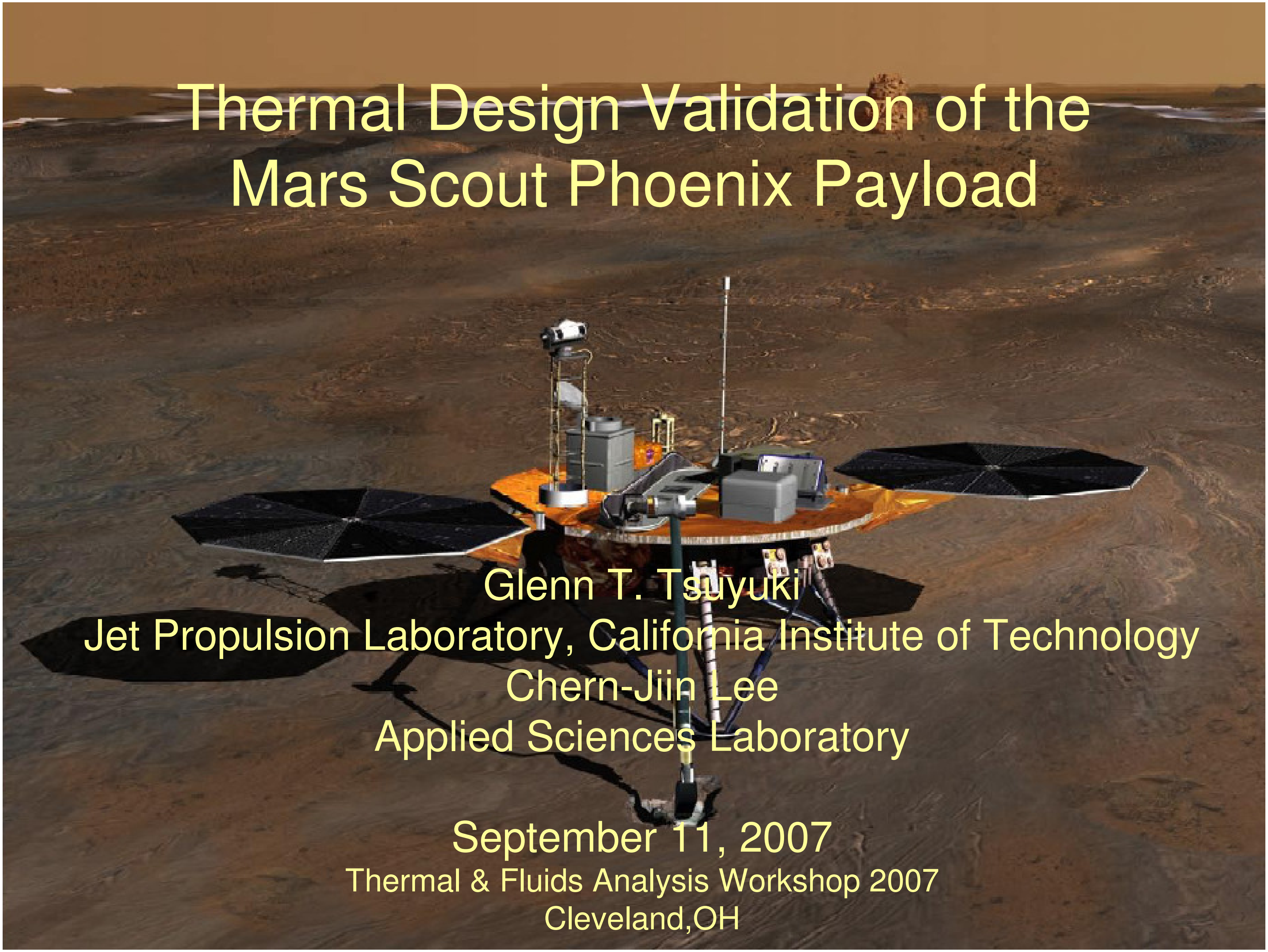

Thermal Design Validation of the Mars Scout Phoenix Payload

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Thermal & Fluids Analysis Workshop 2007
Cleveland,OH

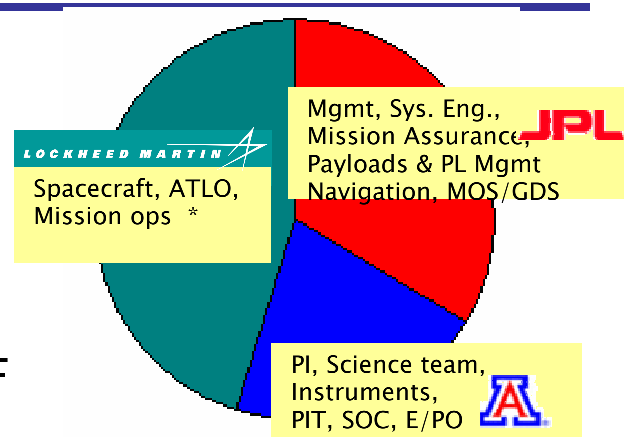
Outline

- Phoenix Mission Description
- Phoenix Flight System & Payload
- Initial Payload Design Responsibility Approach
  - Lessons Learned
- Revised Approach for Payload Design Validation
- Conclusions

Phoenix Overview

What is Phoenix?

