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(For oral presentation at the Washington meeting of the American Physical Society, April 29, 30 and May 1, 1948)

ABSTRACT

Production of Mesons by the 184-inch Berkeley Cyclotron. Part I. Experimental Arrangement. Eugene Gardner and C. M. G. Lattes, Radiation Laboratory, Department of Physics, University of California, Berkeley. We have observed tracks which we believe to be due to mesons in photographic plates placed near a target bombarded by 380 Mev alpha particles. The plates used were Ilford Nuclear Research Plates, type C.2. The identification of the particles responsible for the tracks was first made on the basis of the appearance of the tracks; they show the same type of scattering and variation of grain density with residual range found in cosmic ray meson tracks by Lattes, Occhialini, and Powell[1], and about two-thirds of them produce observable stars at the end of their range. For a 10-minute exposure in the cyclotron, about 50 meson tracks are found along the 3-inch edge of a photographic plate. Carbon, beryllium, copper, and uranium have been used so far as target materials, and all are found to give mesons. When a carbon target was bombarded with 300 Mev alpha particles, mesons were found but with reduced yield.

[1] C. M. G. Lattes, G. P. S. Occhialini, and C. F. Powell, Nature 160, 453, 486 (1947)

This paper is based on work performed with the support of the Atomic Energy Commission under Contract W-7405-eng-48 with the Radiation Laboratory, University of California, Berkeley, California.

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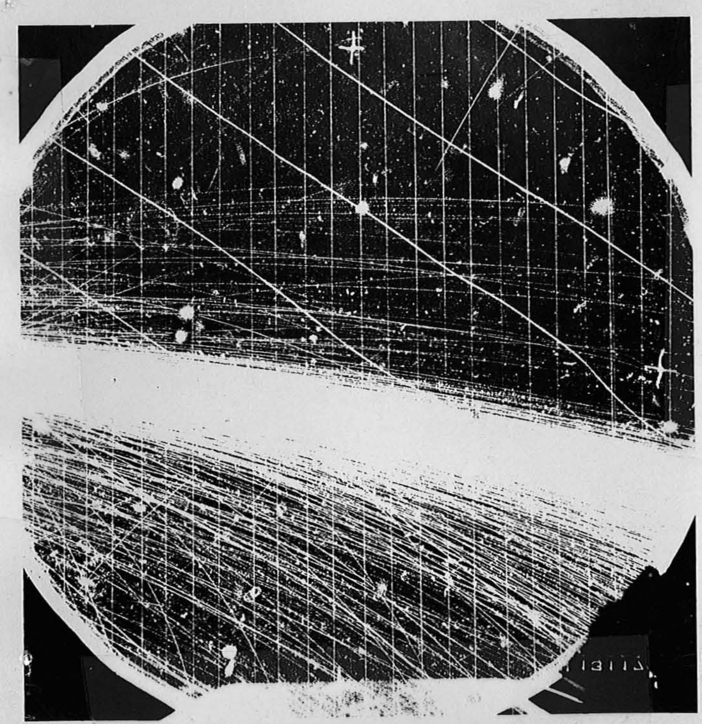
Production of Mesons by the 184-inch Berkeley Cyclotron. Part 1.

Experimental Arrangement. Eugene Gardner and C. M. G. Lattes,
Radiation Laboratory, Department of Physics, University of California, Berkeley.

The first attempt to detect mesons produced by the 184-inch Berkeley cyclotron was made with a cloud chamber in the neutron beam. It was thought that once in a while a meson would be produced in a collision between a high energy neutron and some nucleus in the chamber. If a meson were produced in the cloud chamber it would be recognized by its bending in the magnetic field and its ionization in the gas. No mesons were found by this method.

A more recent application of the cloud chamber to the search for mesons was to pass the deflected alpha-particle beam directly into the cloud chamber. A typical cloud chamber picture is shown in the next slide. (The cloud chamber work was done by a group under the direction of Professor Wilson Powell.)

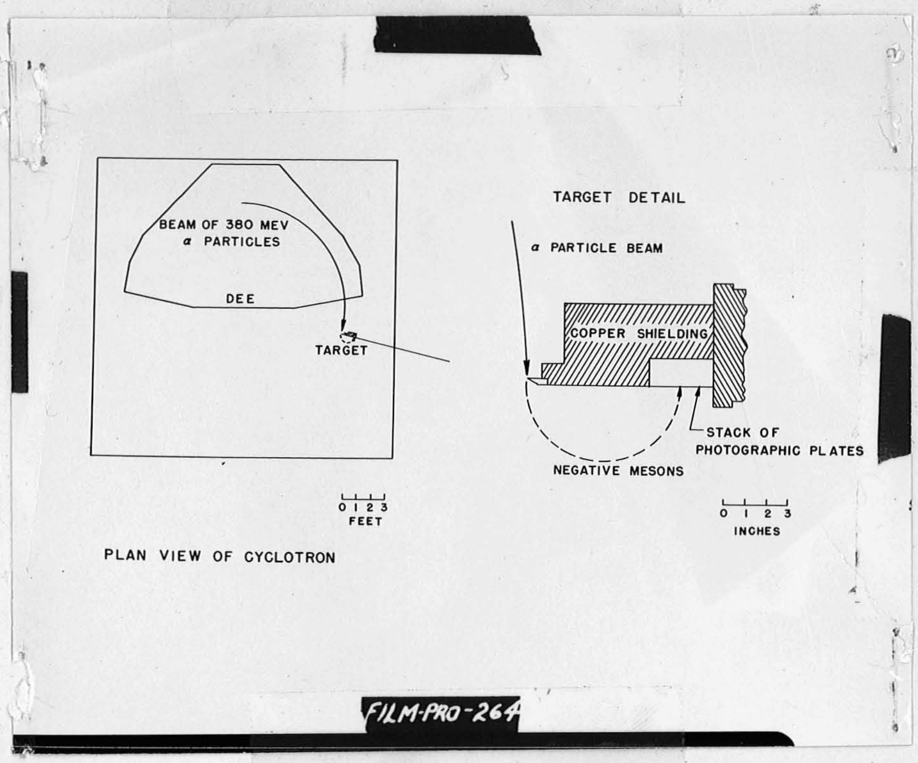


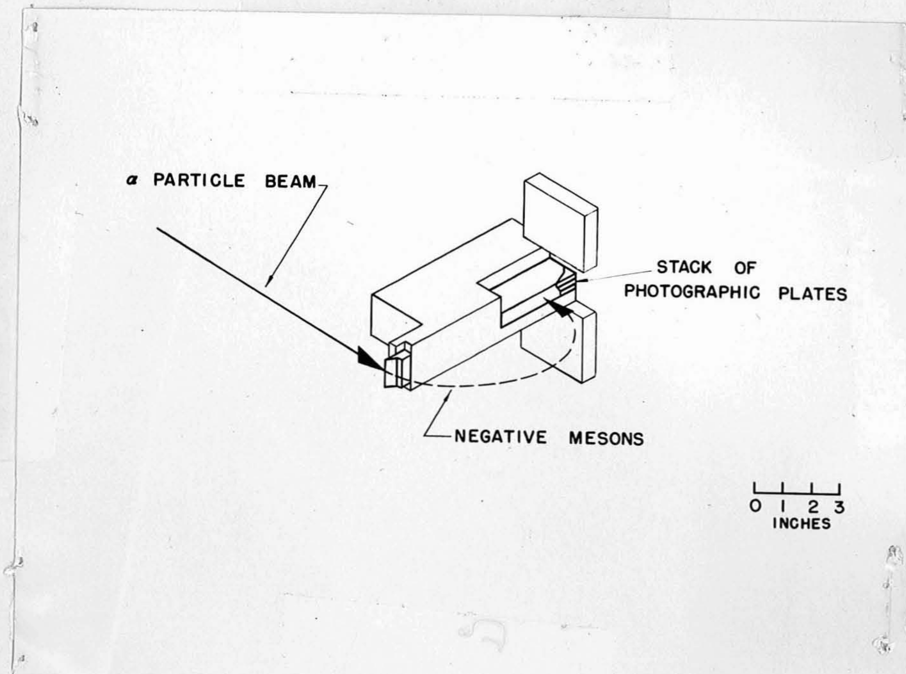
No mesons have been found by this method, either. It is now thought that mesons can be detected in this way; but the cross section is small, and it would take a large number of pictures per meson.

Another unsuccessful method of looking for mesons was to place photographic plates directly in the circulating beam of alpha particles in the cyclotron. This method suffers from the same trouble as the cloud chamber: you have to look at a great length of track to find an event giving meson production.

