E-NIS Instrument Description

Filippo Maria Zerbi
On behalf of the ENIS Team

Top Level Requirements

	Slitless Baseline	DMD Option
Accuracy in redshift	$\sigma_{\Delta z} \leq 0.001(1+z)$	
Survey Area	> 20,000 deg^2	
Statistics and Depth	(4-6)x10^7 #galaxies @H<19.5 (AB)[1]	1.5x10^8 #galaxies @H<22.0 (AB)

Wavelength Range	1.0-2.0 microns	0.9-1.7 um (baseline) 0.8-1.8 um (goal)
Spectral Resolution	500 (constant. Res.element 2 pixels)	400 (min 300 max 600 across the wavelength range, Variation over FoV < 5-10 %)
Pre-imaging	Required for: • Associate the emmission lines in the dispersed image with a counterpart in teh field • Provide position of teh objects • Provide zero-point in the wavelength scale • Remove ambiguitieswith zero order spectra contamination • Give object size and orientation.	Required for: • On-Board Target Selection.
PSF	Better than 80% EE in 1 arcsec (Imaging mode), better that 80% EE in one detector pixel (spectroscopic mode)	
Level of Straylight in the FoV	<20% Zodiacal Light at ecliptic poles	<10% Zodiacal Light at ecliptic poles

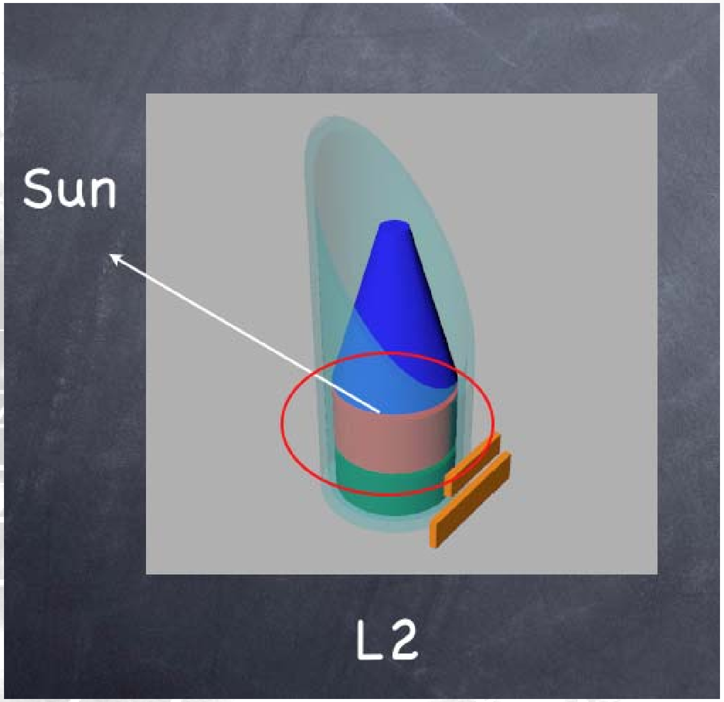
Study Guidelines

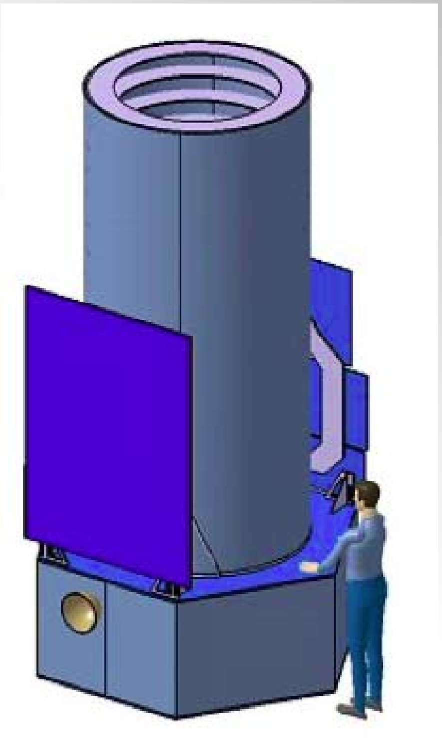
E-NIS has carried out at System and Subsystem level 2 parallel studies

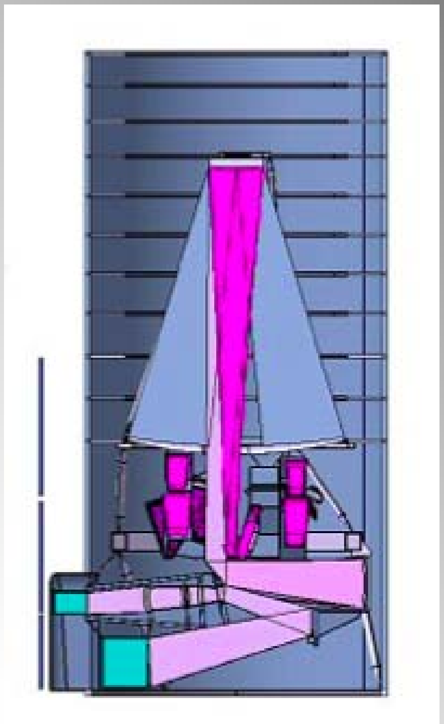
Baseline
- -Slitless Spectrograph
- -R=500 between 1.0 and 2.0 um
- -FoV 0.5x1.0 sqdeg
- -8 detector chips
- -Dispersion obtained via Grism
- -Counter-dispersion for Imaging
- -Extraction based on Roll Angles (or Multiple Filters)
- -Limited pre-processing on board (cosmic-ray hits flagging)

DMD Option
- -Multi-slit Spectrograph
- -4 arms (2 arms under study)
- -8 detector chips
- -R=200-400
- -Wl Range 0.9-1.7 um
- -FoV 0.43 sqdeg (4x 0.23x0.5)
- -Dispersion obtained via Grism
- -Pre-Imaging mode available
- -Pre-processing on-board (T.S.)
- -Downlink limited to processed data

