

# Titan S-Band Arecibo-Goldstone Experiment, Oct-Nov 1997

From: G. Black

To: D. Campbell  
R. Jurgens  
M. Slade  
S. Ostro  
A. Hine  
M. Nolan  
J. Giorgini  
R. Frye

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Titan was observed at S-band using Arecibo as the transmit system and Goldstone 70 m as the receive system. Although seven dates were planned so as to span Titan longitudes at  $45^\circ$  intervals, only the last three were attempted with data obtained for a significant length of time only on the last two days.

Table 1: Observing Log

DOY	Date	Time (UT)		Longitude	Titan	
		Start	End		RTT	Declination
294	Oct 21	06:41:30	06:46:15	0	2:20:02	3.76
302	Oct 29	04:42:30	05:55:41	180	2:20:23	3.56
306	Nov 2	04:10:30	05:35:30	270	2:20:57	3.45

All runs used a 50 kHz bandwidth, with 4 hops and a 30 second dwell time per hop. RCP transmitted; only LCP was received. The first two spectra are the sums for days 302 and 306 respectively. The last panel shows the sum of these two days with the 302 spectrum shifted by +305 Hz to compensate for an offset in the transmitter frequency on that day since, as mentioned below, the transmitter was not locked to an external frequency standard. The frequency also drifted around during the observation by several 10's of Hz. The drift has been ignored since it is much smaller than Titan's bandwidth. The spectra are given in units of the standard deviation of the noise, and have been smoothed to 400 Hz (Titan's S-band bandwidth).

Table 2: System Parameters

Arecibo:		
xmit power		900 kW
zenith gain		8 K/Jy
average gain during track*		7.2 K/Jy
frequency		2380 MHz
polarization		RCP
Goldstone:		
zenith gain		1 K/Jy
system temp		24 K
receive bandwidth		50 kHz
polarization		LCP
hops		4
hop dwell		30 sec

\* assuming gain falls linearly from 8 K/Jy at 15° zenith angle to 6 K/Jy at 20°.

## Misc. Notes

- Day 302: Bad RFI occurred from 05:14 through 05:16. These times are not included in the final spectrum. RFI was strong enough to be seen in the individual spectra.
- Day 303: During the 1997 UR asteroid run, it was discovered that the Arecibo transmitter was not properly locked, and was off by of order 300 Hz. The system was re-cabled and was on frequency for day 306. That offset should still place the Titan echo within the 12 kHz hop bandpass.
- Day 303: A boresight test of the DSS14 pointing was conducted using 3C138 as the target. Offsets were found to be ax=-0.001 and el=-0.0037.

## Results

From the final spectrum (both days 302 and 306), the  $2.5\sigma$  peak at zero frequency yields an upper limit for Titan's 12.6 cm cross section of  $1.7 \times 10^6 \text{ km}^2$ , or a specific cross section  $\leq 0.08$ . Uncertainties in this value arise from a possible overestimate of the gain of the Arecibo antenna and possible pointing errors at Arecibo. Both of those would increase the cross section upper limit.

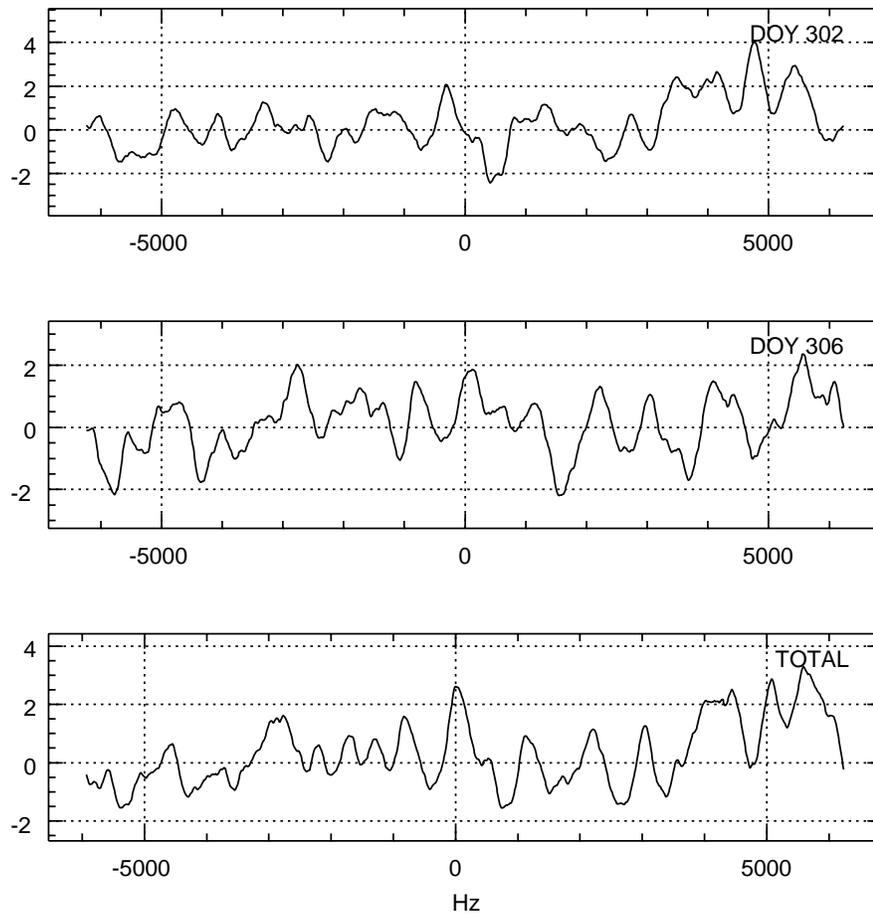


Figure 1: Titan S-Band spectra. Bistatic experiment 1997.