Pixellated Picosecond Photomultipliers

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Current Devices - 1

- Hybrid Silicon Devices
- Advantages:
  - Excellent energy resolution
  - Large number of pixels
- Disadvantages:
  - Silicon is slow

Current Devices - 2

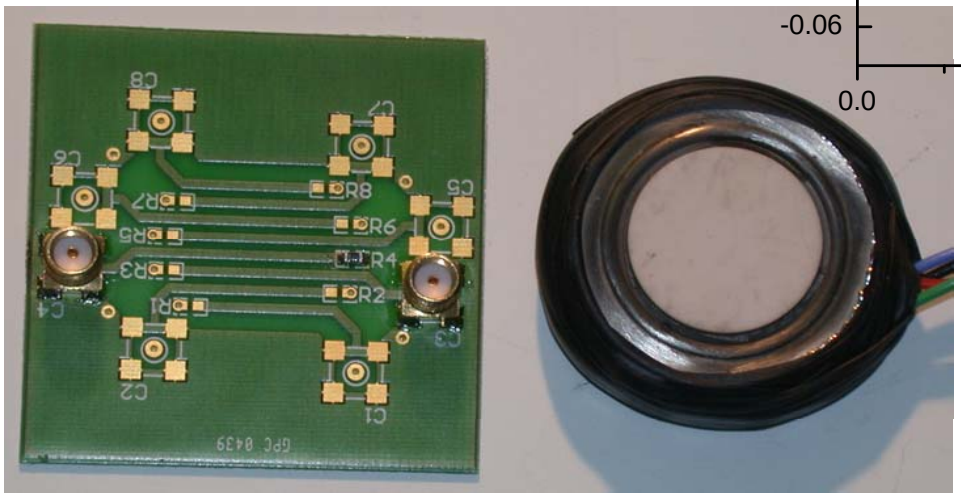
- Mesh Dynode Photomultipliers
- E.g. Hamamatsu R2486
- 16 × 16 crossed wire anode
- Fill factor 55%
- Counting efficiency ?
- Time response: 5.5 ns rise time

