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INTER-OFFICE MEMORANDUM

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FINAL DETERMINATION March 1945

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L. M. Redman
JAN 29, 1981
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To: J. R. Oppenheimer and R. F. Bacher

From: L. G. Parratt, J. Allen and D. P. MacMillan

Subject: Summary of and Recommendation for the Future of the X-ray Counter Experiment

1. As directed in March and again in September, we, in Group G-2, have now essentially completed the development of the flash x-ray counter experiment for implosion studies at P-site. The performance of this method is briefly summarized in this memorandum, and a definite recommendation is made as to the future of the experiment in our implosion project as a whole.

2. The present status of the experiment is as follows: the buildings and one detector post are constructed, have been tested and are ready for use; the x-ray equipment from Westinghouse has been largely rebuilt and is generally satisfactory (about one x-ray shot in five must be discarded because of inconstant intensity); x-ray scattering by the gadget and by the detector post and its contents has been brought under control; the problem of supplying adequate power to the counters has been successfully solved; the indicator circuits from the counters have been worked out; and the counters themselves have been developed and constructed as well as could be expected. The one remaining factor not yet adequately evaluated is the day-to-day consistency of the counter response; studies of the last two weeks indicate that this factor may require further development. Finally, the magnetic method, which is to be used in conjunction with the counter method, has been placed in very satisfactory working condition.

3. The present performance of the counter experiment is perhaps best illustrated in Figs. 1-4. Fig. 1 is a theoretical profile of a Pb-cored Al gadget model for the linear array of 44 1-mm counters arranged with 1-mm and 2-mm spacings as shown. The effect of the penumbra, caused by an x-ray focal spot 12 mm wide and of uniform intensity, is indicated. The model consists of a 3-cm Pb core in a collapsed Al gadget of size corresponding before collapse to 6" in diameter and 1½" in wall thickness. Fig. 2 shows the observed response of the counters to the x-ray shadow of this model as totalled for 6 x-ray shots. The x-ray intensity should be previously adjusted to give about 90% probability of counting in the illuminated region and should be constant for all the shots; the intensity in Fig. 2, although selected to be constant, is a little too high and the observed shadow appears too small. The intensity was better adjusted in obtaining the profile of Fig. 3.

4. The statistical nature of the counter data is indicated in Figs. 3 and 4. Fig. 3 shows a profile of a Pb disc and of a concentric Pb annular shield. This profile was obtained with a total of 20 successive x-ray shots; Fig. 4 shows the breakdown of these data as the 20 shots were accumulated. The statistics of each counter is such that the mean probable error in firing is just about twice as large as expected from simple random probability. This factor of 2 is not unreasonable for counters of the very small volume and elongated shape in this experiment. It is concluded that a minimum of 6 to 8 shots is required in averaging out the statistics of the yes-no type of response of each counter in determining the shadow diameter with an accuracy of 10 to 15 percent.

5. Although practically all of the difficult technical problems have been solved and the method has been shown to be feasible on the basis on which it was undertaken, our recommendation now is to abandon the experiment. Our reasons for this recommendation are much less because of technical difficulties than because of recent practical exigencies in the work of the implosion project as a whole. These reasons are outlined below.

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6. The experiment was undertaken about a year ago as the most promising (though not entirely satisfactory) method of studying implosions on a scale as large as 1/3. Since then, the Ra-La and the Betatron experiments have been developed and appear to give data on 1/3 to 1/2 scale implosions with accuracies of the order of 25% in compression (Ra-La) and 5% in diameters (Betatron). These accuracies are considerably better than the 10 to 15% in diameters that may be realized in the counter experiment.

7. The few charges (e.g., less than a dozen 6-inch lens charges per week) that may be expected from S-site during the next several months are not sufficient to feed the Ra-La, Betatron and Counter experiments simultaneously. Because of the statistical nature of counter data, the counter experiment requires about ten times as many charges to yield a significant datum than does either of the other two experiments.

