

# Status of the Landsat Data Continuity Mission

*presented by*

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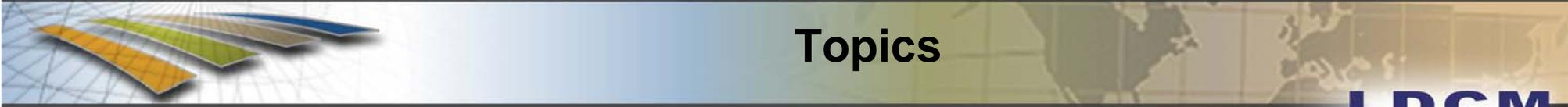
*at the*

**Landsat Science Team Meeting**

**US Forest Service**

**Fort Collins, Co.**

**Jan. 6, 2009**



## Topics

**LDCM**

- **Programmatic Status**
  - **New Launch Readiness Date**
- **OLI Status**
- **S/C Status**
- **Mission Operations Element Status**
- **TIRS Status**



## Programmatic Status

# Initial Confirmation

**LDCM**

- **LDCM approved to proceed into Project Life Cycle Phase B**
  - **Key Decision Point – B (KDP-B) Review (Initial Confirmation) conducted on September 25, 2008**
    - **As a NASA Category 1 Mission, LDCM requires highest level approval of the Agency Program Management Council chaired by NASA Associate Administrator, Chris Scolese, to initiate each phase of the project life cycle**
    - **Phase B is the system preliminary design phase following concept studies, Pre-Phase A, and concept and technology development, Phase A**
    - **LDCM spent 9 years in formulation, re-formulation, Pre-Phase A, and Phase A**

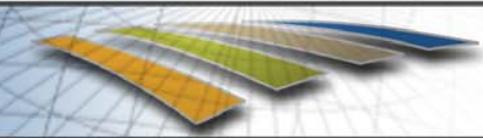
## LDCM at KDP-B

<b>NASA Life Cycle Phases</b>	<i>Pre-Systems</i>		<b>FORMULATION</b>			<b>Approval for Implementation</b>		<b>IMPLEMENTATION</b>						
	<i>Acquisition</i>		<i>Systems Acquisition</i>			<i>Operations</i>		<i>Decommissioning</i>						
<b>Project Life Cycle Phases</b>	<b>Pre-Phase A:</b> Concept Studies		<b>Phase A:</b> Concept & Technology Development		<b>Phase B:</b> Preliminary Design & Technology Completion		<b>Phase C:</b> Final Design & Fabrication		<b>Phase D:</b> System Assembly, Int & Test, Launch		<b>Phase E:</b> Operations & Sustainment		<b>Phase F:</b> Closeout	
<b>Project Life Cycle Gates &amp; Major Events</b>	KDP A FAD		KDP B Preliminary Project Plan		KDP C Baseline Project Plan		KDP D		KDP E Launch		KDP F End of Mission		Final Archival of Data	

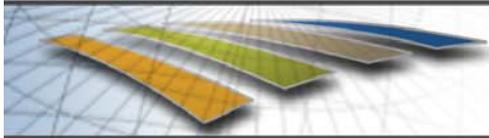
## KDP-B Process

**LDCM**

- **In preparation for KDP-B, LDCM conducted a System Requirements Review/Mission Definition Review/Preliminary Non-Advocate Review in May 2008**
  - **System Requirements Review (SRR)**
    - Examines functional and performance requirements defined for the system and ensures the requirements and the selected concept will satisfy the mission
  - **Mission Definition Review (MDR)**
    - Examines proposed requirements, mission architecture, and flow down to all functional elements of the mission to ensure the overall concept is complete, feasible, and consistent with available resources
  - **Preliminary Non Advocate Review (PNAR)**
    - PNAR is conducted as part of the MDR to provide Agency management with an independent assessment of the readiness of the project to proceed to Phase B (mission executable within current cost and schedule)
  
- **SRR/MDR/PNAR is conducted by a Standing Review Board (SRB)**
  - **Independent review panel which conducts system level reviews and follows mission for entire development life cycle**
  - **Role of the SRB**
    - Provides expert assessment of technical and programmatic approach, risk posture, and progress against baseline
    - Advisory role to Agency
    - Makes recommendations to improve performance or reduce risk
    - Provides independent cost and schedule assessments

