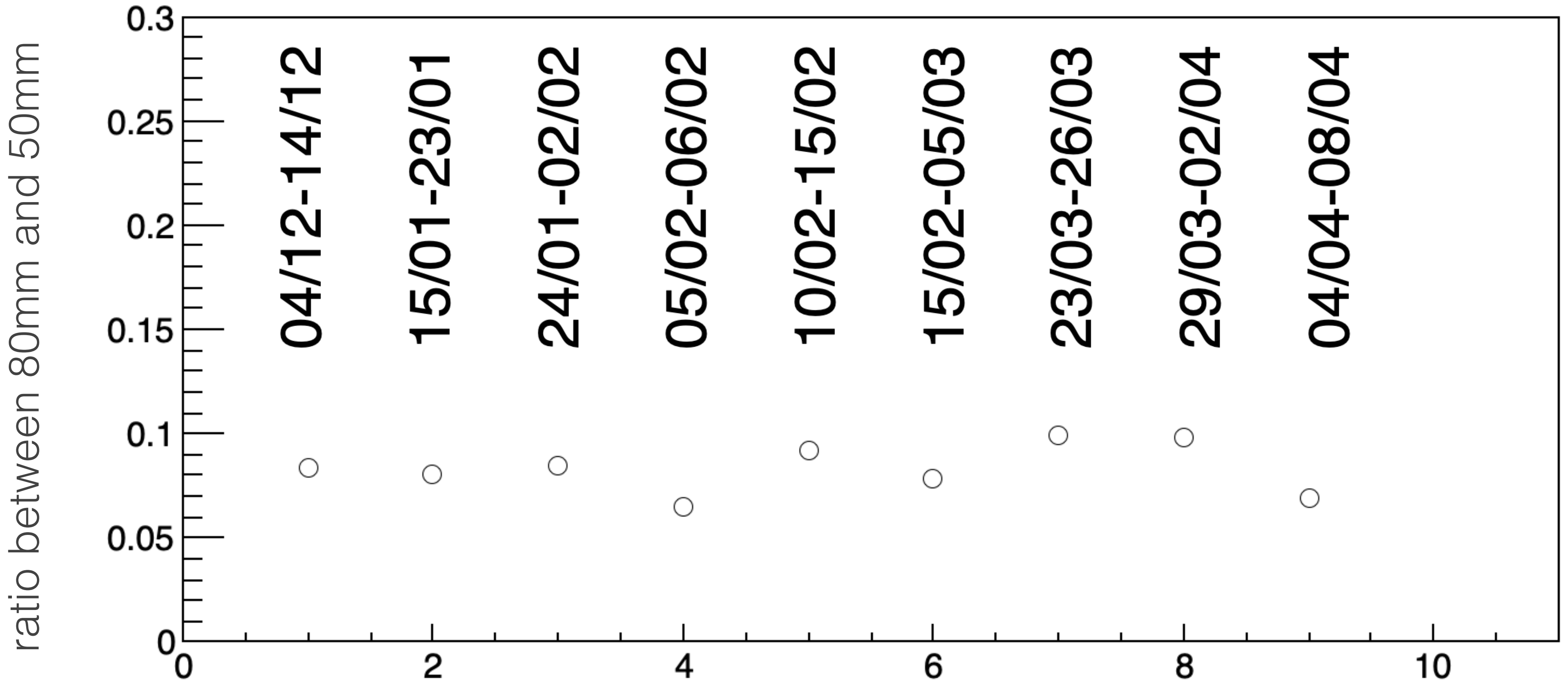


The Radon Contamination

We can estimate the amount of each component and its behavior in the different periods

