Status of Monte Carlo and digitization code

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Open developments

- Improve data/MC agreement on 55Fe calibrations
- Data/MC comparison on other sources:
    - **AmBe (!!!)**
    - Eu, Ba
    - Am
- Simulation of X-Y non-uniformities with new 55Fe map
- Improve data/MC agreement of LIME background spectra (Flaminia’s talk)
- PMT simulation (Rafael’s talk)
- **CYGNO-04 background simulation (!!!)**
- MC catalog
- Optimize DIGI file format

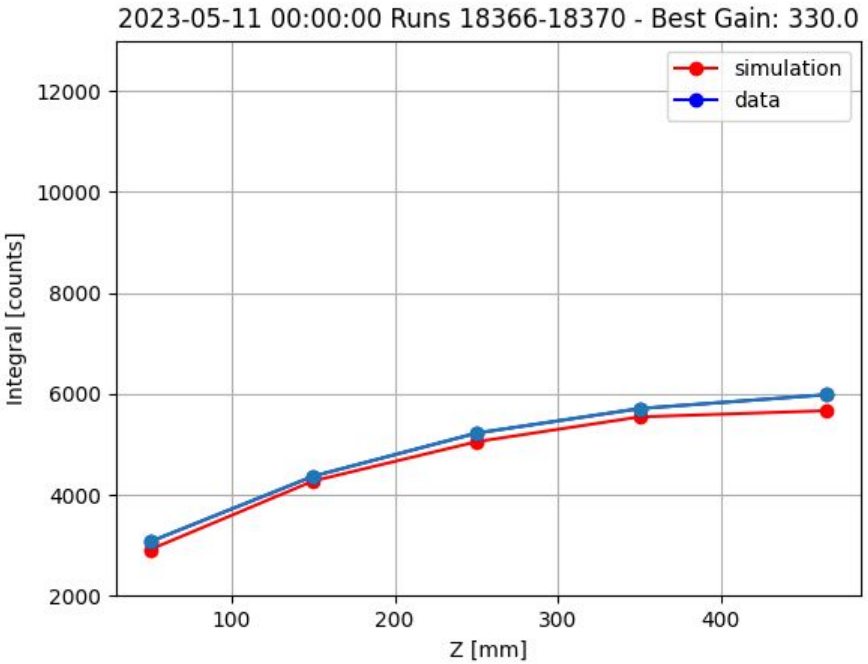
Status of digitization (LIME)

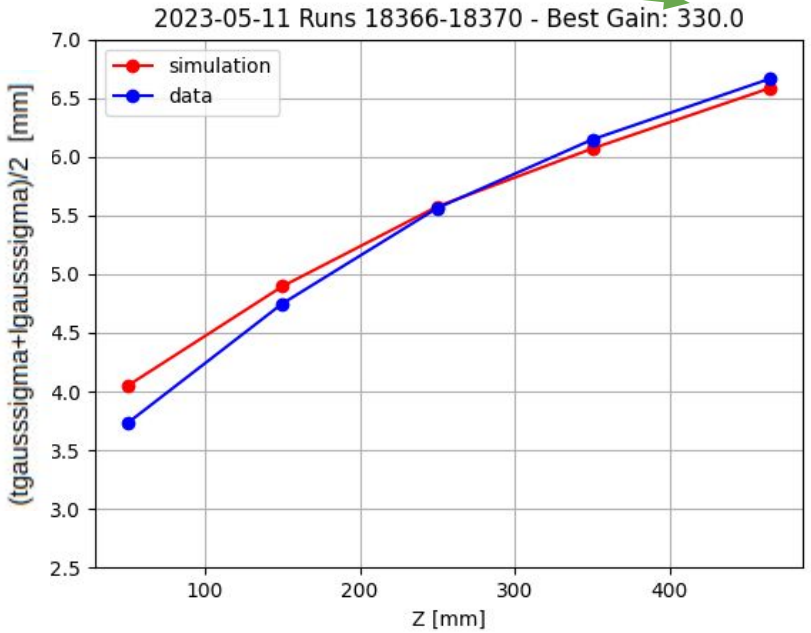
- We now have to tune the gain parameter to reproduce LY variability in data (the **gain in digitization is now a parameter not dependent on the HV**, and we don't use the gain measured at LNF).
- For a correct use of the simulation, the user will need to set the right gain parameter (soon this parameter might be inferred from real LY)
- We started the comparison with other X-ray sources used in RUN 3, other than 55Fe, but we realized the **digitization is not able to reproduce 55Fe data in all periods**.
- The only data that we are able to reproduce with the simulation are calibrations runs in May (RUN 3).
- After May we see inconsistencies in data, also visible on background data/MC comparison (see Flaminia's talk).

