IAC-08-A3.5.2

The Dawn Project's Transition to Mission Operations: On Its Way to Rendezvous with (4) Vesta and (1) Ceres

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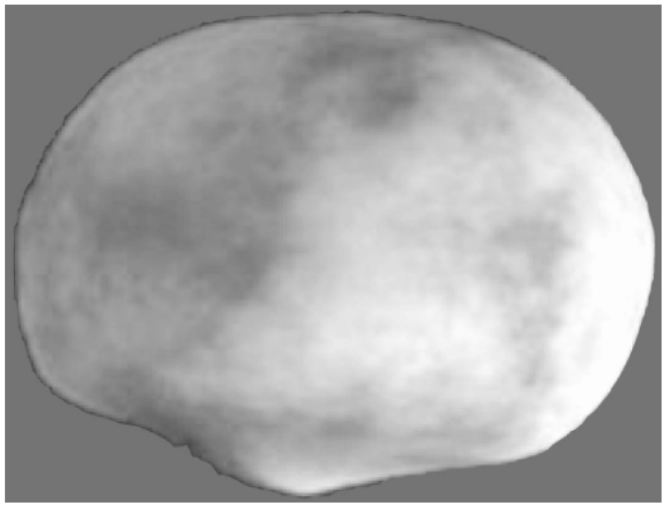
Dawn Project Highlights

- Dawn is the 9th project in NASA's Discovery Program.
- Objective is to investigate the geophysical properties of (1) Ceres and (4) Vesta.
  - Dawn will be the first mission to rendezvous with a main belt asteroid and the first mission to orbit two target bodies.
- Selected major participants:
  - University of California, Los Angeles
    - Principal investigator
  - JPL
    - Project and systems management, delivery of some portions of spacecraft, systems engineering, mission design and navigation, and mission operations
  - Orbital Sciences Corporation
    - Spacecraft development, integration, and test

Science Motivation

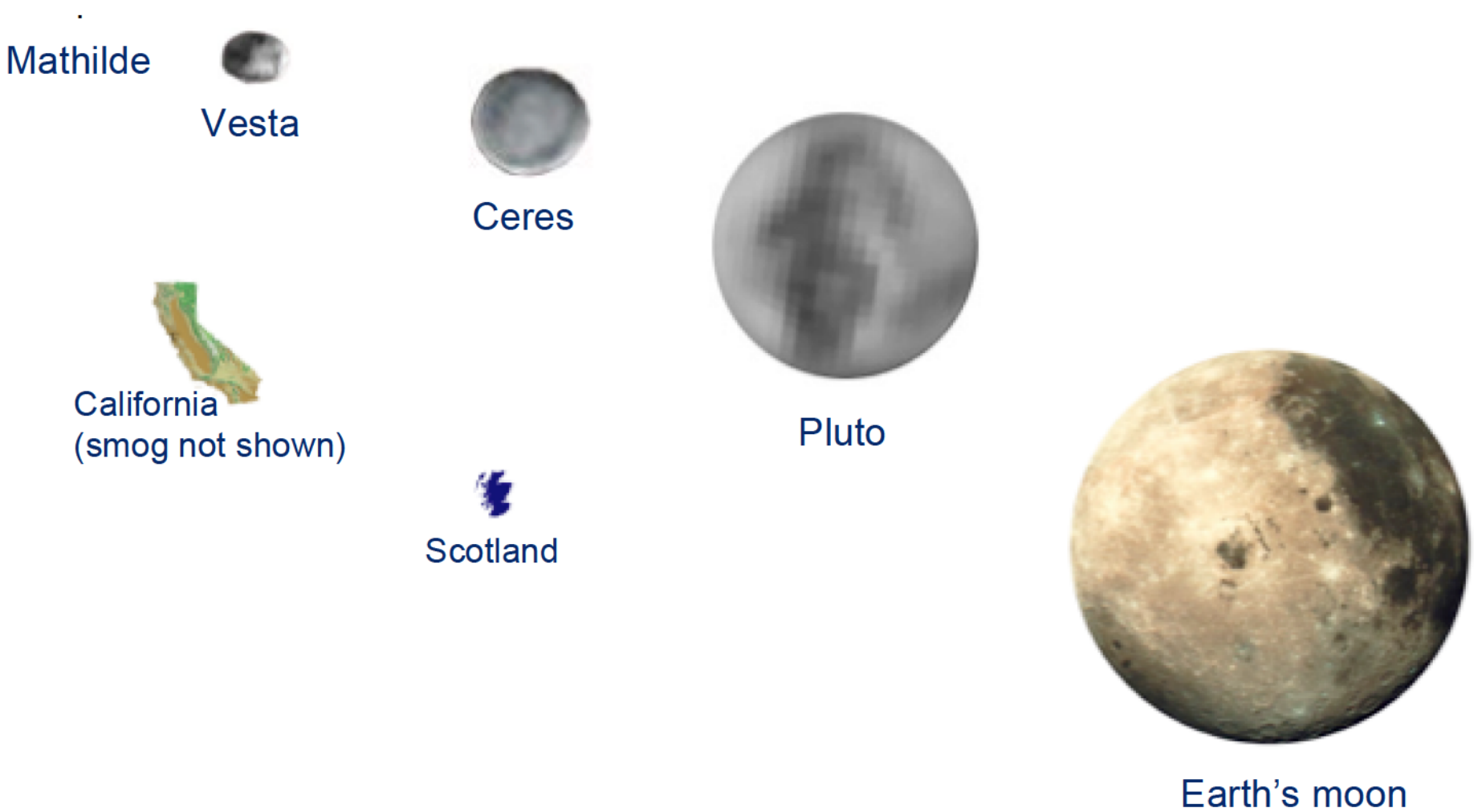
- By comparing Vesta and Ceres, Dawn will yield insights into conditions and processes acting at the formation of the solar system.
  - Although they are at similar distances from the Sun, Vesta was melted and is dry, while Ceres did not melt and retained water.
- Vesta and Ceres are unlike any asteroids that have been visited by spacecraft.
  - They are the two most massive asteroids.
  - Vesta is believed to be the source of the HED meteorites.



