

# Engineering a Successful Mission: Lessons from the Lunar Reconnaissance Orbiter



Presentation at the Supply Chain 2011 Conference

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# Abstract

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- *Engineering a Successful Mission: Lessons from the Lunar Reconnaissance Orbiter*
- Abstract—Schedule pressure is common in the commercial world, where late delivery of a product means delayed income and loss of profit. Research spacecraft developed by NASA, on the other hand, tend to be driven by the high cost of launch vehicles and the public scrutiny of failure--the primary driver is ensuring proper operation in space for a system that cannot be retrieved for repair. The Lunar Reconnaissance Orbiter (LRO) development faced both schedule pressure and high visibility. The team had to balance the strong push to meet a launch date against the need to ensure that this first mission for Exploration succeeded. This presentation will provide an overview of the mission from concept through its first year of operation and explore some of the challenges the systems engineering team faced taking a mission from preliminary design review to pre-ship review in 3 years.



# Topics

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- LRO Objectives
- LRO Results to Date
- Programmatic Environment During Development
- Challenges and Approaches
- I&T Overview
- Observations and Lessons Learned



# LRO Beginning

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- January 2004, the President announced the “Vision for Space Exploration”, sending a “series of robotic missions” to the moon “beginning no later than 2008”.
- Announcement of Opportunity for LRO instruments released in June 2004; target launch October 2008.
- **Six** instruments selected in December 2004.
  - Selected instruments had strong relationship to recently-flown instruments
- Funding started in early 2005.
- Technology demonstration payload added in April 2005:
  - Mini-RF development significantly behind other instruments
  - Data rate and power consumption are significant



# LRO Objectives, Polar Focus

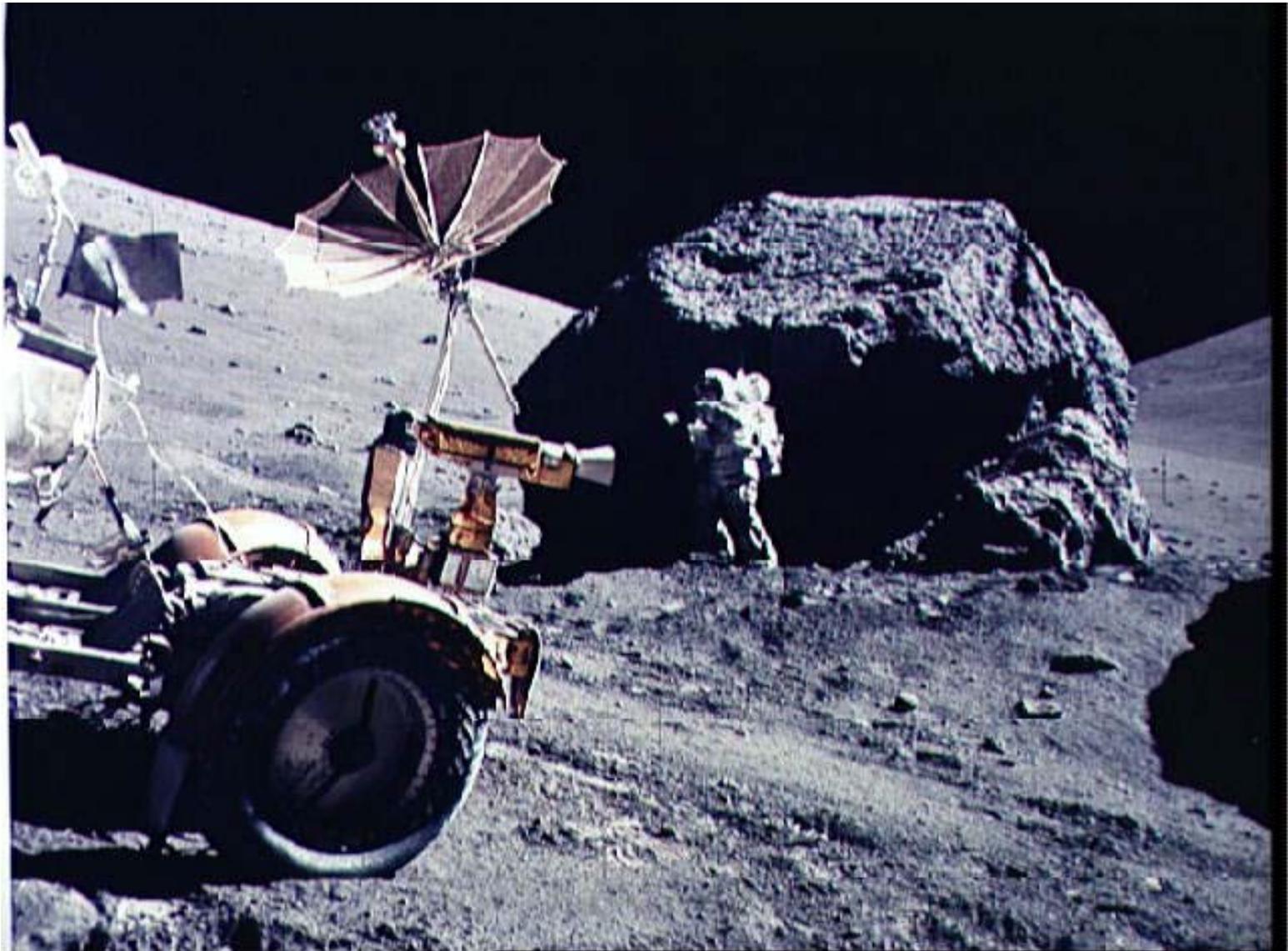
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- Characterize landing sites
  - High-resolution mapping
  - Surface characterization (slope, roughness)
- Identify resources
  - Water
  - Minerals
  - Sunlight
- Characterize radiation environment
  - Energy deposited in tissue-equivalent plastic
  - Neutron albedo



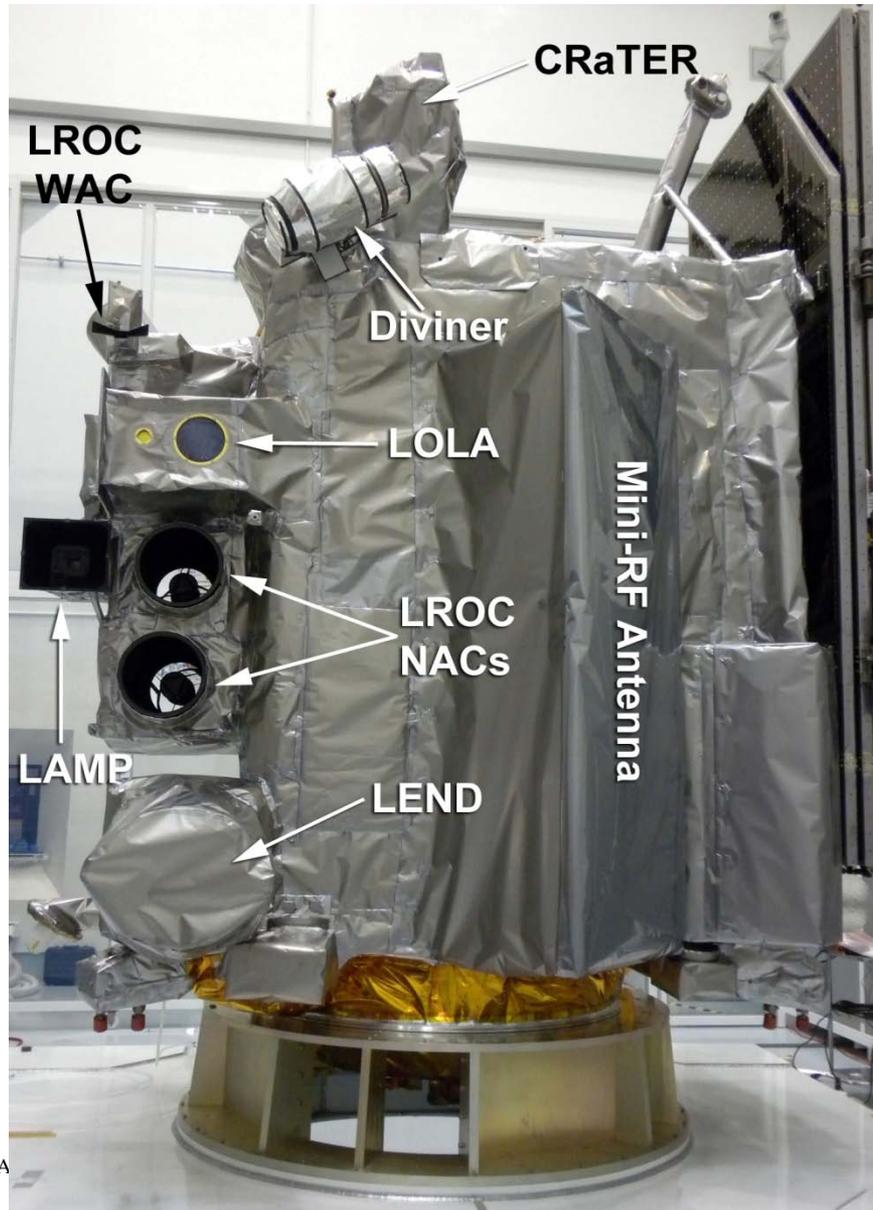
# Lunar Rover, Schmidt, Big Boulder

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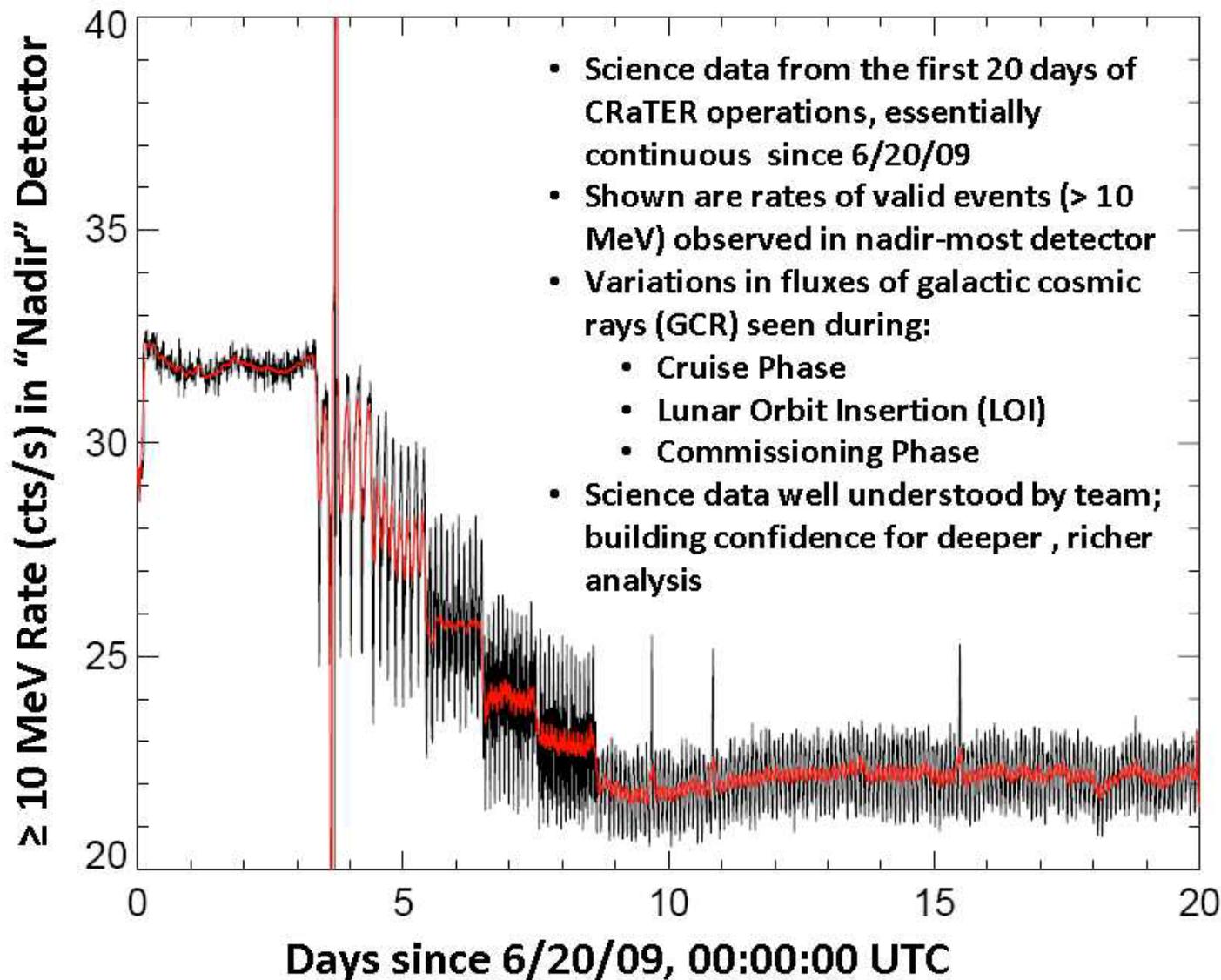


# LRO Payload Layout





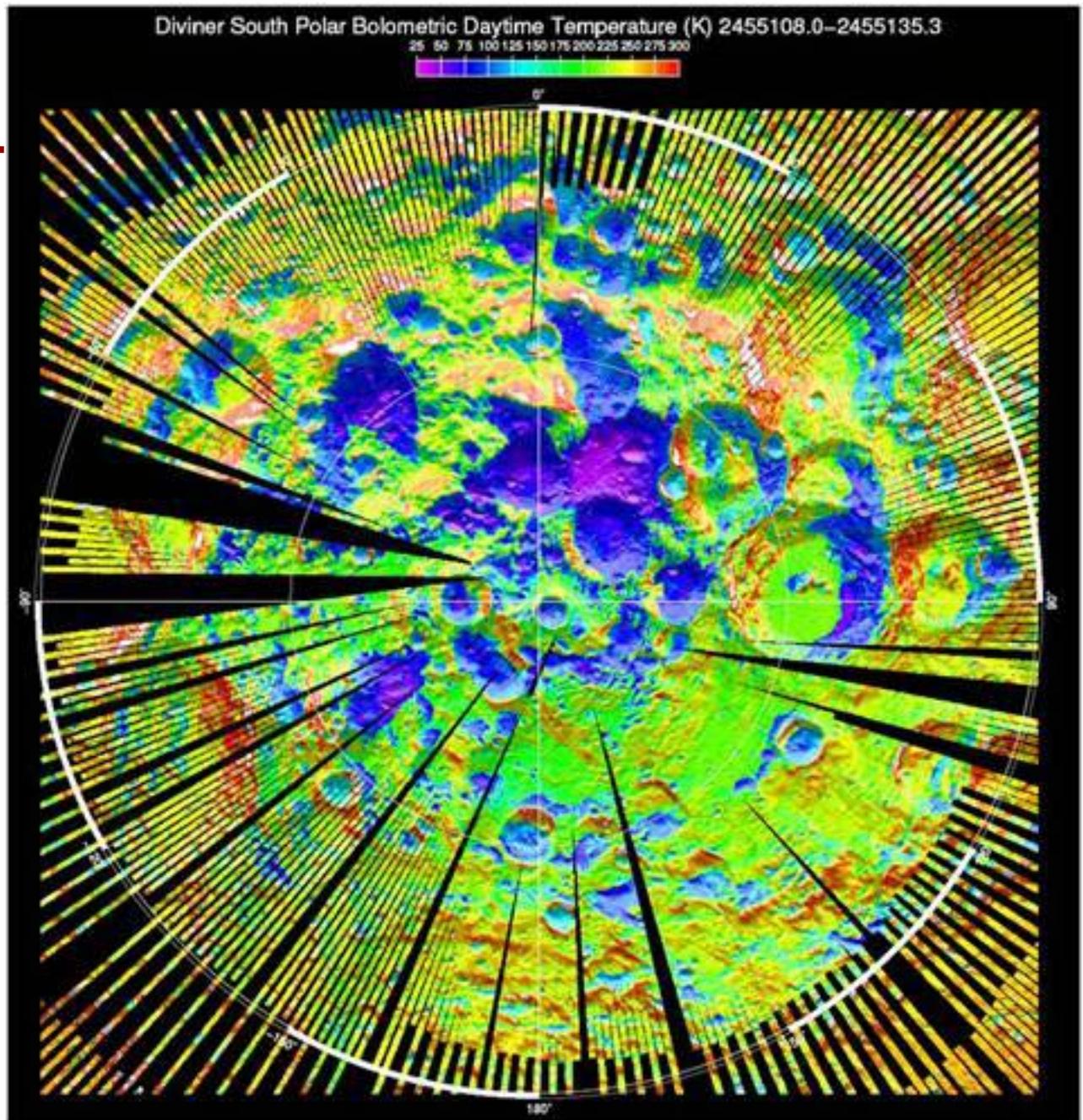
# CRaTER





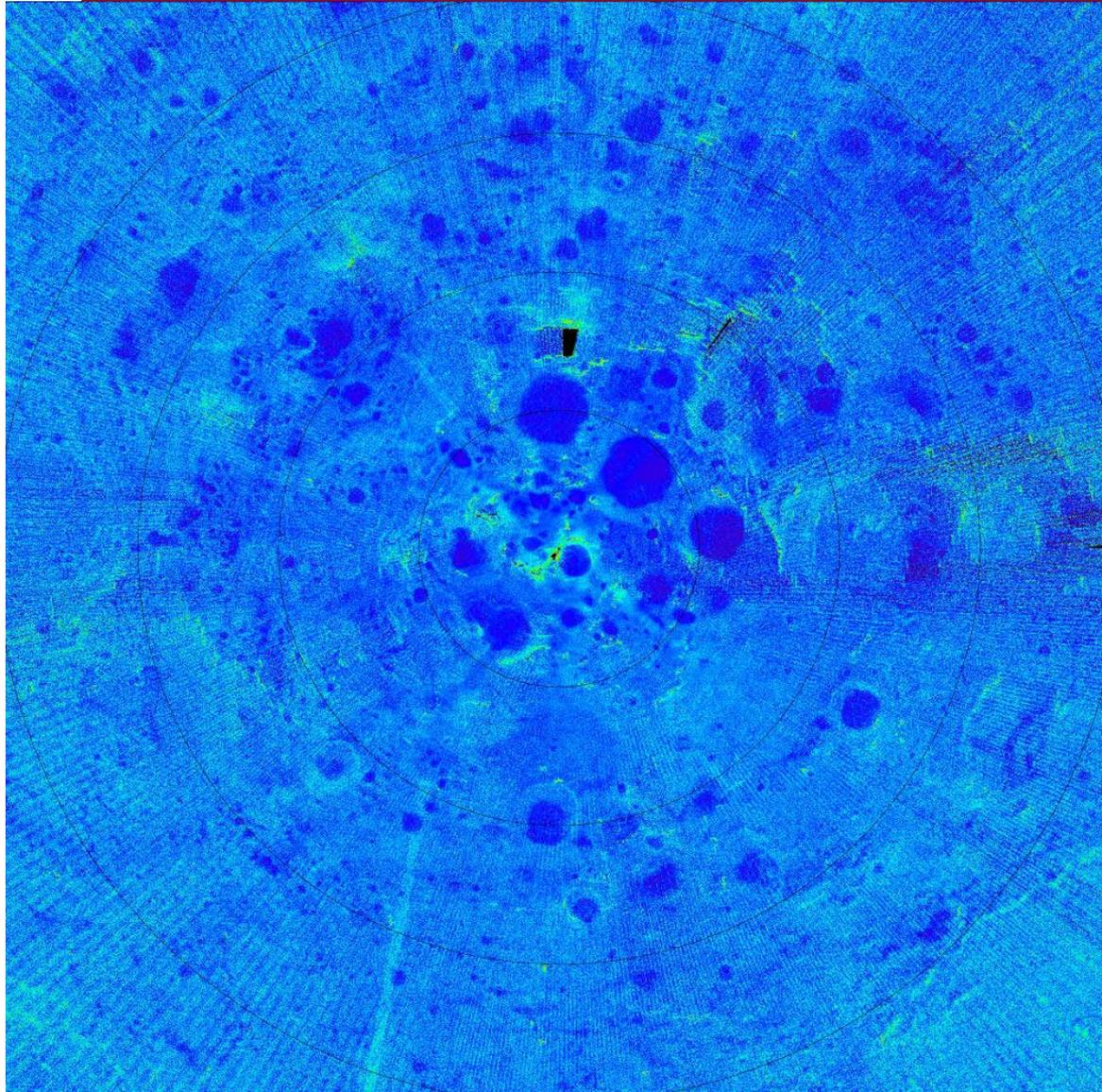
# Diviner

Temperatures  
down to ~35 K!