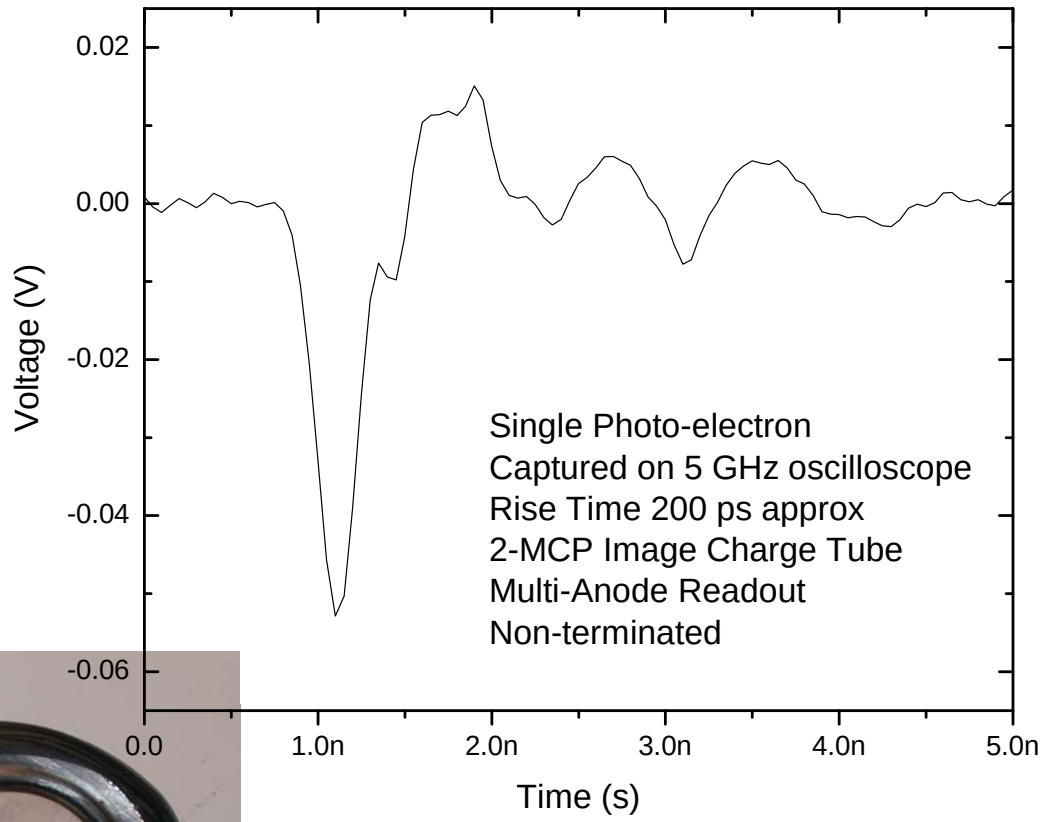
MCP Pore Size / Plate Size

MCP Diameter	Pore Diameter	Rise Time – 2 MCPs
18 mm	3 μm	80 ps
25 mm	6 μm	125 ps
40 mm	6 μm	125 ps
75 mm	10 μm	200 ps
Larger	25 μm	600 ps ?

Readout - 1

- Image Charge:
- Resistive layer localises charge
- Signal is a.c. coupled to external anode
- 50 Ω strip multi-anode option

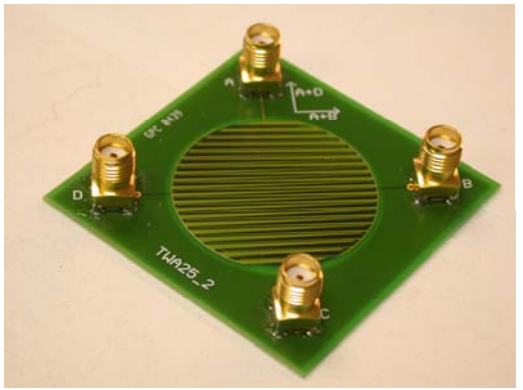


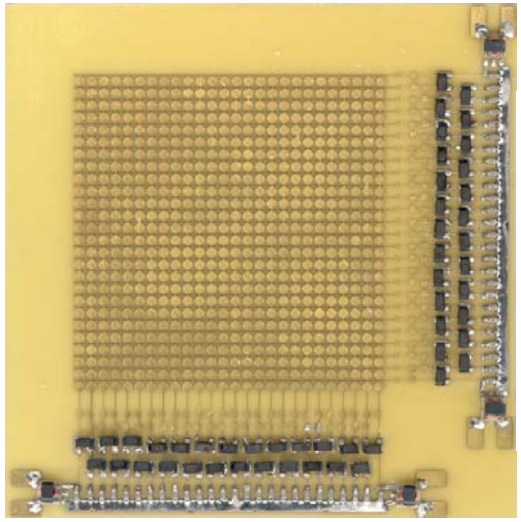


Readout - 2

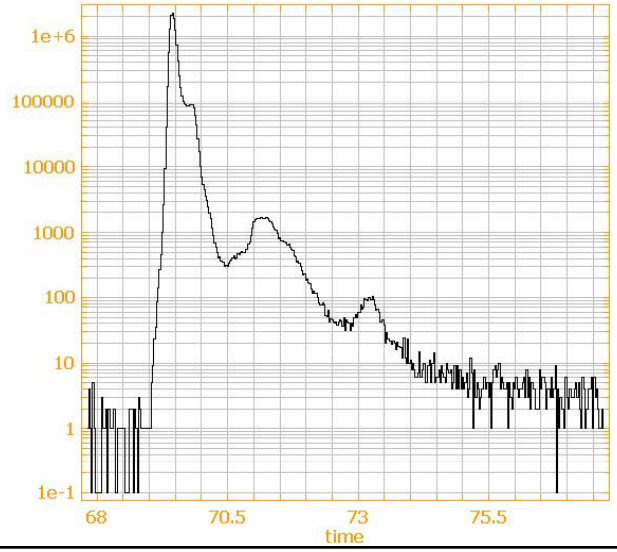
- Image Charge also works for photon counting imaging
- Wedge & Strip anode achieves < 50 μm FWHM position resolution
- Delay Line anode achieves 100 μm FWHM and 110 ps FWHM photon jitter accuracy

