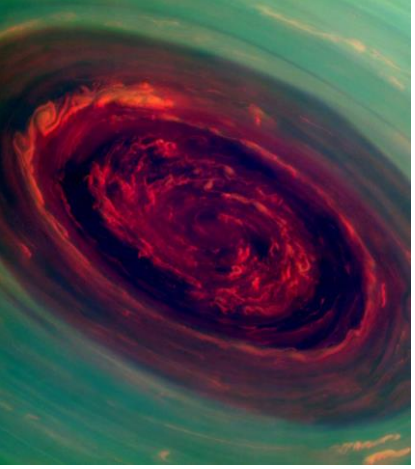
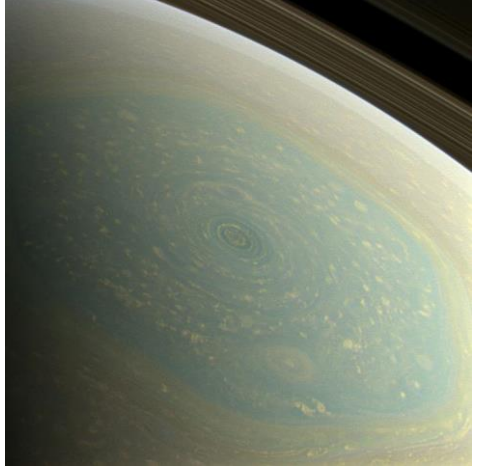
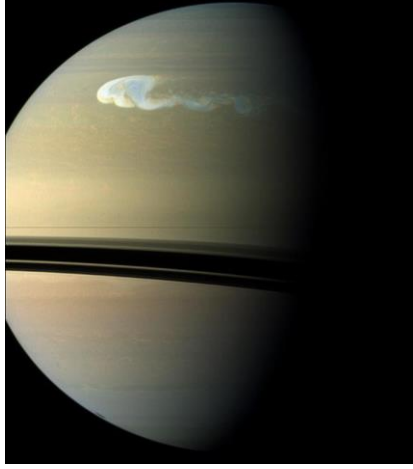


Science Planning & Sequence Team
CASSINI

SATURN TARGET WORKING TEAM

Rev 77_78 Segment Legacy Package

Segment Boundary: July 24, 2008 – July 27, 2008
2008-206T01:21:00 – 2008-209T01:06:00 (SCET)

Integration Began 01/15/2004
Segment Delivered to S42 Sequence 01/24/2008
Lead Integrator was Barbara Larsen

Legacy Package Assembled by Keven Uchida

Table of Contents

Segment Overview and Final Products

Segment Summary

- This was an ~3 day long, Equinox Mission apoapse segment. The S/C was in an inclined orbit.
- Distances ranged between 16-20 Rs. The segment began with a view from the equator, then moved to increasing sub-S/C latitudes, and ended at a maximum of +34 degrees. Saturn was mostly lit throughout, with phase angles ranging between 20 and 41 degrees.
- There were two ISS OPNAV satellite observations, one leading off the segment. UVIS led the bulk of the observations in this segment, with three UVIS auroral observations, distributed throughout the segment, to measure temporal variations. CIRS performed radial scans of the unlit side of the ring. RSS performed a boresight calibration.
- The science activities, as originally planned, exceeded the downlink capability in this segment. Two 34m stations were upgraded/changed to 70m stations to increase the total downlink capacity. There is no information o whether science data volume cuts also were needed, but the data volume overage was resolved by the time of segment delivery for sequencing.
- There were no ORS boresight constraints/issues in this segment.

Final Sequenced SPASS

Request	Riders	Start (SCET)	Start (Epoch)	Duration	End (SCET)	Primary	Secondary	Comments
SATURN_77_78 Segment		2008-206T01:21:00		002T23:45:00	2008-209T01:06:00			
NAV_077SK_OPNAV061_PRIME	N	2008-206T01:21:00		000T01:29:00	2008-206T02:50:00	ISS_NAC to Satellites	POS_X to NSP	Starts at Earth point, ends at NEW waypoint
NAV_077SA_WAYPTTURN061_PRIME		2008-206T02:50:00		000T00:01:00	2008-206T02:51:00	ISS_NAC to Saturn	NEG_X to Sun	
NEW WAYPOINT		**2008-206T02:51:00**		**001T13:15:00**	**2008-207T16:06:00**	**ISS_NAC to Saturn**	**NEG_X to Sun**	
UVIS_077SA_AURORA003_PRIME	I, V	2008-206T02:51:00		000T12:45:00	2008-206T15:36:00	ISS_NAC to Saturn	NEG_X to Sun	
SP_077EA_DLTURN206_PRIME		2008-206T15:36:00		000T00:30:00	2008-206T16:06:00	XBAND to Earth	POS_X to NSP	SP Turn to Earth
SP_077EA_G34BWGNON206_PRIME	C	2008-206T16:06:00		000T09:00:00	2008-207T01:06:00	XBAND to Earth	Rolling/Bias	
Apoapse Per = 7.0 d, inc =...		2008-207T00:08:28		000T00:00:01	2008-207T00:08:29			
SP_078SA_WAYPTTURN207_PRIME		2008-207T01:06:00		000T00:30:00	2008-207T01:36:00	ISS_NAC to Saturn	NEG_X to Sun	SP Turn to Waypoint
UVIS_078SA_AURORA001_PRIME	I, R, V	2008-207T01:36:00		000T13:00:00	2008-207T14:36:00	ISS_NAC to Saturn	NEG_X to Sun	
NAV_078SK_OPNAV071_PRIME	R	2008-207T14:36:00		000T01:29:00	2008-207T16:05:00	ISS_NAC to Satellites	NEG_X to Sun	Starts at waypoint, ends at Earth point
NAV_078EA_DLTURN071_PRIME	R	2008-207T16:05:00		000T00:01:00	2008-207T16:06:00	XBAND to Earth	POS_X to NSP	
NEW WAYPOINT		**2008-207T16:06:00**		**000T10:30:00**	**2008-208T02:36:00**	**XBAND to Earth**	**POS_X to NSP**	
SP_078EA_G70METNON207_PRIME	C, R	2008-207T16:06:00		000T03:00:00	2008-207T19:06:00	XBAND to Earth	POS_X to NSP	
RSS_078EA_BORESIGHT002_PRIME	C, R	2008-207T19:06:00		000T01:00:00	2008-207T20:06:00	XBAND to Earth	PIC	
SP_078EA_G34BWGNON407_PRIME	C	2008-207T20:06:00		000T06:00:00	2008-208T02:06:00	XBAND to Earth	POS_X to NSP	
SP_078SA_WAYPTTURN208_PRIME		2008-208T02:06:00		000T00:30:00	2008-208T02:36:00	ISS_NAC to Saturn	NEG_X to Sun	SP Turn to Waypoint
NEW WAYPOINT		**2008-208T02:36:00**		**000T23:04:00**	**2008-209T01:40:00**	**ISS_NAC to Saturn**	**NEG_X to Sun**	
UVIS_078SA_AURORA002_PRIME	I, V	2008-208T02:36:00		000T05:00:00	2008-208T07:36:00	ISS_NAC to Saturn	NEG_X to Sun	
CIRS_078RI_SUBMU27LP001_PRIME	C, R, U, V	2008-208T07:36:00		000T09:00:00	2008-208T16:36:00	CIRS_FP1 to Rings	POS_Z to NSP	
SP_078EA_DLTURN208_PRIME	R	2008-208T16:36:00		000T00:30:00	2008-208T17:06:00	XBAND to Earth	POS_X to NSP	
SP_078EA_G70METNON208_PRIME	C, R	2008-208T17:06:00		000T08:00:00	2008-209T01:06:00	XBAND to Earth	Rolling/Bias	

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_077EA_G34BWGNON206_PRIME	206 16:06	207 01:06	0	929	64	992	3499	2506	27	234	53	1306	651	-655	900	7%	655
SP_078EA_G70METNON207_PRIME	207 16:06	207 19:06	655	1083	63	1802	3499	1697	13	72	18	1905	1082	-823	900	7%	823
SP_078EA_G34BWGNON407_PRIME	207 20:06	208 02:06	823	32	4	859	3499	2640	0	166	35	1060	415	-645	900	7%	645
SP_078EA_G70METNON208_PRIME	208 17:06	209 01:06	645	1144	63	1852	3499	1647	0	207	47	2106	3006	899	900	7%	0

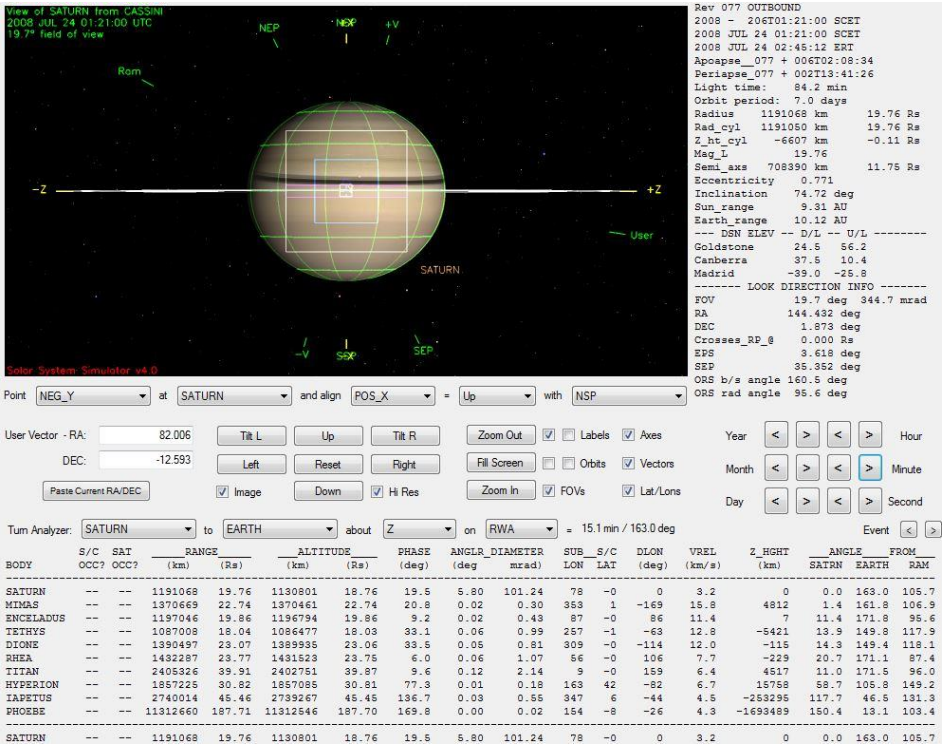
DATA VOLUME REPORT --- TRANSFER FRAME OVERHEAD NOT INCLUDED

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	206 01:01	206 16:06	54.3	11.4	0.0	5.4	350.0	32.6	65.2	0.0	70.6	231.1	100.0	0.0	12.3	932.8
OBSERVATION_OPN	206 01:01	206 16:06	0.0	0.0	0.0	0.0	26.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	26.1
SP_077EA_G34BWGNON206_PRIME	206 16:06	207 01:06	32.4	6.8	86.4	3.2	0.0	19.4	38.9	0.0	42.1	2.5	0.0	0.0	0.0	231.7
DAILY TOTAL SCIENCE	206 01:01	207 01:06	86.7	18.2	86.4	8.7	350.0	52.0	104.0	0.0	112.7	233.5	100.0	0.0		
OBSERVATION_NOR	207 01:06	207 16:06	54.0	11.3	0.0	5.4	500.0	32.4	64.8	0.0	70.2	235.5	100.0	0.0	12.3	1085.9
OBSERVATION_OPN	207 01:06	207 16:06	0.0	0.0	0.0	0.0	13.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.1
SP_078EA_G70METNON207_PRIME	207 16:06	207 19:06	10.8	2.3	24.1	1.1	0.0	6.5	13.0	0.0	14.0	0.0	0.0	0.0	0.0	71.7
DAILY TOTAL SCIENCE	207 01:06	207 19:06	64.8	13.6	24.1	6.5	500.0	38.9	77.8	0.0	84.2	235.5	100.0	0.0		
OBSERVATION_NOR	207 19:06	207 20:06	3.6	0.8	10.8	5.0	0.0	2.2	4.3	0.0	4.7	0.0	0.0	0.0	0.8	32.1
SP_078EA_G34BWGNON407_PRIME	207 20:06	208 02:06	21.6	4.5	62.3	7.6	0.0	13.0	25.9	0.0	28.1	1.6	0.0	0.0	0.0	164.6
DAILY TOTAL SCIENCE	207 19:06	208 02:06	25.2	5.3	73.1	12.6	0.0	15.1	30.2	0.0	32.8	1.6	0.0	0.0		
OBSERVATION_NOR	208 02:06	208 17:06	54.0	11.3	129.6	5.4	325.0	32.4	64.8	0.0	70.2	234.8	190.0	0.0	12.3	1129.8
OBSERVATION_SI	208 02:06	208 17:06	0.0	0.0	16.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.0
SP_078EA_G70METNON208_PRIME	208 17:06	209 01:06	28.8	6.0	75.6	2.9	0.0	17.3	34.6	0.0	37.4	2.2	0.0	0.0	0.0	204.8
DAILY TOTAL SCIENCE	208 02:06	209 01:06	82.8	17.4	221.2	8.3	325.0	49.7	99.4	0.0	107.6	237.0	190.0	0.0		

