C A S S I N I

T I T A N 039TI(T25) MISSION DESCRIPTION

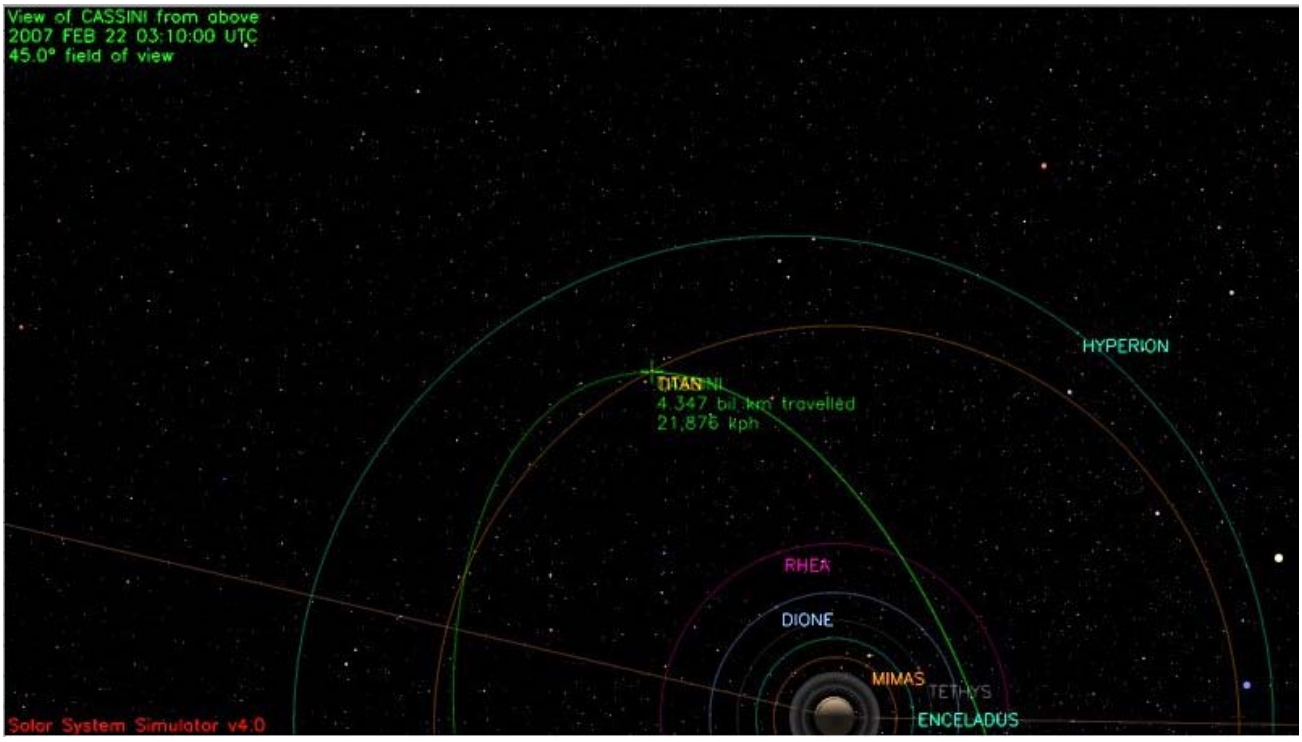
February 2007

Jet Propulsion Laboratory
California Institute of Technology

1.0 OVERVIEW

On Thursday, Feb. 22, 2007, Cassini returns to Titan for its twenty-sixth targeted encounter (T25). The highest inclination of the 180 degree transfer has been reached, and we are beginning to crank down the inclination. This is the highest we will be until spring of 2008. This also starts a series of outbound (from Saturn) encounters – from T25 to T34. We've been on a series of inbound (to Saturn) encounters since T16. The closest approach to Titan occurs at 03:12:24 spacecraft time, and at an altitude of 1000 kilometers (621 miles) above the surface with a speed of 6.2 kilometers per second (13,940 mph). The latitude at closest approach is 30 degrees and the encounter occurs on orbit number 39. The data will be played back on Friday, Feb. 23, 2007.

This encounter is set up with two maneuvers: an apoapsis maneuver on Feb. 7, and an approach maneuver, scheduled for Feb. 19. This is the first in a series of outbound Titan encounters (until T34), and occurs about 2 days before Saturn closest approach.



