THE CASSINI RADAR: INSTRUMENT AND INVESTIGATION

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The Cassini Radar is an instrument aboard the multinational Cassini/Huygens Mission to Saturn, The radar will provide surface mapping of Saturn's satellite Titan at 14 GHz (Ku band) with resolutions as fine as 0.5 km, unaffected by atmospheric opacity. The radar's SAR mode provides medium-to-high resolution synthetic aperture radar images; its altimeter mode measures the relative surface elevation of the suborbital tracks; its scatterometer mode measures Titan's surface backscatter coefficients at various angles; and its radiometer mode measures surface brightness temperature. In addition to characterization of gross morphology and landforms, the radar will reveal statistical measures of wave structures on liquid surfaces and solid surface roughness at spatial scales near the radar wavelength. Given a nominal mission profile, the sensor is capable of mapping almost 100% of Titan's surface using its radiometer, and 30% at SAR resolution. This combination will permit identification of major terrain units and characterization of principal surface modification processes.

Regional-scale characterization of Titan's surface and surface-atmosphere interactions are principal Cassini objectives. Specific radar investigation objectives are:

1. to study surface structures, patterns and erosional process
2. to determine extent of ocean cover
3. to determine and measure temporal changes
4. to study the probe landing site

The Huygens probe may be able to characterize its own local environment, and the orbiter's twelve remote sensing instruments will contribute to more broad discovery. However, mapping of the surface depends principally on three orbiter imaging investigations: a mapping spectrometer, a camera, and the radar. For the radar, SAR mode will naturally be used to characterize the surface spatially at the highest resolution. However, due to the limited observation times, the radiometer will be employed in a novel scanning mode to generate global mosaics at 100 km resolution, both to provide a synoptic view and to plan the more detailed observations. Altimetry and scatterometry

modes will be used to provide information on surface height and statistical roughness.

The radar instrument is a joint NASA/ESA/ASI effort. It is designed to operate in its four observational modes on both inbound and outbound portions of each Titan flyby. The radar shares the 4-meter high-gain antenna with telecommunications and radio science systems, each of which have separate RF feeds. The radar feed provides five independently-aimed beams to increase Titan surface coverage on each pass. The center beam has a circular cross-section (3-dB beamwidth of 0.350), and is utilized by all radar modes. The four side beams have an approximately elliptical cross-section (3-dB major-axis beamwidth 1.350). Nominally, the side-looking beams will be used in imaging modes only. Useful operation is anticipated from 15 to 28 degrees incidence angles, with SAR noise-equivalent backscatter varying from about -30 dB to -15 dB at from 2 to 7 looks. SAR pulse interleaving is not employed, but SAR, radiometer and altimeter collection periods are interleaved so that any combination of data types can be used. In order to isolate high pulsed load currents from the spacecraft, energy is stored in a large capacitor bank. At this writing the instrument is undergoing final checkout with the spacecraft at Cape Kennedy, and we anticipate a nominal launch of the Cassini spacecraft on October 6, 1997.

The spacecraft will use gravity assists at Venus (April 1998 and June 1999), Earth (August 1999) and Jupiter (December 2000) to arrive at the Saturn system in July 2004. In November 2004, following the Huygens probe entry and impact, Cassini will orbits the system and associated flybys of Titan will begin. The mission tour contains about 60 Saturn orbits with various orientations; orbital periods ranging from over a hundred days to less than ten; Saturn periapses from under three Saturn radii (about 180,000 kilometers) to more than seven (420,000 kilometers); and over forty close flybys of Titan. Given both the large number of investigations and the number of objects of interest in the Saturnian system, the primary restrictive resource for Cassini investigations is likely to be observation time. Titan passes will be divided among those instruments that have capability to observe there. Radar passes will produce almost 0.75 Gb of data if all its modes are employed, corresponding roughly to the coverage obtained by the Mariner 4 flyby of Mars. Data produced during 10 - 12 minutes of high-resolution imaging account for about 30% of the total amount. The low-resolution radar images of Titan will be comparable to or better than Arecibo and Venera 15/16 images of Venus. The high-resolution images will be comparable to the Magellan images of high latitudes of Venus or to the Mariner 9 images of Mars.

This presentation will include a review of the Cassini radar design and summarize its as-built capabilities; we will also discuss scientific objectives and mission observation plans for accomplishing them. Parts of the research described in this paper were carried out by the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration.