EPDM Report

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March 2018

Radon Purge of Shielding

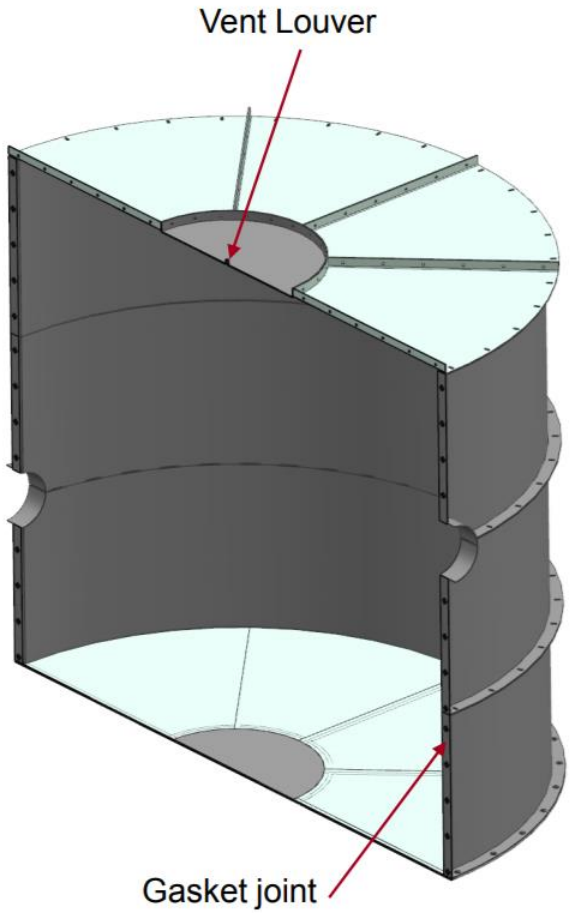
Need to reduce radon concentration in air gaps within shielding to <1 Bq/m^3 to limit detector-bulk ER background from prompt radon daughter decays.
Want gasket to produce less than 1/10th our limit.

The total length of the gasket material will be
4 x height + 4 x circumference =
4 * 2966 mm + 4* pi * 3278 mm = 53 m

The gas volume of the radon shield is estimated as 200 ft^3 = 5.7 m^3.

To produce <0.1 Bq/m^3 in the 5.7 m^3 for 5 slpm purge flow (which reduces radon in volume by factor 8x), the gasket must emanate < 0.1 * 8 * 5.7 Bq = 4.5 Bq.

Enclose lead shield in hermetic metal enclosure with flanges around stem penetrations & input continuous flow of boil-off liquid-nitrogen gas
(50–500 µBq/m^3 radon activity)



Sample

EPDM before being placed in small emanation chamber. Held together by a zip tie with a very low emanation rate.

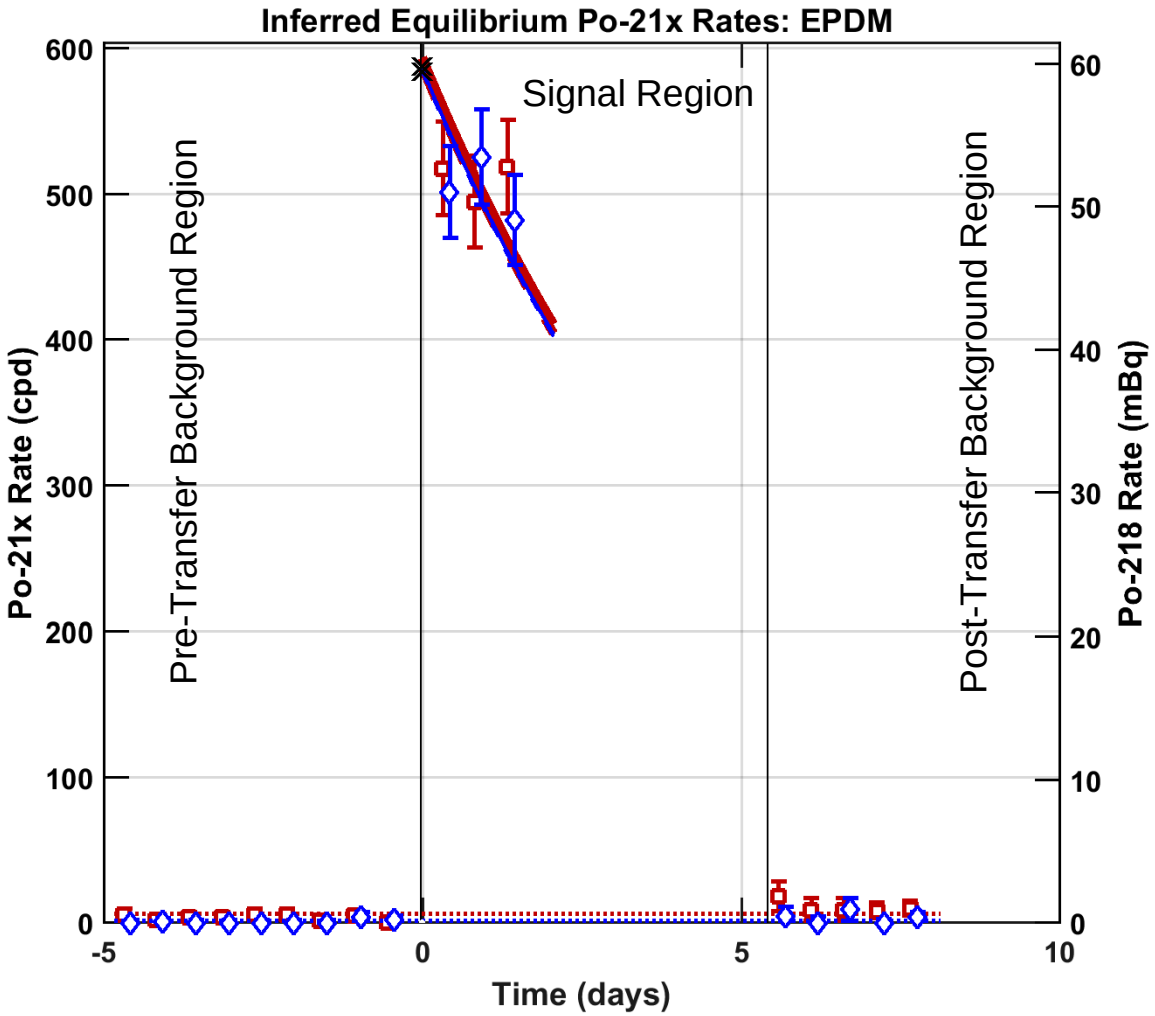
5 mm x 8 mm cross section, 38 ± 3 in. long.

