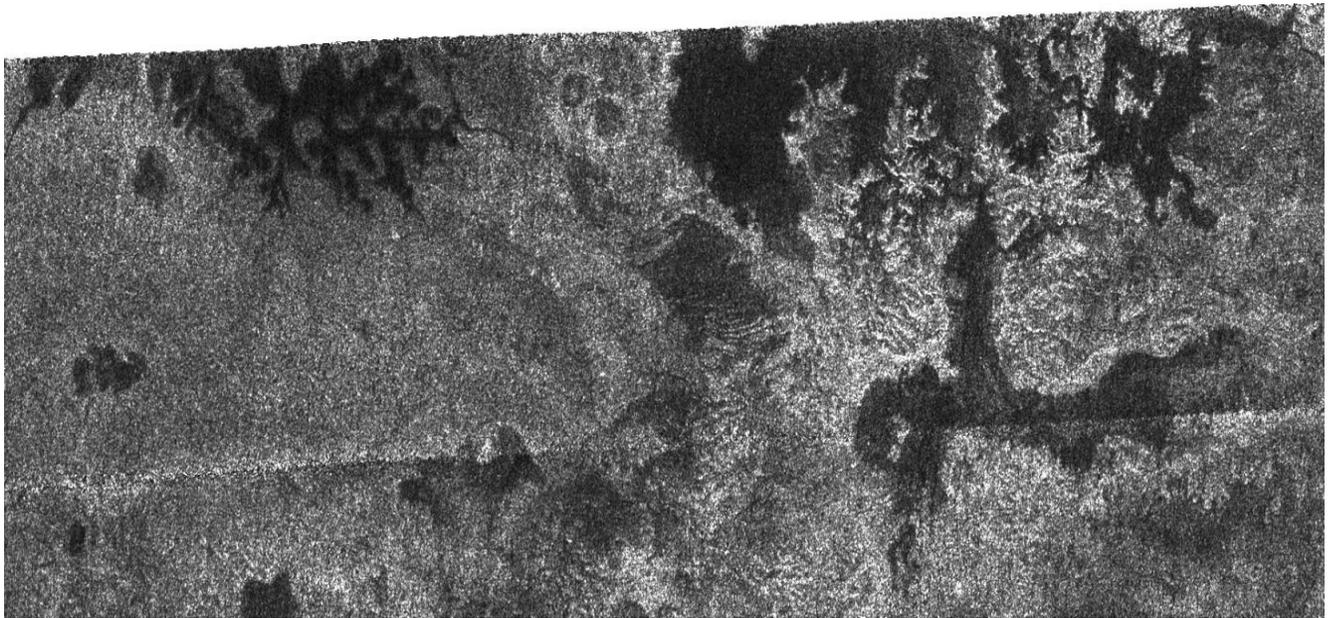


C A S S I N I



TITAN 035TI(T21)
MISSION DESCRIPTION

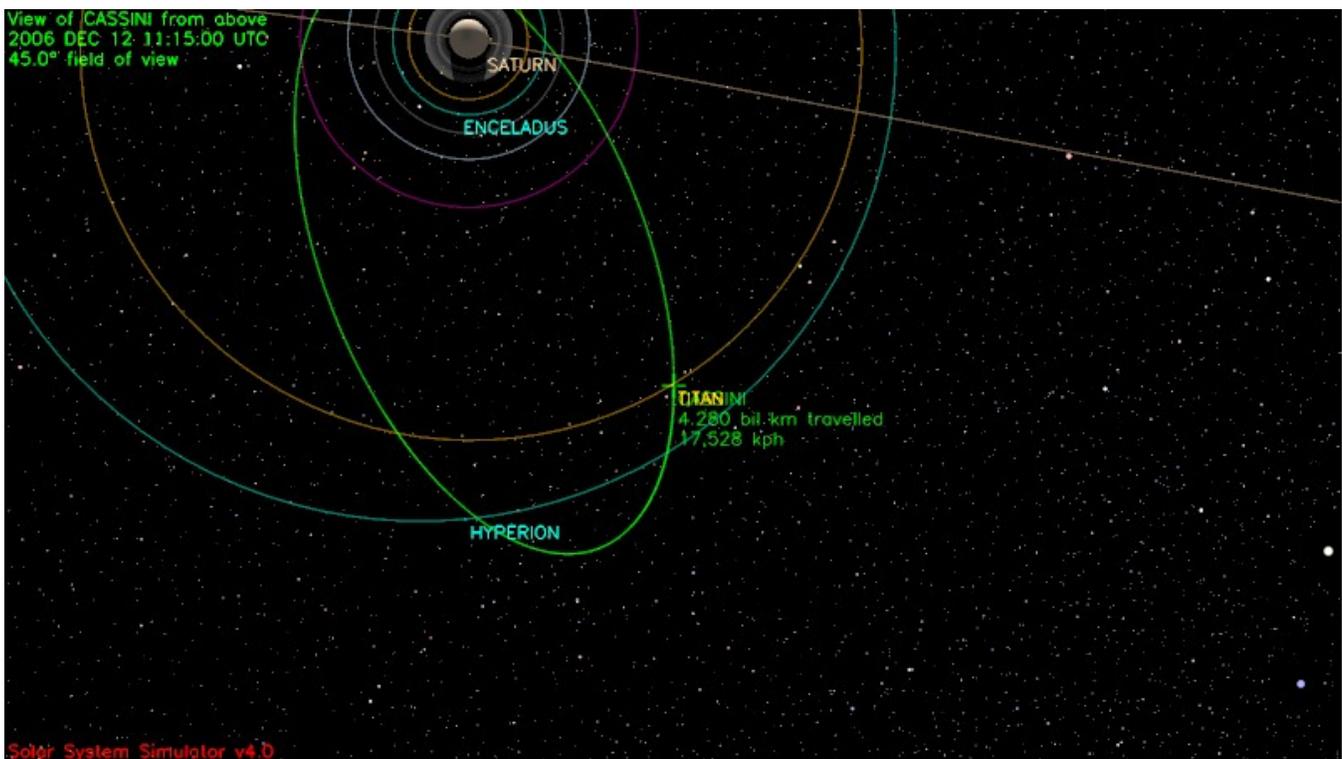
December 2006

Jet Propulsion Laboratory
California Institute of Technology

1.0 OVERVIEW

After a 48-day hiatus from Titan, Cassini returns for its twenty-second targeted encounter, Titan-21. The closest approach to Titan occurs on Tuesday, December 12, at spacecraft time 2006-346T11:41:31 (Dec. 12 at 3:41AM Pacific Time) at an altitude of 1000 km (~621 miles) above the surface and at a speed of 5.9 kilometers per second (13,200 mph). The latitude at closest approach is 43.9° N (over the uncharted area known only as 'Belet') and the encounter occurs on orbit number 35.

This encounter is set up with two maneuvers: an apoapsis maneuver on November 26, and an approach maneuver, scheduled for December 9. This inbound encounter occurs about 3 days before Saturn closest approach.



1.1 ABOUT TITAN

If Titan were a planet, it would likely stand out as the most important planet in the solar system for humans to explore. Titan, the size of a terrestrial planet, has a dense atmosphere of nitrogen and methane and a surface covered with organic material. It is Titan that is arguably Earth's sister world and the Cassini-Huygens mission considers Titan among its highest priorities.

Although it is far colder and lacks liquid water, the chemical composition of Titan's atmosphere resembles that of early Earth. This, along with the organic chemistry that takes place in Titan's atmosphere, prompts scientists to believe that Titan could provide a laboratory for seeking insight into the origins of life on Earth. Data from the Huygens probe, which touched down on Titan's surface in January 2005, and the Cassini orbiter has shown that many of the processes that occur on Earth also apparently take place on Titan – wind, rain, volcanism, tectonic activity, as well as river channels, and drainage patterns all seem to contribute in shaping Titan's surface. However, at an inhospitable -290 degrees Fahrenheit (-179 degrees Celsius), the chemistry that drives these processes is fundamentally different from Earth's. For example it is methane that performs many of the same functions on Titan that water does on Earth.

