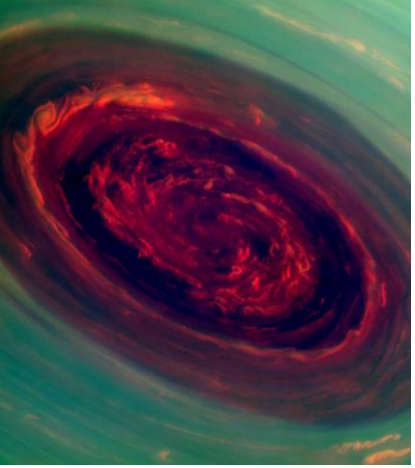
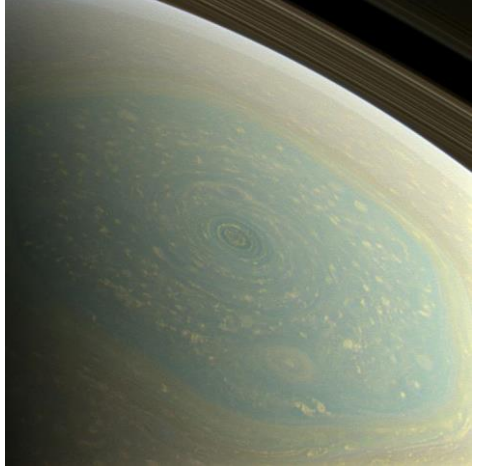
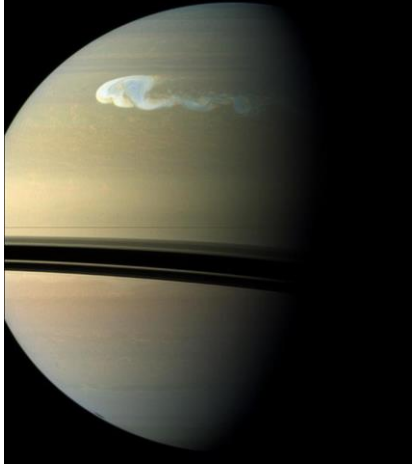


Science Planning & Sequence Team
CASSINI

SATURN TARGET WORKING TEAM

Rev 264 Segment Legacy Package

Segment Boundary: March 6, 2017 – March 9, 2017
2017-065T20:35:00 – 2017-068T23:43:00 (SCET)

Integration Began 04/11/2016
Segment Delivered to S98 Sequence 08/08/2016
Lead Integrator was Martin Brennan

Legacy Package Assembled by Martin Brennan

Table of Contents

Segment Overview and Final Products

Segment Summary

- Saturn 264 is a periapse segment within the F-Ring Orbits period, having a periapse of 2.439 R_S , starting ~1 day before perikrone and ends ~2 days after.

- The high inclination F-Ring segment begins on the night side, approaching the N. Pole, then passes through perikrone on the day side, where the POST science was planned, including a VIMS/CIRS He/H2 ratio measurement (CIRS NADIROCC and VIMS GAMCRUOCC) and the highest resolution satellite Pan observation of the mission.

- The Pan observation warranted a Dual Playback of 473Mb.

- This was an extremely contentious data volume segment. After all of the Jumpstart periapse observation period's activities were populated into CIMS, the segment was found to have nearly 4Gb of oversubscribed data. Multiple rounds of data cuts were required, including cuts to PIE observations and dropping riders.

- The magnitude of the Dual Playback led to carryover into the next XD segment (XD 264/265), but was accepted by the XD Leads.

- CMT management during Solar Occultation: NEG_Y to Sun angle < 12° is allowed to occur only when the Sun is behind Saturn, in order to enable the acquisition of high-phase observations.

- The pre-integration placement of the ISS Enceladus Plume activity did not allow time for a downlink turn after the activity, therefore the downlink attitude was established before the EN Plume PIE.

- This segment contained a "jumpstart" period. Due to the challenging geometry and unique science of this phase of the mission, the timeline for the days around periapse was decided in advance of full segment integration. Detailed pointing analysis, constraint checking, and reaction-wheel bias optimization (RBOT) was performed on the periapse period. Changes were required, see RBOT summary on page 26.

Final Sequenced SPASS

Rev 264 Jumpstart

Gap 1

Request	Riders	Start (SCET)	St	Duration	End	Primary	Secondary	Comments
Sequence 598, length = 70 days		2017-034T07:05:00		070T07:50:00	2017-104T14:55:00			
SATURN_264 Segment		2017-065T20:35:00		003T03:08:00	2017-068T23:43:00			
SP_264SA_WAYPTTURN065_PRIME		2017-065T20:35:00		000T00:44:00	2017-065T21:19:00	ISS_NAC to Saturn	POS_Z to NSP	
NEW WAYPOINT		2017-065T21:19:00		001T12:21:00	2017-067T09:40:00	ISS_NAC to Saturn	POS_Z to NSP	
UVIS_264SA_AURDSTARE001_PRIME	I,V	2017-065T21:19:00		000T01:45:00	2017-065T23:04:00	VIMS_IR to Saturn_North_Pole	POS_Z to NSP	Collaborative Rider(s): VIMS. Collaborate with VIMS
CIRS_264SA_NADIROCC001_PIE		2017-065T23:04:00		000T02:00:00	2017-066T01:04:00	CIRS_FP4 to Saturn	POS_Z to NSP	PIE, Track occ lat=0, lon=40; Verify Gam Cru lat, lon with Phil
VIMS_264SA_NPOLMAP001_PRIME	C,I,U	2017-066T01:04:00		000T06:00:00	2017-066T07:04:00	ISS_NAC to Saturn_North_Pole	POS_Z to NSP	
VIMS_264RI_GAMCRUOCC001_PIE	C,E,I,U	2017-066T07:04:00		000T02:46:00	2017-066T09:50:00	VIMS_IR to 187.791/-57.113	POS_Z to NSP	
VIMS_264SA_GAMCRUOCC001_PIE	C	2017-066T09:50:00		000T01:24:00	2017-066T11:14:00	VIMS_IR to 187.791/-57.113	POS_Z to NSP	Collaborative Rider(s): CIRS
Begin Custom		2017-066T11:14:00		000T00:00:01	2017-066T11:14:01	ISS_NAC to Saturn	POS_Z to NSP	
CIRS_264SA_LIMBINT001_PRIME	I,E,M,U	2017-066T11:14:00		000T05:21:00	2017-066T16:35:00	CIRS_FPB to Saturn	PIC	Pick up at ISS_NAC to Saturn, POS_Z to NSP; Hand off at ISS_NAC to Pan, NEG_Z to Sun.
Begin Dual Playback Science		2017-066T16:35:00		000T00:00:01	2017-066T16:35:01			
ISS_264PN_PAN001_PIE	C,E,M,U,V	2017-066T16:35:00		000T02:30:00	2017-066T19:05:00	ISS_NAC to Pan	NEG_Z to Sun	Collaborative Rider(s): CIRS. Pick up at ISS_NAC to Pan, NEG_Z to Sun; Hand off at ISS_NAC to Saturn, NEG_Z to NSP.
Periapse RP = 2.439 Rs, lat ...		2017-066T18:30:53		000T00:00:01	2017-066T18:30:54			
End Dual Playback Science		2017-066T18:51:30		000T00:00:01	2017-066T18:51:31			
ISS_264SA_LIMBINT001_PRIME	M,U,V	2017-066T19:05:00		000T01:26:00	2017-066T20:31:00	ISS_NAC to Saturn	NEG_Z to NSP	Pick up at ISS_NAC to Saturn, NEG_Z to NSP; Hand off at CIRS_FPB to Saturn, NEG_Z to NSP.
CIRS_264SA_LIMBMAP001_PIE	I,U	2017-066T20:31:00		000T06:00:00	2017-067T02:31:00	CIRS_FPB to Saturn	PIC	Pick up at CIRS_FPB to Saturn, NEG_Z to NSP; Hand off at ISS_NAC to Saturn, NEG_Z to NSP. Saturn Equator 10N, North limb
VIMS_264SA_SPOLMAP001_PRIME	C,U	2017-067T02:31:00		000T02:29:00	2017-067T05:00:00	ISS_NAC to Saturn	NEG_Z to NSP	Pick up at ISS_NAC to Saturn, NEG_Z to NSP; Hand off at ISS_NAC to Saturn, NEG_Z to NSP.
VIMS_264SA_SSTRMLAT001_PRIME	U	2017-067T05:00:00		000T01:36:00	2017-067T06:36:00	ISS_NAC to Saturn	NEG_Z to NSP	Pick up at ISS_NAC to Saturn, NEG_Z to NSP; Hand off at ISS_NAC to Saturn (0.286,0.0,0.573 deg. offset), NEG_Z to
VIMS_264SA_SEQREGMAP001_PRIME	U	2017-067T06:36:00		000T02:24:00	2017-067T09:00:00	ISS_NAC to Saturn	NEG_Z to NSP	Pick up at ISS_NAC to Saturn (0.286,0.0,0.573 deg. offset), NEG_Z to NSP;
SP_264SU_WAYPTTURN067_PRIME		2017-067T09:00:00		000T00:40:00	2017-067T09:40:00	UVIS_SOL_OFF to Sun	POS_Z to NSP	Pick up at ISS_NAC to Saturn (10.0,5.0,0.0 deg. offset), NEG_Z to NSP; Hand off at UVIS_SOL_OFF to Sun, POS_Z to NSP.
NEW WAYPOINT		2017-067T09:40:00		000T06:29:00	2017-067T16:09:00	UVIS_SOL_OFF to Sun	POS_Z to NSP	
End Custom		2017-067T09:40:00		000T00:00:01	2017-067T09:40:01	UVIS_SOL_OFF to Sun	POS_Z to NSP	
ISS_264RI_HIPHASEFB001_PRIME	V	2017-067T09:40:00		000T01:00:00	2017-067T10:40:00	ISS_NAC to Rings	POS_Z to NSP	No Preference to Secondary pointing. No Preference to Secondary
ISS_264SA_LIMBINT002_PRIME	U,V	2017-067T10:40:00		000T00:30:00	2017-067T11:10:00	ISS_NAC to Saturn	POS_Z to NSP	
UVIS_264SA_AURSTARE001_PRIME	I,V	2017-067T11:10:00		000T02:41:00	2017-067T13:51:00	UVIS_FUV to Saturn	POS_Z to NSP	Collaborative Rider(s): VIMS. Slew/stare, collaborate with VIMS
ISS_264SA_LIMBINT003_PRIME	U,V	2017-067T13:51:00		000T00:30:00	2017-067T14:21:00	ISS_NAC to Saturn	POS_Z to NSP	
ISS_264RI_HIPHASEFB002_PRIME	V	2017-067T14:21:00		000T01:24:00	2017-067T15:45:00	ISS_NAC to Rings	POS_Z to NSP	No Preference to Secondary pointing. No Preference to Secondary
SP_264EA_DLTURN067_PRIME		2017-067T15:45:00		000T00:24:00	2017-067T16:09:00	XBAND to Earth	NEG_X to NEP	
NEW WAYPOINT		2017-067T16:09:00		000T10:11:00	2017-068T02:20:00	XBAND to Earth	NEG_X to NEP	
ENGR_264SC_KPTYBIAS067_PRIME		2017-067T16:09:00		000T01:30:00	2017-067T17:39:00	NEG_Z to DELTA_H (0.0,0.0,-58.0 deg. offset)	NEG_X to Sun	
SP_264EA_C70METNON067_PRIME	C	2017-067T17:55:00		000T07:55:00	2017-068T01:50:00	XBAND to Earth	Rolling	
Pointer Reset in preparatio...		2017-068T01:50:00		000T00:00:01	2017-068T01:50:01			
SP_264SA_WAYPTTURN068_PRIME		2017-068T01:50:00		000T00:30:00	2017-068T02:20:00	CIRS_FP1 to Saturn	POS_Z to NSP	
NEW WAYPOINT		2017-068T02:20:00		000T08:45:00	2017-068T11:05:00	CIRS_FP1 to Saturn	POS_Z to NSP	
CIRS_264SA_COMPSIT002_PRIME	V	2017-068T02:20:00		000T08:15:00	2017-068T10:35:00	CIRS_FP1 to Saturn	POS_Z to NSP	Collaborative Rider(s): VIMS
SP_264EA_DLTURN468_PRIME		2017-068T10:35:00		000T00:30:00	2017-068T11:05:00	XBAND to Earth	NEG_X to 275.0/67.0	
NEW WAYPOINT		2017-068T11:05:00		000T13:05:00	2017-069T00:10:00	XBAND to Earth	NEG_X to 275.0/67.0	
SP_264EA_YGAP068_PRIME		2017-068T11:05:00		000T01:30:00	2017-068T12:35:00	XBAND to Earth	NEG_X to 275.0/67.0	
ISS_264EN_PLUME001_PIE	C,E,U,V	2017-068T12:35:00		000T02:08:00	2017-068T14:43:00	ISS_NAC to Enceladus	NEG_X to NSP	SOST PIE
SP_264EA_C70METNON068_PRIME	C	2017-068T14:43:00		000T09:00:00	2017-068T23:43:00	XBAND to Earth	NEG_X to 275.0/67.0	CDA. NEG_X to 275/67

