

# Tests of an MCP-PMT with an Active Ion Barrier

**A. Brandt**<sup>1</sup>, L. Moore<sup>1</sup>, V. A. Chirayath<sup>1</sup>, C. Noel<sup>1</sup>,  
J. Defazio<sup>2</sup>,

<sup>1</sup>University of Texas at Arlington, <sup>2</sup>Photonis, Inc.

# Characteristics of microchannel plate photomultiplier tubes (MCP-PMT)

High gain

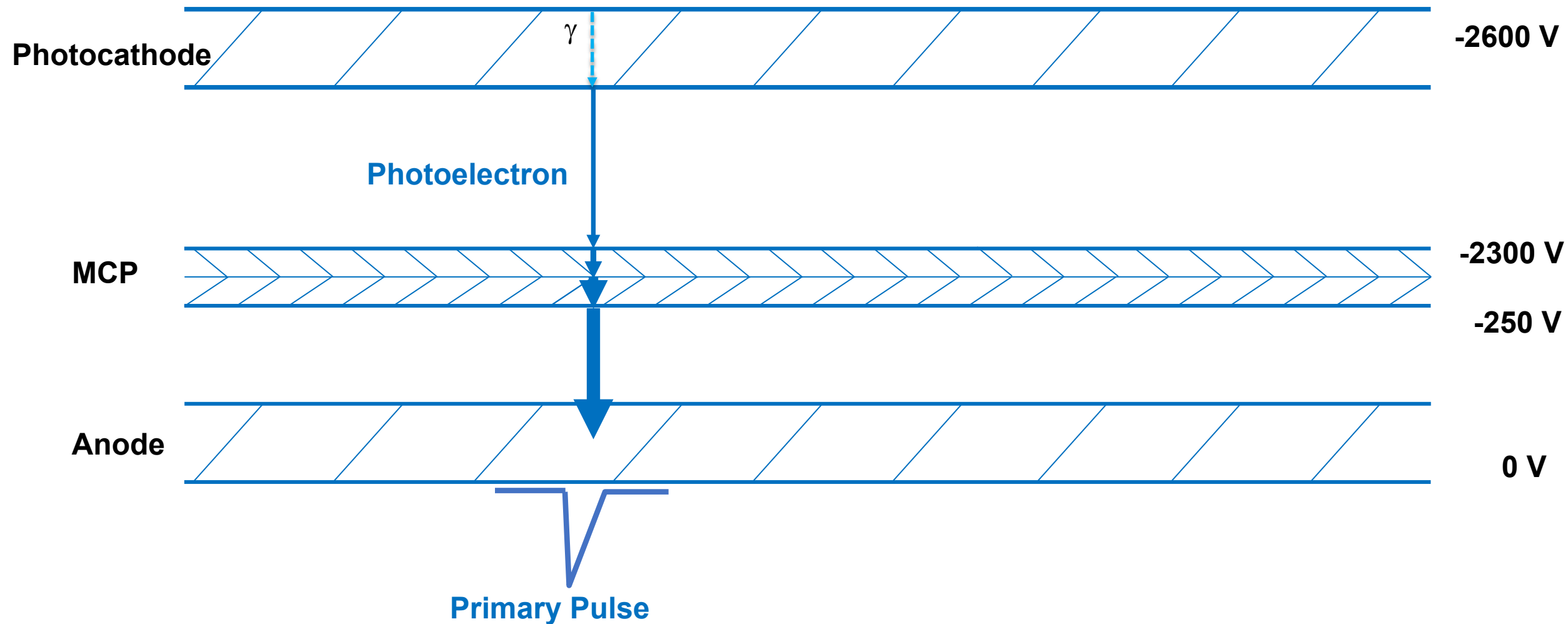
Low noise

Excellent timing resolution

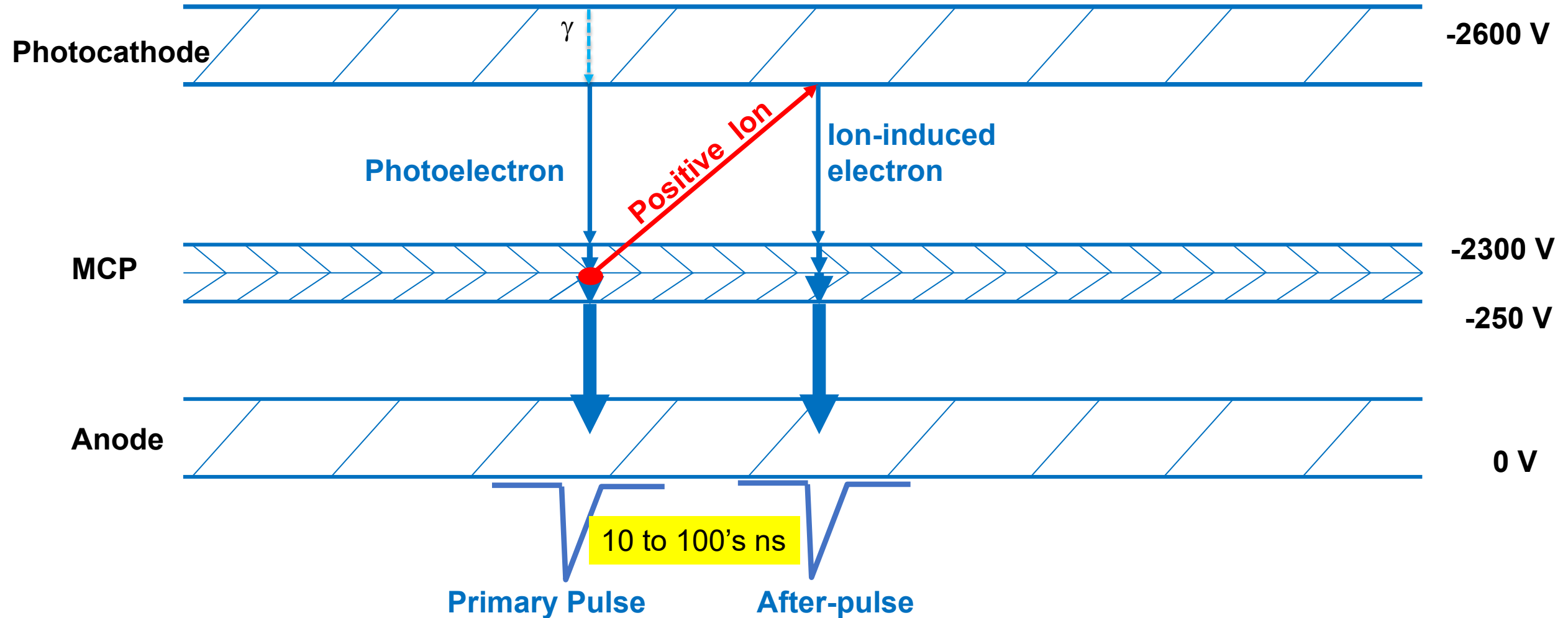
High rate capability

Insensitive to strong magnetic fields

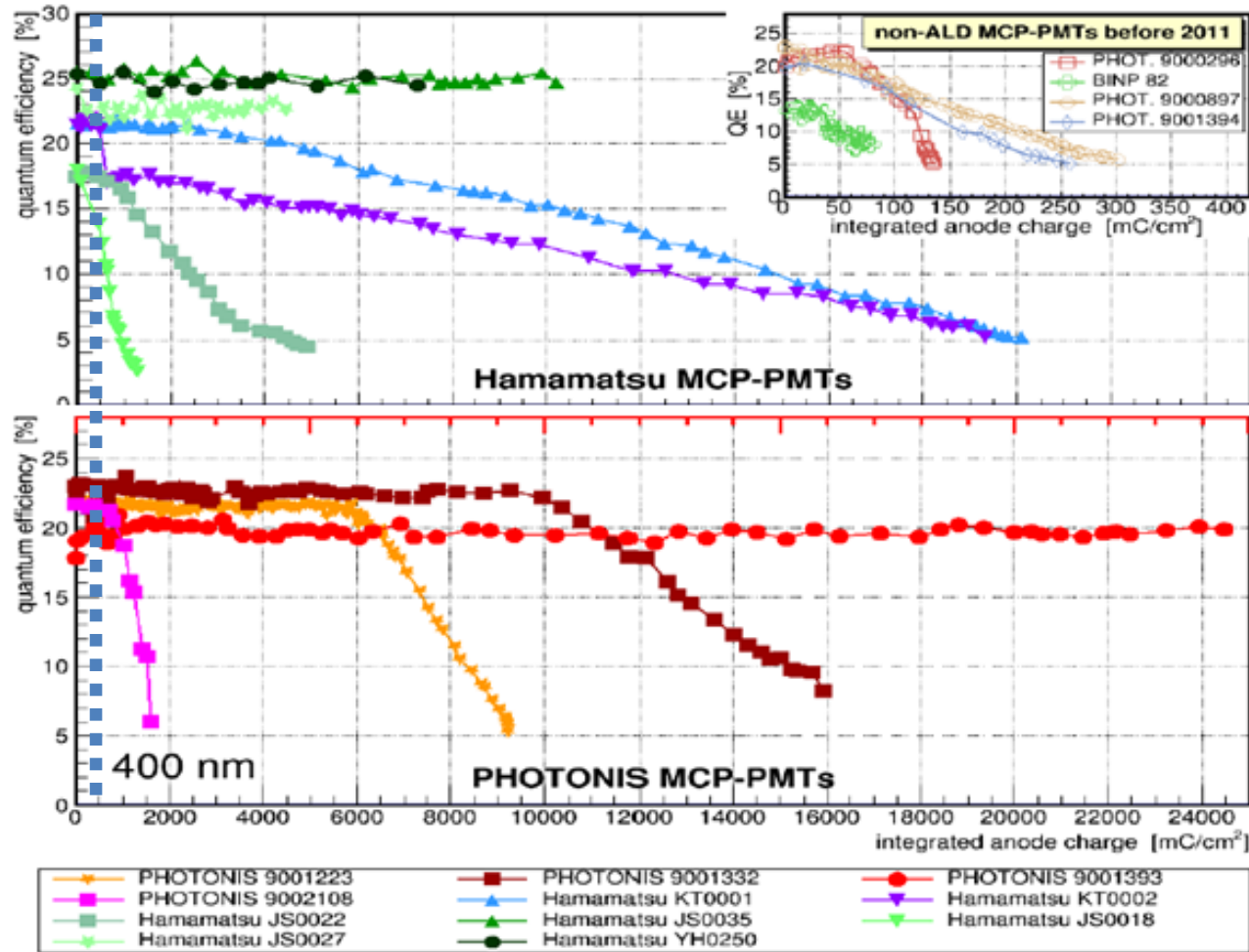
# MCP-PMT Layout



# MCP-PMT Ion Feedback



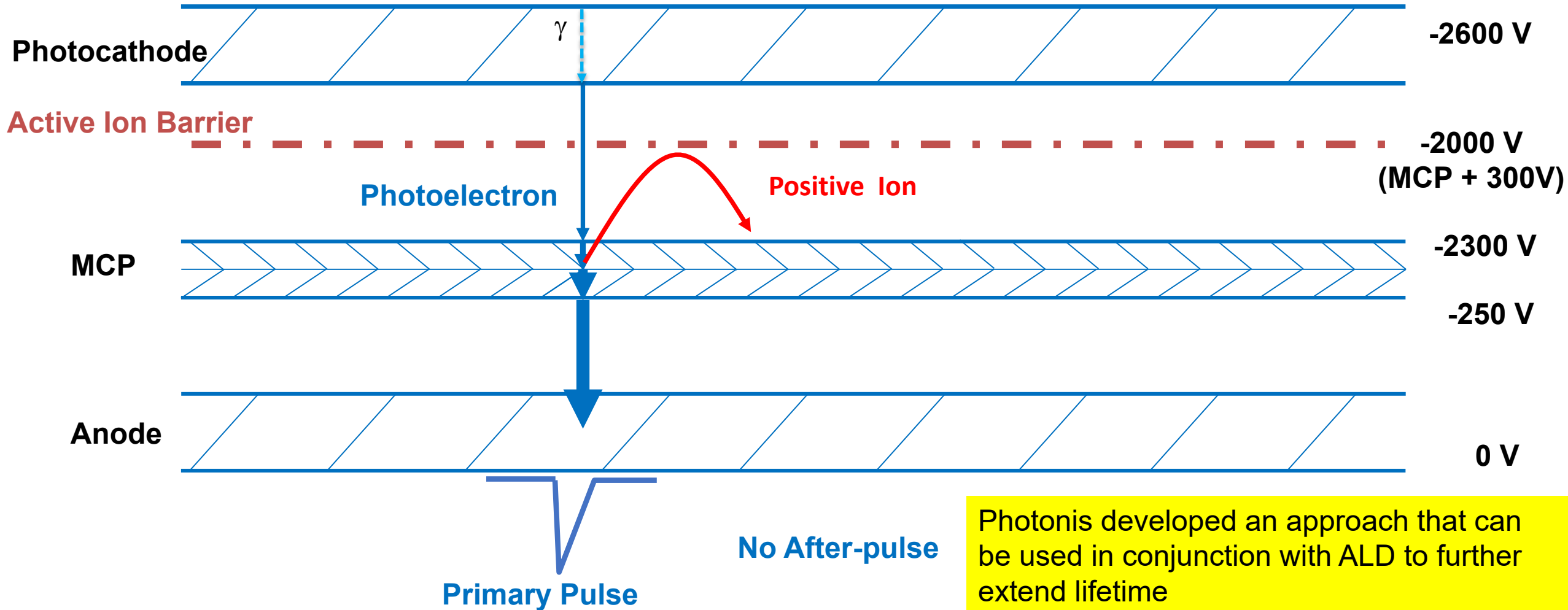
# MCP-PMT Lifetime



- Prior to 2011  $L < 0.5 \text{ C/cm}^2$
