

UVIT-PMB

Optics

*Integration Alignment Tests and
Calibration*

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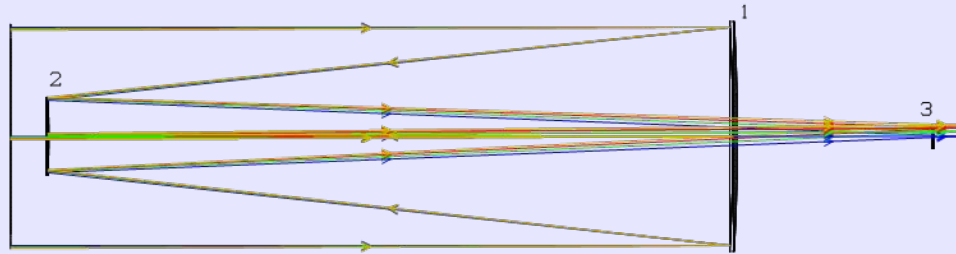
Indian Institute of Astrophysics

June 8, 2012

- ❑ Optical Integration/Alignment – FUV/NUV
- ❑ Thermal effect on Focus –FUV/NUV
- ❑ Baffle Test- NUV
- ❑ Focus Test- NUV/FUV
- ❑ UVIT Collimator- Integration/Alignment/Thermal
- ❑ Further Works to be done

UVIT - Optical Layout

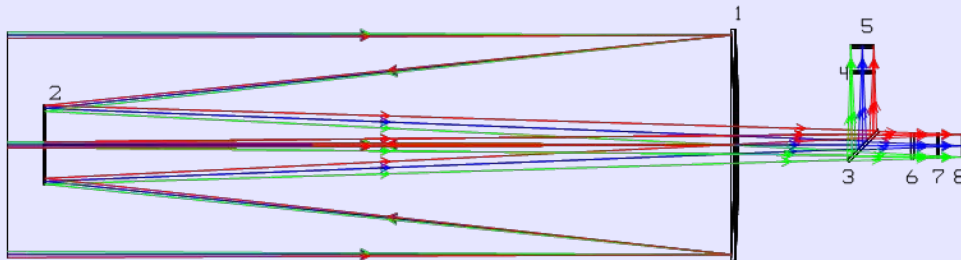
FUV Channel



- 1- PRIMARY MIRROR
- 2- SECONDARY MIRROR
- 3- FILTER
- 4- DETECTOR WINDOW



NUV/VIS Channel



- 1- PRIMARY MIRROR
- 2- SECONDARY MIRROR
- 3- BEAM SPLITTER
- 4- NUV FILTER
- 5- NUV DETECTOR WINDOW
- 6- VIS CORRECTOR
- 7- VIS FILTER
- 8- VIS DETECTOR WINDOW



Aperture : 375mm
Focal Length: 4750mm
Plate Scale: 23.2mic/arc Sec
Field: 28arc min
130 -180nm
Caf2, Baf2, Sapphire, Silica,
Grating, Block
Det.Window- MgF2

NUV: 200 -300nm
Caf2, Silica, NUV13,
NUV15, NUVB4, NUVN2
Grating, Block
Det. Window: Silica

VIS: Bk7, VIS1, VIS2, VIS3,
ND, Block
Det.Window- Bk7

Primary Secondary Optical Parameters–LEOS

Optical parameters	Primary Mirror			Secondary Mirror		
	FUV	NUV	Collimator	FUV	NUV	Collimator
Clear aperture	>376mm	>376mm	>376mm	>136mm	>136mm	>136mm
Surface Error	1/55RMS &l/8.3PTV	1/51RMS &l/9.5PTV	1/52.1RMS &l/8.0PTV	1/65RMS &l/8.2PTV	1/57.6RMS &l/8.5PTV	1/59.8RMS &l/8.4PTV
Surface roughness	<10A	<10A	<10A	<10A	<10A	<10A
Reflectivity	130-180nm	180-200/ 200-600nm	130-180nm	130-180nm	180-200/ 200-600nm	130-180nm
	>60%	>70%/ 80%	>60%	>60%	>70%/ 80%	>60%
	73.5%	83.5/88.1%	73.9%	73.1%	80.4/87.8%	73.7%

FUV Primary: R @ 200 to 300nm: ~83.3%

Mirror Assembly & Mechanical Interface

Mirror Assembly-LEOS

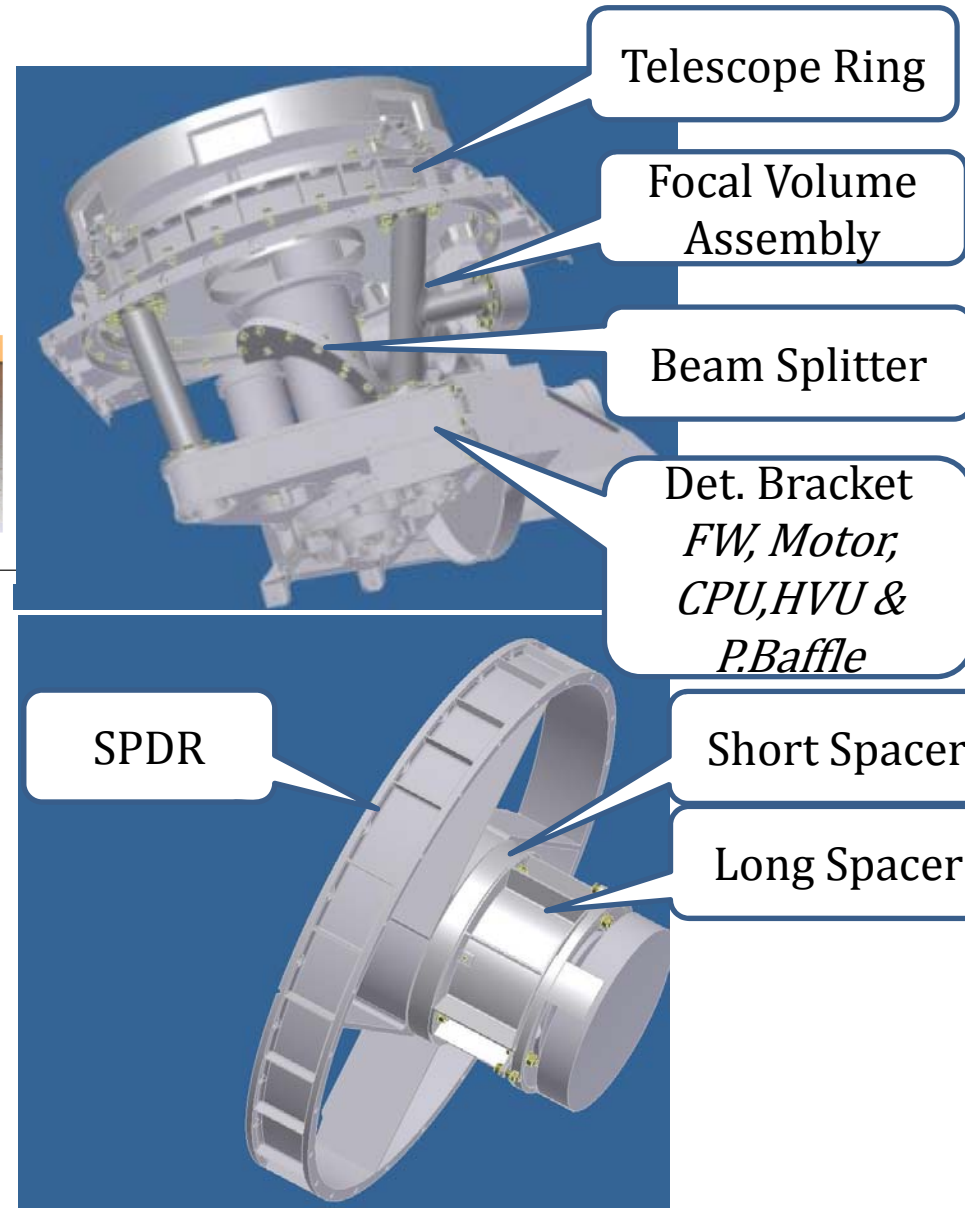


Mirrors are tested and qualified by LEOS on Optical, thermal & Vibration aspects

NUV telescope Integration Started with Focal Volume Assembly/NUV PMA

PMA Placed on TR (Six point Support)

