

# CYGNUS Prototype: First measurements using a gas time projection chamber

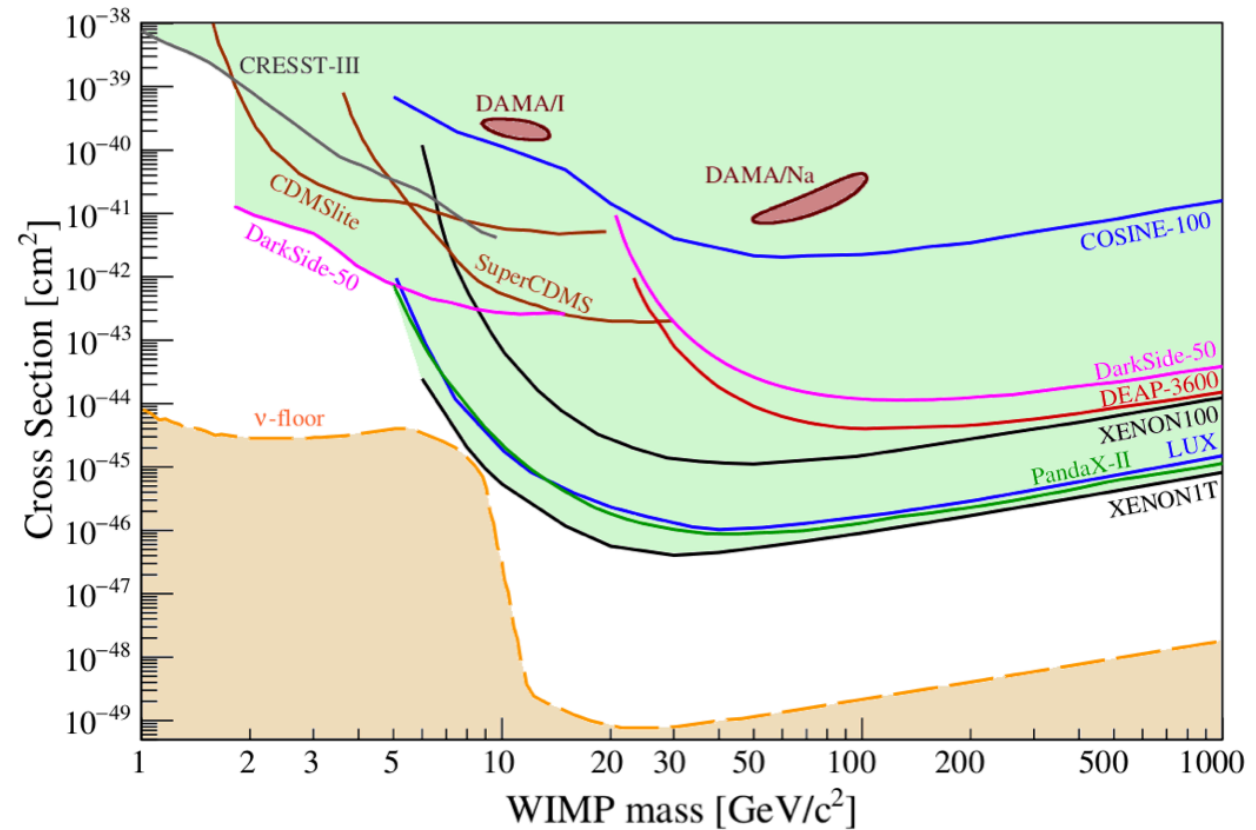
Lachlan McKie

PhD Student

[lachlan.mckie@anu.edu.au](mailto:lachlan.mckie@anu.edu.au)

# WIMP Direct detection

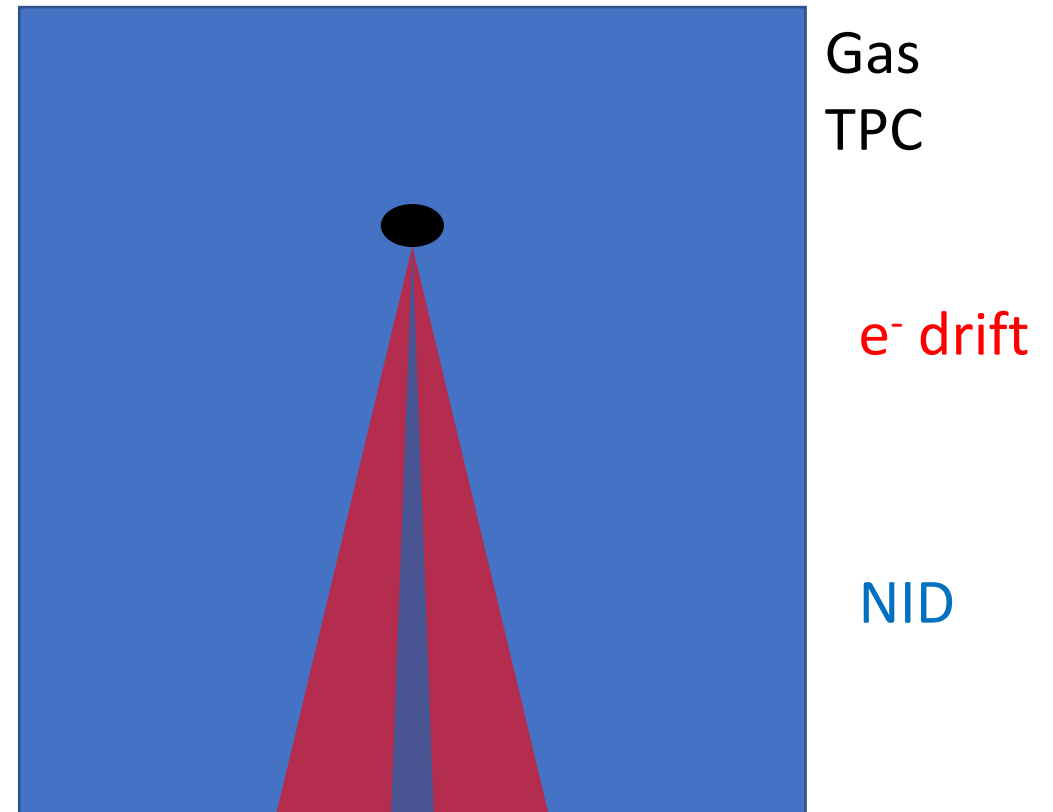
- Future WIMP searches will be limited by the neutrino floor



# Key challenges for upscaling detectors

## Drift gas

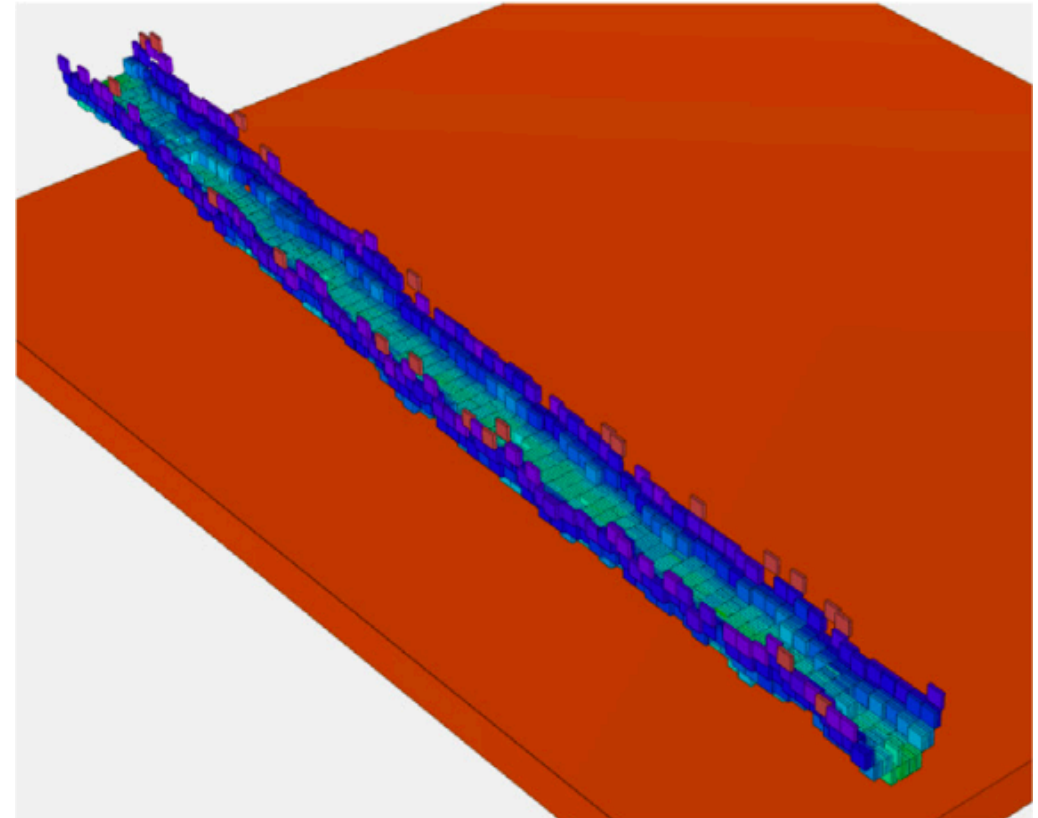
- Charge diffusion over larger drift ranges.
- Proposed solution is negative ion drift (NID) gases



# Key challenges for upscaling detectors

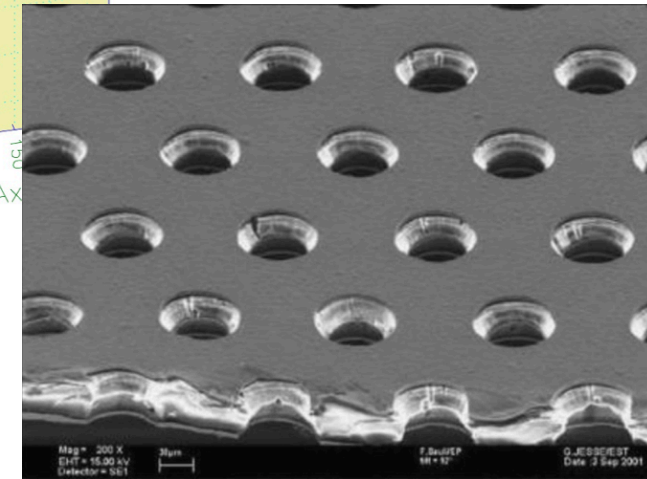
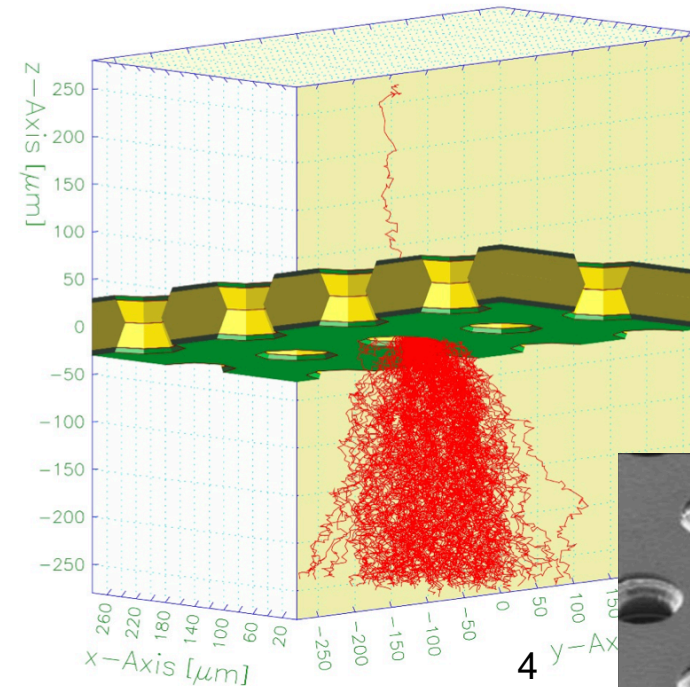
## Readout technologies

- Economical, high resolution signal readout.
- Proposed solution is Gas Electron Multipliers (GEMs)



# Gas electron multiplier (GEM)

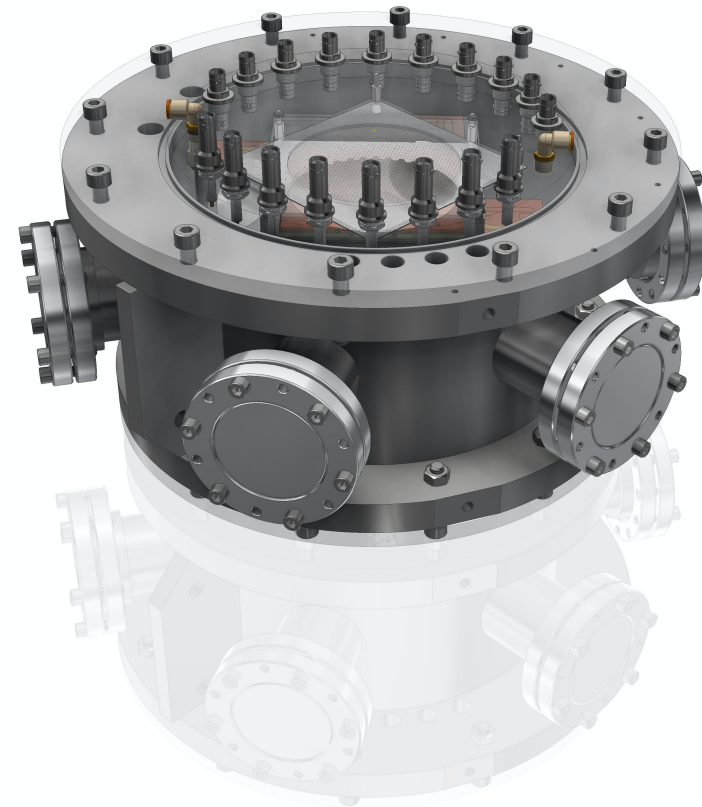
- Amplifies signal at lower operating voltages
- Maintains spatial resolution



