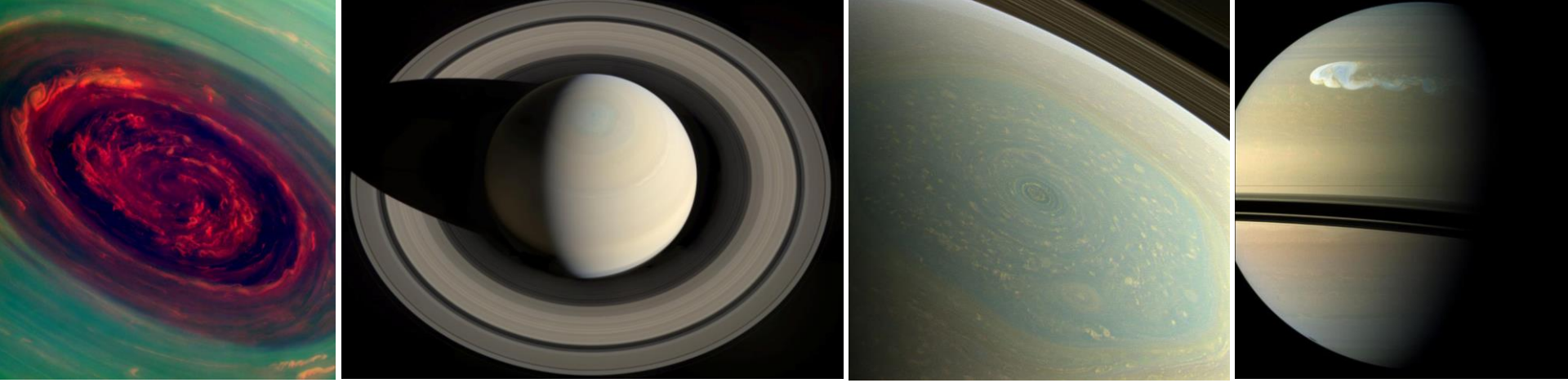

Science Planning & Sequence Team
CASSINI

# SATURN TARGET WORKING TEAM

**Rev 178 Segment Legacy Package**

**Segment Boundary: Jan 3, 2013 – Jan 8, 2013**
**2013-003T11:05:00 – 2013-008T00:21:00 (SCET)**

**Integration Began 03/26/2012**
**Segment Delivered to S76 Sequence 05/10/2012**
**Lead Integrator was Shawn Brooks**

**Legacy Package Assembled by Keven Uchida**

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# Segment Overview and Final Products

# Segment Summary

- This was an ~4.5 day long Solstice Mission, periapse segment. The S/C was in an inclined orbit. Saturn was viewed over almost the entire range of phase angles.
- There were two high priority “PIE” activities in this segment: RSS conducted an egress atmospheric occultation experiment, monitoring the S/C signal as it reappeared from behind Saturn’s limb. This was complemented with a CIRS Far-IR observation toward the same latitude where RSS had earlier observed the occultation egress.
- VIMS and CIRS led the majority of atmospheric observations – compositional, regional and auroral mapping. VIMS also observed two stellar occultations – one of Gamma Eridani and the other of L2 Puppis. UVIS performed two auroral mapping observations and one of the Sun as it was occulted by Saturn. ISS performed two limb scan observations, and one out-of-discipline Titan monitoring observation.
- On DOY 004 the sun moved behind Saturn and was occulted by the planet during the entire time of an ISS limb scan activity ISS_178SA_LIMBSCAN001 (see page 20). ISS wrote a waiver requesting CMT management during the occultation, to allow for observing with ORS boresight to Sun angles < 12 degrees.
- Data volume-wise, 100 Mb of carryover was accepted from the previous XD_176/177 segment, and 384 Mb of carryover from this segment was accepted by the following XD_177_178 segment.