Torque & Look for Distortion on Mirror Surface

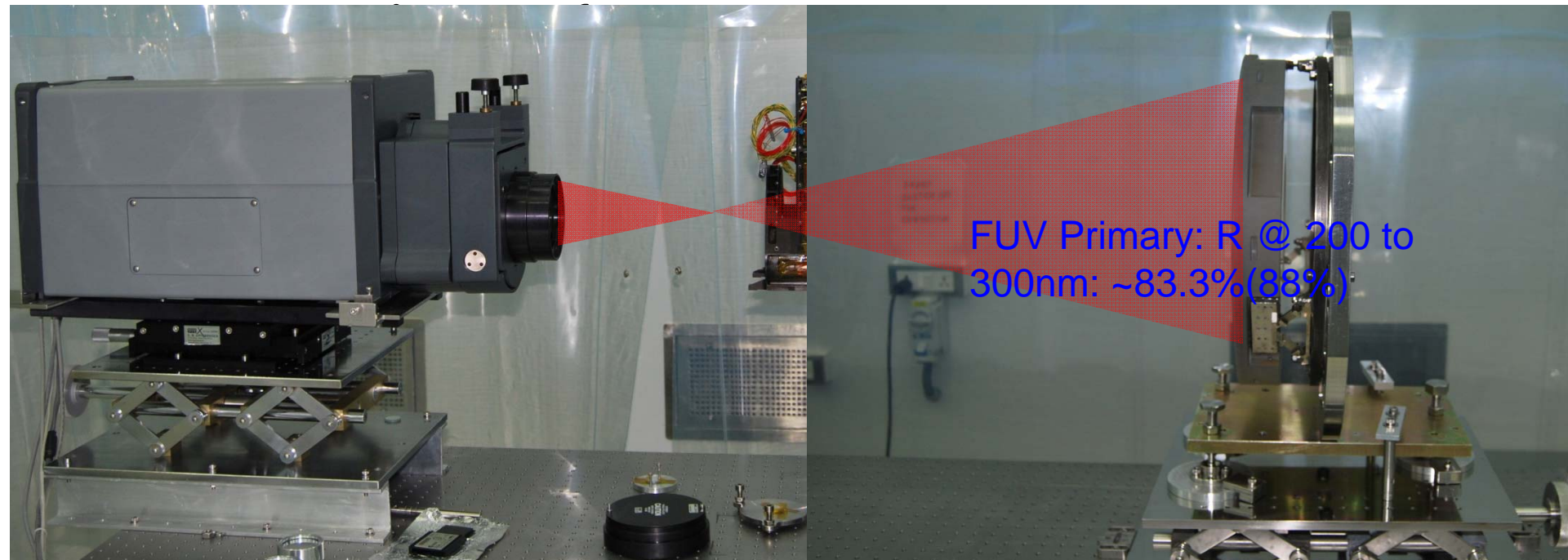


Alignment Requirements

To meet 1 arc sec resolution for Optics

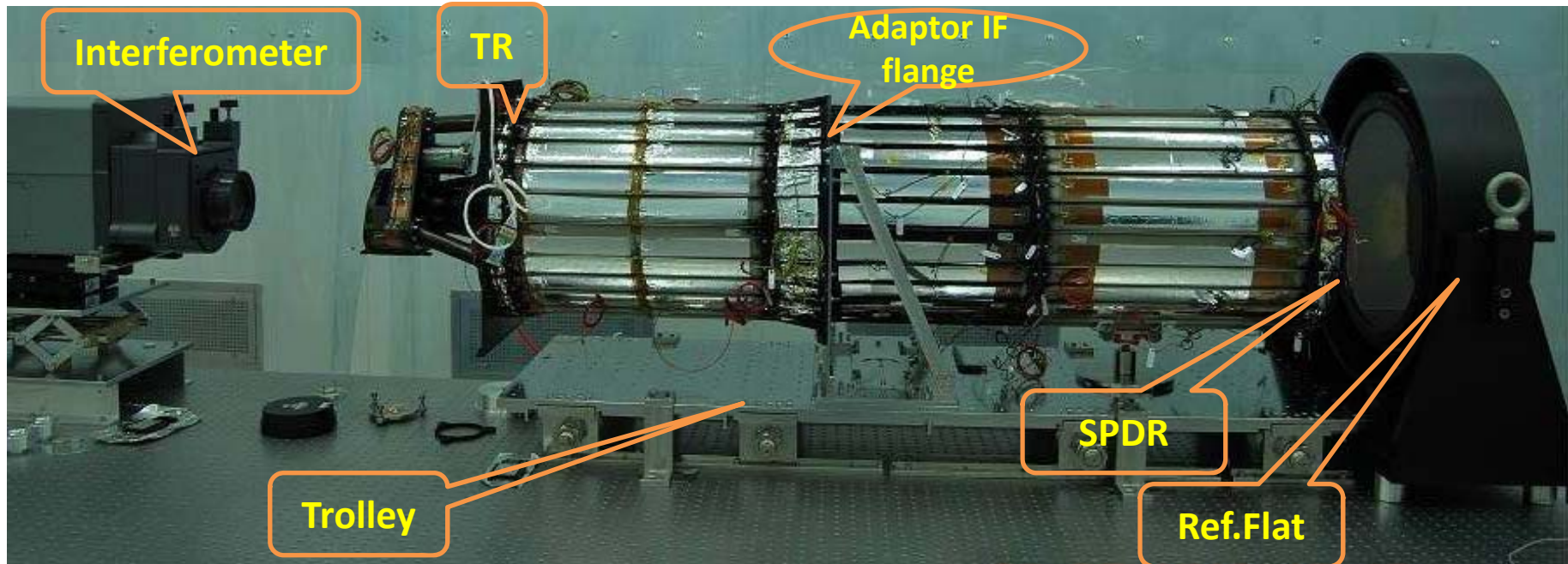
- Secondary to be aligned to the optical axis to have coma $<0.1\lambda$ on wavefront
 - Residual Astig $<0.2\lambda$ on wavefront
 - Primary -Secondary Separation correct to 0.1mm
 - Axial position of the detectors should be correct to ± 0.05 mm (averaged on all the filters and their wave band)
 - Plane of the detector perpendicular to optical axis to $<6'$
- ☐ Center of Field to be brought to the center of Detector $<30''$**

PRIMARY MIRROR TESTING LEOS/IIA



- FUV/Collimator mirror tested for Coma: Coma $< 0.02 \lambda$
- ❑ FUV Primary – NUV Secondary for NUV Telescope
- ❑ Collimator Primary – FUV Secondary for FUV telescope
- ❑ NUV Primary – Collimator Secondary for Collimator (*Allows large shift of Secondary for correcting coma*)