Environment



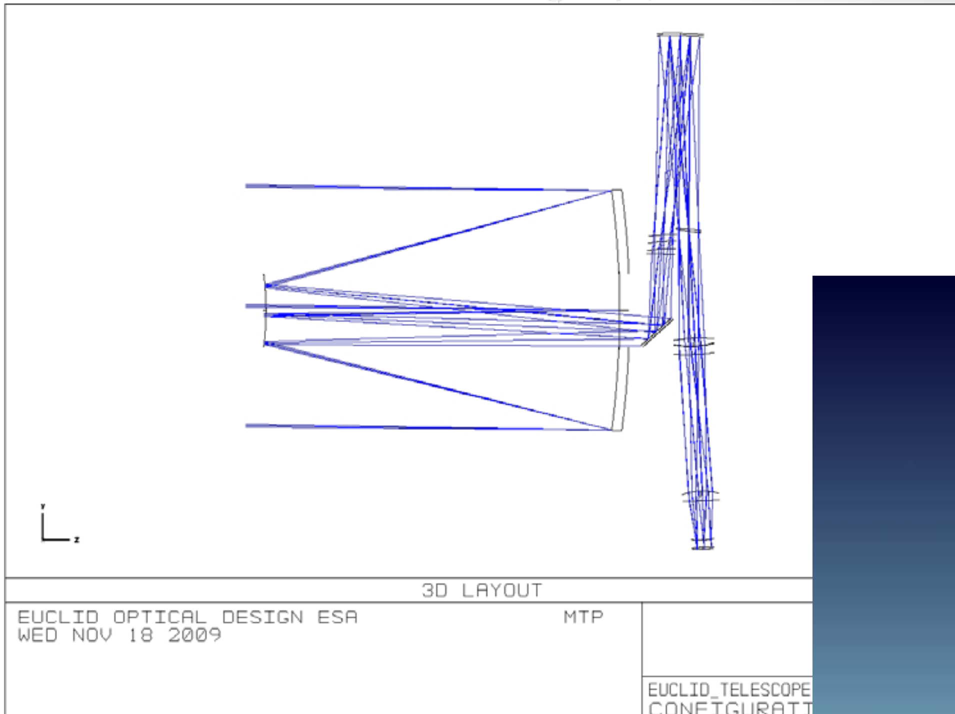




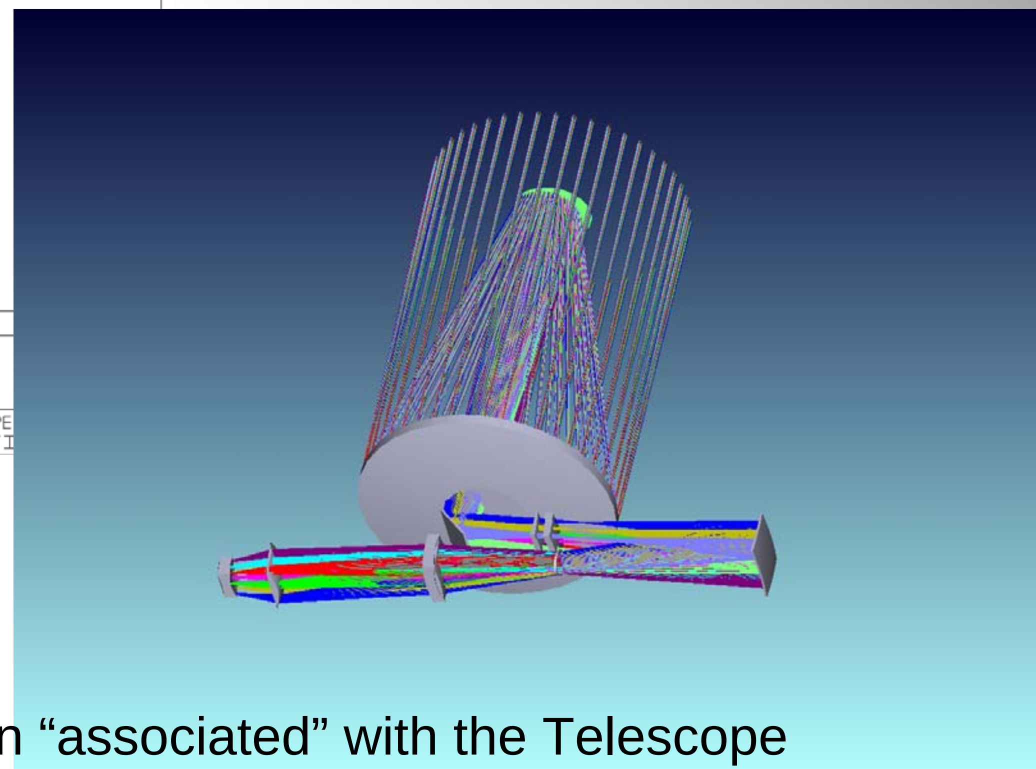
Volume Allocation	Cylinder of 2100 mm diameter and 1100 mm height
Mass Allocation	125 Kg (110 Kg +15 KgHarness)
Power Allocation	110 W (electrical Power)
Cooling Power	90 W
Data-Rate allocation	120 Gbit/day

Table 5-1 Allocated Budgte Assumption for E-NIS

Telescope and reference design

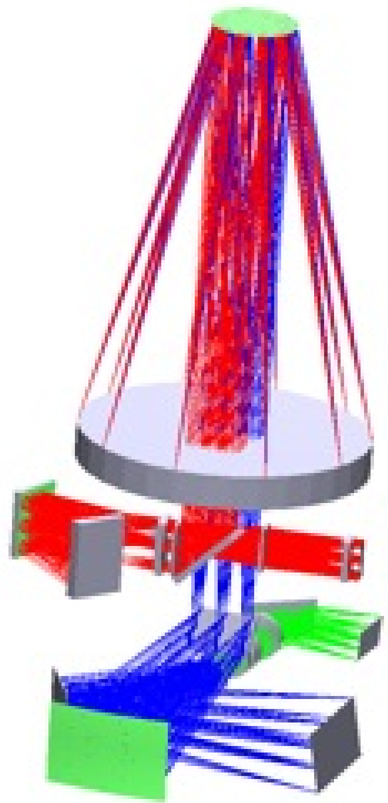


Korsch with a focal exit pupil, primary diameter 1.2 meter, with a central obscuration 0.37 m. with afocal pupil for NIS.



Reference “basic” slitless design “associated” with the Telescope

Groβe Koalition



Sharing the room (an not only the room) with our Imaging cousins

Euclid dithers at spacecraft level in a pattern (0,0 ;+40,+100 ; +40, +200 ; +40, +300 arcesconds)

Alternate Exposure and "auxilliary"time in a cycle of approx. 550 sec.

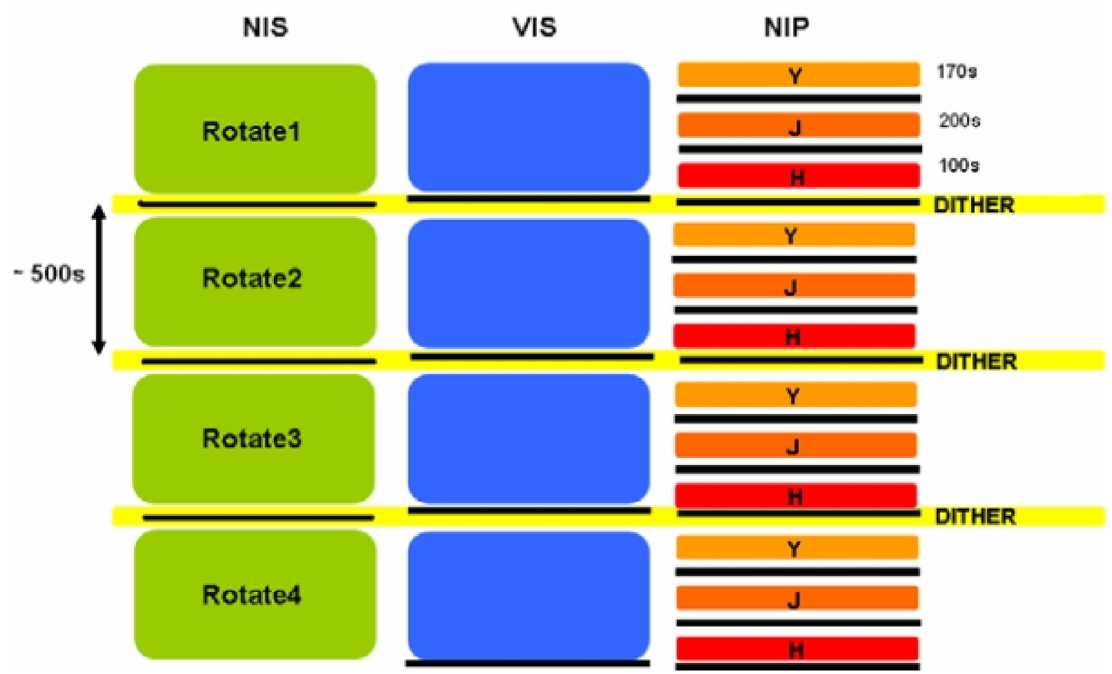


Figure 4.20: Euclid observation sequence.

Study Development Philosophy

Parallel Slitless-Baseline and DMD-Option Studies: **DMD Option has relevant differences (reflected in the performances).**

We have nonetheless tried to maximize similarities in terms of:

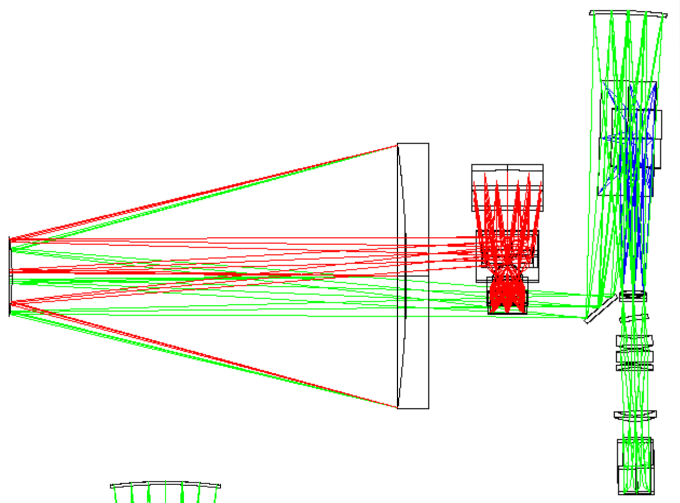
- Volumes/Interfaces
- Location of important subsystems
- Thermal Architecture
- Focal Plane architecture
- Components, Motors, Materials, etc.

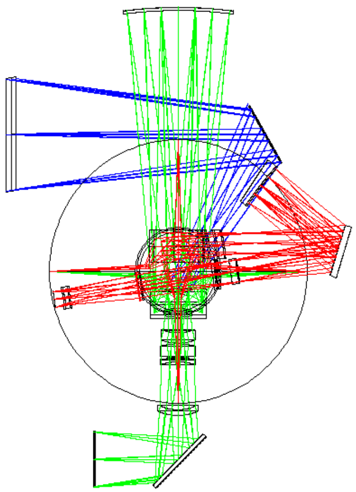
This in order to:

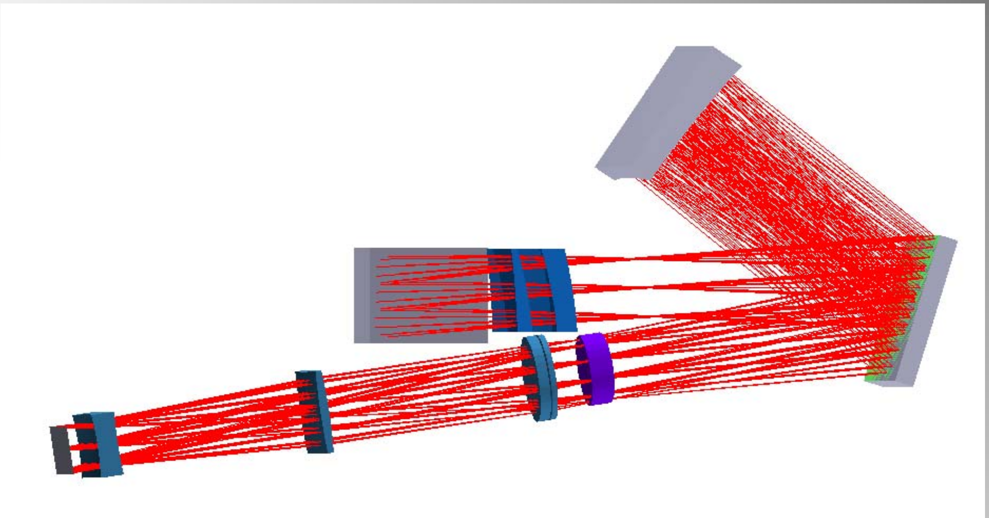
- Not duplicate the study of similar subsystem (same LEGO brick, different construction).
- Allow "swapping" baseline with option at and advanced state.

