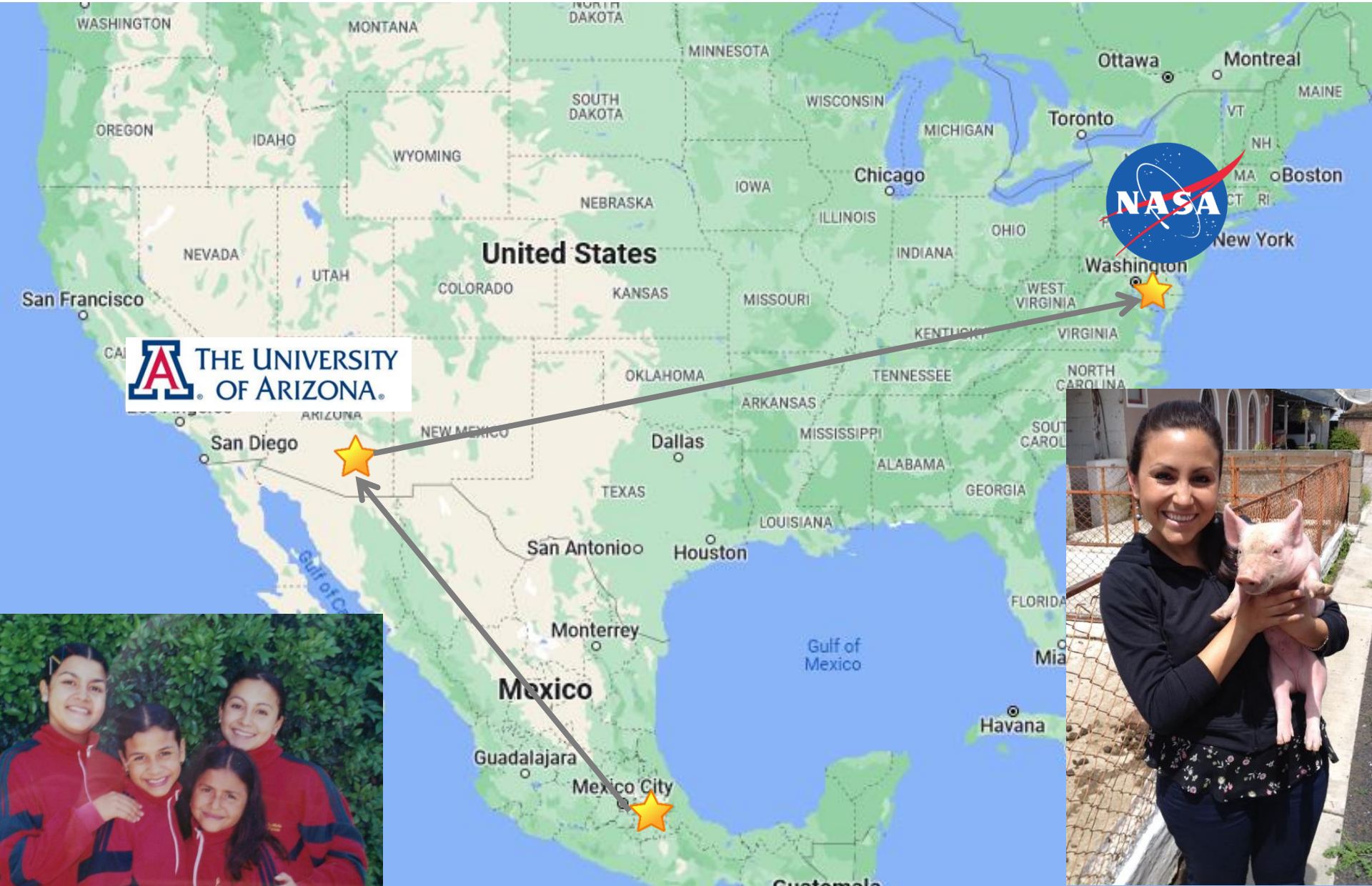
Optical Engineering and educational outreach at NASA

Margaret Z. Dominguez, Ph.D.
Optics Associate Branch Head/ Optical Engineer
2021 OPTICA Ambassador

James Corsetti, Ph.D.
Optical Engineer

UK OPTICA Student Chapters:
Bath University, Aston University, Oxford University, Bristol University
November 14-15, 2023

