



Special Topic

Presenter

Date 10/02/02

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ET-Mounted Shuttle Observation Camera

STS-112 FRR

October 2, 2002

JSC/MS/L. D. Austin



Agenda

Presenter **JSC/Lambert D. Austin**

Date **10/02/02**

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- **Camera Overview and Verification**
 - **Systems Integration/Lambert Austin**
- **Flight Hardware**
 - **ET Project/Neil Otte**
- **Ground Systems**
 - **KSC/Mike Madden**
- **Network Configuration / Modifications**
 - **GSFC/Ted Sobchak**
- **Demo Video**



SRB Separation: 80 degree FOV



Special Topic – ET Observation Camera Mission Specific Certification

Presenter **JSC/Lambert D. Austin**

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- **Camera & telemetry package approved at 07/99 PRCB**
- **Camera ascent design environments baselined in NSTS 07700 Vol X 06/00 PRCB**
- **Camera implementation on STS-112 approved at 12/01 PRCB**
- **The following System Integration functions verified acceptable certification for the ET camera system**
 - **Aeroheating and protuberance airload environments were defined for camera faring regions and the 2 S-band antennas**
 - **Protuberance airloads and thermal environments were determined to be acceptable by the ET project**
 - **Debris assessments were performed to evaluate the hazard associated with potential loss of quartz window from camera on LO2 tank**
 - **No orbiter window impacts predicted**
 - **Wing leading edge & lower wing impacts predicted, and determined not to be a flight safety issue**



Camera Verification

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- **ET Certificate of Qualification (COQ) approved March 2000**
- **Safety Assessment Report (SAR) reviewed/approved by March 9 2000 SSRP**
 - No update to Integrated Hazards required
- **MSFC independent assessment performed and ET response to findings completed June 2000**
 - Required testing successfully completed 11/00
- **Frequency Approved June 2000 by JSC Frequency Manager**
 - 2272.5 MHz for 5 years – can be extended if required
- **KSC facilities modifications completed Spring 2002**
- **Verification Testing Completed**
 - Network Test - June 2002
 - Integrated flight & ground hardware test - **September 2002**



System Summary

Presenter JSC/Lambert D. Austin

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- **System implemented at KSC by mod kit**
 - Installed and functionally tested in ET checkout cell in the VAB
- **System operated from firing room during launch operations**
 - Battery charging completed prior T-11 hr hold (good for 70 min.)
 - System activated at L-10 minutes (Remote On/Off)
 - Turns off at L+15 min
- **System to provide live coverage (T-9 min to MET 15 min)**
 - Pre-Launch and Flight Video
- **Video will be transmitted to MILA/KSC for airing through PAO real-time**
 - Then included in play-backs



ET Camera Hardware Design

Presenter **MSFC/ Neil Otte**

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- **Camera System Review**
 - **MSFC Technical Exchange Forum (TEF) was convened to review the camera design due to challenges encountered with the COTS hardware during design and qualification**
 - **TEF provided insight to systems using COTS hardware and made recommendations to mitigate associated functional risk**
 - **Verification plan was revised to incorporate most recommendations**
 - **No safety of flight issues were identified at the review**
 - **System was reviewed by SSP organizations and risk of functional failure was identified**
 - **System Safety Review Panel, Integration Control Board, PRCB, Interface Working Group, Space Shuttle Engineering Integration Group**