1.1 TITAN OVERVIEW

If Titan were in orbit around the Sun, it would likely stand out as the most important object 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 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 T25 SCIENCE HIGHLIGHTS

- RADAR: A full RADAR prime pass, from roughly -5 hours from closest approach to +5 hours from closest approach. The central +/- 15 minutes is the high resolution imaging of Titan's surface by SAR [Synthetic Aperture RADAR]. This RADAR SAR swath crosses six other swaths (TA, T3, T16, T18, T19, and T23). We have only had one other set of criss-crossing SAR swaths, T23 over T8, so this is MAJOR! T25 also covers high northern latitude lake territory, above Senkyo and Belet, and will try to extend the SAR observations for a few extra minutes to observe the Hotei Arcus feature – all within +/- 20 minutes of closest approach. RADAR rounds out the time with their standard radiometry, scatterometry, and altimetry.
- ISS: New Territory! The area north of Belet, Adiri, and Dilmun will be observed over the next several flybys with some of the highest resolution observations coming in T26. Nevertheless, the medium resolution global map observations at +5 hours from T25 will be very exciting.
- MAPS: T25 is an upstream, inner flank transition flyby with the closest approach near the inner flank/wake transition area. It is the first flyby with a good chance to find itself in the Saturnian magnetosheath or even the solar wind - because of the unique local time (near noon). If this happens, the MAPS instruments will actually be observing a wake crossing instead.
- CIRS: The highlight for the infrared instrument is the mid-IR limb temperature map on T25 that is designed to measure the altitude variation of temperature with latitude/longitude. CIRS aligns their slit at normal to the surface and marches from equator to pole. These observations are repeated at regular intervals throughout the mission to search for seasonal changes. They are also used for some limb compositional studies despite low spectral resolution.

