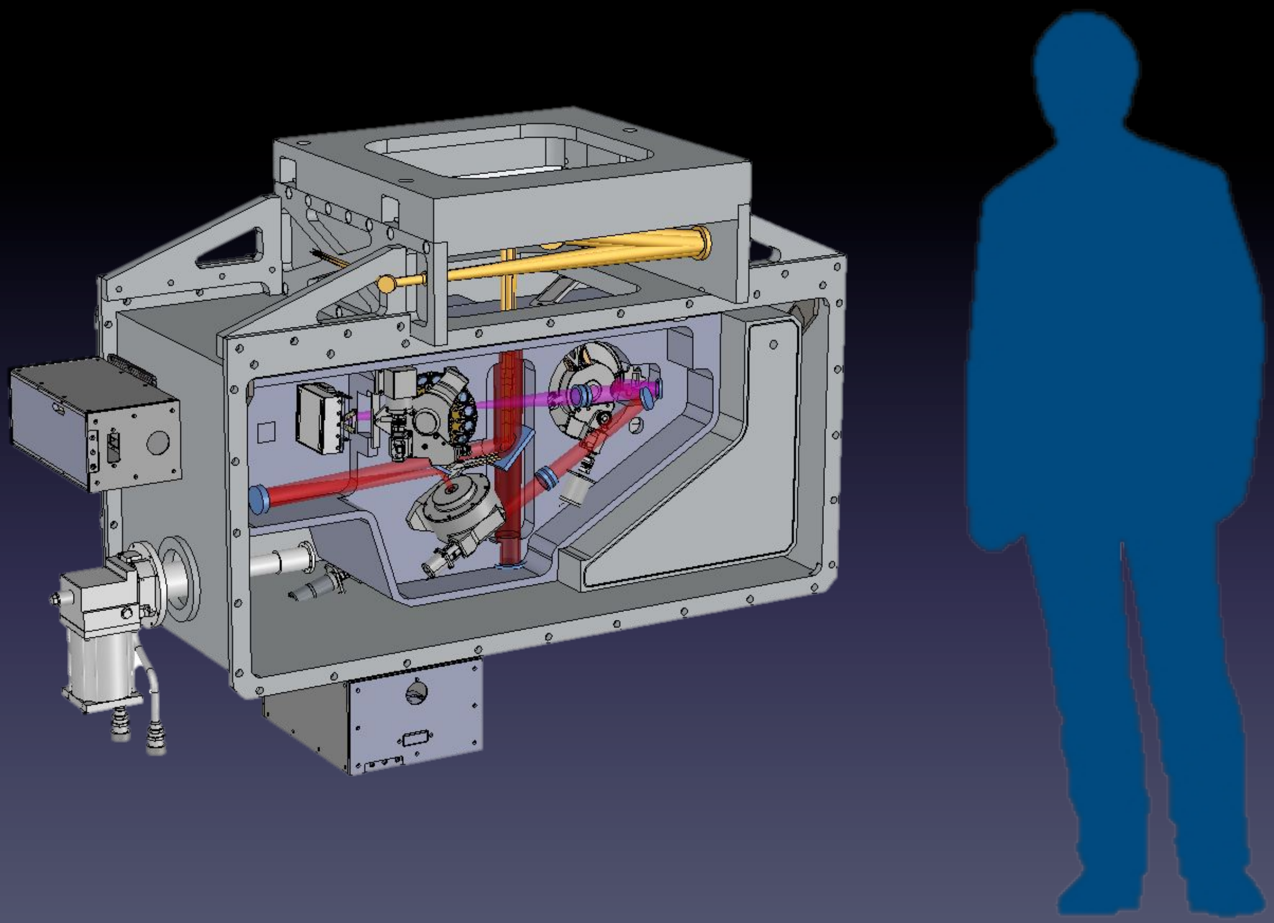
iSHELL STATUS

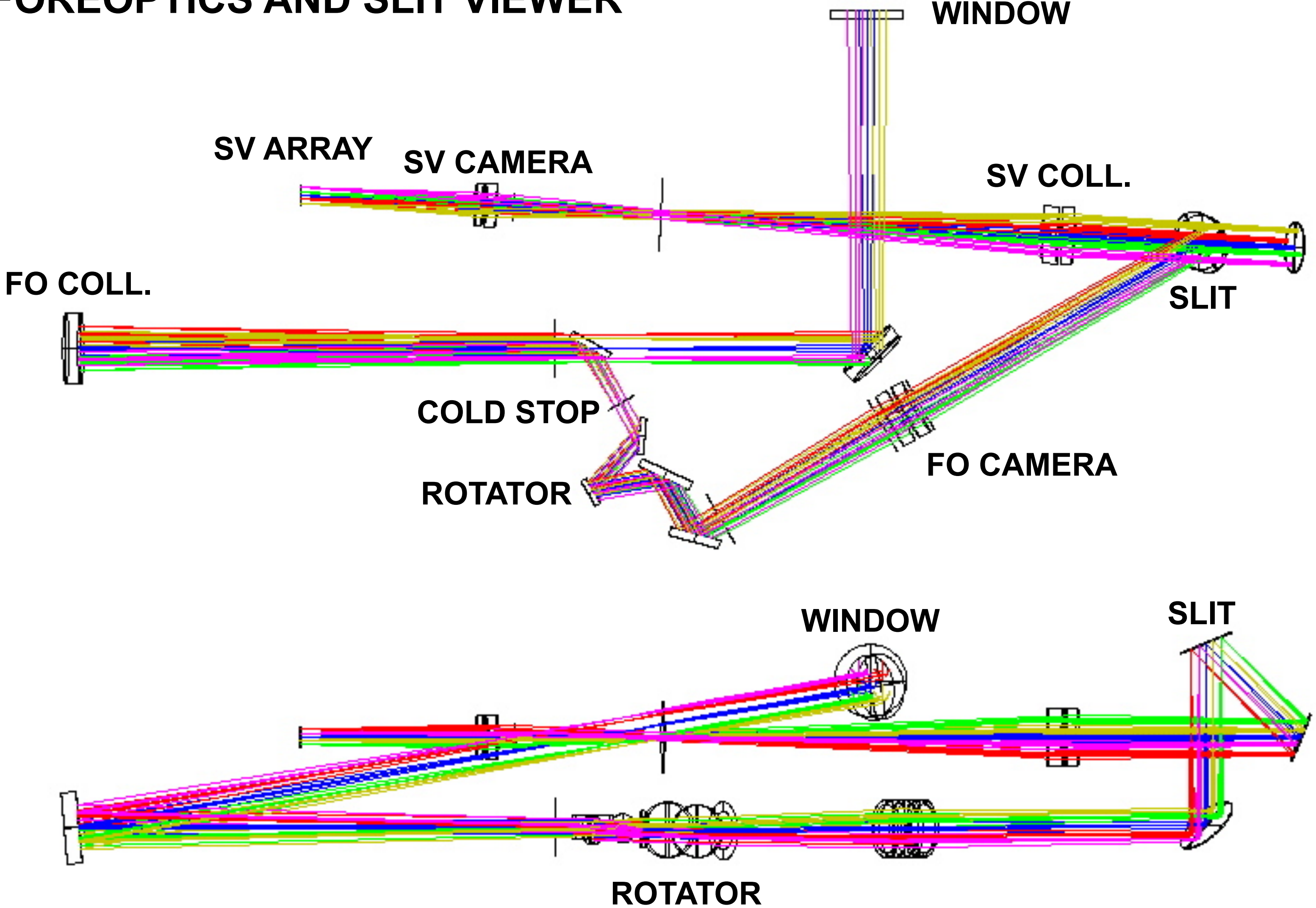


iSHELL status

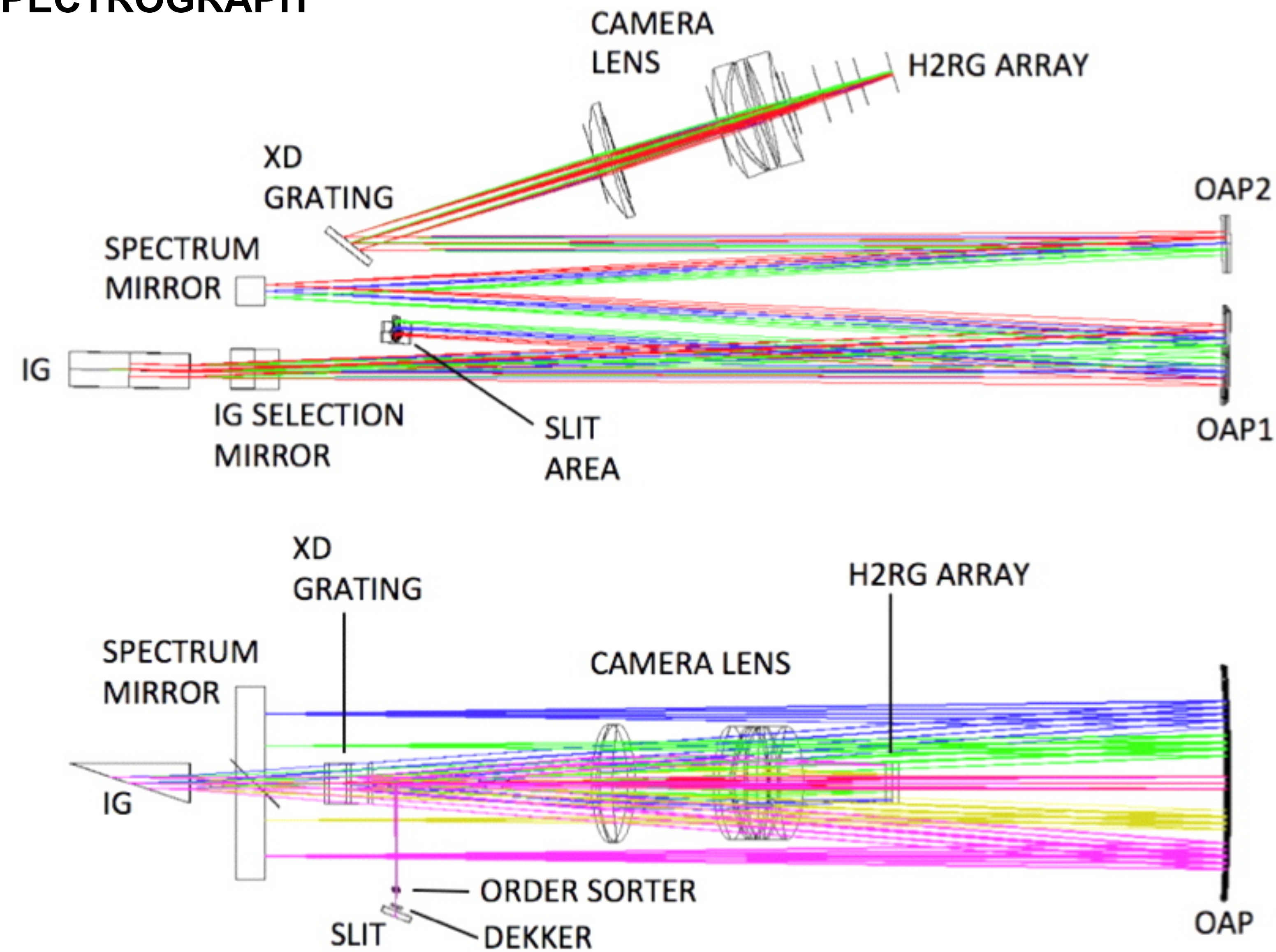
Progress since the Sep. MOWG meeting.

