A.E.E.T.-227

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GOVERNMENT OF INDIA
ATOMIC ENERGY COMMISSION

NUCLEAR DATA MEASURING FACILITIES IN INDIA

Compiled by

Indian Nuclear Data Group
Nuclear Physics Division

ATOMIC ENERGY ESTABLISHMENT TROMBAY
BOMBAY, INDIA
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Indian Nuclear Data Group

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Preface

Late in 1963, the International Nuclear Data Scientific Working Group (INDSWG) circulated a questionnaire to the various national data groups asking them to compile and furnish information on nuclear data measuring facilities within their respective countries. Only those facilities used in measuring nuclear data as defined by the INDSWG were included within this scope of this questionnaire. On the basis of then available information, the Indian Nuclear Data Group (INDG) submitted a preliminary report to the INDSWG. It was however felt by the INDG that a more detailed compilation of the data measuring facilities beyond those covered by the INDSWG questionnaire was worthwhile. Accordingly suitable questionnaires were framed and circulated to all Universities and research institutions in India. The present report is based on the replies received. It is believed to give a fairly complete picture of the nuclear data measuring facilities in the country. Revisions will be issued from time to time whenever they are felt necessary. The INDG takes this opportunity to thank all those who collaborated in the preparation of this report. The assistance rendered by Shri T. Ramanujam is also gratefully acknowledged.

Bombay,
May 1965.

INDIAN NUCLEAR DATA GROUP

CONTENTS

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I. BETA RAY SPECTROMETERS

1. Saha Institute Beta Ray Spectrometer

1. Organisation responsible for
   a. design and construction : LKB - PRODUKTER, Fabriksaktie-bolag, Stockholm 12, Sweden.

   b. operation : Saha Institute of Nuclear Physics

2. Location : Saha Institute of Nuclear Physics, 92, Acharya Prafulla Chandra Road, CALCUTTA-9.

3. Main purpose of the apparatus : Study of β-decay schemes, β-γ coincidence and internal conversion.

4. Status : Year of first operation 1958.

5. Scientist in charge of experimental programme : R. Bhattacharyya

6. Number of staff employed : Two

7. Literature on research accomplished :

1. Direct Determination of Internal Conversion Coefficients, Paresh Mukherjee, Phys. Rev. 118, 794 (1960).

2. Study of Church and Weneser Effect in the Decay of Hf^{181}, P.N.Mukherjee, Ph.D. thesis, Calcutta University (1960).

3. Decay of Pm^{148}, A.K.Sengupta, Ph.D. thesis, Calcutta University, (1961).

4. Decay of Eu^{152}, P.N.Mukherjee, I.Dutt, A.K.Sengupta and R.L. Bhattacharya, Physica 26, 179, (1961)

5. Decay of Ag^{105}, R.Bhattacharya Ph.D. thesis, Calcutta University (1962)

6. Decay of Tc^{96}, S.Shastry, B.B. Barman Roy and R.Bhattacharya, Nuclear Phys. 56, 491 (1964)

8. Programme in progress : Internal conversion study of γ-rays Mo^{96}; shape factor measurements of Hg^{203} and Ca^{45} and $\beta - \gamma$ coincidence and internal conversion measurements in the decay of Sn^{125}.

9. Future programme : Shape factor measurements on some other nuclei.

10. Special specifications:

- Type of spectrometer: LKB 3024 Siegbahn-Slatis Beta-Ray spectrometer
- Vacuum chamber: Dimensions i) Length 68 cms. Diameter 25 cms
  Slit systems ii) Baffle system
  Vacuum iii) 10^{-4} mm of Hg
- Magnet power supply: Rated at 60 volts, 600 amps and driven by a 44 KW 3 phase induction motor
- Characteristics: Resolution - 1%
  Transmission - 1%
- Energy range that can be investigated: Approximately 7 MeV
- Stabilization of the power supply: 0.1%
- Magnet cooling arrangement: Most of the water is fed through the magnet coils, only about 10% being carried through the diffusion pump cooler and baffle cooler.
- Detectors: G.M.Counter and Anthracene Scintillation Counter.
- Type of source: Very thin source deposited on a mylar film
- Beta-gamma coincidence facility: Available

2. TIFR Beta Ray Spectrometer I

1. Organisation responsible for

a. design and construction : LKB-PRODUKTER Fabriksakbolag, Stockholm, Sweden.

b. operation : Tata Institute of Fundamental Research.

2. Location : Tata Institute of Fundamental Research, Colaba, Bombay-5.

3. Main purpose of the apparatus : To study the shapes of beta spectra and measurement of internal conversion coefficients by beta gamma coincidence arrangement.

4. Status : Year of first operation 1954

5. Scientist in charge of experimental programme : B.V. Thosar

6. Number of staff employed : Four

7. Literature on research accomplished : About 13 papers have been published during the period 1954 - 61.

Recent publications:

1. Beta spectra of Nd^{147}, R.P. Sharma, S.H.Devare and Babulal Saraf, Phys. Rev. 125, 2071 (1962)

2. Decay scheme of Cd^{115m}, R. P. Sharma and S.H.Devare, Phys. Rev. 131, 384 (1963).

3. Internal conversion studies of the $2^+ \longrightarrow 0^+$ transitions in some deformed even even nuclei, B.V.Thosar, M.C.Joshi, R.P.Sharma and K.G.Prasad, Nuclear Phys. 50, 305 (1964).

8. Programme in progress : Measurement of internal conversion coefficient and shapes of beta spectra by beta gamma coincidence technique.

9. Future programme : Along similar lines

10. Special specifications:

- Type of spectrometer: Intermediate image beta ray spectrometer

- Vacuum chamber: Dimensions - Two angular slits mounted inside the vacuum chamber, one fixed in the centre (width can be varied between 0 and 10 mm, 8% transmission at maximum slit width), the other near the source whose position determines the acceptance angle.

Vacuum - 10^{-5} mm of Hg

- Magnet power supply : The magnet current is supplied by a motor generator set and is controlled by a current regulator. Maximum power 700 amps, 60 volts.

- Stabilization of the power supply : A 10% decrease of the line voltage, plus a 2% decrease of line frequency, plus a 20% increase of magnet resistance, does not give more than 0.1% variation of magnet current.

- Magnet cooling arrangement: Chilled water is passed through the coils. A flow of about 10 litres/minute at an inlet temperature of maximum 25°C is required when magnet is run at maximum power.

