

About the Experiment

- S94 Rev 235 T119 Titan Bistatic and Occultation Observations
 - Egress occultation: 2-way/3-way mode
 - Last in the mission ☹
 - Egress Bistatic observation: 1-way mode
 - Telemetry OFF, Ranging OFF
 - Covered by Canberra

- Science Highlights (From Essam Marouf)

The RSS Titan observations on T119 include an egress atmospheric occultation and an egress bistatic surface scattering experiment. The atmospheric occultation is the last RSS Titan occultation in the Cassini Mission lifetime. It will profile the thermal structure of the atmosphere at latitude of about 39.8°N , complementing previous latitude coverage and helping in characterization of seasonal changes on Titan. The occultation will also yield the electron density profile of the ionosphere. The T119 egress bistatic ground track crosses northwest of Ligea Mare (sea) over a region known to host many small lakes of liquid hydrocarbons (likely mainly methane). The track extends from about $(72^{\circ}\text{N}, 155^{\circ}\text{W})$ to about $(78^{\circ}\text{N}, 125^{\circ}\text{W})$, and captures scattering angles decreasing from about 80 to 65 degrees, partly grazing and partly within the Brewster angle range. Measurements of the absolute power of the polarized components of mirror-like surface reflections (surface echoes), when detectable, yield information about surface reflectivity, dielectric constant (composition), and roughness.

DSN Antennas

- DSN Coverage

	Pre	BOT	EOT	Post									
16 127	1215	1515	2050	2250	DSS-43	CAS	RS	T119	BISOC	L3	6797	1645	1A1
16 127	1450	1750	2050	2250	DSS-35	CAS	RS	T119	BISOC	L3	6797	N750	1A1

- First time using DSS-35
 - T117 in February was first, but antenna was red
 - Has capability to simultaneously support X- and Ka-band RCP and LCP
- DSS-43 will provide uplink for the occultation
 - DSS-35 will be backup
- Receivers scheduled
 - 2 closed-loop receivers per antenna
 - Open-loop receivers (RSRs, WVSRs)
 - Open-loop data are prime. Closed-loop data are backup
 - Will need ramp info in closed-loop data for processing
 - RCP and LCP will be recorded
 - 1-way and 2-way/3-way modes

S94 T119 Open-Loop Receivers Assignment

DSS	Operator	Station	Open-loop Receiver	Channels	Subchannels	Bandwidths KHz
43	Jay/Dustin	rsops1	RSR1	RSR1A -> XRCP RSR1B -> XLCP	1, 2, 3, 4 1, 2, 3, 4	1, 16, 50, 100 (1-way w/ offset) 1, 16, 50, 100
43	Elias	rsops2	RSR2	RSR2A -> SRCP RSR2B -> SLCP	1, 2, 3, 4 1, 2, 3, 4	1, 16, 50, 100 1, 16, 50, 100
35	Danny	rsops3	WVSR1	WVSR1A -> XRCP WVSR1B -> XLCP	1, 2, 3, 4 4, 5, 6 7, 8, 9 1, 2, 3	1, 16, 50, 100 1, 16, 50 (2-way) 1, 16, 50 (1-way) 1, 16, 50, 100
35	Danny	rsops5	WVSR2	WVSR2A -> KRCP WVSR2B -> KLCP	1, 2, 3, 4 4, 5, 6 7, 8, 9 1, 2, 3	1, 16, 50, 100 1, 16, 50 (2-way) 1, 16, 50 (1-way) 1, 16, 50, 100
43	Elias/ Dustin	rsops4	VSR1	VSR1A -> XRCP VSR1B -> XRCP	1, 2, 3 1, 2, 3	1, 16, 50 (2-way) 1, 16, 50 (1-way)
43	Danny	rsops5	PRSR1	PRSR1A* -> SRCP *(if available)	1, 2, 3 4, 5, 6	1, 16, 50 (2-way) 1, 16, 50 (1-way)

RSSG will be in Ops Room at 4:30 am on Friday, May 6 (127/1130)

