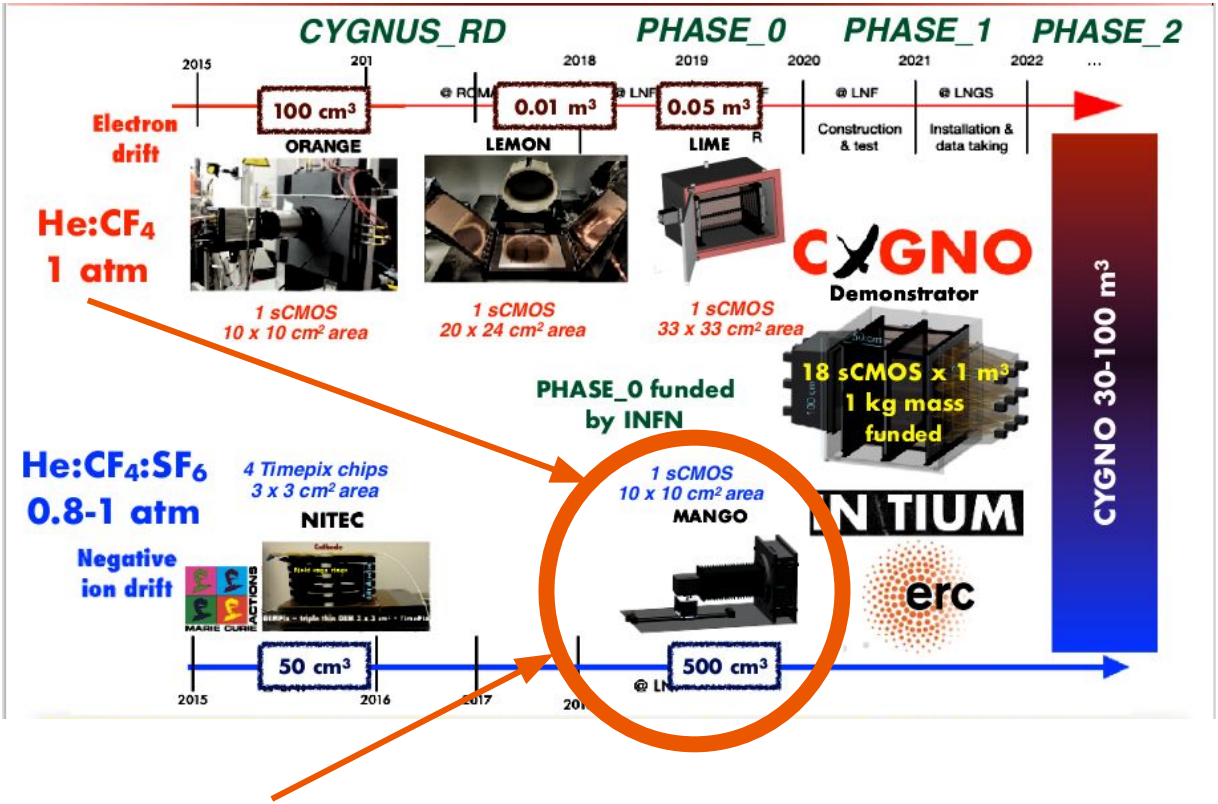
MANGO

A brief update on the initial tests and analysis performed

D. Marques, E. Baracchini, A.F.V. Cortez, G. Dho

Part of this project has been funded by the European Union's Horizon 2020 research and innovation programme under the ERC Consolidator Grant Agreement No 818744

MANGO in the CYGNO roadmap



MANGO - Objectives

MANGO: a Multipurpose Apparatus for Negative ion studies with GEM Optical readout

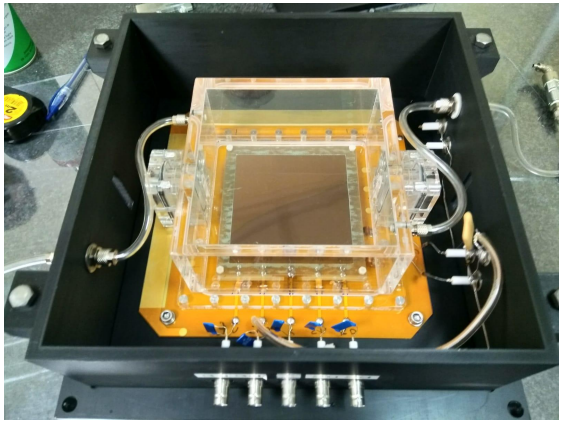
- Goal of the tests/analysis performed in Frascati, in November:
  - ➔ Test MANGO's performance.
  - ➔ Analyse the ^{55}Fe spectra → Compare the results with ORANGE prototype.
  - ➔ Study different parameters.
  - ➔ Study Kentaro's field cage performance (ongoing work).
- Data analysis:
  - ➔ Emanuele and Igor's reconstruction code is optimized for LEMON.

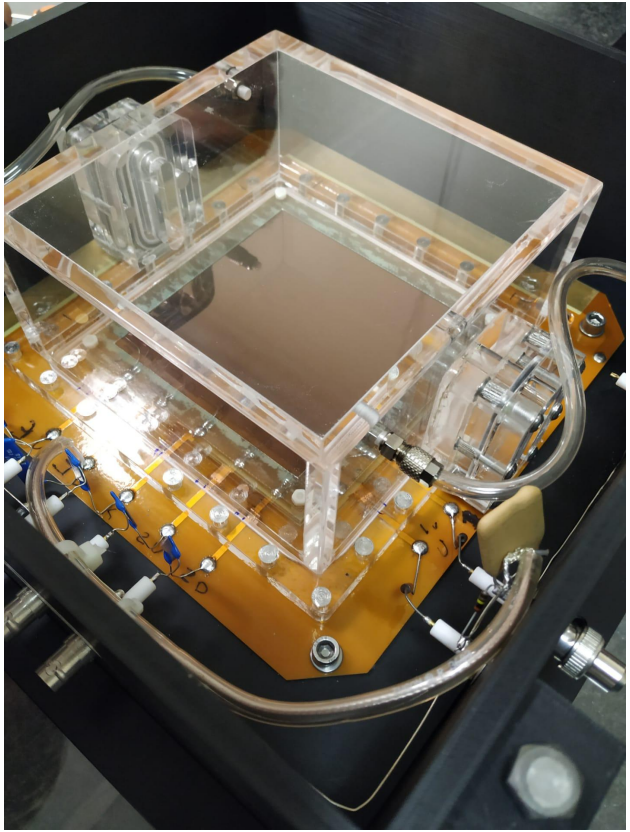
    ↓

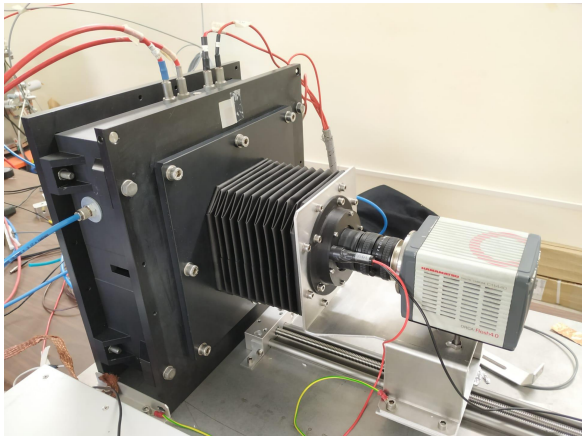
    We performed some optimizations on the code to use it on MANGO data:
    - ↳ Some extra cuts were applied
    - ↳ Some parameters were studied and changed