CYGNUS-1

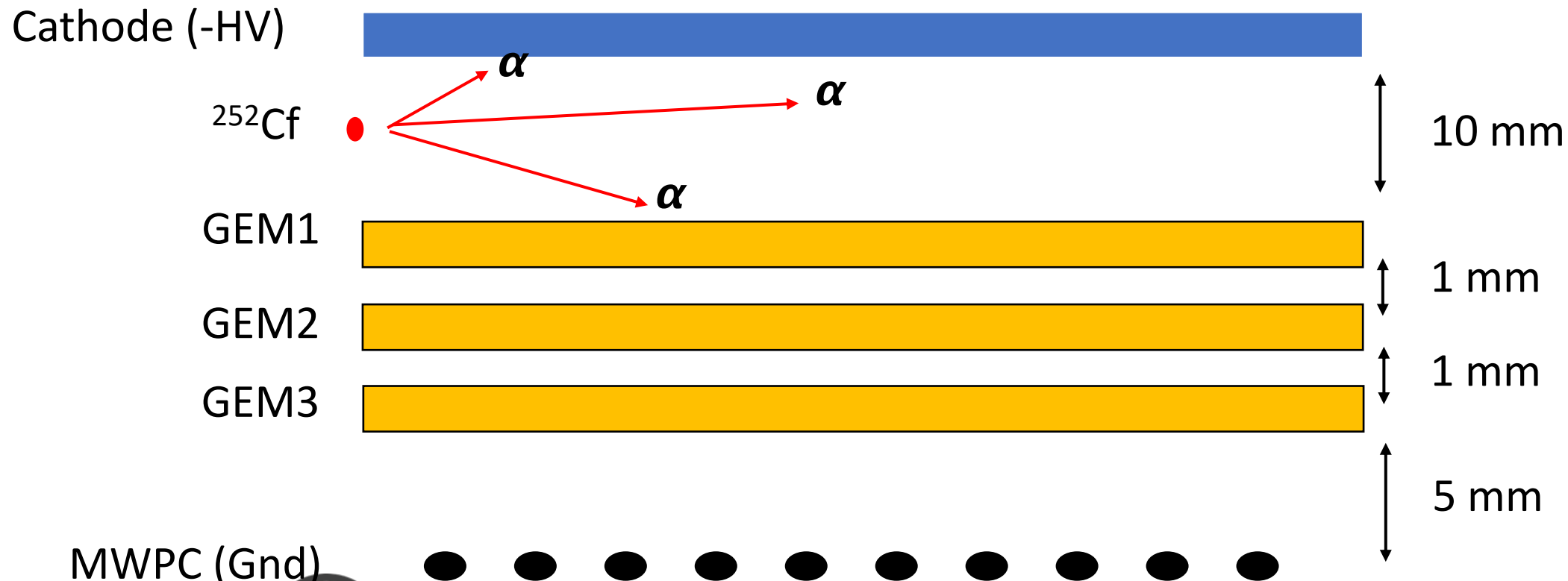


CYGNUS Lite



# CYGNUS Lite experimental setup

Drift gas: Ar:CO<sub>2</sub> 70:30%  
Atmospheric pressure



# Drift field strength

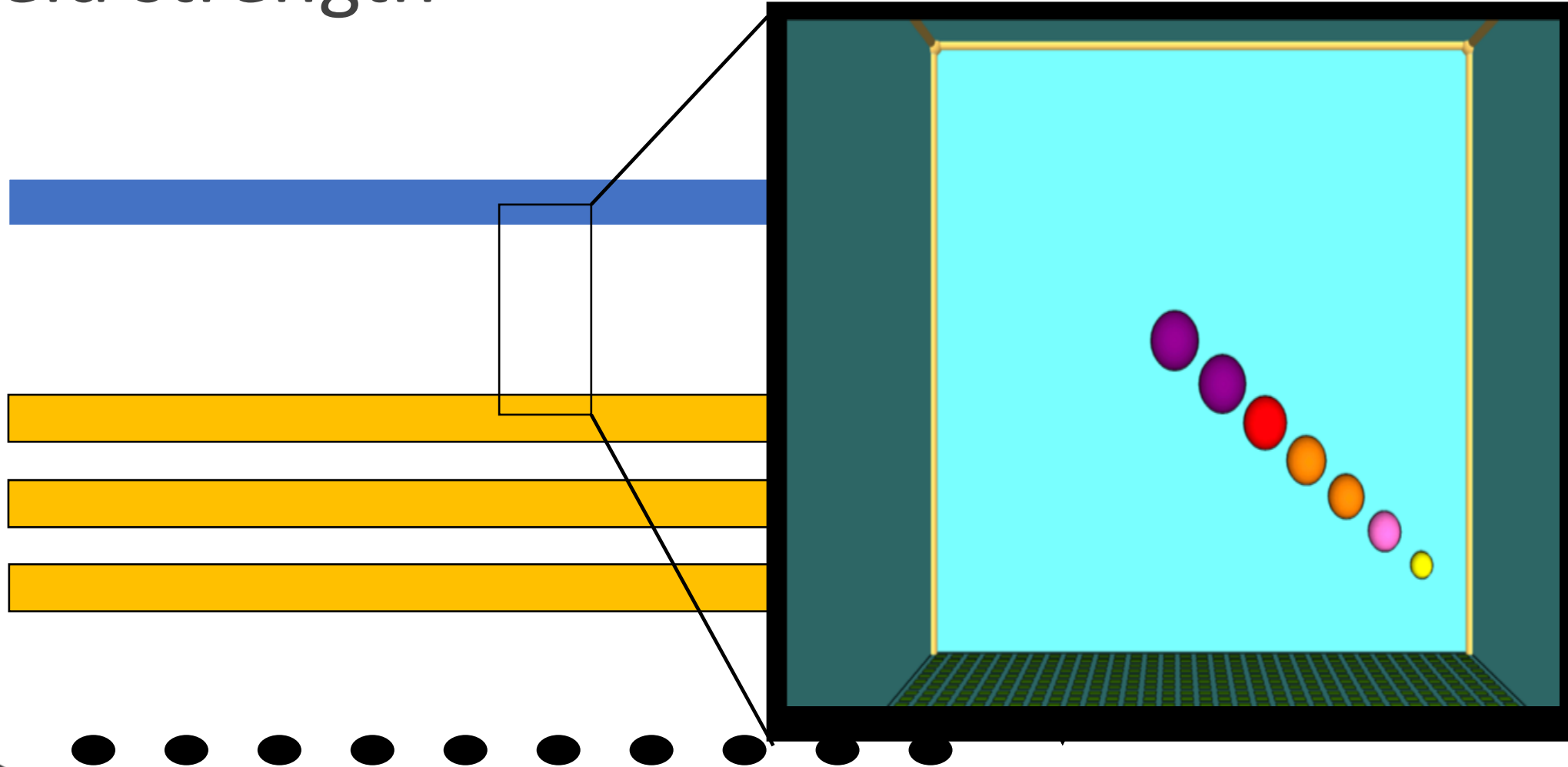
Cathode (-HV)

GEM1

GEM2

GEM3

MWPC (Gnd)





# GEM Voltages

Cathode (-HV)



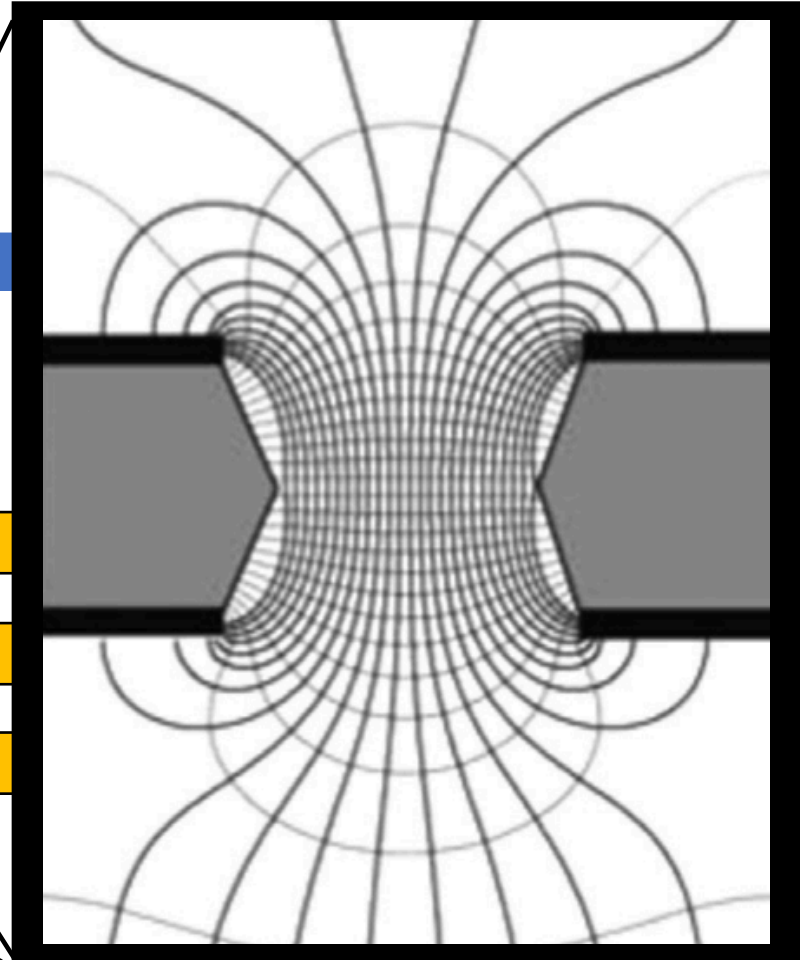
GEM1



GEM2



GEM3



MWPC (Gnd)

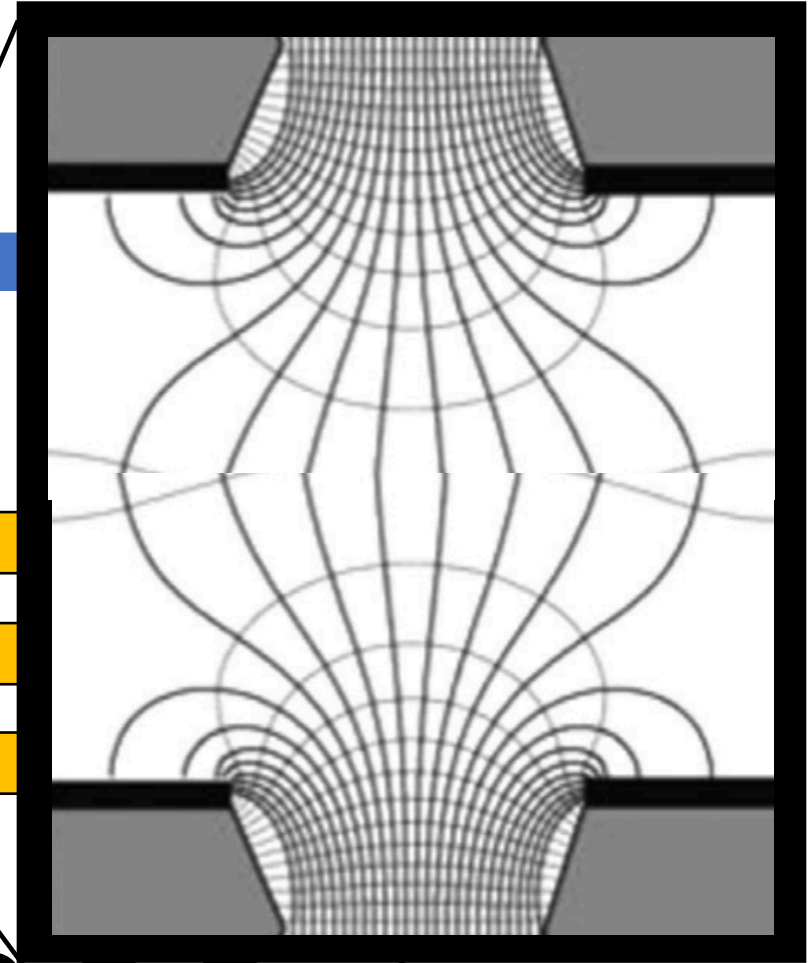
# Transfer Field Strength

Cathode (-HV)

GEM1

GEM2

GEM3



# Induction Field Strength

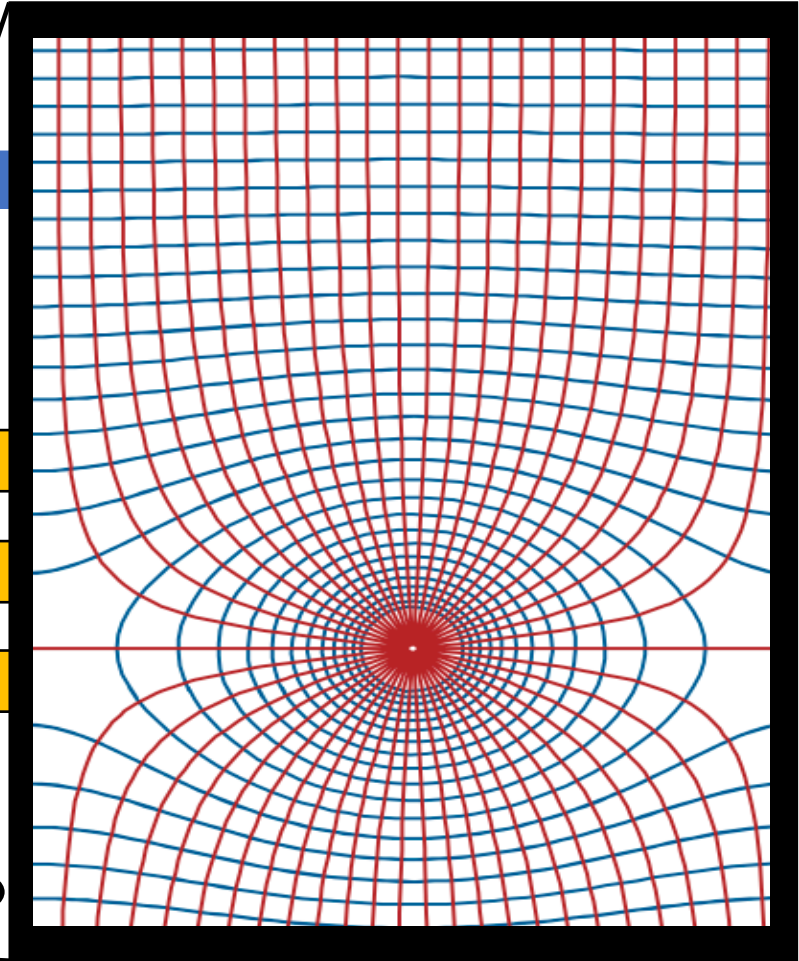
Cathode (-HV)

