

# **CRISM (Compact Reconnaissance Imaging Spectrometer for Mars) on MRO**

## **Instrument and Investigation overview**

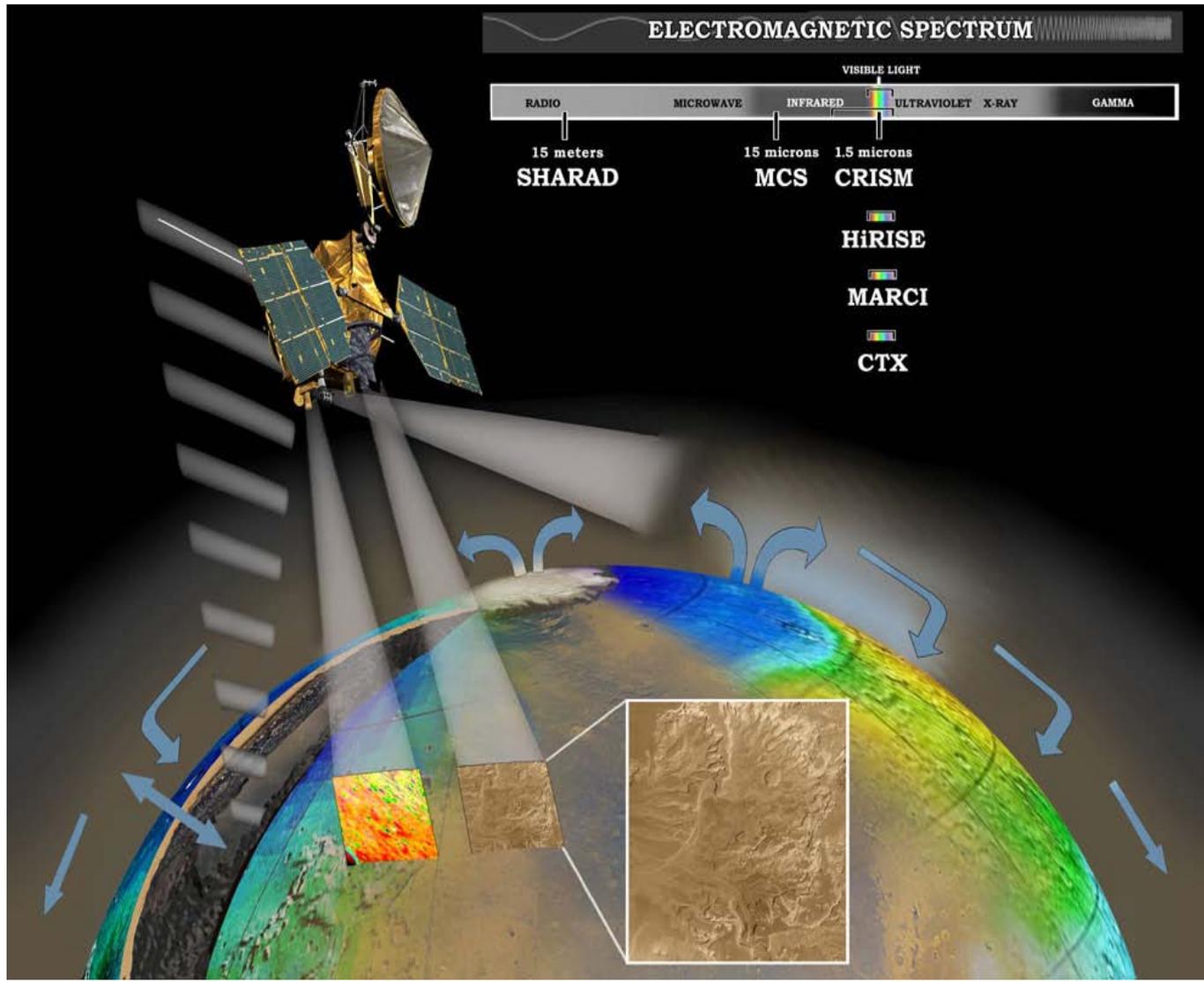
Scott Murchie

*Applied Physics Laboratory, Laurel, MD 20723*

18 March 2012

# MRO / CRISM overview

# CRISM is 1 of 6 MRO Instruments to Map Mars' Surface and Atmosphere



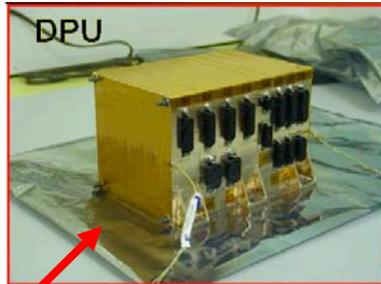
CRISM, HiRISE, and CTX characterize surface geologic features

MARCI, MCS, and CRISM track spatial and seasonal variations in the atmosphere

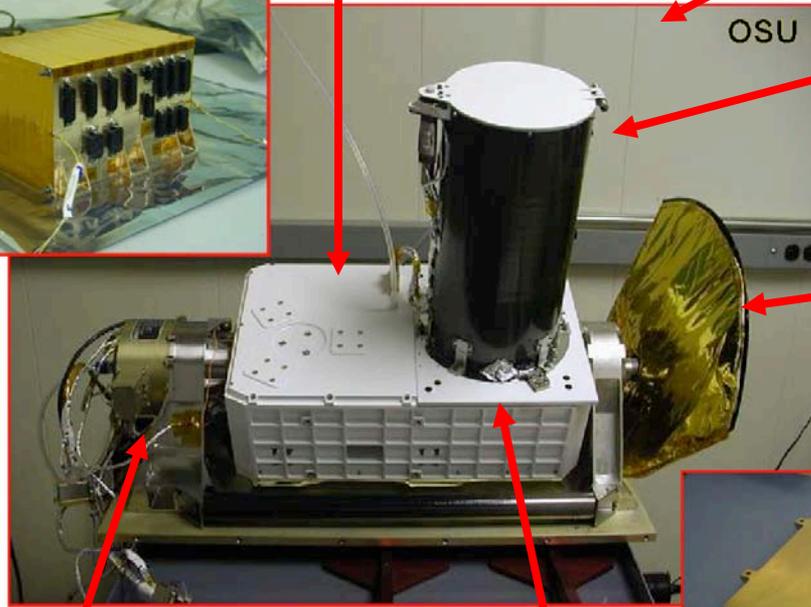
# Hardware overview

3 cryocoolers keep IR detector at 110-125K to control noise

Optical Sensor Unit

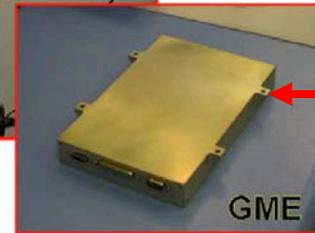


Data Processing Unit controls data acquisition, pixel binning, data editing



Baffle with 1-time deployed cover cuts out of field stray light

Radiator pointing toward evening terminator cools spectrometer optics to -70C to -80C

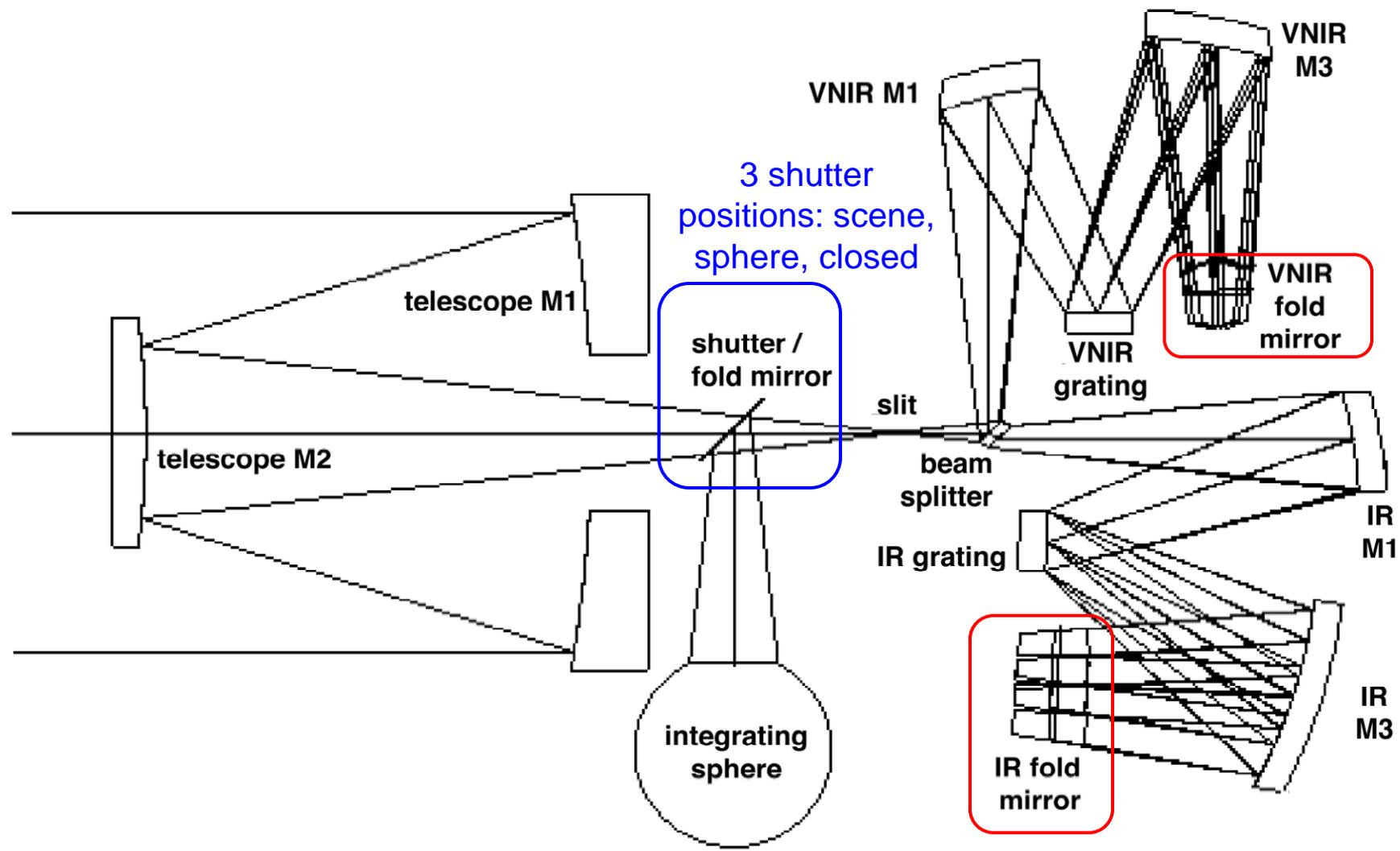


Gimbal Motor Electronics controls gimbal

Gimbal allows observations at multiple geometries to separate surface and atmosphere ( $\pm 60^\circ$  along-track)

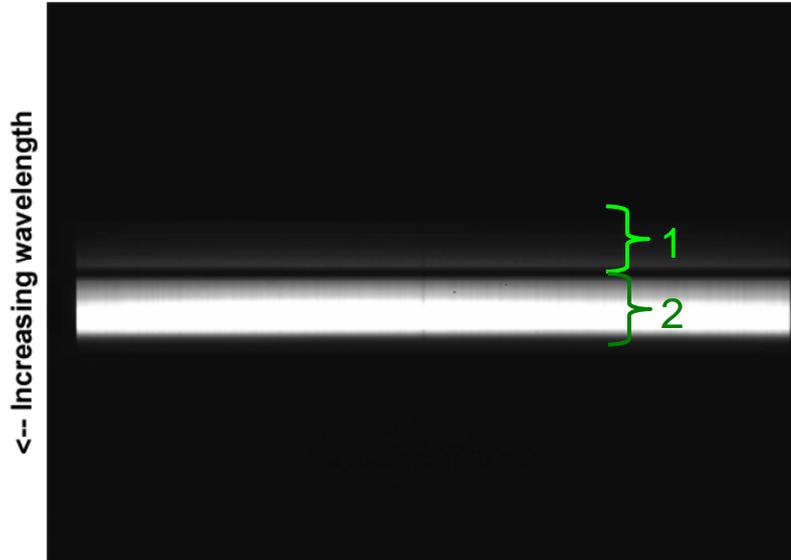
Internal calibration: shutter for dark measurements, integrating sphere for radiometric calibration

Wavelength range	0.4-3.9 $\mu$ m
Spectral sampling	6.55 nm/channel
Spatial sampling	18 m/pixel from 300 km

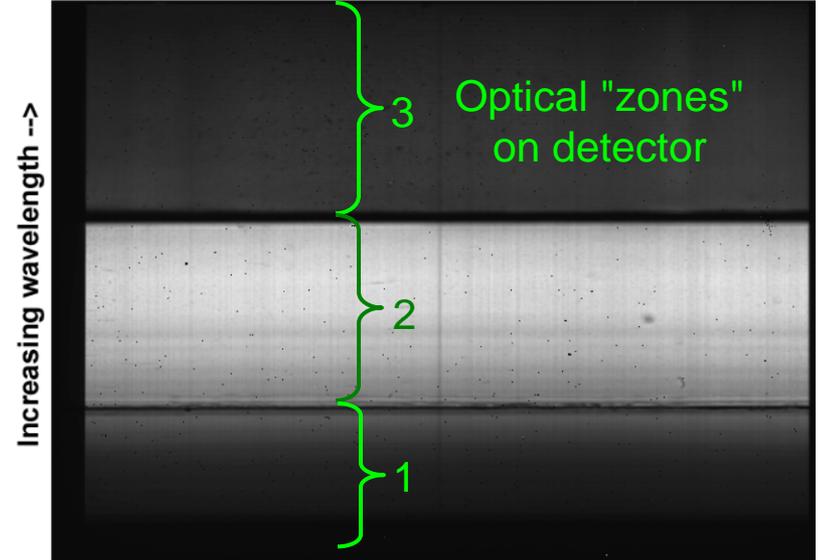


2 different detectors

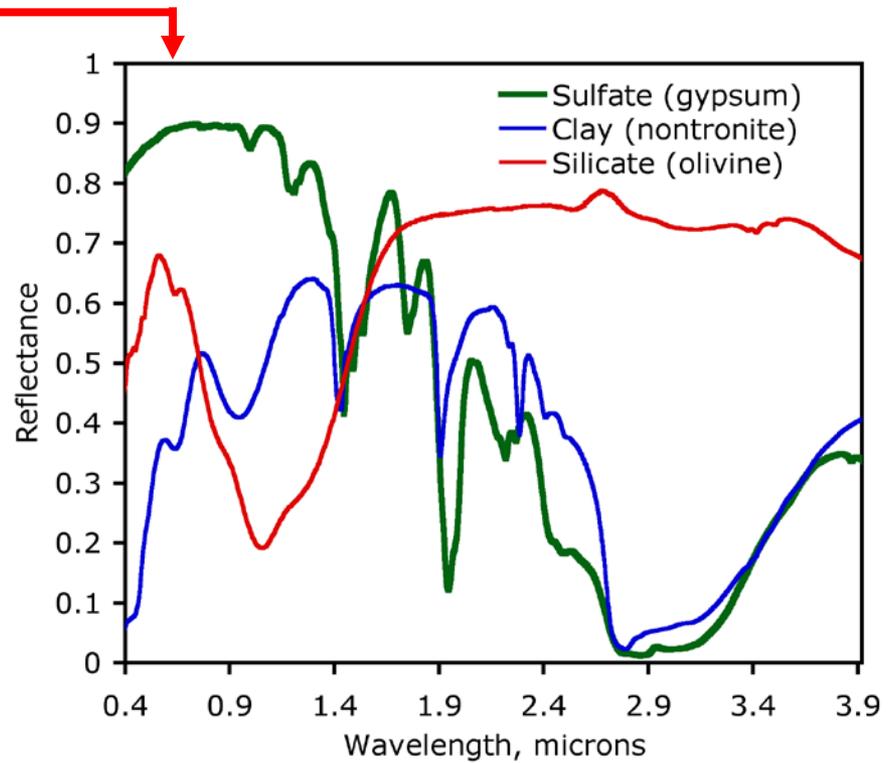
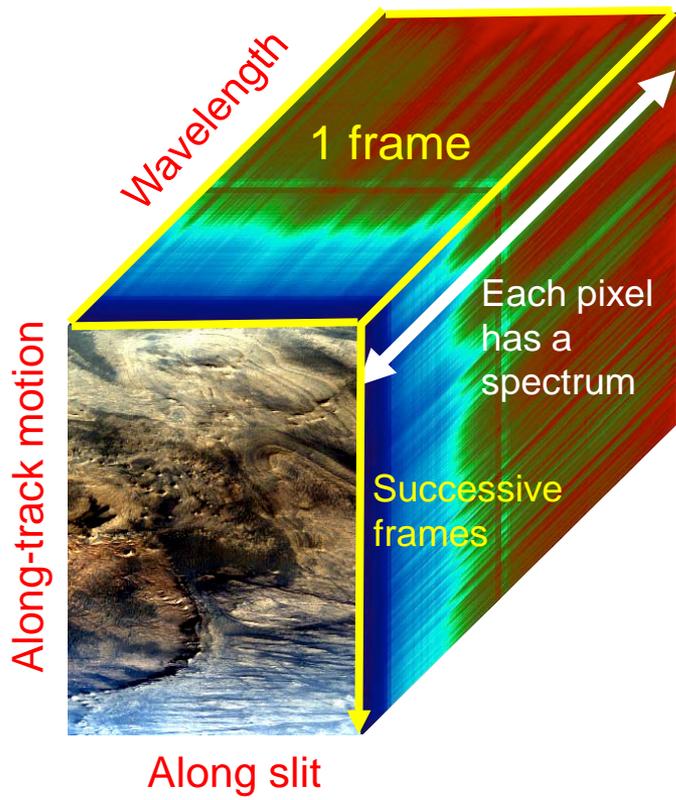
VNIR spatial direction



IR spatial direction



# Basic Structure of the Data: Successive Frames Acquired Along Track



Each readout of the detector is 1 line of a spatial image. The whole image is built as MRO moves along its ground track.