EPDM after being placed in small emanation chamber.

Overview

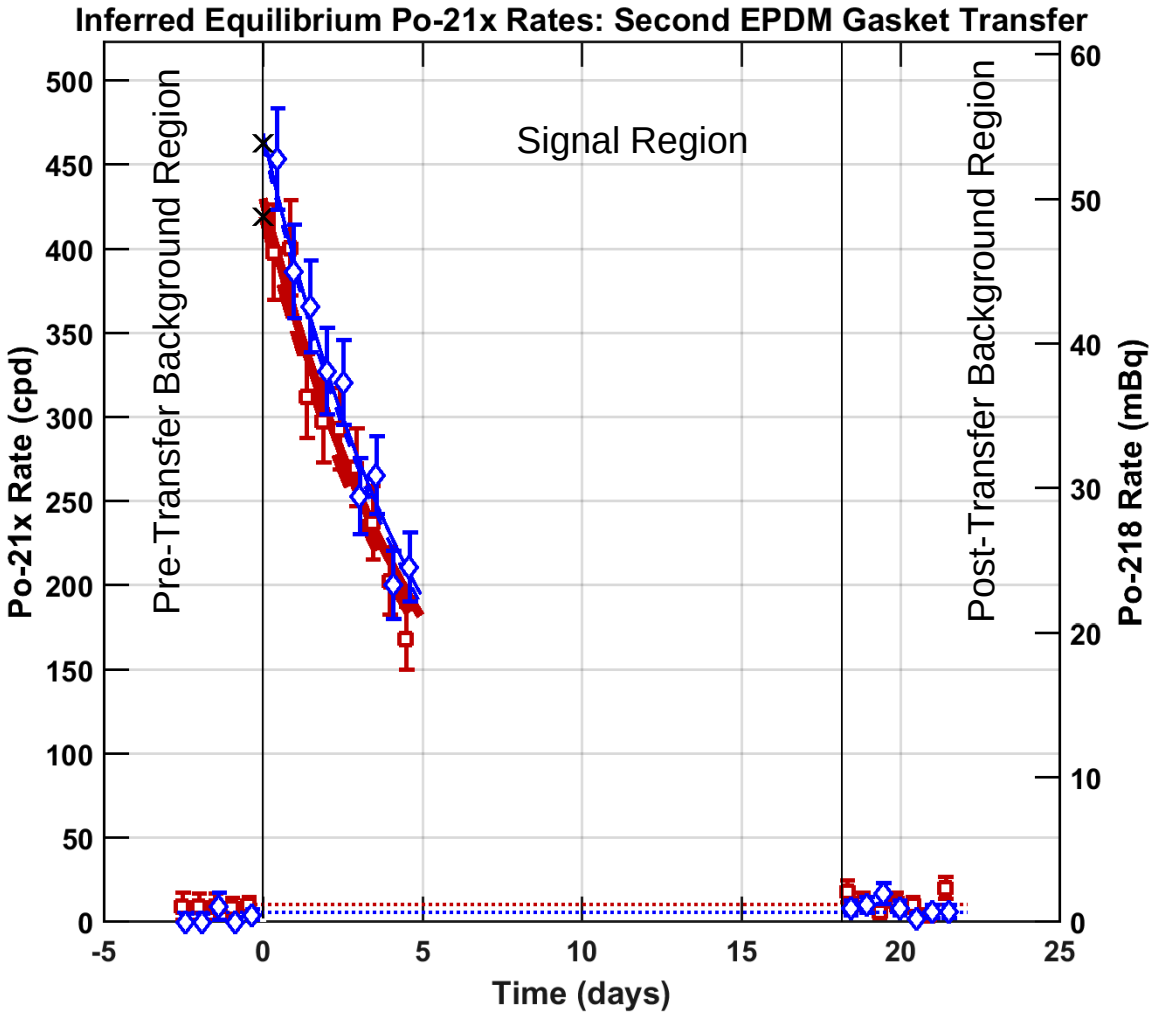
- Emanated the EPDM 2 times in January to February 2018.
  - First transfer was measured for a shorter time than usual, because, due to its high rate, uncertainties were already very low compared to the central value.
- Gain corrections based off of Po-214 peak for the sample runs, since the Po-218 peak overlapped the Po-210 peak.
- 1 gasket 38 ± 3 inches long was emanated.
- Measurements indicated an emanation rate of **52 ± 5 mBq/m.**
  - This is consistent with Butyl, which emanated at about 50 mBq/m.
  - This rate is acceptable for purge flows >2.5 slpm, which are planned.
  - This is higher than a previous measurement of different EPDM, which emanated at a rate of at 6.2 ± 0.8 mBq/m.

First Emanation (Jan. 24 – 31)



- Emanated at 101 Torr. This is high enough to include recoil emanation from the chamber and sample.
- Only Po-214 count is reliable as the Po-218 peak has a large overlap with the Po-210 peak.
- Po-214 count indicates a rate of $\mathbf{55.16^{+2.81}_{-2.71}}$ **mBq.**
- **The sample was probably still degassing room air so this measurement is not used in the conclusions.**

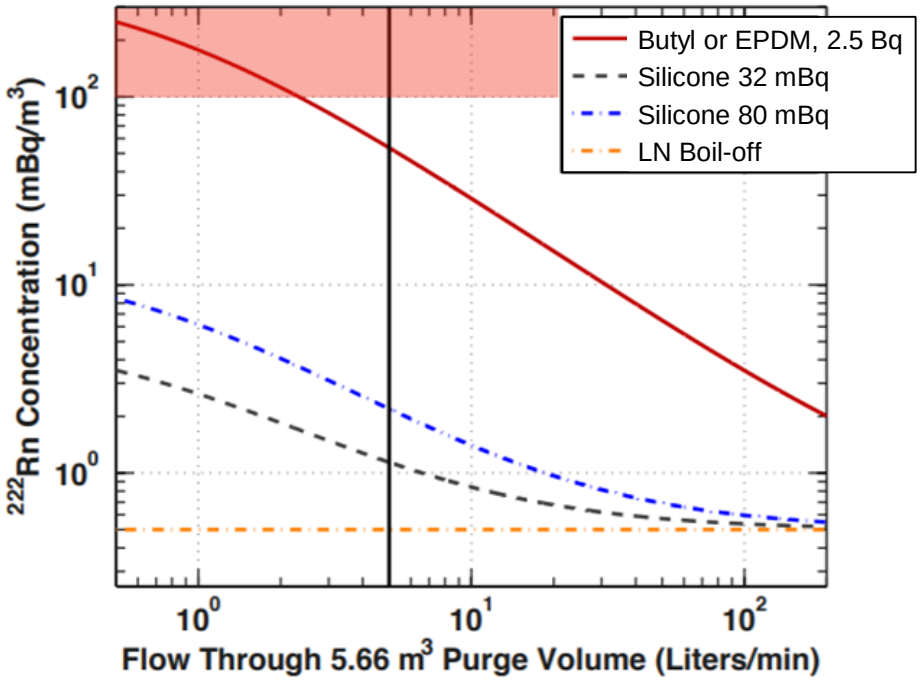
Second Emanation (Jan. 31 – Feb. 8)



- Emanated at 100 Torr. This is high enough to include recoil emanation from the chamber and sample.
- Only used Po-214 count for analysis as Po-218 has a large overlap with the Po-210 signal.
- Background run immediately after not used as rate was high due to radon absorbed and then degassed by Teflon in the detector.
- Po-214 count indicates a rate of **50 ± 2 mBq.**

Conclusion

- The EPDM gasket emanates at **50 ± 2 mBq.**
  - Our sample is 38 ± 3 in. (97 ± 8 cm) long.
  - **This gives a rate of 52 ± 5 mBq/m for EPDM emanation.**
- This is 8x higher than the rate we measured earlier for a different EPDM sample, which emanated at 6.2 ± 0.8 mBq/m.



- This emanation rate is consistent with that of the Butyl gasket we emanated earlier (~50 mBq/m). Both meet Super CDMS's goals.
- All gasket candidates meet goals at the planned flow rate (5 slpm), but if the flow rate is reduced by about a factor of two, only silicone will meet goals.

Backup Slides

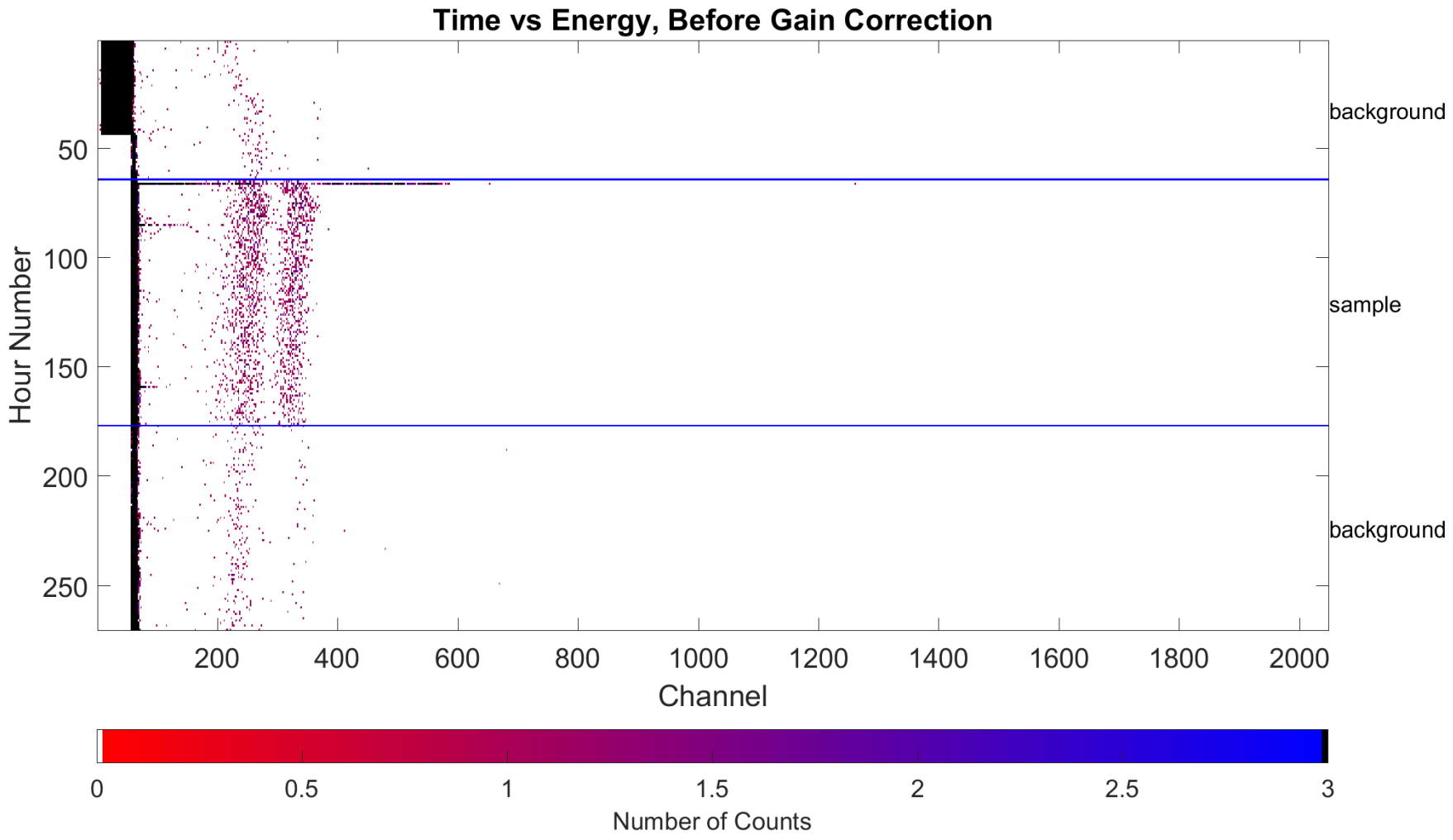
Dust Level Upper Limit

- If all 50 mBq from the EPDM came from dust, that would mean the dust concentration on the 0.97 m long gasket was

