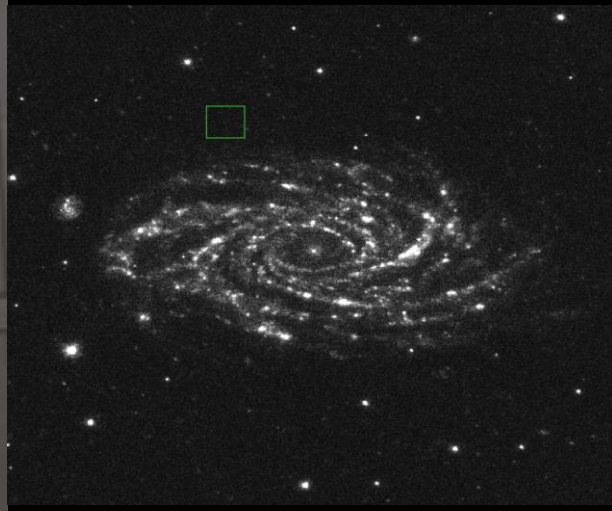
Optics Transmission and Detectors' QE of UVIT on AstroSat

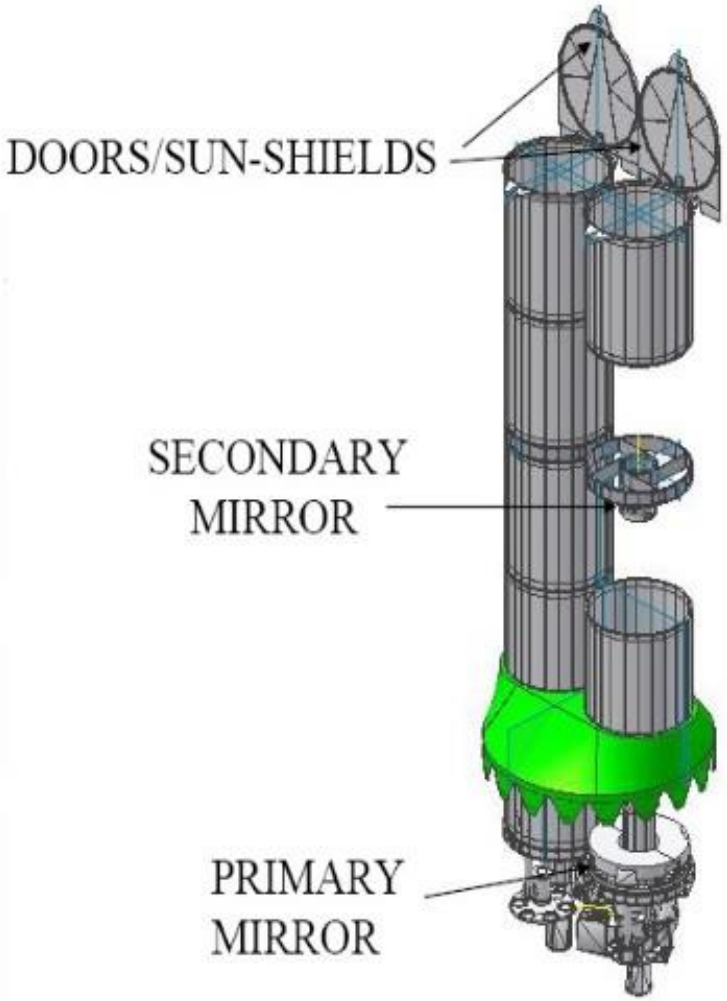
Doors are closed until 6 weeks after reaching the orbit to minimize contamination

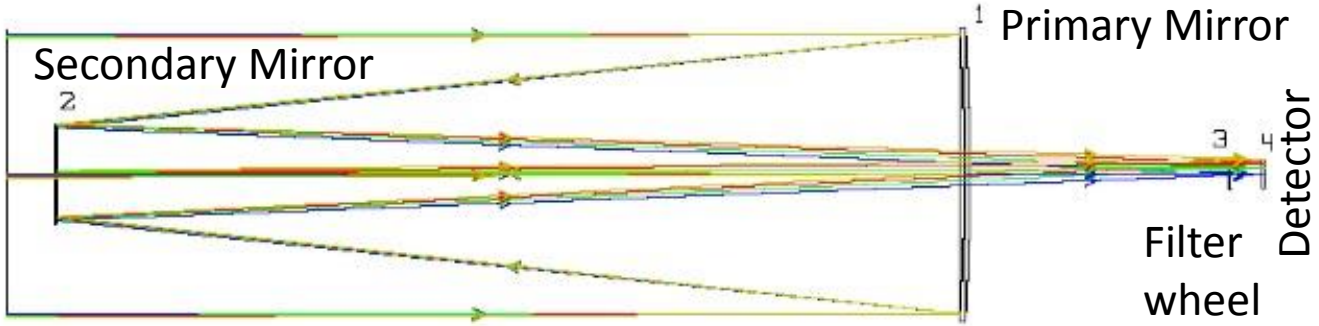
UVIT Twin Telescope

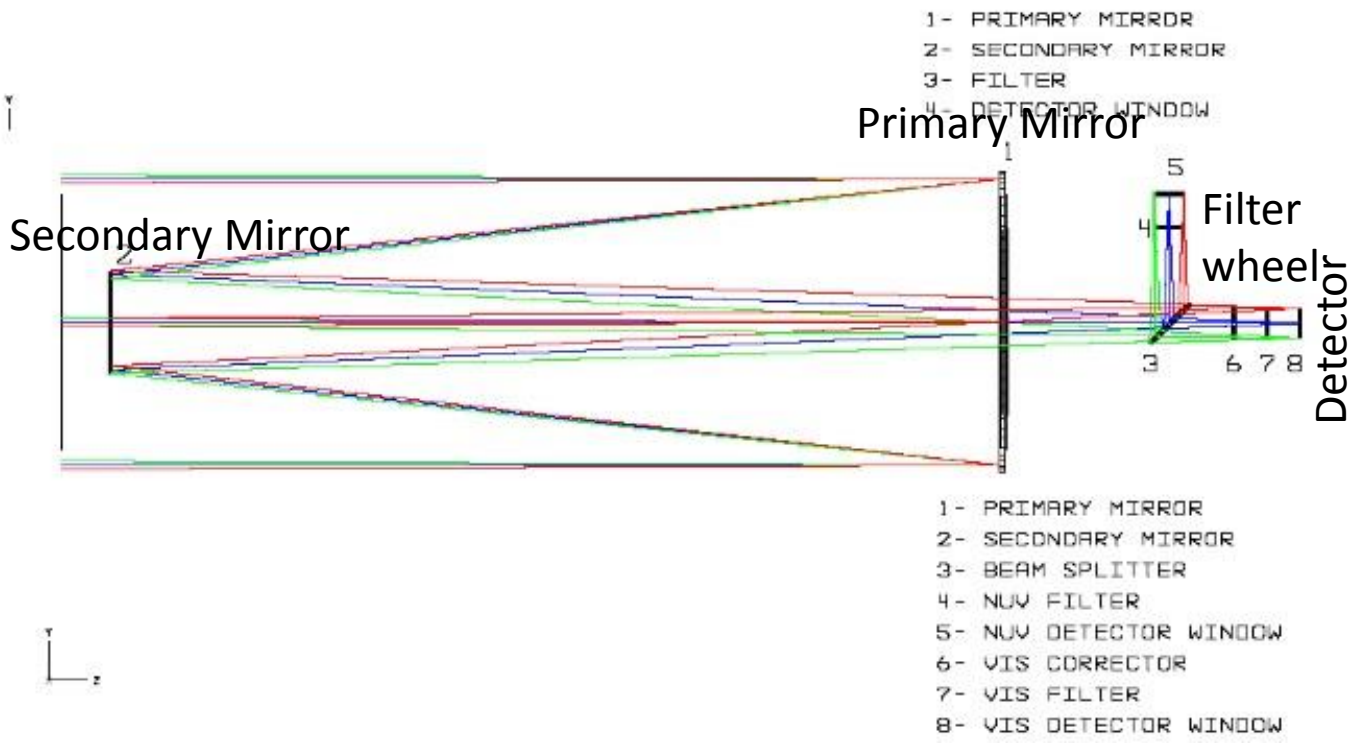


K. Sankarasubramanian on behalf of Stalin & UVIT team

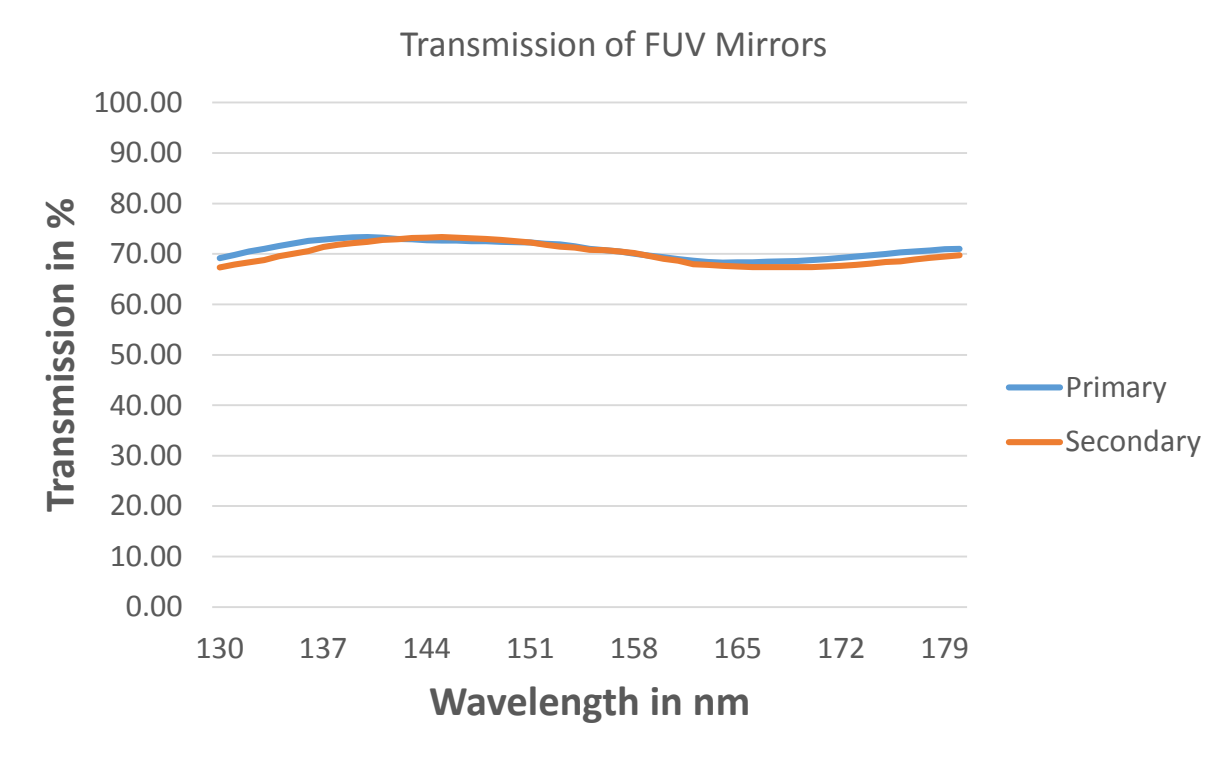
Ultra-violet Imaging Telescope (UVIT)