Simulation of 55Fe calibration in RUN 3

The digitization tuned with LNF data still works really well once we adjust the **gain of the GEMs.** (also, we need a fine-tuning of sigma0T)

330 is not HV

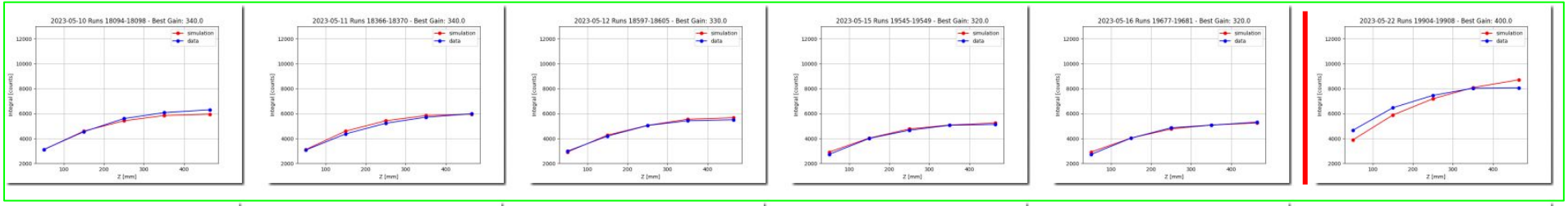


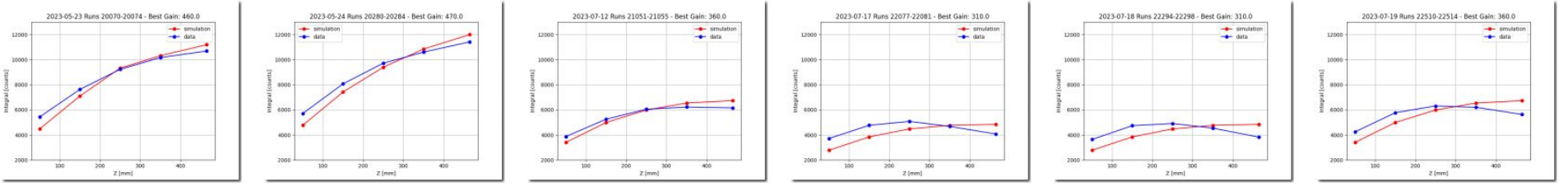


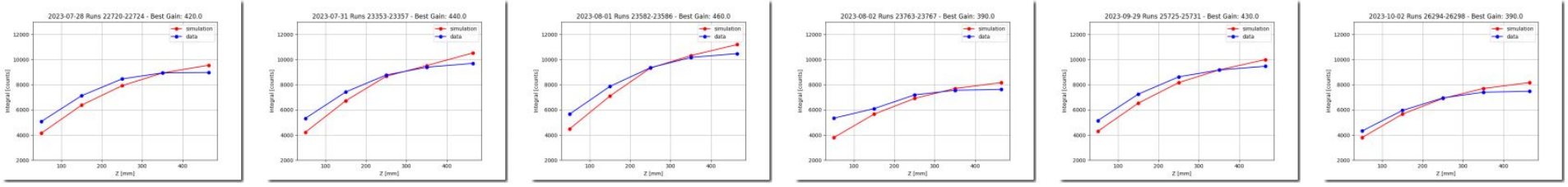
Other 55Fe calibration data/MC comparison (RUN 3)