Each pixel has a spectrum whose absorptions can be compared with minerals

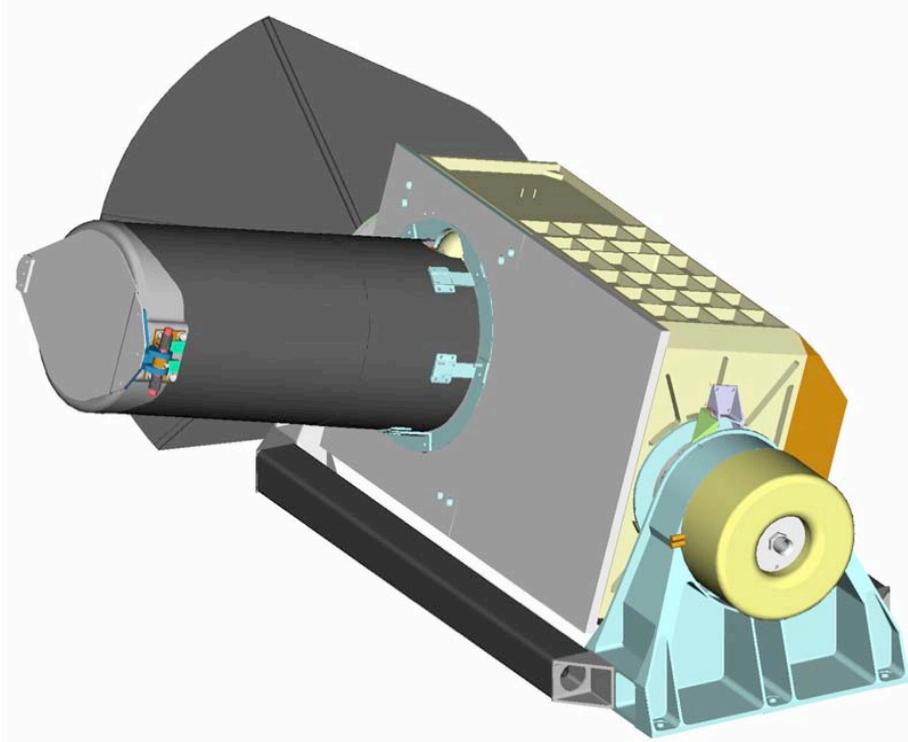
# Instrument Configuration for Operation

Primary variables that are set to define observation types

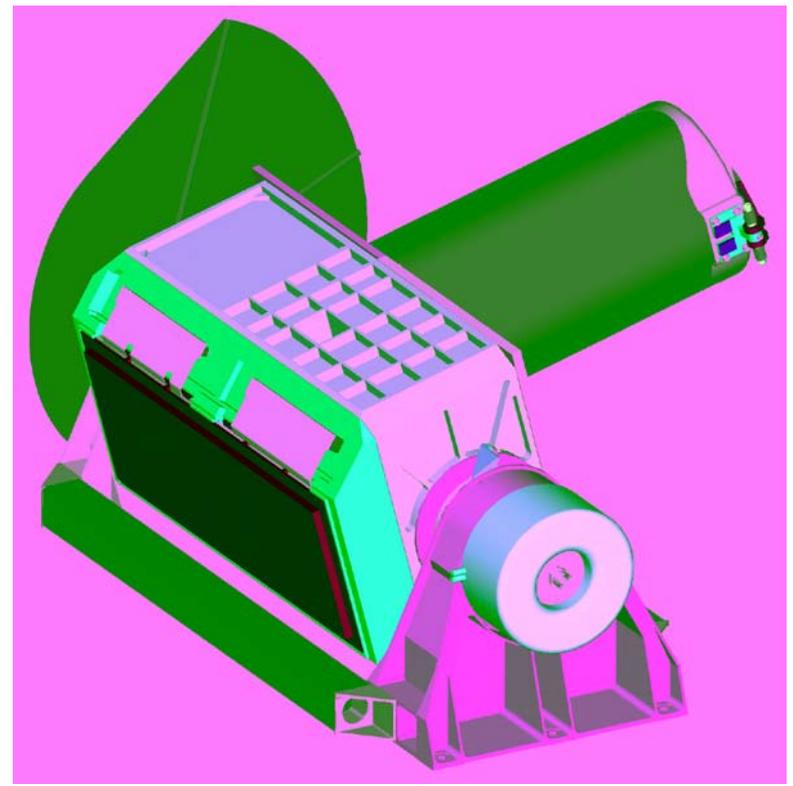
- **Pointing**
  - Fixed at nadir
  - Track a point and repeatedly scan across it (nadir or limb)
- **Number of wavelengths**
  - All 544 with useful data
  - Subsets (72, 94, or 262 selected VNIR+IR wavelengths or all 107 VNIR) for global mapping

These variables are set to manage data volume and to "square" the pixels

- **Frame rate**
  - 1 Hz (for internal calibration)
  - 3.75 Hz (hyperspectral observations)
  - 15 or 30 Hz (global mapping)
- **Spatial pixel binning**
  - None (18 m) or 2x (36 m) for high-resolution observations
  - 5x (100 m) or 10x (200 m) for global mapping



+60°

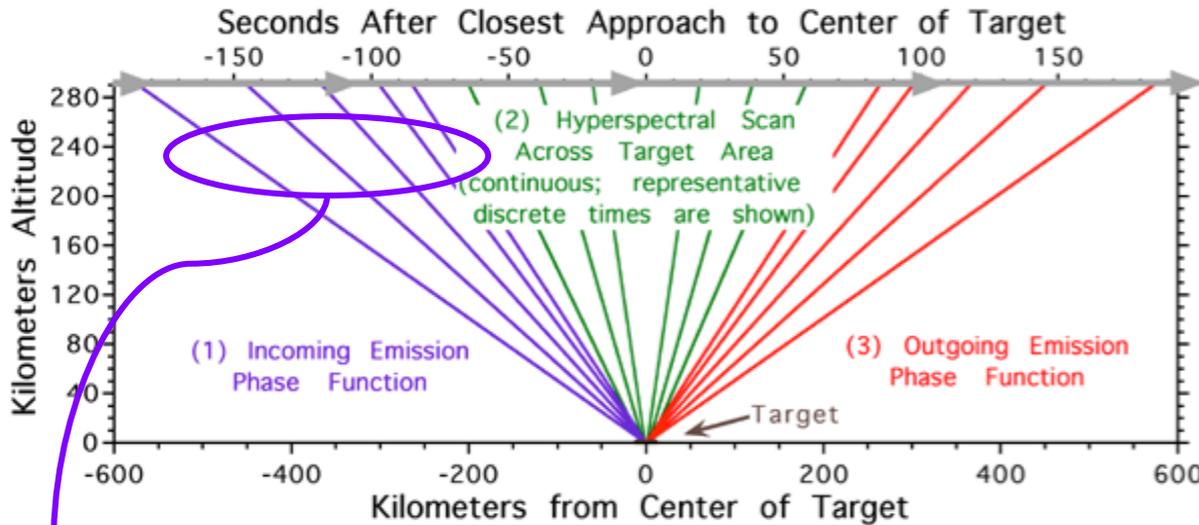


-60°

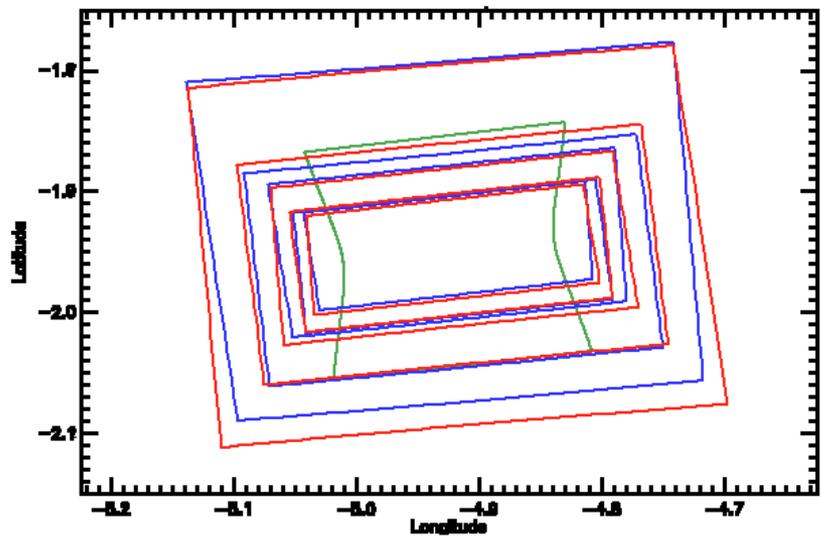
- Mars has MUCH more compositional diversity than imagined
  - New observing modes were constructed to get high spatial resolution and better wavelength coverage
- CRISM has taken on an increasing role in monitoring the atmosphere
  - The MCS instrument is used differently than originally anticipated
  - CRISM added a new kind of observation to track water vapor, trace gases
  - We started observing the planet's limb to address new science (vertical structure of the atmosphere)
- The hardware is aging
  - In 2010 the gimbal began to get sticky so that scan range was reduced
  - The coolers, required for IR data, are less efficient and now require occasional power toggling. We use them only part of the time. (When the coolers are off, only VNIR data are taken.)

# Types of Observations

# First Basic Observation Type: Gimbaled (example shown is Full-Resolution Targeted)



1<sup>st</sup> 5 images discontinued Sep. 2010 due to gimbal stickiness



Idealized footprints for target at nadir

- "Targeted" because s/c actively points
- Up to 11 images at varying emission angles: "Emission phase function"
- Central image may be unbinned (18 m/pixel), 2x binned (36 m/pixel), or 10x binned (~180 m/pixel)
- 1st 5 and last 5 are 10x binned
- Central high-resolution swath for geology; whole set to separate surface/atmosphere

# Types of Gimballed Observations: Surface Pointed

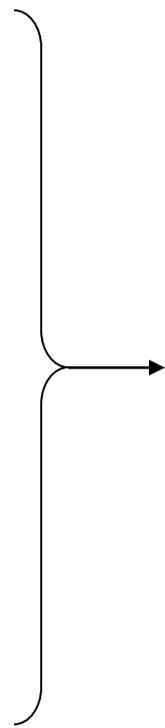
100 km

Normal targeted

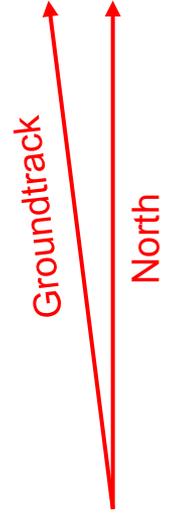
**FRT:** 1x binned,  
18 m/pixel,  
544 channels.  
High-priority targets.

**HRS:** 2x binned,  
36 m/pixel,  
544 channels.  
Limited data volume.

**HRL:** 2x binned,  
36 m/pixel,  
544 channels.  
Coverage.



**EPF:** 6-13 images,  
10x binned, 180  
m/pixel, 544 channels.  
Free-standing for  
atmospheric  
monitoring. Also  
included with FRT,  
HRL, HRS.



Super-resolution targets



**New beginning Mar. 2011:**

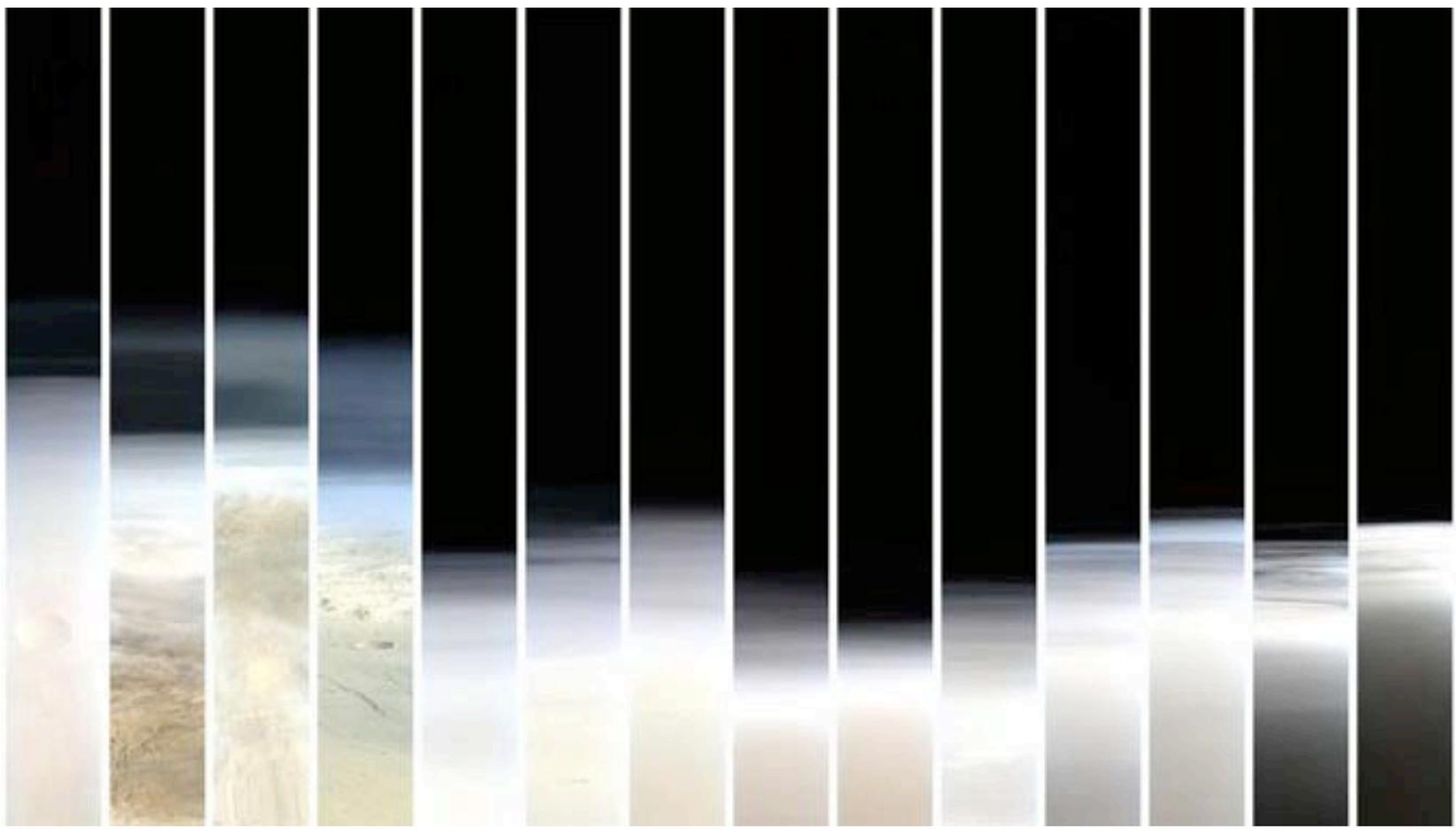
**“ATO’s”:** FRT’s with high along-track overlap frame-to-frame, allowing recovery of 3-12 m/pixel resolution.

