WFI Calibration

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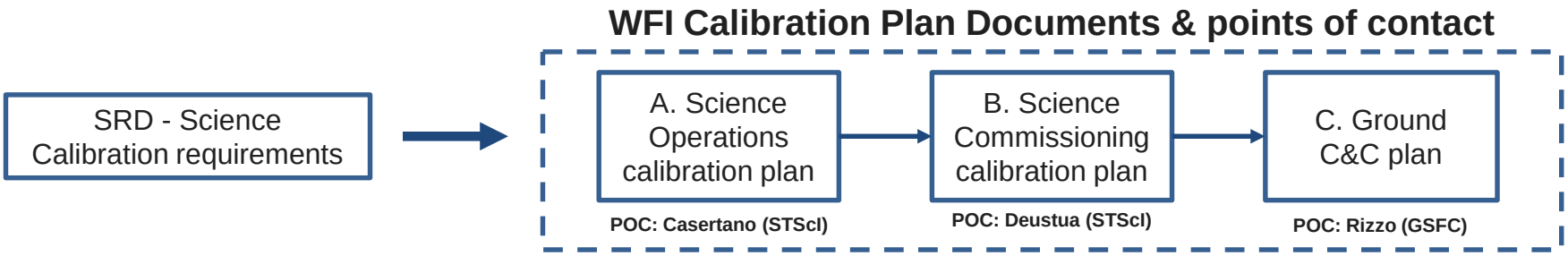
WFI Systems/Calibration WG

WFIRST/WFI Calibration Plan



- Overall calibration strategy defined by consensus between Science, SOC and WFI Systems teams
  - Science Operations Plan released by ~Mission PDR (owned by SOC/SITs)
  - Science Commissioning Plan released by ~Mission PDR (owned by SOC/SITs)
  - Ground C&C plan has been released and is the subject of this presentation

- Weekly Calibration WG meetings https://outerspace.stsci.edu/x/74HnAQ

- Holding a Calibration Workshop series since ~December
  - Share info between SITs, SOC, and Instrument Systems
  - Develop test plan together so everyone has buy-in

Ground C&C Scope

- Inspired from successful HST/WFC3 C&C Plan
- WFI will perform characterizations at component and sub-assembly levels in the natural build-up of the instrument
  - Provide earliest possible feedback and insights
  - Evaluate & track the progress of the instrument throughout the project phases (help avoid problems at later stages)
  - Identify areas of high priority for characterization at higher levels
  - Help confirm science requirement flowdown
  - Help define on-orbit Calibration operations & frequency (e.g. Count rate non-linearity)
- WFI will perform instrument-level C&C during TVAC campaign
  - Correlate lower-level characterizations and models
  - Gain confidence that there is no showstopper to meet on-orbit science requirements
  - Provide initial data for data pipeline
- Payload/Observatory will perform minimum test/verification after Instrument AI&T
  - Tie together Instrument-level products with Telescope & Observatory models
  - Very little further characterization expected at this stage (focus is on optical alignment and verification – more work is planned on this in the coming months)

Comprehensive WFI Ground C&C Plan is captured in WFIRST-WFI-PLAN-0100

Ground C&C Plan Layout

Level	Element	Comments
Component	Filters	Individual verification/characterization plans are established at the different levels (e.g. SCA characterization plan) Activities are tracked in Ground C&C Plan
	Prism/Grism	
	SCAs	
Sub-assembly	EWA	
	FPS	
	RCS	
Instrument	WFI	WFI Systems is responsible for Instrument-level C&C during Ball's TVAC campaign
Payload	WFI + Telescope	Responsibility of Payload with assistance of WFI team, monitored by WFI systems & with inputs from science team

Instrument C&C TVAC Campaign

- A notional 30-day cryo calibration campaign is budgeted for in the schedule
  - Will occur at Ball but WFI is responsible for it
  - A GSFC-furnished Optical Stimulus (SORC) will be used to provide point source and flat field illumination at the right optical prescription (used both for verification and calibration)
  - The SORC will be calibrated at GSFC and verified at Ball before the campaign
- Cryo calibration activities will be interlaced with verification and other trending activities as needed
- The goals of the instrument C&C are:
  - Measure the characteristics of the instrument over the range of operational parameters and configurations
  - Correlate lower-level characterizations and models
  - Gain confidence that there is no showstopper to meet on-orbit science requirements
  - Provide initial products for data pipeline