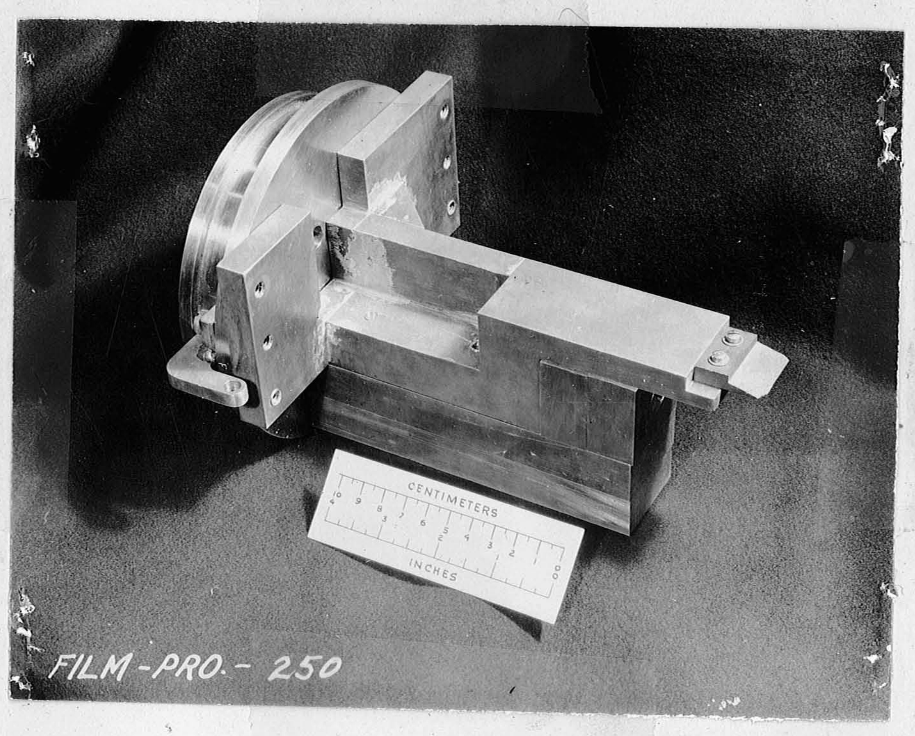
The recent successful attempt to detect mesons followed a suggestion of Professor Edwin M. McMillan. In this method some material, for example carbon, is bombarded with alpha particles; and the photographic plates are placed off to the side where they will not be struck by the direct beam, but where they can be struck by mesons. The 184-inch Berkeley cyclotron can accelerate alpha particles to about 380 Mev. This means that each nucleon has about 95 Mev. This is not enough to make a meson, even if it could all be converted into mass. However, the internal momenta of the nucleons may add up to give a collision in which more than average energy is available.

The arrangement used for detecting negative mesons is shown in the next slides. The negative mesons are deflected by the magnetic field outward from the region occupied by the circulating beam.


BEAM OF 380 MEV
α PARTICLES
DEE
TARGET
0 1 2 3
FEET
PLAN VIEW OF CYCLOTRON
TARGET DETAIL
α PARTICLE BEAM
COPPER SHIELDING
STACK OF
PHOTOGRAPHIC PLATES
NEGATIVE MESONS
0 1 2 3
INCHES
FILM-PRO-264

