DAWN-FC

DAWN - Framing Camera

Dawn FC DC065 Report

DA-FC-MPAE-RP-304
Issue: 1
Revision: a
5 December 2013

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Document Change Record

Iss./Rev.	Date	Pages affected	Description
Draft	22/03/2011	All	first version
1/-	29/03/2011	Most	
1/a	05/04/2011	10	Added two streaks to the table

Distribution Record

Holder		Issue/Revision									
		D	1	2							
Configuration File (Doc)											
MPS											
IB	Büttner		C								
UC	Christensen										
PGM	Gutiérrez-M.	C	C								
TM	Maue	C	C								
AN	Nathues	A	A								
MLR	Richards	C	C								
SSc	Schröder	C	C								
HSI	Sierks	C	C								
ISZ	Szemerey										
DLR	Carsenty										
DLR	Jaumann										
DLR	Michaelis										
DLR	Mottola		C								
IDA	Fiethe										
IDA	Michalik										
JPL	Raymond		C								
JPL	Polanskey		C								
UCLA	Joy		C								
Legend: A - Approval C - Copy U - Updated Pages											

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1 General aspects

1.1 Scope

This document contains the operations reports as well as the results of the analysis of the data acquired by both Framing Cameras during the DC065 operational slot. The scope of the activities was exclusively engineering, so no associated science report will be released.

1.2 Introduction

This report is structured in several parts.

Section 2 describes the conducted operations, including the different activities and a brief description of each.

Section 3 includes the activity log of the operational slot.

Section 4 reports on the general health status of the cameras.

Section 5 explains the evolution of the sensors since launch and analysis their change in performance.

The conclusions are covered in section 6.

1.3 Applicable Documents

no.	document name	document number, Iss./Rev.
AD1	DC065 Walkthrough	DC065_Walkthrough_r4.ppt
AD2	FC Semi-Annual Checkout Sequence	DA-FC-MPAE-TN-076, 2/-

1.4 Reference Documents

no.	document name	document number, Iss./Rev.
RD1	Dawn FC DC048 Report	DA-FC-MPAE-RP-304, 1/a
RD2	Dawn FC DC041 Report	DA-FC-MPAE-RP-295, 1/-
RD3	Dawn FC DC038 Report	DA-FC-MPAE-RP-290, 1/-
RD4	Dawn FC DC034 Report	DA-FC-MPAE-RP-285, 1/-
RD5	DC018 Report	DA-FC-MPAE-RP-286, 1/-
RD6	DC014 Report	DA-FC-MPAE-RP-287, 1/-
RD7	Framing Camera ICO Report	DA-FC-MPAE-RP-268, D/c

2 Description of the activities

2.1 Overview

The operations of the Framing Cameras within the frame of DC065 were planned to be conducted between November 11th 2013 (DOY 319) and December 3rd (DOY 337). There were two activities:

- FC1 non-pointed semi-annual checkout
- FC2 non-pointed semi-annual checkout

2.2 FC1 non-pointed semi-annual checkout

The background of this activity is the need for the mechanisms on the cameras to be operated twice a year for maintenance. FC1 was due for this maintenance because its last operation had been during DC052 in December 2012. The details of the activity are described in AD2. A total of 65 images were acquired during this activity.

2.3 FC2 non-pointed semi-annual checkout

The scope of the activities for FC2 was the same as for FC1. Under normal circumstances FC2 should have undergone a pointed checkout in order to follow the sensitivity of the camera over the cruise phase. However in order to save hydrazine this check was delayed to a later point in time and a non-pointed checkout was performed instead.

3 Operations summary

Given the routine nature of this operation and the experience accumulated by the team in the recent years it was acceptable to run this operation unsupervised. The success of the test was confirmed by the Snitch report and the analysis of the images.

