Yale

HRPPD Measurement at Yale

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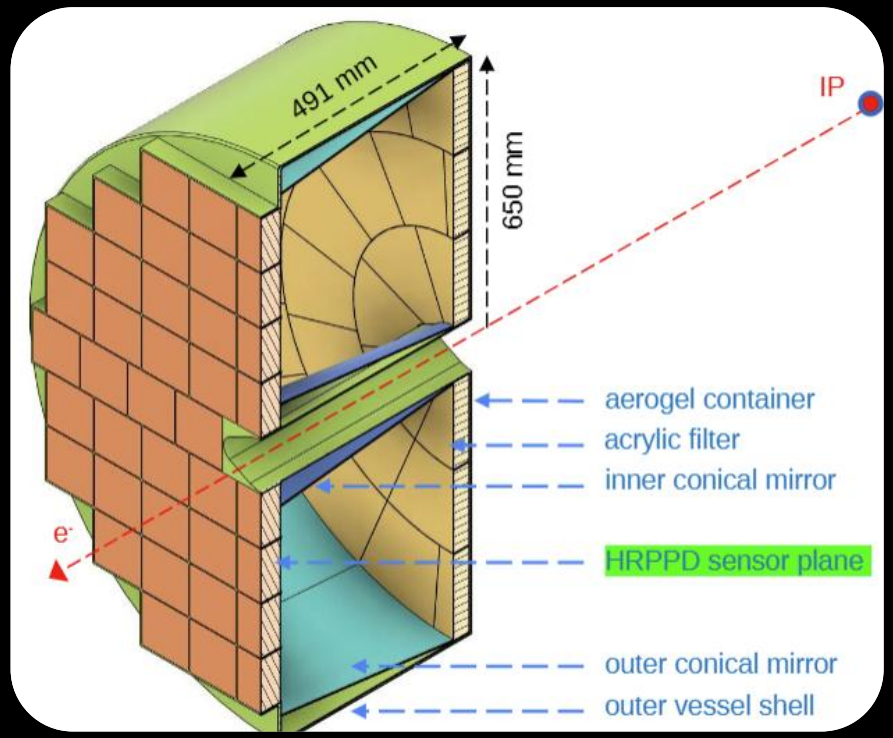
pfRICH

