Chapter III

EXPERIMENTAL

3.1 Equipment and Coincidence Arrangement

The coincidence counting system was arranged using the following items.

1. NE 2" x 2" NaI (Tl) (well)
2. Harshaw 2" x 2" NaI (Tl) (Solid)
3. ORTEC 401A/402B Bin and Power Supply. (two)
4. RIDL Model 29-1 Instrument Case and Power Supply.
5. ORTEC 113 Preamplifier. (two)
6. ORTEC 410 Amplifier.
7. ORTEC 451 Spectroscopy Amplifier.
8. ORTEC 413 Strobed Single Channel Analyser. (two)
9. ORTEC 431 Timer-Counter. (two)
10. ORTEC 771 Timer-Counter.
11. RIDL Model 32-3 Slow/Fast Coincidence/Anticoincidence Unit.
12. ORTEC 456 High Voltage Supply. (two)
13. NE G591 Precision Pulse Generator.
14. Tektronix Type 547 Oscilloscope.
15. ORTEC 719 Timer.

These electronics modules were connected to work as a coincidence counting system in the following diagram:

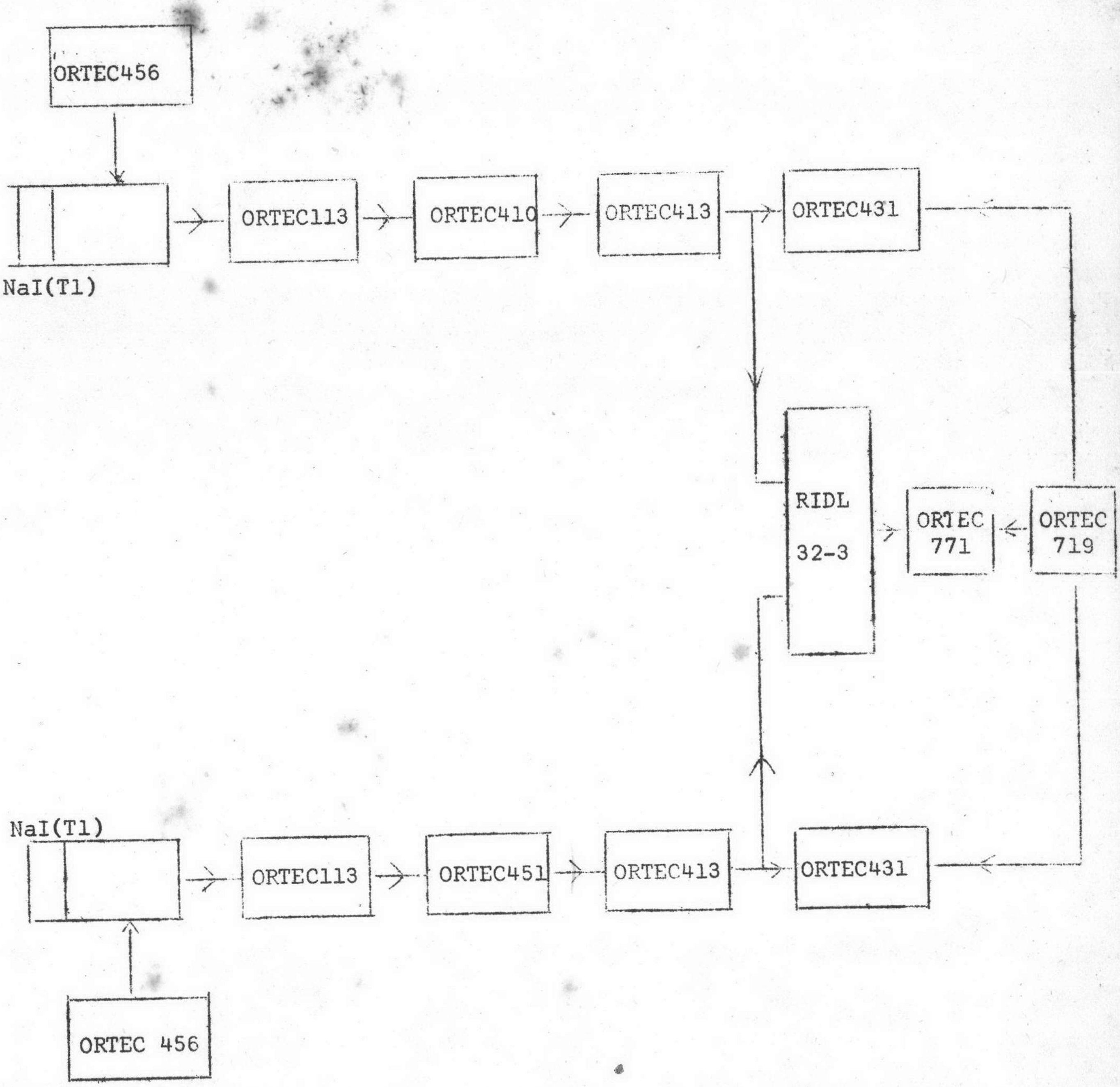

Fig. 4 Block diagram of the coincidence counting system arranged for the experiment.

BNC connectors and cable No. RG-59/U were used for all connections of these modules.

3.2 The Isotope Sources Used in the Experiment

Radioisotopes sources of Co-60 and Mn-56 has been used in the study of the absolute activity measurement by the coincidence counting system. The Co-60 sources are standard sources while the Mn-56 source are produced by 5 Ci Pu-238/Be source.

3.2.1 The Co-60 Standard Sources

Two IAEA standard Co-60 sources of the following has been measured:

1. Standard Co-60 source of 1.113 μCi on 1st January 1966.

2. Standard Co-60 source of 10.90 μCi on 1st January 1968.

The standard Co-60 source of 11.46 μCi on 1st October 1974 from the commercial products of the Radiochemical Centre, Amersham had also been measured by the set up system.

The absolute activity of these three source were calculated and the results were compared with the labeled activity.

3.2.2 The Mn-56 Produced by 5Ci Pu-238/Be Neutron Source

