SECTION F — Discussion: Stereo, Spectra and Micro Studies

Note: A participant's full name and address are given with the first contribution to the Discussion. Authors' full names and addresses are given with the title of each paper. For subsequent entries the addresses are omitted.

Paper F-1: A Stereoscopic High-Speed Framing Camera Technique for the Study of Shaped-Charge Liner Collapse, *Bradley O. Reese*, Stanford Research Institute, Menlo Park, California.

William P. Brooks (*Sandia Corporation, Div. 5133, Albuquerque, New Mexico*): What is the stereo angle?

B. O. Reese: The half-angle is about 10.5 degrees — approximately 21 degrees total included angle. A smaller angle results in great difficulty in obtaining adequate plotting accuracy.

W. P. Brooks: Can depth be seen in the viewer?

B. O. Reese: Yes, anyone with good eye muscles can see the depth in my viewer accurately, even though the angles are not correct.

Dr. David C. Oakley (*University of California, Lawrence Radiation Laboratory, Livermore, California*): We do stereo slightly differently, and use two mirrors instead of five. They are mounted perpendicular to the plane of the central rays. The jet is pointed perpendicular to the axis of the camera, and thus does not endanger it. It is easy to set up. (See Fig. 1(F-1).)

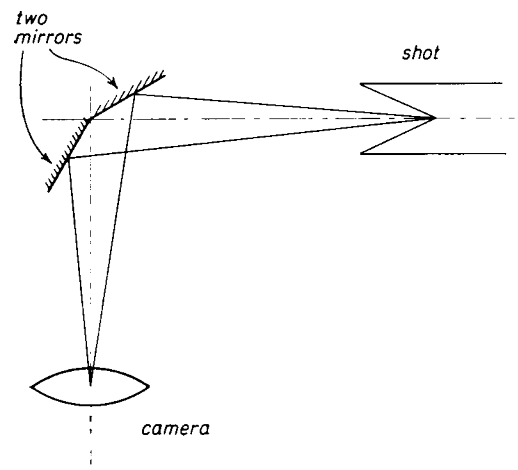

Figure 1 (F-1).

B. O. Reese: That sounds like a worth-while simplification that would eliminate much tedium in the setting-up procedure.

Paper F-3: Design and Application of a High-Speed Time-Resolving Spectrograph, *Donald Baker Moore and John K. Crosby*, Stanford Research Institute, Menlo Park, California.

Dr. F. L. Curzon (*Department of Physics, University of British Columbia, Vancouver, B.C., Canada*): In your paper you gave quotations of temperatures of explosions. Were these determined from a blackbody approximation or were they excitation temperatures determined from lines in spectra?

J. K. Crosby: Blackbody temperatures.

Dr. F. L. Curzon: How did you do this — by obtaining a wavelength intensity distribution curve, or from the intensity at isolated wavelengths in the spectrum?

J. K. Crosby: From the intensity at isolated points in the spectrum.

Dr. F. L. Curzon: Did you therefore assume that the sources were optically thick, as you appear to have done from the answer to the previous question.

J. K. Crosby: Yes. The temperature determination is made by assuming that the shock is optically thick and radiates as a blackbody. Then, the intensity at a particular wavelength defines the temperature of the shock. The temperatures, as a result, are to some extent wavelength dependent.

Martin R. Dachs (*Farrand Optical Company, 4401 Bronx Blvd., New York 70, New York*): You mentioned a color temperature of 50,000 K. This color temperature would peak in the vacuum ultraviolet. Did you, therefore, measure the peak of the radiated output in this vacuum region? Our company experience indicates that in our spark lamps the emitted energy falls off extremely rapidly in the ultraviolet. This is discussed further in the paper by Philip Nolan, presented at this Congress.

J. K. Crosby: The spectrograph will not transmit in the ultraviolet so that we cannot measure around the peak of the intensity curve at these temperatures (10,000 to 50,000 K). However, the visible end of these spectra can still be observed and the temperature estimated from them.

Paper F-4: High-Speed Time-Resolved Spectroscopic Instruments, *Francis D. Harrington*, Optics Division, U.S. Naval Research Laboratory, Washington, D.C.

George H. Lunn (*Atomic Weapons Research Establishment, Aldermaston, Berkshire, England*): May I suggest an improvement to the optics of a time-resolved spectrograph using a pinhole aperture? In order to improve light-gathering power and especially to give a wide-angle view, B. S. Brown of our establishment suggested the use of a very small sphere instead of a pinhole. We have satisfactorily used a 0.5-mm diameter quartz ball in an ultraviolet system for a time-resolved spectrograph, using a rotating drum and giving a time resolution of about 3×10^{-6} sec. No other objective lens is required.

