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Proposal for the Observation of Gamma-Ray Bursts with the MAGIC Telescope

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Abstract

We present a detailed strategy for the observation of Gamma Ray Bursts (GRBs) for the first half year of 2005. Because of similarities, X-Ray Flashes (XRFs) and Soft Gamma Repeaters (SGR) are also included in our proposal. All observations will be mainly triggered by alerts from SWIFT. In addition, the HETE-2 and INTEGRAL satellites can contribute a small number of alerts. The SWIFT collaboration expects a total alert rate of about 15 per months – although with big uncertainties – out of which 1–2 should be observable due to our duty cycle. The overlap in sky converages between SWIFT and MAGIC seems to be favorable for MAGIC. As it is still unknown how many alerts SWIFT will deliver exactly, and how its sky coverage matches with the one of MAGIC, we cannot predict the alert frequency now to better than 100% uncertainty. This leads to an expected observation time of 5±5 hours per month. This number includes observation during the moon-time. We give a detailed description of the observation procedures in La Palma and propose to spend few dedicated nights to test the automatic alert procedure with the subsystem experts. We suggest to review the situation in half a year from now.

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1 Introduction

1.1 Observation of GRBs

The support structure and mirrors of the MAGIC telescope were designed to be exceptionally light in order to react quickly to GRB alerts from satellites. The aim was to turn the telescope toward the burst position within 30 s [1, 2], in order to have a fair chance to detect a burst when the prompt γ–emission is still ongoing. During the commissioning phase, it could be proven that the goal was achieved. The telescope is able to turn 180° in azimuth within 20 s and 90° in zenith within 10 s.

Very high energy (VHE) GRB observations have the potential to constrain the current GRB models on both the prompt and the extended phase of GRB emission [3, 4]. Models based on either internal or external shocks predict VHE gamma-ray fluences comparable to, or in certain situations stronger than, the keV-MeV radiation, with durations ranging from shorter than the keV-MeV burst to extended TeV afterglows [5, 6, 7, 8].

Possible causes range from proton-synchrotron emission [9] to photon-pion production [10, 11] and inverse-Compton scattering in the burst environment [12, 13, 6, 14, 15]. A long-term high energy (HE) γ-emission can come from accelerated protons in the forward-shock, as predicted in [16]. This model predicts GeV inverse Compton emission up to one day after the burst. Even considering pure electron-synchrotron radiation, measurable GeV-emission for a significant fraction of GRBs is predicted [14].

GeV-emission in GRBs is particularly sensitive to the Lorentz factor and the photon density of the emitting material – and thus to the distance of the radiating shock from the source – due to the $\gamma\gamma \rightarrow e^+e^-$ absorption in the emission region. Direct comparison of the prompt GRB flux at ~ 10 GeV and ~ 100 keV may allow to determine the magnetic field strength [17].

Several attempts were made in the past to observe GRBs in the GeV range, each indicating some excess over background but without stringent evidence. The only significant detections were performed by EGRET, that was able to observe seven GRBs emitting HE photons with energies between 100 MeV and 18 GeV [18, 19]. The data shows a HE spectral component presumably due to the ultra-relativistic acceleration of hadrons and producing a spectral index of -1 with no cut-off up to the TASC detector energy limit at 200 MeV [20, 21]. Recent results indicate that the spectrum of some GRBs contains a very hard, luminous, long-duration component [21]. There have been results suggesting gamma rays beyond the GeV range from the TIBET air shower array in coincidence with BATSE bursts [22], rapid follow-up observations by the Whipple Air Cherenkov Telescope [23], and coincident and monitoring studies by HEGRA-AIROBICC [24], Whipple [25] and the Milagro prototype Milagrito [26]. The GRAND array has reported some excess of observed muons during seven BATSE bursts [27].

To estimate the observability of GRB by MAGIC, sources of the third and fourth BATSE catalogue were studied [28, 29]. Their spectra were extended to GeV energies with a simple power-law and using the observed high-energy spectral index: the extrapolated fluxes were at last compared with MAGIC sensitivities. Setting conservative cuts on observation times and significances, and assuming an energy threshold of 15 GeV, a $5\,\sigma$-signal rate of $0.5-2$ per year was obtained for an assumed observation delay between 15 and 60 s and a BATSE trigger rate (~ 360/year). As the SWIFT alert rate is about a factor 2 lower, including even fainter bursts than those observed by MAGIC, this number still have to be lowered.