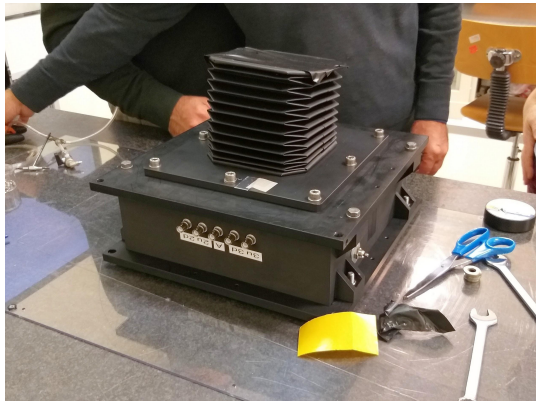
    } for better selection of the ^{55}Fe events

MANGO - Experimental setup



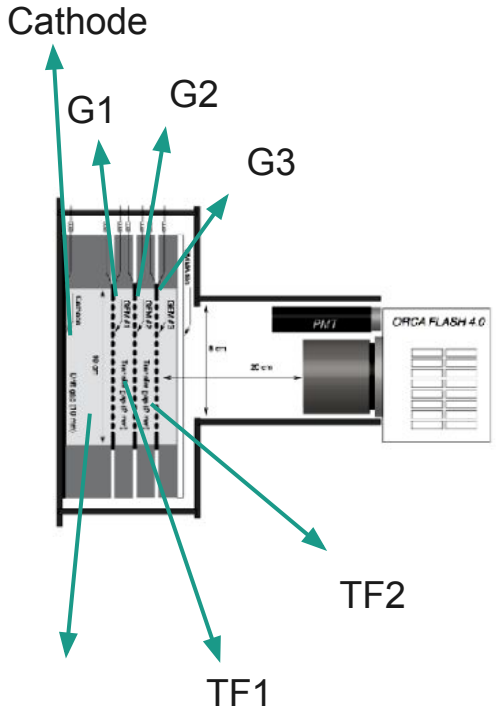


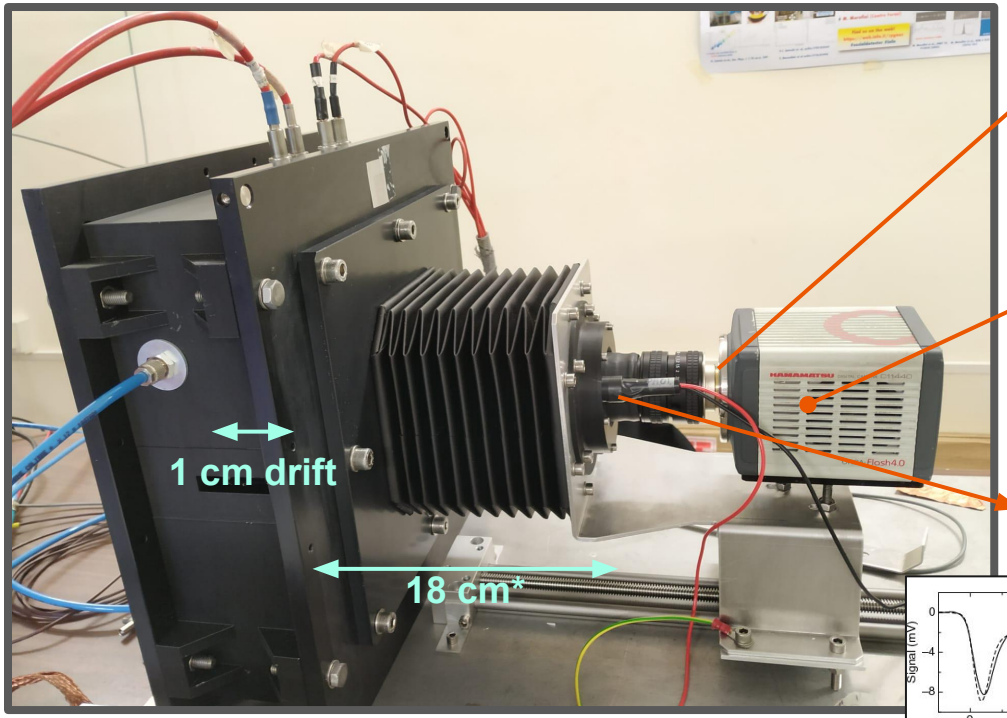




MANGO - Experimental setup

*From camera's lense to GEM

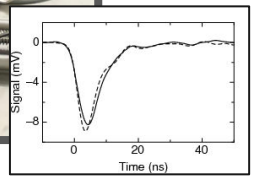




1 lense spacer: 2mm

Exposure time: 500 ms

PMT: 30 mV threshold



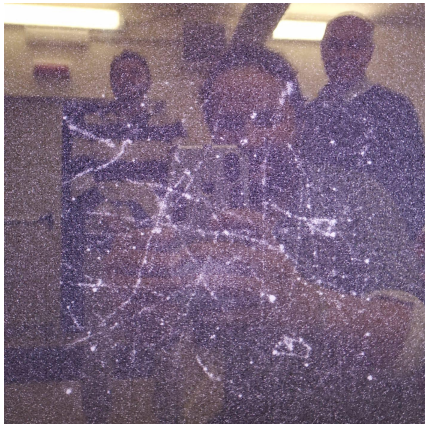
Acquired signal: Picture, PMT trace and GEM signal after preamplifier

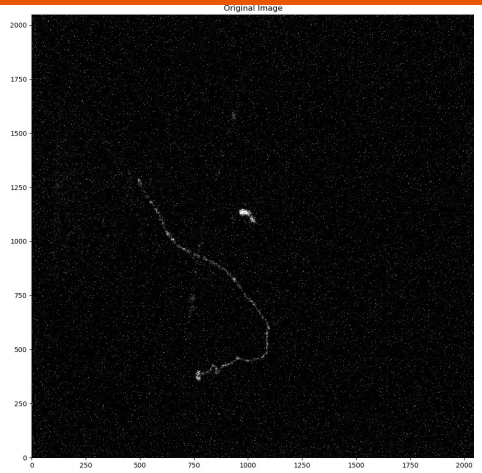
MANGO - Tests carried out

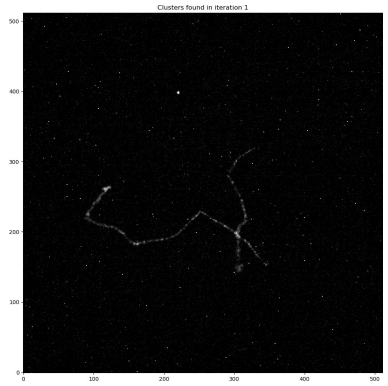
Parameters studied:

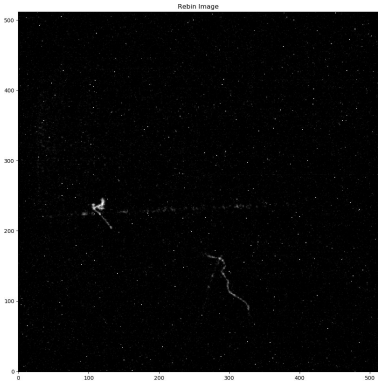
Kentaro's field cage

- ➔ Gain curve
- ➔ Drift distance
- ➔ Drift field voltage
- ➔ GEM voltage configuration
- ➔ Transfer field
- ➔ Cosmic runs

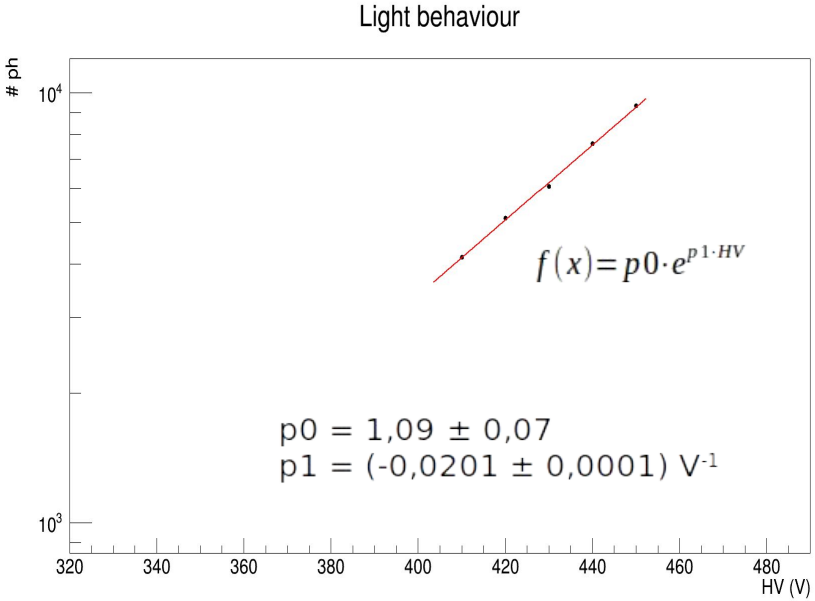




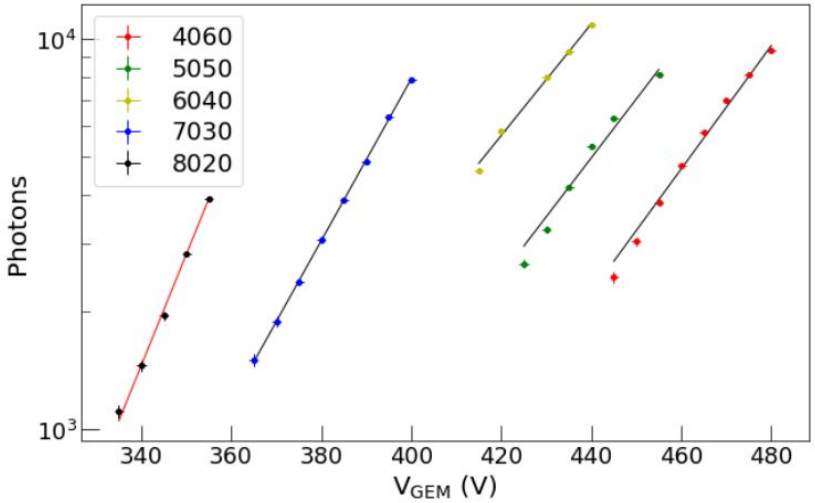




MANGO - Results - GEM voltage (gain curve)



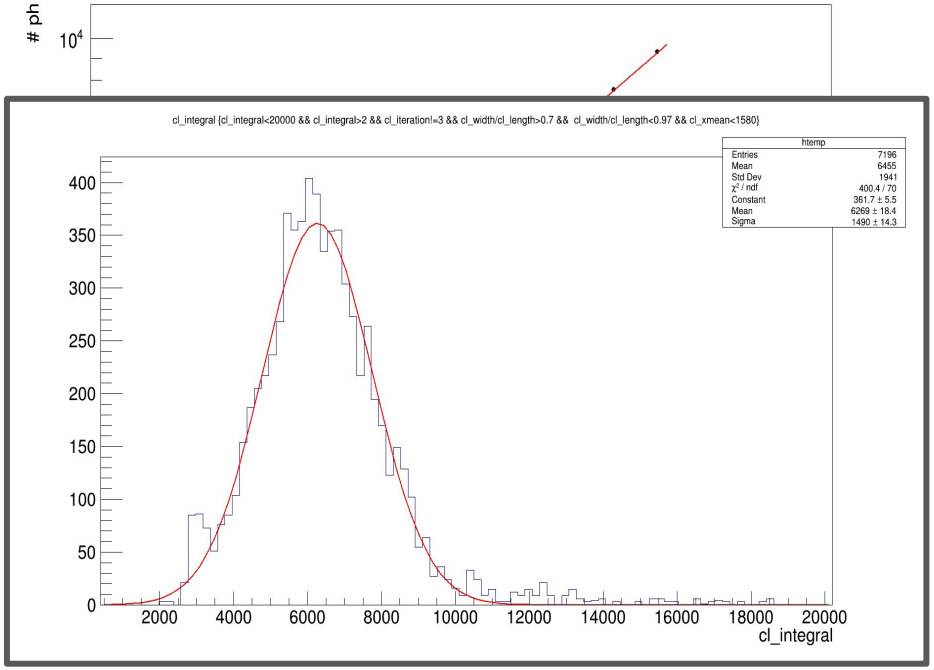
From R. Campagnola's thesis



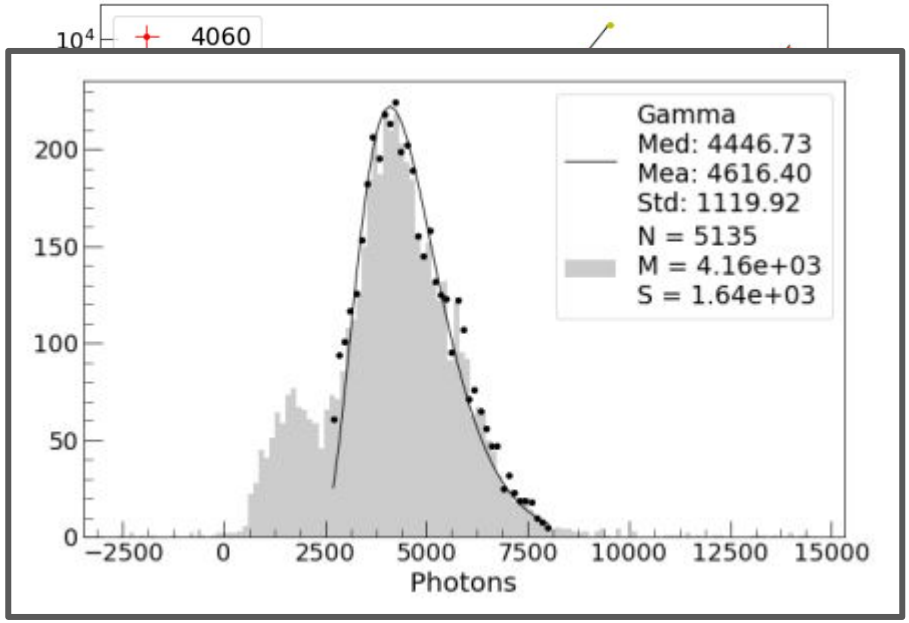
We see **consistency** with the previous **ORANGE** prototype data

MANGO - Results - GEM voltage (gain curve) - Fit

Light behaviour



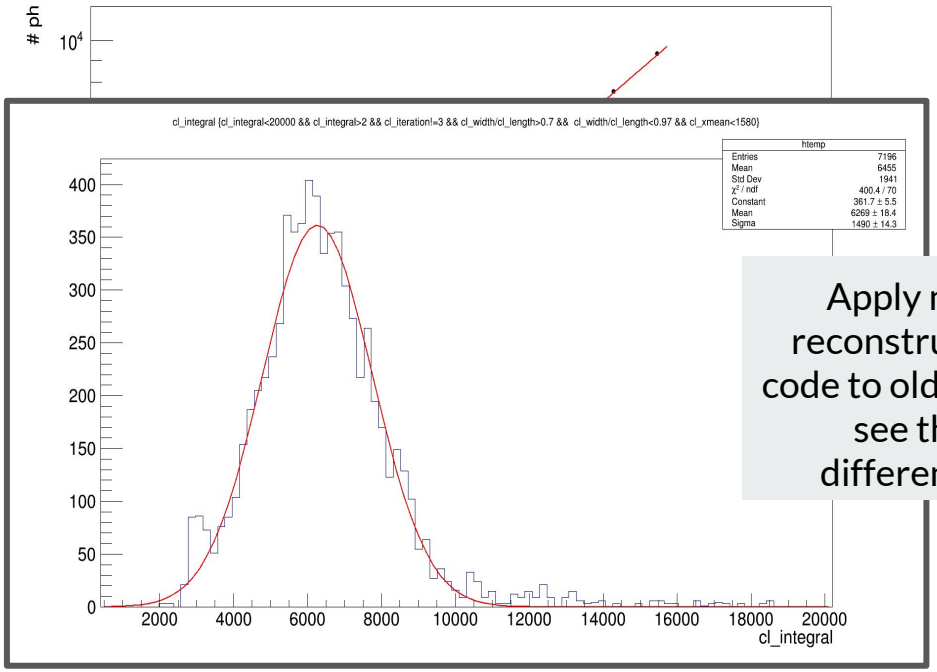
From R. Campagnola's thesis



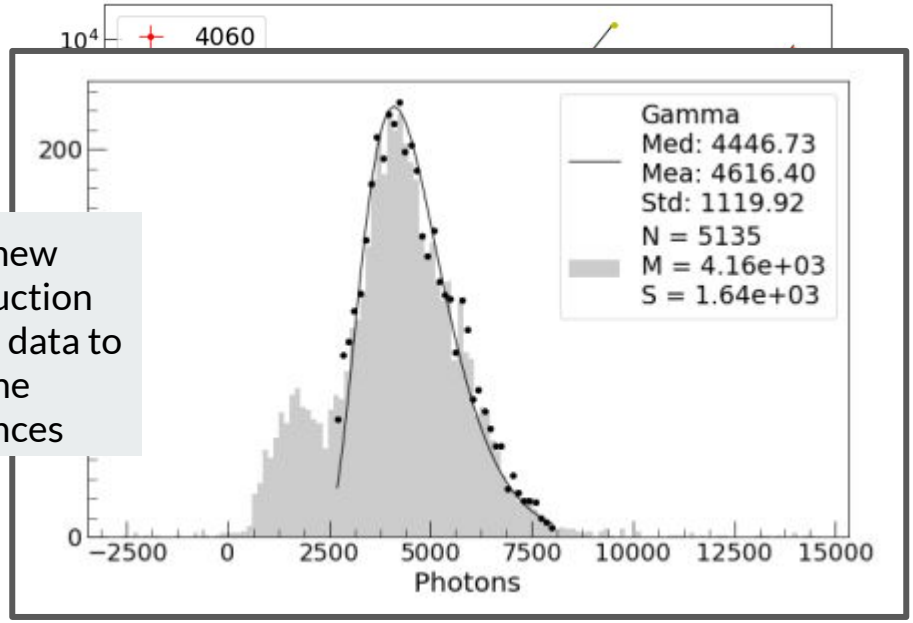
We see **consistency** with the previous **ORANGE** prototype data

MANGO - Results - GEM voltage (gain curve) - Fit

Light behaviour



From R. Campagnola's thesis



Apply new reconstruction code to old data to see the differences

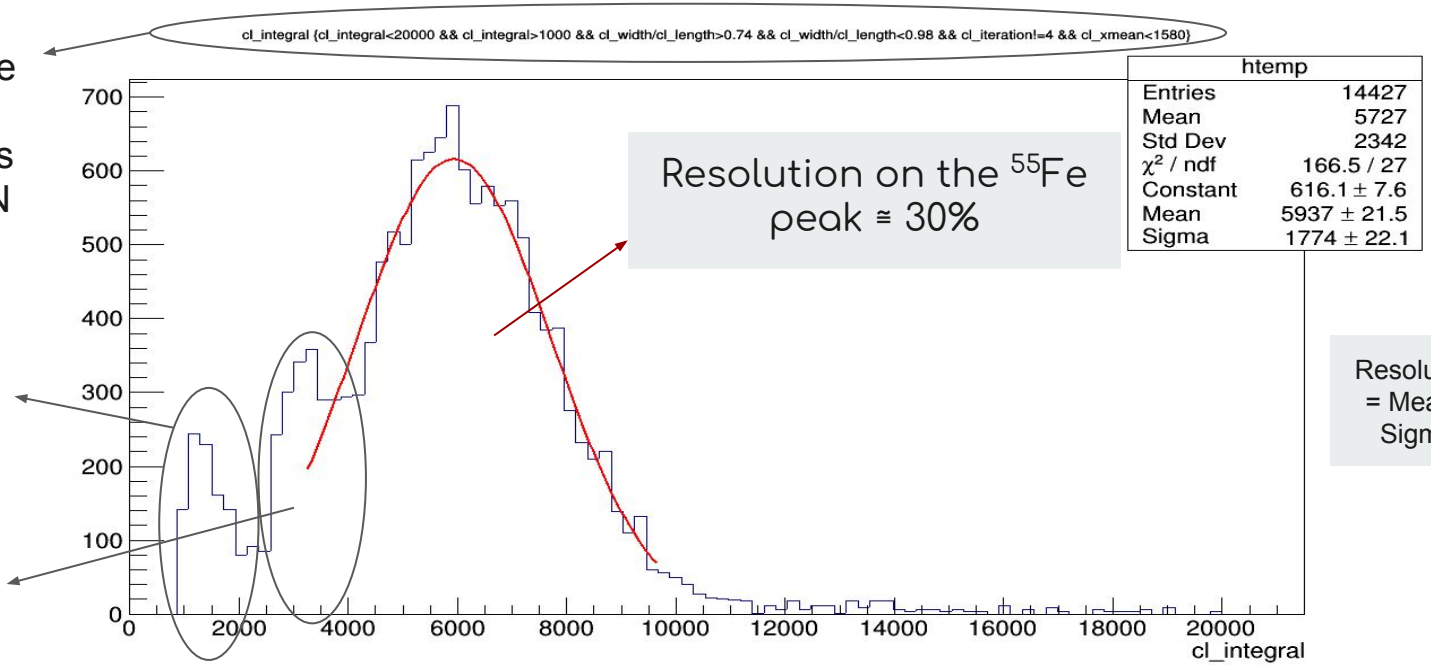
We see **consistency** with the previous **ORANGE** prototype data

MANGO - Results - Iron Spectrum

Special cuts had to be applied since the reconstruction code is optimized for LEMON

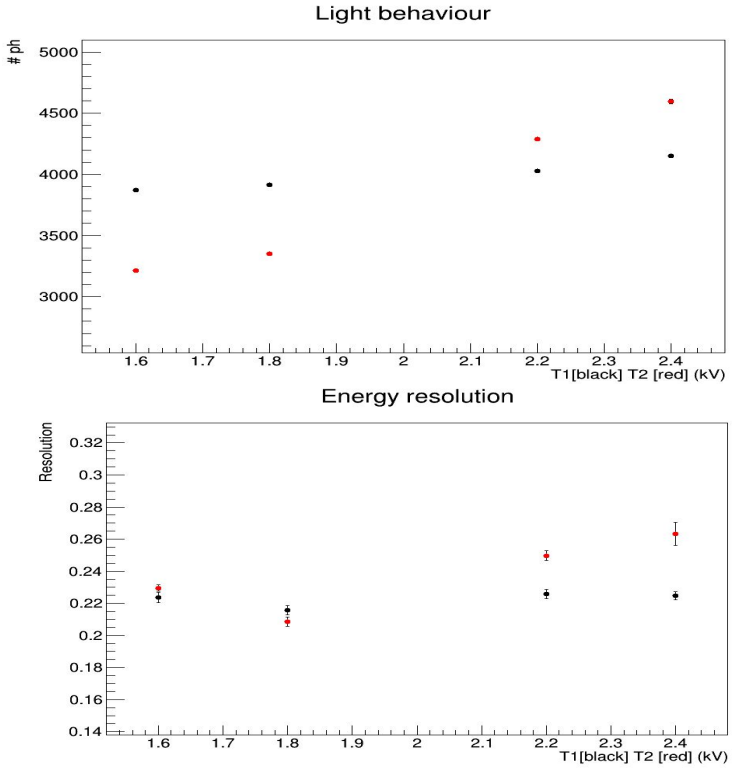
Noise - Deleted by iteration 3

Unknown - Most likely pieces of cosmic reconstructed as ^{55}Fe-like events



We are currently studying alternative ways to analyse the data

MANGO - Results - Transfer Field



Black points are for T1 changing and T2 fixed, and vice-versa for red

We can see that **fixing** the **second** transfer field (T2) results in a more stable performance (comparing to the other case).

We can see that **fixing** the **first** transfer field (T1) originates slightly different results.

↓

There's an increase of the light produced for higher fields but at cost of a worse energy and spatial resolution.

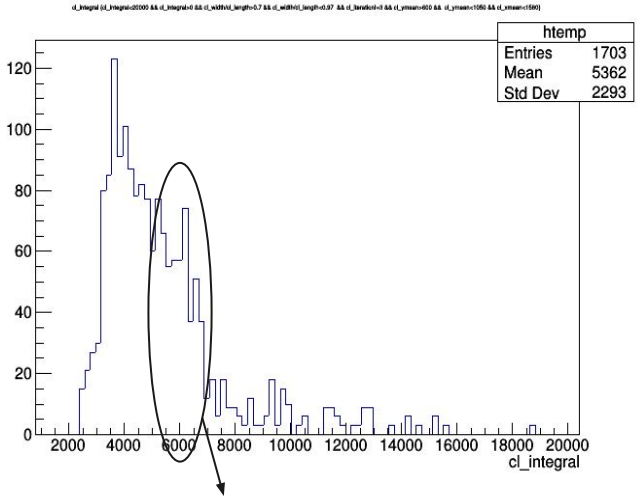
Different values can be used in accordance with the necessities!

MANGO - Results - Kentaro's field cage

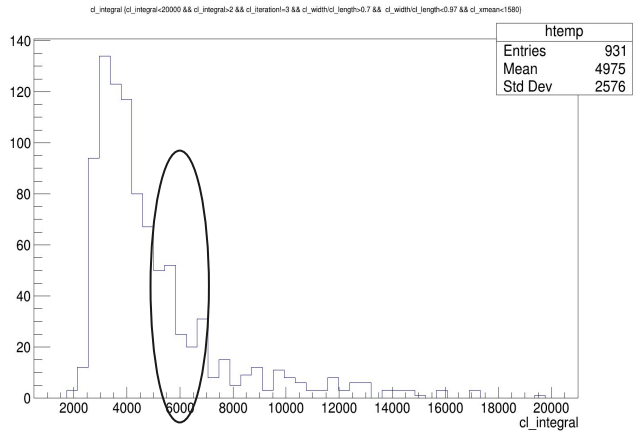
→ Kentaro field cage successfully mounted

→ Working and tested up to 900 V/cm

→ We found some problems while analysing the data



Iron peak - "Shoulder"



Run in the same exact conditions but without source

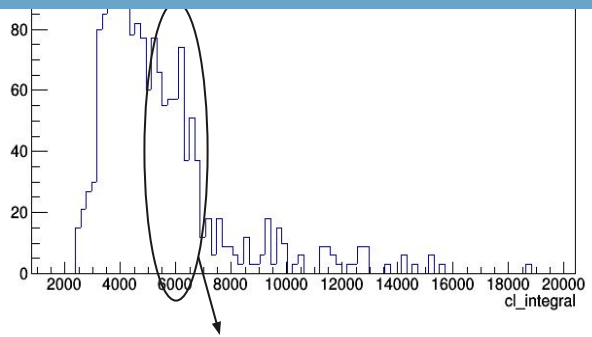
MANGO - Results - Kentaro's field cage

→ Kentaro field cage successfully mounted

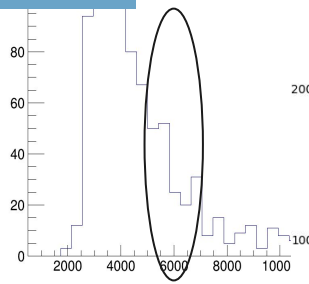
→ Working and tested up to 900 V/cm

→ [illegible] the dat

After analysing some pictures we saw that the reconstruction code wasn't properly reconstructing cosmics

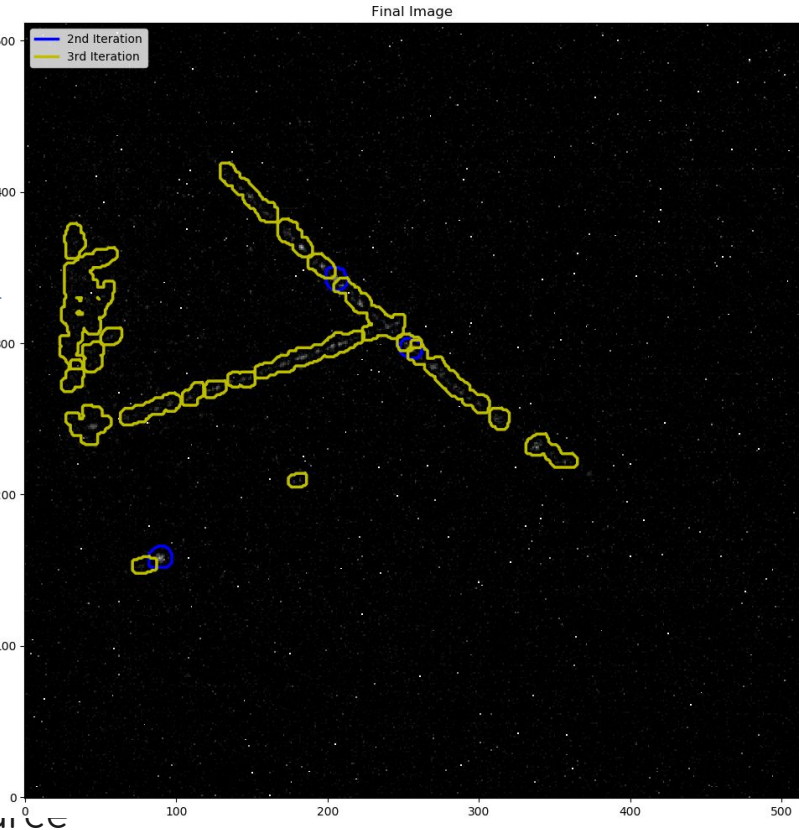


Iron peak - "Shoulder"