Final Sequenced SMT and Data Volume

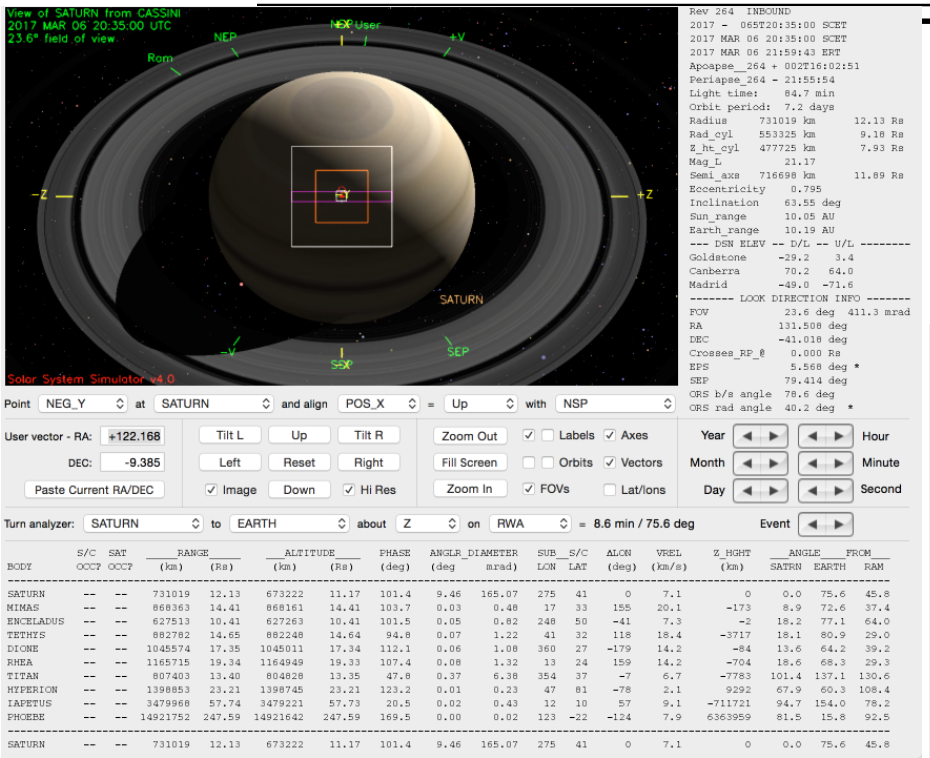
DATA VOLUME SUMMARY --- TRANSFER FRAME OVERHEAD INCLUDED (80 BITS PER 8800-BIT FRAME)

			OBSERVATION_PERIOD							DOWNLINK_PASS							
			P4						P5	RECORDED		PLAYBACK					
DOWNLINK PASS NAME	Start doy hh:mm	End doy hh:mm	START (Mb)	SCI (Mb)	HK+E (Mb)	TOTAL (Mb)	CPACTY (Mb)	MRGN (Mb)	OPNAV (Mb)	SCI (Mb)	ENGR (Mb)	TOTAL (Mb)	CPACTY (Mb)	MARGN (Mb)	NET_MARGN (Mb)	(%)	CAROVR (Mb)
SP_264EA_C70METNON067_PRIME	067 17:55	068 01:50	0	3123	192	3315	3322	7	0	457	47	3818	2456	-1363	169	1%	1363
SP_264EA_C70METNON068_PRIME	068 14:43	068 23:43	1363	1736	54	3153	3322	169	0	521	53	3727	3310	-418	630	5%	418

DATA VOLUME REPORT --- TRANSFER FRAME OVERHEAD NOT INCLUDED

Event	Start doy hh:mm	End doy hh:mm	CAPS (Mb)	CDA (Mb)	CIRS (Mb)	INMS (Mb)	ISS (Mb)	MAG (Mb)	MIMI (Mb)	RADAR (Mb)	RPWS (Mb)	UVIS (Mb)	VIMS (Mb)	PROBE (Mb)	ENGR (Mb)	TOTAL (Mb)
OBSERVATION_NOR	065 20:35	067 17:55	0.0	81.2	316.9	26.4	1151.9	74.1	125.0	0.0	250.5	309.7	759.0	0.0	189.5	3284.3
SP_264EA_C70METNON067_PRIME	067 17:55	068 01:50	0.0	14.9	74.7	2.9	0.0	14.1	20.0	0.0	322.1	4.3	0.0	0.0	0.0	452.9
DAILY TOTAL SCIENCE	065 20:35	068 01:50	0.0	96.2	391.6	29.2	1151.9	88.2	145.0	0.0	572.6	314.1	759.0	0.0	189.5	
OBSERVATION_NOR	068 01:50	068 14:43	0.0	24.3	149.5	4.6	200.0	22.9	32.5	0.0	524.6	16.2	272.5	0.0	526.6	1773.7
SP_264EA_C70METNON068_PRIME	068 14:43	068 23:43	0.0	17.0	86.4	3.2	0.0	16.0	22.7	0.0	366.4	4.9	0.0	0.0	0.0	516.7
DAILY TOTAL SCIENCE	068 01:50	068 23:43	0.0	41.3	235.9	7.9	200.0	38.9	55.1	0.0	891.0	21.2	272.5	0.0	526.6	