3.1 Snitch report for FC1

```
Snitch v2.03


This report covers the following sessions
e:/data/flight/working_archive/fc1/14_vcc/13338_0


Snitch report for session e:/data/flight/working_archive/fc1/14_vcc/13338_0
Searching for third party reports in folder \.


Data integrity report
=====================
Files fc1_72pb_133381030_0600_0.dat,fc1_76pb_133381030_0600_0.dat do not
contain any gaps
```

```
Command execution report
========================
62 UDP commands were executed

* UDP executions
AutoStart was executed 1 times
CALAcquireSeveralImages was executed 9 times
DLAcquireImage was executed 38 times
FCPrepPowerDown was executed 1 times
FEE_CALPara was executed 2 times
MCUCloseCD was executed 1 times
MCUFWInit was executed 1 times
MCUGotoFilterX was executed 5 times
MCUOpenCD was executed 1 times
PCUSwitchEnableAndVerify was executed 2 times
PCUSwitchPowerAndVerify was executed 1 times

* UDP execution collisions
DLAcquireImage started at 439301377, 1 seconds before DLAcquireImage could
finish at 439301378
DLAcquireImage started at 439303537, 2 seconds before DLAcquireImage could
finish at 439303539

The camera received 61 commands for a total of 61
with 0 commands errors for a total of 0

Image performance report
========================
Of the 65 images downloaded in this session

* OpNav selection
0 images were selected as OpNav

* Image acquisition mode
10 images were acquired in DARK mode
28 images were acquired in FLATFIELD mode
20 images were acquired in NORMAL mode
3 images were acquired in SERIAL mode
3 images were acquired in STORAGE mode
```

1 images were acquired in TEST_CH mode

* Exposure time

32 images were acquired with an exposure of 0.000 <millisecond>

2 images were acquired with an exposure of 140000.000 <millisecond>

6 images were acquired with an exposure of 15000.000 <millisecond>

2 images were acquired with an exposure of 160000.000 <millisecond>

2 images were acquired with an exposure of 230000.000 <millisecond>

9 images were acquired with an exposure of 300000.000 <millisecond>

2 images were acquired with an exposure of 35000.000 <millisecond>

2 images were acquired with an exposure of 37000.000 <millisecond>

2 images were acquired with an exposure of 40000.000 <millisecond>

4 images were acquired with an exposure of 800.000 <millisecond>

2 images were acquired with an exposure of 85000.000 <millisecond>

* Filter number

51 images were acquired in filter number "1"

2 images were acquired in filter number "2"

2 images were acquired in filter number "3"

2 images were acquired in filter number "4"

2 images were acquired in filter number "5"

2 images were acquired in filter number "6"

2 images were acquired in filter number "7"

2 images were acquired in filter number "8"

* Image compression algorithm

46 images were compressed with "Set Partitioning in Hierarchical Trees (SPIHT LIFT)" algorithm

19 images were compressed with "Set Partitioning in Hierarchical Trees (SPIHT TAP)" algorithm

* Image compression type

27 images were compressed "LOSSLESS"

38 images were compressed "LOSSY"

* Image compression ratio

Compression ratio varied between 0 and 2 with an average of 0.0307692

Image quality report

==========

* Saturated pixels

12 images with 0 saturated pixels

1 images with 10 saturated pixels

1 images with 14 saturated pixels

1 images with 2 saturated pixels

4 images with 4 saturated pixels

1 images with 6 saturated pixels

* Brightest pixel value

The brightest pixel in the images varied between 8430 and 16383, with an average of 13019.4

HK report

=========

* Time span

This session covers the period between 2013-12-02T22:09:25 and 2013-12-03T02:01:09

(SCLK between 439294165 and 439308069)

* Consumables

The filter wheel performed 12 moves for an accumulated total of 294

The front door performed 2 moves for an accumulated total of 32

* Image processing

(All totals since last power up)

65 images were acquired for a total of 65

0 allocation errors ocurred for an accumulated total of 0

0 image processing errors ocurred for an accumulated total of 0

* Temperatures

The temperature of the CCD varied between -62.4222 and -48.6958 C

The temperature of the CH varied between -130.6 and -15.8875 C

* Memory consumption

The session started with 62177 blocks of free image memory, varied between 58375 and 62177 and finished with 62177 blocks free

* System flags

The camera was booted nominally

* Door position

The session started with the door encoder value at 35 and finished with 35

UDP HK report

==========

* Time span

This session covers the period between 2013-12-02T22:11:56 and 2013-12-03T02:01:11

(SCLK between 439294316 and 439308071)

* File handles

The number of free handles changed from 1389 to 1387 in the course of the session

During the session it reached a maximum of 1389 and a minimum of 1358

* Processing queues

OpNav processing queue changed from 0 to 0 in the course of the session, with a maximum of 23 and a minimum of 0

Science1 processing queue changed from 0 to 0 in the course of the session, with a maximum of 0 and a minimum of 0

Science2 processing queue changed from 0 to 0 in the course of the session, with a maximum of 0 and a minimum of 0

Science3 processing queue changed from 0 to 0 in the course of the session, with a maximum of 23 and a minimum of 0

* Downlink queues

OpNav downlink queue changed from 0 to 0 in the course of the session, with a maximum of 0 and a minimum of 0

Science1 downlink queue changed from 0 to 0 in the course of the session, with a maximum of 0 and a minimum of 0

Science2 downlink queue changed from 0 to 0 in the course of the session, with a maximum of 0 and a minimum of 0

Science3 downlink queue changed from 0 to 0 in the course of the session, with a maximum of 0 and a minimum of 0

* Thermal control

The camera head heater had an average duty cycle of 41.6815, with a maximum of 76.9004 and a minimum of 0

The baffle heater had an average duty cycle of -2.97056, with a maximum of 25.5059 and a minimum of -31.1751

```
Event report
============
* Warnings and errors
4 notifications of type 2008 -> Error Log: The log is corrupted HANDLE =
1 notifications of type 2088 -> MCU: Door was commanded to close, but encoder
says, it's closed.
3 notifications of type 2240 -> Downlink Manager: Some queues where reset =

* HK Monitor alarms (experimental, handle with care)
37 alarms found !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
```

3.2 Snitch report for FC2

```
Snitch v2.03

This report covers the following sessions
e:/data/flight/working_archive/fc2/14_vcc/13322_0

Snitch report for session e:/data/flight/working_archive/fc2/14_vcc/13322_0
Searching for third party reports in folder \.

Data integrity report
=====================
Files fc2_82pb_133221040_0930_0.dat,fc2_86pb_133221040_0930_0.dat do not
contain any gaps

Command execution report
========================
62 UDP commands were executed

* UDP executions
AutoStart was executed 1 times
CALAcquireSeveralImages was executed 9 times
DLAcquireImage was executed 38 times
FCPrepPowerDown was executed 1 times
FEE_CALPara was executed 2 times
MCUCloseCD was executed 1 times
MCUFWInit was executed 1 times
MCUGotoFilterX was executed 5 times
```

MCUOpenCD was executed 1 times

PCUSwitchEnableAndVerify was executed 2 times

PCUSwitchPowerAndVerify was executed 1 times

* UDP execution collisions

DLAcquireImage started at 437845099, 2 seconds before DLAcquireImage could finish at 437845101

The camera received 61 commands for a total of 61

with 0 commands errors for a total of 0

Image performance report

==========

Of the 65 images downloaded in this session

* OpNav selection

0 images were selected as OpNav

* Image acquisition mode

10 images were acquired in DARK mode

28 images were acquired in FLATFIELD mode

20 images were acquired in NORMAL mode

3 images were acquired in SERIAL mode

3 images were acquired in STORAGE mode

1 images were acquired in TEST_CH mode

* Exposure time

32 images were acquired with an exposure of 0.000 <millisecond>

2 images were acquired with an exposure of 140000.000 <millisecond>

6 images were acquired with an exposure of 15000.000 <millisecond>

2 images were acquired with an exposure of 160000.000 <millisecond>

2 images were acquired with an exposure of 230000.000 <millisecond>

9 images were acquired with an exposure of 300000.000 <millisecond>

2 images were acquired with an exposure of 35000.000 <millisecond>

2 images were acquired with an exposure of 37000.000 <millisecond>

2 images were acquired with an exposure of 40000.000 <millisecond>

4 images were acquired with an exposure of 800.000 <millisecond>

2 images were acquired with an exposure of 85000.000 <millisecond>

* Filter number

51 images were acquired in filter number "1"

2 images were acquired in filter number "2"

2 images were acquired in filter number "3"

2 images were acquired in filter number "4"

2 images were acquired in filter number "5"

2 images were acquired in filter number "6"

2 images were acquired in filter number "7"

2 images were acquired in filter number "8"

* Image compression algorithm

46 images were compressed with "Set Partitioning in Hierarchical Trees (SPIHT LIFT)" algorithm

19 images were compressed with "Set Partitioning in Hierarchical Trees (SPIHT TAP)" algorithm

* Image compression type

64 images were compressed "LOSSLESS"

1 images were compressed "LOSSY"

* Image compression ratio

Compression ratio varied between 0 and 2 with an average of 0.0307692

Image quality report

==========

* Saturated pixels

18 images with 0 saturated pixels

1 images with 2 saturated pixels

1 images with 4 saturated pixels

* Brightest pixel value

The brightest pixel in the images varied between 3451 and 16383, with an average of 8124.85

HK report

=========

* Time span

This session covers the period between 2013-11-16T01:02:06 and 2013-11-16T04:53:50

(SCLK between 437835726 and 437849630)

* Consumables

The filter wheel performed 12 moves for an accumulated total of 12374

The front door performed 2 moves for an accumulated total of 460

* Image processing

(All totals since last power up)

65 images were acquired for a total of 65

0 allocation errors ocurred for an accumulated total of 0

0 image processing errors ocurred for an accumulated total of 0

* Temperatures

The temperature of the CCD varied between -66.0403 and -52.3885 C

The temperature of the CH varied between -130.6 and -15.8875 C

* Memory consumption

The session started with 62177 blocks of free image memory, varied between 58627 and 62177 and finished with 62177 blocks free

* System flags

The camera was booted nominally

* Door position

The session started with the door encoder value at 9 and finished with 9

UDP HK report

==========

* Time span

This session covers the period between 2013-11-16T01:04:33 and 2013-11-16T04:53:48

(SCLK between 437835873 and 437849628)

* File handles

The number of free handles changed from 1389 to 1387 in the course of the session

During the session it reached a maximum of 1389 and a minimum of 1360

```
* Processing queues

OpNav    processing queue changed from 0 to 0 in the course of the session,
with a maximum of 23 and a minimum of 0

Science1 processing queue changed from 0 to 0 in the course of the session,
with a maximum of 0 and a minimum of 0

Science2 processing queue changed from 0 to 0 in the course of the session,
with a maximum of 0 and a minimum of 0

Science3 processing queue changed from 0 to 0 in the course of the session,
with a maximum of 23 and a minimum of 0


* Downlink queues

OpNav    downlink queue changed from 0 to 0 in the course of the session,
with a maximum of 0 and a minimum of 0

Science1 downlink queue changed from 0 to 0 in the course of the session,
with a maximum of 0 and a minimum of 0

Science2 downlink queue changed from 0 to 0 in the course of the session,
with a maximum of 0 and a minimum of 0

Science3 downlink queue changed from 0 to 0 in the course of the session,
with a maximum of 0 and a minimum of 0


* Thermal control

The camera head heater had an average duty cycle of 46.0968, with a maximum
of 81.0739 and a minimum of 0

The baffle heater had an average duty cycle of -1.23113, with a maximum of
30.1649 and a minimum of -26.1751


Event report

============

* Warnings and errors

1 notifications of type 2008 -> Error Log: The log is corrupted HANDLE =

1 notifications of type 2088 -> MCU: Door was commanded to close, but encoder
says, it's closed.

2 notifications of type 2240 -> Downlink Manager: Some queues where reset =


* HK Monitor alarms (experimental, handle with care)

37 alarms found !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
```

4 Health status assessment

During the operational slot the camera performed nominal from the engineering point of view. All the images were acquired as scheduled and received without any missing packet.

5 Image analysis

The images acquired during the operational slot were analyzed in four aspects. First, the correctness of the exposure times was assessed as per AD2. Second, the dark current was analyzed to evaluate the evolution of bulk dark current and the warm pixel generation rate. Third, the status of the extra charge was assessed. Finally, the images were examined for the presence of streaks caused by particles slowly drifting away from the spacecraft.

5.1 Exposure times

As in previous checkouts standard exposure times were used for darks and flats and a random star field was imaged with the usual exposure times:

Table 1: Exposure times of star field per filter.

