SAMOS Pre-Ship Review

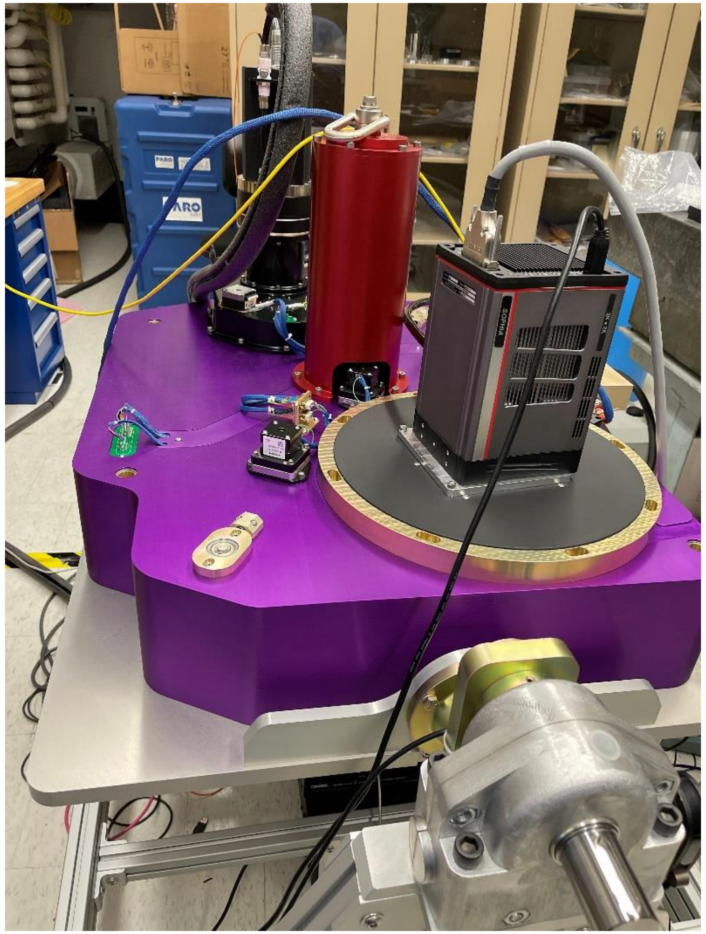
September 20, 2023

Robberto, Smee, Barkhouser, Koeppe, Piotrowski, Hammond

SAMOS Timeline

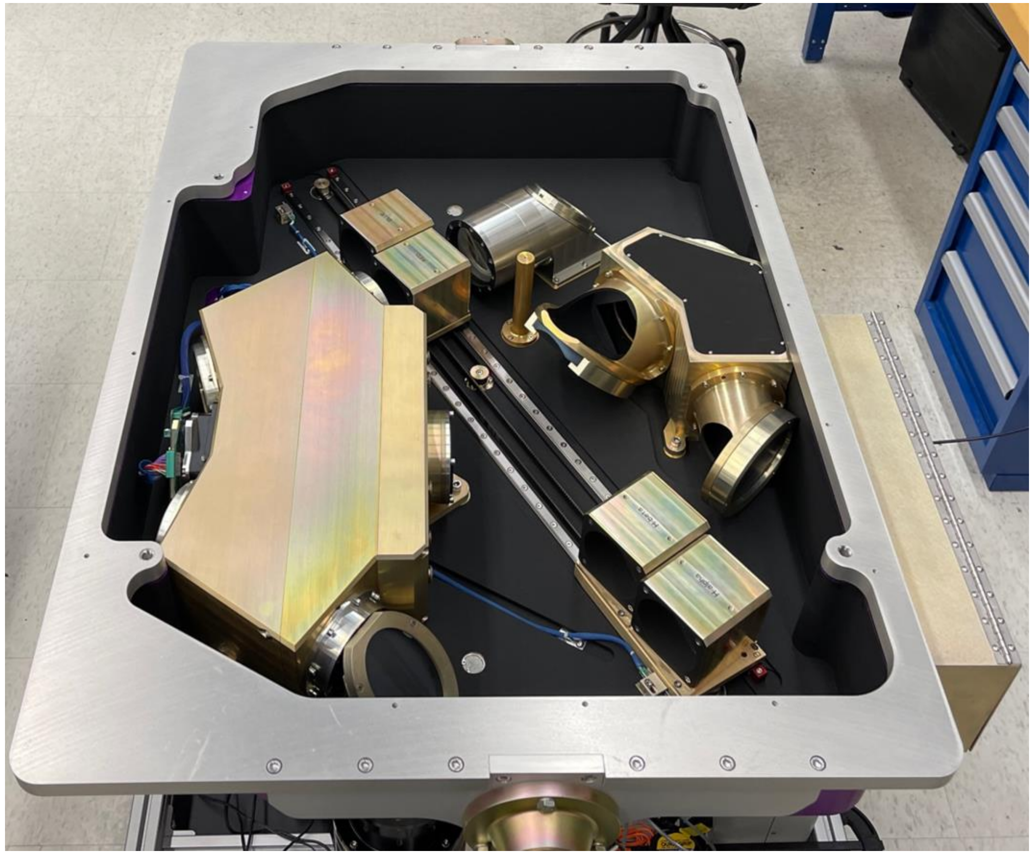
- NSF Funds awarded 2016
- PDR completed March 2018
- Hardware complete ~ 2021/2022
- Software complete 2023
- AIT complete August 2023
- Pre-Ship Review September 20, 2023

SAMOS in IDG Lab @ JHU



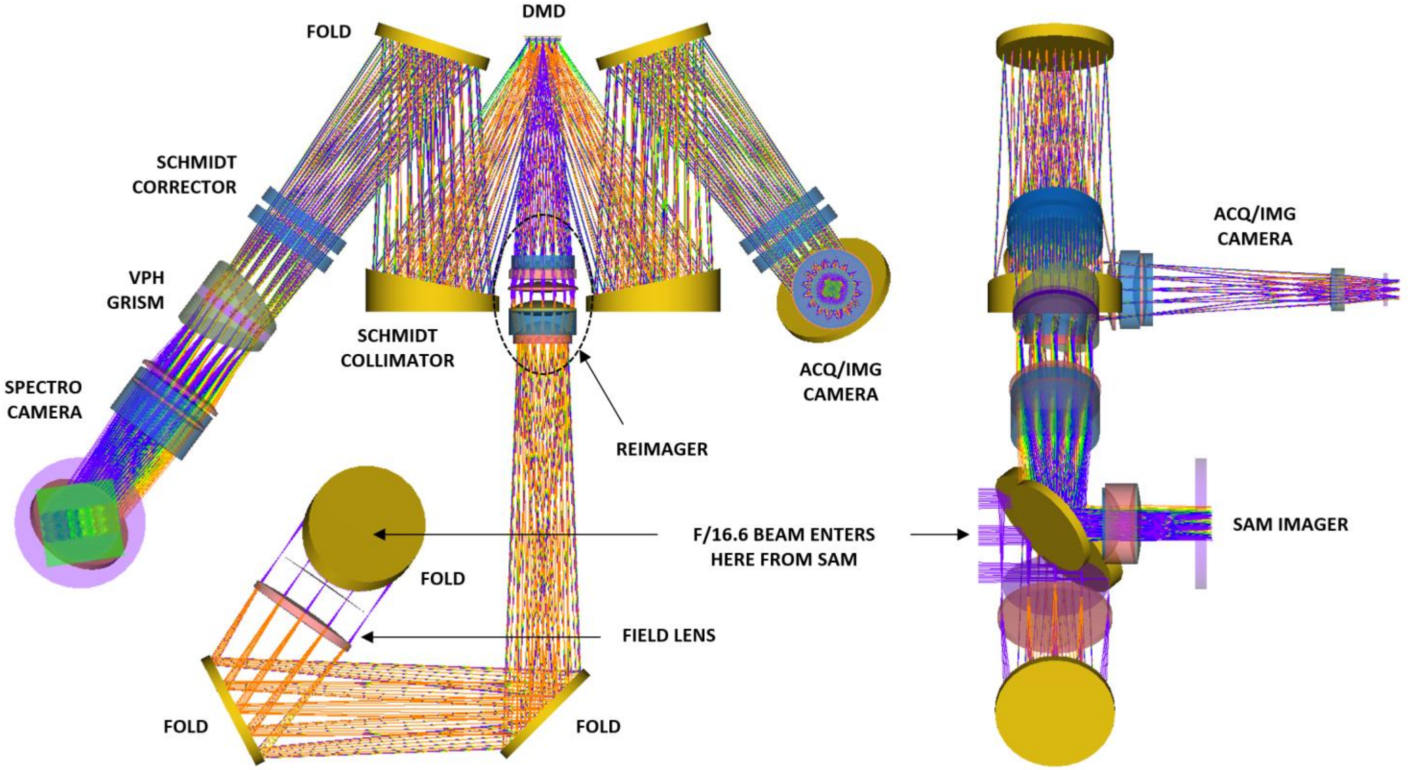
Pre-Ship Review Agenda

- Optomechanical Compliance
- Optical Performance
- Mechanical Performance
- Packaging and Shipment Plan
- Lab activities/schedule at SOAR
- Commissioning activities/schedule



The Optomechanics

- The SAMOS uses a highly folded optical layout containing numerous reflective, refractive, and diffractive optics
- All optics are mounted by dead-reckoning, (i.e. without adjustment) but for focus shims at the reimager, DMD, and CCDs.
- Optics (lenses, mirrors, prisms) were fabricated by Optimax
- Gratings were fabricated by KOSI
- Optomechanical components fabricated by JHU IDG.

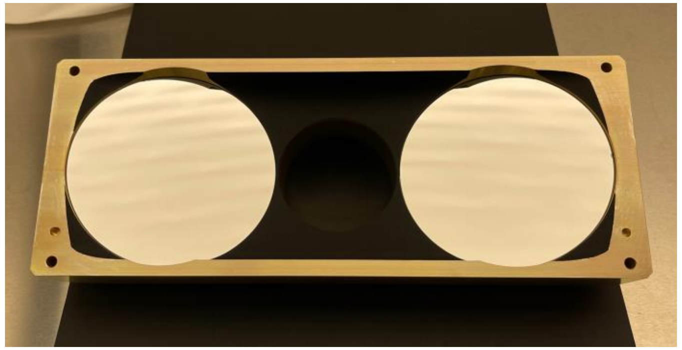


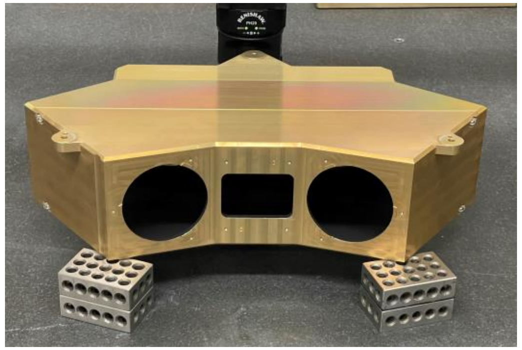
Optical Element Metrology

- Optimax provided full inspection reports with each optic.
- JHU verified all lens diameters prior to installation. Thicknesses were verified at the assembly level to verify vertex-to-vertex spacings.
  - In all cases, JHU measurements agreed with Optimax inspection reports.
  - By all appearances, Optimax did a fantastic job fabricating the SAMOS optics.

Optomechanical Metrology

- JHU measured all lens diameters to verify compliance
  - In particular radial clearance required to ensure decenter tolerance compliance
  - Clearance required for cold survival limit (-20 °C)
- CMM measurements of Schmidt collimator surface (outside CA) to verify segment alignment.
  - Results indicate that both segments are within tolerance
- CMM measurements of Schmidt housing indicate that all optomechanical reference features are extremely accurate
  - Schmidt fold and corrector interfaces are accurate to 0.002 degrees.
  - Reference hole (dowels and bores) true positions good to 50 um.

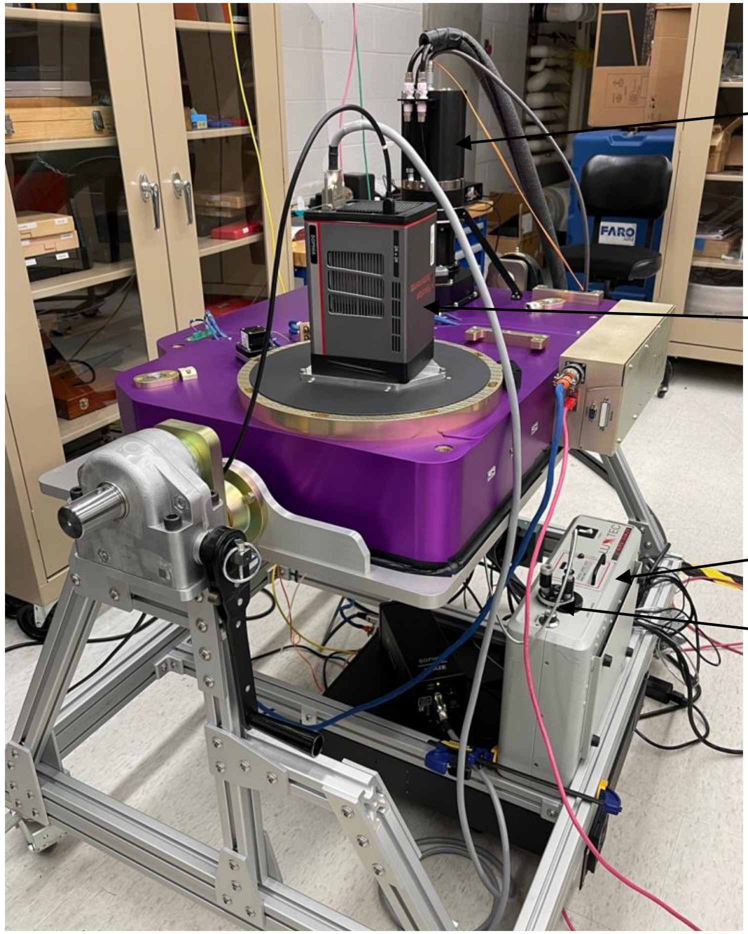




Optomechanical Metrology Cont.

- Optical bench reference features measured in various ways.
  - On the CNC machine during final machining.
  - Using FARO arm upon completion.
- Optomechanical system alignment verified optically.
  - Central pinhole at the field stop location falls within 90 um of DMD center!
    - Placement tolerance of the DMD die in the package is 150 um.
  - DMD image is centered on the imaging channel CCD to within 14 pixels
- Grism alignment is very good.
  - All spectra are aligned to the spectral channel CCD pixels to better than +/- 2 pixels (13 um per pixel on the Sophia test camera) over the spectral range
  - Need to check how well the central wavelength falls on the detector.

