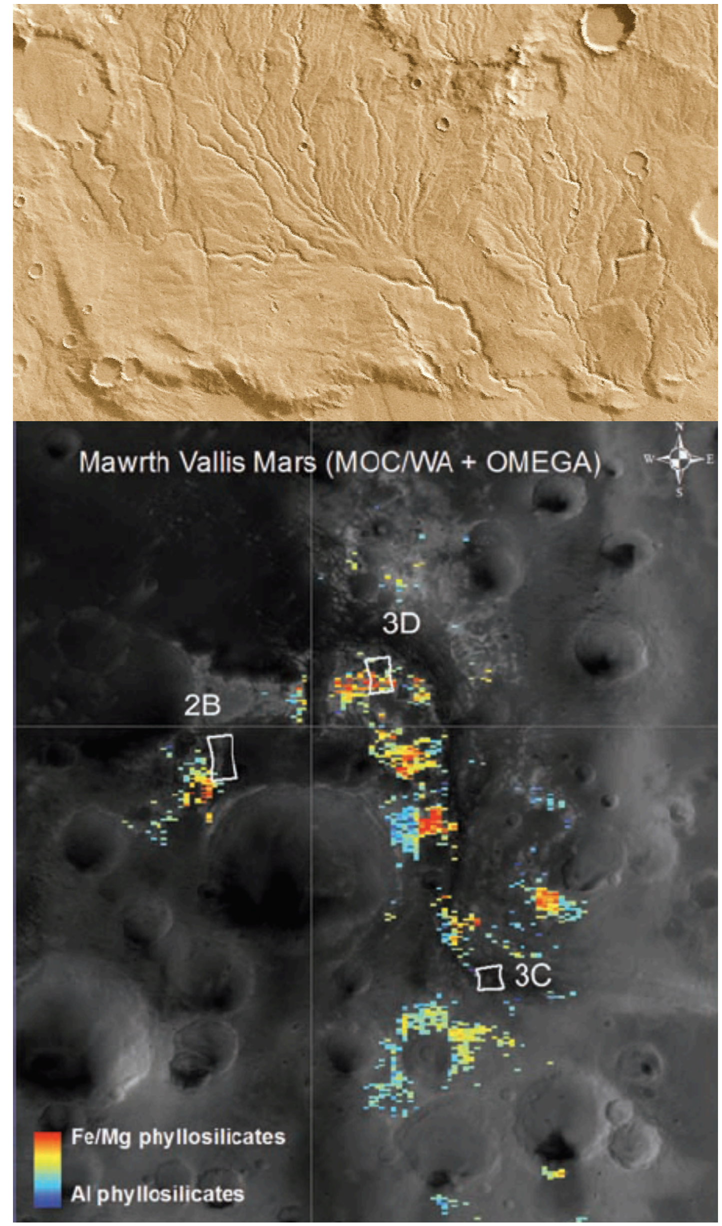
MAVEN

MAVEN Overview

Bruce Jakosky
University of Colorado
MAVEN Principal Investigator

Why Do We Think That The Martian Climate Has Changed Over Time?

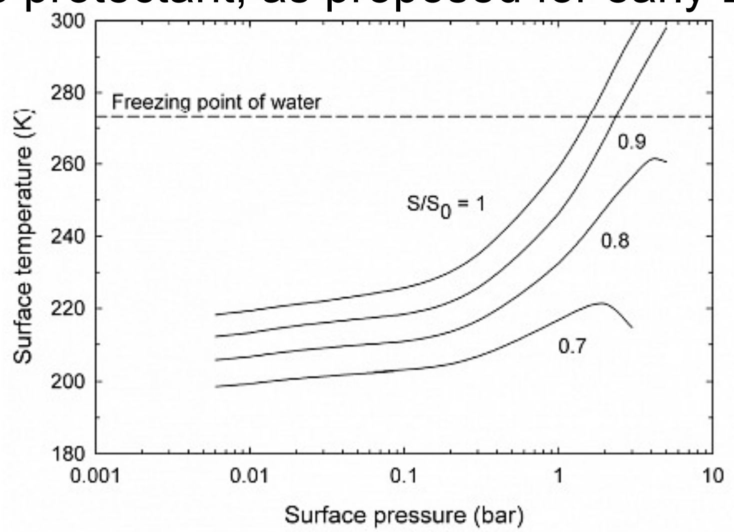
- Geological and morphological evidence
  - Valley networks, ancient crater degradation
  - MER evidence for standing surface water
  - Widespread evidence for crater lakes
  - Aqueous mineral deposits in ancient terrain
- Isotopic evidence
  - $^{15}N/^{14}N$, $^{38}Ar/^{36}Ar$, D/H all are enhanced in the atmosphere
  - Requires loss of 50-90 % of atmospheric gas
- *Not requiring climate change*
  - *Outflow channels*
  - *Gullies*



Bishop et al., 2008

What Could Have Sustained An Early Warmer And Wetter Environment?

- Greenhouse warming required to raise temperature from current ambient surface temperature average of ~220K.
  - Degree of greenhouse warming required unclear.
- Problem exacerbated by faint young Sun problem
  - Sun ~30% dimmer in total output 4 b.y. ago.
- Possible greenhouse agents
  - CO_2 and H_2O?
  - CH_4, NH_3?
  - Organic haze protectant, as proposed for early Earth?



Kasting, 1991

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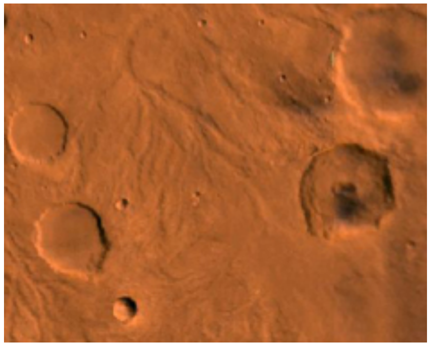
What Will MAVEN Do? (1 of 2)

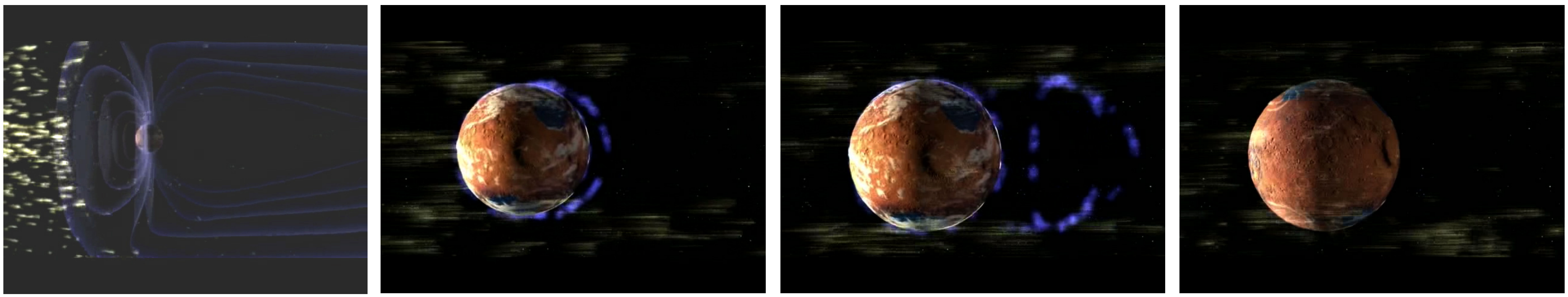


Ancient Valleys

Mars' atmosphere is cold and dry today, but there was once liquid water flowing over the surface.

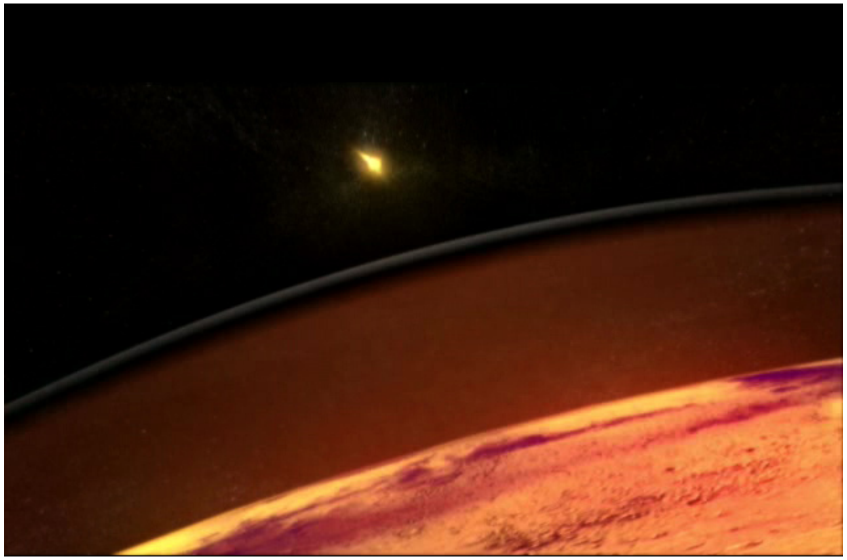
Where did the water and early atmosphere go?

