XMM-Newton CCF Release Note

XMM-CCF-REL-311

RGS Bad Pixels

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February 27, 2014

1 CCF components

Name of CCF	VALDATE	EVALDATE	Blocks changed	XSCS flag
RGS1_BADPIX_0033	2013-01-01		BADPIX	NO

2 Changes

This release is the product of a analysis of the diagnostic and science data corresponding to 2013 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 year 2013, 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 RGS1 data corresponding to 2013, 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. We find a case of 1 hot column observed in 2013, which had been flagged in an earlier period but recovered later, behaving more or less normally.

In summary, we have looked for hot stuff both in diagnostic and science data corresponding to 2013, and produced a new table of hot stuff for 2013 confirming all earlier results, but adding a new hot column.

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 2013. The hot spots are attributed to stress produced in CCD1 at the bond places.

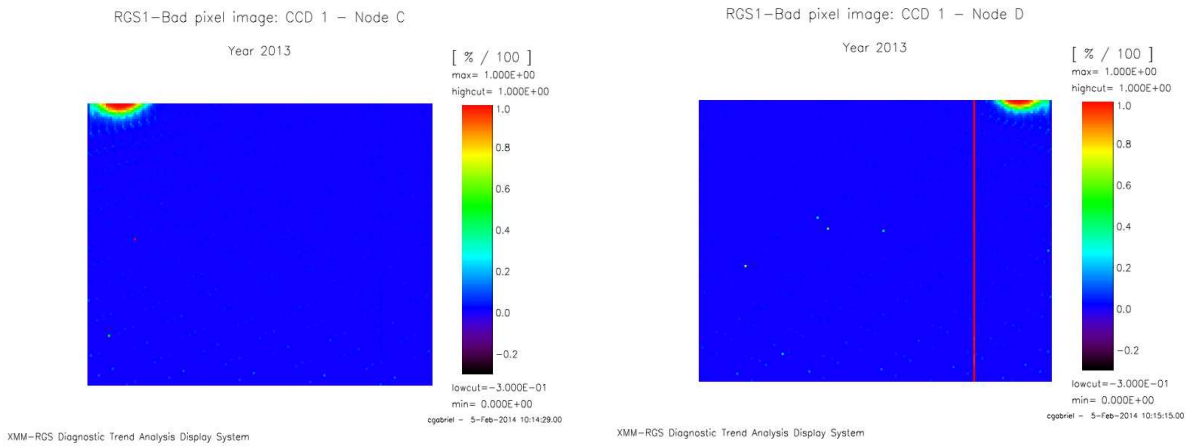

Figure 1: RGS1 - CCD1 node C (left) and D (right) diagnostic bad pixel maps corresponding to 2013, showing the two "hot spots"

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. This has been fully confirmed in the diagnostic data corresponding to 2013.

3.2.1 Using science data for detecting hot pixels / columns

The difference in the CCD operating conditions in diagnostic and science modes (fundamentally a 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 completed previous analysis including the whole of the RGS data corresponding to 2013, computing the occurrence of bad pixel / columns (without any rejection). This data has been used for extending science bad pixel maps, containing the detection frequency for the new time period.

The threshold for declaring a segment / column to be hot in the science data is set by an occurrence of at least 95% being found hot by `rgsbadpix`. As long as the number of such occurrences is low, it is not justified 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 are flagged 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 shows a persistent hot column (RGS1 - CCD1 - Column 146 on the C side) in the 2013 averaged bad pixel map from the science data, which is not found hot in the diagnostic data. This column had been already declared advisory in the past from begin of 2006 to April 2007 (RGS1_BADPIX_0031.CCF), but for a period of 5 years was clearly below the threshold for a hot column and behaving normally in around 20% of the observations.

The other columns found hot with a probability of near 100% in the former years continue with that behaviour. They are 3 hot columns and 1 hot segment (31 pixels) for RGS1 and 6 hot columns for RGS2 in addition to the new hot column. Therefore the new CCF, valid for the time from begin 2013 on, has exactly the same contents as the former one with the addition of the new hot column.

Table 1 gives the contents of the valid CCFs from November 2002 on, including the new one proposed.

Name of CCF	Validity	Upl	Upl	Adv	Adv	Adv	Adv	Adv	Adv	Adv
RGS1_BADPIX_0030	NOV02-DEC05	1D-38			*4C-114*	4C-152	6D-76	6D-156		
RGS1_BADPIX_0031	JAN06-APR07	1D-38		1C-146	*4C-114*	4C-152	6D-76	6D-156	1CD-spots	
RGS1_BADPIX_0032	APR07-DEC12	1D-38	1CD spots		*4C-114*	4C-152	6D-76	6D-156		
RGS1_BADPIX_0033	JAN13-	1D-38	1CD spots	1C-146	*4C-114*	4C-152	6D-76	6D-156		
RGS2_BADPIX_0030	NOV02-DEC05	9C-94						3D-78	3D-151	
RGS2_BADPIX_0031	JAN06-DEC06	9C-94		1C-33	1C-59	1D-171	1D-136	3D-78	3D-151	5C-126
RGS2_BADPIX_0032	JAN07	9C-94		1C-33	1C-59	1D-171	1D-136	3D-78	3D-151	

Table 1: Contents of the RGS Badpix CCFs, valid for data from November 2002 on, including **in boldface** the new proposed CCF - 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.

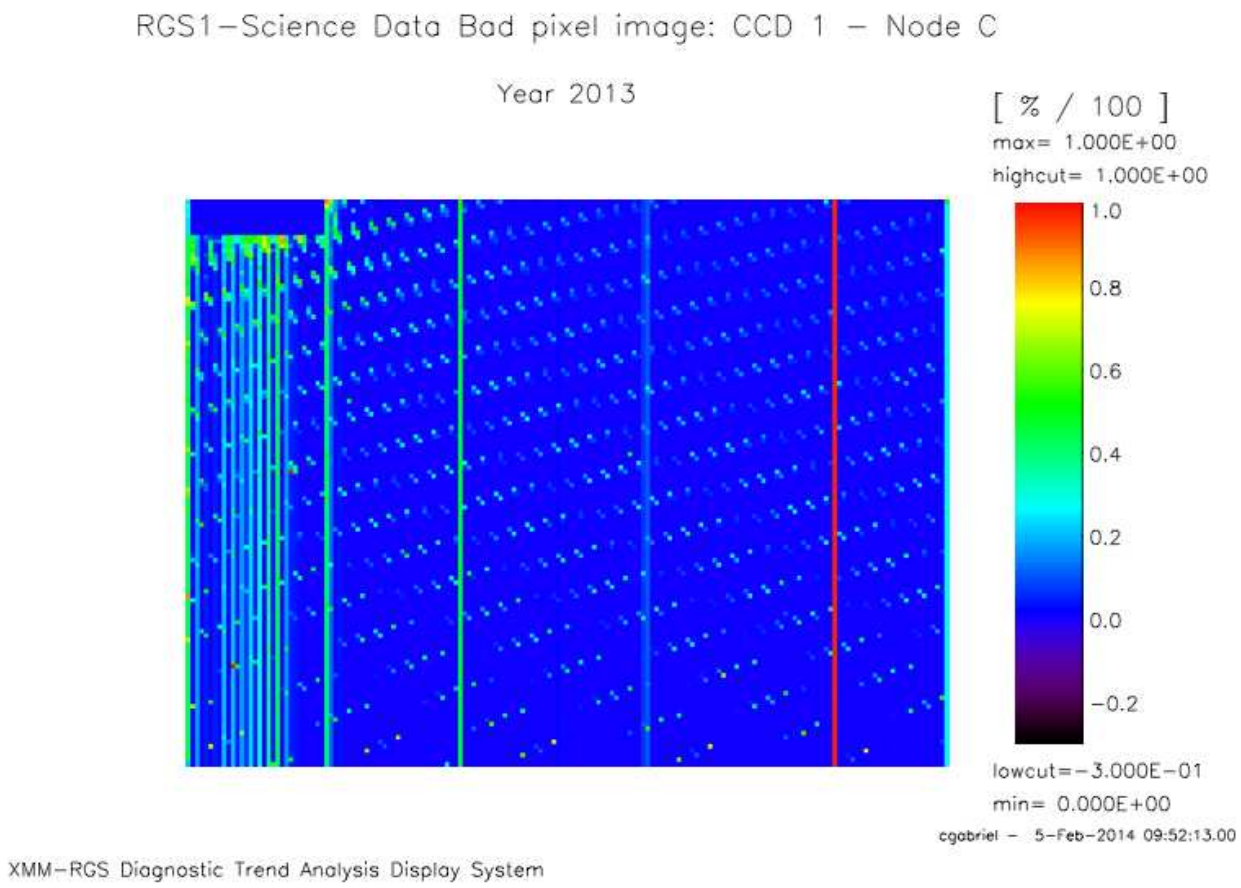

Figure 2: Bad pixel image of RGS1 - CCD1 - Node C, as derived from all science observations in year 2013, showing the new hot column, as well as the very often disturbed region below the "hot spot"

4 Scientific Impact of this Update

An advisory hot column is added to the suite, making the analysis of data in the affected period easier and more straightforward.

5 Estimated Scientific Quality

The inclusion of an advisory hot column on the basis of its detection as such in more than 97% of all the science data is pretty robust.

6 Expected Updates

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