*Beginning June 2012 we will deliver a text file listing FRTs taken in this mode.*

# Types of Gimbaled Observations: Limb-Pointed

500 km

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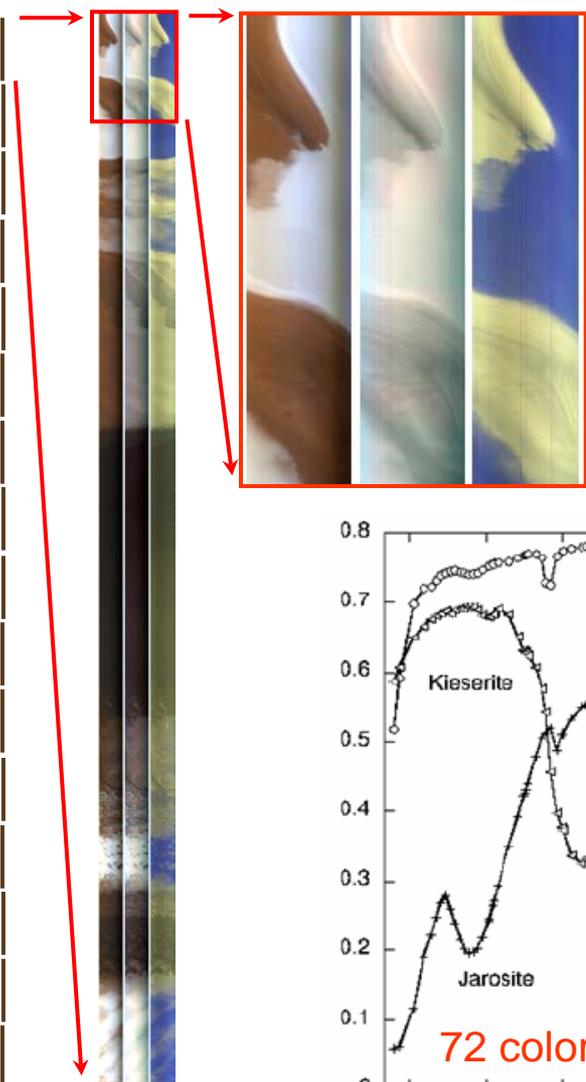


**New in July 2009:**

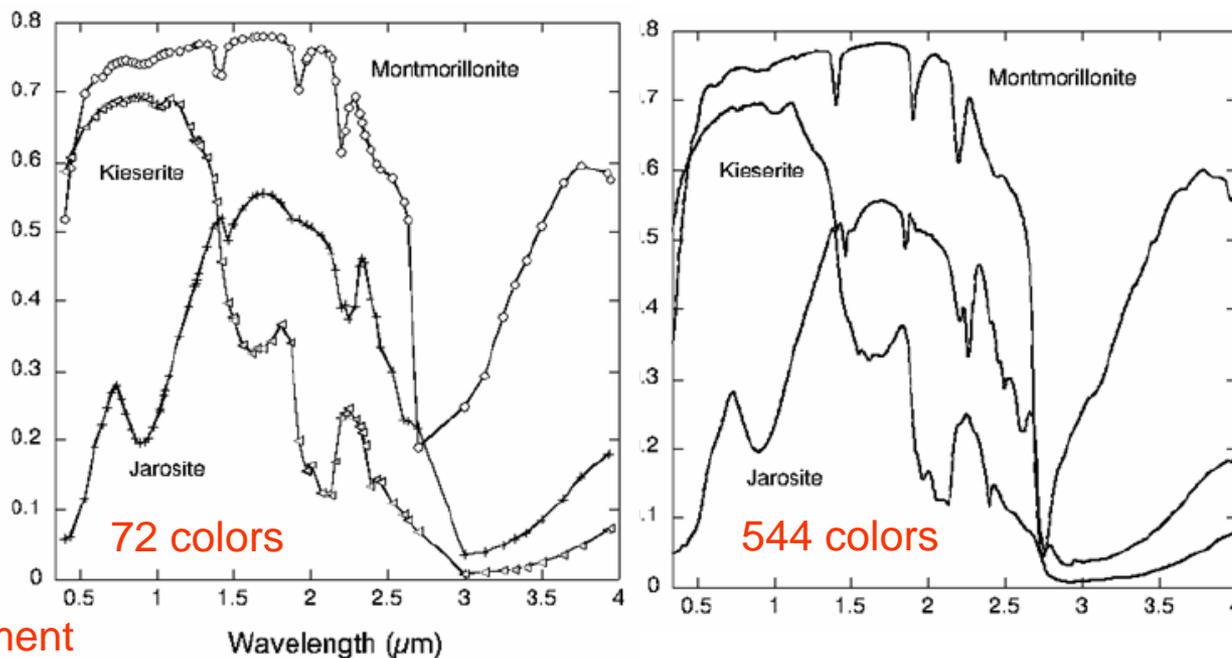
**LMB:** ~36 images per orbit past both terminators, 10x binned, 880 m/pixel, 544 channels.

*Group of 2-3 orbits every 2 months.*

# Second Basic Observation Type: Nadir (example shown is Multispectral Survey)



- Lower-resolution strips to build a global map for context & to find new targets, and sample the atmosphere
- At first selected wavelengths, commonly 72
- Beginning 2010 hyperspectral strips also used
- 5x-binned to 100 m/pixel, or 10x to 200 m/pixel
- 72-channel multispectral "noodles" are mosaicked to create a global map



1 orbit 3-min segment

100 km



## SURFACE MAPPING:

### 200 m/pixel strips:

**MSP:** VNIR+IR  $\geq 72$  ch.

New in Jan. 2010:

**HSP:** VNIR+IR, 262 ch.

**HSV:** VNIR only, 107 ch.



550 km  
long

### 100 m/pixel strips:

**MSW:** VNIR+IR,  $\geq 72$  ch.

(discontinued July 2008)

New in Jan. 2012:

**MSV:** VNIR only, 107 ch.



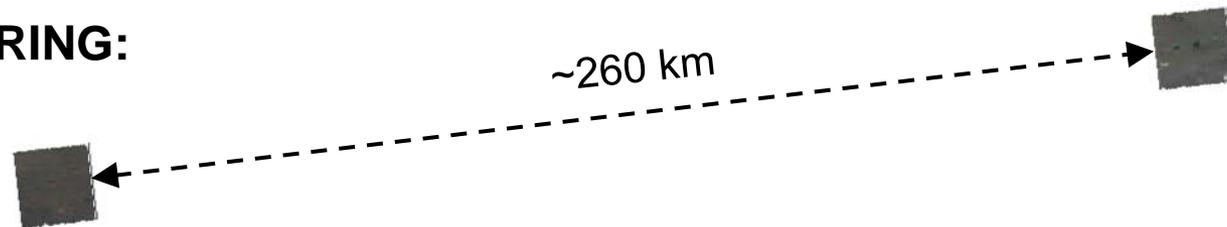
Groundtrack



North

## ATMOSPHERE MONITORING:

**TOD:** 180 m/pixel, 544 channels. Samples of atmosphere to monitor trace gases.



~260 km

# Current Status of Observing Plan

Objective	Implementation / Measurement Strategy
Find new targets of interest: aqueous deposits, crustal composition Put targeted measurements into geologic context	Beginning 2006: Map the planet in 72 channels, 200 m/pixel (MSP)
	Beginning 2010: Map key areas in VNIR and key IR wavelength ranges hyperspectrally (HSP)
	Beginning 2012: 2x higher resolution coverage in VNIR (MSV)
Separate the surface and atmosphere Provide information on spatial/seasonal variations in aerosols, H <sub>2</sub> O, CO, and ices	Beginning 2006: EPF at each targeted observation
	Beginning 2006: Regularly acquire global grids of EPFs to monitor seasonal variations in atmosphere
	Beginning 2007: Increase sampling density (TODs)
	Beginning 2009: Sample vertical structure seasonally using limb scans (LMB)
Measure surface targets with high spatial and spectral resolutions and high SNR	Beginning 2006: measure thousands of targets at full spectral resolution and high spatial resolution (FRT, HRL, HRS)
	Beginning 2010: measure key sites with small-scale compositional variations using super-resolution (ATO)

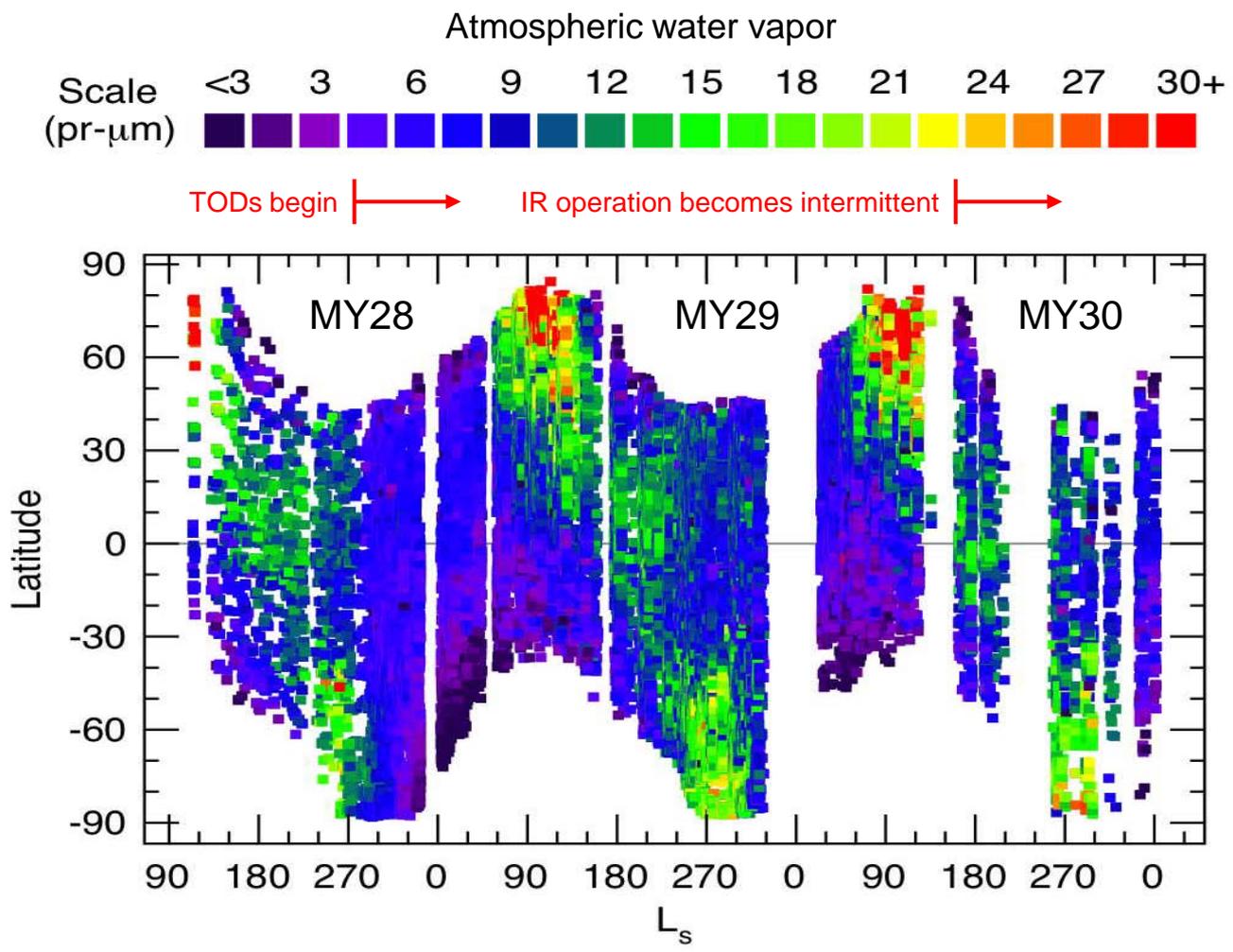
# Campaign 1: Multispectral Survey to Provide Global Context and Find Targets

Through March 2012 77% of Mars has been mapped at VNIR and IR wavelengths at low atmospheric opacity, using 54,600 VNIR+IR strips.

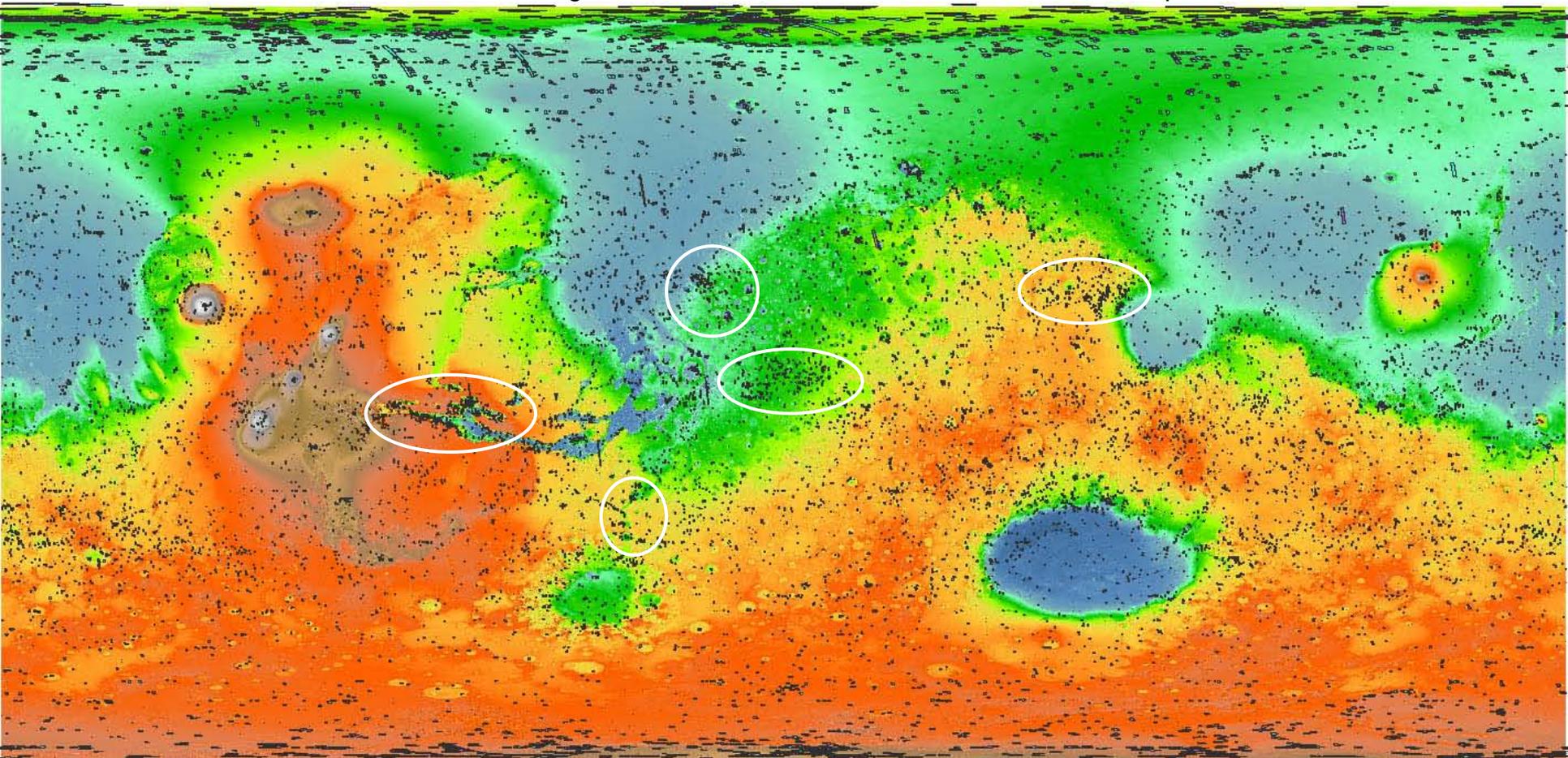


# Campaign 2: Monitor Spatial and Seasonal Variations in Aerosols and Trace Gases

Over 3 Mars years, 6518 EPFs have been taken in grids, plus 21,340 with targets.  
~28,000 TODs have been taken.  
1098 individual limb scans have been taken in 16 groups.



