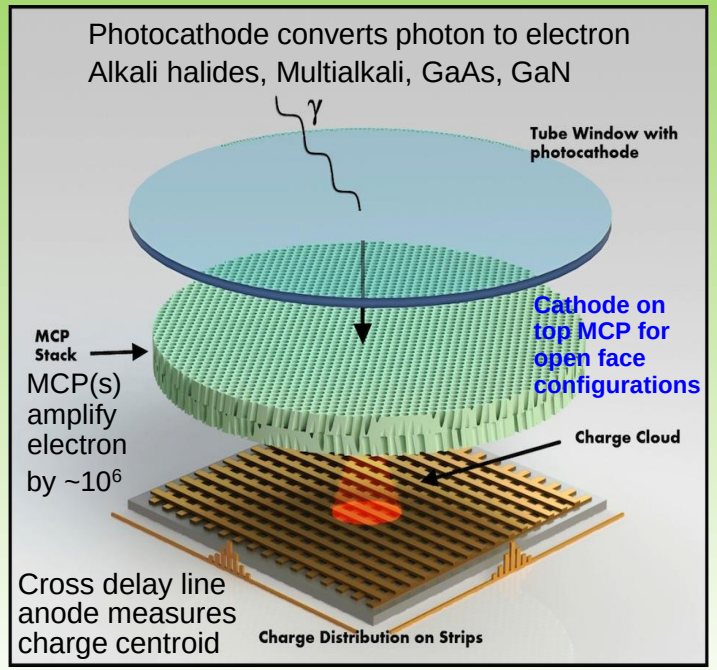
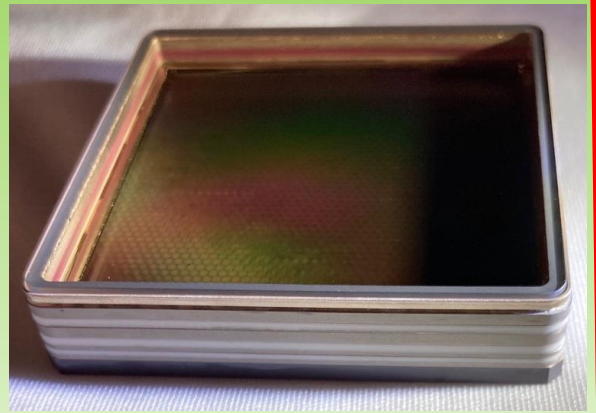
Advances in UV Imaging Microchannel Plate Detectors for Future Missions

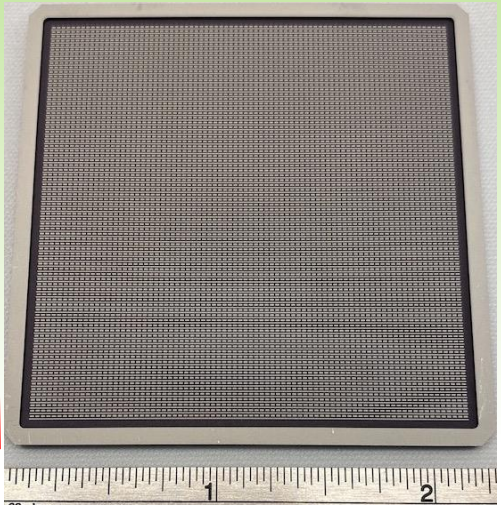
O.H.W. Siegmund, J.B. McPhate, J.V. Vallerga. Space Sciences Laboratory, University of California, Berkeley





First 50 mm Photonis Planacon sealed tube with a pair of 10 μm pore ALD borosilicate substrate 60:1 MCPs and a bialkali photocathode deposited onto a plano sapphire window. A cross strip readout forms the base of the Planacon, providing high spatial resolution imaging.

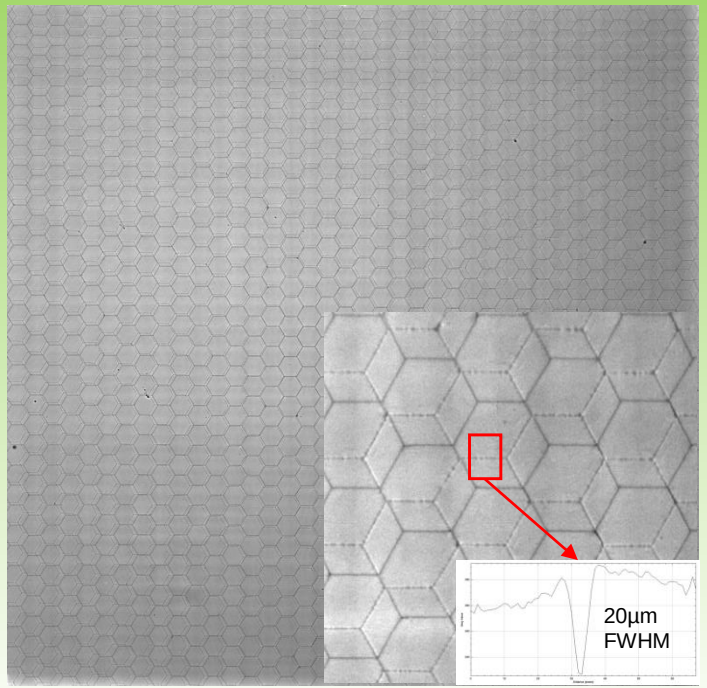
XS anodes have high spatial resolution at relatively low MCP gain. A multilayer ceramic 50mm XS anode has coplanar charge collection strips in one axis and interposing charge collection pads connected together by subsurface vias for the orthogonal axis.