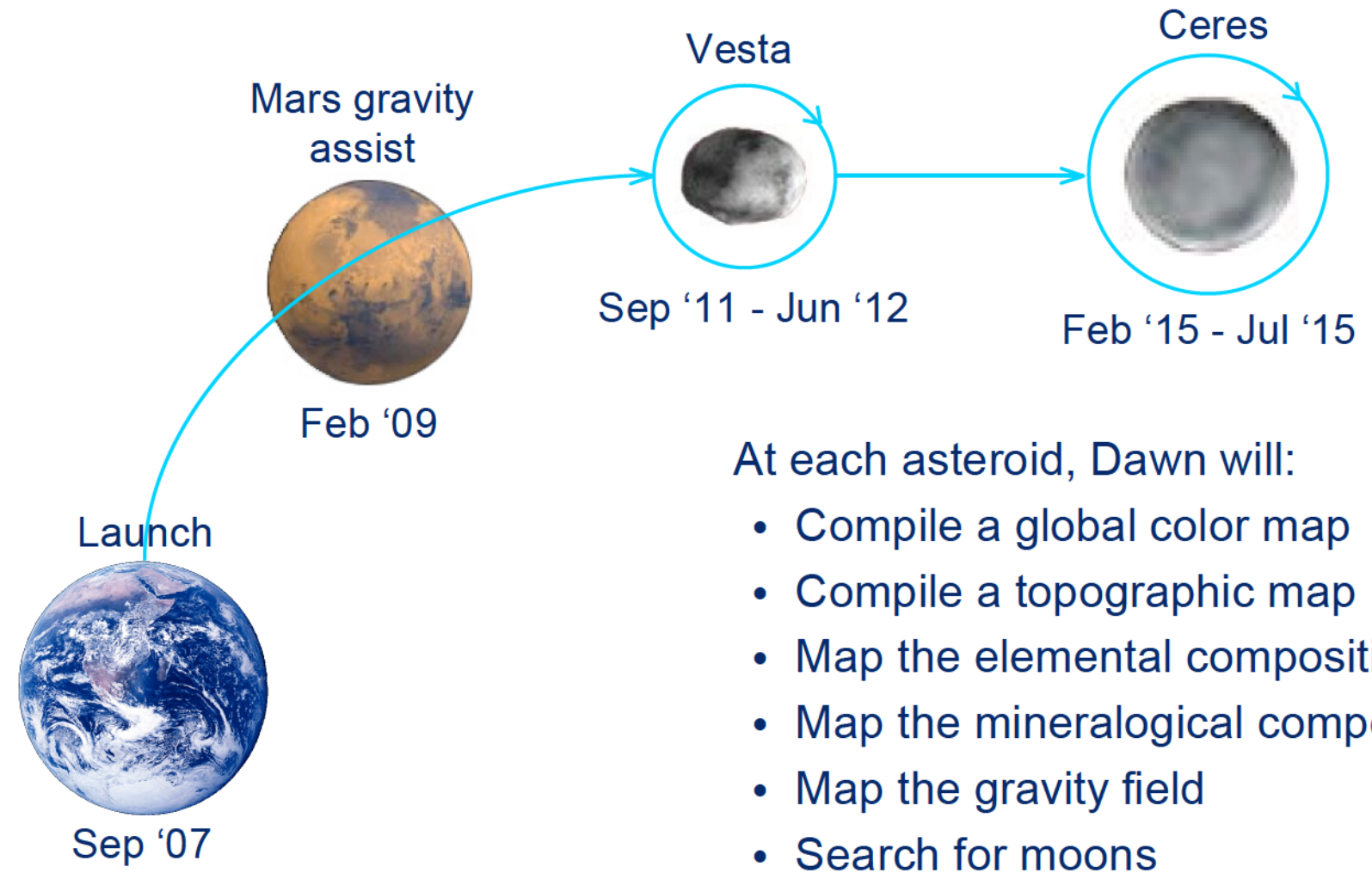
Smoothed HST image of Vesta

Eucritic meteorite

Ceres and Vesta Size in Context



Mission Itinerary



Note: Text is not to scale.

At each asteroid, Dawn will:

- Compile a global color map
- Compile a topographic map
- Map the elemental composition
- Map the mineralogical composition
- Map the gravity field
- Search for moons

