

Wide field instrument update [Cycle4]

Optics:

- Final grism & IFU design
- Error budget detail started; telescope error budget well along
- Early discussion of cycle5 optical design
 - Looking mainly for improved coronagraph interfaces, possible 'more rectangular' WFI layout

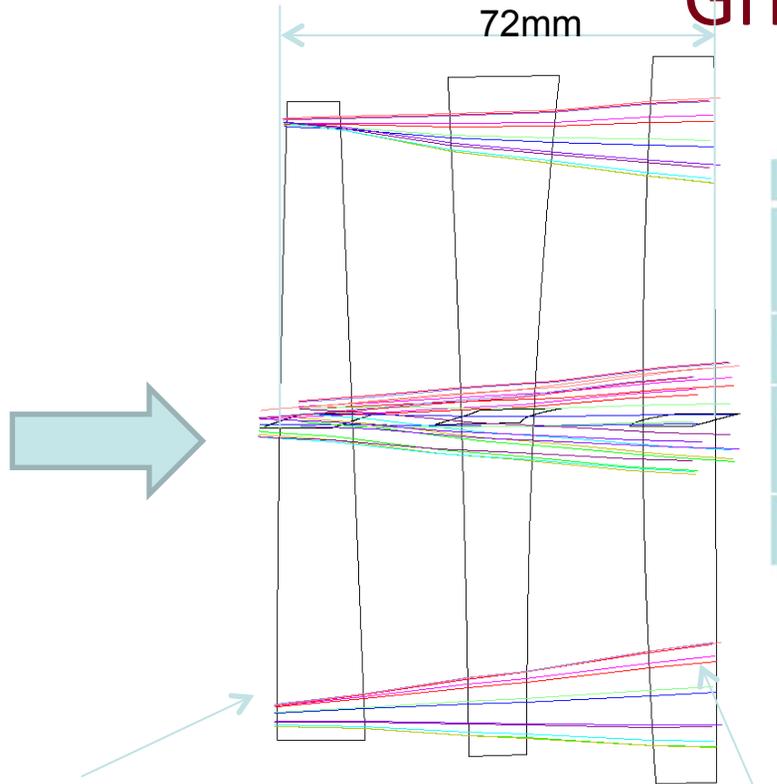
Overall:

- Instrument packaging well along
- I&T discussion started; included is modeling of 'half pass test' which allows
 - Instrument only test w/out costly GSE

Grism update

- Design frozen [Internal review, December]
 - Now all surfaces are fused silica; strong, well known, rad hard material with lots of flight history
 - Design residual is below diffraction limit. Significant improvement from cycle3
- Packaging ongoing – tight clearances as expected, preliminary assembly view below
- Diffractive surfaces being prototyped in visible-testable versions
 - Later this FY we plan to prototype the other elements and make current, NIR prescription diffractive surface prototypes
 - Will start building and testing filter mounts
 - Building toward qualifiable mounted grism and filter prototypes

Grism Layout



Grism element summary						
Element		Radius of curvature (mm)	Material	Thickness (mm)	Dia. (mm)	Wedge (°)
Element 1	S1 Filter	1323.23	Fused silica	12	112	1.067
	S2 diffractive	Infinity				
Element 2	S1 spherical	1991.829	Fused silica	12	120	-3.784
	S2 spherical	662.244				
Element 3	S1 spherical	785.451	Fused silica	12	126	0
	S2 Grating	Infinity				

Element #1: Fused silica
 Surface #1: Filter (spherical)
 Surface #2: Diffractive lens (flat)

Element #2: Fused silica
 Surface #1: spherical
 Surface #2: Spherical

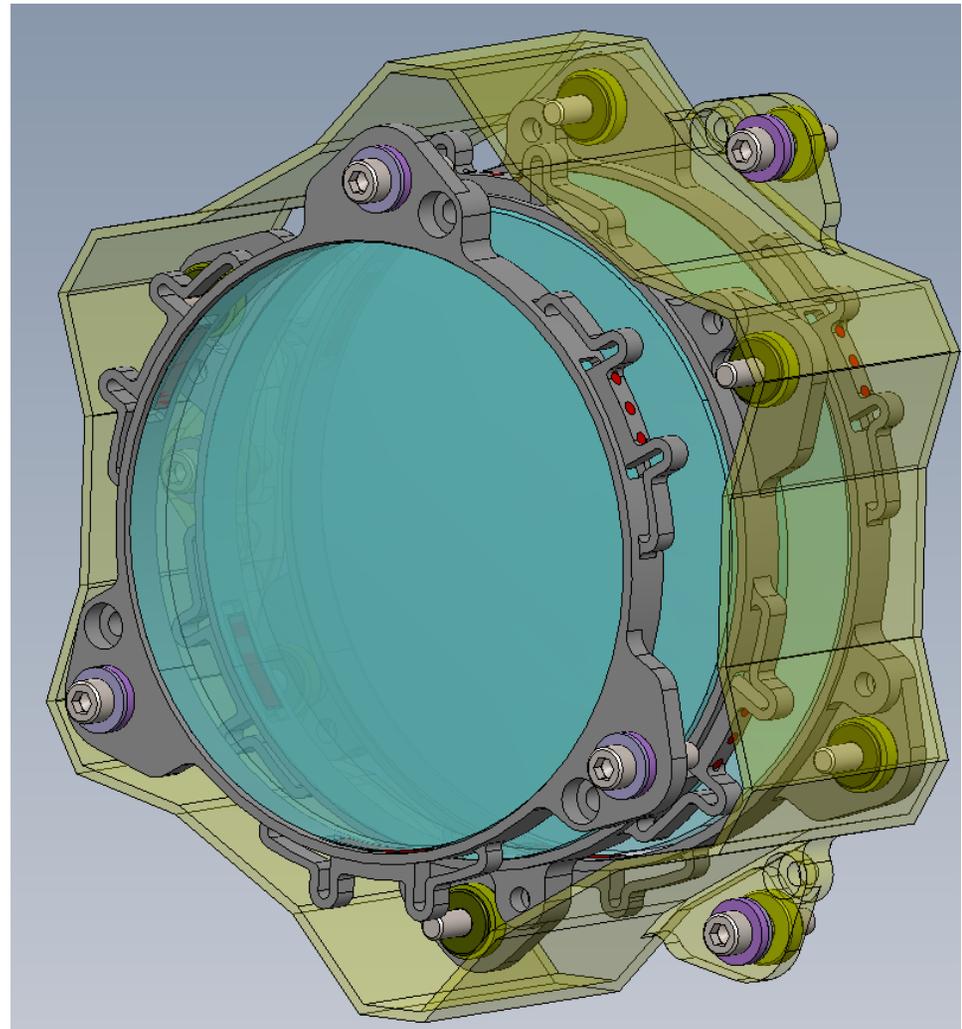
Element #3: Fused silica
 Surface #1: Spherical
 Surface #2: Grating (flat)

The filter can be on any spherical surface, but the first surface is smaller, also more perpendicular to the beam.

