NANCY GRACE ROMAN SPACE TELESCOPE

Roman Community Forum

Wide Field Instrument Updates

June 26, 2024

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With thanks to the many that contributed to this content!!!

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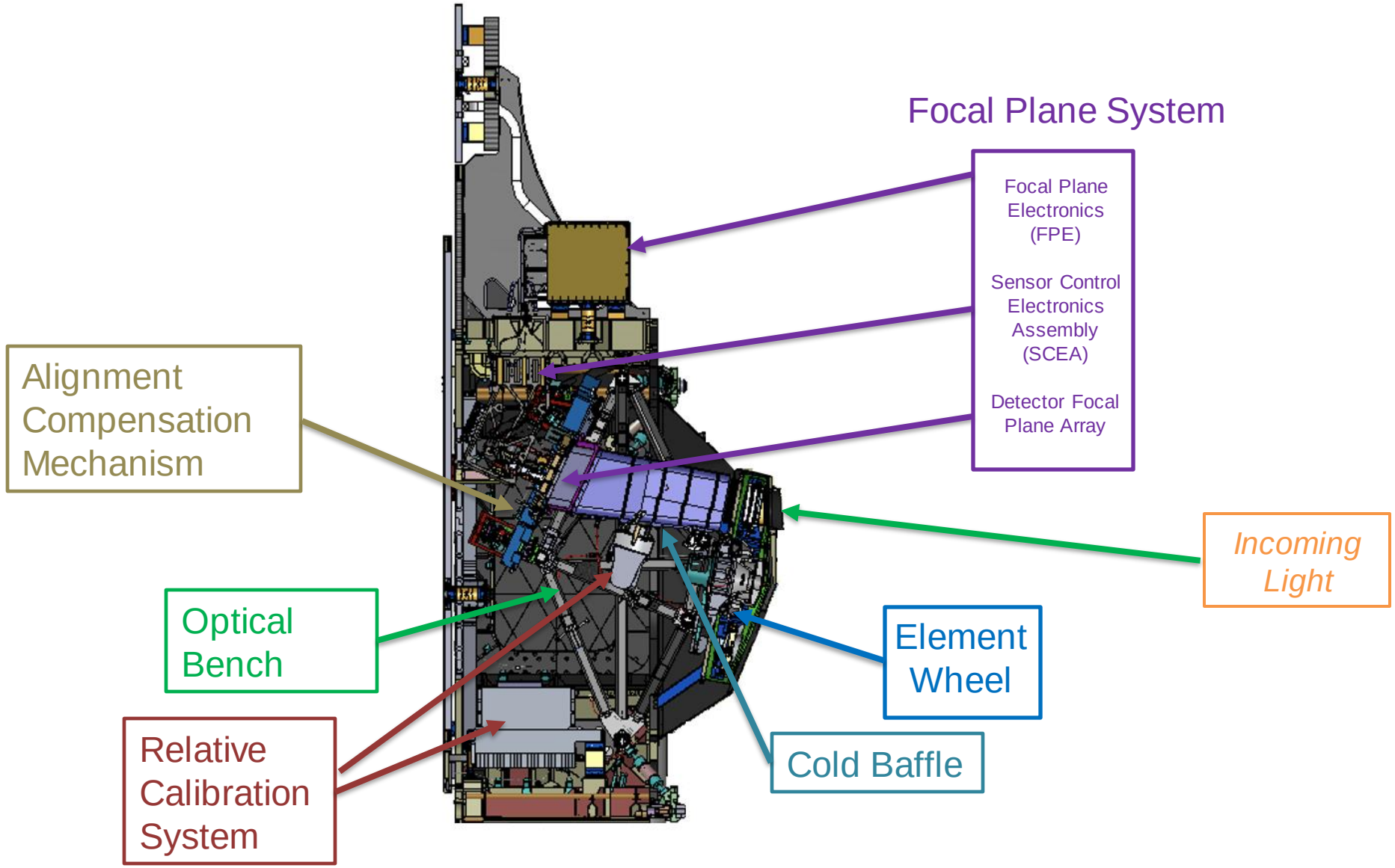
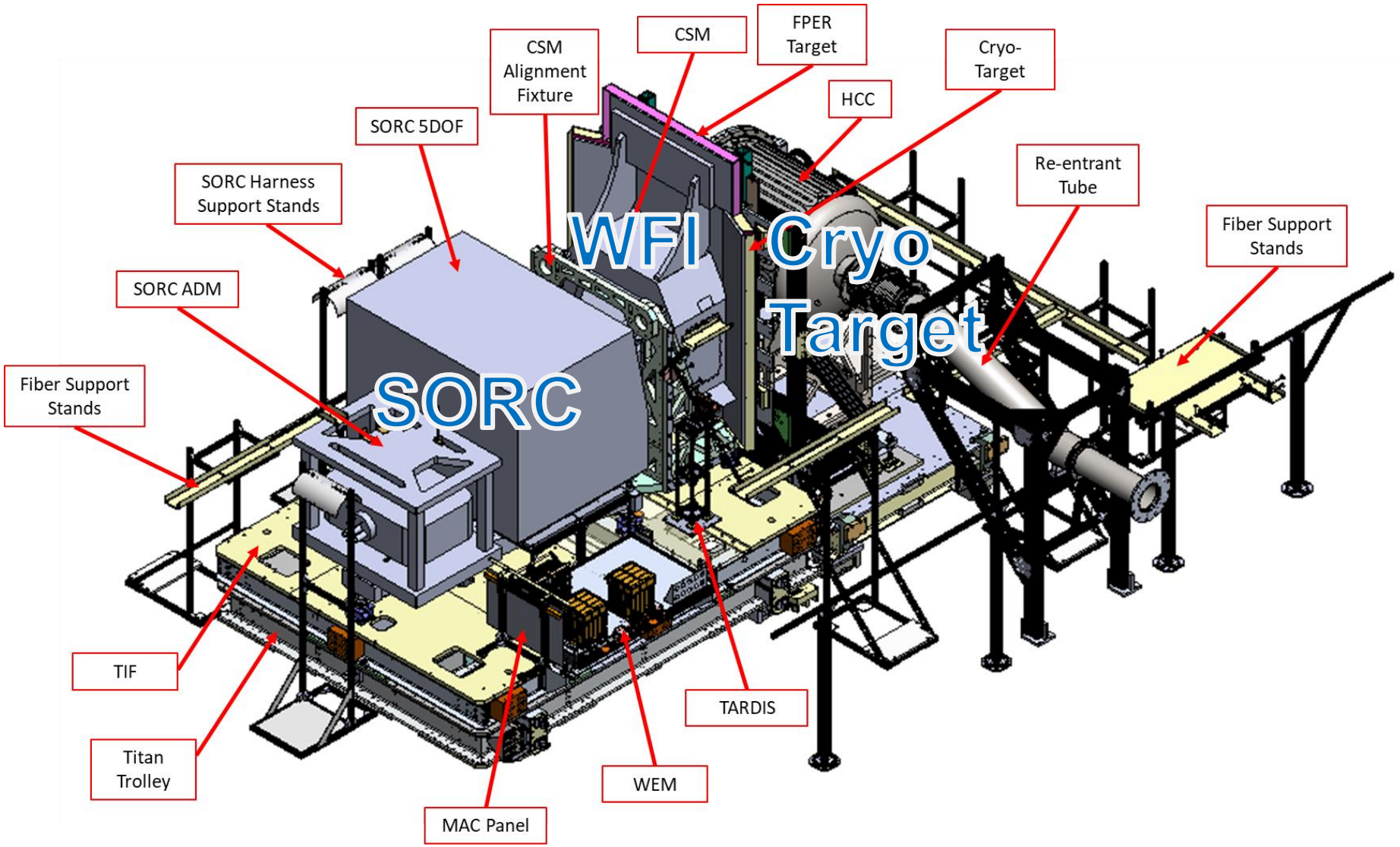
Wide Field Instrument – Key Subsystem Overview



