



Using ENVI with HiRISE Image Data

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Table of Contents

| | |
|--|-----------|
| I. Introduction | 3 |
| What is ENVI and IDL? | 3 |
| HiRISE Overview | 3 |
| II. Getting Started with ENVI | 4 |
| Installing the HiRISE Toolkit for ENVI | 4 |
| Starting the ENVI Software | 4 |
| Importing a HiRISE RDR Dataset | 5 |
| III. Working with HiRISE Data | 7 |
| Familiarizing Yourself with the ENVI Interface | 7 |
| Using the HiRISE Toolkit Utilities | 10 |
| Image Exploration and Analysis Tools | 12 |
| IV. Conclusion | 15 |
| Using ENVI with other Mars Datasets | 15 |

Introduction

What is ENVI and IDL?

ENVI is a desktop software program for remote sensing and raster GIS applications. ENVI is the ideal software for the visualization, analysis, and presentation of all types of digital imagery. Developed by leading researchers in the field, ITT Visual Information Solutions' ENVI provides a complete remote sensing package with the most advanced and user-friendly image processing tools. ENVI's intuitive and customizable graphical user interface allows you to start processing your data immediately.

ENVI's underlying language IDL (the *Interactive Data Language*) is fully accessible allowing you to customize ENVI to meet your specific requirements. IDL is an interpreted computer language and interactive software environment that is ideal for data analysis, visualization, and cross-platform application development. IDL is specifically designed for the visualization and analysis of large, multi-dimensional technical datasets. IDL is the language of choice for technical professionals, offering simple syntax, array-oriented architecture, and rich library of analysis and visualization routines.

HiRISE Overview

The HiRISE (High Resolution Imaging Science Experiment) camera is a science instrument on board the MRO (Mars Reconnaissance Orbiter) spacecraft platform. Ball Aerospace designed and built the HiRISE instrument for the MRO mission, while the spacecraft bus design was performed by Lockheed Martin and the Jet Propulsion Laboratory. The MRO spacecraft was launched in August of 2005 and settled into its final orbit around Mars during the fall of 2006 for the start of the primary science phase of its mission.

The HiRISE instrument acquires data with unprecedented image quality, resolution, and coverage, providing both panchromatic and color images. The camera produces high spatial resolution images with 1 to 2 meters/pixel content. Consequently, HiRISE will be used to investigate deposits and landforms resulting from geologic and climatic processes and assist in the evaluation of candidate landing sites.

For more information, please visit the official HiRISE website at the University of Arizona Lunar and Planetary Laboratory:

<http://hirise.lpl.arizona.edu/>

Getting Started with ENVI

Installing the HiRISE Toolkit for ENVI

In an effort to provide support to the planetary scientists working with HiRISE RDR (Reduced Data Record) image data, a custom toolkit has been developed by ITT Visual Information Solutions as an extension to the ENVI software package. This toolkit is distributed as a plugin to ENVI that adds the following functionality to the software package:

- Custom data input utility for PDS .JP2, PDS .IMG, JPEG, PNG, TIFF
- Support for PDS attached and detached label (*.LBL) files
- Input of Mars map projection metadata
- Interactive PDS metadata viewer
- Automatic band center wavelength & FWHM designation
- Custom cursor location tool that displays both planetocentric and planetographic coordinates
- Calibration to I/F utility

In order to utilize this toolkit you must have access to a licensed copy of ENVI v.4.3 or newer. To download and install this toolkit simply visit the following webpage, download the ZIP file, unpack, and follow the instructions in the "README.txt" file:

<http://www.ittvis.com/Downloads/toolkits.aspx>

Starting the ENVI Software

Before attempting to start the software program, please ensure that ENVI is properly installed as described in the *Installing and Licensing ENVI* documentation manual included with the software on data CD-ROM #3.

Starting ENVI on Windows

- For ENVI Runtime, select **Start → All Programs → ENVI #.# → ENVI**.
- For ENVI+IDL, select **Start → All Programs → ENVI #.# → ENVI+IDL**.