- Project manager from Oceanit hired (Dan Kokubun); started work Nov. 2012.
- Tolerance analysis completed.
- Preliminary alignment plan completed.
- Optical specifications completed. Selection of vendors nearly complete.
- Cryostat concept completed.
- Preliminary Design Review set for April 1 & 2. Optics will be at Critical Design Review stage (and ordering will proceed starting in May).

FOREOPTICS AND SLIT VIEWER



SPECTROGRAPH



Remaining optical design tasks to CDR

- Immersion grating specs ✔
- Refractive camera versus TMA/FMA ✔
- Final optical element specs ✔ and drawings ✖
- Opto-mechanical tolerancing ✖ (80%)
- Optical element mount designs ✖
- Negotiate irregularity specs with vendors ✔
- Final ghost image analysis ✔
- Integrate baffling into cryostat layout ✖ (50%)
- Final XD grating specs ✔
- Final order sorting filter specs ✔
- Final calibration system design and layout ✔
- Optical alignment plan ✖ (50%)
- Documentation ✖ (50%)

Remaining optical design tasks to CDR

- Immersion grating specs ✔
- Refractive camera versus TMA/FMA ✔
- Final optical element specs ✔ and drawings ✖
- Opto-mechanical tolerancing ✔
- Optical element mount designs ✔
- Negotiate irregularity specs with vendors ✔
- Final ghost image analysis ✔
- Integrate baffling into cryostat layout ✖ (50%)
- Final XD grating specs ✔
- Final order sorting filter specs ✔
- Final calibration system design and layout ✔
- Optical alignment plan ✔
- Documentation ✔

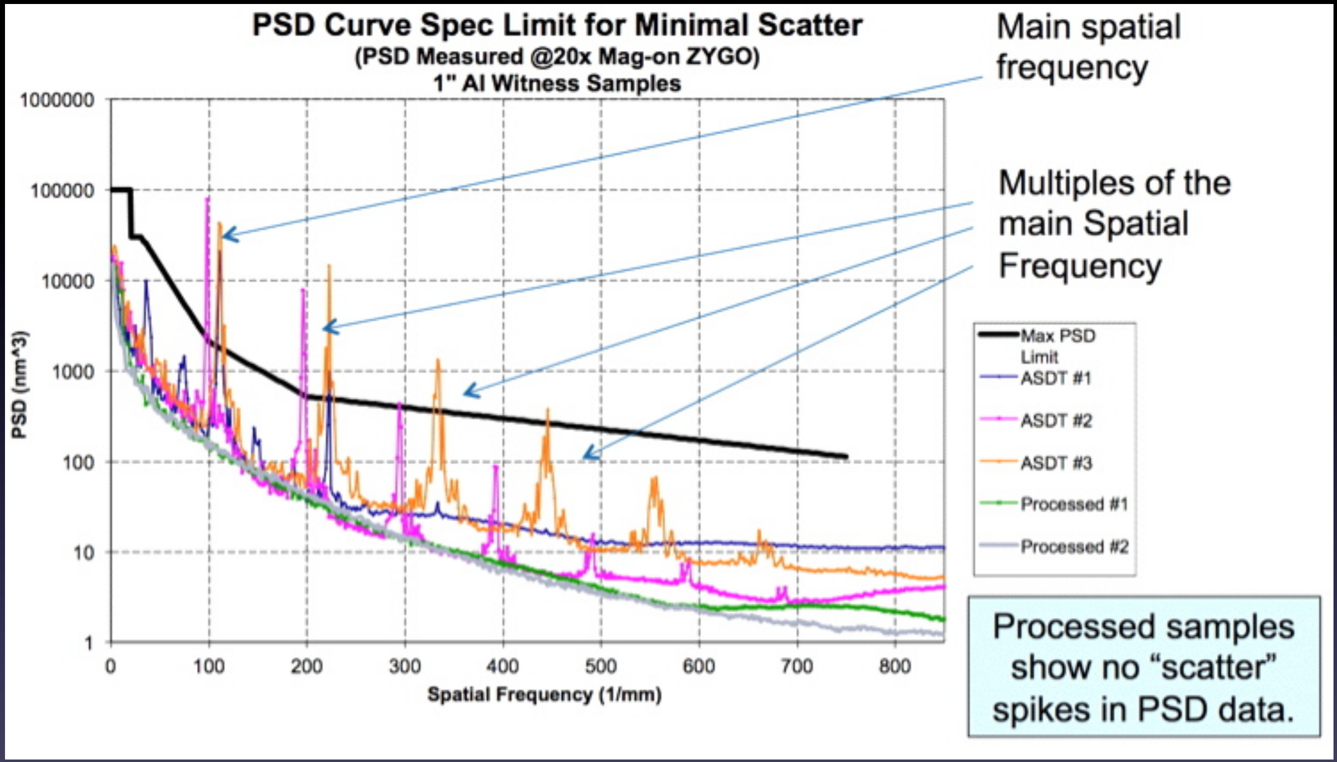
Diamond-machined aluminum off-axis parabolas (OAPs)

Three options for OAP fabrication

1. Corning NetOptix about $200 K using LEC technique to minimize diamond turning 'grooves'
2. Use standard diamond-turning procedure on RSP aluminum material to minimize grooves. Risky?
3. Use standard diamond-turning procedure on standard material and since grooves have minimal effect on scattered light (e.g. Durham Precision Optics about $30 K)

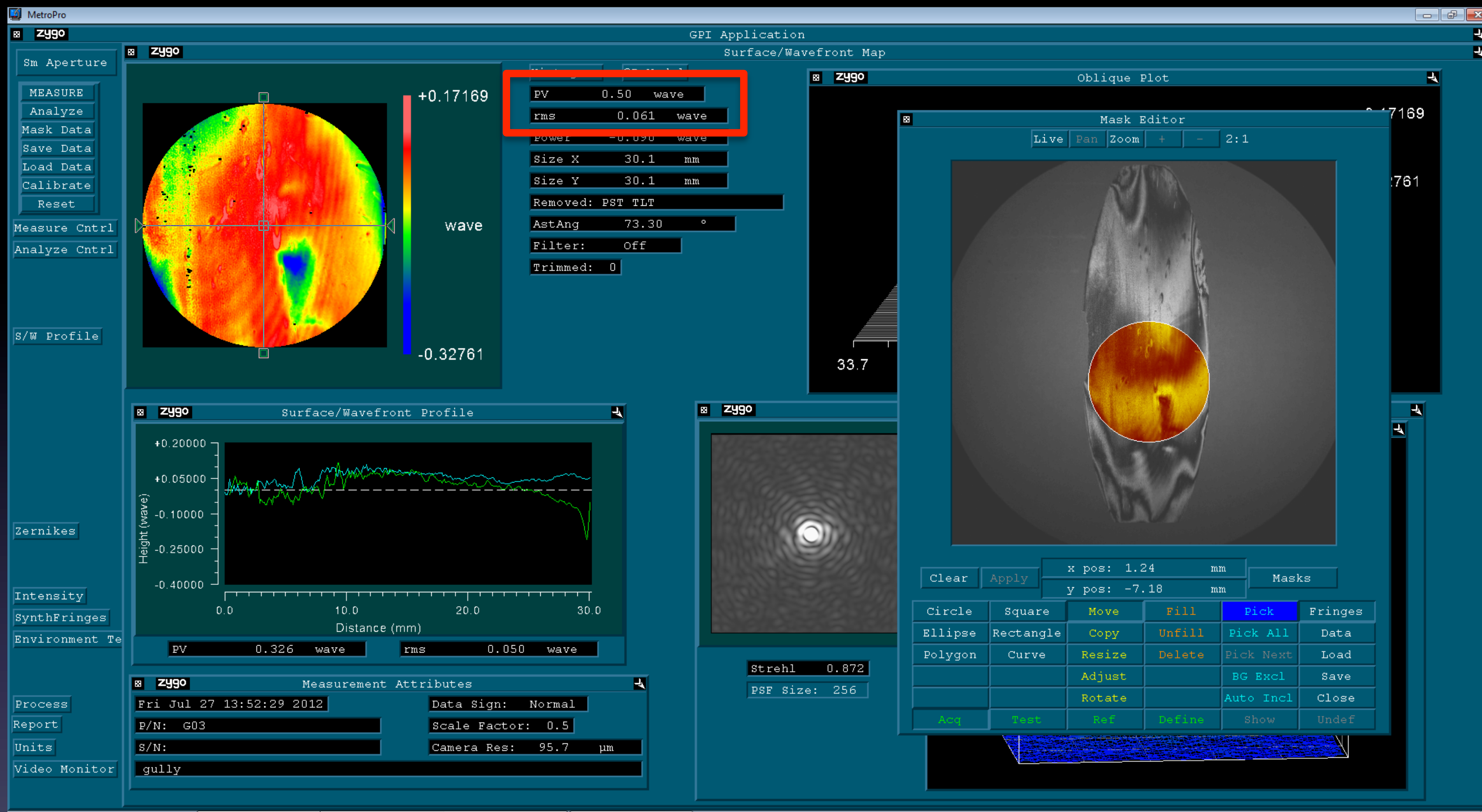
Diamond-machined Al OAPs

Power Spectral Density (PSD)



- Typical PSD from diamond-machined mirror from Corning standard and LEC process
- Amount of scatter is proportional to area under curve
- Scatter due to periodicity is therefore small

LM grating successfully fabricated



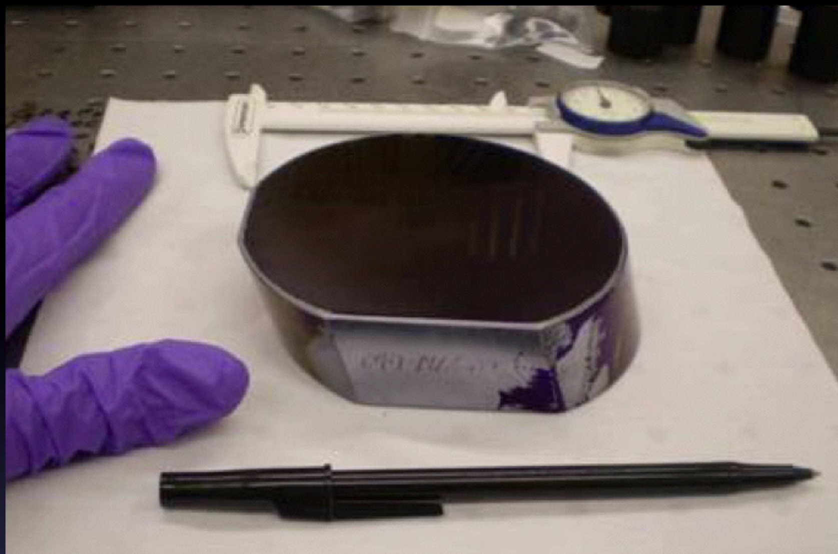
- Fabricated by contact lithography process at UT
- Meets spec., surface 0.061 waves RMS at 2.1 μm
- Grating will serve as backup since UT 'can do better'

