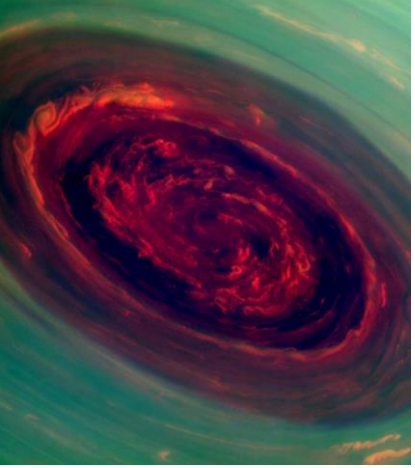
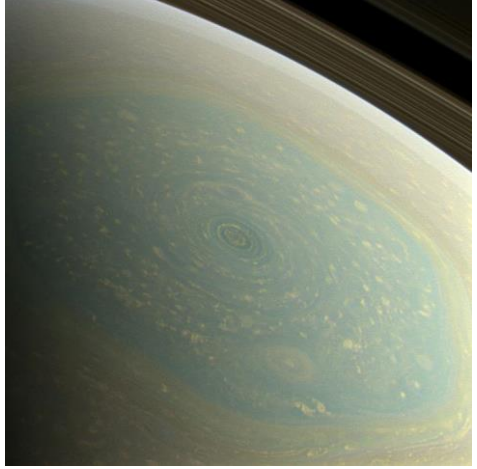
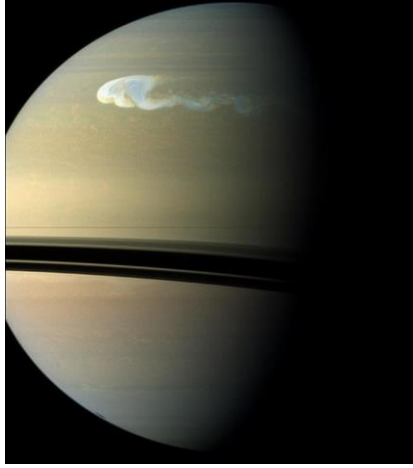


Science Planning & Sequence Team
CASSINI

# SATURN TARGET WORKING TEAM

**Rev 31 Segment Legacy Package**

**Segment Boundary: October 29, 2006 – October 31, 2006**
**2006-302T10:42 – 2006-304T17:57 (SCET)**

**Integration Began 12/16/2002**
**Segment Delivered to S25 Sequence 01/28/2003**
**Lead Integrator was Jarod Gross**

**Legacy Package Assembled by Kyle Cloutier**

# Table of Contents





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

# Segment Overview and Final Products

# Segment Summary

- Saturn 31 is a short Prime Mission segment, covering 2.5 days outbound from periapse. The spacecraft viewed Saturn from high sub-spacecraft latitudes and high phase angles.
- Saturn science in this segment includes a VIMS thermal cylindrical map, ISS Saturn WAC Photopolarimetry 160 deg phase mosaic, and a UVIS EUV/FUV imaging observation.
- Other observations in this segment include an Enceladus volatile observation and a VIMS stellar calibration.

