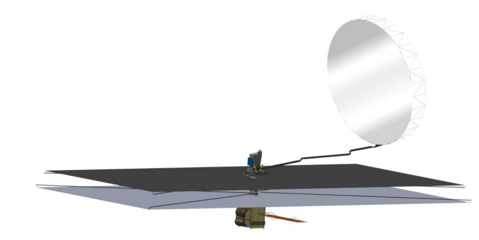
SALTUS Space Observatory Architecture

Leon K. Harding[1,], Jonathan W. Arenberg[1,**], Benjamin Donovan[1], Dave Oberg[1], Ryan Goold[1], Bob Chang[1], Christopher Walker[2], Dana Turse[3], Jim Moore[4], Jim C. Pearson Jr[4], John N. Kidd Jr[5], Zach Lung[6], Dave Lung[6]*

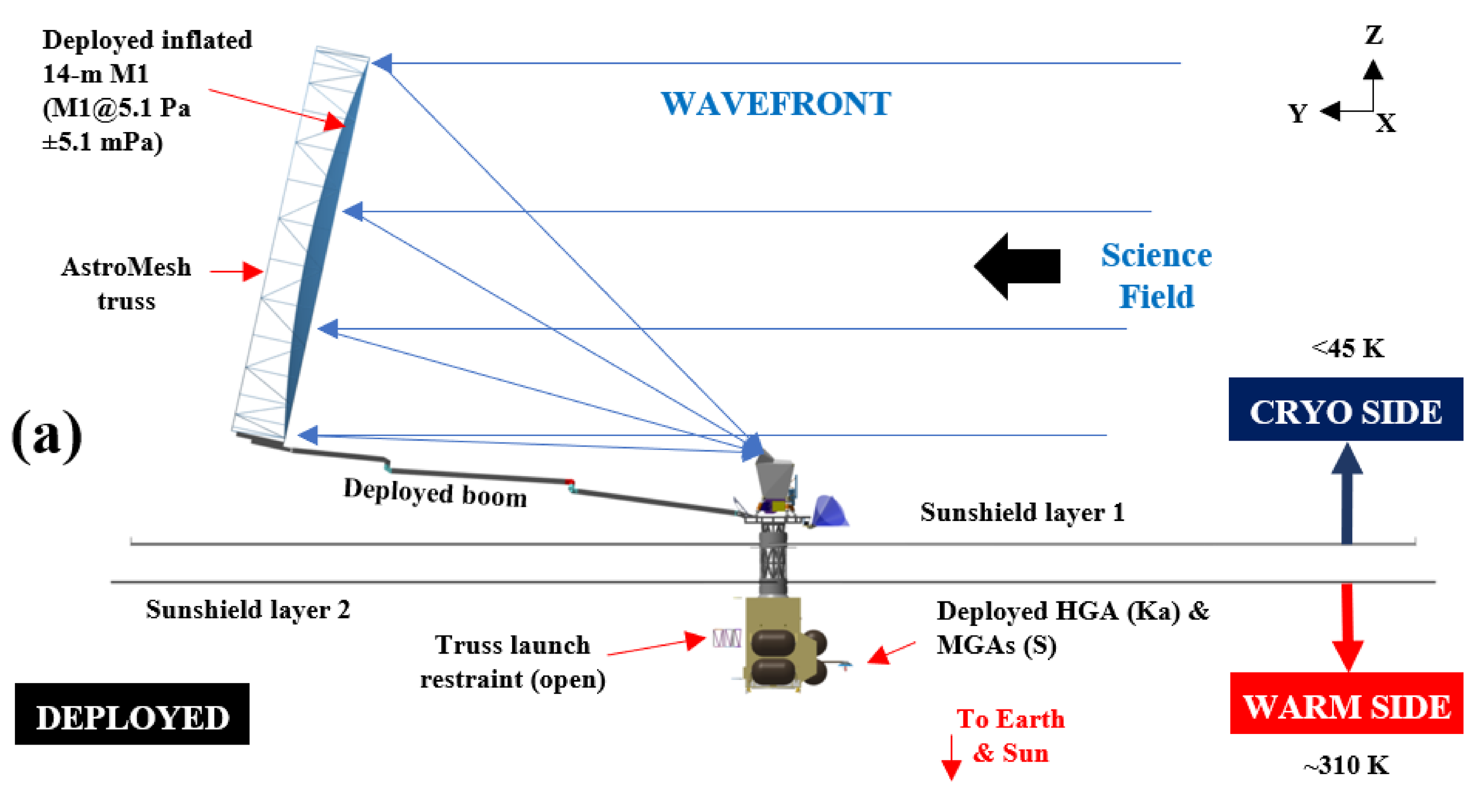
[1]Northrop Grumman Corporation, USA; [2]University of Arizona, USA; [3]Redwire Space Solutions LLC, USA; [4]NeXolve, USA; [5]Ascending Node Technologies LLC, USA; [6]DA2 Ventures, USA