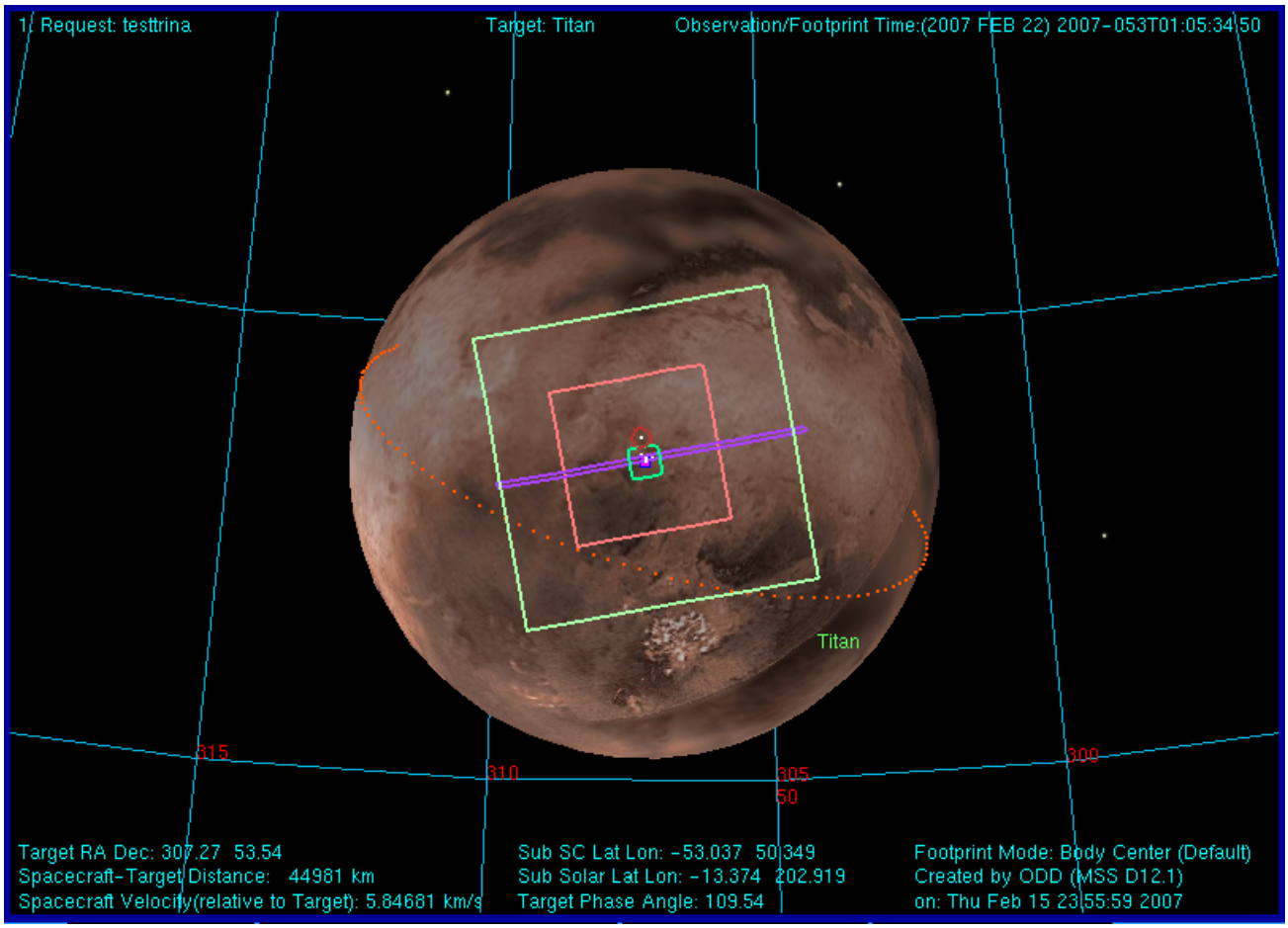
1.3 T25 SAMPLE SNAPSHOTS

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 remote sensing instrument fields of view are shown in all three 