Margaret's journey



James's journey





1850 MELIORA

UNIVERSITY of ROCHESTER



Networking and mentoring

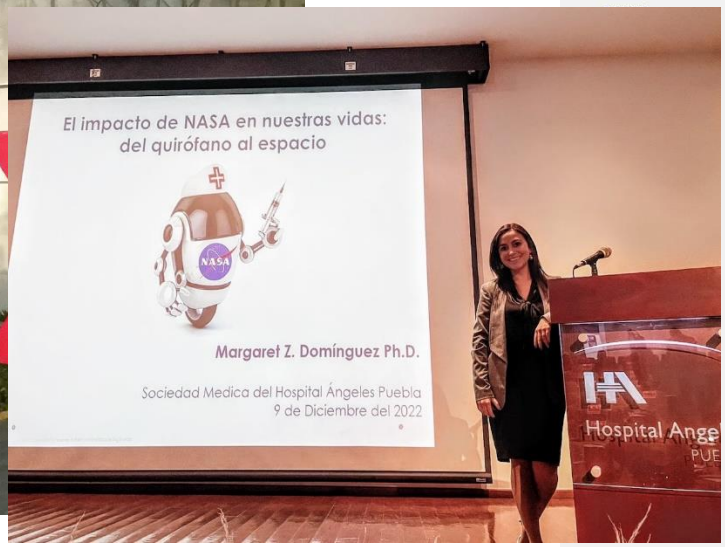






Outreach efforts



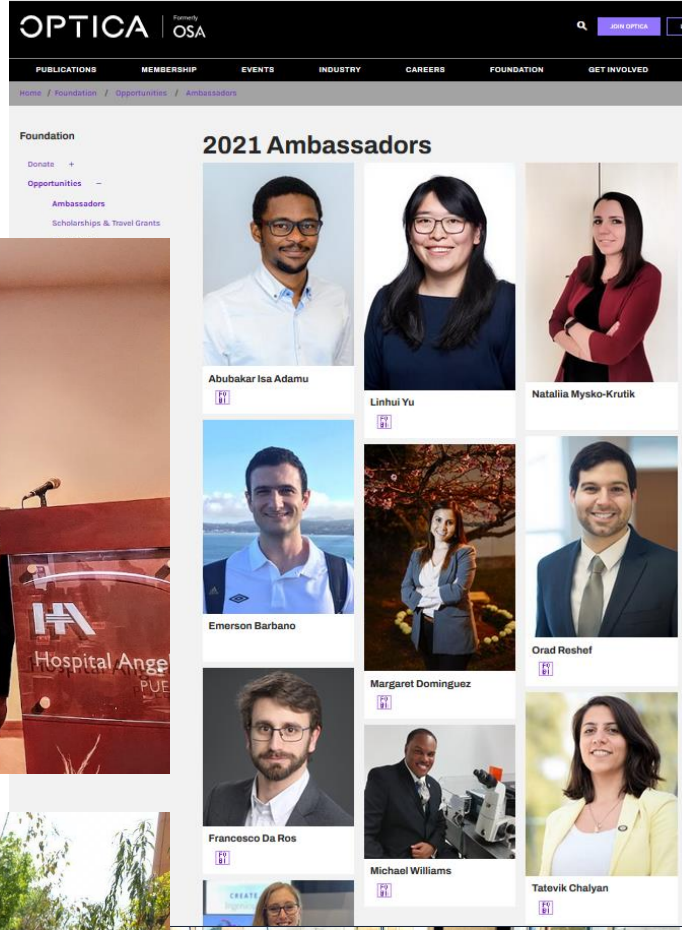














Outreach efforts

DISCOVER ENGINEERING



Latina SciGirls

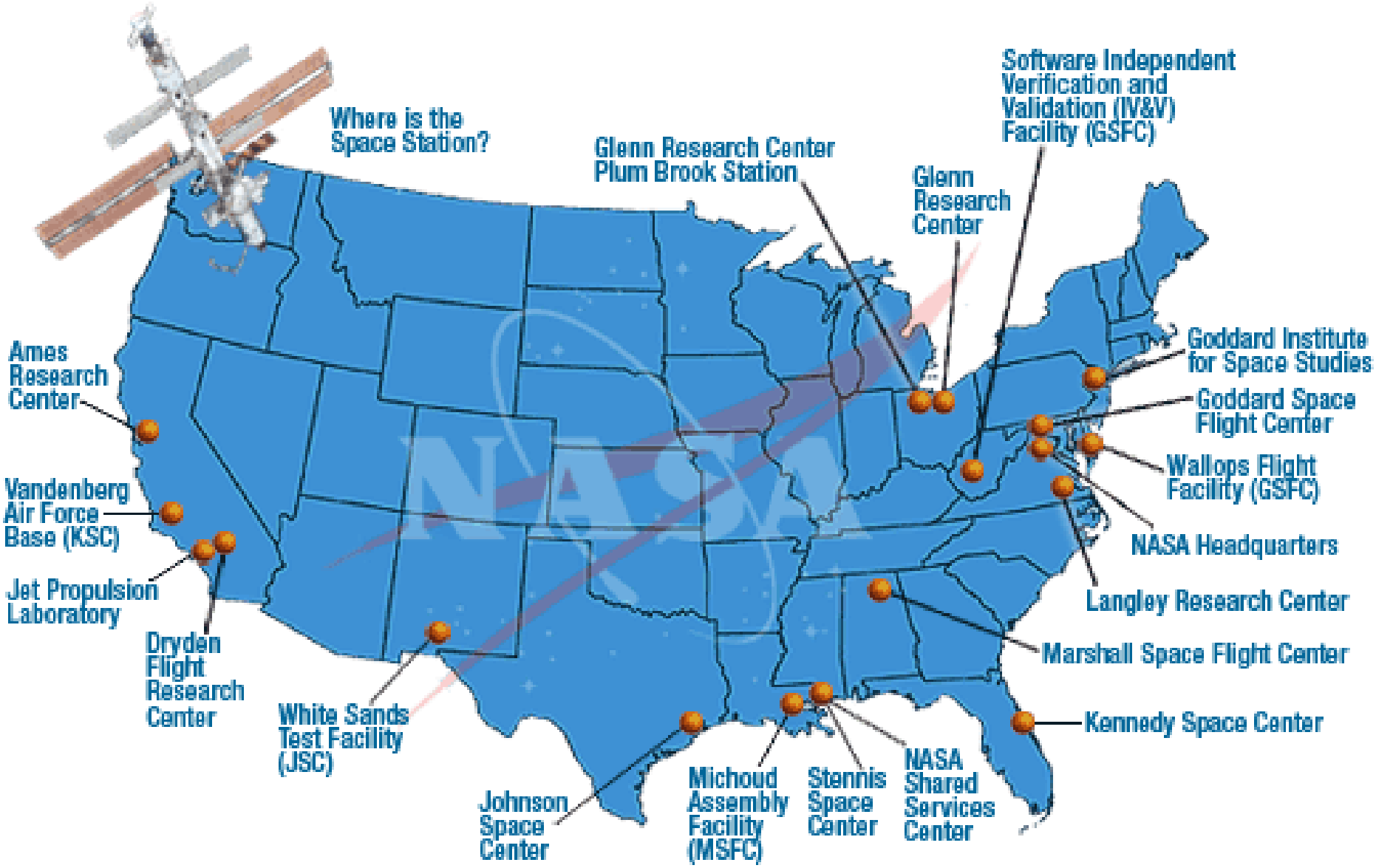
TECHNOLOchicas

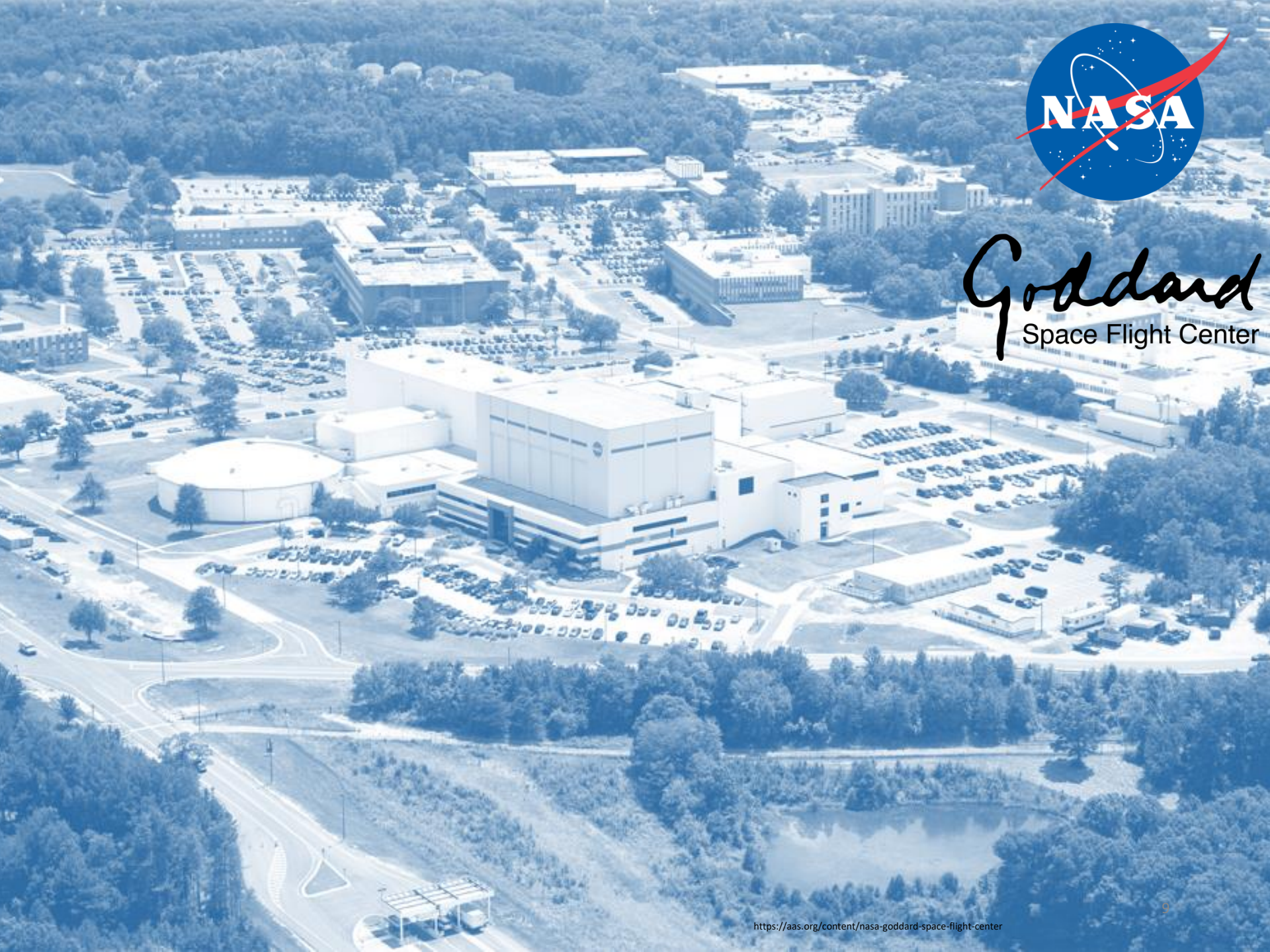




Outreach efforts

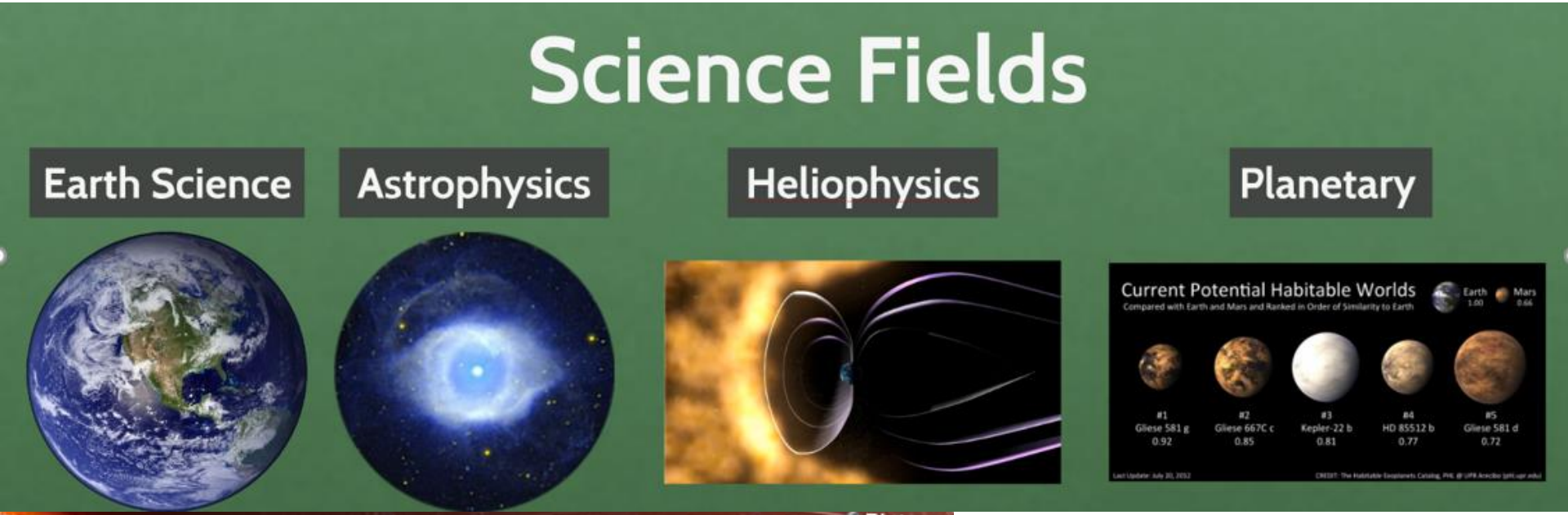


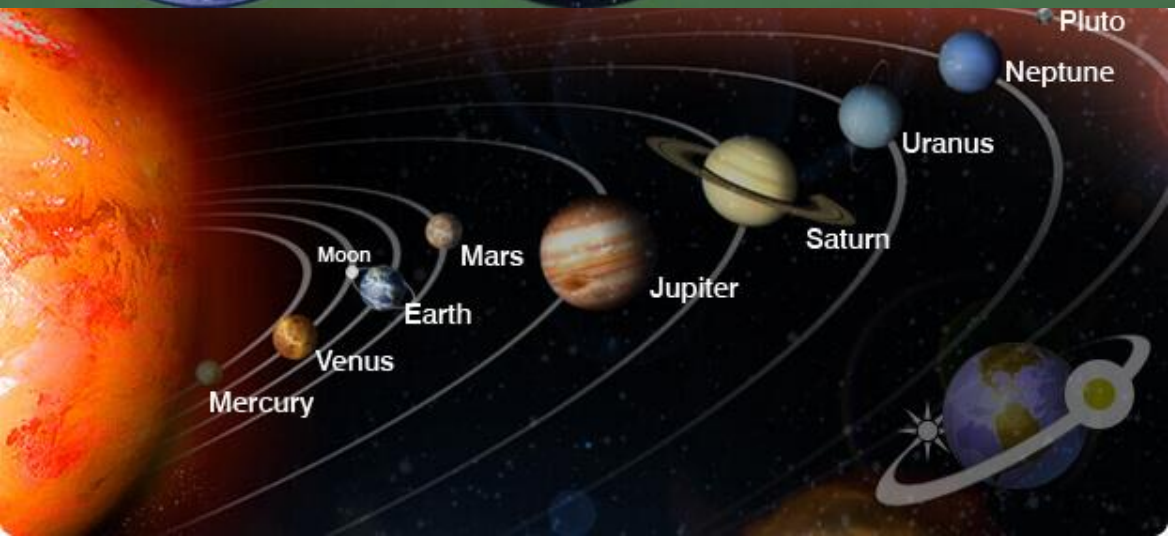

Where is the Space Station?
Glenn Research Center Plum Brook Station
Glenn Research Center
Software Independent Verification and Validation (IV&V) Facility (GSFC)
Goddard Institute for Space Studies
Goddard Space Flight Center
Wallops Flight Facility (GSFC)
NASA Headquarters
Langley Research Center
Marshall Space Flight Center
Kennedy Space Center
NASA Shared Services Center
Stennis Space Center
Michoud Assembly Facility (MSFC)
Johnson Space Center
White Sands Test Facility (JSC)
Dryden Flight Research Center
Jet Propulsion Laboratory
Vandenberg Air Force Base (KSC)
Ames Research Center