Locations of targeted observations, overlain on MOLA elevation map



21,340 targeted observations have been taken. 15,057 are at full resolution (18 m/pixel) and 6,282 are at half resolution (36 m/pixel). The highest concentrations are at major outcrops of phyllosilicate- and sulfate-bearing deposits formed in wet environments.

# Targeted Observation Data Product Overview

# A High-Resolution Targeted Observation is a Collection of Related Images

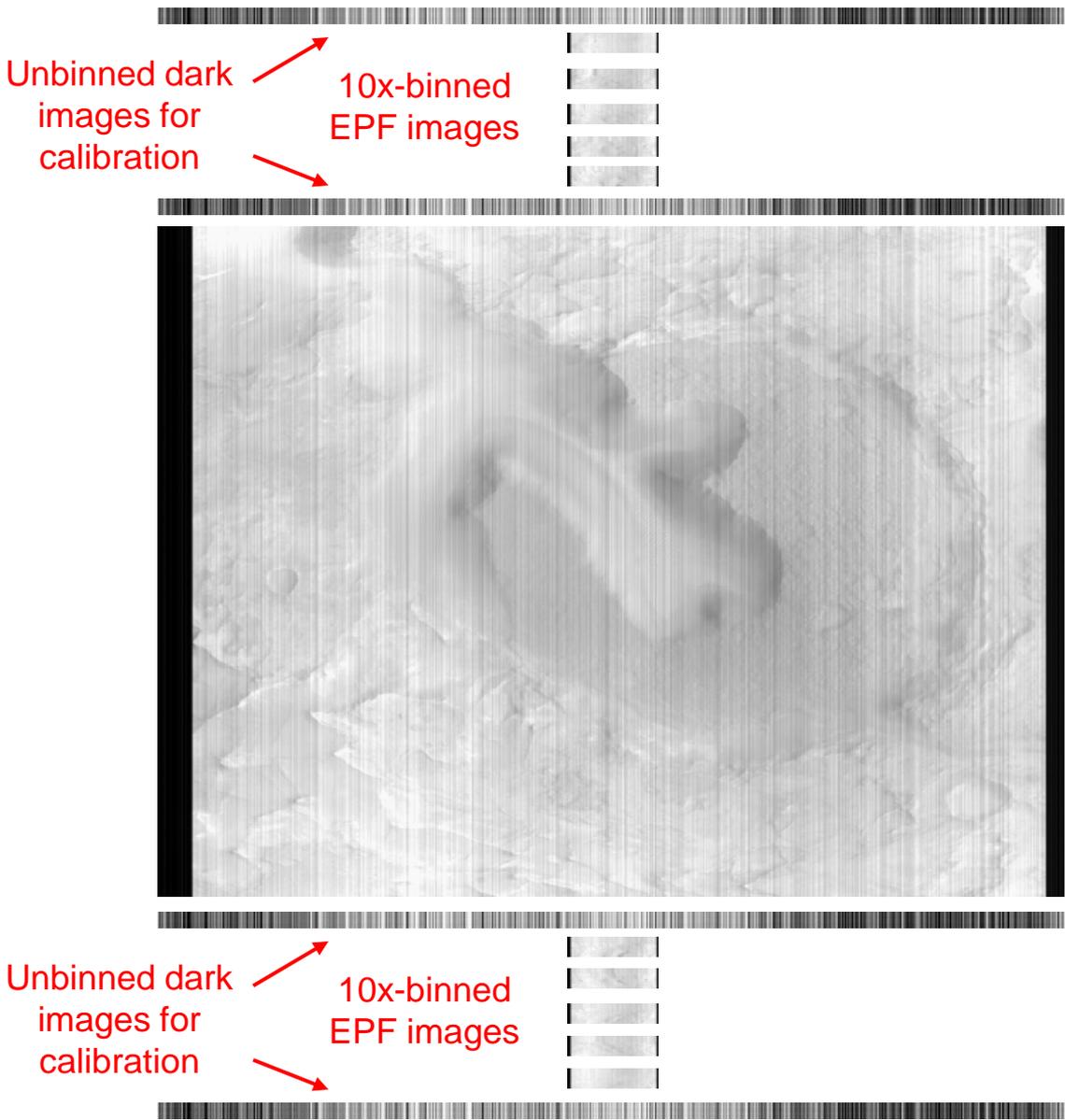


Image 00

Images 01-05

Image 06

Image 07

Image 08

Images 00-0D

Image 0E

File names for all the images share a unique 8-digit hex target ID, e.g., 00003E12

Each image has a unique hex counter in the file name (00, 01, ..., 0D, 0E)

# After Sept. 2010 Restrictions on Gimbal Angle Led us to Drop 5 Incoming Images

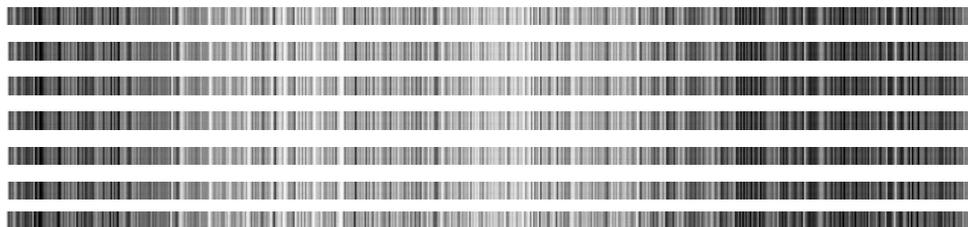


Image 00

**Images 01-05 replaced with darks**

Image 06

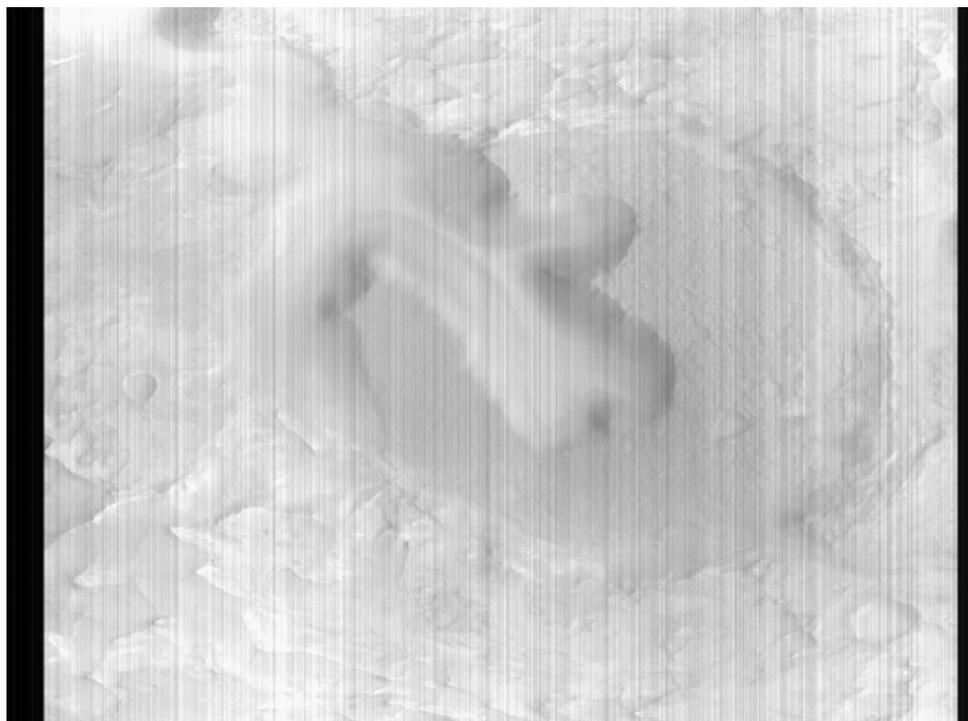
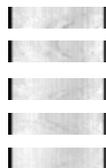


Image 07

Image 08



Images 00-0D

Image 0E

\* Targeted Reduced Data Records

Scene radiance,  
units  $W\ m^{-2}\ sr^{-1}\ \mu m^{-1}$



Multiband image of radiance;  
assembled from multiple frames

A separate ASCII table with house-  
keeping from each frame of the data

2163871423,	2835413809,	0.00,	-13275.00,	225.00,
2298090386,	2835413986,	0.00,	-13275.00,	225.00,
2365200485,	2835413764,	0.00,	-13050.00,	225.00,
2365201753,	2835413691,	0.00,	-13050.00,	225.00,
2298094130,	2835413828,	0.00,	-13050.00,	225.00,
2163877667,	2835413775,	0.00,	-13050.00,	225.00,
2365205505,	2835413724,	0.00,	-12825.00,	225.00,
2230989084,	2835413775,	0.00,	-12825.00,	225.00,
2163881483,	2835413764,	0.00,	-12825.00,	225.00,
2289711914,	2835413872,	0.00,	-12825.00,	225.00,
2155495431,	2835413757,	0.00,	-12600.00,	225.00,
2155496715,	2835413815,	0.00,	-12600.00,	225.00,
2222606852,	2835413819,	0.00,	-12600.00,	225.00,
2289717018,	2835413845,	0.00,	-12375.00,	225.00,
2289718298,	2835413795,	0.00,	-12375.00,	225.00,
2155501911,	2835413791,	0.00,	-12375.00,	225.00,
2356829813,	2835413903,	0.00,	-12375.00,	225.00,
2222613388,	2835413848,	0.00,	-12150.00,	225.00,
2356832413,	2835413918,	0.00,	-12150.00,	225.00,
2155507123,	2835413858,	0.00,	-12150.00,	225.00,

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OBSERVATION_TYPE = "FRT"
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OBSERVATION_ID = "16#00004DE#"
MRO:OBSERVATION_NUMBER = 16#07#
MRO:ACTIVITY_ID = "IF164"
MRO:SENSOR_ID = "L"
MRO:DETECTOR_TEMPERATURE = -149.765
MRO:OPTICAL_BENCH_TEMPERATURE = -51.554
MRO:SPECTROMETER_HOUSING_TEMP = -75.171
MRO:SPHERE_TEMPERATURE = -51.158
MRO:FPE_TEMPERATURE = 0.800
PRODUCT_VERSION_ID = "2"
SOURCE_PRODUCT_ID = {
  "CDR41000000000_DM0000000L_3",
  "CDR41000000000_LL0000000L_3",
  "CDR41000000000_SH0000001L_0",
  "CDR41000000000_SS0000001L_5",
  "CDR41000000000_TD0000000S_2",
  "CDR410003692813_SF0000000L_4",
  "CDR420847411200_NU1000001L_4",
  "CDR440910732409_BK0003800L_2",
  "CDR440910732415_UB0003800L_2",
  "CDR440910732449_SP0003801L_4",
  "CDR440910732449_SP0042581S_2",
  "CDR440910732471_BK0003800L_2",
  "CDR440910732477_UB0003800L_2",
  "CDR440910736166_BI0000000L_2",
  "CDR440910736205_BI1000000L_2",
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  "CDR440910740371_BK1030100L_2",
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  "CDR6_1_0000000000_BS_L_0",
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  "CDR6_1_0000000000_EB_L_0",
  "CDR6_1_0000000000_GH_L_2",
  "CDR6_1_0000000000_HD_J_1",
  "CDR6_1_0000000000_HK_J_1",
  "CDR6_1_0000000000_HV_J_1",
  "CDR6_1_0000000000_LC_L_1",
  "CDR6_1_0000000000_LI_J_0",
  "CDR6_1_0000000000_VL_L_0",
  "CDR6_2_0835294537_PP_L_0",
  "CDR6_4_0910656020_ST_J_0",
  "FRT00004DE_07_SC164L_EDR0"
}
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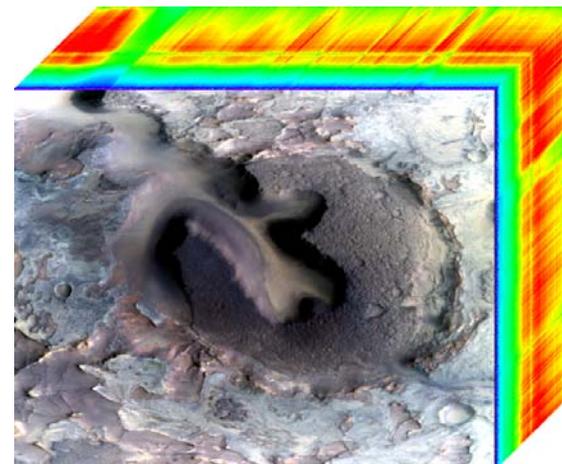
Detached PDS label for each image, giving the observation  
time and setup, and all the files used to process the data

Scene I/F, unitless



Multiband image of I/F;  
assembled from multiple frames

- **FRT** = Class Type
  - FRT (Full Resolution Targeted Observation)
  - HRL (Half Resolution Long Targeted Observation)
  - HRS (Half Resolution Short Targeted Observation)
  - EPF (Atmospheric Survey EPF)
  - LMB (Limb Scan)
  - TOD (Tracking Optical Depth Observation)
- Mapping:
  - MSP (Multispectral Survey, VNIR+IR, 200 m/pix)
  - HSP (Hyperspectral Survey, VNIR+IR, 200 m/pix)
  - HSV (Hyperspectral Survey, VNIR only, 200 m/pix)
  - MSW (Multispectral Window, VNIR+IR, 100 m/pix)
  - MSV (Hyperspectral Window, VNIR only, 100 m/pix)
- **00003E12** = 8-digit hexadecimal Observation ID
- **07** = Hex counter for image within observation
- **IF166** = Processing, internal command macro used
  - RAnnn – Radiance / Macro#
  - IFnnn – I/F / Macro#
- **L** = Sensor ID
  - S for VNIR
  - L for IR
- **TRR3** = TRDR, current version = 3
- **IMG** = file extension
  - IMG for binary image data
  - LBL for detached ASCII PDS label
  - TAB for detached ASCII table of housekeeping



Full-resolution target

Observation 3E12

Counter

Calibrated to I/F

IR detector

Software version 3

**FRT00003E12\_07\_IF166L\_TRR3.IMG**

The file name fully describes the type of data, which detector it comes from, the version of the processing, and gives the unique ID and counter

# Backplanes =DDR<sup>\*</sup>

## Separate VNIR and IR DDRs

- Geometric information for every pixel of an image including lat, lon, i, e, and g. For map projection, photometric correction.
- Additional information includes elevation, slope magnitude and azimuth, and TES bolometric albedo and thermal inertia. Used for data analysis.