# Final Sequenced SPASS



| | Request | Riders | Start (SCET) | Start (Epoch) | Duration | End (SCET) | Primary | Secondary | Comments |
|---|---|---|---|---|---|---|---|---|---|
| | SATURN_178 Segment | | 2013-003T11:05:00 | | 004T13:16:00 | 2013-008T00:21:00 | | | |
| | SP_178SA_WAYPTTURN003_PRIME | | 2013-003T11:05:00 | | 000T00:40:00 | 2013-003T11:45:00 | ISS_NAC to Saturn | POS_X to 136.6/38.0 | |
| | **NEW WAYPOINT** | | **2013-003T11:45:00** | | **000T21:50:00** | **2013-004T09:35:00** | **ISS_NAC to Saturn** | **POS_X to 136.6/38.0** | |
| Gap 1 | VIMS_178SA_AURSTARE001_PRIME | C, U | 2013-003T11:45:00 | | 000T05:00:00 | 2013-003T16:45:00 | VIMS_IR to Saturn | POS_X to 136.6/38.0 | |
| Gap 1 | UVIS_178SA_AURSTARE004_PRIME | C, I, V | 2013-003T16:45:00 | | 000T07:00:00 | 2013-003T23:45:00 | UVIS_FUV to Saturn | POS_X to 136.6/38.0 | Collaborative Rider(s): VIMS |
| Gap 1 | CIRS_178SA_REGMAP001_PRIME | V | 2013-003T23:45:00 | | 000T06:00:00 | 2013-004T05:45:00 | CIRS_FPB to Saturn | POS_X to NSP | slow scans 70S to 90S |
| Gap 1 | VIMS_178SA_SPOLMOV001_PRIME | C, I, U | 2013-004T05:45:00 | | 000T03:10:00 | 2013-004T08:55:00 | VIMS_IR to Saturn | POS_X to 136.6/38.0 | |
| | SP_178EA_DLTURN004_PRIME | | 2013-004T08:55:00 | | 000T00:40:00 | 2013-004T09:35:00 | XBAND to Earth | NEG_X to NEP | |
| | **NEW WAYPOINT** | | **2013-004T09:35:00** | | **000T20:39:00** | **2013-005T06:14:00** | **XBAND to Earth** | **NEG_X to NEP** | |
| | SP_178EA_G70METSEQ004_PRIME | C | 2013-004T09:35:00 | | 000T05:00:00 | 2013-004T14:35:00 | XBAND to Earth | NEG_X to NEP | CAPS. NEG_X to NEP or NSP. CIRS heating |
| | ENGR_178SC_KPTYBIAS004_PRIME | | 2013-004T18:35:00 | | 000T01:30:00 | 2013-004T20:05:00 | NEG_Z to DELTA_H (0.0,0.0,44.0 deg. offset) | NEG_X to Sun | |
| | **SP_178NA_DEADTIME004_PRIME** | | **2013-004T20:05:00** | | **000T00:19:59** | **2013-004T20:24:59** | **XBAND to Earth** | **NEG_X to NEP** | |
| | **Begin Custom** | | **2013-004T20:24:59** | **LMB_E178_Saturn_RSS_Occ_Egr-00** | **000T00:00:01** | **2013-004T20:25:00** | | | |
| Gap 2 | UVIS_178SU_USUNOCC001_PRIME | V | 2013-004T20:24:59 | LMB_E178_Saturn_RSS_Occ_Egr-00( | 000T02:11:00 | 2013-004T22:35:59 | UVIS_SOL_OFF to Sun | NEG_X to NSP | Pick up at XBAND to Earth, NEG_X to NEP; Hand off at UVIS_SOL_OFF to Sun, NEG_X to NSP. Collaborative riders: VIMS. |
| Gap 2 | ISS_178SA_LIMBSCAN001_PRIME | V | 2013-004T22:35:59 | LMB_E178_Saturn_RSS_Occ_Egr-00( | 000T01:00:00 | 2013-004T23:35:59 | ISS_NAC to Saturn | NEG_X to NEP | Pick up at UVIS_SOL_OFF to Sun, NEG_X to NSP; Hand off at ISS_NAC to Saturn, NEG_X to NEP. |
| | RSS_178SA_OCCOUT001_PIE | | 2013-004T23:35:59 | LMB_E178_Saturn_RSS_Occ_Egr-00( | 000T03:38:00 | 2013-005T03:13:59 | XBAND to Earth | NEG_X to NEP | Pick up at ISS_NAC to Saturn, NEG_X to NEP; Hand off at XBAND to Earth, NEG_X to NEP. |
| | **End Custom** | | **2013-005T03:13:59** | **LMB_E178_Saturn_RSS_Occ_Egr+0(** | **000T00:00:01** | **2013-005T03:14:00** | | | |
| | **SP_178NA_DEADTIME005_PRIME** | | **2013-005T03:13:59** | **LMB_E178_Saturn_RSS_Occ_Egr+0(** | **000T00:20:01** | **2013-005T03:34:00** | **XBAND to Earth** | **NEG_X to NEP** | |
| | ISS_178TI_M90R1CLD005_PRIME | M, V | 2013-005T03:34:00 | E178_M90R1CLD005+000T00:00:00 | 000T02:00:00 | 2013-005T05:34:00 | ISS_NAC to Titan | NEG_X to Sun | |
| | SP_178SA_WAYPTTURN005_PRIME | M | 2013-005T05:44:00 | | 000T00:30:00 | 2013-005T06:14:00 | ISS_NAC to Saturn (0.0,20.0,0.0 deg. offset) | POS_Z to NSP | |
| | **NEW WAYPOINT** | | **2013-005T06:14:00** | | **000T10:40:00** | **2013-005T16:54:00** | **ISS_NAC to Saturn (0.0,20.0,0.0 deg. offset)** | **POS_Z to NSP** | |
