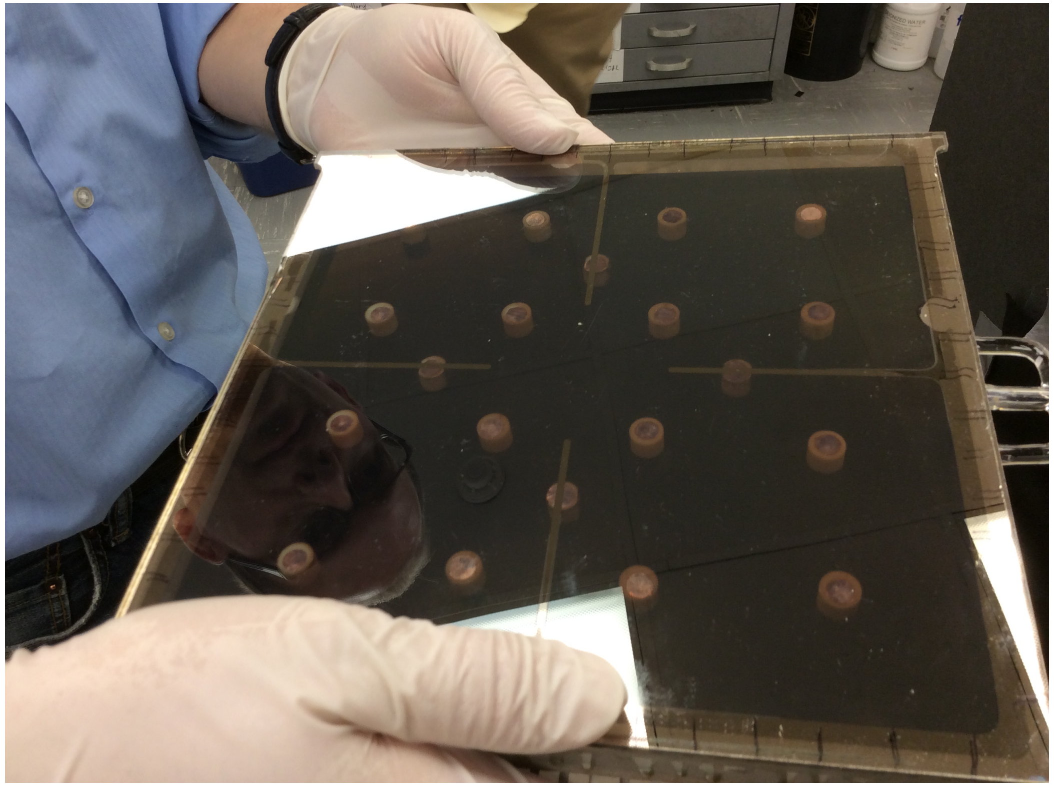
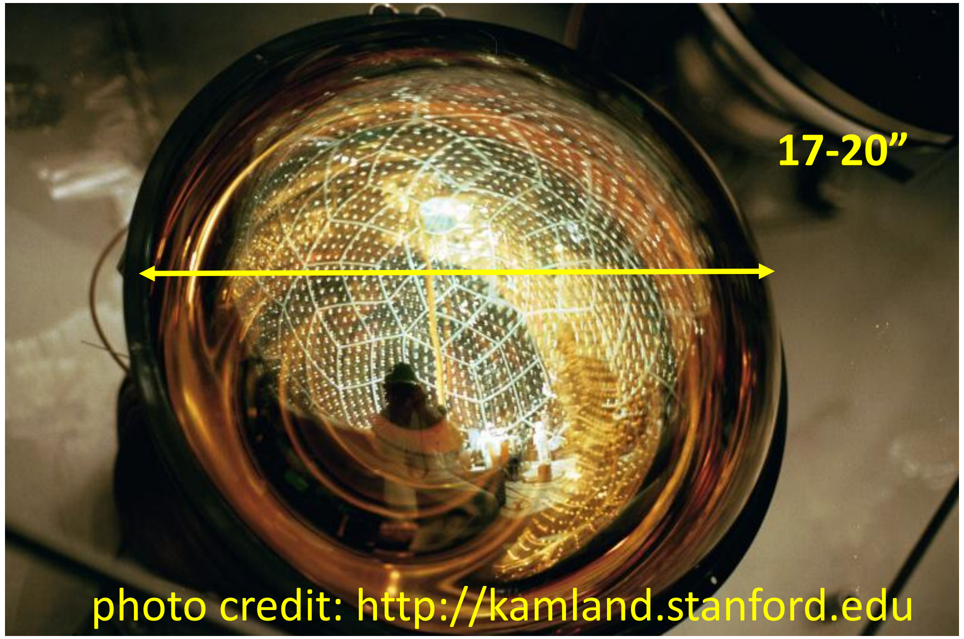
Brief overview of LAPPD technology