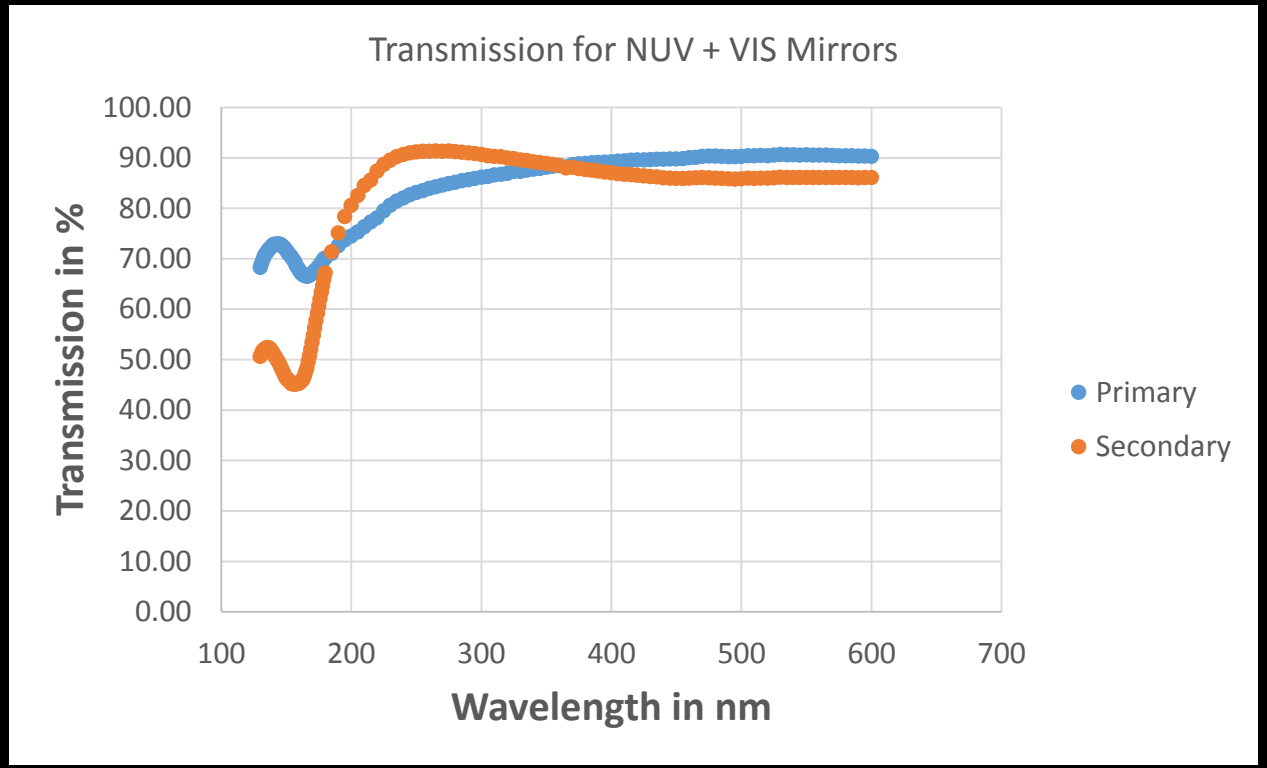






Transmission of Mirrors in UVIT





Transmission data of Primary and Secondary mirrors for FUV and NUV Mirrors of UVIT obtained by LEOS Team

Filters in UVIT

Slot No.	Filter Type	Thickness (mm)	Passband (nm)
0	Block with Aluminium		
1	CaF_2 – 1	2.50	>125
2	BaF_2	2.40	>135
3	Sapphire	2.00	>142
4	Grating – 1	4.48	
5	Silica	2.70	> 159
6	Grating – 2	4.48	
7	CaF_2 – 2	2.50	>125

FUV – FM Filter Wheel Configuration
130 – 180nm

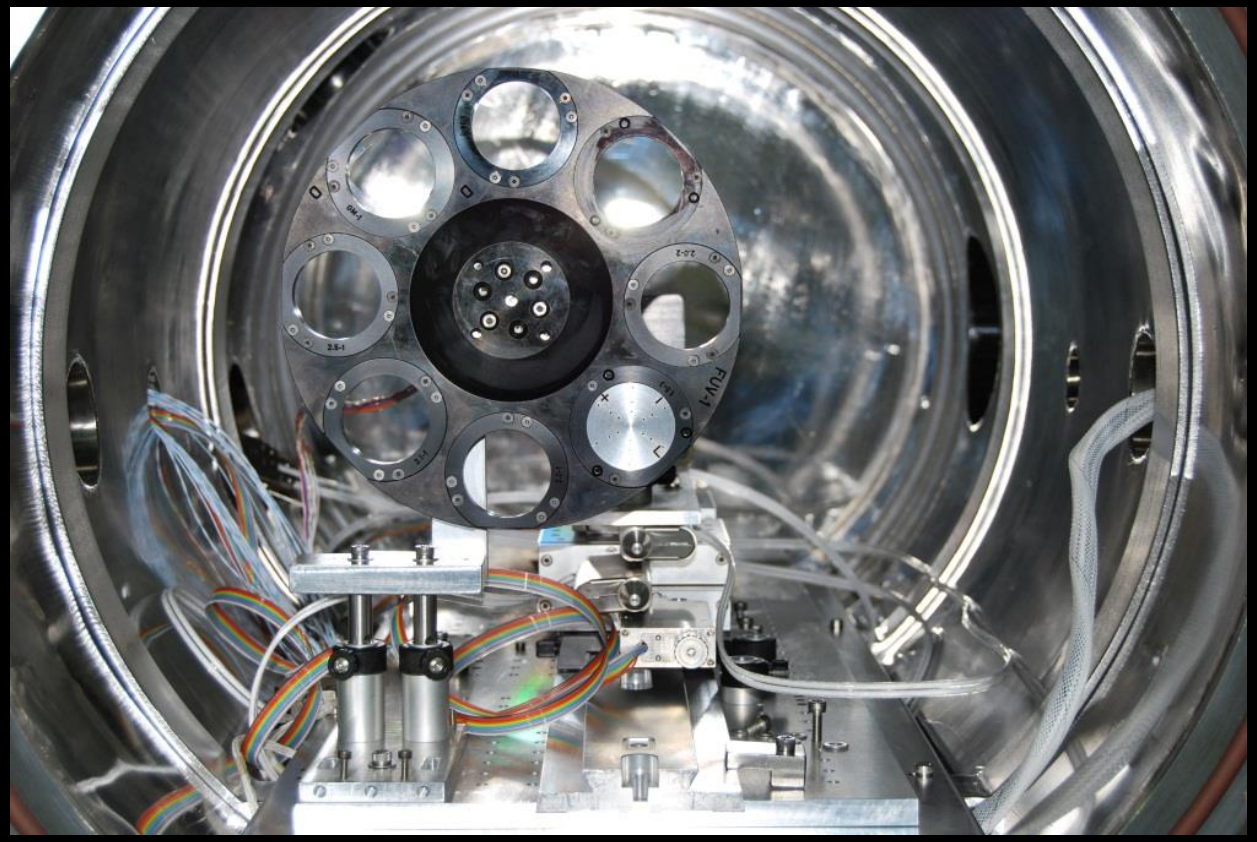
NUV – FM Filter Wheel Configuration (200 – 300nm)

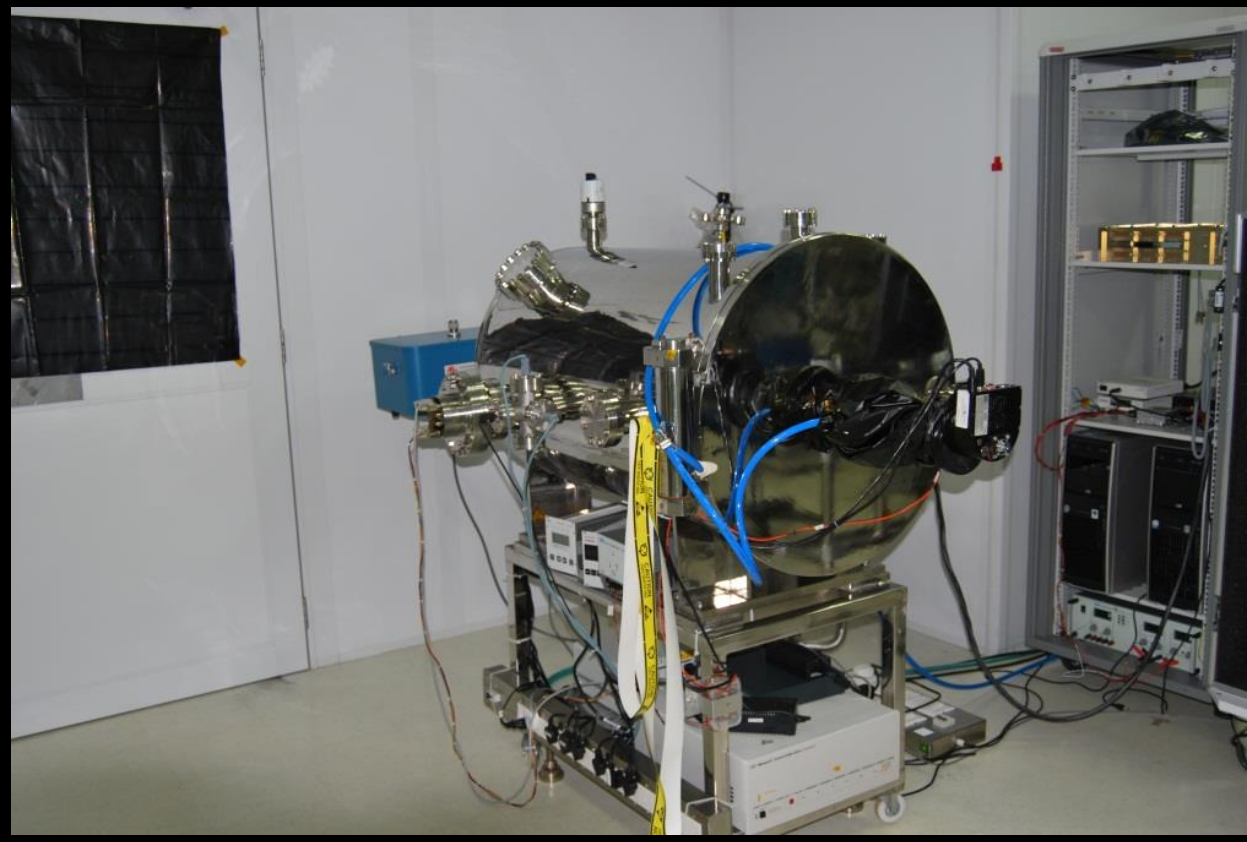
Slot No.	Filter Type	Thickness (mm)	Passband (nm)	Material
0	Block with Aluminium			
1	Fused Silica	3.00	> 159	
2	NUVB15	2.97	200 – 230	Silica (UV)
3	NUVB13	3.15	230 – 260	Silica (UV)
4	Grating	4.48		
5	NUVB4	3.33	250 – 280	Silica (UV)
6	NUVN2	3.38	275 – 285	Silica (UV)
7	Fused Silica	3.30	> 159	

