

# JPL Power Systems for Current Planned Missions Space Power Workshop 2006

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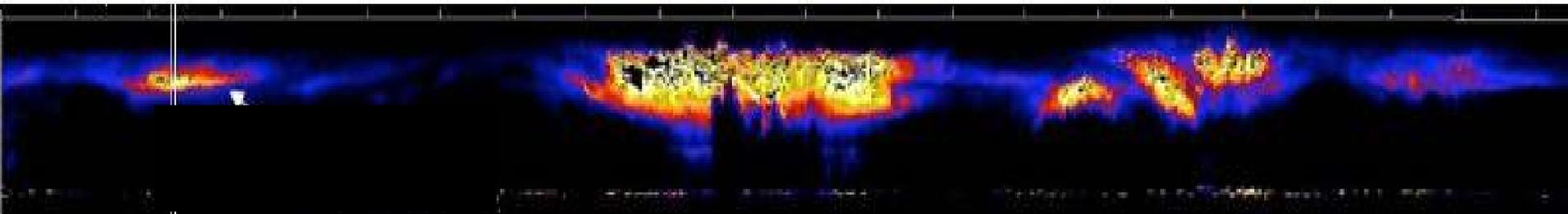
Jet Propulsion Laboratory  
California Institute of Technology

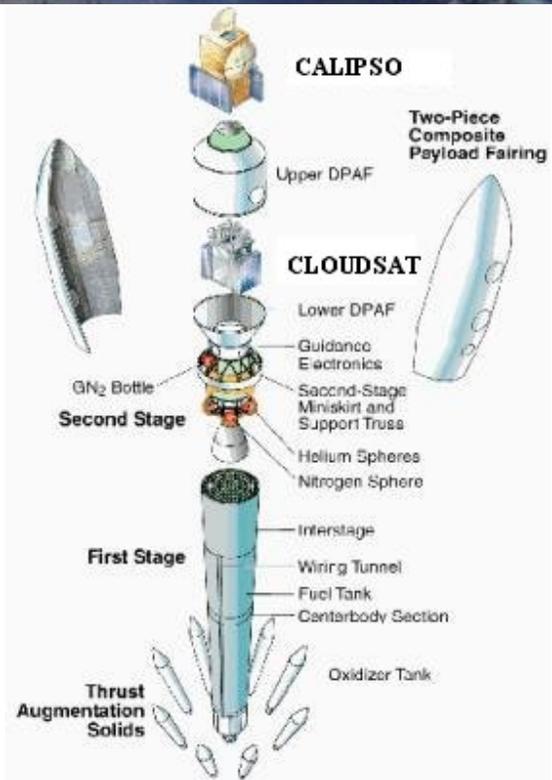
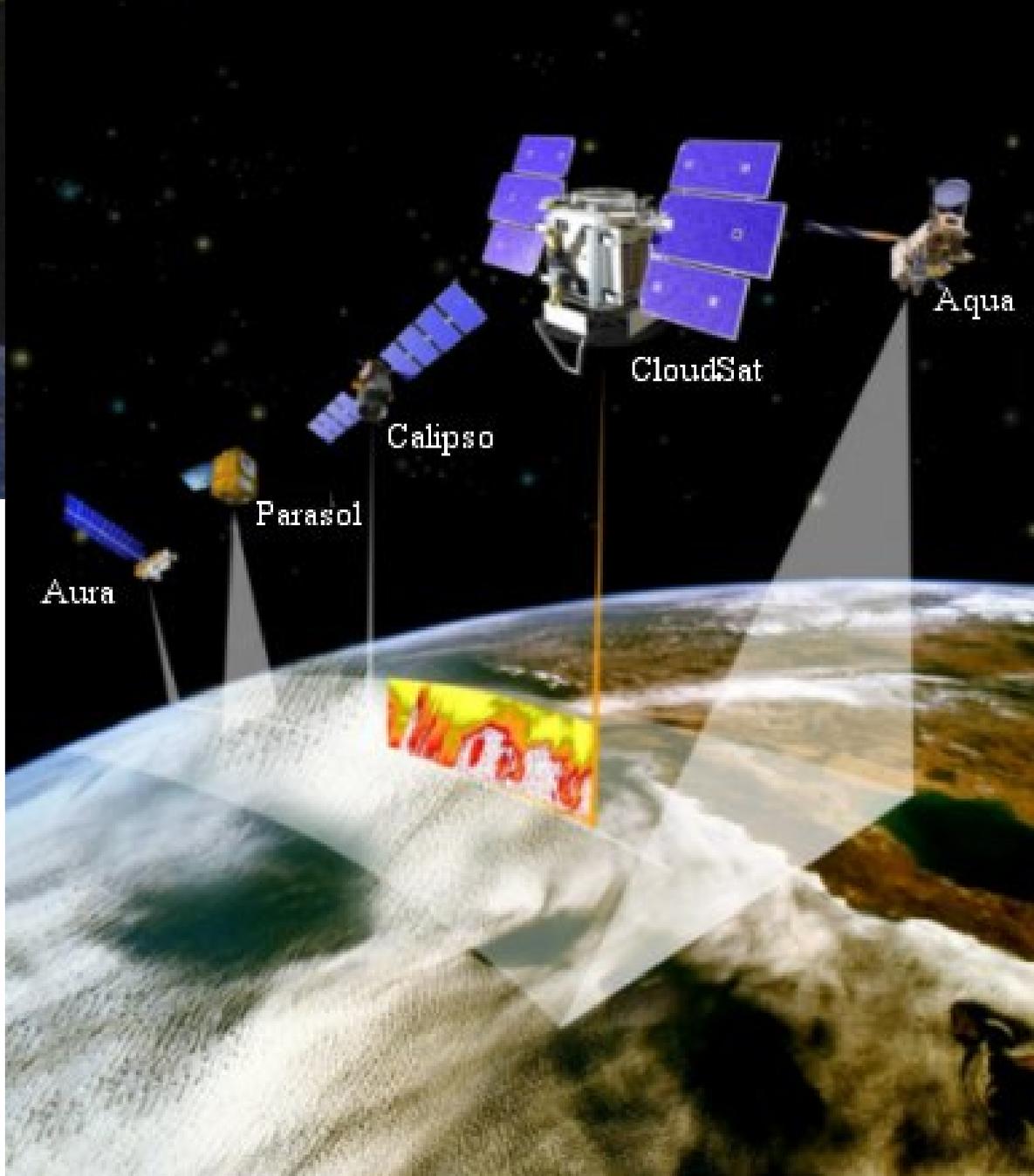
# Partial List of Future JPL Missions

- Cloudsat: Radar Cloud Sensing Earth Orbiter
- Dawn: Asteroid Rendezvous Mission - SEP
- Phoenix: Mars Scout Lander Mission
- Juno: Solar Powered Jupiter Orbiter
- OCO: Earth orbiting carbon observatory
- Kepler: Planet finder observatory
- Hershel: Far infrared/sub-millimeter Telescope
- WISE: Wide-field Infrared Survey Explorer
- MSL: Mars Science Laboratory - Rover

# Cloudsat Fact Sheet

- Launch Date: Early 2006
- Objective: Radar studies of clouds
- Partners: JPL, Canadian Space Agency, USAF, DOE, Ball Aerospace, CSU
- Unique Features: Advanced Radar Instrument  
Formation Flying with Aqua, CALIPSO, PARASOL, and Aura
- Power Source: Solar Powered
- Energy Storage: Nickel-Hydrogen
- Driving Requirements: LEO Orbit, Shared Launch
- Planned Lifetime: 2 Years

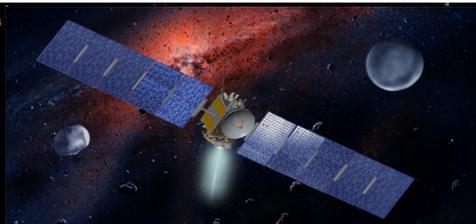




# Dawn Fact Sheet

- Launch Date: was, June 2006; now cancelled ?
- Objective: Visit asteroids, Ceres and Vesta
- Partners: JPL, OSC, UCLA, LANL, MPS, DLR, ASI
- Unique Features: Solar Electric Propulsion
- Power Source: 11 KW Triple-Junction Rigid Array
- Energy Storage: Nickel-Hydrogen CPV with bypass
- Driving Requirements: Power into IPS versus solar range
- Planned Lifetime: 10 Years

