THE EUROMOON MISSION: SCIENCE EXPLORATION GOALS AND MODEL PAYLOAD. Bernard H. Foing and the EUROMOON Team, *ESA Space Science Department, ESTEC/SCI-SO, PBox 299, 2200 AG, Noordwijk, NL, bfoing@estec.esa.nl*.

EUROMOON MISSION STATEMENT

EuroMoon is a mission under study by ESA and industrial partners, with the following goals:
- to celebrate the New Millennium in an innovative, fast and effective way, while promoting space to the general public and to the youth in particular
- to open ways towards the preparation for an extraterrestrial outpost near the lunar South pole
- to provide an opportunity for new science, technology and other activities.

The Euromoon objectives are, in order:
- to make a soft and accurate landing on the western rim of the south pole crater, under eternal light
- to perform a precursor orbiter LunarSat in 2000
- to investigate the landing site environment for suitability for a future base (such as thermal, solar illumination, topography, soil resources, dust and exospheric environment)
- to witness evolution by cameras and provide beacon for subsequent missions
- to use telepresence and remote interactive exploration
- to provide other open science opportunities
- to allow a robotic Millennium Challenge to the exploration of the South Pole.

EUROMOON PAYLOAD OBJECTIVES

The EuroMoon payload main objectives are to characterize the site in a "peak of eternal light" where the EuroMoon spacecraft will land, to provide information critical for the landing, to perform surface operations from the lander and from mobile elements, and to start activities of an initial outpost on the Moon. The EuroMoon lander during an orbital phase before landing, and the LunarSat orbiter will also provide multi-colour imaging, and high-resolution data for topography, resource mapping, geodesy, navigation. Prime science potential contribution from Euromoon concern:
- the origin and evolution of the Earth-Moon system
- the bombardment history of the Earth and the inner Solar system
- geological processes and comparative planetology
- lunar ices, volatiles and exospheric environment
- the Moon as a test-bed for solar system exploration
- the Moon as a platform for telepresence and robotics

In addition to the general mission objectives, the scientific mission of Euromoon should be to investigate, explore and characterize the South pole region of the Moon. This requires:
- mapping the topography, terrain, shape and slopes of the South pole region
- mapping at high resolution of the landing site
- monitoring the illumination conditions of the region, in particular in selected areas (both lighted and dark)
- investigating the thermal environment
- investigating chemical and mineral composition
- studying the physical characteristics of the terrain
- investigate the floor of the South-Pole Aitken basin
- surveying ressources
- characterizing the local environment
- investigate and explore the properties of polar ices and volatiles.

REQUIRED MEASUREMENTS FROM EUROMOON

These broad goals require several measurements:
1) Morphology and topography of the south polar region, with a digital elevation model better than 50m/pixel, and vertical precision of 20 m and high resolution mapping at 5m/pixel of potential landing sites
2) Maps of the terrain within permanent dark areas at 100m/pixel resolution
3) Lighting conditions within 10 degrees of the pole, from winter to summer, including location/duration of eclipse periods in near-permanent lighted areas
4) Investigation of thermal environment, including temperature in dark areas (temporary or permanent cold traps) and thermal variations in different areas.
5) Exploration of the surface terrain and morphology around the lander, with 3D topographic and spectral mapping through at least 5-colour imaging
6) Mineralogical and elemental composition characterization of the terrain and rocks near the lander and in the far-field from the lander
7) Characterization of ice and volatiles deposits in the dark areas including measurement of extent, location, purity (ice-to-dust ratio), chemical and isotopic make-up, from direct surface measurements
8) Additional scientific and exploration objectives to be defined

RESULTS FROM THE EUROMOON SCIENCE AND PAYLOAD WORKSHOP (29-30 october 97)

A first "Euromoon Science and Payload Workshop" was held successfully on 29-30 october 1997 at ESTEC, with an audience between 40 to 70 participants, and a high quality of presentations and discussions. A book of some 40 abstracts has been edited prior to the workshop, and copies are available on request. The aim of the workshop was to review the potential payloads for Euromoon, based on their objectives, expected benefits, requirements and readiness for the mission. Based on previous studies and specific constraints from the mission, a preliminary strawman payload has been discussed.

