June 29, 2010

Cassini-Huygens Mission to Saturn 6th Anniversary

Mission Overview

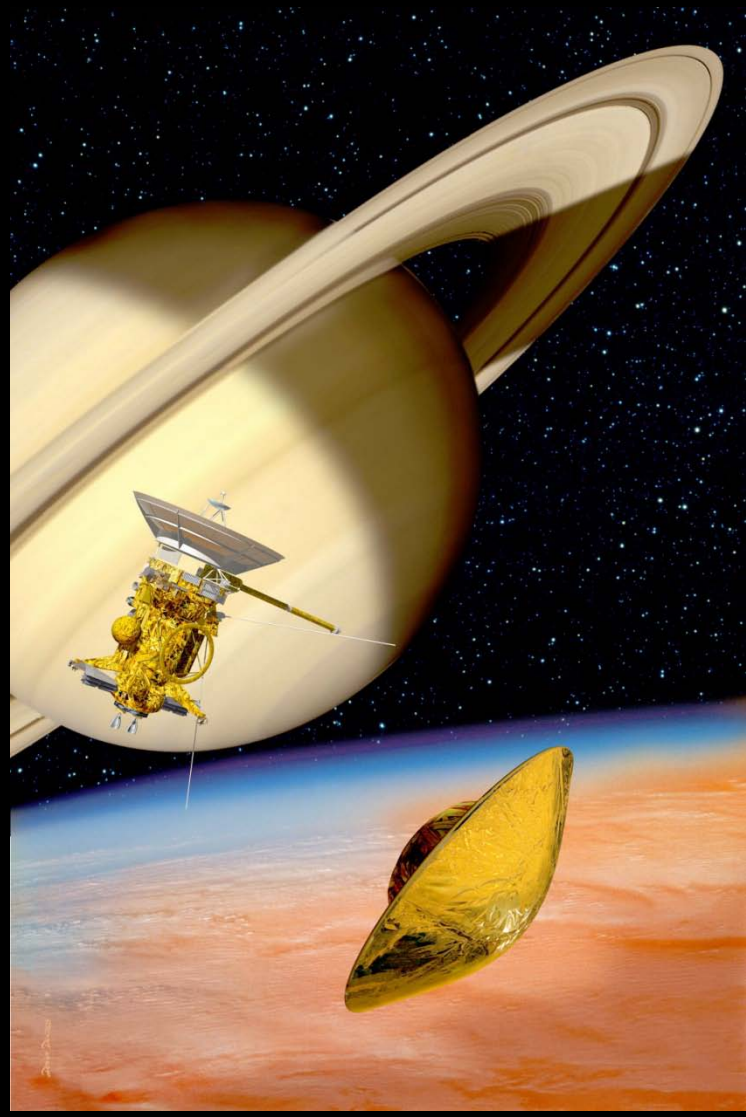
Huygens and Cassini
The Scientists and the Machines


Christiaan Huygens

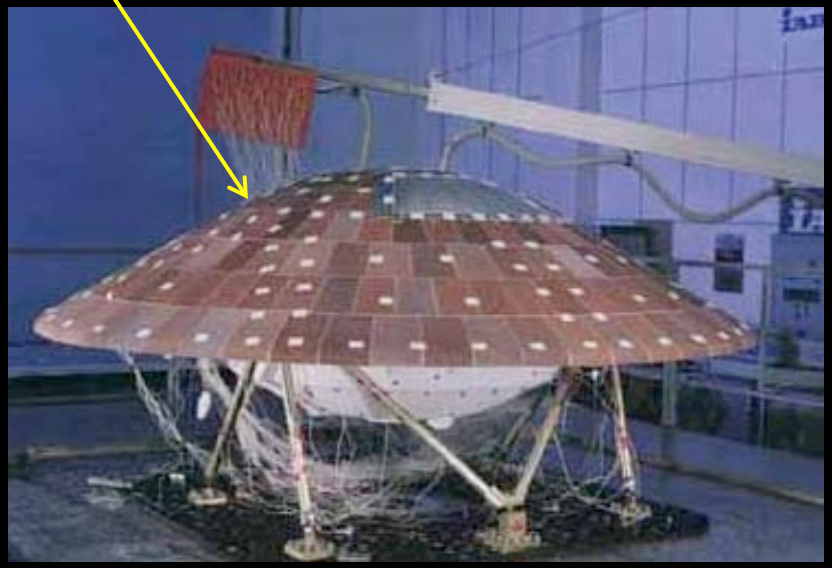

Giovanni Domenico Cassini

Christiaan Huygens (1629-1695) Dutch scientist, who discovered the true nature of Saturn's rings, and in 1655, Titan

