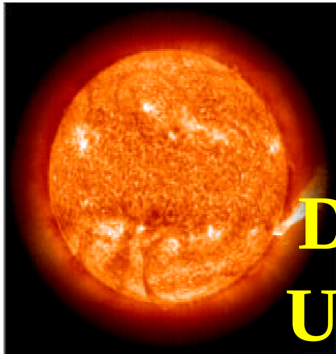

Development of imaging arrays for solar UV observations based on wide band-gap materials

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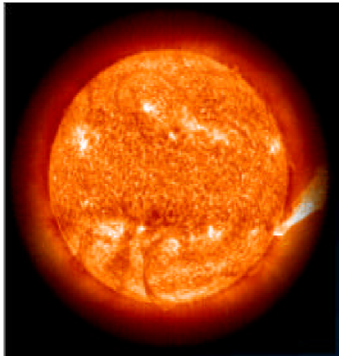
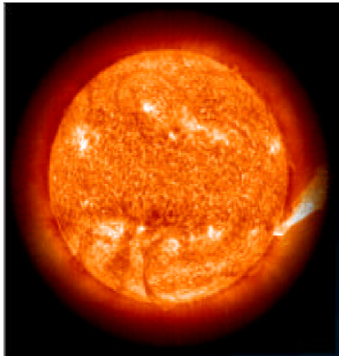


Outline of the talk

1. Introduction: Why new detectors?
2. Requirements for new detectors
3. Prospects towards new semiconductor devices
4. Prototype wide band-gab sensors: GaN, AlGaN devices
5. Efficiency measurements with new one-pixel devices



Conclusions of last years talk:

- SOHO UV instruments have been very stable due to the successful cleanliness program.

but

- SOHO UV detectors have been remarkably unstable.

Those were either channel plate devices, or (intensified) CCDs!

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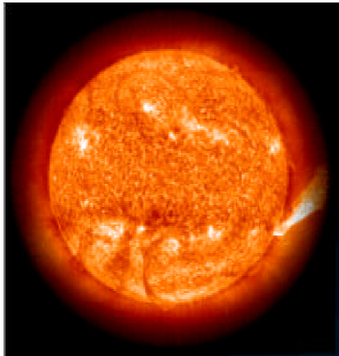
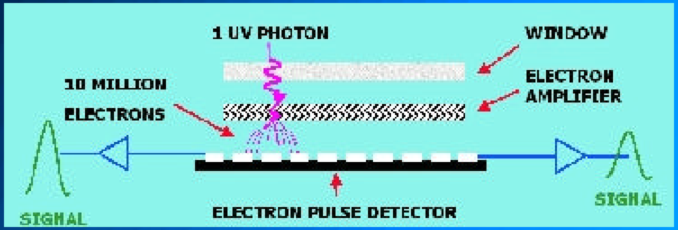
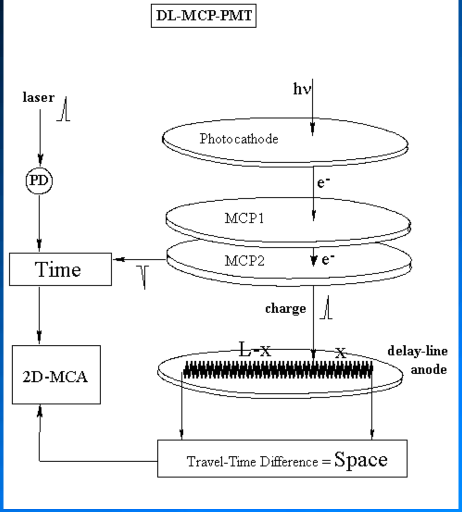
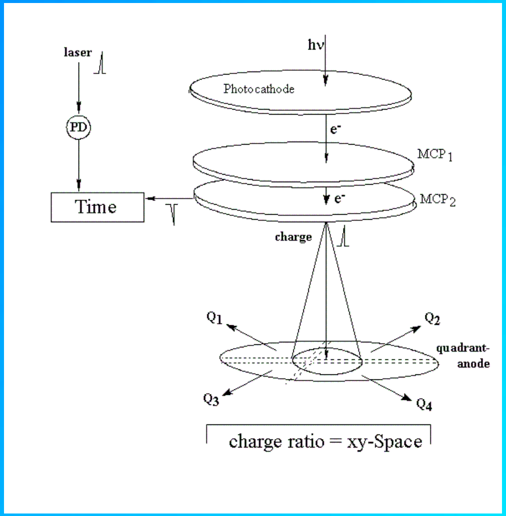
MCP detectors







Cross delay line anode + time to digital converter



Cross strip anode + charge ratio centroiding

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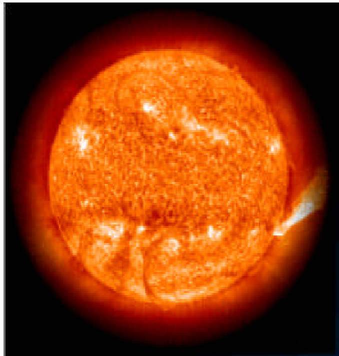
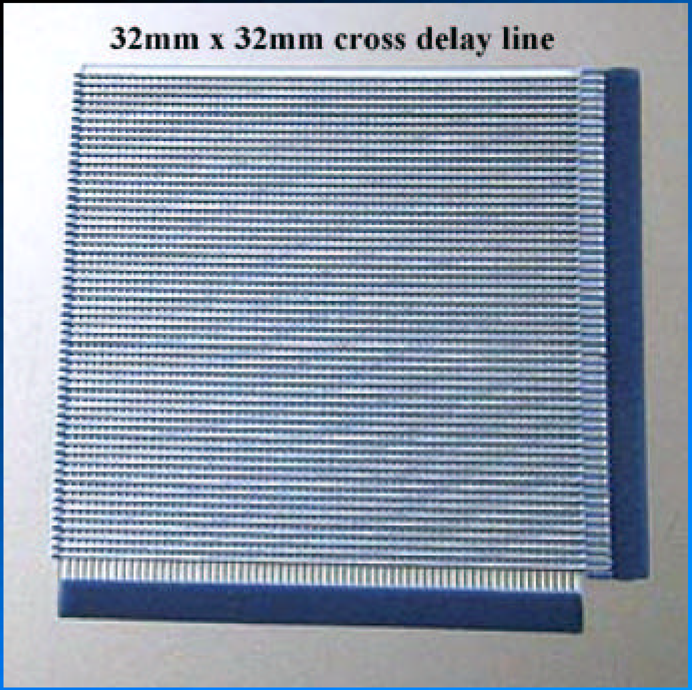
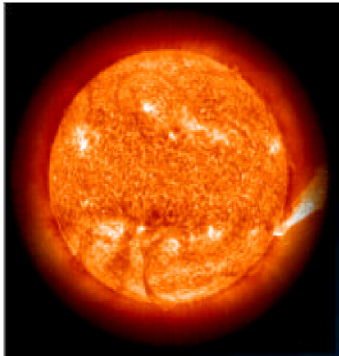


Anode design options



courtesy: O. Siegmund

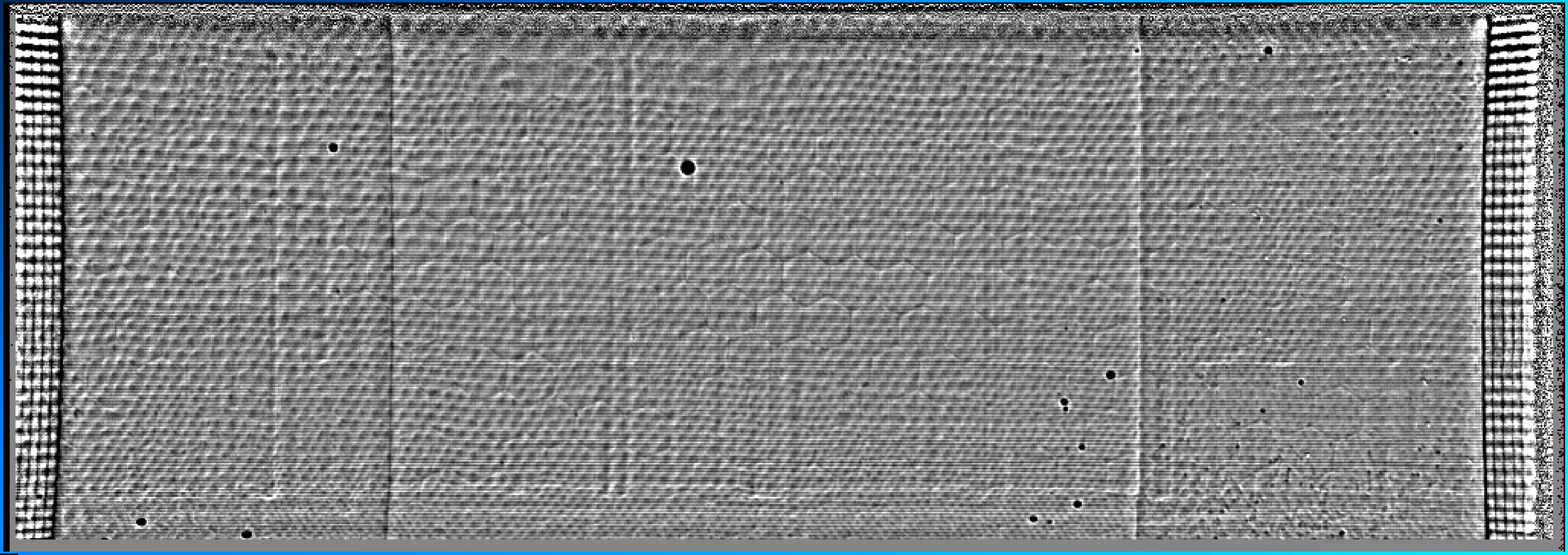
- Wedge and strip anode
- Cross Delay line anode
- Cross strip anode
- CCD



Example: flatfield of SUMER XDL detector

- Distortion
- ADC nonlinearity
- Multifiber bundles (hexagonal)
- Moire pattern (from 3 MCPs)
- Dead pores

Unstable due to scrubbing!



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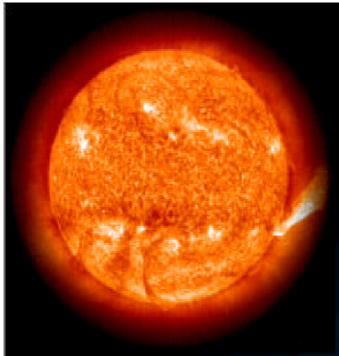
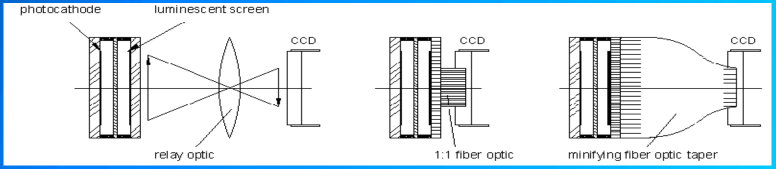
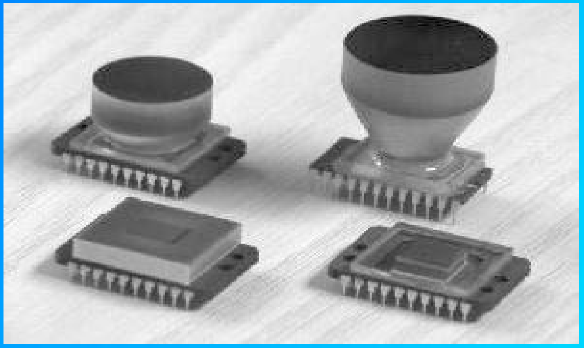


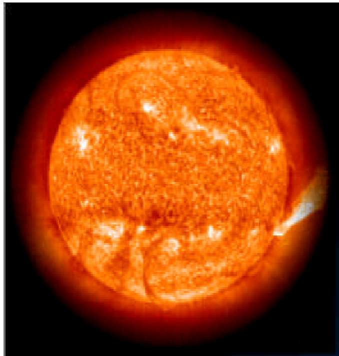
Intensified CCDs

MCP coupled to CCD via lens or fiber-optic taper



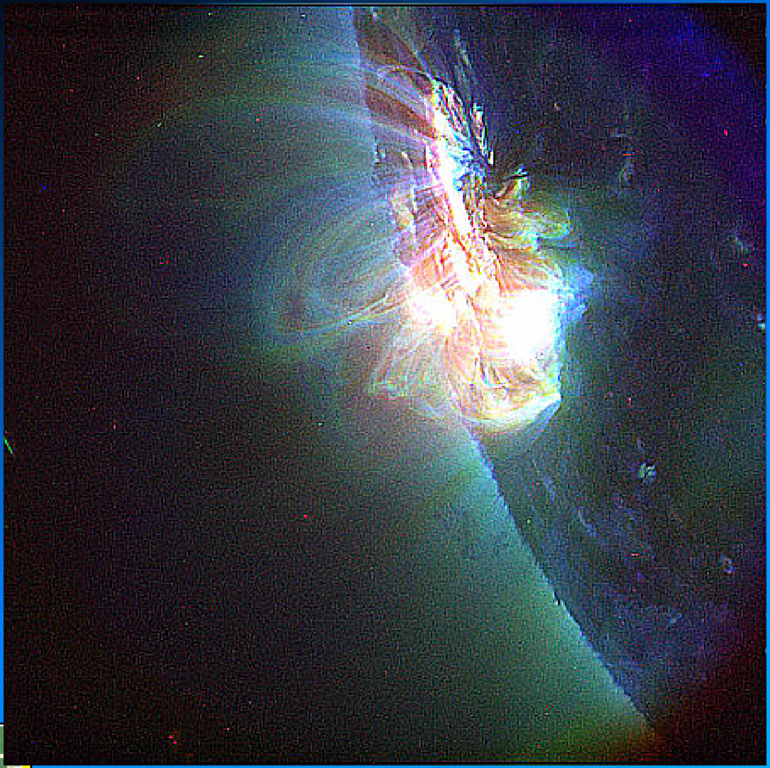
„Ultra Compact Design“

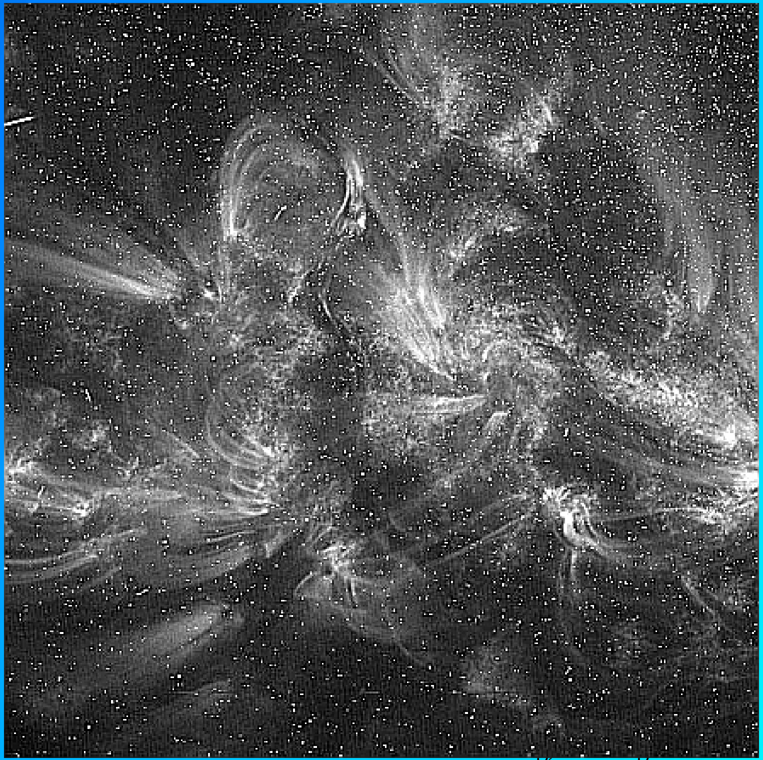


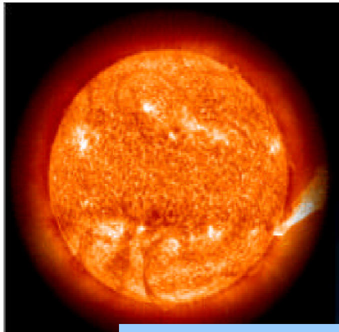


Quest for high resolution

0.5 arcsec
~ 350 km at Sun

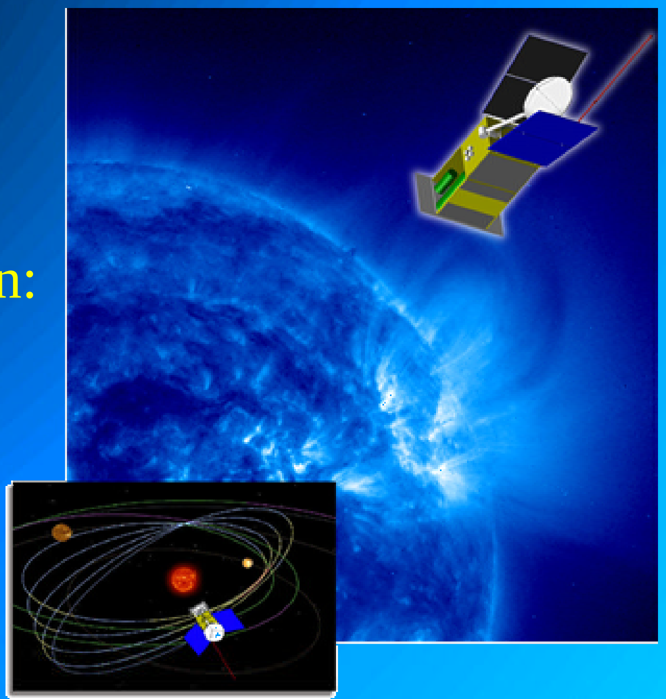




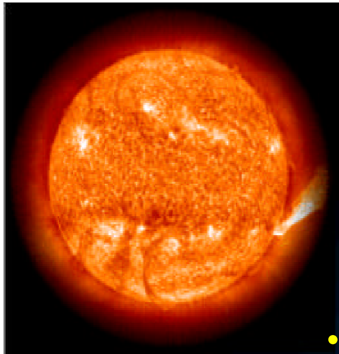


Solar Orbiter mission

High-resolution mission to the Sun and Inner Heliosphere



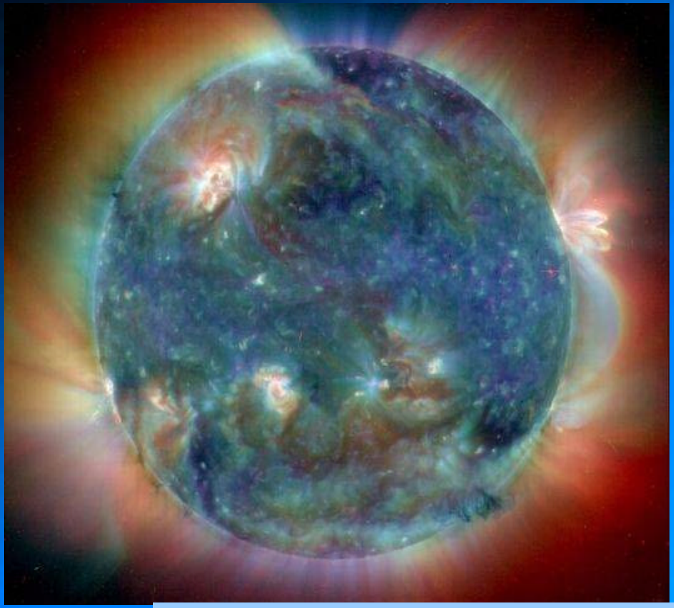
Payload instrumentation:
- o EUV spectrograph
- o EUV imagers
- o UV coronograph

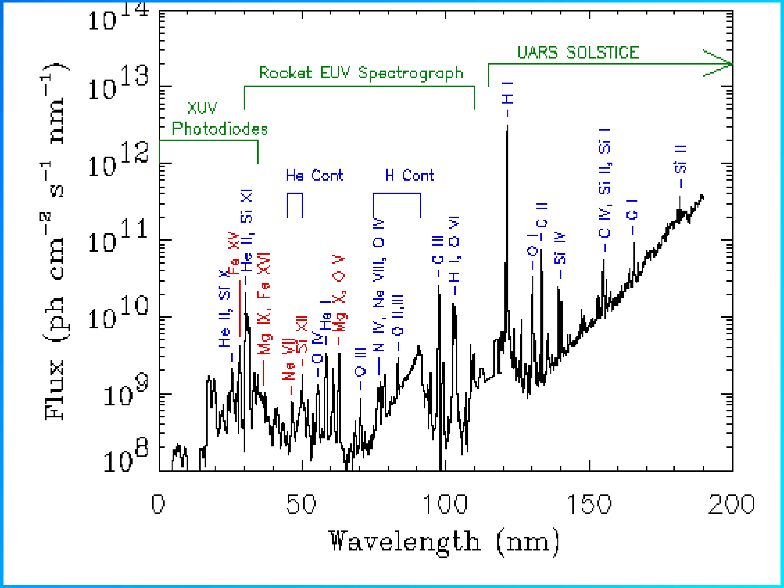


What are our goals?

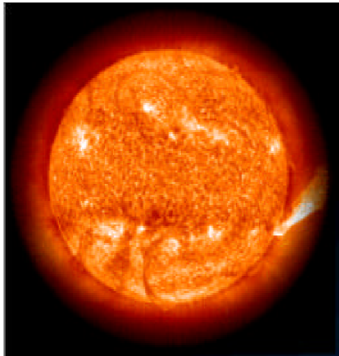
- large pixel array
- radiation hard
- smallest pixel size
- high count rate

- sensitive in a huge wavelength range
- solar blind
- stable calibration
- low dark noise

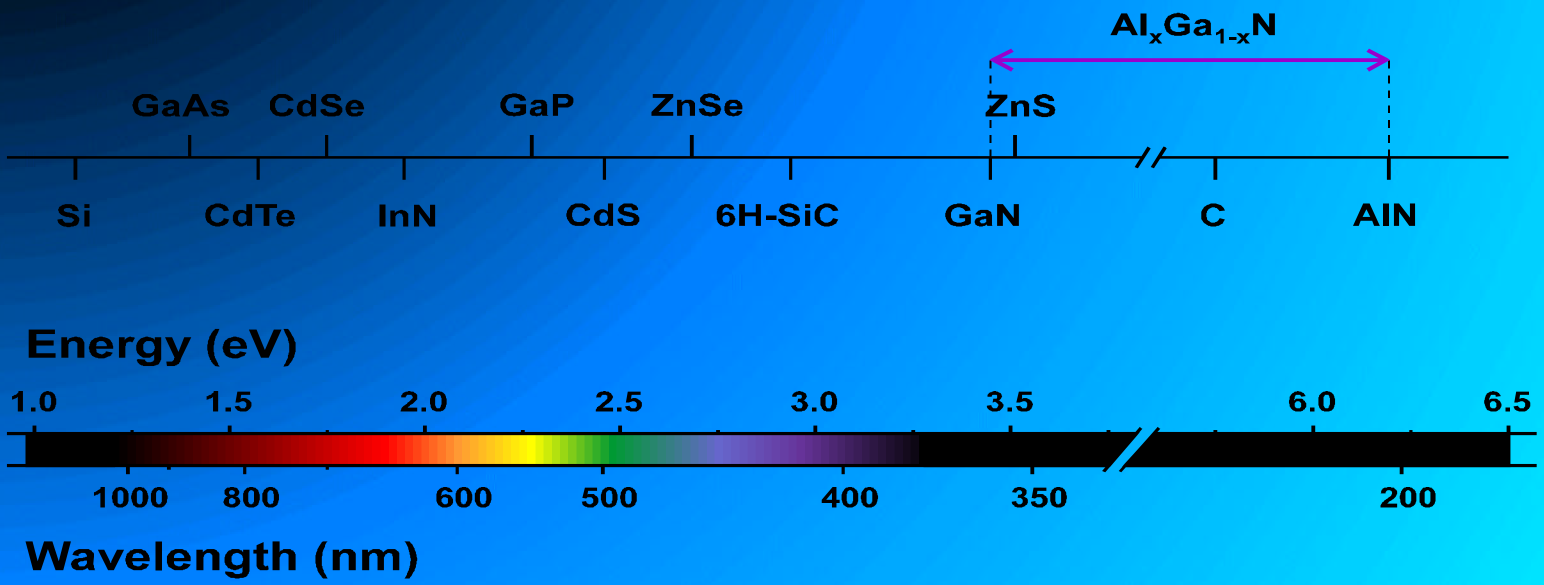




Imaging sensors with high sensitivity and resolution,
Large pixel format but smallest pixel size!



Wide band-gap materials



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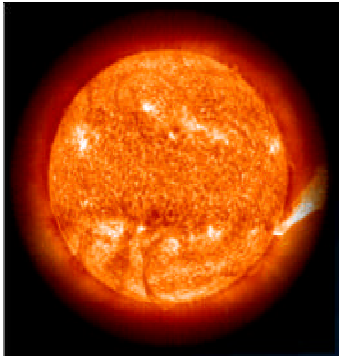

Advantages/disadvantages

Silicon Detectors	Wide Bandgap Detectors
Need cooling to -60 C or less (Dark current & radiations)	Room temperature operations (simpler & cost-effective)
Contaminants stick and polymerize (cold trap)	Low contamination risk, long-term stability
Degradation of the charge transfer efficiency by ionizing radiation	Rad-hardness Whole mission lifetime increased
Cosmic ray hits plague the signal (points & strikes)	Smaller cross-section => less artifacts
QE insufficient, inhomogeneous, and unstable	Higher QE. Stability and flat-field improved
MCP Intensifiers needed	VUV sensitive
Minimal pixel size ~10 microns	Potentially much smaller
Most sensitive in visible, filters needed (fragile, absorbing UV)	Visible-Blind Some filters can be removed Gain in effective area

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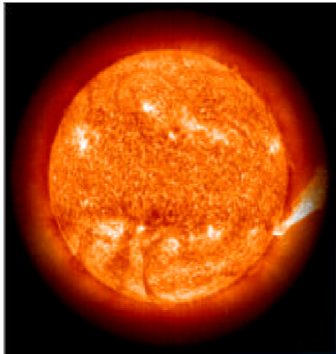
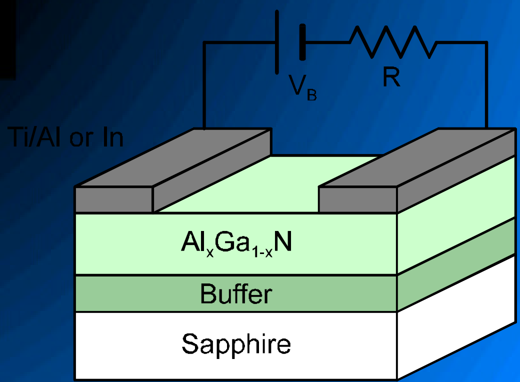
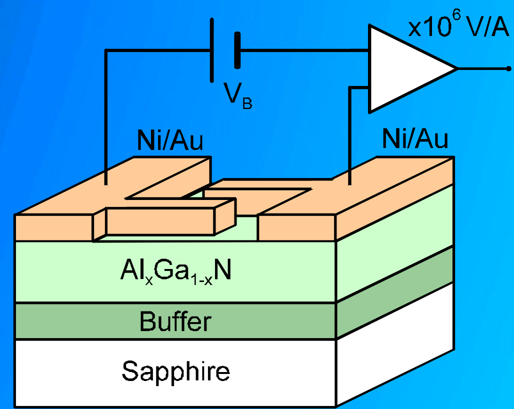


