



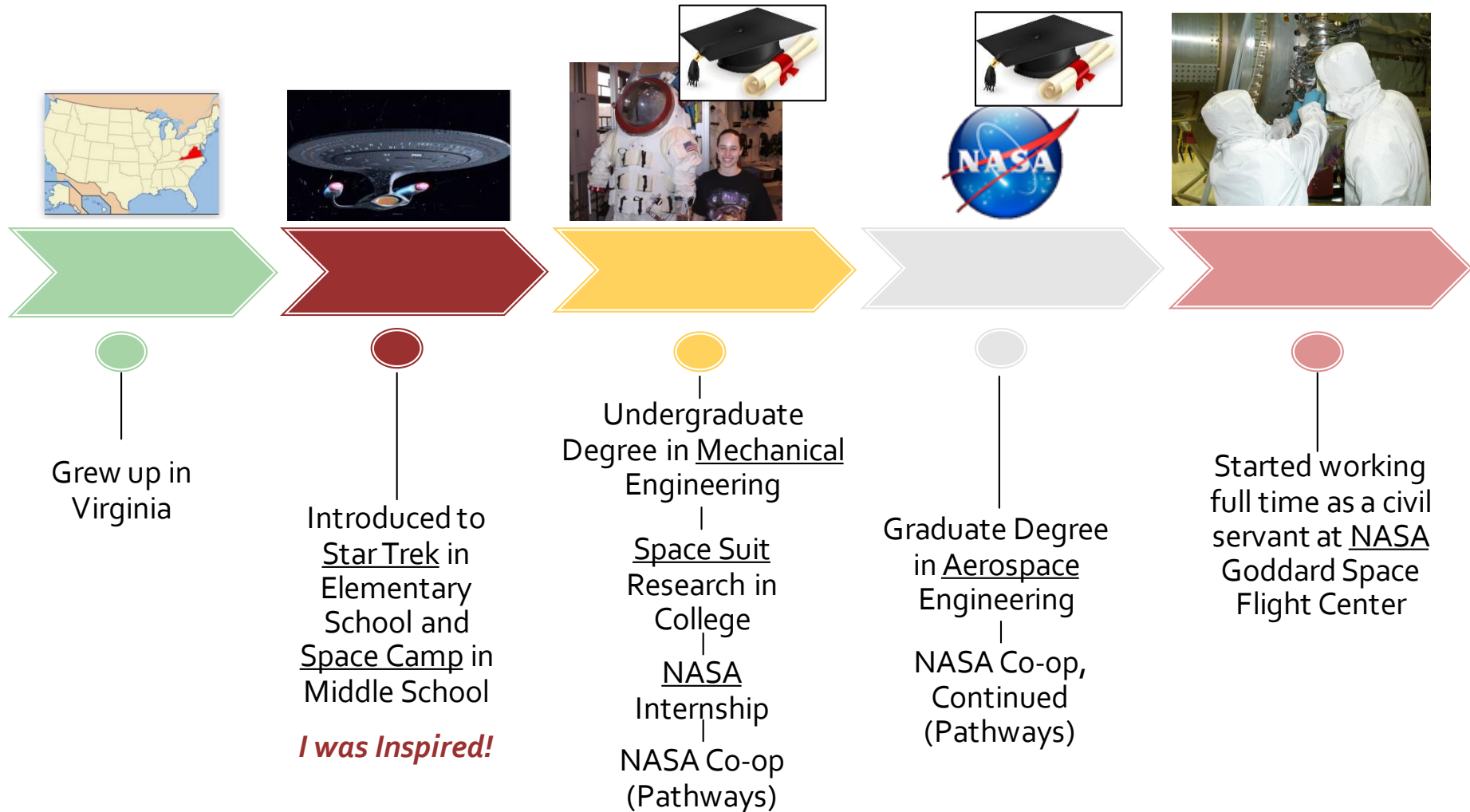
# Experiences of a NASA Engineer

Presented by: Heather  
Mechanical & Aerospace Engineer at  
NASA Goddard Space Flight Center

