Saturn Scatterometry Rev 255

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- Sequence: s97
- Rev: 255
- Observation Id: ri_255_1
- Target Body: Saturn

1 Introduction

This memo describes one of the Cassini RADAR activities for the s97 sequence of the Saturn Tour. A sequence design memo provides the science context of the scheduled observations, an overview of the pointing design, and guidelines for preparing the RADAR IEB. A 4.5-hour warmup occurs first using the parameters shown in table 3.

2 CIMS and Division Summary

CIMS ID	Start	End	Duration	Comments
255RI_WARMUP001_RIDER	2017-002T01:12:00	2017-002T05:37:00	04:25:0.0	
255RI_RADSCNOUT001_PIE	2017-002T05:37:00	2017-002T10:00:00	04:23:0.0	

Table 1: ri_255_1 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 show a high-level view of the sequence design.

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. Subsequent sections will show and discuss the keyword selections made for each division. Each division table shows a set of nominal parameters that are determined by the operating mode (eg., distant scatterometry, SAR low-res inbound). The actual division parameters from the config file are also shown, and any meaningful mismatches are flagged.

Division	Name	Start	Duration	Data Vol	Comments
a	distant_warmup	00:00:0.0	04:28:0.0	16.0	Warmup
b	distant_radiometer	04:28:0.0	00:22:0.0	1.3	Distant Radiometer
c	distant_radiometer	04:50:0.0	00:04:0.0	0.2	Radiometer quick steps
d	distant_scatterometer	04:54:0.0	00:01:12.0	4.2	Ring scatterometry
e	distant_scatterometer	04:55:12.0	00:01:18.0	5.1	Ring scatterometry
f	distant_scatterometer	04:56:30.0	00:01:30.0	6.6	Ring scatterometry
g	distant_scatterometer	04:58:0.0	00:02:0.0	9.6	Ring scatterometry
h	distant_scatterometer	05:00:0.0	00:04:0.0	19.2	Ring scatterometry
i	distant_scatterometer	05:04:0.0	00:04:12.0	18.9	Ring scatterometry
j	distant_scatterometer	05:08:12.0	00:01:48.0	7.6	Ring scatterometry
k	distant_scatterometer	05:10:0.0	00:01:24.0	5.5	Ring scatterometry
l	distant_scatterometer	05:11:24.0	00:01:48.0	6.5	Ring scatterometry
m	distant_scatterometer	05:13:12.0	00:01:18.0	4.1	Ring scatterometry
n	distant_scatterometer	05:14:30.0	00:05:6.0	14.4	Ring scatterometry
o	distant_scatterometer	05:19:36.0	00:01:24.0	4.3	Ring scatterometry
p	distant_scatterometer	05:21:0.0	00:06:0.0	19.4	Ring scatterometry
q	distant_scatterometer	05:27:0.0	00:02:48.0	9.4	Ring scatterometry
r	distant_scatterometer	05:29:48.0	00:04:12.0	12.6	Ring scatterometry
s	distant_scatterometer	05:34:0.0	00:01:30.0	4.1	Ring scatterometry
t	distant_scatterometer	05:35:30.0	00:02:18.0	5.8	Ring scatterometry
u	distant_scatterometer	05:37:48.0	00:02:12.0	5.1	Ring scatterometry
v	distant_scatterometer	05:40:0.0	00:13:0.0	32.8	Ring scatterometry
w	distant_scatterometer	05:53:0.0	00:02:0.0	4.7	Ring scatterometry
x	distant_scatterometer	05:55:0.0	00:03:0.0	6.1	Ring scatterometry
y	distant_scatterometer	05:58:0.0	00:14:0.0	28.6	Ring scatterometry
z	distant_scatterometer	06:12:0.0	00:03:0.0	5.6	Ring scatterometry
lbrace	distant_scatterometer	06:15:0.0	00:16:0.0	67.2	Ring scatterometry
vbar	distant_scatterometer	06:31:0.0	00:34:0.0	126.5	Ring scatterometry
rbrace	distant_radiometer	07:05:0.0	01:45:0.0	6.2	Radiometry of rings
Total				457.5	

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

Name	Nominal	Actual	Mismatch	Comments
mode	radiometer	radiometer	no	
start_time (min)	varies	0.0	no	
end_time (min)	varies	268.0	no	
time_step (s)	varies	3600.0	no	Used by radiometer only modes - saves commands
bem	00100	00100	no	
baq	don't care	5	no	
csr	6	6	no	6 - Radiometer Only Mode
noise_bit_setting	don't care	4.0	no	
dutycycle	don't care	0.38	no	
prf (Hz)	don't care	1000	no	
tro	don't care	0	no	
number_of_pulses	don't care	8	no	
n_bursts_in_flight	don't care	1	no	
percent_of_BW	don't care	100.0	no	
auto_rad	on	on	no	
rip (ms)	34.0	34.0	no	
max_data_rate	0.248	0.992	yes	Kbps - set for slowest burst period
interleave_flag	off	off	no	
interleave_duration (min)	don't care	10.0	no	

Table 3: ri_255_1 Div a distant_warmup block

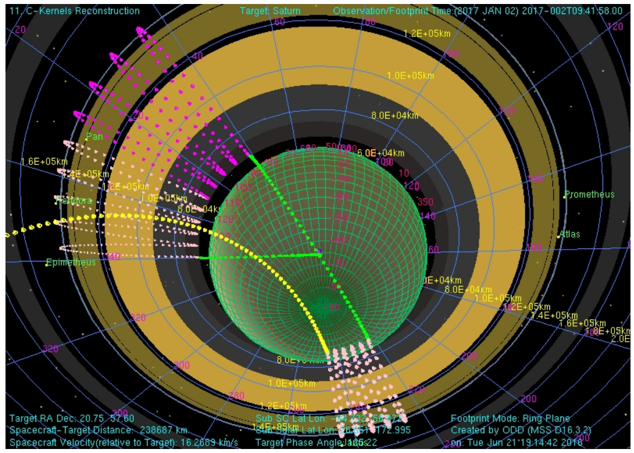

Figure 1: PDT view of RI 255 observation.

3 Overview

This observation is a Saturn rings spoke scan during one of the F-ring orbits. The primary goal is to collect passive radiometry from relatively close range. A secondary goal is to collect active real aperture scatterometry data. These data are intended to test IEB design software changes to support active observations of the rings during the F-ring and proximal orbits during the last year of the Cassini mission. Data volume is limited, so active observations are only collected for the first half of the observation when the range to the rings is lowest. Range to the beam footprint varied from about 55,000 km to 170,000 km during the active observation. Rapid motion of the beam footprint due to the spoke scans led to severe time domain clipping since there are not enough instructions to track the range gate adequately. Only real aperture results are expected to be useful, and the varying clipping will make calibration a challenge. Nonetheless, this observation serves a useful purpose by verifying the active radar data collection while targetting the ring particles each of which orbits in their own separate Keplerian paths.

4 Revision History

1. Dec 20, 2017: Initial Release

Name	Nominal	Actual	Mismatch	Comments
mode	scatterometer	scatterometer	no	
start_time (min)	varies	294.0	no	
end_time (min)	varies	295.2	no	
time_step (s)	don't care	6.0	no	Used when BIF > 1, otherwise set by valid time calculation
bem	00100	00100	no	
baq	5	5	no	
csr	0	0	no	0 - Normal Operation, 8 - with auto-gain
noise_bit_setting	4.0	4.0	no	Scat signal set higher than ALT/SAR
dutycycle	0.70	0.70	no	
prf (Hz)	varies	11500	no	Set to cover target doppler bandwidth
tro	6	6	no	6 - allows for some noise only data in time domain
number_of_pulses	varies	140	no	depends on PRF choice (can have more shorter pulses)
n_bursts_in_flight	varies	2	no	Used to increase PRF and data rate at long range
percent_of_BW	0.0	10.0	yes	
auto_rad	on	on	no	
rip (ms)	34.0	34.0	no	
max_data_rate	200.000	58.000	yes	Kbps - determines burst period
interleave_flag	off	off	no	
interleave_duration (min)	don't care	10.0	no	

Table 4: ri_255_1 Div d distant_scatterometer block

5 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