TEDish

Yale

# HRPPD Measurement at Yale

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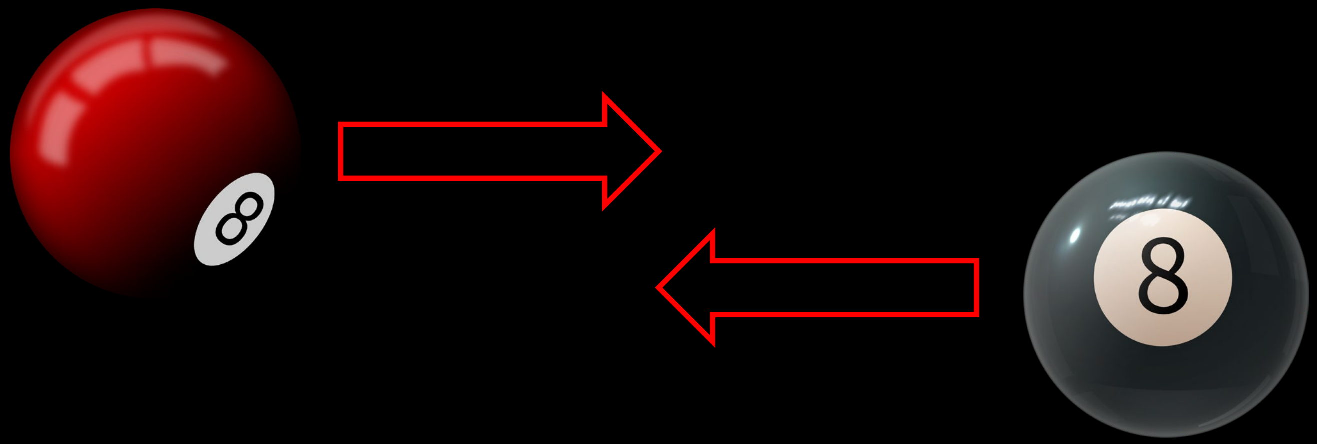
Supported in part by

U.S. DEPARTMENT OF ENERGY | Office of Science

# Picture this



… You know this one

TEDish

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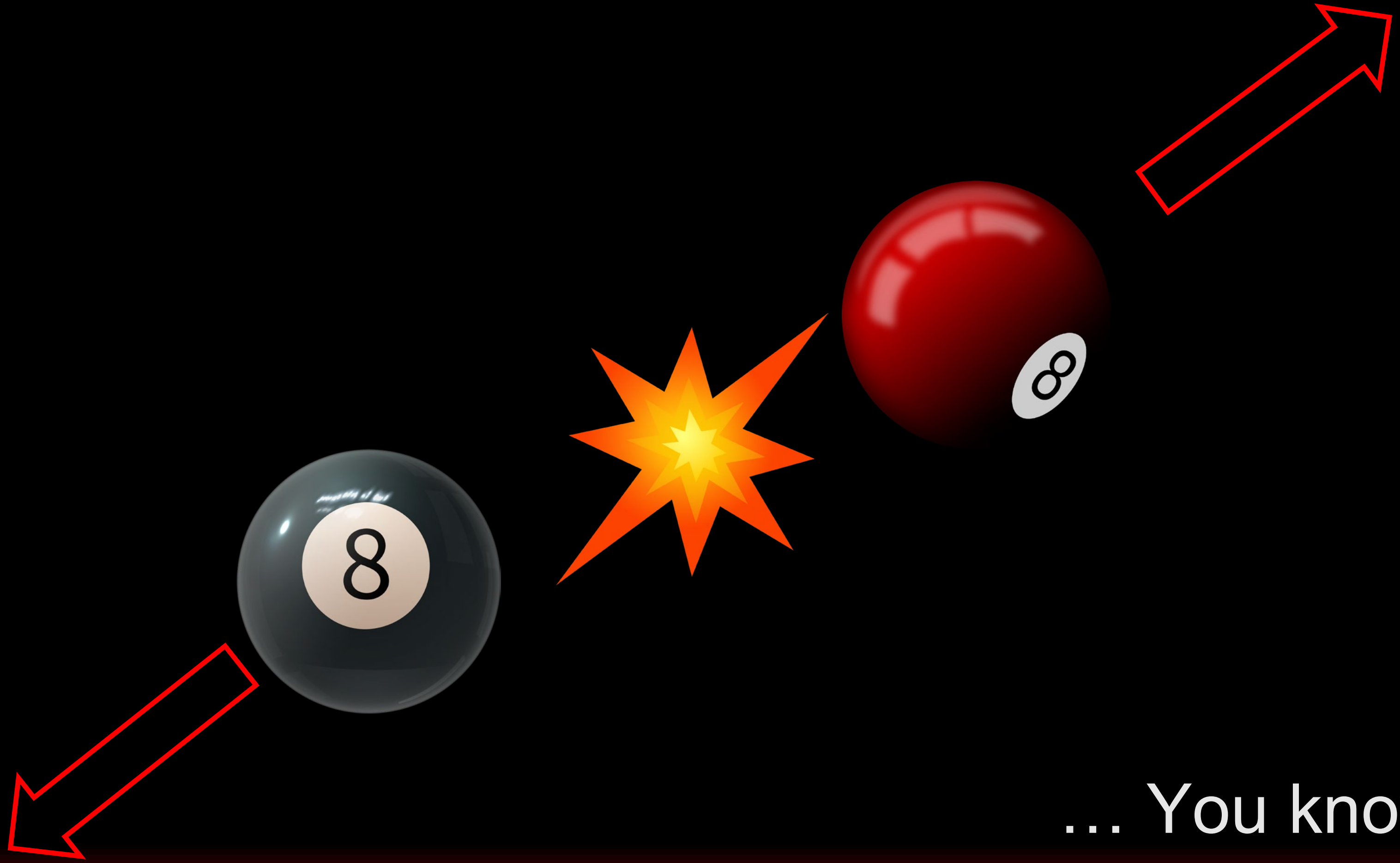


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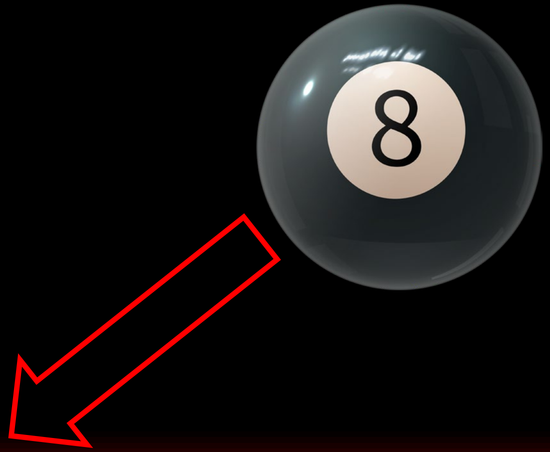
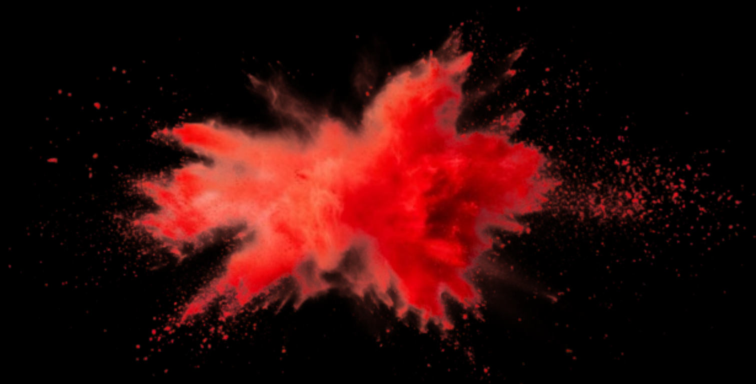
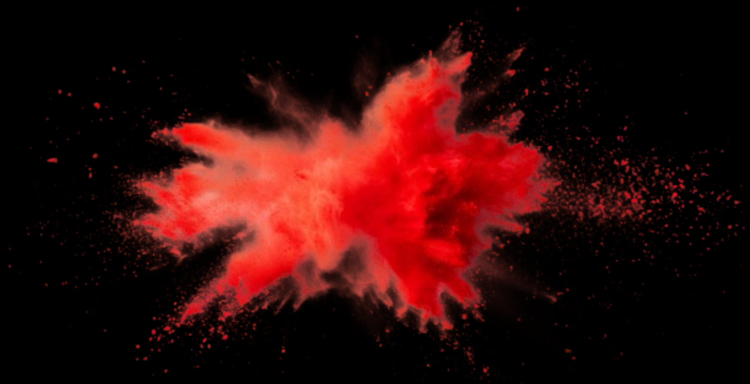