DAWN



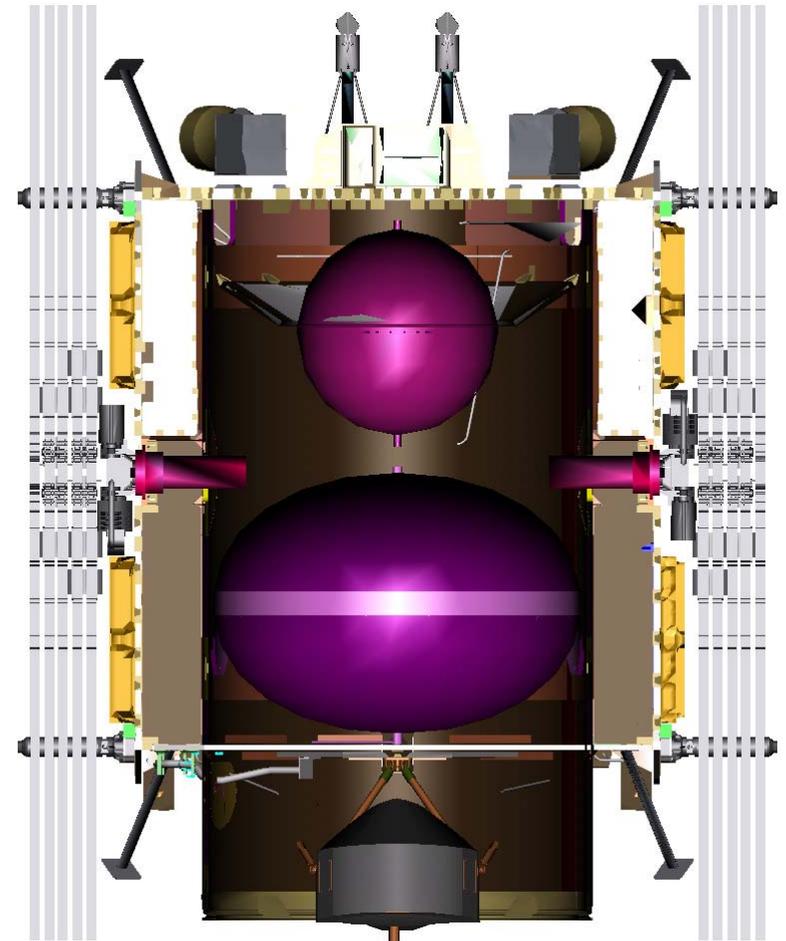
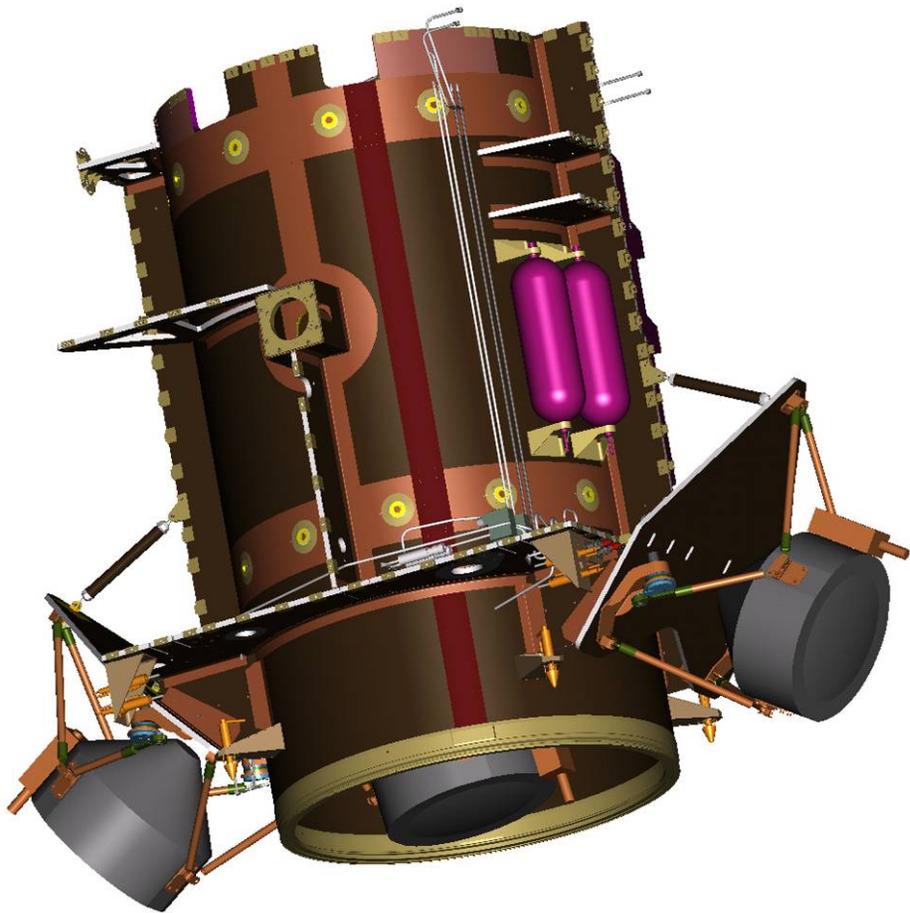
# Dawn Spacecraft with 5 panel, 11 KW Dutch Space Solar Arrays

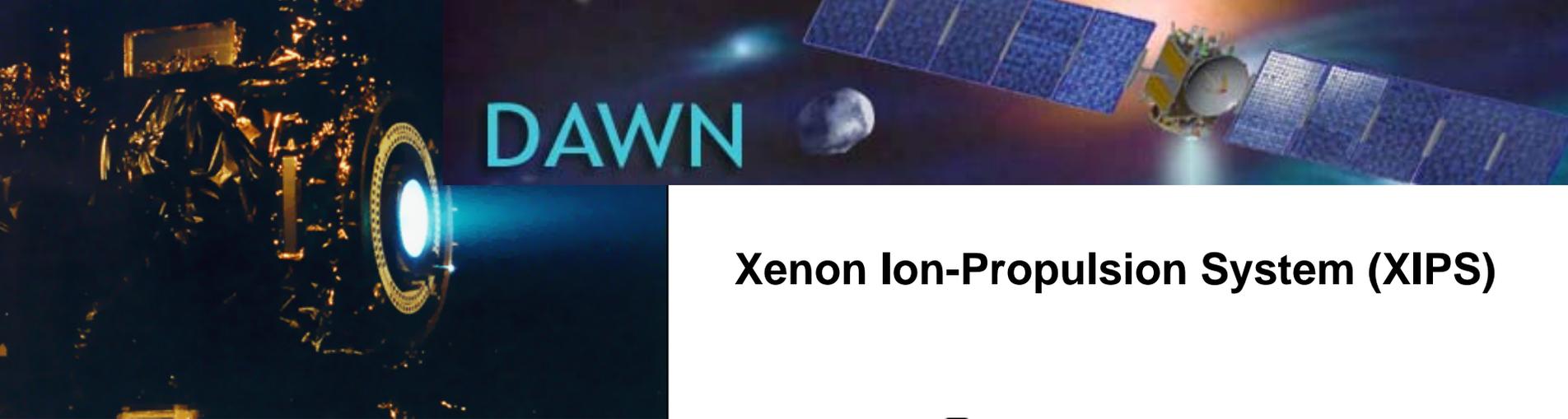


# Dawn Spacecraft Configuration

## External View

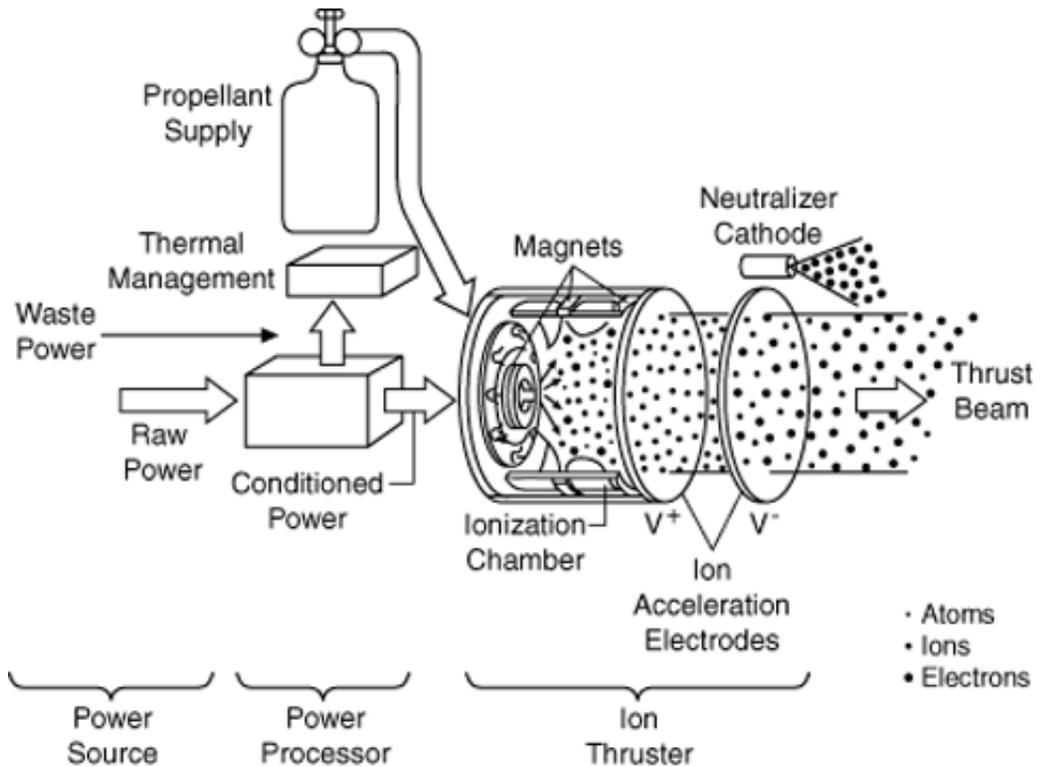
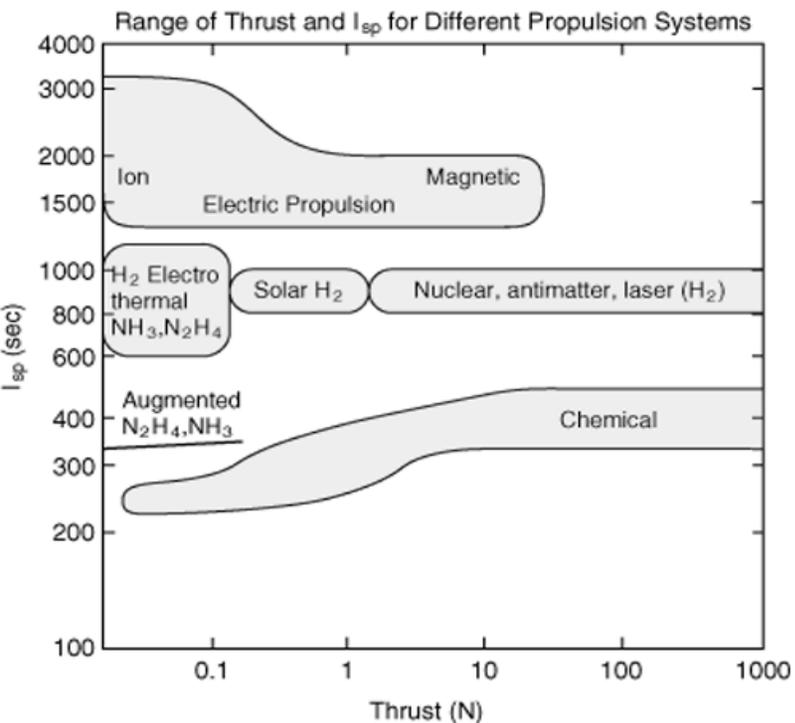
## Cut-away View