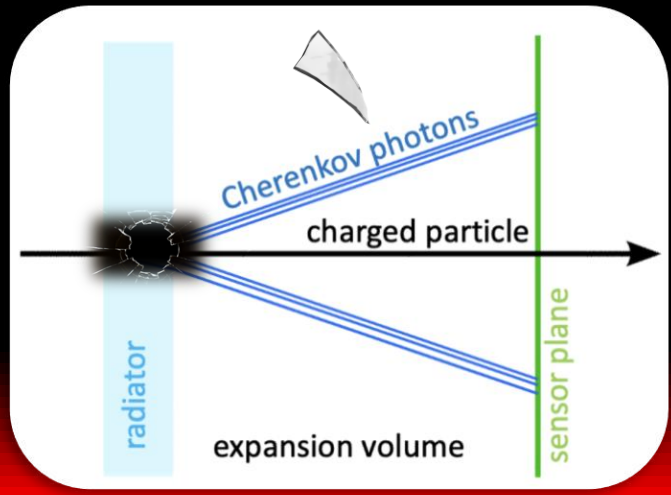


Sub-detector of ePIC planned to be used for particle identification

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

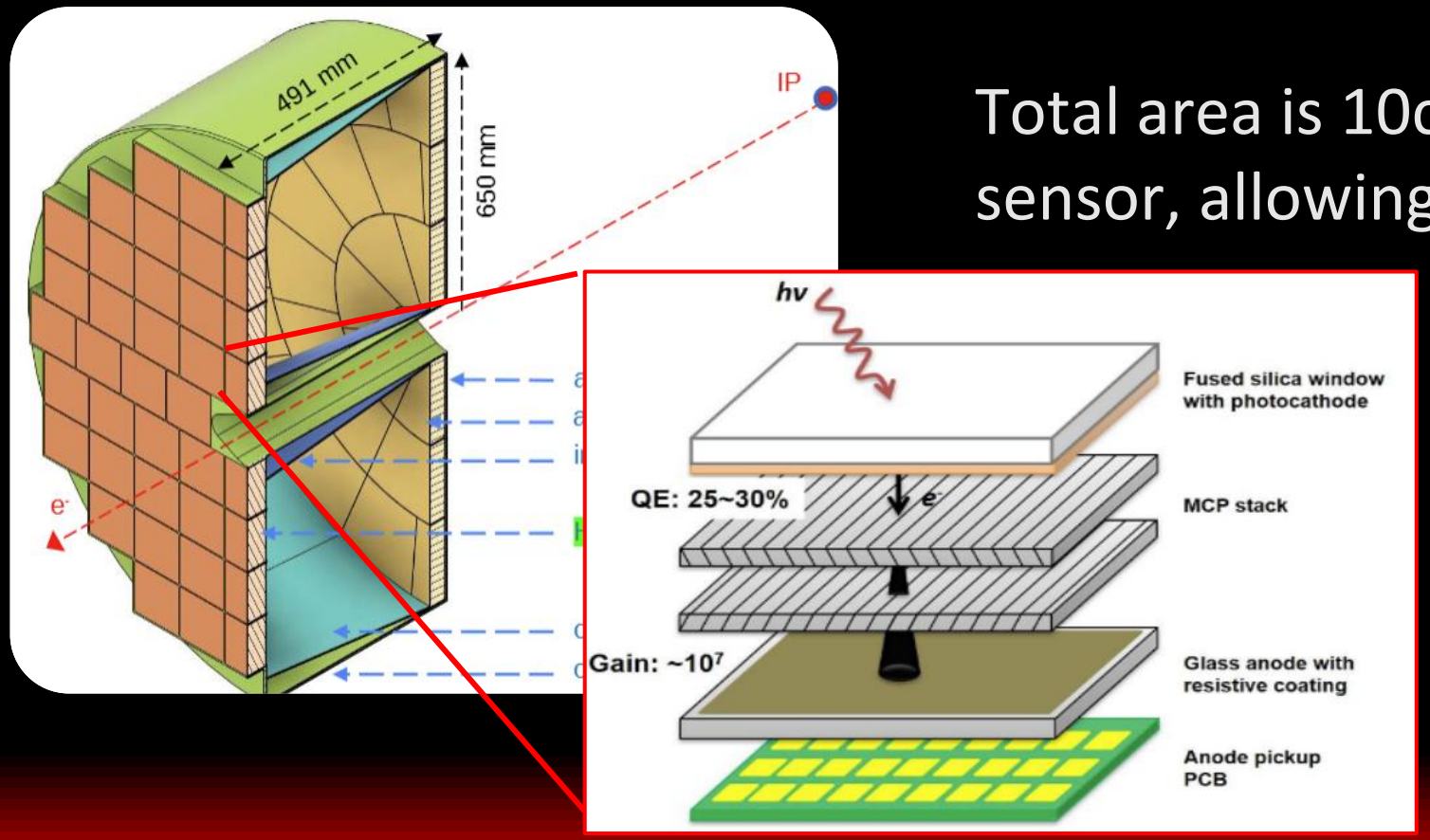


HRPPD

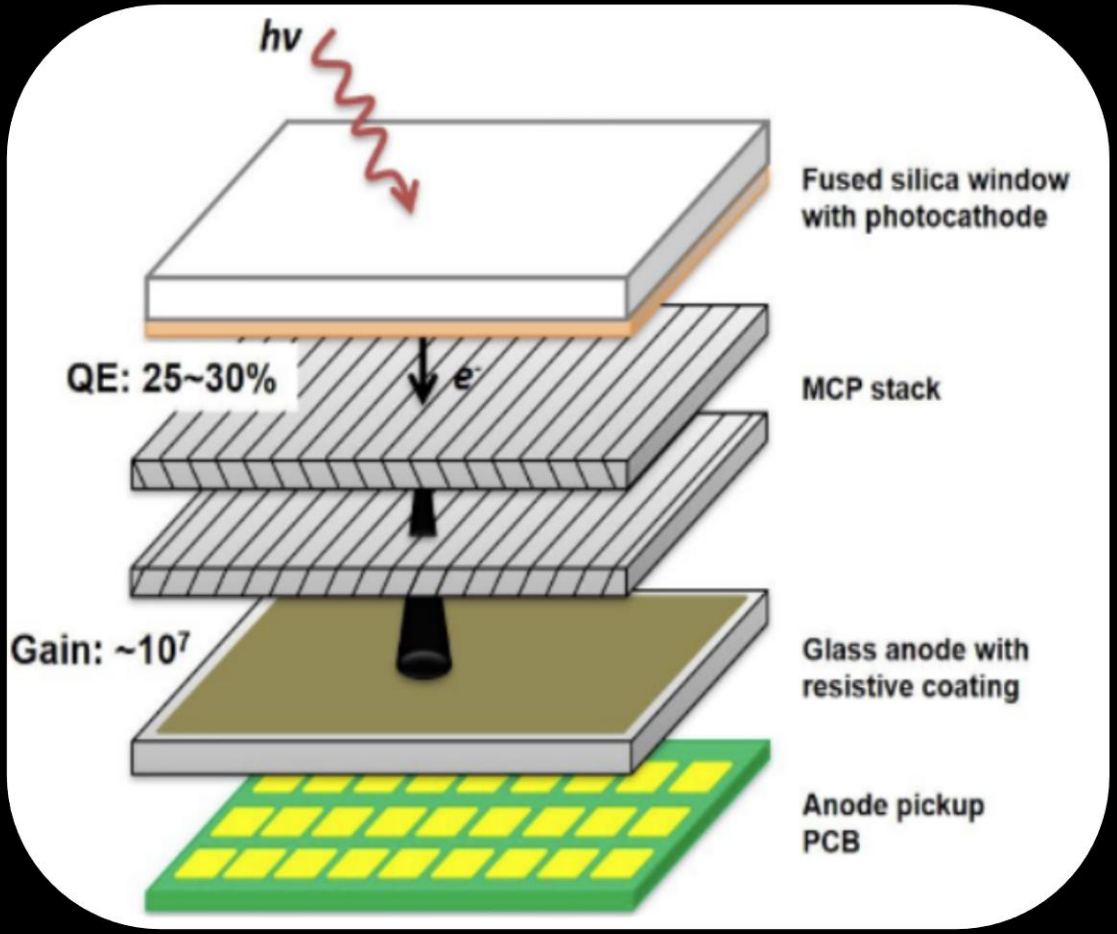
High-Rate Picosecond Photodetectors (HRPPDs) proposed as photosensor for use in pfRICH

