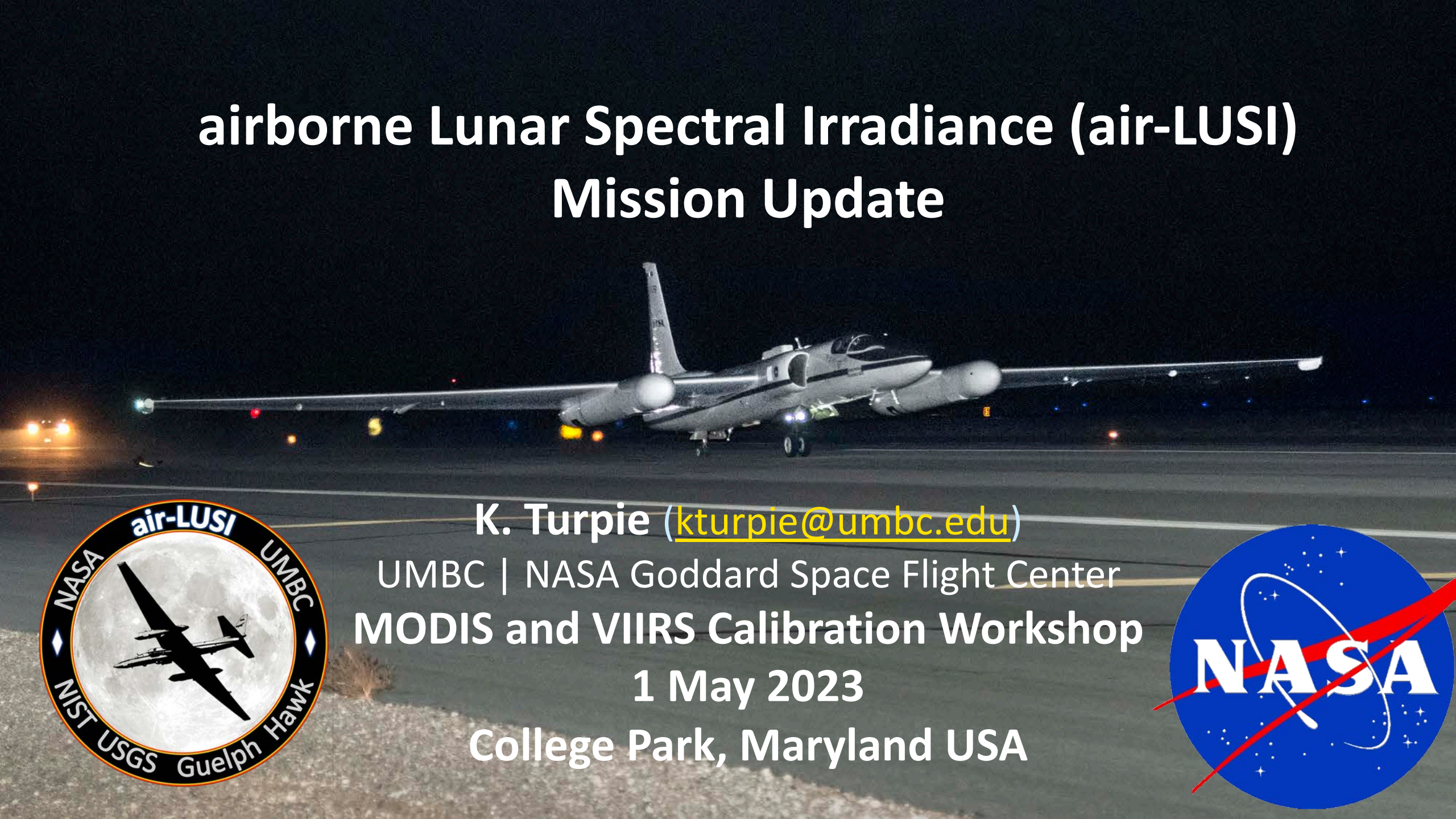
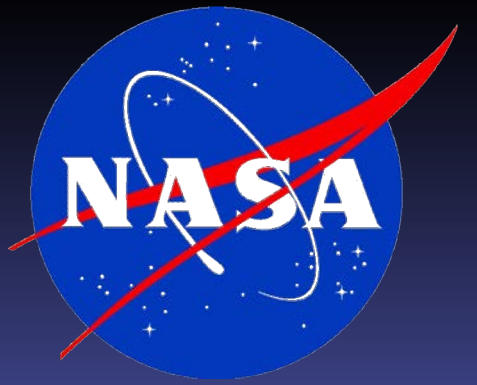
airborne Lunar Spectral Irradiance (air-LUSI) Mission Update



