

# Field Cages Validation for CYGNO-04



A. Biondi, G. Dho, G. Mazzitelli

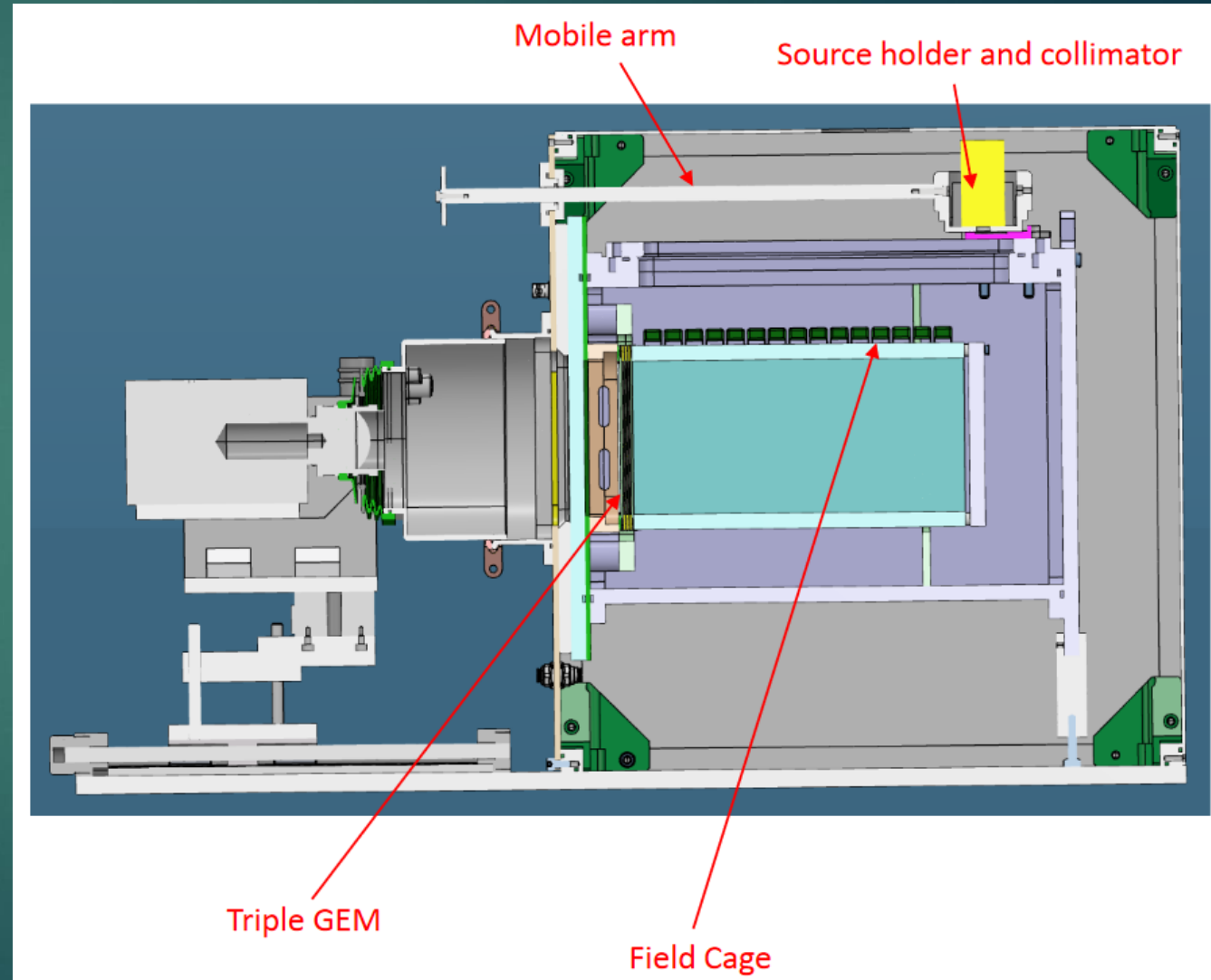


27/06/2024

# EXPERIMENTAL SETUP

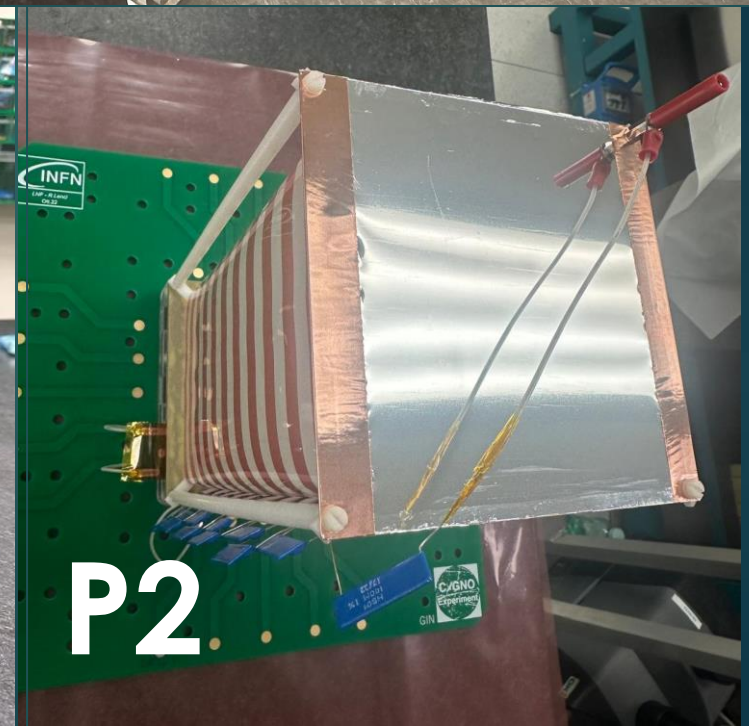
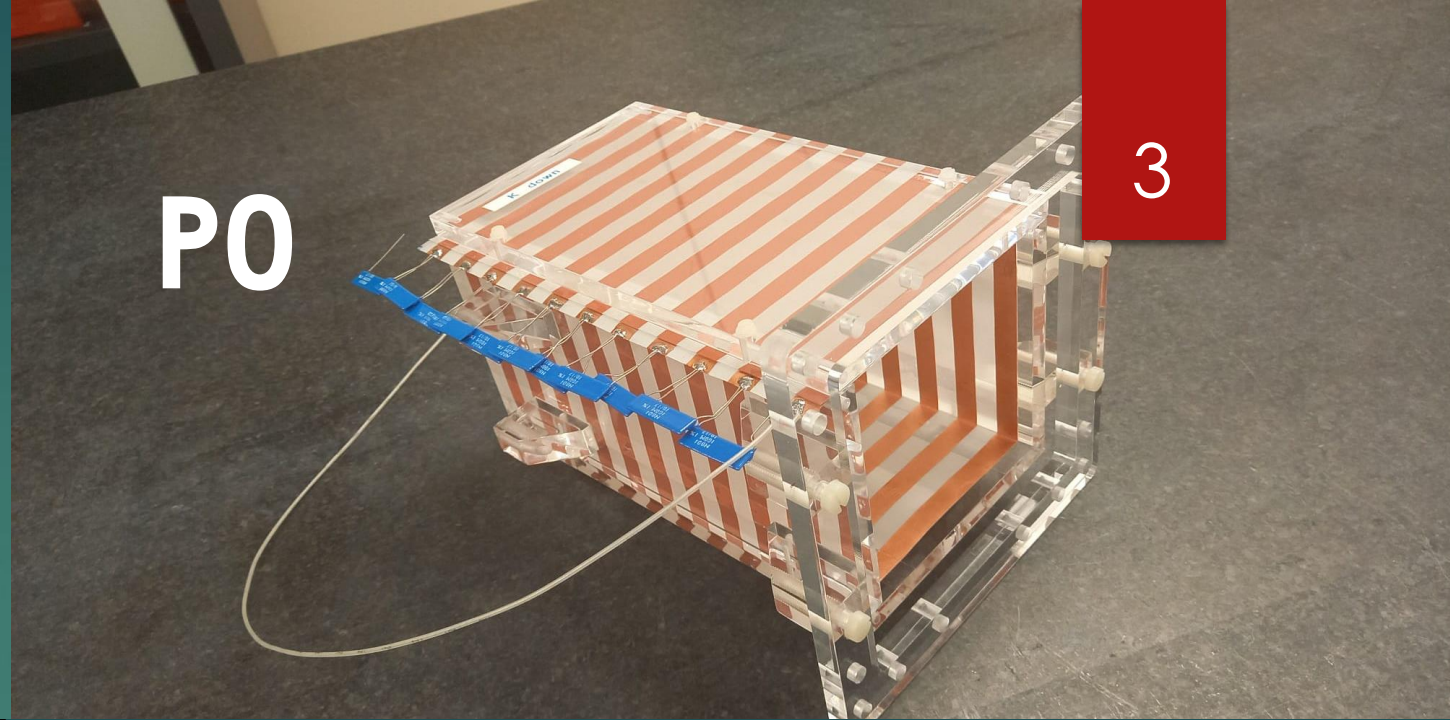
2

