XMM-Newton CCF Release Note

XMM-CCF-REL-292

RGS Bad Pixels

C. Gabriel

August 9, 2012

1 CCF components

Name of CCF	VALDATE	EVALDATE	Blocks changed	XSCS flag
RGS1_BADPIX_0030	2002-11-27	2005-12-31	BADPIX	NO
RGS1_BADPIX_0031	2006-01-01	2007-04-08	BADPIX	NO
RGS1_BADPIX_0032	2007-04-09	—	BADPIX	NO
RGS2_BADPIX_0030	2002-11-04	2005-12-31	BADPIX	NO
RGS2_BADPIX_0031	2006-01-01	2006-12-31	BADPIX	NO
RGS2_BADPIX_0032	2007-01-01	—	BADPIX	NO

2 Changes

This release is the product of a re-analysis of the whole data collected so far with the RGS instruments on board XMM-Newton for extracting bad pixels/columns. In particular, we

- confirm previous results related to the persistent hot columns we observe in the Diagnostic Data corresponding to the last years up to 2011,
- confirm in the same data the further existence of the two areas with increased offsets ("hot spots"), on both upper part sides of CCD 1 in RGS1, so each one corresponding to a readout node. These areas have been already flagged in previous releases of the RGS Badpix CCFs, first as advisory hot segments, later on as uploaded bad segments. From 9 April 2007 data corresponding to those segments in the science data are masked and not transmitted to avoid overstressing the telemetry.
- analyse the time variation of hot segments / columns throughout the mission, as observed in the science data but not detected in the diagnostic data. While there is a certain slight increase in the number of hot stuff in the past ten years since the operational temperature of the RGS

CCDs has been lowered in November 2002, the general tendency is extraordinary stable. The columns flagged as advisory bad columns, to ease the data analysis making it more efficient at the same time, have to be monitored in order not to discard them unnecessarily. A few cases have been observed of columns being persistently hot in certain periods and then recovering and behaving normally.

In summary, we have looked for hot stuff both in diagnostic and science data between 2002 and 2012, and produced a table of hot stuff per year with the aim of extending and simplifying the RGS BADPIX CCFs.

3 Analysis

3.1 The "hot spots"

As part of the continous monitoring of the RGS instruments, offset maps are produced, as the averages of the diagnostic images over three consecutive revolutions. They are then taken into the ODF data for the offset subtraction. A significant high signal in the offset maps is an indicator for a hot pixel. Bad pixel maps are based on the relative number of any pixel found bad divided by the total number of exposures, ie. every pixel vary between 0 (never found bad) and 1 (always "hot"). The two "hot spots" are clearly seen in the bad pixel maps shown in Figures 1a and 1b, containing the averaged bad pixel maps for the whole of the year 2011. The hot spots are attributed to stress produced in CCD1 at the bond places.

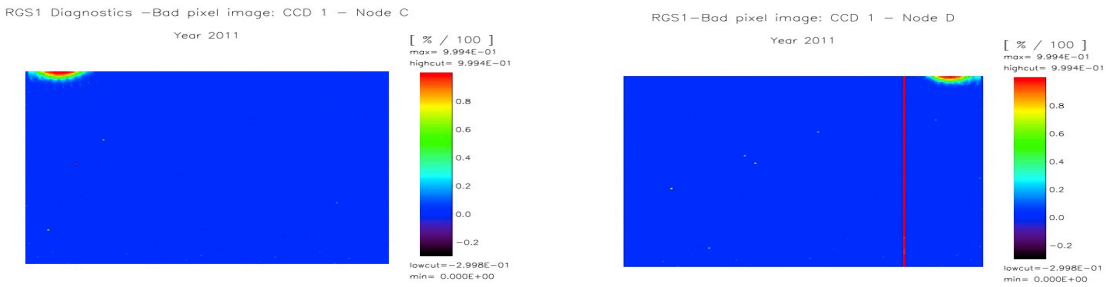

Figure 1: RGS1 - CCD1 node C (left) and D (right) diagnostic bad pixel maps corresponding to 2011, showing the two "hot spots"

3.2 The permanent hot columns

Figure 1b shows also the only RGS1 hot column found in the diagnostic data (column 38 of CCD 1 on the D side - we define as hot columns the ones with more than 80% in the diagnostic bad pixel map). It is known from the very early times of XMM-Newton in orbit as permanently hot and it is uploaded to on-board bad pixel rejection, therefore not telemetered. Together with another hot column in the RGS2 instrument (CCD 9, column 94 of the C readout side) they represent the only uploaded RGS hot columns.

3.2.1 Using science data for detecting hot pixels / columns

The difference in the CCD operating conditions in diagnostic and science modes (fundamentally the different exposure time) is the reason why the hot stuff seen in the diagnostic data represents only a fraction of the hot pixels / columns affecting the RGS data. A very efficient SAS algorithm, *rgsbadpix*, is capable of detecting them in the science data. This has been used in the past to complete the hot stuff picture. For this release, we have re-analysed the whole of the RGS data computing the occurrence of bad pixel / columns (without any rejection) for the whole mission. This data has been used for constructing science bad pixel maps, containing the detection frequency per time periods.

Figure 2 shows two persistent hot columns in the 2011 averaged bad pixel map from the science data, which are not found hot in the diagnostic data. Several columns found hot with a probability of near 100% have been established. A total number of 3 hot columns and 1 hot segment (31 pixels) for RGS1 and 6 hot columns for RGS2 have been found for the last period after 2007. The threshold for declaring a segment / column to be hot in the science data was set by an occurrence of at least 95% being found hot. The number of such occurrences is not high enough to justify uploading them as bad columns since the telemetry rate is not compromised. However, to ease and speed-up processing those hot pixels / columns detected with high frequency we flag them in the RGS Bad Pixel tables, so as to reject them alternatively during the data reduction. On top of this there is always the probability that some of the columns could recover, as observed from the different periods we have analysed, and which should be seen by monitoring their evolution, as we did here. This is obviously only possible if they are not uploaded.

