THE ABILITY OF COS-B TO MEASURE
GAMMA-RAY BURSTS*

G. BOELLA, M. GORISSE, and J. PAUL,
B. G. TAYLOR, and R. D. WILLS

THE CARAVANE COLLABORATION

Istituto di Scienze Fisiche dell'Università di Milano, Italy
Service d'Electronique Physique, Centre d'Etudes Nucléaires de Saclay, France
Space Science Dept., ESTEC, Noordwijk, The Netherlands
Cosmic Ray Working Group, Huygens Laboratory, Leiden, The Netherlands
Max Planck Institut für Extraterrestrische Physik, Garching, Germany
Institute Fisica, Università di Palermo, Italy

(Received 20 August, 1975)

Abstract. The COS-B satellite for gamma-ray astronomy, launched on 7 August, 1975, features as part
of the main instrument a 1.1 m², 10 mm thick, plastic scintillator for the vetoing of charged particle
events. This detector which has an average effective area of 360 cm² for gamma rays in the interval
0.1 to 1 MeV has been instrumented to detect and record the temporal structure of cosmic gamma
ray bursts.

The instrument will be sensitive to gamma bursts down to 3% of the typical intensities measured by
the Vela satellite system. The best time resolution achievable is 1.6 ms.

The satellite will be placed in a 100 000 km eccentric orbit and with absolute timing accuracies of
fractions of a millisecond achievable, a long base line is available for the triangulation of the source
position, given comparable data from other satellites.

1. Introduction

The observation of gamma-ray bursts of cosmic origin was first reported by Klebesadel
et al. (1973). More than 20 short bursts of photons in the energy range 0.1–1.5 MeV
have been detected in the data records of the Vela satellites from August 1967 to
June 1973. The burst durations range from less than 0.1 s to some 30 s with time in-
tegrated flux densities in the region of $10^{-4}$ to $10^{-5}$ erg cm$^{-2}$ in this energy interval.
Searches of the data experiments have revealed the detection of some events correlated
with Vela measurements.

The bursts observed so far exhibit a wide variety of temporal behaviours, often
with two main pulses in a single event and often with statistically significant fine
structure at or possibly below the 16 ms resolution of the Vela detector system.

According to Strong et al. (1974), the source locations of nine of the gamma bursts
have been determined from a knowledge of the onset time of the bursts measured at

* Paper presented at the COSPAR Symposium on Fast Transients in X- and Gamma-Rays, held at

Astrophysics and Space Science 42 (1976) 103–110. All Rights Reserved
Copyright © 1976 by D. Reidel Publishing Company, Dordrecht-Holland
each satellite, but with an accuracy of only several degrees. Three locations have been
determined unambiguously and six have been assigned a pair of directions, one being
the true direction and the other its mirror image in the orbital plane of the satellites.
Given these poor statistics, there appears to be no strong correlation with galactic
features and, combined with a three-halves power law test of the signal strengths, it
is concluded that the sources are distributed more or less uniformly throughout the
sampled volume.

The energy spectra of six of the bursts have been determined from IMP-6 data by
Cline et al. (1973). The pulse spectra can be represented by exponentials in the energy
range observed with characteristic energies near 150 keV. The pulse spectra appear to
be superimposed on a softer, slower decaying component with a characteristic ex-
ponent of the order 75 keV. One event, 14 May, 1972, was observed down to 10 keV
by instruments on OSO-7 as reported by Wheaton et al. (1973). Until now there has
been no correlation with transient phenomena observed by ground-based optical or
radio astronomers.

A review of the observational data to mid-1974 has been made by Strong (1974).
Many theories have been put forward, but are not reviewed here. Clearly, before
the suggested theories can be adequately tested, more observational data are required,
including:

(i) source location, unambiguously, to a precision much better than one degree
initially, but to arc seconds if correlations with radio and optical observations are
to be attempted,
(ii) temporal structure to the highest resolution throughout the duration of the
burst,
(iii) energy spectra, over as wide a range as possible, sampled as rapidly as possible
to relate spectra and temporal structure,
(iv) size spectrum.

Obviously these data can be obtained with a major effort in the production and
operation of new specialized instruments, but with the attendant time scale and cost
implications. However, at short notice the COS-B experiment has been instrumented
to give information in the period 1975–1978 on source locations (given other observa-
tions for burst confirmation and triangulation) and temporal structure. The COS-B
orbit is highly eccentric with an apogee height of 100 000 km, providing a large baseline
between COS-B and other instruments. A timing accuracy of better than 1 ms can
be achieved.

2. Gamma-Burst Detection

The COS-B experiment described by Bignami et al. (1974) features a dome-shaped,
$1.1 \text{ m}^2 \times 10 \text{ mm}$ thick plastic scintillator (SPF) viewed by nine photomultipliers for
the rejection of charged particles, referred to as the anticoincidence counter or ACO
(Figure 1).