Segment Geometry

Seg Start (Left)

Seg End (below)




```
Rev 077 OUTBOUND
2008 -  206T01:21:00 SCET
2008 JUL 24 01:21:00 SCET
2008 JUL 24 02:45:12 ERT
Apoapse__077 + 006T02:08:34
Periapse_077 + 002T13:41:26
Light time:    84.2 min
Orbit period:  7.0 days
Radius     1191068 km      19.76 Rs
Rad_cyl    1191050 km      19.76 Rs
Z_ht_cyl     -6607 km      -0.11 Rs
Mag_L          19.76
Semi_axs    708390 km      11.75 Rs
Eccentricity    0.771
Inclination    74.72 deg
Sun_range       9.31 AU
Earth_range    10.12 AU
--- DSN ELEV -- D/L -- U/L --------
Goldstone       24.5   56.2
Canberra        37.5   10.4
Madrid         -39.0  -25.8
------- LOOK DIRECTION INFO -------
FOV             19.7 deg  344.7 mrad
RA             144.432 deg
DEC              1.873 deg
Crosses_RP_@     0.000 Rs
EPS              3.618 deg
SEP             35.352 deg
ORS b/s angle 160.5 deg
ORS rad angle  95.6 deg
```

Point NEG_Y at SATURN and align POS_X = Up with NSP

User Vector - RA: 82.006 DEC: -12.593 Paste Current RA/DEC

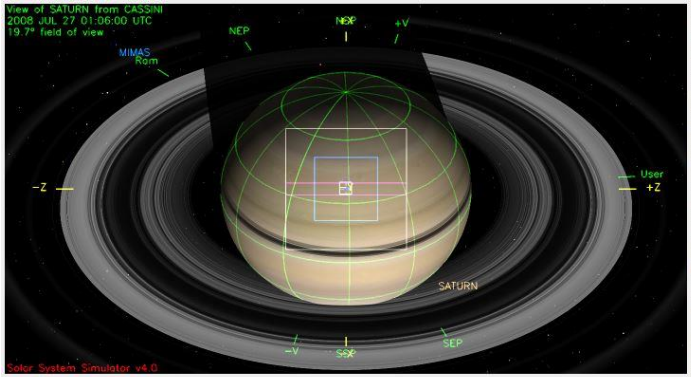
Tilt L | Up | Tilt R | Left | Reset | Right | Image | Down | Hi Res

Zoom Out | Fill Screen | Zoom In | Labels | Orbits | FOVs | Axes | Vectors | Lat/Lons

