MASSACHUSETTS INSTITUTE OF TECHNOLOGY

LINCOLN LABORATORY



**Final Technical Report**

**for**

**NASA Contract NAGW-1168**
**Observations of Optical Counterparts of Gamma-ray Bursts**
**(Lincoln Laboratory Program 624)**

**sponsored by**

**Code EZ, Astrophysics Division**
**NASA Headquarters**
**600 Independence Ave.**
**Washington, DC 20546**

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# 1. Introduction

This is a final report for a contract begun in December, 1987 and ended in March, 1989 to use the existing Lincoln Laboratory Experimental Test Site in Socorro, NM to search for optical counterparts to gamma-ray bursts. The objective was to develop an autonomous staring system to search for stationary, transient optical flashes. The search was to use an existing 31-inch telescope equipped with a sensitive video detector. The approach for the search was to develop real-time processing software to monitor the video signal from the detector and to record any transient, point-like flashes that occurred in the field of view. The system would have been able to detect fainter flashes ($B \approx 15^m$ in $\frac{1}{30}$ s, $\Delta m_v = 0.25^m$) than other systems but lacked a large field of view (only 1.2° diameter) necessary to give a high probability of detecting a random flash on the sky. As such, the plan was to monitor known gamma-ray burst error boxes and wait for a repetition of an earlier event. The high payoff of good sensitivity with high angular resolution (1 pixel = 10″ and good time resolution ($\frac{1}{30}$ s) to allow post-burst searches warranted funding if the cost was not prohibitive. The contract was for about $75,000 for the first year of a proposed three-year effort. The contract began in the middle of the three-year cycle for High Energy Astrophysics Gamma-Ray Astronomy Research and Analysis Program. A proposal submitted in response to NASA Research Announcement 89-OSSA-4 to continue the effort was rejected. This final report briefly describes the portion of the plan completed under the original contract.

## 2. Review of Work Performed

In the first 15 months of the original contract (1987 December - 1989 March), the efforts were in the following areas.

### 2.1 Selecting the optimum hardware

Initially, there were three hardware options. The original plan of using an existing image processor (Vicom) was compromised by poor support and hardware problems. Consequently, we considered using a pair of identical image processing systems (RCI) purchased (not under this contract) during 1988 for data analysis at Lincoln laboratory and data acquisition at the ETS. These appeared well-suited for the search but were to be allocated for other programs. Lastly, new VME-based image processors were available commercially but were barely adequate and required new purchases. It was the VME-based option that seemed our best choice. However, we were made aware, in 1988 November, that the new RCI image processor hardware was no longer to be allocated completely to other programs. At that point, we chose the RCI image processors as the search hardware.

### 2.2 Data characterization

Using temporary, slow hardware and test data on video tape, we studied existing data to learn its characteristics, e.g., temporal jitter, scintillation duration and amplitude, sensitivity, gain linearity, and detector saturation limits.

### 2.3 Refining the search algorithm and partitioning the algorithm tasks

When the specific hardware was defined, we began tests on its components to determine how portions of the algorithm would run, e.g., the real-time search through pixels or the master control program. Timing was the most critical parameter, so we tested hardware to be sure that there would be a reasonable duty cycle.

## 3. Summary

The work described above was performed under contract to NASA between December, 1987 and March, 1989 and was to form the basis of a real-time processing system to detect and characterize optical flashes occurring inside known gamma-ray burst error boxes. The software was partially complete when the contract ended, and no observations occurred.

At the point the contract ended, we were confident that the ETS telescopes and data processing hardware were adequate for the search. The remainder of the contract was to be devoted to 1) developing the detailed observing plan, 2) completing the real-time processing algorithm with emphasis on getting the best sensitivity and avoiding contamination from man-made satellites, and 3) observations.