Interferometric test setup



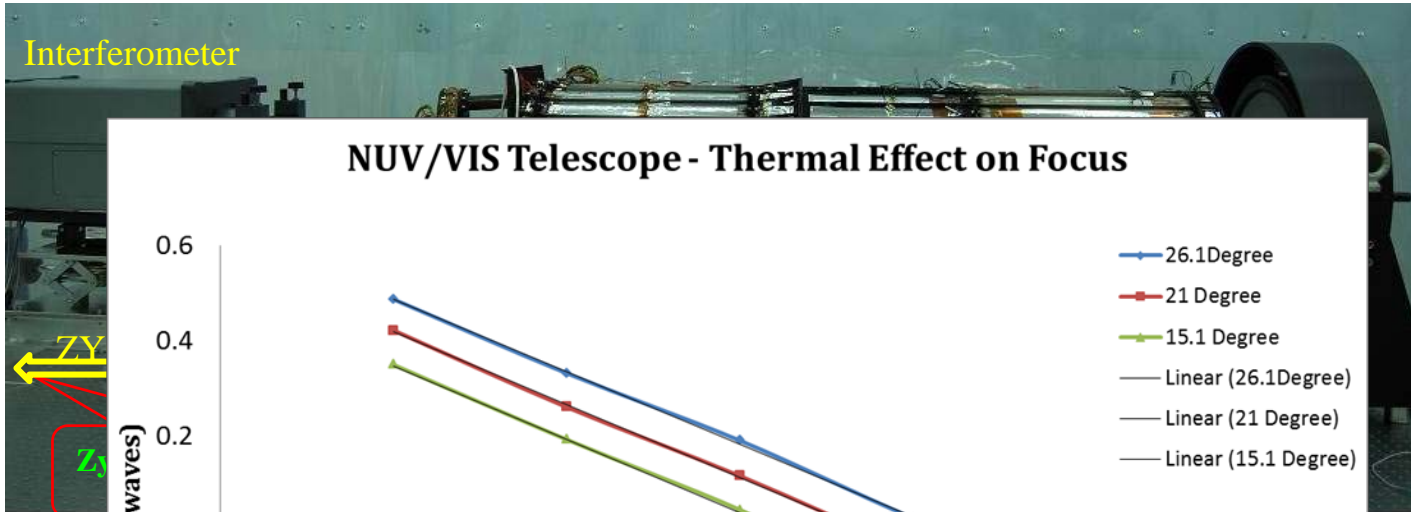
- Telescope Mounted on Moving trolley with support taken from Satellite Adaptor interface flange
- Telescope axis is established by theodolite and Interferometer is aligned to telescope axis
- Secondary assembly is attached to telescope tube and aligned to have minimal coma and field center
- Field Center is measured by Reference flat /Theodolite

Alignment Achieved - NUV Telescope

- Coma $\sim 0.02 \lambda$ ($< 0.1 \lambda$)
- Residual Astig: 0.07λ (0.2λ)
- Field Center ~ 20 arc Sec (< 30 arc Sec)
- Primary /Secondary Inter Separation
50micron(< 100 micron)

ie., Deviation of Focus away from the target
 < 0.5 mm

Thermal Effect on Focus

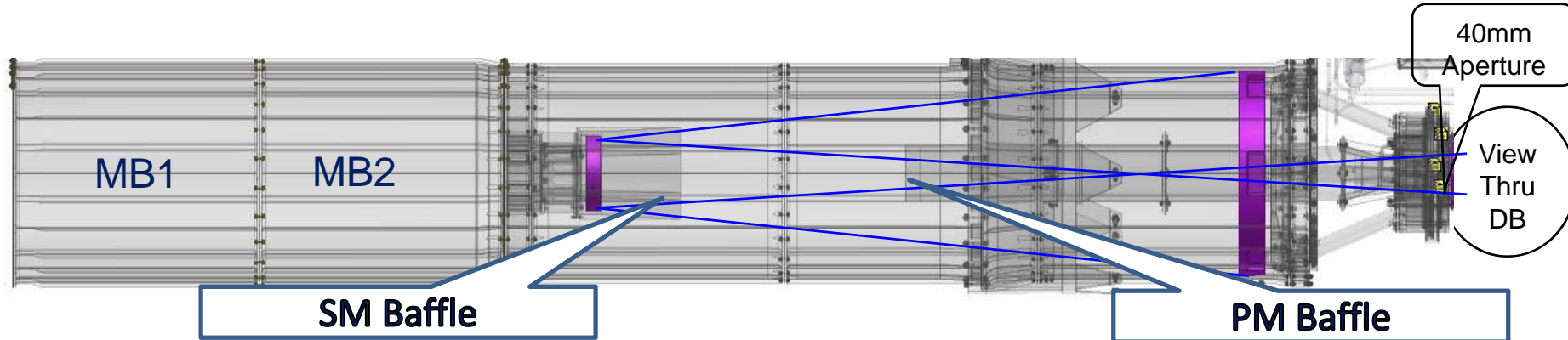


ZYGO Position (mm)	Temperature					
	60% ENE Radius (micron)	24.00	24.25	24.50	24.75	25.00
24.00	32.4					
24.25	26.1					
24.50	20.1					
24.75	15.0					
25.00	17.7	0.125	15.8	-0.041	14.8	0.000
25.25	22.9	-0.285	15.8	-0.186	15.8	-0.100
25.50	28.8	-0.406	22.6	-0.348	22.5	-0.200
25.75	36.5		31.3		28.8	
26.00	43.8		38.4		36.7	

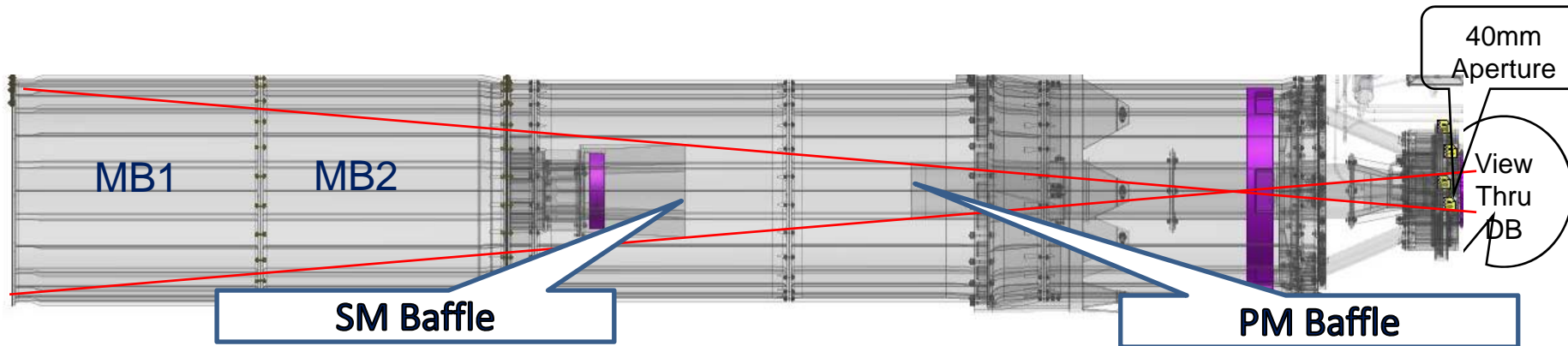
Focus Shift <25 micron/C

Baffle Test

- a) From any point of the 40 mm dia aperture near the window of the VIS-CPU
- Complete PM should be seen through SM - **YES**
 - Outside the Secondary baffle should not be seen directly - **YES**



Baffle Test- Contd..

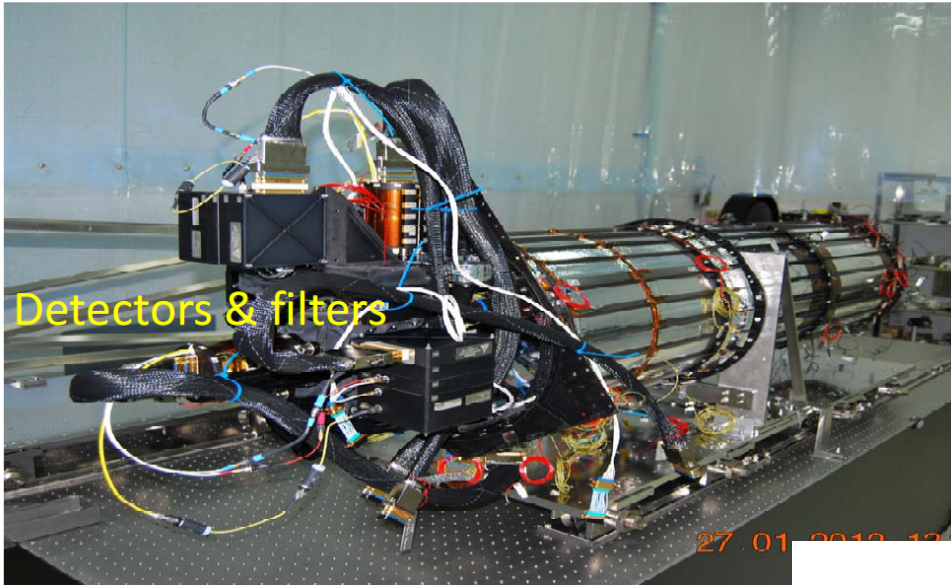


Edge of the Main baffle, via reflections in PM and SM, should not be seen – **YES** [at radii $>(\text{ID of the M-baffle} - 2 \text{ mm})$]