Optical Performance Test Setup



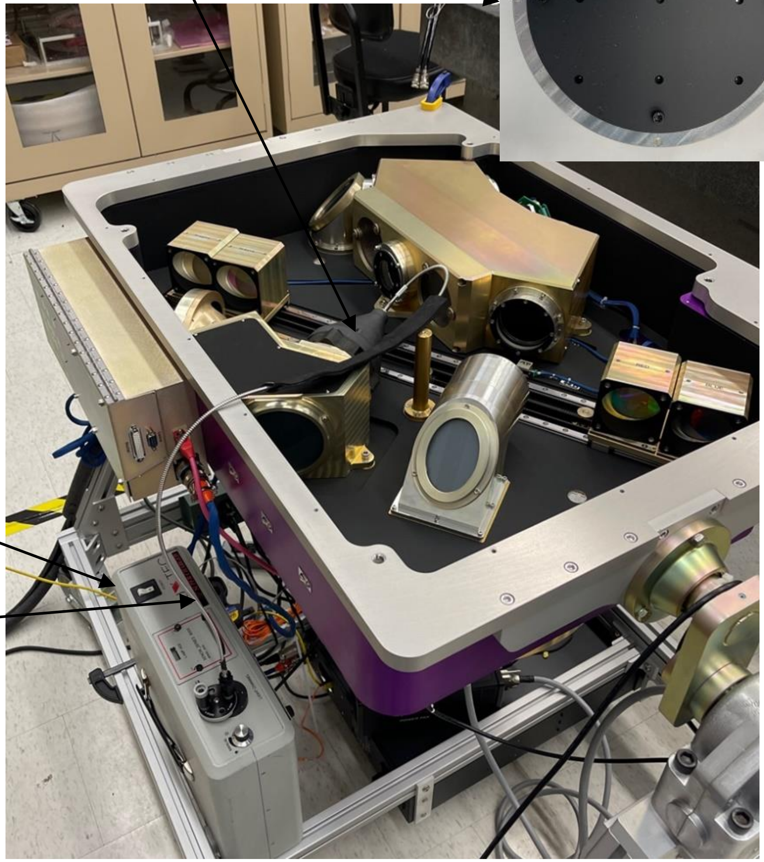
Spectral Instruments SI850 CCD camera, 1k x 1k, 13um pixels

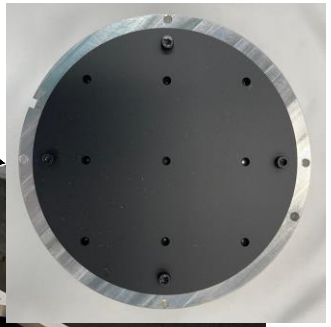
Spec Channel Camera, for test only (Teledyne Sophia blue sensitive CCD, 2k x 2k)

Xenon Source (Also use Halogen and Hg line source)