The Huygens probe landed near a bright region now called Adiri, and it photographed light hills with dark river beds that empty into a dark plain. It was believed that this dark plain could be a lake or at least a muddy material, but it is now known that Huygens landed in the dark region, and it is solid. Scientists believe it only rains occasionally on Titan, but the rains are extremely fierce when they come.

Only a small number of impact craters have been discovered. This suggests that Titan's surface is constantly being resurfaced by a fluid mixture of water and possibly ammonia, believed to be expelled from volcanoes and hot springs. Some surface features, such as lobate flows, appear to be volcanic structures. Volcanism is now believed to be a significant source of methane in Titan's atmosphere. However, there are no oceans of hydrocarbons as previously hypothesized. Dunes cover large areas of the surface.

The Cassini-Huygens mission, using wavelengths ranging from ultraviolet to radio, is methodically and consistently revealing Titan and answering long-held questions regarding Titan's interior, surface, atmosphere, and the complex interaction with Saturn's magnetosphere. While many pieces of the puzzle are yet to be found, with each Titan flyby comes a new data set that furthers our understanding of this world

as we attempt to constrain scenarios for the formation and evolution of Titan and its atmosphere.

1.2 TITAN-21 SCIENCE HIGHLIGHTS

– RADAR obtains SAR (Synthetic Aperture RADAR) imagery of the poorly-covered northern mid-latitude trailing hemisphere, which may include some areas of dunes. This is the least explored area on Titan to date. Observations also include Radiometry and Scatterometry to build up southern hemisphere coverage.

- UVIS has a EUVFUV observation, one of several throughout the tour, to image Titan at a variety of phase angles. These are used to investigate the scattering properties of high altitude aerosols, the latitudinal distribution of acetylene, methane, and some other hydrocarbons, and to look for auroral emissions. UVIS also observes an occultation of the star Alpha Per. Stellar occultations provide detailed vertical profiles of some hydrocarbons and haze in the altitude range 300 to 1500 kilometers. Each occultation samples a different latitude and different time of day so we gradually build up a 3-dimensional picture over the long term by observing many occultations.

– The ISS outbound and inbound observations will image the surface of Titan and attempt to track atmospheric and surface changes. ISS will also be looking at surface color variations and monitor limb hazes.

