WFI technical update

- Wide Field Instrument (WFI) design update
  - Cycle5 trade space
    - Expanded field IFU (adding PZCS measurement)
    - Working telescope mechanical interface details
  - Cycle4 analysis and design
    - Athermalized mounts (meets budgeted figure strain to 170K)
      - Previous designs had not reached this level of detail
    - Error budget 'grass roots' with integration flow and compensators
      - Previous designs had not reached this level of details
    - PSFs (imaging and grism) and grism dispersion sent to simulation teams
  - Cycle4 Integrated modeling underway
    - New: high-level CGI models included
    - New: Grism assembly and EW details included
    - New: athermalized mirror mounts; cooldown distortion included
    - Coming later: full error budget including fab, cooldown, alignment, gravity, I&T, and compensation
    - Coming later: IFU not yet included
- Risk reduction ramping up {beyond H4RGs}
  - Element wheel eng. Dev. Unit
  - EDU grism; EDU filter substrate
  - FGS performance and architecture exploration

Element and science mode table

							SN									
							detect			HLS		uLensing		available for GO?	FGS pointing quality	
EW Order	name	Mode	Element	min (um)	max	R	shallow	med/ deep	spec	Imaging	Spec	monitor	color			
1	Z	WIM	Z087	0.760	0.977	4.0							freq 2x daily	all	fine	
6	Y		Y106	0.927	1.192	4.0	x			Photo-z						
5	J		J129	1.131	1.454	4.0	x	x		Photo- z & shape						
3	H		H158	1.380	1.774	4.0		x								
2	F184		F184	1.683	2.000	5.81										
7	W		W149	0.927	2.000	1.442						15 min cadence				
4	GRS	WSM	GRS	1.35	1.95	461λ					x				TBD	
	IFU	IFU	IFU	0.600	2.000	75			x		?				fine	

WIM == wide imaging mode

WSM == wide spectroscopy mode

IFU == integral field spectroscopy

Note: IFU or coronagraph (small field of view channels) science requires fine pointing, so parallel GRS mode may not be possible

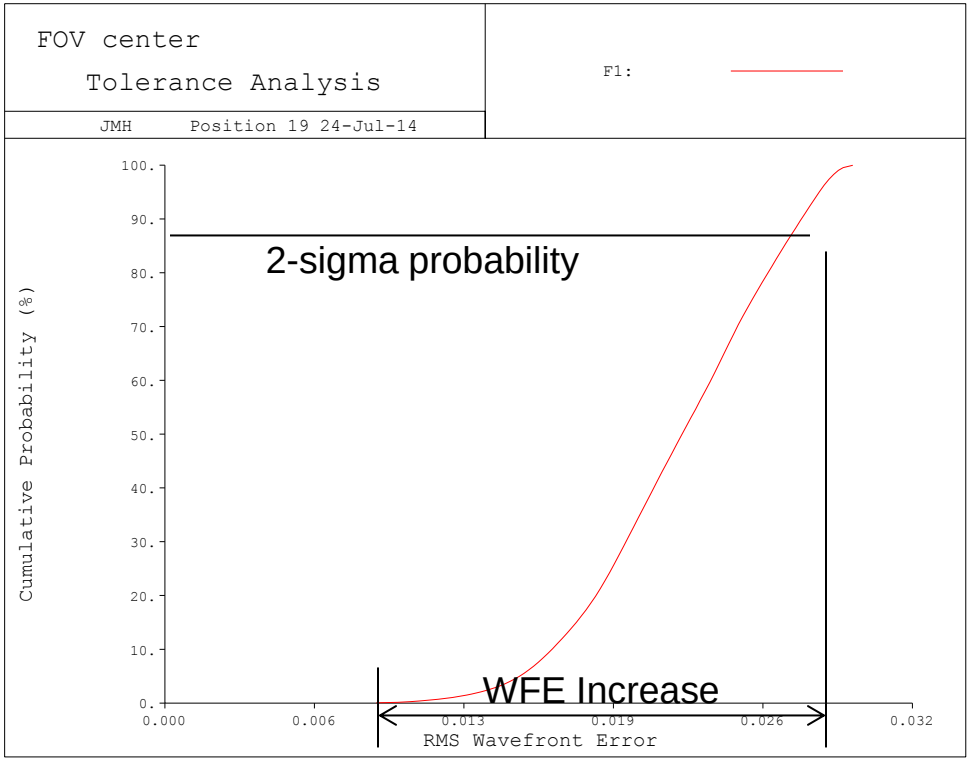
Note: the 8th and final position in the element wheel is a dark and a counterbalance for the grism assembly.

Example error budget input – tolerancing run on filter element

Tolerancing Run 8: Filter perturbations effect on wavefront error (Compensated by WFI, F1, FPA)

Group Tol #	PARAMETER	(units)	FAB & ALIGN TOTALS Comped	Un-Comped
WFI Bandpass Filter (F1-6)				
Movement relative to Side 1				
300	Decentering, Horiz. (u-axis)	mm	0.137	0.050
301	Decentering, Vertical (w-axis)	mm	0.137	0.050
302	Focus (v-axis)	mm	0.137	0.050
303	Tilt, Horizontal (u-axis)	mrad	0.350	0.145
304	Tilt, Vertical (w-axis)	mrad	0.350	0.145
Consider Side 2 relative to Side 1:				
310	Center Thickness	mm	0.102	0.001
311	Wedge Angle (u-axis)	mrad	0.726	0.005
312	Wedge Angle (w-axis)	mrad	0.147	0.005
BP1 Fabrication:				
316	Radius of curvature	mm	0.128	0.001
318	Surface Figure (P-V Irreg.)	HeNe f	0.025	0.001
BP2 Fabrication:				
326	Radius of curvature	mm	0.052	0.002
328	Surface Figure (P-V Irreg.)	HeNe f	0.025	0.001

During I&T, errors in the fabrication and alignment of one component can be compensated with other motions (individual and groups.) Untraceable or sub-resolution errors are not compensated.