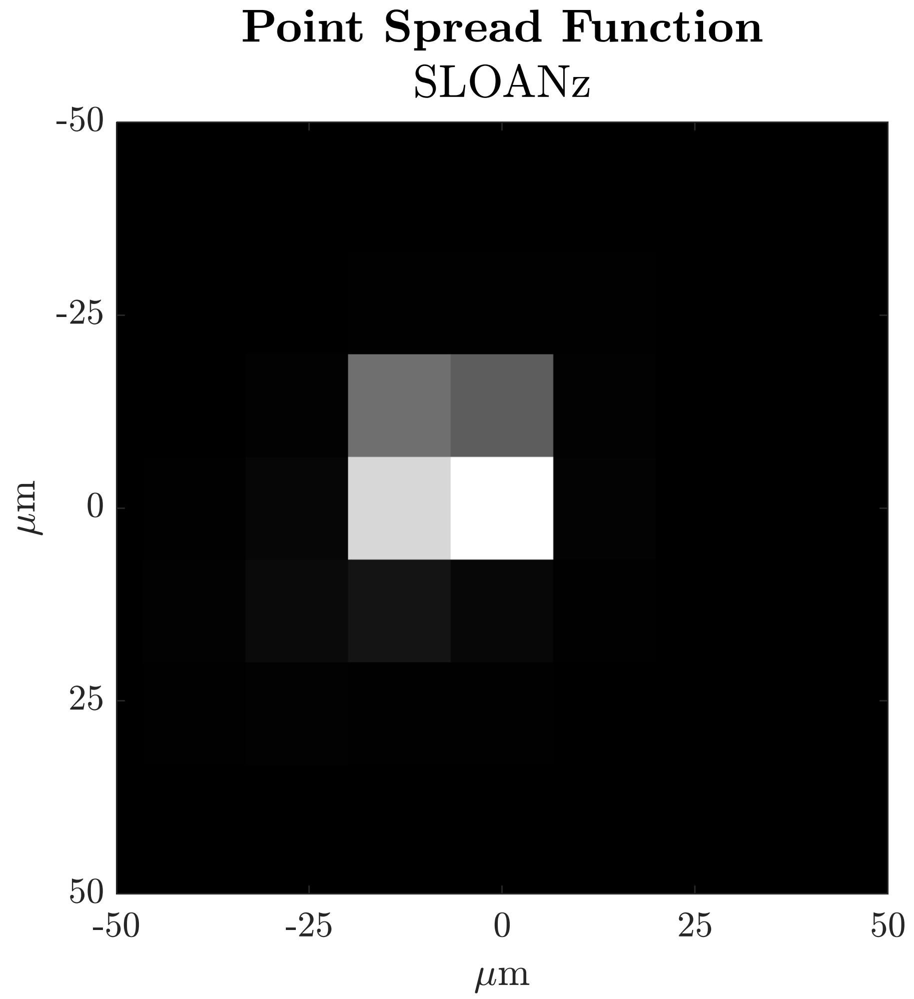
Fiber

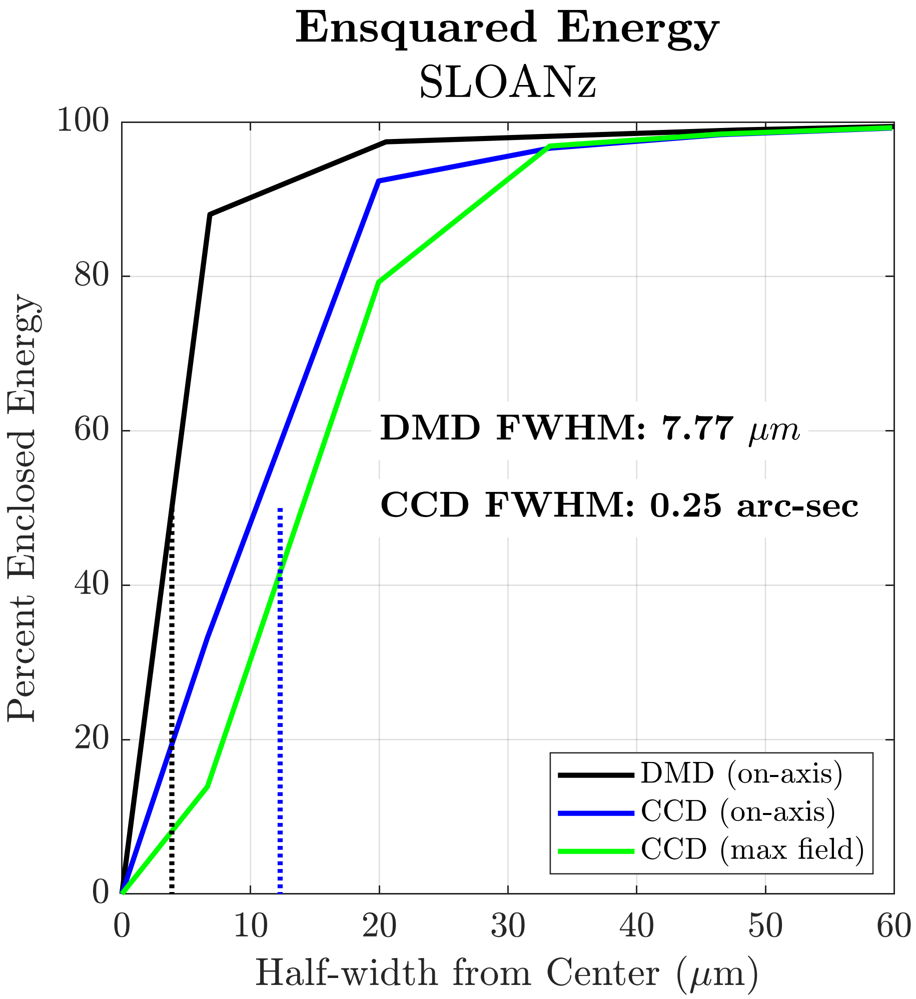
Fiber fed pinhole projector





Optical Performance: DMD/Imaging Channel z-Band

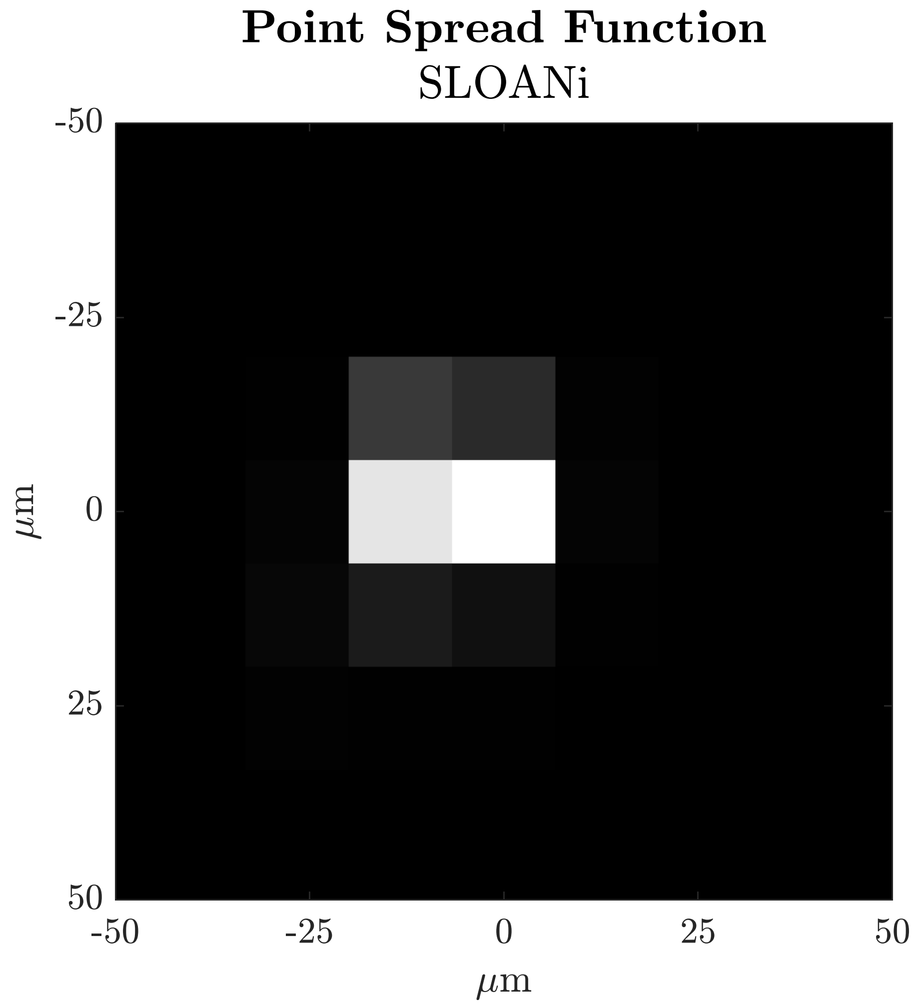


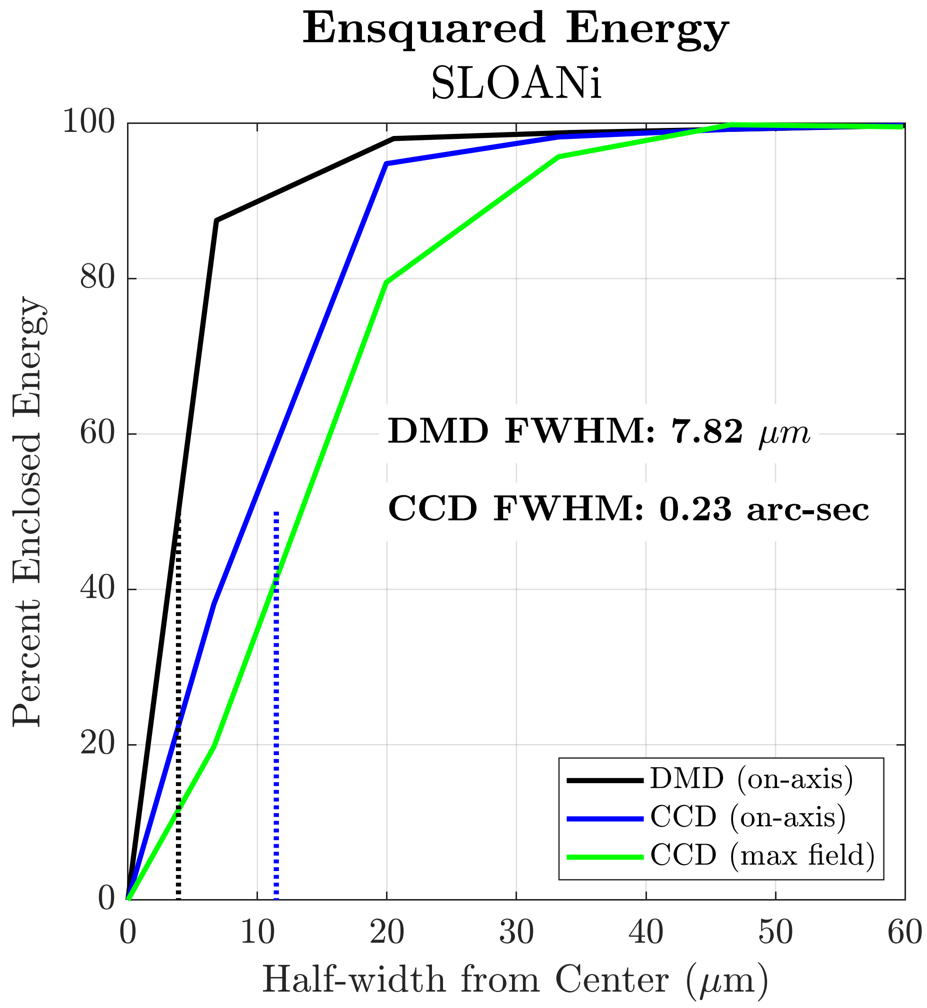


Required FWHM @ DMD: **14.0 μm**
Achieved FWHM @ DMD: **7.77 μm**

Required FWHM @ CCD: **0.30 arc-sec**
Achieved FWHM @ CCD: **0.25 arc-sec**

Optical Performance: DMD/Imaging Channel i-Band

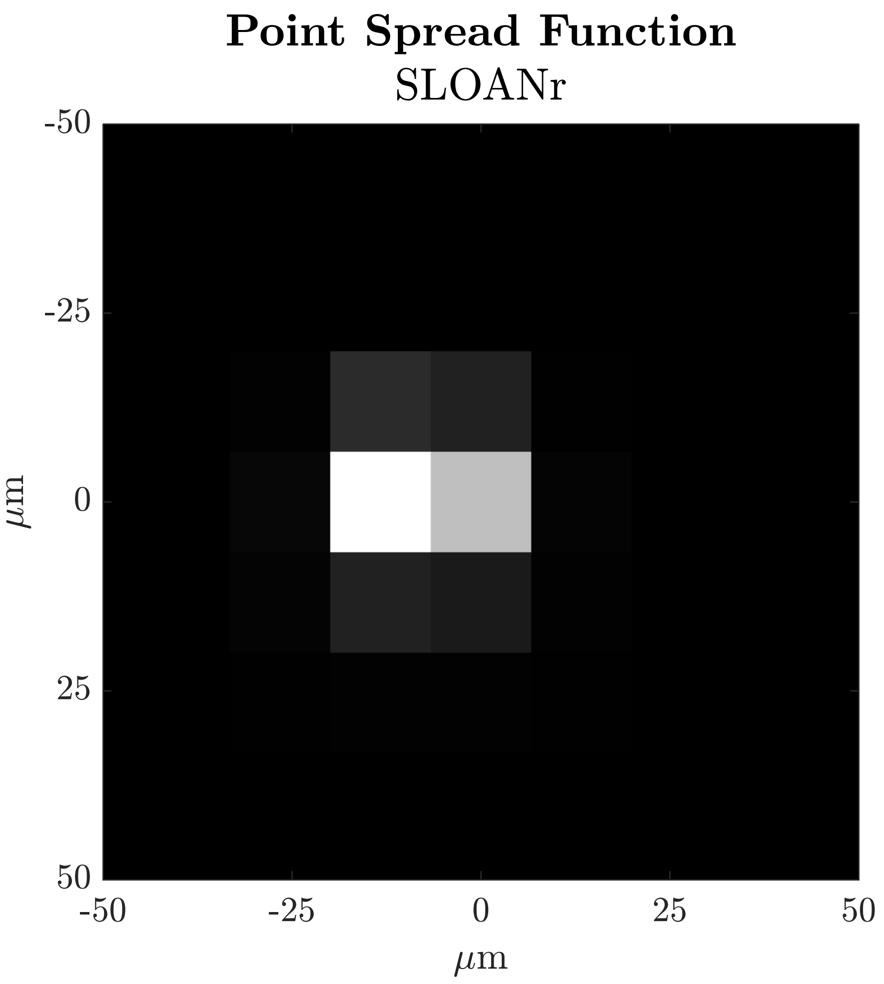


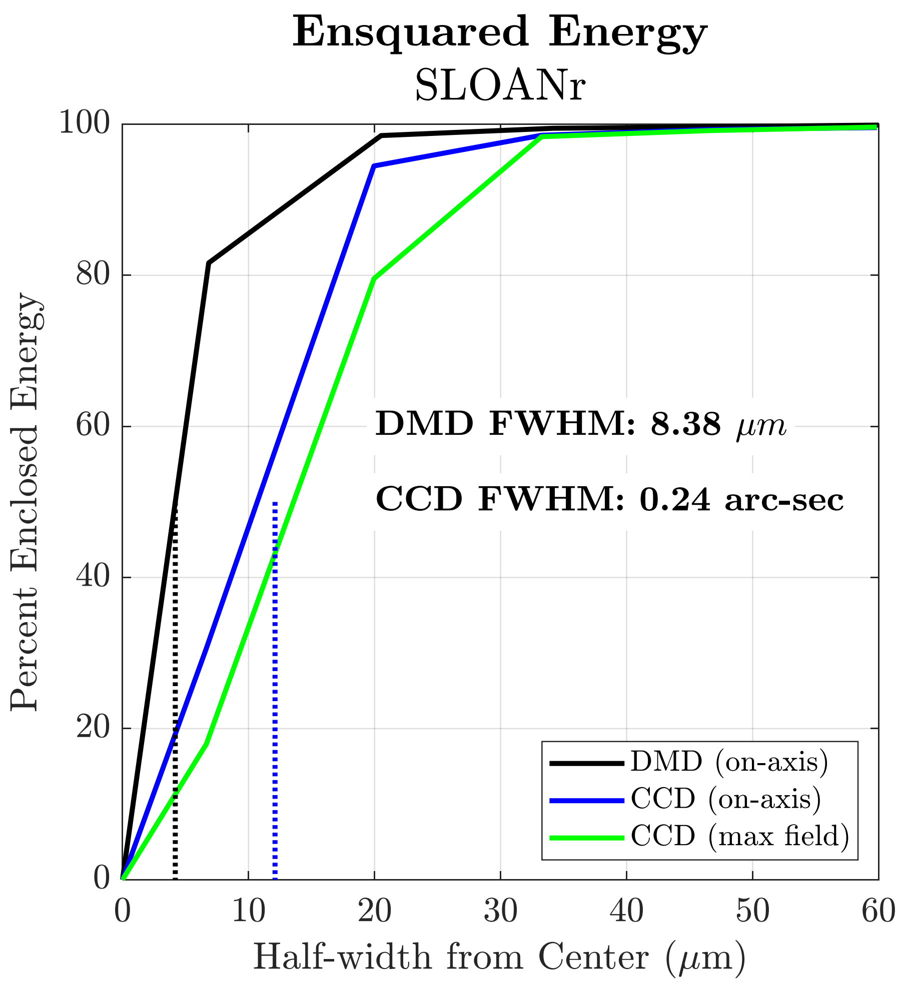


Required FWHM @ DMD: **14.0 μm**
Achieved FWHM @ DMD: **7.82 μm**

Required FWHM @ CCD: **0.30 arc-sec**
Achieved FWHM @ CCD: **0.23 arc-sec**

Optical Performance: DMD/Imaging Channel r-Band

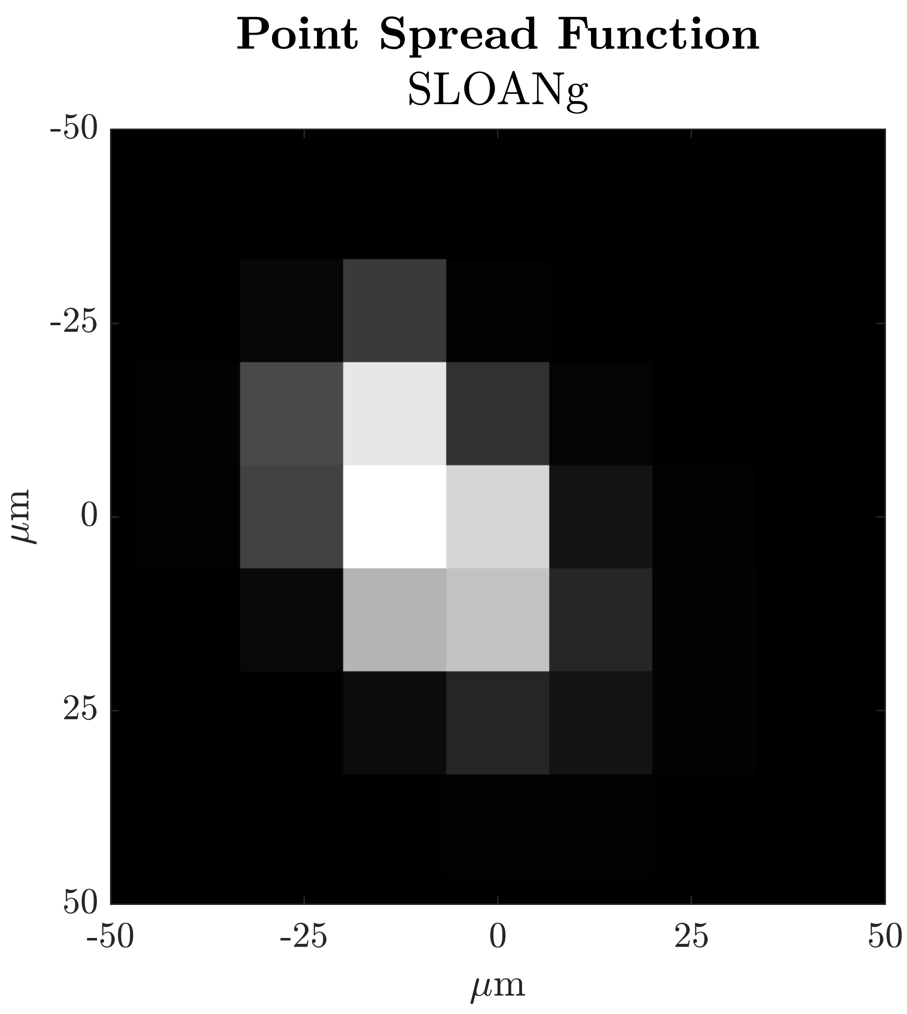


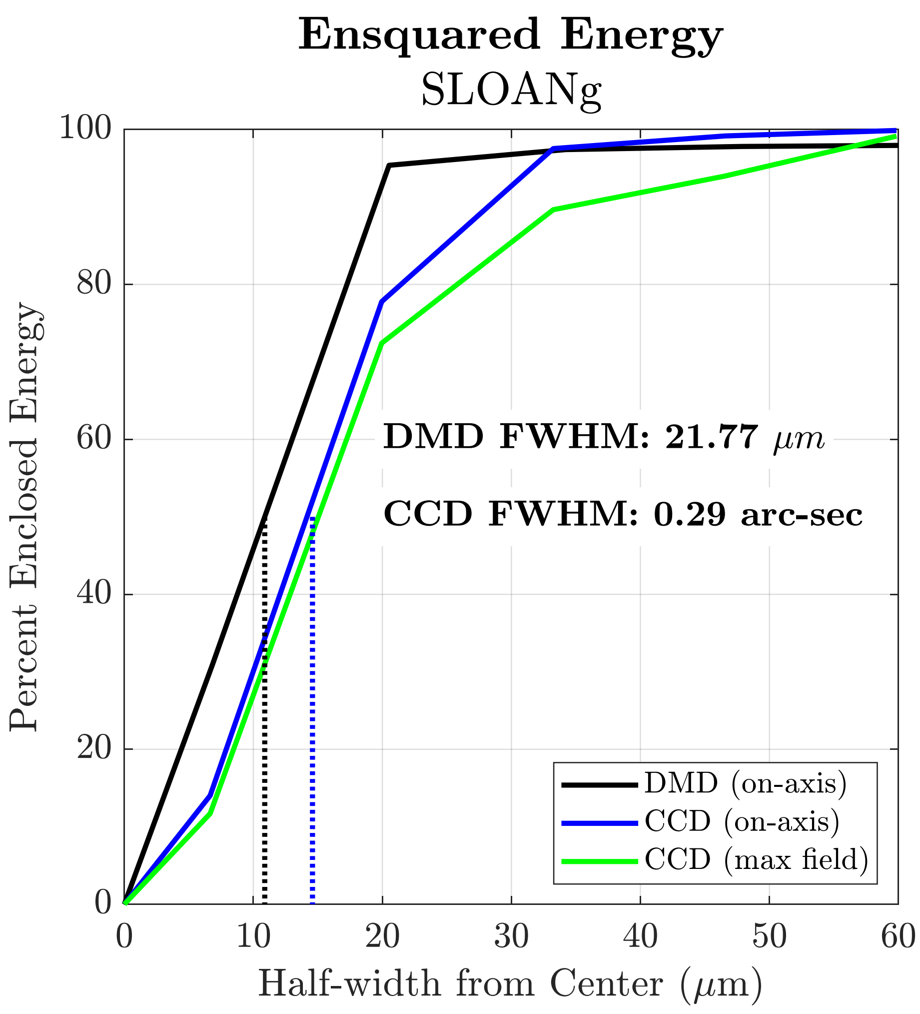


Required FWHM @ DMD: **14.0 μm**
Achieved FWHM @ DMD: **8.38 μm**

Required FWHM @ CCD: **0.30 arc-sec**
Achieved FWHM @ CCD: **0.24 arc-sec**

Optical Performance: DMD/Imaging Channel g-Band [1 of 2]

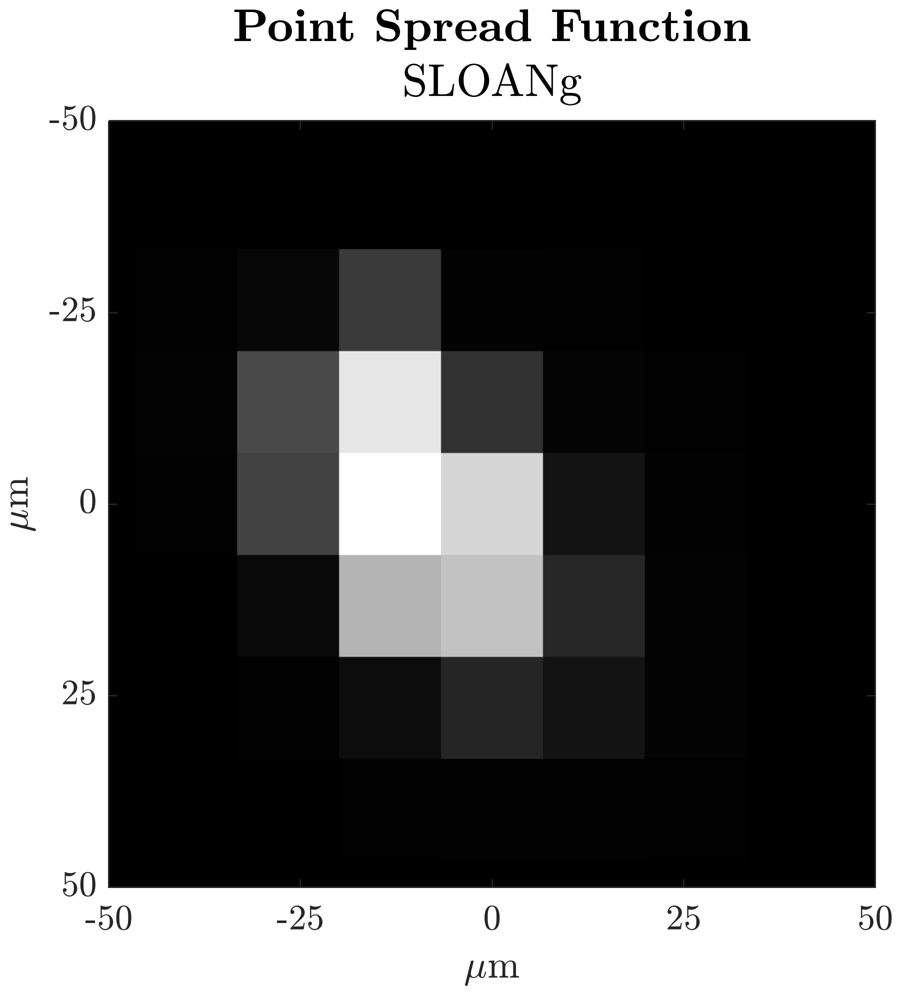


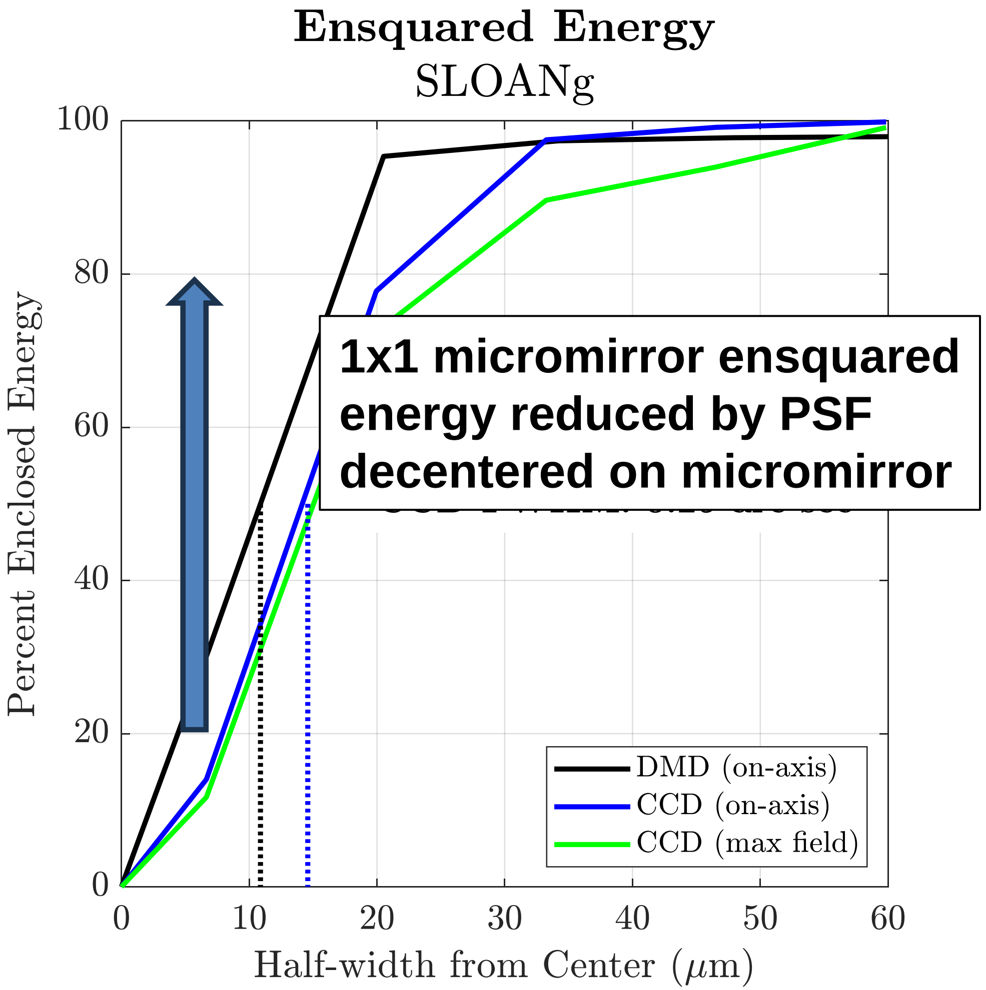


Required FWHM @ DMD: **14.0 μm**
Achieved FWHM @ DMD: **21.77 μm**

Required FWHM @ CCD: **0.30 arc-sec**
Achieved FWHM @ CCD: **0.29 arc-sec**

Optical Performance: DMD/Imaging Channel g-Band [2 of 2]

