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Author
Wakerling, R.K.

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Summary of the Research Progress Meetings of July 29 and August 5

R. K. Wakerling

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Summary of the Research Progress Meetings of July 29 and August 5

R. K. Wakerling

Fragment Energy Distribution in High Energy Neutron Fission. S. C. Wright.

Investigations have been started on the ionization resulting from single fission fragments produced in fission by 90 Mev neutrons. The technique used is similar to that employed by M. Deutsch in his work on slow neutron fission. The counter consists of five units of the type shown schematically in Figure 1. The material under investigation was placed on the target plate and the ionization in the region between the target plate and the grid detected by the collection on the collector plate of the electrons released. A potential of -1200 volts was placed on the target plate with -600 volts on the grid of the counter. The last unit in the series of five had a target plate of U^{235} that could be put into place for use in low energy fission. As a means of checking the ionization chamber, the low energy distribution was compared to that of Deutsch and found to check very well. Figure 2 shows the arrangement of the counter, amplifier, etc.

A curve of the number of fission fragments versus the ionization produced by the fragments exhibits one peak in contrast to the two peaks usually found in slow neutron fission. Figures 3 and 4 show the curves of the numbers of pulses as a function of the energy of the fission fragments in the cases of uranium and thorium bombarded with 90 Mev neutrons. The same type of curve was found when 45 Mev neutrons were used. These results are in agreement with predictions based on the chemical investigation of the distribution of the masses of fission fragments. The maximum energy spent by a single fragment and the average energy of the fragments do not seem to differ appreciably from the slow neutron case.

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Total Cross Sections for High Energy Neutrons. J. DeJuren.

With the apparatus described at a previous meeting employing bismuth fission ionization chambers, the results on the determination of the total cross sections for 90 Mev neutrons have been extended. The geometry of the experimental arrangement is such that the solid angle subtended by the detector chamber at the absorber is .0003 steradians. The change in the ratio of detector to monitor caused by small angle scattering is quite negligible. The absorbers were two mean free paths in length or less.

The hydrogen cross section was measured using 1.9 mean free paths of pentane and a carbon absorber of mass per unit area equal to the mass of carbon per unit area in the pentane distributed over the same length. This procedure makes it unnecessary to use a long counting interval without absorber to determine the cross sections of both the carbon and pentane independently, since only counting intervals employing pentane and carbon are needed. The measurement must be made with extreme accuracy for the cross section desired is a small fraction of the carbon cross section. In two separate measurements the hydrogen cross section determined in this manner was .0745 ±.002 b and .073 ±.003 b.

The difference between the deuterium and hydrogen cross sections was determined in the same manner by using equal numbers of molecules per unit area of D_2O and H_2O. The cross section D - H was found to be .031 ±.002 b.

In Figure 5 is shown the radii of the nucleii as a function of the cube root of the mass numbers for a number of substances. The radius is computed from the expression

$$R = \sqrt{\sigma_T/2\pi}$$

184 inch Cyclotron. J. Vale.

In the 184-inch cyclotron the deflector pulses occur with random orientation with respect to the ion bunches; that is to say, the deflector may be pulsed at a time when an ion bunch is either outside the deflector or at some location along its length. The result is that there is a spreading of the deflected ions. The Electronics Department has been working on the design of a device for phasing the deflector pulse with respect to the rf cycle of the machine. A preliminary form of this instrument has been tried and found to operate successfully. In a brief trial the output of the cyclotron was found to be increased from .6 to 1 as measured in the cave. Some remarkable oscilloscope photographs were shown which exhibit the ability of this device to phase the deflector pulse.

Linear Accelerator Operations. D. Gow.

In the month from June 15 to July 15 the linear accelerator was in operation 125 hours out of a total working time of 309 hours, or 40.5 percent of the time. The innage is being stepped up continuously, and it is felt that in the succeeding month the percentage of useful time will be 60 percent. The usable current of the machine has increased steadily and is now nearly 10^{-9} amperes. This beam is concentrated in a circle of diameter approximately $\frac{1}{4}$ inch at the end of the accelerator. This is higher than the previous normal running current by a factor of nearly 3. The divergence of the beam at the exit end is roughly 10^{-3} radians. The Van de Graaff generator operates very steadily and is stable for long periods of time. A deflecting magnet is being developed so that it will be possible to use the 4 Mev proton beam from the Van de Graaff generator aside from the linear accelerator. During the period under consideration most of the time available has been devoted to experiments on proton-proton scattering by both the counter and photographic film methods.