b) From behind the SM

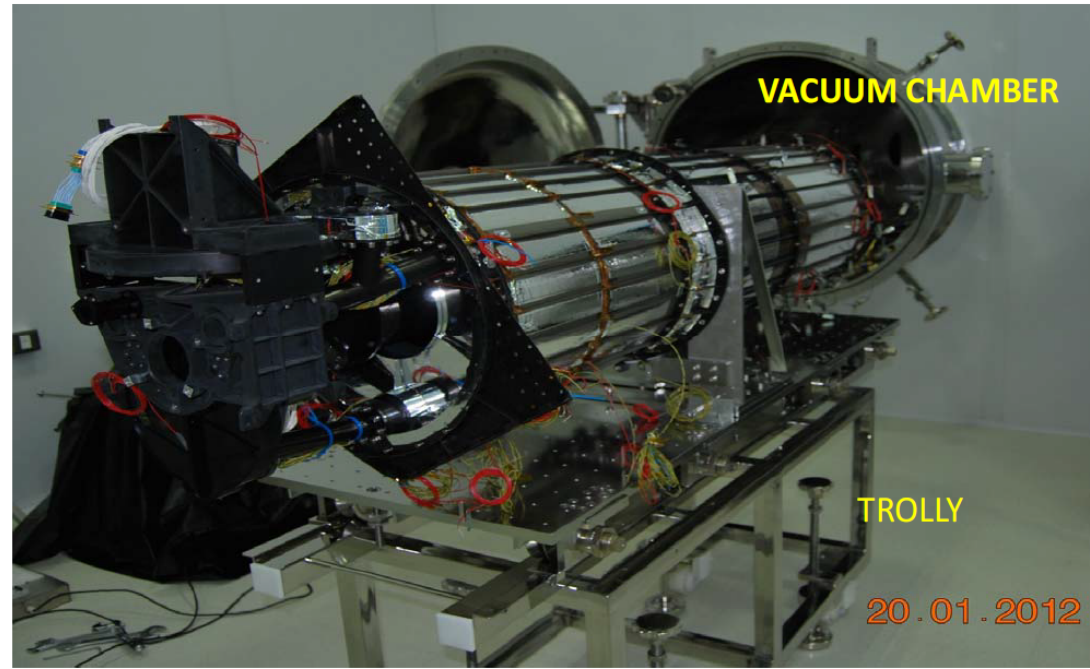
Every point of the 40 mm dia aperture should be seen via reflection from every point of PM. - **YES**

NUV/VIS Telescope of UVIT at CREST, IIA



Readiness for Focus Test

NUV/VIS telescope of UVIT
being placed in vacuum chamber at CREST, IIA



Telescope Focus test setup

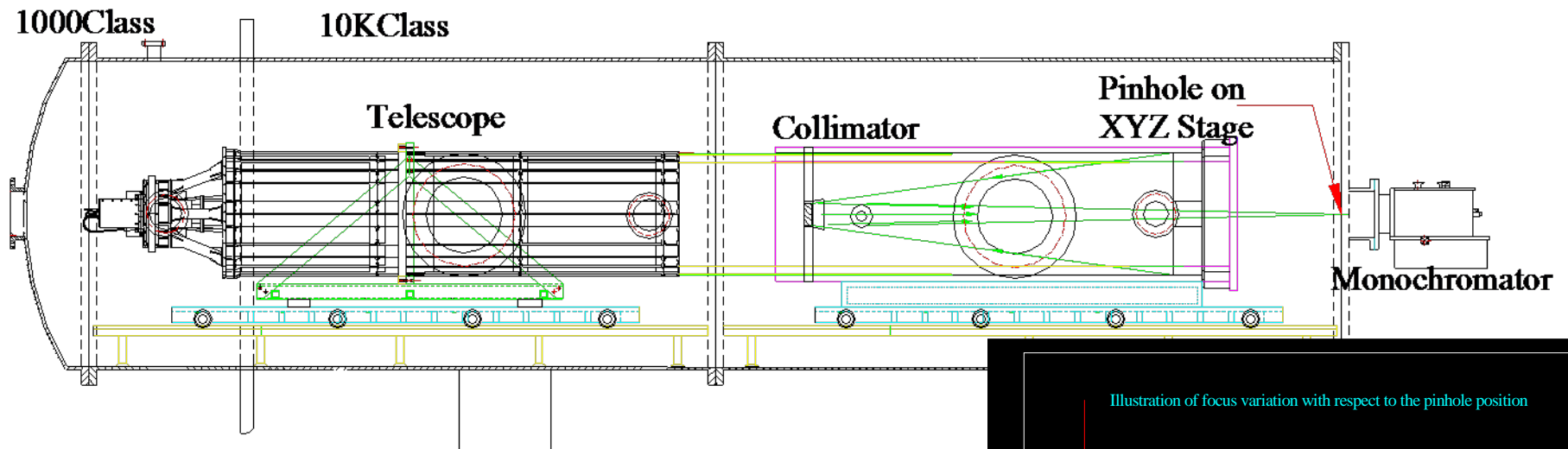
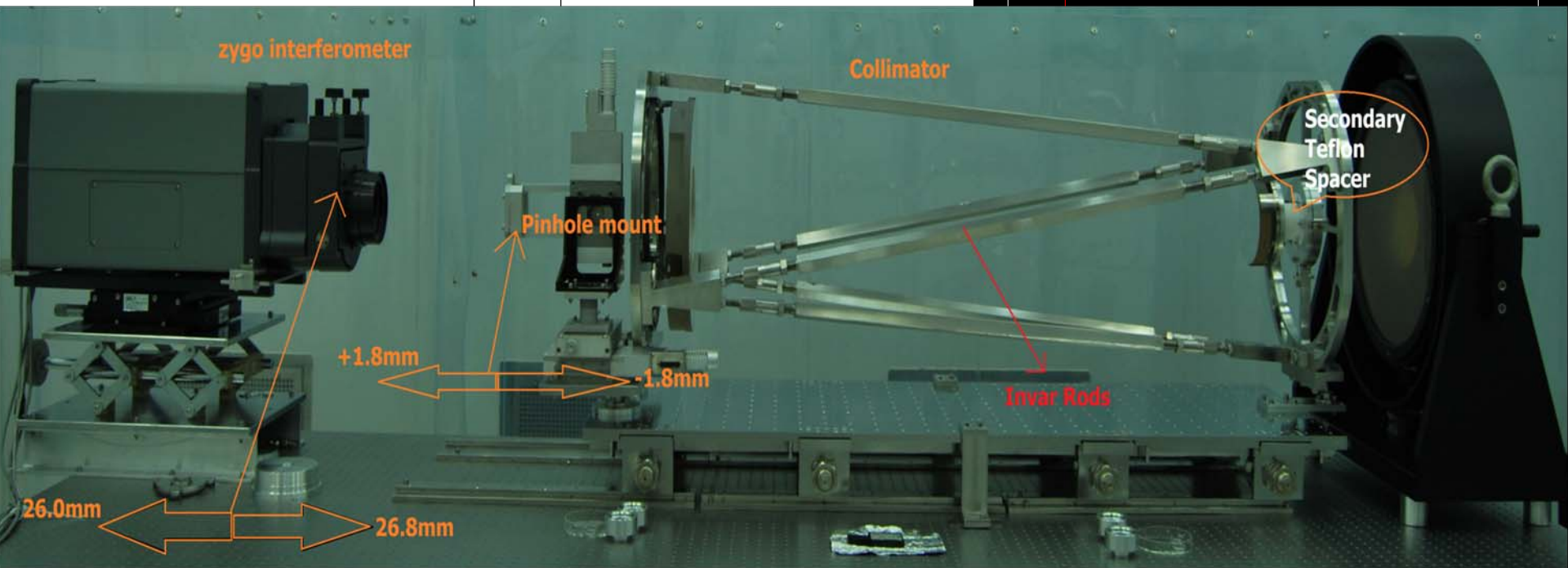


