# Simulations: experiment at Sapienza
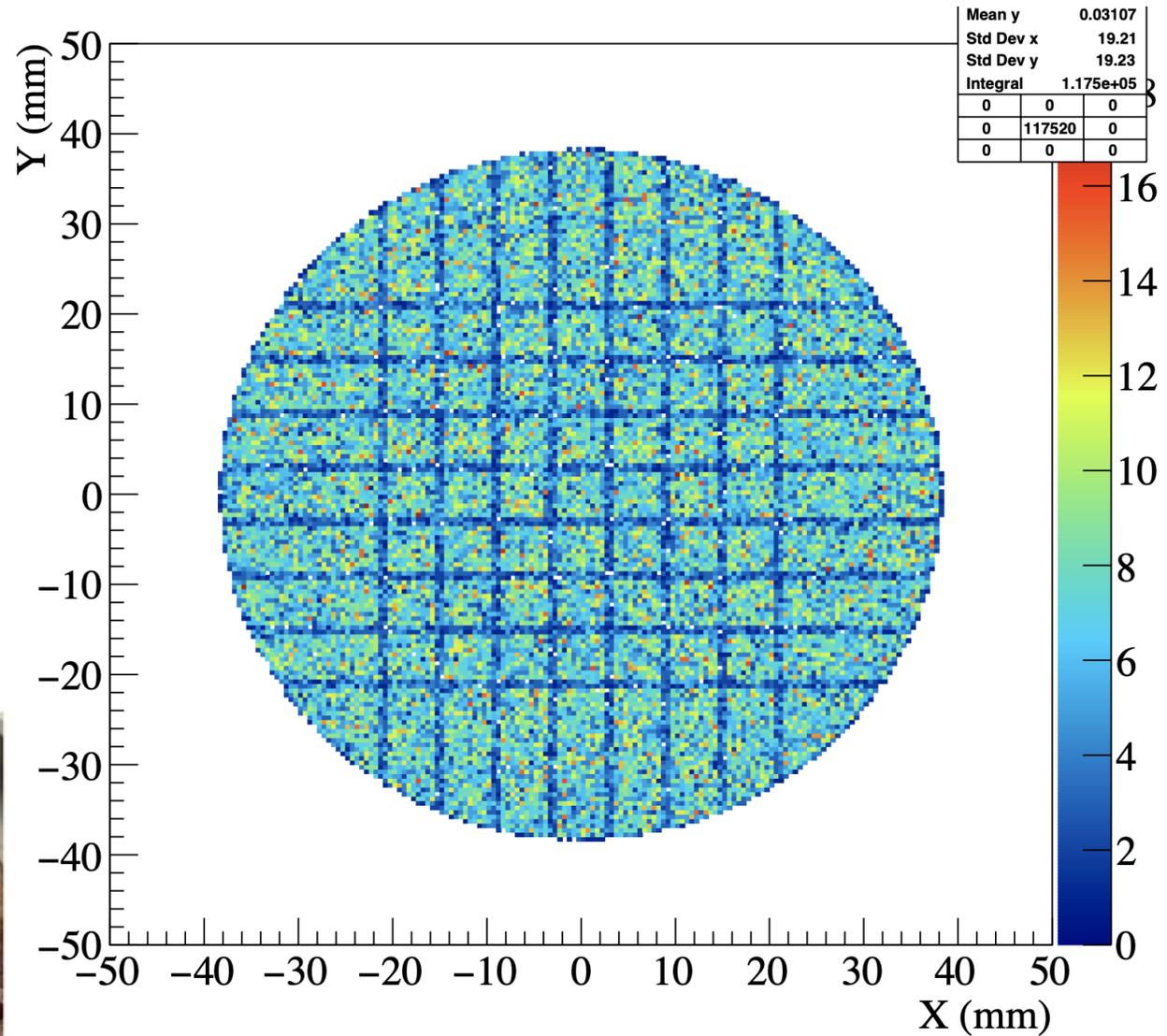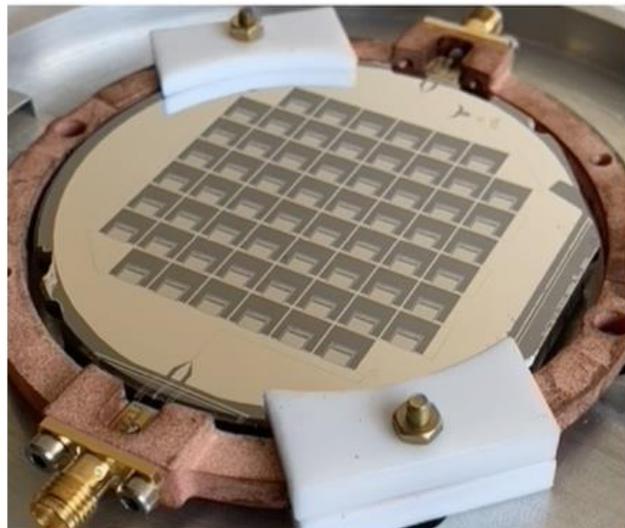
Eric Vázquez Jáuregui

IF-UNAM, México

January 15, 2025
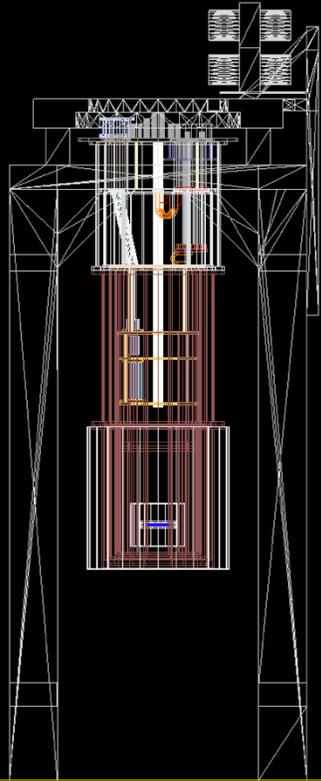
# Setup at Sapienza

# Wafer details and cryostat

- Single Si crystal
3" in diameter and 5 mm thick

- Dice mass: 0.34 g

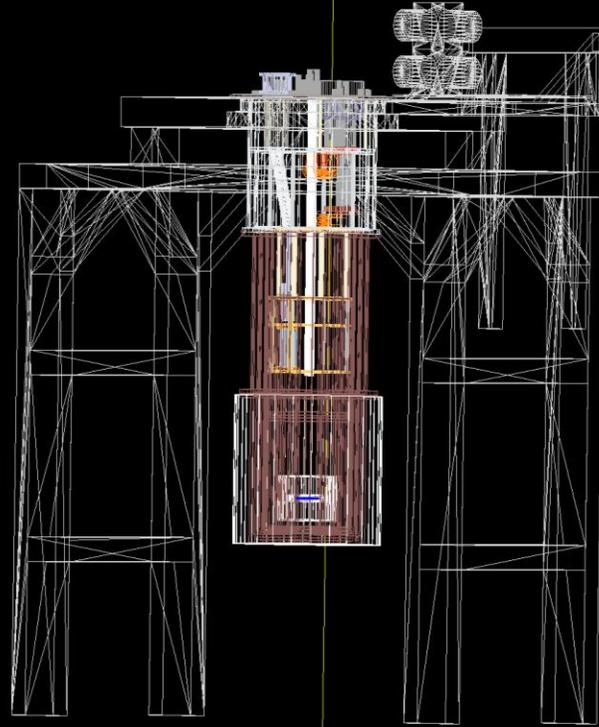- Sapienza cryostat with geometry built from measurements and drawings

- Grooves included: 0.5 mm

- Dice dimensions: 5.4 x 5.4 x 5 $mm^3$

- Bottom disk: 0.5 mm (included in the 5 mm dice)
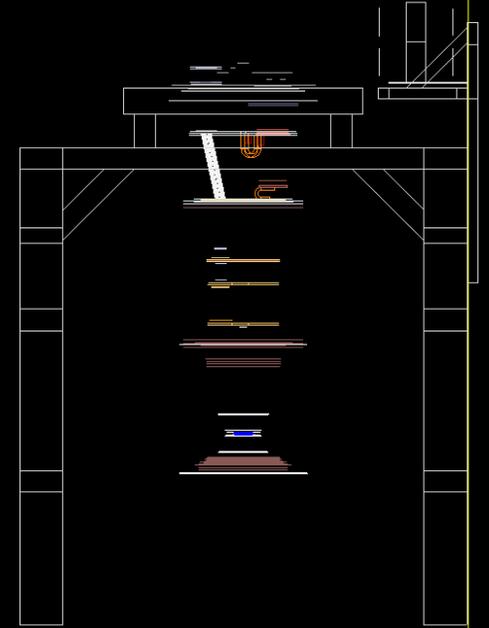
- Copper ring included

