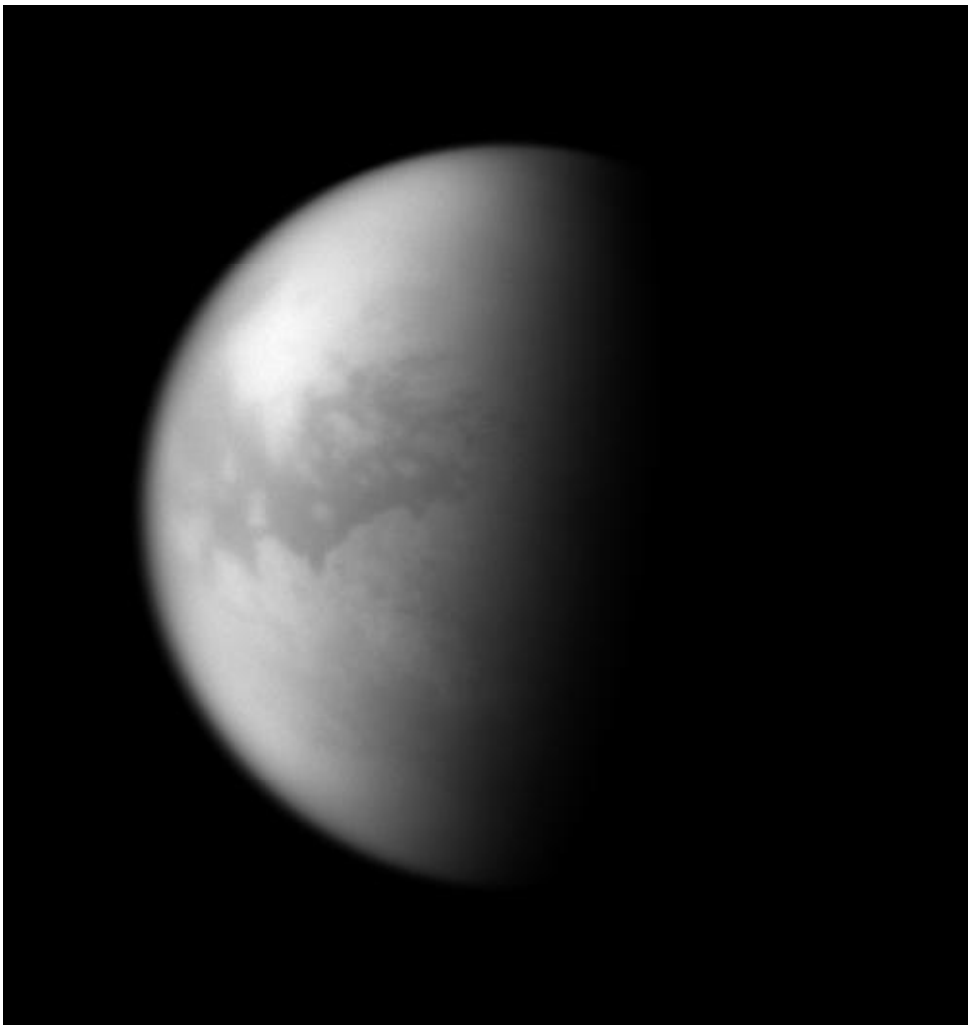
C A S S I N I



T I T A N 053TI(T38)
MISSION DESCRIPTION

Dec 4 2007

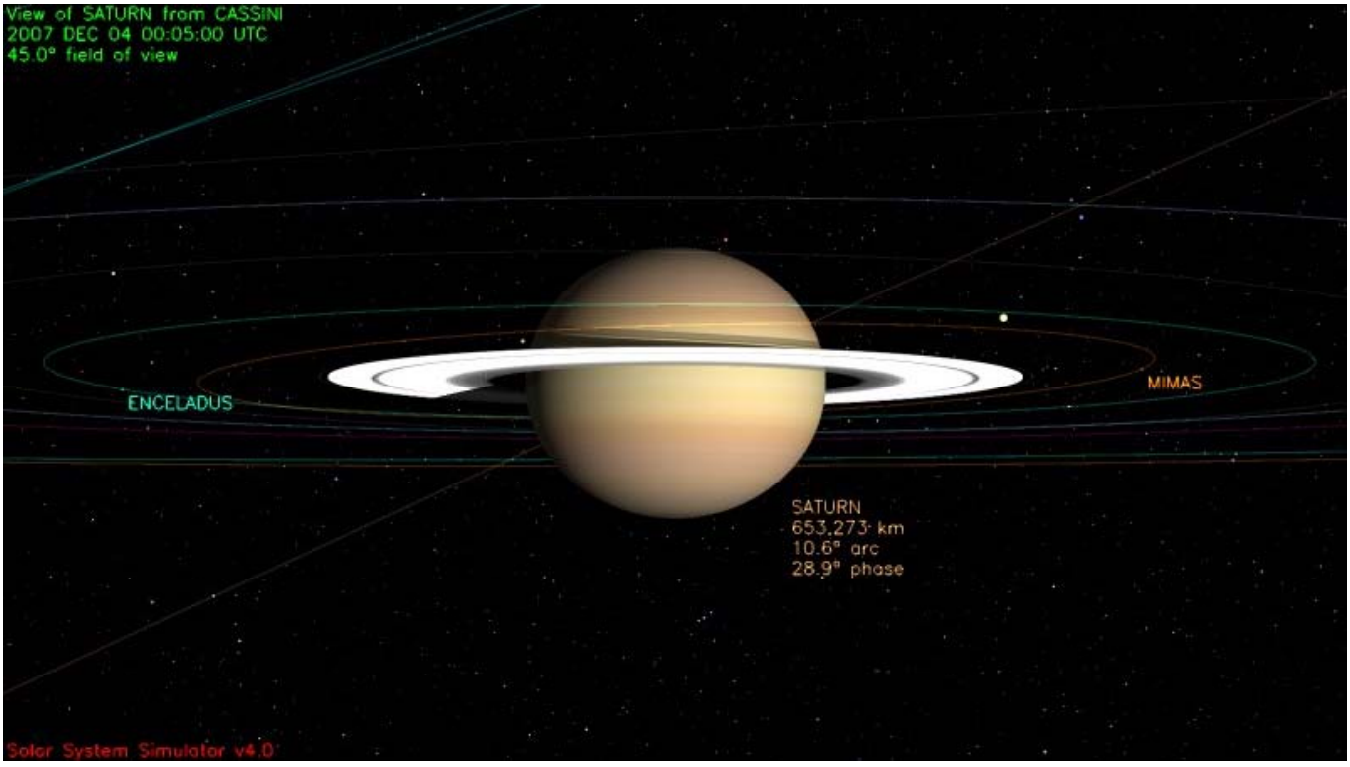
Jet Propulsion Laboratory
California Institute of Technology