# Agenda

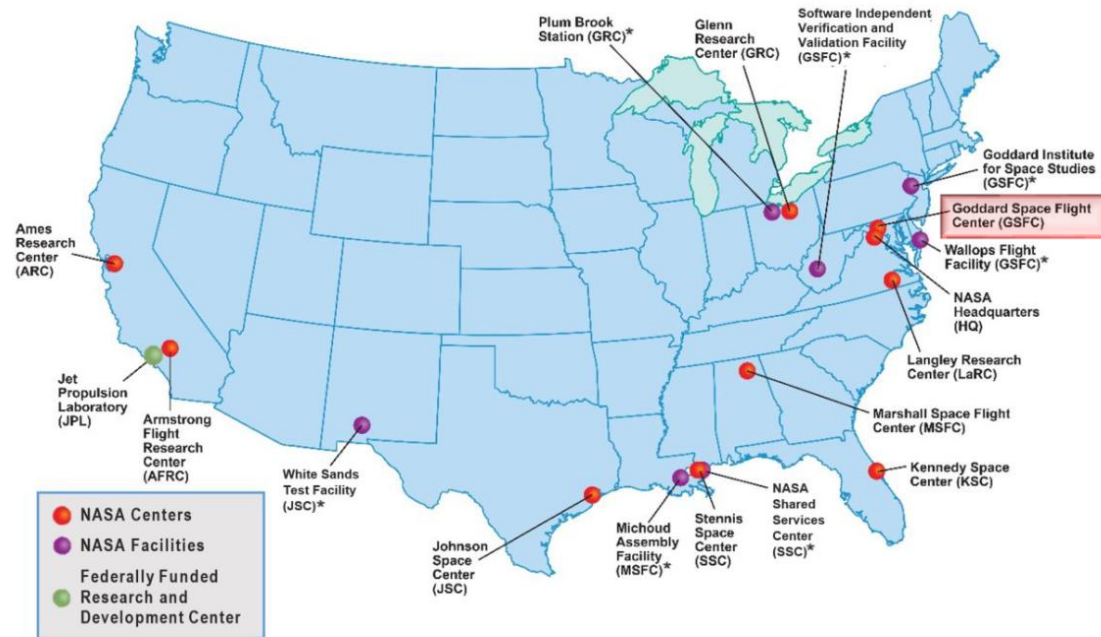
- My path to NASA
- Map of NASA Centers
- Missions and proposals I've worked on
- What a NASA engineer does:
  - Design, analyze, build, test, launch, and fly exploration spacecraft!
- What a NASA engineer does outside of work (my hobbies)

# My Path to NASA



# Map of NASA Centers

- There are about 10 NASA Centers across the country and they each do different things.
- You probably are familiar with "Houston, we have a problem" – that's mission control for the space station. They train the astronauts and run the station.
- You've also probably seen pictures of launches from Kennedy space center in Florida.
- There are other Centers that specialize in research into aircraft and spacecraft advances.
- Then there's NASA Goddard in Maryland, which is one of the locations that actually builds spacecraft which explore the universe. That's where I work. 😊

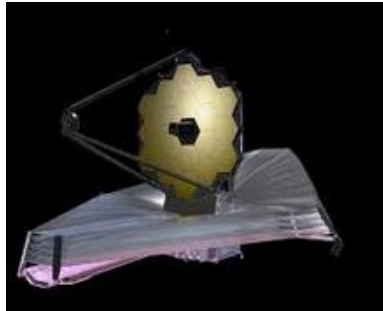


\*Acronym indicates the managing NASA Center for the Facility

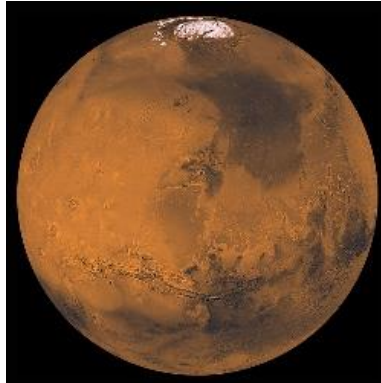
Image Source:

[https://www.nasa.gov/sites/default/files/atoms/files/nasa\\_2018\\_strategic\\_plan.pdf](https://www.nasa.gov/sites/default/files/atoms/files/nasa_2018_strategic_plan.pdf)

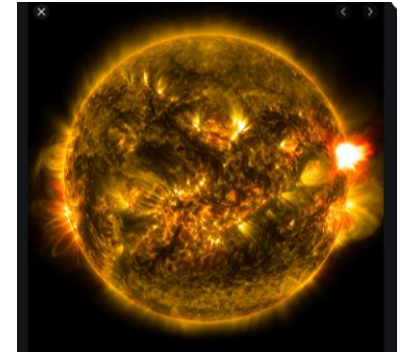
# Missions or Proposals I've Worked On



James Webb  
Space  
Telescope  
(JWST)



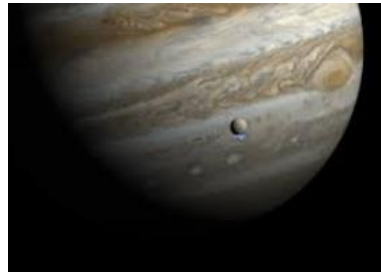
Mars  
(MOMA for  
ExoMars  
Rover)



The Sun, our  
nearest star  
(SDO)



International  
Space Station  
(ELC)



Jupiter's icy  
moon Europa  
(Europa Clipper)



Moon  
(LADEE)

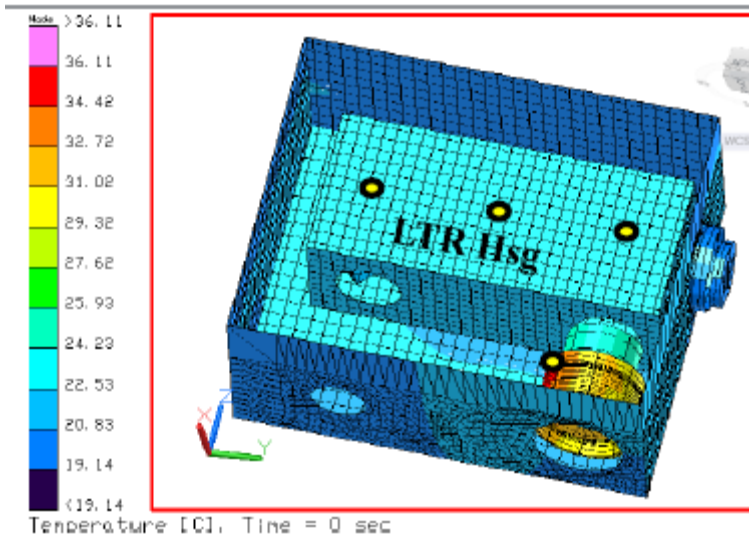
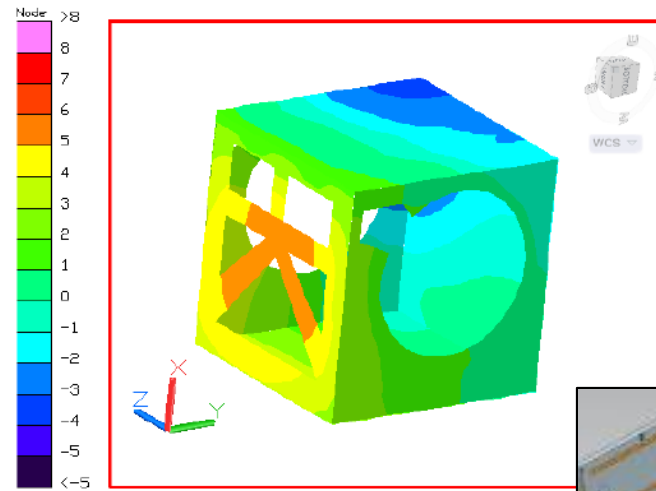
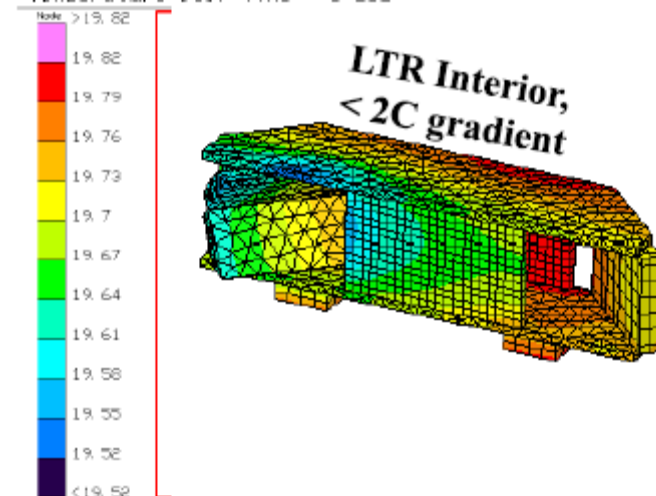
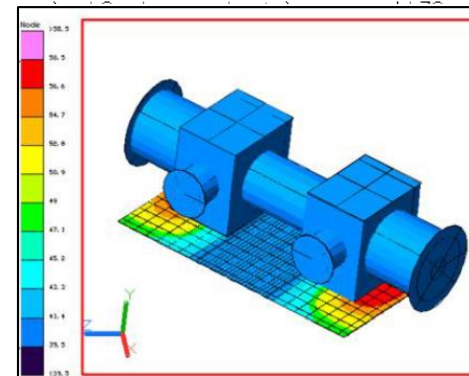
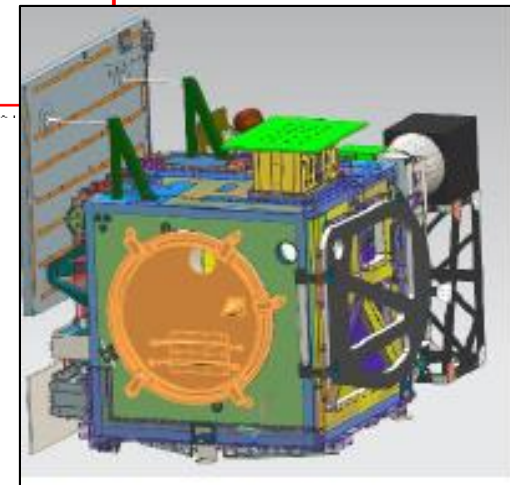


