The current and future capabilities of MCP based UV detectors

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200+ Detector Years in Orbit!

Mission	# of Detectors	Years
EUVE	7	8.3
ALEXIS	6	12
SUMER (SOHO)	2	4
UVCS (SOHO)	2	11.5+
FUSE	2	7.9+
IMAGE	2	5.7
ALICE (Rosetta)	1	4.1+
GALEX	2	4.1+
ALICE (New Horizons to Pluto)	1	1.3+
COS (Hubble)	1	0 (Sept 08)

+ still operating

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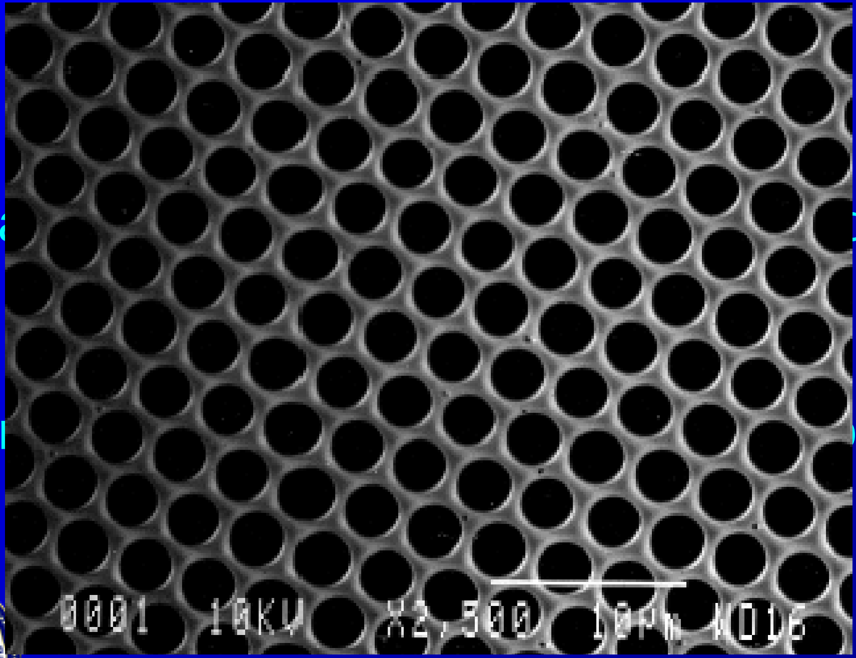
Imaging, Photon Counting Detectors

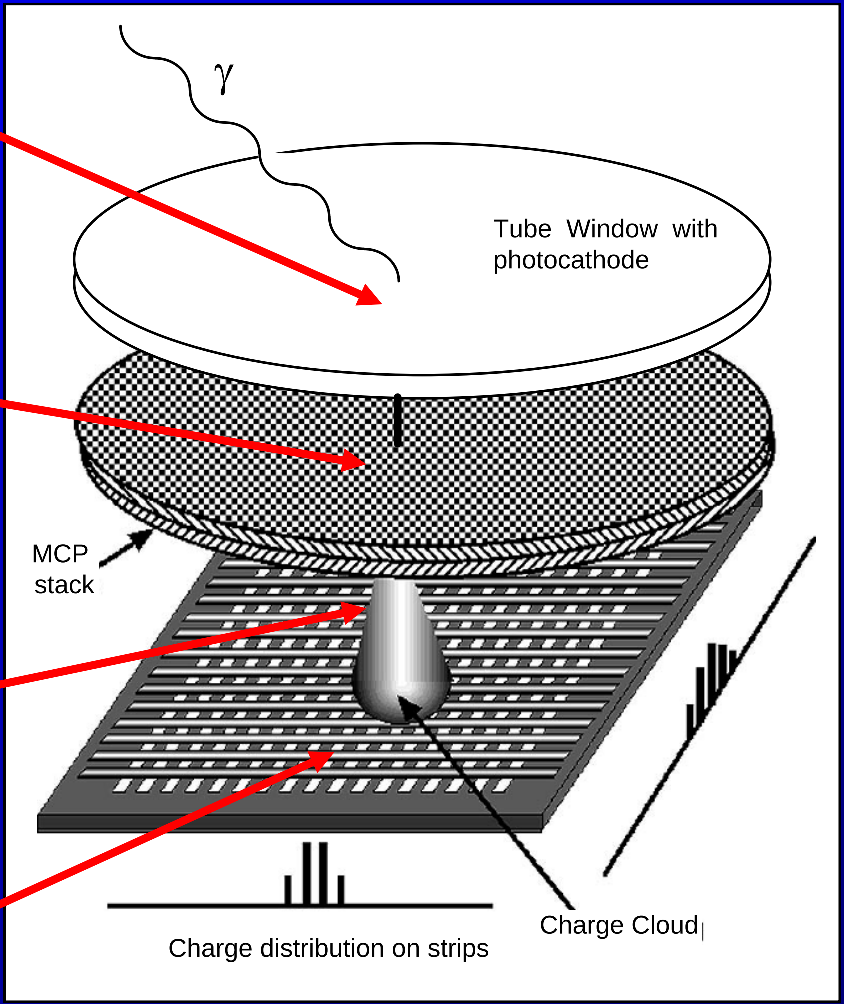
Photocathode converts photon to electron