- GIN prototype built to test and validate field cage and cathode assembly
- $^{55}\text{Fe}$  source with 5.9 keV emission in source holder
- 10x10 cm<sup>2</sup> readout area, 23 cm drift
- 50x50  $\mu\text{m}^2$  effective camera granularity
- 1 camera (Fusion) and 2 PMTs



# TESTED SETUPS

- "Glued" Field Cage with Cu Cathode (P0)
- "Ethereal" Field Cage with Cu Cathode (P1)
- "Ethereal" Field Cage with Aluminized Mylar Cathode (P2)





# GLUED FC WITH CU CATHODE

4

## ➤ FC Characteristics:

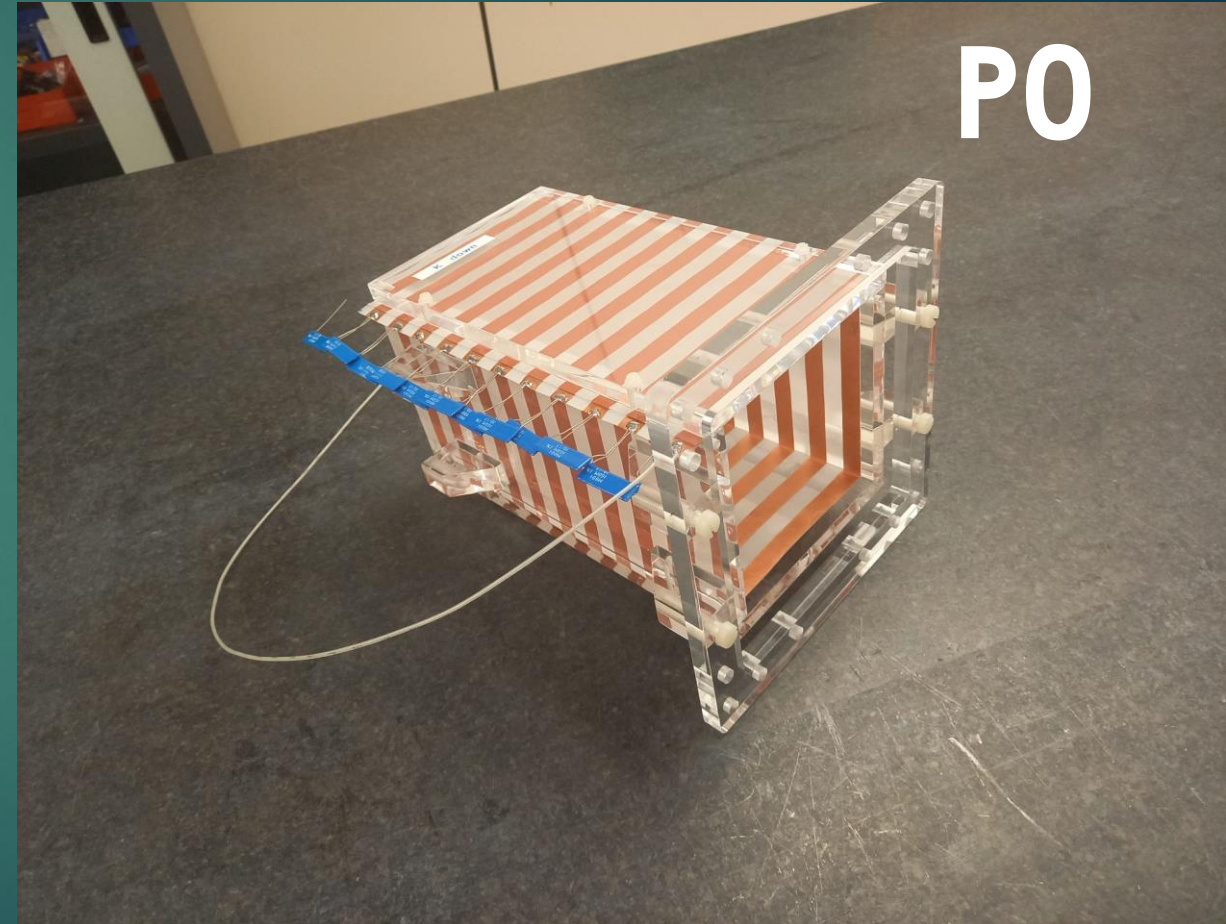
- Glued on PVC
- Electric contact when glued together on one side

## ➤ Cathode Characteristics:

- Copper sheet (1 mm thickness)
- Simple construction

## ➤ FC failure:

- Unstable, impossible to take measures in controlled conditions



# ETHEREAL FC WITH CU CATHODE

5

## ➤ FC Characteristics:

- Rolled up on DELRIN Pillars
- Glued to itself
- Not connected to PVC

## ➤ Measure Plan:

- Studied Light yield with  $^{55}\text{Fe}$  Source scanning VGEM, drift field and source position
- Field Cage map with muons and natural radioactivity

