DAWN-FC

DAWN - Framing Camera

Dawn FC DC074/75 Report

DA-FC-MPAE-RP-323
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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 DC074/75 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 DC074/75 were planned to be conducted between July 22nd 2014 (DOY 203) and August 19th 2014 (DOY 231). There were two activities:

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

Additionally the software of both cameras was updated. This concerned the low level software as well as the UDP library (update to version 3.09.03). **(Pablo, write here more)**

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 DC065 in November/December 2013. 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/14258_0


Snitch report for session e:/data/flight/working_archive/fc1/14_vcc/14258_0
Searching for third party reports in folder \.


Data integrity report
=====================
fc1_72pb_142580000_1200_0.dat has 32746 packet(s) missing in 2 gap(s)
Files fc1_76pb_142580000_1200_0.dat do not contain any gaps
```

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

* UDP executions
AutoStart was executed 1 times
CALAcquireSeveralImages was executed 9 times
DLAcquireImage was executed 38 times
DawnLibInit was executed 1 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 461730173, 2 seconds before DLAcquireImage could finish at 461730175
DLAcquireImage started at 461731088, 3 seconds before DLAcquireImage could finish at 461731091
DLAcquireImage started at 461731223, 1 seconds before DLAcquireImage could finish at 461731224

The camera received 930 commands for a total of 930
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
19 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
1 images were acquired in UNK 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>
1 images were acquired with an exposure of 85000.000 <millisecond>
1 images were acquired with an exposure of 85000.994 <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
11 images were compressed "LOSSLESS"
54 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
11 images with 0 saturated pixels
1 images with 2 saturated pixels
1 images with 22 saturated pixels
4 images with 4 saturated pixels
2 images with 6 saturated pixels

* Brightest pixel value
The brightest pixel in the images varied between 3465 and 16384, with an average of 10415.1

HK report

=========

* Time span

This session covers the period between 2014-08-18T17:20:01 and 2014-08-19T15:53:39

(SCLK between 461654401 and 461735619)

* Consumables

The filter wheel performed 12 moves for an accumulated total of 306

The front door performed 2 moves for an accumulated total of 34

* 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 -62.6087 and 6.8066 C

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

* Memory consumption

The session started with 65525 blocks of free image memory, varied between 57664 and 65525 and finished with 62171 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 2014-08-19T12:05:13 and 2014-08-19T15:53:42

(SCLK between 461721913 and 461735622)