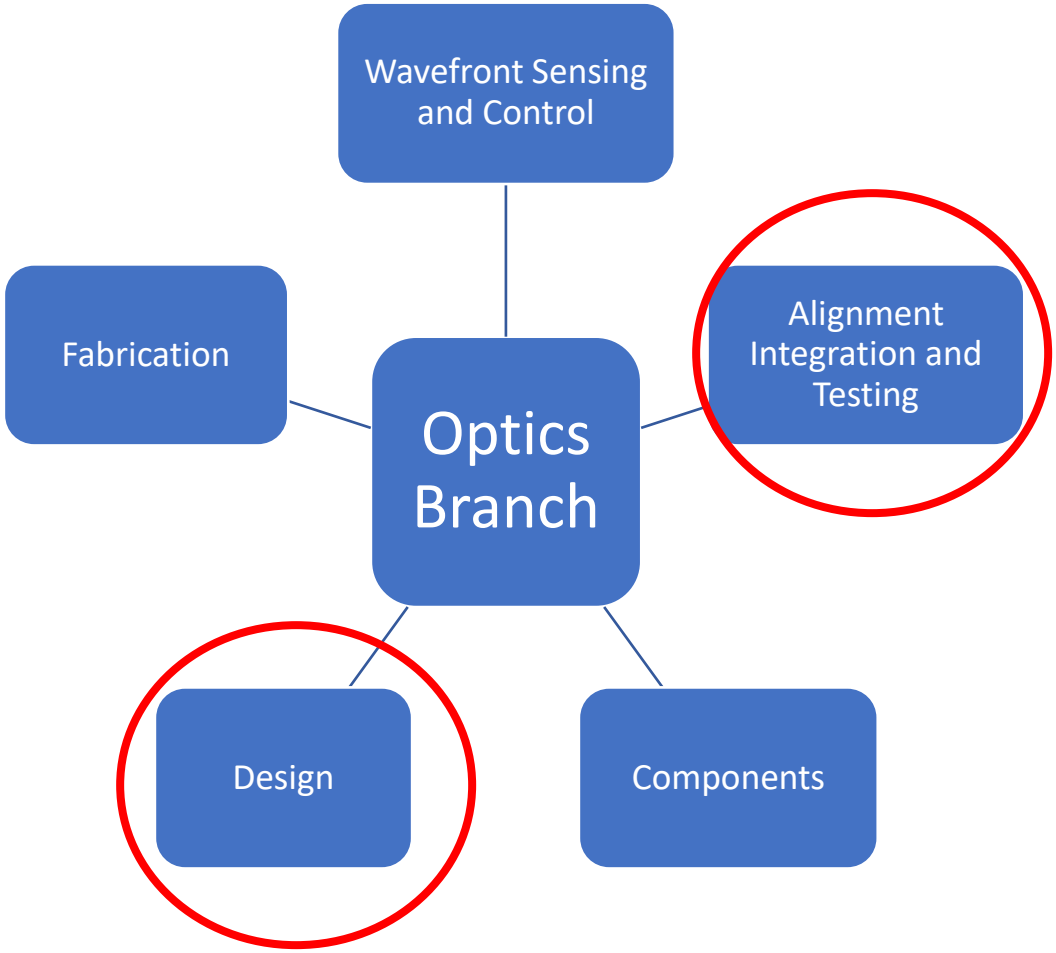
https://aas.org/content/nasa-goddard-space-flight-center

NASA Goddard Space Flight Center





NASA Goddard: Optics branch



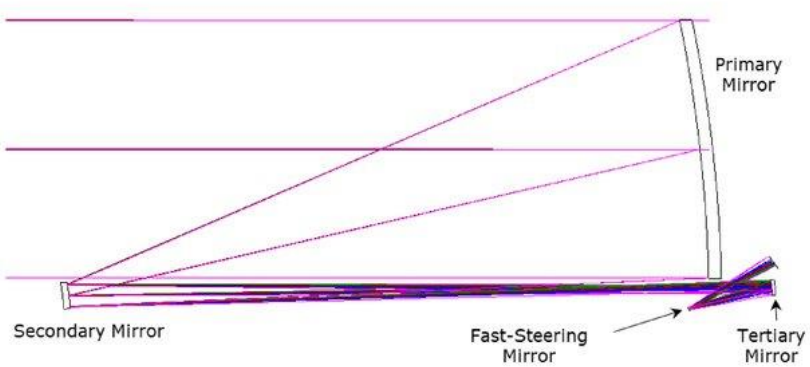
Optical system design

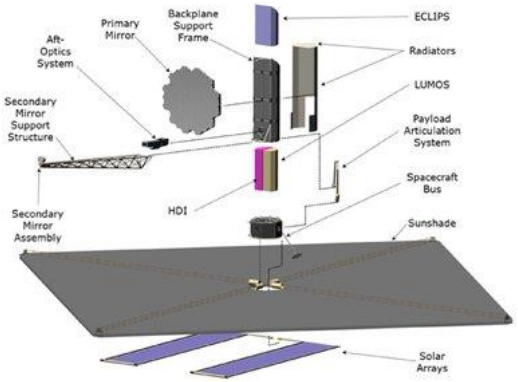
- Optical engineers responsible for the simulation and analysis of a variety of optical systems
  - Cameras, telescopes, microscopes, spectrometers, polarimeters, etc.
- Optical designs: combination of any number of lens elements, mirrors, prisms, filters, diffraction gratings, polarization elements, etc.
  - Source and detector also important considerations
- Use specialized optical design software packages
- At NASA Goddard:
  - Optical design work begins by developing a set of optical performance and other (mass, volume, schedule, cost, etc.) requirements
  - Work closely with scientists and other engineering disciplines (mechanical, thermal, etc.) to ensure all can develop realistic subsystems around the optical design while meeting science requirements
  - “Optical” design work spans EM spectrum from x-ray to microwave

Optical system design

Support different project class, from small research projects and cubesats all the way to very large Class A programs like James Webb and Roman Space Telescopes

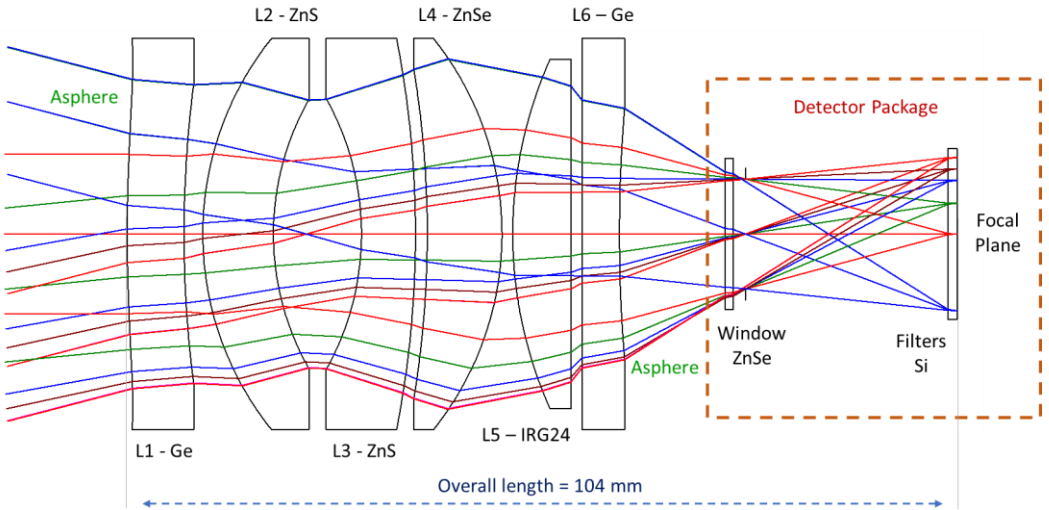
- 9 m diameter
- λ = 0.2 – 2.5 µm
- Reflective telescope
- Application: LUVOIR (now HWO)





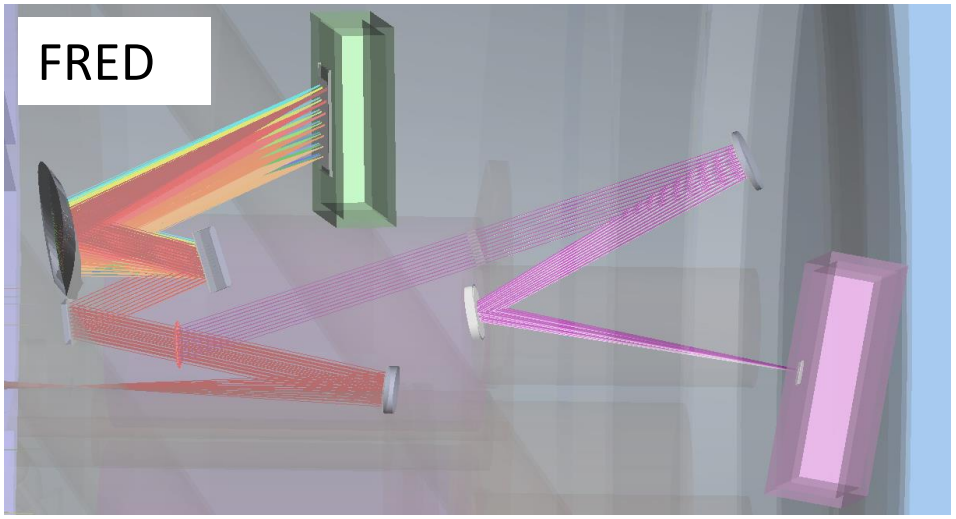
vs.

