Internal Report No. 41

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IMP DETECTOR TESTS

by

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The standard testing procedure for IMP detectors was as follows:

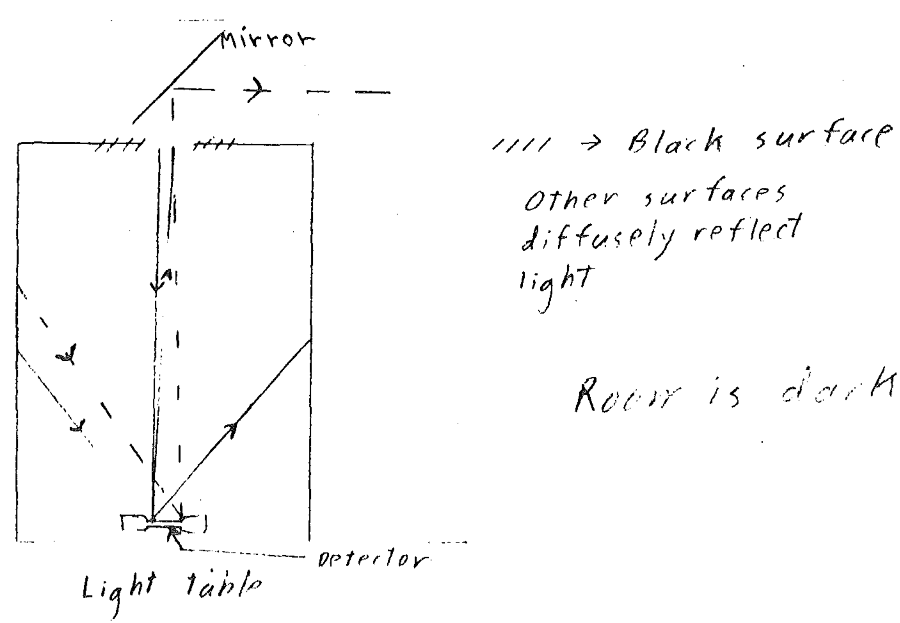
1) Record detector #, serial #, shipping date, date received
2) Visual instpection (15 min.)
3) Photography (15 min.)
4) Optical size scan (1 hr.)
5) Vertical clearance test and thickness measurement (2 hrs.)
6) Mount in holders
7) Thermal vacuum
8) α-depletion (3 hrs.)

The time in parentheses is the time needed per detector for an experienced person.

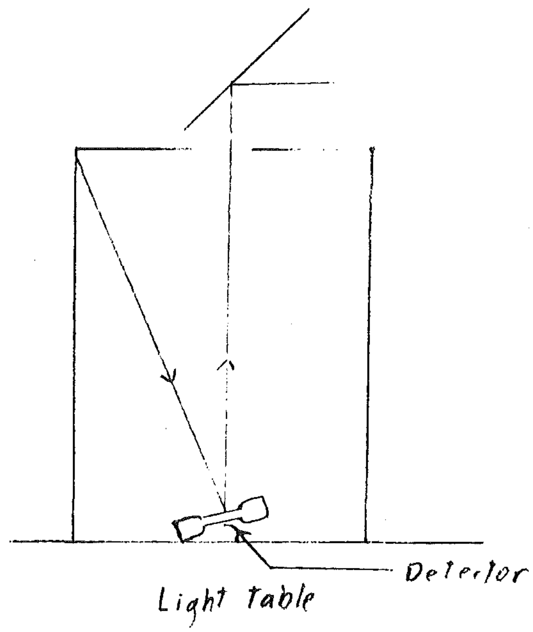
Description of Tests

2) Visual inspection - check for scratches, defects, or anything noteworthy about a detector. Detectors were inspected by eye, with a magnifying glass, and under a microscope. Visual instpection sheets were made up with a complete list of things to check for (samples in IMP-J Detector Data notebook). See Figure 1 for picture of detector in blue ring holder.

