CYGNO Experiment

# VGEM scanning analysis

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# Objective and Tasks

- Compare three different sensors:
    - FUSION BT (runs from 6306 to 6313)
    - FUSION QUEST (runs from 6332 to 6339)
    - THORIT (naked FLASH) (runs from 6355 to 6362*)

- Overground datasets:
    - Natural Radioactivity (NR)
    - $^{55}Fe$

- Tasks
    - Noise study DONE
    - Linearity DONE
    - Efficiency **ON-GOING** TODAY

# Efficiency Estimation: Methodology

- We have gone through some different methodology
  - Cuts and subtraction between NR and $^{55}Fe$
  - Some problems:
    - Overground cosmic rays delete many iron spots with a rate that varies with the VGEM energy
    - Background variation from one run to another (humidity, temperature, ?)
- Current methodology

→ Tested on FUSION QUEST

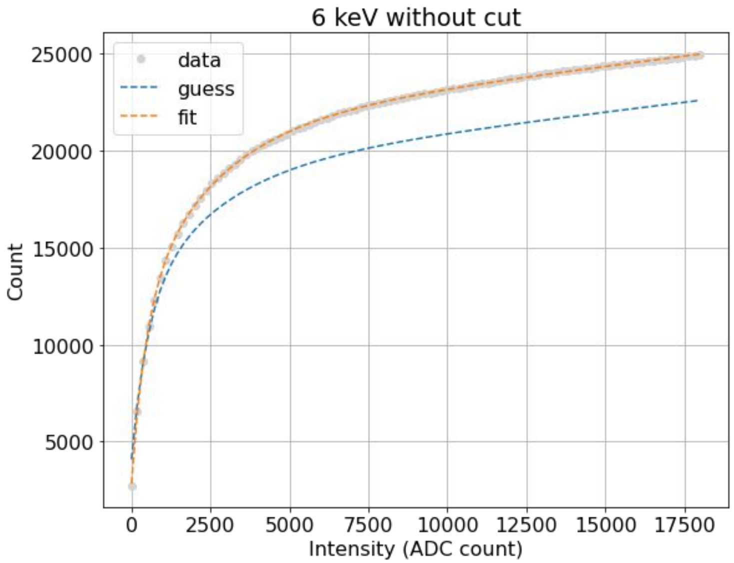
1. Fit NR to use as guess inicial parameters to step 2
2. Fit $^{55}Fe$ data
3. Get the s-curve ($^{55}Fe$ component) for all the VGEM data
4. Create a MC toy to inject iron spots in the NR dataset *(iron events rate and region are estimated)*
5. Apply the same (1,2,3) steps to simulated data
6. Estimate the iron-spot loss rate for each VGEM value *(loss due to overlap with cosmic tracks)*
7. Correct the efficiencies by this value

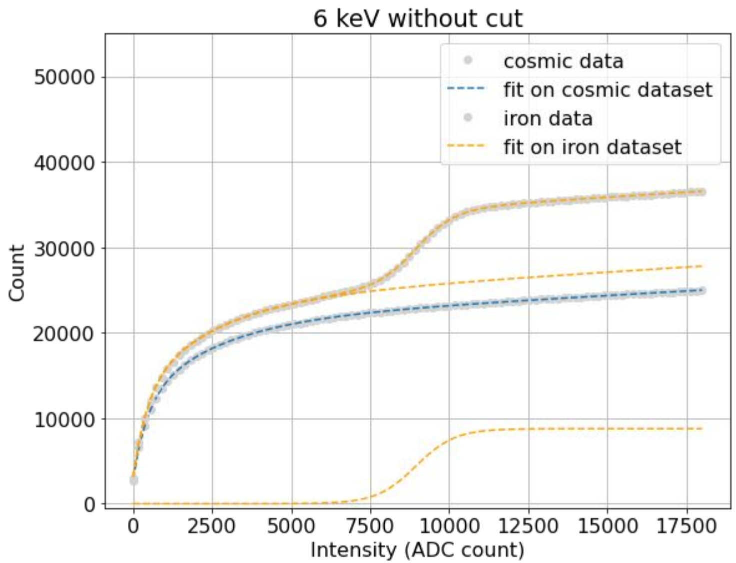
# Efficiency Estimation: Methodology

- Current methodology

1- Fit NR to use as guess inicial parameters to step 2
2- Fit $^{55}Fe$ data

*(cumulative distributions)*



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- Current methodology

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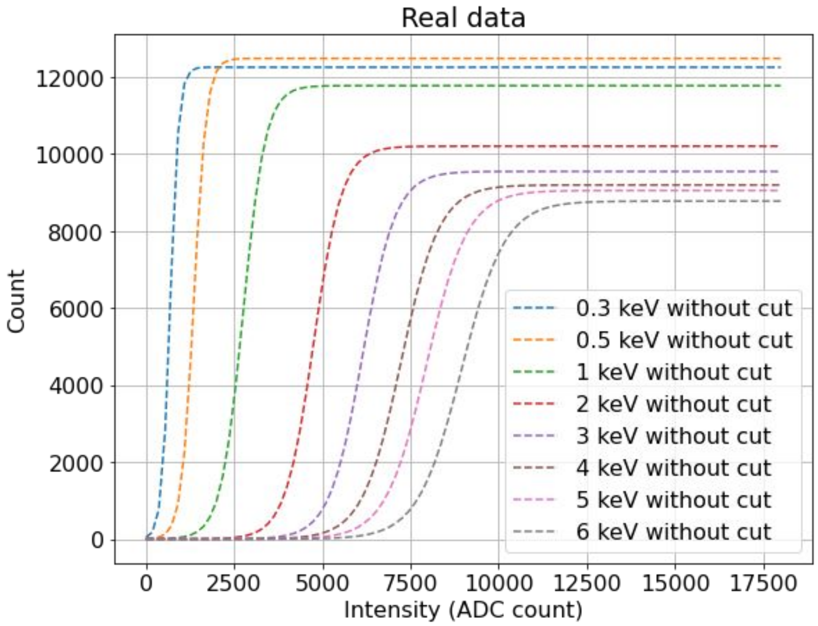
3- Get the s-curve ($^{55}$Fe component) for all the VGEM data