MCP(s) amplify electron by 10^4 to 10^8

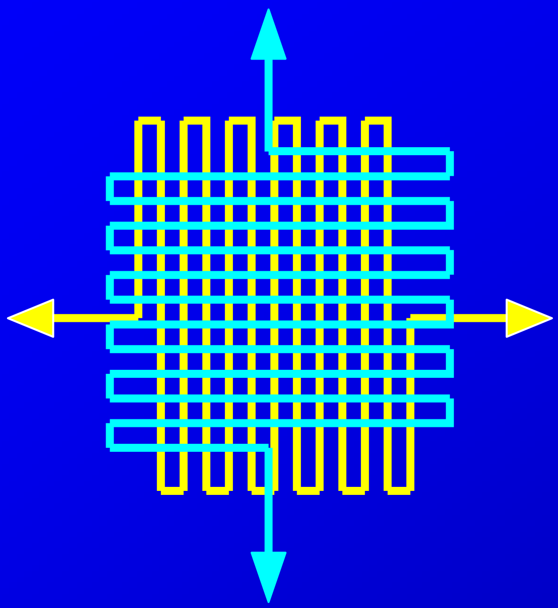
Rea… …de

Patter… …id

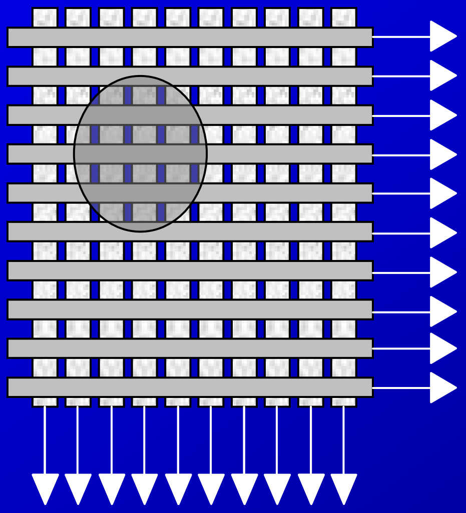




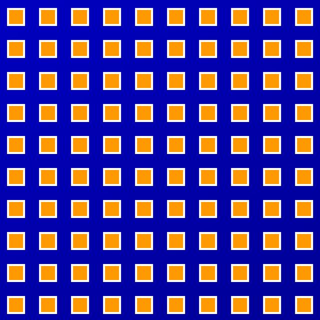
Anode Types



Cross Delayline
(XDL)



Cross Strip
(XS)

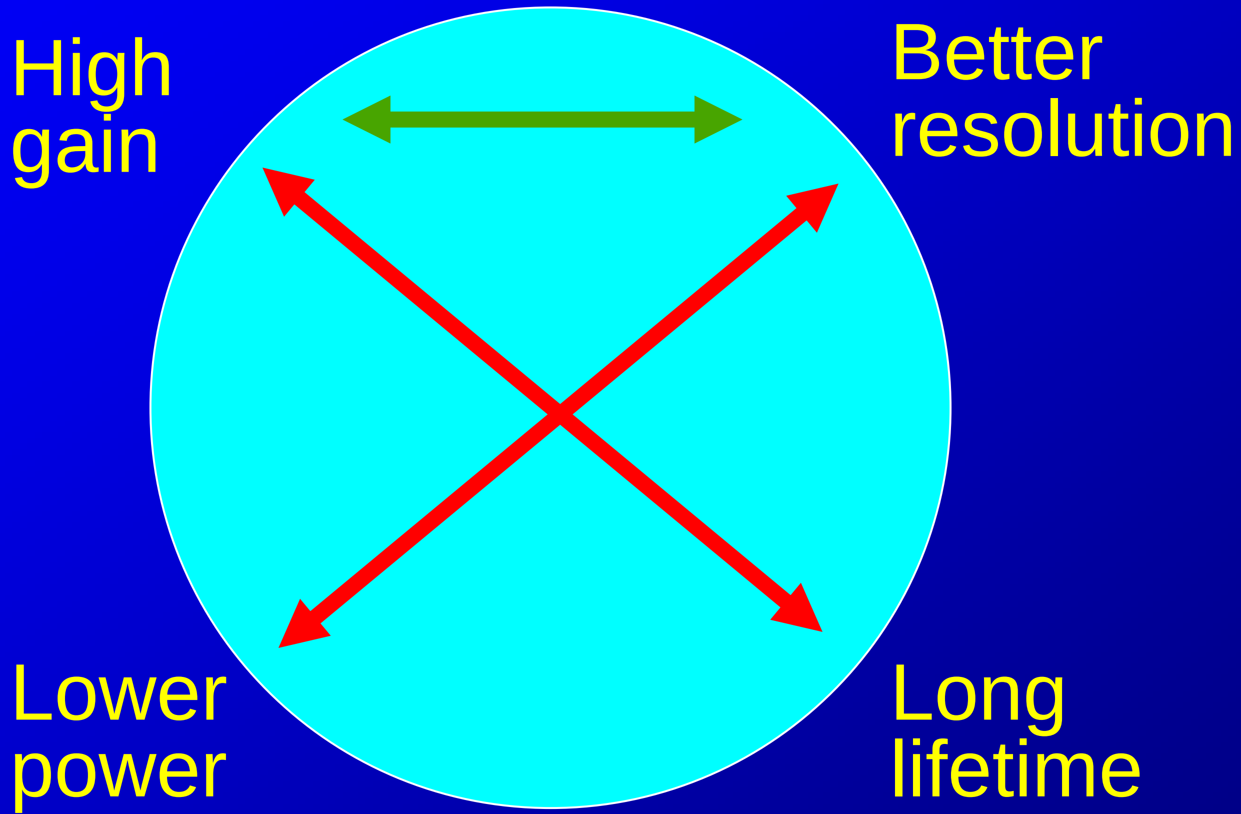


Medipix ASIC
Intensified CCD

Design/Performance Flexibility

Input aperture	Window/door
Photocathode (QE, bandpass)	KBr - CsI - CsTe - GaN (xray to optical)
MCPs (format, resolution)	d < 160mm, r > 7cm, pore spacing > 3µm
Anode (resolution, gain, rate)	Delayline (4 amps) Cross Strip (128 amps) Medipix ASIC (65k amps)

Tradeoff example (XDL)



Case study of two UV spectrometer detectors

Cosmic Origins Spectrograph

"Hubble class" instrument

Large, reliable, stable, well calibrated and tested.

Extreme QA

ALICE on New Horizons

Pluto mission

Low power, mass, telemetry

"Moderate" resolution, calibration, testing, QA

Case study of two UV spectrometer detectors (cont.)

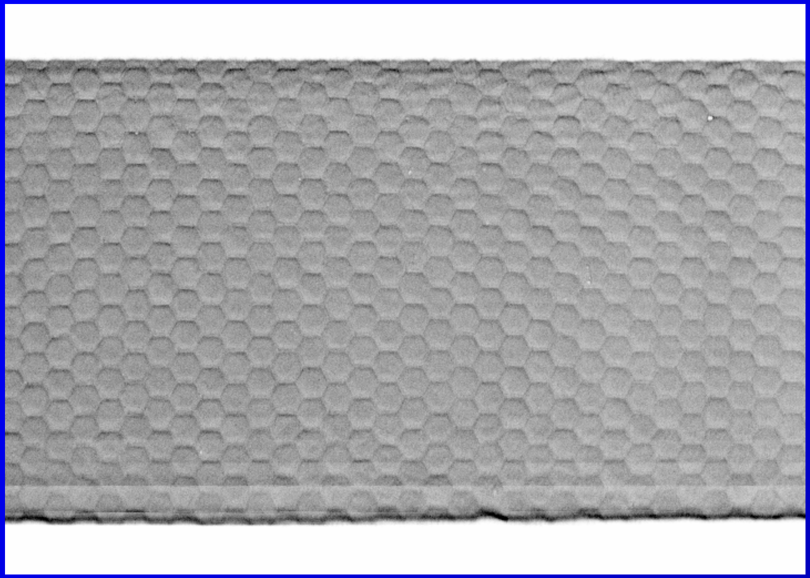
Parameter	COS	ALICE
Size (mm)	178 x 10	38 x 20
Format (pxls)	32768 x 1024	1024 x 32
Resolution (µm)	25	80
Mass (kg)	33.4	0.66
Power (W)	37	1.1
Cost	$$$$$$$$$$	$

Both have: curved MCPs, vacuum doors, CsI photocathodes, 20 kHz ct rates (10% deadtime)

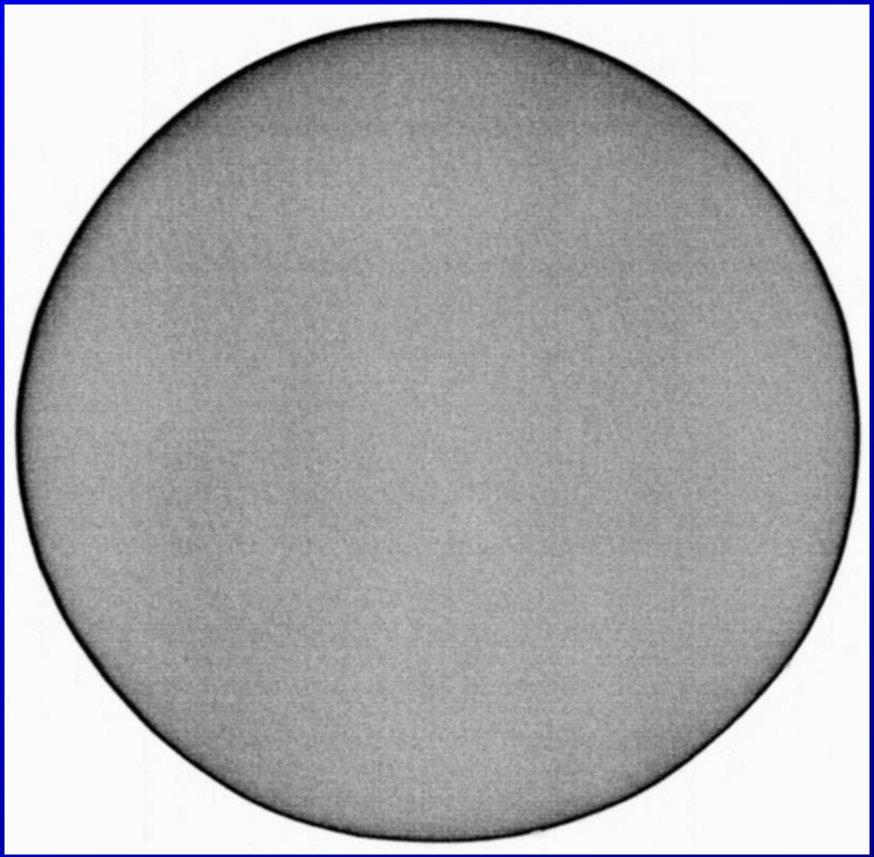
Improvements in MCP Detectors since COS

- MCP fixed pattern noise improved
- Electronics (Time to Digital Converters)
  - Faster (250 kHz at 10% deadtime)
  - FPGA logic
  - Lower power
- Readout technologies
  - Crossed Strip
  - Medipix and Timepix ASICs

