CRISM DDRs, TRDRs, and MTRDRs

CRISM Science Operations Center

CRISM Data Files

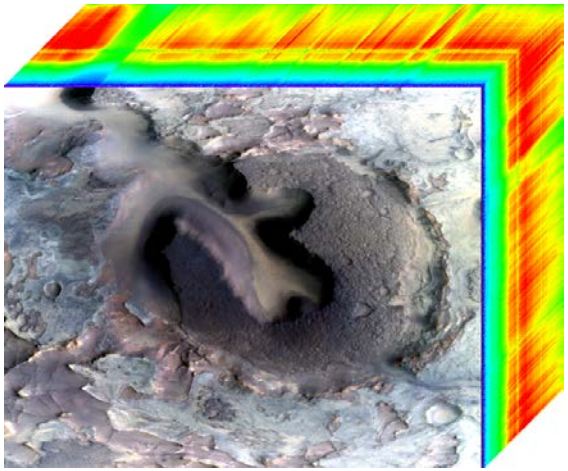
These slides detail the filename conventions and content of the 3 most commonly used types of CRISM data files

- TRDR
  - Radiometrically calibrated spectral image data
  - Filename like FRT000094F6_07_IF166L_TRR3.IMG
- DDR
  - “Backplanes” for TRDR files; geometry data including lat/lon, emission angles, elevation, etc…
  - Filename like FRT000094F6_07_DE166L_DDR1.IMG
  - CAT needs to have DDRs and corresponding PDS labels along with the image data either in same directory (usual practice) or in a parallel directory structure like:
    - ...trdr/TRDR/YYYY_DDD/FRT000094F6/.IMG, *.LBL
    - ...ddr/DDR/YYYY_DDD/FRT000094F6/*.DDR, *.LBL
- MTRDR
  - Further filtering and processing of TRDR data to reduce noise and correct atmospheric and photometric effects, and map project

TRDR Nomenclature

- **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

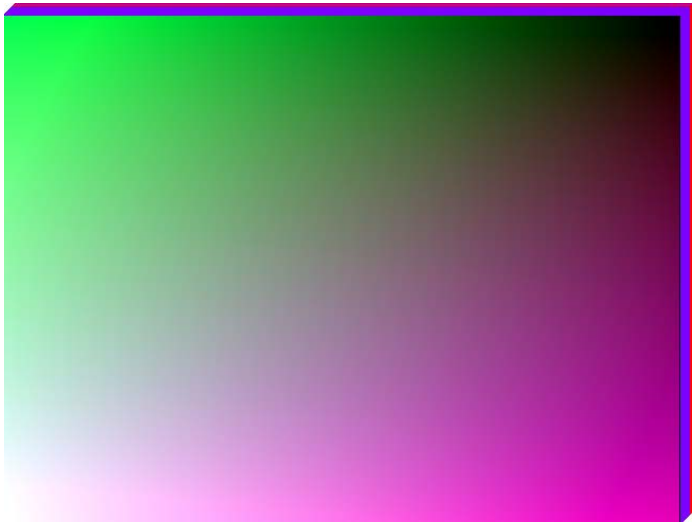
FRT00003E12_07_IF166L_TRR3:
The file name fully describes the type of data, which detector it comes from, the version of the processing, and gives the unique ID and counter

Backplanes =DDRs*
Separate VNIR and IR DDRs

*** Derived Data Records**

- 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.

Backplanes, various units



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

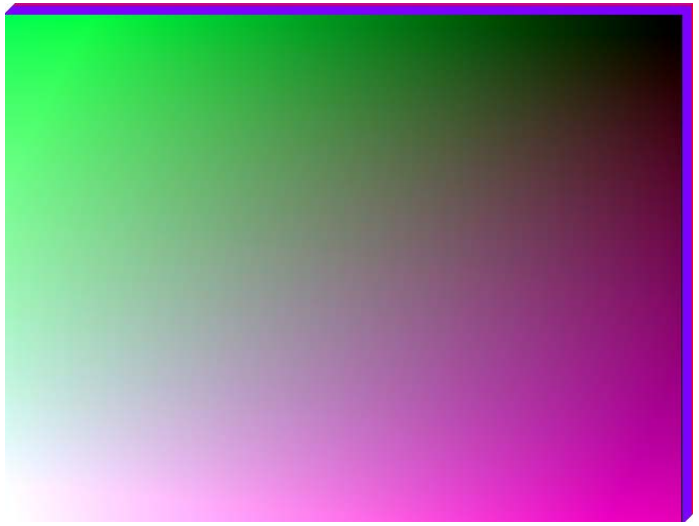
```
TARGET_CENTER_DISTANCE       = 3633.060355 <KM>
                               /* distance to Mars center at first frame */
SOLAR_DISTANCE               = 212192706.948812 <KM>
SOLAR_LONGITUDE              = 204.982066 <DEGREES>
MRO:FRAME_RATE               = 3.75 <HZ>
PIXEL_AVERAGING_WIDTH        = 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",
                                "Bolometic 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

DDR Nomenclature

- **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
  - DEnnn – 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

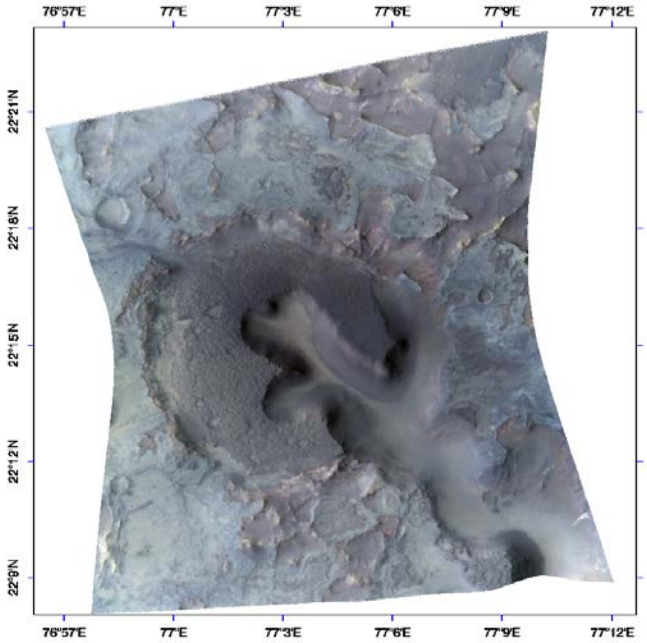


Full-resolution target
Observation 3E12
Counter
Derived information
IR detector
Software version 1

FRT00003E12_07_DE166L_DDR1:

Usage of DDRs

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

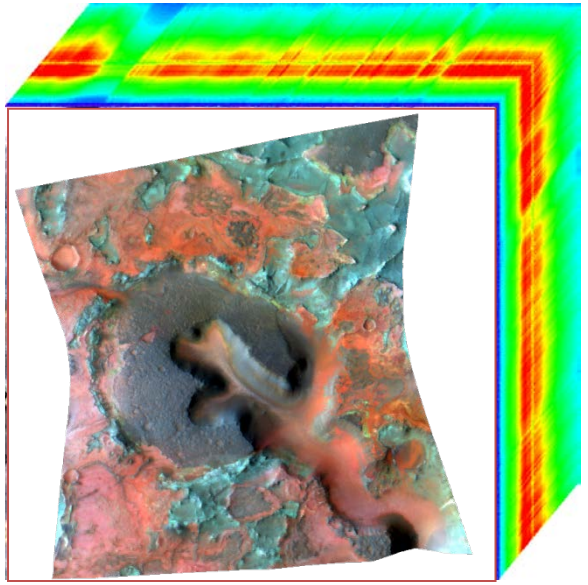
What is an MTRDR?

1) An image cube of I/F from a TRR3 for a targeted observation's central swath, with additional processing:
   - The best current correction for atmospheric gases
   - Lambertian photometric correction
   - First-order empirical normalization of atmospheric opacity to the nearest-nadir geometry
   - Residual cross-track optical distortions ("spectral smile") fitted and normalized
   - VNIR data transformed to align with IR data in sensor space
   - "Bad bands" removed
   - Map projected to a global standard (equirectangular, rolling center latitude of projection)
2) An image cube of spectral indices ("summary products") derived from these corrected, normalized data
3) An image cube of map-projected geometric information from the DDRs

- **Our current, best, "whole image" correction to what an idealized version of CRISM would see if it only pointed an nadir**

MTRDR Nomenclature

- **FRT =** Class Type
  - FRT (Full Resolution Targeted Observation)
  - HRL (Half Resolution Long Targeted Observation)
  - HRS (Half Resolution Short Targeted Observation)
- **00003E12** = 8-digit hexadecimal Observation ID
- **07** = Hex counter for image within observation
- **IF166** = Processing, internal command macro used
  - IFnnn – I/F / Macro#
  - SUnnn – Summary products / Macro#
  - DEnnn – Derived data / Macro#
- **J** = Sensor ID
  - J for joined (for IF and SU)
  - L for IR (for DE)
- **MTR3** = MTRDR, calibration version = 3
- **IMG** = file extension
  - IMG for binary image data
  - LBL for detached ASCII PDS label



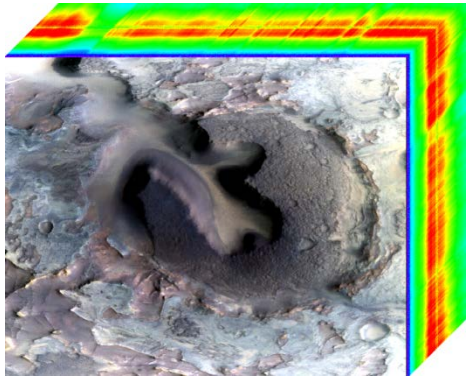
Full-resolution target
Observation 3E12
Counter
Calibrated to I/F
Joined VNIR+IR data
Software version 3

FRT00003E12_07_IF166J_MTR3.IMG

The file name describes the type of data, an overview of the processing, and gives the unique ID and counter

Non-Map Projected Version of the Corrected Data (TER)

Scene I/F, unitless



Multiband image of corrected I/F; VNIR re-projected to IR; “bad bands” STILL PRESENT