SLITLESS BASELINE

Baseline Slitless Optical Design







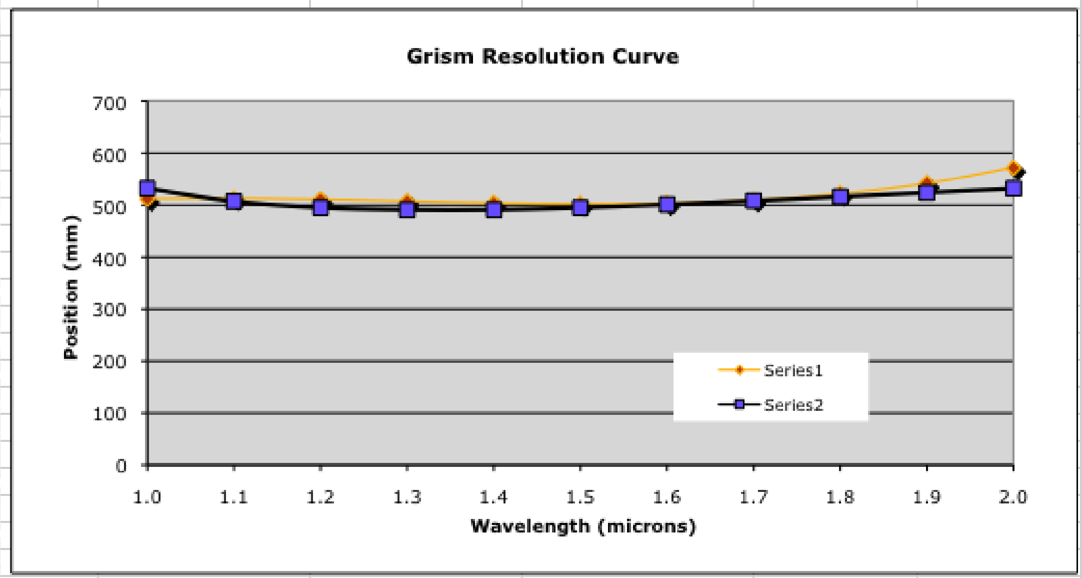
With respect to ESA design:

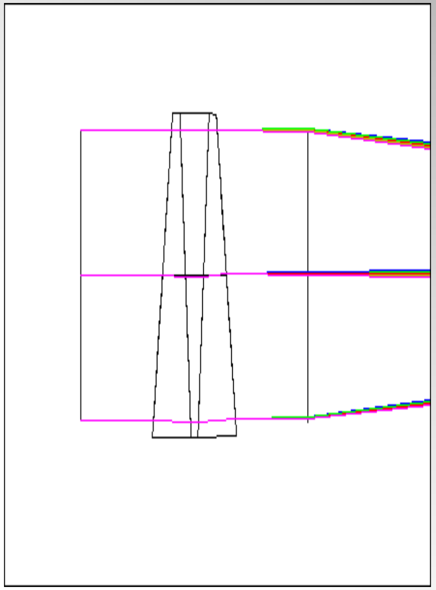
- Camera with shorter physical length (same focal).
- Larger back Focal Distance to accommodate filters
- Folding

Constant Resolution Grism

Science likes dispersers with constant resolution in the Wl Range.
-- Grisms and Prisms provide variable Resolution.

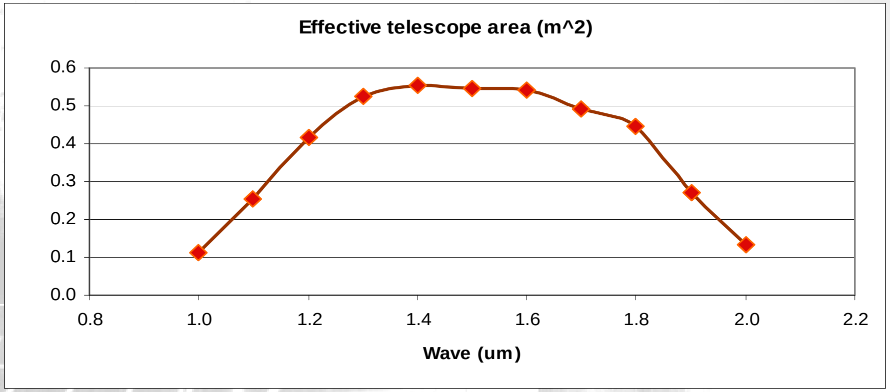
Silica - ZnSe – Silica – Grating

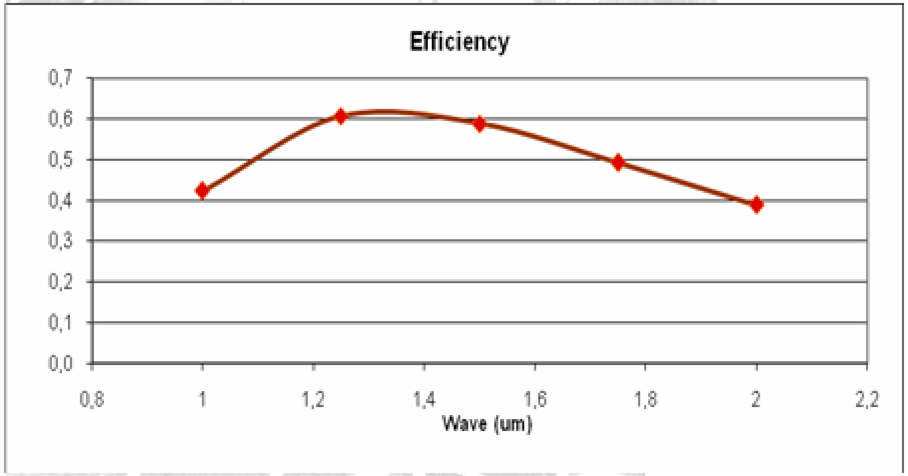




Un-deviated wavelength for "rolling"

Efficiency





Wavelength	1.0	1.2	1.4	1.6	1.8	2.0	notes
M1	98%	98%	98%	98%	98%	98%	(protected Silver)
M2	98%	98%	98%	98%	98%	98%	(protected Silver)
POM	98%	98%	98%	98%	98%	98%	(prot. Ag, or Au)
CL 1+2	98%	98%	98%	98%	98%	98%	(0.5% AR coating)
M3	98%	98%	98%	98%	98%	98%	(Au)
Fold. mirror	96%	96%	96%	96%	96%	96%	(double pass Au)
Grism(min)	15%	55%	75%	75%	65%	20%	(NICMOS)
Camera	96%	96%	96%	96%	96%	96%	(0.5% AR coating)
S-FTM16	99%	99%	98%	97%	94%	92%	(internal transm. 60 mm thick.)
FPA DQE	90%	90%	90%	90%	90%	90%	(from revised measurements)
Filters	92%	96%	96%	96%	96%	92%	(assumed for typical filters)
Overall	11%	41%	55%	54%	46%	14%	

Table 7-1– EUCLID NIS efficiency budget.

“minimal” figure obtained with very conservative assumptions about the grating efficiency

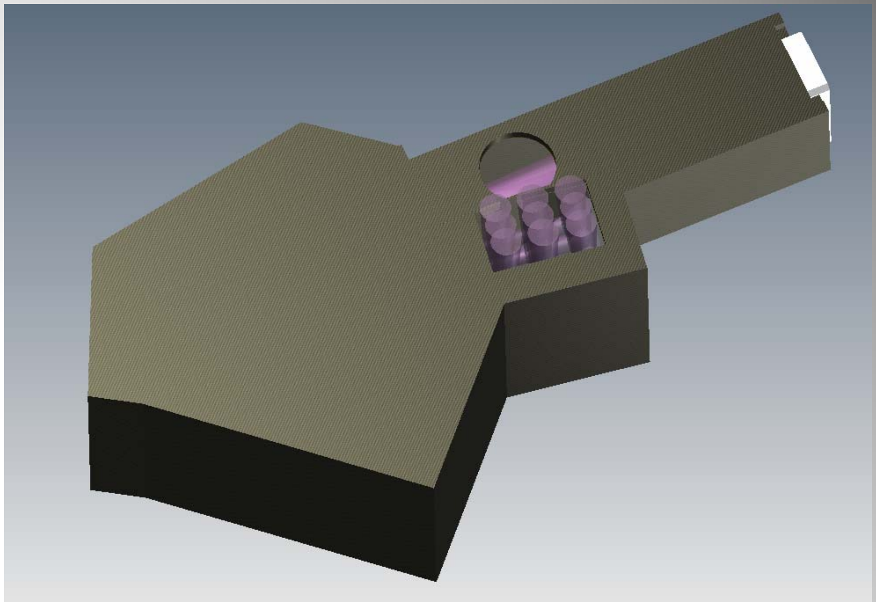
Theoretical computation checked against existing “similar” device used for nominal figure