Venus  
Mission  
(Proposal)



Earth Science &  
Climate Change  
(ATLAS for ICESat-2)

# What a NASA Thermal Engineer Does: Design & Analysis



- Create thermal models to predict hot spots and cold spots
- Verify spacecraft components will remain within temperature limits

# What a NASA Engineer Does: Integration (Building a Spacecraft)



# What a NASA Engineer Does: Thermal Vacuum Testing

Image Source: [https://environmentaltest.gsfc.nasa.gov/forms/ETIF\\_Handbook\\_FINAL\\_web.pdf](https://environmentaltest.gsfc.nasa.gov/forms/ETIF_Handbook_FINAL_web.pdf)



- The spacecraft is placed in a thermal vacuum chamber, which pulls out all the air so it's a vacuum, like space. (You still have gravity, but at least there's no air, so thermally this is a similar environment as in space.)
- The chamber walls are controlled to go hot and cold, to cycle the spacecraft's temperature. In space, if you're in low earth orbit like the International Space Station is, you cycle from cold to hot every 90 minutes!
- As you're testing the spacecraft, watch out for yellow alerts and red alerts and save the day!

# What a NASA Engineer Does: Mechanical Vibration Testing



Image Source:  
[https://environmentaltest.gsfc.nasa.gov/forms/ETIF\\_Handbook\\_FINAL\\_web.pdf](https://environmentaltest.gsfc.nasa.gov/forms/ETIF_Handbook_FINAL_web.pdf)

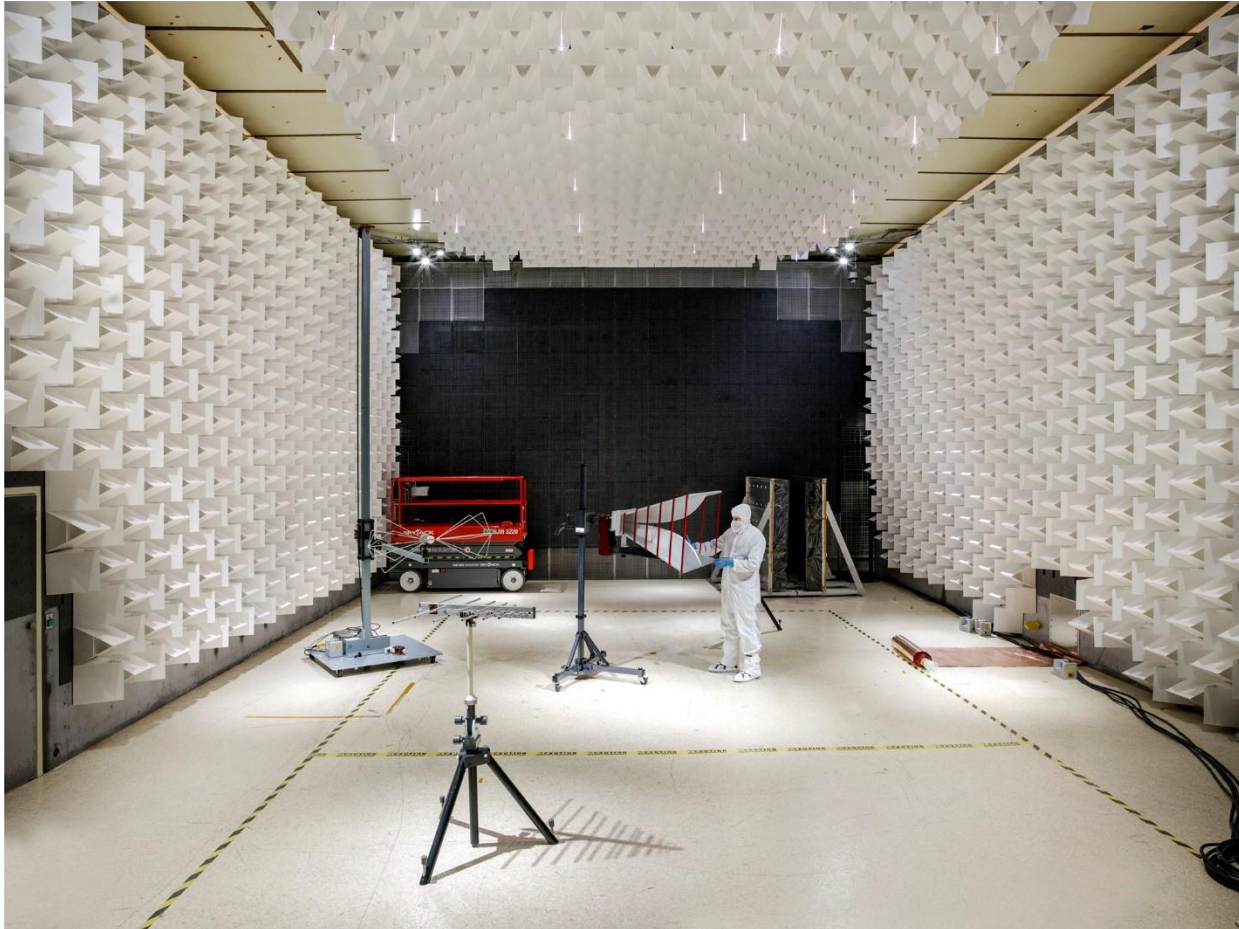
- Spacecraft is mounted to a vibration table (“shaker table”), which can shake it up to 2,000 times per second!
- This simulates the vibration of launch, and tests to ensure no screws come loose during the test, etc. If it does, we fix it and test it again.

