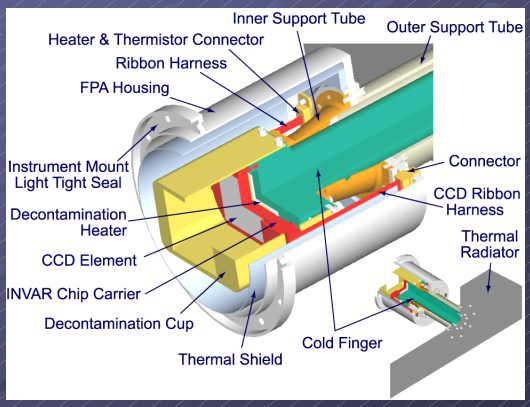
Space Instrumentation (10c)

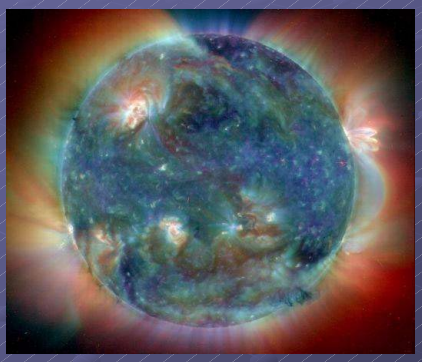
Lectures for the IMPRS June 23 to June 27 at MPAe Lindau
Compiled/organized by Rainer Schwenn, MPAe,
supported by Drs. Curdt, Gandorfer, Hilchenbach, Hoekzema, Richter, Schühle

Thu, 26.6., 15:40 UV detectors fore solar observations (Schühle)

