RADAR Titan Flyby during S61/T71

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- Sequence: s61
- Rev: 134
- Observation Id: t71
- Target Body: Titan
- Data Take Number: 220
- PDT Config File: S61_ssup_psiv1_100426_pdt.cfg
- SMT File: S61_100329.rpt
- PEF File: z0610c.pef

1 Introduction

This memo describes the Cassini RADAR activities for the T71 Titan flyby. This SAR data collection occurs during the S61 sequence of the Saturn Tour. This is a partial radar pass with ride-along main swath SAR imaging. A sequence design memo provides the science context of the scheduled observations, an overview of the pointing design, and guidlines for preparing the RADAR IEB.

2 CIMS and Division Summary

CIMS ID	Start	End	Duration	Comments
134TI_T71WARMUP001_RIDER	2010-187T15:22:45	2010-187T18:22:45	03:00:0.0	
134TI_T71INRAD001_PRIME	2010-187T18:22:45	2010-187T22:07:45	03:45:0.0	
134TI_T71FCAPS001_PRIME	2010-187T22:07:45	2010-187T23:33:45	01:26:0.0	
134TI_T71FCAPS004_PRIME	2010-187T23:34:45	2010-188T00:04:45	00:30:0.0	
134TI_T71RASAR001_PRIME	2010-188T00:04:45	2010-188T00:40:45	00:36:0.0	
134TI_T71FCAPS002_PRIME	2010-188T00:40:45	2010-188T00:50:45	00:10:0.0	
134TI_T71FCAPS003_PRIME	2010-188T01:12:45	2010-188T02:37:45	01:25:0.0	
134TI_T71OUTRAD001_PRIME	2010-188T02:37:45	2010-188T06:22:45	03:45:0.0	

Table 1: t71 CIMS Request Sequence

Each RADAR observation is represented to the project by a set of requests in the Cassini Information Management System (CIMS). The CIMS database contains requests for pointing control, time, and data volume. The CIMS requests

Division	Name	Start	Duration	Data Vol	Comments
a	Warmup	-9:00:0.0	03:19:0.0	11.8	Warmup
b	standard_radiometer_inbound	-5:41:0.0	00:05:0.0	0.3	Inbound radiometry
c	scatterometer_compressed	-5:36:0.0	00:18:0.0	7.2	Compressed Scatt/Rad scan
d	scatterometer_compressed	-5:18:0.0	00:42:0.0	19.2	Compressed Scatt/Rad scan
e	scatterometer_compressed	-4:36:0.0	00:26:0.0	13.3	Compressed Scatt/Rad scan
f	scatterometer_compressed	-4:10:0.0	00:25:0.0	14.4	Compressed Scatt/Rad scan
g	scatterometer_compressed	-3:45:0.0	01:03:0.0	14.4	Compressed Scatt/Rad scan
h	standard_scatterometer_inbound	-2:42:0.0	00:04:0.0	22.8	Normal Scatt/Rad scan
i	standard_radiometer_inbound	-2:38:0.0	02:32:0.0	9.0	Inbound Radiometry Filler
j	standard_sar_hi	-0:06:0.0	00:01:0.0	14.0	Inbound Ride-along SAR
k	standard_sar_hi	-0:05:0.0	00:10:0.0	140.4	Ride-along SAR Main Swath
l	standard_sar_hi	00:05:0.0	00:01:0.0	14.0	Outbound Ride-along SAR
m	standard_radiometer_outbound	00:06:0.0	02:25:0.0	8.6	Outbound Radiometry Filler
n	scatterometer_compressed	02:31:0.0	00:07:0.0	1.6	Compressed Scatt/Rad scan
o	standard_scatterometer_outbound	02:38:0.0	00:04:0.0	22.8	Normal Scatt/Rad scan
p	scatterometer_compressed	02:42:0.0	01:03:0.0	14.4	Compressed Scatt/Rad scan
q	scatterometer_compressed	03:45:0.0	00:25:0.0	14.4	Compressed Scatt/Rad scan
r	scatterometer_compressed	04:10:0.0	00:26:0.0	13.3	Compressed Scatt/Rad scan
s	scatterometer_compressed	04:36:0.0	00:42:0.0	19.2	Compressed Scatt/Rad scan
t	scatterometer_compressed	05:18:0.0	00:19:0.0	7.6	Compressed Scatt/Rad scan
u	standard_radiometer_outbound	05:37:0.0	00:23:0.0	1.4	Outbound radiometry
Total				384.1	

Table 2: Division summary. Data volumes (Mbits) are estimated from maximum data rate and division duration.

Div	Alt (km)	Slant range (km)	B3 Size (target dia)	B3 Dop. Spread (Hz)
a	177770	off target	0.23	off target
b	111211	off target	0.14	off target
c	109546	off target	0.14	off target
d	103557	104586	0.13	182
e	89594	90008	0.12	155
f	80958	off target	0.10	off target
g	72659	off target	0.09	off target
h	51761	off target	0.07	off target
i	50435	off target	0.07	off target
j	1555	2211	0.01	2217
k	1395	1812	0.00	2306
l	1395	1812	0.00	2306
m	1555	2211	0.01	2217
n	48108	off target	0.06	off target
o	50428	off target	0.07	off target
p	51754	off target	0.07	off target
q	72643	73400	0.09	129
r	80938	off target	0.10	off target
s	89567	91562	0.12	148
t	103515	off target	0.13	off target
u	109829	off target	0.14	off target

Table 3: Division geometry summary. Values are computed at the start of each division. B3 Doppler spread is for two-way 3-dB pattern. B3 size is the one-way 3-dB beamwidth

show a high-level view of the sequence design. Table 1 shows the CIMS request summary for this observation. Although the CIMS requests show Low-SAR intervals, in reality the radar will be operated in Hi-SAR mode through most of this flyby.