Stimulus schematic

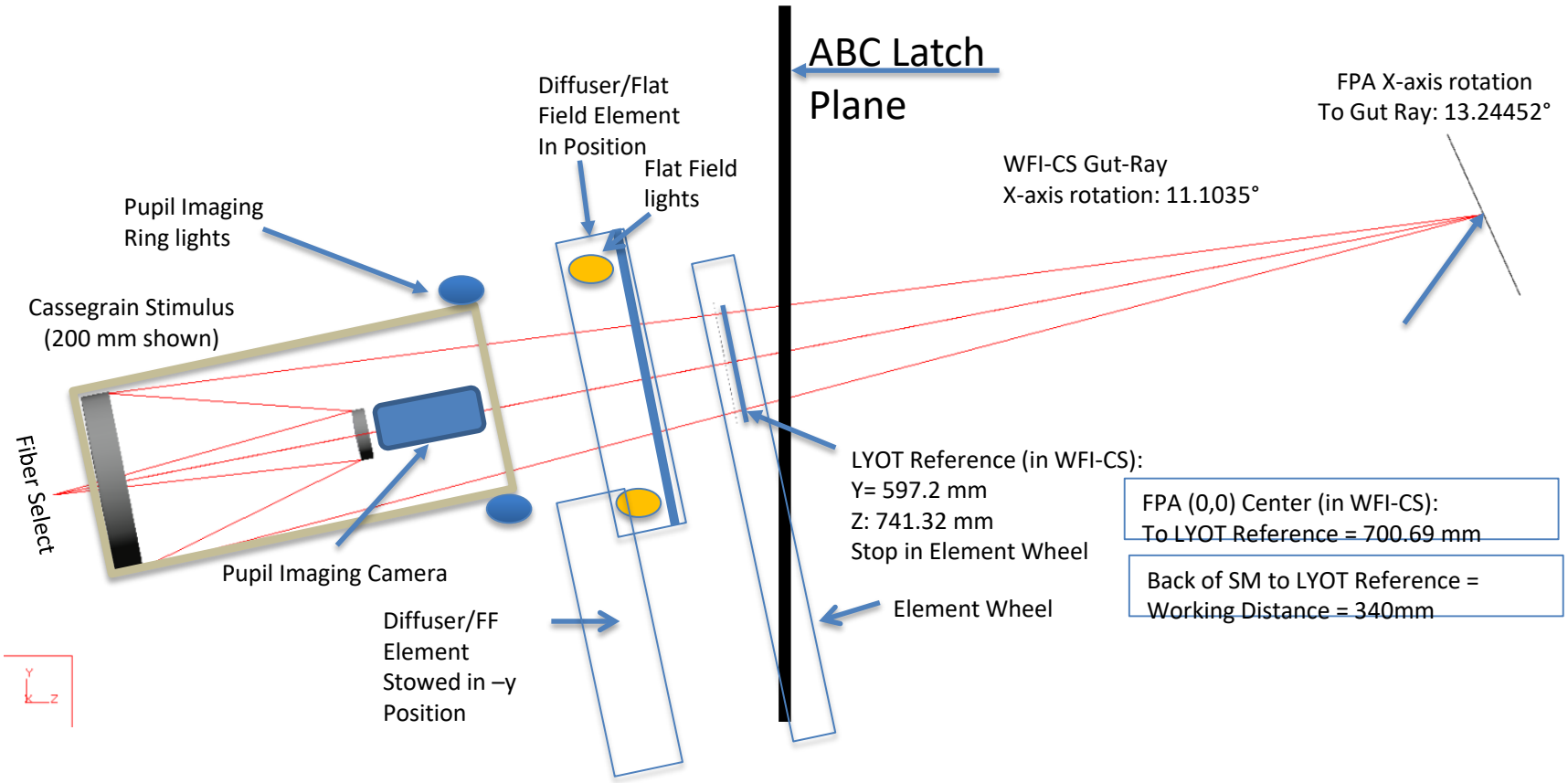


Image courtesy: Stimulus team

Stimulus Range

- Can be articulated in both axis:
- ±6° about WFI-CS X-axis shown
- ±10° about WFI-CS Y-axis shown