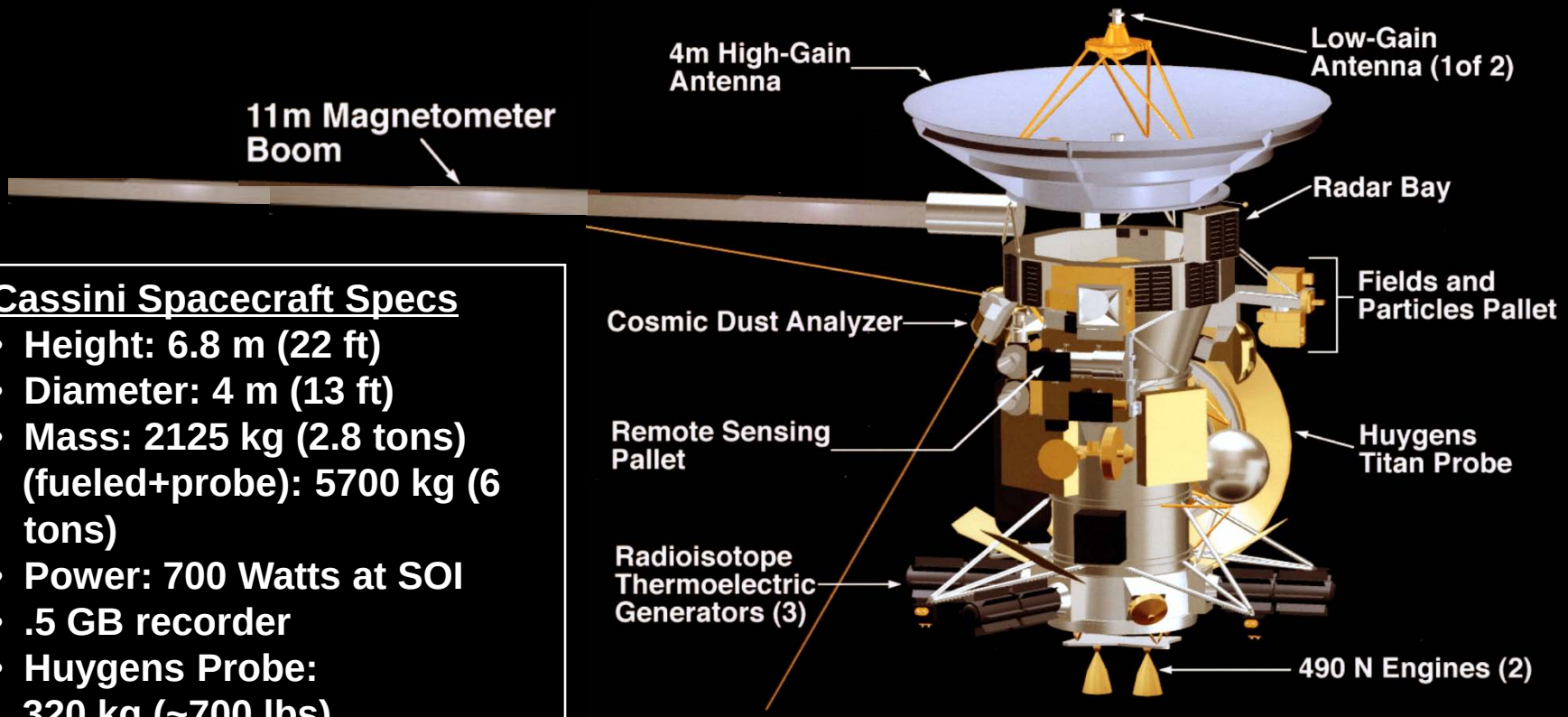
Giovanni Domenico Cassini (1625-1712), Italo-French astronomer, who discovered several of Saturn's satellites: Iapetus, Rhea, Tethys and Dione. In 1675, he discovered what is today called "Cassini Division" the gap in-between the two main rings of Saturn



Cassini Orbiter & Huygens Probe



Cassini Spacecraft



Cassini Spacecraft Specs

- Height: 6.8 m (22 ft)
- Diameter: 4 m (13 ft)
- Mass: 2125 kg (2.8 tons) (fueled+probe): 5700 kg (6 tons)
- Power: 700 Watts at SOI
- .5 GB recorder
- Huygens Probe: 320 kg (~700 lbs)

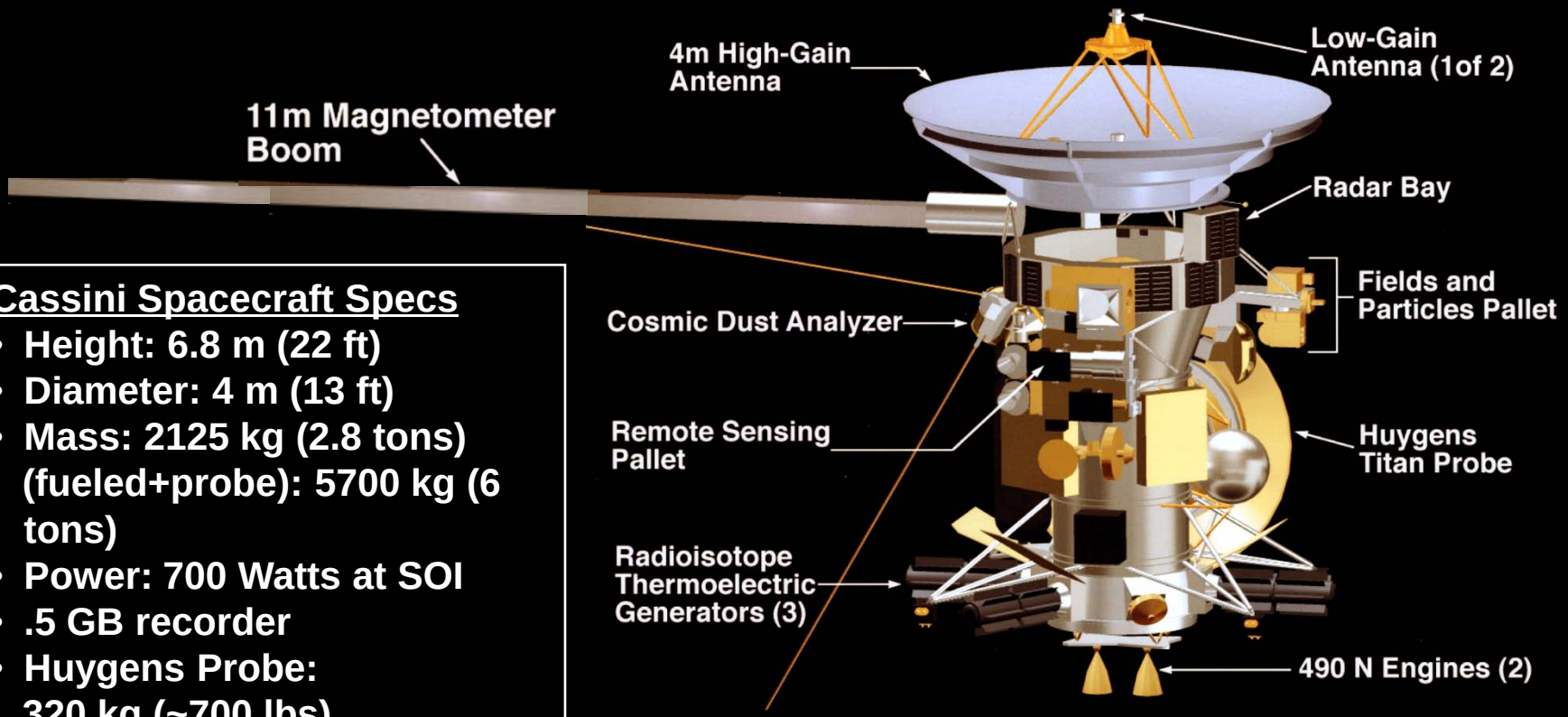
Cassini Instruments:

Optical Remote Sensing (ORS)
CIRS: Composite Infrared Spectrometer
ISS: Imaging Science Subsystem
UVIS: Ultraviolet Imaging Spectrograph
VIMS: Visual and Infrared mapping Spectrometer