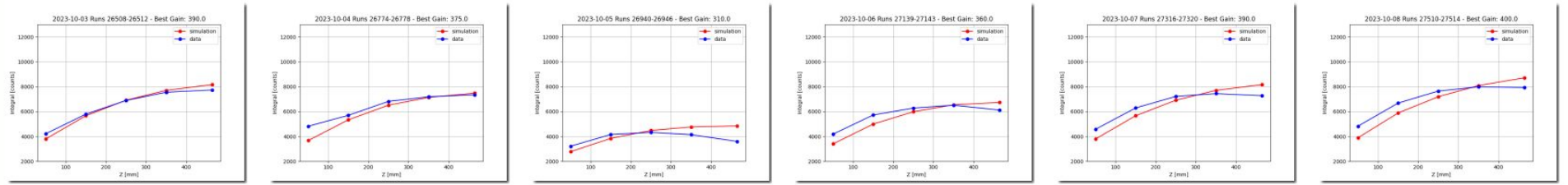
May

Issue with booster







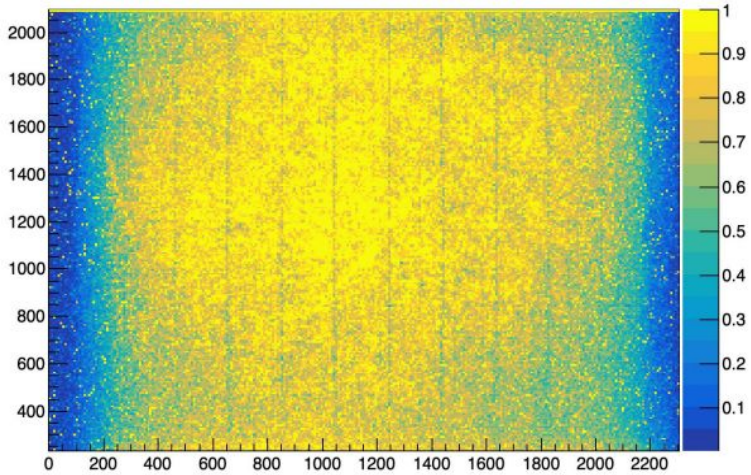


X-Y non-uniformities

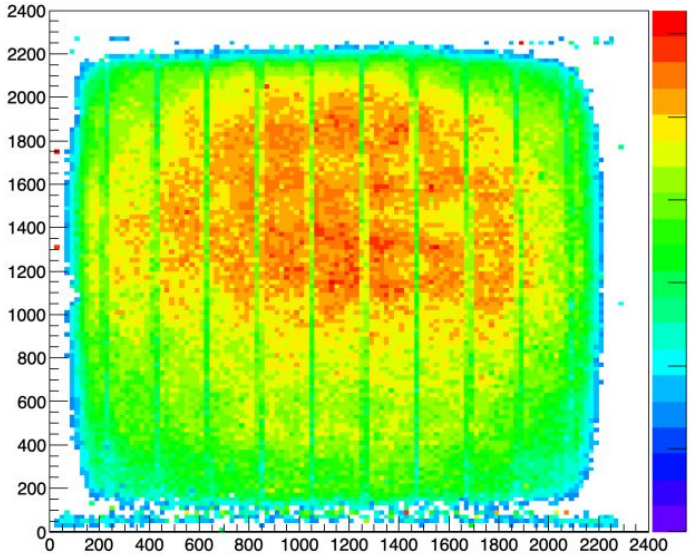
We learned that using the ‘cosmic’ map (left) in digitization, we can simulate both vignetting and gain non-uniformity (~15%). This is relevant when simulating energy resolution.

We now have a new map (right) made with uncollimated 55Feiron at LNGS. We should try to simulate 55Fe resolution with this new map.

