PRESENT STATUS OF THE KENS FACILITY

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§1. Facility

Construction of the neutron scattering research facility-(KENS) was completed at the end of March, 1980, as a part of the KEK-Booster Synchrotron Utilization Facility. The layout of the constructed facility, as shown in Fig. 1, is close the that envisaged in the original proposal.[1,2] It consists of three rooms - the main experimental area, the cold neutron experimental area and the data acquisition room. The neutron source is located near to the center of the main experimental area and the biological shield which surrounds the source effectively devides this hall into two areas, A and B. Nine beam tubes, H_1 to H_9 which glance at the normal moderator deliver thermal and epithermal neutrons to these two areas. Four further beam tubes, which view the cold moderator transfer cold neutrons either directly to area B (C_4) or to the cold neutron experimental area via three neutron guide tubes, (C_1, C_2, C_3). Five spectrometers HIT, MAX, LAM-40, SAN and TOP are already installed around the neutron source as displayed in Fig. 1. The present appearance of the facility is indicated in the photographs (Figs. 2-5) of these experimental areas and the data acquisition room which were taken recently. Approval for operation of the facility was obtained at the end of May and the first proton beams arrived at the neutron target on June 18. We still remember vividly the impressive experience we had on that day. Early in the morning, we were informed that the beam line magnets would be switched on at about 10:00 a.m. Anticipating that initially a small fraction of the full proton beam would arrive at the target, we had decided to place a He^3 counter at the exit of a beam tube in order to detect the small neutron flux produced by the first proton beam and we watched the data diplay panel in vain for about an hour. At 11:00 we were surprised to receive a telephone call from the operation center asking "Are you aware that the full proton beams are already reaching on your target?" Nearly the full proton beam had arrived at our target at the moment of switching on the magnets and our He^3 counter had therefore been saturated from the outset.

The proton beam size at the target was found to be 52×45 mm^2 (defined as within positions of 1/50 intensity) as displayed in Fig. 6. This is acceptably small compared with the target size $78^H \times 57^V$ mm^2. Figure 7 is the first neutron diffraction pattern obtained from an iron block and the spectrum of incoherent elastic scattering from a polyethylene plate measured on that day by using a single He^3 counter. These results convinced us that neutron beams were really being emitted from our new spallation source.

The following day the cold neutron moderator was cooled to 17K during operation of the source and the first cold neutron beams were detected at the exits of the neutron guides on June 20. Since then the KENS neutron source has been operating routinely without problems until the time of the present report. In the intervening period, many data on the neutron source have been accumulated, together with experimental data from the operating spectrometers. This paper briefly summarises these results. More detailed discussions can be found in the other papers comprising this KENS report.

§2. Target Assembly

The KENS neutron source employs a tungsten target cooled by pure water.$^{1)}$ The neutron flux emitted from the ambient and cold moderators was measured by means of activation of Au foils. By normalizing the fluxes with respect to the number of fast neutrons emitted from the source, the conversion ratios of the fast to epithermal and cold neutrons for our moderator-reflector system were determined to be 5.26×10^{-3} (n/str.eV.p) for 1 eV neutrons and 3.12×10^{-2} (n/str.p) respectively. These values are somewhat smaller than our original estimate of the intensity of the KENS neutron source, but they are still reasonable compaired with the expected value at other spallation neutron sources. The 47 equivalent peak flux intensities of the cold (3 meV), thermal (81 meV) and epithermal (1 eV) neutrons on the moderator surface were estimated to be 1.6×10^{15}, 5.7×10^{14} and 2.6×10^{14} (n/cm^2-sec-eV) respectively at full power operation (6×10^{11} PPP x 38 P/2.5 sec). The neutron energy spectra from moderators were also determined by measuring the incoherent scattering from V metal.

§3. Biological Shield

The radiation levels on the surface of the biological shield

and at the beam stopper were measured to be 0.6 mR/hr and 0.8 mR/hr respectively, in accordance with the design value of less than 1 mR/hr. Radiation levels in the experimental areas A and B were found to be below 2 mR/hr even when the shutters of the three beam tubes H_3, H_5, C_4 were completely open. Access to the spectrometers is, therefore, allowed even during operation time as we had originally expected.

