tectability are no longer set by the photometer, but by what can now be photographed. Not only must one depend upon photographs to show where measurable stars are located, but one is also at the mercy of background objects which are a little too faint to be revealed photographically. If such objects are unwittingly included within the diaphragm of the photoelectric photometer, they can introduce serious errors into the measurement of resolved stars which themselves are only a little brighter than the photographic limit. A fair number of faint stars have already been measured with this photon counter, including several which are fainter than 23rd magnitude. Rough measures as faint as 25th magnitude ought to be feasible if the locations of such objects were known and if background troubles could be avoided.

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Hall, John S. Differential and a.c. methods.

A photoelectric performance diagram, somewhat similar to that first introduced by Kron (1939), was constructed from data obtained at the 40-inch Ritchey-Chrétien Reflector in Washington, D. C. Errors of observation produced by noise due to shot effect, scintillation, sky illumination, and dark-current fluctuations have been determined for stars of different brightness and for different types of photometers.

For star-to-star comparisons errors caused by variable transparency usually greatly exceed those produced by noise considerations alone. If we exclude the observations of faint objects, there appears to be little or no advantage in using any one type of photometer provided it has suitable gain and stability.

For differential or single-star photometry, such as polarimetry, the overall accuracy appears to be primarily limited by shot noise. If this were strictly so, the signal-to-noise ratio would be $\sqrt{2}$ times more favorable for equipment having two photomultipliers rather than one. With this in mind there appears to be little difference in the accuracy which may be achieved by either an a.c. technique, such as that described by Lyot (1948), or by the d.c. technique used by Hiltner (1952, 1951).

For differential photometry involving colorimetry, however, changes in differential atmospheric absorption may provide the most serious limitation to overall accuracy. An a.c. technique, which is similar to that first used by Carpenter (1950) and which utilizes a single multiplier, is

highly efficient, simple, and should be free from the effects of scintillation noise.

In both two-color photometry and in polarimetry it has been found advantageous to use an a.c. amplifier to indicate very small differences at high gain together with a second amplifier, in parallel with it, to indicate the total effective energy.

In the determination of colors from measurements in a number of spectral regions, it is apparent that a very efficient and accurate photometer may be made by separating the stellar spectrum into discrete energy units and by directing each of these regions to separate photomultipliers, amplifiers, and recorders. Such an arrangement would permit simultaneous measures in all regions, keep errors due to transparency changes and to scintillation at a minimum, and accurately define the spectral regions under observation.

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Hiltner, W. A. 1951, *Observatory* **71**, 234.

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Hiltner, W. A. Image tubes for astronomical purposes.

The present goal in the development of image tubes is one of effectively increasing the quantum efficiency of photographic emulsions. Present photographic emulsions operate at an efficiency not much greater than one tenth of one per cent, although a figure of one-half of one per cent is often quoted. In contrast, the quantum efficiencies of the best photo-cathodes approach 25 per cent and here lies a possible solution to more efficient observations.

A simple image tube consists of a photocathode, usually semitransparent, followed by an electron lens which focuses the photoelectrons on either a luminescent screen or a photographic emulsion. Three types of image tubes will be considered:

1. Simple image tubes in which a photographic emulsion is the electron sensitive material.
2. Simple image tubes in which a phosphor is the electron sensitive material.
3. Image tubes with electron multiplication in which a phosphor is the electron sensitive material. In the last two cases a photographic emulsion is used in an auxiliary camera which photographs the image.

A priori, a gain in speed in an image tube can be anticipated since the original quantum has an