Search for Short Time Emission in the UHE Range above 20 TeV with the HEGRA Detector

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Abstract

It is presented an all sky search for short time emission (STE) in 1 to 10 minutes time windows above 20 TeV within the acceptance window of the wide angle air Čerenkov detector AIROBICC, which is part of the HEGRA experiment at La Palma. Data from March 1992 to March 1993 were analysed, corresponding to the first year of operation of AIROBICC.

1 Introduction

STE of gamma rays or cosmic rays is expected from a wide variety of objects at different scales of distances, covering from nearby Galactic objects as pulsars and supernovas to cosmological distances as quasars and primordial black holes (PBH). Specially interesting objects are the gamma ray bursts (GRB) whose origin remains unclear although the cosmological hypothesis is the most accepted scenario [1].

We chose a time scale of minutes because it is sensitive to most interesting violent features of these objects while keeping enough statistics to apply classical methods of search. A search with the same detector for STE from PBH (in a scale of seconds) and from GRB (reported by BATSE) can be found in [2]. We also report on several BATSE GRB recorded by AIROBICC in the period of time we analysed.

2 The detector

The data analysed in this paper were recorded at the HEGRA site, the mountain Roque de los Muchachos, at 2200 m a.s.l. in La Palma (Canary Islands, Spain) with AIROBICC. This detector is an array of 49 stations placed in a regular 30 m grid spacing covering about 33000 m^2. Each station consists of one photomultiplier tube viewing the sky and sampling the Čerenkov light

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disk produced by EAS. Its principle of operation is similar to that of classical scintillator arrays but recording the light disk instead of the particle disk. As the light disk is thinner than the particle disk, a higher resolution, about 0.3 degrees, is achieved but one has to pay the price of restricting the observation to clear moonless nights. Another advantage of AIROBICC is its low energy threshold, estimated to be of 20 TeV for vertical gamma initiated showers. Detailed descriptions of AIROBICC and the rest of the HEGRA complex can be found in [3] and [4].

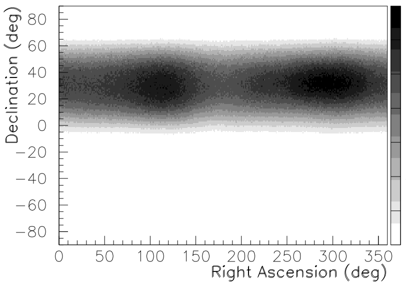

Figure 1: *Distribution of the showers recorded by AIROBICC in its first year of operation.*

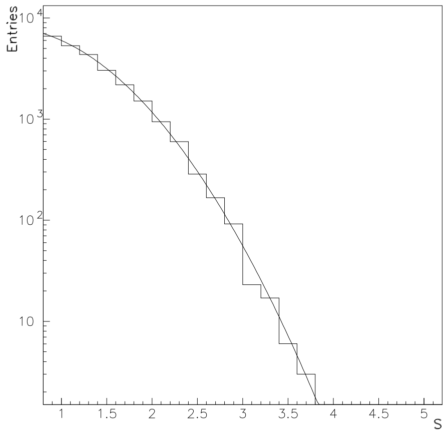

Figure 2: *Histogram of the significances found in a small part of the data in the 10 minutes time scale.*

The data were recorded during the first year of operation of AIROBICC (several improvements have been made since then), from March 1992 to March 1993. Due to the wide acceptance of AIROBICC, about 1 sr, a significant part of the sky was surveyed as showed in Fig. 1. About 40 millions showers were recorded and around 25 millions were usable for this work. The only selection cut applied is more than 6 stations fired, which results in a resolution of $\sigma_{63\%} \sim 0.6$ deg [4].

3 The analysis

The detection of a STE will be characterised by a concentration of a few events in a small angular window (which depends on the resolution of the detector) and in a reduced time period (depending on the physical mechanism of emission).

Hence the analysis consisted in the scan of the whole data set looking for

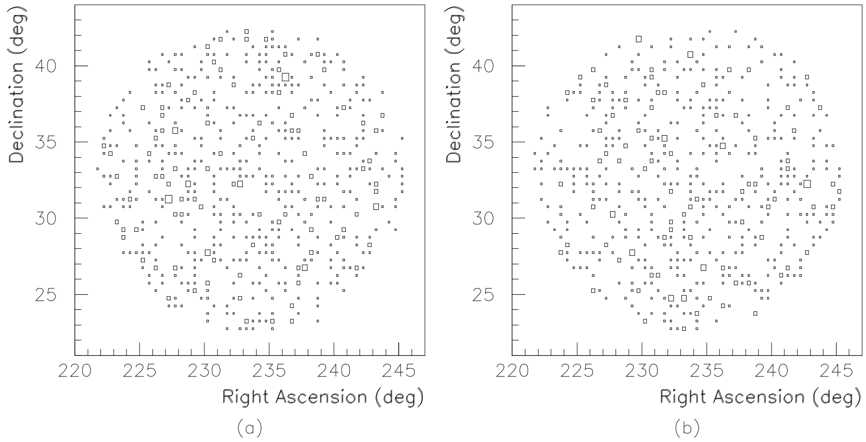

Figure 3: *Distribution of events around 10 deg in (a) previous 10 minutes and (b) next 10 minutes for GRB 920525B.*

transient excesses of events coming from a reduced part of the sky. Events are read sequentially and for every incoming event a window of 0.6 deg radius around the event (ON window) and a ring shaped window of inner radius 1.0 deg and outer radius 2.0 deg centred in the event (OFF window) are defined. These windows are held for around 10 minutes (the exact time interval depends on the trigger rate: a higher rate leads to a shorter time window because the buffer for the events is of fixed size) and all the events falling inside them in three different time windows, centred in the incoming event, of size 1, 4 and around 10 minutes, are counted. This procedure is similar to that of classical point sources search techniques ([6], [5], [7]). This analysis will provide us with a set of candidates to STE whose distribution of significances will tell us whether they are normal background fluctuations or not.

4 Conclusions and Outlook

Fig. 2 shows the excesses in the distribution of significances found in a small part of the data set, a Gaussian fit is also shown. The mean of this fit is 0.03 and the sigma is 0.9 which is in reasonable agreement with a randomly distributed background (Gaussian with mean = 0 and sigma = 1). Only half of the Gaussian is fitted because the search method is only sensitive to excesses (there is always 1 event inside the ON window).

The same analysis is being performed with data generated with Monte

Carlo (MC) techniques using the method explained in [6]. With this method data are obtained which have the same time distribution (dead times, etc.) and the same angular distribution (in local coordinates) but a random pattern in equatorial coordinates, so we are sure that there are neither sources nor STE at all in the generated sample. Results of the complete search and its comparison with the MC will be presented at the conference. It will also be presented a specific search over a few BATSE GRB that were coincident with AIROBICC data taking time.

Four BATSE GRB (GRB 920525B, GRB 921118, GRB 930103B, GRB 930123), a number corresponding to that fraction of sky and time viewed by AIROBICC with respect to that of BATSE, have been recorded with our detector with enough statistics. As an example Fig. 3 shows the event distribution around 10 deg for the (a) previous and (b) next 10 minutes for GRB 920525B. No evidence of GRB can be seen, only a finer analysis including gamma/hadron separation ([8], [7]) may reveal it.

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