# LAMP



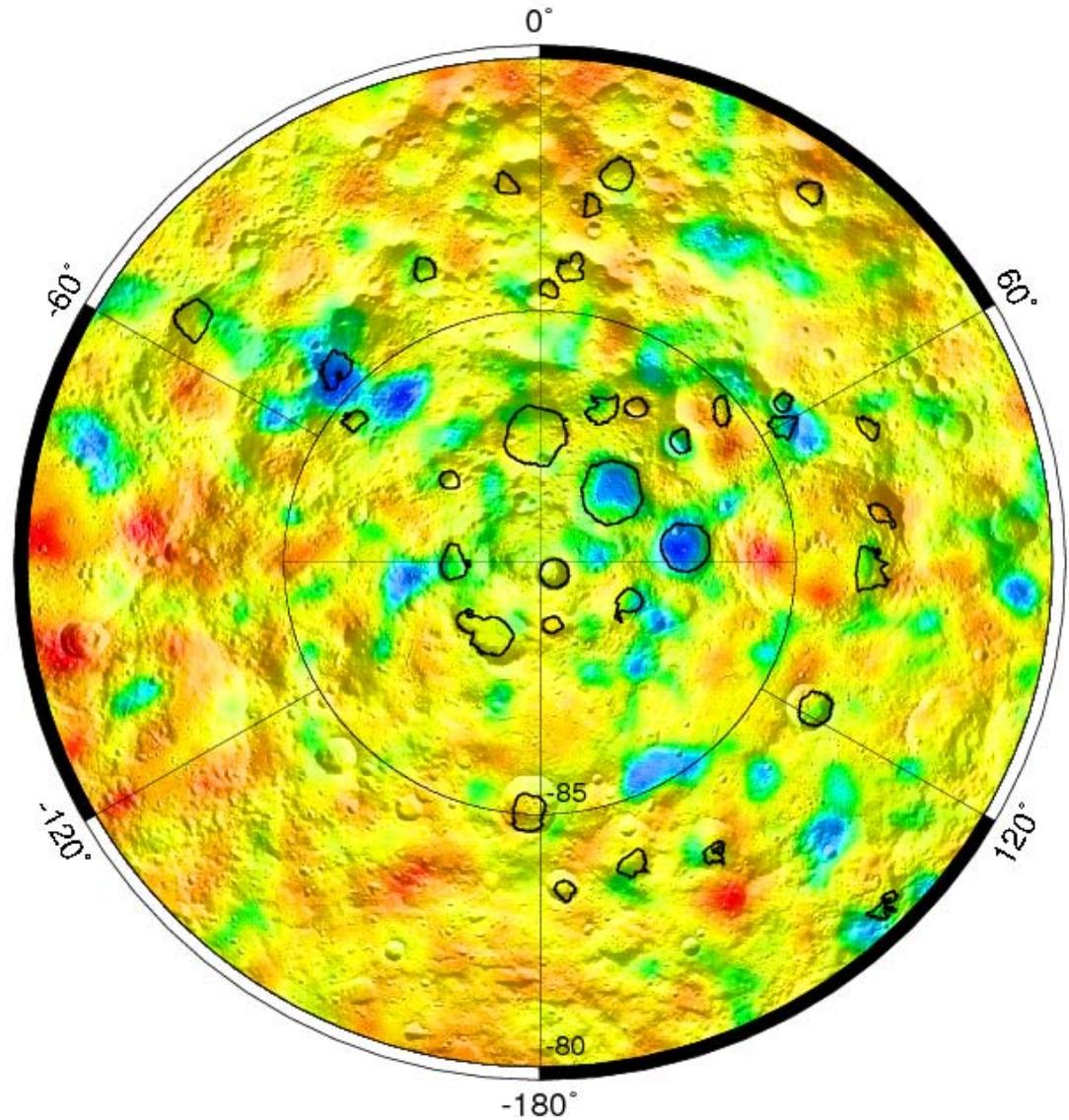
Permanently shadowed craters are dark under ultraviolet illumination

South Pole—  
Lyman Alpha,  
nighttime only



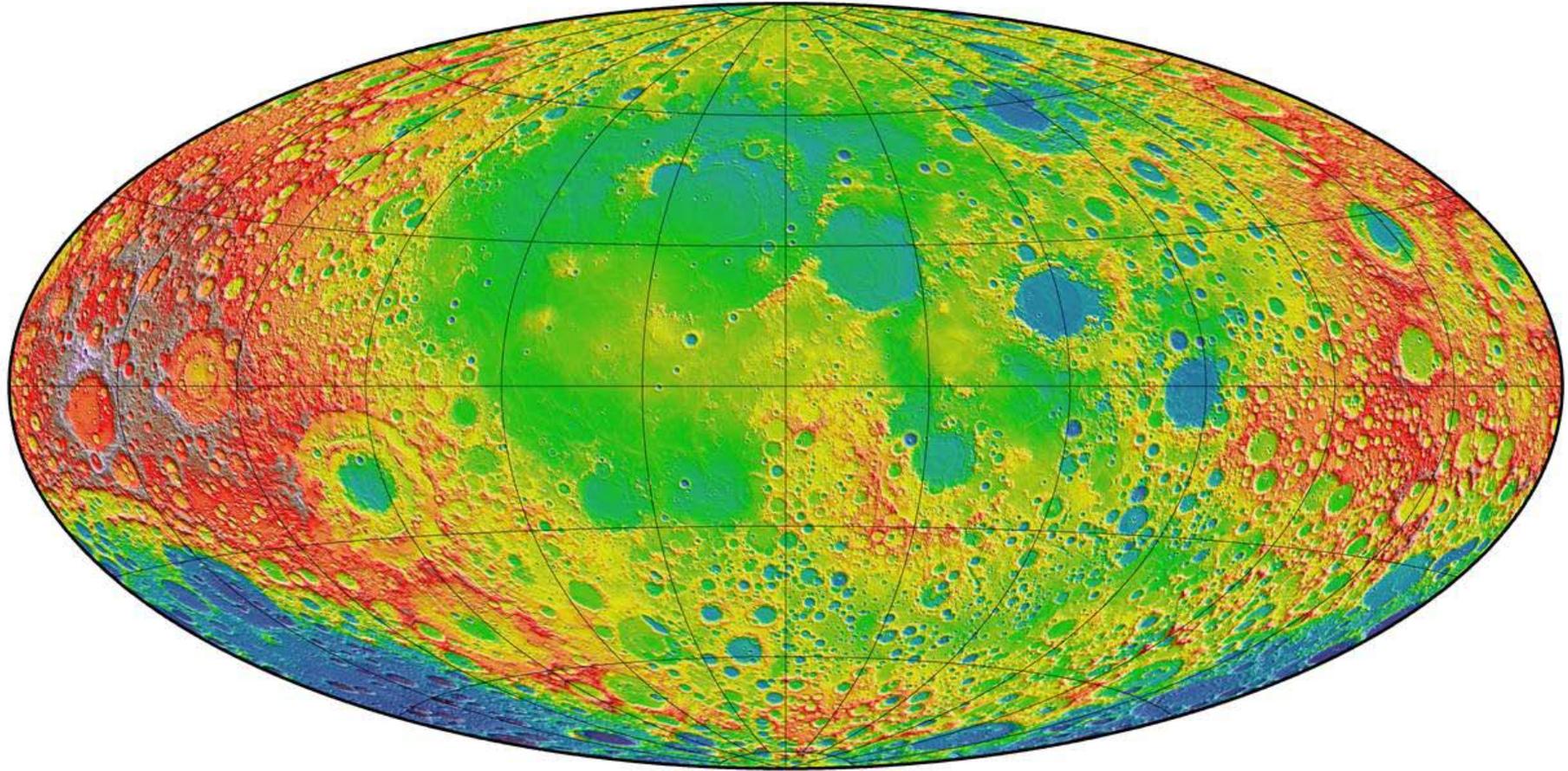
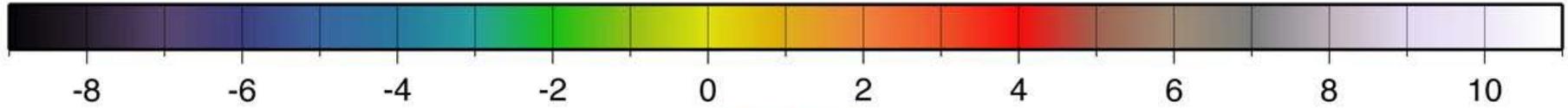
# LEND

Neutron absorption  
does not always  
correlate with  
permanent  
shadows





# LOLA Global Topography





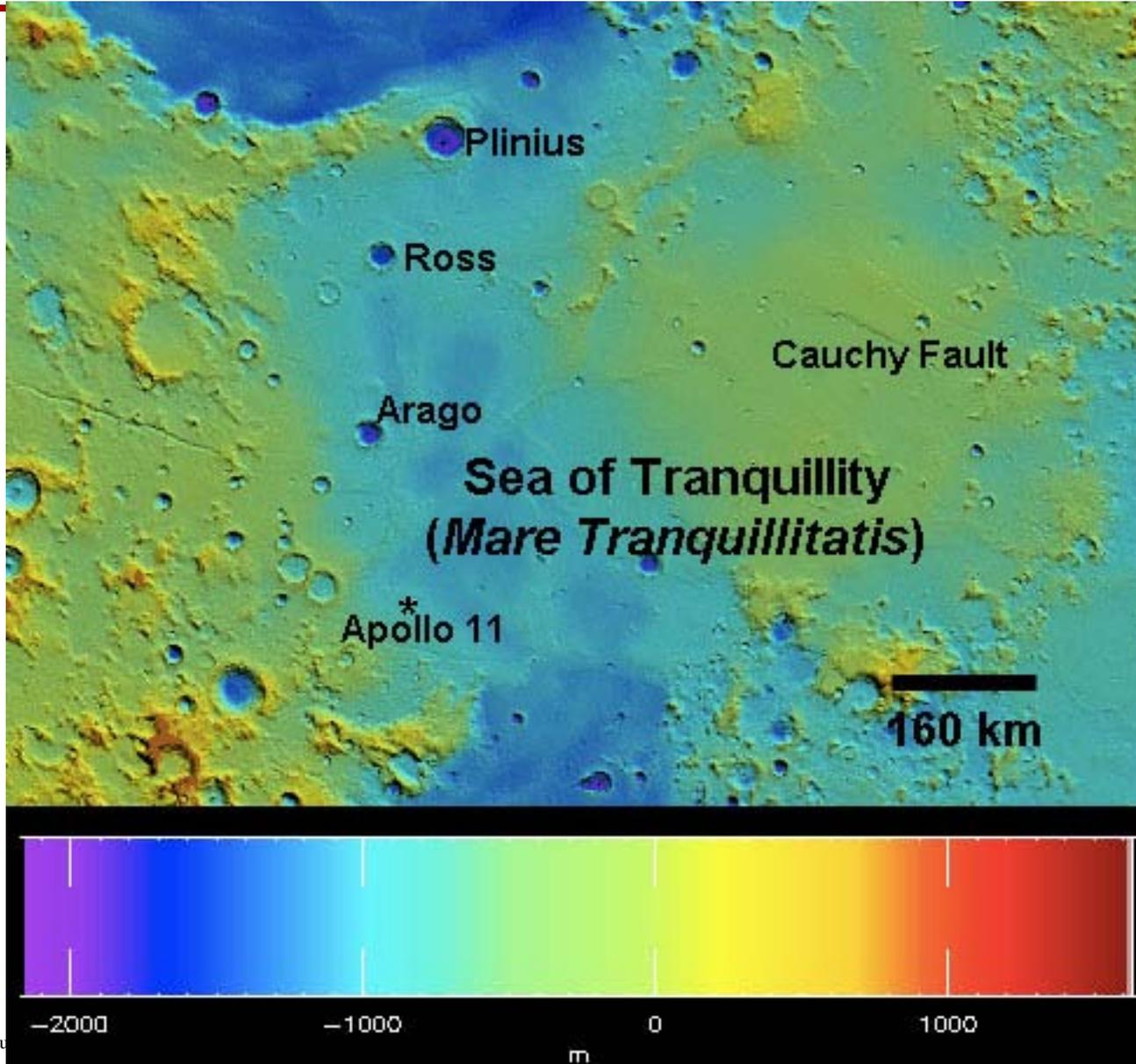
# Lunar Far Side Altitudes

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# LOLA Laser Altimetry Data



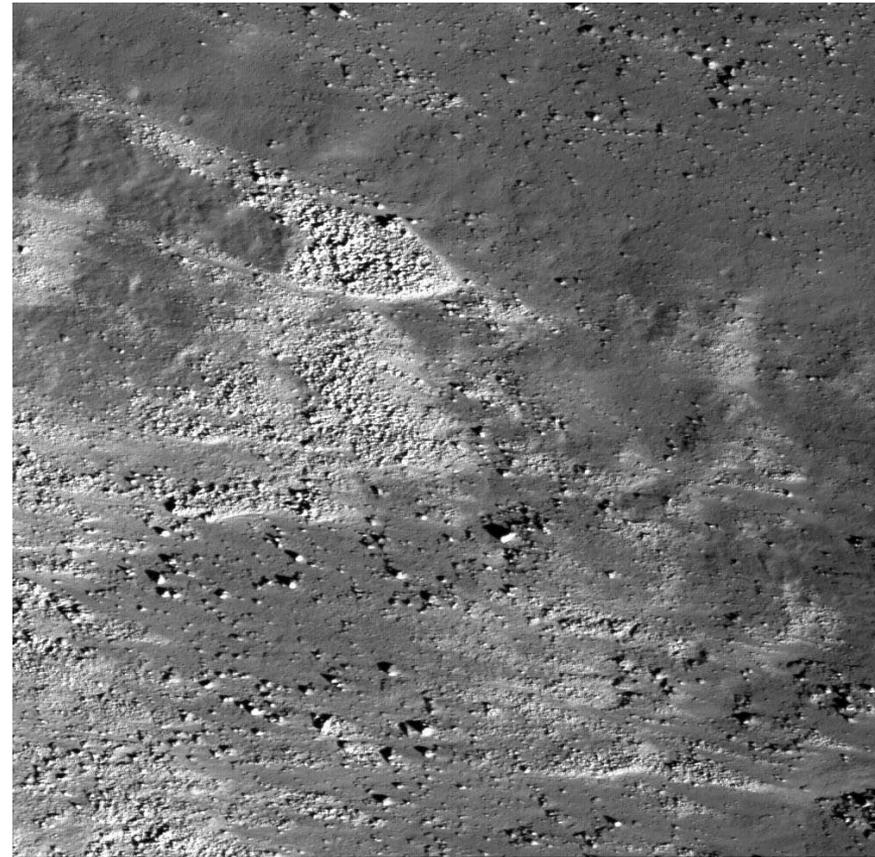


# LROC—Wide and Narrow Angles



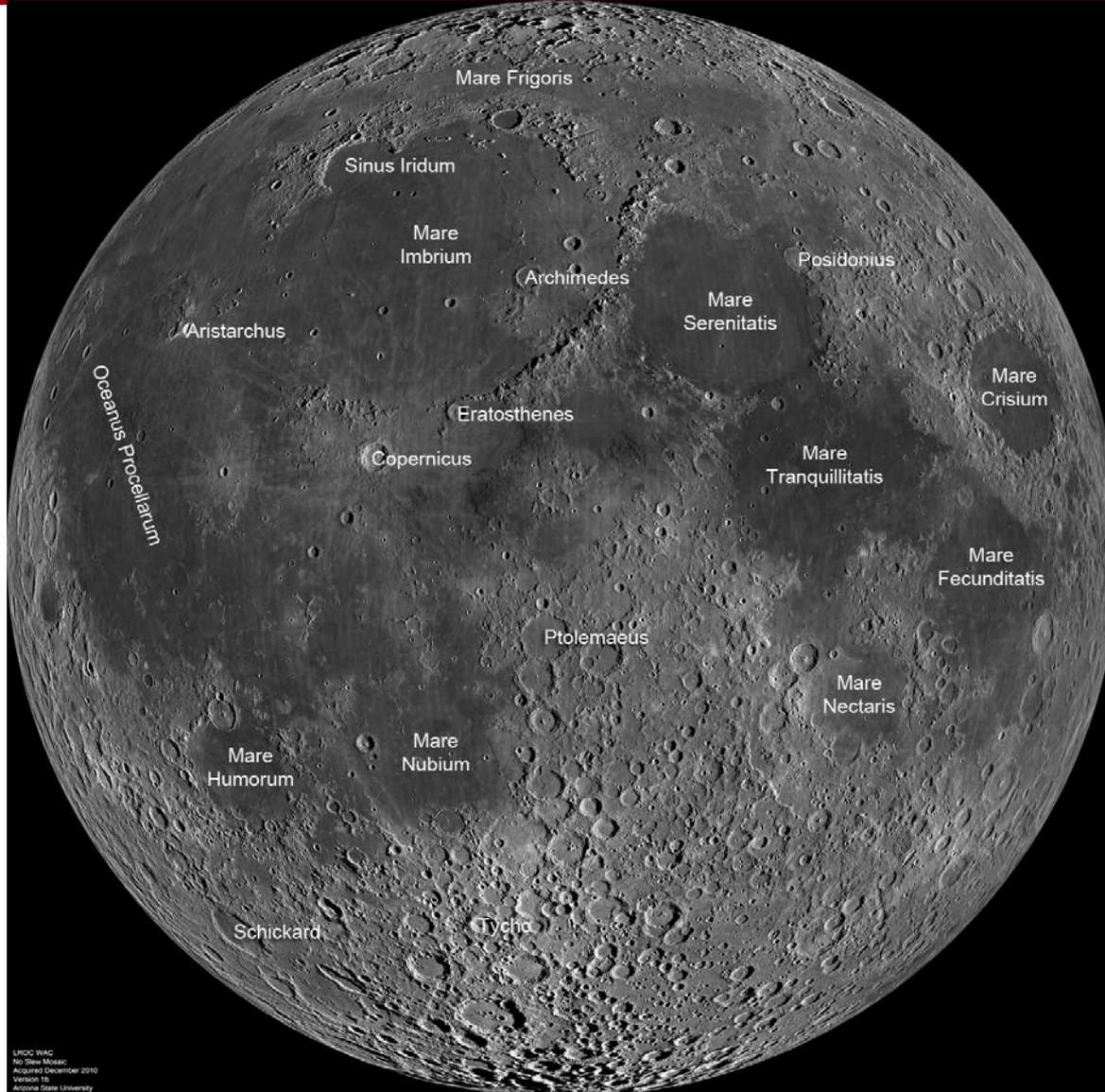
WAC Mosaic of “Cobra Head”  
\*Image width: 55 km