GEM1

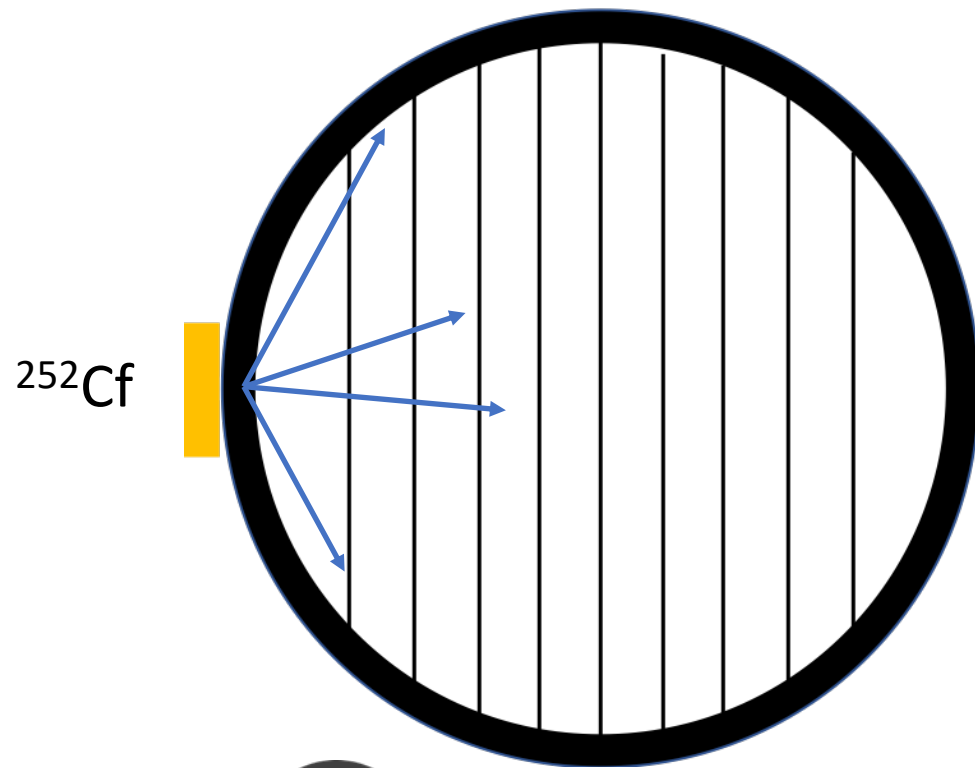
GEM2

GEM3

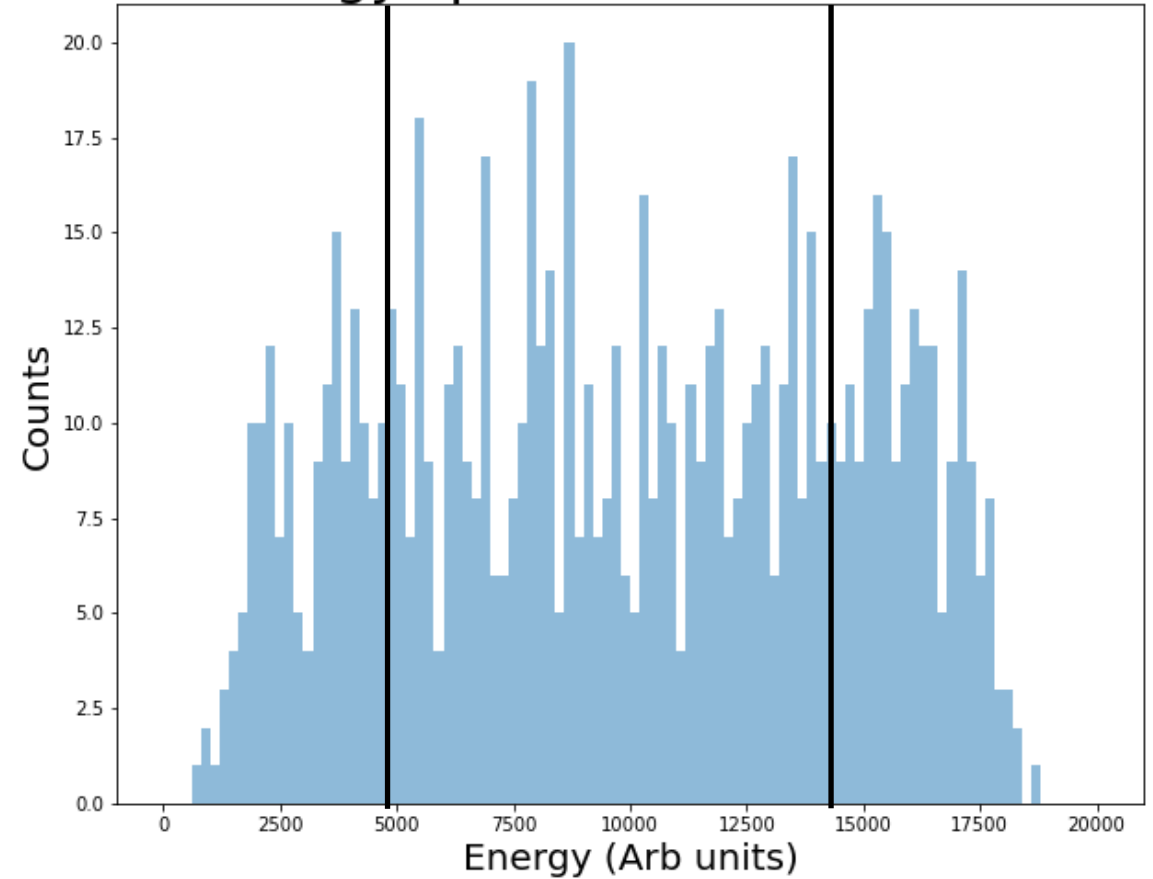
MWPC (Gnd)