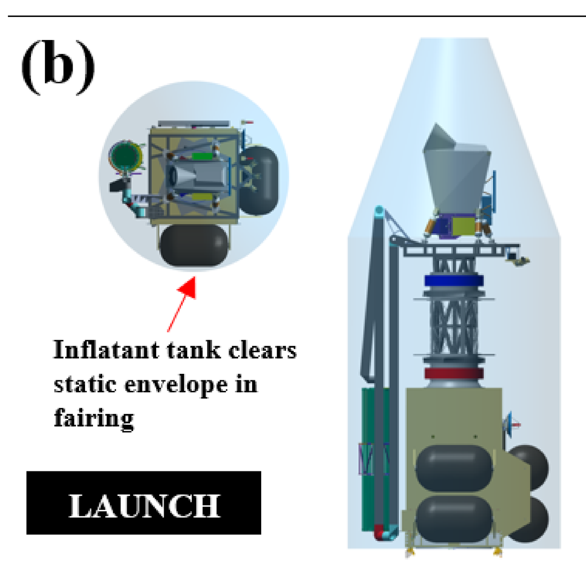
*leon.harding@ngc.com
**jon.arenberg@ngc.com



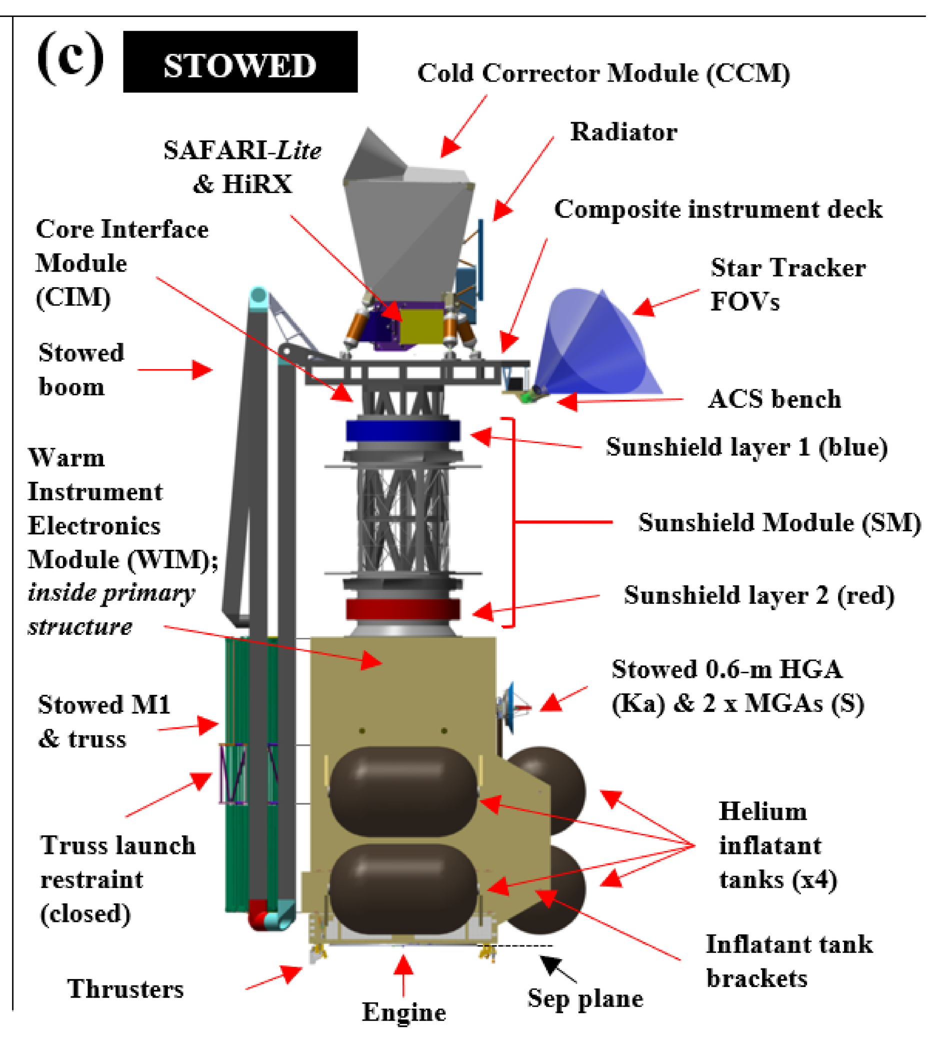
MISSION SUMMARY

We describe the space observatory architecture of the *Single Aperture Large Telescope for Universe Studies (SALTUS)* mission, a NASA Astrophysics Probe Explorer concept. *SALTUS* will address key far-infrared science using a 14-m diameter <45 K primary reflector (M1) and will provide unprecedented levels of spectral sensitivity for planet, solar system, and galactic evolution studies, and cosmic origins. Drawing from Northrop Grumman's extensive NASA mission heritage, the observatory flight system is based on the LEOStar-3 spacecraft platform to carry the *SALTUS* Payload. The Payload is comprised of the inflation control system (ICS), Sunshield Module (SM), Cold Corrector Module (CCM), Warm Instrument Electronics Module, and Primary Reflector Module (PRM). The 14-m M1 is an off-axis inflatable membrane radiatively cooled by a two-layer sunshield (~1,000 m^2 per layer). The CCM corrects for residual aberration from M1 and delivers a focused beam to two instruments – the High Resolution Receiver (HiRX) and SAFARI-*Lite*. The CCM and PRM reside atop a truss-based composite deck which also provides a platform for the attitude control system. The *SALTUS* 5-year mission lifetime is driven by a two-consumable architecture: the propellant system and the ICS. The Core Interface Module (CIM), a multi-faceted composite truss structure, provides a load path with high stiffness, mechanical attachment, and thermal separation between the Payload and spacecraft. The SM attaches outside the CIM with its aft end integrating directly to the bus. The spacecraft maintains an attitude off M1's boresight with respect to the Sun line to facilitate the <45 K thermal environment. *SALTUS* will reside in a Sun-Earth halo L2 orbit with a maximum Earth slant range of 1.8 million km thereby reducing orbit transfer delta-v. The instantaneous field of regard provides two continuous 20º viewing zones around the ecliptic poles resulting in full sky coverage in six months. See the QR code (bottom right) for a SALTUS special issue in JATIS. We highlight references [1], [2], and [3] for content directly applicable to the SALTUS architecture presented here.



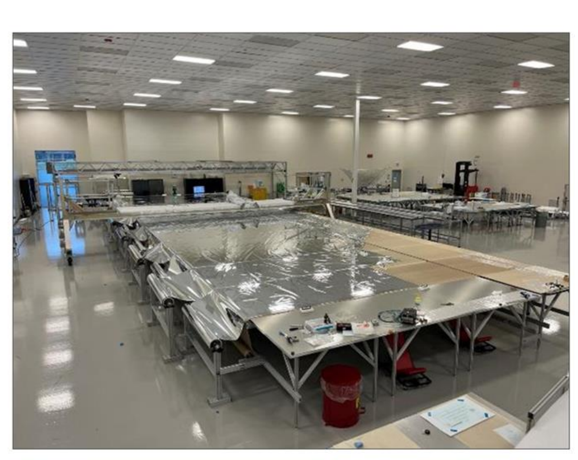


OBSERVATORY PROPERTIES			
	BOL		EOL
Parameter	Stowed	Deployed	Deployed
CG (x, y, z) m	0.05, 0.01, 2.42	-0.02, 0.42, 2.59	-0.09, 0.62, 3.14
Inertia (Ixx) kg.m^2	24423	80223	75363
Inertia (Iyy) kg.m^2	24178	39155	33572
Inertia (Izz) kg.m^2	7733	63333	55586



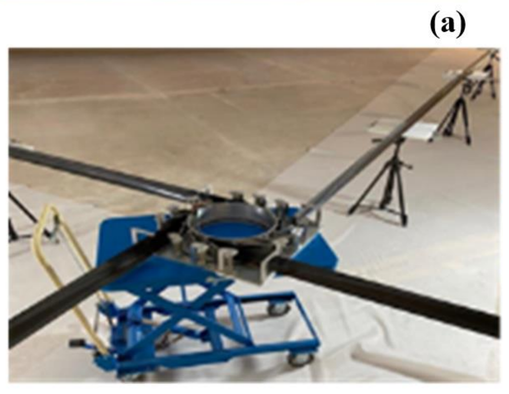
(a) *SALTUS* deployed configuration. The "warm side" is Earth and Sun facing. M1 boreslight is ~90º (±20º pitch, ±5º roll) to the Sun line, and the Z axis can rotate 360º around this line. **(b)** *SALTUS* launch configuration. The observatory fits in the static envelope of the LV fairing. We also show observatory Center of Gravity (CG) w.r.t. the spacecraft origin at the separation plane ("Sep plane"), and inertia in stowed and deployed configurations. **(c)** *SALTUS* stowed configuration. Sunshield layers are colored to indicate layer 1 (blue, cryo side) and layer 2 (red, warm side). See [1].

(a)

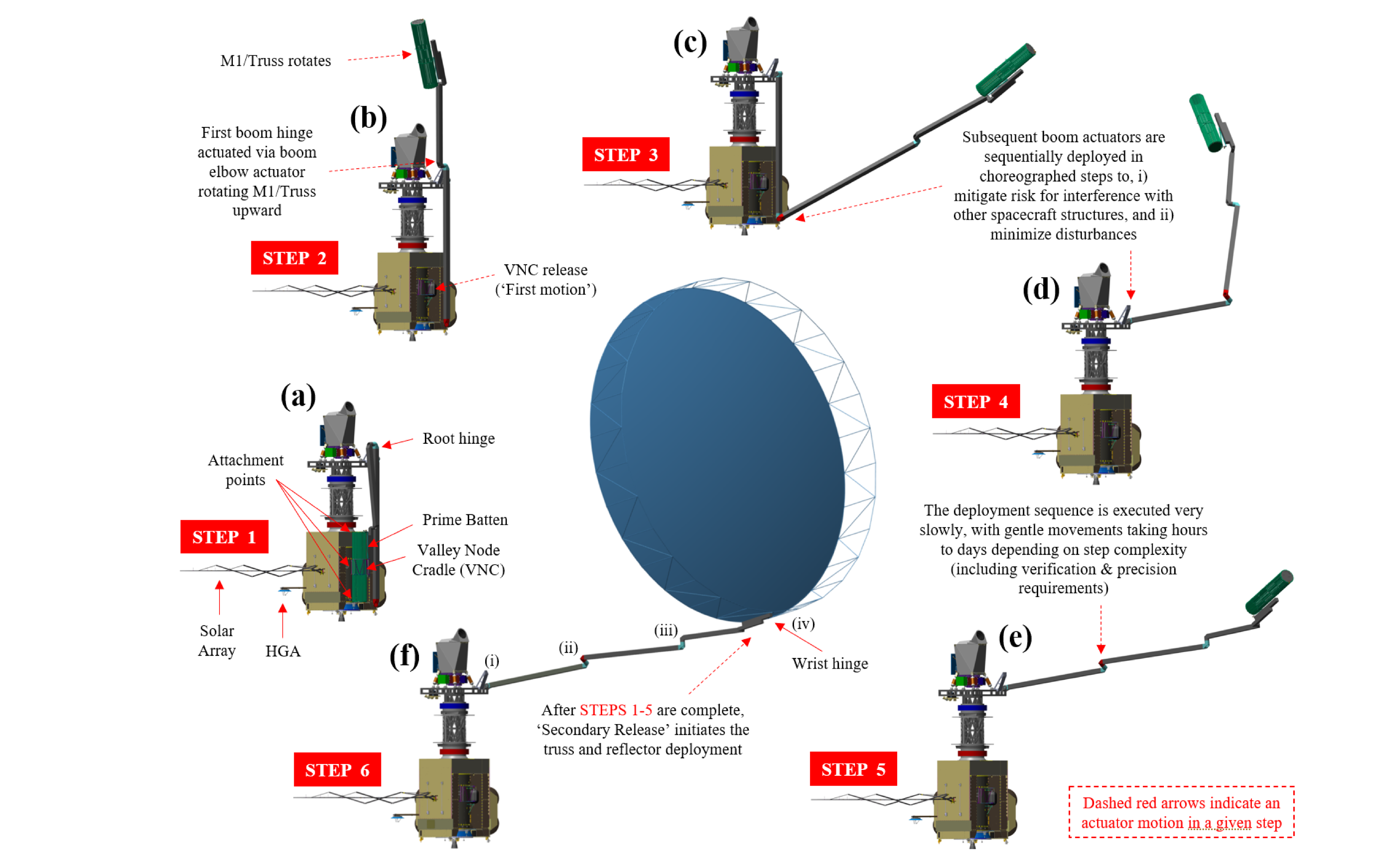


(b)