Illustration of focus variation with respect to the pinhole position



Focus Test Results

NUV Detector

Field : ON/Off axis

Filter Name: Silica

$\lambda = 250\text{nm}$

Resolution <1.4 " (1.8")

V: 90° 12' 24", Hz: 180° 30' 09"

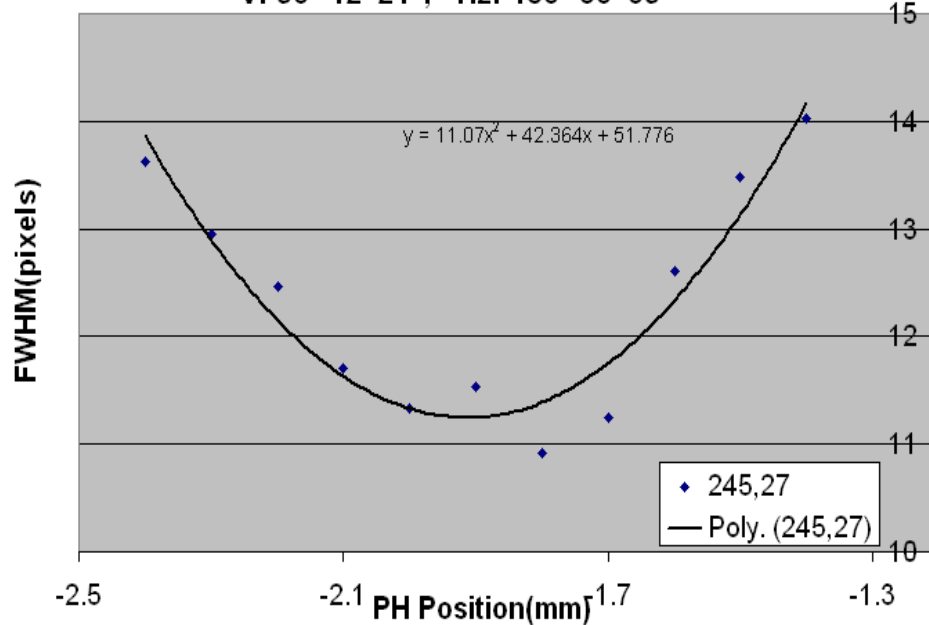


Image Position		PH Position (mm)	FWHM (Pixels)
X	Y		
265.806	469.06	-1.87	8.40
28.4422	249.935	-1.88	9.89
255.489	242.691	-1.61	10.26
492.229	247.087	-1.87	8.04
245.982	27.1857	-1.91	11.25

NUV Detector- Filters focus Position

Field : ON axis

Filter Name	Wavelength	Focus	FWHM
Silica (3.0)	$\lambda=250\text{nm}$	-1.554	11.605
Silica (3.3)	$\lambda=275\text{nm}$	-1.503	9.505
NUV B13	$\lambda=250\text{nm}$	-1.494	11.199
NUV N2	$\lambda=280\text{nm}$	-1.494	10.647
NUV B4	$\lambda=265\text{nm}$	-1.454	9.685
NUV B15	$\lambda=220\text{nm}$	-1.704	16.112

Focus Test Results NUV-VIS

VIS Detector, Silica Filter, 250nm

Image Co-ordinates		FWHM	
X	Y	-1.76mm	-1.64mm
265.806	469.06	8.5	10
255.489	242.691	10.5	10
28.4422	249.935	10	11
492.229	247.087	8.5	10
245.982	27.1857	11	12

NUV Detector, BK7 Filter, 400nm

Image Co-ordinates		FWHM	
X	Y	-1.76mm	-1.64mm
253.689	46.5414	8.5	8.5
254.847	273.005	9	9
23.6008	272.548	9	9
492.402	260.589	9.5	10
255.4052	488.701	10	10.5

0.105arc sec/unit

FUV Telescope

FUV Telescope is integrated & aligned with interferometer

Filter wheel, Motor, CPU & HVU are integrated

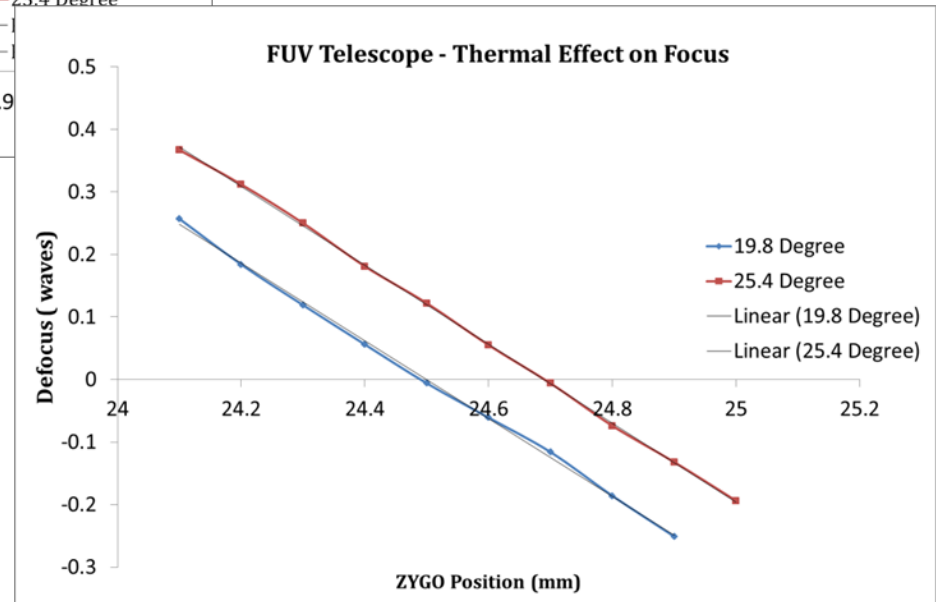
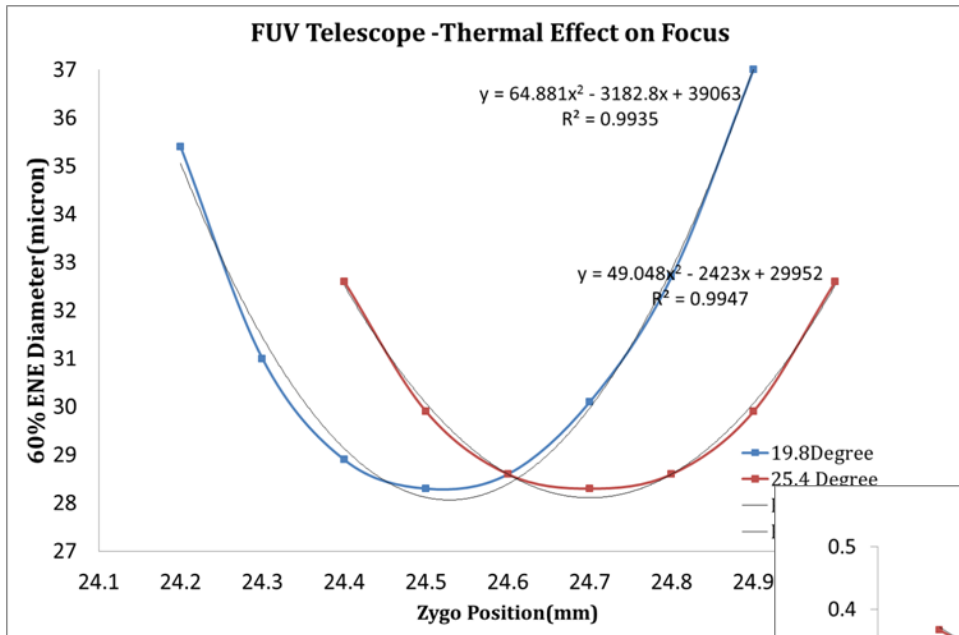
Telescope is moved inside the chamber for Focus test