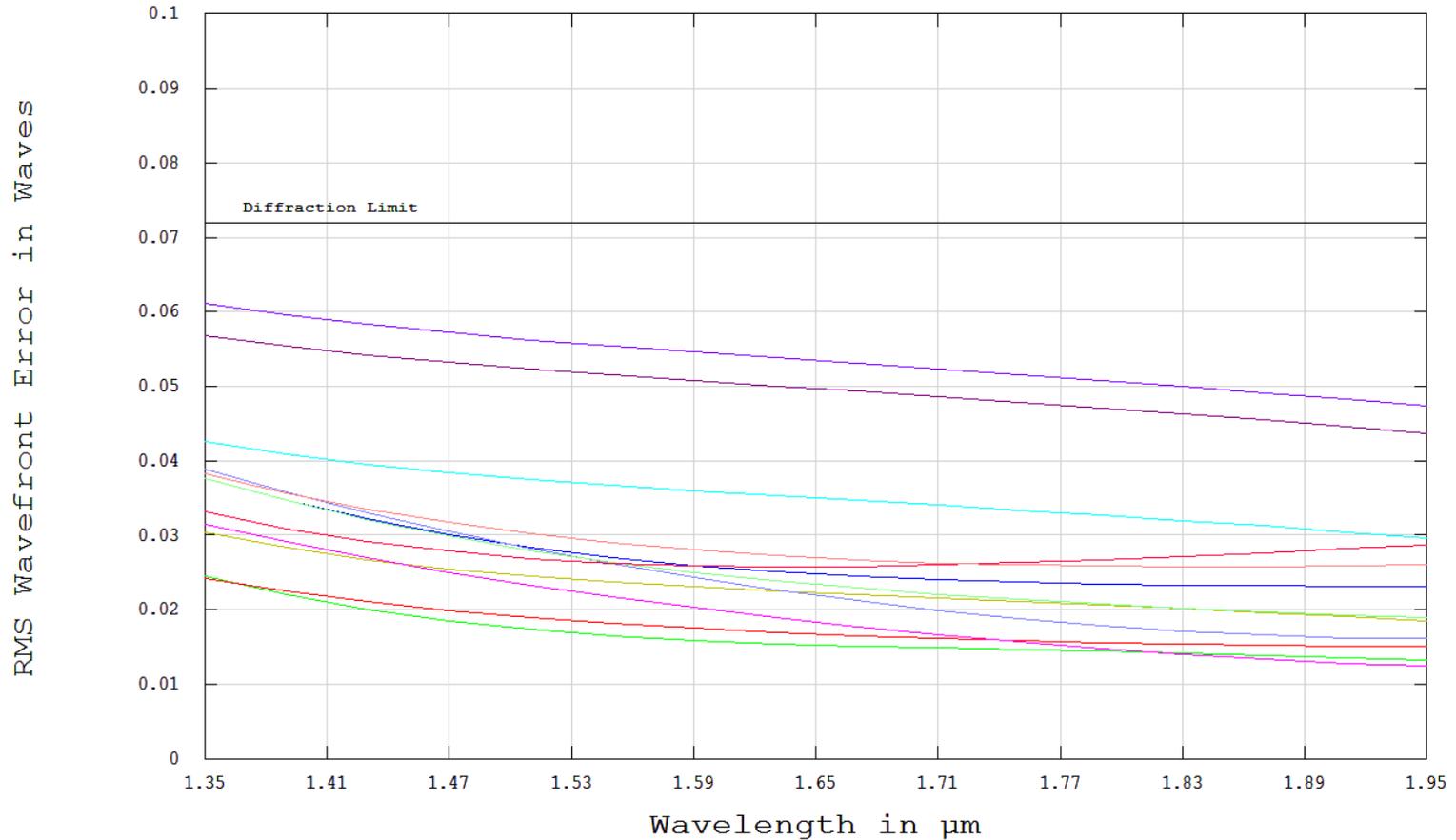
Grism mounts and assembly view - preliminary

Need to be able to internally align via 6 DOF adjustment on each of the 3 elements

Tight clearance of housing to ray trace



RMS Wavefront vs. field – Diffraction limited



RMS Wavefront Error vs Wavelength

Filter set and temperature trades

WFI red edge:

- Notional filter set if we extend red science cutoff to 2.4 μ m [2.4 μ m filter, 2.5 μ m red edge of nominal detector response]
- It has been pointed out that the reddest $R \sim 4$ and the microlensing wide filters would have high in-band internal emissions from a 270 K telescope
- For Cycle4, we are leaving the IFU and Grism bandpasses as for cycle3, and leaving the filter set TBD – the # of filters is the same and there is no coupling of the filter bandpass to other elements of the engineering

Filter optical prescription:

S1 RoC -1,568.18 mm

S2 RoC -1,567.32

Same for all bands

110mm diameter

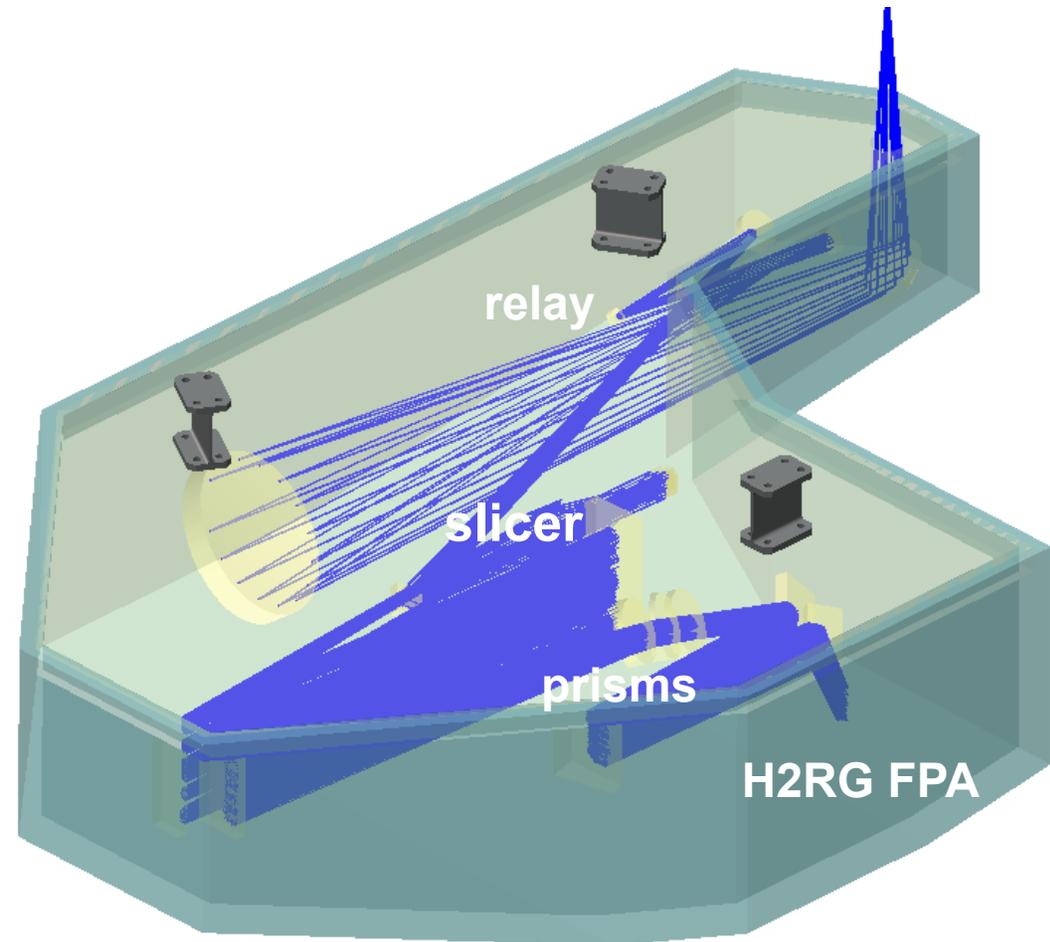
Thickness 6mm

#	min	max	center	width	R	Overlap
Z088	0.760	0.997	0.878	0.237	3.71	0.05
Y109	0.947	1.242	1.094	0.295	3.71	0.062
J136	1.179	1.547	1.363	0.367	3.71	0.078
H170	1.469	1.927	1.698	0.458	3.71	0.097
K212	1.830	2.400	2.115	0.570	3.71	0.120
W167	0.947	2.400	1.673	1.030	1.44	0.062
GRS	1.350	1.950	1.650	0.600	75.00	

