

**PDS ANALYST'S NOTEBOOK FOR MSL AND MER: ADDITION OF IMAGE MEASUREMENT TOOLS.**

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**Introduction:** The PDS Analyst's Notebook (AN) (<http://an.rsl.wustl.edu>) [1] provides access to science information from several of NASA's landed missions: Mars Science Laboratory (MSL) [2], Mars Exploration Rover (MER) [3], Mars Phoenix Lander [4], LCROSS, and Lunar Apollo surface mission data archives.

The AN enriches data archives by integrating sequence information, engineering and science data, observation planning and targeting, and documentation into web-accessible pages to facilitate "mission replay". The AN provides end to end tracking of archived data from the planning stage to the final science product. In this paper, we focus on the MSL and MER AN and highlight the addition of image measurement tools as a value-added component.

**Populating the Notebook:** The MSL and MER AN contain data, documentation, and support files that are incorporated on a daily basis into the science team's version of the Notebook. This approach assists with data validation and builds on strong collaboration between data producers and PDS archivists that begins soon after mission selection with creation of the project data management and archive plans.

The public version of the MSL and MER AN is comprised of peer-reviewed, released data and is updated coincident with PDS data releases as defined in mission archive plans. All data and documents have been ITAR cleared.

**Data.** The MSL and MER AN contain archives from all science instruments. The data are provided by the instrument teams and are supported by documentation describing data format, content, and calibration.

**Documents.** The MSL and MER AN also contain data set documentation and sol (i.e., Mars day) documents. The sol documents are the mission manager and documentarian reports that provide a view into science operations—insight into why and how particular observations were made. The reports have not been edited except for grammar and spelling, and to remove spacecraft and instrument sensitive materials.

**Science Plans.** Observation planning and targeting information is extracted from each of MSL's and MER's science plans. This information includes instrument settings such as filters used and sensors selected, as well as observation parameters such as distance to target. Effort has been made to link source commands with resulting data products, albeit with limits due to the absence of round trip data tracking.

**Navigating through the Notebook:** A number of methods allow user access the AN contents.

**Mission Summaries.** A searchable and sortable summary table provides an overview of surface operations by sol. Links enable quick access to details for a given sol.

**Sol Summaries.** The Sol Summaries are the primary interface to integrated data and documents contained within the MSL and MER AN (Fig. 1). Data, documents, planned observations, and mosaics are grouped for easy scanning. Detailed information is displayed as items are selected by the user.

Data products are displayed in order of acquisition, and are grouped into logical sequences, such as a series of image data. Sequences and the individual products that comprise them may be viewed in detail and downloaded, either directly or as part of a cart order.

Context mosaics, which are not calibrated science products, are created for sequences of MSL Navcam, Mastcam and MAHLI single frame images acquired for the purpose of creating a mosaic but which do not have formal data product in the mission archive [5].

Detail data product views vary by instrument. PDS labels, data set documents, and activity details are available for all products. In some cases, derived data also are available. Image data are presented in both browse and full-resolution versions.

**Maps.** The MSL and MER rover traverses are plotted on a HiRISE basemap using the raw and corrected drive telemetry provided by the projects. Users may zoom and pan the map. Clicking on a traverse location brings up links to corresponding data.

**Searching.** Data products may be searched by time (sol, spacecraft clock time, and UTC date), location (rover-specific site and position), instrument, command sequence, product type, image eye and filter, and product ID. Sol documents may be searched by type, time, and filename. In addition, free text searches are supported. Results are displayed based on user settings, and searches can be bookmarked for later recall.

**Online Help.** Guidance is provided through a series of searchable help pages. Topics include release notes, landing site, coordinate frame, instruments, data processing, and data product file naming and structure.

**Image Measurement Tools:** Two new measurement functions are now available in the MSL and MER AN for single frame images (Fig. 2).

The location tool shows both the location within the image (in pixel (i, j) space) and position on the ground (in rover and site frame (x, y, z) space) for given points within the image. In addition, the azimuth and elevation for any point within the image are available in both site

and rover frame. Ground positions are computed for image stereo pairs and currently are restricted to Navcam, Hazcam, and Pancam data.

The measurement tool provides the distance between two user-selected points within a given image. Exclusion zones for portions of an image pair without stereo coverage are identified to assist the user. These zones occur where there is no left/right image overlap or where there is insufficient image contrast for automated stereo processing to match features between the left and right images.

**Future Development:** A number of Notebook functions are based on previous user suggestions, and feedback continues to be sought. (User feedback should be submitted to an@wunder.wustl.edu or by using the

online form.) Work continues to incorporate additional features, especially in the areas of related observations and visualization, as well as data transformation.

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**References:** [1] Stein, T.C. et al. (2010), LPS XLI, Abstract #1414. [2] Grotzinger, J. et al. (2012) Space Science Reviews, 170, 5-56. [3] J.A. Crisp, et al. (2003) doi:10.1029. [4] Arvidson, R.E. (2008) Jet Propulsion Laboratory Document D-29392. [5] Stein, T.C. et al. (2015), LPS XLVI, Abstract #1435.

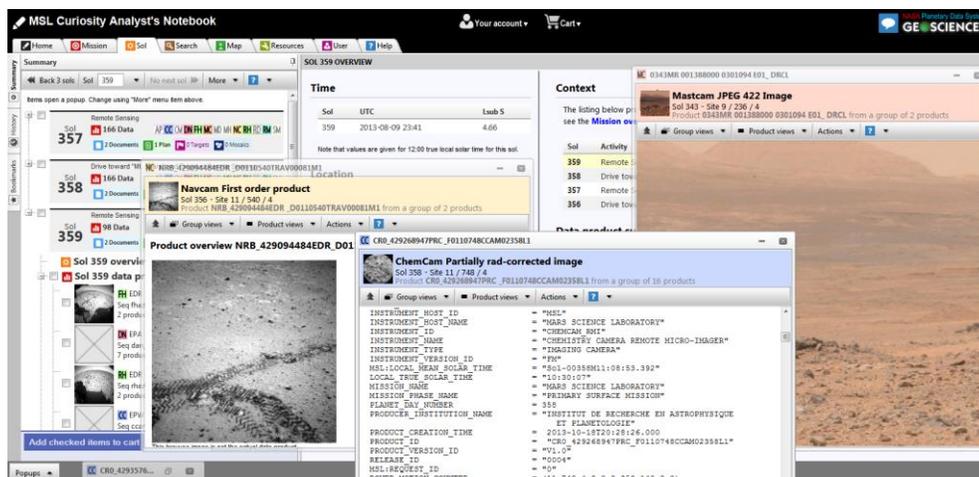


Fig. 1. Example MSL Analyst's Notebook Sol Summaries web page.



Fig. 2. MSL Navcam sol 772 image NLB\_461587528RADLF0401378NCAM00346M1 showing distance measurements. The blue area delineates the portions of the image where distance measurement is not possible due to lack of stereo coverage.