Wedge & Strip





Delay Line



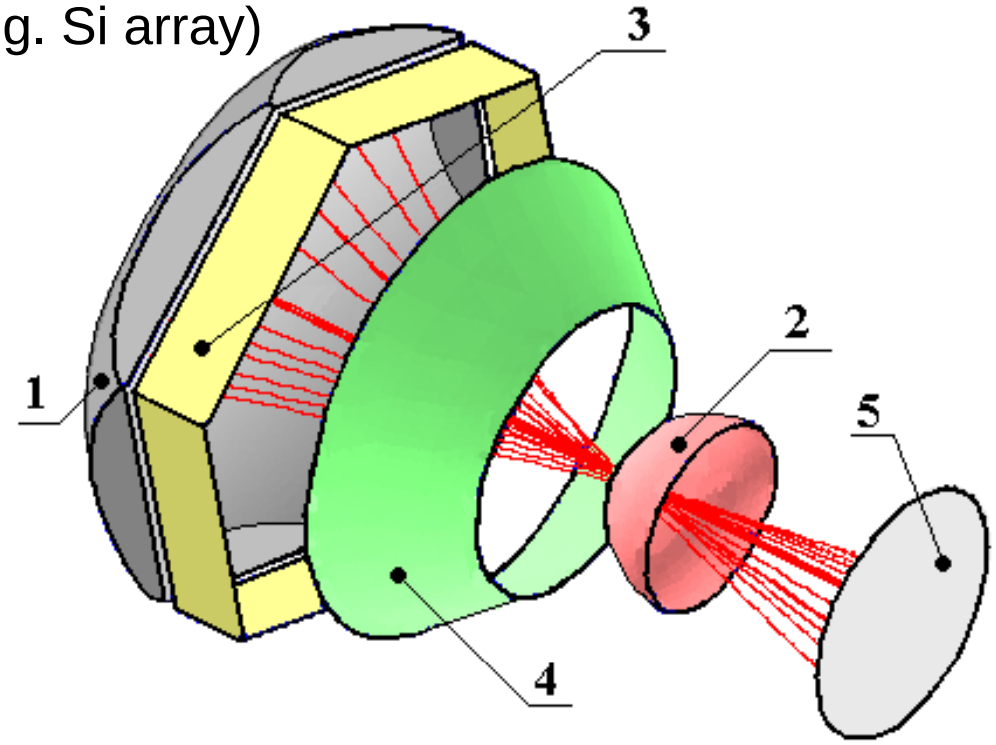
Increased Scale

- Electrostatic Input
- Magnetic Effects
- Fibre-optic taper or lens gives loss of signal
- Tube designs are usually round
- Photek designed hexagonal imaging tube for OWL