# Final Sequenced SPASS



| Request | Riders | Start (SCET) | Start (Epoch) | Duration | End | Primary | Secondary | Comments |
|---|---|---|---|---|---|---|---|---|
| SATURN rev 31 Segment | | 2006-302T10:42:00 | | 002T07:15:00 | 2006-304T17:57:00 | | | |
| SP_031SA_WAYPTTURN302_PRIME | | 2006-302T10:42:00 | | 000T00:30:00 | 2006-302T11:12:00 | ISS_NAC to Saturn | NEG_Z to NSP | |
| **NEW WAYPOINT** | | **2006-302T11:12:00** | | **001T07:15:00** | **2006-303T18:27:00** | **ISS_NAC to Saturn** | **NEG_Z to NSP** | |
| VIMS_031SA_THRCYLMAP002_PRIME | C, U | 2006-302T11:12:00 | | 000T11:00:00 | 2006-302T22:12:00 | ISS_NAC to Saturn | NEG_Z to NSP | |
| ISS_031SA_1X2WPH161001_PRIME | U, V | 2006-302T22:12:00 | | 000T10:15:00 | 2006-303T08:27:00 | ISS_NAC to Saturn | NEG_X to Sun | |
| SP_031EA_DLTURN303_PRIME | | 2006-303T08:27:00 | | 000T00:30:00 | 2006-303T08:57:00 | XBAND to Earth | POS_X to NEP | |
| SP_031EA_G70METNON303_PRIME | C, E | 2006-303T08:57:00 | | 000T09:00:00 | 2006-303T17:57:00 | XBAND to Earth | 5_Hr_Rolling | |
| SP_031SA_WAYPTTURN303_PRIME | | 2006-303T17:57:00 | | 000T00:30:00 | 2006-303T18:27:00 | ISS_NAC to Saturn | NEG_X to NSP | |
| **NEW WAYPOINT** | | **2006-303T18:27:00** | | **001T00:00:00** | **2006-304T18:27:00** | **ISS_NAC to Saturn** | **NEG_X to NSP** | |
| UVIS_031SA_EUVFUV003_PRIME | C, I, M, V | 2006-303T18:27:00 | | 000T11:00:00 | 2006-304T05:27:00 | UVIS_FUV to Saturn | NEG_X to NSP | |
| UVIS_031EN_ICYATM005_PRIME | C, I | 2006-304T05:27:00 | | 000T01:30:00 | 2006-304T06:57:00 | UVIS_FUV to Enceladus | NEG_Z to NSP | |
| VIMS_031ST_RCARCAL001_PRIME | C | 2006-304T06:57:00 | | 000T01:30:00 | 2006-304T08:27:00 | VIMS_IR to 143.061/-62.789 | NEG_X to Sun | |
| SP_031EA_DLTURN304_PRIME | | 2006-304T08:27:00 | | 000T00:30:00 | 2006-304T08:57:00 | XBAND to Earth | POS_X to NEP | |