Cosmic map (LNF)



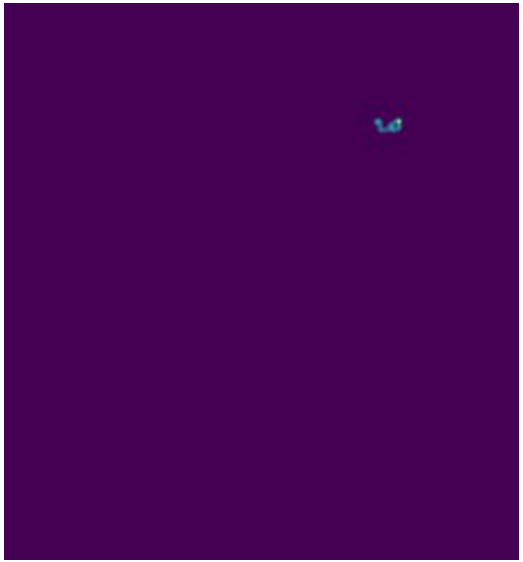
Uncollimated iron map (LNGS)



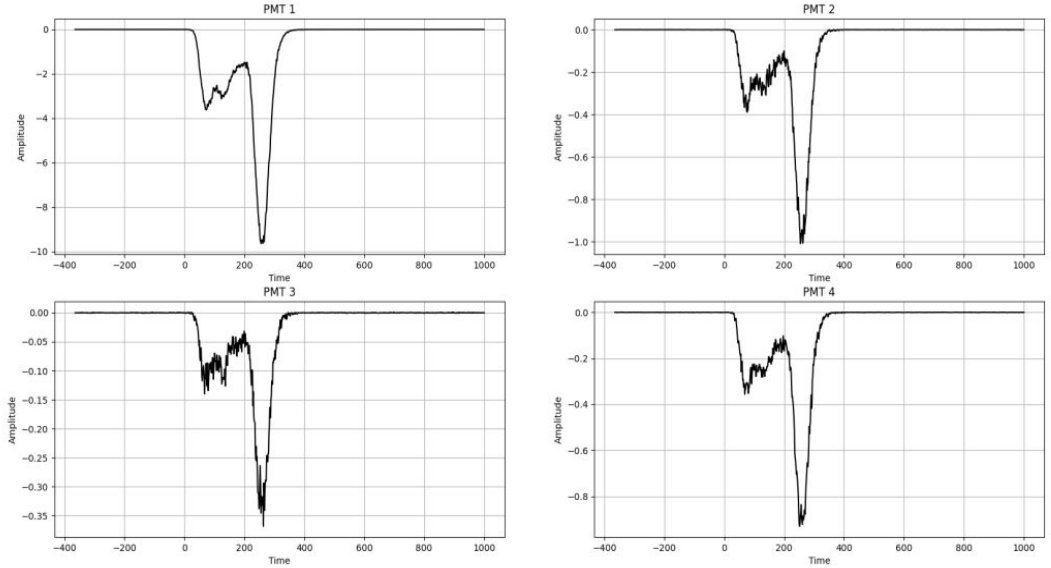
Status of digitization (PMTs)

We can now simulate camera and waveforms, and we started optimizing the waveform simulation (Rafael's talk today)