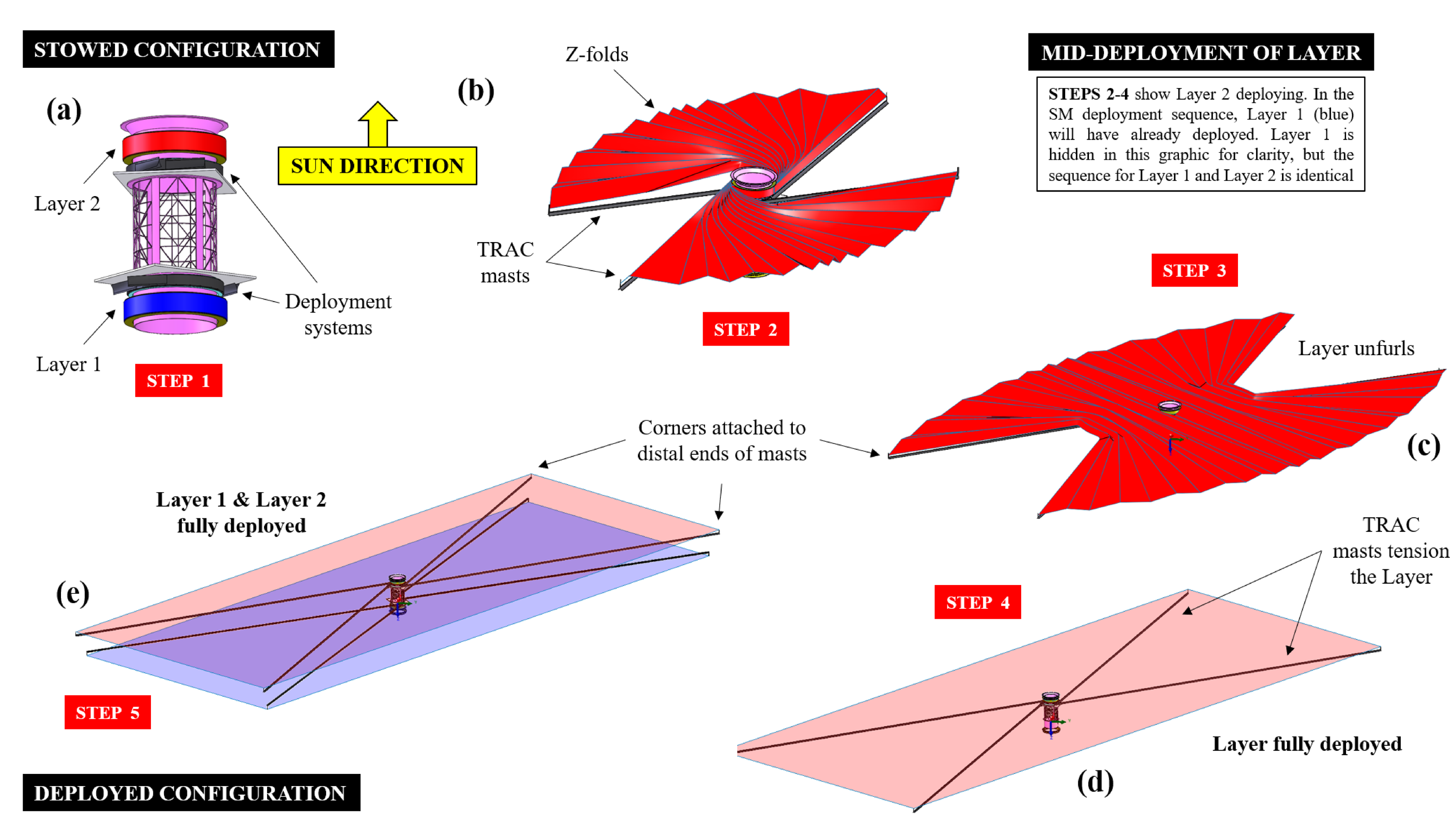
(c)