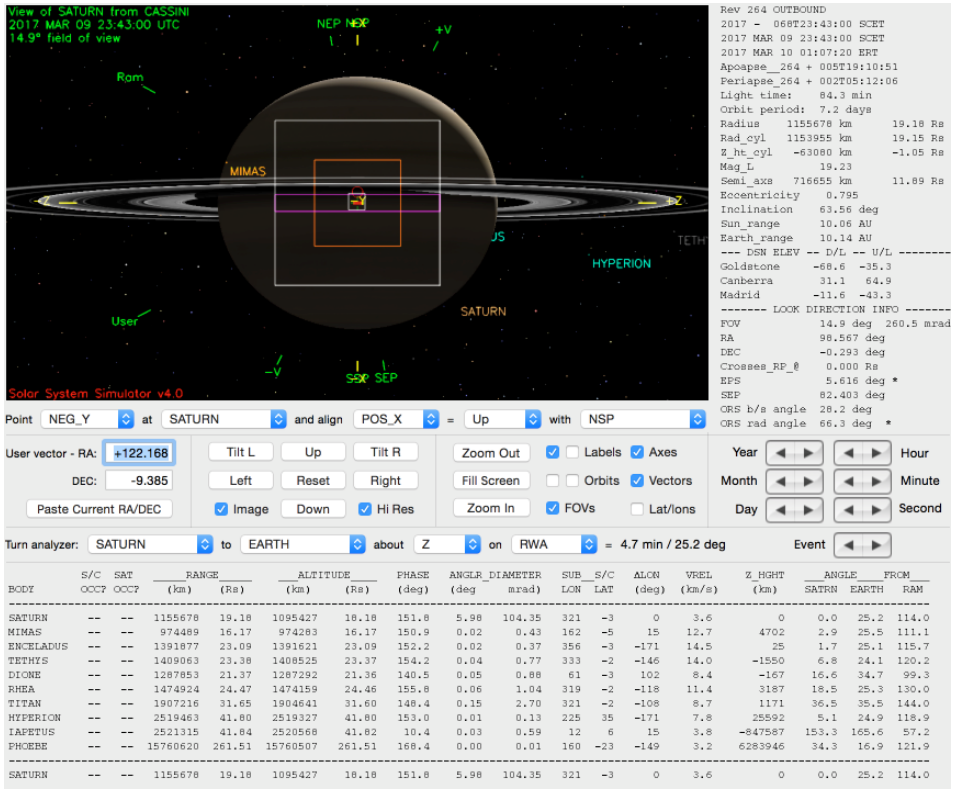
Segment Geometry



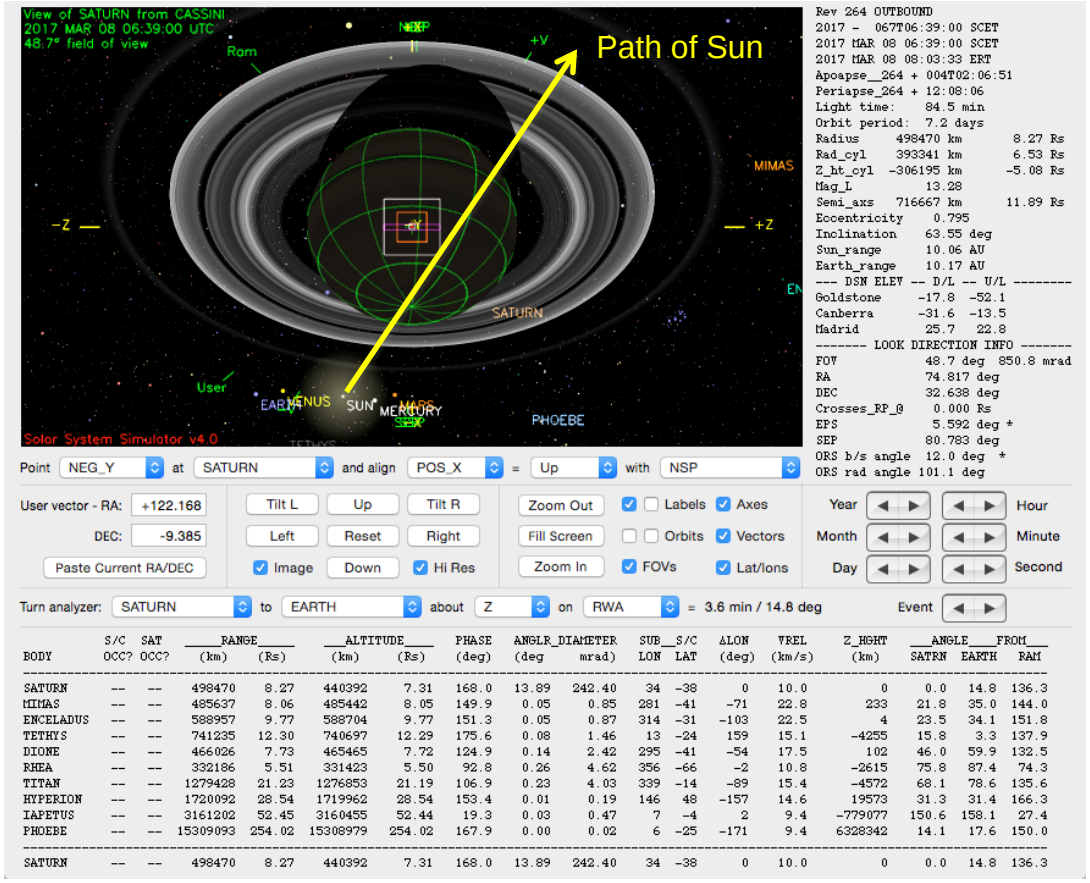
	Saturn Range	Phase Angle	Sub-S/C Lat.
Segment Start	12.13	101.4	41
Periapse	2.44	42.1	-9
Segment End	19.18	151.8	-3

← Seg 264 Start (Left)

↓ Seg 264 End (below)



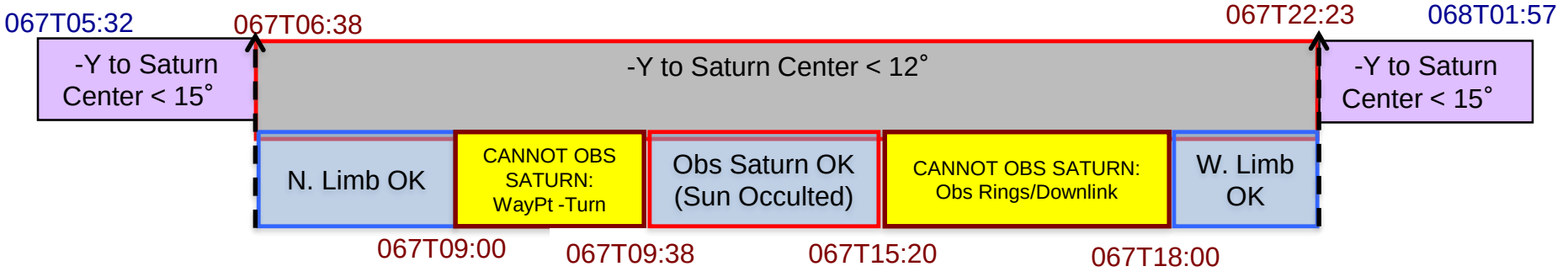
CMT Violation Geometry




```
Rev 264 OUTBOUND
2017 -  067T06:39:00 SCET
2017 MAR 08 06:39:00 SCET
2017 MAR 08 08:03:33 ERT
Apoapse__264 + 004T02:06:51
Periapse_264 + 12:08:06
Light time:    84.5 min
Orbit period:  7.2 days
Radius      498470 km       8.27 Rs
Rad_cyl     393341 km       6.53 Rs
Z_ht_cyl   -306195 km      -5.08 Rs
Mag_L         13.28
Semi_axs    716667 km      11.89 Rs
Eccentricity    0.795
Inclination    63.55 deg
Sun_range      10.06 AU
Earth_range    10.17 AU
--- DSN ELEV -- D/L -- U/L --------
Goldstone     -17.8  -52.1
Canberra      -31.6  -13.5
Madrid         25.7   22.8
------- LOOK DIRECTION INFO -------
FOV            48.7 deg  850.8 mrad
RA             74.817 deg
DEC            32.638 deg
Crosses_RP_@    0.000 Rs
EPS             5.592 deg *
SEP            80.783 deg
ORS b/s angle  12.0 deg  *
ORS rad angle 101.1 deg
```