DANAE Sapienza

NUCLEUS

NUCLEUS

MC model in GEANT4 implementing the Sapienza cryostat

# Monte Carlo simulations of backgrounds using GEANT4

# What we have now

Two GitHub repositories:


Experiment at Sapienza:

https://github.com/ericvj/BULLKID_Sapienza


Experiment at Gran Sasso:

https://github.com/ericvj/BULLKID_GranSasso

Code  Issues  Pull requests  Actions  Projects  Security  Insights  Settings

👤 **BULLKID_Sapienza** Private

Unwatch 1 ▾   Fork 0 ▾   ☆ Star 0 ▾

main ▾   1 Branch   0 Tags

Go to file    Add file ▾    `<>` Code ▾

**About**

ericvj Update README.md          a778cc5 · last week    🕐 **4 Commits**

Code for Monte Carlo simulations using GEANT4.11.3 for the BULLKID experiment

| | | |
|---|---|---|
| 📁 Sapienza | Update to two wafer geometry at Sapienza | last week |
| 📄 Makefile | Uploading code and GEANT4 | 4 months ago |
| 📄 README.md | Update README.md | last week |
| 📄 geant4-v11.1.3.tar.gz | Uploading code and GEANT4 | 4 months ago |

📖 Readme
〰 Activity
☆ 0 stars
👁 1 watching
⑂ 0 forks

📖 **README**  ✏

BULLKID at Sapienza with GEANT4.11.1.p03

**Releases**

No releases published
Create a new release

**Packages**

No packages published
Publish your first package

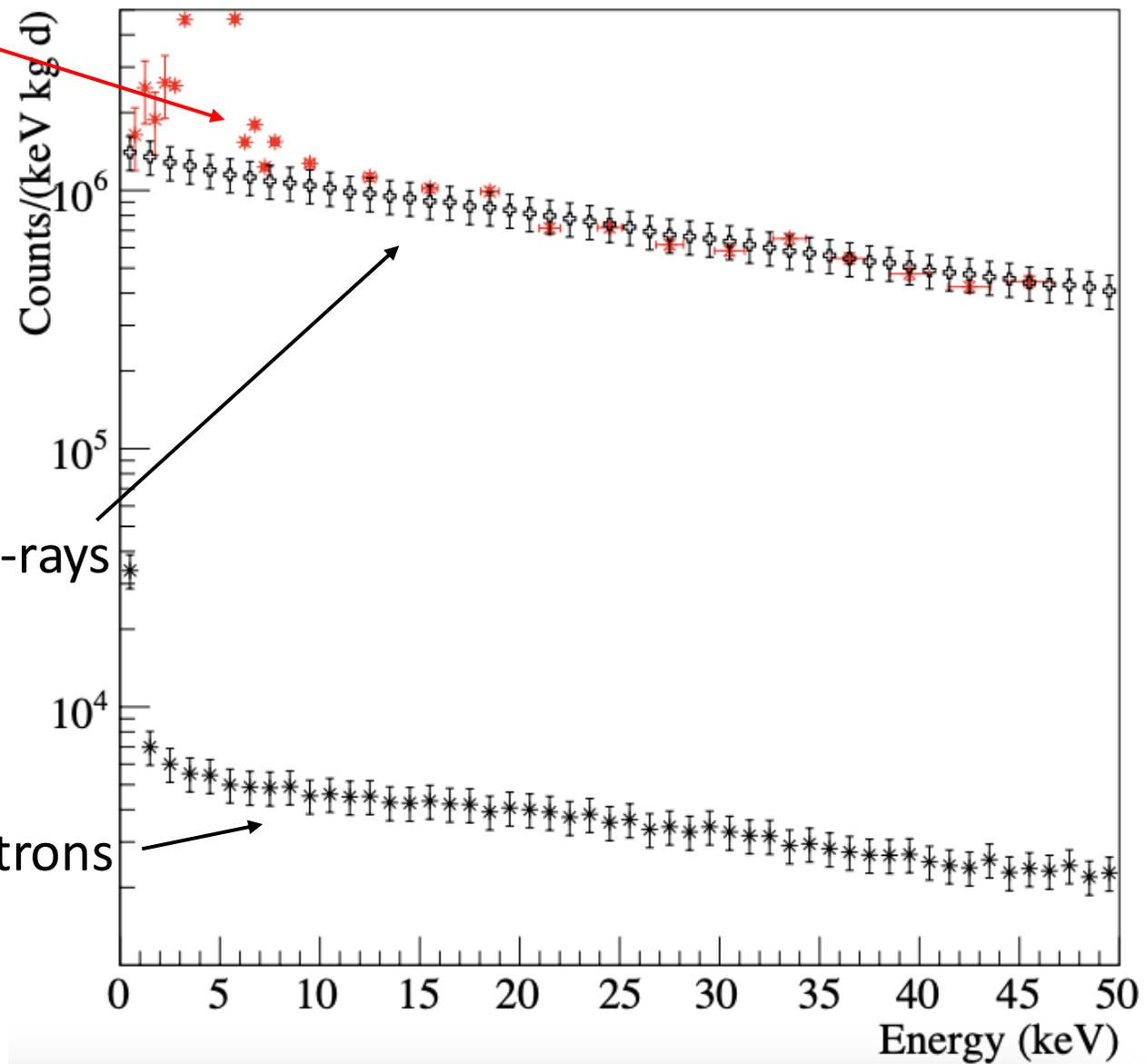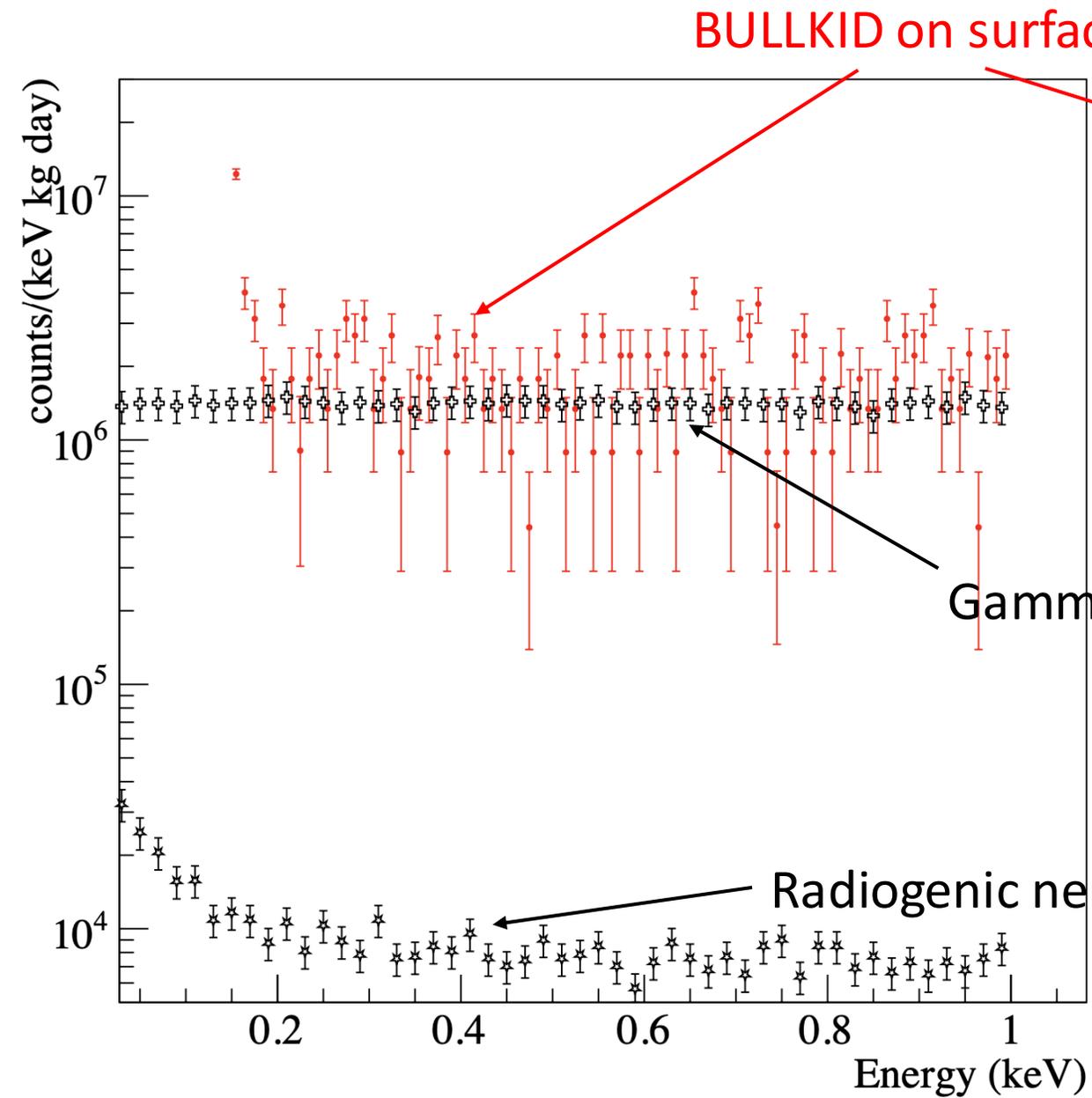**Languages**

