

Mars Exploration Rover (MER) Project Engineering Camera Calibration Report

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MER 420-6-786
JPL D-25540

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7/19/04



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Change Log

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07/19/2004	Initial Release	Initial

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1 Introduction

1.1 Document Scope

This document describes the results of the Mars Exploration Rover (MER) Engineering Camera pre-launch calibration effort.

The pre-launch calibration of the MER Engineering Cameras focused primarily on the geometric calibration of the cameras at the system-level (i.e., flight cameras mounted on the rover prior to launch). These calibration data were used to derive a geometric “camera model” for each individual camera.

Although the calibration focused mainly on the geometric aspects of the cameras, effort was made to measure relative (flat field) and absolute responsivities. The results of this effort are described in sections 3.2 and 3.2.

1.2 Background

There are 14 Flight Model (FM) Engineering cameras (7 on Spirit and 7 on Opportunity). This report describes the analysis of the calibration data from the FM Engineering Cameras.

Camera Set Designator	Rover Number	Mission Letter	Vehicle Name
FM-1	2	A	Spirit
FM-2	1	B	Opportunity

Table 1.1. MER camera and venue nomenclature.

In addition to the FM cameras, there are also 14 (EM) Engineering Cameras in the MER Testbed (6 cameras in the Surface System Testbed (SSTB), 4 on the SSTB-lite, 2 in the Flight Software Testbed (FSWTB) 1 in the CETB, and 1 non-testbed camera. While a subset of the EM cameras has been geometrically calibrated, the analyses of those data are not included in this report.

1.3 References

For information on the MER Engineering Cameras (and the MER Imaging System in general), see the JGR paper by Maki et al., 2003

Maki, J. N., et al., Mars Exploration Rover Engineering Cameras, *J. Geophys. Res.*, 108(E12), 8071, doi:10.1029/2003JE002077, 2003.)

Detailed information about the camera models can be found in the following:

Gennery, D. B., Least-squares camera calibration including lens distortion and automatic editing of calibration points, in *Calibration and Orientation of Cameras in Computer*

Vision, ch. 5, edited by A. Grun and T. Huang, pp. 123–136, Springer-Verlag, New York, 2001.

Yakimovsky, Y., and R. Cunningham, A system for extracting three-dimensional measurements from a stereo pair of TV cameras, January 7, 1977, Comput. Graph. Image Process., 7, 195–210, 1978.

2 Calibration Data

2.1 Deliverables

The Engineering Camera calibration effort focused on the following deliverables (listed in order of priority):

Item	Priority	Deliverable
Geometric calibration of all MER cameras at the system-level	Highest	CAHVOR(E) Camera Model files.
Relative responsivity (flat field) calibration of the Navcams and Hazcams	Medium	Flat field correction images.
Absolute responsivity of the Navcams and Hazcams	Low	Responsivity coefficients
Additional calibration data were gathered for purposes of characterizing detector dark current and detector read noise. Analysis of those data are not included in this report.	Lowest	None

Table 2.1. Calibration deliverables.

2.2 Data Set Description

The MER Engineering Camera calibration data are divided into two types: The subsystem calibration (also called “camera standalone”) and the system-level calibration (in which the cameras were mounted on the rover and controlled through the rover avionics).

The types of data acquired for each camera are listed in table 2.2.

Type of Measurement	MER A							MER B						
	LNAV 112	RNAV 113	FLHAZ 107	FRHAZ 109	RLHAZ 106	RRHAZ 108	DIMES 118	LNAV 102	RNAV 117	FLHAZ 120	FRHAZ 122	RLHAZ 119	RRHAZ 121	DIMES 123
Subsystem Calibration														
Dark Frames	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Focus Target	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Dot Target	X		X	X	X	X	X	X	X	X	X	X	X	X
White Board	X		X	X	X	X				X		X	X	X
Ambient Integrating Sphere	X	X	X	X	X	X	X	X	X	X		X	X	X
Stray Light Tests	X		X				X	X	X	X				X
Light Transfer Tests (ambient)	X		X	X	X	X	X	X	X	X	X	X	X	X
Light Transfer Tests (-120 C)	X	X	X	X	X	X		X	X	X	X	X	X	
Flat Field at -120 C	X	X	X		X	X		X	X	X	X	X	X	
Flat Field at transitional temperatures	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Subsystem Alignment	X	X	X	X	X	X		X	X	X	X	X	X	
System-Level Calibration														
System Level Geometric Calibration	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Pointing Characterization	X	X						X	X					
Stereo Ranging Tests	X	X	X	X	X	X		X	X	X	X	X	X	
Rover Equipment Deck Imaging	X	X						X	X					
Thermal Stability Imaging	X	X	X	X	X	X		X	X	X	X	X	X	

Table 2.2: MER Engineering Camera calibration data set at a glance.

2.3 Subsystem Calibration

The subsystem camera calibration was performed before the cameras were delivered to ATLO (Assembly Test and Launch Operations). Approximately 16,800 Engineering Camera images were collected during the subsystem calibration. These data are stored in the PDS “deep archive” and are organized by serial number according to the descriptors listed in table 2.3.

Descriptor	Camera	Number of Images
mer_camera_cal_sn_102_edr	MER B, Left Navcam	1009
mer_camera_cal_sn_106_edr	MER A Rear Left Hazcam	1168
mer_camera_cal_sn_107_edr	MER A Front Left Navcam	1171
mer_camera_cal_sn_108_edr	MER A Rear Right Hazcam	936
mer_camera_cal_sn_109_edr	MER A Front Right Hazcam	1026
mer_camera_cal_sn_112_edr	MER A Left Navcam	1058
mer_camera_cal_sn_113_edr	MER A Right Navcam	972
mer_camera_cal_sn_117_edr	MER B Right Navcam	996
mer_camera_cal_sn_118_edr	MER A DESCENT Imager	2501
mer_camera_cal_sn_119_edr	MER B Rear Left Hazcam	928
mer_camera_cal_sn_120_edr	MER B Front Left Hazcam	1013
mer_camera_cal_sn_121_edr	MER B Rear Right Hazcam	912
mer_camera_cal_sn_122_edr	MER B Front Left Hazcam	668
mer_camera_cal_sn_123_edr	MER B Descent Imager	2480
Total Number of Images		16838

Table 2.3. List of MER subsystem-level Engineering Camera Calibration data. These data will be delivered to the PDS as a deep archive delivery.

2.4 System-level calibration

The system-level calibration was performed while the cameras were on the flight vehicles. Approximately 5,800 image data products were collected as part of the ATLO calibration effort. These data are stored in the PDS deep archive and are organized by serial number according to the descriptors listed in table 2.4:

Descriptor	Camera	Number of Images
Mer_atlo1_descent_edr	MER B Descent Imager	148
Mer_atlo1_fcaml_edr	MER B Front Hazcam	522
Mer_atlo1_ncaml_edr	MER B Navcam	1965
Mer_atlo1_rcaml_edr	MER B Rear Hazcam	338
Mer_atlo2_descent_edr	MER A Descent Imager	181
Mer_atlo2_fcaml_edr	MER A Front Hazcam	453
Mer_atlo2_ncaml_edr	MER A Navcam	1972
Mer_atlo2_rcaml_edr	MER A Rear Hazcam	257
Total Number of Images		5836

Table 2.4. List of MER system-level Engineering Camera Calibration data. These data will be delivered to the PDS as a deep archive delivery.

3 Analysis

3.1 Geometric Calibration

All of the MER Engineering Cameras have been geometrically calibrated at the system level using the data listed in table 2.4. The derived results are stored in a CAHVOR(E) camera model file (see references in section 1.3 for more information regarding the CAHVOR(E) camera models). The entire set of CAHVOR(E) camera models for the MER flight cameras are provided in Appendix A.

The CAHVOR(E) camera model describes the relationship between the 2-dimensional detector frame and the 3-dimensional real-world frame. The camera models enable ray tracing, general image projection/reprojection, and the removal of geometric lens distortion. These projection techniques apply to the generation of epipolar aligned images for stereo processing, mosaic generation, and stereo ranging. For more information regarding the camera models used on MER, see the references listed in section 1.3

3.2 Relative Responsivity (flat fields)

All 14 of the flight MER Engineering camera flat field response patterns were measured during the subsystem calibration (table 2.1). These measurements were done at ambient temperatures (+20 C), at cold temperatures (-120), and at various transitional temperatures between -120 and +20 C. The derived flat field files are listed in table 3.1.

Flat Field Filename
MER_FLAT_SN_102.IMG
MER_FLAT_SN_106.IMG
MER_FLAT_SN_107.IMG
MER_FLAT_SN_108.IMG
MER_FLAT_SN_109.IMG
MER_FLAT_SN_112.IMG
MER_FLAT_SN_113.IMG
MER_FLAT_SN_117.IMG
MER_FLAT_SN_119.IMG
MER_FLAT_SN_120.IMG
MER_FLAT_SN_121.IMG
MER_FLAT_SN_122.IMG

Table 3.1. Engineering Camera derived flat field files.

See Appendix B for a comparison of the actual derived flat field data to the modelled response. The files listed in table 3.1 will be delivered to the PDS deep archive.

3.3 Absolute Responsivity

Absolute responsivity measurements were made at the subsystem level (table 2.4). Due to the relatively low prioritization of this task during pre-launch data reduction, the responsivity measurements have not been derived from this data set. However, estimates of the absolute responsivity were derived by comparing Navcam/Hazcam images to Pancam images of the same target. The results of these “proxy” responsivity estimates are shown in table 3.2

Vehicle	Camera	Camera Serial Number	R_0 in units of $(W/(m^2 \text{ st nm}))/(\text{DN}/\text{sec.})$	R_1 in units of $(W/(m^2 \text{ st nm}))/(\text{DN}/\text{sec.})$
MER-A	Left Navcam	112	1.496E-05	1.437E-09
MER-A	Right Navcam	113	1.496E-05	1.437E-09
MER-A	Left Front Hazcam	107	1.496E-05	1.437E-09
MER-A	Right Front Hazcam	109	1.496E-05	1.437E-09
MER-A	Left Rear Hazcam	106	1.496E-05	1.437E-09
MER-A	Right Rear Hazcam	108	1.496E-05	1.437E-09
MER-B	Left Navcam	102	1.496E-05	1.437E-09
MER-B	Right Navcam	117	2.693E-05	1.437E-09
MER-B	Left Front Hazcam	120	1.496E-05	1.437E-09
MER-B	Right Front Hazcam	122	1.496E-05	1.437E-09
MER-B	Left Rear Hazcam	119	1.496E-05	1.437E-09
MER-B	Right Rear Hazcam	121	1.496E-05	1.437E-09

Table 3.2. Navcam/Hazcam absolute responsivity estimates. All of the Engineering Cameras have approximately identical responsivities, with the exception of Navcam SN 117, which is less sensitive than the average MER Engineering Camera by approximately a factor of 1.8. The responsivity as a function of temperature, $R(T) = R_0 + R_1 * T$, where T is the temperature in degrees C.

3.4 Dark Current

Engineering Camera dark current data have been collected for all cameras and have been verified to be similar to that of the Pancam and MI cameras. For more information on the MER camera dark current, see the Pancam and MI calibration reports. The dark current values from the MER Engineering Cameras are less than 1% of the total signal of a well-exposed pixel at typical Martian operating temperatures.

3.5 Pointing Characterization

The ability of the PMA to point to a target was characterized during ATLO. The PMA units on both rovers exhibited virtually identical pointing characteristics.

MER 2 PMA Pointing Summary	Measured Values (pixels)	Measured Values (degrees)	Requirement (degrees)
Left Navcam Repeatability			
Average Error (az), degrees	0.590	0.028	0.1
Average Error (el), degrees	2.115	0.099	0.1
Right Navcam Repeatability			
Average Error, in degrees (az)	0.525	0.025	0.1
Average Error, in degrees (el)	2.084	0.098	0.1
Left Pancam Repeatability			
Average Error, in degrees (az)	1.655	0.026	0.1
Average Error, in degrees (y)	4.692	0.075	0.1
Right Pancam Repeatability			
Average Error, in degrees (az)	1.281	0.020	0.1
Average Error, in degrees (el)	4.182	0.067	0.1

Table 3.2 Pointing performance for the Spirit PMA, as measured in ATLO.

Appendix A – Geometric Camera Models

MER A Camera Models	MER B Camera Models
<pre> Filename: /oss/mera/ops/ops/surface/tactical/staging/ ssw/products/./050/028/d0148-000- 0006_001_0141097355-043.dat Type: img_model - Camera Model Tables Spacecraft: MER A (SCID=254) DVT:2004-173T13:41:16.734 - 0141097355.043 Packetized: 2004-174T18:49:51.415 - 0141202270.052 ERT:2004-174T19:25:12.107 APID=50 Subtype=28 Version=0 [Front Left Hazcam] Camera Model ID: 58 Camera Serial Number: 107 Camera ID: Front Left Hazcam Filter Position: No filter/unknown Model Class: CAHVORE Model Type: 3 Model Parameter: 0.370000 Array Center Vector length 3 [0] Center Vector: 0.606185 [1] Center Vector: -0.043367 [2] Center Vector: -0.234891 Array Axis Vector length 3 [0] Axis Vector: 0.712013 [1] Axis Vector: 0.037316 [2] Axis Vector: 0.701174 Array Horizontal Vector length 3 [0] Horizontal Vector: 353.340667 [1] Horizontal Vector: 474.872862 [2] Horizontal Vector: 350.820311 Array Vertical Vector length 3 [0] Vertical Vector: 44.010163 [1] Vertical Vector: 16.904013 [2] Vertical Vector: 683.916158 Array Optical Vector length 3 [0] Optical Vector: 0.712953 [1] Optical Vector: 0.038186 [2] Optical Vector: 0.700171 Array Radial Distortion Terms length 3 [0] Radial Distortion Terms: 0.000003 [1] Radial Distortion Terms: -0.013032 [2] Radial Distortion Terms: -0.007540 Array Entrance Pupil Terms length 3 [0] Entrance Pupil Terms: 0.000942 </pre>	<pre> Filename: /oss/merb/flight/ops/lc/downlink/data_prods /staging/ssw/products/./050/028/p0001-001- 0028_001_0124528157-209.dat Type: img_model - Camera Model Tables Spacecraft: MER B (SCID=253) DVT:2003-346T19:09:17.816 - 0124528157.209 Packetized: 2003-350T02:32:24.377 - 0124814015.109 ERT:2003-350T03:08:42.308 APID=50 Subtype=28 Version=0 [Front Left Hazcam] Camera Model ID: 33 Camera Serial Number: 120 Camera ID: Front Left Hazcam Filter Position: No filter/unknown Model Class: CAHVORE Model Type: 3 Model Parameter: 0.370000 Array Center Vector length 3 [0] Center Vector: 0.609331 [1] Center Vector: -0.041064 [2] Center Vector: -0.233849 Array Axis Vector length 3 [0] Axis Vector: 0.703447 [1] Axis Vector: -0.005161 [2] Axis Vector: 0.710729 Array Horizontal Vector length 3 [0] Horizontal Vector: 351.361730 [1] Horizontal Vector: 452.204294 [2] Horizontal Vector: 353.494013 Array Vertical Vector length 3 [0] Vertical Vector: 35.806531 [1] Vertical Vector: -1.751429 [2] Vertical Vector: 682.704520 Array Optical Vector length 3 [0] Optical Vector: 0.704402 [1] Optical Vector: -0.006062 [2] Optical Vector: 0.709775 Array Radial Distortion Terms length 3 [0] Radial Distortion Terms: 0.000003 [1] Radial Distortion Terms: -0.012015 [2] Radial Distortion Terms: -0.007525 Array Entrance Pupil Terms length 3 [0] Entrance Pupil Terms: 0.001442 </pre>