- *H_2O and CO_2 can go into the crust or be lost to space.*
- *MAVEN will focus on volatile loss to space.*



Turn-off of the Martian magnetic field allowed turn-on of solar-wind stripping of the atmosphere ~ 3.7 billion years ago; combined with solar-EUV-driven loss, resulted in the present thin, cold atmosphere.

What Will MAVEN Do? (2 of 2)



- Determine the structure and composition of the Martian upper atmosphere today
- Determine rates of loss of gas to space today
- Measure properties and processes that will allow us to determine the integrated loss to space through time

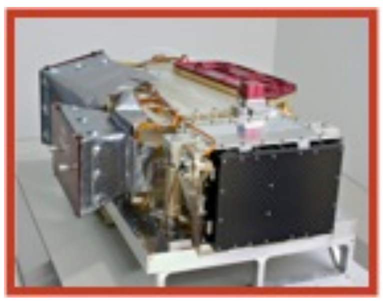
MAVEN will answer questions about the history of Martian volatiles and atmosphere and help us to understand the nature of planetary habitability.

The MAVEN Science Instruments

Mass Spectrometry Instrument

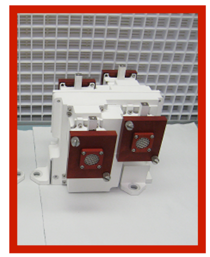
Neutral Gas and Ion Mass Spectrometer; Paul Mahaffy, GSFC

Remote-Sensing Package



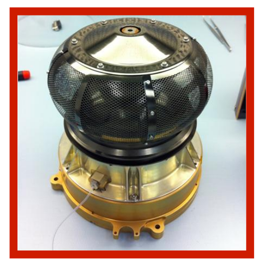
Imaging Ultraviolet Spectrometer; Nick Schneider, LASP

Particles and Fields Package



Solar Energetic Particles; Davin Larson, SSL

SupraThermal and Thermal Ion Composition; Jim McFadden, SSL



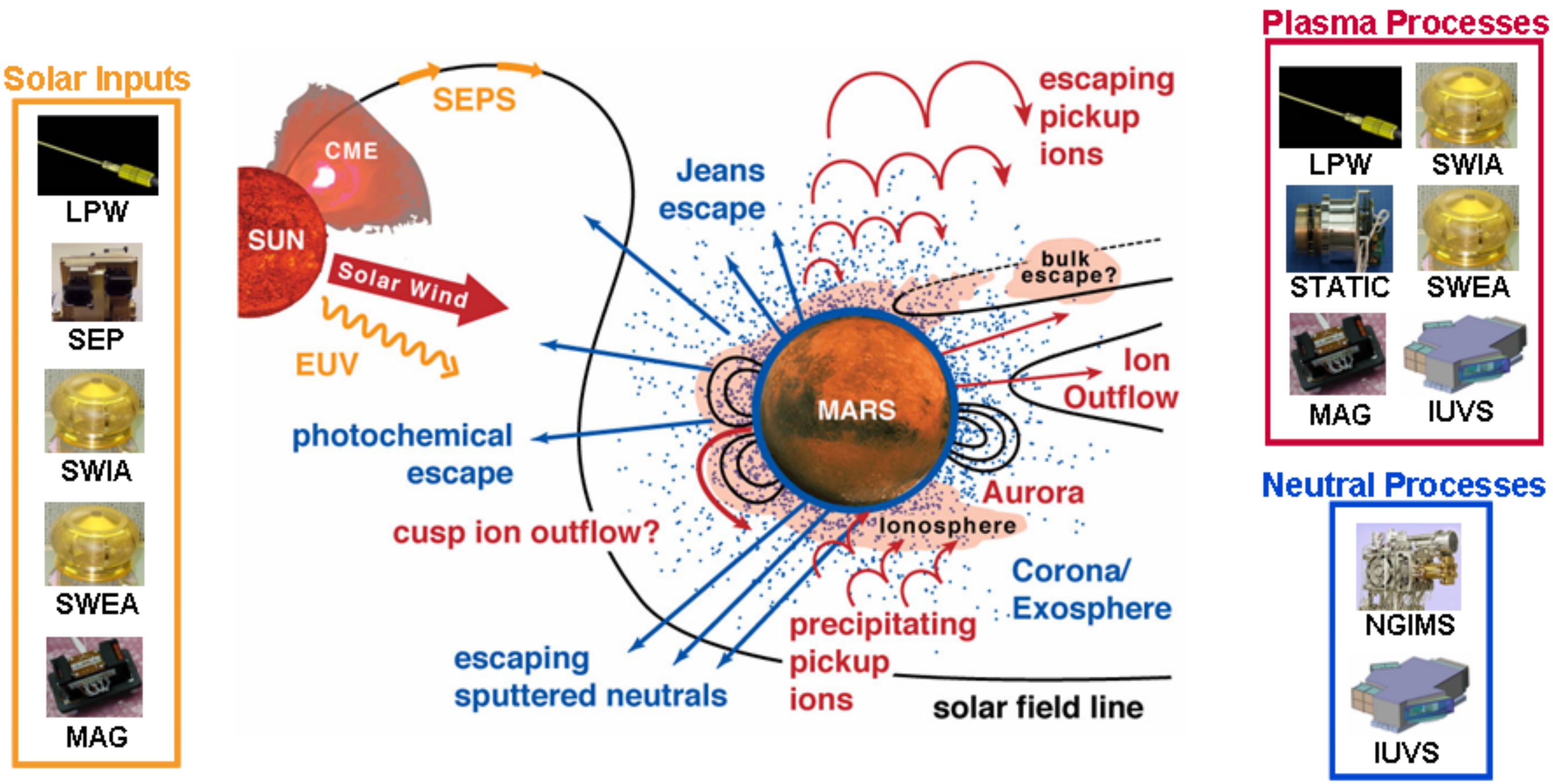
Solar Wind Electron Analyzer; David Mitchell, SSL

Solar Wind Ion Analyzer; Jasper Halekas, SSL

Langmuir Probe and Waves; Bob Ergun, LASP

Magnetometer; Jack Connerney, GSFC

MAVEN Will Measure the Drivers, Reservoirs, and Escape Rates

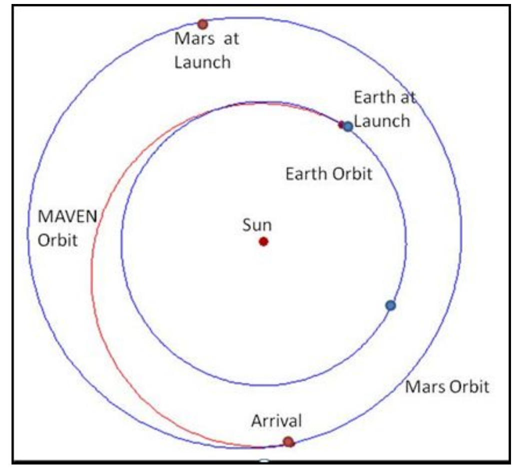


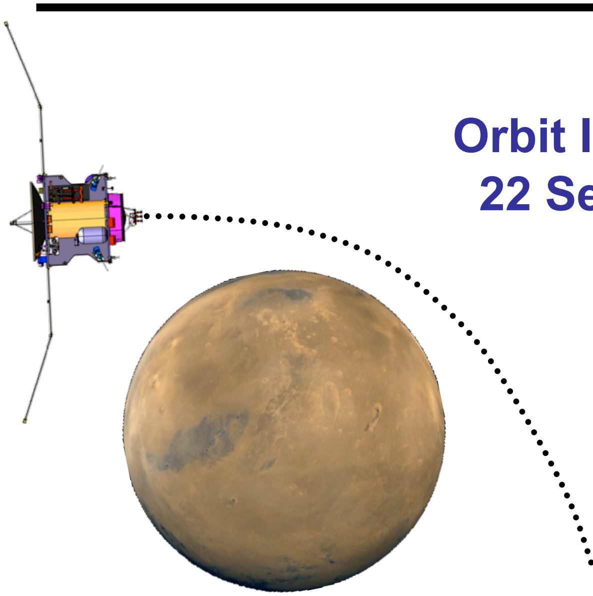
- MAVEN will determine the present state of the upper atmosphere and today's rates of loss to space.
- Measurements will allow determination of the net integrated loss to space through time.