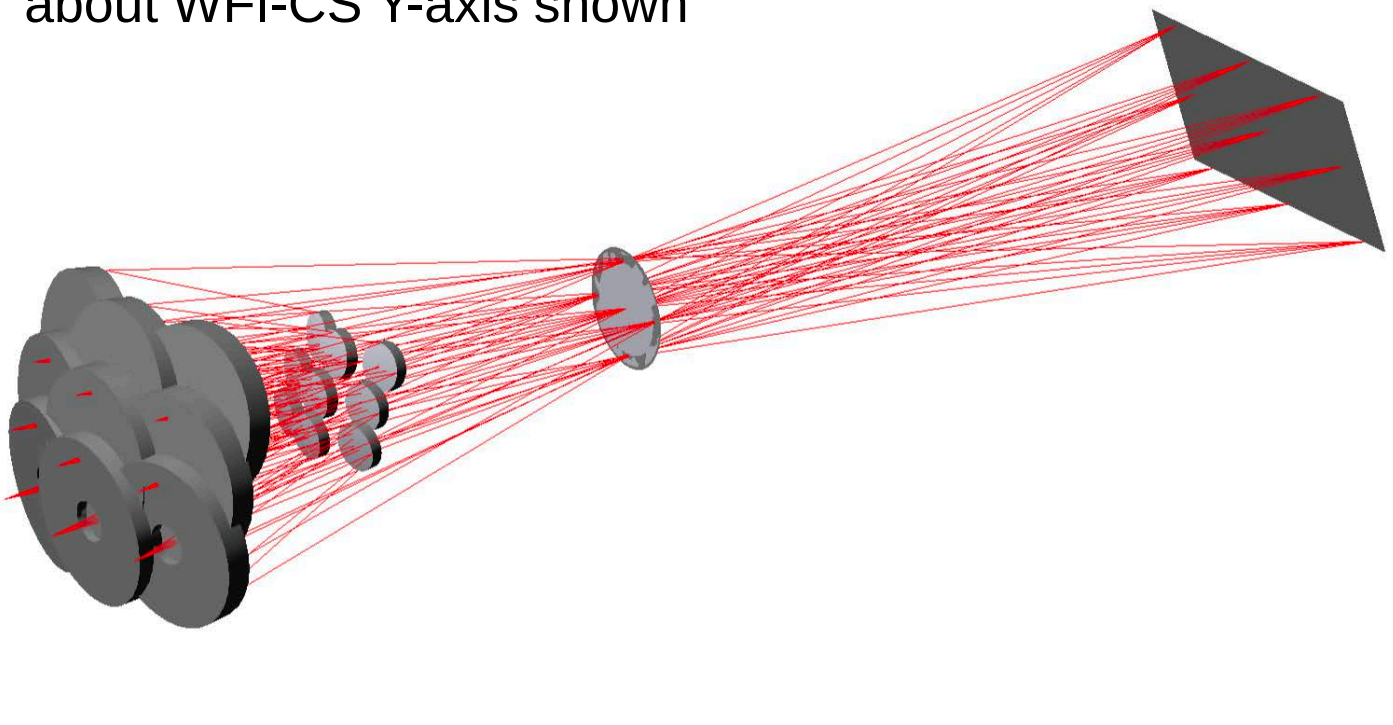
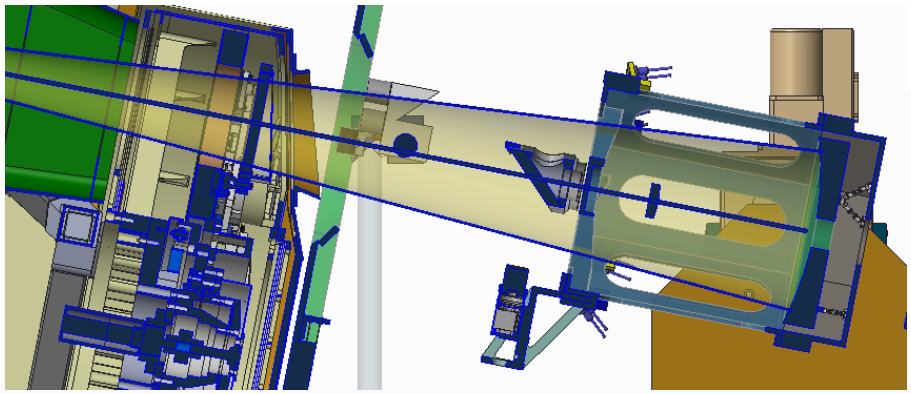
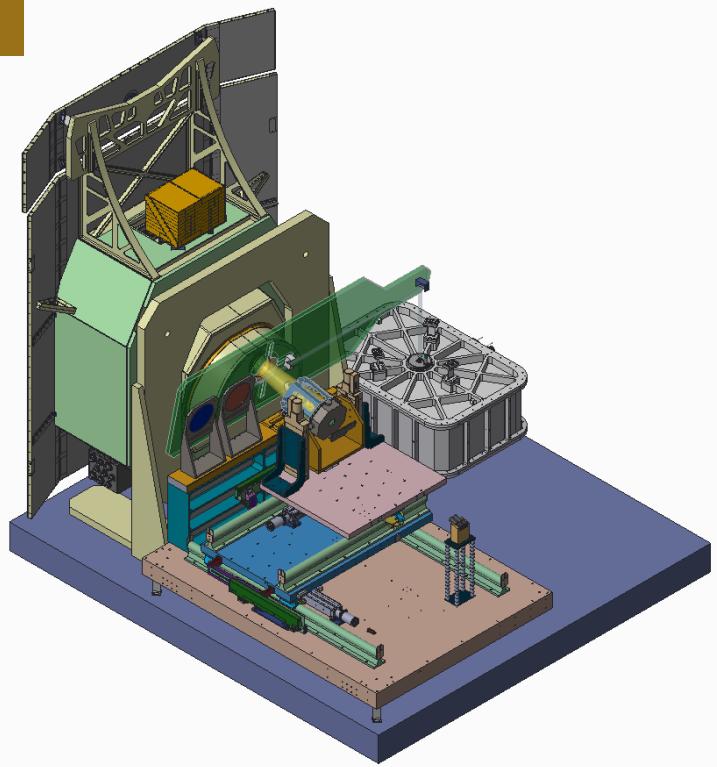