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



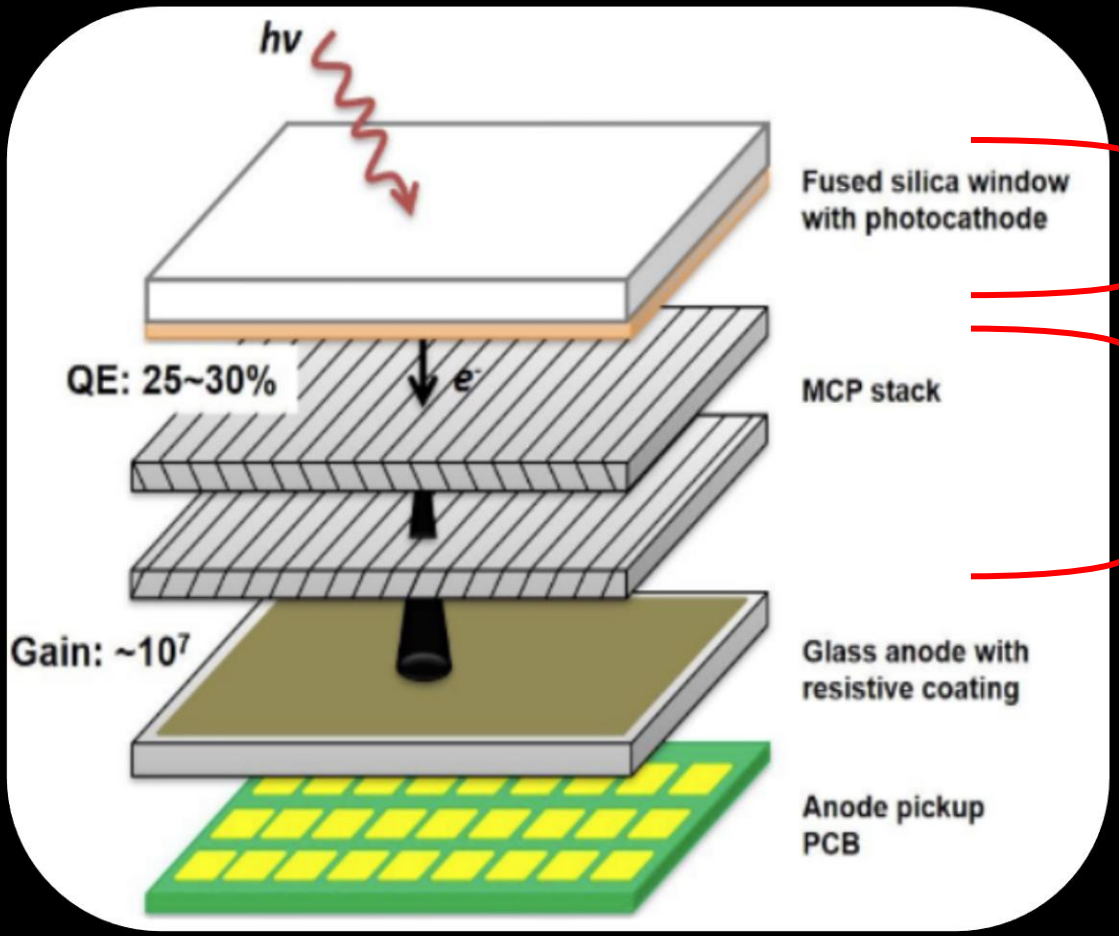
HRPPD



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

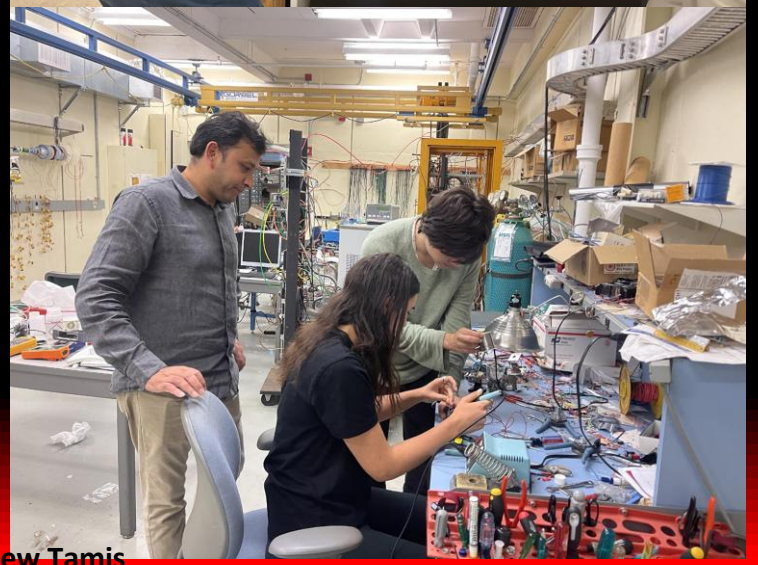
MCP Voltage controls gain

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



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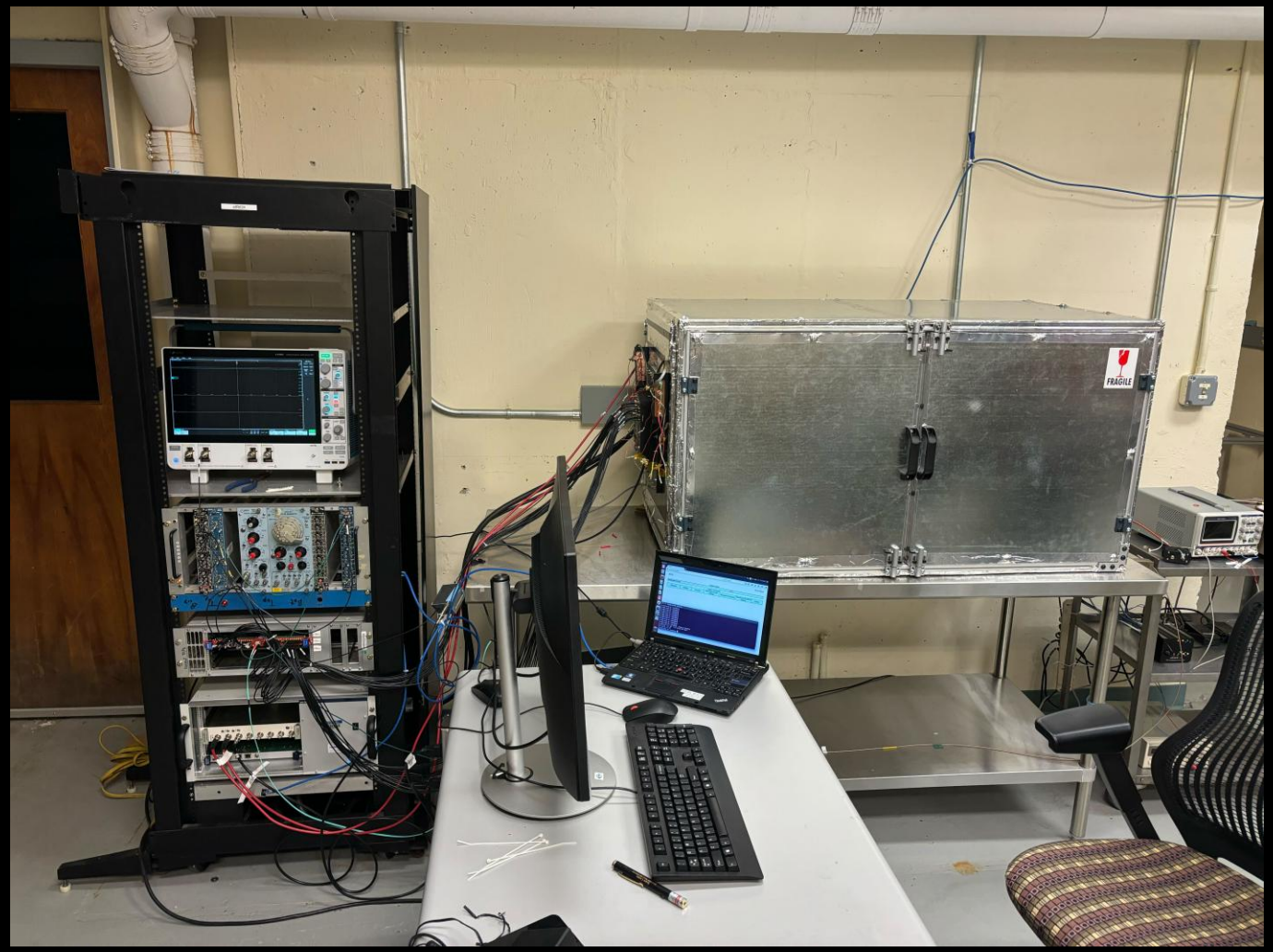
Faculty/Staff Scientists Postdocs Graduate Students Undergraduates High School