New LDCM Launch Readiness Date**LDCM**

- **Major finding of SRB**
  - **Original launch readiness date, July, 2011 was considered excessively aggressive and added risk to the mission**
    - **“The existing LDCM development schedule is not achievable. There is less than a 20% chance that the July 2011 Launch Readiness Date (LRD) can be achieved.”**
- **Mission schedules must reflect a 70% confidence level (70% chance of making launch date)**
- **Project recognized schedule risk early in mission development**
  - **Had consistently expressed concerns with the “sporty” schedule**
  - **Was #1 Problem/Issue**
    - **Lack of project held funded reserve**



# Derivation of New LRD

**LDCM**

- **Five Independent Schedule Assessments were conducted**

	<b>LDCM</b>	Code 420 MCR	Code 420 Aerospace	GSFC RAO	SMD Aerospace	IPAO
LRD	<b>July 2011</b>	Feb 2014	July 2013	Sept 2012 – Mar 2013	Sept 2013	Feb 2013

- **In developing a Revised LRD, the GSFC Resource Analysis Office (RAO) and IPAO schedule assessments were used as reference**
  - **RAO => retarget the launch date by 14 to 20 months**
  - **IPAO => retarget the launch date by 20 months**
- **Retargeted Launch Date – Dec. 2012**

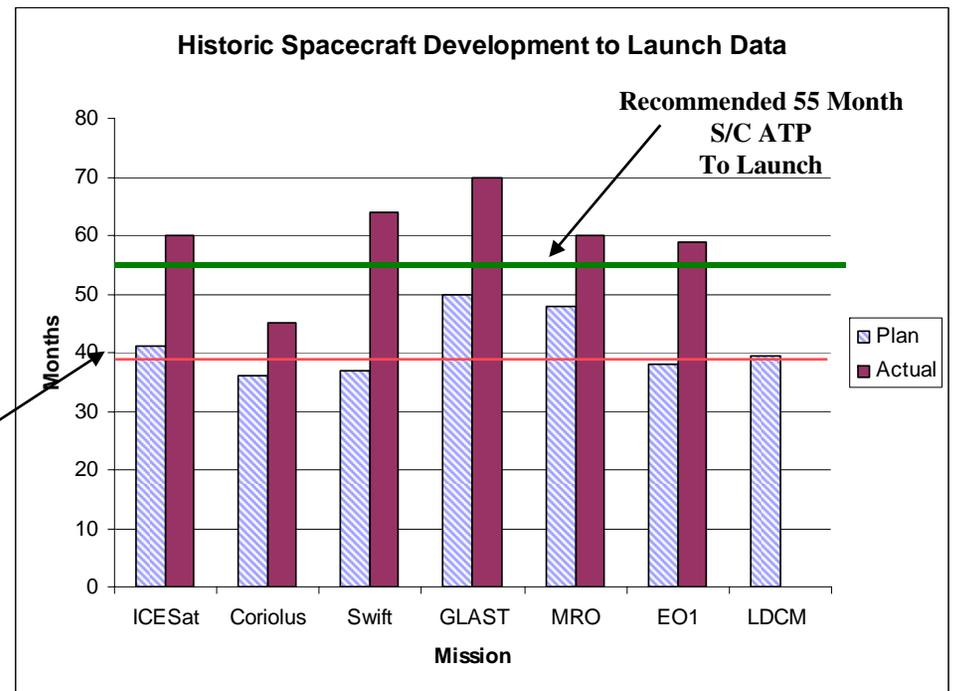
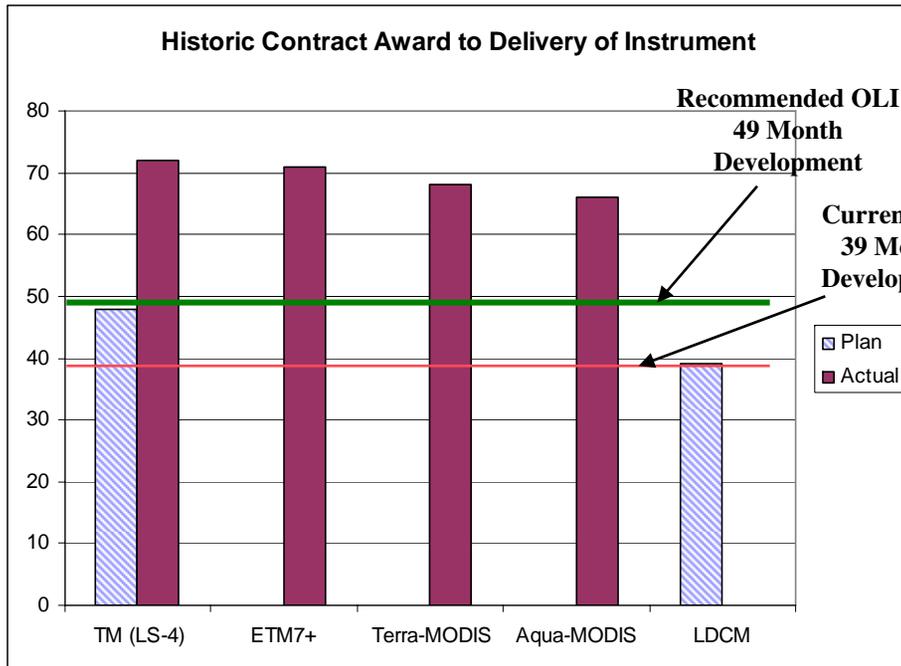
## Changes to Schedule or “What Did We Do With An Extra 17 Mos.”

