James Webb Space Telescope(JWST) EEE Parts Program Report

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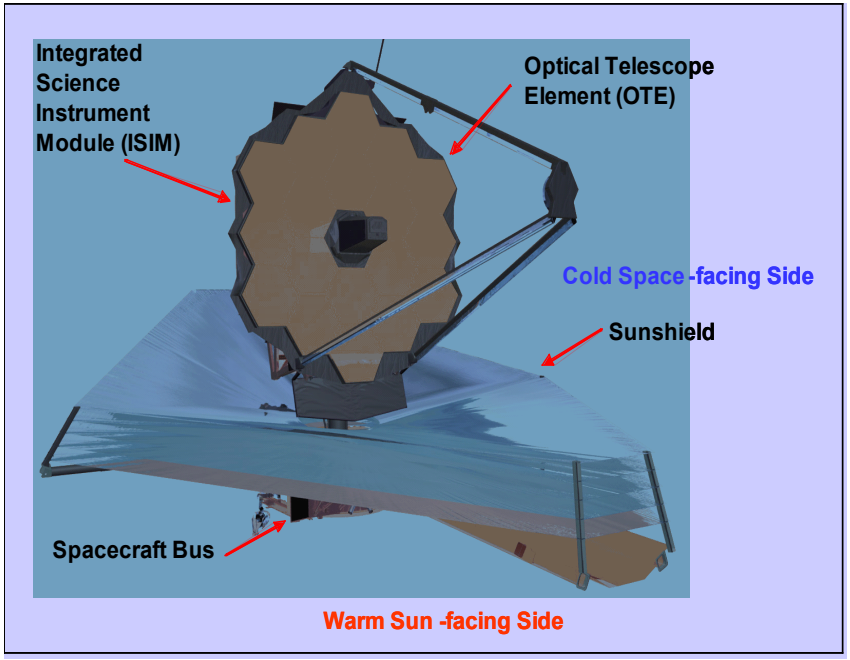
JWST Worldwide Team/Partners.

Organization

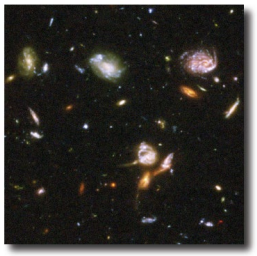
- **Mission Lead: Goddard Space Flight Center**
- **International collaboration with ESA & CSA**
- **Prime Contractor: Northrop Grumman Space Technology**
- **Instruments:**
  - **Near Infrared Camera (NIRCam) – Univ. of Arizona**
  - **Near Infrared Spectrograph (NIRSpec) – ESA**
  - **Mid-Infrared Instrument (MIRI) – JPL/ESA**
  - **Fine Guidance Sensor (FGS) – CSA**
- **Operations: Space Telescope Science Institute at John Hopkins U in Baltimore**



Description

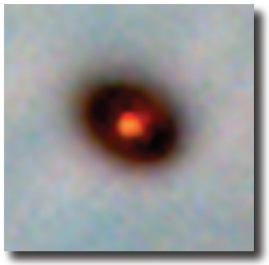
- Deployable infrared telescope with 6.5 meter diameter segmented adjustable primary mirror
- Cryogenic temperature telescope and instruments for infrared performance
- **Launched Dec 25, 2021 on an ESA-supplied Ariane 5 rocket to Sun-Earth L2**
- 5-year science mission (10-year goal)

JWST Science Themes

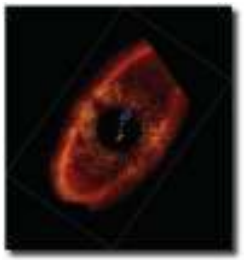


End of the dark ages: First light and reionization

The assembly of galaxies



Birth of stars and proto-planetary systems



Planetary systems and the origin of life

James Webb Space Telescope (JWST)

For JWST Information

www.JWST.nasa.gov

https://blogs.nasa.gov/webb/

- **Launched Dec 25, 2021 on an ESA-supplied Ariane 5 rocket to Sun-Earth L2**

JWST Status

On Jan 8, 2022 at 1:17 p.m. EST, NASA's James Webb Space Telescope completed all of its large-scale deployments with the extension and latching of its starboard primary mirror wing.

Now that the telescope is structurally fully deployed – Webb was commissioned July 22, 2022.