- Phoenix will be the next NASA Mars landed mission
- Phoenix utilizes the terminated MSP'01 lander, improved through Return To Flight upgrades
- Phoenix will fly many of the lost MPL (Mars 98) payloads and some from MSP'01
- Phoenix utilizes a powered descent system unlike MPF and MER
  - More scalable
  - Provides soft landing capabilities
  - More precise placement on the surface
- Key Partners
  - The University of Arizona provides the PI, Peter Smith, and several instruments as well as the PIT and SOC
  - JPL provides Project Management, Systems Engineering, MOS/GDS, as well as the RA and MECA instruments
  - Lockheed Martin provides the Flight System and Operations support
  - Instruments are supported as well through contributions from all over the world

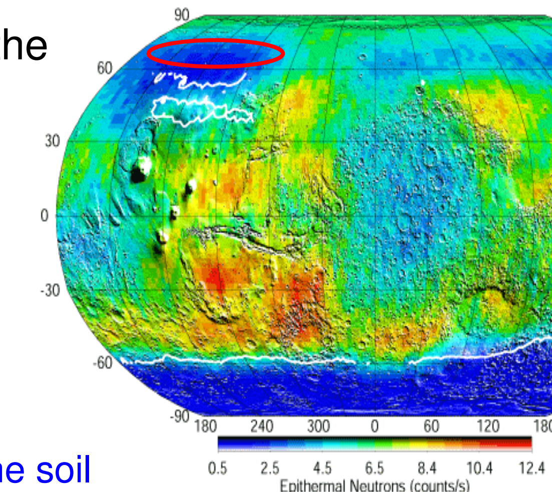


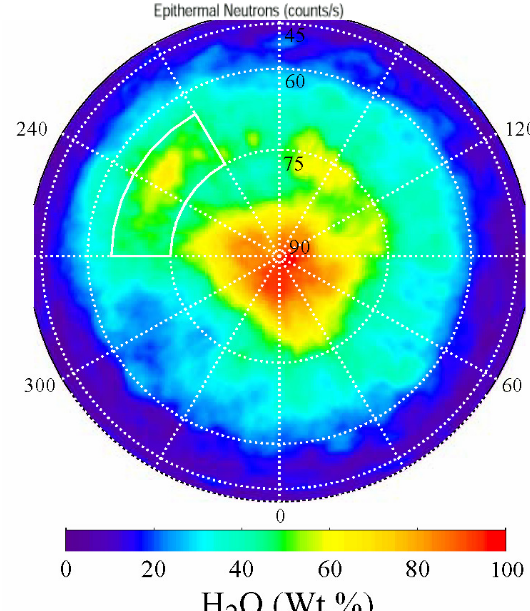
- CSA/MDR/Optech
  - Provides MET station and optical Lidar
- Max Planck Institute for Aeronomy (MPAe)
  - Provides RA camera ('01) and calibration
- University of Neuchatel/Swiss Federal Institute of Technology
  - Provides Atomic Force microscope for MECA ('01)
- University of Copenhagen
  - Provides magnets for MECA and SSI cal target

Phoenix

Science Objectives

- Verify the Odyssey discovery of near surface ice in the northern plains
  - Find a safe landing site between 65 and 72° N
  - Land during northern summer after any CO_2 frost has evaporated
  - Dig to an ice layer (or to 1meter), provide samples for analysis
- Study the history of water in all its phases
  - Determine the vertical profile of water, chemistry and minerals
  - Identify the altered (aqueous) minerals that make up the soil
  - Investigate the wet chemistry of the soil in special beakers
  - Study the geomorphology at all scales from regional to single grain
- Study the polar weather and climate concentrating on the boundary layer
- Determine the habitability and biological potential of the ice-soil mixture
  - Does unfrozen water periodically wet the soil?
  - Are there sources of energy for micro-organisms?
  - Do all the biogenic elements exist in a usable form?
  - Are there severe hazards to life (oxidants, toxins, etc.)?