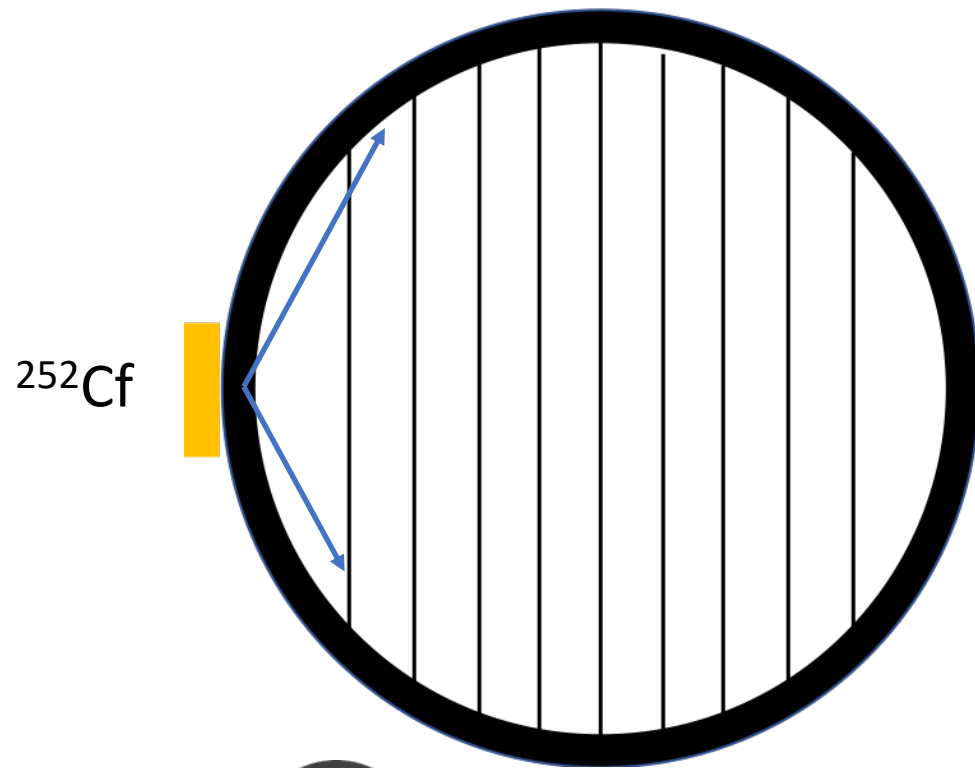
# Energy selection



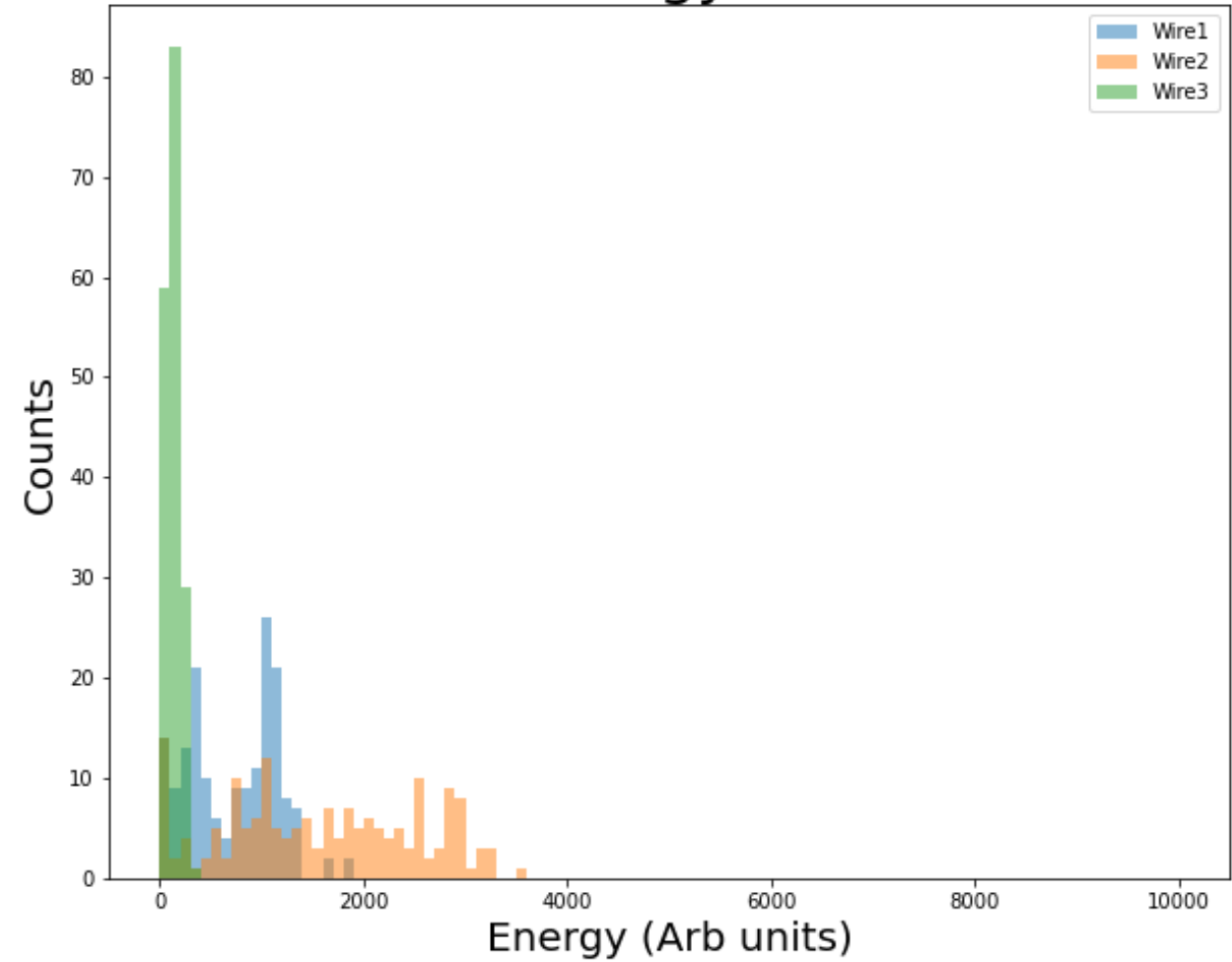
Energy spectrum CYGNUS Lite



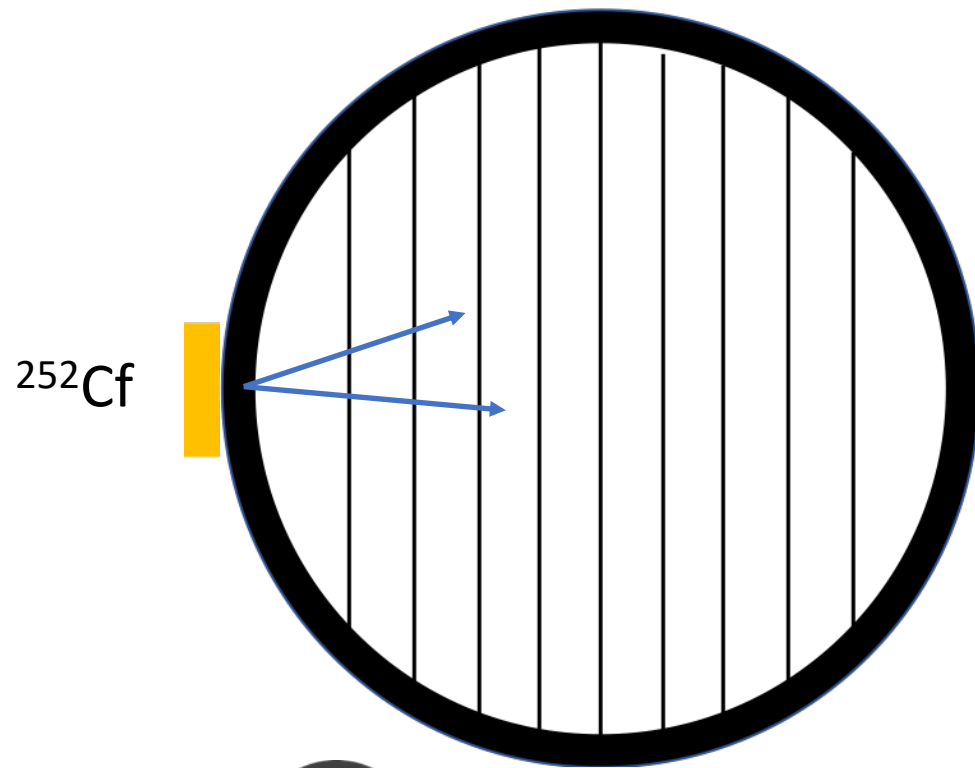
# Low energy events



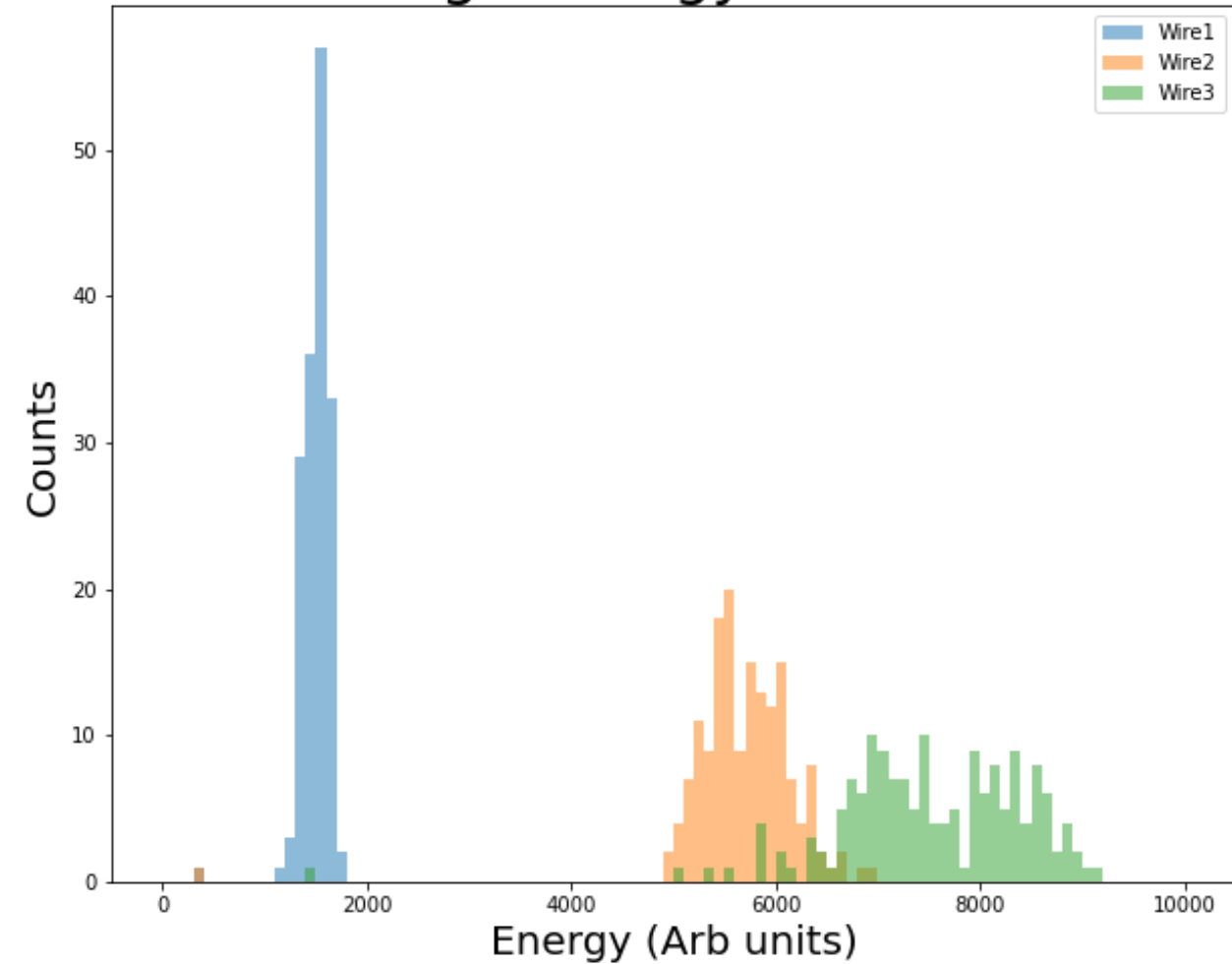
## Low energy events

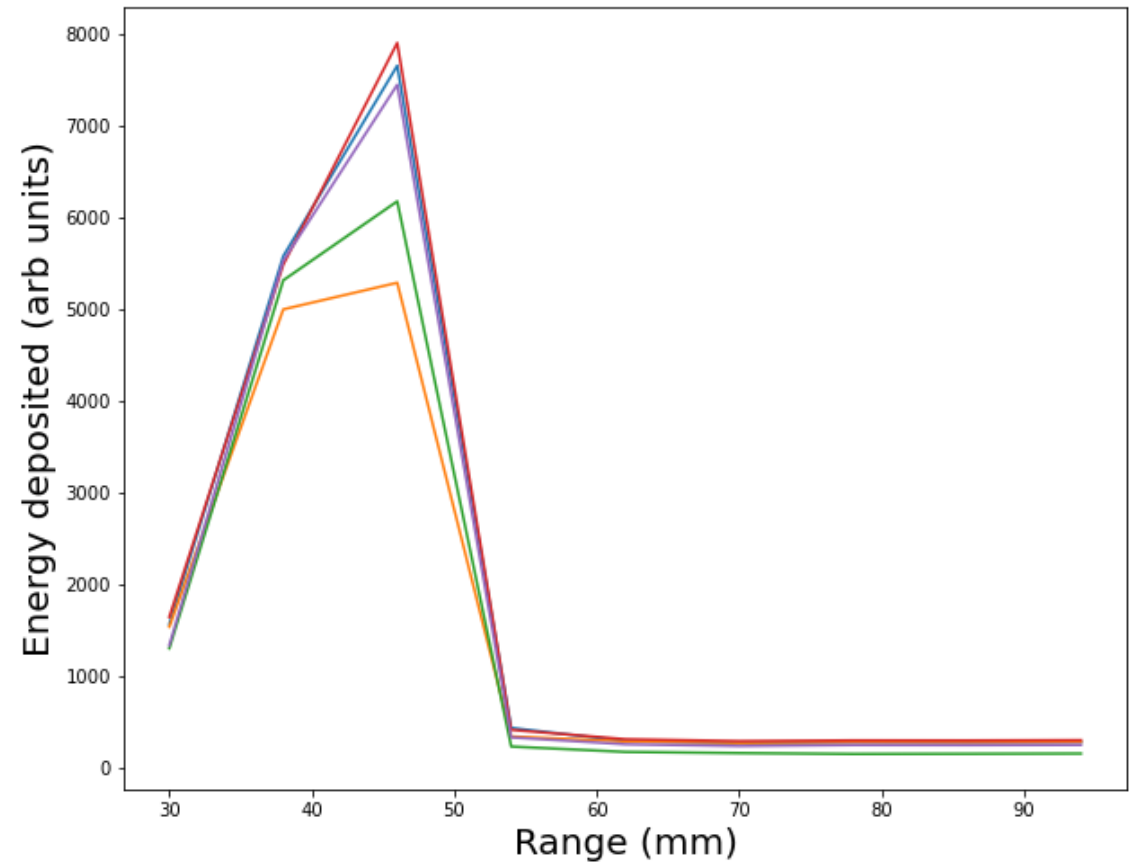
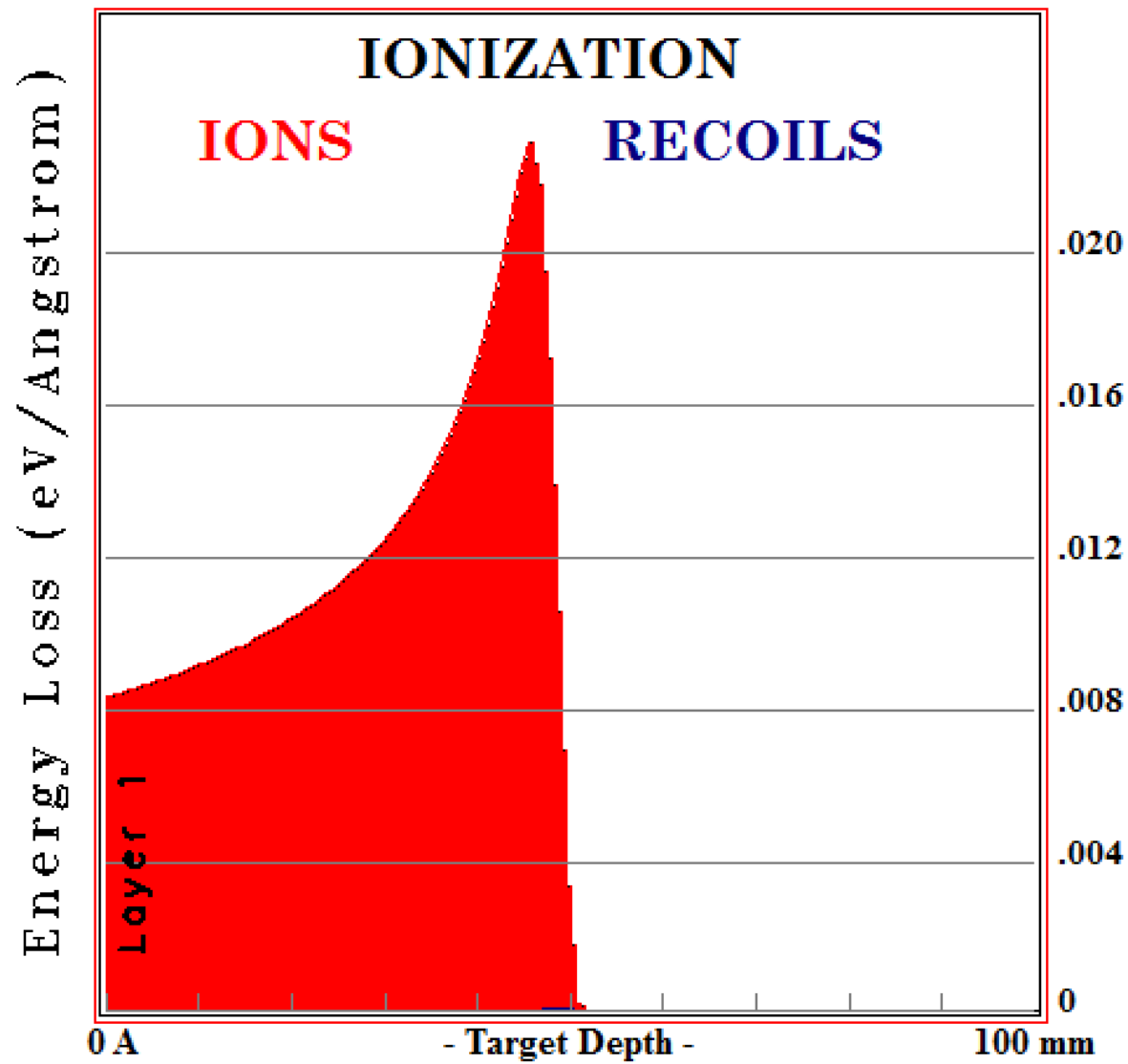