- Characteristics : Resolution 1.8% to 4%
  Transmission 1% to 8%
  Energy range from 50 keV to 7000 keV

- Detectors : Scintillation detectors

- Type of source : Circular source of 2 mm diameter deposited on mylar film attached to an aluminium ring.

- Beta gamma coincidence facility : The source side pole piece has been modified in such a way that a scintillation gamma detector can be placed just behind the source at a distance of 5 cms from the source. The photomultiplier is protected from the magnetic field with the help of compensating coils. A conventional fast slow coincidence circuit with resolving time 50 to 100 musec. is used for coincidence measurements.

3. TIFR Beta Ray Spectrometer II

1. Organisation responsible for design, construction and operation : The pole pieces, the vacuum chamber and magnetometer were imported from Uppasala, Sweden. All other mechanical construction and electronics were done at Tata Institute of Fundamental Research.

2. Location : Tata Institute of Fundamental Research, Colaba, Bombay-5.

3. Main purpose of the apparatus : To study internal and external conversion electron energies accurately.

4. Status : Year of first operation 1964

5. Scientist incharge of experimental programme : B.V. Thosar

6. Number of staff employed : Three

7. Available reference for more detailed description : 1. Performance of the double focussing beta ray spectrometer, H.G.Devare and S.R. Amtey, Proc. Nuclear Physics Symposium, Chandigarh, 1964 (Department of Atomic Energy, Bombay.).

8. Programme in progress : Complete automation is being done

9. Future programme : Determination of conversion coefficients by internal - external conversion method.

10. Special specifications:

- Type of spectrometer : 2π- type double focussing beta ray spectrometer.

- Vacuum chamber: Dimension - Internal cylinder diameter 74 cms, height 20 cms; external cylinder diameter 154 cms, height 31 cms; two radial and one vertical baffle adjustable from outside the chamber; one slit on the detector of width 2 mm and height 15 mm.

  Vacuum - Final vacuum achieved 5×10^{-5} mm of Hg with the help of 4" diffusion pump backed up by Edwards rotary pump 1 SC 150 B.

- Magnet power supply : Transformer rectifier power supply. Rating - 0 - 4 Amps at 65 volts maximum.

- Stabilization of the power supply : Servo system maintains the spectrometer field constant within 1 part in 10^5 using a rotating coil magnetometer.

- Magnet cooling arrangement : Air cooling

- Characteristics :

Resolution	0.19%	0.24%
Transmission	0.03%	0.15%

  These are obtained from preliminary measurements. These can be improved further.

- Energy range that can be investigated : Min. 100 keV; Max. 2 MeV.
- Detectors : End window type G.M. counter or scintillation detector as required.
- Type of source : Line source deposited on aluminised mylar. 2 mm width, height 15 mm.

4. TIFR Beta Ray Spectrometer III

1. Organisation responsible for design, construction and operation	: Nuclear Spectroscopy Group, Tata Institute of Fundamental Research.
2. Location	: Tata Institute of Fundamental Research, Colaba, Bombay-5.
3. Main purpose of the apparatus	: Study of beta spectrum.
4. Status	: Year of first operation 1956
5. Scientist in charge of experimental programme	: B.V.Thosar
6. Number of staff employed	: Three
7. Literature on research accomplished	: 1. On the decay of Cs^{129}, S.Jha, H.G.Devare and R.M. Singhru, Nuovo Cimento 18, 1108 (1960). 2. On the decay of I^{132}, H.G. Devare, Nuclear Phys. 28, 148 (1961).
8. Programme in progress	: The spectrometer is being modified for e - γ angular correlation work.
9. Future programme	: e - γ angular correlation and study of beta spectrum.

10. Special specifications:

- Type of spectrometer : Thin lens type beta ray spectrometer
- Vacuum chamber : Dimensions 5' long brass tube i.d. $8\frac{3}{4}$" o.d. $9\frac{1}{2}$"

Slit system	4 annular baffles and one baffle for ring focus
Vacuum	Final vacuum 5×10^{-5} mm of Hg

- Magnet power supply: Motor generator type - Power 5 kilowatts
- Stabilization of the power supply: Chopper amplifier and servo system stabiliser. Magnet current stabilized to 1 part in 10^4.
- Magnet cooling arrangement: Cooling done by circulation of chilled water through chopper tubes welded to the bobbin.
- Characteristics: Resolution 1.8%
  Transmission 0.3%
- Energy range that can be investigated - Max. 3 MeV
- Detectors: End window type G.M.Counter or scintillation detector as required.
- Type of source: 6 mm. diameter deposited on mylar
- Beta-gamma coincidence facility: This is being incorporated.

II. CRYSTAL SPECTROMETERS

1. Single Crystal Spectrometer

1.	Organisation responsible for design, construction and operation	: Nuclear Physics Division Atomic Energy Establishment Trombay.
2.	Location	: Apsara Reactor Atomic Energy Establishment Trombay, Bombay 74, India
3.	Main purpose of apparatus	: Cross section measurements (both scattering and absorption) and study of Double Bragg effects in the reflection of neutrons by single crystals.
4.	Status	: Year of first operation 1957
5.	Scientist in charge of experimental programme	: K.R. Rao
6.	Number of staff employed	: Three
7.	Literature on research accomplished	: 1. Higher order contamination in a single crystal spectrometer V.P.Duggal, K.R.Rao, C.L.Thaper and V.Singh, Proc. of Nuclear Physics Symposium, Waltair, 1960 (Department of Atomic Energy, Bombay, 1960). 2. Anamolous reflections in a single crystal spectrometer, V.P.Duggal, K.Raghavendra Rao, C.L.Thaper and V.Singh, Proc. Indian Acad. Sci. Vol. LIII, No. 2, 59 (1961). 3. Removal of Higher Order in the Thermal Region from a Neutron Crystal Spectrometer, V.P.Duggal and C.L. Thaper, Rev. Sci. Instr. 33, 49 (1962) 4. Neutron cross section measurements in thermal and subthermal energy range, V.P.Duggal and C.L. Thaper, Proc. of Nuclear Physics Symposium, Madras, 1962 (Department of Atomic Energy, Bombay, 1962)

: 5. Frequency distribution of atomic vibrations in solids and resonant absorption of slow neutrons, K.R. Rao and C.L. Thaper, Proc. of Nuclear Physics Symposium, Bombay, 1963, (Department of Atomic Energy, Bombay, 1963)

9. Programme in progress : The spectrometer is being used at present for studies of resonance absorption and resonance scattering in Iridium and its compounds.