*(cumulative distributions)*



# Efficiency Estimation: Methodology

- Current methodology

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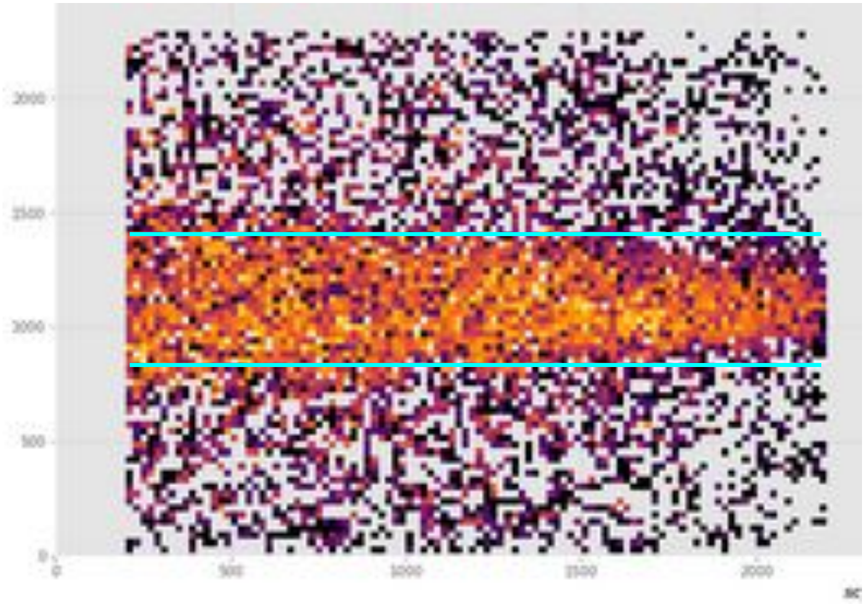

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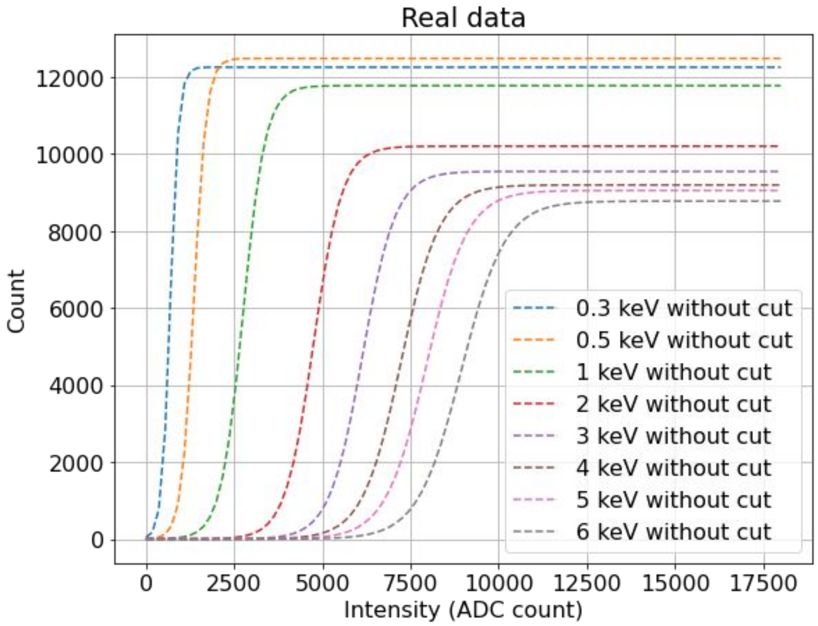
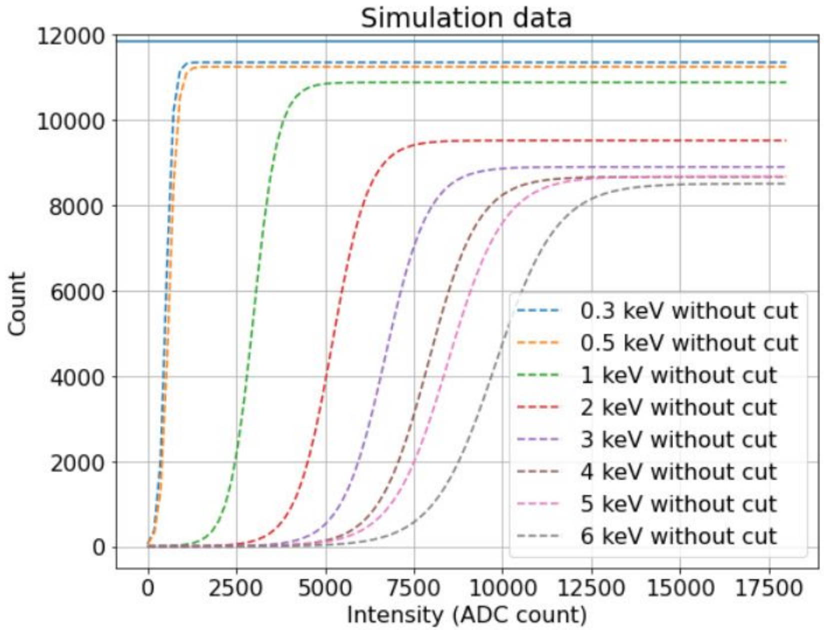
*(cumulative distributions)*