WFI I&T Status

- **WFI has been fully integrated at BAE Systems (formerly Ball Aerospace) and has successfully cleared key phases of testing**
  - **Thermal Vacuum Test 1 – TVAC1 (Fall 2023)**
    - Test the functionality of all instrument systems
    - Establish a pre-environmental (vibe, acoustics) instrument performance baseline with a focus on optical performance
    - Performed risk reduction activities to assess and prepare for science performance tests in the second TVAC campaign in Spring 2024 (TVAC2)
  - **Vibration Test (Early 2024)**
  - **Acoustic Test (Early 2024)**
    - Vibe and Acoustics subject the instrument to a simulated launch environment
  - **Thermal Vacuum Test 2 – TVAC2 (Spring 2024)**
    - Post-environmental performance baseline
    - "Run for the record" for WFI requirements verification and science calibration
  - **Electromagnetic Interference/Electromagnetic Compatibility (June 2024)**
    - Checking that electronics/electricals do not generate unwanted noise and work together smoothly

What is in the TVAC chamber?



SORC – Telescope simulator for WFI

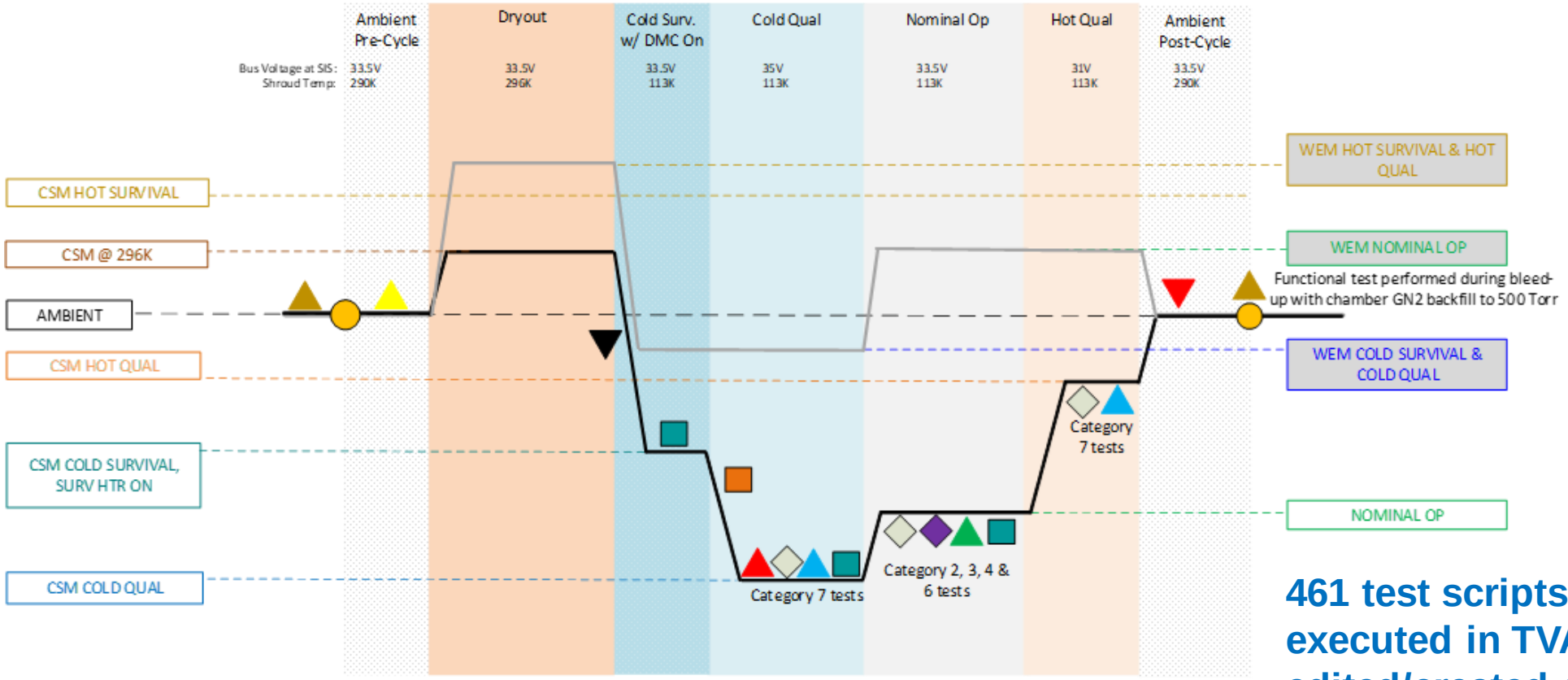
- **Stimulus of ray cones (SORC)**
- **Key Capabilities**
  - **Projector** to place point sources at any point on focal plane.
  - **Diffuse**r to illuminate across the field.
  - **Blackbody** to block/thermally illuminate WFI.
  - **Metrology** to register SORC to WFI, WFI element wheel.

SORC in the Space Environment Simulator at GSFC, 3/23

SORC has been shipped back to GSFC after successfully playing its role in the TVAC campaigns!!

Moving into the Titan chamber

Completed TVAC2 test profile



LEGEND:

- CSM Temperature Plateau
- WEM Temperature Plateau
- CSM Profile
- WEM Profile
- Open/Close Chamber Door
- Ambient Functional
- Aliveness Test
- CPT Short Test
- CPT Full Test
- Survival Heater Checkout
- ACM Deployment
- ACM Stow
- Optical Performance Testing
- ACM Phase Retrieval
- Thermal Balance
- MPA Decontamination Cycle

TEST CATEGORIES:

Category 1: Must-Occur Engineering Tests (TVAC1)
Category 2: Must-Occur Engineering Tests (TVAC2)
Category 3: Pre/Post Vibe Comparisons (TVAC1 and TVAC2)
Category 4: TVAC1 / TVAC2 Agnostic
Category 5: Risk Reduction (TVAC1)
Category 6: Final Flight Reference Items (TVAC2)
Category 7: Qual Plateau Tests

461 test scripts were executed in TVAC2, many edited/created on the fly, generating ~270 TB of data, many thanks to the teams (primarily engineers) that supported this effort!!!

WFI I&T Status – Key Changes after TVAC1

- **Baffles added to filters, grism, and prism to mitigate thermal stray light paths identified in TVAC1**