Recent missions, HST-COS, GALEX, ICON, GOLD, JUNO, LRO-LAMP, Pluto-ALICE, CHESS, FORTIS, SISTINE, JUICE, ICON, GOLD, EMM-EMUS.

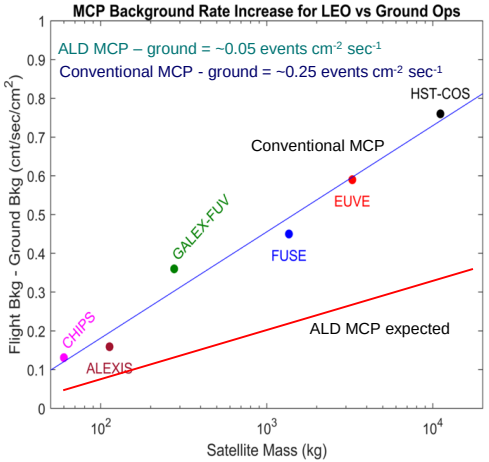
ALD MCP Detector Performance

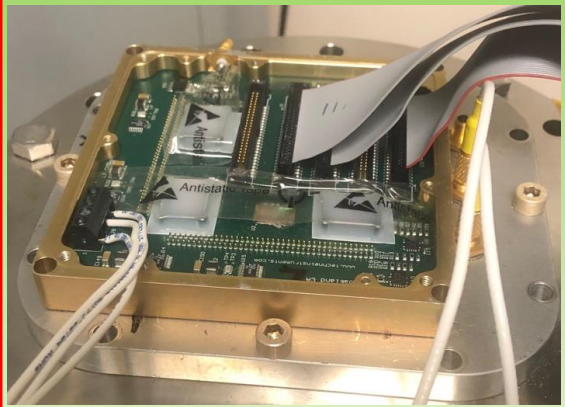
We have achieved significant progress in establishing MCP detectors up to >100mm (200mm max) with high spatial resolution, high QE, good stability & low background.



UV photon counting accumulated image. XS Planacon tube. 46 x 46 mm area. 10µm pore ALD MCP pair, 60:1 L/d,13° bias, MgO emissive layer. 25µm gap between the MCP pair. Gain ~ 2 x 10^6.

MCP detectors have been flown on various LEO missions by SSL – UC Berkeley for ~40 years. The background rate increase in orbit is very consistent with log of the satellite mass. This suggests that much of the background is conversion Bremsstrahlung X-Rays. ALD low efficiency gamma ray MCPs will reduce background 2.5x.





The GRAPH Custom ASIC implements a charge sensitive amplifier (CSA) and fast ADC into single 16 channel device. ~7.4W for 50mm Planacon.

Digital stream piped to separate FPGA board for event processing.

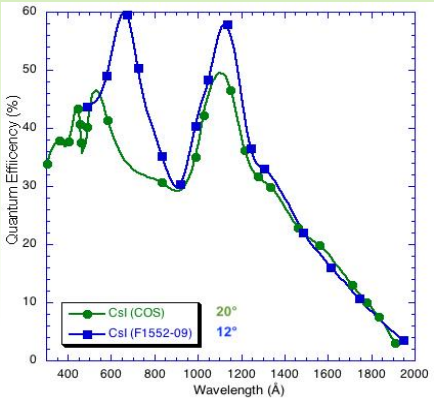
160ns CSA return to baseline allows ~10% deadtime at 6MHz event rate.

In initial testing, shows good linearity and high SNR capability.

Atomic Layer Deposited Microchannel Plate Detectors with Cross Strip Readouts

ALD MCP's

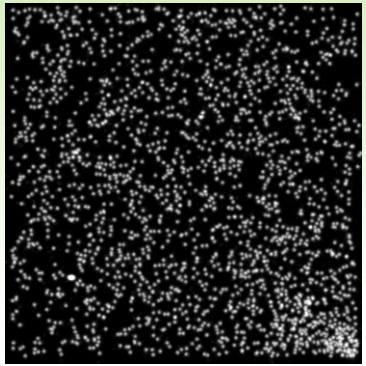
200mm 20μm pore devices flown
100mm 10μm pore devices demonstrated
Cylindrical curvature demonstrated
>50% QE CsI demonstrated on ALD MCPs
<25% hexagonal modulation attained
>5 x 10^{13} events cm^{-2} lifetimes achieved
Background rates <0.06 $cm^{-2}s^{-1}$ attained
Achieved ≤0.8 % MeV gamma efficiency



UV QE for an opaque CsI cathode optimized MCP with 60% open area, 10 μm pores, 40:1 l/d, 12° bias, compared with the opaque CsI coated MCPs (12μm pores, 19° bias) used for the HST-COS instrument.

Cross Strip Anodes and Electronics

Open face 50mm & 100mm XS formats commissioned
50mm Planacon sealed tube XS demonstrated.
Spatial resolution of ~20μm FWHM shown in all formats
Standard PXS-II electronics achieves ~5 MHz rates
GRAPH 16 channel ASIC operational
GRAPH achieves 46 mW/channel, ~7W 50mm sensor
GRAPH noise measurement is close to PXS-II
GRAPH power test indicates 7.4 W for a 50 mm XS



Background event image for a pair of 54mm, 10μm pore ALD MCPs with MgO emissive layers, 60:1 l/d, 13° bias. Event rate 0.06 counts cm^{-2} sec^{-1}(~2.4 x 10^{-7} counts $resel^{-1}$ sec^{-1}). Overall background ~5x better than standard glass MCPs (less K^{40} beta decay).