Prime receivers. Monitor throughout experiment

Monitor during occultation to look for DST going out of lock

Aseel – VOCA

Elias – Ops Room Displays

Danny – Check WVSR/VSR/PRSR availability & RSR/WVSR/VSR/PRSR disk space

Bistatic Calibrations

- Calibrations will be performed during
 - Pre-cal (antennas at stow)
 - 3-hr pre-cal periods are scheduled
 - Observation (mini-cals)
 - Pre-determined and carefully selected times (during turns)
 - Must be completed within 6-8 minutes
 - Harder to plan for DSS-43 than in the past
 - Time windows were not long enough to completed RCP and LCP
 - SNT Measurements
 - Completed within 3-4 minutes
 - Add LCP measurements
 - Post-Cal (antennas at stow)
 - 2-hr post-cal periods are scheduled
- Pre-cal calibrations are the longest
- Need to add LCP SNT measurements to the bistatic procedure

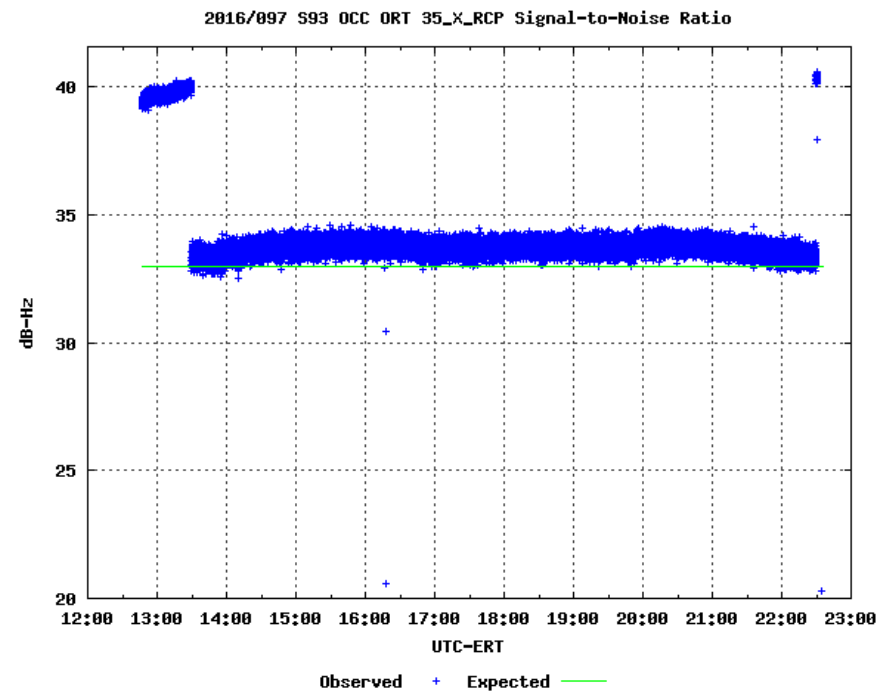
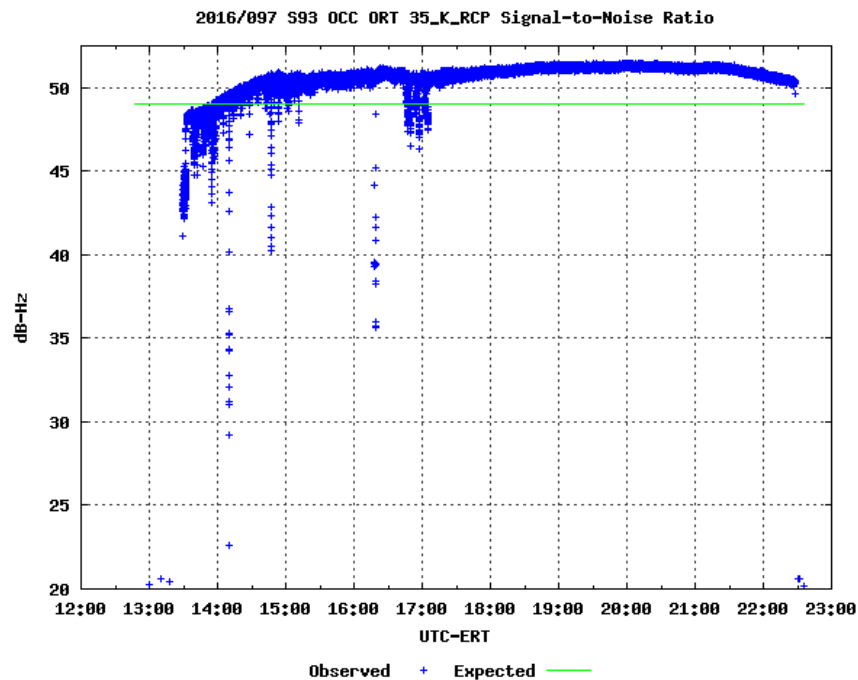
ORTs