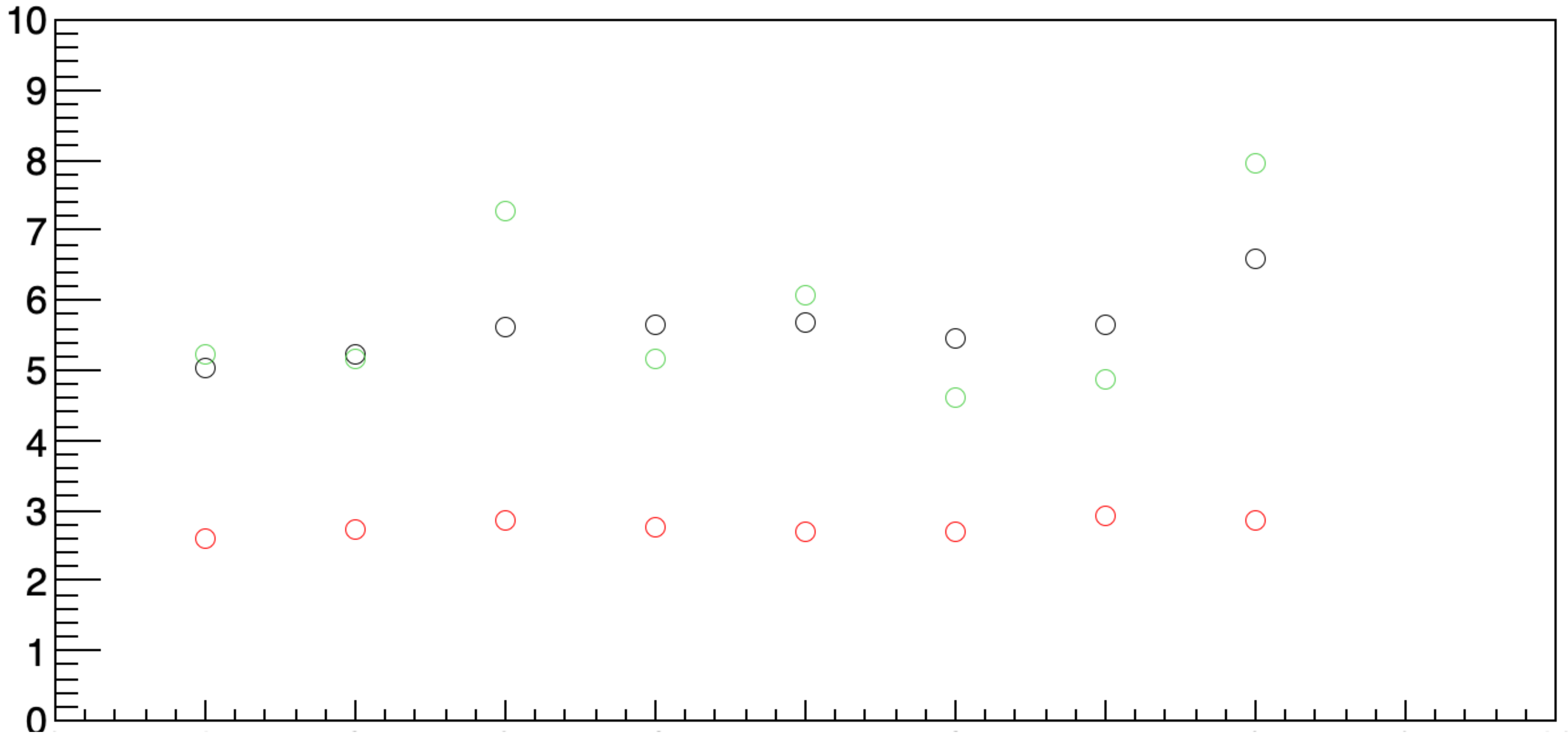


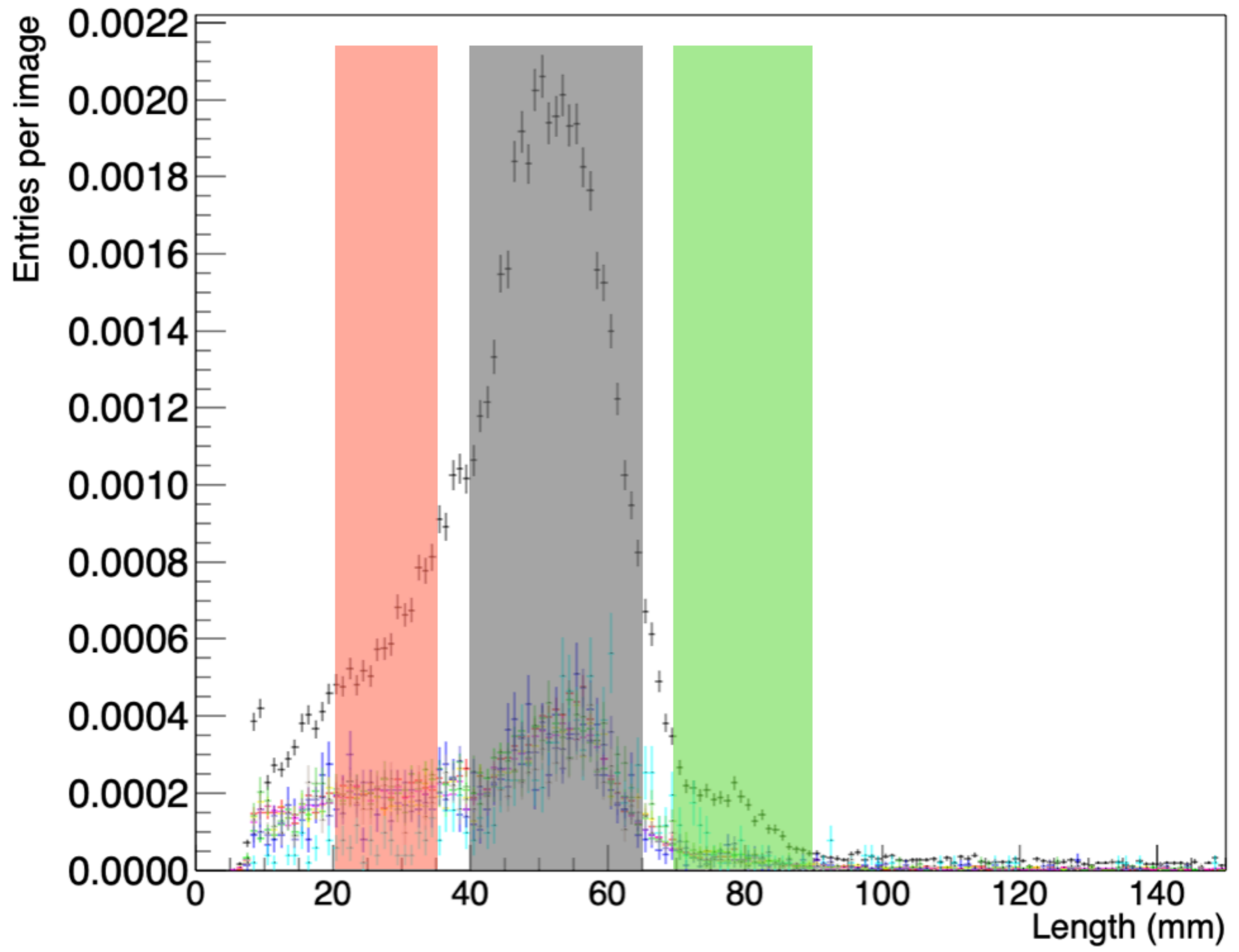




The ratio between 80mm and 50mm is quite stable in all periods around 10%

The Radon Contamination