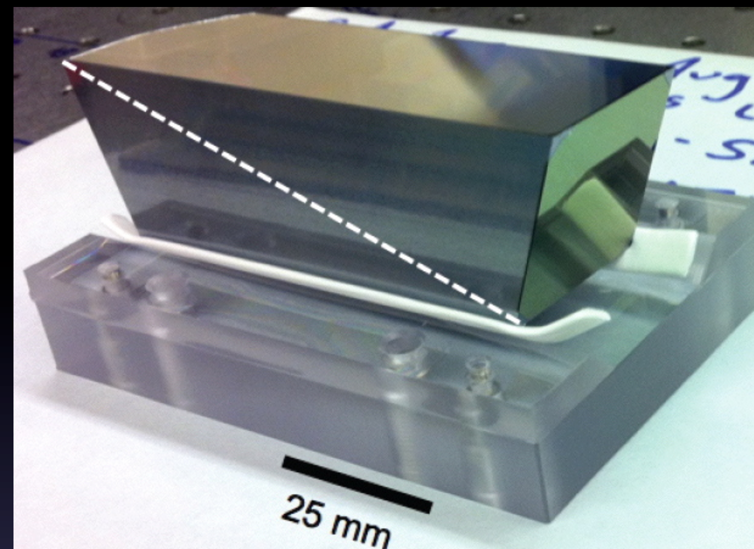
Immersion grating update

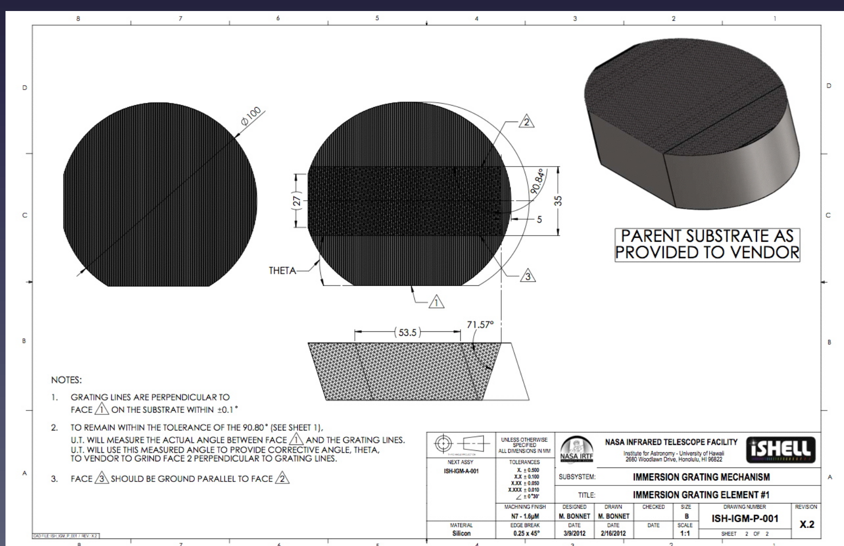
Schedule has slipped in an effort to better understand the sources of the dominant errors:

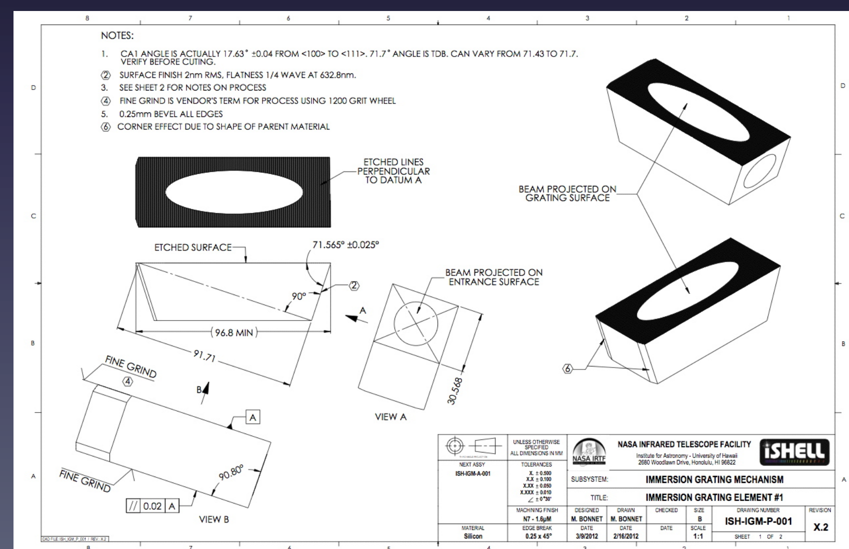
- Using new light meter to improve UV beam uniformity (contact lithography)
- Purchased own Zygo
- Plasma etch specialist now employed (Cindy Brooks)
- Plan to pattern *LM* grating (contact lithography) and *JHK* grating (e-beam lithography) in March 2013