*fine tuning might be needed*



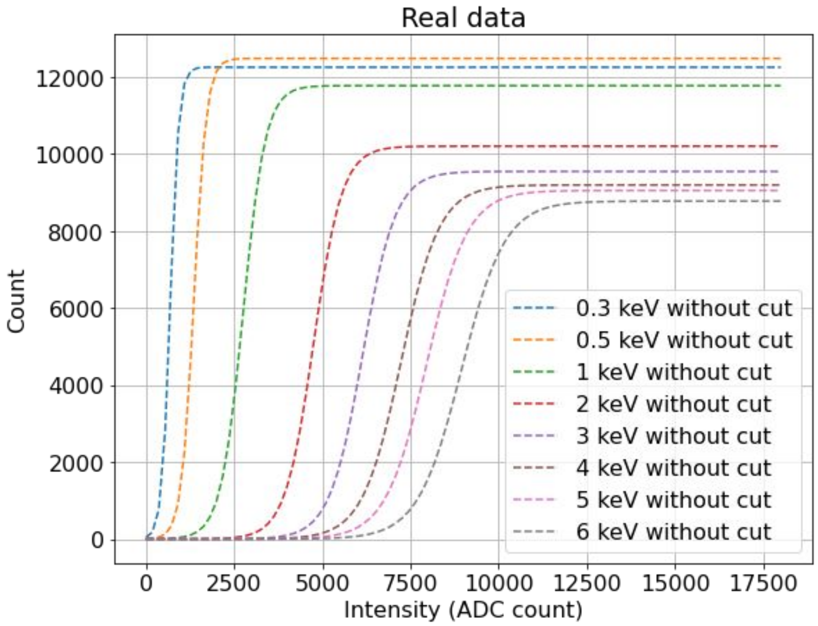



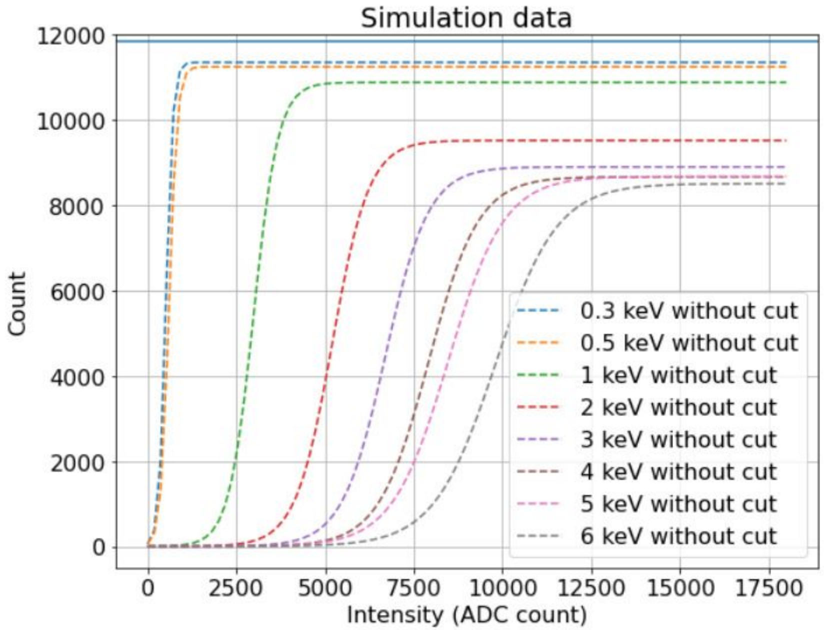
# Efficiency Estimation: Methodology

- Current methodology

6- Estimate the iron-spot loss rate for each VGEM value
7- Correct the efficiencies by this value

TO BE DONE



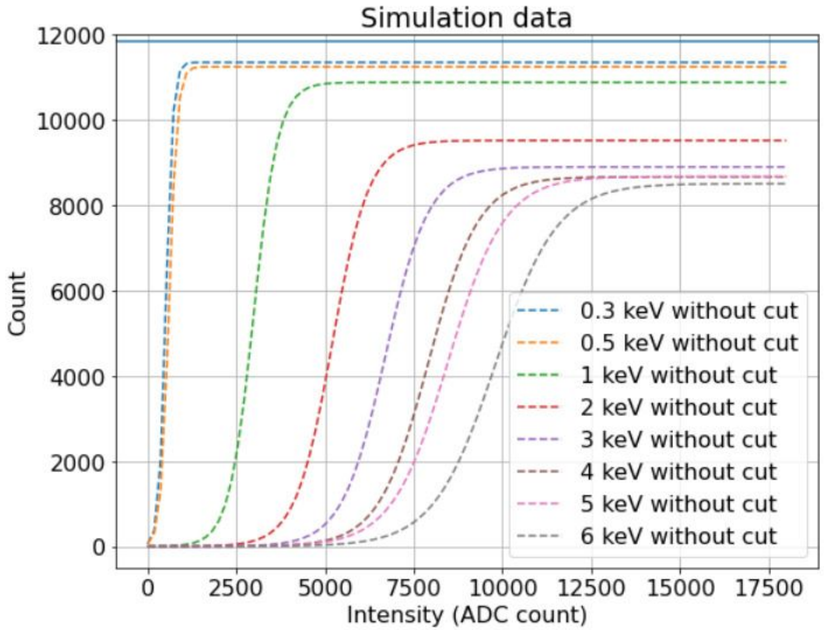
# Efficiency Estimation: Methodology

- Current methodology

  *Correction for efficiency + loss rate → recover the original rate of iron spots (blue line)*