Alignment Achieved - FUV Telescope

- Coma $\sim 0.02 \lambda$ ($< 0.1 \lambda$)
- Residual Astig: 0.04λ (0.2λ)
- Field Center ~ 10 arc Sec (< 30 arc Sec)
- Primary /Secondary Inter Separation
50micron(< 100 micron)

ie., Deviation of Focus away from the target
 < 0.2 mm

Thermal Effect on Focus-FUV TELESCOPE



Focus Shift <
189micron/5.6 Deg

Preliminary FWHM for FUV

Filter Name	Wavelength	Focus	FWHM
Caf2	$\lambda=150\text{nm}$	-1.50	13.5
Caf2	$\lambda=150\text{nm}$	-1.49	14.6
Sapphire	$\lambda=160\text{nm}$	-1.39	15.6
Silica	$\lambda=170\text{nm}$	-1.49	12.1
Baf2	$\lambda=150\text{nm}$	-1.32	14.5

Integrated UVIT Payload in 100Class

NUV/VIS Telescope

FUV /VIS Focal Volume

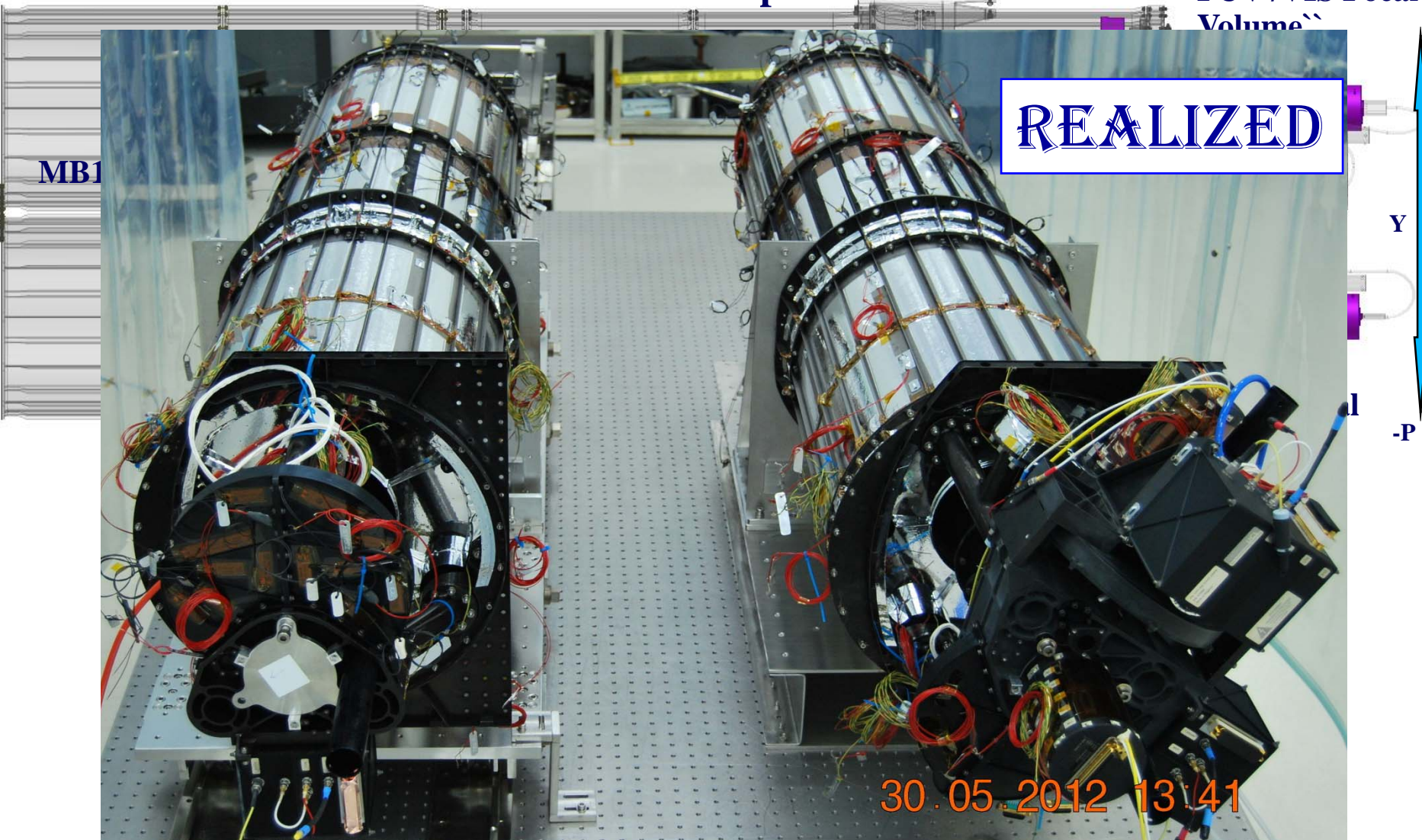