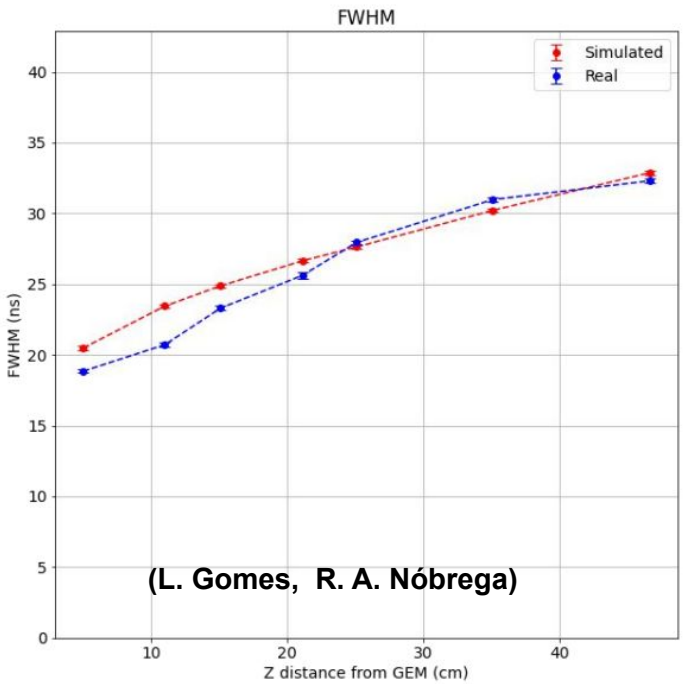
50 keV ER

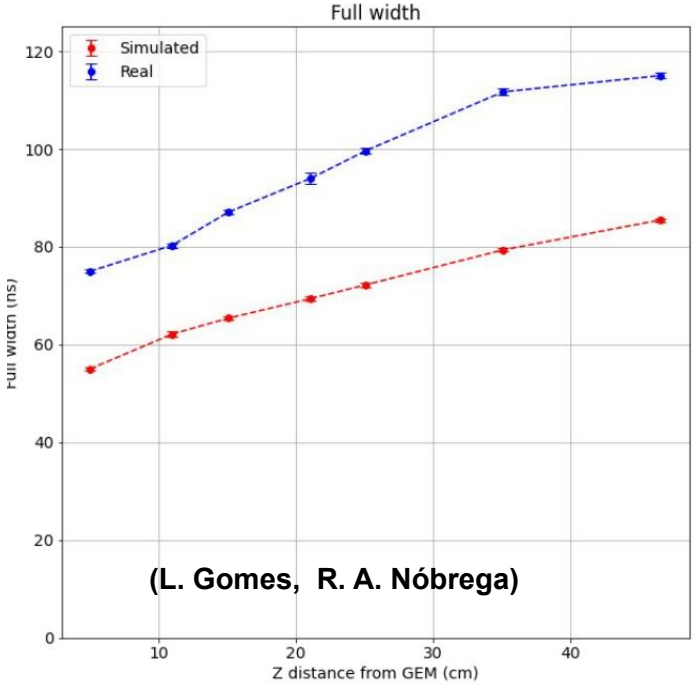


50 keV ER



The digitization code already is able to reproduce **FWHM** of 55Fe waveforms.



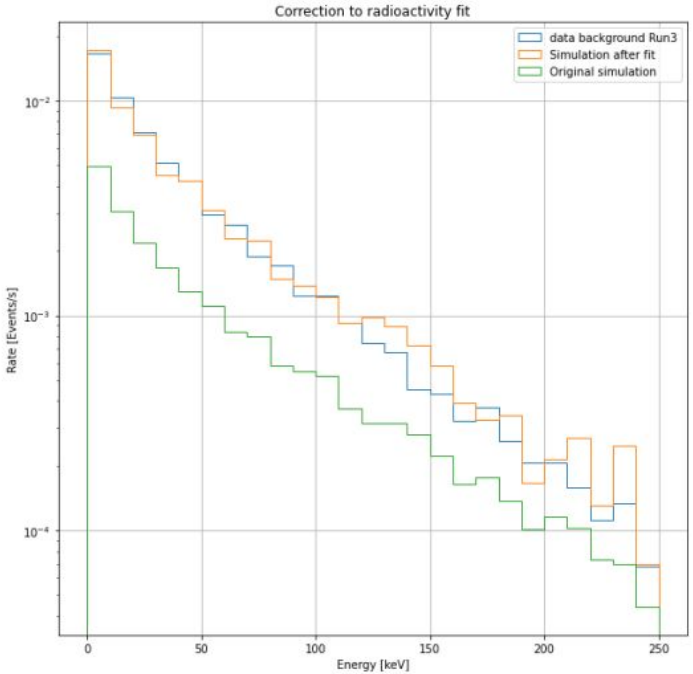


Next steps would be: 1) compare **integral** and **amplitude** of 55Fe, and 2) then start comparison with **other sources**