Proton-proton Scattering at 32 Mev. Counter Method. B. Cork.

Earlier measurements made on the 37" frequency modulated cyclotron are being extended with the use of 32 Mev protons from the linear accelerator. This machine has the advantage of producing a well collimated, monoenergetic beam. At this energy the beam currents are of course smaller; and since the apparatus was designed before the linear accelerator reached the peak of operation, it was conservatively designed to operate with currents of something less than 10^{-10} amperes. The linear accelerator gives 9×10^{10} amperes.

The apparatus consists essentially of a series of annular counters, as may be seen from Figure 6, which shows an axial section of the counter. Figure 7 shows an exterior view of the assembled counter, while Figure 8 shows an interior view of the counter partly assembled. The ring-shaped counters are designed to accept protons scattered into sectors of roughly five degrees angular width. By means of this arrangement the number of protons scattered into each angular range may be detected. A coincidence arrangement may also be employed to detect protons scattered 90° apart in angle into counters at angles 51° and 39°, and 45° and 45°. This gives a check on the contamination present in the hydrogen gas which fills the counter. The entire counter was very carefully made to close tolerances so that the geometry is known with a high degree of precision. The chamber itself is now separated from the exit tube of the linear accelerator by a thin nylon foil in place of the original mica foil shown in the diagram. Pure hydrogen gas is supplied directly to the scattering region from a palladium leak. The gas in the chamber is maintained at a pressure of one atmosphere. The counters are separated from the hydrogen chamber by a thin aluminum spinning and are filled with argon at a pressure of one atmosphere.

When this apparatus was first tried, it was found that there were a large number of counts coming from neutrons. This led to the placement of an 11 inch iron ore concrete wall between the counter and the linear accelerator. In addition, the beam was further collimated by placing on the accelerator side of the wall a series of defining slits. Also, the aluminum foil which separates the beam integrator from the counter chamber had to be moved further away from the counters because of the neutrons produced in it. Many of the neutrons were found to have an energy of approximately 30 million volts, and as yet there has been no explanation as to how or where they arise.

In the process of attempting to cut down this neutron background, experiments were made with various collimating materials. It was found that bismuth and lead were the best materials. To reduce the background to a sufficiently low level, it was found necessary to add another 11 inch wall of concrete. However, background is still high. The neutron background from the 184-inch cyclotron has been reduced by having the counters sensitive only during the $\frac{1}{2}$ per-cent of the time while the linear accelerator oscillators are on. Background measurements with the linear accelerator in operation are made both with and without the proton beam. The counter itself is calibrated by using a known alpha source.

Precautions are being taken to make certain that all of the protons are being detected. It is estimated that .5 Mev of energy is used by the protons in the counter. They give large pulses at angles greater than 27°. In order to increase the size of the pulses at small angles and to cut out counts from 16 Mev protons that are known to be present in the beam, foils have been placed over the apertures of the small angle counters. A great deal of effort has been devoted to getting the apparatus into smoothly working order, so that data are now being obtained that are thought to be reliable.

Proton-proton Scattering Measurements at 32 Mev with Photographic Film.

W. Panofsky.

Concurrent with the scattering measurements using the counter apparatus described in the last section, observations are being made employing photographic emulsions. In this work the experimental arrangement used by the group at Rochester doing similar experiments has been modified to do away with the exit slits and consequently with the problems that they represent. The arrangement is an extremely simple one. Stacks of photographic plates are mounted in the holder shown in Figure 9 through which the collimated proton beam passes. In the scattering region the beam diameter is approximately 3/32 inch. To cut out unwanted energies of particles from the beam it is first sent through an analyzing magnet before passing to the collimating slit area. The plate holder has been carefully designed to allow an accurate knowledge of the location of the photographic plates with respect to the collimating slots and the axis of the beam.