- Arradance, Inc. develops Atomic Layer Deposition (ALD) (SBIR Proposal with UTA uses ALD-coated MCP's in Photonis MCP-PMT's produces first long lifetime MCP-PMT's  $L > 8 \text{ C/cm}^2$ )
- All long lifetime MCP-PMT's use ALD

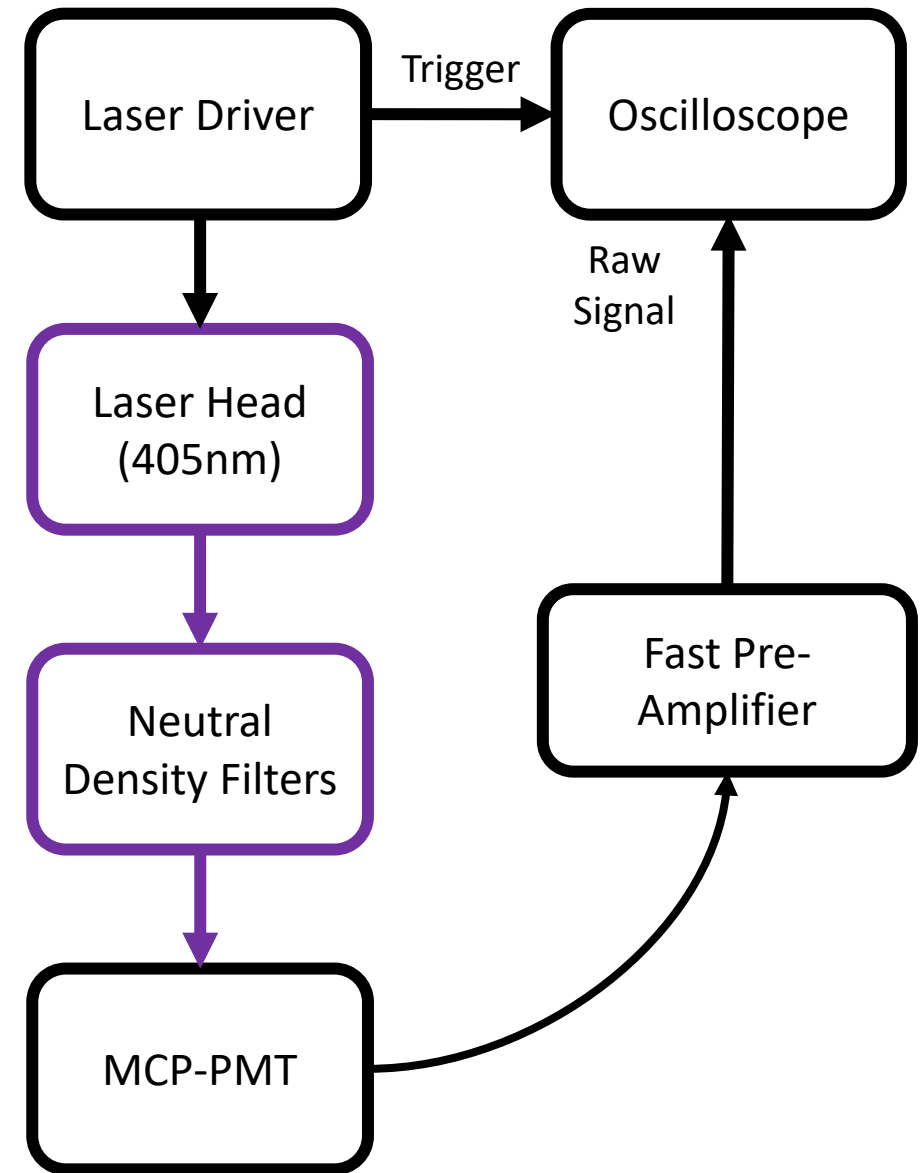
Lehmann et al., Nuclear Inst. and Methods in Physics Research, A 958 (2020) 162357.

