Development of an affordable, sub-pico second photo-detector

Evan Angelico, Andrey Elagin, Henry Frisch, Todd Seiss, Eric Spieglan[1], Bernhard Adams

[1]Enrico Fermi Institute, University of Chicago, United States
[2]Incom, Inc. 294 Southbridge Road, Charlton, MA 01507

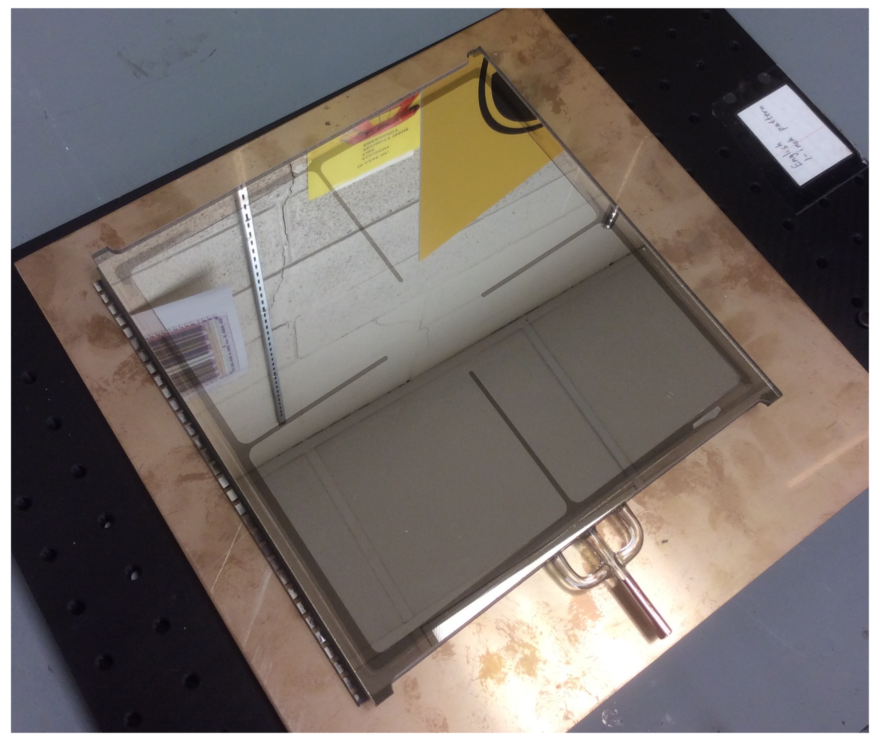

Figure 1: Top-down view of a sealed, LAPPD photo-detector "tile" made by the team at University of Chicago

Introduction

Spatial resolutions of less than a few microns have been achieved in photo-detection. Timing resolution, on the other hand, has largely been ignored. Moving from hundreds of pico-seconds (current technology) to a few pico-seconds or less would allow neutrino experiments, particle colliders, medical imaging, and others to explore uncharted territory.

Applications of LAPPDs

- The ANNIE experiment at Fermilab intends to use water-Cherenkov and LAPPDs to reduce backgrounds in neutrino experiments
- Eric Oberla used MCPs to reconstruct 3+1 dimensional particle tracks in *water*, introducing the first 'Optical Time Projection Chamber'
- LAPPDs may be able to separate Cherenkov light from scintillation light to detect neutrino-less double beta decay

Second Generation LAPPD: Inside-Out

The proposed second generation LAPPD would make cost saving simplifications to the manufacturing process while maintaining fast timing characteristics.

- Replace glass packaging with a higher analog bandwidth ceramic packaging
- Split the anode into two separate entities: the inside-out anode and the external readout board

In place of the first generation anode is a homogeneous thin metal film.