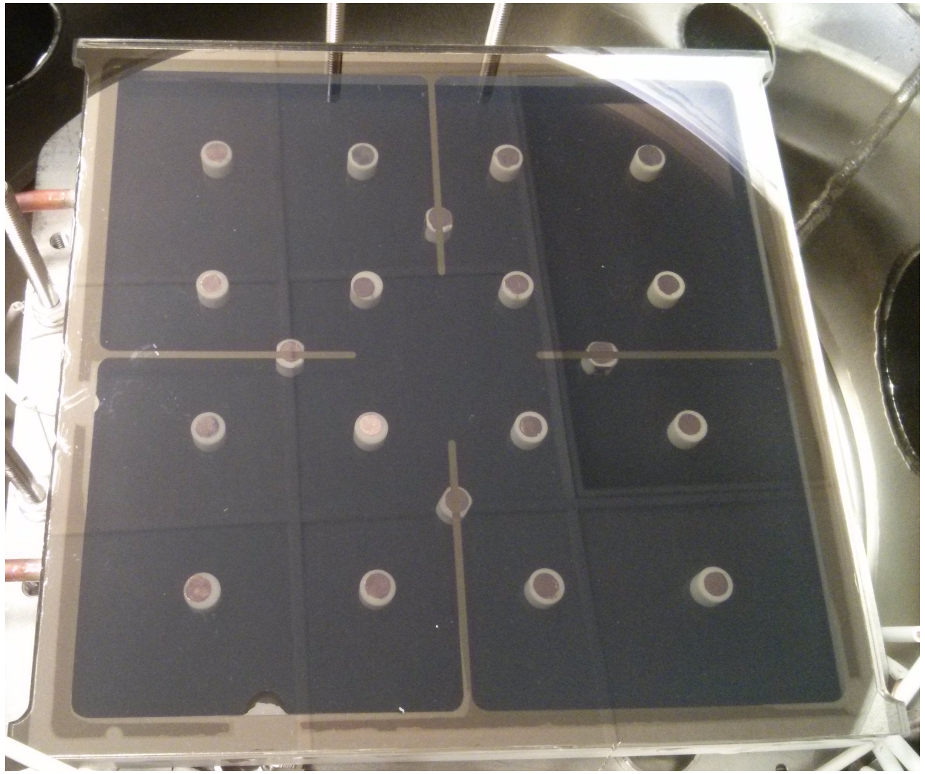


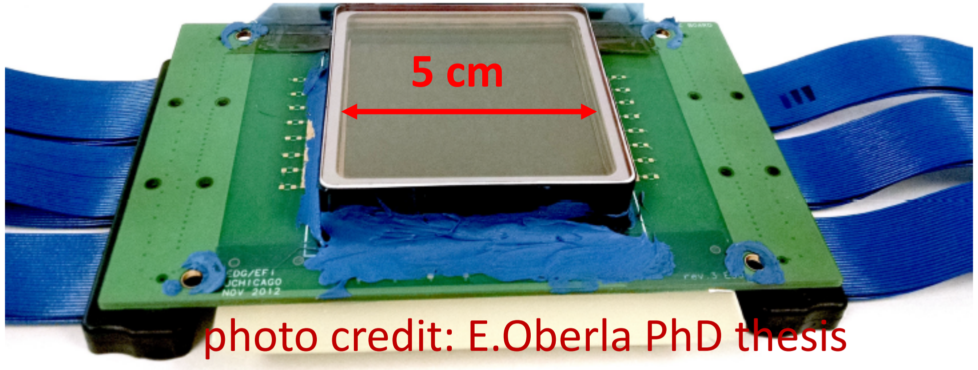
tts ~ 3-10ns

dx ~ 20''

pixel size ~ 20''