Cover image: Through the obscuring haze come glimpses of Titan's dune seas. The dark, equatorial region known as Shangri-la is visible here. Cassini radar images show that Shangri-la and other dark regions around the moon's middle are filled with vast stretches of parallel dunes. These regions appear to be lowland areas surrounded by brighter, higher terrain. Lit terrain seen here is on the anti-Saturn side of Titan (5,150 kilometers, or 3,200 miles across). North is up and rotated 21 degrees to the right. The image was taken with the Cassini spacecraft narrow-angle camera on Oct. 19, 2007 using a combination of spectral filters sensitive to wavelengths of polarized infrared light centered at 746 and 938 nanometers. The view was acquired at a distance of approximately 1.4 million kilometers (851,000 miles) from Titan and at a Sun-Titan-spacecraft, or phase, angle of 80 degrees. Image scale is 8 kilometers (5 miles) per pixel. Credit: NASA/JPL/Space Science Institute

1.0 OVERVIEW

Sixteen days after Cassini's Titan-37 flyby, the spacecraft revisits Titan for its thirty-ninth targeted encounter. The closest approach to Titan occurs on Tuesday, December 4, at 2007-339T00:06:50 spacecraft time at an altitude of 1,300 kilometers (~807 miles) above the surface and at a speed of 6.3 kilometers per second (14,000 mph). The latitude at closest approach is 79 degrees S and the encounter occurs on orbit number 53.

This encounter is set up with two maneuvers: an apoapsis maneuver on November 26, and a Titan approach maneuver, scheduled for December 2. T38 is the third in a series of outbound encounters that will last until the end of the prime mission, and occurs less than two days after Saturn closest approach. This is the third in a series of seven Titan southern hemisphere encounters.



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 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 existence of oceans or lakes of liquid methane on Saturn's moon Titan was predicted more than 20 years ago. Radar and imaging data from Titan flybys have provided convincing evidence for large bodies of liquid. With Titan's colder temperatures and hydrocarbon-rich atmosphere, these lakes and seas most likely contain a combination of liquid methane and ethane (both hydrocarbons), not water.

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.

1.1 TITAN-38 SCIENCE HIGHLIGHTS

- **VIMS** will carry out high-resolution (kilometer) surface coverage of the Ontario lake area at closest approach. This will be a good opportunity to characterize the environment of the lake at optical wavelengths. This North-South flyby will also allow us to see the Huygens landing site at 5 to 10 kilometer resolution. More opportunities in the extended mission will allow us to assess Titan's spin rate, which seems to be different from synchronous with its orbit around Saturn (just as our moon's spin rate is synchronous with its orbit around the Earth). Imaging will start at Adiri and then continue southward to Lacus Ontario. The instrument will also conduct medium resolution mapping of Titan's southern hemisphere, and search for atmospheric and surface changes relative to images taken early in the mission.
- **ISS** will conduct a high-resolution regional mapping just after closest approach. There may be an opportunity for stereo imaging in conjunction with images from an earlier flyby. The instrument will ride along with VIMS observations of Lacus Ontario and the landing site. As we recede, ISS will make a regional-scale mapping of the equatorial bright-dark boundary around 7-10 N, 213 W. and a full-disk, color mosaic.
- **CIRS** will obtain information on surface & tropopause temperatures, and on tropospheric CH4. Other observations include vertical sounding of stratospheric compounds on Titan via a rare far-infrared limb scan, including H2O and vertical aerosol sounding of Titan's stratosphere.
- **UVIS** makes several slow scans across Titan's visible hemisphere to form spectral images. The objective is to obtain spectral images of Titan in the EUV and FUV to map the aurora and dayglow, to map hydrocarbon absorption, and to measure scattering and absorption by aerosols in the stratosphere. The UVIS slit will be scanned across Titan's disk to build up an image at many wavelengths.
- **MAG** will examine the transition area from the southern lobe to the outer flank region of its induced magnetosphere.
- **RPWS** objectives are to study the density and temperature of ionospheric electrons and to look for plasma waves that participate in the interaction of Saturn's magnetosphere with Titan.