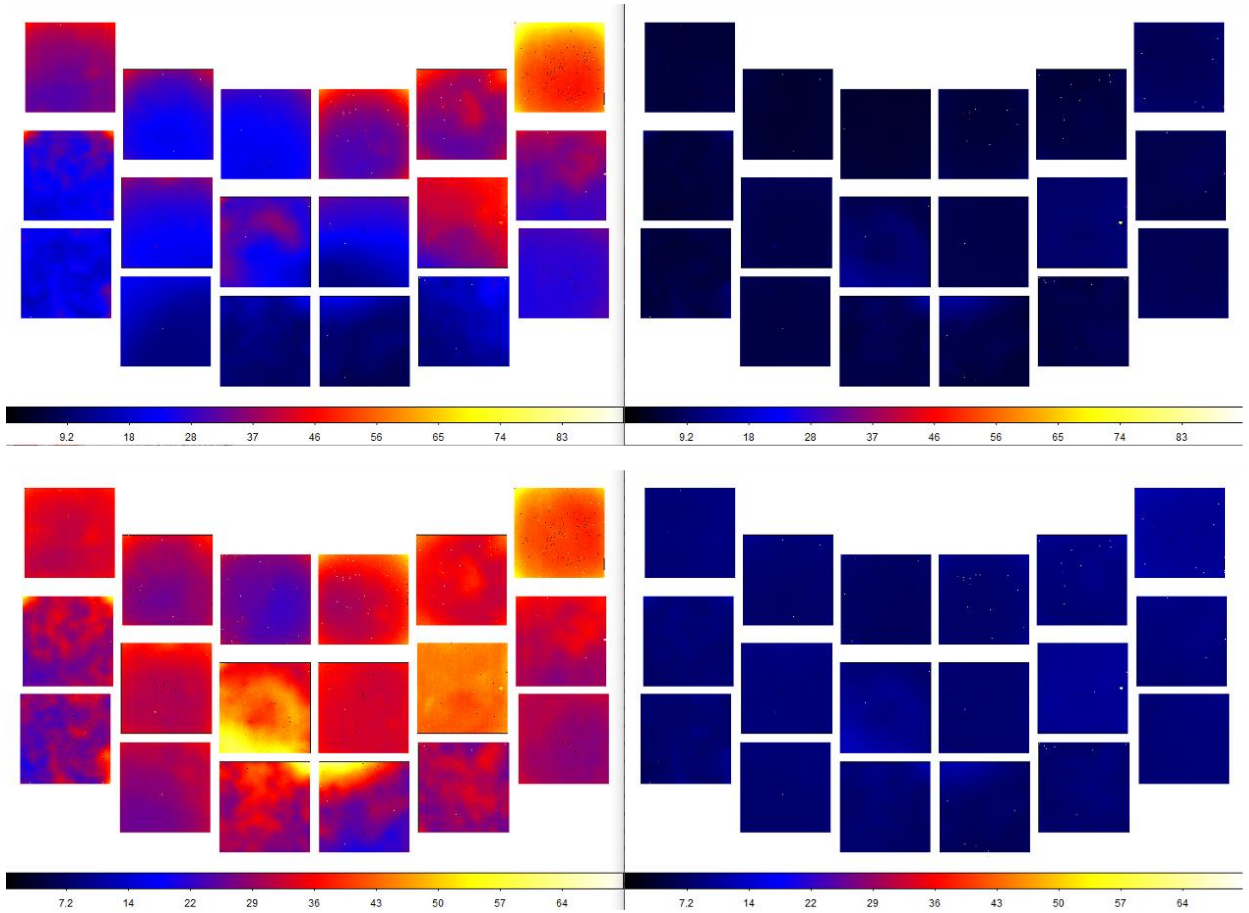
- **Telescope simulator (SORC) has undergone several upgrades to mitigate stray light, improve mechanisms, and expand light source capabilities**

- **SCA operating temperature reduced to 89.5 K after correlation of TVAC1 thermal model confirmed additional margin available; requirement also being updated**

