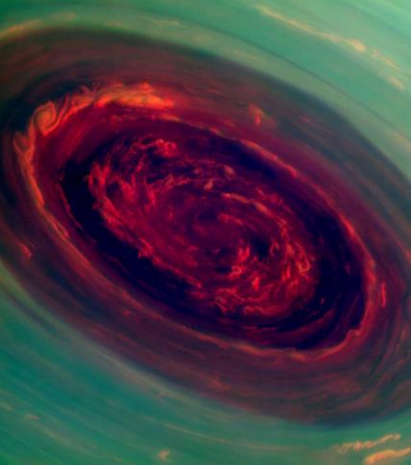

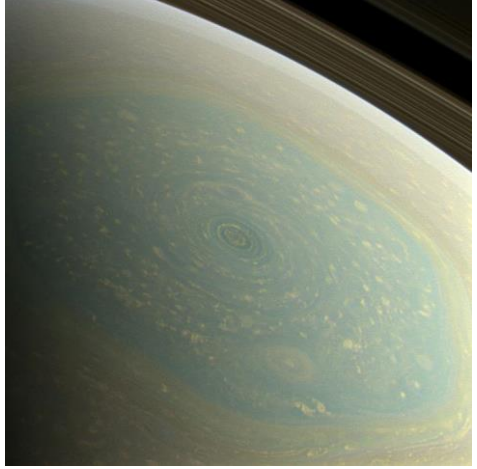
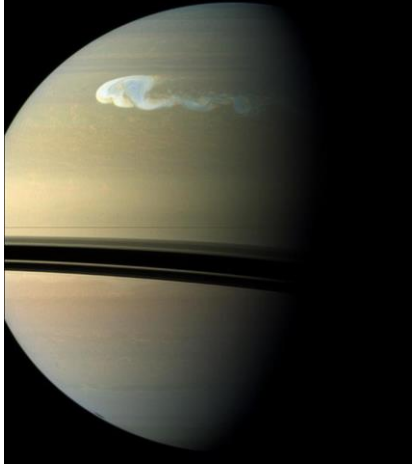

Science Planning & Sequence Team
CASSINI

SATURN TARGET WORKING TEAM

Rev 222 Segment Legacy Package

Segment Boundary: Sept 30, 2015 – Oct 2, 2015
2015-273T04:17:00 – 275T08:17:00 (SCET)

Integration Began 01/26/2015
Segment Delivered to S91 Sequence 04/03/2015
Lead Integrator was Keven Uchida

Legacy Package Assembled by Keven Uchida

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*** N.A. = Slide present but content not available.**

Segment Overview and Final Products

Segment Summary

- This was an approximately two day long high value **periapse** segment with the S/C in an equatorial orbit. The segment covers a wide range of Saturn phase angles/illumination.
- A good fraction of the segment time was pre-populated/reserved with high value, pre-planned observations (PIEs) to observe Dione and several stellar occultation events by Saturn (See SPASS and Science Highlights, pages 8 and 9 of this package). The rest of the “gaps” were populated with atmospheric observations taking advantage of spacecraft’s close proximity to Saturn; VIMS Global map, VIMS Storm remnant observations, CIRS limb observations, and UVIS EUV/FUV observations.
- Data volume was not an issue, having upgraded the last DSN station to a 70m. With that, we were able to accommodate all reasonable data volume requests from science.
- There were no Sun constraints/issues in planning this segment.