MAVEN Mission Architecture

**20-Day Launch Period:
November 18 –
December 7, 2013**

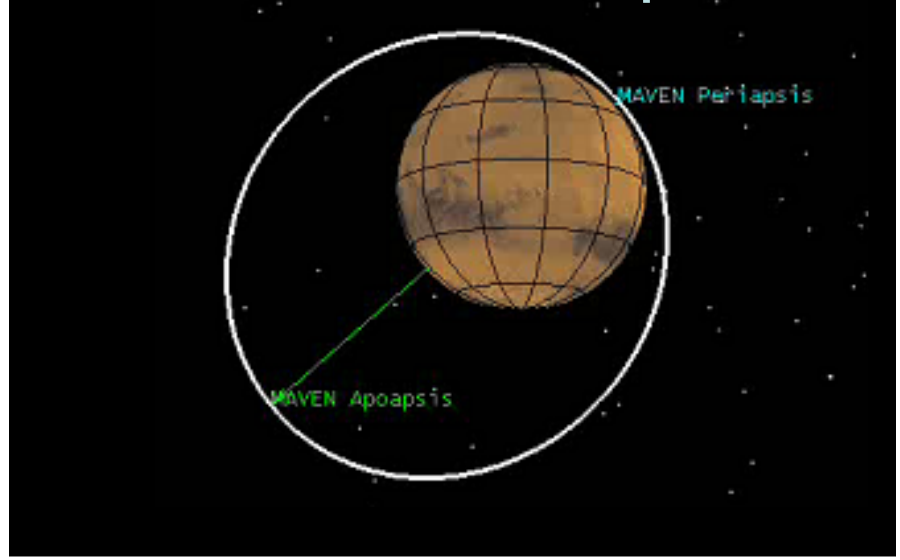
Ten Month Ballistic Cruise to Mars





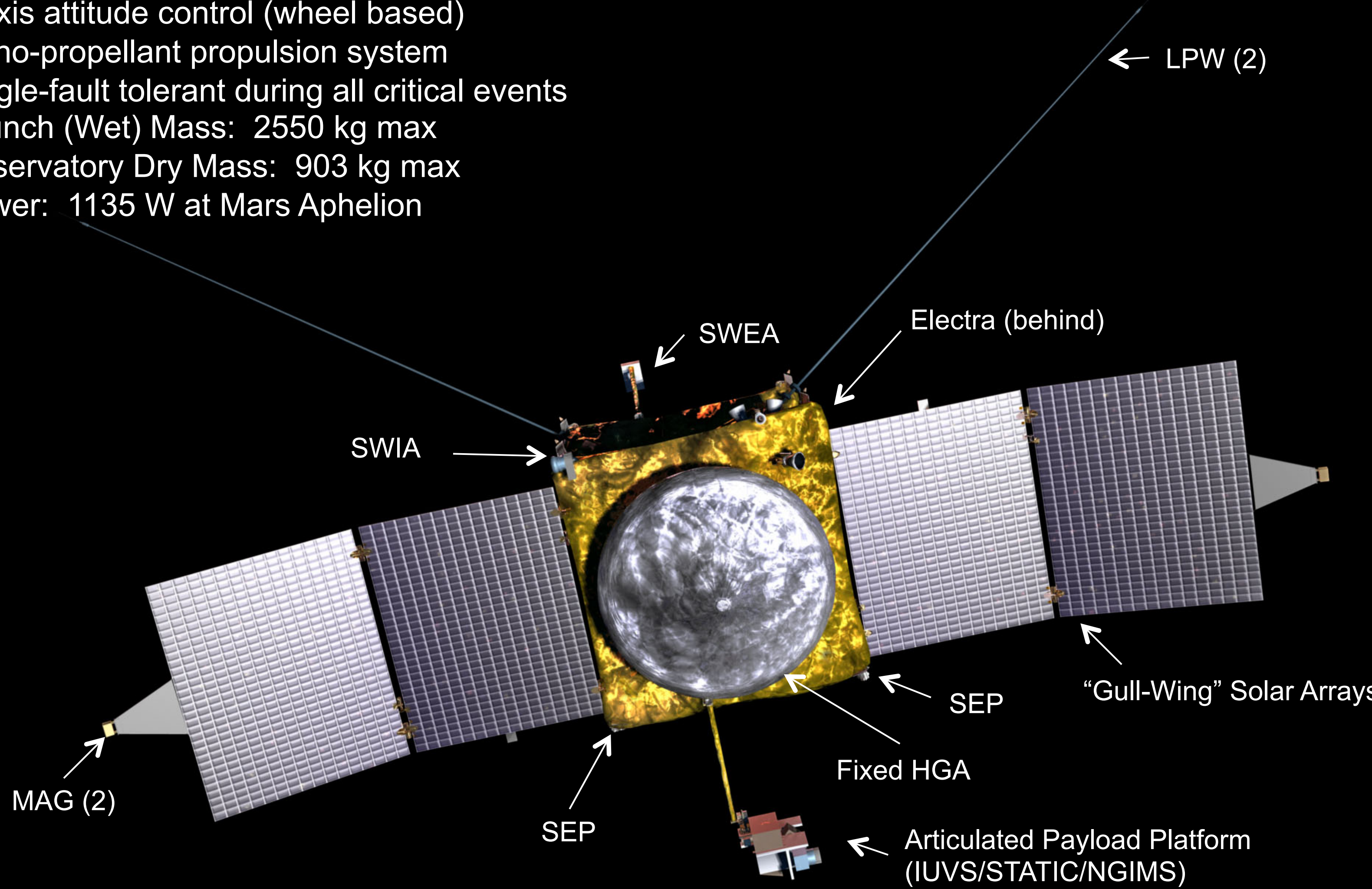
**Orbit Insertion:
22 Sept 2014**

One Year of Science Operations

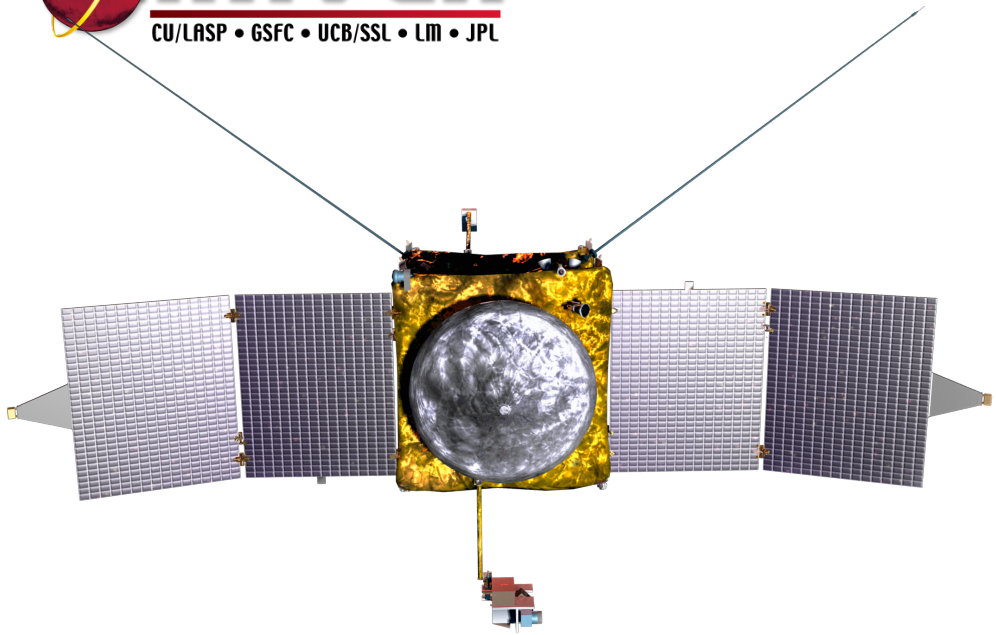


The MAVEN Spacecraft

- 3-axis attitude control (wheel based)
- Mono-propellant propulsion system
- Single-fault tolerant during all critical events
- Launch (Wet) Mass: 2550 kg max
- Observatory Dry Mass: 903 kg max
- Power: 1135 W at Mars Aphelion



The MAVEN Spacecraft

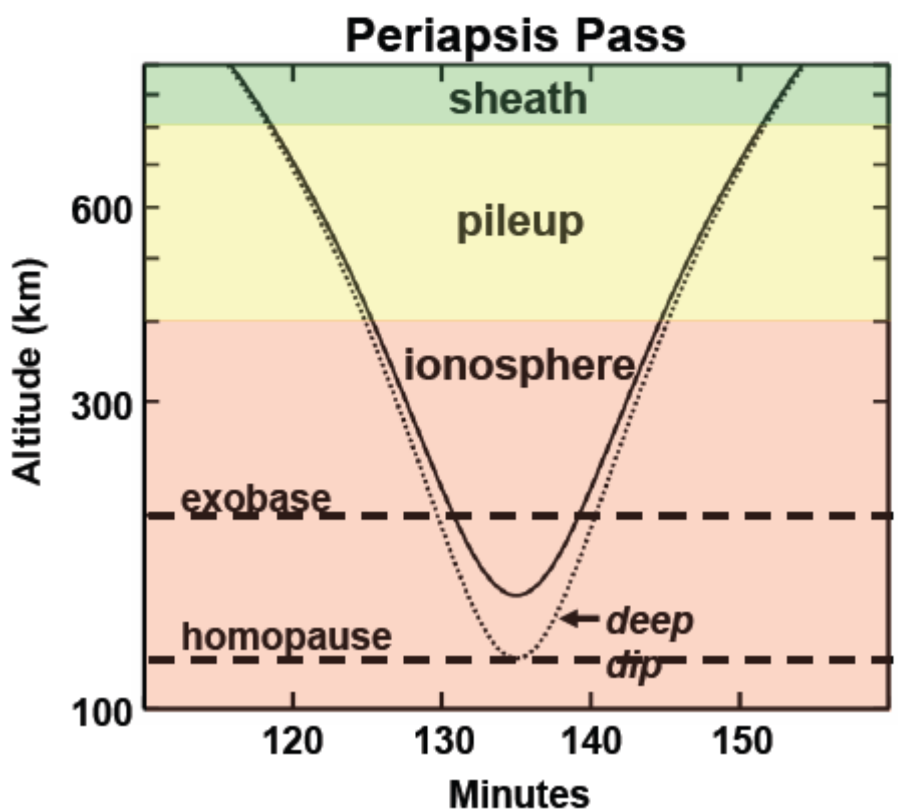


Same weight fully loaded as a GMC Yukon – 2550 kg.