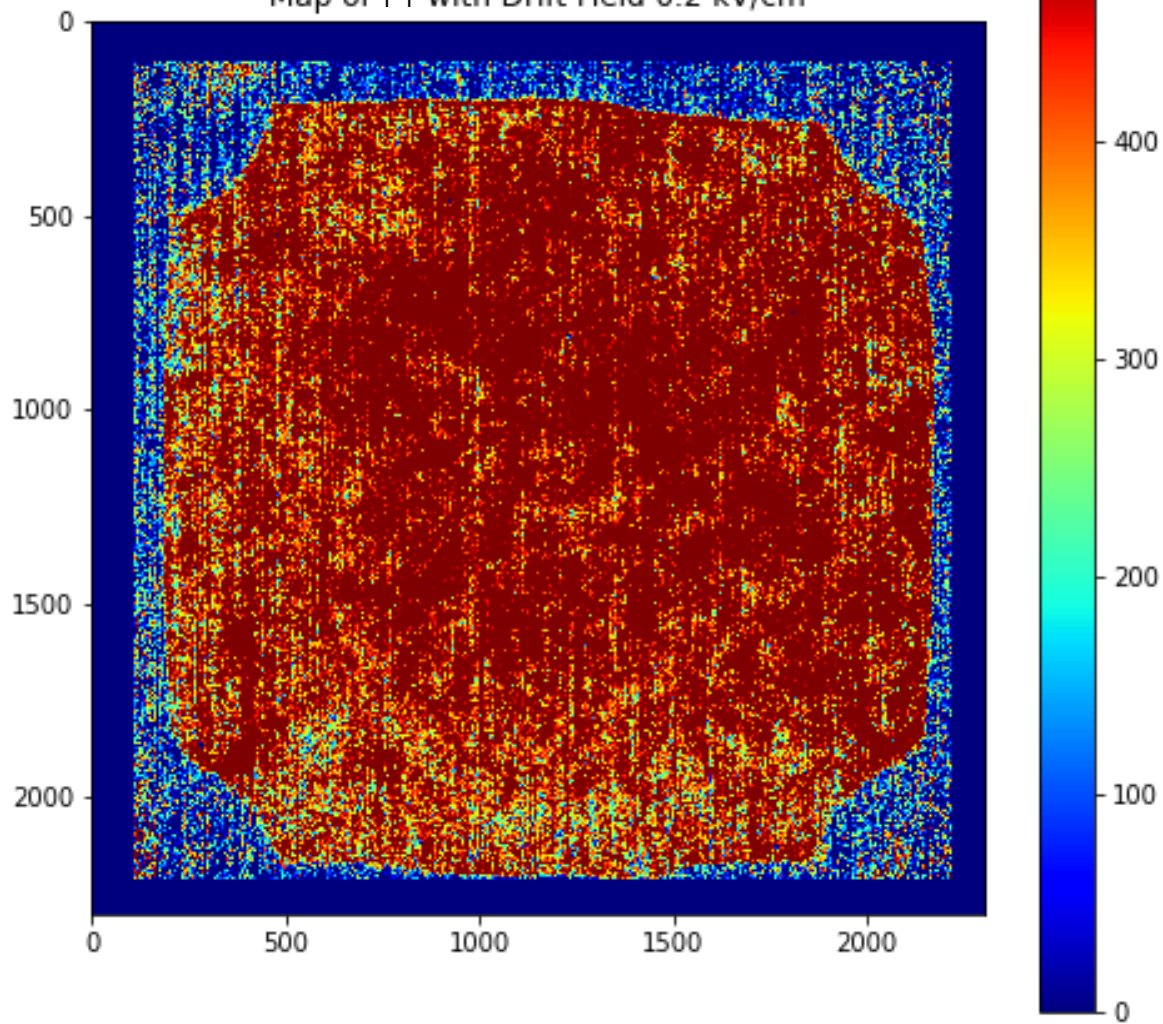




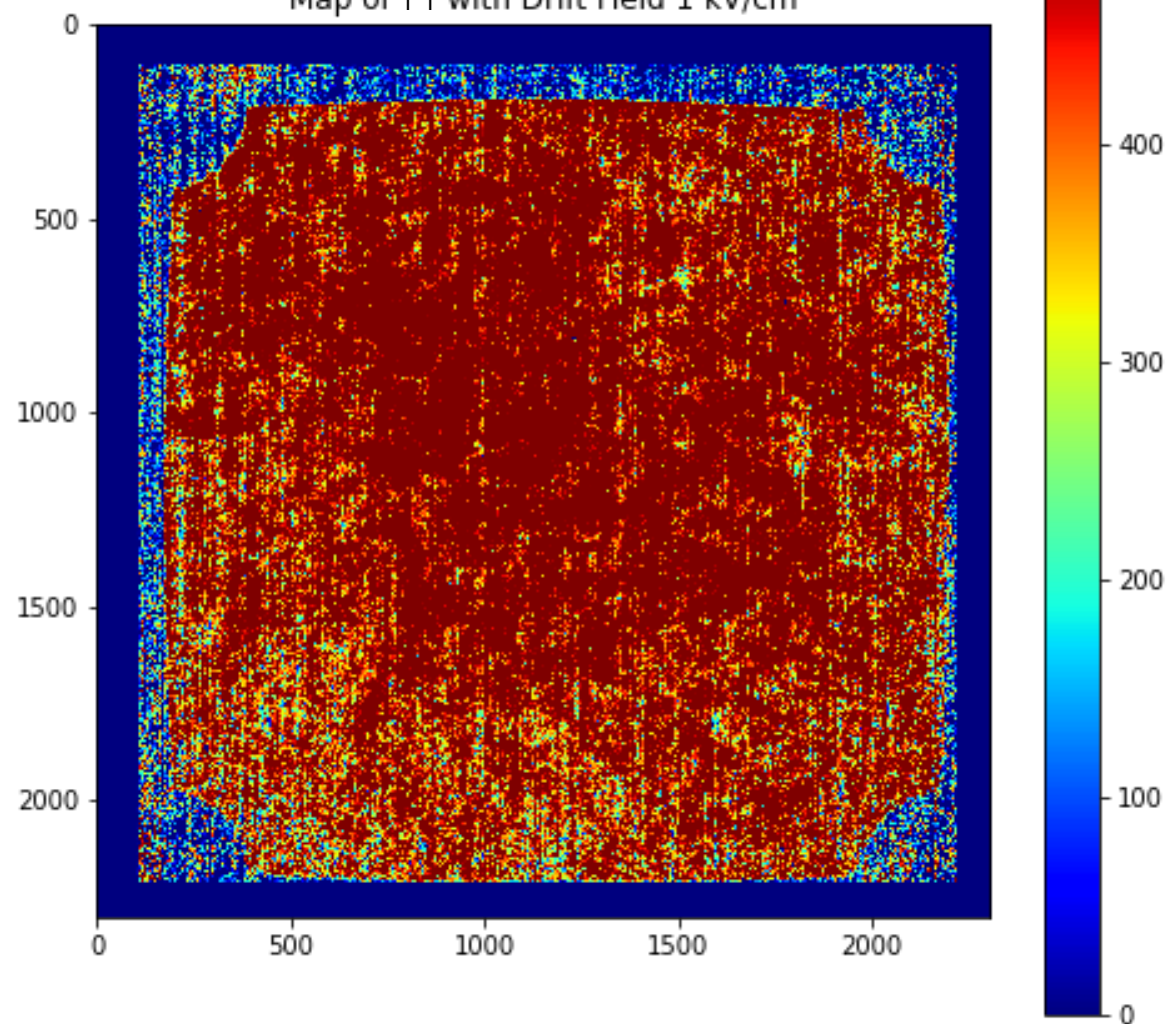
# P1-FC MAP I

6

Map of P1 with Drift Field 0.2 kV/cm



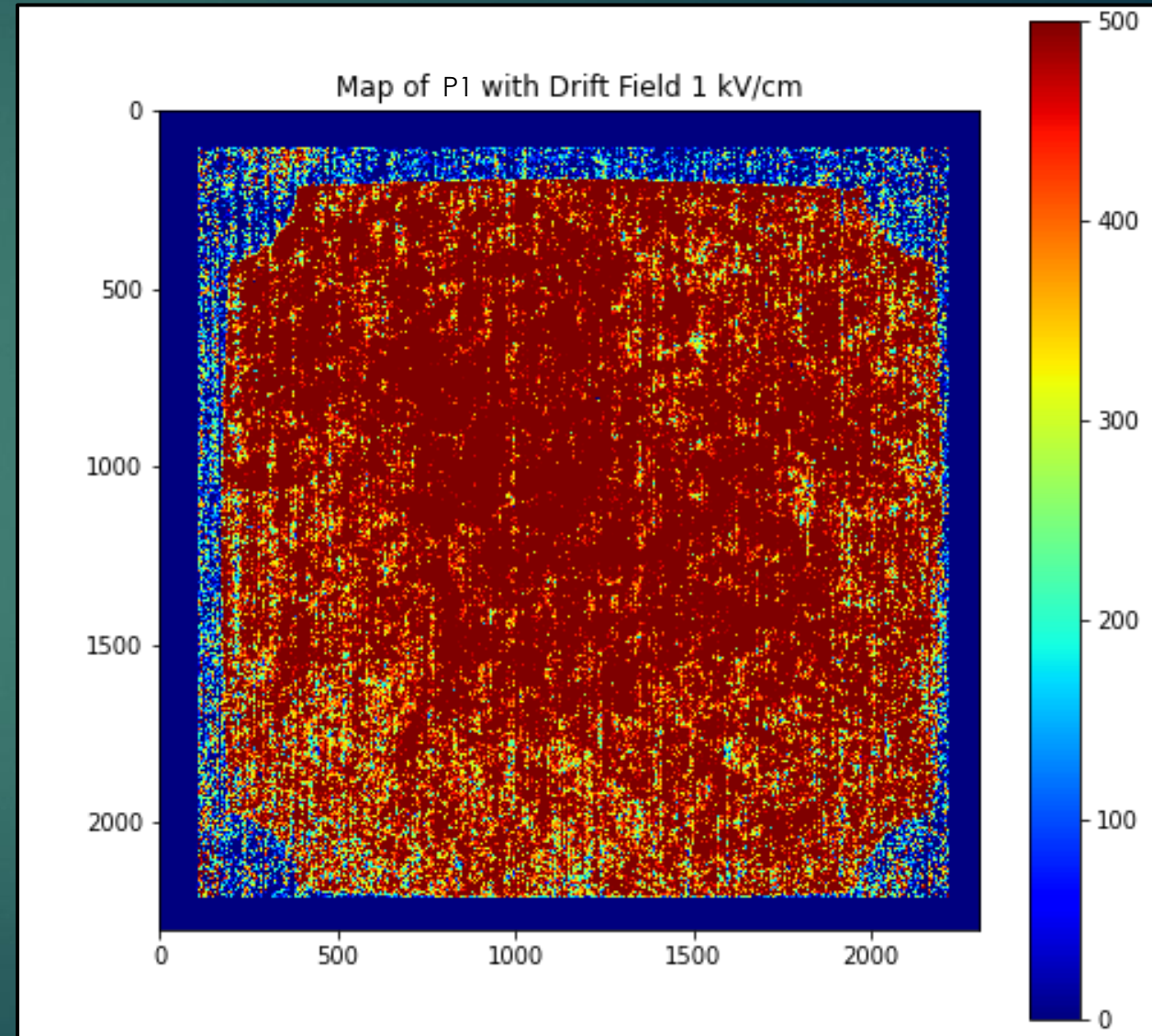
Map of P1 with Drift Field 1 kV/cm



# P1– FC MAP II

7

- Well defined borders with higher fields
- Corner disuniformity due to FC pillars
- Up-Down disuniformity < 10%
- Right-Left disuniformity < 5%
- **Performances validated for CYGNO-04**