# What a NASA Engineer Does: Acoustics Chamber Testing



- Spacecraft would be placed in the chamber, and blasted with sound.
- This simulates the sound of launch, and tests to ensure nothing shakes loose or breaks.
- At the loudest volume, over 100 decibels, it would be enough to crush bones!

# What a NASA Engineer Does: EMI Chamber Testing

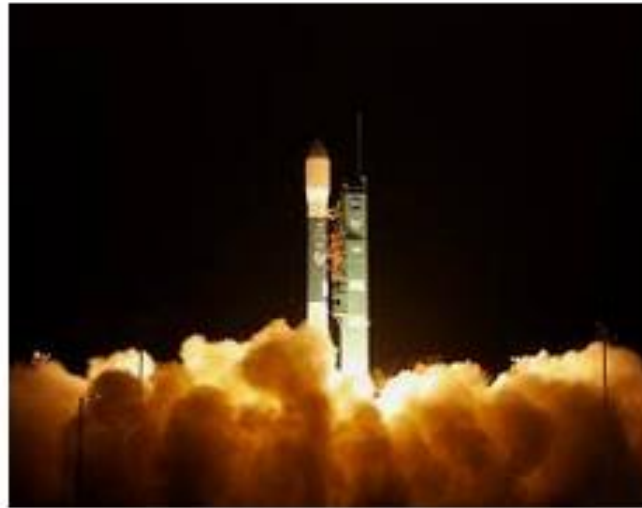


- Spacecraft would be placed in the chamber, and subjected to electromagnetic radiation.
- This simulates the radiation environment of space, and ensures the spacecraft still performs as expected.
- Stands for:  
Electromagnetic Interference/  
Electromagnetic Compatibility  
(EMI/EMC)

Image Source: <https://environmentaltest.gsfc.nasa.gov/5493web/facilities.htm>

# What a NASA Engineer Does: Launch!

- Exciting moment: During a practice run, I had the chance to be on console and on headset and say “Thermal is GO for launch!”



# What a NASA Engineer Does: Fly the Spacecraft, Mission Operations



- Monitor health, safety, and performance of the spacecraft in-flight
- Watch out for yellow alerts and red alerts and save the day!
- You're flying a spaceship!

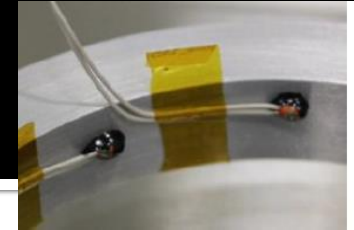


# What a NASA Thermal Engineer Does

- Trick question: Is space hot or cold?
  - It's actually both. It depends where you are.
  - In the sun, it's hot, but if you're behind a planet in an eclipse (shadow), it's very cold.
  - Space temperature ranges from about -455F (deep space, in shadow, close to absolute zero) to 2,500F (Parker solar probe, very close to sun)
- As mentioned before, our job is to make sure the spacecraft is like Goldilocks – not too hot, not too cold, but just right. We “save the day” so it works in space.
- Some of the hardware we use to achieve that is: thermal radiators, heaters, temperature sensors, copper or aluminum straps, heat pipes, and space blankets called multi-layer insulation or MLI.
- Do you remember the shiny outer layer of the Hubble Space Telescope? That is a space blanket. That is part of what a thermal engineer does.