Potential filter set for 250K telescope temperature, 2.5 μ m detector cutoff

Cycle4 IFU – packaging finalized

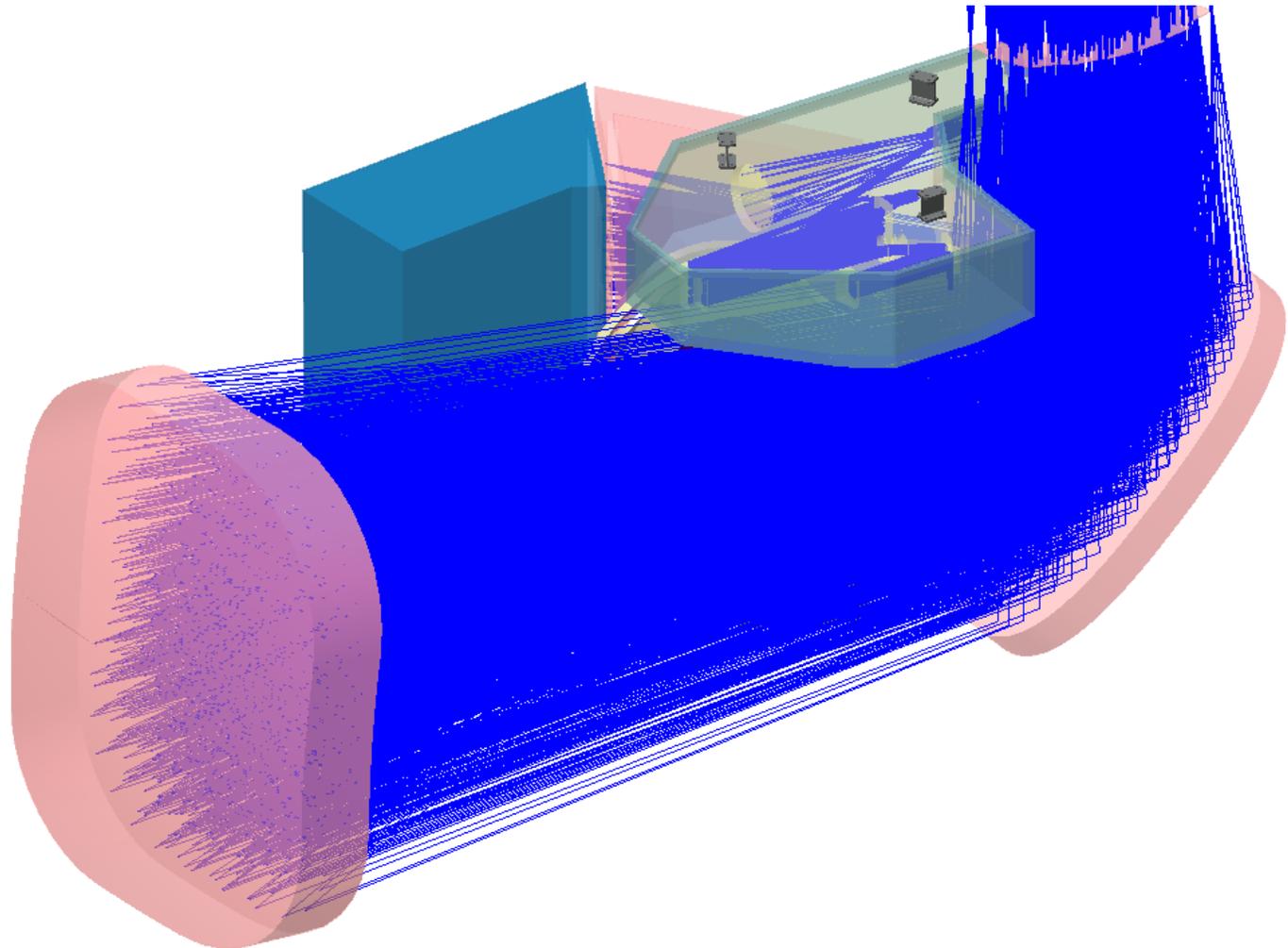
- Imaging performance margin increased (was already diffraction limited)



Shorter IFU relay [slicer & spectrograph similar to Cycle3]

IFU Layout with wide field optics & ray trace

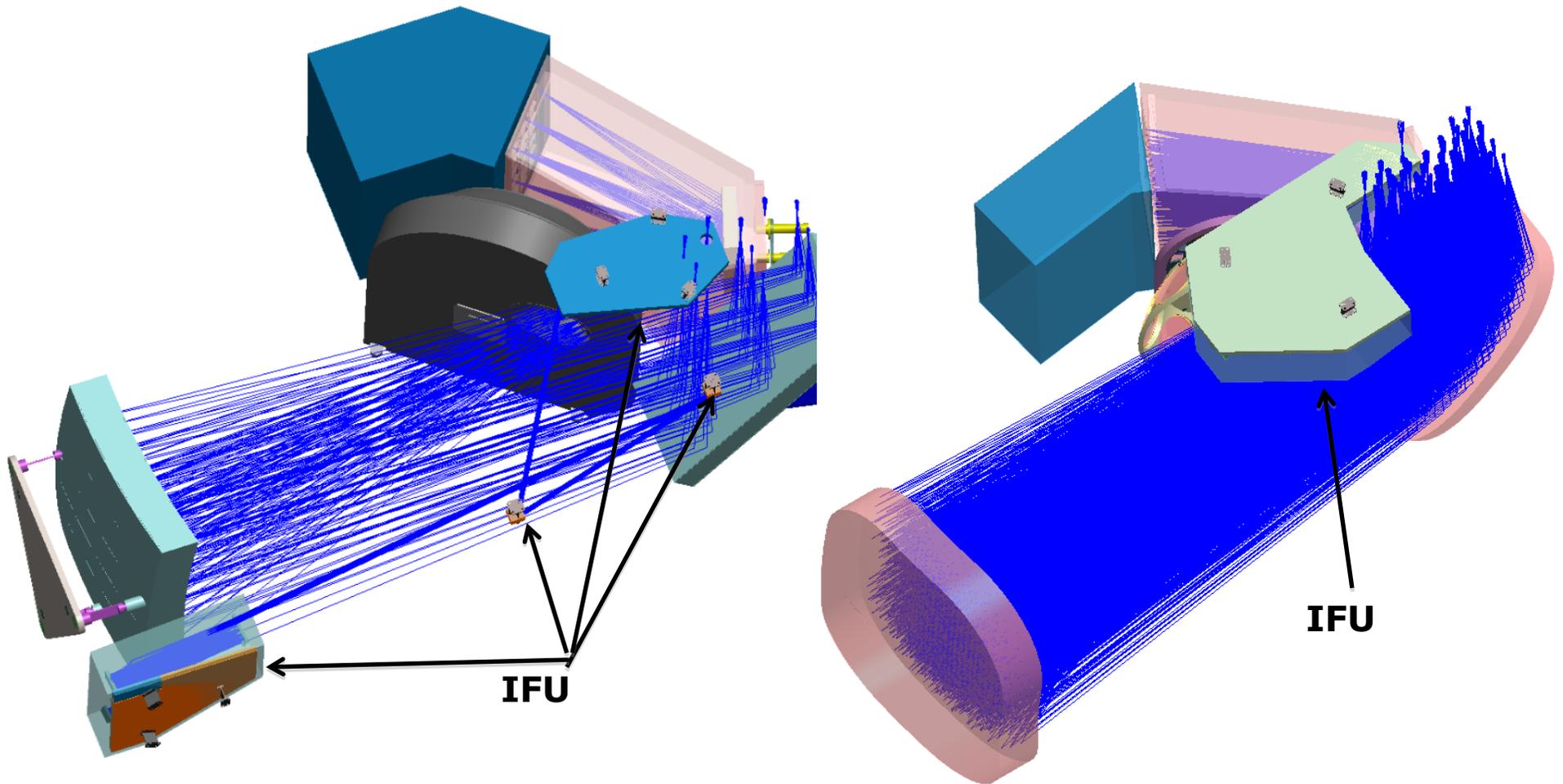
- Side View



WFIRST Cycle 3 and Cycle 4 IFU Concepts

- Cycle 3 IFU
 - Four Sub-assemblies located throughout the WFI instrument.
 - IFU mass = 10.1 kg.
 - IFU overall Dimensions = 580 x 1500 x 280 mm {0.24 m³}.
- Cycle 4 IFU
 - Identical science performance {some additional optical performance margin for cycle4}
 - Single compact assembly.
 - IFU mass = 6 to 7 kg (ROM estimate).
 - IFU overall Dimensions = 300 x 500 x 125 mm {0.019 m³, 12x reduction}.
 - Improved Structural/Thermal performance, mass, I&T, and overall implementation cost.