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 instruments fields of view in the figures is listed at the top of the next page.

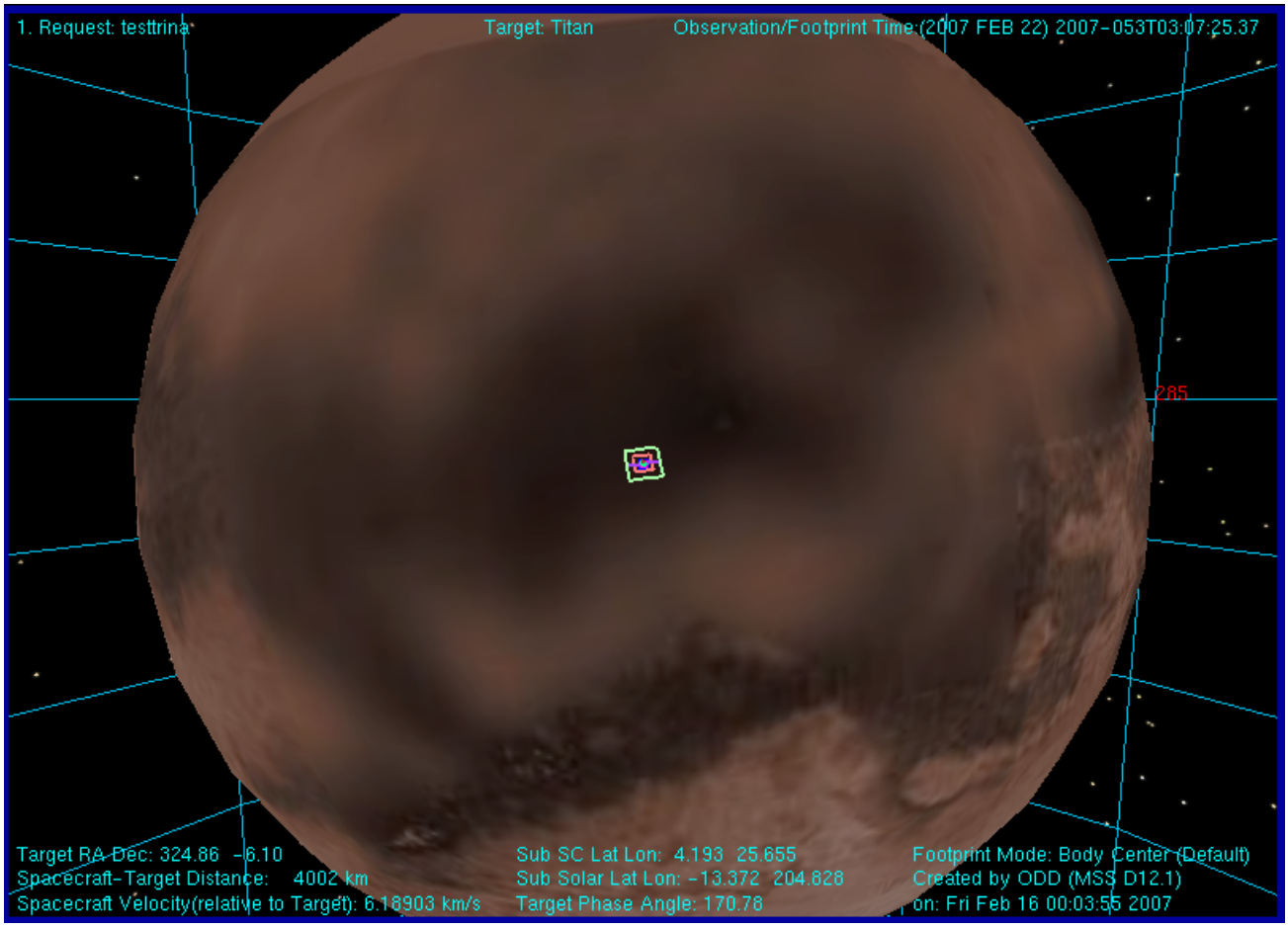
Key to ORS Instrument Fields of View in Figures

