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TO A B&L ZOOM 500..(U) PERKIN-ELMER CORP DANBURY CONN
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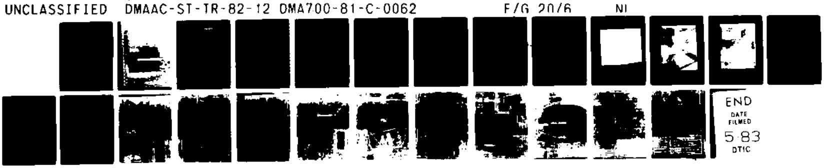

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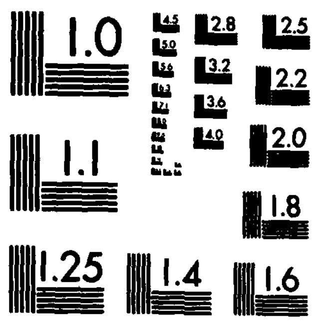


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20. ABSTRACT CONT'D

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**Engineering Report Number:** ER-540

**Prepared By:** J. Dunn
J. Sivinski

**Date:** January 1983

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APPROVED: William C. Mahoney
William C. Mahoney
Deputy Director
Directorate of Systems & Techniques

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## Abstract:

A breadboard experiment was performed which utilized a Bausch & Lomb Zoom 500 stereomicroscope, fabrications of an Expanded Exit Pupil (EEP) device and a High Intensity Light Source (HILS). Experimental results showed it was possible to achieve a stereo image on the EEP screen that permits stereo viewing without the aid of supportive polarized glasses or anaglyphic differentiation. A projected stereo image was achieved throughout the Zoom 500 magnification range, however a significant reduction in the resolution of photographic inputs was measured. Brightness measurement showed that in all magnification used, a brightness exceeding 130-footlamberts was achieved. Unaided stereo viewing was possible within limits of head movement of ± 6 inches on axis and ± 1.5 inches off axis.

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## 1. INTRODUCTION

As part of contract #DMA-700-81-C0062 from DMA/AC, Perkin-Elmer was tasked to determine the feasibility of using an Expanded Exit Pupil/High Intensity Light Source (EEP/HILS) device with a Bausch & Lomb Zoom 500 stereomicroscope. This feasibility and utilization evaluation was performed using an existing breadboard EEP/HILS. A Zoom 500 stereomicroscope was made available by DMA/AC for this evaluation and the following is a description of the experimental setup and the test results.

The purpose of this evaluation was to determine if with the addition of an EEP/HILS device to Bausch & Lomb Zoom 500 stereomicroscope, one could achieve a projected stereo image without the aid of supportive glasses or anaglyphic differentiation throughout the Zoom 500 magnification range given sufficient display brightness. The purpose included discovering whether this stereo fusion could be maintained provided head motions do not exceed ± 6 inches in and out, and ± 1.5 inches laterally with respect to the optical axes of the stereomicroscope.

## 2. EXPERIMENTAL SETUP DESCRIPTION

The basic purpose for an expanded exit pupil (EEP) device is to augment the stereo viewing capability of commercially available zoom stereo optical devices for viewing photographic images by enhancing viewer comfort, reducing viewer fatigue, and improving the effective use of stereomicroscopes such as the Bausch & Lomb Zoom 500. The EEP allows the operator to view the scene on a screen in stereo without the aid of auxiliary equipment and with some freedom of head movement while retaining the binocular capability when required. This human engineering consideration for the operator should yield greater productivity over extended viewing periods with considerably less eye strain and body fatigue. When the operator observes something of interest using the EEP, he or she may want to inspect the object using the full resolving power of the Zoom 500. The operator would then move the EEP out of the way and view the object through the Zoom 500 stereomicroscope. When he or she is through with this close inspection, he or she may want to go back to the EEP viewing and this would be accomplished by rotating the EEP back into position.