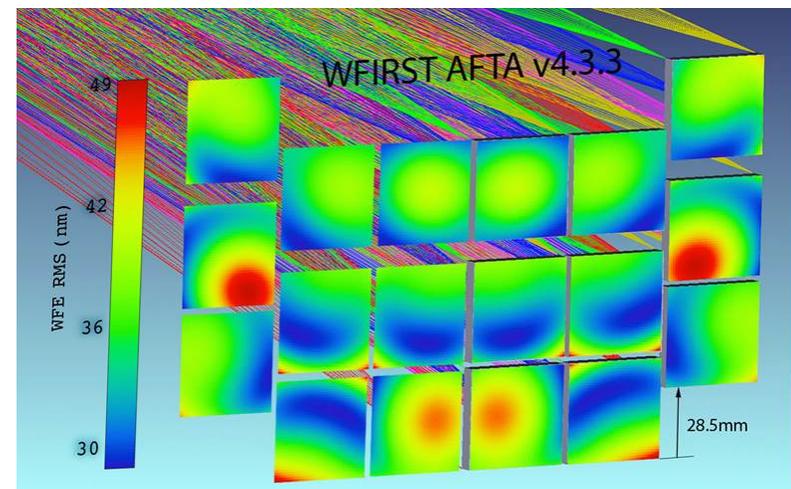
WFIRST Cycle3 {left} and Cycle4 {right} IFU Concepts with WFI Opt Layout, approx. to same scale



AFTA Cycle3 and Cycle4 IFU Concepts

Payload Design Cycle goals

- Cycle3 (Initial design; initial look at integrated modeling (IM))
 - Design:** initial IFU end to end design; 270K telescope; WFI 2.1um detector cutoff, passive WFI thermal design; cursory I&T look; costing w/ CATE
 - Integrated modeling:** IC thermally uncontrolled
- Cycle4 (Current)
 - Design changes:** Coaxial telescope {still 270K}, simpler WFI optics; 2.5um detector cutoff, cryocooler; Elec. boxes in main WFI volume; more compact slicer IFU design; initial look at I&T; offline trade study of IFU; coronagraph detail TBD
 - Integrated modeling updates:** WFI w/ grism; IC thermally controlled; coronagraph IM of interface points only
- Cycle5 {so far}:
 - Design changes:** Full payload optimization {incl. Cor}; possible study of 250K telescope; first full look at downselected coronagraph; may include calibration subsystem; more rectangular WFI layout {proposal at right}
 - Integrated modeling updates:** include coronagraph & IFU



WFI packaging

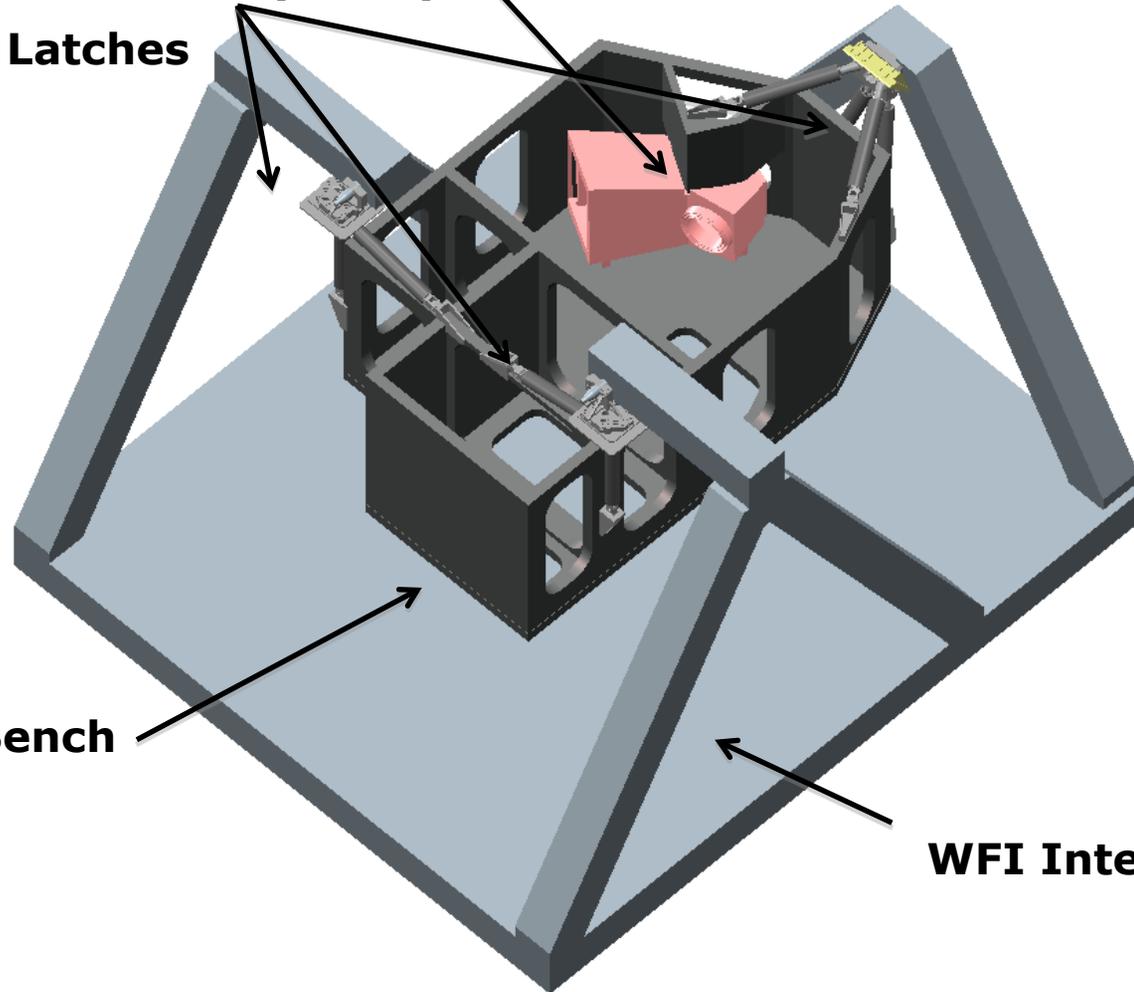
- Working overall packaging with a intent to identify at least one potential build order where access, routing, etc are feasible (I&T flow)
 - This is a preliminary, very early look at this topic
- We also have identified a potential instrument-level optical test that does NOT require massive ground support equipment (eg JWST/OSIM or a proxy 2.4m telescope)
 - “half pass test” described below