Microwave Remote Sensing
RADAR: Cassini Radar
RSS: Radio Science Subsystem

Magnetospherie and Plasma Science (MAPS)
CAPS: Cassini Plasma Spectrometer
CDA: Cosmic Dust Analyzer
INMS: Ion and Neutral Mass Spectrometer
MAG: Dual Technique Magnetometer
MIMI: Magnetospheric Imaging Instrument
RPWS: Radio and Plasma Wave Science

Cassini Spacecraft



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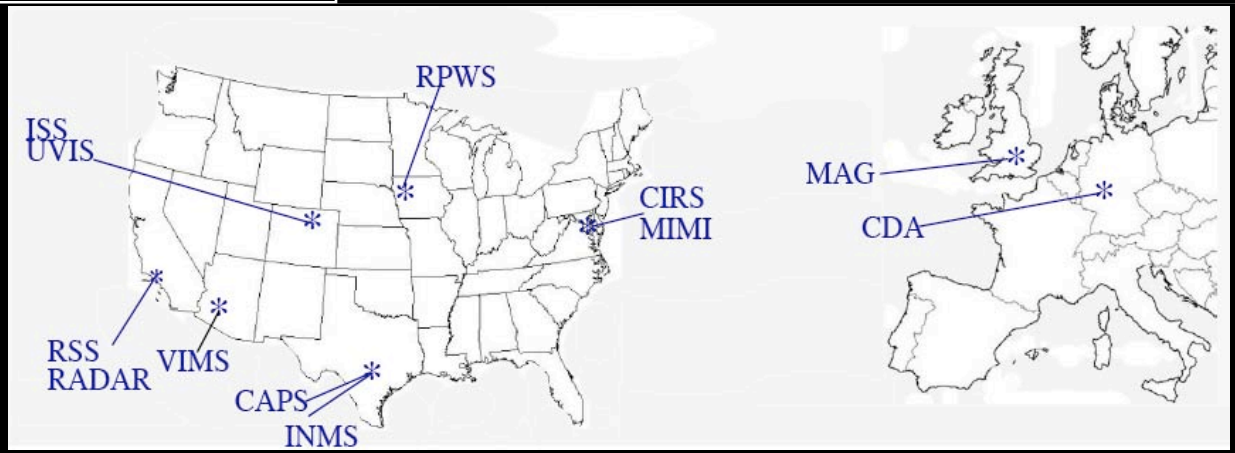
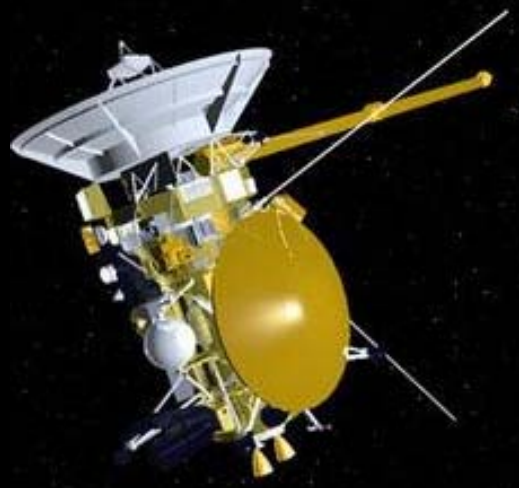


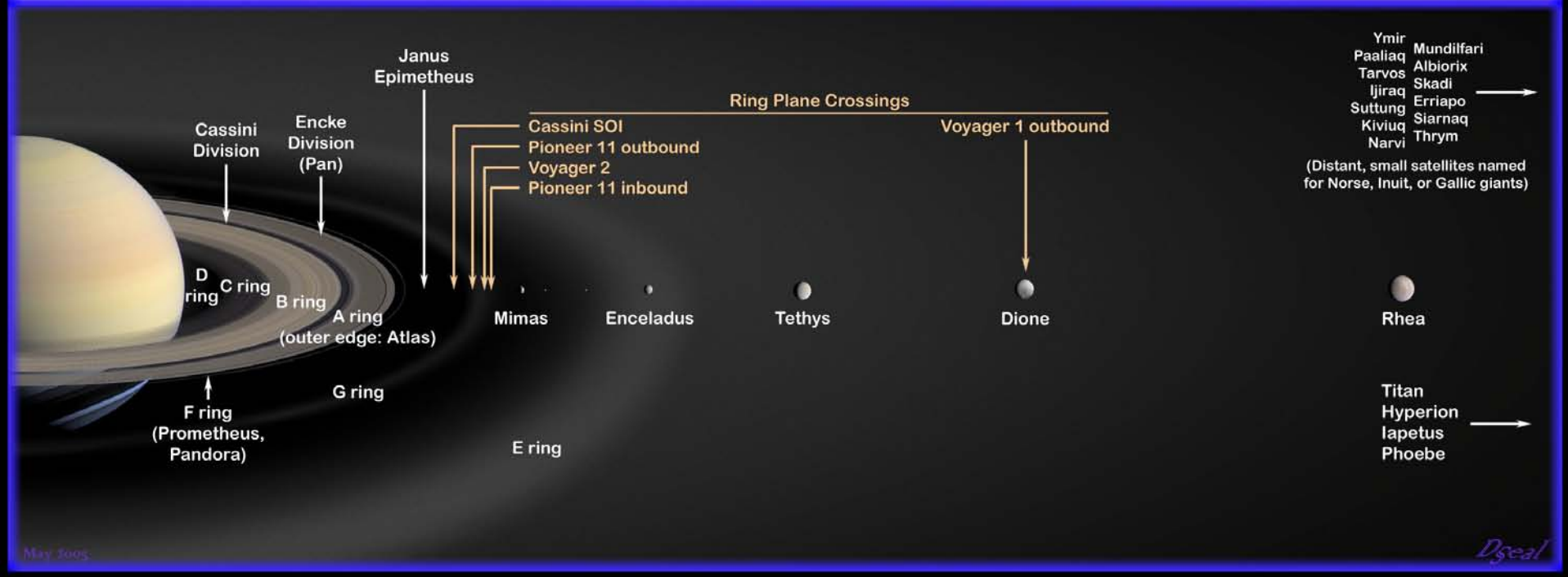

United States
France
Germany
Belgium
Italy
Denmark
United Kingdom
Switzerland
Netherlands
Czech Republic
Austria
Spain
Finland
Ireland
Hungary
Sweden
Norway
International
Participation in
CASSINI
Saturn Orbiter and
Huygens Titan
Probe

Numbers



- 1 Cassini-Huygens
- 5 Scientific disciplines
  - Saturn, Titan, Rings, Icy Satellites, Magnetosphere
- 18 Instruments (12 Orbiter)
- 30 Project Science Group (PSG) Executive
- ~80-100 Scientists at PSG Plenary session
- ~270 Scientists on Investigation Teams (more than half are in Europe)
  - Does not include science associates and postdocs

THE SATURNIAN SYSTEM



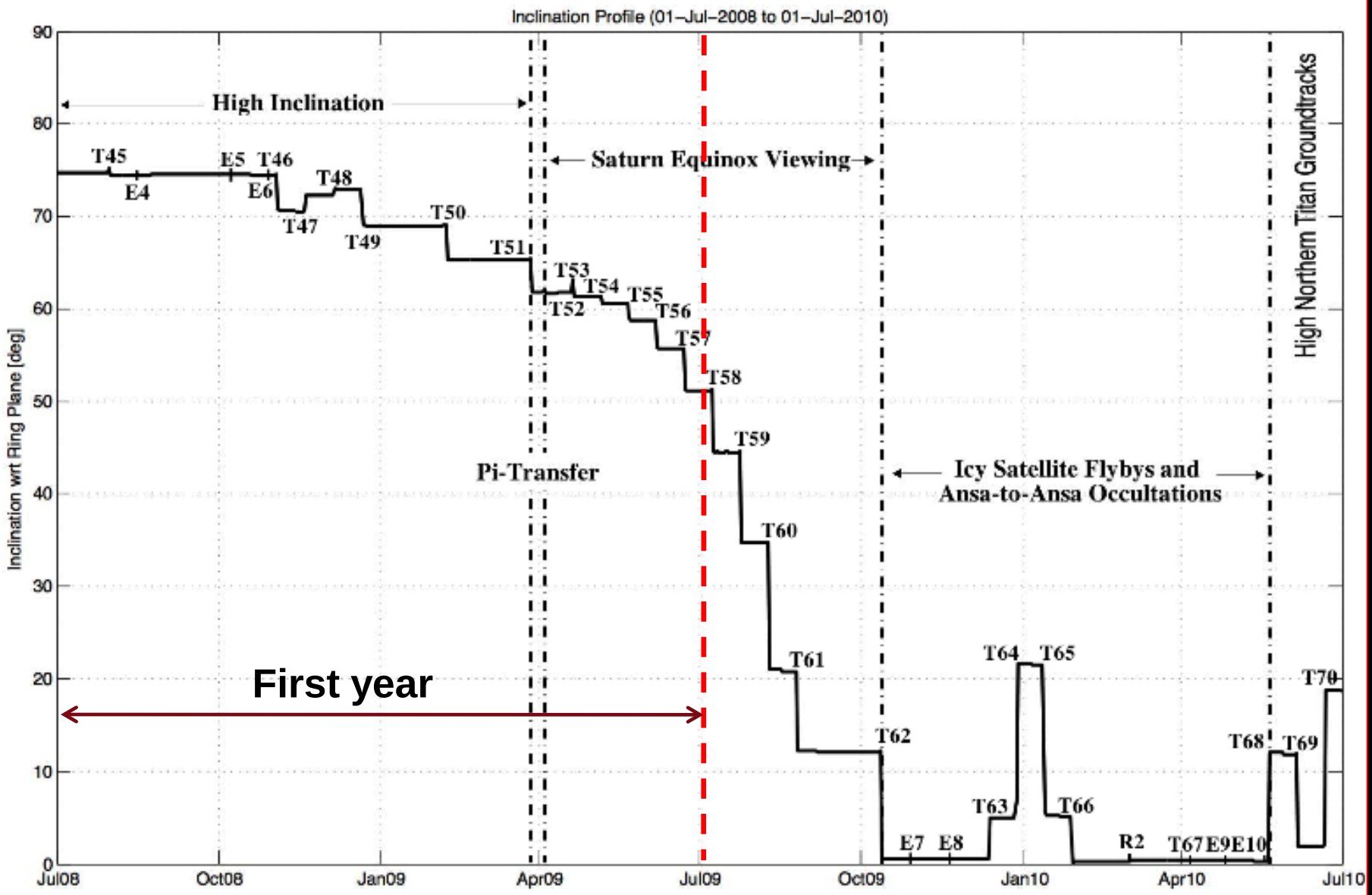
Cassini Equinox Mission Tour

- 2.25 year duration (1 July 2008 – 11 Oct. 2010)
  - Saturn Equinox in August 2009
- Similar in intensity to Prime Mission
- Equinox tour produces the maximum scientific return possible with Cassini-Huygens spacecraft

Equinox Mission Overview

- 26 Titan flybys
  - 7 dusk encounters, 3 high northern groundtracks, a mid-tail wake crossing, numerous “quality” RSS occultations, separate solar and earth equatorial occultations
- 7 Enceladus flybys less than 2050 km
  - 1 at 50 km, 2 at 100 km, 1 at 200 km, and the others at 340, 438 and 1600 km
- Additional Icy/Rocky satellite flybys
  - 1 Dione at 500 km (downstream wake flyby), 1 Rhea at 100 km, and 1 Helene at 1500 km
- Three ansa-to-ansa ring/Saturn RSS occultations
- High number of mid-latitude northern hemisphere Saturn occultations, although a lack of high northern occultations.
- 5 equatorial targeted Saturn periapsis passages (i.e. no targeted/pseudo-targeted icy satellite flybys)
- 28 spacecraft orbits with inclination > 64.3 degrees (not including T44-to-T45 4:9 transfer)

Equinox Mission Inclination Profiles

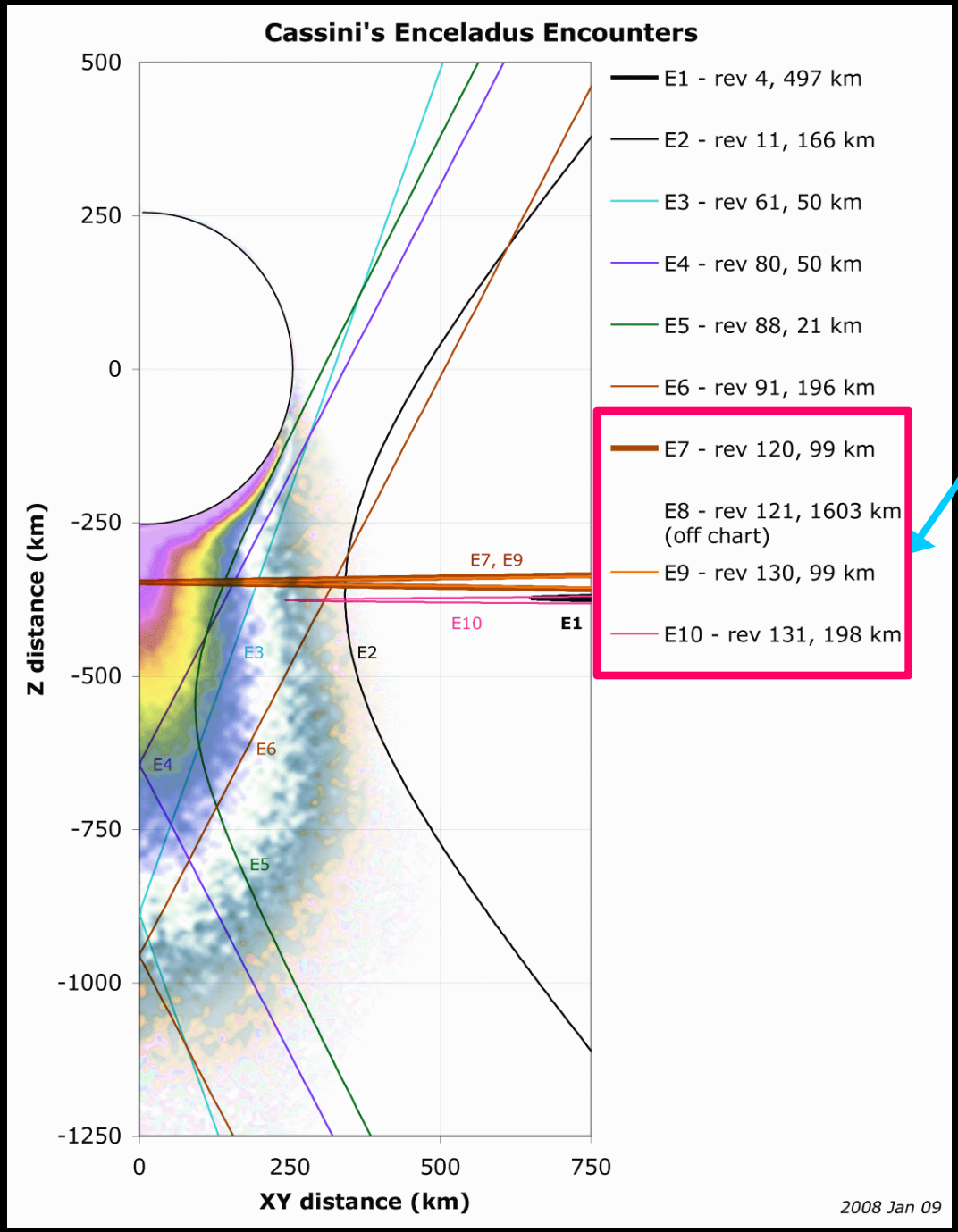


Cassini Mission Overview

Four-Year Prime Tour + Two-Year Extended Mission (Proposed), July 2004 - July 2010

Equinox Scientific Objectives

- New discoveries
  - Enceladus' plumes, Titan's complex surface
- Theoretical advances
  - Importance of Titan and Enceladus for organic chemistry
  - Dynamics of satellites imbedded in the rings
  - Satellite geophysics (e.g. Iapetus ridge)
- New opportunities, temporal and spatial
  - New seasons for Saturn and Titan
  - New ring event: Equinox (August 2009) is prime opportunity for ring discoveries
  - New places to explore in Saturn's huge magnetosphere
- Address incomplete AO objectives
  - Titan Radar coverage increases from 22% to 30%
- Gather information needed for future missions
  - Spatial and temporal coverage for Titan and Enceladus



7 Enceladus flybys

E4 - E10

4 in past year

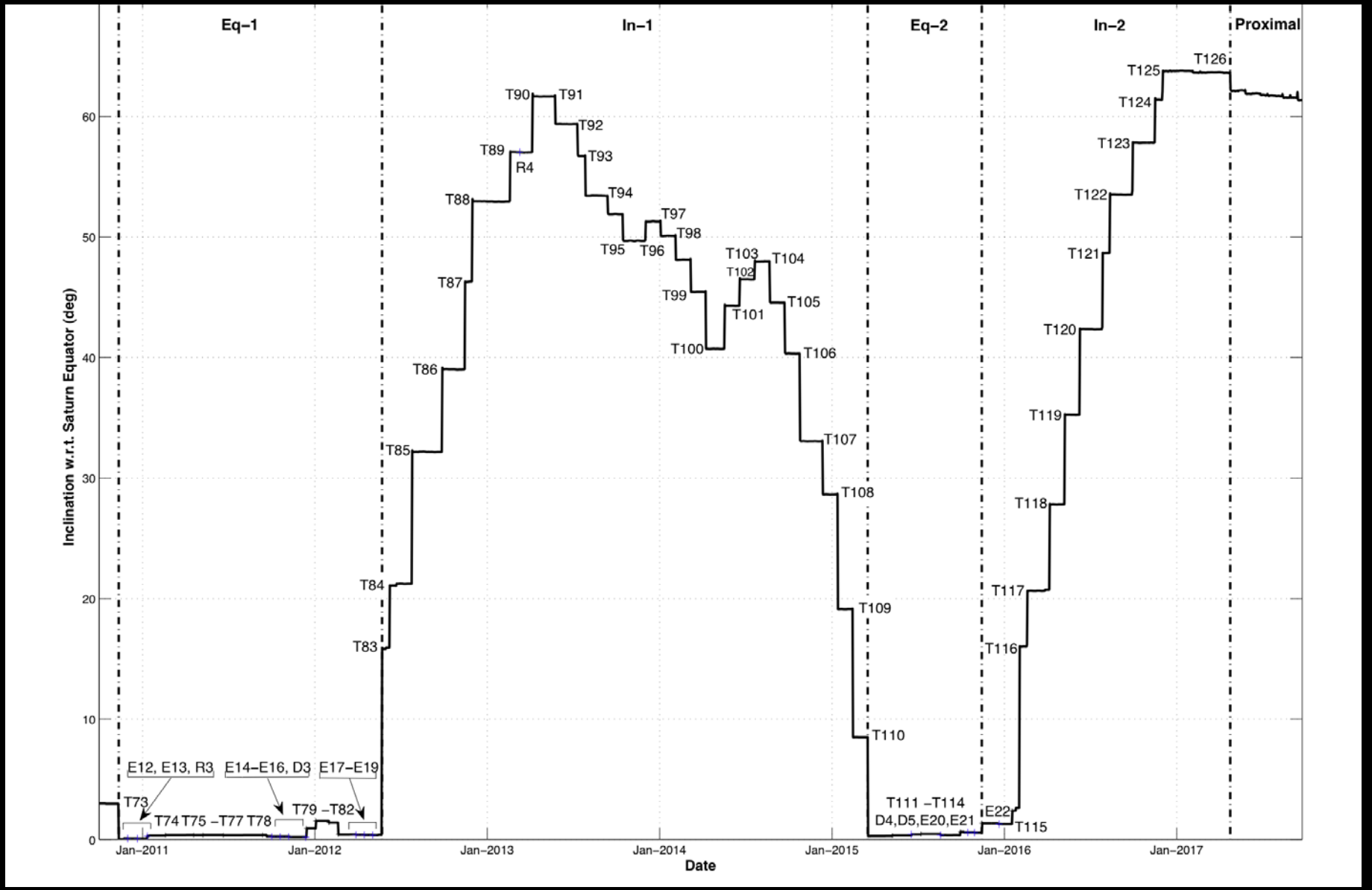
Looking ahead to the Solstice Mission!