| Gap 3 | VIMS_178SA_GAMERIOCC001_PRIME | C, I, M | 2013-005T06:14:00 | | 000T02:10:00 | 2013-005T08:24:00 | VIMS_IR to 59.507/-13.509 | PIC | Collaborative Rider(s): CIRS |
| Gap 3 | CIRS_178SA_COMPSIT004_PRIME | U, V | 2013-005T08:24:00 | | 000T08:20:00 | 2013-005T16:44:00 | CIRS_FP3 to Saturn (0.0,20.0,0.0 deg. offset) | POS_Z to NSP | include 20 min inertial pointing after SRU violation and before 2013-005T11:00:00 |
| Gap 3 | Periapse R = 7.432 Rs, lat ... | | 2013-005T15:10:21 | | 000T00:00:01 | 2013-005T15:10:22 | | | |
| Gap 3 | SP_178SA_WAYPTTURN405_PRIME | | 2013-005T16:44:00 | | 000T00:10:00 | 2013-005T16:54:00 | ISS_NAC to Saturn | POS_Z to NSP | |
| | **NEW WAYPOINT** | | **2013-005T16:54:00** | | **000T22:42:00** | **2013-006T15:36:00** | **ISS_NAC to Saturn** | **POS_Z to NSP** | |
| Gap 3 | VIMS_178SA_L2PUPOCC001_PRIME | C, I | 2013-005T16:54:00 | | 000T01:39:00 | 2013-005T18:33:00 | VIMS_IR to 108.385/-44.64 | PIC | Collaborative Rider(s): CIRS |
| Gap 4 | CIRS_178SA_NADIROCC001_PIE | E | 2013-005T18:33:00 | | 000T05:00:00 | 2013-005T23:33:00 | CIRS_FP1 to Saturn | POS_Z to NSP | PIE |
| Gap 4 | VIMS_178SA_NPOLMOV001_PRIME | C, E, I | 2013-005T23:33:00 | | 000T06:23:00 | 2013-006T05:56:00 | VIMS_IR to Saturn | POS_Z to NSP | |
| Gap 4 | UVIS_178SA_AURSLEW002_PRIME | C | 2013-006T05:56:00 | | 000T07:00:00 | 2013-006T12:56:00 | UVIS_FUV to Saturn | POS_Z to NSP | |
| Gap 4 | VIMS_178SA_AURSTARE002_PRIME | C, U | 2013-006T12:56:00 | | 000T02:00:00 | 2013-006T14:56:00 | VIMS_IR to Saturn | POS_Z to NSP | |
| | SP_178EA_DLTURN006_PRIME | | 2013-006T14:56:00 | | 000T00:12:00 | 2013-006T15:08:00 | ISS_NAC to Saturn (0.0,-30.0,0.0 deg. offset) | POS_Z to NSP | |
| | SP_178EA_DLTURN406_PRIME | | 2013-006T15:08:00 | | 000T00:28:00 | 2013-006T15:36:00 | XBAND to Earth | POS_X to NEP | |
| | **NEW WAYPOINT** | | **2013-006T15:36:00** | | **000T11:10:00** | **2013-007T02:46:00** | **XBAND to Earth** | **POS_X to NEP** | |
| | SP_178EA_C34HEFSEQ006_PRIME | C | 2013-006T15:36:00 | | 000T09:00:00 | 2013-007T00:36:00 | XBAND to Earth | POS_X to NEP | CAPS. POS_X to NEP or NSP. CIRS heating |
| | ENGR_178SC_KPTYBIAS407_PRIME | | 2013-007T00:36:00 | | 000T01:30:00 | 2013-007T02:06:00 | POS_Z to DELTA_H (0.0,0.0,-60.002 deg. offset) | NEG_X to Sun | |
| | SP_178SA_WAYPTTURN007_PRIME | | 2013-007T02:06:00 | | 000T00:40:00 | 2013-007T02:46:00 | ISS_NAC to Saturn | POS_X to 136.5/38.0 | |
| | **NEW WAYPOINT** | | **2013-007T02:46:00** | | **000T06:20:00** | **2013-007T09:06:00** | **ISS_NAC to Saturn** | **POS_X to 136.5/38.0** | |
| Gap 5 | ISS_178SA_LIMBSCAN002_PRIME | V | 2013-007T02:46:00 | | 000T01:00:00 | 2013-007T03:46:00 | ISS_NAC to Saturn | POS_X to 136.5/38.0 | |
| Gap 5 | VIMS_178SA_REGMAP001_PRIME | C | 2013-007T03:46:00 | | 000T04:40:00 | 2013-007T08:26:00 | VIMS_IR to Saturn | POS_X to NSP | |
| Gap 5 | SP_178EA_DLTURN007_PRIME | | 2013-007T08:26:00 | | 000T00:40:00 | 2013-007T09:06:00 | XBAND to Earth | NEG_Y to 296.5/42.6 | non-inertial secondary intended to accommodate MIMI's requested attitude during this period |
| | **NEW WAYPOINT** | | **2013-007T09:06:00** | | **000T15:24:00** | **2013-008T00:30:00** | **XBAND to Earth** | **NEG_Y to 296.5/42.6** | |
| | SP_178EA_G70METNON007_PRIME | | 2013-007T09:06:00 | | 000T05:15:00 | 2013-007T14:21:00 | XBAND to Earth | Rolling | CAPS. POS_X to NEP or NSP. CIRS heating |
| | SP_178EA_YGAP407_PRIME | | 2013-007T14:21:00 | | 000T01:00:00 | 2013-007T15:21:00 | XBAND to Earth | NEG_Y to 296.5/42.6 | |
| | SP_178EA_C34HEFSEQ007_PRIME | C | 2013-007T15:21:00 | | 000T09:00:00 | 2013-008T00:21:00 | XBAND to Earth | Rolling | MIMI. NEG_Y to Saturn (0,0,-9.5). CIRS heating |