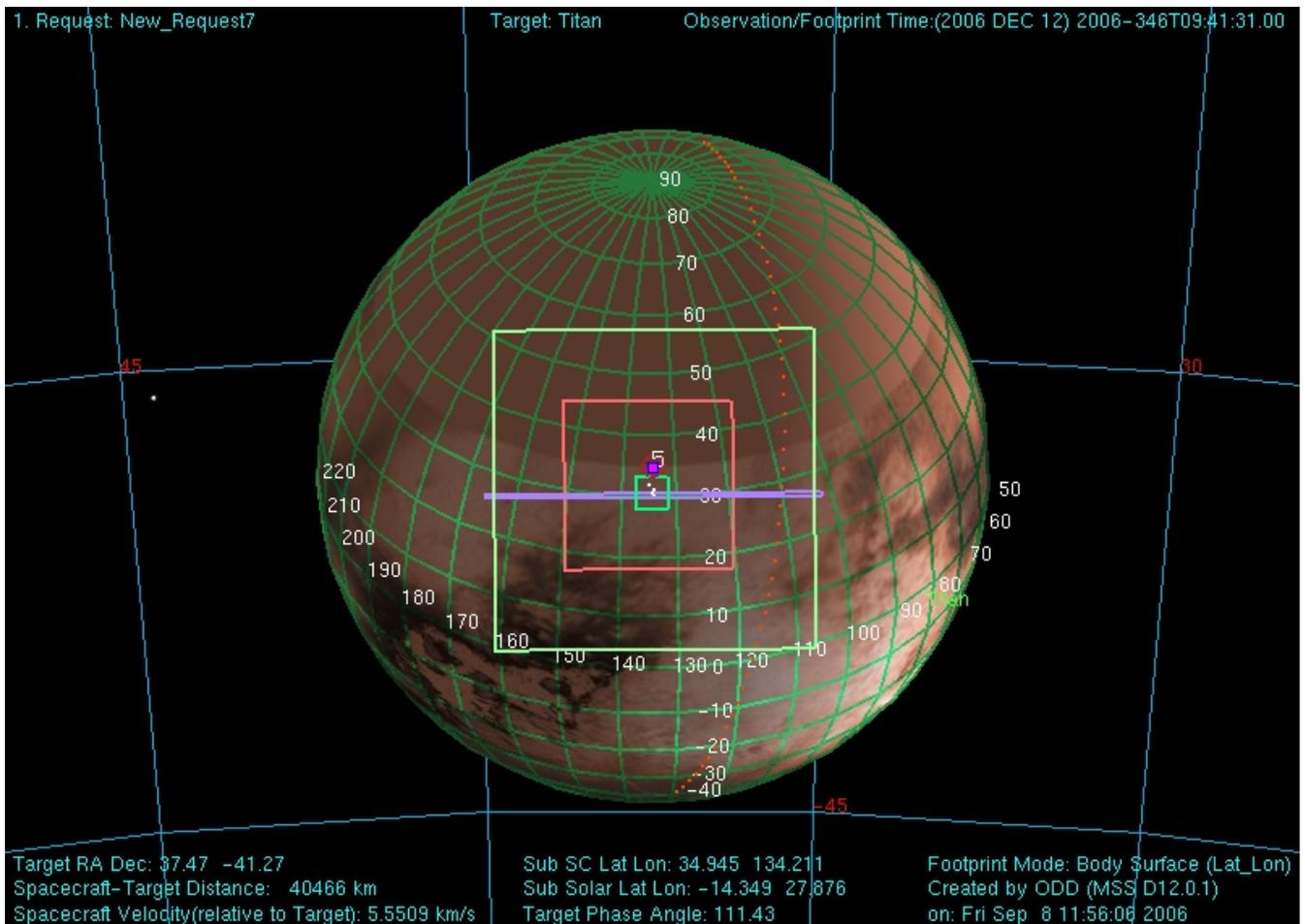
– MAPS - Analysis of plasma wake, ions escaping from Titan, and Titan's interaction with Saturn's magnetosphere down to a low altitude (1000 kilometers). INMS specifically will be looking at atmospheric and ionospheric thermal structure of Titan's atmosphere.