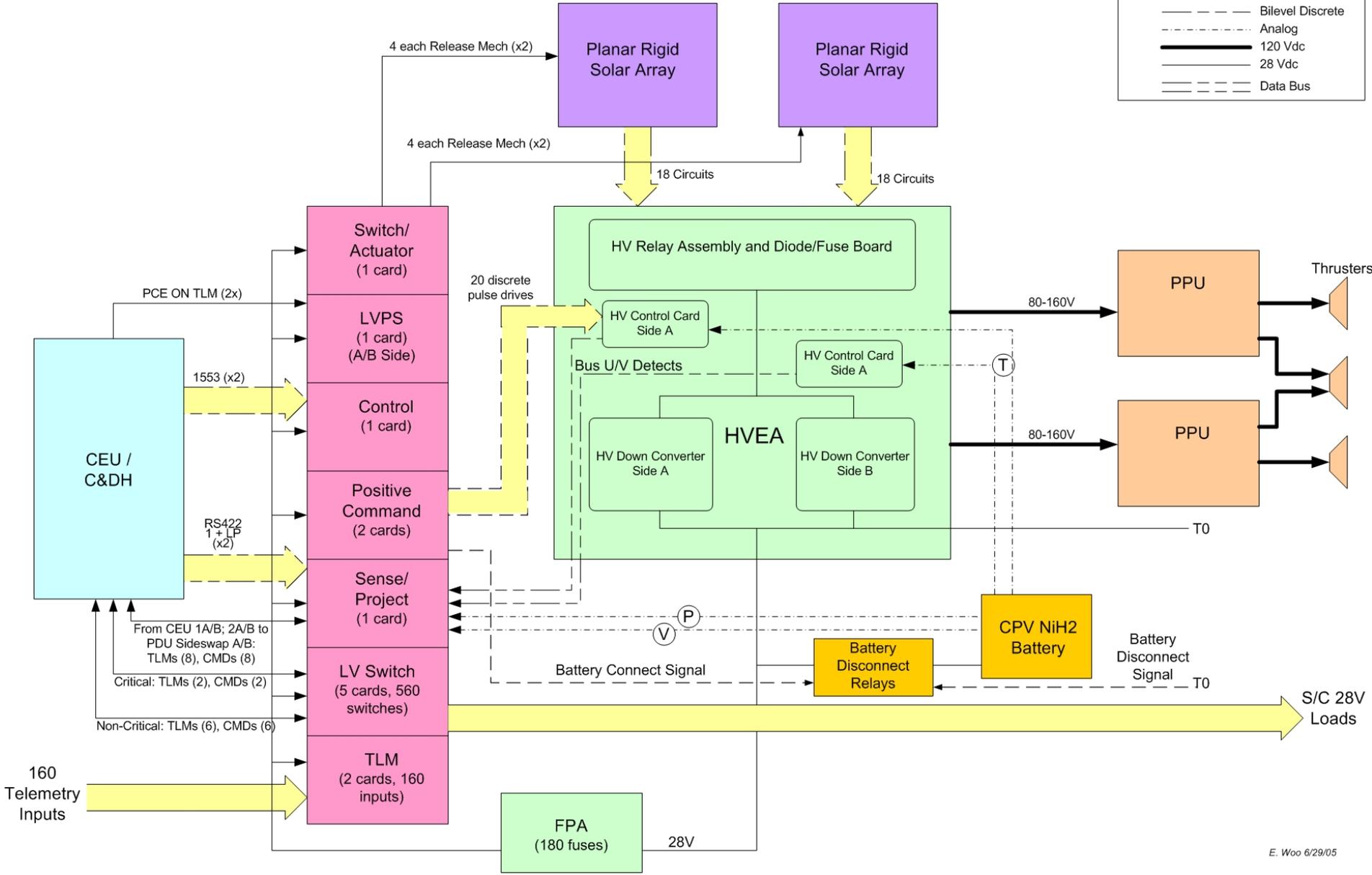
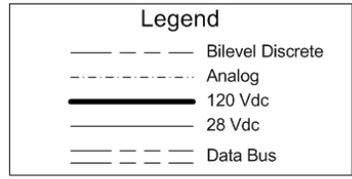


## Xenon Ion-Propulsion System (XIPS)

### Propulsion Figures of Merit



# Dawn Power Subsystem Functional Block Diagram



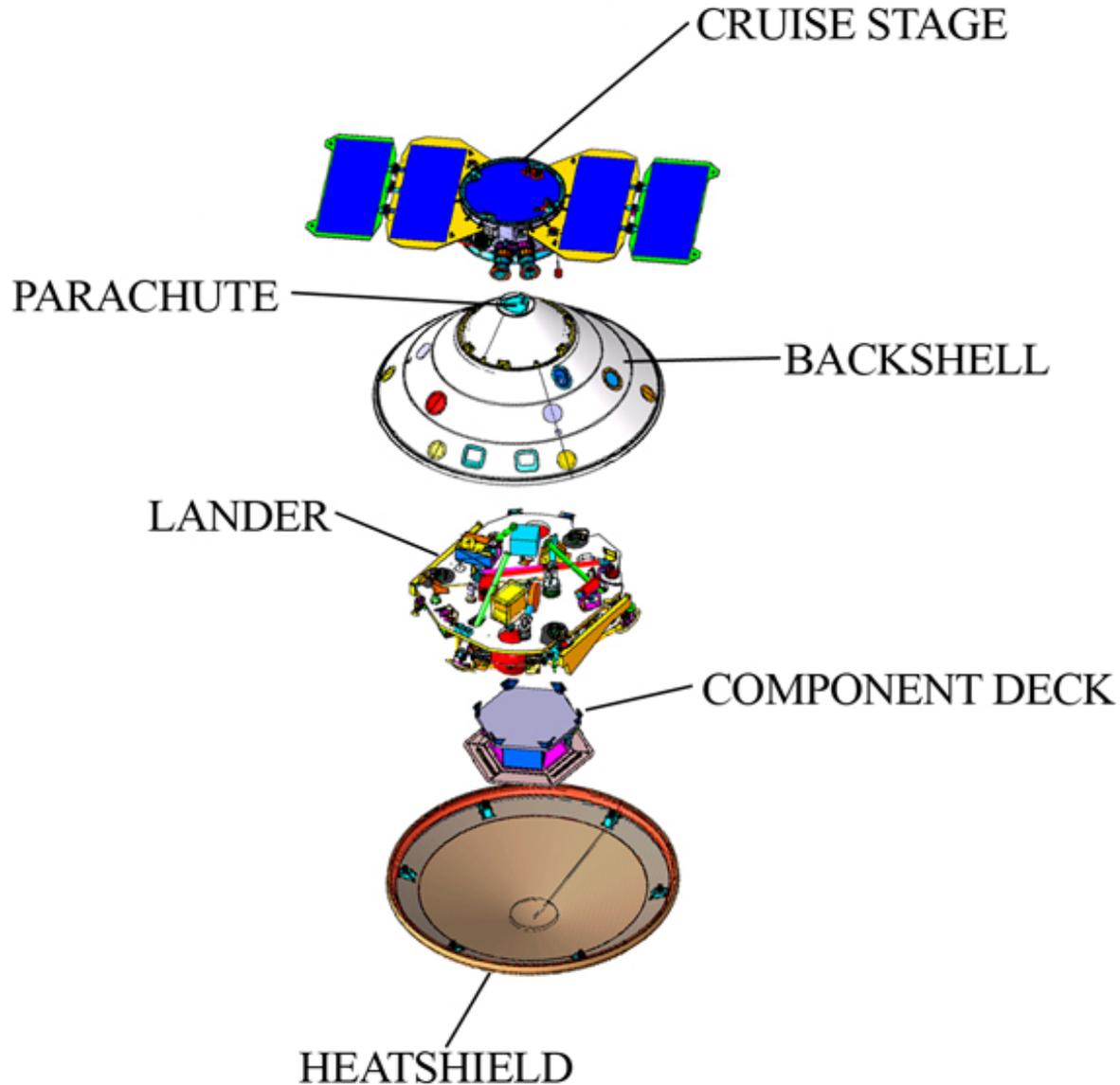


# Phoenix Fact Sheet

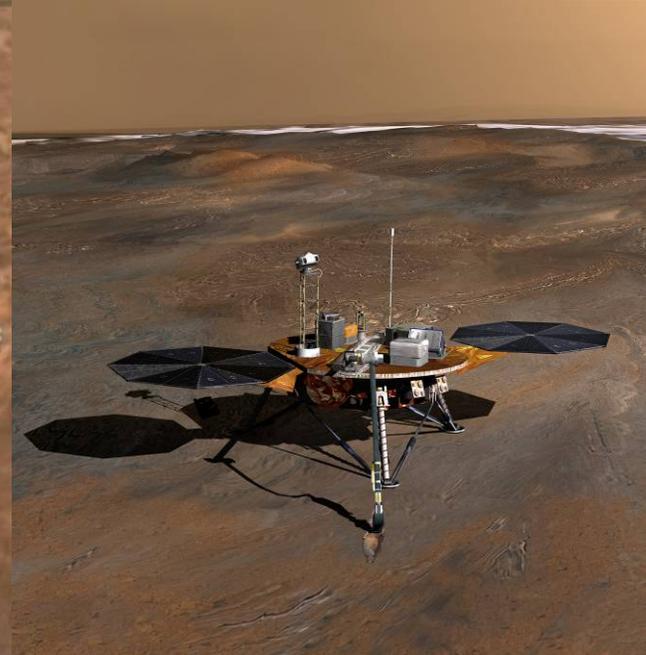
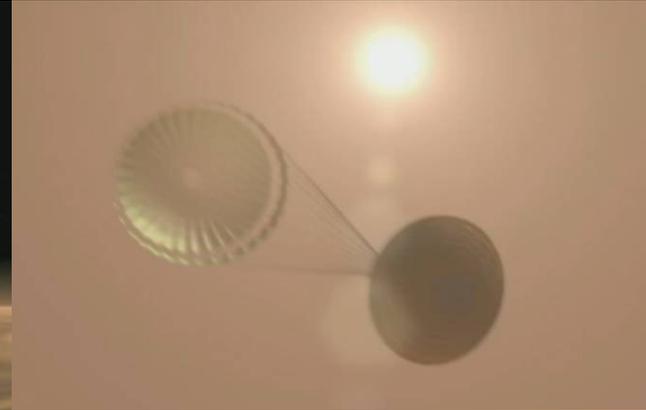