Final Sequenced SPASS

	Request	Riders	Start (SCET)	Start (Epoch)	Duration	End	Primary	Secondary	Comments
	SATURN_222 Segment		2015-273T04:17:00		002T04:00:00	2015-275T08:17:00			
	SP_222SA_WAYPTTURN273_PRIME		2015-273T04:17:00		000T00:06:00	2015-273T04:23:00	XBAND to Earth (0.0,0.0,-12.0 deg. offset)	POS_X to 40.6/83.5	First turn of two part turn.
	SP_222SA_WAYPTTURN473_PRIME		2015-273T04:23:00		000T00:34:00	2015-273T04:57:00	ISS_NAC to Saturn	NEG_X to Sun	Second turn of two part turn
Gap 1	NEW WAYPOINT		2015-273T04:57:00		000T17:05:00	2015-273T22:02:00	ISS_NAC to Saturn	NEG_X to Sun	
Gap 1	ISS_222SA_FEATRAK001_PRIME	C, U, V	2015-273T04:57:00		000T02:03:00	2015-273T07:00:00	ISS_NAC to Saturn	NEG_X to Sun	
Gap 1	Begin Custom Period		2015-273T07:00:00		000T00:00:01	2015-273T07:00:01			
Gap 1	CIRS_222DI_DIONE001_PIE	U, V	2015-273T07:00:00		000T00:50:00	2015-273T07:50:00	CIRS_FP3 to Dione	NEG_X to NEP	Collaborative Rider(s): VIMS. Pick up at ISS_NAC to Saturn, NEG_X to Sun; Hand off at ISS_NAC to Dione, NEG_X to NEP. Collaborative Rider(s): VIMS
Gap 1	ISS_222DI_DIONE002_PIE	C, E, U, V	2015-273T07:50:00		000T01:30:00	2015-273T09:20:00	ISS_NAC to Dione	NEG_X to NEP	Collaborative Rider(s): CIRS, UVIS, VIMS. Pick up at ISS_NAC to Dione, NEG_X to NEP; Hand off at ISS_NAC to 321.0/-3.7, NEG_X to NEP. Collaborative Rider(s): CIRS, UVIS, VIMS. 2 min dwells. Set S/C at inertial hand-off position 20 min before request end.
Gap 1	CIRS_222DI_DIONE003_PIE	M, U, V	2015-273T09:20:00		000T01:51:00	2015-273T11:11:00	CIRS_FP1 to Dione (0.588,0.0,-0.527 deg. offset)	NEG_X to NEP	Collaborative Rider(s): VIMS. Pick up at ISS_NAC to 321.0/-3.7, NEG_X to NEP; Hand off at ISS_NAC to Saturn, NEG_X to Sun. Collaborative Rider(s): VIMS
Gap 1	End Custom Period		2015-273T11:10:59		000T00:00:01	2015-273T11:11:00			
Gap 2	VIMS_222SA_DELOPHOCC001_PRIME	M	2015-273T11:11:00		000T01:20:00	2015-273T12:31:00	VIMS_IR to 243.586/-3.694	NEG_X to Sun	
Gap 2	VIMS_222SA_STORMLAT001_PRIME	C, I, U	2015-273T12:31:00		000T02:54:00	2015-273T15:25:00	ISS_NAC to Saturn	NEG_Z to NSP	
Gap 2	VIMS_222RI_30PSCOCC101_PIE	M	2015-273T15:25:00		000T02:44:00	2015-273T18:09:00	VIMS_IR to 0.49/-6.014	NEG_X to NSP	
Gap 3	Periapse R = 2.899 Rs, lat ...		2015-273T16:17:17		000T00:00:01	2015-273T16:17:18			
Gap 3	CIRS_222SA_LIMBINT001_PRIME	M, V	2015-273T18:09:00		000T03:13:00	2015-273T21:22:00	CIRS_FPB to Saturn	NEG_X to Sun	Observe illuminated limb from 20S to 60S (although in ring shadow)
	SP_222EA_DLTURN273_PRIME		2015-273T21:22:00		000T00:40:00	2015-273T22:02:00	XBAND to Earth	NEG_X to NSP	
	NEW WAYPOINT		2015-273T22:02:00		000T11:10:00	2015-274T09:12:00	XBAND to Earth	NEG_X to NSP	
	ENGR_222SC_KPTYBIAS273_PRIME		2015-273T22:02:00		000T01:30:00	2015-273T23:32:00	NEG_Z to DELTA_H (0.0,0.0,-77.997 deg. offset)	NEG_X to Sun	
	SP_222EA_C70METNON273_PRIME	C, E	2015-273T23:42:00		000T05:55:00	2015-274T05:37:00	XBAND to Earth	Rolling	NEG_X to 40.6/83.5 (NSP) or NEP.
	SP_222SA_WAYPTTURN274_PRIME		2015-274T08:32:00		000T00:40:00	2015-274T09:12:00	ISS_NAC to Saturn	NEG_X to NSP	
	NEW WAYPOINT		2015-274T09:12:00		000T14:05:00	2015-274T23:17:00	ISS_NAC to Saturn	NEG_X to NSP	
Gap 4	UVIS_222ST_ZETAORI001_PIE		2015-274T09:12:00		000T01:07:00	2015-274T10:19:00	UVIS_FUV to 84.05/-1.202 (0.0,78.521,0.0 deg. offset)	POS_Z to 174.9/-33.0	
Gap 4	UVIS_222SA_EUVFUV001_PRIME	C, I, V	2015-274T10:19:00		000T04:41:00	2015-274T15:00:00	ISS_NAC to Saturn	PIC	
Gap 4	UVIS_222ST_ZETAORI002_PIE		2015-274T15:00:00		000T02:13:00	2015-274T17:13:00	UVIS_FUV to 84.05/-1.202	POS_Z to 174.9/-33.0	
Gap 5	VIMS_222SA_GLOBALMAP001_PRIME	C	2015-274T17:13:00		000T05:24:00	2015-274T22:37:00	ISS_NAC to Saturn	NEG_X to NSP	
	SP_222EA_DLTURN274_PRIME		2015-274T22:37:00		000T00:40:00	2015-274T23:17:00	XBAND to Earth	NEG_X to 40.6/83.5	
	NEW WAYPOINT		2015-274T23:17:00		000T09:18:00	2015-275T08:35:00	XBAND to Earth	NEG_X to 40.6/83.5	
	SP_222EA_C70METOTP274_PRIME	C, E, N	2015-274T23:17:00		000T09:00:00	2015-275T08:17:00	XBAND to Earth	4_Hr_Rolling	NEG_X to 40.6/83.5 (NSP). 4 Hr rolling