Run in the conditions

source

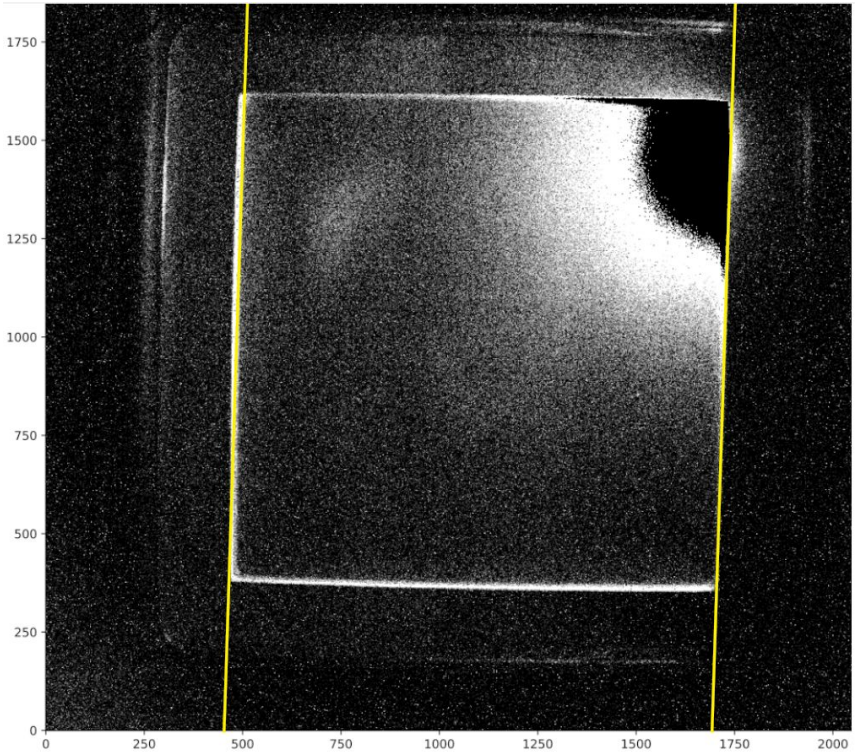


MANGO - Results - Optics

To have a better perception of what each pixel exactly sees, we performed a quick but precise measurement:

Knowing the GEM's size, we know that 1239 pixels correspond to 10 cm

Each pixel looks an area of **80 μm × 80 μm**



MANGO - Results - Ongoing work

The data taken is still being analysed → Since the reconstruction code is not (yet) optimized for MANGO, the **results** are still **preliminary**.

↓

Ongoing work with the reconstruction code team (Igor Abritta & Emanuele Di Marco)

↓

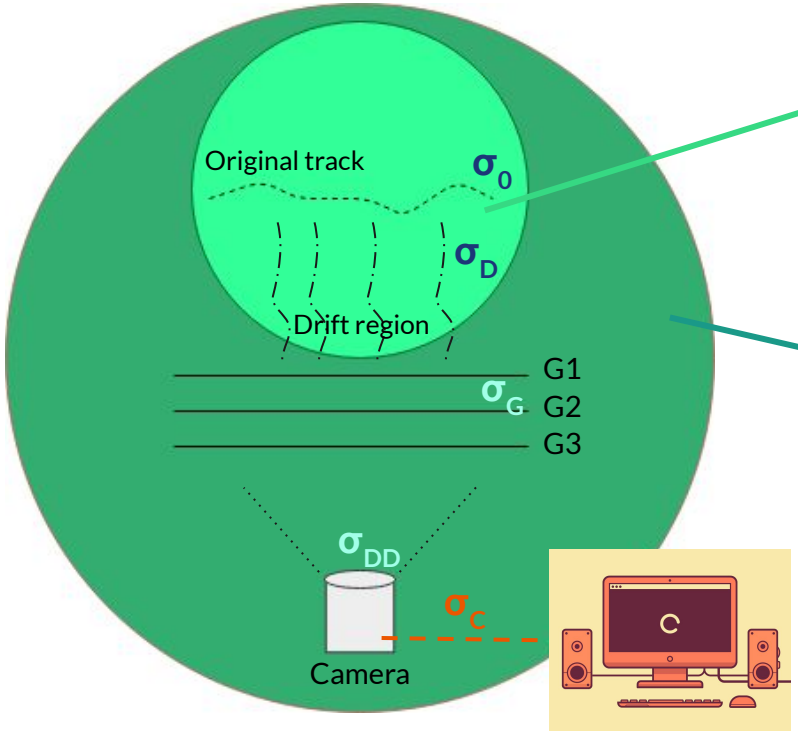
We plan to use this code on the old data to improve the comparison.

← Long data taking with muons ready to be analysed

↓

Study the field uniformity and develop 3D reconstruction of the tracks.

MANGO - Simulation vs Data - Concept



Simulation - GEANT4 & Garfield++

$$\sigma_{track^*} = \sqrt{{\sigma_0}^2 + {\sigma_D}^2}$$

Data

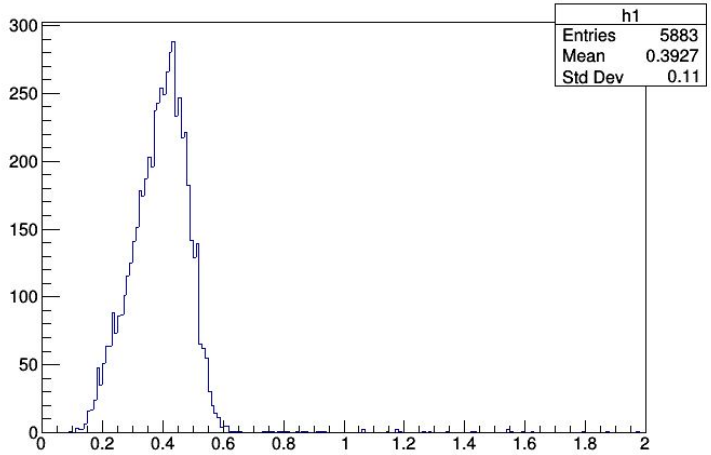
$$\sigma_{track} = \sqrt{\begin{array}{c} {\sigma_0}^2 + {\sigma_{Diffusion}}^2 + \\ {\sigma_{GEM}}^2 + {\sigma_{Digitization}}^2 + {\sigma_{Code}}^2 \end{array}}$$

$$\sigma_{track} = \sqrt{{\sigma_0}^2 + {\sigma_D}^2 + {\sigma_G}^2 + {\sigma_{DD}}^2 + {\sigma_C}^2}$$

MANGO - Simulation vs Data - Results

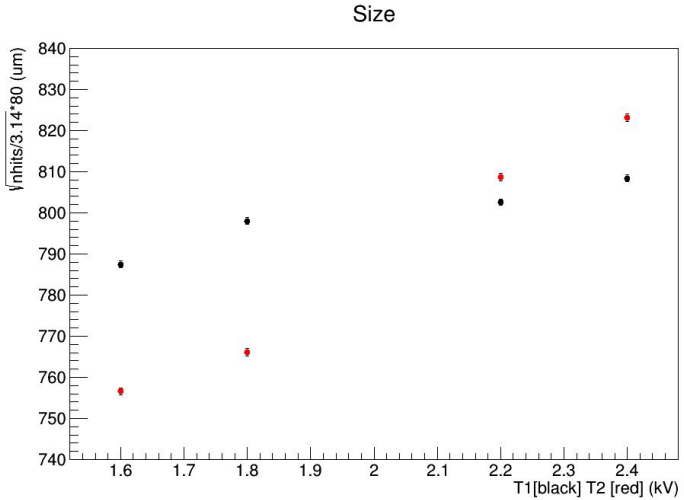
Simulation: $\sigma_{track^*} = \sqrt{{\sigma_0}^2 + {\sigma_D}^2}$