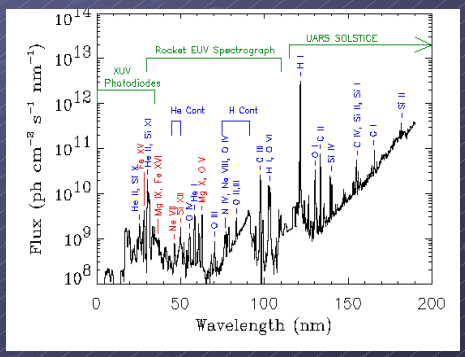


UV detectors for solar observations

Udo Schühle, MPAE, 26 June 2003



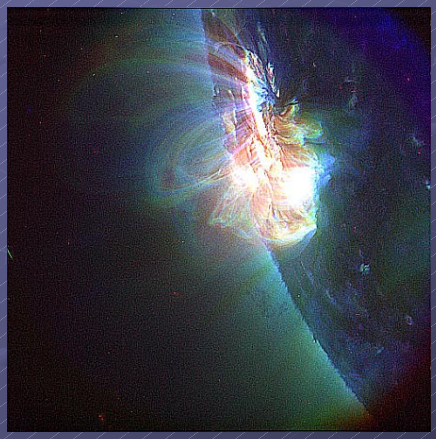
TRACE-image of the Sun in the EUV

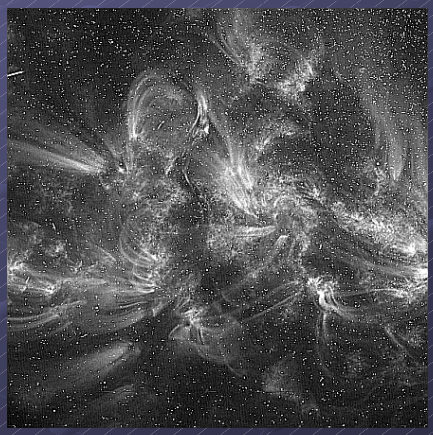


Emission spectra of the Sun in the VUV

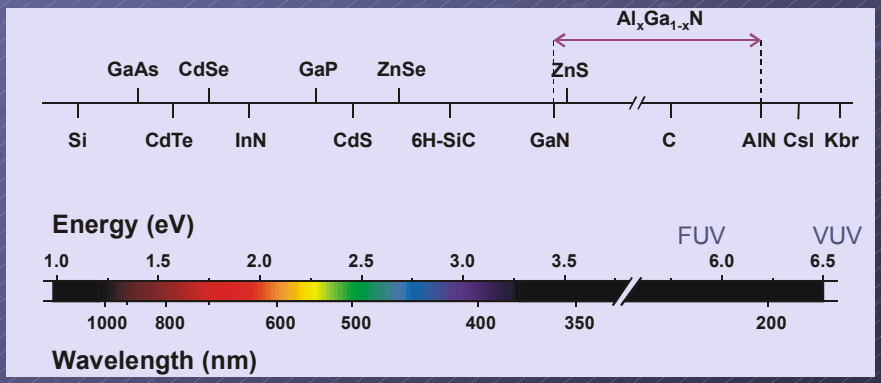
The quest for higher resolution

0.5 Arcsec
~ 350 km at Sun

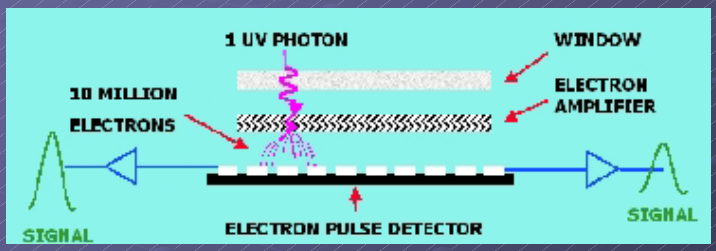


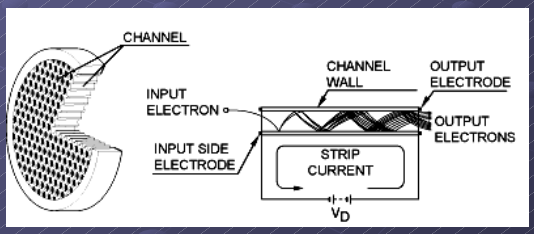


Photocathode materials

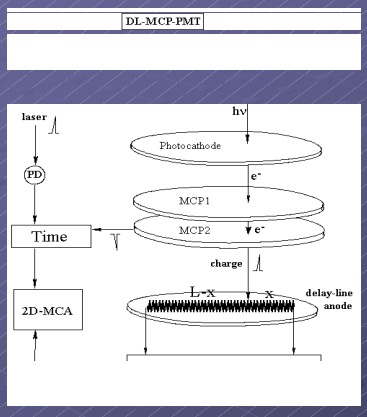


Multichannel plate (MCP) detectors

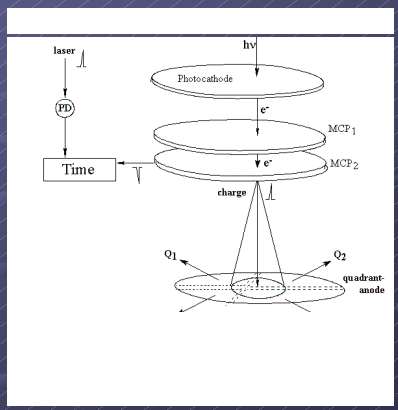




Readout schemes of microchannel plate detectors

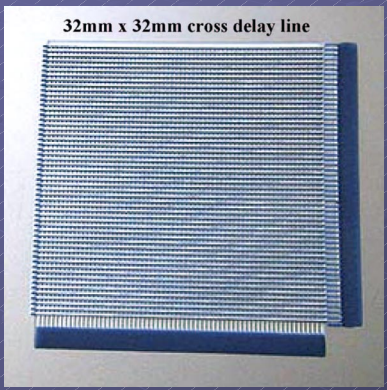


