

TRUE COINCIDENCE BACKGROUND FROM K<sup>40</sup>.

A. Roberts, Hawaii DUMAND Center

We estimate here the rate of events in which two or more photoelectrons are produced in the cathode of a 16" PMT by a single K<sup>40</sup> disintegration. For this purpose we have written a computer program TRUEK, which works as follows.

A hemispherical cathode is assumed, of radius RAD. All calculations are done in terms of this unit; for a 16" PMT, RAD=20 cm. The mean cathode efficiency EFFC is also entered into the program as data.

The volume outside the photocathode is divided into hemispherical shells of constant thickness; in the present program that thickness is set at .05 RAD or 1 cm. A single K<sup>40</sup> atom is assumed to disintegrate on the polar axis in the center of the shell, emitting 43 quanta isotropically<sup>1</sup>. The number of quanta striking the photocathode is calculated. Using this as a mean value, and assuming a Poisson distribution, the probability of 1,2...40 quanta striking the cathode is calculated. These probabilities are stored for each shell. We also store a weighting factor for the shell area, WFPAC, proportional to the square of the shell radius. As many shells as desired may be used; it turns out that the probability of getting two or more photoelectrons becomes small beyond about 1.5 PMT radii from the tube surface.

Having thus stored the probability of n quanta, we now find the probability distribution of the number of photoelectrons, taking as the mean of the Poisson distribution EFFC x n, where EFFC is the photocathode efficiency, and n goes from 1 to 40. Each of these probabilities is weighted by the population of the corresponding photon bin, and the resulting values stored in an array.

The final results is both the photon distribution and the electron distribution. The results are then normalized to the K<sup>40</sup> decay rate of 13 disintegrations/sec liter, and histogrammed.

The approximations made in this program are as follows.

1. The decays are all assumed identical, with 43 isotropically emitted photons.
2. Absorption, scattering, and reflection are ignored; for distances no more than 50 cm, this seems reasonable.
3. The wavelength band assumed for the Cerenkov radiation is 300 to 650 nm.
4. We ignore the edge effects of the hemispherical cathode and source; the calculation is done essentially by taking half of a spherical geometry. This is valid as far as photons striking the cathode from outside are concerned; but it ignores completely those cases in which quanta enter through the transparent portion of the envelope and strike the photocathode from behind. The calculation is therefore expected to yield values somewhat too

The results of the calculation, for RAD=20cm, EFFC=0.25 are shown in Figs. 1 and 2., for an integration carried out to 2.5 PMT diameters from the surface. That this is sufficient is shown by Fig. 3, which displays the total number of decays with 2 or more photoelectrons as a function of the outer limit of integration. The number of events with 2 or more electrons is surprisingly high, and constitutes a significant contribution to the PMT background.

It is clearly highly desirable that an experimental measurement of the number of such events be made.