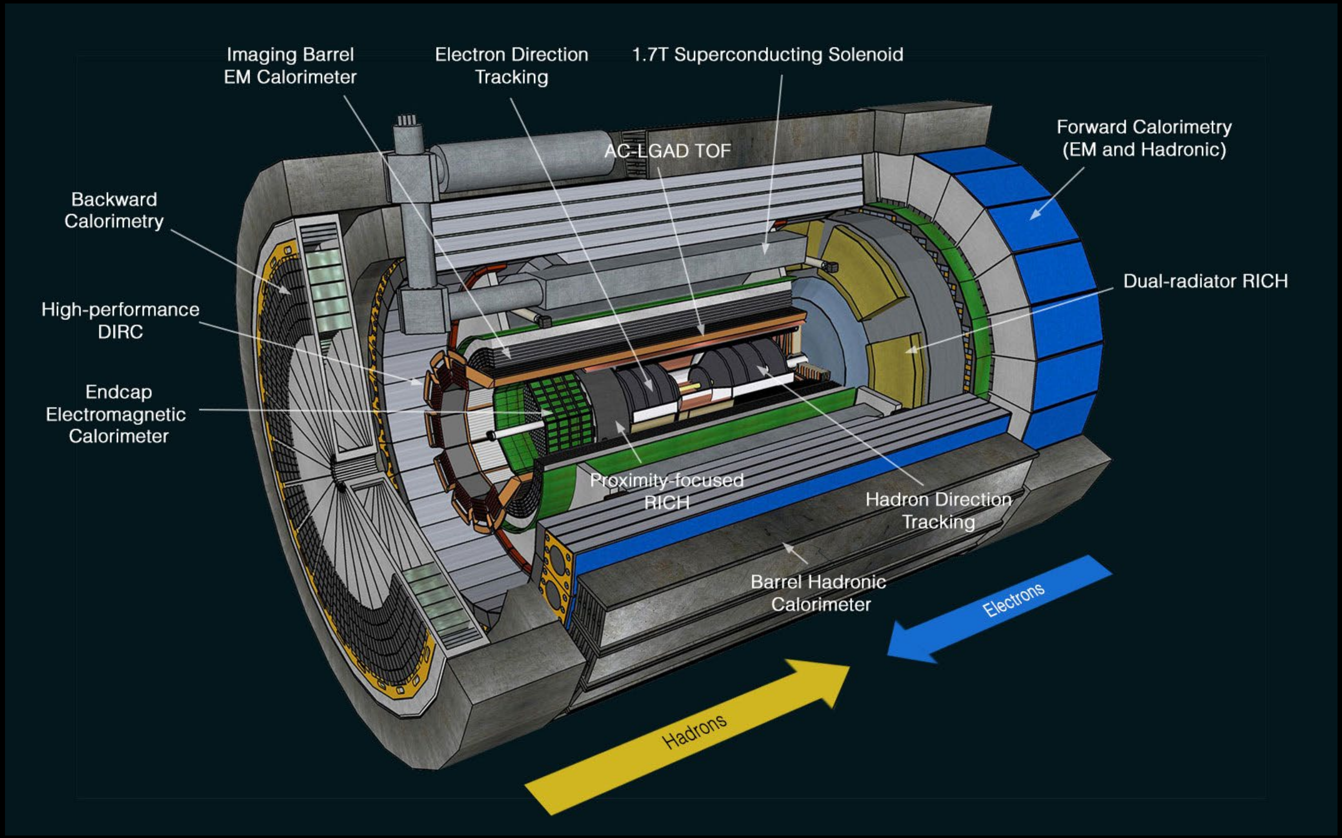
… But there’s a problem

# Picture This

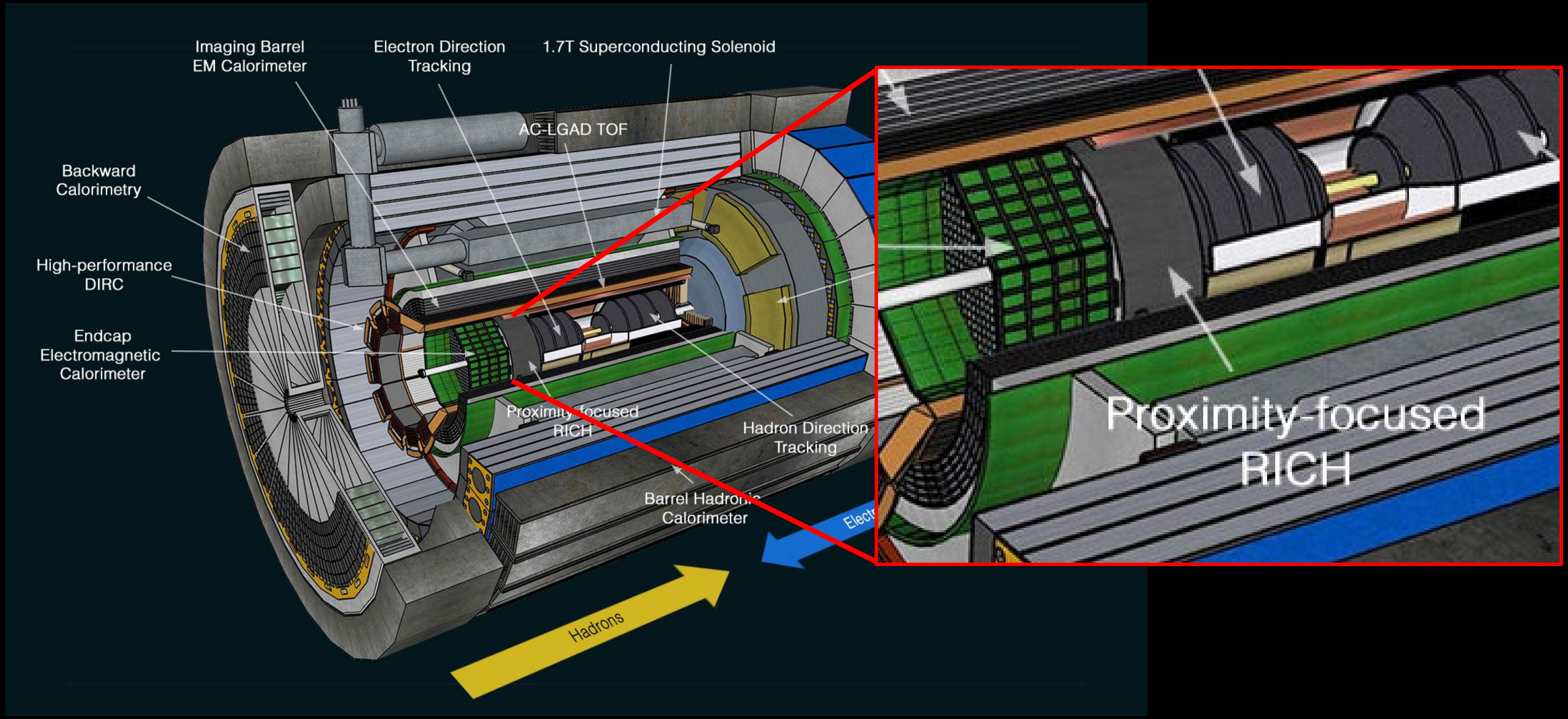


… Or two

# The Full ePIC Story



# The Full ePIC Story… and our little slice




Specialized to a task – finding the electron

and others!

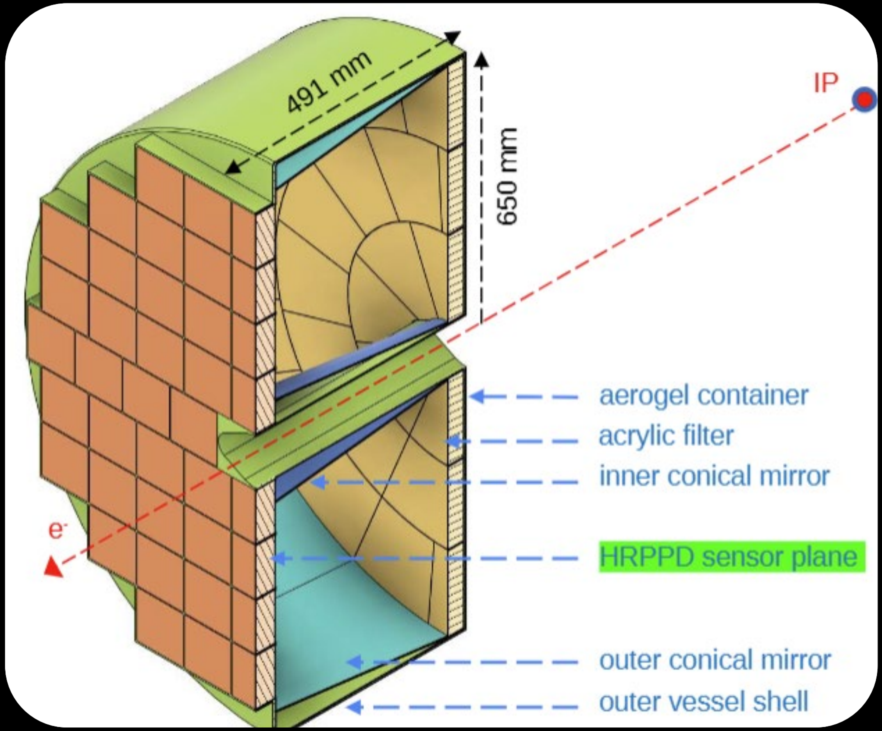
# pfRICH

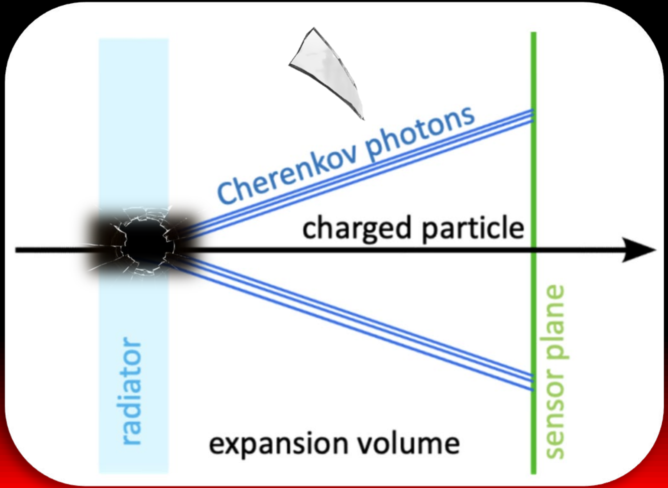
Sub-detector of ePIC planned to be used for particle identification