# P2 - Al MYLAR CATHODE

8

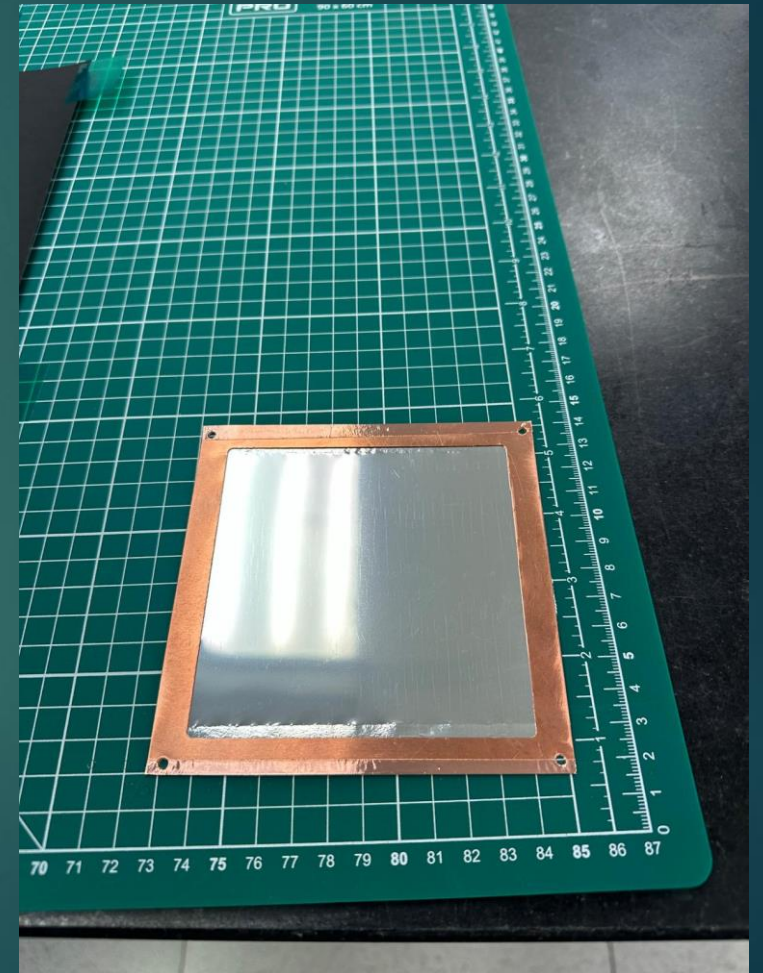
## ➤ Same ethereal FC

## ➤ Cathode Characteristics:

- 0.9  $\mu\text{m}$  Aluminized Mylar film inspired by DRIFT collaboration
- Pro:
  - Thin foil should allow to reject events which cause simultaneous events on both sides of cathode
  - Crispy surface supposed to reduce radon progeny attachment and favour detection on both sides of the cathode
- Con:
  - Copper tabs for electric contacts (more instabilities)
  - Extremely delicate and fragile