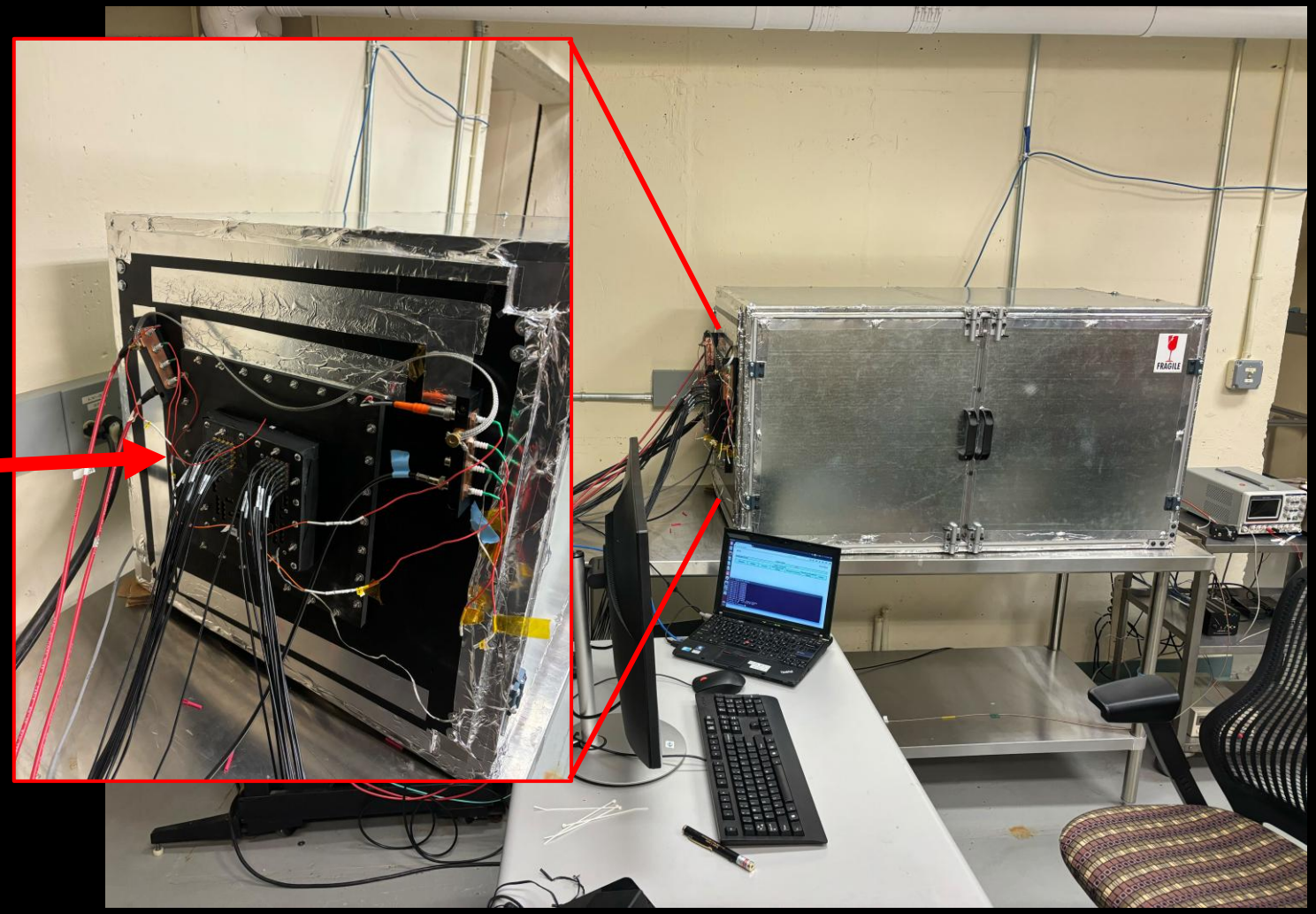
Testing Setup



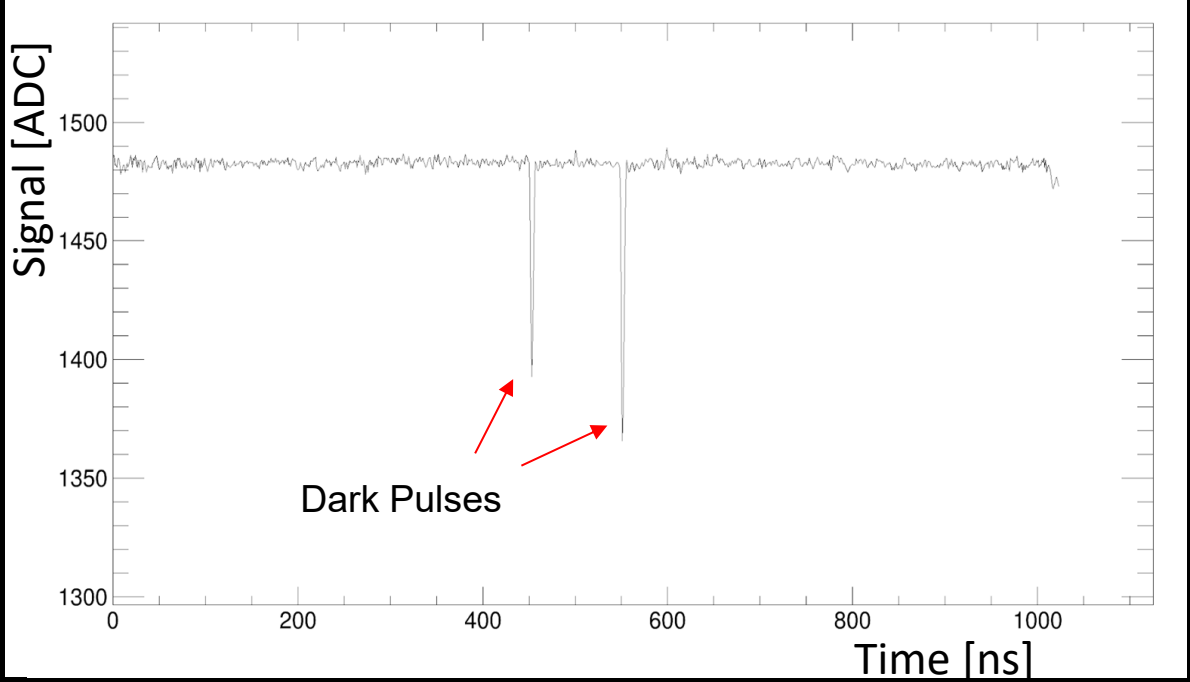
Testing Setup

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

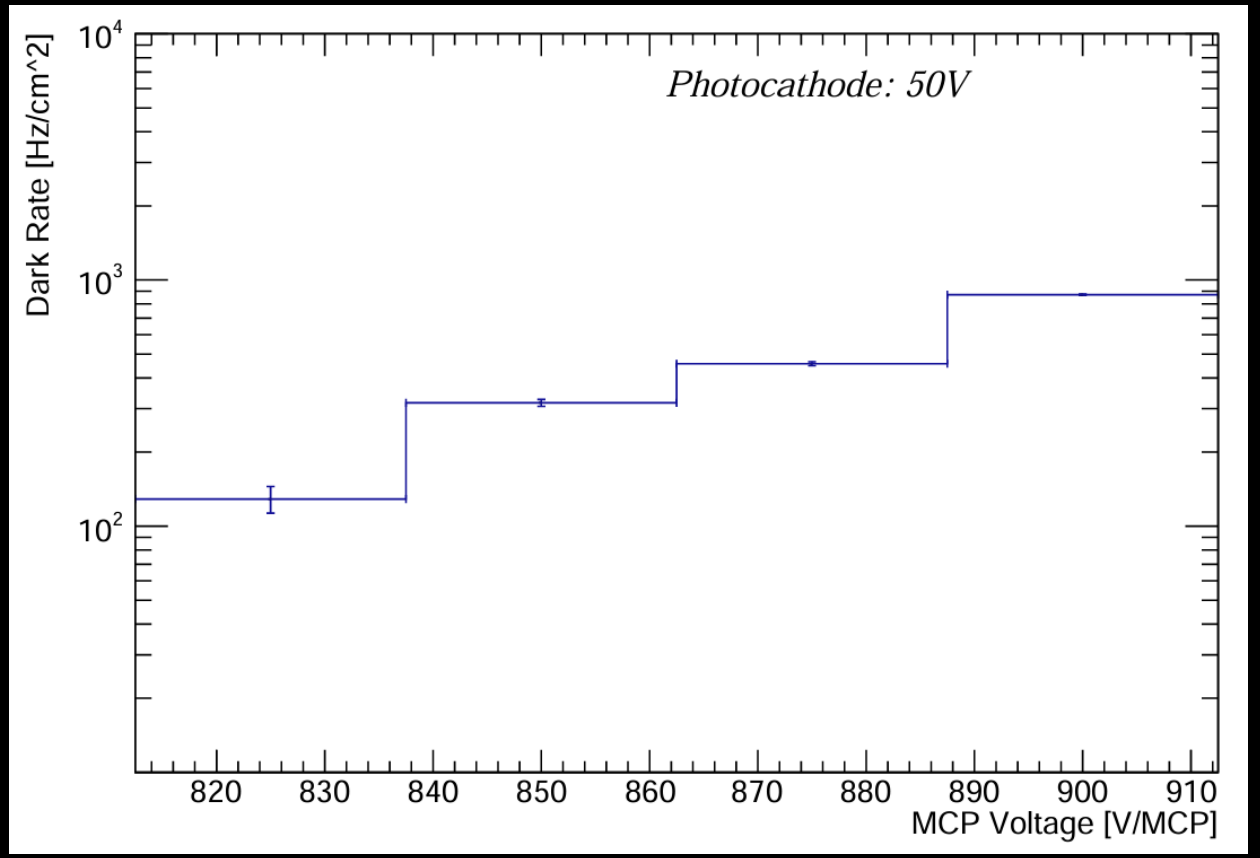
Take Dark rate as number of collected peaks over total collection time

Normalize per pixel size (3mm x 3 mm)