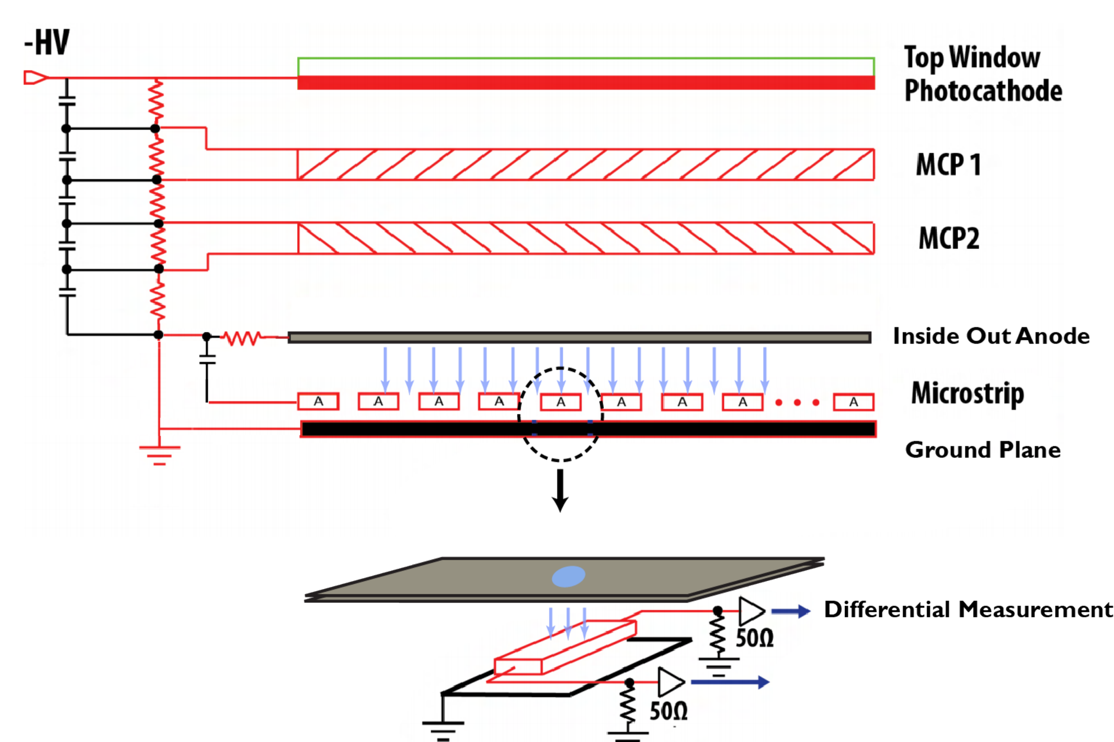

Figure 2: Circuit diagram of the second generation LAPPD

Test Setup

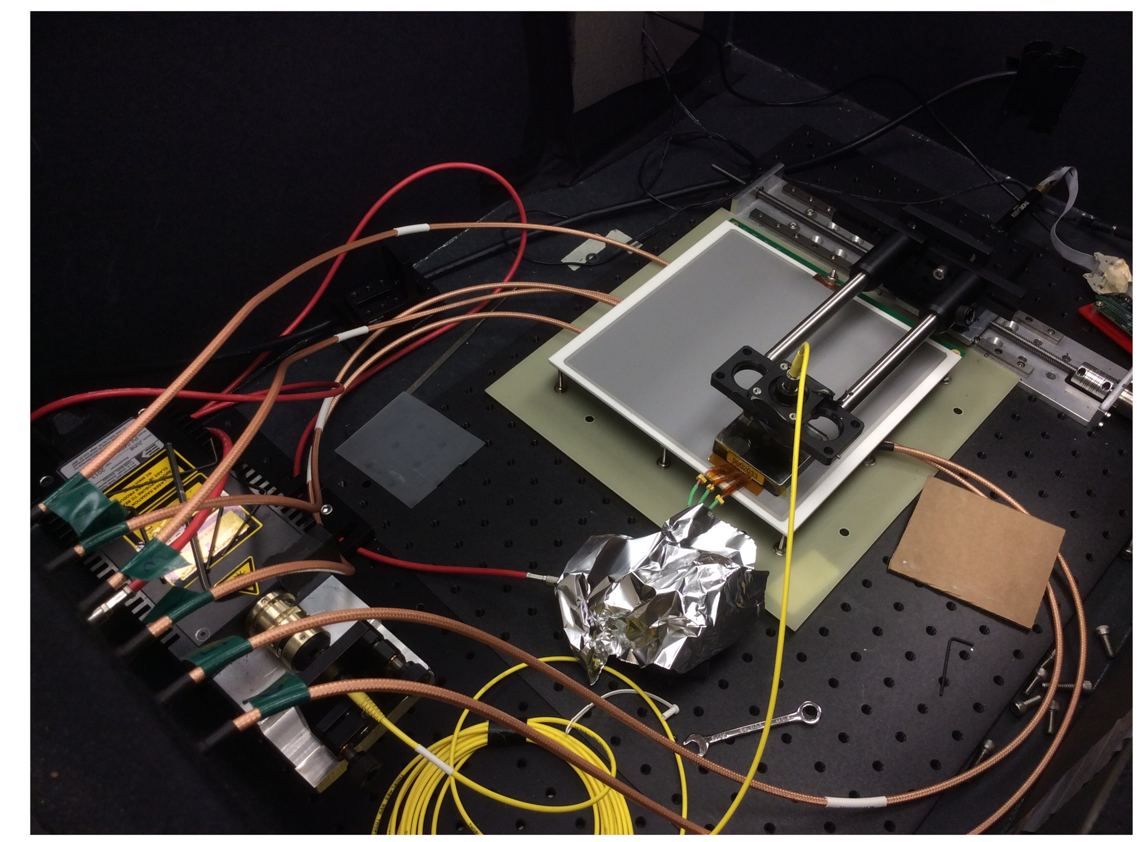

Figure 3: Laser arm setup in HEP lab 321

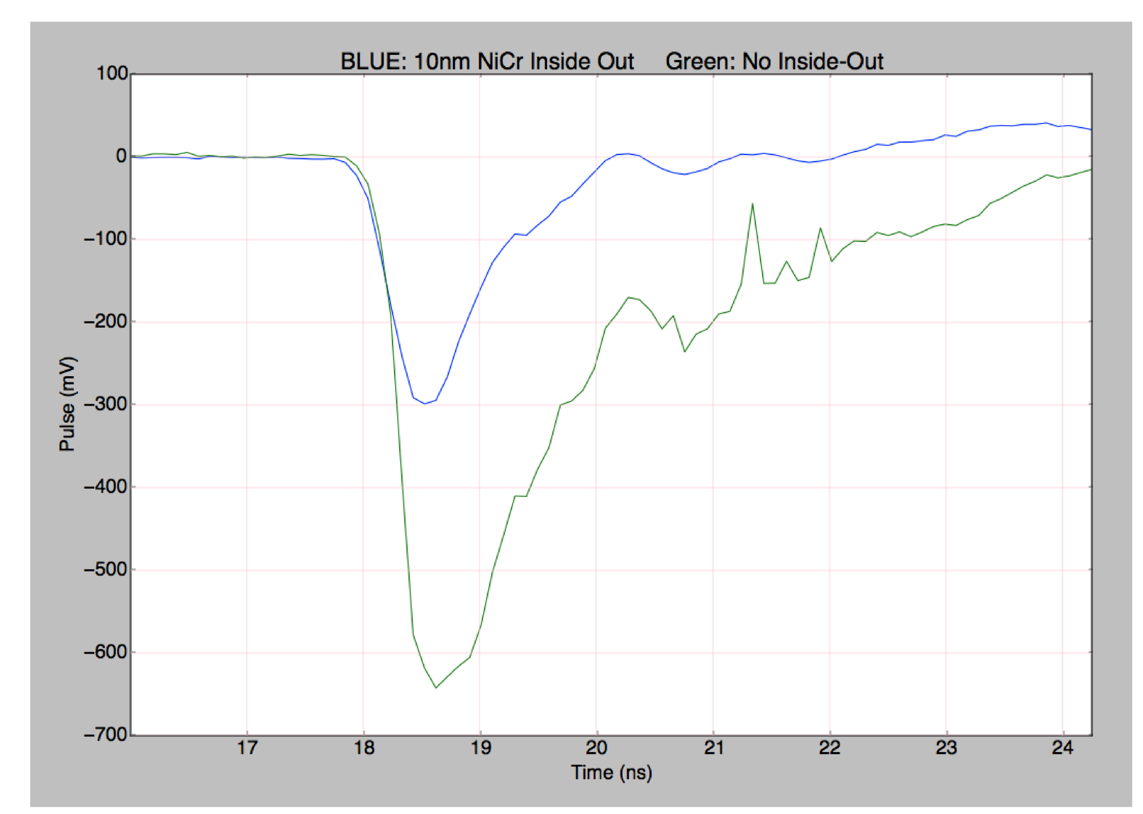