# 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) | NET_MARGN (%) | CAROVR (Mb) |
| SP_178EA_G70METSEQ004_PRIME | 004 09:35 | 004 14:35 | 1039 | 2014 | 95 | 3148 | 3322 | 174 | 0 | 218 | 29 | 3395 | 1663 | -1733 | -1173 | -12% | 1732 |
| SP_178EA_C34HEFSEQ006_PRIME | 006 15:36 | 007 00:36 | 1732 | 2557 | 207 | 4496 | 3322 | -1173 | 0 | 197 | 53 | 3572 | 707 | -2865 | -207 | -2% | 2865 |
| SP_178EA_G70METNON007_PRIME | 007 09:06 | 007 14:21 | 2865 | 630 | 36 | 3530 | 3322 | -207 | 0 | 74 | 31 | 3427 | 1694 | -1733 | 0 | 0% | 1733 |
| SP_178EA_C34HEFSEQ007_PRIME | 007 15:21 | 008 00:21 | 1733 | 14 | 4 | 1751 | 3322 | 1571 | 0 | 219 | 53 | 2023 | 704 | -1319 | 0 | 0% | 1319 |

DATA VOLUME REPORT --- TRANSFER FRAME OVERHEAD NOT INCLUDED

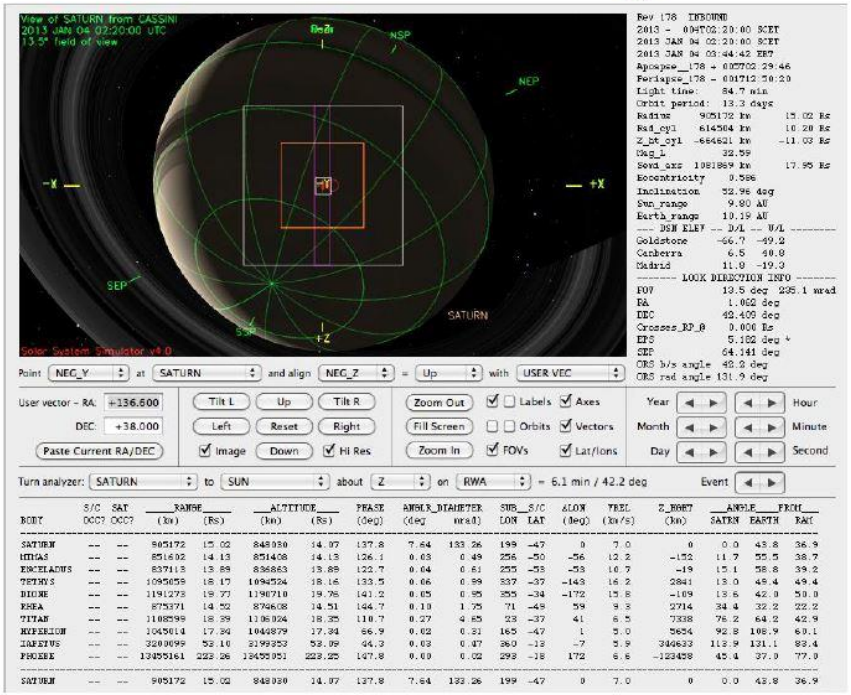
| Event | Start doy hh:mm | End doy hh:mm | CAPS (Mb) | CDA (Mb) | CIRS (Mb) | INMS (Mb) | ISS (Mb) | MAG (Mb) | MIMI (Mb) | RADAR (Mb) | RPWS (Mb) | UVIS (Mb) | VIMS (Mb) | PROBE (Mb) | ENGR (Mb) | TOTAL (Mb) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OBSERVATION_NOR | 003 11:05 | 004 09:35 | 81.0 | 42.4 | 195.6 | 8.1 | 210.0 | 40.0 | 68.8 | 0.0 | 525.3 | 274.7 | 550.0 | 0.0 | 94.0 | 2090.1 |
| SP_178EA_G70METSEQ004_PRIME | 004 09:35 | 004 14:35 | 18.0 | 9.4 | 43.2 | 1.8 | 0.0 | 8.9 | 15.3 | 0.0 | 116.6 | 2.7 | 0.0 | 0.0 | 0.0 | 216.0 |
| DAILY TOTAL SCIENCE | 003 11:05 | 004 14:35 | 99.0 | 51.9 | 238.8 | 9.9 | 210.0 | 48.9 | 84.1 | 0.0 | 642.0 | 277.5 | 550.0 | 0.0 | 94.0 | |
| OBSERVATION_NOR | 004 14:35 | 006 15:36 | 176.5 | 107.7 | 340.9 | 27.7 | 360.5 | 87.2 | 150.0 | 0.0 | 316.9 | 291.2 | 675.0 | 0.0 | 204.9 | 2738.5 |
| SP_178EA_C34HEFSEQ006_PRIME | 006 15:36 | 007 00:36 | 32.4 | 17.0 | 64.8 | 3.2 | 0.0 | 16.0 | 27.5 | 0.0 | 29.2 | 4.9 | 0.0 | 0.0 | 0.0 | 195.1 |
| DAILY TOTAL SCIENCE | 004 14:35 | 007 00:36 | 208.9 | 124.7 | 405.7 | 31.0 | 360.5 | 103.2 | 177.5 | 0.0 | 346.1 | 296.2 | 675.0 | 0.0 | 204.9 | |
| OBSERVATION_NOR | 007 00:36 | 007 09:06 | 30.6 | 16.0 | 67.2 | 3.1 | 188.3 | 15.1 | 26.0 | 0.0 | 27.5 | 0.0 | 250.0 | 0.0 | 35.5 | 659.3 |
| SP_178EA_G70METNON007_PRIME | 007 09:06 | 007 14:21 | 18.9 | 9.9 | 0.0 | 1.9 | 0.0 | 9.3 | 16.1 | 0.0 | 17.0 | 0.0 | 0.0 | 0.0 | 0.0 | 73.1 |
| DAILY TOTAL SCIENCE | 007 00:36 | 007 14:21 | 49.5 | 25.9 | 67.2 | 5.0 | 188.3 | 24.5 | 42.1 | 0.0 | 44.5 | 0.0 | 250.0 | 0.0 | 35.5 | |
| OBSERVATION_NOR | 007 14:21 | 007 15:21 | 3.6 | 1.9 | 0.0 | 0.4 | 0.0 | 1.8 | 3.1 | 0.0 | 3.2 | 0.0 | 0.0 | 0.0 | 4.2 | 18.1 |
| SP_178EA_C34HEFSEQ007_PRIME | 007 15:21 | 008 00:21 | 32.4 | 17.0 | 86.4 | 3.2 | 0.0 | 16.0 | 27.5 | 0.0 | 29.2 | 4.9 | 0.0 | 0.0 | 0.0 | 216.7 |
| DAILY TOTAL SCIENCE | 007 14:21 | 008 00:21 | 36.0 | 18.9 | 86.4 | 3.6 | 0.0 | 17.8 | 30.6 | 0.0 | 32.4 | 4.9 | 0.0 | 0.0 | 4.2 | |

*Negative SSR Margins did not result in a loss in science data due to under-utilization/compression.