REALIZED

MB1

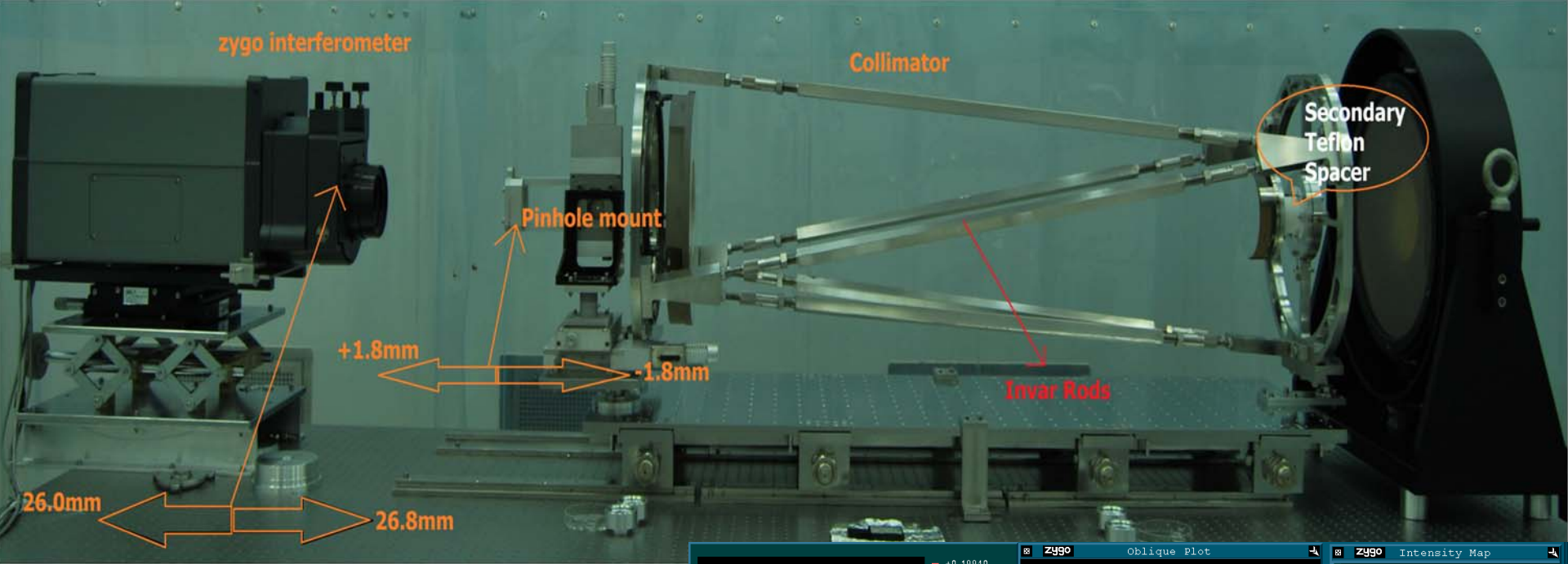
Y

-P

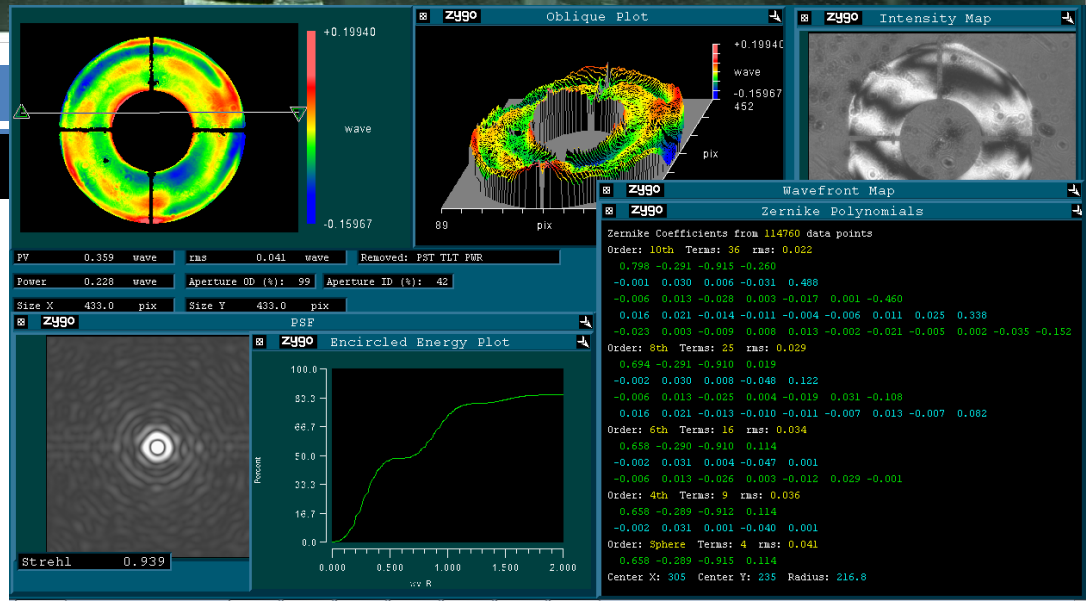
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UV Collimator

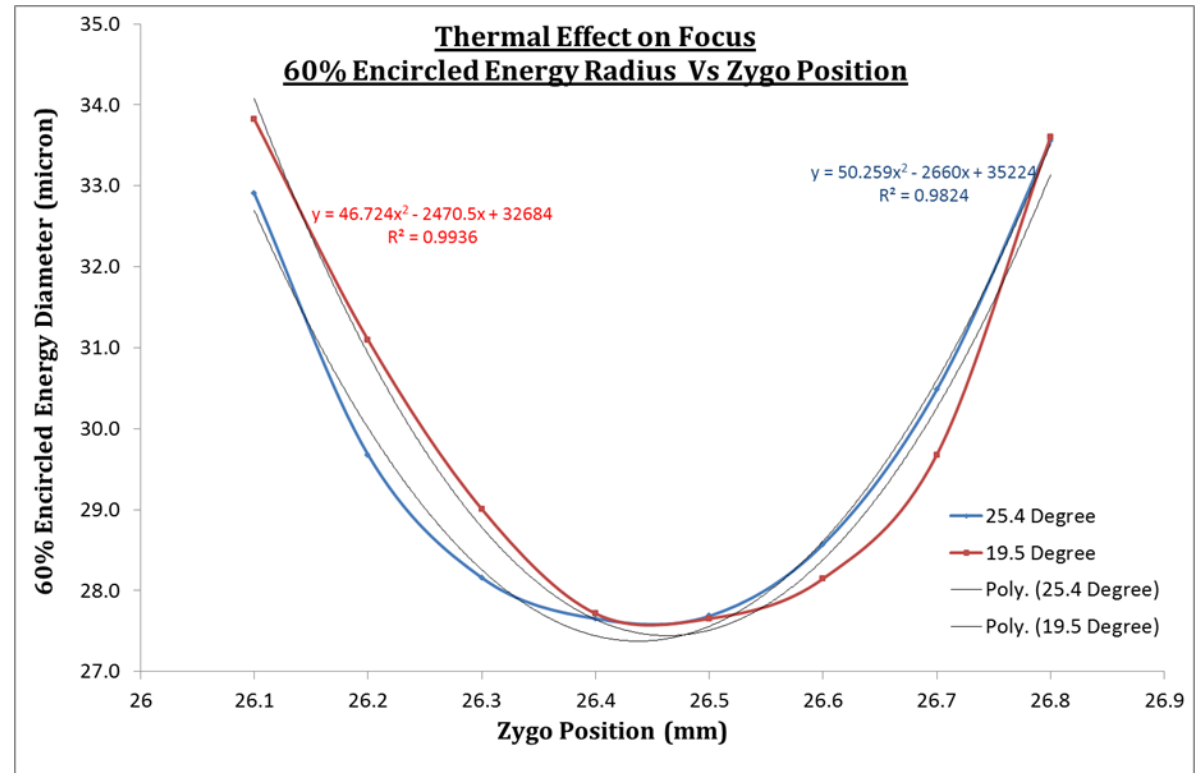


X-Astig	Y-Astig	X-Coma
-0.001	0.030	0.006



UV Collimator- Thermal Effect on Focus

Zygo Position (mm)	Temperature	
	25.4 Deg	19.5 Deg
	ENE Diameter @60%(micron)	ENE Diameter @60% (micron)
26	38.0	
26.1	32.9	33.8
26.2	29.7	31.1
26.3	28.2	29.0
26.4	27.7	27.7
26.5	27.7	27.7
26.6	28.6	28.1
26.7	30.5	29.7
26.8	33.6	33.6



Focus Shift: 26micron/5.9Degree

Further Work

- FUV Focus Test
- Alignment between Telescope on Satellite Adaptor
- Sensitivity test
- Alignment Checks at ISITE post environmental test