Utilizes Cherenkov radiation emitted when a particle goes faster than the speed of light in a medium

- Wall of aerogel is used as the radiator

This radiation forms a ring at a distance proportional to a particle's velocity, which together with momentum can determine the mass



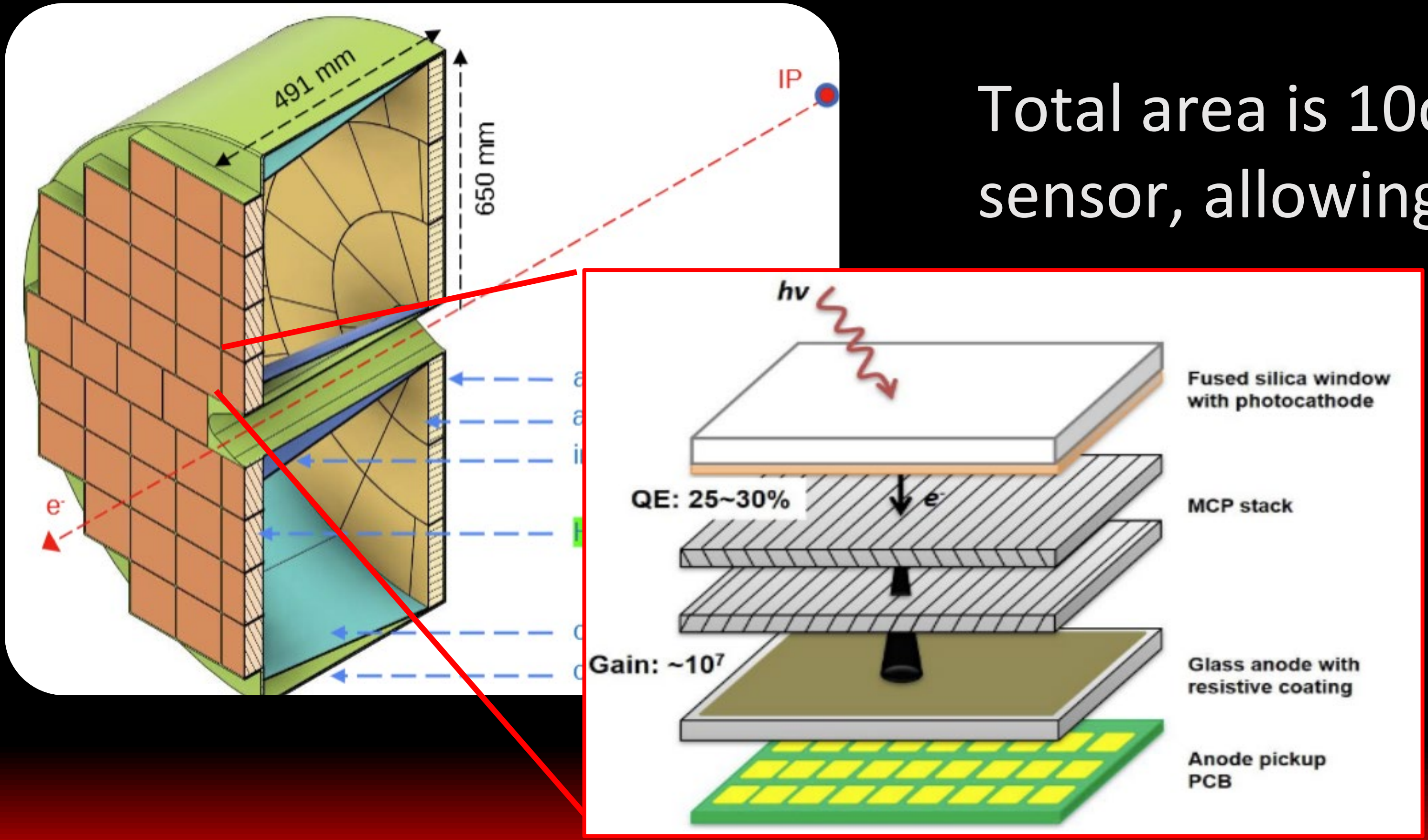



# HRPPD

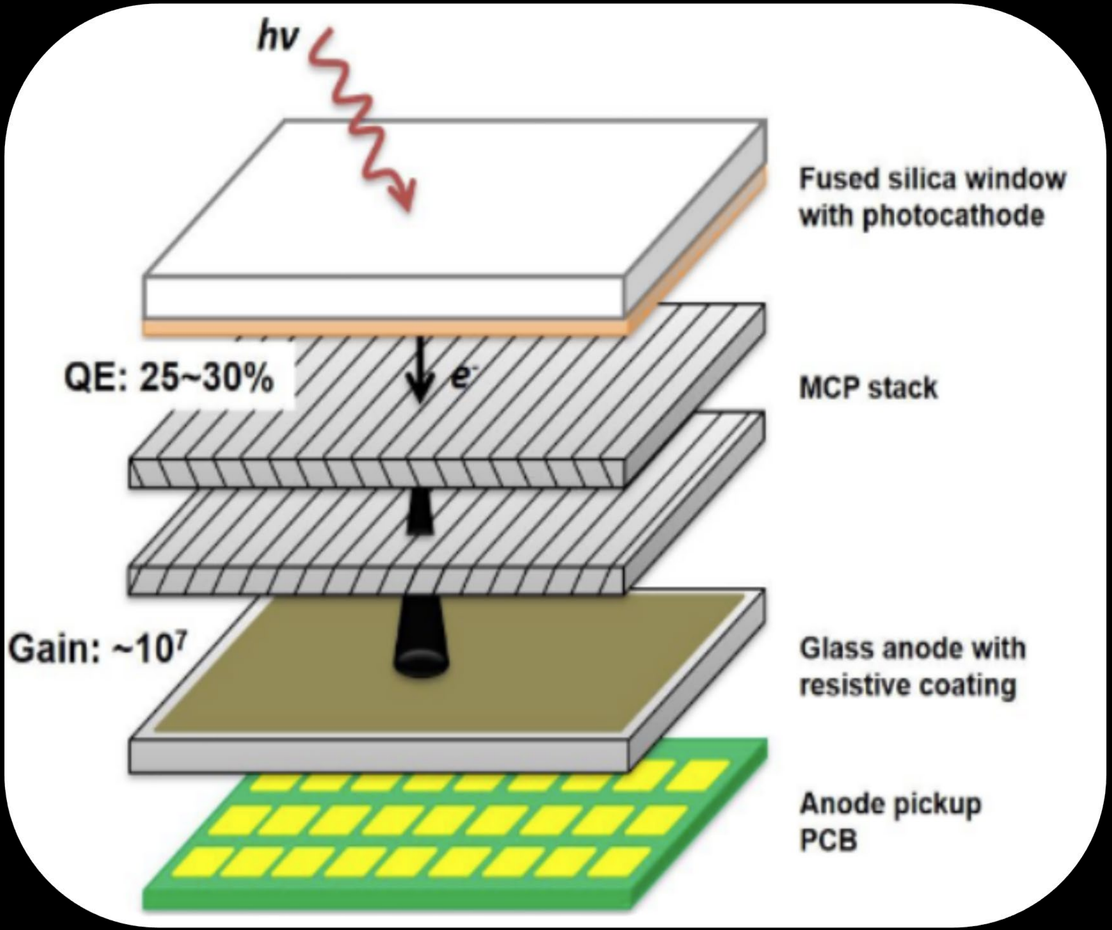
High-Rate Picosecond Photodetectors (HRPPDs) proposed as photosensor for use in pfRICH