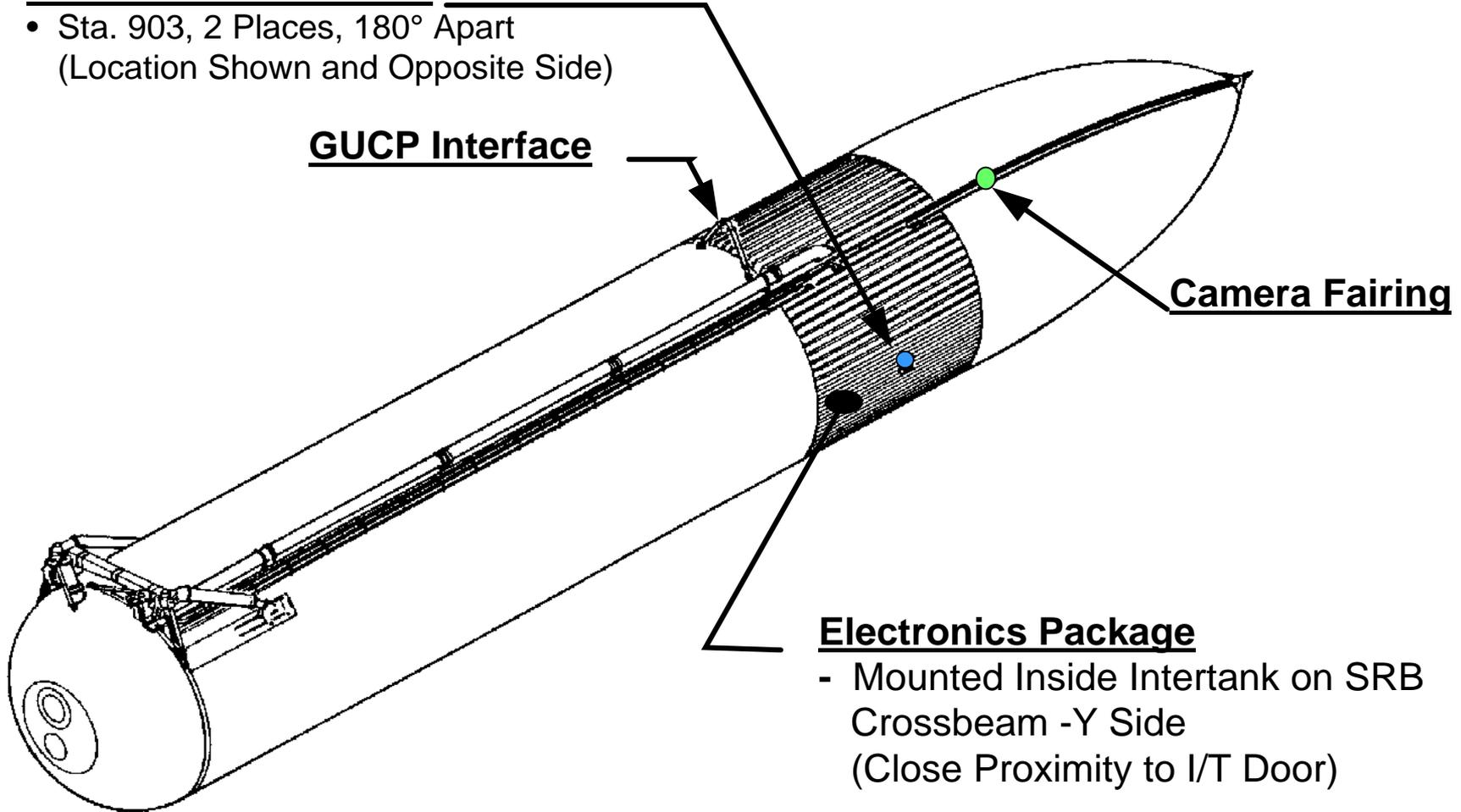


ET Camera Hardware Design

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Two S-band Antennas

- Sta. 903, 2 Places, 180° Apart
(Location Shown and Opposite Side)



