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The High Resolution Imaging Science Experiment (HiRISE) during MRO's Primary Science Phase (PSP)

Alfred S. McEwen [a,*], Maria E. Banks [a], Nicole Baugh [a], Kris Becker [b], Aaron Boyd [a], James W. Bergstrom [c], Ross A. Beyer [d], Edward Bortolini [c], Nathan T. Bridges [e], Shane Byrne [a], Bradford Castalia [a], Frank C. Chuang [f], Larry S. Crumpler [g], Ingrid Daubar [a], Alix K. Davatzes [h], Donald G. Deardorff [d], Alaina DeJong [a], W. Alan Delamere [i], Eldar Noe Dobrea [e], Colin M. Dundas [a], Eric M. Eliason [a], Yisrael Espinoza [a], Audrie Fennema [a], Kathryn E. Fishbaugh [j], Terry Forrester [a], Paul E. Geissler [b], John A. Grant [j], Jennifer L. Griffes [k], John P. Grotzinger [k], Virginia C. Gulick [d], Candice J. Hansen [e], Kenneth E. Herkenhoff [b], Rodney Heyd [a], Windy L. Jaeger [b], Dean Jones [a], Bob Kanefsky [d], Laszlo Keszthelyi [b], Robert King [a], Randolph L. Kirk [b], Kelly J. Kolb [a], Jeffrey Lasco [c], Alexandra Lefort [l], Richard Leis [a], Kevin W. Lewis [k], Sara Martinez-Alonso [m], Sarah Mattson [a], Guy McArthur [a], Michael T. Mellon [m], Joannah M. Metz [k], Moses P. Milazzo [b], Ralph E. Milliken [e], Tahirih Motazedian [a], Chris H. Okubo [b], Albert Ortiz [a], Andrea J. Philippoff [a], Joseph Plassmann [a], Anjani Polit [a], Patrick S. Russell [l], Christian Schaller [a], Mindi L. Searls [m], Timothy Spriggs [a], Steven W. Squyres [n], Steven Tarr [c], Nicolas Thomas [l], Bradley J. Thomson [e,o], Livio L. Tornabene [a], Charlie Van Houten [c], Circe Verba [b], Catherine M. Weitz [f], James J. Wray [n]

[a] *Lunar and Planetary Lab, University of Arizona, Tucson, AZ 85721, USA*
[b] *U.S. Geological Survey, 2255 N. Gemini Drive, Flagstaff, AZ 86001, USA*
[c] *Ball Aerospace & Technologies Corp., 1600 Commerce St., Boulder, CO 80301, USA*
[d] *NASA Ames Research Center and SETI Institute, Moffett Field, CA 94035, USA*
[e] *Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Dr., Pasadena, CA 91109, USA*
[f] *Planetary Science Institute, 1700 E. Ft. Lowell, Tucson, AZ 85719, USA*
[g] *New Mexico Museum of Natural History and Science, 1901 Mountain Road NW, Albuquerque, NM 87104, USA*
[h] *Department of Earth and Environmental Science, Temple University, 1901 N. 13th St. Philadelphia, PA 19122, USA*
[i] *Delamere Support Systems, 525 Mapleton Ave., Boulder, CO 80304, USA*
[j] *Smithsonian Institution, National Air and Space Museum, 6th at Independence SW, Washington, DC 20560, USA*
[k] *Division of Geological and Planetary Sciences, California Institute of Technology, Pasadena, CA 91125, USA*
[l] *University of Bern, Sidlerstr. 5, CH-3012 Bern, Switzerland*
[m] *University of Colorado, 392 UCB, Boulder, CO 80309, USA*
[n] *Cornell University, 428 Space Sciences Building, Ithaca, NY 14853, USA*
[o] *Applied Physics Laboratory, Laurel, MD 20723, USA*

