4.4.1 SMART-1

Introduction

SMART-1 is planned for launch in 2001 as the first 'Small Mission for Advanced Research in Technology' of ESA's Horizons 2000 scientific programme. It is dedicated to testing new technologies, principally deep-space solar electrical propulsion, in preparation for future cornerstone missions. It will be operated as a Principal Investigator (PI)-type ESA mission, and will include flyby of, or rendezvous with, planetary objects.

Two launch opportunities have been studied for the 300-350 kg spacecraft: either an Ariane-5/ASAP-V into a standard Geostationary Transfer Orbit (GTO), or a dedicated launcher, such as Eurockot, into an escape trajectory. Two types of solar electric propulsion are under consideration:

— Stationary Plasma Thrusters (e.g. PPS-1350), provide high thrust (~70 mN) and medium specific impulse (~1500 s);
— Ion thrusters (e.g. RIT-10, T5), provide low thrust (~25 mN) and high specific impulse (~3000 s).

Scientific objectives

Although SMART-1 is principally aimed at demonstrating electrical propulsion, a scientific payload will be included to explore Near Earth Objects (NEOs) and/or the Moon. Important science, such as astrophysical observations, will be conducted during cruise phases. The total payload mass will be 10-25 kg, depending on the mission scenario selected. Some science goals and their required instrumentation can be summarised as:

Planetary Science could include: gravimetry and NEO mass (flyby tracking); NEO coarse volume and density (microcameras); NEO rotational properties (cameras); planetary coarse imaging and albedo (narrow-field of view visible and UV imager); geology, morphology, stereo mapping and topography (high-resolution camera); mineralogy (visible and IR mapper); geochemistry (X-ray spectro-imager); planetary environment (wide-field of view and UV imager).

Cruise Science could include: Earth magnetospheric auroral imaging and Lyman-a geocoronal emission (Lyman-a/UV camera); large-field sky imaging (visible and UV cameras); monitoring of variability of active galactic nuclei, cataclysmic variables and active binaries (X-ray spectro-imager); molecular line observations (O_2 sub-mm receiver).

Mission options

Taking launcher and electric propulsion technical constraints into account, three SMART-1 mission options (with different model payload capabilities) were identified:

— A mission within the Earth-Moon system. This includes missions to the Moon, with weak capture in an elliptical lunar orbit, and tours offering lunar flybys and visits to the L4/L5 Lagrangian points. A mission in this category can be flown with both SPT and ion engines, offering 10-20 kg scientific payload and a minimum mission lifetime of 250-450 days.
— A flyby of a NEO, either an asteroid or a comet. This mission is compatible with an Ariane-5 piggyback launch into GTO, but only by using an ion engine. The payload is limited to maximum 10 kg and the minimum mission lifetime exceeds 2.5 years.

For further information, see http://www.estec.esa.nl/spdwww/smart1/html/index.html

Figure 4.4.1.1. Artist's impression of the SMART-1 spacecraft and targets.

— A NEO rendezvous mission is feasible with a dedicated launcher such as Eurockot. The expected payload mass, depending on the selected asteroids and launch date, is approximately 20 kg, with some limited growth possibility. The minimum mission lifetime is about 1.5 years, varying greatly according to the targets.

SMART-1's 'Announcement of Opportunity for Scientific Payload' was issued on 6 March 1998, with the responses due in by 16 April 1998. The payload selection by ESA's Science Programme Committee is planned for the end of May 1998. The SMART-1 Science Payload Review Committee has recommended a NEO rendezvous mission following a lunar gravity assist flyby. A core science payload has been preselected, and a technology payload is to be selected in July 1998.