● C++ 98.7%   ● Other 1.3%

# What we have now

- How to use in one-two-three:

1. clone:  gh repo clone ericvj/BULLKID_Sapienza or
   git clone git@github.com:ericvj/BULLKID_Sapienza.git

2. cd BULLKID_Sapienza

3. make

provides compilation of GEANT4 and experiment

- You need a github account, request access to GEANT4 code
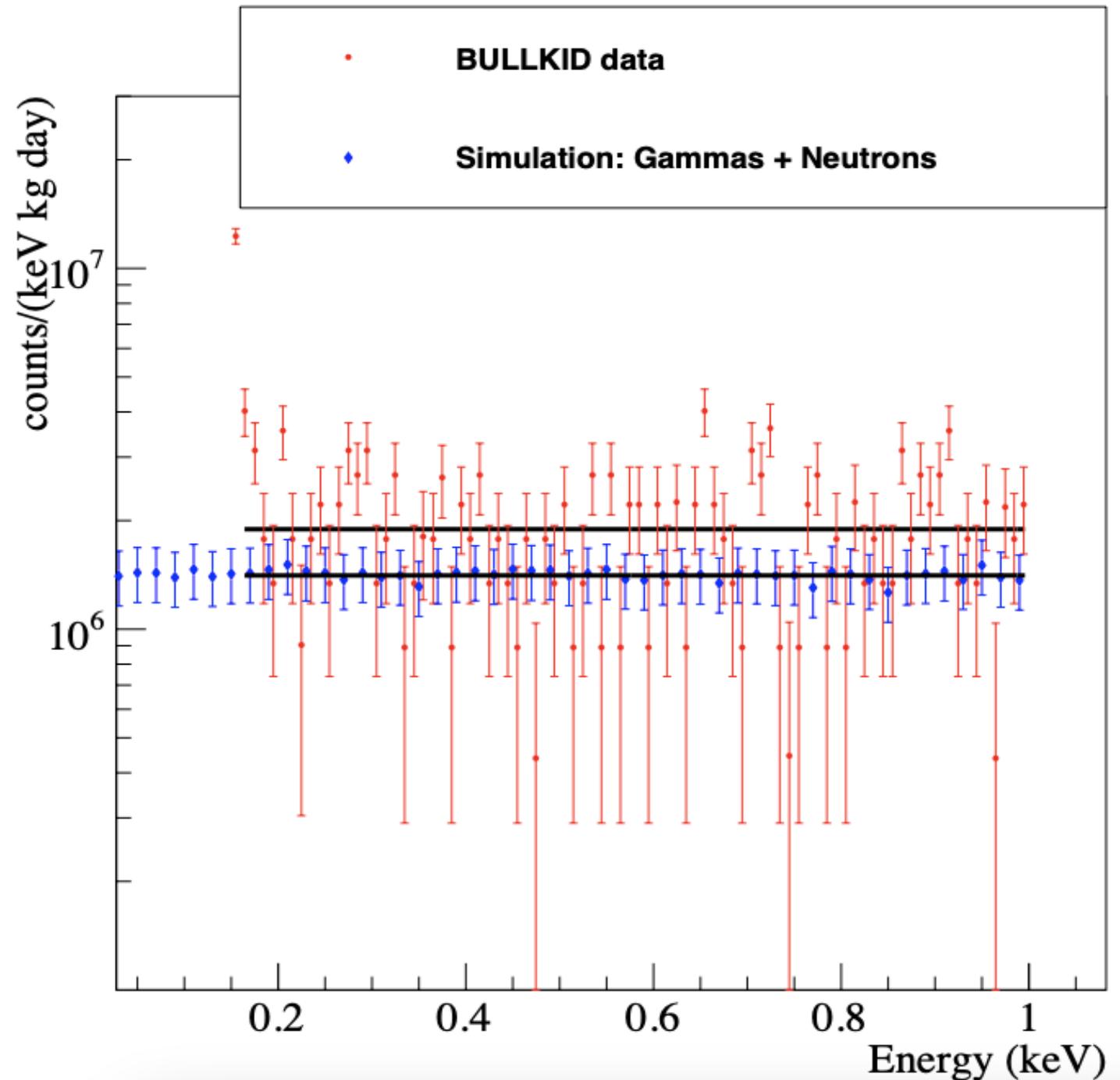
Ready and working!

# Results for gammas and neutrons

BULLKID on surface

Gamma-rays

Radiogenic neutrons

# Comparison to the experiment

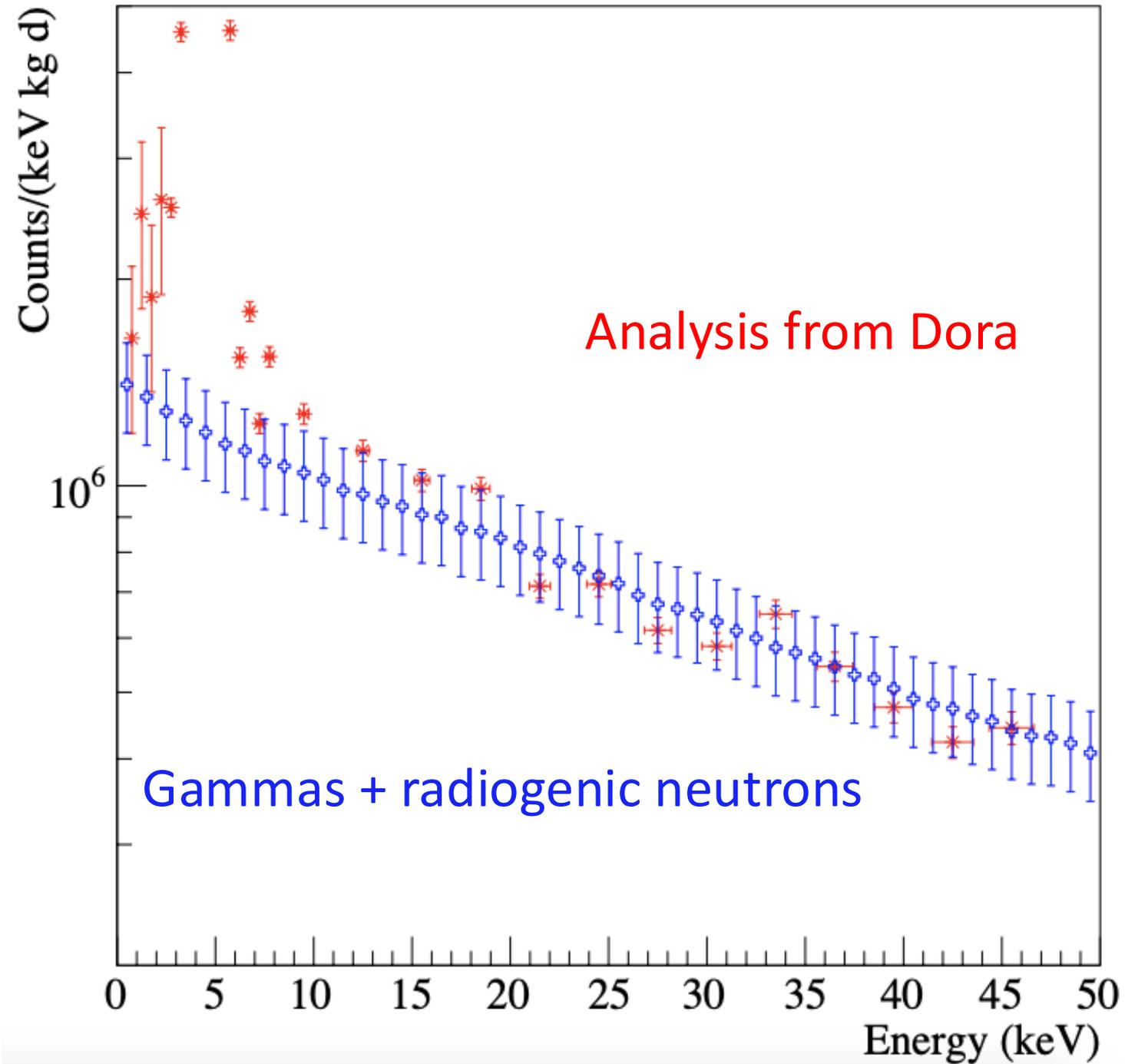All events in one dice, tagging events in the first ring of dices surrounding it