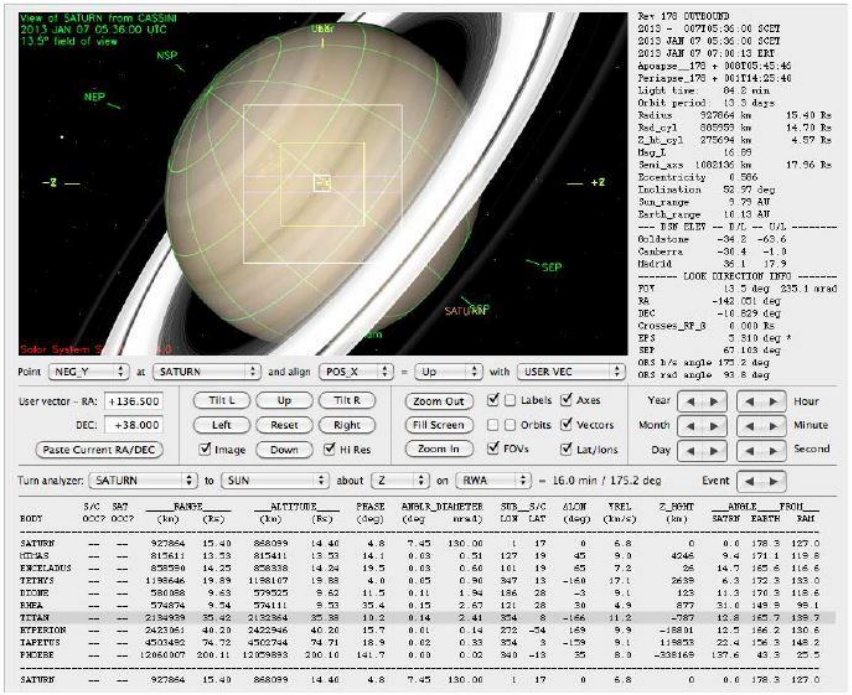
# Segment Geometry

## Segment Geometry

**Inbound**



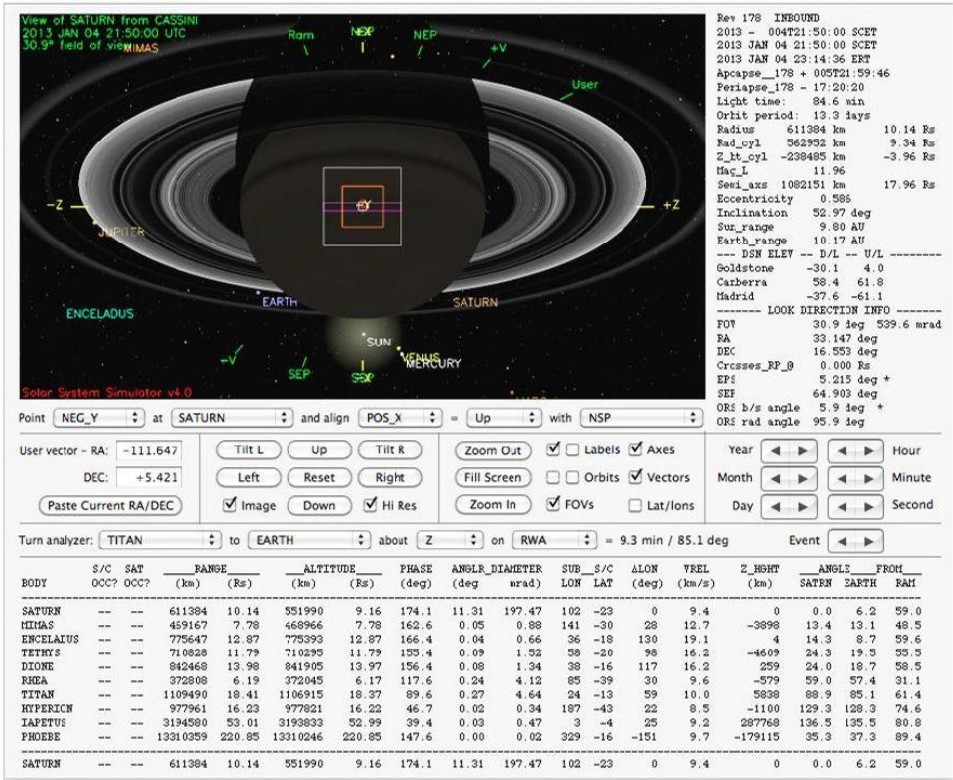
**Outbound**



| | Time (SCET) | Saturn Range | Phase Angle | Sub_Spacecraft Lattitude |
|---|---|---|---|---|
| Segment Start | 2013-003T11:05:00 | 18.4 $R_{Sat}$ | 121.7° | 52°S |
| Ring Plane Crossing | 2013-005T06:07:40 | 8.3 $R_{Sat}$ | 154.9° | 0° |
| Periapse | 2013-005T15:10:21 | 7.4 $R_{Sat}$ | 110.6° | 34°N |
| Segment End | 2013-008T00:21:00 | 19.4 $R_{Sat}$ | 21.6° | 3°N |

# Solar Geometry – ORS Boresight Concerns

## CMT Violation Geometry




- Saturn-Sun angle is less than 8.4° for the entirety of Gap 2.
- Saturn subtends 11.0° at the beginning of Gap 2; it's apparent size is 11.6° at the end of Gap 2.
- There is a downlink scheduled at the beginning of the CMT violation period.

Saturn-Sun angle < 15° : 2013-004T17:58:26 – 005T03:33:31

Saturn-Sun angle < 12° : 2013-004T19:14:56 – 005T02:42:48

solar ingress/solar egress: 2013-004T22:09:40 – 005T00:41:40

RSS ingress/RSS egress: 2013-004T22:05:59 – 005T01:35:42

# Daily Science Highlights

**DOY 003 (3 January 2013)**: The Saturn_178 segment opened with VIMS and UVIS pointing at the southern polar regions of Saturn, which was under the darkness of a Saturnian winter, to study the planet's aurorae.

**DOY 004 (4 January 2013)**: The first science activity of the day was a regional mapping of southern polar vortex by CIRS with the goal of measuring the temperature of this feature. VIMS followed the CIRS activity by taking mosaics of this same region. After the subsequent downlink, UVIS observed the Sun being occulted by Saturn to probe the planet's atmosphere. With the Sun safely behind the planet, ISS observed the atmosphere at very high phase angles. Such geometries highlight small particles and hazes in the atmosphere.

**DOY 005 (5 January 2013)**: The spacecraft began the day with its high-gain antenna pointed towards the Earth. The RSS team monitored the signal from the spacecraft as it reappeared from behind Saturn's limb during this egress atmospheric occultation experiment. ISS then pointed its cameras to observe Titan, looking for any meteorological activity as part of its long-term Titan monitoring campaign. VIMS then observed the refraction and attenuation of starlight through Saturn's atmosphere as it observed not one, but two, stars – gamma Eridani and L2 Puppis – being occulted by Saturn. Between these two occultations, CIRS targeted the northern storm region at 37° N latitude with its array of mid-infrared detectors. The day rounded out with CIRS integrating with its far-infrared detector on the same latitude from which RSS observed the Earth occultation. One of the goals of this joint RSS/CIRS campaign was to determine the helium abundance in Saturn's atmosphere, a quantity which is not easily pinned down.

**DOY 006 (6 January 2013)**: VIMS imaged the northern pole region of Saturn to characterize the curious northern hexagon. Then UVIS and, subsequently, VIMS focused again on the Saturnian aurorae, this time observing the northern auroral zones for a total of 9 hours. Following this Cassini turned its antenna back towards the Earth to relay the bounty of scientific data recorded during the past two days.

**DOY 007 (7 January 2013)**: During a very brief observation, ISS imaged the limb of Saturn in a geometry that is complementary to that obtained on DOY 004 when Cassini was on the far side of Saturn. Finally, VIMS mapped out the northern mid-latitudes before the spacecraft turned back to Earth-point and relays the remainder of the data taken during a very busy Saturn_178 segment.

# Segment Integration Planning

# Timeline Gaps and Suggested Observations



| Gap | Start | End | Duration | Phase angle | Range ($R_{Saturn}$) | SSC latitude | Suggested observations/activities |
|---|---|---|---|---|---|---|---|
| 1 | 2013-003T19:45:00 | 004T08:55:00 | 000T13:10:00 | 130.0° – 147.4° | 16.5 – 13.4 | 50° S – 42° S | VIMS south pole |
| 2 | 2013-004T20:45:00 | 004T22:56:00 | 000T02:11:00 | 171.6° – 176.0° | 10.4 – 9.9 | 25° S – 20° S | solar occultation |
| 3 | 2013-005T06:14:00 | 005T19:33:00 | 000T13:19:00 | 154.1° – 87.7° | 8.3 – 7.7 | 0° – 48° N | VIMS stellar occultations |
| 4 | 2013-005T23:33:00 | 006T14:56:00 | 000T15:23:00 | 68.9° – 21.2° | 8.2 – 11.8 | 53° N – 35° N | north pole observations |
| 5 | 2013-007T02:46:00 | 007T08:26:00 | 000T05:40:00 | 3.8° – 7.4° | 14.7 – 16.1 | 20° N – 15° N | Great Northern Storm region |