PRELIMINARY Analysis Example – TVAC1 vs. TVAC2 Thermal Background

TVAC1 (no baffles)
BB @ ~270 K

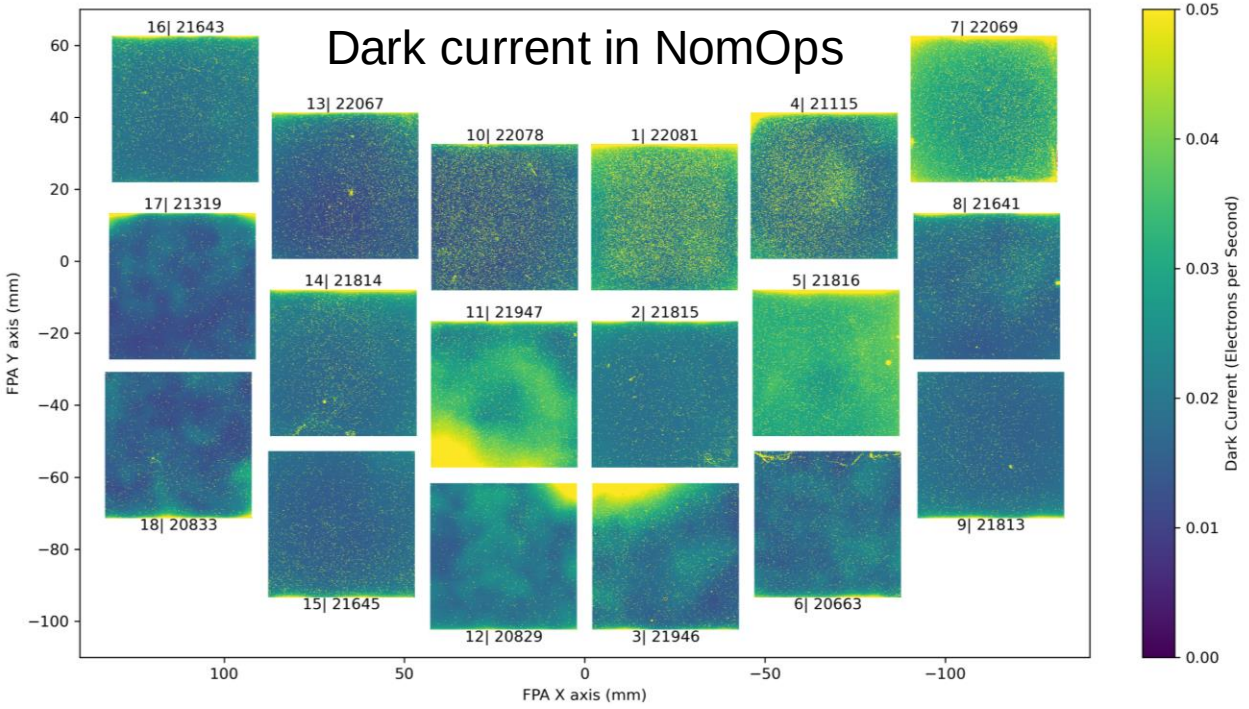
TVAC2 (w/ baffles)
BB @ ~270 K

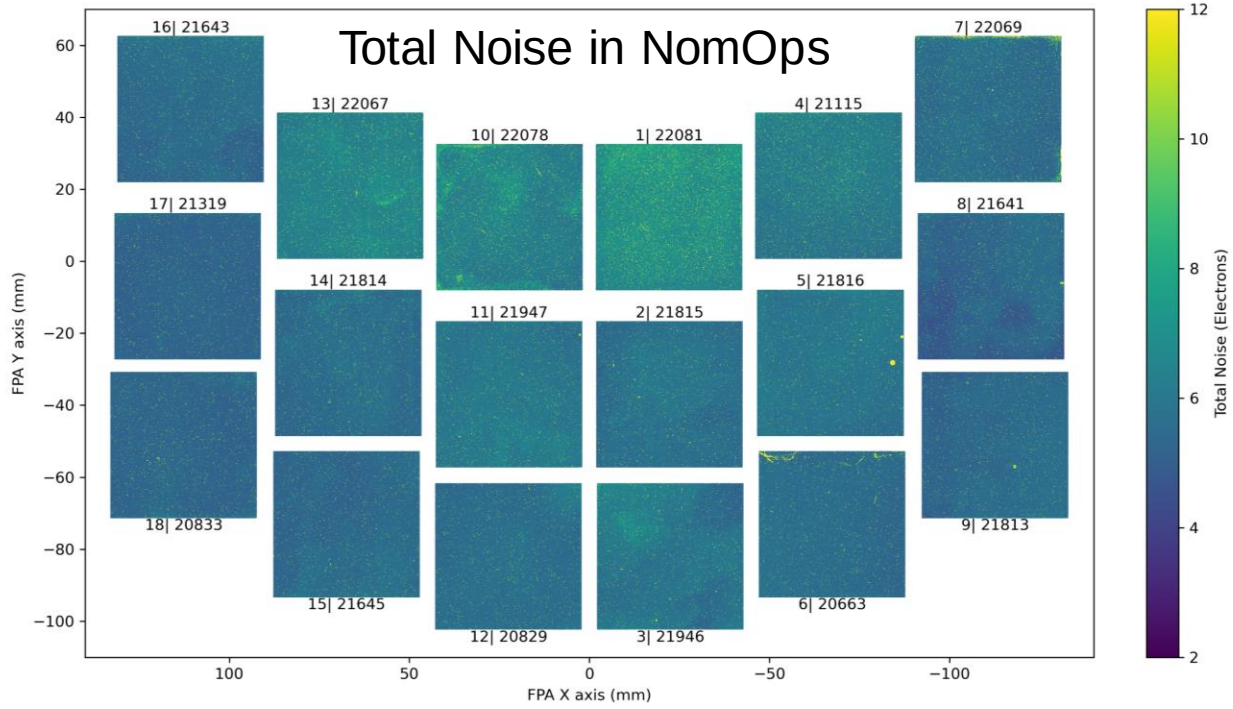


EWA position	Blackbody @ ~270K (Overtest)	
	TVAC1 (median e-/pix/s)	TVAC2 (median e-/pix/s)
HOME_DARK	0.343	0.204
POS_10_F087	0.441	0.356
POS_9_W146	7.336	6.885
POS_8_F184	5.907	5.577
POS_7_F158	0.686	0.578
POS_5_F129	0.367	0.260
POS_4_F106	0.760	0.638
POS_3_F062	0.694	0.555
POS_2_F213	201.642	186.663
POS_1_GRISM	33.130	8.276
POS_6_PRISM	27.393	6.640