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A B S T R A C T

The High Resolution Imaging Science Experiment (HiRISE) on the Mars Reconnaissance Orbiter (MRO) acquired 8 terapixels of data in 9137 images of Mars between October 2006 and December 2008, covering ~0.55% of the surface. Images are typically 5–6 km wide with 3-color coverage over the central 20% of the swath, and their scales usually range from 25 to 60 cm/pixel. Nine hundred and sixty stereo pairs were acquired and more than 50 digital terrain models (DTMs) completed; these data have led to some of the most significant science results. New methods to measure and correct distortions due to pointing jitter facilitate topographic and change-detection studies at sub-meter scales. Recent results address Noachian bedrock stratigraphy, fluvially deposited fans in craters and in or near Valles Marineris, groundwater flow in fractures and porous media, quasi-periodic layering in polar and non-polar deposits, tectonic history of west Candor Chasma, geometry of clay-rich deposits near and within Mawrth Vallis, dynamics of flood lavas in the Cerberus Palus region, evidence for pyroclastic deposits, columnar jointing in lava flows, recent collapse pits, evidence for water in well-preserved impact craters, newly discovered large rayed craters, and glacial and periglacial processes. Of particular interest are ongoing processes such as those

* Corresponding author. Address: Lunar and Planetary Lab, University of Arizona, Sonett Space Sciences, 1541 E. University Blvd., Tucson, AZ 85721, USA.
E-mail address: mcewen@lpl.arizona.edu (A.S. McEwen).

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driven by the wind, impact cratering, avalanches of dust and/or frost, relatively bright deposits on steep gullied slopes, and the dynamic seasonal processes over polar regions. HiRISE has acquired hundreds of large images of past, present and potential future landing sites and has contributed to scientific and engineering studies of those sites. Warming the focal-plane electronics prior to imaging has mitigated an instrument anomaly that produces bad data under cold operating conditions.

1. Introduction

The Mars Reconnaissance Orbiter (MRO) was launched on August 12, 2005, carrying six scientific instruments (Zurek and Smrekar, 2007). In addition to the HiRISE camera, MRO carries the Compact Reconnaissance Imaging Spectrometer for Mars (CRISM; Murchie et al., 2007), the Shallow Radar (SHARAD; Seu et al., 2007), the Context Camera (CTX; Malin et al., 2007), the Mars Color Imager (MARCI; Malin et al., 2001a), and the Mars Climate Sounder (MCS; McCleese et al., 2007). The Primary Science Phase (PSP) covered a bit more than one Mars year, from November 2006 until December 2008, with MRO in its 255 × 320 km mapping orbit, and is followed by the Extended Science Phase (ESP). Expectations for HiRISE were described by McEwen et al. (2007a); this paper updates that information, summarizes results from the PSP (including results not yet published elsewhere), and describes expectations for the ESP (January 2009 to December 2010).

The HiRISE camera features a 0.5 m diameter primary mirror, 12 m effective focal length, and a focal-plane subsystem (FPS) that can acquire images containing up to 28 Gb (giga-bits) of data in as little as 6 s. HiRISE images are acquired via 14 charge-coupled device (CCD) detectors, each with two output channels, and with multiple choices for pixel binning and number of Time Delay and Integration (TDI) lines. The 10 CCDs that cover the full swath width (1.14°) are covered by broadband red filters (RED) and four extra CCDs in the middle are covered by blue-green (BG) and near-infrared (IR) filters to provide 3-color coverage in the center 20% of the image swath. Fig. 1 shows the layout of the HiRISE FPS.

2. Data acquisition during the PSP

As of December 2008 (end of PSP) HiRISE had acquired 9137 images of Mars consisting of 8 terapixels of data. The images would cover 0.65% of the planet if there were no overlapping data for stereo or change detection. However, ~21% of the images are stereo pairs, ~6% are repeats to monitor seasonal processes (with an average ~5× repetition), and ~1% are re-imaged following excessive gaps or poor seeing, thus ~85% of our images provide unique

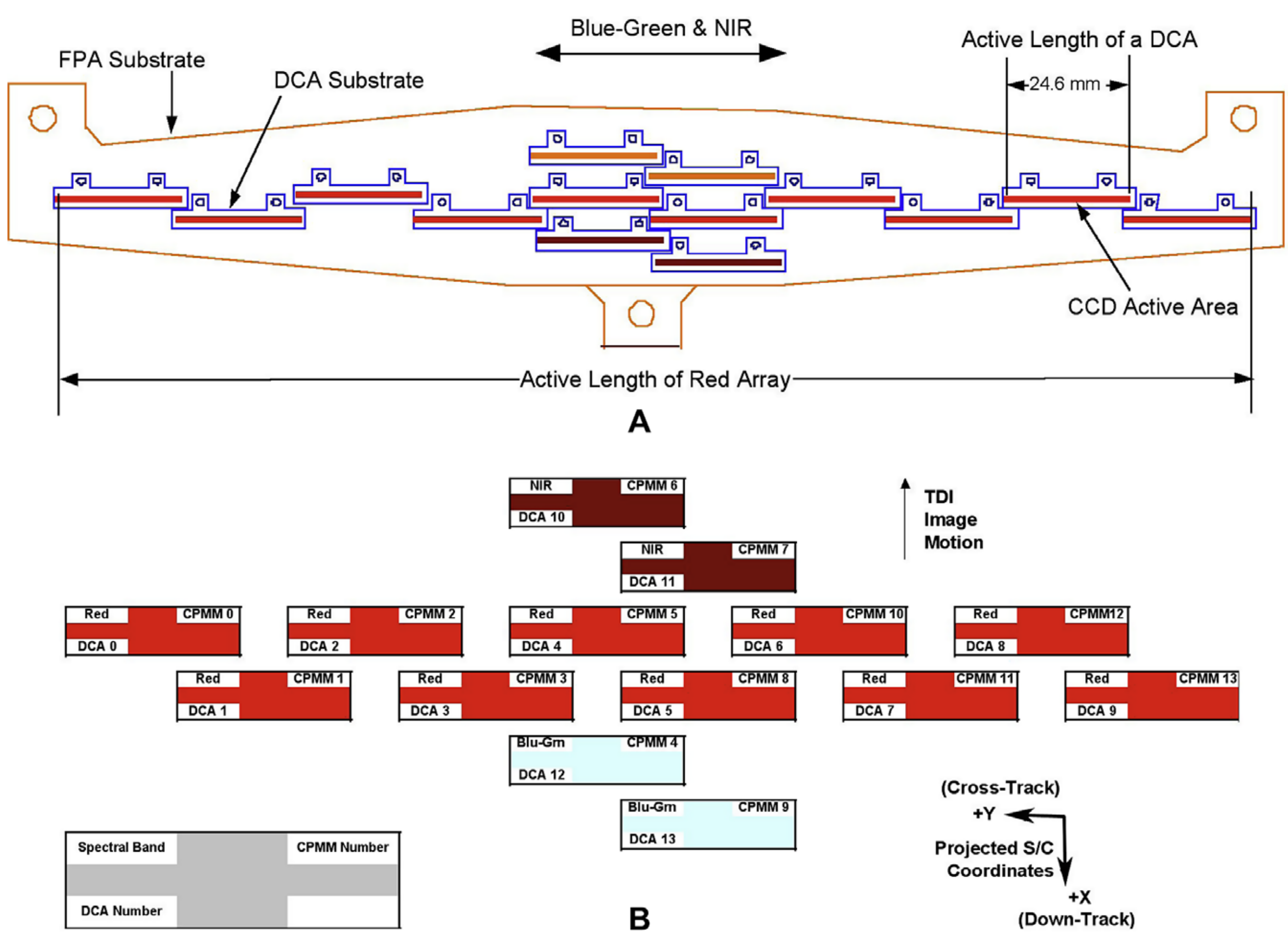

Fig. 1. Top (labeled "A"): Layout of CCDs on the base plate, approximately to actual scale. Bottom (B): Reference data on each Detector Chip Assembly (DCA), which consists of the CCD and CPMM. Spacecraft motion would be down as shown here, although HiRISE will typically image on the ascending side of the orbit.