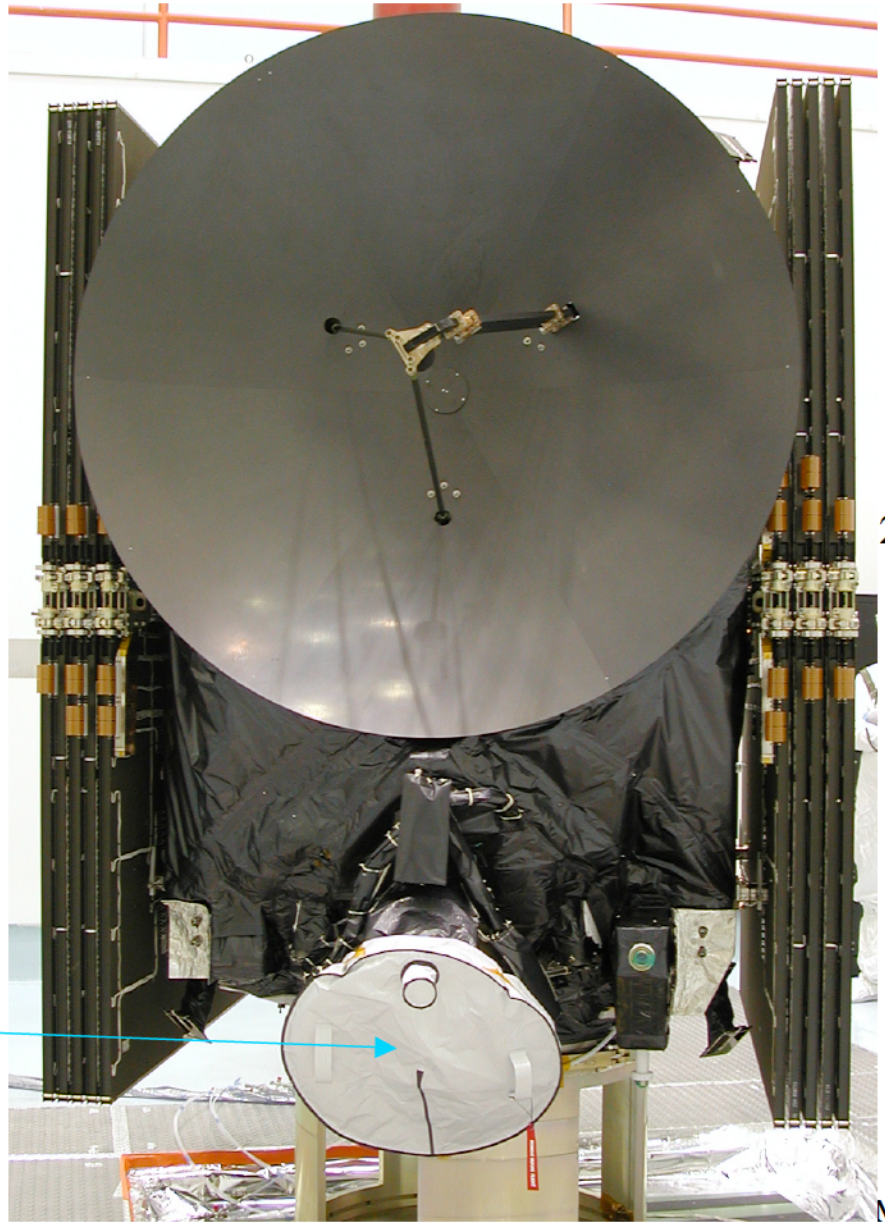
Flight System

Dry flight system..... 747 kg

Hydrazine..... 46 kg

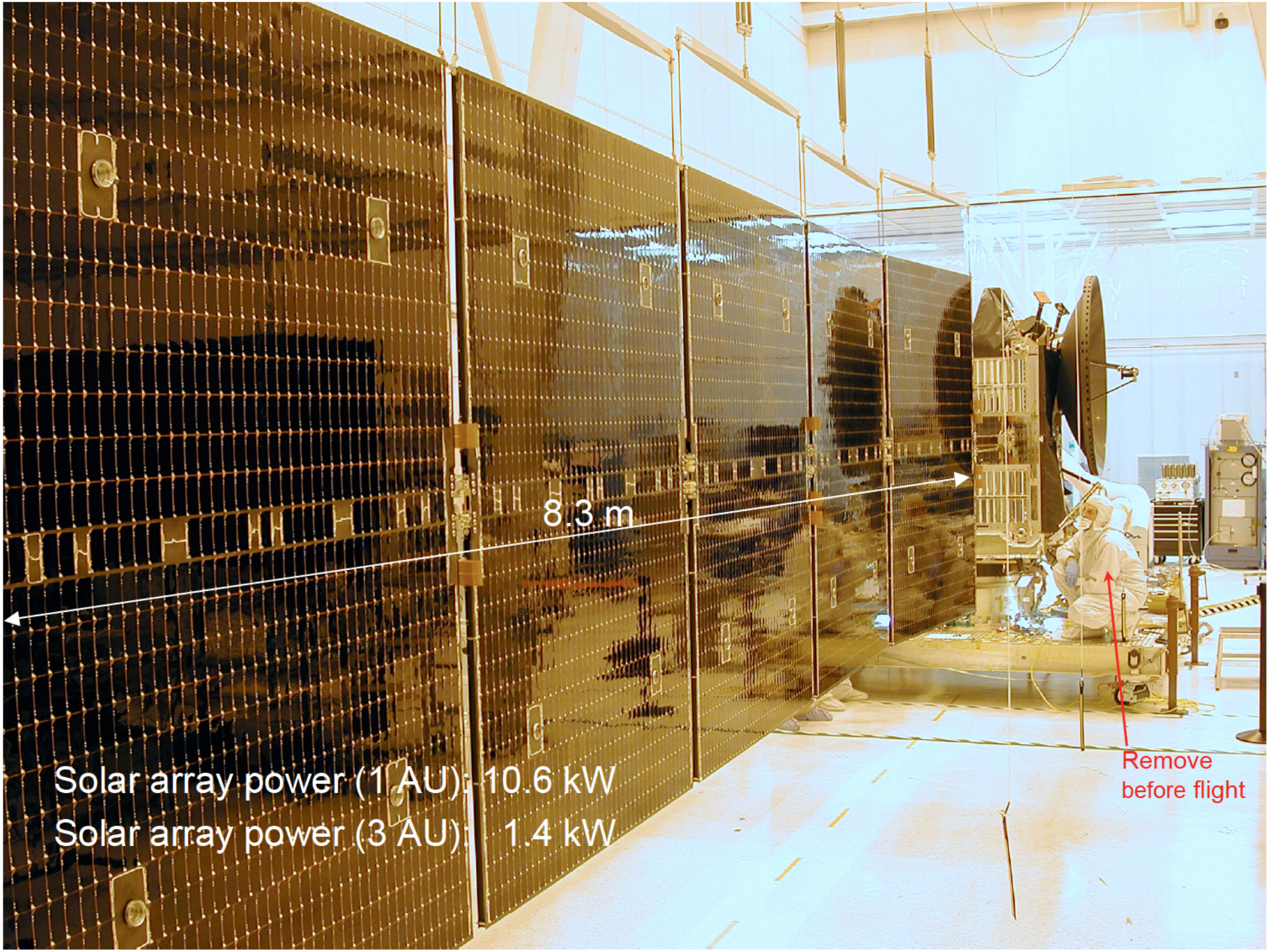
Xenon..... 425 kg

Total injected mass...1218 kg



2.3 m

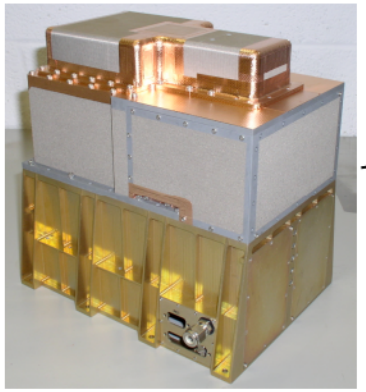
