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IN-FLIGHT CALIBRATIONS OF UFFO-PATHFINDER

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Abstract. The Ultra-Fast Flash Observatory (UFFO), which will be launched onboard the *Lomonosov* spacecraft, contains two crucial instruments: UFFO Burst Alert & Trigger Telescope (UBAT) for detection and localization of Gamma-Ray Bursts (GRBs) and the fast-response Slewing Mirror Telescope (SMT) designed for the observation

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of the prompt optical/UV counterparts. Here we discuss the in-space calibrations of the UBAT detector and SMT telescope. After the launch, the observations of the standard X-ray sources such as pulsar in Crab nebula will provide data for necessary calibrations of UBAT. Several standard stars will be used for the photometric calibration of SMT. The celestial X-ray sources, *e.g.* X-ray binaries with bright optical sources in their close angular vicinity will serve for the cross-calibration of UBAT and SMT.

1 Methods

The UFFO-Pathfinder (Chen *et al.* 2011; Lim *et al.* 2012; Na *et al.* 2011; Park *et al.* 2012) consists of two scientific instruments. One is UBAT (Jung *et al.* 2011; Kim *et al.* 2012; Na *et al.* 2012; Rodrigo *et al.* 2012) for X-ray/gamma-ray observations of GRBs, and the second one is SMT (Jeong *et al.* 2011, 2012; Kim *et al.* 2011) of filed of view $17' \times 17'$ for optical/UV observations of GRB afterglows. UBAT provides SMT positional information of a burst and SMT afterwards slews to this location to start collecting the optical/UV data. After the launch the positional accuracy of SMT will be checked and compared with the positional accuracy of UBAT on the real sky sources. We searched for the brightest X-ray/gamma-ray sources in the sky (see Table 1), which have bright optical sources (in filter V and/or B $<$ 10–5 mag) in close angular vicinity $\sim$5 arcmin and we intend to use them for UBAT-SMT positional cross-calibration and check up of the system (see Fig. 1).

By observing the Crab pulsar (Kirsch *et al.* 2005) we plan to carry out flux and positional accuracy calibrations of UBAT itself. After the launch we plan to take observations of several standard photometric stars in order to perform photometric calibration of SMT.

Table 1. An example of the brightest celestial X-ray sources, here the three brightest sources in the energy range 20–100 keV from the Fourth IBIS/ISGRI Soft Gamma-Ray Survey Catalog (Bird *et al.* 2010), which is the all sky catalogue compiled from the observations by the INTEGRAL satellite. Objects such as radio pulsars, high mass X-ray binaries (HMXRB) etc. will be used for cross-calibrations of SMT and UBAT.

Object	RA (deg)	dec (deg)	Flux at 20–100 keV ($\mathrm{ph.s^{-1}.cm^{-2}}$)	Type
Crab	83.63	22.02	0.27	Radio Pulsar
Cyg X-1	299.60	35.20	0.21	HMXRB
4U 1700–377	255.99	−37.85	0.05	HMXRB

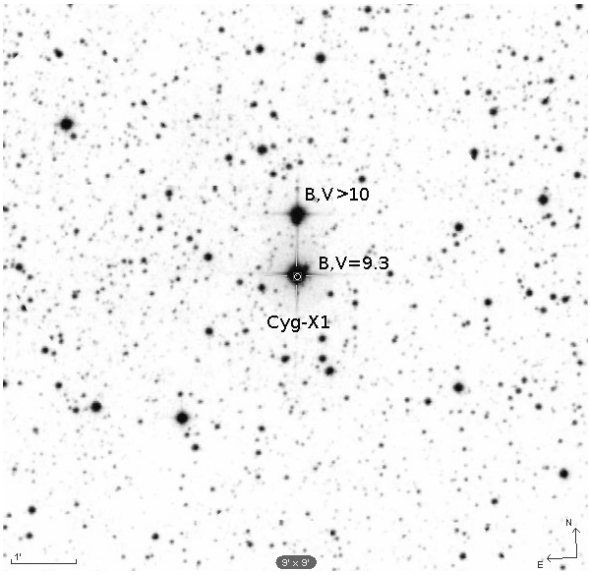

Fig. 1. An example of a bright celestial X-ray source (X-ray binary Cyg-X1) which is also bright in the optical range and also has a bright optical source, star V1674 Cyg, at a distance of 54 arcsec. X-ray source like this can be used for cross-calibration of SMT and UBAT.

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