VIS – FM Filter Wheel Configuration
(320 – 550nm)

Slot No.	Filter Type	Thickness (mm)	Passband (nm)	Material
0	Block with Aluminium			
1	VIS 3	3.00	400 – 530	UBK 7
2	VIS 2	3.00	370 – 410	UBK 7
3	VIS 1	3.00	320 – 360	UBK 7
4	Neutral Density Filter	3.00		
5	BK7 Window	3.00		

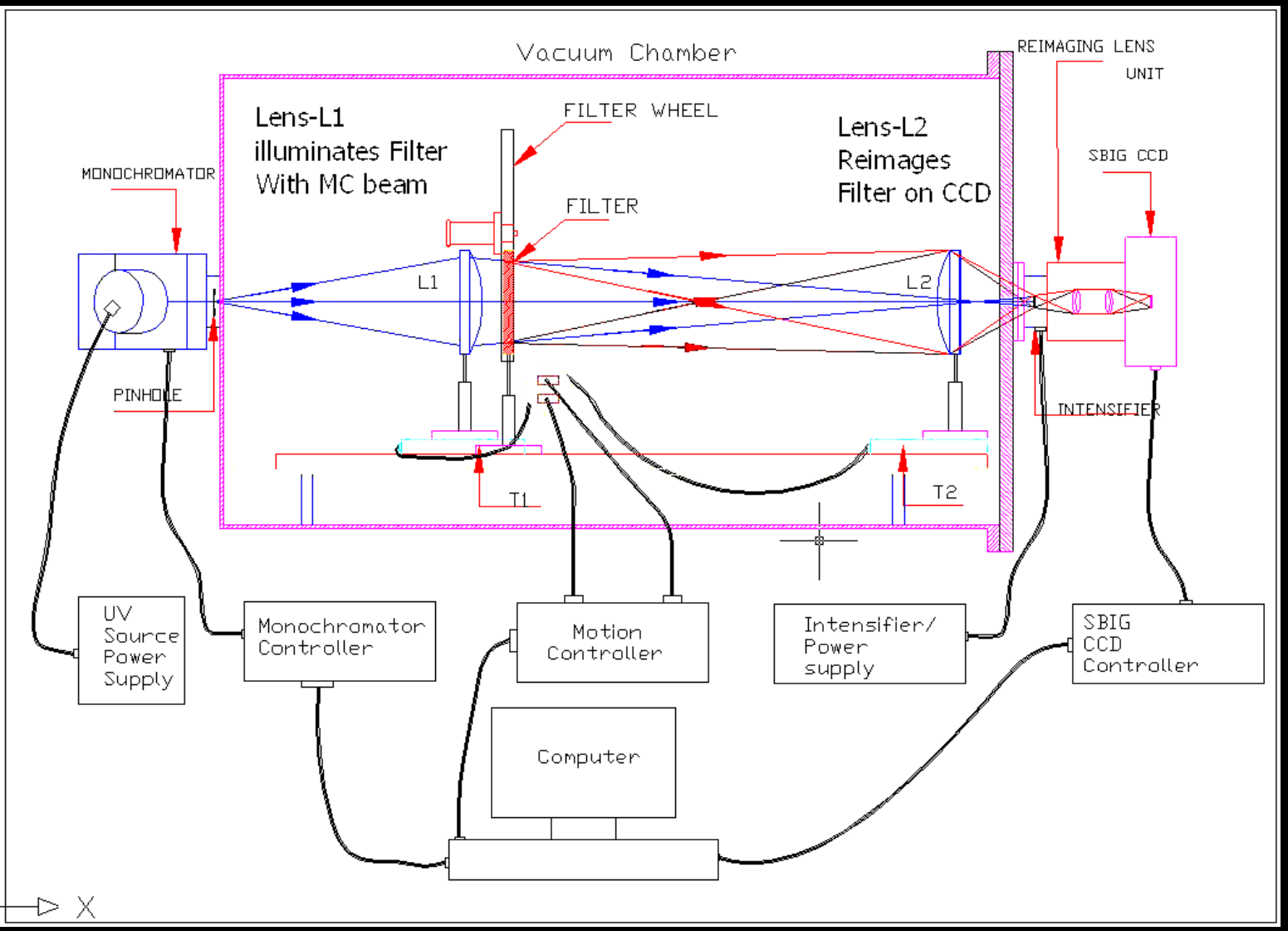
Filters Characterization on ground





- ✓ Spatial Transmission Variation
- ✓ Spectral Transmission Variation

Spatial & Spectral Transmission Experiment



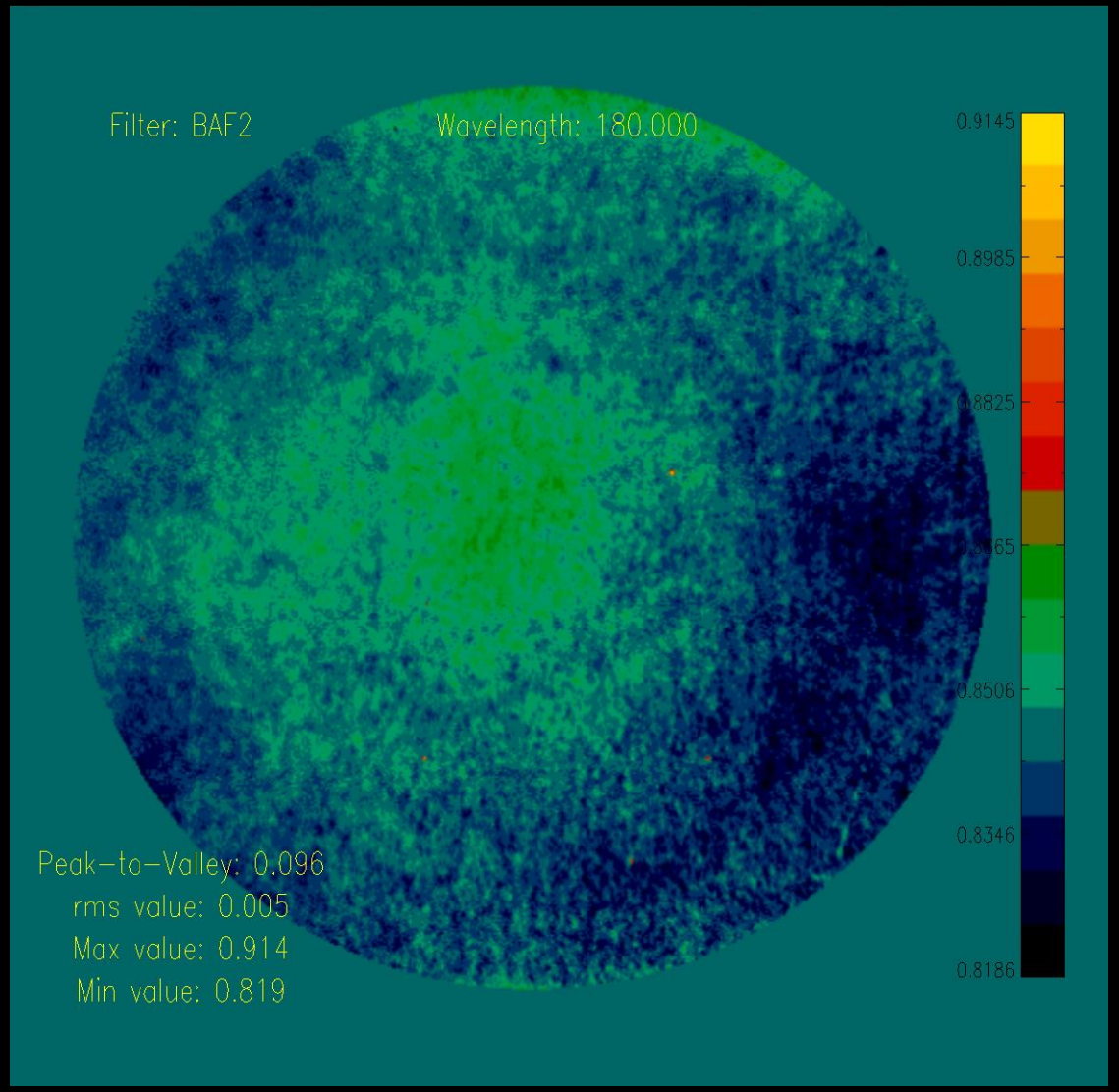
Principle:

- Image of the filter illuminated by a monochromatic source
- Ratio of the image with and without filter provides the spatial non-uniformity in the filter
- Central wavelength of the filters is used to estimate the spatial variation

- Same experiment is used to estimate the spectral transmission
- Above procedure was repeated for different wavelength with the Monochromator