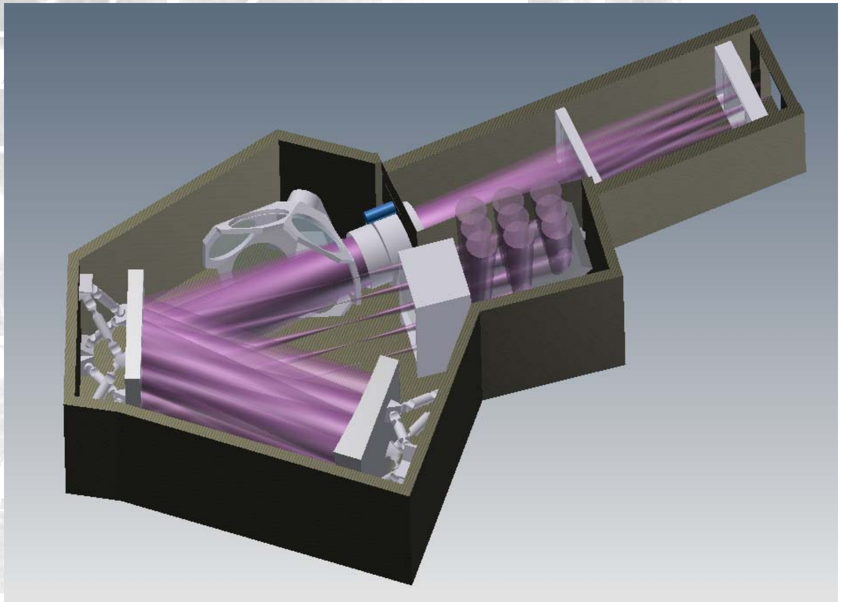
Wavelength	1.0	1.2	1.4	1.6	1.8	2.0	notes
Grism(nom.)	60%	86%	85%	80%	72%	60%	(VIMOS, GAIA)

Table 7-2– EUCLID NIS nominal grism efficiency

Mechanical Concept

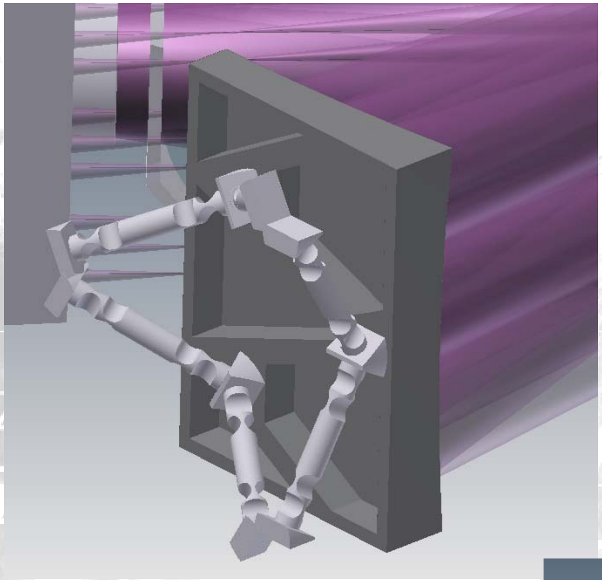
Main structure in CFRP-Al honeycomb sandwich panels



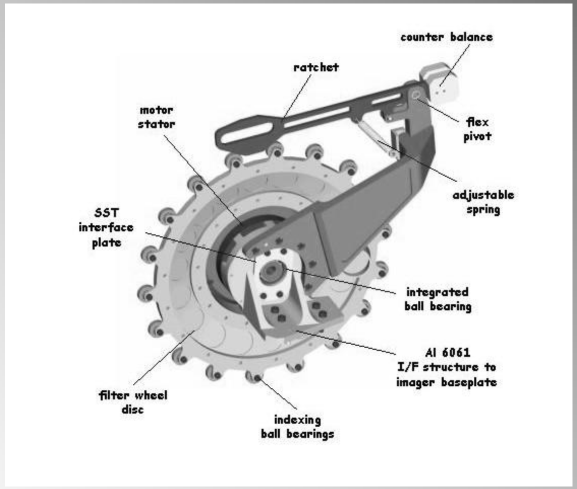


Perimetral frame, glued basis, screwed top

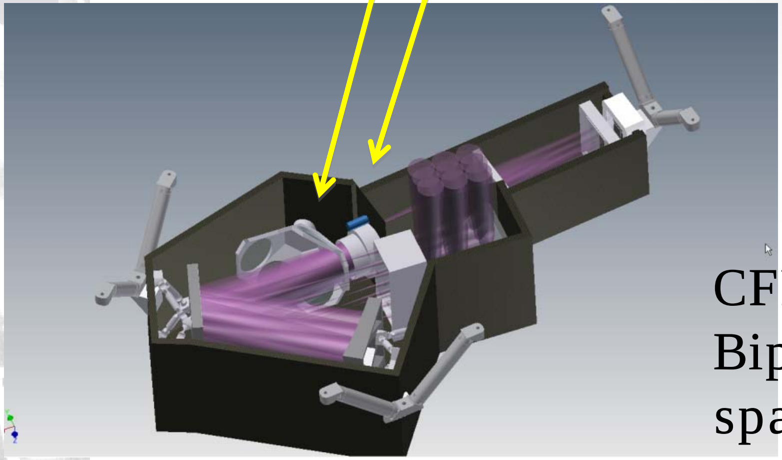
Highlighted details



MIRI Imager filter wheel: “template” for functions (2; conservative)