1.3 SAMPLE SNAPSHOTS

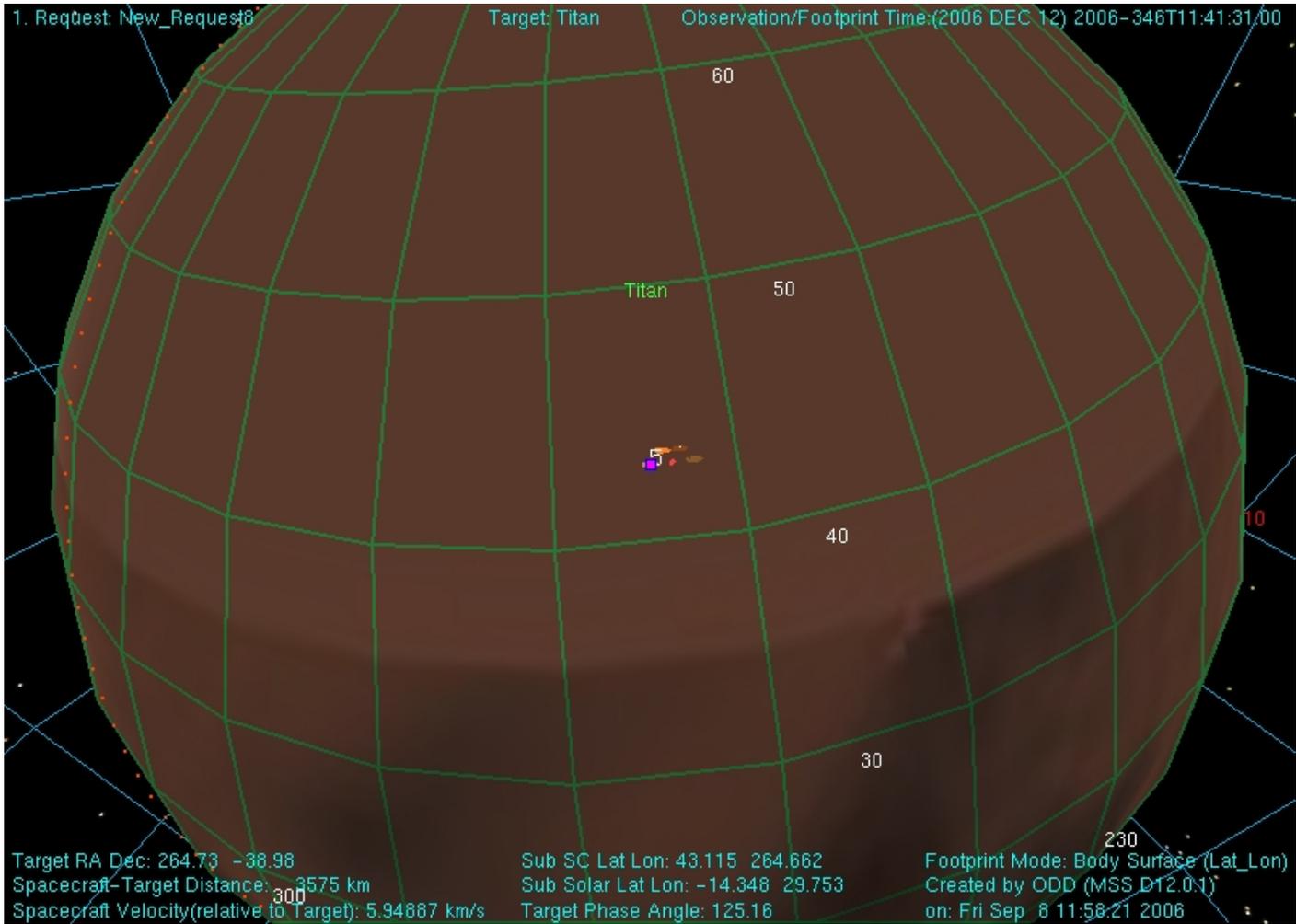
Three views of Titan from Cassini before, during, and after closest approach to Titan are shown below. The views are oriented such that the direction towards the top of the page is aligned with the Titan North Pole. The optical fields of view are shown in the first two plots and the remote sensing instrument fields of view are shown in the third, assuming they are pointed towards the center of Titan. The sizes of these fields of view vary as a function of the distance between Cassini and Titan. A key for use in identifying the remote sensing instruments fields of view in the figures is listed at the top of the next page.