| SP_031EA_G70METNON304_PRIME | C | 2006-304T08:57:00 | | 000T09:00:00 | 2006-304T17:57:00 | XBAND to Earth | Rolling | |

# Final Sequenced SMT and Data Volume



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

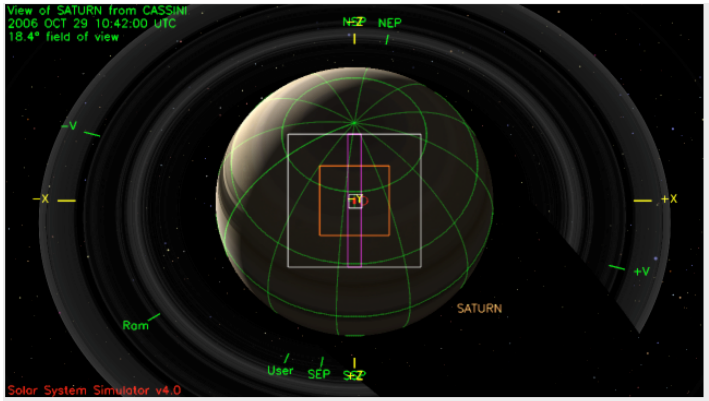
| | | | OBSERVATION_PERIOD | | | | | | | DOWNLINK_PASS | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | P4 | | | | | | P5 | RECORDED | | PLAYBACK | | | | |
| DOWNLINK PASS NAME | Start doy hh:mm | End doy hh:mm | START (Mb) | SCI (Mb) | HK+E (Mb) | TOTAL (Mb) | CPACTY (Mb) | MRGN (Mb) | OPNAV (Mb) | SCI (Mb) | ENGR (Mb) | TOTAL (Mb) | CPACTY (Mb) | MARGN (Mb) | NET_MARGN (%) | CAROVR (Mb) |
| SP_031EA_G70METNON303_PRIME | 303 08:57 | 303 17:57 | 2171 | 1171 | 76 | 3417 | 3514 | 97 | 0 | 259 | 53 | 3730 | 3848 | 117 | 2201 | 11% | 0 |
| SP_031EA_G70METNON304_PRIME | 304 08:57 | 304 17:57 | 0 | 1381 | 51 | 1432 | 3514 | 2083 | 0 | 259 | 53 | 1744 | 3862 | 2117 | 4707 | 26% | 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 | 302 10:42 | 303 08:57 | 80.1 | 27.4 | 79.2 | 4.0 | 300.0 | 39.6 | 72.1 | 0.0 | 105.4 | 42.2 | 410.0 | 0.0 | 0.0 | 1160.0 |
| SP_031EA_G70METNON303_PRIME | 303 08:57 | 303 17:57 | 32.4 | 14.5 | 86.4 | 1.6 | 0.0 | 19.4 | 43.7 | 0.0 | 58.8 | 0.0 | 0.0 | 0.0 | 0.0 | 256.9 |
| DAILY TOTAL SCIENCE | 302 10:42 | 303 17:57 | 112.5 | 41.9 | 165.6 | 5.6 | 300.0 | 59.0 | 115.8 | 0.0 | 164.2 | 42.2 | 410.0 | 0.0 | | |
| OBSERVATION_NOR | 303 17:57 | 304 08:57 | 162.0 | 24.2 | 201.6 | 2.7 | 248.0 | 32.4 | 72.9 | 0.0 | 98.0 | 204.7 | 321.7 | 0.0 | 0.0 | 1368.1 |
| SP_031EA_G70METNON304_PRIME | 304 08:57 | 304 17:57 | 32.4 | 14.5 | 86.4 | 1.6 | 0.0 | 19.4 | 43.7 | 0.0 | 58.8 | 0.0 | 0.0 | 0.0 | 0.0 | 256.9 |
| DAILY TOTAL SCIENCE | 303 17:57 | 304 17:57 | 194.4 | 38.7 | 288.0 | 4.3 | 248.0 | 51.8 | 116.6 | 0.0 | 156.8 | 204.7 | 321.7 | 0.0 | | |