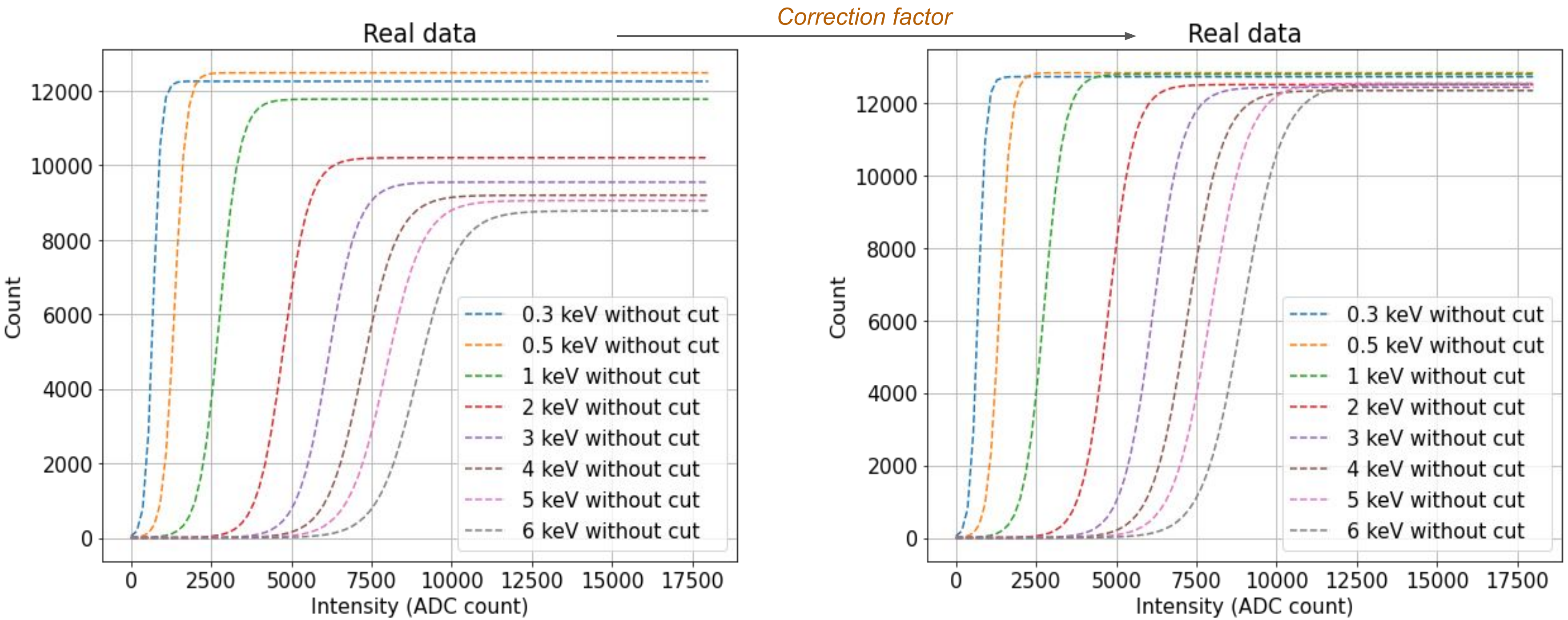
Correction factors:

- 0.3 keV = 0.9632936345518253
- 0.5 keV = 0.9728999630958749
- 1.0 keV = 0.920507211042794
- 2.0 keV = 0.8159967539634213
- 3.0 keV = 0.7681397161894474
- 4.0 keV = 0.7451245685039914
- 5.0 keV = 0.7218164020394229
- 6.0 keV = 0.7015190115104887



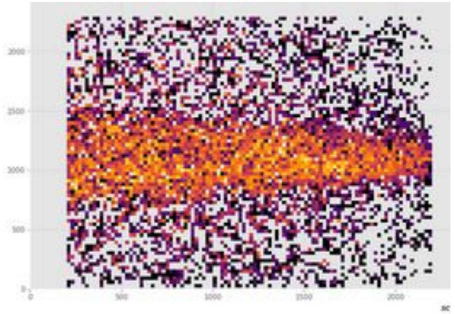
# Efficiency Estimation: Methodology

- Current methodology



# Efficiency Estimation: Final Comments

- Next steps:
  - Fine tuning of iron-spot rate and incident region
  - Rerun the algorithm
  - Estimate efficiencies considering measurement errors
  - Apply to the other sCMOS sensors

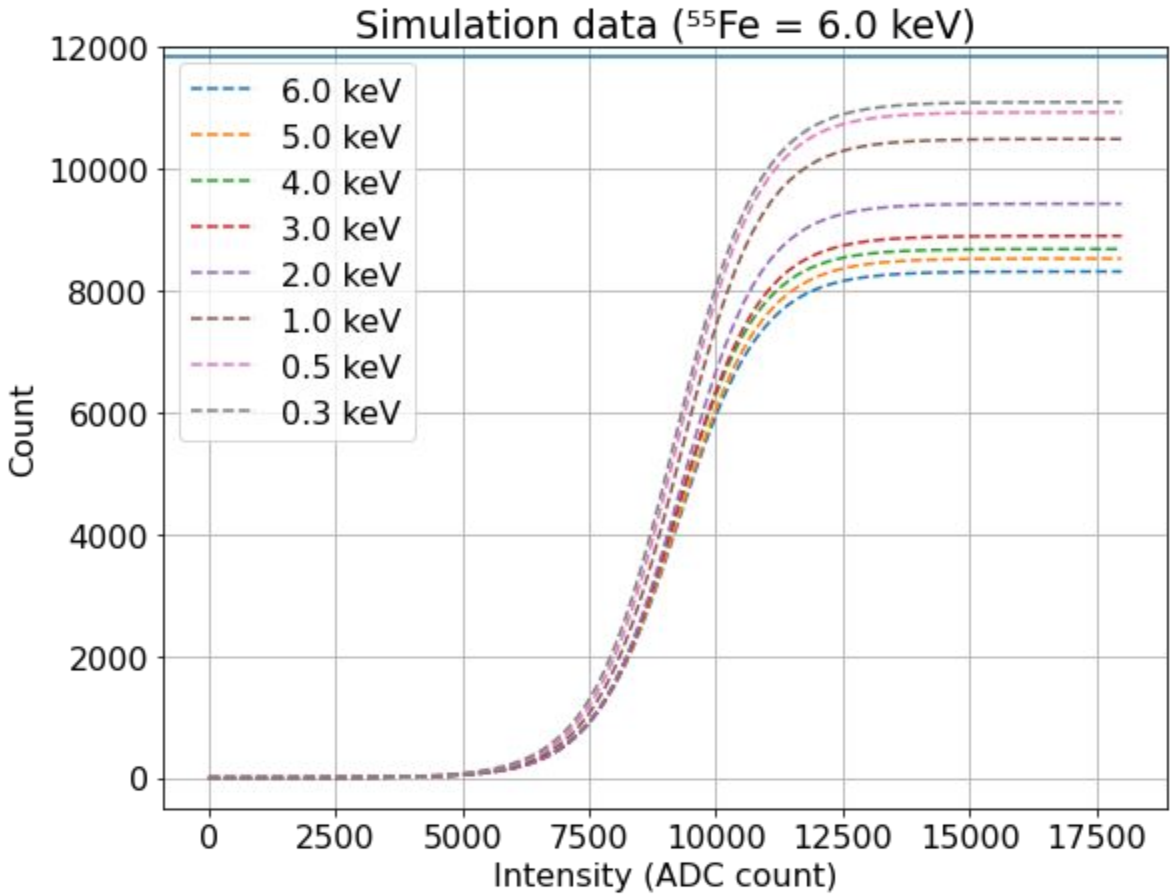


- Other/complementary possibilities:
  - Inject iron simulated spots into electronic noise dataset to measure efficiency
  - …?