68 HRPPDs make up sensor plane of pfRICH

Total area is 10cm x 10 cm, 1024 pixels per sensor, allowing pitch of 3.375 mm



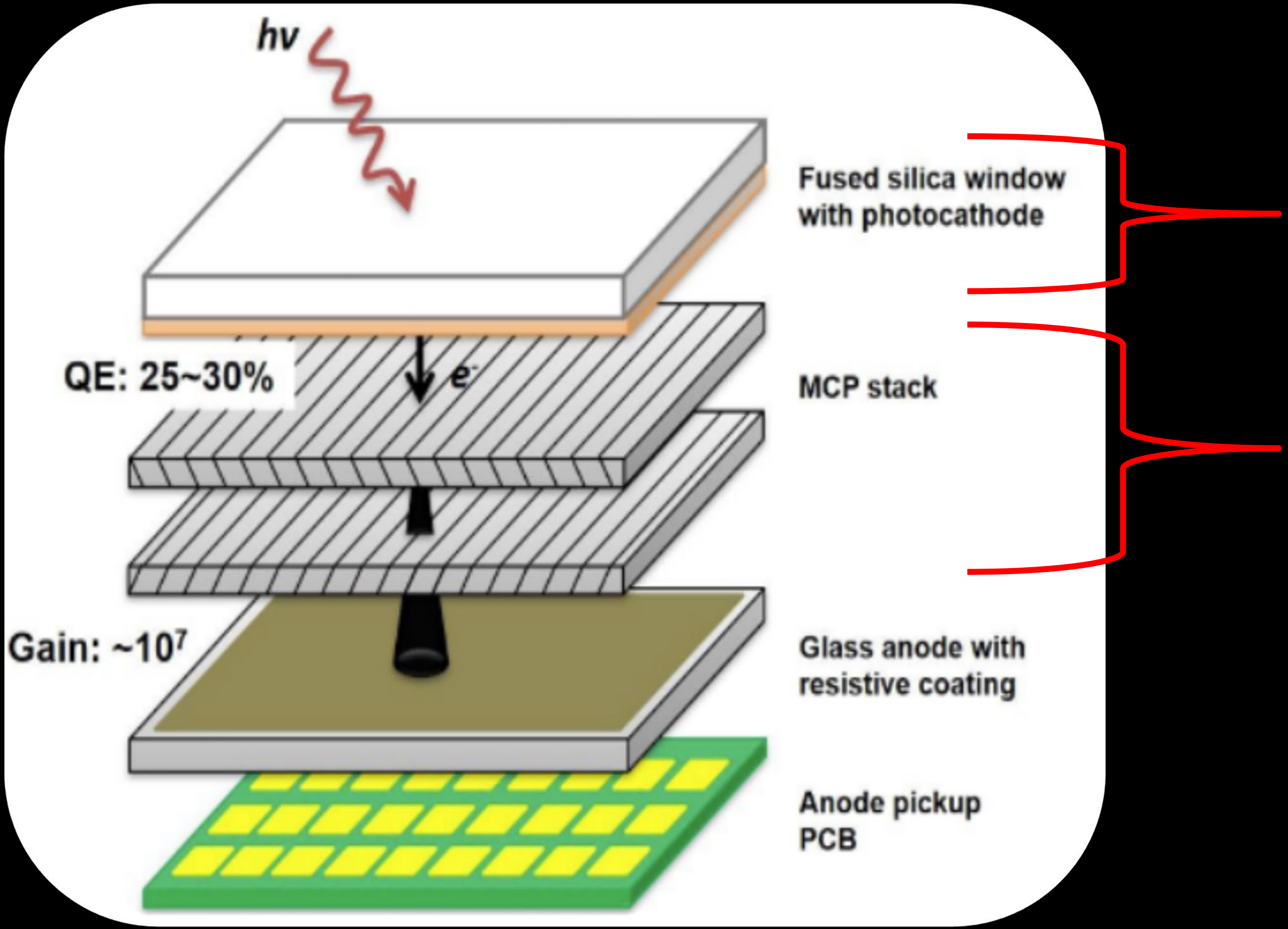
# HRPPD




Incident photons dislodge an electron from cathode

Electron causes an electron cascade across Microchannel Plate (MCP) stacks that is picked up at anode.

# HRPPD




Important to study effects of voltage settings used in running

Photocathode voltage controls detection efficiency

MCP Voltage controls gain

# ePIC Involvement: Testing HRPPDs for pfRICH

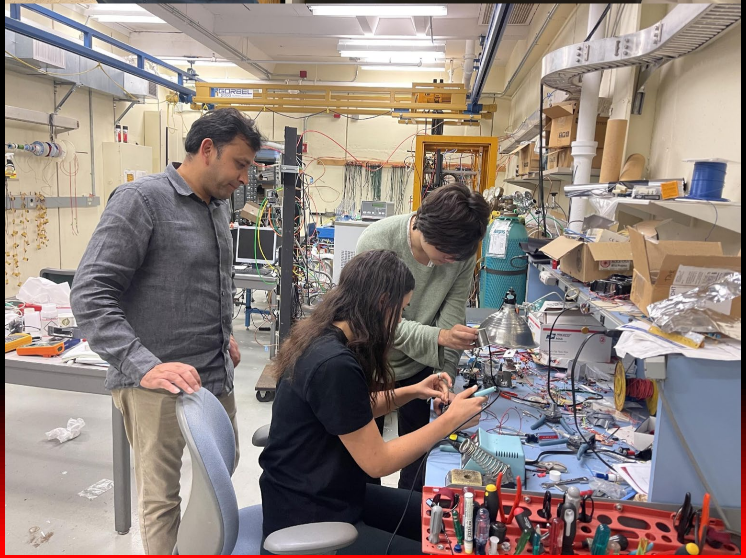
Yale University

Yale is interested in testing HRPPDs - performing tests such as

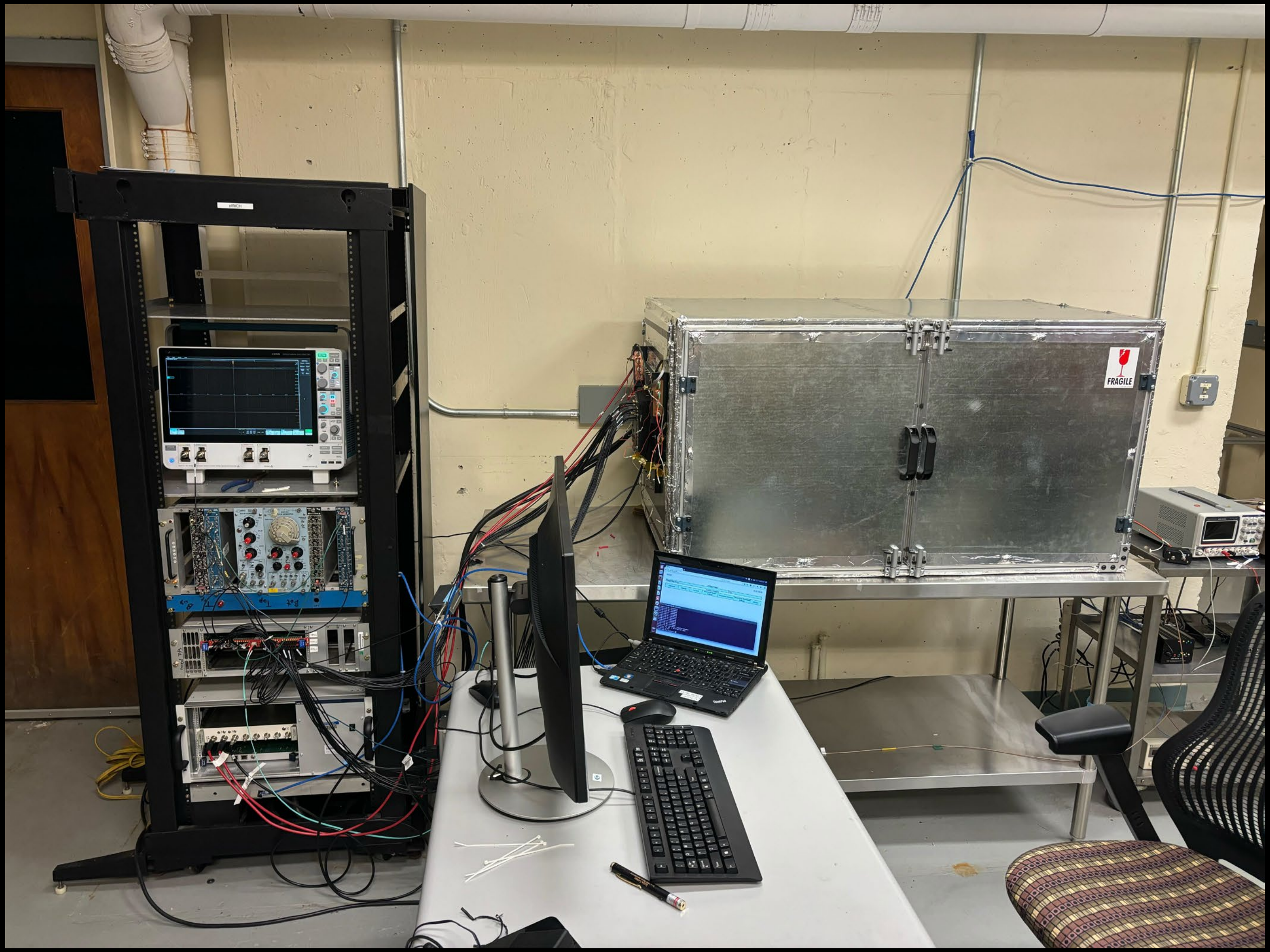
- Dark rate – amount of background caused by thermal excitations
- Quantum efficiency – fraction of incident photons that produce a signal
- Gain – Number of electrons produced per detected photon

pfRICH team: Laura Havener, Prakhar Garg, Nikolai Smirnov, Zoltan Varga, Andrew Tamis, Youqi Song, Daniel Zhang, Henry Kaplan, Yasmine Samolada, Grace Burton, Olivia Birney, Rohan Arya Gondi, James, Omare Goodson