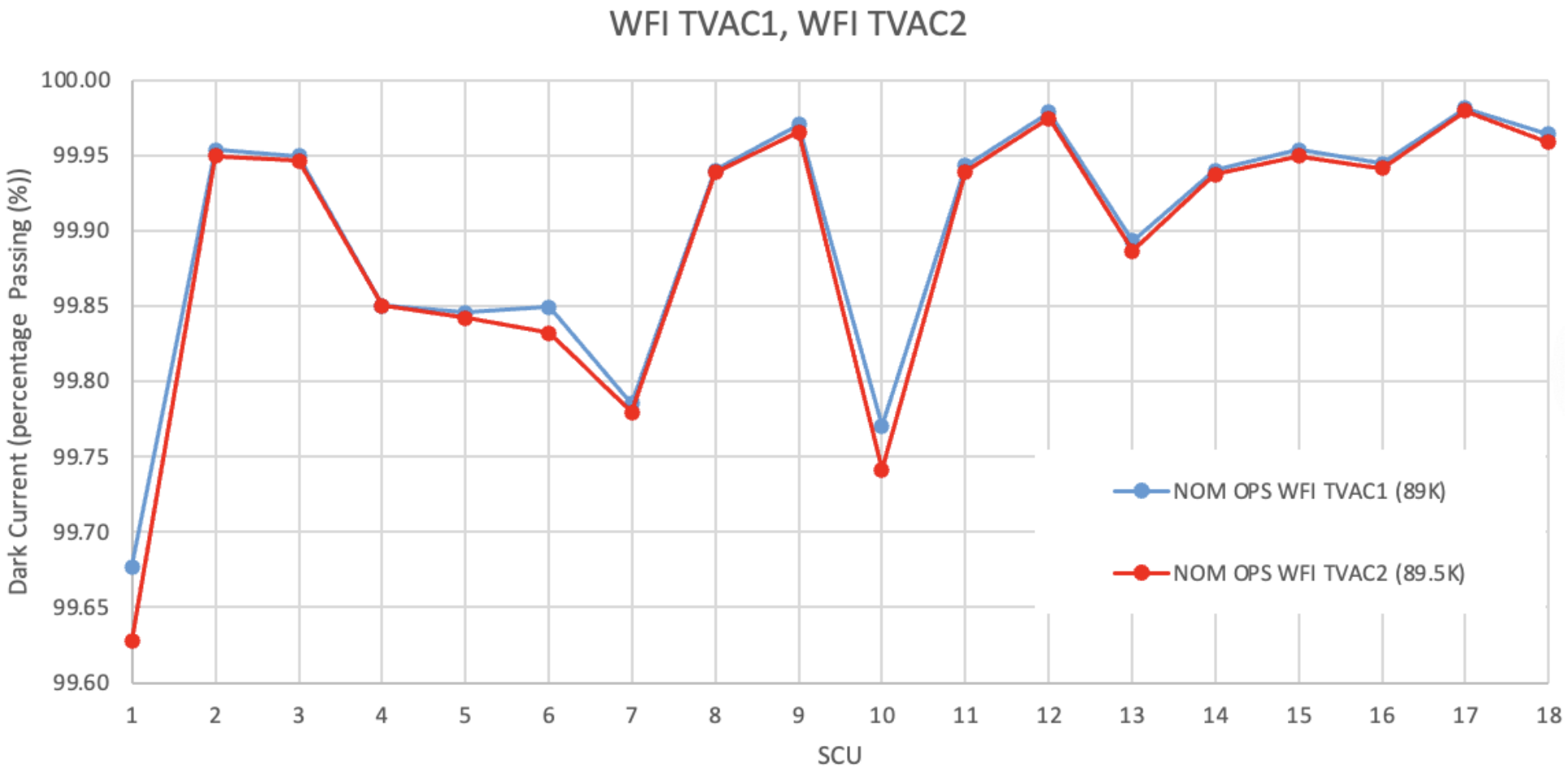
PRELIMINARY Analysis Example – FPS Dark Current, Noise

- Background was lower in TVAC2 compared to TVAC1.
- Mosaic Plate Assembly (MPA) temperature was slightly higher during TVAC2 (89.5 K) compared to TVAC1 (89.0 K)
- Dark current, total noise, and CDS noise are mostly unchanged since TVAC1, all SCAs still meet requirements.



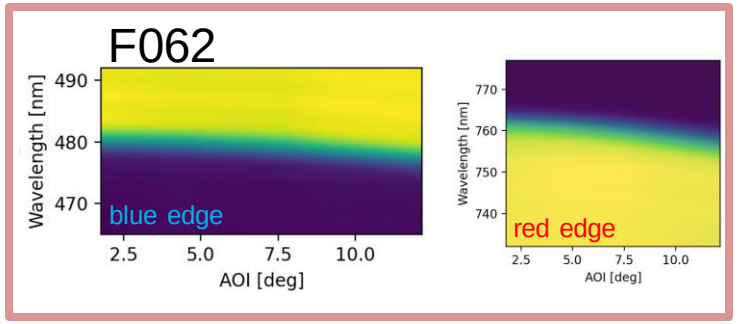


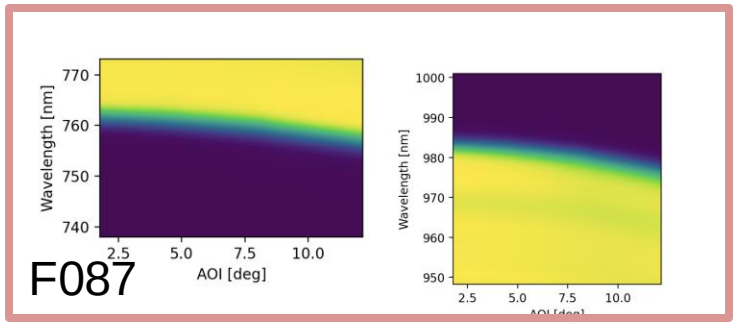
PRELIMINARY Analysis Example – Dark Current/Operability