Final Sequenced SMT and Data Volume

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

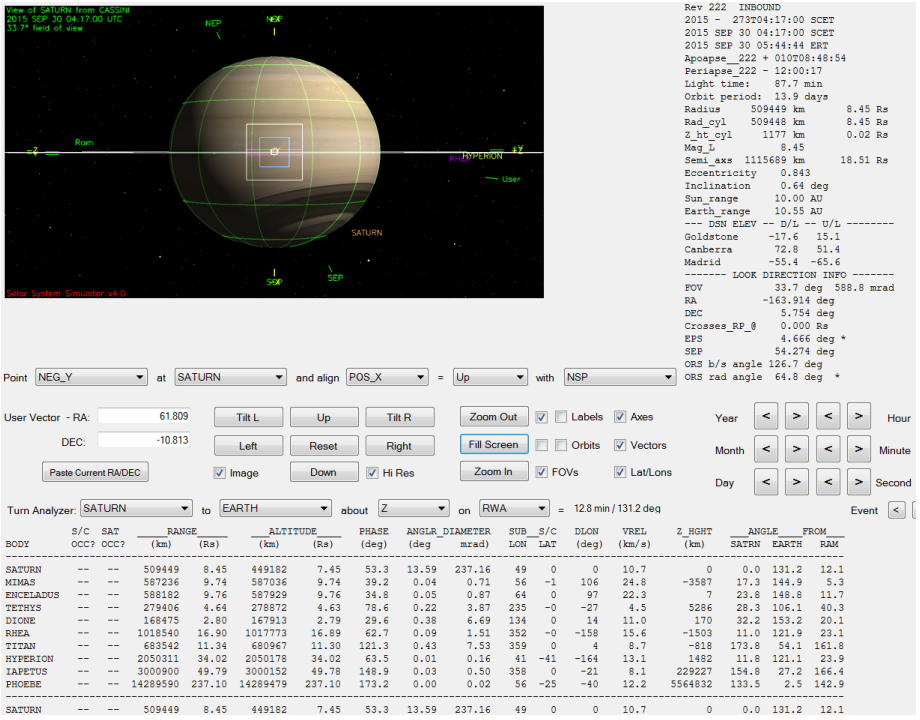
			OBSERVATION_PERIOD							DOWNLINK_PASS							
			P4						P5	RECORDED		PLAYBACK					
DOWNLINK PASS NAME	Start doy hh:mm	End doy hh:mm	START (Mb)	SCI (Mb)	HK+E (Mb)	TOTAL (Mb)	CPACTY (Mb)	MRGN (Mb)	OPNAV (Mb)	SCI (Mb)	ENGR (Mb)	TOTAL (Mb)	CPACTY (Mb)	MARGN (Mb)	NET_MARGN (Mb)	(%)	CAROVR (Mb)
SP_222EA_C70METNON273_PRIME	273 23:42	274 05:37	370	2640	82	3092	3322	230	0	353	35	3481	1959	-1522	-162	-1%	1522
SP_222EA_C70METOTP274_PRIME	274 23:17	275 08:17	1522	1695	75	3292	3322	30	0	385	53	3729	2514	-1215	-162	-1%	1215

