Observations of Phobos and its shadow with the HRSC/SRC on Mars Express: A Summary

J. Oberst, H. Hoffmann, K. D. Matz, T. Roatsch, M. Wählisch, B. Giese, *) and G. Neukum **)

*) German Aerospace Center, Institute of Planetary Research, Berlin, Germany
**) Freie Universität, Berlin, Germany

The Mars Express (MEX) spacecraft is in an elliptic near-polar orbit and occasionally approaches the Martian satellite Phobos. 25 individual flyby maneuvers were executed as of Dec. 31, 2005 (see Table 1 for an overview), and Phobos could be observed from ranges between 5000 km and as close as 150 km (see Fig.1 for sample image). In addition, the Phobos shadow was captured on four occasions as it moved across the surface of Mars. The spacecraft is equipped with the HRSC (High Resolution Stereo Camera), a pushbroom scanner for multispectral stereo mapping of the planet surface, and the SRC (Super Resolution Channel), a panchromatic 1K x 1K framing camera, suited to carry out astrometric observations.

The HRSC and SRC data from the satellite encounters have been used for topographic modeling of Phobos [1] as well as for astrometric measurements of the satellite position [2]. These positional data, which had accuracies of 0.5 – 5 km, differed substantially from the various available predictions, and motivated the beginning of renewed Phobos orbit modeling efforts [3]. These models bear on tidal dissipation and internal structure of Mars, possibly even on the higher-order terms of the Phobos gravity field [3].

The shadow observations (which were carried out by HRSC) are used as an independent check on the orbit models, as the shadow locations are not affected by uncertainties in spacecraft trajectory- and pointing data. Predictions on the basis of new Phobos orbit models and observations appear to be in agreement within the measurement accuracy of the shadow position, which is approx. 10% the shadow size. Besides position, measurements were made for the size, elongation, orientation, and brightness of the shadow (which is affected by the properties of the Mars atmosphere).

More Phobos flybys and shadow observations are being planned during the Mars Express extended mission. These new observations will further improve the Phobos ephemeris to accuracy levels of better than 5% of the Phobos' size. Furthermore, the large number of added observations by both cameras, HRSC and SRC, will allow us to update the current shape models of Phobos.

References: [1] Giese et al. (2005) *Zeitschrift für Photogrammetrie, Fernerkundung und Geoinformation*, 5, 435-440. [2] Oberst et al. (2006) *Astronomy&Astrophysics*, in press. [3] Lainey et al. (2005), EOS Trans AGU, G51A-0802.

Figure. 1: Image of the Martian satelllite Phobos, obtained by SRC during orbit 2151 (Sep 16, 2006), from a range of 3800 km.

Table 1: Mars Express Phobos Flybys, as of Dec. 31, 2005

Orbit	Date and Time	M. Anomaly	Flyby Dist., km
413	2004-05-18T08:34	32.02°	1881
649	2004-07-23T12:40	185.11°	1834
682	2004-08-01T18:35	178.02°	1465
715	2004-08-11T00:30	171.36°	1207
748	2004-08-20T06:25	164.77°	1239
756	2004-08-22T12:06	169.14°	147
1064	2004-11-16T14:22	114.14°	4676
1163	2004-12-14T08:06	94.43°	3815
1212	2004-12-28T01:18	91.70°	1966
1558	2005-04-03T23:51	40.59°	3588
1574	2005-04-08T11:21	53.57°	3797
1607	2005-04-17T17:15	47.54°	3977
1769	2005-06-02T03:41	202.77°	1440
1901	2005-07-09T03:25	181.73°	3109
2151	2005-09-16T23:24	136.73°	3825
2192	2005-09-28T11:02	131.80°	2924
2233	2005-10-09T23:50	127.02°	2111
2381	2005-11-20T09:06	94.23°	3169
2397	2005-11-24T20:39	100.80°	1672
2405	2005-11-27T02:15	106.72°	1426
2446	2005-12-08T13:44	96.60°	2026
2463	2005-12-13T08:03	75.12°	4233
2479	2005-12-17T19:26	83.87°	2913
2487	2005-12-20T01:15	89.69°	2571
2501	2005-12-24T00:51	272.40°	4745