sensitive area ~





tts ~ 100ps

dx ~ 1mm

pixel size ~ 1.5mm

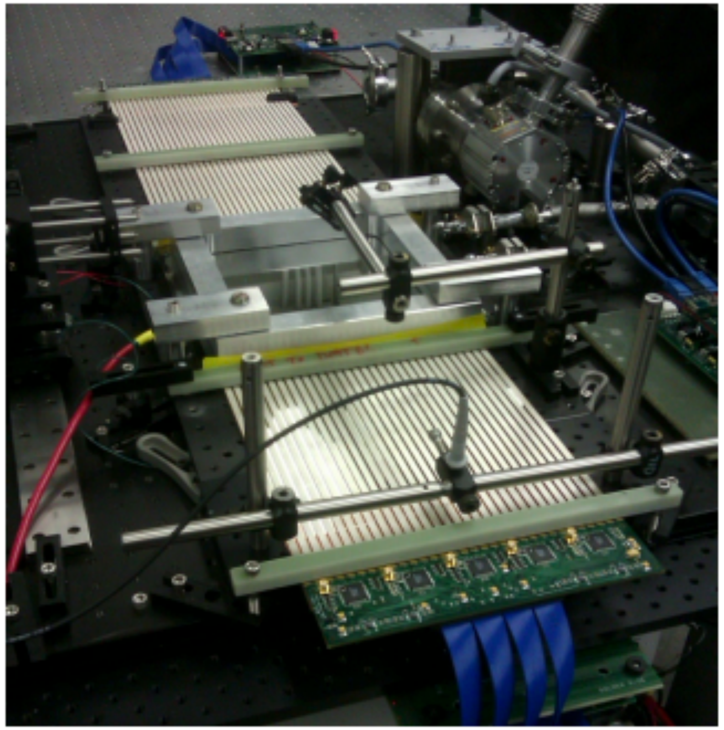
sensitive area ~5cm x 5cm

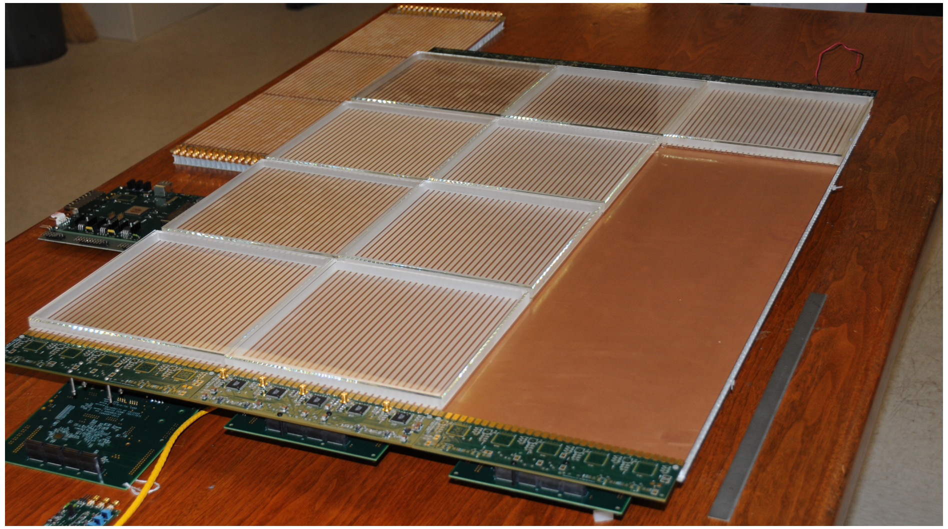
tts ~ 50ps

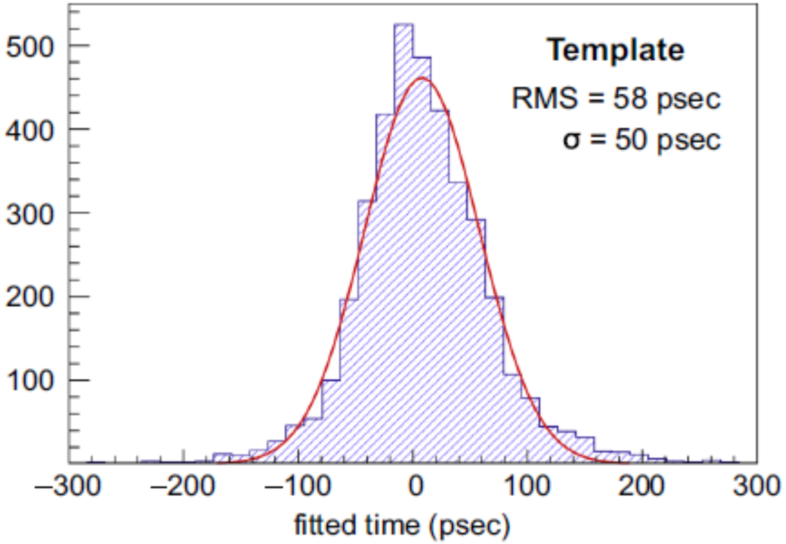
dx ~ 0.7mm

sensitive area ~20cm x 20cm

Matt Wetstein, 2014



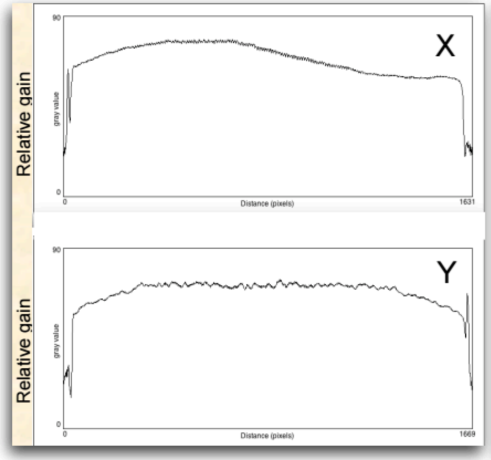


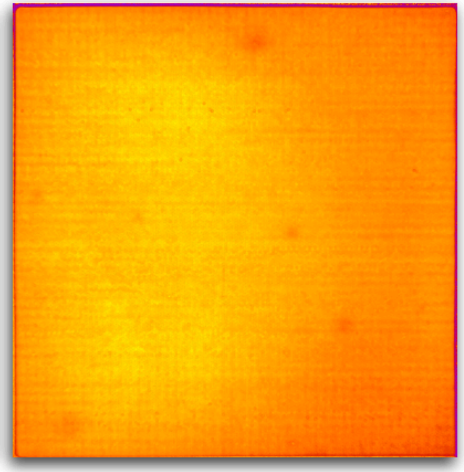


“Demountable” LAPPD

- O-ring top-seal and aluminum photocathode.
- Otherwise, a fully operational demonstration of the LAPPD design, with full integrated front-end electronics.