- For underground data, this analysis should be less problematic
  - steps 1, 2 and 3 would probably be enough

# Back-up

# *Exercise: Iron of same energy into NR with different VGEM*



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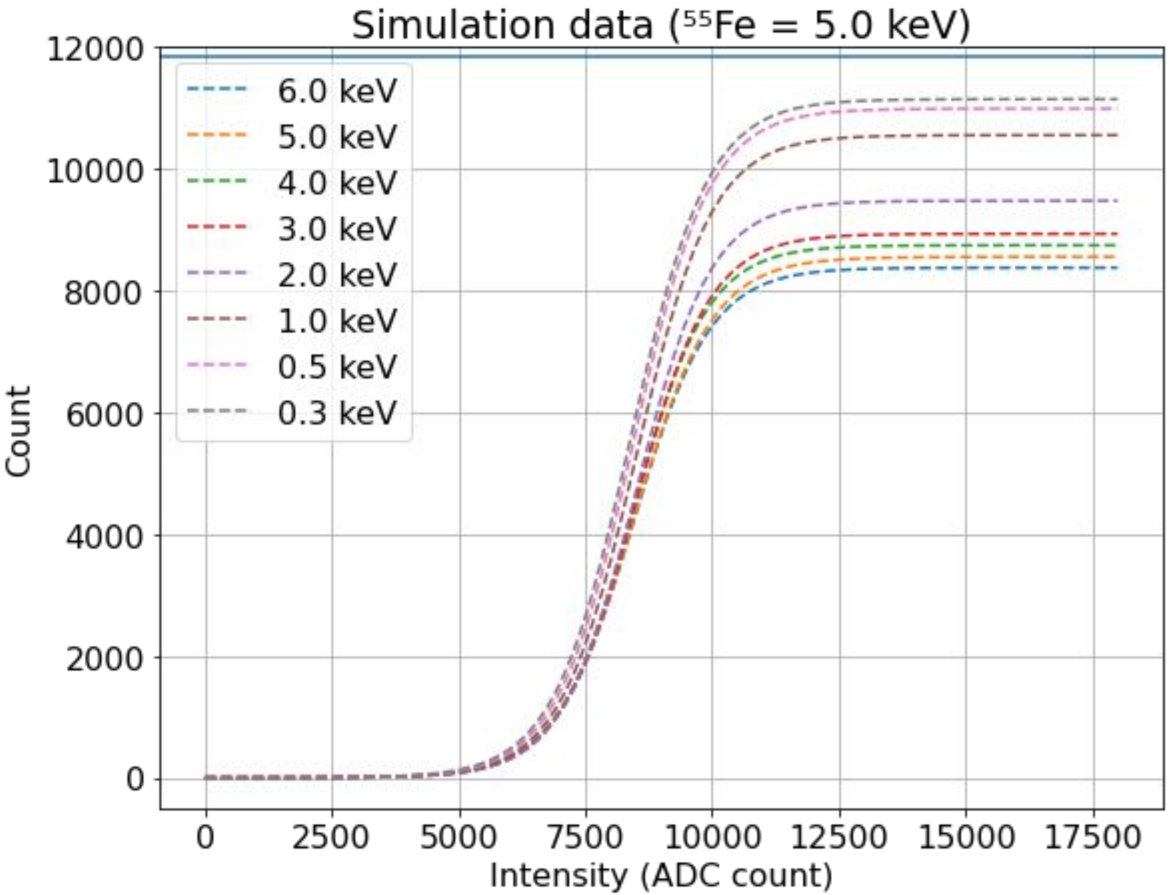

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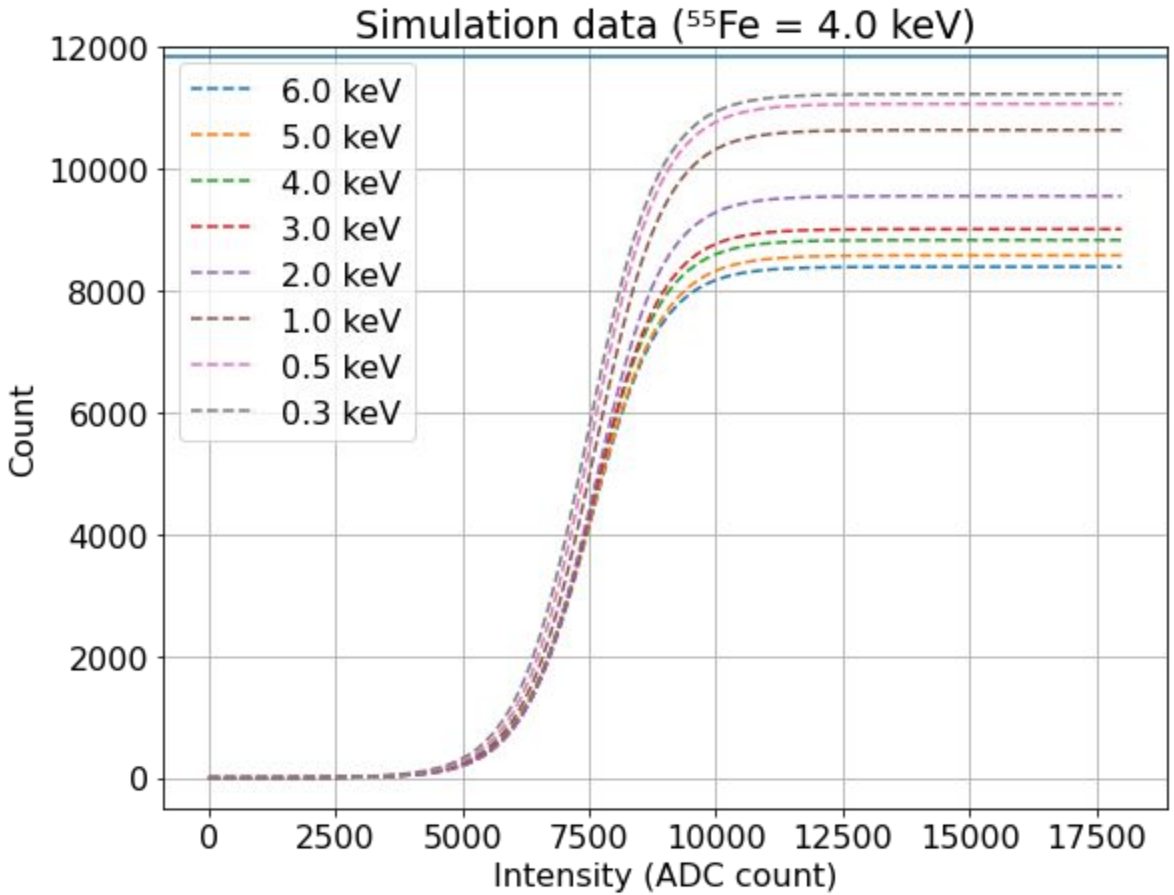