BODY	S/C OCC?	SAT OCC?	RANGE (km)	RANGE (Rs)	ALTITUDE (km)	ALTITUDE (Rs)	PHASE (deg)	ANGLR_DIAMETER (deg	ANGLR_DIAMETER mrad)	SUB_S/C LON	SUB_S/C LAT	ALON (deg)	VREL (km/s)	Z_HGHT (km)	ANGLE_FROM SATRN	ANGLE_FROM EARTH	ANGLE_FROM RAM
SATURN	--	--	498470	8.27	440392	7.31	168.0	13.89	242.40	34	-38	0	10.0	0	0.0	14.8	136.3
MIMAS	--	--	485637	8.06	485442	8.05	149.9	0.05	0.85	281	-41	-71	22.8	233	21.8	35.0	144.0
ENCELADUS	--	--	588957	9.77	588704	9.77	151.3	0.05	0.87	314	-31	-103	22.5	4	23.5	34.1	151.8
TETHYS	--	--	741235	12.30	740697	12.29	175.6	0.08	1.46	13	-24	159	15.1	-4255	15.8	3.3	137.9
DIONE	--	--	466026	7.73	465465	7.72	124.9	0.14	2.42	295	-41	-54	17.5	102	46.0	59.9	132.5
RHEA	--	--	332186	5.51	331423	5.50	92.8	0.26	4.62	356	-66	-2	10.8	-2615	75.8	87.4	74.3
TITAN	--	--	1279428	21.23	1276853	21.19	106.9	0.23	4.03	339	-14	-89	15.4	-4572	68.1	78.6	135.6
HYPERION	--	--	1720092	28.54	1719962	28.54	153.4	0.01	0.19	146	48	-157	14.6	19573	31.3	31.4	166.3
IAPETUS	--	--	3161202	52.45	3160455	52.44	19.3	0.03	0.47	7	-4	2	9.4	-779077	150.6	158.1	27.4
PHOEBE	--	--	15309093	254.02	15308979	254.02	167.9	0.00	0.02	6	-25	-171	9.4	6328342	14.1	17.6	150.0
SATURN	--	--	498470	8.27	440392	7.31	168.0	13.89	242.40	34	-38	0	10.0	0	0.0	14.8	136.3

- Pointing to NEG_Y to Saturn (center) would lead to a CMT (<12˚) violation between ~2017-067T06:38:07 and ~2017-067T22:22:36.
- Minimum NEG_Y to Sun angle is ~2.5˚ at ~2017-067T12:28:00.
- Between 067T06:39 – 09:00 observing above the Equator (northern limb) brings one out of the 12˚ cone, but not the 15˚ cone *A waiver will be required.*
- Cannot observe Saturn from 067T09:00 – 09:38, therefore perform Waypoint turn, ending custom period
- Between 067T09:38:14 – 15:20:30 Sun is behind Saturn, CMT management allows NEG_Y to Saturn for limb observations. *A waiver will be required.*
- Cannot observe Saturn from ~067T15:20 – 18:00, therefore observe Ring at Hi-Phase (067T14:21 – 15:45), then NEG_Y to Earth for YGAP/Downlink (067T15:45 – 068T01:50)



Periapse Quicklooks (1/2)

UVIS_264SA_AURDSTARE001_PRIME
CIRS_264SA_NADIROCC001_PIE
VIMS_264SA_NPOLMAP001_PRIME
VIMS_264RI_GAMCRUOCC001_PIE
VIMS_264SA_GAMCRUOCC001_PIE
Begin Custom
CIRS_264SA_LIMBINT001_PRIME
Begin Dual Playback Science
ISS_264PN_PAN001_PIE
Periapse R = 2.439 Rs, lat ...
End Dual Playback Science
ISS_264SA_LIMBINT001_PRIME
CIRS_264SA_LIMBMAP001_PIE
VIMS_264SA_SPOLMAP001_PRIME
VIMS_264SA_SSTRMLAT001_PRIME
VIMS_264SA_SEQREGMAP001_PRIME
SP_264SU_WAYPTTURN067_PRIME
End Custom
ISS_264RI_HIPHASEFB001_PRIME
ISS_264SA_LIMBINT002_PRIME
UVIS_264SA_AURSTARE001_PRIME
ISS_264SA_LIMBINT003_PRIME
ISS_264RI_HIPHASEFB002_PRIME

- UVIS had a collaborative observation (AURDSTARE) with VIMS, using a fixed stare-type pointing at the day-side illuminated northern Saturn auroral oval
- CIRS NADIROCC PIE worked in combination with the following VIMS GAMCRUOCC PIE activity in order to determine Saturn's helium abundance. The CIRS NADIROCC was to yield the temperature at the same latitude (1 deg South) and longitude of the VIMS Gamma Crucis stellar occultation point.
- VIMS performed four 3x3 mosaics of Saturn's North Pole region.
- VIMS tracked the star Gamma Crucis for 4 hours during a back-to-back ingress occultation of the F-D Rings and then Saturn. This type of Ring occultation provided the best-quality profiles of dense regions in the B ring.
- The VIMS Saturn occultation yielded T/mu near the 1 mbar level, which, in combination with the temperature data from the prior CIRS NADIROCC, solves for mu (the mean molecular weight of the atmosphere) and thus significantly constrains the helium abundance.
- CIRS performed a high resolution Saturn illuminated limb integration (LIMBINT) with mid-IR sounding to obtain stratospheric thermal structure. This unique configuration and proximity to Saturn (between 6 and 3 Rs) provided a vertical profile of temperature and hydrocarbon abundances throughout Saturn's stratosphere.
- ISS captured high resolution images of the ring moon Pan, providing images about eight times better than the previous best. The shape and surface morphology of the equatorial bands on the ring-related satellites are important for constraining satellite-ring relationships. With other images of Atlas and Daphnis acquired in 2017, knowledge of the similarities and differences of the details of the ring moons are an order-of-magnitude improvement over earlier data. This high value data was preserved in a dual playback plan.

Periapse Quicklooks (2/2)

UVIS_264SA_AURDSTARE001_PRIME
CIRS_264SA_NADIROCC001_PIE
VIMS_264SA_NPOLMAP001_PRIME
VIMS_264RI_GAMCRUOCC001_PIE
VIMS_264SA_GAMCRUOCC001_PIE
Begin Custom
CIRS_264SA_LIMBINT001_PRIME
Begin Dual Playback Science
ISS_264PN_PAN001_PIE
Periapse R = 2.439 Rs, lat ...
End Dual Playback Science
ISS_264SA_LIMBINT001_PRIME
CIRS_264SA_LIMBMAP001_PIE
VIMS_264SA_SPOLMAP001_PRIME
VIMS_264SA_SSTRMLAT001_PRIME
VIMS_264SA_SEQREGMAP001_PRIME
SP_264SU_WAYPTTURN067_PRIME
End Custom
ISS_264RI_HIPHASEFB001_PRIME
ISS_264SA_LIMBINT002_PRIME
UVIS_264SA_AURSTARE001_PRIME
ISS_264SA_LIMBINT003_PRIME
ISS_264RI_HIPHASEFB002_PRIME

- ISS performed an integration of images along the Saturn bright limb (LIMBINT) studying the composition of the high atmosphere
- CIRS did a Saturn limb mapping (LIMBMAP) PIE at10 deg N. latitude. CIRS placed their arrays at 100, 400, and 700 km above the 1-bar level on Saturn. This allowed us to derive the vertical profile of temperature from 10 microbars to 10 millibars in Saturn's atmosphere. We will study Saturn's QQO (quasi-quadrennial oscillation) in which the equatorial temperature changes over several Earth years due to vertical motion in the stratosphere.
- VIMS began a series of observations; the first of which is completing 2 Saturn South Pole Mapping mosaics (SPOLMAP). This was followed by a look at Saturn's South Storm Alley (SSTRMLAT), imaging a mosaic of the entire regional band centered at 35 deg S. latitude. As Cassini quickly reached out >9 Saturn radii from the planet, the equator was in better view and VIMS completed its series with mapping mosaics of the South Equatorial region (SEQREGMAP) centered at 5 deg S. latitude.
- ISS had a series of Rings and Saturn observations surrounding the Sun's occultation behind Saturn. Leading into the Saturn Solar occultation ingress, ISS observed the faint Rings at high phase angles (HIPHASE). While the Sun is behind Saturn, ISS completed a Limb Integration by taking images along Saturn's bright limb studying the composition of the high atmosphere.
- UVIS now took the lead with an observation of the dark Southern Auroral Oval of Saturn (AURSTARE). This was a collaborative activity with VIMS, where the first half was a fixed stare pointing to support VIMS and ISS imaging followed by repeated slews across the 55-90 deg S. latitude auroral oval region.
- ISS then repeated its Saturn LIMBINT and Rings HIPHASE observations as the Sun emerged from behind Saturn.

Daily Science Highlights (1/3)

6 Mar 2017 (DOY 065): The Saturn 263 segment began with a UVIS collaborative observation (AURDSTARE) with VIMS, staring at the day-side illuminated northern Saturn auroral oval for 1.75 hours; ISS rode along to monitor day-side clouds with the WAC as a WINDS-type observation. Next was the 2 hour long CIRS NADIROCC PIE that was of highest priority for this orbit, where the combination of CIRS NADIROCC PIE and VIMS GAMCRUOCC PIE activities will help CIRS determine Saturn's helium abundance. The VIMS observation yielded T/mu near the 1 mbar level. The CIRS NADIROCC yielded the temperature at the same latitude (1 deg South) and longitude of the Gamma Crucis stellar occultation point. This allowed us to solve for mu (the mean molecular weight of the atmosphere) and thus the helium abundance. Previous similar attempts had been unsuccessful due to various technical issues, so this was one of the last chances in the mission to get this key measurement.