Gain Uniformity



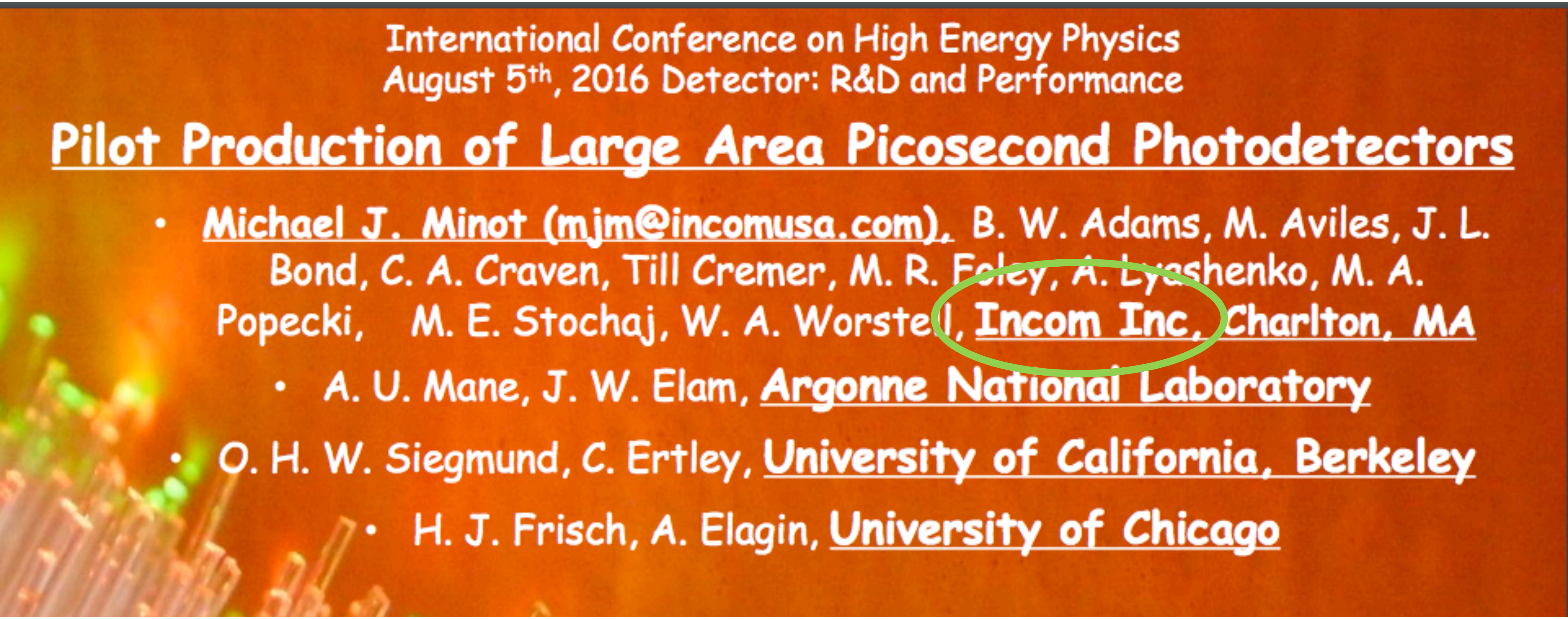


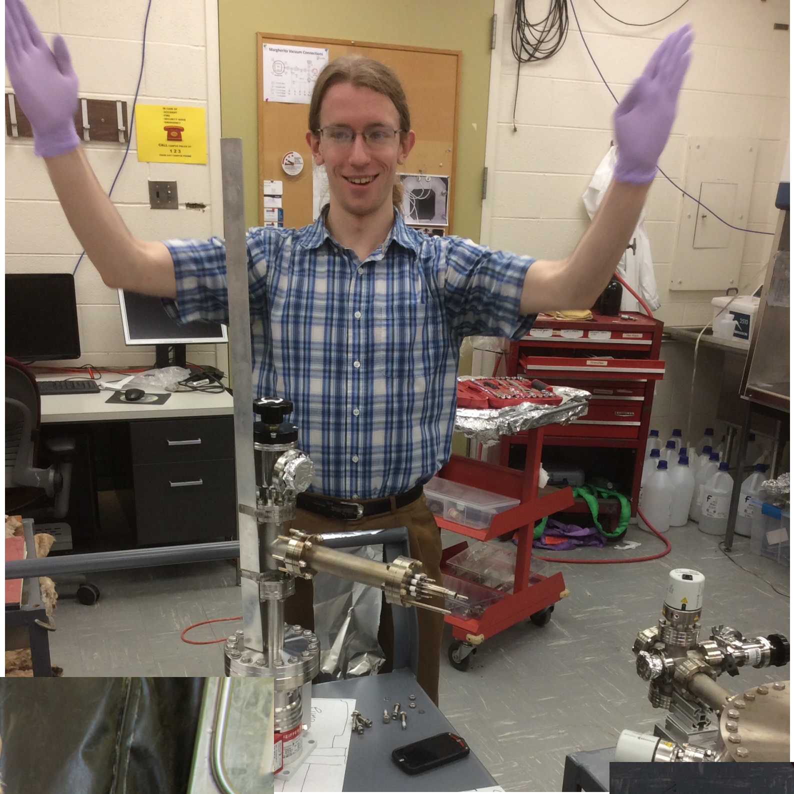
Demonstrated characteristics:

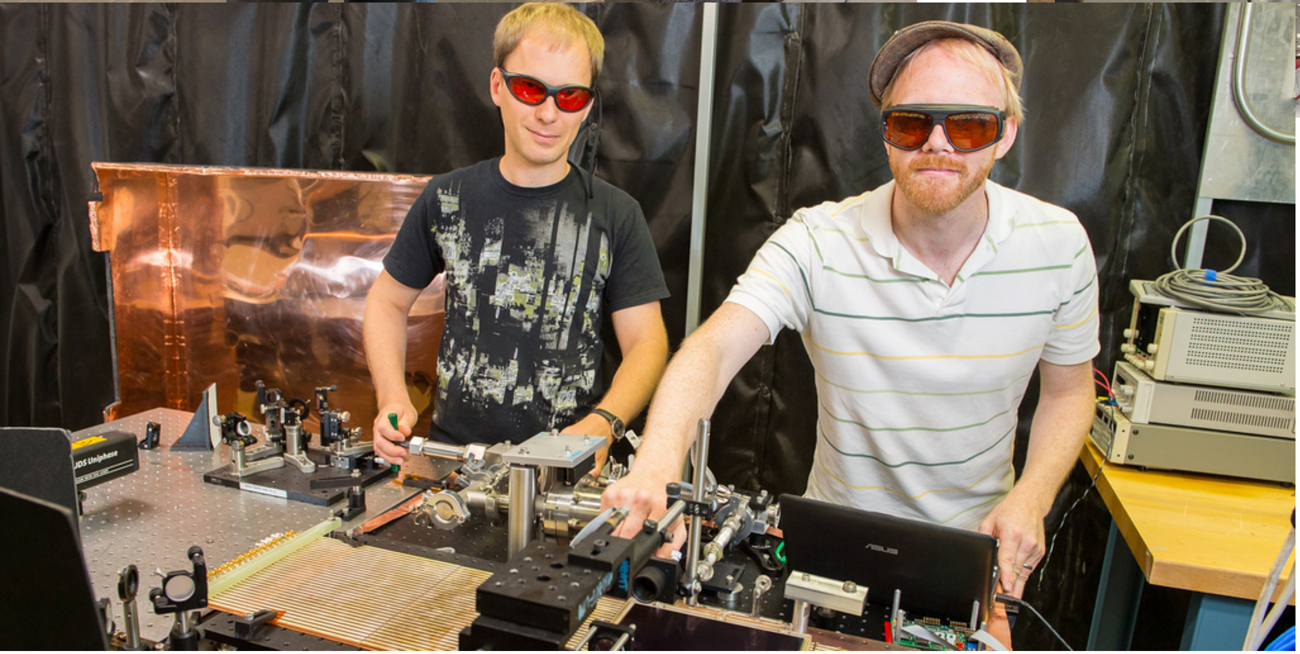
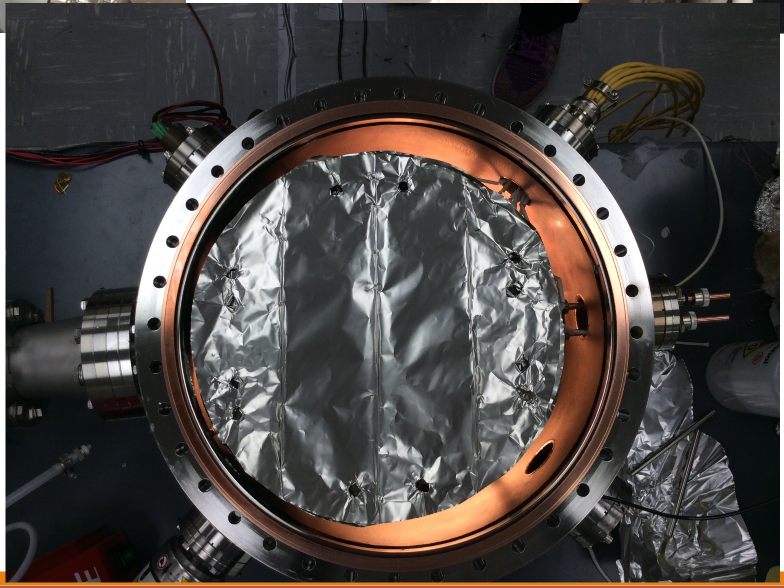
single PE timing ~50ps
multi PE timing ~35 ps
differential timing ~5 ps
position resolution < 1 mm
gain >10^7