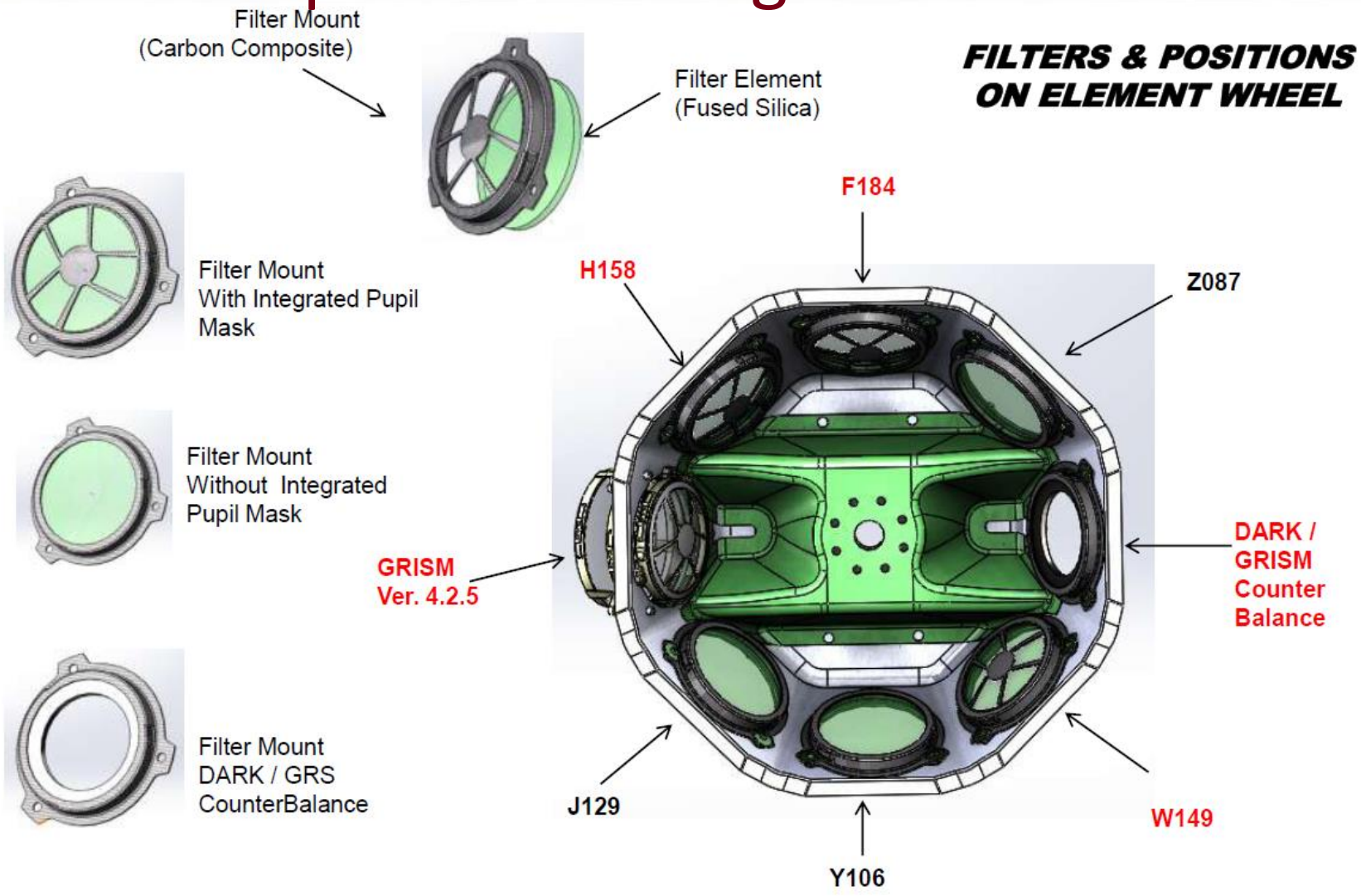


Sample statistical curve – units are rms um (waves @1um wavelength)