7 Mar 2017 (DOY 066): VIMS performed four 3x3 mosaics of Saturn's North Pole region for 6 hours with CIRS, ISS and UVIS riding along. Next VIMS tracked the star Gamma Crucis for 4 hours during a back-to-back ingress occultation of the F-D Rings and then Saturn, while CIRS and ISS rode along. These VIMS Rings & Saturn GAMMCRUOCC PIE activities were of highest priority for this orbit. Gamma Crucis is the third-brightest VIMS star and with its high inclination to Saturn's ring plane (63 deg) provided our best-quality stellar occultation profiles of dense regions such as the B ring. In the Prime mission we acquired 16 Gamma Crucis occultations, which have provided the key data to estimate the mass of the B ring, by identifying weak density waves, as well as several other significant investigations. **This was the only PIE level Gamma Crucis Rings occultation in the F/Prox orbits.** With the greatly-extended time baseline, these occultations should permit us to improve our models for the B ring waves, as well as identify new features in the dense rings.
The VIMS Saturn GAMCRUOCC PIE is a collaborative activity with CIRS and will help to determine the He/H2 ratio in Saturn's lower stratosphere by obtaining quasi-simultaneous observations of a stellar occultation by VIMS (which yields the scale height, or T/mu) and a limb scan by CIRS NADIROCC PIE (which yields the temperature profile, T(Z)) at the same latitude (1 deg South) and longitude of the ingress Gamma Crucis stellar occultation point. Previous similar attempts have been unsuccessful due to various technical issues, so this is one of the last chances in the mission to get this key measurement.

Daily Science Highlights (2/3)

7 Mar 2017 (DOY 066) continued: CIRS had a 5.5 hour high resolution Saturn illuminated limb integration (LIMBINT) with mid-IR sounding to obtain stratospheric thermal structure with ISS and UVIS as riders. This unique configuration and proximity to Saturn (between 6 and 3 Rs) provided a vertical profile of temperature and hydrocarbon abundances throughout Saturn's stratosphere.

As Cassini passed through periapse and skirts the edge of the F-ring, ISS captured high resolution images of the ring moon Pan for 2.5 hours. **The close encounter with Pan provided images about eight times better than previous best.** The shape and surface morphology of the equatorial bands on the ring-related satellites are important for constraining satellite-ring relations. With other images of Atlas and Daphnis in 2017, knowledge of the similarities and differences of the details of the ring moons were obtained in order-of-magnitude improvements over existing data. **This is a PIE level activity of highest priority for this orbit, warranting a dual playback plan to better guarantee that the high value data is preserved and downlinked.**

Then ISS performed an integration of images along the Saturn bright limb (LIMBINT) studying the composition of the high atmosphere for 1.5 hours with UVIS and VIMS riding. CIRS ended the day with a 6 hour Saturn limb mapping (LIMBMAP) PIE at 10 deg N. latitude. This PIE level science observation was of highest priority for this orbit. CIRS placed their arrays at 100, 400, and 700 km above the 1-bar level on Saturn. This allowed us to derive the vertical profile of temperature from 10 microbars to 10 millibars in Saturn's atmosphere. We will study Saturn's QQO (quasi-quadrennial oscillation) in which the equatorial temperature changes over several Earth years due to vertical motion in the stratosphere.

8 Mar 2017 (DOY 067): Just a few hours after periapse and in view of Saturn’s dark south pole, VIMS began a 6.5 hour series of observations with CIRS and UVIS riding along; the first of which was completing 2 Saturn South Pole Mapping mosaics (SPOLMAP). This was followed by a look at Saturn’s South Storm Alley (SSTRMLAT), imaging a mosaic of the entire regional band centered at 35 deg S. latitude. As Cassini quickly reached out >9 Saturn radii from the planet, the equator is in better view and VIMS completed its series with mapping mosaics of the South Equatorial region (SEQREGMAP) centered at 5 deg S. latitude.

Daily Science Highlights (3/3)

8 Mar 2017 (DOY 067) continued: Next ISS had a series of Rings and Saturn observations surrounding the Sun's occultation behind Saturn. Leading into the Saturn Solar occultation ingress, ISS observed the faint Rings at high phase angles (HIPHASE) for 1 hour, VIMS rode along. While the Sun was behind Saturn, ISS was able to complete a 30 minute Limb Integration by taking images along Saturn's bright limb studying the composition of the high atmosphere, UVIS and VIMS are riders. UVIS now took the lead with a 2.6 hour observation of the dark Southern Auroral Oval of Saturn (AURSTARE), VIMS and ISS rode. This was a collaborative activity with VIMS, where the first half was a fixed stare pointing to support VIMS and ISS imaging followed by repeated slews across the 55-90 deg S. latitude auroral oval region. ISS then repeated its Saturn LIMBINT and Rings HIPHASE observations as the Sun emerged from behind Saturn.

Finally the day ended with a very important downlink pass using Canberra's 70 meter station in order to return most of the valuable periapse science, as well as the accomplishing the first playback of the high value Pan PIE data.

9 Mar 2017 (DOY 068): CIRS performed an 8 hour sit and stare (COMPSIT) observation studying the composition of the South Saturnian atmosphere as the spacecraft extended father out in its orbit, 15-17 Saturn radii from the planet. This was a collaborative activity with VIMS, who took an image every hour.

Finally the Saturn segment ended with a 2 hour ISS Enceladus Plume PIE observation as part of our plume monitoring campaign. At a distance of about 1 million km from Enceladus, this observation allowed us to observe brightness variations in the entire plume on short timescales, which is excellent for testing theories of the plume production. Additionally, the mean anomaly covered has been observed twice before and the plume varied considerably in brightness between those observations. More data covering this region will help up us characterize these variations, which will lead to better understanding of the long term plume behavior.

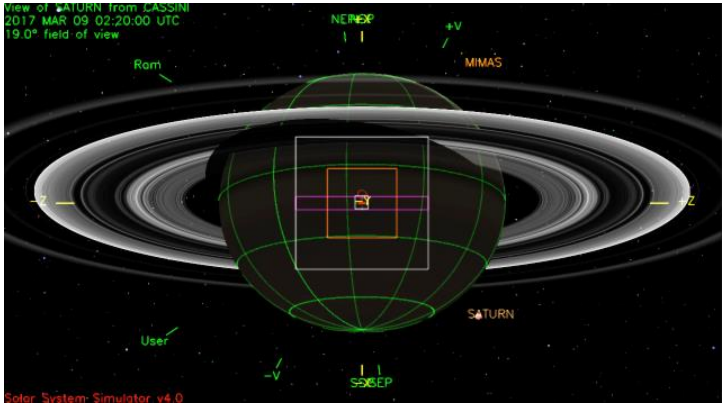
The second and final downlink of the segment was also on Canberra's 70 meter station, which was the second playback of the high value Pan PIE data.

Segment Integration Planning

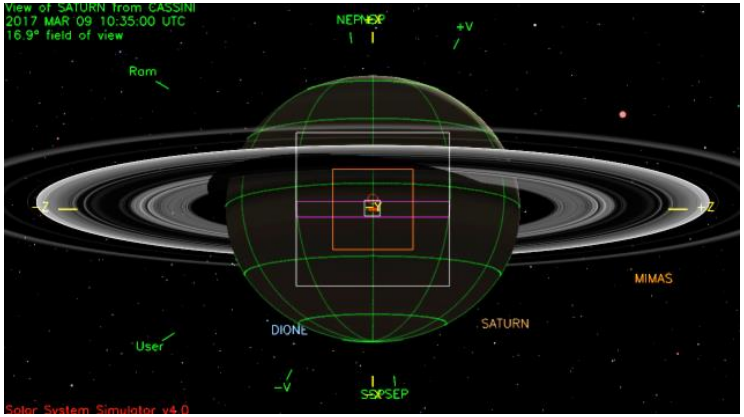
GAP Information (Gaps > 1hr duration)

Gap	Start	End	Duration	Phase angle (range)	Rs range	Sub-S/C Lat.
1	2017-068T02:20:00	2017-068T10:35:00	000T08:15:00	164.7 to 159.0	15.05 to 16.95	-15 to -10

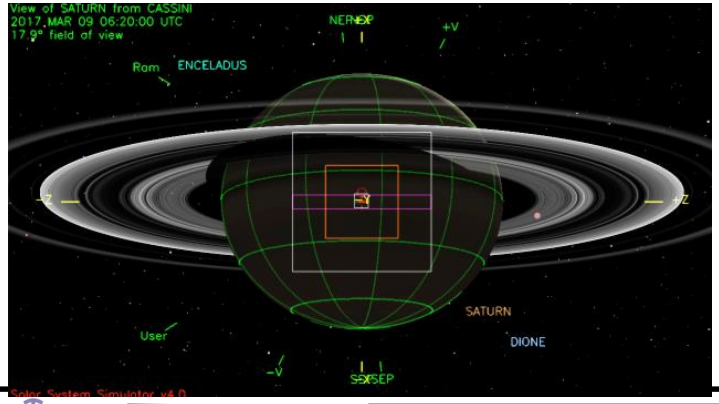
Gap Beginning



Gap End



Gap Middle



Initial SMT and Data Volume

Beginning of Integration:

DATA VOLUME SUMMARY --- TRANSFER FRAME OVERHEAD INCLUDED (80 BITS PER 8800-BIT FRAME)

