Cryogenic Testing of the Thermal Vacuum Chamber and Ground Support Equipment for the James Webb Space Telescope in Chamber A at Johnson Space Center

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Introduction

• This will be a top level summary of a large number of tests performed to get ready to test the cryogenic portion of JWST as a unit

• Schematically this is similar to taking the title of the talk and making it:
  – Cryo Testing the T/V Chamber and GSE for JWST
    » Lots of shorthand and acronyms!

• Cold telescope and Instruments in the same chamber with room temperature ground support equipment (GSE) makes the cryogenic testing of JWST very challenging
Testing the James Webb Space Telescope (JWST)

• The Science Instrument Package – Integrated Science Instrument Module (ISIM) and pieces of the Optical Telescope Element (OTE) have been cryogenically tested separately at GSFC and MSFC respectively.

• Now they come together to be tested as a unit, OTIS = ISIM + OTE, at Johnson Space Center (JSC).

• Because this test is very complex, a number of preliminary tests were performed on the GSE.

• Due to the size of the sunshield and the phasing of the spacecraft and telescope, “test-as-you-fly” was not possible.
  – JWST verification pioneers the new verification paradigm, stitching together tests with validated models.
OTIS cryo test is scheduled for 92 days, beginning mid-July 2017.

Test is on the JWST Observatory critical schedule path.

Pathfinder developed as a schedule risk reduction.

Chamber A:
- Height 36m,
- Diameter 20m

20K helium shroud:
- Height 20m,
- Diameter 14m.

Door diameter 12m
Preliminary Tests - Pathfinder

OGSE-1  OGSE-2  Thermal Pathfinder (TPF)
Chamber A

- Chamber A
- Nitrogen Shroud
- Helium Shroud
- OTE/ISIM
- 40 ft Entry Door
- Nitrogen floor Shroud
- Entry Rails
Chamber A and Ground Support Equipment (GSE)

- Down Rods
- Down Rod Studs
- USF
- CoCOA Plug
- 4x PG Booms and Canisters (not shown)
  - With PG Boom GHe Shroud Closeouts
- DTA Offloader Frame
- HOSS
- ADM Bracket
- DSERS Frame
Instrumentation

- Pressure Transducers
- Residual Gas Analyzers (RGAs)
- Thermometry
- Calorimeters [see right]
  - Non-directional
- Radiometers [see below]
  - 11° acceptance (half angle)

.Winston Cone Concentrator

Concentrate and collimate incoming flux

Measure temperature offset using pair of thermometers

.Sensing Thermometer With Absorber

Reference Thermometer

.Hole with grommet

.060” Al disc, 2.5” diameter

3.5” square MLI section, 20 layers w/ Dacron separators

.Diode wires
Troublesome Instrumentation

- **Cryogenic Quartz Crystal Microbalances (CQCMs)**
  - While the depositing surface remains cold the electronics dissipate many mW and sometimes have difficulties below 25 K
  - MLI with black outer layer is effective at radiation suppression

- **Cryogenic Accelerometers**
  - Dissipate 40 mW and very often do not work at low T

- **Beware of instrumentation that uses “cryogenic” in the title – it’s usually not!**
Testing Optical Ground Support Equipment (GSE)

- Cryogenic Photogrammetry Modules (CPMs)
- Center of Curvature Optical Assembly (CoCOA)

Room T CoCOA
Surrounded by MLI
And Heater Panels
(shutter is at bottom)
(Purge Lines shown in Green)
The Little Tests

- Shroud emissivity
- Shroud specularity
  - >98% for mid IR
- CPM stray radiation
  - Measured and acceptable
  - Radiation from windows <25 mW
- CoCOA stray radiation
  - CoCOA plug shows very little reflection
  - CoCOA Shutter blocks T>70 radiation
The Big Tests

• Chamber Commissioning
• Optical GSE 1
• Optical GSE 2
• Thermal Pathfinder
Leak Checking

Helium Leak Checks
Example finding major contributions
- PG circuit leak is greatest
- Leak detector and RGA are proportional

Air Leak Checks
Example: proving air leak in purge system
- Helium could not be used
- RGA proves to be a good leak detector
Summary

• JWST is a very complex space mission
• Integration and Test provided new challenges
  – Huge Cold Telescope
  – Warm GSE in the Same Chamber
• Risk Reduction for the final cryogenic test required several preparatory tests
• We are now ready for the real thing!
JWST Arrives for Final Cryo Test

Questions?