Peak: ~450 μm



Data: $\sigma_{track} = \sqrt{{\sigma_0}^2 + {\sigma_D}^2 + {\sigma_G}^2 + {\sigma_{DD}}^2 + {\sigma_C}^2}$

Peak: ~800 μm



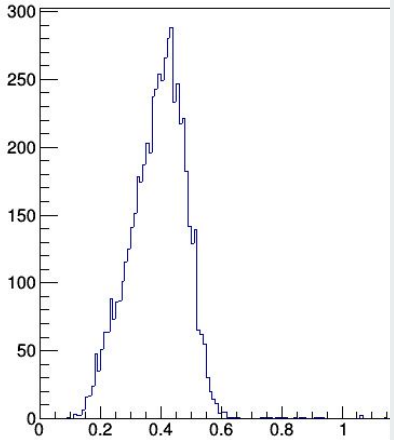
MANGO - Simulation vs Data - Results

Simulation: $\sigma_{track^*} = \sqrt{{\sigma_0}^2 + {\sigma_D}^2}$

Peak: ~450 μm

Data: $\sigma_{track} = \sqrt{{\sigma_0}^2 + {\sigma_D}^2 + {\sigma_G}^2 + {\sigma_{DD}}^2 + {\sigma_C}^2}$

Peak: ~800 μm

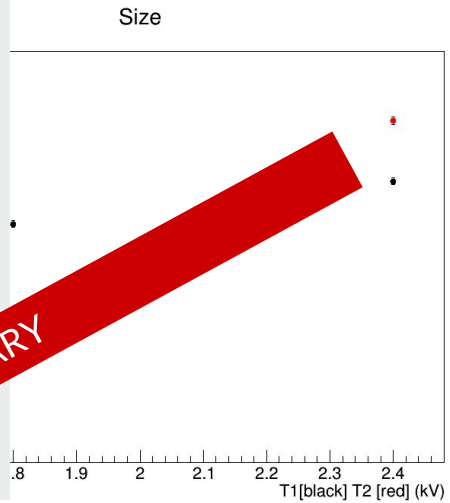


The contribution from the readout (σ*) can be calculated as:

$$\sigma^* = \sqrt{{\sigma_{track}}^2 - ({\sigma_0}^2 + {\sigma_D}^2)}$$

resulting in:

$$\sigma^* \approx 661\ \mu m$$



PRELIMINARY

MANGO - Conclusion & Future Work

➔ The first results indicate: **good performance**.

➔ The results are **in accordance** with the previous prototype (ORANGE).

➔ Simulations are being performed and improved to be compared with the analysed data.

↓

Obtain the **value** of the **diffusion** caused by the **GEMs**

➔ Use electronegative mixtures to test MANGO's performance with **negative ions**.

➔ Test alternative **micro-structures** (COBRA_125**) for charge gain and scintillation yield using MANGO prototype.

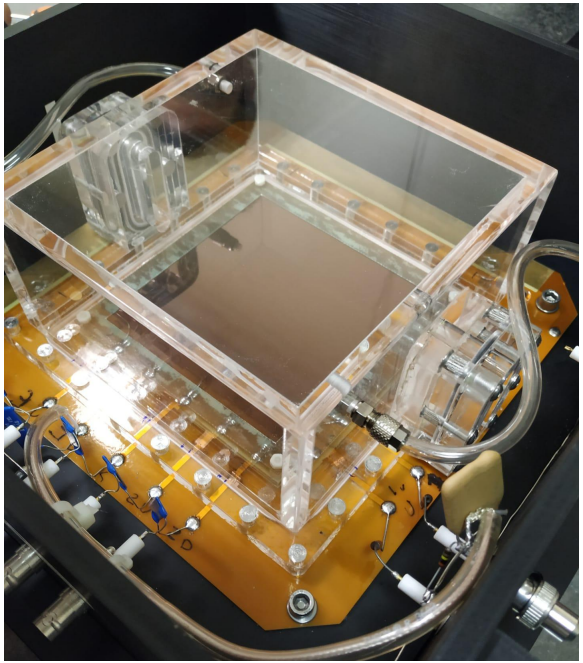
↓

To do in January / February !

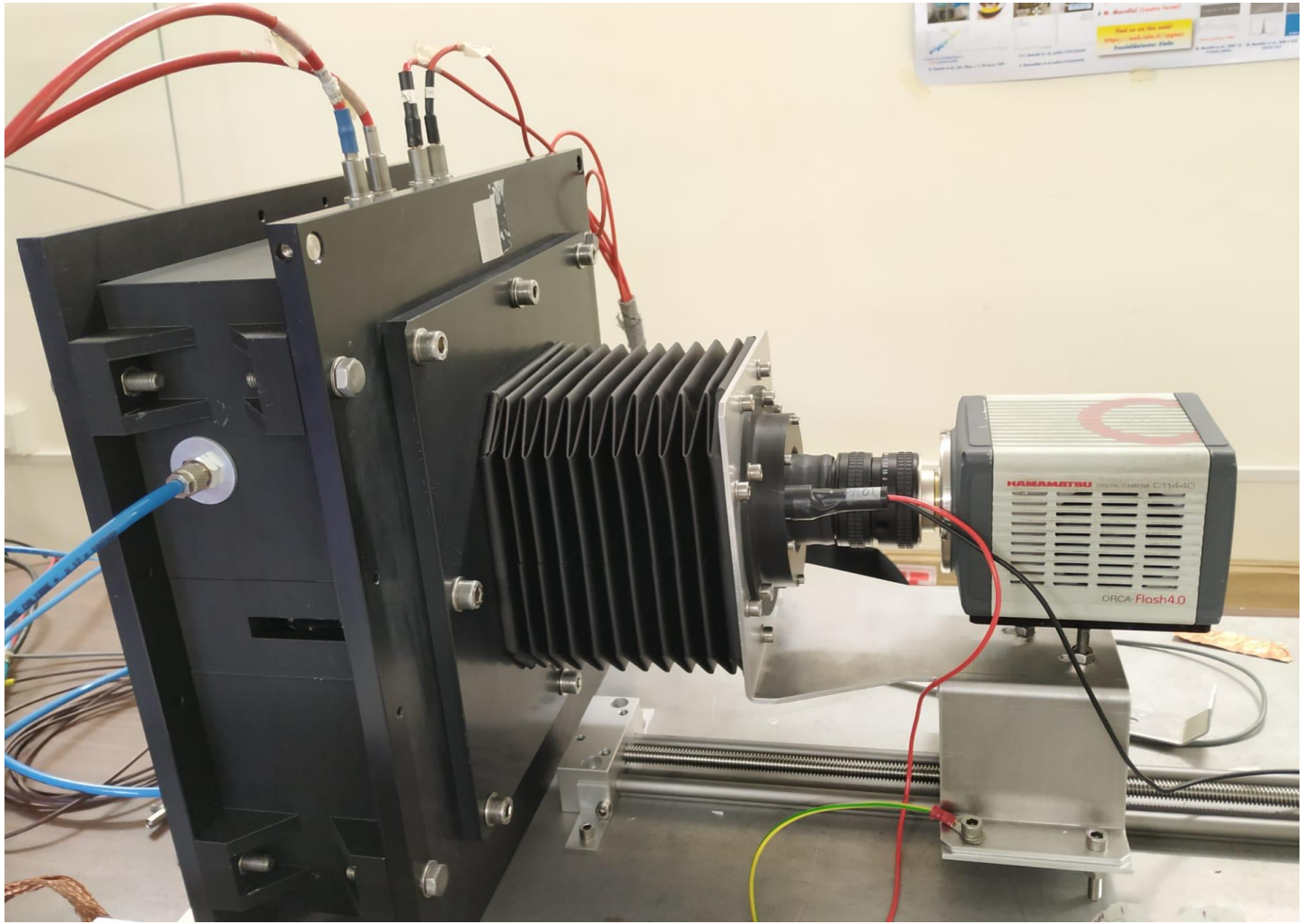
**SEE ANDRÉ'S TALK TOMORROW!