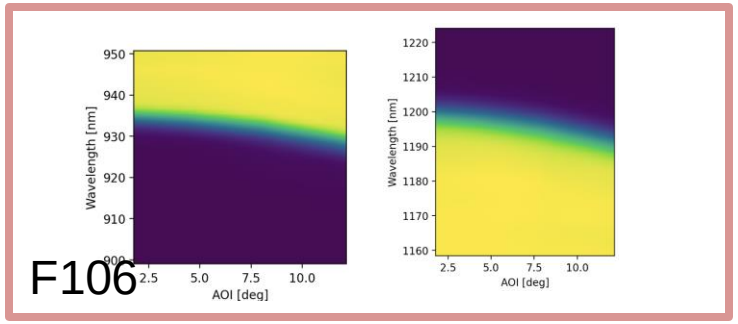


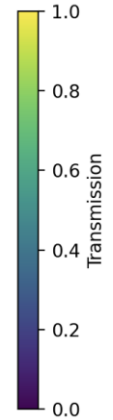
Excellent stability of operability fraction, consistent with expectations after Roman Detector Anomaly Review Board recommendations; SCAs that start with less operability appear to change more, as expected

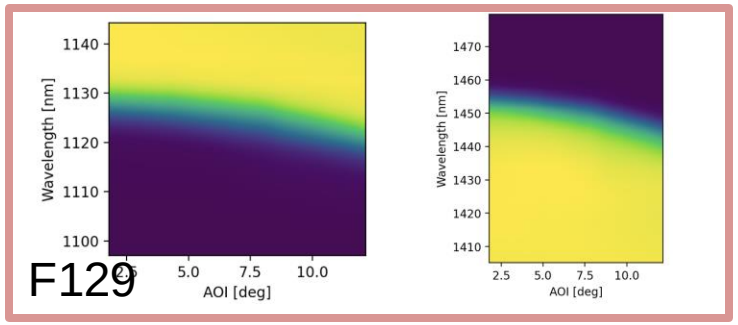
PRELIMINARY Analysis Example – Filter Bandpass Edges AOI Dependence and Pupil Images