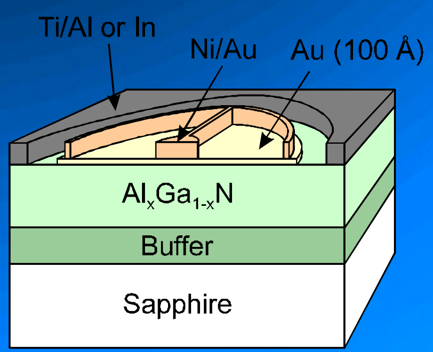
$Al_xGa_{1-x}N$ Photodetector types



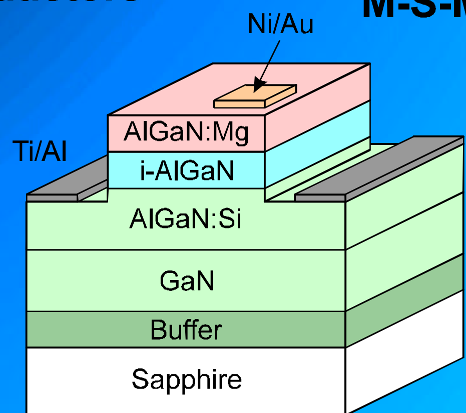
Photoconductors



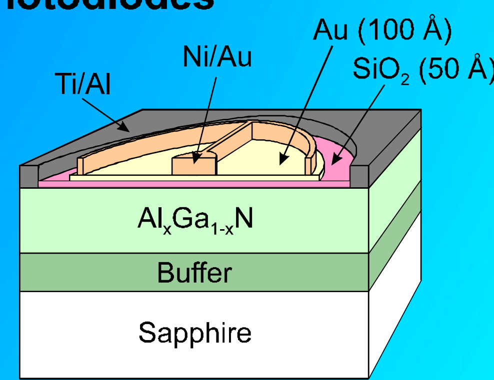
M-S-M Photodiodes



Schottky Photodiodes



***p-i-n* Photodiodes**



M-I-S Photodiodes

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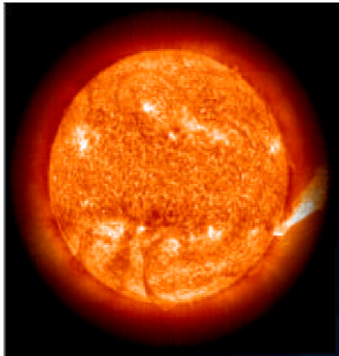
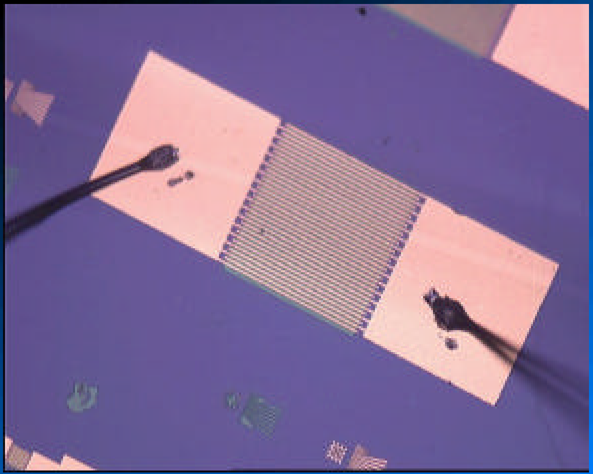
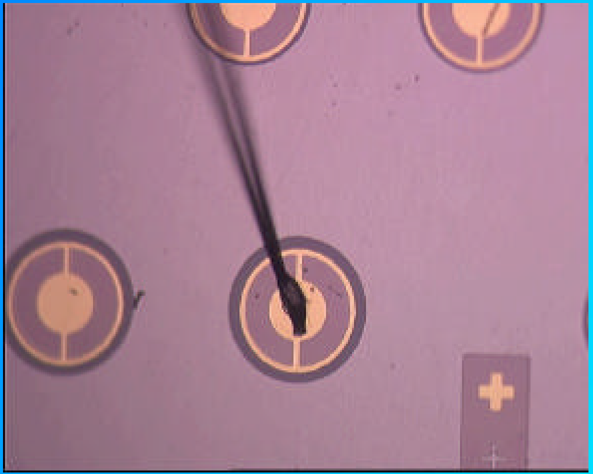
SPIE Annual Meeting, San Diego
3 - 8 August 2003