# Segment Geometry






```
Rev 031 OUTBOUND
2006 -  302T10:42:00 SCET
2006 OCT 29 10:42:00 SCET
2006 OCT 29 12:00:22 ERT
Apoapse__031 + 009T12:24:52
Periapse_031 + 001T10:31:53
Light time:     78.4 min
Orbit period:   12.0 days
Radius      938598 km      15.57 Rs
Rad_cyl     555922 km       9.22 Rs
Z_ht_cyl    756252 km      12.55 Rs
Mag_L          44.39
Semi_axs   1010097 km      16.76 Rs
Eccentricity    0.722
Inclination    54.96 deg
Sun_range       9.17 AU
Earth_range     9.42 AU
--- DSN ELEV -- D/L -- U/L --------
Goldstone      44.2    12.5
Canberra      -48.4   -69.1
Madrid         26.8    54.6
------- LOOK DIRECTION INFO -------
FOV            18.4 deg  320.6 mrad
RA            -84.449 deg
DEC           -50.295 deg
Crosses_RP_@    0.000 Rs
EPS             5.918 deg *
SEP            72.117 deg
ORS b/s angle  49.3 deg
ORS rad angle 128.1 deg
```

Point NEG_Y at SATURN and align NEG_Z = Up with NSP

User vector - RA: +81.514 DEC: -17.304 Paste Current RA/DEC

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

Zoom Out Fill Screen Zoom In

Labels Axes Orbits Vectors FOVs Lat/lons

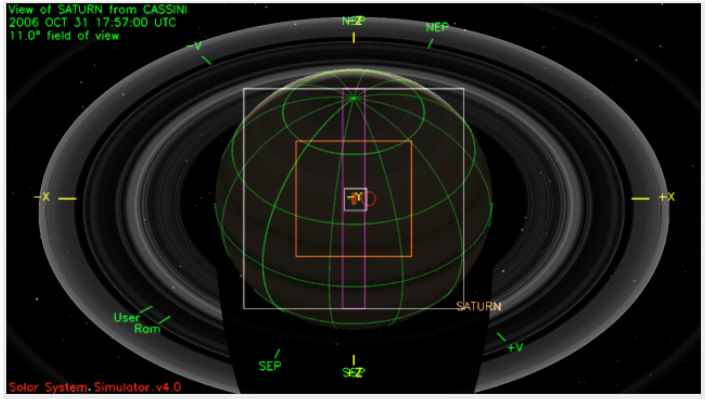
Year Month Day Hour Minute Second

Turn analyzer: SATURN to EARTH about Z on RWA = 7.0 min / 54.2 deg Event

| BODY | S/C OCCP | SAT OCCP | 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 | -- | -- | 938598 | 15.57 | 882110 | 14.64 | 130.7 | 7.36 | 128.51 | 293 | 54 | 0 | 6.6 | 0 | 0.0 | 54.2 | 154.7 |
| MIMAS | -- | -- | 924605 | 15.34 | 924412 | 15.34 | 137.9 | 0.03 | 0.45 | 87 | 54 | 75 | 10.4 | 4256 | 11.6 | 46.2 | 143.6 |
| ENCELADUS | -- | -- | 825076 | 13.69 | 824826 | 13.69 | 125.1 | 0.04 | 0.62 | 161 | 66 | 13 | 8.6 | -34 | 13.6 | 58.7 | 143.7 |
| TETHYS | -- | -- | 890224 | 14.77 | 889695 | 14.76 | 112.4 | 0.07 | 1.21 | 269 | 58 | -56 | 13.6 | -5533 | 18.3 | 72.5 | 158.0 |
| DIONE | -- | -- | 1184039 | 19.65 | 1183477 | 19.64 | 130.2 | 0.05 | 0.95 | 345 | 40 | -155 | 16.0 | 91 | 15.6 | 55.5 | 166.2 |
| RHEA | -- | -- | 784612 | 13.02 | 783849 | 13.01 | 99.0 | 0.11 | 1.96 | 276 | 74 | -23 | 8.4 | 3197 | 34.2 | 84.8 | 137.7 |
| TITAN | -- | -- | 1896267 | 31.46 | 1893692 | 31.42 | 126.3 | 0.16 | 2.72 | 353 | 24 | -156 | 11.7 | -6784 | 32.5 | 59.6 | 163.9 |
| HYPERION | -- | -- | 1273419 | 21.13 | 1273266 | 21.13 | 52.0 | 0.01 | 0.26 | 204 | 22 | -17 | 6.3 | 28273 | 88.8 | 128.8 | 87.0 |
| IAPETUS | -- | -- | 3610887 | 59.91 | 3610141 | 59.90 | 139.1 | 0.02 | 0.41 | 15 | 9 | 89 | 5.0 | -175655 | 73.3 | 35.8 | 84.1 |
| PHOEBE | -- | -- | 14009788 | 232.46 | 14009676 | 232.46 | 104.8 | 0.00 | 0.02 | 214 | -22 | 68 | 8.0 | 3670978 | 111.4 | 68.8 | 45.5 |
| SATURN | -- | -- | 938598 | 15.57 | 882110 | 14.64 | 130.7 | 7.36 | 128.51 | 293 | 54 | 0 | 6.6 | 0 | 0.0 | 54.2 | 154.7 |

Segment Start: 2006-302T10:42

Segment End: 2006-304T17:57




```
Rev 031 OUTBOUND
2006 -  304T17:57:00 SCET
2006 OCT 31 17:57:00 SCET
2006 OCT 31 19:15:07 ERT
Apoapse__031 + 011T19:39:52
Periapse_031 + 003T17:46:53
Light time:     78.1 min
Orbit period:   12.0 days
Radius     1563146 km      25.94 Rs
Rad_cyl    1230435 km      20.42 Rs
Z_ht_cyl    964084 km      16.00 Rs
Mag_L          41.86
Semi_axs   1010230 km      16.76 Rs
Eccentricity    0.722
Inclination    54.97 deg
Sun_range       9.17 AU
Earth_range     9.39 AU
--- DSN ELEV -- D/L -- U/L --------
Goldstone      28.4    58.7
Canberra       33.1     8.6
Madrid        -35.0   -23.0
------- LOOK DIRECTION INFO -------
FOV            11.0 deg  192.7 mrad
RA            -43.305 deg
DEC           -39.055 deg
Crosses_RP_@    0.000 Rs
EPS             5.978 deg *
SEP            74.261 deg
ORS b/s angle  22.8 deg
ORS rad angle  90.6 deg
```