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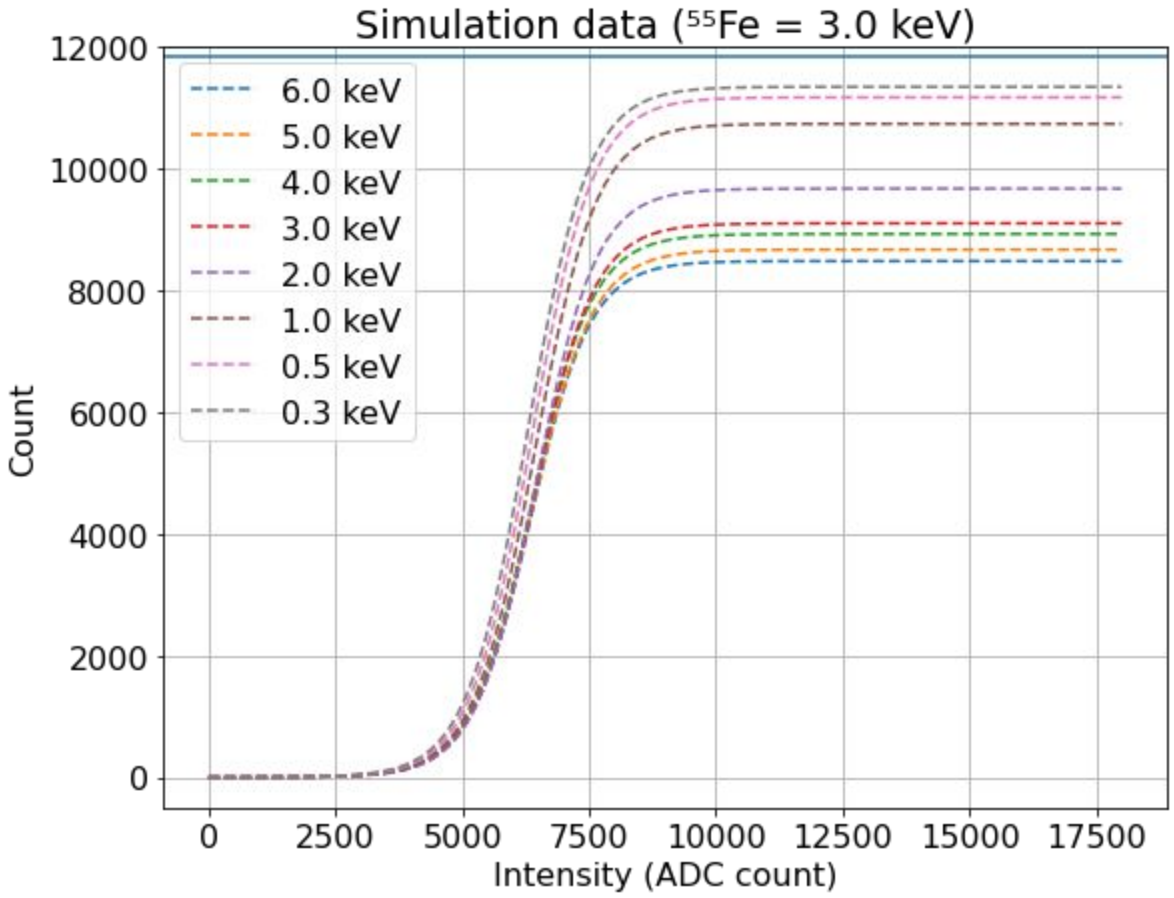

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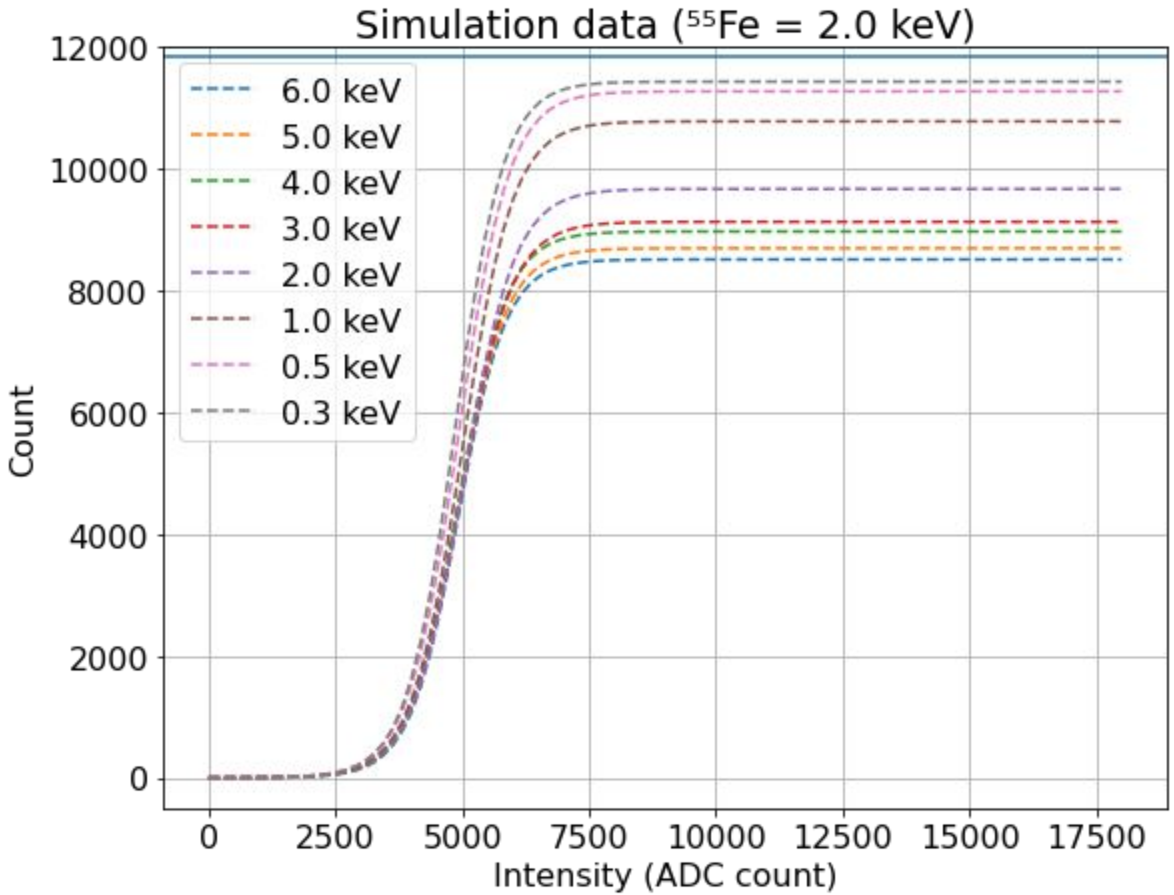

