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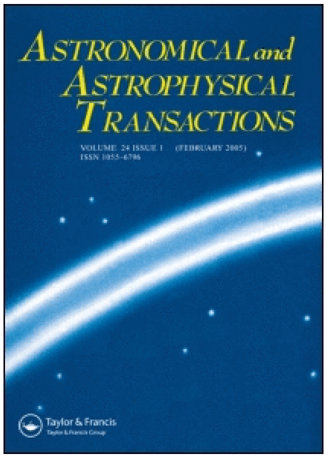

Astronomical & Astrophysical Transactions
The Journal of the Eurasian Astronomical Society
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713453505

The european observation network: Ground-based support for gamma-ray satellites

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Online Publication Date: 01 August 1997
To cite this Article: Hudec, R., Spurný, P., Florián, J., Boček, J., Tichý, M., Tichá, J., Vyskočil, L., Wenzel, W., Barthelmy, S., Cline, T., Gehrels, N., Fishman, G., Meegan, C., Kouveliotou, C., Mutafov, A. and Hovorka, F. (1997) 'The european observation network: Ground-based support for gamma-ray satellites', Astronomical & Astrophysical Transactions, 14:1, 65 - 77
To link to this article: DOI: 10.1080/10556799708213573
URL: http://dx.doi.org/10.1080/10556799708213573

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Astronomical and Astrophysical Transactions, 1997, Vol. 14, pp. 65–77
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Printed in India

Session 7 : High-Energy Astrophysics and Active Galaxies

THE EUROPEAN OBSERVATION NETWORK: GROUND-BASED SUPPORT FOR GAMMA-RAY SATELLITES

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(Received December 1, 1995)

While there is extended monitoring of the sky at gamma rays from satellites, mainly provided by the *COMPTON Gamma Ray Observatory*, there is still a lack of high-quality optical simultaneous and quasi-simultaneous data. On the other hand, the still puzzling nature of Gamma Ray Bursts requires a complex and multispectral approach. The situation changed significantly after the introduction of the BACODINE system which is able to notify ground-based observers immediately after the detection of bursts on the *GRO* satellite. We present and discuss preliminary results obtained with the European Observation Network providing such follow-up optical observations. This network consists of nine observatories in the Czech Republic, Germany and Bulgaria and has been involved into the BACODINE activities since April 1, 1994.

KEY WORDS Gamma ray: bursts, astronomical photography, CCD imaging

1 INTRODUCTION: THE PUZZLING NATURE OF GAMMA RAY BURSTS

Although observed for more than 20 years, the physical nature of, and even the distance to, Gamma Ray Bursts (GRB) is still unknown. These objects were initially believed to be related to the old neutron stars in our Galaxy, the situation has however changed dramatically since the launch of the NASA *Gamma Ray Observatory (GRO)* providing us with strong evidence that these triggers are distributed isotropically but not homogeneously on the sky, with no concentration toward the Galactic Plane.

It is generally believed that the identification of GRB with objects known from other wavelengths could solve the GRB mystery. However, the deep searches inside GRB error boxes have failed to detect obvious quiet counterparts. There is however still hope that deep simultaneous and quasi-simultaneous optical (as well as on other wavelength) observations could provide evidence for flaring and/or fading counterparts.

The deep optical monitoring however is still missing. After the closure of the Sonneberg Observatory on January 1, 1995, the only operating optical very wide-field monitoring system of the sky is operated by the Ondřejov Observatory. Although very wide-field, this system suffers low limiting magnitude. More sensitive very wide-field sky patrols are under consideration and/or study (ASPA, OTM) however are not yet available.

At the present, the deep simultaneous optical data for GRB cannot be provided. The only possibility is to provide deep quasi-simultaneous data. To do it, a very sophisticated system has been developed in the US (BACODINE), allowing the notification of ground-based observers about times and positions of GRB within 1 min after their detection by the satellite (*GRO*). Also the satellite *HETE* will soon provide such notifications.

It is obvious that a coordinated effort of many observing sites is preferable due to weather restrictions and other reasons.

2 THE EON NETWORK

The European Observation Network (EON) is operated to coordinate the efforts of several European Observatories in GRB optical alert searches. The main goal of the network is to provide optical data for GRBs detected by the BATSE experiment onboard of the *CGRO* satellite immediately (i.e. with minimal delays possible) after their detection.

The rapid circulation of GRB data is provided by the BACODINE project (Barthelmy *et al.*, 1994) within 0.3–30 s after their detection on the satellite. There are several possibilities as to how to distribute the BACODINE data. The Internet e-mail connection has been selected for the operation of EON. Recently, full access to the Internet has been available at five observing sites, limited access is available at a further two observatories and the remaining two sites have no Internet connection yet but are notified by phone and/or fax.

EON has been included in BACODINE activities since April 1, 1994. It was obvious from the beginning that wide-field optical devices would be needed for the analyses, due to the large error areas produced by BACODINE. Typically, fields of

Table 1. Table of EON Observing Sites (stand March 20, 1995)

Location	*FOV*	*Lim.mag.*	*Exp. time*	*Detector*	*Aperture*	*Remark*
Ondrejov CZ	10 arcmin	21	5 min	CCD	65 cm	For deep anal.
Ondrejov CZ	180 deg	11	4 h	Plates	0.8 cm	
Ondrejov CZ	1 deg	16	5 min	CCD	18 cm	
Ondrejov CZ	4 deg	14	5 min	CCD	8 cm	
Ondrejov CZ	13 deg	9	1/25 s	SIT Vid.	5 cm	Lim.mag. for flashes
Ondrejov CZ	20 deg	12	1 min	CCD	2 cm	
Klet CZ	5 deg	18	30 min	Plates	63/85 cm	
Klet CZ	10 arcmin	21	5 min	CCD	57 cm	For deep anal.
Upice CZ	7.5 deg	15	30 min	Film	35 cm	
Hradec Král. CZ	7 deg	16	30 min	Film	42/61 cm	
Sonneberg D	30 deg	15	50 min	Plates	5 cm	
Sonneberg D	10 deg	17	50 min	Plates	40 cm	
Sonneberg D	8 deg	17	50 min	Plates	40 cm	
Sonneberg D	4 deg	18	30 min	Plates	50/70 cm	
Egloffstein D	20 deg	12	1 min	CCD	2 cm	
Rozhen BG	4.5 deg	18.5	25 min	Plates	50/70 cm	
Avren BG	15 deg	14	55 min	Plates	5.6 cm	
Belogradch. BG	25 deg	13.5	45 min	Plates	6.8 cm	

view (FOV) of about 20×20 degrees are required, although smaller FOV instruments can be used to cover the trigger position by multiple exposures and/or to cover the central maximal probability area. However, telescopes with FOV below about 3 deg are unsuitable for the coverage of GRB error boxes, although they might be very useful for deep analyses of optical candidate positions provided by wide-field instruments.

The goal is to cover the full area of the error box of the GRB preferably by several following exposures/frames and to look for any kind of optical activity inside (new and/or variable object). The first exposure should be started as soon as possible after the GRB.

It is evident that very rapid optical observations could be provided mainly by robotic devices directly connected via the Internet socket (e.g. Hudec and Soldán, 1995; Soldán and Hudec, 1995). Such devices are however not yet available for the mentioned purposes and so all the participating observing devices are being operated in a manual mode so far. We hope nevertheless to achieve the following largets.

(1) Minimize the time delays between GRB and deep optical imaging. Currently, the minimal delay represents about 5 h. There are good reasons to believe that optical data with delays of no more than ~ 1 h can be collected for particular GRB even in the case of manual operation. The observations, however, should be carried out by a network of several observing stations to minimize the human, instrumental and weather influences which possibly prevent rapid optical coverage of the detected triggers.

Table 2. Statistics of observability in Central Europe of BACODINE triggers exceeding 2000 BATSE counts, April 1, 1994 – April 1, 1995

Category	*Number of triggers*
Total triggers communicated	44
Non-observable triggers (day sky or below horizon)	21
Observable triggers but GRB occurred during day time	12
As above but position is close to horizon	2
Observable triggers at night time	5
As above but position close to horizon	4

(2) Collect enough data to confirm or discount that these analyses can yield useful data for undestanding GRB and to support future more sophisticated experiments in this direction.

(3) Study in detail the methods of analyses, background and evaluation problems, etc. which will occur also in future automated experiments.

This is why we have established an observational network of several observing sites on the European continent. The present participation is illustrated by Table 1. The table lists wide-field instruments available for the project but there are also two larger narrow-FOV view telescopes for deep analyses of positions of revealed optical candidates. Here we discuss the first results collected and experience.

3 THE OBSERVING SITES

Currently, there are nine observatories with 18 telescopes/cameras included in the EON BACODINE activities. Some of the observatories have other telescope and/or cameras not listed in Table 1, which may be used if the main instruments are down for some reason. Most of the telescopes use photographic emulsions because most CCD telescopes have too small a FOV to provide useful coverage.

However, we have developed and tested very wide-field CCD cameras meeting the BACODINE demands for the FOV. These devices are in operation in Ondřejov and Egloffstein. Analogous devices will also be operated on the American continent by the SBAG group, using analogous optics and cameras (Schwartz and Brooks, 1994, private communication). Recently, negotations have started to include new observing sites.

4 THE OBSERVATIONS

The list of observations obtained is given in Table 3. There are both follow-up data and patrol data provided by the patrol photographic devices operated by the Ondřejov Observatory (Hudec *et al.*, 1984).

Table 3. List of follow-up observations of GRB provided by EON (BACODINE/BATSE and COMPTEL) (preliminary) (Observatory–Date–Time–FOV–Lim.mag.–Lim.mag. for 1s-Detector type (PG photographic, CC CCD) – Number of plates (if more than one was taken)/Plate No.)

GRB940301 20:18 UT	
Upice	940304 22:40–22:55 7.5 deg 15 7 PG
Upice	940304 23:08–23:23 7.5 deg 15 7 PG
Upice	940311 23:05–23:20 7.5 deg 15 7 PG
Ondrejov	940228 20:21–04:26 180 deg 4 3 PG 2
Ondrejov	940301 01:11–04:22 180 deg 9 3 PG 1
Ondrejov	940301 01:11–04:22 180 deg 4 3 PG 1
Ondrejov	940303 18:18–00:03 180 deg 4 3 PG 3
GRB940428 10:36 UT	
Ondrejov	940427 20:09–02:07 180 deg 4 3 PG 4
Ondrejov	940428 19:56–21:52 180 deg 9 3 PG 1
Ondrejov	940428 19:56–21:52 180 deg 4 3 PG 3
Klet	940504 01:23–01:38 5 deg 17 8 PG
Klet	940516 00:46–01:06 5 deg 17 8 PG
GRB940415 17:01 UT	
Sonneberg	940416 00:05–00:45 30 deg 14 6 PG Te611345
Sonneberg	940416 00:08–00:42 10 deg 16 8 PG GC 11038
Sonneberg	940416 00:44–01:46 10 deg 16 8 PG GC 11039
Sonneberg	940420 01:18–01:46 10 deg 16 8 PG GC 11042
Sonneberg	940420 01:49–02:15 10 deg 16 8 PG GC 11043
Ondrejov	940414 20:12–00:01 180 deg 9 3 PG 2
Ondrejov	940414 20:22–02:46 180 deg 4 3 PG 3
Ondrejov	940415 19:07–02:30 180 deg 4 3 Pg 3
GRB940520 00:21:40 UT	
Ondrejov	940518 23:30–01:30 180 deg 9 3 PG 1
Ondrejov	940518 23:30–01:30 180 deg 4 3 PG 4
Ondrejov	940521 20:30–01:20 180 deg 4 3 PG 2
Ondrejov	940522 20:35–01:30 180 deg 4 3 PG 3
GRB940602 00:17:33 UT	
Ondrejov	940601 23:15–01:05 180 deg 8 2 PG 2
Ondrejov	940601 23:15–01:05 180 deg 4 3 PG 3
Ondrejov	940601 20:50–01:05 180 deg 6 2 PG 1 S
Ondrejov	940601 20:50–01:05 180 deg 4 3 PG 6 S
Ondrejov	940603 20:55–01:00 180 deg 7 2 PG 1
Ondrejov	940603 20:55–01:00 180 deg 4 3 PG 2
Ondrejov	940606 21:00–01:00 180 deg 9 3 PG 2
Ondrejov	940606 21:00–01:00 180 deg 4 3 PG 6
Ondrejov	940607 21:00–01:00 180 deg 9 3 PG 2
Ondrejov	940607 21:00–01:00 180 deg 4 3 PG 4
Upice	940603 23:46–24:00 7.5 deg 15 7 PG
Upice	940604 00:13–00:28 7.5 deg 15 7 PG
Upice	940606 22:48–23:03 7.5 deg 15 7 PG
Upice	940606 23:54–00:11 7.5 deg 15 7 PG

Table 3. Continued

Rozhen	940603 00:20–00:40 5 deg 17 8 PG
Avren	940604 00:12–01:00 15 deg 13.5 5 PG
Avren	940605 00:03–00:53 15 deg 13.5 5 PG
Avren	940609 23:31–00:31 15 deg 13.5 5 PG
Klet	940608 00:29–00:49 5 deg 17 8 PG
Klet	940608 23:20–23:40 5 deg 17 8 PG
GRB940623 05:25:48 UT	
Ondrejov	940621 21:00–01:00 180 deg 4 3 PG 4
Ondrejov	940621 21:00–01:00 180 deg 2 –4 PG 1
Ondrejov	940622 21:00–01:00 180 deg 2 –4 PG 3
Ondrejov	940623 21:00–01:00 180 deg 4 –2 PG 1
Ondrejov	940623 21:00–01:00 180 deg 4 3 PG 6
Ondrejov	940624 21:00–01:00 180 deg 5 –1 PG 1
Ondrejov	940624 21:00–01:00 180 deg 4 3 PG 5
Ondrejov	940625 21:00–01:00 180 deg 4 3 PG 7
Ondrejov	940625 21:00–01:00 180 deg 7 2 PG 1
Ondrejov	940626 21:00–01:00 180 deg 4 –2 PG 1
Ondrejov	940626 21:00–01:00 180 deg 4 3 PG 7
Ondrejov	940627 21:00–01:00 180 deg 4 3 PG 3
Upice	940625 21:05–21:10 7.5 deg 12.5 5 PG
Upice	940625 21:17–21:22 7.5 deg 12.5 5 PG
Upice	940701 22:40–22:45 7.5 deg 13.5 6 PG
GRB940708 20:42 UT	
Sonneberg	940708 22:18–22:58 30 deg 12.5 5 PG 1 Te19 8787
Ondrejov	940707 22:01–00:52 180 deg 4 2 PG 1
Ondrejov	940708 23:05–02:13 180 deg 8 2 PG 1
Ondrejov	940708 23:04–02:13 180 deg 4 2 PG 3
GRB940717 20:23 UT	
Ondrejov	940716 20:49–01:23 180 deg 8 2 PG 1
Ondrejov	940716 20:40–01:16 180 deg 4 2 PG 3
Ondrejov	940717 21:30–01:26 180 deg 4 2 PG 1
Ondrejov	940720 20:37–01:28 180 deg 4 2 PG 5
GRB940806 09:33 UT	
Sonneberg	940806 21:51–22:12 10 deg 15.2 7 PG 1
Ondrejov	940805 20:12–23:07 180 deg 8 2 PG 1
Ondrejov	950805 23:14–02:01 180 deg 8 2 PG 1
Ondrejov	940805 21:22–23:58 180 deg 8 2 PG 1
Ondrejov	940806 00:10–03:00 180 deg 8 2 PG 1
Ondrejov	940806 20:39–02:02 180 deg 4 2 PG 2
Ondrejov	940807 21:15–02:05 180 deg 4 2 PG 3
GRB940808 14:49:24 UT	
Upice	940809 21:00–21:20 7.5 deg 15 7 PG 1
Upice	940809 21:30–21:50 7.5 deg 15 7 PG 1
Upice	940811 20:39–20:57 7.5 deg 15 7 PG 1
Upice	940811 21:40–22:01 7.5 deg 15 7 PG 1
Ondrejov	940807 21:15–02:06 180 deg 4 2 PG 3
Ondrejov	940809 19:59–23:01 180 deg 8 2 PG 1

Table 3. Continued

Ondrejov	940808	23:09–02:09	180	deg	8	2	PG	2
Ondrejov	940809	19:59–02:09	180	deg	4	2	PG	7
GRB940814 20:10 UT								
Ondrejov	940813	19:43–02:21	180	deg	4	2	PG	3
Ondrejov	940814	19:51–21:47	180	deg	8	2	PG	1
Ondrejov	940814	19:51–21:47	180	deg	4	2	PG	3
Ondrejov	940815	19:50–22:39	180	deg	8	2	PG	2
Ondrejov	940815	19:50–22:39	180	deg	4	2	PG	5
Ondrejov	940815	22:53–02:24	180	deg	8	2	PG	2
Ondrejov	940815	22:53–02:24	180	deg	4	2	PG	4
GRB940817 08:40 UT								
Ondrejov	940816	19:34–23:25	180	deg	4	2	PG	7
Ondrejov	940817	00:30–03:30	180	deg	4	2	PG	1
Ondrejov	940817	00:30–03:30	180	deg	8	2	PG	1
GRB940918 14:51 UT								
Ondrejov	940917	22:13–03:12	180	deg	4	2	PG	2
Ondrejov	940918	18:15–03:30	180	deg	4	2	PG	4
Ondrejov	940919	19:41–03:21	180	deg	4	2	PG	2
GRB940921 03:09 UT								
Ondrejov	940820	18:23–03:38	180	deg	4	2	PG	1
Ondrejov	940821	22:02–03:31	180	deg	4	2	PG	1
Ondrejov	940822	20:23–02:51	180	deg	4	2	PG	4
Ondrejov	940823	18:19–22:39	180	deg	8	2	PG	1
GRB941003 17:01 UT								
Ondrejov	940802	21:59–03:51	180	deg	4	2	PG	3
Ondrejov	940804	17:50–22:44	180	deg	8	2	PG	1
Ondrejov	940804	22:45–03:50	180	deg	8	2	PG	1
Ondrejov	940804	18:17–03:50	180	deg	4	2	PG	1
GRB941014 08:20 UT								
Ondrejov	941013	20:53–23:43	180	deg	8	2	PG	1
Ondrejov	941014	00:08–03:45	180	deg	8	2	PG	1
Ondrejov	941014	00:07–04:01	180	deg	4	2	PG	8
Ondrejov	941014	17:32–21:04	180	deg	8	2	PG	1
Ondrejov	941014	17:32–00:08	180	deg	4	2	PG	3
Ondrejov	941015	01:19–04:02	180	deg	8	2	PG	1
Ondrejov	941015	18:05–23:02	180	deg	8	2	PG	1
Ondrejov	941016	03:48 04:02	180	deg	8	2	PG	1
GRB941014 23:15 UT								
Ondrejov	941013	20:53–23:43	180	deg	8	2	PG	1
Ondrejov	941014	00:08–03:45	180	deg	8	2	PG	1
Ondrejov	941014	00:07–04:01	180	deg	4	2	PG	8
Ondrejov	941014	17:32–21:04	180	deg	8	2	PG	1
Ondrejov	941014	17:32–00:08	180	deg	4	2	PG	3
Ondrejov	941015	01:19–04:02	180	deg	8	2	PG	1

Table 3. Continued

Ondrejov	941015 18:05–23:02 180 deg 8 2 PG 1
Ondrejov	941016 03:48 04:02 180 deg 8 2 PG 1
Klet	941015 04:37–04:47 5 deg 15.5 8 PG 1
Klet	941015 04:51–04:59 5 deg 15.5 8 PG 1
GRB 941017 10:18 UT	
Ondrejov	941016 03:48–04:02 180 deg 8 2 PG 1
Ondrejov	941017 19:17–04:10 180 deg 4 2 PG 1
Ondrejov	941018 03:09–04:05 180 deg 8 2 PG 1
Ondrejov	941018 23:10–04:10 180 deg 8 2 PG 1
GRB 941023 12:15 UT	
Ondrejov	941025 17:45–19:49 180 deg 4 2 PG 4
Ondrejov	941025 21:09–00:09 180 deg 8 2 PG 1
Avren	941107 01:22–02:01 15 deg 13.0 5 PG 1
GRB 941114 02:02 UT	
Ondrejov	941114 02:03–03:45 180 deg 4 1 PG 1
Ondrejov	941122 19:14–22:51 180 deg 8 2 PG 1
GRB 941123 19:50 UT	
Ondrejov	941123 16:19–19:35 180 deg 4 2 PG 1
Ondrejov	941123 19:36–00:58 180 deg 4 2 PG 1
Ondrejov	941128 22:30–03:30 180 deg 8 2 PG 1
GRB 941127 14:30 UT	
Ondrejov	941128 20:02–01:35 180 deg 4 2 PG 2
Ondrejov	941128 22:30–03:30 180 deg 8 2 PG 1
GRB 950207 07:23 UT	
Ondrejov	950207 18:32–00:51 180 deg 4 2 PG 1
Ondrejov	950208 00:53–05:05 180 deg 4 2 PG 1
Ondrejov	950212 17:50–20:44 180 deg 8 2 PG 1
GRB 950211 02:24 UT	
Ondrejov	950211 21:13–01:03 180 deg 4 2 PG 1
Ondrejov	950211 20:34–03:58 180 deg 4 2 PG 2
Ondrejov	950212 17:50–20:44 180 deg 8 2 PG 1
GRB 950317 19:44 UT	
Ondrejov	950320 18:55–21:55 180 deg 8 2 PG 1
Ondrejov	950320 18:55–21:55 180 deg 4 2 PG 3
GRB 950325 17:36 UT	
Ondrejov	950328 18:50–22:50 180 deg 8 2 PG 1
Ondrejov	950328 18:50–22:50 180 deg 4 2 PG 5

It is evident that, typically, particular GRB triggers are covered by particular observing sites. This is related to weather, human and instrumental influences and strongly supports the operation of several observing sites simultaneously.

5 THE RESULTS AND THE EXPERIENCE

5.1 GRB Data Distribution

The experience with GRB data provided by BACODINE to sites connected to Internet is excellent. The typical time delays of recorded messages are from 1 to 10 min although longer delays may occur in the case of inhomogenities in the network. The incoming messages causes a beep signal to alert the observer.

There are, however, some losses caused by the absence of observers during rest, etc. Paging systems now available and covering major parts of the EON area seem to be a promising alternative.

5.2 Photographic Telescopes

Photographic telescopes usually provide deep imaging (up to 18 mag) over large FOV (up to 10 degrees). The evaluation of data obtained is however slow (photographic development processes included) and require special devices and procedures, such as blink comparators, etc.

5.3 CCD Cameras

The wide-field CCD cameras with FOV of order of 20 deg represent a promising alternative. A limiting magnitude of about 12 can be obtained very rapidly, within 10 s or so, but another gain with longer exposures can be obtained only depending on the darkness of the sky. Usually 13 or 14 mag can be obtained as a limiting magnitude in very good observing conditions for exposures of several minute durations.

Many following images can be recorded easily, displayed and analysed either by automated processing software or by computer blinking software. The analysis can be much more rapid as compared with photographic devices.

5.4 Search Strategy

Multiple-plate approach. We usually take multiple (at least four) exposures for each trigger to have confirmation for detected optical triggers as well as to have a good comparison basis to look for enhanced optical activity possibly related to a particular GRB phenomenon. Using this approach, we use a plate/frame taken (at least) several days after the GRB event with the same device and under the same conditions for comparison. We then use a blinkmicroscope plate comparator to look for new and variable objects. An analogous procedure is applied for CCD frames.

The background problem. Our experience indicates that it is rather typical to have more than one star-like emulsion defect and more than one variable star on the photographic plate (the typical FOV being about 8×8 deg and the typical limiting magnitude about 17). The following background sources are dominant.

(1) Emulsion defects. The experience obtained from previous photographic work indicates that there are about 10^{-3} to 10^{-4} star-like emulsion defects on typical photographic emulsion per mm^2 (Greiner *et al.*, 1987; Varady and Hudec, 1992; Hudec, 1993). Hence having a typical burstalert photographic plate with dimensions of 16×16 cm^2 (or even more in some cases), one can indeed expect more than one new star-like image on each of the plates whose exclusion and/or classification may be difficult or even impossible (Greiner *et al.*, 1987; Varady and Hudec, 1992; Hudec, 1993). This is why no final conclusion usually can be arrived at having only one photographic plate and why we take plates in couples to provide confirmation. The correct elimination of star-like emulsion defects is extremely important because these objects may have an occurrence analogous to those of real optical transients (confusing). Also the CCD detection technique is not absolutely free of additional false objects and requires analogous procedures, i.e. double or multiple exposures.

(2) Variable Stars. Another problem is the occurrence of new and variable stars (both known and unknown) on the images. Our experience is that it is rather common to detect more than one already known and more than one new variable star while comparing the burst alert plate with a plate taken usually 1 week later. This can be again very confusing because we (actually) are looking for fading optical counterparts to GRBs (and hence optically variable objects). On a pair of suitable plates reaching 18 m an experienced observer can (as a rough average) discover by blinking about one variable ≤ 17 m per one square deg near the milky way, and about 0.1 variable ≤ 17 m per one square deg in higher galactic latitudes (Hudec and Wenzel, 1995), the detection probability being of the order of 0.1 for good plates and a reasonable searching technique. Hence on a 8×8 deg plate one can expect to discover about six variable stars. This number will be correspondingly higher with fainter limiting magnitude and/or when blinking more than two plates. It is typical that some of these variables are previously known but some are real new discoveries. While for the rediscoveries the type of variable is usually known, the classification of newly detected variables must be carried out in order to establish the nature of the object, since we have to exclude the possibility that among them is the real (fading) optical counterpart of the GRB. This is usually possible by further studying the newly discovered variable star on archival or future exposures and by obtaining its spectrum. The ideal case is however that the corresponding GRB error box will be significantly reduced to check for more reliable positional coincidences.

Variable stars as a measure of the reliability of the searching method. It is evident that both known and as yet unknown variable stars are be found on deep wide-field astronomical plates taken within the project of GRB alert. Since the actual number of variable stars is well defined (Hoffmeister *et al.*, 1985), their discovery probability strongly depends on the quality of optical data and method used. It is obvious that the rate of recovered variable stars can be hence used as a reasonable measure confirming the suitability of the searching method used. We conclude that if no optically variable objects are found, then the method used is not suitable for discoveries of optical activity since variable stars have escaped notice. It is obvious that in the same way the real fading counterparts to GRBs could also be missed.

5.5 Other Influences

Currently we receive messages for all BACODINE triggers above 2000 BATSE counts. We have received 44 triggers between April 1, 1994 and April 1, 1995, for most of them however no rapid optical data (below 24 h) could be obtained due to the following reasons.

(1) The GRB position was unobservable, either on the southern hemisphere, i.e. below the horizon, or on day sky (position close to the Sun), see also Table 2.

(2) Weather conditions.

(3) Full Moon. Most of the devices involved have high speeds (f-ratios) and hence require dark skies. Optical observations with most devices are limited or even impossible during the time period within 5 days from the full Moon. More than 50% of the triggers have occurred during these periods in the time interval studied.

(4) Instrumental influences. There are periods during which some devices were down, e.g. due to maintenance services and/or repairs. Also, some of the devices were included after April 1, 1994: Ondřejov 20 deg FOV CCD camera on January 1, 1995, Egloffstein CCD camera on December 15, 1994, and Hradec Králové telescope on December 15, 1994. The Sonneberg telescopes have had only limited operation since January 1, 1995 due to the closure of the observatory. Rozhen, Sofia and Belogradchik observatories have suffered from limited response due to problems with receiving e-mail messages until March 15, 1995 (no Internet connection, BITNET connection problematic). The Rozhen and Sofia observatories will be connected to the Internet network during April 1995.

(5) Human influences. There may be substantial loses in time due to involving humans in the loops. This is why we have started to consider and develop an automated device (e.g. Hudec and Soldán, 1995; Soldán and Hudec, 1995).

(6) Positional problems. The first BACODINE position is a rough estimate and the final position may be outside even the mentioned 20 deg FOV area. This is why we, in the case of laborious and time-consuming plate evaluation, usually wait for final analysis until a final error box position and size are known. Recently, there has been a significant improvement in this direction. The Huntsville BATSE as well as preliminary IPN positions are distributed by the BACODINE team for the BACODINE triggers. Although delayed, this information is very helpful especially in the cases of very deep frames/plates whose detailed evaluation over the full area is laborious and time-consuming.

6 SUMMARY

Optical follow-up data have been collected and analysed for 25 GRB provided by BACODINE during the time period between April 1, 1994, and April 1, 1995. Deep follow-up data have been provided for eight GRB and only patrol data are available for 17 GRB triggers. The minimal delay is 0 min for patrol observations and 5h22m for alert observations. The deepest limiting magnitude for stars is 11 for patrol data and 17 for photographic data.

The ideal situation of a GRB above 2000 BATSE counts threshold occurring during the night with no clouds and no moon, and the position observable, is very rare. We have surely to wait for better statistics. Automatic devices would be useful although manual operation can provide some valuable information. A network of several observing sites is preferable to eliminate some additional influences and increase the chance for succesful follow-up observations. No OBVIOUS candidates have been found so far. The general question related to the mentioned activities is WHAT ARE WE LOOKING FOR? Candidates have been found which probably are unknown variable stars. The background of variable stars is large especially in the case of large error boxes and deep limits where typically one or more variable objects should be detected according to statistical expectations. Refined GRB positions may help a lot to avoid misinterpretations of real fading candidates as unknown variable stars. On the other hand, the detection of variable stars may be used as a measure for the efficiency of the searching and analysing procedures used.

Acknowledgements

The development and operation of the network is partially supported by a grant from the Grant Agency of the Czech Republic No. 205-93-0890 as well as by a grant from the Academy of Sciences of the Czech Republic No. 303103. The work of W. W. was supported by funds of the German Bundesministerium für Forschung und Technologie under contract No. 05-2S052A. The optical observations of the two COMPTEL triggers were carried out in collaboration with the NMSU group, B. McNamara and T. Harrison.

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