Electronics Package

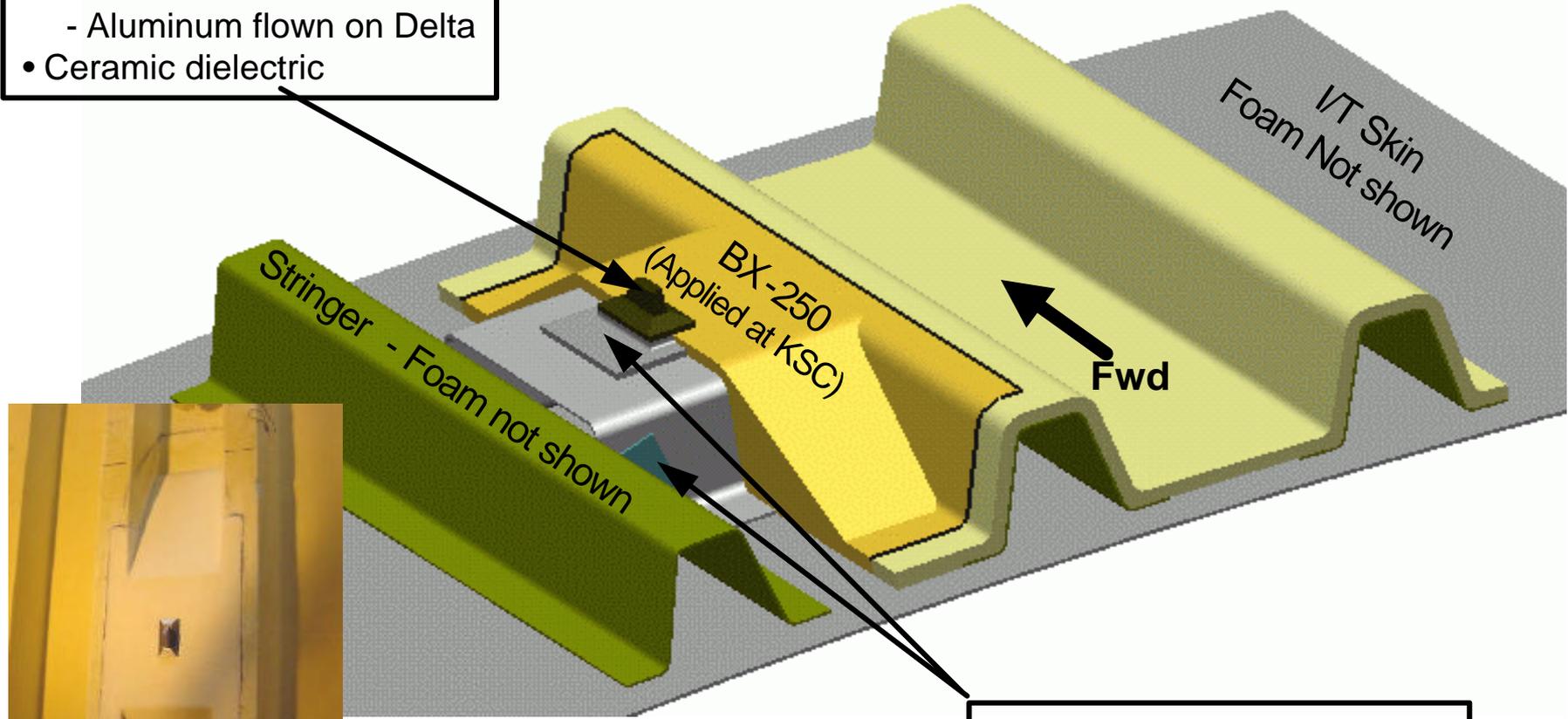
- Mounted Inside Intertank on SRB Crossbeam -Y Side
(Close Proximity to I/T Door)



Camera Antenna Design

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- Antenna - COTS**
- Cres 303 Stainless Steel
 - Aluminum flown on Delta
 - Ceramic dielectric