* File handles

The number of free handles changed from 3989 to 0 in the course of the session

During the session it reached a maximum of 3989 and a minimum of 0

* Processing queues

OpNav processing queue changed from 0 to 0 in the course of the session, with a maximum of 29 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 29
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 1 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 1 and
a minimum of 0


* Thermal control

The camera head heater had an average duty cycle of 46.2815, with a maximum of 80.4718 and a
minimum of 0

The baffle heater had an average duty cycle of 19.862, with a maximum of 47.2398 and a minimum of
-11.2251


Event report

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

* Warnings and errors

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 =

1 notifications of type 3300 -> Checksum: The CRC does not match

4 notifications of type 3434 -> MMB: Manager has the wrong size

4 notifications of type 3435 -> MMB: Manager Magic Number 1 is incorrect:

4 notifications of type 3436 -> MMB: Manager Magic Number 2 is incorrect:

4 notifications of type 3442 -> MMB: Manager has the wrong version:


* 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/14230_0


Snitch report for session e:/data/flight/working_archive/fc2/14_vcc/14230_0

Searching for third party reports in folder \.


Data integrity report
```

```
====================
fc2_82pb_142301100_0245_0.dat has 27 packet(s) missing in 1 gap(s)
fc2_86pb_142301100_0245_0.dat has 1403 packet(s) missing in 1 gap(s)

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 459326288, 9 seconds before DLAcquireImage could finish at 459326297
DLAcquireImage started at 459326378, 2 seconds before DLAcquireImage could finish at 459326380

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

Image performance report
========================
Of the 64 images downloaded in this session

* OpNav selection
0 images were selected as OpNav

* Image acquisition mode
9 images were acquired in DARK mode
28 images were acquired in FLATFIELD mode
19 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
1 images were acquired in UNK 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>
8 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>
1 images were acquired with an exposure of 85000.000 <millisecond>
1 images were acquired with an exposure of 85000.994 <millisecond>

* Filter number
50 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
45 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
19 images were compressed "LOSSLESS"
45 images were compressed "LOSSY"

* Image compression ratio
Compression ratio varied between 0 and 2 with an average of 0.03125

Image quality report
====================
* Saturated pixels
17 images with 0 saturated pixels
1 images with 2 saturated pixels
1 images with 8 saturated pixels

* Brightest pixel value
The brightest pixel in the images varied between 2485 and 16383, with an average of 9971.11

HK report

=========

* Time span