# Active Ion Barrier (aka Grid)



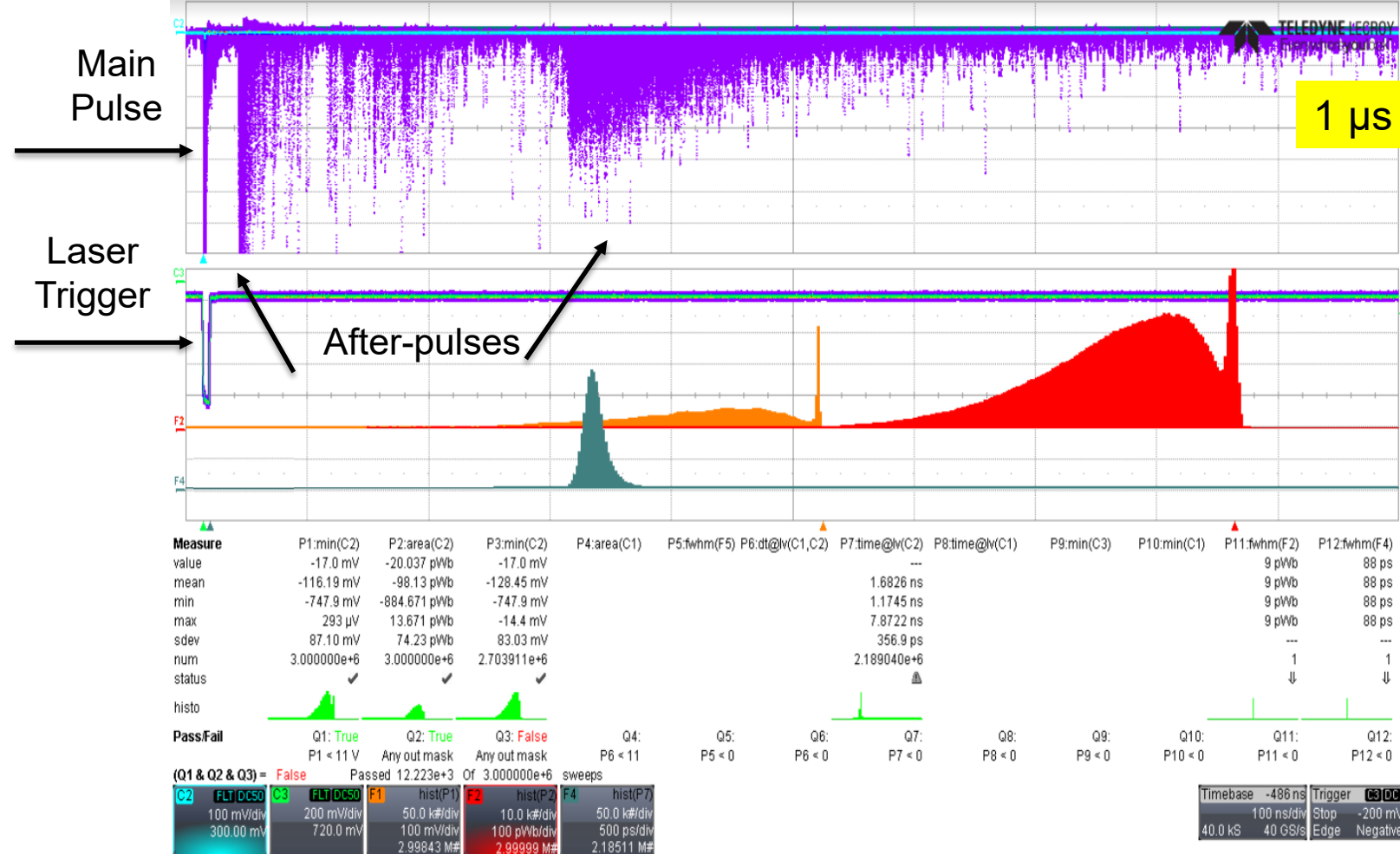
# Laser/Scope Setup

- Teldyne-LeCroy 760Zi-A 6 GHz 40 GS/sec Oscilloscope
- Hamamatsu PLP-10 picosecond laser (405 nm)
- **2 MCP-PMT's**
  - Grid
  - ALD+Grid



# Method:

- Two-fold coincidence for after-pulse rate measurements
  - Laser Trigger
  - Main Pulse
- Triple coincidence for detailed after-pulse studies
  - Laser Trigger
  - Main Pulse
  - After-pulse

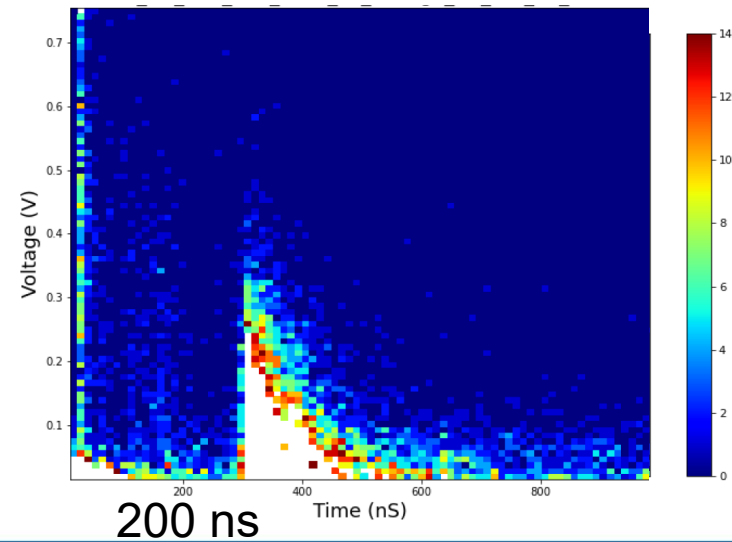




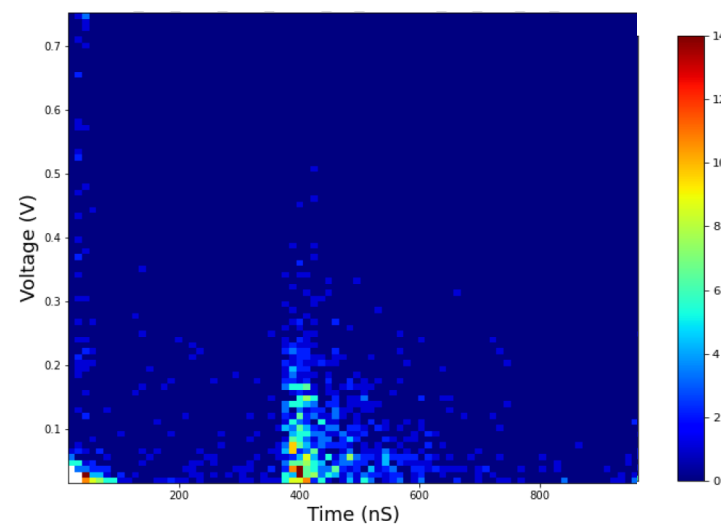
# After-pulse Time as $f(\text{Grid state})$