Same length as a school bus – wingtip-to-wingtip length of 37ft.

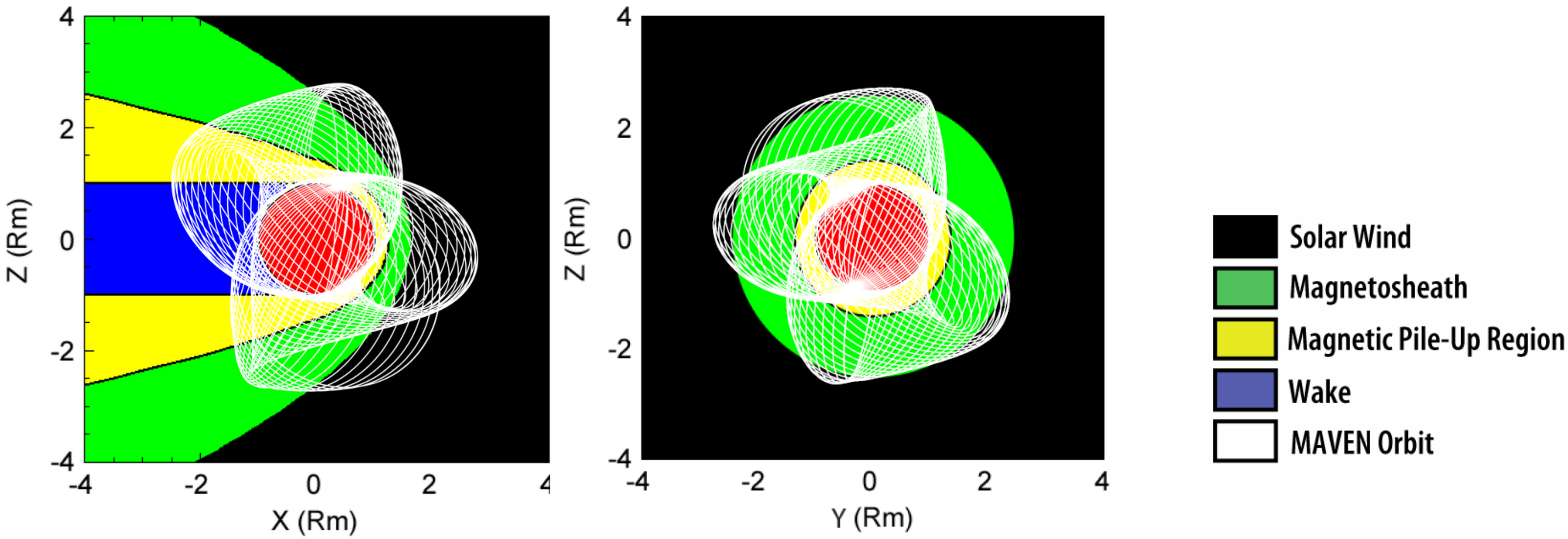
Elliptical Orbit Allows Measurement of All Relevant Regions of Upper Atmosphere

- Nominal periapsis near 150 km.
- Five "deep-dip" campaigns with periapsis near 125 km.



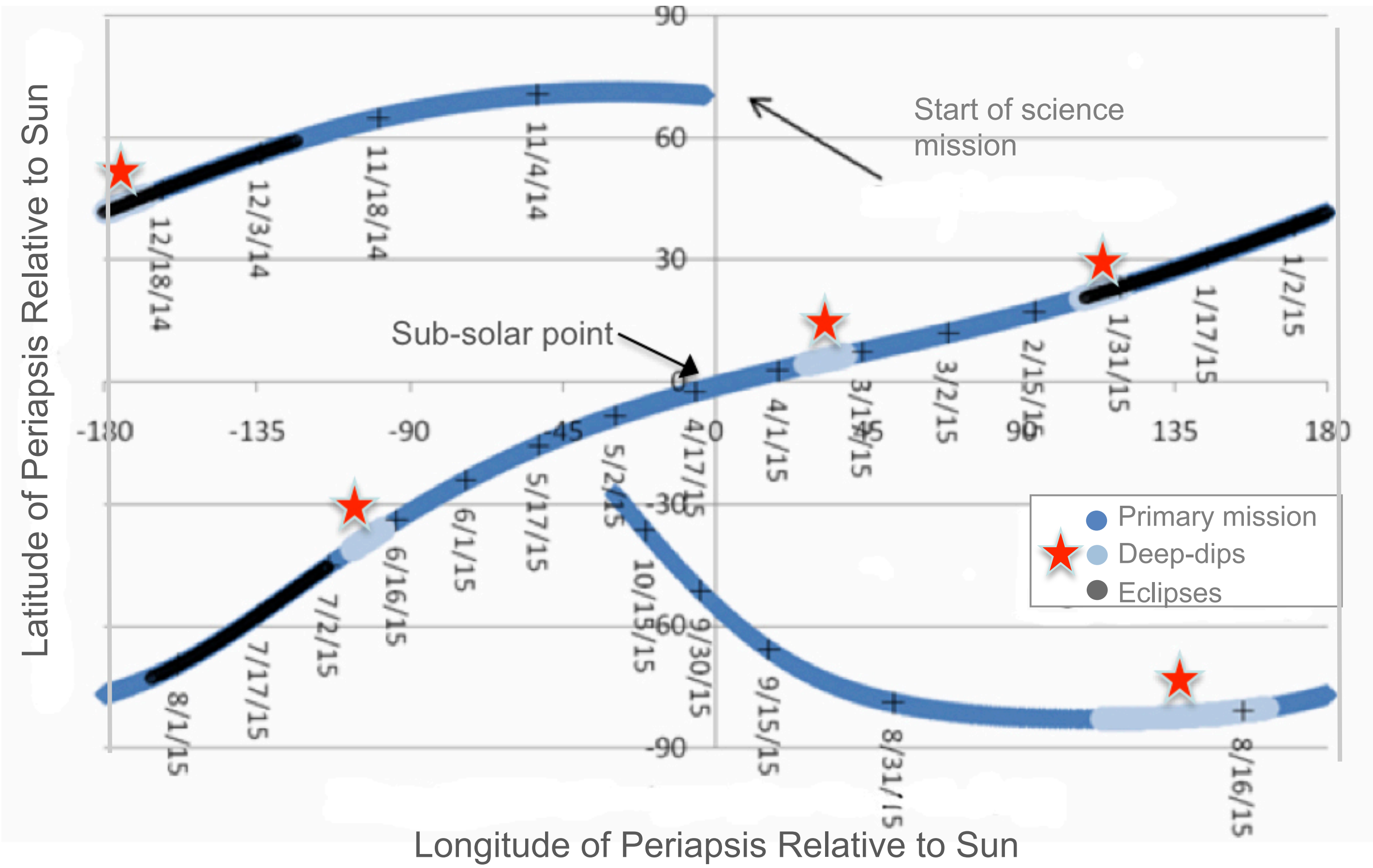
MAVEN Orbit and Primary Mission

- Elliptical orbit to provide coverage of all altitudes
- The orbit precesses in both latitude and local solar time
- One-Earth-year mission allows thorough coverage of near-Mars space