- Launch Date: August, 2007
- Objective: Dig to 1.6 meter depth looking for water at Mars polar cap
- Partners: JPL, LMA Denver, Max Planck Institute, University of Arizona
- Unique Features: 2 meter arm for digging
- Power Source: Ultraflex Solar Arrays, ATK / Able
- Energy Storage: Lithium Ion - Lithion
- Driving Requirements: Power for Digging and Telecom  
Solar Array Performance
- Planned Lifetime: Not intended to survive Winter

# Phoenix Spacecraft Configuration by Element



# Phoenix Entry Descent and Landing Sequence (EDL)



# Phoenix Spacecraft Final Configuration

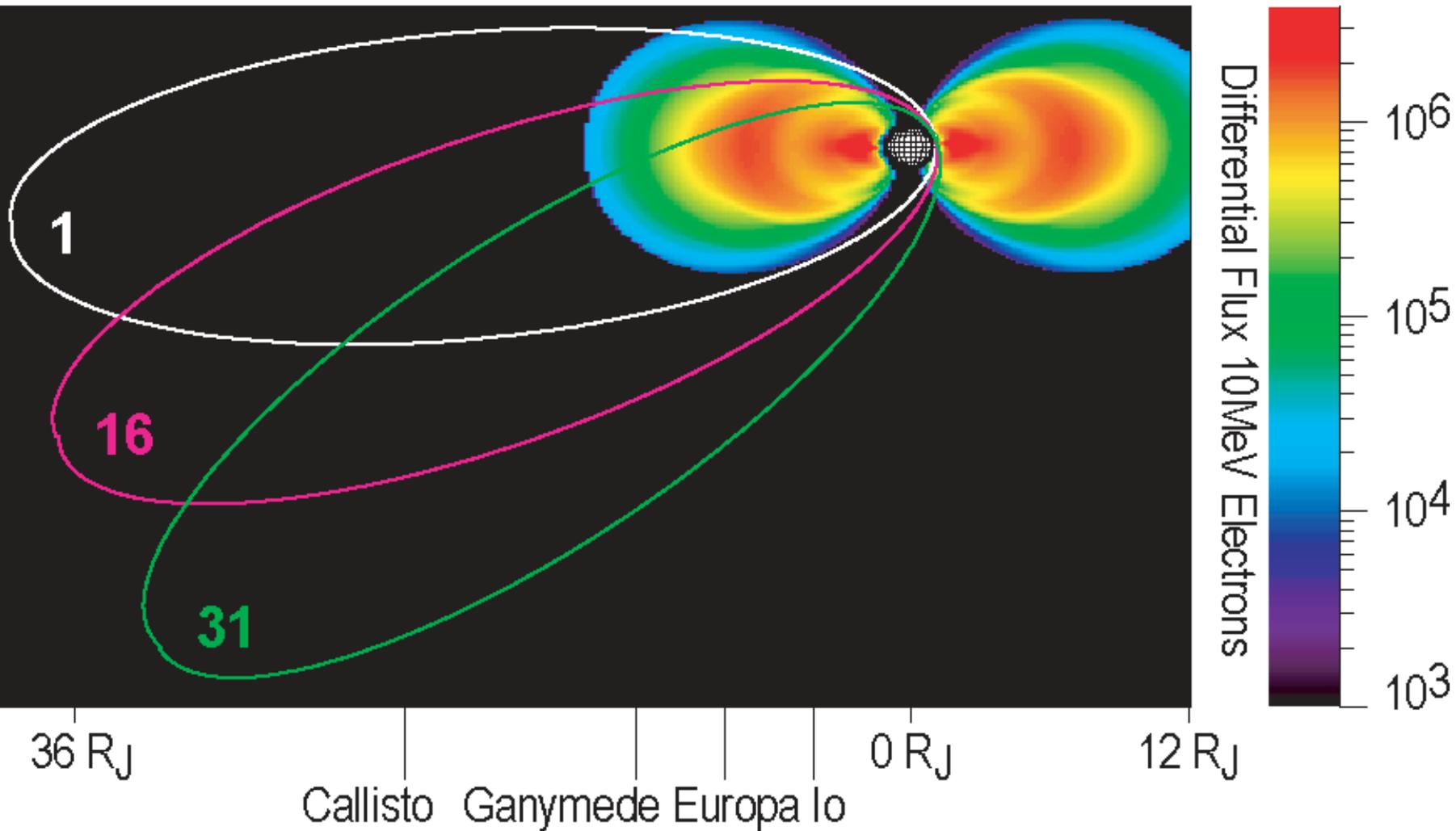




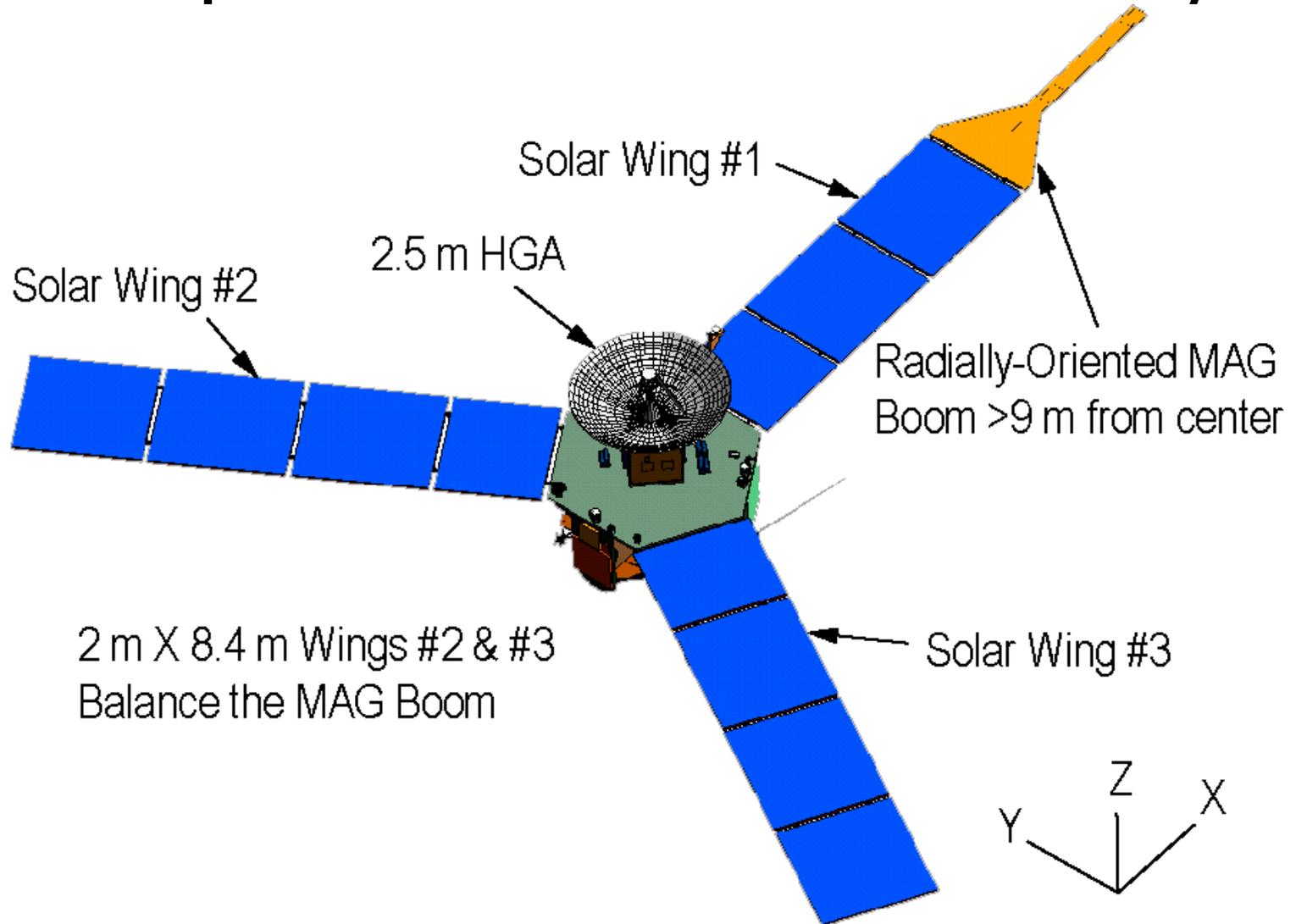
# Juno Fact Sheet

- Launch Date: 2010
- Objective: Look Jupiters water abundance and core structure via fields
- Partners: JPL, LMA Denver, SWRI
- Unique Features: Radiation: (1MeV Equiv.)  
3.9\*E14 for Vmp, with RDM of 2  
6.9\*E14 for Imp, with RDM of 2
- Power Source: 1st Solar Powered S/C to Jupiter
- Energy Storage: Lithium Ion
- Driving Requirements: 5+ AU Range, Spin Stabilized
- Planned Lifetime: 8 Year Lifetime