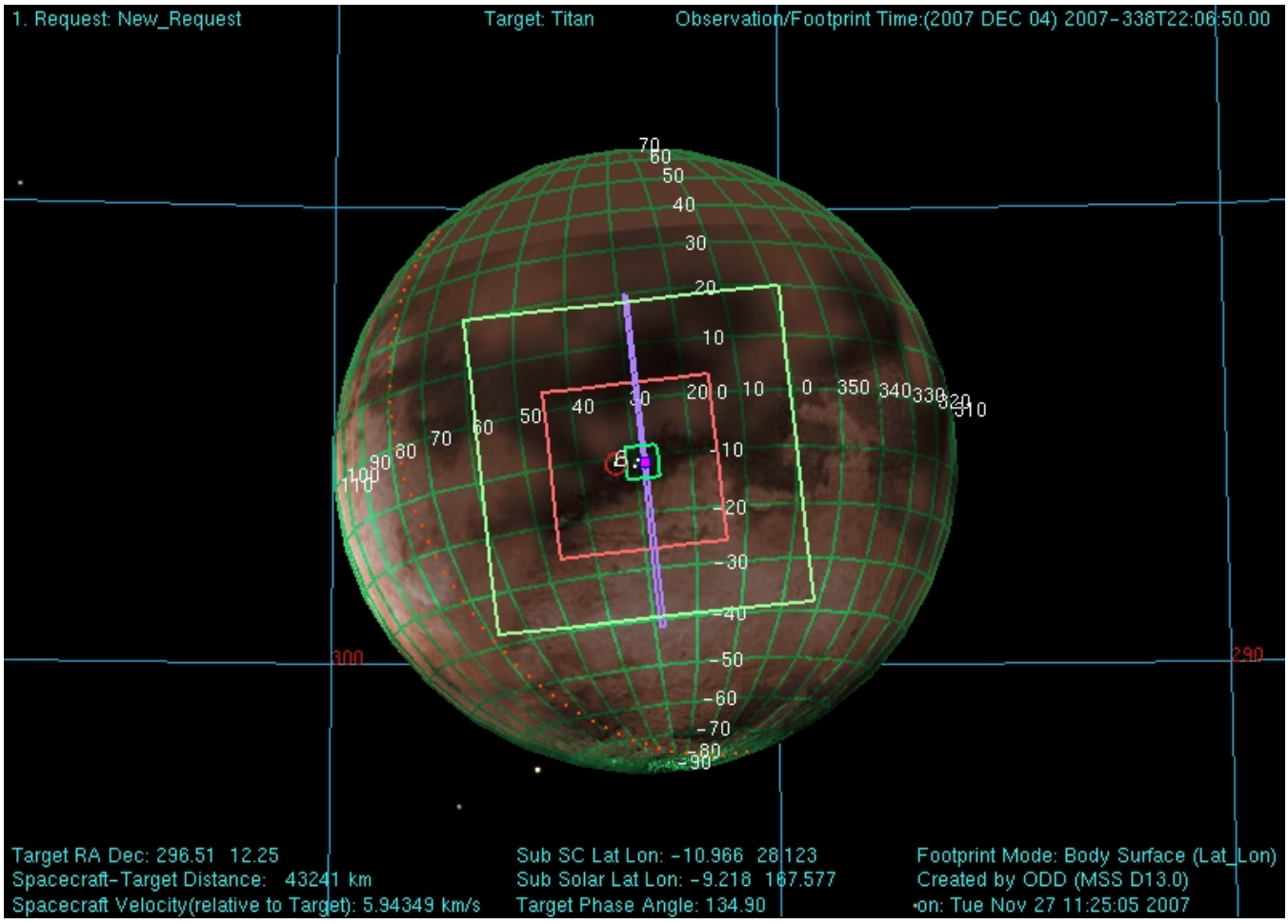
1.2 SAMPLE SNAPSHOTS

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 remote sensing instruments' fields of view are shown 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.