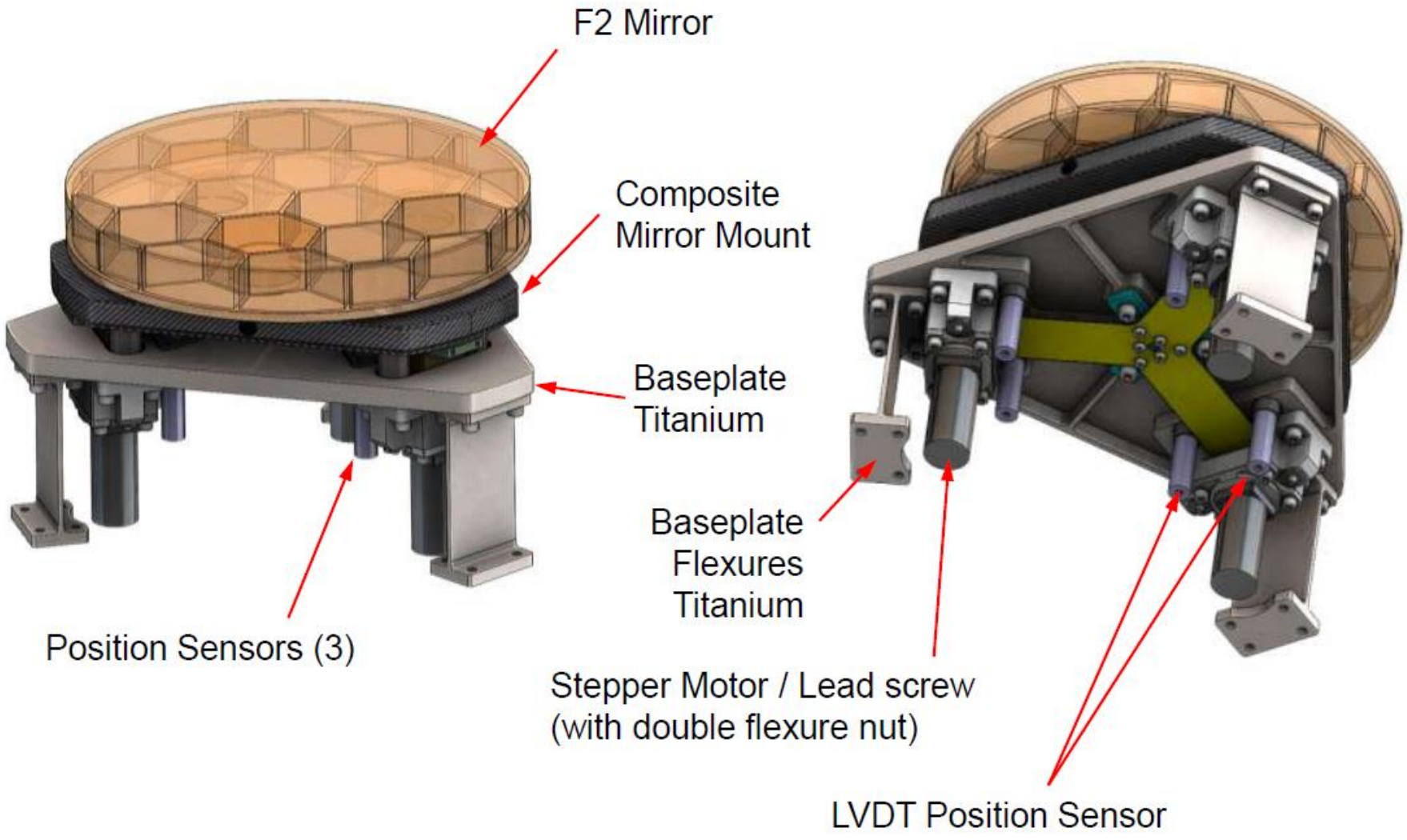
Cycle5 trade space

- Wide Field channel – no driving need for changes at this time
- IFU – see Cycle5 trade space below

Element wheel EDU is designed and long lead parts are being ordered



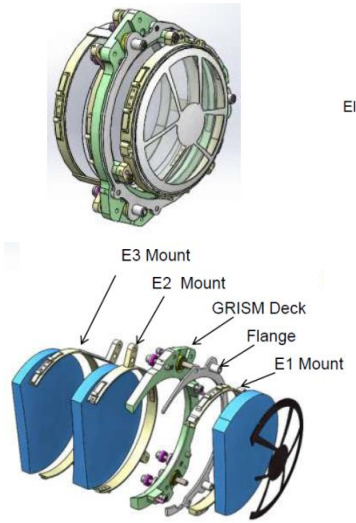
F2 [focus adjustable fold mirror]

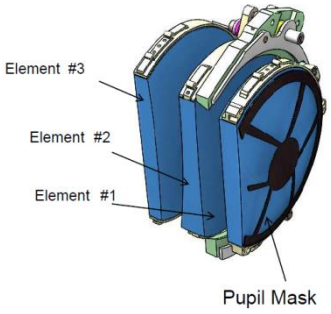


Grism activity – risk reduction

Working toward EDU grism

- Tolerance analysis completed: using precision fabrication, 25um/0.025° alignment, we meet the Cycle3 error budget
- Discussion with Kruk/Hirata – trade of mapping speed vs error budget
  - Recall that prior error budget was based on poorer performing design
  - We may be able to build this design to a tighter budget
  - Potential increase in GRS mapping speed
- Fab progress at right





Grism Activity	when	comments
optical design	done	
substrate fabrication	done	parfocality - need to iterate with vendor
mount design	done	
integrated modeling	in progress	part of Cycle4 IM underway now
visible testable coupon to show high diffraction efficiency	in progress	initial test at HeNe (0.63um) shows >90%; so inefficiency and blaze error must both be
NIR diffractive fabrication	being ordered	
mount fabrication	next	
cold component testing	late FY14	
assembly	early FY15	
cold assembly testing	mid FY15	TRL5
environmental testing	TBD	
cold retest	TBD	TRL6