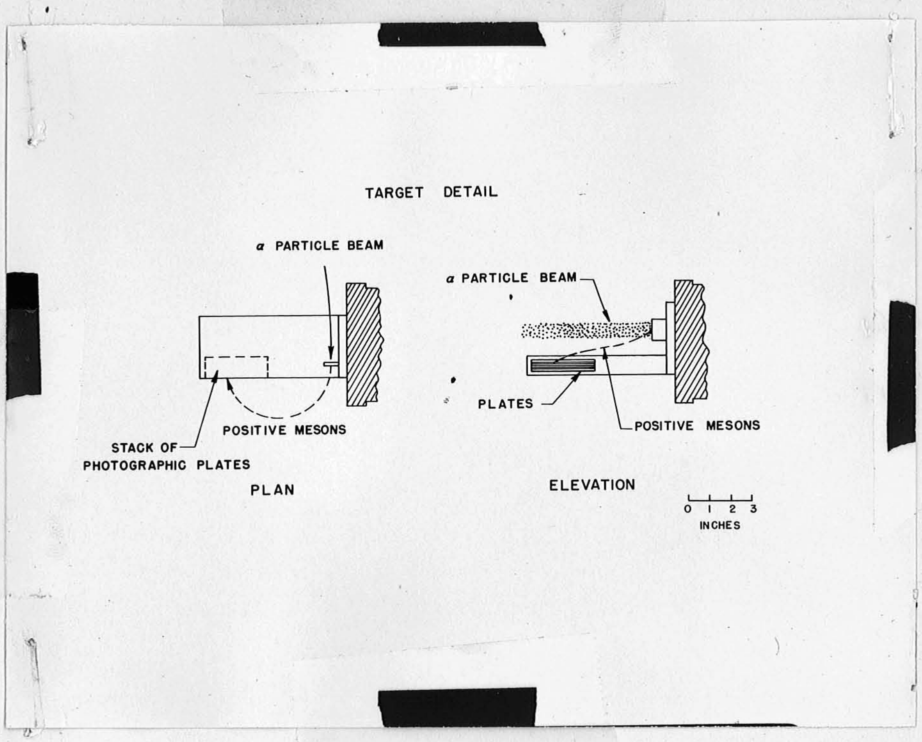

α PARTICLE BEAM
STACK OF
PHOTOGRAPHIC PLATES
NEGATIVE MESONS
0 1 2 3
INCHES

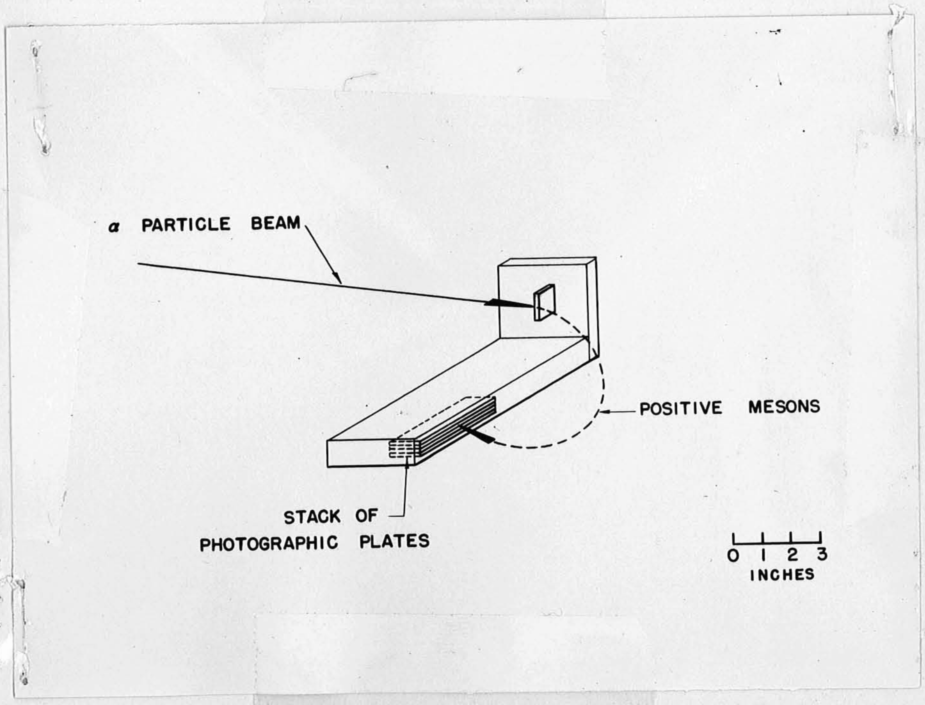
The next slide shows a photograph of the apparatus used for detecting negative mesons (photographic plates not shown)



Positive mesons formed at the target are deflected by the magnetic field back into the region occupied by the circulating beam. In order to detect the positive mesons we have placed plates below the circulating beam, as shown in the next slides.

An alternate method of exposing plates to positive mesons is to modify the shielding on the back of the plate holder used for exposure to negative mesons in such a way that positive mesons can strike the back edge of the plate. Plates run in this way have tracks of negative mesons on one 3-inch edge of the plate and tracks of positive mesons on the other.


TARGET DETAIL
α PARTICLE BEAM
STACK OF PHOTOGRAPHIC PLATES
POSITIVE MESONS
PLAN
α PARTICLE BEAM
PLATES
POSITIVE MESONS
ELEVATION
0 1 2 3
INCHES


α PARTICLE BEAM
POSITIVE MESONS
STACK OF PHOTOGRAPHIC PLATES
0 1 2 3
INCHES

Meson tracks are recognized by their scattering and their rapid change in grain density. The appearance of the tracks can be seen from the next slides. These are taken from plates placed in a position to receive negative mesons.

(see Back of Report)

On plates placed in a position to receive positive mesons, tracks are seen to come in from the edge of the plate. Positive mesons do not make stars, but some secondary meson tracks are seen to begin at the low energy ends of primary positive mesons. It is believed that all of the heavy positive mesons disintegrate into lighter ones, but that some of the light meson tracks are not found because of unfavorable angle or bad background or both. The observations made so far on the positive mesons are in agreement with the observations of Lattes, Occhialini, and Powell[1]. The next slide shows the track of a positive

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[1] Lattes, Occhialini, and Powell, Nature 160, 453, 486 (1947)