Faculty/Staff Scientists Postdocs Graduate Students Undergraduates High School



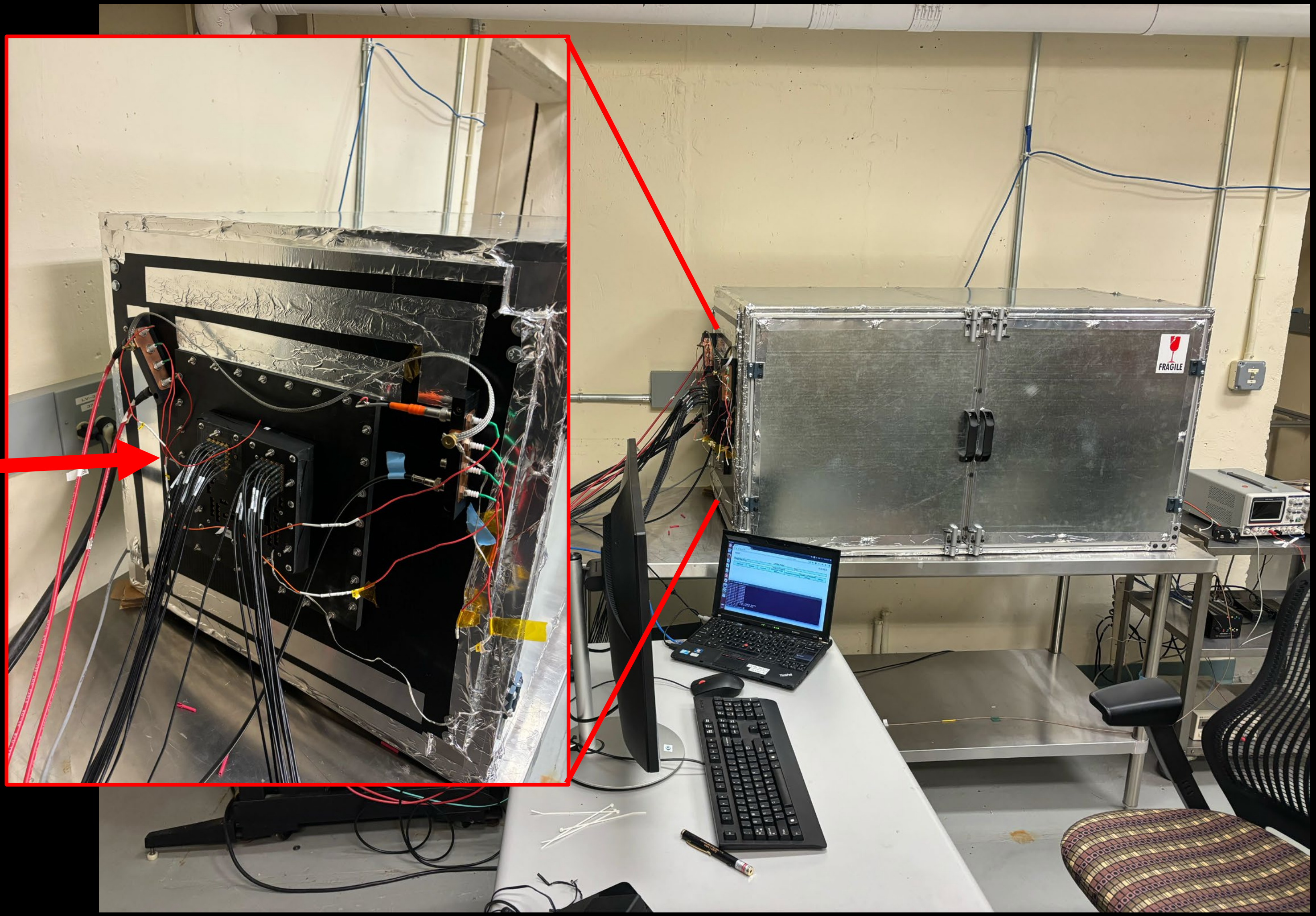
# Testing Setup



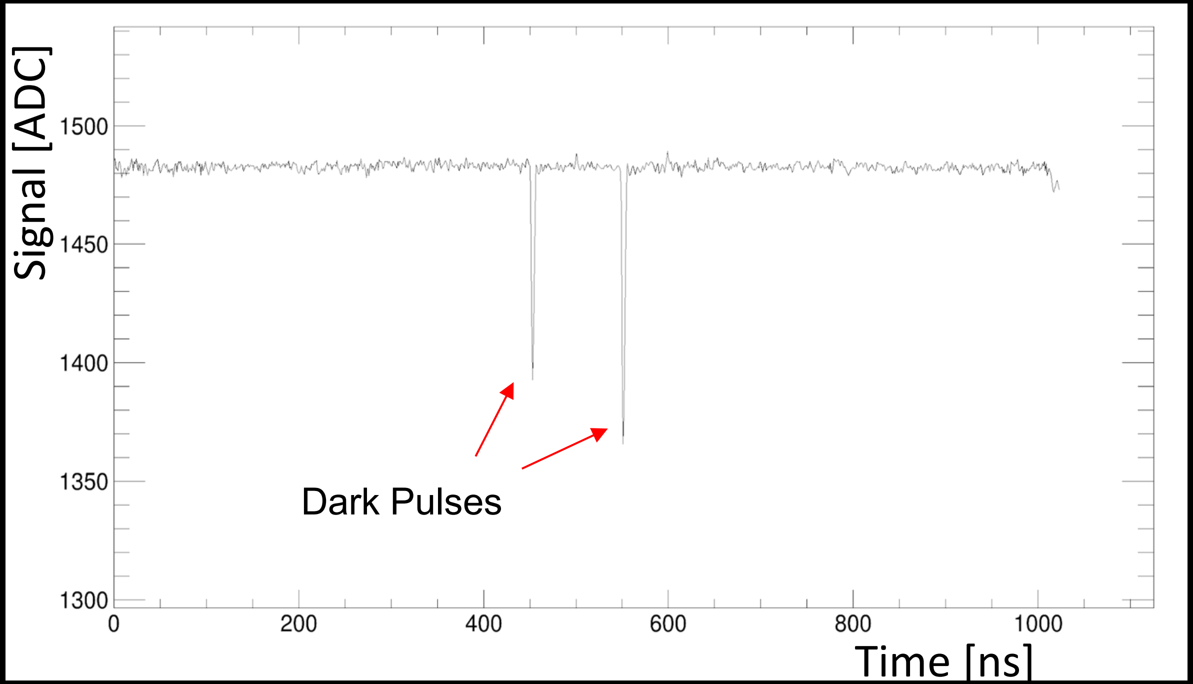
# Testing Setup

HRPPD is mounted in a dark box

32 pixels are able to be read out at once



# Dark Rate Measurement




Trigger randomly (500hz) with 1000 ns collection windows

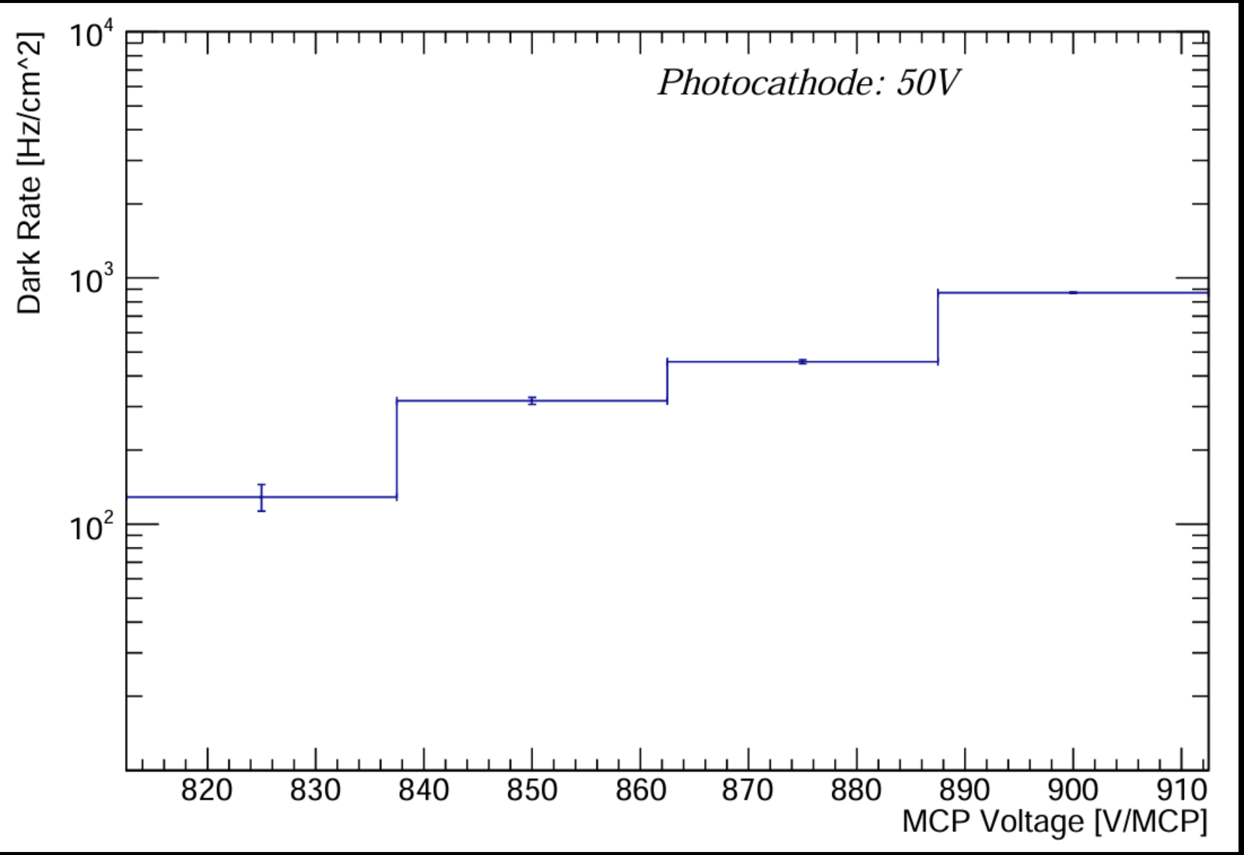
Take Dark rate as number of collected peaks over total collection time