Data: $1.8927 \times 10^6$ d.r.u.

Sim: $1.4094 \times 10^6$ d.r.u.

- Errors in the simulation are dominated by systematics from the gamma-ray (~15%) and neutron (~8.7%) spectra measurements
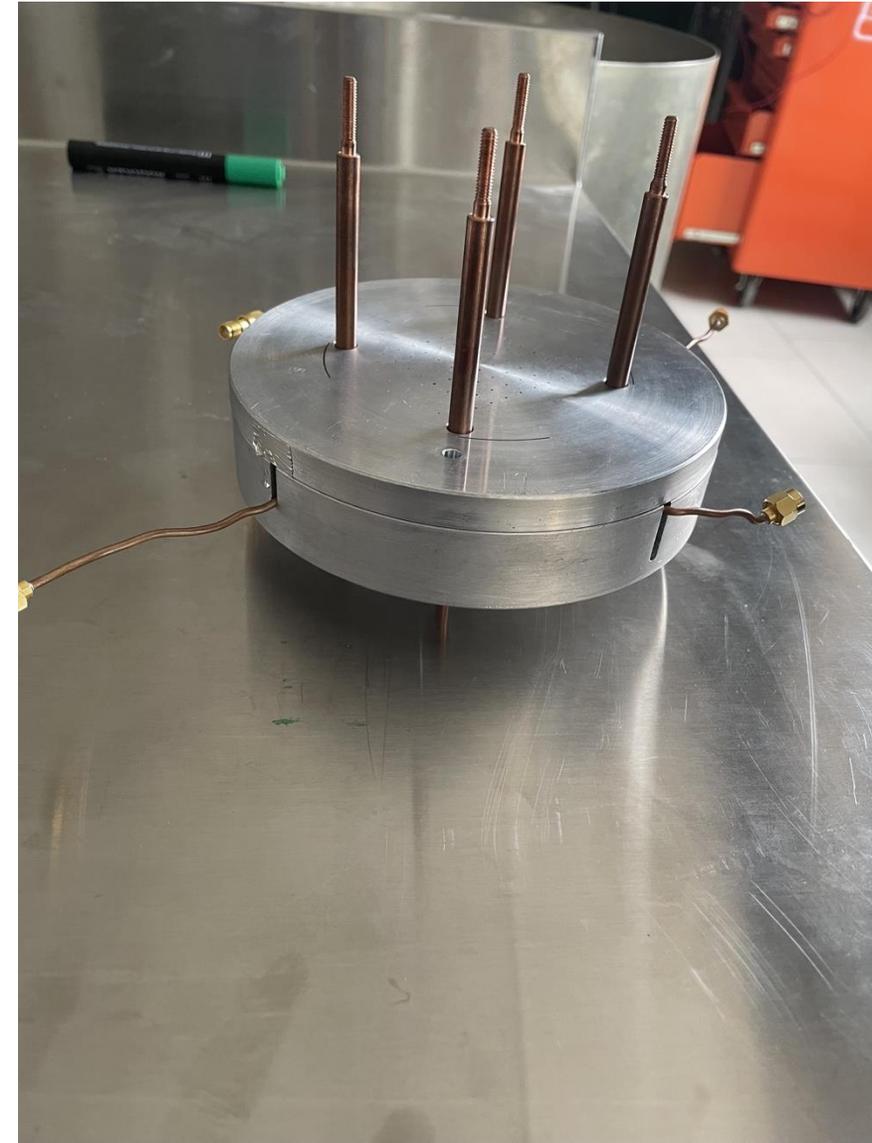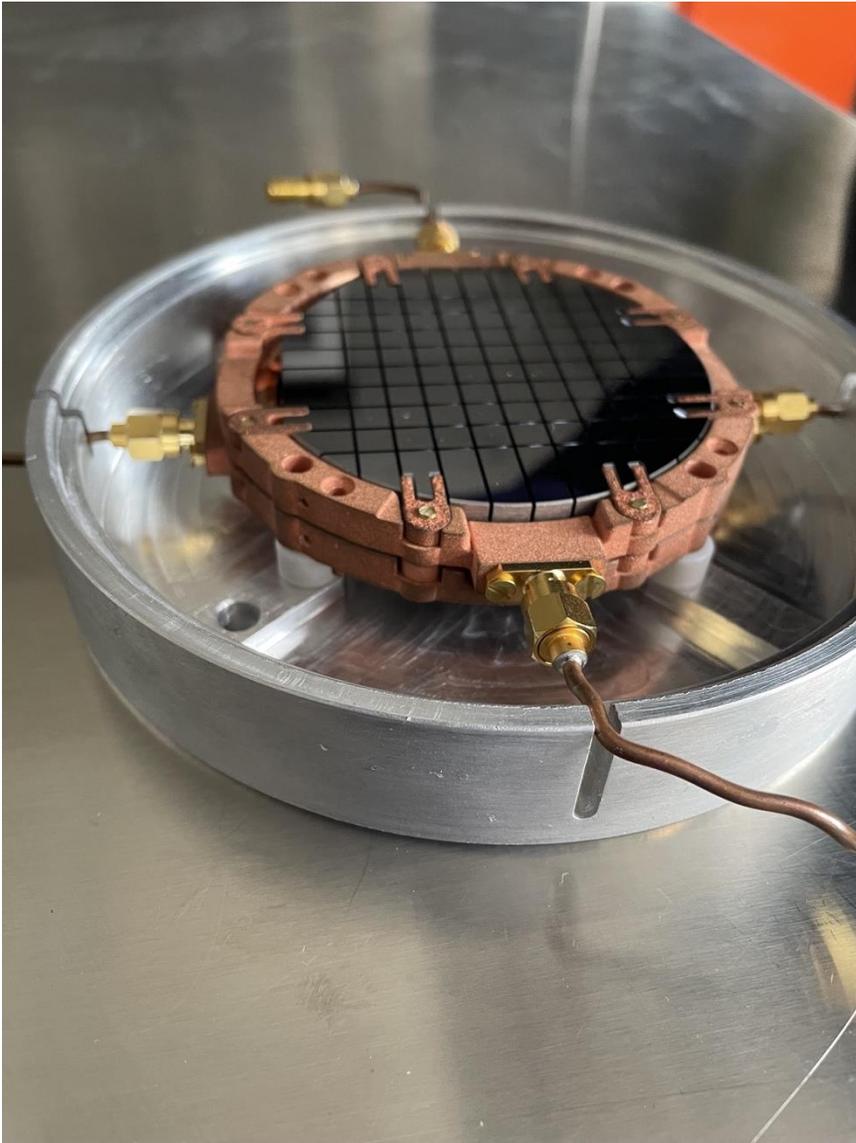
Error = 17.3%