ET-115 Antenna Installation

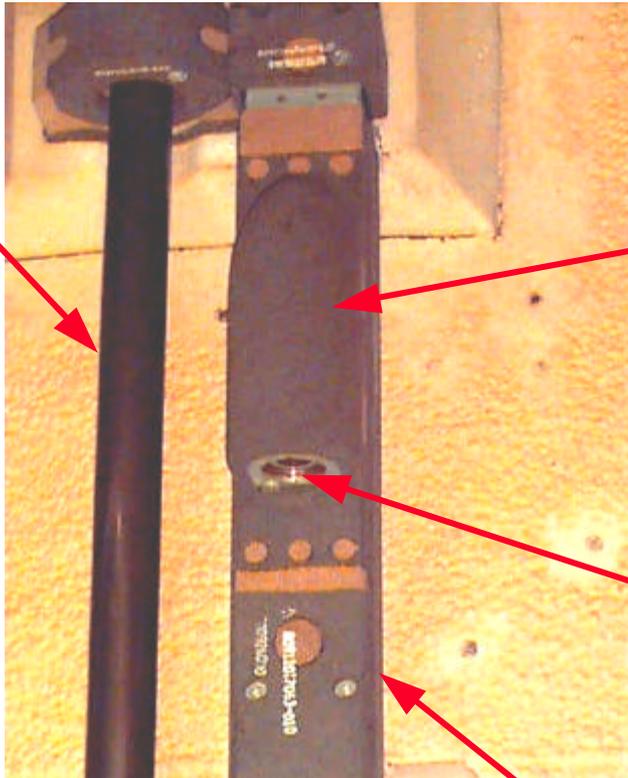
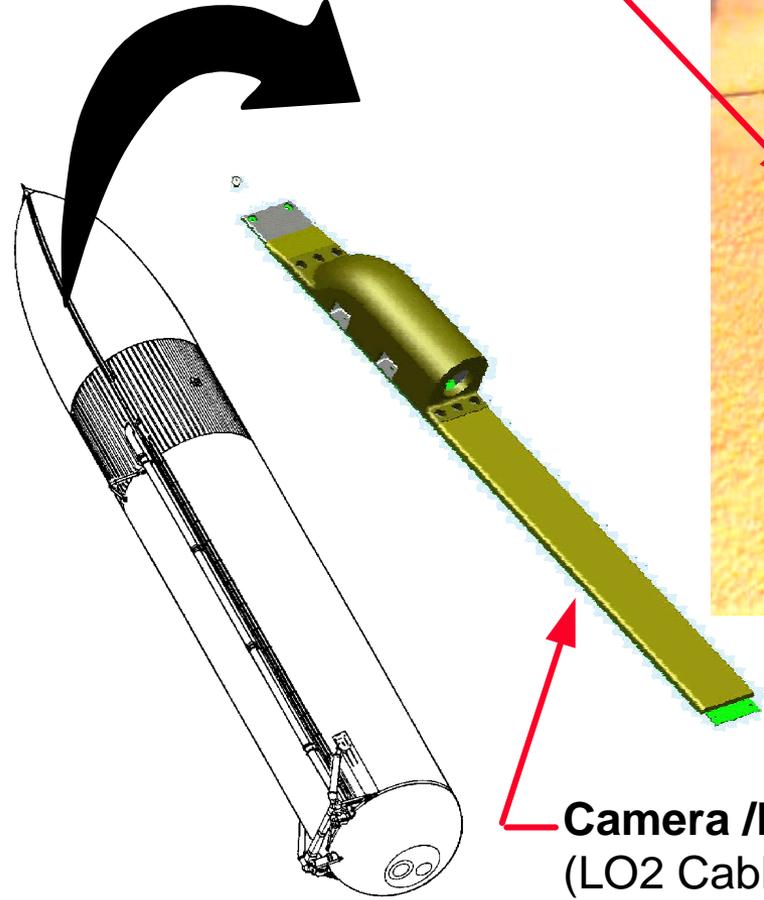
Ground Plane, Spacer Plate & Attach Clips (4 Req'd)
ET Unique



Camera Antenna Design

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Existing GO2 Pressurization Line



Fairing Assembly

- **COTS**
 - 1/4" quartz window
 - 3/16" flown on Delta
- **ET Unique**
 - Al 2219 with SLA for thermal protection

Camera – COTS

- Flown on Delta, Atlas & Titan

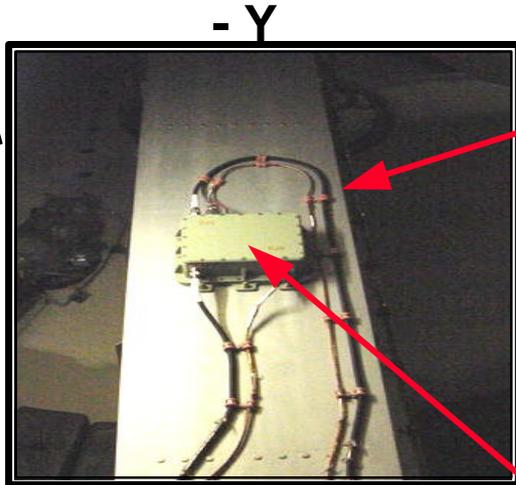
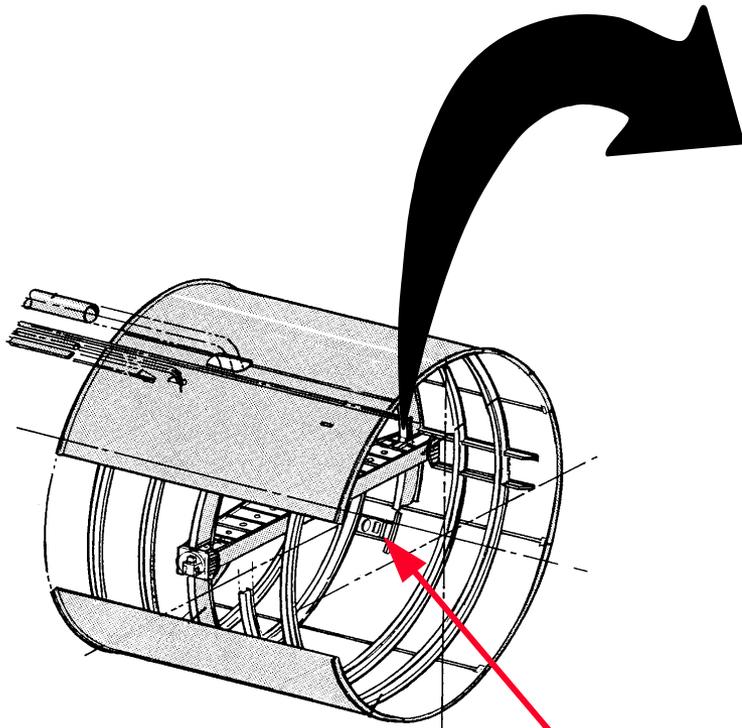
Modified Cable Tray Cover

ET Unique

Camera /Fairing/Cable Tray Assy
 (LO2 Cable Tray Cover Sta. 718)

Electronics Package Design

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- Cabling**
- **COTS**
 - Video coaxial cable and connectors
 - Antenna cable
 - **ET Unique**
 - Power cable
 - Installation hardware

- GUCP Connection** – **ET Unique**
- For battery charging, on/off capability, and battery health monitoring

- Electronics Package**
- **COTS**
 - **Electronic Components**
 - Batteries – Flown on Delta
 - 10 watt Transmitter
 - 5 watt flown on Delta
 - G-Switch, Power Splitter, PC Board
 - **ET Unique**
 - Structural design and attach hardware



Flight Hardware Certification Summary

Presenter **MSFC/ Neil Otte**

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- **Camera System Hardware Qualification Testing**
 - **System Electromagnetic Interference (EMI) – SL-E-0002 requirements verified**
 - **Compatibility testing performed at ESTL (JSC) and Goddard – No Issues**
 - **Fairing, Antenna, and Electronics Box vibration**
 - **RF and corona testing***
 - **Electronics Box proof test***
 - **Electronics Box explosive environments test***
- **Camera System Hardware Acceptance**
 - **Functional verification of components**
 - **Transmitter burn-in****
 - **Electronics Box - Proto-flight vibration*, thermal cycling*, and burn-in****
 - **Antenna pattern verification***
 - **Camera proto-flight vibration* and burn-in****

**As recommended by TEF or other review board*

***To a lesser degree than recommended by TEF, associated risk accepted*



Flight Hardware Certification Summary

Presenter **MSFC/ Neil Otte**

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- **Analysis of ET Camera System Complete**
 - **Standard structural and thermal analysis was performed for system components and no issues with design were identified**
 - **Environments coordinated with Level II**
 - **Factor of safety greater than 2.0 was required for all new hardware**
 - **Analysis performed to assess safety of camera system**
 - **Intertank hazardous gas analysis with battery leakage performed - No Issue**
 - **FMEA analysis identified two new Aerodynamically Sensitive Items (ASI) as Criticality 1 for becoming debris (existing failure mode)**
 - **Camera Fairing**
 - **Antenna**
 - **Retention rationale for new Crit 1 ASI was documented in CIL and inspections added to CIL Implementation Drawing**
 - **Flight Camera System Safety Analysis Report was generated and reviewed**

ET Camera System Certification is Complete



Status

Presenter **MSFC/ Neil Otte**

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- **Installation of Camera System on ET-115**
 - Following initial installation, camera system did not provide video
 - Troubleshooting and remediation led to failure of a COTS connector
 - Required MRB repair of video cable
 - Prior to final closeout and acceptance, a team of experts assembled by MSFC inspected and reviewed the camera installation
 - No safety of flight issues were identified
- **ET-115 Modification Complete and System Verified**
 - Final functional test of the ET hardware indicated nominal performance
- **CHIT defining system operational requirements approved at 5/21/02 PRCB**
- **Integrated functional tests are planned following rollout of the vehicle**

ET Shuttle Observation Camera System is Ready for Flight



Ground Systems Overview

Presenter KSC/M. Madden

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- **Ground systems provide 3 functions for camera system**
 - **Camera On/Off Command**
 - **Camera System Battery Charge**
 - **Camera Battery health monitoring (voltage & current), RS485 Network**
- **Interface with camera system is accomplished through the ET GUCP utilizing existing/spare circuits and wires**
- **Commands issued and health monitoring of camera system is accomplished utilizing a laptop PC at console C10.**
- **Procedures for testing/operating camera system have been identified and incorporated.**
- **Both Pad A & Pad B have been modified and tested to accommodate Shuttle Observation Camera and are ready to support.**



Network Support for ET TV

Presenter **GSFC/T. Sobchak**

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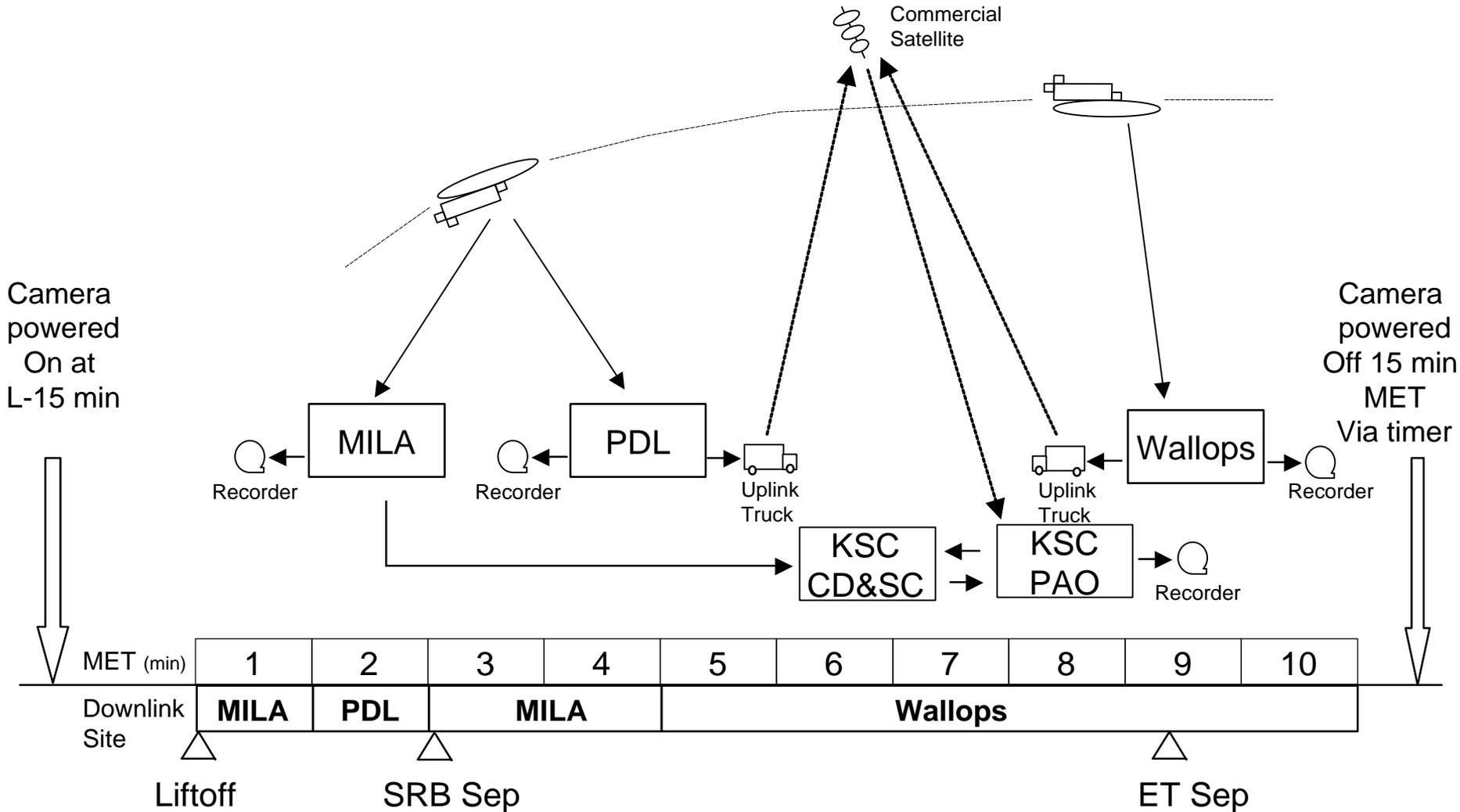
- **NASA sites MIL, PDL, and Wallops (WPS) will receive, record, and remote ET TV during launch to KSC PAO for release on NASA Select**
 - MIL provides TV via existing hardline interface to KSC
 - PDL & WPS simultaneously send TV via TV trucks and satellite links rented for launch day
- **Predicted launch support coverage analysis completed**
- **Site modifications have been completed**
- **Compatibility testing of the ET TV transmitter and camera with NASA sites has been completed**
 - Included hardware testing at MIL
- **End to End Test with MIL, PDL, WPS and KSC was completed 6/26/02**
 - Demonstrated satellite links and site interfaces with KSC PAO
- **Forward plan is RF signal presence and quality checks with MIL during flow**
 - Pad Testing (L-3 weeks); TCDT checks (L-2 weeks); launch count signal presence





Camera Operational Links

Presenter GSFC/T. Sobchak	
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READY TO FLY!

Presenter **JSC/Lambert D. Austin**

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- **All ET Camera systems design and operational requirements have been verified**
- **Final integrated system and network test pending TCDT**
- **Shuttle ET Camera is ready to fly**