Starting ENVI on UNIX & Linux

- For ENVI Runtime, enter **envi_rt** at the UNIX command line.
- For ENVI+IDL, enter **envi** at the UNIX command line.
- **NOTE:** If these commands do not produce the expected results, you need to set ENVI environment aliases. Please consult the "Setting Up the ENVI Environment" section of the *Installing and Licensing ENVI* manual.

Starting ENVI on Macintosh

- ENVI for Mac OS X can be run one of two ways:
 1. From an Applescript application. To launch the software simply click on the appropriate icon in the */Applications/itt/idl###/* directory.
 2. From a UNIX X-Windows prompt. First launch X11 from the Applications folder. X11 displays a UNIX X-Windows command line in an OS X window:
 - For ENVI Runtime, enter **envi_rt** at the UNIX command line.
 - For ENVI+IDL, enter **envi** at the UNIX command line.
 - NOTE: If these commands do not produce the expected results, you need to set ENVI environment aliases. Please consult the "Setting Up the ENVI Environment" section of the *Installing and Licensing ENVI* manual.

Importing a HiRISE RDR Dataset

Once the *HiRISE Toolkit for ENVI* has been installed as described above, 3 new menu options and a display utility will be added to the software package:

1. **File → Open External File → MRO → HiRISE RDR**
 - Use this utility to open the HiRISE datasets. This menu option should be used when opening HiRISE images in PDS .JP2, PDS .IMG, JPEG, PNG, and TIFF file formats.
2. **File → Open External File → MRO → View PDS Metadata**
 - Use this utility to view the PDS metadata in an interactive viewer.
3. **Basic Tools → Calibrate HiRISE to I/F**
 - Use this utility to apply the scaling factor & offset.
4. Within a main image or zoom display window of HiRISE data, you can click-and-drag with the middle mouse button and see a custom cursor location dialog that display both planetocentric and planetographic coordinates. This utility does not work within the Scroll window as the middle mouse button performs the meta scroll functionality.

In order to import a HiRISE RDR dataset into the ENVI software package, simply select "**File → Open External File → MRO → HiRISE RDR**" from the main ENVI menu [Fig. 1] and select the desired image file. The image data will be automatically loaded into the *Available Bands List* and an image display group within the ENVI software package.