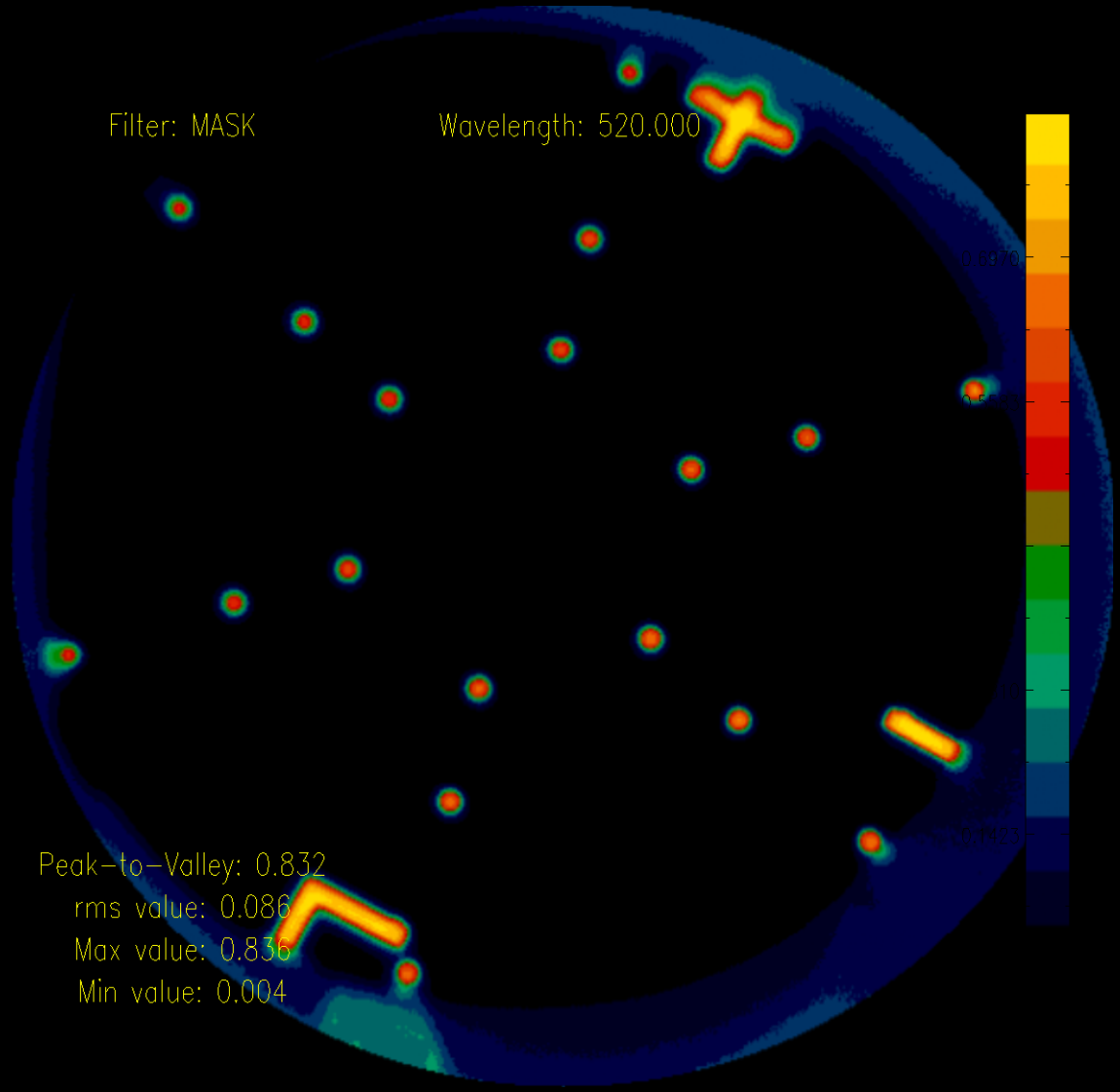
Ref: FM_UVIT_Filter_Calibration Ver 1.1 June 2012

Spatial Transmission - Example



BaF_2 Spatial Variation at 180nm

MASK Image at 180nm



Spatial Transmission Results - FUV

Filter Slot No.	Filter Name	Wavelength (nm)	Exp. Time (Sec)	PTV	Max.	Min.	RMS	Requirement (Uniformity)	Remarks
4	CaF2-1	180.0	2.0	0.080 (1.5%)	0.922	0.842	0.003	~ ± 10%	Complied
3	BaF2	180.0	3.0	0.096 (2.0%)	0.914	0.819	0.005	~ ± 10%	Complied
2	Sapphire	180.0	3.0	0.098 (1.7%)	0.815	0.716	0.006	~ ± 10%	Complied
6	CaF2-2	180.0	2.0	0.096 (3.0%)	0.924	0.828	0.004	~ ± 10%	Complied
0	Silica	180.0	3.0	0.085 (1.0%)	0.907	0.822	0.004	~ ± 10%	Complied

- **After 15 pix Gaussian filtering to include 3.3mm beam size and 2mm drift**

Spatial Transmission Results - NUV

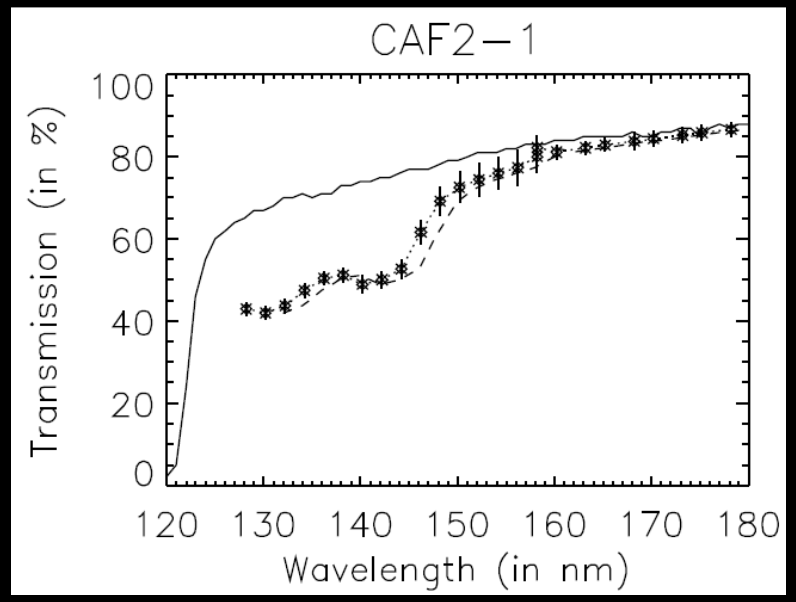
Filter Slot No.	Filter Name	Wavelength (nm)	Exposure Time (Sec)	PTV	Max.	Min.	RMS	Requirement (Uniformity)	Remarks
6	Silica3.0	300.0	2.0	0.093 (5.0%)	0.976	0.883	0.005	~ ± 10%	Complied
7	NUVB15	214.0	2.0	0.180	0.220	0.040	0.016	~ ± 10%	
0	NUVB13	244.0	2.0	0.121 (4.5%)	0.739	0.618	0.008	~ ± 10%	
2	NUVB4	264.0	2.0	0.103 (3.6%)	0.750	0.647	0.007	~ ± 10%	Complied
3	NUVN2	280.0	2.0	0.101 (4.0%)	0.750	0.648	0.009	~ ± 10%	Complied
4	Silica3.3	300.0	2.0	0.105 (5.0%)	0.989	0.884	0.005	~ ± 10%	Complied

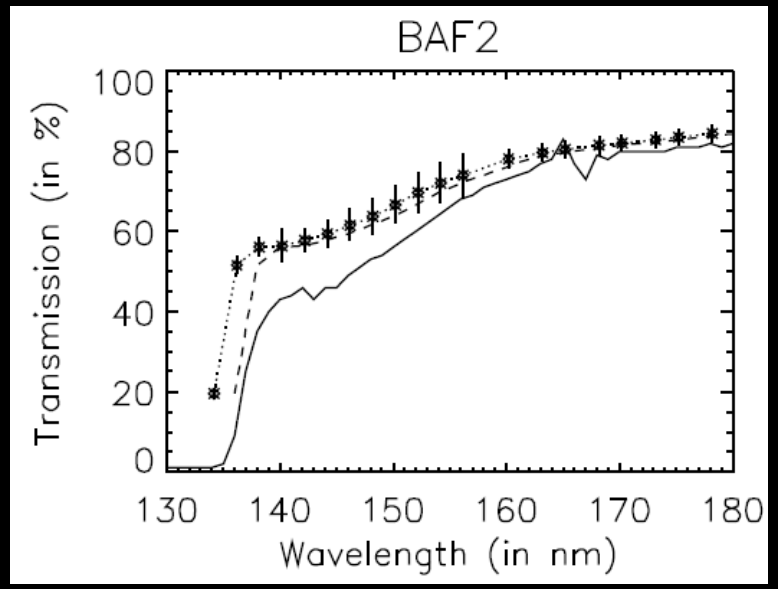
- **After 15 pix Gaussian filtering to include 3.3mm beam size and 2mm drift**