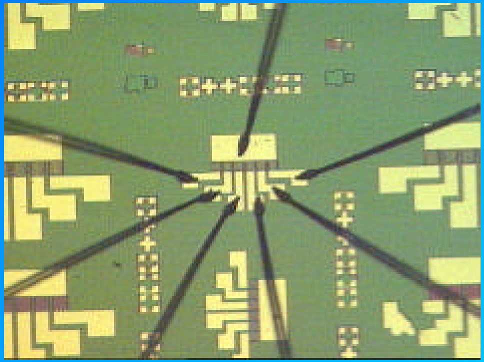
Devices fabricated for tests



MSM GaN device



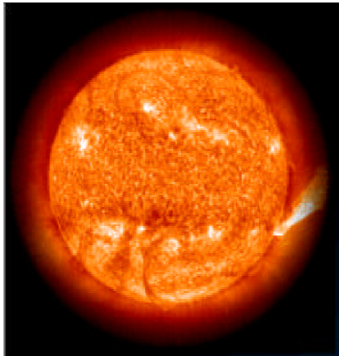
Schottky GaN device



1x 6 linear micro-array of MSM photodiodes fabricated on

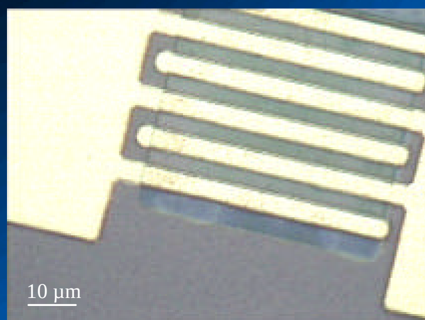
AlGaN/Si(111) samples

ISOM-UPM



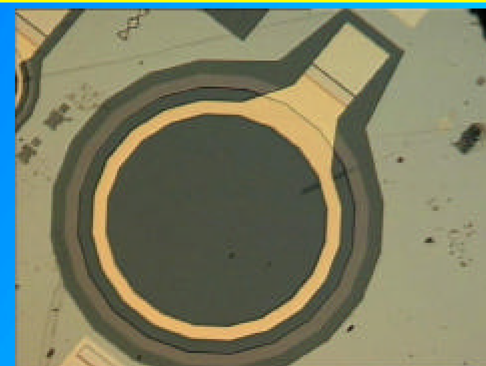
Single-photodetectors

Metal-semiconductor-metal

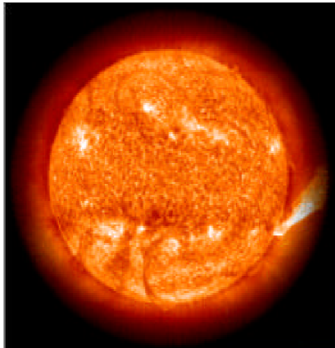


- Active areas: 500 x 500 µm^2
  250 x 250 µm^2
  50 x 50 µm^2
  30 x 30 µm^2
- Finger widths (Pt/Ti/Au or Ni/Au) and spacings: 2,4,7 and 10 µm

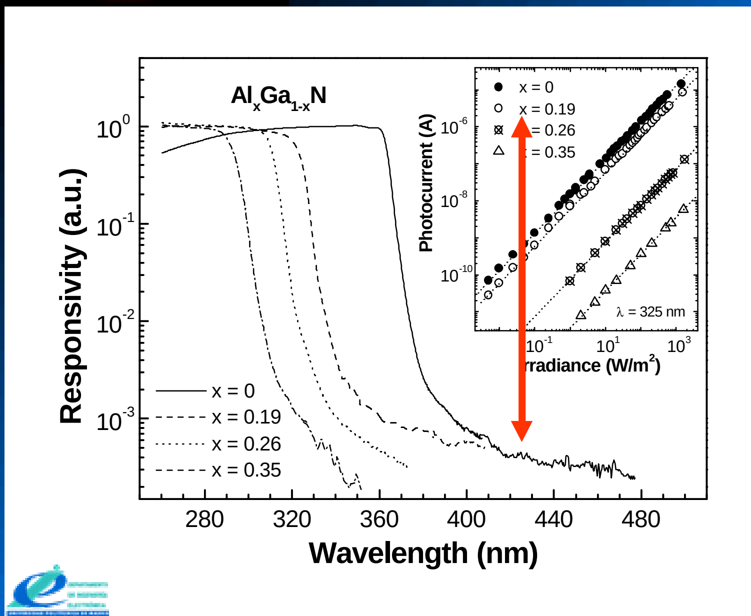
Schottky photodiodes



- Extended Ti/Al or Ti/Al/Ti/Au ohmic contact.
- Active areas: 1 mm, 600 µm, 400 µm and 200 µm diameter disks.
- Semitransparent 100 Å-thick Au.
- Ni (300 Å)/ Au (1000 Å) pad.
- Passivation: SiO_2 or SiN.

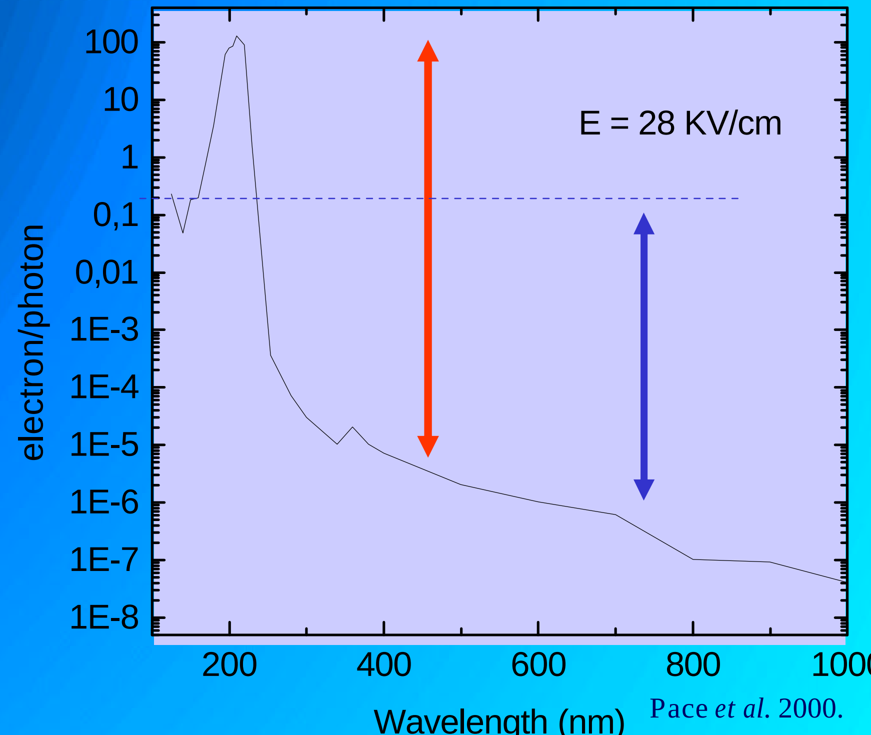


Solar-blindness of present WBGS detectors



Pau *et al.* 2003.

Nitride



Pace *et al.* 2000.