# High energy events

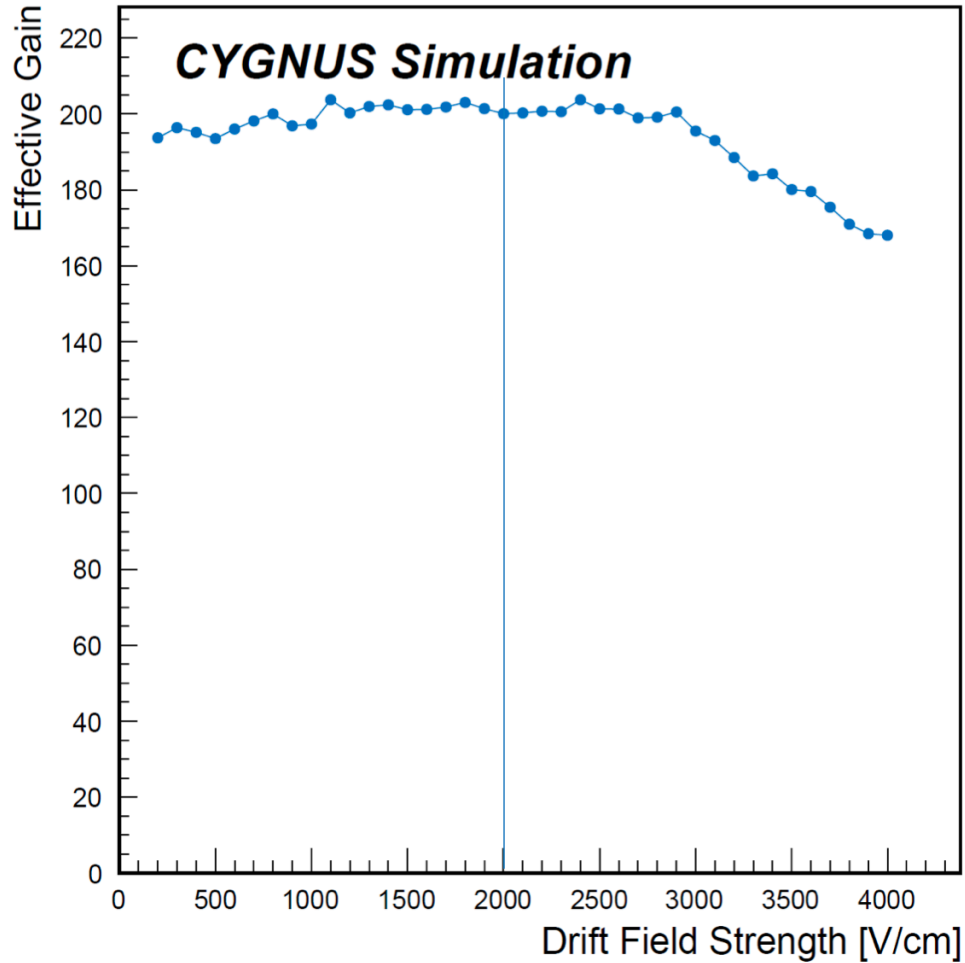


## High energy events

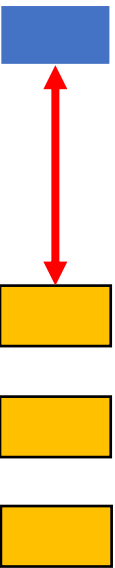
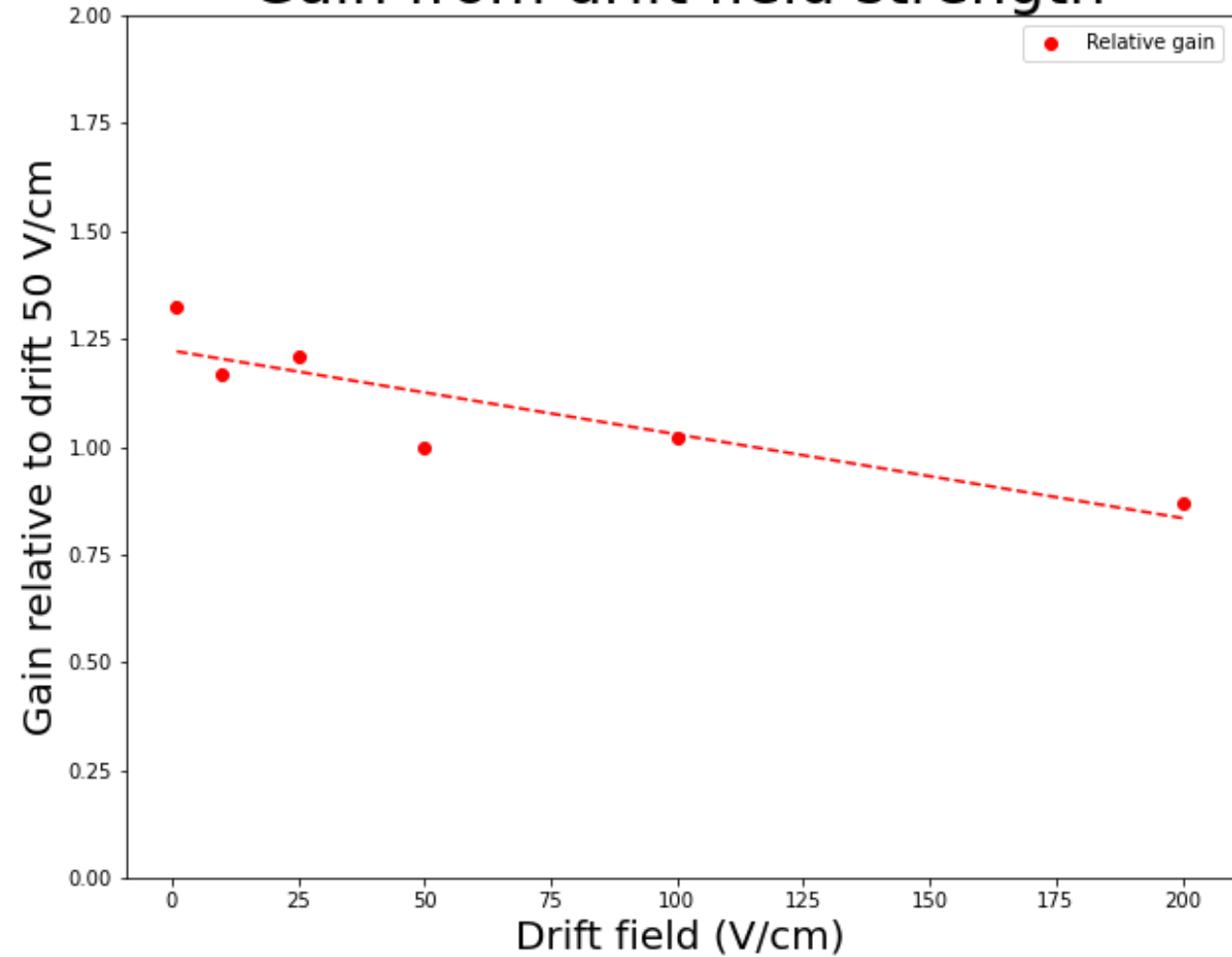




# Drift field results

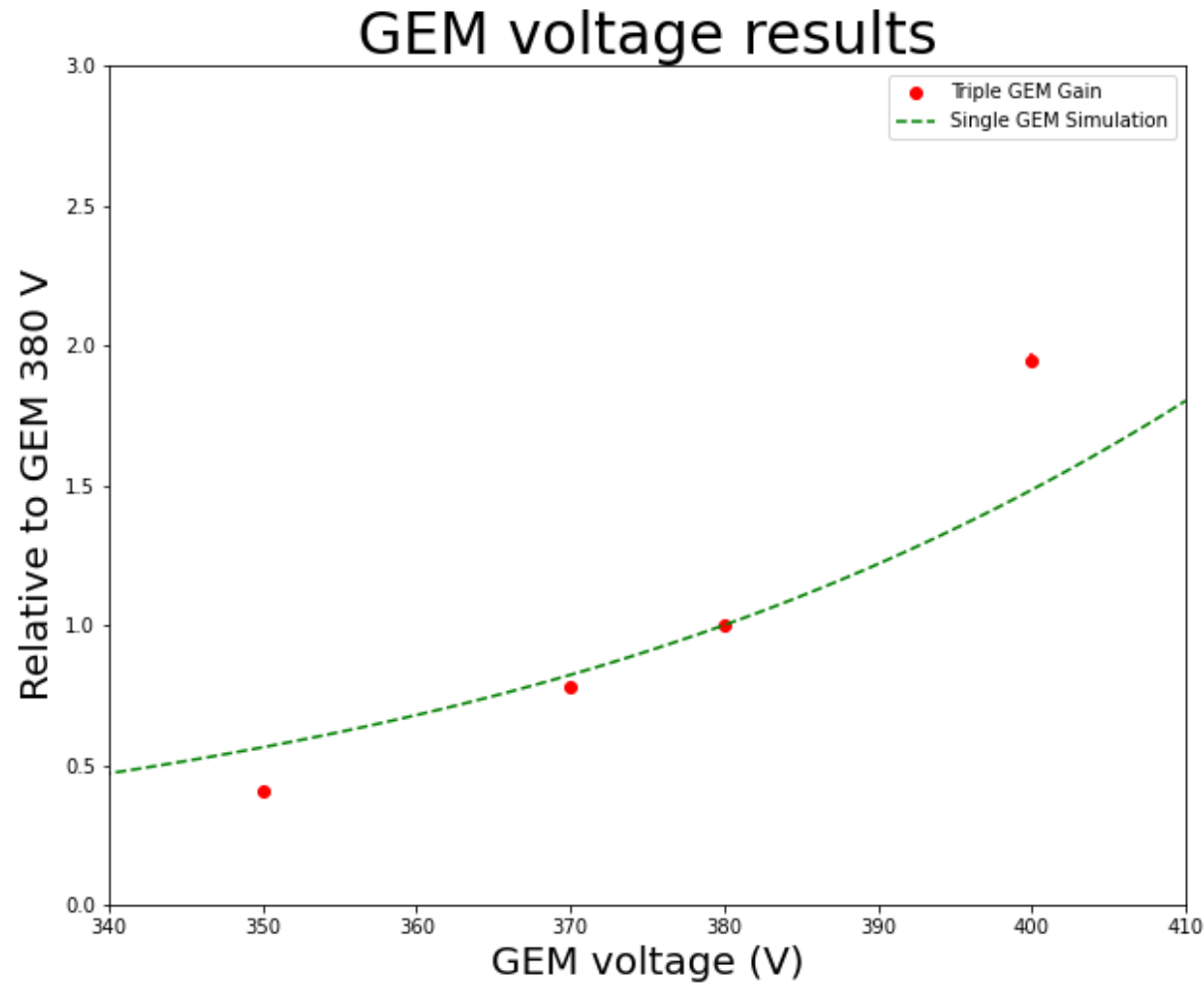


## Gain from drift field strength

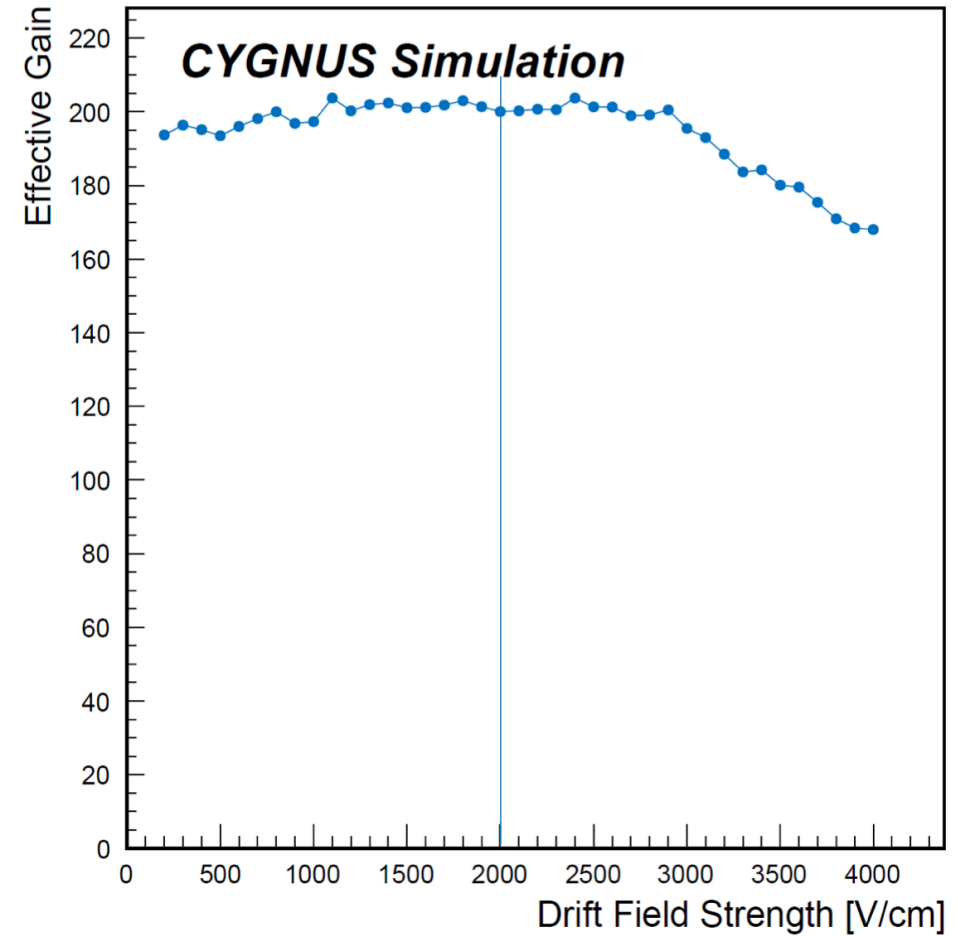
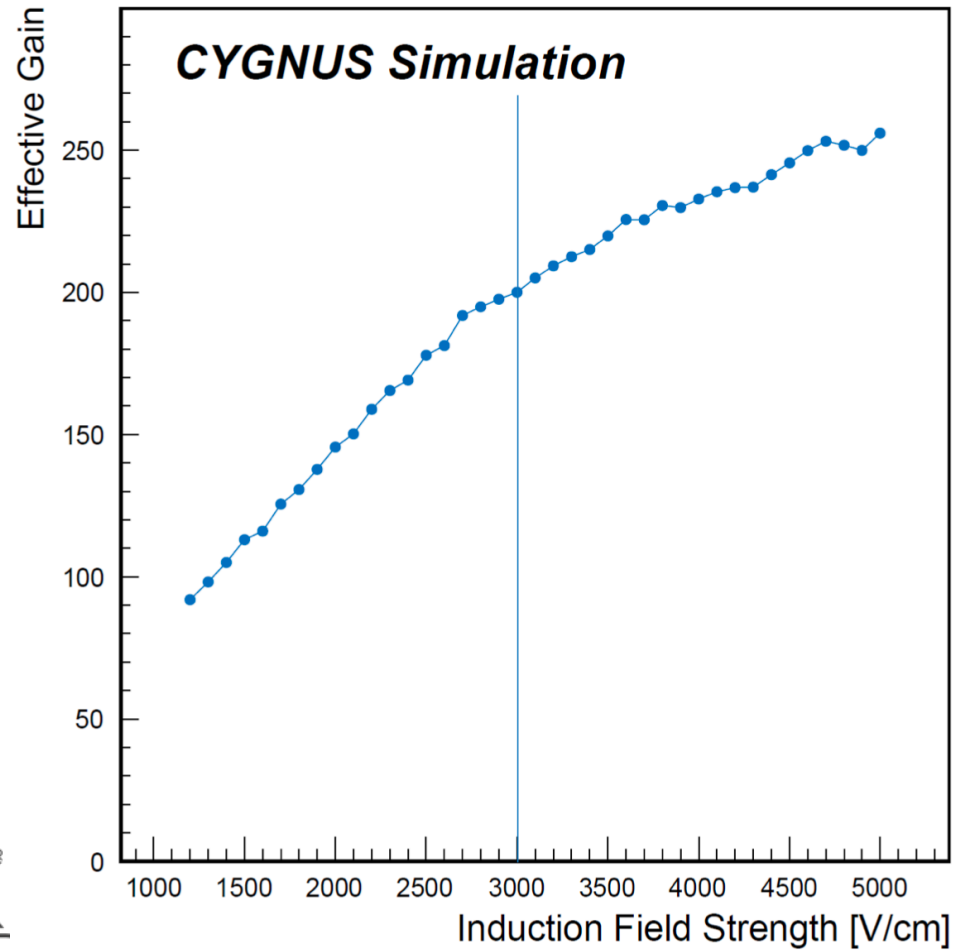