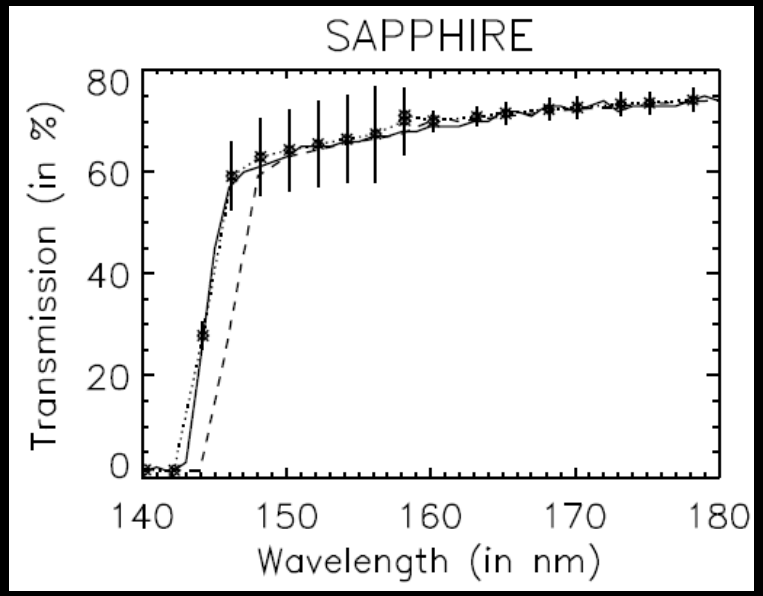
Spatial Transmission Results - VIS

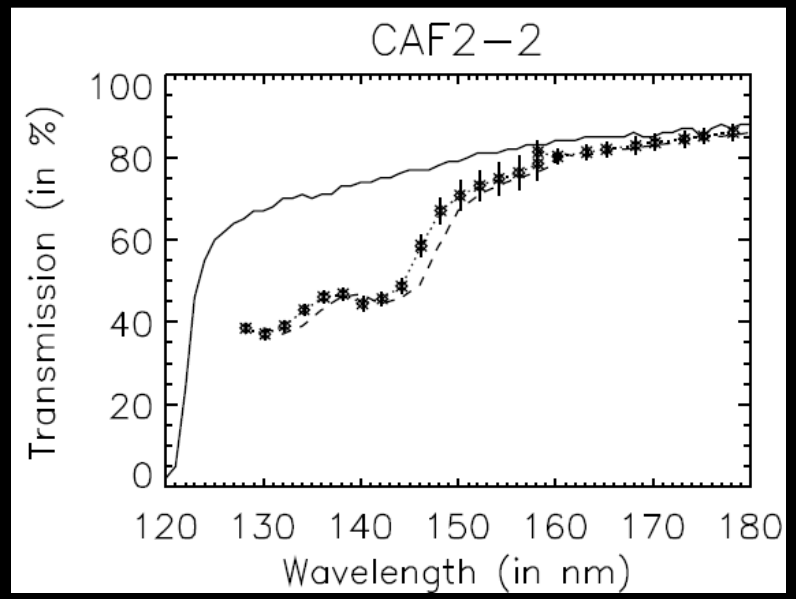
Filter Slot No.	Filter Name	Wavelength (nm)	Exposure Time (Sec)	PTV	Max.	Min.	RMS	Requirement (Uniformity)	Remarks
3	VIS1	340.0	0.75	0.120	0.770	0.651	0.015	~ ± 10%	Refer (3)
2	VIS2	390.0	1.0	0.096	0.883	0.786	0.009	~ ± 10%	Complied
1	VIS3	470.0	3.0	0.118	1.001	0.883	0.007	~ ± 10%	Refer (3)
5	BK7	420.0	1.5	0.097	0.970	0.873	0.006	~ ± 10%	Complied
4	NDF	420.0	1.5	0.193	1.016	0.823	0.004	~ ± 10%	Refer (4)

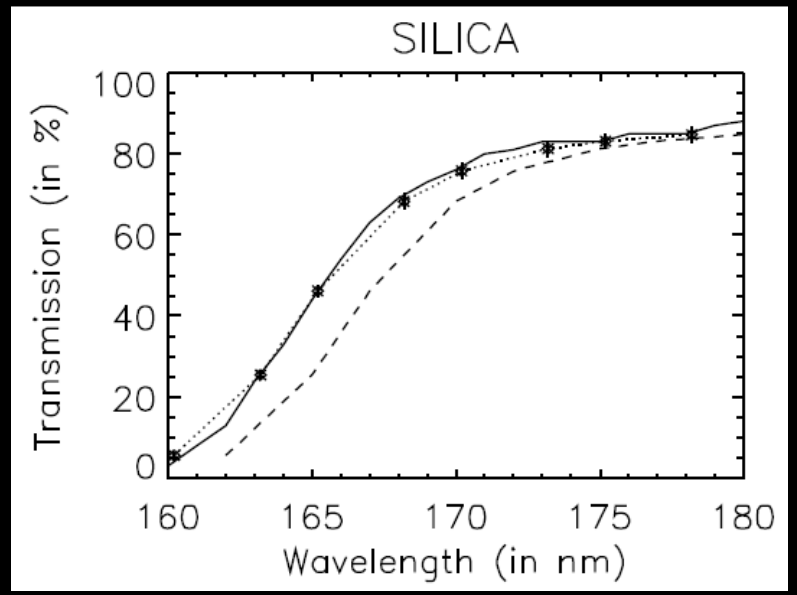
Spectral Transmission Results - FUV





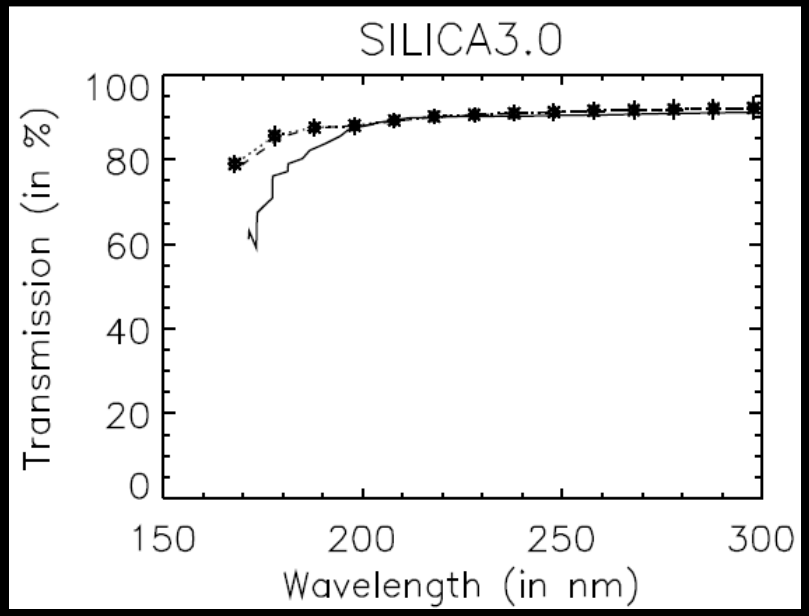


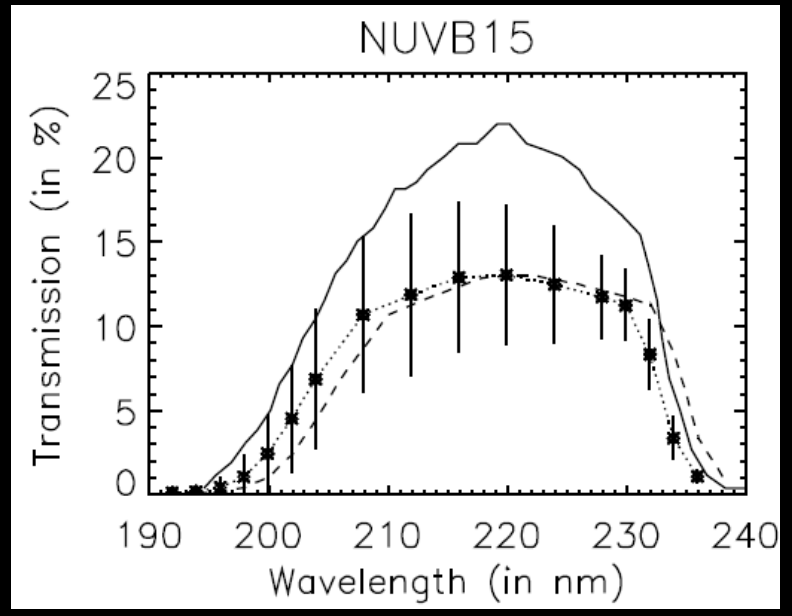


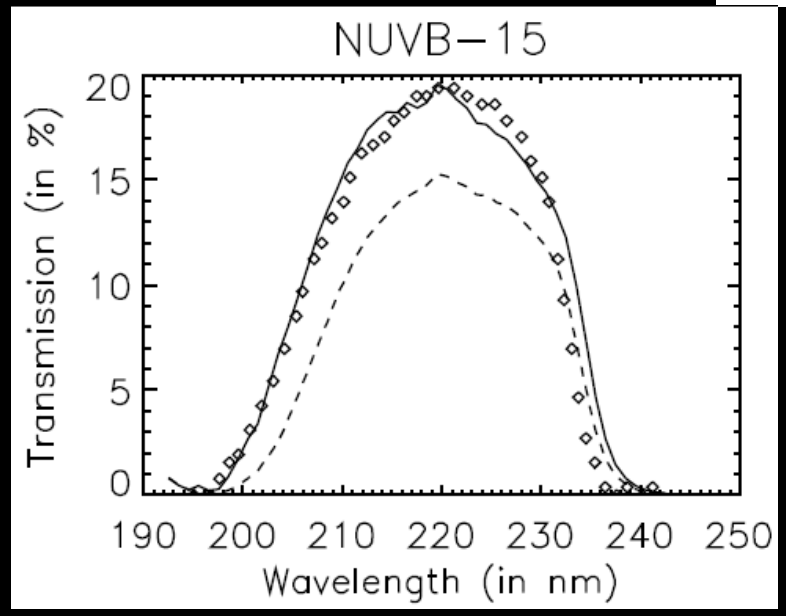


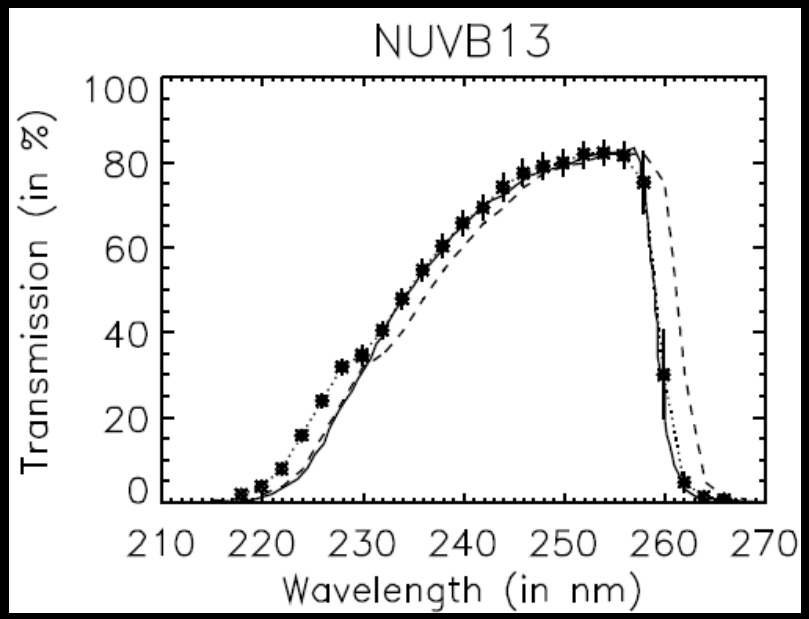
Dashed Line: Measured
Data points: Shifted by -1.8nm (offset)
Solid Line: Expected (literature/vendor)

