Operational Readiness Review

HELIX TVAC Test at the In-Space Propulsion Facility

January 28, 2022

ORR Committee Membership

- Chair – John Zang – Space Environments Complex Manager
- Jose Mendez – NEAT Facility Manager
- Rick Senyitko – Code FT Controls and Data Engineer
- Joel Mitchell – Representing the GSFC Balloon Program Office
- Rene Fernandez – Code QS (S&MA)
- Paul Kuehn – Area 9 Safety Committee Chair

Agenda

- Committee Membership
- Project Overview
- Objectives / Requirements
- Project Schedule
- Facility Test Status
- Control System configuration and status
- Limits, aborts, permissives
- Instrumentation and data system configuration
- Facility and test package instrumentation
- Data quality requirements and data quality validation
- Project and facility staffing

Agenda

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- Checksheets
- Test Sequence
- Status of maintenance
- Status of safety committee reviews
- Status of safety request for action
- Status of safety permit
- Status of hazard analysis verifications
- Security requirements

Project Overview

High Energy Light Isotope eXperiment (HELIX)

- Long-duration balloon-borne experiment designed to measure the chemical and isotopic abundances of light cosmic ray nuclei
- Measures composition of light cosmic rays in the energy range of 0.1 GeV/n up to 3 GeV/n to study propagation processes of the cosmic rays
- Instrument includes a 1 Tesla superconducting magnet
- Launch TBD: Possible Antarctic launch
- Same team brought the CREST payload to ATF in 2011 and has asked for a similar test setup

ISP Facility Top Level Test Requirements

Test Requirements

- Vacuum: 4 torr
- Facility Temperature: LN2 cold wall temperature (77 K)
- Solar Simulation: Front sun @ 23deg and albedo for hot case and cold case conditions
- Days at Test Condition: 6
- Instrumentation: 12 TCs on payload
- Power: Multiple 15A 120 VAC receptacles
- Controls/Data: Ethernet feedthrough
- Special Test Equipment: Custom lamp array structure, LHe/GHe supply and LN2/GN2 supply for superconducting magnet