Beam Splitter

Dichroic beam splitter UVIT

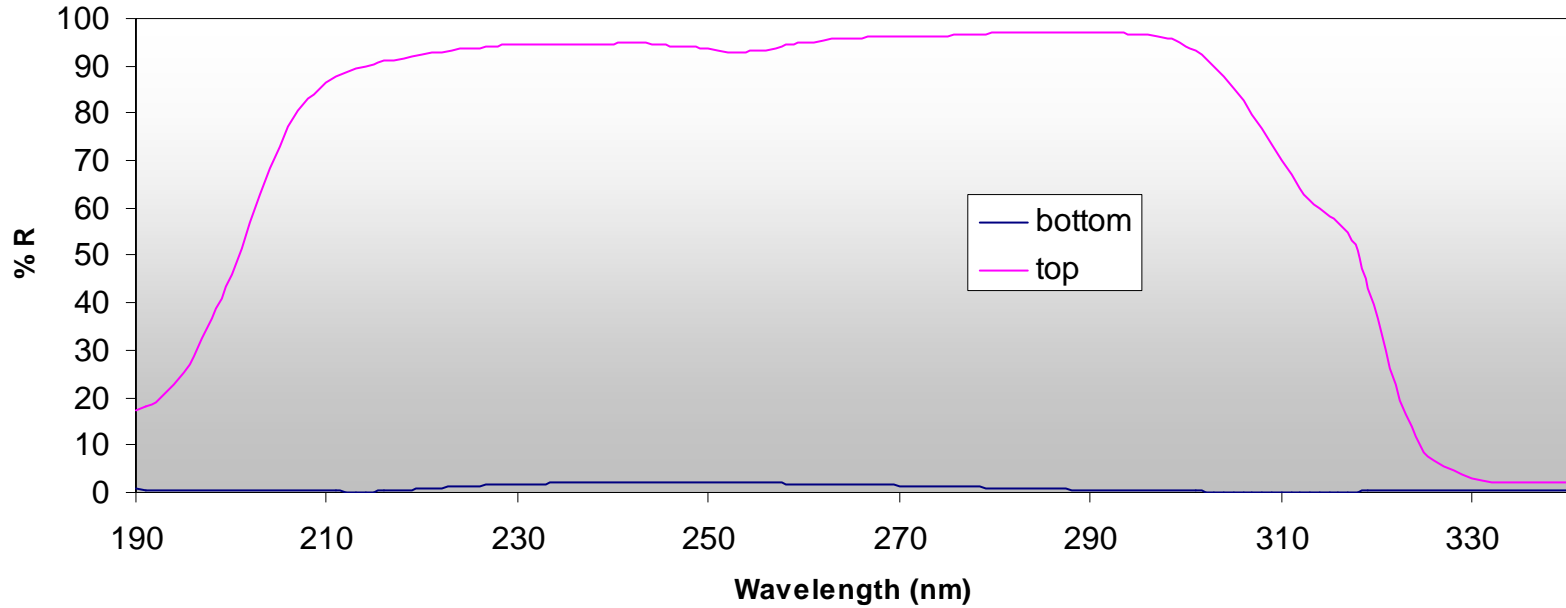
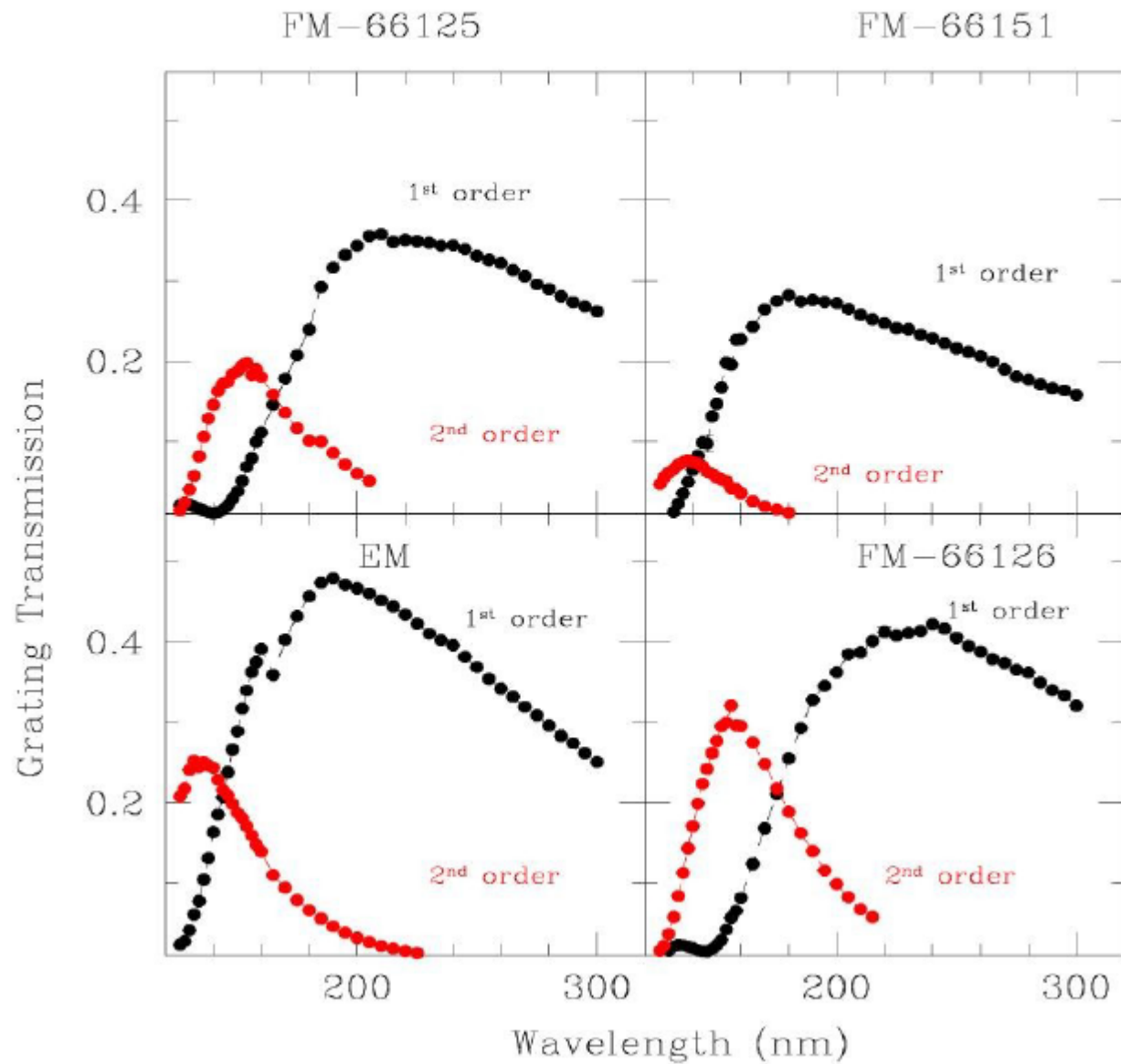
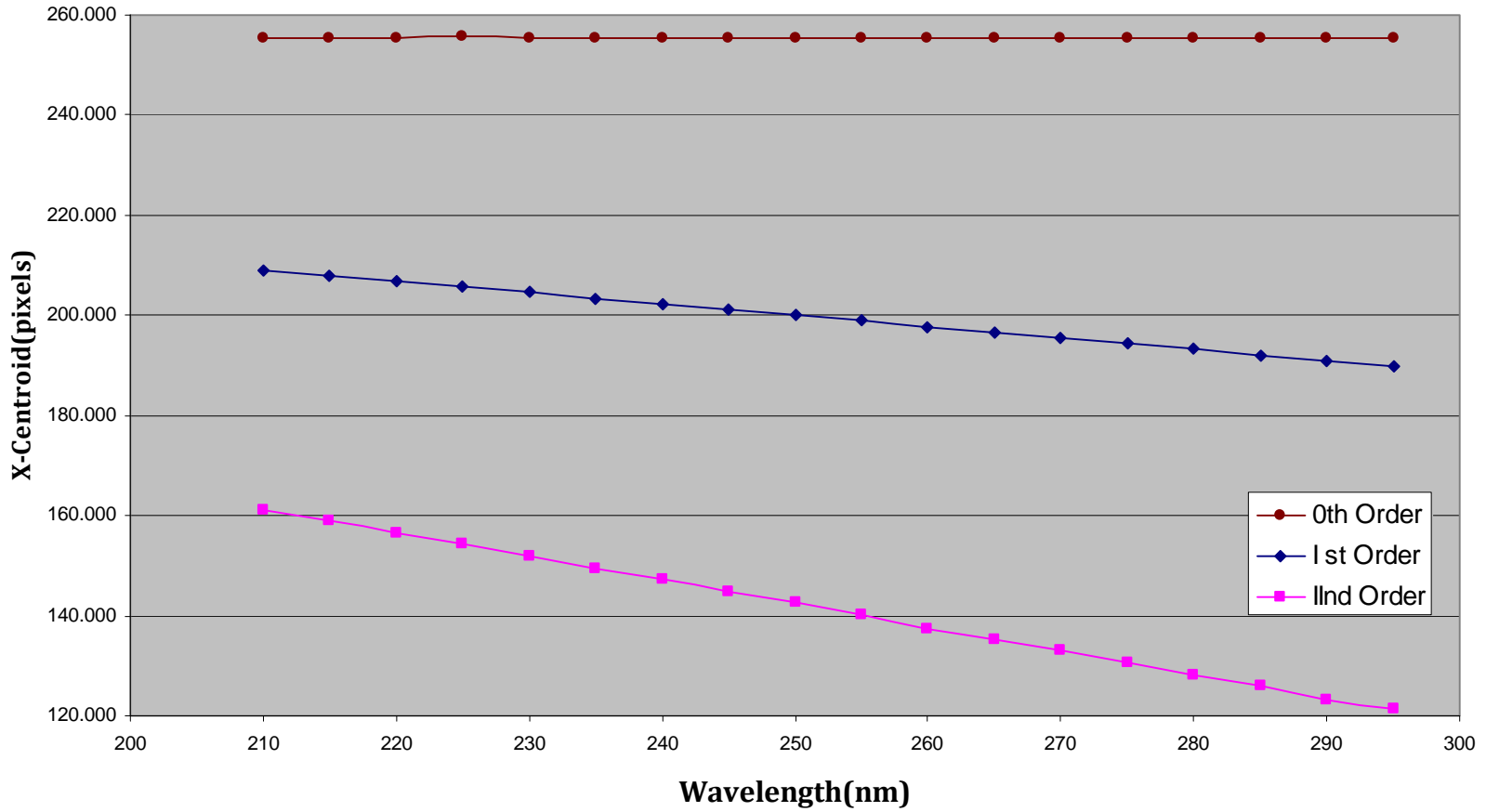


Fig 3. Transmission results for the EM and FM gratings of UVIT. The names of the grating are given in each panel. (C.S Stalin)



Grating Dispersion FM-66126



ND FILTER 1