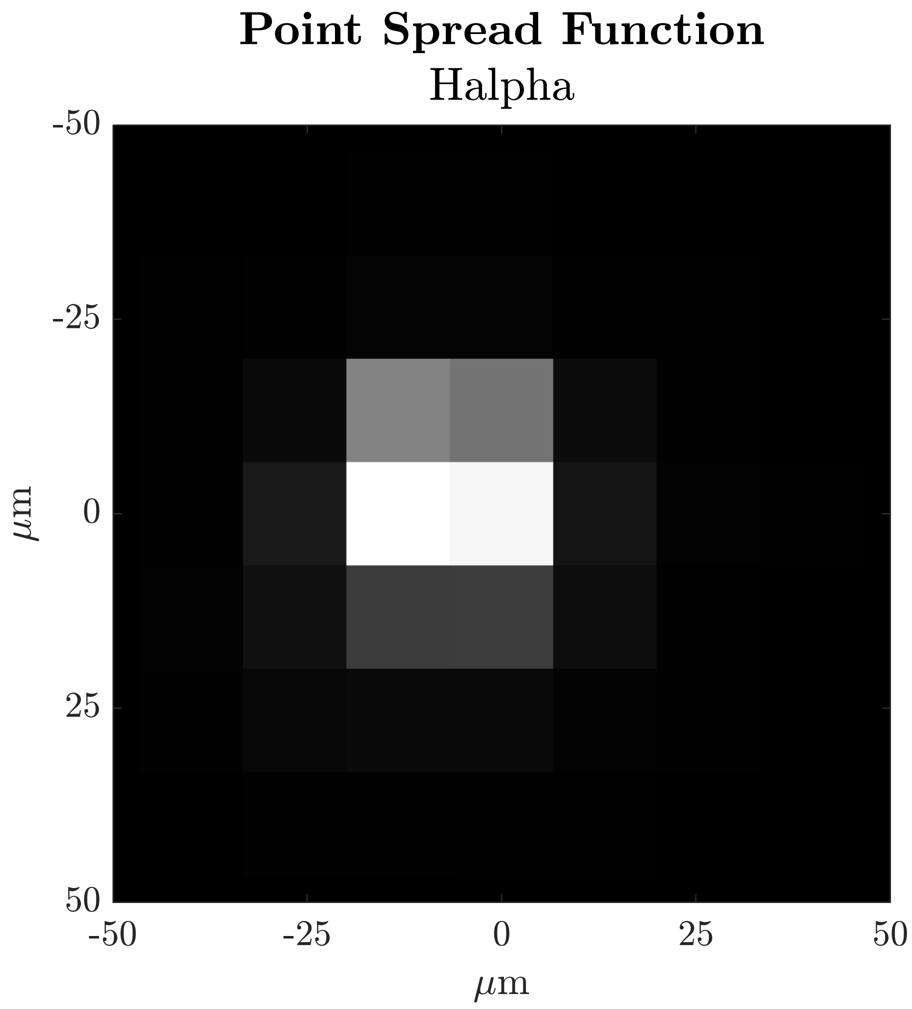


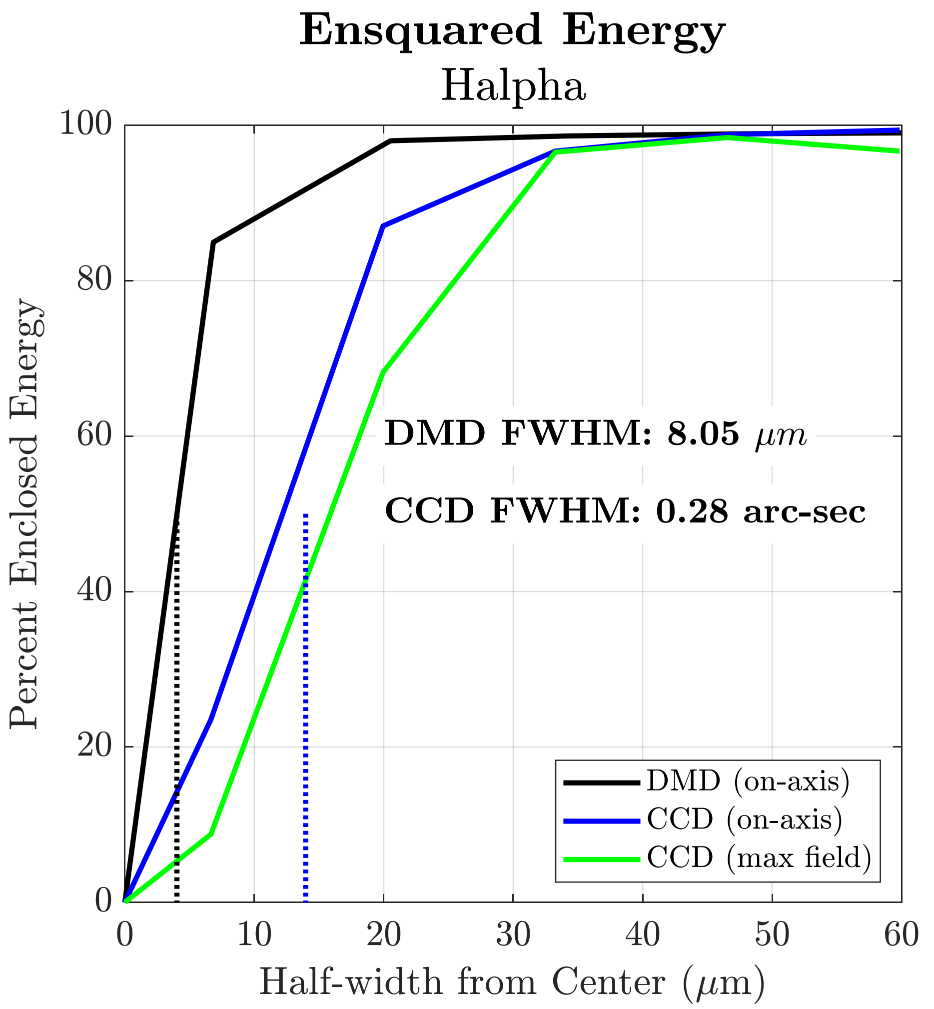


Required FWHM @ DMD: **14.0 μm**
Achieved FWHM @ DMD: **21.77 μm**

Required FWHM @ CCD: **0.30 arc-sec**
Achieved FWHM @ CCD: **0.29 arc-sec**

Optical Performance: DMD/Imaging Channel Halpha

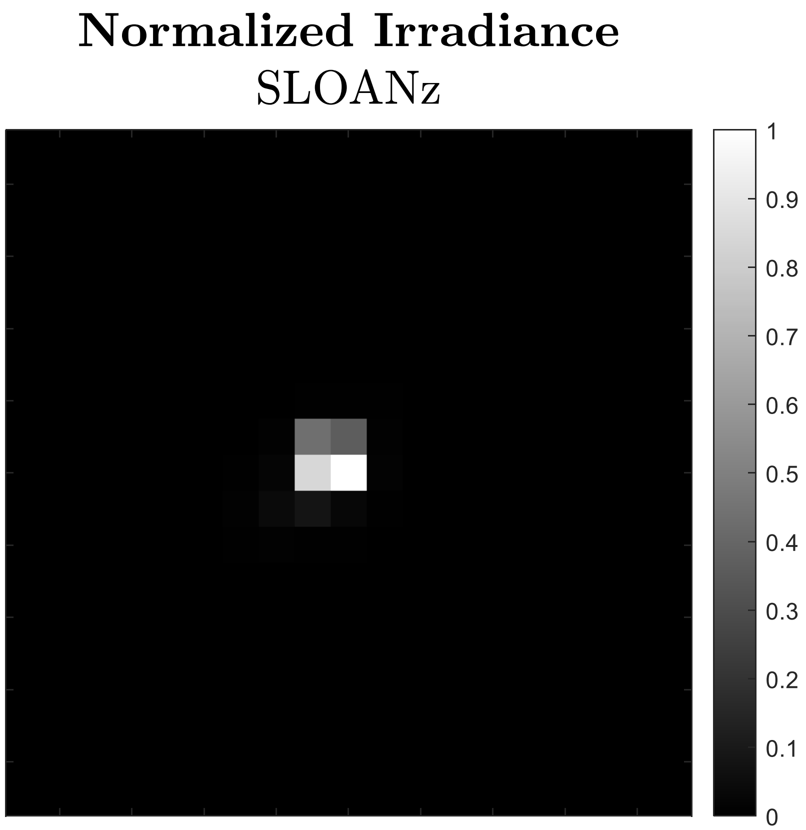


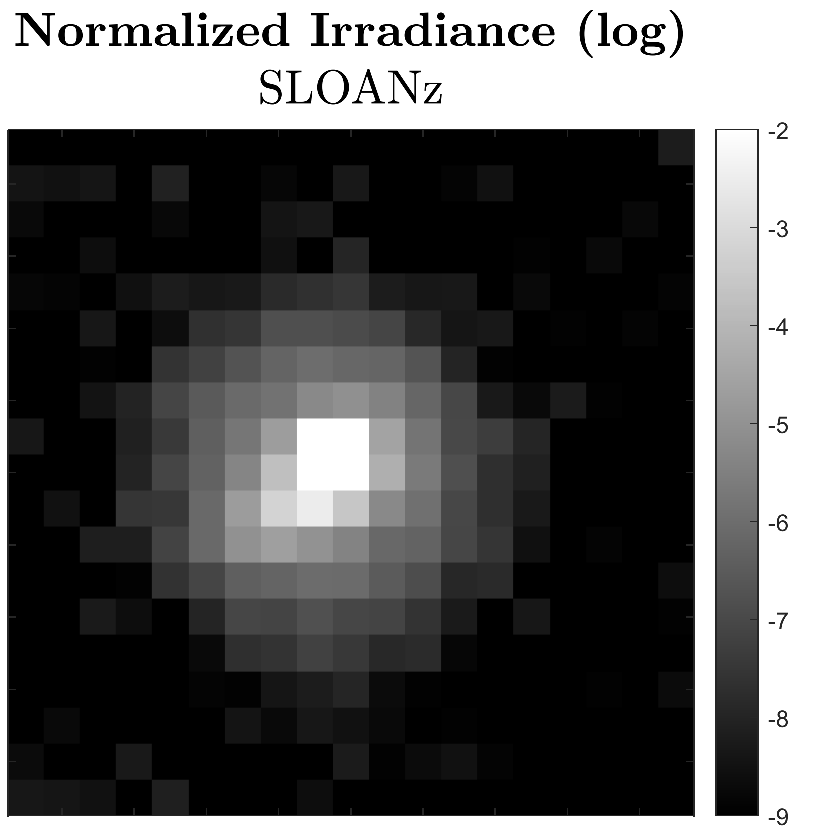


Required FWHM @ DMD: **14.0 µm**
Achieved FWHM @ DMD: **8.05 µm**

Required FWHM @ CCD: **0.30 arc-sec**
Achieved FWHM @ CCD: **0.28 arc-sec**

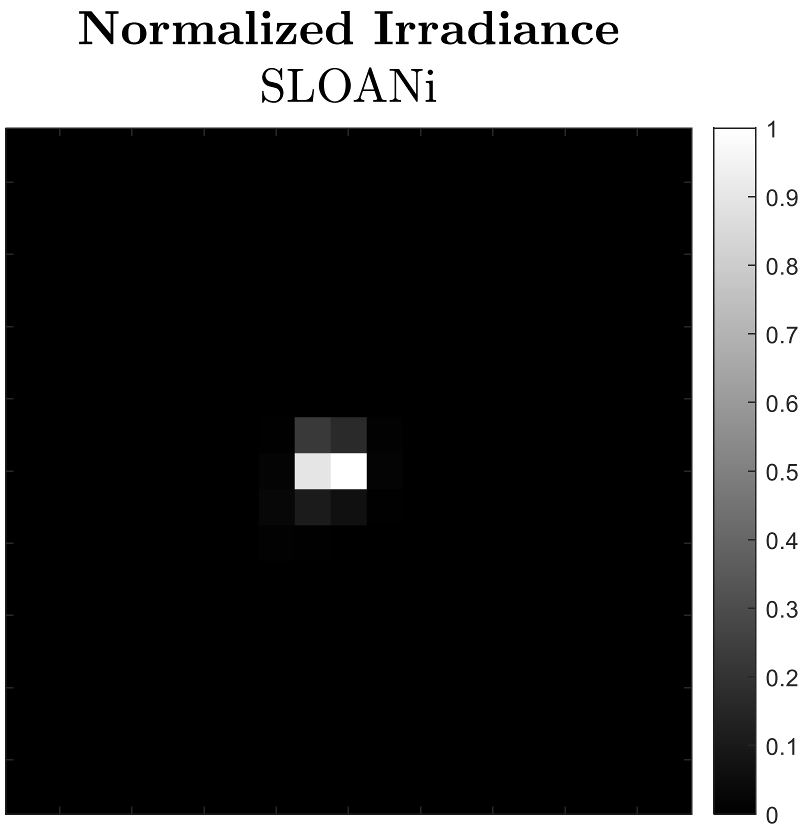
Optical Performance: Scattered Light z-Band

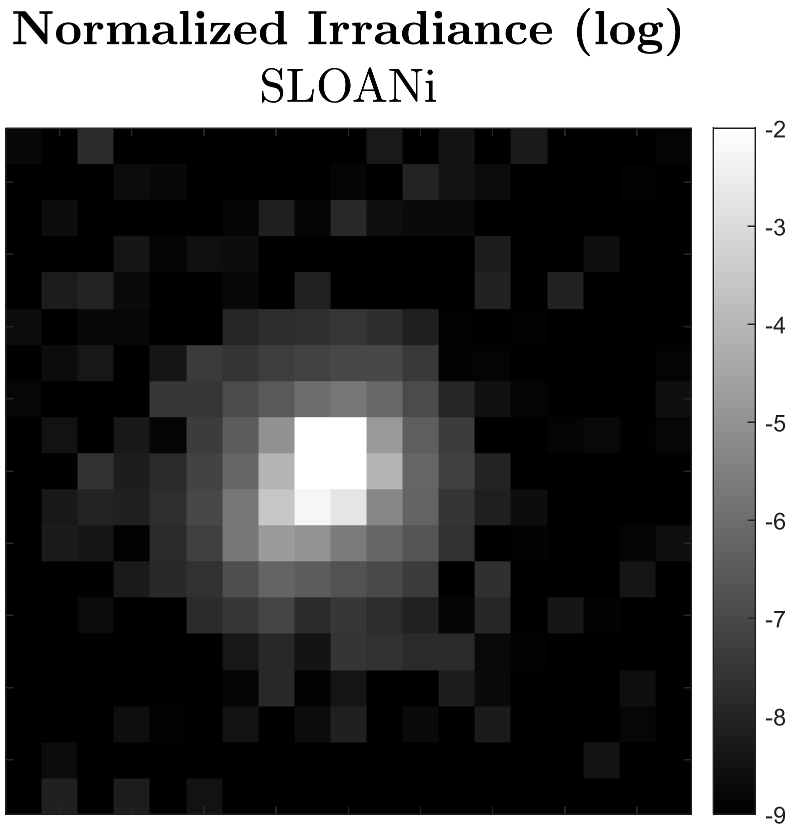




Total scattered power: 1.45%

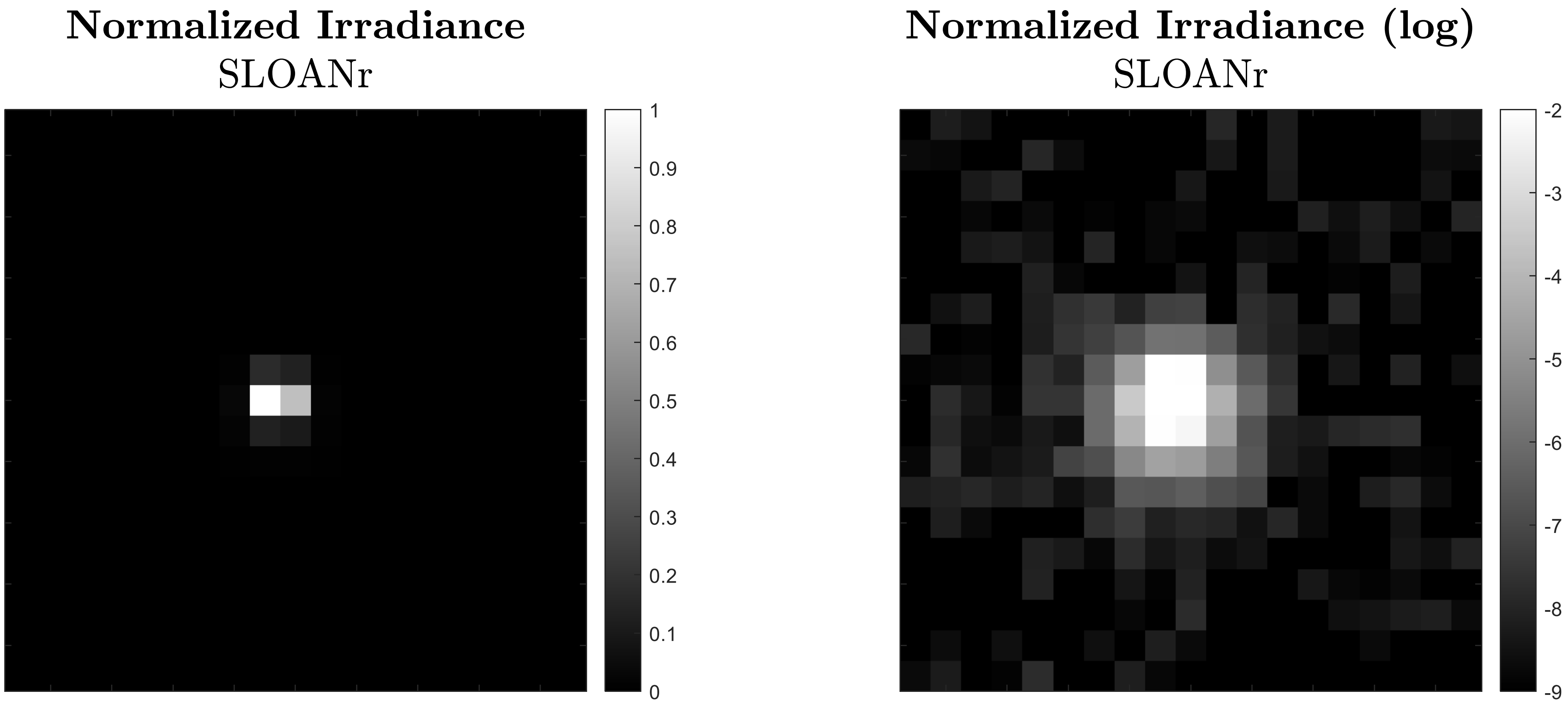
Optical Performance: Scattered Light i-Band