Analysis from Dora

Gammas + radiogenic neutrons

# Is it possible to shield on surface and considerably reduce the background?

# Simulation of shielding configurations at Sapienza: holder material and Pb shield
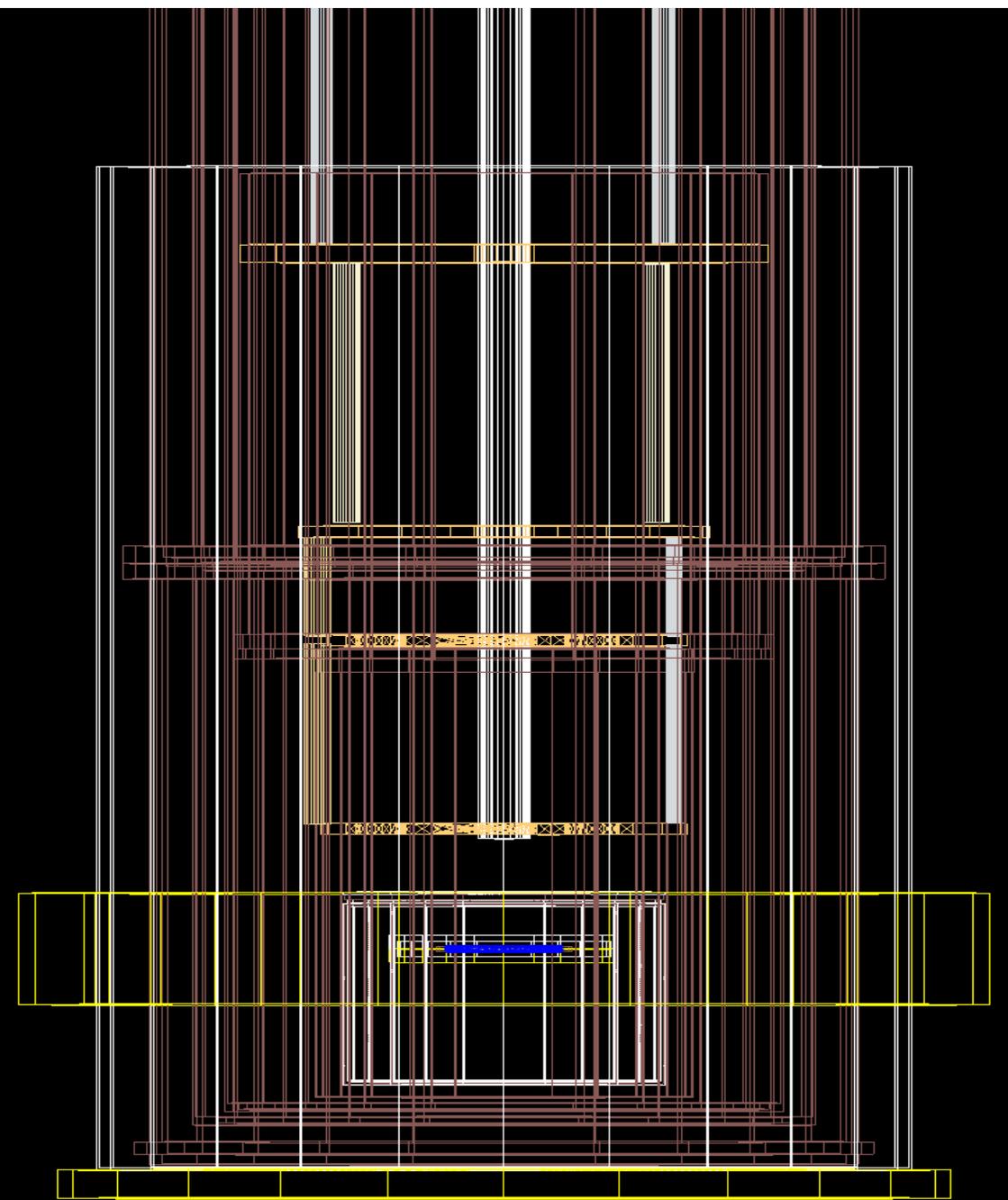
# Change of holder material:
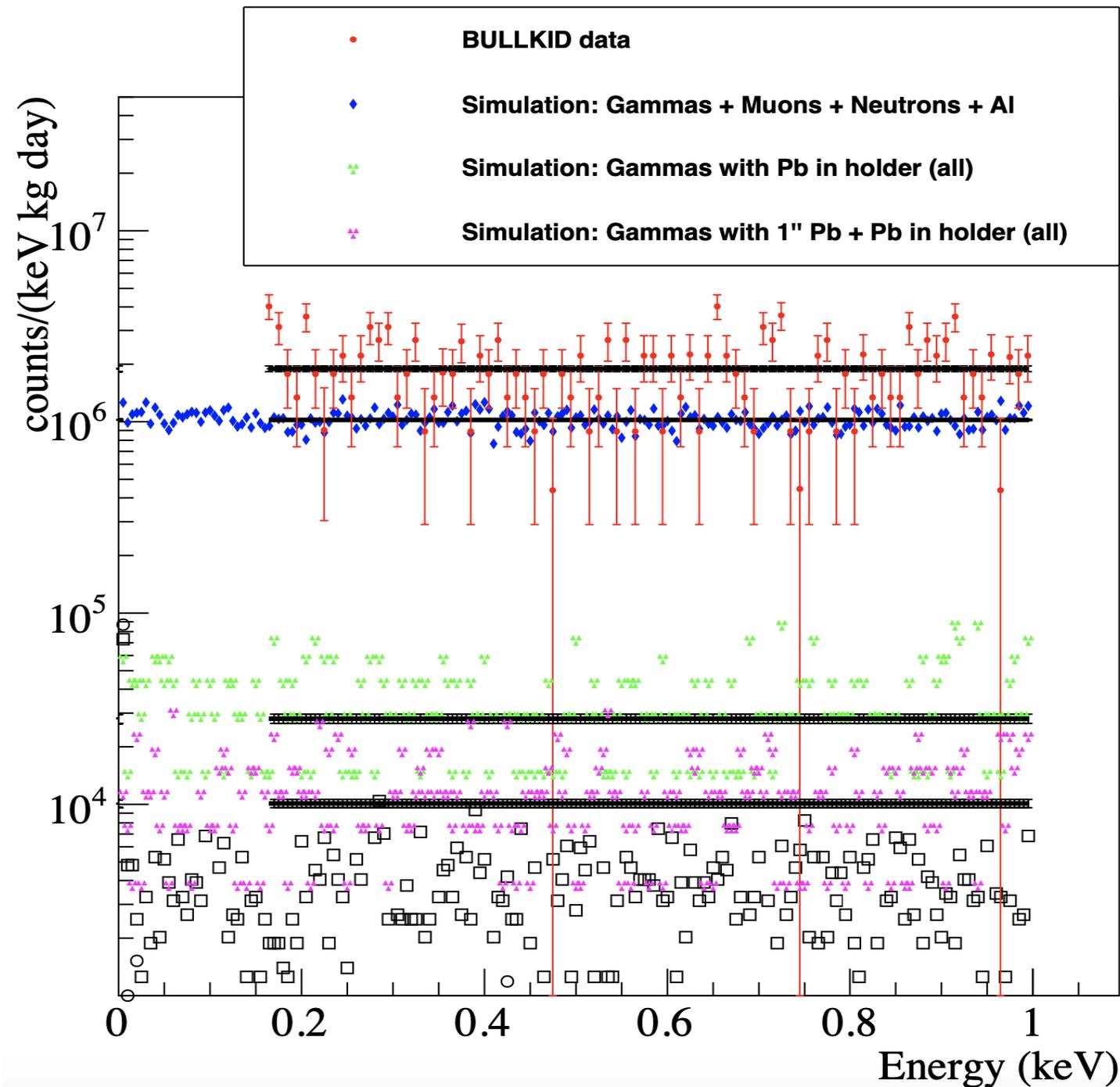# Al -> Pb