NAC closeup of WAC region marked  
by arrow \*Image width: 500 m





# Near-Side Composite from WAC

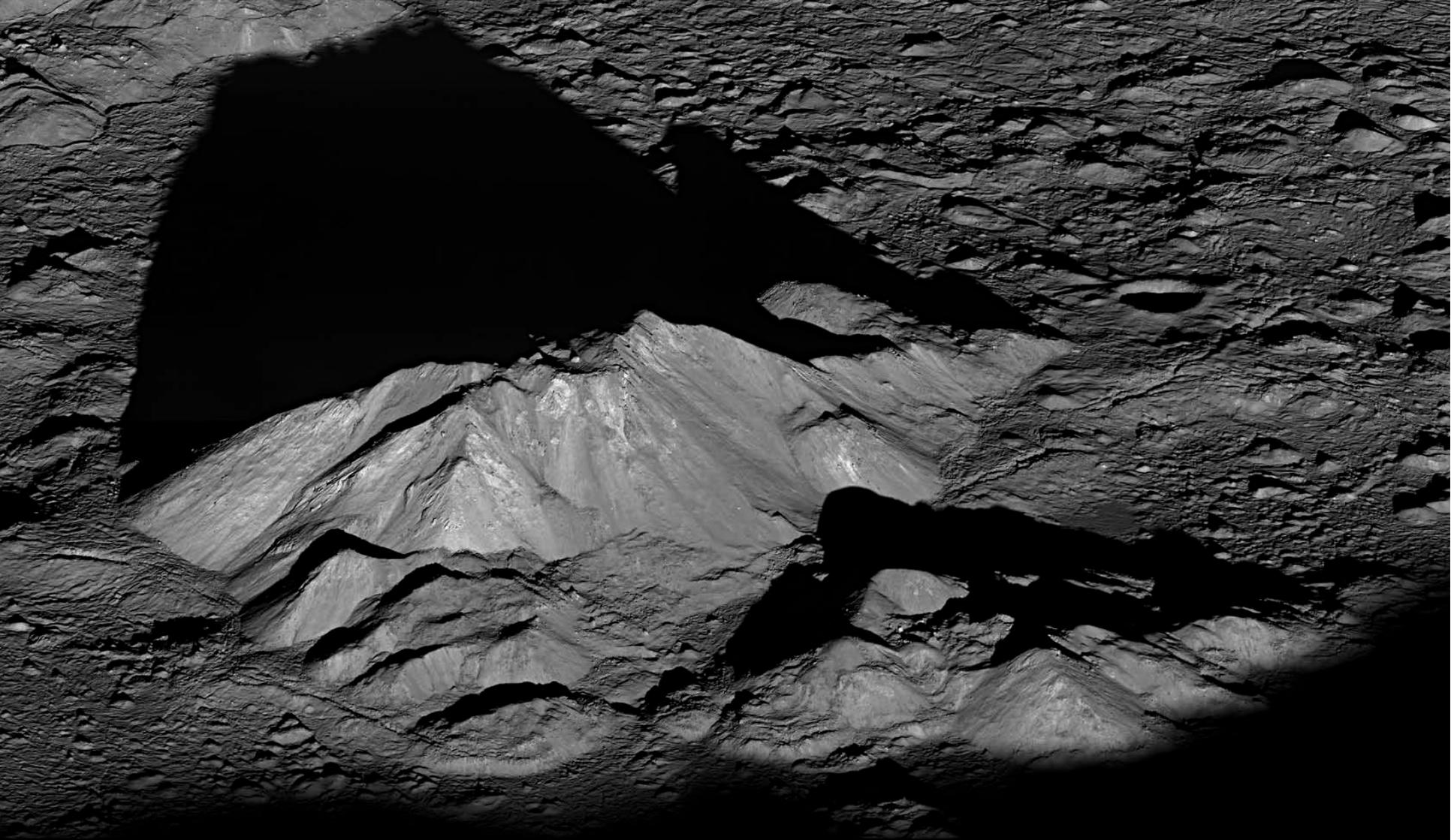


LRO/WAC  
No. 0566 Mosaic  
Acquired December 2010  
Version 1.0  
Arizona State University



# LROC—Tycho Central Peak

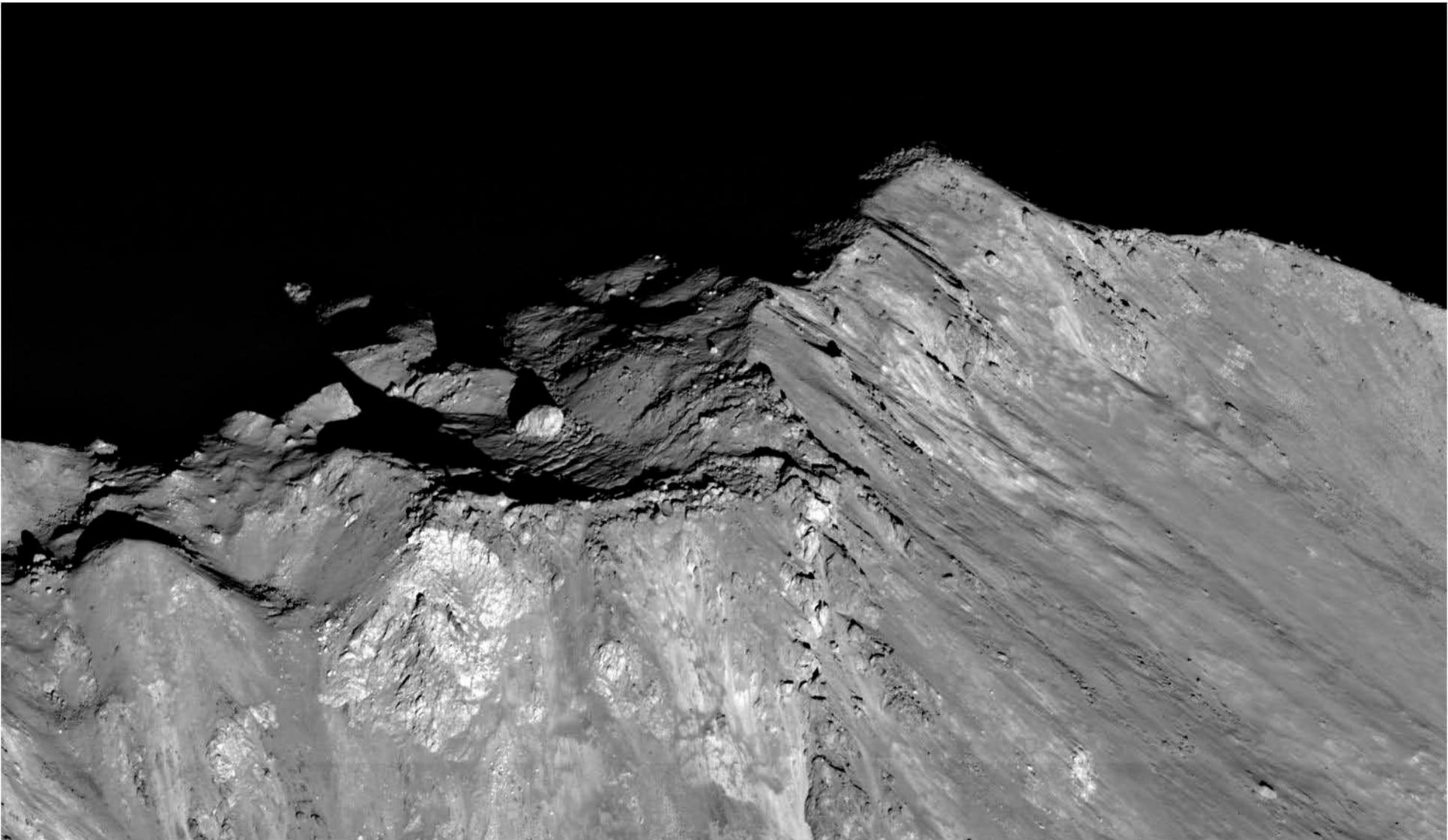
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# LROC—Tycho Central Peak

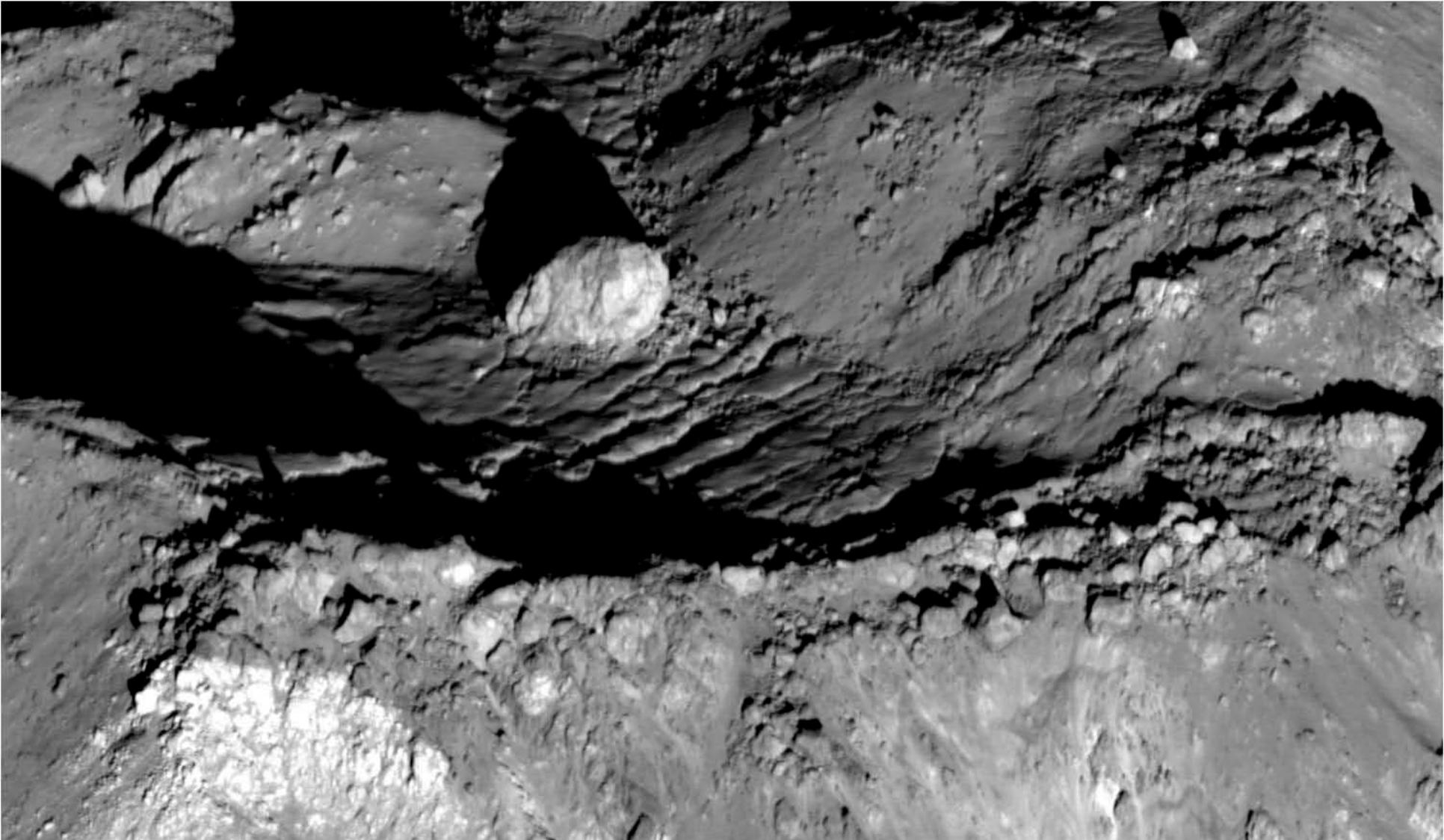
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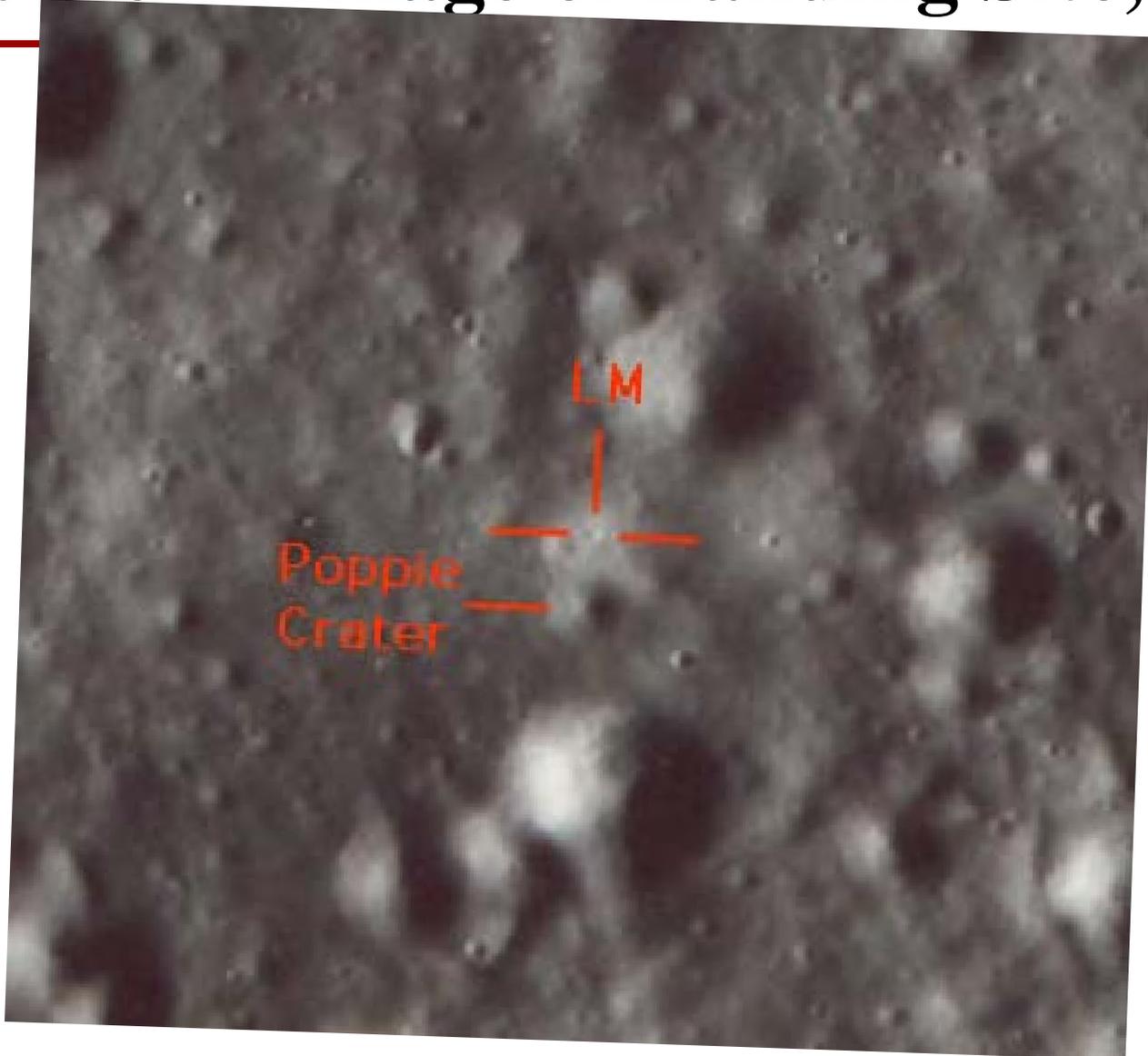
# LROC—Tycho Central Peak

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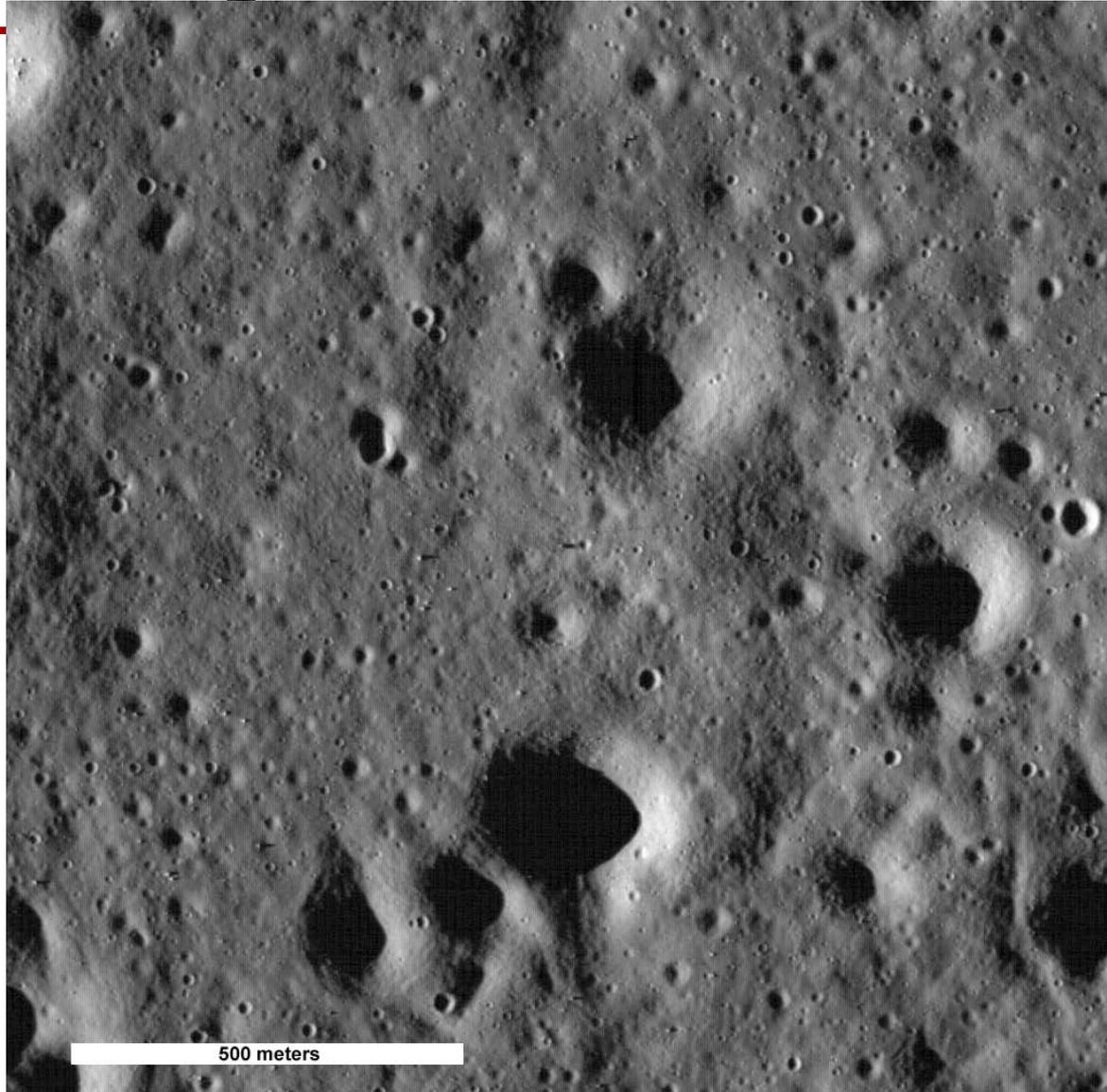


# Apollo 17 Image of Landing Site, 1972



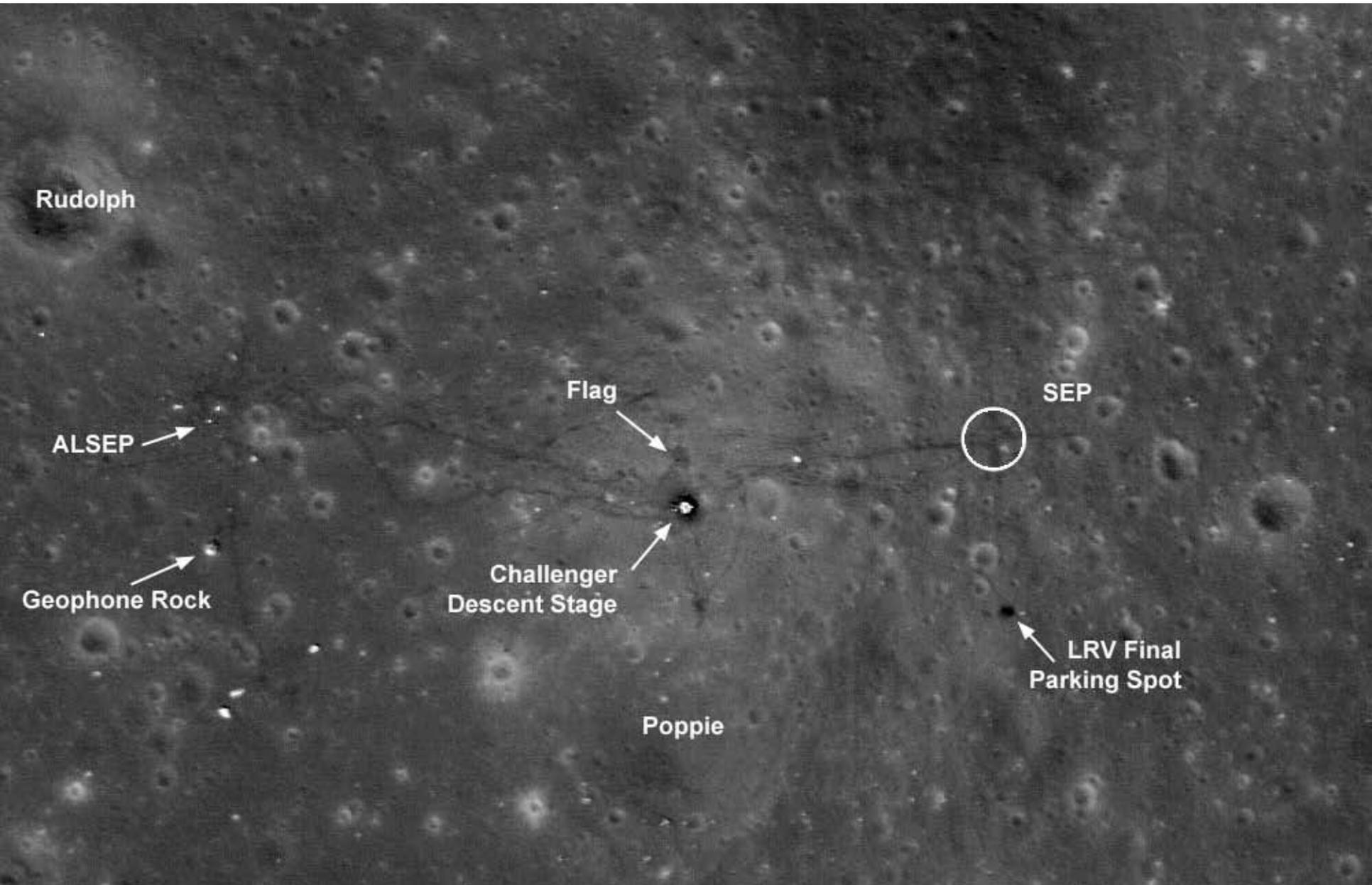


# LRO Image from 100 km, 2009





# LRO Image from 50 km





# LRO Image from 25 km

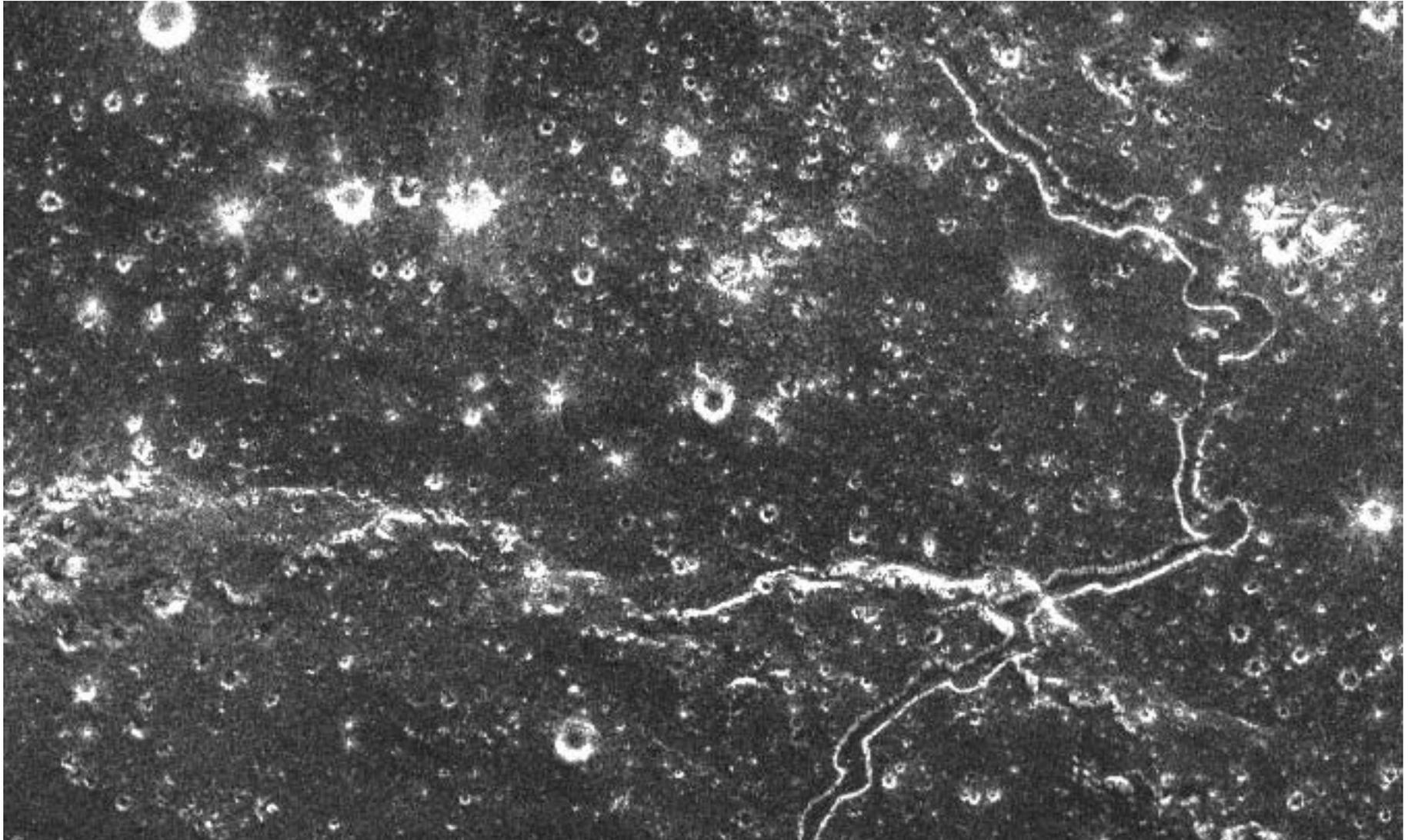
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# Mini-RF—Herodetus

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# Schedule

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- We had a Level 1 requirement to launch in 2008
- HQ continued to emphasize this requirement
  - Exploration Systems Mission Directorate's (ESMD) credibility with Congress and OMB was tied to getting this first mission done on time
  - HQ offered extra funding after CDR in order to hold schedule
    - Some money was applied in key areas
    - Overall effect reduced cost by saving schedule: one component can hold up the entire development
- Independent Review Team expressed concern with LRO's schedule at each review
- LRO engineers frequently expressed concern with schedule
- LRO established a budget at confirmation which did not overly constrain the mission
- Project management and systems team needed to balance schedule against technical risk



# LRO Fortune Cookie

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People forget how fast you did a job –  
but they remember how well you did it.  
Lucky Numbers 40, 27, 33, 5, 14, 9



# The Constant Challenge

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- Find ways to get things done faster without compromising the technical integrity
  - Work harder (we all did this—good team spirit)
  - Add more people (mechanical team)
  - Design for parallel development
  - Test early
  - Manage risk
  - Challenge the standard way of doing business
  - Focus on the people
  - Make decisions and move on
- All of the above were necessary!



# Risk Management

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- Monthly meetings with each of the subsystem leads provided input to our risk management process
  - One-on-one atmosphere was good for identifying potential issues at the system level
  - Kept the subsystem leads thinking about risk
  - Kept the database up-to-date
- Monthly risk management board meetings provided:
  - Insight to project management
  - Forum for project-level decisions about risks
- The LRO team did not wait for monthly meetings to address critical risks
- Example: propulsion tank NTC issue
- Example: hard drive radiation test failure
- Example: C&DH power converter delayed delivery
  - Built flight spare card with slightly lower quality part
  - Started investigating risk associated with flying this part
  - Bought time while we worked with the vendor to get flight part delivered



# Focus on the People

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- We solved problems quickly by bringing our full talent to bear
  - Diverse perspectives
  - Minority opinions
- Constant effort to get people to voice their concerns
  - Some people don't want to be a bother
  - Some people don't realize the full impact of their concern
  - Some people don't think their voice will make a difference
- Some people require more effort
  - Maybe their style doesn't match your style
  - Perhaps they have less experience
  - Perhaps they worry too much
  - Or maybe they just think differently
- Example: propulsion trade to solve NTC problem
- Example: coarse sun sensor circuit design issue
  - Small discrepancy bothered engineers performing test
  - Pursued source (with systems support) until flaw was discovered



# Over 50 Issues Between CDR and I&T!

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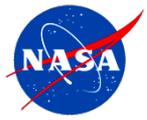
- Nearly every component had some sort of *unforeseeable* problem during the build phase, with technical risk-vs.-schedule or subsystem-vs.-subsystem decisions required:
  - C&DH:
    - Assembly issues—rework
    - SBC noise problem—rearrange spacewire ports
    - Power supply parts delays—build extra unit
  - Comm
    - Transponder Software design flaw—change ground stations
    - Transponder Hardware design flaw—replace part, jumpers
    - Modulator assembly problems—bring in-house
    - Modulator performance at cold—modify circuit
    - TWTA design error in ground protection circuit—fly as-is
  - GN&C
    - Wheel board layout problem—redo
    - Star Tracker resets—change part
    - MIMU part failure—replace part



# Over 50 Issues (cont.)!

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- Nearly every component had some sort of *unforeseeable* problem during the build phase, with technical risk-vs.-schedule or subsystem-vs.-subsystem decisions required:
  - Software performance problems—update code
  - Power: PSE frequency shift during vibe—tighten and retest
  - Payloads
    - CRaTER ETU part failure—flight parts OK
    - Diviner actuator damaged during test by long screw—re-work
    - LAMP board damaged by long screw—replace board
    - LEND power surge during thermal vacuum—replace unit (flight spare)
    - LOLA housing corrosion—fly as is
    - LOLA overtest during sine burst—no damage
    - LOLA corona during thermal vacuum—no damage
    - LROC NAC vibration failure—redesign mount for secondary
    - Mini-RF strut failure during thermal vac—redesign strut



# Flight Integration Begins, Jan 2008

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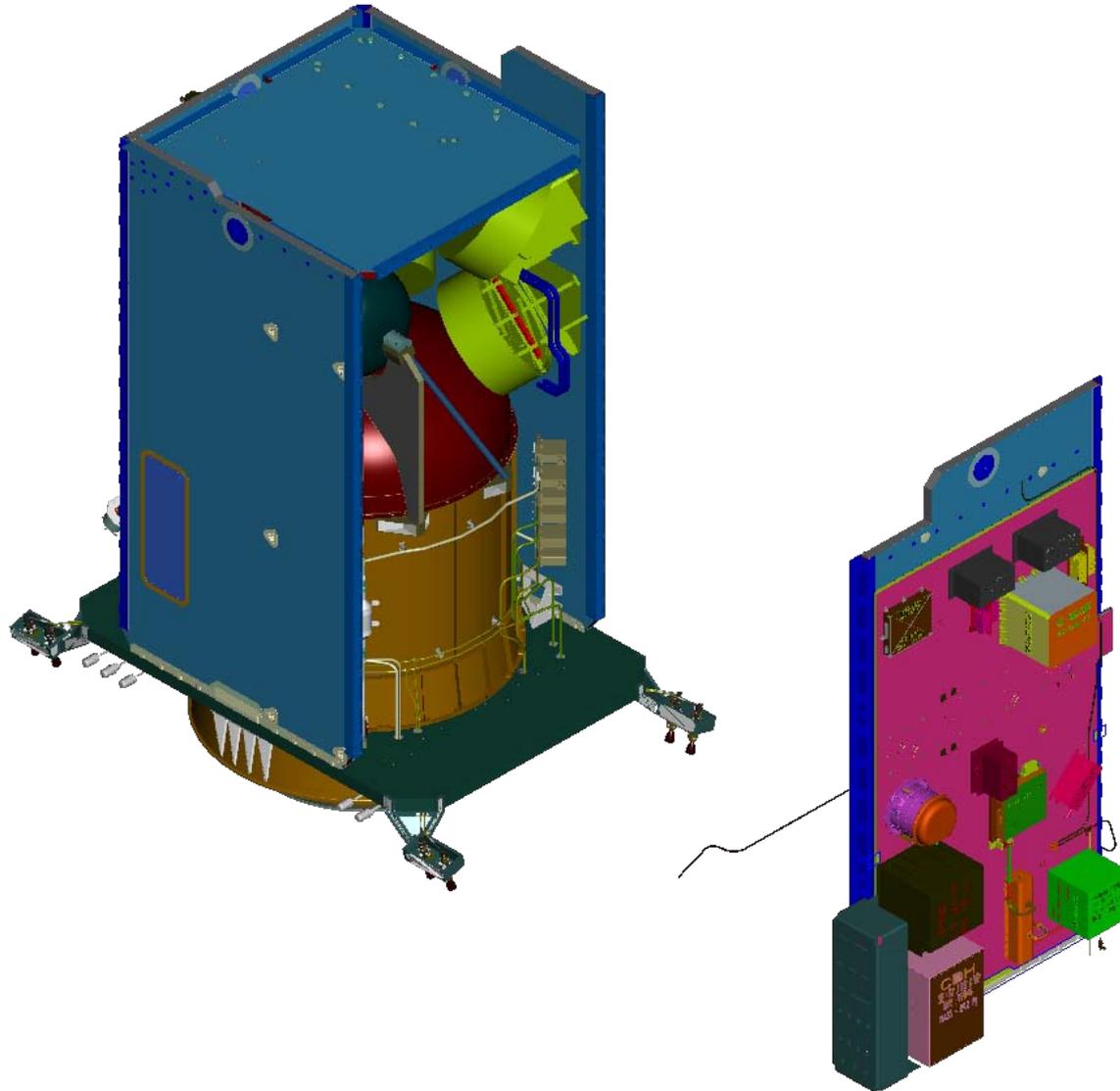
# PDE Safe-to-Mate, January 2008





# Propulsion Tank and Wheel Locations

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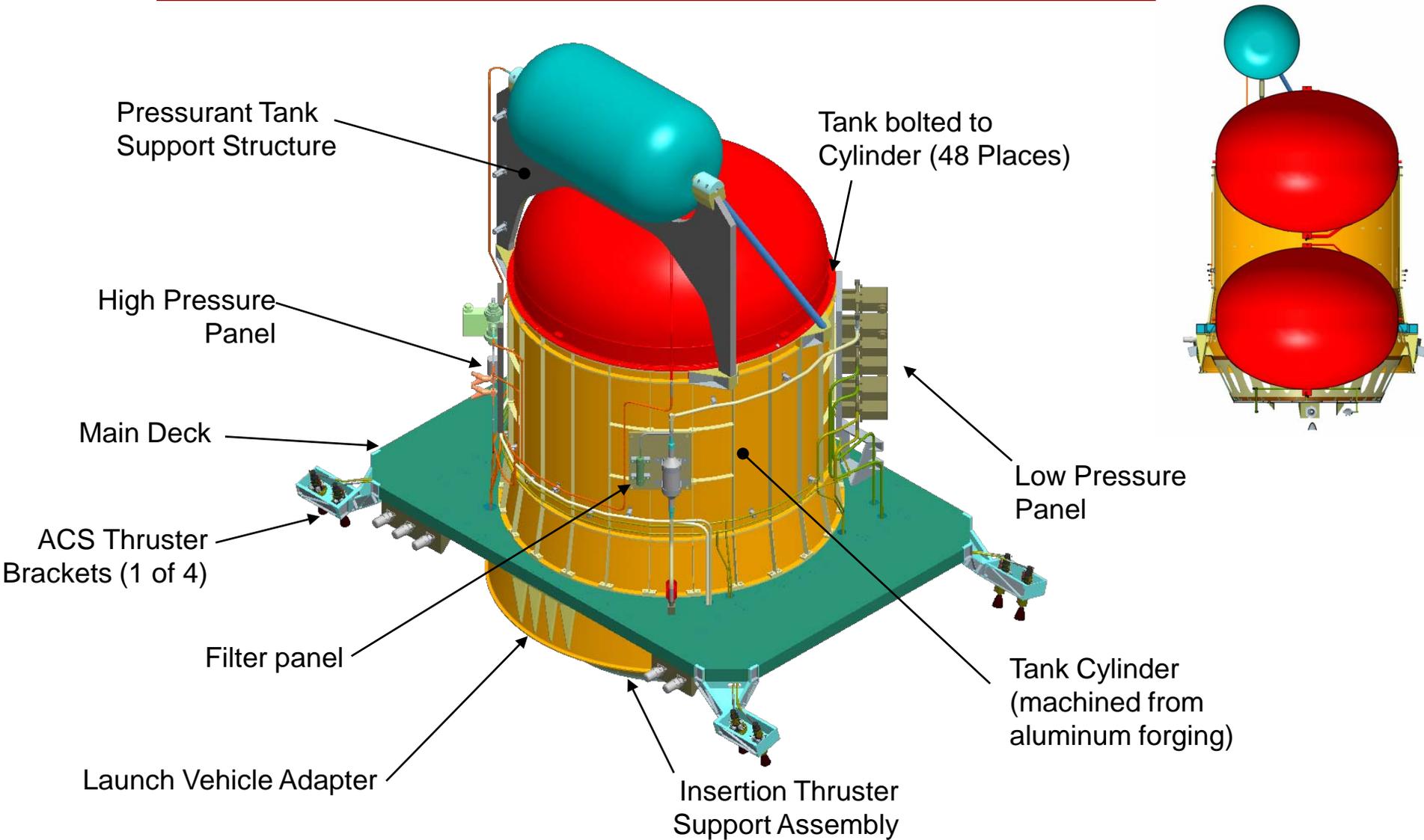


# Reaction Wheels, January 2008



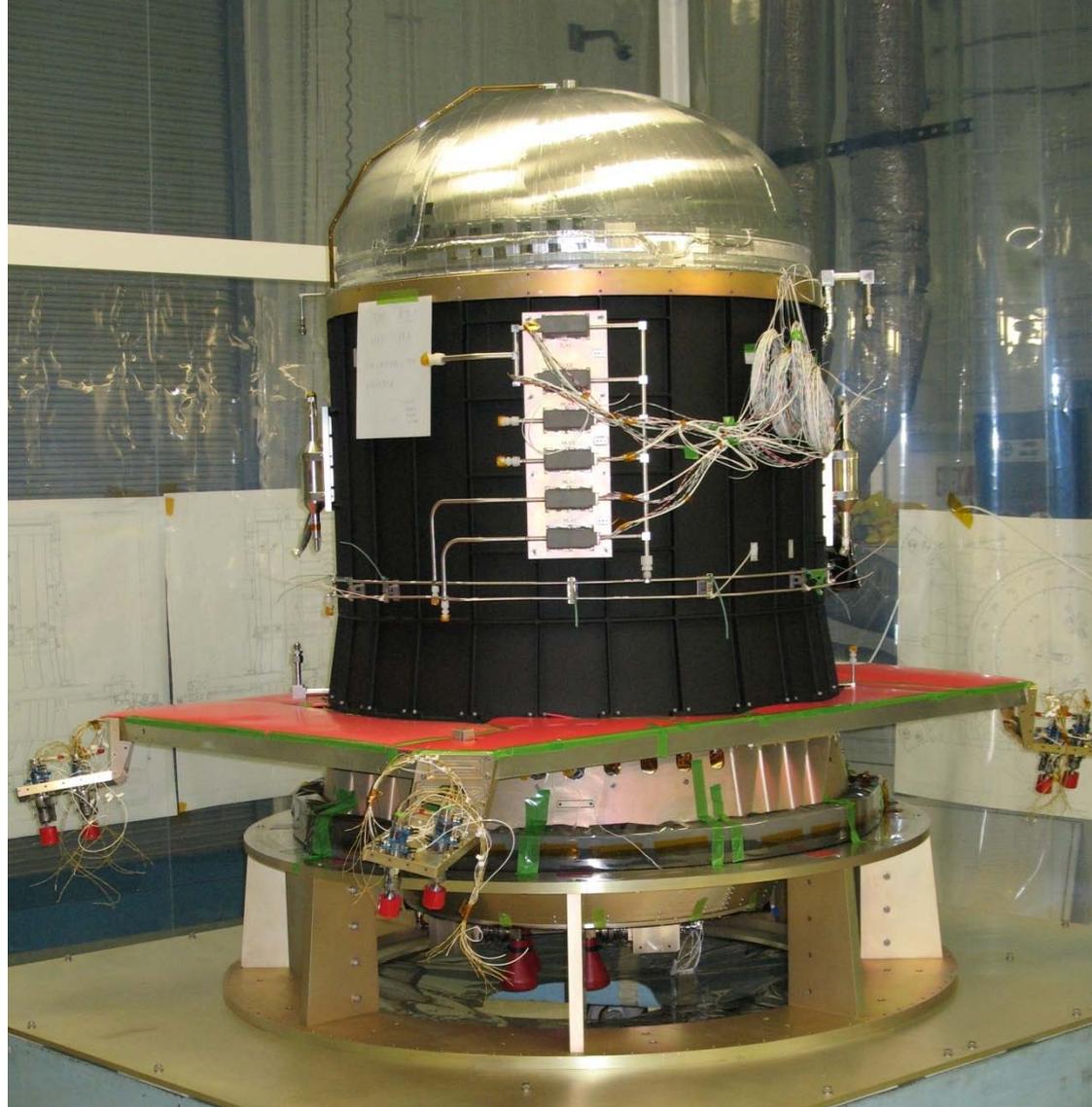


# LRO Propulsion Module





# Propulsion Module



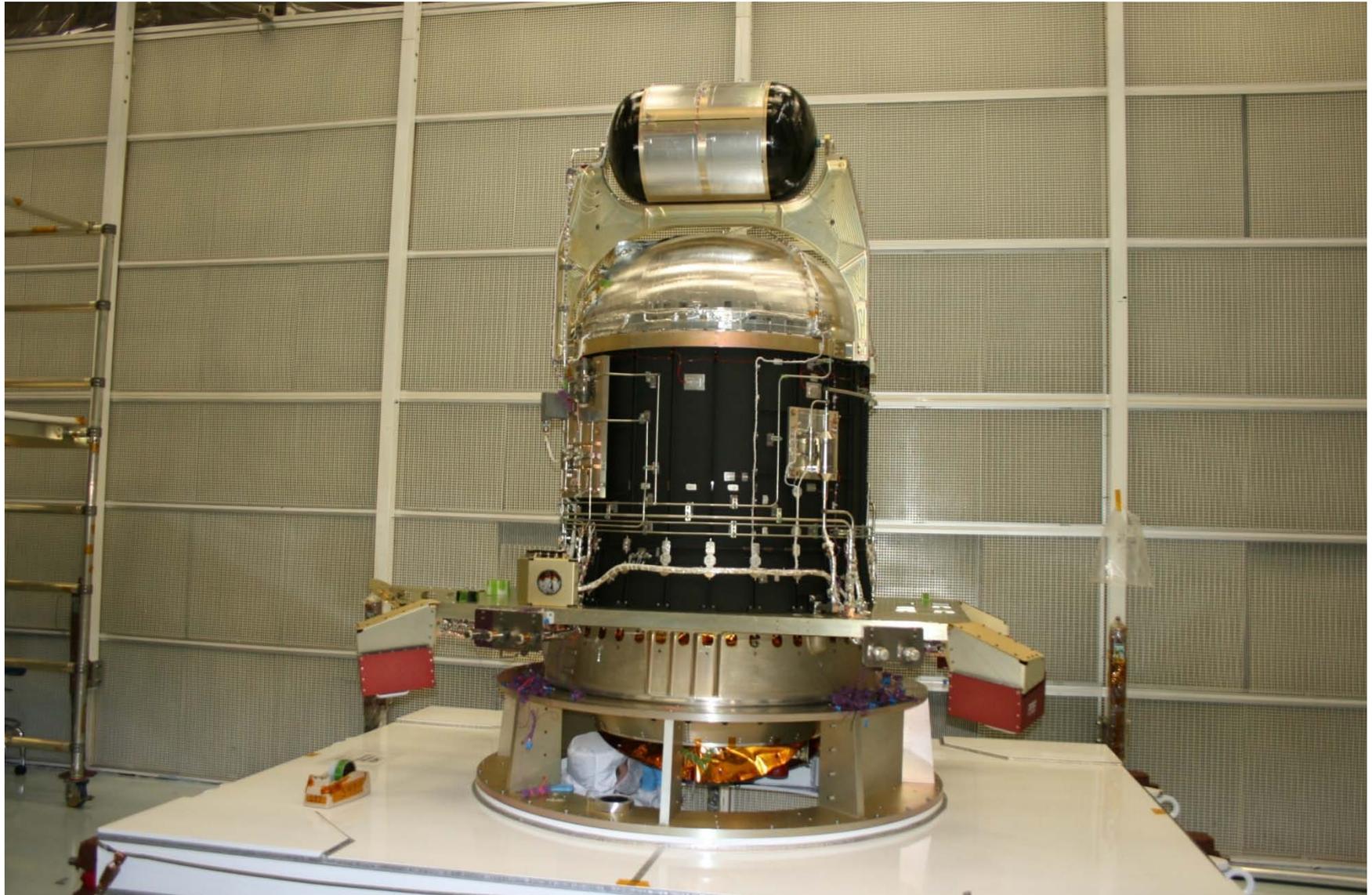


# Assembly Team





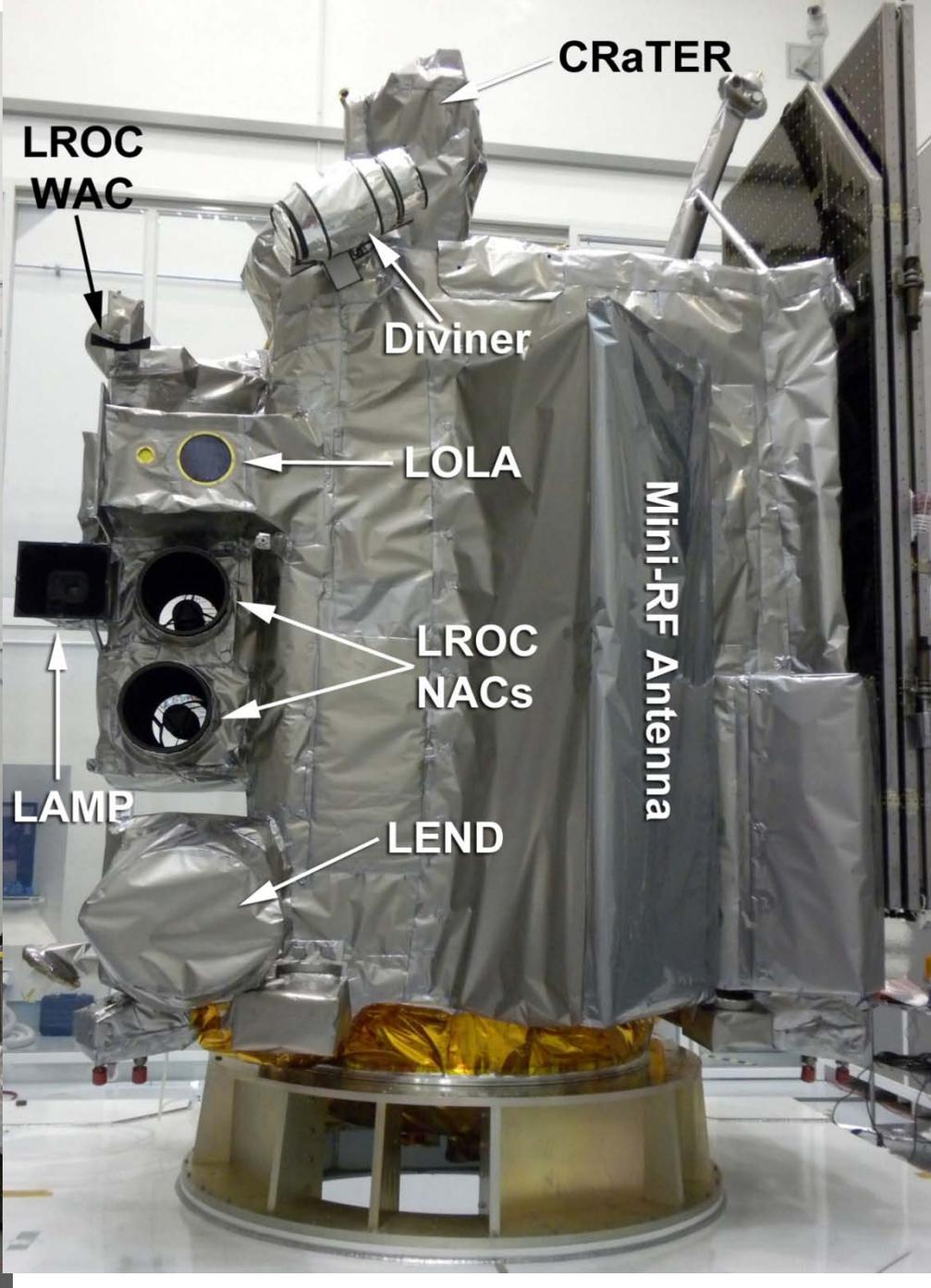
# Propulsion Module, January 2008





# +Y Panel Integration, 3/13/08









# WS1 Antenna Assembly at White Sands

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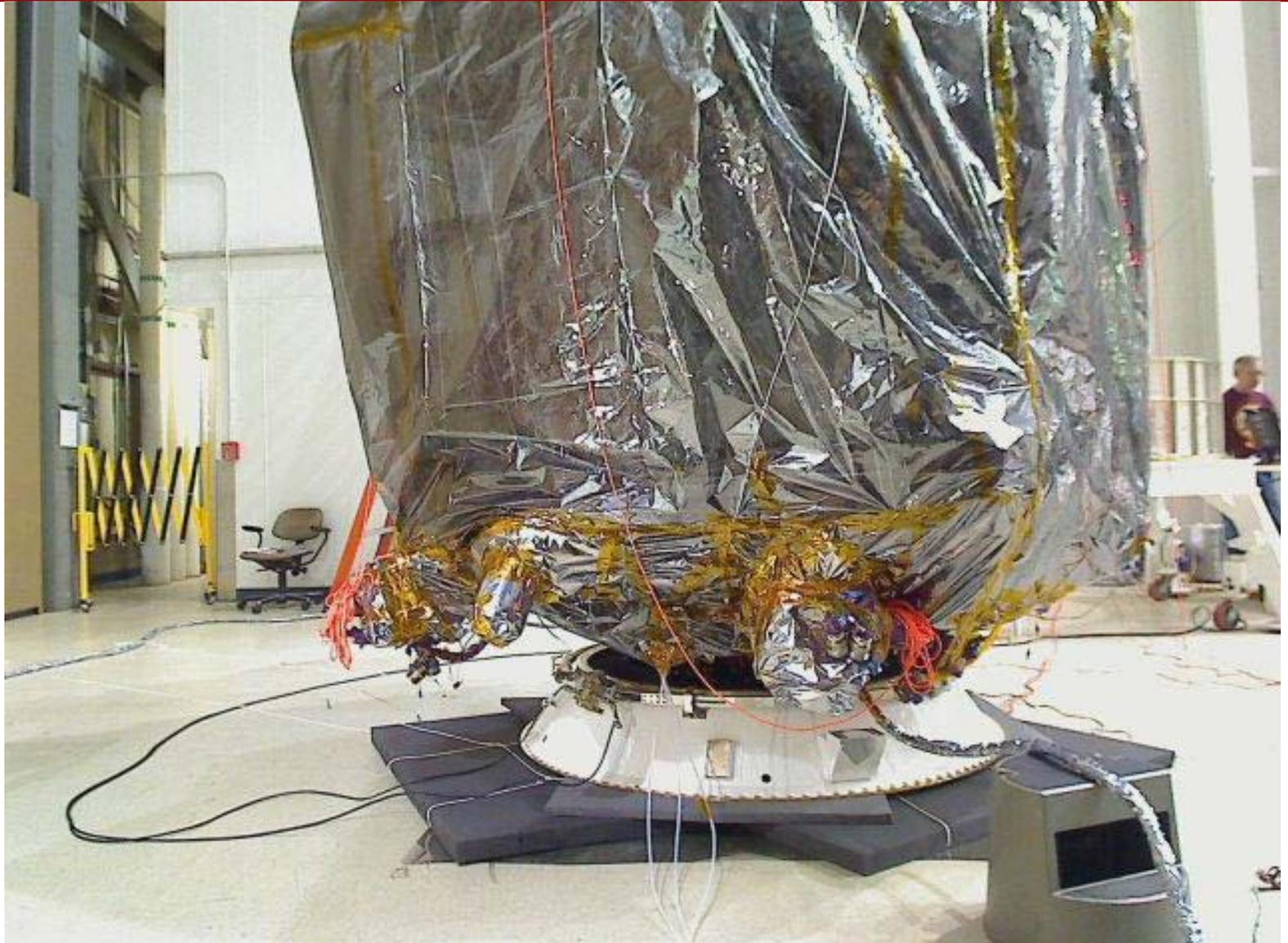


# Shock Test (before)





# Shock Test (after)





# EMI





# Thermal Vacuum





# Final Preparation for Ship

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- Systems and Mission Assurance worked together to ensure clear and complete documentation
- Acceptance Reports for components
  - Pointer to all documentation
  - Signoff by component owner, subsystem lead, and cross-cutting systems (mechanical systems, avionics systems, thermal systems)
- Work Order Authorizations were not closed until:
  - Associated PR's were closed
  - All paperwork was complete and in the database
- Requirements were not considered “verified” until:
  - WOA was closed
  - Reports were in the configuration management system



# On the Truck





# LRO Crew at Astrotech

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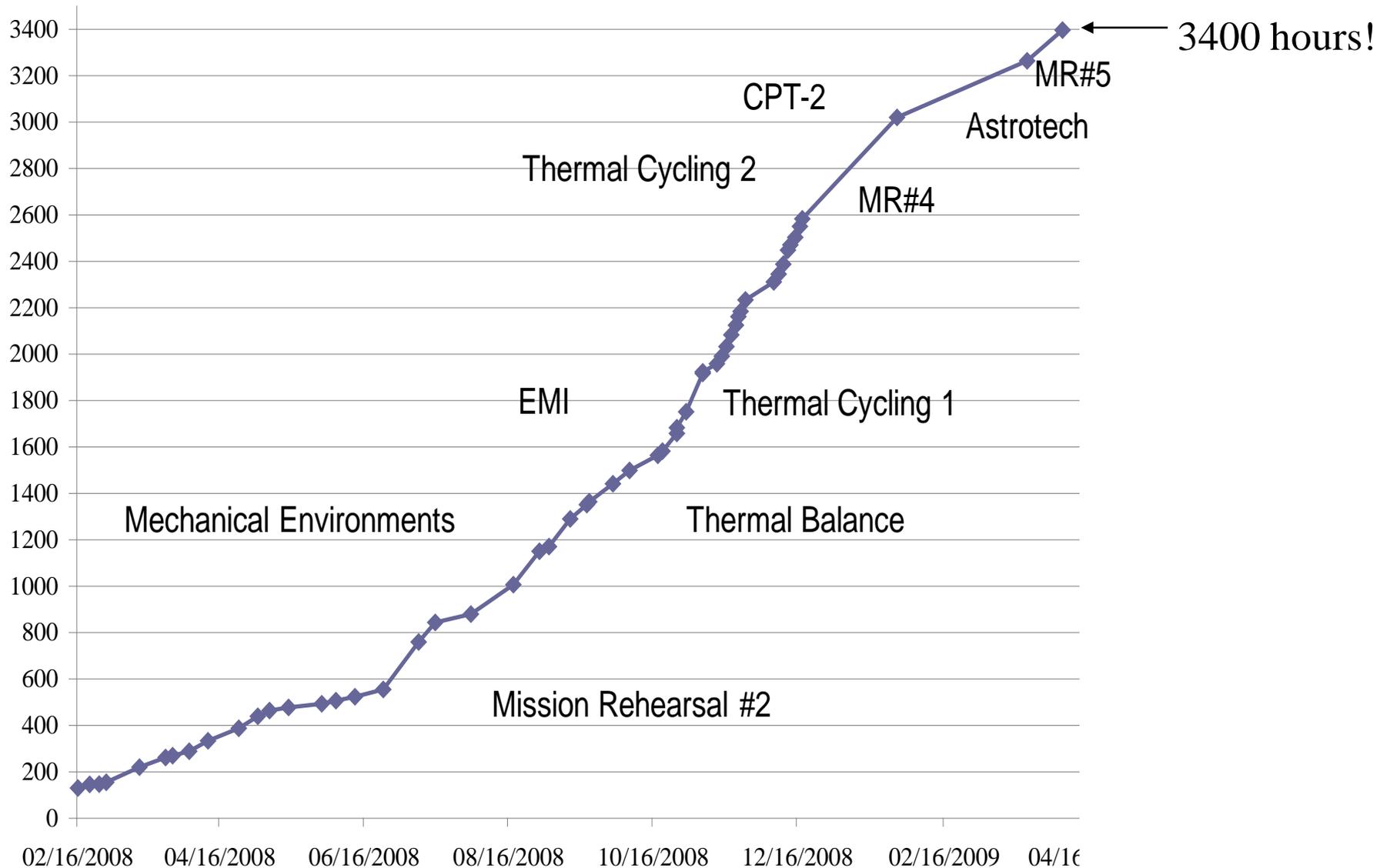
# Launch Site Operations

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- The end is in sight—don't stumble now!
- Shipped in February 2009 for April launch
- Vehicle issues pushed launch into June
  - Used extra time for additional operations testing
- Extra attention at launch site
  - Upper-level management gets very interested
  - Engineers become hyper-vigilant
- Project loses control of the schedule
  - Launch vehicle and range issues dominate
  - Spacecraft team must stay flexible
- Lots of fun and lots of stress!

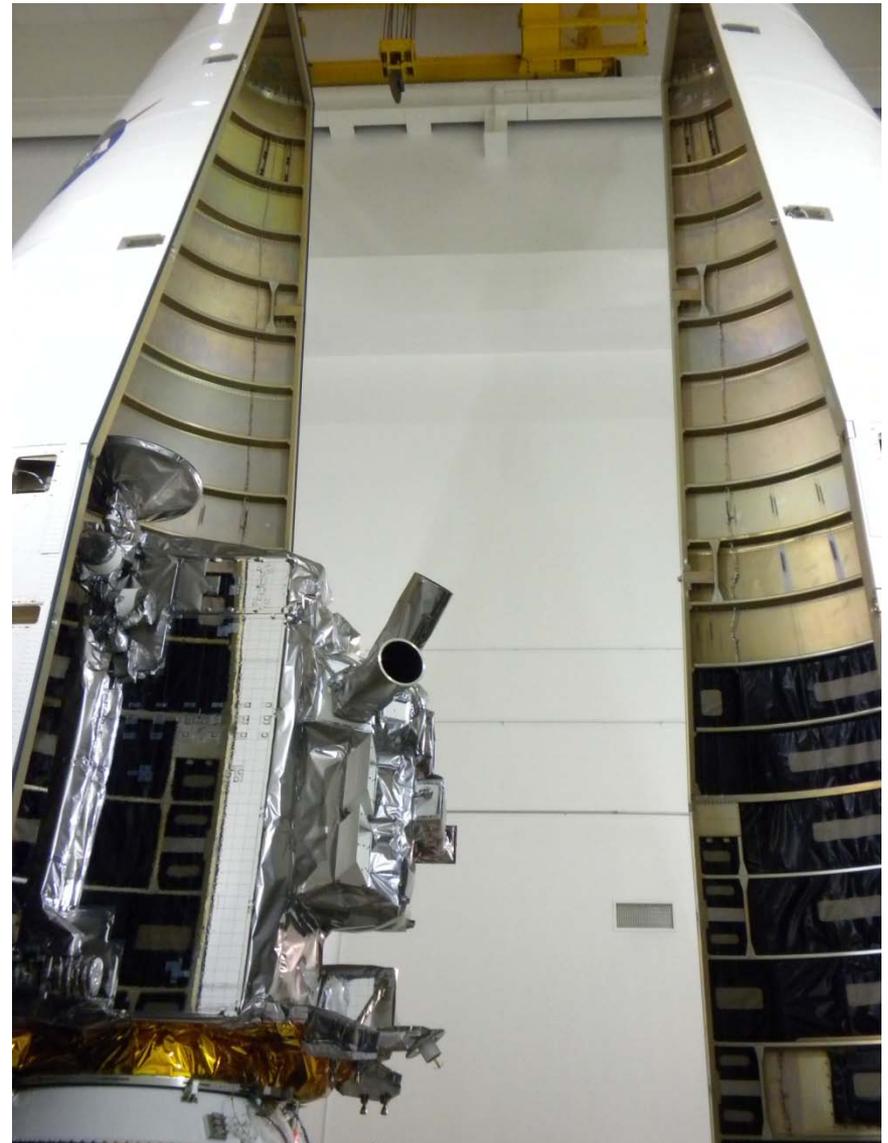


# Cumulative Orbiter Hours





# Stacked and Ready for the Fairing





# Onto the Rocket!







# June 18, 2009





# Mistakes

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- Expect mistakes!
  - We all make mistakes; the challenge is to avoid the fatal ones
  - Treat mistakes and failures as a normal part of the job—keep things out in the open, clean up, and move on
- Some of our biggest mistakes:
  - Underestimated the system-level complexity of the High-Gain Antenna System and the Solar Array System
    - Interplay of thermal with RF and with actuator electronics
    - Gimbal blankets
    - Resistive losses in solar array cables
  - Failed to anticipate the impact of the change in the center's engineering services contract
    - Major contract change right in the middle of the build phase
    - Created uncertainty, impacted workforce, delayed harness
  - Underestimated some warning signs on overloaded engineers
    - High performers don't always take a break when they should, and sometimes take on more than they can handle
    - Extended schedule created extra stress—working hard for longer than expected
    - Impacted efficiency rather than integrity of the system



# Failures and Flaws

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- Coarse Sun Sensor interface circuit—wrong resistance
  - Found during ACS testing before environmental testing
  - Removed C&DH and replaced resistors
- Solar array gimbal power dissipation—14x higher than planned in thermal design
  - Found during thermal balance testing
  - Added radiator and removed blankets
- LEND high voltage arcing—damaged detectors
  - Found during thermal vacuum testing
  - Replaced instrument with flight spare after final Orbiter CPT
  - Further issues on orbit, but additional safing has protected the instrument and kept all detectors running
- LOLA blanket too tight—causing alignment issues
  - Found shortly after instrument activation
  - Only impacts some measurements over cold surfaces—instrument still achieving objectives



# Observations and Lessons Learned

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Observations on motivation (inspired by Daniel Pink, *Drive*):

- **Autonomy**
  - Team members at all levels were invited to promote their best ideas in support of the mission as a whole—ownership of solutions
  - Systems engineering held the big picture view, facilitated communication, documented design decisions, verified system-level performance
  - Team members understood their control over mission success and were, therefore, motivated to excel
- **Mastery**
  - We challenged our experts in a constructive way
    - Used basic physics, expected explanations in those terms
    - Encouraged a discipline lead to represent their own perspective, but with an eye to the system impact
  - We expected ownership and probing inquiry of anomalies and design issues
- **Purpose**
  - Headed to the moon, paving the way for the new exploration
  - We tried to make sure everyone realized the criticality of every piece of the system
  - We held regular get-togethers and we celebrated our victories along the way, encouraging a sense of team



# Observations and Lessons Learned

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- Don't be afraid to point out to stakeholders decisions that can be made to relieve your problems (launch vehicle example)
- Programmatic constraints affect the development:
  - Tight schedules force decisions
  - Tight budget approaching confirmation forces optimization
  - Extra money after CDR can save schedule and probably save money in the long run
- Even if the schedule is tight, make sound technical choices (remember the fortune cookie)



# Observations and Lessons (cont.)

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- Interface tests save money in the long run—test early and often
- Plan early for parallel development and assembly
- Decouple delivery events so that integration can move forward even if one item is late
- Systems engineering is all about the team
  - Success depends on the performance of the entire team
  - Some people on the team will require more effort, but the extra effort is required to get different perspectives
  - Watch for overloading, especially in those requiring little effort, and definitely in yourself
  - Be flexible and optimistic



# Credits

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## LRO Credits

compiled by David Everett, 9/22/09

### Project Office

Craig Tooley	Project Manager	GSFC code 451
Cathy Peddie	Deputy Project Manager	GSFC code 451
Bill Sluder	Deputy Project Mgr/Resources	GSFC code 451
Keith Opperhauser	Project Support Mgr	GSFC code 451
Deanna Adamczyk	Financial Manager	GSFC code 451
Tricia Gregory	Admin/Project Support	
Julie Janus	Contracting Officer	
Amy Aqueche	Contract Specialist	
Jim Smith	Mission Business Mgr	
Mary Bernhard	General Business (-2007)	
Vanessa Hernandez-Martinez	Resource Analyst	
Linnette Morales	Resource Analyst	
Bob Hesenperger	EVM	
Andy Eaker	Scheduling Lead	
Marty Campbell	Scheduling	
Debbie Dusterwald	CM/DM Manager	
Dorothy Hall	CM/DM	
Warren Shultzaberger	CM/DM	
Angela Hess	MIS	
Jen Brill	MIS	
Kristina Safdie	Risk Management (2006-present)	
Adrian Rad	Risk Management (2004-2006)	
LaShonda Jacobs-Terry	Procurement (CSS, Star Tracker)	

### **GSFC Science Team**

Rich Vondrak	Project Scientist (2008)	GSFC code 690
Gordon Chin	Project Scientist (2004-2007)	GSFC code 693
Tom Morgan	Project Scientist (2007)	NASA HQ
John Keller	Deputy Project Scientist	GSFC code 691

### **Payload Team**

Arlin Bartels	Payload Systems Manager
Mary Reden	Payload Systems Engr
Joe Cerullo	Payload Systems Engr
Stan Scott	Science Data Mgmt

### **Systems Engineering Team**

Dave Everett	Mission Systems Engineer	GSFC code 599
Martin Houghton	Deputy MSE, Mission Design	GSFC code 599
Rick Saylor	Deputy MSE, I&T	Honeywell
Phil Luers	Avionics Systems	GSFC code 561
Tom Ajluni	Spacecraft Bus & LV Systems	ATK
Steve Andrews	Safing Engineer, HGAS Systems Lead	GSFC code 599
Mark Beckman	Flight Dynamics	GSFC code 595
Rivers Lamb	Flight Dynamics	GSFC code 595
Leslie Hartz	Systems Analysis	GSFC code 599
Eric Holmes	GN&C Systems	GSFC code 591
Mike Pryzby	Orbiter Systems	ATK
Steve Wasserzug	Mechanical/Thermal Systems	ATK
Charlie Wildermann	SW/HW Systems	GSFC code 580
Joe Novotka	Electrical Systems, EMI/EMC	QSS
Judy Brannen	Requirements Database Manager	Constellation Software Engineering
Tom Jones	Launch Vehicle Mgr	GSFC code 429

**EEE Parts Team**

Rich Williams	EEE Parts Lead	GSFC code 562
Chris Greenwell	EEE Parts Support	QSS
		Ball Aerospace and Technologies Corporation
Bruno Munoz	EEE Parts Support	MEI Technologies
Maxine Windhausen	LRO Parts Storage & Procurement	GSFC code 562
Henning Leidecker	EEE Parts Expert Consultant	

**Contamination Control**

Chris Lorentson	Contamination Control Lead	GSFC code 546
Rachel Rivera	Contamination Engineering	GSFC code 546
Joe Hammerbacher	Contamination I&T	SGT
Glenn Rosecrans	Contamination Analyst	SGT
Patsy Dickens	Contamination support and Documentation	SGT
Marcello Rodriguez	Purge Systems and contamination support	GSFC code 546
Alfred Wong	Cleanroom Support Systems	SGT
Leon Bailey	Contamination Control Technician	ManTech
Karrie Houston	Contamination Engineering	GSFC code 546

**I&T Team**

Joanne Baker	Orbiter I&T Lead	GSFC code 568
Mike Wright	Deputy I&T Manager	GSFC code 568
Kevin Blahut	GSE Systems Engineer	ATK
Harold "Rex" Richardson	I&T Engineer	ATK
Massoud Ainloo	Senior Test Engineer	MEI
Joshua Grodin	I&T Engineer	MEI
Gary Lepore	I&T Engineer	MEI
Marsha Shanahan	FlatSat Manager	MEI
Carroll Trickey	Senior Electrical Technician	OSC
Patrick Kilroy	I&T Engineer	GSFC Code 568
George Moore	I&T Engineer	GSFC Code 568
Greg Greer	ITOS Lead Engineer	Hammers
Warren Thompson	Front End Processor Developer	Hammers
Michael Smit	Spacecraft Simulator Developer	Hammers
Matt Lew	Spacecraft Simulator Developer	Hammers
Karen Calvert	ITOS Developer	Hammers