- 40 mm diameter
- λ = 2.1 – 12.3 µm
- Refractive camera lens
- Application: cubesat constellation

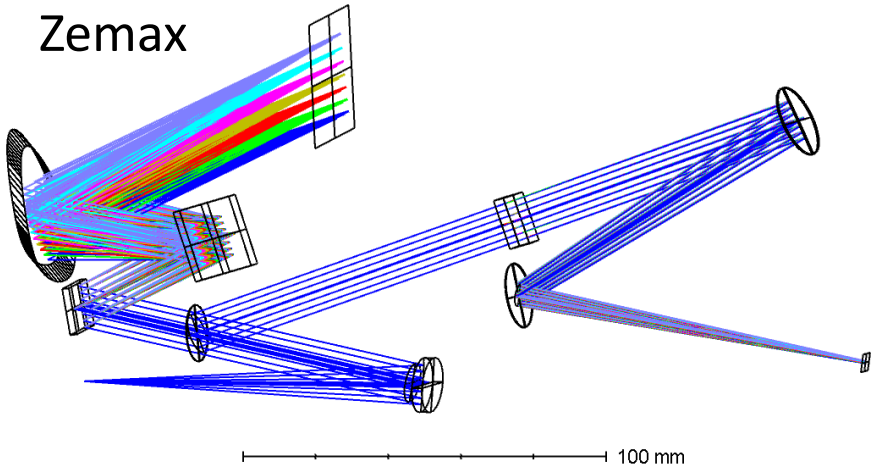


Optical design software

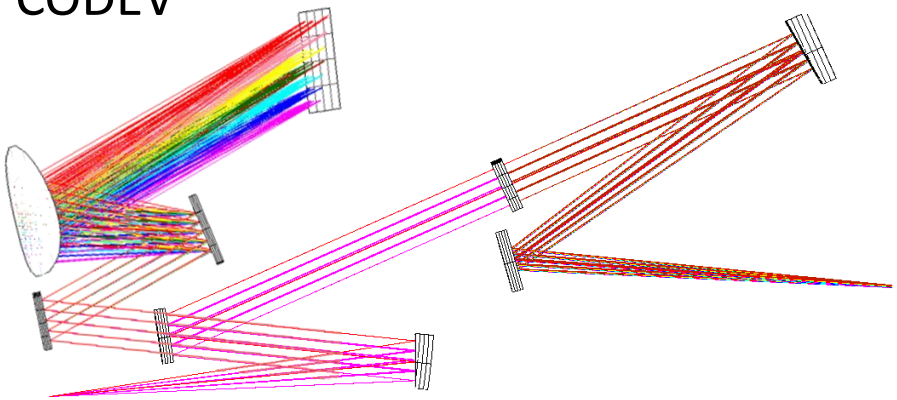
- CODEV and Zemax are primarily sequential ray tracers, useful for designing a variety of optical systems
- FRED and LightTools are non-sequential ray trace programs, useful for stray light and other analyses



Zemax



CODEV

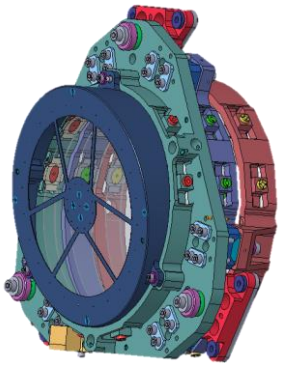


Optical Alignment, Integration and Testing

- Complete optical instrument support (concept to science)
- Science instrument alignment, test, and calibration
- Thermal-vacuum instrument expertise
- Spacecraft alignment, integration, and test
- Optical metrology:
  - Theodolites, autocollimators, alignment telescopes
  - Interferometers
  - Scanning white light interferometer (SWLI)
  - Laser trackers, laser radars
  - Coordinate Measurement Machines (CMM) with non-contact capability
  - MicroVu optical CMM

Individual elements



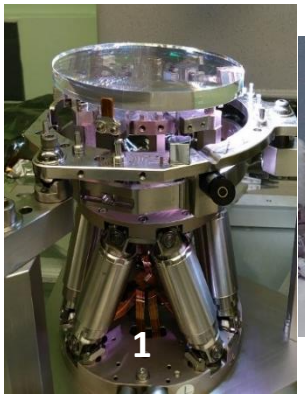


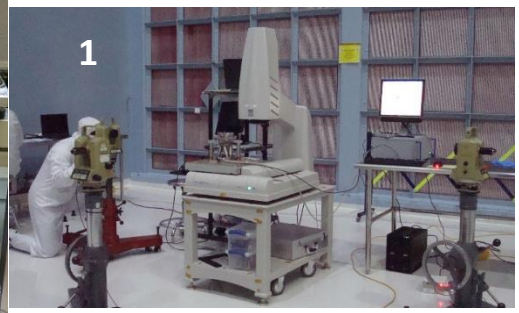
Assembly

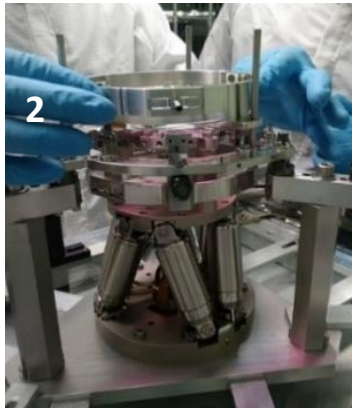
Optical Alignment, Integration and Testing

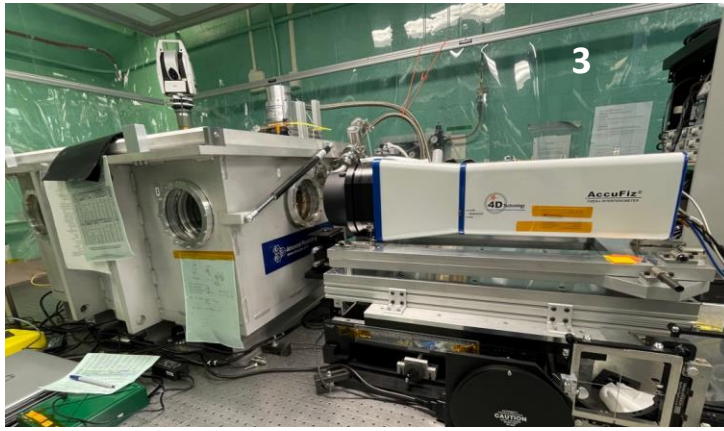
Grism Example

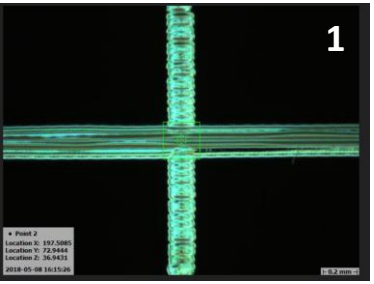
1. **Align** it using various tools and fiducials
2. **Integrate**: element to element
3. **Test** optical performance using various instruments, depending on the requirements

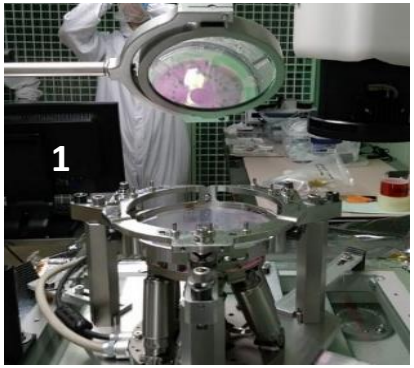


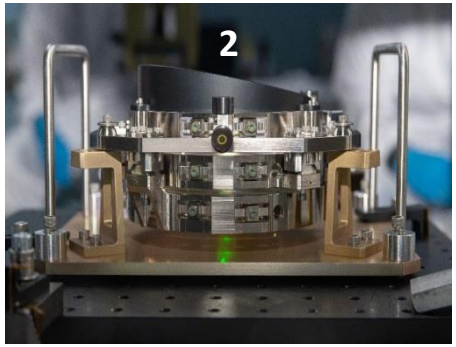


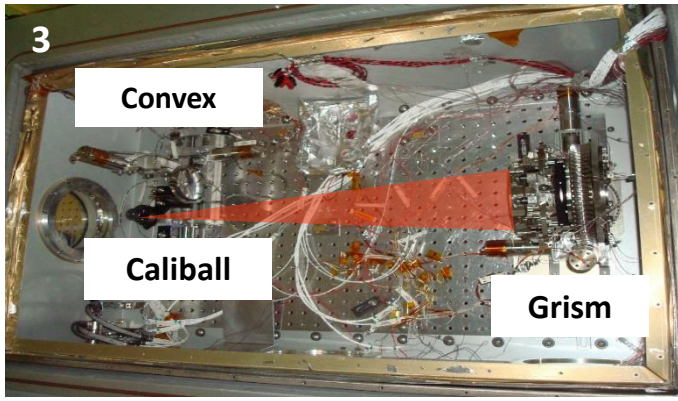












Astrophysics

Decadal Survey Missions

1990

1999

2003

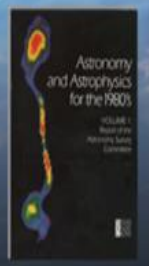
2021

2027

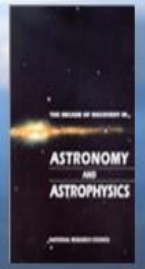
204?