(a) Single deployed quadrant of the Solar Cruiser sail system utilizing 30 m TRAC masts with a side dimension of 40-m. (b) Membrane manufacturing facility at NeXolve which is capable of producing sunshield layers to meet the *SALTUS* area. (c) A four-mast TRAC deployment system matured to TRL-6. Image credit: NeXolve (a, b), Redwire Space (a, c). Northrop Grumman obtained permission from NeXolve and Redwire Space to include this graphic. See [1].



(a)-(f) *SALTUS* Primary Reflector Module (PRM) deployment sequence. The solar array and HGA are deployed prior to PRM deployment. The sunshield is deployed following PRM deployment. This sequence is important to avoid a cryogenic PRM deployment (which is a more complex proposition). Note, each hinge will not be required to fully deploy or latch before the next hinge actuator in the sequence initiates its motion. This strategy allows for positioning optimizations, clearance optimizations, moment of inertia impacts, etc., and will be refined in Phase A. STEP 6 (f) (i-iv) shows the four actuator boom locations. See [1] and [4] for details on the deployable reflector.



SALTUS sunshield deployment sequence. **(a)** Stowed configuration showing each sunshield layer and deployment system location. The stowed layers, deployment system, and TRAC masts are co-spooled on a stowage hub. **(b)** TRAC masts are deployed using a single brushless DC motor mechanism. **(c)** The deployment mechanism continues to unfurl the layer. **(d)** Tension is driven into the layer on full deployment. The corners of each layer are mechanically attached to the distal ends of each mast. **(e)** STEPS 1-4 are repeated for the second layer ensuring a non-cryogenic deployment for both layers. Once both layers are deployed, all major observatory deployments are complete, and the cryogenic thermal environment begins to stabilize to <45 K. See [1] and [5].

REFERENCES

1. Harding et al., *JATIS (special issue)*, submitted (QR code)
2. Arenberg et al., *JATIS (special issue),* submitted (QR code)
3. Kim et al., *JATIS (special issue)*, submitted (QR code)
4. M. W. Thompson,*"The AstroMesh Deployable Reflector"*, AP-S International Symposium, IEEE Antennas and Propagation Society (1999)
5. M. Cannella, et al., *"Design and Overview of the Solar Cruiser Mission"*, 35th Annual Small Satellite Conference, SSC21-XIII-02 (2021)

FIND SALTUS PUBLICATIONS HERE:

SCAN ME!

SPIE Journal of Astronomical Telescopes, Instruments, & Systems (JATIS) special issue: "The SALTUS Probe-Class Mission Concept"