- Grid MCP-PMT

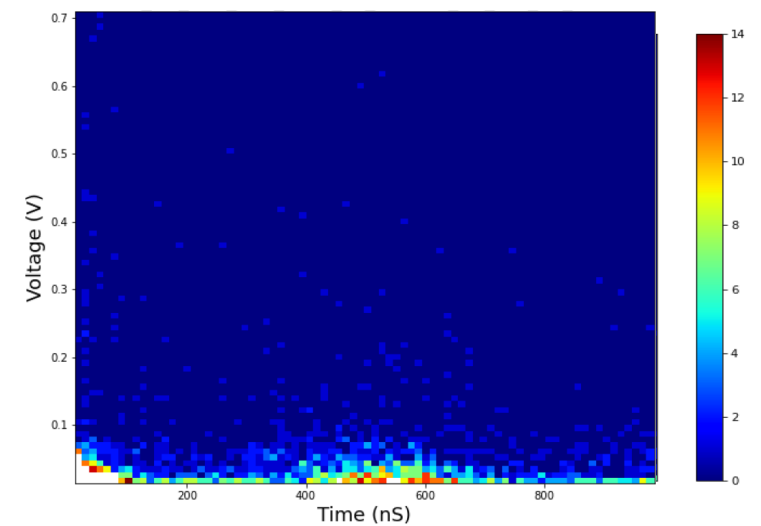
Grid Off



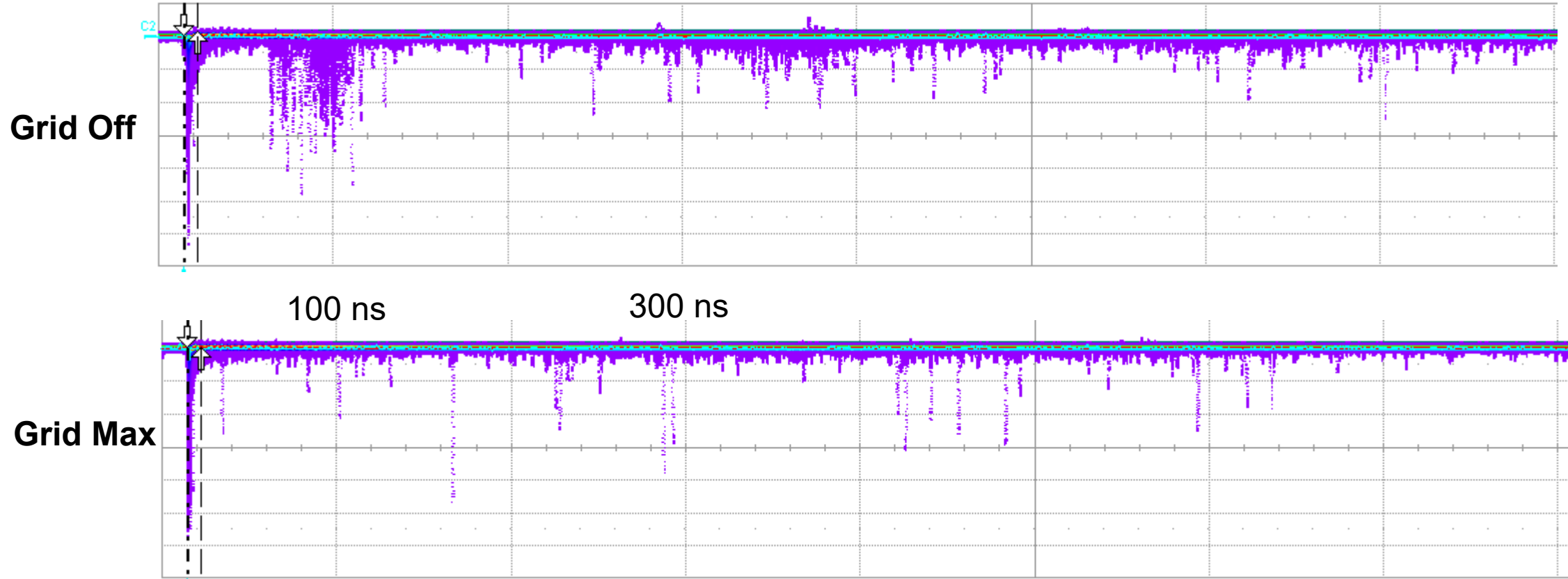
Grid On



Grid Max

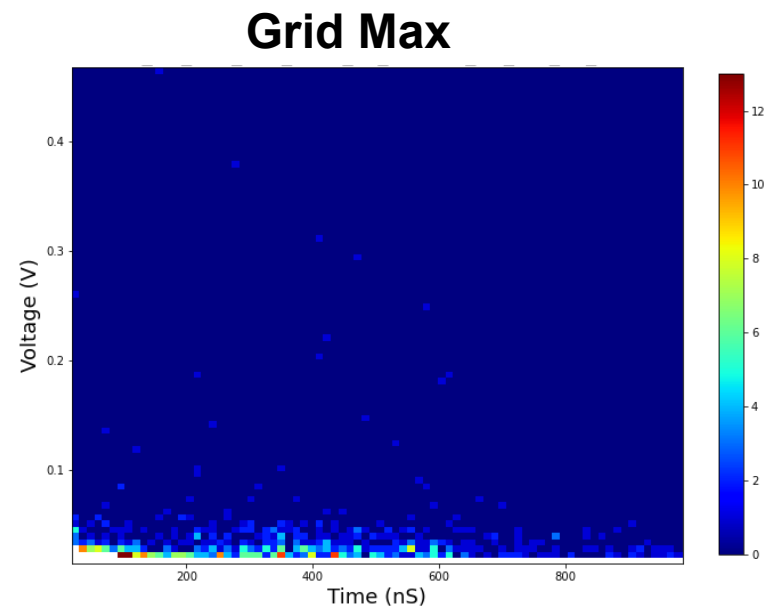
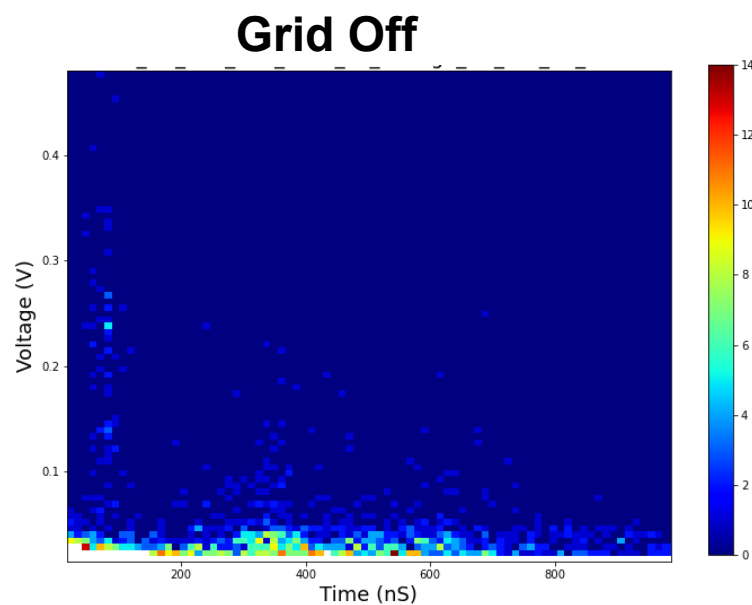