Radiators (white panels)



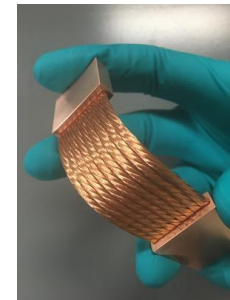
Bonded Sensors



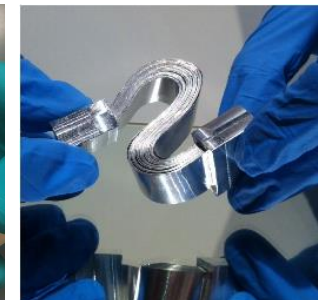
Kapton film heater



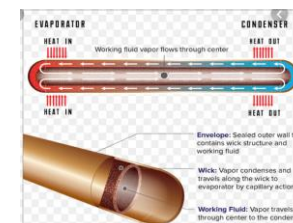
MLI Blanket



Cu Heat Strap



Al Heat Strap



Heat Pipe



MLI on Hubble

# What a Thermal Engineer Does... Outside of NASA: My Hobbies 😊



## Favorite Classes:

- Science & Math

## Favorite Activities in College and/or After:

- Soccer
- Ballet & Ballroom Dancing
- Singing in Choir
- Theater/Acting
- Playing saxophone and piano
- Board games & spending time with friends
- Tutoring for kids
- Engineers Without Borders (designed a constructed wetlands to filter pathogens out of drinking water for a village in Brazil)



# Questions?

- Bonus: Additional fun NASA experiences I've had...



**Instrument Wiring  
Mock-up for JWST**



**Full-Size Mockup  
of SDO**



**Installing Thermal  
Insulation on  
Spacecraft in Clean  
Room (space  
blankets)**



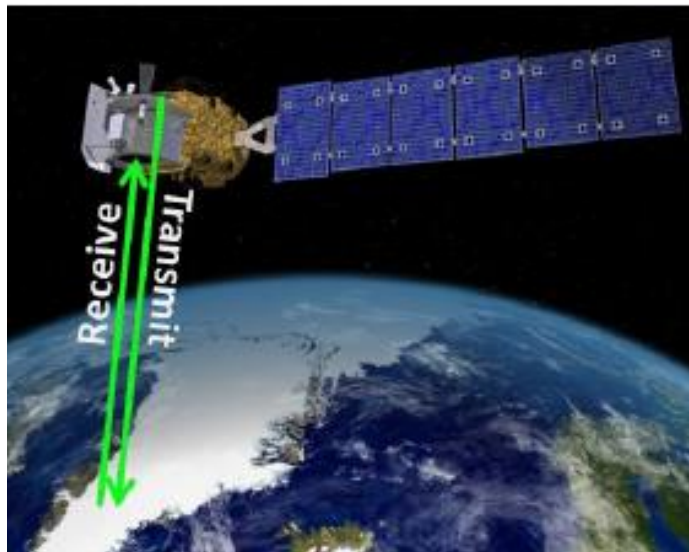
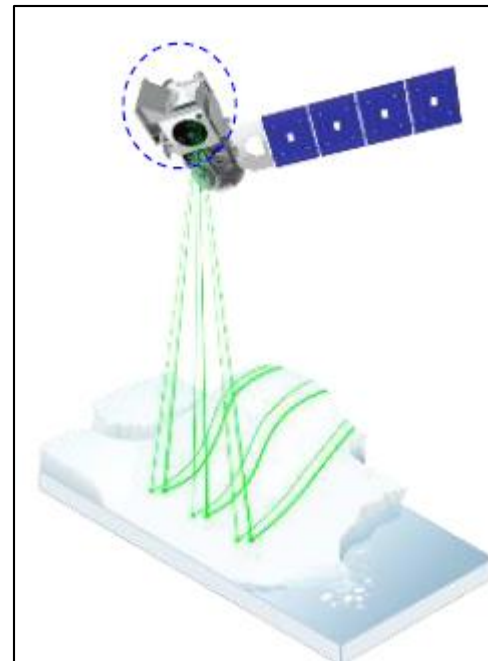
**Making Flight  
Hardware**