Year / Month / Day — Hour / Minute / Second

Tum Analyzer: SATURN to EARTH about Z on RWA = 15.1 min / 163.0 deg Event

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	DLON (deg)	VREL (km/s)	Z_HGHT (km)	ANGLE FROM SATRN	ANGLE FROM EARTH	ANGLE FROM RAM
SATURN	--	--	1191068	19.76	1130801	18.76	19.5	5.80	101.24	78	-0	0	3.2	0	0.0	163.0	105.7
MIMAS	--	--	1370669	22.74	1370461	22.74	20.8	0.02	0.30	353	1	-169	15.8	4812	1.4	161.8	106.9
ENCELADUS	--	--	1197046	19.86	1196794	19.86	9.2	0.02	0.43	87	-0	86	11.4	7	11.4	171.8	95.6
TETHYS	--	--	1087008	18.04	1086477	18.03	33.1	0.06	0.99	257	-1	-63	12.8	-5421	13.9	149.8	117.9
DIONE	--	--	1390497	23.07	1389935	23.06	33.5	0.05	0.81	309	-0	-114	12.0	-115	14.3	149.4	118.1
RHEA	--	--	1432287	23.77	1431523	23.75	6.0	0.06	1.07	56	-0	106	7.7	-229	20.7	171.1	87.4
TITAN	--	--	2405326	39.91	2402751	39.87	9.6	0.12	2.14	9	-0	159	6.4	4517	11.0	171.5	96.0
HYPERION	--	--	1857225	30.82	1857085	30.81	77.3	0.01	0.18	163	42	-82	6.7	15758	58.7	105.8	149.2
IAPETUS	--	--	2740014	45.46	2739267	45.45	136.7	0.03	0.55	347	6	-44	4.5	-253295	117.7	46.5	131.3
PHOEBE	--	--	11312660	187.71	11312546	187.70	169.8	0.00	0.02	154	-8	-26	4.3	-1693489	150.4	13.1	103.4
SATURN	--	--	1191068	19.76	1130801	18.76	19.5	5.80	101.24	78	-0	0	3.2	0	0.0	163.0	105.7




```
Rev 078  INBOUND
2008 -  209T01:06:00 SCET
2008 JUL 27 01:06:00 SCET
2008 JUL 27 02:30:27 ERT
Apoapse__078 + 002T00:57:28
Periapse_078 - 001T11:31:27
Light time:    84.5 min
Orbit period:  7.0 days
Radius      943867 km      15.66 Rs
Rad_cyl     782511 km      12.98 Rs
Z_ht_cyl    527790 km       8.76 Rs
Mag_L          22.79
Semi_axs    708384 km      11.75 Rs
Eccentricity    0.771
Inclination    74.71 deg
Sun_range       9.32 AU
Earth_range    10.15 AU
--- DSN ELEV -- D/L -- U/L --------
Goldstone       25.3   56.9
Canberra        37.1    9.6
Madrid         -39.1  -25.2
------- LOOK DIRECTION INFO -------
FOV             19.7 deg  344.7 mrad
RA             158.958 deg
DEC            -31.108 deg
Crosses_RP_@     0.000 Rs
EPS              3.386 deg
SEP             32.817 deg
ORS b/s angle 139.4 deg
ORS rad angle 129.5 deg
```

Point NEG_Y at SATURN and align POS_X = Up with NSP

User Vector - RA: 82.006 DEC: -12.593 Paste Current RA/DEC

Tilt L | Up | Tilt R | Left | Reset | Right | Image | Down | Hi Res

Zoom Out | Fill Screen | Zoom In | Labels | Orbits | FOVs | Axes | Vectors | Lat/Lons

Year / Month / Day — Hour / Minute / Second

Tum Analyzer: SATURN to EARTH about Z on RWA = 13.3 min / 138.4 deg Event

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	DLON (deg)	VREL (km/s)	Z_HGHT (km)	ANGLE FROM SATRN	ANGLE FROM EARTH	ANGLE FROM RAM
SATURN	--	--	943867	15.66	885397	14.69	40.6	7.32	127.79	332	34	0	5.2	0	0.0	138.4	58.3
MIMAS	--	--	1063325	17.64	1063124	17.64	35.4	0.02	0.39	35	31	137	19.0	3042	7.9	143.0	50.4
ENCELADUS	--	--	791918	13.14	791666	13.14	47.8	0.04	0.65	142	42	30	15.1	29	12.1	130.5	56.2
TETHYS	--	--	1018408	16.90	1017876	16.89	38.3	0.06	1.06	64	31	98	16.5	5389	16.7	139.4	43.8
DIONE	--	--	1210367	20.08	1209804	20.07	38.2	0.05	0.93	331	26	-137	8.6	-67	14.4	142.1	65.6
RHEA	--	--	1262818	20.95	1262052	20.94	43.0	0.07	1.22	327	25	-121	6.0	2939	22.2	138.0	73.4
TITAN	--	--	1702362	28.25	1699787	28.20	45.7	0.17	3.03	29	18	105	10.7	-4068	45.0	130.9	23.1
HYPERION	--	--	2068709	34.33	2068556	34.32	55.2	0.01	0.16	347	28	-116	3.7	27307	44.3	127.0	91.2
IAPETUS	--	--	3039065	50.43	3038819	50.41	129.7	0.03	0.49	355	13	-48	2.9	-23853	109.8	53.1	166.4
PHOEBE	--	--	11630795	192.98	11630684	192.98	171.4	0.00	0.02	63	-5	-13	5.8	-1887370	132.1	10.2	147.6
SATURN	--	--	943867	15.66	885397	14.69	40.6	7.32	127.79	332	34	0	5.2	0	0.0	138.4	58.3