**LDCM**

- **17 mos. was used to either add schedule to current activities where short falls existed, add reserve, or both**
  - **Changes were based on recommendations from RAO**
    - **OLI - RAO recommended additional 8 - 16 mos.**
      - **Extended current 39 month development to 49 mos.**
        - » **Use extra 10 months as Project held reserve**
    - **S/C – RAO recommended additional 9 -14 months**
      - **Avg. development time across all s/c - 10 months longer than LDCM**
      - **Added 6 mos. to existing GD schedule**
      - **Use remaining 4 months as project held reserve on S/C**
    - **Obs. I&T – RAO recommended additional 5 – 8 months**
      - **Extended Obs. I&T by 6.5 months**
        - » **Add 3 mos. to existing Obs. I&T schedule**
        - » **Use remaining 3.5 months as project held reserve**
    - **Launch Site Processing extended from 2 months to 2.5 months**
      - **Add 2 weeks to maintain GSFC schedule reserve standards**

# Historical Schedule Comparisons

**LDCM**



Current 38 Month S/C ATP to Launch

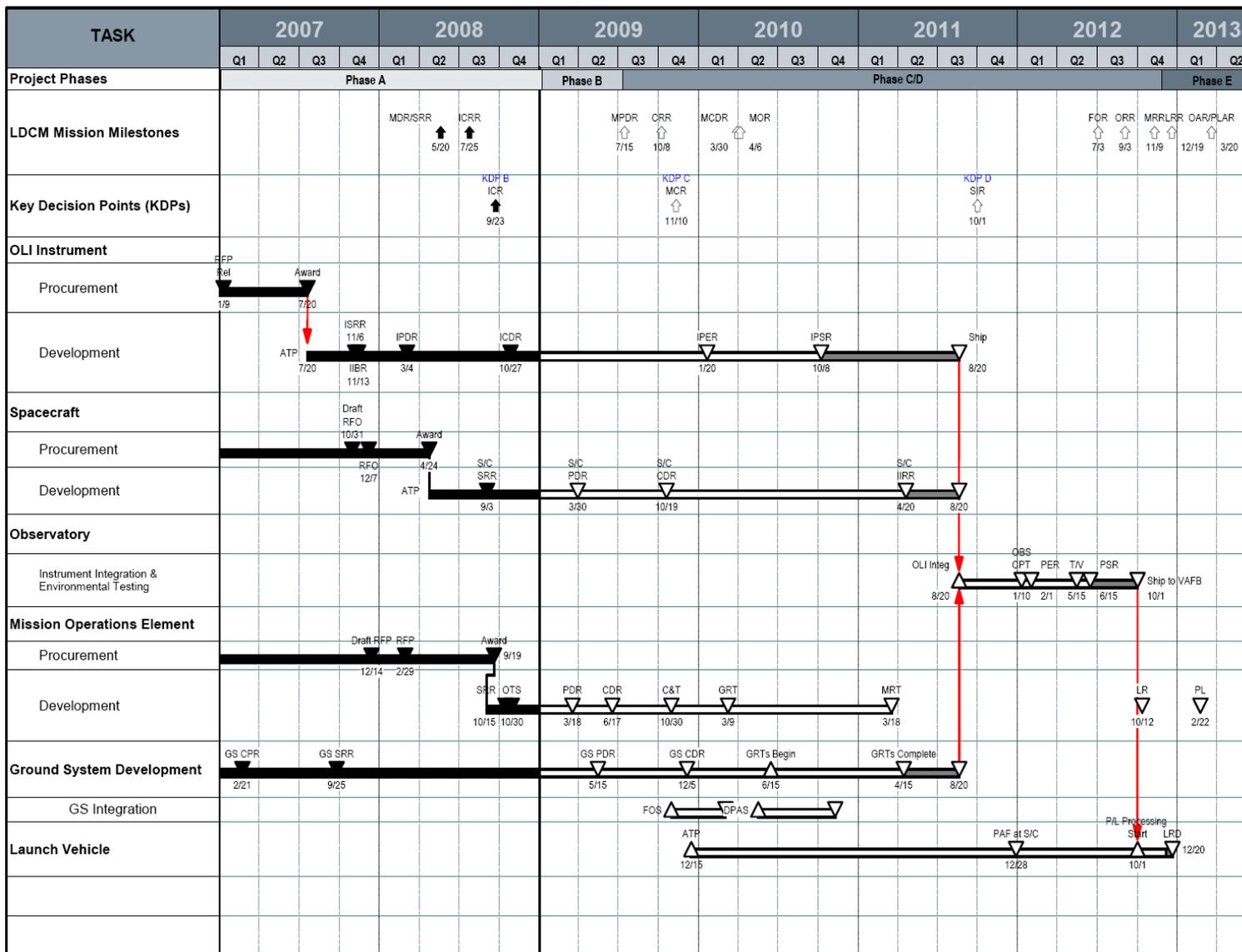


## New LRD

**LDCM**

- **Revised LRD provides**
  - **Appropriate level of confidence**
  - **Sufficient schedule reserves on the critical path**
    - **Allows for some schedule erosion between now and Confirmation**
      - **Confirmation is where a commitment to Congress is made**
    - **Reserve meets GSFC's, *Schedule Margins and Budget Reserves to be Used In Planning Flight Projects and In Tracking Their Performance***
  - **Approved by NASA Agency Program Management Council**