Image courtesy: Stimulus team

Stimulus model

Image courtesy: Stimulus team





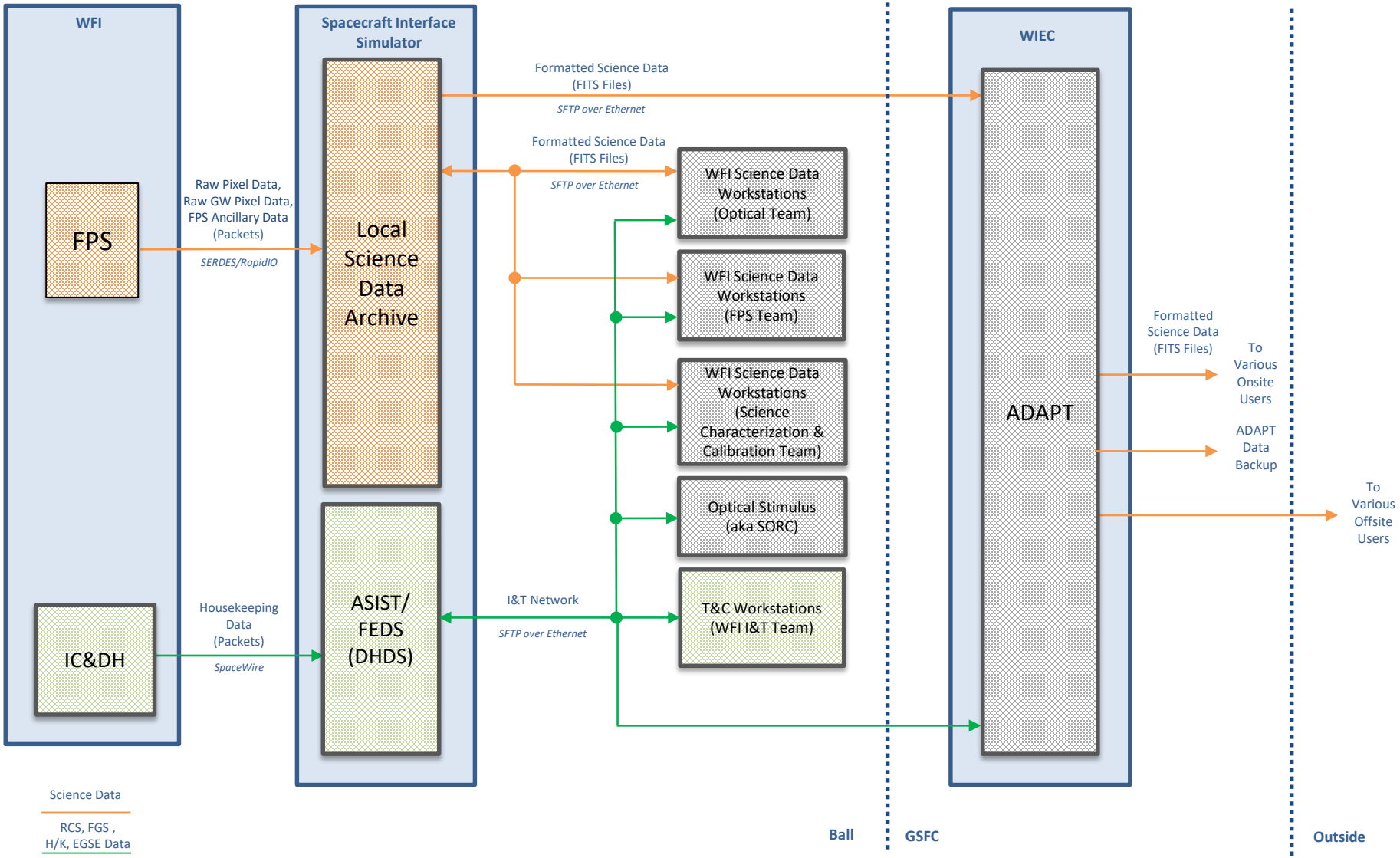
C&C Activities During Instrument TVAC

Category	Descriptions
FPS	Darks, total noise, thermal background, out-of-band rejection, thermal transient characterization, persistence, linearity, science modes testing, science trending test
RCS	Flatness, Self-cal, Count-rate non-linearity, Lamp-on/lamp-off, stability
Flatfields	Broadband and narrow band flatfields
Stray light	Stray light and vignetting
Geometric calibration	Registration across filters, distortion

- ~20 characterization tests identified & their importance was prioritized
- Grassroots campaign time estimate fits into ~30 day calibration allocation

Science input on test definition is very much welcome!

Science Data Handling for WFI I&T



Data Deliverables to Science Operations Center

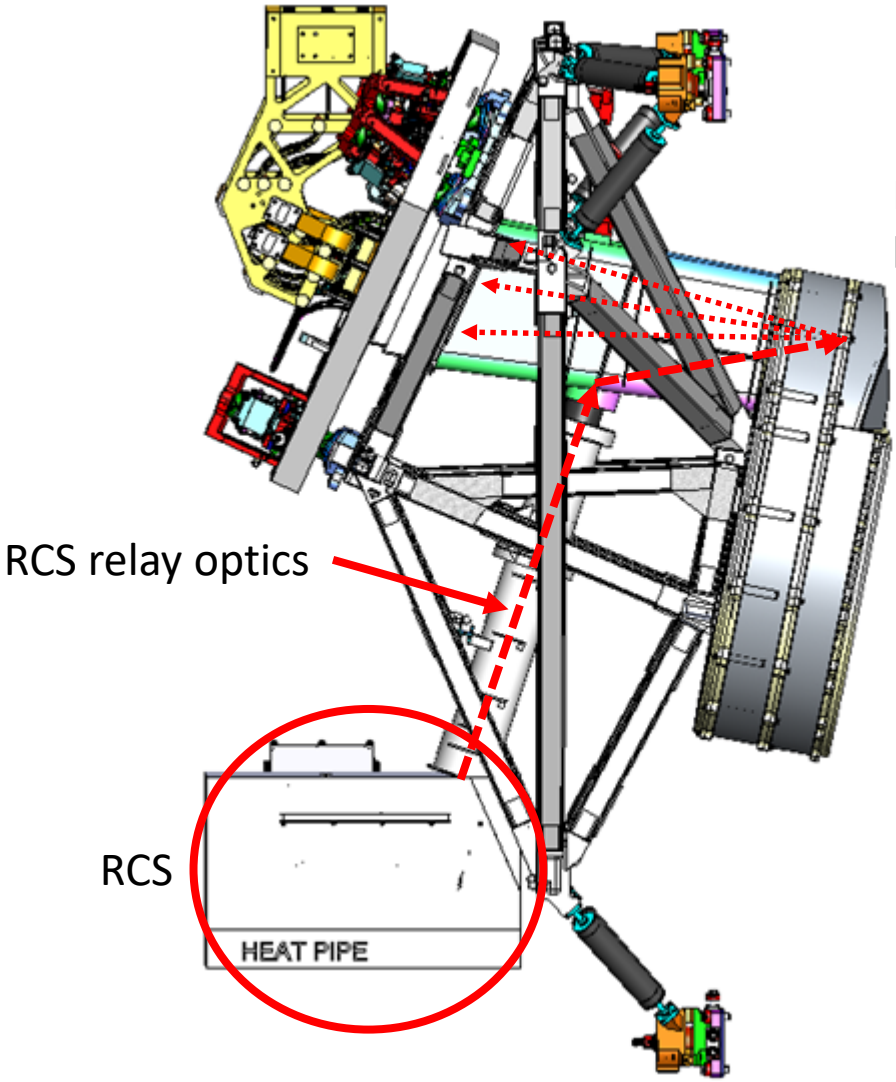
Calibration product	Name in JWST pipeline	Product details & description	Name(s) of test(s) that will acquire data for this product
