A COMBINED STEREO CAMERA/LASER ALTIMETER EXPERIMENT PACKAGE FOR THE BEPICOLOMBO POLAR ORBITER. J. Oberst[1], R. Wagner, H. Hoffmann, R. Jaumann, and G. Neukum, [1](all authors at: DLR Institute of Space Sensor Technology and Planetary Exploration, Rutherfordstr. 2; D−12489 Berlin, Germany, Juergen.Oberst@dlr.de).

BepiColombo, a mission to Mercury initiated by the European Space Agency (ESA), is scheduled for launch near the beginning of the next decade. Our team proposes to contribute an instrument package to the Mercury Polar Orbiter (MPO) which combines a camera and a laser altimeter. The camera portion of the instrument, inherited from the HRSC (High Resolution Stereo Camera) on Mars Express, is a multiple line scanner, operated in the pushbroom mode. The scanner (Table 1) is proposed to have nine line sensors, 5128 pixels each, oriented perpendicular to the spacecraft's motion. Three of the sensors are pointed forward, nadir, and backward, respectively, to collect stereo data. Other sensors are designed to obtain image data at multiple phase angles, or in color. From a periapsis height of 400 km, the camera, operating at a scan rate of approx. 300 Hz, will obtain a ground pixel size of 10 m. The laser will operate at e.g. 1 Hz, its clock being precisely synchronized with the scanner. The science goals of the instrument are in the general reconnaissance as well as geoscientific studies of the planet (Table 2, see also abstract by Wagner et al., this meeting).

Observations of the libration of Mercury are among the foremost goals of BepiColombo, for which our instrument is uniquely suited. Owing to the slow rotation rate of the planet, image data from adjacent orbits will have good overlap (>50%) near the equator, which is essential for the tracking of Mercury's librations. The typical data analysis will include the automatic extraction of large numbers (estimated > 25,000 per orbit) of triple−tiepoints between the stereo images using digital image matching techniques. These tiepoints, in combination with the range measurements by the laser allow us to accurately model the orbit and attitude of the spacecraft, surface topography, as well as rotation of the planet. For the analysis, the synchroneous operation of the laser and the camera is essential, as this will allow us to directly obtain the image line/sample coordinates of all laser surface reflection points (>5000 per orbit) and include them in the analysis.

We simulated data acquisition and analysis for triple stereo image swaths of 30 minutes near pericenter and generated a set of 100 triple−tiepoints (in practice this number will be much larger, see above). The camera parameters described above and the nominal parameters of the spacecraft's polar orbit were adopted. The results of our model suggest that one can determine the orientation of Mercury's rotational axis within less than 1 degree after one orbit. Our current model assumes that unbiased inertial spacecraft trajectory data are given and suffer from random errors only.

Table 1: Instrument Package Summary

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Laser Altimeter:

−oper. altitude: 400−1500 km
−typical shot rate: 1 Hz
−vertical (relative) resolution: < 1 m (expected final absolute accuracy: 40 m)
−pericenter shot spacing: 3000 m (apocenter: 2170 m)

Multiple−Line Scanner:

−9 CCD lines (3 high−res/stereo; 2 photometric; 4 color) 5128 pixels each
−pixel size: 7 μm
−focal length: 280 mm
−pericenter swath width: 51.28 km (apo.: 192.1 km)
−pericenter pixel size: 10 m (apocenter: 37.45 m)
−pericenter scan rate: approx 300 Hz

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Total weight of combined instrument (including digital units): 12.5 kg

Table 2: Key Science Issues

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General Reconnaissance

−explore "other" hemisphere, not seen by Mariner 10
−obtain global images at uniform resolution < 200 m/pxl in "full" color
−carry out high−resolution imaging in selected areas < 10 m/pxl (2−5% of surface).

Surface Geology

−update the global inventory of multi−ring structures and young ray craters
−determine the shape of the mercurian production function in the crater diameter range from basin sizes down to meter−sized craters
−carry out detailed crater size−frequency measurements on geologic units at smaller crater sizes, e.g. on ejecta blankets of large craters or basins in order to further refine the time−stratigraphic system
−carry out inter−planet comparisons.

Surface properties, landforms, and geological processes

−determine photometric properties of surface materials (albedo, porosity, roughness, etc.) by using images under a wide range of phase angles
−resolve origin of inter−crater and low−land plains units (volcanicversus ejecta)

−search for volcanic domes or rilles for undisputed evidence of volcanic activity
−investigate detailed stratigraphy in selected areas by mapping on high resolution imagery.

Geodesy / Precision Cartography
−determine overall shape, such as ellipsoid parameters and COM/COF offsets
−measure the orientation of the spin axis;
−determine precession and librations
−map global topography at absolute spatial and vertical precision better than 200 m and 40 m, respectively
−map high−resolution topography (2−5% of total area) at (relative) spatial and vertical resolution of better than 20 m and 1 m, respectively.

Planetary Interior
−measure moments of inertia to obtain constraints for Mercury's deep interior
−update global inventory of thrust faults to obtain constraints on the planet's thermal history
−measure heights and dip angles of thrust fault to estimate the amount of globalcontraction
−analyse topography and gravity data to derive thickness and compensation state of the crust.

Mineralogy
−carry out global multispectral mapping at resolutions of 200 to 1000 m/pxl
−map spectral units associated with impact craters and their ejecta in order to define the vertical zoning of material units, making use of craters as windows" into the mercurian crust
−determine origin inter−crater and low−land plains units (volcanic versus ejecta)
−evaluate effects of space weathering.
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