Ion thruster cover

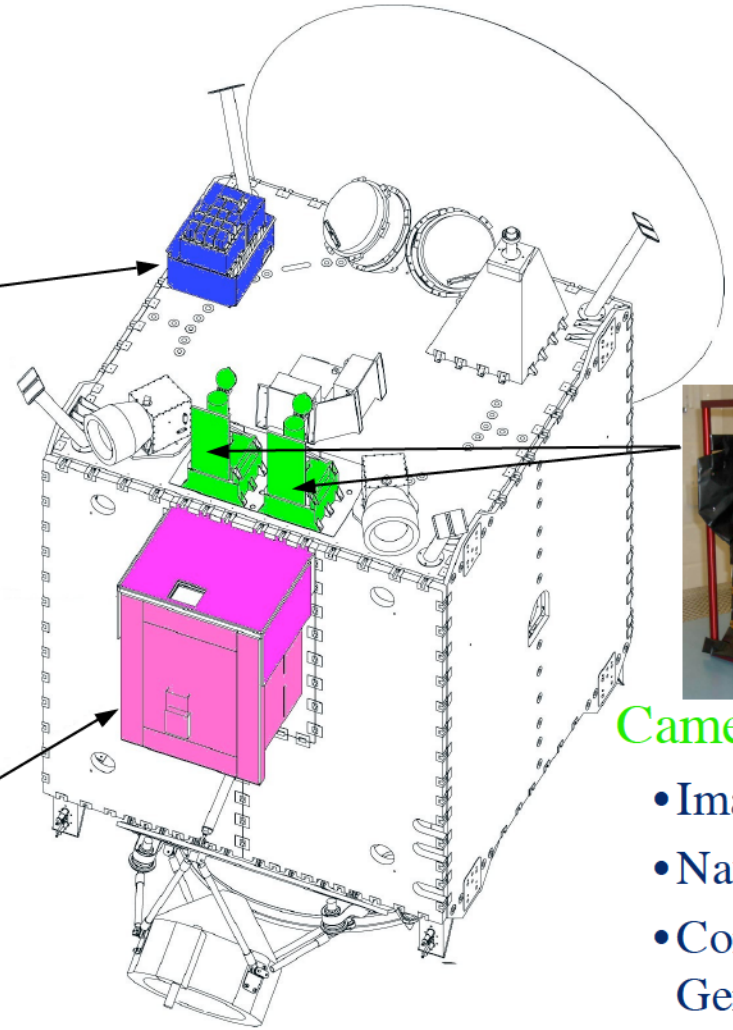

8.3 m
Solar array power (1 AU): 10.6 kW
Solar array power (3 AU): 1.4 kW
Remove
before flight

Payload

γ-ray and neutron spectrometer

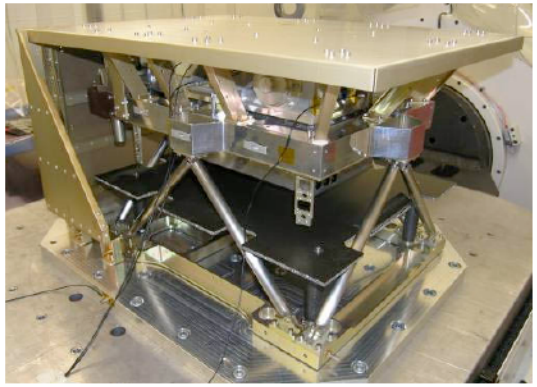
- Mapping of elemental abundances

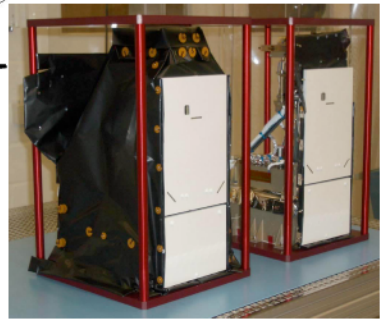




Visible/IR mapping spectrometer

- High resolution mineralogical and thermal emissivity mapping
- Contributed by Italy's ASI





Cameras (2)