OWL Tube Design - 1

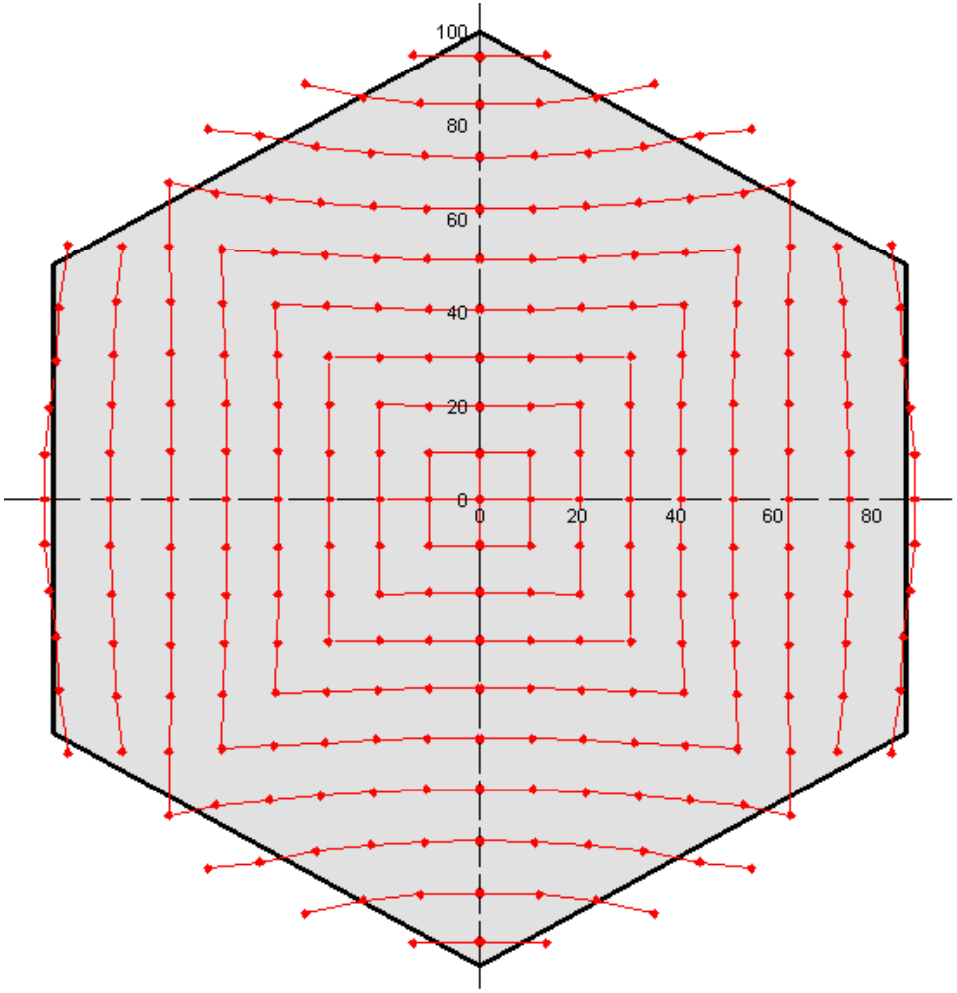
OWL Tube Design - 2

- 1 – Photocathode
- 2 – Anode with round aperture
- 3,4 – Focusing electrodes
- 5 – Electron image plane (e.g. Si array)



OWL Tube Design - 3

- Spatial distortion pattern
- The lines show the images (reduced to the photocathode) of a set of embedded squares