			OBSERVATION_PERIOD							DOWNLINK_PASS							
			P4						P5	RECORDED		PLAYBACK					
DOWNLINK PASS NAME	Start doy hh:mm	End doy hh:mm	START (Mb)	SCI (Mb)	HK+E (Mb)	TOTAL (Mb)	CPACTY (Mb)	MRGN (Mb)	OPNAV (Mb)	SCI (Mb)	ENGR (Mb)	TOTAL (Mb)	CPACTY (Mb)	MARGN (Mb)	NET_MARGN (Mb)	NET_MARGN (%)	CAROVR (Mb)
SP_264EA_C70METNON067_PRIME	067 17:55	068 01:50	0	6762	192	6954	3322	-3631	0	461	47	3830	2456	-1375	1191	21%	1374
SP_264EA_C70METNON068_PRIME	068 14:43	068 23:43	1374	437	54	1866	3322	1456	0	199	53	2118	3310	1191	1191	36%	0

Science data allocation > SSR Capacity

DATA VOLUME REPORT --- TRANSFER FRAME OVERHEAD NOT INCLUDED

Event	Start doy hh:mm	End doy hh:mm	CAPS (Mb)	CDA (Mb)	CIRS (Mb)	INMS (Mb)	ISS (Mb)	MAG (Mb)	MIMI (Mb)	RADAR (Mb)	RPWS (Mb)	UVIS (Mb)	VIMS (Mb)	PROBE (Mb)	ENGR (Mb)	TOTAL (Mb)
OBSERVATION_NOR	065 20:35	067 17:55	0.0	101.1	406.8	36.5	1703.1	148.2	163.9	0.0	2181.0	566.3	1394.0	0.0	189.5	6890.4
SP_264EA_C70METNON067_PRIME	067 17:55	068 01:50	0.0	14.9	74.7	2.9	0.0	14.1	24.2	0.0	322.1	4.3	0.0	0.0	0.0	457.2
DAILY TOTAL SCIENCE	065 20:35	068 01:50	0.0	116.0	481.5	39.3	1703.1	162.3	188.1	0.0	2503.1	570.6	1394.0	0.0	189.5	
OBSERVATION_NOR	068 01:50	068 14:43	0.0	24.3	28.8	4.6	200.0	22.9	39.4	0.0	72.7	15.2	25.0	0.0	53.8	486.9
SP_264EA_C70METNON068_PRIME	068 14:43	068 23:43	0.0	17.0	86.4	3.2	0.0	16.0	27.5	0.0	42.4	4.9	0.0	0.0	0.0	197.5
DAILY TOTAL SCIENCE	068 01:50	068 23:43	0.0	41.3	115.2	7.9	200.0	38.9	67.0	0.0	115.2	20.2	25.0	0.0	53.8	

Waypoints

Standard Waypoints*

OBS_NAME	START	END	POS_X_2_NSP	POS_X_2_NEP	NEG_X_2_NSP	NEG_X_2_NEP	POS_Z_2_NSP	POS_Z_2_NEP	NEG_Z_2_NSP	NEG_Z_2_NEP	NEG_X_2_SUN	NEG_Z_2_EARTH
SP_264NA_OBSERV065_NA	2017-065T20:35:00	2017-067T17:55:00	**BAD**	**BAD**	**BAD**	**BAD**	**BAD**	**BAD**	**BAD**	**BAD**	**BAD**	**BAD**
SP_264NA_OBSERV068_NA	2017-068T01:50:00	2017-068T14:43:00	**BAD**	**BAD**	**BAD**	**BAD**	**BAD**	**BAD**	**BAD**	**BAD**	**BAD**	**BAD**

RBOT Friendly Waypoints

OBSERVATION PERIOD	START	END	POS_X	NEG_X	POS_Z	NEG_Z
SP_264NA_OBSERV065_NA	2017-065T20:35:00	2017-067T17:55:00	------	------	------	------
SP_264NA_OBSERV068_NA	2017-068T01:50:00	2017-068T14:43:00	------	------	------	------

*Note: Waypoints issues above are due to Sun violations, which end at 2017-068T01:53
NEG_X to NSP secondary waypoint is good after 2017-068T01:53

Good Downlinks

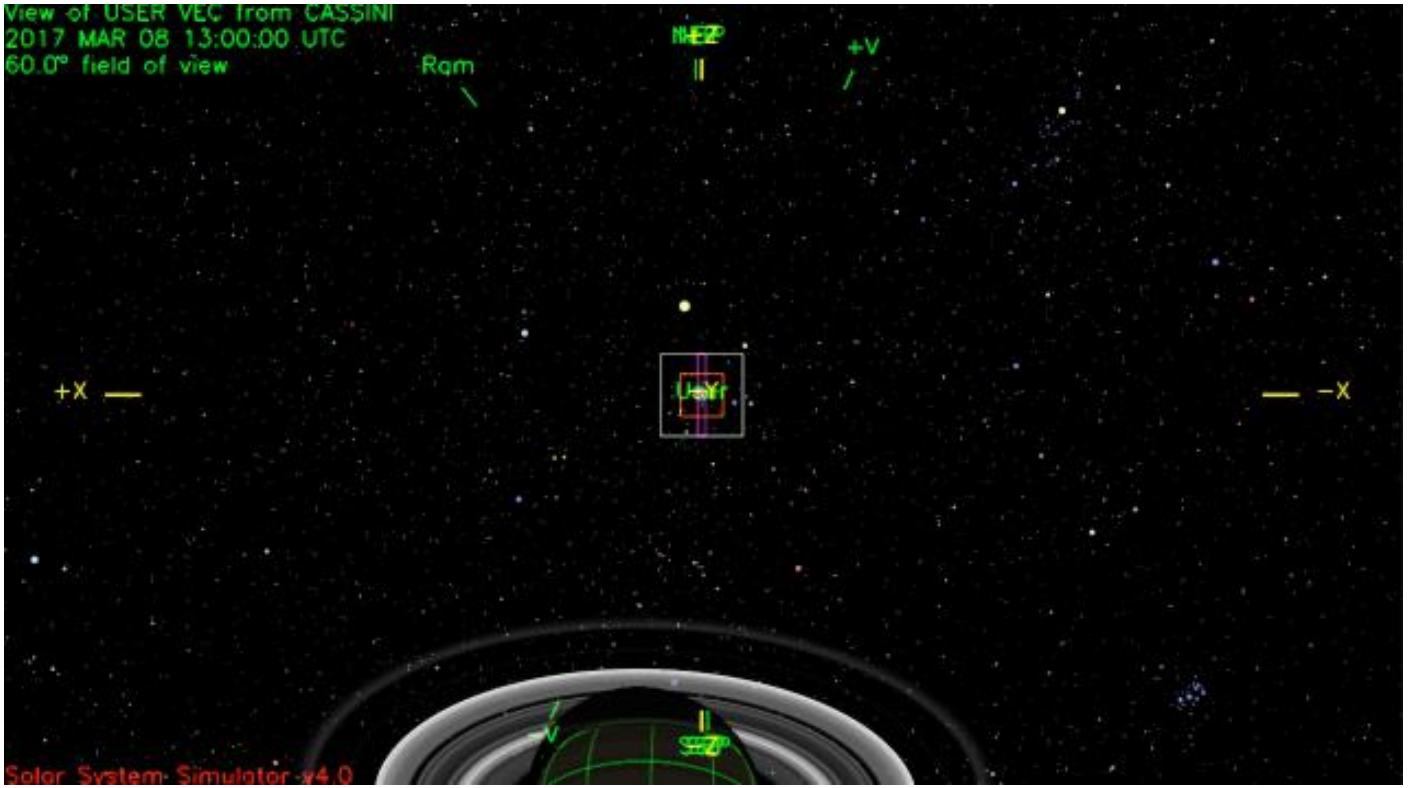
DOWNLINK	START	END	POS_X_2_NSP	POS_X_2_NEP	NEG_X_2_NSP	NEG_X_2_NEP	POS_Y_2_NSP	POS_Y_2_NEP	NEG_Y_2_NSP	NEG_Y_2_NEP	ROLL_FLAG
SP_264EA_C70METNON067_PRIME	2017-067T17:55:00	2017-068T01:50:00	OK	OK	OK	OK	**BAD**	**BAD**	OK	OK	OK
SP_264EA_C70METNON068_PRIME	2017-068T14:43:00	2017-068T23:43:00	OK	OK	OK	OK	**BAD**	**BAD**	OK	OK	OK

- **NEG_Y to Saturn not safe: ~2017-067T05:32:41 to 068T01:56:19 (ORS to Sun < 15 deg.)**
  - **ORS to SUN < 12 deg: ~2017-067T06:38:07 to 067T22:22:36**
  - **Minimum ORS to SUN angle is ~2.5 deg**