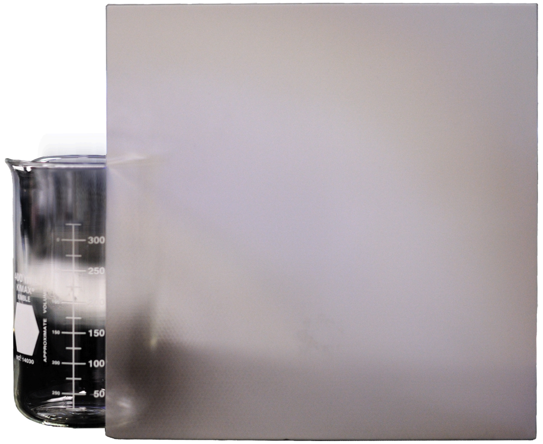
RSI 84, 061301 (2013),
NIMA 732, (2013) 392
NIMA 795, (2015) 1

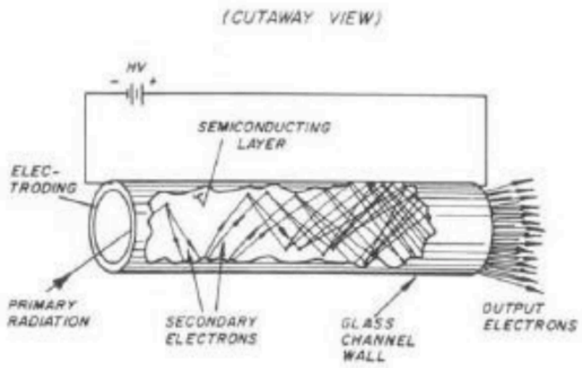
See arXiv:1603.01843
for a complete LAPPD bibliography

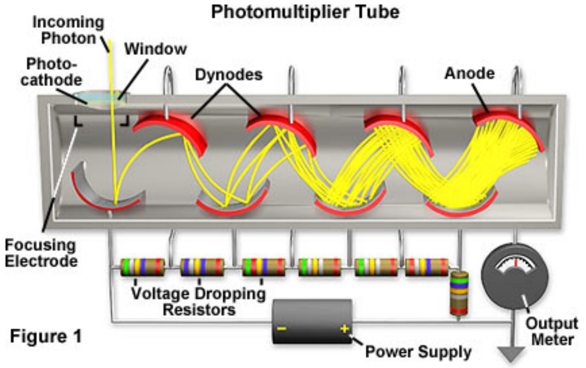

International Conference on High Energy Physics
August 5th, 2016 Detector: R&D and Performance
Pilot Production of Large Area Picosecond Photodetectors
• Michael J. Minot (mjm@incomusa.com), B. W. Adams, M. Aviles, J. L. Bond, C. A. Craven, Till Cremer, M. R. Foley, A. Lyashenko, M. A. Popecki, M. E. Stochaj, W. A. Worstell, Incom Inc, Charlton, MA
• A. U. Mane, J. W. Elam, Argonne National Laboratory
• O. H. W. Siegmund, C. Ertley, University of California, Berkeley
• H. J. Frisch, A. Elagin, University of Chicago