Completed

1. ORT on DOY 097 (Apr 6 PDT) over DSS-35, X- and Ka-band

16 097 1200 1330 2230 2245 DSS-35 CAS TP SEQ RS OCORT 6767 N750 1A1

- Also prime TP
- Monopulse data acquired
- Station performed multiple Monopulse on-point phase calcs in 1-way and 2-way modes
 - Canberra reported post-pass that “the Monopulse system was continuously circling the spacecraft position, this confirming it was struggling to hold on to the spacecraft”
 - Problem with new XKA LNA?!!
 - Was replaced earlier this year
 - Need more on-point phase calibrations – Opportunity on DOY 103
- No KLCP data acquired



ORTs cont'd

2. ORT on DOY 103 (Apr 12 PDT) over DSS-35, X- and Ka-band

Completed

16 103 1015 1315 2215 2230 DSS-35 CAS TP SEQ RS BIORT 6773 N750 1A1

- Also prime TP
- Practiced bistatic calibrations during 3-hr pre-cal
 - Team D supporting
 - Followed procedure without problems, but did not disable diodes during minical
 - Asked for values of Ka-band diodes
 - 12.5k = 2.177752
 - 50k = 13.31784
 - Similar to values prior to T117

Ka-band

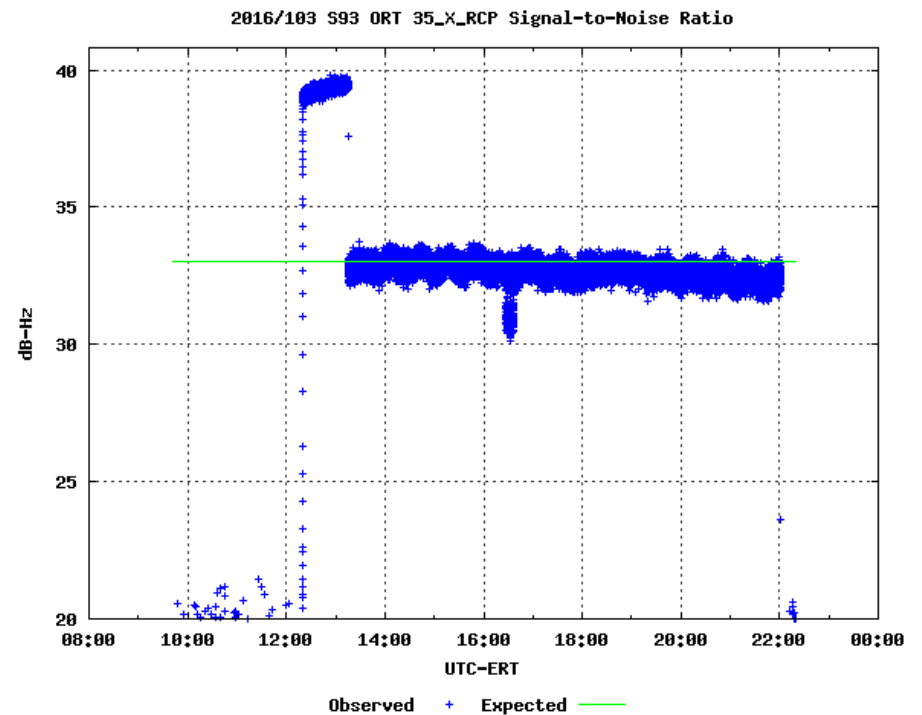
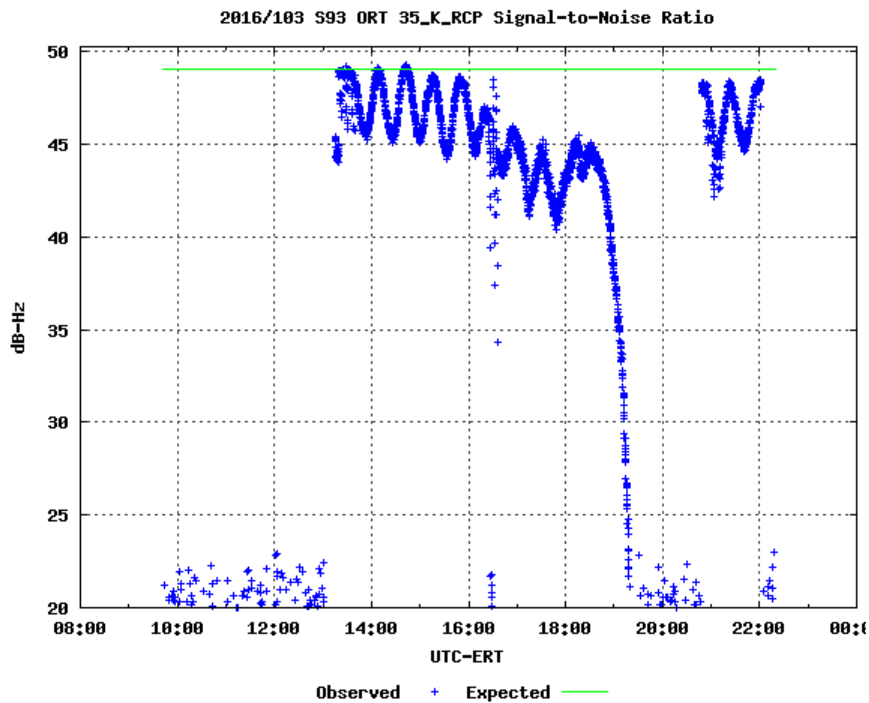
Diode Calibration Values		
0.25	0.008057	K
0.5	0.039114	K
1	0.102887	K
2	0.252757	K
4	0.582315	K
8	1.312727	K
12.5	2.269171	K
50	13.413794	K

- Used 50K for Ka-band calibrations
- KLCP signal verified
- Monopulse data acquired
 - During 1-way, antenna was driven off-point by the Monopulse system
 - Tau value was updated pre-pass based on DOY 097 data
- Station performed Monopulse on-point phase cals in 1-way and 2-way modes
 - Post-pass data analysis confirmed Tau value instability

ORTs cont'd

ORT on DOY 103 DSS-35, X- and Ka-band continued

- Canberra's lead engineer recommendation was to declare the LNA orange for degraded Monopulse performance
 - Need to frequently perform on-point phase calibrations
 - Last opportunity before T119 is on DOY 120
 - Be aware that at any time, that the antenna may be driven off-point by the Monopulse system