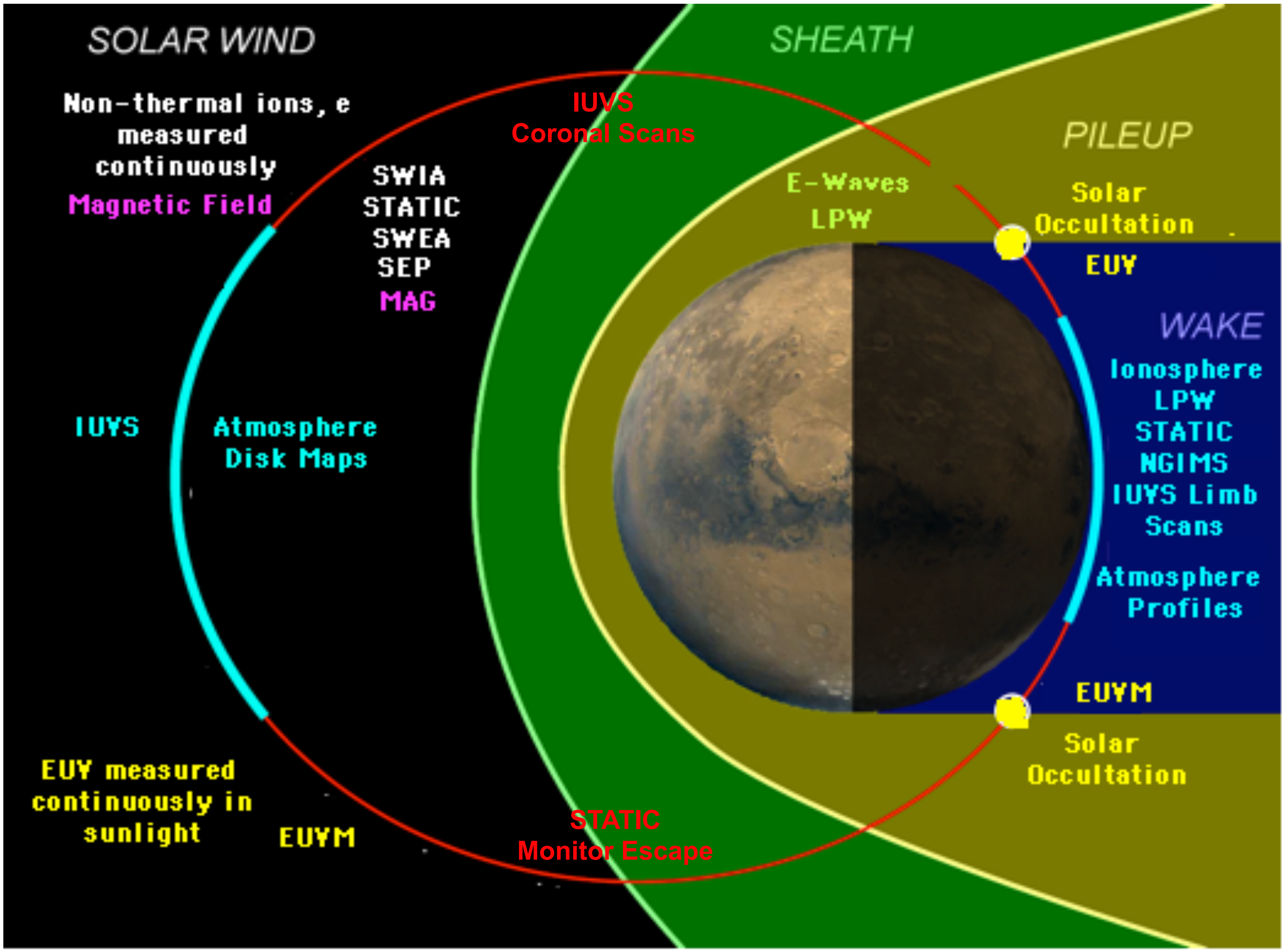


Latitude and Local Time Coverage

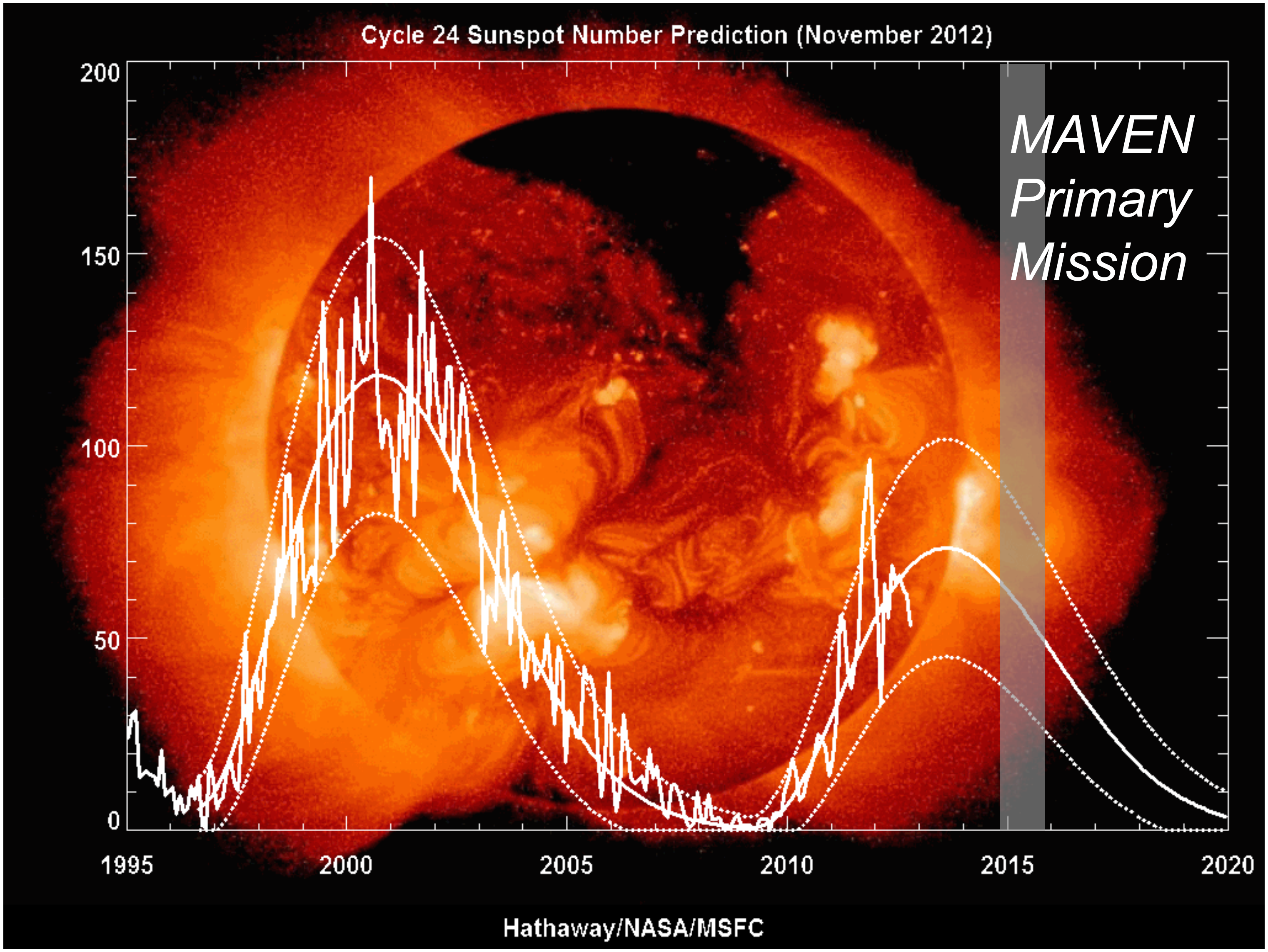
- One-Earth-year mission provides coverage of all local solar times and most latitudes.
- Figure shows periapsis location for each orbit.
- Deep dips near subsolar region, midnight, terminator, crustal B region, polar cap