Next step: cut substrate to shape

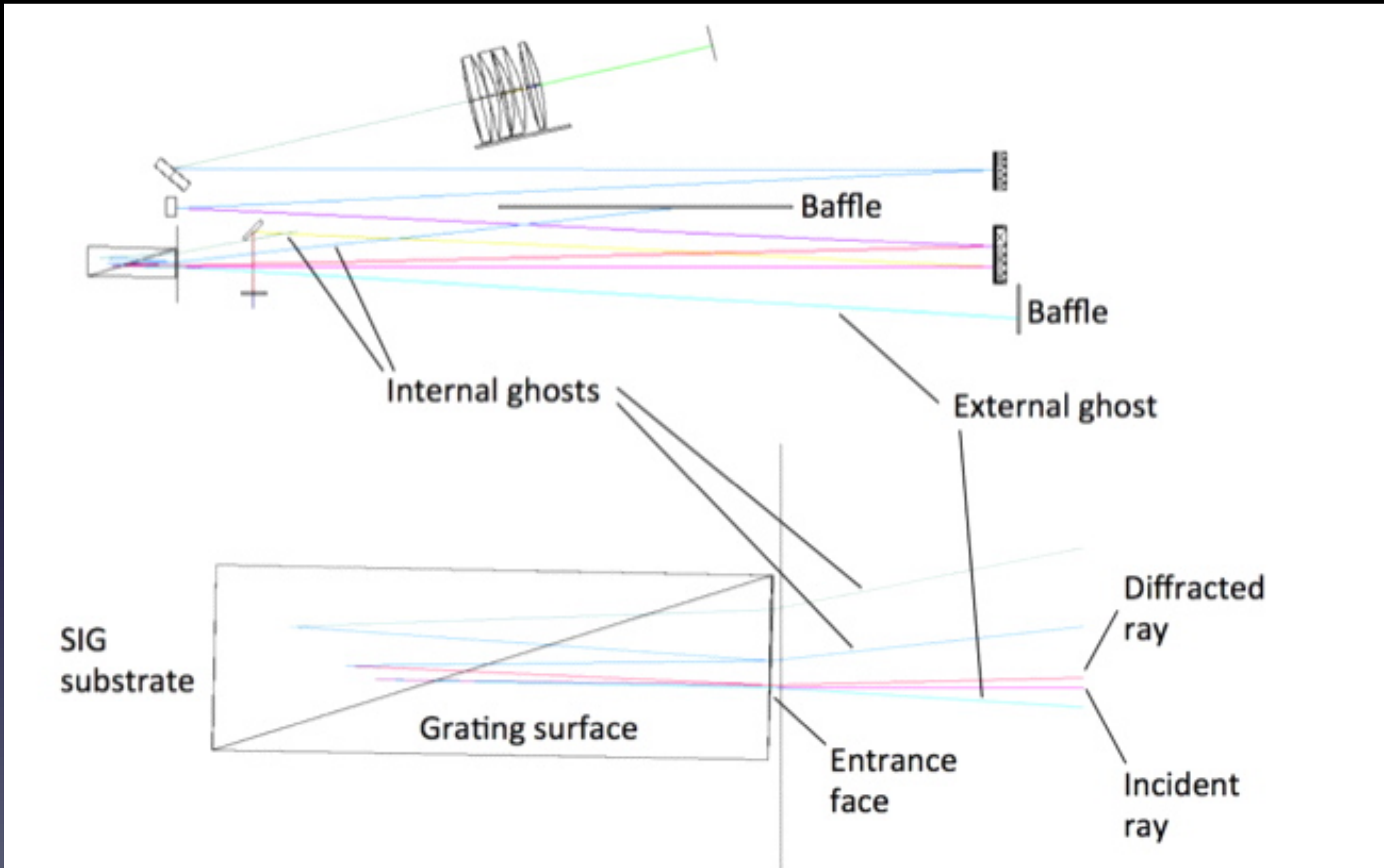




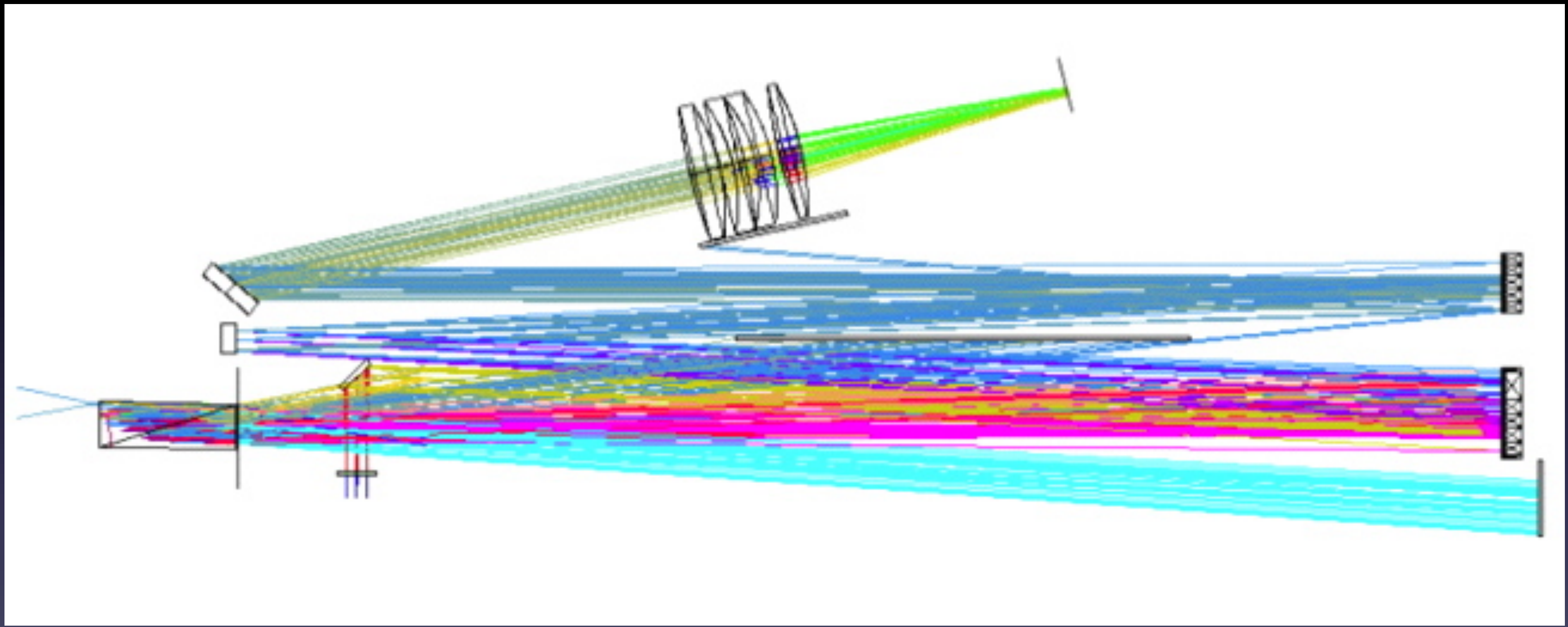




Immersion grating: stray light



Immersion grating: stray light



Summary of high-level thermal design requirements

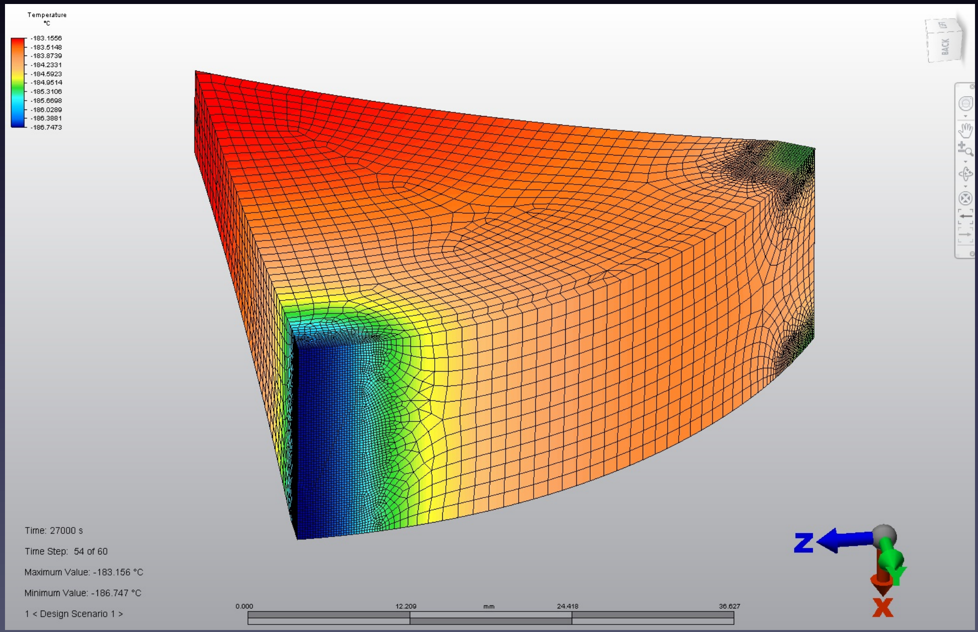
1. Optical enclosure temperature < 78 K, stability < 1 K
2. Detector array cooling/warming rate < 0.5 K/min
3. Lens element cooling/warming rate < 0.5 K/min (rate measured for the SpeX optical mounts)
4. Spectrograph array temperature 38 K, stability < 0.1 K
5. Guider array temperature 30 K, stability < 0.1 K
6. Immersion grating temperature 80 K, stability < 0.1 K
7. If used, liquid nitrogen hold-time must be longer than about two days
8. Cooling/warming times must be no longer than three days with a goal of two days

iSHELL opto-mechanical progress

- Lens mount design is based on SpeX and NSFCAM designs (up to 80 mm diameter)
- Since some iSHELL lenses are bigger (100 mm diameter and twice the mass) we are conducting a thermal analysis to assess the risk of breaking the lenses on cooling
- iSHELL design includes one sensitive LiF_2 lens
- FEA modeling of transient thermal analysis
- FEA modeling of internal stress distributions
- We are confirming results with a similar analysis of the existing SpeX LiF_2 lens
- Models are showing that stresses are high but within limits. Contact resistance of the mounting points is significant

iSHELL opto-mechanical progress

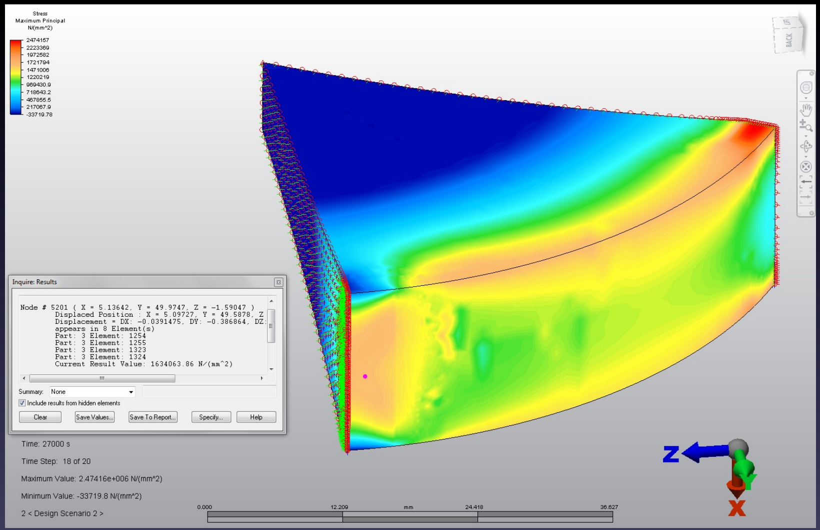
- Transient cooling at 0.5 K/min down to 80 K
- Individual lenses held with 5 hard points and 4 springs
- Analysis includes conduction and radiation
- Contact resistance is modeled

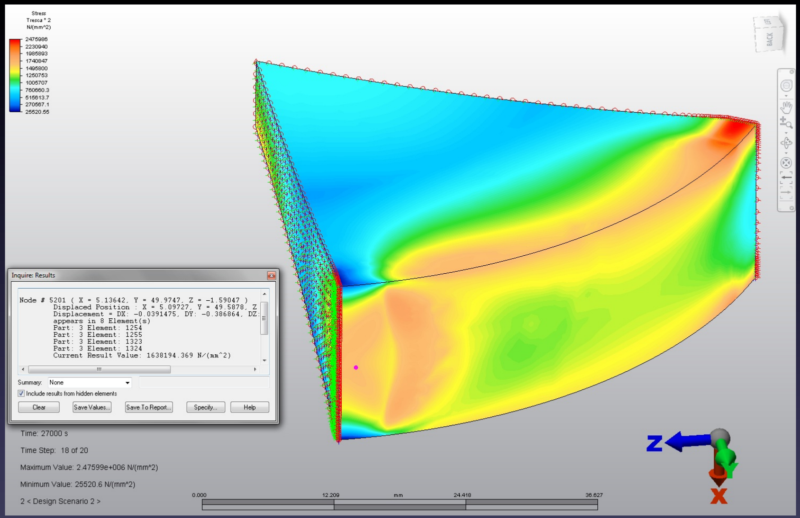


- Maximum temperature gradient is 3.6 K

iSHELL opto-mechanical progress

- Coupled transient thermal analysis to stress analysis
- Thermal gradients cause internal stresses
- Effects most pronounced at the mounting points

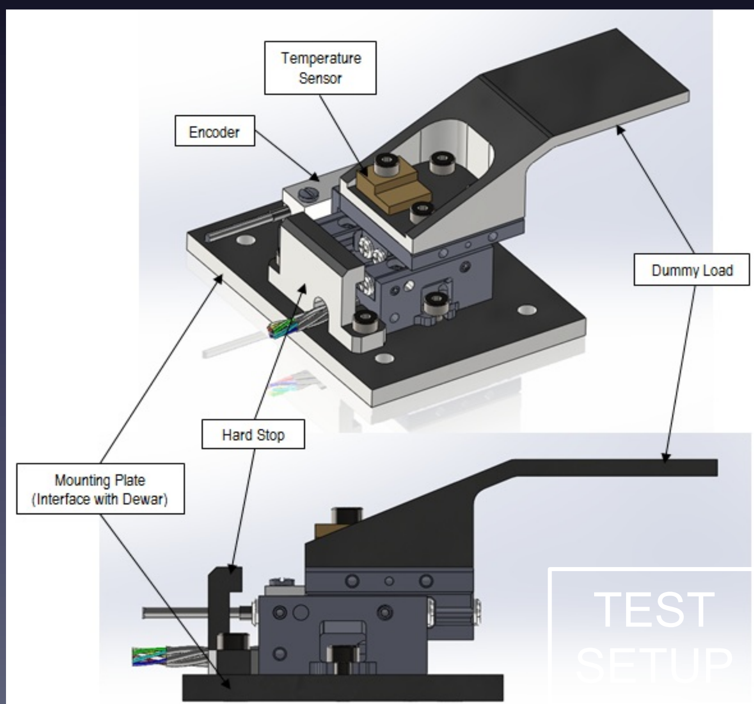


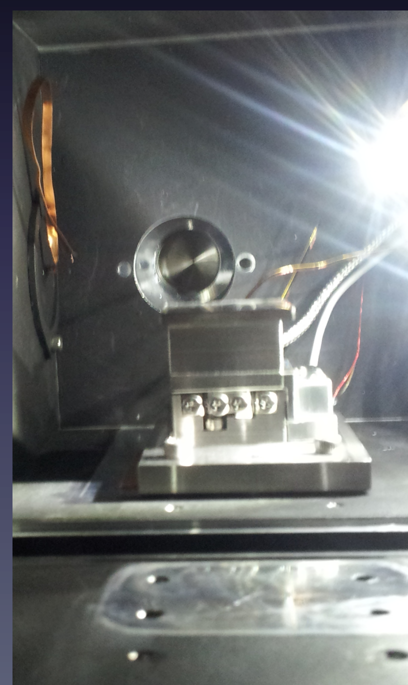


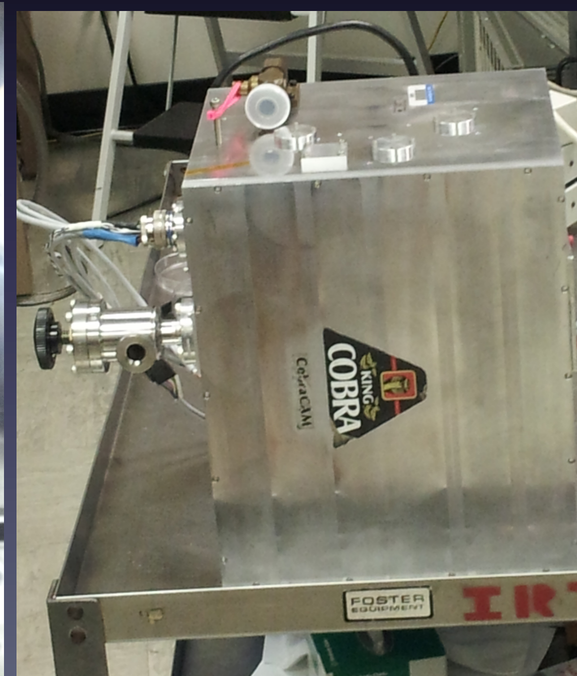
- Maximum principle stresses are at a level of 2.5 MPa
- Maximum shear stress tolerated is at a level of 1.25 Mpa
- JWST NIRCAM criteria “resolved stress” < 2.0 Mpa for a similar LiF lens

Dekker piezo-stage testing (Bonnet)

- Refurbished an old instrument into a test dewar.
- Test plan includes cryo & vacuum test, position hold test, re-initialization test, hard-stop test and lifecycles.
- First test unsuccessful. No movement at 77K. Stage was sent back to vendor. Second test on the way. Alternative design is being considered

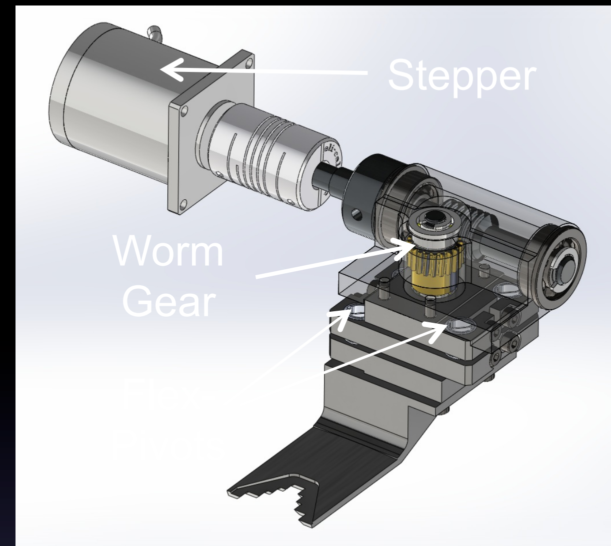


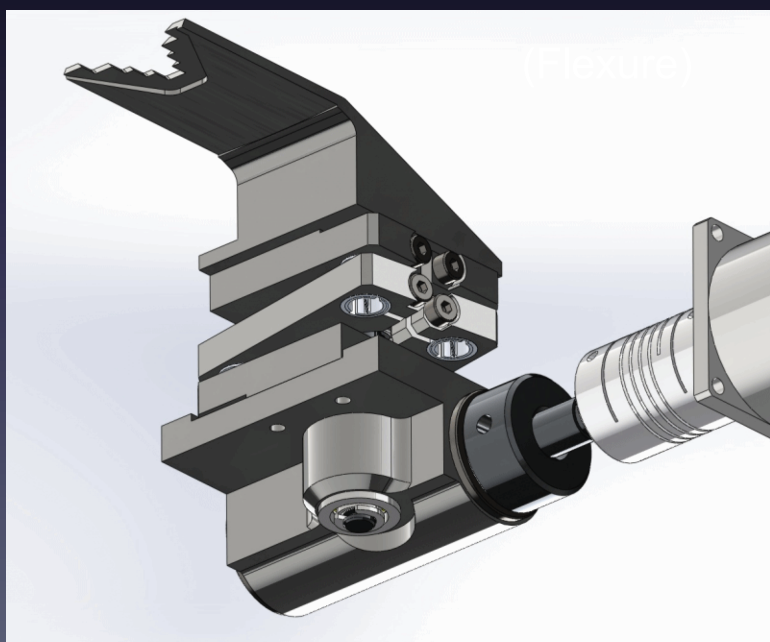


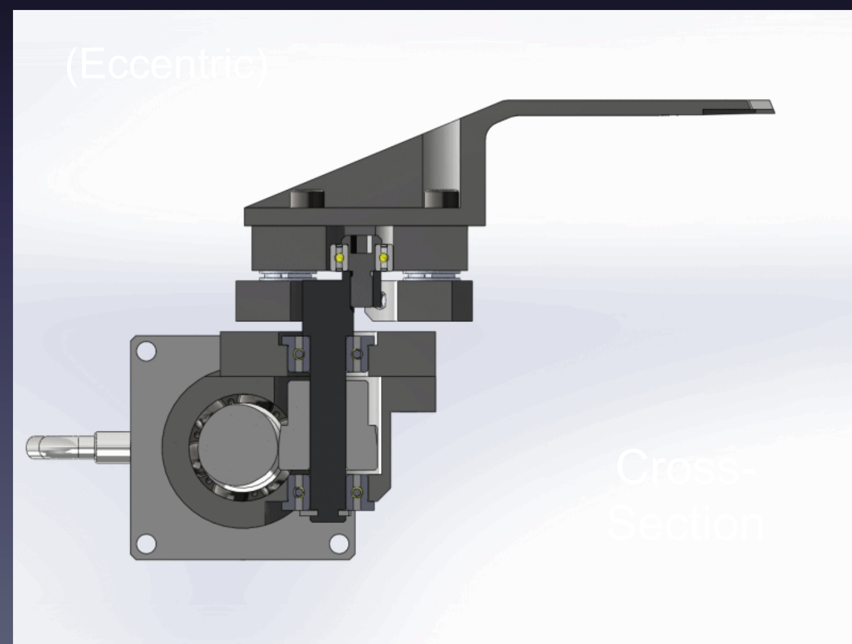


iSHELL Dekker Piezo-Stage: Alternative Concept

- Flexure Stage designed using Flex-Pivots.
- Powered using a Stepper + Worm Gear + Eccentric Cam.







Cross-disperser tilt control

Choice of position sensor:

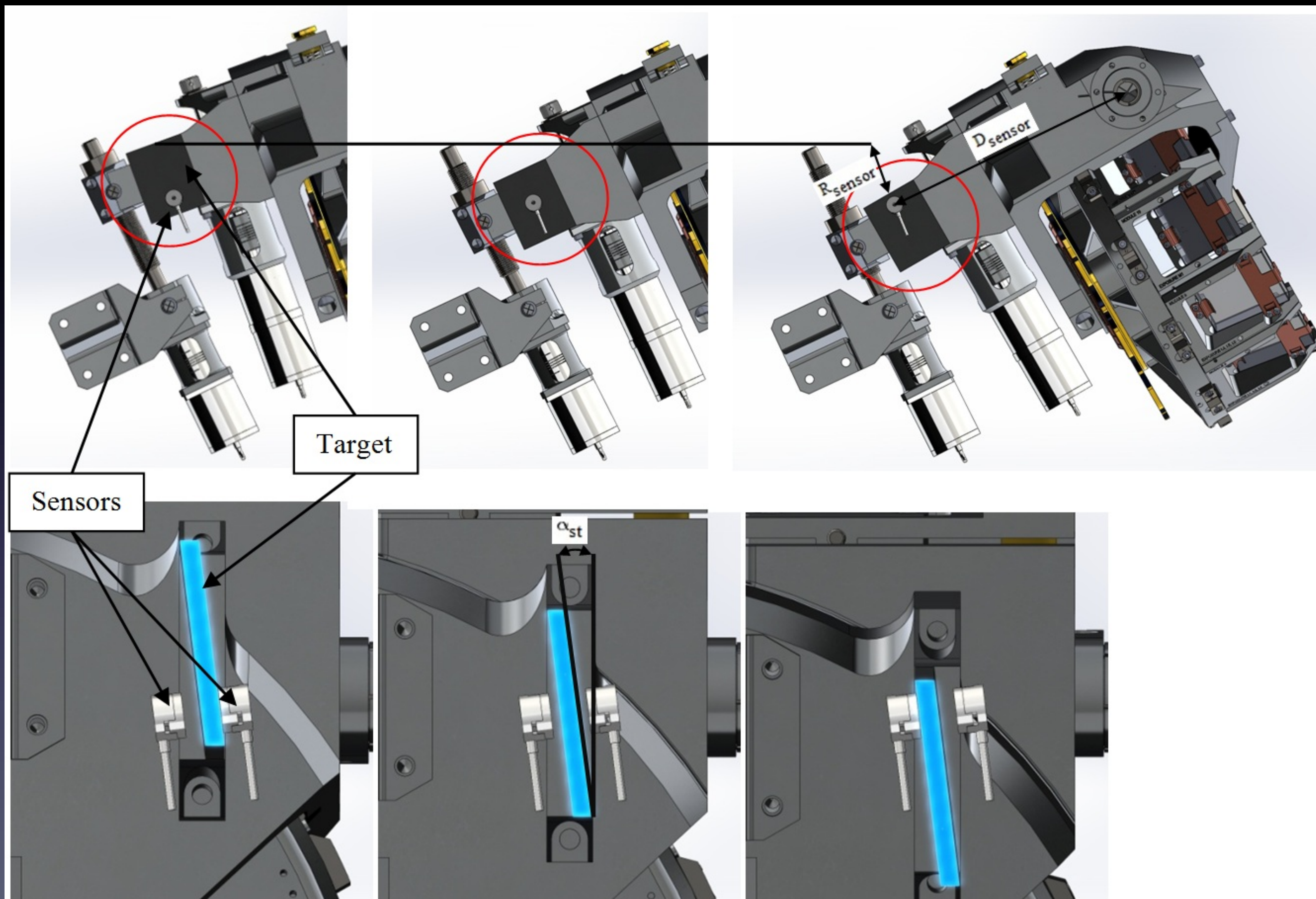
1. Hall effect sensor (F.W. Bell FH-301-040)

Pros	Cons
- Price - Already implemented in SpeX - Passive Sensing. Can be used simultaneously with Detector Readout.	- Unknown Accuracy ⇨ Too much effort needed to quantify at the level of accuracy required. - Range is limited. “Physical range reduction trick” (*) isn’t applicable. - No package or mount included. - Potential irregular magnetization

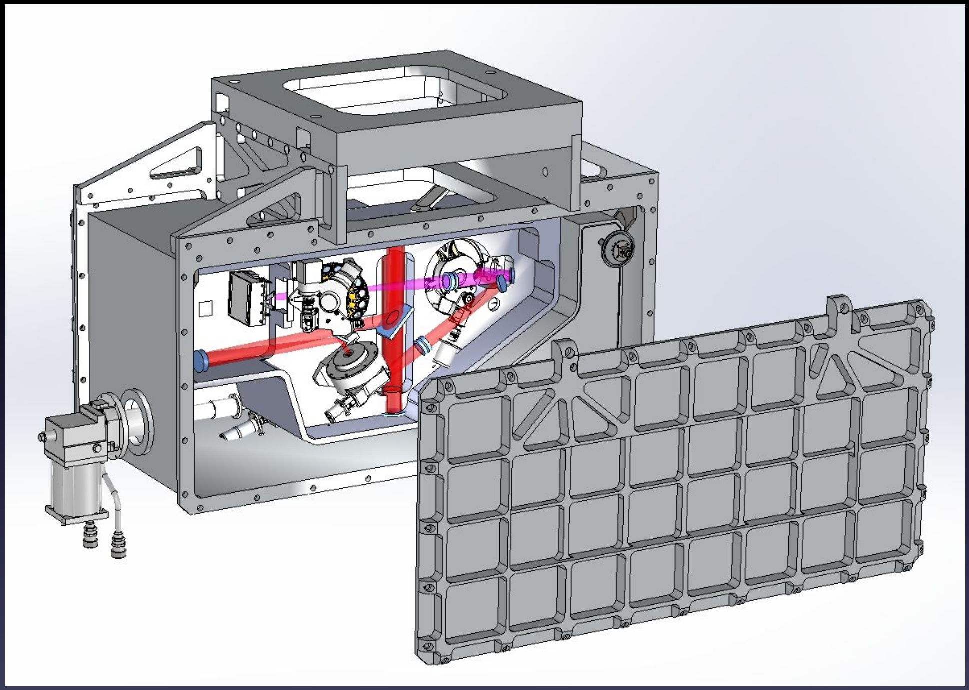
2. Eddy current sensor (Kaman DIT-5200L / 20N)

Pros	Cons
- Known accuracy. - Comes as a set: Sensors + Electronics. - Extremely Linear. - Range can be tuned using a “Physical range reduction trick”. (*) - Easier to implement	- Price. - Needs Coax cables. - Active sensor: can perturb detector readout. - Needs 10/15 minutes to warm up and give reliable data after turning it on => RF switch needed.