The CIMS requests form the basis of a pointing design built using the project pointing design tool (PDT). The details of the pointing design are shown by the PDT plots on the corresponding tour sequence web page. (See https://cassini.jpl.nasa.gov/radar.) The RADAR pointing sequence is ultimately combined with pointing sequences from other instruments to make a large merged c-kernel. C-kernels are files containing spacecraft attitude data.

A RADAR tool called RADAR Mapping and Sequencing Software (RMSS) reads the merged c-kernel along with other navigation data files, and uses these data to produce a set of instructions for the RADAR observation. The RADAR instructions are called an Instrument Execution Block (IEB). The IEB is produced by running RMSS with a radar config file that controls the process of generating IEB instructions for different segments of time. These segments of time are called divisions with a particular behavior defined by a set of division keywords in the config file. Table 2 shows a summary of the divisions used in this observation. Table 3 shows a summary of some key geometry values for each division.

3 Overview

T71 is a partial radar pass with ride-along SAR imaging in the South polar area near T7 and crossing the ends of the T55, T56 and T58 swaths. Complete inbound and outbound radiometry scans with two polarizations are collected along with coincident compressed scatterometry. No altimetry or regular scatterometry scans are collected.

4 Mode Specific Operation and Performance

Many details of standard radar sequencing during the 4 main modes (Radiometry, Scatterometry, Altimetry, and SAR) have been discussed in previous sequence memos for prior observations. Refer to these for details. Some selecte

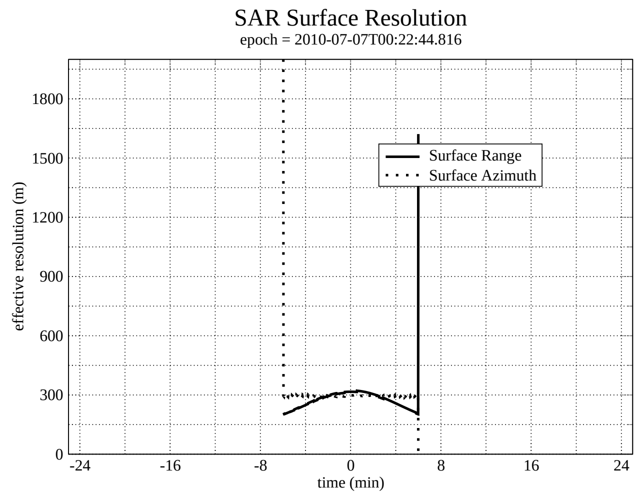

Figure 1: SAR projected range and azimuth resolution. These values are computed from the IEB parameters and are not related to the pixel size in the BIDR file. The pixel size was selected to be always smaller than the real resolution.

performance highlights are illustrated in figures and explained in the following subsections.

4.1 SAR Resolution Performance

For all of the SAR divisions the effective resolution can be calculated from the same equations used in the high-altitude imaging discussion. Figure 1 shows the results from these equations using the parameters from the IEB as generated by RMSS. The calculations are performed for the boresight of beam 3 which is the center of the swath.

Projected range increases with decreasing incidence angle, so the range resolution varies across the swath with better resolution at the outer edge. The SAR pointing profile decreases the incidence angle as time progresses and altitude increases, so there is progressive deterioration of range resolution away from closest approach. The projected range resolution rapidly deteriorates as the incidence angle decreases toward zero at the very beginning and end of the swath.

Azimuth resolution is a function of the synthetic aperture size which is determined by the length of the receive window in each burst (assuming the receive window is always filled with echos). Azimuth resolution deteriorates less quickly because the number of pulses and the length of the receive window are increased as altitude increases which mitigates the increasing doppler bandwidth of the beam patterns. The receive window length increases to fill the round trip time until the science data buffer is filled. At this point it is no longer possible to extend the receive window, and azimuth resolution starts to deteriorate more rapidly.

5 Revision History

1. June 9, 2011: Final release

6 Acronym List

ALT	Altimeter - one of the radar operating modes
BAQ	Block Adaptive Quantizer
CIMS	Cassini Information Management System - a database of observations
Ckernel	NAIF kernel file containing attitude data
DLAP	Desired Look Angle Profile - spacecraft pointing profile designed for optimal SAR performance
ESS	Energy Storage System - capacitor bank used by RADAR to store transmit energy
IEB	Instrument Execution Block - instructions for the instrument
ISS	Imaging Science Subsystem
IVD	Inertial Vector Description - attitude vector data
IVP	Inertial Vector Propagator - spacecraft software, part of attitude control system
INMS	Inertial Neutral Mass Spectrometer - one of the instruments
NAIF	Navigation and Ancillary Information Facility
ORS	Optical Remote Sensing instruments
PDT	Pointing Design Tool
PRI	Pulse Repetition Interval
PRF	Pulse Repetition Frequency
RMSS	Radar Mapping Sequencing Software - produces radar IEB's
SAR	Synthetic Aperture Radar - radar imaging mode
SNR	Signal to Noise Ratio
SOP	Science Operations Plan - detailed sequence design
SOPUD	Science Operations Plan Update - phase of sequencing when SOP is updated prior to actual sequencing
SSG	SubSequence Generation - spacecraft/instrument commands are produced
SPICE	Spacecraft, Instrument, C-kernel handling software - supplied by NAIF to use NAIF kernel files.
TRO	Transmit Receive Offset - round trip delay time in units of PRI