### \* Derived Data Records

### Backplanes, various units



Multiband images of backplanes; one-for-one correspondence with spatial position in TRDR

```

TARGET_CENTER_DISTANCE = 3633.060355 <KM>
/* distance to Mars center at first frame */
SOLAR_DISTANCE = 212192706.948812 <KM>
SOLAR_LONGITUDE = 204.982066 <DEGREES>
MRO:FRAME_RATE = 3.75 <HZ>
PIXEL_AVERAGING_WIDTH = 10
MRO:INSTRUMENT_POINTING_MODE = "DYNAMIC POINTING"
SCAN_MODE_ID = "LONG"

/* This DDR label describes one data file: */
/* 1. A multiple-band backplane image file with wavelength-independent, */
/* spatial pixel-dependent geometric and timing information. */

/* See the CRISM Data Products SIS for more detailed description. */

OBJECT = FILE
^IMAGE = "FRT00010DFE_0A_DE157L_DDR1.IMG"
RECORD_TYPE = FIXED_LENGTH
RECORD_BYTES = 256
FILE_RECORDS = 210

OBJECT = IMAGE
LINES = 15
LINE_SAMPLES = 64
SAMPLE_TYPE = PC_REAL
SAMPLE_BITS = 32
BANDS = 14
BAND_STORAGE_TYPE = BAND_SEQUENTIAL
BAND_NAME = ("INA at areoid, deg",
             "EMA at areoid, deg",
             "Phase angle, deg",
             "Latitude, areocentric, deg N",
             "Longitude, areocentric, deg E",
             "INA at surface from MOLA, deg",
             "EMA at surface from MOLA, deg",
             "Slope magnitude from MOLA, deg",
             "MOLA slope azimuth, deg clkwise from N",
             "Elevation, meters relative to MOLA",
             "Thermal inertia, J m^-2 K^-1 s^-0.5",
             "Bolometric albedo",
             "Local solar time, hours",
             "Spare")

END_OBJECT = IMAGE
END_OBJECT = FILE
    
```

A detached PDS label gives the companion observation, its time and setup, and describes each layer of the DDR

- **FRT** = Class Type
  - FRT (Full Resolution Targeted Observation)
  - HRL (Half Resolution Long Targeted Observation)
  - HRS (Half Resolution Short Targeted Observation)
  - EPF (Atmospheric Survey EPF)
  - LMB (Limb Scan)
  - TOD (Tracking Optical Depth Observation)
- Mapping:
  - MSP (Multispectral Survey, VNIR+IR, 200 m/pix)
  - HSP (Hyperspectral Survey, VNIR+IR, 200 m/pix)
  - HSV (Hyperspectral Survey, VNIR only, 200 m/pix)
  - MSW (Multispectral Window, VNIR+IR, 100 m/pix)
  - MSV (Hyperspectral Window, VNIR only, 100 m/pix)
- **00003E12** = 8-digit hexadecimal Observation ID
- **07** = Hex counter for image within observation
- **DE166** = Processing, internal command macro used
  - DE $n$ nn – Derived information / Macro#
- **L** = Sensor ID
  - S for VNIR
  - L for IR
- **DDR1** = DDR, current version = 1
- **IMG** = file extension
  - IMG for binary image data
  - LBL for detached ASCII PDS label



*Full-resolution target*  
*Observation 3E12*  
*Counter*  
*Derived information*  
*IR detector*  
*Software version 1*

**FRT00003E12\_07\_DE166L\_DDR1.IMG**

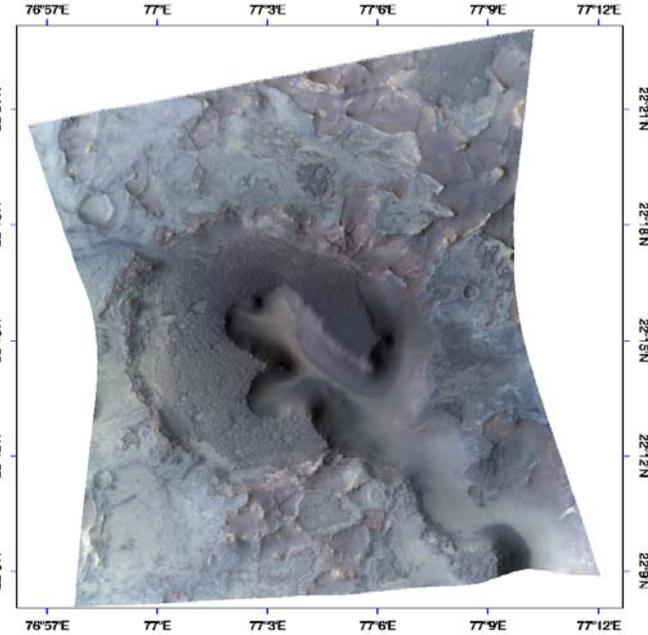


f

I/F in sensor space



Latitude, longitude,  
incidence, emission, and  
phase angle

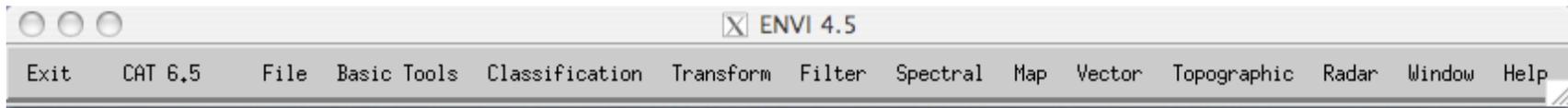


Map-projected I/F data or  
other data from DDRs (e.g.,  
slope, elevation, etc.)

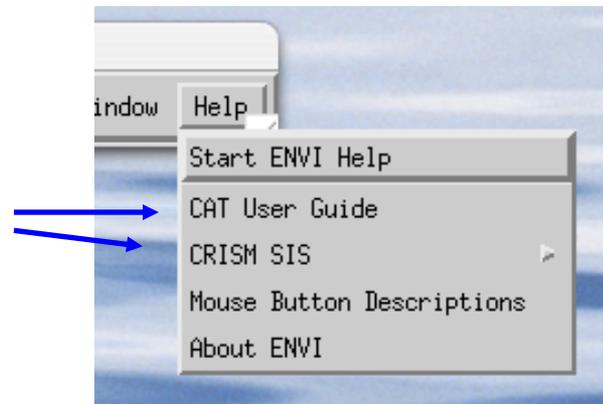
Note: Map convention is planetocentric, positive east longitude

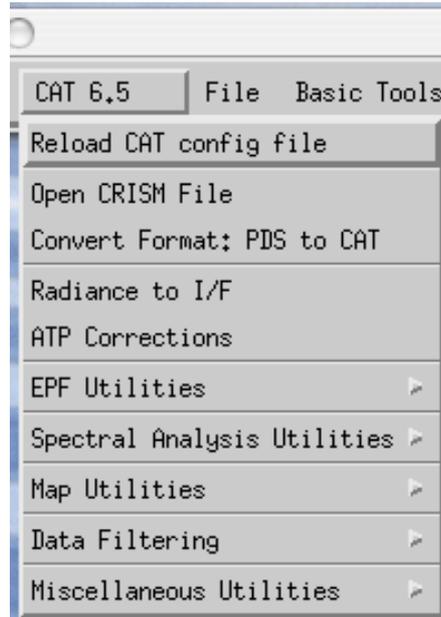
# CRISM Analysis Tool (CAT)

- Runs as extension to ENVI (ITT VIS)
- Tools to:
  - Open and display CRISM images
  - Apply certain standard corrections
  - Produce summary parameters
- The following summarizes key CAT operations on TRDRs that analysts in the user community commonly do
- Later you'll see that much of this is pre-applied to MTRDRs, plus CAT capabilities for MTRDRs



- When CAT installed, ENVI starts with CAT menu added
  - includes CAT version number
- Additional CAT-specific items added under Help and Display/Tools menus



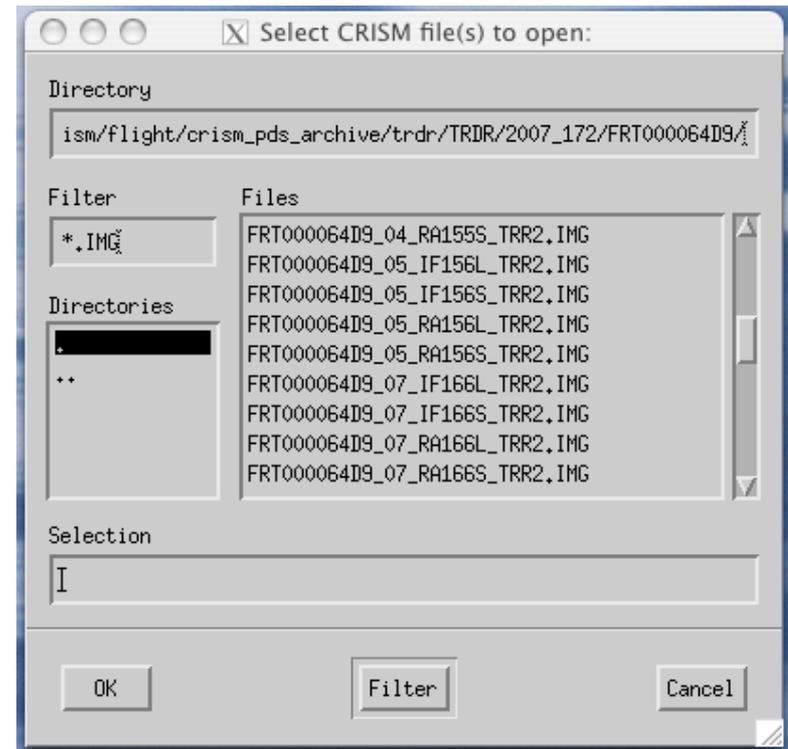


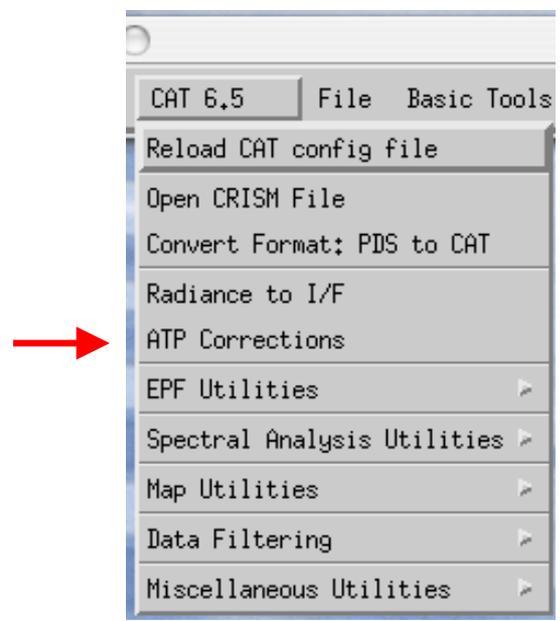
## INPUT DATA:

- CRISM PDS image file (\*.IMG)
- Corresponding PDS label (\*.LBL)
  - example: FRT000064D9\_07\_IF166L\_TRR3.IMG  
FRT000064D9\_07\_IF166L\_TRR3.LBL

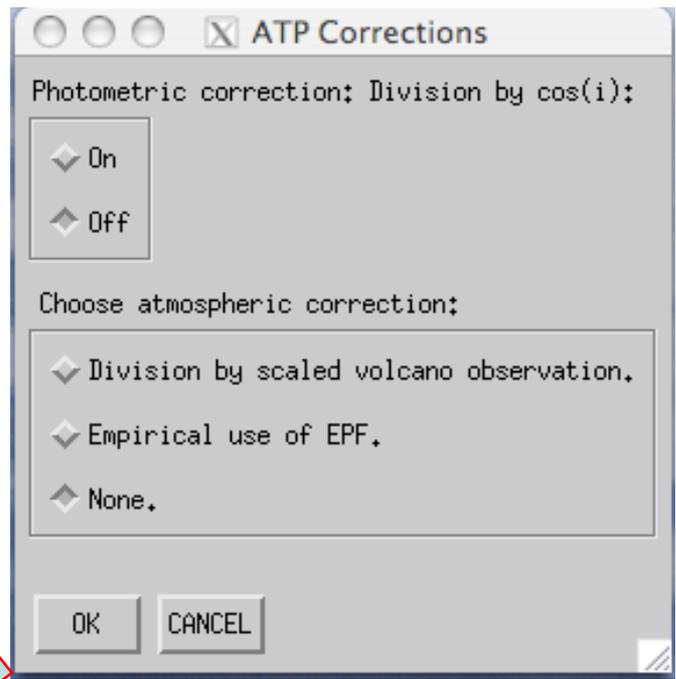
select input file in the ENVI dialog box that pops up

Opens CRISM data in ENVI  
*Available Bands and Display* windows

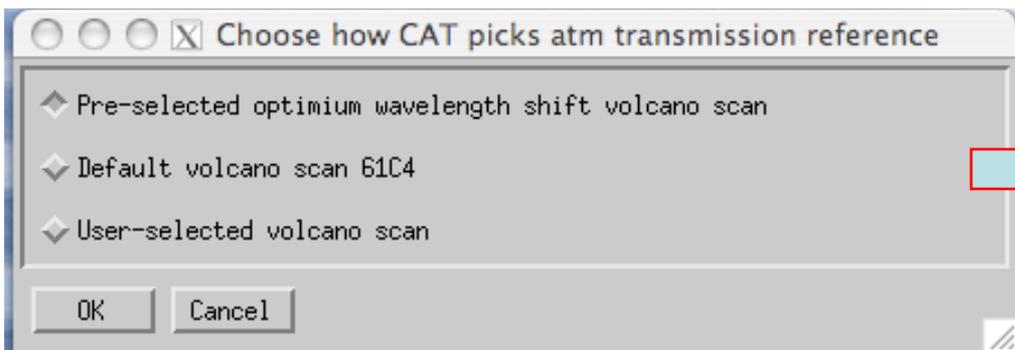
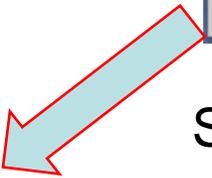




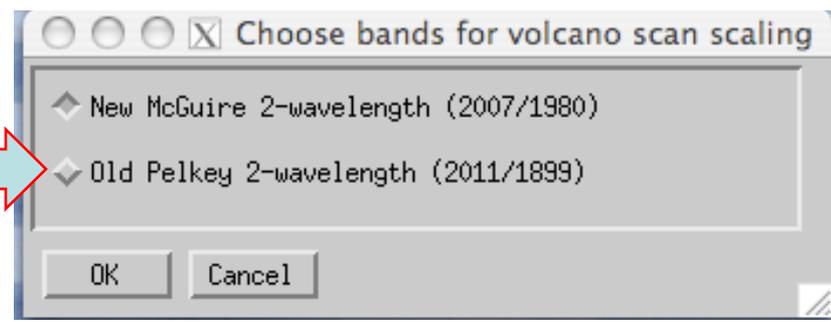
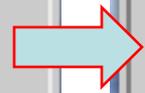
File selection dialog... then make selections for an atmospheric "correction"



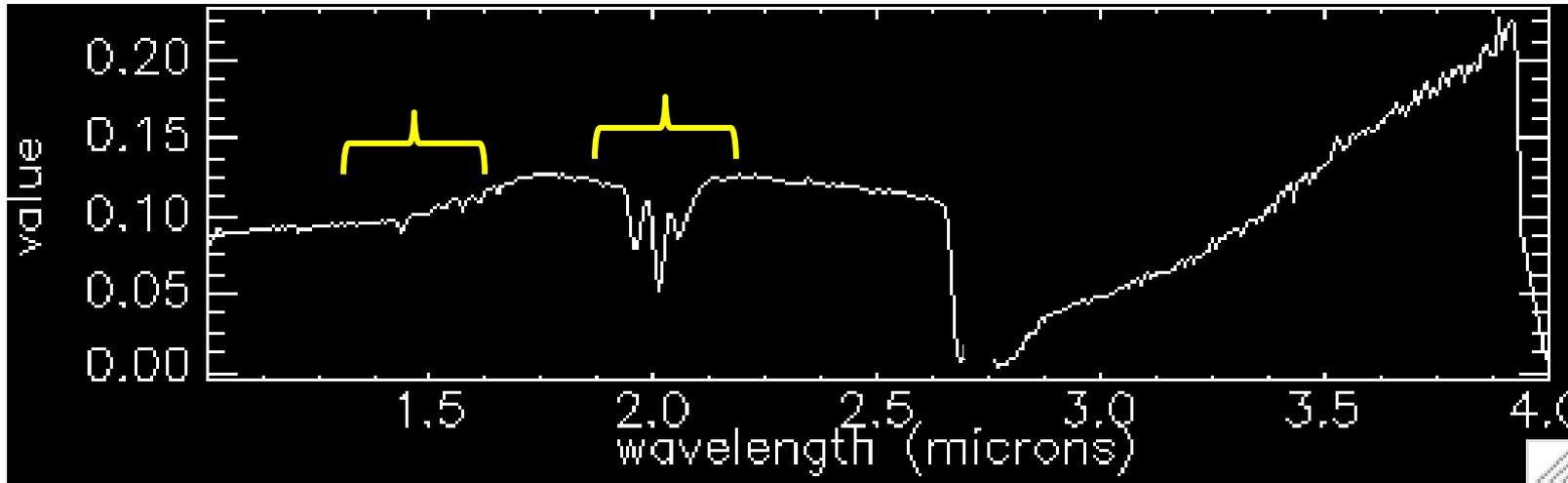
Pick the "volcano scan" file to use...