10. Future programme : Along similar lines

11. Special specifications:

- Type : Single crystal, plane crystal
- Collimator : Cross section area of the collimator some times 1 mm x 5 cms, some times 5 mm x 5 cms.
- Crystals available: Various crystals have been used from time to time, Be($11\bar{2}2$), Ge(111), Al(111), NaCl(200), KCl etc.
- Energy range : With Be($11\bar{2}2$) max. energy 3 ev., 0.005 to 0.3 ev
- Sample, Useful area: 5 mm x 5 cm.
- Distance from crystal to detector : 150 cms.
- Other details: Accuracy in angular position is 1 minute.

2. Double Crystal Spectrometer I

1. Organisation responsible for design, construction and operation : Nuclear Physics Division, Atomic Energy Establishment Trombay.
2. Location : Canada India Reactor, Atomic Energy Establishment Trombay, Bombay 74.
3. Main purpose : Crystal structure analysis
4. Status : First year of operation 1961
5. Scientist in charge of experimental programme : R. Chidambaram
6. Number of staff employed : Five

7. Literature on research : 1. Neutron diffraction study of the structure of Potassium oxalate monohydrate Lone pair co-ordination of the hydrogen bonded water molecule in crystals, R.Chidambaram, A.S. Sequeira and S.K. Sikka, Jour. Chem. Physics, 41 (1964) 3616 - 3622.

2. Fast Recording of Neutron Diffraction Intensity Data, R. Chidambaram, A.S. Sequeira and S.K. Sikka, Nucl. Instr. & Methods 26 (1964) 340-342.

8. Programme in progress : Study of crystal structure of $K_2Zn(CN)_4$, $BeSO_4$, $_4H_2O$.

9. Future programme : Study of crystal structure of hydrogen bonded crystals and cupric complexes. When the Double Crystal Spectrometer II goes into operation, this spectrometer will be modified for low temperature work.

10. Special specifications:

- Crystals and planes available : lead (200)
- Incident energy variable or fixed : Fixed
- Range of scattering angle : 0° - 100°
- Steps in which scattering angle can be changed : 6'
- Accuracy of counter setting : 1'
- Collimators (location, size, and divergence) :

  i. inpile, soller type - 1¼" x 1¾" x 24", 5/8°, (FWHM)

  ii. between monochromator and sample 5/8" x 1¾" x 24", 1.5° (FWHM)

  iii. between sample and counter, soller type - ¾" x 1¾" x 24", 5/8° (FWHM)

- Filters: Polycrystalline bismuth 4" long

- Other operational features: Half angling by belt drive; spectrometer operation automatic; each reflection requires separate setting.

3. Double Crystal Spectrometer II

1.	Organisation responsible for design, construction and operation	: Nuclear Physics Division, Atomic Energy Establishment Trombay.
2.	Location	: Canada India Reactor, Atomic Energy Establishment Trombay, Bombay-74.
3.	Main purpose of apparatus	: Crystal structure analysis
4.	Status	: In operation from September 1964
5.	Scientist in charge of experimental programme	: R. Chidambaram
6.	Number of staff employed	: Five
7.	Future programme	: Study of crystal structures of hydrogen bonded crystals and cupric complexes.

8. Special specifications:

- Crystals and planes available : Lead (200)
- Incident energy variable or fixed : fixed
- Range of scattering angle : 0° - 120°
- Steps in which scattering angle can be changed : 6'
- Accuracy of counter setting: 1'
- Collimator (location, size, and divergence) :

  i. inpile - Tapered - 1" x 1½" to 1½" x 2" length 72"

  ii. between monochromator and sample, ¾" x 1½" x 36", 0.4° (FWHM)

iii. between sample and counter, tapered, collimator of length 15" tapering from ¼" x 1½" to 1½" x 1½" on the counter side

- Filters : Polycrystalline bismuth 4" long

- Other operational features : Half angling by belt drive; automatic operation; twenty reflections in one layer can be scanned with one initial setting.

4. Double Crystal Spectrometer III

1. Organisation responsible for	
a. design and construction	: M/s John Curran Co. Ltd., Cardiff, U.K.
b. operation	: Nuclear Physics Division, Atomic Energy Establishment Trombay.
2. Location	: Canada India Reactor, Atomic Energy Establishment Trombay, Bombay-74.
3. Main purpose of apparatus	: Magnetic scattering studies
4. Status	: First operated at Apsara Reactor in the year 1959. Transferred to Canada India Reactor in January 1960.
5. Scientist in charge of experimental programme	: N.S. Satya Murthy
6. Number of staff employed	: Four
7. Programme in progress	: Study of magnetic structure and properties of iron-tin, iron-germanium, and manganese-tin systems.
8. Future programme	: Along similar lines

9. Special specifications:

- Crystals and planes available : Al(111)
- Incident energy fixed or variable : fixed
- Range of scattering angle : - 30° to 130°
- Steps (smallest in which the scattering angle can be changed): 1/12°
- Accuracy of counter setting : 1'
- Collimators (location, size and divergence):

  i. inpile, 2" x 2" x 60", 1.5° (FWHM)

  ii. between monochromator and sample, soller type - 2" x 2" x 24", 0.6° (FWHM)

  iii. between sample and counter, 2" x 2" x 12" , 1.2° (FWHM)

- Filters : Polycrystalline bismuth 4" long
- Other features: Sample half angling is by belt drive mechanism; operation of spectrometer automatic; facilities are available to heat samples and cool them down to liquid helium temperatures; fields upto 15 kOe can be applied on the sample.

5. Polarized Neutron Spectrometer

1. Organisation responsible for design, construction and operation	: Nuclear Physics Division, Atomic Energy Establishment Trombay.
2. Location	: Canada India Reactor, Atomic Energy Establishment, Trombay, Bombay 74.
3. Main purpose of apparatus	: To study spin densities in magnetic crystals.
4. Status	: Scheduled for completion in June 1965.
5. Scientist in charge of experimental programme	: N. S. Satya Murthy

6. Number of staff employed : Four

7. Special specifications:

- Crystals and planes available : Co-Fe(111), (200)
  Magnetite (220)

- Incident energy fixed or variable: fixed. For normal operation a wave length of about 1 Å will be employed, but the monochromator and shielding are designed for a wavelength range of 0.8 Å to 1.5 Å .

- Details of field applied on monochromator: The monochromator is mounted between the pole pieces of 3000 Oe permanent magnet with a 2" air gap.

- Details of guide field: The guide field has a 3" square section and is 36" long. The value of the guide field is approximately 100 Oe.

- Spin flipper, type and details: Radio frequency type, made of 14 gauge copper wire, is 10" long and 1½" in dia.

- Range of scattering angles:

- Smallest step in which scattering angle can be changed : 1/8°

- Accuracy of counter setting: 1'

- Other features: A special feature of the spectrometer is an additional thrust bearing independently mounted above the sample table. An electromagnet producing fields upto 15 KOe can be mounted on this bearing. The magnet can be stationary or can be coupled to rotate with the sample table. Half angling is by a belt drive.

6. Triple Axis Spectrometer I

1. Organisation responsible for design, construction and operation : Nuclear Physics Division
  Atomic Energy Establishment
  Trombay.

2. Location : Canada India Reactor,
  Atomic Energy Establishment
  Trombay, Bombay 74

3. Main purpose of apparatus : Study of inelastic scattering of slow neutrons from solids and liquids.

4. Status : Year of first operation 1962

5. Scientist in charge of experimental programme : P.K. Iyengar

6. Number of staff employed : Five

7. Available reference for more detailed description : Dispersion relations for phonons in magnesium, P.K.Iyengar, G. Venkataraman, K.R.Rao, P.R.Vijayaraghavan and A.P.Roy, Proc. of Symposium on Inelastic Scattering of Neutrons in Solids and Liquids, Chalk River, Vol. II (I.A.E.A., Vienna 1963).

8. Literature on research accomplished : 1. Dispersion relations for phonons in magnesium, P.K.Iyengar, G. Venkataraman, K.R. Rao, P.R.Vijayaraghavan and A.P.Roy, Proc. of Symposium on Inelastic Scattering of Neutrons in Solids and Liquids, Chalk River, Vol. II (I.A.E.A., Vienna 1963).

2. Dispersion relations for phonons in magnesium, P.K. Iyengar, G. Venkataraman, P.R.Vijayaraghavan and A.P. Roy, J. Phys. Chem. Solids Issue on International Conference on Lattice Dynamics held at Copenhagen in 1963.

9. Programme in progress : Study of phonon spectrum in iron

10. Future programme : Study of dispersion relations for phonons in various crystals.

11. Special specifications:

- Crystals and planes available as monochromator: Al(111), (200)
- Incident energy fixed or variable : Fixed
- Range of Scattering angle : 0° - 90°

- Steps in which scattering angle can be changed: 1/16°
- Accuracy of scattering angle setting: 1'
- Steps in which sample orientation can be changed: 3'
- Accuracy of setting sample orientation : 1'
- Crystals and planes available as analyser : Al(111), Cu(111)
- Outgoing energy fixed or variable: Continuously variable
- Range of analyzing spectrometer : 70° (2θA)
- Accuracy of positioning of analyzing spectrometer: 1'
- Collimator (location, size and divergence) :

  i. Inpile, 2" x 2" x 120", 0.75° (FWHM)

  ii. between monochromator and sample, 2" x 2" x 24"

  iii. between sample and analyser, soller type - 2" x 2" x 12", 1.25° (FWHM).

- Filter: Polycrystalline, bismuth 4"
- Other operational features: Sample orientation drive is by a motor cum reduction gear system; scattering angle drive is by a motor cum belt system, analyzing spectrometer by a motor operated belt system; spectrometer is operated automatically by an electro-mechanical drive control; the control can be programmed for 'constant momentum transfer' operation of the spectrometer; motor movements are unidirectional in a given programme.

7. Triple Axis Spectrometer II

1. Organisation responsible for design, construction and operation	: Nuclear Physics Division Atomic Energy Establishment Trombay.
2. Location	: Canada India Reactor, Atomic Energy Establishment, Trombay, Bombay-74.
3. Main purpose of apparatus	: Study of lattice dynamics and atomic motions in liquids.

4. Status : Completed in May 1964

5. Scientist in charge of experimental programme : K. R. Rao

6. Number of staff employed : Three

7. Proposed programme : Study of atomic motions in liquids.

8. Special specifications:

- Crystals and planes available: Monochromator Al(111), Analyser Pb(111)
- Incident energy fixed or variable : Continuously variable
- Range of monochromator angle ($2\theta_M$) : 20° - 70°
- Steps in which $2\theta_M$ can be changed: 1/8°
- Accuracy of $2\theta_M$ setting: 1'
- Range of scattering angle: 0° - 110°
- Steps in which scattering angle can be changed: 1/8°
- Accuracy of scattering angle setting: 1'
- Steps in which sample orientation can be changed: 1/8°
- Accuracy of sample orientation: 2'
- Outgoing energy fixed or variable: Variable but normally the outgoing energy is fixed at a particular value
- Filters: Polycrystalline bismuth (7"): provision has been made for introducing quartz single crystal filters
- Other features: Monochromator and scattering angle drives are motor operated belt drives. Sample orientation is changed by a motor cum reduction gear system; operation of the spectrometer is automatic and non-linear increments can be achieved by means of paper tape instructions.

8. Beryllium Detector Spectrometer

1. Organisation responsible for design, construction and operation	: Nuclear Physics Division Atomic Energy Establishment Trombay.
2. Location	: Canada India Reactor, Atomic Energy Establishment, Trombay, Bombay-74.
3. Main purpose of apparatus	: Study of molecular vibrations and torsional oscillations in molecular compounds; study of lattice dynamics.
4. Status	: Year of first operation 1961
5. Scientist in charge of experimental programme	: P.K. Iyengar
6. Number of staff employed	: Five
7. Available reference for more detailed description	: 1. Study of Ammonium Halides by Neutron Spectrometry, G. Venkataraman, K. Usha, P.K. Iyengar, P.R. Vijayaraghavan and A.P. Roy, Proc. of Symposium on Inelastic Scattering of Neutrons in Solids and Liquids, Chalk River, 1962, (I.A.E.A., 1963). 2. A 'Window Filter' for Neutron Spectrometry, P.K. Iyengar, Nucl. Instr. and Methods 25 (1964) 367 - 369.
8. Literature on research accomplished	: 1. Study of Ammonium Halides by Neutron Spectrometry, G.Venkataraman, K. Usha, P.K.Iyengar, P.R. Vijayaraghavan and A.P. Roy, Proc. of Symposium on Inelastic Scattering of Neutrons in Solids and Liquids, Chalk River, 1962 (I.A.E.A., 1963). 2. Anharmonicity of the torsional oscillations in NH_4Cl, G.Venkataraman, K. Usha Deniz, P.K.Iyengar, P.R.Vijayaraghan and A.P. Roy, Solid State Communications 2 (1964), p.17-19.