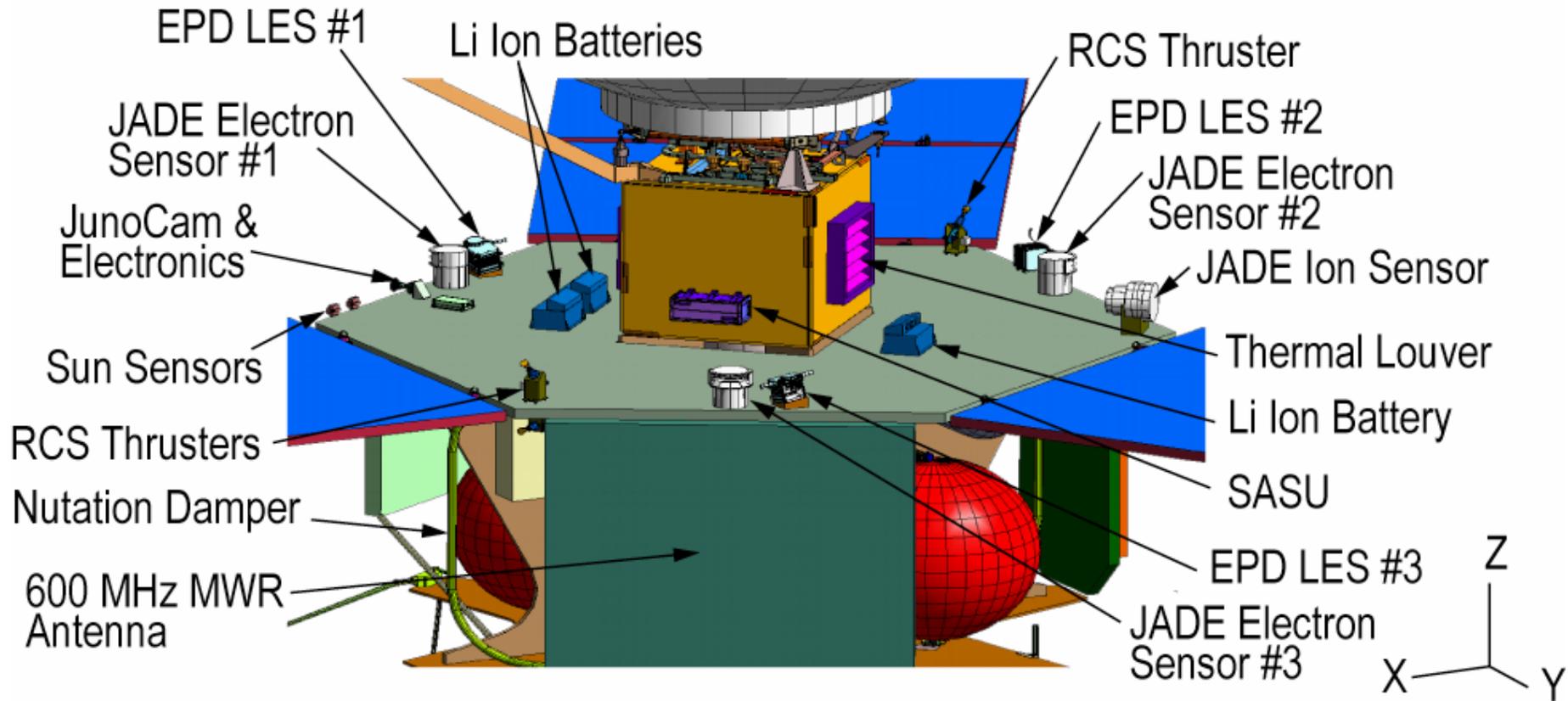
# Radiation Belts and Juno Orbit

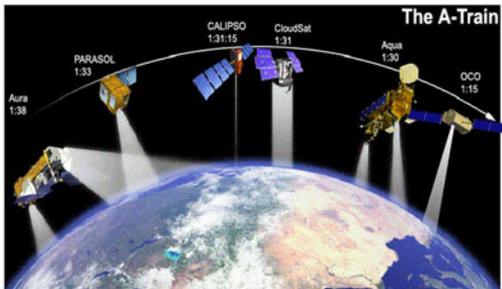


# Juno Spacecraft and Solar Arrays

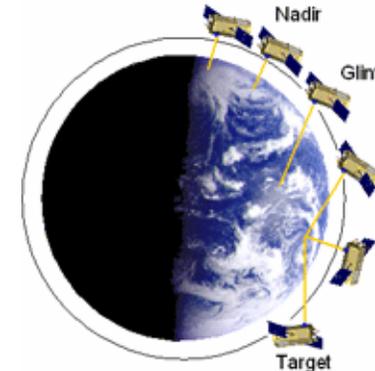


# Spacecraft Details



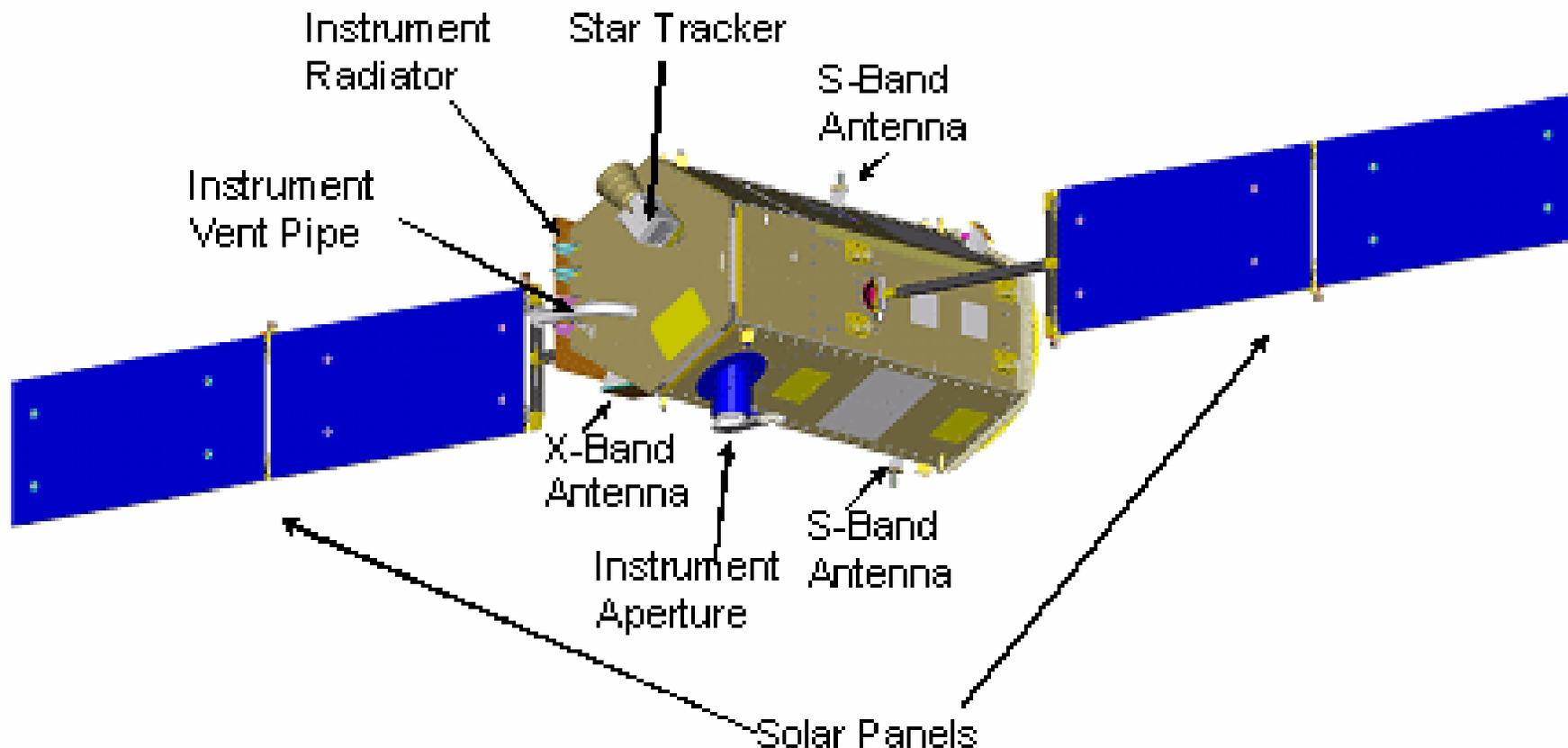


# OCO Fact Sheet



- Launch Date: Month, Year
- Objective: Study of Earths CO<sub>2</sub> Cycle
- Partners: JPL, OSC, Hamilton Sundstrand
- Unique Features:
  - LeoStar-2 Bus,
  - Fourier Transform Near Infrared Spectrometers (3 bands)
- Power Source: Solar Powered
- Energy Storage: Nickel-Cadmium
- Driving Requirements: LEO; Nadir, Glint & Target Modes
- Planned Lifetime: 3 Years (TBR)

# OCO Configuration



*Watching the Earth breathe... mapping CO<sub>2</sub> from space.*

**OCO**  
**Orbiting Carbon Observatory**





# Kepler Fact Sheet



- Launch Date: 2008
- Objective: Search for Earth-like planets monitoring 100,000 stars looking for line of sight crossings
- Partners: JPL, Ball Aerospace, Ames
- Unique Features: 42 CCD focal plane
- Power Source: Solar Powered
- Energy Storage: Lithium-Ion; 18650 (8S:16P)
- Driving Requirements: 42 inch telescope  
Earth trailing orbit
- Planned Lifetime: 4 Years