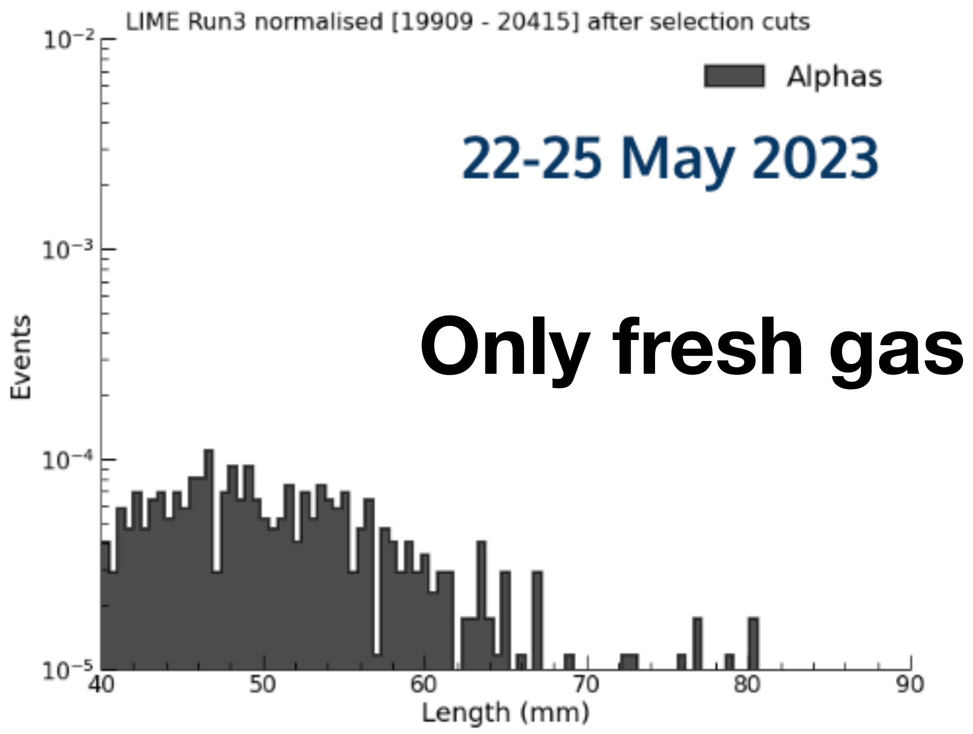


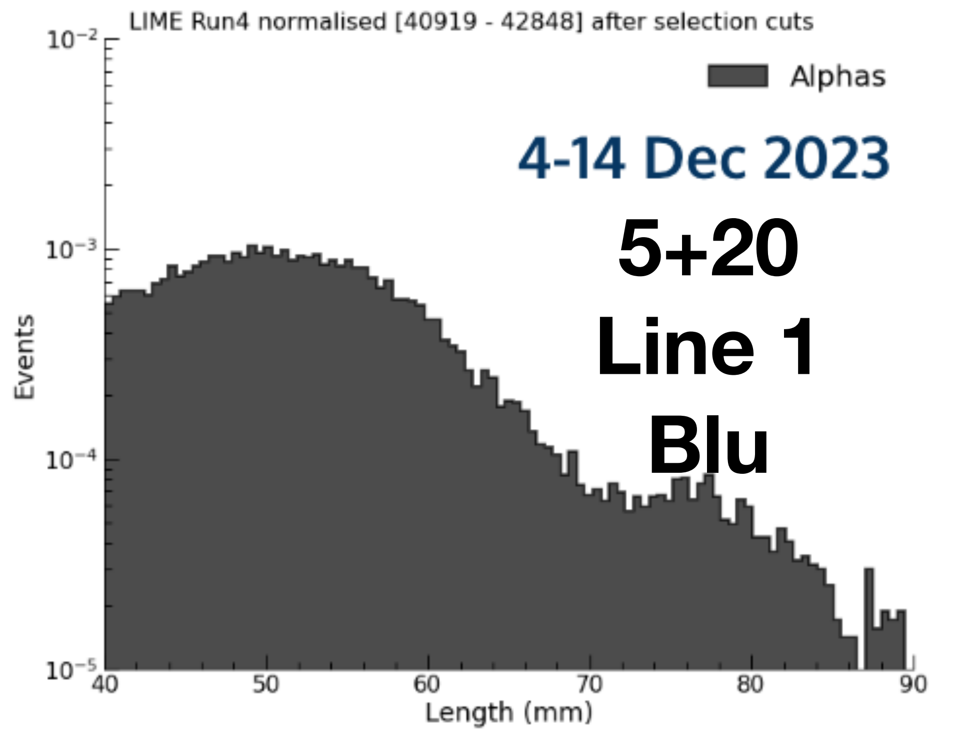
The low energy component has decreased by a factor 2.5 while the other ones by a factor 5, after the filter introduction