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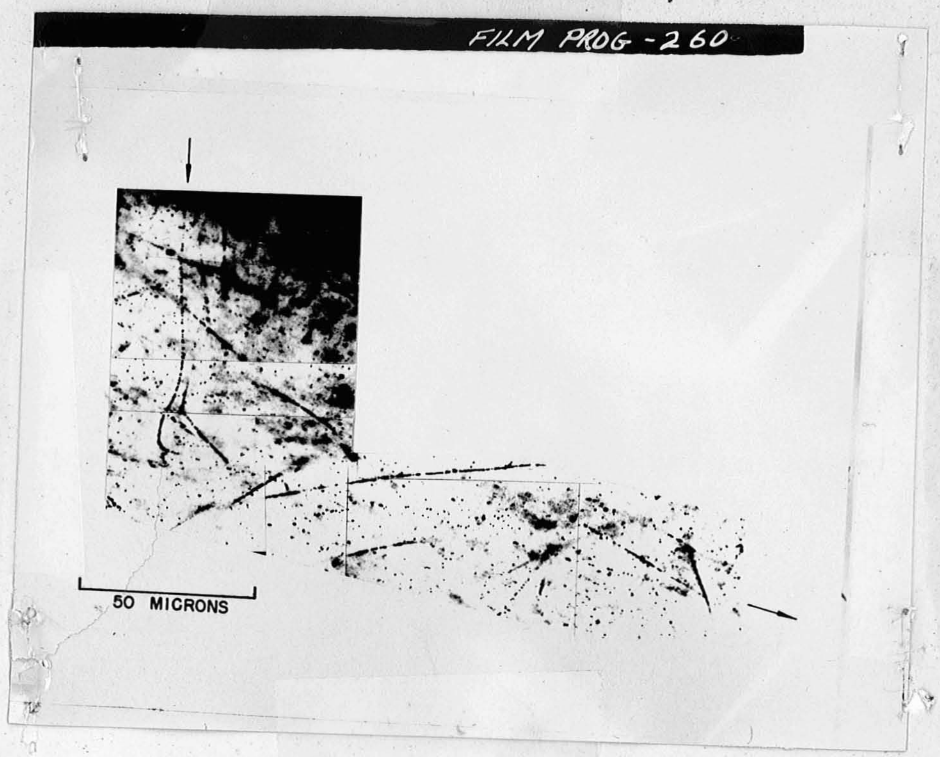
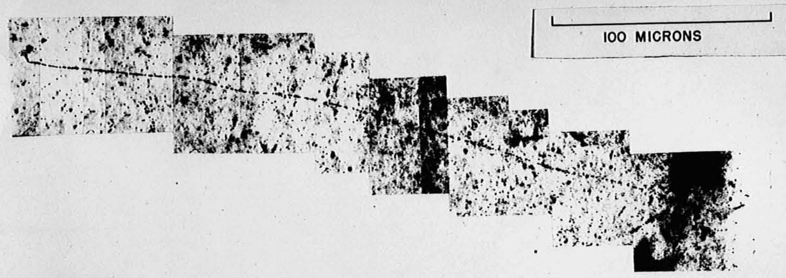
meson coming in from the top. It slows down and stops, and gives rise to a secondary meson going off toward the right.