Because this specific implementation of the EEP distributes the available light over an expanded viewing area, a high intensity light source (HILS) is required to keep the viewed projection light level above that which is normally required for viewing through the Zoom 500 eyepieces alone. The HILS concept causes concern for the well being of the operator's eyes. The system must be designed so that as the operator changes from EEP viewing to direct Zoom 500 viewing, he or she does not inadvertently suffer eye damage. A system can be designed with sufficient interlocks which would only allow the full intensity when the EEP is in place and a reduced intensity for all other cases. This system should also have a manual override for those few cases when the imagery is of very high density.

## 2.1 EXPANDED EXIT PUPIL (EEP) DYNASCOPE

A stereo Dynascope[R], purchased from Vision Engineering, was adapted for use in this evaluation. The Dynascope projects an expanded exit pupil by using a lenticular lens disk. The lenticular lens disk is rotated at 3000 RPM to remove the visual effects of the edges of the small screen lenses.

This lenticular lens expands the exit pupil of the Zoom 500 by a factor greater than 10. It also allows the viewer some head positioning flexibility while still maintaining stereo fusion.

## 2.2 HIGH INTENSITY LIGHT SOURCE (HILS)

Because the EEP expands the pupil by a factor greater than ten, the illumination requirements are increased by a factor greater than one hundred. The minimum screen display brightness required for viewing in an average illuminated room is 100 footlamberts. A high pressure Xenon arc lamp light source is capable of producing this level of illumination. The HILS fabricated for this experiment was spectrally filtered to remove the unwanted infrared (heat) radiation. Previous calculations for related projects have shown that when a filtered HILS is used in a stereo illuminator, the illuminated transparencies will increase in temperature from room temperature to 95°F. This rise in temperature is acceptable and does not require any special cooling (ordinary film will show slight deformation at 130°F).

[R] Dynascope is a Registered Trademark of Vision Engineering

The HILS unit can be optically coupled to the Zoom 500 by use of fiber optic bundles that are mechanically linked to the Rhomboid prism assembly of the Zoom 500. This mechanical linkage, along with an electronic interlock system removes the possibilities of an inadvertent exposure of the viewer's eyes to the HILS by causing the light bundles to track the rhomboids. The HILS, because it is a high pressure Xenon arc lamp, provides an effective color temperature of approximately 5000°K in the visible wavelengths. This illumination is significantly "whiter" and brighter than that produced by a Tungsten Halogen Lamp and will present the viewer with pleasing color imagery through the EEP and microscope.

## 2.3 OPTICAL SETUP

A Bausch & Lomb Zoom 500 stereomicroscope equipped with a 1x objective and 10x wide-field eyepieces was made available to Perkin-Elmer by DMA/AC for this brief study. It was set up in a laboratory breadboard type configuration. The Zoom 500 stereomicroscope was mounted on a vertical support structure. The EEP unit was supported above the microscope on this vertical column and a HILS unit provided the illumination. (Figures 1 to 3 are photographs of the experimental setup). The evaluation was limited to the 1x objectives and 10x eyepieces supplied. The results indicate that an EEP unit is optically and mechanically suitable for stereo viewing with the Zoom 500 stereomicroscope.

The tests were made with the EEP's small adjustable mirrors located at the eyepiece unit pupils. These mirrors were adjusted to project the microscope's optical (rotational) axes to the screen center.

The microscope 10x eyepieces were adjusted to project the eyepiece focal plane of the Zoom 500 to the Dynascope's screen at approximately 6.7x magnification. When this is combined with the 1.5x Dynascope viewer magnification, the system magnification closely matches that of the 10x eyepiece when the microscope alone is used.

For use with the Zoom 500 stereomicroscope, the HILS should employ a 10 mm diameter randomized lightguide irradiated at its input end with 400-700 mm wavelength energy supplied by a compact high pressure Xenon arc lamp. The output end of the fiber lightguide should be imaged to fill the microscope's entrance pupil at the