## ➤ Measure Plan:

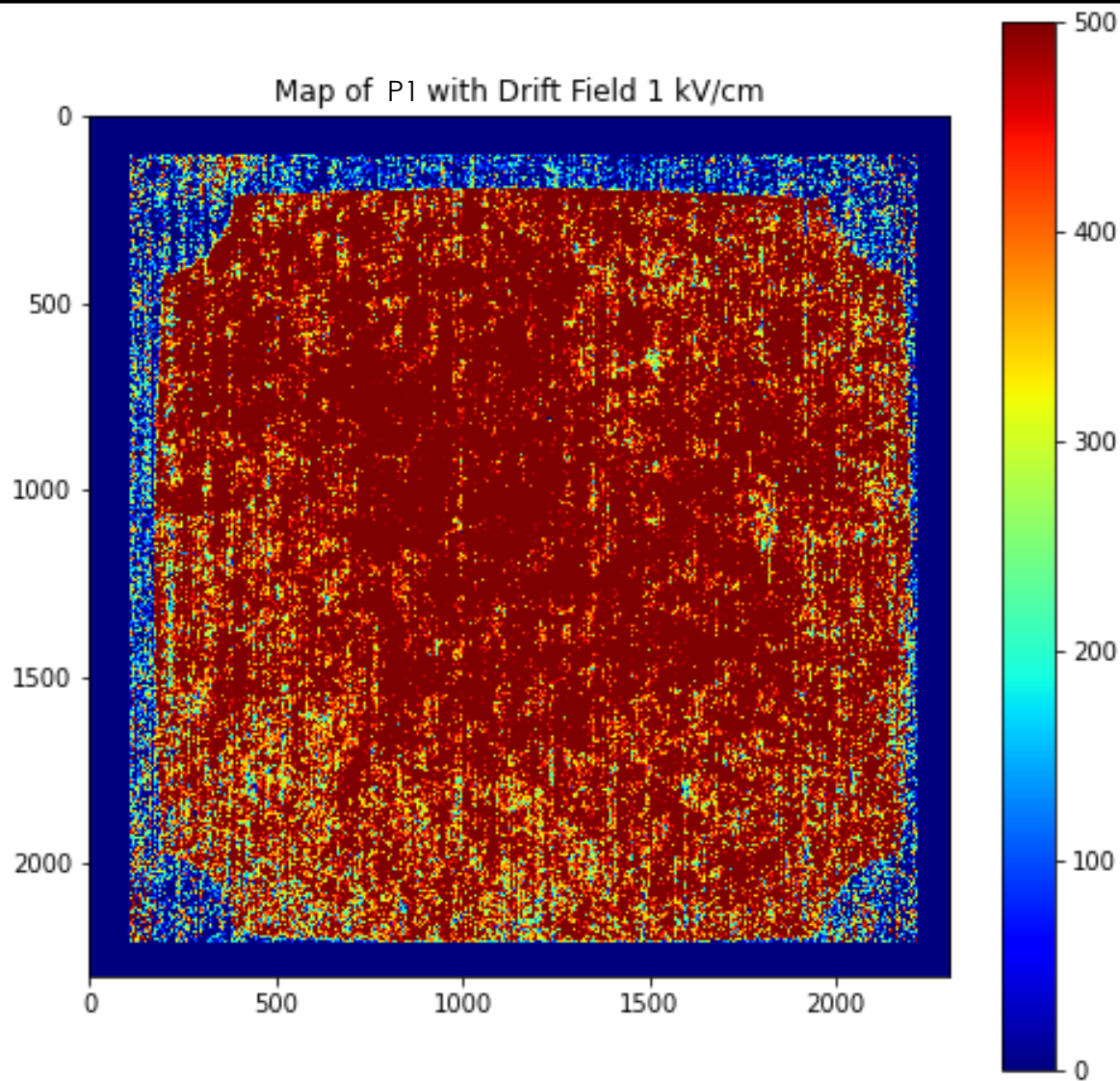
- Same as P1



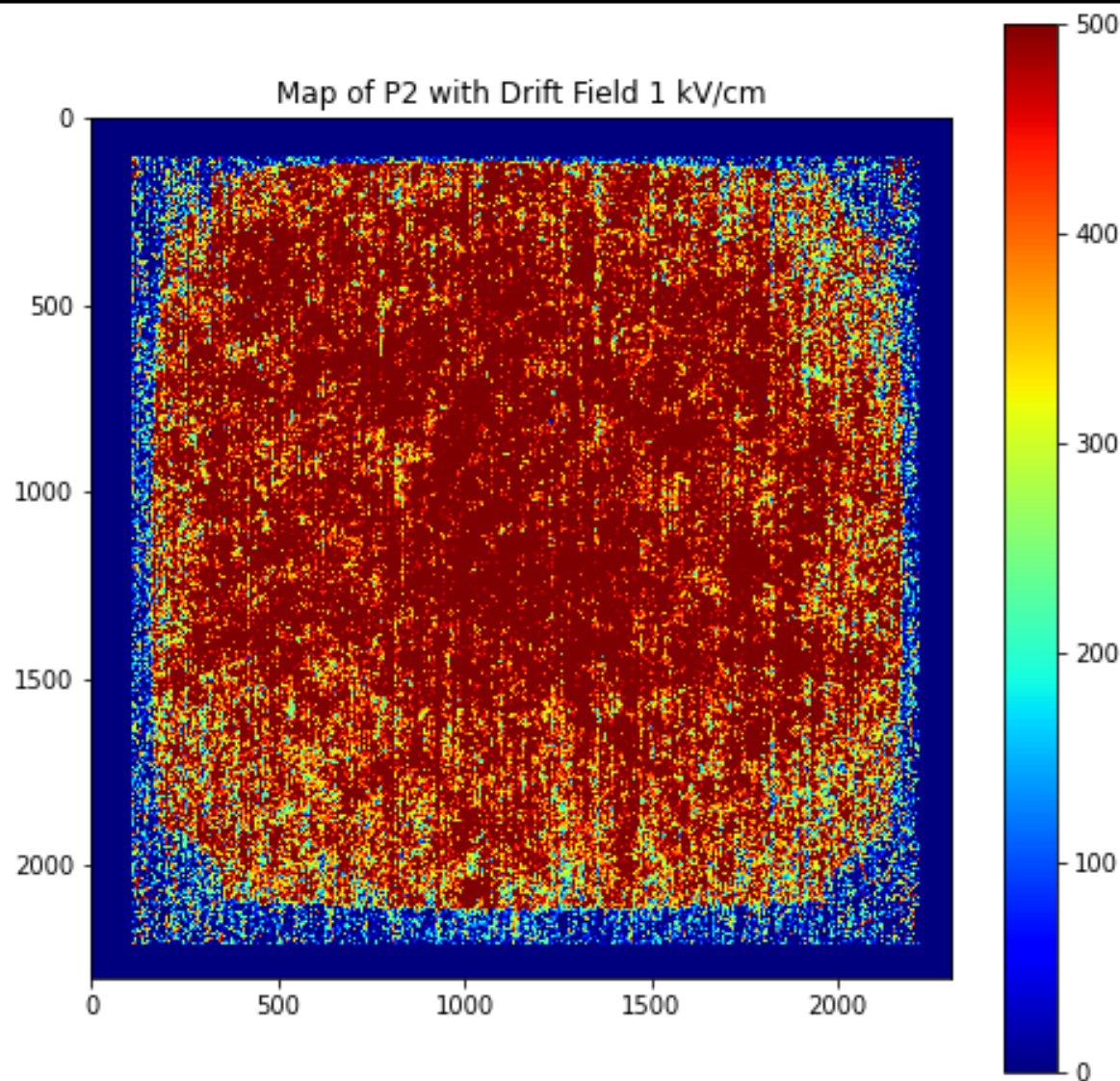


# P1/P2 COMPARISON - MAP

Map of P1 with Drift Field 1 kV/cm



Map of P2 with Drift Field 1 kV/cm



# P1/P2 COMPARISON - MAP II

10

## ➤ P2 Cathode Disuniformities:

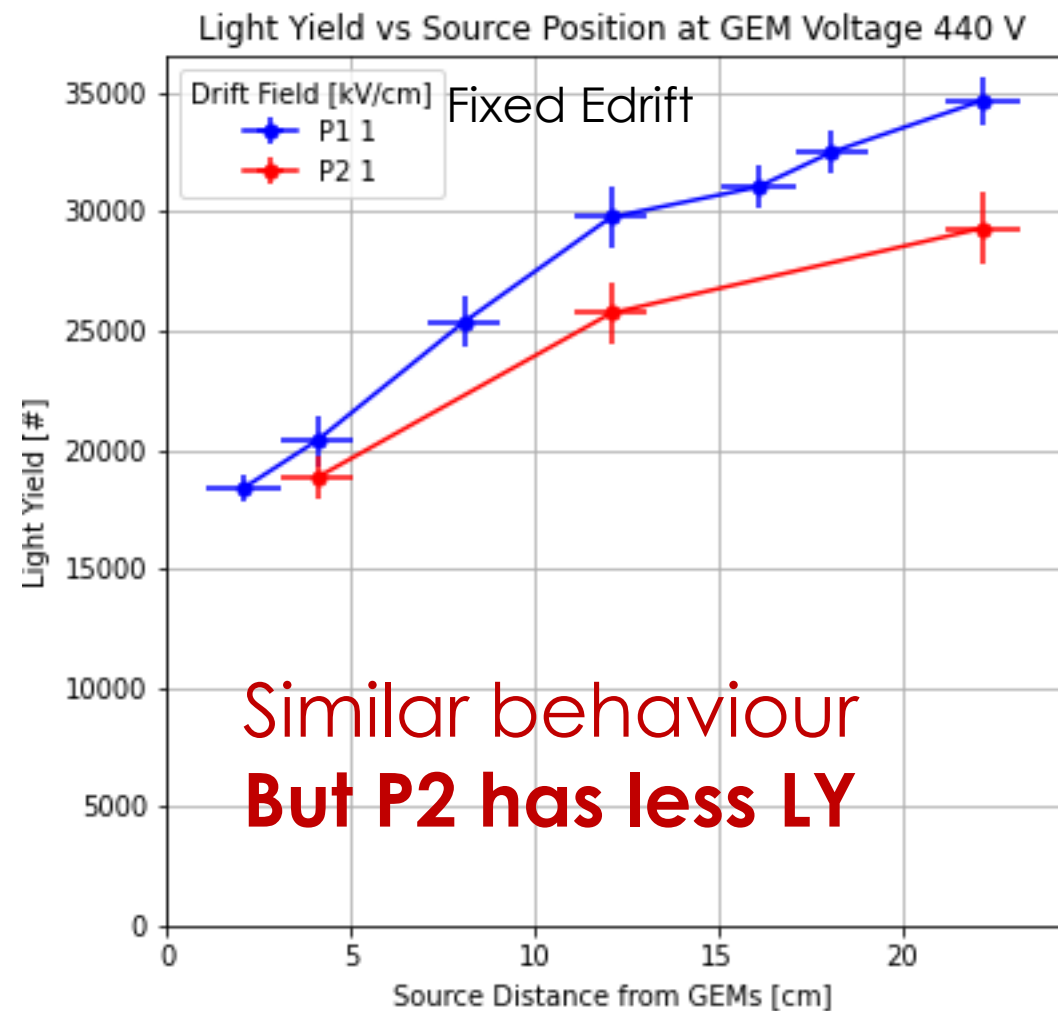
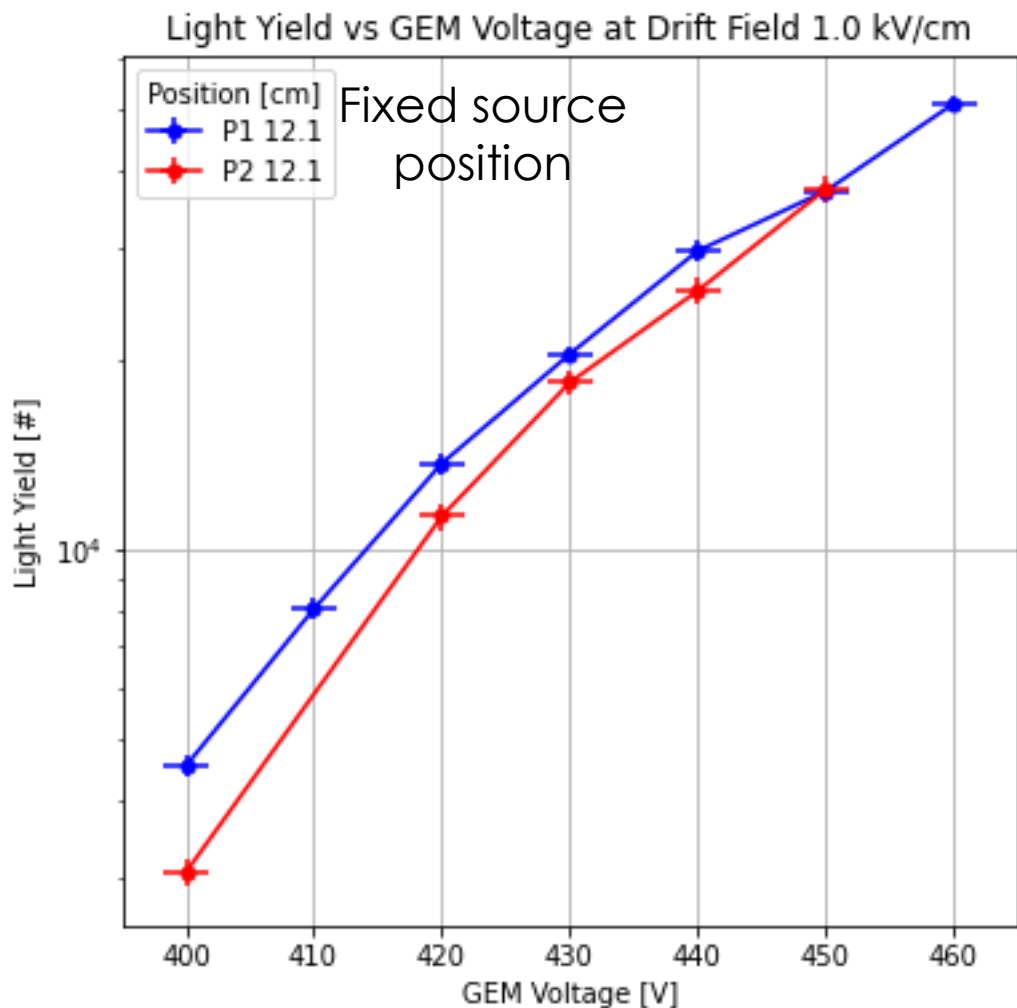
- Up-Down < 10%
- Right-Left < 5%