**Cold Optics Radiation Shield
(CORS)**

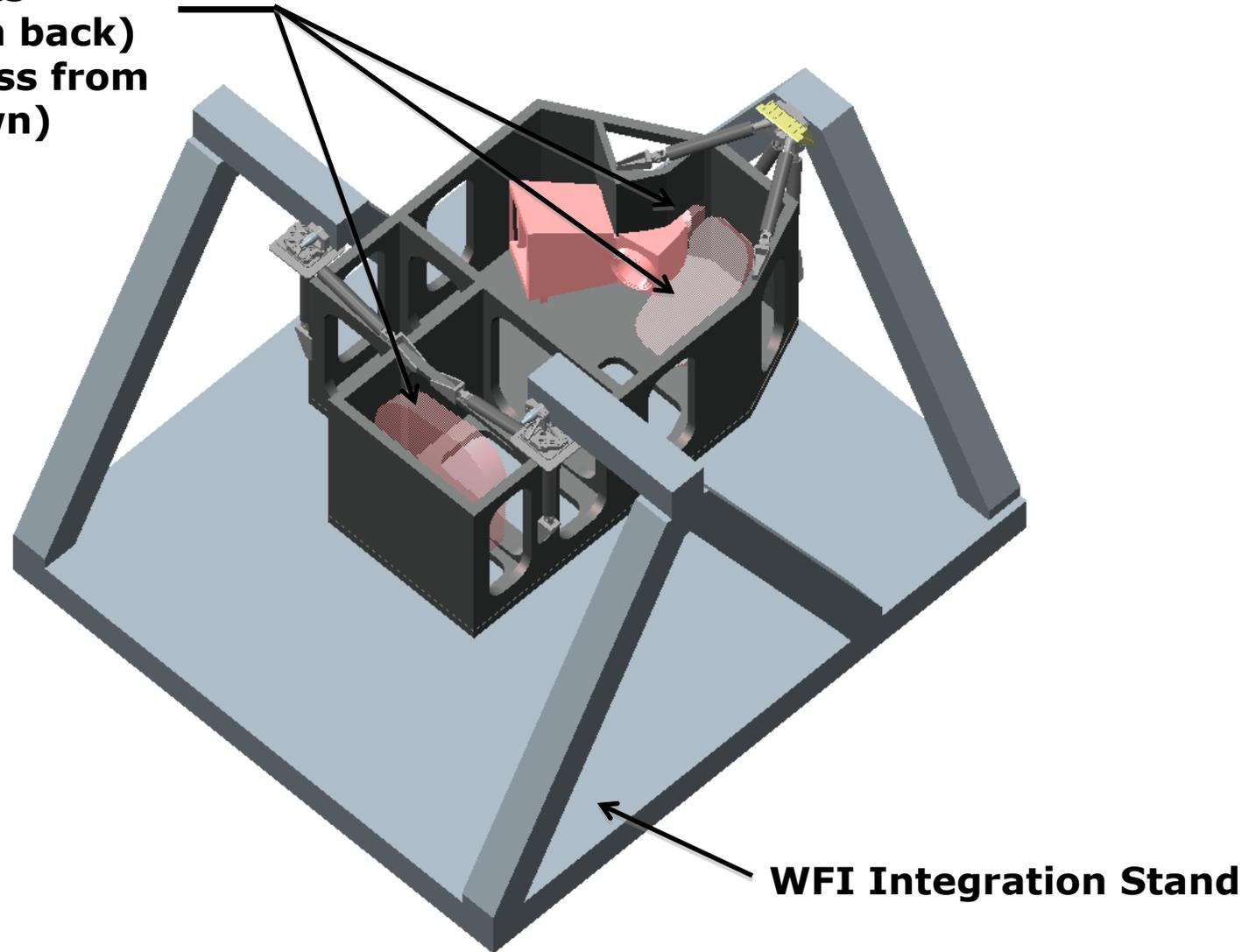
WFI Latches

Optical Bench

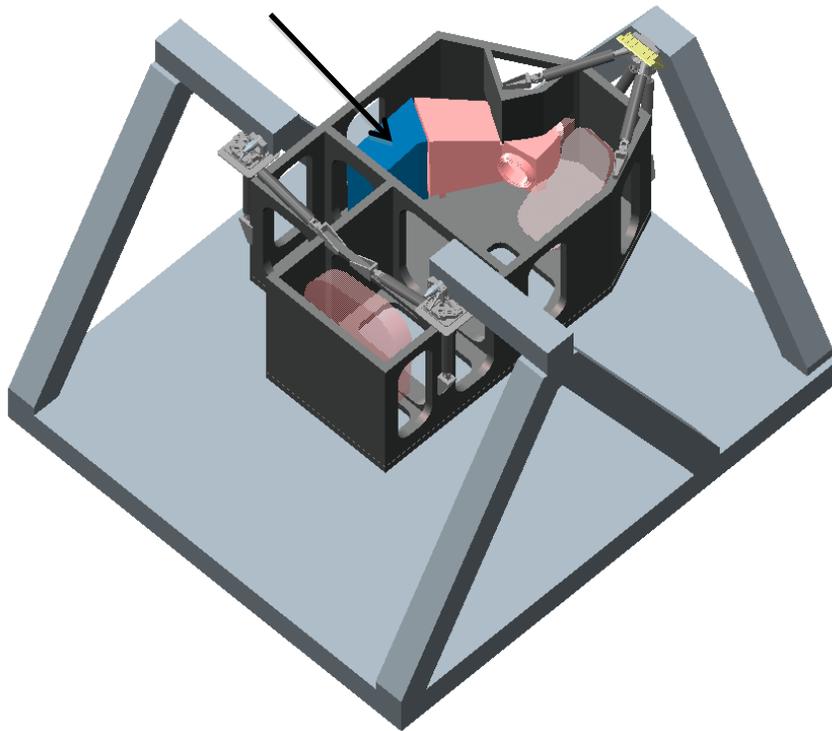
WFI Integration Stand



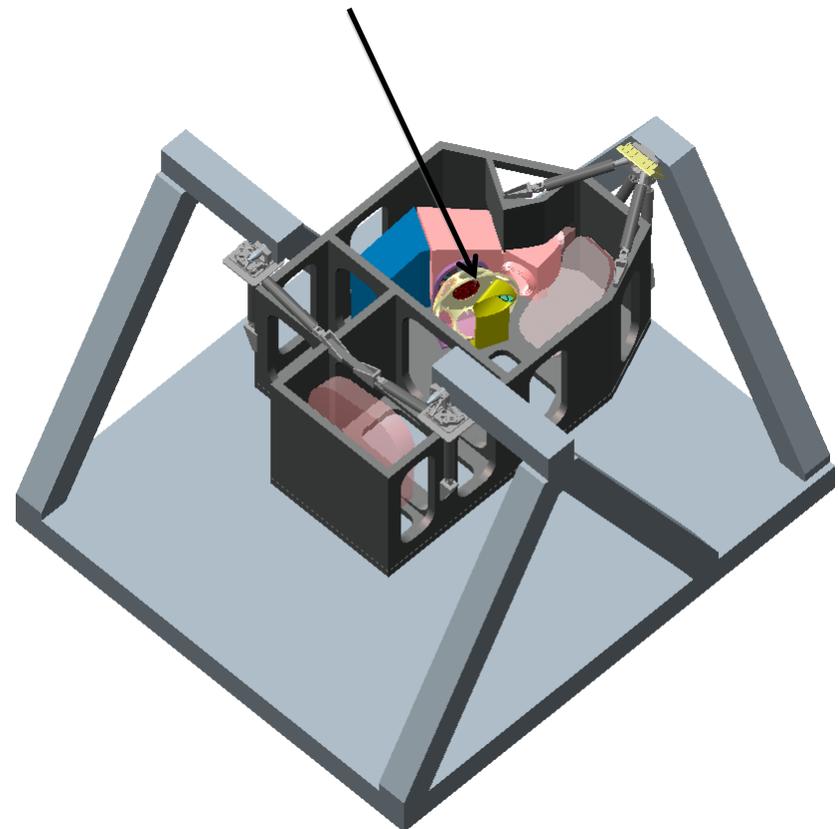
**F1, M3, F2 optics
(F2 access from back)
Alignment access from
sides (not shown)**