# 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_178EA_G70METSEQ004_PRIME | 004 09:35 | 004 18:35 | 0 | 391 | 95 | 486 | 3322 | 2836 | 0 | 232 | 53 | 771 | 2762 | 1990 | 2518 | 40% | 0 |
| SP_178EA_G70METSEQ006_PRIME | 006 15:36 | 006 18:36 | 0 | 1756 | 190 | 1946 | 3322 | 1376 | 0 | 70 | 18 | 2034 | 810 | -1225 | 528 | 15% | 1224 |
| SP_178EA_C34HEFNON006_PRIME | 006 18:36 | 007 00:36 | 1224 | 0 | 0 | 1224 | 3322 | 2098 | 0 | 256 | 35 | 1516 | 473 | -1044 | 528 | 20% | 1043 |
| SP_178EA_G70METNON007_PRIME | 007 09:06 | 007 13:51 | 1043 | 183 | 36 | 1262 | 3322 | 2060 | 0 | 74 | 28 | 1364 | 1502 | 138 | 528 | 24% | 0 |
| SP_178EA_C34HEFSEQ007_PRIME | 007 15:21 | 008 00:21 | 0 | 23 | 6 | 30 | 3322 | 3292 | 0 | 232 | 53 | 315 | 704 | 389 | 389 | 55% | 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 | 003 11:05 | 004 09:35 | 81.0 | 42.4 | 0.0 | 8.1 | 0.0 | 81.5 | 68.8 | 0.0 | 105.8 | 0.0 | 0.0 | 0.0 | 94.0 | 481.8 |
| SP_178EA_G70METSEQ004_PRIME | 004 09:35 | 004 18:35 | 32.4 | 17.0 | 86.4 | 3.2 | 0.0 | 16.0 | 27.5 | 0.0 | 42.1 | 4.9 | 0.0 | 0.0 | 0.0 | 229.6 |
| DAILY TOTAL SCIENCE | 003 11:05 | 004 18:35 | 113.4 | 59.4 | 86.4 | 11.3 | 0.0 | 97.5 | 96.4 | 0.0 | 148.0 | 4.9 | 0.0 | 0.0 | 94.0 | |
| OBSERVATION_NOR | 004 18:35 | 006 15:36 | 162.1 | 120.6 | 86.4 | 26.3 | 57.7 | 80.1 | 137.8 | 0.0 | 1055.9 | 0.0 | 13.3 | 0.0 | 188.1 | 1928.3 |
| SP_178EA_G70METSEQ006_PRIME | 006 15:36 | 006 18:36 | 10.8 | 5.7 | 21.6 | 1.1 | 0.0 | 5.3 | 9.2 | 0.0 | 14.0 | 1.6 | 0.0 | 0.0 | 0.0 | 69.3 |
| SP_178EA_C34HEFNON006_PRIME | 006 18:36 | 007 00:36 | 21.6 | 11.3 | 64.8 | 2.2 | 0.0 | 10.7 | 18.4 | 0.0 | 121.7 | 3.3 | 0.0 | 0.0 | 0.0 | 253.9 |
| DAILY TOTAL SCIENCE | 004 18:35 | 007 00:36 | 194.5 | 137.6 | 172.8 | 29.5 | 57.7 | 96.1 | 165.3 | 0.0 | 1191.7 | 4.9 | 13.3 | 0.0 | 188.1 | |
| OBSERVATION_NOR | 007 00:36 | 007 09:06 | 30.6 | 16.0 | 0.0 | 3.1 | 0.0 | 15.1 | 26.0 | 0.0 | 90.4 | 0.0 | 0.0 | 0.0 | 35.5 | 216.7 |
| SP_178EA_G70METNON007_PRIME | 007 09:06 | 007 13:51 | 17.1 | 9.0 | 0.0 | 1.7 | 0.0 | 8.4 | 14.5 | 0.0 | 22.4 | 0.0 | 0.0 | 0.0 | 0.0 | 73.2 |
| DAILY TOTAL SCIENCE | 007 00:36 | 007 13:51 | 47.7 | 25.0 | 0.0 | 4.8 | 0.0 | 23.6 | 40.5 | 0.0 | 112.8 | 0.0 | 0.0 | 0.0 | 35.5 | |
| OBSERVATION_NOR | 007 13:51 | 007 15:21 | 5.4 | 2.8 | 0.0 | 0.5 | 0.0 | 2.7 | 4.6 | 0.0 | 7.1 | 0.0 | 0.0 | 0.0 | 6.3 | 29.4 |
| SP_178EA_C34HEFSEQ007_PRIME | 007 15:21 | 008 00:21 | 32.4 | 17.0 | 86.4 | 3.2 | 0.0 | 16.0 | 27.5 | 0.0 | 42.4 | 4.9 | 0.0 | 0.0 | 0.0 | 229.9 |
| DAILY TOTAL SCIENCE | 007 13:51 | 008 00:21 | 37.8 | 19.8 | 86.4 | 3.8 | 0.0 | 18.7 | 32.1 | 0.0 | 49.5 | 4.9 | 0.0 | 0.0 | 6.3 | |

# Waypoint Selection

RBOT - Friendly

| OBSERVATION PERIOD | START | END | POS_X | NEG_X | POS_Z | NEG_Z |
|---|---|---|---|---|---|---|
| SP_178NA_OBSERV003_NA | 2013-003T11:05:00 | 2013-004T09:20:00 | 136.6/ 38.0 | ------ | ------ | 136.6/ 38.0 |
| SP_178NA_OBSERV004_NA | 2013-004T18:20:00 | 2013-006T15:36:00 | ------ | ------ | ------ | ------ |
| SP_178NA_OBSERV007_NA | 2013-007T00:36:00 | 2013-007T15:21:00 | 136.5/ 38.0 | ------ | ------ | ------ |

- **NEG_Y to Saturn not safe from 2013-004T17:58:26 to 005T03:33:31 (ORS to Sun < 15° ).**
- **Using POS_Z to NSP during SP_178NA_OBSERV004_NA places Titan in the SRUs from ~2013-005T06:14:00 until ~005T11:14:00**

Potential waypoint solutions during SP_178NA_OBSERV004_NA:

- 2013-005T06:14:00 – ~005T11:14:00: [NEG_Y to Saturn (0,±15,0); POS_Z to NSP]
- insert 10-minute WAYPTTURN
- ~2013-005T11:24:00 – 006T14:56:00: [NEG_Y to Saturn; POS_Z to NSP]

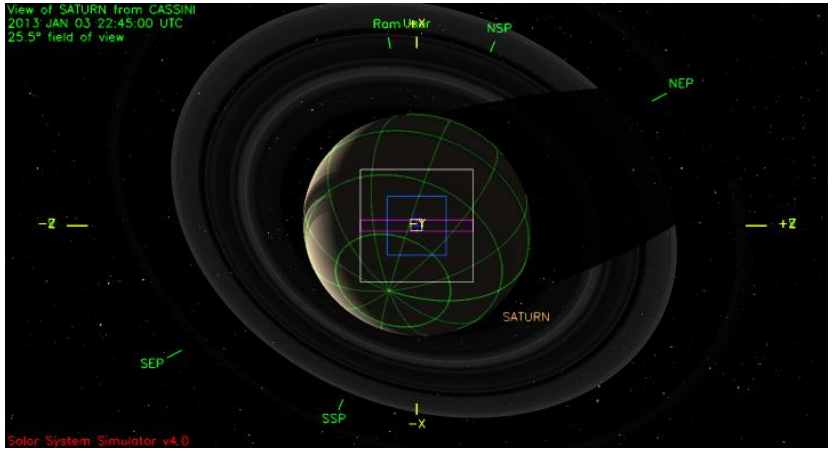
*-- or --*

- 2013-005T06:14:00 – 006T14:56:00: [NEG_Y to Saturn; NEG_X to Sun]

# Waypoints Chosen (1 of 2)

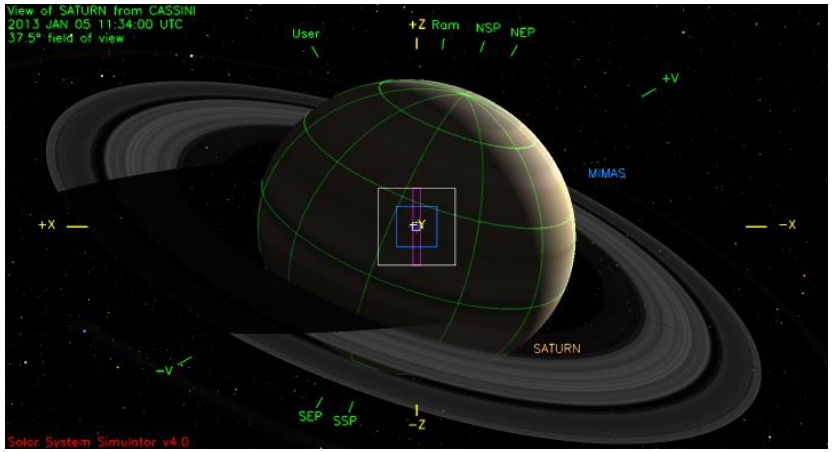


Waypoint 1 (2013-003T11:45:00 – 004T09:35:00): NEG_Y to Saturn, POS_X to 136.6/38.0



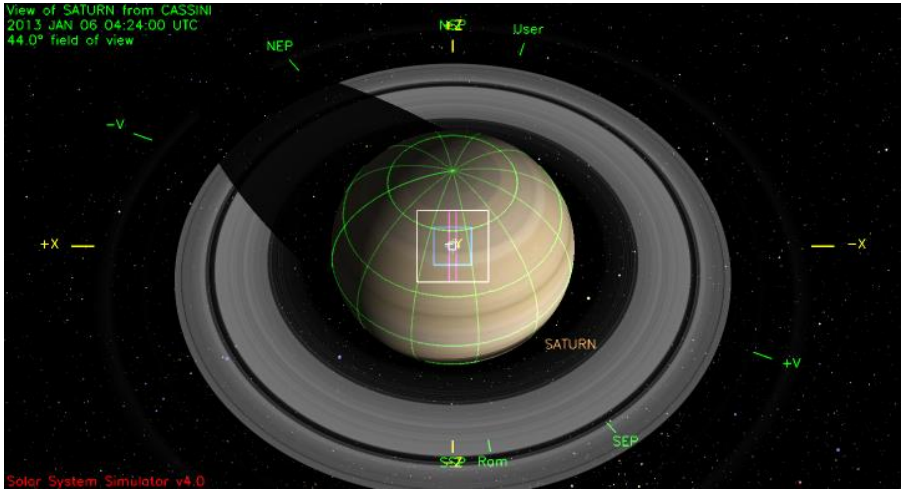

Waypoint 2 (2013-004T18:35:00 – 005T05:34:00): No acceptable valid waypoint, custom period used.

Waypoint 3 (2013-005T06:14:00 – 005T16:54:00): NEG_Y to Saturn (0,+20,0), POS_Z to NSP

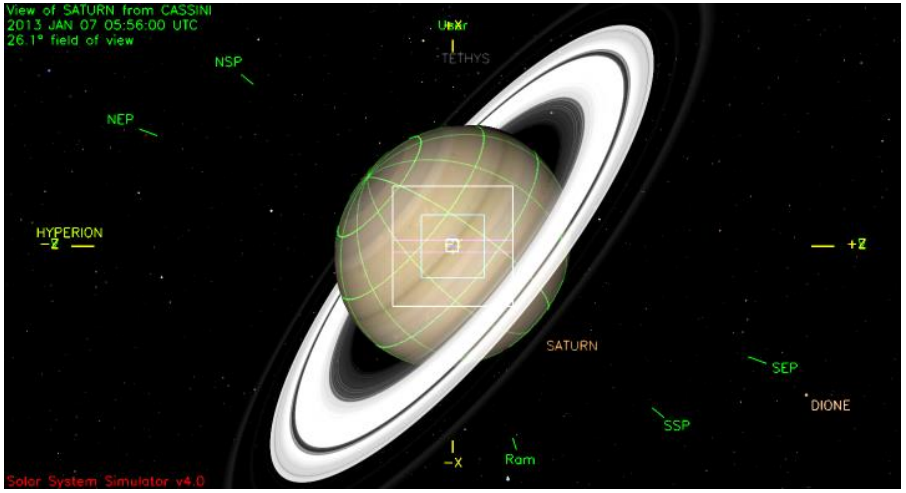


# Waypoints Chosen (2 of 2)

Waypoint 4 (2013-005T16:54:00 – 006T15:36:00): NEG_Y to Saturn, POS_Z to NSP




Waypoint 5 (2013-007T02:46:00 – 007T09:06:00): NEG_Y to Saturn, POS_X to 136.5/38.0



# Notes (1/3)

- Pointing:
  - Any SP turns that will violate turn margin policy and/or require hand edit to spturn script output
    - The DSS-14/DSS-45 split pass on DOY 006 is meant to have a six-hour roll. The SP SASF generated by the spturn script must be edited for proper implementation. (We chose to not make this a UNQ pass, as that would decrease playback capacity over DSS-14.)
  - Any YGAP window issues (approved deviations from guidelines) esp. if segment ENDS with YGAP
    - The YGAPs on DsOY 004 and 006 have been placed ***after*** the prime downlink. NAV and SCO have agreed to this.
  - RBOT: exceptions to guidelines, jettison days
    - No RBOT-friendly waypoint secondary was identified or used between 2013-004T09:35:00 and 2013-007T02:46:00. The safety of the waypoints used during this period has been verified with `waypt_widget`.