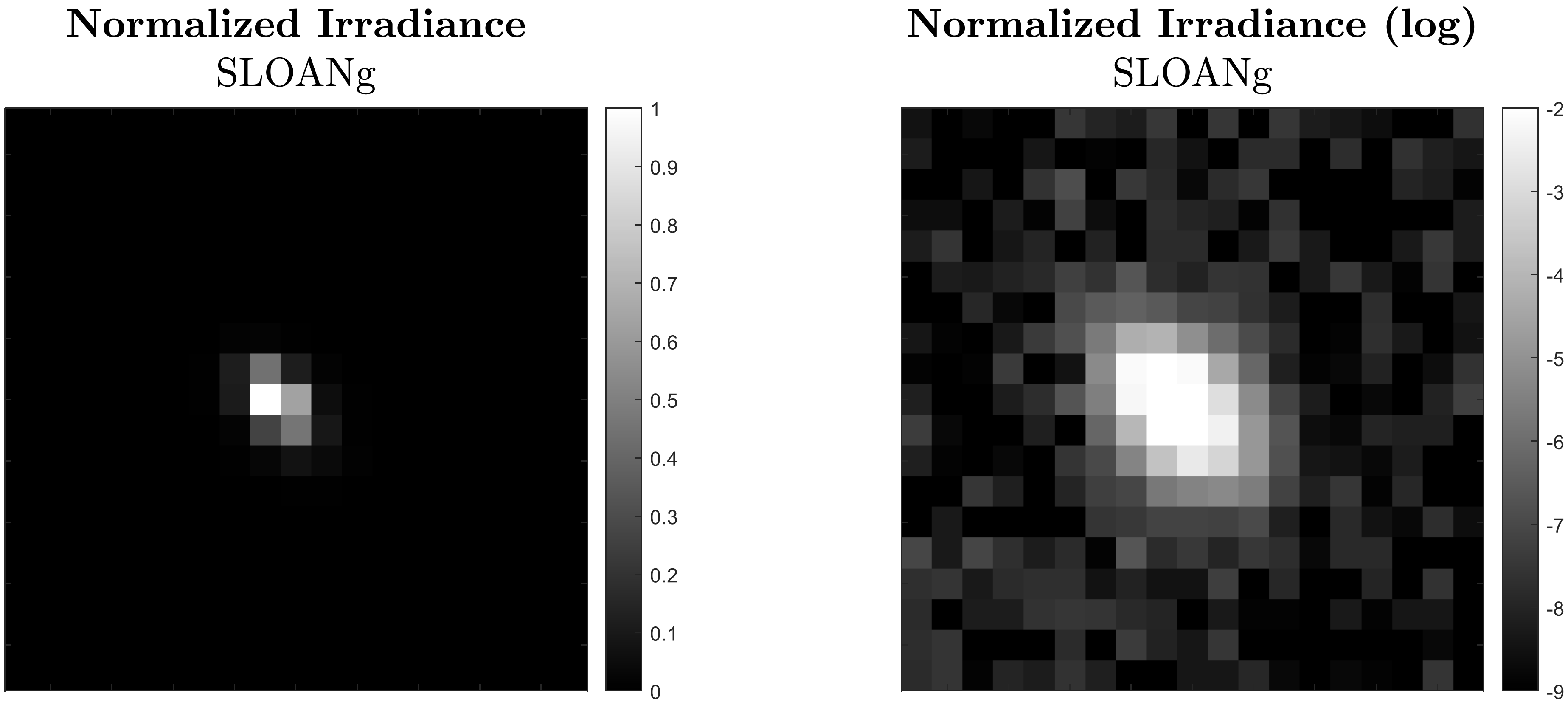
Total scattered power: 1.45%

Optical Performance: Scattered Light r-Band



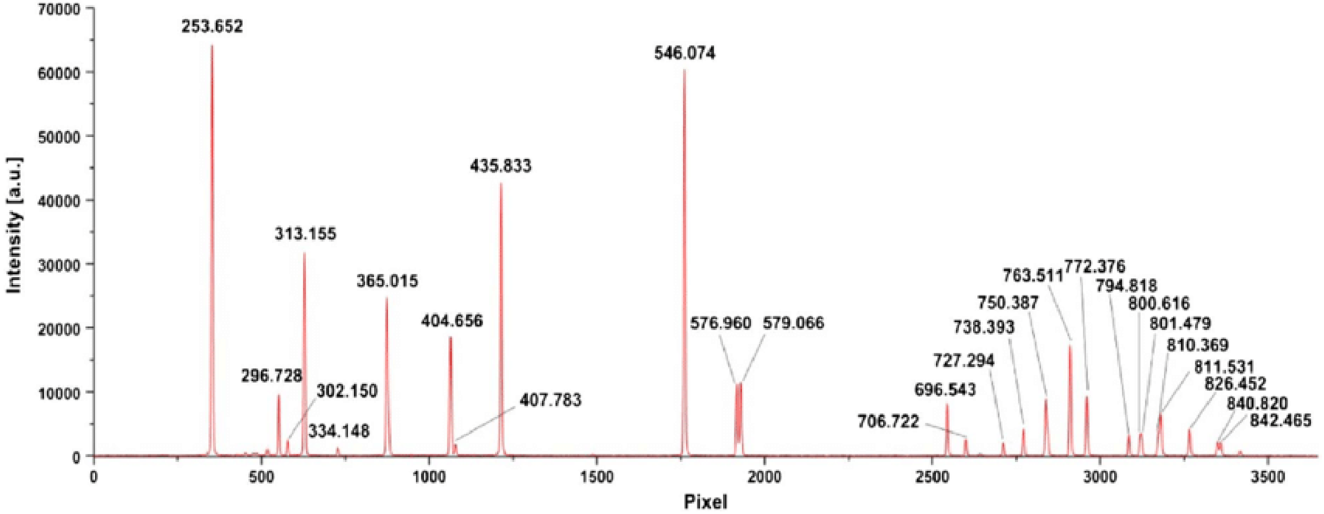
Total scattered power: 1.25%

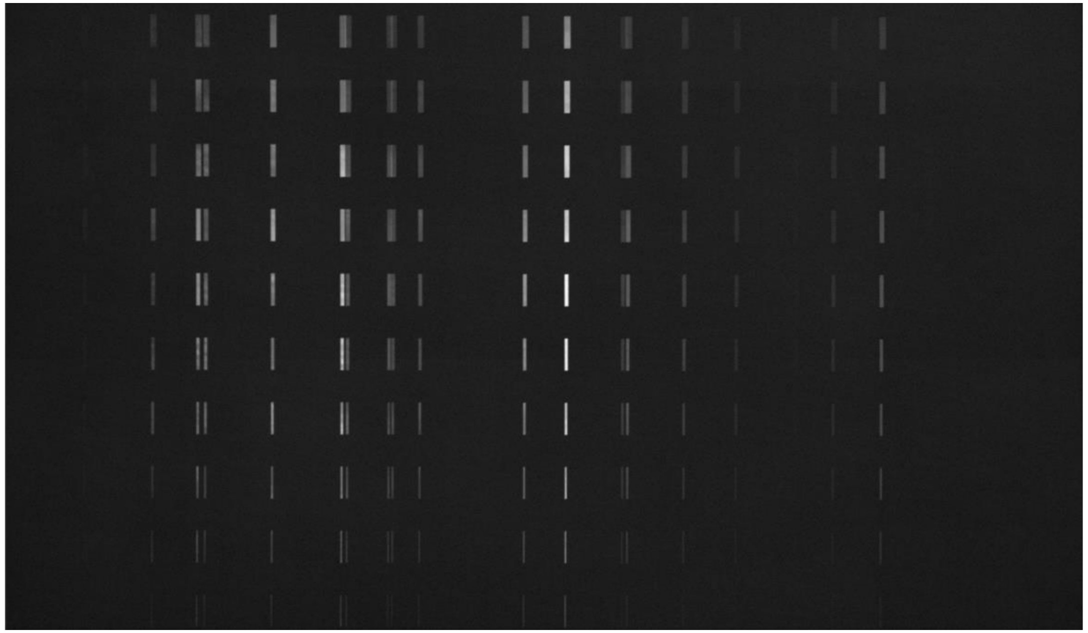
Optical Performance: Scattered Light g-Band



Total scattered power: 0.97%

Optical Performance: Mercury-Argon Calibration Source





10 micromirror slit

9 micromirror slit

.

.

.

.

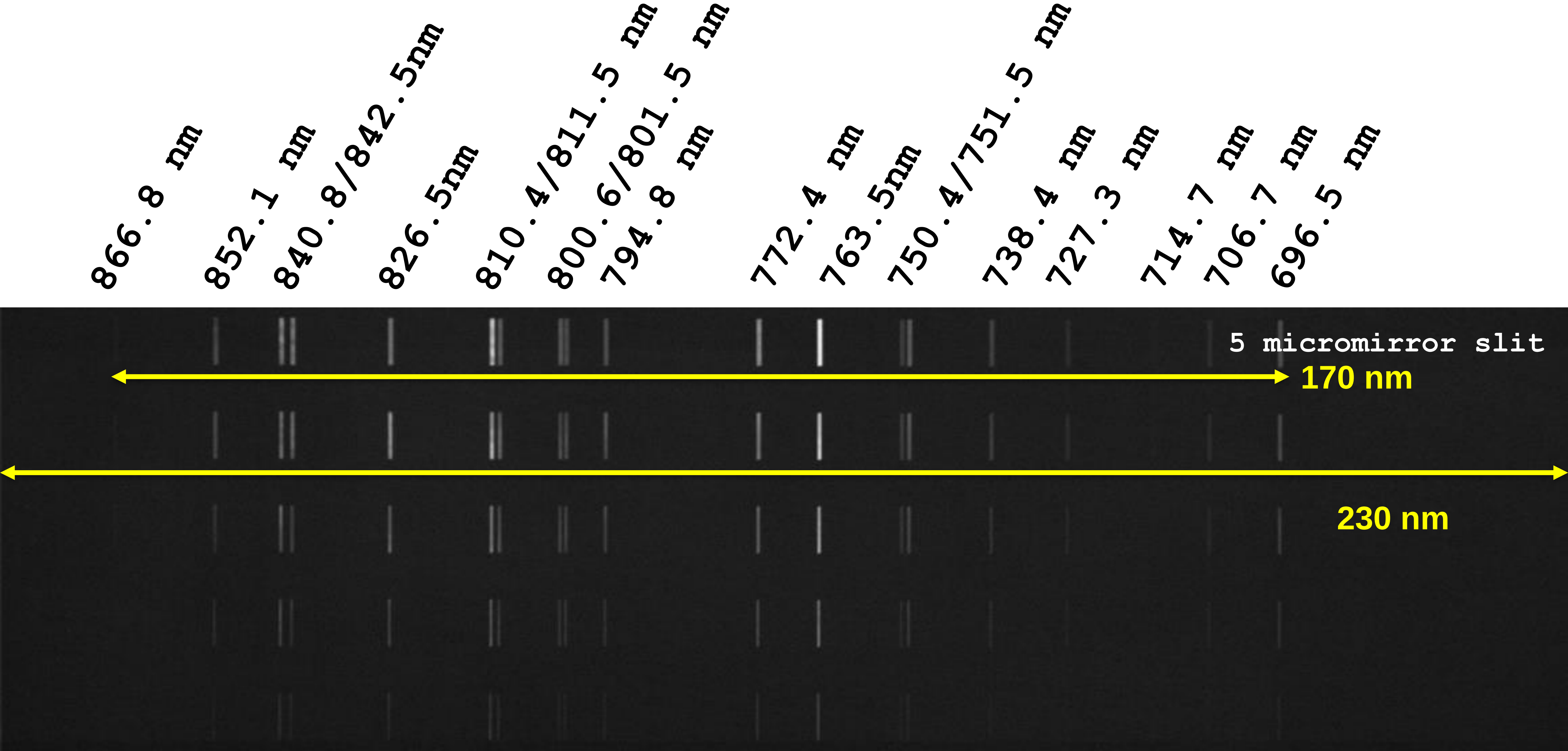
.

.

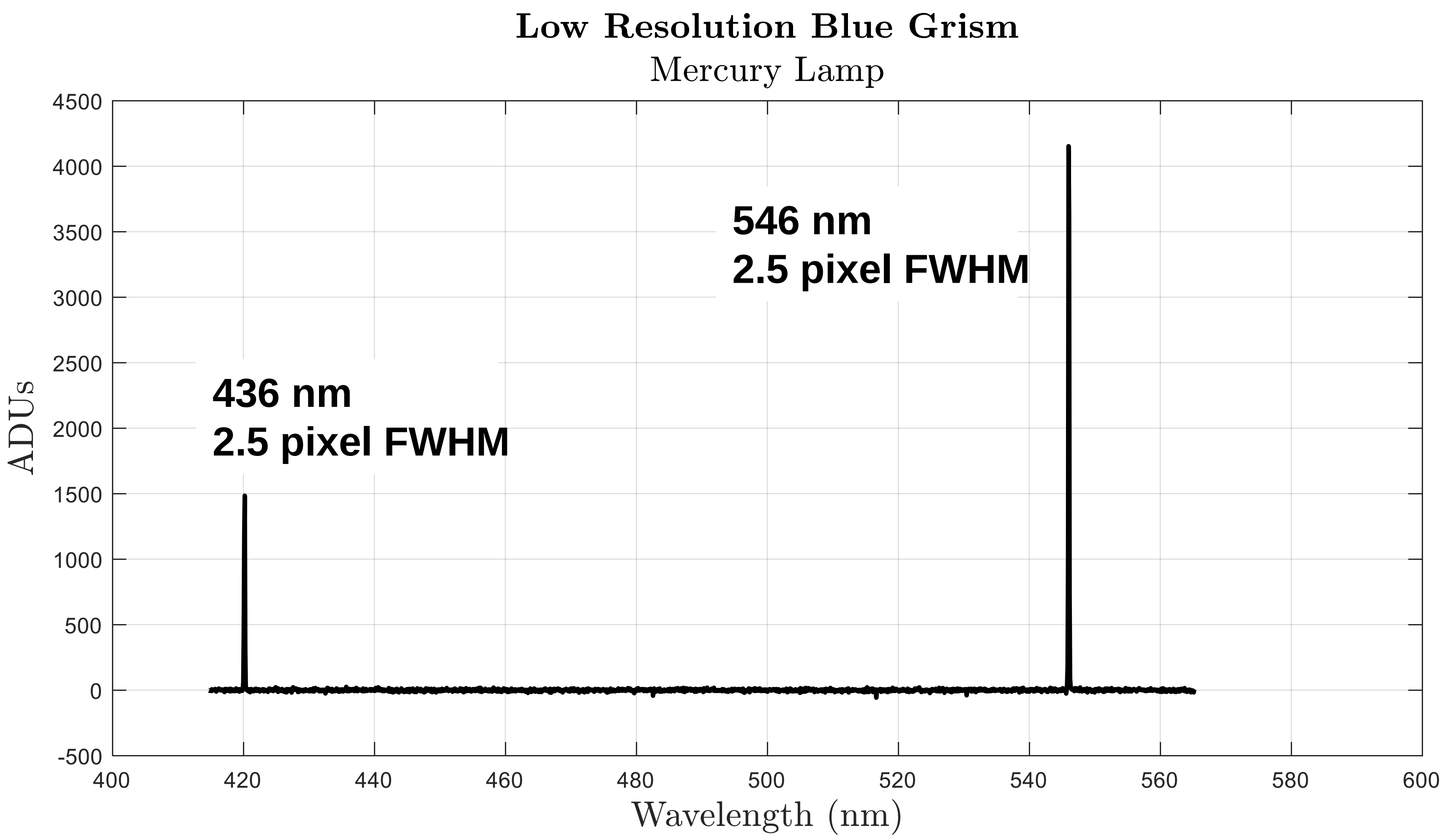
.