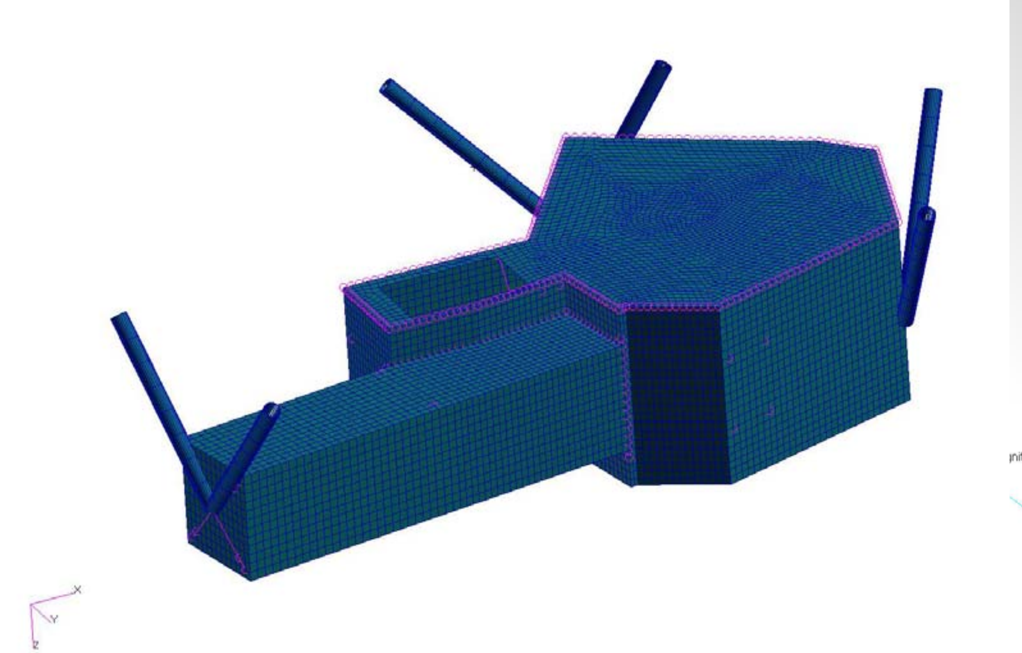


Bipods mounting of a light-weighted SiC Mirror

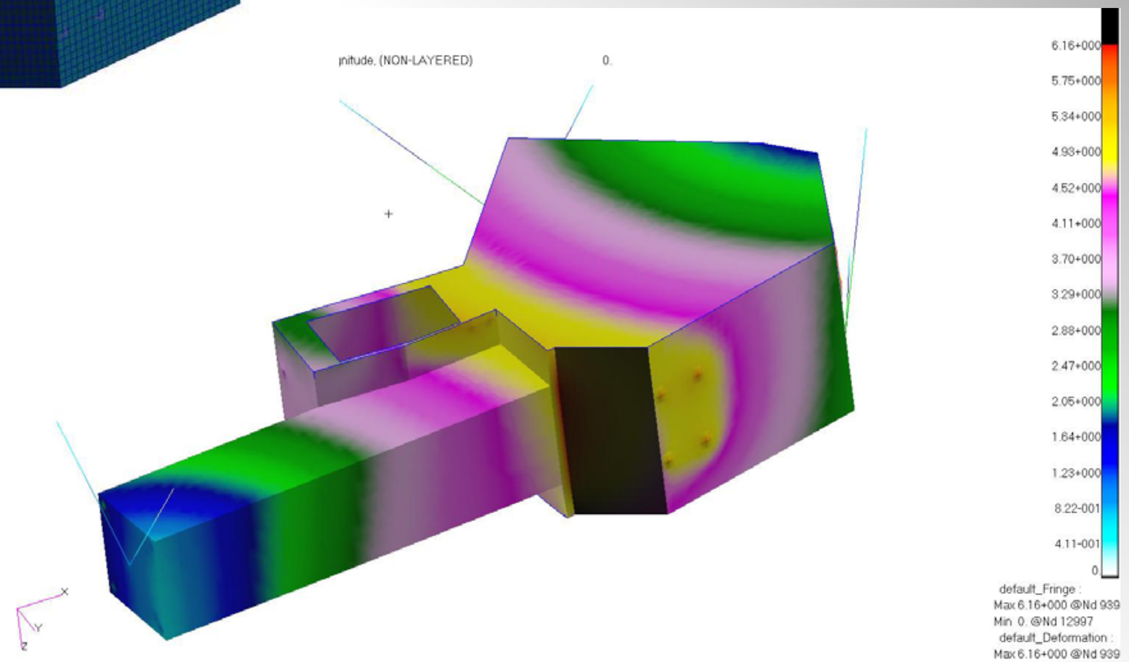


CFRP – Titanium Bipods connection to the spacecraft

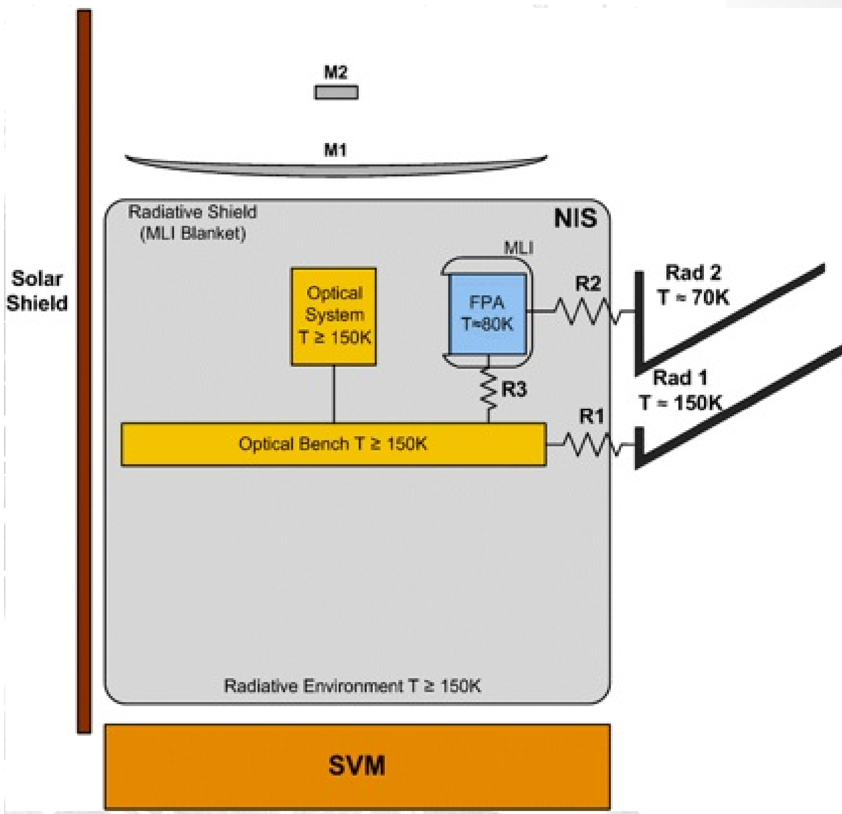
FEA Model



- Model with 13044 nodes and 12951 shell elements
- Bipods modeled with beam elements, 8 elements for each truss.

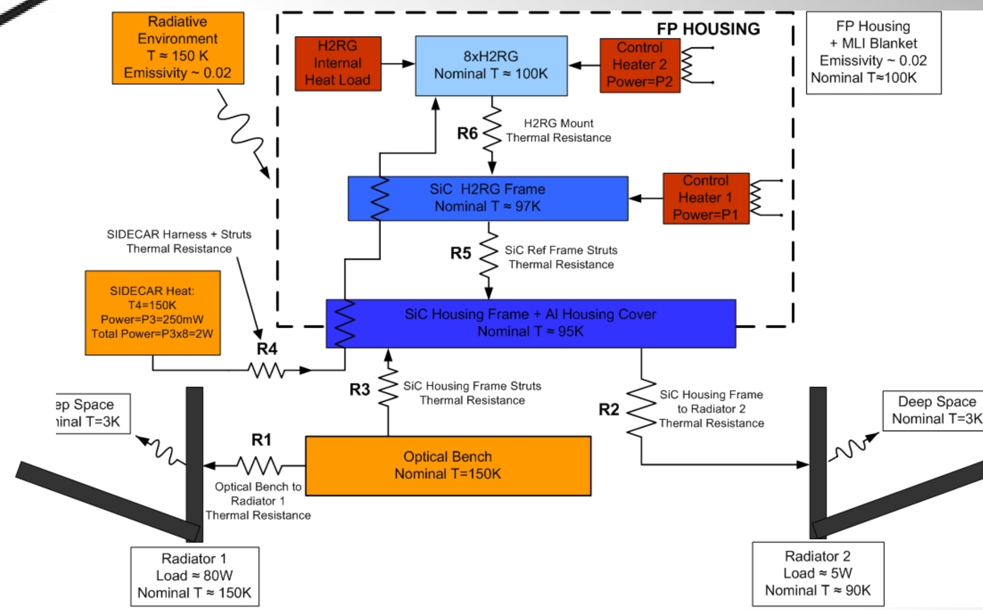


First eigenfrequency 87 Hz, second 110 Hz, third 114 Hz.... High enough.



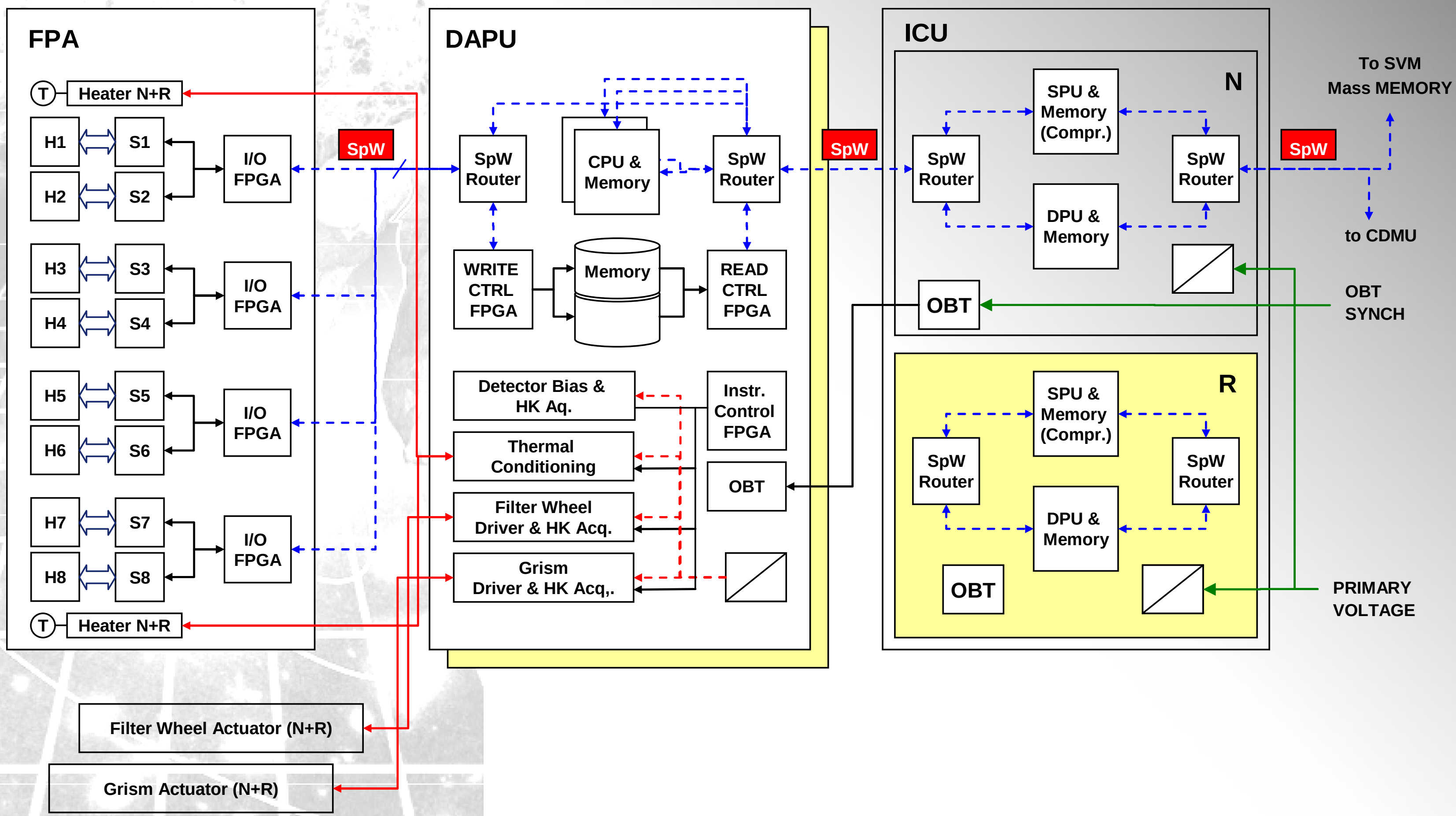
Double Passive Radiator System (V-grooves):

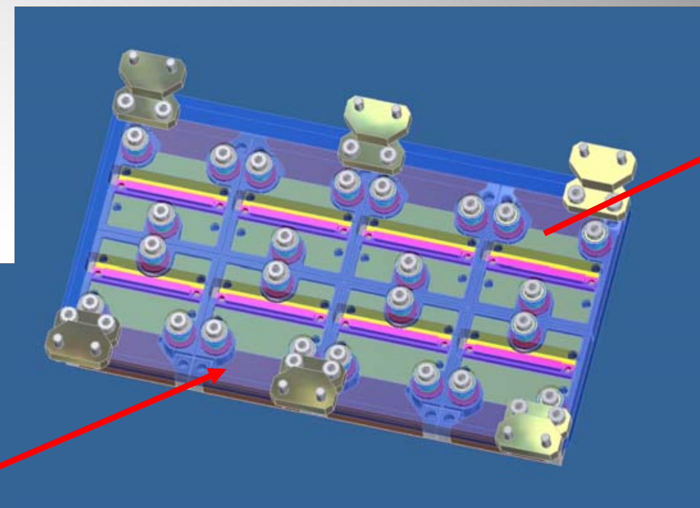
- Rad1 (150 K) for the bench and pre-cooler for FPA. (80 W)
- Rad2 (70-90 K) for the FPA. (5 W)