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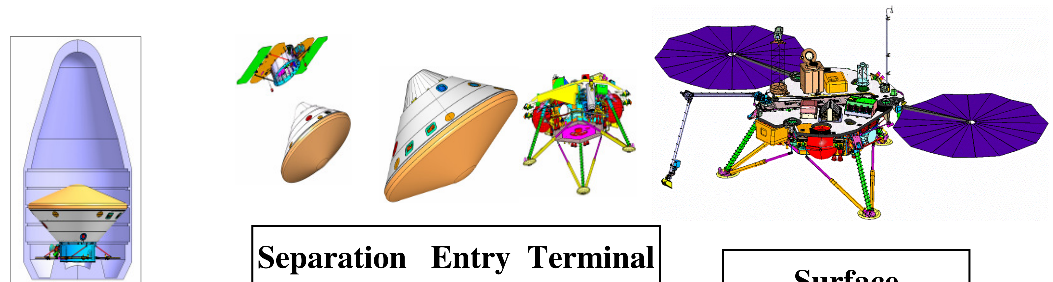
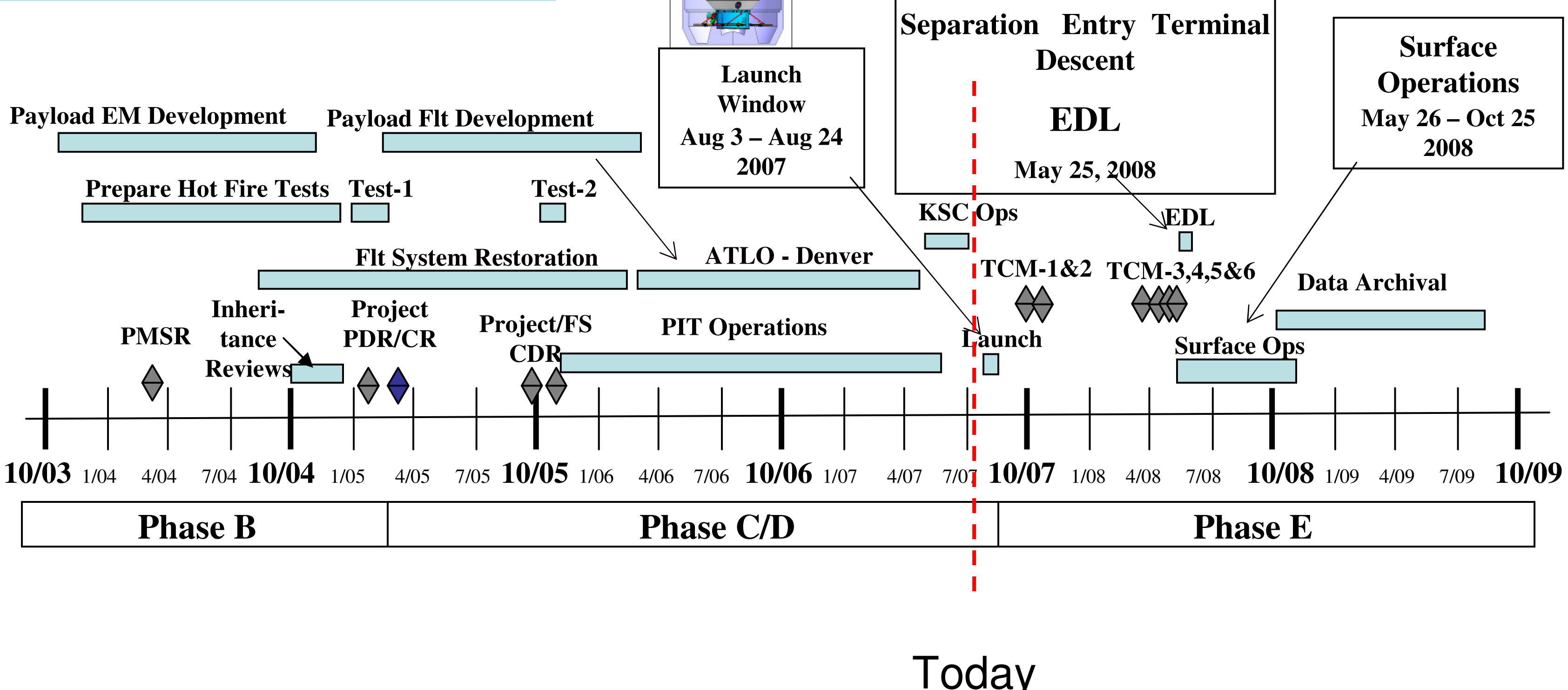
Phoenix