MER A Camera Models	MER B Camera Models
[1]	[1]
Entrance Pupil Terms: 0.002280	Entrance Pupil Terms: 0.001522
[2]	[2]
Entrance Pupil Terms: 0.001613	Entrance Pupil Terms: 0.000483
Array Camera Reference Vector length 3	Array Camera Reference Vector length 3
[0]	[0]
Camera Reference Vector: 0.000000	Camera Reference Vector: 0.000000
[1]	[1]
Camera Reference Vector: 0.000000	Camera Reference Vector: 0.000000
[2]	[2]
Camera Reference Vector: 0.000000	Camera Reference Vector: 0.000000
Array Camera Reference Quaternion length 4	Array Camera Reference Quaternion length 4
[0]	[0]
Camera Reference Quaternion: 0.000000	Camera Reference Quaternion: 0.000000
[1]	[1]
Camera Reference Quaternion: 0.000000	Camera Reference Quaternion: 0.000000
[2]	[2]
Camera Reference Quaternion: 0.000000	Camera Reference Quaternion: 0.000000
[3]	[3]
Camera Reference Quaternion: 1.000000	Camera Reference Quaternion: 1.000000
Camera Temperature: 20.000000	Camera Temperature: 20.000000
[Front Right Hazcam]	[Front Right Hazcam]
Camera Model ID: 59	Camera Model ID: 34
Camera Serial Number: 109	Camera Serial Number: 122
Camera ID: Front Right Hazcam	Camera ID: Front Right Hazcam
Filter Position: No filter/unknown	Filter Position: No filter/unknown
Model Class: CAHVORE	Model Class: CAHVORE
Model Type: 3	Model Type: 3
Model Parameter: 0.370000	Model Parameter: 0.370000
Array Center Vector length 3	Array Center Vector length 3
[0]	[0]
Center Vector: 0.605777	Center Vector: 0.609774
[1]	[1]
Center Vector: 0.055065	Center Vector: 0.060081
[2]	[2]
Center Vector: -0.235306	Center Vector: -0.234332
Array Axis Vector length 3	Array Axis Vector length 3
[0]	[0]
Axis Vector: 0.702176	Axis Vector: 0.706252
[1]	[1]
Axis Vector: -0.007688	Axis Vector: 0.034860
[2]	[2]
Axis Vector: 0.711962	Axis Vector: 0.707102
Array Horizontal Vector length 3	Array Horizontal Vector length 3
[0]	[0]
Horizontal Vector: 347.882684	Horizontal Vector: 353.645269
[1]	[1]
Horizontal Vector: 451.204960	Horizontal Vector: 476.675400
[2]	[2]
Horizontal Vector: 357.288613	Horizontal Vector: 350.756881
Array Vertical Vector length 3	Array Vertical Vector length 3
[0]	[0]
Vertical Vector: 39.944126	Vertical Vector: 33.985059
[1]	[1]
Vertical Vector: -7.191921	Vertical Vector: 19.794709
[2]	[2]
Vertical Vector: 688.965306	Vertical Vector: 683.515455
Array Optical Vector length 3	Array Optical Vector length 3
[0]	[0]
Optical Vector: 0.701760	Optical Vector: 0.707943
[1]	[1]
Optical Vector: -0.012920	Optical Vector: 0.036219
[2]	[2]
Optical Vector: 0.712296	Optical Vector: 0.705340
Array Radial Distortion Terms length 3	Array Radial Distortion Terms length 3
[0]	[0]
Radial Distortion Terms: 0.000028	Radial Distortion Terms: 0.000008
[1]	[1]
Radial Distortion Terms: -0.013534	Radial Distortion Terms: -0.012790
[2]	[2]

MER A Camera Models	MER B Camera Models
Radial Distortion Terms: -0.007456	Radial Distortion Terms: -0.007496
Array Entrance Pupil Terms length 3	Array Entrance Pupil Terms length 3
[0]	[0]
Entrance Pupil Terms: 0.000568	Entrance Pupil Terms: 0.001158
[1]	[1]
Entrance Pupil Terms: 0.001915	Entrance Pupil Terms: 0.001904
[2]	[2]
Entrance Pupil Terms: 0.002274	Entrance Pupil Terms: 0.000674
Array Camera Reference Vector length 3	Array Camera Reference Vector length 3
[0]	[0]
Camera Reference Vector: 0.000000	Camera Reference Vector: 0.000000
[1]	[1]
Camera Reference Vector: 0.000000	Camera Reference Vector: 0.000000
[2]	[2]
Camera Reference Vector: 0.000000	Camera Reference Vector: 0.000000
Array Camera Reference Quaternion length 4	Array Camera Reference Quaternion length 4
[0]	[0]
Camera Reference Quaternion: 0.000000	Camera Reference Quaternion: 0.000000
[1]	[1]
Camera Reference Quaternion: 0.000000	Camera Reference Quaternion: 0.000000
[2]	[2]
Camera Reference Quaternion: 0.000000	Camera Reference Quaternion: 0.000000
[3]	[3]
Camera Reference Quaternion: 1.000000	Camera Reference Quaternion: 1.000000
Camera Temperature: 20.000000	Camera Temperature: 20.000000
[Rear Left Hazcam]	[Rear Left Hazcam]
Camera Model ID: 60	Camera Model ID: 35
Camera Serial Number: 106	Camera Serial Number: 119
Camera ID: Rear Left Hazcam	Camera ID: Rear Left Hazcam
Filter Position: No filter/unknown	Filter Position: No filter/unknown
Model Class: CAHVORE	Model Class: CAHVORE
Model Type: 3	Model Type: 3
Model Parameter: 0.370000	Model Parameter: 0.370000
Array Center Vector length 3	Array Center Vector length 3
[0]	[0]
Center Vector: -0.352830	Center Vector: -0.352486
[1]	[1]
Center Vector: 0.027840	Center Vector: 0.029107
[2]	[2]
Center Vector: -0.220359	Center Vector: -0.219509
Array Axis Vector length 3	Array Axis Vector length 3
[0]	[0]
Axis Vector: -0.820494	Axis Vector: -0.817454
[1]	[1]
Axis Vector: -0.017232	Axis Vector: 0.003886
[2]	[2]
Axis Vector: 0.571396	Axis Vector: 0.575981
Array Horizontal Vector length 3	Array Horizontal Vector length 3
[0]	[0]
Horizontal Vector: -414.354735	Horizontal Vector: -412.111787
[1]	[1]
Horizontal Vector: -461.547168	Horizontal Vector: -454.507817
[2]	[2]
Horizontal Vector: 286.204206	Horizontal Vector: 294.672076
Array Vertical Vector length 3	Array Vertical Vector length 3
[0]	[0]
Vertical Vector: -170.157896	Vertical Vector: -153.453457
[1]	[1]
Vertical Vector: -9.813575	Vertical Vector: 5.657748
[2]	[2]
Vertical Vector: 669.513537	Vertical Vector: 667.135065
Array Optical Vector length 3	Array Optical Vector length 3
[0]	[0]
Optical Vector: -0.818510	Optical Vector: -0.816478
[1]	[1]
Optical Vector: -0.020424	Optical Vector: 0.005312
[2]	[2]
Optical Vector: 0.574129	Optical Vector: 0.577352
Array Radial Distortion Terms length 3	Array Radial Distortion Terms length 3
[0]	[0]

MER A Camera Models	MER B Camera Models
Radial Distortion Terms: 0.000022 [1]	Radial Distortion Terms: 0.000005 [1]
Radial Distortion Terms: -0.012974 [2]	Radial Distortion Terms: -0.013636 [2]
Radial Distortion Terms: -0.007563	Radial Distortion Terms: -0.007433
Array Entrance Pupil Terms length 3 [0]	Array Entrance Pupil Terms length 3 [0]
Entrance Pupil Terms: 0.000972 [1]	Entrance Pupil Terms: 0.002913 [1]
Entrance Pupil Terms: 0.001178 [2]	Entrance Pupil Terms: 0.002490 [2]
Entrance Pupil Terms: 0.001015	Entrance Pupil Terms: 0.001988
Array Camera Reference Vector length 3 [0]	Array Camera Reference Vector length 3 [0]
Camera Reference Vector: 0.000000 [1]	Camera Reference Vector: 0.000000 [1]
Camera Reference Vector: 0.000000 [2]	Camera Reference Vector: 0.000000 [2]
Camera Reference Vector: 0.000000	Camera Reference Vector: 0.000000
Array Camera Reference Quaternion length 4 [0]	Array Camera Reference Quaternion length 4 [0]
Camera Reference Quaternion: 0.000000 [1]	Camera Reference Quaternion: 0.000000 [1]
Camera Reference Quaternion: 0.000000 [2]	Camera Reference Quaternion: 0.000000 [2]
Camera Reference Quaternion: 0.000000 [3]	Camera Reference Quaternion: 0.000000 [3]
Camera Reference Quaternion: 1.000000	Camera Reference Quaternion: 1.000000
Camera Temperature: 20.000000 [Rear Right Hazcam]	Camera Temperature: 20.000000 [Rear Right Hazcam]
Camera Model ID: 61	Camera Model ID: 36
Camera Serial Number: 108	Camera Serial Number: 121
Camera ID: Rear Right Hazcam	Camera ID: Rear Right Hazcam
Filter Position: No filter/unknown	Filter Position: No filter/unknown
Model Class: CAHVORE	Model Class: CAHVORE
Model Type: 3	Model Type: 3
Model Parameter: 0.370000	Model Parameter: 0.370000
Array Center Vector length 3 [0]	Array Center Vector length 3 [0]
Center Vector: -0.352856 [1]	Center Vector: -0.352347 [1]
Center Vector: -0.071599 [2]	Center Vector: -0.071376 [2]
Center Vector: -0.220484	Center Vector: -0.218263
Array Axis Vector length 3 [0]	Array Axis Vector length 3 [0]
Axis Vector: -0.817110 [1]	Axis Vector: -0.797769 [1]
Axis Vector: 0.006074 [2]	Axis Vector: -0.005895 [2]
Axis Vector: 0.576450	Axis Vector: 0.602934
Array Horizontal Vector length 3 [0]	Array Horizontal Vector length 3 [0]
Horizontal Vector: -413.667588 [1]	Horizontal Vector: -403.318552 [1]
Horizontal Vector: -448.794903 [2]	Horizontal Vector: -459.244833 [2]
Horizontal Vector: 287.678977	Horizontal Vector: 306.418265
Array Vertical Vector length 3 [0]	Array Vertical Vector length 3 [0]
Vertical Vector: -170.387722 [1]	Vertical Vector: -142.127421 [1]
Vertical Vector: 1.125681 [2]	Vertical Vector: -1.605314 [2]
Vertical Vector: 673.049507	Vertical Vector: 680.026212
Array Optical Vector length 3 [0]	Array Optical Vector length 3 [0]
Optical Vector: -0.815498 [1]	Optical Vector: -0.798053 [1]
Optical Vector: 0.004208	Optical Vector: -0.008088

MER A Camera Models	MER B Camera Models
[2]	[2]
Optical Vector: 0.578744	Optical Vector: 0.602532
Array Radial Distortion Terms length 3	Array Radial Distortion Terms length 3
[0]	[0]
Radial Distortion Terms: 0.000011	Radial Distortion Terms: 0.000005
[1]	[1]
Radial Distortion Terms: -0.015912	Radial Distortion Terms: -0.012461
[2]	[2]
Radial Distortion Terms: -0.006998	Radial Distortion Terms: -0.007520
Array Entrance Pupil Terms length 3	Array Entrance Pupil Terms length 3
[0]	[0]
Entrance Pupil Terms: 0.000920	Entrance Pupil Terms: 0.003556
[1]	[1]
Entrance Pupil Terms: 0.001679	Entrance Pupil Terms: 0.003197
[2]	[2]
Entrance Pupil Terms: 0.002273	Entrance Pupil Terms: 0.000849
Array Camera Reference Vector length 3	Array Camera Reference Vector length 3
[0]	[0]
Camera Reference Vector: 0.000000	Camera Reference Vector: 0.000000
[1]	[1]
Camera Reference Vector: 0.000000	Camera Reference Vector: 0.000000
[2]	[2]
Camera Reference Vector: 0.000000	Camera Reference Vector: 0.000000
Array Camera Reference Quaternion length 4	Array Camera Reference Quaternion length 4
[0]	[0]
Camera Reference Quaternion: 0.000000	Camera Reference Quaternion: 0.000000
[1]	[1]
Camera Reference Quaternion: 0.000000	Camera Reference Quaternion: 0.000000
[2]	[2]
Camera Reference Quaternion: 0.000000	Camera Reference Quaternion: 0.000000
[3]	[3]
Camera Reference Quaternion: 1.000000	Camera Reference Quaternion: 1.000000
Camera Temperature: 20.000000	Camera Temperature: 20.000000
[Left Navcam]	[Left Navcam]
Camera Model ID: 174	Camera Model ID: 196
Camera Serial Number: 112	Camera Serial Number: 102
Camera ID: Left Navcam	Camera ID: Left Navcam
Filter Position: No filter/unknown	Filter Position: No filter/unknown
Model Class: CAHVOR	Model Class: CAHVOR
Model Type: 0	Model Type: 0
Model Parameter: 0.000000	Model Parameter: 0.000000
Array Center Vector length 3	Array Center Vector length 3
[0]	[0]
Center Vector: 0.427748	Center Vector: 0.411970
[1]	[1]
Center Vector: 0.114460	Center Vector: 0.105641
[2]	[2]
Center Vector: -1.248564	Center Vector: -1.249215
Array Axis Vector length 3	Array Axis Vector length 3
[0]	[0]
Axis Vector: -0.989991	Axis Vector: -0.972195
[1]	[1]
Axis Vector: -0.011243	Axis Vector: -0.193555
[2]	[2]
Axis Vector: 0.140682	Axis Vector: 0.131811
Array Horizontal Vector length 3	Array Horizontal Vector length 3
[0]	[0]
Horizontal Vector: -450.458717	Horizontal Vector: -247.726578
[1]	[1]
Horizontal Vector: -1193.412639	Horizontal Vector: -1296.609863
[2]	[2]
Horizontal Vector: 75.082092	Horizontal Vector: 67.858466
Array Vertical Vector length 3	Array Vertical Vector length 3
[0]	[0]
Vertical Vector: -344.660526	Vertical Vector: -331.070280
[1]	[1]
Vertical Vector: 4.426849	Vertical Vector: -63.484371
[2]	[2]
	Vertical Vector: 1279.291928
	Array Optical Vector length 3