Cross-disperser tilt control



Mechanical Layout (Kokubun)

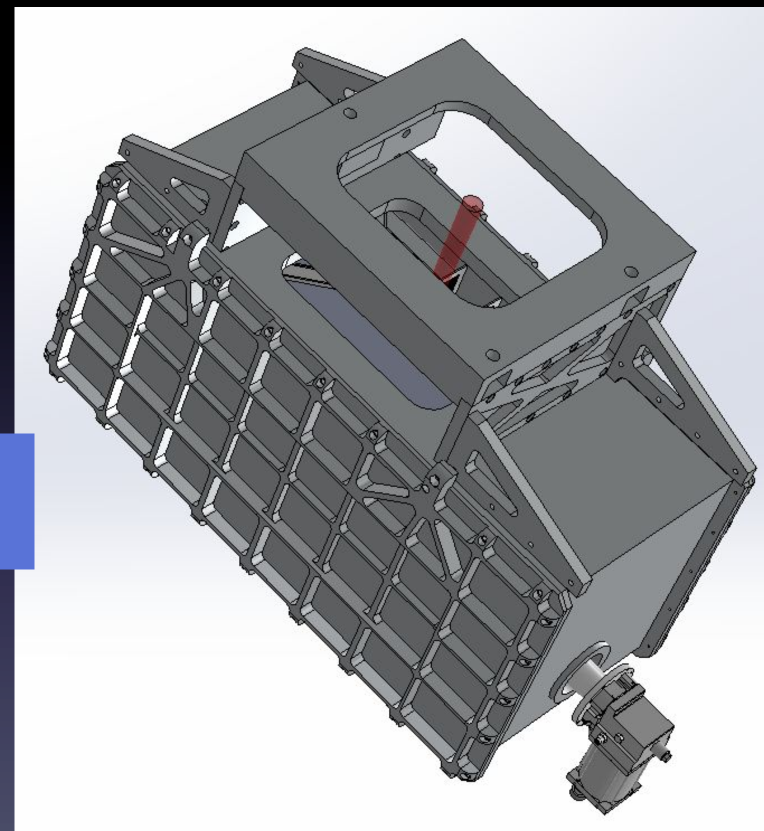


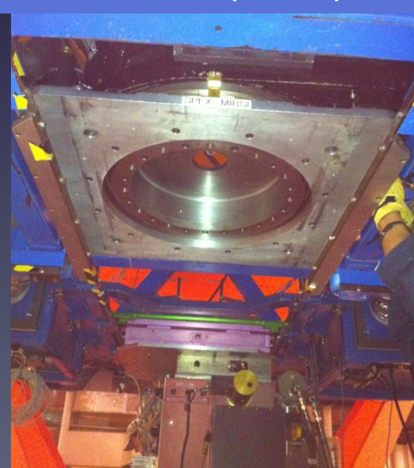
	item	mass (lb)	
Optical Bench Assembly	Optical Bench	193	
	Image Rotator Mechanism	4.7	
	Cross Disperser Mechanism	19.4	
	Radiation Shield	8.2	
	Slit Mechanism	5.2	
	Order Sorting Mechanism	5.2	
	Immersion Grating Mechanism	5.2	
	Filter Wheel Mechanism	5.6	
	Detector, H2RG	6.6	
	Detector, Alladin	1.2	
	LN Can w/12L LN	40	
	Optics + Mounts	20	
			314.3
Cryostat Assembly	Cryostat	230	
	Trusses	8.9	
	Cryo Cooler	30	
	He Lines	20	
	Copper Flanges	5	
	Aladdin Controller	13.6	
	H2RG Controller	21.4	
			328.9
	Telescope Interface	108	108
		Total Est	751.2

- Estimated weight: 751 lbs
- Estimated Hold time at zenith: 2.2 days

Telescope interface

- Three point interface to the Multiple Instrument Mount (MIM cart) to facilitate initial alignment
- Gussets provide open access to the calibration optics and cryostat window

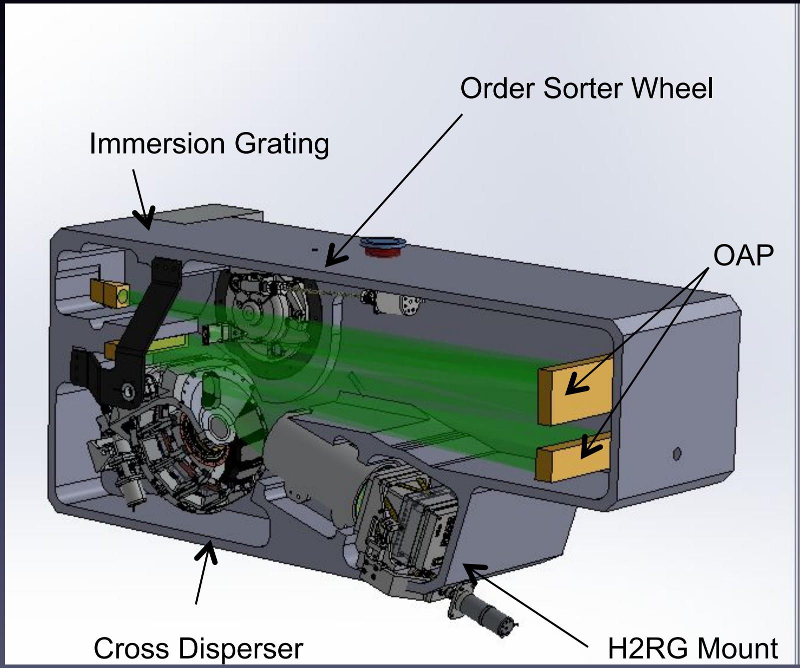




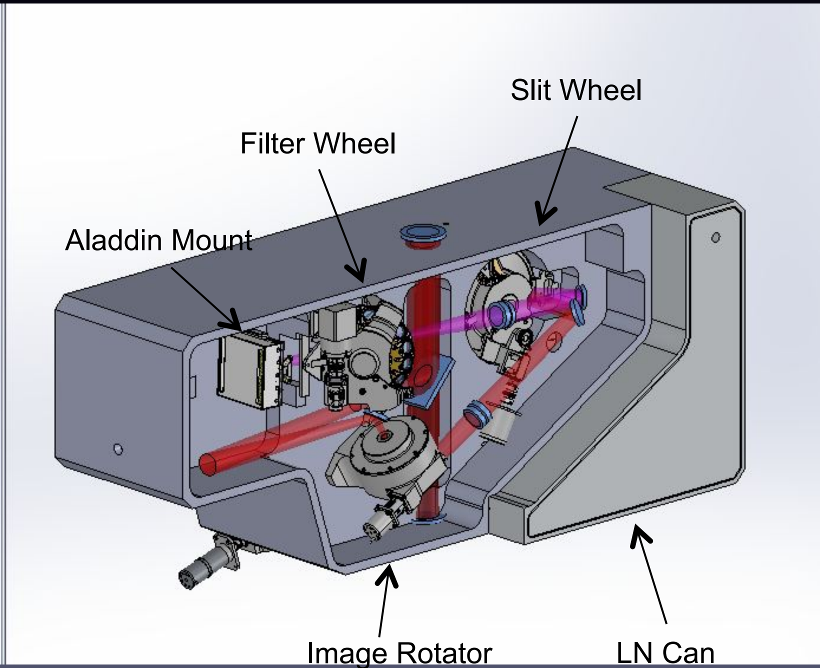
Multiple Instrument Mount (MIM)

Optical Bench

- Two sided bench
- Milled from a single billet
- Pocketed for weight reduction



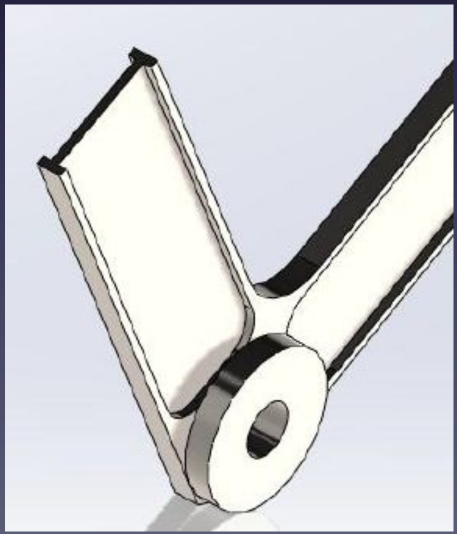
Spectrometer Side

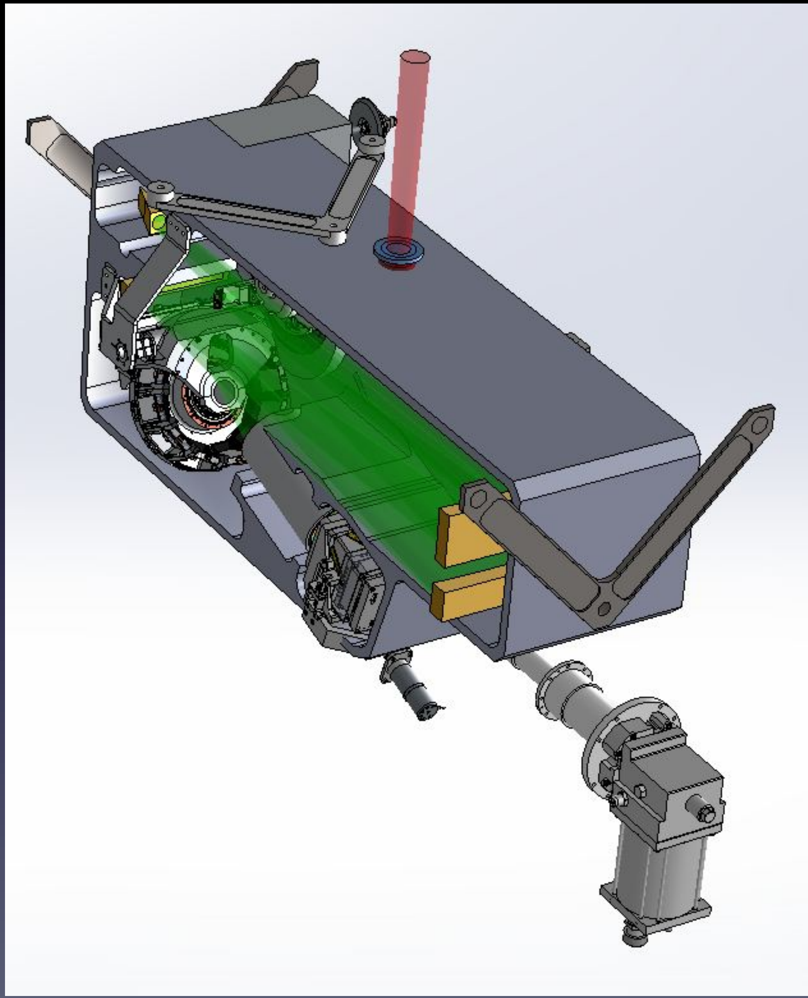


Fore Optics Side

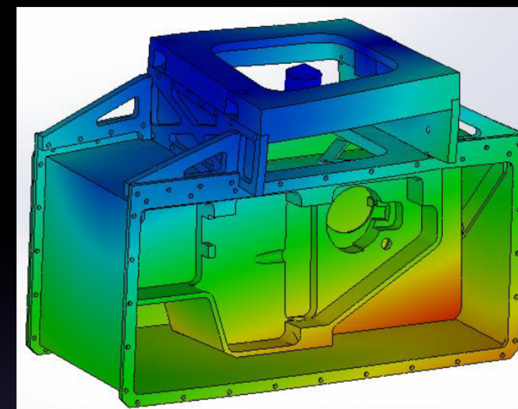
Trusses

- Three truss configuration (Titanium)
- Truss cross section optimized for maximum strength and thermal resistance
- Approximately 5W combined thermal load conducting through the trusses





