NUCLEAR DATA MEASURING FACILITIES

IN

JAPAN

July 1965

Japanese Nuclear Data Committee

Nuclear Data Measuring Facilities in Japan

This is the 1st revision of "Measuring Facilities List" (INDSWG No. 21) edited in November 1963. The same as the present edition was submitted to the 8th Meeting of the European-American Nuclear Data Committee held in May 1965 as the "Report to EANDC on Nuclear Data Measuring Facilities in Japan."

Contents

July 1965

Japanese Nuclear Data Committee

I Fast chopper spectrometer

K U R Fast chopper spectrometer

Organization : Research Reactor Institute, Kyoto University .

Location : Kumatori-cho, Osaka-fu, Japan .

Main purpose : Research on neutron physics .

Status : Just completed .

Number of staff employed : 3

Scientist in charge : S. Okamoto

Future program : Neutron cross section measurements .

Reactor at which the spectrometer is installed : K U R (a Swimming-pool-type reactor of 1 MW)

Rotor : Five rotors is prepared as follows ;

No.	Dia.(cm)	Slit width(mm).	Distance between slits(mm).	Number of slits.	Material.	Max. speed (rpm) .
1	30	0.5	5.0	10	K-Monel	13,000
2	25	2.0	4.0	8	K-Monel	16,000
3	15	2.0	3.0	6	K-Monel	16,000
4	25	2.0	4.0	8	Plastics	8,000
5	15	2.0	3.0	6	Plastics	8,000

Minimum neutron pulse duration : 2 μsec.

Flight path :

Maximum length ; 20 m

Useful diameter ; 50 cm

Transmitting medium ; Helium

Type and number of neutron detector : Two detectors are prepared,

1) B^{10} loaded ZnS scintillator in $8\phi'' \times \frac{5}{8}''$,

2) Hornyak Buttons type plastic scintillator in same size .

Time analyser : 1024 channels

Resultant specification : Performance tests are now being carried on .

II Crystal spectrometer

JAERI Crystal monochromator

Organization : Japan Atomic Energy Research Institute.

Location : Tokai-mura, Ibaraki-ken, Japan.

Main purpose of the apparatus : Research on slow neutron physics.

Statuse : Being used since 1962.

Scientist in charge of experimental programme : Y. Ohno

Number of staff employed : 4

Available reference for more detailed description :

Y. Ohno et al. ; "The JAERI Neutron Crystal Spectrometer", Pile neutron research in physics, P.585 IAEA, 1962.

Y. Ohno et al. ; "The Construction and Performance of the JAERI Neutron Crystal Spectrometer", JAERI 1030, 1962, (In Japanese).

Important characteristics not included in the list :

Automatic data recording system for the data treatment with eight bits paper-tape punched typewriter.

Reactor at which it is installed : JRR-2, (a CP-5 type reactor of 10-MW).

Type : SINGLE and PLANE crystal spectometer.

Collimator : Cross section area ; 30 x 35 mm.
Angular divergency ; 20' and 2' of arc prepared.

Crystal available : LiF(200), LiF(111), Be(0002) and Calcite.

Useful neutron energy range :

Up to	3 eV		LiF(200)
"	5 eV	with	LiF(111)
"	20 eV		Be(0002)

Sample specifications :

Useful area : 35 mm X 30 mm
Distance from crystal and detector : 160 cm
Possibility of activation measurements : Possible

Accuracy in angular positioning for the crystal-sample coupling :

Less than $\pm$ 5 sec. of arc.

Energy resolution at some typical angles :

$\Delta E/E = 3\ \%$ at 0.025 eV of the neutron energy using LiF(200) plane and a collimater of 20' angular divergency.

III Mechanical monochromator

JAERI Mechanical monochromator

Organization : Japan Atomic Energy Research Institute.

Location : Tokai-mura, Ibaraki-ken, Japan.

Main purpose of the apparatus :

1) Neutron cross sections measurements for the cold neutron energy region.
2) To remove the higher order contaminations of the neutron from the JAERI neutron crystal spectrometer.