Cross delay line anode + time to digital converter



Cross strip anode + charge ratio centroiding

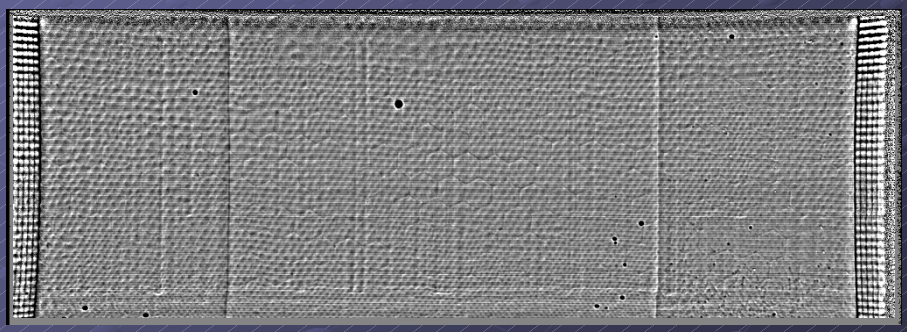
Anode design options



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

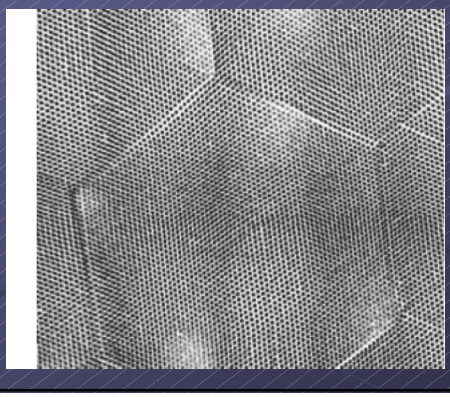
Example: flatfield of SUMER XDL detector

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



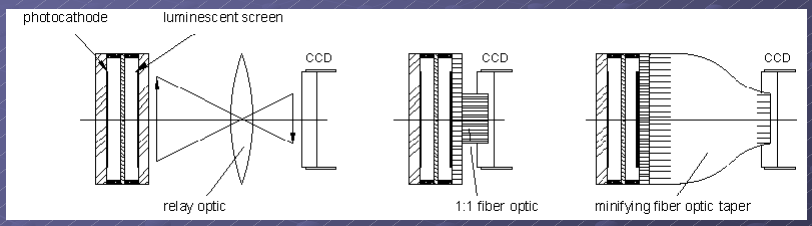
Flatfield pattern & resolution

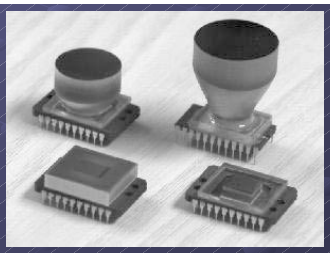
- Pore structure limiting the resolution
- Multifiber bundle boundaries
- Moire pattern by superposition of MCPs



Intensified CCD

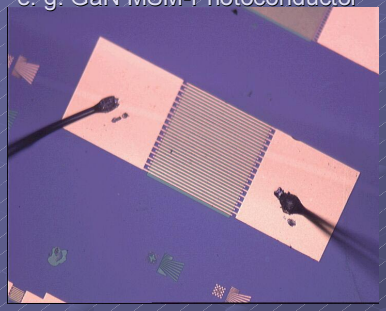
MCP coupled to CCD via lens or fiber-optic taper