Taking into account the local rate of GRBs estimated in [30], late afterglow emission from a few tens of GRBs per year should be observable over the whole sky above our energy threshold. The model of [17] predicts delayed GeV-emission that should be significantly detectable by MAGIC in 100 s.

1.2 Observation of XRFs

While the major energy from the prompt GRBs is emitted in γ-rays with a peak energy of 200 keV, X-ray flashes (XRFs) are characterized by peak energies below 50 keV and a dominant X-ray fluence. Because of similar properties, a connection between XRFs and GRBs is suggested. Some theories [31] suggest that XRFs are produced from GRBs observed "off-axis". Alternatively, an increase of the baryon load within the fireball itself [32] or low efficiency shocks [33] could produce XRFs. If there is a connection between XRFs and GRBs, they should originate at rather low redshifts ($z < 0.6$) because otherwise, the XRF energies would not fit into the observed correlation between GRB peak energy and isotropic energy release [34].

1.3 Observation of SGRs

Soft Gamma Repeaters (SGRs) are believed to be extremely rare strong magnetic neutron stars that periodically emit γ-rays. Only four identified SGRs were discovered in the last 20 years: SGR0526-66, SGR1806-20, SGR1900+14, SGR1627-41. GRBs and SGRs can be explained within the same gamma jet model where the jet is observed at different beam-angles and different times [35].

The BAT instrument on the SWIFT satellite triggered on an outburst from SGR1806-20 on January 30$^{\text{th}}$, 2005. The fluence was about $10^{-5}\text{erg}\cdot\text{cm}^{-2}$ in the range between 15 and 350 keV. This event was five orders of magnitude smaller than the giant flare from this source on the December 27$^{\text{th}}$, 2004 [36]. MAGIC has enough sensitivity for observing events with fluences bigger than $2.5\times10^{-2}\text{erg}\cdot\text{cm}^{-2}\text{s}^{-1}$ at 100 keV, when a spectral index of -2.0 and 100 s of observation time are assumed. Therefore if an SGR as the giant flare of SGR1806-20 occurs, MAGIC would be able to detect its γ-ray emission.

Gamma-ray satellites react in the same way to XRFs, SGRs and GRBs. In case of a detection the coordinates are distributed to other observatories (see section 2.1). Only from later analysis the difference can be established. We include therefore the observation of XRFs and SGRs by MAGIC in our proposal.

2 The Burst Alarm System at La Palma

Current status:

The Burst Alarm System *gspot* (Gamma Sources Pointing Trigger) is installed and working in La Palma since last summer. It performs a full-time survey of the *GRB Coordinates Network* (GCN) alerts [37]. Different satellite experiments send GRB coordinates to the GCN which distributes the alerts to registered users. The Burst Alarm System is composed of a core program which manages the monitoring of the GCN and the communication with the Central Control (CC). It also handles three communication channels to notice the shifters about an alert. It is a C based daemon running 24 hours a day on the *www* machine, our external server, in a *stand alone* mode. It does not need to be operated and is fully automatic. It manages network disconnections within the external net and/or the internal one.

2.1 The Connection to the GCN

The connection to the GCN is performed by *gspot* through a TCP/IP connection to a computer at the Goddard Space Flight Center (GSFC). This computer distributes the alerts from the satellite experiments through an internet socket connection. *gspot* acts as a server while the client, running at the GSFC, manages the communication of the data concerning the GRBs and concerning the status of the connection.

The format of the data distributed through the GCN differ between the individual satellites and the kind of package. Currently three satellites participate in the GRB survey: HETE-2 [38], INTEGRAL [39] and SWIFT [40]. The alerts include the UTC, the GRB coordinates (not always), error on coordinates (not always) and intensity (photon counts) of the burst. The first notices from HETE-2 and INTEGRAL usually do not include the coordinates. In few cases only coordinates are distributed in refined notices. The SWIFT alerts are predicted to arrive with coordinates between 30-80 sec after the onset of the burst. The error on the coordinates from the BAT detector will be 4 arcmin which is smaller than the size of one inner pixel of the MAGIC camera.

In case of alert, *gspot* stores the informations and enters an **Alarm State**. The duration of the alarm depends on the following parameters:

- **Darkness of the sky**: The Sun has to be below the astronomical horizon or have a zenith angle larger than 108°.
- **Position of GRB**: The GRB equatorial coordinates are transformed into local horizontal coordinates. The resulting GRB zenith angle has to be smaller than 70°. If the Moon is shining, the maximal zenith angle is reduced to 65°.
- **Position of Moon**: The angular distance from the GRB to the Moon has to be at least 30°.