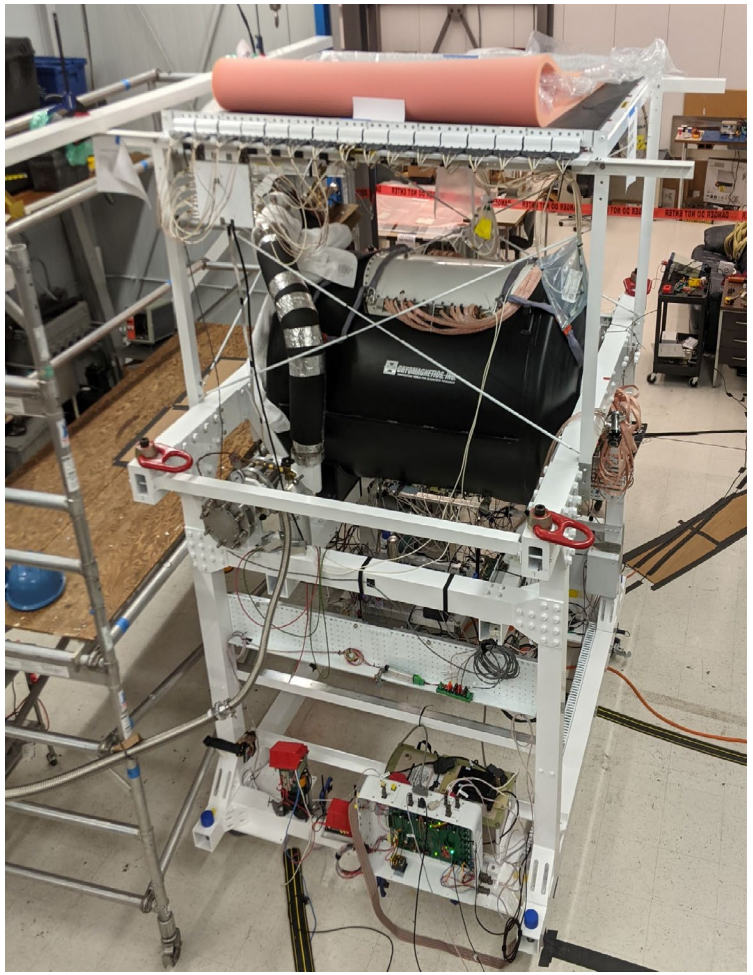
Test Schedule

- The basic test schedule is provided below:
  - HELIX Test Hardware Arrival: 1/26/22
  - HELIX Magnet LN2 Chilldown: 1/27/22 – 1/28/22
  - HELIX LHE Fill: 1/29/22
  - ISP Facility Test Chamber Evacuation: 2/2/22
  - ISP Facility Cold Wall Fill: 2/3/22
  - Anticipated Test Completion: 2/9/22