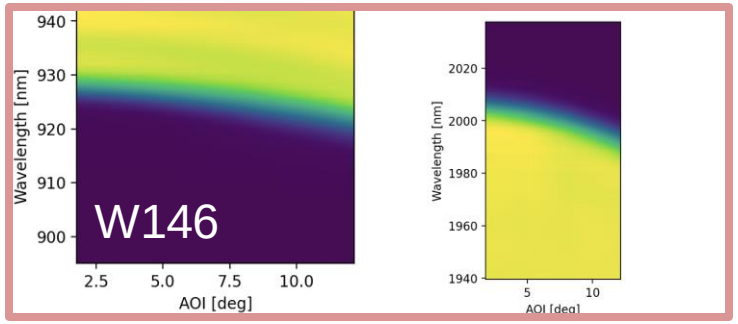


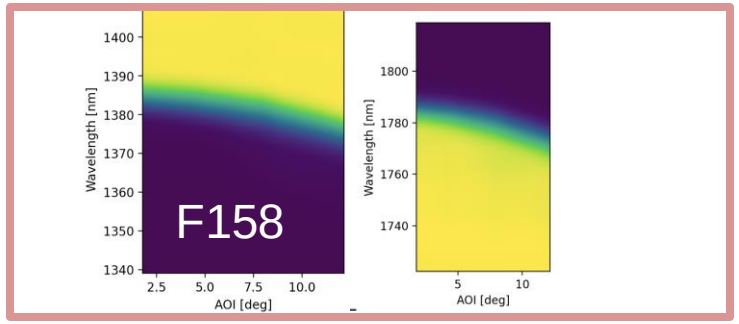


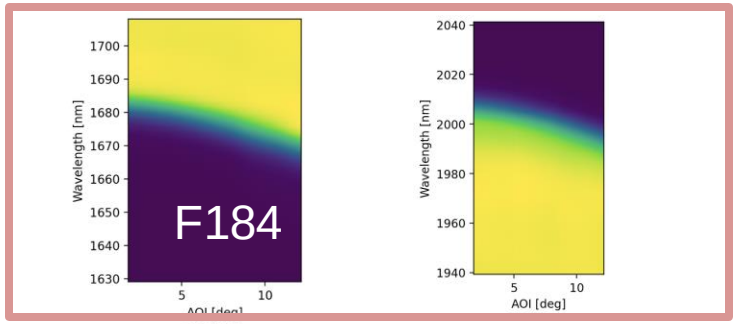


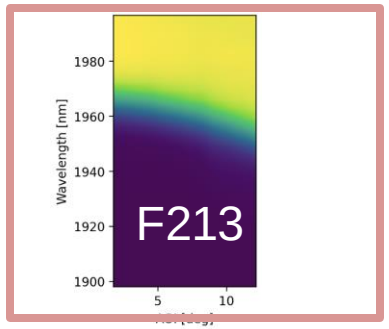


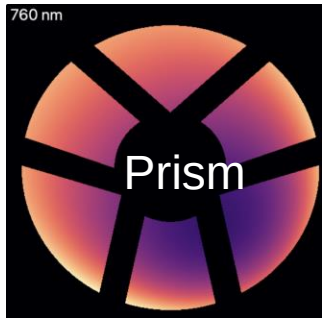










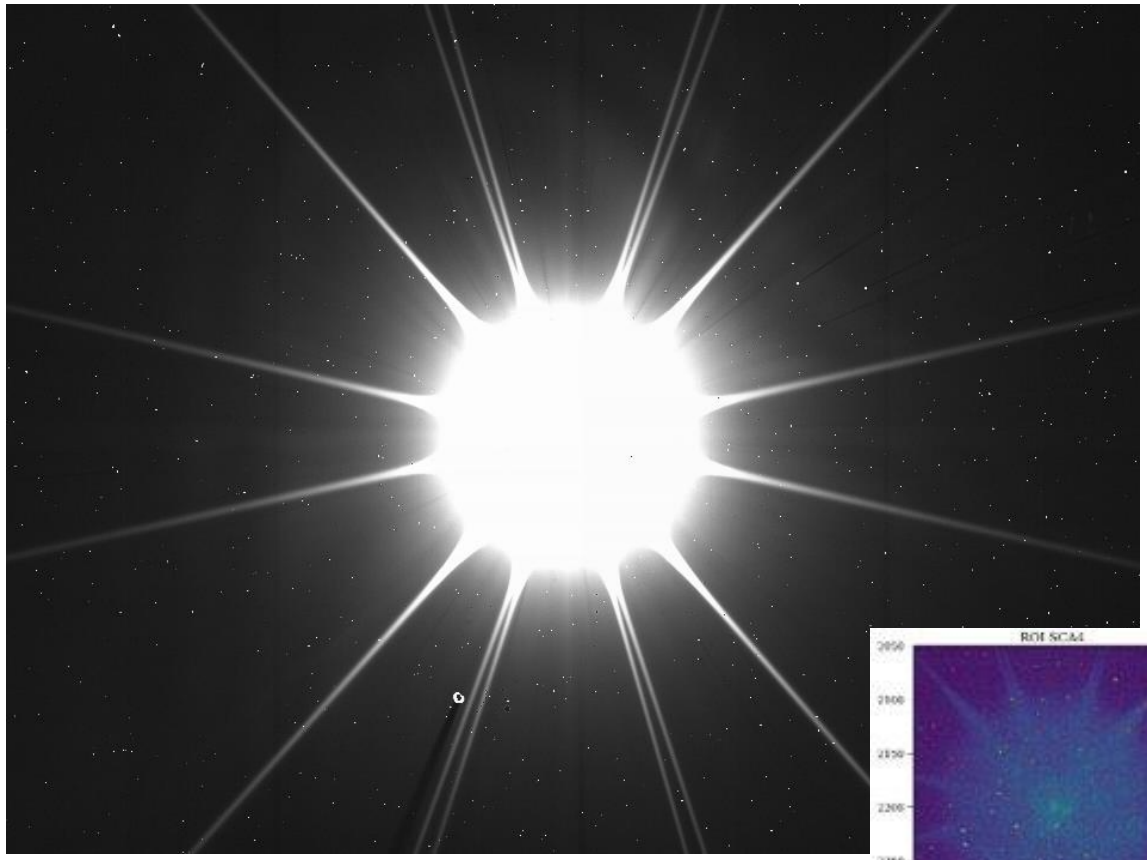


Retrieved pupil transmission at grism and prism blue edges at center field

PRELIMINARY Analysis Example – Bright Source Risk Reduction Tests

- **Bright sources expected in nearly every Roman observation field**
  - Designed risk reduction tests to understand what to expect from such sources in science observations
  - Investigate SCA pixel response to very deep saturation
  - Investigate persistence after very deep saturation
- **Simulated sources ranging from brighter than 4th to 18th magnitude were projected through the F146 filter and Grism using the Split-IR SORC mode**
  - 55 frame - ~180 sec exposures with interleaved darks
  - Grism exposures also included wavelength dependent measurements to better understand diffraction/scattering/throughput

Projected bright source on SCA 4, ~25e9 e- in core pixel



Persistence in PSF core immediately after exposure

Analysis ongoing!

Science Test Overview in TVAC2

- **Detectors (science monitor tests, multiple times for trending)**
  - Darks
  - Noise
  - Linearity
- **Filters**
  - Bandpass edges (except F213 red)
