XMM-Newton Calibration Technical Note

Status of the EPIC-pn absolute timing capabilities using the Crab pulsar

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1 Introduction

This document summarizes the current status of the XMM-Newton EPIC-pn absolute timing capabilities. This document will be updated whenever new calibration observations of the Crab are processed.

2 Calibration observations of the Crab

The Crab pulsar is observed twice yearly with EPIC-pn in both Timing (TI) and Burst (BU) modes as part of the routine observations to calibrate the XMM-Newton relative and absolute timing capabilities. These observations are typically performed ∼6 months apart around February-March, and August-September. Additionally, the Crab has been subject to a number or non-routine calibration observations in both modes. All of these observations are used for the monitoring of the timing capabilities of the EPIC-pn camera.

The latest observations from XMM-Newton revolution 3612 have been processed using the most up-to-date version of SAS (currently SAS v18.0) and analysed as described in:

`http://xmm2.esac.esa.int/docs/documents/CAL-TN-0211-1-1.pdf`.

3 Current status of the absolute timing capabilities of EPIC-pn

The absolute timing performance of EPIC-pn is calculated by measuring the delay between the X-ray and the radio pulse. The radio ephemeris is provided by the Jodrell Bank radio telescope, which observes the Crab regularly. We show, in Fig. 1, the pulse delays over the lifetime of the mission. The pulse delay values for TI and BU modes, as well as the total, are also reported in Table 1. The 1σ confidence interval can be used as a proxy for the absolute timing accuracy of EPIC-pn.

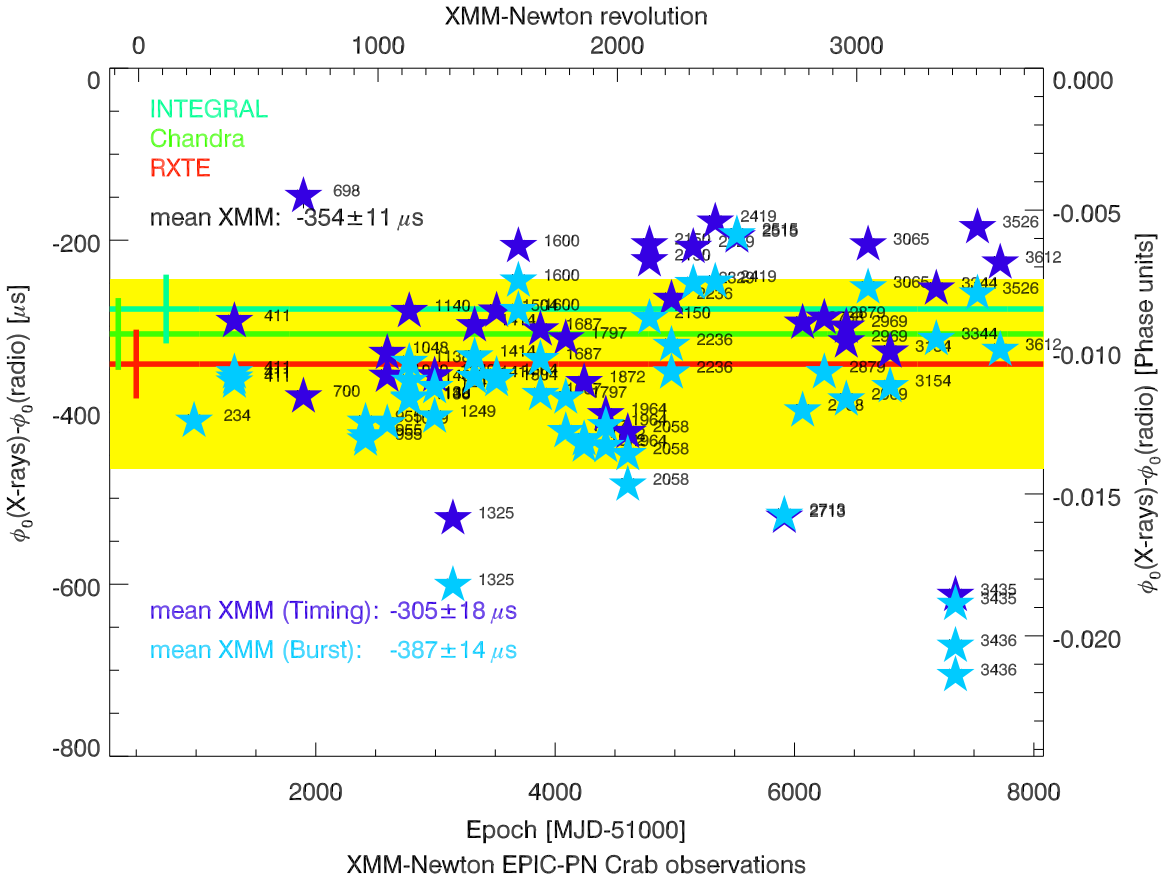

Figure 1: Absolute timing with respect to the Jodrell Bank radio ephemeris of the Crab. The yellow band indicates the confidence interval of the XMM-Newton measurements in units of $\pm 1\sigma$ from the mean. The blue, green, and red lines indicate the INTEGRAL (Kuiper et al. , 2003, A&A, 411, L31), Chandra (A.Rots, private communication), and RXTE (Rots et al., 2004, ApJ, 605, L129) measurements. The small coloured vertical bars indicate the 1σ statistical error.

Table 1: Absolute timing accuracy of EPIC-pn.

Mode	Pulse delay (μs)
Timing	-305 ± 105
Burst	-387 ± 101
Total	-354 ± 110

3.1 Comments on the current results

The most recent Crab observations provide pulse delays which are fully consistent with the expected values. However, the Crab observations in revolutions 3435 and 3436 show significantly discrepant values that contribute to a degradation of the overall absolute timing accuracy of EPIC-pn. The cause of this discrepancy requires further investigation.

It should be noted that the timing mode data from revolution 3612 (Obsid 0811023201) were affected by a time jump that occurred approximately 25% of the way into the observation, which was not recognized by the OAL software. As such, data from the time jump and thereafter were excluded from the subsequent data analysis.