NASA's Deep Impact Mission: Decision Making

Earth Orbital Facilities

STRATEGY INFORMATION SHEET

BACKGROUND INFORMATION

NASA

The Hubble Space Telescope is another source of data for the Deep Impact mission. It has some advantages over Earth-based observatories as a source of data. The Hubble Space Telescope is a cooperative program of the European Space Agency and the National Aeronautics and Space Administration to operate a long-lived space-based observatory. The space telescope has many science instruments including three cameras, two spectrographs, and fine guidance sensors (used for astrometric observations). Because this telescope is above the Earth's atmosphere, its instruments can produce high-resolution images of celestial (sky) objects without interference from Earth's atmosphere, which blurs images. Hubble Space Telescope's resolution is about ten times better than ground-based telescopes. Hubble Space Telescope is not constrained by clouds or bad weather as the Earth-based telescopes are. Hubble must be in a position in its orbit around the Earth in which it can view the comet. To accommodate this, the Deep Impact spacecraft can be maneuvered sixty days before impact to adjust the impact time of the comet.

Even though Hubble operates around the clock, it is not used for observation all the time. When it is not used for observations, the Hubble Space Telescope is performing one of several "housekeeping" functions such as turning the telescope toward a new target, avoiding the Sun or moon, switching the communications antenna or receiving commands or downlinking data. When possible, two of Hubble's instruments are used simultaneously while observing a particular section of the sky. You read in "Earth-Based Observatories" that acquiring observation time is competitive, as only one in every ten proposals is accepted.

Procedure:

1. Read about the proposal process for obtaining observing time on the Hubble Space Telescope and summarize the process in your journal or notebook at the following Web site: http://www.stsci.edu/observing/proposal_process.html

2. Hubble Space Telescope observation time is measured in orbits. Hubble orbits the Earth every 96 minutes. Each orbit contains a certain amount of useful time when a target can be observed. This time is called the visibility period. The visibility period depends on the declination of the target. Orbits are grouped into larger units called visits. Because the orbit of Hubble is relatively low, most targets are blocked by the Earth for varying lengths of time during each orbit. The visibility period is the amount of unblocked time per orbit during which an observation can be made. The best visibility period, called the Continuous Viewing Zone, and includes targets lying within 24 degrees of the orbital poles and not blocked at all during the Hubble orbit. Low sky observations occur when Hubble's observation would be adversely affected by scattered light from earthshine or other zodiacal light. Observations are restricted when the Hubble Space Telescope is in the Earth's shadow during the observation time. Both low observations and shadow observations complicate scheduling and reduce Hubble's efficiency. Use table 6.1 in the Hubble primer book to indicate the orbit visibility of Comet 9P/Tempel 1 based on the declination of 9 degrees to find the number of minutes of regular visibility and number of minutes of low visibility during an orbit of the Hubble Space Telescope.

Target	Declination (degrees)	Regular Visibility (minutes)	Low Visibility (minutes)
Moving	Object near elliptic plane	53	48
Fixed	0-18°	52	47
Fixed	18-33°	53	48
Fixed	33-43°	54	48
Fixed	43-48°	55	45
Fixed	48-53°	56	45
Fixed	53-58°	57	45
Fixed	58-63°	56	46
Fixed	63-68°	57	45
Fixed	68-73°	58	43
Fixed	73-88°	59	42
Fixed	88-90°	60	41
Any	Any	25	Incompatible
Any	Any CVZ declination	96	Incompatible

3. When determining which information to include in a proposal for using the Hubble Space Telescope, target information is necessary. The Solar System Dynamics Group at the Jet Propulsion Laboratory has an online Solar System Data and Ephemeris Computation Service that provides access to highly accurate ephemerides for solar system objects. An ephemeris table gives the positions of celestial objects at different times and from different observing sites.

Helpful Hint
You may use the "Back" button on your browser to correct your input or start the procedure again.

Use the following procedure to find information about Comet 9P/Tempel 1 from the Hubble Space Telescope at the time of impact:

a. A computer with Internet access, go to http://ssd.jpl.nasa.gov/cgi-bin/eph
b. Click on the button that says "Target Body."
c. Under Select Small-Body, type in "9P/Tempel 1", then choose "Search". Then choose "9P/Tempel 1 [2005.50]" and click on "Use Selected Asteroid/Comet."
d. Click on "Observer Location."
e. Under "Lookup Named Location", type in "Hubble Space Telesco", then click on "search."
f. Click on "Time Span."
g. Enter the start date and time as 2005 -07 - 04 - 00:00 for July 4, 2005.
h. Enter the stop date and time as: 2005 - 07 - 04 - 23:50 for the end of the same day.
i. Click on "Use Specified Settings."
j. Click on "Output Quantities and Format."
k. Choose the following settings: 1, 9, 10, 20, 21, 25, and 29. Be sure to de-select all other check-boxes.
l. Click on "Use Selected Settings."
m. Click on "Generate Ephemeris."

4. You may want to print the "Generate Ephemeris" page. Use the data on this page to find the following information. Remember this information is specific to the dates you input and the observer location of the Hubble Space Telescope. Record this information in your journal or notebook.

5. You may use the information at http://www.ii.metu.edu.tr/emkodtu/met204/lectures/section4/page1.html to help answer the questions below, but your responses have to be in your own words. Write your responses in your lab notebook or journal.

a. What is the right ascension of the target?
b. Describe what right ascension measures.
c. What is the declination of the target?
d. Describe what declination measures.
e. What is the total magnitude of the target?
f. Describe how the magnitude of celestial objects is measured?
g. What is the nuclear magnitude of the target?
h. Based on your answer for "f," is the nuclear or total magnitude brighter?
i. What fraction of the target's circular disk does the Sun illuminate?
j. What is the apparent range of the target from the observer? How does this compare to the average distance of the Earth to the Sun?
k. What is the definition of an astronomical unit (AU)?
l. How long does it take for light reflected from the target to reach the observer?
m. What is the apparent lunar elongation angle between the target body center and the center of the moon? Will the target center be behind the moon on this date and from this location?
n. What fraction of the lunar disk will be illuminated by the Sun? Why is it better to be a smaller percent rather than a large percent?
o. Which constellation would one look to find the target? (Go to http://ircatalog.gsfc.nasa.gov/constel_names.html to find the name of the constellation based on the three-letter abbreviation.)

The following is information provided to you from the Deep Impact mission planning team.

There are two scenarios for time of impact under consideration. The first is July 4, 2005 at 00:00 UT. In this scenario, the Hubble Space Telescope window is about 45 minutes. The second scenario is July 4, 2005 at 06:00 UT. In this scenario the window is about 25 minutes. Based on the information you have found about the proposal process, the amount of time the target is visible from the Hubble Space Telescope and the information about the target found using the Ephemeris Generator, write a report to your group explaining the pros and cons of using the Hubble Space Telescope as a secondary data gathering method. Include your recommendation on whether or not this method should be included in your report and if so, which of the two times proposed would work best. For more information that will help you with this report, refer to the interview of astronomer Dr. Karen Meech in Appendix C. The last paragraph in this interview contains her thoughts about using the Hubble Space Telescope.

Web site
http://oposite.stsci.edu/pubinfo/spacecraft/Primer/
General information about the Hubble space telescope.