Waypoints Chosen

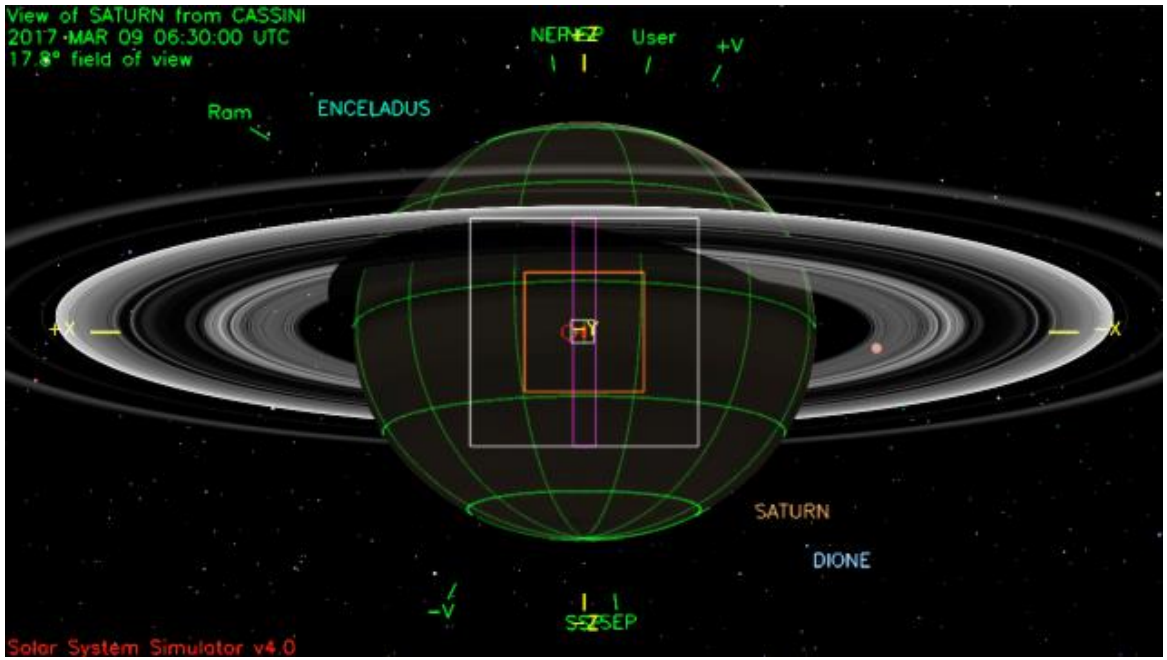
Waypoint 1 (2017-065T21:19:00 – 2017-067T09:40:00): No acceptable valid waypoint, custom period used.

Waypoint 2 (2017-067T09:40:00 – 2017-067T16:09:00): UVIS_SOL_OFF to Sun, POS_Z to NSP



Waypoints Chosen

Waypoint 3 (2017-068T02:20:00 – 2017-068T11:05:00): CIRS_FP1 to Saturn, POS_Z to NSP



Waypoint 4 (2017-068T11:05:00 – 2017-069T00:10:00): Downlink attitude (XBAND to Earth, NEG_X to 275.0/67.0) was established before ISS Enceladus Plume Observation due to the activity's placement against downlink during POST planning

Notes (1/2)

- Pointing:
  - Waypoints:
    - RBOT friendly waypoints used when compatible with science
    - No Valid Waypoint for Periapse Period (2017-065T21:19 – 067T09:40 SCET, Duration 001T12:21): Use Custom Period
  - Custom Period (2017-066T11:14 – 067T09:40 SCET) – Used to minimize turn times among instruments and avoid Waypoint issues
  - Collaborative PRIME/RIDER activities:
    - UVIS_264SA_AURDSTARE001_PRIME: Collaborative w/ VIMS Rider
    - VIMS_264SA_GAMCRUOCC001_PIE: Collaborative w/ CIRS Rider
    - ISS_264PN_PAN001_PIE: Collaborative w/ CIRS Rider
    - UVIS_264SA_AURSTARE001_PRIME: Collaborative w/ VIMS Rider
    - CIRS_264SA_COMPSIT002_PRIME: Collaborative w/ VIMS Rider
  - YGAP068 placed with ISS EN_PLUME PIE between YGAP068 and C70METNON068 downlink, due to firm ISS EN_PLUME PIE placement
    - Checked and approved by SCO per email Laura Burke (08/08) and NAV per email Julie Bellerose (08/08)
  - CIRS and VIMS temperature/boresite violations:
    - CIRS Max Temp = 77.00K (ΔT = 2.40K) at 2017-068T00:42 SCET (During SP C70METNON067 Rolling Downlink)
      - CIRS provided approval via email (Paul Romani 7/20)
      - **Operational FR Wavier will be required (See SPLAT item)**
    - VIMS Max Temp = 62.25K (ΔT = 2.59K) at 2017-066T20:52 SCET (During CIRS LIMBMAP001 PIE)
      - VIMS provided approval via email (Bob Brown 7/11)
      - **Consumable FR waiver will be required (See SPLAT item)**
    - CIRS Boresite to Sun < 15° during DOY 067– 068 (During VIMS SPOLMAP001, SSTRMLAT001, SEQREGMAP001; ISS HIPHASEFB(001 & 002), LIMBINT(002 & 003); UVIS AURSTARE001; SP WAYPTTURN068)
      - CIRS Boresite to Sun angle < 12° occur only during Solar Occultation behind Saturn
      - CIRS provided approval via email (Paul Romani 7/20)
      - **Operational FR Wavier will be required (See SPLAT item)**
  - **CMT Management required during the period 2017-067T09:45:15 – 15:13:29 SCET for the following violations (see SPLAT item):**
    - NEG_Y to SUN angle < 12° (Min NEG_Y to Sun angle = 0.543° at 2017-067T09:49:10)
      - CMT Management required during the following activities:
        - ISS HIPHASEFB001 (violation at 067T09:46:00 -10:34:15)
        - ISS LIMBINT002 (violation at 067T10:43:00-11:06:10)
        - UVIS AURSTARE001 (violation at 067T11:12:55-13:45:55)
        - ISS LIMBINT003 (violation at 067T13:53:55-14:17:25)
        - ISS HIPHASEFB002 (violation at 067T14:24:00-15:13:00)
    - Sun occulted behind Saturn between 2017-067T09:38:15 – 15:20:29 (from Tour Atlas)

Notes (2/2)

- Pointing (continued):
  - Periapse Jumpstart of Merged PDT & AACS analysis for teams early PDT deliveries during 2017-065T20:35 – 068T01:50 (see SPLAT item)
- Data Volume:
  - Dual Playback:
    - Hi-value data (066T16:35:00 – 18:51:30): ISS PAN PIE & RPX
    - Dual Playback/Hi-value data volume: 472.76Mb
  - SMT Warnings:
    - SP_264EA_C70METNON067_PRIME Priority List conflicts with selected SSR. (SSRAP4,SSRBP4): OKAY b/c Dual Playback (1st playback)
    - SP_264EA_C70METNON068_PRIME Priority List conflicts with selected SSR. (SSRAP4,SSRBP4): OKAY b/c Dual Playback (2nd playback)
  - Segment Carryover:
    - 418Mb Carryover into XD 264/265 segment: XD accepts carryover per email (Kelly Perry 7/15)
- DSN:
  - No Level 3 requests identified
  - Juno Conflict with C70METNON067 (conflicting period 2017-067T10:26 – 19:41): Juno to accommodate Cassini per Juno_Passes_RevK.xlsx
  - ap_downlink report check warnings dispositions (except %70M stations, ignore):
    - SP_264EA_C70METNON067_PRIME has an unusual priority playback list: OKAY b/c Dual Playback (1st playback)
    - SP_264EA_C70METNON068_PRIME has an unusual priority playback list: OKAY b/c Dual Playback (2nd playback)
- Resource checker dispositions:
  - C70METNON067: First_Part value of SSRAP4 does not match default… : OKAY b/c Dual Playback
  - C70METNON068: First_Part value of SSRAP4 does not match default… : OKAY b/c Dual Playback
- Opmodes:
  - No unusual opmodes
- Hydrazine:
  - N/A
- Special Activities:
  - PIES:
    - CIRS_264SA_NADIROCC001_PIE (2017-065T23:04:00 – 066T01:04:00)
    - VIMS_264RI_GAMCRUOCC001_PIE (2017-066T07:12:00 – 066T09:50:00)
    - VIMS_264SA_GAMCRUOCC001_PIE (2017-066T09:50:00 - 066T11:14:00)
    - ISS_264PN_PAN001_PIE (2017-066T16:35:00 - 066T19:05:00)
    - CIRS_264SA_LIMBMAP001_PIE (2017-066T20:31:00 - 067T02:31:00)
    - ISS_264EN_PLUME001_PIE (2017-068T12:35:00 - 068T14:43:00)

Liens (1/2)

Sequence Liens (should all be SPLAT items):

- Dual Playback:
  - "During DSN negotiations ensure that SSR-A is emptied before the pointers are reset. This item cannot be closed until the DSN negotiations are complete for both downlink passes, or the dual playback is deleted."
- CMT Management waiver required for the period 2017-067T09:45:15 – 15:13:29 SCET due to the following CMT violations:
  - NEG_Y to Sun < 12 deg violation during the following activities:
    - ISS_264RI_HIPHASEFB001_PRIME (violation at 067T09:46:00 -10:34:15)
    - ISS_264SA_LIMBINT002_PRIME (violation at 067T10:43:00-11:06:10)
    - UVIS_264SA_AURSTARE001_PRIME (violation at 067T11:12:55-13:45:55)
    - ISS_264SA_LIMBINT003_PRIME (violation at 067T13:53:55-14:17:25)
    - ISS_264RI_HIPHASEFB002_PRIME (violation at 067T14:24:00-15:13:00)
  - Min NEG_Y to Sun angle = 0.543 deg at 2017-067T09:49:10
  - Sun is occulted behind Saturn between 2017-067T09:38:15 – 15:20:29 (from Tour Atlas)
- CIRS Boresite to Sun < 15 deg Operational FR waiver required for DOY 067– 068 (During VIMS SPOLMAP001, SSTRMLAT001, SEQREGMAP001; ISS HIPHASEFB(001 & 002), LIMBINT(002 & 003); UVIS AURSTARE001; SP WAYPTTURN068)
  - CIRS Boresite to Sun angle < 12 deg occur only during Solar Occultation behind Saturn
  - Sun is occulted behind Saturn between 2017-067T09:38:15 – 15:20:29 (from Tour Atlas)
- CIRS heating violation Operational FR waiver required during SP_264EA_C70METNON067_PRIME Rolling Downlink
  - CIRS Max Temp = 77.00K (dT = 2.40K) at 2017-068T00:42 SCET
- VIMS heating violation Consumable FR waiver required during CIRS_264SA_LIMBMAP001_PIE
  - VIMS Max Temp = 62.25K (dT = 2.59K) at 2017-066T20:52 SCET
- VIMS_264RI_GAMCRUOCC001_PIE to include 20 min period starting roughly at 2017-066T07:14 to include a Bias prior to the stellar occultation starting time of 2017-066T07:45:25.48 from Tour Atlas, per AACS Periapse Jumpstart Analysis. Coordinate with VIMS Rep.

