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GRB optical prompt follow-up with BART

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Abstract. BART is a small aperture robotic telescope built for GRB prompt lookups and, in the meantime, for the photometric monitoring work. Routine operation of the telescope started in May 2001 and since then, five GRB alerts were followed, twice with the worldwide fastest response.

Now, after three months out of service during the summer 2002, the system is again up, running and awaiting a new version of operating software.

1. Introduction

The Burst Alert Robotic Telescope is an independent robotic telescope system, which is able to perform all-night observation without a human intervention. It's main objective is providing rapid follow-up to GRB alerts. Secondary target of this system is to provide long-term photometric monitoring of astrophysical high energy sources. In idle time, the system makes a slow wide field sky survey in order to have a comparsion material for potencial GRB alert material.

2. System setup

System is built with the idea of simple replicability of commercially available components with several custom improvements we did. Computer is a standard PC with operating system Linux. Software used was written from scratch and is available on internet.

2.1. Hardware

We use the Meade LX-200 25.4 cm f/6.3 system as a base platform. The Schmidt-Cassegrain system we call Narrow-field and use the SBIG ST-9 camera with Johnson's filters in it's focus. The resulting field of view is 22x22 arc minutes, typical limiting magnitude of a 120 s exposure is 16 in R. Images may be combined to get deeper.

Wide-field camera, which is attached to the base telescope is a Meopta f/1.7 lens with SBIG ST-8 attached. It uses fixed Johnson R filter. On 120 s there is typically limiting magnitude 15.

2.2. Software

Operating software is running under Linux, and is completely written in Python scripting language. It's able to serve two CCD cameras and one telescope from one computer and perform requested observations based on their priority and target accesibility on the sky. Additionally it handles an image archive and a simple http management interface.

There is a new version of the software, gaining from the one-year experience of using it's predecessor, which is being written in C and will supersede the original version in a near future. It's modular, network-based, with central accessibility server and peer-to-peer features between device and client nodes and can be simply adopted to drive any other telescope.

3. Alert response

The robotic telescope reacted to five GRB alerts during the first half of the year 2002. Basic information summarizes Table 1.

Alert	τ_{MIN}	$\tau_{MIN} - \tau_N$	**WF**	**NF**
GRB 020124	11.5 h	10 h	>14 (15)	-
GRB 020305	10.45 h	30 m	>14.3 (16)	>17(18.5)
GRB 020317	57.8 m	**90 s**	>13 (14.5)	-
GRB 020331	5.54 h	4.8 h	>12.5	>16
XRB 020406	29 h	24.5 h	$>\sim$ 14	-

Table 1. T_{MIN} is the time between the trigger and the first exposure. There is also interesting time $T_{MIN} - T_N$ between receiving the GCN notice and start of observation.

The only real-time response to a GRB alert is marked bold, others were delayed due to daytime and/or waiting for the clear sky. There is no positive detection, the corresponding magnitude limits are in the table 1.

Twice the system had a good chance to detect an OT, but once (020305) the NF camera, which was potentially able to detect an OT 10 hours after the burst, pointing to the center of error box, missed the OT position by few arc-minutes. Second time (020317) there was a fast — less than one hour — response, but this intermediate 2 s burst was probably dark.

GRB 020124 This alert, reported in GCN1220 by Ricker et al. (2002a), was a success for BART, as it was the first alert we followed after seven months of waiting. The position of a later found — GCN1221 by Price et al. (2002a) — optical transient is clearly empty even on 30 minute combined exposure down to the limiting magnitude 15. We reported our limits in GCN1236 (Jelínek et al 2002a)

GRB 020305 The alert, published in GCN1261 by Ricker et al. (2002b), came with delay 10.5 h after trigger at the vast beginning of the night, and the

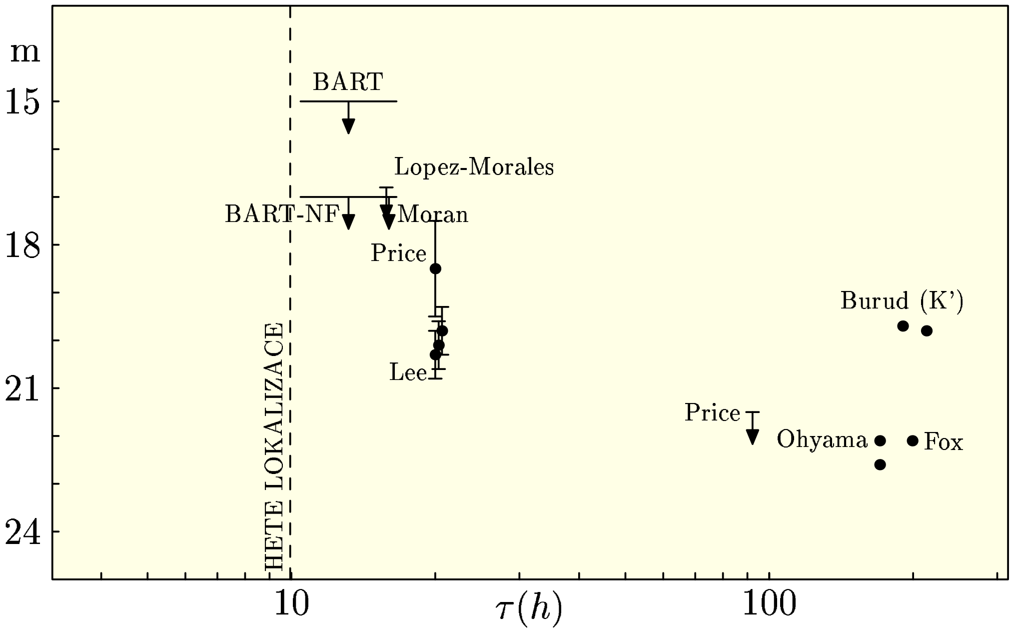

Figure 1. Early-time plot of observations of GRB 020305. Limits are marked by arrows, actual detections by dots. Length of horizontal bar denotes the length of period covered by observation.

telescope started observing in 30 minutes automatically, right after startup. For WF was the 11 h delay too long and the narrow field missed the position by less than a third of a field of view. Despite of this, we were worldwide first to observe the error box of the GRB. See also Fig. 1. Our observation was published in GCN (Jelínek et al. 2002b)

GRB 020317 This follow-up was a real success of the instrumental part of the experiment. It proved that we are really able to do a real-time follow up to the GCN alert (Ricker et al. 2002c). The burst was, however, probably dark. (Jelínek et al. 2002c)

GRB 020331 Observing conditions were really poor, observation started after 5 hours due to weather. Limiting magnitude on WF is 12.5, which is 2.5 mag below that achieved on good conditions.

XRB 020406 Very long waiting for a good weather. Mentioned mainly for completeness.

4. Acknowledgements

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5. Internet

For more info and images concerning this project you may visit it's internet presentation, which may be found at

`http://lascaux.asu.cas.cz/`

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