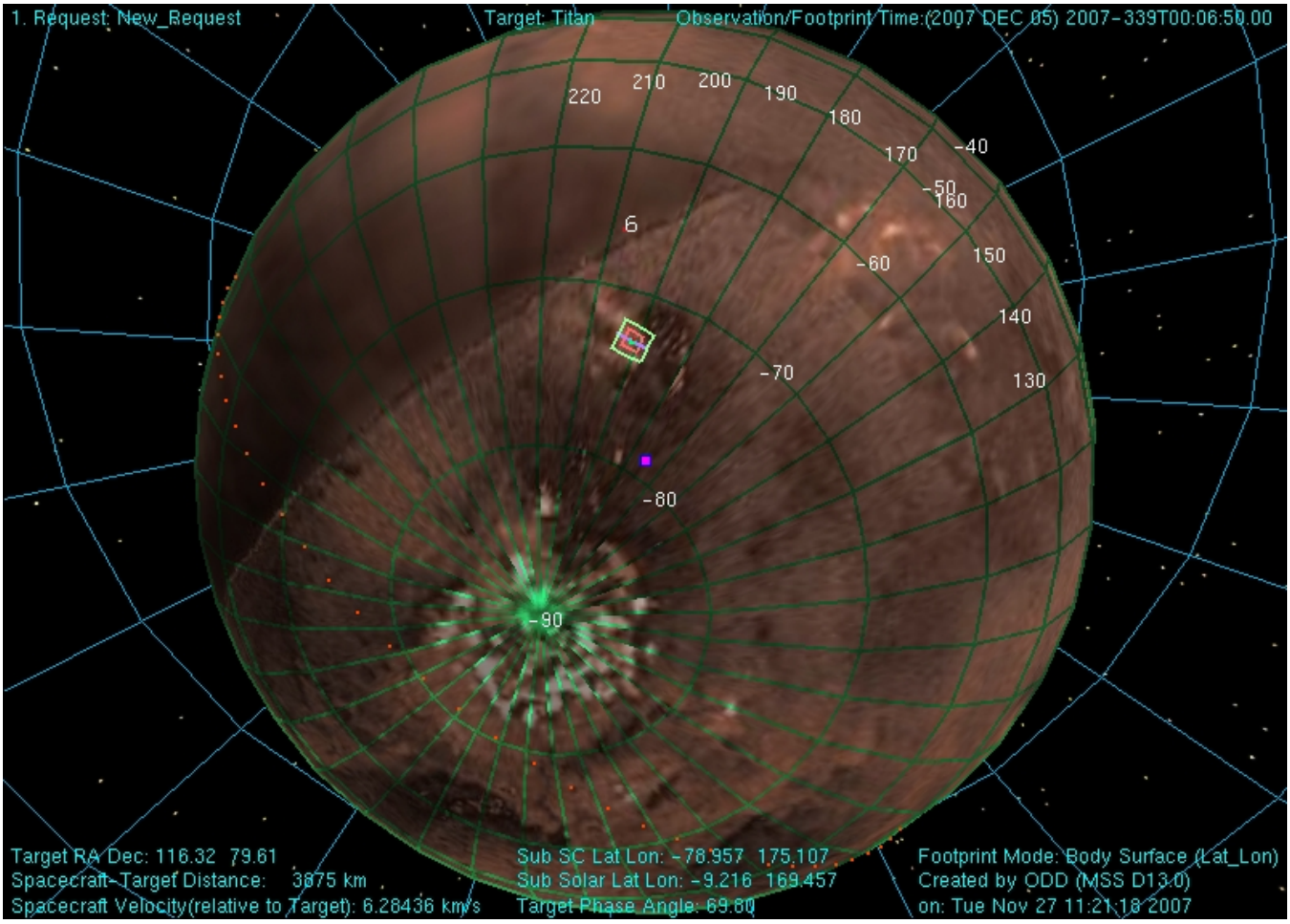
Key to ORS Instrument Fields of View in Figures