# Dec. 2012 LRD Schedule



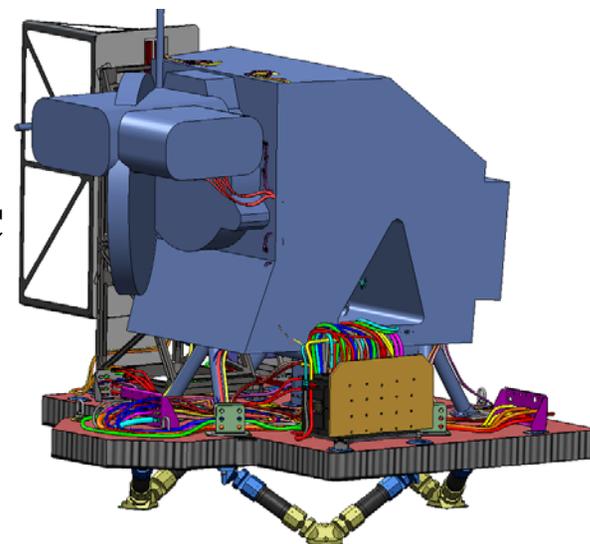


## Operational Land Imager Status

## OLI Status

**LDCM**

- **OLI CDR successfully conducted Oct. 27-30**
- **Flight Hardware**
  - **Optical Bench completed and delivered to BATC**
  - **All flight optics completed and delivered to BATC**
  - **All 16 flight butcher block filter assemblies delivered to BATC**
  - **All 16 EDU focal plane modules completed**
  - **EDU Instrument Support Electronics box completed**
  - **EDU Focal Plane Electronics in box-level testing**
- **New OLI Baseplate**
  - **Baseplate helps 'buffer' the maturity gap between the observatory elements**
    - **Limits impacts to OLI interface from either changes in spacecraft or TIRS designs**
      - **Either the baseplate itself and/or the thermal control subsystem (radiator sizes, blanket designs, etc.)**
    - **Allows work to keep moving on the telescope, the electronics box designs, the focal plane, etc.**
    - **Allows OLI to shipped to GD as a whole unit and break down after testing**
  - **Baseplate (as proposed) will delay OLI delivery from late Oct. 2010 to mid-Dec. 2010**



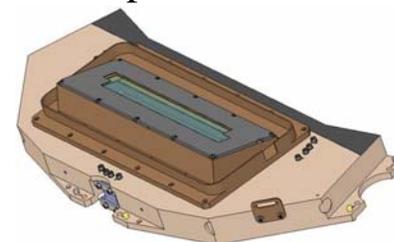
## OLI Status

LDCM

- **Some Issues Along The Way**

- **Ghosting**

- During CDR preparations it was discovered OLI ghosting violates requirements by a factor of ~2
      - Further analysis of the OLI optical model showed reflections from the FPA window onto adjacent bands on the focal plane module