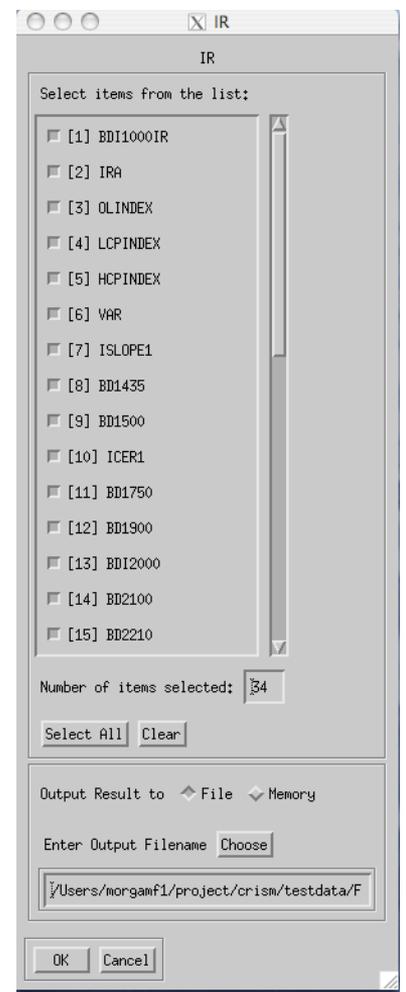
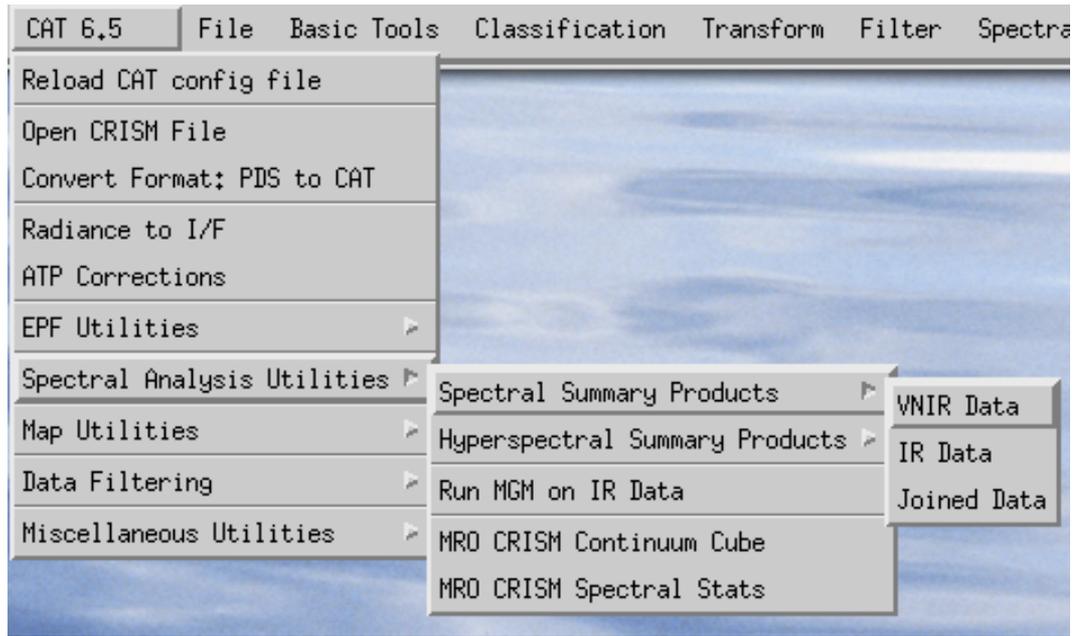
Select scaling wavelengths...



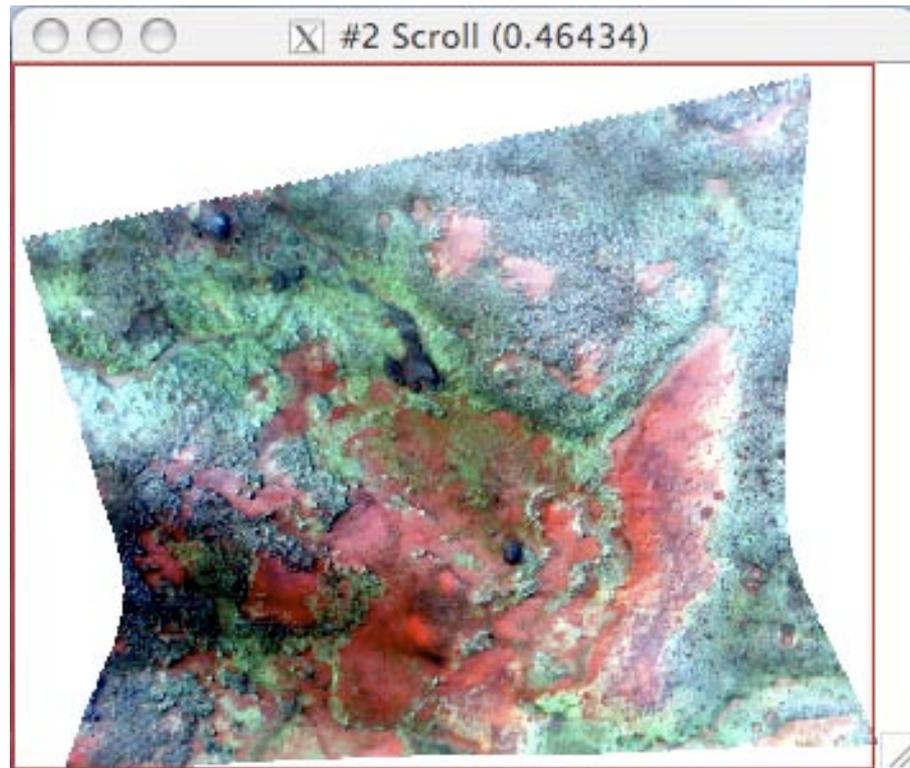
- Atmospheric Correction: to correct for absorption by CO<sub>2</sub>
  - “Volcano scan”: special observation viewing nadir on traverse across Olympus Mons
  - Atmospheric transmission  $\sim$  (base spectrum) / (summit spectrum)
  - Correct a scene spectrum by scaling the transmission to match the scene at 2 wavelengths near the CO<sub>2</sub> 2-micron band, then divide
    - One near absorption peak, one in wings
    - Adjusts for variable atmospheric optical depth- elevation, season...



- Summary Parameters: algebraic measures of the strengths and positions of possible mineral absorptions, and measures of the spectral continuum.



- Project Single Cube Data
  - Map projection using coordinates from DDR



# Java CRISM Analysis Tool (JCAT)

- Available **free** at <http://crism.jhuapl.edu/JCAT>
- Password protected, contact Hari.Nair@jhuapl.edu for access
- JCAT has core CAT capabilities and the most basic ENVI capabilities:
  - Download CRISM files from the PDS (TRDR, DDR files)
  - Map project images, either stereographic (default) or rectangular
  - Manipulate image data - choose display bands, perform contrast stretches, save to PNG format
  - Plot and export pixel spectra (I/F or ratioed)
  - Export overlay for use with Google Mars
- Still development code, but being used by the Mars Exploration Student Data Teams (MESDT)

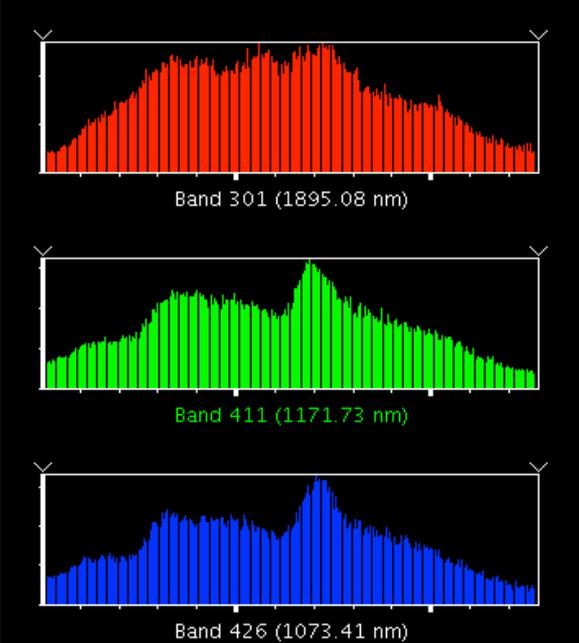
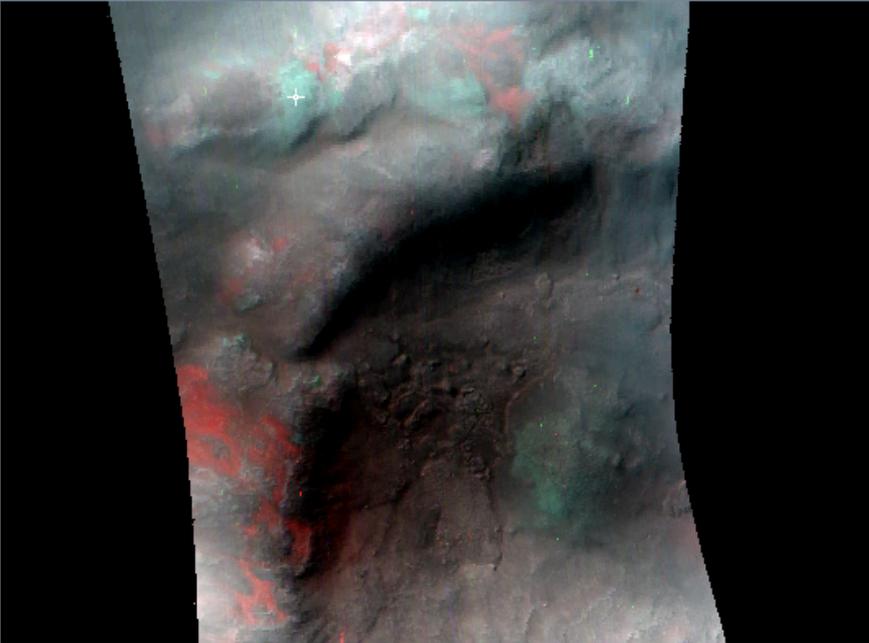
Java CRISM Analysis Tool (JCAT)

File View Browser Help

JCAT Image 0 (Stereographic, hrl0000985d)

Image Histogram Plot Tools

Image

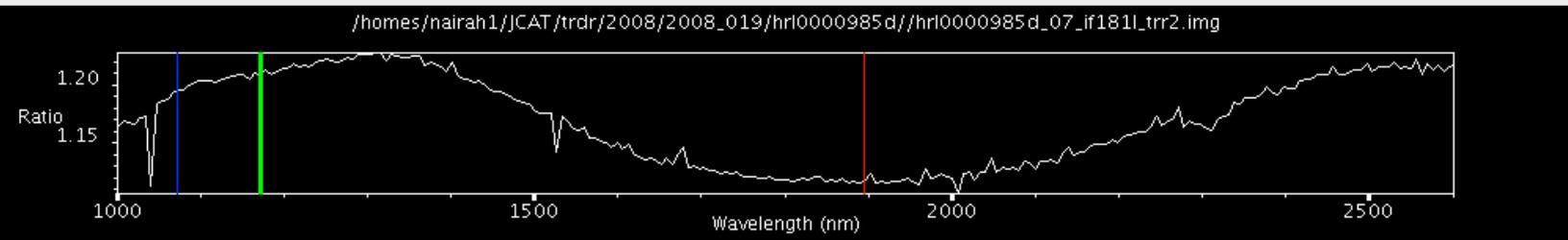


Screen (x, y) = (180, 215)  
Data (x, y) = (226, 370)  
Background (x, y) = (226, 350)

(R, G, B) = (144, 200, 192)  
lat, lon = (-39.4865, -46.8929)  
Spectrum Box Size = 3x3

Rerender Update Histogram

/homes/nairah1/JCAT/trdr/2008/2008\_019/hrl0000985d/hrl0000985d\_07\_if181l\_trr2.img



Ratio

Wavelength (nm)

# Accessing CRISM Data Via PDS Geosciences Node

- Planetary Data System (PDS) Geosciences Node - <http://geo.pds.nasa.gov/>
- PDS CRISM Archives: <http://geo.pds.nasa.gov/missions/mro/crism.htm>
- Orbital Data Explorer: <http://ode.rsl.wustl.edu/mars/>
  - Specialized PDS web tool
  - Allows users to:
    - search, retrieve, and order PDS products
    - search across missions and instruments (e.g. CRISM, HiRISE, CTX)
    - search across PDS nodes
    - search via maps and forms
    - search MRO coordinated observations

**Mars Orbital Data Explorer** PDS Geosciences Node  
Washington University in St. Louis

Home Data Product Search Map Search Tools Data Set Browser Download Help & Resources

**DATA PRODUCT SEARCH** [Reset Form](#)

Planetary science data stored in PDS is organized by [data products](#) and [data sets](#). A data set is a collection of related data products, usually products acquired by a particular instrument and processed in a certain way. The data set also includes all documentation and supporting materials needed to understand and use the data products. A data product is a set of measurements resulting from a science observation, usually products acquired by a particular instrument and processed in a certain way.

