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SUPPORT OF THE BALLOON-BORNE

ULTRAVIOLET STELLAR SPECTROGRAPH

Final Report for NASA Contract NASW-3935
May 1986

CENTER FOR SPACE SCIENCE AND ASTROPHYSICS
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Stanford, California

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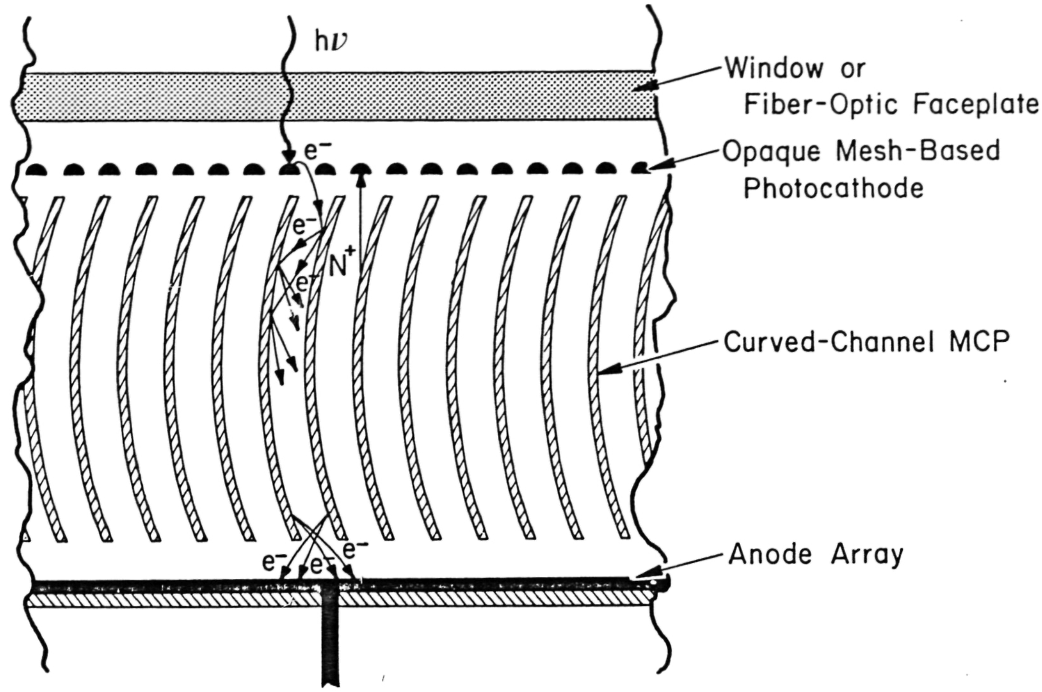
Under this contract we have fabricated, evaluated, and environmentally tested a (256 x 1024)-pixel imaging ultraviolet Multi-Anode Microchannel Array (MAMA) detector system for flight on the Balloon-Borne Ultraviolet Stellar Spectrograph (BUSS). The goal of the program was to replace the existing SEC Vidicon with the pulse-counting MAMA detector in order to, first, improve the overall sensitivity of the BUSS telescope and spectrograph for observations of stars down to $m_v = 7$ and fainter, and, second, to improve the spectral resolution and wavelength accuracy by eliminating the image drifts in the Vidicon caused by magnetic field effects.

