Introduction on the Detector research for WSO-UV/LSS

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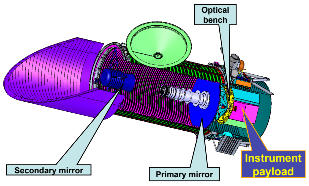
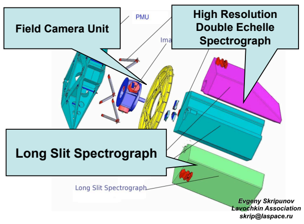
The World Space Observatory - Ultraviolet (WSO-UV) is a space astronomy project led by Russia, with contributions from China, Spain, Germany, Italy, United Kingdom and a number of other countries in the world. WSO-UV consists of a 1.7-meter diameter telescope and three focal plane science instruments.



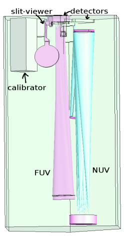


The telescope is a R-C system with Aluminum+MgF2 reflective coatings. The science instrument payloads are envisaged to include an imaging instrument in UV and possibly optical wavelength ranges, a high resolution spectrograph with a spectral resolution of 50000 working in 115nm ~ 320nm wavelength range, and a low spectral resolution spectrograph with one-dimension spatial sampling capability, the Long Slit Spectrograph (LSS).

LSS will produce moderate spectral resolution (R=1000-2500) spectra over 102nm ~ 320nm band along a slit of 75 arcsec in length and 1 arcsec in width. The spatial resolution of the instrument will be ~1 arcsec. A two-channel scheme is proposed to optimize performance. Each channel, the FUV and the NUV channel, of LSS has its own detector.

The Long Slit Spectrograph

Parameter	requirements
Wavelength coverage	**102~320 nm sub-channels possible**
Width of slit	**1″ ~ 82 µm**
Length of slit	**75″ ~ 6.2 mm**
Spectral resolution	**1000~2500**
Spatial resolution	**0.5″~1″**
sensitivity	**Maximize FUV**
Time resolution in HTR mode	**1 second**
Life time	**5 years**



Detector parameters

NUV channel	
Wavelength Range	160nm~320nm
Pixel	20µm x 20 µm
Active area	55mm x 3mm
Quantum efficiency	>25%
Photon counting with time tags is preferred	

FUV channel	
Wavelength Range	102nm~170nm
Spatial resolution	40µm x 40 µm
Active area	60mm x 6mm
Quantum efficiency	>20%
Photon counting with time tags is preferred	

The first choice of LSS detectors is MCP with centroid sensing anode. The advantage is obvious.

- It's easier to find large, flexible format MCP.
- The technology has been proven in the previous UV mission.
- The QE of more than 40% is possible in NUV and sensitivity is attainable at FUV.

To optimize detector efficiency, Caesium Telluride (Cs2Te) is chosen for the photocathode of NUV channel detector and CsI is for the FUV channel.

For the FUV channel, the sensing wavelength down to 102 nm necessitates an open-faced design with the photocathode deposited directly on the front side of MCP. The detector has a vacuum door which will be finally deployed when in-orbit.

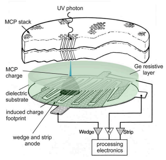
The wavelength range of the NUV detector allows a sealed tube design with input window to be used. This will remove the complexity and the increased risk associated with a vacuum door, and simplifies operation of the detector both on ground testing and operation in orbit. The window is made of Magnesium Fluoride to accommodate the wavelength range. A semi-transparent Caesium Telluride photocathode is deposited on the inner side of the window.

The LSS optical design has been engineered to match with commercially available structure and MCP format, avoiding a highly custom design and reducing costs substantially. The high aspect ratio imaging area required by the spectrometer will be accommodated within a circular detector with a nominal 75 mm active diameter.

The detectors will use a small pore MCP stack operating at a gain of ~10^7 electrons.

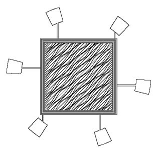
The electron pulse will be read out using the Image Charge technique, a method whereby the event charge is collected on a resistive layer deposited on a dielectric window, which serves to instantaneously localize the event whilst allow it to discharge over a longer timescale. The transient arrival of the event pulse is detected by a centroiding charge division readout, such as the Vernier anode, which is capacitively coupled to the back side of the dielectric window. This technique enhances performance by mitigating distortions produced by redistribution of secondary electrons produced on the anode, and greatly simplifies the tube manufacture by allowing the readout to be outside the tube vacuum envelope. Several designs of centroiding readout schemes were considered, the Vernier anode being the current baseline option.

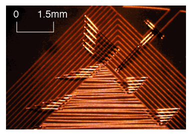
Image Charge Technique



- Stable charge footprint distribution on the readout
- No partition noise – caused by quantisation of charge
- No image degradation due to secondary electron effects
- Substrate provides electrical isolation
- Can always operate anode at ground – lower noise
- Intensifier or flange mounted detector - can use external readout
- Readouts easily interchanged

Vernier Anode – enhanced performance geometric charge division





- Geometric charge division using 9 electrodes
- 3 groups of 3 sinusoidal electrodes
- 3 cyclic phase coordinates
- Cyclically varying electrodes allow
  - Determination of a coarse position using a Vernier type technique
  - Spatial resolution greater than charge measurement accuracy
  - The full unique range of the pattern can be utilized
- Typically 3000 x 3000 FWHM pixel format
- Easy to reformat – e.g. 6000 x 1500, etc.
- Up to 200 kHz max. global count rate

Current Situation

The funding for the detectors has not yet been approved and so the detector building has not yet actually started. The optical system has got funded to start a technique research and a CCD system will be needed to build to test the system and this will provide us a chance to evaluate the feasibility of the backup strategy to use CCD as the LSS detectors.

With the development of CCD technology, EUV and soft X-ray CCD may attain a rather high sensitivity on our FUV waveband (especially at 102nm to 120nm) that is not lower than photon cathode and is highly potential to be capable to fulfill LSS application. Taking advantage of the chance, we will evaluate the nowadays E2V soft X-ray CCD's performance on the FUV band and the E2V NIMO, enhanced nocoat CCDs will be evaluated.

Reported CCD QE