Thank you all!

CYGNO Experiment

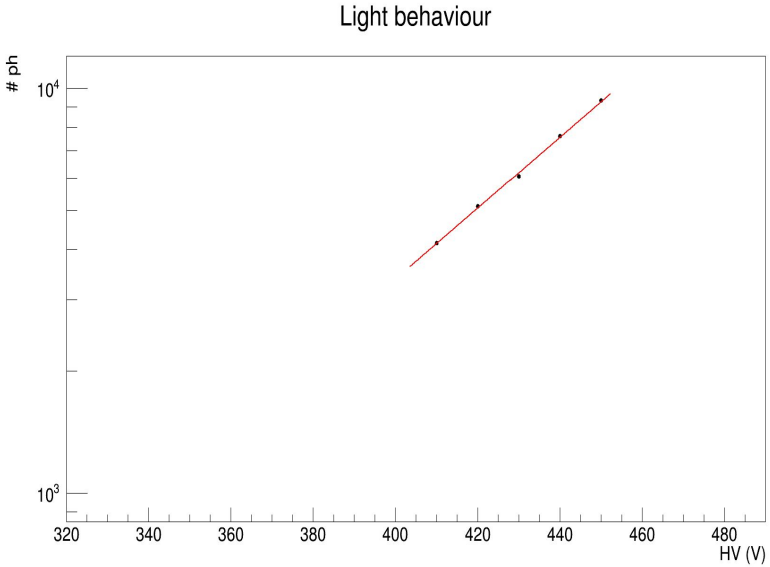


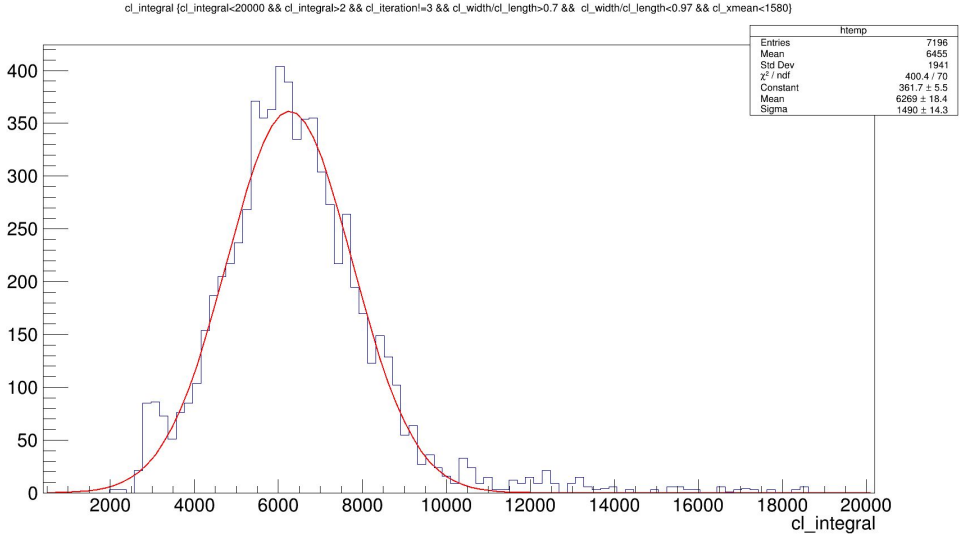
Back-up slides


HAMAMATSU
DIGITAL CAMERA C11440
ORCA-Flash4.0

- Data taken between 25/11 - 6/12, 2019
- Runs: 2322 - 3366

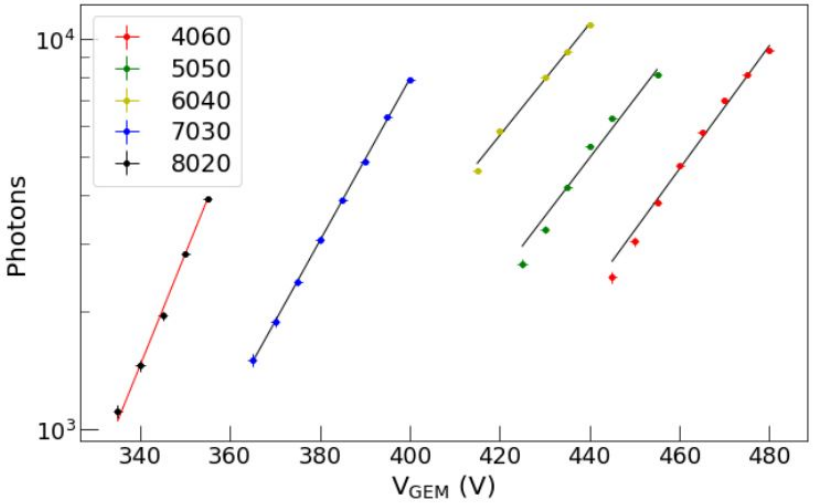
MANGO - Results - GEM voltage (gain curve) - Fit

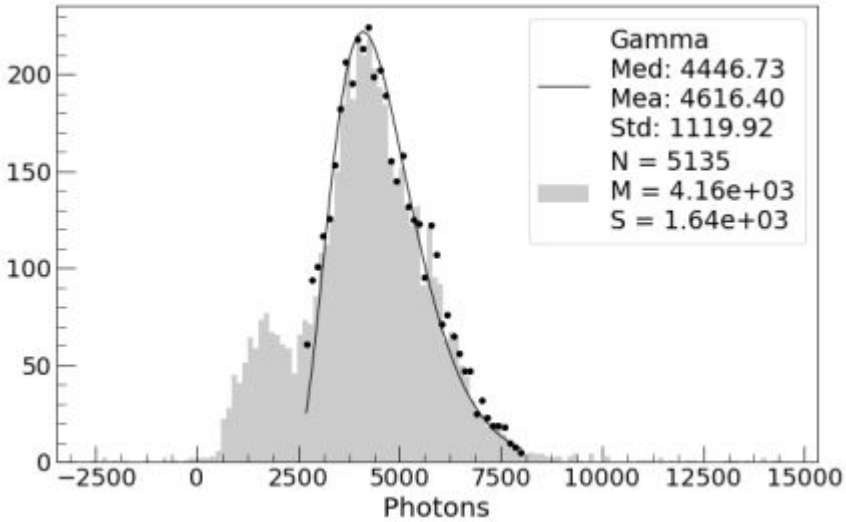




MANGO - Results - GEM voltage (gain curve) - Fit

From R. Campagnola's thesis





MANGO - Results - GEM voltage (gain curve) - Fit

From R. Campagnola's thesis