If one or more of these conditions fail, *gspot* enters into a **Yellow Alarm State** (it means the GRB is not observable at the moment). In this case the program saves the alert in a list and calculates when the GRB will become observable for MAGIC. In the moment when the criteria listed above will be fulfilled for this burst, and the time intervall after the burst onset is smaller than 5 hours, *gspot* enters into **Red Alarm State**. If all the mentioned conditions are satisfied from the beginning, *gspot* enters into Red Alarm State immediately. If more than one alert is recived and the burst can not be observed immediately, the alert information are saved in a list. The software is weightning the alerts in respect to the time when they will became observable, the delay after the onset and the strenght of the burst. The best candidate will be send to the CC when it will enter the Red Alarm state.

However, in both cases (**RED** or **YELLOW** Alarm State), *gspot* establishes the communication with the CC and sends the GRB equatorial coordinates (RA/DEC J2000). For the communication with CC the format defined in [41] is used. At the same time, the shifters and the GRB-MAGIC group are contacted.

2.2 The Interface to the Central Control

An interface of *gspot* sends all the relevant information to the CC. When *gspot* is not in alarm state, standard packages are continuously exchanged between CC and *gspot*. These packages contain the main global status of the two subsystems. In case of alert, *gspot* starts to send special alert packages to the CC, containing information about the GRB and the "color" of the alert. The exchange of the alert packages continues until:

- *gspot* receives from the CC the confirmation that the alert notice has been received. (The CC must send back the alert in order to perform a cross-check of the relevant data.)
- the alarm state expires after **5 hours**

The CC informs the shift crew about the alert and undertakes further steps only in case of a **red alerts**. In this case, a pop-up window appears with all the alert information received by the burst monitor. The operator has to confirm the notice by closing the pop-up window. He can decide whether to stop the current scheduled observation and to point the GRB. A new button will be displayed in the CC allowing to point the telescope to the GRB coordinates.

2.3 GRB Archive and Emails to the GRB-mailing List

In case of alert – even if it did not contain the necessary coordinates – the information is translated into "human language" and stored in ASCII files. At the same time, an e-mail is sent to the MAGIC GRB-mailing list *grb@mppmu.mpg.de*.

2.4 The GRB Web Page

The status of the GRB Alert System and relevant informations about the last alert are displayed on a separate web page. The page is hosted at the web server in La Palma and can be accessed under:

http://www.magic.iac.es/site/grbm/

The web page updates itself automatically every 10 seconds. In this way the status of the Burst Alarm System can be checked by the shifters and from outside.

2.5 The Acoustic Alert

A further CC-independent acoustic alarm called *phava* (PHonetic Alarm for Valued Alerts) will be installed in La Palma soon. It will provide a loud acoustic signal even if the CC is switched off, so that persons in the counting house can be noticed about the alert situation. The signal will be on as long as *gspot* remains in alarm state for a minimum of one minute. The device features also a display with the status of the system and the alert.

2.6 Summary of Alerts Received Until Now

Since July 15th, 2004, *gspot* has been working stably at La Palma. It received about 100 alerts from HETE-2 and INTEGRAL, out of which 21 contained GRB's coordinates. Time delays to the onset of the burst were of the order of several minutes to tens of minutes. The Burst Monitor can be considered stable since November 2004. Since then we have received the following two significant alerts:

19th	December	2004	1:44 am	INTEGRAL	Zd $\sim 60°$	time delay 71 sec.
28th	January	2005	5:36 am	HETE-2	Zd $\sim 65°$	time delay 73 min.

In both cases the weather conditions at La Palma were bad.

2.7 Experience from SWIFT GRBs until now

According to the SWIFT home page [40], the satellite has detected 16 GRBs since mid-December last year. The bursts were detected by chance during the commissioning phase. Since February 15th the satellite sends burst allerts to the GCN in real time. The current sample contains three bursts which could have been observed by MAGIC. The coordinates of the last burst from February 15th were send via an alert within few seconds. Also in this cases the weather conditions did not allow any observation.

