James Webb Space Telescope(JWST) EEE Parts Program Report

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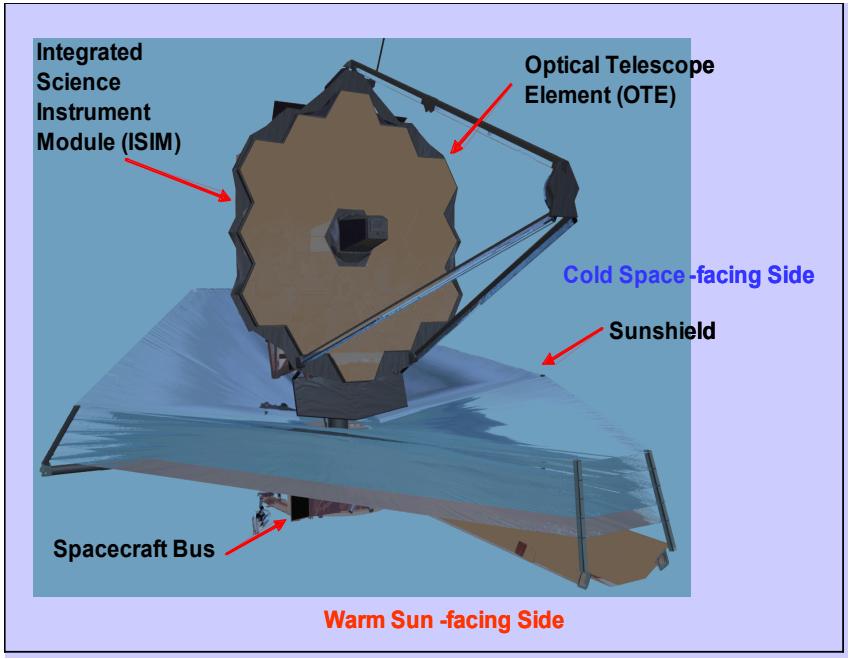
JWST Worldwide Team/Partners.

Organization

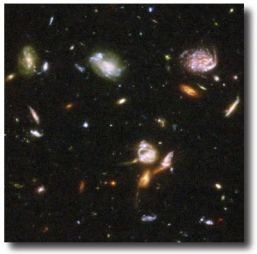
- **Mission Lead: Goddard Space Flight Center**
- **International collaboration with ESA & CSA**
- **Prime Contractor: Northrop Grumman Space Technology**
- **Instruments:**
  - **Near Infrared Camera (NIRCam) – Univ. of Arizona**
  - **Near Infrared Spectrograph (NIRSpec) – ESA**
  - **Mid-Infrared 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 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 – with the secondary mirror tripod and both primary mirror wings in place – the three-month process of aligning all of Webb's telescope optics into a precise system can now commence.

JWST Parts Program Requirements

- **JWST minimum mission life is 5 years with a goal to operate beyond 10 years.**
- **The EEE parts selection was Level 1 EEE Parts per the EEE-INST-002 Instructions for EEE Parts Selection, Screening, Qualification, and Derating.**
- **Level 1 parts are selected and processed for missions requiring the "*highest reliability and lowest level of risk.*"**
- **Level 1 is the highest reliability designation per the EEE-INST-002.**

JWST EEE components were selected to meet mission requirements

JWST Programmatic Challenges 1

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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 posed several 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. Received alerts that impacted JWST during week of launch.

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 major challenge/problem.

JWST encountered numerous challenges

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 delays posed a serious problem .**
- **Root Cause : 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

- **Project ordered EEE Long Lead Spares & material for JWST ISIM Critical assemblies and Harnesses.**

- **Established Radio Frequency Identification (RFID) tools to track hardware & Material**

- **The schedule Integrity – addressing Long Lead EEE devices and material > 4 months.**
- **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 major Issue

JWST ISIM EEE Parts Spares Implementation Program-Cont.

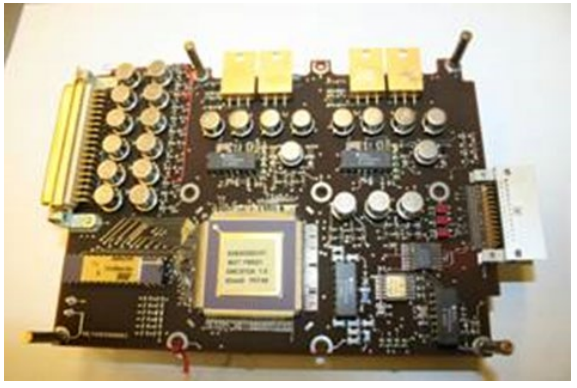
- **JWST is a NASA Flagship Program**
- **JWST Spares program was implemented to target EEE Parts assemblies removal & builds to ~ 4 months - ~ 50% schedule reductions.**
- **JWST strived to be good steward of NASA's assets**
- **Due to the size and scale of the project, it is necessary to track the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

JWST Long Lead Items was a major Issue as well as reduction in assets.

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**

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

Reference

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