Normalize per pixel size (3mm x 3 mm)

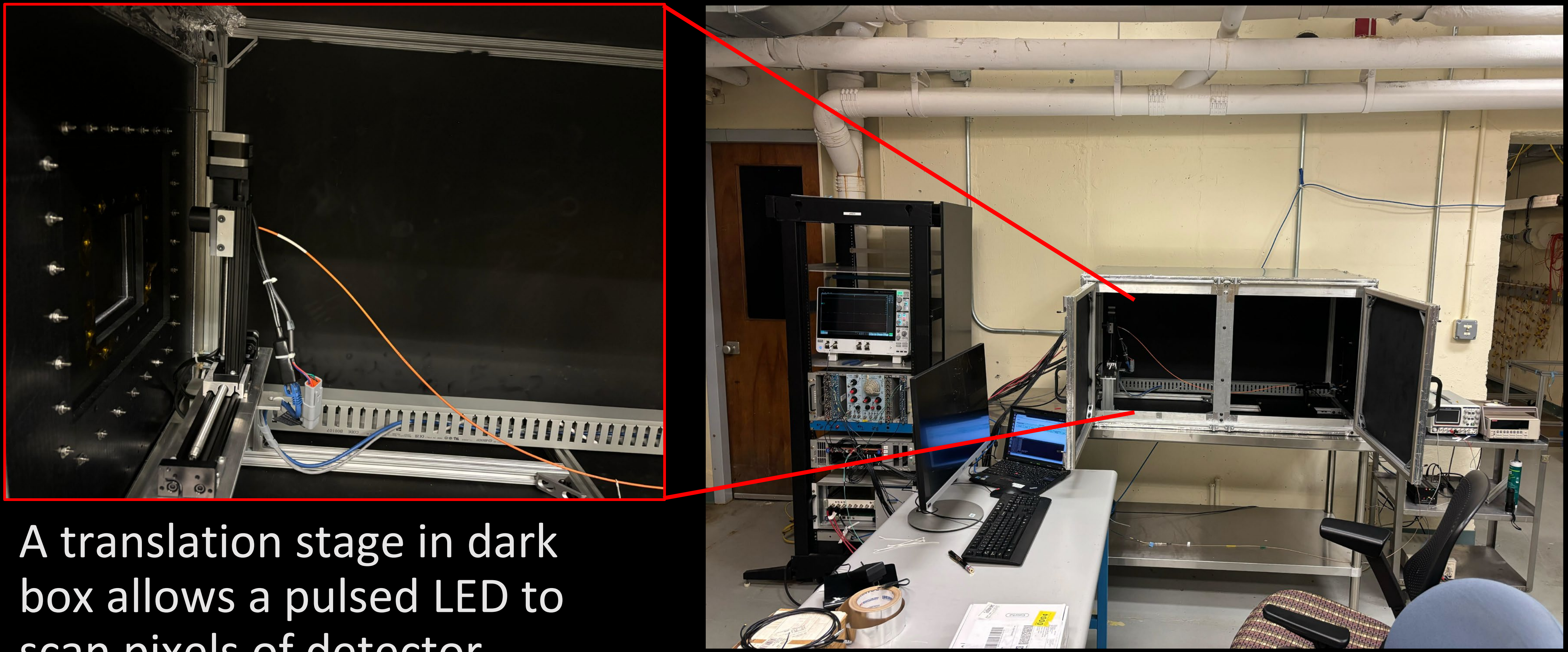
# Dark Rate Results

Depending on MCP setting, dark rate varies between $10^2$-$10^3$Hz/$cm^2$

For one channel, corresponds to one peak in roughly 100,000 randomly sampled events



# LED Scan



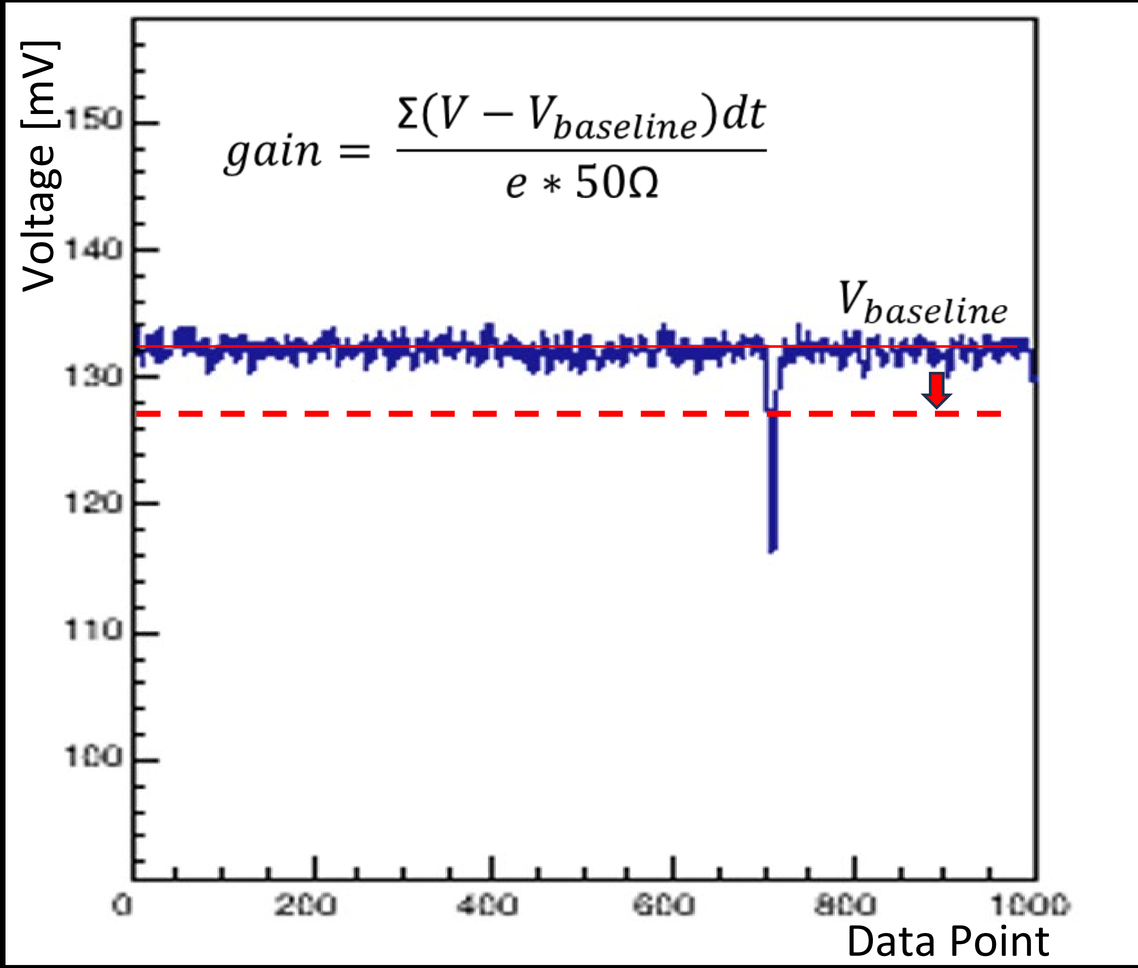
A translation stage in dark box allows a pulsed LED to scan pixels of detector

# Gain Measurement

Lower LED so that roughly 1/20 events have a peak above 10mV.

