Roman Space Telescope

Jet Propulsion Laboratory
California Institute of Technology

Roman Coronagraph Instrument As-built Optics Update

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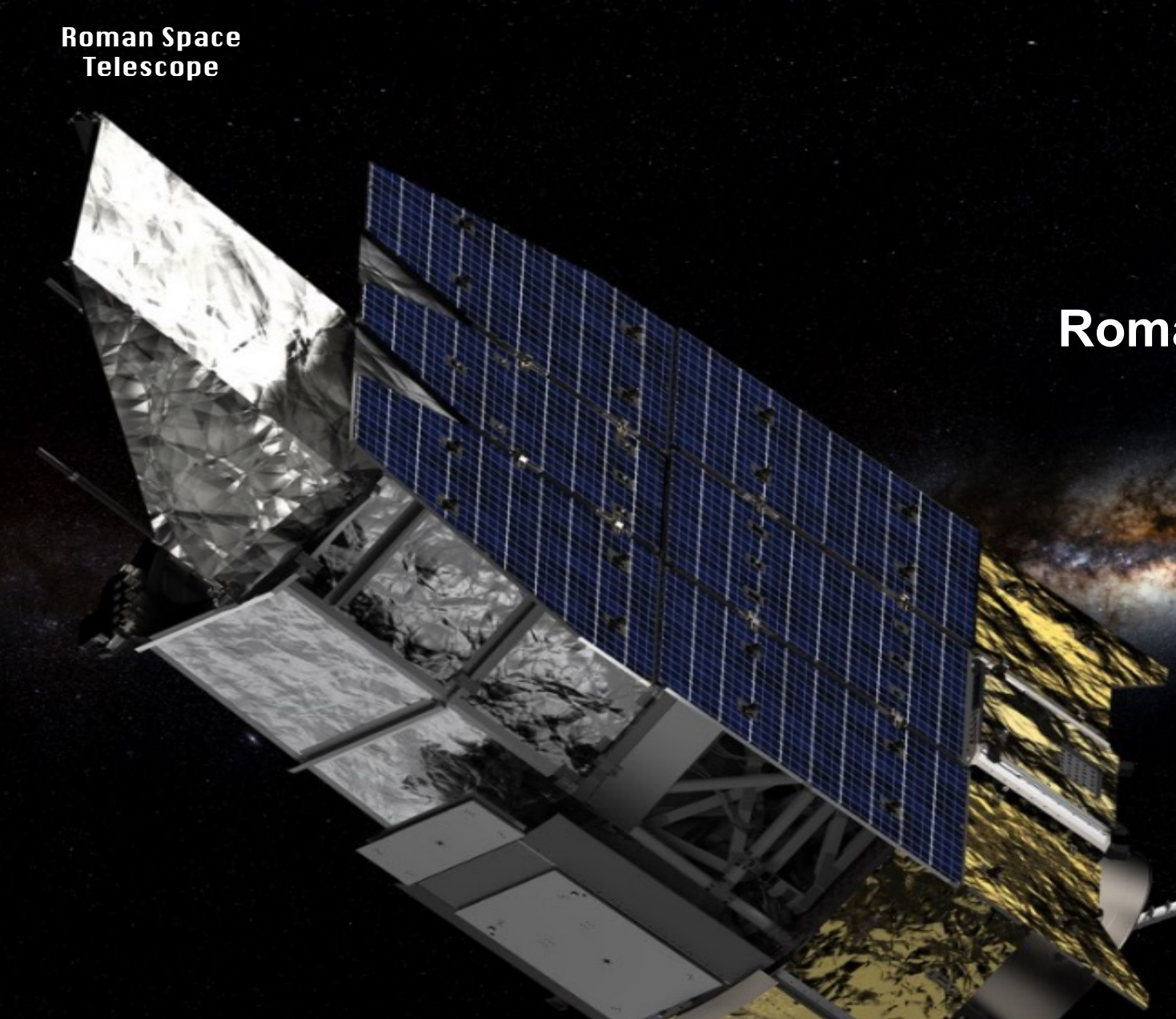

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Summary

- The Roman Coronagraph Instrument has been receiving flight and engineering design unit (EDU) optics from domestic vendors and international partners
- These as-built optics are meeting or exceeding the required specifications.
- The diverse set of optics are in various states of readiness, and none have been mounted in subassemblies.
- The tables presented here are intended to provide a snapshot of the performance metrics of these optics with respect to their required specifications.

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Telescope Optics

- The aggregate surface figure error (SFE) of the as-built Optical Telescope Assembly (OTA) and the Tertiary Collimating Assembly (TCA) that feeds the CGI are provided by L3 Harris and the Roman Payload System.
- Excludes defocus

	As-built SFE (nm rms)	Required SFE* (nm rms)
OTA + TCA Optics Only (not mounted):	12.49	38.2
Margin:	67%	

* Note: value shown is half of the total wavefront error to be delivered to CGI. The margin will decrease as the OTA and TCA are assembled and aligned.

CGI Front-End Optics

- These CGI front-end optics are from the Fast Steering Mirror (FSM) to the Focal Plane Mask (FPM), excluding the deformable mirrors.
- The DMs use actuator stroke to correct the WFE from both the OTA/TCA and the CGI Front-End.

		Surface Irregularity										Reflectivity			
		SFE Z5+ (nm rms)		SFE Z4+ (nm rms)		Transmitted WFE (nm rms)		Microroughness (Ang/rms per mm^2)		Scratch/Dig		Reflectivity, 430-549 nm (%)		Reflectivity, 550-900 nm (%)	
		As-built	Req	As-built	Req	As-built	Req	As-built	Req	As-built	Req	As-built	Req	As-built	Req
CGI Front-End (up to Focal Plane Mask)				**9.43**	**13.70**							**90.89%**	**75.20%**	**88.40%**	**81.67%**
margin:				**31%**								**63%**		**37%**	
FSM						-	-		10		20/10				
FCM (flat) 10492264	SN 005	-	-	2.5	3.3	-	-	3.9	10		20/10	98.80%	96.5%	98.43%	97.5%
	SN 006	-	-	2.2	3.3	-	-	4.3	10		20/10	98.80%	96.5%	98.43%	97.5%
OAP1 (pre-coat)		3.486	5	-	-	-	-		10		20/10	98.98%	96.5%	98.6%	97.5%
OAP2 (pre-coat)		3.698	5	-	-	-	-		10		20/10	98.98%	96.5%	98.6%	97.5%
OAP3 (pre-coat)		4.273	5	-	-	-	-		10		20/10	98.98%	96.5%	98.6%	97.5%
OAP4 (pre-coat)		3.724	5	-	-	-	-		10		20/10	98.98%	96.5%	98.6%	97.5%
OAP5 (pre-coat)		4.249	5	-	-	-	-		10		20/10	98.98%	96.5%	98.6%	97.5%
SFM (post-coat) (10492203)	SN001	-	-	2.812	6.4	-	-		10		20/10	98.98%	96.5%	98.6%	97.5%
	SN002	-	-	4.021	6.4	-	-		10		20/10	98.98%	96.5%	98.6%	97.5%
	SN004	-	-	2.417	6.4	-	-		10		20/10	98.98%	96.5%	98.6%	97.5%
	SN005	-	-	1.9	6.4	-	-		10		20/10	98.98%	96.5%	98.6%	97.5%
Shaped Pupil Fold (flat) 10492357	SN 004	-	-	2.3	3.3	-	-	4.6	10		20/10	97.83%	96.5%	97.74%	97.5%
	SN 008	-	-	2.1	3.3	-	-	4.5	10		20/10	97.83%	96.5%	97.74%	97.5%
Focal Plane Mask substrate															

- FSM and FPM substrates not yet available
- Selected set for the purpose of comparison to requirements are highlighted in dark green
- Light green are as built values for a larger clear aperture

CGI Back-End Optics

- These CGI back-end optics are from the FPM to the EXCAM fold mirror
- The back-end optics affect image quality on the detector

				Surface Irregularity						Reflectivity			
		Focal Length Tolerance from Nominal		SFE Z5+ (nm rms)		SFE Z4+ (nm rms)		Transmitted WFE (nm rms)		Reflectivity, 430-549 nm (%)		Reflectivity, 550-900 nm (%)	
		As-built	Req (+/- mm)	As-built	Req	As-built	Req	As-built	Req	As-built	Req	As-built	Req
CGI Back-End (after Focal Plane Mask)				**19.56**	**36.06**					**96.97%**	**89.86%**	**95.86%**	**92.69%**
margin:				**46%**						**70%**		**43%**	
OAP6 (pre-coat)		0.175	0.5	3.141	5	-	-	-	-	98.98%	96.5%	98.6%	97.5%
OAP7 (pre-coat)		0.178	1	3.957	5	-	-	-	-	98.98%	96.5%	98.6%	97.5%
OAP8 (pre-coat)		0.06	0.25	2.801	5	-	-	-	-	98.98%	96.5%	98.6%	97.5%
Color Filter													
Direct Imaging Lens (as-built EDU lenses)				-	-	-	-	15.6	30	-	-	-	-
DI Lens 1 (as-built EDU lenses)				-	-	-	-	-	-	-	-	-	-
DI Lens 2 (as-built EDU lenses)				-	-	-	-	-	-	-	-	-	-
Camera fold mirror	U002	-	-	-	-	4.2	5	-	-				
	U005	-	-	-	-	2.1	5	-	-				
	U008	-	-	-	-	1.2	5	-	-				

Spectroscopy & Polarization Optics

- Spectroscopy and Polarization Optics include three prisms and a doublet imaging lens each.

Spectroscopy & Polarization		Transmitted WFE (nm rms)	
		As-built	Req
margin:			
Spectroscopy optics (prisms + DI lens) (as-built EDU lenses)		16.5	43
		62%	
Polarization optics (prisms + DI lens) (as-built EDU lenses)		21.7	43
		50%	

Phase Retrieval & Pupil Imaging Lenses

				Surface Irregularity						Transmission					
		Focal Length Tolerance from Nominal		SFE Z5+ (nm rms)		Microroughness (Ang/rms per mm^2)		Scratch/Dig		Transmission, Band 1 546-604 nm		Transmission, Band 3 675-785 nm		Transmission, Band 4 783-866 nm	
		As-built	Req (+/- mm)	As-built	Req	As-built	Req	As-built	Req	As-built	Req	As-built	Req	As-built	Req
Phase Retrieval Lenses		ROC tol (mm)	ROC tol, +/- (mm)	fringes @633	fringes @633										
Phase Retrieval #1, S1 (10492329-1)	SN 4	-0.512	0.667	0.199	0.250	4.447	10	√	20/10	>99.5%	99%	>99.5%	99%	>99.5%	99%
Phase Retrieval #1, S2 (10492329-1)	SN 4	-	-	-	-	7.702	10	√	20/10	>99.5%	99%	>99.5%	99%	>99.5%	99%
Phase Retrieval #1, S1 (10492329-1)	SN 5	-0.100	0.667	0.128	0.250	4.609	10	√	20/10	>99.5%	99%	>99.5%	99%	>99.5%	99%
Phase Retrieval #1, S2 (10492329-1)	SN 5	-	-	-	-	5.543	10	√	20/10	>99.5%	99%	>99.5%	99%	>99.5%	99%
Phase Retrieval #2, S1 (10492329-2)	SN 3	-0.737	0.758	0.104	0.25	5.808	10	√	20/10	>99.5%	99%	>99.5%	99%	>99.5%	99%
Phase Retrieval #2, S2 (10492329-2)	SN 3	-	-	0.041	0.25	4.677	10	√	20/10	>99.5%	99%	>99.5%	99%	>99.5%	99%
Phase Retrieval #2, S1 (10492329-2)	SN 4	-0.286	0.758	0.146	0.25	6.167	10	√	20/10	>99.5%	99%	>99.5%	99%	>99.5%	99%
Phase Retrieval #2, S2 (10492329-2)	SN 4	-	-	0.032	0.25	5.031	10	√	20/10	>99.5%	99%	>99.5%	99%	>99.5%	99%
Phase Retrieval #3, S1 (10492329-2)	SN 3	-0.178	1.266	0.120	0.25	4.760	10	√	20/10	>99.5%	99%	>99.5%	99%	>99.5%	99%
Phase Retrieval #3, S2 (10492329-2)	SN 3	-	-	0.070	0.25	7.459	10	√	20/10	>99.5%	99%	>99.5%	99%	>99.5%	99%
Phase Retrieval #3, S1 (10492329-2)	SN 5	-0.031	1.266	0.159	0.25	4.786	10	√	20/10	>99.5%	99%	>99.5%	99%	>99.5%	99%
Phase Retrieval #3, S2 (10492329-2)	SN 5	-	-	0.068	0.25	4.985	10	√	20/10	>99.5%	99%	>99.5%	99%	>99.5%	99%
Phase Retrieval #4, S1 (10492329-2)	SN 3	-1.698	3.622	0.171	0.25	4.361	10	√	20/10	>99.5%	99%	>99.5%	99%	>99.5%	99%
Phase Retrieval #4, S2 (10492329-2)	SN 3	-	-	0.104	0.25	1.699	10	√	20/10	>99.5%	99%	>99.5%	99%	>99.5%	99%
Phase Retrieval #4, S1 (10492329-2)	SN 4	0.731	3.622	0.241	0.25	4.724	10	√	20/10	>99.5%	99%	>99.5%	99%	>99.5%	99%
Phase Retrieval #4, S2 (10492329-2)	SN 4	-	-	0.112	0.25	4.702	10	√	20/10	>99.5%	99%	>99.5%	99%	>99.5%	99%
Pupil Imaging Lenses		ROC tol (mm)	ROC tol, +/- (mm)	fringes @633	fringes @633										
Pupil Imaging Lens, L1, S1 (10492328-	SN 4	0.007	0.038	0.141	0.25	5.18	10	√	20/10	>99.5%	99%	>99.5%	99%	>99.5%	99%
Pupil Imaging Lens, L1, S2 (10492328-	SN 4	-0.549	1.455	0.207	0.25	6.205	10	√	20/10	>99.5%	99%	>99.5%	99%	>99.5%	99%
Pupil Imaging Lens, L1, S1 (10492328-	SN 5	0.013	0.038	0.247	0.25	5.591	10	√	20/10	>99.5%	99%	>99.5%	99%	>99.5%	99%
Pupil Imaging Lens, L1, S2 (10492328-	SN 5	-0.596	1.455	0.118	0.25	6.078	10	√	20/10	>99.5%	99%	>99.5%	99%	>99.5%	99%
Pupil Imaging Lens, L2, S3 (10492328-	SN 4	-	-	0.08	0.25	6.074	10	√	20/10	>99.5%	99%	>99.5%	99%	>99.5%	99%
Pupil Imaging Lens, L2, S4 (10492328-	SN 4	0.097	0.098	0.154	0.25	5.238	10	√	20/10	>99.5%	99%	>99.5%	99%	>99.5%	99%
Pupil Imaging Lens, L2, S3 (10492328-	SN 5	-	-	0.137	0.25	6.119	10	√	20/10	>99.5%	99%	>99.5%	99%	>99.5%	99%
Pupil Imaging Lens, L2, S4 (10492328-	SN 5	0.082	0.098	0.233	0.25	6.394	10	√	20/10	>99.5%	99%	>99.5%	99%	>99.5%	99%

- Transmission data hasn't yet been parsed into individual bands.
- Likely choice for flight highlighted