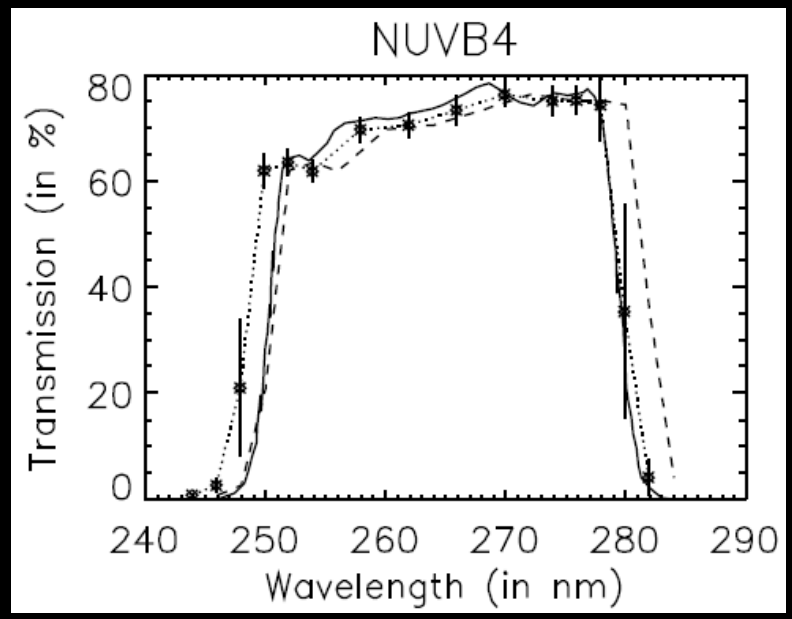
Spectral Transmission Results - NUV

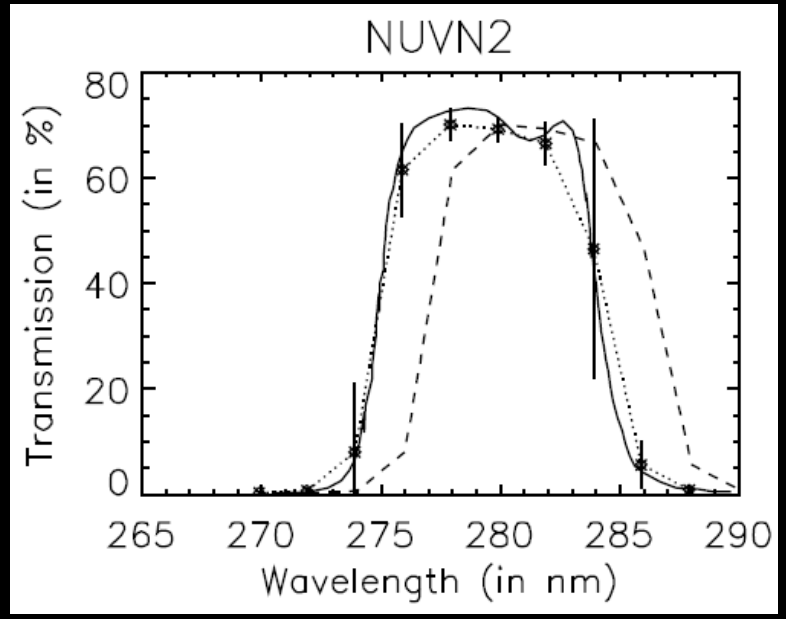












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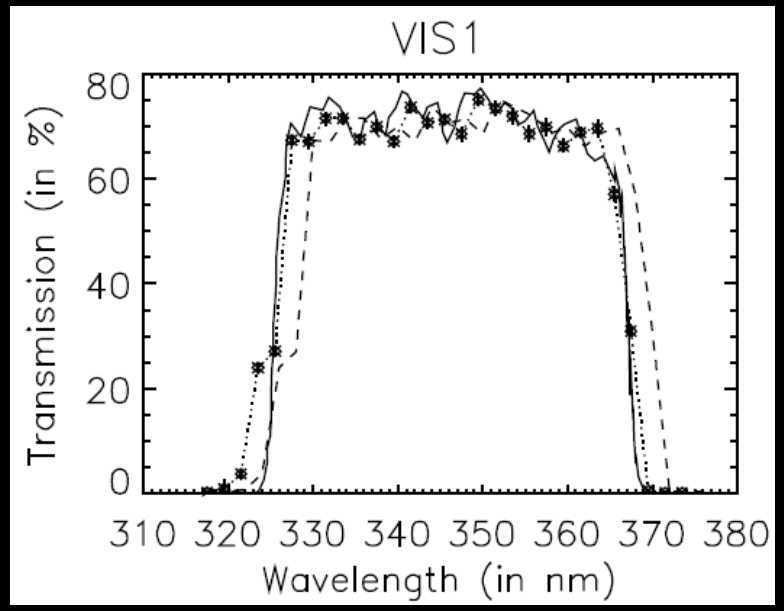
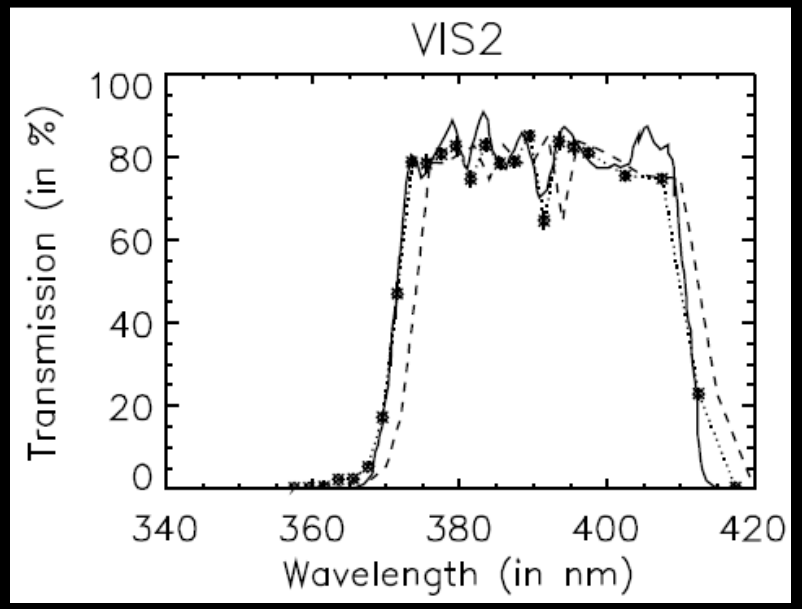
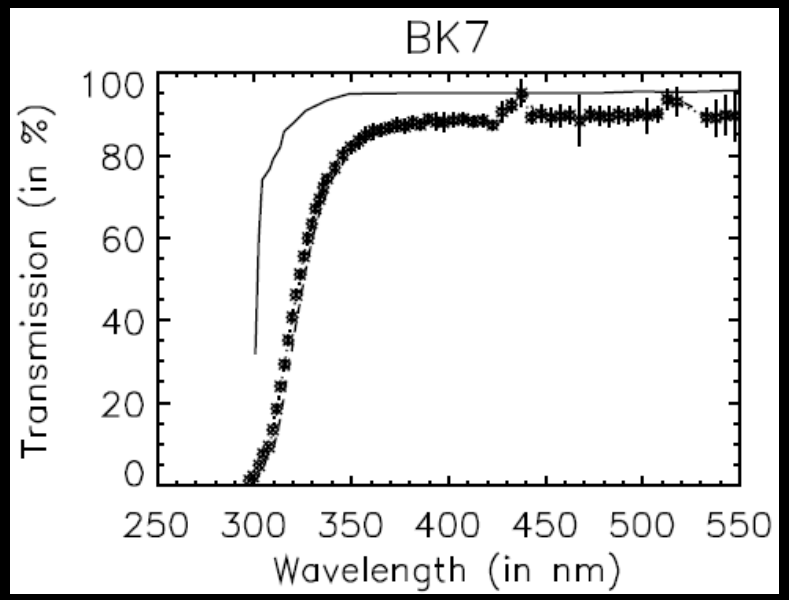
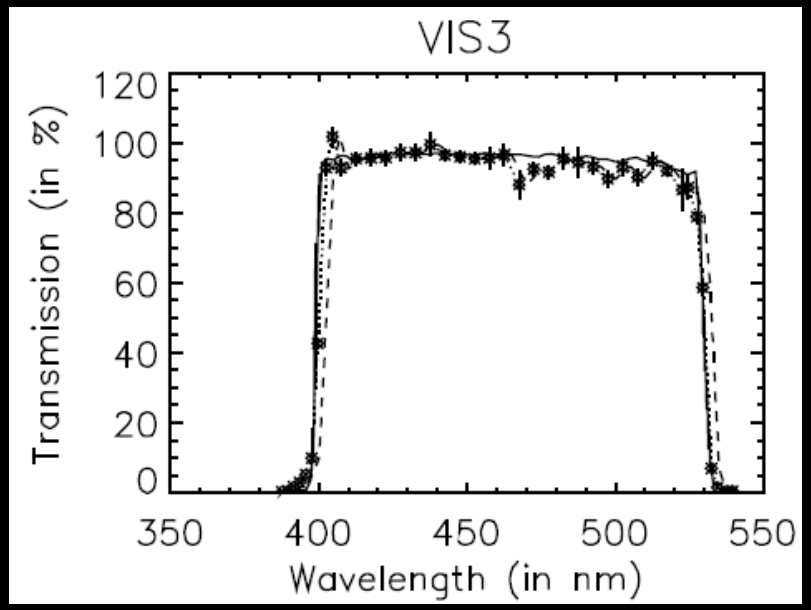
Spectral Transmission Results - VIS