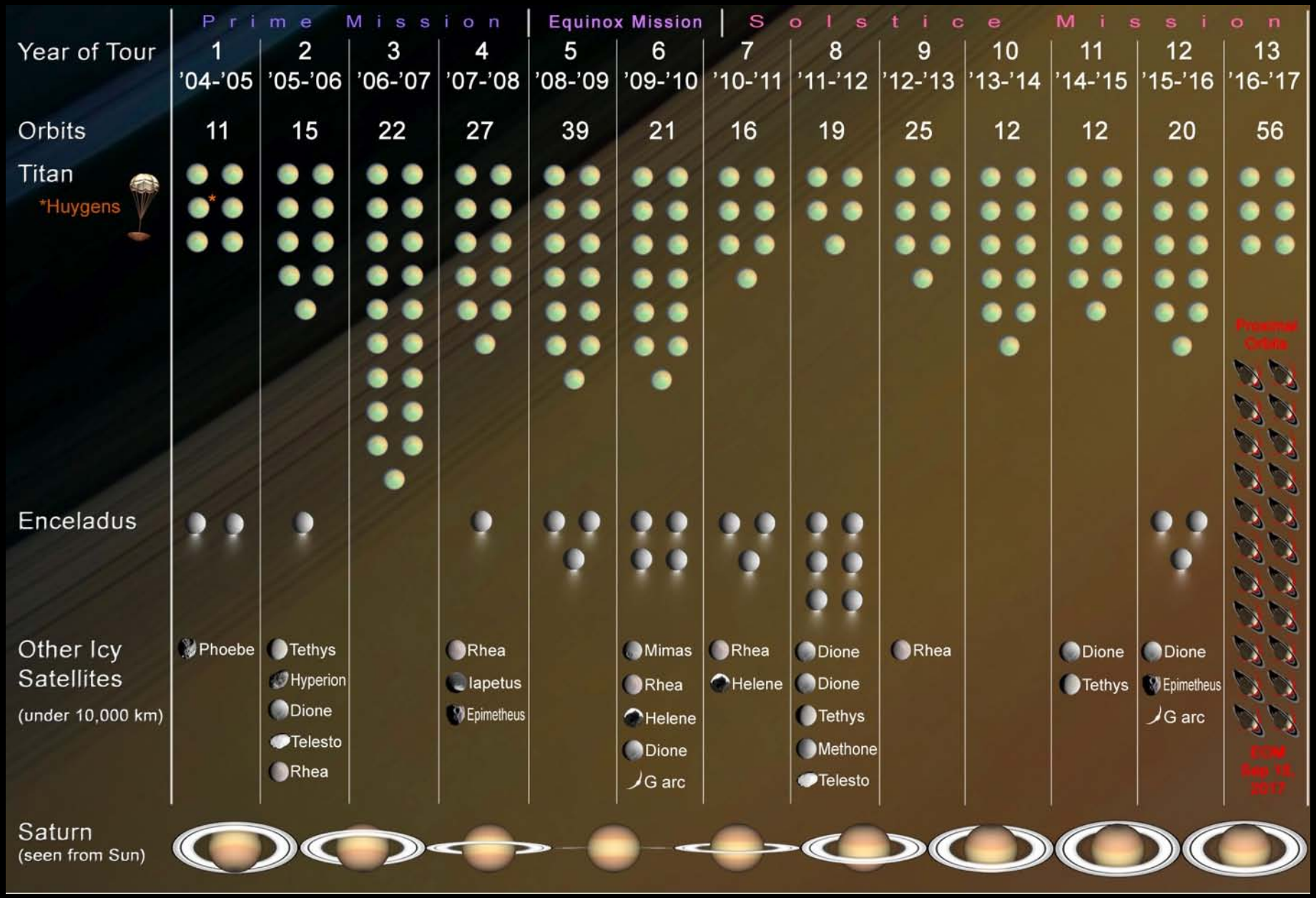
Solstice Mission Overview

- Oct 11, 2010 – Sept 15, 2017
  - Cassini will be operating on a reduced budget, simplified operations plan
- Northern summer solstice: May 24, 2017

- 38 Titan flybys less than 2000 km (54 targeted flybys, T73-T126)
  - Varying geometries for ORS, RADAR and RSS occultation experiments
- 12 Enceladus flybys less than 5000 km
  - 3 at 50 km, 3 at 75 km, 1 at 100 km, and the others at 500, 1230, 1840, 2550, and 5000 km
- Additional icy satellite flybys
  - 3 Dione flybys (100 km, 475 km, and 500 km), 2 Rhea flybys (75 km, 1000 km)
- Many Saturn solar and stellar occultations at a variety of latitudes
- 4 equatorial targeted Saturn periapsis passages (i.e. no targeted/pseudo-targeted icy satellite flybys)
- 2 inclined sequences to focus on ring, magnetospheric science

Looking ahead:
Solstice Mission Inclination Profiles

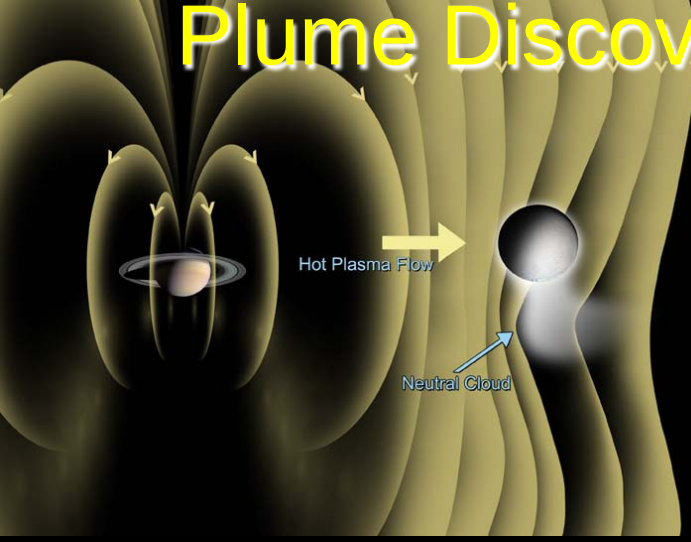


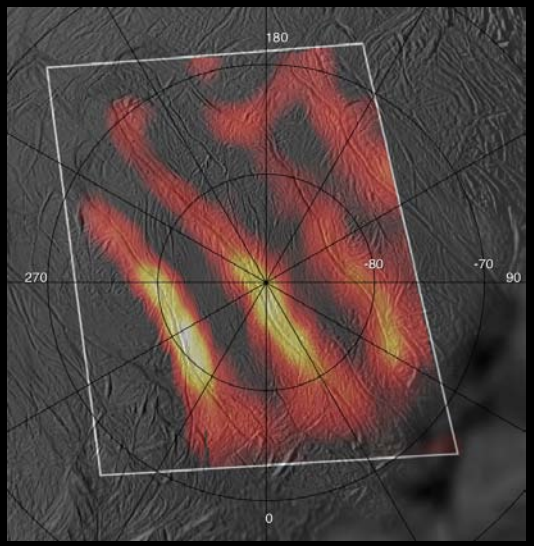

Prime Mission
Equinox Mission
Solstice Mission
Year of Tour
1 '04-'05
2 '05-'06
3 '06-'07
4 '07-'08
5 '08-'09
6 '09-'10
7 '10-'11
8 '11-'12
9 '12-'13
10 '13-'14
11 '14-'15
12 '15-'16
13 '16-'17
Orbits
11
15
22
27
39
21
16
19
25
12
12
20
56
Titan
*Huygens
Enceladus
Other Icy Satellites
(under 10,000 km)
Phoebe
Tethys
Hyperion
Dione
Telesto
Rhea
Rhea
Iapetus
Epimetheus
Mimas
Rhea
Helene
Dione
G arc
Rhea
Helene
Dione
Dione
Tethys
Methone
Telesto
Rhea
Dione
Tethys
Dione
Epimetheus
G arc
Proximal Orbits
EOM Sep 15, 2017
Saturn
(seen from Sun)

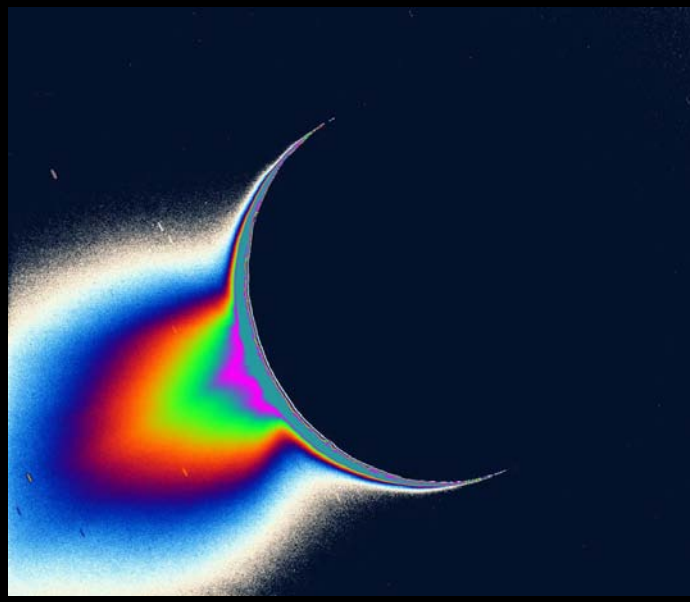
Solstice Scientific Objectives

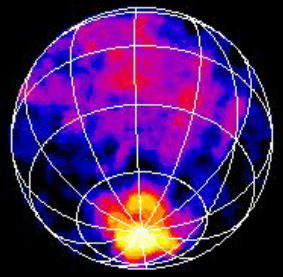
- Seasonal-temporal changes *(a sampling:)*
  - Saturn: Observe seasonal variations in temperature, clouds, and composition in three spatial dimensions.
  - Rings: Determine the production mechanisms of spokes, and the microscale properties of ring structure, by observing at the seasonally maximum opening angle of the rings near Solstice.
  - MAPS: Observe Saturn's magnetosphere over a solar cycle, from one solar minimum to the next.
  - Icy Satellites: Identify long-term secular and seasonal changes at Enceladus through observations of the south polar region, jets and plumes.
  - Titan: Determine seasonal changes in the methane-hydrocarbon hydrological cycle: of lakes, clouds, aerosols, and their seasonal transport.
- New questions *(a sampling:)*
  - Saturn: Study the life cycles of Saturn's newly discovered atmospheric waves, south polar hurricane, and newly rediscovered north polar hexagon.
  - Perform focused studies of the evolution of newly discovered "propeller" objects.
  - Determine whether Dione exhibits evidence for low-level activity, now or in recent geological time.