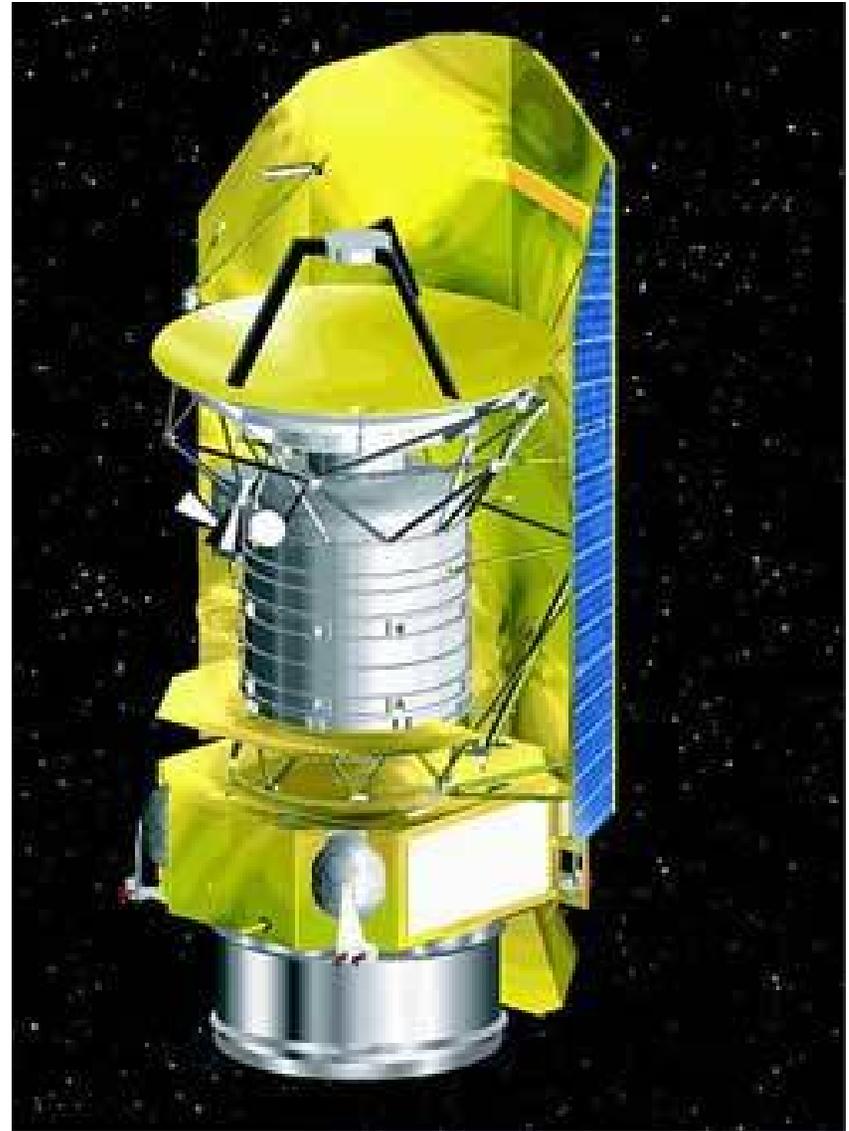
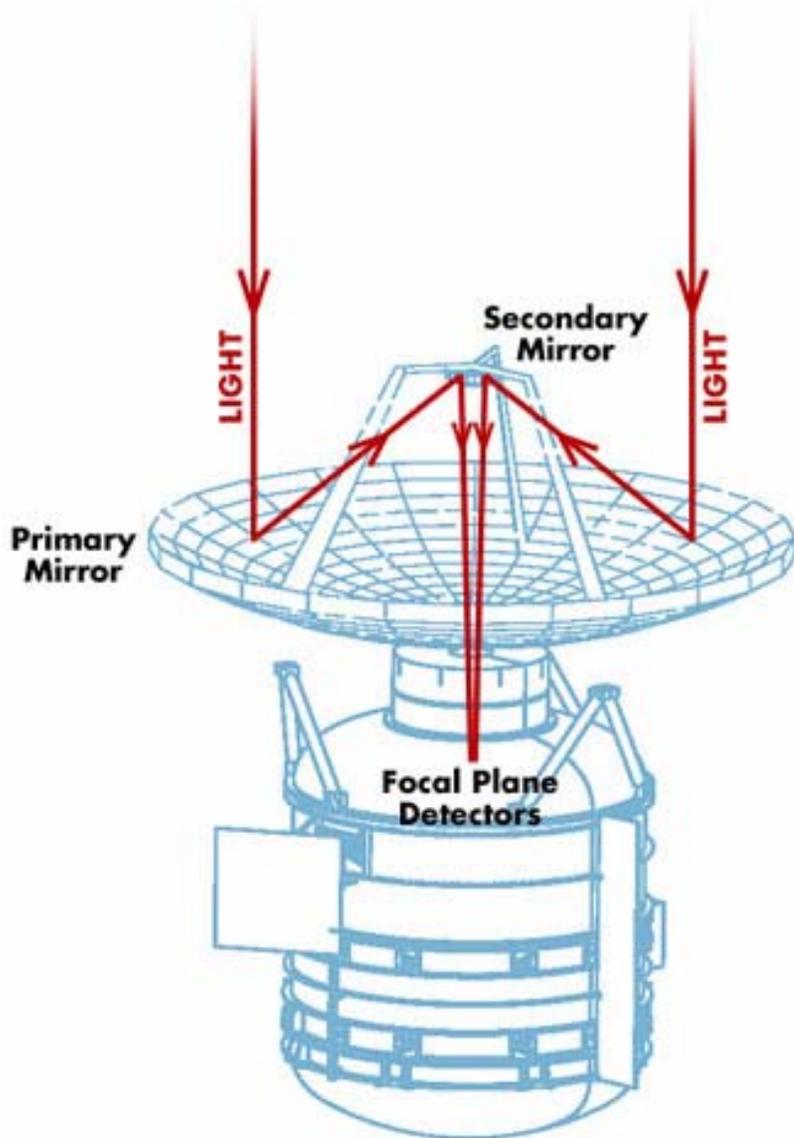


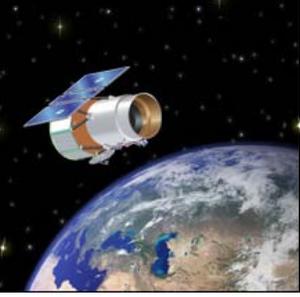
# Herschel Fact Sheet



- Launch Date: 2007
- Objective: Observe in full 60-670  $\mu\text{m}$  range
- Partners: JPL, Ball Aerospace, ESA, CIT
- Unique Features: 3.5 Meter Aperture is largest diameter Space Telescope  
SiC Mirror cooled to 80K
- Power Source: Solar Powered (1KW)
- Energy Storage: Nickel-Hydrogen (TBR)
- Driving Requirements: Earth-Sun L2 Orbit  
Shared Ride with Planck
- Planned Lifetime: 3 Years

# Herschel Configuration





# WISE Fact Sheet

- Launch Date: June, 2009
- Objective: Mid-Infrared Survey of entire sky  
3-25  $\mu\text{m}$
- Partners: JPL, Ball, SDL, UC Berkeley, CIT
- Unique Features: 40 cm aperture, Solid H<sub>2</sub> Cryostat
- Power Source: Solar Powered
- Energy Storage: Nickel-Hydrogen (TBR)
- Driving Requirements: 500 km sun-synch LEO
- Planned Lifetime: 0.5 Years

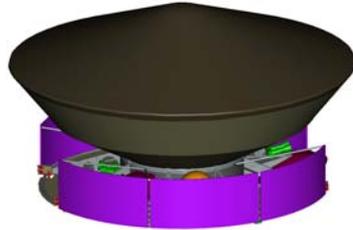


# MSL Fact Sheet



- Launch Date: Fall 2009
- Objective: Search for Evidence of Life on Mars using Sample Analysis
- Partners: JPL + International Instruments
- Unique Features: Precision Landing – Sky Crane  
Extended Operating Latitudes
- Power Source: Baseline is one MMRTG:  
Multi-Mission Radioisotope  
Thermoelectric Generator
- Energy Storage: Dual Lithium Ion
- Driving Requirements: Single MMRTG ~ 100 W
- Planned Lifetime: Two+ Earth Years Capability

# MSL Mission Overview



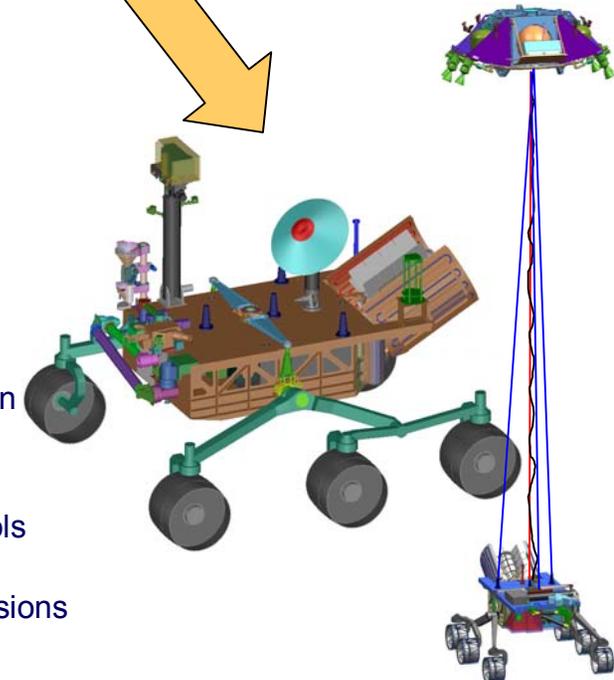
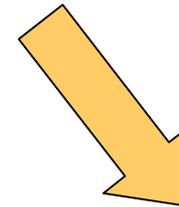
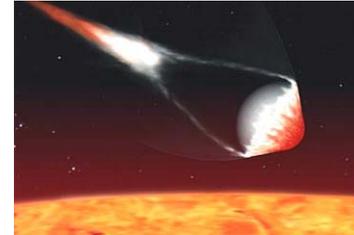
## CRUISE/APPROACH

- 10-12 month flight time



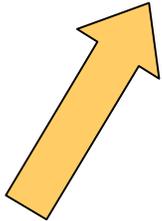
## ENTRY/ DESCENT/ LANDING

- Direct Entry
- Comm provided by UHF link to different relay orbiters, based on latitude
- Sky crane landing system



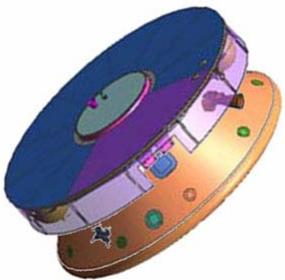
## SURFACE MISSION

- 700 kg rover
- One Mars year prime mission
- 20 km mobility capability
- Approx 100+ kg payload of instruments and support tools
- Radioisotope Power Source assumed, pending final decisions