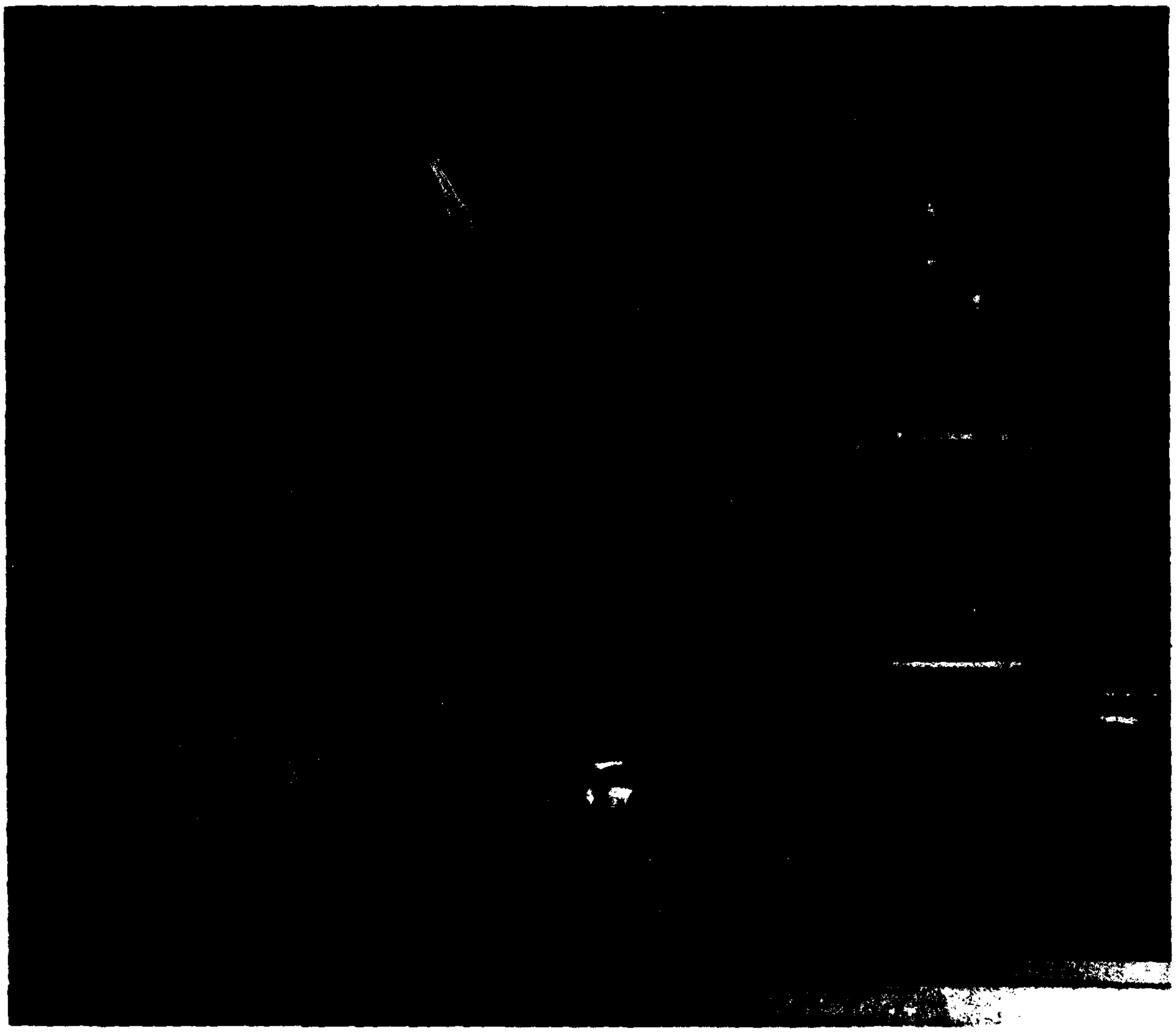


Figure 1. Experimental Setup

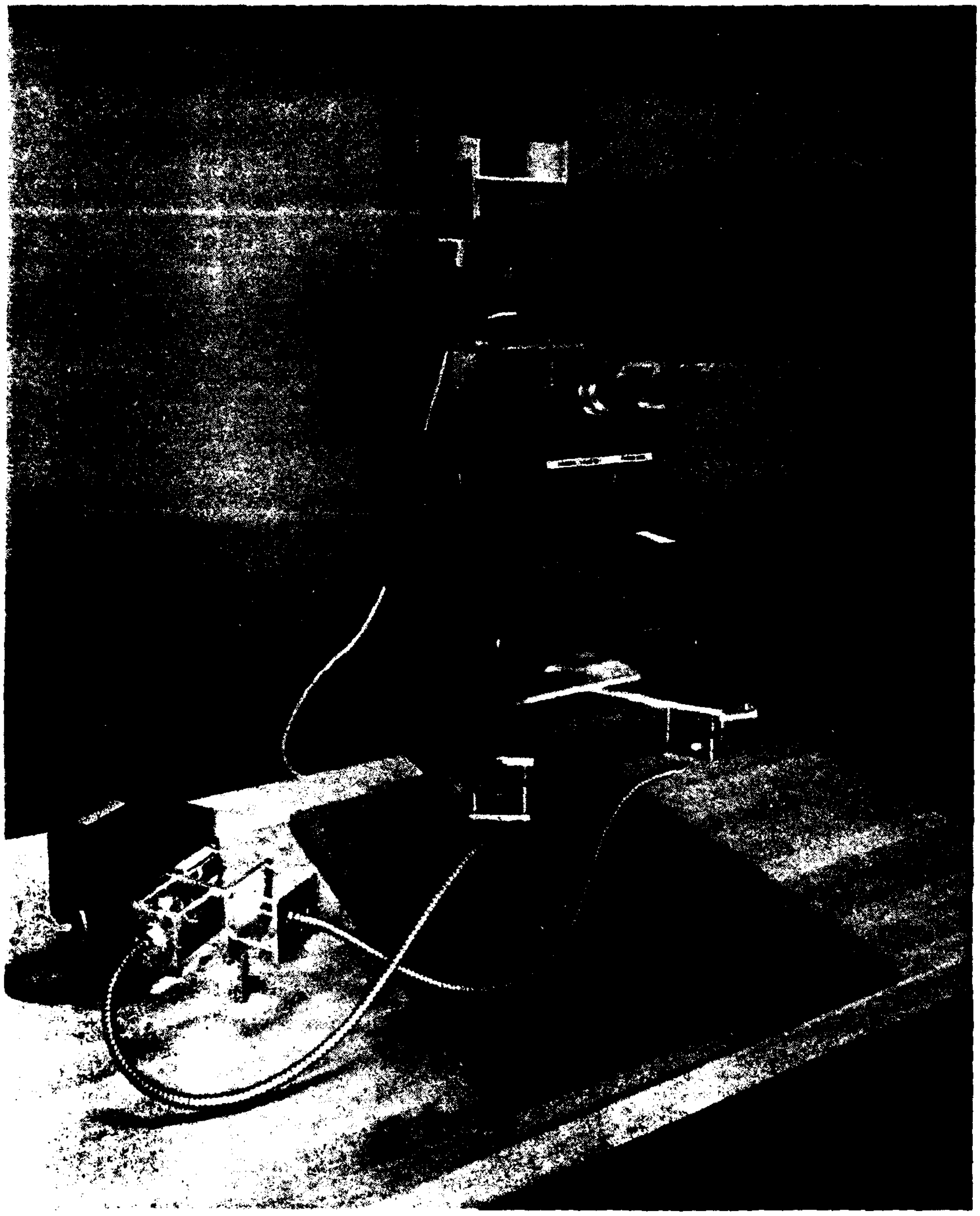


Figure 2. Experimental Setup

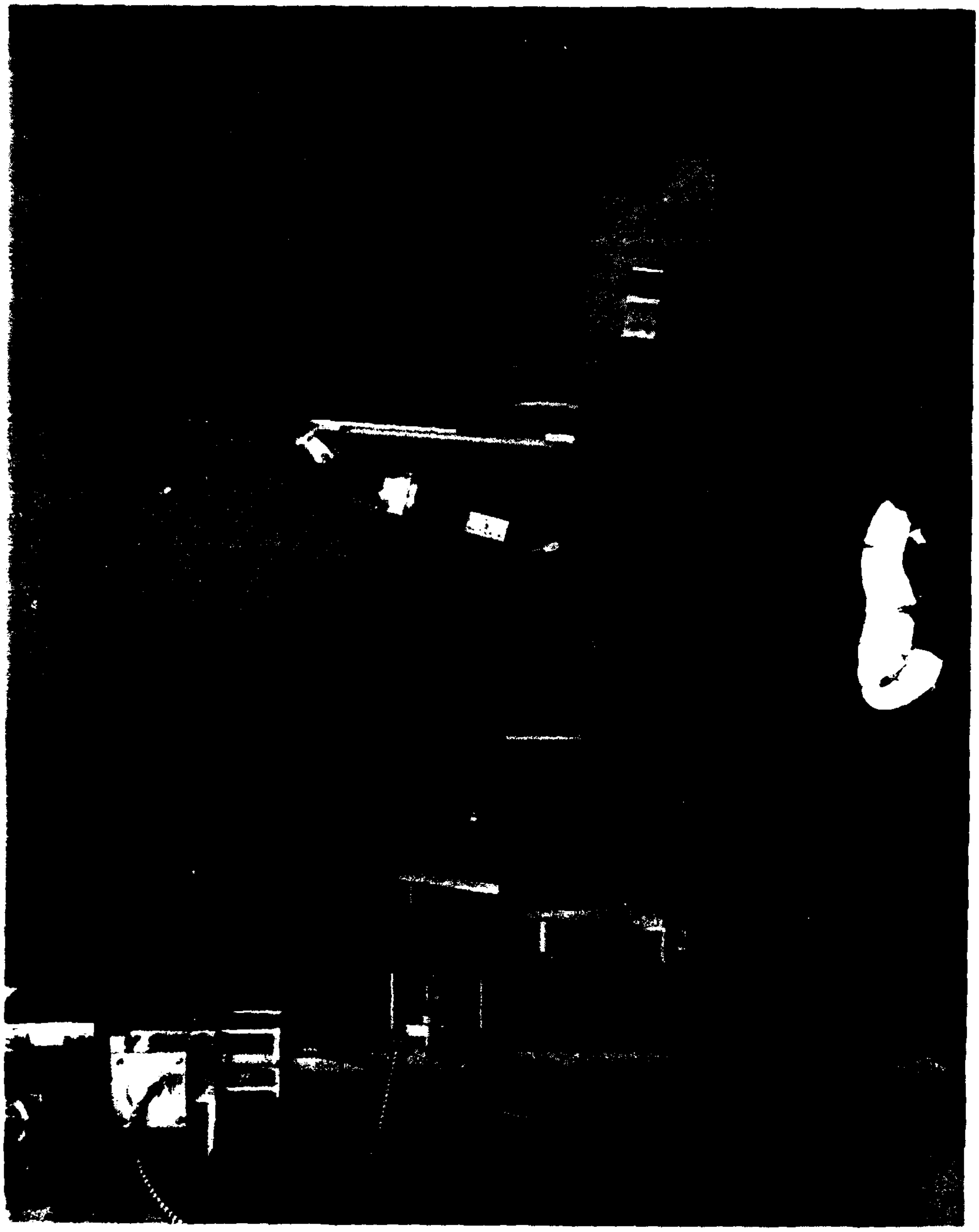


Figure 3. Experimental Setup

numerical aperture of intended use. The breadboard facility at Perkin-Elmer used a 6 mm fiber optic lightguide which did not completely fill the pupil of the Zoom 500. This condition limited the ultimate resolution measured, but did not otherwise effect the qualitative results of the experiment. It should also be noted that with the specific configuration used for the breadboard, the orientation of the stereo image flips 180° between viewing with the EEP and viewing with the Zoom 500.