	Saturn Range	Phase Angle	Sub-S/C Lat.
Segment Start	19.76	19.5	0
Apoapse	20.68	24.1	13
Segment End	15.66	40.6	34

Solar Geometry – ORS Boresight Concerns

No ORS Boresight Solar Constraints on Science Pointing

Daily Science Highlights

July 24, 2008 DOY 206
UVIS with ISS and VIMS riding did a slow scan to study Saturn's auroral zone at high latitude. Hints of auroral patterns that repeat in longitude have previously been detected in high latitude observations. Over the duration of the study, images may show response of the aurora to changes in the solar wind.

July 25, 2008 DOY 207
Saturn's aurora was again the day's science focus. A comparison of images acquired at different times may reveal major changes in emissions inside the polar auroral region. Spectral information may also be compared to previous data to enhance understanding of changing chemical distributions in Saturn's auroras, gases, and hazes.

RSS performed a boresight calibration.

July 26, 2008 DOY 208
After additional auroral study, CIRS made a set of slow radial scans of the unlit side of the rings. By recording spectra at high spectral resolution out to a wavelength of 1 mm and less (hence sub-millimeter) CIRS mapped the thermal characteristics and the composition.

Segment Integration Planning

Timeline Gaps and Suggested Observations

Rev 077_078 TOL/Strawman

Request	Start Time	Epoch Relative Start Time	Duration	EndTime	Effective Rate	Data Volume	SPASS Type	Primary Pointing	Secondary Pointing	Agreement
OPNAV	2008-206T01:21:00		000T01:30:00	2008-206T02:51:00	600	155.52	Non-SPASS			
UVIS Atmospheres	2008-206T02:51:00		000T12:45:00	2008-206T15:36:00	1300	103.739	Non-SPASS			
D/L Turn	2008-206T15:36:00		000T00:30:00	2008-206T16:06:00	0	1030.56	Prime			
SP_077EA_G34BWGNON206_PRIME	2008-206T16:06:00		000T09:00:00	2008-207T01:06:00	0	0	Prime			
Waypoint Turn	2008-207T01:06:00		000T00:30:00	2008-207T01:36:00	600	155.52	Non-SPASS			
UVIS Atmospheres	2008-207T01:36:00		000T13:00:00	2008-207T14:36:00	1300	103.739	Non-SPASS			
OPNAV & D/L Turn	2008-207T14:36:00		000T01:30:00	2008-207T16:06:00	0	1030.56	Prime			
SP_078EA_G34HEFNON207_PRIME	2008-207T16:06:00		000T09:00:00	2008-208T01:06:00	0	0	Prime			RSS USOPIM here
Waypoint Turn	2008-208T01:06:00		000T00:30:00	2008-208T01:36:00	600	155.52	Non-SPASS			
UVIS Atmospheres	2008-208T01:36:00		000T06:00:00	2008-208T07:36:00						
CIRS Rings	2008-208T07:36:00		000T08:00:00	2008-208T15:36:00	1300	103.739	Non-SPASS			
UVIS Tethys Icy Occ	2008-208T15:36:00		000T01:30:00	2008-208T17:06:00						
OPNAV & D/L Turn	2008-208T17:06:00		000T02:00:00	2008-208T19:06:00	0	1030.56	Prime			
SP_078EA_G34HEFNON208_PRIME	2008-208T19:06:00		000T06:00:00	2008-209T01:06:00	0	0	Prime			

Initial SMT and Data Volume

Beginning of Integration:

Revs 77/78 Prelim Data Volume Report (reflects the current margin policy)