MER A Camera Models	MER B Camera Models
Vertical Vector: 1249.216269	[0]
Array Optical Vector length 3	Optical Vector: -0.964543
[0]	[1]
Optical Vector: -0.987140	Optical Vector: -0.215917
[1]	[2]
Optical Vector: 0.115434	Optical Vector: 0.151779
[2]	Array Radial Distortion Terms length 3
Optical Vector: 0.110584	[0]
Array Radial Distortion Terms length 3	Radial Distortion Terms: 0.000960
[0]	[1]
Radial Distortion Terms: 0.019876	Radial Distortion Terms: -0.002183
[1]	[2]
Radial Distortion Terms: -0.014281	Radial Distortion Terms: 0.018547
[2]	Array Entrance Pupil Terms length 3
Radial Distortion Terms: 0.020876	[0]
Array Entrance Pupil Terms length 3	Entrance Pupil Terms: 0.000000
[0]	[1]
Entrance Pupil Terms: 0.000000	Entrance Pupil Terms: 0.000000
[1]	[2]
Entrance Pupil Terms: 0.000000	Entrance Pupil Terms: 0.000000
[2]	Array Camera Reference Vector length 3
Entrance Pupil Terms: 0.000000	[0]
Array Camera Reference Vector length 3	Camera Reference Vector: 0.457290
[0]	[1]
Camera Reference Vector: 0.457810	Camera Reference Vector: 0.026050
[1]	[2]
Camera Reference Vector: 0.027790	Camera Reference Vector: -1.096200
[2]	Array Camera Reference Quaternion length 4
Camera Reference Vector: -1.096680	[0]
Array Camera Reference Quaternion length 4	Camera Reference Quaternion: 0.065924
[0]	[1]
Camera Reference Quaternion: 0.070093	Camera Reference Quaternion: 0.006818
[1]	[2]
Camera Reference Quaternion: 0.001171	Camera Reference Quaternion: 0.992507
[2]	[3]
Camera Reference Quaternion: 0.997401	Camera Reference Quaternion: -0.102653
[3]	Camera Temperature: 20.000000
Camera Reference Quaternion: -0.016658	[Right Navcam]
Camera Temperature: 20.000000	Camera Model ID: 197
[Right Navcam]	Camera Serial Number: 117
Camera Model ID: 175	Camera ID: Right Navcam
Camera Serial Number: 113	Filter Position: No filter/unknown
Camera ID: Right Navcam	Model Class: CAHVOR
Filter Position: No filter/unknown	Model Type: 0
Model Class: CAHVOR	Model Parameter: 0.000000
Model Type: 0	Array Center Vector length 3
Model Parameter: 0.000000	[0]
Array Center Vector length 3	Center Vector: 0.452404
[0]	[1]
Center Vector: 0.435019	Center Vector: -0.090348
[1]	[2]
Center Vector: -0.085753	Center Vector: -1.248825
[2]	Array Axis Vector length 3
Center Vector: -1.249092	[0]
Array Axis Vector length 3	Axis Vector: -0.967006
[0]	[1]
Axis Vector: -0.988104	Axis Vector: -0.212014
[1]	[2]
Axis Vector: -0.049381	Axis Vector: 0.141240
[2]	Array Horizontal Vector length 3
Axis Vector: 0.145646	[0]
Array Horizontal Vector length 3	Horizontal Vector: -246.433204
[0]	[1]
Horizontal Vector: -452.075834	Horizontal Vector: -1294.549308
[1]	[2]
Horizontal Vector: -1233.255239	Horizontal Vector: 69.794922
[2]	Array Vertical Vector length 3
Horizontal Vector: 79.557598	[0]
Array Vertical Vector length 3	Vertical Vector: -329.064749
[0]	[1]

MER A Camera Models	MER B Camera Models
Vertical Vector: -342.762187 [1]	Vertical Vector: -75.301543 [2]
Vertical Vector: -13.628939 [2]	Vertical Vector: 1273.320289
Vertical Vector: 1273.248298	Array Optical Vector length 3
Array Optical Vector length 3 [0]	[0]
Optical Vector: -0.989044 [1]	Optical Vector: -0.959404 [1]
Optical Vector: -0.039669 [2]	Optical Vector: -0.246709 [2]
Optical Vector: 0.142189	Optical Vector: 0.136667
Array Radial Distortion Terms length 3 [0]	Array Radial Distortion Terms length 3 [0]
Radial Distortion Terms: 0.000300 [1]	Radial Distortion Terms: 0.001281 [1]
Radial Distortion Terms: -0.004874 [2]	Radial Distortion Terms: -0.011721 [2]
Radial Distortion Terms: 0.018766	Radial Distortion Terms: 0.036593
Array Entrance Pupil Terms length 3 [0]	Array Entrance Pupil Terms length 3 [0]
Entrance Pupil Terms: 0.000000 [1]	Entrance Pupil Terms: 0.000000 [1]
Entrance Pupil Terms: 0.000000 [2]	Entrance Pupil Terms: 0.000000 [2]
Entrance Pupil Terms: 0.000000	Entrance Pupil Terms: 0.000000
Array Camera Reference Vector length 3 [0]	Array Camera Reference Vector length 3 [0]
Camera Reference Vector: 0.457810 [1]	Camera Reference Vector: 0.457290 [1]
Camera Reference Vector: 0.027790 [2]	Camera Reference Vector: 0.026050 [2]
Camera Reference Vector: -1.096680	Camera Reference Vector: -1.096200
Array Camera Reference Quaternion length 4 [0]	Array Camera Reference Quaternion length 4 [0]
Camera Reference Quaternion: 0.070093 [1]	Camera Reference Quaternion: 0.065924 [1]
Camera Reference Quaternion: 0.001171 [2]	Camera Reference Quaternion: 0.006818 [2]
Camera Reference Quaternion: 0.997401 [3]	Camera Reference Quaternion: 0.992507 [3]
Camera Reference Quaternion: -0.016658	Camera Reference Quaternion: -0.102653
Camera Temperature: 20.000000 [Left Pancam, filter L1]	Camera Temperature: 20.000000 [Left Pancam, filter L1]
Camera Model ID: 176	Camera Model ID: 198
Camera Serial Number: 104	Camera Serial Number: 115
Camera ID: Left Pancam	Camera ID: Left Pancam
Filter Position: Pancam Left-Eye Filter L1: empty	Filter Position: Pancam Left-Eye Filter L1: empty
Model Class: CAHVOR	Model Class: CAHVOR
Model Type: 0	Model Type: 0
Model Parameter: 0.000000	Model Parameter: 0.000000
Array Center Vector length 3 [0]	Array Center Vector length 3 [0]
Center Vector: 0.401265 [1]	Center Vector: 0.382152 [1]
Center Vector: 0.163027 [2]	Center Vector: 0.149178 [2]
Center Vector: -1.245082	Center Vector: -1.246381
Array Axis Vector length 3 [0]	Array Axis Vector length 3 [0]
Axis Vector: -0.989679 [1]	Axis Vector: -0.965675 [1]
Axis Vector: -0.046318 [2]	Axis Vector: -0.224240 [2]
Axis Vector: 0.135607	Axis Vector: 0.131104
Array Horizontal Vector length 3 [0]	Array Horizontal Vector length 3 [0]
Horizontal Vector: -349.960356 [1]	Horizontal Vector: 315.089938 [1]
	Horizontal Vector: -3647.728413 [2]

MER A Camera Models	MER B Camera Models
Horizontal Vector: -3576.595824 [2] Horizontal Vector: 44.320764 Array Vertical Vector length 3 [0] Vertical Vector: -10.046627 [1] Vertical Vector: -28.461764 [2] Vertical Vector: 3591.399075 Array Optical Vector length 3 [0] Optical Vector: -0.991056 [1] Optical Vector: -0.047812 [2] Optical Vector: 0.124591 Array Radial Distortion Terms length 3 [0] Radial Distortion Terms: 0.022997 [1] Radial Distortion Terms: 0.024872 [2] Radial Distortion Terms: -0.407146 Array Entrance Pupil Terms length 3 [0] Entrance Pupil Terms: 0.000000 [1] Entrance Pupil Terms: 0.000000 [2] Entrance Pupil Terms: 0.000000 Array Camera Reference Vector length 3 [0] Camera Reference Vector: 0.457810 [1] Camera Reference Vector: 0.027790 [2] Camera Reference Vector: -1.096680 Array Camera Reference Quaternion length 4 [0] Camera Reference Quaternion: 0.070093 [1] Camera Reference Quaternion: 0.001171 [2] Camera Reference Quaternion: 0.997401 [3] Camera Reference Quaternion: -0.016658 Camera Temperature: 20.000000 [Left Pancam, filter L2] Camera Model ID: 177 Camera Serial Number: 104 Camera ID: Left Pancam Filter Position: Pancam Left-Eye Filter L2: 750 nm Model Class: CAHVOR Model Type: 0 Model Parameter: 0.000000 Array Center Vector length 3 [0] Center Vector: 0.401265 [1] Center Vector: 0.163027 [2] Center Vector: -1.245082 Array Axis Vector length 3 [0] Axis Vector: -0.989679 [1] Axis Vector: -0.046318 [2]	Horizontal Vector: 47.302857 Array Vertical Vector length 3 [0] Vertical Vector: -20.801368 [1] Vertical Vector: -26.864694 [2] Vertical Vector: 3660.536632 Array Optical Vector length 3 [0] Optical Vector: -0.962756 [1] Optical Vector: -0.233389 [2] Optical Vector: 0.136490 Array Radial Distortion Terms length 3 [0] Radial Distortion Terms: 0.000998 [1] Radial Distortion Terms: 0.003762 [2] Radial Distortion Terms: -0.057232 Array Entrance Pupil Terms length 3 [0] Entrance Pupil Terms: 0.000000 [1] Entrance Pupil Terms: 0.000000 [2] Entrance Pupil Terms: 0.000000 Array Camera Reference Vector length 3 [0] Camera Reference Vector: 0.457290 [1] Camera Reference Vector: 0.026050 [2] Camera Reference Vector: -1.096200 Array Camera Reference Quaternion length 4 [0] Camera Reference Quaternion: 0.065924 [1] Camera Reference Quaternion: 0.006818 [2] Camera Reference Quaternion: 0.992507 [3] Camera Reference Quaternion: -0.102653 Camera Temperature: 20.000000 [Left Pancam, filter L2] Camera Model ID: 199 Camera Serial Number: 115 Camera ID: Left Pancam Filter Position: Pancam Left-Eye Filter L2: 750 nm Model Class: CAHVOR Model Type: 0 Model Parameter: 0.000000 Array Center Vector length 3 [0] Center Vector: 0.382152 [1] Center Vector: 0.149178 [2] Center Vector: -1.246381 Array Axis Vector length 3 [0] Axis Vector: -0.965675 [1] Axis Vector: -0.224240 [2] Axis Vector: 0.131104

MER A Camera Models	MER B Camera Models
Axis Vector: 0.135607	Array Horizontal Vector length 3
Array Horizontal Vector length 3	[0]
[0]	Horizontal Vector: 315.089938
Horizontal Vector: -349.960356	[1]
[1]	Horizontal Vector: -3647.728413
Horizontal Vector: -3576.595824	[2]
[2]	Horizontal Vector: 47.302857
Horizontal Vector: 44.320764	Array Vertical Vector length 3
Array Vertical Vector length 3	[0]
[0]	Vertical Vector: -20.801368
Vertical Vector: -10.046627	[1]
[1]	Vertical Vector: -26.864694
Vertical Vector: -28.461764	[2]
[2]	Vertical Vector: 3660.536632
Vertical Vector: 3591.399075	Array Optical Vector length 3
Array Optical Vector length 3	[0]
[0]	Optical Vector: -0.962756
Optical Vector: -0.991056	[1]
[1]	Optical Vector: -0.233389
Optical Vector: -0.047812	[2]
[2]	Optical Vector: 0.136490
Optical Vector: 0.124591	Array Radial Distortion Terms length 3
Array Radial Distortion Terms length 3	[0]
[0]	Radial Distortion Terms: 0.000998
Radial Distortion Terms: 0.022997	[1]
[1]	Radial Distortion Terms: 0.003762
Radial Distortion Terms: 0.024872	[2]
[2]	Radial Distortion Terms: -0.057232
Radial Distortion Terms: -0.407146	Array Entrance Pupil Terms length 3
Array Entrance Pupil Terms length 3	[0]
[0]	Entrance Pupil Terms: 0.000000
Entrance Pupil Terms: 0.000000	[1]
[1]	Entrance Pupil Terms: 0.000000
Entrance Pupil Terms: 0.000000	[2]
[2]	Entrance Pupil Terms: 0.000000
Entrance Pupil Terms: 0.000000	Array Camera Reference Vector length 3
Array Camera Reference Vector length 3	[0]
[0]	Camera Reference Vector: 0.457290
Camera Reference Vector: 0.457810	[1]
[1]	Camera Reference Vector: 0.026050
Camera Reference Vector: 0.027790	[2]
[2]	Camera Reference Vector: -1.096200
Camera Reference Vector: -1.096680	Array Camera Reference Quaternion length 4
Array Camera Reference Quaternion length 4	[0]
[0]	Camera Reference Quaternion: 0.065924
Camera Reference Quaternion: 0.070093	[1]
[1]	Camera Reference Quaternion: 0.006818
Camera Reference Quaternion: 0.001171	[2]
[2]	Camera Reference Quaternion: 0.992507
Camera Reference Quaternion: 0.997401	[3]
[3]	Camera Reference Quaternion: -0.102653
Camera Reference Quaternion: -0.016658	Camera Temperature: 20.000000
Camera Temperature: 20.000000	[Left Pancam, filter L3]
[Left Pancam, filter L3]	Camera Model ID: 200
Camera Model ID: 178	Camera Serial Number: 115
Camera Serial Number: 104	Camera ID: Left Pancam
Camera ID: Left Pancam	Filter Position: Pancam Left-Eye Filter L3:
Filter Position: Pancam Left-Eye Filter L3:	670 nm
670 nm	Model Class: CAHVOR
Model Class: CAHVOR	Model Type: 0
Model Type: 0	Model Parameter: 0.000000
Model Parameter: 0.000000	Array Center Vector length 3
Array Center Vector length 3	[0]
[0]	Center Vector: 0.382152
Center Vector: 0.401265	[1]
[1]	Center Vector: 0.149178
Center Vector: 0.163027	[2]
[2]	Center Vector: -1.246381
Center Vector: -1.245082	Array Axis Vector length 3
Array Axis Vector length 3	

MER A Camera Models	MER B Camera Models
[0]	[0]
Axis Vector: -0.989679	Axis Vector: -0.965675
[1]	[1]
Axis Vector: -0.046318	Axis Vector: -0.224240
[2]	[2]
Axis Vector: 0.135607	Axis Vector: 0.131104
Array Horizontal Vector length 3	Array Horizontal Vector length 3
[0]	[0]
Horizontal Vector: -349.960356	Horizontal Vector: 315.089938
[1]	[1]
Horizontal Vector: -3576.595824	Horizontal Vector: -3647.728413
[2]	[2]
Horizontal Vector: 44.320764	Horizontal Vector: 47.302857
Array Vertical Vector length 3	Array Vertical Vector length 3
[0]	[0]
Vertical Vector: -10.046627	Vertical Vector: -20.801368
[1]	[1]
Vertical Vector: -28.461764	Vertical Vector: -26.864694
[2]	[2]
Vertical Vector: 3591.399075	Vertical Vector: 3660.536632
Array Optical Vector length 3	Array Optical Vector length 3
[0]	[0]
Optical Vector: -0.991056	Optical Vector: -0.962756
[1]	[1]
Optical Vector: -0.047812	Optical Vector: -0.233389
[2]	[2]
Optical Vector: 0.124591	Optical Vector: 0.136490
Array Radial Distortion Terms length 3	Array Radial Distortion Terms length 3
[0]	[0]
Radial Distortion Terms: 0.022997	Radial Distortion Terms: 0.000998
[1]	[1]
Radial Distortion Terms: 0.024872	Radial Distortion Terms: 0.003762
[2]	[2]
Radial Distortion Terms: -0.407146	Radial Distortion Terms: -0.057232
Array Entrance Pupil Terms length 3	Array Entrance Pupil Terms length 3
[0]	[0]
Entrance Pupil Terms: 0.000000	Entrance Pupil Terms: 0.000000
[1]	[1]
Entrance Pupil Terms: 0.000000	Entrance Pupil Terms: 0.000000
[2]	[2]
Entrance Pupil Terms: 0.000000	Entrance Pupil Terms: 0.000000
Array Camera Reference Vector length 3	Array Camera Reference Vector length 3
[0]	[0]
Camera Reference Vector: 0.457810	Camera Reference Vector: 0.457290
[1]	[1]
Camera Reference Vector: 0.027790	Camera Reference Vector: 0.026050
[2]	[2]
Camera Reference Vector: -1.096680	Camera Reference Vector: -1.096200
Array Camera Reference Quaternion length 4	Array Camera Reference Quaternion length 4
[0]	[0]
Camera Reference Quaternion: 0.070093	Camera Reference Quaternion: 0.065924
[1]	[1]
Camera Reference Quaternion: 0.001171	Camera Reference Quaternion: 0.006818
[2]	[2]
Camera Reference Quaternion: 0.997401	Camera Reference Quaternion: 0.992507
[3]	[3]
Camera Reference Quaternion: -0.016658	Camera Reference Quaternion: -0.102653
Camera Temperature: 20.000000	Camera Temperature: 20.000000
[Left Pancam, filter L4]	[Left Pancam, filter L4]
Camera Model ID: 179	Camera Model ID: 201
Camera Serial Number: 104	Camera Serial Number: 115
Camera ID: Left Pancam	Camera ID: Left Pancam
Filter Position: Pancam Left-Eye Filter L4: 600 nm	Filter Position: Pancam Left-Eye Filter L4: 600 nm
Model Class: CAHVOR	Model Class: CAHVOR
Model Type: 0	Model Type: 0
Model Parameter: 0.000000	Model Parameter: 0.000000
Array Center Vector length 3	Array Center Vector length 3
[0]	[0]
Center Vector: 0.401265	Center Vector: 0.382152

MER A Camera Models	MER B Camera Models
[1] Center Vector: 0.163027	[1] Center Vector: 0.149178
[2] Center Vector: -1.245082	[2] Center Vector: -1.246381
Array Axis Vector length 3	Array Axis Vector length 3
[0] Axis Vector: -0.989679	[0] Axis Vector: -0.965675
[1] Axis Vector: -0.046318	[1] Axis Vector: -0.224240
[2] Axis Vector: 0.135607	[2] Axis Vector: 0.131104
Array Horizontal Vector length 3	Array Horizontal Vector length 3
[0] Horizontal Vector: -349.960356	[0] Horizontal Vector: 315.089938
[1] Horizontal Vector: -3576.595824	[1] Horizontal Vector: -3647.728413
[2] Horizontal Vector: 44.320764	[2] Horizontal Vector: 47.302857
Array Vertical Vector length 3	Array Vertical Vector length 3
[0] Vertical Vector: -10.046627	[0] Vertical Vector: -20.801368
[1] Vertical Vector: -28.461764	[1] Vertical Vector: -26.864694
[2] Vertical Vector: 3591.399075	[2] Vertical Vector: 3660.536632
Array Optical Vector length 3	Array Optical Vector length 3
[0] Optical Vector: -0.991056	[0] Optical Vector: -0.962756
[1] Optical Vector: -0.047812	[1] Optical Vector: -0.233389
[2] Optical Vector: 0.124591	[2] Optical Vector: 0.136490
Array Radial Distortion Terms length 3	Array Radial Distortion Terms length 3
[0] Radial Distortion Terms: 0.022997	[0] Radial Distortion Terms: 0.000998
[1] Radial Distortion Terms: 0.024872	[1] Radial Distortion Terms: 0.003762
[2] Radial Distortion Terms: -0.407146	[2] Radial Distortion Terms: -0.057232
Array Entrance Pupil Terms length 3	Array Entrance Pupil Terms length 3
[0] Entrance Pupil Terms: 0.000000	[0] Entrance Pupil Terms: 0.000000
[1] Entrance Pupil Terms: 0.000000	[1] Entrance Pupil Terms: 0.000000
[2] Entrance Pupil Terms: 0.000000	[2] Entrance Pupil Terms: 0.000000
Array Camera Reference Vector length 3	Array Camera Reference Vector length 3
[0] Camera Reference Vector: 0.457810	[0] Camera Reference Vector: 0.457290
[1] Camera Reference Vector: 0.027790	[1] Camera Reference Vector: 0.026050
[2] Camera Reference Vector: -1.096680	[2] Camera Reference Vector: -1.096200
Array Camera Reference Quaternion length 4	Array Camera Reference Quaternion length 4
[0] Camera Reference Quaternion: 0.070093	[0] Camera Reference Quaternion: 0.065924
[1] Camera Reference Quaternion: 0.001171	[1] Camera Reference Quaternion: 0.006818
[2] Camera Reference Quaternion: 0.997401	[2] Camera Reference Quaternion: 0.992507
[3] Camera Reference Quaternion: -0.016658	[3] Camera Reference Quaternion: -0.102653
Camera Temperature: 20.000000	Camera Temperature: 20.000000
[Left Pancam, filter L5]	[Left Pancam, filter L5]
Camera Model ID: 180	Camera Model ID: 202
Camera Serial Number: 104	Camera Serial Number: 115
Camera ID: Left Pancam	Camera ID: Left Pancam
Filter Position: Pancam Left-Eye Filter L5:	Filter Position: Pancam Left-Eye Filter L5:
530 nm	530 nm
	Model Class: CAHVOR

MER A Camera Models	MER B Camera Models
Model Class: CAHVOR	Model Type: 0
Model Type: 0	Model Parameter: 0.000000
Model Parameter: 0.000000	Array Center Vector length 3
Array Center Vector length 3	[0]
[0]	Center Vector: 0.382152
Center Vector: 0.401265	[1]
[1]	Center Vector: 0.149178
Center Vector: 0.163027	[2]
[2]	Center Vector: -1.246381
Center Vector: -1.245082	Array Axis Vector length 3
Array Axis Vector length 3	[0]
[0]	Axis Vector: -0.965675
Axis Vector: -0.989679	[1]
[1]	Axis Vector: -0.224240
Axis Vector: -0.046318	[2]
[2]	Axis Vector: 0.131104
Axis Vector: 0.135607	Array Horizontal Vector length 3
Array Horizontal Vector length 3	[0]
[0]	Horizontal Vector: 315.089938
Horizontal Vector: -349.960356	[1]
[1]	Horizontal Vector: -3647.728413
Horizontal Vector: -3576.595824	[2]
[2]	Horizontal Vector: 47.302857
Horizontal Vector: 44.320764	Array Vertical Vector length 3
Array Vertical Vector length 3	[0]
[0]	Vertical Vector: -20.801368
Vertical Vector: -10.046627	[1]
[1]	Vertical Vector: -26.864694
Vertical Vector: -28.461764	[2]
[2]	Vertical Vector: 3660.536632
Vertical Vector: 3591.399075	Array Optical Vector length 3
Array Optical Vector length 3	[0]
[0]	Optical Vector: -0.962756
Optical Vector: -0.991056	[1]
[1]	Optical Vector: -0.233389
Optical Vector: -0.047812	[2]
[2]	Optical Vector: 0.136490
Optical Vector: 0.124591	Array Radial Distortion Terms length 3
Array Radial Distortion Terms length 3	[0]
[0]	Radial Distortion Terms: 0.000998
Radial Distortion Terms: 0.022997	[1]
[1]	Radial Distortion Terms: 0.003762
Radial Distortion Terms: 0.024872	[2]
[2]	Radial Distortion Terms: -0.057232
Radial Distortion Terms: -0.407146	Array Entrance Pupil Terms length 3
Array Entrance Pupil Terms length 3	[0]
[0]	Entrance Pupil Terms: 0.000000
Entrance Pupil Terms: 0.000000	[1]
[1]	Entrance Pupil Terms: 0.000000
Entrance Pupil Terms: 0.000000	[2]
[2]	Entrance Pupil Terms: 0.000000
Entrance Pupil Terms: 0.000000	Array Camera Reference Vector length 3
Array Camera Reference Vector length 3	[0]
[0]	Camera Reference Vector: 0.457290
Camera Reference Vector: 0.457810	[1]
[1]	Camera Reference Vector: 0.026050
Camera Reference Vector: 0.027790	[2]
[2]	Camera Reference Vector: -1.096200
Camera Reference Vector: -1.096680	Array Camera Reference Quaternion length 4
Array Camera Reference Quaternion length 4	[0]
[0]	Camera Reference Quaternion: 0.065924
Camera Reference Quaternion: 0.070093	[1]
[1]	Camera Reference Quaternion: 0.006818
Camera Reference Quaternion: 0.001171	[2]
[2]	Camera Reference Quaternion: 0.992507
Camera Reference Quaternion: 0.997401	[3]
[3]	Camera Reference Quaternion: -0.102653
Camera Reference Quaternion: -0.016658	Camera Temperature: 20.000000
	[Left Pancam, filter L6]
	Camera Model ID: 203

MER A Camera Models	MER B Camera Models
Camera Temperature: 20.000000 [Left Pancam, filter L6] Camera Model ID: 181 Camera Serial Number: 104 Camera ID: Left Pancam Filter Position: Pancam Left-Eye Filter L6: 480 nm Model Class: CAHVOR Model Type: 0 Model Parameter: 0.000000 Array Center Vector length 3 [0] Center Vector: 0.401265 [1] Center Vector: 0.163027 [2] Center Vector: -1.245082 Array Axis Vector length 3 [0] Axis Vector: -0.989679 [1] Axis Vector: -0.046318 [2] Axis Vector: 0.135607 Array Horizontal Vector length 3 [0] Horizontal Vector: -349.960356 [1] Horizontal Vector: -3576.595824 [2] Horizontal Vector: 44.320764 Array Vertical Vector length 3 [0] Vertical Vector: -10.046627 [1] Vertical Vector: -28.461764 [2] Vertical Vector: 3591.399075 Array Optical Vector length 3 [0] Optical Vector: -0.991056 [1] Optical Vector: -0.047812 [2] Optical Vector: 0.124591 Array Radial Distortion Terms length 3 [0] Radial Distortion Terms: 0.022997 [1] Radial Distortion Terms: 0.024872 [2] Radial Distortion Terms: -0.407146 Array Entrance Pupil Terms length 3 [0] Entrance Pupil Terms: 0.000000 [1] Entrance Pupil Terms: 0.000000 [2] Entrance Pupil Terms: 0.000000 Array Camera Reference Vector length 3 [0] Camera Reference Vector: 0.457810 [1] Camera Reference Vector: 0.027790 [2] Camera Reference Vector: -1.096680 Array Camera Reference Quaternion length 4 [0] Camera Reference Quaternion: 0.070093 [1]	Camera Serial Number: 115 Camera ID: Left Pancam Filter Position: Pancam Left-Eye Filter L6: 480 nm Model Class: CAHVOR Model Type: 0 Model Parameter: 0.000000 Array Center Vector length 3 [0] Center Vector: 0.382152 [1] Center Vector: 0.149178 [2] Center Vector: -1.246381 Array Axis Vector length 3 [0] Axis Vector: -0.965675 [1] Axis Vector: -0.224240 [2] Axis Vector: 0.131104 Array Horizontal Vector length 3 [0] Horizontal Vector: 315.089938 [1] Horizontal Vector: -3647.728413 [2] Horizontal Vector: 47.302857 Array Vertical Vector length 3 [0] Vertical Vector: -20.801368 [1] Vertical Vector: -26.864694 [2] Vertical Vector: 3660.536632 Array Optical Vector length 3 [0] Optical Vector: -0.962756 [1] Optical Vector: -0.233389 [2] Optical Vector: 0.136490 Array Radial Distortion Terms length 3 [0] Radial Distortion Terms: 0.000998 [1] Radial Distortion Terms: 0.003762 [2] Radial Distortion Terms: -0.057232 Array Entrance Pupil Terms length 3 [0] Entrance Pupil Terms: 0.000000 [1] Entrance Pupil Terms: 0.000000 [2] Entrance Pupil Terms: 0.000000 Array Camera Reference Vector length 3 [0] Camera Reference Vector: 0.457290 [1] Camera Reference Vector: 0.026050 [2] Camera Reference Vector: -1.096200 Array Camera Reference Quaternion length 4 [0] Camera Reference Quaternion: 0.065924 [1] Camera Reference Quaternion: 0.006818 [2] Camera Reference Quaternion: 0.992507

MER A Camera Models	MER B Camera Models
Camera Reference Quaternion: 0.001171 [2] Camera Reference Quaternion: 0.997401 [3] Camera Reference Quaternion: -0.016658 Camera Temperature: 20.000000 [Left Pancam, filter L7] Camera Model ID: 182 Camera Serial Number: 104 Camera ID: Left Pancam Filter Position: Pancam Left-Eye Filter L7: 450 nm Model Class: CAHVOR Model Type: 0 Model Parameter: 0.000000 Array Center Vector length 3 [0] Center Vector: 0.401265 [1] Center Vector: 0.163027 [2] Center Vector: -1.245082 Array Axis Vector length 3 [0] Axis Vector: -0.989679 [1] Axis Vector: -0.046318 [2] Axis Vector: 0.135607 Array Horizontal Vector length 3 [0] Horizontal Vector: -349.960356 [1] Horizontal Vector: -3576.595824 [2] Horizontal Vector: 44.320764 Array Vertical Vector length 3 [0] Vertical Vector: -10.046627 [1] Vertical Vector: -28.461764 [2] Vertical Vector: 3591.399075 Array Optical Vector length 3 [0] Optical Vector: -0.991056 [1] Optical Vector: -0.047812 [2] Optical Vector: 0.124591 Array Radial Distortion Terms length 3 [0] Radial Distortion Terms: 0.022997 [1] Radial Distortion Terms: 0.024872 [2] Radial Distortion Terms: -0.407146 Array Entrance Pupil Terms length 3 [0] Entrance Pupil Terms: 0.000000 [1] Entrance Pupil Terms: 0.000000 [2] Entrance Pupil Terms: 0.000000 Array Camera Reference Vector length 3 [0] Camera Reference Vector: 0.457810 [1] Camera Reference Vector: 0.027790	[3] Camera Reference Quaternion: -0.102653 Camera Temperature: 20.000000 [Left Pancam, filter L7] Camera Model ID: 204 Camera Serial Number: 115 Camera ID: Left Pancam Filter Position: Pancam Left-Eye Filter L7: 450 nm Model Class: CAHVOR Model Type: 0 Model Parameter: 0.000000 Array Center Vector length 3 [0] Center Vector: 0.382152 [1] Center Vector: 0.149178 [2] Center Vector: -1.246381 Array Axis Vector length 3 [0] Axis Vector: -0.965675 [1] Axis Vector: -0.224240 [2] Axis Vector: 0.131104 Array Horizontal Vector length 3 [0] Horizontal Vector: 315.089938 [1] Horizontal Vector: -3647.728413 [2] Horizontal Vector: 47.302857 Array Vertical Vector length 3 [0] Vertical Vector: -20.801368 [1] Vertical Vector: -26.864694 [2] Vertical Vector: 3660.536632 Array Optical Vector length 3 [0] Optical Vector: -0.962756 [1] Optical Vector: -0.233389 [2] Optical Vector: 0.136490 Array Radial Distortion Terms length 3 [0] Radial Distortion Terms: 0.000998 [1] Radial Distortion Terms: 0.003762 [2] Radial Distortion Terms: -0.057232 Array Entrance Pupil Terms length 3 [0] Entrance Pupil Terms: 0.000000 [1] Entrance Pupil Terms: 0.000000 [2] Entrance Pupil Terms: 0.000000 Array Camera Reference Vector length 3 [0] Camera Reference Vector: 0.457290 [1] Camera Reference Vector: 0.026050 [2] Camera Reference Vector: -1.096200 Array Camera Reference Quaternion length 4 [0]

MER A Camera Models	MER B Camera Models
[2]	Camera Reference Quaternion: 0.065924
Camera Reference Vector: -1.096680	[1]
Array Camera Reference Quaternion length 4	Camera Reference Quaternion: 0.006818
[0]	[2]
Camera Reference Quaternion: 0.070093	Camera Reference Quaternion: 0.992507
[1]	[3]
Camera Reference Quaternion: 0.001171	Camera Reference Quaternion: -0.102653
[2]	Camera Temperature: 20.000000
Camera Reference Quaternion: 0.997401	[Left Pancam, filter L8]
[3]	Camera Model ID: 205
Camera Reference Quaternion: -0.016658	Camera Serial Number: 115
Camera Temperature: 20.000000	Camera ID: Left Pancam
[Left Pancam, filter L8]	Filter Position: Pancam Left-Eye Filter L8:
Camera Model ID: 183	440 nm - Solar ND
Camera Serial Number: 104	Model Class: CAHVOR
Camera ID: Left Pancam	Model Type: 0
Filter Position: Pancam Left-Eye Filter L8:	Model Parameter: 0.000000
440 nm - Solar ND	Array Center Vector length 3
Model Class: CAHVOR	[0]
Model Type: 0	Center Vector: 0.382152
Model Parameter: 0.000000	[1]
Array Center Vector length 3	Center Vector: 0.149178
[0]	[2]
Center Vector: 0.401265	Center Vector: -1.246381
[1]	Array Axis Vector length 3
Center Vector: 0.163027	[0]
[2]	Axis Vector: -0.965675
Center Vector: -1.245082	[1]
Array Axis Vector length 3	Axis Vector: -0.224240
[0]	[2]
Axis Vector: -0.989679	Axis Vector: 0.131104
[1]	Array Horizontal Vector length 3
Axis Vector: -0.046318	[0]
[2]	Horizontal Vector: 315.089938
Axis Vector: 0.135607	[1]
Array Horizontal Vector length 3	Horizontal Vector: -3647.728413
[0]	[2]
Horizontal Vector: -349.960356	Horizontal Vector: 47.302857
[1]	Array Vertical Vector length 3
Horizontal Vector: -3576.595824	[0]
[2]	Vertical Vector: -20.801368
Horizontal Vector: 44.320764	[1]
Array Vertical Vector length 3	Vertical Vector: -26.864694
[0]	[2]
Vertical Vector: -10.046627	Vertical Vector: 3660.536632
[1]	Array Optical Vector length 3
Vertical Vector: -28.461764	[0]
[2]	Optical Vector: -0.962756
Vertical Vector: 3591.399075	[1]
Array Optical Vector length 3	Optical Vector: -0.233389
[0]	[2]
Optical Vector: -0.991056	Optical Vector: 0.136490
[1]	Array Radial Distortion Terms length 3
Optical Vector: -0.047812	[0]
[2]	Radial Distortion Terms: 0.000998
Optical Vector: 0.124591	[1]
Array Radial Distortion Terms length 3	Radial Distortion Terms: 0.003762
[0]	[2]
Radial Distortion Terms: 0.022997	Radial Distortion Terms: -0.057232
[1]	Array Entrance Pupil Terms length 3
Radial Distortion Terms: 0.024872	[0]
[2]	Entrance Pupil Terms: 0.000000
Radial Distortion Terms: -0.407146	[1]
Array Entrance Pupil Terms length 3	Entrance Pupil Terms: 0.000000
[0]	[2]
Entrance Pupil Terms: 0.000000	Entrance Pupil Terms: 0.000000
[1]	Array Camera Reference Vector length 3
Entrance Pupil Terms: 0.000000	[0]
[2]	Camera Reference Vector: 0.457290
Entrance Pupil Terms: 0.000000	[1]

MER A Camera Models	MER B Camera Models
Array Camera Reference Vector length 3 [0] Camera Reference Vector: 0.457810 [1] Camera Reference Vector: 0.027790 [2] Camera Reference Vector: -1.096680 Array Camera Reference Quaternion length 4 [0] Camera Reference Quaternion: 0.070093 [1] Camera Reference Quaternion: 0.001171 [2] Camera Reference Quaternion: 0.997401 [3] Camera Reference Quaternion: -0.016658 Camera Temperature: 20.000000 [Right Pancam, filter R1] Camera Model ID: 184 Camera Serial Number: 103 Camera ID: Right Pancam Filter Position: Pancam Right-Eye Filter R1: 450 nm Model Class: CAHVOR Model Type: 0 Model Parameter: 0.000000 Array Center Vector length 3 [0] Center Vector: 0.413705 [1] Center Vector: -0.135215 [2] Center Vector: -1.246372 Array Axis Vector length 3 [0] Axis Vector: -0.990622 [1] Axis Vector: -0.007005 [2] Axis Vector: 0.136451 Array Horizontal Vector length 3 [0] Horizontal Vector: -474.046354 [1] Horizontal Vector: -3554.067848 [2] Horizontal Vector: 56.808555 Array Vertical Vector length 3 [0] Vertical Vector: -4.611697 [1] Vertical Vector: -13.887297 [2] Vertical Vector: 3586.811043 Array Optical Vector length 3 [0] Optical Vector: -0.993079 [1] Optical Vector: 0.017077 [2] Optical Vector: 0.116202 Array Radial Distortion Terms length 3 [0] Radial Distortion Terms: 0.022082 [1] Radial Distortion Terms: -0.033675 [2] Radial Distortion Terms: 0.611672 Array Entrance Pupil Terms length 3	Camera Reference Vector: 0.026050 [2] Camera Reference Vector: -1.096200 Array Camera Reference Quaternion length 4 [0] Camera Reference Quaternion: 0.065924 [1] Camera Reference Quaternion: 0.006818 [2] Camera Reference Quaternion: 0.992507 [3] Camera Reference Quaternion: -0.102653 Camera Temperature: 20.000000 [Right Pancam, filter R1] Camera Model ID: 206 Camera Serial Number: 114 Camera ID: Right Pancam Filter Position: Pancam Right-Eye Filter R1: 450 nm Model Class: CAHVOR Model Type: 0 Model Parameter: 0.000000 Array Center Vector length 3 [0] Center Vector: 0.443429 [1] Center Vector: -0.142099 [2] Center Vector: -1.246638 Array Axis Vector length 3 [0] Axis Vector: -0.974596 [1] Axis Vector: -0.180627 [2] Axis Vector: 0.132429 Array Horizontal Vector length 3 [0] Horizontal Vector: 176.690830 [1] Horizontal Vector: -3612.502474 [2] Horizontal Vector: 64.120658 Array Vertical Vector length 3 [0] Vertical Vector: -34.618632 [1] Vertical Vector: -6.528287 [2] Vertical Vector: 3620.840003 Array Optical Vector length 3 [0] Optical Vector: -0.973043 [1] Optical Vector: -0.185358 [2] Optical Vector: 0.137249 Array Radial Distortion Terms length 3 [0] Radial Distortion Terms: 0.013087 [1] Radial Distortion Terms: 0.023504 [2] Radial Distortion Terms: -0.374157 Array Entrance Pupil Terms length 3 [0] Entrance Pupil Terms: 0.000000 [1] Entrance Pupil Terms: 0.000000

MER A Camera Models	MER B Camera Models
[0]	[2]
Entrance Pupil Terms: 0.000000	Entrance Pupil Terms: 0.000000
[1]	Array Camera Reference Vector length 3
Entrance Pupil Terms: 0.000000	[0]
[2]	Camera Reference Vector: 0.457290
Entrance Pupil Terms: 0.000000	[1]
Array Camera Reference Vector length 3	Camera Reference Vector: 0.026050
[0]	[2]
Camera Reference Vector: 0.457810	Camera Reference Vector: -1.096200
[1]	Array Camera Reference Quaternion length 4
Camera Reference Vector: 0.027790	[0]
[2]	Camera Reference Quaternion: 0.065924
Camera Reference Vector: -1.096680	[1]
Array Camera Reference Quaternion length 4	Camera Reference Quaternion: 0.006818
[0]	[2]
Camera Reference Quaternion: 0.070093	Camera Reference Quaternion: 0.992507
[1]	[3]
Camera Reference Quaternion: 0.001171	Camera Reference Quaternion: -0.102653
[2]	Camera Temperature: 20.000000
Camera Reference Quaternion: 0.997401	[Right Pancam, filter R2]
[3]	Camera Model ID: 207
Camera Reference Quaternion: -0.016658	Camera Serial Number: 114
Camera Temperature: 20.000000	Camera ID: Right Pancam
[Right Pancam, filter R2]	Filter Position: Pancam Right-Eye Filter
Camera Model ID: 185	R2: 750 nm
Camera Serial Number: 103	Model Class: CAHVOR
Camera ID: Right Pancam	Model Type: 0
Filter Position: Pancam Right-Eye Filter	Model Parameter: 0.000000
R2: 750 nm	
Model Class: CAHVOR	Array Center Vector length 3
Model Type: 0	[0]
Model Parameter: 0.000000	Center Vector: 0.443429
Array Center Vector length 3	[1]
[0]	Center Vector: -0.142099
Center Vector: 0.413705	[2]
[1]	Center Vector: -1.246638
Center Vector: -0.135215	Array Axis Vector length 3
[2]	[0]
Center Vector: -1.246372	Axis Vector: -0.974596
Array Axis Vector length 3	[1]
[0]	Axis Vector: -0.180627
Axis Vector: -0.990622	[2]
[1]	Axis Vector: 0.132429
Axis Vector: -0.007005	Array Horizontal Vector length 3
[2]	[0]
Axis Vector: 0.136451	Horizontal Vector: 176.690830
Array Horizontal Vector length 3	[1]
[0]	Horizontal Vector: -3612.502474
Horizontal Vector: -474.046354	[2]
[1]	Horizontal Vector: 64.120658
Horizontal Vector: -3554.067848	Array Vertical Vector length 3
[2]	[0]
Horizontal Vector: 56.808555	Vertical Vector: -34.618632
Array Vertical Vector length 3	[1]
[0]	Vertical Vector: -6.528287
Vertical Vector: -4.611697	[2]
[1]	Vertical Vector: 3620.840003
Vertical Vector: -13.887297	Array Optical Vector length 3
[2]	[0]
Vertical Vector: 3586.811043	Optical Vector: -0.973043
Array Optical Vector length 3	[1]
[0]	Optical Vector: -0.185358
Optical Vector: -0.993079	[2]
[1]	Optical Vector: 0.137249
Optical Vector: 0.017077	Array Radial Distortion Terms length 3
[2]	[0]
Optical Vector: 0.116202	Radial Distortion Terms: 0.013087
Array Radial Distortion Terms length 3	[1]
[0]	Radial Distortion Terms: 0.023504
Radial Distortion Terms: 0.022082	[2]

MER A Camera Models	MER B Camera Models
[1] Radial Distortion Terms: -0.033675 [2] Radial Distortion Terms: 0.611672 Array Entrance Pupil Terms length 3 [0] Entrance Pupil Terms: 0.000000 [1] Entrance Pupil Terms: 0.000000 [2] Entrance Pupil Terms: 0.000000 Array Camera Reference Vector length 3 [0] Camera Reference Vector: 0.457810 [1] Camera Reference Vector: 0.027790 [2] Camera Reference Vector: -1.096680 Array Camera Reference Quaternion length 4 [0] Camera Reference Quaternion: 0.070093 [1] Camera Reference Quaternion: 0.001171 [2] Camera Reference Quaternion: 0.997401 [3] Camera Reference Quaternion: -0.016658 Camera Temperature: 20.000000 [Right Pancam, filter R3] Camera Model ID: 186 Camera Serial Number: 103 Camera ID: Right Pancam Filter Position: Pancam Right-Eye Filter R3: 800 nm Model Class: CAHVOR Model Type: 0 Model Parameter: 0.000000 Array Center Vector length 3 [0] Center Vector: 0.413705 [1] Center Vector: -0.135215 [2] Center Vector: -1.246372 Array Axis Vector length 3 [0] Axis Vector: -0.990622 [1] Axis Vector: -0.007005 [2] Axis Vector: 0.136451 Array Horizontal Vector length 3 [0] Horizontal Vector: -474.046354 [1] Horizontal Vector: -3554.067848 [2] Horizontal Vector: 56.808555 Array Vertical Vector length 3 [0] Vertical Vector: -4.611697 [1] Vertical Vector: -13.887297 [2] Vertical Vector: 3586.811043 Array Optical Vector length 3 [0] Optical Vector: -0.993079 [1] Optical Vector: 0.017077	Radial Distortion Terms: -0.374157 Array Entrance Pupil Terms length 3 [0] Entrance Pupil Terms: 0.000000 [1] Entrance Pupil Terms: 0.000000 [2] Entrance Pupil Terms: 0.000000 Array Camera Reference Vector length 3 [0] Camera Reference Vector: 0.457290 [1] Camera Reference Vector: 0.026050 [2] Camera Reference Vector: -1.096200 Array Camera Reference Quaternion length 4 [0] Camera Reference Quaternion: 0.065924 [1] Camera Reference Quaternion: 0.006818 [2] Camera Reference Quaternion: 0.992507 [3] Camera Reference Quaternion: -0.102653 Camera Temperature: 20.000000 [Right Pancam, filter R3] Camera Model ID: 208 Camera Serial Number: 114 Camera ID: Right Pancam Filter Position: Pancam Right-Eye Filter R3: 800 nm Model Class: CAHVOR Model Type: 0 Model Parameter: 0.000000 Array Center Vector length 3 [0] Center Vector: 0.443429 [1] Center Vector: -0.142099 [2] Center Vector: -1.246638 Array Axis Vector length 3 [0] Axis Vector: -0.974596 [1] Axis Vector: -0.180627 [2] Axis Vector: 0.132429 Array Horizontal Vector length 3 [0] Horizontal Vector: 176.690830 [1] Horizontal Vector: -3612.502474 [2] Horizontal Vector: 64.120658 Array Vertical Vector length 3 [0] Vertical Vector: -34.618632 [1] Vertical Vector: -6.528287 [2] Vertical Vector: 3620.840003 Array Optical Vector length 3 [0] Optical Vector: -0.973043 [1] Optical Vector: -0.185358 [2] Optical Vector: 0.137249 Array Radial Distortion Terms length 3

MER A Camera Models	MER B Camera Models
[2]	[0]
Optical Vector: 0.116202	Radial Distortion Terms: 0.013087
Array Radial Distortion Terms length 3	[1]
[0]	Radial Distortion Terms: 0.023504
Radial Distortion Terms: 0.022082	[2]
[1]	Radial Distortion Terms: -0.374157
Radial Distortion Terms: -0.033675	Array Entrance Pupil Terms length 3
[2]	[0]
Radial Distortion Terms: 0.611672	Entrance Pupil Terms: 0.000000
Array Entrance Pupil Terms length 3	[1]
[0]	Entrance Pupil Terms: 0.000000
Entrance Pupil Terms: 0.000000	[2]
[1]	Entrance Pupil Terms: 0.000000
Entrance Pupil Terms: 0.000000	Array Camera Reference Vector length 3
[2]	[0]
Entrance Pupil Terms: 0.000000	Camera Reference Vector: 0.457290
Array Camera Reference Vector length 3	[1]
[0]	Camera Reference Vector: 0.026050
Camera Reference Vector: 0.457810	[2]
[1]	Camera Reference Vector: -1.096200
Camera Reference Vector: 0.027790	Array Camera Reference Quaternion length 4
[2]	[0]
Camera Reference Vector: -1.096680	Camera Reference Quaternion: 0.065924
Array Camera Reference Quaternion length 4	[1]
[0]	Camera Reference Quaternion: 0.006818
Camera Reference Quaternion: 0.070093	[2]
[1]	Camera Reference Quaternion: 0.992507
Camera Reference Quaternion: 0.001171	[3]
[2]	Camera Reference Quaternion: -0.102653
Camera Reference Quaternion: 0.997401	Camera Temperature: 20.000000
[3]	[Right Pancam, filter R4]
Camera Reference Quaternion: -0.016658	Camera Model ID: 209
Camera Temperature: 20.000000	Camera Serial Number: 114
[Right Pancam, filter R4]	Camera ID: Right Pancam
Camera Model ID: 187	Filter Position: Pancam Right-Eye Filter
Camera Serial Number: 103	R4: 860 nm
Camera ID: Right Pancam	Model Class: CAHVOR
Filter Position: Pancam Right-Eye Filter	Model Type: 0
R4: 860 nm	Model Parameter: 0.000000
Model Class: CAHVOR	Array Center Vector length 3
Model Type: 0	[0]
Model Parameter: 0.000000	Center Vector: 0.443429
Array Center Vector length 3	[1]
[0]	Center Vector: -0.142099
Center Vector: 0.413705	[2]
[1]	Center Vector: -1.246638
Center Vector: -0.135215	Array Axis Vector length 3
[2]	[0]
Center Vector: -1.246372	Axis Vector: -0.974596
Array Axis Vector length 3	[1]
[0]	Axis Vector: -0.180627
Axis Vector: -0.990622	[2]
[1]	Axis Vector: 0.132429
Axis Vector: -0.007005	Array Horizontal Vector length 3
[2]	[0]
Axis Vector: 0.136451	Horizontal Vector: 176.690830
Array Horizontal Vector length 3	[1]
[0]	Horizontal Vector: -3612.502474
Horizontal Vector: -474.046354	[2]
[1]	Horizontal Vector: 64.120658
Horizontal Vector: -3554.067848	Array Vertical Vector length 3
[2]	[0]
Horizontal Vector: 56.808555	Vertical Vector: -34.618632
Array Vertical Vector length 3	[1]
[0]	Vertical Vector: -6.528287
Vertical Vector: -4.611697	[2]
[1]	Vertical Vector: 3620.840003
Vertical Vector: -13.887297	Array Optical Vector length 3
[2]	[0]
Vertical Vector: 3586.811043	

MER A Camera Models	MER B Camera Models
Array Optical Vector length 3	Optical Vector: -0.973043
[0]	[1]
Optical Vector: -0.993079	Optical Vector: -0.185358
[1]	[2]
Optical Vector: 0.017077	Optical Vector: 0.137249
[2]	Array Radial Distortion Terms length 3
Optical Vector: 0.116202	[0]
Array Radial Distortion Terms length 3	Radial Distortion Terms: 0.013087
[0]	[1]
Radial Distortion Terms: 0.022082	Radial Distortion Terms: 0.023504
[1]	[2]
Radial Distortion Terms: -0.033675	Radial Distortion Terms: -0.374157
[2]	Array Entrance Pupil Terms length 3
Radial Distortion Terms: 0.611672	[0]
Array Entrance Pupil Terms length 3	Entrance Pupil Terms: 0.000000
[0]	[1]
Entrance Pupil Terms: 0.000000	Entrance Pupil Terms: 0.000000
[1]	[2]
Entrance Pupil Terms: 0.000000	Entrance Pupil Terms: 0.000000
[2]	Array Camera Reference Vector length 3
Entrance Pupil Terms: 0.000000	[0]
Array Camera Reference Vector length 3	Camera Reference Vector: 0.457290
[0]	[1]
Camera Reference Vector: 0.457810	Camera Reference Vector: 0.026050
[1]	[2]
Camera Reference Vector: 0.027790	Camera Reference Vector: -1.096200
[2]	Array Camera Reference Quaternion length 4
Camera Reference Vector: -1.096680	[0]
Array Camera Reference Quaternion length 4	Camera Reference Quaternion: 0.065924
[0]	[1]
Camera Reference Quaternion: 0.070093	Camera Reference Quaternion: 0.006818
[1]	[2]
Camera Reference Quaternion: 0.001171	Camera Reference Quaternion: 0.992507
[2]	[3]
Camera Reference Quaternion: 0.997401	Camera Reference Quaternion: -0.102653
[3]	Camera Temperature: 20.000000
Camera Reference Quaternion: -0.016658	[Right Pancam, filter R5]
Camera Temperature: 20.000000	Camera Model ID: 210
[Right Pancam, filter R5]	Camera Serial Number: 114
Camera Model ID: 188	Camera ID: Right Pancam
Camera Serial Number: 103	Filter Position: Pancam Right-Eye Filter
Camera ID: Right Pancam	R5: 900 nm
Filter Position: Pancam Right-Eye Filter	Model Class: CAHVOR
R5: 900 nm	Model Type: 0
Model Class: CAHVOR	Model Parameter: 0.000000
Model Type: 0	Array Center Vector length 3
Model Parameter: 0.000000	[0]
Array Center Vector length 3	Center Vector: 0.443429
[0]	[1]
Center Vector: 0.413705	Center Vector: -0.142099
[1]	[2]
Center Vector: -0.135215	Center Vector: -1.246638
[2]	Array Axis Vector length 3
Center Vector: -1.246372	[0]
Array Axis Vector length 3	Axis Vector: -0.974596
[0]	[1]
Axis Vector: -0.990622	Axis Vector: -0.180627
[1]	[2]
Axis Vector: -0.007005	Axis Vector: 0.132429
[2]	Array Horizontal Vector length 3
Axis Vector: 0.136451	[0]
Array Horizontal Vector length 3	Horizontal Vector: 176.690830
[0]	[1]
Horizontal Vector: -474.046354	Horizontal Vector: -3612.502474
[1]	[2]
Horizontal Vector: -3554.067848	Horizontal Vector: 64.120658
[2]	Array Vertical Vector length 3
Horizontal Vector: 56.808555	[0]
Array Vertical Vector length 3	Vertical Vector: -34.618632
[0]	[1]

MER A Camera Models	MER B Camera Models
Vertical Vector: -4.611697 [1]	Vertical Vector: -6.528287 [2]
Vertical Vector: -13.887297 [2]	Vertical Vector: 3620.840003
Vertical Vector: 3586.811043	Array Optical Vector length 3
Array Optical Vector length 3 [0]	[0]
Optical Vector: -0.993079 [1]	Optical Vector: -0.973043 [1]
Optical Vector: 0.017077 [2]	Optical Vector: -0.185358 [2]
Optical Vector: 0.116202	Optical Vector: 0.137249
Array Radial Distortion Terms length 3 [0]	Array Radial Distortion Terms length 3 [0]
Radial Distortion Terms: 0.022082 [1]	Radial Distortion Terms: 0.013087 [1]
Radial Distortion Terms: -0.033675 [2]	Radial Distortion Terms: 0.023504 [2]
Radial Distortion Terms: 0.611672	Radial Distortion Terms: -0.374157
Array Entrance Pupil Terms length 3 [0]	Array Entrance Pupil Terms length 3 [0]
Entrance Pupil Terms: 0.000000 [1]	Entrance Pupil Terms: 0.000000 [1]
Entrance Pupil Terms: 0.000000 [2]	Entrance Pupil Terms: 0.000000 [2]
Entrance Pupil Terms: 0.000000	Entrance Pupil Terms: 0.000000
Array Camera Reference Vector length 3 [0]	Array Camera Reference Vector length 3 [0]
Camera Reference Vector: 0.457810 [1]	Camera Reference Vector: 0.457290 [1]
Camera Reference Vector: 0.027790 [2]	Camera Reference Vector: 0.026050 [2]
Camera Reference Vector: -1.096680	Camera Reference Vector: -1.096200
Array Camera Reference Quaternion length 4 [0]	Array Camera Reference Quaternion length 4 [0]
Camera Reference Quaternion: 0.070093 [1]	Camera Reference Quaternion: 0.065924 [1]
Camera Reference Quaternion: 0.001171 [2]	Camera Reference Quaternion: 0.006818 [2]
Camera Reference Quaternion: 0.997401 [3]	Camera Reference Quaternion: 0.992507 [3]
Camera Reference Quaternion: -0.016658	Camera Reference Quaternion: -0.102653
Camera Temperature: 20.000000	Camera Temperature: 20.000000
[Right Pancam, filter R6]	[Right Pancam, filter R6]
Camera Model ID: 189	Camera Model ID: 211
Camera Serial Number: 103	Camera Serial Number: 114
Camera ID: Right Pancam	Camera ID: Right Pancam
Filter Position: Pancam Right-Eye Filter R6: 930 nm	Filter Position: Pancam Right-Eye Filter R6: 930 nm
Model Class: CAHVOR	Model Class: CAHVOR
Model Type: 0	Model Type: 0
Model Parameter: 0.000000	Model Parameter: 0.000000
Array Center Vector length 3 [0]	Array Center Vector length 3 [0]
Center Vector: 0.413705 [1]	Center Vector: 0.443429 [1]
Center Vector: -0.135215 [2]	Center Vector: -0.142099 [2]
Center Vector: -1.246372	Center Vector: -1.246638
Array Axis Vector length 3 [0]	Array Axis Vector length 3 [0]
Axis Vector: -0.990622 [1]	Axis Vector: -0.974596 [1]
Axis Vector: -0.007005 [2]	Axis Vector: -0.180627 [2]
Axis Vector: 0.136451	Axis Vector: 0.132429
Array Horizontal Vector length 3 [0]	Array Horizontal Vector length 3 [0]
Horizontal Vector: -474.046354 [1]	Horizontal Vector: 176.690830 [1]
	Horizontal Vector: -3612.502474

MER A Camera Models	MER B Camera Models
Horizontal Vector: -3554.067848 [2] Horizontal Vector: 56.808555 Array Vertical Vector length 3 [0] Vertical Vector: -4.611697 [1] Vertical Vector: -13.887297 [2] Vertical Vector: 3586.811043 Array Optical Vector length 3 [0] Optical Vector: -0.993079 [1] Optical Vector: 0.017077 [2] Optical Vector: 0.116202 Array Radial Distortion Terms length 3 [0] Radial Distortion Terms: 0.022082 [1] Radial Distortion Terms: -0.033675 [2] Radial Distortion Terms: 0.611672 Array Entrance Pupil Terms length 3 [0] Entrance Pupil Terms: 0.000000 [1] Entrance Pupil Terms: 0.000000 [2] Entrance Pupil Terms: 0.000000 Array Camera Reference Vector length 3 [0] Camera Reference Vector: 0.457810 [1] Camera Reference Vector: 0.027790 [2] Camera Reference Vector: -1.096680 Array Camera Reference Quaternion length 4 [0] Camera Reference Quaternion: 0.070093 [1] Camera Reference Quaternion: 0.001171 [2] Camera Reference Quaternion: 0.997401 [3] Camera Reference Quaternion: -0.016658 Camera Temperature: 20.000000 [Right Pancam, filter R7] Camera Model ID: 190 Camera Serial Number: 103 Camera ID: Right Pancam Filter Position: Pancam Right-Eye Filter R7: 985 nm Model Class: CAHVOR Model Type: 0 Model Parameter: 0.000000 Array Center Vector length 3 [0] Center Vector: 0.413705 [1] Center Vector: -0.135215 [2] Center Vector: -1.246372 Array Axis Vector length 3 [0] Axis Vector: -0.990622 [1] Axis Vector: -0.007005 [2]	[2] Horizontal Vector: 64.120658 Array Vertical Vector length 3 [0] Vertical Vector: -34.618632 [1] Vertical Vector: -6.528287 [2] Vertical Vector: 3620.840003 Array Optical Vector length 3 [0] Optical Vector: -0.973043 [1] Optical Vector: -0.185358 [2] Optical Vector: 0.137249 Array Radial Distortion Terms length 3 [0] Radial Distortion Terms: 0.013087 [1] Radial Distortion Terms: 0.023504 [2] Radial Distortion Terms: -0.374157 Array Entrance Pupil Terms length 3 [0] Entrance Pupil Terms: 0.000000 [1] Entrance Pupil Terms: 0.000000 [2] Entrance Pupil Terms: 0.000000 Array Camera Reference Vector length 3 [0] Camera Reference Vector: 0.457290 [1] Camera Reference Vector: 0.026050 [2] Camera Reference Vector: -1.096200 Array Camera Reference Quaternion length 4 [0] Camera Reference Quaternion: 0.065924 [1] Camera Reference Quaternion: 0.006818 [2] Camera Reference Quaternion: 0.992507 [3] Camera Reference Quaternion: -0.102653 Camera Temperature: 20.000000 [Right Pancam, filter R7] Camera Model ID: 212 Camera Serial Number: 114 Camera ID: Right Pancam Filter Position: Pancam Right-Eye Filter R7: 985 nm Model Class: CAHVOR Model Type: 0 Model Parameter: 0.000000 Array Center Vector length 3 [0] Center Vector: 0.443429 [1] Center Vector: -0.142099 [2] Center Vector: -1.246638 Array Axis Vector length 3 [0] Axis Vector: -0.974596 [1] Axis Vector: -0.180627 [2] Axis Vector: 0.132429

MER A Camera Models	MER B Camera Models
Axis Vector: 0.136451	Array Horizontal Vector length 3
Array Horizontal Vector length 3	[0]
[0]	Horizontal Vector: 176.690830
Horizontal Vector: -474.046354	[1]
[1]	Horizontal Vector: -3612.502474
Horizontal Vector: -3554.067848	[2]
[2]	Horizontal Vector: 64.120658
Horizontal Vector: 56.808555	Array Vertical Vector length 3
Array Vertical Vector length 3	[0]
[0]	Vertical Vector: -34.618632
Vertical Vector: -4.611697	[1]
[1]	Vertical Vector: -6.528287
Vertical Vector: -13.887297	[2]
[2]	Vertical Vector: 3620.840003
Vertical Vector: 3586.811043	Array Optical Vector length 3
Array Optical Vector length 3	[0]
[0]	Optical Vector: -0.973043
Optical Vector: -0.993079	[1]
[1]	Optical Vector: -0.185358
Optical Vector: 0.017077	[2]
[2]	Optical Vector: 0.137249
Optical Vector: 0.116202	Array Radial Distortion Terms length 3
Array Radial Distortion Terms length 3	[0]
[0]	Radial Distortion Terms: 0.013087
Radial Distortion Terms: 0.022082	[1]
[1]	Radial Distortion Terms: 0.023504
Radial Distortion Terms: -0.033675	[2]
[2]	Radial Distortion Terms: -0.374157
Radial Distortion Terms: 0.611672	Array Entrance Pupil Terms length 3
Array Entrance Pupil Terms length 3	[0]
[0]	Entrance Pupil Terms: 0.000000
Entrance Pupil Terms: 0.000000	[1]
[1]	Entrance Pupil Terms: 0.000000
Entrance Pupil Terms: 0.000000	[2]
[2]	Entrance Pupil Terms: 0.000000
Entrance Pupil Terms: 0.000000	Array Camera Reference Vector length 3
Array Camera Reference Vector length 3	[0]
[0]	Camera Reference Vector: 0.457290
Camera Reference Vector: 0.457810	[1]
[1]	Camera Reference Vector: 0.026050
Camera Reference Vector: 0.027790	[2]
[2]	Camera Reference Vector: -1.096200
Camera Reference Vector: -1.096680	Array Camera Reference Quaternion length 4
Array Camera Reference Quaternion length 4	[0]
[0]	Camera Reference Quaternion: 0.065924
Camera Reference Quaternion: 0.070093	[1]
[1]	Camera Reference Quaternion: 0.006818
Camera Reference Quaternion: 0.001171	[2]
[2]	Camera Reference Quaternion: 0.992507
Camera Reference Quaternion: 0.997401	[3]
[3]	Camera Reference Quaternion: -0.102653
Camera Reference Quaternion: -0.016658	Camera Temperature: 20.000000
Camera Temperature: 20.000000	[Right Pancam, filter R8]
[Right Pancam, filter R8]	Camera Model ID: 213
Camera Model ID: 191	Camera Serial Number: 114
Camera Serial Number: 103	Camera ID: Right Pancam
Camera ID: Right Pancam	Filter Position: Pancam Right-Eye Filter
Filter Position: Pancam Right-Eye Filter	R8: 880 nm - Solar ND
R8: 880 nm - Solar ND	Model Class: CAHVOR
Model Class: CAHVOR	Model Type: 0
Model Type: 0	Model Parameter: 0.000000
Model Parameter: 0.000000	Array Center Vector length 3
Array Center Vector length 3	[0]
[0]	Center Vector: 0.443429
Center Vector: 0.413705	[1]
[1]	Center Vector: -0.142099
Center Vector: -0.135215	[2]
[2]	Center Vector: -1.246638
Center Vector: -1.246372	Array Axis Vector length 3
Array Axis Vector length 3	[0]

MER A Camera Models	MER B Camera Models
[0]	Axis Vector: -0.974596
Axis Vector: -0.990622	[1]
[1]	Axis Vector: -0.180627
Axis Vector: -0.007005	[2]
[2]	Axis Vector: 0.132429
Axis Vector: 0.136451	Array Horizontal Vector length 3
Array Horizontal Vector length 3	[0]
[0]	Horizontal Vector: 176.690830
Horizontal Vector: -474.046354	[1]
[1]	Horizontal Vector: -3612.502474
Horizontal Vector: -3554.067848	[2]
[2]	Horizontal Vector: 64.120658
Horizontal Vector: 56.808555	Array Vertical Vector length 3
Array Vertical Vector length 3	[0]
[0]	Vertical Vector: -34.618632
Vertical Vector: -4.611697	[1]
[1]	Vertical Vector: -6.528287
Vertical Vector: -13.887297	[2]
[2]	Vertical Vector: 3620.840003
Vertical Vector: 3586.811043	Array Optical Vector length 3
Array Optical Vector length 3	[0]
[0]	Optical Vector: -0.973043
Optical Vector: -0.993079	[1]
[1]	Optical Vector: -0.185358
Optical Vector: 0.017077	[2]
[2]	Optical Vector: 0.137249
Optical Vector: 0.116202	Array Radial Distortion Terms length 3
Array Radial Distortion Terms length 3	[0]
[0]	Radial Distortion Terms: 0.013087
Radial Distortion Terms: 0.022082	[1]
[1]	Radial Distortion Terms: 0.023504
Radial Distortion Terms: -0.033675	[2]
[2]	Radial Distortion Terms: -0.374157
Radial Distortion Terms: 0.611672	Array Entrance Pupil Terms length 3
Array Entrance Pupil Terms length 3	[0]
[0]	Entrance Pupil Terms: 0.000000
Entrance Pupil Terms: 0.000000	[1]
[1]	Entrance Pupil Terms: 0.000000
Entrance Pupil Terms: 0.000000	[2]
[2]	Entrance Pupil Terms: 0.000000
Entrance Pupil Terms: 0.000000	Array Camera Reference Vector length 3
Array Camera Reference Vector length 3	[0]
[0]	Camera Reference Vector: 0.457290
Camera Reference Vector: 0.457810	[1]
[1]	Camera Reference Vector: 0.026050
Camera Reference Vector: 0.027790	[2]
[2]	Camera Reference Vector: -1.096200
Camera Reference Vector: -1.096680	Array Camera Reference Quaternion length 4
Array Camera Reference Quaternion length 4	[0]
[0]	Camera Reference Quaternion: 0.065924
Camera Reference Quaternion: 0.070093	[1]
[1]	Camera Reference Quaternion: 0.006818
Camera Reference Quaternion: 0.001171	[2]
[2]	Camera Reference Quaternion: 0.992507
Camera Reference Quaternion: 0.997401	[3]
[3]	Camera Reference Quaternion: -0.102653
Camera Reference Quaternion: -0.016658	Camera Temperature: 20.000000
Camera Temperature: 20.000000	[EDL Descent Imager]
[EDL Descent Imager]	Camera Model ID: 169
Camera Model ID: 171	Camera Serial Number: 123
Camera Serial Number: 118	Camera ID: EDL Descent Imager
Camera ID: EDL Descent Imager	Filter Position: No filter/unknown
Filter Position: No filter/unknown	Model Class: CAHVOR
Model Class: CAHVOR	Model Type: 0
Model Type: 0	Model Parameter: 0.000000
Model Parameter: 0.000000	Array Center Vector length 3
Array Center Vector length 3	[0]
[0]	Center Vector: -0.000318
Center Vector: -0.000954	[1]
[1]	Center Vector: -0.864737

MER A Camera Models	MER B Camera Models
Center Vector: -0.865025	[2]
[2]	Center Vector: 0.004388
Center Vector: 0.006423	Array Axis Vector length 3
Array Axis Vector length 3	[0]
[0]	Axis Vector: -0.001537
Axis Vector: 0.003038	[1]
[1]	Axis Vector: -0.334609
Axis Vector: -0.334895	[2]
[2]	Axis Vector: 0.942356
Axis Vector: 0.942251	Array Horizontal Vector length 3
Array Horizontal Vector length 3	[0]
[0]	Horizontal Vector: -0.817862
Horizontal Vector: -2.773939	[1]
[1]	Horizontal Vector: -1319.884526
Horizontal Vector: -1329.587622	[2]
[2]	Horizontal Vector: 77.557951
Horizontal Vector: 78.976148	Array Vertical Vector length 3
Array Vertical Vector length 3	[0]
[0]	Vertical Vector: 1217.312286
Vertical Vector: 1227.942274	[1]
[1]	Vertical Vector: -174.152524
Vertical Vector: -171.111650	[2]
[2]	Vertical Vector: 490.582537
Vertical Vector: 468.829410	Array Optical Vector length 3
Array Optical Vector length 3	[0]
[0]	Optical Vector: -0.008482
Optical Vector: 0.035227	[1]
[1]	Optical Vector: -0.267211
Optical Vector: -0.324036	[2]
[2]	Optical Vector: 0.963601
Optical Vector: 0.945389	Array Radial Distortion Terms length 3
Array Radial Distortion Terms length 3	[0]
[0]	Radial Distortion Terms: 0.005004
Radial Distortion Terms: 0.001160	[1]
[1]	Radial Distortion Terms: 0.002115
Radial Distortion Terms: -0.002318	[2]
[2]	Radial Distortion Terms: 0.013527
Radial Distortion Terms: 0.021769	Array Entrance Pupil Terms length 3
Array Entrance Pupil Terms length 3	[0]
[0]	Entrance Pupil Terms: 0.000000
Entrance Pupil Terms: 0.000000	[1]
[1]	Entrance Pupil Terms: 0.000000
Entrance Pupil Terms: 0.000000	[2]
[2]	Entrance Pupil Terms: 0.000000
Entrance Pupil Terms: 0.000000	Array Camera Reference Vector length 3
Array Camera Reference Vector length 3	[0]
[0]	Camera Reference Vector: 0.000000
Camera Reference Vector: 0.000000	[1]
[1]	Camera Reference Vector: 0.000000
Camera Reference Vector: 0.000000	[2]
[2]	Camera Reference Vector: 0.000000
Camera Reference Vector: 0.000000	Array Camera Reference Quaternion length 4
Array Camera Reference Quaternion length 4	[0]
[0]	Camera Reference Quaternion: 0.000000
Camera Reference Quaternion: 0.000000	[1]
[1]	Camera Reference Quaternion: 0.000000
Camera Reference Quaternion: 0.000000	[2]
[2]	Camera Reference Quaternion: 0.000000
Camera Reference Quaternion: 0.000000	[3]
[3]	Camera Reference Quaternion: 1.000000
Camera Reference Quaternion: 1.000000	Camera Temperature: 20.000000
Camera Temperature: 20.000000	[Microscopic Imager, Cover Closed]
[Microscopic Imager, Cover Closed]	Camera Model ID: 195
Camera Model ID: 173	Camera Serial Number: 110
Camera Serial Number: 105	Camera ID: Microscopic Imager
Camera ID: Microscopic Imager	Filter Position: Microscopic Imager Cover
Filter Position: Microscopic Imager Cover	Closed
Closed	Model Class: CAHVOR
Model Class: CAHVOR	Model Type: 0
Model Type: 0	Model Parameter: 0.000000

MER A Camera Models	MER B Camera Models
Model Parameter: 0.000000	Array Center Vector length 3
Array Center Vector length 3	[0]
[0]	Center Vector: 1.120980
Center Vector: 1.058880	[1]
[1]	Center Vector: 0.084947
Center Vector: -0.054903	[2]
[2]	Center Vector: 0.105077
Center Vector: 0.275421	Array Axis Vector length 3
Array Axis Vector length 3	[0]
[0]	Axis Vector: 0.025729
Axis Vector: -0.005821	[1]
[1]	Axis Vector: -0.014067
Axis Vector: 0.058380	[2]
[2]	Axis Vector: 0.999570
Axis Vector: 0.998277	Array Horizontal Vector length 3
Array Horizontal Vector length 3	[0]
[0]	Horizontal Vector: -605.098814
Horizontal Vector: 26.031857	[1]
[1]	Horizontal Vector: 2279.629747
Horizontal Vector: -2337.838852	[2]
[2]	Horizontal Vector: 576.574483
Horizontal Vector: 631.369970	Array Vertical Vector length 3
Array Vertical Vector length 3	[0]
[0]	Vertical Vector: -2269.908949
Vertical Vector: 2365.204651	[1]
[1]	Vertical Vector: -629.901082
Vertical Vector: 57.405196	[2]
[2]	Vertical Vector: 571.473228
Vertical Vector: 525.651774	Array Optical Vector length 3
Array Optical Vector length 3	[0]
[0]	Optical Vector: -0.003143
Optical Vector: -0.061672	[1]
[1]	Optical Vector: -0.044770
Optical Vector: 0.126116	[2]
[2]	Optical Vector: 0.998992
Optical Vector: 0.990097	Array Radial Distortion Terms length 3
Array Radial Distortion Terms length 3	[0]
[0]	Radial Distortion Terms: 0.001715
Radial Distortion Terms: 0.007629	[1]
[1]	Radial Distortion Terms: 0.070042
Radial Distortion Terms: -0.104219	[2]
[2]	Radial Distortion Terms: -0.724357
Radial Distortion Terms: 0.624037	Array Entrance Pupil Terms length 3
Array Entrance Pupil Terms length 3	[0]
[0]	Entrance Pupil Terms: 0.000000
Entrance Pupil Terms: 0.000000	[1]
[1]	Entrance Pupil Terms: 0.000000
Entrance Pupil Terms: 0.000000	[2]
[2]	Entrance Pupil Terms: 0.000000
Entrance Pupil Terms: 0.000000	Array Camera Reference Vector length 3
Array Camera Reference Vector length 3	[0]
[0]	Camera Reference Vector: 1.121830
Camera Reference Vector: 1.048823	[1]
[1]	Camera Reference Vector: 0.083616
Camera Reference Vector: -0.053605	[2]
[2]	Camera Reference Vector: 0.160306
Camera Reference Vector: 0.328496	Array Camera Reference Quaternion length 4
Array Camera Reference Quaternion length 4	[0]
[0]	Camera Reference Quaternion: -0.004108
Camera Reference Quaternion: -0.027773	[1]
[1]	Camera Reference Quaternion: 0.010736
Camera Reference Quaternion: 0.011828	[2]
[2]	Camera Reference Quaternion: -0.612627
Camera Reference Quaternion: 0.707667	[3]
[3]	Camera Reference Quaternion: 0.790289
Camera Reference Quaternion: 0.705901	Camera Temperature: 20.000000
Camera Temperature: 20.000000	[Microscopic Imager, Cover Open]
[Microscopic Imager, Cover Open]	Camera Model ID: 194
Camera Model ID: 172	Camera Serial Number: 110
Camera Serial Number: 105	Camera ID: Microscopic Imager

