

# The Effect of Foil Wrapping on Scintillator Efficiency

Amanda Carney, Tracy Fendrick, Elizabeth Greer  
*Department of Physics, Marian High School, Omaha, NE 68134*

(Submitted 23 February 2001)

Twenty scintillator detectors recovered from the Chicago Air Shower Array were tested for detection efficiency with and without a foil wrapping. Each detector was placed between two reference detectors and three-fold coincidence counts were recorded over a period of time. For these detectors an average efficiency gain of 15% was realized.

## **Introduction:**

As part of the Cosmic Ray Observatory Project [1] a number of acrylic scintillator type particle detectors were recovered from Dugway Utah. These detectors were originally part of the Chicago Air Shower Array (CASA) project [2]. The CASA detectors consist of a 61 cm x 61 cm x 1.27 cm saw cut acrylic scintillator with a 5.1 cm diameter photomultiplier tube mounted at the center of one face. Since the cross section of the scintillator varies significantly from that of the PMT, it is necessary for most light rays to undergo a series of reflections before reaching the face of the PMT. No light guides were used for the CASA detector configuration. The location of the photomultiplier tube is perpendicular to the main surface of the detector. The purpose of this investigation is to determine if a foil reflector surrounding the scintillator will improve detector efficiency.

## **Procedure:**

Twenty CASA detectors, recovered from the Dugway Utah site, were disassembled and cleaned. The saw cut edges of the acrylic were polished using successive grades of fine grit sandpaper, rubbing compound and finishing with polishing compound to remove surface imperfections left from the original sawing process.



The PMT's were resoldered, tested, and attached to the scintillator panel using optical glue.



The power supplies were then reassembled and tested.



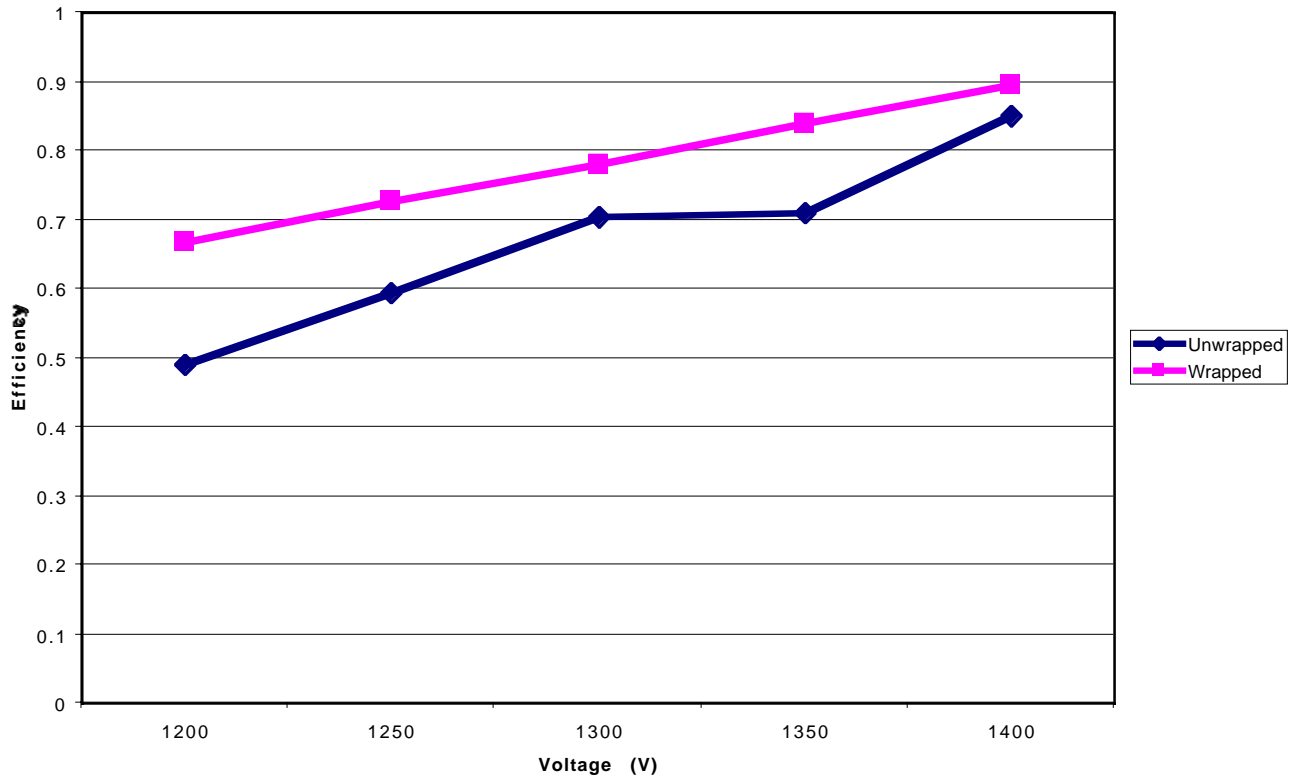
The scintillators were placed in light tight boxes with black facing. The detectors were then tested for light tightness using an oscilloscope and flash light and retested by comparing counts from twenty minutes of exposure to both light and dark.

The finished detectors were placed in a telescope with two reference detectors, one above and one below. The discriminator threshold was fixed at 80 mV for each run and a pulse width of 100 ns was maintained as output from the discriminator. The experiment was run until reference detectors counted 200 two-fold coincidences. Efficiency was measured as the fraction of three-fold to two-fold coincidences. Operating voltage of the PMT was varied from 1200 to 1400 volts in 50 V increments. Graphs of efficiency versus voltage for each of the detectors is seen in appendix 1. Each detector was then disassembled. Foil was wrapped around the acrylic. Then the detectors were reboxed, tested for light tightness, and retested for efficiency using the protocol outlined above.

**Data and Results:**

Figure one provides a summary of average detector efficiency as a function of PMT voltage for both wrapped and unwrapped detectors. As can be seen from the graph, an average efficiency improvement of 17% was realized by the wrapping, with maximum efficiency achieved between 1350 and 1400 volts.

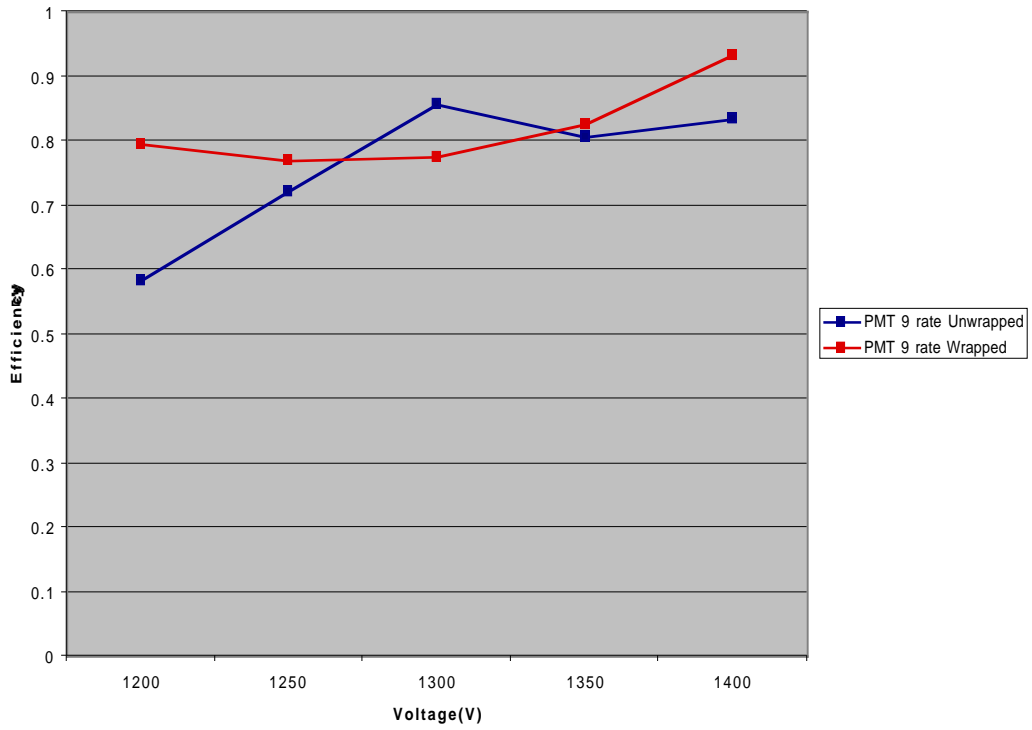
**Fig. 1**



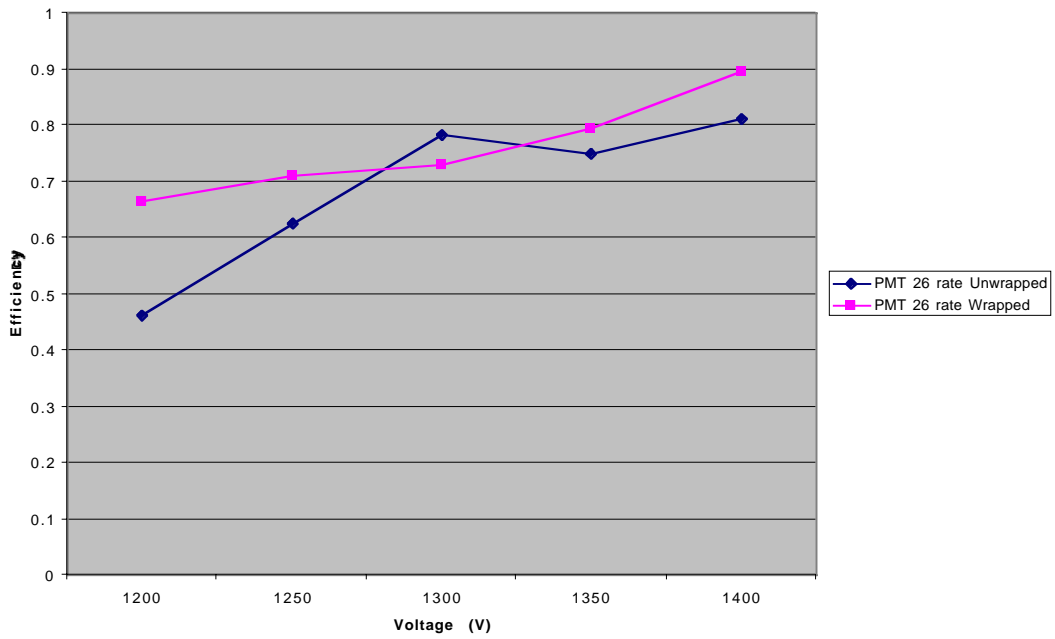
**Appendix 1:**

The following are graphs of efficiency versus voltage for each individual detector.

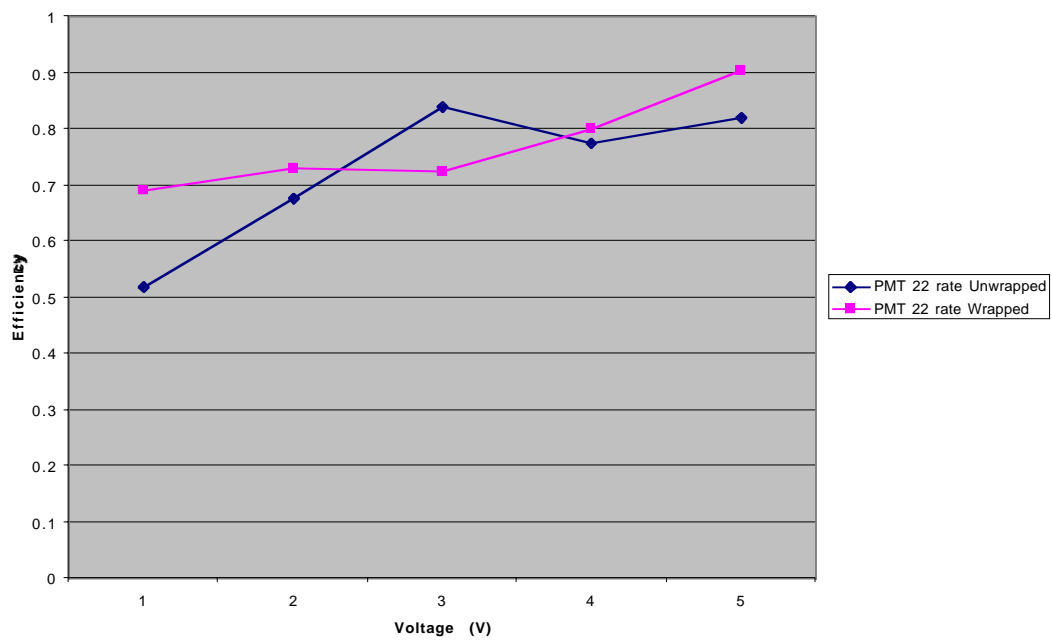
PMT9 Comparison



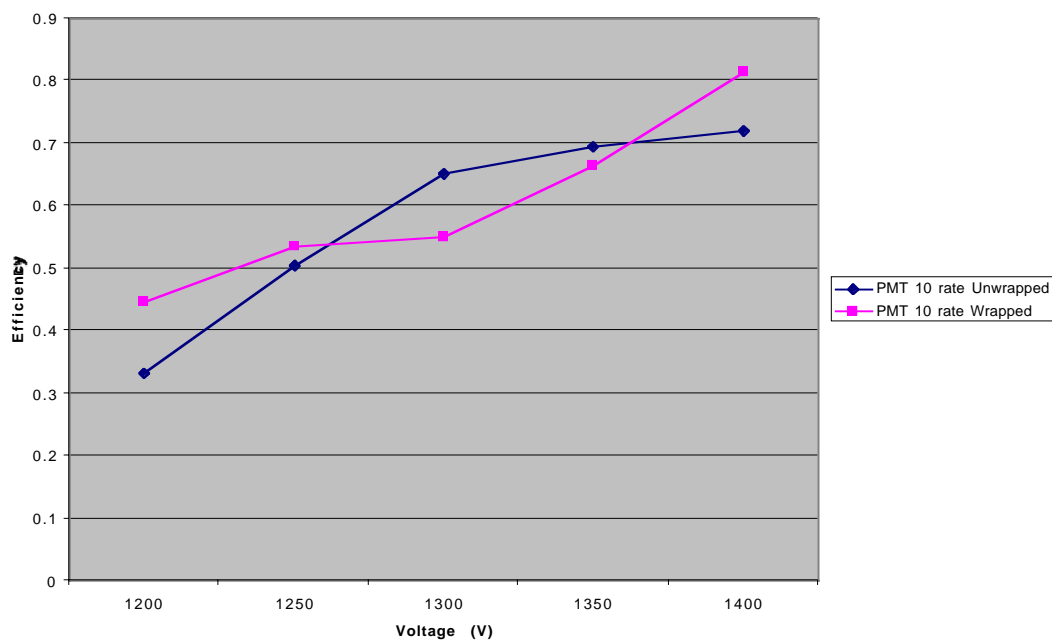
PMT 26 Comparison



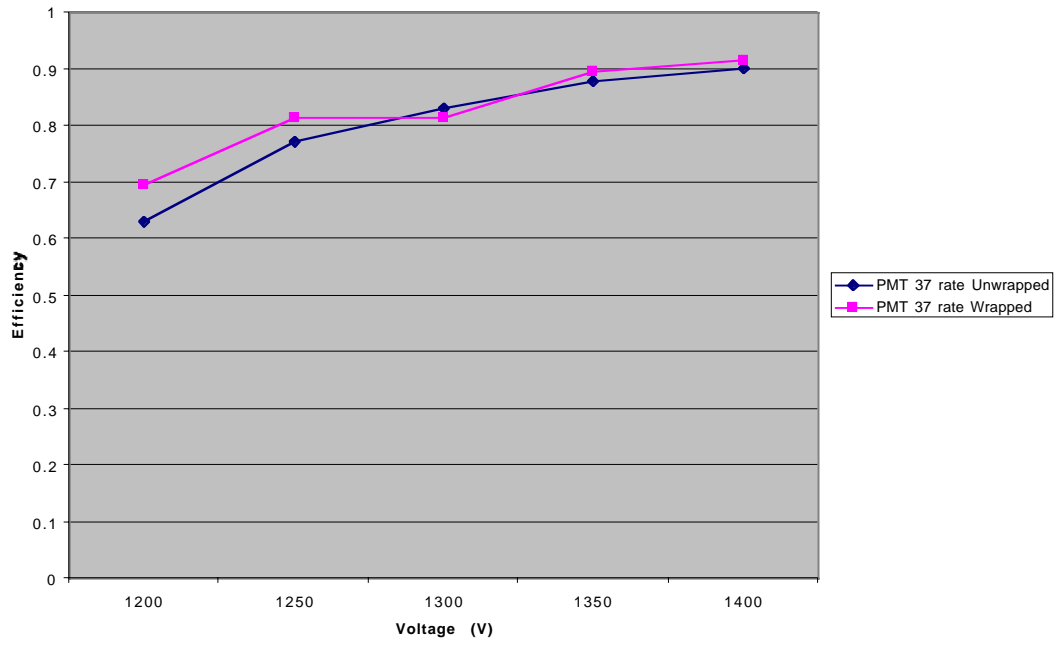
PMT22 Comparison



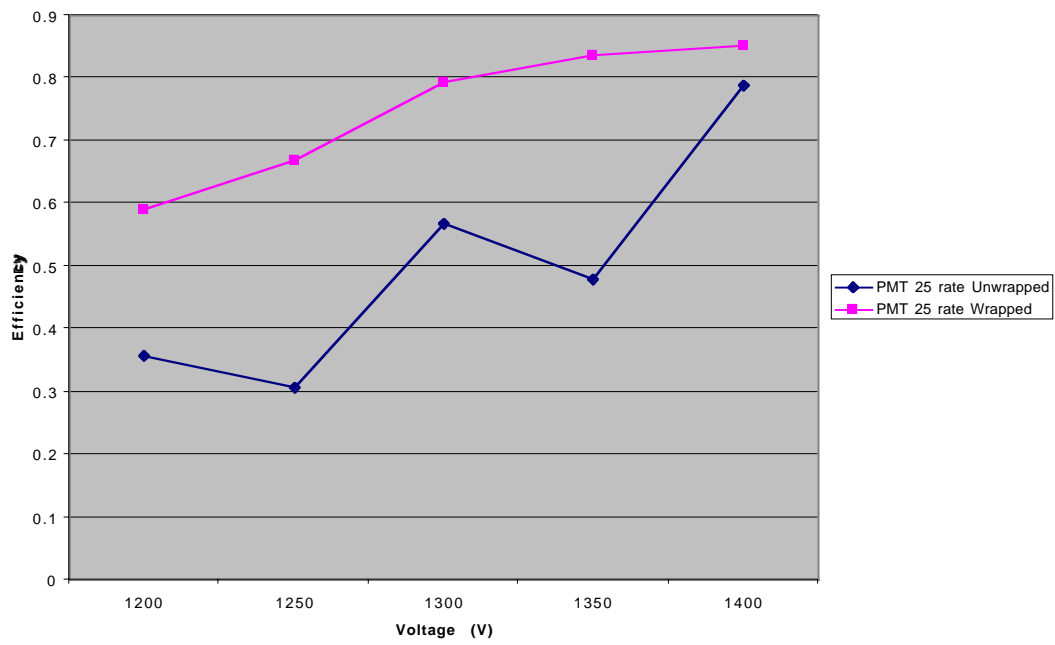
PMT 10 Comparison



PMT 37 comparison



PMT 25 Comparison



PMT 30 Comparison