Status : First operation at the JRR-1 reactor on 1963.

Scientist in charge of experimental programme : Y. Ohno

Number of staff employed : 2

Available reference for more detailed description :

K. Okamoto; "The Construction and Performance of JAERI Mechanical Neutron Velocity Selector", JAERI 1069, 1964, (In Japanese).

Important characteristics not included in the list :

To be inserted into a horizontal hole of JRR-2 when this monochromator is to be coupled with the crystal spectrometer.

Reactor at which it is installed :

JRR-1 (a Water-boiler-type reactor of 50 kW) or

JRR-2 (a CP-5 type reactor of 10 MW) .

Rotor :

Type; Cylindrical rotor with helical slots.
Diameter; 19.5 cm.
Materials of rotor body and slits; KR Monel, cadmium lined.
Type and number of slits; 80 helical slits of 1.5 mm x 4 cm with a pich of 10 meter.
Maximum rotational speed and stability; 15,000 rpm with a stability better than 0.1 % .

Transmission efficiency : 75 %.

Neutron energy range : 0.00033 eV to 0.033 eV.

Beam cross-sectional area : 35 mm x 30 mm.

Typical resolution : 25 % .

K U R Mechanical monochromator

Organization : Research Reactor Institute, Kyoto University.

Location : Kumatori-cho, Osaka-fu, Japan.

Main purpose of the apparatus : Research on neutron physics with monochromatized neutron burst.

Status : Just completed.

Number of staff employed : 3

Scientist in charge : S. Okamoto

Future programme : Very short life gamma ray analysis induced by pulsed monochromatic neutron irradiation.

Reactor at which the monochromator is installed : K U R (a Swimming-pool-type reactor of 1 MW).

Type : Tripple rotors on a co-axis, distance between the 1st and 3rd rotor being 5 meters.

Rotors : Type ; Disc with two windows,
Diameter ; 35 cm,
Material ; K-Monel,
Maximum speed ; 12,000 rpm,
Three rotors mounted on the same axis.

Minimum neutron pulse length : 14 μsec.

Detector and analyzer : Gamma or neutron detectors and 512 channels analyzer for pules height or time-of-flight analyzer.

Available neutron energy : Up to 200 eV .

IV Pile oscillator

JAERI Pile oscillator

Organization : Japan Atomic Energy Research Institute.

Location : Tokai-mura, Ibaraki-ken, Japan.

Main purpose of the apparatus :

Measurements of thermal-neutron absorption cross sections.

Status : Operated since 1958.

Scientist in charge of experimental programme : T. Fuketa

Number of staff employed : 1

Available reference for more detailed descriptions :

T. Fuketa, "Paired-chamber type pile oscillator", Nucl. Inst. and Meth., 13, 35, 1961.

T. Fuketa, M. Ishii, and S. Otomo, "Paired-chamber type pile oscillator", Pile neutron research in physics P. 633 IAEA, 1962.

Reactor at which it is installed : JRR-1 (a water-boiler-type reactor of 50 kW).

Principle of oscillation : Local flux perturbation.

Location in the reactor : Reflector.

Medium surrounding the oscillator : Graphite.

Nature of neutron flux at oscillator position :

Spectrum : Thermal, Cadmium to Indium ratio; 10,

Intensity: 3×10^{11} n/cm^{2}sec,

Gradient along oscillator direction : Less than 5 % .

Sample used as reference : Boron-10 or gold foil.

Maximum size and dimensions of the tested sample :

20 mm in diameter and about 100 mm in length.

Oscillator wave :

Shape; Sine wave,

Period; 0.5 c/sec $\sim$ 2 c/sec variable,

Stroke; $\pm$ 75 mm $\sim$ $\pm$ 200 mm variable.

Sencitivity or minimum absorption detectable :

Less than 0.5×10^{-3} cm^2 in the whole macroscopic cross section $\Sigma_a V$ of the sample.

V Phased-chopper spectrometer

JAERI Neutron spectrometer

Organization : Japan Atomic Energy Research Institute.