    - Ball's new baseline design now tilts FPA window 16.7 degrees based on results of refined ghosting analysis. Corrects for all ghosts.
      - Project independent analysis of Ball's optical design expected to be completed in January



- **OLI EDU FPM Surface Leakage**

- Ball formed Anomaly Review Board (ARB) with GSFC Project representatives
      - Track down root cause, recommend corrective action, assess project impact and risk
    - Cause of leakage thought to be high resistivity silicon PIN material that is sensitive to process variations
    - RVS performing “Design of Experiment” to understand variations and improve process. Complete in April 2009.
    - Project and Ball developing decision milestone dates regarding use-as-is vs. pursuit of new fabrication cycle.
      - Potential OLI delivery impact between zero and ~4 months



## Spacecraft Status

# LDCM Spacecraft

LDCM

Contract awarded to General Dynamics Advanced Information Systems in April 2008

## COMMUNICATIONS

- S-band to GN/LGN: 1, 32kbps uplink: and 2k, 16k, 32k, or 1 Mbps downlink
- Omni antennas
- TDRSS - SA: 1 kbps return and 2 or 32 Kbps forward
- X-band: 384 Mbps science data

## PROPULSION

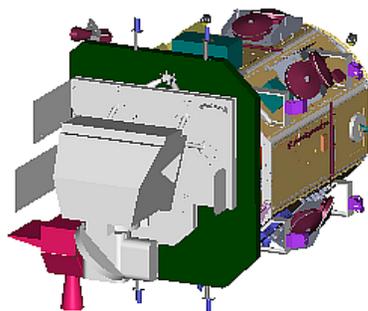
- Hydrazine blow-down propulsion module
- Eight 22N Redundant Thrusters

## GUIDANCE, NAVIGATION & CONTROL

- 2 of 3 star trackers active
- High precision IRU
- Honeywell reaction wheels
- SADA with damper
- 3-axis stabilized
- Zero momentum biased

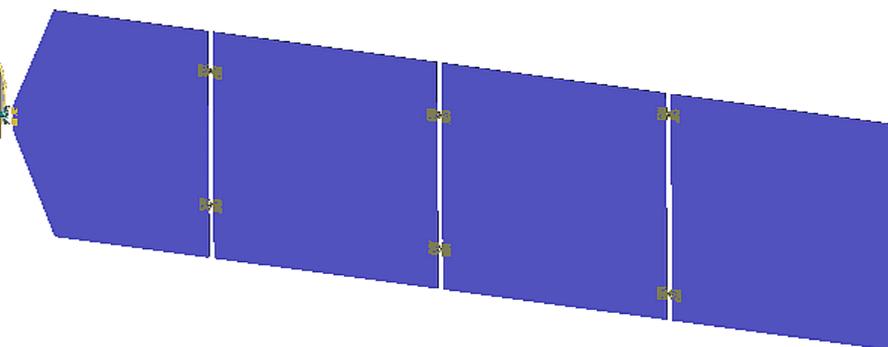
## THERMAL CONTROL

- Passive with heaters
- Constant conductance heat pipes (if needed)