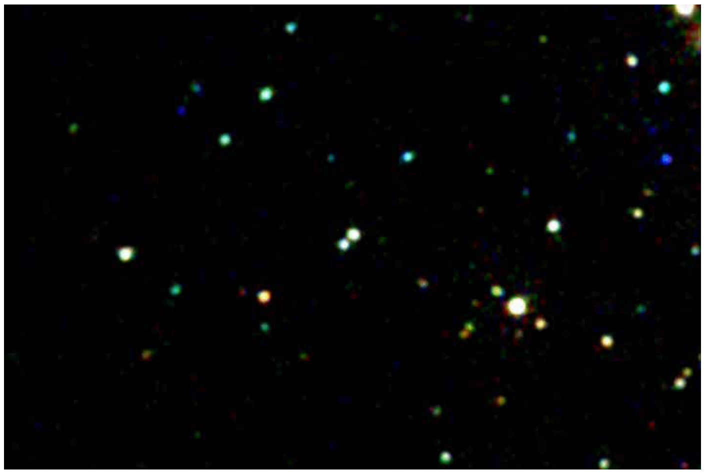
Measurements Throughout The Orbit



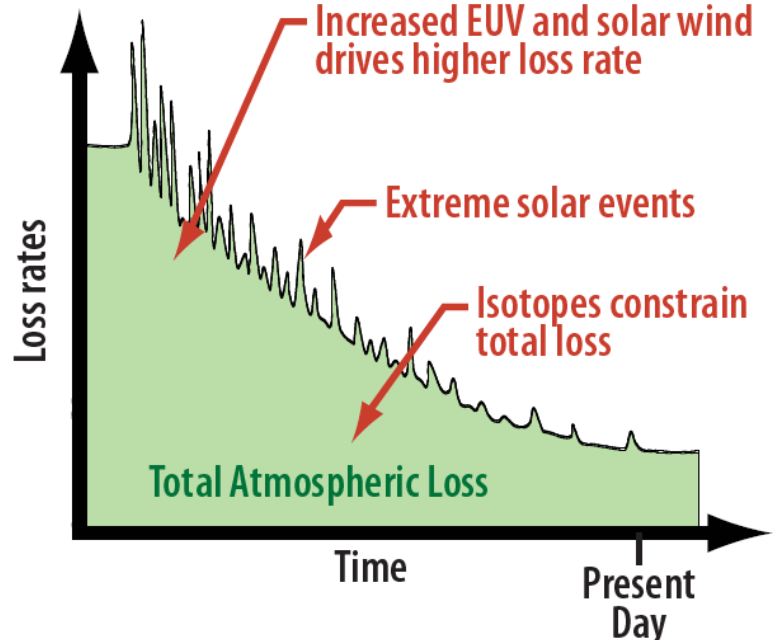
MAVEN's Timing in the Solar Cycle



Constraining the Total Atmospheric Loss Through Time



History of Solar Activity



Solar wind pickup

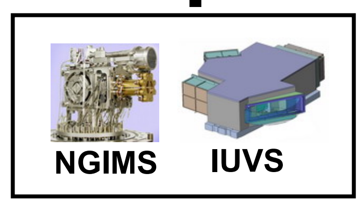
Ion outflow

Sputtering

Photochemical and Jeans escape

Ion bulk escape

Physical & Empirical Models



Isotope Ratios

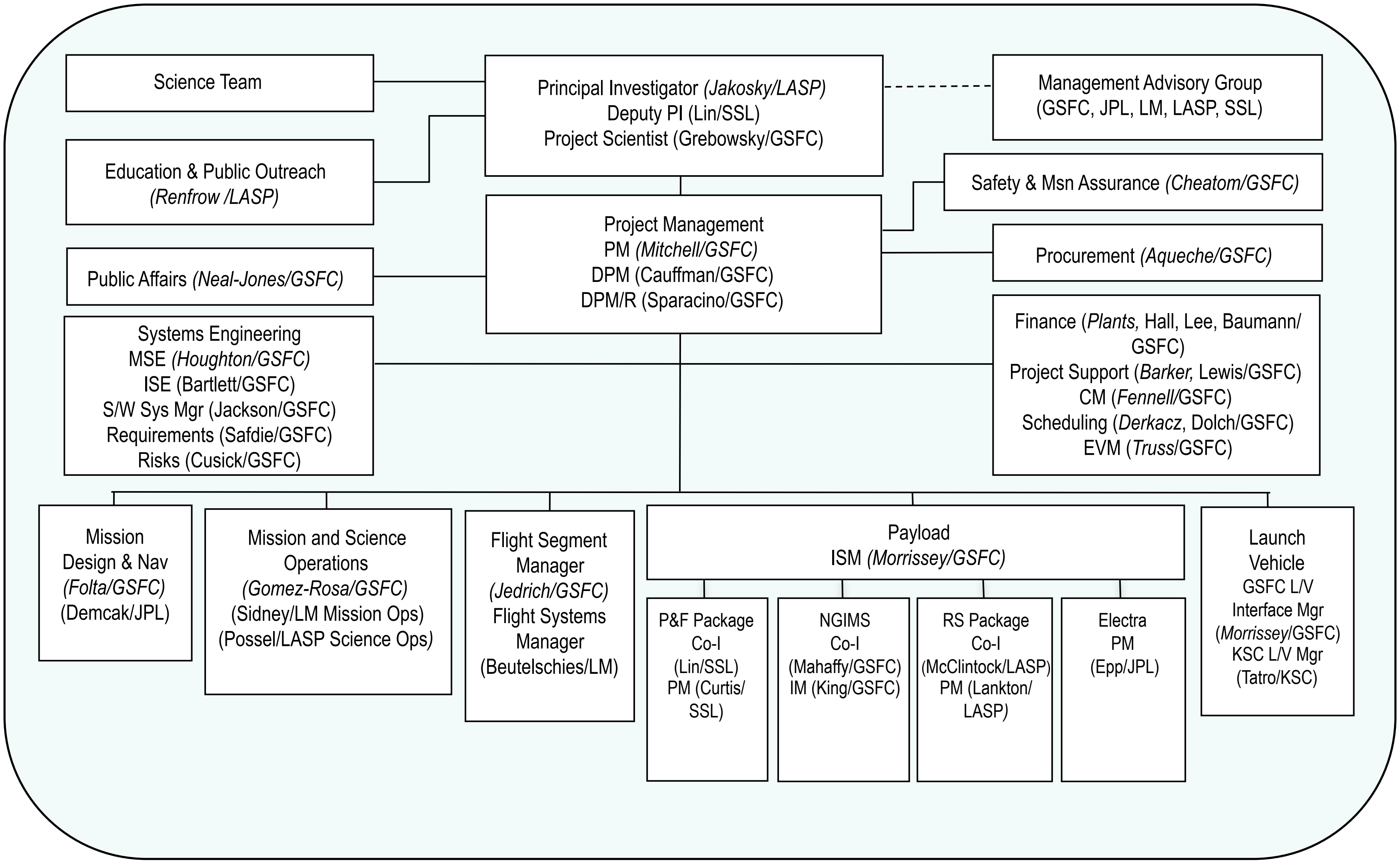
MAVEN Relay Capability

- MAVEN carries an Electra comm. relay package, as required in the original Mars Scout AO
  - MAVEN is backup to MRO and ODY
  - Full end-to-end relay demo will be carried out during transition phase
- MPO and HQ wish to minimize impingement on MAVEN primary mission, while maximizing total Mars science return
  - MAVEN could get called on to carry out relay during primary mission
  - Carrying out relay ops impacts MAVEN science
- Post-primary-mission relay activity will depend on MAVEN health, health and science from other assets, etc.
  - MAVEN actually is a pretty good relay orbiter despite its elliptical orbit
  - There is room for both relay and science in extended mission
  - No firm plans are in place yet for how MAVEN will be utilized as a relay or how science and relay activities will be integrated together

MAVEN Extended Mission Capability

- MAVEN can continue to do valuable science in an extended mission.
- MAVEN also serves relay function as backup to MRO and ODY
- Lifetime limited by fuel usage for corridor control and wheel desats
- Current fuel allocation provides enough fuel for:
  - Cruise TCMs
  - MOI, including mid-burn interrupt and restart
  - Transition phase
  - Full primary mission, including five deep-dip campaigns
  - Extended science mission, currently ~29 months (if no MOI interrupt)
  - Raise periapsis for longer lifetime (not a rqmnt. for planetary protection)
  - Six years additional operations
- Can trade extended-mission science duration for additional deep-dip campaigns during extended mission
- Valuable MAVEN science can be done for full nine years of possible extended mission

MAVEN Project Organization



NOTE: Leads are shown in Italics

As of July 3, 2012

The MAVEN Science Team

Overall science leads:
- Bruce Jakosky (PI)
- Bob Lin (DPI)
- Joe Grebowsky (PS)
- Janet Luhmann

NGIMS:
- Paul Mahaffy
- Mehdi Benna
- Wayne Kasprzak

IUVS:
- Nick Schneider
- Bill McClintock
- Erik Richard
- Ian Stewart
- John Clarke
- Franck Montmessin
- Greg Holsclaw

SWIA:
- Jasper Halekas
- Davin Larson

SWEA:
- David L. Mitchell
- Christian Mazelle
- Jean-Andre Savaud
- Dominique Toublanc

STATIC:
- Jim McFadden
- David Brain
- Bill Peterson
- Francois Leblanc

LPW:
- Bob Ergun
- Greg Delory
- Laila Andersson
- Anders Eriksson

LPW-EUV:
- Frank Eparvier
- Tom Woods
- Phil Chamberlin

SEP:
- Davin Larson
- Jasper Halekas
- Rob Lillis

MAG:
- Jack Connerney
- Jared Espley

AAG:
- Richard Zurek
- Bob Tolson
- Darren Baird

IDS:
- Tom Cravens
- Xiaohua Fang
- Jane Fox
- Roger Yelle
- Andy Nagy
- Dan Baker
- Steve Bougher