Key to ORS Instrument Fields of View in Figures

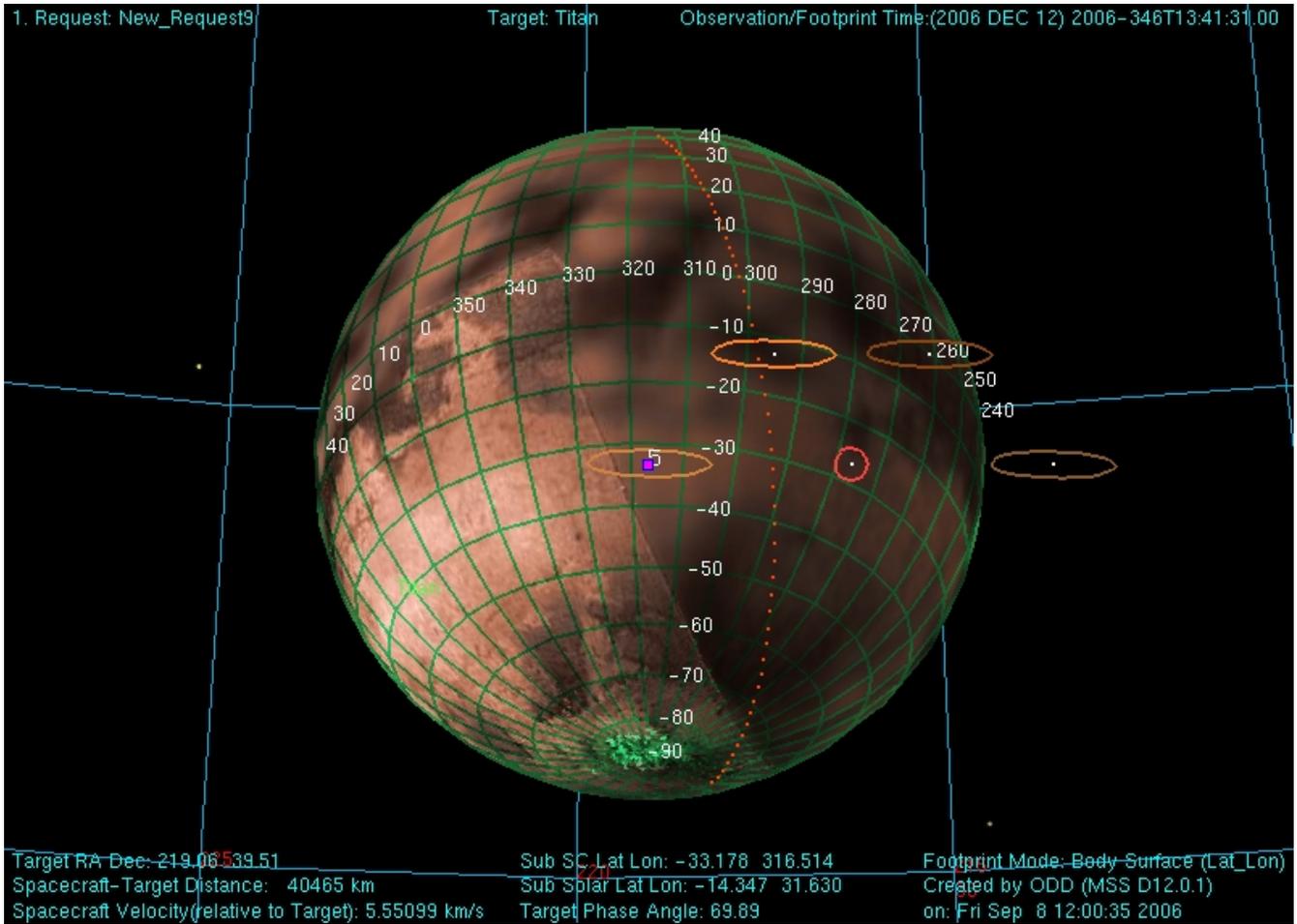
Instrument Field of View	Depiction in Figure
ISS WAC (imaging wide angle camera)	Largest square
VIMS (visual and infrared mapping spectrometer)	Next largest pink square
ISS NAC (imaging narrow angle camera)	Smallest green square
CIRS (composite infrared spectrometer) – Focal Plane 1	Small red circle near ISS_NAC FOV
UVIS (ultraviolet imaging spectrometer)	Vertical purple rectangle centered within largest square



View of Titan from Cassini 2 hours before Titan-21 closest approach



View of Titan from Cassini at Titan-21 Closest Approach



View of Titan from Cassini 2 hours after Titan-21 closest approach

Timeline and Geometry Table below

Colors: yellow = maneuvers; blue = geometry; pink = T21-related; green = data playbacks