Measurements are being made of the angles of the tracks made by the protons in the emulsion. This is the scattering angle. In this analysis the area of the scattering volume is assumed to be negligible. Tracks will be counted in the angular range from 10° to 80°. In distinction to a counter method the background problem is a considerably less important one. Neutrons may be excluded from consideration by counting only those tracks which start in the photographic emulsion and further by counting only those tracks within a certain track range. The number of tracks that do not check the range is only approximately 6 percent and represents the effects of contamination. Thus far no significant data have been gathered, for a major part of the time has been devoted to the matter of checking the background.

Status of the Synchrotrons at Michigan and Cornell. E. McMillan.

Professor McMillan reported briefly on his recent trip to the East, during which he visited Michigan and Cornell and saw the synchrotrons that are in process of construction at these places. At Michigan, where Professor Crane is building a race track type synchrotron, one quadrant of the magnet has been completed and operated at 60 cycles for the purpose of magnetic measurements. When the instrument is completed, it is planned to operate it at 20 cycles. Preliminary results show small phase lags so that it appears that the magnetic field is perhaps better than it needs to be. This machine, which is designed to produce 300 Mev electrons, does not use betatron injection, but rather will employ a Cockroft Walton accelerator for the injection. It appears that this machine is still several months from completion.

The 300 Mev synchrotron at Cornell is essentially complete and the magnet has been operating for a short while at approximately 40 percent of full voltage. It is planned to operate it continuously at 60 cycles. Thus far an elaborate series of phase lag measurements have been made which exhibit the same characteristics as those made here, in spite of the fact that the magnet is considerably more symmetrical. They plan to look for a beam within two or three weeks.

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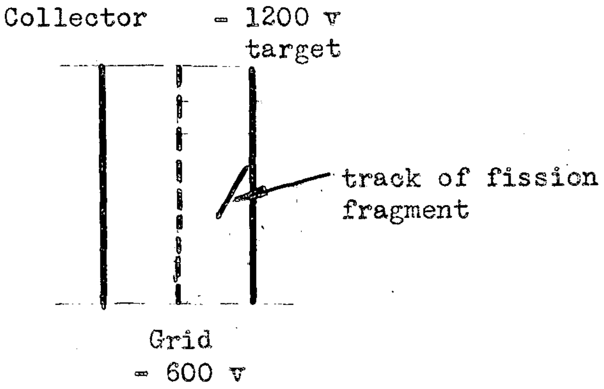

Figure 1

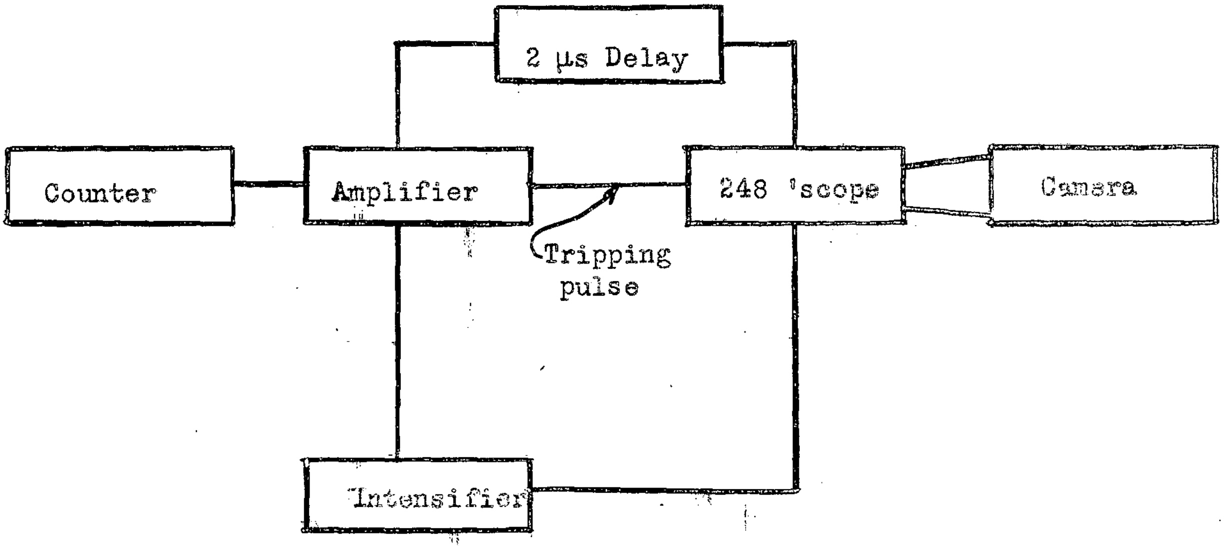

Figure 2

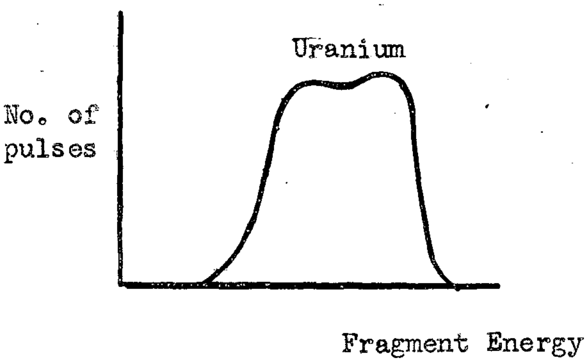

Figure 3

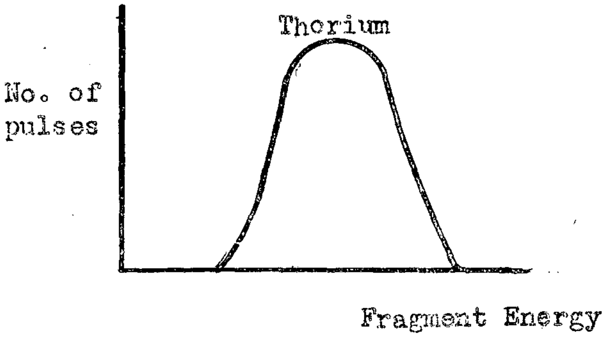

Figure 4

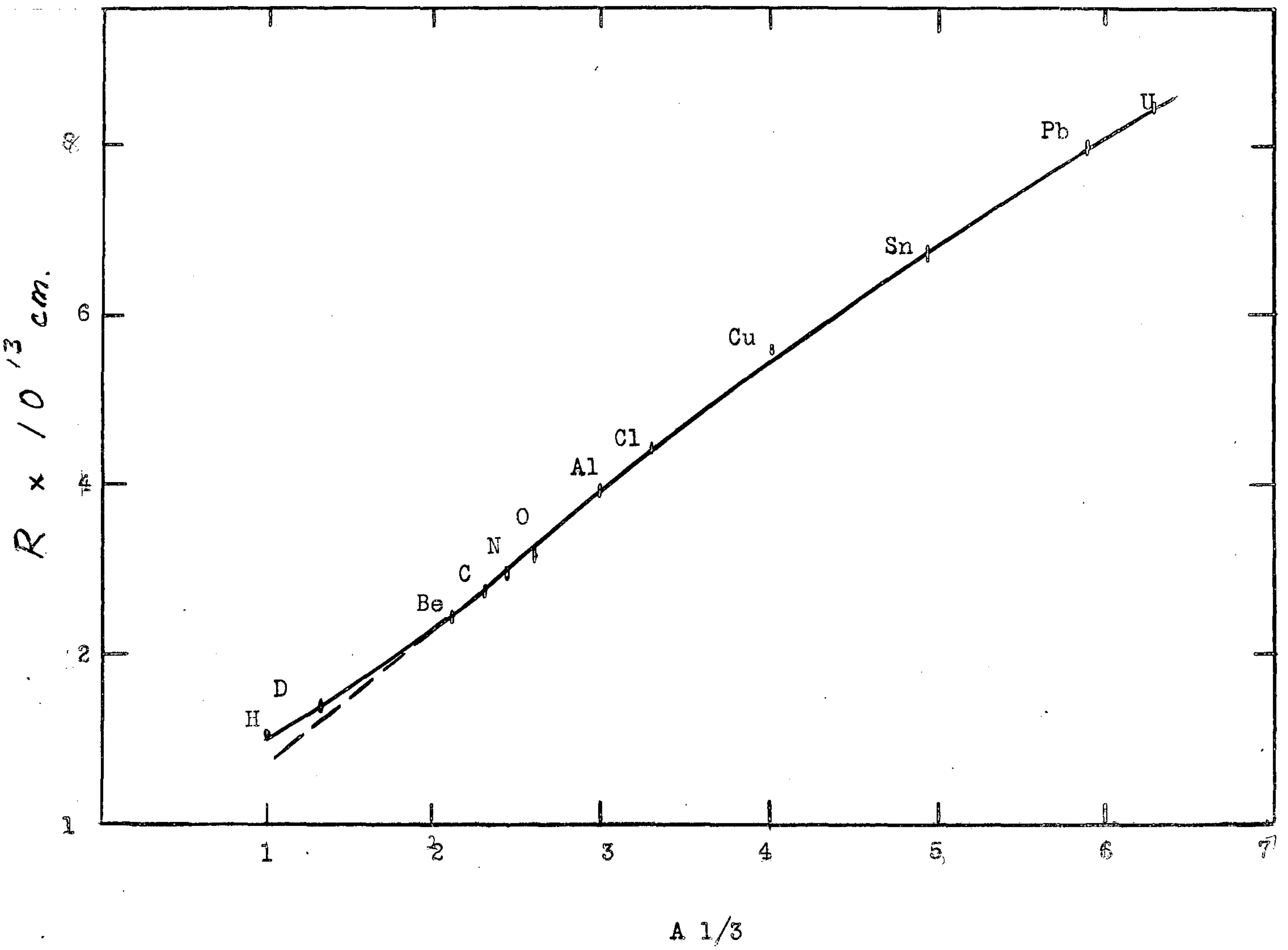

Figure 5.

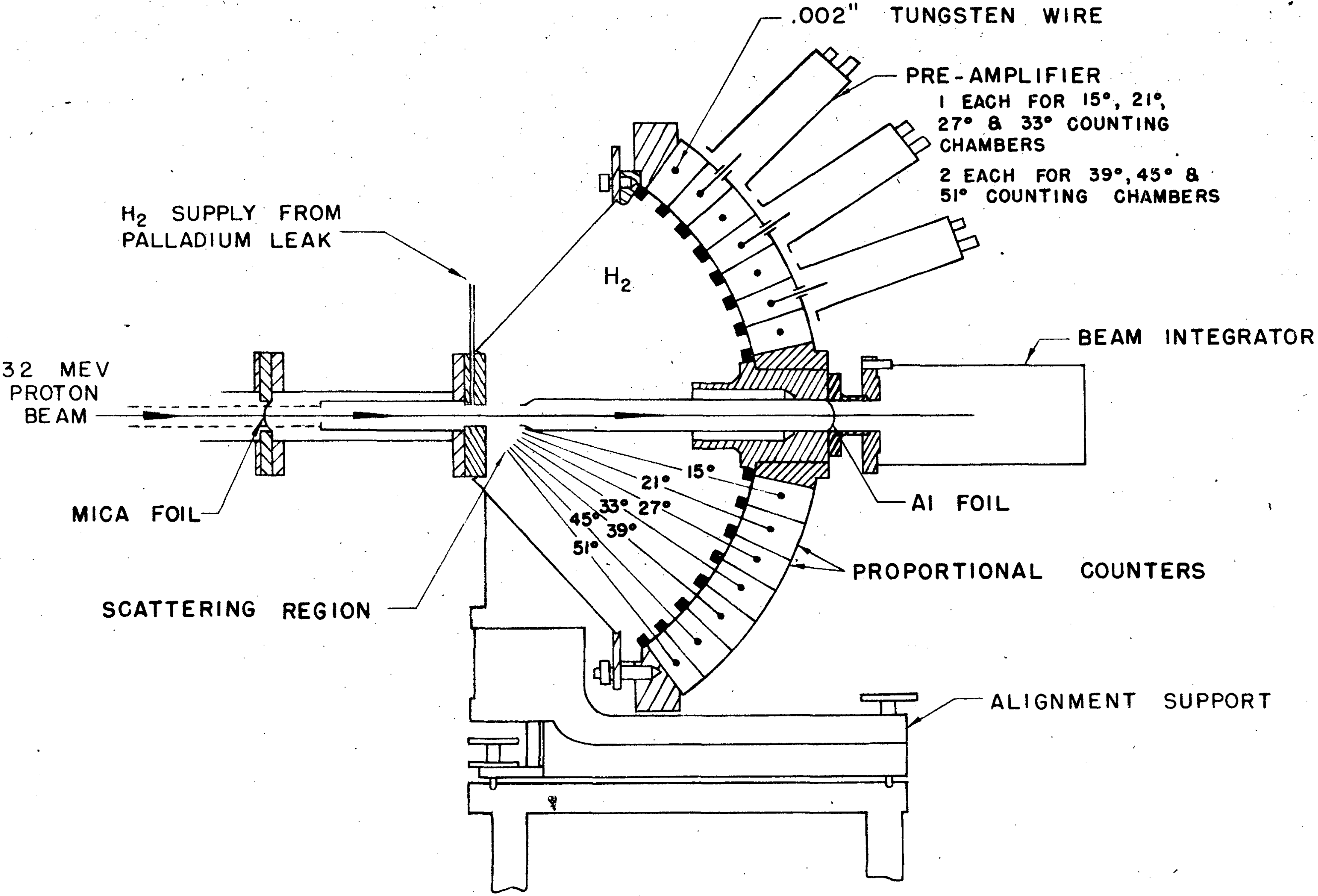

FIG. 6

PROTON-PROTON SCATTERING CHAMBER

FIG. 7

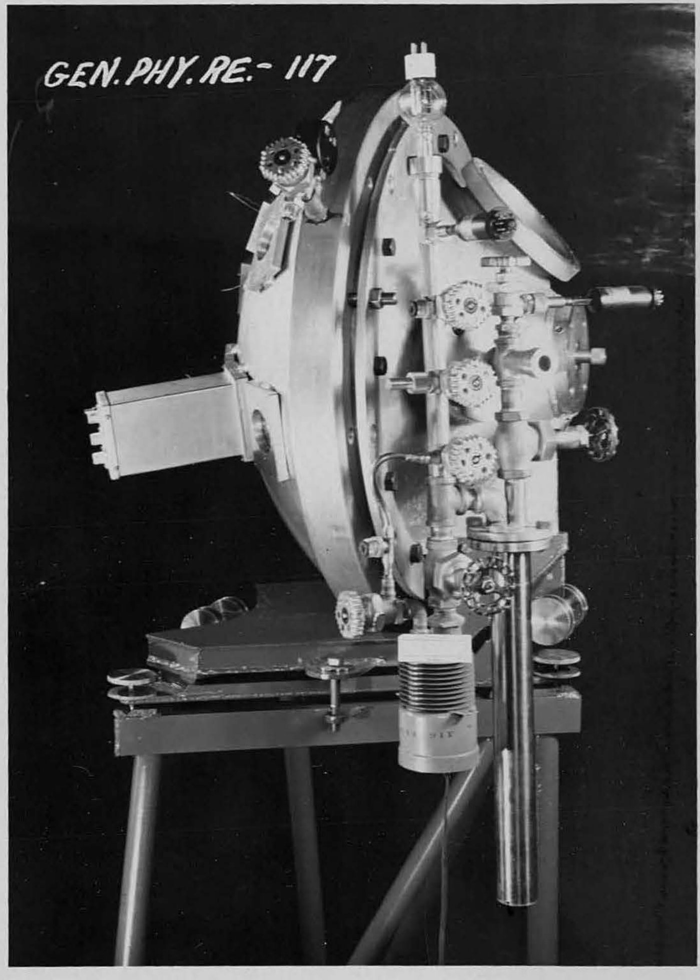

FIG. 8

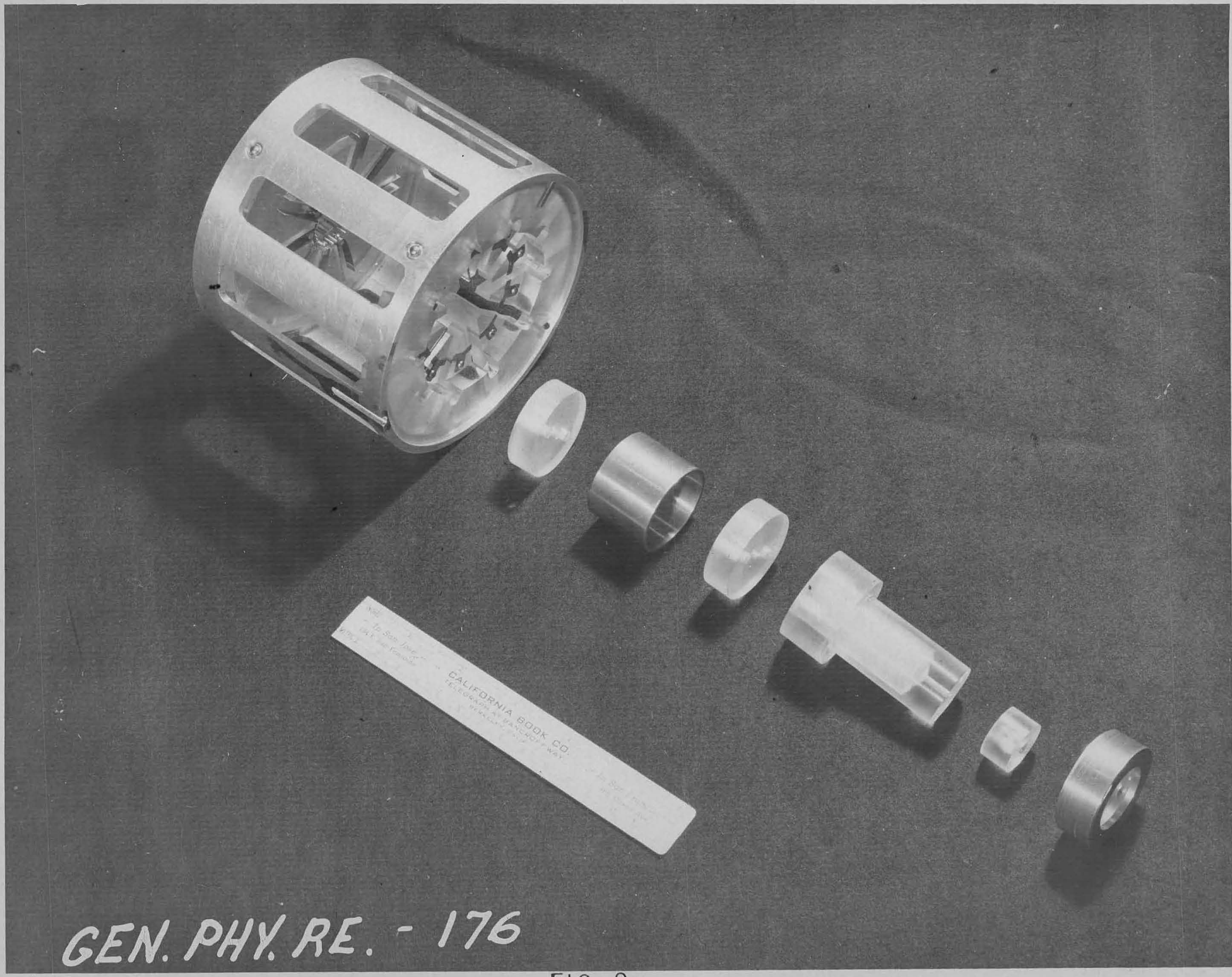

FIG. 9

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