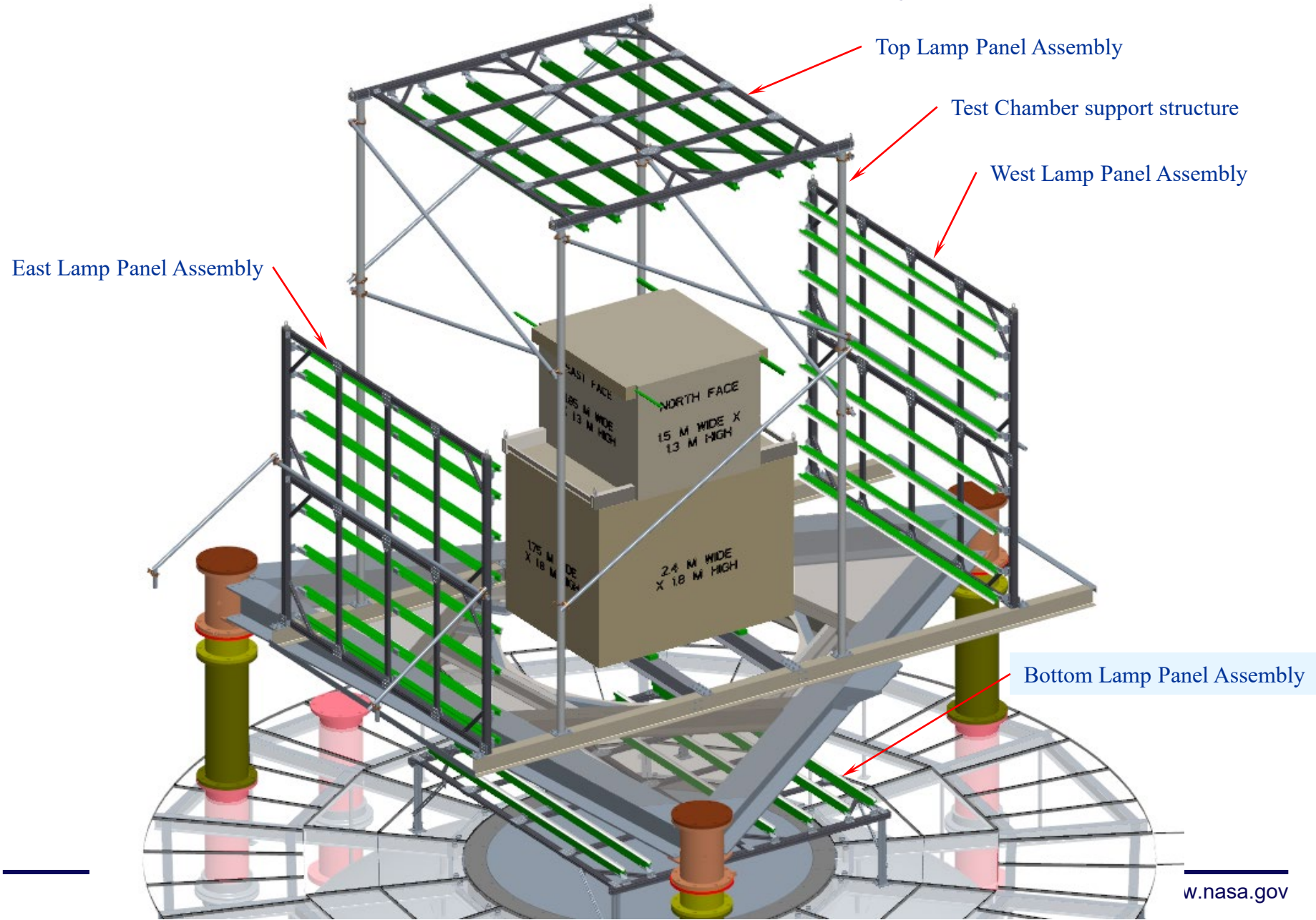
HELIX Test Article Description

- Dimensions:
  - Top Tier: 1.85W x 1.5L x 1.3H m
  - Bottom Tier: 2.4W x 1.75L x 2.4H m
- Weight: 2000 kg
- Foam thermal enclosure covers exterior

Interior View



HELIX STE – Solar Sim Lamp Array Structure



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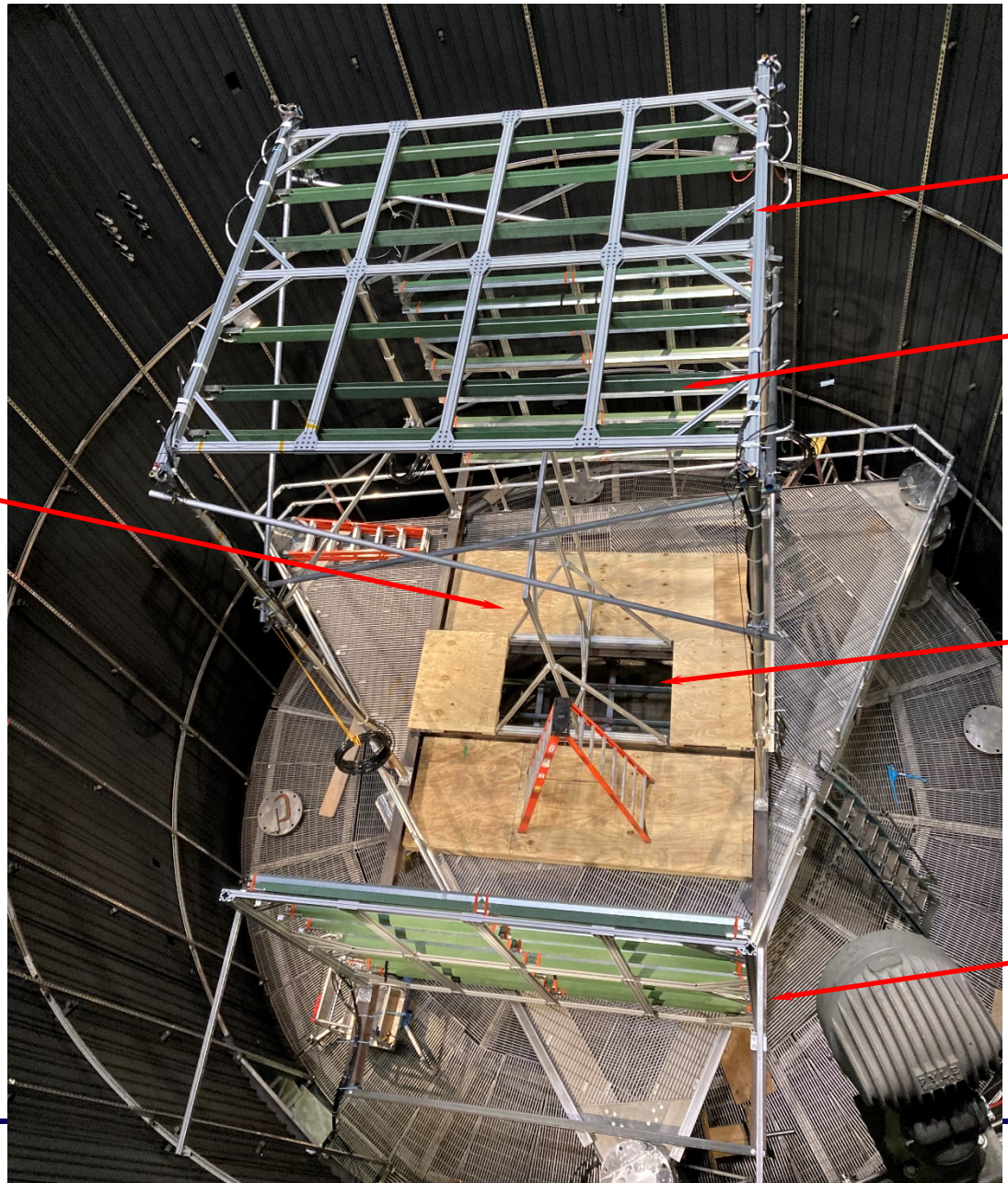
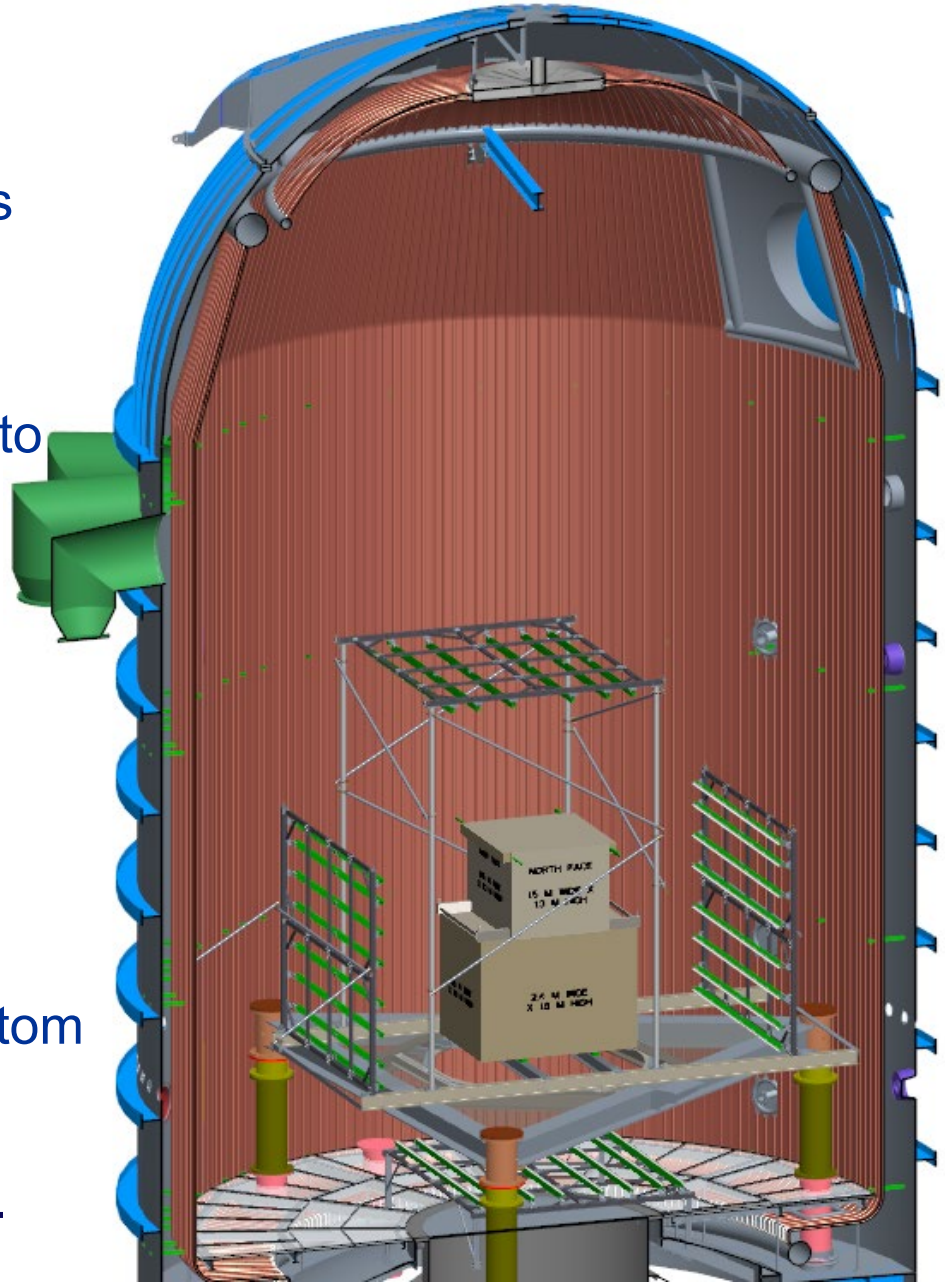


ISP Facility Environment Configuration

- Vacuum
  - Roughing pumps and blowers evacuate chamber to 4 Torr
- Thermal
  - Chamber LN2 cold wall filled to maintain 77 K temperature
  - Chamber top cap not filled
- Solar Simulation
  - 12’ line sources with up to sixteen 120 V 750 W infrared quartz lamps
  - 6x line sources top
  - 8x line sources sides and bottom
  - Configured to meet HELIX requirements



Facility Systems Status

- ISP Facility Thermal Vacuum Systems Checkout on 12/17/22
  - Evacuated test chamber to 4 Torr
  - Filled LN2 cold wall to bottom of flash tank

- Solar Simulation Lamps installed and calibrated

Control Systems Status

- PLC/HMI programs under configuration control, no changes unless software change request is approved
- Facility 400kW backup generator tested, transfer of power test to facility
- PTC Control 250kW UPS generator tested
- Facility UPS tested

Limits, Aborts, Permissives

- No unique limits, aborts, or permissives for HELIX test
- Standard facility operating conditions still apply

Instrumentation and Historian System Status

- Data system not used for HELIX test
- Historian for controls system tested
- Data Transfer Agreement sign off in progress

Facility and Test Package Instrumentation

- 12 Thermocouples record surface temperatures of payload

Thermocouple temperature sensor locations (2021/12/06)

Location description	Thermocouples Calibration offset (celsius)	Note
Identification Name	Number (array- like)	
TopCen	0	Top face, on foam centrally
NoUp	1	North Face, upper foam centrally
NoLo	2	North Face, lower foam centrally
EastUp	3	East Face, upper foam centrally
EastLo	4	East Face, lower foam centrally
SoUp	5	South Face, upper foam centrally
SoLo	6	South Face, lower foam centrally
WestUp	7	West face, upper foam centrally
WestLo	8	West Face, lower foam centrally
BtmCen	9	Bottom face, on foam centrally
EastFr	10	East Face, mid gondola frame centrally
SoFr		
11	South face, gondola frame at the bottom East side	

Staffing

- 24 hour test operations

- ISP Facility test conductors 8 hour shifts
- HELIX personnel 8 hours shifts
- Mechanical system operators 8 hour shifts
- Electrical / I&C operators 12 hour shifts

- SMA Representative first shift

Training

- NASA and TFOME Qualified Operator training up to date
  - Refresher training completed in December and January

- HELIX personnel training credentials provided

Checksheets / Facility Operations

- To achieve the desired test conditions, the facility will operate the following systems within their normal operating parameters:
  - Vacuum
  - Gaseous Nitrogen
  - Liquid Nitrogen
  - Instrument Air
  - Cooling Water
  - Controls and Instrumentation
  - Electrical
  - Thermal Simulators
  - Safety (Low O2 Sensors and Area Warning System)
- These systems are covered under Safety Permit #3211-13-0002, Rev 13, dated 12/7/21
- HELIX Test Conductor Checksheet signed and approved

Test Sequence: Test Preparation

- Upon test hardware arrival, unload hardware and set up at the ISP Facility ramp level staging area
- Assemble test article for test configuration
- Chill magnet vessel with LN2
- Purge nitrogen from magnet vessel
- Fill magnet vessel with LHE
- Charge magnet
- Lift payload and lower into test chamber
- Attach gas feedthroughs, thermocouples, power and control lines
- Top off magnet with LHE if necessary in the test chamber
- Replace top lamp array in the test chamber

Test Sequence: Test Execution

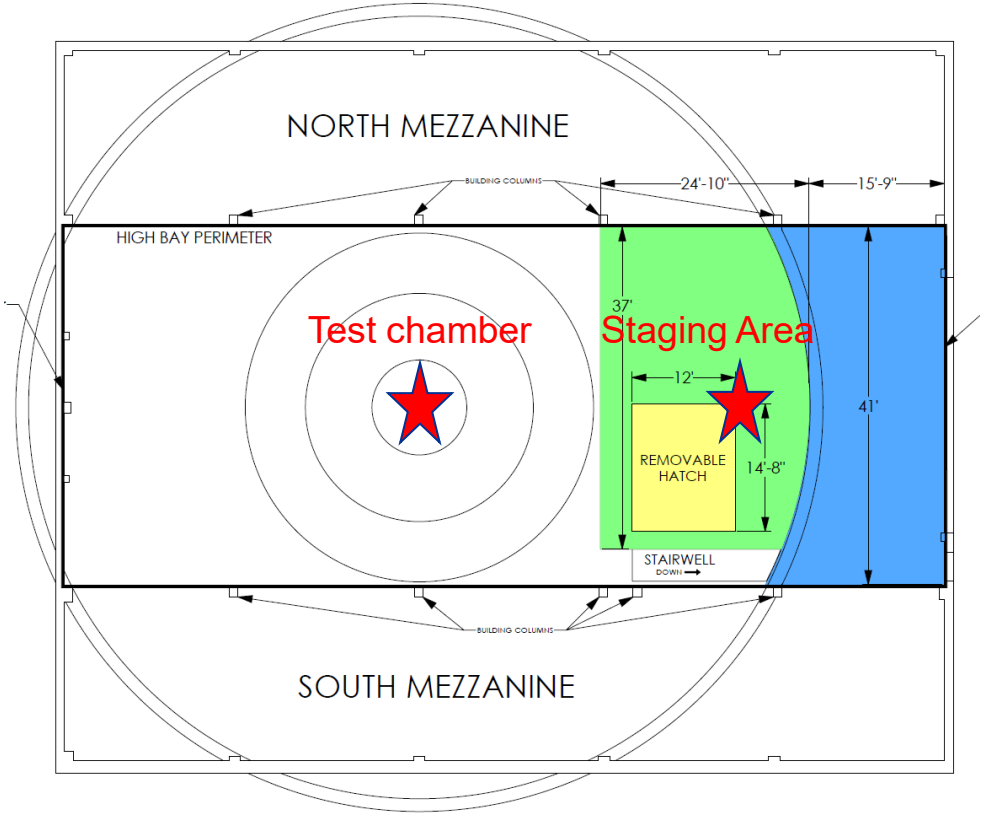
- Close test chamber top cap and begin test operations
- Notional test sequence, actual test sequence will be dependent on time to achieve thermal equilibrium

	Day 1	Day 2	Day 3	Day 4	Day 5	
	Chamber Status	Chamber Status	Chamber Status	Chamber Status	Chamber Status	
0:00						0:00
1:00	Evacuation already					1:00
2:00						2:00
3:00						3:00
4:00		COLD CASE (6 hr)				4:00
5:00						5:00
6:00						6:00
7:00						7:00
8:00						8:00
9:00	Cold wall start (13 hr)					9:00
10:00		Repress	**Reset Lamps (8 hr) and Adjust Instrument**	HOT CASE (6 hr)		10:00
11:00						11:00
12:00						12:00
13:00		in case				13:00
14:00		hot/cold case				14:00
15:00		reaches				15:00
16:00		inoperable		COLD CASE (6 hr)		16:00
17:00		temperatures				17:00
18:00			Pumpdown+Equilibrate w/ cold wall (16 hr)			18:00
19:00						19:00
20:00						20:00
21:00						21:00
22:00	HOT CASE (6 hr)					22:00
23:00				Repress		23:00

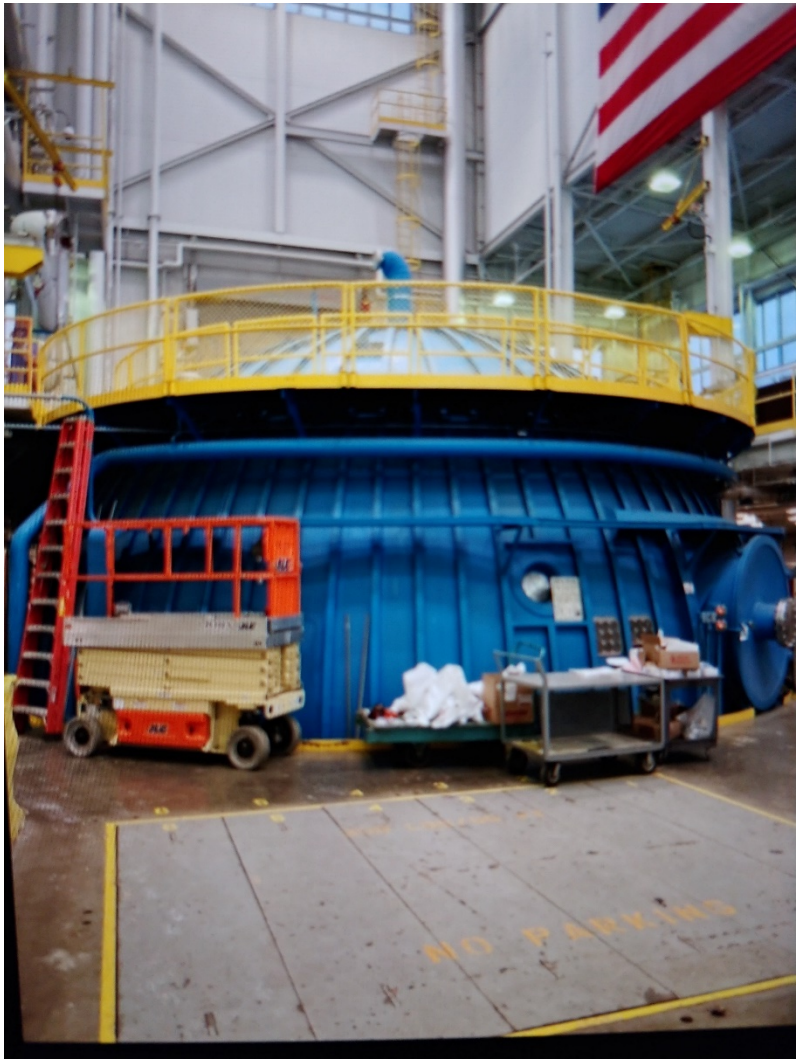
Lift Operations

- Two Lifts between ramp staging area and test chamber
  - Lift 1
    - Lamp array tower

  - Lift 2
    - HELIX payload



Lift Operations cont.



Ramp Level Staging Area

Facility Maintenance Status

- All test-related squawks / nonconformances closed out

Safety Permit Status

- Safety Permit Issued 1/28/22
- All actions and verifications complete

Security requirements

- Two foreign national HELIX test members
- Access Control Plan approved by NASA Security and Export Control

Actions