LIME background

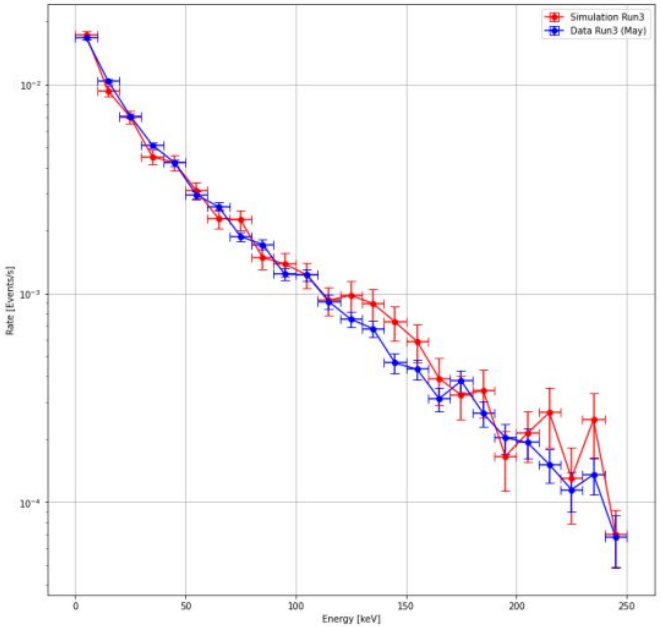
Differences between the measured spectrum and the simulated one are likely due to an internal source of background that we are not taking into account.

(F. Di Giambattista) differences in spectra



normalizing

(F. Di Giambattista) RUN 3 background

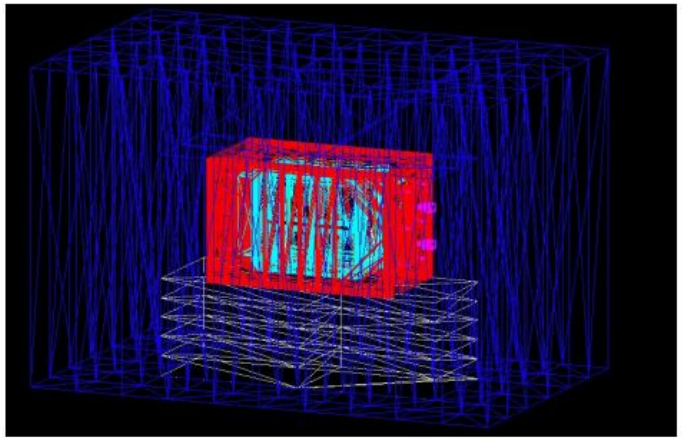


Also NR spectrum is being studied with promising results (Flaminia's talk today)

CYGNO-04 simulation

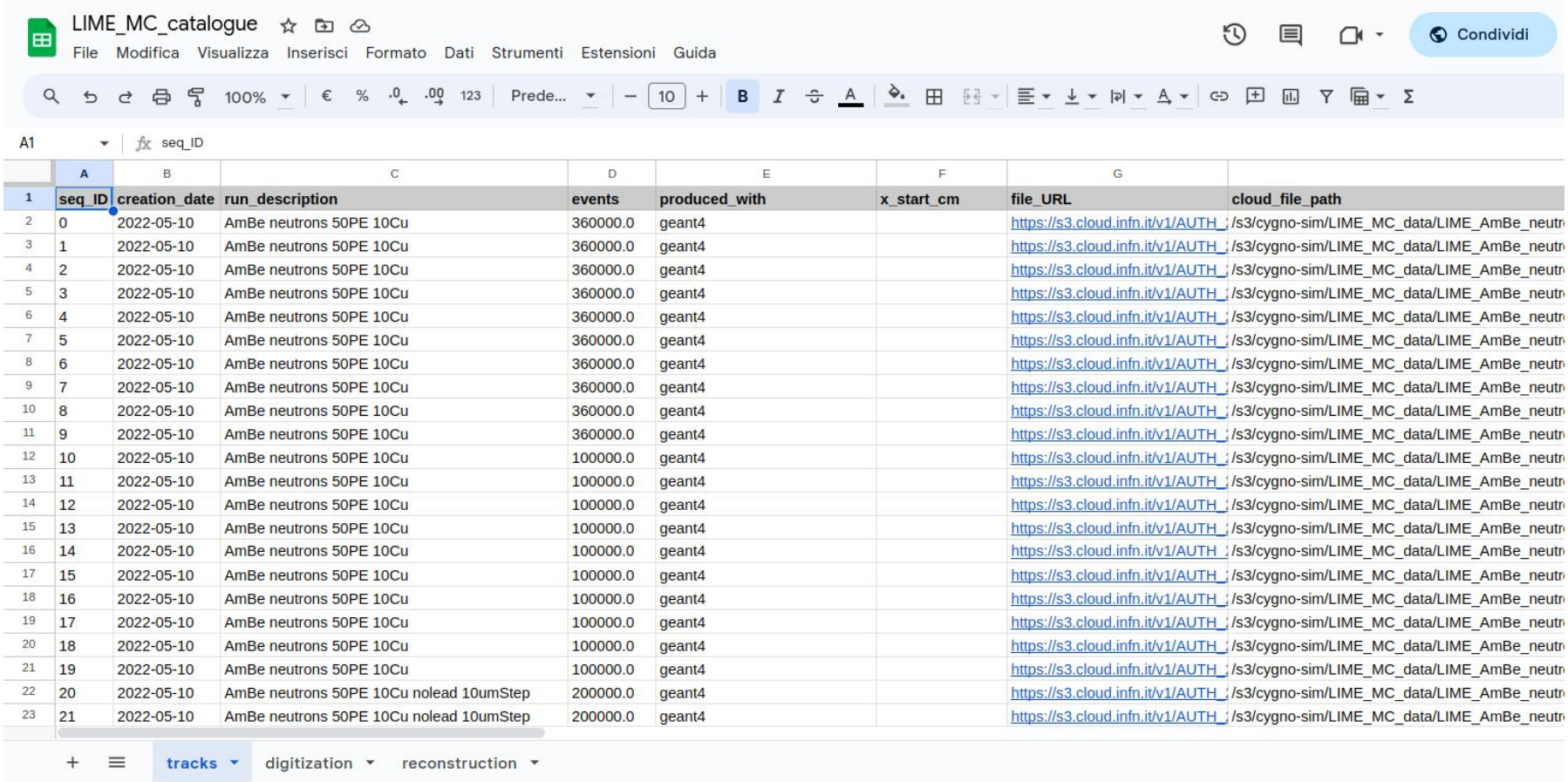
- Need to optimize materials for low background in CYGNO-04 (**need a simulation**)