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

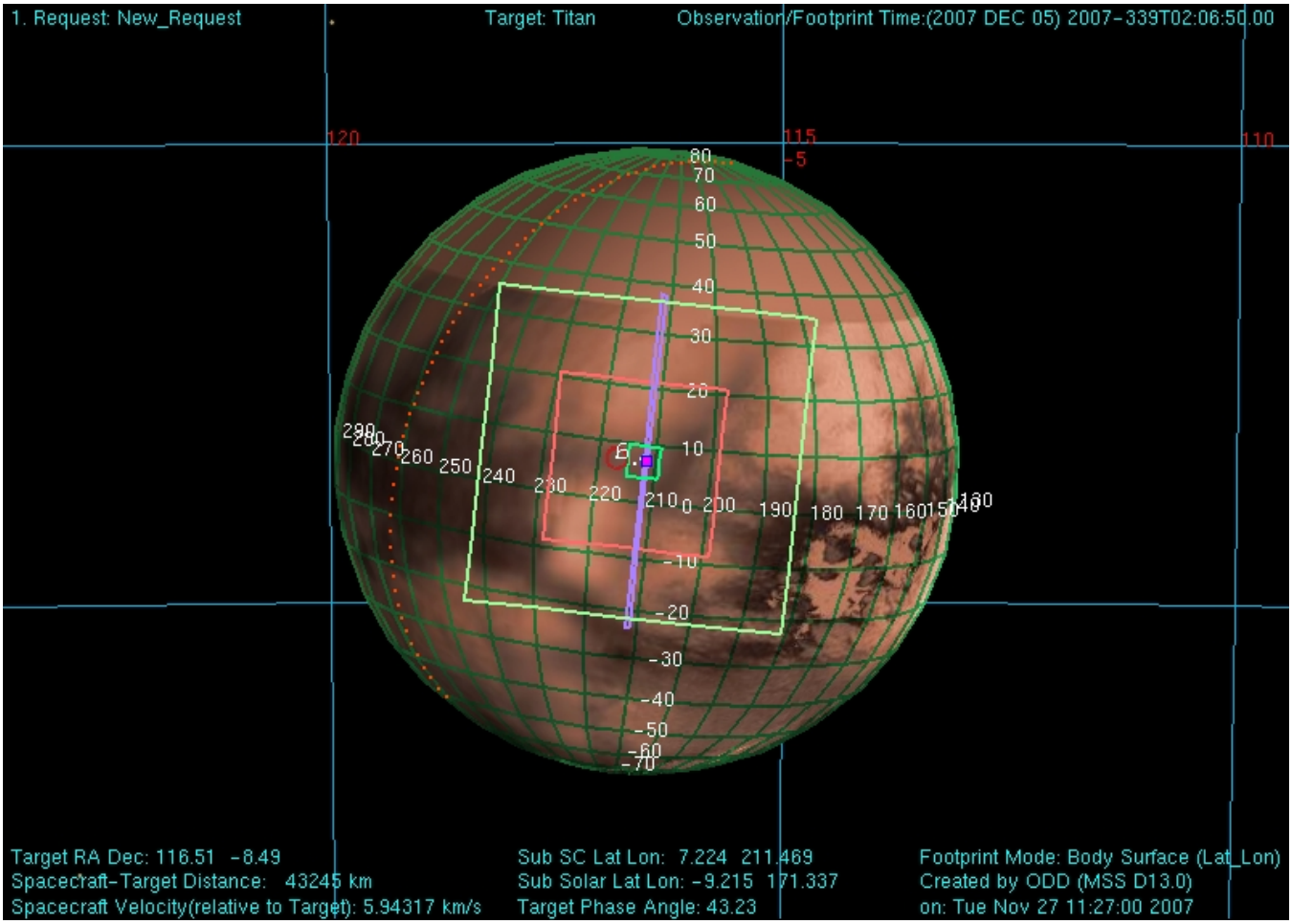
View of Titan from Cassini two hours before Titan-38 closest approach



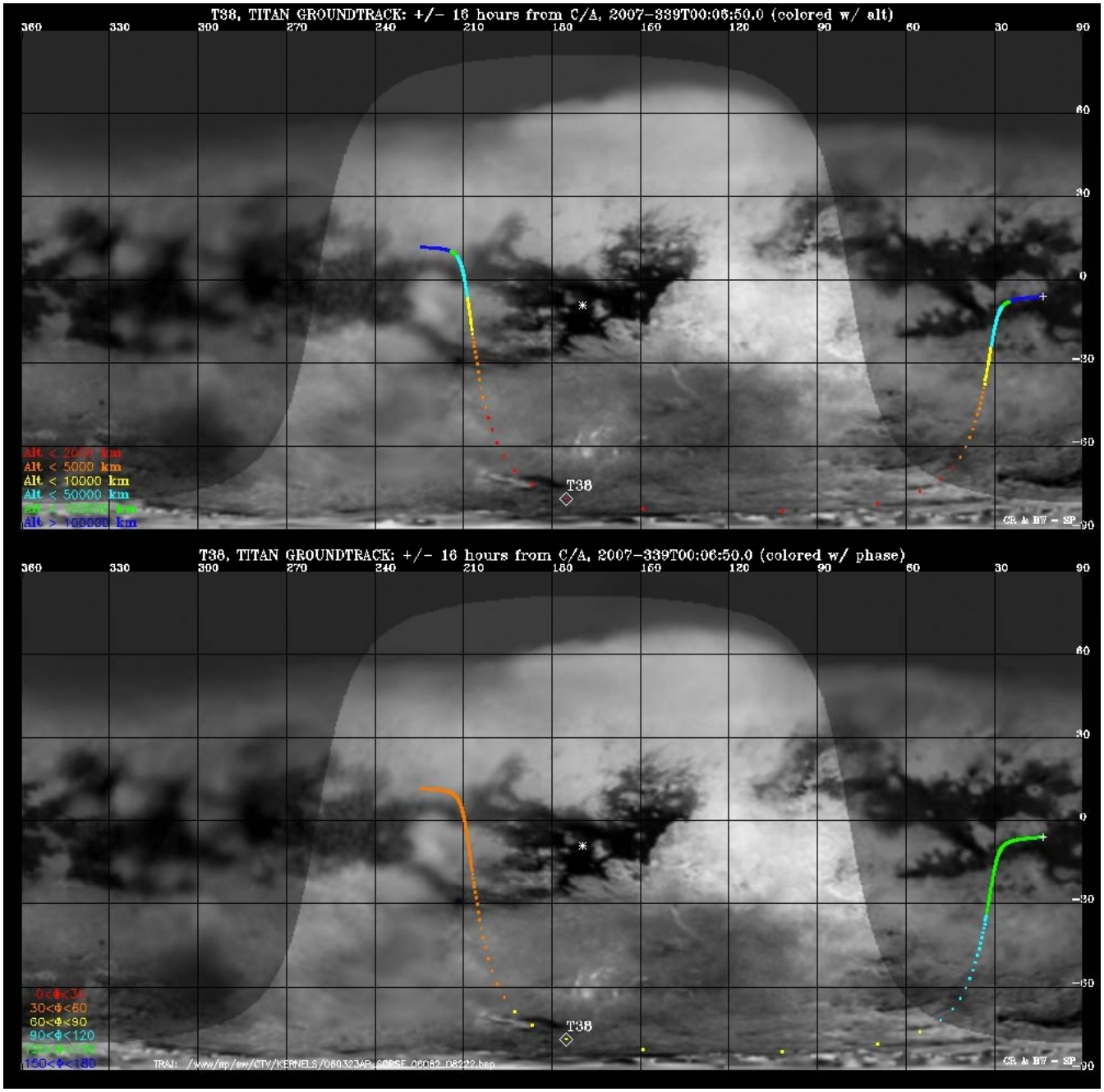
View of Titan from Cassini at Titan-38 closest approach