Filter	Exposure (ms)
1	15000
2	37000
3	40000
4	140000
5	160000
6	85000
7	35000
8	230000

Is is worth mentioning that in RCS attitude control mode most of these exposure times lead to significant smearing of the images. However this does not hamper the evaluation of the status of the cameras.

5.2 Dark current

The dark current generation rate was analyzed and compared with previous in flight measurements. The bulk dark current shown in Figure 1 is consistent with that determined during ICO (dotted line). To assess the generation rate of warm pixels, we compare the histograms for DC065 with DC053 in Figure 2. The number of warm pixels has increased slightly since DC053. Figure 3 shows the same plots for FC2. For both cameras, the hottest pixel has a dark current generation rate below 50 DN/s.

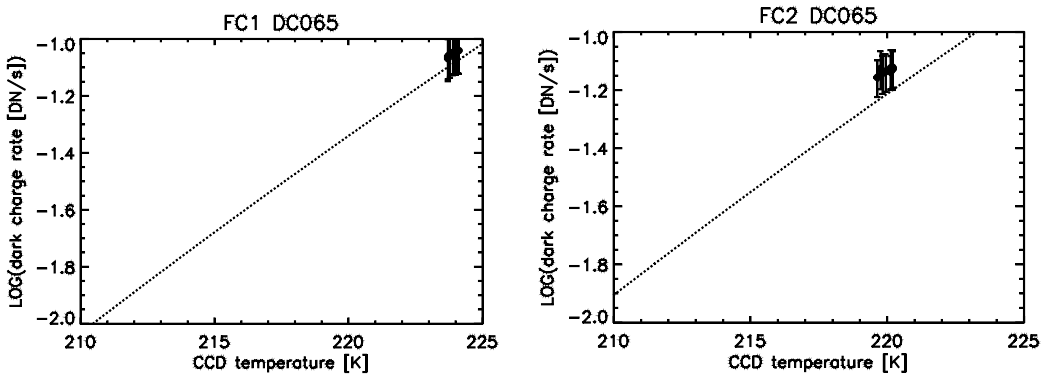

Figure 1: Bulk dark current for DC048. Left: FC1, right: FC2. The dotted line is the bulk dark current model derived from ICO observations.

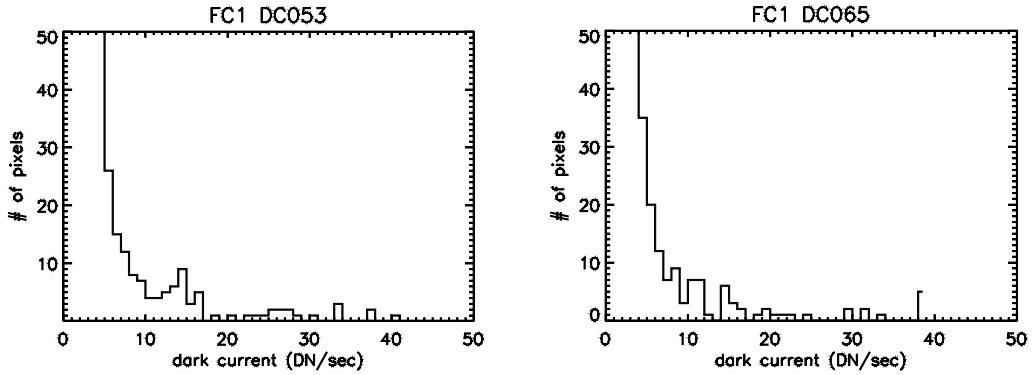

Figure 2: FC1 warm pixel histograms for DC053 and DC065.