**Similar to  
P1**

- P1 has 12% more light than P2 from maps
- Borders less defined
- More precise estimation of electric field ongoing

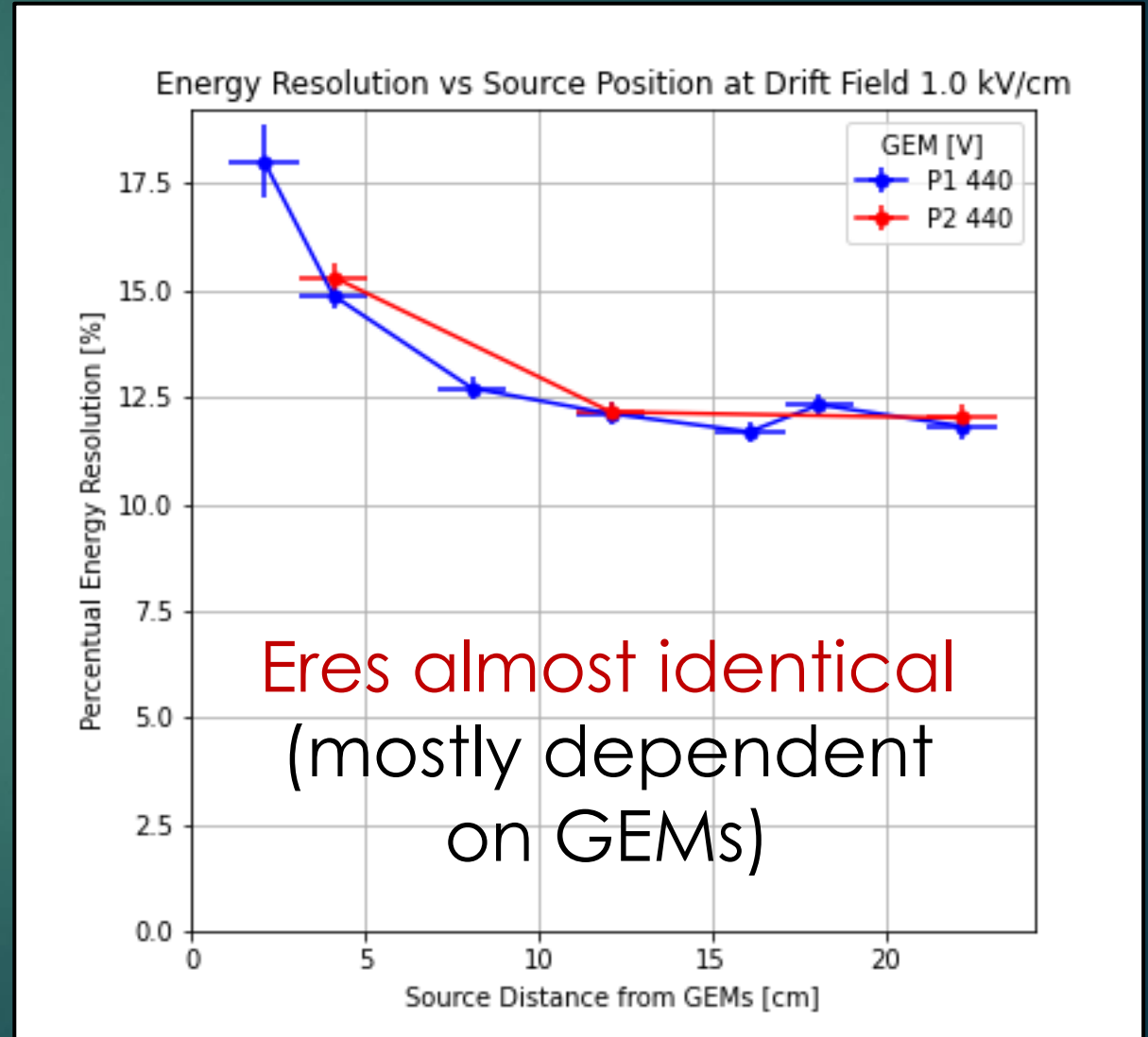


# P1/P2 COMPARISON I



# P1/P2 COMPARISON II

- The electric field seems less defined yielding lower light intensity
- Reduction of light of 15% on  $^{55}\text{Fe}$  data
- $E_{\text{thr}}$  of  $0,5 \text{ keV}_{ee}$  may be not achieved
- **Further study to understand P2 are necessary before validating it for CYGNO-04**

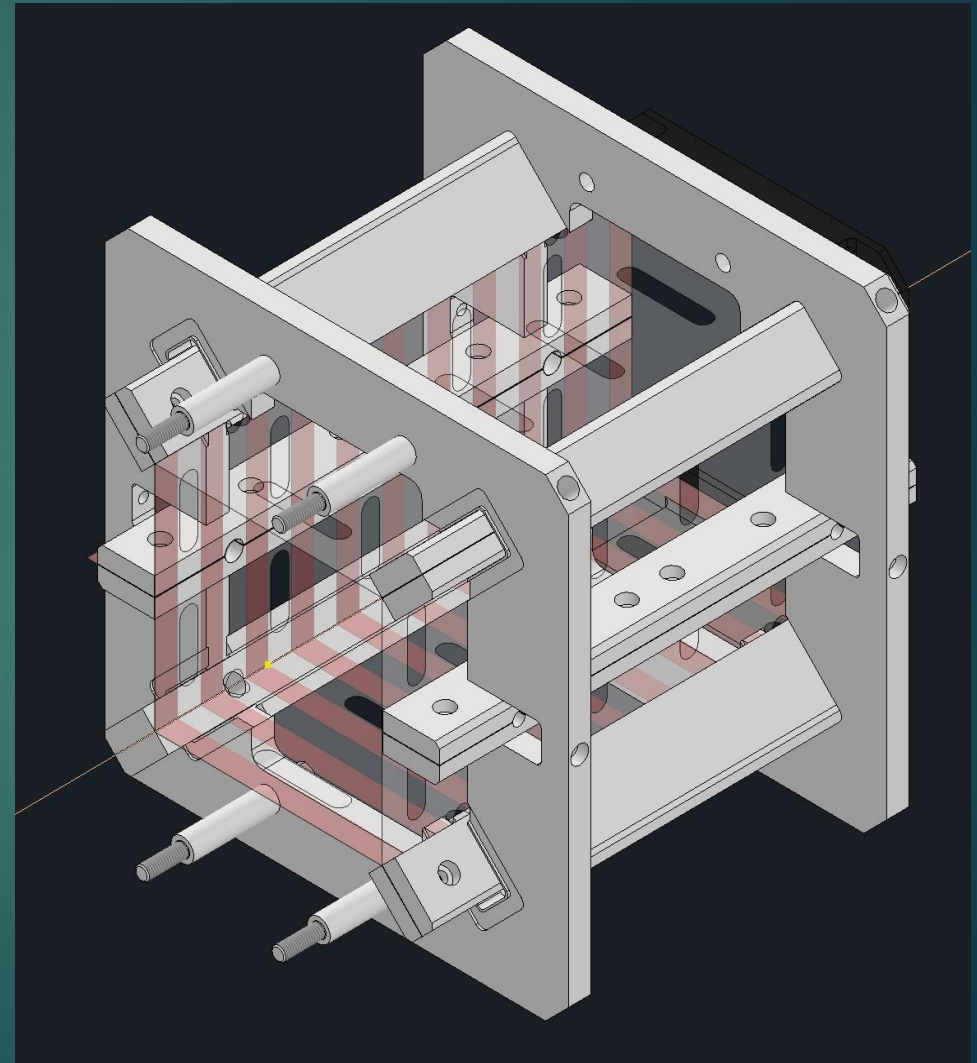




# FIELD CAGE P3

13

- Ethereal version of Field Cage with self-sustaining structure (foressen for CYGNO-04)
- Currently in Production at LNF
- Will be tested soon



# CONCLUSIONS AND OUTLOOKS

14

## ➤ **Conclusions:**

- The Glued Field Cage is unstable and is rejected for CYGNO-04
- P1 was validated thanks to compliance with uniformity and LY
- P2 has similar uniformity, but electric field looks less consistent (lower LY and border definition)

## ➤ **Outlooks:**

- Aging test is ongoing for the various components of all versions of field cages
- P2 could aid dark matter search but mounting procedure needs to be better understood. New tests will be undertaken.
- P1 validated for CYGNO-04, with the options to switch to P2 when construction under control.