- Imaging science
- Navigation
- Contributed by Germany's MPS & DLR

Gravimetry

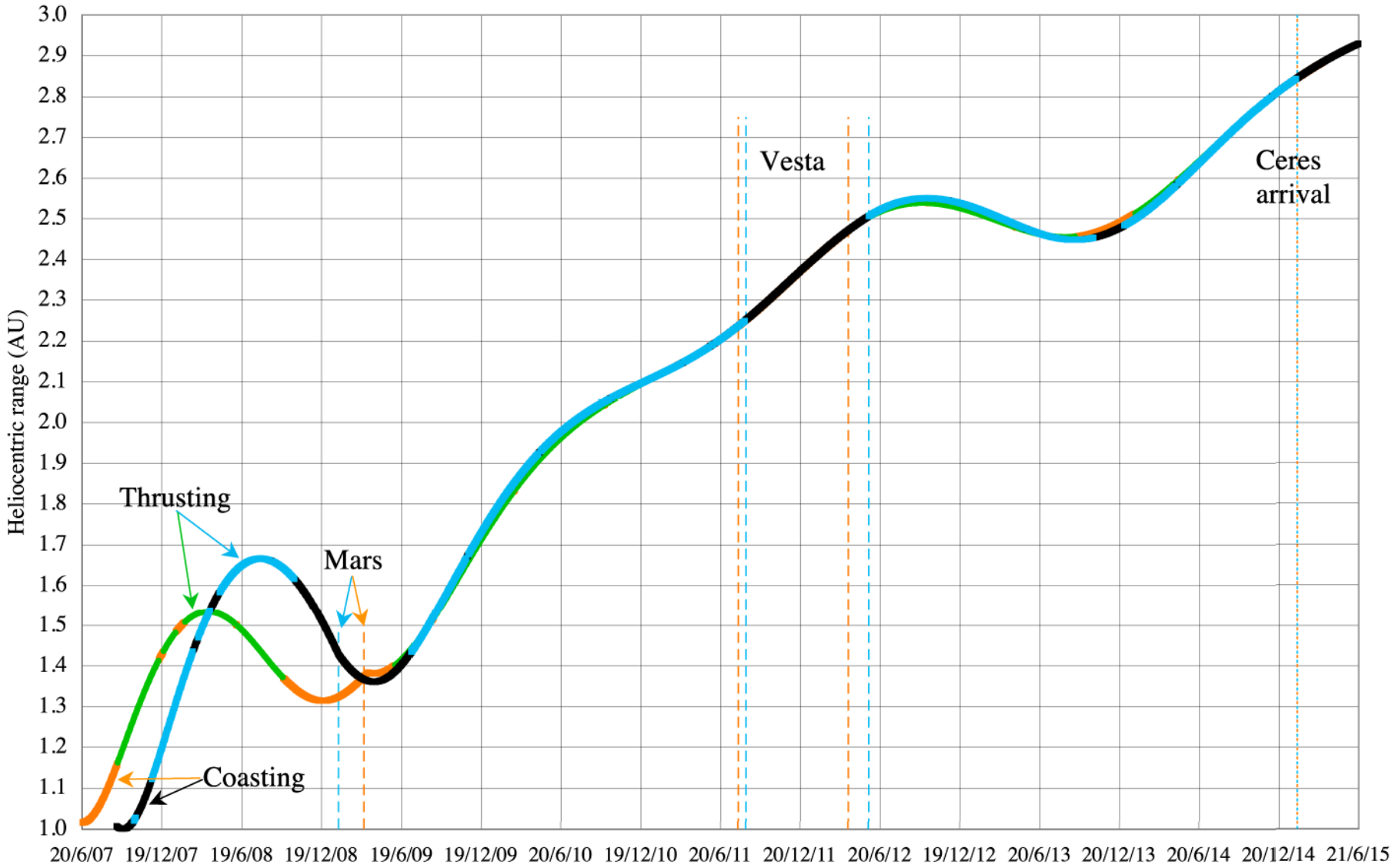
- Accomplished with other flight and ground systems

Flight System

Launch

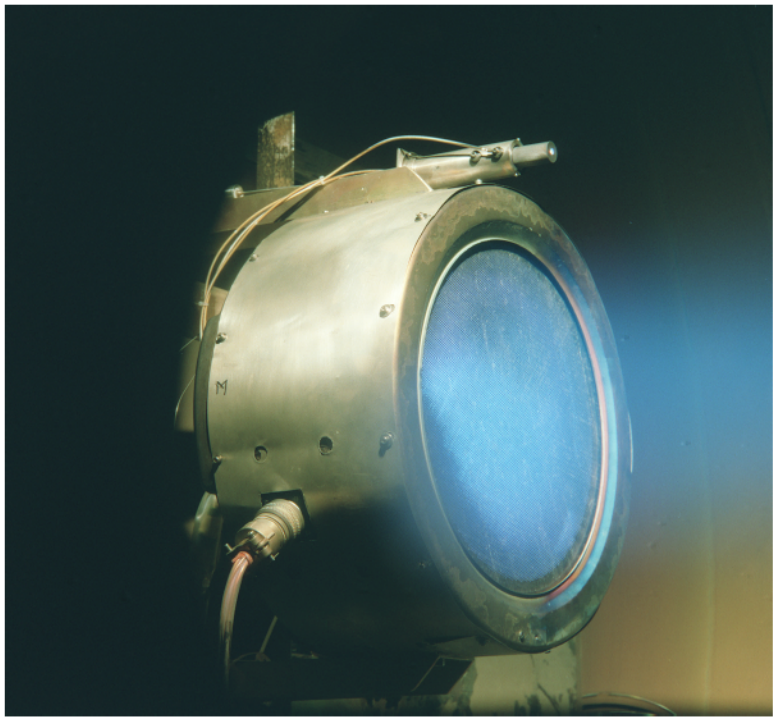
- Cape Canaveral's Space Launch Complex 17B
- Delta II 7925H-9.5
  - 327th Delta launch
  - 76th consecutive successful Delta II launch
- 27 September 2007
  - 14 minutes into 29-minute launch window
- $C_3 = 11.3\ km^2/s^2$

Accommodation of Launch Delay



Ion Propulsion Enables Dawn

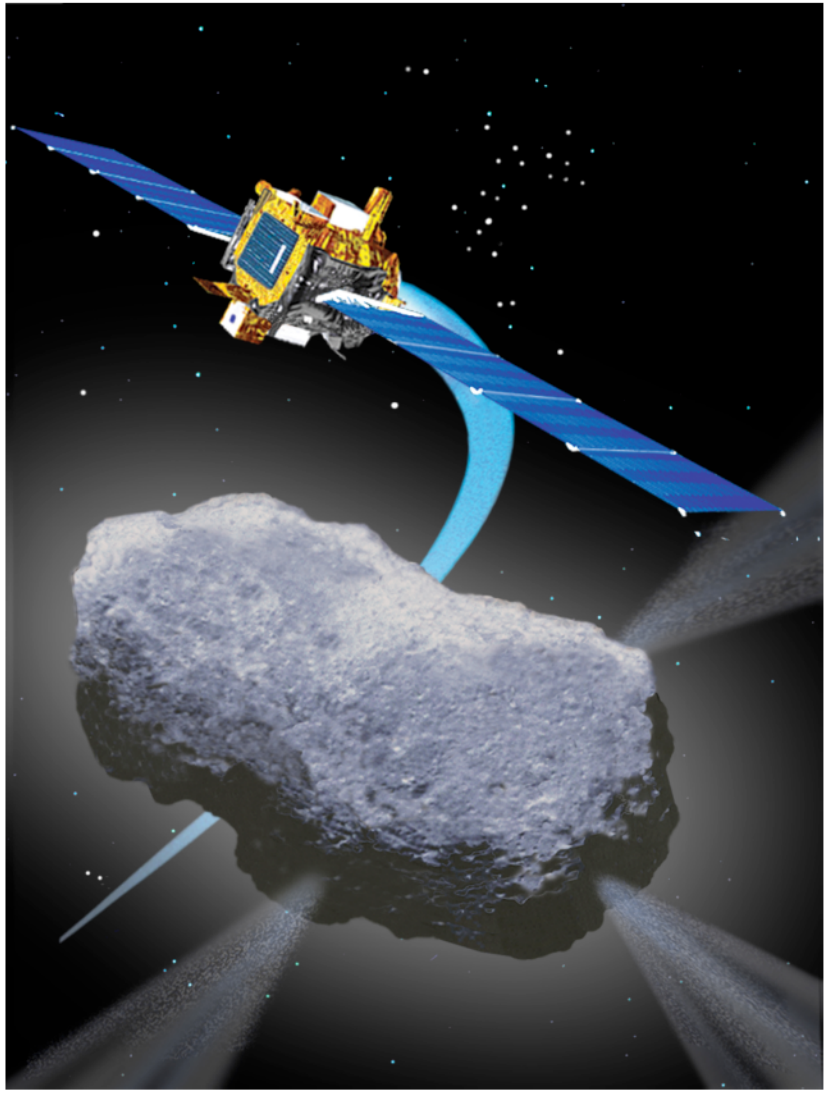
- It would not be possible to rendezvous with either one of Dawn's targets using a conventional propulsion system within the constraints of the Discovery Program.
- Without ion propulsion, a mission only to Vesta (the easier target to reach) would require:



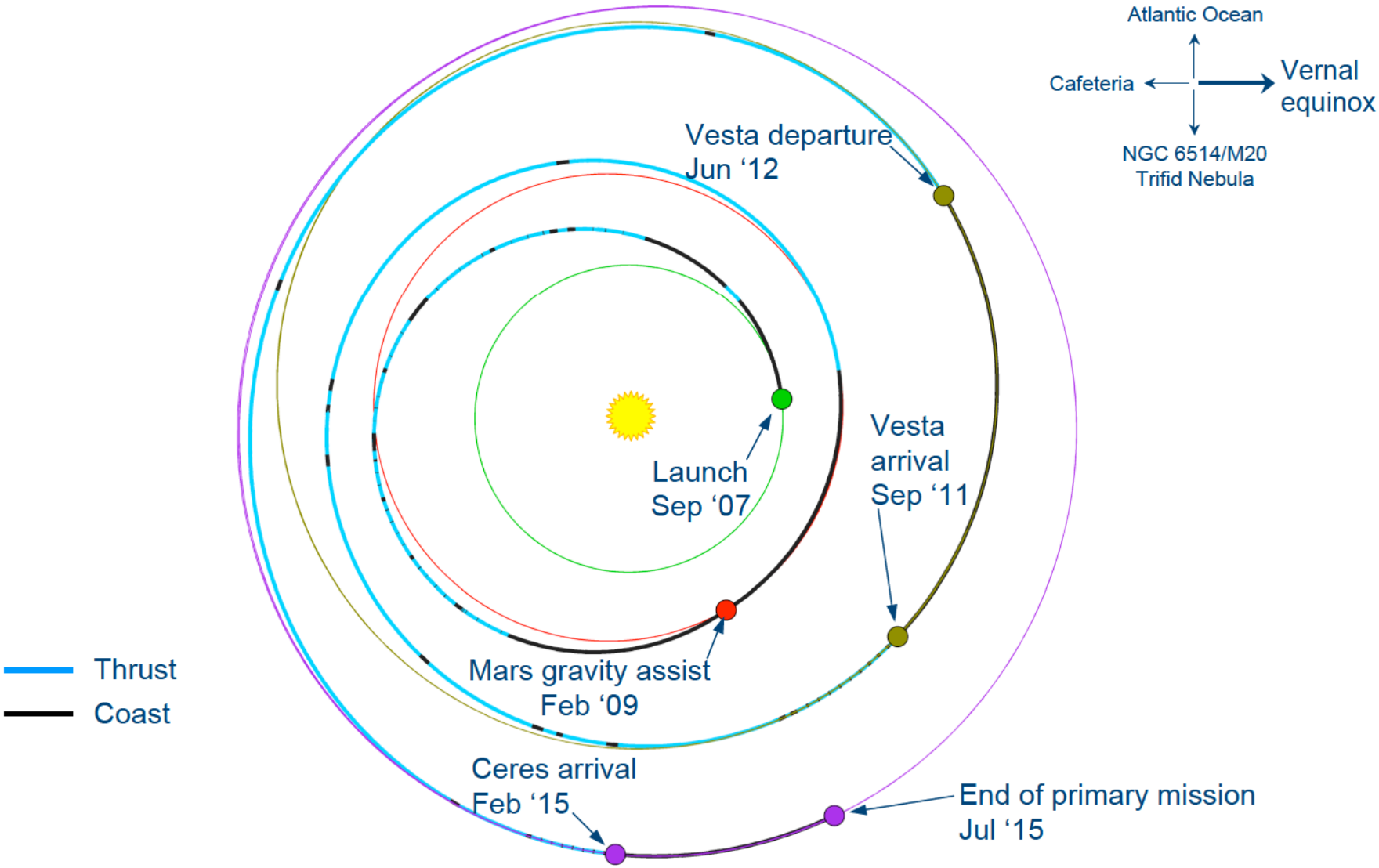
- A high energy version of the Atlas V or Delta IV, instead of the Delta II.
- A bipropellant system with ~ 2500 kg of propellants.
- Loss of heritage structural design.
- A highly constrained launch period and launch window

Use of Ion Propulsion

- Dawn's ion propulsion system is inherited directly from the design used on Deep Space 1.
  - Dawn has 3 thrusters + 2 sets of control and power processor electronics.
- Dawn $\Delta v \approx 11$ km/s $\approx$ Delta 7925H Δv
- Dawn will thrust for ~ 50,000 hours (~ 5.7 years).
- Experience to date:
  - 6100 hours of thrusting
    - 84% of time since end of 80-day post-launch flight system checkout
    - 69% of time since launch
    - $5 \cdot 10^{-9}$% of time since Big Bang
  - $\Delta v = 1.7$ km/s



Interplanetary Trajectory



Near-Term Events

- Beginning of optimal coast period in early November
  - Trajectory correction maneuver opportunities on approach to Mars
- Solar conjunction in December
  - Sun-Earth-probe angle < 3° for 19 days
- Closest approach to Mars on ~ 18 February
  - Exact date and time depend upon progress of thrusting
  - Encounter time could be controlled but we optimize it for Vesta
- Presentation of IAC-08-A3.5.3 in ~ 2 minutes
- Lunch at ~ 12:30
- Return to Los Angeles
  - Note to self: Buy cat food on the way home from the airport.