It is difficult to make a good estimate of the cross section for formation of mesons. So far we have studied only one energy region, and we do not know how many mesons there are with higher or lower energies. (For mesons entering the plates at right angles to the edge, this energy is roughly 2-6 Mev. For mesons entering at other angles the energy is higher.) There are also other uncertainties, such as how many times the alpha particles in the beam go through the target. By making some plausible assumptions, we have estimated the cross section for the mesons which we observe on our plates as 10^{-29} cm^2, but this estimate may be off by a factor of 10 in either direction.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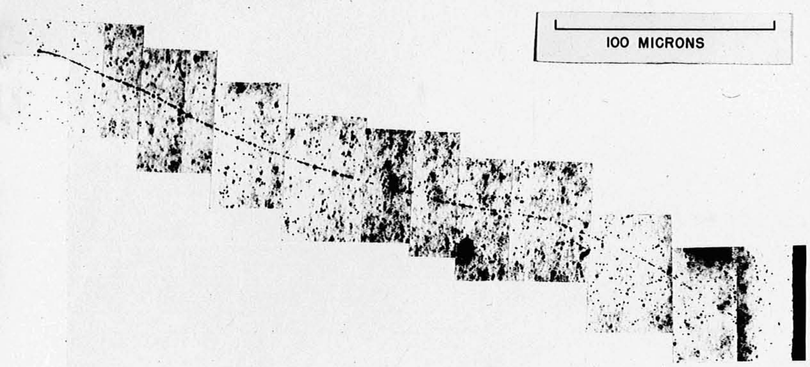
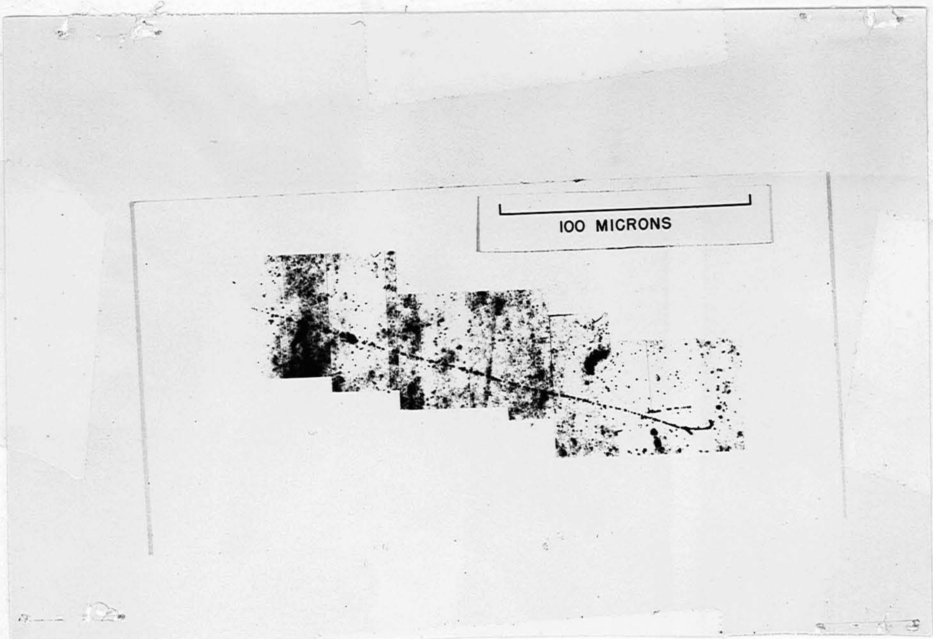
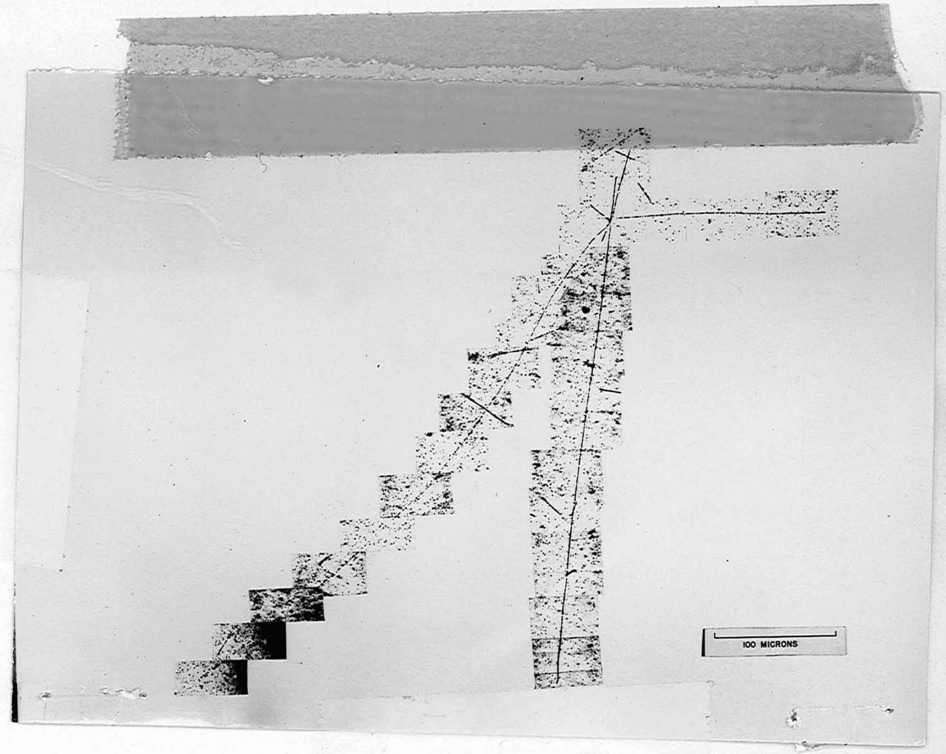
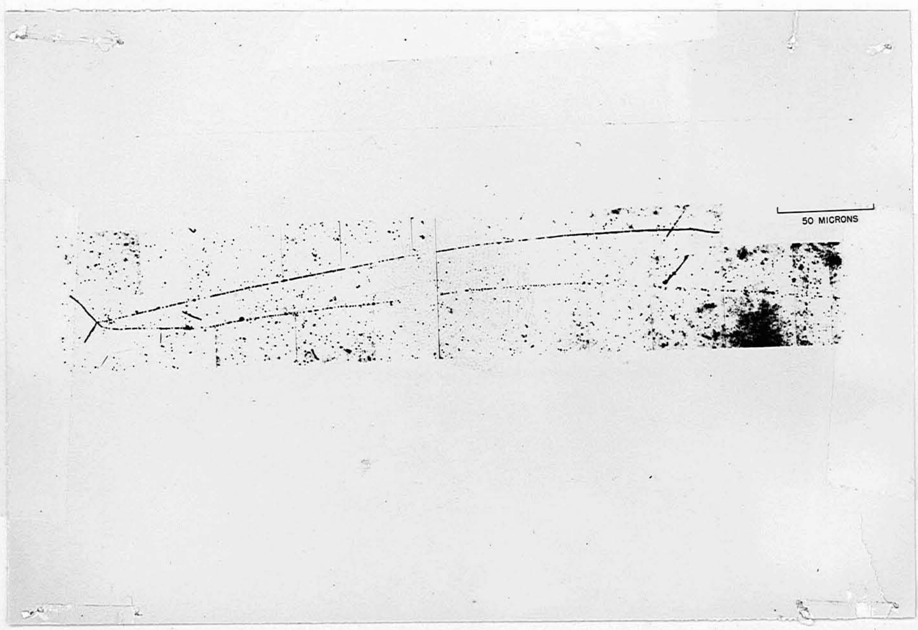

100 MICRONS


100 MICRONS


100 MICRONS


100 MICRONS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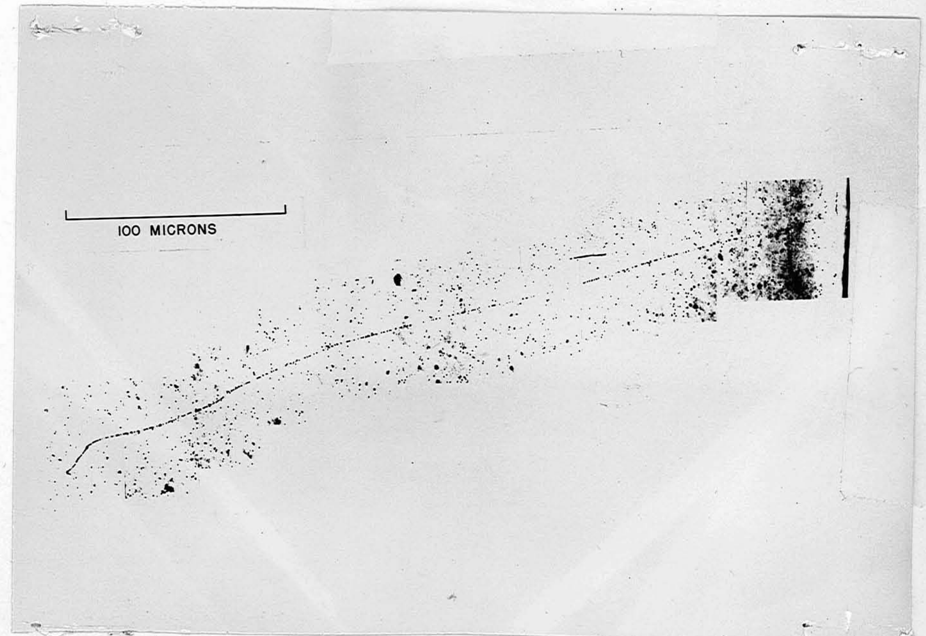
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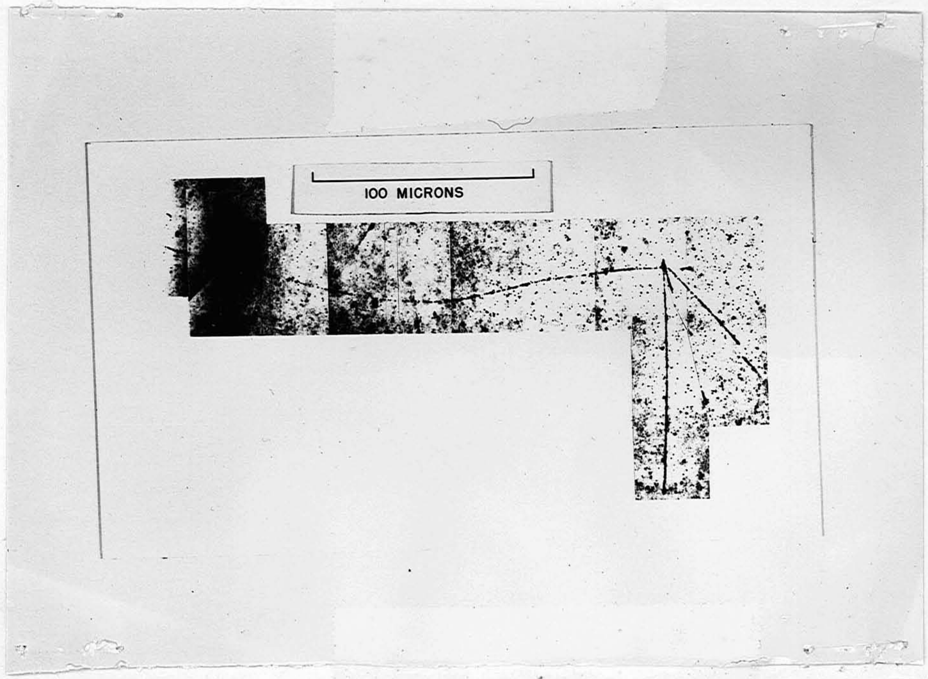
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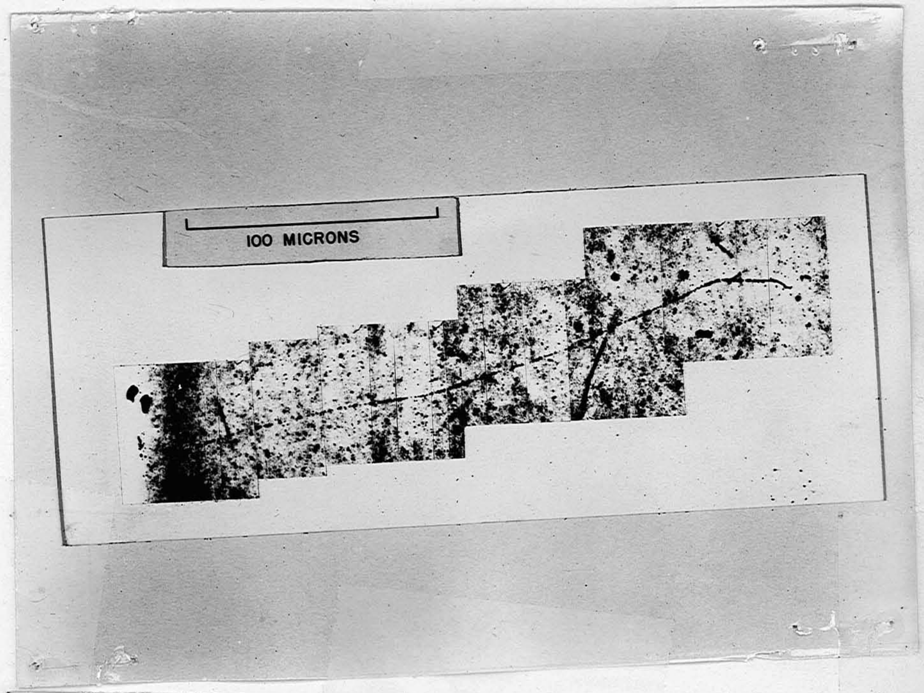
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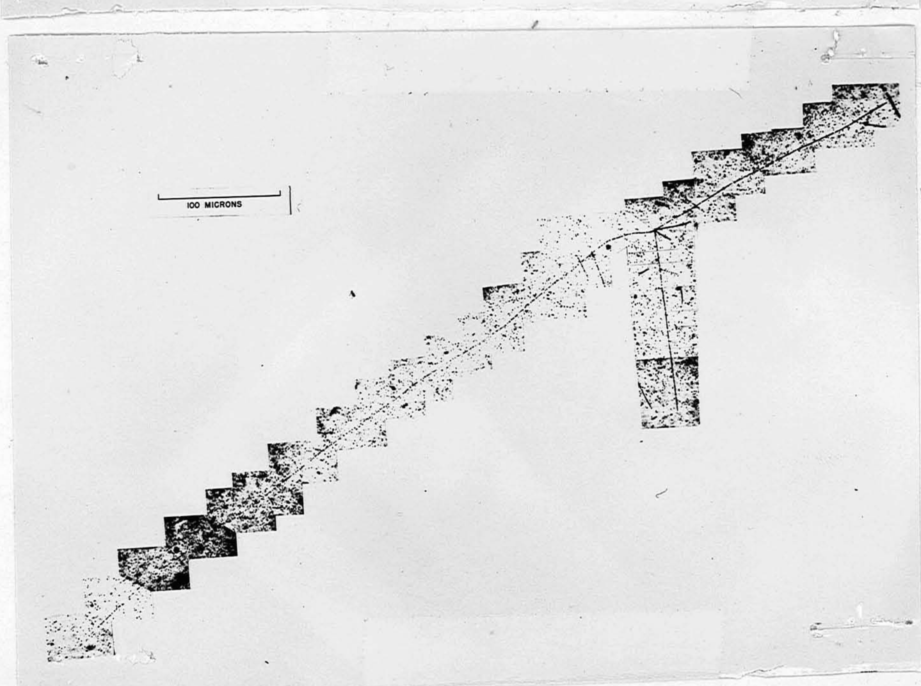
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