XMM-Newton CCF Release Note

XMM-CCF-REL-351

Astrometry: time variable boresight. A new update.

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1 CCF components

Name of CCF	VALDATE	List of Blocks changed	CAL VERSION	XSCS flag
XMM_BORESIGHT_0028	2000-01-01T00:00:00	OM_ANGVAR EMOS1_ANGVAR EMOS2_ANGVAR EPN_ANGVAR RGS1_ANGVAR RGS2_ANGVAR		No

2 Changes

The XMM-Newton Time Variable Boresight was implemented in 2012. It is described in the release notes XMM-CCF-REL-286 and XMM-CCF-REL-290.

The extrapolations made to derive corrections to the Euler angles based on past data imply that new updates of these corrections may be necessary from time to time. Updates were made in 2014, 2015 and at beginning of 2017. These updates were made taking into account new data obtained after the previous updates. They were implemented in XMM_BORESIGHT_0024.CCF, XMM_BORESIGHT_0025.CCF (slighly modified into XMM_BORESIGHT_0026.CCF) and the last one XMM_BORESIGHT_0027.CCF (see XMM-CCF-REL-315, XMM-CCF-REL-330, XMM-CCF-REL-332 and XMM-CCF-REL-343).

The application of the new CCF values implies an extrapolation of the fit made on past observations. After some time we have observed a deviation in the offsets trend with respect to the last update predictions, particularly for the EPIC instruments. Therefore it is necessary to produce a new update using the most recent data.

Table 1: Best-fit parameters implemented in this CCF.

Instrument/coordinate	P_1	P_2	P_3	P_4	P_5	P_6	P_7
EPIC/Y	$+0.70$	-0.64×10^{-3}	$+2.0 \times 10^{-7}$	-1.7×10^{-11}	$+0.16$	-17.04	364.7
EPIC/Z	$+0.47$	-1.31×10^{-3}	$+2.6 \times 10^{-7}$	-1.8×10^{-11}	$+1.35$	-4.89	364.3
OM/X	-1.52	$+9.61 \times 10^{-4}$	-8.92×10^{-8}		-1.04	-5.71	363.6
OM/Y	-2.12	$+1.74 \times 10^{-3}$	-1.38×10^{-7}		$+0.82$	-8.16	363.5

As we did before, we have analyzed the astrometry offsets derived from the pipeline PPS sources lists for the EPIC and OM instruments adding to the previous data set the observations obtained until November 14, 2017. We have modeled the offsets variation with time by means of a long term variation plus a periodic (nearly one year) oscillation (Talavera &Rodríguez-Pascual [1]).

To avoid large deviations in the extrapolation , for EPIC we have used the IDL function TS_FCAST(X,P,Nval), where X are the fitted values up to November 14, 2017 (Rev. 3284), P=840 and N=420.

As explained in XMM-CCF-REL-290, the same offsets obtained for EPIC can be used to process RGS data.

$$\Delta = (P_1 + P_2 \times T + P_3 \times T^2) + P_4 T^3) + P_5 \times \cos[2\pi \times (T - P_6)/P_7)]$$

where Δ is the measured offset and T is the time in Julian days elapsed since January 1, 2000. The new best-fit parameters are given in Tab.1. As before, the long term component for the EPIC is fitted with a third order polynomial, while for OM the polynomial is of second order.

3 Scientific Impact of this Update

The release notes XMM-CCF-REL-286 and XMM-CCF-REL-290 explain in detail the improvements in the astrometry achieved with the Time Variable Boresight.

The corrections derived using XMM_BORESIGHT_0027.CCF differ less than 0.5 arc sec in the most recent observations with respect to the current fit. However, we have decided to implement this small adjustment to avoid larger deviations as it occurred in the past.

We show in Figures 1 and 2 the offsets and the fitted corrections. The differences between XMM_BORESIGHT_0027.CCF and this new CCF can be seen there.

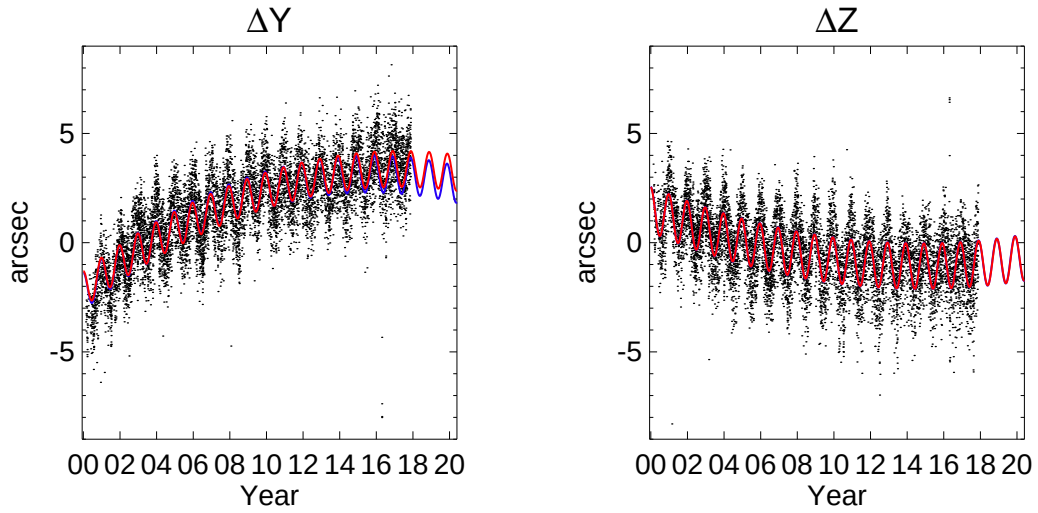

Figure 1: OM measured offsets and fit: in blue CCF_0027, in red CCF_0028

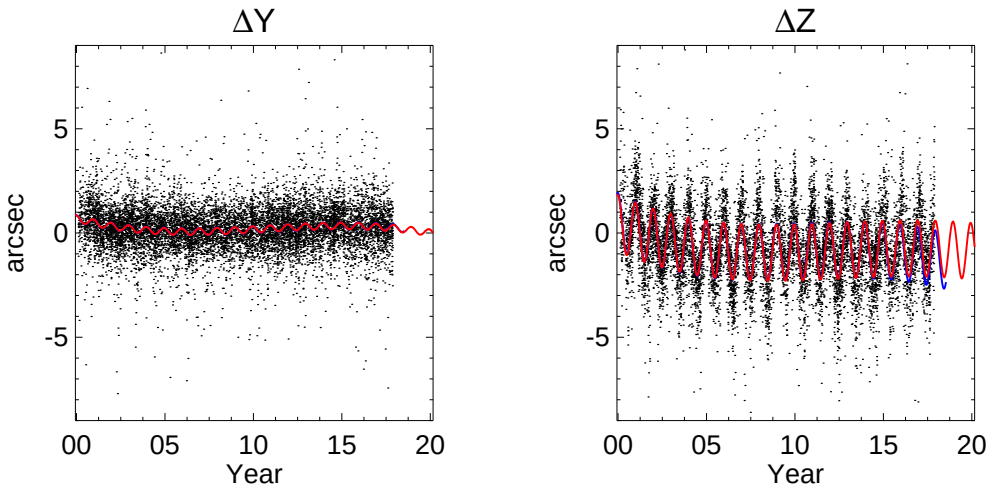

Figure 2: EPIC measured offsets and fit: in blue CCF_0027, in red CCF_0028

4 Estimated Scientific Quality

The quality of the corrections can be assessed by comparing the catalog offsets obtained with the constant and the new variable boresight. This comparison was presented in the previous release notes, XMM-CCF-REL-286 and XMM-CCF-REL-290.

5 Test procedures

The concept of time variable boresight and its implementation were intensively tested in their first issue. At that time more than 4000 observations obtained since the beginning of the XMM-Newton operational life were processed with SAS using the new concept CCF.

Since this new release implements just a small increment in the variation of the Euler angles offsets, we have processed only a couple of recent ODFs to confirm the normal functioning of the related SAS tasks.

6 Summary of the test results

As said before, the tests results can be seen in XMM-CCF-REL-286 and XMM-CCF-REL-290.

7 Expected updates

The fit to the long term trend observed in the measured offsets assumes an extrapolation beyond the available data. This update provides offsets untill 2020. However, following our experience these offsets will deviate from the correct trend in about one year. Therefore we shall continue monitoring the offsets in the future to confirm the predicted trend or to modify the fit as we have been doing with the last updates.

References

[1] Talavera A., Rodríguez-Pascual P., 2011, XMM-SOC-TN-0041, available at:

`http://xmm2.esac.esa.int/~xmmdoc/CoCo/CCB/DOC/Attachments/INST-TN-0041-1-0.pdf`.