# BACKUP

# BACKUP / ETH CU MEASURE PLAN

16

## ➤ **Measure Plan:**

- Fixing Drift Field at 1 kV and scanning GEM Voltage from 400V to 460V
- Fixing GEM at 440V and scanning Drift Field from 0.2 to 1.5 kV/cm
- Same scan at GEM 400V
- Scan of 7 Positions for Fe Source (2.1 to 22.2 cm from GEMs)
- Camera Exposure: 0.15 s for Short Exposures and 0.18s for Long Exposures



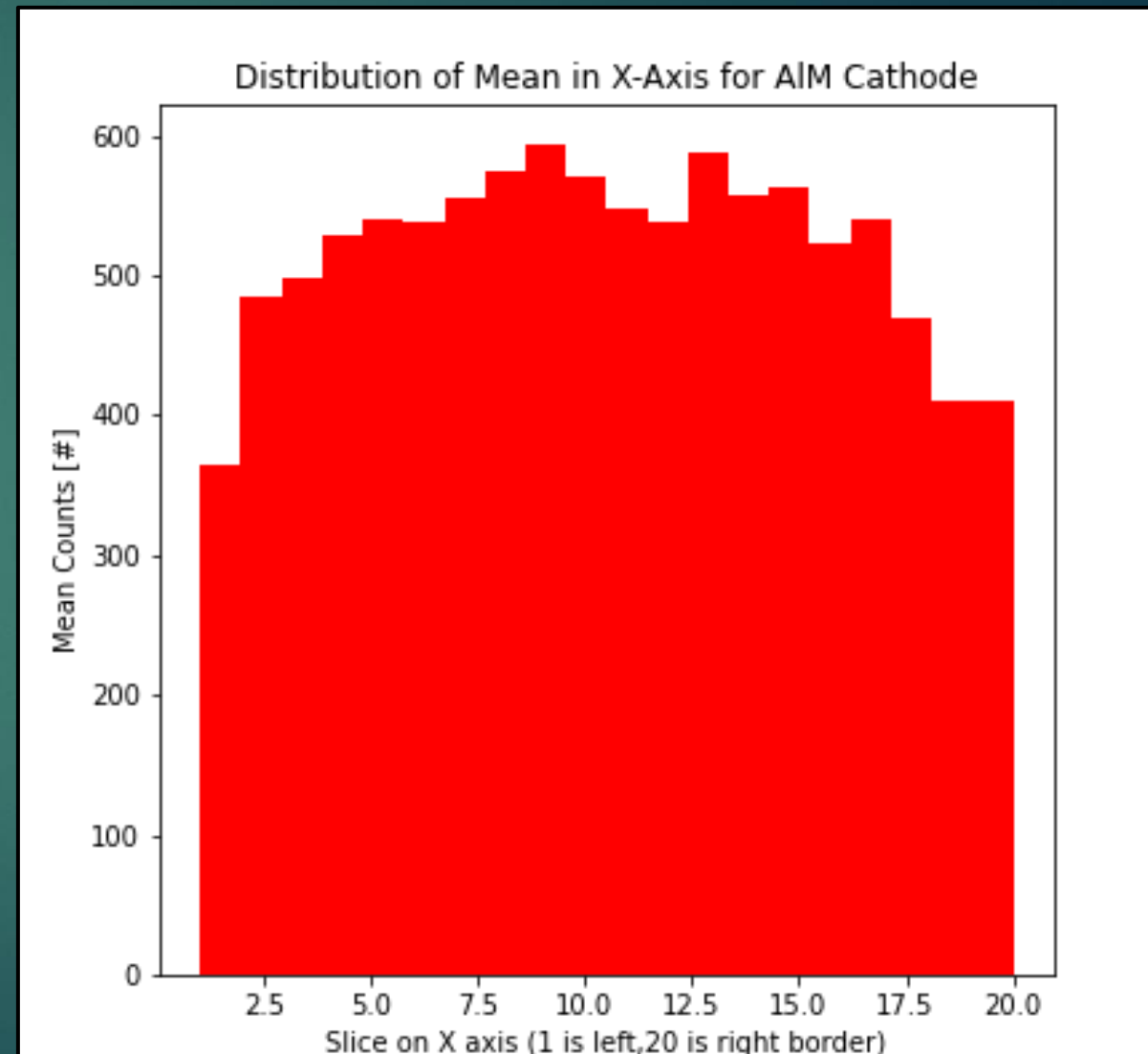
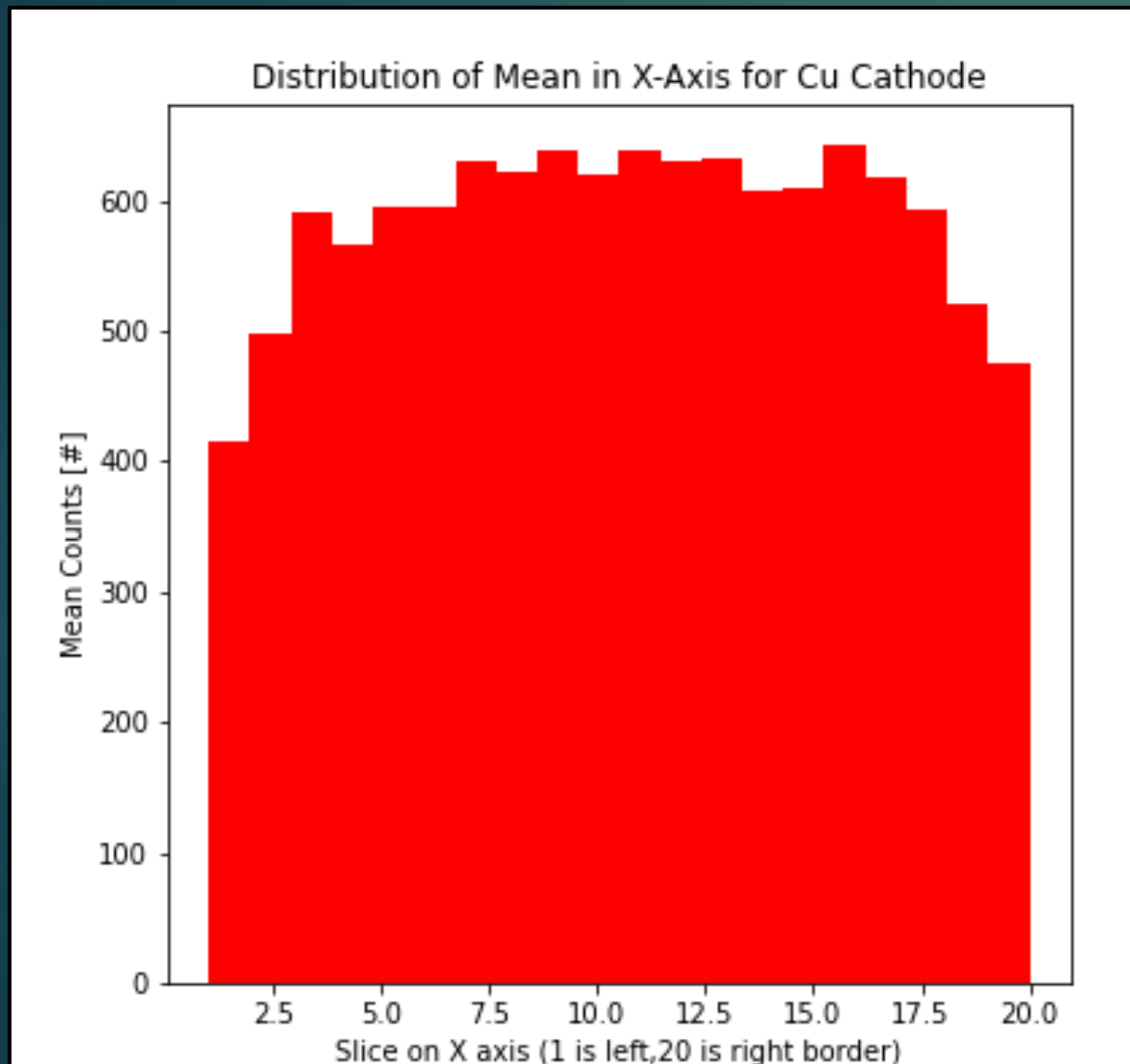
# BACKUP / ETH AIM MEASURE PLAN