JWST Status

- Webb Links : All information available to Public
  - https://blogs.nasa.gov/webb
  - https://webbtelescope.org/

    - **Latest Observations – Globular Cluster M92 (NIRCam Detail)**

- **JWST Team Phase E Team**
  - Supporting the software systems located around world to ensure JHU Mission Operation Center and it Investigators can provide the images.

  - For ~ end of year the A Team of investigators will continue to showcase the capabilities of the Webb telescope.

JWST Webb is Showcasing it amazing capabilities

JWST Programmatic Challenges 1

:

1) The scope of EEE parts for JWST is > 6000 unique line items in over 60 Sub systems .

2) The program spans over 20 years. Issues of obsolescence and design changes were constantly mitigated. I have been a member of the team for ~ 12 years.

3) International Traffic and Arms Regulations (ITAR) and Export Administration Regulations (EAR) had to be managed with foreign partners, i.e. ESA and CSA, and their respective contractors and subcontractors.

4) The JWST NIRSpec instrument developed components for use at cryogenic temperatures, 38 K- 40K (-235° C to -233° C).

JWST encountered various unique challenges

JWST Programmatic Challenges-continued

5) EEE Parts problems averaged 1 every 6 weeks for ~ 13 years

6) Government Industry Data Exchange Reports (GIDEP) had to be assessed in a timely manner. They averaged ~10 per month for EEE Parts.

7) NASA GSFC EEE Parts Analysis Lab directly handled over 600 JWST parts jobs over the past decade including screening, qualification, Destructive Physical Analysis, and Failure Analysis.

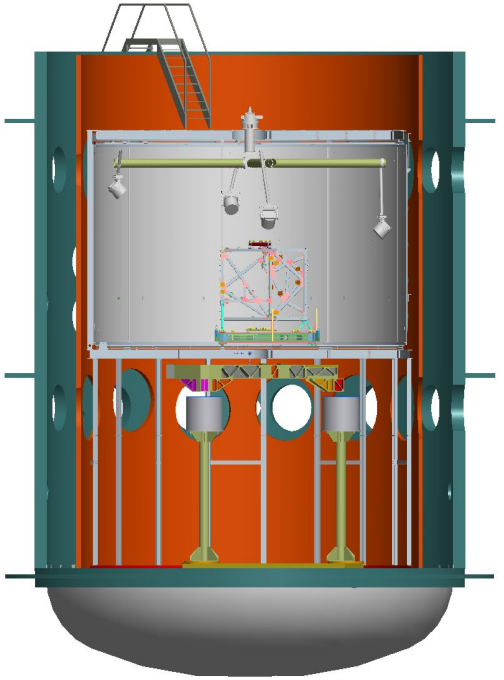
8) Long Lead Devices, Material – Greater than 4 months availability was a significant challenge/problem.

JWST encountered numerous challenges

JWST Test Sites

Chamber A and part of the JSC JWST team

Hampton University Proton Therapy Institute



ISIM Element Cryo-Vac testing at GSFC

JWST performed tests to mitigate potential risks.

JWST EEE Parts Problems Encountered

- DC DC Converters – QCI Conformance
- **OP AMP – Radiation Risk**
- Detectors Anomaly
- ASICs Long Lead & Firmware concerns
- **Magnetics**
- **Harnesses Workmanship Anomalies**
- Resistor Fabrication Issues
- Capacitors Fabrication Issues
- **Long Lead Devices and Material**

The worst problem is the one we do not know.

JWST EEE Parts Problem - Magnetics

- **Problem: JWST encountered communication loss between a key assembly.**
- **Root Cause : There was an opening in one of the primary windings of the a HV magnetic coil.**
- **-it was diagnosed using IR camera, DPA, CT scans tools/process.**
- **Resolution: It was resolved via extensive teamwork between, manufacturer, NASA and one of its partners.**
- **Conclusion: It is extremely important to establish an excellent relationship with your team and partners.**

JWST EEE Parts Problem- ISIM Harnesses

- **Problem: The harness performance was changed between ETU and flight and more noise was detected during verification testing.**
- **Root Cause : A material and possible workmanship event impacted the cable's performance.**
- **Resolution: GSFC worked with harness manufacturer an critical material supplier to ensure system compliance.**
- **Conclusion: The problem(s) were resolved by 1. Supplier integrity 2. Establishing a great rapport with harness supplier and material manufacturer.**