This session covers the period between 2014-07-22T16:01:55 and 2014-07-22T19:53:39

(SCLK between 459316915 and 459330819)

* Consumables

The filter wheel performed 12 moves for an accumulated total of 12386

The front door performed 2 moves for an accumulated total of 462

* 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 -66.376 and -52.6869 C

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

* Memory consumption

The session started with 62171 blocks of free image memory, varied between 57664 and 62171 and finished with 62171 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 2014-07-22T16:05:13 and 2014-07-22T19:53:10

(SCLK between 459317113 and 459330790)

* File handles

The number of free handles changed from 3989 to 3989 in the course of the session

During the session it reached a maximum of 3989 and a minimum of 3951

* Processing queues

OpNav processing queue changed from 0 to 0 in the course of the session, with a maximum of 28 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 28
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 51.0609, with a maximum of 85.4139 and a
minimum of 0

The baffle heater had an average duty cycle of 22.0659, with a maximum of 52.0212 and a minimum
of -6.22505


Event report

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

* Warnings and errors

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 =

1 notifications of type 3300 -> Checksum: The CRC does not match

2 notifications of type 3434 -> MMB: Manager has the wrong size

2 notifications of type 3435 -> MMB: Manager Magic Number 1 is incorrect:

2 notifications of type 3436 -> MMB: Manager Magic Number 2 is incorrect:

2 notifications of type 3442 -> MMB: Manager has the wrong version:


* 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. In the FC2 data set image number 32551 is missing. Since it obviously got a number, we assume that it was taken but got lost due to a gap. **(Pablo, check and write here)**

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

It 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 DC074/75 with DC065 in Figure 2. The number of warm pixels has increased slightly since DC065. Figure 3 shows the same plots for FC2. For both cameras, the hottest pixel of FC1 has a dark current of 71 DN/s, and the hottest pixel of FC2 has 53 DN/s.

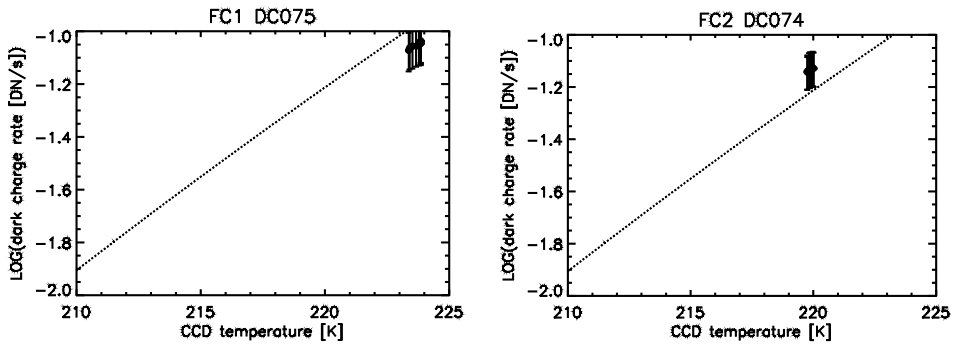

Figure 1: Bulk dark current for DC074/75. Left: FC1, right: FC2. The dotted line is the bulk dark current model derived from ICO observations.

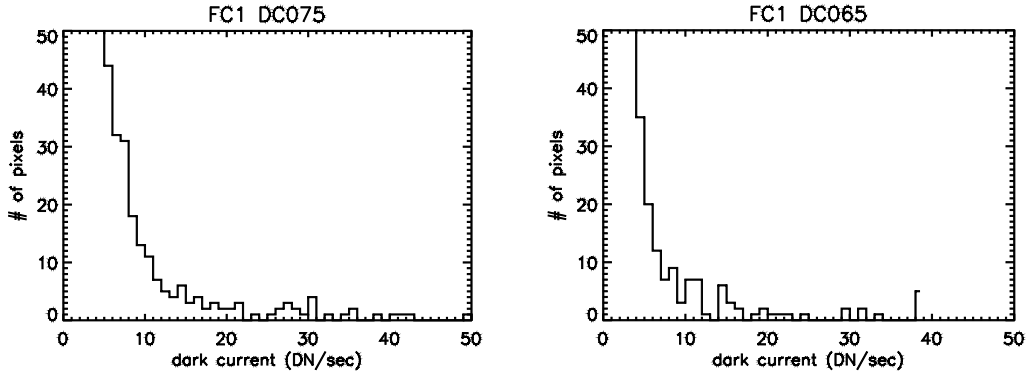

Figure 2: FC1 warm pixel histograms for DC075 and DC065.

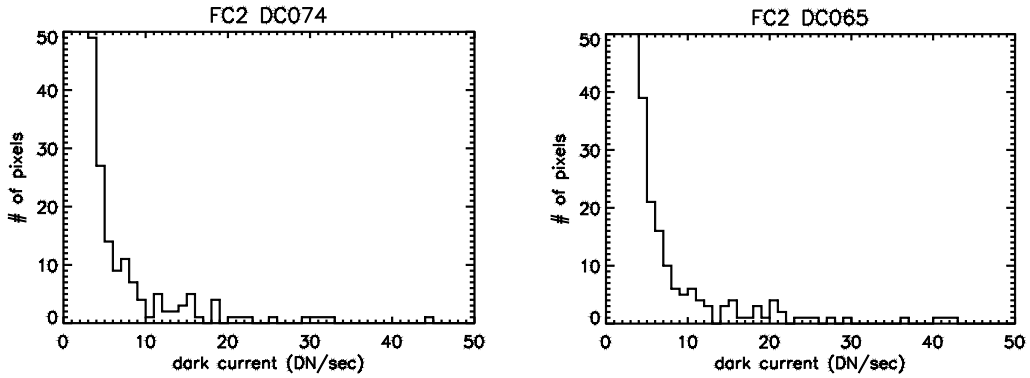

Figure 3: FC2 warm pixel histograms for DC074 and DC075.

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 DC075 images, as shown in Figure 4. The level of extra charge has not increased compared to DC065 (Figure 5).

Figure 4: FC1 extra charge levels in DC075.

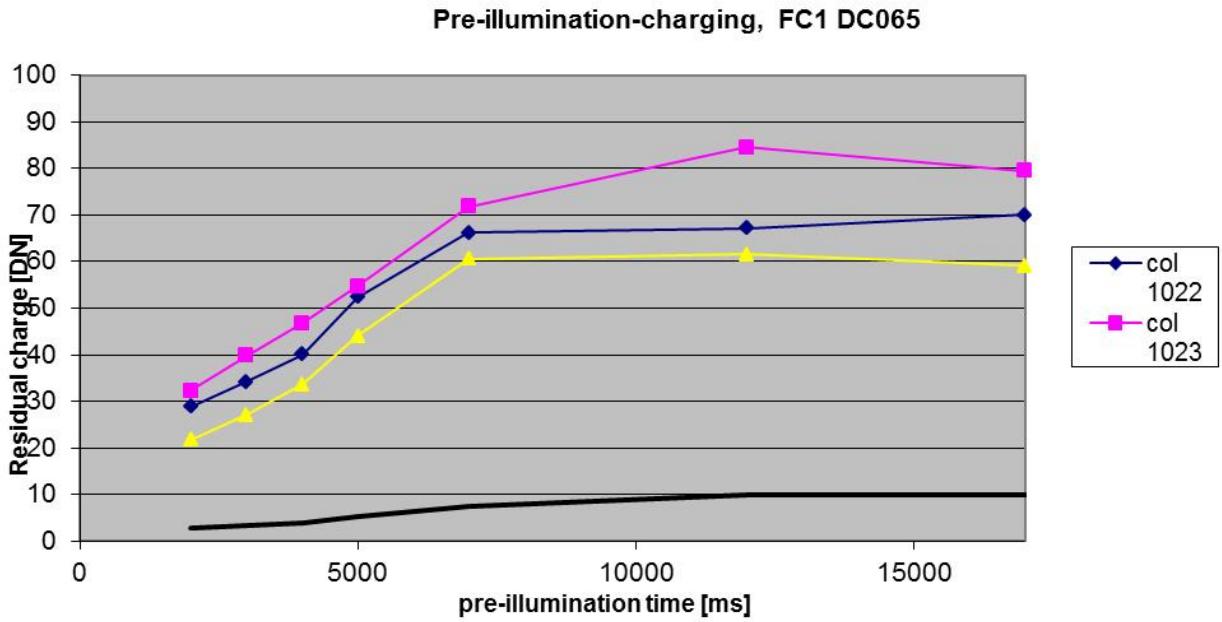

Figure 5: FC1 extra charge levels in DC065.

5.4 Image streaks

Pablo, perhaps, you can write something here?

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.