Point NEG_Y at SATURN and align NEG_Z = Up with NSP

User vector - RA: +81.514 DEC: -17.304 Paste Current RA/DEC

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

Zoom Out Fill Screen Zoom In

Labels Axes Orbits Vectors FOVs Lat/lons

Year Month Day Hour Minute Second

Turn analyzer: SATURN to EARTH about Z on RWA = 4.8 min / 26.0 deg Event

| BODY | S/C OCCP | SAT OCCP | 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 | -- | -- | 1563146 | 25.94 | 1505064 | 24.97 | 157.1 | 4.42 | 77.13 | 320 | 38 | 0 | 3.3 | 0 | 0.0 | 26.0 | 118.2 |
| MIMAS | -- | -- | 1464363 | 24.30 | 1464166 | 24.29 | 153.2 | 0.02 | 0.28 | 232 | 41 | -42 | 15.1 | -2806 | 5.9 | 30.7 | 120.3 |
| ENCELADUS | -- | -- | 1753282 | 29.09 | 1753028 | 29.09 | 161.8 | 0.02 | 0.29 | 15 | 33 | 168 | 14.4 | 14 | 5.0 | 21.0 | 119.3 |
| TETHYS | -- | -- | 1614398 | 26.79 | 1613868 | 26.78 | 155.2 | 0.04 | 0.67 | 290 | 37 | -96 | 14.3 | -1350 | 10.5 | 29.6 | 127.2 |
| DIONE | -- | -- | 1447678 | 24.02 | 1447117 | 24.01 | 149.3 | 0.04 | 0.78 | 255 | 42 | -58 | 11.6 | -0 | 13.7 | 35.5 | 125.7 |
| RHEA | -- | -- | 1997918 | 33.15 | 1997151 | 33.14 | 165.7 | 0.04 | 0.77 | 354 | 29 | -167 | 11.2 | -3234 | 9.6 | 18.7 | 125.7 |
| TITAN | -- | -- | 2599770 | 43.14 | 2597195 | 43.09 | 171.5 | 0.11 | 1.98 | 354 | 22 | -170 | 8.4 | -7213 | 16.7 | 14.0 | 130.0 |
| HYPERION | -- | -- | 1031512 | 17.12 | 1031363 | 17.11 | 92.9 | 0.02 | 0.32 | 318 | 7 | -14 | 5.2 | 17505 | 65.6 | 91.3 | 93.0 |
| IAPETUS | -- | -- | 4282654 | 71.06 | 4281907 | 71.05 | 134.5 | 0.02 | 0.35 | 21 | 9 | 117 | 3.7 | 2299 | 48.9 | 40.2 | 83.5 |
| PHOEBE | -- | -- | 14556820 | 241.53 | 14556707 | 241.53 | 108.8 | 0.00 | 0.02 | 203 | -21 | 108 | 4.2 | 3539743 | 78.9 | 64.7 | 66.2 |
| SATURN | -- | -- | 1563146 | 25.94 | 1505064 | 24.97 | 157.1 | 4.42 | 77.13 | 320 | 38 | 0 | 3.3 | 0 | 0.0 | 26.0 | 118.2 |

| | Saturn Range | Phase Angle | Sub-S/C Lat. |
|---|---|---|---|
| Segment Start | 15.57 Rs | 130.7 deg | 54 |
| Segment End | 25.94 Rs | 157.1 deg | 38 |

# Solar Geometry – ORS Boresight Concerns



**No ORS Boresight Solar Constraints on Science Pointing.**

# Daily Science Highlights

Saturn science in this segment included a VIMS thermal cylindrical map, ISS Saturn WAC Photopolarimetry 160 deg phase mosaic, and a UVIS EUV/FUV imaging observation. Other observations in this segment included an Enceladus volatile observation and a VIMS stellar calibration.

---

UVIS_031_EN_ICYATM005_PRIME: Mapped volatiles in system in immediate neighborhood of satellite. Observations targeted to Enceladus were to test connection of volatile changes to plume eruptions.

# Segment Integration Planning

# Timeline Gaps and Suggested Observations



| Request | Start | Dur | End | Original Request Start |
|---|---|---|---|---|
| SP Turn | 302T10:42 | 0:30 | 302T11:12 | |
| VIMS | 302T11:12 | 10:00 | 302T22:12 | |
| UVIS_031RI_IMPACT009_PRIME | 302T22:12 | 6:00 | 303T04:12 | 302T23:46 |
| ISS_031SA_1X2WP160B00<X>_PRIME | 303T04:12 | 4:25 | 303T08:27 | 303T05:12; 4 pickets |
| SP Turn | 303T08:27 | 0:30 | 303T08:57 | |
| Gold HEF | 303T08:57 | 9:00 | 303T17:57 | |
| SP Turn | 303T17:57 | 0:30 | 303T18:27 | |
| UVIS_031SA_EUVFUV003_PRIME | 303T18:27 | 11:00 | 304T05:27 | |
| UVIS_031RI_IMPACT004_PRIME | 304T05:27 | 3:00 | 304T08:27 | 303T23:46; Dur was 6:00 |
| SP Turn | 304T08:27 | 0:30 | 304T08:57 | |
| Gold HEF | 304T08:57 | 9:00 | 304T17:57 | |

Periapse = 2006-301T00:14:56 (4.7 Rs)

Segment = 2006-302T10:42 to 2006-304T17:57 (Peri+1T10:27:04 to Peri+3T16:42:04)

Geometry Info

| SCET | Range | Saturn Phase |
|---|---|---|
| 2006-302T10:42 | 16.6 Rs | 130° |
| 2006-303T14:20 | 22.9 Rs | 147° |
| 2006-304T17:57 | 26.9 Rs | 157° |

# Initial SMT and Data Volume

## Beginning of Integration:

DATA VOLUME SUMMARY

| | | | 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) | MARGIN (Mb) | MARGIN (%) | OPNAV (Mb) | SCI (Mb) | ENGR (Mb) | TOTAL (Mb) | CPACTY (Mb) | MARGIN (Mb) | MARGIN (%) | CAROVR (Mb) |
| SP_031EA_G34HEFNON303_PRIME | 303 08:57 | 303 17:57 | 0 | 2032 | 75 | 2107 | 3569 | 1462 | 41% | 0 | 216 | 53 | 2376 | 929 | -1448 | -156% | 1448 |
| SP_031EA_G70METNON304_PRIME | 304 08:57 | 304 17:57 | 1448 | 644 | 51 | 2142 | 3569 | 1427 | 40% | 0 | 216 | 53 | 2411 | 3695 | 1285 | 35% | 0 |

DATA VOLUME REPORT

| 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 | 302 10:42 | 303 08:57 | 80.1 | 13.9 | 79.2 | 4.0 | 712.7 | 48.1 | 72.1 | 0.0 | 104.9 | 37.1 | 880.0 | 0.0 | 0.0 | 2032.2 |
| SP_031EA_G34HEFNON303_PRIME | 303 08:57 | 303 17:57 | 32.4 | 4.9 | 86.4 | 1.6 | 0.0 | 19.4 | 29.2 | 0.0 | 42.4 | 0.0 | 0.0 | 0.0 | 0.0 | 216.3 |
| OBSERVATION_NOR | 303 17:57 | 304 08:57 | 54.0 | 8.1 | 79.2 | 2.7 | 48.0 | 32.4 | 48.6 | 0.0 | 70.7 | 270.0 | 30.0 | 0.0 | 0.0 | 643.7 |
| SP_031EA_G70METNON304_PRIME | 304 08:57 | 304 17:57 | 32.4 | 4.9 | 86.4 | 1.6 | 0.0 | 19.4 | 29.2 | 0.0 | 42.4 | 0.0 | 0.0 | 0.0 | 0.0 | 216.3 |