Cassini Titan-21 Timeline - December 2006

Orbiter UTC	Ground UTC	Pacific Time	Time wrt T21	Activity	Description
328T16:30:00	Nov 24 17:42	Fri Nov 24 09:42 AM	T21-17d19h	Start of Sequence S26	Start of Sequence which contains Titan-21.
334T13:44:00	Nov 30 14:56	Thu Nov 30 06:56 AM	T21-11d22h	Descending Ring Plane Crossing	
337T00:39:00	Dec 03 01:51	Sat Dec 02 05:51 PM	T21-09d11h	Ascending Ring Plane Crossing	
343T06:32:00	Dec 09 07:44	Fri Dec 08 11:44 PM	T21-03d05h	OTM #82 Prime	Titan-21 minus 4 day targeting maneuver
344T06:32:00	Dec 10 07:44	Sat Dec 09 11:44 PM	T21-02d05h	OTM #82 Backup	
345T15:17:00	Dec 11 16:29	Mon Dec 11 08:29 AM	T21-20h24m	Start of the TOST Segment	
345T15:17:00	Dec 11 16:29	Mon Dec 11 08:29 AM	T21-20h24m	Turn cameras to Titan	
345T15:47:00	Dec 11 16:59	Mon Dec 11 08:59 AM	T21-19h54m	Deadtime	22 minutes long; used to accommodate changes in flyby time
345T16:08:31	Dec 11 17:20	Mon Dec 11 09:20 AM	T21-19h33m	Titan atmospheric observations	Obtain information on the thermal structure of Titan's stratosphere
346T02:41:31	Dec 12 03:53	Mon Dec 11 07:53 PM	T21-09h00m	Titan limb observations	Search Titans Nightside for Atmospheric Lighting and Auras
346T04:11:31	Dec 12 05:23	Mon Dec 11 09:23 PM	T21-07h30m	Titan atmospheric observations	Search Titans Nightside Exobase to Dayside Exobase
346T10:31:31	Dec 12 11:43	Tue Dec 12 03:43 AM	T21-01h10m	Stellar Occultation	Observe star as light from it passes through Titan's atmosphere
346T10:57:31	Dec 12 12:09	Tue Dec 12 04:09 AM	T21-00h44m	Transition to Thrusters	Thrusters are needed to compensate for Titan Atmosphere torque and target motion compensation
346T11:18:31	Dec 12 12:30	Tue Dec 12 04:30 AM	T21-00h23m	Sample Titan's Upper Atmosphere	INMS will attempt to determine atmospheric and ionospheric thermal structure.
346T11:41:31	Dec 12 12:53	Tue Dec 12 04:53 AM	T21+00h00m	Titan-21 Flyby Closest Approach Time	Altitude = 1000 km (620 miles), speed = 5.9 km/s (13,200 mph); high phase inbound, 125 deg phase at closest approach, low phase outbound
346T11:41:31	Dec 12 12:53	Tue Dec 12 04:53 AM	T21+00h00m	Titan Outbound RADAR Imaging	RADAR will obtain Synthetic Aperture RADAR (SAR) images of Titan's Surface
346T11:56:31	Dec 12 13:08	Tue Dec 12 05:08 AM	T21+00h15m	Titan outbound RADAR Altimetry Observations	Determine Altititude of Titan Surface while spacecraft is pointing Nadir
346T12:10:00	Dec 12 13:22	Tue Dec 12 05:22 AM	T21+00h29m	Descending Ring Plane Crossing	
346T12:11:31	Dec 12 13:23	Tue Dec 12 05:23 AM	T21+00h30m	Transition to Reaction Wheels	Wheels are used for greater spacecraft stability.
346T12:33:31	Dec 12 13:45	Tue Dec 12 05:45 AM	T21+00h52m	Scatterometry Measurements	Titan Outbound RADAR Scatterometry observations
346T13:18:31	Dec 12 14:30	Tue Dec 12 06:30 AM	T21+01h37m	Radiometry Measurements	Titan Outbound RADAR Radiometry observations
346T15:41:31	Dec 12 16:53	Tue Dec 12 08:53 AM	T21+04h00m	Titan surface observations	Full disk observations for surface and atmospheric mapping
347T01:09:31	Dec 13 02:21	Tue Dec 12 06:21 PM	T21+13h28m	Deadtime	5 minutes long; used to accommodate changes in flyby time
347T01:15:00	Dec 13 02:27	Tue Dec 12 06:27 PM	T21+13h34m	Turn to Earth-Line	
347T01:36:00	Dec 13 02:48	Tue Dec 12 06:48 PM	T21+13h55m	Begin Playback of T21 Data	Madrid 34M Handover to Goldstone 70M
347T12:18:00	Dec 13 13:30	Wed Dec 13 05:30 AM	T21+01d01h	End Playback of T21 Data	
349T00:02:00	Dec 15 01:14	Thu Dec 14 05:14 PM	T21+02d12h	Saturn Periapse	R = 7.6 Rs, lat = -37 deg, phase = 23 deg

OWLT (mins)	72.5
C/A Time	Tue Dec 12 04:53 AM

1.4 FLYBY GEOMETRY

The Flyby Geometry table is not available for Titan-21.

1.5 **PLAYBACK TIMELINE**

The Playback Timeline is not available for Titan-21