- DSN:
  - Rev 178 Saturn Atmospheric Occultation Experiment:

    ***Level 3 request* from 2013-004/2045 to 2013-005/0530**

    Stations: DSS-45, DSS-34, DSS-55, DSS-63
  - The downlink on DOY 006 has been split between DSS-14 and DSS-45.
  - `ap_downlink` produced the following errors:

    ```
    Error: SP_178EA_G70METSEQ006_PRIME is a SEQ upload pass and should be at least 9 hours in duration
    Error: SP_178EA_C34HEFSEQ006_PRIME is a SEQ upload pass and should be at least 9 hours in duration
    ```

    both of which can be ignored. This error is produced because it is a split downlink. In fact, a 9-hour DSN pass (DSS-45) has been requested in order to support sequence uplink activities during this DSN pass.
  - `ap_downlink` also complains about:

    ```
    Warning: 70m usage for sequence exceeds project commitment of <= 35%; is at 44%
    Warning: number of sequence upload passes is 4; should be 5 or more
    ```

    both of which can be ignored. The DSS-43 downtime forces the former. Per the latter, there are actually only 3 sequence upload passes in this segment. The others are contained in the other segments.
  - A 4-hour, 45-minute DSS-14 pass has been added on DOY 007 to help mitigate the impact of the DSS-43 downtime.

# Notes (2/3)

- DSN (cont'd):
  - The DOY 007 DSS-14 downlink is followed by a YGAP, which is itself followed by the DOY 007 DSS-45 downlink. Thus the YGAP is sandwiched between downlinks, the second of which is a full 9-hour downlink.
  - G70METSEQ004_PRIME was moved later by 15 minutes.
  - C70METSEQ006_PRIME was downgraded from DSS-43 to DSS-45, as a result of extended maintenance on DSS-43. A three-hour DSS-14 track was added at the beginning of this pass to compensate for the loss of the 70-meter antenna.
  - A full 9-hour track has been requested on DSS-45 on DOY 006, in order to preserve the full uplink opportunity on one station. As a result, overlapping requests for DSS-14 and DSS-45 exist. SP_178NA_G70METNON006_SP can consequently be made downlink-only. Or SP_178NA_C34HEFSEQ006_SP can begin three hours later if an uplink transfer is deemed acceptable by the S76 SIP leads.

- Resource checker:
  - CIMS_RESOURCE_CHECK_021 – A unique opmode is required to transition from RSS2RWAF to RSS3RWAS, as a direct transition between the two is not allowed. See note in CIMS request ENGR_178SC_URSS3RWAS004_PPS.
  - CIMS_RESOURCE_CHECK_022-_023 – The full 9-hours of the sequence upload pass is actually preserved. See note about `ap_downlink` errors on the previous page of this package.
  - CIMS_RESOURCE_CHECK_024 – This gap is not only intentional, it is necessary to insure that SID suspend commands can be properly added to the segment. See '**Liens**' slide below.

- Opmodes:
  - transition to RSS2RWAF @ 2013-004T21:31:00 – allows for warm-up of RSS' S- and X- bands in preparation for the impending RSS occultation experiment; RWA full
  - transition to RSS3RWAS @ 2013-004T23:35:59 – allows for warm-up of RSS' Ka-band; **RWA slow**; ISS and VIMS sleep; CDA no articulation
  - The *transition* between RSS2RWAF and RSS3RWAS must be done as a unique opmode, although neither opmode itself is unique. See note in CIMS request ENGR_178SC_URSS3RWAS004_PPS.

# Notes (3/3)

- Data Volume:
  - The Saturn TWT has agreed to accept 100 Mb of carryover from XD_176/177.
  - The XD TWT has agreed to accept 384 Mb of carryover from Saturn_178 into XD_177/178.
  - No SMT warnings
- Hydrazine:
  - N/A
- Special Activities:
  - Per the discussion in the 'Opmodes' section above, Cassini will be in an opmode which precludes CDA articulation from 2013-004T23:35:59 until 2013-005T03:14:38. CDA has acknowledged this (*per e-mail from G. Moragas-Klostermeyer*).
  - CMT management will be required during the observation ISS_178SA_LIMBSCAN001_PRIME (2013-004T22:35:59 – 2013-004T23:35:59); see slide entitled 'NEG_Y to Sun Violation'.

# Liens (1/1)

**Sequence Liens (should all be SPLAT items):**

- List any Liens to be worked in SIP *i.e.*
  - S76000007 – A waiver will be required for CMT management during ISS_178SA_LIMBSCAN001_PRIME. See 'Special Activities' section on previous slide. This SPLAT item can be considered resolved once a waiver for this has been approved.
  - S76000008 – Use of the preferred science attitude for CIRS_178SA_COMPSIT004_PRIME places Titan and Rhea in the SRUs and provokes an SRU violation. The magnitude of the offset required to prevent this SRU violation is so large as to significantly compromise the science goals of the observation. In order to allow CIRS to observe Saturn at its preferred orientation, CIRS has agreed to insert a 20-minute quiescent period during this observation after the violation geometry has been exited. This 20-minute inertial stare will allow AACS to re-initialize the SRUs. The 10-minute gap in the timeline at 2013-005T05:34:00 left by SPST will insure that the spacecraft is left at an inertial attitude for long enough that an initial SID SUSPEND command can be issued. This SPLAT item can be considered resolved once AACS has confirmed that the necessary SID commands have been incorporated into the S76 background sequence.

# CMT Management: -Y to Sun violation

- NEG_Y to Sun CMT Management and flight rule waivers will be needed for the ISS Limb Scan on DOY 004 during the solar occultation
  - Time of Saturn Solar Occultation is from the tour atlas.
  - Timing uncertainty is ±0.7953 min; use ± 6 minutes pad as determined using Brad Wallis' "ask_carnac.pro"