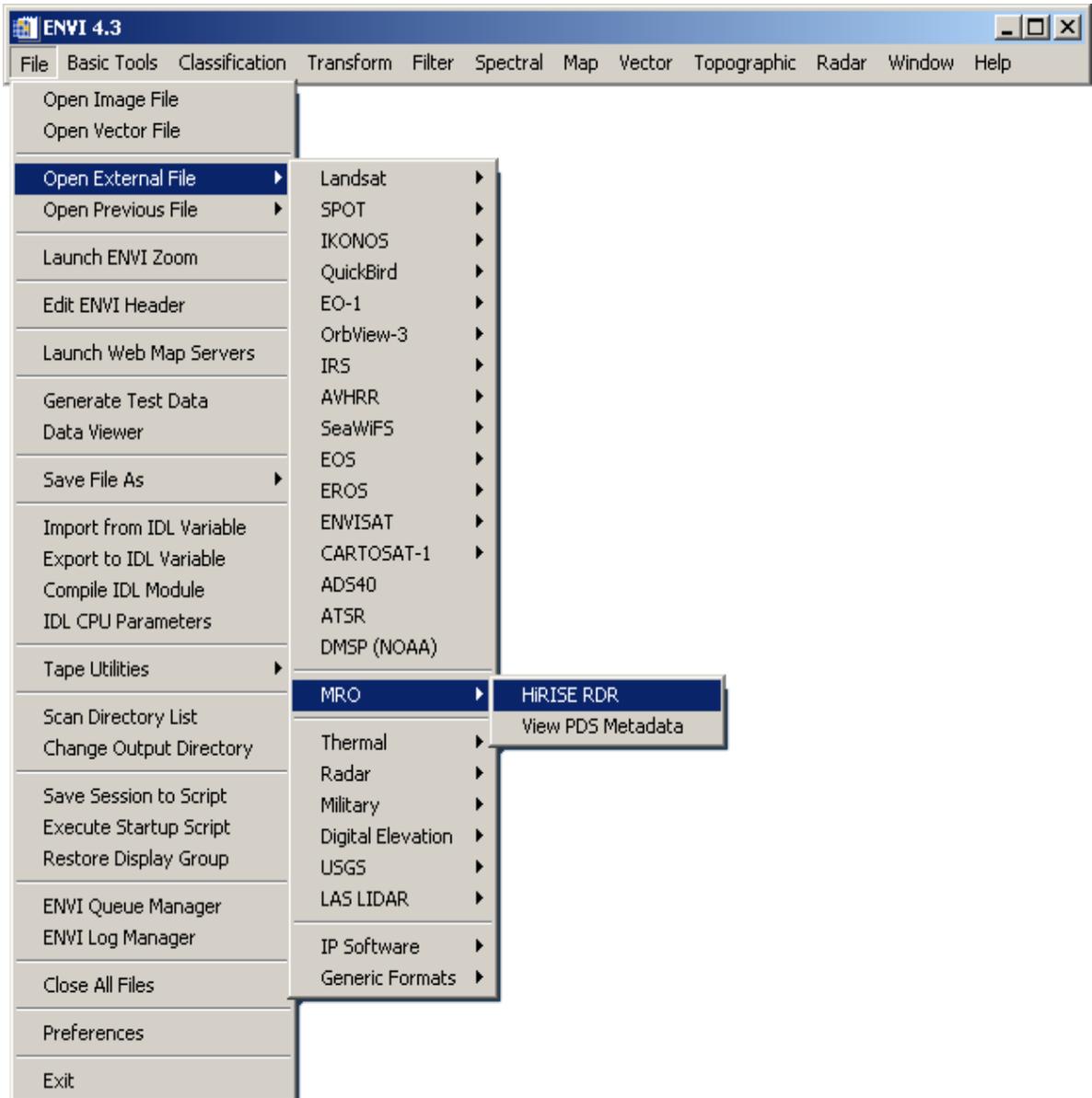


Figure 1: The main ENVI menu system

Working with HiRISE Data

Familiarizing Yourself with the ENVI Interface

When a HiRISE image is opened using the **"File → Open External File → MRO → HiRISE RDR"** menu option the contents of the dataset will be listed in the Available Bands List dialog [Fig. 2] and the image will be displayed within a display window group [Fig. 3].

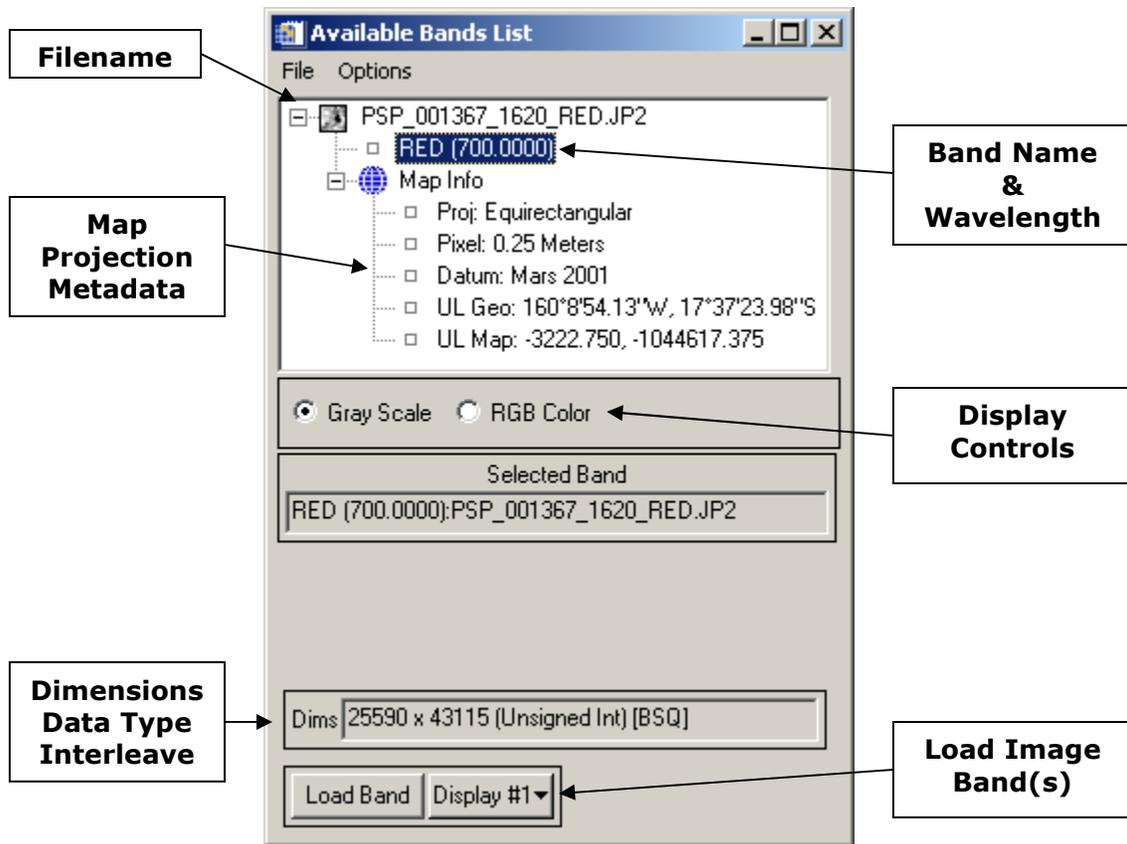


Figure 2: The Available Bands List

The ENVI display group consists of 3 separate windows that can be used to explore large images [Fig. 3]:

- Main (1:1 scale) image window
- Scroll (thumbnail) window
- Zoom (magnified) window

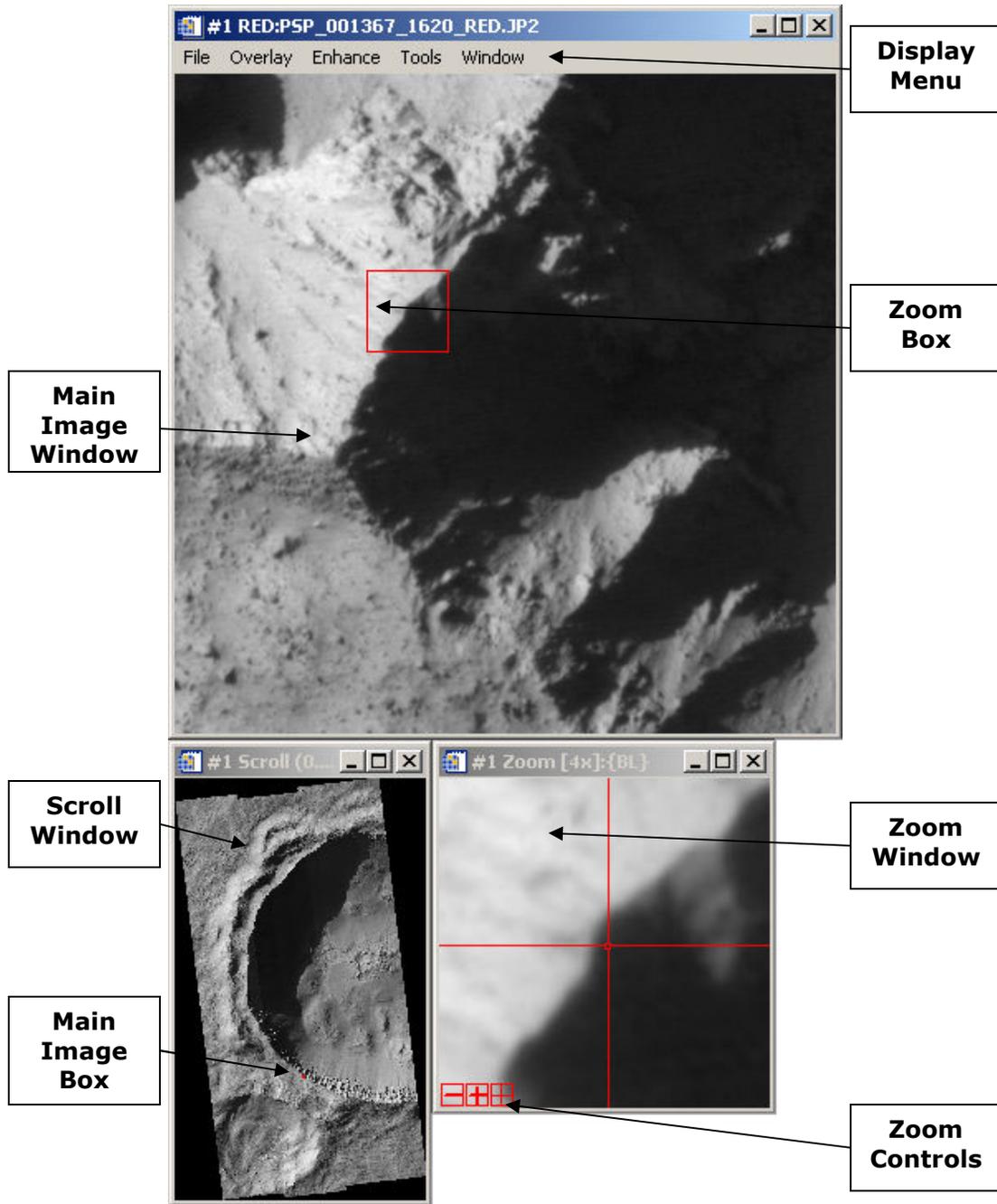


Figure 3: An image display group

The main image display window has its own menubar and displays the imagery at 1:1 full resolution. Within the main image window is a zoom box that can be moved using the mouse which controls the location and content of the zoom window. In the lower-left hand corner of the zoom window are the controls for increasing and decreasing magnification, along with the crosshair toggle. The scroll window displays a thumbnail of the entire image subsampled down to a low resolution, and contains a box that controls the location of the main image window.

All three windows in the display group can be moved and resized, and each will display a context menu with additional utilities and options when you right-click within the window [Fig. 4].

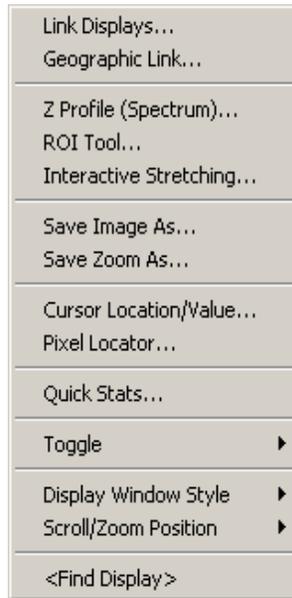


Figure 4: Context menu obtained via right-click within display windows

A useful utility for exploring imagery that is built into the ENVI software package is the cursor location / value dialog. This tool can be launched by performing one of the following operations:

- **Double-click** within the main image window
- Right-click within any window and select "**Cursor Location/Value...**"
- Select "**Tools → Cursor Location/Value...**" from the display menu

The cursor location / value utility displays the current mouse cursor location (column, row), along with the screen display intensities, map projection, geolocation in both map coordinates and latitude & longitude, and pixel data value [Fig. 5].

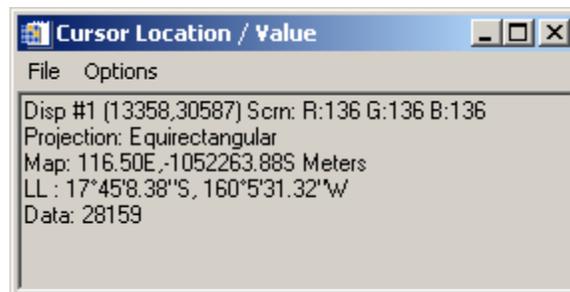


Figure 5: The cursor location / value utility

This dialog will automatically update as you move the mouse cursor within any of the 3 image display windows.

Using the HiRISE Toolkit Utilities

In addition to the ability to input and display images from HiRISE RDR datasets, the *HiRISE Toolkit for ENVI* also provides a custom cursor location dialog that displays map coordinates in both planetocentric and planetographic systems. The planetocentric coordinates are essentially the same as those reported by ENVI's cursor location / value utility, but the planetographic are slightly different depending upon the latitude of the image. This custom cursor location tool only works with PDS format datasets.

In order to utilize the *HiRISE Cursor Location* utility, simply press the **middle mouse button** and hold it down while you move the mouse cursor (i.e. click-and-drag) in either the main image or zoom windows [Fig. 6].

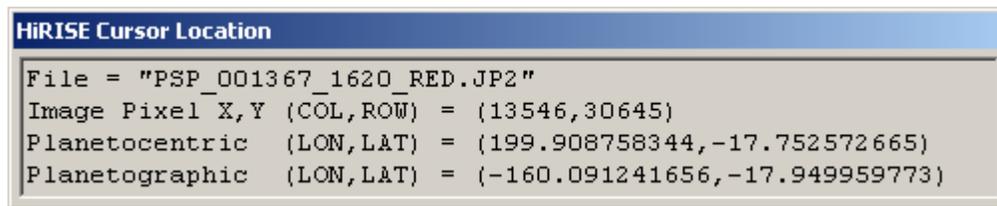


Figure 6: The HiRISE cursor location utility

Another utility included with the *HiRISE Toolkit for ENVI* provides a calibration conversion of the image to I/F units by applying the scaling factor (i.e. gain) and offset parameters found within the metadata of PDS format datasets. To run this tool simply select "**Basic Tools → Calibrate HiRISE to I/F**" from the main ENVI menu, select a previously opened HiRISE dataset and specify any desired subsetting, then specify a new output file to create on disk. The resulting dataset should be automatically loaded into the software and displayed.

The final component of the *HiRISE Toolkit for ENVI* is an interactive dialog for viewing the metadata from PDS format labels. To use this utility simply select "**File → Open External File → MRO → View PDS Metadata**" from the main ENVI menu and select a PDS format dataset. The metadata from the PDS label will be loaded into a tree format graphical user interface [Fig. 7].



Figure 7: The PDS metadata viewer

Image Exploration and Analysis Tools

There are a number of tools built into the ENVI main image display menu that can be useful for exploring and analyzing HiRISE datasets. The **Enhance** menu contains a number of tools that are useful for controlling the appearance of the imagery. Within this menu are a number of filters that can be applied to the image in order to sharpen or smooth the image. Furthermore, there are a number of pre-built stretches that can be applied based on the contents of any of the 3 image display windows (Image, Zoom, or Scroll). For example, a gaussian stretch can be applied to the image based on the histogram content of the entire image dataset by selecting "**Enhance → [Scroll] Gaussian**" [Fig. 8].

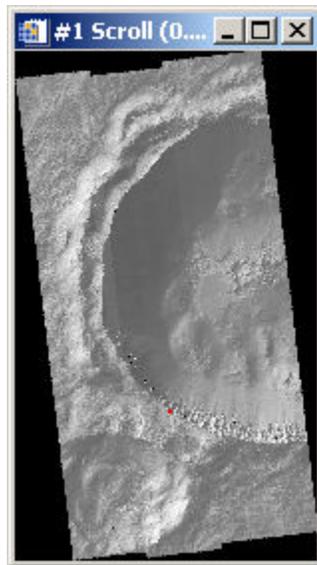


Figure 8: HiRISE image display with gaussian stretch applied

In addition, there is an interactive histogram manipulation tool that can be accessed by selecting "**Enhance → Interactive Stretching...**".

A quick and easy way to move the active cursor within the center crosshairs of the zoom window to a specific geographic location can be obtained by selecting "**Tools → Pixel Locator...**" from the image display menu. This will display the *Pixel Locator* dialog, within which you can enter a map coordinate in either easting & northing or longitude & latitude by pressing the toggle button [Fig. 9].

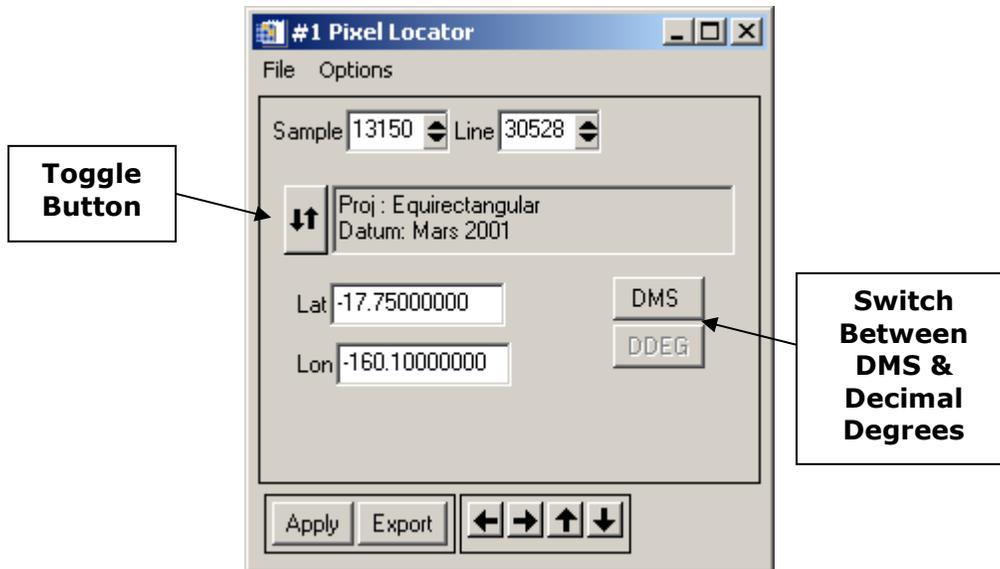


Figure 9: The pixel locator tool

Once you press the *Apply* button within the *Pixel Locator* dialog the image display will move to center the zoom window on the desired geolocation.

Another utility that may be useful is the measurement tool, which allows you to draw line segments on any of the 3 display windows and see a report of the distance in a wide variety of units. In order to utilize this tool, simply select "**Tools** → **Measurement Tool...**" from the image display menu. The *Display Measurement Tool* dialog will be displayed, within which you can select the active display window and the units to report (e.g. "**Units** → **Meters**"). Once this is accomplished, use the mouse to click between the points in order to measure the distance of the line segments [Fig. 10]. To complete the segments or start a new line simply click using the right mouse button.

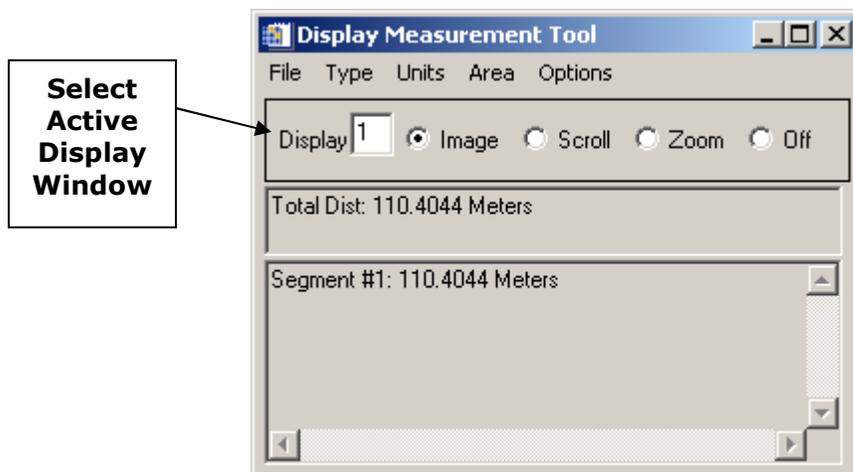


Figure 10: The display measurement tool

A tool is also available for extracting arbitrary line profiles (i.e. transects) of the image data. This utility can be accessed by selecting "**Tools → Profiles → Arbitrary Profile (Transect)...**" from the display menu. This will display the *Spatial Profile Tool* dialog. Once again, you can choose to extract a line profile from any of the three image display windows.

In order to use the spatial profile tool, simply draw a line using the left mouse button within the active display window, then click the right mouse button twice in order to complete and extract the profile. The line profile of the data values for the pixels across the transect will be displayed within a separate line plot dialog [Fig. 11].