# GEM Voltage results



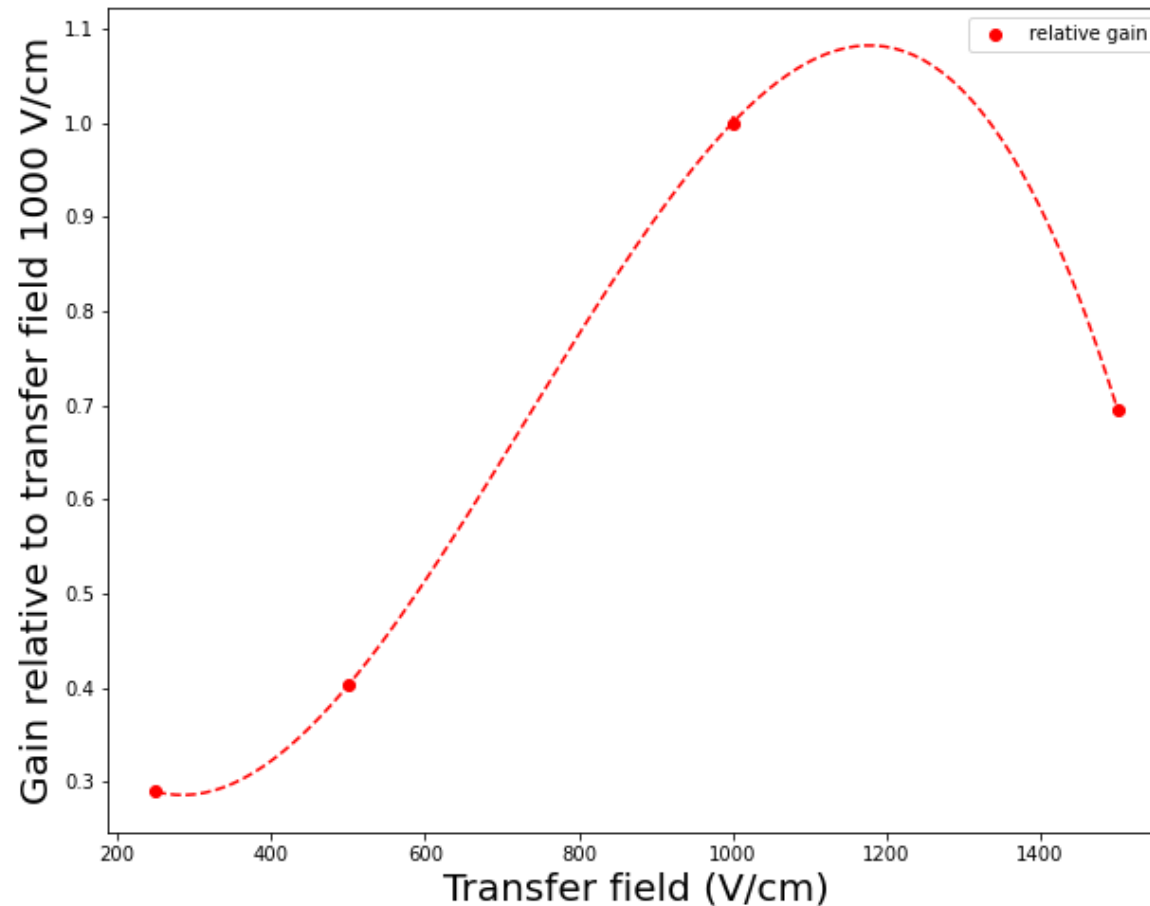
# Transfer Gap



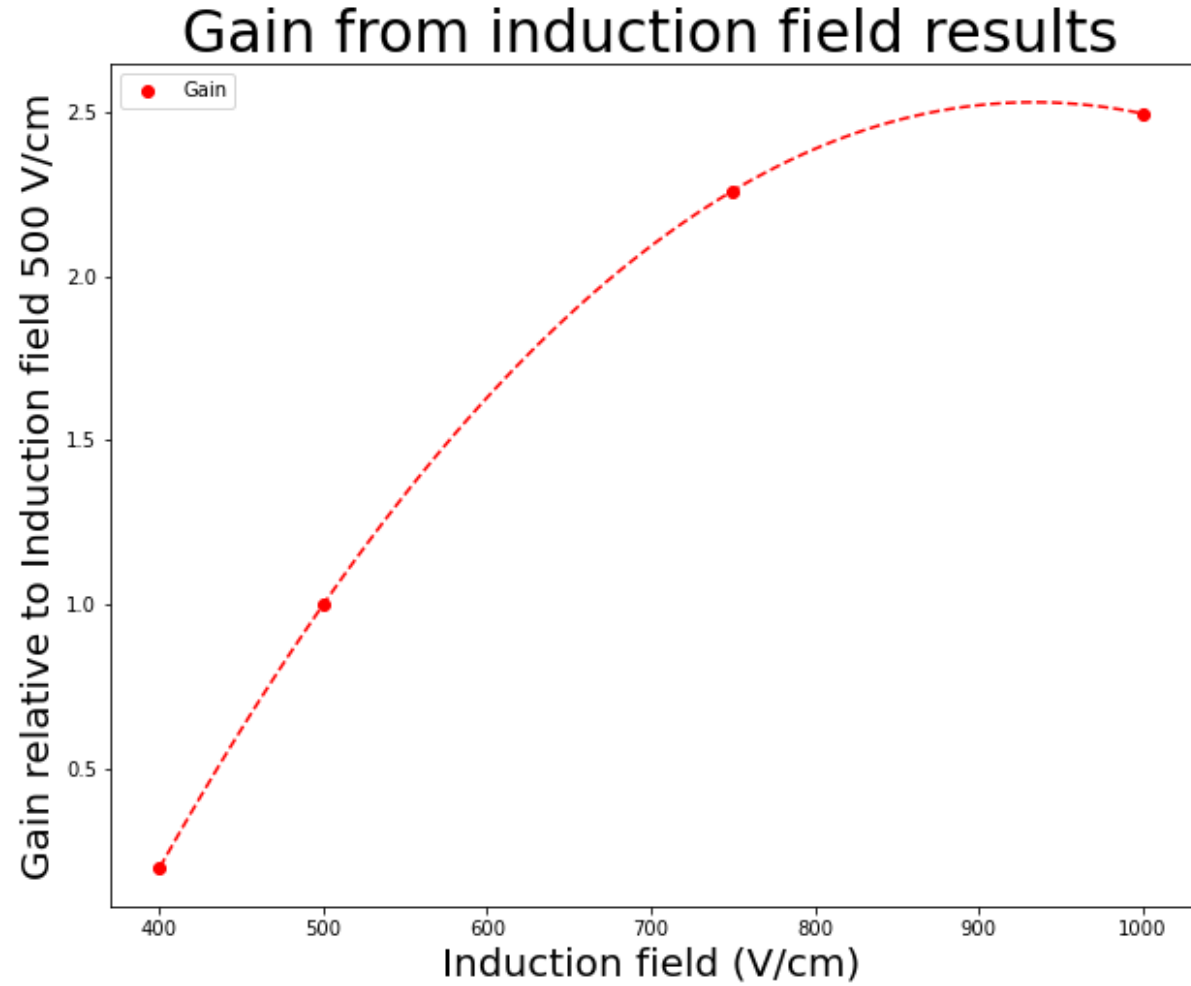
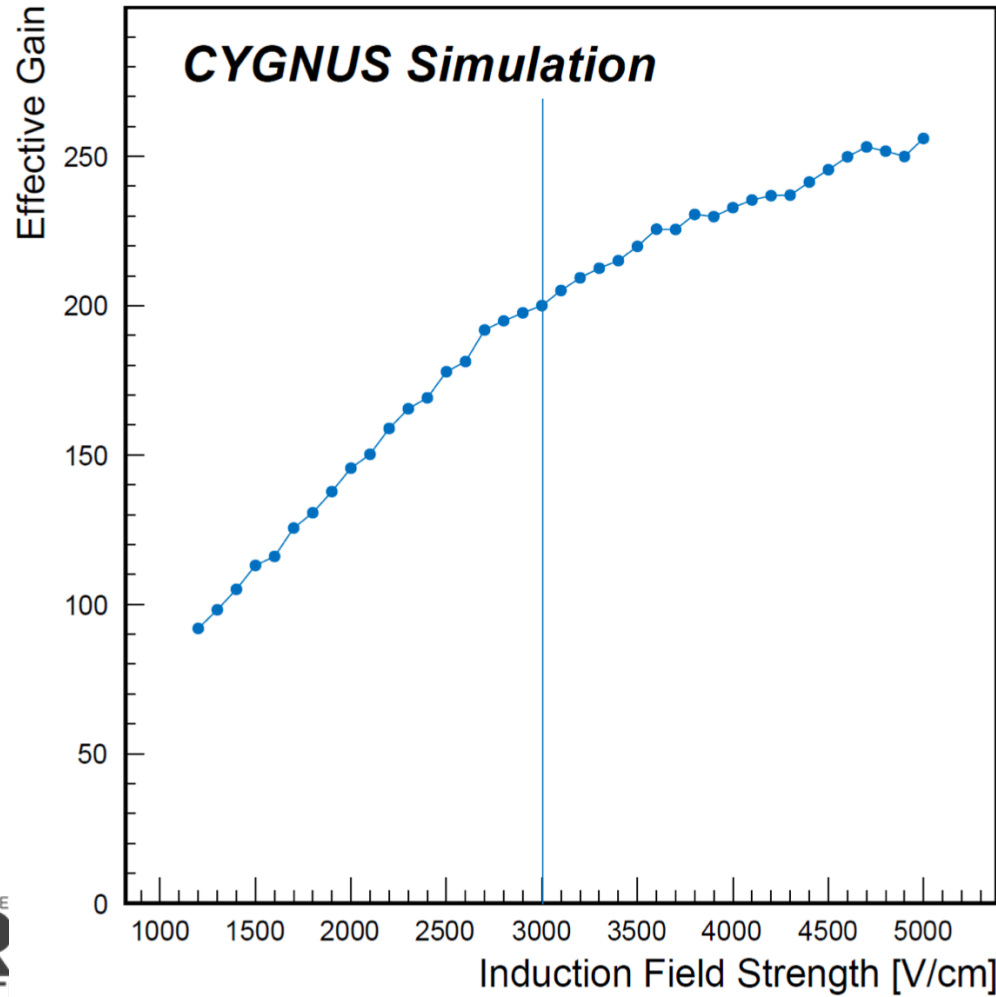
# Transfer Gap results