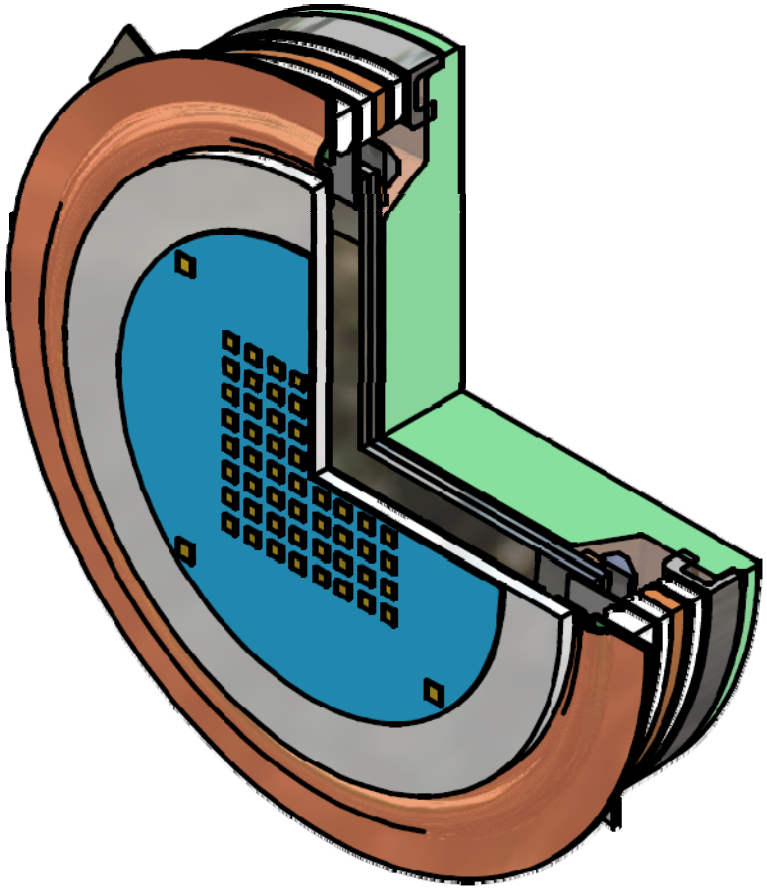


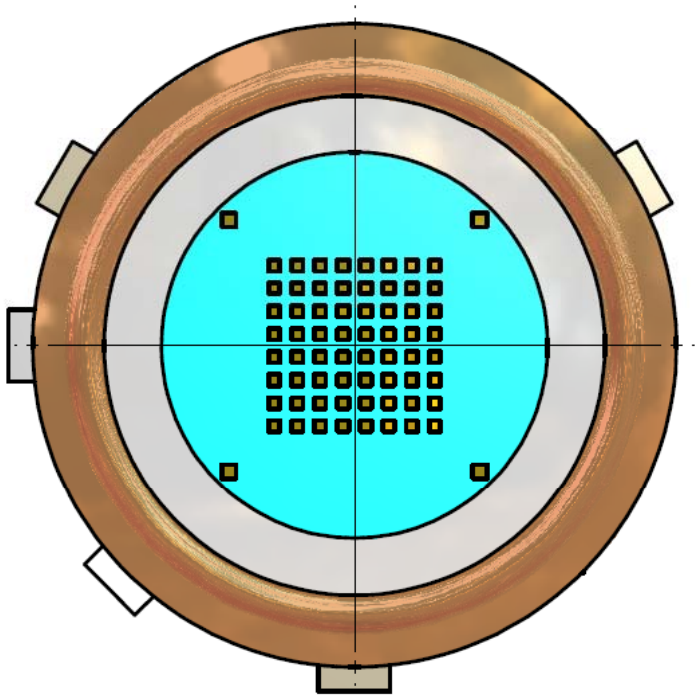
Parameter	Tube (A) Toshiba	Tube (B) Hamamatsu	Tube (C) CERN Cross Over	Tube (D) CERN Fountain	Photek Ltd. Hexagonal Design
External Diameter, mm	500	420	500	254	200 (172 across the flats)
Active Diameter, mm	400	400	260	228	190
Fill Factor for tiled mosaic arrays	50%	67%	33%	62%	96%
Internal Length, mm	690	625	347	346	290
Magnification	0.18	0.17	0.1	0.15	0.3
Pixel Size µm	330	330	250	4000	560
Temporal Resolution Spread Centre-Edge	6.0 ns	0.38 ns	2.4 ns	0.28 ns	3.0 ns
Field at Photocathode, V/mm	1.2	2.8	1.7	24.6	7
External magnetic fields sensitivity	Yes	Yes	Yes	No	No
Image Distortion	1.2%	6%	7%	59%	14%

Future – Hi Content

- “A Scaled-up High Content Photon-Counting Detector for Life Science Applications”
- Three year STFC PIPSS project
- Leicester Uni, CERN, Photek, Manchester Uni, GCI
- Spin out technologies from Space and Particle Physics
- MCP detector design, image readouts, multi-channel ASIC electronics
- Applications requiring:
  - Photon counting
  - Picosecond event timing
  - Parallel multi-channel acquisition
  - High throughput

Hi Content Tube Design





Hi Content Detector Specifications

- Detector format: 25 mm and 40 mm diameter
- Multi-channel parallel event acquisition
  - Up to 1024 channels – using CERN NINO ASIC
  - Discrete pixel format: 8 × 8, 16× 16, up to 32 × 32
- High event time resolution
  - Small pore MCPs – 80 ps pulse rise time
  - 20 ps goal using CERN HPTDC ASIC
- Counting rates
  - Maximum event rate/ch - 10 Mcounts/sec
  - ~100 Mcount/s total (MCP limited)
- Highly flexible and economic
  - Channel grouping for simultaneous acquisition
  - <1% of the cost per channel c.f. current devices

Thank you for listening