Integrate out each peak in time (by summing bins times their width)

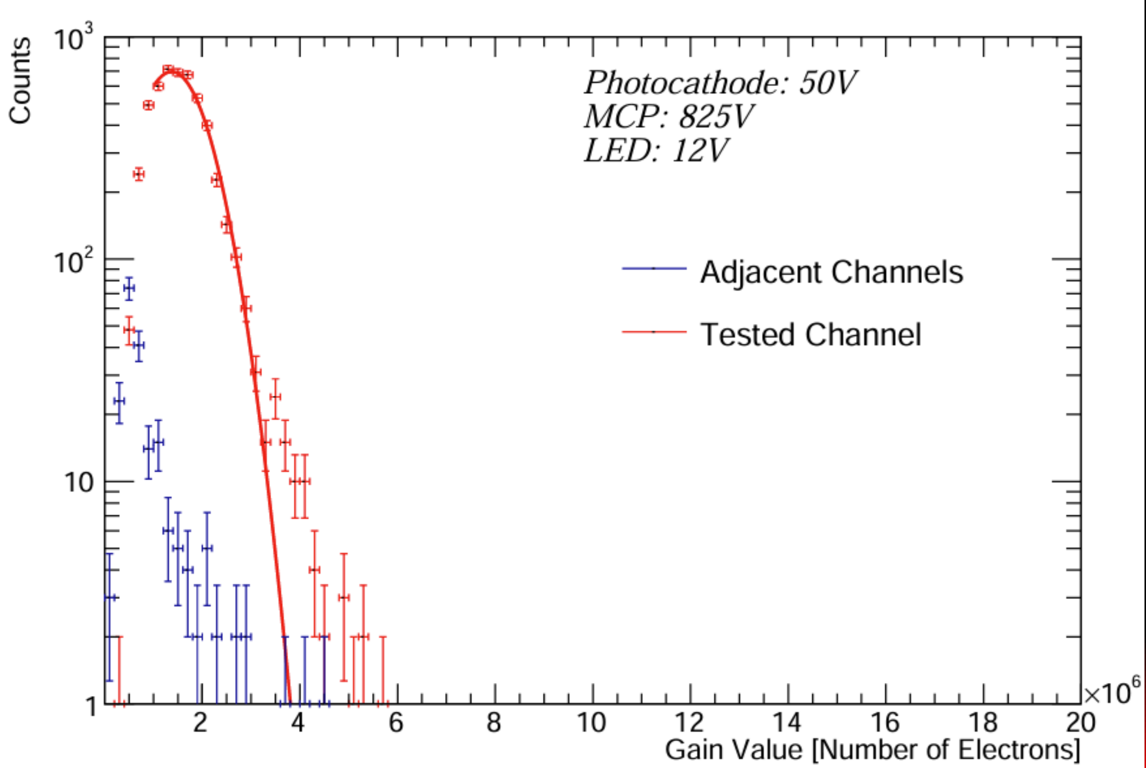
This allows us to determine total number of electrons per peak corresponding to one photon