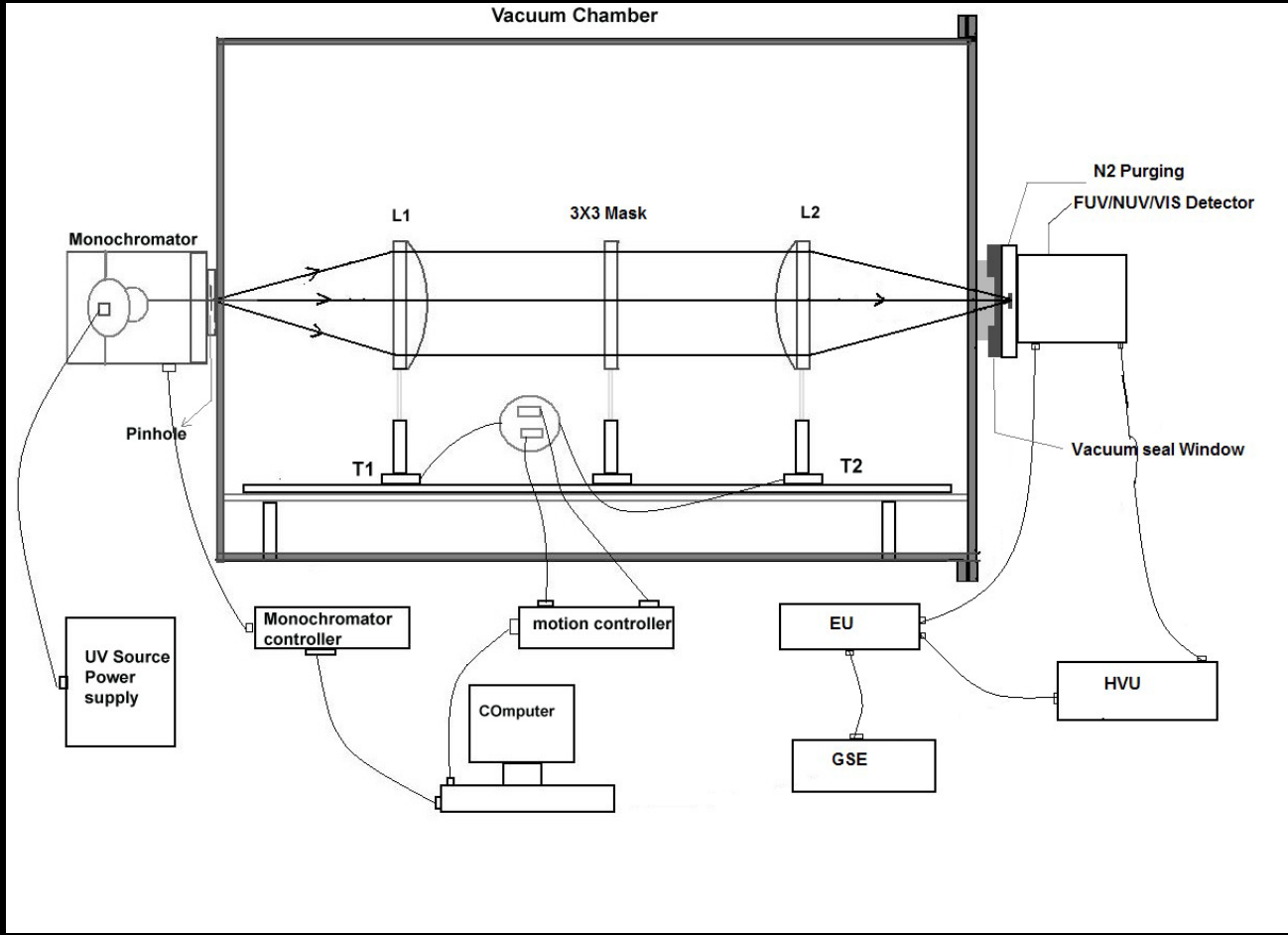






Dashed Line: Measured
Data points: Shifted by -2.5nm (offset)
Solid Line: Expected (literature/vendor)

Quantum Efficiency of Detectors -Experiments



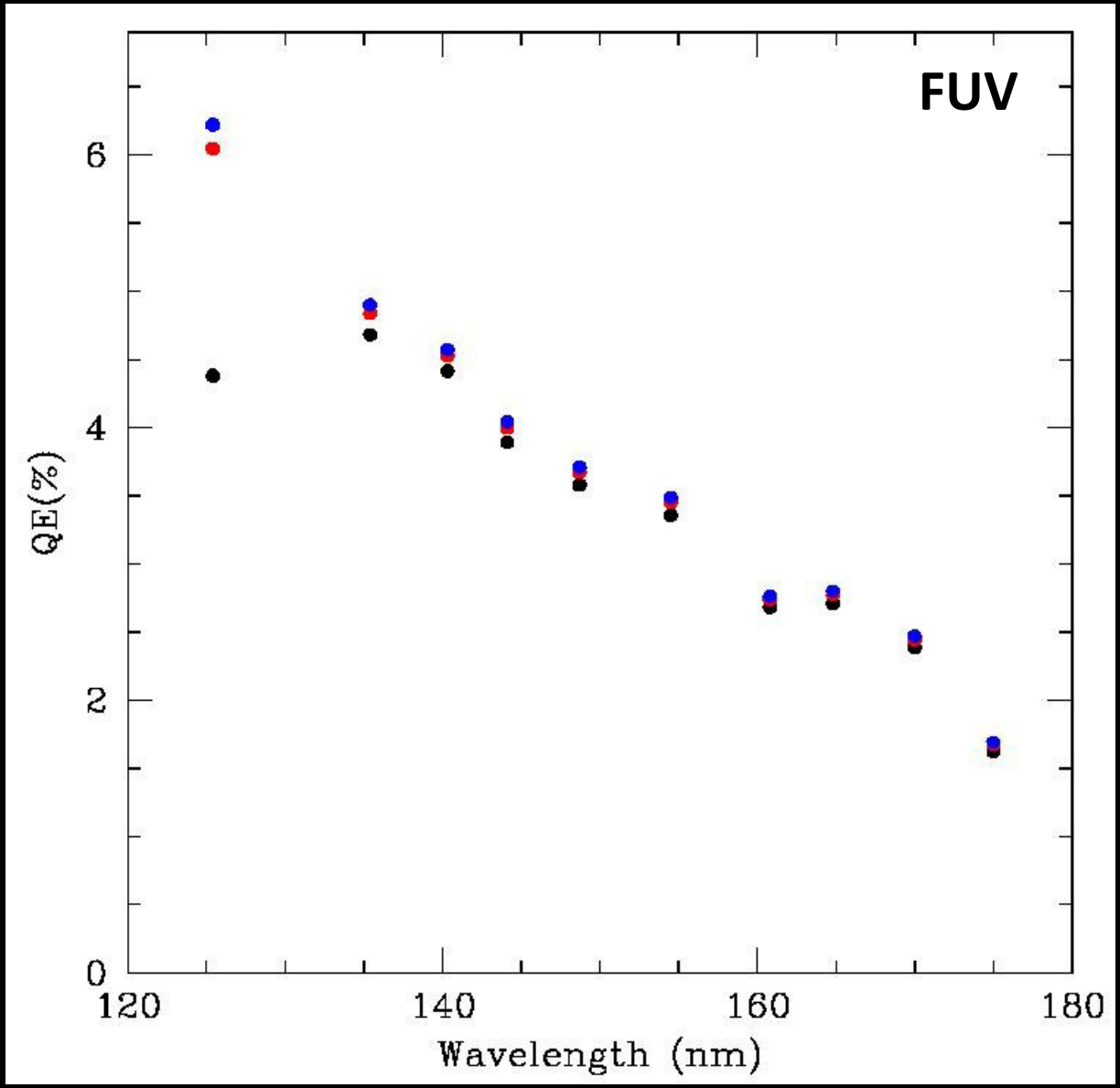
Calibration tests were carried out to measure:
1. QE of the FUV detector
2. QE of the NUV detector
3. QE of the VIS detector

The QE measurement for each detector involves two steps:
1. Measurement of the number of photons detected by the detector
2. Measurement of the total number of photons falling on the detector surface

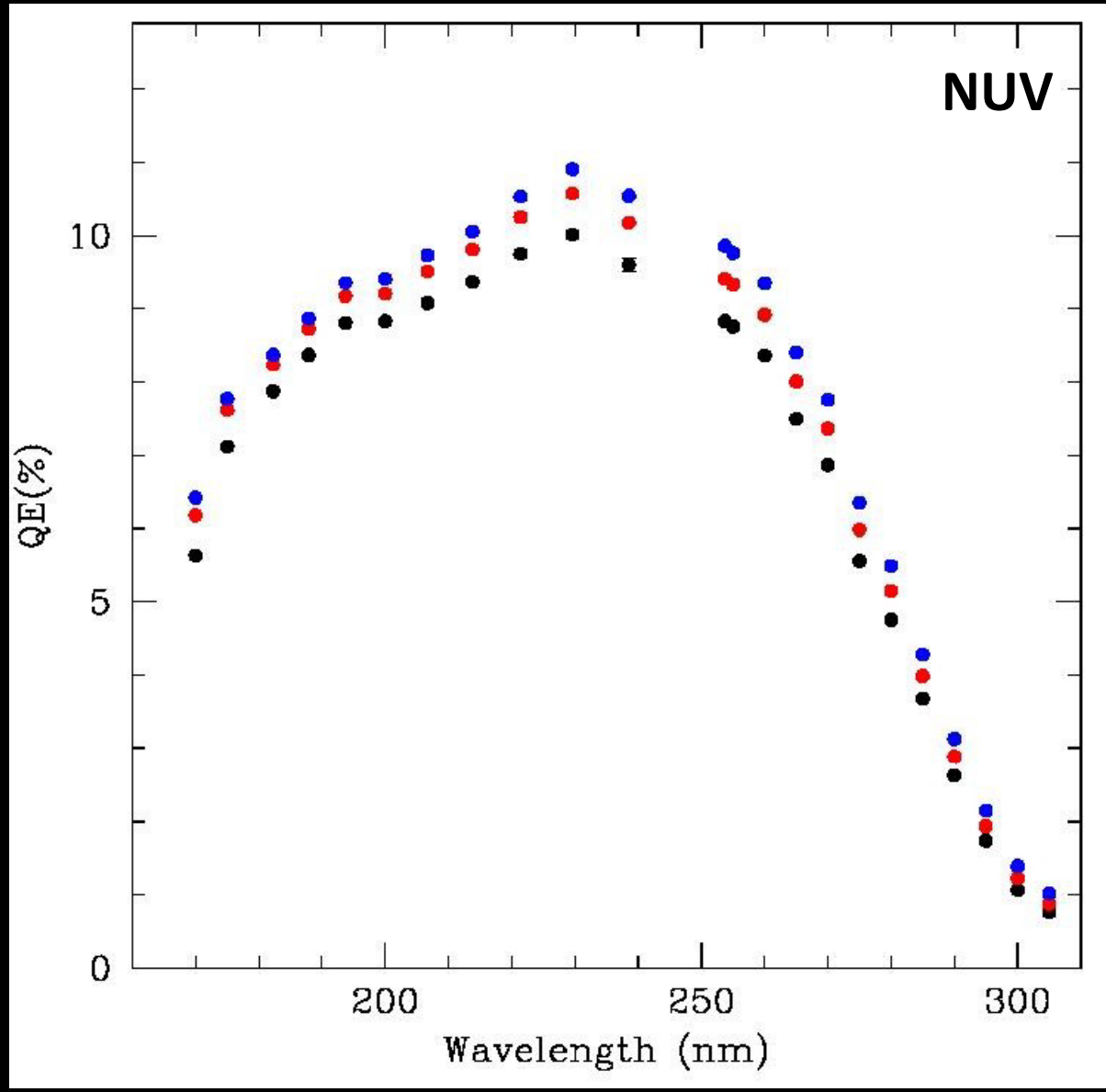
Both these tests need the same experimental conditions to be maintained