$$\frac{50\ mBq}{0.97m * 10\frac{mBq}{g}} = 5.2\frac{g}{m}$$

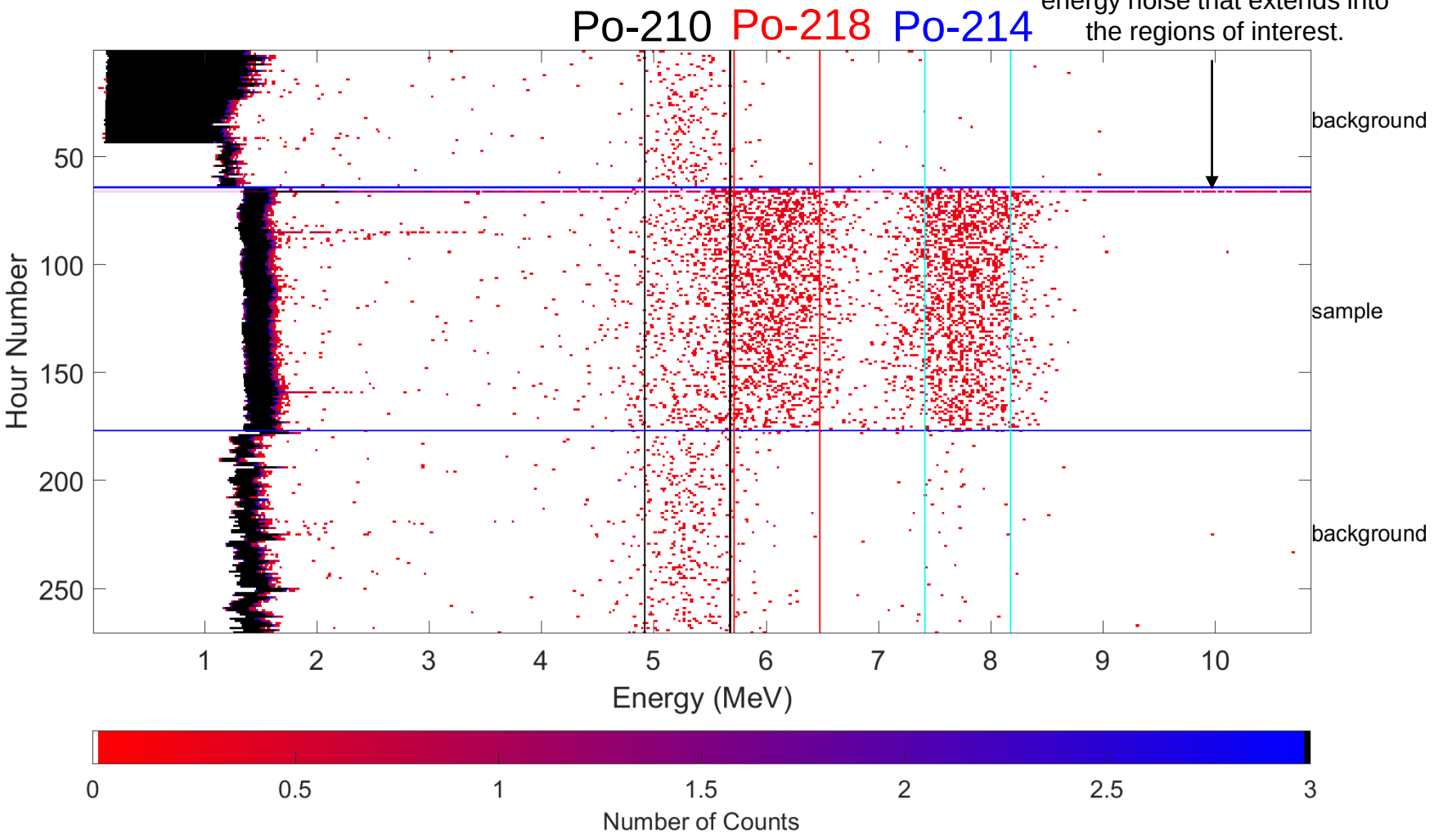
  - This assumes 40 mBq of radium per gram of dust, and that 25% of the radon from surface dust (10 mBq) emanates.
- This would mean a total of 5 grams of dust on the gasket.
- That much dust would be clearly visible on the gasket, but there was no visible mass of dust, so it's safe to assume this emanation is mostly from the gasket itself.