# Example of shielding configurations simulated

- Pb in holder: 1.9 kg

- 1" Pb base + 1" belt + Pb in holder (all): (130 + 1.9) kg

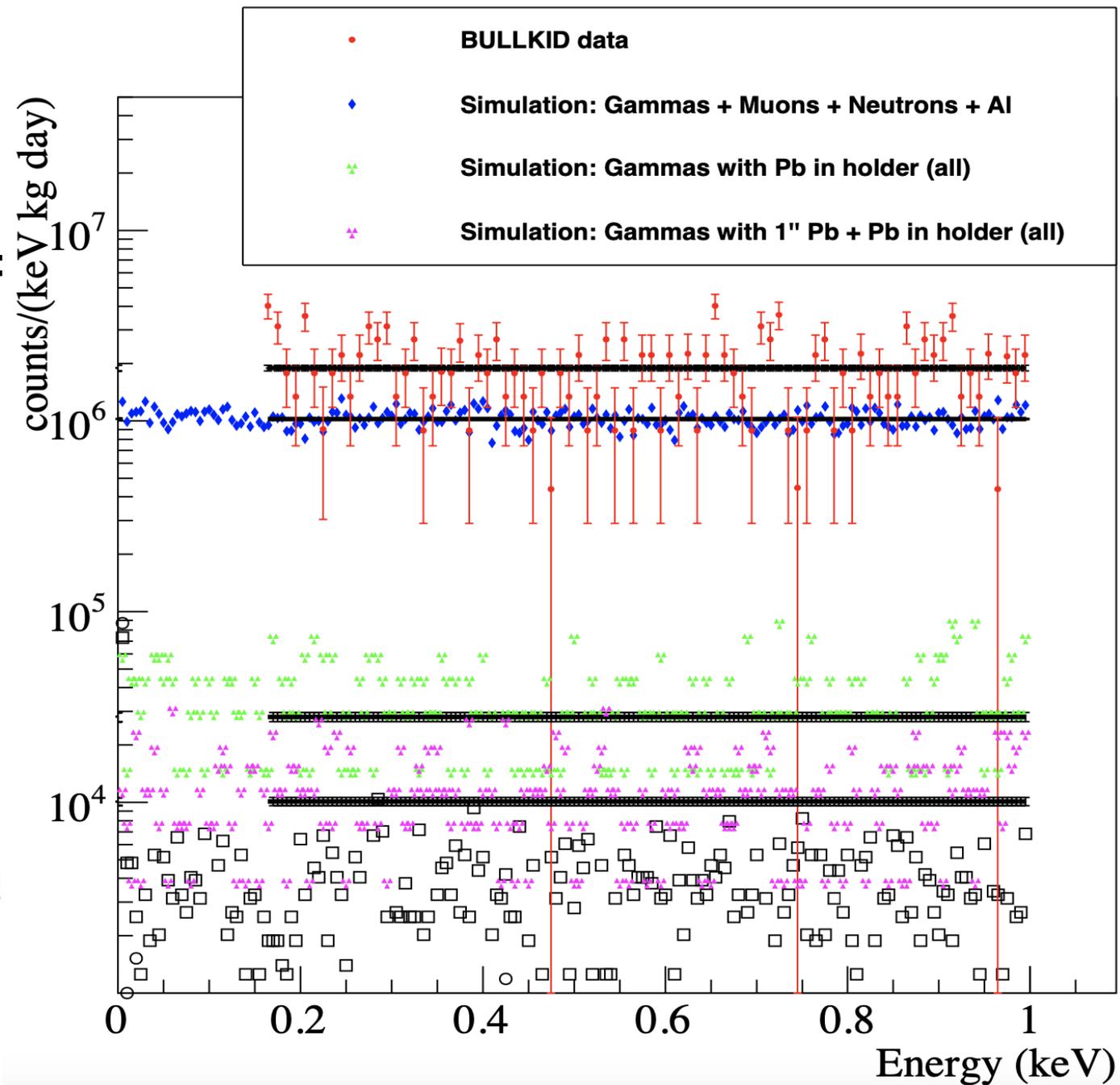Data = $1.89 \times 10^6$

Pb in all holder= $2.80 \times 10^4$
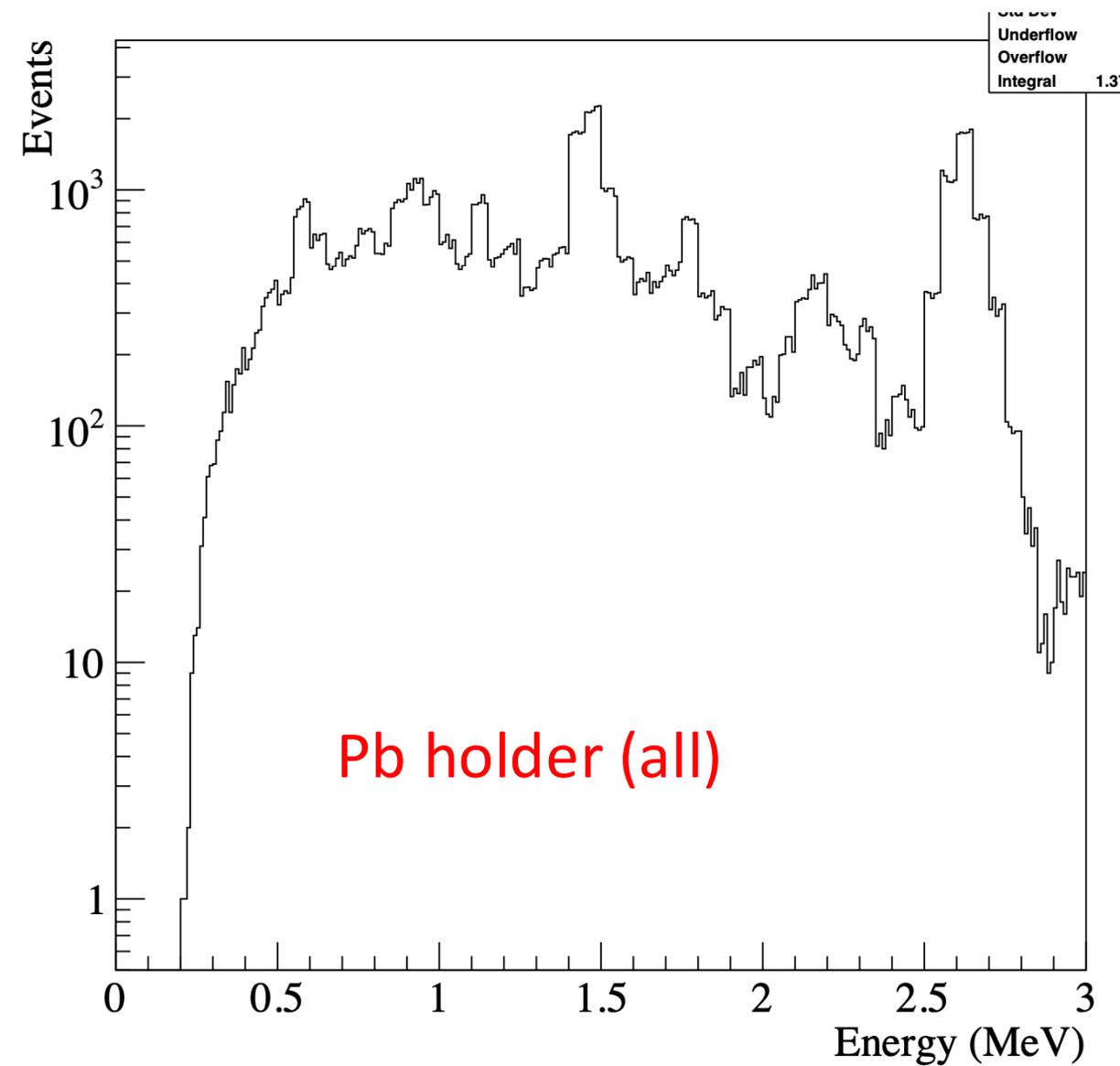
Pb in all holder + 1" Pb castle= $1.01 \times 10^4$

BULLKID data

Simulation: Gammas + Muons + Neutrons + Al

Simulation: Gammas with Pb in holder (all)