K. Turpie (kturpie@umbc.edu)
UMBC | NASA Goddard Space Flight Center

MODIS and VIIRS Calibration Workshop
1 May 2023
College Park, Maryland USA

air-LUSI Team



UMBC

Kevin Turpie, PI

McMaster University

Andrew Gadsden, Co-I

Andrew Newton

NIST

Steve Grantham

Tom Larason

Stephen Maxwell

John Woodward, Co-I

USGS

science for a changing world

Tom Stone, Co-I

Franzeska Becker

Samuel Choi

Gary Hoffman

Tyler Latsha

Timothy Williams

Robert York

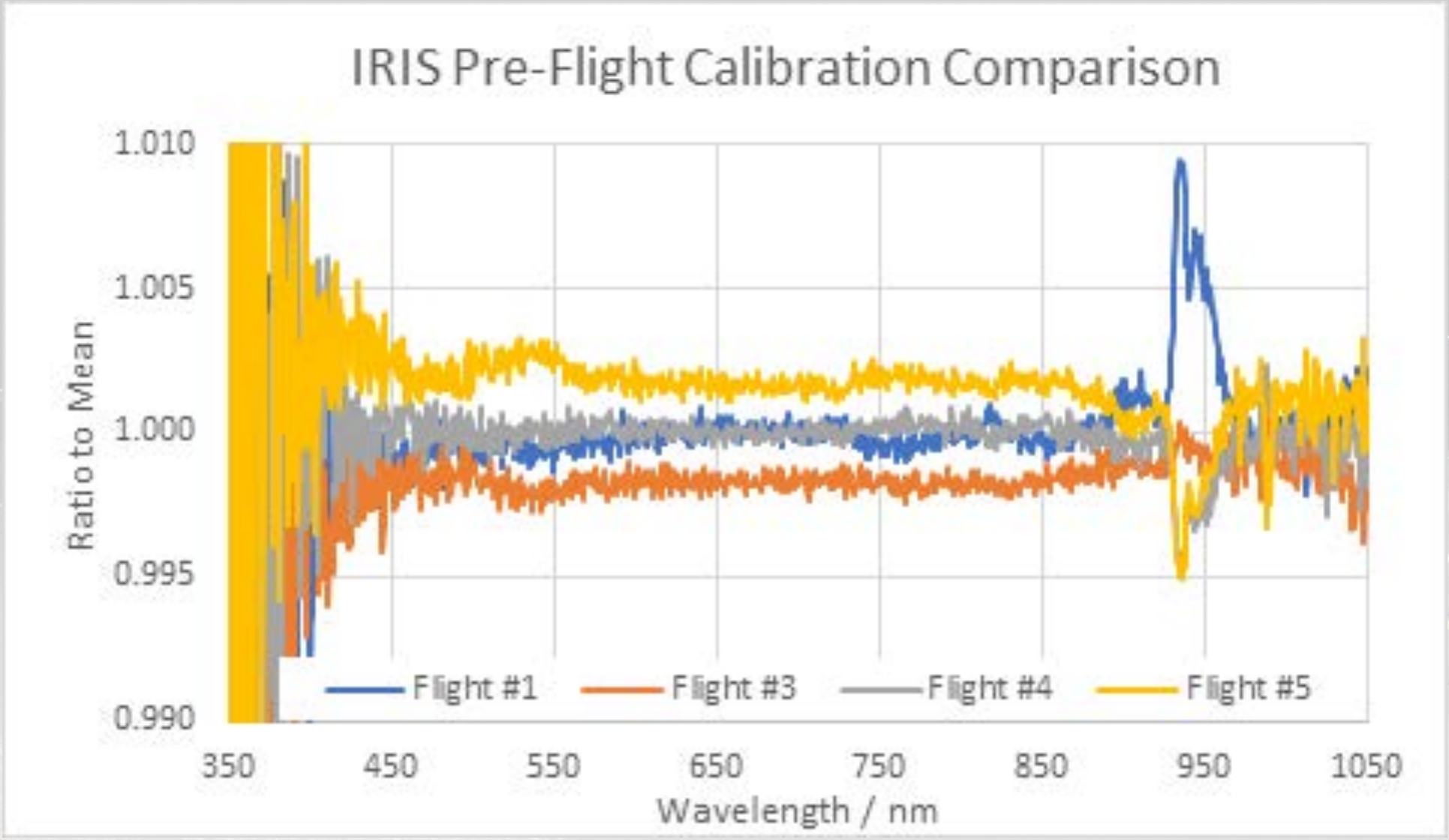
Operational Flight Campaign – 01: Time Line