1 micromirror slit

Optical Performance: Line Source Resolution

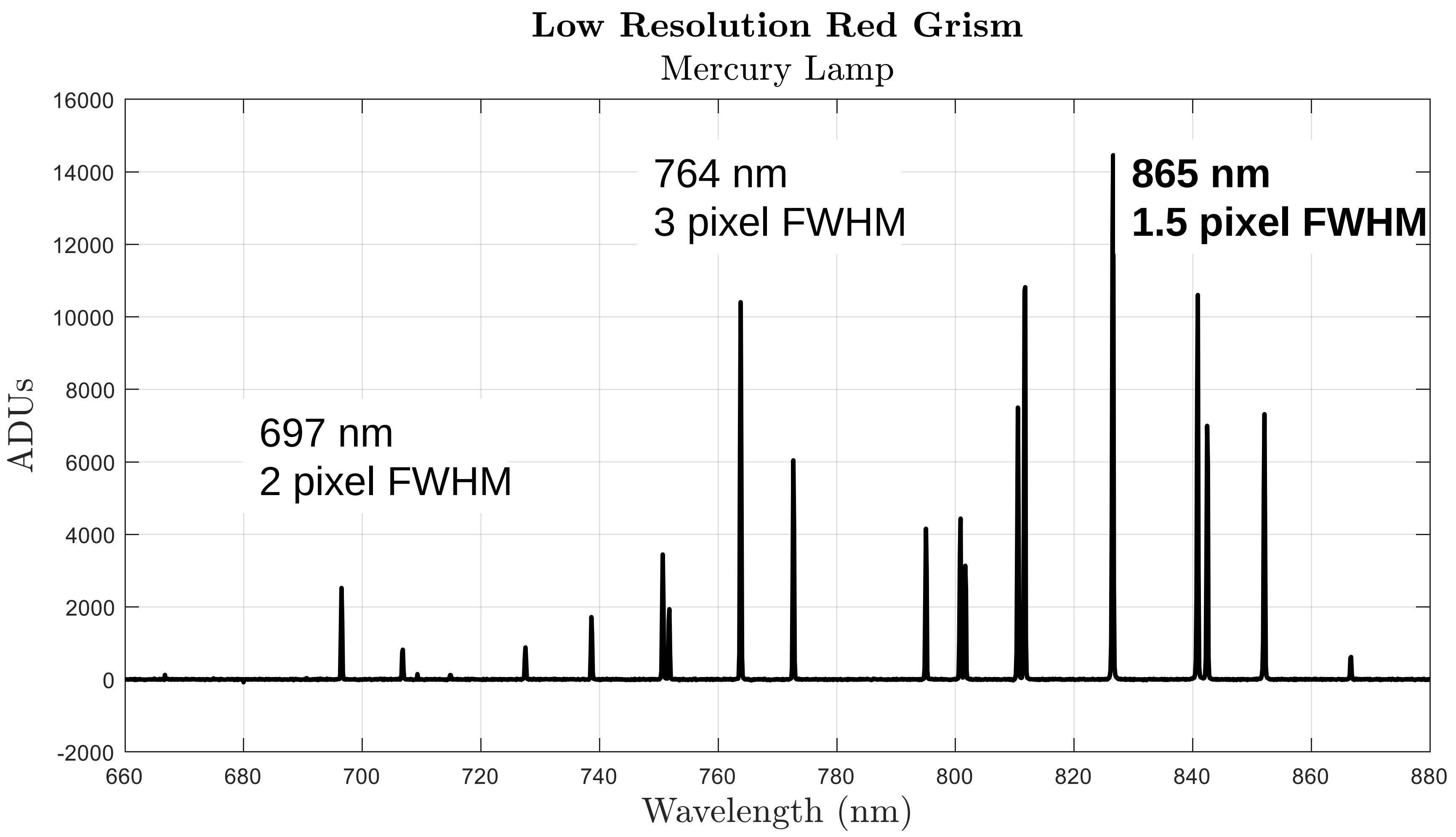


Optical Performance: Blue Grism Resolution

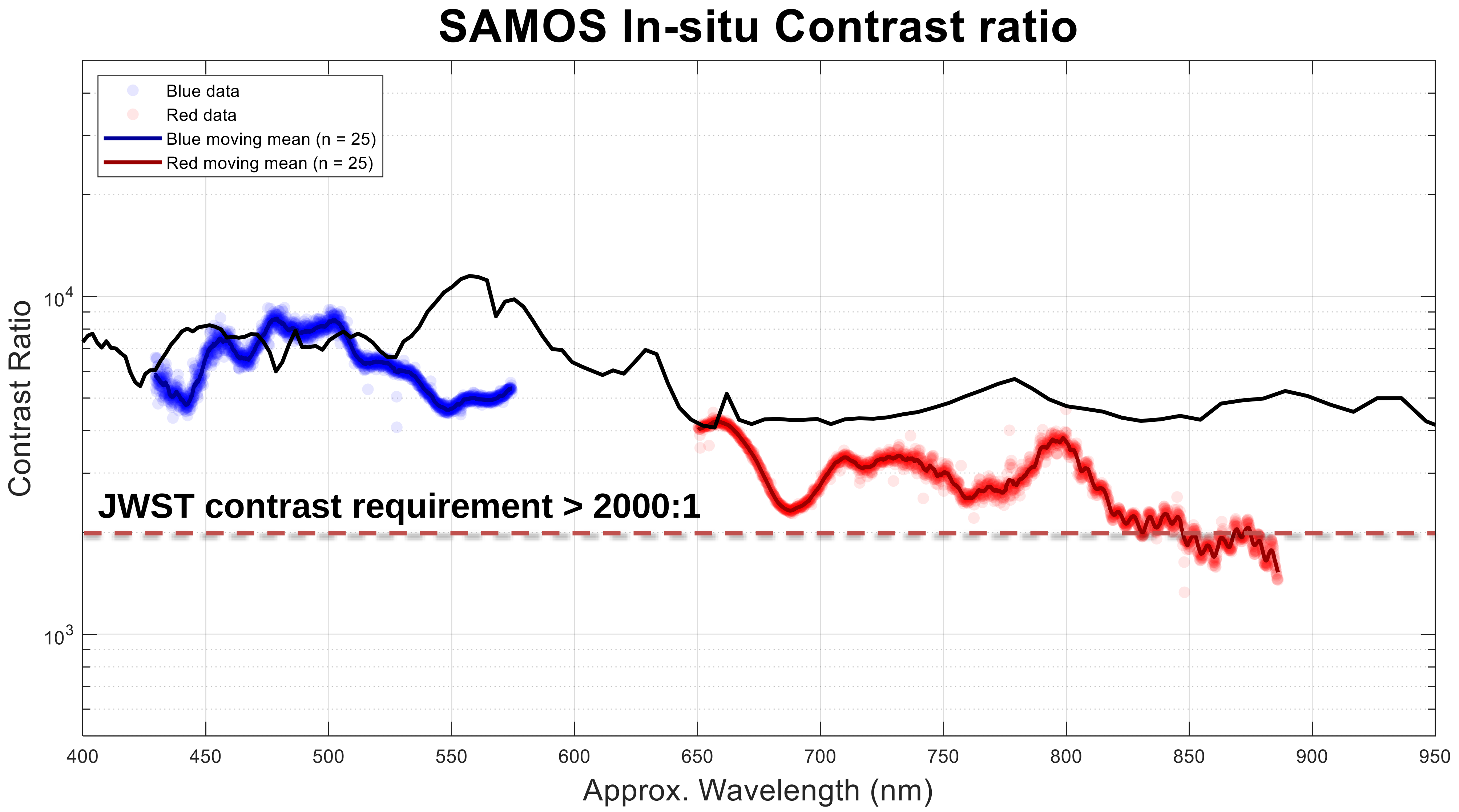


Optical Performance: Red Grism Resolution

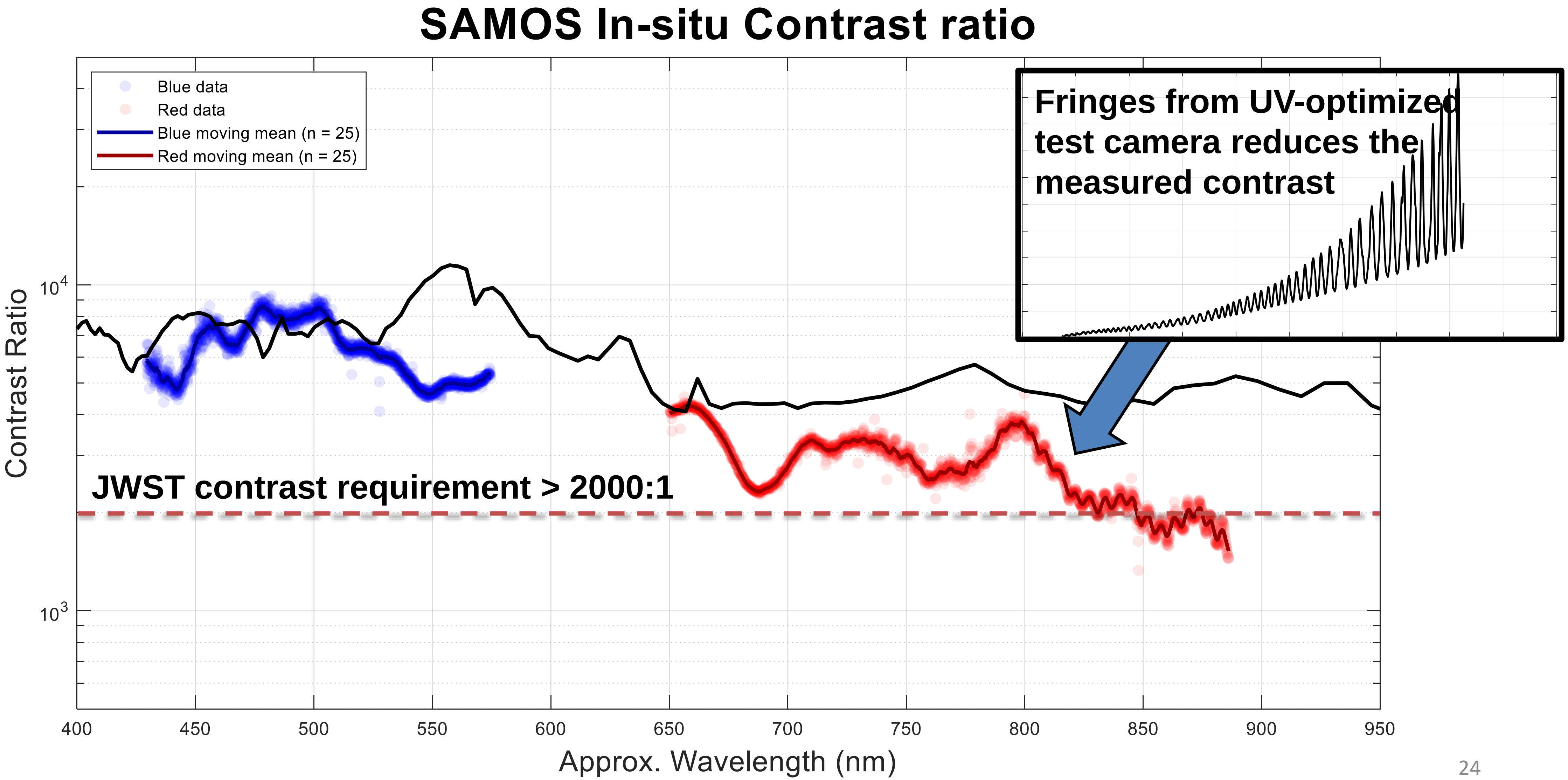
Point source



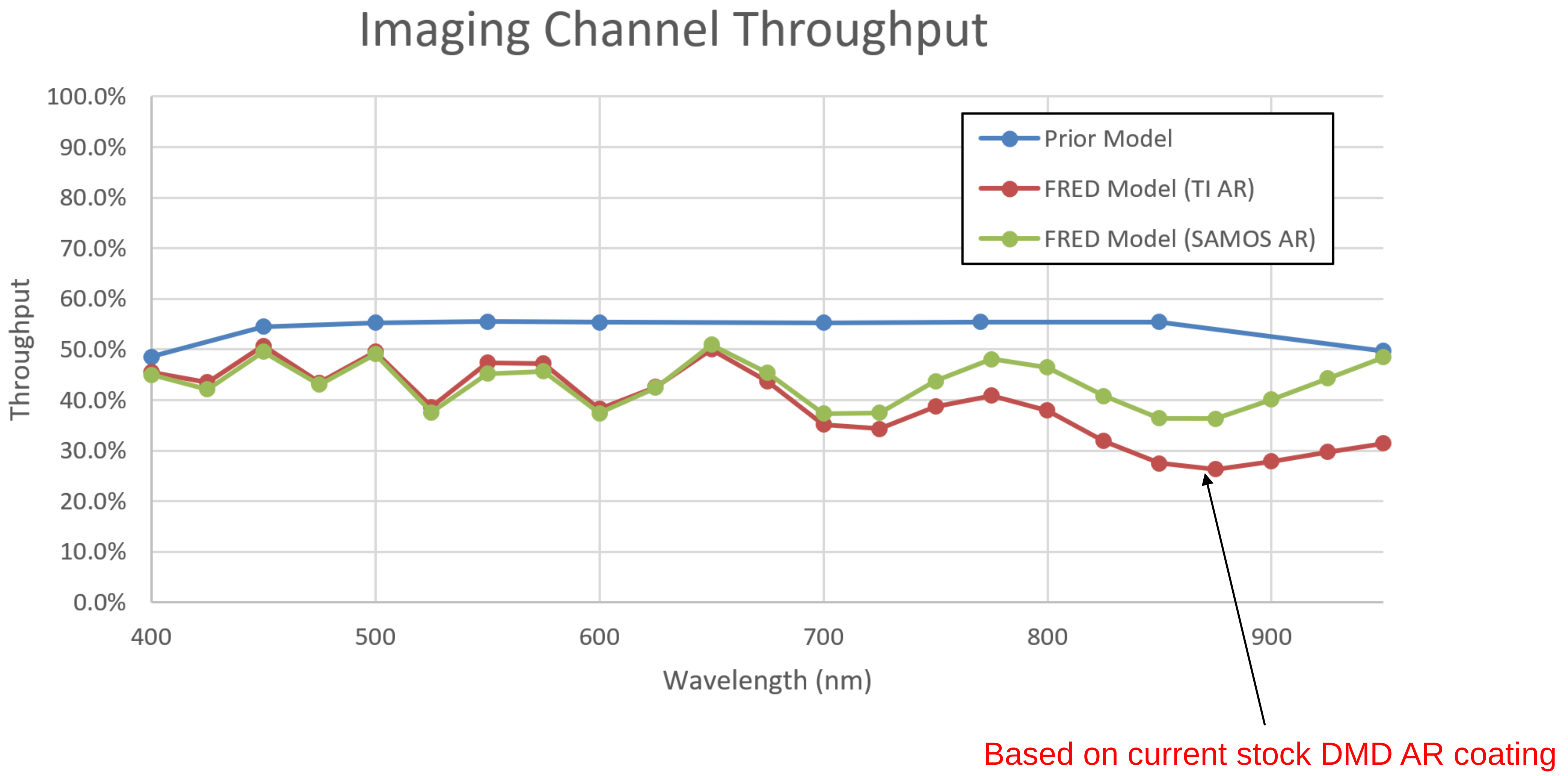
Optical Performance: Contrast Ratio [1 of 2]