Gain from GEM transfer field

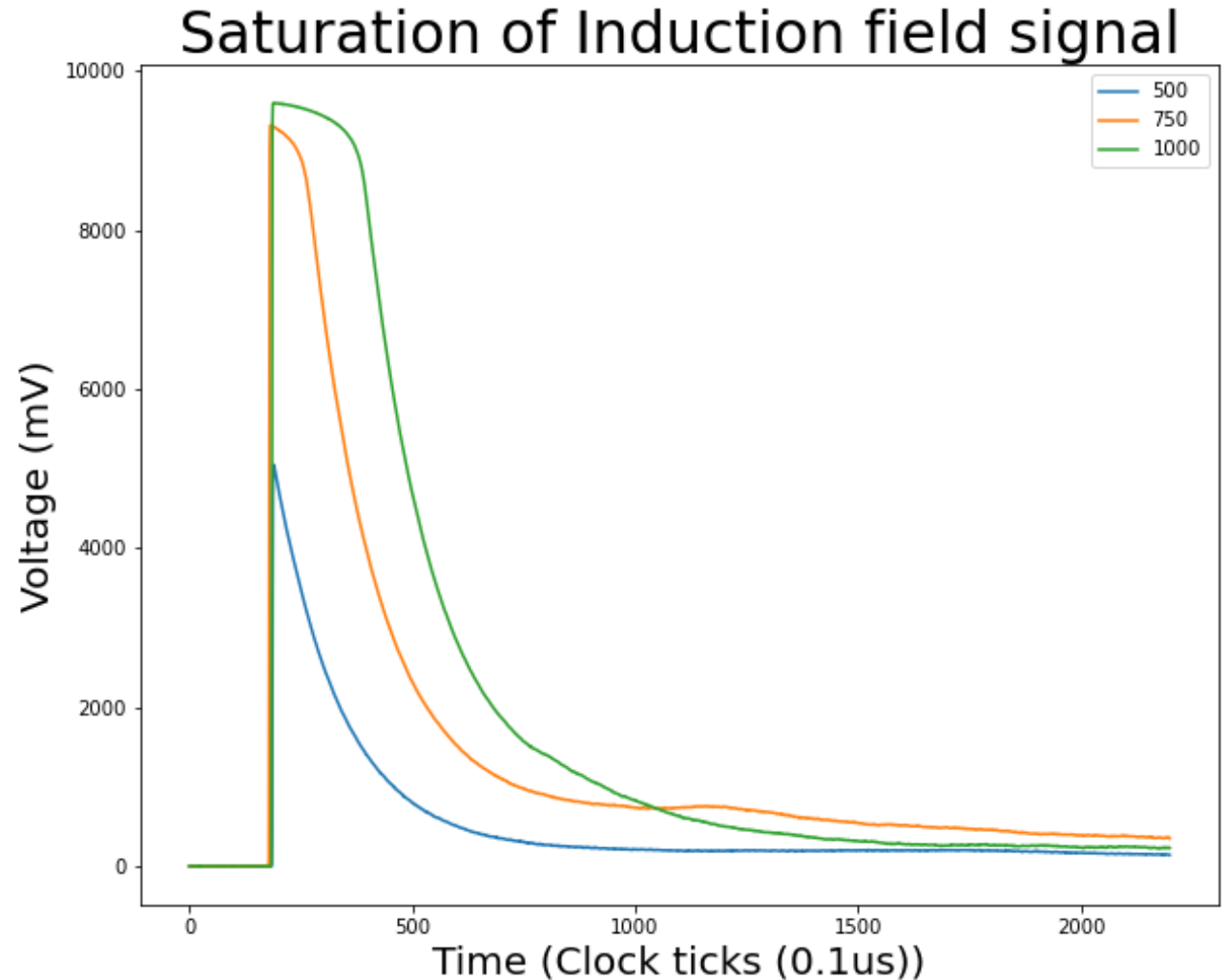


# Induction Field results

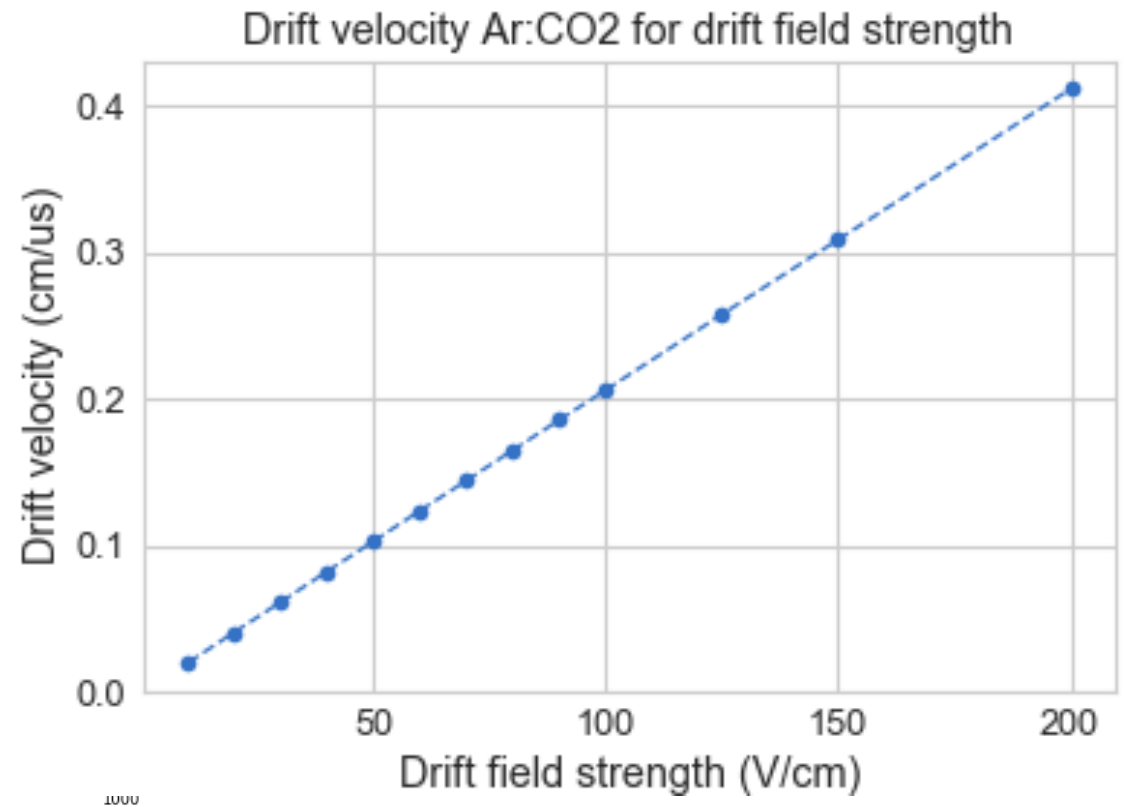
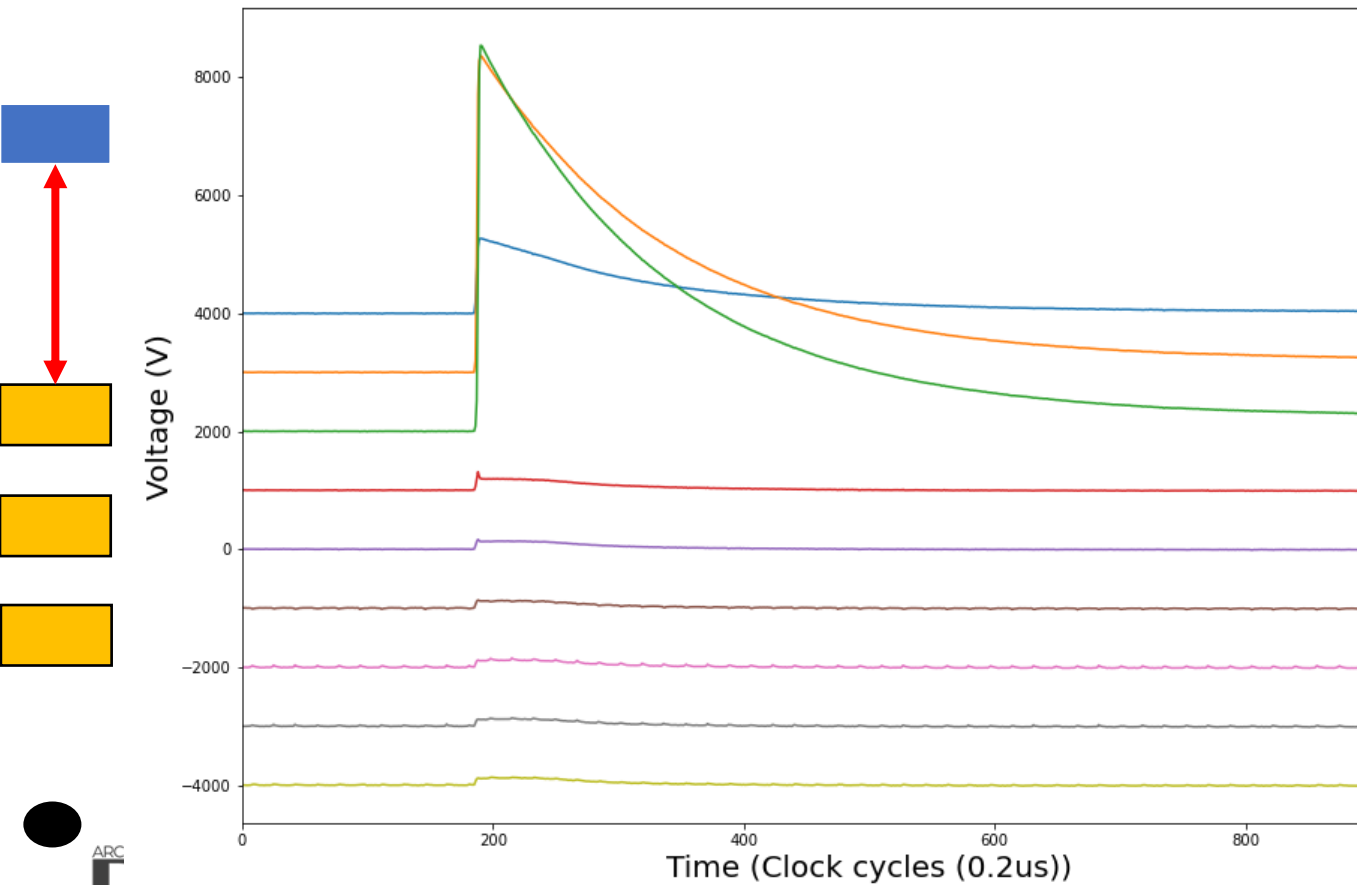


# Induction Field results

- Signal saturation
- Dark matter nuclear recoil energy  $\sim 26\text{keV}$
- Alpha particle energy  $6.2\text{MeV}$

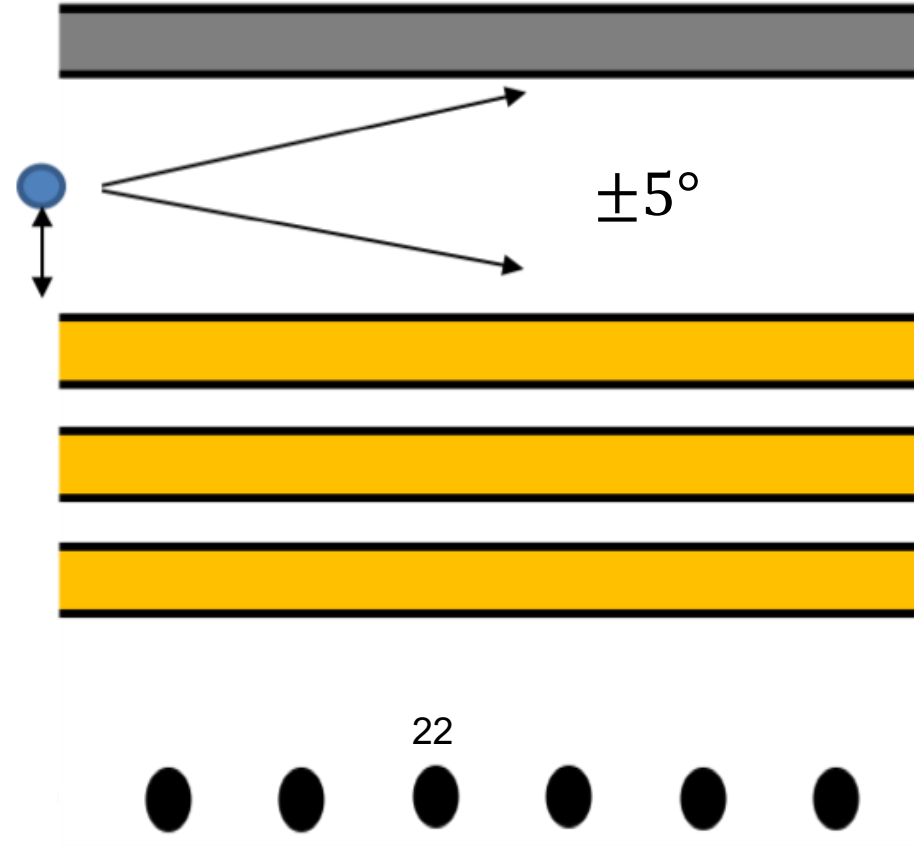
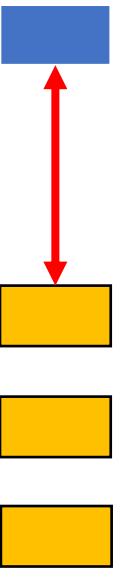
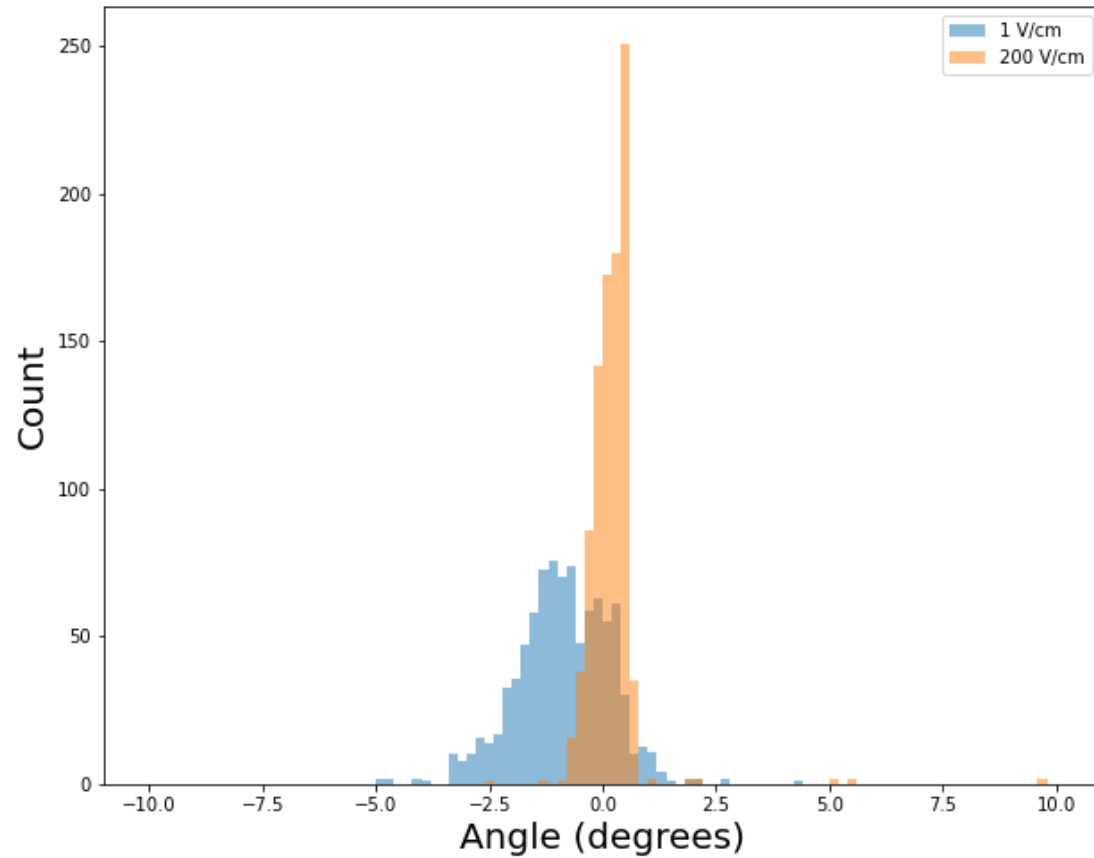