Same experimental setup is used with and without hole mask (to reduce light by 0.1% to not to saturate FM detectors); While UVIT FM detectors were used with hole mask, standard NIST diode is used without hole mask

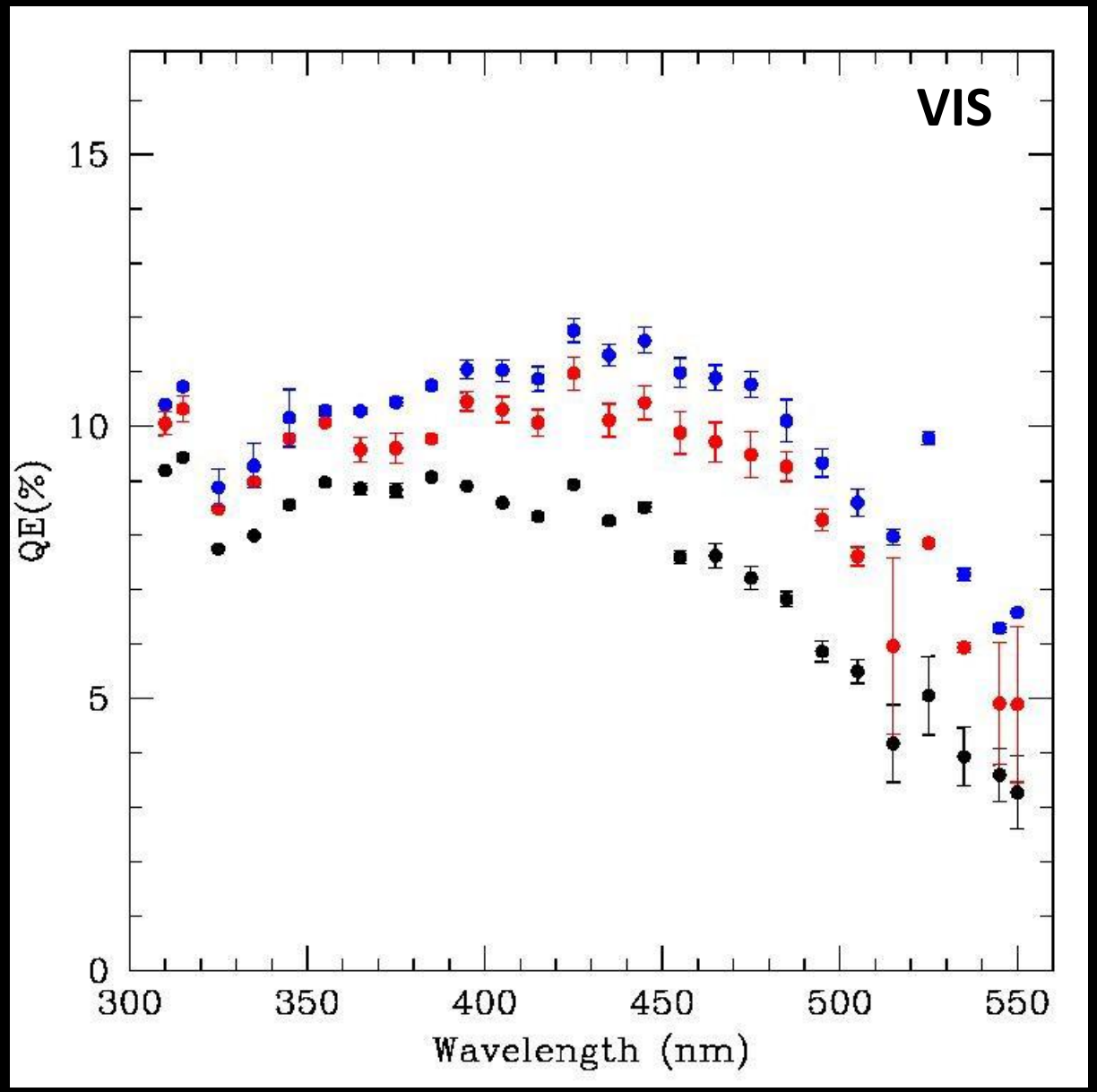
Quantum Efficiency of Detectors - Results



black dots: 30x30, red dots: 50x50, blue: 70x70



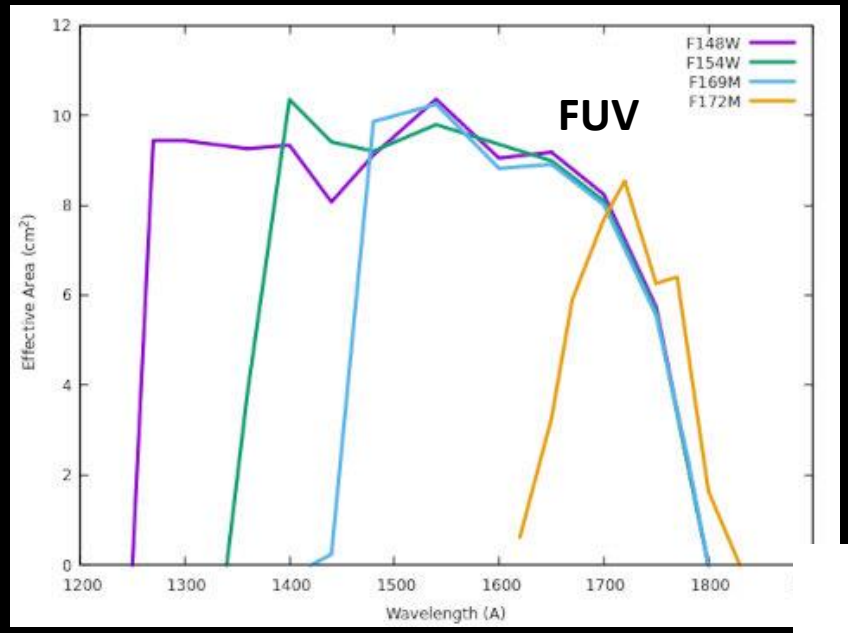
Quantum Efficiency of Detectors - Results

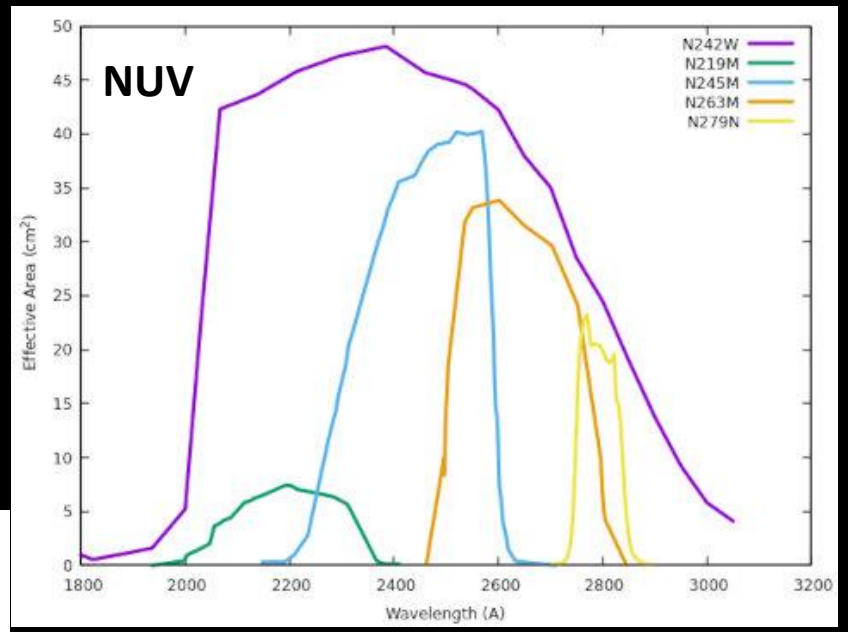


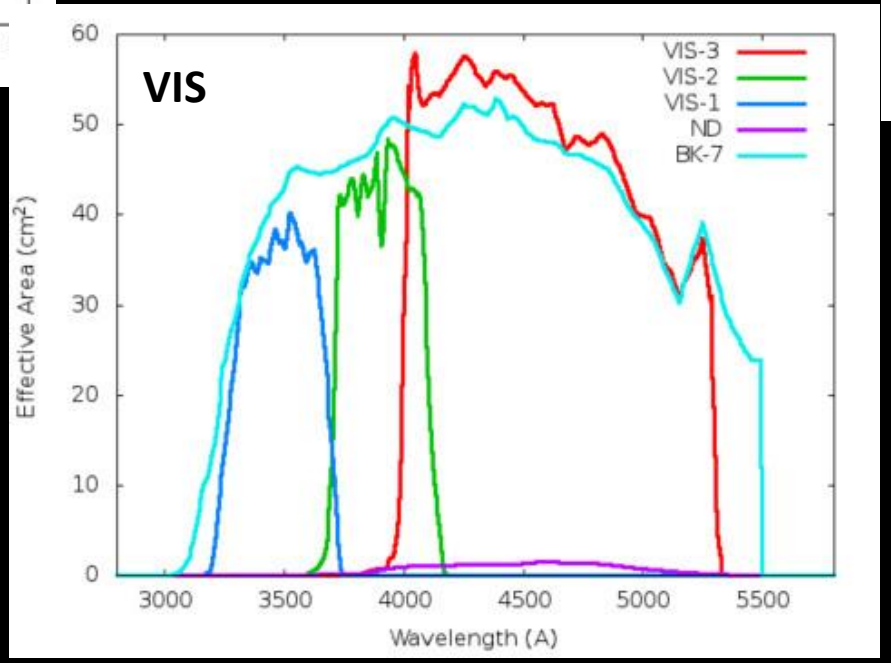
black dots: 30x30, red dots: 50x50, blue: 70x70

The Mirror, Filter Transmissions and QE of detectors are used in estimating the Effective areas of UVIT at all the wavelengths of the filters.

Effective Area Curves







Effective Area = Product of QE, the transmissions of optics, the reflectivity, and un-blocked area of the telescope