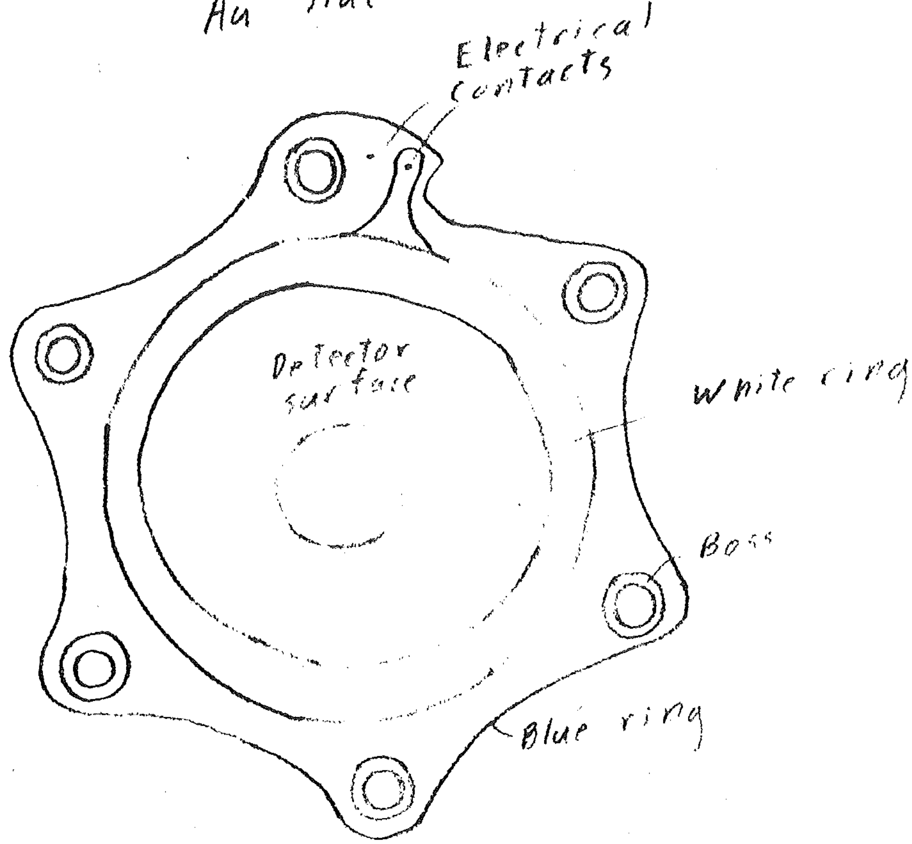
3) A photography jig (in the clean room) was used to get contrast on the picture.



Flat detector surface comes out black. Rough epoxy comes out light. If jig top is reflecting and the detector is placed at an angle, the flat detector top (acts like a mirror) comes out light and the surrounding epoxy is darker



Au side



Al side

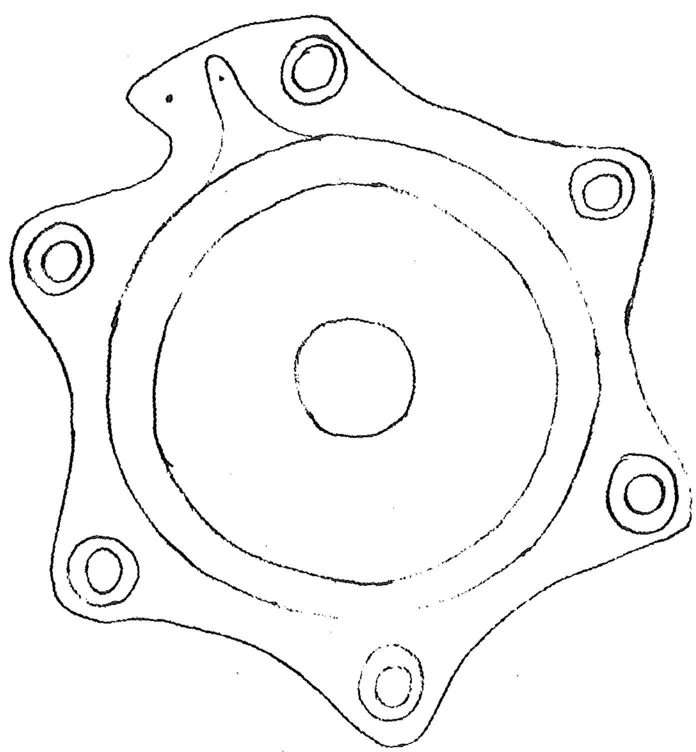
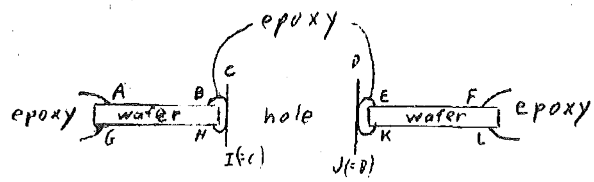