```
SPACECRAFT_ID                = MRO
INSTRUMENT_NAME              = "COMPACT RECONNAISSANCE IMAGING
                                SPECTROMETER FOR MARS"
INSTRUMENT_ID                = CRISM
TARGET_NAME                  = MARS
PRODUCT_TYPE                 = MPTARGETED_RDR
PRODUCT_CREATION_TIME        = 2010-11-21T17:44:07
START_TIME                   = 2008-08-21T17:20:57.794
STOP_TIME                    = 2008-08-21T17:22:57.529
SPACECRAFT_CLOCK_START_COUNT = "4/0903806478.04596"
SPACECRAFT_CLOCK_STOP_COUNT  = "4/0903806597.52710"
ORBIT_NUMBER                 = "NULL"
OBSERVATION_TYPE             = "FRT"
OBSERVATION_ID               = 16#0000C202#
MRO:OBSERVATION_NUMBER       = 16#07#
MRO:ACTIVITY_ID              = "IF165"
MRO:SENSOR_ID                = "J"

/* Detector and FPE temperature refer to IR component of observation */

MRO:DETECTOR_TEMPERATURE     = -152.306
MRO:OPTICAL_BENCH_TEMPERATURE = -52.930
MRO:SPECTROMETER_HOUSING_TEMP = -76.728
MRO:SPHERE_TEMPERATURE       = -52.672
MRO:FPE_TEMPERATURE          = 0.718
PRODUCT_VERSION_ID           = 3
```

Detached PDS label describing the source files, corrections performed

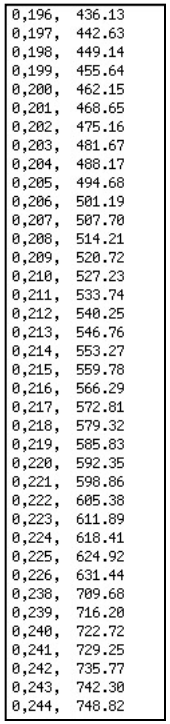
TER = Targeted Empirically-corrected Data Record

- **FRT =** Class Type
  - FRT (Full Resolution Targeted Observation)
  - HRL (Half Resolution Long Targeted)
  - HRS (Half Resolution Short Targeted)
- **00003E12** = 8-digit hexadecimal Observation ID
- **07** = Hex counter within observation
- **IF166** = Processing, internal macro used
  - IFnnn – I/F / Macro#
- **J** = Sensor ID
  - J for joined
- **TER3** = TER, calibration version = 3
- **IMG** = file extension
  - IMG for binary image data
  - LBL for detached ASCII PDS label

Full-resolution target
Observation 3E12
Counter
Calibrated to I/F
Joined VNIR+IR data
Software version 3

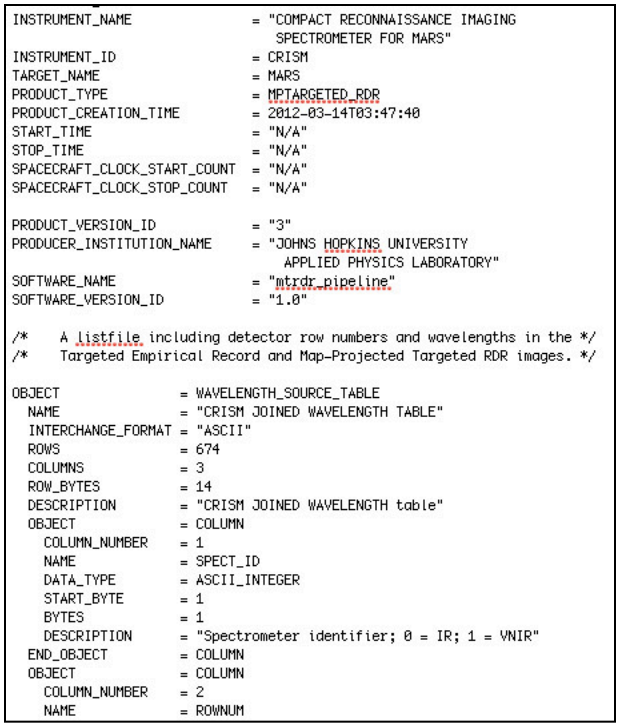
FRT00003E12_07_IF166J_TER3.IMG

Each Type of I/F File is Accompanied by a Table of Wavelengths Present



```
0,196,  436.13
0,197,  442.63
0,198,  449.14
0,199,  455.64
0,200,  462.15
0,201,  468.65
0,202,  475.16
0,203,  481.67
0,204,  488.17
0,205,  494.68
0,206,  501.19
0,207,  507.70
0,208,  514.21
0,209,  520.72
0,210,  527.23
0,211,  533.74
0,212,  540.25
0,213,  546.76
0,214,  553.27
0,215,  559.78
0,216,  566.29
0,217,  572.81
0,218,  579.32
0,219,  585.83
0,220,  592.35
0,221,  598.86
0,222,  605.38
0,223,  611.89
0,224,  618.41
0,225,  624.92
0,226,  631.44
0,238,  709.68
0,239,  716.20
0,240,  722.72
0,241,  729.25
0,242,  735.77
0,243,  742.30
0,244,  748.82
```

ASCII table of image band numbers and wavelengths



```
INSTRUMENT_NAME                = "COMPACT RECONNAISSANCE IMAGING
                                  SPECTROMETER FOR MARS"
INSTRUMENT_ID                  = CRISM
TARGET_NAME                    = MARS
PRODUCT_TYPE                   = MPTARGETED_RDR
PRODUCT_CREATION_TIME          = 2012-03-14T03:47:40
START_TIME                     = "N/A"
STOP_TIME                      = "N/A"
SPACECRAFT_CLOCK_START_COUNT   = "N/A"
SPACECRAFT_CLOCK_STOP_COUNT    = "N/A"

PRODUCT_VERSION_ID             = "3"
PRODUCER_INSTITUTION_NAME      = "JOHNS HOPKINS UNIVERSITY
                                  APPLIED PHYSICS LABORATORY"
SOFTWARE_NAME                  = "mtrdr_pipeline"
SOFTWARE_VERSION_ID            = "1.0"

/*    A listfile including detector row numbers and wavelengths in the */
/*    Targeted Empirical Record and Map-Projected Targeted RDR images. */

OBJECT                = WAVELENGTH_SOURCE_TABLE
  NAME                = "CRISM JOINED WAVELENGTH TABLE"
  INTERCHANGE_FORMAT  = "ASCII"
  ROWS                = 674
  COLUMNS             = 3
  ROW_BYTES           = 14
  DESCRIPTION         = "CRISM JOINED WAVELENGTH table"
  OBJECT              = COLUMN
    COLUMN_NUMBER     = 1
    NAME              = SPECT_ID
    DATA_TYPE         = ASCII_INTEGER
    START_BYTE        = 1
    BYTES             = 1
    DESCRIPTION       = "Spectrometer identifier; 0 = IR; 1 = VNIR"
  END_OBJECT          = COLUMN
  OBJECT              = COLUMN
    COLUMN_NUMBER     = 2
    NAME              = ROWNUM
```

Detached PDS label describing the table

- **FRT =** Class Type
  - FRT (Full Resolution Targeted Observation)
  - HRL (Half Resolution Long Targeted)
  - HRS (Half Resolution Short Targeted)
- **00003E12** = 8-digit hexadecimal Observation ID
- **07** = Hex counter within observation
- **IF166** = Processing, internal macro used
  - IFnnn – I/F / Macro#
- **J** = Sensor ID
  - J for joined
- **TER3** = Product type and calibration version
  - TER, calibration version = 3
  - MTR, calibration version = 3
- **TAB**= file extension
  - TAB for table of wavelengths
  - LBL for detached ASCII PDS label

Full-resolution target

Observation 3E12

Counter

Wavelength table

Joined VNIR+IR data

Software version 3

FRT00003E12_07_WV166J_TER3.TAB