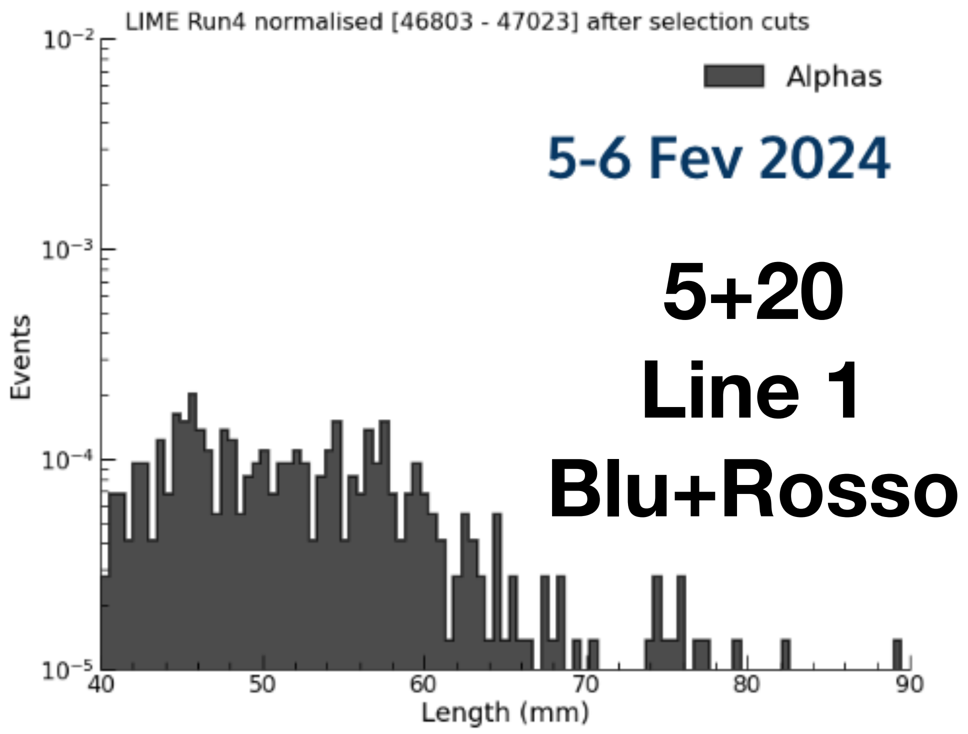
The Radon Contamination

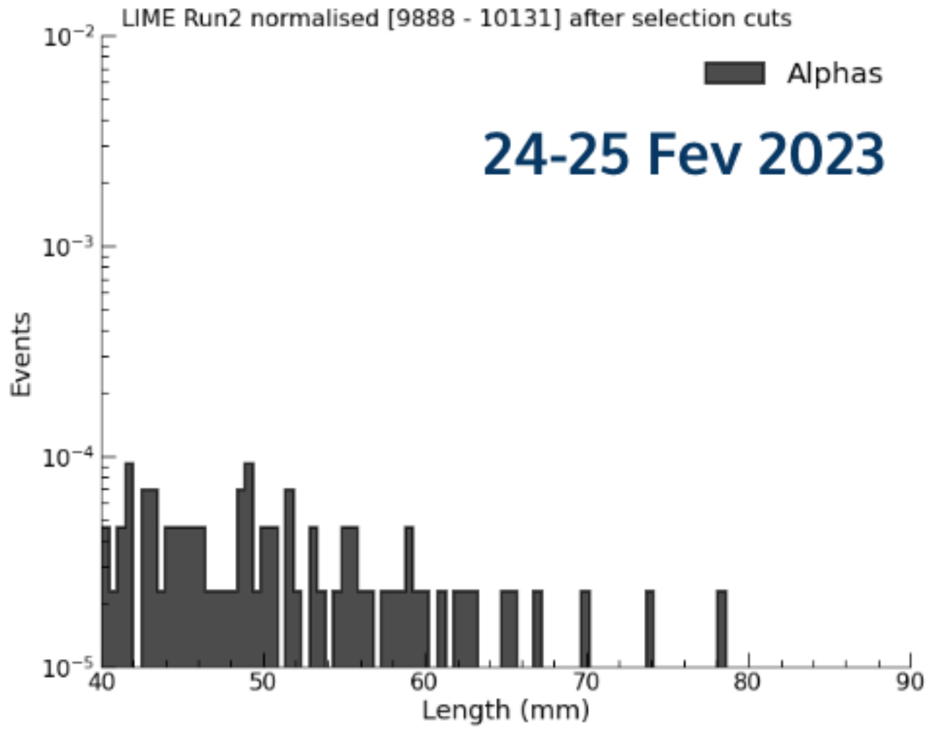
40 to 90mm region

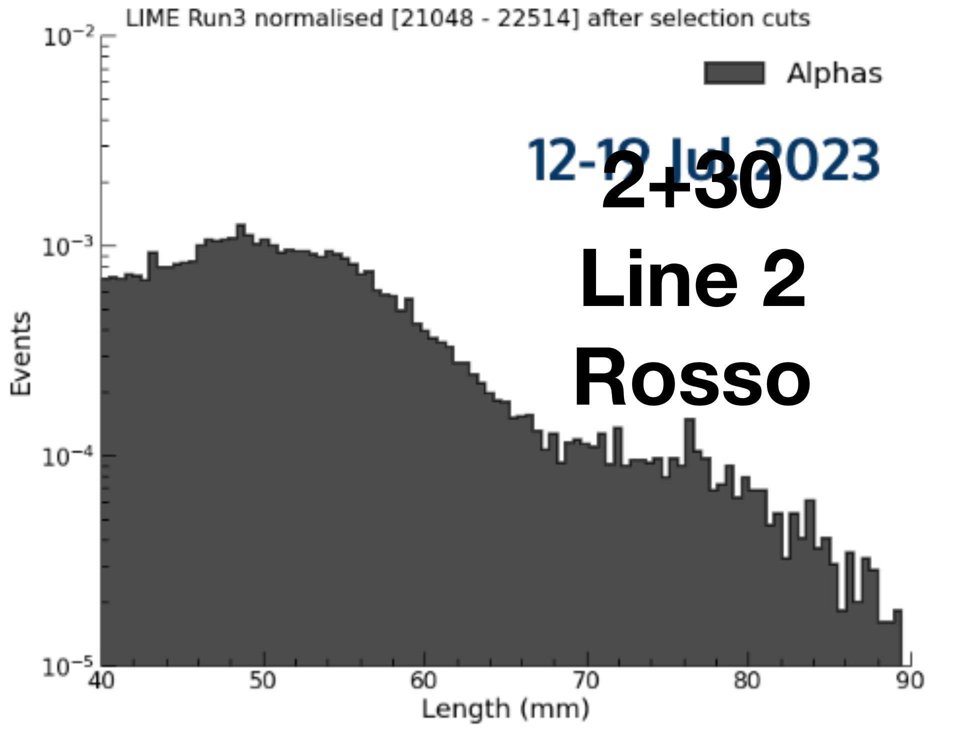
conversion to mm:
sc_lenght*0.15

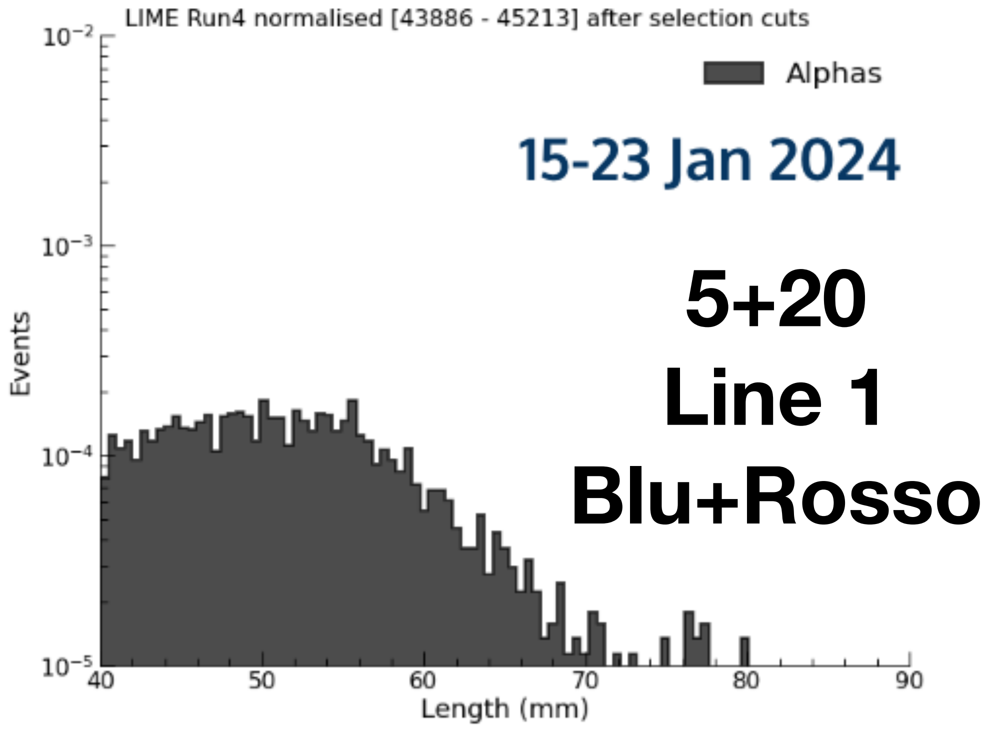


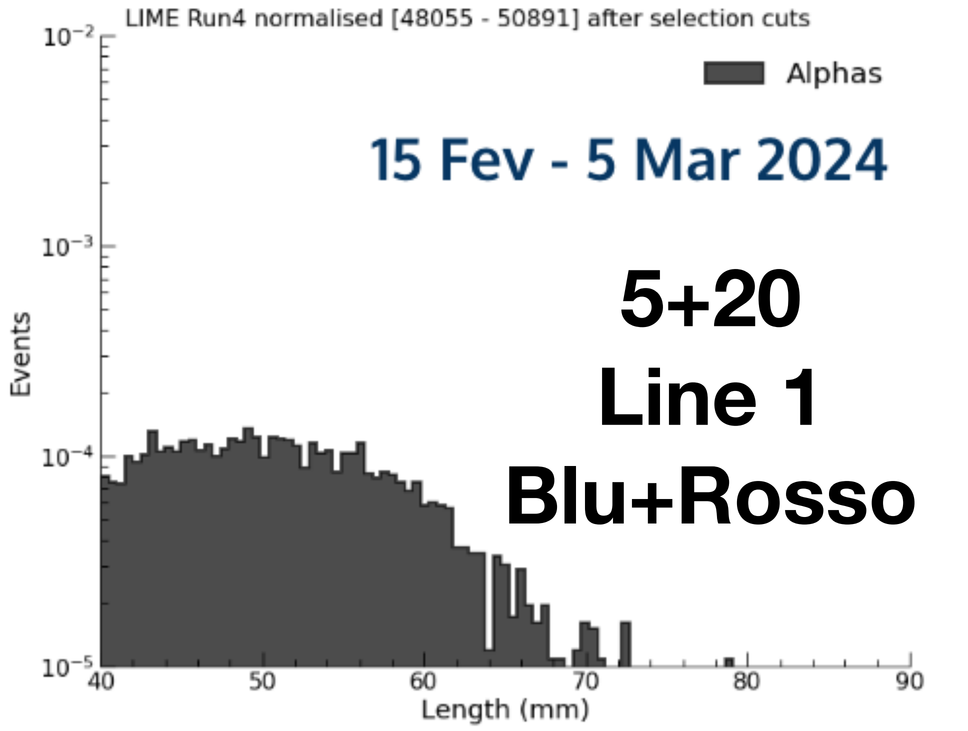


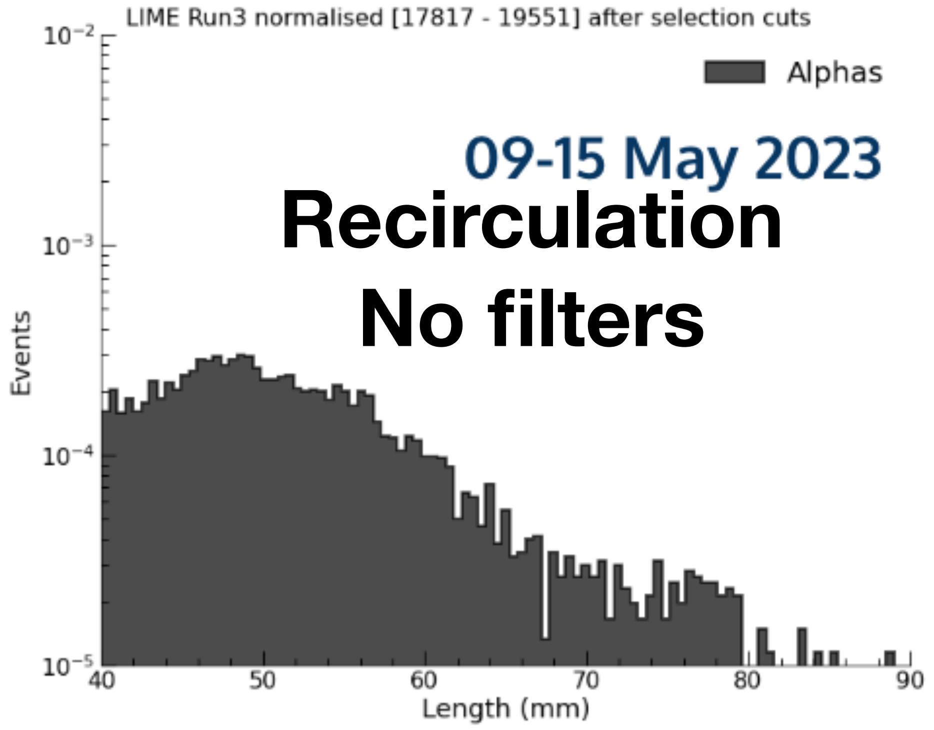


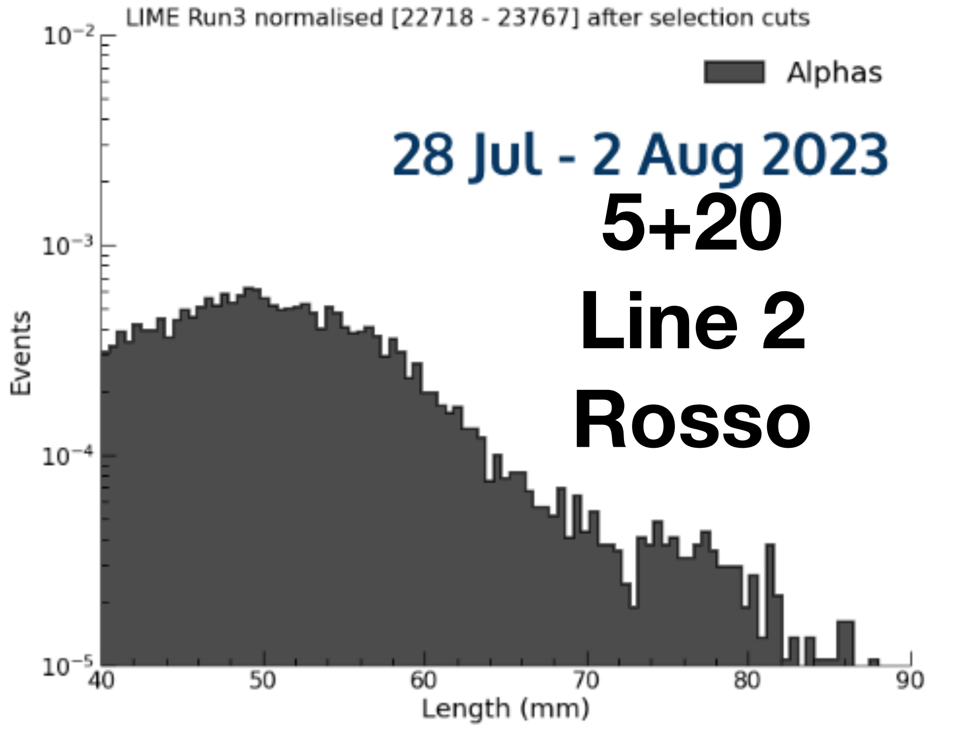


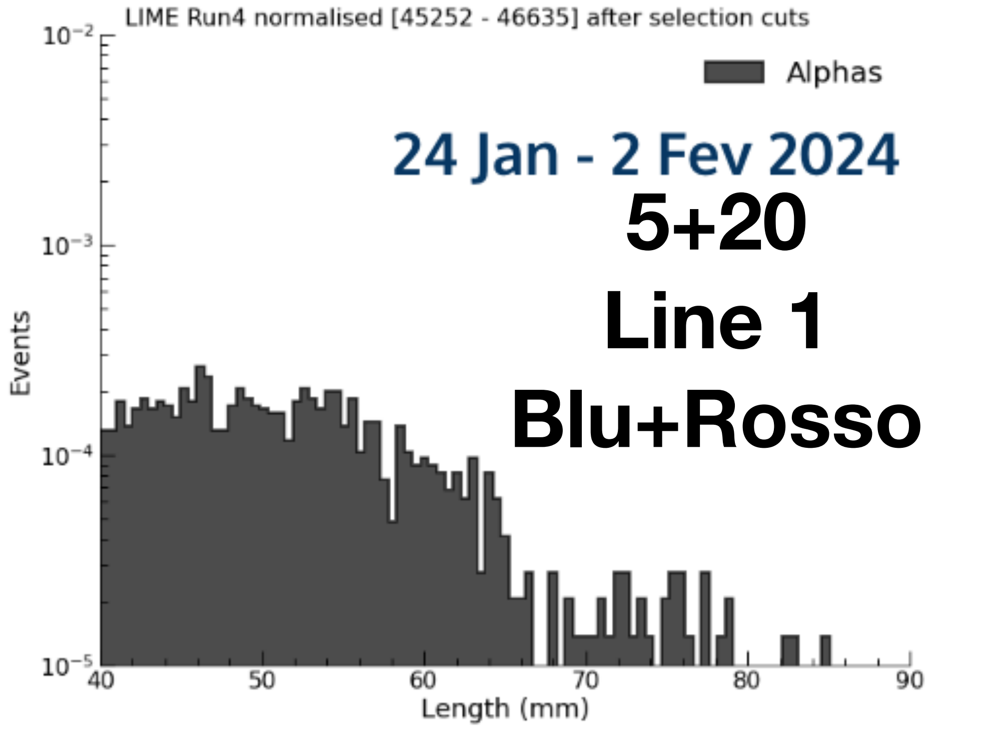


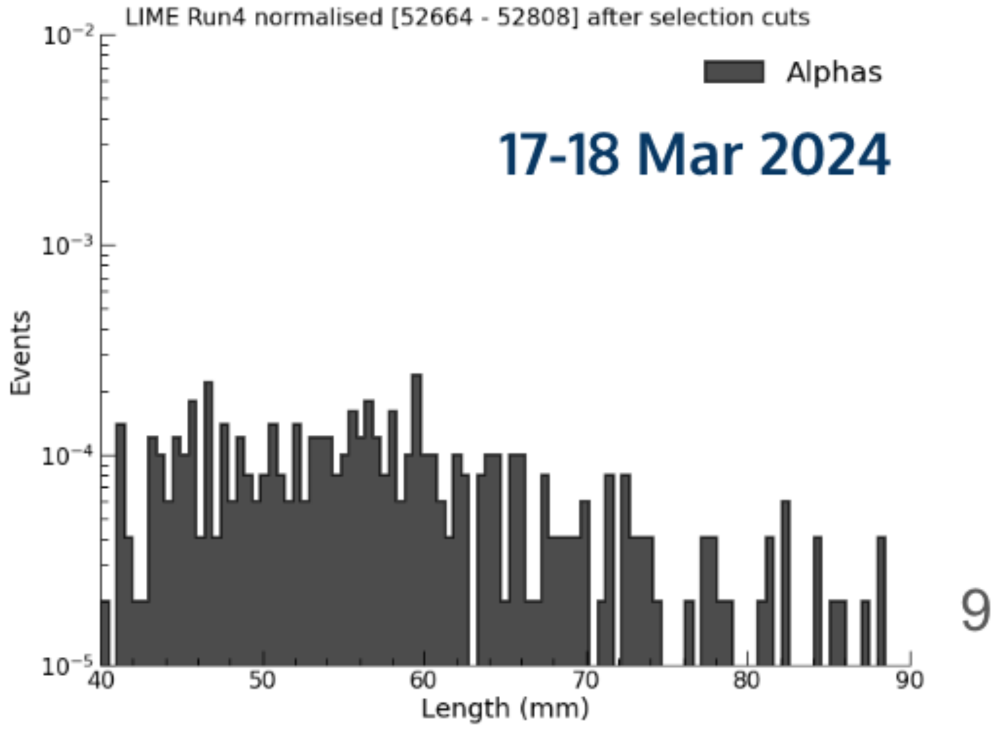




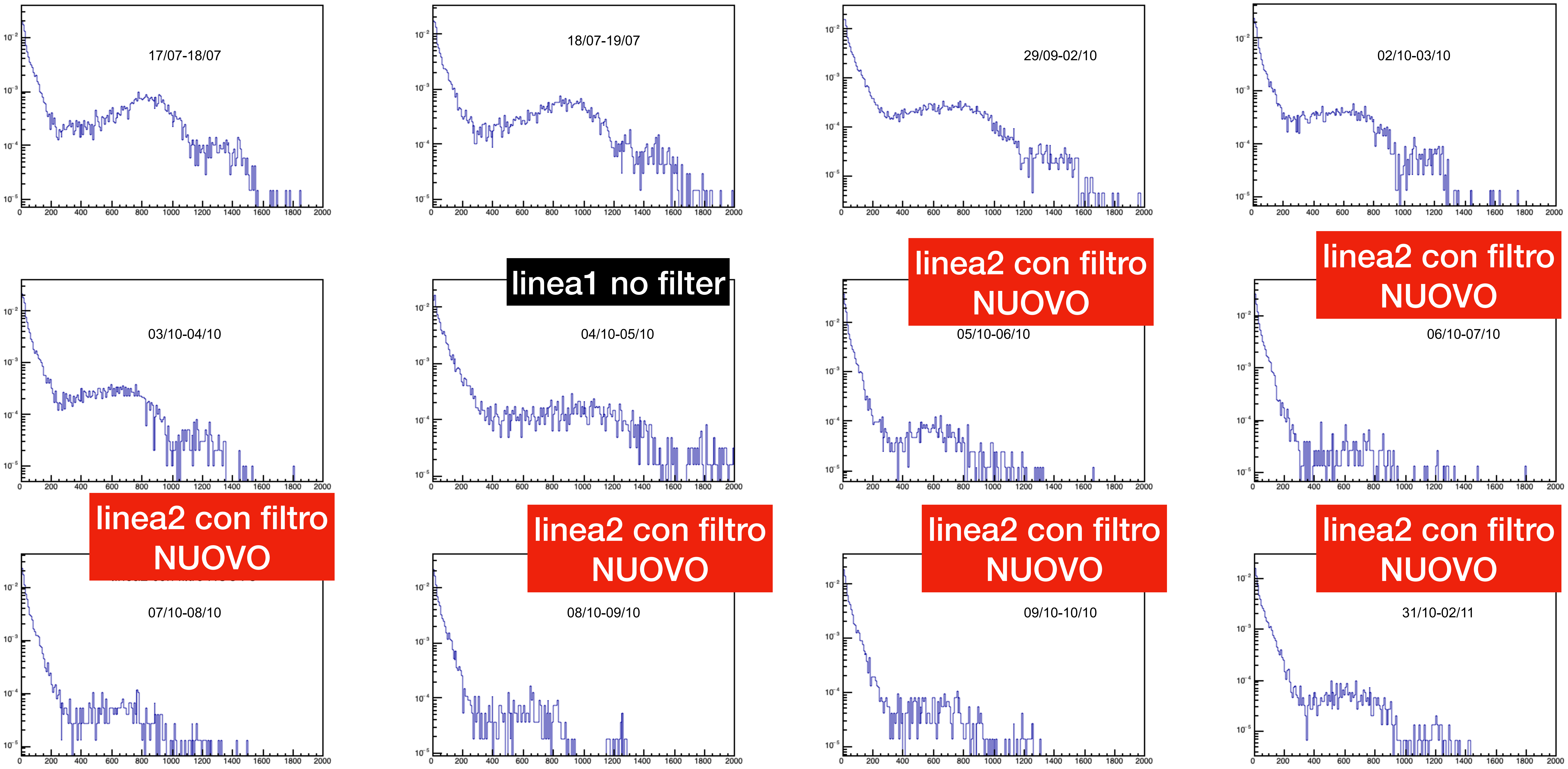








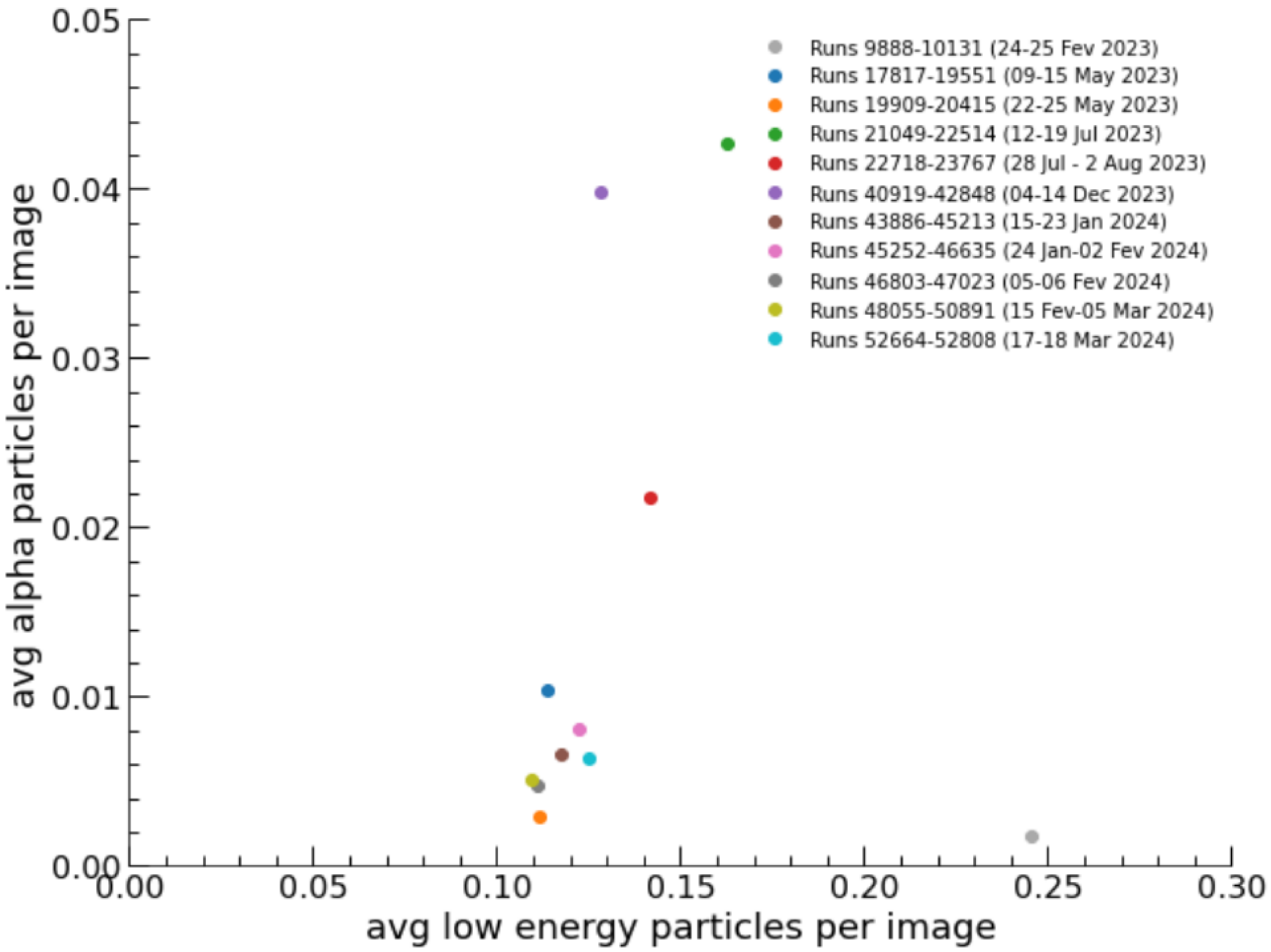
The Radon Contamination



The Radon Contamination

A correlation between the rate of alphas and the rate of low energy background was found both in RUN3 and RUN4;

The radon contamination was not simulated in our MC;



Next steps and conclusion

An alpha particle component attributable to the radon decay chain is visible in LIME:

- lengths compatible with the expected ones from ^{222}Rn, ^{218}Po and ^{214}Po;
- longer lifetime for the ^{214}Po, able to drift and decay at the cathode level;

Positive effect of the gas filters in reducing this component;

The large amount of gammas produced by the Rn decay chain can be responsible of an increase in the low energy part of the spectrum;

We are evaluating the possibility of including it in the MC and use to measurements to evaluate its concentration