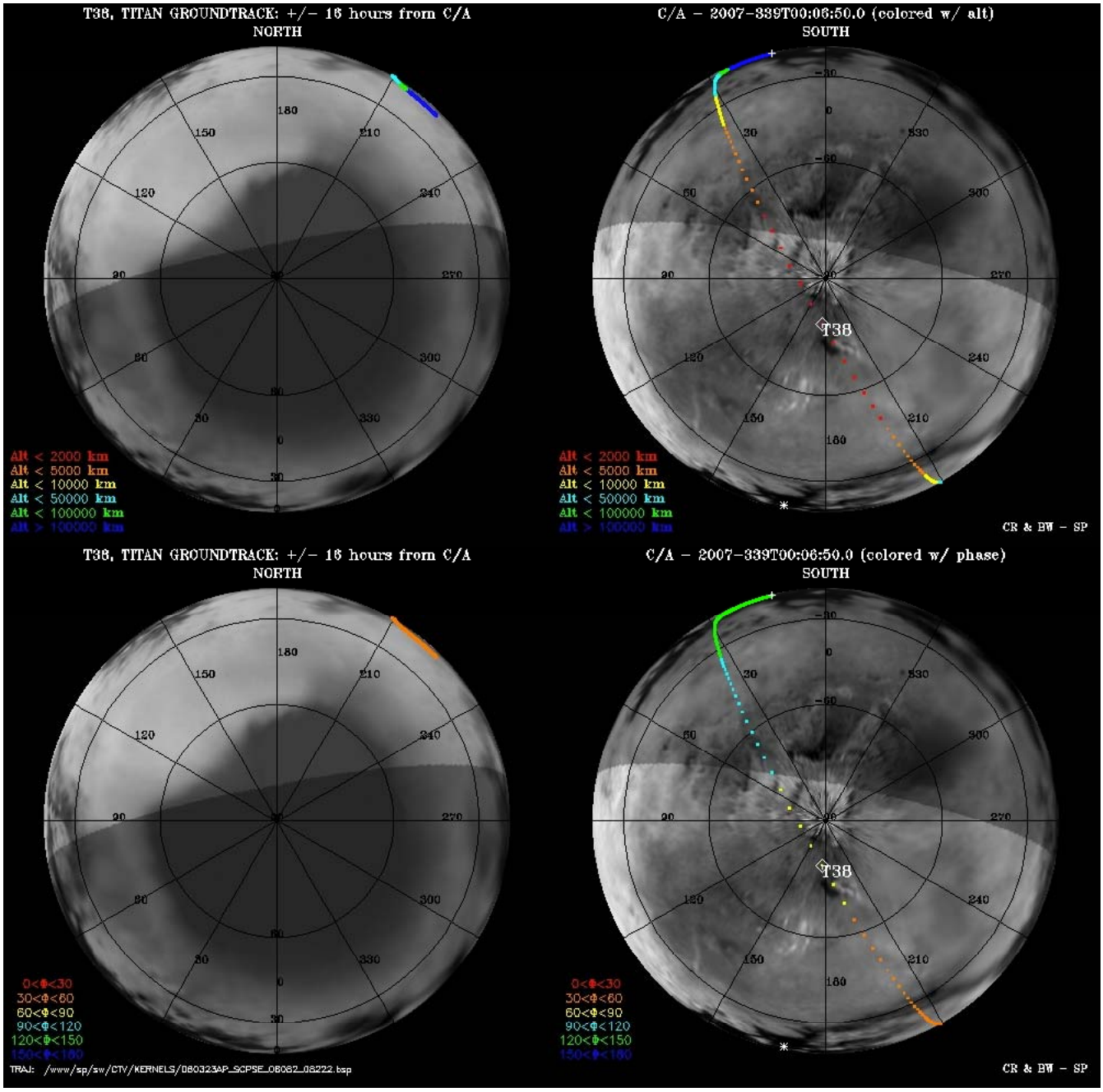
View of Titan from Cassini two hours after Titan-38 closest approach



Titan Groundtracks for T38: Global Plot



Titan Groundtracks for T38: Polar Plot



The T38 timeline is as follows:

Cassini Titan-38 Timeline - December 2007

Colors: yellow = maneuvers; blue = geometry; pink = T38-related; green = data playbacks