1972 Decadal Survey *Hubble*



1982 Decadal Survey *Chandra*



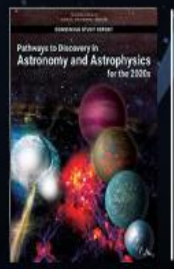
1991 Decadal Survey *Spitzer*



2001 Decadal Survey *Webb*



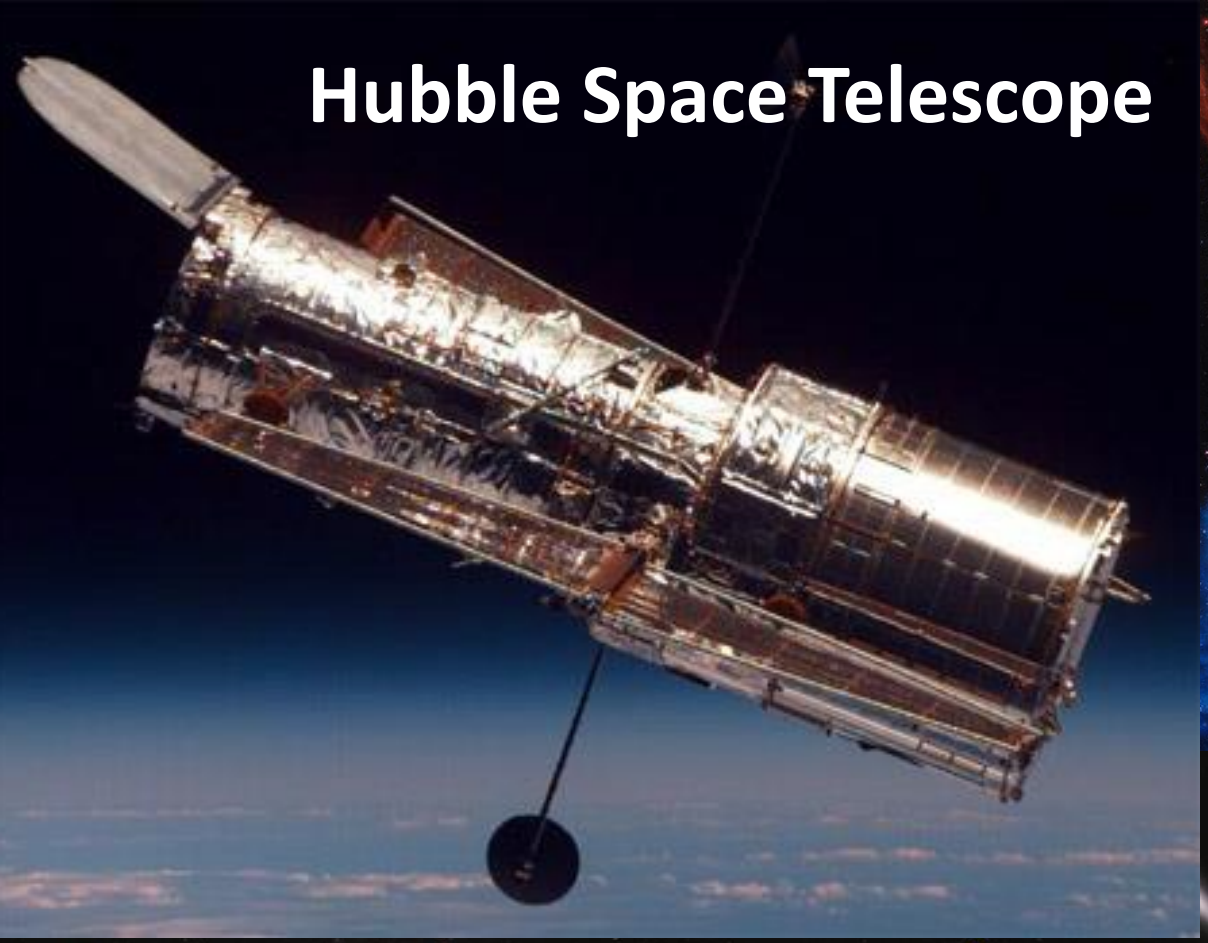
2010 Decadal Survey *Roman*



2021 Decadal Survey *HWO*

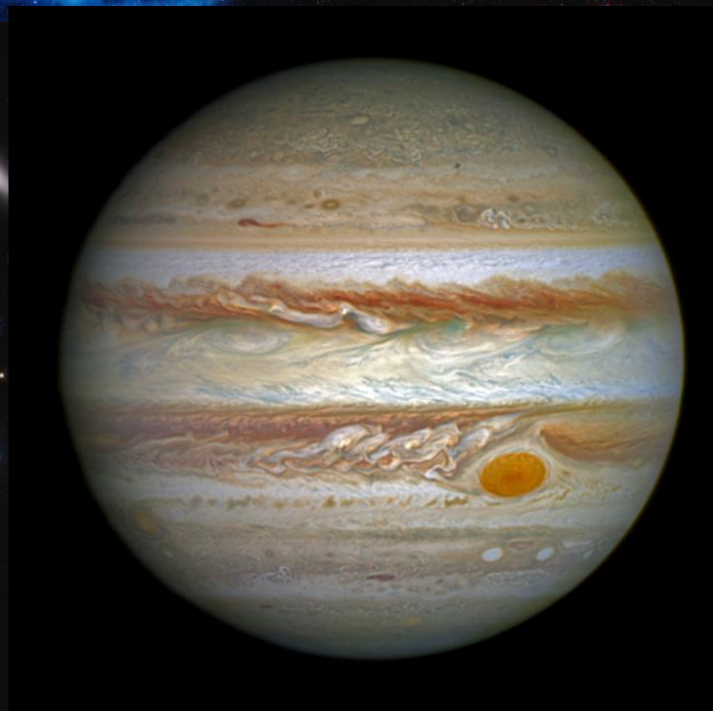
https://stsci.app.box.com/s/9g4aw6pjwryw7iu5klhdsrj7mkl9eqwv

Hubble Space Telescope





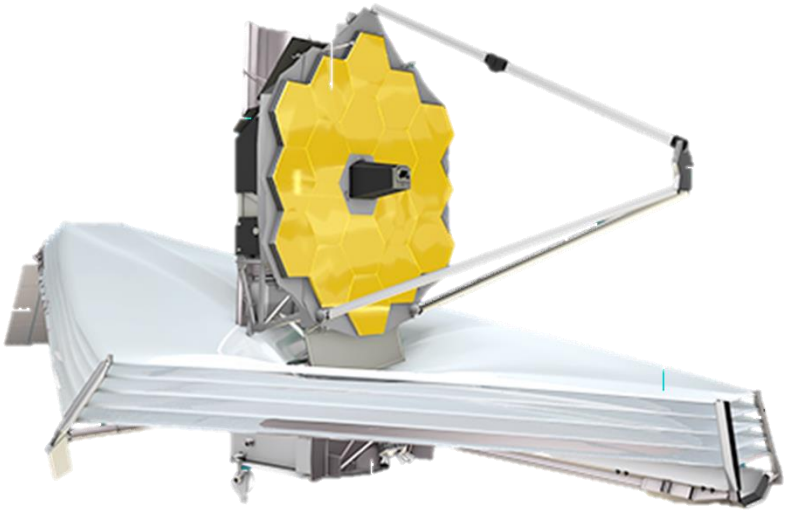




Webb Space Telescope overview

The Webb Space Telescope is an IR NASA observatory:

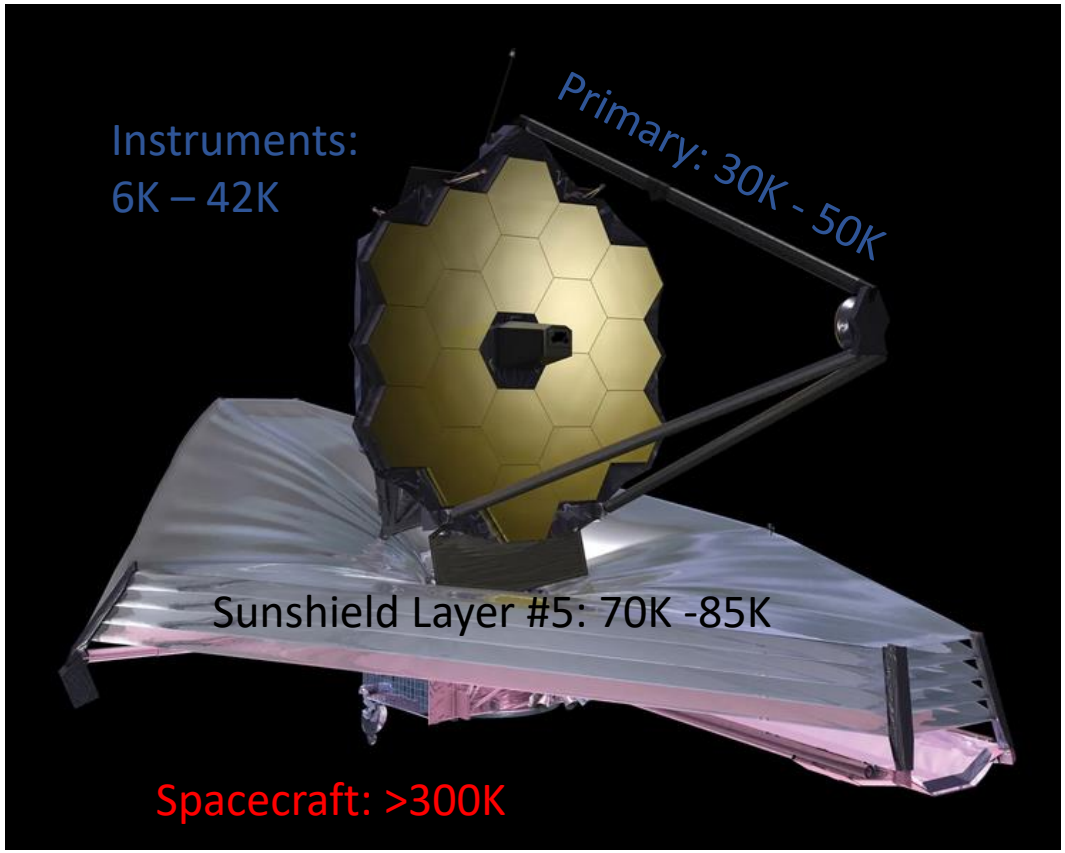
- 6.5 m telescope
- Launched in 2021
- Designed for at least 5 years, with a goal of 10 years