fig. 1

4) Optical size scan - using a traveling microscope that has 10 μ divisions, various diameters were measured (2 perpendicular diameters on each side).



The points shown were measured on annual detectors. A transparent mask with the center etched was placed over the detector to determine the center of the blue ring (see Figure 2). The difference between the blue (ring centers and the hole centers for the annulars was therefore easy to obtain.

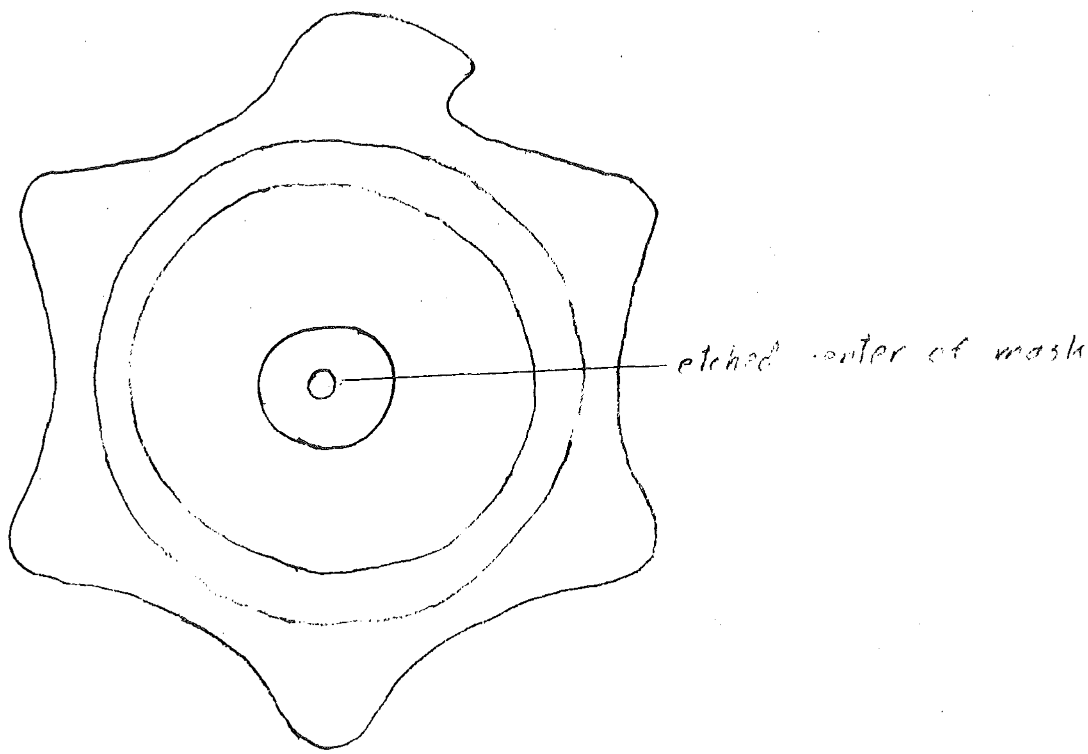
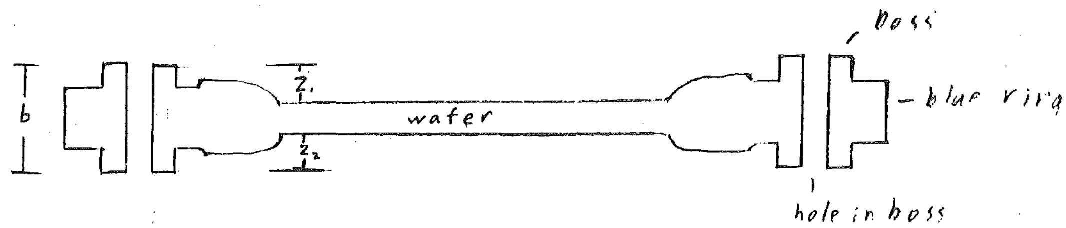


Fig. 2

The standard diameters measured are described in the notebook IMP-J Detectors II.

5) Vertical clearance and thickness measurements were made with a microscope that measures (x, y, z) coordinates to (10μ, 10μ, 1μ). The z levels of all 6 bosses on the blue rings were measured. The epoxy was then scanned to see if any epoxy protruded above the lowest boss. The z level of the detector surface was then measured as a function of position (x, y). To eliminate any effects due to tilt in the detector, the z levels of diametrically opposite points were averaged together.



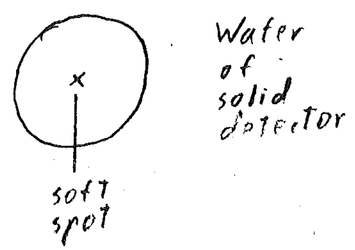
Since the boss thickness b is known, and z_1 and z_2 are measured with the microscope, the detector thickness $b-z_1-z_2$ is known as a function of detector thickness.

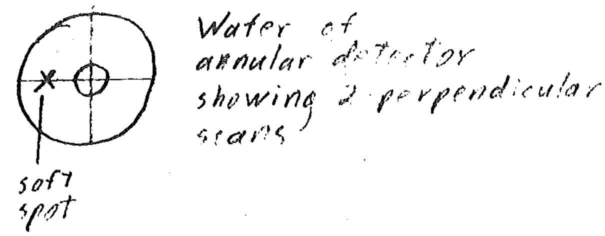
6) A holder has removable covers. The covers are used to protect the detector and are removed when the detector is to be exposed to radiation (electrons, α's). Diagrams of the holders and covers with mounting procedures can be found in Gordon Hurford's detector notebook.

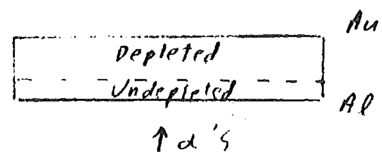
7) Thermal vacuum tests were used to see if the detector can withstand high temperatures and temperature changes. Leakage current, noise, temperature and pressure were continuously monitored with Rustrack recorders. 1000μ detectors were run at 350 v and 50μ detectors were run at 20 v. A typical run went as follows (there wasn't enough time to do more extensive runs):

a) initial check at 1 atmosphere - followed by pumpdown
b) +25° C (1 day)
c) +35° C (1 day)
d) +40° C - bias off (1 day)
e) +35° C (4 days)
f) -35° C (1 day)
g) +35° C (4 days)
h) +25° C (1 day)
i) final check at 1 atmosphere. Bias was turned down in case of detector breakdown. Pure nitrogen was used to air release the vacuum chamber.

8) It was necessary to check that the detector operating voltage was well above the depletion voltage. The depletion voltage at the soft spot (area on detector which has the highest depletion voltage) was measured with 8.785 Mev α's. The soft spot for solid detectors turned out to be in the center of the detector. The soft spot for annulars had to be determined by scanning along 2 perpendicular diameters. For a fixed voltage the spot that collects the least amount of energy from an α particle is the soft spot since only the energy lost in a depleted region is detected.







The α's go into the back (Al) side of the detector. A typical - depletion curve is shown in Figure 3 - note that the origin doesn't correspond to 0 energy. The sharp break in the curve at 150 v is the depletion voltage. Below 150 v the energy peak seen on the pulse height analyzer deteriorates into a broad flat spectrum (indicated by large error bars on the graph). The collection e-ficiency increases slowly until just under 300 v.

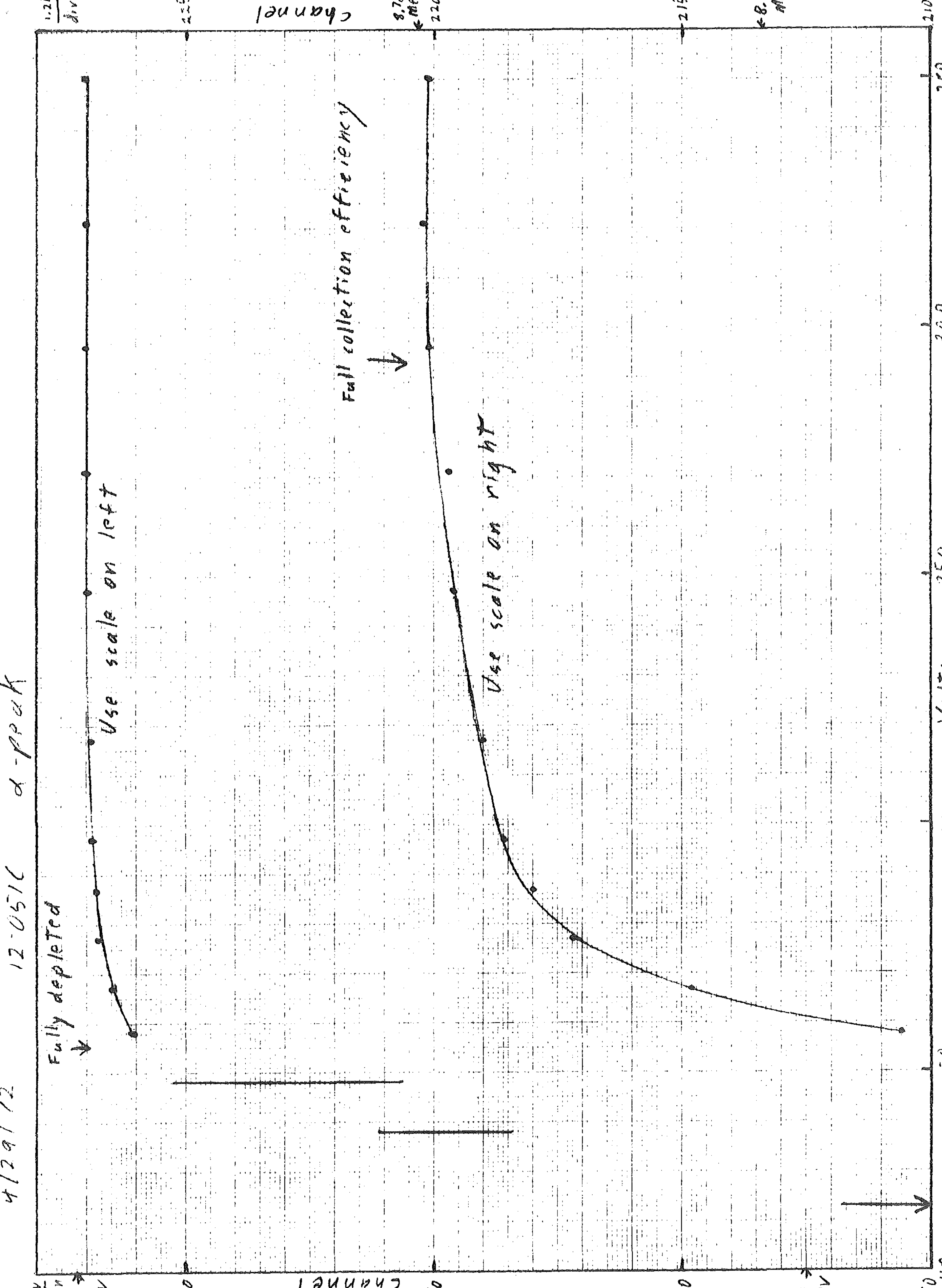

4/29/72
12-051C
α-peak
Fully depleted
Use scale on left
Full collection efficiency
Use scale on right
Volts
channel
8.785 MeV
8.700 MeV
8.8 MeV
7.0 MeV
1.2 keV/division
12 keV/division

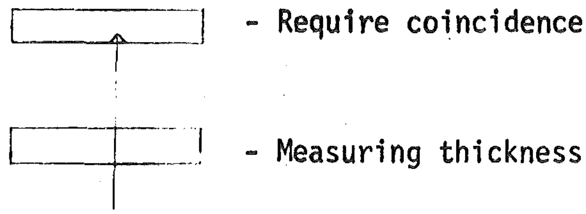
fig. 3

Other Detector Measurements

I) Size scans.

These are described in Internal Report #34 (β-spectrometer)

II) Electron thickness measurements.



An electron beam with enough energy to enter the 2nd detector relativistically was used. A coincidence requirement with the 2nd detector eliminates the total energy peak in the 1st detector. This eliminates many electrons which scattered through large angles. The thickness of the 1st detector can be approximated to 5% using formulas in Rossi's High Energy Particles (sec. 2-5, 2-7).

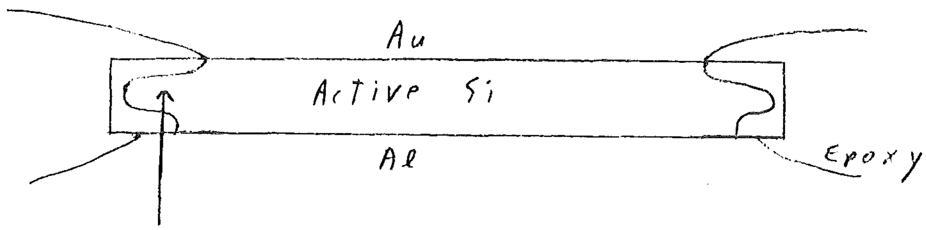
III) Noise, leakage current measurements.

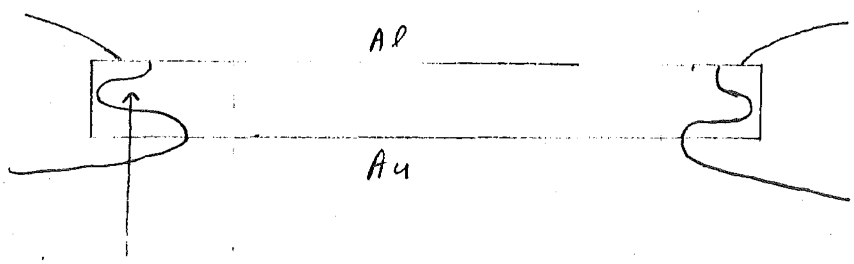
These are described in Internal Report #34 (β-spectrometer).

IV) Tandem measurements.

These involved probing a detector with a finely collimated proton beam. With a back up detector the total beam energy can be measured. By moving the front detector across the beam the thickness as a function of position can be measured. The depletion characteristics of the detector can be measured in this way. However, both sides of the detector must be looked at with the proton beam to determine both the dead layer (Si and expoxy) and the active depleted layer unambigously.

Back up detector - For energetic beam or for Thin detector





Preparation for the tandem runs were time consuming. However, the thickness and depletion measurements with protons are much better than with electrons since protons scatter only through small angles and have a well defined energy-range relationship.