The manganese dioxide of 200 milligrams in polyethylene containers were irradiated at the position close to 5 Ci Pu-238/Be neutron source immersed in 780 litres cylindrical tank for 24 hours. The manganese-56 produced was kept for 30 minutes before counting for 8,000 seconds. The absolute activity of the Mn-56 was calculated from the coincidence counts and the neutron flux at the position of irradiation was calculated.

3.3 The Coincidence Counting

As shown in the block diagram of the coincidence counting system, there are two branches of single channel analyser in the coincidence counting system. In order to observe the coincidence events of two gamma rays in cascade, each branch of the single channel analyser must set to select the pulses response of each energy to pass through the coincidence unit. When the signals from each branch occur within the chosen coincidence resolving time of the coincidence unit (RIDL 32-3) it generates a logic pulse which is sent to the scaler.

3.3.1 Calibration of Gamma Ray Energy

In each branch of the single channel analyser the gamma rays (energy peak) which detected by the NaI (Tl) detector and analyze by the single channel analyser was calibrated their energy peak by standard isotope source of Na-22, Co-60 and Cs-137. These sources emit gamma rays of energies as shown in Table 1.

Table 1

Gamma rays energy from standard source.

Nuclides	Gamma Ray Energy (MeV)
Na-22	0.511 , 1.274
Co-60	1.173 , 1.332
Cs-137	0.661

A plot of energy versus base line has been drawn giving a straight line of energy calibration. This straight line was extrapolated to cover energy of 2 MeV.

3.3.2 Selection of Gamma Rays for Coincidence Counting

In counting the coincidence events of Co-60, one branch of the single channel analyser was set to select the pulses represent the energy of 1.17 MeV and the other branch was set to select the pulses represent the energy of 1.33 MeV.

For coincidence counting of Mn-56, one branch of single channel analyser was set to select the energy of 1.811 MeV and the other branch was set to select the energy of 0.847 MeV.

The window of both single channel analyser were set at 0.25 Volts.