9. Programme in progress : Study of phonon spectrum in magnesium by use of window filter techniques.

10. Future programme : Study of phonon dispersion relations using window filter and study of molecular dynamics using conventional BeO filter.

11. Special specifications:

- Crystals and planes available: Al(111) and Cu(111)
- Incident energy fixed or variable: Variable
- Range of monochromator angles: 0° - 27° (θ_M)
- Steps in which monochromator angle can be changed: 1/8° (in θ_M)
- Accuracy of monochromator setting: 0.01°
- Range of scattering angle: 0° - 110°
- Steps in which scattering angle can be changed: 0.25°
- Accuracy of scattering angle setting: 1'
- Steps in which sample orientation can be changed: 4'
- Accuracy of setting sample orientation: 1'
- Analysers available: a) Polycrystalline Beryllium filter
  b) Polycrystalline Beryllium oxide filter
  c) Window filter employing a Be-BeO combination
- Filter details: a) & b) 2" x 4" cross section and 4" long cadmium wrapped
  c) 7 beryllium pieces, ¼" x 2" x 4" interleaved with cadmium and one 2" x 2" x 4" beryllium oxide piece
- Detector details: a) & b) One 2" diameter 6" long BF_3 counter placed broadside on.
  c) A ring of 12 counters 1" diameter 12" long arranged to see back scattered neutrons from BeO.

- Collimators (Location, size and divergence):

  i. inpile, 2" x 2" x 26", 1°

  ii. between monochromator and sample, soller type - 2" x 2" x 24", 1°

- Inpile filters: Polycrystalline bismuth 4" long; provision has been made to introduce quartz filters if necessary.

- Other features: Monochromator drive is by a motor operated belt drive; counter drive is by similar means; sample orientation variation effected by a motor cum reduction gear system; spectrometer can be programmed for 'constant momentum transfer' mode of operation; such programmes are used for study of phonons by the window filter technique.

9. Rotating Crystal Spectrometer

1. Organisation responsible for design, construction and operation	: Nuclear Physics Division Atomic Energy Establishment, Trombay.
2. Location	: Canada India Reactor, Atomic Energy Establishment, Trombay, Bombay-74.
3. Main purpose of apparatus	: Study of cold neutron scattering from liquids and solids.
4. Status	: Year of first operation December 1963.
5. Scientist in charge of experimental programme	: G. Venkataraman
6. Number of staff employed	: Four
7. Present programme	: Cold neutron scattering from MnO
8. Future programme	: Study of atomic motions in liquid methane.

9. Special specifications:

- Filter details: 2 inches of lead single crystal
  6 inches of quartz single crystal
  4 inches of beryllium

- Rotor: Aluminium single crystal shaped in the form of a sphere of 2" diameter

- Wavelength: 4.1Å

- Distance between sample table and crystal: 25"

- Pulse width at sample table: 21 usec/meter

- Flight path: 3 meters

- Neutron detector: A bank of 6 BF_3 counters; 2" diameter, 18" long filled to 60 cms of Hg with 90% enriched gas.

- Time analysers: Number of channels 100
  Channel widths available 8 usec, 16 usec and 32 usec.

- Resolution at incident energy : 4%

- Range of scattering angle : 0° - 100°

III. MASS SEPARATORS AND SPECIAL MASS SPECTROMETERS

AEET Mass Separator

1. Organisation responsible for design, construction and operation : Nuclear Physics Division
   Atomic Energy Establishment
   Trombay

2. Location : Tata Institute of Fundamental Research, Colaba, Bombay-5

3. Main purpose of apparatus : To supply inactive pure isotropic targets for nuclear reactions, spectroscopy experiments etc.

4. Status : In operation from December 1964

5. Scientist in charge of experimental programme : K.K. Damodaran

6. Number of staff employed : Six

7. Special specifications:

   - Ion source : Extraction voltage - 30 KV
     Ion current in the beam - 10 mA

   - Deflection magnet: Weight - 5 tons
     Power supply - 600 V 20 A D.C.Motor generator
     Stabilization - 1 in 5,000 (expected)
     Max. field - 12 K gauss

   - Vacuum: 10^{-6} mm of Hg

   - Radius of curvature: 50 cms

   - Angular deflection in the ion beam: 60°

   - Collector efficiency: 15%

   - Resolution ($M/\Delta M$) : 150

1. Indian Association for the Cultivation of Science, Mass Spectrometer

1. Organisation responsible for a. design and construction	: Manufactured by M/s Associated Electrical Industries Ltd. U.K.
b. operation	: Indian Association for the Cultivation of Science, Jadhavpur, Calcutta-32.
2. Location	: Department of General Physics & X-rays, Indian Association for the Cultivation of Science, Calcutta-32.
3. Main purpose of apparatus	: Measurement of Relative Isotope Abundance Ratios and analysis of gas mixtures
4. Status	: In working condition
5. Scientist in charge of experimental programme	: B.N. Srivastava
6. Programme in progress	: Measurement of enrichment of stable gas isotopes by the process of thermal diffusion, and measurement of Ionization cross section of atoms and molecules.
7. Future programme	: Study of Ion-Molecule reaction

8. Special specifications:

- Type: MS3 Mass spectrometer
- Ion Source: Nier type ion source; energy of ionising electrons fixed at 70 eV
- Accelerating voltage: 2 KV
- Deflection Magnet: Power supply 230 V, constant to one part in 20,000 per minute with a general drift of less than 1 part in 5,000 per hour; current adjustable between 30 mA and 300 mA.

- Vacuum: 5×10^{-7} mm of Hg
- Curvature radius of ion path: 4"
- Angular deflection of the ion beam : 90°
- Resolution ($M/\Delta M$) : 100

2. Saha Institute Mass Spectrometer

1. Organisation responsible for design, construction and operation	:	Saha Institute of Nuclear Physics
2. Location	:	Saha Institute of Nuclear Physics, 92, Acharya Prafulla Chandra Road, Calcutta-9.
3. Main purpose of apparatus	:	Studies in ion-ion collison, sputtering and other solid state experiments.
4. Scientist in charge of experimental programme	:	D.N. Kundu
5. Number of staff employed	:	Four
6. Programme in progress	:	Studies in ion-ion collison, sputtering and other solid state investigations.
7. Future programme	:	Along similar lines

8. Special specifications:

- Ion source	Source A	Source B
Ion density	10^{-11} A/cm^2	7×10^{-3} A/cm^2
Extraction voltage	8 KV	5 KV
Ion current in beam	0.1 uA	

- Deflection magnet: Weight - $1\frac{3}{4}$ ton
  Power Supply - 2.5 KW

Stabilisation - 1 in 10,000

Maximum field - 3800 gauss

- Vacuum : about 10^{-5} mm of Hg
- Curvature radius of ion path : 38 cm
- Angular deflection of the ion beam : 255°
- Resolution ($M/\Delta M$) : 125

IV. NUCLEAR ORIENTATION AT LOW TEMPERATURE

1. Organisation responsible for design, construction and operation	: Tata Institute of Fundamental Research
2. Location	: Tata Institute of Fundamental Research, Colaba, Bombay-5.
3. Main purpose of the apparatus	: Studies in Nuclear Spectroscopy with oriented nuclei.
4. Status	: Under test
5. Scientist in charge of experimental programme	: Girish Chandra
6. Number of staff employed	: Four
7. Programme in progress	: Preliminary testing of the set up
8. Future programme	: Studies in Nuclear spectroscopy by observing the angular distribution of gamma rays from oriented nuclei. The assembly of a regulated 75 KW power supply for the magnet is being undertaken.

9. Special specifications:

- Adiabatic demagnetisation magnet: It is a water cooled magnet and supplied by Pacific Electric Motor Co., Oakland, California.
- Weight of the magnet : 3½ tons
- Power supply : Amplidyne type motor generated with a chopper amplifier current regulator. Maximum voltage - 60 V and current 300 A with the two coils in parallel.
- Stabilisation : 1 in 10^4
- Maximum gap : 5½"
- Maximum field at maximum gap: 9½ k gauss
- Helium pumping capacity: Edward's rotary pump with maximum pumping speed of 3000 litres per minute is being used.
- Thermometry: A magnetic thermometer measuring the susceptibility of the cooling salt, calbirated between 1°K - 4.2°K with the help of helium vapour pressure vs temperature scale
- Radiation detection system for gamma rays: NaI(Tl) scintillation counters.

V. PARTICLE ACCELERATORS

1. AEET 5.5 MeV Van de Graaff Accelerator

1.	Organisation responsible for	
	a. design and construction	: High Voltage Engineering Corporation Burlington, Mass., U.S.A.
	b. Operation	: Nuclear Physics Division, Atomic Energy Establishment Trombay
2.	Location	: Van de Graaff Laboratory, Atomic Energy Establishment Trombay, Bombay-74.
3.	Main purpose of apparatus	: Charged particle reaction studies, neutron scattering studies, fast neutron fission studies.
4.	Status	: Started operation in February 1962.
5.	Scientist in charge of experimental programme	: A.S.Divatia and N. Sarma
6.	Number of staff employed	:
	a. Operation and development	: Twelve
	b. Research	: Twenty five
7.	Available reference for more detailed description	: "5.5 Million volt Van de Graaff Accelerator at Trombay", A.S. Divatia, T.G.Varghese, Joseph John, M.R.Dwarakanath, T.P.David, M.S.Bhatia, K.B.Nambiar, P.R. Dhoot, K.K.Sekharan, N.S.Thampi, P.R.Sunder Rao and J.C.Maliakal; AEET/NP/5, 1962.
8.	Programme in progress	: 1. Proton and alpha particle scattering 2. He^3 induced reactions 3. (p, n', γ) reactions 4. Fission studies 5. (n, α) reactions 6. (p' γ) and (α', γ) angular correlation experiments 7. (p,n) & (α,n) reactions.

9. Future programme : Along similar lines

10. Special specifications:

- Type of accelerator: HVEC type CN 5.5 MeV Van de Graaff Accelerator, manufactured by the High Voltage Engineering Corporation, U.S.A.
- Nature of accelerated particles: Protons and alpha particles; arrangements for accelerating He^3 ions are being made at present.
- Energy: 1 MeV - 5.5 MeV
- Energy stabilization: 0.1% (Slit controlled corona stabilization)
- Maximum beam current: 10 micro amps upto 5 MeV and 5 micro amps between 5 and 5.5 MeV.
- Current stabilization: $\pm$ 10%
- Targets available: Lithium and tritium targets for neutron production.

2. AEET 400 keV Van de Graaff Accelerator

1. Organisation responsible for
   a. design and construction : High Voltage Engineering Corporation (Europa) Amsterdam.
   b. operation : Nuclear Physics Division, Atomic Energy Establishment Trombay.
2. Location : Engineering Hall No. 1 North Site, Atomic Energy Establishment, Trombay, Bombay-74.
3. Main purpose of apparatus : For use as a pulsed neutron source for a lead spectrometer of the slowing down type. The system as a whole is to be used to study feasibility of estimating non-destructively the plutonium content in an irradiated fuel rod using a lead spectrometer.
4. Status : The machine was installed in August 1962.

5. Scientist in charge of experimental programme : M.P. Navalkar

6. Number of staff employed : Eight

7. Literature on research accomplished : "A feasibility study of non-destructive assay of plutonium 239 in irradiated fuel rods using ... slowing down time spectrometer" K.Chandramoleswar, M.P.Navalkar, D.V.S.Ramakrishna, R. Ramanna and K.R. Subbaramu; Proc. III Geneva Conference, 1964.

8. Programme in progress : At present measurements with pure samples of U-235 and Pu-239 are in progress to investigate the feasibility of making non-destructive tests of irradiated fuel rods.

9. Future programme : Once the feasibility experiments are completed, the experiment will be extended to the actual estimation of plutonium in an irradiated rod.

10. Important characteristics not included in the list : A slowing down time spectrometer has been constructed with about 100 tons of lead.

11. Special specifications:

- Type of accelerator: PN-400 neutron generator manufactured by High Voltage Engineering Corporation (Europa), Amsterdam.
- Nature of accelerated particles: Deuterons
- Energy: 100 - 400 keV
- Energy stabilization: $\pm$ 10%
- Maximum beam current: 150 microamperes on D.C. and 100 microamperes on pulsed condition.
- Current stabilisation: 10%
- Targets available: Tritium targets
- Neutron energy: 14 MeV
- Pulsation system: Makes use of a pulsing electrode at the base of ion source bottle.

- Pulse length: Variable in six steps

1. 200 microseconds
2. 200 microseconds
3. 200 microseconds
4. 150 microseconds
5. 50 microseconds
6. 10 microseconds

- Pulse repetition rate: Variable in six steps

1. 1 pulse per second
2. 10 pulse per second
3. 100 pulse per second
4. 500 pulse per second
5. 1000 pulse per second
6. 10,000 pulse per second

Maximum duty cycle is 10 percent

- Peak neutron yield per second during the pulse: 10^8 neutrons per second

- Neutron detector: Different detectors are being used. Some of these are as follows:

1. BF_3 counters
2. Proton recoil counter
3. Scintillation counter using different fast and slow neutron crystals
4. Long counter

- Time analyser: Ten channels, with 20 microseconds; channel width and capable of accepting 10,000 pulses per second

3. Bose Institute Cockroft-Walton Accelerator

1.	Organisation responsible for design, construction and operation	: Bose Institute
2.	Location	: Bose Institute, 93/1 Acharya Prafulla Chandra Road, Calcutta-9.
3.	Main purpose of apparatus	: Mono-energetic neutron generation
4.	Status	: Year of first operation
		i. Prototype construction in 1955

ii. High current medium voltage accelerator, 1959.

iii. High voltage Cockroft-Walton Accelerator completed and put on operational schedule, 1961.

5. Scientist in charge of experimental programme : A.M. Ghose

6. Number of staff employed : Six

7. Available reference for more detailed description : 1. A netron generator using T(d,n) reaction, A. Banerjee, Science and Culture, 454 (1955).

2. 'Construction of a 14 MeV neutron generator utilising $T^3(d,n)He^4$ reaction', B. Mitra, Indian J. Phys. 33, 149 (1959).

8. Literature on research accomplished : 1. 'Total cross section measurements with 14 MeV neutrons', B. Mitra Proc. of Nuclear Physics Symposium, Bombay 1962 (Department of Atomic Energy, Bombay, 1962)

2. 'A directional neutron counter for fast neutrons', B. Mitra, Proc. of Nuclear Physics Symposium, Bombay 1962 (Department of Atomic Energy, Bombay, 1962)

3. 'Measurement of (n, p) cross section of 14 MeV neutrons in low Z elements', B.Mitra and A.M. Ghose, Proc. of Nuclear Physics Symposium, Bombay 1962 (Department of Atomic Energy, Bombay, 1962)

9. Programme in progress : i. Reaction cross section measurements of 14 Mev neutrons

ii. Non-elastic cross section of 14 MeV neutrons

10. Future programme : Along similar lines

11. Special specifications:

- Type of accelerator: 'Home made' accelerator of Cockcroft Walton type
- Nature of accelerated particles: deuterons
- Energy: Maximum energy 250 KV
- Energy stabilization: Stabilization obtained by electronic stabilization of the H.F. AC input power
- Maximum beam current: 250 uA
- Targets available: Tritium titanium target; Reaction $t(d,n)He^4$
- Admissible current on target: 200 uA (target liquid air cooled)
- Current stabilization: By stabilizing R.F. ion-source power, and control of ion source pressure while in operation.
- Neutron yield in 4π geometry: 5×10^9 n/sec.
- Neutron detector: Three types of detectors are used:
    1. Calibrated flat response BF_3 counter
    2. Scientillation counter employing plastic phosphor
    3. Threshold detectors

4. Saha Institute Cockcroft Walton Accelerator

1. Organisation responsible for design, construction and operation	: Saha Institute of Nuclear Physics
2. Location	: Saha Institute of Nuclear Physics, 92, Acharya Prafulla Chandra Road, Calcutta-9.
3. Main purpose of apparatus	: Study of fast neutron reactions cross sections and fast neutron induced transmutations with $\beta - \gamma$ spectroscopy.
4. Status	: Year of first operation 1959

5. Scientist in charge of experimental programme : D.N. Kundu

6. Number of staff employed : Five

7. Literature on research accomplished :

1. Activation cross-section with 14 MeV neutrons, S.K.Mukherjee, A.Ganguly and N. Majumdar, Proc. Phys. Soc. (London) 77, 508 (1961).

2. Neutron-alpha reaction in Indium with 14 MeV neutrons, B.Sen, Nuclear Phys. 38, 601(1962).

3. (n,α) reactions on light nuclei at 14 MeV, B.Sen, Nuclear Phys. 41, 435 (1963).

4. Radioactive Decay of Cu^{68}, H. Bhakru and S.K. Mukherjee, Nuclear Phys. 52,125 (1964).

5. Decay of Lu^{178}, H.Bhakru and S.K. Mukherjee, Nuclear Phys. 55, 161 (1964).

6. The (n,α) reaction on C^{12} at at 14 MeV, M.L. Chatterjee and B. Sen, Nuclear Phys. 51, 583 (1964).

7. A high intensity neutron generator, S.K. Mukherjee, N. Majumdar and A. Ganguly, Indian J. Phys. 34, 307 (1960).

8. Decay of Sr^{93}, H. Bhakru and S.K. Mukherjee, Nuclear Phys.

9. Decay of Hf^{183}, H. Bhakru and S.K.Mukherjee, Nuclear Phys.

8. Programme in progress : Study of fast neutron reactions, cross sections and fast neutron induced transmutations.

9. Future programme : To change the site to make improvements so as to enhance neutron flux.

10. Special specifications :

- Type of accelerator: Cockroft Walton generator (home made)
- Nature of accelerated particles : Deutrons
- Energy: 400 keV
- Energy stabilization: Voltage stabilization $\pm$ 0.1%
- Maximum beam current: 1.2 mA
- Current stabilization: nil
- Targets available (admissible current on target): Tritium, about 1 mA over $\frac{1}{4}$ inch diameter
- Neutron yield in a 4π geometry: 10^{11}/sec.
- Neutron energy: 14 MeV.

5. Saha Institute Cyclotron

1. Organisation responsible for design, construction and operation : Saha Institute of Nuclear Physics
2. Location : Saha Institute of Nuclear Physics, 92, Acharya Prafulla Chandra Road, Calcutta-9.
3. Main purpose of apparatus : Internal beam irradiation of targets for producing isotopes for $\beta - \gamma$ spectroscopy.
4. Status : Full beam operation 1959
5. Scientist in charge of experimental programme : D.N. Kundu

6. Number of staff employed : Eight

7. Literature on research accomplished :

1. Heavy water Electrolysis generation of Deuterium Gas Provided with Automatic Switch off and Safety Devices, P.K. Datta, J. Sci. Instr. 37, 352 (1960).

2. Disintegration of Rhodium^{97}, B.Basu and A.P. Patro, Nuclear Phys. 33, 347 (1962).

3. Gamma Spectrum and coincidence studies of Ru^{100}, B. Basu and A. P. Patro, Nuclear Phys. 29, 672 (1962).

4. Characteristics of the Ion Source of the Calcutta 37-inch Cyclotron, P.K. Datta, A.P.Patro, B.Basu and A. Chatterjee, Indian J. Phys. 36, 196 (1962).

5. Decay of Ag^{103}, A.P. Patro and B. Basu, Phys. Rev. 127, 1258 (1962).

6. Decay of Yttrium^{85}, A.P.Patro and B. Basu, Nuclear Phys. 37, 272 (1962).

7. Decay of Antimony^{113}, A.P. Patro and B. Basu, Nuclear Phys. 34, 538 (1962).

8. Decay of In^{107} and Gamma Spectrum of Cd^{107}, B. Basu and A.P. Patro, Nuclear Phys. 46, 59 (1963).

8. Programme in progress : Beam extraction

9. Future programme : Experiments on external beam

10. Special specifications

- Type of accelerator: Cyclotron (Home made)

- Nature of accelerated particles: protons

- Energy: Fixed - about 3.5 MeV
- Energy stabilisation: Nil
- Maximum beam current: 40 uA average; the machine operates on 50 cycles A.C.
- Targets available: only internal beam facility is available

6. TIFR Cockcroft Walton Accelerator

1. Organisation responsible for	
a. design and construction	: Phillips Company, Netherlands.
b. Operation	: Nuclear Reactions Group, Tata Institute of Fundamental Research.
2. Location	: Tata Institute of Fundamental Research, Colaba, Bombay-5.
3. Main purpose	: Study of nuclear reactions and pulsed neutron investigations of moderating and multiplying media.
4. Status	: In operation from 1953
5. Scientist in charge of experimental programme	: E. Kondaiah
6. Number of staff employed	: Sixteen
7. Literature on research accomplished	: 1. Surface direct interaction of 14 MeV neutrons with Fluorine, E. Kondaiah, Nuclear Phys. 27, 166(1961)
	2. Multiplication constants of BeO-U lattices using pulsed neutrons, B.V.Joshi, S.B.D.Iyengar, K.Satyanarayana and C.S.Somanathan, Proc. of Nuclear Physics Symposium, Madras, 1962 (Dept. of Atomic Energy, Bombay, 1962).

8. Programme in progress : Study of (n, α), (n, p) reactions

9. Future programme : 1. Systematic studies of (n, α) and (n, p) reactions.

2. Determination of multiplication constants of U-BeO lattices using pulsed neutron technique.

10. Important characteristics not included in the list. : The accelerator has two accelerating tubes (referred to hereafter as (a) and (b)) working on the same high tension. The second one was added in 1963.

11. Special specifications:

- Type: Cockcroft Walton type

  a. Phillips - 0 to 1 MeV - Main

  b. Home made - 0 to 400 kev - auxiliary unit

- Nature of accelerated particles: Protons and deuterons

- Energy: a. 0 - 1 MeV in main unit
  b. 0 - 400 kev in auxiliary unit

- Energy stabilization: Nil

- Maximum beam current: a. 200 uA in main unit
  b. 400 uA in auxiliary unit

- Current stabilization: Nil

- Targets and reactions available: Be, H^3 and H^2

- Neutron yield in 4π geometry during continuous operation: 10^{10} to 10^{11} neutrons/second.

- Neutron energy: 2 MeV - 14 MeV

- Pulsation system: Electronic pulsing of ion source probe voltage

- Pulse repetition rate: 50 c/s to 500 c/s.

- Neutron detector: Plastic scintillator and BF_3 counter

- Time analyser: number of channels : 50
  Minimum channel width: 3 usec.

7. TIFR 3.5 MeV Electron Linear Accelerator

1. Organisation responsible for design, construction and operation	: Tata Institute of Fundamental Research.
2. Location	: Tata Institute of Fundamental Research, Colaba, Bombay-5.
3. Main purpose of apparatus	: Experience in Accelerator design, and construction; use as an electron irradiation source.
4. Status	: Completed as 1.5 MeV accelerator in 1960; as 3.5 MeV in 1962
5. Scientist in charge of experimental programme	: R.V.S. Sitaram
6. Number of staff employed	: Six
7. Programme in progress	: Study of: 1. Solid state and Biological irradiation effects 2. Bremsstrahlung properties 3. Accelerator techniques 4. Nuclear resonance fluorescence
8. Future programme	: Along similar lines
9. Important characteristics not included in the list	: It is travelling wave electron linear accelerator operating at 3 G.C./sec. 2 usec pulses. Pulse repetition rate variable upto 400 P.P.S. normally operated at 100 P.P.S. with peak pulse current of about 30 mA. It is powered by a 2 M.W. magnetron. Provision has been made to introduce any desired target into the vacuum chamber. For irradiation purposes, the beam comes out through a thin window.

10. **Special specifications:**

- Nature of accelerated particles: Electrons
- Energy: 3.5 MeV fixed
- Energy stabilization: About ± 10%
- Maximum beam current: 30 mA pulse - 25 us. max. average
  10 uA average continous operation
- Current stabilization: ± 10% of value set
- Pulsation system: 5-M.W. line type pulse modulator
- Pulse length: 2 usec.

VI. PILE OSCILLATORS

Pile Oscillator

1. Organisation responsible for design, construction and operation : Reactor Engineering Division Atomic Energy Establishment Trombay

2. Location : Engineering Hall No. 1 Atomic Energy Establishment, Trombay, Bombay-74.

3. Main purpose of apparatus : Measurement of absorption cross sections of reactor materials

4. Status : Under test

5. Scientist in charge of experimental programme : M. Srinivasan

6. Number of staff employed : Four

7. Future programme : Includes measurement of absorption cross section of organic coolants and Zircalloy and other reactor grade material produced in India.

8. Reactor at which the Oscillator is installed : ZERLINA (Trombay)

9. Special specifications:

- Principle of oscillation: Overall modulation
- Location in the reactor: Core
- Medium surrounding the oscillator: Heavy water
- Nature of neutron flux at oscillator position: Thermal
- Gradient along oscillator direction: Cosine
- Sample used for reference: Boron (exact form in which it is to be used has yet to be finalised)
- Maximum size and dimensions of the test sample: Not yet optimised
- Oscillation wave Shape : Square
  Period : 20 to 50 seconds
  Stroke : 100 to 160 cms
- Sensitivity of minimum absorption detectable: 0.01 cm^2