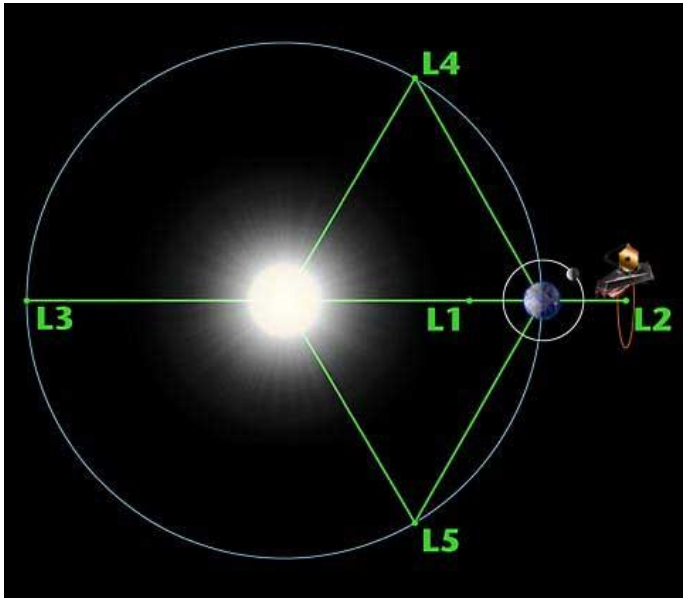


- Four instruments:
  - Near-Infrared Camera or NIRCam
  - Near-Infrared Spectrograph or NIRSpec
  - Mid-Infrared Instrument or MIRI
  - Fine Guidance Sensor/Near InfraRed Imager and Slitless Spectrograph

Webb Space Telescope temperature

0 K = -459° F = -273° C





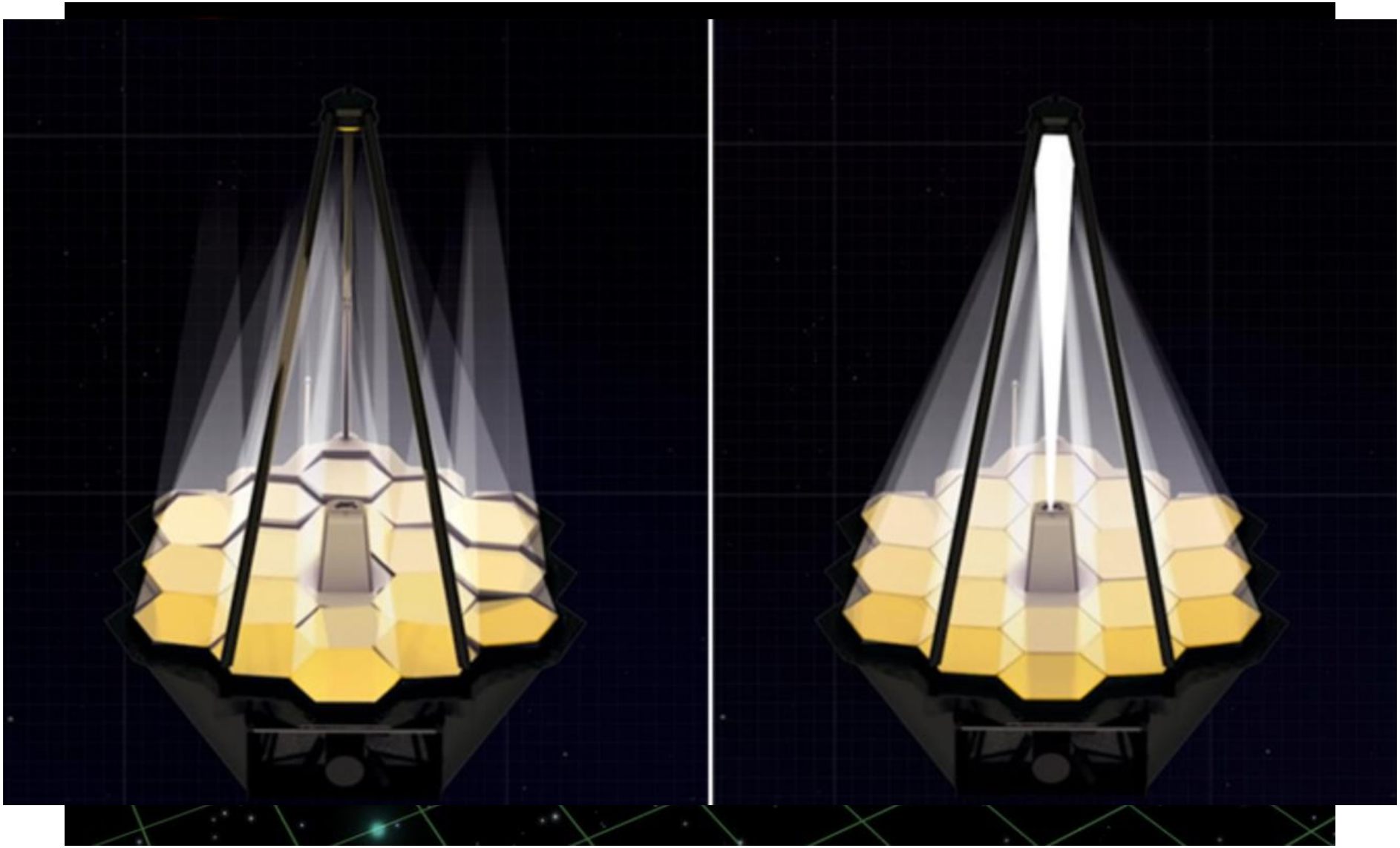
Located at L2
behind the sunshield

Sunshield protection: SPF of ~ 1.2 million





Webb Space Telescope timeline



Webb Space Telescope first images



Hubble vs Webb





https://jwst.stsci.edu/science

Nancy Grace Roman Space Telescope

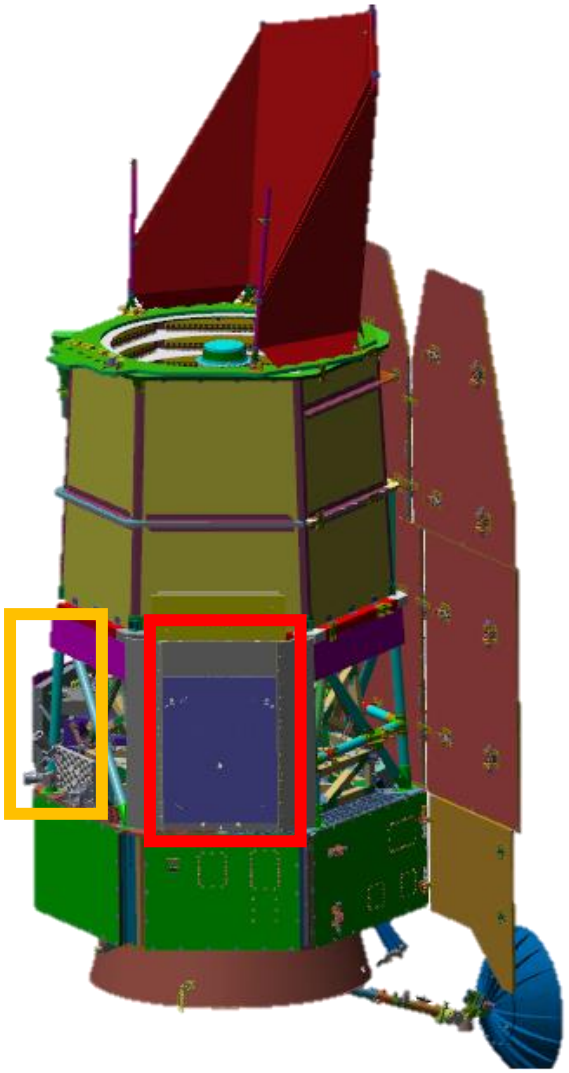


https://www.nasa.gov/press-release/nasa-telescope-named-for-mother-of-hubble-nancy-grace-roman

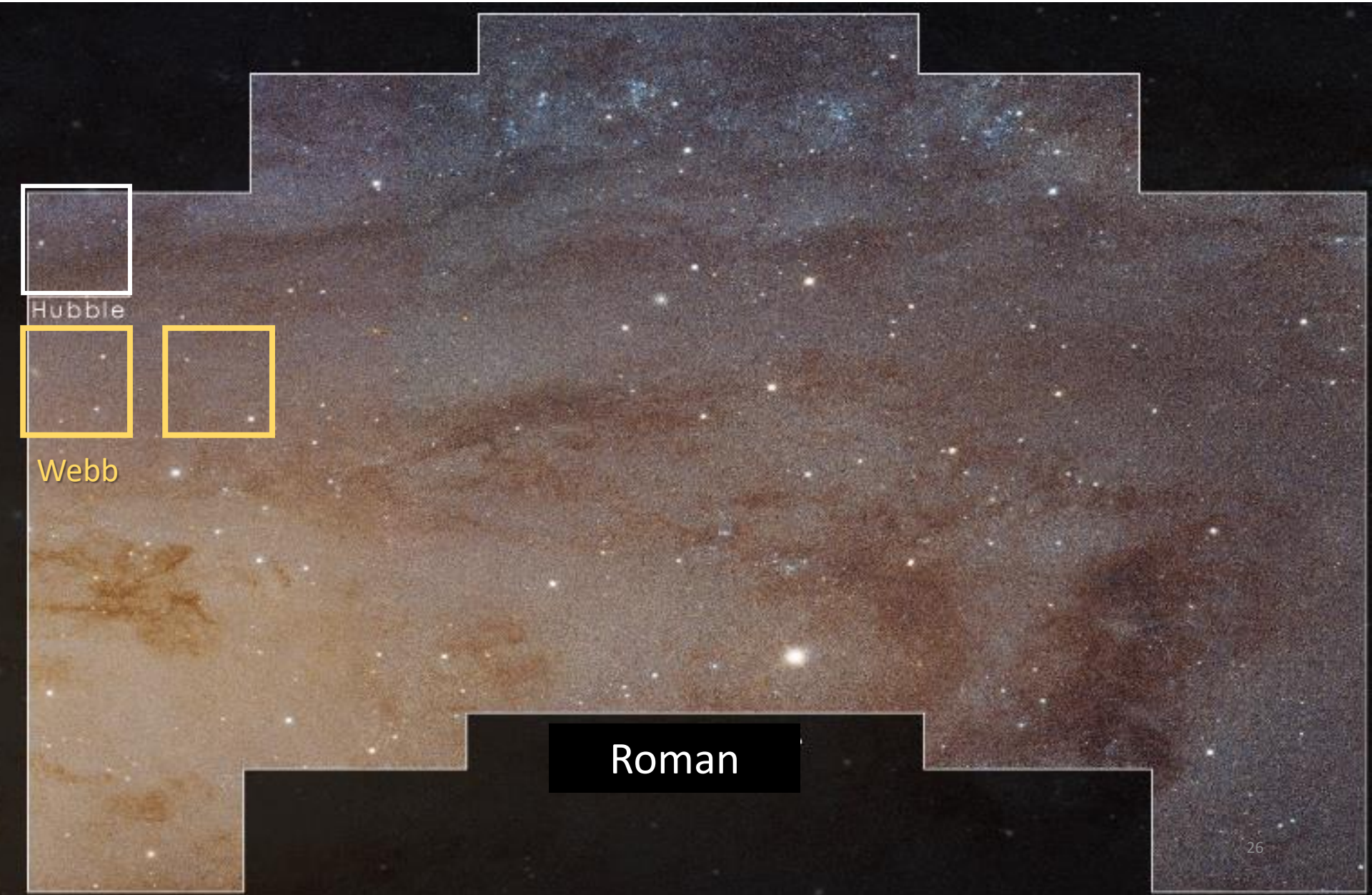
Roman Space Telescope overview

The Roman Space Telescope is an IR NASA observatory:

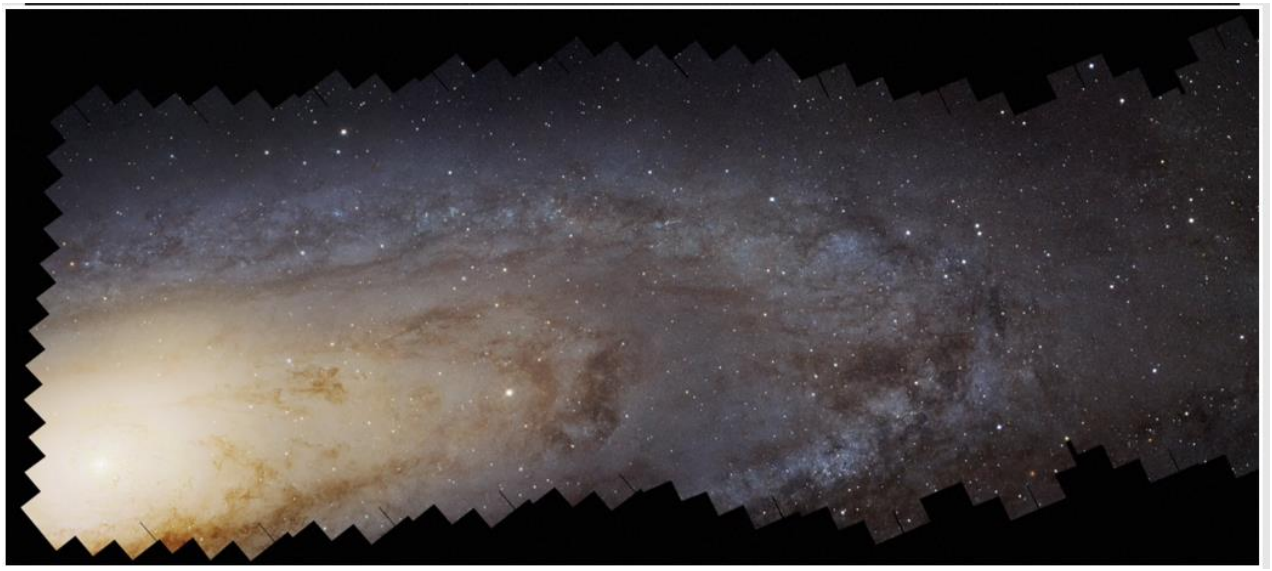
- 2.4m telescope
- Launch in 2026-2027
- Designed for at least 5 years, with a goal of 10 years
- Two instruments:
  - Wide Field Instrument
  - Coronagraph Instrument