  - Edge transmission across physical extent of filter
  - Narrow band flats with 10 nm wavelength step size
  - Broad band flats
- **Spectroscopy – Grism and Prism**
  - Dispersion
  - Bandpass edges
  - (Narrow band flats provide wavelength dependent response for calibration)
- **sRCS**
  - LED performance and trending
  - Flats – Dark and Lamp-On-Lamp-Off (LOLO) – flatness, smoothness
  - Count rate dependent non-linearity (CRNL)
- **Backgrounds**
  - Thermal backgrounds and out-of-band
- **Other tests**
  - Bright point source saturation

WFI I&T Status – Summary and Outlook

- **The WFI has successfully passed through all key tests!**
- **Near-term analysis of TVAC2 data**
  - **Pre-ship review (PSR; end of July)**
    - Demonstrate requirements verification at WFI-level
    - Plan for longer-term characterization and calibration
- **WFI ships back to GSFC (mid-Aug)**
- **In parallel:**
  - **WFI integration and testing at level of space craft and integrated payload assembly (SCIPA)**
  - **Long-term WFI characterization and calibration work**
    - Collaborate with our SOC/SSC partners on calibration reference products and pipeline inputs
    - Collaborate with science stakeholders (you!) on calibration plans
  - **Commissioning planning**

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