MCP Fixed pattern noise

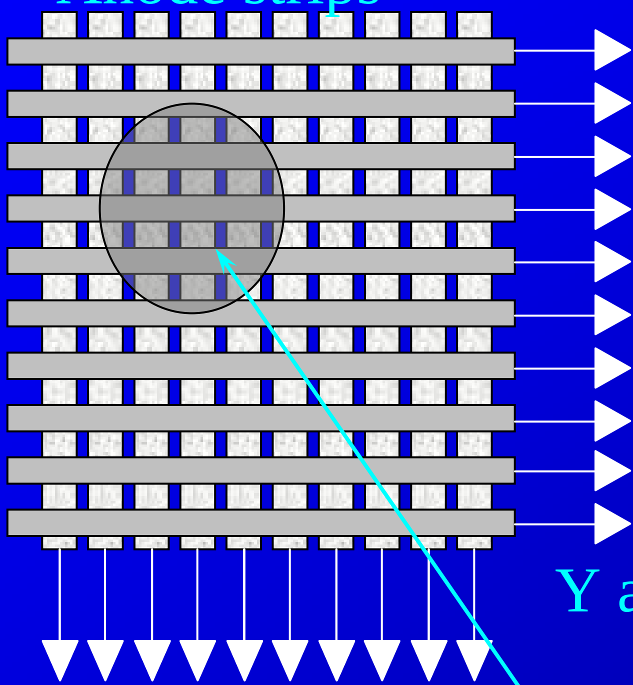


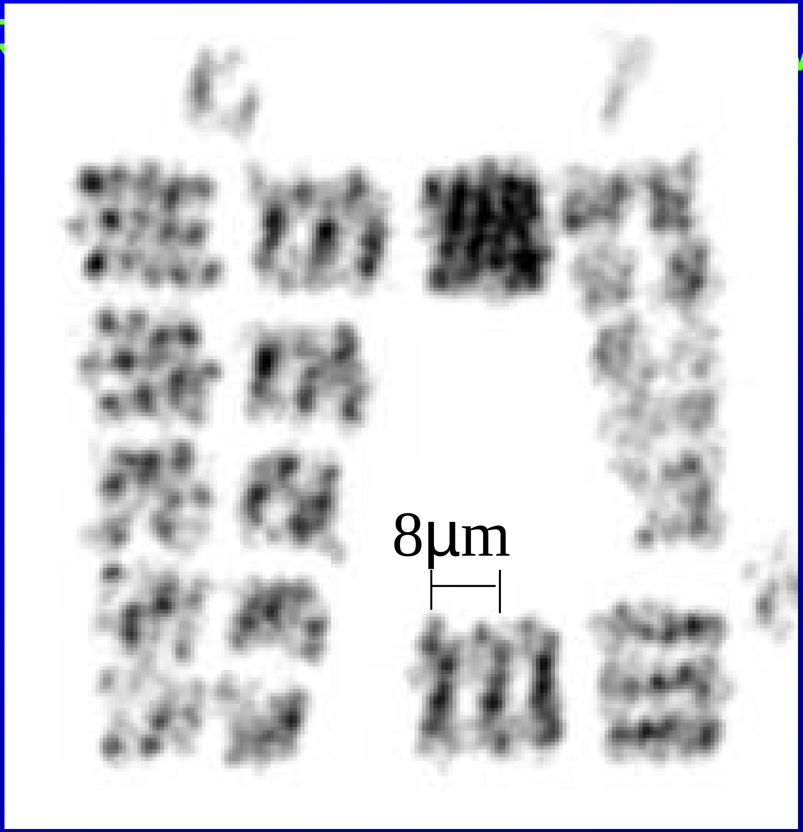
COS flat field
16 x 10 mm



Optical tube flat field
25 mm

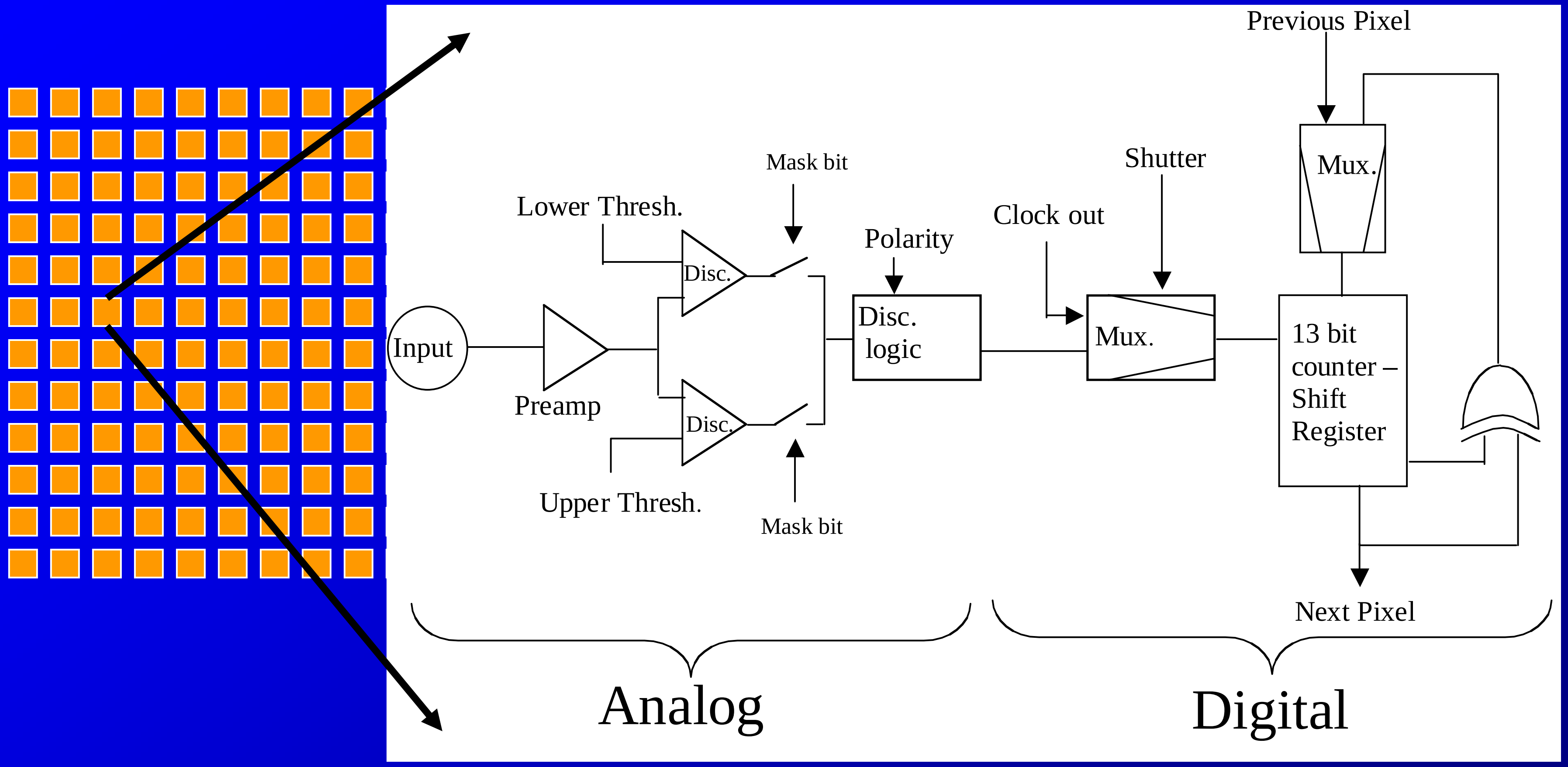
Cross Strip Anode





Resolution mask,
5 µm pores