Simulation: Gammas with 1" Pb + Pb in holder (all)
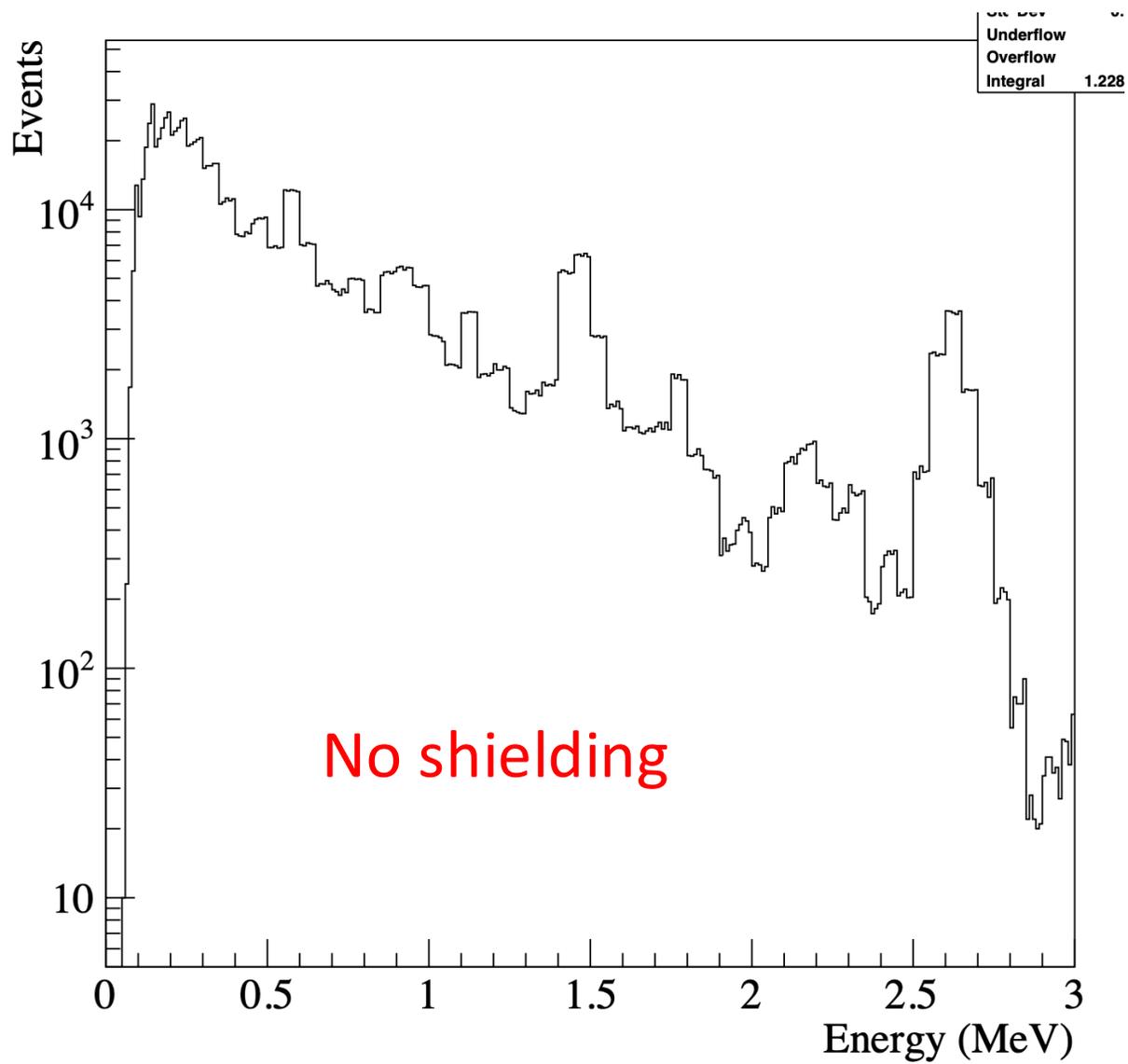
counts/(keV kg day)
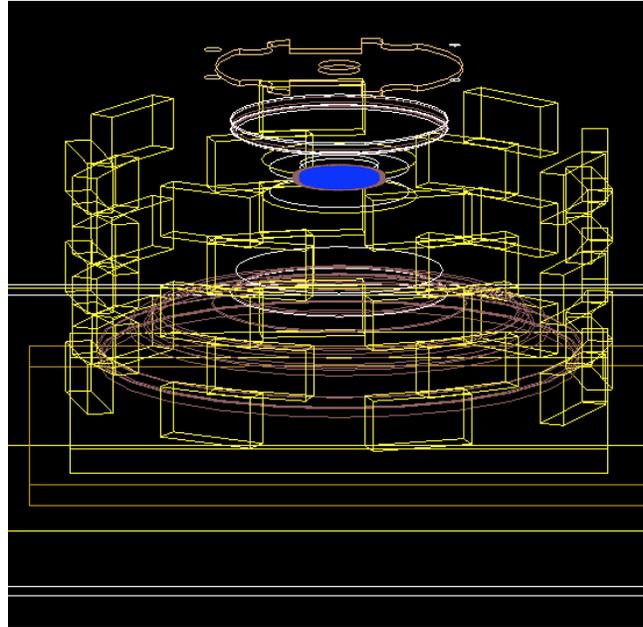
Energy (keV)