Second Transfer

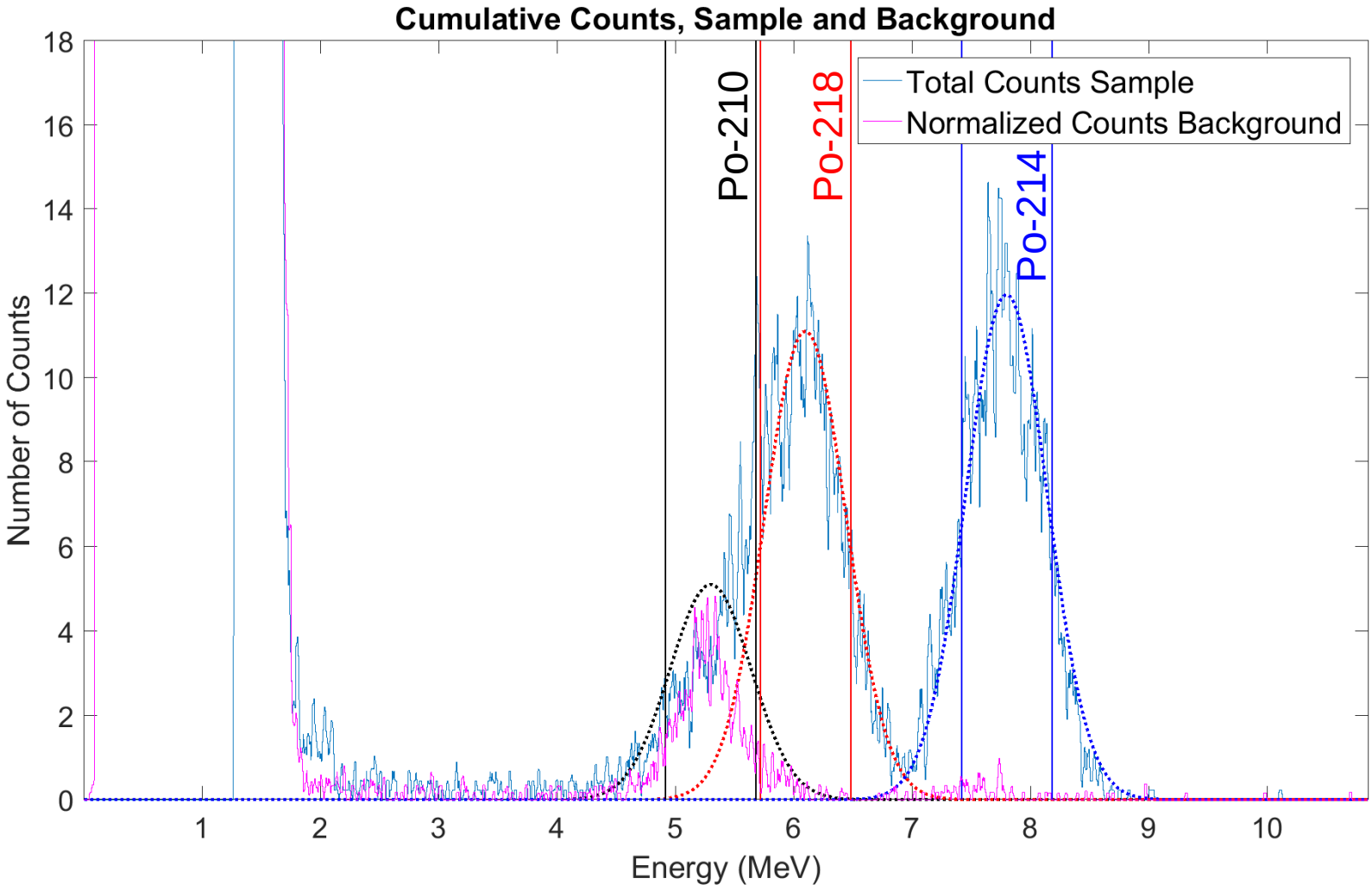


Second Transfer

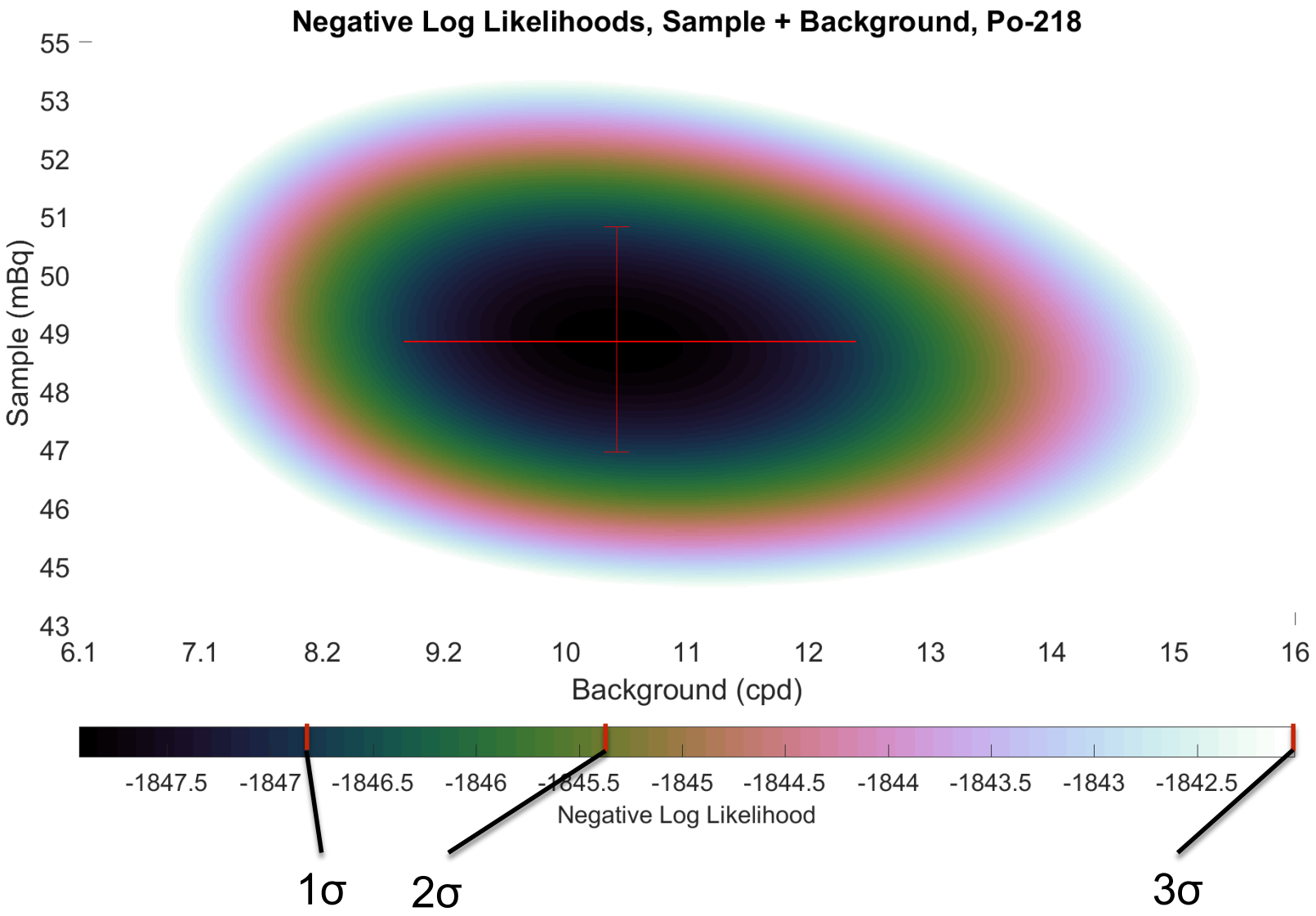
Data removed because of low energy noise that extends into the regions of interest.