Location : Tokai-mura, Ibaraki-ken, Japan.

Main purpose : Inelastic scattering of neutron by solids and liquids; mainly phonon and magnon scattering.

Status : Operated since June 1964.

Number of staff employed : 4

Scientist in charge : Y. Hamaguchi

Available reference :

1) Specification JAERI - memo 532-624 (in Japanese)
2) Hazard Report-1 JAERI - memo 1032 (in Japanese)
3) Hazard Report-2 JAERI - memo 1421 (in Japanese)

Future programme :

1) Inelastic scattering by several hydrides, at varicus temperatures, e.g. ZrHx, TiHx, VHx, TaHx, etc.
2) Critical magnetic scattering.

Reactor at which the spectrometer is installed :

JRR-2 (a CP-5 type reactor of 10 MW).

Type : Tripple phased-rotor type, distance between the 1st and the 3rd rotor being 3 meters.

Rotors : Type: Disc with two windows; axis holizontal,
Diameter: 50 cm,
Material of the rotor body; Precipitation type aluminum alloy,
Window : 3 cm X 3 cm,
Maximum speed: 12,000 rpm,
Stability: 0.5 % .

Minimum neutron pulse length : 1.13×10^{-4} sec.

Flight path : 2 meters in maximum; medium: air.

Location of the detectors : Surrounding specimen for the scattering angle of $0^{\circ} \sim 90^{\circ}$.

Type and number of neutron detectors : Ten BF_3 counters are assembled.

Time analyzer : Number of channels: 256,
Minimum channel width: 5 microsec,
Counting capacity per channel: 16,384,
Special devices for automatic operation: None.

Resultant specifications :
Wavelength range: 1 Å ~ 10 Å,
Beam cross sectional area: 3 cm X 3 cm,
Typical resolving power: $\Delta\lambda/\lambda = 7.5$ % at 2 Å.

VI Particle accelerators

JAERI Electron linear accelerator

Organization : Japan Atomic Energy Research Institute.

Location : Tokai-mura, Ibaraki-ken, Japan.

Main purpose of the apparatus : X-ray production, neutron production.

Status : Operated since Dec. 1960.

Scientist in charge of experimental programme : H. Takekoshi

Number of staff employed : 7

Manufacturer : High Voltage Engg. Corp. USA.

Nature of accelerated particles : Electrons.

Minimum and maximum energy of acceleration : 2 ~ 20 MeV.

Maximum beam current : 100 mA (4 microsec width) at 20 MeV.

Target : Pb, Neutron yield: 2.4×10^{12} sec^{-1}.

Pulse length : 4 ~ 0.04 microsec.

Pulse repetition rate : 50 ~ 300 cps.

Peak neutron yield per second during the pulse : 2×10^{15}.

Neutron flight path :

Number of neutron beams: 2
Maximum length: 50 m, 10 m.
Intermediate stations: None.
Useful diameter: 30 cm, 8 cm.
Transmitting medium: Vacuum.

Neutron detector : BF_3 counters, Li glass scintillation counters.

Time analyzer : Two sets of;

Number of channels; 256
Minimum channel width; 0.25 μsec
Counting capacity per channel; 2^{16},
and

Number of channels; 4096

Minimum channel width; 30 nsec

Counting capacity per channel; 10^5,

respectively.

JAERI 5.5 MV Van de Graaff accelerator

Organization : Japan Atomic Energy Research Institute.

Location : Tokai-mura, Ibaraki-ken, Japan.

Main purpose of the apparatus : Fast neutron physics.

Status : Installed since 1962.

Scientist in charge of experimental programme : K. Tsukada

Number of staff employed : 5

Type of accelerator : Model CN, High Voltage Engg. Corp. USA.

Nature of accelerated particles : H^+, D^+, T^+, He^{3+}, He^{3++}, He^{4+}, He^{4++}.

Minimum and maximum energy of acceleration : 1.0 $\sim$ 5.5 MeV.

Energy stabilization : Less than $\pm$5 kV (for analyzed protons).