Orbiter UTC	Ground UTC	Pacific Time	Time wrt T38	Activity	Description
304T18:40:00	Oct 31 19:56	Wed Oct 31 11:56 AM	T38-34d05h	Start of Sequence S35	Start of Sequence which contains Titan-38
336T07:44:00	Dec 02 09:00	Sun Dec 02 01:00 AM	T38-02d16h	OTM #136 Prime	Titan-38 targeting maneuver.
337T06:41:51	Dec 03 07:57	Sun Dec 02 11:57 PM	T38-01d17h	Descending Ring Plane Crossing	
337T07:39:52	Dec 03 08:55	Mon Dec 03 12:55 AM	T38-01d16h	Saturn Periapse	Saturn periapse, R = 2.5 Rs, lat = -6 deg, phase = 155 deg
337T09:10:00	Dec 03 10:26	Mon Dec 03 02:26 AM	T38-01d15h	OTM #136 Backup	
338T09:14:00	Dec 04 10:30	Tue Dec 04 02:30 AM	T38-14h52m	Start of the TOST segment	
338T09:14:00	Dec 04 10:30	Tue Dec 04 02:30 AM	T38-14h52m	Turn cameras to Titan	
338T09:44:00	Dec 04 11:00	Tue Dec 04 03:00 AM	T38-14h22m	Deadtime	15 minutes 50 seconds long; used to accommodate changes in flyby time
338T09:59:50	Dec 04 11:15	Tue Dec 04 03:15 AM	T38-14h07m	Titan atmospheric Observations-CIRS	Obtain information on CO, HCN, CH4. Integrate on disk at airmass 1.5--2.0.
338T14:06:50	Dec 04 15:22	Tue Dec 04 07:22 AM	T38-10h00m	Titan atmospheric observations-ISS	WAC Photometry
338T15:06:50	Dec 04 16:22	Tue Dec 04 08:22 AM	T38-09h00m	Titan atmospheric Observations-UVIS	Spectral scans across Titan's visible hemisphere
338T18:36:50	Dec 04 19:52	Tue Dec 04 11:52 AM	T38-05h30m	Titan atmospheric observations-CIRS	Obtain information on surface & tropopause temperatures, and on tropospheric CH4.
338T21:36:50	Dec 04 22:52	Tue Dec 04 02:52 PM	T38-02h30m	Titan atmospheric observations-CIRS	Vertical sounding of stratospheric compounds on Titan, including H2O.
338T22:51:50	Dec 05 00:07	Tue Dec 04 04:07 PM	T38-01h15m	Titan atmospheric observations-CIRS	Vertical aerosol sounding of Titan's stratosphere.
338T23:16:50	Dec 05 00:32	Tue Dec 04 04:32 PM	T38-00h50m	Titan atmospheric observations-CIRS	Vertical temperature sounding of Titan's tropopause & stratosphere.
338T23:51:50	Dec 05 01:07	Tue Dec 04 05:07 PM	T38-00h15m	Titan surface observations-VIMS	High resolution mapping
339T00:06:50	**Dec 05 01:22**	**Tue Dec 04 05:22 PM**	**T38+00h00m**	**Titan-38 Flyby Closest Approach Time**	**Altitude = 1300 km (807 miles), speed = 6.3 km/s (14,000 mph); 70 deg phase at closest approach**
339T02:17:32	Dec 05 03:33	Tue Dec 04 07:33 PM	**T38+02h11m**	Ascending Ring Plane Crossing	
339T02:06:50	Dec 05 03:22	Tue Dec 04 07:22 PM	T38+02h00m	Titan surface observations-ISS	Regional Map
339T04:06:50	Dec 05 05:22	Tue Dec 04 09:22 PM	T38+04h00m	Titan atmospheric observations-CIRS	Obtain information on surface & tropopause temperatures, and on tropospheric CH4.
339T05:06:50	Dec 05 06:22	Tue Dec 04 10:22 PM	T38+05h00m	Titan surface observations-ISS	Global Map
339T08:06:50	Dec 05 09:22	Wed Dec 05 01:22 AM	T38+08h00m	Titan surface observations-VIMS	Regional Map
339T09:06:50	Dec 05 10:22	Wed Dec 05 02:22 AM	T38+09h00m	Titan atmospheric observations-CIRS	Obtain information on CO, HCN, CH4. Integrate on disk at airmass 1.5--2.0.
339T11:06:50	Dec 05 12:22	Wed Dec 05 04:22 AM	T38+11h00m	Monitoring of surface and atmosphere-ISS	Monitoring for surface/atmosphere changes; attempt to see surface color variations; monitor limb hazes.
339T13:06:50	Dec 05 14:22	Wed Dec 05 06:22 AM	T38+13h00m	Titan surface observations-VIMS	Regional Map
339T14:06:50	Dec 05 15:22	Wed Dec 05 07:22 AM	T38+14h00m	Titan atmospheric observations-CIRS	Obtain information on the thermal structure of Titan's stratosphere.
339T23:43:50	Dec 06 00:59	Wed Dec 05 04:59 PM	T38+23h37m	Deadtime	15 minutes 10 seconds long; used to accommodate changes in flyby time
339T23:59:00	Dec 06 01:15	Wed Dec 05 05:15 PM	T38+23h53m	Turn to Earth-line	
340T00:29:00	Dec 06 01:45	Wed Dec 05 05:45 PM	T38+01d00h	Playback of T38 Data	Madrid 70