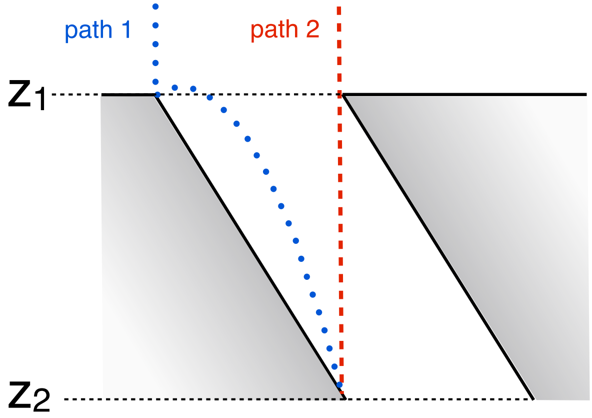



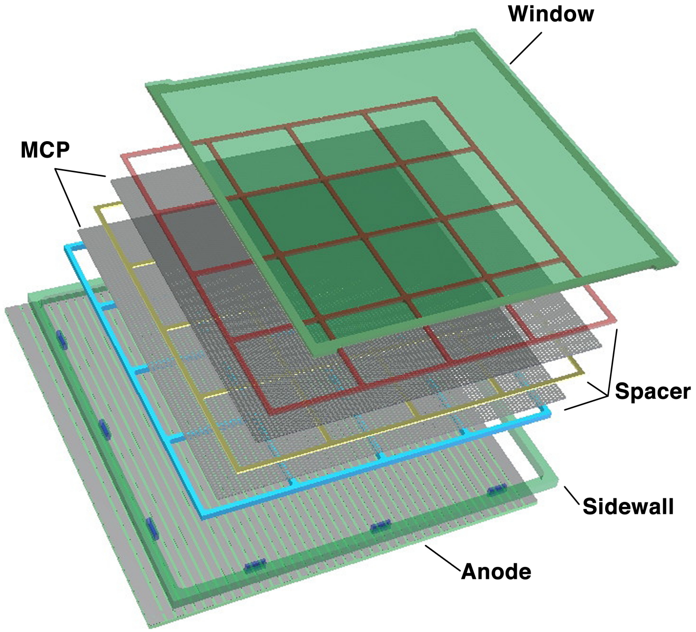



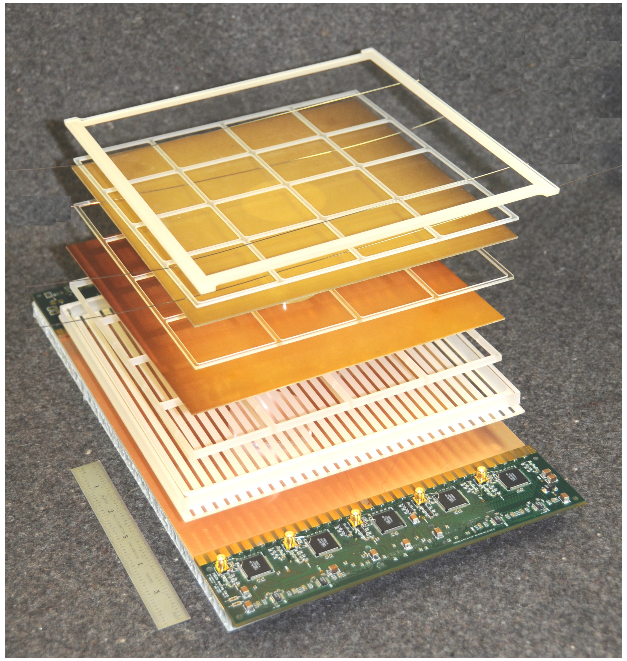


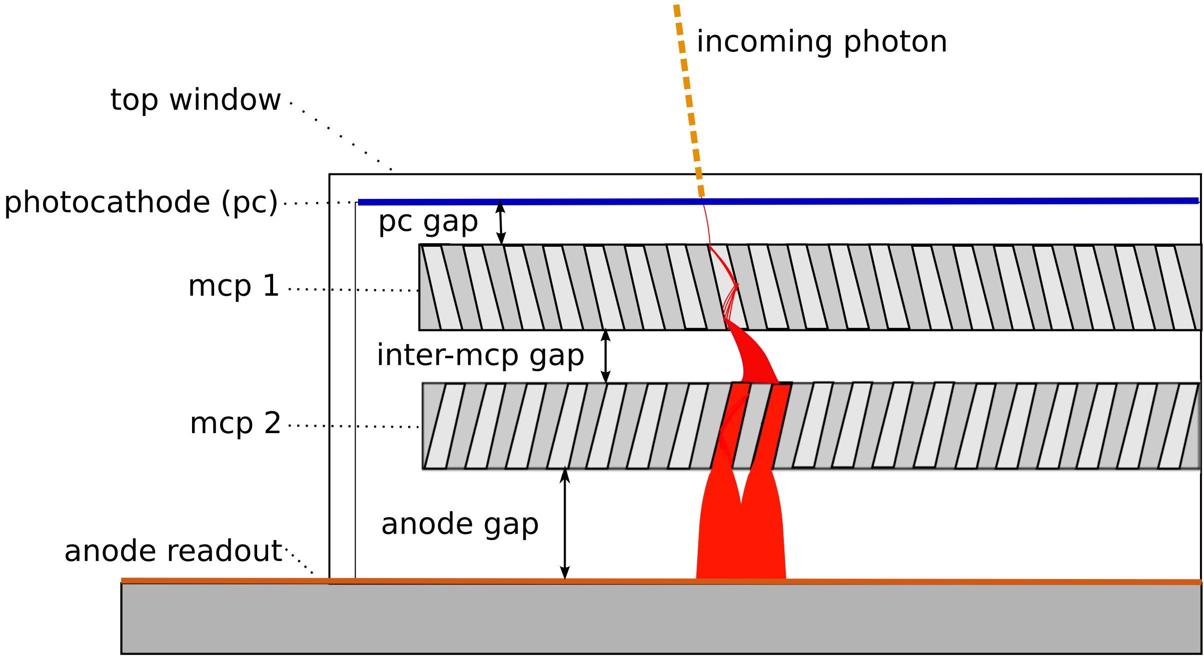

(CUTAWAY VIEW)
HV
SEMICONDUCTING LAYER
ELECTRODING
PRIMARY RADIATION
SECONDARY ELECTRONS
GLASS CHANNEL WALL
OUTPUT ELECTRONS


Photomultiplier Tube
Incoming Photon
Window
Photo-cathode
Dynodes
Anode
Focusing Electrode
Voltage Dropping Resistors
Output Meter
Power Supply
Figure 1


path 1
path 2
z_1
z_2


Window
MCP
Spacer
Sidewall
Anode




incoming photon
top window
photocathode (pc)
pc gap
mcp 1
inter-mcp gap
mcp 2
anode gap
anode readout

2.2. Timing Detector Technology

Sebastian White. Arxiv 1409.1165v2

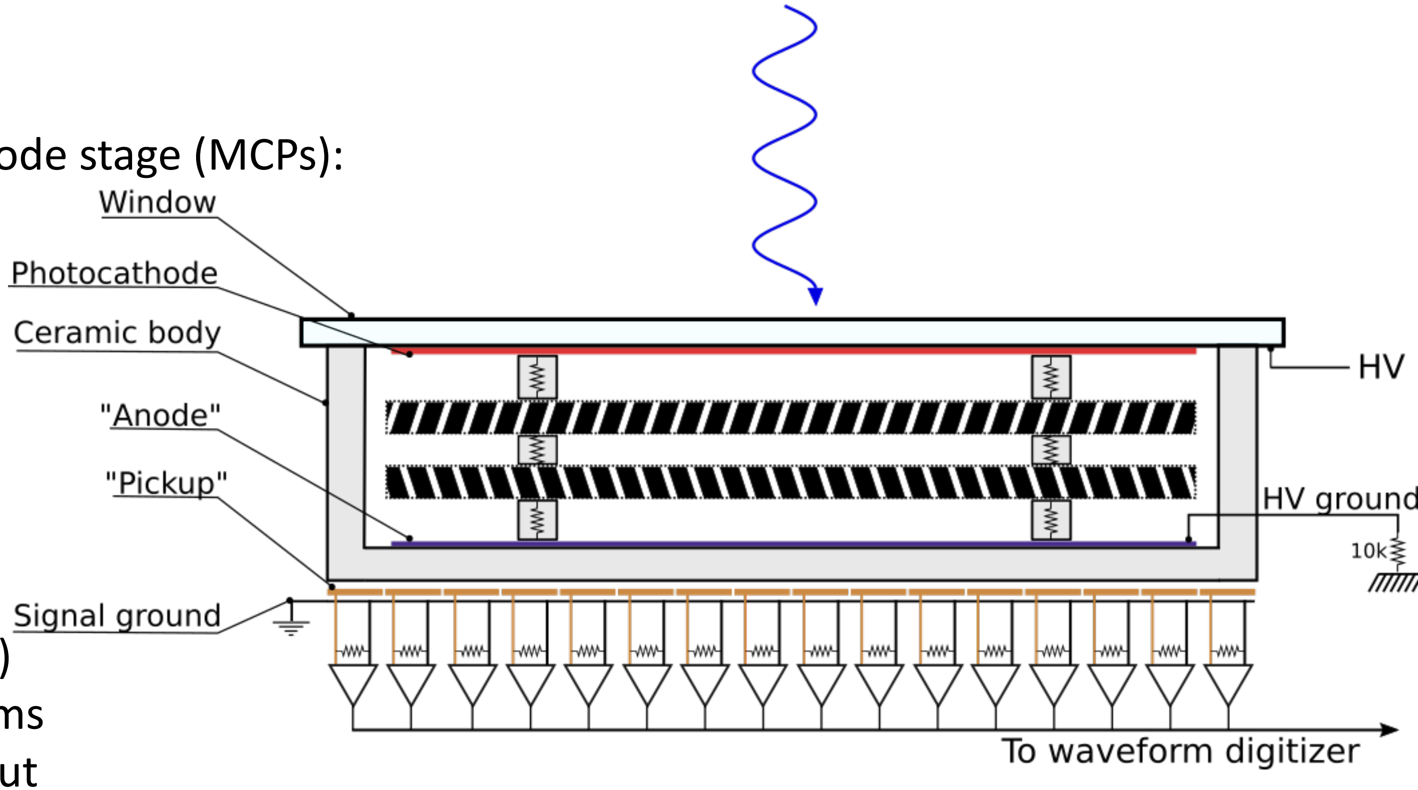
Not surprisingly, a survey of current and planned HEP experiments quickly shows that there are no existing detectors that simultaneously meet the time precision and rate capability requirement of the CMS end cap at HL-LHC.

This is a solvable problem, definitely on CEPC timescale

Rate limitations come from "voltage sagging" in the dynode stage (MCPs):

$$I_{tot} = I_{DC} + \tilde{I}_{\gamma}$$

$$V = IR$$



Solutions:

- Use external HV divider with zeners and caps
- Operate in low gain mode (low current in the shower)
- With both of the above points, O.H.W. Siegmund claims as been able to achieve ~100 MHz /cm^2 rates without amplitude degredation

The power issue:

Saturation condition: current of showers are 1% of DC current

$$\frac{I_{DC}}{100} = N\delta t I_\gamma$$

N = number of photons (or particles) hitting the LAPPD per second

= we should determine this for CEPC?

For atlas, I found a weak source suggesting

that this is about 1e17 per LAPPD per second

https://cds.cern.ch/record/1601801/files/ATL-INDET-SLIDE-2013-630.pdf

$$P = I_{DC}V + N\delta t I_\gamma V$$
$$= 101 I_\gamma N \delta t V$$

Gain of 10^7

$$I_\gamma = 1 \times 10^{-6}$$
$$N = 1 \times 10^{17}$$
$$\delta t = 0.5 \times 10^{-9}$$
$$V = 2000$$

→ P ~ 20MW

Gain of 10^5

$$I_\gamma = 1 \times 10^{-8}$$

→ P ~ 200kW