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	273 04:17	273 23:42	0.0	293.0	115.1	40.4	649.6	79.9	59.4	0.0	630.9	203.9	544.0	0.0	81.1	2697.3
SP_222EA_C70METNON273_PRIME	273 23:42	274 05:37	0.0	89.3	54.9	31.9	0.0	10.5	18.1	0.0	142.3	3.2	0.0	0.0	0.0	350.2
DAILY TOTAL SCIENCE	273 04:17	274 05:37	0.0	382.3	170.0	72.3	649.6	90.4	77.5	0.0	773.1	207.1	544.0	0.0	81.1	
OBSERVATION_NOR	274 05:37	274 23:17	0.0	187.8	104.1	85.8	50.0	31.4	54.1	0.0	443.2	383.6	340.0	0.0	73.8	1753.8
SP_222EA_C70METOTP274_PRIME	274 23:17	275 08:17	0.0	17.0	86.4	3.2	0.0	16.0	27.5	0.0	226.0	4.9	0.0	0.0	0.0	381.1
DAILY TOTAL SCIENCE	274 05:37	275 08:17	0.0	204.8	190.5	89.0	50.0	47.4	81.6	0.0	669.2	388.6	340.0	0.0	73.8	

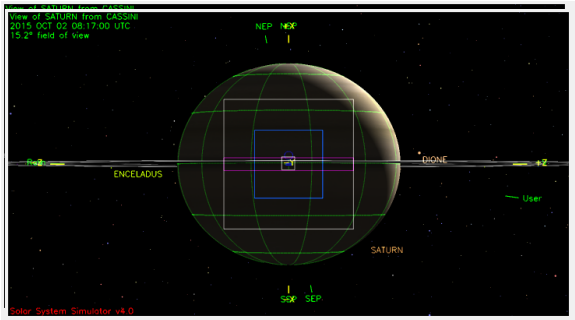
Segment Geometry

Segment Start: 2015-273T04:17:00



	Saturn Range	Phase Angle	Sub-S/C Lat.
Segment Start	8.45	53.3	0
Periapse	2.90	69.3	1
Segment End	18.89	137.7	-1

Segment End: 2015-275T08:17:00



Solar Geometry – ORS Boresight Concerns

No ORS Boresight Solar Constraints on Science Pointing
During This Segment

Science Highlights - SATURN 222 (1/2)

DOY 273 (30 Sept 2015):

ISS_222SA_FEATRAK001_PRIME: The Saturn 222 segment started off with Saturn emission angle scan observations – ISS was Prime, and CIRS, UVIS and VIMS rode along. Imaging was performed on latitudes at a low emission angle, medium emission angle, and high emission angle as the planet rotated. Additional latitudes were included as time and data volume permit.

CIRS_222DI_DIONE00[1, 2, and 3]_PIE: Immediately following the FEATRAK, the ORS instruments then turned toward DIONE PIE observations. The observations happened in three parts/requests:

- It began with CIRS as Prime, and VIMS and UVIS as collaborative riders. CIRS mapped the anomalous Pac-Man terrain, which was located at low latitudes on Dione's leading hemisphere. CIRS, in particular, observed how the anomalous region and its surroundings cool at different rates as they move from day- to night-time. These observations provided additional local time coverage that allowed the surface's anomalous thermo-physical properties to be better constrained.
- Once the CIRS-led observations were complete, there was custom handoff to ISS. For ISS (now with CIRS, UVIS and VIMS as collaborative riders) this "Voyager-class" flyby of Dione in rev 222 provided a good equatorial view on the leading hemisphere of Dione. This terrain included ridges, grooves, and tectonically deformed craters, as well as large plains which are relatively crater poor and thus younger. Closest-approach altitude was 40,800 km, and imaging with the NAC was revealed surface details at spatial resolutions down to 250 m/pixel.
- The last part of the PIE had ISS giving control back to CIRS, via another custom handoff. VIMS and UVIS were collaborative riders.

VIMS_222SA_DELOPHOCC001_PRIME: Here VIMS went solo, monitoring an atmospheric occultation of del Oph.

