First Landing Site Workshop for MER 2003


Introduction: The High Resolution Stereo Camera (HRSC) imaging experiment onboard the Mars Express (MEX) mission to be launched in 2003 will provide unique high-resolution multispectral stereo images [1]. A Super-Resolution Channel (SRC) will obtain very high-resolution images (2.3 m/pixel) within the context of the HRSC nadir swath. Here, we present the instrument characteristics and imaging modes of the SRC, and we outline the capabilities of HRSC/SRC to support rover operations of the MER 2003 mission, to characterize the landing site properties, and to provide information on the wider geological context of the landing sites. At the workshop, we will also give an overview of the current activities of the HRSC Science Team to select target sites to be imaged during the nominal operational lifetime of the mission of 1 Martian year.

Instrument: The HRSC is a multiple line pushbroom instrument. Nine superimposed image tracks are acquired nearly simultaneously (along-track) by 9 CCD line sensors (each with >5000 pixels) mounted in parallel and behind one single optics. At a periapsis height of 250 km, the swath width is about 52 km and the resolution is ~10 m/pixel. The HRSC will cover ≥ 50% of the Martian surface at a spatial resolution of ≤15 m/pixel, in stereo, four colors, and at five phase angles. More than 70% of the surface can be observed at a spatial resolution of ≤30 m/pixel [2], assuming an average HRSC data transfer capacity of 1 Gbit/day. Thus, the HRSC will close the existing gap between medium to low-resolution coverage on the one hand and the very high resolution images of the Mars Observer Camera (MOC) on the Mars Global Surveyor (MGS) mission as well as the in-situ observations and measurements by landers on the other hand. The goals of the HRSC will not be met by any other planned mission or experiment. It will also make a significant contribution to the scientific objectives of the MEX lander module Beagle II by providing information on the geological context of the landing site.

The scientific output of the HRSC experiment is significantly extended by using an additional external Super Resolution Channel (SRC). The SRC is based on an ongoing instrument development for the Rosetta Lander and will be mounted on the MEX spacecraft below the HRSC stereo scanner in a common honeycomb structure in order to minimize interfaces with the spacecraft (Fig. 1). It is a framing device and uses an interline CCD detector to cope with the very short exposure times. The 1 m focal length telescope provides a spatial resolution of 2.3 m/pixel at an altitude of 250 km. The design is characterized by

- CCD area array detector with 1024 x 1032 pixels.
- Highly miniaturized and low-power detector and control electronics.
- Compact 3D multi-chip module technology using thinfilm multilayer metallization, dycostrate, plasmaetching and chip-on-wire technology.
- Selectable dynamic range of 8 and 14 bit per pixel.
- Internal data buffer.
- Light-weight Maksutov-Cassegrain telescope with a focal length of 1 m and an f-number of 9.

Figure 1: SRC optics and HRSC/SRC instrument.

Imaging Operations: The channel is operated in parallel with the HRSC stereo scanner yielding nested-in super-resolution images in order to avoid any location problems and to obtain the contextual information. One SRC image covers only 4% of the nominal HRSC sensor swath (one HRSC pixel is covered by 25 SRC pixels). Approximately 230 HRSC lines are required to image an SRC frame. Near pericenter it takes less than 1 s to scan an SRC frame with HRSC lines. Both single spot observations and overlapping image strips can be acquired. SRC imaging can be specifically commanded in order to obtain adjacent and overlapping single images for assembling larger image mosaics (Figs. 2-4). Theoretically, it is even possible to obtain SRC stereo images of limited areas by taking – during one orbit – a forward-looking mosaic and a backward-looking mosaic. However, the instrument is not mounted on a steering platform. Therefore, the spacecraft has to be slewed in order to acquire SRC image mosaics. Currently, the possibilities to obtain SRC image mosaics are under study, particularly with respect to spacecraft pointing.

Objectives: The major task to be fulfilled by the SRC within the framework of the HRSC/SRC experiment is to support the HRSC science objectives by obtaining very high-resolution panchromatic imagery for photo-
geologic purposes (e.g. investigating gullies possibly eroded by recent water release [3] and layered deposits which might indicate a different climate in the early martian history [4]), and to decipher morphological details which remain ambiguous or cannot be resolved by nominal HRSC data. *This is especially important for landing site characterization.* MOC images clearly show that many areas which appear to be quite flat and featureless at medium resolution exhibit a remarkable surface roughness at a spatial resolution in the meter range. Detailed information on the surface characteristics of possible landing sites is a prerequisite for planning future lander missions and surface operations in detail and to address questions like mission safety or environmental conditions.

**MER 2003 Landing Site Imaging:** The MEX spacecraft will arrive at Mars at the end of December, 2003. The first mapping orbit will be reached on January 4th, 2004, and the first periapsis pass will take place on January 4th, 2004, at 08:52 a.m. (UTC). The geographic position of the first periapsis will be located at 14.77°S and 114.8°E, and the elevation of the Sun above the equator will be ~50°. The location of the periapsis will drift towards South during the following orbits, and good imaging conditions of the latitudinal belt of the MER 2003 landing sites (15°S to 10°N) will be restricted to the period before the end of January, 2004. The MEX spacecraft is in its commissioning phase during the first two months after arrival at Mars. Thus, negotiations with ESA will be required to take images *immediately after arrival at Mars.*


**Figure 2:** Geometry of images obtained during one orbit for assembling contiguous SRC image mosaics.

**Figure 3:** Different modes of spacecraft slewing and corresponding footprints of SRC image mosaics.

**Figure 4:** Example of projected SRC footprints assembled into an image mosaic (cf. Fig. 2).