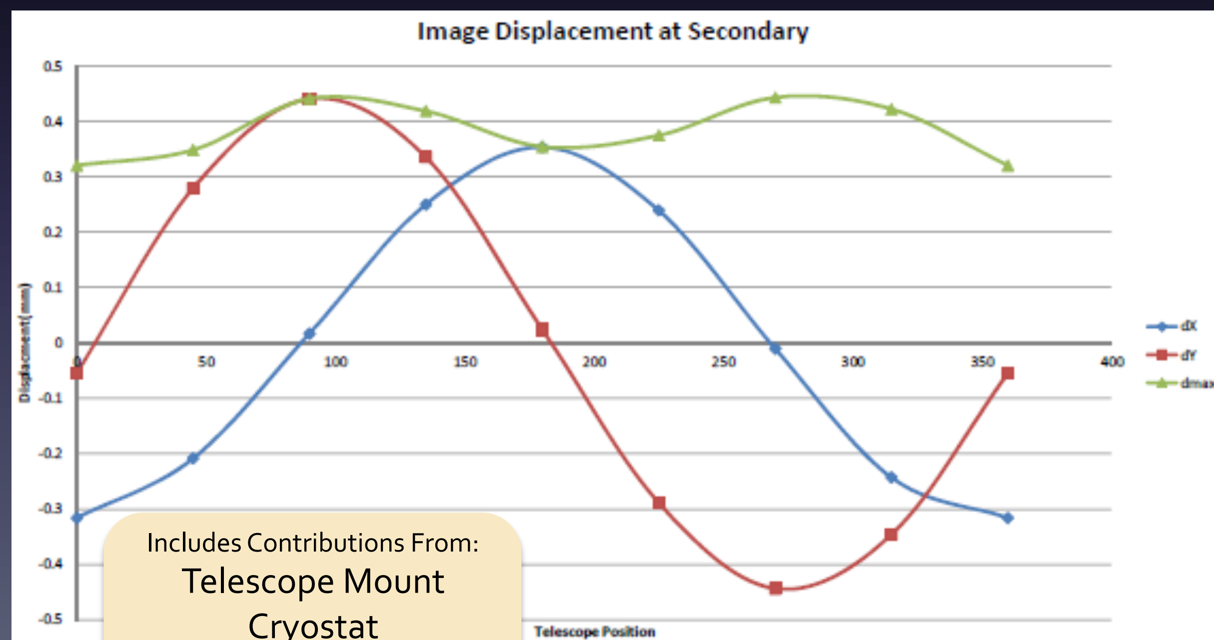
Flexure Study



Requirement: Co-alignment of the cold stop and telescope exit pupil to within 1% of their diameters...

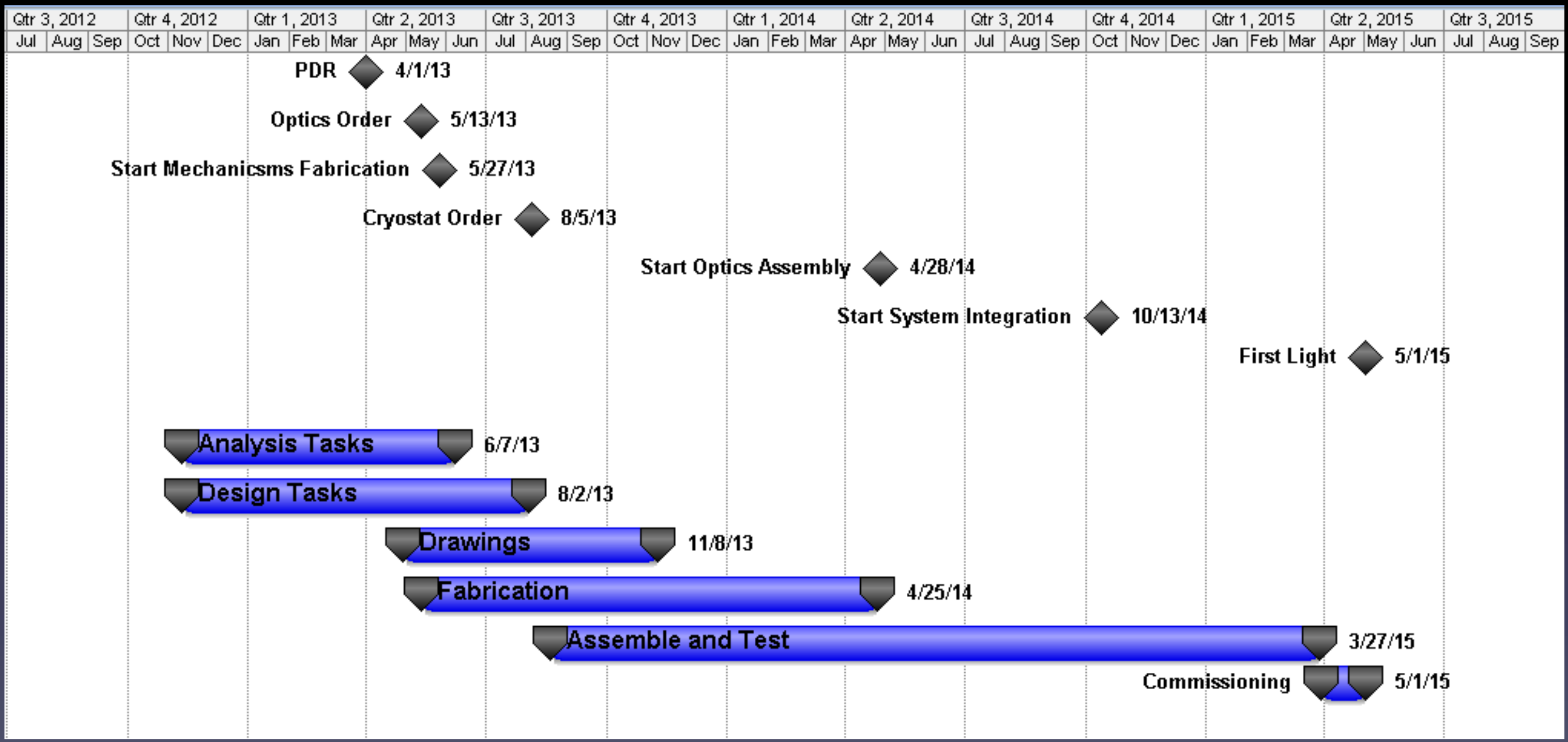
This is equivalent to 2.4mm image displacement at the secondary

- Worst case gravity vectors used (60° from zenith)
- The resulting angular deflection of the optical axis is expressed as image displacement at the secondary
- Total contribution is 0.45 mm at the most - *20% of the allowable flexure*



Includes Contributions From:
Telescope Mount
Cryostat
Trusses
Optical Bench

Schedule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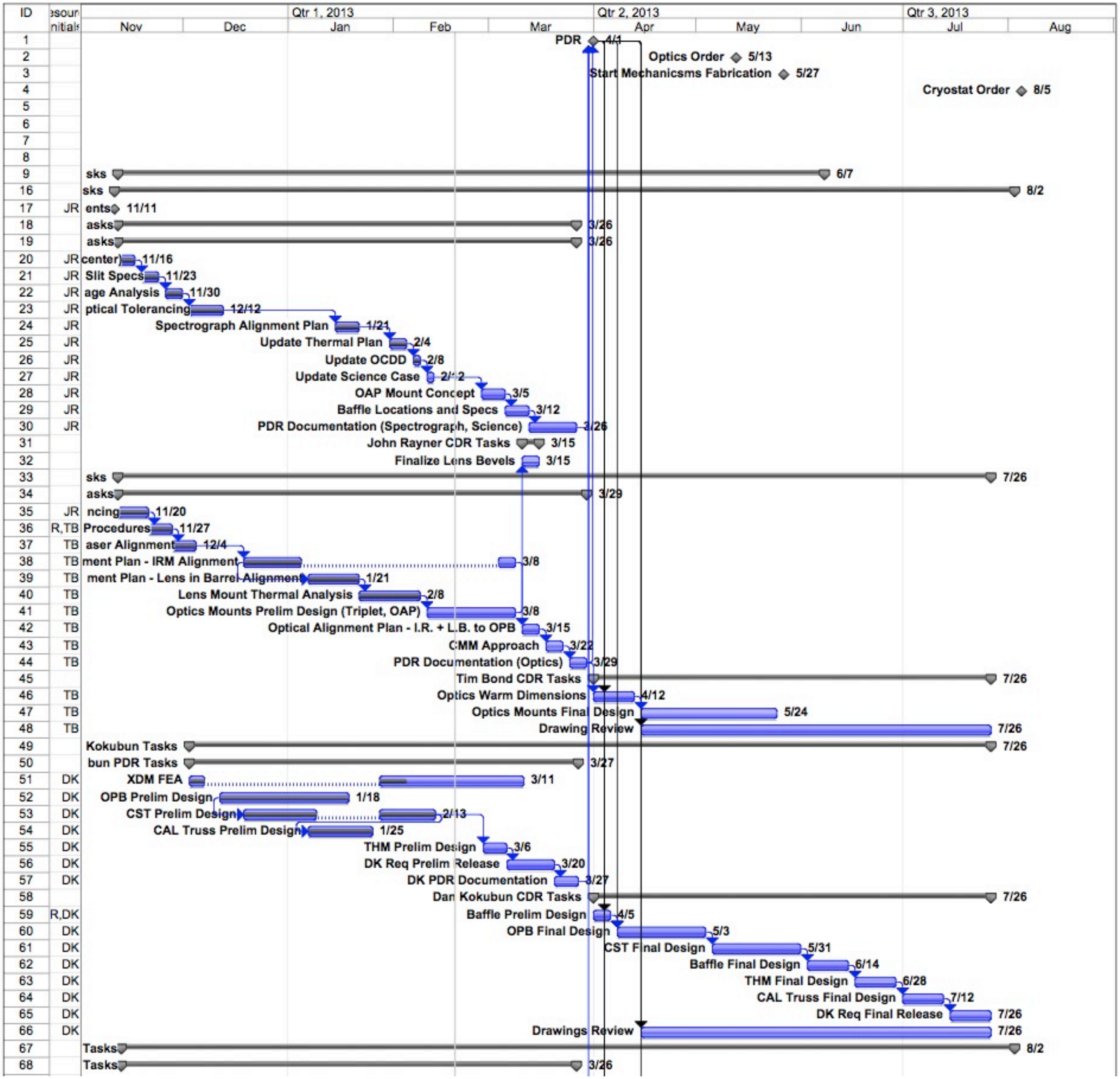
PDR 4/1/13
Optics Order 5/13/13
Start Mechanicsms Fabrication 5/27/13
Cryostat Order 8/5/13
Start Optics Assembly 4/28/14
Start System Integration 10/13/14
First Light 5/1/15
Analysis Tasks 6/7/13
Design Tasks 8/2/13
Drawings 11/8/13
Fabrication 4/25/14
Assemble and Test 3/27/15
Commissioning 5/1/15