MC = $1.02 \times 10^6$
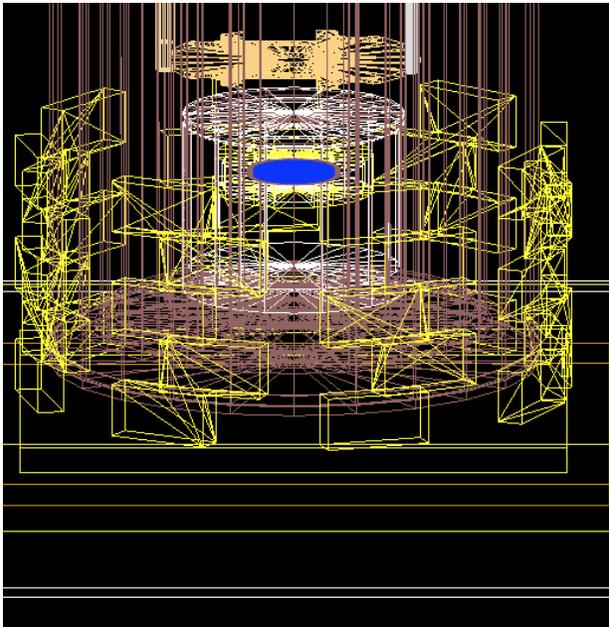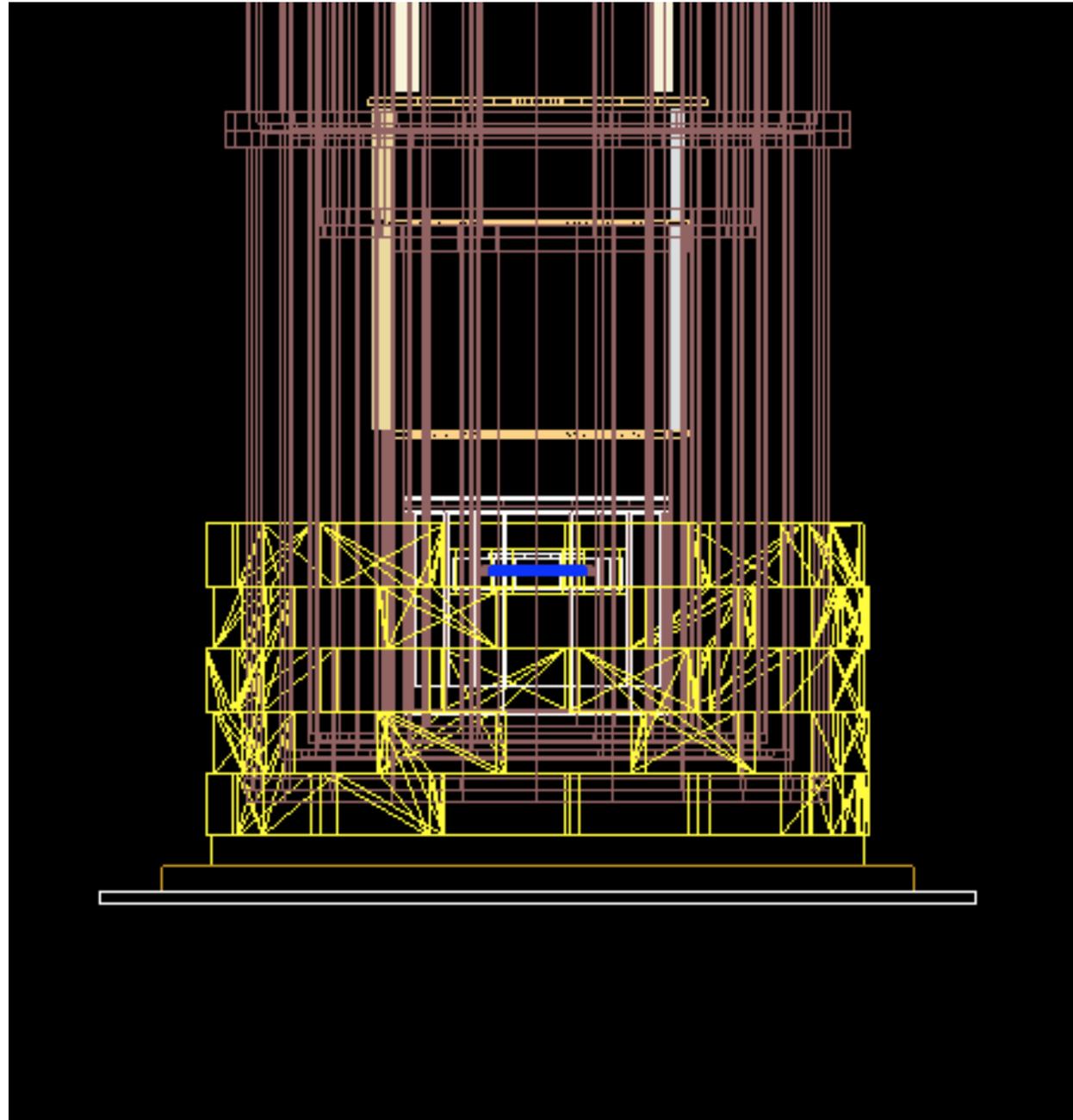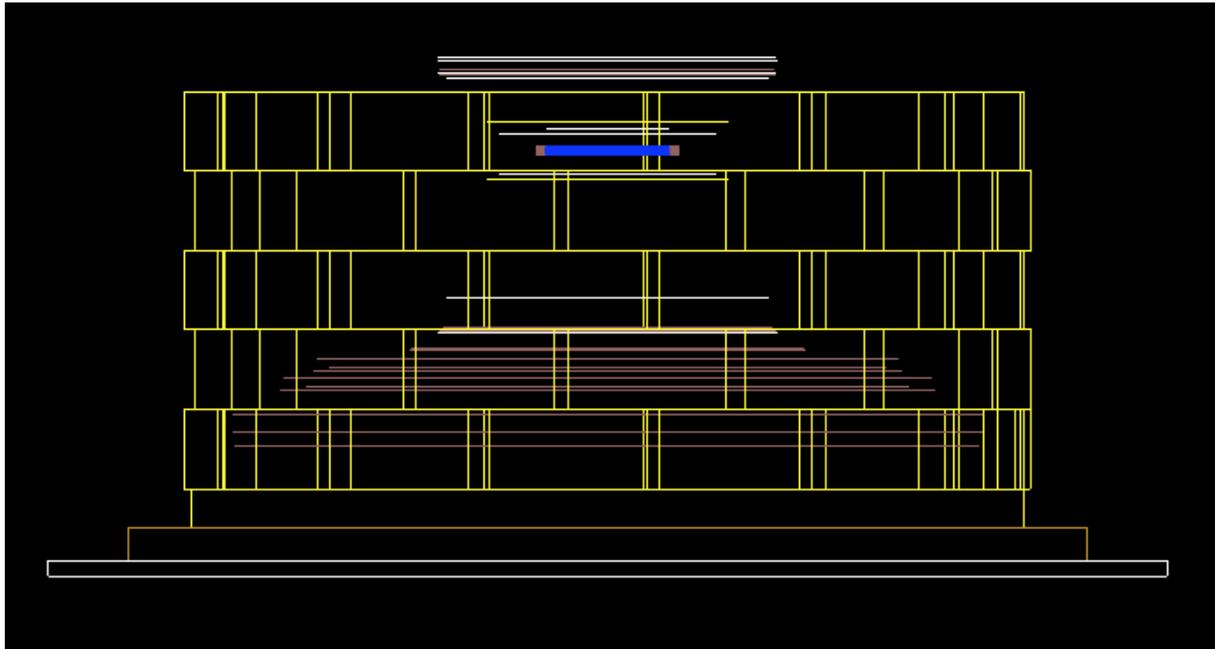Pb in all holder + 1" castle= $1.01 \times 10^4$

Pb mass= 182.5 kg
Thickness: 1 inch
Height: ~32.5 cm

~ 2 orders of magnitude!!

No shielding

Pb holder (all)

# Going back to the experiment: comparison to data with shielding

OXFORD INSTRUMENTS

26 cm (5 bricks)

Lead holder

2.5 cm

3.5 cm

23.5 cm

5 cm

10 cm

115 cm

2.5 cm

55.5 cm
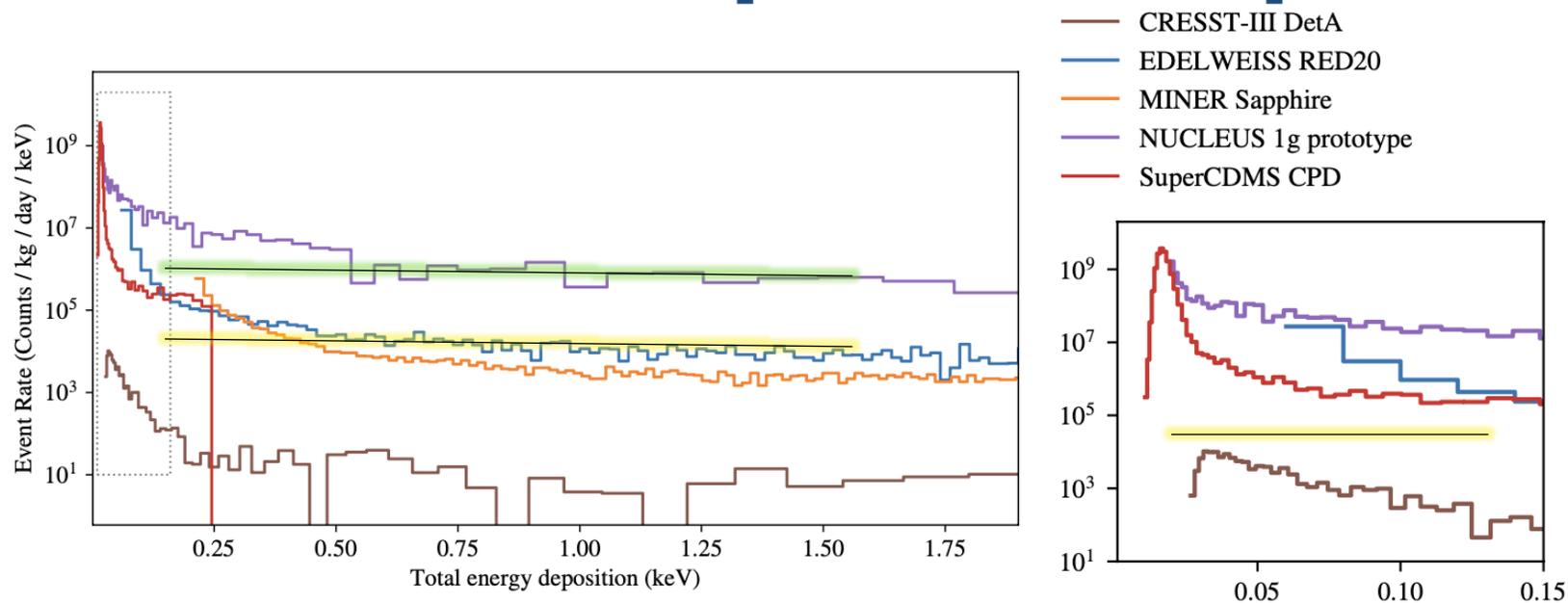
89 cm

nu-floor

# Results in a few days

# Summary and Conclusions

✓Very good agreement between data and simulations

✓Reduction by nearly two orders of magnitude on surface (with relatively little effort)



**Background issue in phonon experiments**

P. Adari, et al.: EXCESS workshop: Descriptions of rising low-energy spectra SciPost Phys. Proc. 9 (2022) 001

✓Results in a few days to compare data and simulations