COMPTEL OBSERVATIONS OF GAMMA-RAY FLARES IN OCTOBER 1991

M. Varendorff, D. Forrest, M. McConnell, J. Ryan, R. Suleiman
University of New Hampshire, Institute for the Study of Earth, Oceans and Space,
Durham NH 03824, USA

R. Diehl, G. Lichti, G. Rank, V. Schönfelder
Max-Planck Institut für extraterrestrische Physik, D-8046 Garching, FRG

K. Bennett, L. Hanlon, C. Winkler
Astrophysics Division, Space Science Department of ESA, ESTEC
2200 AG Noordwijk, The Netherlands

B.N. Swanenburg
SRON-Leiden, P.B. 9504, NL-2300 RA Leiden, The Netherlands

ABSTRACT

The COMPTEL experiment on GRO images $0.75 - 30$ MeV celestial gamma–radiation that falls within its 1 steradian field of view. During observation 12 (primary target Cen A) in October 1991 the sun had been in the fov and several solar flares associated with the active region 6891 had been observed. Time profile and energy spectra had been produced, using COMPTEL's primary mode of operation (the telescope mode). Additionally the number of counts received in the D2-single burst detector (the secondary mode of operation) are given. We summarize the preliminary results on all of these flares.

INTRODUCTION

The imaging Compton Telescope, COMPTEL, onboard NASA's Compton Gamma Ray Observatory is a powerful tool for studying both the photon and neutron emission from energetic solar flares[1,2]. Since shortly after its launch in April 1991, COMPTEL has observed a number of solar flares, including the flares on June 9, 11 and 15, 1991[3,4].

In COMPTEL's imaging telescope or double scatter' mode ($0.75 - 30$ MeV), it measures both positions and spectra of cosmic γ-ray sources that fall within its 1 steradian field of view. A pulse shape discrimination and time of flight measurement allows the separation between γ-rays and neutrons. In addition, in burst or 'single detector' mode COMPTEL accumulates independent $0.1 - 1.1$ MeV and $1 - 10$ MeV spectra in two of its lower NaI detectors.

In COMPTEL's 'double scatter' mode, a photon which Compton–scatters in one of the seven upper D1 detectors, is then detected in one of the lower fourteen high–Z D2 detectors. In the simplest case of a single Compton scatter in D1 and complete absorption in D2, the possible γ-ray source positions lie on a circle of radius $\bar{\varphi}$ around the direction of the scattered photon, with

$$\cos\bar{\varphi} = 1 - \frac{1}{\epsilon_2} + \frac{1}{\epsilon_1 + \epsilon_2}, \qquad (1)$$

where ϵ_1 and ϵ_2 are the energy deposits measured in the upper (D1) and lower (D2) detectors, respectively (in units of the electron rest–mass). In the case of solar flares,

the position of the source is known and the location information is used for event selection to suppress the background. This also allows us to compile a spectrum, where events from the sun with only partly absorption in the lower D2-detector are suppressed, leading to a nearly diagonal response.

A descritption of the 'single mode' together with a catalog of spectra obtained from solar flares can be found in these proceedings[5].

DATA and ANALYSIS

In October 1991 the sun was in a very active phase and produced several X-class flares. Comptel registered 9 solar flares in its 'single mode' in October 1991. During observation period 12 from October 17 to 31, 1991, the sun was in the field of view of the telescope. The instrument was pointed towards the Cen-A region on the sky. BATSE registered several hundred solar flares during this time. For the stronger ones we produced time profiles of the COMPTEL data. We used the flare onset time and duration measured by BATSE, to select an appropriate time window. Only telescope events which satisfy the optimum event selection criteria, and which were consistent with the solar position, were used.

If the time profile showed evidence for the presence of a flare signal, an image was produced, to verify, that the signal is coming from the direction of the sun.

RESULTS

In Figure 1 we display the raw time profiles (not yet deadtime corrected) of 5 solar flares.

Two of the flares, 24.10.91 2:36:21 and 27.10.91 5:36:23, were so intense, that the instrument showed severe deadtime effects up to 90%. For the flare on 24.10.91 16:53:22s the instrument was shut off shortly after the onset of the flare because of a SAA passage. The flare on 30.10.91 6:16:18 occured just ~200 seconds after the SAA pass of the satellite. In figure 2 we show the energy loss spectra of two solar flares. For information on the background in the energy histograms, the measured countrate 15 orbits earlier and 15 orbits later is given. These orbits can be used as a good first estimate of the background count rate. For the flare of 27.10.91 5:39:35s the real background will be lower, because of the mentioned deadtime effect.

Table 1. Summary of the observed solar flares

Flare (date)	onset time (UT)	class	duration (s)	telescope src/bkg
24.10.	2:37:10	X2.1	110	181/ 5
24.10.	16:54:15	M3.2	25	74/ 35
27.10.	2: 7:30	X1.9	140	610/ 65
27.10.	5:39:35	X6.1	375	614/ 50
30.10.	6:16:18	X6.1	1650	1357/ 600

We summarize our results in Table 1. For each flare the onset time and duration of the impulsive phase in the energy range from 0.72 to 30 MeV is given. Furthermore the total number of counts and the estimated number of background counts in the 'telescope mode' during the impulsive phase of the flares are given. A

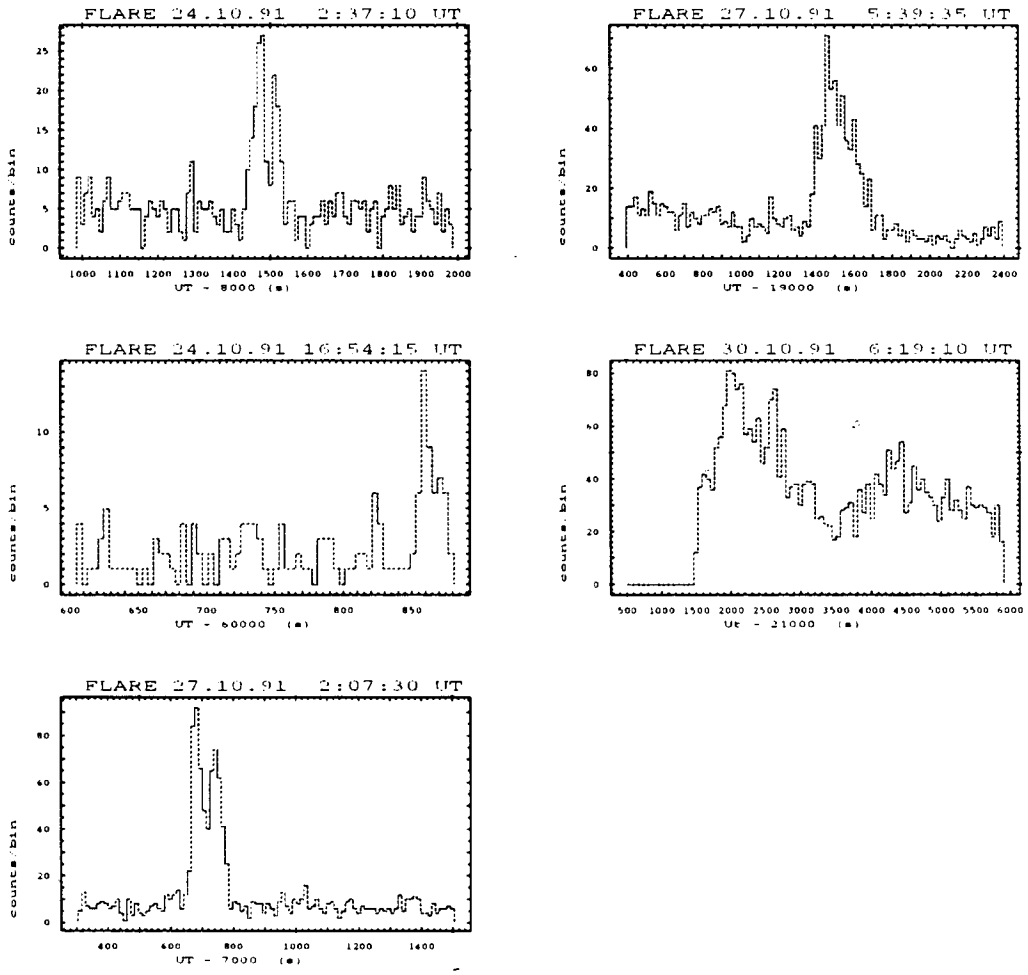

Figure 1. Time profiles of solar flares detected in COMPTEL telescope mode.

more detailed study of the background is still in progress. This should allow us to better define the extent of the γ-ray emission.

SUMMARY

This paper reports on the preliminary results of the analysis of 10 solar flares during an observation in Ocotber 1991. For the time profiles and spectra only data from COMPTEL's telescope mode were used. The total number of counts from solar flares using the single detector mode are given as well. Results from spectral studies and analysis from neutrons from solar flares in June 1991 and a catalog of preliminary spectra and countrates from the single detector mode data can be found in these proceedings.

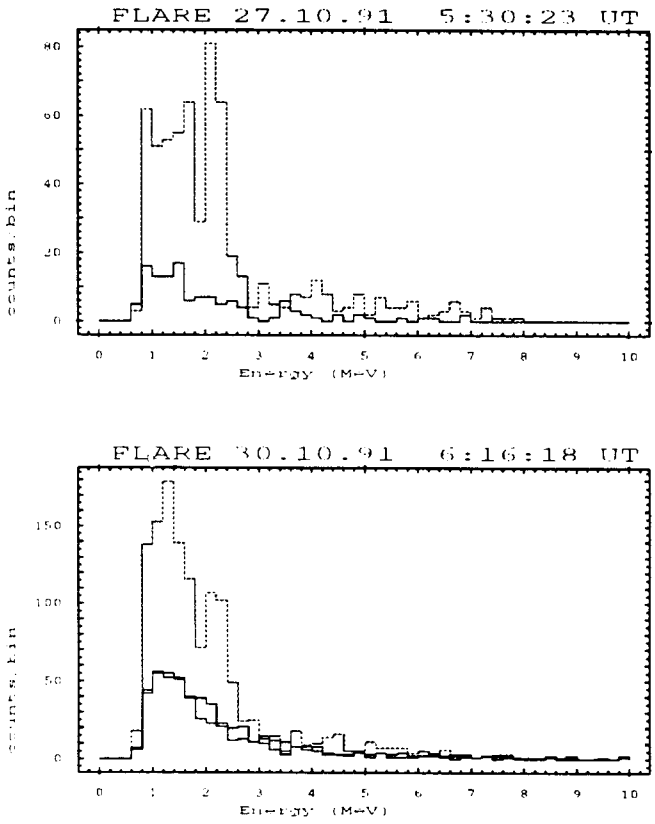

Figure 2. Energy loss spectra of solar flares with background spectrum overlayed.

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