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

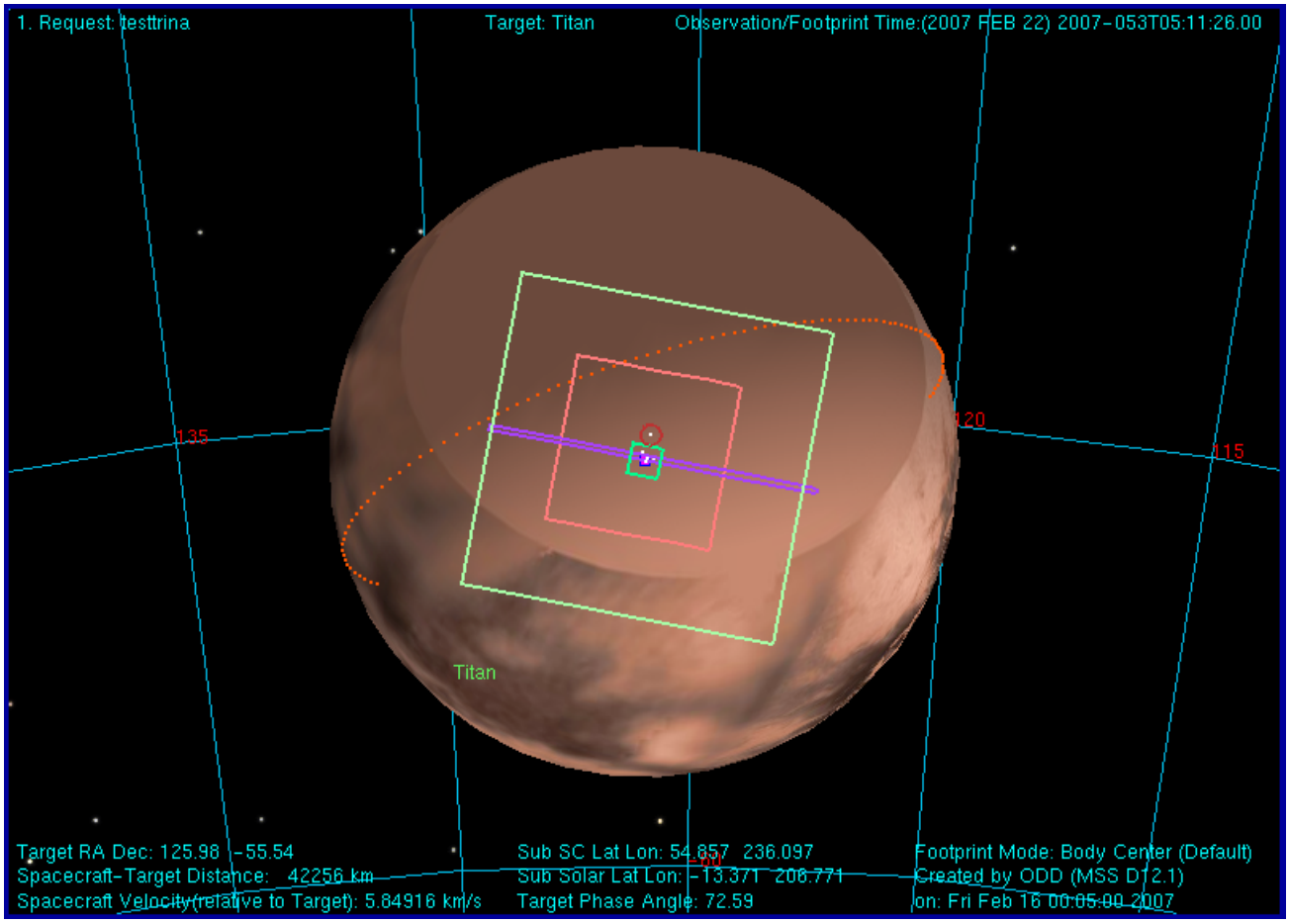
Inbound


1: Request: testtrina
Target: Titan
Observation/Footprint Time:(2007 FEB 22) 2007-053T01:05:34.50
Titan
315
310
305
300
50
Target RA Dec: 307.27 53.54
Spacecraft-Target Distance: 44981 km
Spacecraft Velocity(relative to Target): 5.84681 km/s
Sub SC Lat Lon: -53.037 50.349
Sub Solar Lat Lon: -13.374 202.919
Target Phase Angle: 109.54
Footprint Mode: Body Center (Default)
Created by ODD (MSS D12.1)
on: Thu Feb 15 23:55:59 2007

Closest Approach



Outbound


1. Request: testtrina
Target: Titan
Observation/Footprint Time:(2007 FEB 22) 2007-053T05:11:26.00
135
120
115
Titan
Target RA Dec: 125.98 -55.54
Spacecraft-Target Distance: 42256 km
Spacecraft Velocity(relative to Target): 5.84916 km/s
Sub SC Lat Lon: 54.857 236.097
Sub Solar Lat Lon: -13.371 206.771
Target Phase Angle: 72.59
Footprint Mode: Body Center (Default)
Created by ODD (MSS D12.1)
on: Fri Feb 16 00:05:00 2007

1.4 T25 TIMELINE, GEOMETRY, and PLAYBACK TIMELINE

Cassini Titan-25 Timeline - February 22, 2007

Colors: yellow = maneuvers; blue = geometry; pink = T25-related; green = data playbacks