#### REFERENCES.

1. A. Roberts, DUMAND 78, Vol. 1, p. 139.

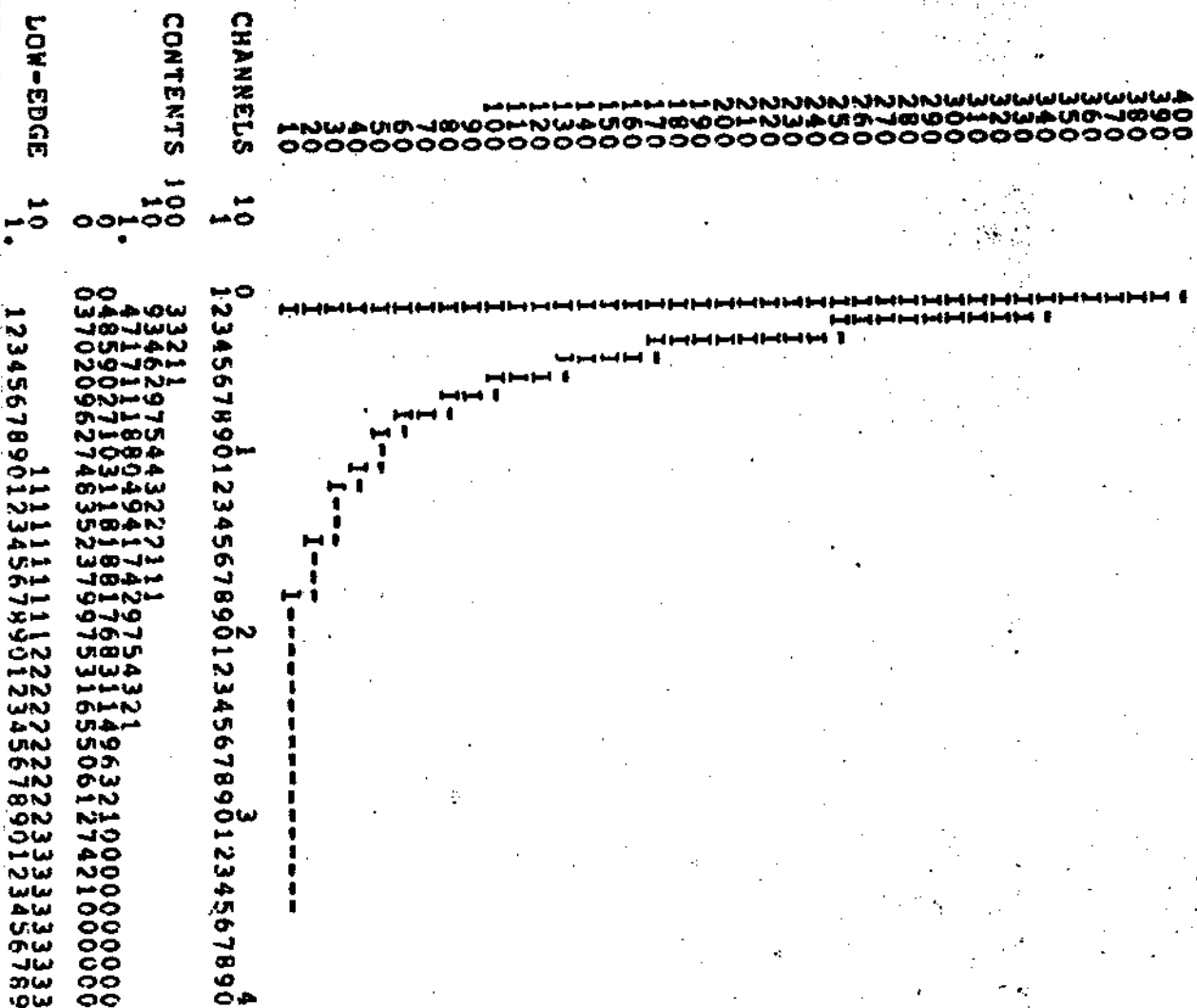


Fig. 1. Photon Distribution: the number of cases in which 1, 2, ...40 photons strike the PMT cathode for a K<sup>40</sup> distribution extending out to 2.5 PMT radii beyond the tube.



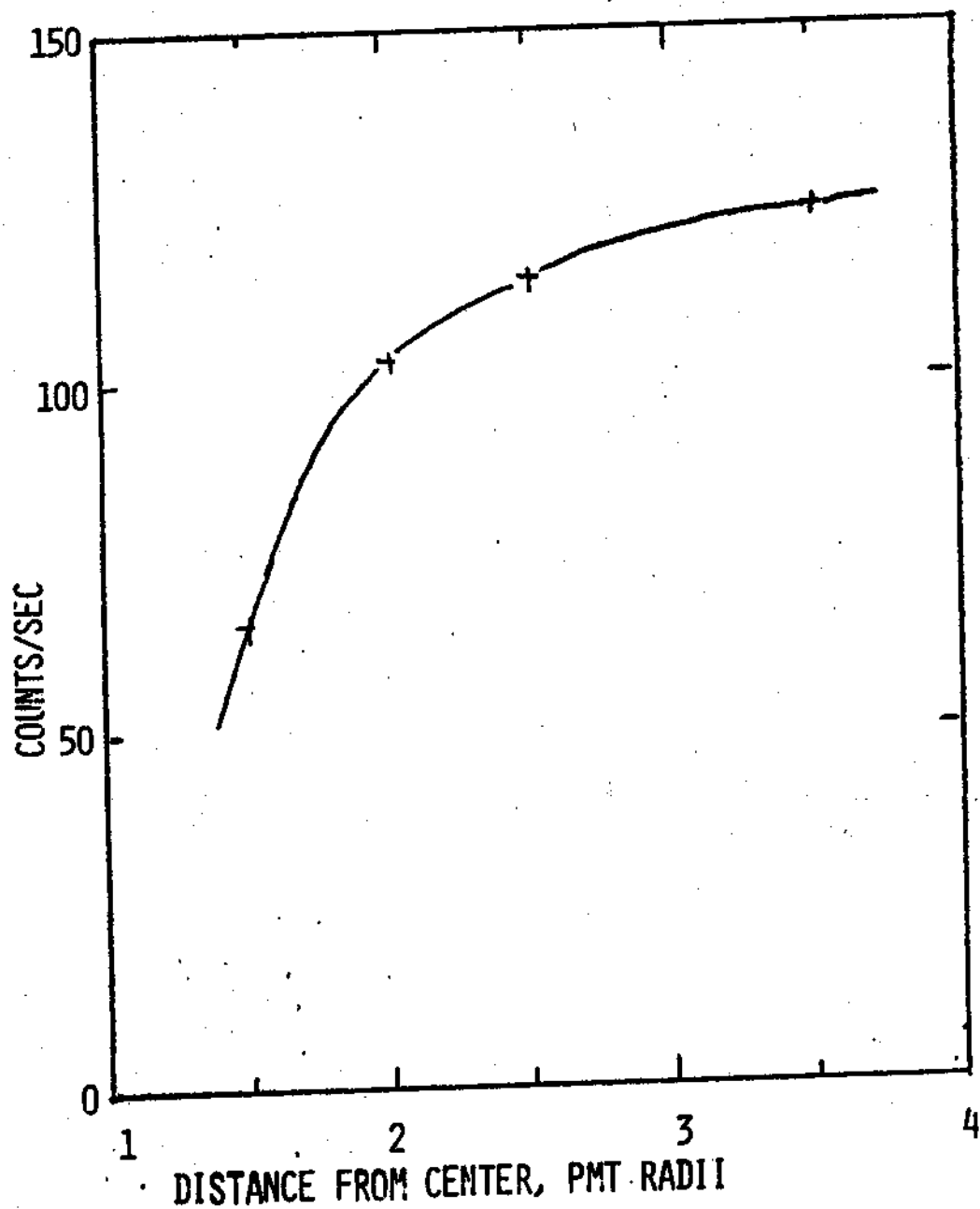


Fig. 3. Number of  $K^{40}$  counts/sec with 2 or more photoelectrons, for a PMT radius of 20 cm, as a function of the upper limit of integration. By 2.5 radii beyond the PMT, the rate has flattened out.