## STRUCTURE

- Aluminum primary structure
- Externally mounted components
- Clear instrument FOVs
- Clear instrument radiative paths



## ELECTRICAL POWER

- Single wing single axis articulated GaAs solar array provides 4300 W at EOL
- 125 amp-hour NiH<sub>2</sub> battery
- Unregulated 22 V - 36 V power bus
- Two power distribution boxes

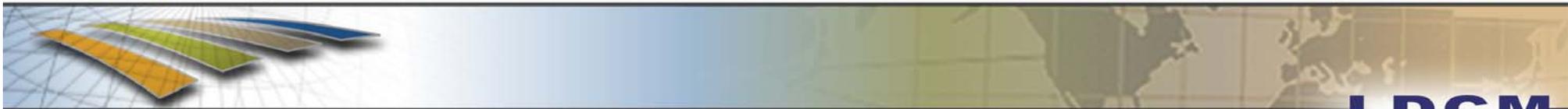
## COMMAND & DATA HANDLING

- cPCI architecture; RAD750 CPU
- 3.1 Tbit (BOL) solid state recorder
- 265 Mbps peak OLI data transfer
- 26.2 Mbps peak TIRS data transfer
- High rate PB at 384 Mbps

## S/C Status

LDCM

- **SRR held Sept. 3-4, 2008**
  - **4 Deficiencies:**
    - **Requirements Flow Down**
    - **Open requirements**
    - **Instrument Interfaces**
    - **Fault Management**
  - **GSFC and GD worked together to ensure all SRR deficiencies adequately addressed**
    - **Major areas of concentration included instrument interfaces (both OLI and TIRS) and resolution of open requirements**
- **Delta SRR was successfully conducted on Dec. 17<sup>th</sup>**
- **Working towards PDR at end of March**



## Mission Operations Element Status

The header banner features a background image of a satellite's solar panel array on the left and a world map on the right. The text "Mission Operations Element (MOE)" is centered in a bold, black font. The acronym "LDCM" is positioned on the right side of the banner in a large, bold, blue font.

## Mission Operations Element (MOE)

**LDCM**

- **NASA awarded the MOE to The Hammers Company in Sept., 2008**
- **Provides the primary means to control and monitor the spacecraft**
  - **Mission planning and scheduling**
  - **Command and control**
  - **Monitoring and analysis**
  - **Flight dynamics**
  - **Onboard memory management**
- **MOE SRR successfully conducted in Nov.**
- **1<sup>st</sup> instance of the MOE delivered to GSFC in Nov.**
  - **Off-The-Shelf version**