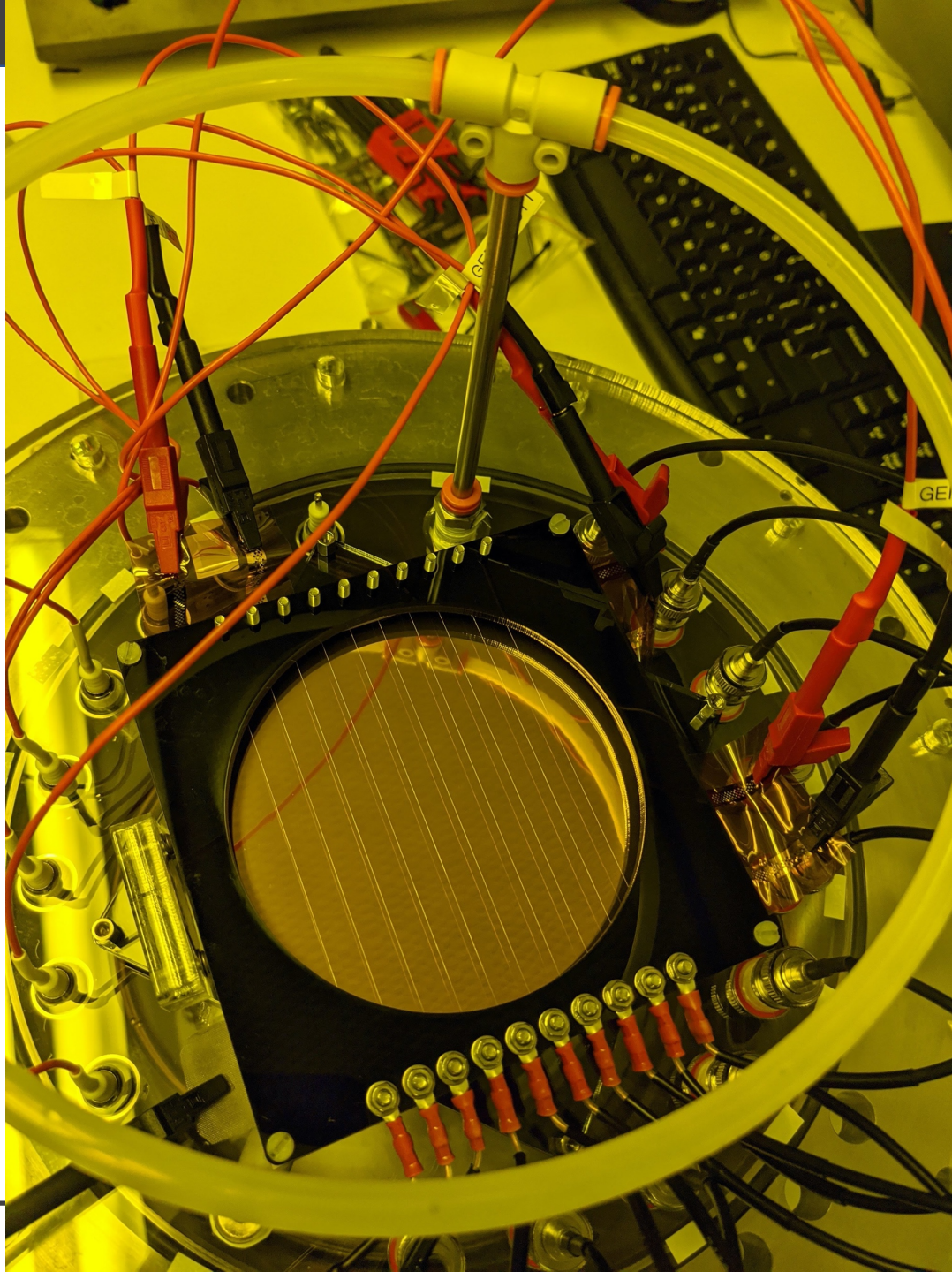
# Drift field: Track inclination



# Drift field: Track inclination

Track inclination



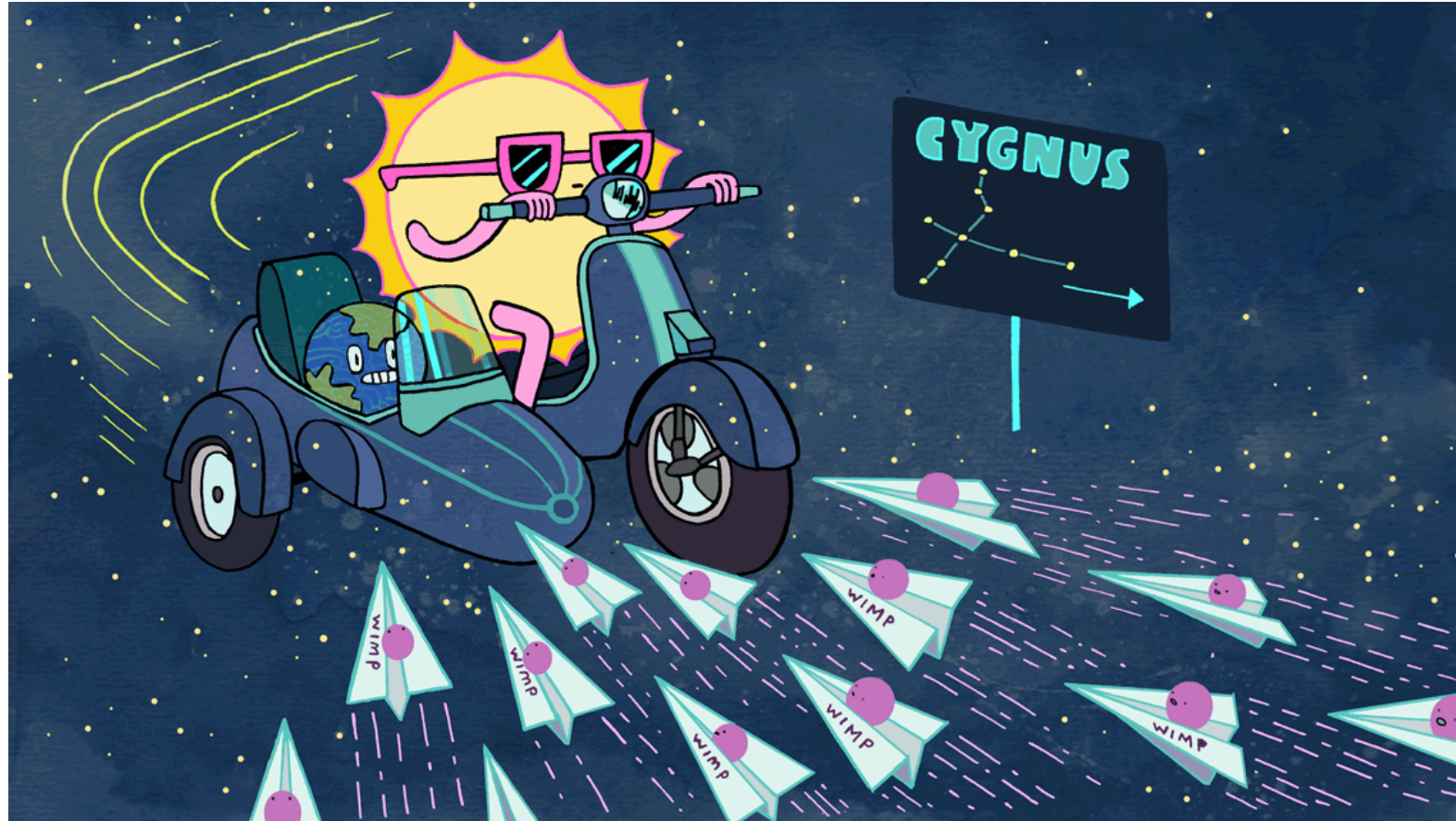


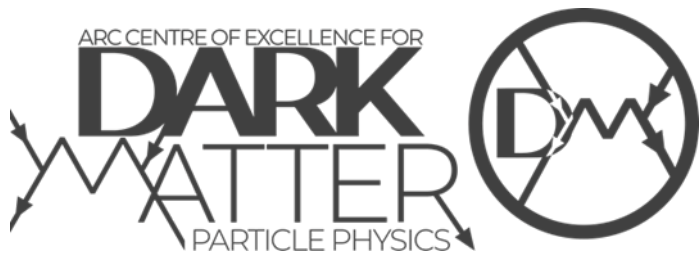


# Summary

- Developed platform for future directional dark matter experiments.
- Gas electron multiplier studies reflect a positive outlook for future directional dark matter work.

# Questions



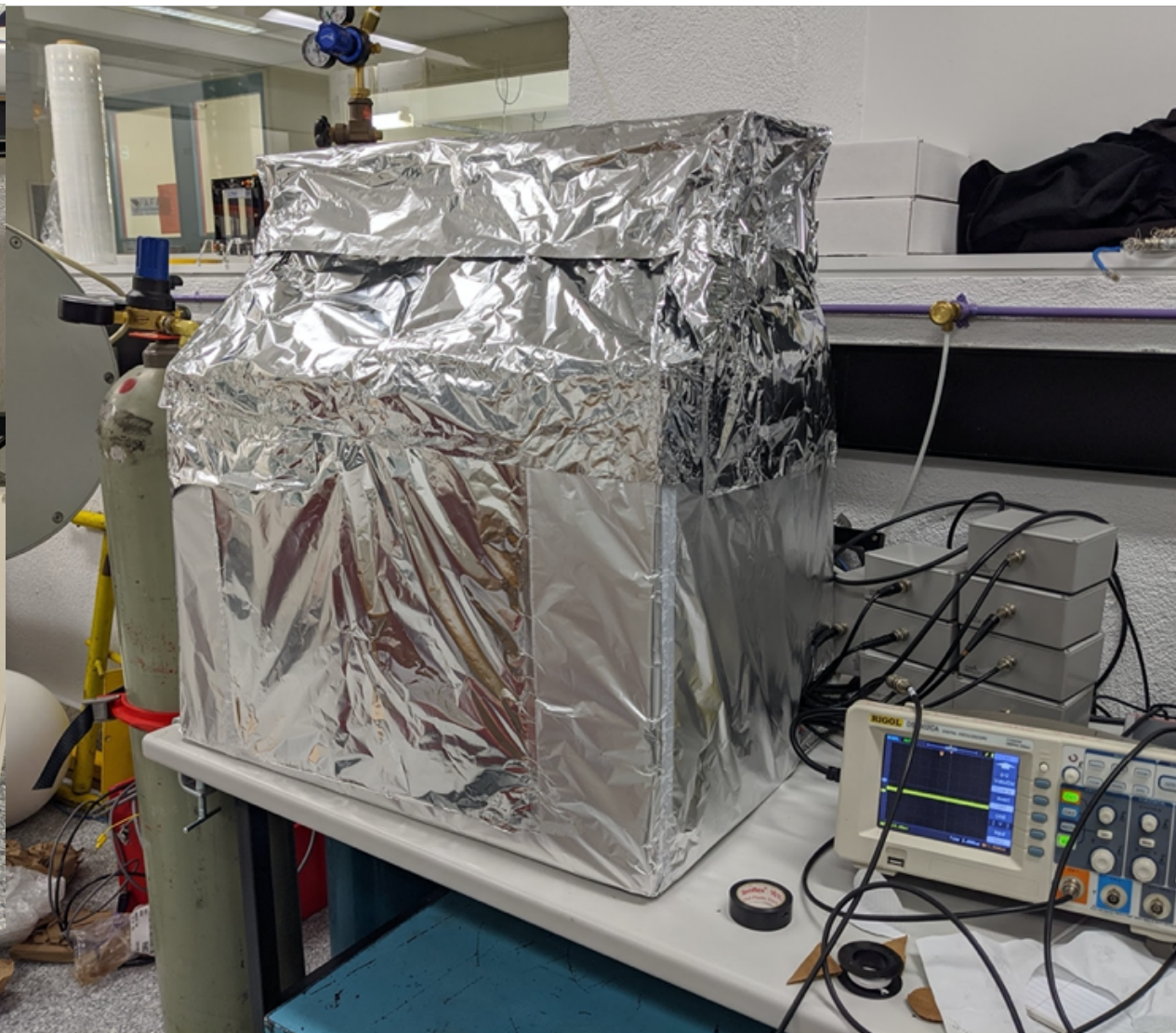


## NATIONAL PARTNER ORGANISATIONS:



## INTERNATIONAL PARTNER ORGANISATIONS:





# Background reduction

- Background radon progeny in DRIFT caused by mesh cathode
- Replaced by aluminised mylar cathode arXiv: 1502.03535



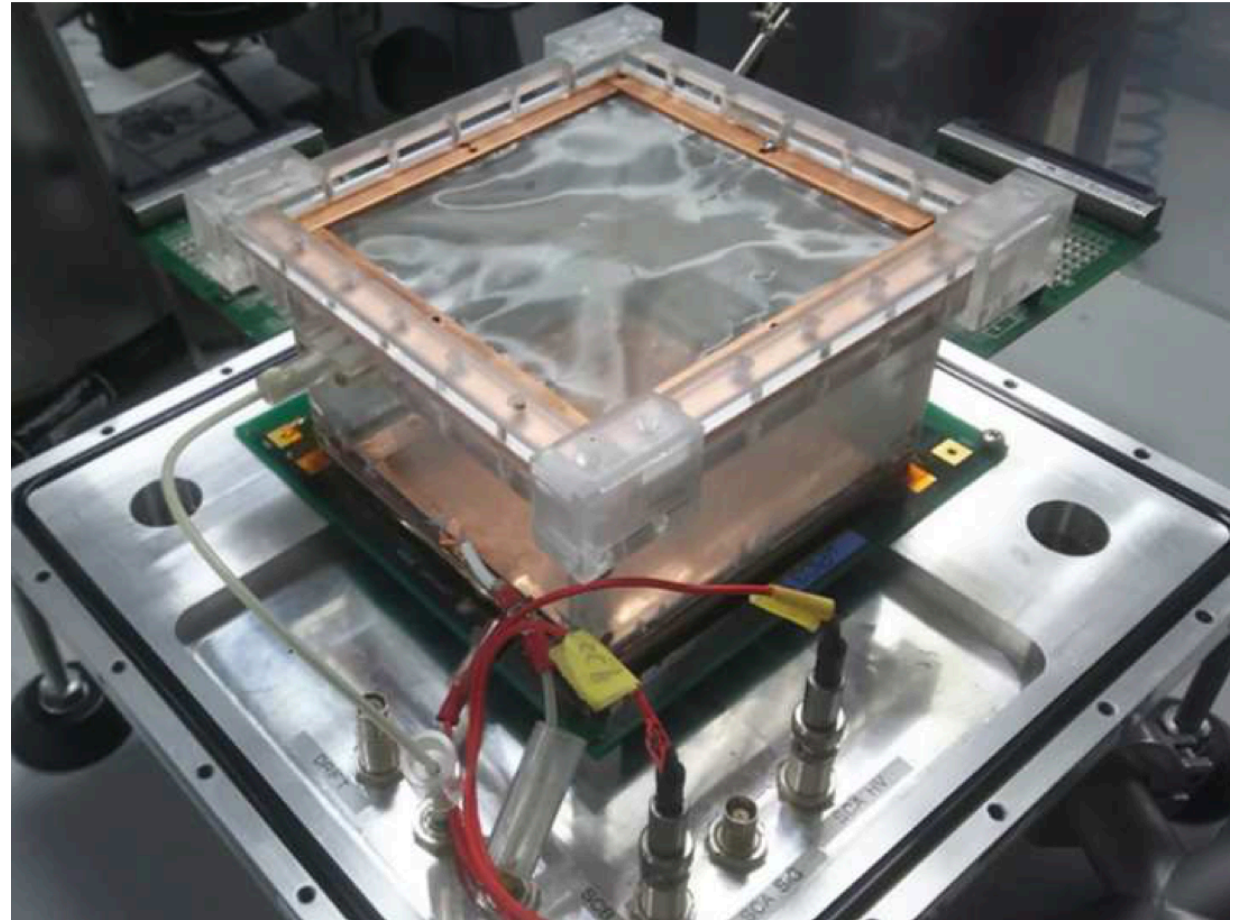
# Background reduction

- Replace aluminised mylar with indium tin oxide (ITO).

DOI:10.1063/1.5010122

- Further background reduction and improved drift cage capability with sheet resistors

[arXiv:1903.01663](https://arxiv.org/abs/1903.01663)



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