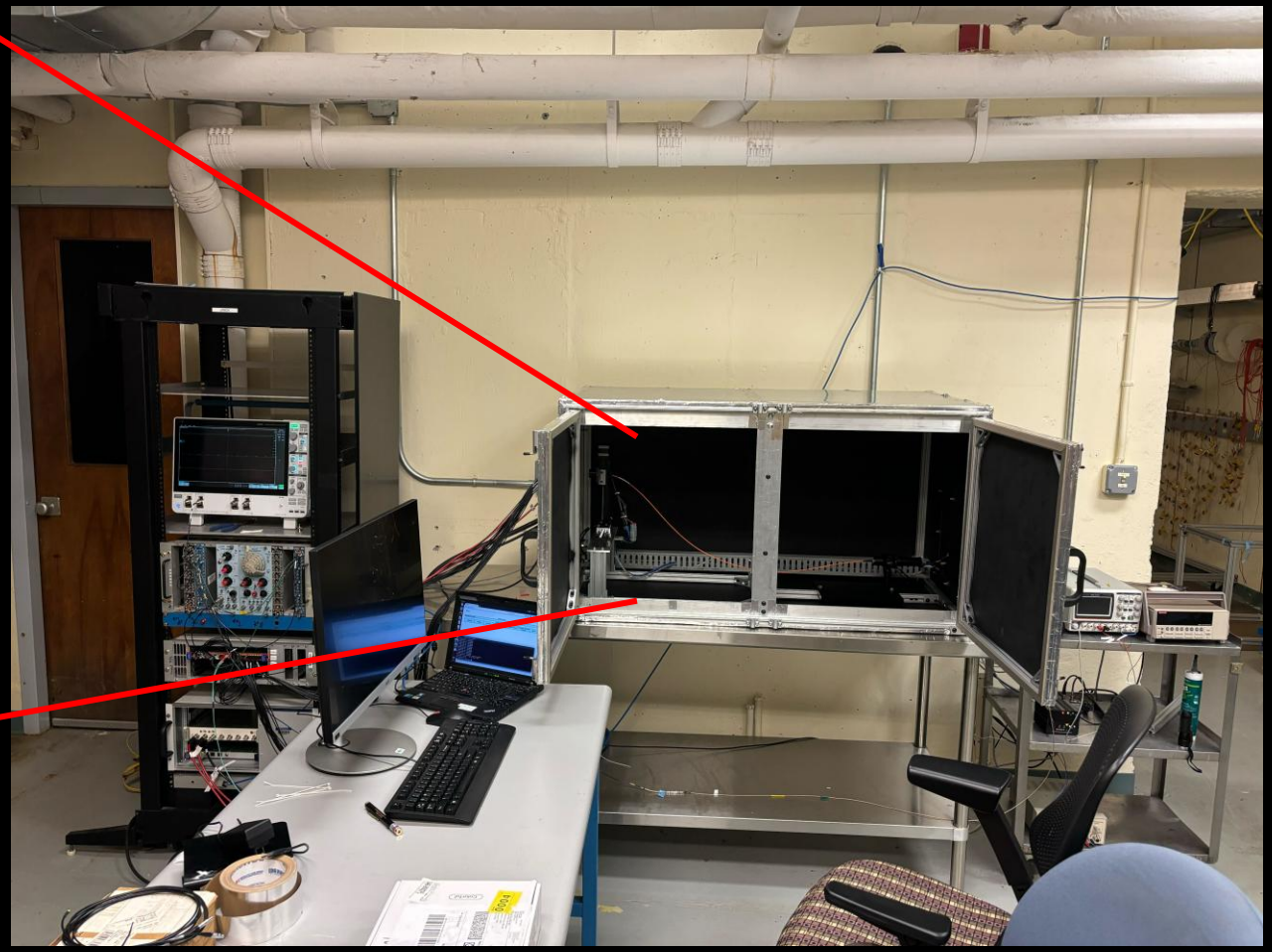
Dark Rate Results

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



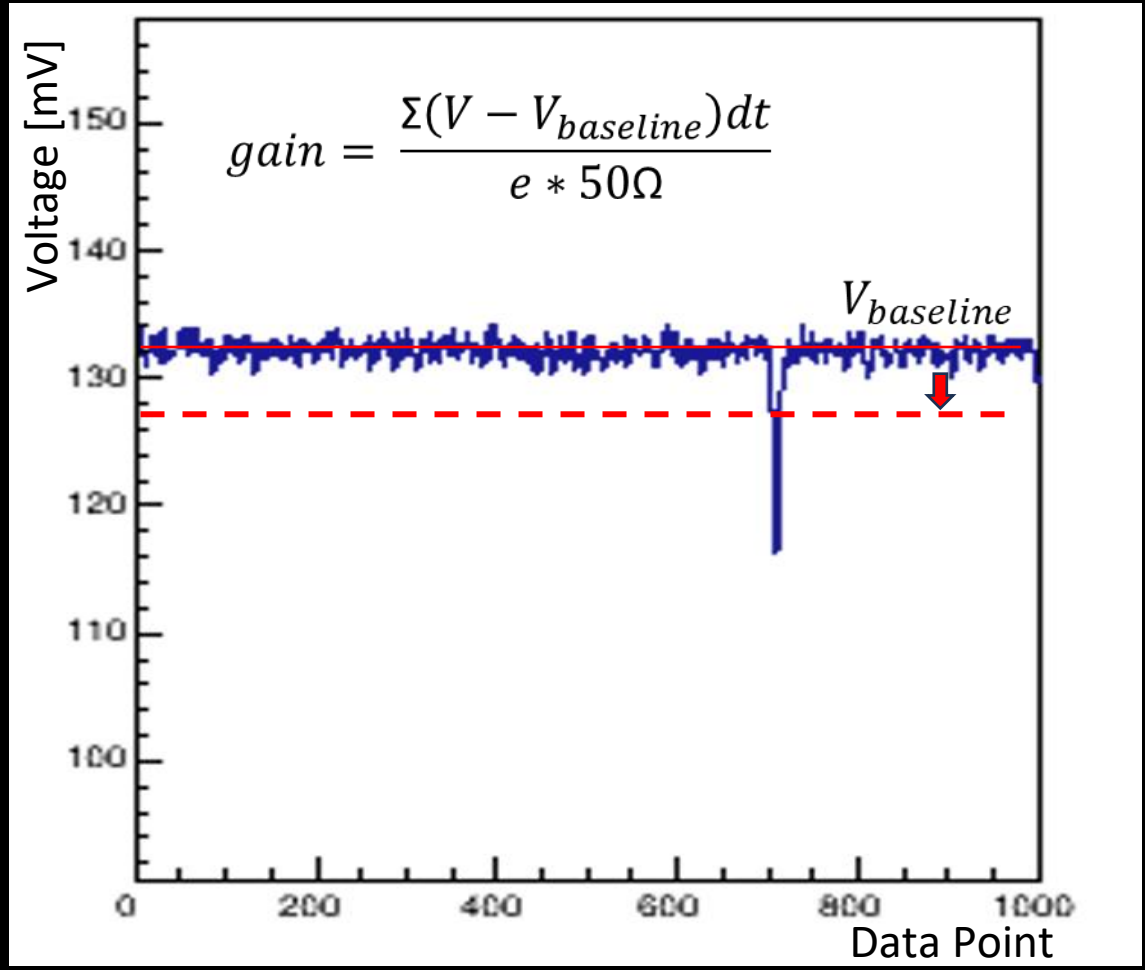
A translation stage in dark box allows a pulsed LED to scan pixels of detector