**STEP 1. SELECT DATA SETS TO SEARCH (A SELECTION IS REQUIRED)**

- Select One or More Desired Data Sets (Released PDS Archives) (Show Options - 1 Parameter Set)
- Select Any Desired Special Product Data Sets (Non-PDS) *New Option* (Show Options - 0 Parameters Set)

**STEP 2. SET ADDITIONAL FILTERING PARAMETERS (OPTIONAL)**

- Select a Product ID or filter by a partial Product ID (Show Options - 0 Parameters Set)
- Filter by Existing and Proposed Landing Sites *New Option* (Show Options - 0 Parameters Set)
- Find by Product Location (Show Options - 0 Parameters Set)
- Filter by Time Range (Show Options - 0 Parameters Set)

**STEP 3. PREVIEW SEARCH RESULTS SUMMARY (OPTIONAL)**

[Preview Search Results Summary](#)

**STEP 4. SUBMIT QUERY**

[View Results in Table](#) [Select Results on Map Display](#)

Display Product Thumbnails on search results page

SEARCH for Products

**Mars Orbital Data Explorer** PDS Geosciences Node  
Washington University in St. Louis

Home Data Product Search Map Search Tools Data Set Browser Download Help & Resources

**SEARCH RESULTS** [Output Results](#) [View on Map](#) [Back to Search](#)

Products Found: 71,027 [Display Product Thumbnails](#) [Update Cart](#)

Instrument	Type	Product ID	Obs. Time	
MRO CRISM	TRDR	<a href="#">FRT000446C_07_IF1665_TR3</a>	2007-03-11T08:41:14.800	<input type="checkbox"/>
MRO CRISM	DDR	<a href="#">FRT0004476_07_DE164L_DDR1</a>	2007-03-11T12:13:02.921	<input type="checkbox"/>
MRO CRISM	DDR	<a href="#">FRT0004476_07_DE164S_DDR1</a>	2007-03-11T12:13:02.996	<input type="checkbox"/>
MRO CRISM	TRDR	<a href="#">FRT0004476_07_IF164L_TR3</a>	2007-03-11T12:13:02.920	<input type="checkbox"/>
MRO CRISM	TRDR	<a href="#">FRT0004476_07_IF164S_TR3</a>	2007-03-11T12:13:02.955	<input type="checkbox"/>
MRO CRISM	DDR	<a href="#">FRT000449A_07_DE165L_DDR1</a>	2007-03-11T21:41:45.806	<input type="checkbox"/>
MRO CRISM	DDR	<a href="#">FRT000449A_07_DE165S_DDR1</a>	2007-03-11T21:41:45.838	<input type="checkbox"/>
MRO CRISM	TRDR	<a href="#">FRT000449A_07_IF165L_TR3</a>	2007-03-11T21:41:45.806	<input type="checkbox"/>
MRO CRISM	TRDR	<a href="#">FRT000449A_07_IF165S_TR3</a>	2007-03-11T21:41:45.837	<input type="checkbox"/>
MRO CRISM	DDR	<a href="#">FRT0004424_07_DE163L_DDR1</a>	2007-03-12T14:04:27.859	<input type="checkbox"/>
MRO CRISM	DDR	<a href="#">FRT0004424_07_DE163S_DDR1</a>	2007-03-12T14:04:27.859	<input type="checkbox"/>
MRO CRISM	TRDR	<a href="#">FRT0004424_07_IF163L_TR3</a>	2007-03-12T14:04:27.859	<input type="checkbox"/>
MRO CRISM	TRDR	<a href="#">FRT0004424_07_IF163S_TR3</a>	2007-03-12T14:04:27.859	<input type="checkbox"/>
MRO CRISM	DDR	<a href="#">FRT0004443_07_DE163L_DDR1</a>	2007-03-12T21:27:39.774	<input type="checkbox"/>
MRO CRISM	DDR	<a href="#">FRT0004443_07_DE163S_DDR1</a>	2007-03-12T21:27:39.711	<input type="checkbox"/>
MRO CRISM	TRDR	<a href="#">FRT0004443_07_IF163L_TR3</a>	2007-03-12T21:27:39.773	<input type="checkbox"/>
MRO CRISM	TRDR	<a href="#">FRT0004443_07_IF163S_TR3</a>	2007-03-12T21:27:39.710	<input type="checkbox"/>
MRO CRISM	DDR	<a href="#">FRT00044F7_07_DE164L_DDR1</a>	2007-03-12T21:46:02.584	<input type="checkbox"/>
MRO CRISM	DDR	<a href="#">FRT00044F7_07_DE164S_DDR1</a>	2007-03-12T21:46:02.584	<input type="checkbox"/>
MRO CRISM	TRDR	<a href="#">FRT00044F7_07_IF164L_TR3</a>	2007-03-12T21:46:02.583	<input type="checkbox"/>
MRO CRISM	TRDR	<a href="#">FRT00044F7_07_IF164S_TR3</a>	2007-03-12T21:46:02.583	<input type="checkbox"/>
MRO CRISM	DDR	<a href="#">FRT0004404_07_DE165L_DDR1</a>	2007-03-13T01:48:36.660	<input type="checkbox"/>
MRO CRISM	DDR	<a href="#">FRT0004404_07_DE165S_DDR1</a>	2007-03-13T01:48:36.460	<input type="checkbox"/>
MRO CRISM	TRDR	<a href="#">FRT0004404_07_IF165L_TR3</a>	2007-03-13T01:48:36.659	<input type="checkbox"/>
MRO CRISM	TRDR	<a href="#">FRT0004404_07_IF165S_TR3</a>	2007-03-13T01:48:36.659	<input type="checkbox"/>
MRO CRISM	DDR	<a href="#">FRT0004413_07_DE163L_DDR1</a>	2007-03-13T04:59:29.409	<input type="checkbox"/>

**Product Description:** The detector is subsampled in [\(more...\)](#)  
[View About this Product Type \(Data Page\)](#)  
[PDS Volume](#) [ASCII/ADMG.TXT](#) [ESRATA.TXT](#) [Catalog Files](#) [Document Files](#)  
[Data Product Software Interface Specification \(PDF\)](#)  
[Archive Software Interface Specification Document \(PDF\)](#)

[Browse](#) [Meta Data](#) [Label](#) [Related Products](#) [Map Context](#)

Browse Image - the image below is not the actual data product

[Add Product to Cart](#) [Remove Product from Cart](#) [Cart & Download Help](#)

CRISM Instrument Team Web Site  
[FRT00044F7\\_07\\_IF164S\\_TR3](#)

**PDS Product Files** **Derived Files**

Product Files & Labels	
<a href="#">FRT00044F7_07_IF164S_TR3.jpg</a>	115,049
<a href="#">FRT00044F7_07_IF164S_TR3.tbl</a>	9
<a href="#">FRT00044F7_07_RA164S_H3A3.tbl</a>	513
<a href="#">Product Data File</a>	
<b>Referenced Files</b>	<b>KB</b>

RETRIEVE and View Products

[See Handout](#)

**Mars Orbital Data Explorer** PDS Geosciences Node  
Washington University in St. Louis

Home Data Product Search Map Search Tools Data Set Browser Download Help & Resources

Mars ODE Map Interface - North Polar

Zoom In Zoom Out Full Extent Prev Extent Next Extent Pan Select Products by Area Remove Area Selection Select Projection Map Help

**Map Display Controls**

Selected Layers Set Filters (Optional) View Selection Results

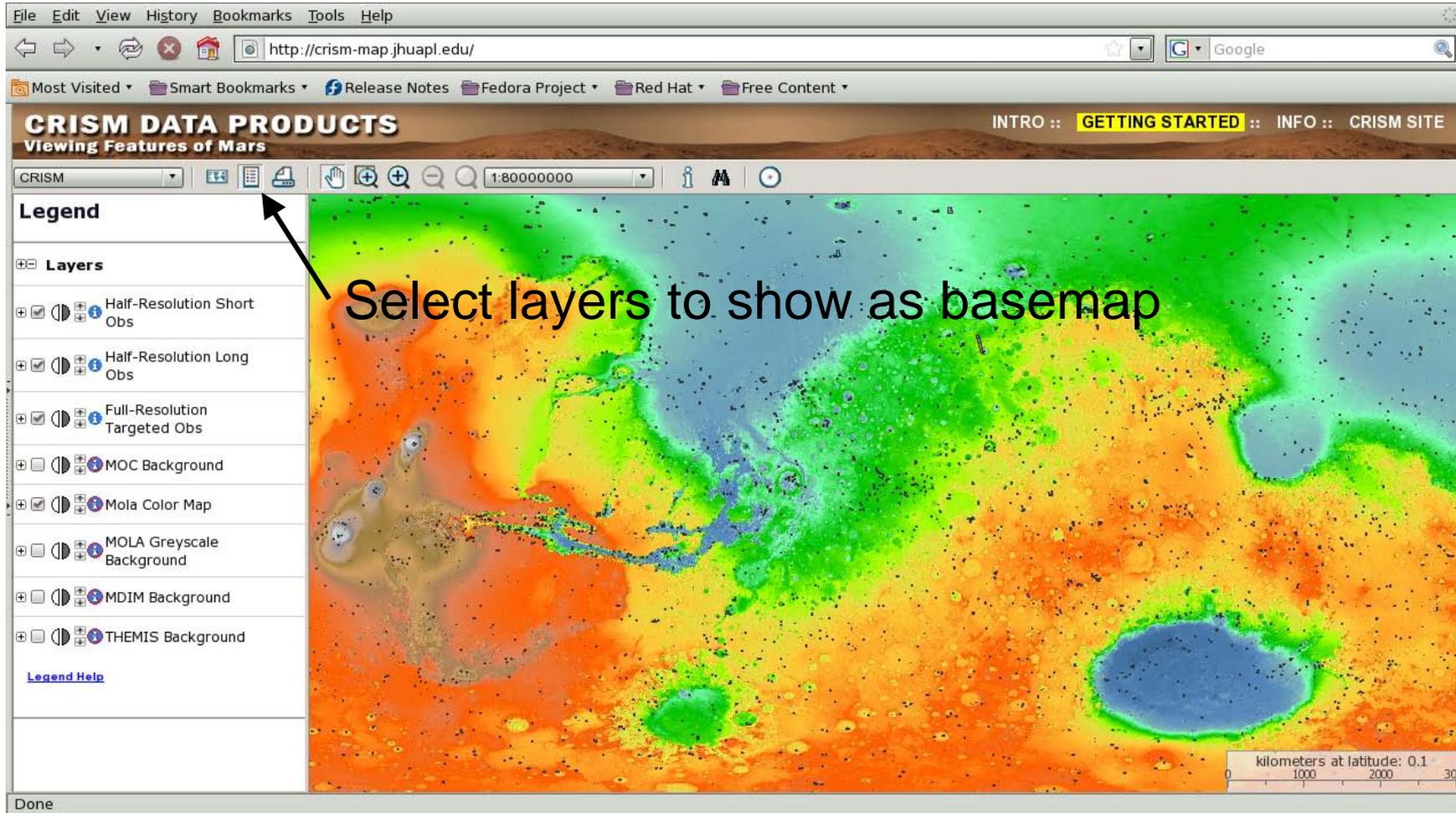
Instrument	Product ID	
MRO CRISM	<a href="#">FRT0004472_07_DE164L_DDR1</a>	<input type="checkbox"/>
MRO CRISM	<a href="#">FRT0004472_07_DE164S_DDR1</a>	<input type="checkbox"/>
MRO CRISM	<a href="#">FRT0004472_07_IF164L_TR3</a>	<input type="checkbox"/>
MRO CRISM	<a href="#">FRT0004472_07_IF164S_TR3</a>	<input type="checkbox"/>
MRO CRISM	<a href="#">FRT00044C2_07_DE164L_DDR1</a>	<input type="checkbox"/>
MRO CRISM	<a href="#">FRT00044C2_07_DE164S_DDR1</a>	<input type="checkbox"/>
MRO CRISM	<a href="#">FRT00044C2_07_IF164L_TR3</a>	<input type="checkbox"/>
MRO CRISM	<a href="#">FRT00044C2_07_IF164S_TR3</a>	<input type="checkbox"/>
MRO CRISM	<a href="#">FRT0004372_07_DE164L_DDR1</a>	<input type="checkbox"/>
MRO CRISM	<a href="#">FRT0004372_07_DE164S_DDR1</a>	<input type="checkbox"/>
MRO CRISM	<a href="#">FRT0004372_07_IF164L_TR3</a>	<input type="checkbox"/>
MRO CRISM	<a href="#">FRT0004372_07_IF164S_TR3</a>	<input type="checkbox"/>

40 km  
Lon: -90.256, Lat: 84.929

MAP Products

Accessing Data Via  
<http://crism-map.jhuapl.edu/>

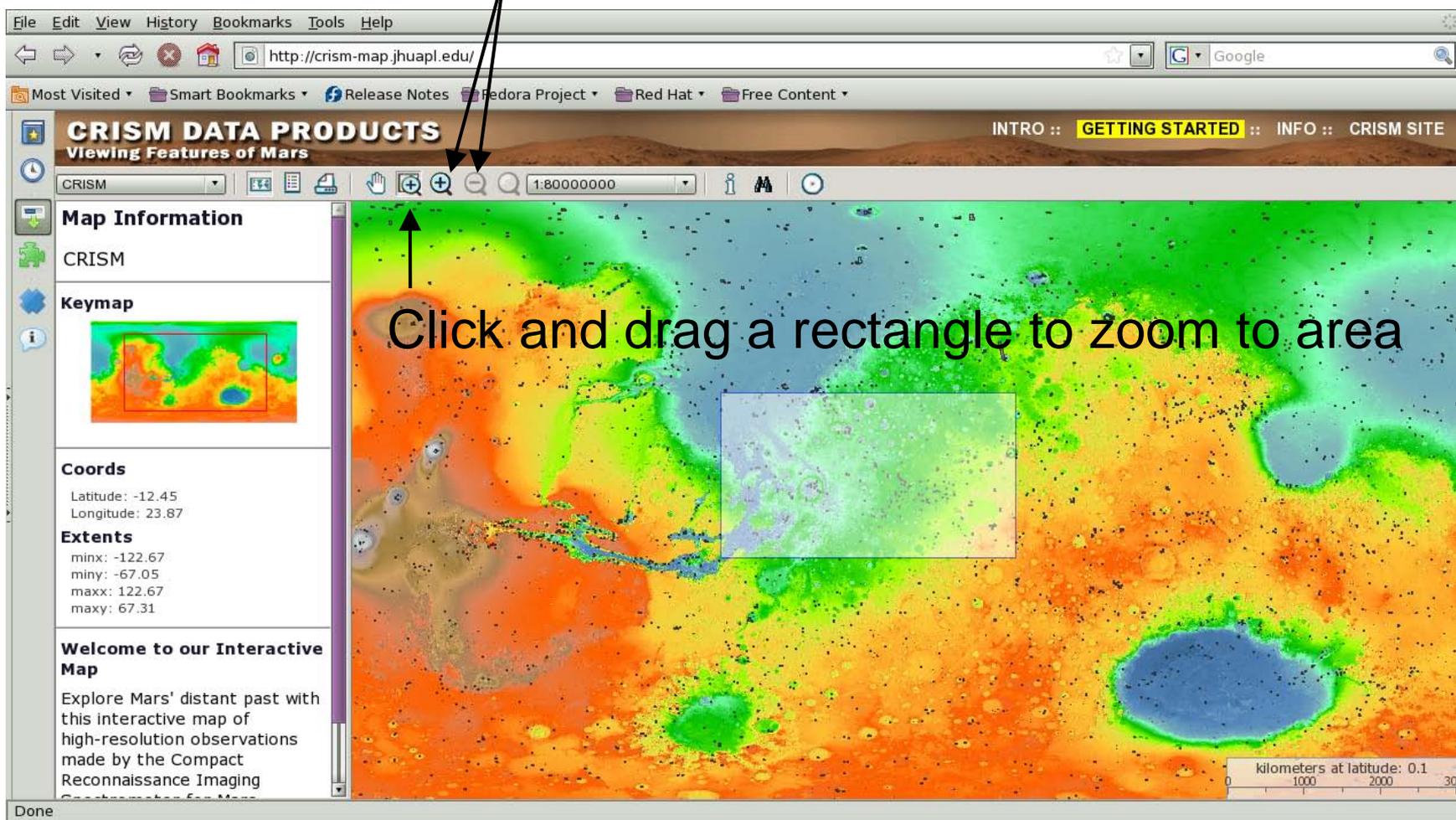
Each black spot is a CRISM targeted observation