Maximum beam current : 20 μA (1.0$\sim$5.0 MV)
10 μA (> 5.0 MV).

Targets and reactions available :

a) Neutron yield in 4π geometry obtained by using a double foil gas target of 1 atm, 3 cm long.

10^9	neutrons/10 μA	$D(d,n)He^3$ at 3 MeV,
2.5 X 10^9	"	$T(p,n)He^3$ at 3 MeV,
5.5 X 10^9	"	$T(d,n)He^4$ at 1 MeV,
5 X 10^9	"	Li(p,n)Be at 2.2 MeV.

b) Neutron energy:

1.6	$\sim$	8.7 MeV	$D(d,n)He^3$,
0	$\sim$	4.7 MeV	$T(p,n)He^3$,
11.6	$\sim$	22.5 MeV	$T(d,n)He^4$,
0	$\sim$	3.8 MeV	Li(p,n)Be.

Pulsation system : Terminal pulsing system,

Beam bunching system: Mobley type.

Pulse length : 10 ns (full width at half maximum) before the bunching,

$\sim$ 1.0 ns (") after the bunching.

Pulse repetition rate : 10^6 p.p.s.

Peak neutron yield per second during the pulse :

3×10^{12} neutrons/5 mA, 1 atm, 3 cm length,

(with the pulsed ion beam bunching system).

Neutron detector : Plastic scintillator (5"ϕ X 2") with three phototubes (RCA 6810A).

Time analyzer : Number of channels: 256,

Minimum channel width: 0.25 ns,

Counting capacity per channel: 2^{20}.

Devices to measure angular distributions :

Rotating table (flight path: 1$\sim$4 meters).

JAERI 2 MV Van de Graaff accelerator

Organization : Japan Atomic Energy Research Institute.

Location : Tokai-mura, Ibaraki-ken, Japan.

Main purpose of the apparatus : Fast neutron physics.

Status : Operated since 1957.

Scientist in charge of experimental programme : K. Tsukada

Number of staff employed : 2

Type of accelerator : Model AK, High Voltage Engg. Corp. USA.

Nature of accelerated particles : H^+, D^+, T^+, e^- .

Minimum and maximum energy of acceleration : 0.2 ~ 2.0 MeV.

Energy stabilization : Less than $\pm$ 2 keV (for analyzed proton).

Maximum beam current : 50 μA for positive ions.

Targets and reactions available :

a) Neutron yield in 4π geometry by using double foil gas target.

(1 atm, 3 cm length)

1 X 10^9 neutrons/10 μA	$D(d,n)He^3$ at 2 MeV,
2.5 X 10^9 "	$T(d,n)He^4$ at 1 MeV,
4.0 X 10^9 "	$T(p,n)He^3$ at 2 MeV.

b) Neutron energy

1.65 ~ 5.2 MeV	$D(d,n)He^3$,
12 ~ 18.2 MeV	$T(D,n)He^4$,
0 ~ 1.2 MeV	$T(p,n)He^3$.

Pulsation system : Terminal pulsing system,

Beam bunching system; None .

Pulse length : 3 ns (full width at half maximum).

Pulse repetition rate : 5 X 10^6 p.p.s.

Peak neutron yield per second during the pulse :

6 X 10^{10} neutrons/150 μA, 1 atm, 3 cm length.
($T(p,n)He^3$ at 2 MeV).

Electrostatic accelerator
(Electrotech. Lab.)

Organization : Electrotechnical Laboratory, Ministry of International Trade and Industry.

Location : Tanashi-machi, Kitatama-gun, Tokyo, Japan.

Main purpose : Neutron physics research.

Status : First operation; 1958.

Scientist in charge of experimental programme : E. Teranishi.

Number of staff employed : 4

References for more detailed description :

1) E. Teranishi, Researches of the Electrotechnical Laboratory, No. 617 (1961).
2) B. Furubayashi et al., Jour. Phys. Soc. of Japan, 18,1235 (1963).

Manufacturer : Toshiba Electric Co. , Japan.

Nature of accelerated particles : Protons and deuterons.

Minimum and maximum energy : 0.7 MeV $\sim$ 2.7 MeV.

Energy stabilization : $\pm$ 0.1 %.

Maximum beam current : 25 μA on target.

Targets and reactions available :

$Li(p,n)Be$, $T(p,n)He^3$, $D(d,n)He^3$, $T(D,n)He^4$

(admissible current on target: Less than 10 μA).

Neutron yield: Less than 10^8 n/4π.

Neutron energy: 1 keV $\sim$ 5.5 MeV,
14 MeV $\sim$ 17 MeV.

Cockcroft-Walton accelerator

(Tokyo Institute of Technology)

Organization : Research Laboratory of Nuclear Reactor,
Tokyo Institute of Technology.

Location : Oh-okayama, Megro-ku, Tokyo, Japan.

Main purpose of the apparatus :
Research of neutron-induced reactions and pulsed neutron experiments for reactor physics.

Status : Operated since 1960. Pulsation systems are installed in 1964.

Scientist in charge of experimental programme : Prof. N. Yamamuro

Number of staff employed : 5

Type of accelerator: Cockcroft-Walton type,
Manufacturer:
Power supply; Fuji General Electric Co.
Accelerator tube and Pulsing system; Hitachi Ltd.

Nature of accelerated particles : Protons or deuterons.

Minimum and maximum energy of acceleration : 200 to 400 keV.

Energy stabilization : 0.1 % .

Maximum beam current : 500 μA before the analyzing magnet.

Targets :
Ti-T neutron yield 10^{10} sec^{-1} in 4π geometry,
neutron energy 14 MeV

As a pulse generator;

Pulsation system : Nanosec pulse; Terminal deflector type,
Microsec pulse; RF ion source with grid,
Associated α particle method (Time-of-flight experiments are carried out by this method).

Pulse length : Nanosec pulse; Minimum 5 ns,
Microsec pulse; 10, 25, 50 and 100 microsec.

Pulse repetition rate : Nanosec pulse; 2 and 8 Mc/sec,
Microsec pulse; 1, 10, 100, 300 and 1000 c/sec.

Peak neutron yield per sec during the pulse : 10^7 sec^{-1}.

Neutron flight path : 1 ~ 3 meters (associated α particles method).

Neutron detector : Plastic and liquid scintillation counters,
BF_3 and He^3 proportional counters.

Time analyzer : Technical Measurement Co. USA, Model 212 Pulsed neutron logic unit,
Nanosec region; Time-to-pulse height analyzer(home made),
Microsec region; 32-channels time analyzer(home made).

Cockcroft-Walton accelerator

(Rikkyo University, Tokyo)

Organization : Department of Physics, Rikkyo (St. Paul's) University.

Location : Ikebukuro, Toshima-ku, Tokyo, Japan.

Main purpose of the apparatus : Research in nuclear and radiation physics.

Status : Operated since 1956.

Scientist in charge of experimental programme ; Prof. E. Tajima

Number of staff employed : 6

Type of accelerator : Cockcroft-Walton type, "home made",

Nature of accelerated particles : Deuterons.

Minimum and maximum energy of acceleration : 0 $\sim$ 200 keV.

Energy stabilization : 0.1 % for fast component,
1 % for slow component.

Maximum beam current : 600 μA.

Targets and reactions available :

1) $D(d,n)He^3$; $\sim 10^7$ neutrons/sec/4π , $E_n \cong 2.4 \sim 2.8$ MeV,
2) $T(d,n)He^4$; $\sim 10^{8\sim 9}$ neutrons/sec/4π , $E_n \cong 14$ MeV.

Pulse operation; Not available .

Cockcroft-Walton accelerator

(Kyushu University, Engg.)

Organization : Institute of Applied Nuclear Physics,
Faculty of Engineering, Kyushu University.

Location : Hakozaki-machi, Fukuoka City, Japan.

Main purpose of the apparatus :
Research of neutron-induced reactions and neutron source for reactor physics.

Status : Operated since 1959.

Scientist in charge of experimental programme : Prof. M. Sonoda

Number of staff employed : 6

Available reference for more detailed description :
Jour. Phys. Soc. Japan 15, 1680 (1960),
Memo. Coll. Engg. Kyushu Univ. 20, 367 (1961).

Type of accelerator : Cockcroft-Walton Type (home made).

Nature of accelerated particles : Protons or deuterons.

Minimum and maximum energy of acceleration : Less than 500 kV.

Energy stabilization : 0.130 kV/mA.

Maximum beam current : $\sim$ 1 mA.

Targets and reactions available (admissible current on target):
Ti-D or Ti-T 200 μA,
Neutron yield in 4π geometry 5×10^9,
Neutron energy $\sim$ 3- and 14-MeV.

The machine is not operated pulsatively , but time-of-flight experiments are carried out by associated alpha particle method.

Neutron flight path : 1 $\sim$ 2 meters.

Neutron detector : Liquid scintillator with pulse-shape discrimination.

Time analyzer: Number of channels; 128 or 256,
Minimum channel width; 0.5 nanosec,
Counting capacity per channel; 99,999 .

Cockcroft- Walton accelerator

(Kyoto University, Engg.)

Organization : Department of Nuclear Engineering, Kyoto University.

Location : Gokasho, Uji City, Kyoto-fu, Japan.

Main purpose of the apparatus :

Research of neutron-induced reactions and pulsed-neutron experiments in reactor physics.

Status : Completed in 1963.

Scientist in charge of experimental programme : Prof. H. Nishihara and Prof. M. Sakisaka .

Programme in progress :

Pulsed-neutron experiments in multiplying system (natural uranium and light water system) and non-multiplying system (light water system).

Neutron reactions of light nuclei.

Fluctuations of neutron-induced reaction cross sections near 14 MeV.

Inelastic scattering of neutrons.

Fast neutron induced fissions.

Future programme :

Interaction of low-energy heavy ion with matter.

Neutron-wave induced by modulated neutron source.

VII Mass separators

Electrotechnical Lab. mass separator

Organization : Electrotechnical Laboratory, Ministry of International Trade and Industry.

Location : Tanashi-machi, Kitatama-gun, Tokyo, Japan.

Main purpose of the apparatus :
Source production for radioisotope standard and preparation for monochromatic neutron generation.

Status : Completed on 1958.

Scientist in charge of experimental programme : O. Yura

Number of staff employed : 1

Available reference for more detailed description :
I. Kohno, " Isotope separation with ETL mass separator and purity of some collected isotopes." Bull, ETL 26 771, (1962).

Ion source : Ion density; 10 mA/cm^2,
Extraction voltage; 50 kV (maximum),
Ion current in the beam; 10 mA (ion source output),
Throughput per week; 30 hours (machine time).

Deflection magnet :
Weight; 5.5 tons,
Power supply; 17.5 kW,
Stabilization; 0.03 % per day,
Maximum magnetic field; 6000 gauss.

Vacuum : $5 \sim 10 \times 10^{-6}$ Torr. (in operation).

Curvature radius of ion path : 70 cm.

Angular deflection of the ion beam : 60°.

Collector efficiency: 1 % defined as collected isotope/consumed material.

Resolution : $(M/\Delta M)$ is 250 .

I N S mass separator

Organization : Institute for Nuclear Study, University of Tokyo.

Location : Tanashi-machi, Kitatama-gun, Tokyo, Japan.

Main purpose of the apparatus :
Production of separated or enriched isotopes as the target for the nuclear studies.

Status : Year of first operation; 1957.

Scientist in charge of experimental programme : M. Sakai and K. Kaneko.

Number of staff employed : 3

Available reference for more detailed description :
M. Sakai, Mass Spectroscopy, No. 14, 27, (1960), (In Japanese).

Ion Source : Extraction voltage; - 20 kV maximum,
Acceleration voltage; + 50 kV maximum,
Ion current in the beam; up to 10 mA.

Deflection magnet :
Weight; 17 tons,
Power supply; 20 kW,
Stabilization; 1/3000 $\sim$ 1/10000,
Maximum magnetic field; 7000 gauss.

Vacuum : 1×10^{-5} mm Hg.

Curvature radius of ion path : 90 cm.

Angular deflection of the ion beam : 60°.

Collector efficiency : 0.02 $\sim$ 0.6 (collection/consumption).

Resolution : (M/4 M) 300 $\sim$ 500 .

Kyoto University mass separator

Organization : Department of Physics, Faculty of Science, Kyoto University.

Location : Kitashirakawa, Oiwake-cho, Sakyo-ku, Kyoto, Japan.

Main purpose of the apparatus :

Production of enriched stable isotopes which are used in scientific research, especially, in nuclear physics.

Status : Year of first operation; 1956.

Scientist in charge of experimental programme : J. Muto

Number of staff employed : 4

Available reference for more detailed description :

J. Muto et al., Mem. Coll. Sci. Univ. Kyoto 28A 337 (1958).

Ion source : Ion density; 0.2 $\sim$ 1 A,
Extraction voltage; 5 $\sim$ 50 kV (acceleration voltage),
Ion current in the beam; 0 $\sim$ 5 mA,
Throughout per week;

Deflection magnet : Weight; 7 tons,
Power supply; 10 kW DC motor generator,
Stabilization; High current regulator having 400 cycle chopper-converter, stability; 1/4000.
Maximum magnetic field; 8000 gauss.

Vacuum :

Two sets of evacuating pumps are used. Each set of pumps consists of an 8 inch oil diffusion pump with the pumping speed of 1250 litre/sec at 2 X 10^{-6} mm Hg and a Kinney type rotary pump with pumping speed of 680 litre/min at 1 mm Hg.

Curvature radius of ion path : 60 cm.

Angular deflection of the ion beam : 60°.

Collector efficiency : 10 $\sim$ 30 % .

Resolution : $(M/\Delta M)$ 150 in normal operation,
250 in favourable conditions.

VIII Special mass spectrometer

Hitachi mass spectrometer

Organization : Ozenji Division of Hitachi Central Research Laboratory, Hitachi Ltd..

Location : Ozenji, Kawasaki City, Kanagawa-ken, Japan.

Main purpose of the apparatus :

Measurement of isotopic ratio of uranium, and measurement of fission products in UO_2 fuel for the future.

Status : Year of first operation; 1958.

Scientist in charge of experimental programme : K. Taniguchi

Number of staff employed : 2

Ion source : Electron bombardment, surface ionization,
Extraction voltage; greater than 20 V,
Ion current; $10^{-10} \sim 10^{-15}$ amp..

Deflection magnet : Weight; 1350 kg,
Power supply; 380 Watt,
Stabilization; $1 \sim 2/10,000$,
Maximum magnetic field; 5500 gauss.

Vacuum : $10^{-6} \sim 10^{-7}$ mm Hg.

Curvature radius of ion path : 335 mm.

Angular deflection of the ion beam : 90°.

Resolution ($M/\Delta M$) : Maximum; 3000
Ordinary use; 350 .

IX Research reactors

J R R - 1

Name ; Japan Research Reactor No. 1 (JRR-1).

Situated: Tokai-mura, Ibaraki-ken, Japan.

Critical: Aug. 1957.

Type: Water-boiler type (Light water homogenous reactor).

Owner: Japan Atomic Energy Research Institute.

Operator: Y. Ohno, T. Fuketa.

Designer: Atomics International, USA.

Use:

1) Measurements of thermal neutron absorption cross sections using the pile oscillator inserted into a virtical experimental hole.

2) Measurements of total and partial cross sections for the cold neutron using the mechanical neutron monochromator installed at the thermal column.

Power: 50 kW maximum.

Fuel: Uranyl sulfate solution, enriched to 20 % in U-235.

Flux:

Average thermal neutron flux; 8×10^{11} n/cm^2 sec,
Peak thermal neutron flux; 1.2×10^{12} " ,
Average fast neutron flux; 9×10^{11} " ,
Peak fast neutron flux; 1.2×10^{12} " ,
by gold foil activation method with $\beta - \gamma$ coincidence counting.

Experimental facilities:

Pile oscillator, Mechanical monochromator.

J R R - 2

Name: Japan Research Reactor No. 2 (JRR-2).

Situated: Tokai-mura, Ibaraki-ken, Japan.

Critical: April 1962.

Type: CP-5 type (D_2O-Enriched Uranium Reactor).

Owner: Japan Atomic Energy Research Institute.

Operator: Y. Ohno, Y. Hamaguchi .

Designer: American Machine and Foundry, USA.

Use:

1) Measurements of the slow neutron cross sections of the various elements using the neutron crystal spectrometer.
2) Inelastic scattering measurements for the thermal neutrons using a phased chopper and time-of-flight technique.

Power: 10 MW maximum.

Fuel: 90 % enriched U-Al alloy plate with Al cladding.

Flux: Average thermal flux in the center of the core;

$$1.62 \times 10^7 \ n/cm^2 sec \ W \ ,$$

Peak thermal flux in the center of the core;

$$2.18 \times 10^7 \ n/cm^2 sec \ W \ ,$$

by gold foil activation method.

Experimental facilities:

Crystal spectrometer, Phased chopper for inelastic scattering measurement.

J R R - 3

Name: Japan Research Reactor No. 3 (JRR-3).

Situated: Tokai-mura, Ibaraki-ken, Japan.

Critical: September 1962.

Type: Natural Uranium - Heavy water type.

Owner: Japan Atomic Energy Research Institute.

Designer: Japan Atomic Energy Research Institute.

Power: 10 MW maximum

Fuel: Metalic uranium rod with Al cladding.

Flux: Average thermal neutron flux; 9×10^{12} n/cm^2 sec,

Peak thermal neutron flux; 2×10^{13} n/cm^2 sec,

Peak fast neutron flux; 8.7×10^{12} n/cm^2 sec,

by the design calculations.

Rikkyo Reactor

Name; Rikkyo University Research Reactor (Rikkyo Reactor).

Situated: Sajima, Yokosuka-shi, Kanagawa-ken, Japan.

Critical: December 1961.

Type: TRIGA Mark-II.

Owner: Rikkyo (St. Paul's) University.

Operator:

Designer: General Atomic, USA.

Use: 1) Measurements of gamma ray energy spectrum by neutron capture reaction,

2) Measurements of the mass distribution of fission fragments by the time-of-flight method,

3) Measurements of the cold neutron total cross sections for organic sabstances.

Power: 100 kW maximum.

Fuel: 20 % enriched U - ZrH alloy.

Neutron flux:

Average thermal neutron flux; 1.6×10^{12} n/cm^2 sec,
Peak thermal neutron flux; 4×10^{12} n/cm^2 sec,

by gold foil activation method with β-γ concidence counting.

Experimental facilities:

Crystal monochromator, Mechanical monochromator and square wave Pile oscillator.

KUR

Name: Kyoto University Reactor (KUR)

Situated: Kumatori-cho, Osaka-fu, Japan.

Critical: June 1964.

Type: Swimming-pool type with tank (Light water - enriched uranium reactor).

Owner: Research Reactor Institute, Kyoto University.

Operator: Prof. Kimura

Designer: Internuclear Company, USA. Basic design; Kyoto University.

Use: Research on neutron physics and reactor physics.

Power: 1,000 kW maximum.

Fuel: 90 % enriched uranium - aluminium alloy with aluminium cladding.

Flux: Average thermal neutron flux; 7×10^{12} n/cm^{2}sec,
Peak thermal neutron flux; 1.0×10^{13} n/cm^{2}sec,
by gold foil activation method.

Average fast flux (fission spectrum); 7×10^{12} n/cm^{2}sec,
Peak fast flux (fission spectrum); 1.2×10^{13} n/cm^{2}sec,
by threshold detectors of Al and Mg foils.

Experimental Facilities:

Fast chopper, mechanical monochromator, double and tripple axes diffractometers for the purpose of common use for experiments by universities in the whole country.