

## ONGOING OBSERVATIONS OF PHOBOS AND DEIMOS BY THE HRSC EXPERIMENT ON MARS EXPRESS.

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**Introduction:** With its highly elliptical and near-polar orbit, the European Mars Express is the only orbiter currently operating at Mars where sporadic close flybys of Phobos provide the opportunities to perform high-resolution remote sensing observations.

The High Resolution Stereo Camera experiment (HRSC) on Mars Express observes Phobos on a routine basis at distances below 5500 km. The HRSC is a multiple-line pushbroom instrument with a spatial resolution of 40 m/pixel at 1000 km distance [1] [2]. Its Super-Resolution Channel (SRC), a framing camera, has a spatial resolution of 9.2 m/pixel at 1000 km [3].

HRSC observations of Phobos are aiming to provide complete surface coverage to investigate its geology and surface properties, to validate and improve the current orbit models, to refine its geodetic control net and global shape model. HRSC performs also astrometric observations of the second Martian satellite Deimos at distances of some 10,000 km to improve the Deimos orbit model.



Figure 1. Phobos and the Martian limb, observed by HRSC at 1660 km distance (orbit 3868).

**HRSC Observations and Imaging Data:** Observations during a flyby (Fig. 1) are performed by pointing the spacecraft towards an inertially fixed position. Images in all 9 HRSC channels and by SRC are obtained at distances below about 2000 km. At larger distances, data are acquired only with the SRC and the HRSC nadir channel. SRC normally gathers a sequence of 8 images and the pointing is selected to have a star within the field-of-view detected by the first and last image at long exposure times. This allows us to refine the pointing and to verify the pointing stability.

Until 23 August 2007, Mars Express has performed 4672 orbit revolutions around Mars. HRSC made 71 observations of Phobos and 22 Deimos observations.

About 70% of Phobos' surface has been covered by the SRC, most of it at spatial resolutions  $\leq 20$  m/pixel. The gap in coverage is located at the anti-Mars side between 180°E to 260°E longitude.

As an independent measure to validate the Phobos orbit models, HRSC is also conducting observations of its shadow on the Martian surface.

**First Results and Ongoing Analyses:** The closest Phobos flyby at daylight conditions so far occurred in mid-2004 at a distance of  $\sim 150$  km yielding a spatial resolution for HRSC of 7 m/pixel. The HRSC stereo capability was used to derive a digital elevation model for about 1/3 of the surface with effective resolutions of 100-200m [4].

Analysis of the early HRSC Phobos observations confirmed substantial differences (5 – 10 km) between measured Phobos positions and the orbit model predictions [5] [6]. Meanwhile, new orbit models have been derived [7] [8] that included HRSC astrometric measurements. The ongoing HRSC observations reveal small but significant offsets to the new models with + 1.5 km along-track for [7] and + 2.6 km for [8]. Across-track offsets are in the order of some hundred meters.

**Future Plans:** HRSC will continue with its regular observations of the Martian moons. Mars Express operations planning has been finalized until mid-November 2007. 12 new Phobos and 3 more Deimos observations by HRSC have been accepted, unfortunately, with a gap on the anti-Mars hemisphere of Phobos (where the Phobos GRUNT landing site is anticipated) remaining. At the end of November, 2007, and in mid-2008, Mars Express will perform several orbit maneuvers. Though orbit predicts are not available yet, Phobos flybys are high on the list of priorities which may ultimately close the gap in the surface coverage.

### References:

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