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)

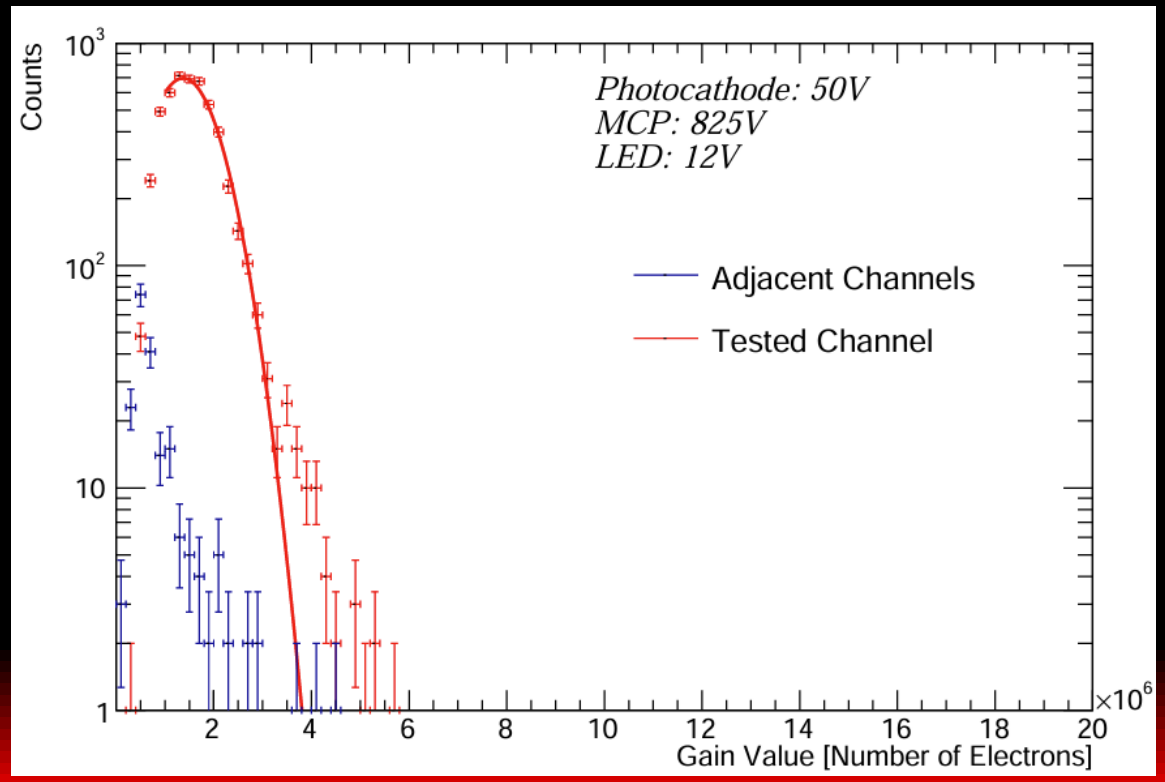
This allows us to determine total number of electrons per peak corresponding to one photon

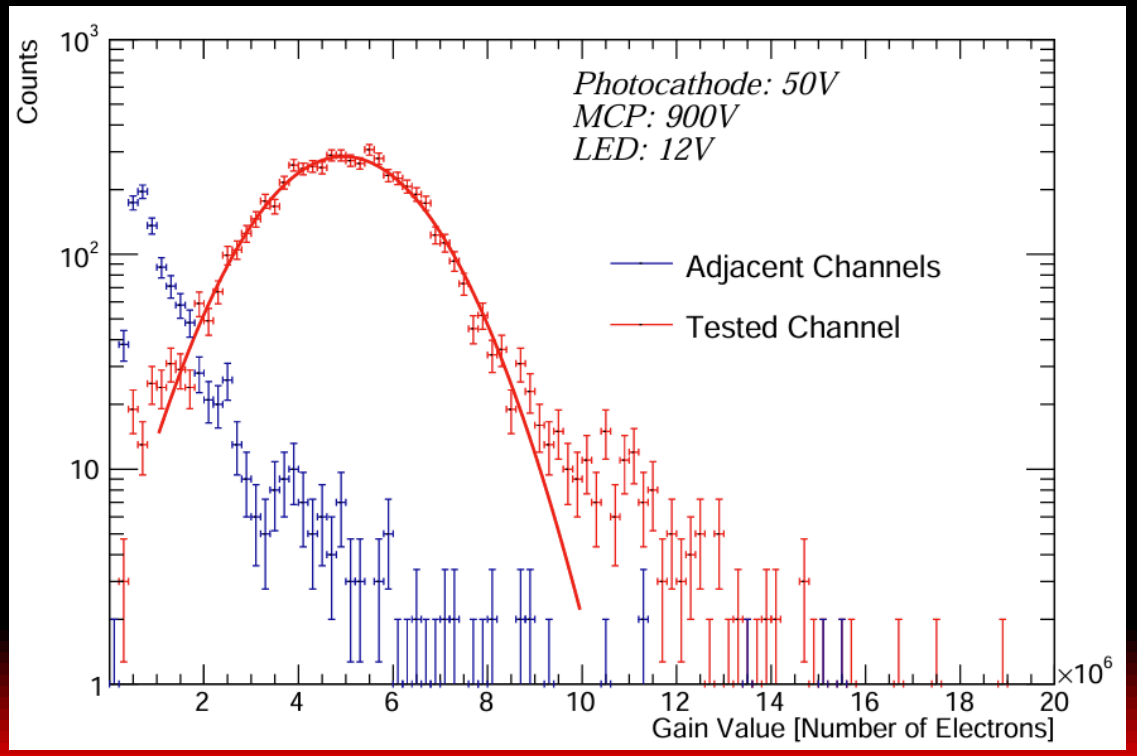


Gain Results

Gain resulting from a single electron varies in a gaussian distribution

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

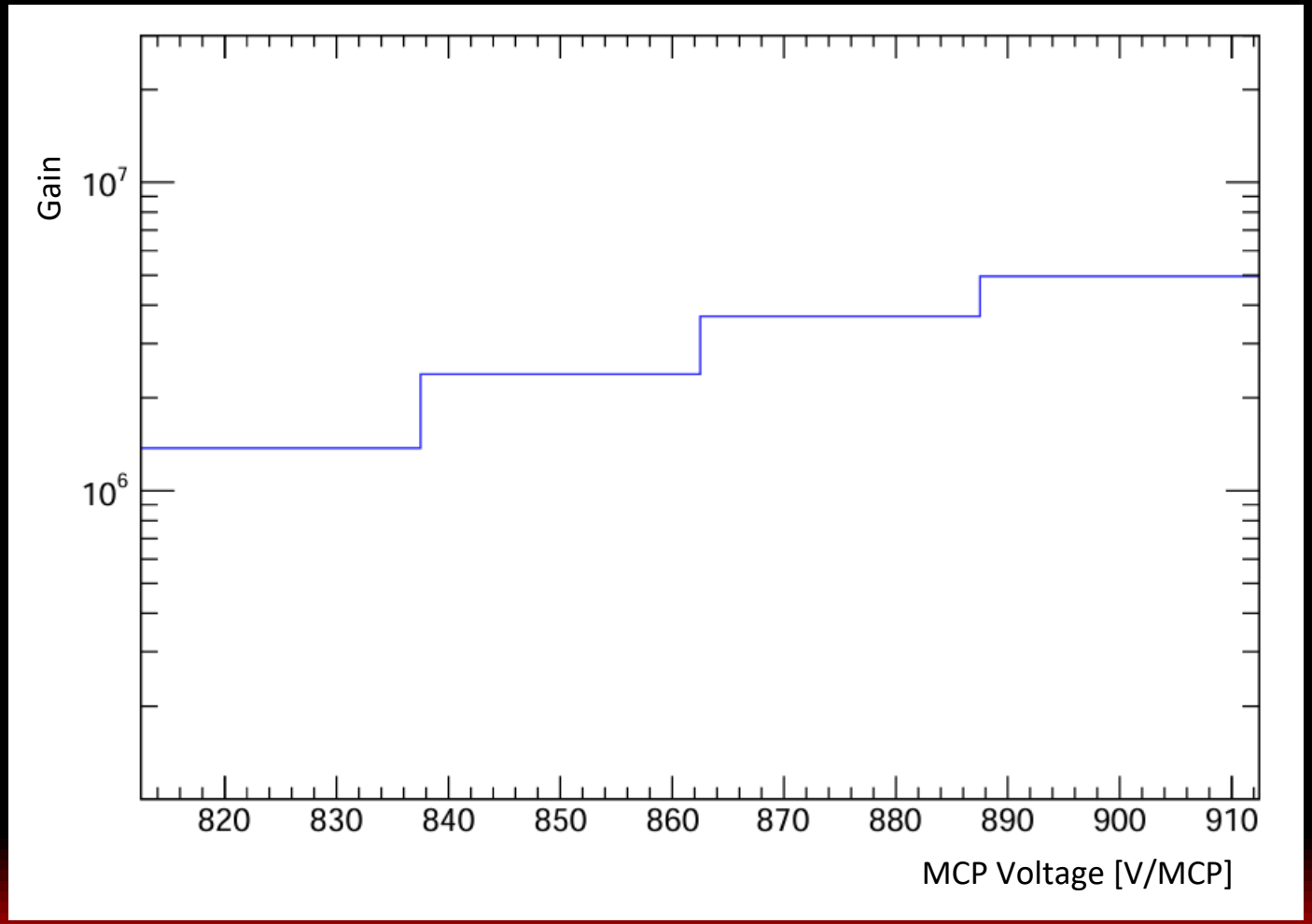




Gain Across MCP Voltage

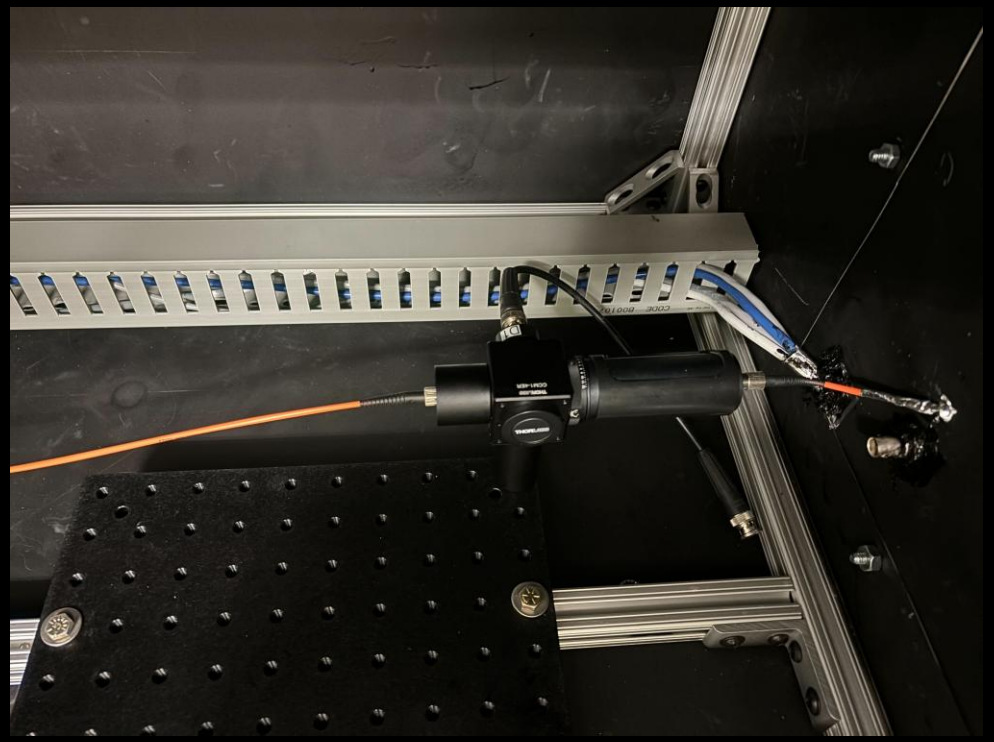
Gain increases exponentially with MCP voltage