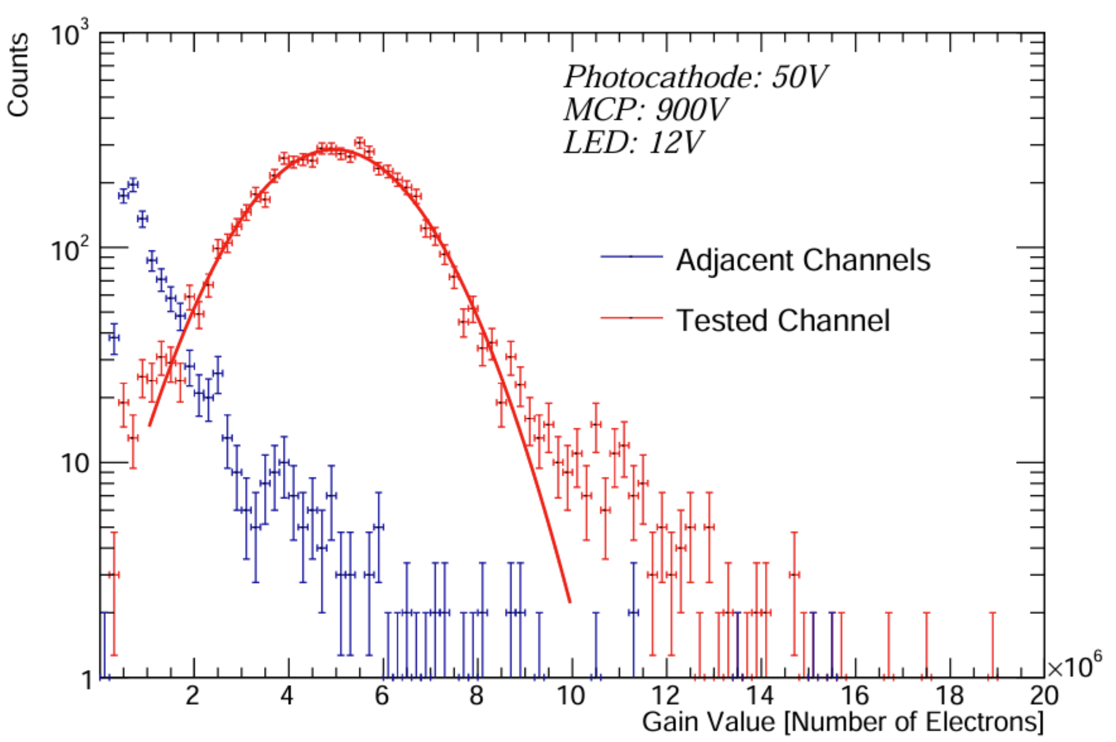


# Gain Results

Gain resulting from a single electron varies in a gaussian distribution

Gain data is fit to identify location of one-photon peak

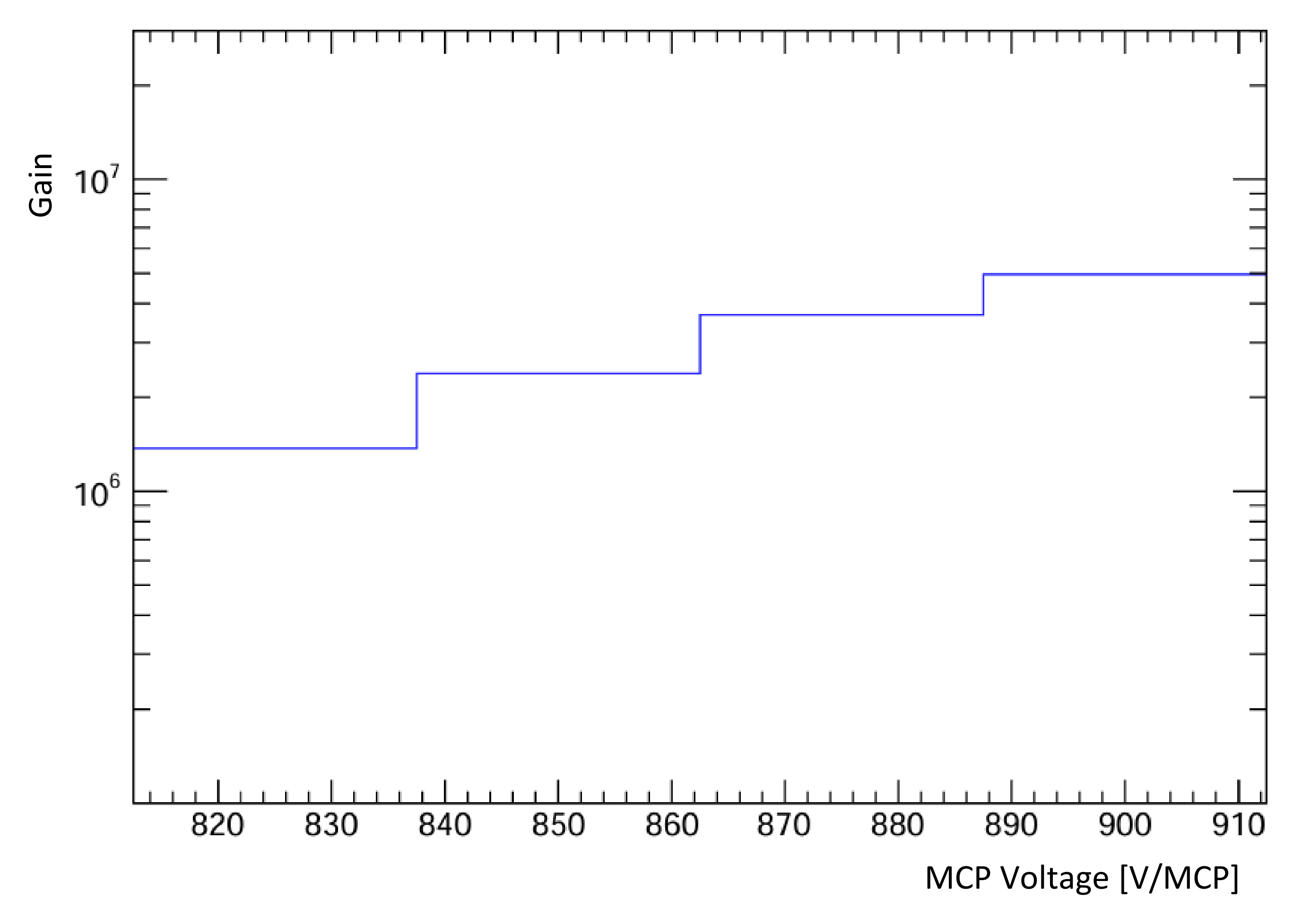


# Gain Across MCP Voltage

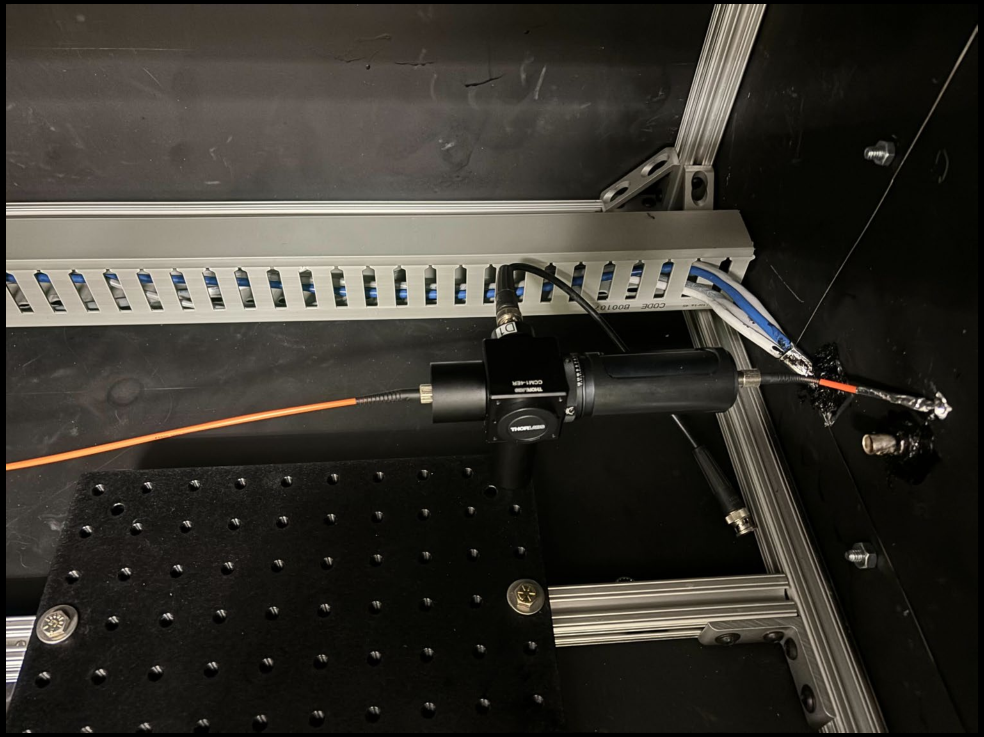
Gain increases exponentially with MCP voltage

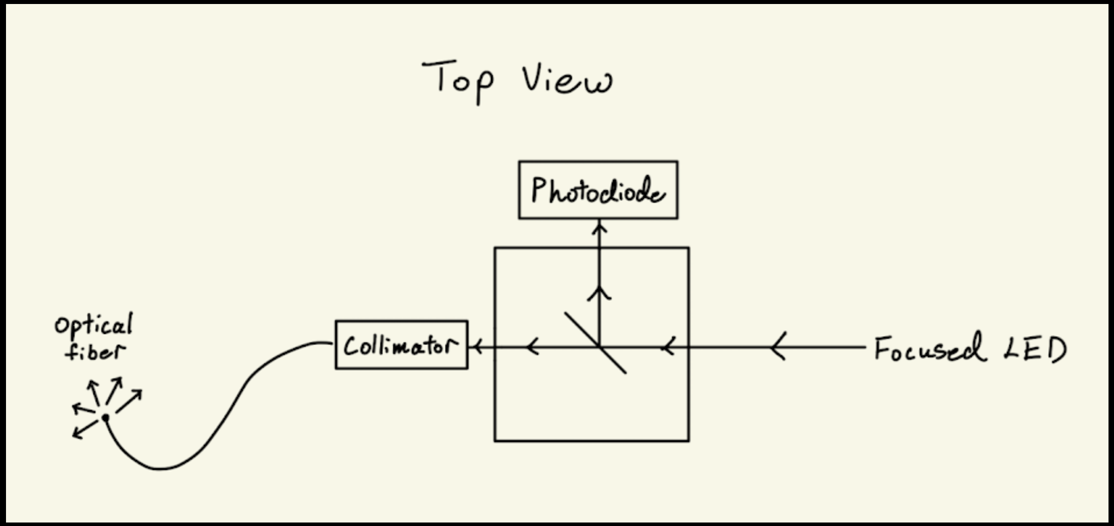
Large gain is desirable for signal detection, but leads to large charge buildup over time



# Optical Setup

Takes in pulsed LED, splits light into a photodiode to measure output collimates remaining light into an optical fiber and passes it to dark box



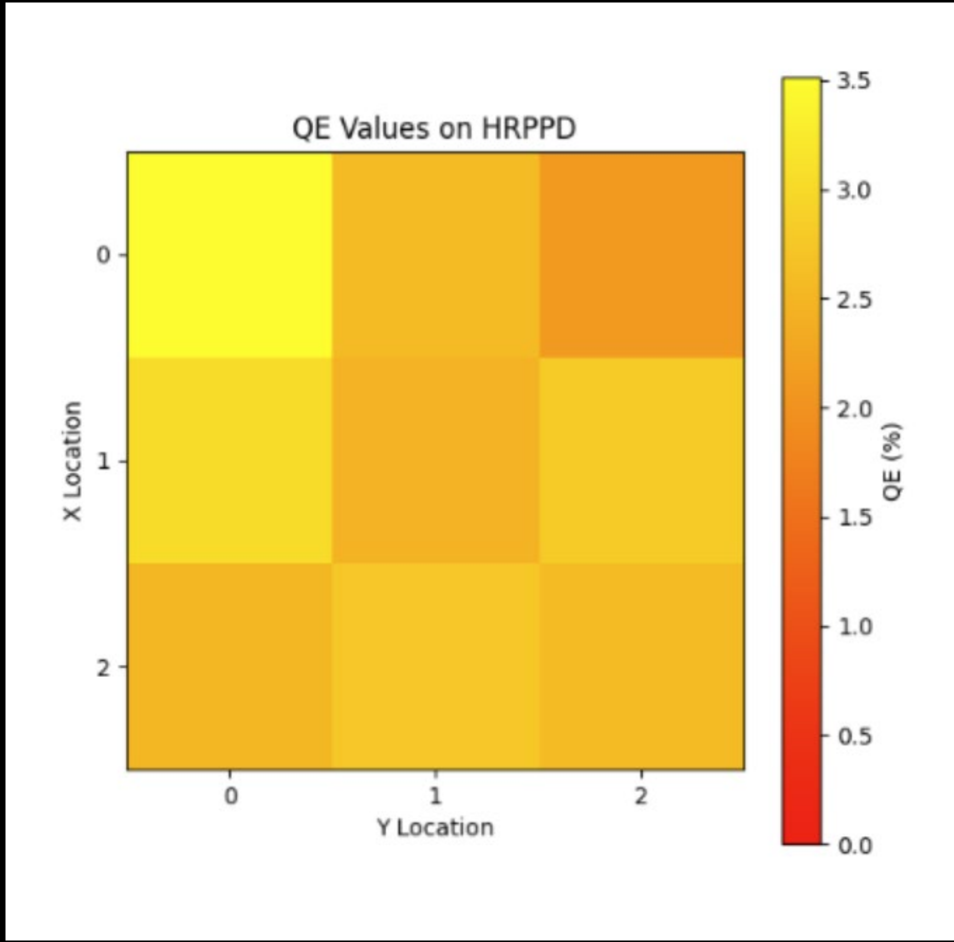


# Quantum Efficiency

Use reference photodiode to measure light incident on HRPPD

By measuring resulting current along with gain measurement, can determine fraction of photons that are detected

HRPPD tested is a faulty older model, QE of HRPPDs expected to be ~35%



# Conclusion

Test stand at Yale is completed and has begun taking dark rate and gain data

Quantum efficiency measurements are in progress

A full scan across HRPPD is possible, and future development will allow for more readout