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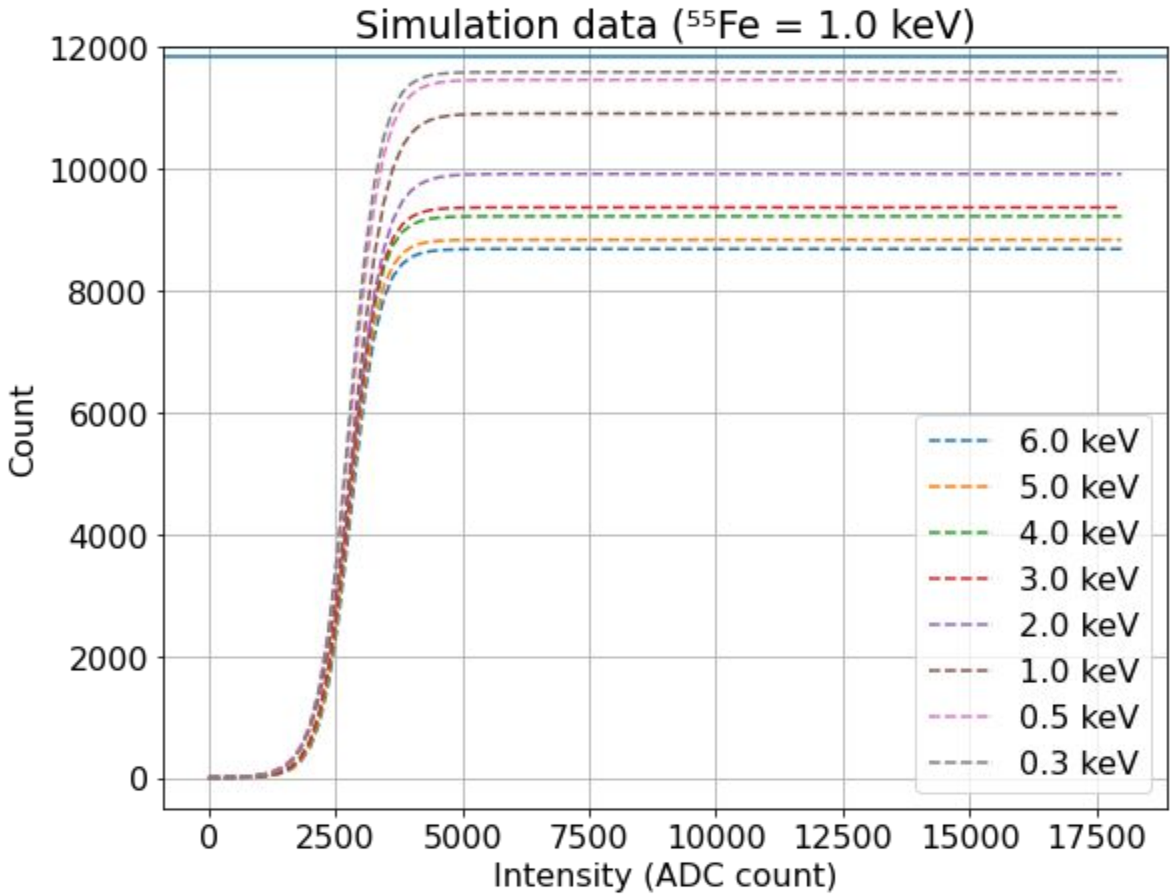
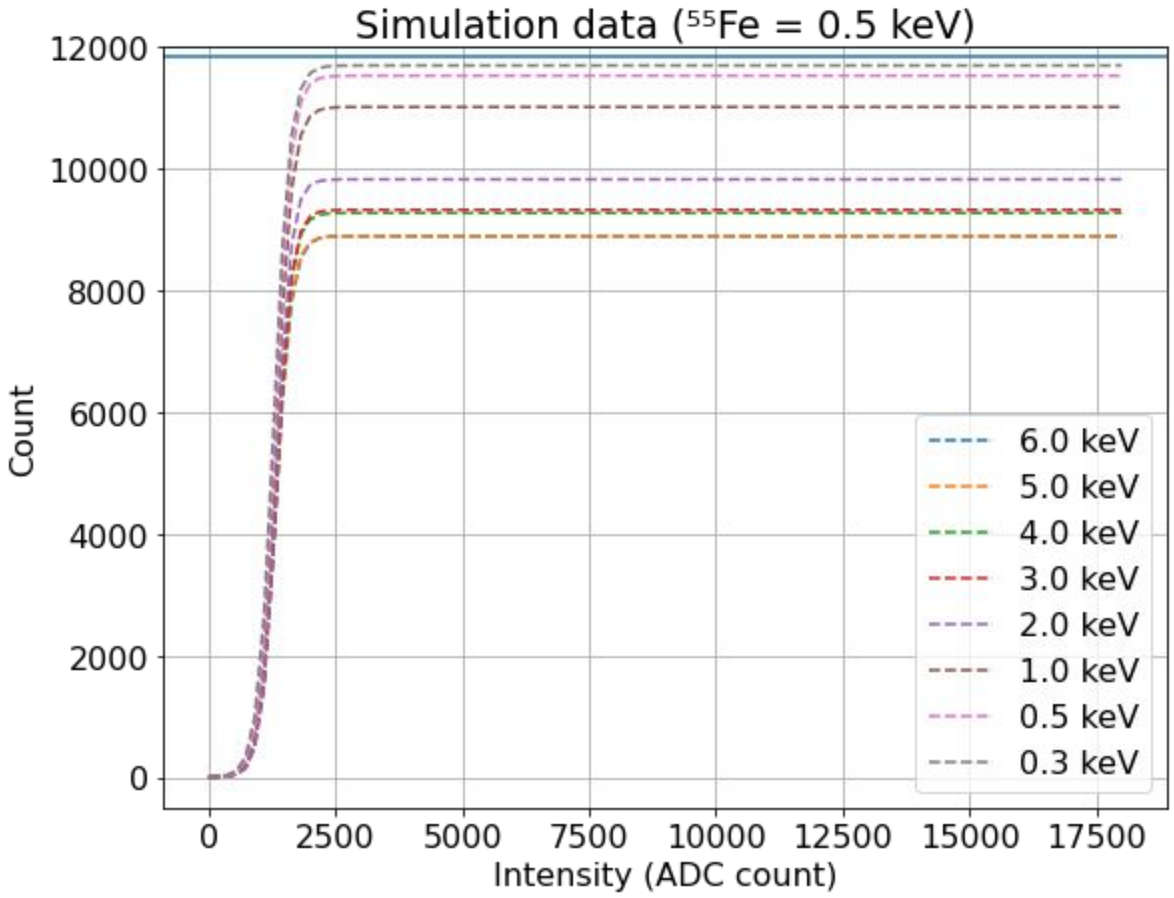