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18 asks 3/26
19 asks 3/26
20 JR center) 11/16
21 JR Slit Specs 11/23
22 JR age Analysis 11/30
23 JR ptical Tolerancing 12/12
24 JR Spectrograph Alignment Plan 1/21
25 JR Update Thermal Plan 2/4
26 JR Update OCDD 2/8
27 JR Update Science Case 2/12
28 JR OAP Mount Concept 3/5
29 JR Baffle Locations and Specs 3/12
30 JR PDR Documentation (Spectrograph, Science) 3/26
31 John Rayner CDR Tasks 3/15
32 Finalize Lens Bevels 3/15
33 sks 7/26
34 asks 3/29
35 JR ncing 11/20
36 R,TB Procedures 11/27
37 TB aser Alignment 12/4
38 TB ment Plan - IRM Alignment 3/8
39 TB ment Plan - Lens in Barrel Alignment 1/21
40 TB Lens Mount Thermal Analysis 2/8
41 TB Optics Mounts Prelim Design (Triplet, OAP) 3/8
42 TB Optical Alignment Plan - I.R. + L.B. to OPB 3/15
43 TB CMM Approach 3/22
44 TB PDR Documentation (Optics) 3/29
45 Tim Bond CDR Tasks 7/26
46 TB Optics Warm Dimensions 4/12
47 TB Optics Mounts Final Design 5/24
48 TB Drawing Review 7/26
49 Kokubun Tasks 7/26
50 bun PDR Tasks 3/27
51 DK XDM FEA 3/11
52 DK OPB Prelim Design 1/18
53 DK CST Prelim Design 2/13
54 DK CAL Truss Prelim Design 1/25
55 DK THM Prelim Design 3/6
56 DK DK Req Prelim Release 3/20
57 DK DK PDR Documentation 3/27
58 Dan Kokubun CDR Tasks 7/26
59 R,DK Baffle Prelim Design 4/5
60 DK OPB Final Design 5/3
61 DK CST Final Design 5/31
62 DK Baffle Final Design 6/14
63 DK THM Final Design 6/28
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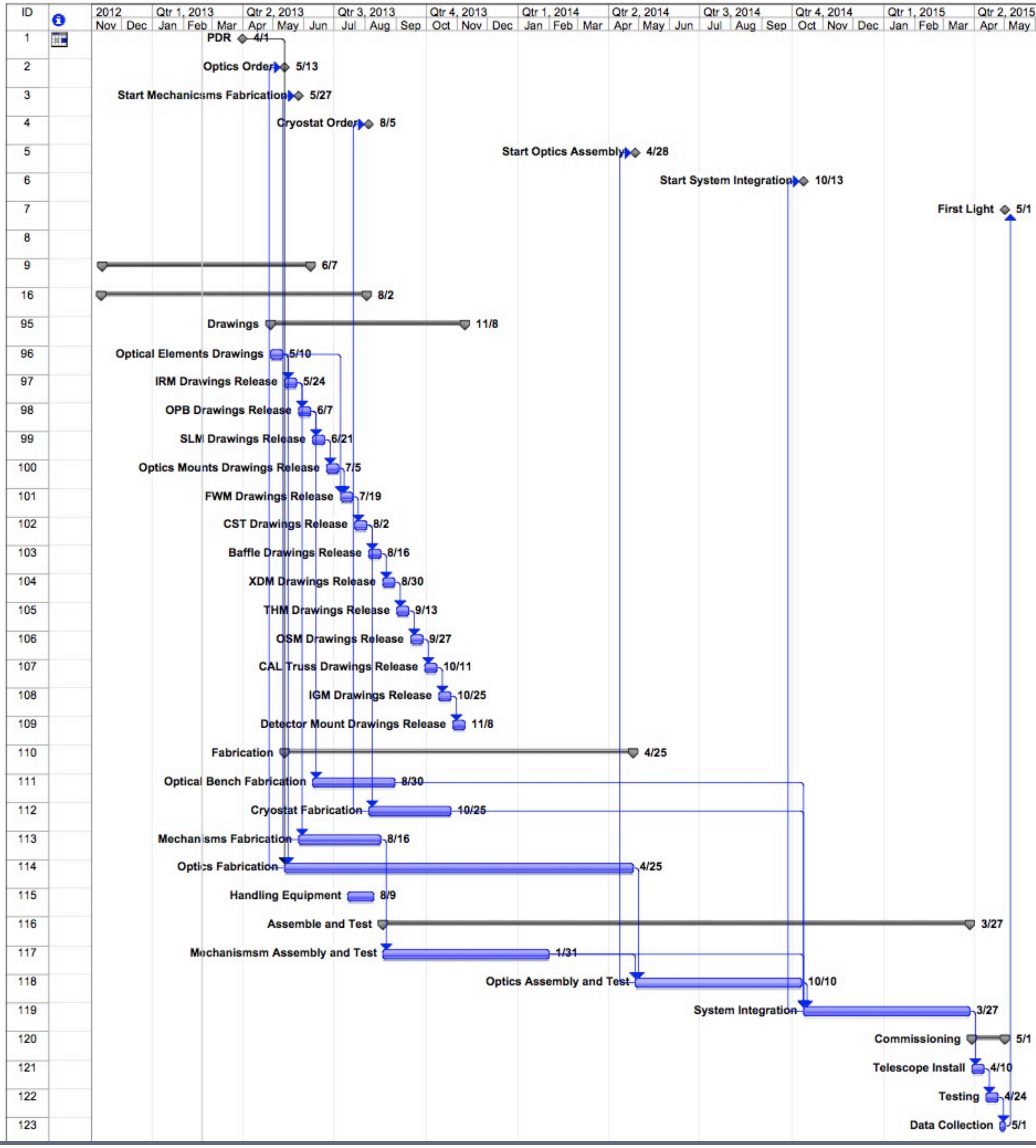
66 DK Drawings Review 7/26
67 Tasks 8/2
68 Tasks 3/26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4 Cryostat Order 8/5
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7 First Light 5/1
8
9 6/7
16 8/2
95 Drawings 11/8
96 Optical Elements Drawings 5/10
97 IRM Drawings Release 5/24
98 OPB Drawings Release 6/7
99 SLM Drawings Release 6/21
100 Optics Mounts Drawings Release 7/5
101 FWM Drawings Release 7/19
102 CST Drawings Release 8/2
103 Baffle Drawings Release 8/16
104 XDM Drawings Release 8/30
105 THM Drawings Release 9/13
106 OSM Drawings Release 9/27
107 CAL Truss Drawings Release 10/11
108 IGM Drawings Release 10/25
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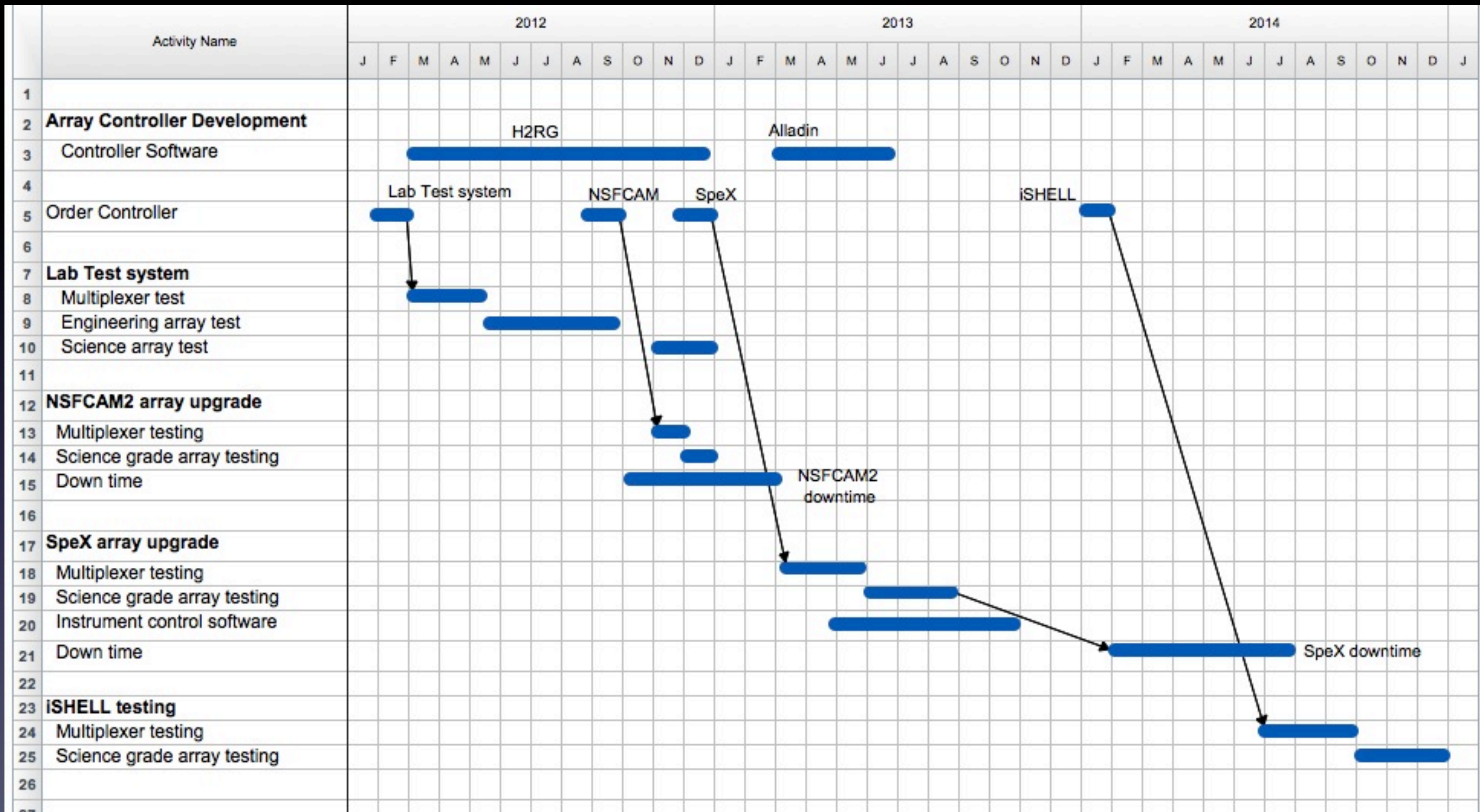
110 Fabrication 4/25
111 Optical Bench Fabrication 8/30
112 Cryostat Fabrication 10/25
113 Mechanisms Fabrication 8/16
114 Optics Fabrication 4/25
115 Handling Equipment 8/9
116 Assemble and Test 3/27
117 Mechanismsm Assembly and Test 1/31
118 Optics Assembly and Test 10/10
119 System Integration 3/27
120 Commissioning 5/1
121 Telescope Install 4/10
122 Testing 4/24
123 Data Collection 5/1

In order to meet this aggressive schedule, we have two mechanical engineers at the IFA and in addition we will:

- Employ a junior ME to work closely with Kokubun to generate designs for the lens barrels, mirror mounts, cryostat subassemblies, and calibration optics.
- Employ two experienced drafters, who will convert CAD models into shop drawings.
- Work closely with the IFA machine shop head to send out work to outside machine shops as necessary to maintain schedule.

Array Controller Schedule



Break