M3 risk reduction / EDU

- Athermalized mount designed in-house
- Starting industry dialog on fabrication options and potential sources

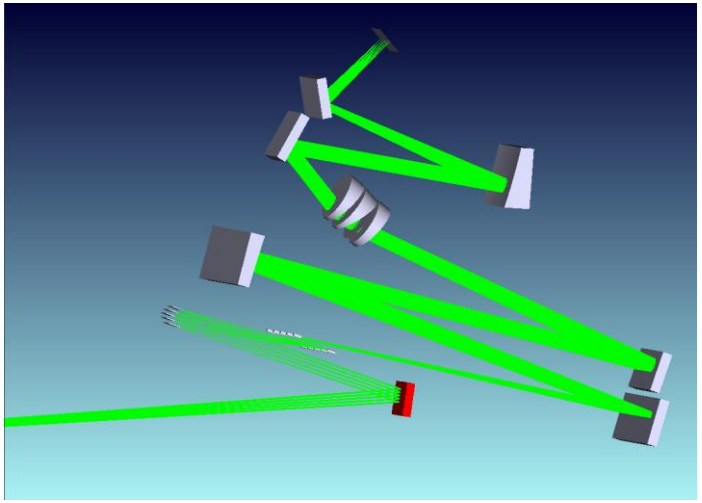
- With these EDUs in hand we can work, funding allowing, towards testing interfaces and portions of the instrument.

WFIRST Second IFU slicer layout

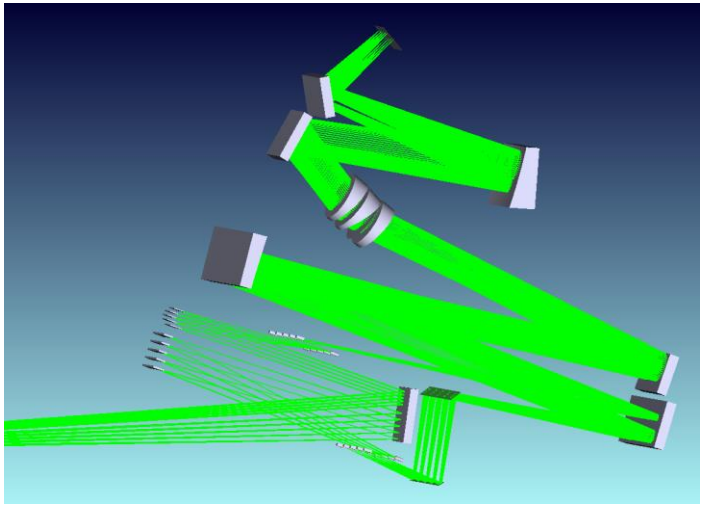
- Goal – implement suggestion from discussion among S. Perlmutter, J. Kruk
  - Takes advantage of unused relay field and unused detector pixels
  - Adds second slicer, to implement function we previously did only via TBD groundbased measurements: photometric redshift calibration spectroscopy {PZCS}
    - Ie verify using spectroscopy on a bright subset of the HLS galaxy survey, that the photometric redshifts (photo-z's) are correct
    - Initial implementation is 21 0.3" slices 6" long, ie field is 6 x 6.3" or ~4x original FOV at ½ focal length ratio.
    - Both sets of spectral together still underfill a H2RG sensor.
  - 'blind' parallel (to HLS imaging survey) spectroscopy in this mode should generate many PZCS spectra