Diamond

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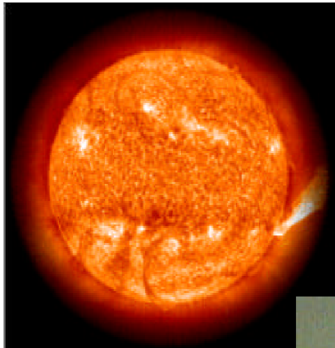
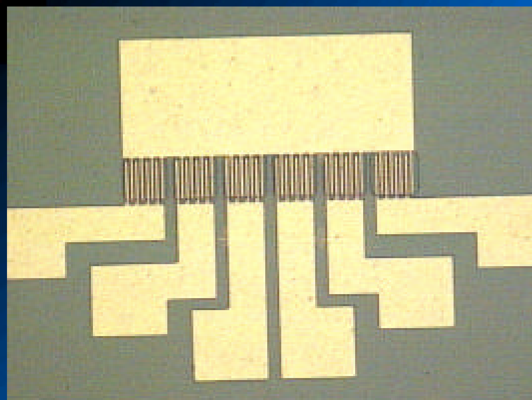
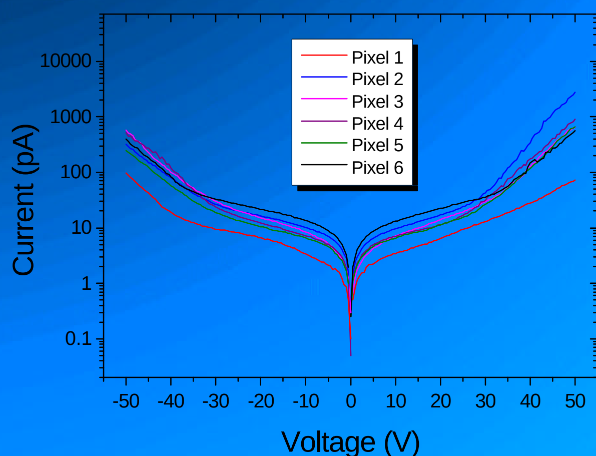
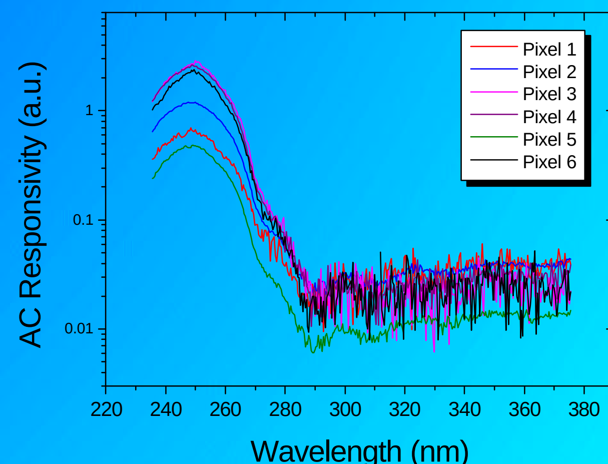


Micro-arrays



- Minimum pixel size: 30 x 30 µm^2.
- Finger widths: 2, 4 and 7 µm.
- Homogeneity studies.
- Pixel-to-pixel cross-talk analysis.
- Image persistence effects.





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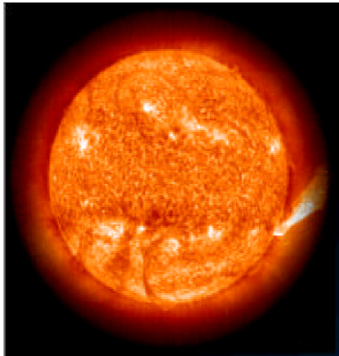
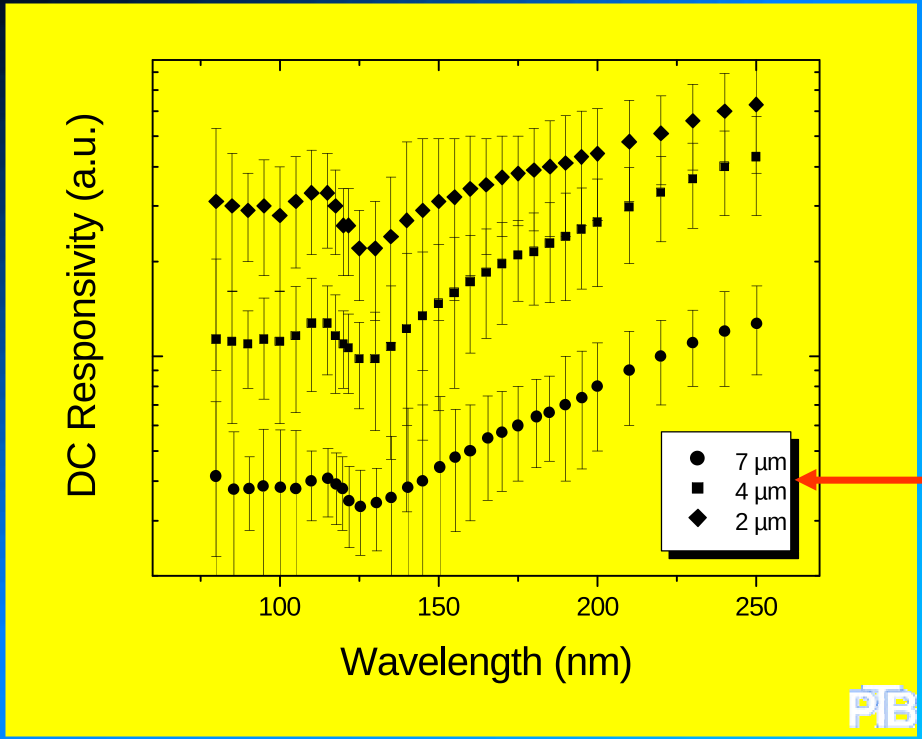
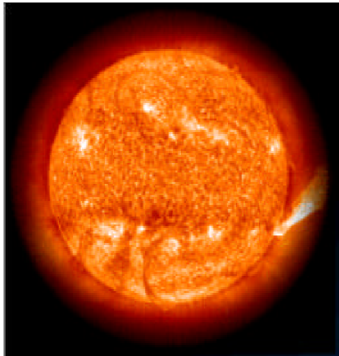


VUV efficiency of MSM GaN devices

Comparison of device structures



Finger width



EUV efficiency of GaN Schottky device

- Absolute responsivity measured at the electron storage ring BESSY II

- Compared to a calibrated PtSi reference diode