The T38 playback timelines is as follows (following page):

T38 (53TI) Playback Timeline **Created Nov 13, 2007**

Event or Observation	Observation Type (APGEN)	Observation Record Start Time (yyyy-dddThh:mm:ss) (SCET)	Record Start Time - Reference Epoch (hh:mm)	Start Playback (Ground UTC)		Start Playback (Pacific Time)	
				Best Estimate	Using Average Data Rates	Best Estimate	Using Average Data Rates
RPWS_053SA_INSURVEY003_PRIME	RPWS_30464	2007-338T09:14:00	-00T14:53	06-Dec Thu 01:50 AM	Tue 10:11 AM	05-Dec Wed 05:50 PM	Tue 02:11 AM
MAG_053OT_SURVEY004_PRIME	MAG_1976	2007-338T09:14:00	-00T14:53	06-Dec Thu 01:50 AM	Tue 10:11 AM	05-Dec Wed 05:50 PM	Tue 02:11 AM
CDA_053OT_DRATE005_RIDER	CDA_524	2007-338T09:14:00	-00T14:53	06-Dec Thu 01:50 AM	Tue 10:11 AM	05-Dec Wed 05:50 PM	Tue 02:11 AM
MIMI_053SA_MAGDYN003_PRIME	MIMI_8000	2007-338T09:14:01	-00T14:52	06-Dec Thu 01:50 AM	Tue 10:11 AM	05-Dec Wed 05:50 PM	Tue 02:11 AM
CDA_053OT_DRATE006_RIDER	CDA_524	2007-338T09:49:54	-00T14:17	06-Dec Thu 01:52 AM	Tue 07:53 AM	05-Dec Wed 05:52 PM	Mon 11:53 PM
CDA_053DR_1502DUST400_RIDER	CDA_524	2007-338T09:49:54	-00T14:17	06-Dec Thu 01:52 AM	Tue 07:53 AM	05-Dec Wed 05:52 PM	Mon 11:53 PM
VIMS_053TI_FIRNADCMP001_CIRS	VIMS_18432	2007-338T09:59:50	-00T14:07	06-Dec Thu 01:53 AM	Tue 07:54 AM	05-Dec Wed 05:53 PM	Mon 11:54 PM
UVIS_053TI_FIRNADCMP001_CIRS	UVIS_5032	2007-338T09:59:50	-00T14:07	06-Dec Thu 01:53 AM	Tue 07:54 AM	05-Dec Wed 05:53 PM	Mon 11:54 PM
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CIRS_053TI_FIRNADCMP001_PRIME	CIRS_4000	2007-338T09:59:50	-00T14:07	06-Dec Thu 01:53 AM	Tue 07:54 AM	05-Dec Wed 05:53 PM	Mon 11:54 PM
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ISS_053TI_PHOTOMWAC001_PRIME	ISS_Phot_1_by_1	2007-338T14:06:50	-00T10:00	06-Dec Thu 02:26 AM	Thu 01:49 AM	05-Dec Wed 06:26 PM	Wed 05:49 PM
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MAG_053TI_MAGTITAN001_PRIME	MAG_1976	2007-338T20:06:50	-00T04:00	06-Dec Thu 03:12 AM	Thu 02:44 AM	05-Dec Wed 07:12 PM	Wed 06:44 PM
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CIRS_053TI_FIRLMBAER001_PRIME	CIRS_4000	2007-338T22:51:50	-00T01:15	06-Dec Thu 03:38 AM	Thu 03:13 AM	05-Dec Wed 07:38 PM	Wed 07:13 PM
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CIRS_053TI_FIRNADMAP002_PRIME	CIRS_4000	2007-339T04:06:50	00T03:59	06-Dec Thu 06:23 AM	Thu 06:18 AM	05-Dec Wed 10:23 PM	Wed 10:18 PM
VIMS_053TI_MONITORNA002_ISS	VIMS_18432	2007-339T05:06:50	00T04:59	06-Dec Thu 06:30 AM	Thu 06:25 AM	05-Dec Wed 10:30 PM	Wed 10:25 PM
ISS_053TI_GLOBMAP001_PRIME	ISS_Phot_1_by_1	2007-339T05:06:50	00T04:59	06-Dec Thu 06:30 AM	Thu 06:25 AM	05-Dec Wed 10:30 PM	Wed 10:25 PM
CIRS_053TI_REGMAP002_ISS	CIRS_4000	2007-339T05:06:50	00T04:59	06-Dec Thu 06:30 AM	Thu 06:25 AM	05-Dec Wed 10:30 PM	Wed 10:25 PM
VIMS_053TI_GLOBMAP003_PRIME	VIMS_18432	2007-339T08:06:50	00T07:59	06-Dec Thu 07:17 AM	Thu 07:22 AM	05-Dec Wed 11:17 PM	Wed 11:22 PM
CIRS_053TI_REGMAP002_VIMS	CIRS_4000	2007-339T08:06:50	00T07:59	06-Dec Thu 07:17 AM	Thu 07:22 AM	05-Dec Wed 11:17 PM	Wed 11:22 PM