SV

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by
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CALIBRATION OF PULSER WITH α-PARTICLES

The WEA pulser and 2005A power supply are used to calibrate the energy lost by charged particles in a silicon detector, i.e., to determine the detector's output charge , which in turn corresponds to a given energy loss. This report describes the calibration procedure for determining the charge-energy loss relation.

An Am^{241} α-source and a 100 μ silicon surface barrier detector are used to calibrate the preamp test pulser. The source and detector are in a container that has a Leybold connector at one end for a simple connection to the pumping system. The electrical schematic[1] for the 7/6/71 calibration is shown in Fig. 1. (The original 5/69 calibration used a slightly different set up.)

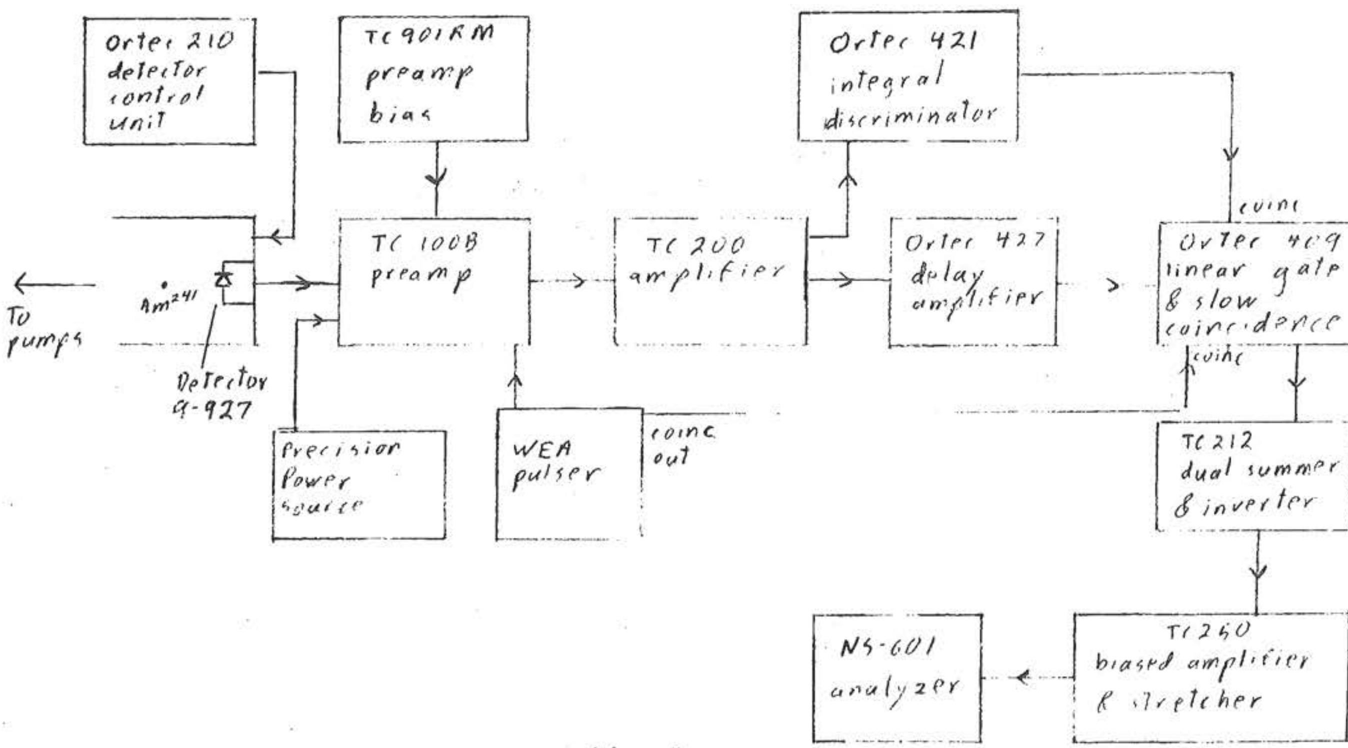


Fig. 1

Fig. 1 caption:

Settings used:

TC 100B	sens. 8 + -
TC 200	Term out int. Fine gain - minimum Polarity - direct 1st differentiator - .4 μsec 2nd differentiator - 1 msec 1st integrator - .4 μsec Coarse gain 4
TC 901	B - 104
NS 601	0 level - 0.00 Threshold - minimum Amplifier gain 10.00 ULD - maximum High level input

A simplified schematic of the test pulser input on the preamp is shown in Fig. 2

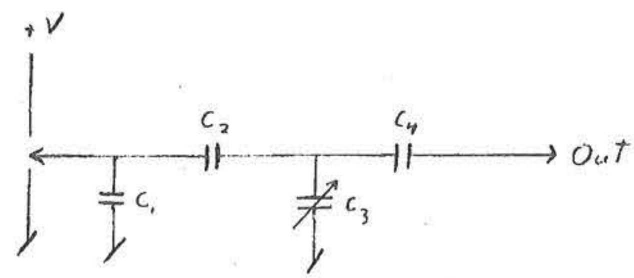


Fig. 2

C_3 is actually composed of several capacitors. For $C_3 \gg C_4$, $q_{out} = \frac{C_4}{C_3} C_2 V$ where q_{out} is the charge on C_4.

Am^{241} decays to Np^{237} by alpha emission. The three most intense α's are 5.486 (86%), 5.443 (12.7%), 5.389 (1.3%) Mev[2]. The energy loss in the detector must be corrected for the window thickness. The window is defined as any dead material. If the

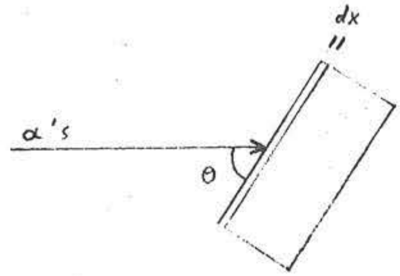


Fig. 3

window's thickness is dx, and the α beam makes an angle θ with the detector, the α beam sees a window of thickness dx csc θ. Measuring the energy loss in some arbitrary pulse height units versus csc θ gives a straight line, as in Fig. 4

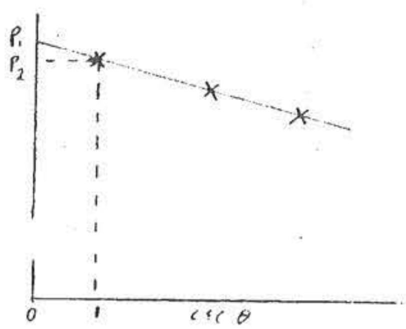


Fig. 4

P_1 corresponds to the total α energy; P_2 corresponds to the energy seen by the detector. If the 5.486 MeV peak is used, the window is $\frac{P_1 - P_2}{P_1}$ X 5.486 MeV. Detector 9-927 has an 8 ± 1 keV (35 $\frac{\mu g}{cm^2}$) window for the Am^{241} α. (Actually, the window was originally measured with the 6.051 MeV α's from Bi^{212} and a different pulser was used. The data are shown in Fig. 5.)

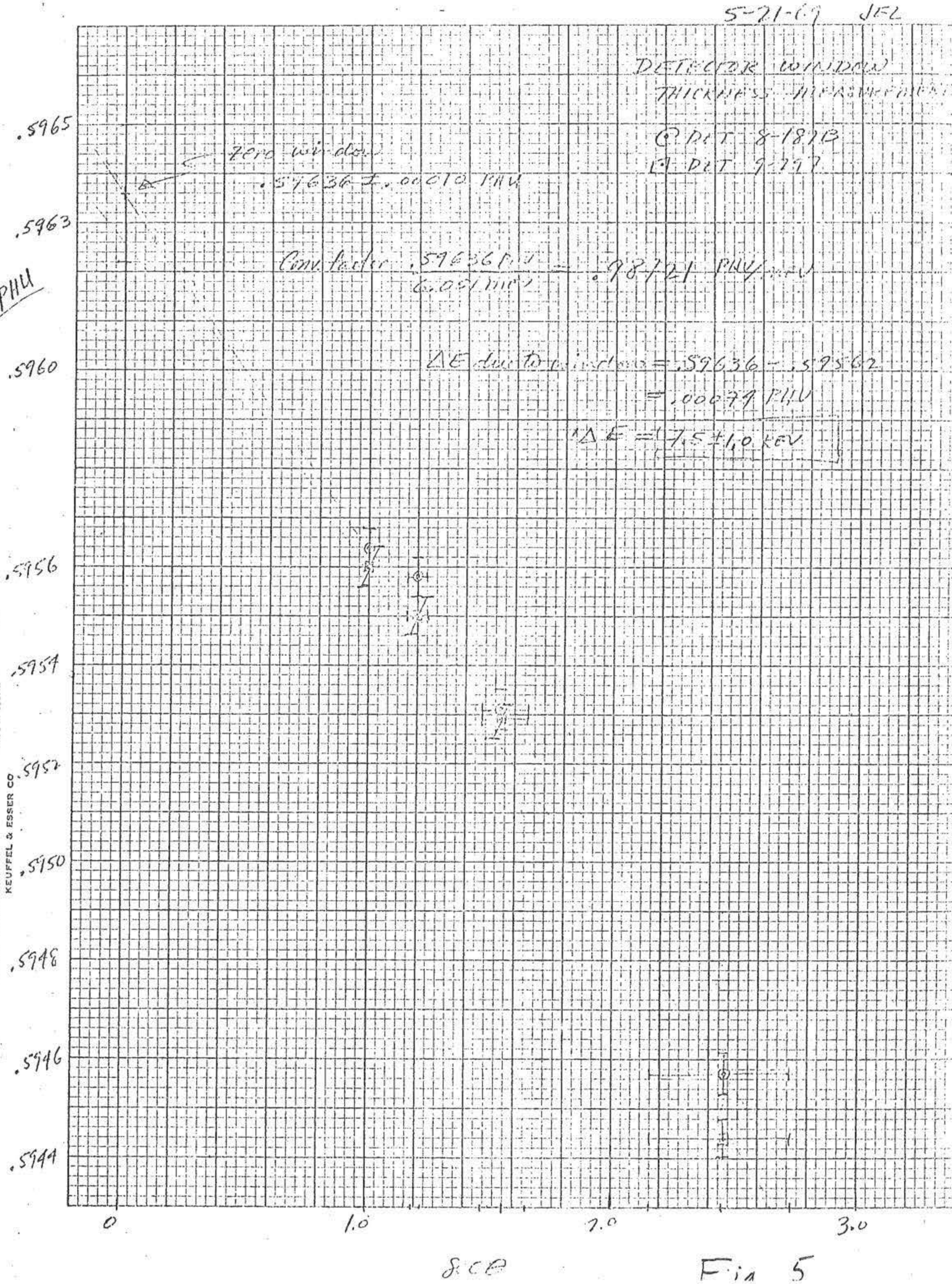

5-21-69 JEL
DETECTOR WINDOW
THICKNESS MEASUREMENT
⊙ DET 8-181B
⊡ DET 9-797
zero window
.59636 ± .00010 PHU
Conv factor .59636 PHU / 6.051 MeV = .98721 PHU/MeV
ΔE due to window = .59636 - .59562
= .00074 PHU
ΔE = 7.5 ± 1.0 keV
PHU
.5965
.5963
.5960
.5956
.5954
.5952
.5950
.5948
.5946
.5944
0
1.0
2.0
3.0
Sec θ

Fig 5

With a known window, the pulser can be calibrated. The detector sees an energy loss of 5.478, 5.435, 5.381 MeV from the Am^{241} α's. Using the bias control and the 32 gain setting of the TC 250 amplifier, the peaks can readily be resolved on the NS-601 pulse height analyzer. The corresponding pulser settings give the pulser calibration.

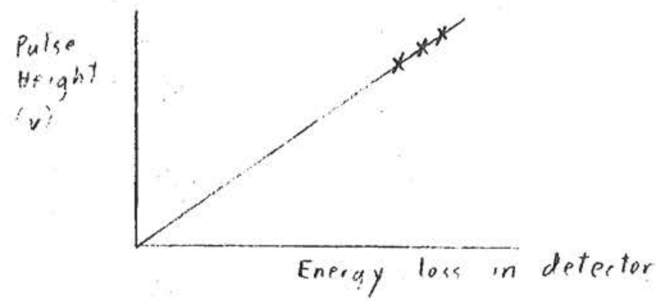


Fig. 6

The 7/6/71 calibration is $1.000 \pm .002 \frac{V}{MeV}$. The values of the capacitors in the TC 100B were chosen to give approximately this value. C_3 (see Fig. 2) can be adjusted to bring the calibration factor extremely close to unity.

The calibration can be checked at different energies with a different detector and different sources. The same procedure is followed. The Th B source gives α's of several energies[2]. From Bi^{212} (36%), the major α energies are 6.090 (27.2%), 6.051 (69.9%), 5.762 (1.7%), 5.597 (1.1%) MeV. The P_0^{212} (64%) decay gives an 8.785 MeV α.

NOTE:

The voltage output of the precision power source can be checked with an accurate voltmeter such as the Fluke, model # 895A. Drifts in the Voltage of 0.002% in one hour have been observed, and so have absolute errors in voltage up to 0.1 mV or 0.02% (whichever is higher). The accuracy claimed by the manufacturer is 0.1 mV or 0.1%.

A second method of calibration using the Tennelec TC 800 mercury pulser and the precision General Radio 10 pf. capacitor will now be described.

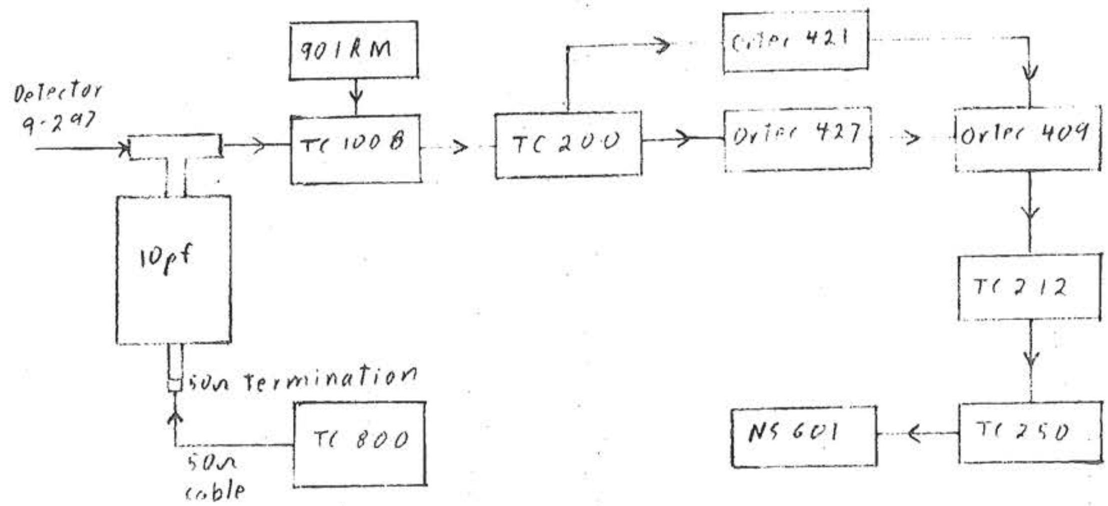
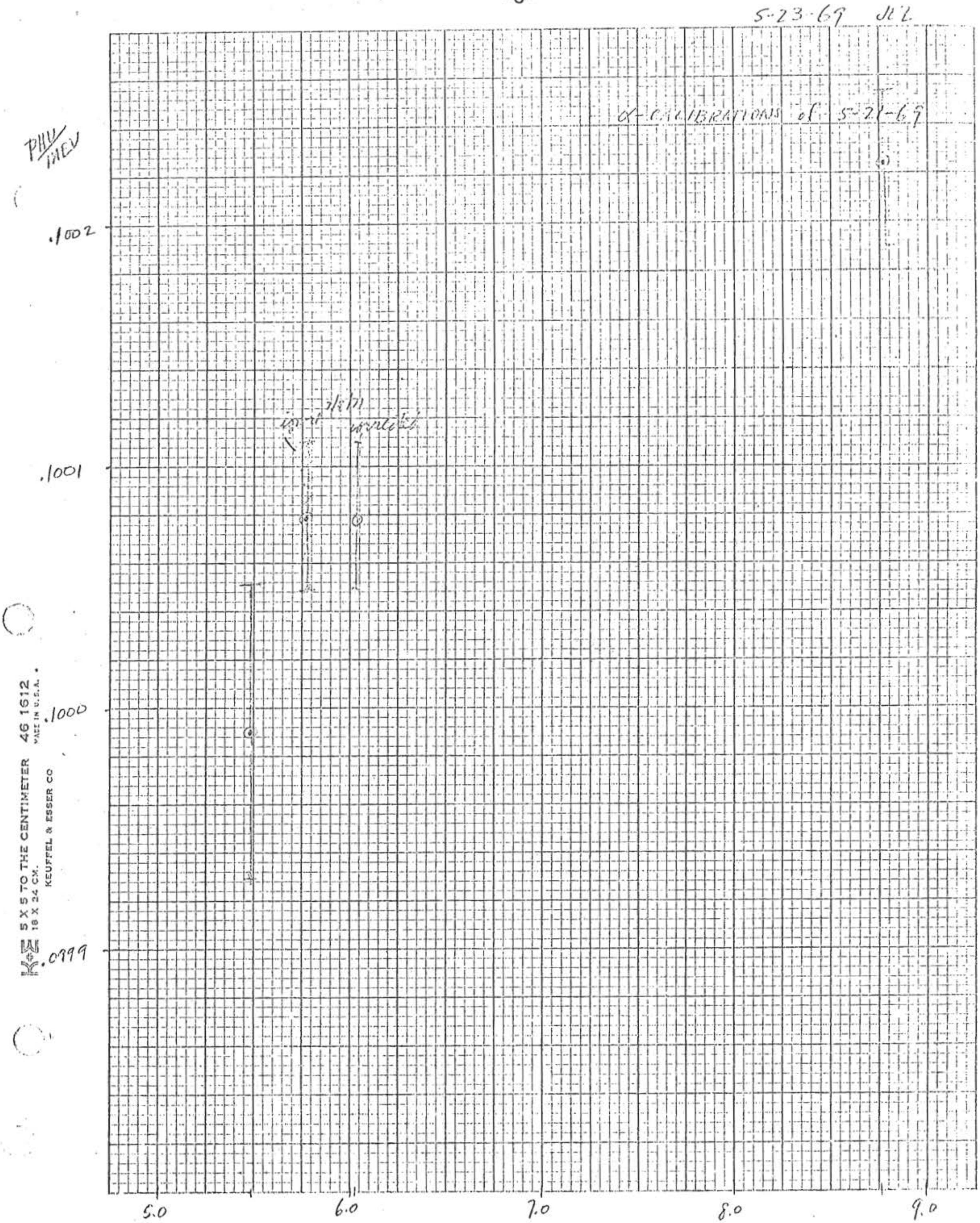


Fig. 7

The set up is shown in Fig. 7. This method of calibration has the advantage that as long as the pulser remains normalized, the calibration remains the same, independent of any changes in preamp TC 100B. Since the precision power source and detector use different inputs to the TC 100B, a change in the preamp can change the WEA pulser calibration. The voltage of the pulse from the TC 800 can be controlled internally or externally. Using the precision power source as a voltage reference, an extremely accurate calibration can be done. The TC 800 has the disadvantage that pulse height units are proportional to the particle energy, but not equal to it (unless the pulser normalization is changed to make them equal).

The original calibration with detector 9-927 was checked with the Am^{241}, Bi^{212}, and Po^{212} α's and was corrected for window thickness. The ratio of pulse height units to MeV is shown in Fig. 8.



ENERGY MEV Fig. 8

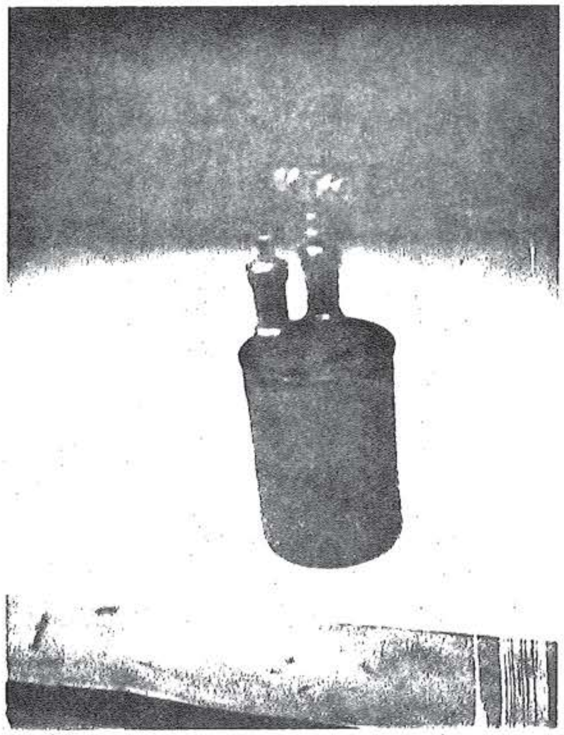


Fig. 9

10 pf capacitor

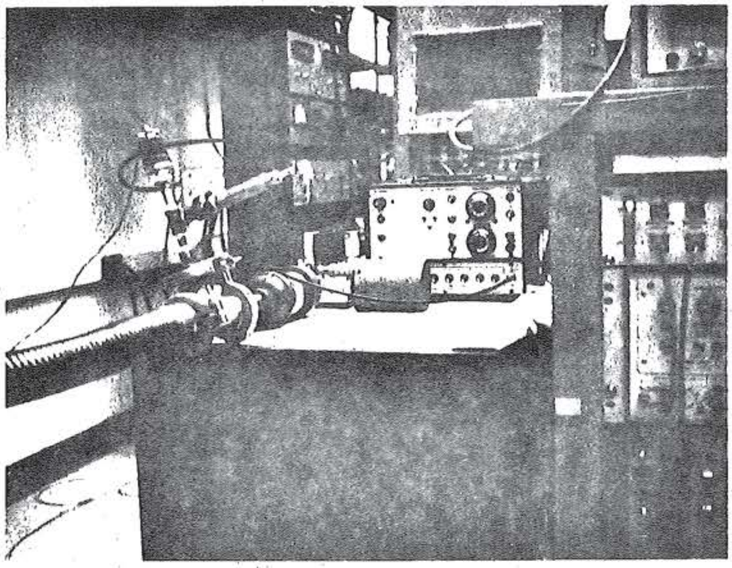


Fig. 10

A. TC 800

B. 10 pf capacitor

C. TC 100B preamp

D. vacuum enclosure for detector 9-297

E. bellows to diffusion pump

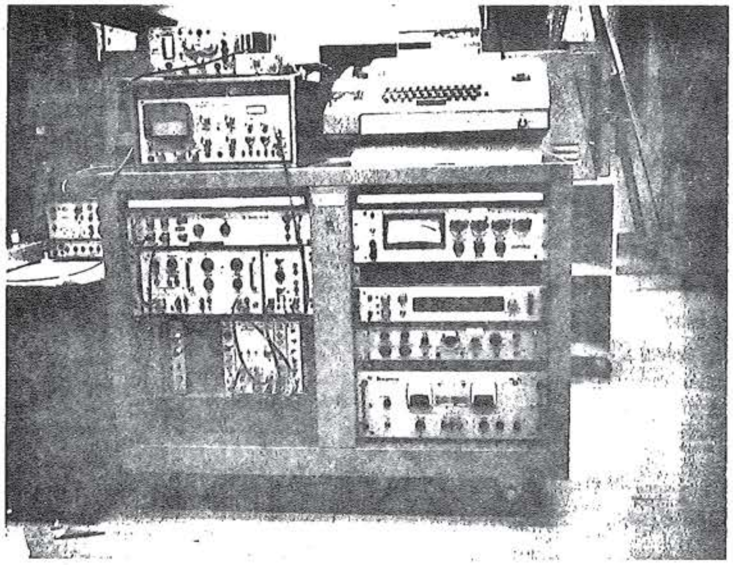


Fig. 11

A. Precision power source

B. NS 601 pulse height analyzer

C. 901 RM power supply

D. TC 200 amplifier

E. TC 250 amplifier

F. WEA pulser

G. Ortec 409 linear gate and slow coincidence

H. Ortec 421 integral discriminator

I. TC 212 inverter

J. Ortec 427 delay amplifier

K. Teletype

L. Ortec detector control unit

References:

1 Internal Report No. 34 on β-Spectrometer Electronics

2 Table of Isotopes, sixth edition by C. M. Lederer, J. M. Hollander, and I. Perlman.

3 Original data in black binder Tennelec Pulser Calibrations. Should be in room 228.