# ALD+Grid After-pulse Scope Pix

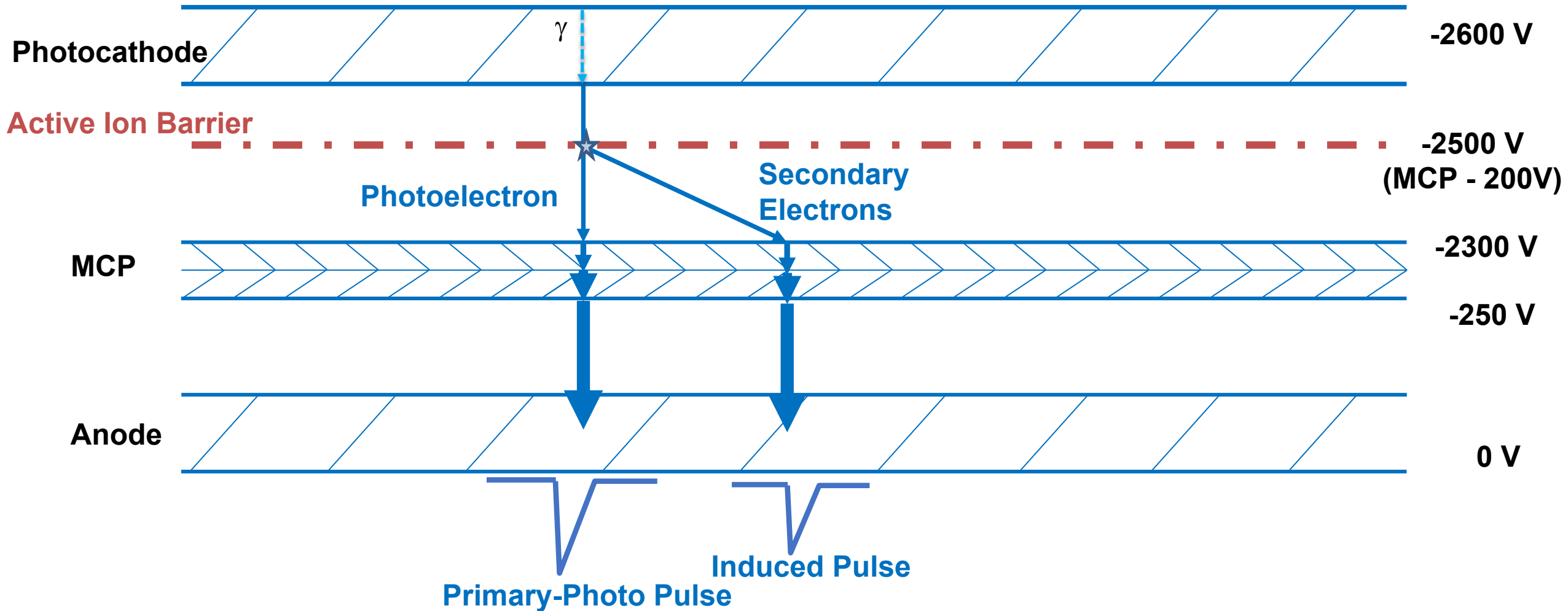


# After-pulse Time as $f(\text{Grid state})$

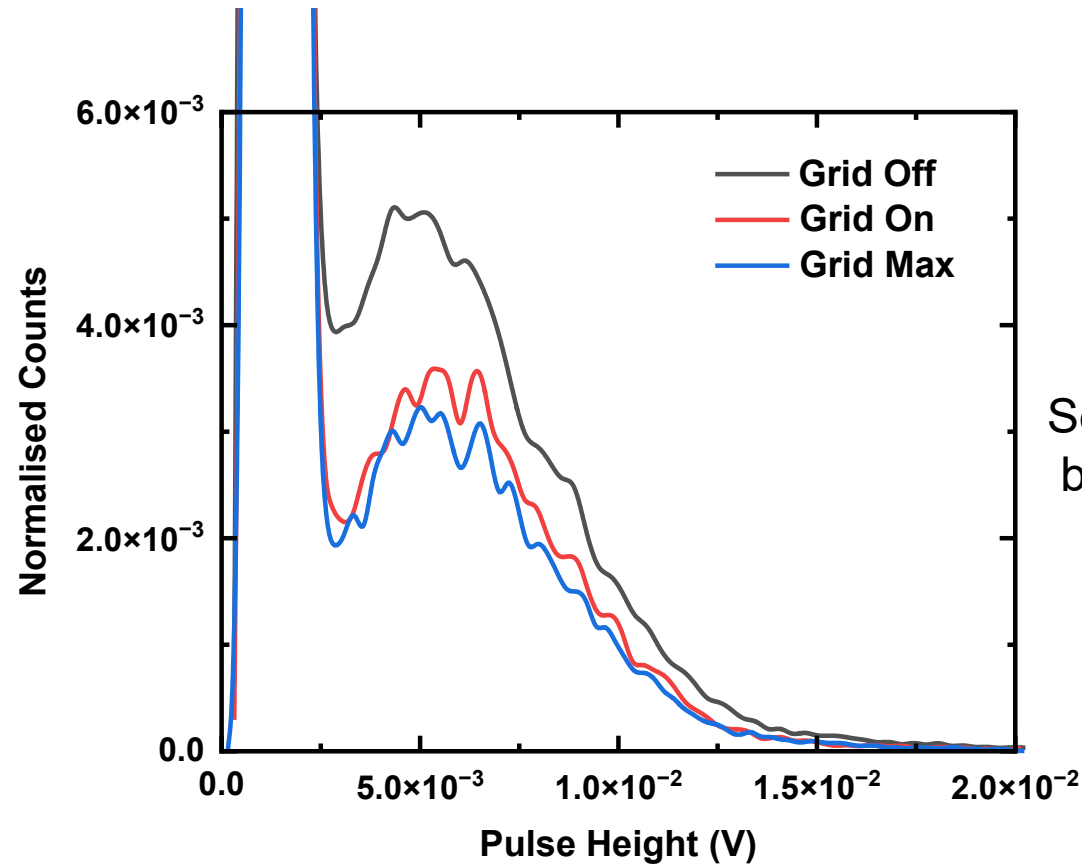
- **ALD+Grid MCP-PMT**



# Other Grid Effects: Secondary electrons

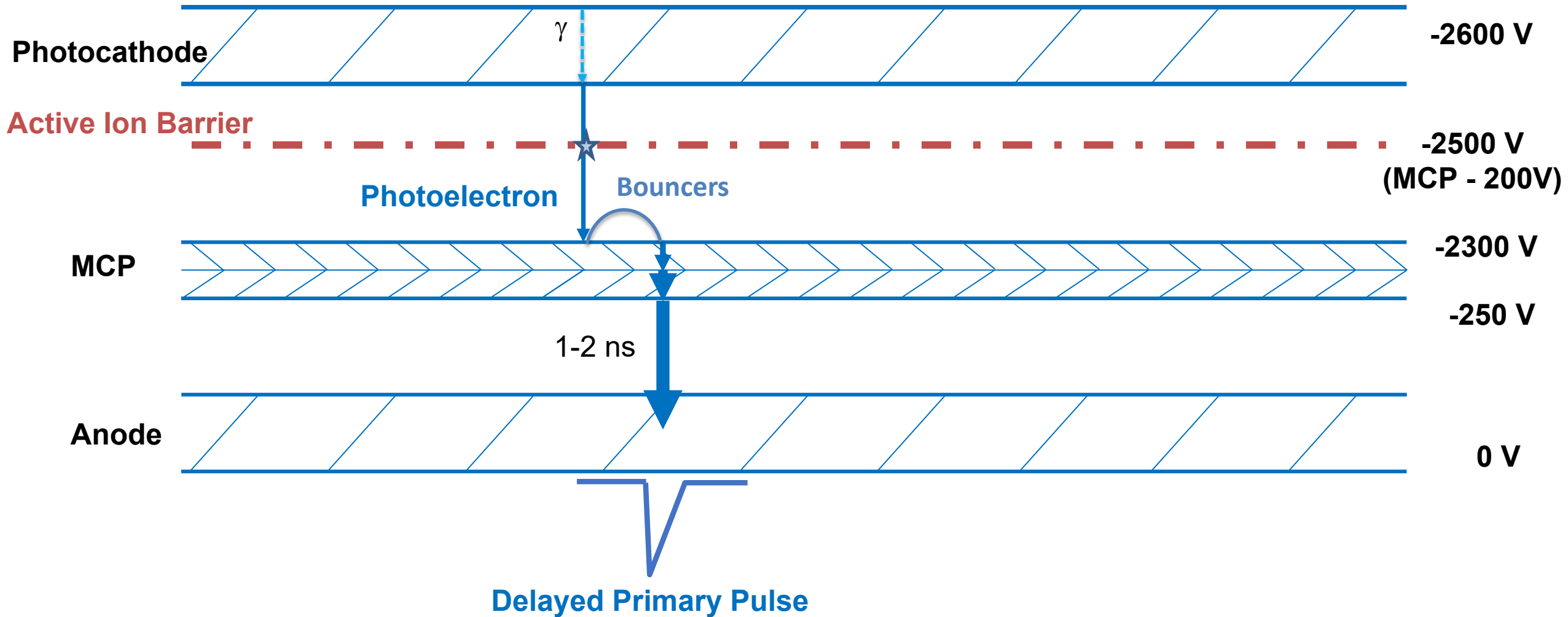


# Other Grid Effects: Secondary electrons

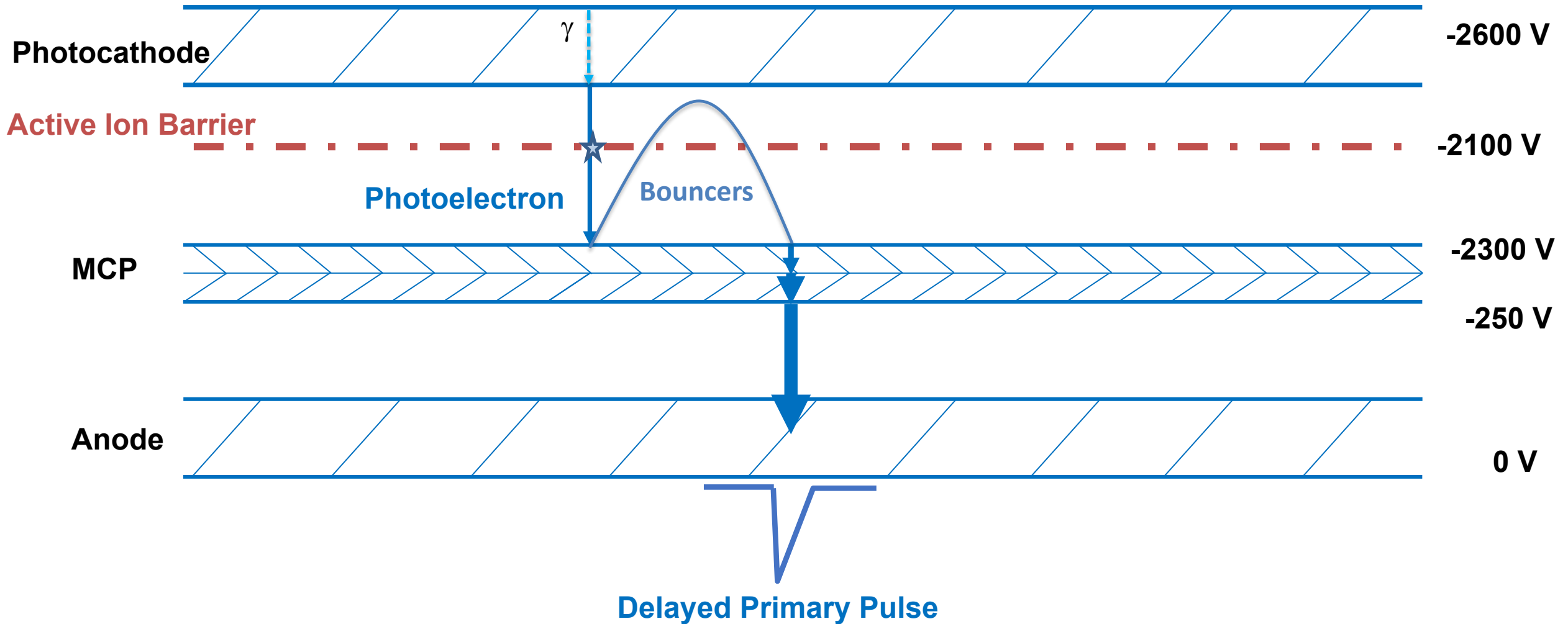