Medipix/Timepix ASIC readout



- ~1 W watt/chip, abuttable
- Developed at CERN

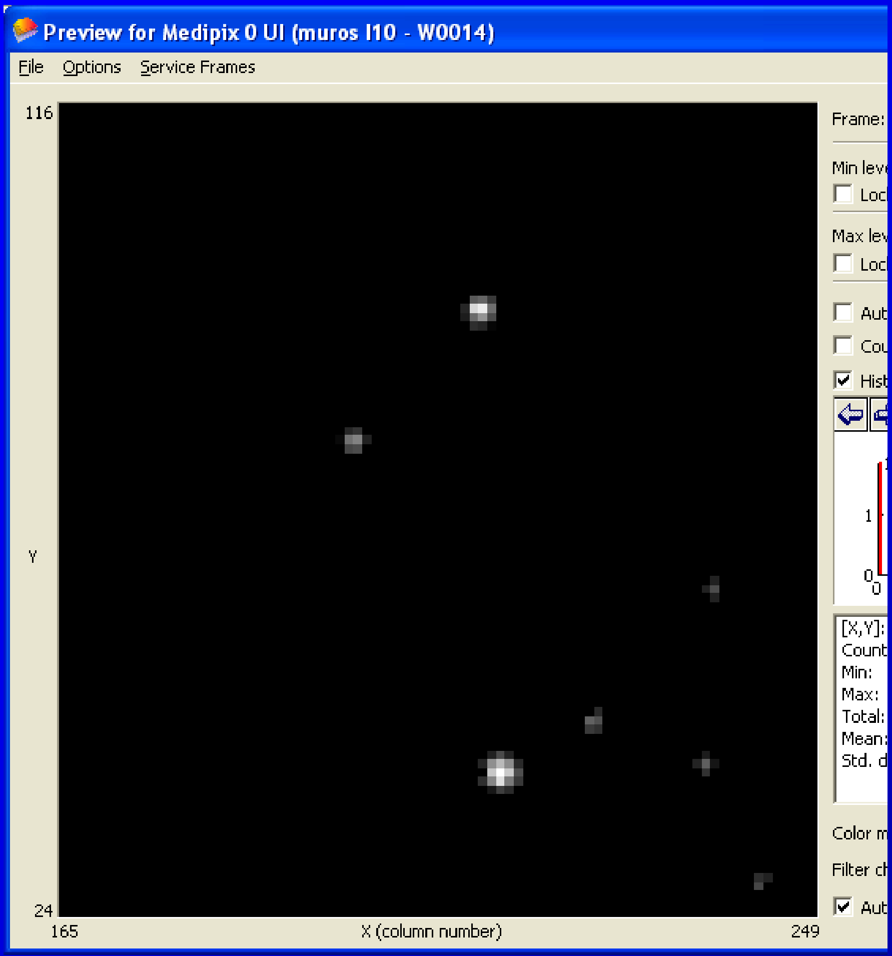
Original Medipix mode readout

256 x 256

(14 mm)

Zoom

Timepix version of Medipix



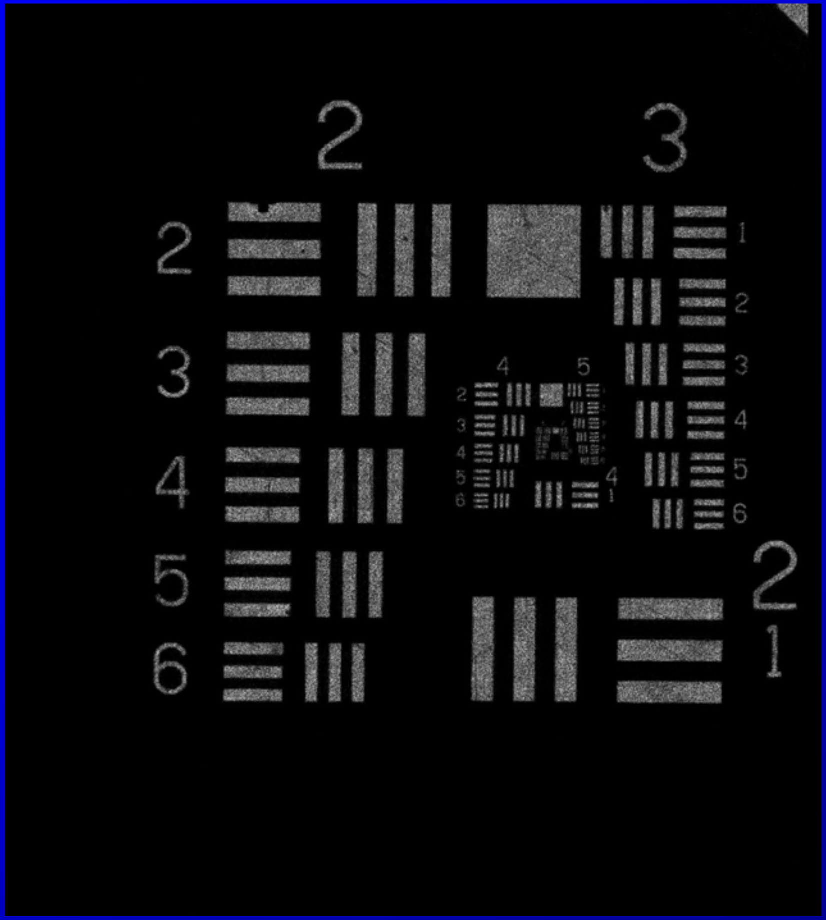
- Amplitude rather than counts using “time over threshold’ technique
- If charge clouds are large, can determine centroid to sub-pixel accuracy
- Tradeoff is count rate as event collisions in frame destroy centroid information

Single UV photon events

Factor of 8 improved resolution!