8. The third factor in our recommendation is the time schedule on which it seems possible to place the experiment in data-taking operation. Only one-half the counters in one detector post have been installed. Only one of two detector posts has been constructed. It is estimated that at least one month of continued effort would be required to have one complete detector post operating, and another month to place the second post in operation. Approximately two weeks of additional operational time (about ten shots) would be required to ascertain the diameter of an imploded gadget. Hence, the earliest reliable implosion data would not be forthcoming before May 1 or June 1.

9. Irrespective of the time schedule for operation, and irrespective of the few remaining experimental difficulties, it is believed that the statistical nature of the counter data (which requires a large number of the very scarce charge castings) and the relatively low accuracy to be expected, dictate now the wisdom of abandoning this experiment in favor of the Ra-La and Betatron methods.

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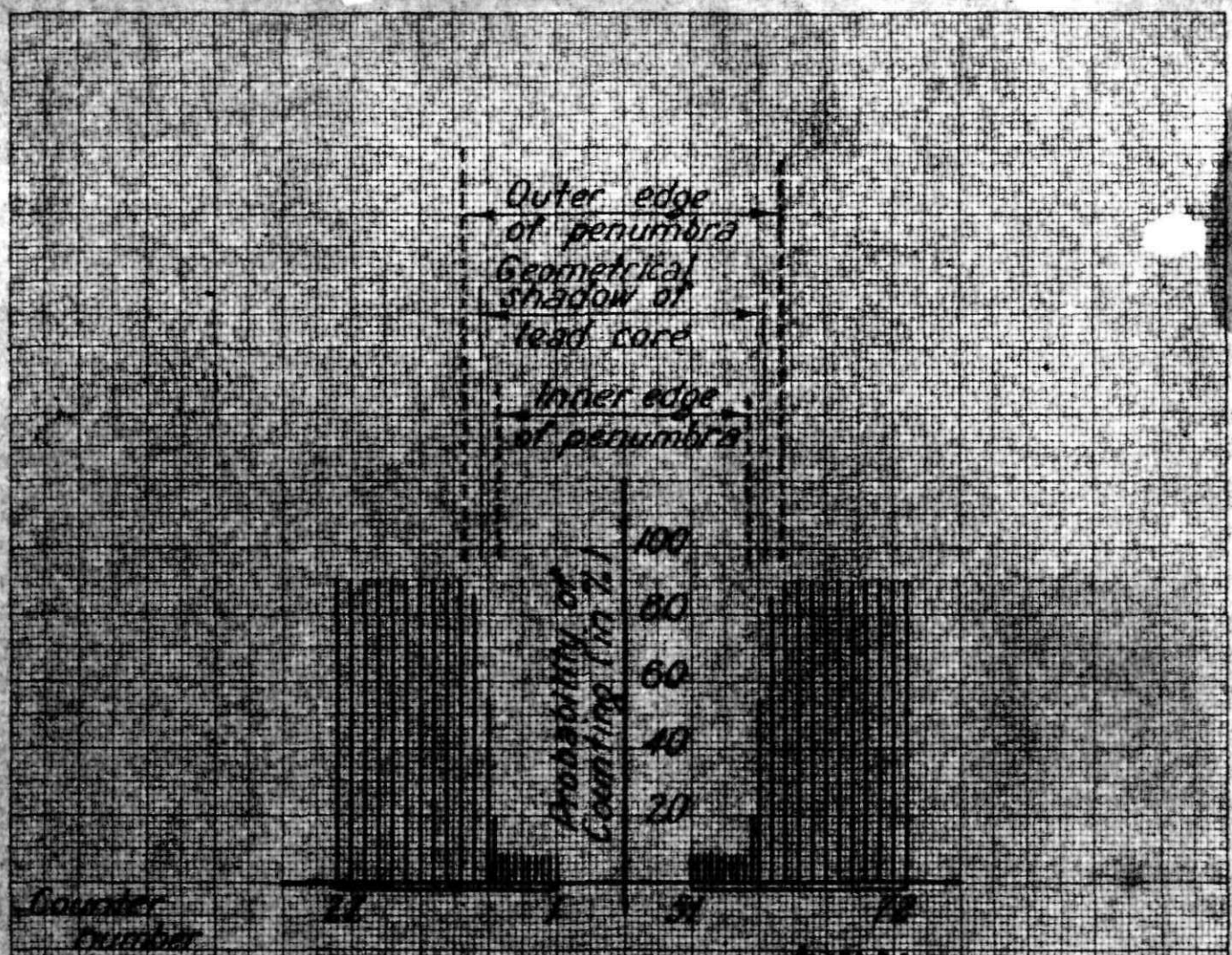

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Fig 1. Calculated ideal pattern for a gadget model assuming uniform 4 % scattered intensity.

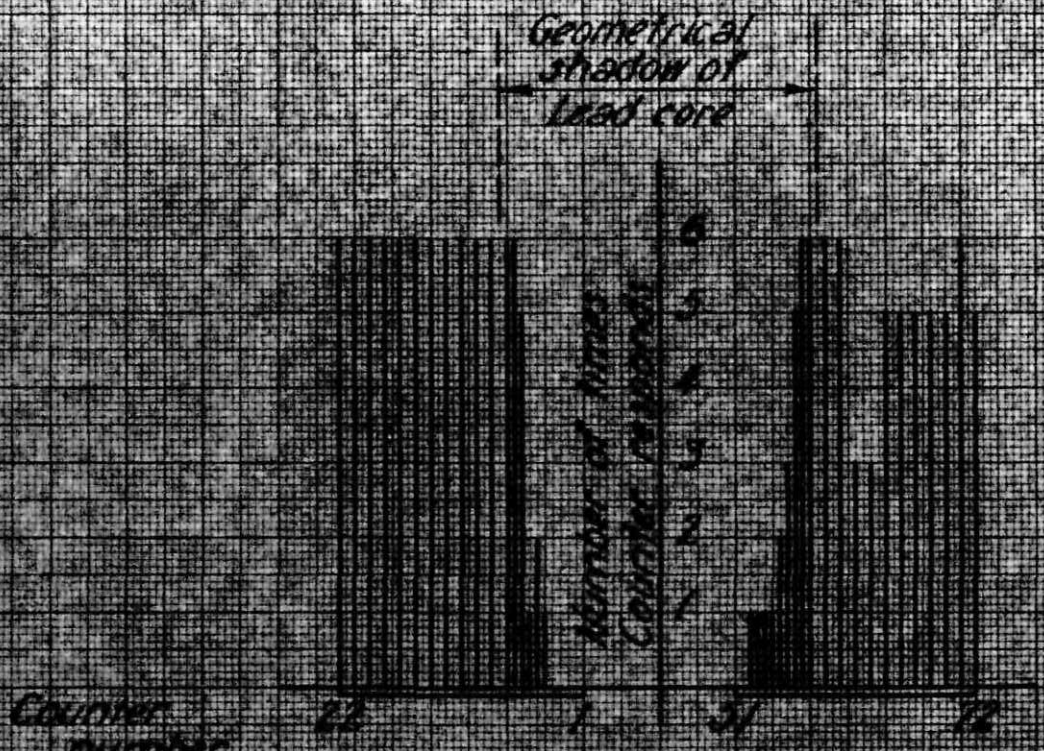

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Fig. 2. Observed pattern for a gadget model for shots selected on basis of X-ray intensity (Intensity range from 0.40 to 0.80 as read on the dosimeter)

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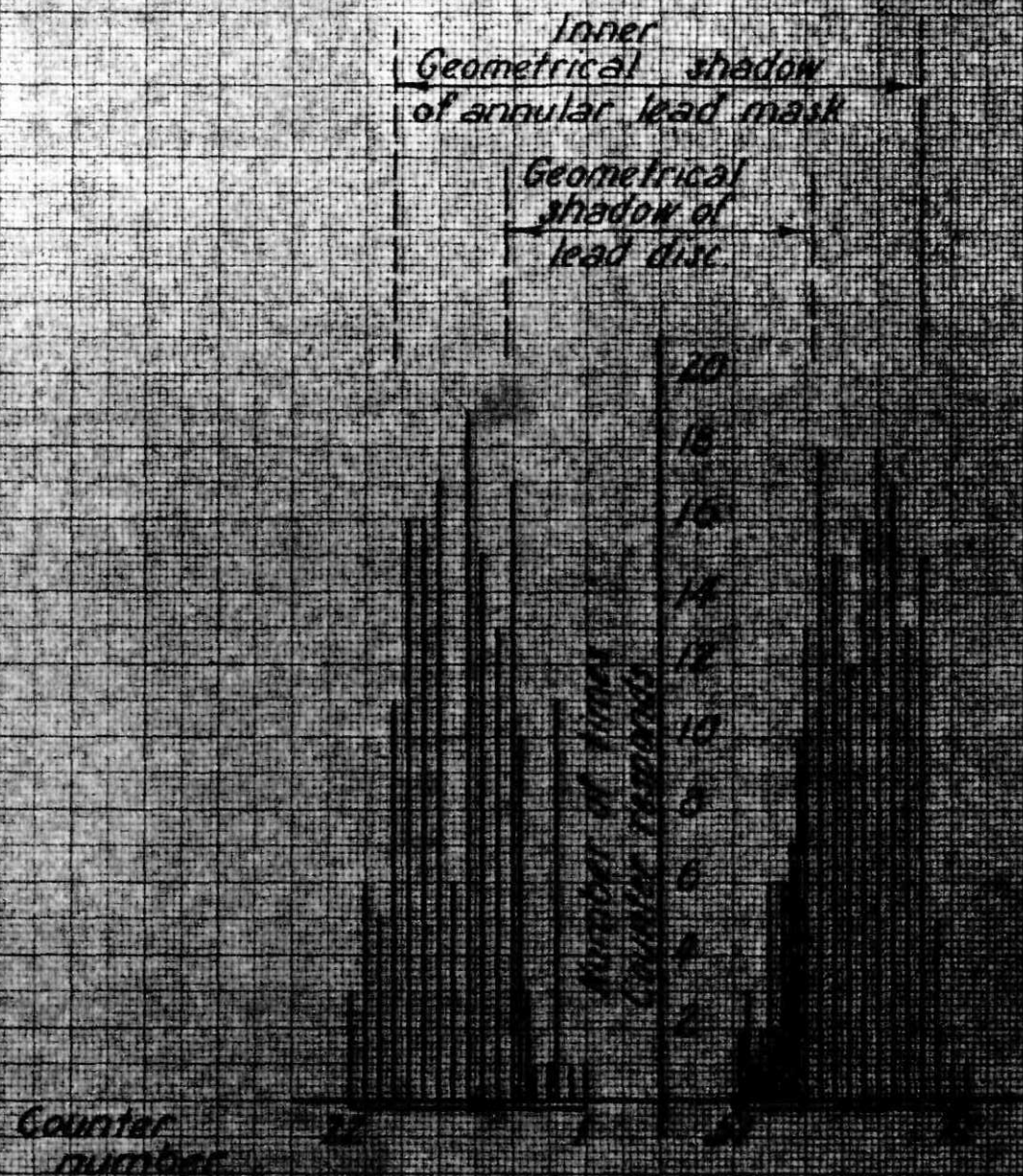

Fig. 3 Observed pattern for a 3 cm lead disc in the center of an annular lead mask 5.1 cm I.D. and 10 in O.D.

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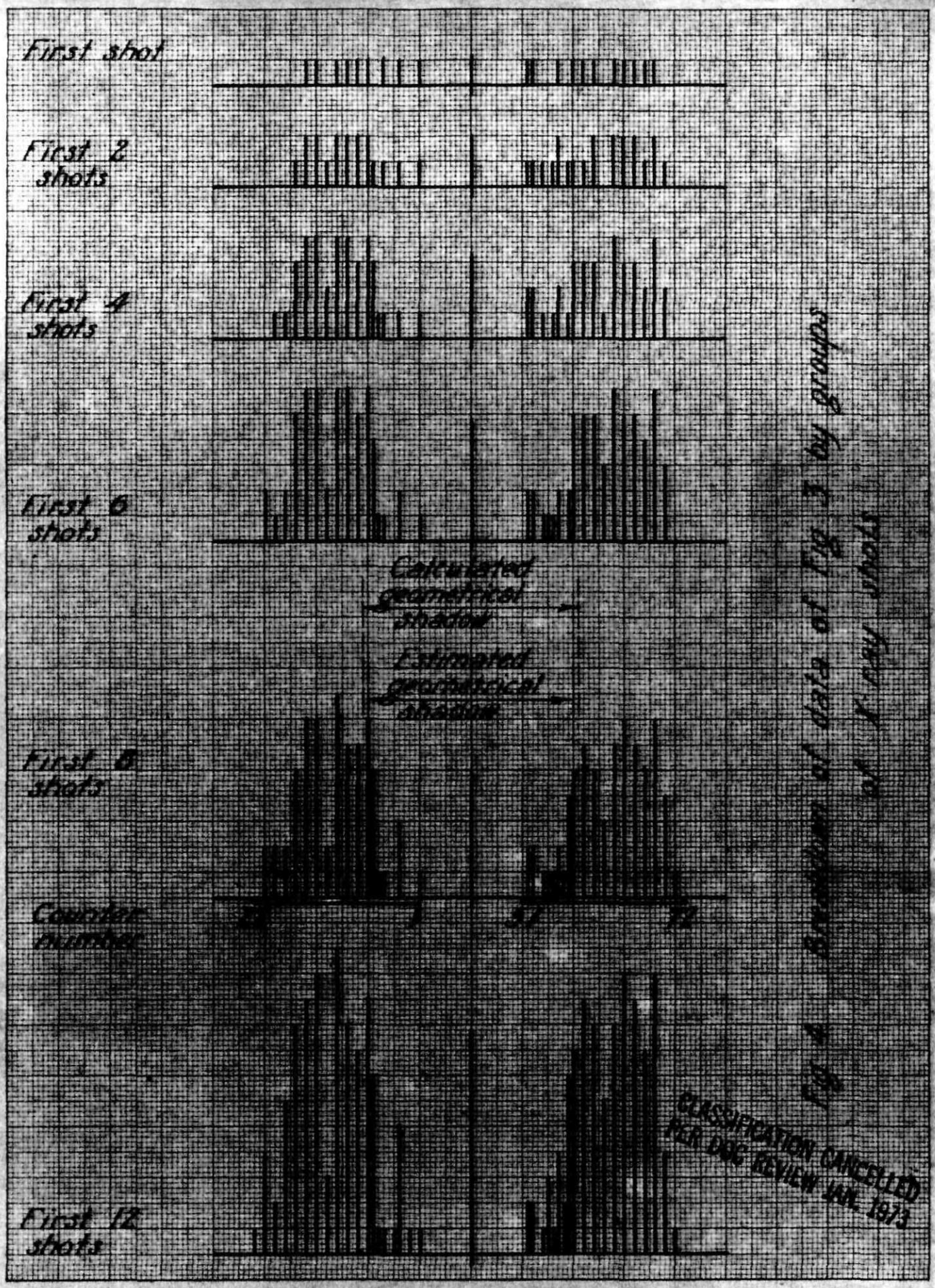

Fig 4 Breakdown of data of Fig 3 by groups of X-ray shots

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