# Waypoint Selection

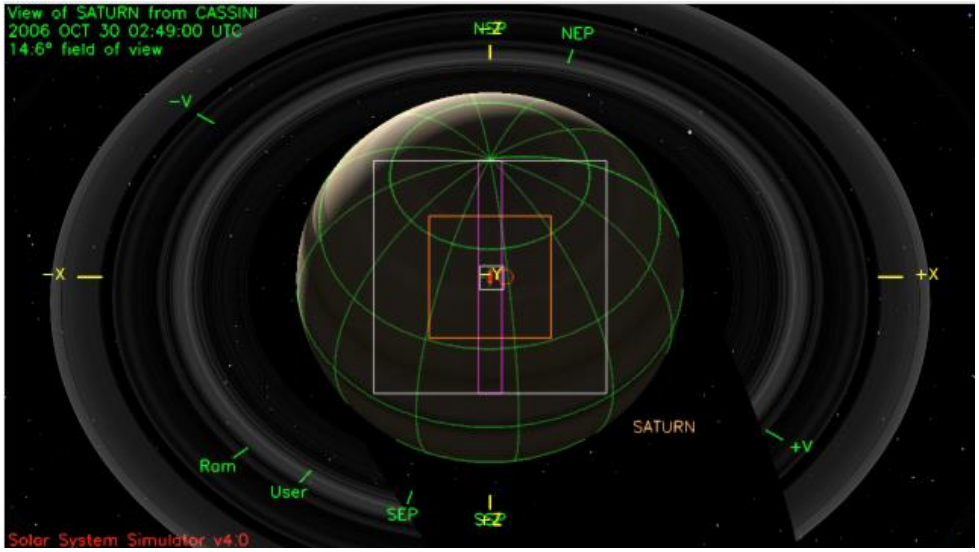
## FR-Safe Waypoint Options

- NAC to Saturn, -Z to NSP
- NAC to Saturn, -X to NSP

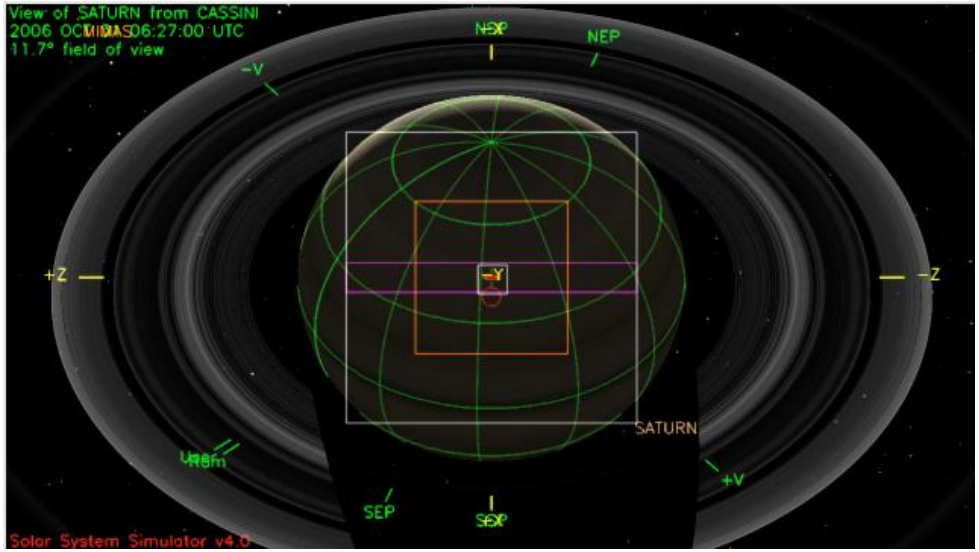
UVIS to pick waypoint attitude for DOY 303 (-Z to NSP or –X to NSP are both safe)

# Waypoints Chosen

Waypoint 1 (2006-302T11:12 – 303T18:27):
NAC to Saturn, NEG_Z to NSP




Waypoint 2 (2006-303T18:27 – 304T18:27):
NAC to Saturn, NEG_X to NSP



# Notes & Liens

- **Pointing**
  - All waypoints have been verified as being Flight Rule-safe.
  - All SP turns have been allocated sufficient time and are Flight-Rule safe.
  - ISS (B. West) elected to forgo analyzing the turns for ISS_031SA_1X2WPH161001_PRIME and agreed to accommodate any surprises or problems wrt turn duration and/or FR violations out of the time allocated to the request.
- **Data Volume**
  - No issues. Carryover 1686 Mb from Gold HEF on DOY 303 to Gold 70-m on DOY 304. Gold 70-m pass still has 7% margin.
- **CIMS**
  - All of the expected requests for this delivery are approved in CIMS.
- **OpModes**
  - All OpMode transitions are in the CIMS delivery. No issues at this time.
- **Flight Rule / Mission Planning Guideline & Constraint Issues**
  - None known at this time.
- **DSN**
  - No DSN schedule conflicts. NAV & MP approve of DSN plan