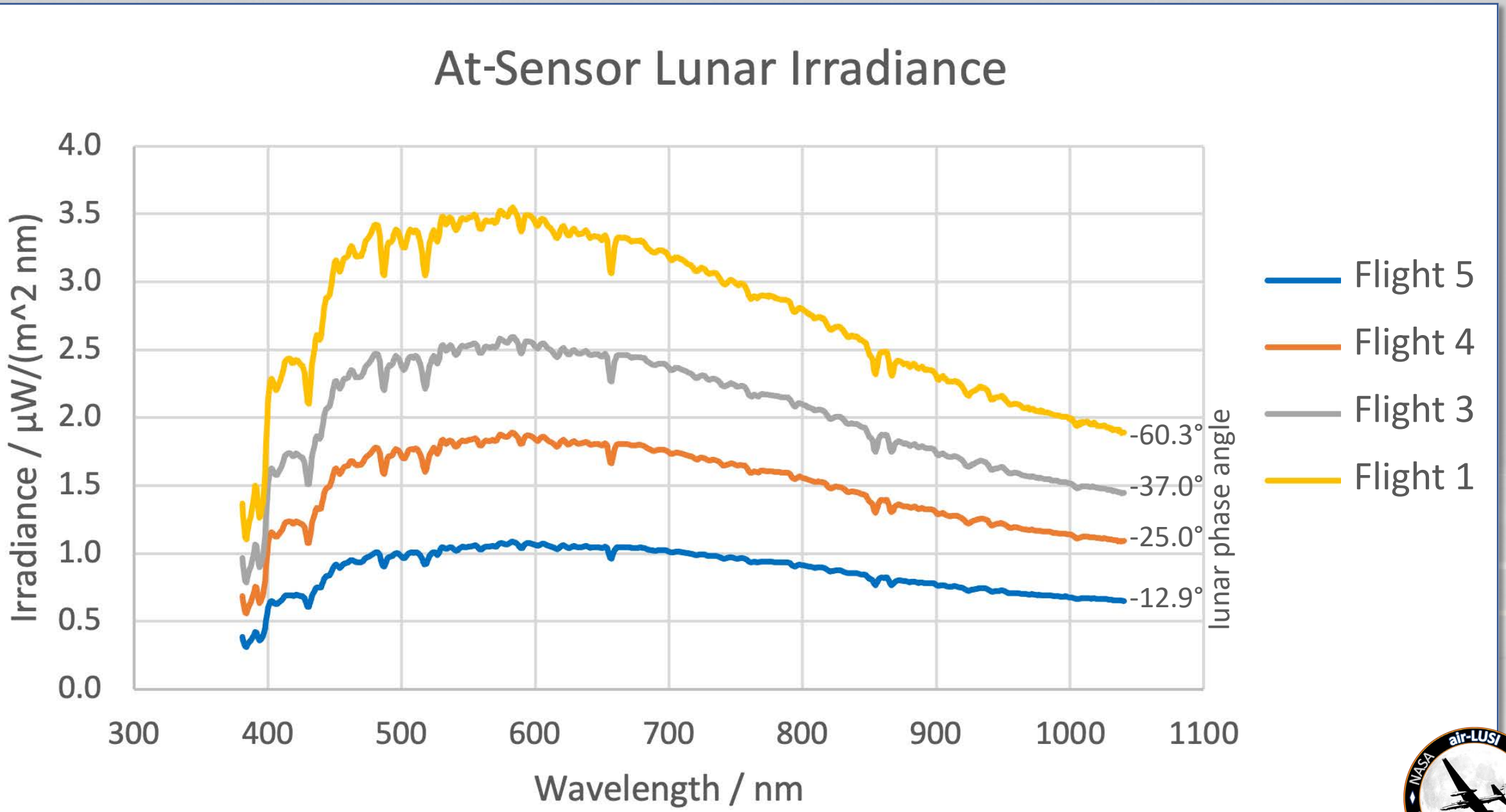
- Dec 2019 - Feb 2022: Updates to air-LUSI after Demonstration Campaign
- 02 Mar – Deployed to AFRC, successful collection four out of five nights:

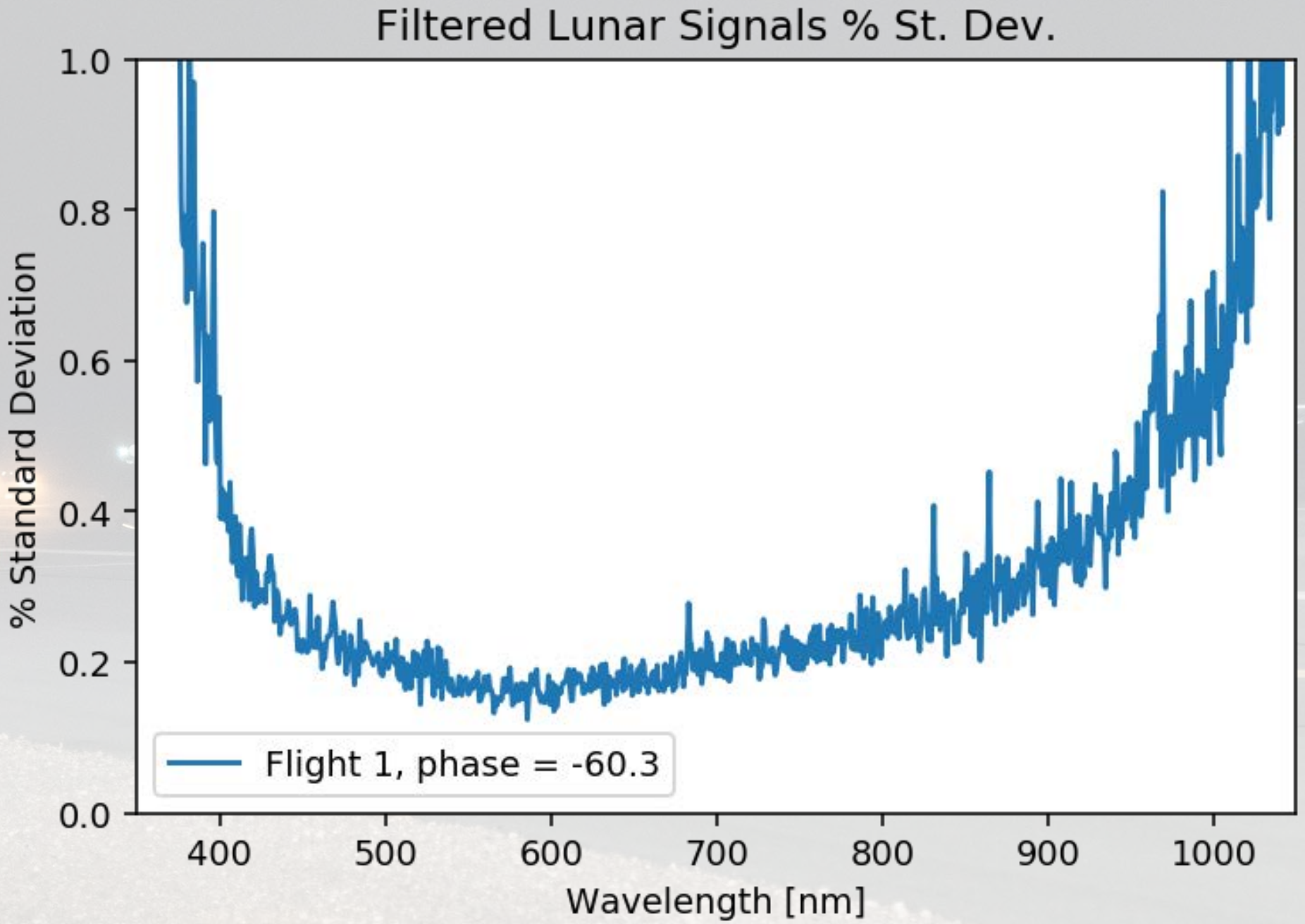
- **12 Mar** – Flight 1: Successful collection, uneventful.
- 13 Mar – Flight 2: Scrubbed because of high winds.
- **14 Mar** – Flight 3: Successful collection, uneventful.
- **15 Mar** – Flight 4: Successful collection, altitude drop at first station.
- **16 Mar** – Flight 5: Successful collection, stratospheric turbulence.