Bias images	Superbias	2-D image of the detector bias (“zeroth” read) structure.	WFI_DARK_BASELINE
Instrument Dark	Dark	Dark calibration images for all modes of detector operation/ Pixel-by-pixel and frame-by-frame dark current values for a given detector readout mode.	WFI_DARK_BASELINE, WFI_THERM_BKGD
Flatfields	Flat	Pixel-by-pixel detector response values	FLATFIELD_SWEEP, FLATFIELD_BROAD
Saturation	Saturation	Pixel-by-pixel saturation threshold values.	SCA_LINEARITY
	Trapdensity	Pixel-by-pixel map of the trap density for persistence correction	SCA_PERSISTENCE
Persistence	Persat	Pixel-by-pixel map of the persistence saturation threshold for persistence correction	SCA_PERSISTENCE, WFI_PERSISTENCE
	Trappars	Default parameter values used in the persistence correction.	SCA_PERSISTENCE
Linearity	Linearity	Pixel-by-pixel polynomial correction coefficients.	SCA_LINEARITY, FPS_LINEARITY
Crosstalk	-	Any prior knowledge of the cross-talk	FPS_CROSSTALK
Read noise map	Readnoise	Pixel-by-pixel map of read noise, which is used in estimating the expected noise in each pixel.	FPS_TOTAL_NOISE, WFI_DARK_BASELINE