Liens (2/2)

Sequence Liens (should all be SPLAT items):

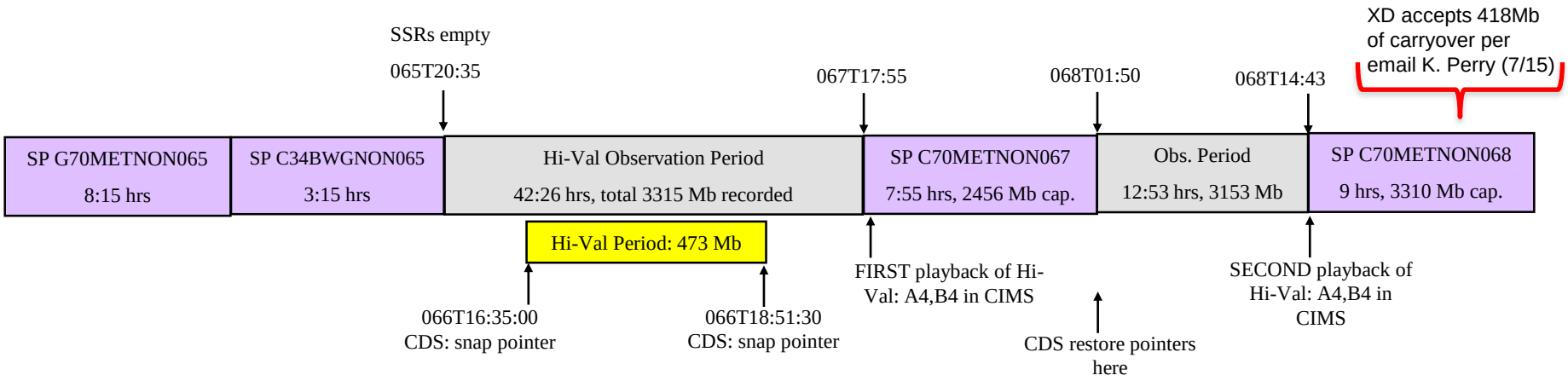
- The following science requests from 2017-065T20:35 – 068T01:50 in Saturn_264 have been designed in PDT during integration. Teams identified shall deliver these designs as part of the Port 1 delivery; SIP Leads to monitor.

  UVIS_264SA_AURDSTARE001_PRIME
  CIRS_264SA_NADIROCC001_PIE
  VIMS_264SA_NPOLMAP001_PRIME
  VIMS_264RI_GAMCRUOCC001_PIE
  VIMS_264SA_GAMCRUOCC001_PIE
  CIRS_264SA_LIMBINT001_PRIME
  ISS_264PN_PAN001_PIE
  ISS_264SA_LIMBINT001_PRIME
  CIRS_264SA_LIMBMAP001_PIE
  VIMS_264SA_SPOLMAP001_PRIME
  VIMS_264SA_SSTRMLAT001_PRIME
  VIMS_264SA_SEQREGMAP001_PRIME
  ISS_264RI_HIPHASEFB001_PRIME
  ISS_264SA_LIMBINT002_PRIME
  UVIS_264SA_AURSTARE001_PRIME
  ISS_264SA_LIMBINT003_PRIME
  ISS_264RI_HIPHASEFB002_PRIME

Dual Playback

Saturn 264	BEGHIVAL	ENDHIVAL	P4 Dual Playback Data Volume	SSR empty before hi-val observation period? (if not verify any carryover on A fits with Hi-Val data)	SSR-A empty after first playback?	PPL set to A4,B4 for first AND second playbacks?	SSRs empty after second playback? (if not does any Hi-Val data carry over?)
PAN & RPX	066T16:35:00	066T18:51:30	472.76 Mb	Yes	Yes	Yes	**No**, but no Hi-Val data carryover.

Playbacks NOT contiguous:

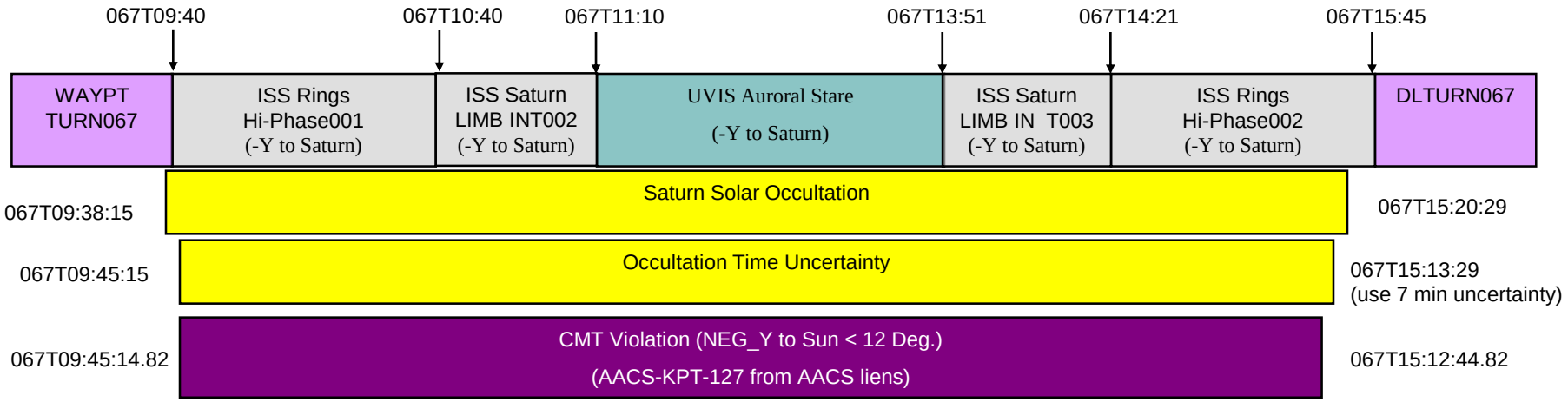


Note: Both playbacks on the same DSN station is as intended, due to incorporating dual playback late in integration

Reminder - ALL instruments' data is played back twice during P4 dual playback periods

-Y to Sun violation (SATURN 264)

- -Y to Sun CMT Management and flight rule waivers will be needed for the ISS Rings HIPHASE(001 & 003), ISS Saturn LIMB INT(002 & 003), and UVIS Auroral Stare on DOY 067 during the Saturn Solar occultation
  - Time of Saturn Solar Occultation is from the tour atlas.
  - Timing uncertainty is ± 7 minutes as determined using Brad Wallis' "ask_carnac.pro"



Rev 264 Periapse RBOT Assessment

- AACS Evaluation of Saturn 264 Jumpstart by David Bates (5/17)
- Nominal plan needs a lot of work
  - Need to insert a large tweak in the middle of two observations
    - 2017-066T13:01 CIRS_264SA_LIMBINT001
    - 2017-066T22:36 CIRS_264SA_LIMBMAP001_PIE
  - And four more tweaks
    - 2017-066T07:12 VIMS_264RI_GAMCRUOCC001
    - 2017-066T10:48 VIMS_264SA_GAMCRUOCC001
    - 2017-066T16:35 ISS_264PN_PAN001
    - 2017-067T15:09 ISS_264RI_HIPHASEFB002
- Tweaks can be greatly reduced if we insert RWA bias during VIMS_264RI_GAMCRUOCC001_PIE at about 2017-066T09:40, along with a small tweak to: VIMS_264SA_GAMCRUOCC001_PIE at 2017-066T10:25
  - Bias during the Ring Occultation is not ideal, but may be possible provided that it can placed towards the beginning of the observation prior to acquiring the star and will require iteration with VIMS Rep.
  - The secondary of the Saturn Occultation is very sensitive. However, the 5 deg offset suggested is acceptable to CIRS, but needs to be about VIMS_IR for VIMS.
- Also need bias placed right before last downlink roll, SP_264EA_C70METNON067 at 2017-067T17:50.
  - Looks like there is enough time for this