MER A Camera Models	MER B Camera Models
Camera ID: Microscopic Imager	Filter Position: Microscopic Imager Cover
Filter Position: Microscopic Imager Cover	Open
Open	Model Class: CAHVOR
Model Class: CAHVOR	Model Type: 0
Model Type: 0	Model Parameter: 0.000000
Model Parameter: 0.000000	Array Center Vector length 3
Array Center Vector length 3	[0]
[0]	Center Vector: 1.120980
Center Vector: 1.058880	[1]
[1]	Center Vector: 0.084947
Center Vector: -0.054903	[2]
[2]	Center Vector: 0.105077
Center Vector: 0.275421	Array Axis Vector length 3
Array Axis Vector length 3	[0]
[0]	Axis Vector: 0.025729
Axis Vector: -0.005821	[1]
[1]	Axis Vector: -0.014067
Axis Vector: 0.058380	[2]
[2]	Axis Vector: 0.999570
Axis Vector: 0.998277	Array Horizontal Vector length 3
Array Horizontal Vector length 3	[0]
[0]	Horizontal Vector: -605.098814
Horizontal Vector: 26.031857	[1]
[1]	Horizontal Vector: 2279.629747
Horizontal Vector: -2337.838852	[2]
[2]	Horizontal Vector: 576.574483
Horizontal Vector: 631.369970	Array Vertical Vector length 3
Array Vertical Vector length 3	[0]
[0]	Vertical Vector: -2269.908949
Vertical Vector: 2365.204651	[1]
[1]	Vertical Vector: -629.901082
Vertical Vector: 57.405196	[2]
[2]	Vertical Vector: 571.473228
Vertical Vector: 525.651774	Array Optical Vector length 3
Array Optical Vector length 3	[0]
[0]	Optical Vector: -0.003143
Optical Vector: -0.061672	[1]
[1]	Optical Vector: -0.044770
Optical Vector: 0.126116	[2]
[2]	Optical Vector: 0.998992
Optical Vector: 0.990097	Array Radial Distortion Terms length 3
Array Radial Distortion Terms length 3	[0]
[0]	Radial Distortion Terms: 0.001715
Radial Distortion Terms: 0.007629	[1]
[1]	Radial Distortion Terms: 0.070042
Radial Distortion Terms: -0.104219	[2]
[2]	Radial Distortion Terms: -0.724357
Radial Distortion Terms: 0.624037	Array Entrance Pupil Terms length 3
Array Entrance Pupil Terms length 3	[0]
[0]	Entrance Pupil Terms: 0.000000
Entrance Pupil Terms: 0.000000	[1]
[1]	Entrance Pupil Terms: 0.000000
Entrance Pupil Terms: 0.000000	[2]
[2]	Entrance Pupil Terms: 0.000000
Entrance Pupil Terms: 0.000000	Array Camera Reference Vector length 3
Array Camera Reference Vector length 3	[0]
[0]	Camera Reference Vector: 1.121830
Camera Reference Vector: 1.048823	[1]
[1]	Camera Reference Vector: 0.083616
Camera Reference Vector: -0.053605	[2]
[2]	Camera Reference Vector: 0.160306
Camera Reference Vector: 0.328496	Array Camera Reference Quaternion length 4
Array Camera Reference Quaternion length 4	[0]
[0]	Camera Reference Quaternion: -0.004108
Camera Reference Quaternion: -0.027773	[1]
[1]	Camera Reference Quaternion: 0.010736
Camera Reference Quaternion: 0.011828	[2]
[2]	Camera Reference Quaternion: -0.612627
Camera Reference Quaternion: 0.707667	[3]
	Camera Reference Quaternion: 0.790289

MER A Camera Models	MER B Camera Models
[3] Camera Reference Quaternion: 0.705901 Camera Temperature: 20.000000	Camera Temperature: 20.000000

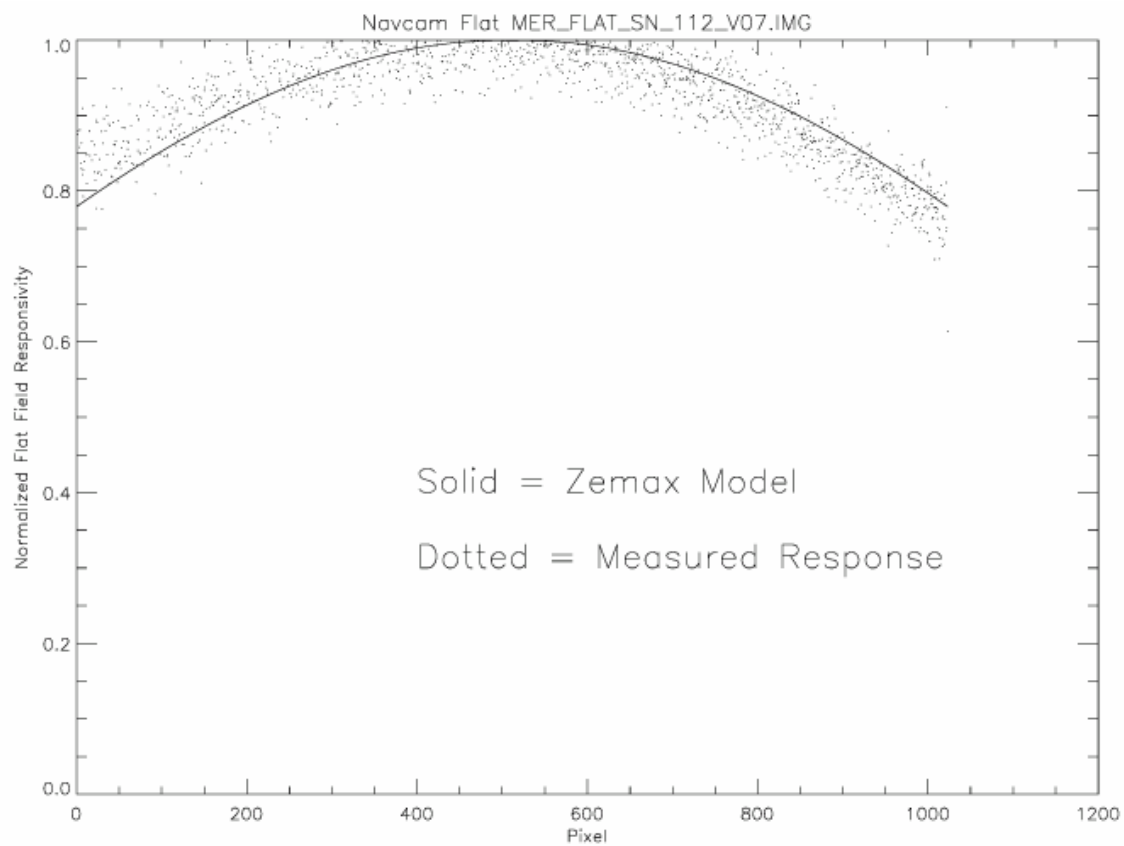
Appendix B. MER flat fields

Figure A.1 Measured MER A Left Navcam Flat Field Response

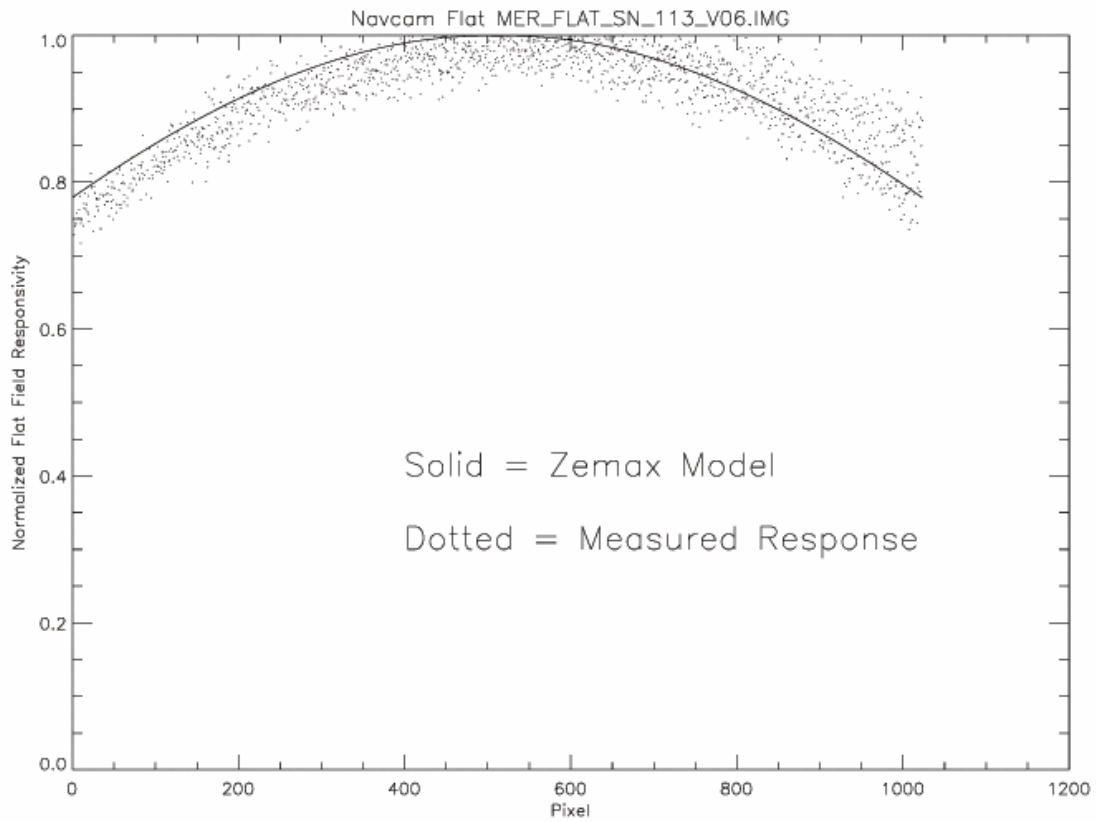


Figure A.2 Measured MER A Right Navcam Flat Field Response

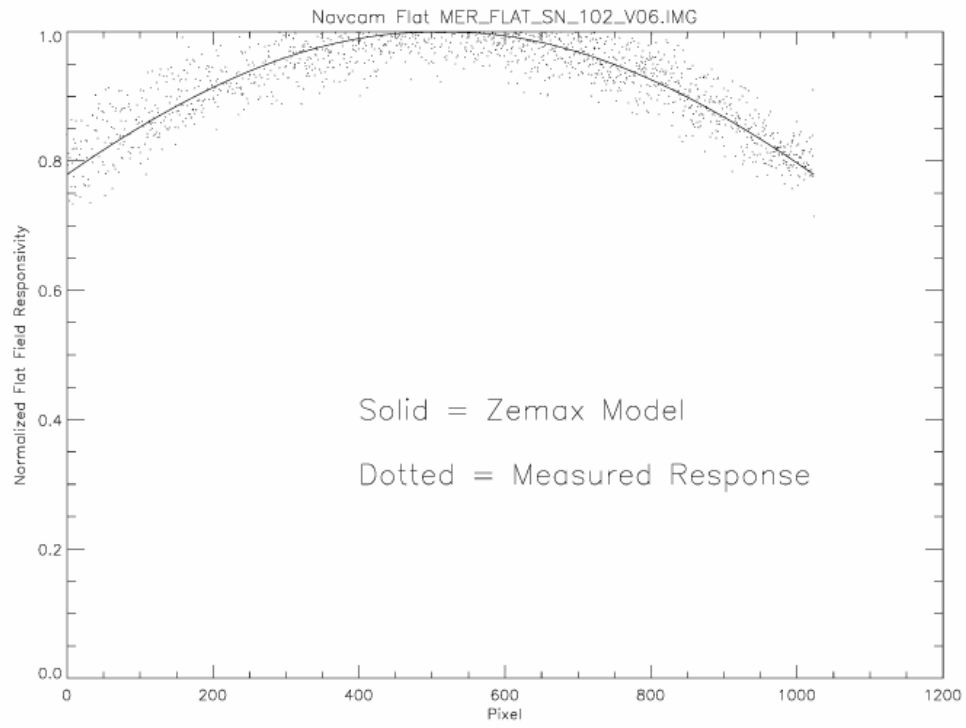


Figure A.3. Measured MER B Left Navcam Flat Field Response

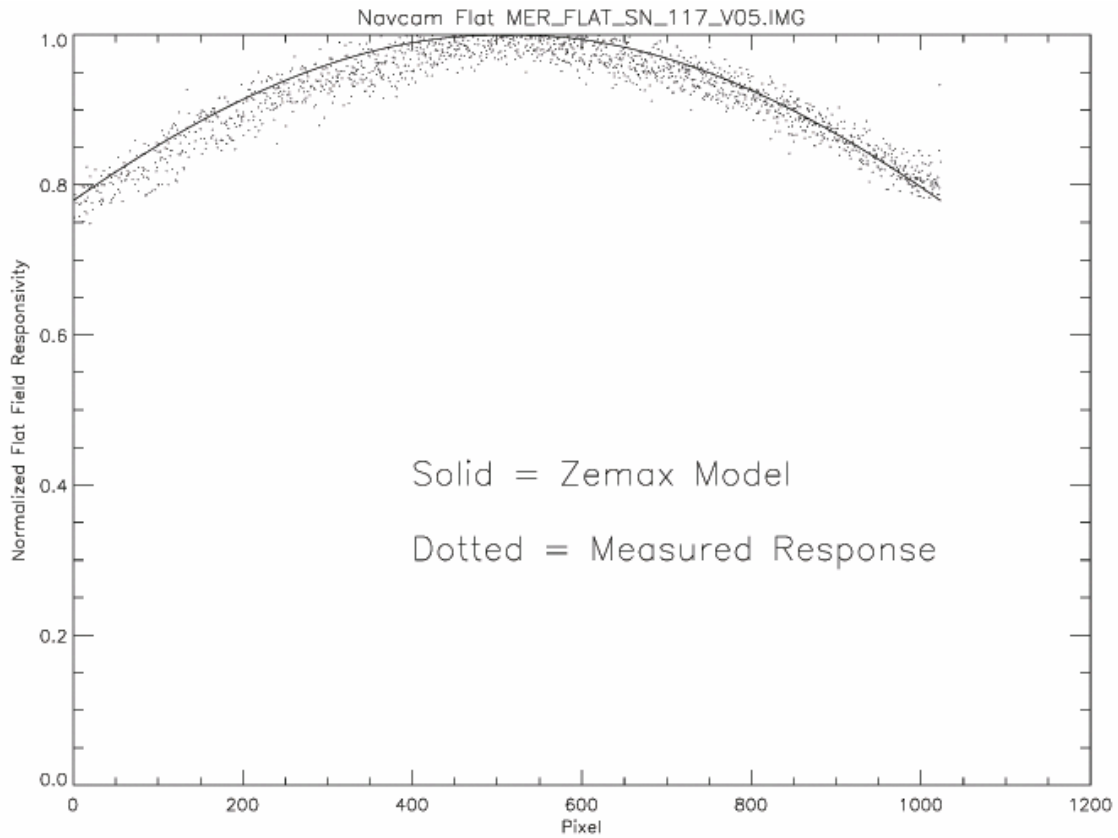


Figure A.4 Measured MER B Right Navcam Flat Field Response