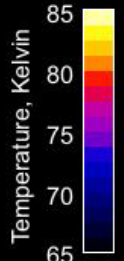
Plume Discovery through Interdisciplinary Science

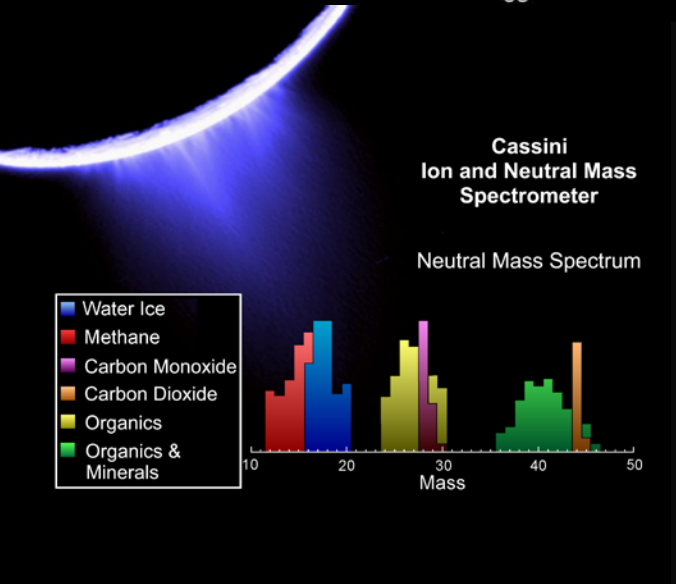


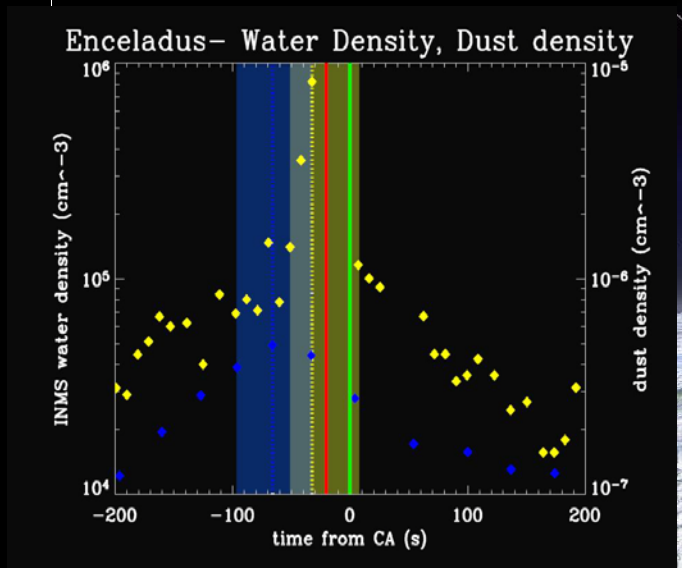










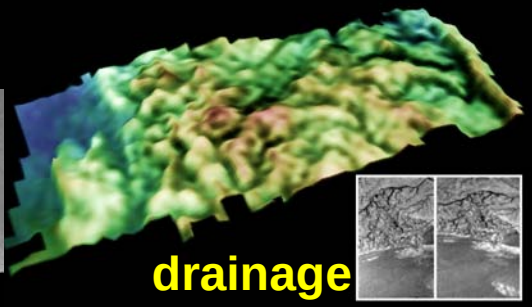


Titan: Complex surface, atmosphere and organics

detached haze

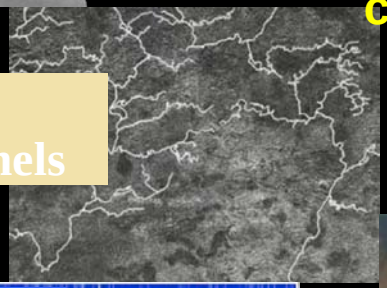
huge cloud systems

mid-latitude streaks

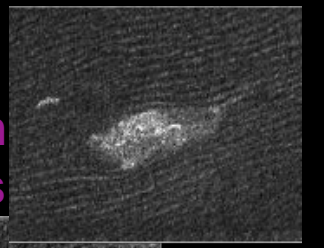


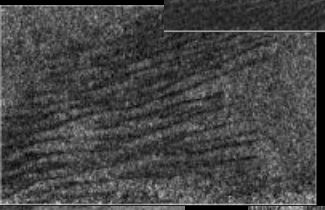
drainage channels

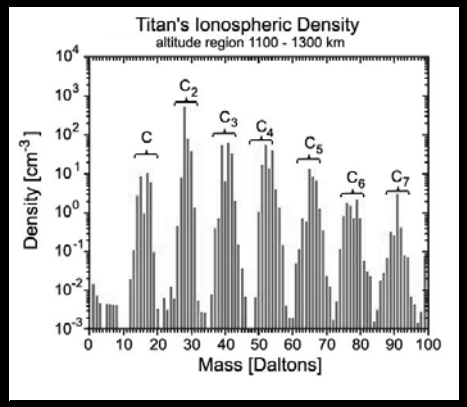
river channels



wind driven dunes

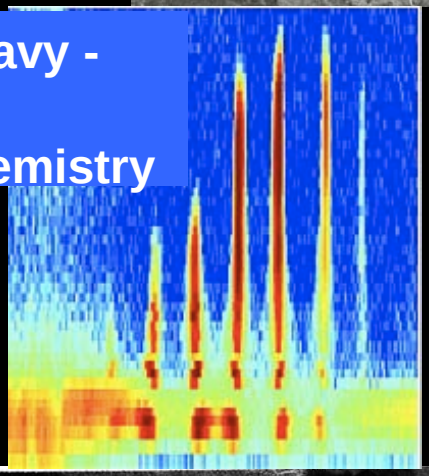




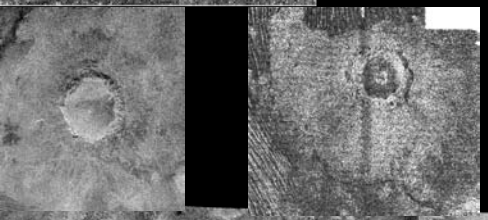


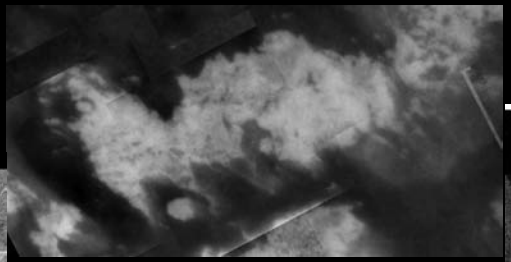
chemically complex atmosphere

Heavy - ion chemistry



mountains





aeolian patterns

Very few craters

lakes