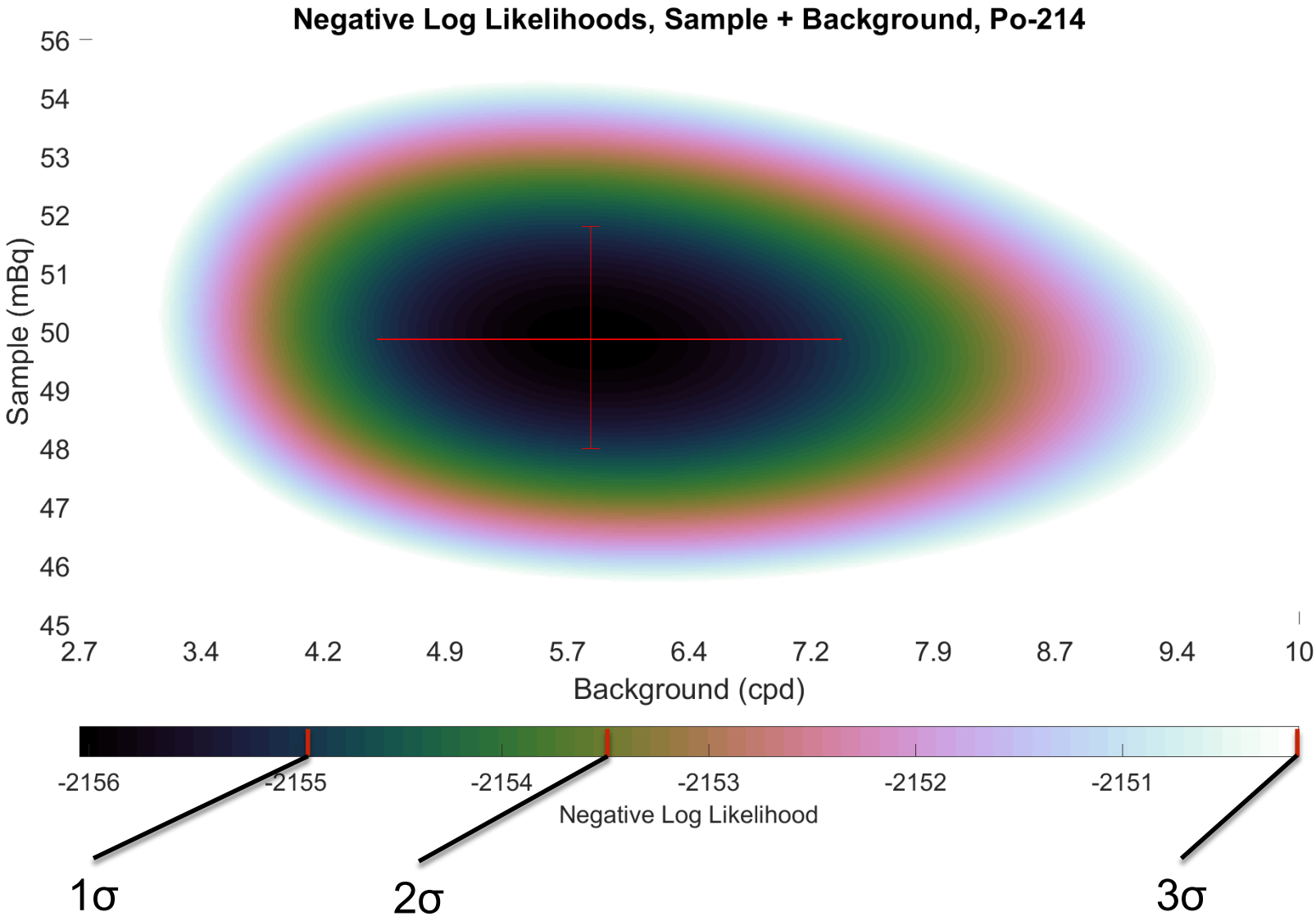
Cumulative Counts Second Transfer



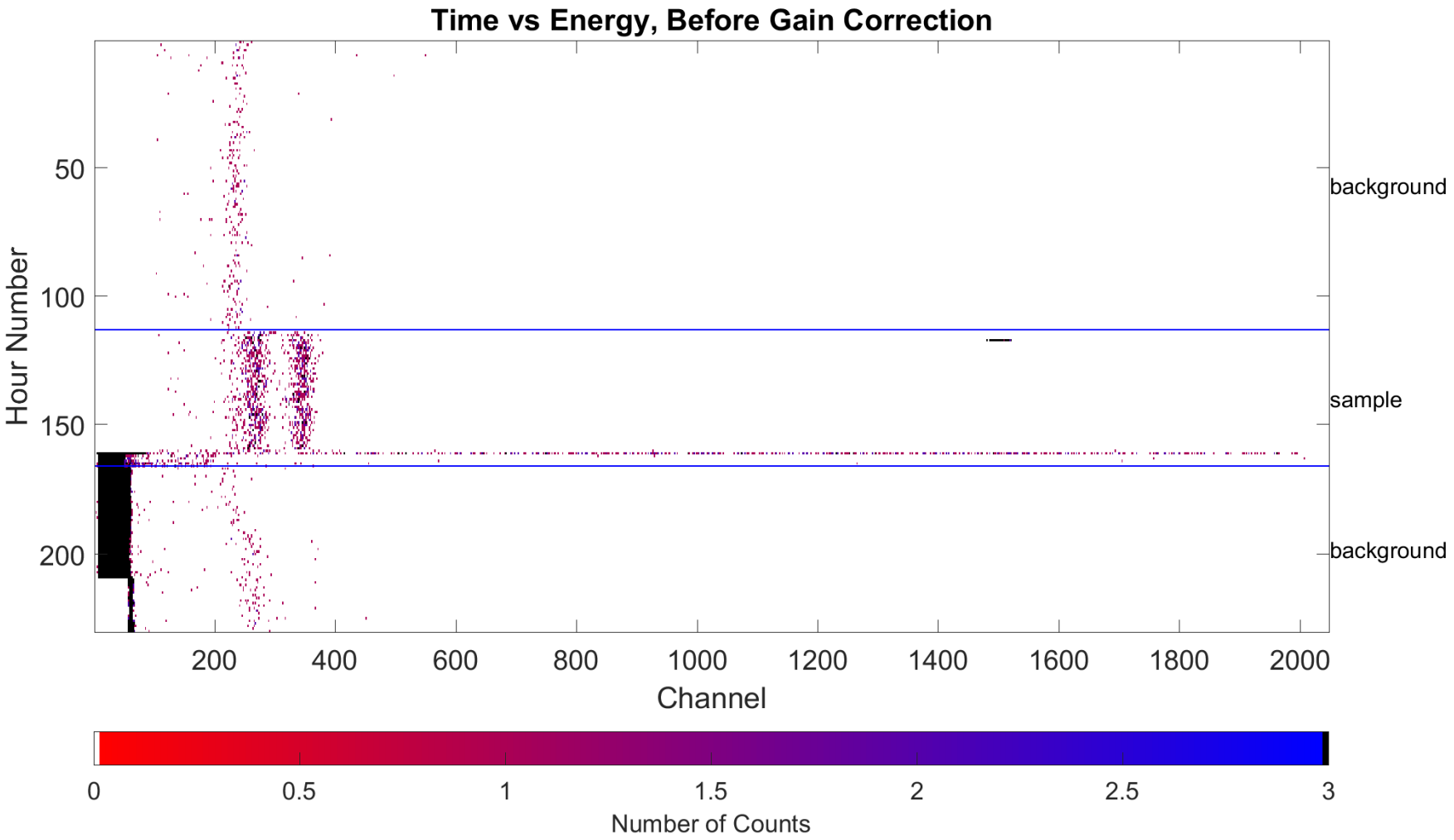
Negative Log Likelihoods for Second Transfer, Po-218