17

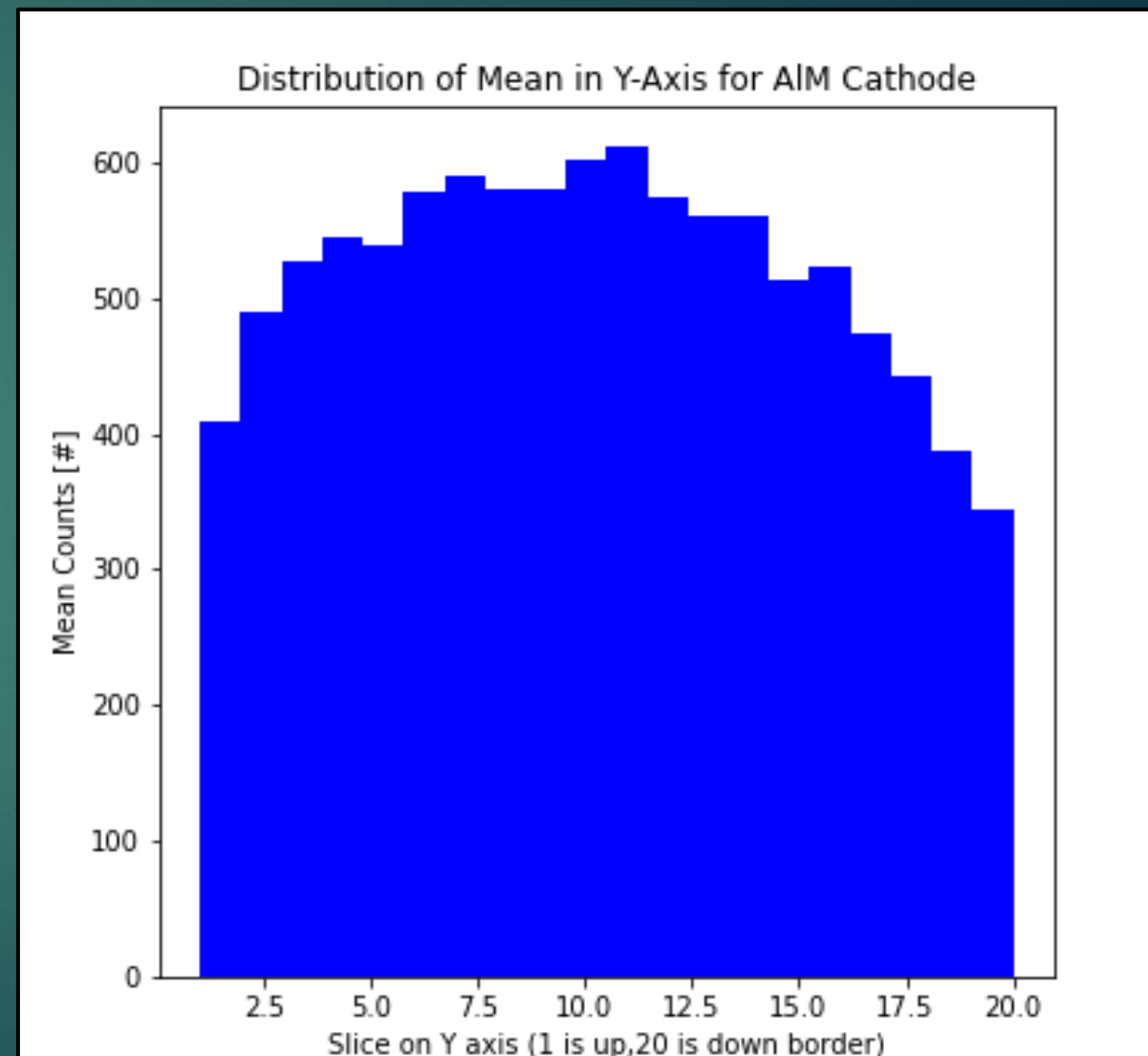
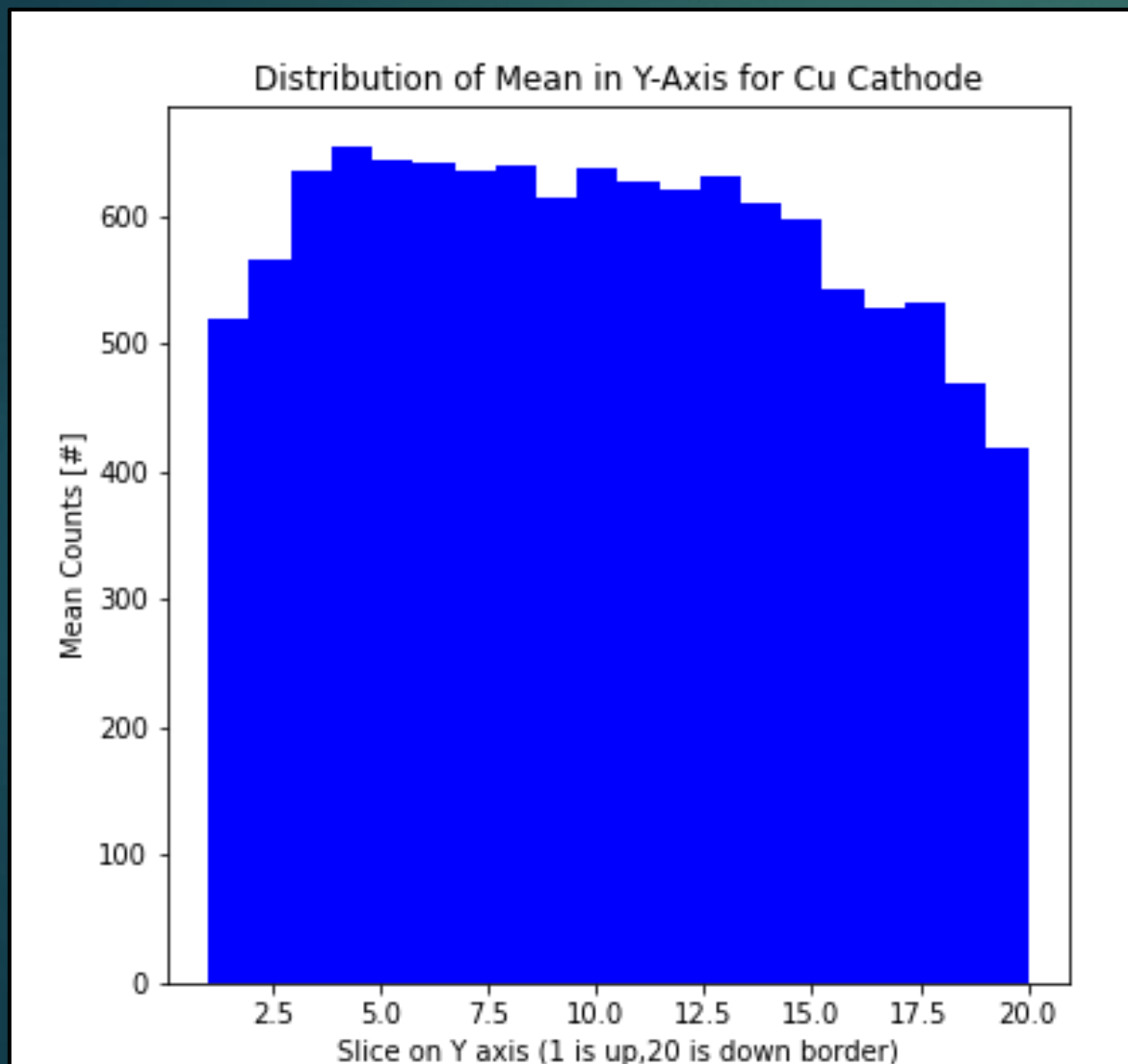
## ➤ **Measure Plan:**

- Positions: 2.1 cm, 12.1 cm, 22.2 cm from GEMs
- Field Values: 0.2, 0.6, 1 kV/cm taken at 400V and 440V
- GEM Voltages: 400 to 450
- Cathode capable of working up to 1.3 kV/cm, but no measures taken due to conditioning
- Camera Exposure: 0.15 s for Short Exposures and 0.18s for Long Exposures

# BACKUP / PROJECTIONS OF MAPS (X-AXIS MEAN)



# BACKUP / PROJECTIONS OF MAPS (Y-AXIS MEAN)





# BACKUP / Systematics on light