## TIRS Status

## TIRS Status

**LDCM**

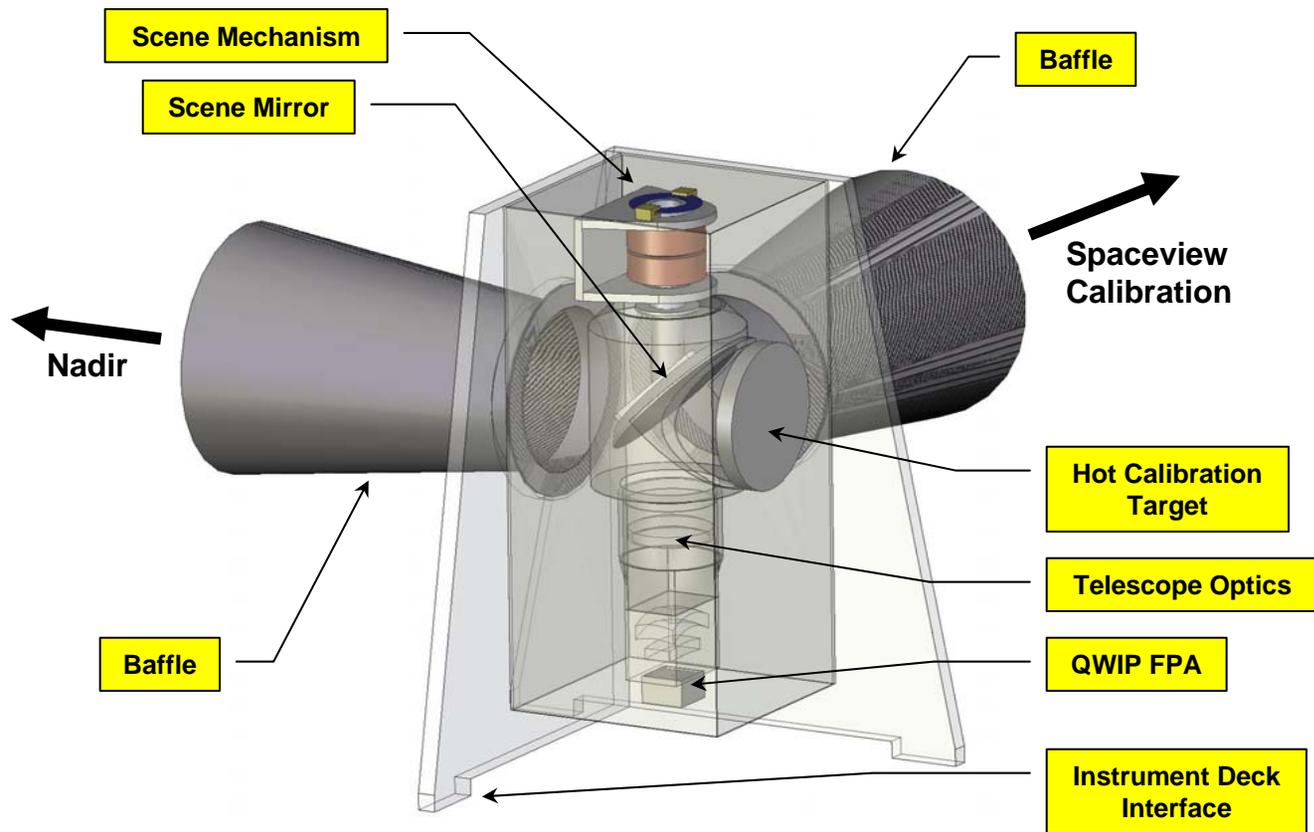
- **A Phase A Study was initiated July 1, 2008.**
  - **The Purpose of this study was to proactively investigate the implementation of a Thermal Infrared Sensor for LDCM and provide risk mitigation to the Dec. 2012 LRD.**
    - **Evaluate / Allocate LDCM requirements.**
    - **Create a feasible concept design.**
    - **Assess the programmatic implementation including the schedule and early procurements needed prior to PDR.**
    - **Begin the instrument development activities.**
  
- **Concept design developed, meets or exceeds the TIRS performance requirements.**
  - **System Concept Review held October 17, 2008**
    - **Independent Review of the current TIRS concept.**

## TIRS Status

**LDCM**

- **Development of Quantum Well Infrared Photodetector (QWIP)**
  - Detectors produced that meet TIRS spectral requirements.
  - ROICs successfully completed both Proton and Gamma Radiation tests.
  - Engineering Model hardware exists for all components of the Focal Plane Array.
- **TIRS Instrument implementation targets LDCM launch date of December, 2012.**
  - Instrument delivery planned for December 2011, allowing 10 mos. integration and test at the spacecraft vendor.
  - Current instrument development schedule is detailed for each subsystem and instrument I&T and meets the required delivery date.
- **System Requirements Review scheduled for February 2 and 3<sup>rd</sup>, 2009**
  - Review all Level 4 and driving level 5 requirements and traceability to Level 3.
  - Review updated concept and system performance against requirements.
- **TIRS PDR scheduled for May 2009**

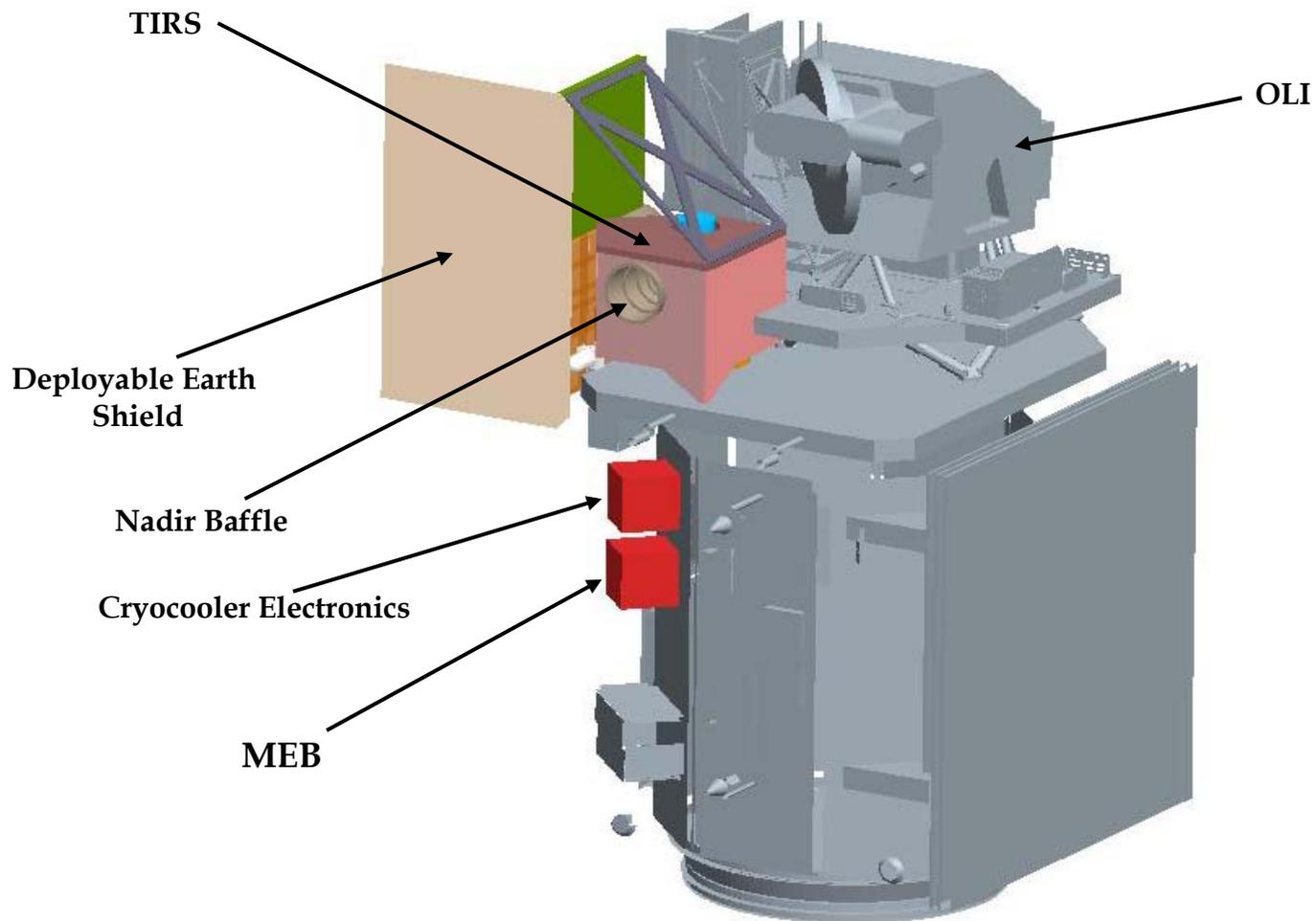
# TIRS Instrument Diagram



TIRS Optical Sensor Unit

# Spacecraft View

**LDCM**



## TIRS Decision

**LDCM**

- **Congressional interest in TIRS remains high**
  - Development of the LDCM spacecraft will not preclude the accommodation of a TIRS instrument
  - Accommodation of TIRS does not impact the performance of the Operational Land Imager
- **Project proceeding down path as if TIRS will be there**
  - Directed by Agency PMC at KDP-B to proceed at risk
- **Management of the TIRS instrument currently under purview of LDCM**
  - TIRS team is fully integrated into LDCM team
- **Resolution is expected from the final FY09 appropriations language**
  - Hopefully this spring