Figure 4: Pulse on direct strip-lines vs Inside-Out sample

Result

The inside-out anode successfully transmits ∼ 35% of an MCP photo-multiplier signal through a 3mm plate of ceramic. This technique can remove major LAPPD manufacturing costs and complications.

Results

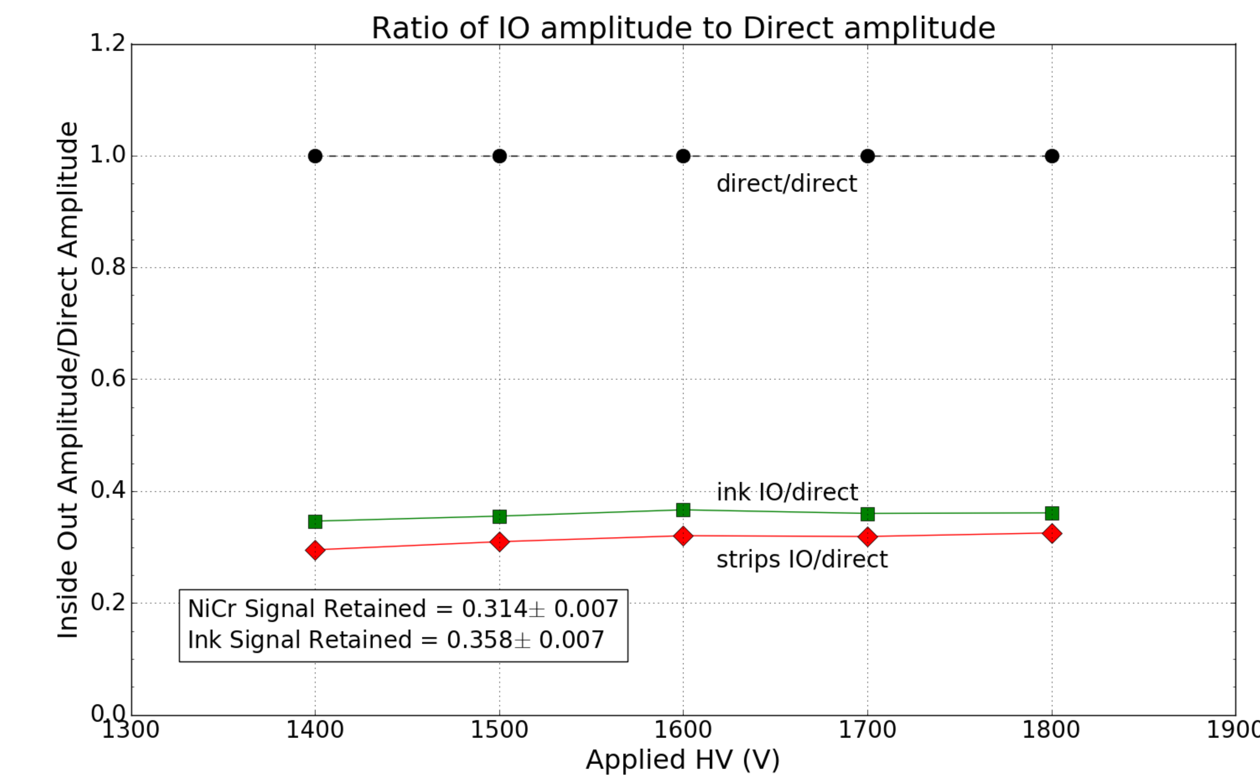

Figure 5: A constant ratio between inside-out and direct signal amplitudes. Signal amplitude is directly proportional to timing resolution.