Orbiter UTC	Ground UTC	Pacific Time	Time wrt T17	Activity	Description
038T02:37:00	Feb 07 03:45	Tue Feb 06 07:45 PM	T25-15d01h	OTM #93	Apoapsis maneuver
048T10:52:00	Feb 17 12:00	Sat Feb 17 04:00 AM	T25-04d16h	Start of sequence S28	Start of the sequence that contains T25
050T01:37:00	Feb 19 02:45	Sun Feb 18 06:45 PM	T25-03d02h	OTM #94	T25 minus 3 day targeting maneuver
050T11:49:50	Feb 19 12:57	**Mon Feb 19 04:57 AM**	**T25-02d15h**	**Periapse**	**Periapse R = 15.6 Rs, lat = -58 deg, phase = 59 deg**
052T10:37:00	Feb 21 11:45	Wed Feb 21 03:45 AM	T25-16h39m	Start of TOST Segment	
052T10:37:00	Feb 21 11:45	Wed Feb 21 03:45 AM	T25-16h39m	Turn cameras to Titan	ISS_NAC to TITAN; POS_X to North_Pole_Dir
052T11:23:25	Feb 21 12:36	Wed Feb 21 04:36 AM	T25-15h48m	ISS Nighttime atmospheric observations	search for and monitor lightning/aurora
052T12:12:24	Feb 21 13:24	Wed Feb 21 05:24 AM	T25-15h00m	Mid-IR atmospheric observations	Obtain information on the thermal structure of Titan's stratosphere. Slew across disk at 4 microrad/s.
052T14:12:24	Feb 21 15:24	Wed Feb 21 07:24 AM	T25-13h00m	Far-IR atmospheric observations	Integrate at airmass of 1.5 to 2.0
052T17:12:24	Feb 21 18:24	Wed Feb 21 10:24 AM	T25-10h00m	ISS observations	particle properties, vertical distributions ~6 km/px. 0.6 Mbit/frame with 2x2 summing.
052T18:12:24	Feb 21 19:24	Wed Feb 21 11:24 AM	T25-09h00m	Mid-IR atmospheric observations	Obtain information on trace constituents in Titan's stratosphere. Integrate on limb at two positions.
052T22:02:24	Feb 21 23:14	Wed Feb 21 03:14 PM	T25-05h10m	Turn HGA to Titan	
052T22:24:24	Feb 21 23:36	Wed Feb 21 03:36 PM	T25-04h48m	RADAR inbound radiometry and scatterometry	Observe surface properties (roughness and composition).
053T02:20:24	Feb 22 03:32	Wed Feb 21 07:32 PM	T25-00h52m	Transition to thrusters	Thrusters are needed to compensate for Titan Atmosphere torque and target motion compensation
053T02:42:24	Feb 22 03:54	Wed Feb 21 07:54 PM	T25-00h30m	RADAR inbound altimetry and SAR	Altimetry measures the altitude of Titan's surface very accuratly, and SAR (Synthetic Aperature RADAR) determines surface features
053T03:12:24	Feb 22 04:24	**Wed Feb 21 08:24 PM**	**T25+00h00m**	**Titan-25 Flyby Closest approach Time**	**Altitude = 1000km (621 miles), speed = 6.2 km/s (13,940 mph), lit outbound and 161 degrees at closest approach, local saturn time = 13.8 hours (near noon), magnetospheric location = flank in, subspacecraft latitude and longitude at closest approach is 30 degrees by 16 degrees west**
053T03:19:24	Feb 22 04:31	Wed Feb 21 08:31 PM	T25+00h07m	RADAR outbound SAR and altimetry	Altimetry measures the altitude of Titan's surface very accuratly, and SAR (Synthetic Aperature RADAR) determines surface features
053T03:42:24	Feb 22 04:54	Wed Feb 21 08:54 PM	T25+00h30m	Transition to Reaction wheels	Wheels are used for greater spacecraft stability.
053T04:04:24	Feb 22 05:16	Wed Feb 21 09:16 PM	T25+00h52m	RADAR outbound scatterometry and radiometry	Observe surface properties (roughness and composition).
053T08:01:24	Feb 22 09:13	Thu Feb 22 01:13 AM	T25+04h49m	Turn cameras to Titan	
053T08:23:24	Feb 22 09:35	Thu Feb 22 01:35 AM	T25+05h11m	ISS global map of surface	Medium resolution of the surface above Senkyo, Belet, and Dilmun
053T11:48:24	Feb 22 13:00	Thu Feb 22 05:00 AM	T25+08h36m	ISS observations	particle properties, vertical distributions ~6 km/px. 0.6 Mbit/frame with 2x2 summing.
053T12:12:24	Feb 22 13:24	Thu Feb 22 05:24 AM	T25+09h00m	FAR-IR atmospheric observations	Integrate at airmass of 1.5 to 2.0
053T14:12:24	Feb 22 15:24	Thu Feb 22 07:24 AM	T25+11h00m	ISS observations	monitoring for surface/atmosphere changes; attempt to see surface color variations; monitor limb hazes, 1-3 km/px
053T16:12:24	Feb 22 17:24	Thu Feb 22 09:24 AM	T25+13h00m	VIMS global observations	
053T17:12:24	Feb 22 18:24	Thu Feb 22 10:24 AM	T25+14h00m	Mid_IR atmospheric observations	Obtain information on the thermal structure of Titan's stratosphere. Slew across disk at 4 microrad/s.
054T00:41:00	Feb 23 01:49	Thu Feb 22 05:49 PM	T25+21h25m	Turn to Earth	
054T01:11:00	Feb 23 02:19	Thu Feb 22 06:19 PM	T25+21h55m	Begin playback	Goldstone 70-meter station

OWLT (mins)	68
C/A Time	################

GEOMETRY TABLE

A flyby geometry table is not available for T25.

PLAYBACK TIMELINE

A flyby playback timeline table is not available for T25.