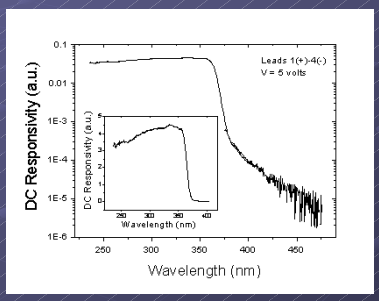


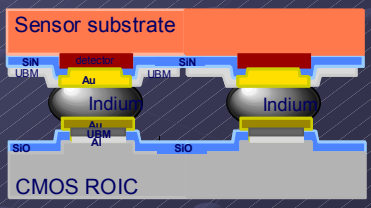


Hybrid design with wide band gap material

e. g. GaN MSM-Photoconductor

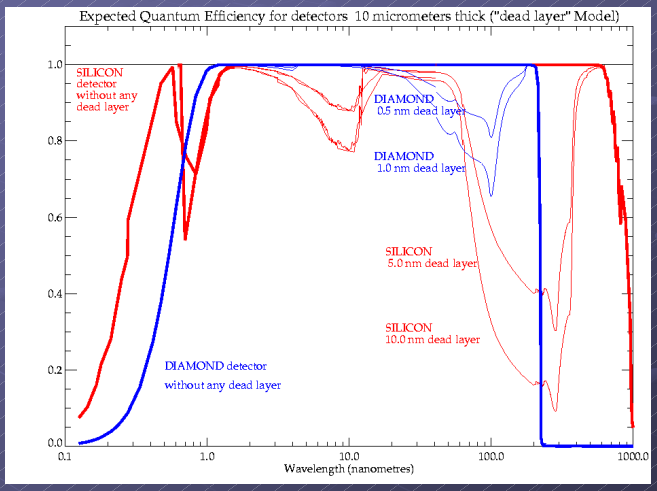






Sensor substrate: Diamond or AlGaN
ROIC: silicon based CMOS structure

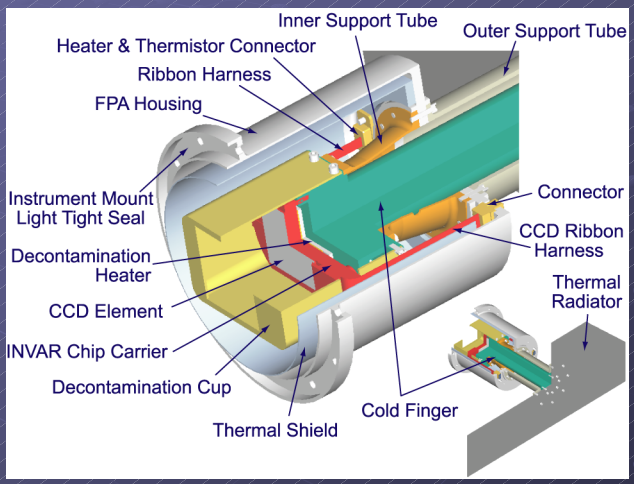
Wide band gab material detectors



Can be selcted to be solar blind

Highly efficient in the VUV and EUV

Focal plane array for space instrumentation

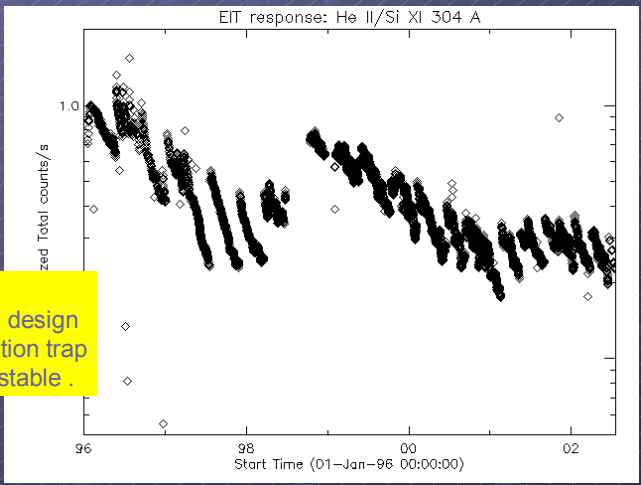


Silicon based sensors vs. Wide band gap sensors

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	Sub-micron pixels (potentially)
Most sensitive in visible, filters needed (fragile, absorbing UV)	Visible-Blind Some filters can be removed Gain in effective area

Drawbacks of current solar EUV sensors

the EUV-teleskope EIT on SOHO

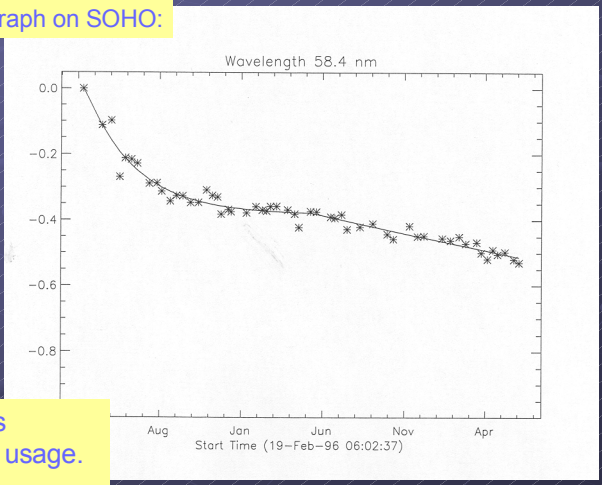


- CCDs need cooling.
- complicates thermal design
- results in contamination trap

--> Efficiency very unstable .

Instability of channel plate detectors

e. g. CDS spectrograph on SOHO:



The gain of channel plates reduces constantly during usage.