### 2.4 RECOMMENDED MECHANICAL SETUP

To use the EEP on the Zoom 500:

- Rotate the interpupillary distance adjustment to the "up" position
- Place the right eyepiece phoria adjustment with the index mark horizontal
- Place the Occluder control lever in the stereo and superimposition mode position
- Place the Optical switch level in the stereo mode position

Changing viewing arrangements, from use of the Dynascope to use of the microscope eyepieces, and vice versa, should require a minimum of effort and time. Moving the Dynascope without tilting it is most desirable, since tilting of the Dynascope requires its rotating disk to be turned off, a somewhat time consuming process. EEP support brackets can provide the capability to transfer from EEP to microscope and back to EEP viewing without turning off the Dynascope. However, for laboratory convenience, the arrangement used in this study tilted the Dynascope and required it to be turned on/off when changing viewing arrangements. This arrangement is described in Perkin-Elmer Blueprint 678-4535-001, entitled Dynascope (2500 Conceptual Layout).

## 3. EXPERIMENT RESULTS

### 3.1 GENERAL RESULTS

The projected imagery was found to be good throughout the magnification range of 10x to 30x, with exceptionally high quality in the central portion of the field. Brightness measurements indicated a display brightness of 130-footlamberts and 530-footlamberts for high magnification and low magnification, respectively. The allowable head movement was measured, demonstrating that the observer could move to ± 6 inches in and out, and ± 1.5 inches laterally and still maintain good stereo fusion. These tasks demonstrated the suitability of the EEP/HILS unit for use with the Zoom 500 stereomicroscope. User reaction to the 180° image rotation may be a factor in application of this EEP concept.

### 3.2 BRIGHTNESS MEASUREMENT

Table 1 gives the measured brightness in footlamberts at the EEP for various zoom lens settings. In all cases but one, the brightness exceeded 150-footlamberts. When the proper 10 mm diameter fiber optic lightguide, which fills the Zoom 500 pupil is used, the brightness should exceed 150-footlamberts in all cases. This exceeds by 50% the minimum display brightness requirement of 100-footlamberts.

TABLE 1

BRIGHTNESS AT EEP EXIT PUPILS WITH 1mm DIAMETER LIGHTGUIDE
(Use of a 10 mm diameter lightguide is expected to increase the brightness substantially.)

| | Left Pupil (ft-L) | Right Pupil (ft-L) |
|---|---|---|
| Low Zoom (∿3x) | 540 | 530 |
| Mid Zoom (∿5x) | 480 | 400 |
| High Zoom (∿30x) | 160 | 130 |

### 3.3 RESOLUTION MEASUREMENTS

Resolution readings at the maximum system magnification of 30x with a medium contrast target gave 128 LP/mm throughout the display area. An EEP with a vibration-free mechanical mounting provision should yield a resolution increase to 144 LP/mm when referenced to the film plane. The resolution achieved when viewing through the eyepieces at the same magnification was about 200 LP/mm. The resolution reduction accompanying the use of the EEP is significant when high resolution materials are viewed for high resolution purposes. Viewing of moderate resolution materials for moderate resolution purposes is satisfactory.