19th	December	2004	1:42 am	Zd $\sim 65°$
26th	December	2004	8:34 pm	Zd $\sim 52°$
15th	Februar	2005	2:33 am	Zd $\sim 17°$

2.8 Comparison between the Satellite Orbits

Figure 1 shows the orbits of the SWIFT, HETE-2 and INTEGRAL satellites. The SWIFT and HETE-2 satellites are situated in a circular orbit with 20.6° and 2° inclination, respectively. One revolution of the SWIFT and HETE-2 satellites last about 100 min. The INTEGRAL satellite has a highly eccentric orbit with a revolution period of three sidereal days around the Earth.

It is difficult to draw strong conclusions from the individual satellites' orbits. The orientation of the satellites' FoV is influenced by the scheduled targets. However, SWIFT is the satellite with the largest inclination and overlaps mostly with the FoV of MAGIC. This increases the chance to receive **Red Alarms** from this satellite.

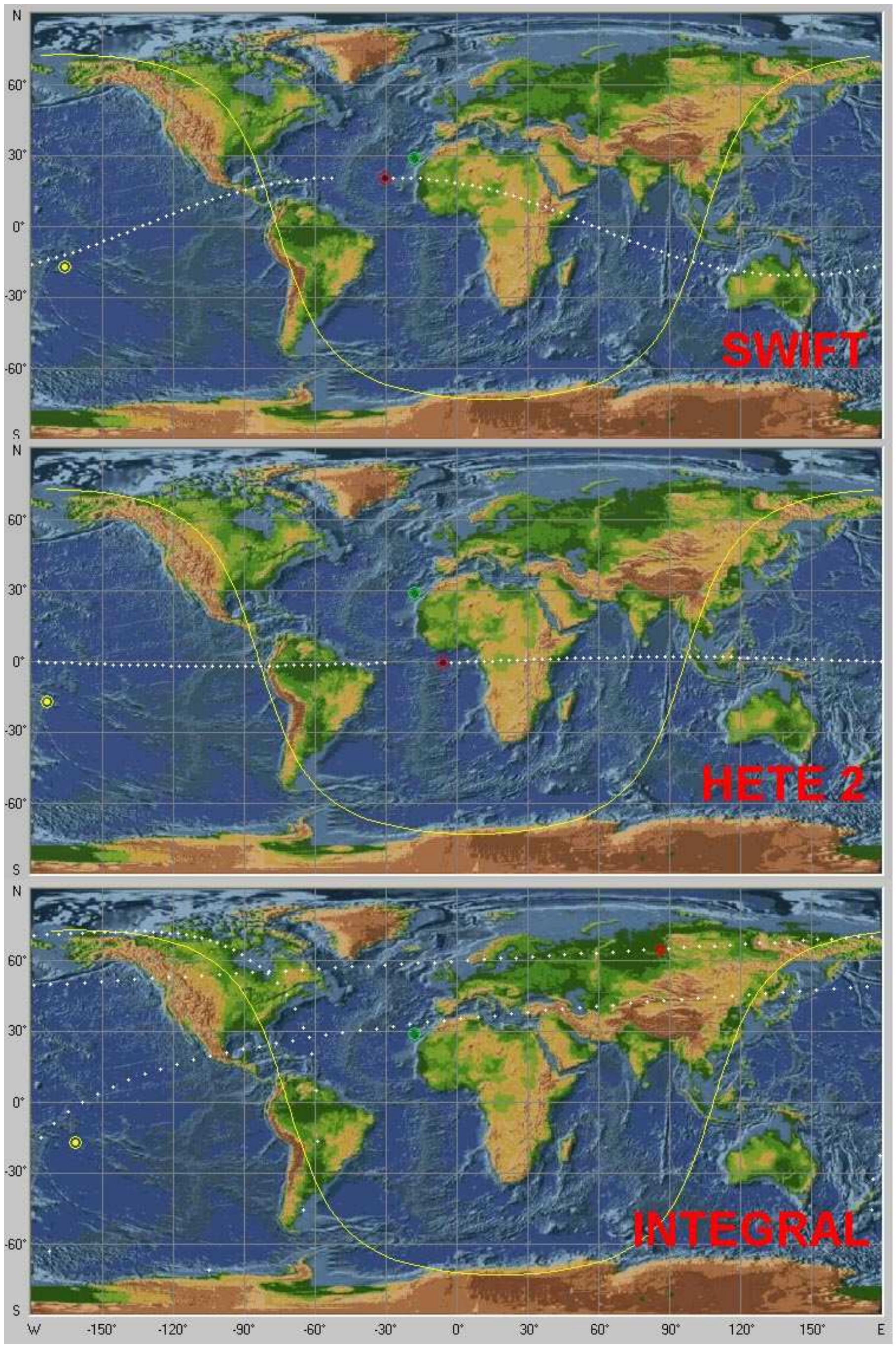

Figure 1: Orbits of the SWIFT (top), HETE-2 (center) and INTEGRAL (bottom) satellites: The pointed lines show the orbit while the drawn lines show the horizon of the Sun. Here, a typical night at La Palma is shown. The SWIFT satellite passes over the Roque seven times each night.