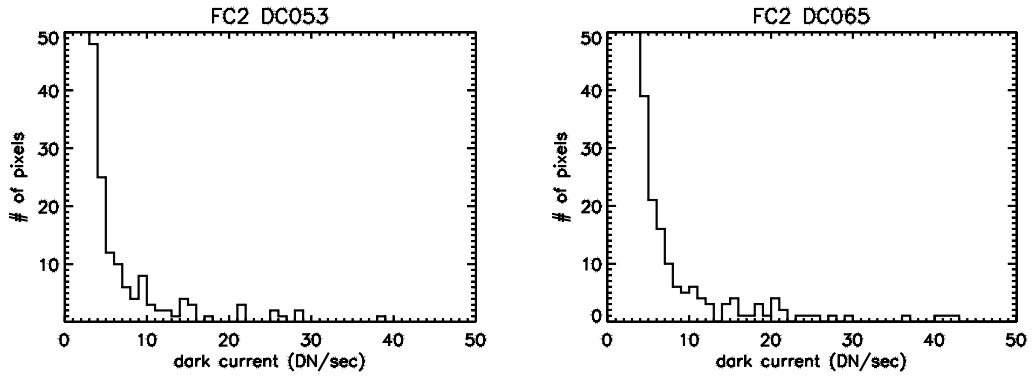

Figure 3: FC2 warm pixel histograms for DC053 and DC065.

5.3 Extra charge

An important part of the semi-annual checkout is monitoring the evolution of extra charge. FC1 is known to show extra charge, and it is found again in the DC053 images, as shown in Figure 4. The level of extra charge has not increased compared to DC041 (Figure 5). No extra charge has been detected in the past for FC2 at the illumination levels provided by the calibration lamp, and

this is still the case in DC048. As the spacecraft approaches Vesta, there are a number of activities planned to conduct the same investigation for the much higher photon flux at the asteroid.

Figure 4: FC1 extra charge levels in DC065.

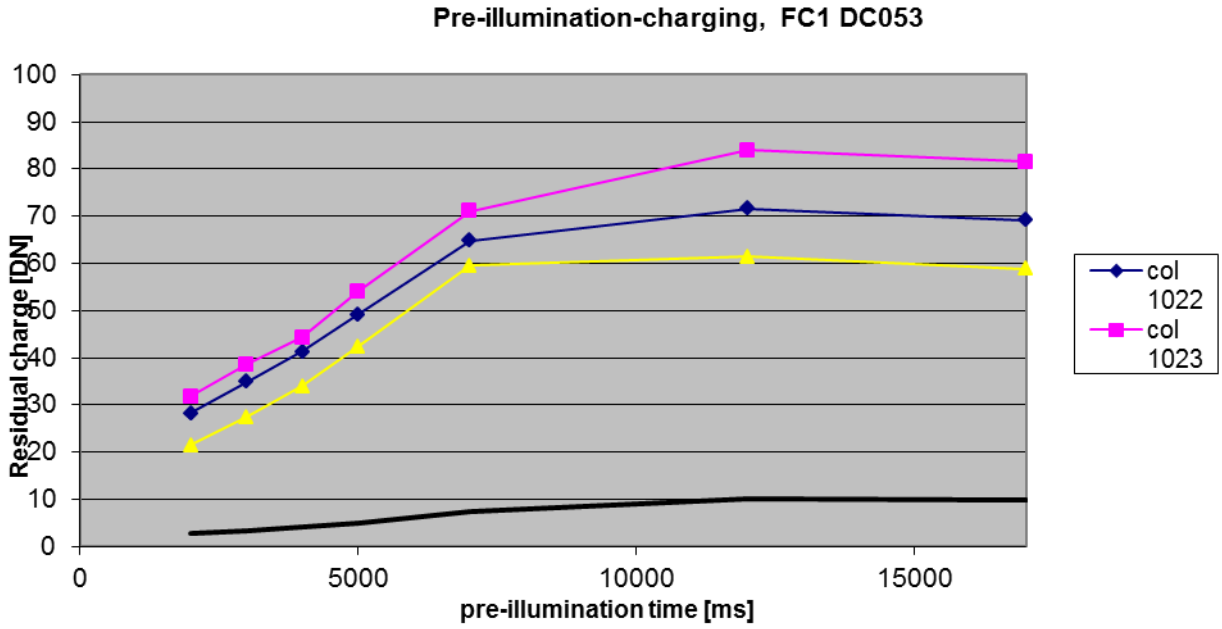

Figure 5: FC1 extra charge levels in DC053.

5.4 Image streaks

No image streaks were found in DC065

6 Conclusions

Concerning the hardware and the software, the operational slot demonstrated that the camera is in good operational condition, including the mechanisms. With respect to the operational procedures, this slot demonstrated again an excellent performance of the instrument, spacecraft and mission teams. The command sequences for the non-pointed semi-annual checkout for both FC1 and FC2 meet the design criteria.