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_077EA_G34BWGNON206_PRIME	206 16:06	207 01:06	0	1666	50	1717	3516	1799	27	228	53	2024	660	-1364	0	0%	1365
SP_078EA_G34HEFNON207_PRIME	207 16:06	207 19:06	1365	1229	51	2645	3516	871	27	76	18	2765	262	-2503	0	0%	2503
SP_078EA_G34HEFNON407_PRIME	207 20:06	208 01:06	2503	30	3	2537	3516	979	0	122	29	2688	459	-2228	0	0%	2229
SP_078EA_G34HEFNON208_PRIME	208 17:06	209 01:06	2229	991	54	3274	3516	242	27	212	47	3560	747	-2813	0	0%	2814

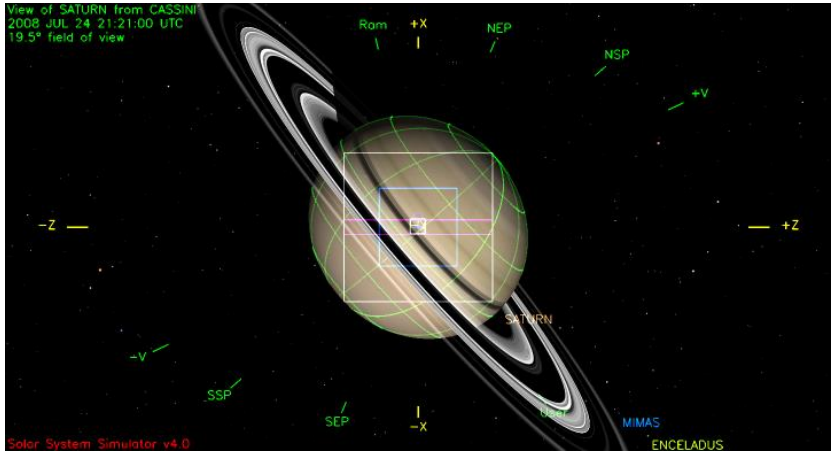
Scott's task: Upgrade to 70m where possible
Others: Special TLM modes?
Riders?

Rev 77/78 Waypoints

- Safe for the entire period
  - ISS_NAC to Saturn, POS_Z to NSP
  - ISS_NAC to Saturn, NEG_X to Sun (UVIS preference)
  - XBAND to Earth, POS_X to NSP
  - XBAND to Earth, NEG_X to NSP

Waypoints Chosen

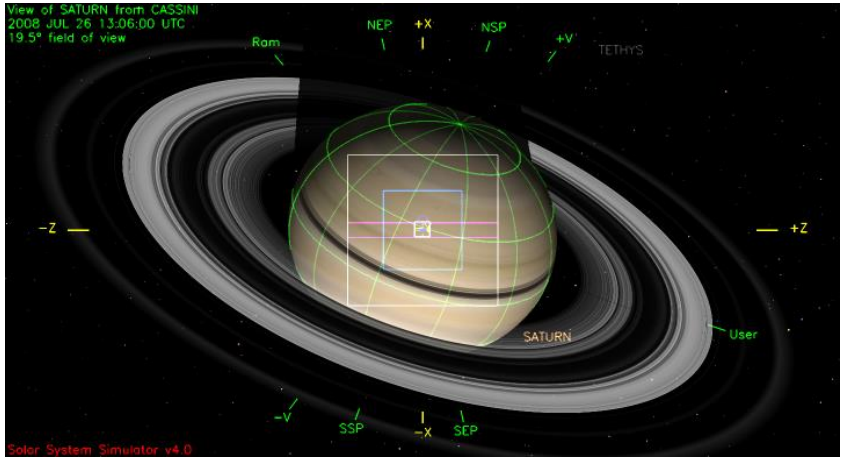
Waypoint 1 (2008-206T02:51:00 – 207T16:06:00): NEG_Y to Saturn, NEG_X to Sun



Waypoint 2 (2008-207T16:06:00 – 208T02:36:00): XBAND to EARTH, POS_X to NSP

Not shown here since ORS is not pointed toward any body in this period.

Waypoint 3 (2008-208T02:36:00 – 209T01:40:00): NEG_Y to Saturn, NEG_X to Sun



Notes and Liens

Notes:

- Pointing: OK
- Data Volume: OK
- DSN:
  - RSS will be requesting that the DSN move the DSS-34 downtime in conflict with SP_078NA_C34BWGRSS208_SP
  - The excess 70M coverage is due to the RSS boresight activity
- Opmodes: OK
- Special Activities:
  - RSS boresight on DOY 208. This interrupts the downlink, so NAV does not get six hours of two-way.

Sequence Liens: