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Full auto optical afterglow searching system: MIKOTS(*)

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Summary. — Recently, to observe afterglow at various places has appeared necessary. To do so, we have set a fully automated afterglow searching system named MIKOTS. The aperture of our telescope, with a CCD camera, is 300 mm and the focal length is about 1000 mm. The CCD has 512×512 pixels size corresponding to a chip size of 10.2 mm $\times$10.2 mm. The field of view, resolution and lower limit magnitude are $37'.0 \times 37'.0$, $4''.12 \times 4''.12$ and 18.1, respectively. This system can start observation less than 15 seconds after receiving the data from GCN.

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1. – Introduction

To date, observation of afterglow from GRB is sprightly all over the world. Afterglow observation is important for GRB mechanism investigation. In particular, each GRB event has to be observed in optical wavelength from the ground. Thanks to the planetary coverage of optical robotic telescopes, we are able to collect the continuous data regardless the weather. One promising place without robotic telescope yet was the Kansai area in Japan. We have thus built and set a fully automated searching system located not in our campus but on the mountain behind Osaka city. The circuits in the astronomical have control on its sliding roof and southern wall. LINUX programs control the telescope, while the CCD camera data are recorded by Windows programs.

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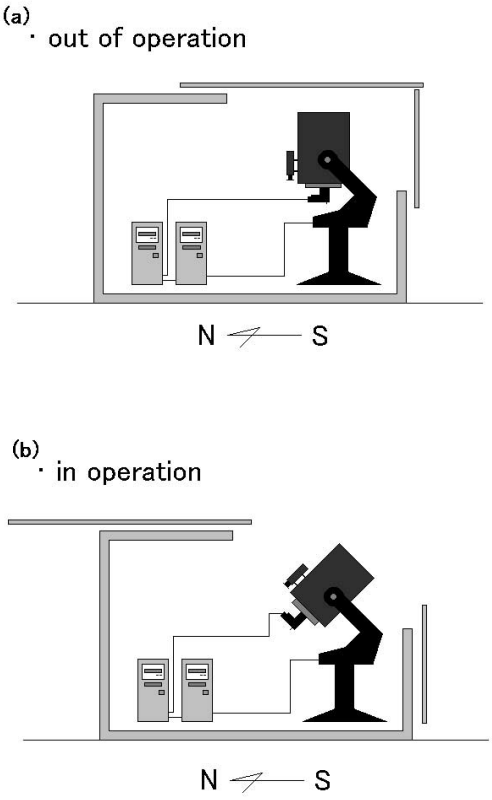

Fig. 1. – Observation box out of and in operation.

We call this system MIKOTS (Miyazaki Ikoma Optical Transient Seeker). MIKOTS is operated by the members of Miyazaki University, Osaka Sangyo University and Osaka City University.

2. – MIKOTS system

To observe optical afterglow automatically, two parts of MIKOTS (namely the telescope system and the observation box) are controlled mechanically. We describe these systems below.

2˙1. *The astronomical observation box.* – The roof on the hut is opened and closed by being one time or changing of weather. Out of operation time, the roof is closed and the telescope with CCD camera (controlled by a PC) is bound for zenith as shown in fig. 1 a. In operation time, the roof is opened and the telescope moves to the position of stand-by mode as shown in fig. 1 b.

The size of this hut is 227 cm ×172 cm ×186 cm high. The roof and the southern wall of the hut are able to freely slide with command signal. Positional data of the hut are indicated below (see table I). They are derived with a GHS watch [1] developed by 3 astronomers, using more than 5 GPS satellites.

TABLE I. – *Position of the astronomical box.*

Longitude (East)	135.657	degree
Latitude (North)	34.719	degree
Altitude	265.1	meter

Figure 2 shows the schedule of MIKOTS in winter season. The roof is controlled by a controller with a timer and rainfall sensors. The observation box usually opens its roof at 20:00 with fine weather and closes it at 5:00. During the night, the roof is closed in case of rain and opened again after the rain. Out of this time, the roof is never opened without manual operation. The time for sliding the roof on the hut takes about 4 seconds.

2˙2. *The telescope system.* – This system consists of the telescope and the CCD camera. The LINUX program named "telcon" controls the telescope and the Windows program named "ccdctrl" controls the CCD camera. We use an equatorial telescope. In operation time, when the LINUX PC receives the data of GRB position from GCN by an optical fiber network, the telescope that views the opposite direction from sun in stand-by mode is moved to GRB position by the command of "telcon" in less than 15 seconds. The afterglow data are analyzed by an automated program and we can derive the flux variations.

3. – Observational conditions

Small observatories with telescope of 300 mm in diameter are operated at Miyazaki in Kyusyu, at Okayama in western area and at Wako and Tokyo in Kanto area. The new site of MIKOTS is added in the Kansai area as shown in fig. 3. Once these 5 same observatories are co-operating, the GRB event is detected in Japan, whatever the weather is, in at least one telescope, and the variation of the flux can be estimated within the lower limit of the system. For MIKOTS, the observed minimum magnitude in case of thin clouds is 15.3.

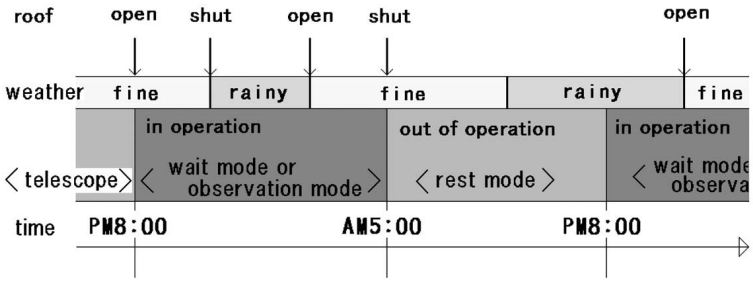

Fig. 2. – MIKOTS schedule in winter.

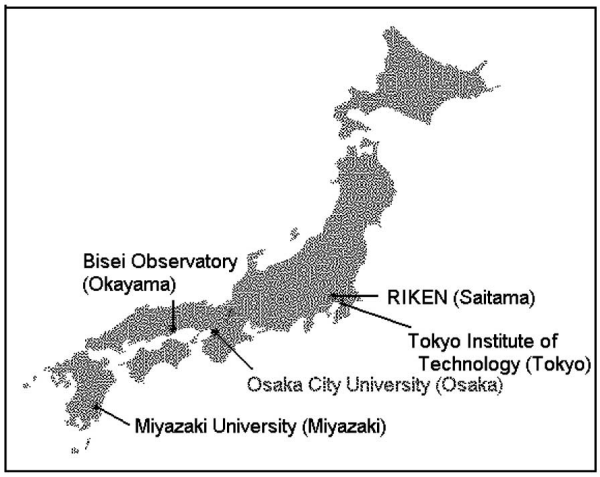

Fig. 3. – The distribution of the same size observatory in Japan.

4. – Conclusions

MIKOTS system which observe optical afterglow from GRB can carry out automatically measurement of the flux variation. The whole system is described as below. Field of view and the angular resolution for the telescope system are $37'.0 \times 37'.0$ and $4''.12 \times 4''.12$, respectively. The time for sliding the roof on the hut takes about 4 seconds. Telescope starts observation within 15 seconds after receiving the data from GCN. We expected the lower limited magnitude becomes 18.1.

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[1] http://uchukan.sendainet.jp/data/occult/gpsradio/micomghs.html.