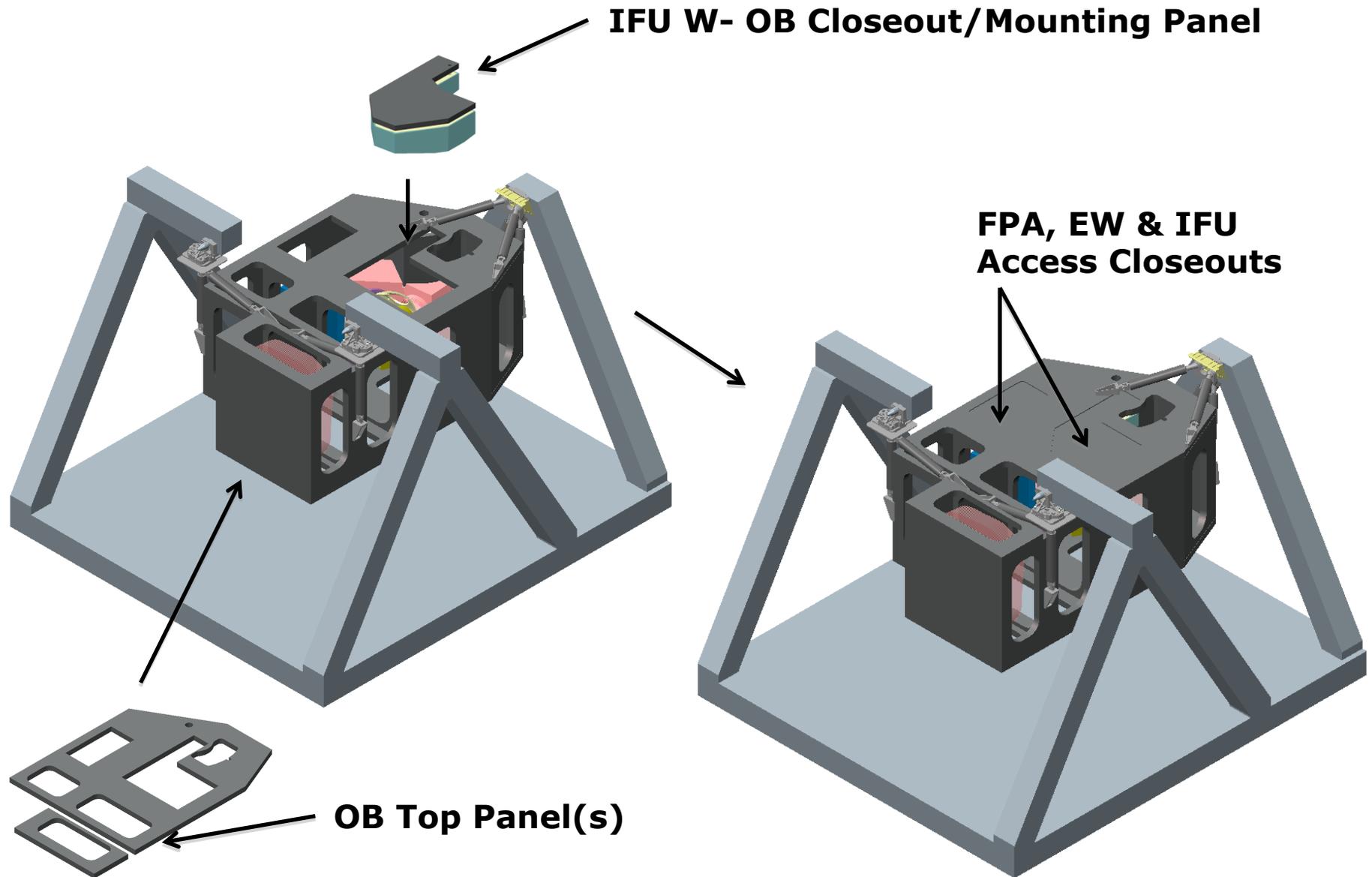


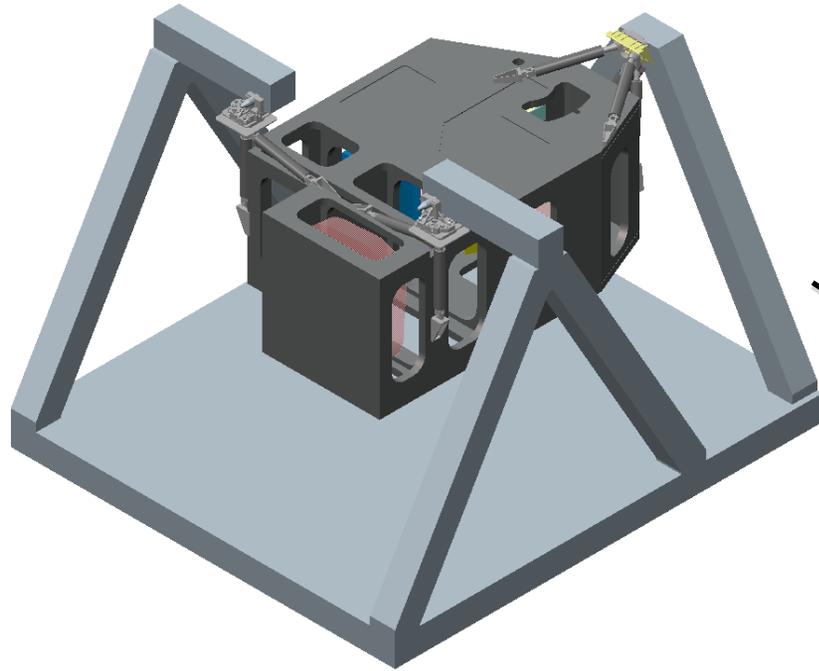
FPA
Top, Side or
Bottom access
(top shown)



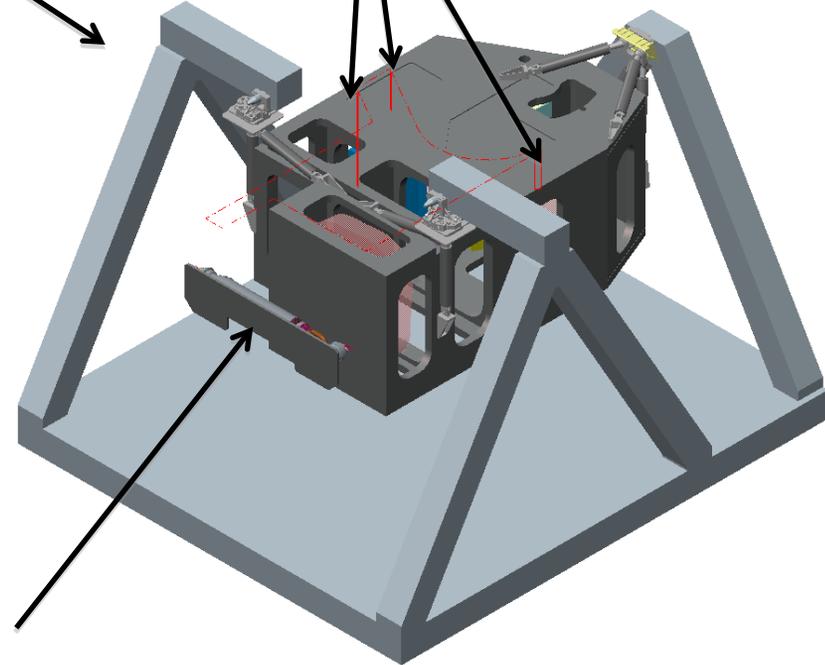
Element Wheel Assembly
(EWA)