F. D. Harrington: This suggestion is very helpful in some cases. Light from a luminous event occurring within the field of view will be concentrated by the small quartz ball into a small image of the phenomenon, and this image will serve as the entrance "slit" of the spectrograph. This means that the total integrated light is contained in the image, and that spatial isolation, if desired, will be lost. Also, if the position or size of the phenomenon changes with time, the position or size of the small image will also change (though by a much smaller amount); and this could possibly affect the wavelength resolution and the time resolution of the resultant time-resolved spectrum. The instruments described in my paper use external objective lenses with f/numbers matching elements of the collimator of the spectrograph. The objective lens maintains a definite spatial field of view in object space. That is, the projection of the pinhole aperture onto the phenomenon remains fixed in object space.

We have used small glass beads to image very short exploding wires when they were used very close to the pinhole aperture of the spectrograph. The object and image distances were selected so that the light of the exploding wire was imaged on the far surface of the glass bead. The image point was brought into contact with an oversized pinhole aperture in the plane of the "slit" of the spectrograph. This method aided in aligning the source and the spectrograph, and helped us collect as much light as possible from the event.

Dr. F. L. Curzon: Have you considered using repetitive exposures of reproducible events as a means of supplementing the f/number, or light-gathering power, of a spectrograph?

F. D. Harrington: No, this was not considered. However, it is possible to use a number of reproducible exposures with a conventional static spectrograph if a time-resolved spectrum is not required. The instruments just described are streak spectrographs which have a continuous-writing feature, and a recycling time. If repetitive exposures of a reproducible phenomenon were used, the spectrograph would have to rewrite over the initial spectrum, and extraordinary synchronization and reproducibility would be required to prevent blurring in time.

With unreproducible events, such as exploding wires, only one exposure is possible, and therefore low f/numbers are required, particularly if the brightness of the phenomenon is of a low level.

Dr. F. L. Curzon: Could the optical phenomenon be streaked along the length of the slit of the spectrograph instead of in the focal plane, after the dispersing element?

F. D. Harrington: The optical event can be streaked externally along the length of the slit of a conventional static spectrograph; and a spectral time history can thus be obtained. In this case, the length of the record is limited by the length of the slit. In most cases, then, the time scale would be quite compressed, and the time resolution would be low. Wavelength resolution would still be maintained. Spectrographs such as the Model 102 (low dispersion) and the N9GS (high dispersion) are capable of recording time-resolved spectra with much better time resolution and longer history records by sweeping in the focal plane of the spectrograph. Moreover, F. L. Curzon's slit streaking procedure is only possible if the optical event is precisely predictable in time, whereas the spectrographs described here do not require such close timing and have been extremely valuable for many events which could not have been closely synchronized.

Paper F-5: High-Speed Photographic Studies of Electrically Exploded Metal Films and Wires, *Louis Zernow, George Woffinden and F. Wright, Jr.*, Aerojet General Corporation, Downey, California.

George A. Theophanis (Avco Corporation, 201 Lowell St., Wilmington, Massachusetts): Did you measure the residual charge on the capacitor after the foils were exploded?

L. Zernow: Yes, we do find a residual charge.

G. A. Theophanis: Specifically, I am interested in the case in which a second current peak was not observed. Did you observe a higher residual charge in this case than in cases in which a second current pulse was observed?

L. Zernow: Yes, there was, but we are not yet in a position to describe the measurements.

Paper F-7: High-Speed Photographic Recording of Dual Data at High Magnification, *B. H. Amstead*, College of Engineering, The University of Texas, Austin, Texas.

Lincoln L. Endelman (The Martin Company, Cocoa Beach, Florida): What procedure did you use for calibrating the strain gage?

B. H. Amstead: The calibration of the light pip was made by observation of the pip through the viewfinder when a given load was placed on the tool. Dynamic calibration was not attempted.

Anonymous: It used to be customary in metal cutting-techniques to transfer the force data onto an oscilloscope and then record it with the secondary objective as a continuous line (or lines) on the film. What advantage do you have recording data through the rotating prism?

B. H. Amstead: With this technique, one can have complete concord of the image and the pip showing tool force. In the oscilloscope technique, the streak data and image are out of phase by 5 frames.