3 Proposed Observation Strategies

3.1 Estimation of the Required Observation Time

A rough estimate of the needed observation time for GRBs derives from the estimated number of GRB follow-up observations which can be expressed in the following formula:

$$N_{obs} = N_{alert} \cdot DC \cdot F_{overlap} \tag{1}$$

where N_{obs} is the mean number of observed bursts, N_{alert} the mean number of sent alerts, DC the duty cycle (including the reduction of sky coverage due to the maximum allowed zenith angle) and $F_{overlap}$ a reduction factor due to the non-overlapping sky coverage between the satellites and MAGIC.

The claimed GRB observation frequency $N_{obs}(SWIFT)$ is predicted to about 150-200 GRBs/year by the SWIFT collaboration [40]. We estimate DC from studies on the MAGIC duty-cycle made by Nicola Galante [29]. The duty-cycle studies are based on real weather data from the year 2002 taking the following criteria:

- maximum wind speeds of 10 m/s
- maximum humidity of 80%
- darkness at astronomical horizon

In these duty-cycle studies also full-moon nights were considered (requiring a minimum angular distance between the GRB and the Moon of 30°) yielding a total of 10%.

The duty-cycle in [29] will be increased by taking into account that MAGIC should also observe the afterglow emission of a burst that occurred up to 5 hours before the start of the shift. The afterglow observation is equivalent to an increase of the duty-cycle of about 6 days per month. However, taking off the full-moon time, we remain with the anticipated 10%.

The overlap factor $F_{overlap}$ is difficult to estimate since the SWIFT satellite will continuously slew to new sources or follow detected bursts. Figure 1 shows that the satellite will pass very precisely over La Palma during the night. Taking into account that it will not look towards the Sun, we expect that $F_{overlap}(SWIFT)$ will be at least 0.5 or higher.

In conclusion, we can calculate a worst case scenario with 150 SWIFT alerts per year and an overlap factor of 0.5 yielding $N_{obs}^{min} \sim 0.6$/month. An upper limit can be derived from 200 SWIFT alerts and a complete overlap with $F_{overlap}(SWIFT) = 1$ yielding $N_{obs}^{max} \sim 1.6$/month.

3.2 Determine the Maximum Zenith Angle

We determine the maximum zenith angle for GRB observations by requiring that the overwhelming majority of possible GRBs will have in principle an observable spectrum. Figure 2 shows the gamma-ray horizon (GRH) as computed in [42, 43]. The GRH is defined as the gamma-ray energy at which a fraction of 1/e of a hypothetical mono-energetic flux gets absorbed after travelling a distance, expressed in redshift z, from the source. One can see that at typical GRB distances of $z = 1$, all gamma-rays above 100 GeV get absorbed before they can reach the Earth.

Even the closest GRB with known redshift ever observed, GRB030329 [44], lies at a redshift of $z = 0.1685$. In this case γ-rays above 200 GeV get entirely absorbed.

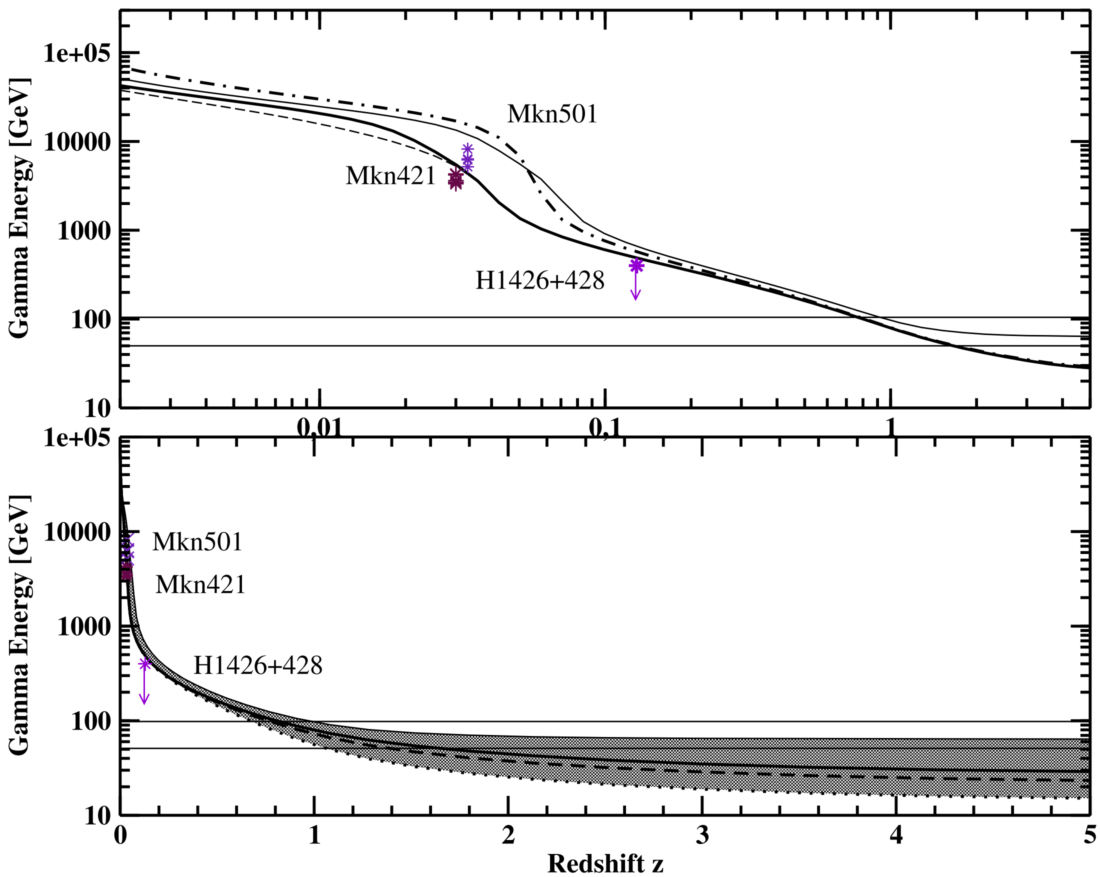

Figure 2: Gamma Ray Horizon as derived in [42]

We assume now a current energy threshold of 50 GeV for MAGIC at a zenith angle of $\theta = 0$[1]. According to [45], the energy threshold of a Cherenkov telescope scales with zenith angle like:

$$E_{thr}(\theta) = E_{thr}(0) \cdot (\cos\theta)^{-2.7} \tag{2}$$

Eq. 2 leads to an energy threshold of about 5.6 TeV at $\theta = 80^\circ$, 900 GeV at $\theta = 70^\circ$ and 500 GeV at $\theta = 65^\circ$. Inserting these results into the GRH (figure 2), one gets a maximal observable GRB distance of $z = 0.1$ at $\theta = 70^\circ$ and $z = 0.2$ at $\theta = 65^\circ$. We think that the probability for GRBs to occur at these distances is sufficiently small in order to neglect the very difficult observations beyond these limits.

3.3 GRB Observations in Case of Moon Shine

gspot allows only GRBs with an angular distance of $> 30^\circ$ from the Moon. Telescope slewing in case

[1] As this proposal is going to be reviewed in a couple of months, improvements of the energy threshold will be taken into account then.

of a GRB alert will be done without closing the camera lids, so that the camera could be flashed by the Moon during such movement. In principle, a fast Moon flash should not damage the PMTs, but the behaviour of the camera and the Camera Control *La Guagua* must be tested. On the other hand, if such tests conclude that it is not safe to get even a short flash from the Moon, the Steering System, while slewing, will have to follow a path around the Moon.

In December 2004, the shift in La Palma observed the Crab-Nebula even during half-moon. During the observation, the nominal HV could be maintained while the currents were kept below $2\,\mu$A. This means that only full-moon periods are not suitable for GRB-observations. We want to stress the fact that observations at moon-time increase the chances to catch GRBs by 80%. It is therefore mandatory that the shifters keep the camera in fully operational conditions with high-voltages switched on from the beginning of a half-moon night until the end. This includes periods where no other half-moon observations are scheduled. If no other data can be taken during those periods, the telescope should be pointed to a Southern direction, close to the Zenith. This increases the probability to overlap with the FoV of SWIFT.

In these conditions, because of higher background with moon-light, we suggest to decrease the maximum zenith angle from $\theta_{max} = 70°$ to $\theta_{max} = 65°$.

3.4 Active Mirror Control Behaviour

To reduce the time before the start of the observation, the use of the look-up tables (LUTs) is necessary. Once generated, the *AMC* will use the LUTs and automatically focus the panels for a given telescope position. The *CC* should send the burst coordinates to the *Drive* and the *AMC* software in the same time. In this way the panels could be focused already during the telescope movement.

3.5 Calibration

For ordinary source observation, the calibration is currently performed in the following way:

- At the beginning of the source observation, a dedicated pedestal run followed by a calibration run is taken.
- During the data runs, interlaced calibration events are taken at a rate of 50 Hz.

We would like to continue taking the interlaced calibration events when a GRB alert is launched, but leave out the pedestal and calibration run in order not to loose valuable time.

3.6 In case of Follow-up: Next Steps

We propose to analyze the GRB data at the following day in order to tell whether a follow-up observation during the next night is useful. We think that a limit of $3\,\sigma$ significance should be enough to start such a follow-up observation of the same place. This follow-up observation can then be used in two ways:

- In case of a repeated outbursts for a longer time period of direct observation.
- Or else, for having off-data at exactly the same sky location.

4 Timing considerations

The first experimental hint for delayed HE γ-ray emission from GRBs came from the detection of a 18 GeV photon from GRB940217 by the EGRET detector – 90 min. after the onset of the burst [18].

Different models predict prompt and delayed HE γ-ray emission. Most of them predict HE photons to be simultaneous with the keV-MeV burst, but also a delayed emission is possible. Our main goal should be to observe the GRB location as quickly as possible. However, in order to confirm or rule out different predictions, we should observe the position for a longer period of time.

Our time estimates are based on the following models:

- Regarding the fireball model [46, 47], two efficient mechanisms are available for the generation of HE photons (from sub-GeV to 100 TeV) [48]:

  1. The prompt emission of ∼100 GeV photons is expected before and during the keV-MeV peak. This emission should have their highest luminosity together with the main GRB peak.
  2. VHE photons generated due to inverse Compton (IC) scattering in relativistic shocks.

  With the presence of a dense ambient medium close to the GRB, the UHE photons will be reprocessed into a softer spectral range. This would lead to VHE emission delayed by few minutes to hours with respect to the beginning of GRB. The time-line including both processes is illustrated in figure 3.

- In [5], two peaks in the GeV light curve are calculated. The first is coincident with the keV-MeV peak, some seconds after the burst onset. The second maximum peaks between ≈ 1.5 hours up to ≈ 25 hours after the burst onset.

- Models in [16, 49] suggest GeV emission after pion production and some thermalization of the UHE component with radiation maxima of up to one day or even one week after the onset of the burst. This radiation is accompanied by long-term neutrino emission.

Based on the model in [48], three different components of VHE emission exists in an GRB. The corresponding components are illustrated in figure 3.

a. There is the prompt 100 GeV peak before and during the first keV-MeV peak,

b. the VHE emission due to Inverse Compton scattering lasting for the whole duration of the GRB pulse and

c. the reprocessed Inverse Compton emission which may last up to hours after the GRB onset.

(b) and (c) are the components which may be detectable by MAGIC and other ground based γ-ray detectors.

To achieve significant emission due to inverse Compton scattering of the sub-MeV radiation, a minimal magnetic field B_{min} is necessary:

$$B_{min} \sim \frac{5 \times 10^{-2}}{\Gamma^3} \frac{\epsilon_{2ph}}{1\,\mathrm{TeV}} \frac{t_{\mathrm{GRB}}}{10\,\mathrm{s}}\,\mathrm{G} \tag{3}$$