## LAUNCH

- Fall 2009
- Delta IV/ATLAS V w/5-m fairing



# MSL Mass Allocations

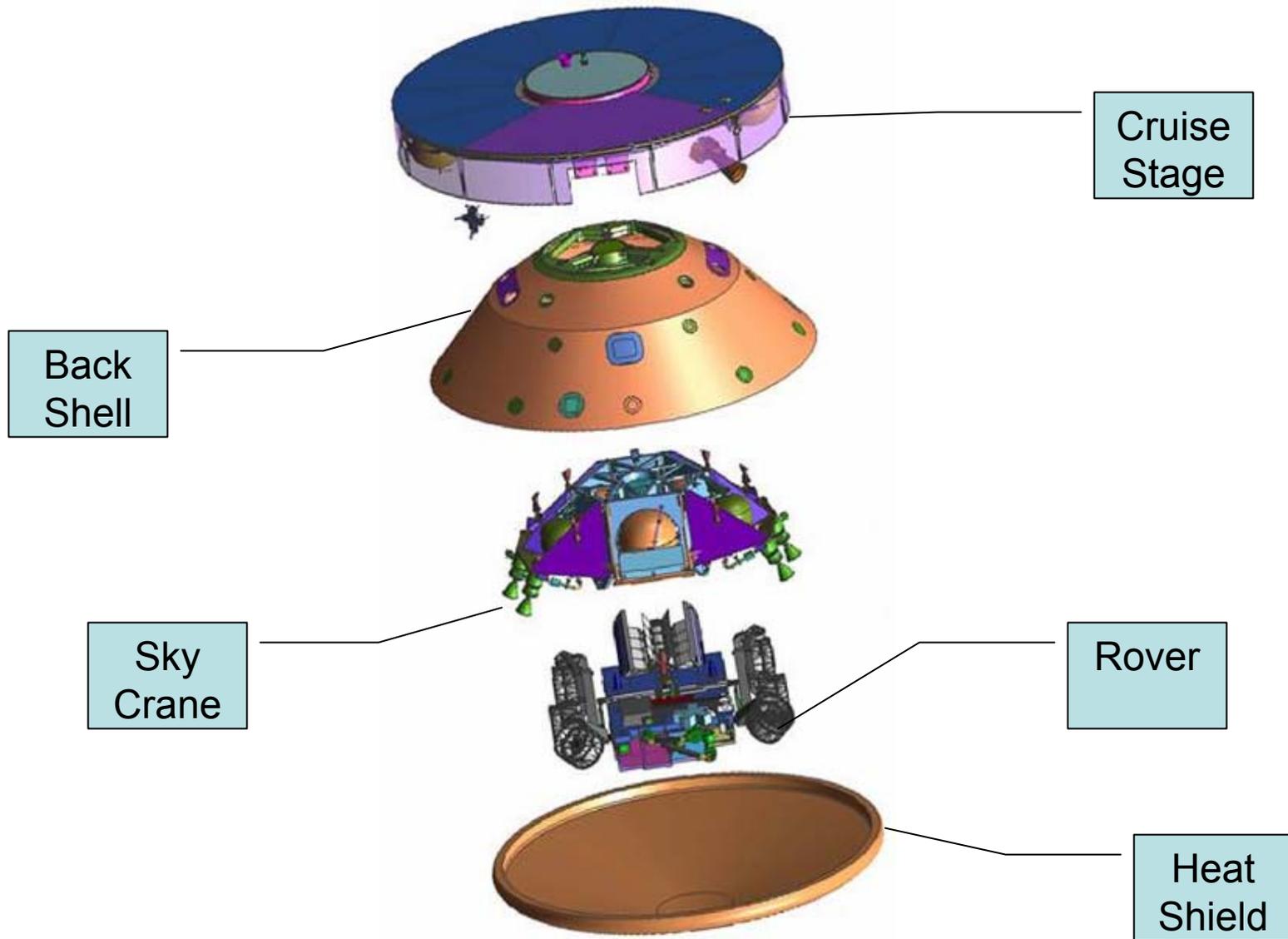


	<b>Allocated Mass kg (lbs)</b>	<b>Cumulative Mass kg (lbs)</b>
<b>Rover</b>	775 kg (1,708 lbs)	775 kg (1,708 lbs)
<b>Descent stage (dry)</b>	544 kg (1,199 lbs)	1,319 kg (2,908 lbs)
<b>Aeroshell (Backshell + Heat Shield)</b>	525 kg (1,157 lbs)	1,844 kg (4,065 lbs)
<b>Heat Shield</b>	78 kg (172 lbs)	820 kg (1,808 lbs)
<b>Cruise Stage</b>	400 kg (882 lbs)	2,244 kg (4,947 lbs)
<b>Descent Stage Propellant</b>	219 kg (483 lbs)	2,463 kg (5,430 lbs)