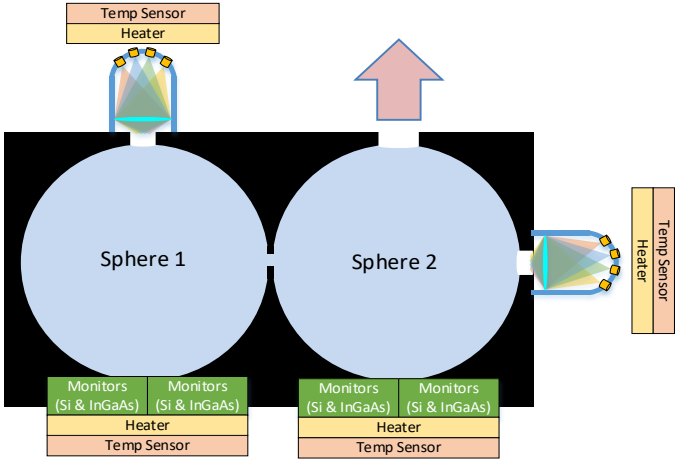
- SOC provided the data product needs for their calibration pipeline (which is based on JWST’s), and were mapped onto tests in the C&C plan

RCS Use cases

Activity	Description	Approx. Frequency	Approx. Duration
Pixel-to-pixel flats	Illuminate the FPA with high-flux flatfields to characterize the pixel-to-pixel response and its variation over time and wavelength	Weekly	~1-6 hr
Persistence	Characterize the FPA persistence and its evolution with time by illuminating the FPA beyond saturation	Quarterly	<1 hr
LOLO	Characterize the CRNL using the LOLO method, by illuminating the FPA during science exposures	Monthly	~ 5 hr (F184 only)
CRNL	Full characterization of the CRNL using the direct method; requires precise knowledge of flux ratios	Quarterly	<24 hr

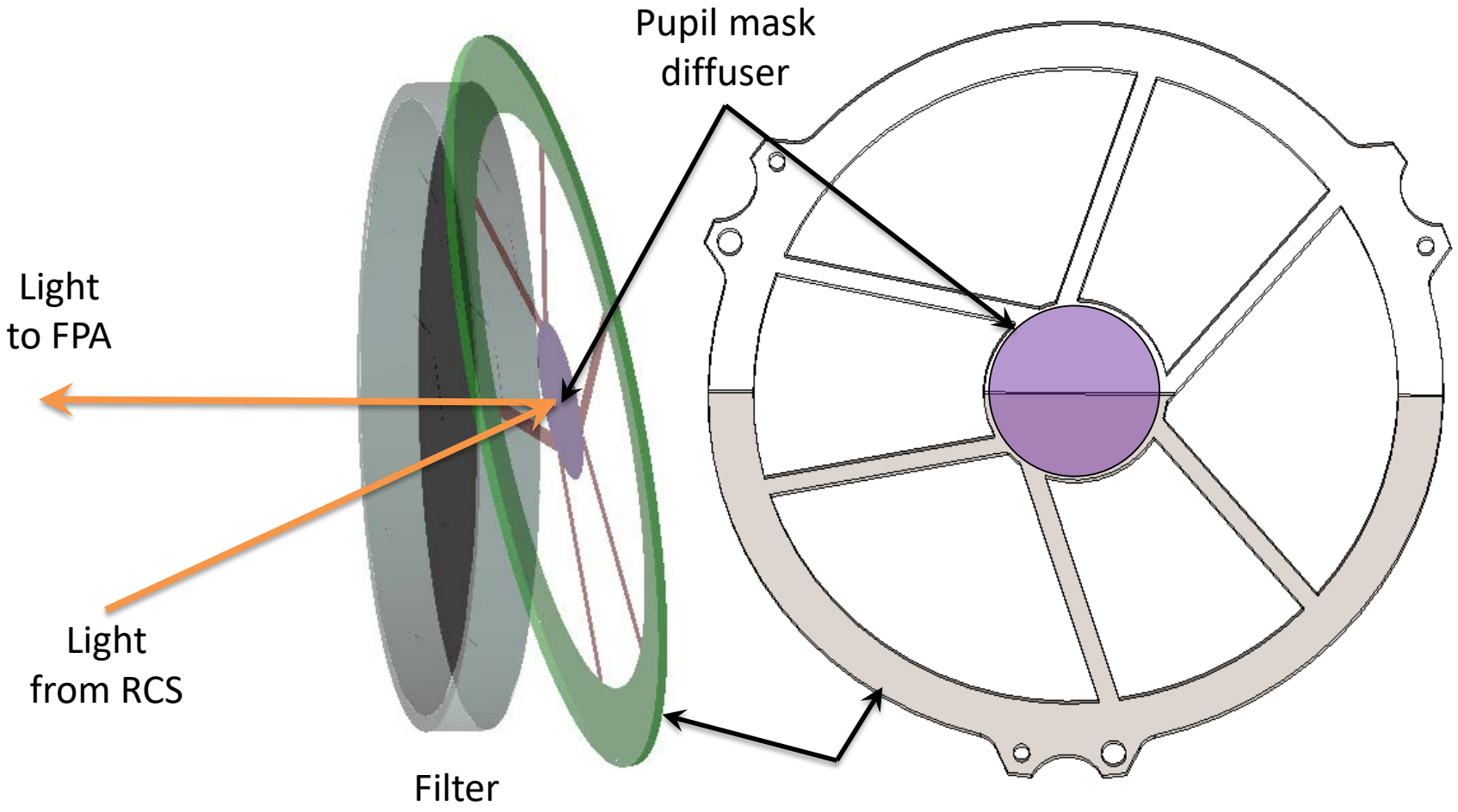
RCS Status





Courtesy Ball Aerospace

Lamp-on/lamp-off mode for F184 only



Courtesy Ball Aerospace

Status

- RCS has its PDR Aug 28-29th
  - LED candidates currently being selected
  - Design maturing but still not clear we can meet the 0.14% flux ratio knowledge requirement
  - Calibration WG is investigating possible requirements relaxation

- GSFC has started a Count-rate Non-Linearity working group
  - Define the test that all flight candidates will go through
  - Inform what the appropriate Concept of Operations should be to determine CRNL
  - Determine wavelength-dependence and angle of incidence dependence
  - Inform the RCS design and on-orbit time
  - CRNL data gathered by DCL testbed (which has similarities to the RCS) with flight candidates
  - CRNL Data is shared on ADAPT
- ADAPT sign-up:
  - https://outerspace.stsci.edu/x/i4VGAg