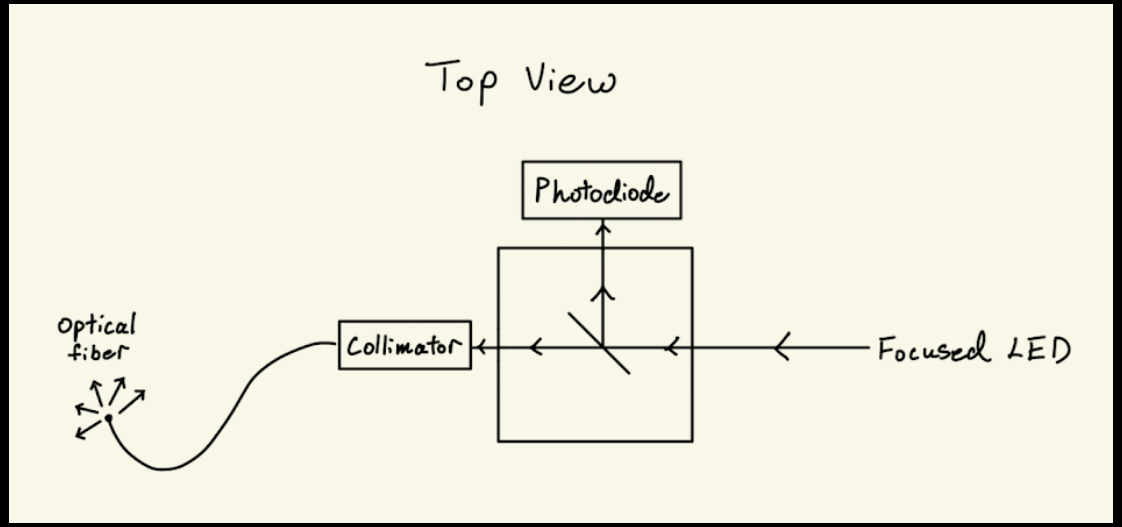
Large gain is desirable for signal detection, but leads to large charge buildup over time



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



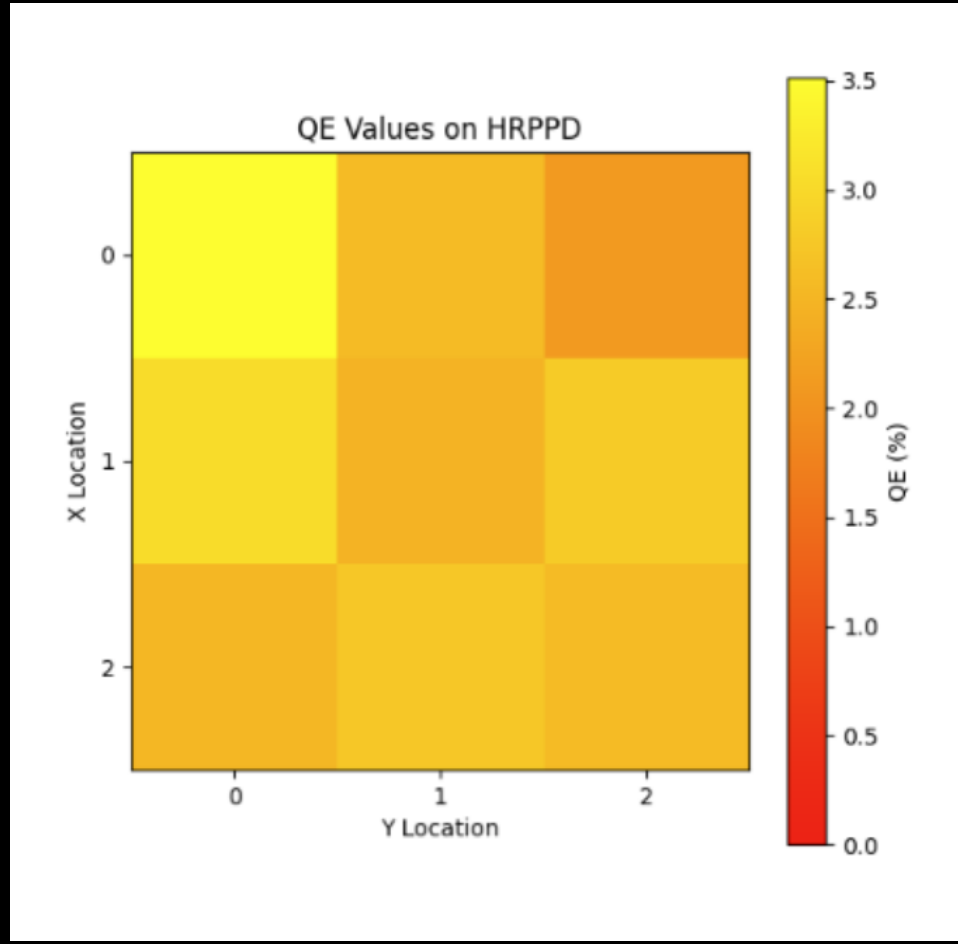


Quantum Efficiency

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