- 22 Mar – Returned air-LUSI to NIST

CALIBRATION PERFORMANCE




At-Sensor Lunar Irradiance
Irradiance / µW/(m^2 nm)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
300
400
500
600
700
800
900
1000
1100
Wavelength / nm
-60.3°
-37.0°
-25.0°
-12.9°
lunar phase angle
Flight 5
Flight 4
Flight 3
Flight 1

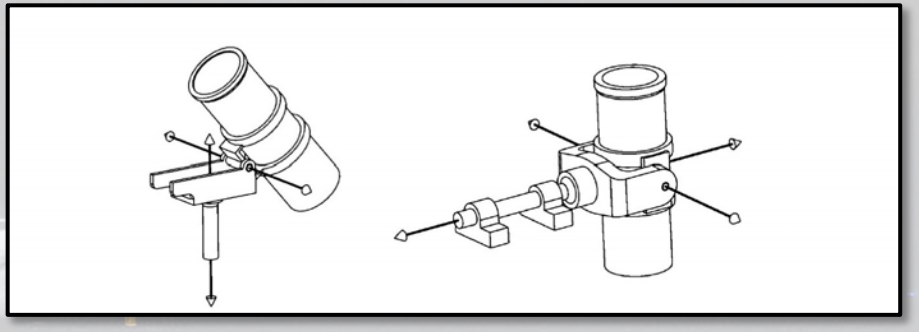


- Flight 1 is the largest SD of all flights (less signal).
- Cosmic ray spikes were culled with a median filter ($r_1 = 0.025$, $r_2 = 0.975$).
- Includes variation in Moon over collect, causing some overestimate.
- Moon usually changes on order of a few tenths of a percent over collect at this phase angle.
- We will remove the secular change with ROLO later.

air-LUSI Future Efforts

Improvements

- Telescope robotics (durability, performance, range); spare actuators.
- Cable management.
- Reduce noise in validation system.
- Temperature control (airborne and ground).
- N2 purge system (new bottle size; optimize flow rates).



Comparisons

- Complete processing for Operational Campaign–01 and error budget.
- Continue collaboration with ESA LIME team.
- Compare processed data to Demonstration Campaign data and ROLO.
- Compare processed data to MLO-LUSI data.

air-LUSI Future Efforts

Lunar Calibration

- Public access to air-LUSI data and code (initially NIST data portal).
- air-LUSI hosted a small lunar calibration workshop with satellite cal teams.
  - Follow up work leading to a public report or peer-review publication.
  - Discussion will open up to broader venue (e.g., GSICS).
- Apply air-LUSI results towards ROLO improvement.

air-LUSI Future Efforts

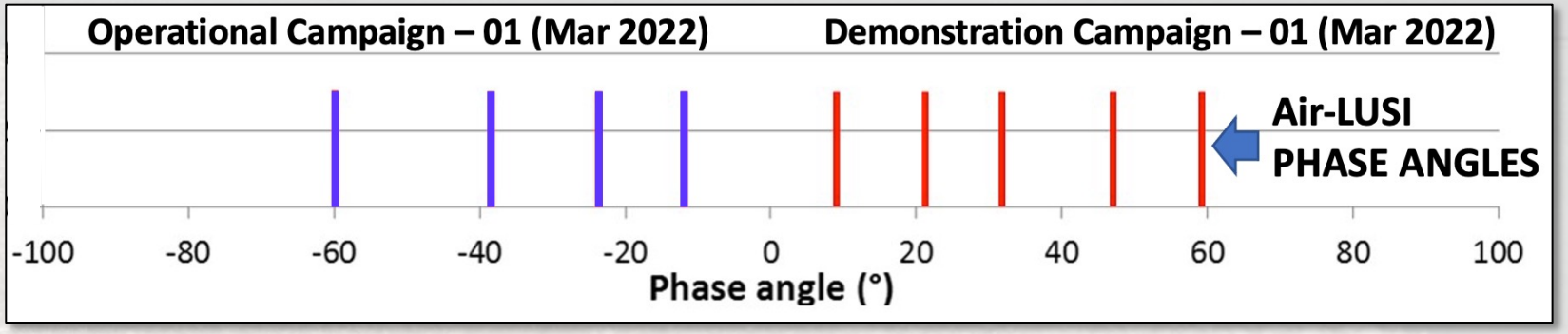
Future Campaigns

- Targeting observation window: Jan 2024.
- Wish to validate and further sample lunar phases.
- Consider other airframes (e.g., WB-57); high alt (above tropo-pause).
- Funding is greatest challenge.

OBSERVATIONAL WINDOW SUMMARY FOR JANUARY 2024

DOW	Date	Avg Phase	Max Elev	Start	Mx|Trans	End
Wed	17-Jan-24	-90.5	62.3	18:40	18:40	20:20
Thu	18-Jan-24	-77.6	71.5	18:40	18:40	21:30
Fri	19-Jan-24	-64.9	76.7	18:40	18:40	22:30
Sat	20-Jan-24	-52.6	80.5	18:40	20:10	23:30
Sun	21-Jan-24	-40.5	82.8	18:40	21:10	0:30
Mon	22-Jan-24	-28.7	83.5	18:40	22:00	1:30
Tue	23-Jan-24	-14.1	82.5	18:40	23:00	2:20
Wed	24-Jan-24	-6.6	80.2	20:30	23:50	3:09
Thu	25-Jan-24	8.1	76.6	21:30	0:40	3:50
Fri (RDO)	26-Jan-24	18.6	72.2	22:20	1:20	4:20
Sat	27-Jan-24	29.6	67.0	23:20	2:00	4:39
Sun	28-Jan-24	40.6	61.4	0:19	2:39	4:59
Mon	29-Jan-24	51.7	55.7	1:29	3:29	5:19
Tue	30-Jan-24	62.7	49.8	2:49	3:39	5:09

Red Day = Overtime Red times = AM next day



THANK YOU

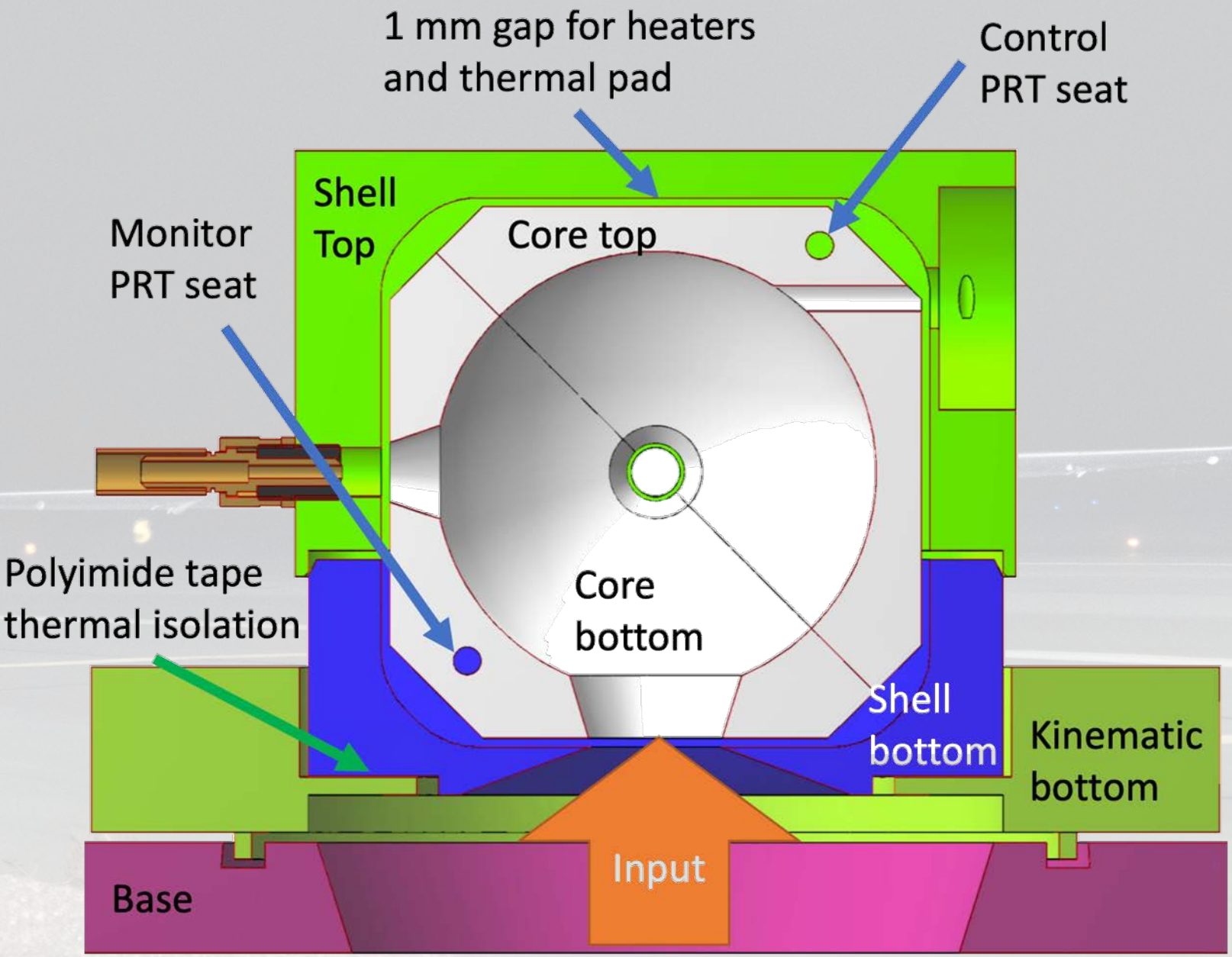
Pre-Campaign Updates to air-LUSI

- Built and tested new telescope integrating sphere with improved temperature control.
- Replaced broken shutter for in-flight LED validation source.
- Replaced in-flight validation source with broader spectrum LED.
- Repaired pressure seals on throughputs in environmental enclosure.

- Performed power conditioning sensitivity tests.
- Added new thermal sensors; updated throughputs, cabling, DAQ.
- Improved some avionics and component interfaces.

- Performed last-minute repair for elevation actuator burnout.
- Adjusted elevation pins on telescope mount to reduce binding.

Telescope
Integrating
Sphere
Assembly



UPDATED air-LUSI TELESCOPE INTEGRATING SPHERE ASSEMBLY (TISA)