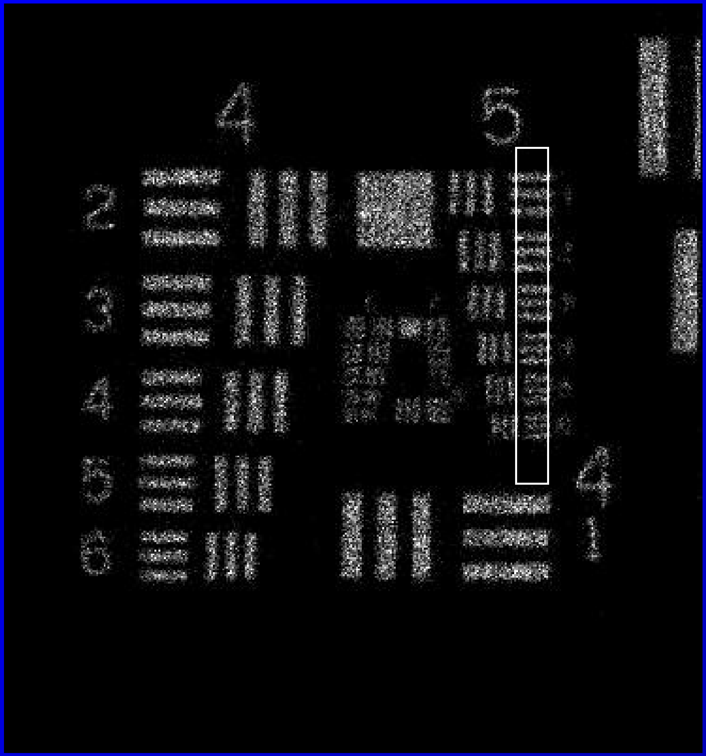
256 x 256 converted to 4096x4096 pixels (3.4µm pixels)

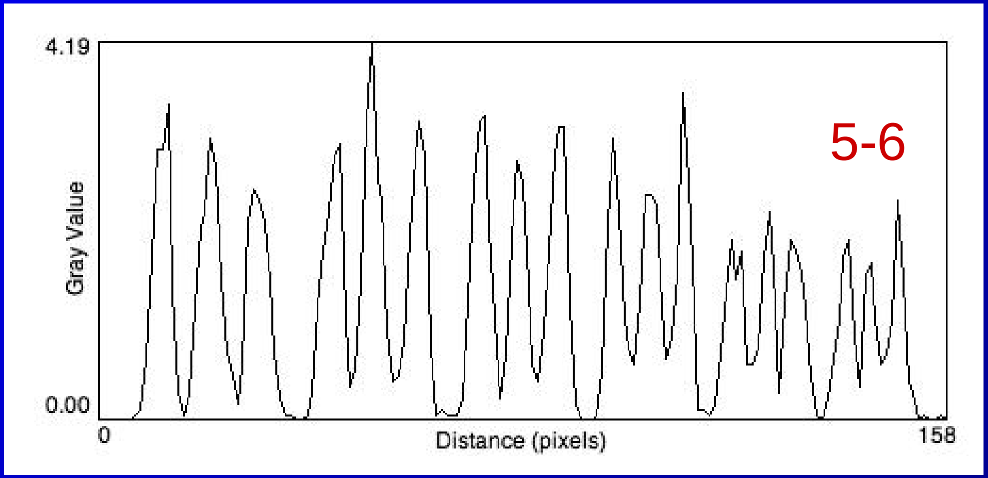
Factor of 8 improved resolution!



256 x 256 converted to 4096x4096 pixels (3.4µm pixels)

Zoomed





5-6 pattern resolved = 57 lp/mm
Linewidth = 8.8 µm

The MCP pore spacing of 8µm limits further improvement

Conclusions

- UV detector performance has improved substantially over the last decade
- We now have many tools to optimize detector to application/science goals
- There are still tradeoffs to be made
- Start early and build prototypes!

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