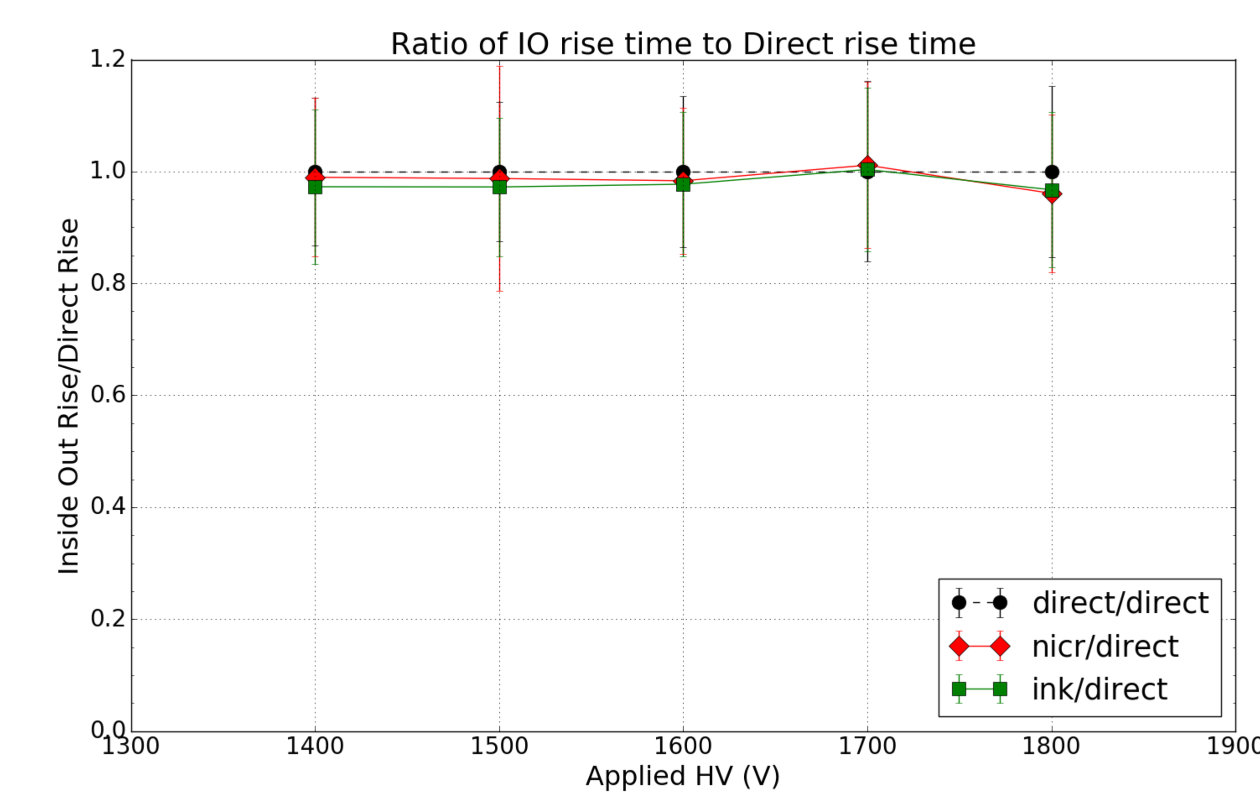

Figure 6: Constant ratio of rise times shows that the inside-out does not affect the fast timing properties of MCP signals.