Negative Log Likelihoods for Second Transfer, Po-214

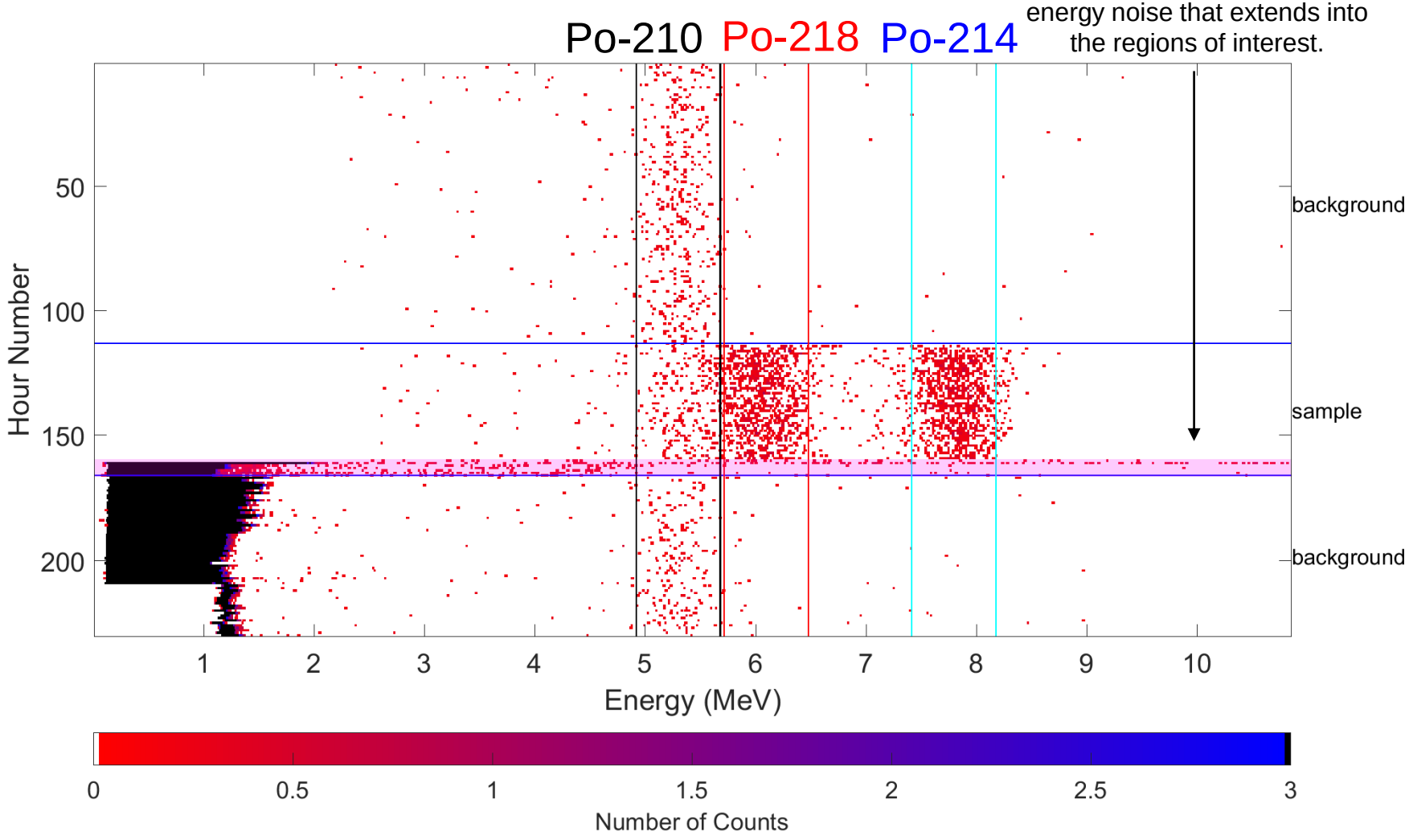


First Transfer

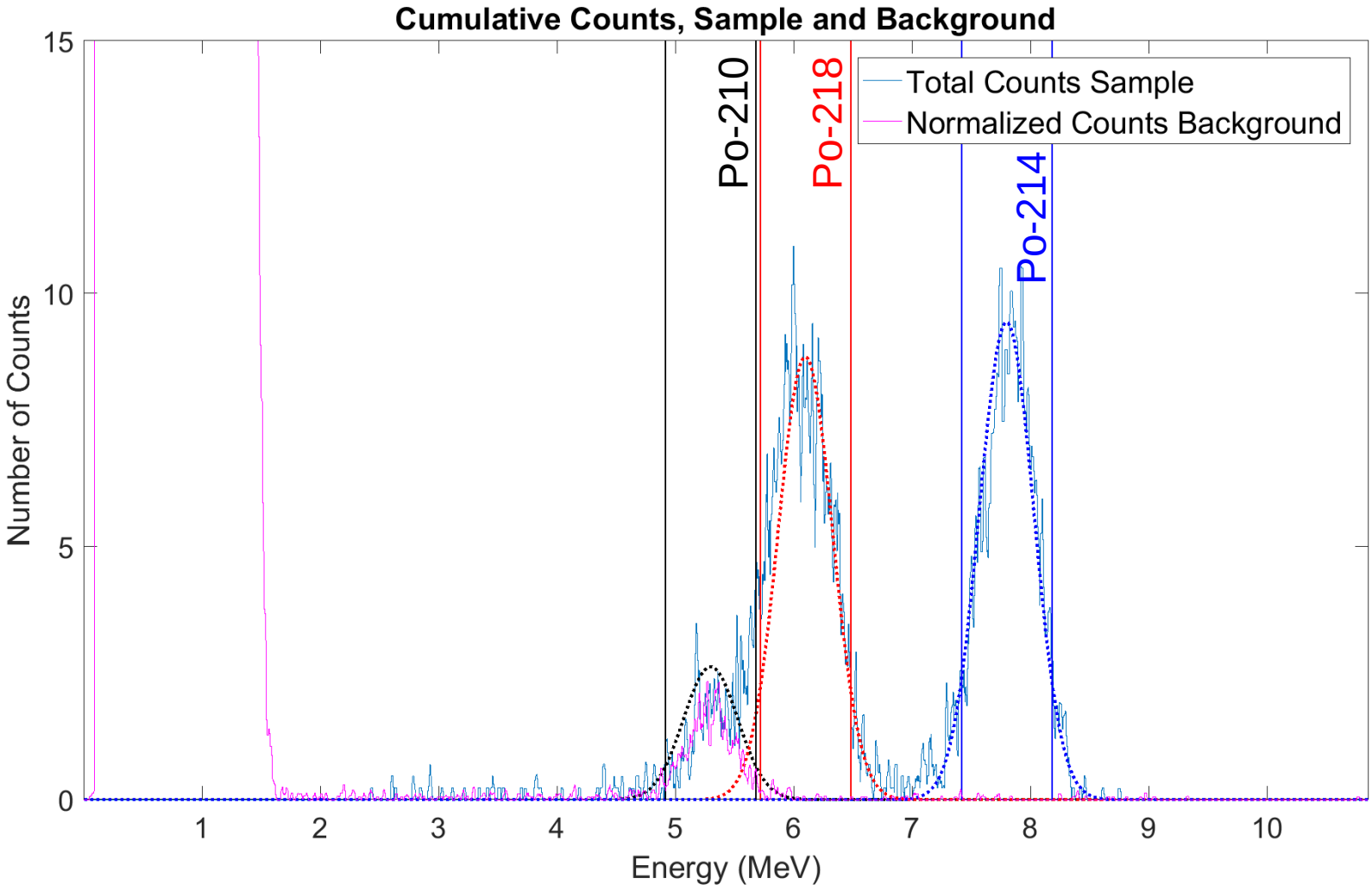


First Transfer

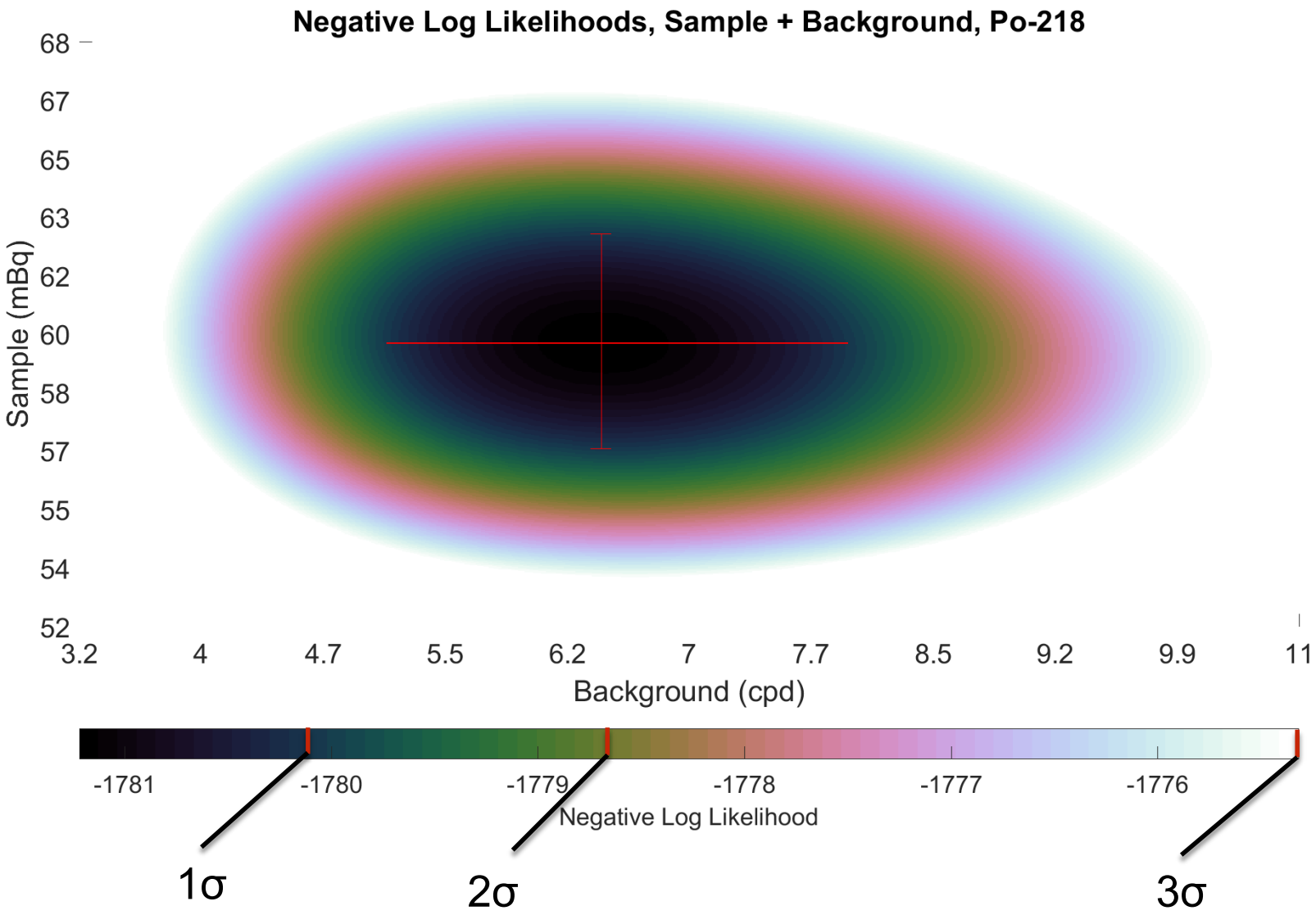
Data removed because of low energy noise that extends into the regions of interest.



Cumulative Counts First Transfer



Negative Log Likelihoods for Second Transfer, Po-218



Negative Log Likelihoods for Second Transfer, Po-214