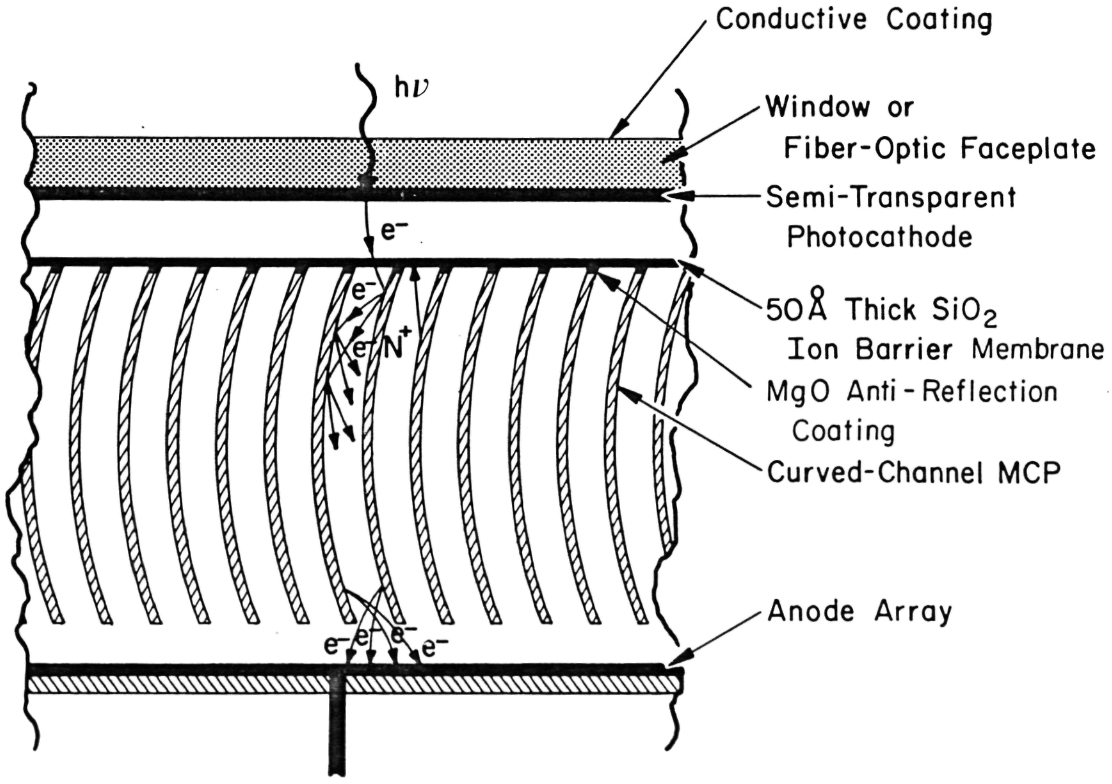
When we started the development of the BUSS detector system, the MAMA detector structure employed a mesh-based in situ processed photocathode as shown in the schematic in Fig. 1a. During the early part of the development program, we discovered that this cathode configuration when used with an activated cathode such as Cs_2Te for the middle ultraviolet, produced a low detective quantum efficiency in the pulse-counting mode and also that the presence of free Cs contaminated the channels of the MCP. This contamination produced a noisy and unstable device, and in some cases, caused internal arcing and damage to the anode array. At the same time, we were developing under separate NASA funding, a sealed MAMA detector tube structure employing a remotely processed photocathode mounted on a window in proximity focus with the front face of the MCP, as shown in Fig. 1b. With the successful development of this tube structure, a number of ultraviolet tubes were constructed for use on the BUSS program.

The configuration of the BUSS detector system in its flight ready configuration is shown in Fig. 2. This detector system was subjected to, and successfully passed, a series of thermal vacuum tests over the temperature range + 30 to -20°C. The quantum efficiency curve for the semi-transparent Cs_2Te photocathode is shown in Fig. 3 and examples of images recorded at ultraviolet wavelengths with this detector system are shown in Figs. 4 and 5. Additional details on the performance characteristics of the detector system are given in the reprint (Timothy, 1985), attached to this report.

At the time that the detector system was ready for integration and flight the BUSS program was halted because of a lack of manpower at the Space Research Laboratory in Utrecht, and uncertainties over the availability of balloons in the US. At this point in time, the BUSS hardware is stored in a working condition in Utrecht and arrangements are being made to ship the entire payload to Stanford University. Further improvements to the basic MAMA detector systems are being implemented at Stanford under NASA contract NASW-4093. In addition, the fabrication of very-large-format ultraviolet MAMA detectors is now being initiated for the NASA Goddard Space Flight Center's Space Telescope Imaging Spectrograph (STIS). We accordingly plan to retain the BUSS payload as an engineering test bed to support these programs while awaiting further flight opportunities.



(a)



(b)

Figure 1. MAMA photocathode structures.
a. In-situ processed mesh-based photocathode.
b. Remotely processed proximity-focused semi-transparent photocathode.