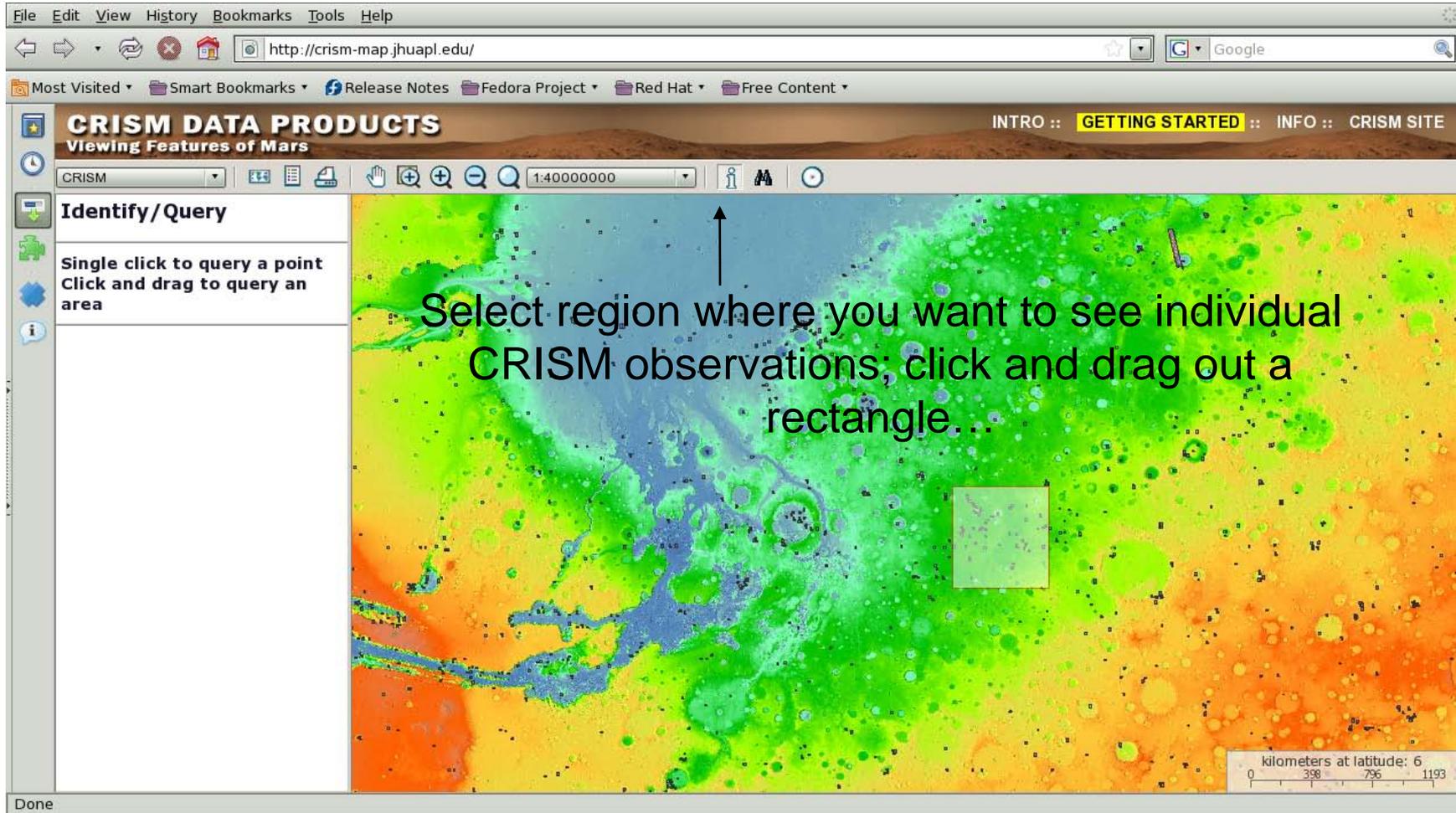
The screenshot shows a web browser window with the URL <http://crism-map.jhuapl.edu/>. The page title is "CRISM DATA PRODUCTS" with a subtitle "Viewing Features of Mars". The navigation menu includes "INTRO :: GETTING STARTED :: INFO :: CRISM SITE". The main map area displays a color-coded topographic map of Mars with numerous small black dots representing CRISM observations. On the left, a "Legend" panel is open, showing a list of layers with checkboxes and icons. An arrow points from the text "Select layers to show as basemap" to the legend panel.

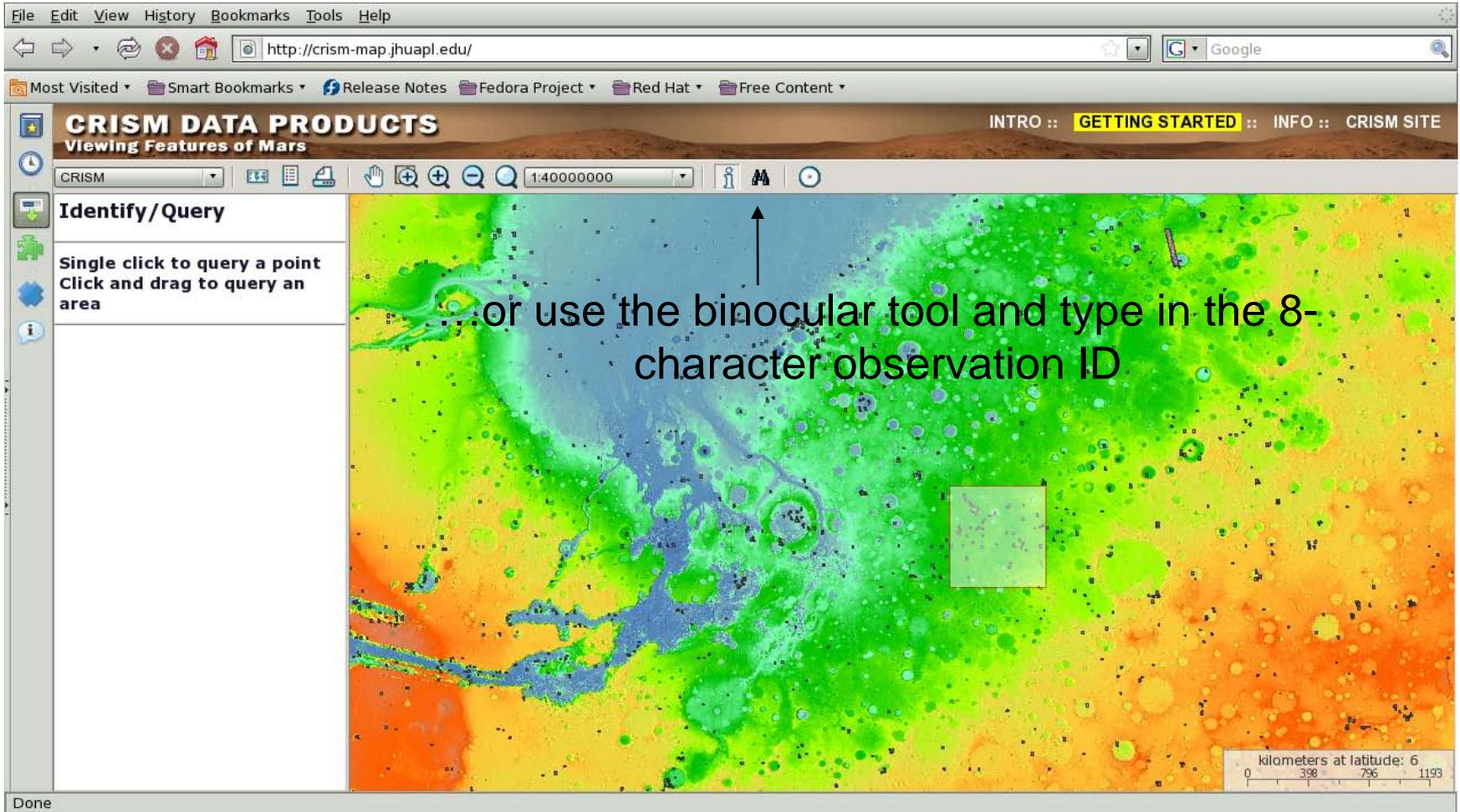
Layer Name	Checked	Icon
Half-Resolution Short Obs	<input checked="" type="checkbox"/>	[Icon]
Half-Resolution Long Obs	<input checked="" type="checkbox"/>	[Icon]
Full-Resolution Targeted Obs	<input checked="" type="checkbox"/>	[Icon]
MOC Background	<input type="checkbox"/>	[Icon]
Mola Color Map	<input checked="" type="checkbox"/>	[Icon]
MOLA Greyscale Background	<input type="checkbox"/>	[Icon]
MDIM Background	<input type="checkbox"/>	[Icon]
THEMIS Background	<input type="checkbox"/>	[Icon]

Zoom in and out

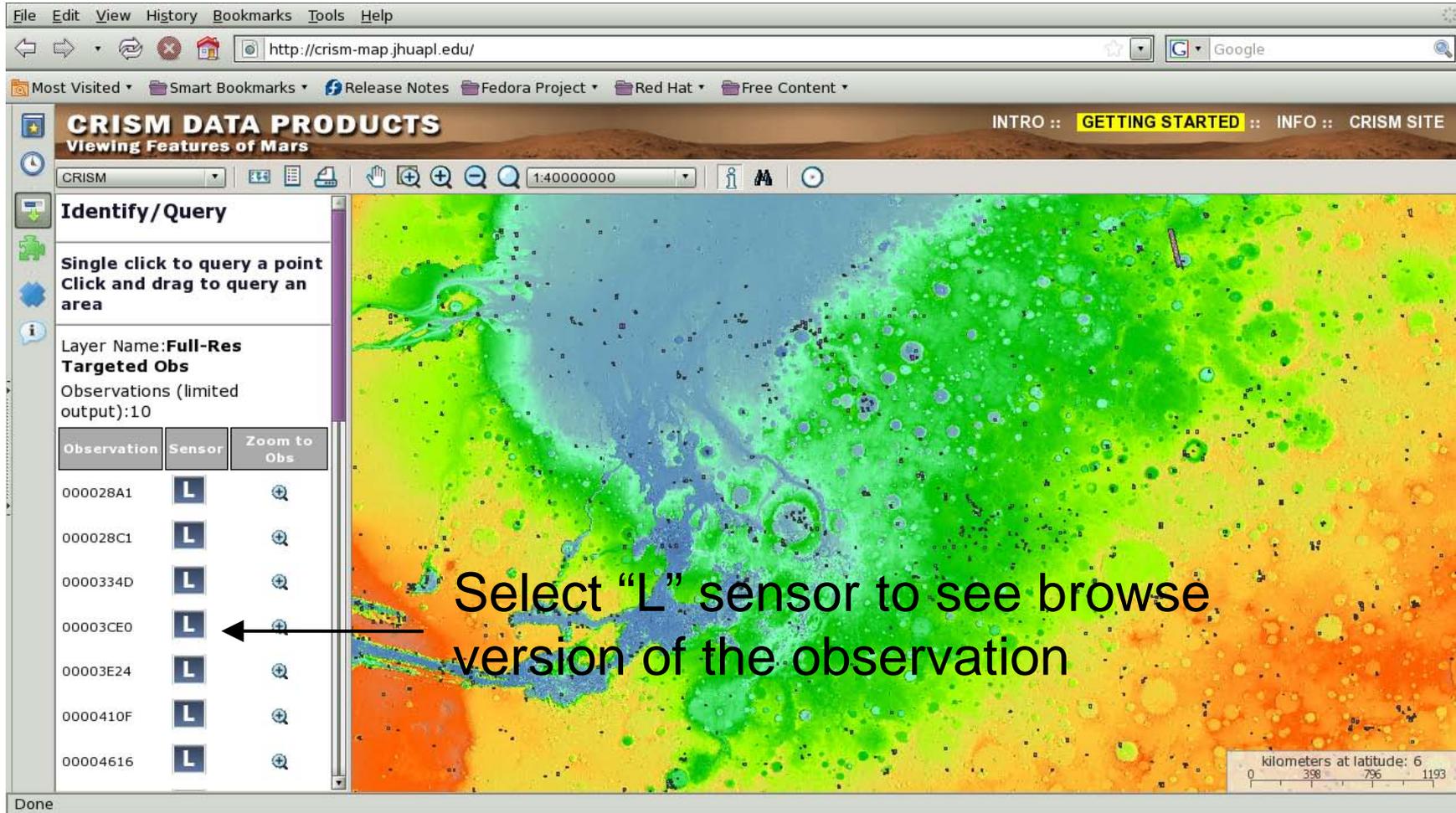


The screenshot shows a web browser window with the URL <http://crism-map.jhuapl.edu/>. The page title is "CRISM DATA PRODUCTS" and the subtitle is "Viewing Features of Mars". The navigation menu includes "INTRO :: GETTING STARTED :: INFO :: CRISM SITE". The main map area displays a color-coded topographic map of Mars with a scale of 1:80000000. A white rectangular box highlights a specific region of interest on the map. A text overlay "Click and drag a rectangle to zoom to area" points to this box. The left sidebar contains "Map Information" (CRISM), a "Keymap" showing the current view's location on a larger map, "Coords" (Latitude: -12.45, Longitude: 23.87), and "Extents" (minx: -122.67, miny: -67.05, maxx: 122.67, maxy: 67.31). A "Welcome to our Interactive Map" section is also present. The browser's status bar at the bottom shows "Done".





The screenshot shows a web browser window with the URL <http://crism-map.jhuapl.edu/>. The page title is "CRISM DATA PRODUCTS" and the subtitle is "Viewing Features of Mars". The navigation menu includes "INTRO :: GETTING STARTED :: INFO :: CRISM SITE". The main content area displays a color-coded topographic map of Mars. A binocular tool is positioned over a specific feature on the map, and an arrow points to the 8-character observation ID "140000000" displayed in the tool's interface. A text overlay reads: "or use the binocular tool and type in the 8-character observation ID". The left sidebar contains an "Identify/Query" section with instructions: "Single click to query a point" and "Click and drag to query an area". A scale bar at the bottom right indicates "kilometers at latitude: 6" with markings at 0, 398, 796, and 1193.



The screenshot shows a web browser window with the URL <http://crism-map.jhuapl.edu/>. The page title is "CRISM DATA PRODUCTS" and the subtitle is "Viewing Features of Mars". The interface includes a navigation menu with "INTRO :: GETTING STARTED :: INFO :: CRISM SITE". A sidebar on the left contains an "Identify/Query" section with instructions: "Single click to query a point" and "Click and drag to query an area". Below this, it shows "Layer Name: Full-Res Targeted Obs" and "Observations (limited output): 10". A table lists observations with columns for "Observation", "Sensor", and "Zoom to Obs". An arrow points to the "L" sensor icon for observation 00003CE0. The main area displays a color-coded map of Mars with various features. A scale bar at the bottom right indicates "kilometers at latitude: 6" with markers at 0, 398, 796, and 1193.

Observation	Sensor	Zoom to Obs
000028A1	L	🔍
000028C1	L	🔍
0000334D	L	🔍
00003CE0	L	🔍
00003E24	L	🔍
0000410F	L	🔍
00004616	L	🔍

Select "L" sensor to see browse version of the observation

NOTE: This will be extensively updated over the next 6-9 months to include new materials you will see today

The screenshot shows a web browser window with the URL [http://crism-map.jhuapl.edu/details.php?data=frt\\_webmap\\_polygons&shape=398&x=-6.808425&y=8.08546](http://crism-map.jhuapl.edu/details.php?data=frt_webmap_polygons&shape=398&x=-6.808425&y=8.08546). The page title is "CRISM DATA PRODUCTS" and the subtitle is "Viewing Features of Mars".

**BROWSE PRODUCTS**

**vnir\_rgb**  
Enhanced visible color  
red = 592nm  
green = 533 nm  
blue = 492nm  
Downloads:  
• PNG  
• PNG w/ geo\_grid  
• Map/Stretch Info

**ir\_ira**  
IR surface brightness  
gray level = brightness at 1330nm  
Downloads:  
• PNG  
• PNG w/ geo\_grid  
• Map/Stretch Info

**ABOUT BROWSE PRODUCTS**

[Interpreting the Browse Products](#)  
[Visible and Near-infrared \(VNIR\) Browse Products](#)  
[Infrared \(IR\) Browse Products](#)

**ACCESS TO MRO DATA IN THE PDS**

The following links provide direct access to the PDS archive of calibrated CRISM data for this observation, as well as to CTX or HiRISE images coordinated with it.

[VNIR image data, calibrated to units of I/F](#)  
[VNIR geometric information, in several units](#)  
[IR image data, calibrated to units of I/F](#)  
[IR geometric information, in several units](#)  
[Accompanying CRISM emission phase function data, and CTX and HiRISE coordinated images](#)

**OBSERVATION DETAILS**

File	FRT000049CA_07_IF165S_TRR2.LBL
Comment	COORD Target - 2892 Faulted Layers in Impact Crater in Meridiani Planum
Year/Day of Year	2007_067
Observation Class	FRT
Observation Id	000049CA
Image Count within Observation Sequence	07
File Type	IF

Background on browse images

Link to data at the PDS

Link to coordinated HIRISE, CTX

"Browse" versions of data

Observation details