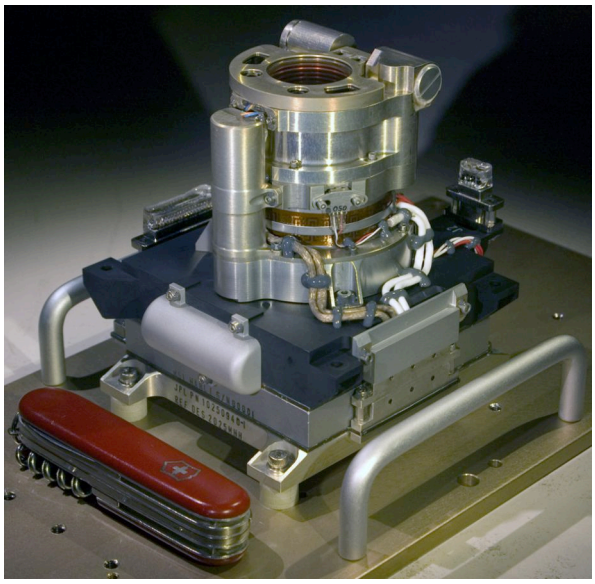
THE MARS HAND LENS IMAGER (MAHLI) ABOARD THE MARS ROVER, CURIOSITY. K. S. Edgett[1], M. A. Ravine[1], M. A. Caplinger[1], F. T. Ghaemi[1], J. A. Schaffner[1], M. C. Malin[1], J. M. Baker[2], D. R. DiBiase[2], J. Laramee[2], J. N. Maki[3], R. G. Willson[3], J. F. Bell III[4], J. F. Cameron[5], W. E. Dietrich[6], L. J. Edwards[7], B. Hallet[8], K. E. Herkenhoff[9], E. Heydari[10], L. C. Kah[11], M. T. Lemmon[12], M. E. Minitti[13], T. S. Olson[14], T. J. Parker[3], S. K. Rowland[15], J. Schieber[16], R. J. Sullivan[4], D. Y. Sumner[17], P. C. Thomas[4], and R. A. Yingst[18], [1]Malin Space Science Systems, [2]Alliance Spacesystems, LLC, [3]Jet Propulsion Laboratory, [4]Cornell University, [5]Lightstorm Entertainment, [6]University of California–Berkeley, [7]NASA Ames Research Center, [8]University of Washington, [9]US Geological Survey–Flagstaff, [10]Jackson State University, [11]University of Tennessee–Knoxville, [12]Texas A&M University, [13]Arizona State University, [14]Salish Kootenai College, [15]University of Hawaii, [16]Indiana University–Bloomington, [17]University of California–Davis, [18]Planetary Science Institute.

Introduction: The Mars Science Laboratory (MSL) rover, Curiosity, is expected to land on Mars in 2012. The Mars Hand Lens Imager (MAHLI) will be used to document martian rocks and regolith with a 2-megapixel RGB color CCD camera with a focusable macro lens mounted on an instrument-bearing turret on the end of Curiosity's robotic arm.



The flight MAHLI camera head with pocket knife (88.9 mm long) for scale.

Overview: The flight MAHLI can focus on targets at working distances of 20.4 mm to infinity. At 20.4 mm, images have a pixel scale of 13.9 µm/pixel. The pixel scale at 66 mm working distance is about the same (31 µm/pixel) as that of the Mars Exploration Rover (MER) Microscopic Imager (MI). MAHLI camera head placement is dependent on the capabilities of the MSL robotic arm, the design for which presently has a placement uncertainty of ~20 mm in 3 dimensions; hence, acquisition of images at the minimum working distance may be challenging.

Instrument: The MAHLI consists of 3 parts: a camera head, a Digital Electronics Assembly (DEA), and a calibration target. The camera head and DEA are connected by a JPL-provided cable which transmits data, commands, and power. JPL is also providing a contact sensor. The camera head will be mounted on the rover's robotic arm turret, the DEA will be inside the rover body, and the calibration target will be mounted on the robotic arm azimuth motor housing.

Camera Head. MAHLI uses a Kodak KAI-2020CM interline transfer CCD (1600 x 1200 active 7.4 µm square pixels with RGB filtered microlenses arranged in a Bayer pattern). The optics consist of a group of 6 fixed lens elements, a movable group of 3 elements, and a fixed sapphire window front element. Undesired near-infrared radiation is blocked using a coating deposited on the inside surface of the sapphire window. The lens is protected by a dust cover with a Lexan® window through which imaging can be accomplished if necessary, and targets can be illuminated by sunlight or two banks of two white light LEDs. Two 365 nm UV LEDs are included to search for fluorescent materials at night.

DEA and Onboard Processing. The DEA incorporates the circuit elements required for data processing, compression, and buffering. It also includes all power conversion and regulation capabilities for both the DEA and the camera head. The DEA has an 8 GB nonvolatile flash memory plus 128 MB volatile storage. Images can be commanded as full-frame or sub-frame and the camera has autofocus and autoexposure capabilities. MAHLI can also acquire 720p, ~7 Hz high definition video. Onboard processing includes options for Bayer pattern filter interpolation, JPEG-based compression, and focus stack merging (z-stacking).

Manufacture and Operation: Malin Space Science Systems (MSSS) built and will operate the MAHLI. Alliance Spacesystems, LLC, designed and built the lens mechanical assembly. MAHLI shares common electronics, detector, and software designs with the MSL Mars Descent Imager (MARDI) and the 2 MSL Mast Cameras (Mastcam). Pre-launch images of geologic materials imaged by MAHLI are online at: http://www.msss.com/msl/mahli/prelaunch_images/.