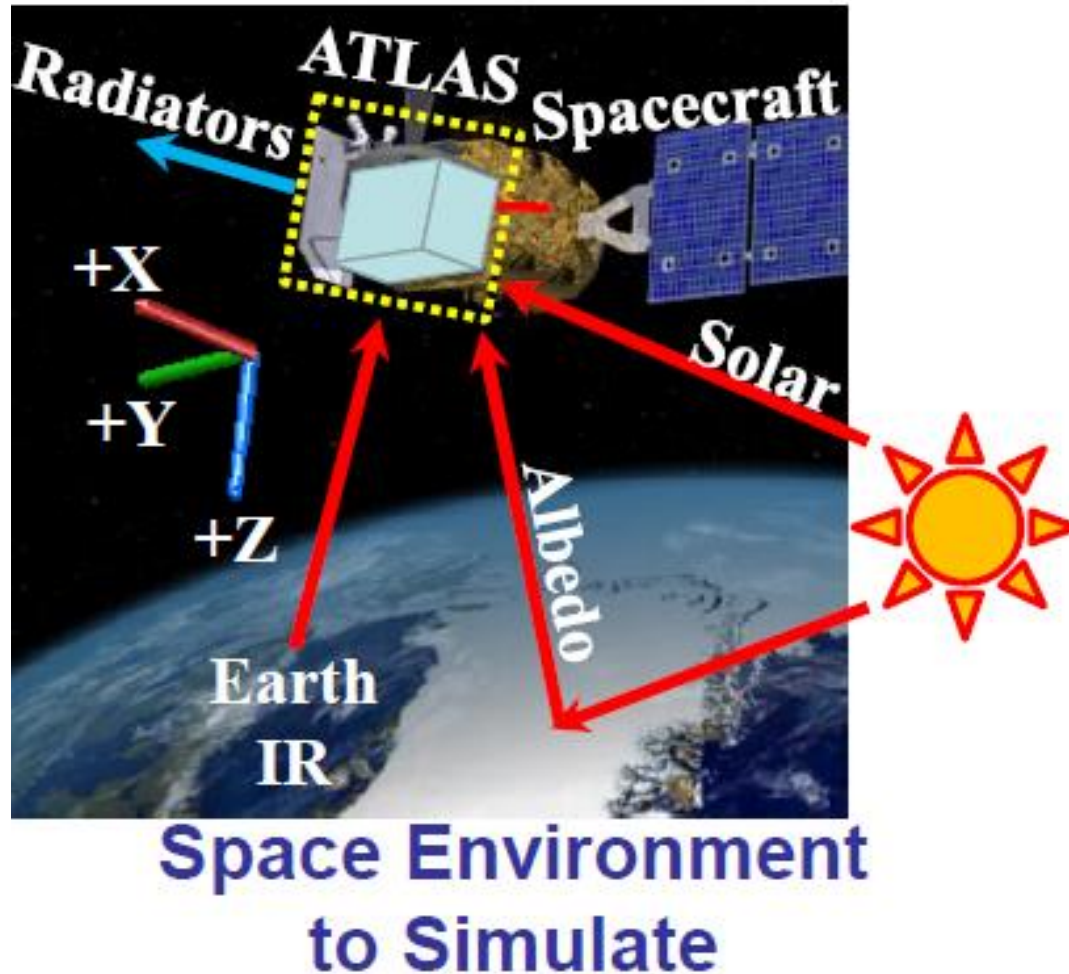
**Assisting with  
Setting Up Test  
Equipment inside  
Thermal Vacuum  
Chamber,  
Preparation for 28-  
day thermal test**

# Backup

# ICESat-2 Images

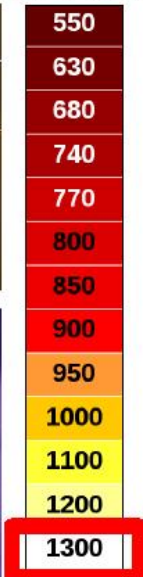


# Thermal Heat Flows In and Out of a Spacecraft



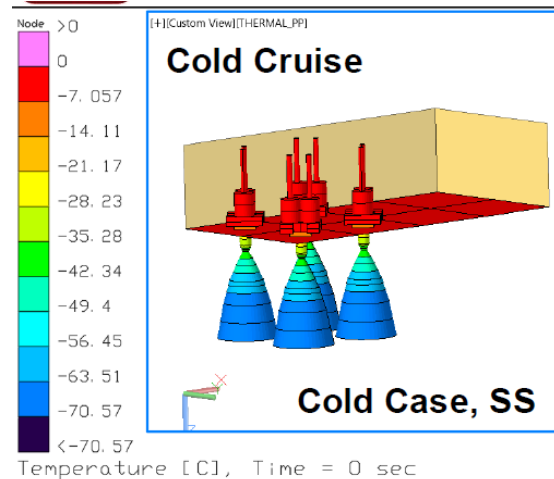
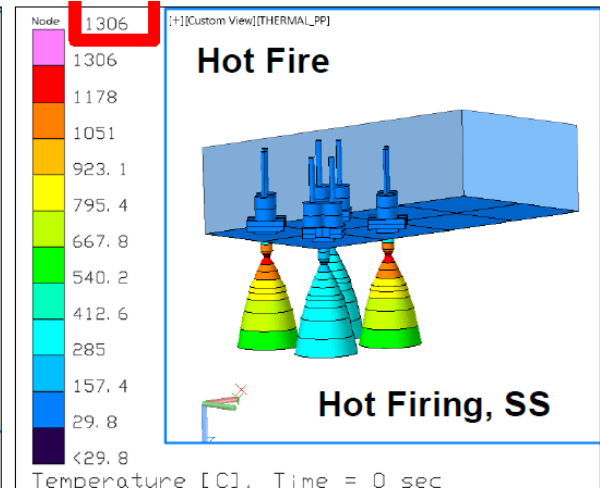
# Thermal Engineering for Spacecraft Propulsion System (Thrusters)

Incandescence  
("glowing" temperature regime):

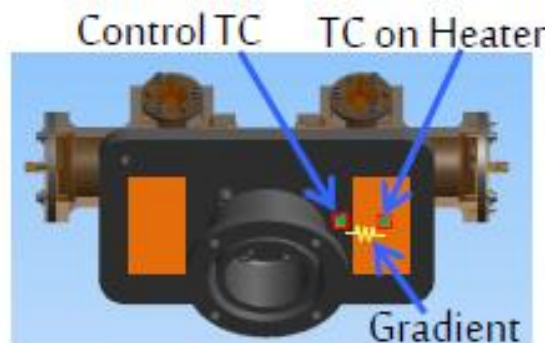
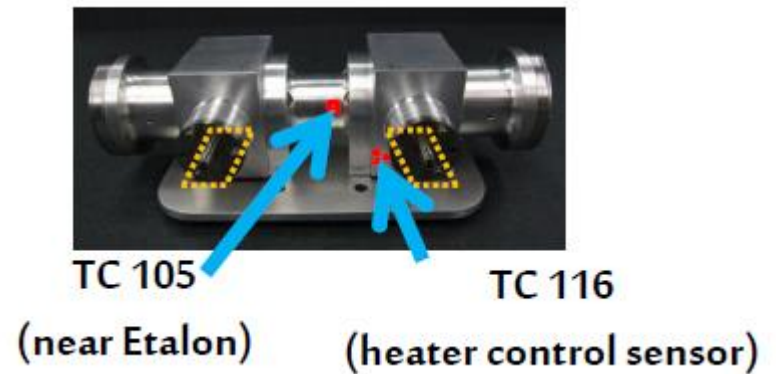
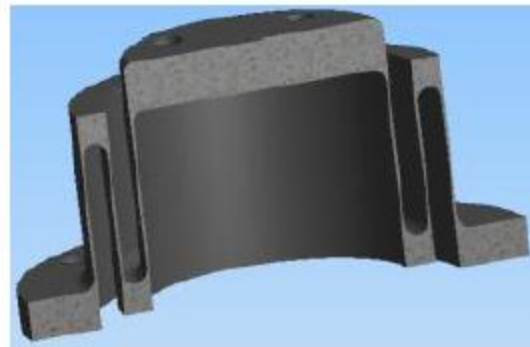


Sample photos for context.  
Photo Credits: MOOG &  
Rich Driscoll.

Temperature  
[C]



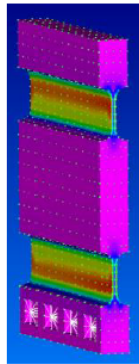
# Additional Design Images



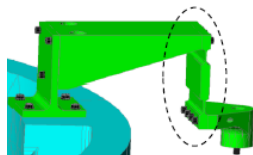
# Example of Thermal Isolator Design



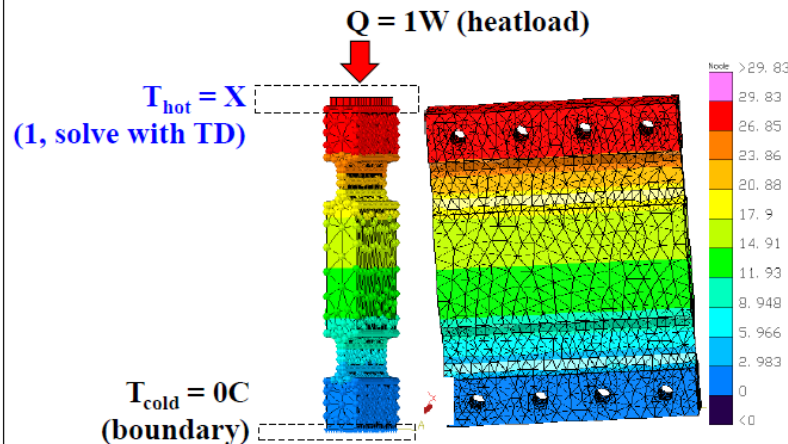
## Modeling Titanium Flexures



Structural Model



Standalone Thermal Model:



1) Solve for  $T_{hot}$ , using standalone Thermal Desktop Model:

$Q = 1W \leftarrow$  heatload applied at one end (top)

$T_c = 0C \leftarrow$  boundary nodes at other end (bottom)

$T_h = X = 29.8 C \leftarrow$  solved from standalone TD model

Note: conduction-only TD model, disabled radiation (in order to back out an equivalent G value)

### Context/Motivation:

- Critical heatflow path into flight hardware
- Used for temperature predictions, verify Wheel does not cause ATLAS structure to exceed temperature limits
- Used for S-T analysis, structural loads from Wheel into ATLAS

### Goals for Modeling:

- Preserve accuracy (conduction and radiation heat exchange)
- Reduce number of nodes and runtime