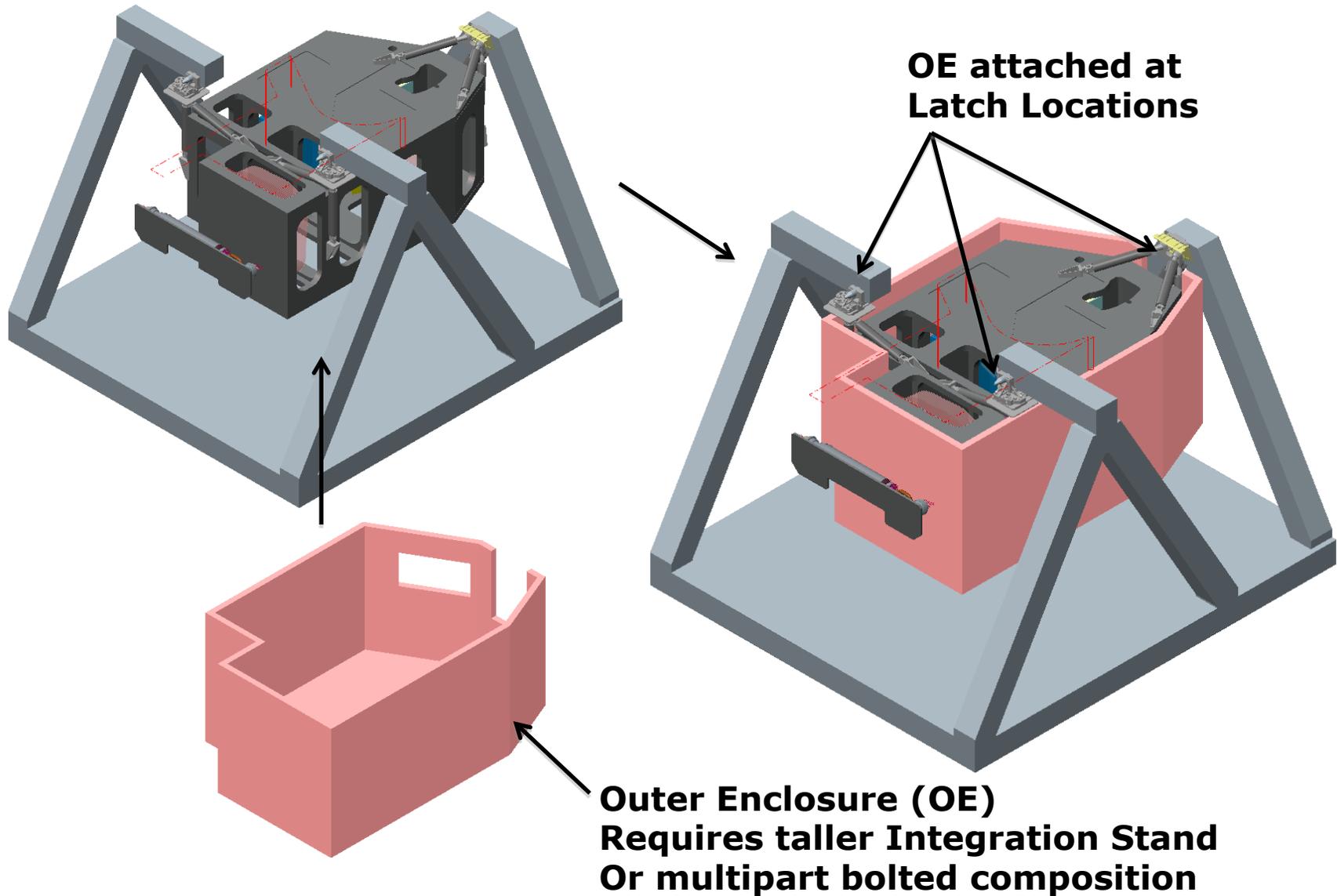


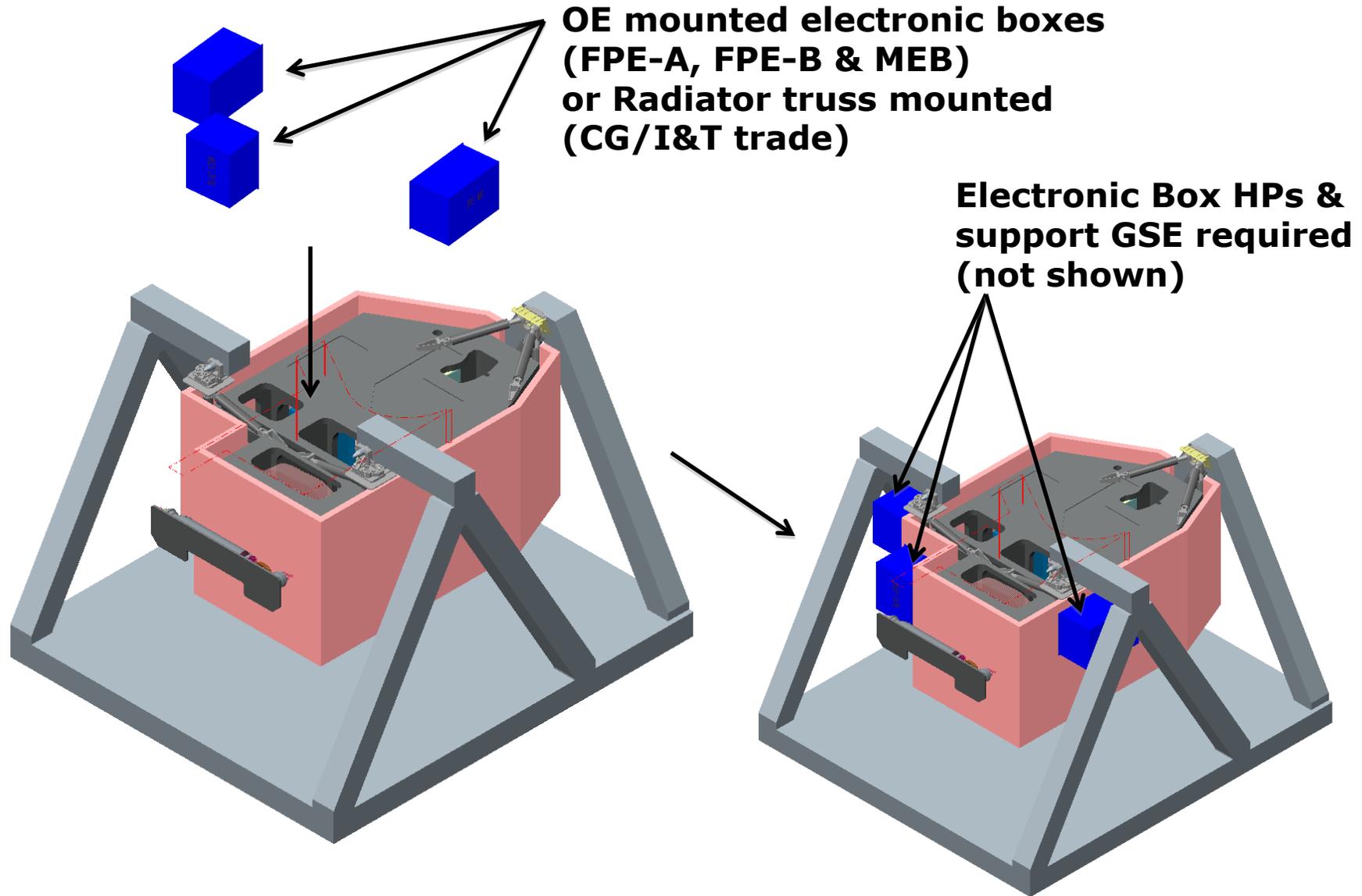


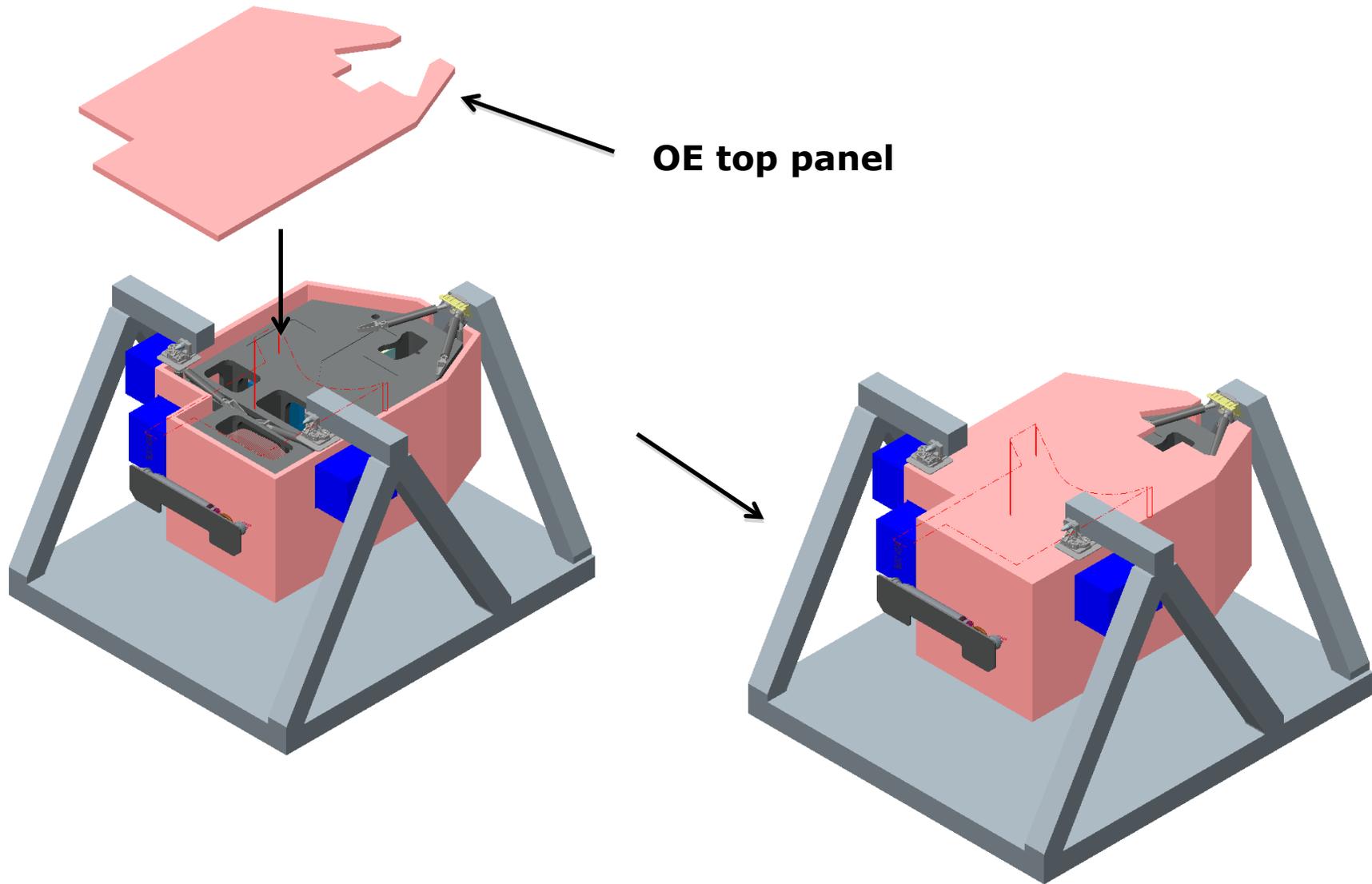
CC cooling line loop. Heat exchanger attachments access (not shown) thru sides and/or top



**Cryo-Cooler(CC)
Requires support GSE**

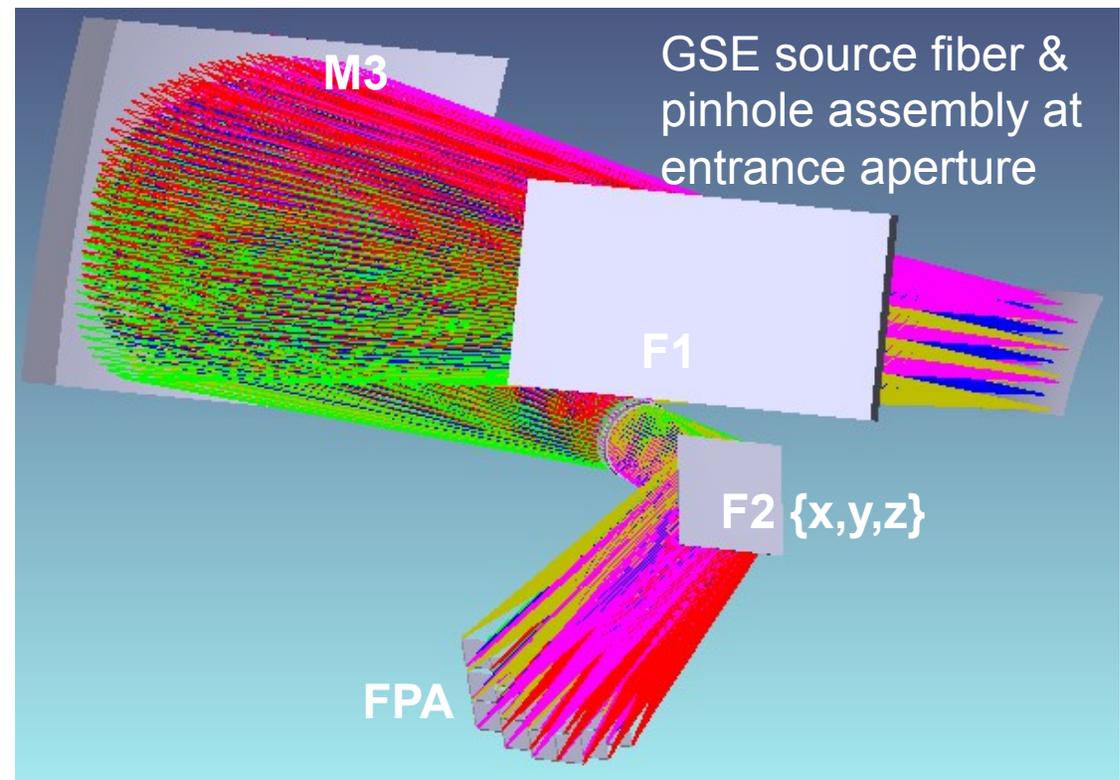






Description of Half pass test

- Assumes mechanical alignment already done
- F2 mechanism allows focus and tip/tilt adjustment
- Iterate F2 position to determine alignment of instrument
- Use GSE alignment capability to achieve required alignment accuracy
- Preliminary wavefront sensing simulations suggest this approach is accurate enough to use



Near term work

- 1/13: Cycle4 configuration freeze
- ~2/19: Complete cycle4 design and model building
- 3/19: Review Cycle4 integrated modeling results [to be available for April report]
- March: Telescope cold coupon materials data
- April: Kickoff cycle5 design work