A decade of GRB follow-up by BOOTES in Spain (2003-2013)

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ABSTRACT

This article covers ten years of GRB follow-ups by the Spanish BOOTES stations: 71 follow-ups providing 23 detections. Follow-ups by BOOTES-1B from 2005 to 2008 were given in the previous article, and are here reviewed, updated, and include additional detection data points as the former article merely stated their existence. The all-sky cameras CASSANDRA have not yet detected any GRB optical afterglows, but limits are reported where available.

Dedicated to the memory of Dolores Pérez-Ramírez and Javier Gorosabel, who passed away while this paper was in preparation

Key words. Gamma-rays: catalogs, gamma-ray burst: general + individual, telescopes

1. Introduction

Ever since the discovery of Gamma-ray bursts (GRB) in 1967 [Klebesadel et al. 1973], it was hoped to discover their counterparts at other wavelengths. The early GRB-related transient searching methods varied (wide-field optical systems as well as deep searches were being employed), but, given the coarse gamma-ray-based GRB localizations provided, generally lacked either sensitivity or good reaction time. The eventual discovery of GRB optical counterparts was done only when an X-ray follow-up telescope was available on the Beppo-SAX satellite (Costa et al. 1997). The optical afterglow could then be searched for with a large telescope in a small errorbox provided by the discovery of the X-ray afterglow. The first optical afterglow of a Gamma-ray burst was discovered this way in 1997 (van Paradijs et al. 1997).

Since then, astronomers have been trying to minimize the time delay between receiving the position and the start of observations – by both personal dedication and by automating the telescope reaction. The ultimate step in automation, to minimize the time delay, is a full robotization of the observatory to eliminate any human intervention in the follow-up process. This way, the reaction time can be minimized from ~10 minute limit that can be achieved with a human operated telescope to below 10 seconds. With improvements in computational methods and in image processing speed, blind (non follow-up) wide-field methods are starting to be practical in the search for optical transients. Although limited in magnitude range, they have al-

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ready provided important observations of the optical emission simultaneous to the gamma-ray production of a GRB (Racusin et al. 2008).

Since 1997, the robotic telescope network BOOTES has been part of the effort to follow-up gamma-ray burst events (Castro-Tirado et al. 2004). As of now, the network of robotic telescopes BOOTES consists of six telescopes around the globe, dedicated primarily to GRB afterglow follow-up. We present the results of our GRB follow-up programme by two telescopes of the network – BOOTES-1B and BOOTES-2 and by the respective stationary very wide field cameras (CASSANDRA). This text covers eleven years of GRB follow-ups: 71 follow-ups providing 21 detections.

Different instruments have been part of BOOTES during the years in question: a 30 cm telescope which was used for most of the time at BOOTES-1 station but at periods also at BOOTES-2, the fast-moving 60 cm telescope at BOOTES-2 (Telma), and also two all-sky cameras, CASSANDRA1 at BOOTES-1 and CASSANDRA2 at BOOTES-2. Results from CASSANDRA are included where available, without paying attention to the complete sample.

This article is a follow-up of a previous article: Jelínek et al. (2010) which provided detailed description of evolution of BOOTES-1B, and analysis of efficiency of a system dedicated to GRB follow-up based on real data obtained during four years between 2005 and 2008. This work is a catalogue of BOOTES-1B and BOOTES-2 GRB observations between 2003 and 2013; it is complete in providing information about successfully followed-up events, but does not provide analysis of missed triggers as did the previous article.

1.1. BOOTES-1B

BOOTES-1 observatory is located at the atmospheric sounding station at El Arenosillo, Huelva, Spain (at lat: 37°06′14″N, long: 06°44′02″W). Over time, distinct system configurations were used, including also two 8 inch S-C telescopes, as described in Jelínek et al. (2010), the primary instrument of BOOTES-1B is a D=30 cm Schmidt-Cassegrain optical tube assembly with a CCD camera. Prior to June 15, 2007, Bessel VRI filters were being used as noted with the observations, any observations obtained after this date have been obtained without filter (C or clear). We calibrate these observations against R-band, which, in the case of no color evolution of the optical counterpart, is expected to result in a small (∼0.1 mag) constant offset in magnitude.

1.2. BOOTES-2

BOOTES-2 is located at CSIC’s experimental station La Mayora (Instituto de Hortofruticultura Subtropical IHSM-CSIC) (at lat: 36°45′33″N, long: 04°02′ 27″W), 240 km from BOOTES-1. It was originally equipped with an identical 30 cm Schmidt-Cassegrain telescope to that at BOOTES-1B. In 2007 the telescope was upgraded to a lightweight 60 cm Ritchey-Chrétien telescope on a fast-slewing NTM-500 mount, both provided by Astelco. The camera was upgraded at the same time to an Andor iXon 1024 × 1024 EMCCD, and in 2012 the capabilities were extended yet again to low resolution spectroscopy, by the installation of the imaging spectrograph COLORES of our own design and construction (Rabaza et al. 2013). Bessel magnitudes are calibrated to Vega system, SDSS to AB.

2. Optical follow-up of GRB events

Here we will detail the individual results for each of the 23 events followed-up and detected in 2003 – 2013. Each GRB is given a short introductory paragraph as a reminder of the basic observational properties of the event. Although we do not discuss the properties at other wavelengths, we try to include a comprehensive reference of literature relevant to each burst. As GCN reports usually summarise the relevant GCN circular traffic, we have omitted the raw GCN circulars except for events for which a GCN report or other more exhaustive paper is unavailable.

Further 48 follow-ups which resulted in detection limits are included in tables I and II but are not given any further attention.

One by one, we show all the successful follow-ups that these telescopes have performed during the first ten years of the Swift era, and since the transition of the BOOTES network to the RTS-2 (Kubánek et al. 2004) observatory control system, which was for the first time installed at BOOTES-2 in 2003, and during the summer of 2004 at BOOTES-1.

GRB 050525A A bright low-redshift (z = 0.606) localized by Swift (Blustin et al. 2006). Plenty of optical data, including the signature of the associated supernova sn2005nc (Della Valle et al. 2006; Resmi et al. 2012).

GRB 050525A was the first BOOTES-1B burst for which a detection was obtained. The telescope started the first exposure 28 s after receiving the notice, 383 s after the GRB trigger. An optical afterglow with V ~ 16 was detected. A weak detection of a bright GRB implied a reexamination of observing strategies employed by BOOTES. The largest, 30 cm telescope was changed to make R-band imaging instead of using the field spectrograph to greatly improve sensitivity in terms of limiting magnitude. The

![Fig. 1 The optical light curve of GRB 050824. The optical lightcurve represents behaviour seen by Sollerman et al. (2007).](image-url)
20 cm telescopes were still observing with V+I filters (for details see Jelínek et al. 2010).

This burst was covered in real time by both All Sky Cameras of BOOTES (CASSANDRA1 and 2), providing an unfiltered limit of > 9.0 (de Ugarte Postigo et al. 2003). BOOTES observation of this GRB is included in Resmi et al. (2012).

**GRB 050824** A dim burst detected by Swift. The optical afterglow of this GRB discovered with the 1.5 m telescope at OSN, redshift $z = 0.83$ determined by VLT (Sollerman et al. 2007).

BOOTES-1B was the first telescope to observe this optical transient, starting 636 s after the trigger with $R \approx 17.5$. The weather was not stable and the focus not perfect, but BOOTES-1B worked as expected. In the end, several hours of data were obtained. BOOTES observation of this GRB is included in Sollerman et al. (2007).

**GRB 050922C** A Swift short and intense long burst (Norris et al. 2005; Krimm et al. 2005) that was observed also by HETE2 (Crew et al. 2005). Optical afterglow mag $\sim 15$, $z = 2.198$ (Jakobsson et al. 2005).

Due to clouds, the limiting magnitude of BOOTES-1B dropped from $\sim 17.0$ for a 30 s exposure to mere 12.9. The afterglow was eventually detected with the $R$-band camera (at the 30 cm telescope) during gaps between passing clouds. The first weak detection was obtained 228 s after the GRB trigger and gave $R \approx 14.6$.

**GRB 051109A** A burst detected by Swift (Fenimore et al. 2005). Optical afterglow mag 15, redshift $z = 2.346$ (Quimby et al. 2005), optical lightcurve by Mirabal et al. (2006).

At BOOTES-1B the image acquisition started 54.8 s after the burst with the 30 cm telescope in $R$-band and one of the 20 cm telescopes in $I$-band (Jelínek et al. 2005). There were still a number of performance problems – most importantly synchronization between cameras such that when the telescope position was to be changed, both cameras had to be idle. As the 30 cm telescope was taking shorter exposures, extra exposures could have been made while waiting for the longer exposures being taken at the 20 cm to finish. The 20 cm detection is, after critical revision, only at the level of 2-$\sigma$. The $R$-band observation shows the object until about 20 minutes after the GRB, when it becomes too dim to measure in the vicinity of a 17.5 m nearby star. Mean decay rate observed by BOOTES is $\alpha = 0.63 \pm 0.06$ ($F_{\text{opt}} \sim t^{-\alpha}$).

The relatively shallow decay observed by BOOTES is in close agreement with what was observed several minutes later by the 2.4 m MDM ($\alpha = 0.62 \pm 0.03$) and according to an unofficial report (Mirabal et al. 2005) there was a decay change later, by about 3 h after the burst to $\alpha = 0.89 \pm 0.05$.

**GRB 080330** A rather bright long burst detected by Swift Afterglow reported to be detected by UVOT, TAROT, ROTSE-III, Liverpool Telescope and GROND. Spectroscopic redshift $z = 1.51$ by NOT (Mao et al. 2008).

This GRB happened during the first day recommissioning of BOOTES-1B after its move from the BOOTES-2 site at La Mayora. The GCN client was not yet operational and at the time of the GRB we were focusing the telescope. The first image was obtained 379 s after the GRB trigger and the optical afterglow was detected with magnitude $\sim 16.3$ on the first image. A bug in the centering algorithm caused a loss of part subsequent data. Further detections were obtained starting 21 min after the GRB when the problem was fixed.

The lightcurve (as seen by Yuan et al. 2008) seems to show an optical flare and then a possible hydrodynamic peak. The data of BOOTES, however, trace only the final part of this behaviour, where the decay accelerates after passing through the hydrodynamic peak.

**GRB 080413A** A rather bright GRB detected by Swift, detected also by Suzaku-WAM, optical afterglow by ROTSE-
III, redshift $z = 2.433$ by VLT+UVES.

BOOTES-1B started obtaining images of the GRB 080413A just 60.7 s after the trigger (46.3 s after reception of the alert). An $R \approx 13.3$ magnitude decaying optical afterglow was found, see Fig. 4 (Kubánek et al., 2008; Jelinek et al., in prep.)

**GRB 080430** A burst detected by Swift. It was a widely observed, low-redshift $z \approx 0.75$ optical afterglow with a slowly decaying optical afterglow (Guidorzi et al., 2008). Observed also at very high energies by MAGIC without detection (Aleksic et al., 2010).

BOOTES-1B obtained the first image of this GRB 34.4 s after the trigger. An optical transient was detected on combined unfiltered images with a magnitude $\approx 15.5$ (Jelinek et al., 2008).

**GRB 090313** GRB by Swift, no prompt X-rays (Mao et al., 2009). An optical afterglow peaking at $R \sim 15.6$. Extensive optical + infrared follow-up, the first GRB to be observed by X-Shooter. Also detected by various observatories in radio. Redshift $z = 3.375$ (de Ugarte Postigo et al., 2010a; Melandri et al., 2010).

The GRB happened during daylight for BOOTES-1B and it was followed-up manually. Due to the proximity of the Moon and limitations of then-new CCD camera driver, many 2 s exposures were taken to be combined later. The optical afterglow was detected with magnitude $\sim 18.3 \pm 0.4$ on a $635 \times 2$ s ($=21$ min) exposure with the mid-time 11.96 h after the GRB trigger.

**GRB 090813** A long GRB by Swift, suspected of being higher-$z$, observed also by Konus-Wind and Fermi-GBM (Cummings et al., 2009). Optical counterpart by the 1.23 m

![Fig. 5](image5.png) Fig. 5 The optical light curve of GRB 080603B (Jelinek et al., 2012b).

![Fig. 6](image6.png) Fig. 6 The optical light curve of GRB 080605 (Jelinek et al., 2013), the dotted line is behaviour observed by Rumyantsev & Pozanenko (2008) and Zafar et al. (2012).
telescope at Calar Alto with a magnitude of $I = 17.0$ (Gorosabel et al. 2009).

BOOTES-1B started observation 53 s after the GRB, taking 10 s unfiltered exposures. The optical transient was weakly detected on a combined image of $10 \times 10$ s whose exposure mean time was 630 s after the burst. The optical counterpart was found having $R = 17.9 \pm 0.3$. Given that the previous and subsequent images did not show any OT detection, we might speculate about the optical emission peaking at about this time. Also the brightness is much weaker than might be expected from the detection by Gorosabel et al. (2009), supporting the high redshift origin.

GRB 100418A A weak long burst detected by Swift (Marshall et al. 2011) with a peculiar, late-peaking optical afterglow with $z = 0.6239$ (de Ugarte Postigo et al. 2011). Also detected in radio (Moin et al. 2013).

The first image of the GRB location was taken by BOOTES-2 at 21:50 UT (40 min after the GRB trigger). The rising optical afterglow was detected for the first time on an image obtained as a sum of 23 images, with an exposure mid-time 107 minutes after the GRB trigger. The optical emission peaked at magnitude $R = 18.7$ another hour later, at an image with the mid-time 163 min after the trigger. A slow decay followed, which permitted us to detect the optical counterpart until 8 days after the GRB.

Because of a mount problem, many images were lost (pointed somewhere else) and the potential of the telescope was not fully used. Eventually, after combining images when appropriate, 11 photometric points were obtained. A rising part of the optical afterglow was seen that way.

GRB 100901A A long burst from Swift. Bright, slowly decaying optical afterglow discovered by UVOT. Redshift $z = 1.408$, Detected also by SMA at 345 GHz (Immler et al. 2010; Gorbovskoy et al. 2012; Hartoog et al. 2013).

The burst happened in daytime in Spain and the position became available only almost ten hours later after the sunset. The afterglow was still well detected with magnitude $R \approx 17.5$ at the beginning. BOOTES-2 had some problems with CCD cooling, and some images were useless. The afterglow was detected also the following night with $R = 19.35$.

GRB 101112A An INTEGRAL-localized burst (Gotz et al. 2010), also detected by Fermi-GBM (Goldstein 2010), Konus-Wind (Golenetskii et al. 2010) and Swift-XRT (Evans & Krimm 2010). Optical afterglow discovered independently by BOOTES-2 and Liverpool Telescope (Guidorzi et al. 2010). Detected also in radio (Chandra et al. 2010).

BOOTES-2 reacted to the GRB101112A and started to observe 47 s after the GRB. A set of 3 s exposures was taken, but due to technical problems with the mount a significant amount of observing time was lost. An optical afterglow was discovered and reported (de Ugarte Postigo et al. 2010b). The optical lightcurve exhibited first a decay, then a sud-
GRB 110205A A very long and bright burst by Swift. Detected also by Konus-Wind and Suzaku-WAM. Optical afterglow peaking at $R \sim 14.0$, extensive multicolour follow-up, $z = 2.22$ “Textbook burst” (Zheng et al. 2012; Gendre et al. 2012).

BOOTES-1B reacted automatically to the Swift trigger. First 10 s unfiltered exposure was obtained 102 s after the beginning of the GRB (with $T_{90} = 257$ s) i.e. while the gamma-ray emission was still taking place. After taking 18 images, the observatory triggered on a false alarm from the rain detector, which caused the observation to be stopped for 20 minutes. After resuming the observation, $3 \times 30$ images were obtained and another false alert struck over. This alert was remotely overridden by P. Kubánek, so that all 20 minutes were not lost. From then on, the observation continued until sunrise. The afterglow is well detected in the images until 2.2 hours after the GRB. 16 photometric points from combined images were eventually published.

BOOTES-2 started observations 15 min after the trigger, clearly detecting the afterglow in R-band until 3.2 hours after the burst. 13 photometric points were obtained. The delay was caused by technical problems. BOOTES observations of this GRB are included in Zheng et al. (2012).

GRB 110213A A bright burst detected by Swift, detected also by Konus-Wind and Fermi-GBM. Optical afterglow $R \sim 14.6$, extensive follow-up (D’Elia et al. 2011).

BOOTES-1B started to observe 15 hours after the GRB (the position was below horizon at the time of the trigger) and continued for an hour, eventually, $100 \times 30$ s unfiltered images were combined, the OT brightness calibrated against USNO-A2 is $18.3 \pm 0.3$ at the exposure mid-time of 15.5 h after the GRB trigger.

GRB 120326A A Swift-detected burst. Afterglow discovered by Tarot (Klotz et al. 2012a). Long-lived optical emission, redshift $z = 1.78$ by GTC. Detected also by Fermi-GBM and Suzaku-WAM (Siegel et al. 2013 and references therein).

At BOOTES-1B the mount failed, because of the serial port communication failure. After a manual recovery, 40 minutes after the GRB, images were taken in hope for a detection, but the counterpart with the brightness of $R \sim 19.5$ was detected only at about 2σ level.

GRB 120327A A bright burst by Swift with an afterglow discovered by UVOT (Sharufatti et al. 2012). Redshift $z = 2.813$ (D’Elia 2013). Extensive optical follow-up.

BOOTES-1B reacted in 41 min (similar failure as the day before: the mount failed, because of the serial port communication failure), obtaining a series of 20 s exposures. These images were combined to get 600 s effective exposures and permitted detection of the afterglow on six such images. The brightness was decaying from $R = 17.5$ to $R = 18.6$.

All-sky camera at BOOTES-1 (CASSANDRA1) covered the event in real time and detected nothing down to $R \sim 7.5$ (Zanioni et al. in prep.).

GRB 121001A A bright and long Swift-detected GRB, originally designated as possibly galactic (D’Elia et al. 2012). Afterglow discovered by Andreev et al. (2012).

BOOTES-2 observed this trigger starting 32 min after the trigger. An optical afterglow is detected in I-band with $I \sim 19.7$ (Vega) for a sum of images between 20:49 – 21:52 UT (Tello et al. 2012).

GRB 121024A A bright Swift-detected GRB with a bright optical afterglow (Pagani et al. 2012; Klotz et al. 2012b). Detected also in radio (Laskar et al. 2012). Redshift $z = 2.298$ by Tanvir et al. (2012).

BOOTES-1B observed the optical afterglow of GRB 121024A. The observations started 40 minutes after the GRB trigger. The sum of 20 minutes of unfiltered images with a mean integration time 54 minutes after the GRB shows a weak detection of the optical afterglow with magnitude $R = 18.2 \pm 0.5$ (Jelinek et al. 2012a).

GRB 130418A A bright and long burst with a well detected optical afterglow somewhat peculiarly detected after a slew by Swift (de Pasquale et al. 2013). Observation by Konus-Wind showed that the burst started already 218 s before Swift triggered (Golenetskii et al. 2013). Redshift $z = 1.218$ by Ukarte Postigo et al. (2013).

BOOTES-2 obtained a large set of unfiltered, $r'$-band and $i'$-band images starting 1.5 h after the trigger. The optical afterglow is well detected in the images. The lightcurve is steadily decaying with the power-law index of $\alpha = -0.93 \pm 0.06$, with the exception of the beginning, where there is a possible flaring with peak about 0.25 mag brighter than the steady power-law.

GRB 130505A A bright and intense GRB with a 14 mag optical afterglow detected by Swift (Cannizzo et al. 2013). Redshift $z = 2.27$ reported by Tanvir et al. (2013).

Fig. 10 The optical light curve of GRB 110205A.
BOOTES-2 obtained the first image of this GRB 11.94 h after the trigger. A set of 60 s exposures was obtained. Combining the first hour of images taken, we clearly detect the optical afterglow, and using the calibration provided by Kann et al. (2013), we measure $R_{\text{C}} = 19.26 \pm 0.06$.

GRB 130606A, a high-redshift GRB detected by Swift (Ukwatta et al. 2013), optical afterglow discovered by BOOTES-2, redshift $z = 5.9$ by GTC (Castro-Tirado et al. 2013).

BOOTES-2 reaction to this GRB alert was actually a failure, the system did not respond as well as it should and it had to be manually overridden to perform the observations. The first image has therefore been taken as late as 13 minutes after the trigger. These observations led to a discovery of a bright afterglow not seen by Swift-UVOT, and prompted spectroscopic observations by 10.4m GTC, which show redshift of this event to be $z = 5.9135$. Overall, 14 photometric points in $i'$-band and 7 in $z'$-band were obtained (Castro-Tirado et al. 2013).

![GRB 130418A](image1)

**Fig. 11.** The optical light curve of GRB 130418A.

![GRB 130606A](image2)

**Fig. 12.** The optical light curve of GRB 130606A. $i'$-band points were shifted 2.4 mag up to match with the $z'$-band points.

### Table 1: BOOTES-1B GRBs in a table

| GRB          | $\Delta T$ | no. pts | result | ref. |
|--------------|------------|---------|--------|-----|
| 030913       | 2 h        | V $> 17.5$, C $> 12$ |
| 050215B      | 22 m       | V $> 16.5$, J $> 15.0$ |
| 050505       | 47 m       | V $> 19$, C $> 16$ |
| 050509A      | 64 m       | V $> 14.9$ |
| 050509B      | 62 s       | V $> 11.5$ |
| 050525A      | 12 m$^1$   | 1       | 16.5 $\pm$ 0.4 | [1] |
| 050528       | 71 s       | $V > 13.8$, J $> 13.0$ |
| 050824       | 10 m       | $R = 18.2 \pm 0.3$ | [2] |
| 050904       | 2 m        | $R > 18.2$ | [3] |
| 050922C      | 4 m        | 3 $R = 14.6 \pm 0.4$ |
| 051109A      | 55 s       | 6 $R = 15.7 \pm 0.4$ |
| 051211B      | 42 s       | $R >$ |
| 051211B      | 4 m        | $R >$ |
| 060421       | 61 s       | $R > 14$ |
| 061110B      | 11 m       | $R > 18$ |
| 071101       | 55 s       | $C > 17.0$ |
| 071109       | 59 s       | $C > 13.0$ |
| 080330       | 6 m        | 6 $C = 16.5 \pm 0.2$ |
| 090413A      | 61 s       | 61 $C = 13.3$ |
| 090430       | 34 s $^*$  | $C = 15.5$ |
| 080603B      | 1 h        | 11 $C = 17.4$ | [4] |
| 080605       | 44 s       | 28 $C = 14.7$ | [5] |
| 081003B      | 41 s       | $C > 17.6$ |
| 090313       | 12 h       | 1 $C = 18.3$ |
| 090519       | 99 s       | $C > 17.6$ |
| 090813       | 53 s       | 1 $C = 17.9$ |
| 090914A      | 3 m$^1$    | $C > 15.8$ |
| 090914B      | 53 s$^1$   | $C > 17.5$ |
| 090918    | 24 m       | $C > 16.7$ |
| 100906A      | 106 s      | $C > 16.5$ |
| 110205A      | 102 s      | 16 $C \sim 14$ | [6] |
| 110212A      | 50 s       | $C > 13.0$ |
| 110213A      | 15 h       | 1 $C = 18.3 \pm 0.2$ |
| 110411A      | 24 s       | $C > 17.8$ |
| 111016A      | 1.25 h     | $C > 17.8$ |
| 120326A      | 40 m       | 1 $C \sim 19.5$ |
| 120327A      | 41 m$^1$   | 6 $C = 17.5$ |
| 120328A      | 7.5 m      | $C > 16$ |
| 120521A      | 11.7 m     | $C > 20.5$ |
| 120711B      | 107 s      | $C > 18.2$ |
| 120729A      | 10 h       | $C > 19.0$ |
| 121017A      | 79 s       | $C > 19.0$ |
| 121024A      | 40 m       | 1 $C = 18.2 \pm 0.5$ |
| 121209A      | 42 s$^1$   | $C > 16.5$ |
| 130122A      | 28 m       | $C > 18.4$ |

Note: 1. Resmi et al. (2012), 2. Sollerman et al. (2007), 3. Haislip et al. (2005), 4. Jelínek et al. (2012b), 5. Jelínek et al. (2013), 6. Zheng et al. (2013). $^1$ marks alerts covered in real time by wide-field camera CASSANDRA-1.

### 3. Summary

Eleven years of BOOTES-1B and BOOTES-2 GRB follow-up history are summarised in the textual and tabular form. Each GRB is given a short introductory paragraph as a reminder of the basic optical properties of the event. Although we do not discuss the properties in other wavelengths, we try to include a comprehensive reference of literature relevant to each burst. One by one, we show all the successful follow-ups that these telescopes have per-
formed during the first ten years of the Swift era, and the transition of the BOOTES network to the RTS-2 (Kubíněk et al. 2001) observatory control system, first installed at BOOTES-2 in 2003, and made definitive during the summer of 2004.

The BOOTES telescopes, in spite of their moderate apertures (≤ 60 cm) have proven to detect a significant number of afterglows — together over 20, contributing to the understanding of the early GRB phase.

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Note — 1. Jelínek et al. (2012b). 2. Jelínek et al. (2013). 3. Zheng et al. (2012).
Table 3: GRB 050525A: Observing log of BOOTES-1B

| \(\Delta T[h]\) | \(\exp[s]\) | mag   | dmag | filter |
|-------------|-------------|-------|------|--------|
| 0.195       | 39 \times 10 s | 16.51 | 0.39 | R      |

Note — Published by Resmi et al. (2012)

Table 4: GRB 050824: Observing log of BOOTES-1B

| \(\Delta T[h]\) | \(\exp[s]\) | mag   | dmag | filter |
|-------------|-------------|-------|------|--------|
| 0.1763      | 18.22       | 0.35  | R    |
| 0.3462      | 19.11       | 0.32  | R    |
| 1.0249      | 19.67       | 0.33  | R    |
| 2.9091      | 19.33       | 0.20  | R    |

Note — Published by Sollerman et al. (2007)

Table 5: GRB 050922C: Observing log of BOOTES-1B

| \(\Delta T[h]\) | \(\exp[s]\) | mag   | dmag | filter |
|-------------|-------------|-------|------|--------|
| 0.0694      | 40          | 14.58 | 0.35 | R      |
| 0.3752      | 900         | 17.01 | 0.39 | R      |
| 0.6193      | 900         | 18.53 | 0.59 | R      |

Table 6: GRB 051109A: Observing log of BOOTES-1B

| \(\Delta T[h]\) | \(\exp[s]\) | mag   | dmag | filter |
|-------------|-------------|-------|------|--------|
| 59.7        | 10          | 15.67 | 0.35 | R      |
| 122.2       | 74          | 16.02 | 0.19 | R      |
| 257.9       | 41          | 16.65 | 0.41 | R      |
| 756.6       | 205         | 17.18 | 0.22 | R      |
| 1021.5      | 313         | 17.68 | 0.26 | R      |
| 508.4       | 908         | 16.98 | 0.54 | I      |

Table 7: GRB 080330: Observing log of BOOTES-1B

| \(\Delta T[h]\) | \(\exp[s]\) | mag   | dmag | filter |
|-------------|-------------|-------|------|--------|
| 0.1061      | 7           | 16.52 | 0.23 | clear  |
| 0.3752      | 210         | 16.61 | 0.13 | clear  |
| 0.6193      | 588         | 17.16 | 0.14 | clear  |
| 0.8547      | 825         | 17.45 | 0.15 | clear  |
| 1.0915      | 862         | 17.29 | 0.13 | clear  |
| 1.3384      | 905         | 17.42 | 0.16 | clear  |
Table 8: GRB 090813: Observing log of BOOTES-1B

| ∆T[h] | exp[s] | mag | dmag | filter |
|-------|--------|-----|------|--------|
| 0.175 | 10 × 10 | 17.9 | 0.3  | clear  |

Table 9: GRB 100418A: Observing log of BOOTES-2

| ∆T[h] | exp[s] | mag | dmag | filter |
|-------|--------|-----|------|--------|
| 1.78  | 1638   | 19.785 | 0.215 | clear |
| 2.09  | 507    | 19.127 | 0.127 | clear |
| 2.55  | 534    | 18.774 | 0.087 | clear |
| 2.72  | 656    | 18.668 | 0.073 | clear |
| 3.10  | 239    | 18.706 | 0.106 | clear |
| 3.43  | 238    | 18.759 | 0.189 | clear |
| 4.70  | 3908   | 19.067 | 0.108 | clear |
| 6.19  | 4328   | 18.897 | 0.115 | clear |

Table 10: GRB 090901A: Observing log of BOOTES-2

| ∆T[h] | exp[s] | mag | dmag | filter |
|-------|--------|-----|------|--------|
| 10.202 | 268 | 17.52 | 0.08 | R |
| 10.719 | 415 | 17.61 | 0.07 | R |
| 11.230 | 354 | 17.67 | 0.09 | R |
| 11.734 | 238 | 17.99 | 0.16 | R |
| 12.346 | 730 | 17.78 | 0.13 | R |
| 12.980 | 759 | 17.68 | 0.12 | R |
| 13.239 | 759 | 17.82 | 0.16 | R |
| 13.971 | 997 | 18.21 | 0.12 | R |
| 14.611 | 1101 | 18.32 | 0.14 | R |
| 33.791 | 4012 | 19.35 | 0.19 | R |

Table 11: GRB 101112A: Observing log of BOOTES-2

| ∆T[s] | exp[s] | mag | dmag | filter |
|--------|--------|-----|------|--------|
| 595.0  | 16      | 16.00 | 0.19 | r' |
| 631.8  | 8       | 16.10 | 0.29 | r' |
| 664.9  | 7       | 16.46 | 0.34 | r' |
| 697.8  | 7       | 16.30 | 0.25 | r' |
| 731.0  | 7       | 15.52 | 0.18 | r' |
| 766.1  | 11      | 15.56 | 0.13 | r' |
| 800.9  | 7       | 15.52 | 0.17 | r' |
| 833.8  | 7       | 15.24 | 0.12 | r' |
| 891.2  | 44      | 15.92 | 0.13 | r' |
| 973.7  | 69      | 16.33 | 0.20 | r' |
| 1044.0 | 69      | 16.62 | 0.23 | r' |
| 1124.2 | 41      | 17.09 | 0.36 | r' |
| 1252.7 | 115     | 17.44 | 0.25 | r' |
| 1393.8 | 116     | 17.86 | 0.38 | r' |
| 1629.5 | 255     | 18.57 | 0.48 | r' |

Table 12: GRB 1110213A: Observing log of BOOTES-1B

| ∆T[h] | exp[s] | mag | dmag | filter |
|-------|--------|-----|------|--------|
| 15.5  | 100 × 30 | 18.29 | 0.30 | clear |

Table 13: GRB 120327A: Observing log of BOOTES-1B

| ∆T[h] | exp[s] | mag | dmag | filter |
|-------|--------|-----|------|--------|
| 0.955 | 654    | 17.50 | 0.12 | clear |
| 1.140 | 674    | 17.65 | 0.12 | clear |
| 1.337 | 748    | 17.82 | 0.13 | clear |
| 1.533 | 660    | 18.24 | 0.21 | clear |
| 1.718 | 673    | 18.17 | 0.21 | clear |
| 1.905 | 656    | 18.59 | 0.29 | clear |

Table 14: GRB 121024A: Observing log of BOOTES-1B

| ∆T[h] | exp[s] | mag | dmag | filter |
|-------|--------|-----|------|--------|
| 0.900 | 1200   | 18.2 | 0.5  | clear |

Table 15: GRB 130418A: Observing log of BOOTES-1B and BOOTES-2

| ∆T[h] | exp[s] | mag | dmag | filter |
|-------|--------|-----|------|--------|
| 1.514 | 3 × 15 s | 17.09 | 0.08 | clear |
| 1.529 | 3 × 15 s | 16.95 | 0.07 | clear |
| 1.544 | 3 × 15 s | 16.90 | 0.06 | clear |
| 1.558 | 3 × 15 s | 16.62 | 0.07 | clear |
| 1.573 | 3 × 15 s | 17.03 | 0.07 | clear |
| 1.590 | 4 × 15 s | 16.92 | 0.06 | clear |
| 1.610 | 4 × 15 s | 17.04 | 0.07 | clear |
| 1.749 | 7 × 15 s | 17.22 | 0.05 | clear |
| 1.865 | 60 s    | 16.92 | 0.18 | R' |
| 1.884 | 4 × 15 s | 17.34 | 0.09 | clear |
| 2.054 | 7 × 15 s | 17.45 | 0.07 | clear |
| 2.089 | 7 × 15 s | 17.46 | 0.06 | clear |
| 2.209 | 6 × 15 s | 17.47 | 0.07 | clear |
| 2.326 | 6 × 15 s | 17.56 | 0.08 | clear |
| 2.444 | 6 × 15 s | 17.71 | 0.09 | clear |
| 2.562 | 6 × 15 s | 17.68 | 0.08 | clear |
| 2.798 | 22 × 60 s | 17.40 | 0.04 | r' |
| 3.061 | 15 × 60 s | 17.90 | 0.09 | r' |
| 3.333 | 15 × 60 s | 17.98 | 0.09 | r' |
| 3.604 | 15 × 60 s | 17.90 | 0.09 | r' |
| 3.866 | 15 × 60 s | 18.05 | 0.11 | r' |
| 4.130 | 15 × 60 s | 18.53 | 0.19 | r' |
| 4.449 | 20 × 60 s | 18.42 | 0.14 | r' |
| 4.808 | 20 × 60 s | 18.61 | 0.23 | r' |
Table 16: GRB 130505A: Observing log of BOOTES-2

| ∆T[h] | exp[s]   | mag  | dmag | filter |
|-------|----------|------|------|--------|
| 12.488| 51 × 60 s| 19.26| 0.06 | clear  |