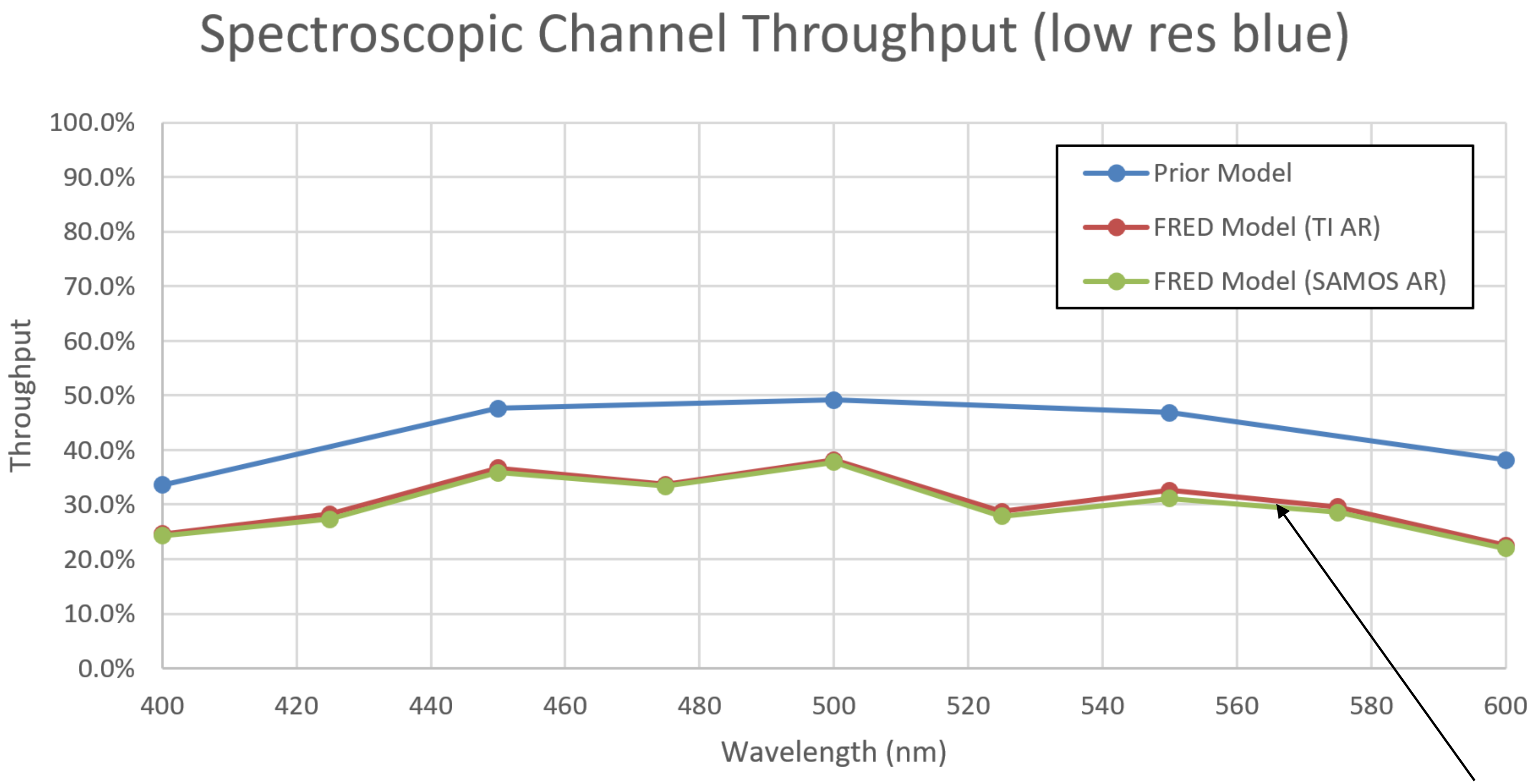
Optical Performance: Contrast Ratio



Optical Performance: Predicted Throughput
Imaging Channel

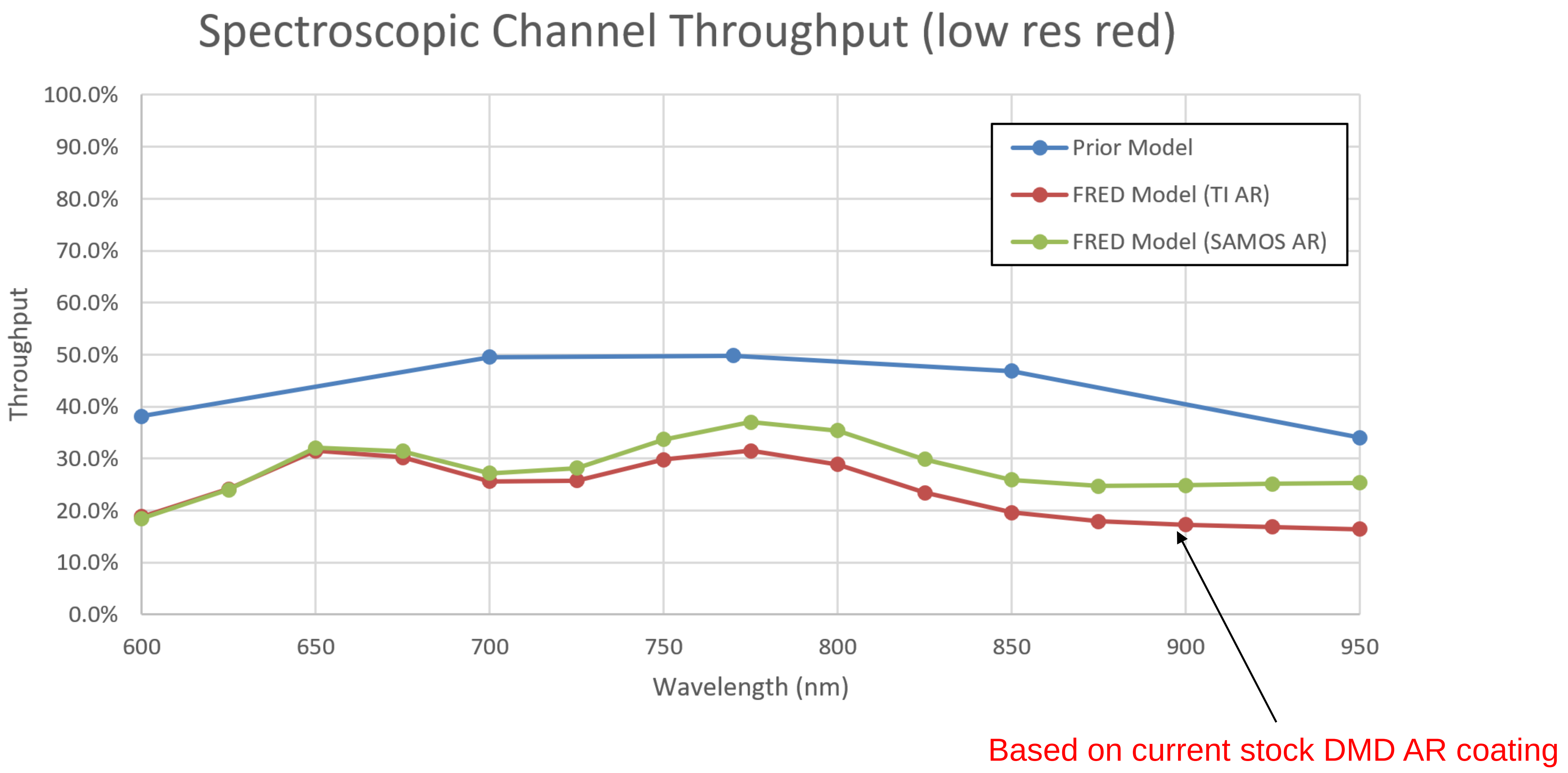


Optical Performance: Predicted Throughput Spectroscopic Channel Low-Res Blue



Based on current stock DMD AR coating

Optical Performance: Predicted Throughput
Spectroscopic Channel Low-Res Red

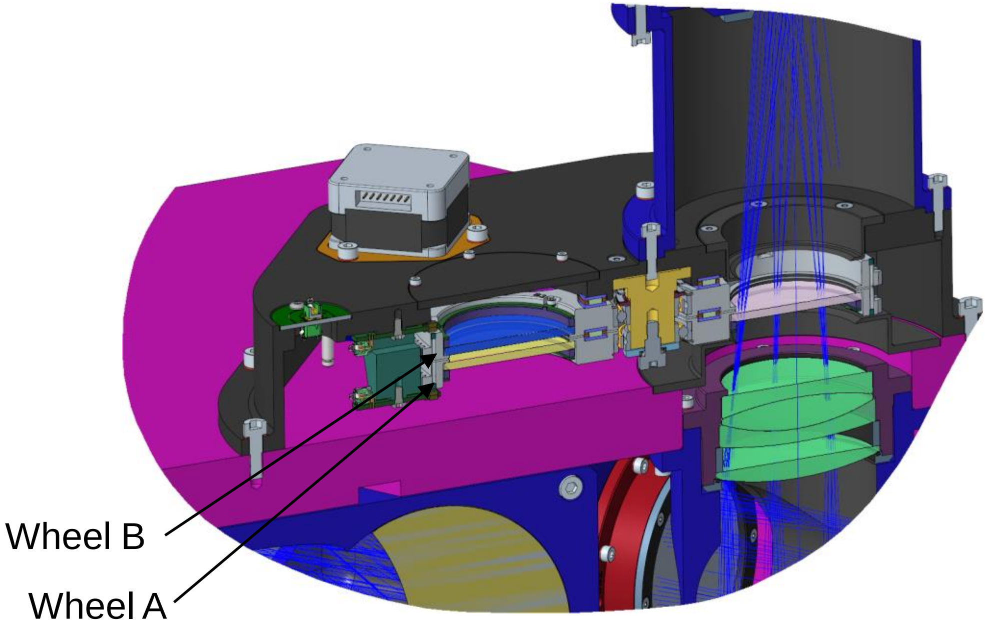


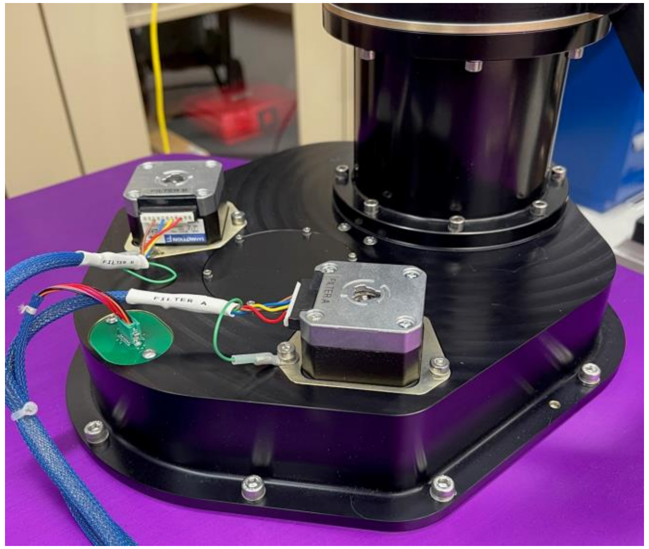
Mechanical Performance

- Filter wheel operation
- Grism exchanger
- Flexure

Filter Wheel

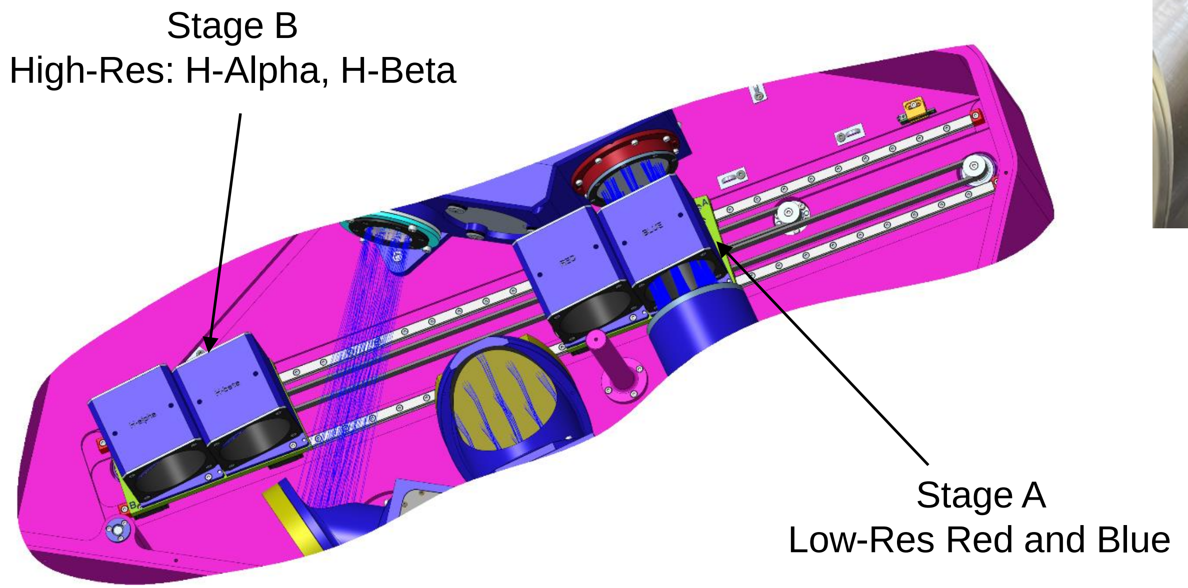
- Dual wheel design
- Six filter holders per wheel
- Design heritage: WHIRC, RSS
- SAMOS wheels both have been actuated dozens of times during I&T and are robust





Grism Exchanger

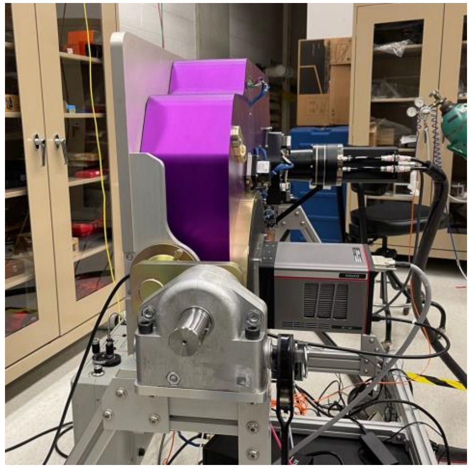
- Dual stage, independently driven, belt-drive design
- Two grisms per stage: low-res stage and high-res stage
- Mechanism shown to be very reliable based on dozens of actuations
- Limits and interlocks have passed functional testing



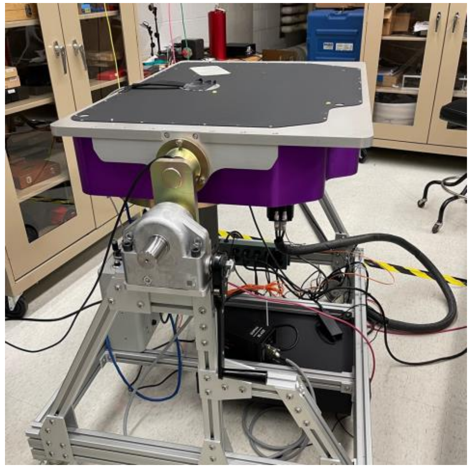
Flexure Measurement

	Spectral (Low-Res Red Grism)		Imaging	
Angle (Deg)	X (Pixel)	Y (Pixel)	X (Pixel)	Y (Pixel)
0	1688	958	526	517
90	1689	957	526	517
180	1689	957	526	517
270	1689	957	526	517