Design work by B. Pasquale, Y. Zheng, D. Vaughnn

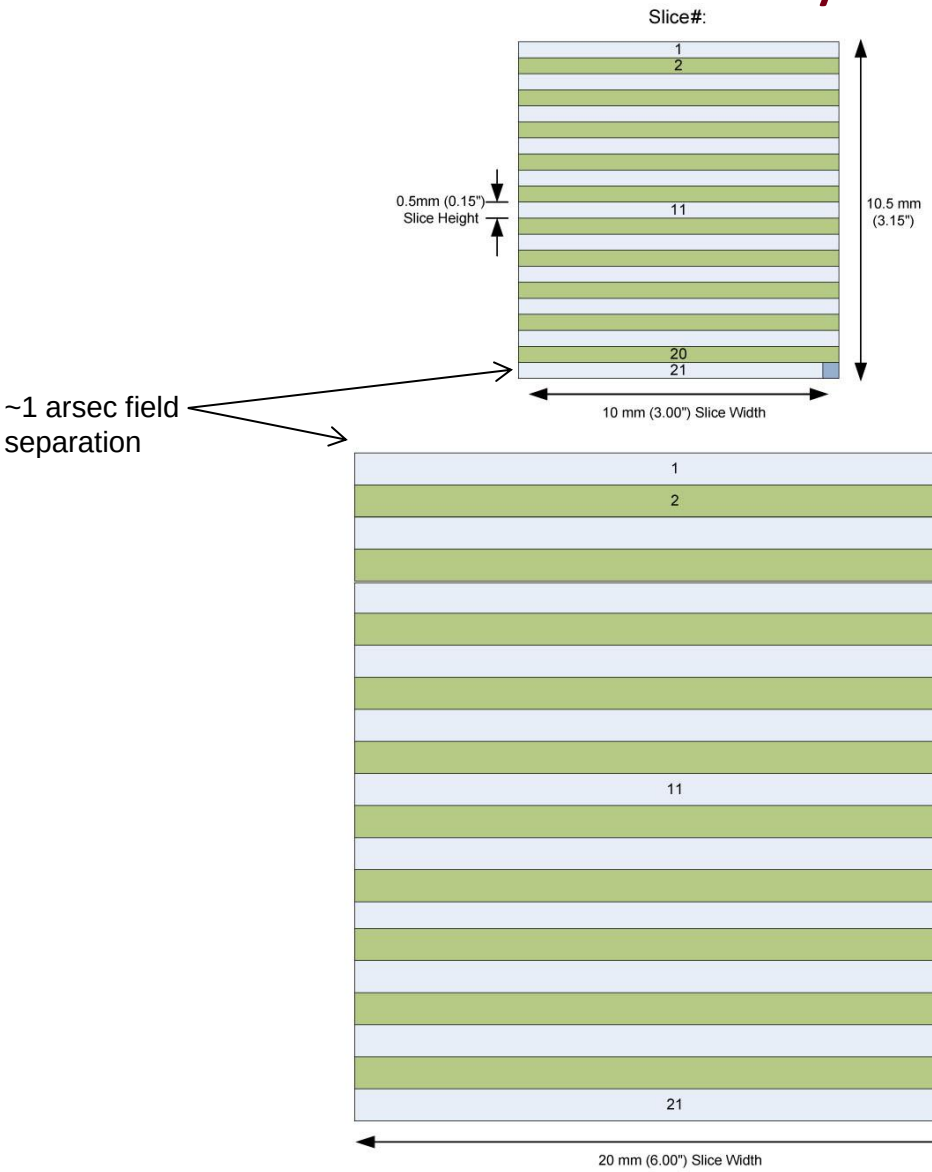
Proposed Cycle5 'dual' slicer Field & back end layout