3.3.3 Detectors Geometry Arrangement

In the experiment, the distance from source to the detectors were set for 4, 5, 6, and 7 centimetres and the angle between the two detectors were arranged to be 180° and 90° for Co-60 source. The distance from source to detectors was adjusted to be only 3 centimetres for Mn-56 source since the activity of Mn-56 was low, also the experiment had been arranged for the geometry of 180° and 90°.

3.3.4 Calculation of the Neutron Flux at the Position of Irradiation

The neutron flux of 5Ci Pu-238/Be neutron source was calculated from the absolute activity of Mn-56 measured by the coincidence method using the simple equation.

$$\phi = \frac{A}{N\sigma\,(1-e^{-\lambda t})}$$

where ϕ = neutron flux ($n/cm^2\ sec^{-1}$)

A = absolute activity of Mn-56

σ = neutron capture cross section of Mn-55 (13.3±0.2b)[4]

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[4] S. F. Mughabghab and D. I. Garber, "Resonance Parameters," in BNL-325, v.1, 3rd. ed. P B/24, 1973.

λ = decay constant of Mn-56 $\frac{0.693}{2.58}hr^{-1}$

t = irradiation time of MnO_2 (24 hours)

N = number of Mn-55 target nuclides

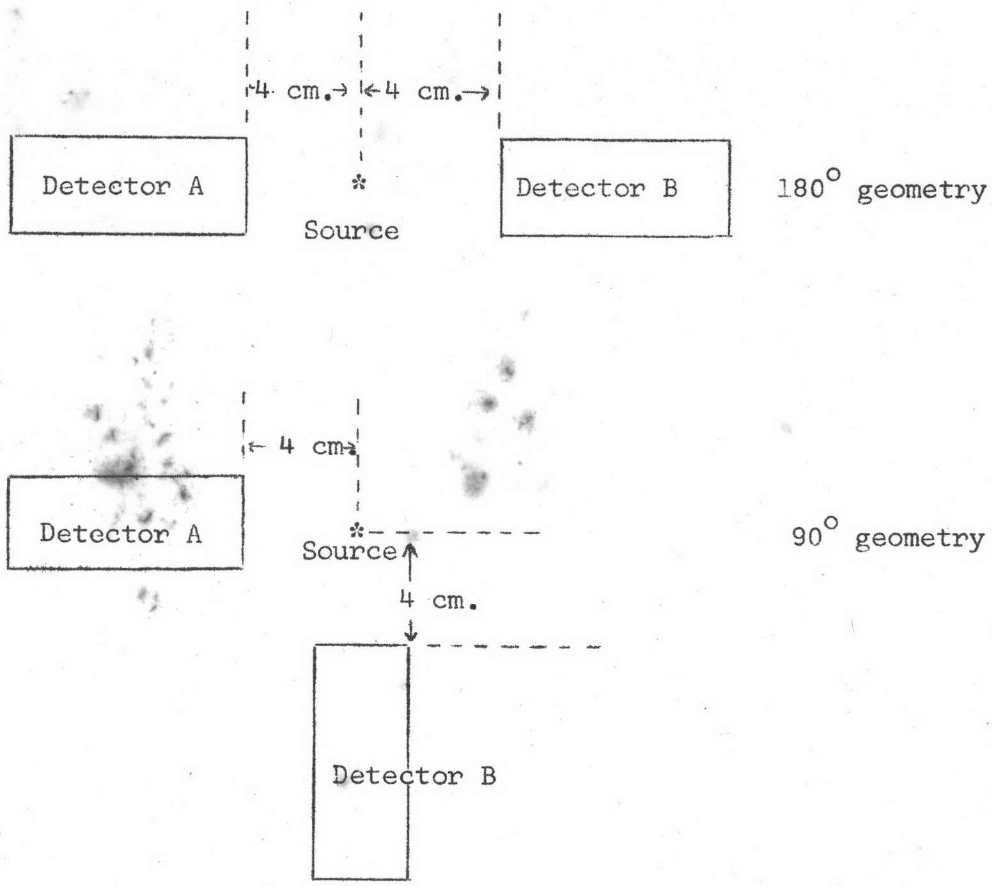

Fig. 5 180° and 90° geometry of detector arrangements