ORTs cont'd

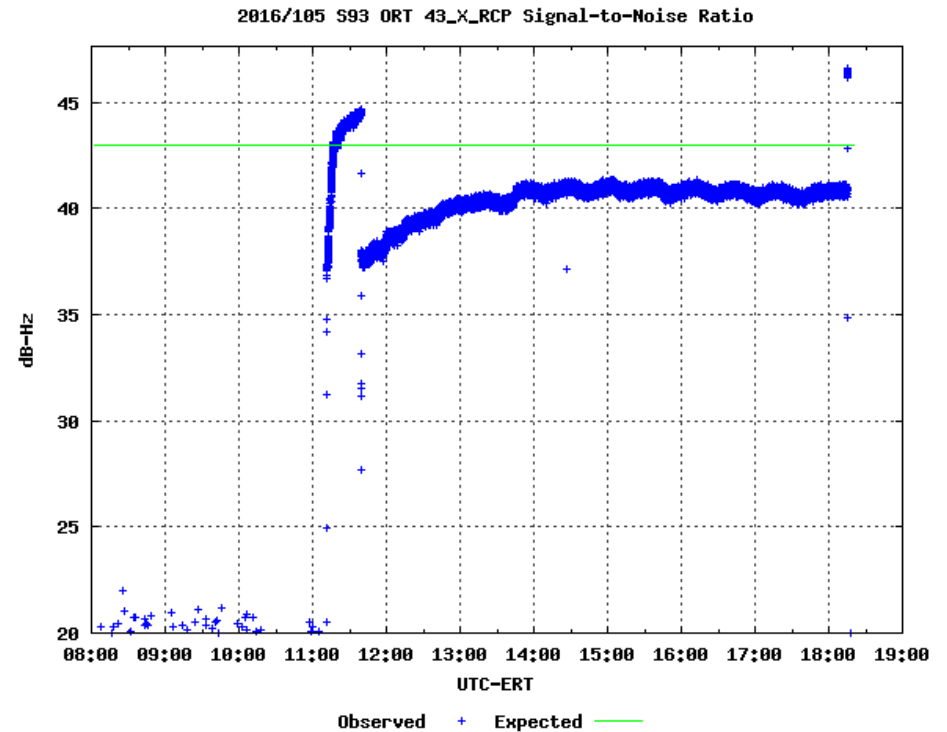
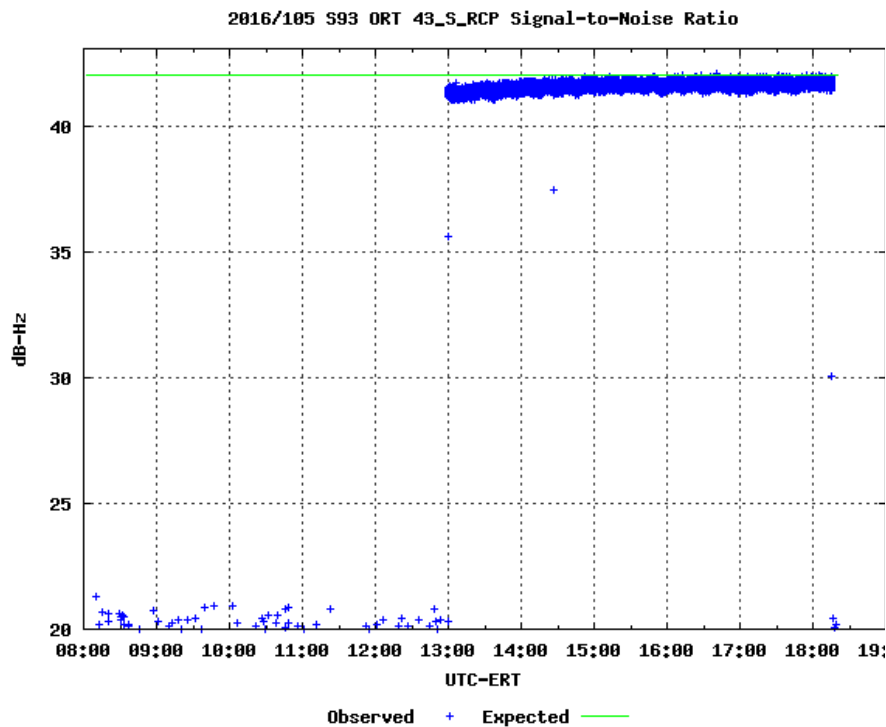
3. ORT on DOY 105 (Apr 14 PDT) over DSS-43, X- and S-band

Completed

16 105 0840 1140 1815 1830 DSS-43 CAS TP SEQ RS BIORT 6775 1647 1A1

Also prime TP

- Practiced bistatic calibrations during 3-hr pre-cal
 - Team B supporting
 - Followed procedure without problems
 - Asked for values of diodes
 - XRCP 12.5k = 22.638 XLCP 12.5k = 12.699
 - SRCP 12.5k = 11.417 SLCP 12.5k = 8.701