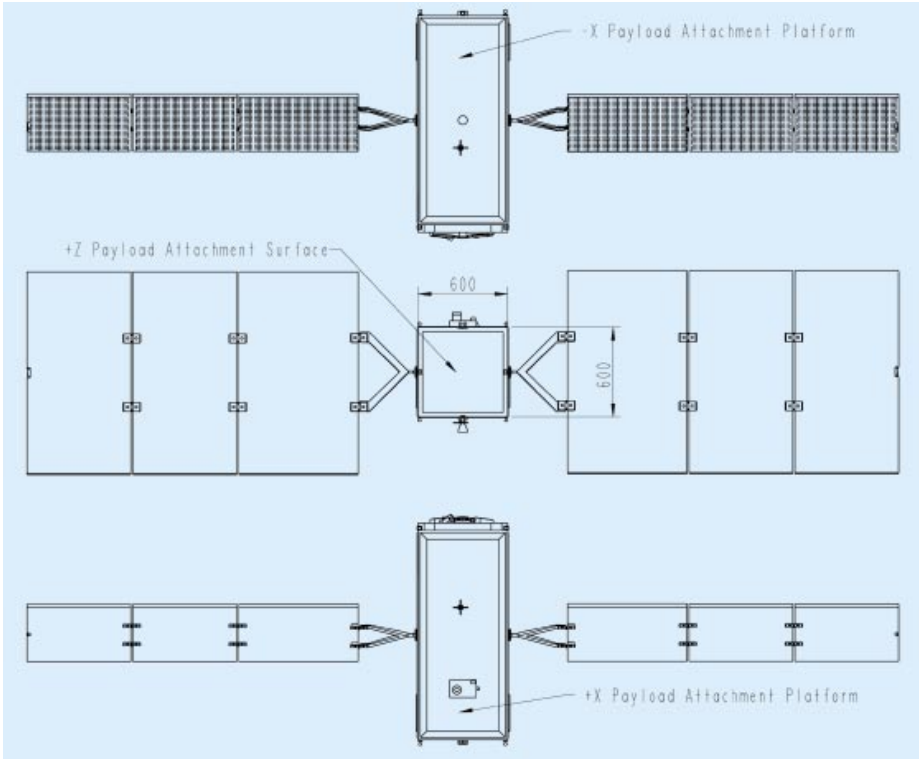

Figure 4.4.1.2. External geometric view of the SMART-1 spacecraft.

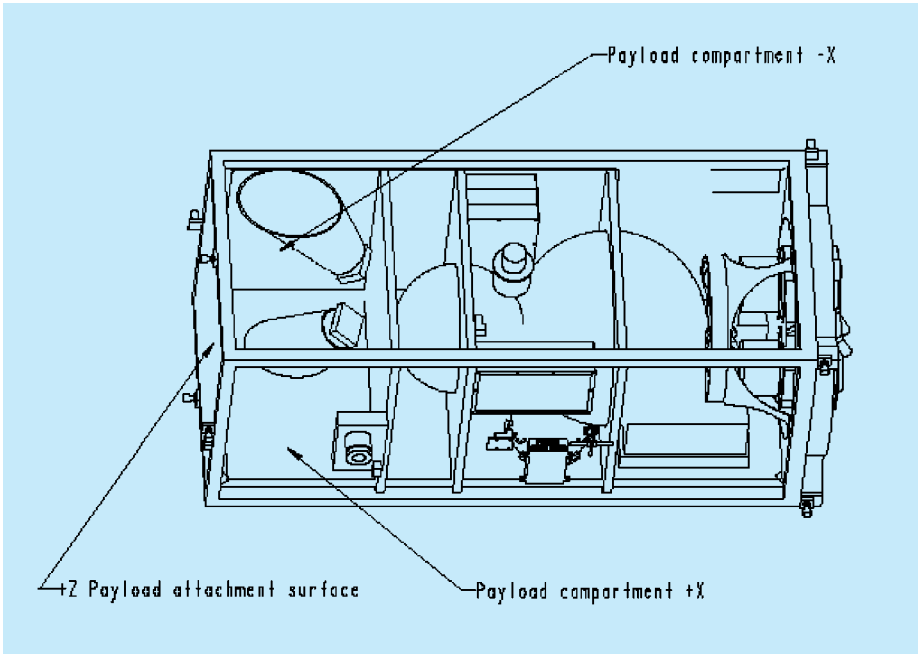

Figure 4.4.1.3. 3D internal view of the SMART-1 spacecraft.