Phoenix Timeline

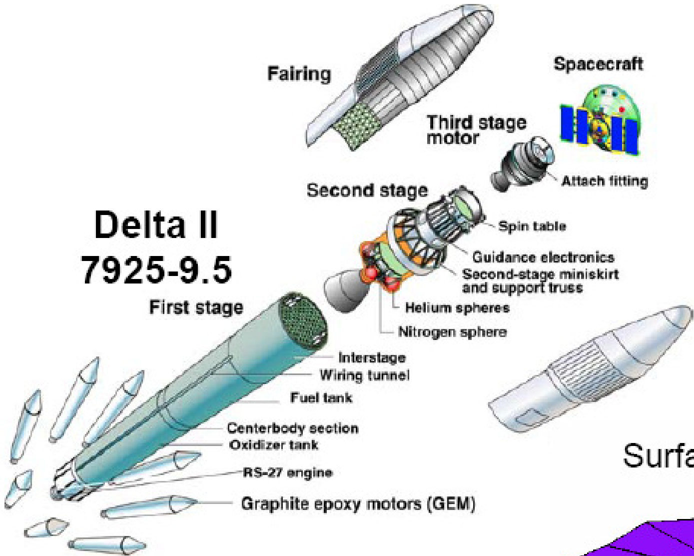
Key Dates:
ATLO Readiness Review March ’06
PIT Readiness Review March ’06
Pre-Ship Review April ’07