ORTs cont'd

Upcoming

4. ORT on DOY 120 (Apr 29 PDT) over DSS-35, X- and S-band

16 120 1535 1705 2100 2300 DSS-35 CAS RS BISTORT MC 6790 N750 1A1

- Also prime TP
- Verify X-band and Ka-band RCP and LCP signals
- Stations to conduct on-point phase calibrations – Last opportunity before T119
- Acquire Monopulse pointing data
- Practice bistatic calibrations during 2-hr post-cal

5. ORT on DOY 126 (May 5 PDT) over DSS-43, X- and Ka-band

16 126 1550 1650 2030 2200 DSS-43 CAS TP RS BISORT 6796 1647 1A1

- Also prime TP
- Verify X-band and S-band RCP and LCP signals
- Practice bistatic calibrations during 2-hr post-cal

Frequency Predicts

- DSS-43 uplink (ETX) predicts should compensate for Doppler shift due to Titan's atmosphere
- NAV delivery on Monday, May 2
 - RSS will generate predicts based on that delivery
 - Ensure that SPS predicts are available
 - RSS (Paul Schinder) will apply the Doppler shifts to the ETX files
 - Modified file will be send to the NOAs by noon on Tuesday, May 3
- RSS (Elias and Danny) will start downlink predicts generation on Tuesday
- RSS usually uses three sets of downlink predicts in the open-loop receivers for occultations:
 - #1: Coherent with atmospheric compensation: generated using Nicole's PREDICTs software and SPS nominal (unmodified) ETX
 - #2: 1-way coherent: 1-way predicts generated using PREDICTS and the Doppler file produced by Paul, offset in real-time to coherent downlink frequency
 - #3: 1-way (no offset): For the times when the DST is not in lock on the uplink

Uplink Strategy

- T119 is an egress only occultation
 - All previous Titan occultations were ingress and egress
 - DST was locked during ingress occultation
- Last 2-way track ends 22 hours before T119
- The occultation is very fast
 - Tropospheric occultation completes within one minute
 - Neutral atmospheric occultation completes within two minutes
- **Challenge: Locking up the DST quickly**
- RSS checked if it's possible to lockup DST during preceding observation (INMS), but that was not possible
 - Boresight-Off-Earth over 30 degrees
- If we have to sweep
 - RSS considered incorporating the sweep in the uplink predicts (not real-time), and using the modified predicts to generate open-loop receiver downlink predicts
 - Will keep the signal near zero residual
- What is best uplink strategy
 - Discussions with SCO
 - Sweeping may not be the best option
 - Guaranteed loss of at least 40 seconds of data if DST doesn't "snap acquire" (at BLF)
 - Option 1: Don't sweep and allow DST to snap acquire
 - Option 2: Sweep in real-time

Uplink Strategy cont'd

- SCO and NOA will monitor BLF during the passes leading up to T119
 - If needed, update BLF
 - Is it possible to update the day before, if needed?
- Meet with SCO on Thursday, 5/5 – The day before T119 – to review new data and decide on final strategy
- Specific instructions must be given to the DSN

Misc

Uplink Strategy

- DSS-43, 18 kW, ramped, sweep
- Backup: DSS-35

DKF – Does not have the correct uplink or AOS/LOS times. Use times in RSS timeline

Don't expect closed-loop receivers to lock up during bistatic experiments

Noise Diodes

- Lu sent request to Canberra to calibrate DSS-43 and DSS-35 noise diodes
- If diodes are not calibrated, follow same procedure as T117
 - For DSS-35 Ka-band, use 50K and 4K instead of 12.5K and 0.5K

DSS-35 Cassini Specific 4th Order Pointing Model

- Crucial to have good pointing models since most of the observation will be conducted on blind pointing
 - Antenna may have Monopulse problems
- Danny sent David Monopulse data from DOY 097 and 103 ORTs
 - Will send one more data set after DOY 120 is completed
- David is on travel. Will send him email

Equipment Status

- NOAs?