JWST EEE Parts Problems - OP AMP – Radiation Risk

- **Problem: Due to microcircuit's packaging material – it was potentially prone to radiation damage during the mission.**
- **Root Cause : Due to the gold plated lids – a Single Event Effects there where proton nuclear interactions with gold plating on the part package caused high LET secondary particles that caused damage in the sensitive part.**
- **Resolution: With great support by John's Pandolf's Langley team – GSFC was able to use the Proton beam at Hampton U by Dr Ray Ladbury, GSFC.**
- **Conclusion: The post testing proved that the device can function during potential Proton radiation. Risk low.**

JWST EEE Parts Problem - Long Lead EEE Devices and Material

- **Problem: Due to demanding schedule and potential costs impacts associated with delays – EEE parts availability delays posed a serious problem .**
- **Key problem: Hardware failures may require rebuilds and consequently schedule delays .**
- **Resolution: JWST initiated the ISIM EEE Spares Implementation program – Critical Long Lead EEE parts and material were procured kitted and/or stored if needed.**
- **Conclusion: The program allowed JWST ISIM to be integrated and released with no significant schedule delays.**

JWST ISIM EEE Parts Spares Implementation Program

- Key program guideline was to order adequate Spares for Critical assemblies and Harnesses.

- Implemented the Radio Frequency Identification (RFID) technology to track hardware & Material

- Provided schedule Integrity – addressing Long Lead EEE devices and material .
- Enabled JWST project to be a good steward of NASA's assets

- Due to the size and scale of the project, it is necessary to track the location and status of every critical component.

JWST Long Lead Items was a significant Issue - possible show stopper!

JWST ISIM EEE Parts Spares Implementation Program-Cont.

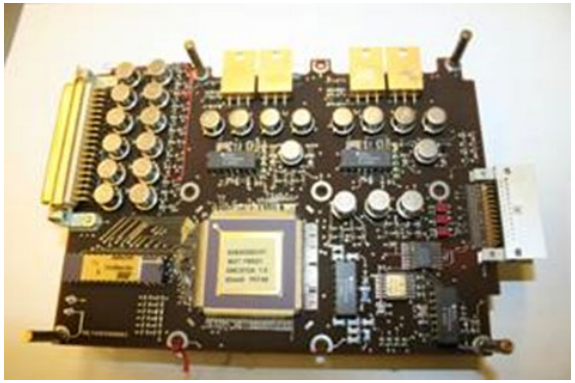
- JWST is a NASA Flagship Program
- JWST Spares program was implemented to target EEE Parts assemblies removal & builds to ~ 4 months - ~ 50% schedule reductions.
- To be a good steward of NASA's assets
- Due to the size and scale of the project, it is necessary to track the location and status of every critical component.

JWST Long Lead Items -- potential show stopper – The ISIM Spares program – mitigated the risk!

JWST Spares Stored Items & Storage Locations

ESD Bins storage of EEE Kits

Gold Shield for Harnesses



Critical Assemblies &/or kits

Long Lead fasteners

Radio Freq ID Tags

Dry box in NASA Lab

EEE Parts Kits are stored in Cleanrooms at NASA, NGAS, & Vendor in California .

JWST ISIM Spares Implementation Plan received RFID Awards and presented at RFID and Artificial Intelligence Technology Conferences in Phoenix, AZ & Orlando, FL & London, England, respectively.

Common Resolution Trends

- **Impacted team member's timely identification of an anomaly.**
- **Established relationship with suppliers and troubleshooters.**
- **Integrity shown during problem analysis.**
- **Trust and respect manifested during analysis and subsequent resolution**
- **The Spares Program was a great plan.**

Team work was critical during problem resolution

Summary

- Problems do not go away overnight. Some problems took 1-3 weeks to resolve while other problems took 2-3 months or longer.
- Team work and establishing relationships was critical to success of the JWST EEE Parts Program
- James Webb Space Telescope is a complex system. There were many EEE Parts challenges – even during the week of the launch.
- EEE Parts Engineers worked with the vast and dedicated JWST team to mitigate technical and non-technical issues- it was a TEAM Effort!!

JWST EEE Parts Engineering Program – Establishing Relationships was Our Most Important Part!

Acknowledgements

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We would especially like to acknowledge our team members who are no longer with us; Terry King, Thomas Duffy, Donnel Curtis GSFC, Wally Foster -UTC, Mark Cooper- JPL.

JWST Team – Remember the Faces

I Just Wanna Say Thanku

Reference

[1] Muzar Jah, Basil Jeffers
Challenges with Electrical, Electronic, and Electromechanical Parts for James Webb Space Telescope August 24, 2016