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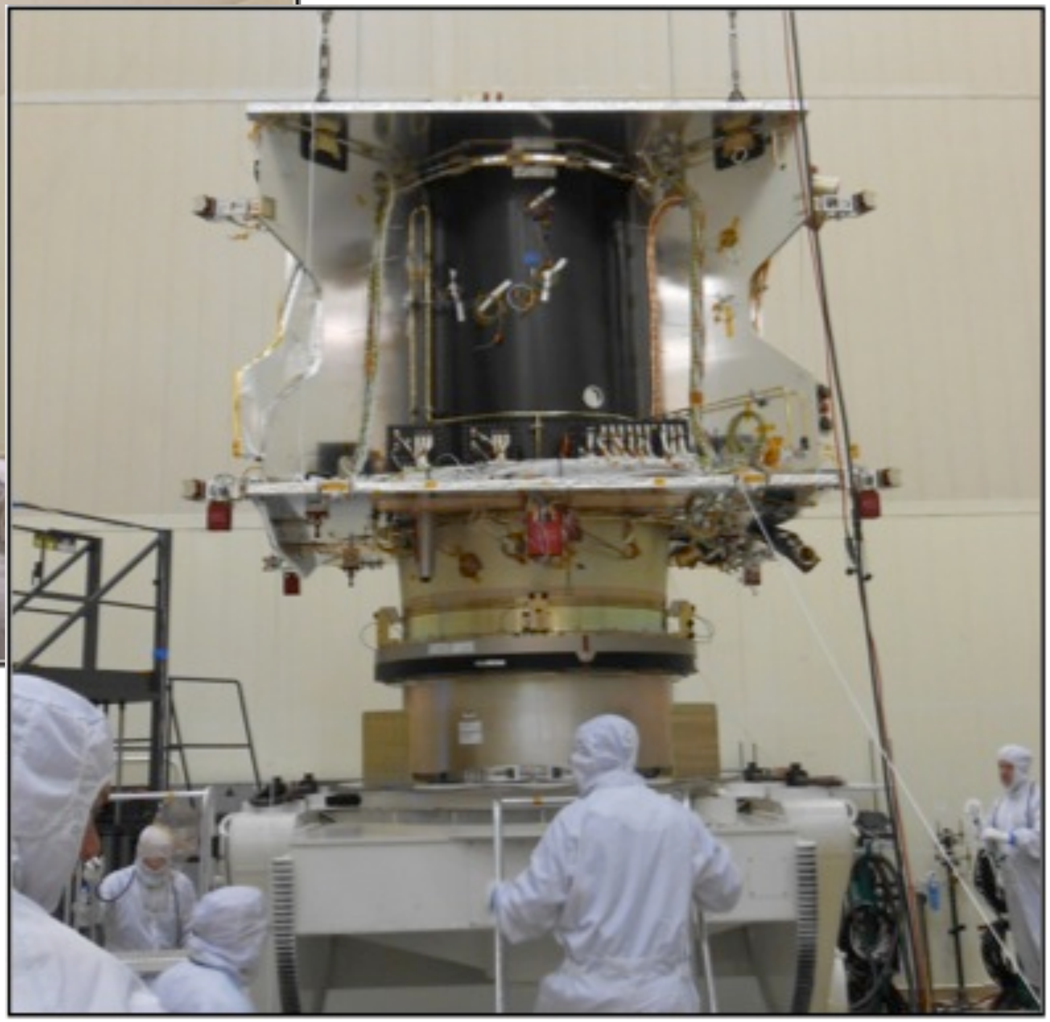
MAVEN Team At Systems Integration Review (June, 2012)

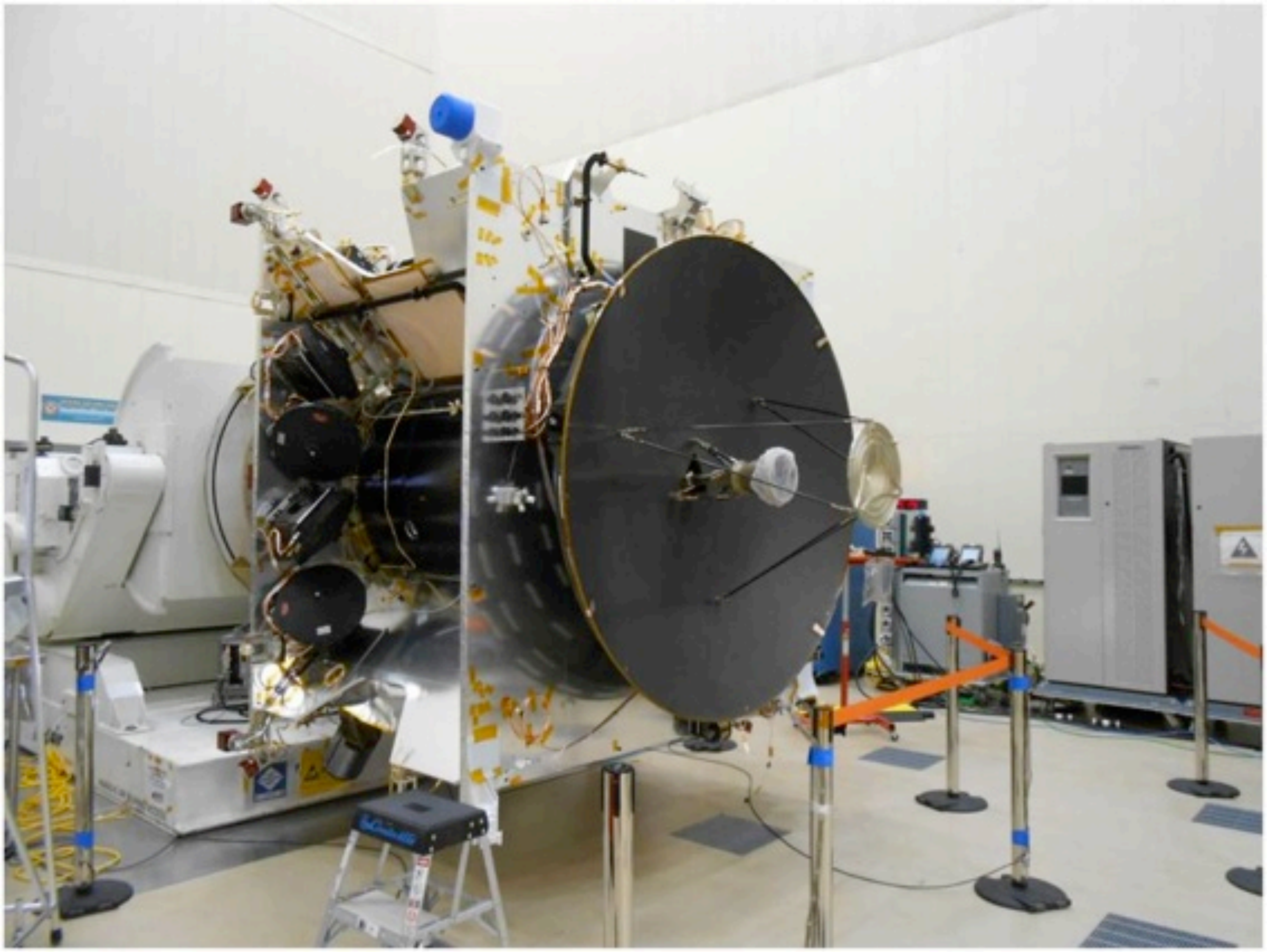
MAVEN Spacecraft In ATLO

Integration of core structure with fuel tank



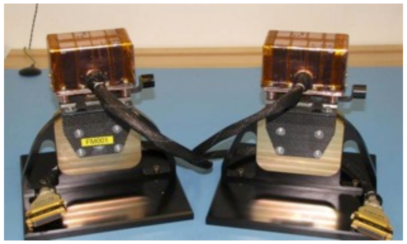
Lift onto rotation fixture, for easier access

MAVEN Spacecraft With HGA Attached

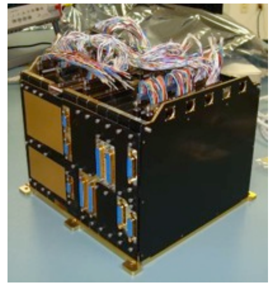


Payload Hardware

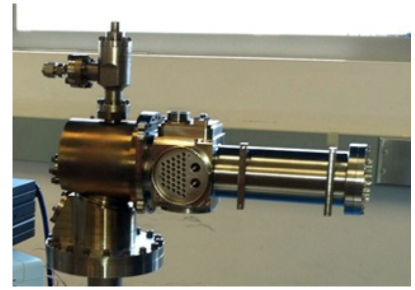
Magnetometer Sensors Flight Models (FM)

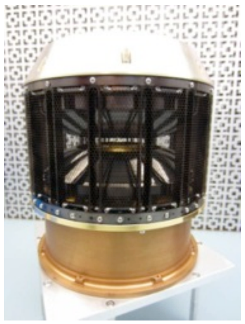


PFDPU Flight Model (FM)



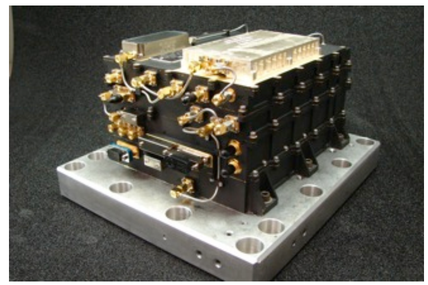
Neutral Gas and Ion Mass Spectrometer (NGIMS) QMS Sensor (FM)



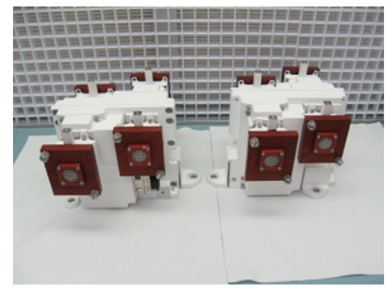


SupraThermal and Thermal Ion Composition (STATIC) Flight Model (FM)

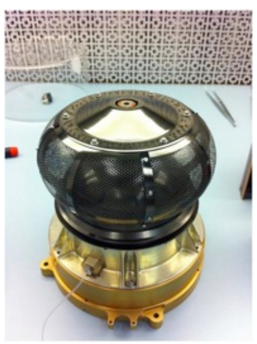
Langmuir Probe and Waves (LPW) Booms Flight Model (FM)