VIMS_222SA_STORMLAT001_PRIME: VIMS continued with “STORMLAT” observations, mapping the day-lit side covering the Great Storm latitude (35 degrees North Lat, planetocentric), with high-spatial resolution (~ 100 km per pixel), for about 100 degrees of longitude over 2.9 hrs. Images were taken every 8 minutes as the planet rotated underneath the S/C. All the other ORS instruments (CIRS, ISS, and UVIS) rode along.

VIMS_222RI_30PSCOCC101_PIE: VIMS then observed the ingress occultation by Saturn of the star delta Ophiuchi to study the vertical temperature profile and aerosol abundance in the planet's stratosphere. This particular occultation was at 46 deg South latitude, so complemented our other planned occultations in S88 - S92, which were all at 40-60 deg North. This was the first southern hemisphere occultation by VIMS since Feb 2013.

Science Highlights - SATURN 222 (2/2)

DOY 273 (Continued):

CIRS_222SA_LIMBINT001_PRIME: Shortly after Periapsis, CIRS (with VIMS riding along) obtained stratospheric thermal structure by means of limb sounding in the mid-IR longitude coverage (within +/– 45 degrees latitude).

The very busy science day is then ended with a downlink, with a simultaneous CIRS DSCAL.

DOY 274 (01 Oct 2015):

UVIS_222ST_ZETAORI00[1 and 2]_PIE: DOY 274 started off with the last PIE of this Segment. This was a double occultation (stars Zeta and Epsilon Orionis) by Saturn. The two requests for this PIE monitor the occultation ingress and egress, respectively. Occultations observed by UVIS sampled the high atmosphere (fraction of a micro-bar down to around a mbar pressure). The lowest altitudes sampled by UVIS overlapped with the highest where CIRS can sample. They provided a measure of temperature and some vertical profiles of hydrocarbons. This high-altitude region was where the photochemistry occurs and where some still mysterious process generates heat. Occultations are special because of the detailed vertical profiles they provide. However, one occultation samples only one latitude and time. These occultations sampled latitudes 23 and 33 degrees North and were part of a series where the ultimate goal was to sample many latitudes over a long time span. In addition to the valuable science these provided some occulttions sample latitudes close to where the spacecraft dipped into the atmosphere in the final few orbits. The measurements of atmospheric density provided by those occultations were important to mission designers to ensure spacecraft safety.

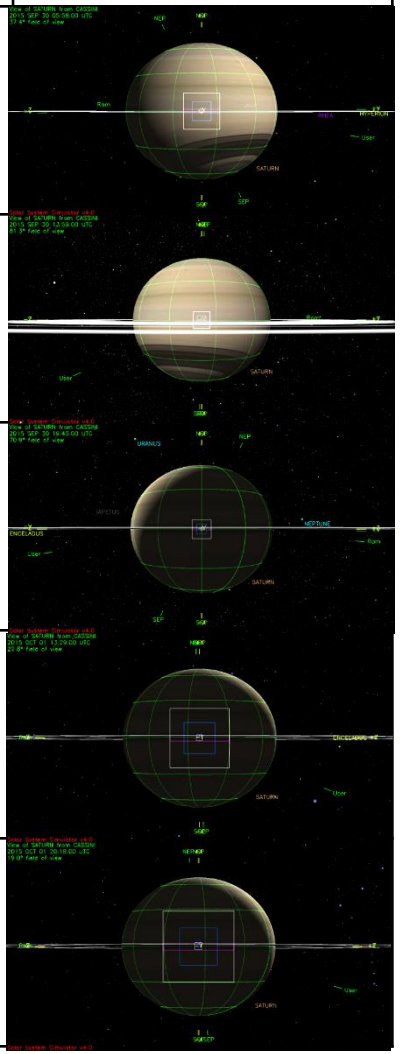
UVIS_222SA_EUVFUV001_PRIME: The gap between the Zeta Ori occultation ingress/egress PIE observations was used by UVIS to conduct EUV/FUV imaging of Saturn. One slow scan was performed across Saturn's illuminated hemisphere to form spectral images. The remaining ORS instruments (CIRS, ISS, and VIMS) rode along,

VIMS_222SA_GLOBALMAP001_PRIME: VIMS finished the science day with Saturn night-time global mapping, covering ~ 50 degrees south to 50 degrees north latitude, spanning about 180 degrees of longitude. The 2 (E-W)*4 (N-S) mosaic was centered at the equator and sub-spacecraft longitude. This mosaic was taken three more times to complete the near-global map of one entire hemisphere of Saturn, under nighttime conditions. CIRS rode along.