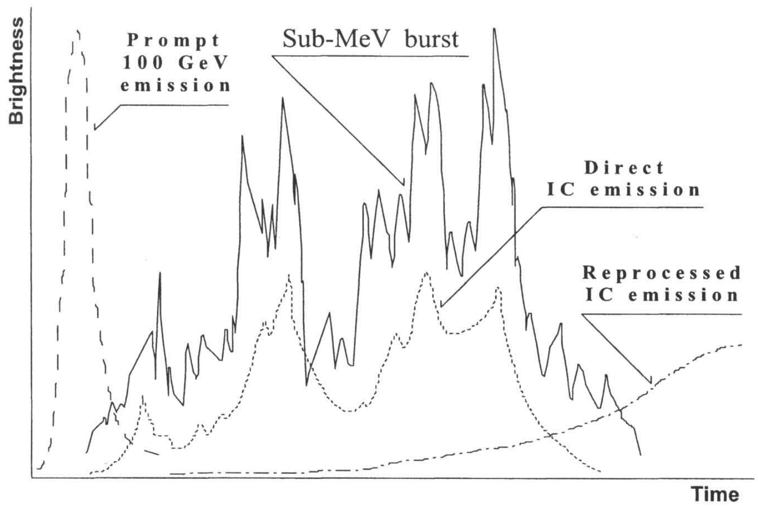

Figure 3: A possible example of GRB time-line as depicted in [48]

If the magnetic field is much stronger than B_{min}, the delay of reprocessed photons may become observable. Taking into account only the components of B orthogonal to the electron path, the delay can be calculated via the following asymptotic expression:

$$t_d \simeq \frac{2^{4/3}}{3}\left(\frac{B_\perp}{B_{min}}\right)^{2/3} \tag{4}$$

For typical values of the absorption threshold $\epsilon_{2ph} = 1\,TeV$, the duration time of GRB main pulse $t_{\mathrm{GRB}} = 10^2\,\mathrm{s}$ and Lorentz factor of the GRB shell $\Gamma = 10^2$, the duration of delayed VHE emission will be 0.8 hours for the component of magnetic field perpendicular to electron's trajectory $B_\perp = 0.1\,\mathrm{G}$, 3.6 hours for $B_\perp = 1.0\,\mathrm{G}$ and 17.3 hours for $B_\perp = 10\,\mathrm{G}$.

The observation of the delayed VHE emission and the time correlation will give informations about the density of the surrounding interstellar gas, the magnetic field and the Lorentz factor of the GRB shell.

It is not easy to determine a reasonable observation time of a GRB based on the described models. Every burst has its own characteristic and time profile. However, observation of the GRB coordinates for/within 5 hours after the alert may set constraints on model parameters of GRB sources.

In case of a **Red Alarm**, we propose to take data for **5 hours**.

In case of a Yellow Alarm, we propose to observe the source from the time when it will become observable until **5 hours** after the GRB beginning.

5 Requirements to start full GRB observations

In the previous sessions we described the status and tasks we still plan to do in order to complete the GRB Alarm System. At the same time, also the other different subsystems of the MAGIC telescope have to implement and test strategies for the GRB survey.

We strongly push the responsible persons of the Drive-, Camera-, AMC- and Central Control subsystems to fulfill the criteria defined in [1]. We suggest to make a one week shift where the experts meet and test the GRB strategies. In order to avoid good observation time we suggest to make the shift during a Moon period. This shift should take place, in arrangement with the different subsystem managers, before April this year. The time limitation is based on the moment when SWIFT will start to work fully automatically and send alerts in real time to the ground stations.

We present now a list of tasks which are crucial for the GRB survey:

- **Fast slewing:**

  One of the most important issues is to implement and test the fast slewing capability of the telescope. In particular, the communication between CC and Cosy has still to be implemented for the case of fast movements.

- **Use of look-up tables:**

  The use of look-up tables to correct the mirror focus during the slewing to the GRB coordinates is desirable. In the alert situation it is a waste of time if we would have to close the camera lids and carry out the full laser adjustment ($\sim$ 5 min) before starting the observation. The reproducibility of the focus with the use of look-up tables has to be proven. In case of using lookup-tables during the slewing, it is necessary to change the protocol between the AMC and CC.

- **Behaviour of the camera during Moon:**

  It has still to be checked what happens when the telescope points directly at the Moon while slewing toward a new position. The GRB Alert System prevents a burst closer than 30° from the Moon to be pointed. However, it can happen that during the movement of the telescope the Moon will enter the FoV. In this case the HV of the PMTs will be reduced automatically and will not increase fast enough for the GRB observation.

6 Tests

We believe that direct, fast GRBs in the MAGIC FOV are too valuable to allow for any technical or personal problems during the alert.

Therefore, we would like to make the following test:

1. A dedicated GRB test worked out in accordance with the shift crew where a fake GRB alert is sent to *gspot*. The shift should decide a night with good weather, but bad observation condition (e.g. due to clouds) for that case such that no real observation time gets lost.

2. Later, a blind test *without telling the shifters beforehand*. These tests are especially important to train the shift crew and make them aware of the importance of being available and reacting fast in such situations.

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