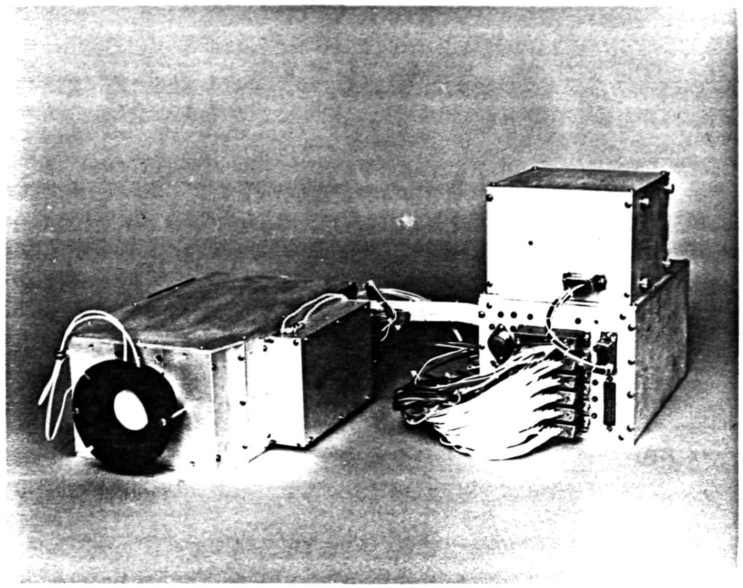


Figure 2. Assembled detector system with sealed MAMA detector tube.

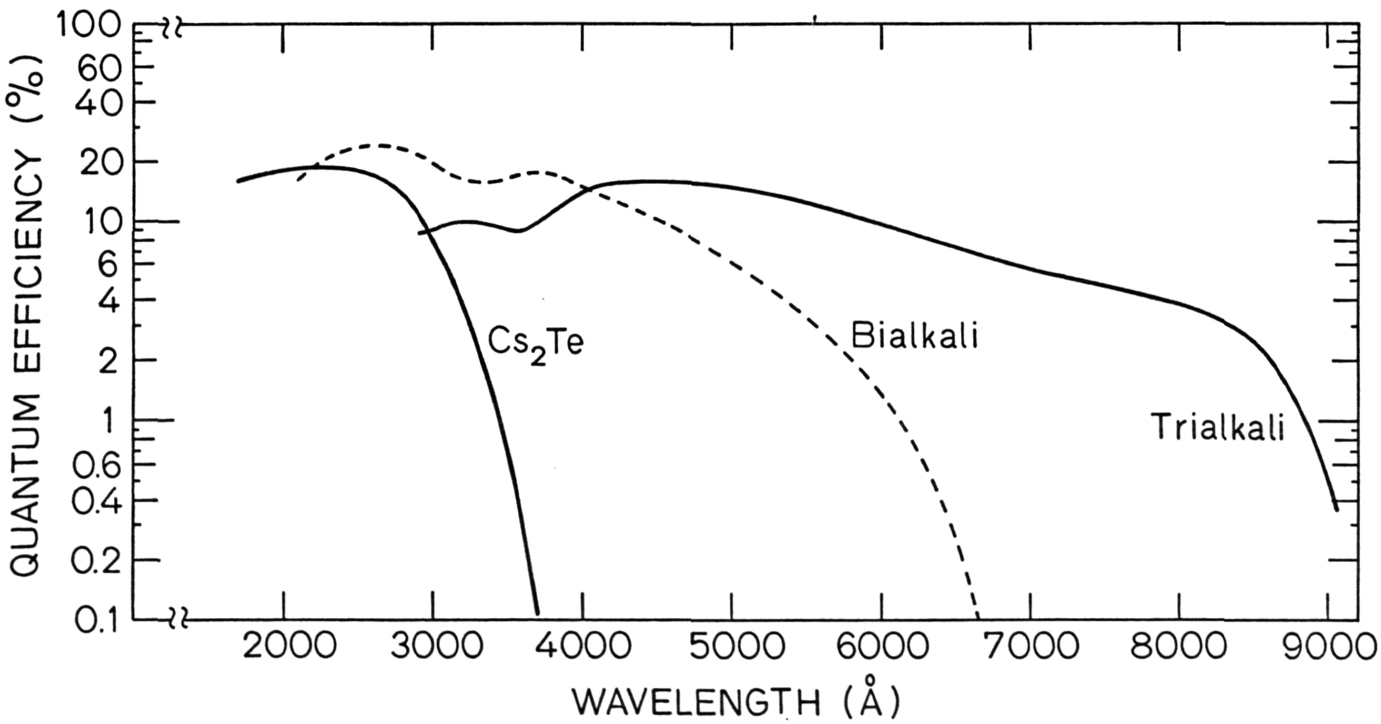
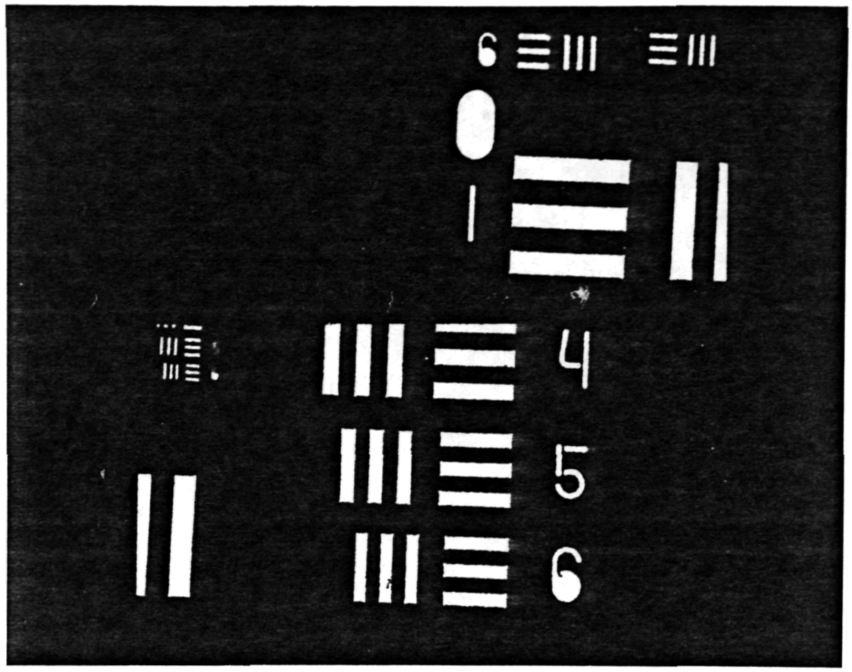
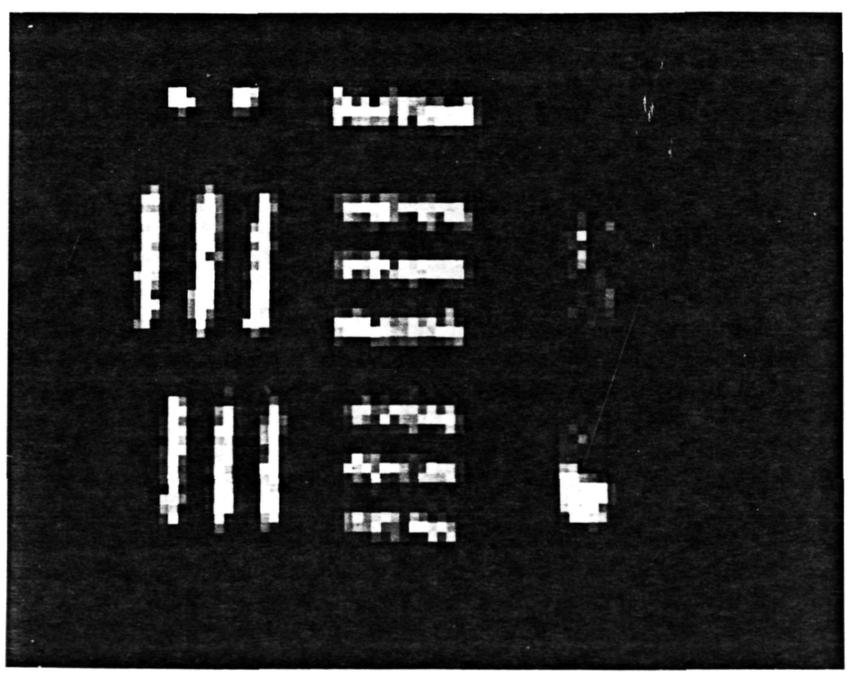


Figure 3. Quantum efficiencies of sealed MAMA detector tubes with
with remotely processed ultraviolet and visible-light photocathodes.



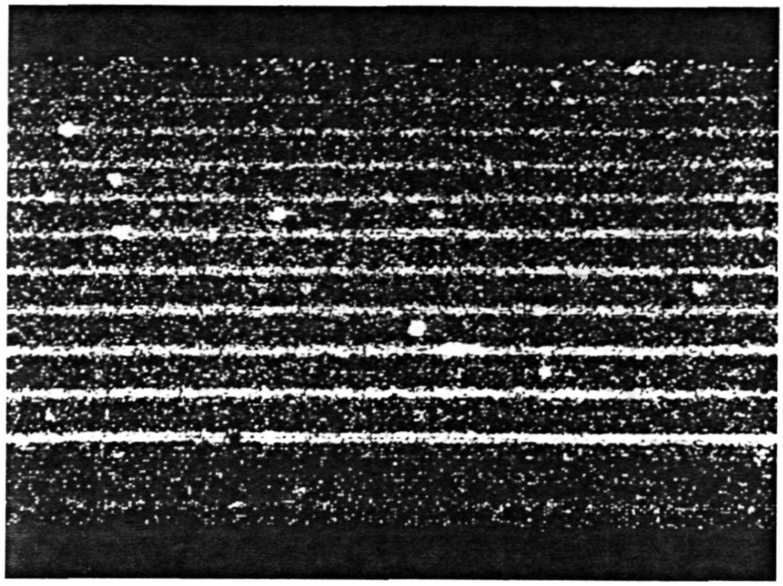
(a)



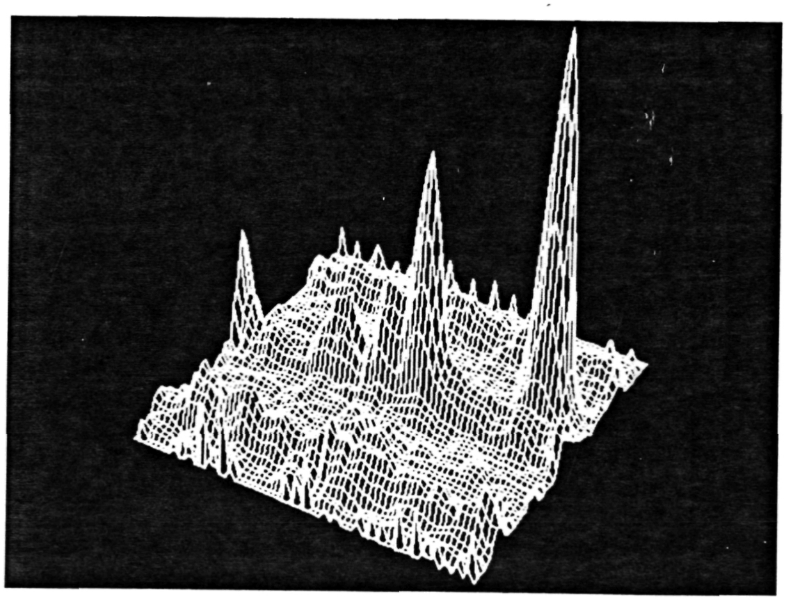
(b)

Figure 4. a. (256 x 1024)-pixel image of USAF test target recorded with the BUSS MAMA detector system. Left half of image is at the top, right half of image is at the bottom.

b. Magnified image of bar pattern at left center of image shown in 4a. Individual 25 x 25 microns^2 can clearly be seen.



(a)



(b)

Figure 5. a. Image of ultraviolet emission lines from a platinum hollow-cathode lamp and continuum emission from an incandescent lamp recorded using the BUSS detector system and the breadboard Space Telescope High Resolution Spectrometer (HRS) optics.

b. Isometric plot of emission lines seen just below center in 5a. (Note image in 5b is laterally reversed from image in 5a.)

Attachment

"Multi-anode microchannel array detector systems: performance characteristics" by J. G. Timothy.