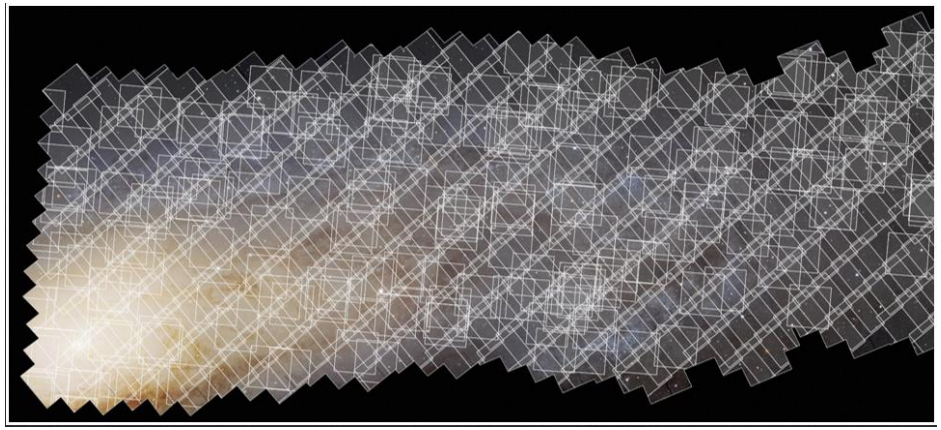


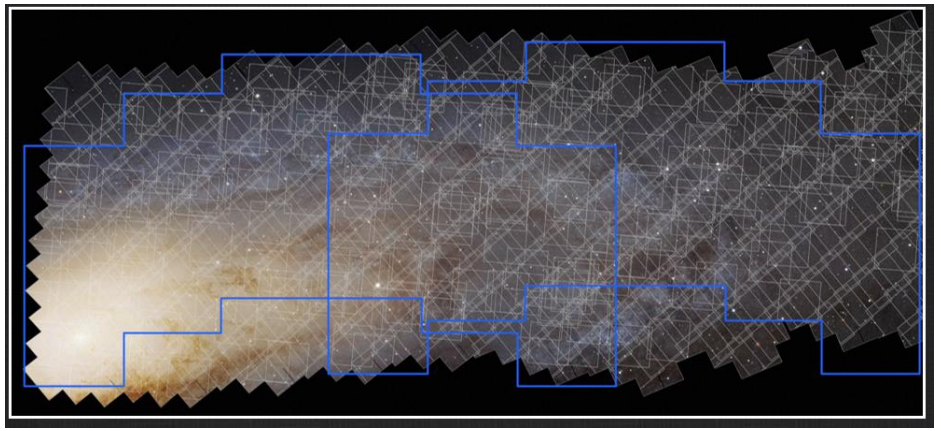
Roman Space Telescope FOV



Roman Space Telescope FOV: Andromeda galaxy



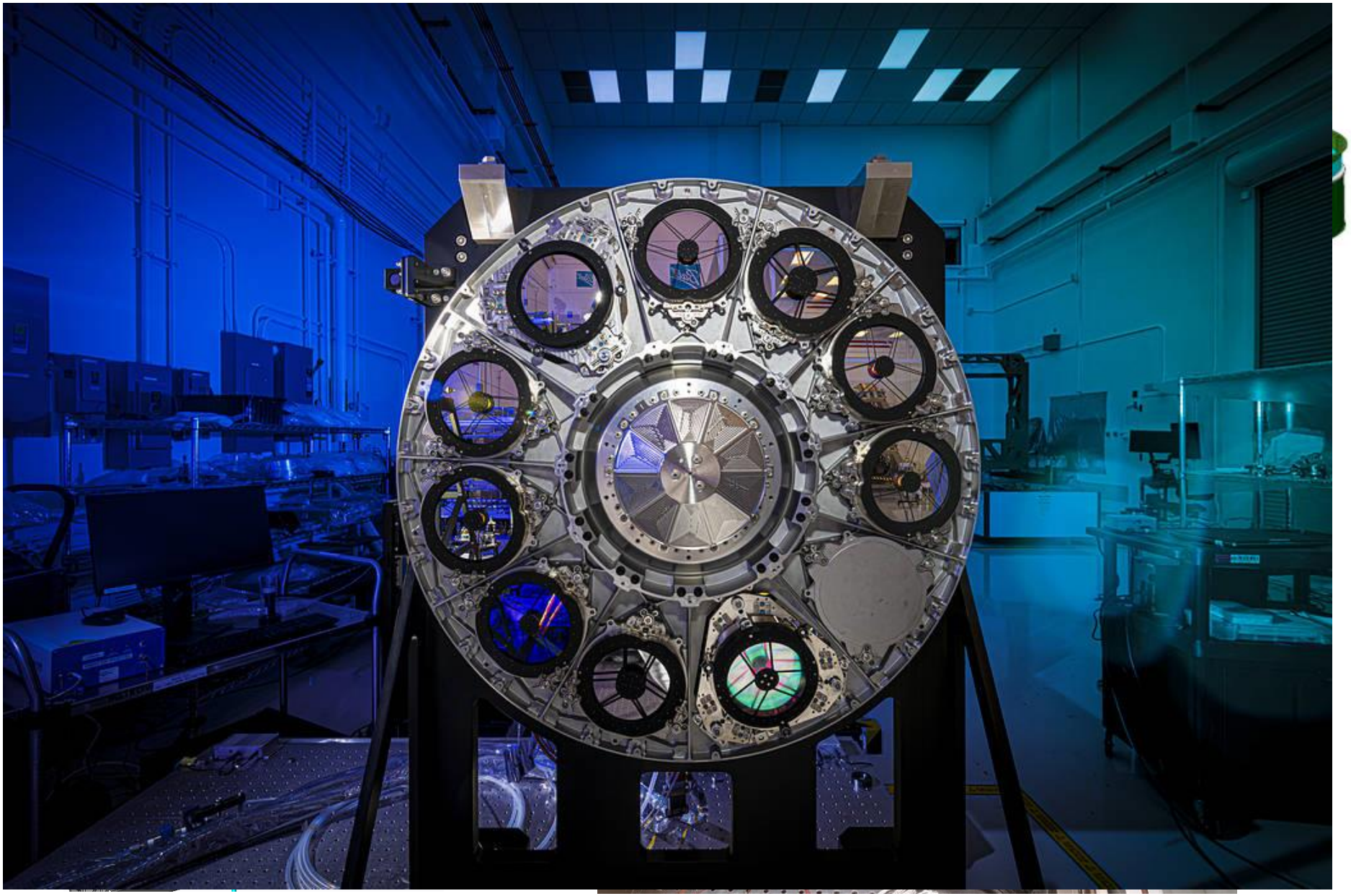




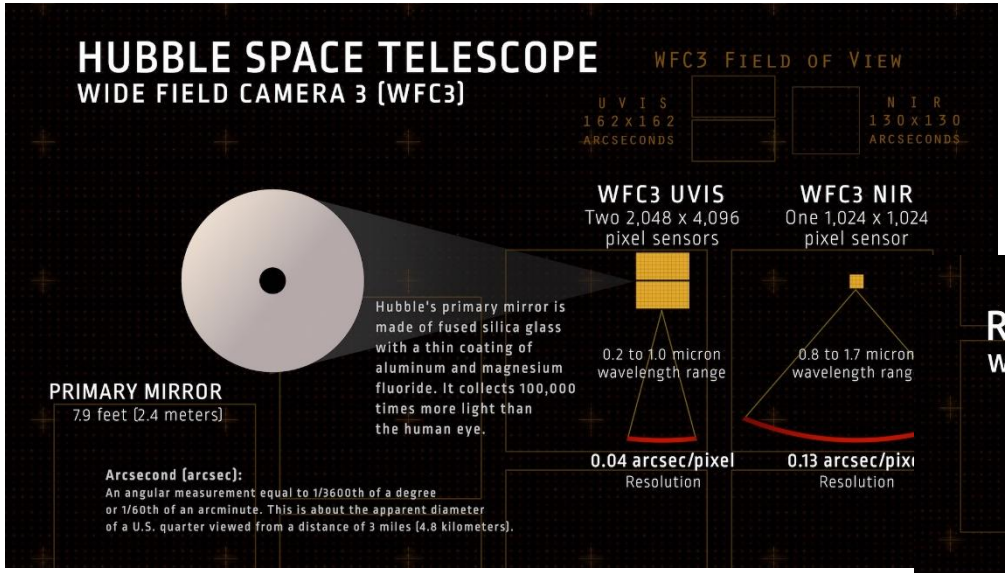
Hubble: 400+ individual pointings

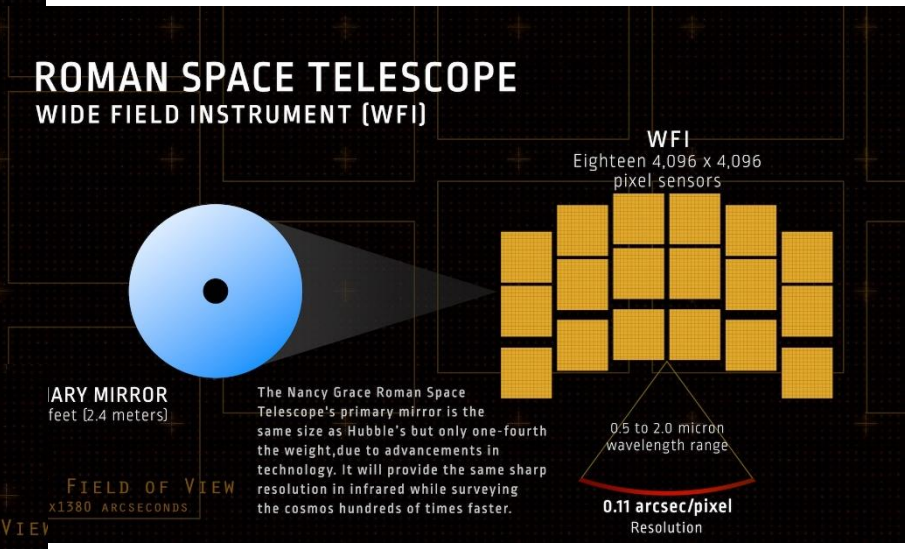
Roman: 2 individual pointings

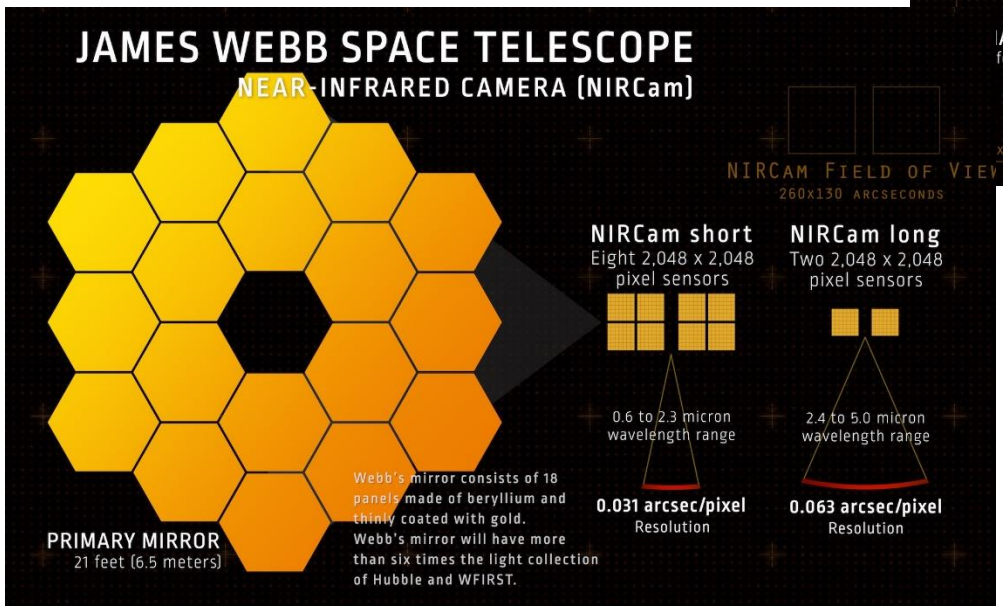
Roman Space Telescope WFI



Telescope comparison







How to get an internship at NASA as a Foreign National?

1) NASA International Partnership Program (Foreign Space Agencies):

- Australia
- New Zealand
- Canada
- Europe
- Portugal
- Norway
- Sweden
- UAE
- …

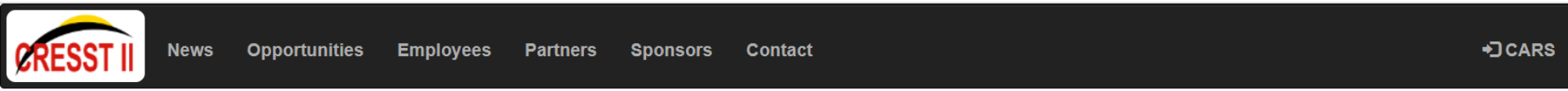
arc-international-internships@mail.nasa.gov

2) Contractor Companies (private sector):

- Boeing Corporation
- Lockheed Martin Corporation
- Northrop Grumman Corporation
- L3 Harris
- Johns Hopkins University
- KBR
- …

Apply directly with each company

3) https://cresst2.umd.edu



CRESST II Summer Internship Program

CRESST II works in conjunction with NASA/Goddard Space Flight Center (GSFC) to facilitate the CRESST II/NASA summer internship program. Summer internships are a 10-week paid internship where students can work alongside NASA scientists on research projects that support the science missions of NASA.

For the 2023 Summer Internship session, the 10-week session will begin on Monday, June 5th and end on Friday, August 11th. Deviations from this specific period are possible with the agreement of the designated mentor.

Applying for an Internship – U.S. Citizens

U.S. citizens interested in an internship at NASA/GSFC, or any other NASA Center must apply directly through the NASA STEM Gateway portal. To be eligible to apply through the portal you must be a U.S. citizen, be enrolled full-time in a degree-granting program at an accredited U.S. college or university, have a cumulative 3.0 GPA (on a 4.0 scale), and be 16 years of age at the time of application. The deadline to apply for the 2023 Summer Internship session is March 1, 2023.

Additional information about eligibility, application deadlines, and internships in general can be found on the NASA STEM Engagement website.

Applying for an Internship – International Students or Green Card Holders

NASA internships advertised on the NASA STEM Gateway portal are exclusively for students who are U.S. citizens. CRESST II has the flexibility to hire undergraduate or graduate international students or green card holders who are enrolled full-time in a degree-granting program at an accredited U.S. college or university. International students or green card holders interested in applying to the CRESST II Internship Program must submit the CRESST II Summer Internship Application along with a resume, college transcript, and a short essay.

The application deadline for Summer 2023 is February 1, 2023. Applicant materials should be emailed directly to the CRESST II Program Associate. During the screening and review process, we will attempt to match applicants with appropriate GSFC scientists and projects. To exemplify the type of opportunities likely to become available, see sample research project reports from previous years.

Note: Citizens from NASA designated countries are not able to work on NASA research projects onsite at GSFC or virtually and therefore are ineligible for the CRESST II Internship Program.

JPL PROGRAMS

JPL Visiting Student Research Program

The JPL Visiting Student Research Program, or JVSRP, offers research opportunities to students who have a compatible research interest with NASA/JPL and have secured funding from third-party sponsors who are not associated with NASA or JPL funding sources.

As part of their fellowship, students are partnered with JPL scientists or engineers, who serve as the students' mentors. Students complete designated projects outlined by their mentors, gaining educational experience in their fields of study while also contributing to NASA and JPL missions and science. Students will also have the opportunity to participate in a number of enrichment activities, including tours, lectures and career advisement, arranged by the JPL Education Office.

Requirements:

- Must have been awarded an internship or fellowship through a third party, such as their government, university, a foundation, or similar organizations.
- The award must include a visiting research experience and funding for the student during the internship or fellowship experience.

4) https://www.jpl.nasa.gov/edu/intern/apply/visiting-student-research-program/

Thank you!

Any questions?