



Cassini: Mission Planning Exercise

Surfaces

By looking at the surface of a planet or a moon, there is a lot to be learned about the history of it. This can include when and how it was made. The type of evidence can be if there are signs of craters and volcanoes. In addition to seeing what has happened to it in the past, it is important to understand what is happening to it now. Are the volcanoes still active? Is there any liquid on the surface? Other useful pieces of information can include finding out what the planet or moon is made of and are there any signs of ingredients for life? This information is obtained by making a map of the surface and investigating what it is made from. It is not a simple task.

Instruments

The RADAR (radio detection and ranging) instrument uses radio waves to investigate the surfaces of the many different moons of Saturn. RADAR is an extremely flexible instrument and can be used for multiple purposes. Normal pictures or a 3D map is created by bouncing pulses of energy off the surface from different angles. The instrument takes note of the time difference of these pulses and converts them into distances that become the basis for the image or map. The conversion to time is made using the following equation:

$$Speed = \frac{Distance}{Time}$$

$$\Rightarrow Distance = Speed \times Time$$

The microwaves emitted by the instrument are at a frequency of 13.78 GHz. The frequency can be converted to a wavelength using the following equation:

$$\lambda = \frac{c}{f}$$
$$\Rightarrow f = \frac{c}{\lambda}$$

In order to find out what the surface is made from, the pulses of beam are sent out just as they would when making an image or map. However, in this case it is the energy of the returning beam that is measured. Each time the beam is bounced off a feature on the surface, some of that energy is absorbed and from this the make-up of the surface can be identified. This method is called radar altimetry.

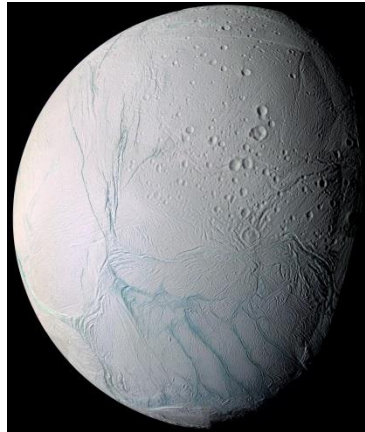
The instrument can also be set up to measure the energy that is being emitted naturally by the surface. This gives important information about the moisture in the atmosphere.

This method is extremely effective because microwaves allow the spacecraft to see through clouds and any atmosphere that may block visible light.



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In addition to RADAR, the Imaging system can also be used. This is a good option when you are close to a moon and there is no atmosphere, as an atmosphere will prevent a clear image being taken. This can be seen clearly in the picture of the moon Enceladus below.



Getting Started

- Do you get close to any moons? If so, which ones and when?
- When do you get closest to the planet?
- When do you cross the ring plane?
- Which of the four instruments do you want to use to make your observations?
- When do you want to make those observations?



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Spreadsheet Instructions

When you have decided what targets you want to go for and the instruments you want to use, you are ready to fill in the spreadsheet.

There are only two different columns that you can put data into:

1. Column C: target. Type in the name of the object you want to focus on, eg Titan.
2. Column D: instrument. Next to the name of the object put in the code for the instrument you want to use.

Key for instruments:

Instrument	Symbol
Imaging	I
Magnetometer	M
Dust detector	D
Radar	R
(asleep)	Z
<i>Telemetry Downlink</i>	<i>T</i>

Importantly, each instrument takes up data in the memory. There is a maximum amount that can be used up in each time period. Once the memory is full, the data must be sent back to Earth. This then means new observations can be made. However, whilst the data is downloaded the spacecraft can't be used for anything else.

		Data Rate (Mb per hour)
Instrument	Symbol	
Imaging	I	200
Magnetometer	M	70
Dust detector	D	100
Radar	R	400
(asleep)	Z	0
<i>Telemetry Downlink</i>	<i>T</i>	<i>-100</i>

Once you have filled in all the slots where you want to make some observations (you don't have to fill in the whole spreadsheet!) you should ensure that the group knows the scientific reasons for making that observation as you may have to negotiate with other groups to get what you want...