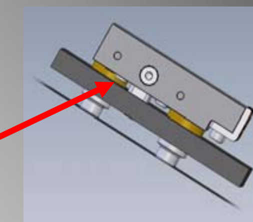


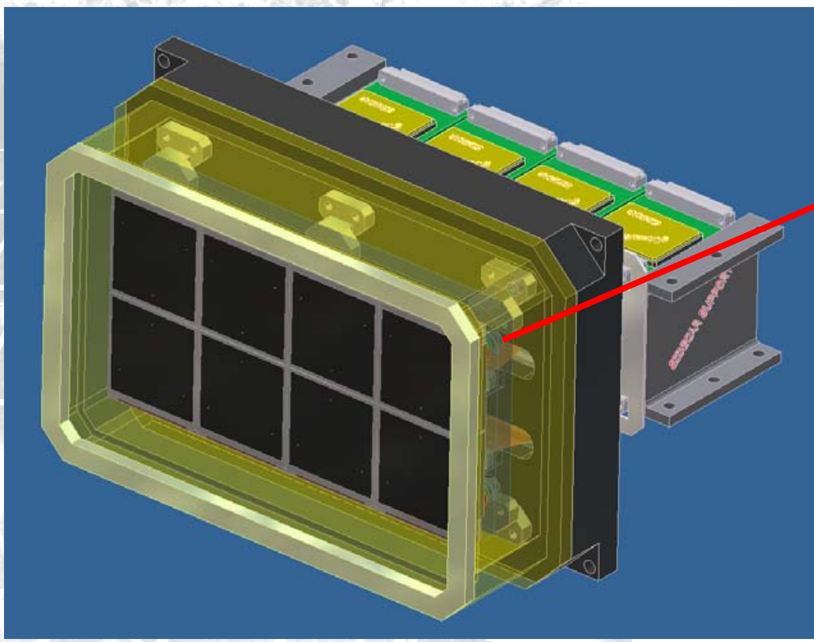
Detectors need to be operated at 100 K with a stability of 10 mK over 500 s.

Electronic Architecture

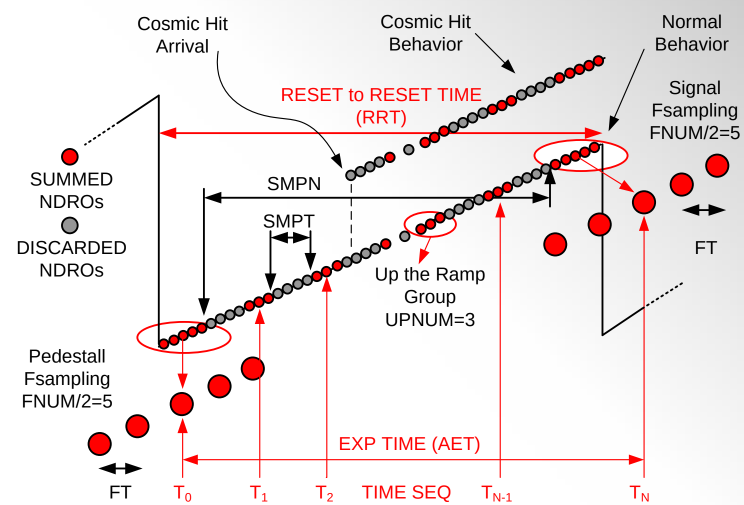






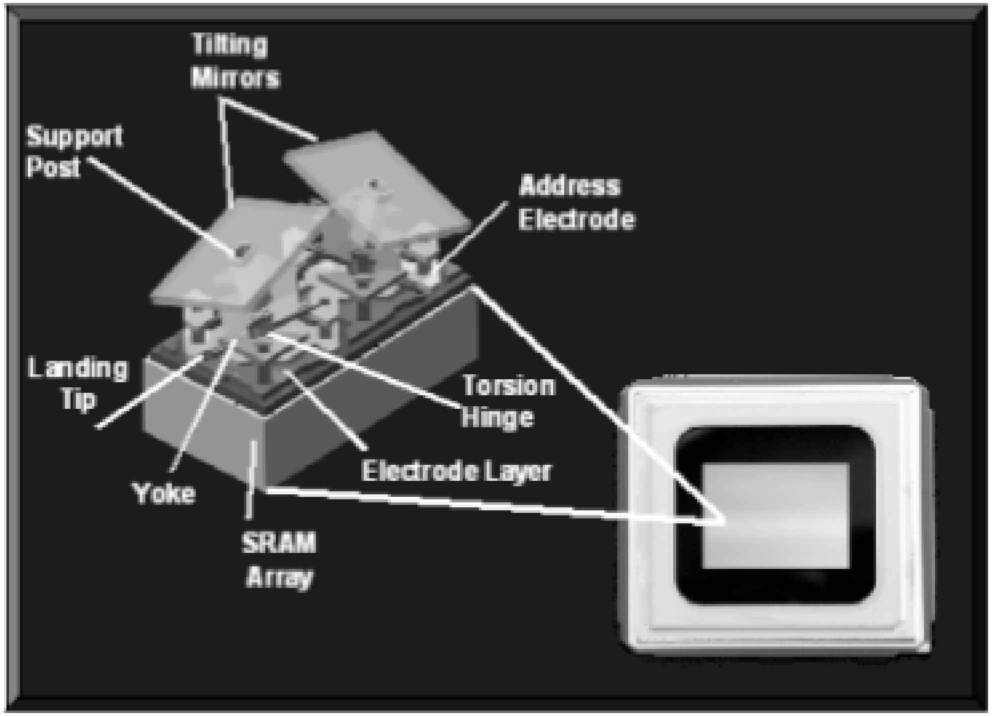


Cosmic Ray Deglitching Strategy

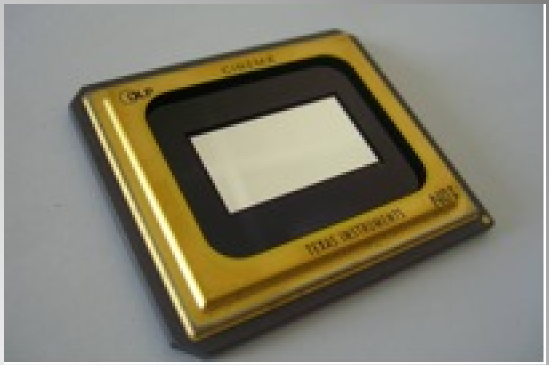


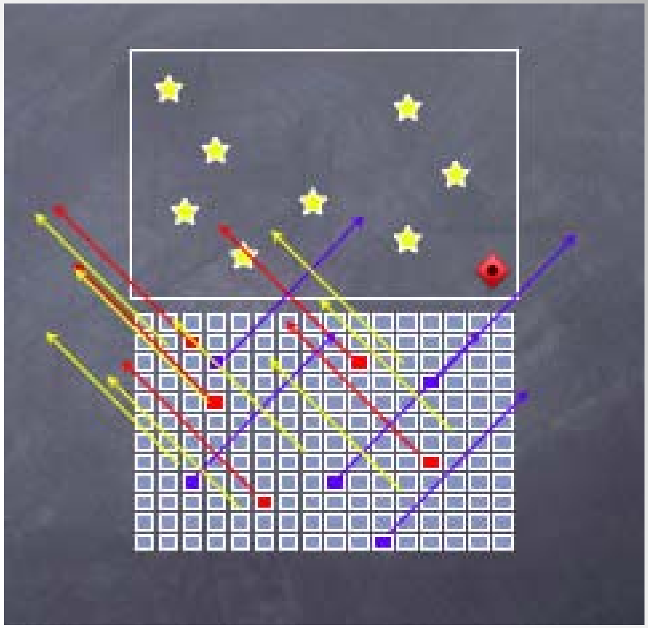
DMD OPTION

The DMDs

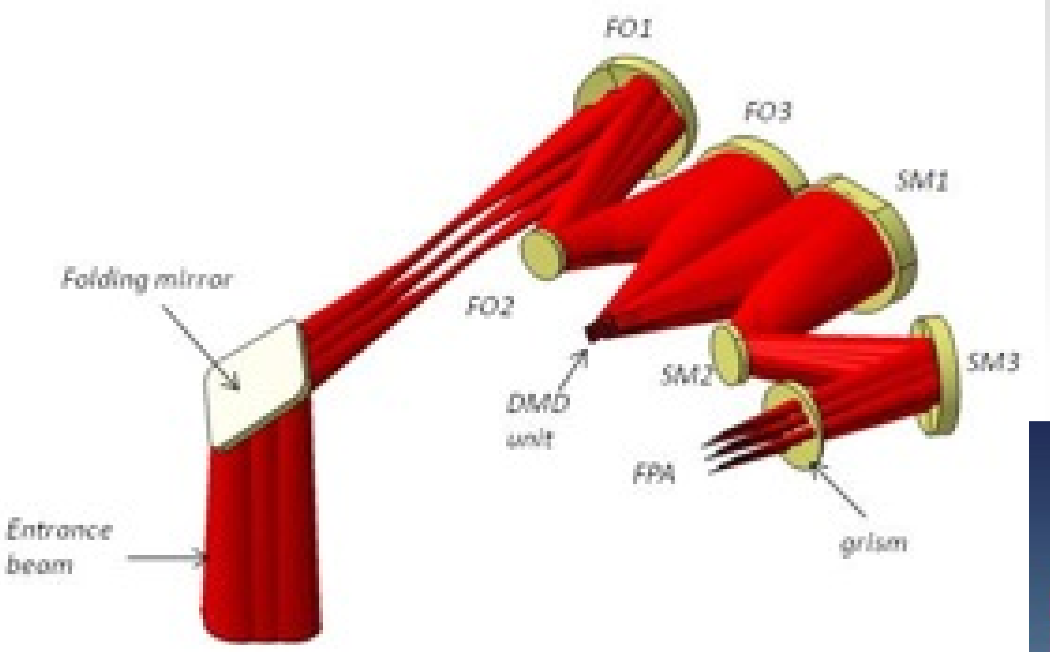


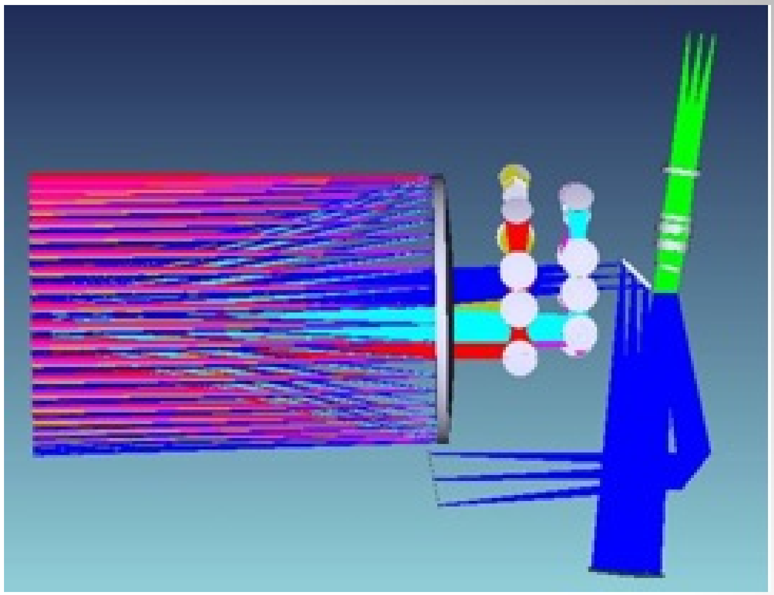
Tilting Mirrors
Support Post
Address Electrode
Landing Tip
Torsion Hinge
Electrode Layer
Yoke
SRAM Array



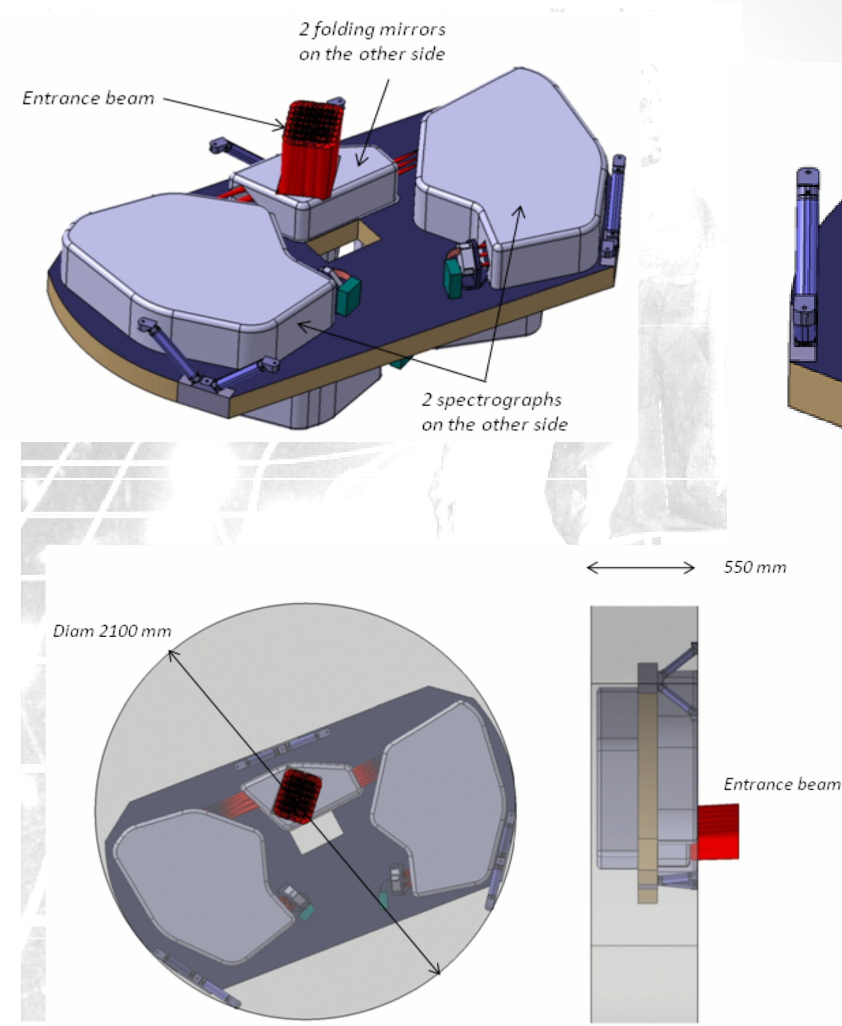


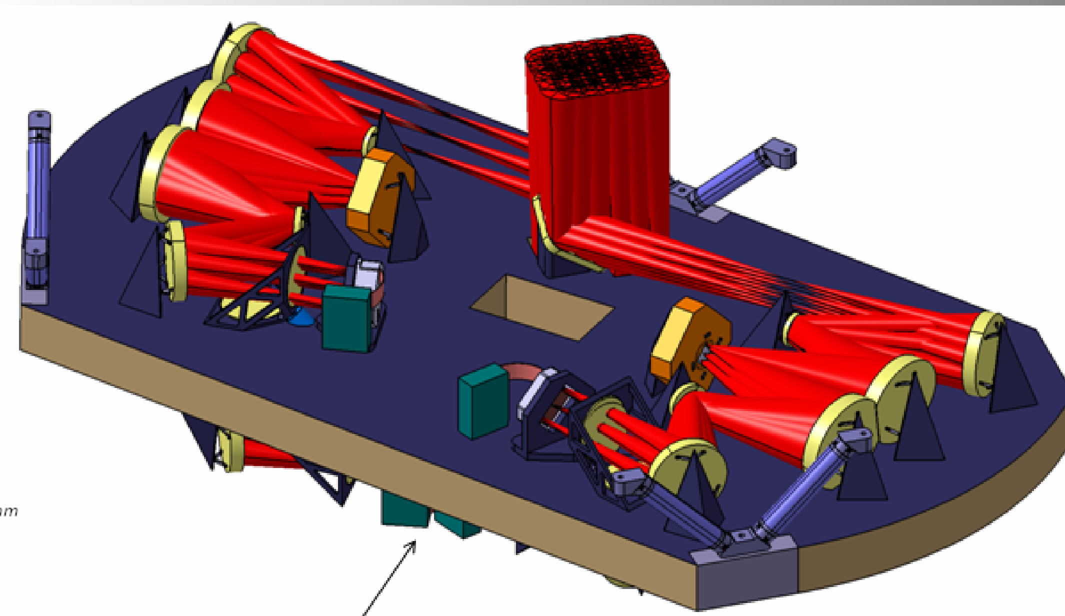
DMD Optical Design



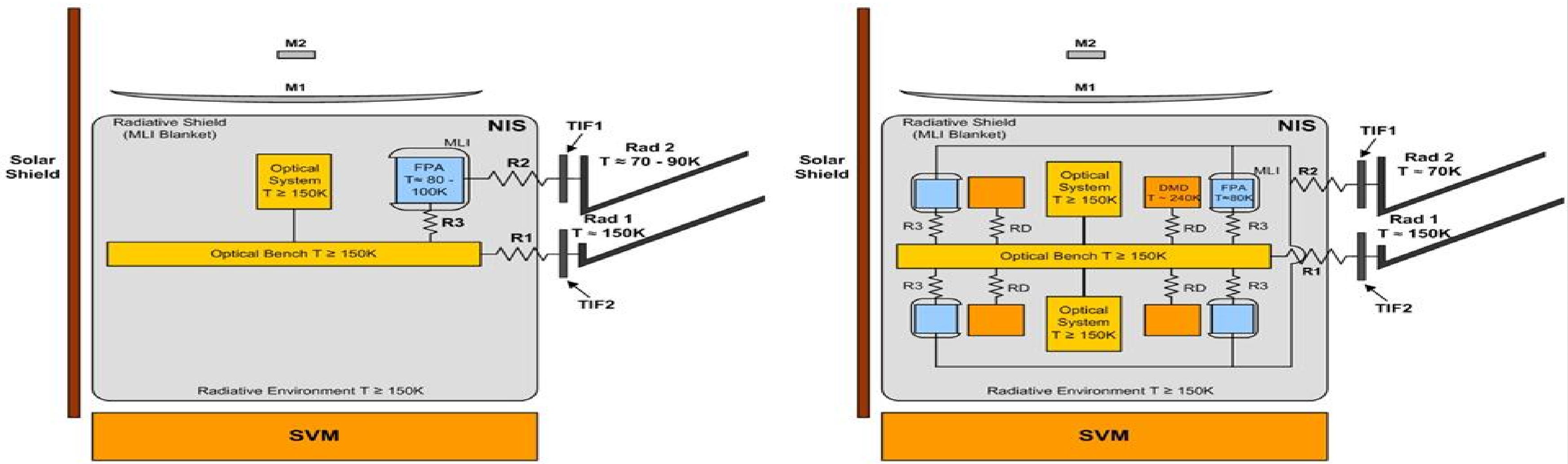


Mechanical Implementation



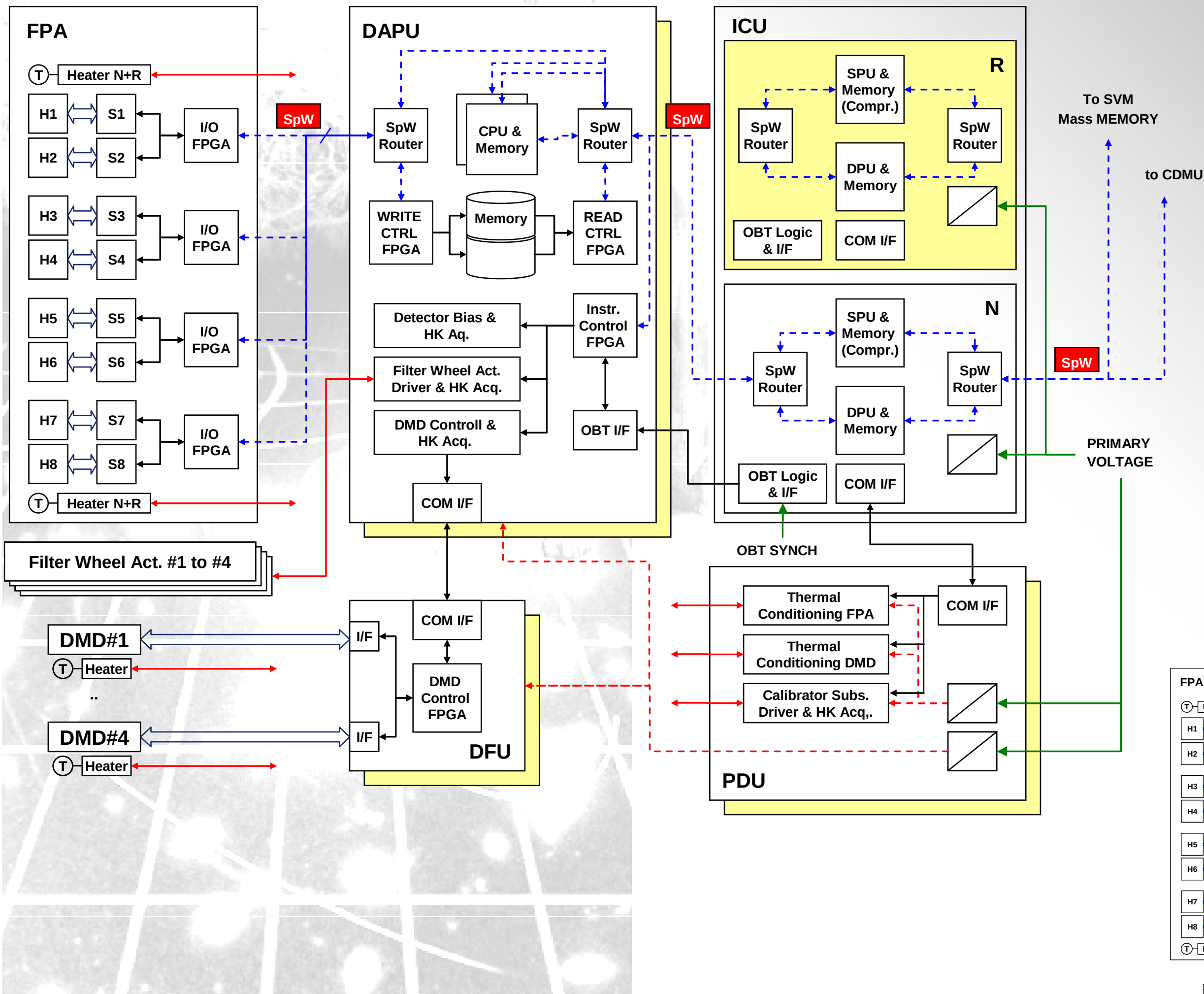


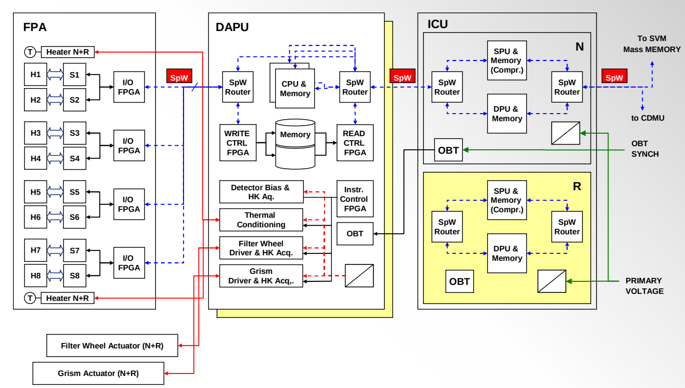
Thermal Architecture



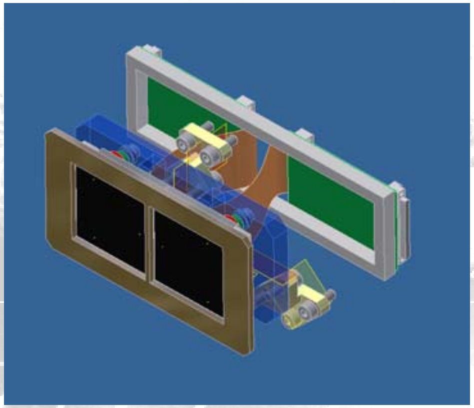
- Same Interfaces with the Spacecraft, Same Radiators.
- Different harness and distribution (at Payload levele)

Electronics Architecture



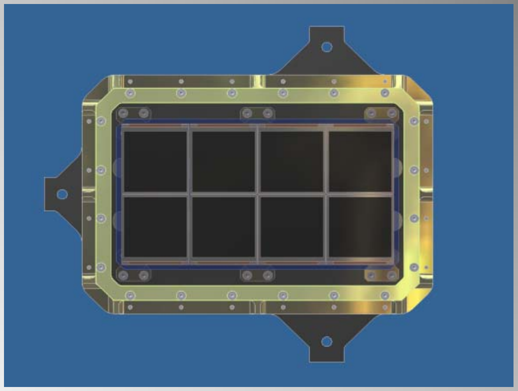


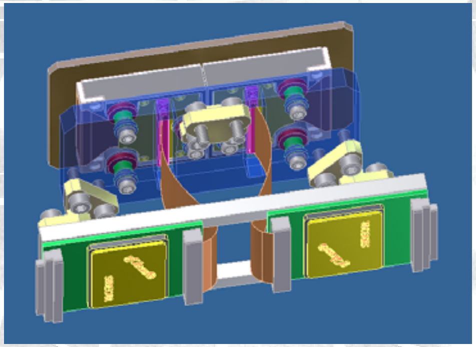
FPAs Architecture



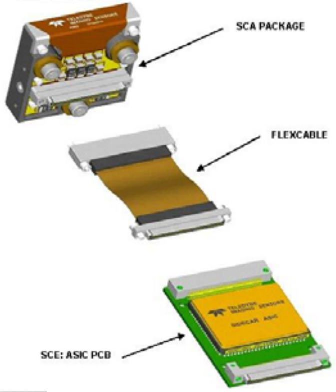
Slitless

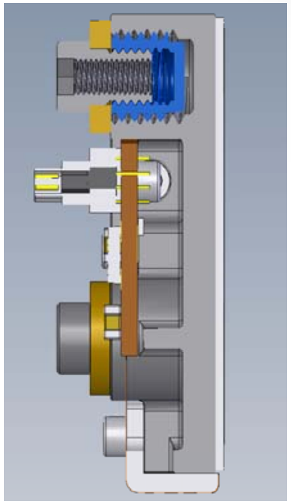
DMD

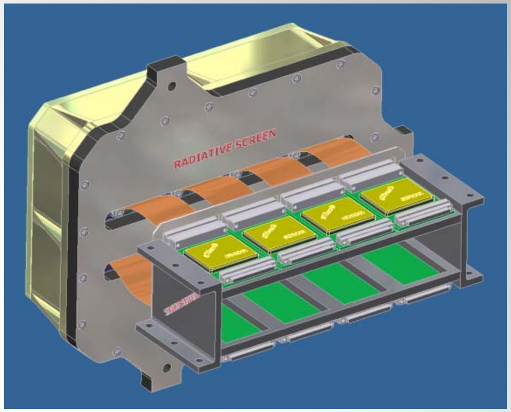




<u>Same Building Blocks</u>







Conclusions

A slitless spectrograph tailored to the top level requirements within the budget assumptions for the study is technically feasible.

A DMD spectrograph tailored to the top level requirements within the budget margins assumptions for the study is technically feasible EXCEPT the DMD subsystem itself currently under qualification.

THANKS !