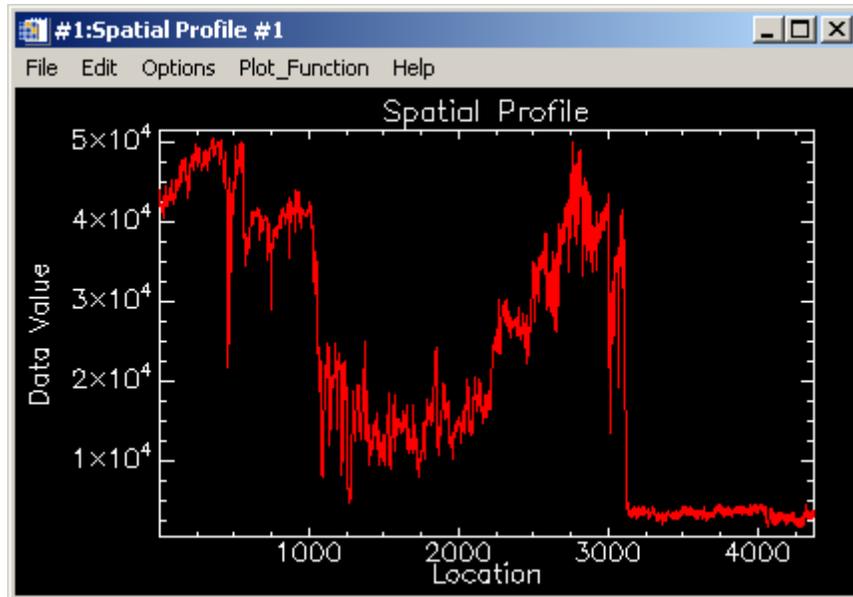


Figure 11: The arbitrary spatial profile tool

One final utility that can be very useful when working with images is the ROI (region of interest) tool built into the ENVI software package. To access the *ROI Tool*, simply select "**Tools → Region Of Interest → ROI Tool...**" from the image display menu. This will launch the ROI Tool dialog, within which you can control the active window and type of ROI being defined using the *ROI_Type* menu.

A common task that can be performed using the *ROI Tool* is to use the mouse to draw a ROI on the image, then compute the area of this region in a wide variety of units. This can be accomplished by defining the ROI using the left button on the mouse then select "**Options → Report Area of ROIs...**" from the *ROI Tool* menu [Fig. 12].



Figure 12: The ROI area information dialog

Conclusion

Using ENVI with other Mars Datasets

ITT Visual Information Solutions recognizes the increased focus towards the exploration and analysis of the other planets in our solar system, and the challenges planetary scientists face when processing that large amounts of data that is becoming available. In addition to the HiRISE instrument, the Mars Reconnaissance Orbiter has other instruments that acquire imagery such as CRISM (Compact Reconnaissance Imaging Spectrometer for Mars), CTX (Context Camera), and MARCI (Mars Color Imager). ENVI's rich suite of image processing and spectral analysis tools make it an excellent software package for the analysis of these datasets.

Furthermore, other raster datasets from previous missions such as the MOLA (Mars Orbiter Laser Altimeter) science investigation can be analyzed using ENVI. In fact, if a dataset is stored in the PDS file format you may be able to open it using the "**File** → **Open External File** → **MRO** → **HiRISE RDR**" option from the *HiRISE Toolkit for ENVI* in order to input the data into the software. A common visualization technique applied to DEM data is the creation of a hill shade image, which uses a combination of shaded relief and a color table to display the topography [Fig. 13].

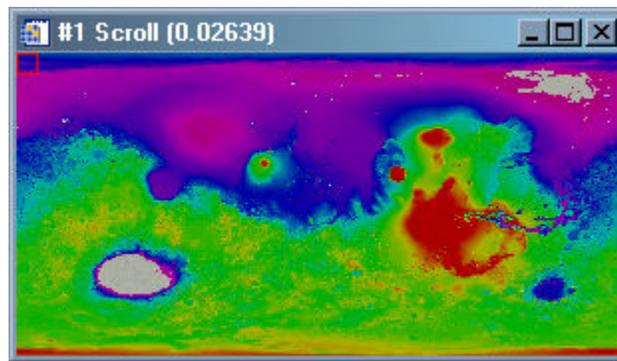


Figure 13: Hill shade image of MOLA DEM data input using HiRISE Toolkit

To learn more about ENVI's functionality please visit:

<http://www.itvis.com/ProductServices/ENVI.aspx>

Or contact your ENVI sales representative at (303)-786-9900 <info@itvis.com>.

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