It was recognised that although Euromoon is not a pure science mission, it represents a great opportunity for technical, educational and scientific activities, in which the community at large, including scientists, engineers, youth, institutes and industries can participate. During the workshop, the EURO-

MOON project received feed-back from the community on how they can "use" the mission scientifically, and provide some of the payload. In the spirit of a workshop, there were invited contributions and additional payload presentations. Several discussions took place on the mission objectives, technical aspects and programmatics. Splinter working groups issued a series of recommendations on Euromoon payload priorities, synergies and implementations, in particular in the areas of imaging systems, orbiter science, and robotics and mobile elements.

SCENARIO FOR POST-LANDING OPERATIONS

The baseline is to land on the near-permanently illuminated smooth west rim of the central south pole crater. The current landing ellipse would allow to reach this point. From there can be deployed the regional rover which has a reach of several kms from the lander exploring the whole permanent lit area with a satisfactory exploratory and geological investigation of the area. The rover can access the geographical south pole and as well the extended summer-lit area first with some continuous moderate telemetry link with the Euromoon lander, then with low telemetry link with Lunarsat every 6 hours. The rover can survive down to the border between the summer-lit area with the permanently dark area in the crater. From this border, excursions of the regional rover of a few hours and few 100m can be attempted, and some dedicated payload for ice exploration in the dark areas can be deployed.

EUROMOON LANDER MODEL PAYLOAD

Based on the general objectives and constraints from EuroMoon, a preliminary core model payload will be presented and discussed. EuroMoon 2000 has been designed with a target payload mass (including some non-scientific payloads) of 40 kg.

MULTI-CAMERA LANDER PACKAGE: All detector heads are mounted directly on miniaturized electronic packages (few cm3 or 25 g each), with a central CDPU to process and store data. There is a sequencing of operations of different cameras from descent, to post-landing operations and mobile element operations. The different cameras include: a) Descent down-looking camera; b) Panoramic camera; c) Stereo camera; d) Close-up Imager Cameras.

MOBILE AND ROBOTIC ELEMENTS: The challenge of the Euromoon lander is not only to land, but also to perform activities on the surface with mobile elements: a) Nanokhod tracked vehicle equipped with APX, close up imager (tethered from lander); b) Mobile penetrometer; c) Robotic arm for instrument deployment, Sample Acquisition and Distribution; d) Mole drilling system; e) Heat flow probe (ROSETTA/MUPUS heritage); f) Broad band low frequency seismometer: interior seismology, and meteoritic impact detection; g) First Biological Ecosystem on the Moon to study radiation/reduced gravity on simplified microbial ecosystem.

AUTONOMOUS MICROROVER: An autonomous microrover (micro-Lunokhod ML) with range few kms has been developed by DLR Koln in cooperation with Russian institutes. It can operate in concert with lander-mounted instruments - providing them with soil samples. It could be a major payload of the small lander studied for Euromoon. The microlunokhod has a system mass of 10 kg and is able to operate as far as 1 km away from the lander. The locomotion subsystem is based on 8 wheels and can climb slopes as stepp as 30 degrees. ML can cope with a low solar elevation at the landing site compatible with near pole operations. For investigations out of the eternal peak of light and into the permanent dark crater, nighttime survival is ensured. It uses a radio-link to the lander station. The speed is 100 m/hour and consumption 3 W. The payload includes a multi-package of microcameras, a soil sampling and storage device. Work is in progress at DLR to prepare a full scale terrestrial demonstrator.

POSSIBLE ORBITAL PHASE PAYLOAD: During the orbital phase of Euromoon, and with the precursor LunarSat orbiter, it is crucial to acquire high resolution data of the potential landing sites and their surroundings in order to limit landing hazards. Also it is necessary to obtain an accurate gravity field along the landing orbit, for accurate navigation, targeting and landing. The radar information is important for deriving the exact topography of the landing site. Finally, the instruments will be used to characterise the resources of sites of interest. Most of the instruments for this orbital transfer have been studied in depth during the MORO orbiter ESA Phase-A study, taking into account the current knowledge after Apollo and Clementine. They consider as well the missions to come in 1998-1999 such as Lunar-Prospector and Lunar A which do not include any imaging of the polar regions. The orbital transfer payload could include: a) High-res camera with stereo capabilities; b) RADAR altimeter/radiometer/scatterometer; c) X-ray fluorescence spectrometer for mapping the elements; d) UV spectrometer to map the OH radicals above ice and other atoms produced in local lunar areas; e) Data relay for Euromoon lander, and mobile elements; f) Additional opportunity instruments.

We shall give the current status of the EuroMoon project and payload definition.