The day (and Segment) ended with a downlink, with a simultaneous CIRS DSCAL.

Segment Integration Planning

Timeline Gaps and Suggested Observations

Gap	Start	End	Duration	Phase angle (range)	Rs range	Sub-S/C Lat.	Snapshot (mid-gap)
1	2015-273T04:57:00	2015-273T07:00:00	000T02:03:00	51.6 – 45.8	8.12 – 7.07	0	
	Suggested activities:	*VIMS or ISS observations of lit Saturn*					
2	2015-273T12:31:00	2015-273T15:25:00	000T02:54:00	24.8 – 51.7	4.11 – 2.99	1	
	Suggested activities:	*ISS observations with VIMS rider*					
3	2015-273T18:09:00	2015-273T21:22:00	000T03:13:00	106.0 – 141.5	3.26 – 4.81	0	
	Suggested activities:	*ISS High Phase Observations, or VIMS Storm Remnant Observations.*					
4	2015-274T10:49:00	2015-274T16:08:00	000T05:19:00	150.6 – 146.6	11.43 – 13.57	-1	
	Suggested activities:	*CIRS Observation with VIMS Rider*					
5	2015-274T17:59:00	2015-274T22:37:00	000T04:38:00	145.4 – 142.5	14.25 – 15.88	-1	
	Suggested activities:	*VIMS N. Hemisphere Map of the Hexagon.*					

Initial SMT and Data Volume

Beginning of Integration:

SMT Report

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 (%)	CAROVR (Mb)
SP_222EA_C70METNON273_PRIME	273 23:32	274 08:32	0	1798	81	1879	3322	1443	0	599	53	2532	2970	438	1138	21%	0
SP_222EA_C70METOTP274_PRIME	274 23:17	275 08:17	0	1201	62	1264	3322	2058	0	498	53	1815	2514	699	699	28%	0

Margin

SMT Report (Team Summary)

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	273 04:17	273 23:32	0.0	290.5	31.7	6.0	250.0	79.6	58.9	0.0	630.1	231.1	204.0	0.0	80.5	1862.3
SP_222EA_C70METNON273_PRIME	273 23:32	274 08:32	0.0	135.8	86.4	0.0	0.0	16.0	27.5	0.0	322.9	4.9	0.0	0.0	0.0	593.6
DAILY TOTAL SCIENCE	273 04:17	274 08:32	0.0	426.3	118.1	6.0	250.0	95.6	86.4	0.0	953.0	236.0	204.0	0.0	80.5	
OBSERVATION_NOR	274 08:32	274 23:17	0.0	143.8	0.0	1.1	0.0	26.2	45.1	0.0	554.4	419.8	0.0	0.0	61.6	1252.2
SP_222EA_C70METOTP274_PRIME	274 23:17	275 08:17	0.0	17.0	86.4	3.2	0.0	16.0	27.5	0.0	338.6	4.9	0.0	0.0	0.0	493.7
DAILY TOTAL SCIENCE	274 08:32	275 08:17	0.0	160.7	86.4	4.4	0.0	42.2	72.7	0.0	893.0	424.8	0.0	0.0	61.6	

	CAPS (Mb)	CDA (Mb)	CIRS (Mb)	INMS (Mb)	ISS (Mb)	MAG (Mb)	MIMI (Mb)	RADAR (Mb)	RPWS (Mb)	UVIS (Mb)	VIMS (Mb)	PROBE (Mb)
TOTAL RECORDED (OPNAV data not included)	0.0	587.1	204.5	10.3	250.0	137.8	159.1	0.0	1846.0	660.8	204.0	0.0

Waypoint Selection

RBOT - Friendly

OBSERVATION PERIOD	START	END	POS_X	NEG_X	POS_Z	NEG_Z
SP_222NA_OBSERV273_NA	2015-273T04:17:00	2015-273T23:32:00	------	35.7/ 83.9	------	------
SP_222NA_OBSERV274_NA	2015-274T08:32:00	2015-274T23:17:00	------	35.7/ 83.9	35.7/ 83.9	------