So far, the count is gradually increasing.

As if lower-energy events were less lost among cosmic events.

It's worth debugging to find one or two cases as a visual example in an attempt to confirm this hypothesis...

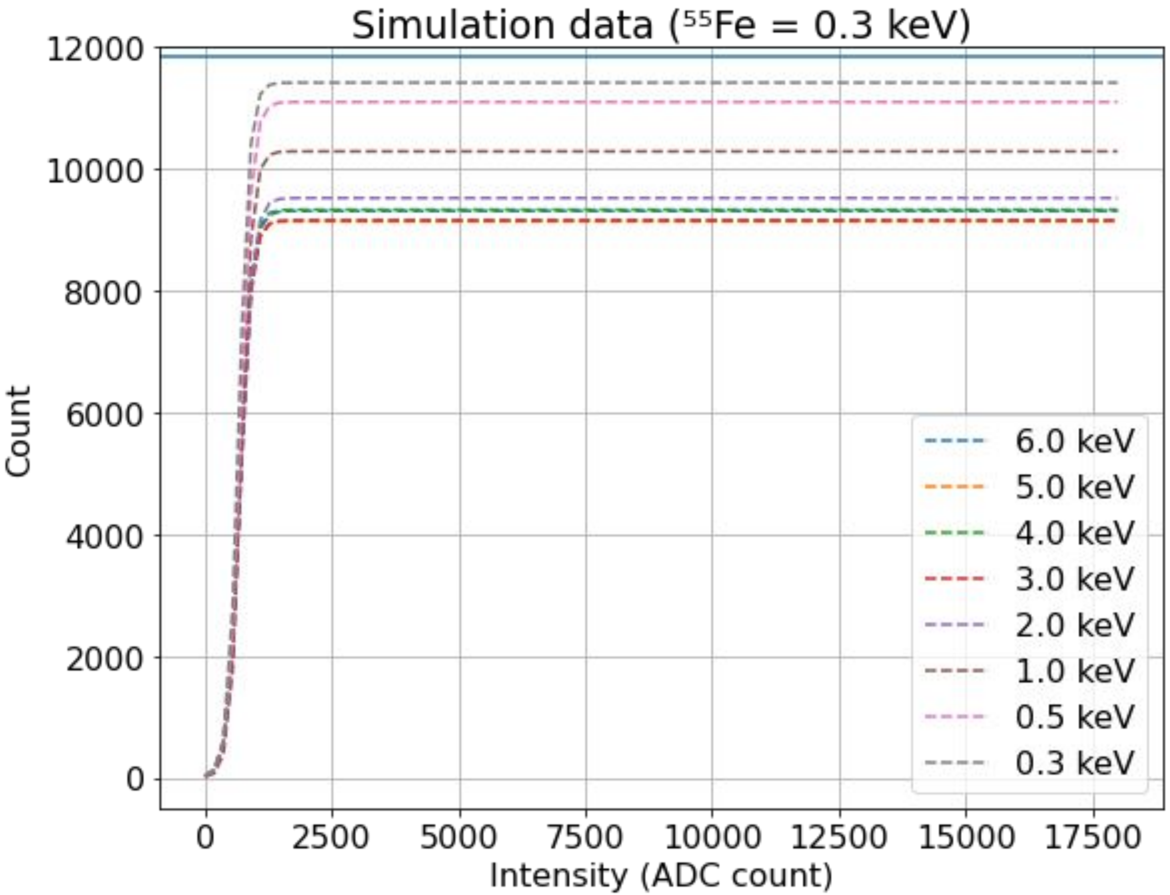
# *Exercise: Iron of same energy into NR with different VGEM*




Here things start to get confusing... some counts increase and others decrease (2 and 3 keV).

But, in a small variation range.

# *Exercise: Iron of same energy into NR with different VGEM*




**Regarding the 1 keV:**

- Events from 2 keV down have their counts reduced.
- Events of 3 and 4 keV remain more or less in the same positions.
- Events of 5 and 6 keV have their counts increased.

**Mixed components:**

- Iron that are lost because of inefficiency
- Iron that are lost because a grouped with cosmic tracks
- ??

**→ Check images to understand**