Secondary electrons removed by turning on Grid

# Other Effects: “Bouncers”

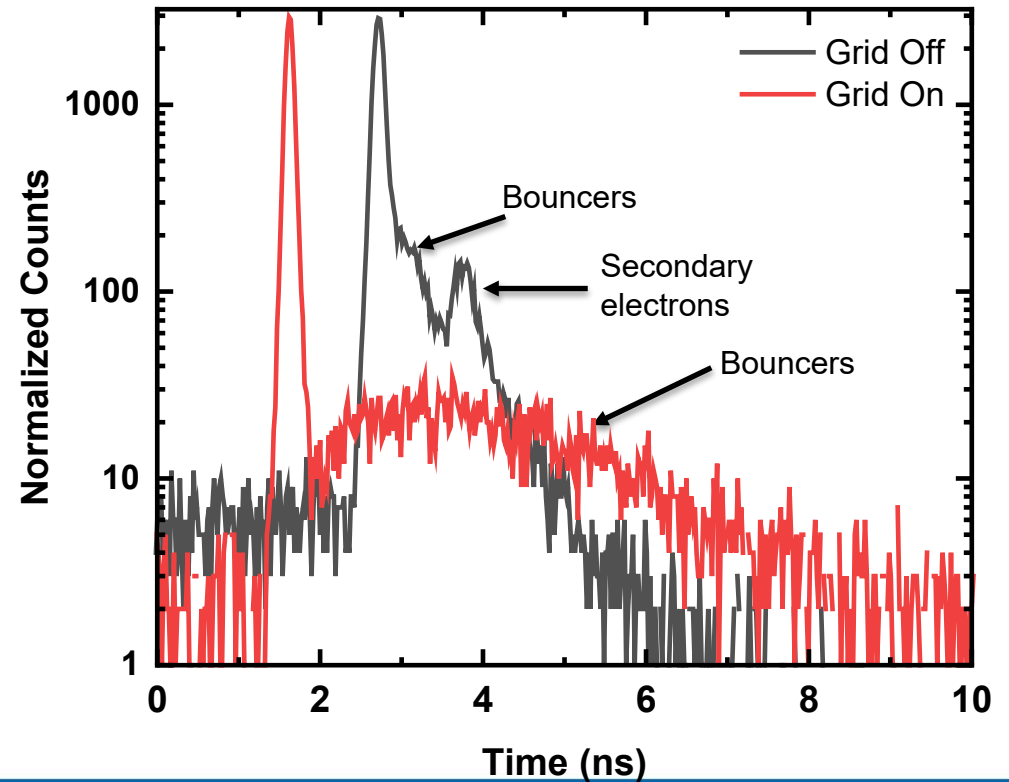
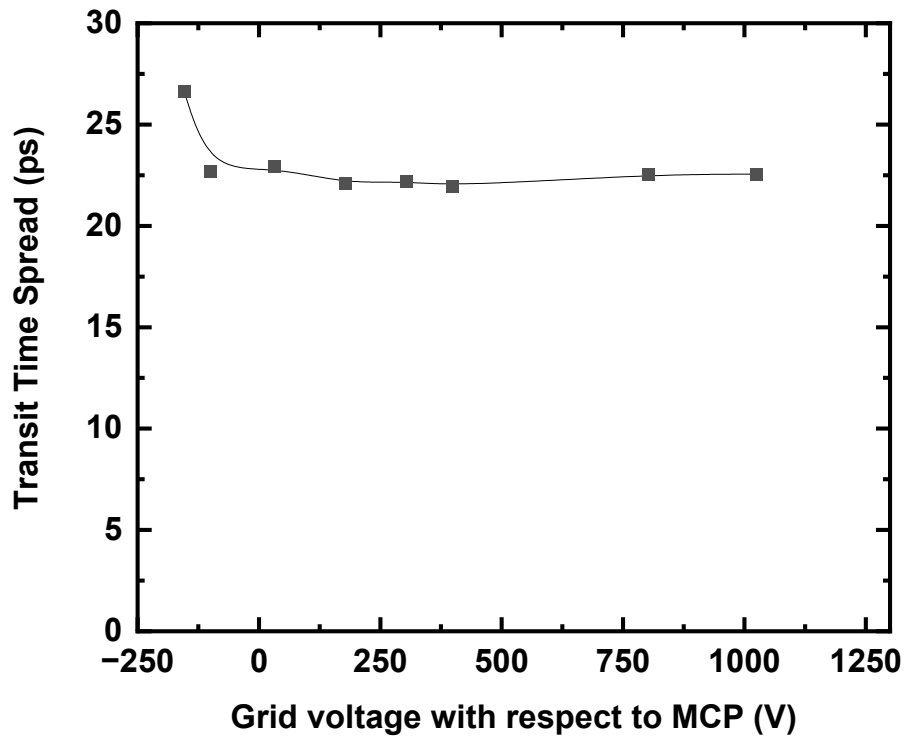


# Other Grid Effects: Delayed Bouncers



# Other Grid Effects

- Improves TTS
- Bouncer peak moved later in time





# Conclusions

**Active ion barrier (Grid):**

**Suppresses positive ions**

**Improves timing resolution by delaying bouncers**

**Combined with ALD likely to be longest lifetime tube by significant factor**

# Planned Work

**Quantify Grid Suppression factor as  $f(\text{Ion species})$**

**Measure Lifetime of Grid and ALD+Grid tubes as  $f(\text{Grid state})$**