Electra UHF Transceiver Flight Model (FM)

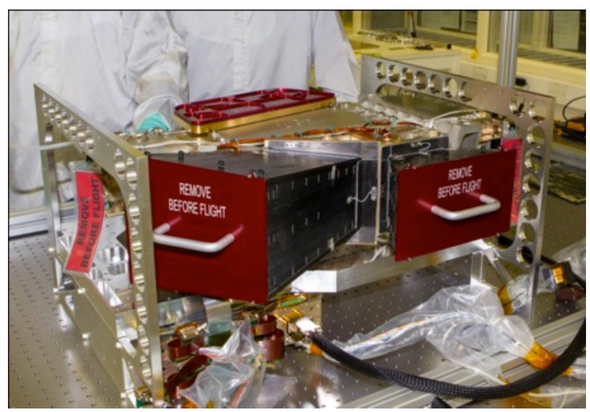


Solar Energetic Particle (SEP) Flight Models (FM)



Solar Wind Electron Analyzer (SWEA) Flight Model Analyzer and Pedestal

Solar Wind Ion Analyzer (SWIA) Flight Model (FM)



Remote Sensing IUVS and RSDPU Flight Models (FM)

Extreme UltraViolet (EUV) Flight Model (FM)

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Mission and Science Operations Will Utilize Existing Facilities

Lockheed Martin Mission Support Area

• MAVEN utilizes extensive operational facilities at LM (MOC) and LASP (SOC).

• Both LM and LASP have very experienced operations teams and well-developed procedures.

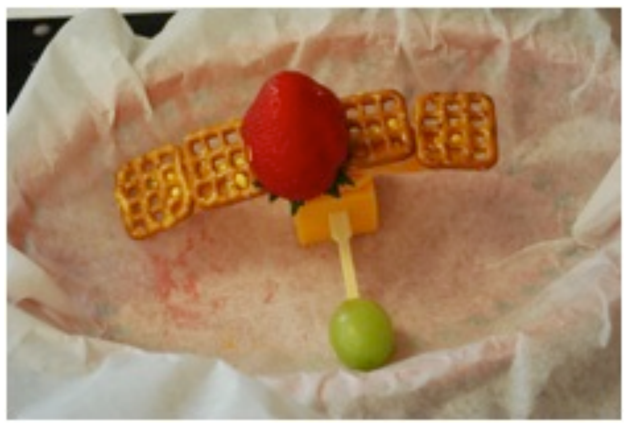
LASP Mission Operations Center

• All operational phases of the MAVEN mission have been carried out at Mars on previous missions by the MAVEN operations team.

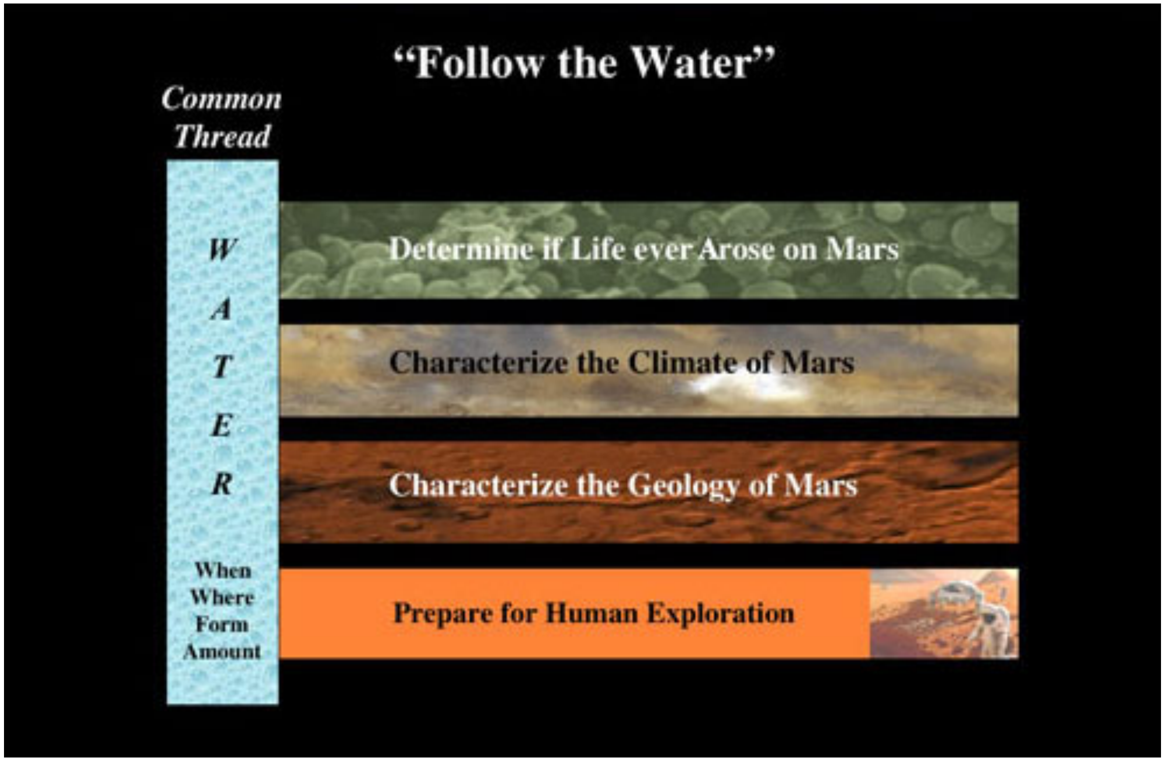
CU/LASP • GSFC • UCB/SSL • LM • JPL

MAVEN Is Committed to a Strong Education and Public Outreach (EPO) Program

- EPO program builds on existing high-quality programs and partnerships to bring MAVEN science to a wide range of audiences with an emphasis on underserved / underrepresented students in after-school programs.
- Uses "social media" to create a multidirectional communication environment that engages the public.
- Includes a "non-traditional-journalist" workshop to inform the general public.

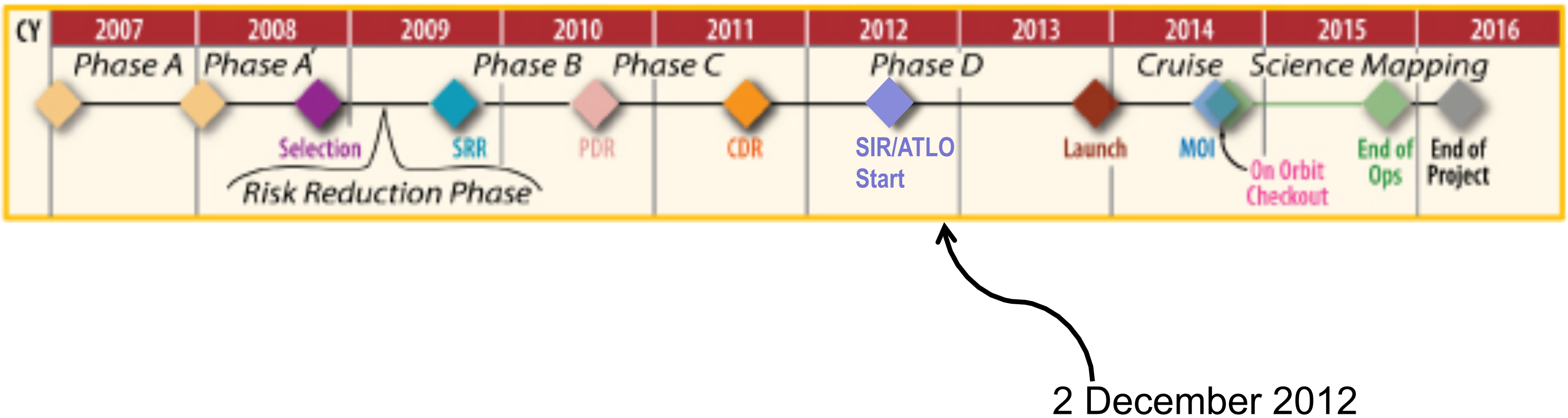


MAVEN Will Continue The Successful "Follow The Water" Theme.



MGS, MPF, ODY, MER, MRO, MEx, PHX, MSL, have been focused largely on the history as determined at the surface. MAVEN's comprehensive approach will provide the history from the top of the atmosphere as the necessary other half of the story.

MAVEN History And Schedule



- MAVEN concept developed starting in Fall 2003
- Proposal submitted for Mars Scout program in 2006
- Selected for competitive Phase A, early 2007
- Selected for development for flight, Sept. 2008
- Preliminary Design Review, July 2010
- MAVEN Confirmed, October 2010
- Critical Design Review, July 2011
- System Integration Review, June 2012
- As of today, launch is 11 mos, 16 days (351 days) away!

MAVEN is on track, on schedule, and on budget.

Follow us at:

MAVEN web sites:	*http://nasa.gov/MAVEN*
	http://lasp.colorado.edu/maven
On Facebook and Twitter:	*"MAVEN2MARS"*