MPCS – A Camera System for the ESA/JAXA Asteroid Sample Return Mission MARCO-POLO

H. Böhnhardt, A. Nathues, H. Perplies, G. Tomasch (1), G. Cremonese (2), V. da Deppo, S. Debei, M. Lazzarin, S. Magrin, S. Marchi, F. Marzari, G. Naletto, M. Zaccariotto (3), B. Fiethe, H. Michalik, B. Osterloh (4), J.M. Castro-Marin, P. Gutierrez, M. Herranz, L. Lara, J.L. Ramos, J. Rodrigo-Campos (5), T. Behnke, H. Michaelis, S. Mottola, J. Oberst, N. Schmitz (6), G. Alonso, I. Perez-Grande, A. Sanz-Andres (7), M. A. Barucci (8), M.T. Capria (9), O. Hainaut (10), J. Licandro (11), K. Muinonen (12)

(1) Max-Planck Institute for Solar System Research, Katlenburg-Lindau, Germany, (boehnhardt@mps.mpg.de), (2) INAF Astronomical Observatory, Padova, Italy, (3) University of Padova, Italy, (4) Technical University, Braunschweig, Germany, (5) Instituto de Astrophysica de Andalucia, Granada, Spain, (6) DLR, Berlin-Adlershof, Germany, (7) Universidad Politecnica de Madrid, Spain, (8) Observatoire de Paris, Meudon, France, (9) INAF National Institute for Astrophysics, Rome, Italy, (10) European Southern Observatory, Garching, Germany, (11) Instituto de Astrophysica de las Canarias, La Laguna, Spain, (12) University of Helsinki, Finland

Abstract

MARCOPOLO, a mission currently studied within the Cosmic Vision Program as a joined ESA/JAXA mission, aims at returning to Earth a sample of original material from a primitive near-Earth asteroid (NEA). The sample will allow studies of the formation and evolution of bodies in the asteroid belt, i.e. at a close and narrow distance range to the Sun and in the immediate neighbourhood of the terrestrial planets. In particular, astrobiological aspects of the (organic and inorganic) material will play an important role. An overview on the MARCOPOLO mission is presented in the paper by Barucci et al. (this conference).

Apart from the sampling device, the MARCO-POLO spacecraft will carry a complement of remote sensing and in-situ experiments aiming at the global characterization of the NEA, at the local characterization of potential sampling sites and at measurements of the sample context. Our on-going study focusses on a camera system for MARCO-POLO in the visible wavelength range, called MPCS (MARCOPOLO Camera System).

MPCS consists of three different cameras: a wide angle camera WAC, a narrow angle camera NAC and a close-up camera CUC. The WAC will provide images for the determination of size and shape of the asteroid as well as its rotation motion and for an overall characteristics of the morphology of the body. The higher spatial resolution of the NAC will enable a complete mapping of the surface morphology and of mineralogical species. Together with results from other on-board instruments, a full geological characterization of the target. Important tasks for the NAC are furthermore the provision of stereo maps of the surface, in particular of potential landing sites for collecting surface samples. When landed, the CUC will image the sampling area before and after the sample is taken in order to provide information on the surface constitution on a microscopic scale.

The WAC and the CUC are dioptric designs of different focal lengths (WAC=65mm; CUC=100mm) and apertures. The NAC is a three-mirror catadioptric design of 400mm focal length equipped with at least 4 filters. Both the NAC and the CUC require focussing mechanism in order to acquire sharp images at distances of 100m and 0.5m, respectively. Identical Si-PIN CMOS hybrid detectors with 2048*2048 pixels and 10 μm pixel size are foreseen in the focal plane of each camera system. All three cameras are controlled and operated by a common command and data processing unit CDPU that is based on Xilinx Virtex FPGAs. A common power control unit PCU provides for the proper power supply of the three cameras. The WAC and the NAC are mounted to the spacecraft body, while the CUC may either be located at the sampling leg of the spacecraft or – like the two other cameras – at the spacecraft body itself.

The paper describes the scientific goals of the MPCS and it provides detailed information on the technical design of the MPCS and its subunits.