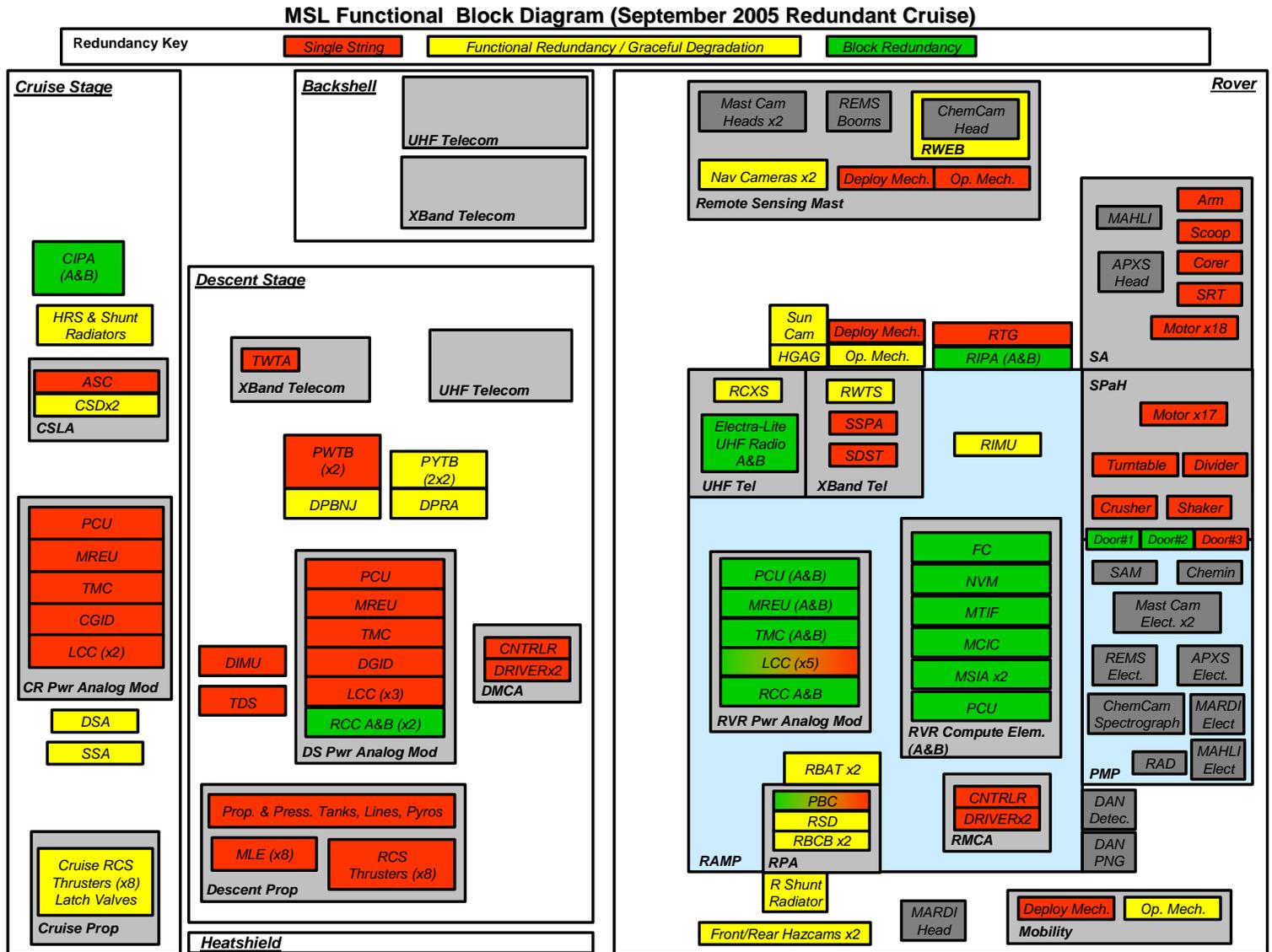
# MSL Cruise Configuration



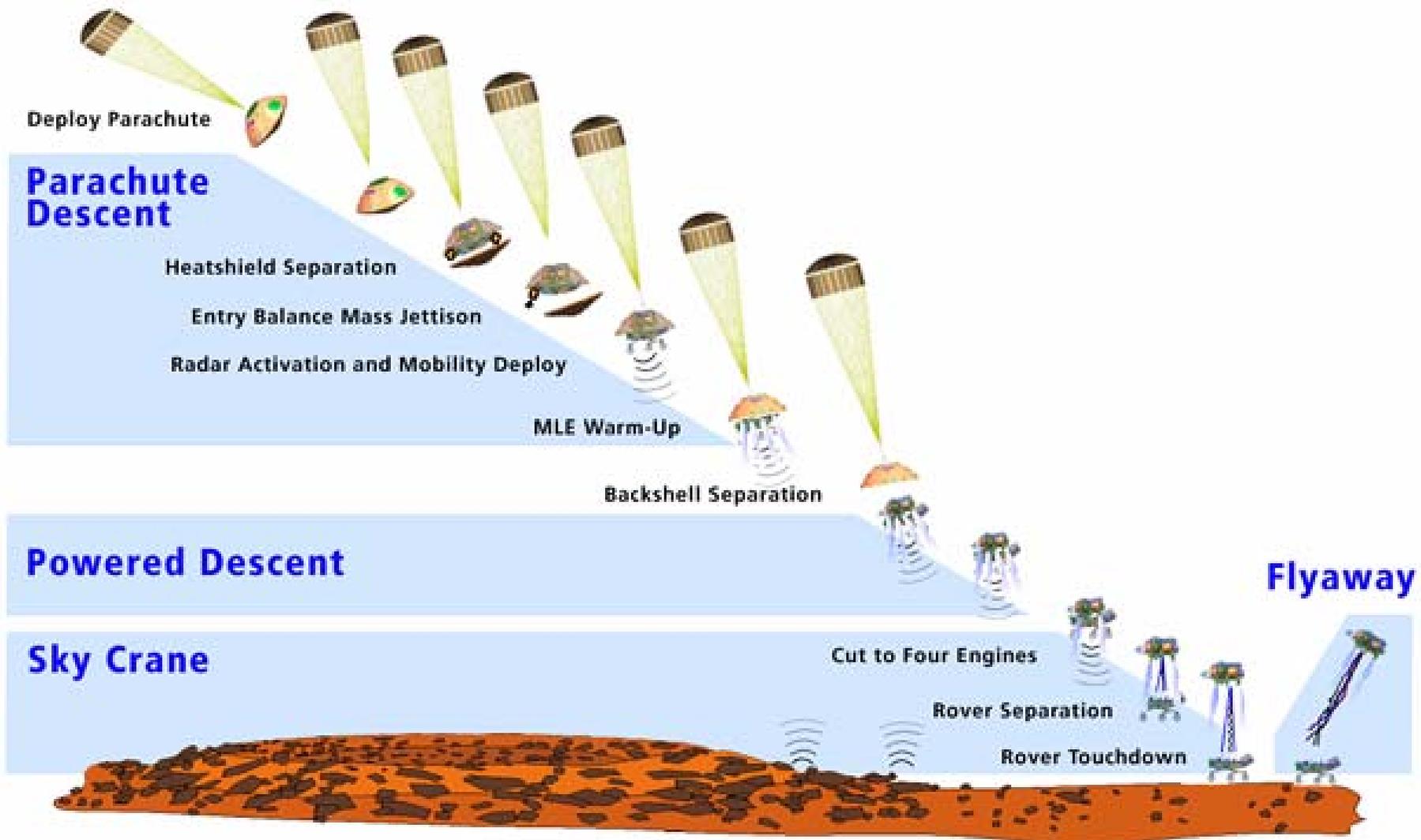
# MSL Cruise Configuration



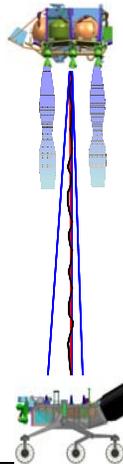
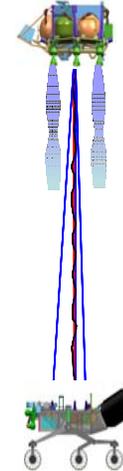
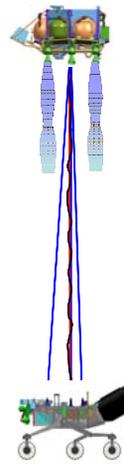
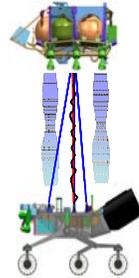
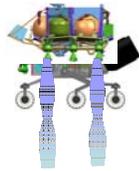
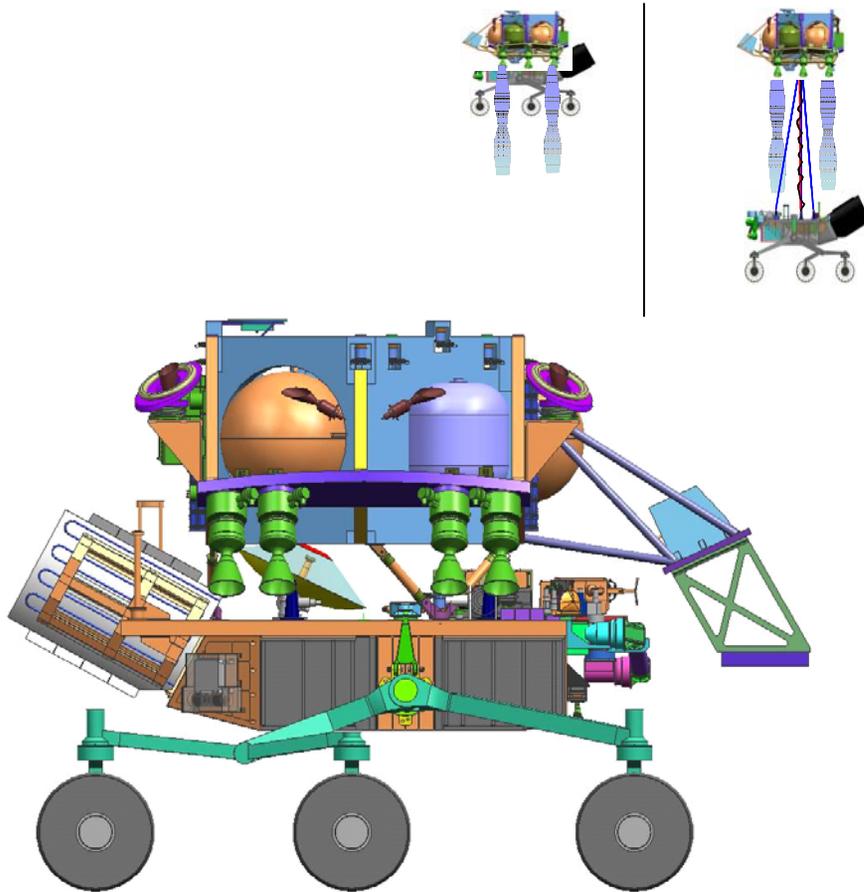
# MSL Overall Block Diagram



# MSL Descent Sequence



# Sky Crane Deployment on Tether



**Post-Deploy  
Settling Phase**  
*Duration = ~2 sec*

**Ready for Touchdown  
Phase**  
*Duration = 0-8 sec*

**Touchdown Phase**  
*Duration < 2 sec*

*Reference Trajectory:  $V_{Vertical} = 0.75 \text{ m/sec}$  &  $V_{Horizontal} = 0.0 \text{ m/sec}$*

# MSL Rover Configuration

## Mast-mounted, on scan platform:

- MastCam (2 camera heads)
- ChemCam (mast unit)

## Mast-mounted, below scan platform:

- REMS (2 "boomlets")

## Payload Module (with sample inlets):

- SAM
- CheMin

## Payload Module (no sample inlets):

- RAD
- APXS Electronics
- ChemCam Electronics
- MSSS Electronics (x4)
  - MAHLI Electronics
  - MastCam Electronics (x2)
  - MARDI electronics
- REMS Electronics

## Arm Mounted:

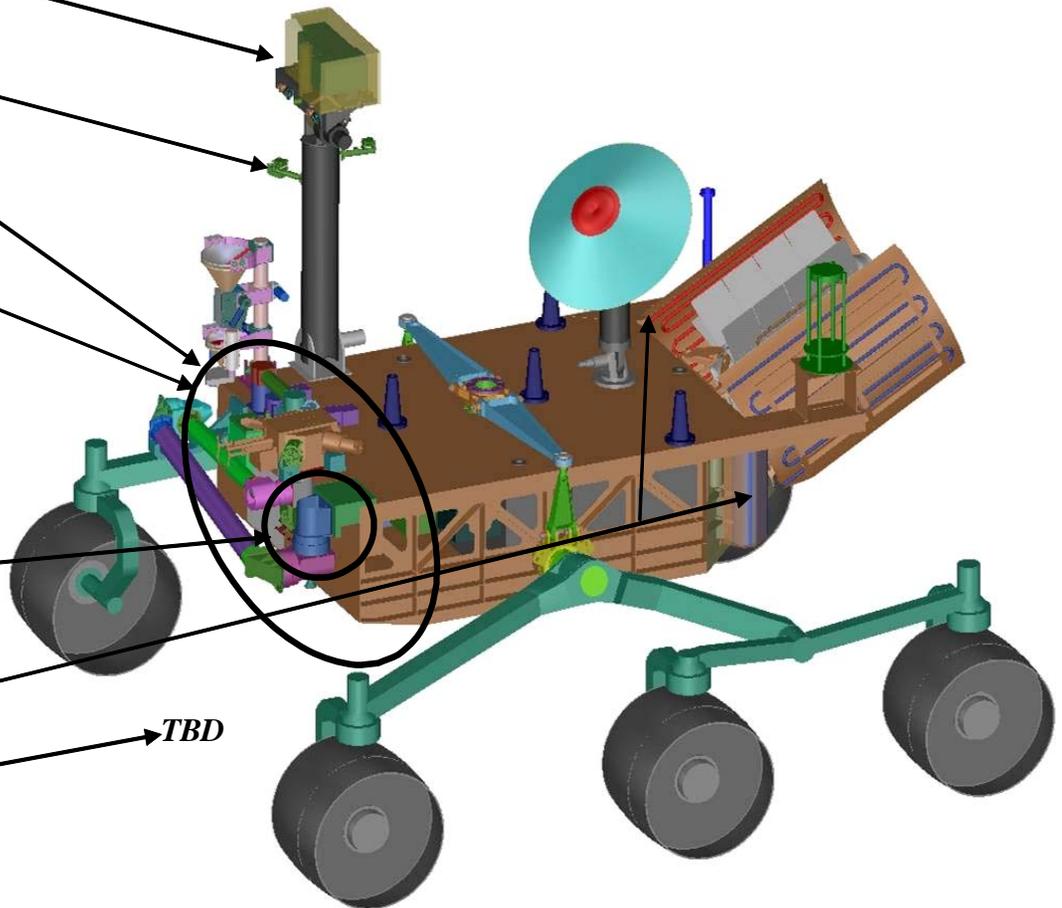
- APXS Sensor Head
- MAHLI Camera Head

## Rover Chassis (adjacent to RPS):

- DAN Digital Electronics
- DAN PNG

## Miscellaneous

- Camera Calibration Target(s)
- APXS Calibration Target
- ChemCam Calibration Target
- REMS UV sensor



7/18/2005

# Comparison of MSL and MER