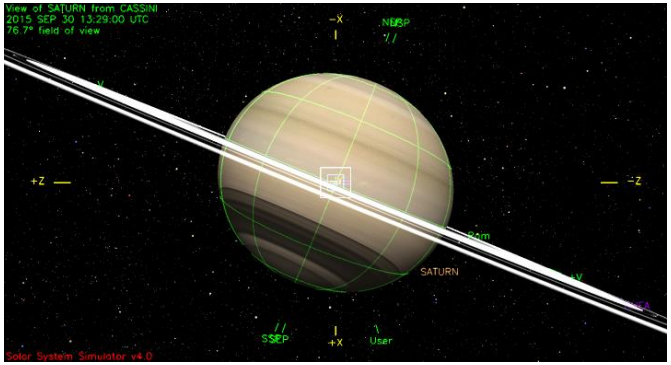
~ equivalent to Neg_X to NSP

Standard Waypoints

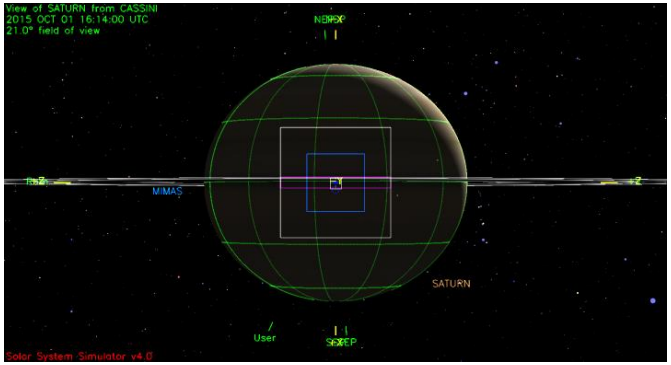
OBS_NAME	START	END	POS_X_2_NSP	POS_X_2_NEP	NEG_X_2_NSP	NEG_X_2_NEP	POS_Z_2_NSP	POS_Z_2_NEP	NEG_Z_2_NSP	NEG_Z_2_NEP	NEG_X_2_SUN	NEG_Z_2_EARTH
SP_222NA_OBSERV273_NA	2015-273T04:17:00	2015-273T23:32:00	**BAD**	**BAD**	OK	**BAD**	**BAD**	**BAD**	**BAD**	**BAD**	OK	**BAD**
SP_222NA_OBSERV274_NA	2015-274T08:32:00	2015-274T23:17:00	**BAD**	**BAD**	OK	OK	OK	OK	**BAD**	**BAD**	OK	OK

Waypoints Chosen

Waypoint 1 (2015-273T04:57 to 273T22:02): NEG_Y to Saturn, Neg_X to Sun



Waypoint 2 (2015-274T09:12 to 274T23:17): NEG_Y to Saturn, Neg_X to NSP.



Notes and Liens

- Pointing:
  - Zeta Ori PIE request pair (UVIS_222ST_ZETAORI001_PIE and UVIS_222ST_ZETAORI002_PIE) has been modified slightly (start/end times and durations) to maximize Zeta ORI ingress-egress observation timing. Approximately same total combined duration. Has been approved by SATURN_TWT.
  - CIRS_222DI_DIONE001, ISS_222DI_DIONE002_PIE, CIRS_222DI_DIONE003_PIE are using a “custom period” to maximize observing efficiency. These PIES also have collaborative riders.
  - RBOT friendly secondaries were used when compatible with science activities
- Data Volume:
  - No issues
- DSN:
  - Last downlink of segment (2015-274T23:17) upgraded to 70m (DSS 45 to DSS 42) for data volume purposes.
- Resource checker:
  - 2015-274T23:17:00 SP_222EA_C70METOTP274_PRIME --- Manually verify identical inertial pointing, the backup OTM may exist in the next segment/sequence.
    - This has been verified.
- Opmodes:
  - No RWA-slow and/or unique opmodes.
- Hydrazine:
  - N/A
- Special Activities:
  - CIRS_222DI_DIONE001, ISS_222DI_DIONE002_PIE, CIRS_222DI_DIONE003_PIE, VIMS_222SA_3OPSOCC101_PIE, UVIS_222ST_ORI00[1-2]_PIE

Sequence Liens (should all be SPLAT items):

- SPLAT Item #S91000005: ISS_222DI_DIONE002_PIE. This and the observations immediately before and after have total target (Dione) motion of 122 degrees over 3h30m. Lien: Any observation >3 hours in which the target body travels > 60 degrees must include 20 minute quiescent periods every 3 hours. Action: Activity has been designed so that the last 20 minutes of this observation is at an inertial attitude to satisfy this guideline.