	Matilda Ewancio	Electrical Technician	OSC
	Brenda Wallace	Electrical Technician	SGT
	Deneen Ferro	Electrical Technician	SGT
	Kim Cousler	Environmental Project Engineer	GSFC Code 549
	Janet Thomas	Environmental Project Engineer	GSFC Code 549
<b>EMI Testing Laboratory at GSFC</b>			
	Mark Branch	EMC Environmental Test Engineer	GSFC Code 549
	Vaughn Nelson		
	Rick Jones		
	Robert Houle		
	Nathan Block		
	Greg Jamroz		
	Andrew Mentges		
<b>Vibration Test Group</b>			
	Timothy Schwartz	Vibroacoustic Environmental Test Engineer	GSFC Code 549
<b>Thermal Vac test Group</b>			
	Ana-Mellina Espiritu	Thermal Vacuum Environmental Test Engineer	GSFC Code 549
<b>Optical Alignment Team</b>			
	Henry Sampler	Optical Alignment Lead	code 551
	Dr. Samuel Hetherington	Optics Support Engineer	code 551
	Carlos Aviado	Optics Support Engineer	Analex
	James Gill	Optics Support Engineer	Analex
	Nicholas Spartana	Optics Support Technician	Analex
	Dean Osgood	Optics Support Technician	Analex
<b>Safety and Mission Assurance Team</b>			
	Ron Kolecki	System Assurance Mgr (SAM)	
	Lydia Lee	Deputy SAM	
	Jana Rezac	Safety Lead	
	Chuck Peterson	Safety	
	Cindy Taylor	Software Quality Engineer	
	Nick Virmani	Manufacturing Engineer	
	Al Lacks	Quality Assurance	
	Joe Calabrese	Quality Assurance	

**Mechanical Team**

Giulio Rosanova	Mechanical System Lead Engineer	543
Pilar Joy	Material Engineer	541
Craig Stevens	Lead Structural Analysis	542
Jeff Pattison	Acoustic Analyst	542
Wayne Chen	SB, IM Structural Analyst	542
Darian Robbins	Mechanical GSE Lead Engineer	543
Gordon Casto	SB, IM Structure Lead Engineer	543
Greg Martins	HGAS Lead Engineer	543
Jason Hair	HGAS Engineering Support	543
Karl Schuler	Senior Technician	543
Larry Madison	Composite Support Engineer	543
Rene Carlos	Coupon Test Engineer	543
Steve Patton	Lead Technician	543
Katheryn Vasquez	MGSE Lead	543
Joe Schepis	Gimbals Lead Engineer	544
Kamal Thakore	GCE Lead Engineer	544
Boris Chernyakov	GCE Support Engineer	ATK
Nick Shurr	Gimbal Engineering Support	544
Charlie English	Technician	547
Chris Kolos	Technician	547
Dave Dollard	Shop Planner	547
Frank Rondeau	Technician	547
Mike Schoolman	Technician	547
Ron Walters	Technician	547
Tim Schwartz	Test Engineer	549
Nick Galassi	Senior Analyst	Aerostress
Bryan Rizzo	SAS Structural Analyst	ATK
Ed Dobins	Designer (MGSE)	ATK
George Mooney	Technician	ATK
Ginger Bronke	Designer (IM)	ATK
Greg Davis	Designer Mass Simulators	ATK
Hal Baesch	Technician (Detailed to PROP Group)	ATK
Heather Borowski	IM Structural Analyst	ATK

Jimmy Lee	QA Mechanical	ATK
Joe Green	Designer (SAS)	ATK
John Harvey	Designer HGAS MGSE	ATK
Ken Pellak	Designer (MGSE)	ATK
Mike Golob	MGSE Engineering Support	ATK
Mike Hersh	SAS Lead Engineer	ATK
Paul Baird	Loads Analyst	ATK
Pete Patterson	MGSE Analyst	ATK
Rodney Deensie	Analyst	ATK
Shelly Conkey	HGAS Structural Analyst	ATK
Steve Wasserzug	PM Lead Engineer	ATK
Suk Yoon	Senior Designer (HGAS)	ATK
Kurt Wolko	Designer (Detailed to PROP Group)	Chesapeake
Chris Ross	PM Designer	ManTech
Dan Hayward	Lead Designer (PM)	ManTech
Jim Baker	Facilitator	ManTech
Glen Byron	HGAS Support	SGT
Justin Ward	SAS Engineer	SGT
Kevin Nims	Analyst	SGT
Lisa.Mryncza	CM Drawings Administrator	SGT
Monique Fetzer	ITP/RAD Lead Engineer	SGT
Nereses Armani	Designer (SB)	SGT
Phil Kurilchik	Designer	SGT
Sandy Shuman	Designer	SGT
Cecilia Chow	Analyst/Dynamics	SGT
Rick Baird	MGSE Designer	SGT
Wasam Aboufasha	SB Analyst	SGT
Brian Kittle	Technician	OSC
Tony Sanders	AM Analyst	Vantage

## **Thermal System**

Charles Baker	LRO Thermal Systems Lead
Christine Cottingham	LRO Thermal Hardware Lead
Sharon Peabody	LRO Thermal Analysis Lead
Matt Garrison	LRO Thermal Instrument Lead
Tony Melak	LRO Thermal High Gain and Solar Array Lead
Jeff Maynard	LRO Thermal High Gain and Solar Array Analyst
Dan Powers	LRO Thermal Analyst
Juan Rodrigues	LRO Thermal Analyst
Bill Chang	LRO Thermal Analyst
Wes Ousley	LRO Thermal Consultant
Walter Ancarrow	LRO Thermal Analyst
Diane Schuster	LRO Hardware Technician
Doug Varney	LRO Hardware Technician
Rosalyn Nelson	LRO MLI Technician
Shirley Adams	LRO MLI Technician
Brenda Estavia	LRO MLI Technician
Hume Peabody	LRO Thermal Analyst
Jesse Armingier	LRO Thermal Analyst
Markham Hacke	ITP Project Manager
Elizabeth Oey	Avionics Radiator Project Manager
Sargon Addi	Avionics Radiator Quality Assurance
Mellina Espirito	Thermal Test Manager
Chris Skocik	Thermal Test Fixture Designer
Sherrod Ware	Thermal Test Fixture Technician
Grace Miller	LRO Thermal Coating Technician
George Harris	LRO Thermal Coating Technician
John Petro	LRO Thermal Coating Technician

Mary Jane Stevenson	LRO Thermal Coating Manager
Wanda Peters	LRO Thermal Coating Manager
Jack Triolo	LRO Thermal Coating Consultant
Marcello Rodrigues	LRO Thermal Coating Engineer
Jay Chung	Kapton Film Heater Manufacturer
George Davis	Mechanical Thermostat Engineer
Doug Brown	Mechanical Thermostat Manager
Warren Chen	Heat Pipe Production Manager
Meshack Aduwu	ITP and Avionics Radiator Heat Pipe Lead
Michael Deiliis	RWA and Battery Heat Pipe Lead
Mario Martins	Lead Test Technician

### **Power System**

Tom Spitzer	Power System Lead
Dong Sui	Power GSE Lead

### **Power System--PSE**

Amri Hernandez-Pellerano	PSE Lead Engineer
Brad Kercheval	PSE Design Engineer
Greg Alkire	PSE Master Controller FPGA Design Engineer
Robert Stone	PSE Slave FPGA & PMC Design Engineer
Jeff Travis	PSE PMC Design & FPGA Test Engineer
Syed Ameen	PSE Hardware Command FPGA Design Engineer
Mehul Patel	PSE Test Conductor
Federico Sanidad	PSE Test Conductor
John Washington	GSE Technician
Tom Rozanski	GSE Technician

## **Power System--Battery**

David Jung	LRO Lead Battery Engineer
Gopal Rao	Staff Engineer
David Sullivan	LRO Battery Test Engineer
Tom Rozanski	Battery Lab Manager

## **ABSL Team**

Raz Sawar	ABSL LRO Project Manager
Dave Curzon	ABSL LRO Project Manager (formerly)
Rod Ng	ABSL LRO Technical Lead
Andy McNamara	ABSL Mechanical/Thermal Engineer
Ralph Ball	ABSL QA Engineer

## **Power System--Solar Array**

John Lyons	Solar Array Lead
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## **Emcore Engineering and Management:**

David Danzilio	GM/VP
Navid Fatemi	Program Director
Brad Clevenger	Director of Operations
Pat Coil	Director of Contracts
Mary Beth Chumney	Proposal mgr.
Kip Dodge	LRO Program Manager
Jeff Hillseth	Mfg. Director
Vivien Bercier	Mfg. Engineering Manager
Jody Wood	Engineering Manager
Jimmy Pappan	LRO Panel Engineer
John Crisman	QA Mgr.
Robert Young	QA
Karen Fellner	QA
Eric Lochausen	Parts and Materials
Teri King	Procurement
Kay Naranjo	Accounting Mgmt
Cheryl Anderson	Accounting
Don Wichhart	Accounting



Fermin Rodriguez	CIC Area Manufacturing
Marianne Trinh	CIC Area Manufacturing
Ashly Donaldson	CIC Area Manufacturing
Lilibeth Manzon	CIC Area Manufacturing
Emelina Marroquin	CIC Area Manufacturing
Deanene Gonzales	CIC Area Manufacturing
Amy Saiz	CIC Area Manufacturing

## National Technical Systems (NTS)—Thermal Vacuum Testing

### **Primary Crew**

#### **Acoustic**

Jori Czajkowski	Technician
Edward Nelsen	Engineer

#### **Thermal Vacuum**

Philip Carr	Program Manager/Engineer
Eric Kogen	Technician

### **Secondary Crew**

Mark Kawai	Technician
James King	Technician
Chris Marin	Technician
Mike Rudy	Technician

### **Support Personnel**

Victor Alfano	Sales
Kent Burgdorfer	Instrumentation Technician
Damian Castello	Fluids Technician
Kelly Delia	Program Coordinator
Ron Foster	Shipping/Receiving Manager

Troy Haag	Maintenance Manager
Jerry Hatley	Electrician
Marie Jensen	Shipping/Receiving
Judy Jones	Quality Control
Larry Jones	Fluids Technician
Sergey Klochko	Instrumentation Engineer
Erik Knowles	Fluids Manager
Tim Kogen	Instrumentation Technician
Marco Macias	Maintenance Technician
Russell Presswood	Machine Shop Manager
Janice Saari	Quality Assurance Manager
Juan Sanchez	Fluids Technician
Randy Shaw	Environmental Manager
Mike Springer	Programs Manager
Gary Thompson	Sales

**Exceptional Suppliers**

Roger Green	Exclusive Welding
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Applied Technology Associates (ATA)—Hot Box Design and Construction

Tony Tenorio  
Steve Dolbey  
Dennis Smith  
Charlene Bausinger  
Troy Jensen  
Larry Martell  
Jeff Stein  
Shatona Martin

QIOPTIQ Space Technology (Cover Glass)

John Martin

## Propulsion System

Chuck Zakrzwski  
under construction

Propulsion Lead

## Attitude Control System

Jim Simpson

ACS Lead Engineer

GSFC code 591

### ACS Hardware Team

Ken McCaughey

ACS Hardware Lead

GSFC code 596

Laurie Easter

Technician

GSFC code 596

Steve Scruggs

Technician

GSFC code 596

Joe Roman

Technician

GSFC code 596

Tracy Price

Technician

Orbital

Rani Lavu

Technician

Orbital

Millie Ewancio

Technician

Orbital

Inpong Sivilay

Technician

Orbital

Carol Zepp

Technician

Orbital

Nat Gill

PDE and RW FPGA

GSFC code 566

Jeff Keck

FPGA Support

Northrop Grumman

Eric Bentley

Mechanical Drafting

Swales Aerospace

### Reaction Wheel Team

Russ Roder

RW Lead and Mechanical Engineer

GSFC code 596

John Wilson

RW Electrical Engineer

GSFC code 596

Joe Vitale

RW Software

GSFC code 596

Mary Kerbe

RW PWB Layout

Orbital Sciences Corporation

Fred Manage

RW and PDE PWB Checking

Orbital Sciences Corporation

Tom Miccolis

RW Parts Engineer

Orbital Sciences Corporation

Bob Read

RW Support Task

Orbital Sciences Corporation

### PDE Team

Jason Badgley

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Noble Jones

PDE Mechanical Engr

GSFC code 596

Tom Gibboney

PDE and GDS Support Task

Orbital Sciences Corporation

Allan Hoffman

PDE Module PWB Layout

Orbital Sciences Corporation

Amanda Virtis

PDE Inhibit Unit PWB Layout

Orbital Sciences Corporation

Star Tracker Team

Noble Jones  
Roberto Casini  
Stefano Lorenzini  
Dorico Procopio  
Massimo Materassi  
Giuseppe Borghi  
Anna Fabri  
Simone Becucci  
Andrea Landi  
Davide Fiorini  
Marco Picchi  
Moreno Stagi

Star Tracker COTR  
Program Manager

GSFC code 596  
Galileo Avionica  
Galileo Avionica

Miniature Inertial Measurement Unit Team

Ed Davis  
Reginald Sherman  
Paul Brueggeman  
Jim Akins  
Marion Rowe  
Jon Lawler  
Kevin Toliver  
Joe Protola  
Jeff Young

MIMU COTR  
Technical Director  
Technical Director  
Technical Director  
Program Manager  
Contract Management  
Product Assurance  
Systems Analysis  
Technical Director

GSFC code 596  
Honeywell International  
Honeywell International

Coarse Sun Sensor Team

Kristen Brown  
Dwight Barefoot  
Mike Kagan  
Kevin Lucciarini  
Jim Mirotta

CSS COTR  
Program Director  
Electrical Engineer  
Quality Assurance Engineer  
Manager, Reliability and Quality Assurance

GSFC code 596  
Adcole Corporation  
Adcole Corporation  
Adcole Corporation  
Adcole Corporation

## ACS Design and Analysis

Joseph Garrick	Lead Analyst	GSFC code 595
Oscar Hsu	RW Sizing, Delta V and Delta H Modes	GSFC code 595
Phil Calhoun	Attitude Kalman Filter	GSFC code 595
Neerav Shah	Analyst	GSFC code 595
Roger Chen	Sun Safe Modes	R&D Research
Gerardo Ortiz-Cruz	Cooperative Education Student	GSFC code 595
Neal Patel	Cooperative Education Student	GSFC code 591
Alice Liu	Jitter Analysis	GSFC code 591
Carl Blaurock	Analysis	Nightsky Systems

## GSFC Dynamic Simulator

George Heisey	GDS Project Lead	Northrop Grumman
Stephen Leake	GDS Software Lead	GSFC code 582
Juan Raymond	GDS Systems Support	
Tom Correll	GDS PMRD Card	GSFC code 596
Agbontaen Imasuen	GDS Hardware	GSFC code 596
Wattana Kem	GDS Hardware	
Namrita Owens	GDS Hardware	GSFC code 564
Brad Smith	GDS Cards	Orbital Sciences Corporation
Rob Thompson	GDS Assembly	
Laurie Easter	GDS Assembly	
Jim Rawlings	GDS Assembly	
Karin Blank	GDS Software	GSFC code 586
Kevin D Fisher	GDS Software	
Victor W. Lu	GDS Software	Emergent Aerospace
Linh Nguyen	GDS Software	GSFC code 596

## PDE and RW Off-Site Teammates - Orbital Sciences Corporation

Karim Iman	Orbital
Tom Gibboney	Orbital
Bob Read	Orbital
Victor Evans	Orbital
Tom Miccolis	Orbital
Peter Koump	Orbital
Bill Seidell	Orbital

Tracy Price	Orbital
Carrol Zepp	Orbital
Milly E.	Orbital
Mary Kerbe	Orbital
Ed Naimaster	Orbital
Amanda Virts	Orbital
Allan Hoffman	Orbital
Steven Heishman	Orbital
Fred Manage	Orbital
Robert Demme	Orbital
Daryl Dillow	Orbital
Anderson Chun	Orbital
Ron Johnson	Orbital
Laura Cook	Orbital
Shirely Jones	Orbital
Glenn Lockett	Orbital
Peggy McCviker	Orbital
Vandell Roseman	Orbital

Printed Wiring Board Manufacturer  
Coretec Denver, INC

**Laser Ranging**

Investigation

Dr. Maria T. Zuber	LOLA Deputy Principal Investigator
Dr. David E. Smith	LOLA Principal Investigator
Dr. Gregory A Neumann	LOLA Co-Investigator
Dr. Frank G. Lemoine	LOLA Co-Investigator
Mark H. Torrence	Science Analysis Support
David R. Rowlands	Science Analysis Support

Management / Systems Engineering

Ron Zellar	Laser Ranging Team Lead
Dr. Xiaoli Sun	System Scientist
Keith Cleveland	LOLA / LRO Quality Assurance Engineer

## Peer Review Panel

Jay Smith	Peer Review Panel Chair
Don Cornwell	Peer Review Panel Member
Dr. Barry Coyle	Peer Review Panel Member
Dr. John Degnan	Peer Review Panel Member
Greg Ellman	Peer Review Panel Member
Dr. Tony Martino	Peer Review Panel Member
Eric Mentzell	Peer Review Panel Member
Ted Michalek	Peer Review Panel Member
Armando Morell	Peer Review Panel Member
Dr. Michael Pearlman	Peer Review Panel Member

## Optics

Luis Ramos-Izquierdo	Optical Systems Lead
Joe Connelly	Optical Engineer
Scott Stan	Optical Engineer

## Fiber Optics

Mark Flanagan	Fiber Optics Lead Engineer
Richard Chuska	EO Test and Manufacturing Engineer
Frank LaRocca	EO Testing Engineer
Shawn Macmurphy	Manufacturing Engineer
Melanie N. Ott	Photonics Group Lead, Lead FO Engineer LRO
Rob Switzer	EO Testing engineer
William Joe Thomes	Photonics Group Operations Manager

## Mechanical

Adam Matuszeski	Mechanical Lead
Donneise Briscoe	Mechanical Fabrication Planner
Shelly Conkey	Mechanical Analyst
Caner Cooperrider	Mechanical Engineer
Ken Cory	Machinist
Dave Dollard	Mechanical Fabrication Planner
Chris Hennen	Mechanical Designer
Sid Johnson	Mechanical Technician
Mike Mulloney	Mechanical Engineer

Andrew Neal	Mechanical Technician
Dave Pfenning	Mechanical Technician
Dave Pfenning	Mechanical Technician
Steve Schmidt	LOLA Mechanical Subsystem Lead
Matt Showalter	Machinist
Craig Stevens	Mechanical Analyst
Buddy Taylor	Mechanical Designer
Bobby Taylor	Mechanical Support
Quan Tu	Machinist

#### Materials

Pilar Joy	Materials Engineer
Diane Kolos	Materials Engineer

#### Ground System

Jan McGarry	Ground System Lead
Thomas Zagwodzki	Ground System Lead
George Bertholdt	Support Engineer
Oscar Brogdon	Support Engineer
David Carter	NGSLR Manager
John Cheek	Support Engineer
Christopher Clarke	Support Engineer
Howard Donovan	Support Engineer
Mike Golob	Support Engineer
Julie Horvath	Support Engineer
Anthony Mallama	Support Engineer
Anthony Mann	Support Engineer
Carey Noll	CDDIS Lead
Donald Patterson	Support Engineer
Randall Rickelfs	SLR System Engineer at Univ. of Texas
Thomas Varghese	Support Engineer
Jerry Wiant	Support Engineer

#### Thermal

Christine Cottingham	Thermal Engineer
Tony Melak	Thermal Engineer

## Bench Checkout Equipment

Pete Liiva

Mike Rodriguez

LOLA BCE Lead

BCE Engineer

## Flight Software

Mike Blau

Kris Naylor

Krishnan Narayanan

Ru Perrera

Lenard Beacraft

Glenn Cammarata

Susie Strege

Larry Shackelford

Scott Walling

Freemon Johnson

Moses McCall

Joel Chiralo

Tawanda Jacobs

Ladd Wheeler

Tim Ray

Tom Johnson

George Varndell

Ji-Wei Wu

Dave McComas

Jeff D'Agostino

Michael Yang

Jacob Hageman

Bruce Trout

Steve Mann

Anne Kosloski

Tom Clement

Mike Paoletta

Eva Stattel

Scott Applebee

Ray Ferrer

Flight Software Lead

FSW Requirements

FSW Requirements

FSW Configuration Management

FSW Configuration Management

FSW Development Team Lead

FSW Developer

FSW Development Team Lead

FSW Developer

FSW Test Team Lead

FSW Testing

FSW Testing

FSW Testing

FSW Testing

Maureen Armbruster	FSW Testing
Ingrid Albright	FSW Testing
Jack Fu	FSW Testing
Anren Hu	FSW Testing
Bob Schwenk	FSW Testing
Gary Welter	FSW Testing
Bob Rapp	FSW Testing
John Heavener	FSW Testing
Dave Grosh	FSW Testing
Janet McDonnell	FSW Testing
Bill Kekszy	FSW Testing
Tom Phillips	FSW Testing

**Ground System and Operations**

Rick Saylor	Ground Sys & Ops Lead	
Rick Saylor	GS&O Lead	HTSI
Jim Clapsadle	Deputy GS&O Lead	HTSI
Howard Calk	GS&O Systems	QSS
Ralph Casasanta	System Engineer	CSC
Christine Marinaccio	GS&O MOC SW Tester	QSS
Mark Neuberger	GS&O MOC SW Tester	HTSI
Dave Waters	MRT Test Lead	HTSI

Mission Operations Team

Jack Murphy	MOT Lead	HTSI
Jabari Carrington	Mission Operations	HTSI
Keith Crew	Mission Operations	HTSI
Garland Dixon	Mission Operations	Boeing
Mike Gardner	Mission Operations	HTSI
Bob Ignasiak	Mission Operations	HTSI
Tim Johnson	Mission Operations	HTSI
Tim Johnson	Mission Operations	HTSI
John Koenig	Mission Operations	Boeing
Joe Kowalski	Mission Operations	HTSI
Jeff Parker	Mission Operations	HTSI
Mehul Patel	Mission Operations	HTSI

Rich Sanidad	Mission Operations	HTSI
Maxine Saylor	Mission Operations	HTSI
Dan Sutermeister	Mission Operations	HTSI
Paul Swenson	MOC System Administrator	HTSI
Mission Operations Center Software		
Theresa Beech	Flexplan Software Eng.	GMV
Hiam Brummer	ITPS Technical Lead	HTSI
Jean-Pierre Chamoun	Flexplan Software Technical Lead	GMV
Sung Cho	ITPS Tester	HTSI
Susan Dyer	ITOS Developer	Hammers
Mike Foreman	ITOS Task Lead	GSFC code 584
Gonzalo García	Flexplan Software Eng.	GMV
Brian Goldman	ITOS Developer	HTSI
Greg Greer	ITOS Technical Lead	Hammers
Karen Keadle-Calvert	ITOS Developer	Hammers
Jay Kim	Flexplan Software Eng.	GMV
Matt Lew	ITOS Developer	Hammers
Barbara Milner	ITOS Task Lead	GSFC code 584
Jean Puckett	ITPS Sys. Admin	HTSI
Denise Reitan	ITPS Developer	HTSI
Mark Richardson	ITOS Developer	HTSI
Sheia Ritter	ITPS Task Lead	GSFC code 583
Tim Singletary	ITOS Developer	Hammers
Mike Smit	ITOS Developer	Hammers
Warren Thompson	ITOS Developer	Hammers
Lucinda Taylor	SW QA	HTSI
Flight Dynamics		
Mark Beckman	Flight Dynamics Lead	GSFC code 595
Rivers Lamb	FD Ground System Lead	GSFC code 595
Michael Mesarch	Maneuver Team Lead	GSFC code 595
Karen Richon	Maneuver Team	GSFC code 595
Dave Folta	Maneuver Team	GSFC code 595
Rick Harmon	FD Ground Attitude Lead	GSFC code 595
Ann Nicholson	FD Task Lead	AI Solutions
Steve Slojkowski	Orbit Team Lead	



## Flight Software Maintenance

Kris Naylor	FSW Sustaining Engineering	CSC
Mike Oben	FSW Sustaining Engineering	GSFC code 582
Scott Snell	FSW Sustaining Engineering	CSC

## Ground Network

April Adams	NENS Documentation Support	HTSI
Bret Aguilar	USN Ops	USN
Hollys Allen	NENS System Engineer	HTSI
Scott Allen	WSC Engineer	HTSI
Leslie Ambrose	GN/SN/PSLA	GSFC code 582
Mike Anderson	NENS WS1 Project Management	HTSI
Velma Anderson	NENS System Engineer	HTSI
Robert Ash	NENS Facilities	SGT
Cathy Barclay	NENS WS1/USN Project Management	HTSI
Joe Baros	NENS RF SOC/Compat	HTSI
Merri Benjamin	NENS O&M/WSC	HTSI
Matthew Bieneman	NENS Engineering	HTSI
Elaine Bowers	NENS Docs	SGT
Matt Boyd	USN Ops	USN
Ronna Brockdorff	GN Architecture	
Bill Brown	NENS Sys Eng	HTSI
David Carter	GN SLR Lead	GSFC code 582
Bill Chaney	NENS Engineering	HTSI
Chris Christopolous	NENS Engineering	HTSI
Dale Cole	NENS I&T	HTSI
Abbas Contractor	NENS Facilities	HTSI
Chris Cook	NENS Security	HTSI
Art Corella	NENS Facilities	SGT
Steve Currier	GN DPM	GSFC code 453
Mark Czumak	NENS Engineering	HTSI
Dumas Donna	NENS Admin	HTSI
Debbie Dukes	NENS O&M/GN	HTSI
Alice Eskins	NENS Docs	HTSI
Richard Feinstein	NENS Facilities	SGT
John Fleming	NENS Engineering	HTSI
Linda Fuller	NENS Docs	HTSI

Fred Gams	NENS RF SOC/Compat	CRC
William Gardner	NENS Security	HTSI
Don Gittle	USN Lead Engineer	USN
Bob Gonzales	SN TO&A	GD
Jane Gracie	NENS Docs	SGT
Joanne Greet-Swank	USN PM Support	USN
Jay Heberle	USN Project Manager	USN
Daniel Hobel	USN Engineering	USN
Bob Hudgins	GN Scheduling	GD
Doug Hughes	USN Engineering	USN
Connie Jefferies	NENS Admin	HTSI
Brad Johnson	PSLA Support	HTSI
Evans Jones	TO Management Support	HTSI
Deepak Kaul	NENS Enigneering	HTSI
John Kim	NENS RF SOC/Compat	HTSI
Mike Kohout	NENS Network Commitment	HTSI
Tom Kovac	NENS Scheduler	HTSI
David Lassiter	GN WS1 Systems	GSFC code 569
Ken Lavery	NENS RF SOC/Compat	
Barry Lusby	NENS O&M/WSC	HTSI
Scott Lynch	USN Engineer	USN
Dale Massey	USN Engineer	USN
Dennis Mateik	NENS O&M/WSC	HTSI
Ken McIntyre	NENS Docs	HTSI
Marco Midon	WS1 Technical Lead	GSFC code 567
Peter Militch	NENS Chief Eng	HTSI
Steve Montgomery	USN Engineer	USN
Yonwoo Nam	NENS I&T	HTSI
Valeria Nitz	NENS Docs	HTSI
Onyeali Onyeberechi	NENS Docs	HTSI
Paul Pardoe	NENS Docs	HTSI
Brent Parker	NENS RF SOC/Compat	HTSI
Pati Peskett	NENS GN Eng	HTSI
Lesley Rahman	NENS O&M	HTSI
Peggy Reno	NENS QA	HTSI

Laurel Rossow	NENS Safety	HTSI
Gregory Sanders	NENS Sys Eng	HTSI
Jul Scarborough	NENS Security	HTSI
Bruce Schupler	NENS Sys Eng	HTSI
Thomas Shult	NENS Ops	USN
Don Small	WS1 Sys Eng	HTSI
Donna Smith	NENS Admin	HTSI
Jeanette Smolinski	NENS GN Eng	HTSI
Bob Stancel	GN Software Engineering	GSFC code 589
Frank Stocklin	GN Architecture Support	GSFC code 450
Rod Summerford	NENS I&T	HTSI
John Taylor	USN Engineer	USN
Steve Testoff	NENS Docs	SGT
Mike Uffer	NENS Eng	HTSI
Scott Underwood	GN Chief Eng	LJT
Bourgondien Van	NENS Facilities	HTSI
Steve Vogelwede	USN SW Engineer	USN
Jim Wiedman	WS1 Security	HTSI
Stephania Young	NENS Scheduler	HTSI

Deep Space Network

Ida Baker	LRO NOPE Lead	ITT
Ed Luers	DSN POC	NASA/JPL
Steve Walderr	DSN MCM	NASA/JPL

NISN

Jim Cameron	NISN Network Engineer	GSFC code 721
Mike Eder	NISN Network Engineer	SAIC
Chris Jermann	NISN IPNOC	SAIC
Chi Le	NISN Network Engineer	GSFC code 721
Chris Spinolo	NISN Network Engineer	GSFC code 721

## Command and Data Handling

William Yuknis	C&DH System Lead (2007-2008) / Technical Lead	GSFC
Quang Nguyen	C&DH System Lead (2004-2007)	GSFC
	Housekeeping I/O Card Engineer / Signal Integrity	
Dennis Albaijes	Engineer	GSFC
Omar Haddad	Jack of All Trades Engineer	GSFC
Noosha Haghani Leviste	Communications Card Engineer	GSFC
Damaris Guevara	Communications Card Engineer	GSFC
James Fraction	Low Voltage Power Converter Engineer	GSFC
	SpaceWire Engineer / Multifunction Analog Card	
John Siedlecki	Digital Engineer	GSFC
	Multifunction Analog Card Test and Verification	
George Moore	Engineer	GSFC
Michael Lin	Multifunction Analog Card Analog Engineer	GSFC
Renee Reynolds	Multifunction Analog Card Digital Engineer	GSFC
Glenn Rakow	SpaceWire Consultant	GSFC
Loc Luu	Test and Diagnostic Software Engineer	GSFC
Tawanda Jacobs	Test and Diagnostic Software Engineer	GSFC
	Communications Ground Support Equipment	
Warren Thompson	Engineer	GSFC
Timothy Johnson	Test Conductor	GSFC
Robert Ignasiak	Test Conductor	GSFC
Scott Pursley	Data Storage Board Engineer	GSFC
Dudley Yuknis	Mascot Engineer	GSFC
Cynthia Lewis	Integration and Test Manager	GSFC
Darryl Younger	Test Facilities Manager	GSFC
Locksley Haynes	Data Storage Board Digital Engineer	GSFC
Cin Swangwatanaratn	Technican Support	GSFC
Brenda Wallace	Technican Support	GSFC
Brenda Feldman	Technican Support	GSFC
Thomas Winkert	Communications Encoder FPGA Engineer	GSFC
Al Grasley	PWB Designer	Northrop Grumman
Al Lookingland	Mechanical Engineer	Northrop Grumman
Tony Granados	PWB/Mechanical Designer	Northrop Grumman
Barbara Neff	Task Manager	Northrop Grumman

Betty Pearsall	Assembly Technician	Northrop Grumman
Charlie McClunin	Packaging Engineer/Checker	Northrop Grumman
Dave Meyers	Planning Inventory Control (PIC)	Northrop Grumman
Doug Lumsden	Program Manager	Northrop Grumman
Eva Rice	Procurement/Buyer	Northrop Grumman
Frank Vreeland	PWB Designer	Northrop Grumman
Mike Merryman	PWB Designer/Manager	Northrop Grumman
Harry Yackman	Packaging Engineer/Checker	Northrop Grumman
Jim Krivensky	PWB Designer	Northrop Grumman
Jeff Keck	Electrical Engineer	Northrop Grumman
Jeff Diehl	Operations/Lab Manager	Northrop Grumman
John Cook	Mechanical Designer	Northrop Grumman
Karen Nearhoff	Assembly Technician	Northrop Grumman
Karen Chaney	Assembly Technician	Northrop Grumman
Keith Ellis	Assembly Technician	Northrop Grumman
Lang Diep	Assembly Technician	Northrop Grumman
Lori Protheroe	QA Inspector	Northrop Grumman
Lorinda Burrows	Assembly Technician	Northrop Grumman
Mike Johnson	QE/QA Manager	Northrop Grumman
Nancy Baily	Configuration Management (CM)	Northrop Grumman
Nicole Hackley	Quality Engineer	Northrop Grumman
Paul Kemlage	Mechanical Designer	Northrop Grumman
Rick Butler	QA Inspector	Northrop Grumman
Richard Burrows	Components Engineer	Northrop Grumman
Roy Kohn	Packaging Engineer/Checker	Northrop Grumman
Ryan Pranschke	Mechanical Engineer	Northrop Grumman
Sean Bowen	Planning Inventory Control (PIC)	Northrop Grumman
Thomas Anderjaska	Test Engineer	Northrop Grumman
Jerry Belote	Planning Inventory Control (PIC)	Northrop Grumman
Tracey Clay	Mechanical Engineering Manager	Northrop Grumman
Tuan Duong	Electrical Engineer	Northrop Grumman
Viguen Ter-Minassian	Mechanical Engineer	Northrop Grumman

Alan Dennis	Lead Electrical Engineer	BAE
Suzanne Miller	EPM and Software Engr	BAE
Cathy Lue Chee Lip	SUROM Software engineer	BAE
Dean Saridakis	Lead Software Engineer	BAE
Marc Vancampen	Lead Mechanical Engineer	BAE
Michael E Smith	Mechanical Engineer STE	BAE
Les Crawley	Quality Assurance	BAE
Steve Johnson	STE Software	BAE
Joseph Hilger	Operations Program Manager	BAE
David Eckhardt	Program Manager	BAE
Mason Fisher	Material Planning	BAE
Everett Drew	Engineering Manager	BAE
Richard Kim	Manufacturing Engineer	BAE
Robert Davidson	Electrical Engineer	BAE
Tim Whalen	Mechanical Analysis	BAE
Rema Smoot	Contracts	BAE
John Carr	Finance	BAE
James Ramsden	Reliability	BAE
Phuong "Tee" Osborne	Assembly Operator	BAE
Tri Nguyen	Assembly Operator	BAE
Pauline Gordon	Assembly Operator	BAE
Hang Tran	Assembly Operator	BAE
Conrad Walker	Assembly Operator	BAE
Margaret High	Assembly Operator	BAE
Judy Bui	Assembly Operator	BAE
Teresa Blaylock	Stock room	BAE
Ben Reardon	9639B Electronics Design Engineer	Symmetricom
Luis Vargas	9639B Electronics Design Engineer	Symmetricom
Sanjiv Patel	9639B Test Engineer	Symmetricom
Johan Welgemoed	9512A Development Engineer	Symmetricom
Doug Harvey	9512A Engineering Technician	Symmetricom
Liz Lasher	9512A Prototype/Senior Assembler	Symmetricom

**Communications****LRO Communications System**

Adan Rodriguez-Arroyo	Communications System Lead	GSFC code 567
Vince Briani	RF Networks (S-/Ka-Band)	ATK, Inc
Daniel Feldman	MEI Task29 Leader (Coupler, Hybrids, coax, waveguides, omni procurements)	MEI Technologies
Rick Jacobs	Senior Buyer (Coupler, Hybrids, coax, waveguides, omni procurements)	MEI Technologies
Bill Klimczak	HGAS RF Support	MEI Technologies
James Lee	QA	ATK, Inc
Anatoly Lyubomirsky	RF support	MEI Technologies
John Pocius	Ground Support Equipment	GSFC code 567
Lamont Poole	Ground Support Equipment	GSFC code 567
Victor Sank	Senior RF Support	MEI Technologies
Steve Seufert	RF Test Support	GSFC code 567
Dale Shama	RF Networks Support	MEI Technologies
Steve Smith	RF Test Support	ATK, Inc
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Richard Burrows	Northrop Parts Manager	Northrop - Lanham
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Kyle Huth	Wirebonding specialist	Independent consultant
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James Praught	Designer	General Dynamics Advanced Informatior
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Daryl Riley	Technician
Steve Smith	Technician
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Brian Klatt	SMA Manager	MIT
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Joesph Mazur	Co-Investigator	The Aerospace Corporation
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Cami Vongsouthy	Safety Eng
Michael Blakely	Environmental Eng
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Glenn Aveni	Contamination Control Eng
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Dave Randall	Test Support
Sam Galaske	Mechanical Design
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LEND PI

**LOLA Team**

David Smith  
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LOLA PI

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LROC PI

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Junior Mechanical Engineer

Steven Mi

Junior Mechanical Engineer

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SOC Senior System Administrator

Ken Bowley

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SwRI Division 15 Drafting Department  
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SwRI Division 15 Parts Control Group  
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