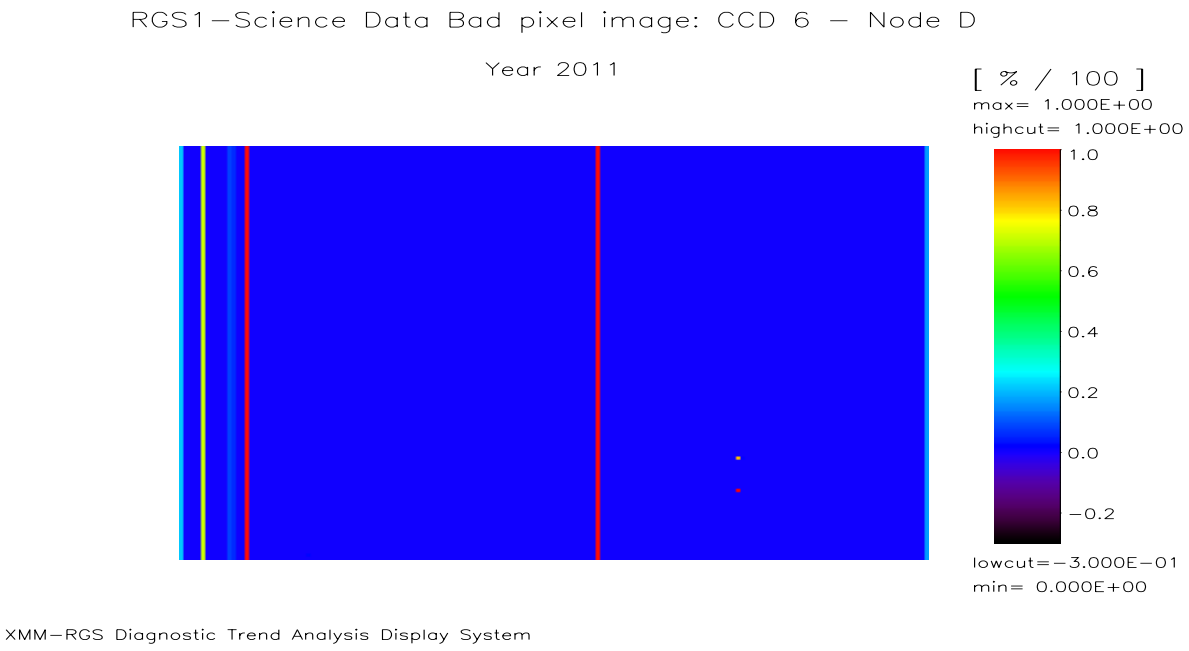

Figure 2: Bad pixel image of RGS1 - CCD6 - Node D, as derived from all science observations in year 2011

Table 1 gives the contents of the new defined CCFs, please refer to the table in the section "CCF

components" heading this release note for the different validity periods.

Name of CCF	Uploaded	Uploaded	Advisory	Advisory	Advisory	Advisory	Advisory	Advisory	Advisory
RGS1_BADPIX_0030	1D-38			*4C-114*	4C-152	6D-76	6D-156		
RGS1_BADPIX_0031	1D-38		1C-146	*4C-114*	4C-152	6D-76	6D-156	1CD-spots	
RGS1_BADPIX_0032	1D-38	1CD spots		*4C-114*	4C-152	6D-76	6D-156		
RGS2_BADPIX_0030	9C-94						3D-78	3D-151	
RGS2_BADPIX_0031	9C-94		1C-33	1C-59	1D-171	1D-136	3D-78	3D-151	5C-126
RGS2_BADPIX_0032	9C-94		1C-33	1C-59	1D-171	1D-136	3D-78	3D-151	

Table 1: Contents of the new defined RGS Badpix CCFs - CCD number and readout side (eg. 4C) are followed by the column number - A description in italics means just a segment instead of a full column.

4 Scientific Impact of this Update

A better systematic determination of hot columns for the different periods has been obtained. We try to minimize the number of CCFs needed, but at the same time reflect the changes produced by hot columns seen only in certain periods.

The validity periods are set partly by clear events (cooling down of RGS1 and RGS2 in November 2002 and upload of the RGS1 hot spots in April 2007), partly more or less arbitrarily as a compromise taking into account the evolution of the hot spots and the frequency of the hot columns found.

5 Estimated Scientific Quality

A better determination of the advisory hot columns in the different periods avoids the unnecessary discarding of two hot columns, which appear to behave normally after 2007, as reflected in the 0032 issues of both RGS Badpix CCFs.

6 Expected Updates

Further analysis of bad pixels with diagnostic and science data, performed yearly, could lead to updates, although this is not expected to happen every year.

7 Test procedures

General checks:

- use fv (or another fits viewer) for file inspection. It should contain 2 binary extensions (BADPIX and BADPIX1)
- use the SAS task CALVIEW to see if the CAL digests and uses the new files.

8 Summary of the test results

The fits viewer fv was used to inspect both CCF files, wrt their structure, validity dates and contents of the first extension (BADPIX). Everything OK.

The SAS task cifbuild was run several times using data corresponding to periods covered and not covered by these CCFs in order to check the correct selections. Selections were correctly done.

The SAS task calview was used to prove that these calibration files are ingested correctly by the CAL, by pointing to the different Calibration Index Files and producing bad pixel plots.