OSSE LIMITS ON PRE- AND POST-BURST EMISSION

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Abstract. The existence of either pre- or post-burst emission can provide substantial new information about the burst source and its local environment. We have data from several events serendipitously in or near the OSSE field of view at the time of the burst. We present pre- and post-burst flux limits from one such event, GRB 940301. The OSSE data for other periods when scheduled observations have included burst locations will enable us to search for pre- and post- burst emission on many time scales.

Key words: Gamma-ray bursts – Counterparts

1. Introduction

There is evidence in Ginga observations for both pre- and post-burst soft X-ray emission in a number of gamma-ray bursts [9, 8]. EGRET has also shown evidence of significant delayed (up to $\sim$ 90 min) high-energy emission from gamma-ray bursts [4]. This indicates that particle acceleration or energy release is not strictly confined to the main impulsive burst.

Observation of any emission outside of the main burst can severely constrain burst models. Delayed hard X-ray/low-energy gamma-ray emission could be produced by annihilation of e^+e^- pairs; decay of radioactive nuclei [2]; deuterium formation (giving a 2.2 MeV line); cooling emission from a neutron star (NS) [1], NS remnants, or surrounding material; aftershocks in a NS; or continued shock acceleration [7].

2. OSSE Instrument

The OSSE instrument [5] on GRO consists of 4 large ($\sim$ 500 cm^2 area each) cylindrical NaI/CsI phoswich detectors, each surrounded by an active NaI shield. Tungsten collimators limit the field of view (FOV) of the detectors to $3.8° \times 11.4°$ (FWHM). The detectors can be rotated through 192° about an axis which is parallel to the long direction of the collimator. The usual observation mode is to alternate source and background pointings with each detector every 2 minutes. The normal spectral energy range of the OSSE detectors is 50 keV to 10 MeV.

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3. OSSE Observations of GRB 940301

The intense burst GRB 940301 (BATSE trigger 2855) occurred at 72637 SOD and was seen by the OSSE central detectors. The COMPTEL source position, distributed shortly after the event, was within the OSSE FOV for the observation of QSO 0716+714 which had started 5 hr earlier. The COMPTEL position was 7.5° off the OSSE scan plane. COMPTEL and OSSE observations of this burst have been described elsewhere [6, 3].

Figure 1 shows the 3 fields of view covered by each of the 4 OSSE detectors during the observation of GRB 940301. The dashed line represents the scan plane and the numbers from 0 to 3 indicate the sequence of the pointings (2-min per position, repeated throughout the observation). The middle position is the source observation and the outer two pointings are background measurements. For 13 hr (from trigger +4.5 hr to +17.5 hr) the middle position of the sequence was shifted slightly to give better response to GRB 940301. At the nominal source position OSSE has 16% of its center of FOV sensitivity (29% for 13 hr). The burst location was observed by OSSE from trigger −4.9 hr to trigger +7 days.

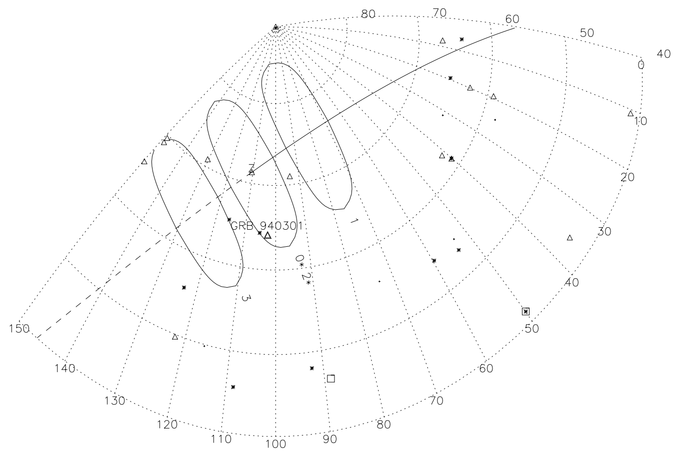

Fig. 1. The observation pointing strategy for GRB 940301. Coordinates are RA and Dec, in degrees.

Figure 2 shows two representative OSSE time histories for GRB 940301 at different time scales, in two different energy ranges. The top plot shows the background-subtracted flux from 50 to 120 keV with 2-min resolution. The lower plot covers 400 to 600 keV, integrated over orbits. No significant

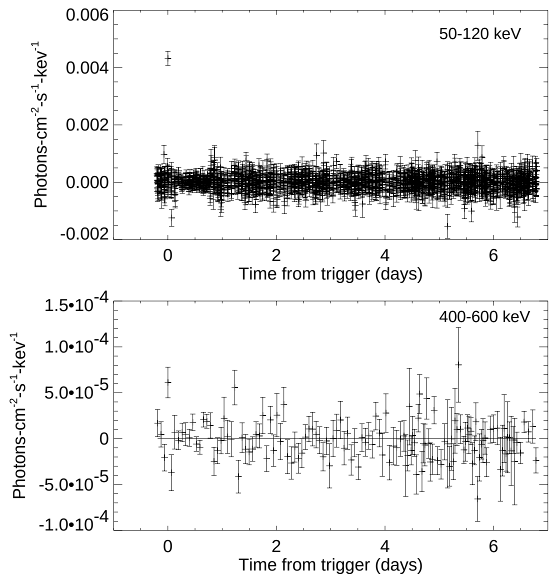

Fig. 2. Background subtracted time histories for flux from the position of GRB 940301.

TABLE I

GRB 940301: Limits as a fraction of burst flux

Energy Range (MeV)	Averaged GRB Flux (2-min) (γ/cm^2/s/MeV)	(3σ Upper limits)/(GRB flux) Pre-GRB (5 hrs)	Post-GRB (90 min)	Post-GRB (7 days)
0.05–0.12	4.3 ± 0.3	0.03	0.05	0.004
0.12–0.25	2.3 ± 0.1	0.02	0.04	0.004
0.25–0.40	0.87 ± 0.07	0.04	0.08	0.007
0.40–0.60	0.51 ± 0.06	0.05	0.10	0.008
0.60–1.5	0.11 ± 0.02	0.12	0.3	0.02

positive flux is seen at any point except at the time of the burst. Similar plots can be generated for any energy between 50 keV and 10 MeV.

Figure 3 shows the 3σ upper limits derived for *average* flux from the nominal position of GRB 940301 (RA: 102.43, Dec: 63.92), integrated over three time scales: 5 hours before the burst, the 90 min (1 orbit) immediately following the burst, and 7 days after the burst. Also shown is the flux from the burst itself, averaged over the 2-min spectral accumulation time. The errors

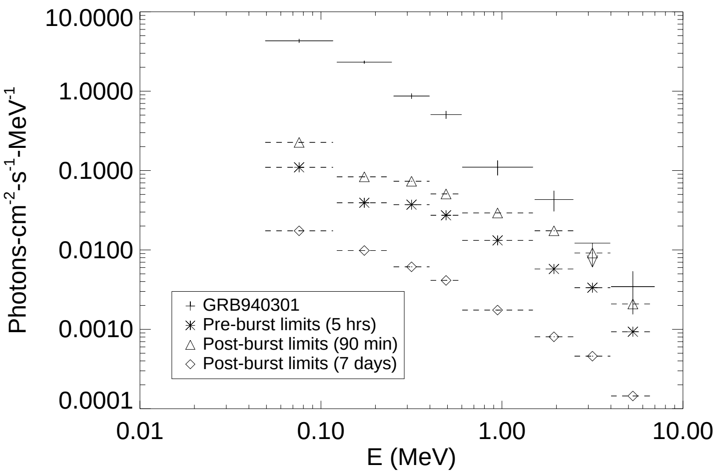

Fig. 3. Upper limits (3σ) on the *average* flux from GRB 940301 both before and after the event, compared with the OSSE measured burst spectrum.

shown are only statistical. There is additional uncertainty in the fluxes and limits since these depend on the position assumed for the source. However, the upper limits as a fraction of the burst flux (Table I) are relatively insensitive to the precise source location.

4. Conclusions

OSSE has observed a number of gamma-ray bursts in or near our field of view. For the strong burst on 94/03/01 we have derived limits on emission from the source location both before and after the event, in absolute units and as a fraction of the burst flux. There are many other cases where scheduled OSSE observations have serendipitously included burst locations. These data will enable us to search for emission from burst sources from minutes to years before and after the events.

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