Cycle4 single slicer

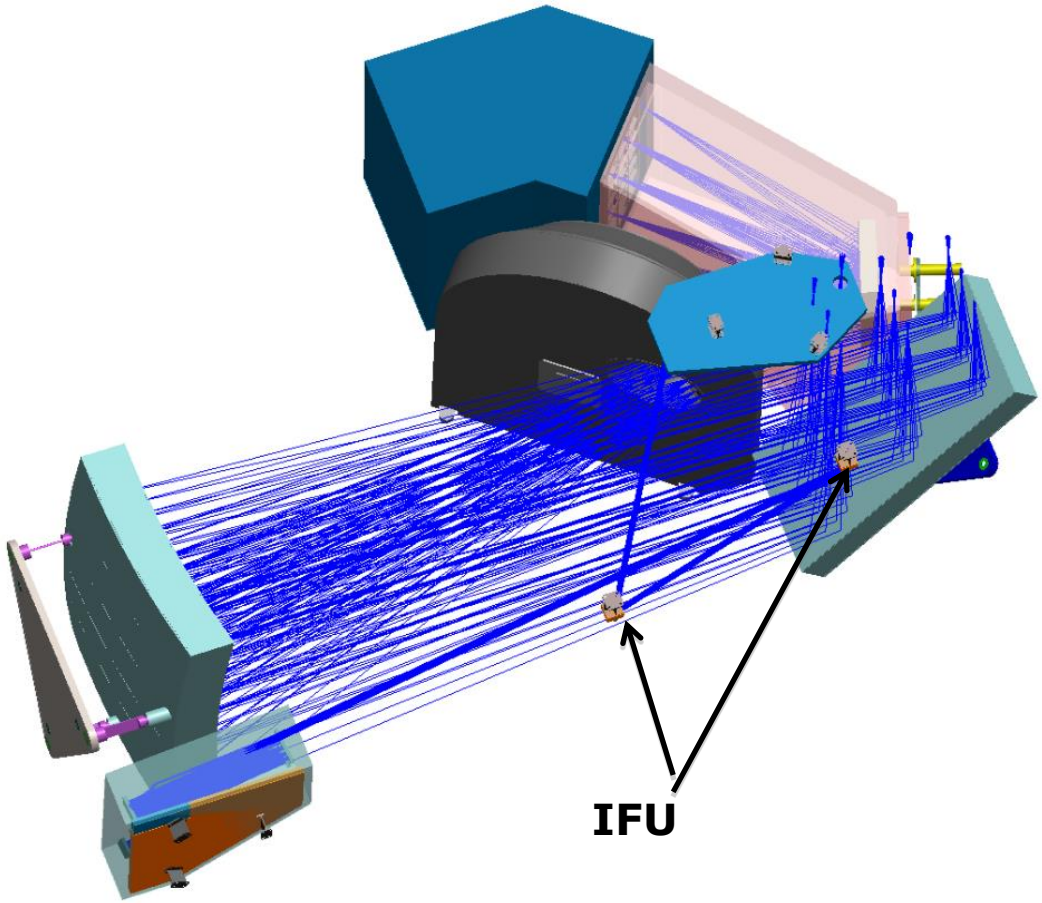


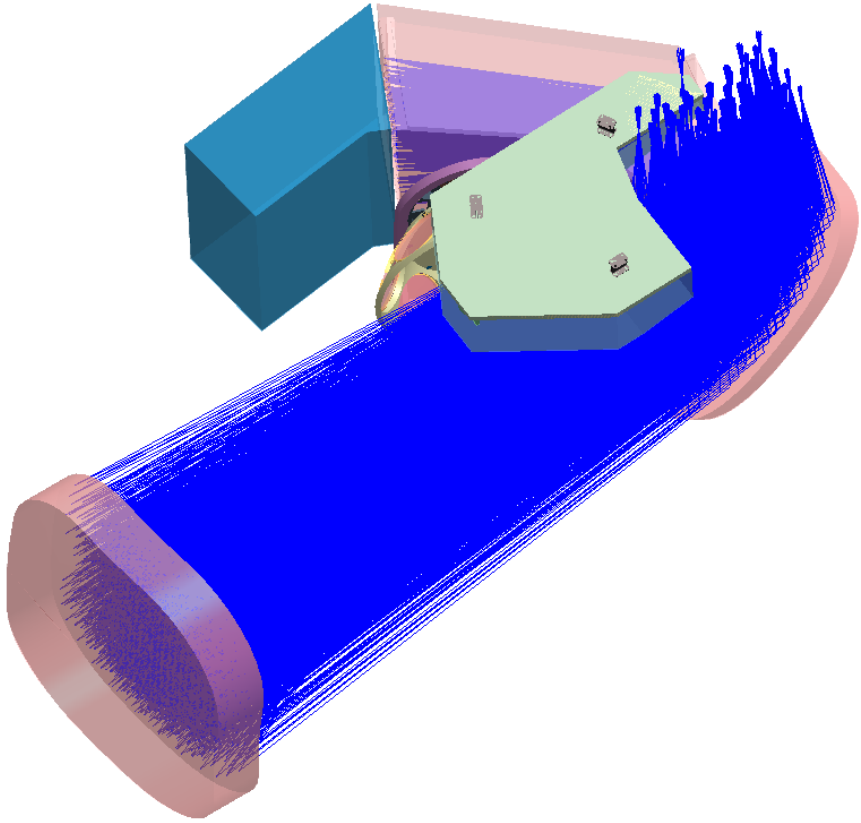
Cycle5 dual slicer



Backup

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

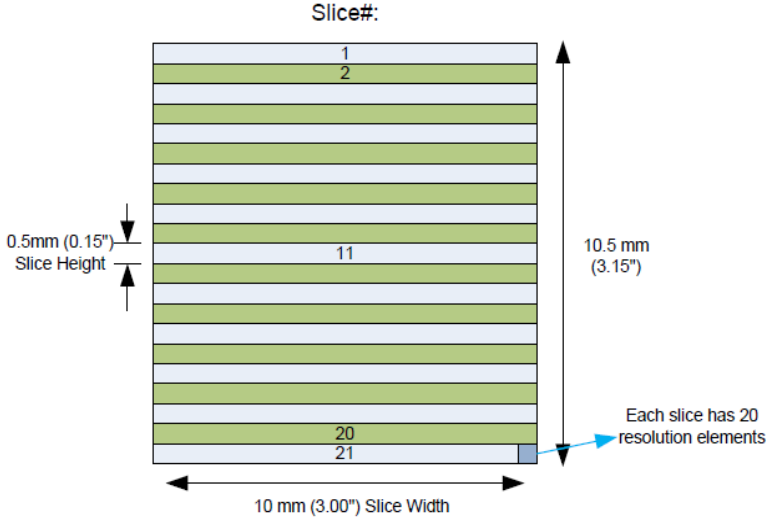




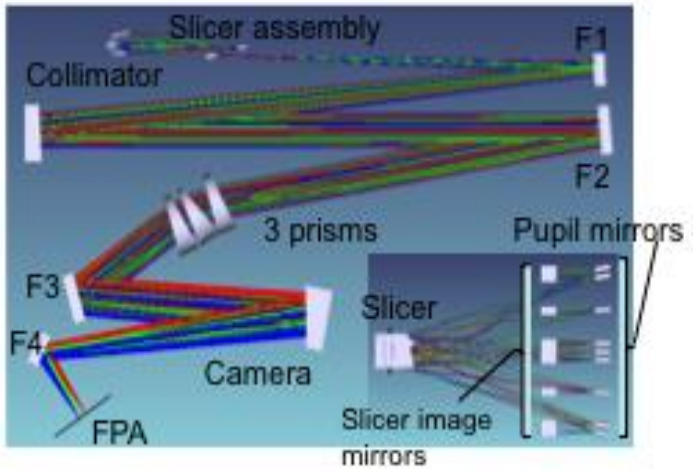
AFTA Cycle3 and Cycle4 IFU Concepts

Integral field unit detail – Cycle4

- While prior point designs used a slitless R~70 grism to obtain SN 1a spectra, an IFU becomes significantly faster for a 2.4m aperture
- SN spectroscopy is enhanced by better ability to remove galaxy and sky backgrounds in an IFU format
- Slicer type IFU is high TRL and is accommodated using a mature H2RG focal array



The image slicer [3"x3.1"] has 21 mirrors, 0.5 mm wide, each 0.15 arcsec field wide. Pixel scale is 0.075" (2 pixels/slice)



Layout of the slicer assembly (inset) and spectrograph modules of the IFU. The relay is not shown.

Cycle4 IFU layout