- external gamma background estimation ~10^3-10^4 events/year with shielding made of water (1 m) and copper (10 cm) **(need a simulation)**



- **Currently we have only estimations from CYGNO-01**

MC catalog (updated semi-manually)



LIME_MC_catalogue

File Modifica Visualizza Inserisci Formato Dati Strumenti Estensioni Guida

Condividi

A1 | seq_ID

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3	1	2022-05-10	AmBe neutrons 50PE 10Cu	360000.0	geant4		https://s3.cloud.infn.it/v1/AUTH_	/s3/cygno-sim/LIME_MC_data/LIME_AmBe_neutr
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8	6	2022-05-10	AmBe neutrons 50PE 10Cu	360000.0	geant4		https://s3.cloud.infn.it/v1/AUTH_	/s3/cygno-sim/LIME_MC_data/LIME_AmBe_neutr
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23	21	2022-05-10	AmBe neutrons 50PE 10Cu nolead 10umStep	200000.0	geant4		https://s3.cloud.infn.it/v1/AUTH_	/s3/cygno-sim/LIME_MC_data/LIME_AmBe_neutr

tracks digitization reconstruction

https://docs.google.com/spreadsheets/d/1XJ0P6zK83egpaPwSXfflgTVpL_o67vL5TJpjC7c9bsA/edit?usp=sharing

Optimize DIGI file format

Present file format produced by digitization is not optimized:
- images containing the sum of signal + noise

→ noise from pedestal runs (images repeated many times)
→ no flexibility if exposure time changes
→ no access to signal only

Proposed format:
- signal only image → full track
- additional step before reco to simulate the sensor readout time and add pedestal

(Also, we should consider using the noise simulation if it helps in this sense).

File format: we should also decide which file format to use (root, h5… ?). Currently there are 2 branches: root, h5

Conclusions: task and people

- Improve data/MC agreement of LIME background spectra (Flaminia)
- Simulation of X-Y non-uniformities new 55Fe map (Pietro)
- **Improve data/MC agreement for 55Fe, other x-ray source, AmBe** (Pietro)
- PMT simulation (Rafael, Luan)
- **CYGNO-04 background simulation** **(??)**
- MC catalog management (Pietro)
- Optimize DIGI file format (??)

⚠️ **We need manpower!** ⚠️