### 3.4 TEMPERATURE MEASUREMENT

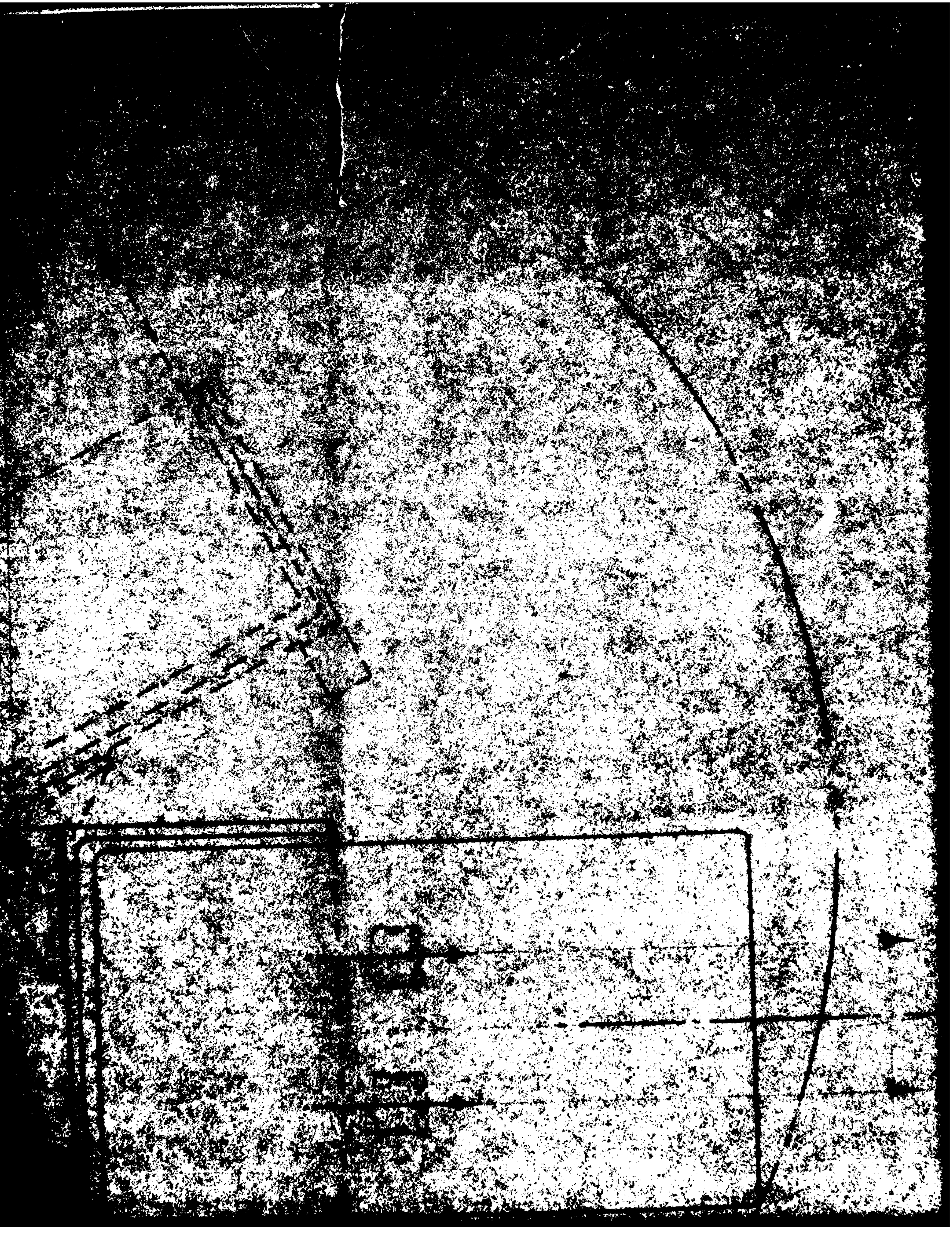
A temperature probe placed in good contact with a neutrally dense portion of the color film (density approximately 1.0 neutral density) reached a temperature of 93°F after 20 minutes of operation. A density of 1.0 implies that 90% of the optical energy is scattered or absorbed in the film. For higher densities, the absorbed energy approaches 100% and the film temperature will be slightly higher, but remain below 100°F.

## 4. SUMMARY

It is feasible to adapt an expanded exit pupil device and a high intensity light source to a Zoom 500 stereomicroscope. This would help maintain productivity at high levels over sustained viewing periods by allowing the analyst to view in stereo in a significantly more relaxed viewing position than is possible with eyepieces alone. Such stereomicroscope adaptation provides the operator with a projected image that can be viewed with considerable head, neck, and body relief. The quantitative measurements made show that this stereomicroscope adaptation yields a moderate-brightness, stereo-projection system, in which image resolutions are satisfactory for most purposes, and the use of the stereomicroscope alone is not restricted for extremely high resolution work.

This capability is not without two notable negative aspects: (1) although satisfactory for moderate-resolution image viewing, a significant reduction in resolution results with high resolution images; and (2) the high illumination requirements of the device necessitates augmentation of the available light of commercially available tables, to a potentially eye damaging intensity if satisfactory safety-interlocks are not incorporated. Therefore, a redesign of the light table light-to-rhomboid system is required.

In applying this microscope adaptation to currently available light tables capable of supporting the Zoom 500, consideration must be given to the nature of the movement of the EEP, i.e., laterally or up/down, freedom of movement, weight redistribution and locking devices.



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