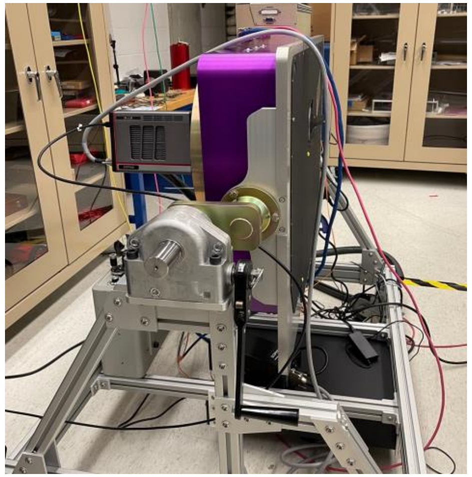
0 deg



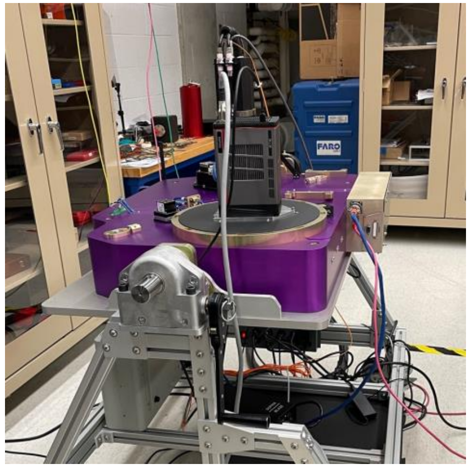
90 deg



180 deg



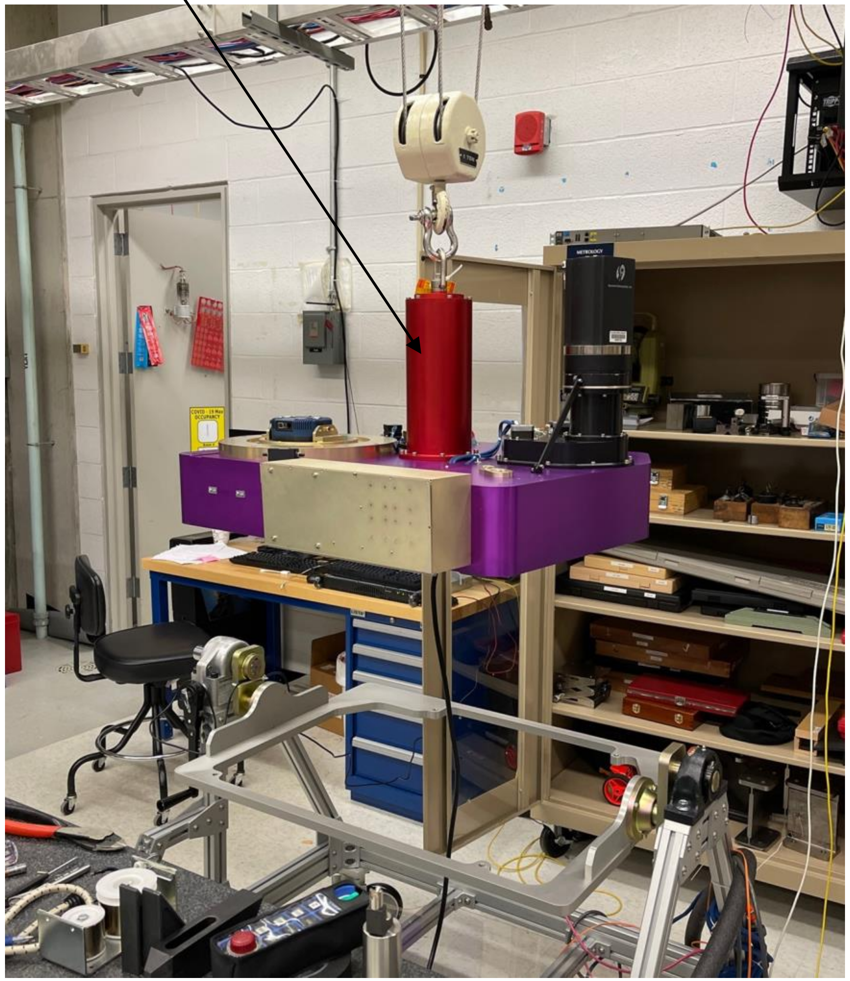
270 deg



Instrument Handling

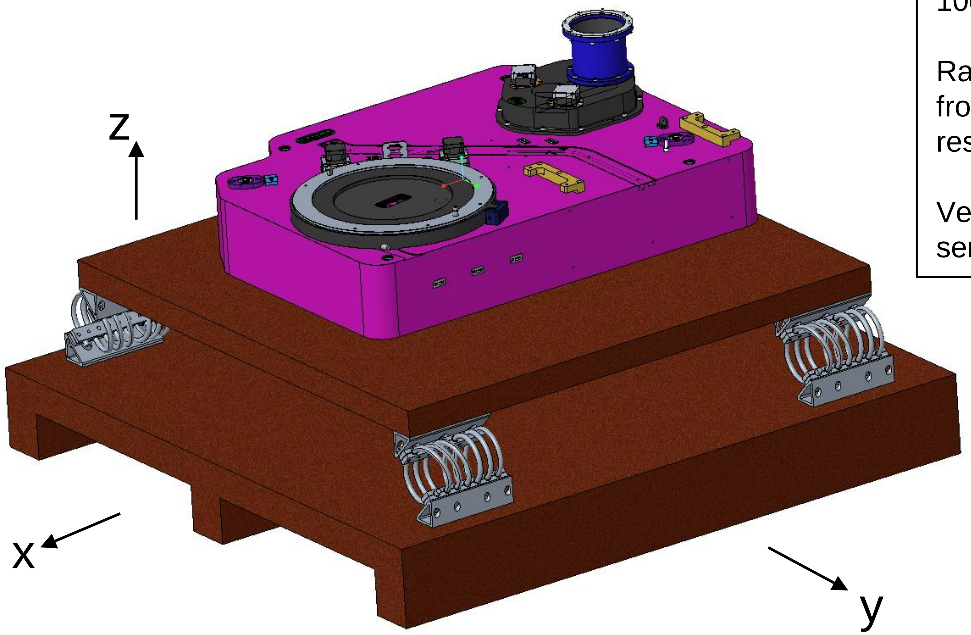
- Dedicated lift fixture mounts to SAMOS optical bench at the instrument in-plane center of gravity
- Hoist ring for crane interface
- Balance is adjustable, within limits, to level the instrument when lifted
- Instrument is level with SAMI and SAMI electronics removed

SAMOS lift fixture



Instrument Shipping Strategy [1 of 2]

- Packaging design and packing performed by Craters & Freighters and IDG
- Instrument and instrument cart to be shipped in separate crates
  - Each crate will have a base that allows for pallet jack and forklift use
  - Instrument will be vapor bagged and boxed in foam
  - Instrument box to be mounted on a shock and vibration isolated platform
  - Imaging camera to be removed from the instrument, boxed, and affixed to the same isolation as the instrument.



Isolation Performance Prediction by Socitec:

10cm Drop Shock → 3.0, 5.5, 2.2, g's in xyz respectively

Random Vibe Response from common carrier PSD (sourced from MIL STD 810H) → 0.7, 0.9, 1.1 grms in xyz respectively.

Vertical (z) natural frequency of 6.5Hz fits with Socitec sensitive equipment target of 5-7Hz.

Socitec FH40-4405 Isolators
(Worksheet in back-up slides.)

Instrument Shipping Strategy [2 of 2]

- Shock recorder to be mounted on isolated instrument platform
  - https://microdaq.com/catalog/product/view/id/3886/s/msr175-shock-temperature-data-logger/category/505/
- Shock indicators (G-load TBD) and tilt indicators to be mounted on case
- Current plan is to have two crates
  - Instrument Crate: 1422mm x 1270mm x 1397mm and 213kg (TBF)
    - Includes SAMOS instrument and separately packed imaging channel camera
  - Crate 2: 1118mm x 1067mm x 1041mm and 104kg (TBF)
    - Includes cart, SAMOS electronics chassis, light sources, cables, tools, and miscellaneous items
- Photos to be taken of crate internals and exterior prior to leaving JHU

Shipment Plan

- Ship end of September
  - Baltimore to Santiago by air (two quotes pending: C&F and PWS)
  - Santiago to SOAR by truck (AURA to arrange)

- **INSURANCE:** Anticipate $2.5M of coverage provided by JHU underwriter. Need to confirm that the insurance goes all the way to the summit rather than only to hand-off in Santiago.

Post Shipment Checks [1 of 2]
To be performed by SOAR/AURA personnel

- Pickup in Santiago
  - Visually inspect crate exterior for damage
  - Compare to photos of crates at JHU pre-departure
  - Check shock indicators
  - Take photos of exterior (all sides) and shock indicators
  - Take closeup photos of any fresh damage
  - Log any discrepancies with the driver and notify JHU through appropriate channels
  - Send all photos to JHU through appropriate channels
- Pickup in La Serena
  - Visually inspect crate exterior for damage
  - Compare to photos of crates at Santiago
  - Check shock indicators
  - Take photos of exterior (all sides) and shock indicators
  - Take closeup photos of any fresh damage
  - Log any discrepancies with the driver and notify JHU through appropriate channels
  - Send all photos to JHU through appropriate channels

Post Shipment Checks [2 of 2]
To be performed by SOAR/AURA personnel

- Arrival at SOAR
  - Visually inspect crate exterior for damage
  - Compare to photos of crates at JHU pre-departure
  - Check shock indicators
  - Take photos of exterior (all sides) and shock indicators
  - Take closeup photos of any fresh damage
  - Log any discrepancies with the driver and notify JHU
  - Send all photos to JHU through appropriate channels
- Post arrival (After driver leaves)
  - Remove lid and inspect internals
  - Compare condition to photos taken at JHU pre-shipment
  - Notify JHU of any discrepancies
  - Replace crate covers
  - Store containers in a safe location
  - Take photos to document condition and forward photos to JHU

Pre-Installation Checkout at SOAR [1 of 2]
December 2023 Baseline

- Unpack crates [1/2 day]
- Reproduce instrument lab configuration [1/2 day]
  - Mount SAMOS on cart (Crane Required: may need crane operator)
  - Connect electrical cables
  - Install pinhole projector
  - Connect light sources
  - Verify spare cable set functionality
- Perform post shipment functional tests [1 day]
- Mount SAMI on SAMOS [1 day]
  - Determine focus shim thickness
  - Shim and thickness dimension forwarded to machine shop for modification
- Mount SAMOS on SAM [1 day]
  - Verify interface
  - Shim feet as needed
  - Return SAMOS to instrument cart

Pre-Installation on SOAR [2 of 2]
December 2023 Baseline

- Install instrument cables [1 day]
  - Nasmyth rack to SAMOS
    - Instrument power cable
    - Instrument communication cable (Ethernet)
    - Imging camera power cable
    - Imaging camera data cable (fiber)
  - Ethernet from computer room to Nasmyth rack (if needed)
  - Install glycol lines
    - SAMOS imaging camera to facility glycol line

Commissioning at SOAR : January – February 2024
1. Installation

- Remove SAMOS from cart and mount on SAM
- Install SAMI dewar
- Install SAMI electronics
- Connect instrument cables
- Connect glycol lines

Commissioning at SOAR
2. Imaging Channel (SISI)

USING DMD IN FULL FIELD MODE:

- Bias, Dark Current and dome flats during the day.
- DMD to SISI CCD maps: uses DMD pinholes with dome flats
- Telescope focus on camera, PSF check. Encircled energy (initially without SAM closed loop).
  - Determine best focus of the telescope
  - Determine image FWHM, Encircled/ensquared flux vs. radius (aperture correction)

    at various field position.
- Standard stars: determine zero-point, flux calibration in all 8+1 filters
  - Use Hamuy spectrophotometric standard, see https://noirlab.edu/science/observing-noirlab/observing-ctio/Spectrophotometric-Standards/Hamuy
- Astrometric field:
  - Zero point of rotator for RADEC orientation.
  - Plate scale, field distortion in all filters.
  - Repeat to check stability of WCS

Commissioning at SOAR
3. Spectroscopic Channel (SAMI)

- Alignment and focus check of SAMI on SAMOS
  - DMD pinholes with quartz lamp should produce horizontal spectra in all gratings
- Bias, Dark Current during the day.
- DMD to SAMI CCD maps: uses DMD pinholes with dome flats
- Flat field datacube during the day.
  - Use quartz lamp, for each grating scan long slits by 100pixel steps. Width to be adjusted depending on lamp brightness and exp.time. Analysis script available but to be checked with SAMI data format (Dana)
- Dispersion data cube
  - Same flat field strategy with arc lamp (CuHeAr for blue gratings; HeArNe for red gratings)
- Throughput for the four gratings, using spectrophotometric standards

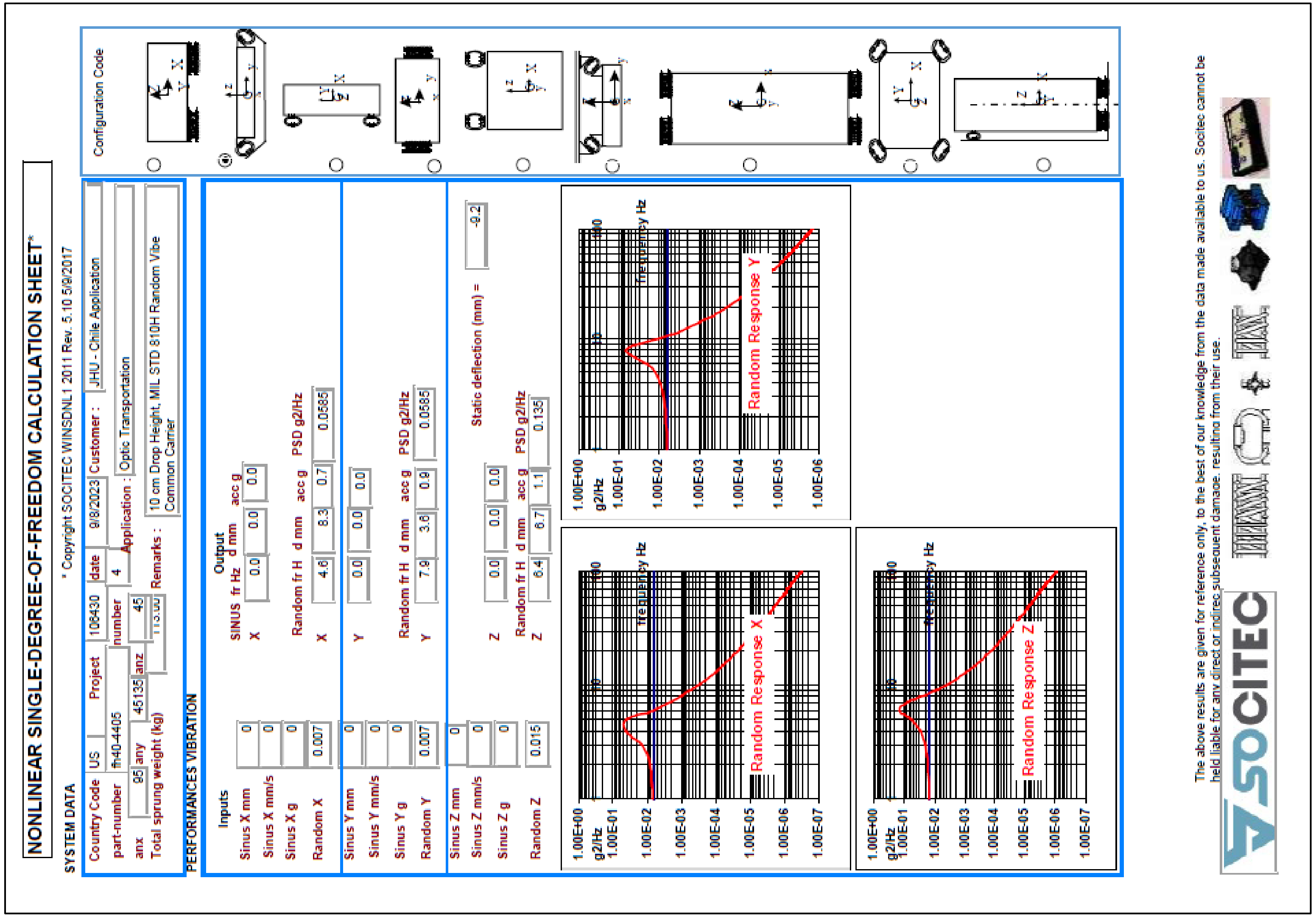
  (Hamuy catalog)

Commissioning at SOAR
4. Science Observations in slit mode

- Spectroscopy of single star (standard)
  - Target close to the center of the field
  - Slit definition
  - Start imaging and spectroscopic acquisition
  - Telescope dither move
  - Adjust slit position, repeat.
- Spectroscopy of cluster (NGC3105 or TBD depending on the epoch)
  - Same procedure as single star using
    - Pre-defined slits
    - Slits determined on-the-flight
- HTS: cycle through a Hadamard datacube on compact target (TBD)

BACK UP

Wire Rope Isolator Spec Worksheet p1/2



NONLINEAR SINGLE-DEGREE-OF-FREEDOM CALCULATION SHEET*

* Copyright SOCITEC WINSDNL1 2011 Rev. 5.10 5/9/2017

SYSTEM DATA

Country Code	US	Project	108430	date	9/8/2023
Customer :	JHU - Chile Application				
part-number	fr40-4405	number	4	Application :	Optic Transportation
anx	95	any	45135	anz	45
Total sprung weight (kg)	113.00	Remarks :	10 cm Drop Height, MIL STD 810H Random Vibe Common Carrier		

PERFORMANCES VIBRATION

Inputs

Sinus X mm	0
Sinus X mm/s	0
Sinus X g	0
Random X	0.007
Sinus Y mm	0
Sinus Y mm/s	0
Sinus Y g	0
Random Y	0.007
Sinus Z mm	0
Sinus Z mm/s	0
Sinus Z g	0
Random Z	0.015

Output

	fr Hz	d mm	acc g	PSD g2/Hz
SINUS X	0.0	0.0	0.0	
Random X	4.6	8.3	0.7	0.0585
SINUS Y	0.0	0.0	0.0	
Random Y	7.9	3.8	0.9	0.0585
SINUS Z	0.0	0.0	0.0	
Random Z	6.4	6.7	1.1	0.135

Static deflection (mm) = -9.2

The above results are given for reference only, to the best of our knowledge from the data made available to us. Socitec cannot be held liable for any direct or indirect subsequent damage resulting from their use.

Wire Rope Isolator Spec Worksheet p2/2