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ABSTRACT SUBMISSION FORM

Title of the Paper	**Four Years of Planetary Cartography with the HRSC**
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ABSTRACT

The *High Resolution Stereo Camera* (HRSC) on the European *Mars Express* mission began operation in January 2004. With this camera system new standards were set for the acquisition, processing and cartographic application of planetary data, in other words a new era of planetary cartography began.

A new cartographic concept for the planet Mars has been designed. The cartographic standard product is the *Topographic Image Map Mars 1:200,000* series. The layout scheme of this map series is flexible also for the generation of maps in other scales, special target maps, thematic maps, and related products.

The HRSC is a pushbroom scanning instrument with 9 CCD line detectors mounted in parallel on the focal plane. Its unique feature is the ability to obtain image data of high resolution, with along-track triple stereo, in four colors, and under five different phase angles. The spatial resolution at the nominal periapsis altitudes is up to 10 m/pixel. The image data acquired are processed in different steps at the *German Aerospace Center* (DLR), generating two important standard products for further use by the scientific community. One product is a Digital Terrain Model (DTM) of the Martian surface, the other product comprises orthoimages in colors. These data are the input for the generation of topographic maps and other map products.

For cartographic processing a new software system has been developed at the *Technical University Berlin* (TUB). The main purpose of the software package *Planetary Image Mapper* (PIMap) is to automate the map generation process. PIMap has been developed in ANSI C++ and is therefore executable under both Microsoft Windows and Linux environments. The software is controlled by an initialization file, which provides all parameters that are necessary to define map properties, contents, and layout. The following data can be processed: Initialization file (mandatory!), orthoimage mosaic, Digital Terrain Model (DTM), planetary features (like topographic names and landing sites), and map series definitions.

Starting with these input data sets, PIMap automatically generates all raster and vector data of the digital map sheet, which is provided as a PDF file. This output format ensures the possibility to edit each graphical element if desired. This is of special importance for interactive finishing with commercial standard software (Corel Draw, Macromedia Freehand, Adobe Illustrator). This might be necessary e.g. for the final placement of topographic feature lettering. PIMap handles arbitrary spherical and ellipsoidal reference bodies; ellipsoidal input coordinates can consist of planetocentric or planetographic latitudes in combination with east or west positive longitudes. Azimuthal, conical, cylindrical, Transverse Mercator, and sinusoidal standard projections are supported.

The HRSC provides both full color and multiple stereo – a unique data set for systematic derivation of Digital Terrain Models (DTM), color orthoimages, and high quality cartographic products. For the compilation of the *Topographic Image Map Mars 1:200,000* equal-area map projections have been selected. This is the *Sinusoidal* projection applied to the map sheets between 85° north and 85° south, and the *Lambert Azimuthal* projection for mapping the regions between 85° and 90° north or south. Each map quadrangle covers two degrees of latitude. Longitude dimensions increase from the equator towards the poles. Altogether the Martian surface is divided into 10,372 individual map sheets. Series-related sheets in larger scales (100k, 50k, etc.) can easily be derived by appropriate subdivision of the particular sheets. Therefore, the *Topographic Image Map Mars 1:200,000* series is expected to be the general guideline for future large-scale planetary mapping purposes.

The first maps within the regular sheet lines have been generated in summer 2004. Until the end 2007, a variety of topographic and also thematic maps of different Martian regions has been produced. It has been shown that HRSC data of highest resolution is suitable for mapping even in scales up to 1:50000. Since 2004 until fall 2007 about 70 map sheet in 15 different regions of the planet Mars have been derived from HRSC data. This comprises sheets of the *Topographic Image Map Mars 1:200,000* series – including the first large-scale map sheets of the north-polar region – as well as special target maps in different scales for selected regions. It is of special interest that also maps as subdivision sheets in larger scales, i.e. 1:100,000 and 1:50,000, have been generated. These experiments clearly demonstrated the high quality of the HRSC image data and the flexibility of PIMap as well. Furthermore, also thematic map products were generated, portraying geolocial and geomorphological features on the basis of the image maps.

It is of particular interest that the PIMap software system was also successfully applied to mapping of Saturnian satellites. At DLR global digital mosaics of the medium-sized icy satellites of the Saturnian system have been generated in the framework of the *Cassini* mission. The 15 tiles of an atlas of Enceladus and Dione were extracted from global mosaics, reprojected, and coordinate grids were superposed as graphic vectors using the PIMAP software.

In summarizing it can be stated that the cartographic software package PIMap accomplishes all cartographic processing steps that are required for topographic image maps. It is an operational software system and a substantial step towards future planetary cartography. Thus, ongoing and future planetary missions that involve cartographic projects will greatly benefit from this development.