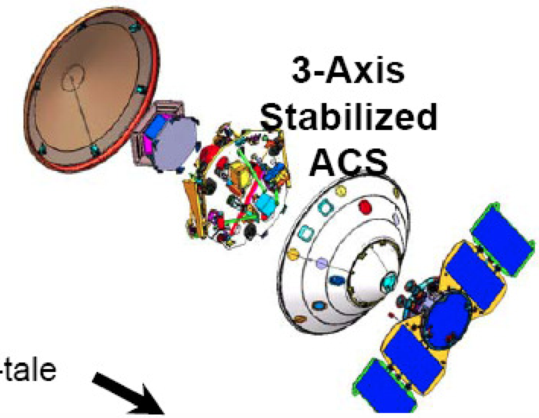


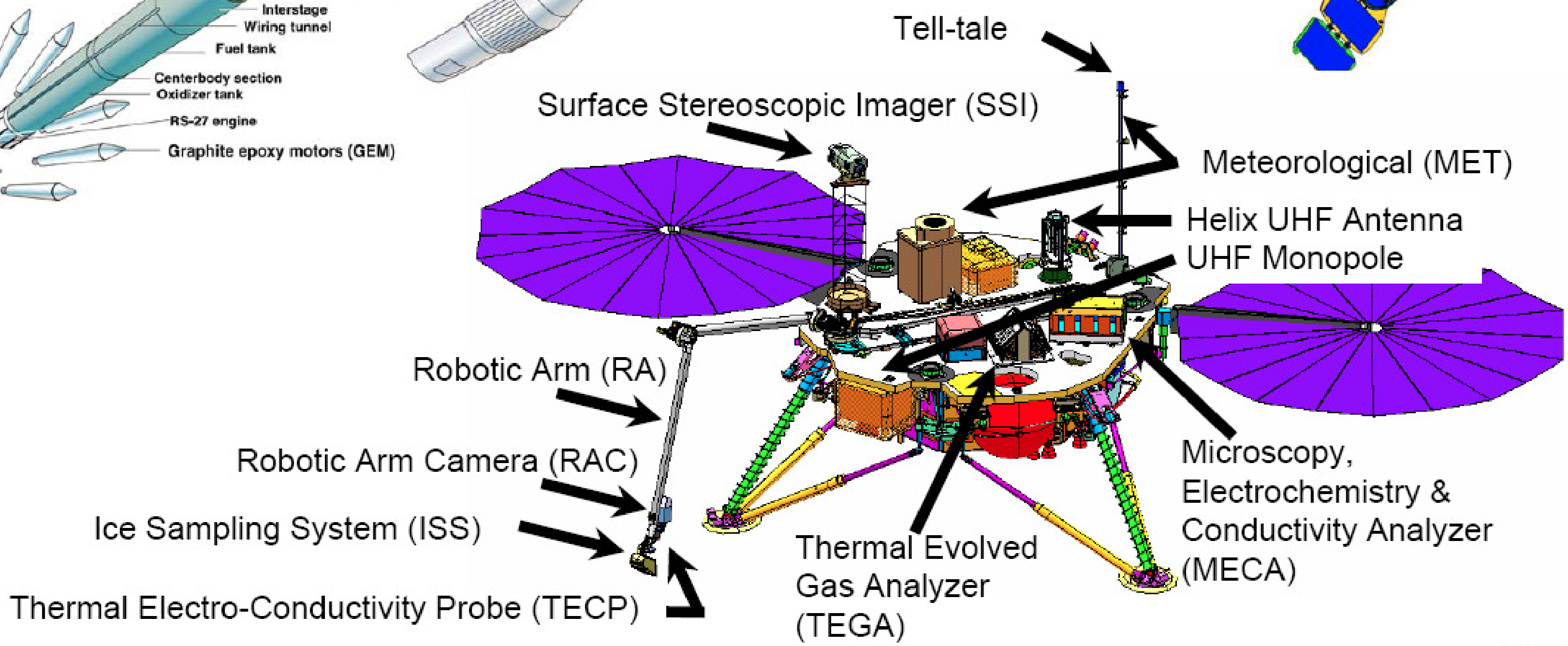


Phoenix

Flight Configurations







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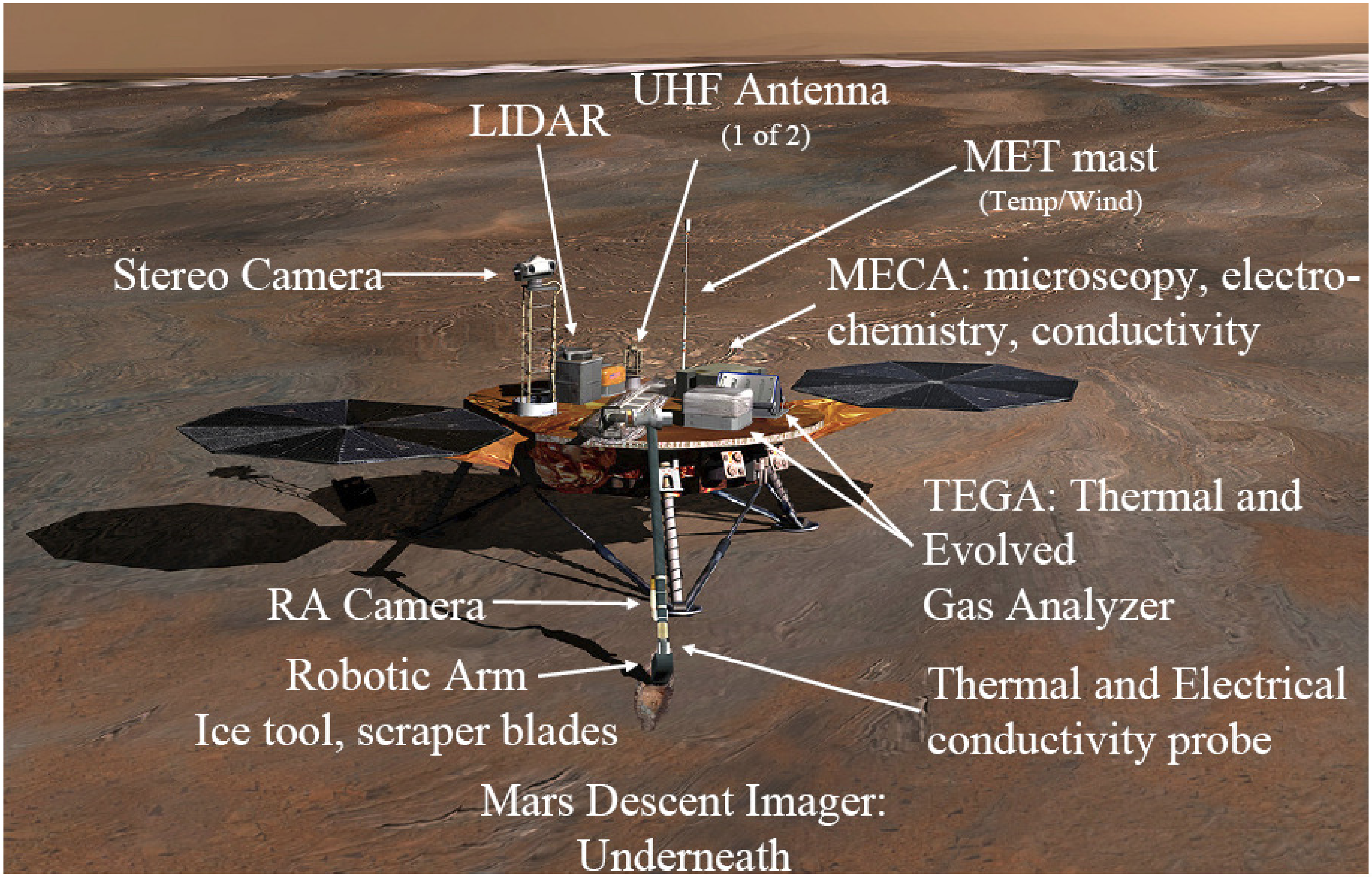
Phoenix

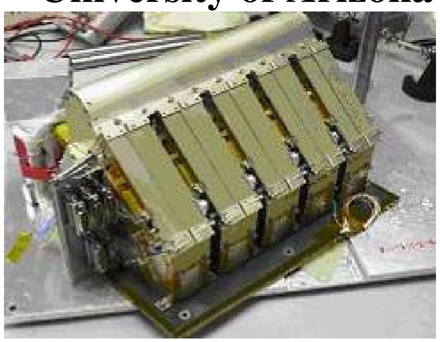
Integrated Science Payload



Payload

EM Surface Stereo Imager
(SSI, MPL)

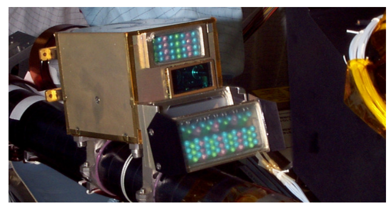
University of Arizona



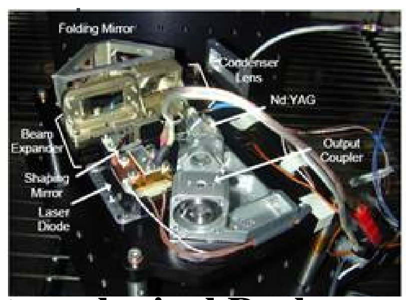
Thermal Evolved Gas
Analyzer (TEGA, MPL)

University of Arizona

Robotic Arm (RA, MPL, MSP'01)
JPL



Robotic Arm Camera (RAC, MSP'01)
Max Plank Institute Aeronomie



EM Meteorological Package with LIDAR
Canadian Space Agency

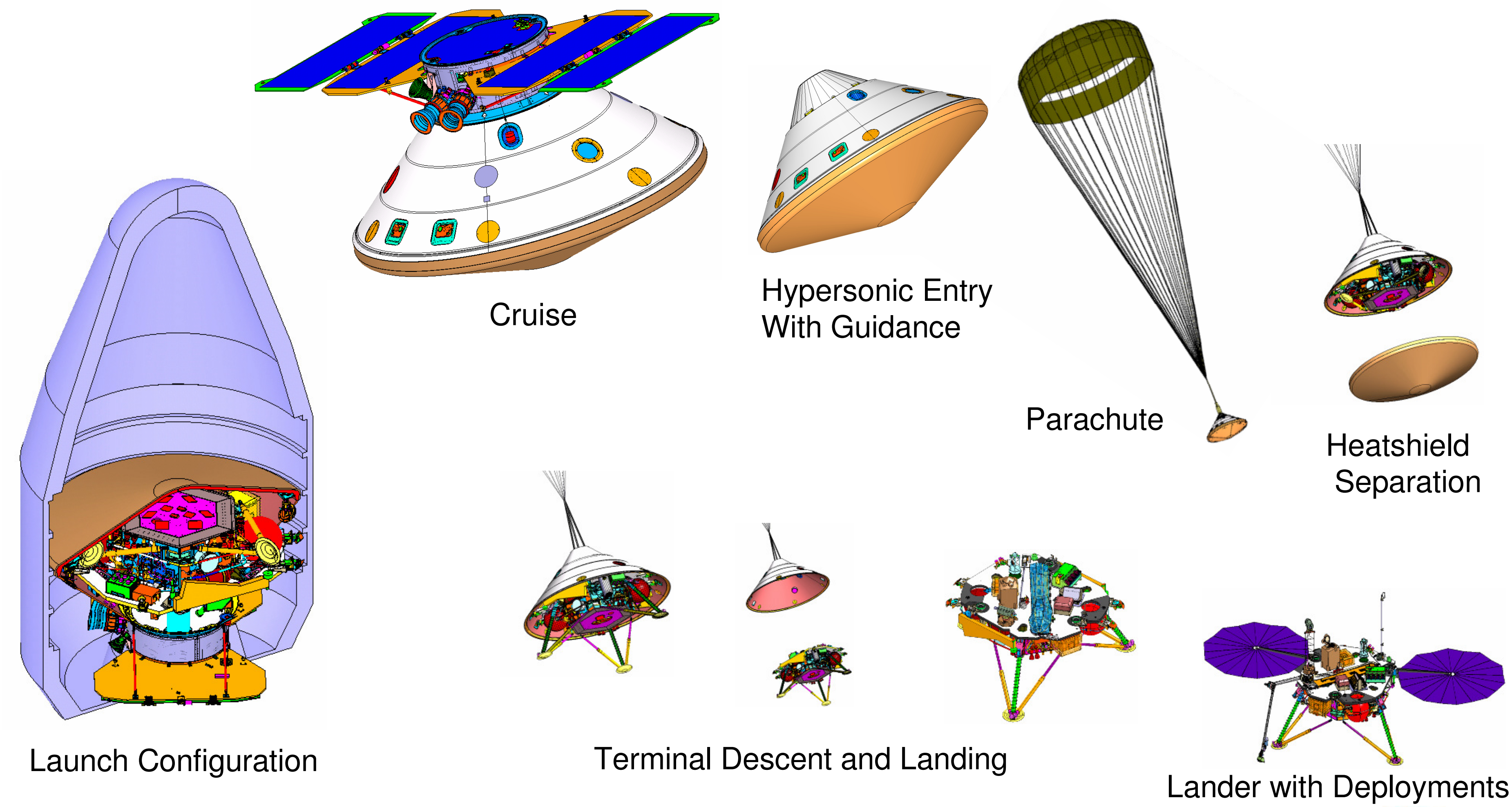
Microscopy, Electrochemistry
& Conductivity Analyzer
(MECA, MSP'01)

JPL

Mars Descent Imager
(MARDI, MSP'01)

MSSS

Mission Phase Overview



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Initial Payload Design Responsibility Approach

- Each payload was responsible for the development & validation of their thermal design
  - Thermal interface information provided by:
    - JPL for Cruise, EDL, & Landed Surface thermal environments
    - LMSSC for spacecraft geometry & thermo-optical properties, and reduced analytical model requirements

Lessons Learned

- The process lacked overall system engineering
- There was a wide spectrum of thermal engineering expertise across the payload element
- Interactions were complicated by the number of institutions involved
  - International partners further slowed the communication process due to ITAR
- Post-CDR changes needed to ensure design validation success

Revised Approach for Payload Thermal Design Validation - 1/2

- JPL took on overall payload system thermal design engineering responsibility
  - Coordinated & communicated all environmental & spacecraft information
    - Facilitated delivery of test-correlated reduced analytical models
  - Identified & rectified thermal engineering proficiency gaps
    - Expanded JPL's involvement with specific payloads

Revised Approach for Payload Thermal Design Validation – 2/2

  - Defined landed operational scenarios with Project System Engineering
- LMSSC became responsible for conducting integrated thermal analyses for all mission phases
  - Analyses results used for design validation
  - Spacecraft & payload analytical models correlated to System-Level Thermal Testing

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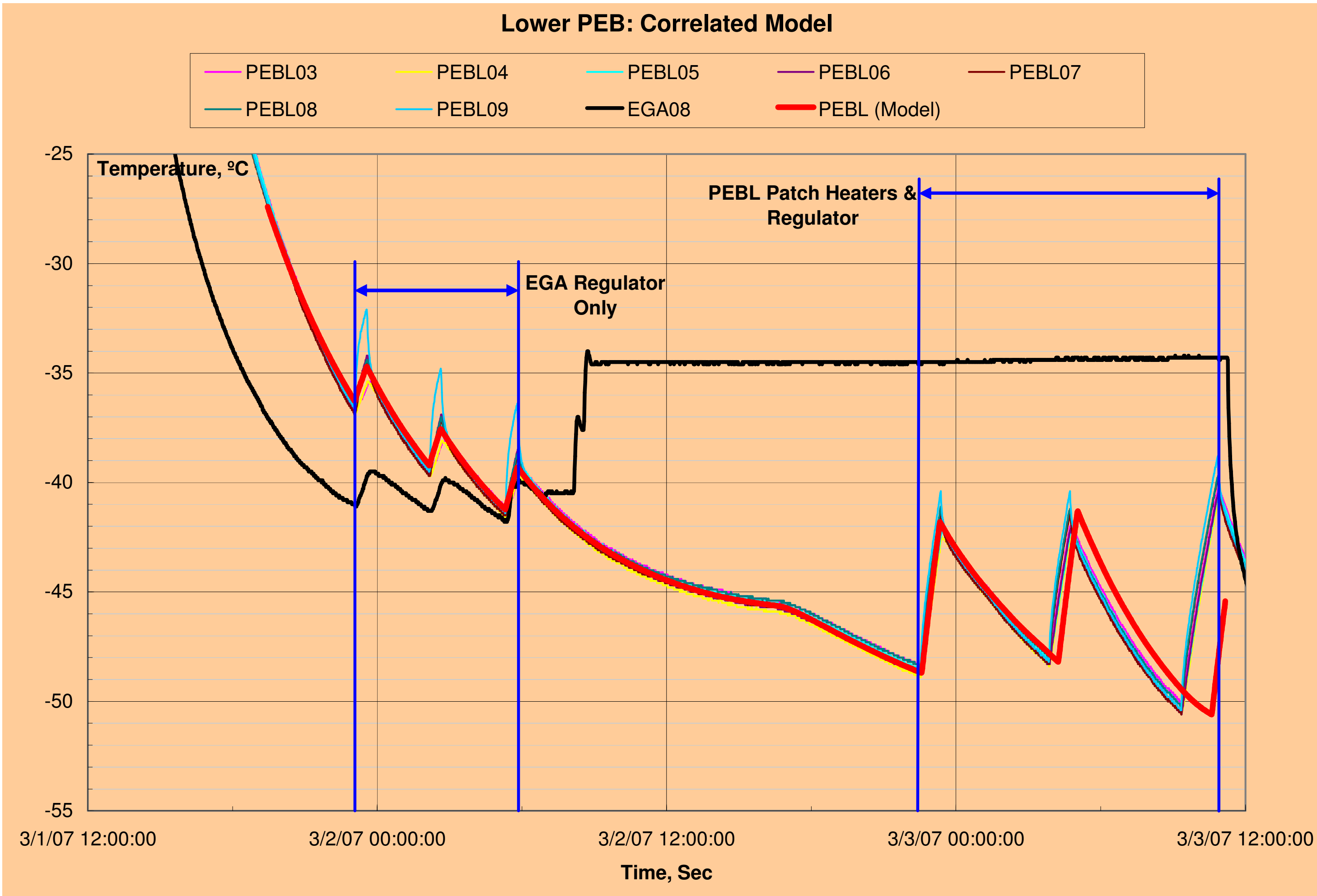
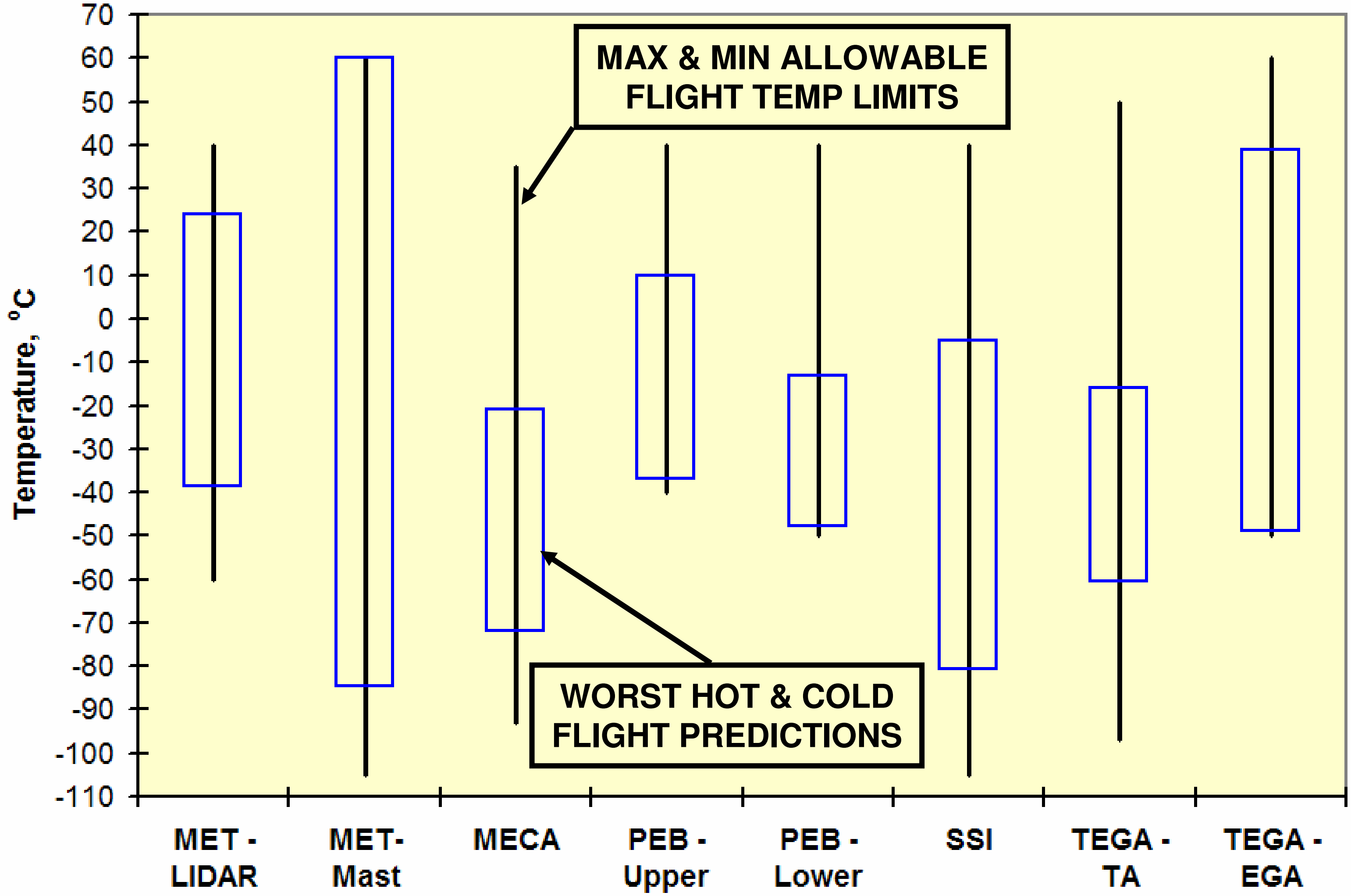
Payload Thermal Design Validation Results – PEB TMM



Phoenix Payload Thermal Design Validation Results – Integrated Model



Conclusions

- Thermal system engineering, especially, for a payload suite is crucial to mission success
- Use the strengths of the spacecraft & payload team members to establish a tractable strategy
  - Also understand team weaknesses to bolster as necessary
- The payload thermal design validation was successful
  - Early cruise flight data are within flight predictions


Questions & Answers