§4. Cold Neutron Source$^{3)}$

The cold neutron source has been operating successfully throughout the whole available machine time. Using a small cryogenerator (PGH 105) of 40 W and a 7 m long He gas transfer tube the cold moderator can be cooled to 16.8K. The temperature of the moderator increases only by one degree during full power operation of the neutron source. The heat deposited by radiation inside the moderator was calculated to be 1W for a proton beam intensity of 7.3×10^{12} proton sec^{-1} which is in good agreement with our earlier estimate. The extend of decomposition of the methane in the moderator by radiation was found to be rather small. The methane gas returned to the reservoir tank from the moderator contained only 0.14% hydrogen after one weeks' operation. The total number of spallation neutrons entering the moderator during this time was about 1.4×10^{18} ns. The extent of this decomposition is only 1/50 of that found after a similar effective operation of the Hokkaido cold neutron source which is installed at an electron LINAC. This suggests that the decomposition in the latter case is mainly due to γ ray radiation. The above results are quite encouraging and they allow us the possibility to increase the intensity of spallation neutrons without changing the present cooling system. The time and energy spectra of the cold neutrons emitted from the cold neutron source were also measured.

§5. Cold Neutron Guide Tubes

Three bent guide tubes of the cross section 20 x 50 mm^2 transport neutrons to the cold neutron experimental area. At the entry of three guides there are three tail cutters which admit only neutrons within the wave range 4-12 Å or 3-11 Å. The intensity of cold neutrons at the exit of the guides was estimated by activation of a Au foil to be about 1 x 10^5 n cm^{-2} sec^{-1}, which is in approximate agreement with that calculated from at the moderator and the guide geometry the flux. More accurate measurements of the absolute value of the intensity of cold neutron flux are in progress to find out the real transmission factor of our guide tubes. The energy spectrum and spatial distribution of the cold neutron beams at the exits of the guides have also been measured.

§6. Spectrometers and Data Acquisition System

Five spectrometers, HIT, MAX, LAM-40, SAN and TOP have already been installed at the facility as shown in Fig. 1. The TOF data recorded by these spectrometers is accumulated in a computer OKITAC-50/60 (575 KB-IC) via a separate time analyzer for each spectrometer.

HIT is the high intensity total scattering spectrometer which

was designed so as to optimise the speed of the measurement.4) Fifty 1/2" diameter He^3 counters and a special electronic device for the amplifiers have unable the counting rate to be increased up to 5 nts/μsec. The scattering from a standard amorphous sample (5 gr) can then be measured up to 50 Å^{-1} with good statistics in a few minutes.

MAX is the multi-analyzer crystal spectrometer with inverted geometry which is equipped with fifteen separate analyzer crystals.5) If appropriate values for the scattering and analyzer angles are selected, the spectrometer can be used to perform energy scans along any desired direction in the reciprocal space. The constant Q mode of operation is, therefore, possible and complete magnon or phonon dispersion relations in a Brillouin zone can be probed at one time. The phonon scattering from an iron single crystal was measured with good S/N ratio in 48 hrs.

LAM-40 is the large analyzer mirror spectrometer equipped with four large PG analyzer mirrors.6) The spectrometer is suitable for measuring the quasi-elastic scattering from hydrogen containing materials at a medium resolution (60 μeV-200 μeV). A beautiful quasi-elastic scattering profile of these materials can be obtained in one hour.

SAN, the small angle scattering spectrometer, is installed at the exit of guide tube C$_1$. Equipped with a two dimensional PSD which may be moved inside a vacuum chamber and with fifteen He^3 counters set at six different fixed positions, the spectrometer can measure simultaneously the scattering in a wide range of momentum transfer from 3 x 10^{-3} to 4 Å^{-1}. By virtue of the pulsed of the incident beam the separation or measurement of inelastic scattering will be possible without significant modification. The small angle scattering from a sample as an Al-10%Zn alloy may be measured with a good S/N ratio in the space of a few minutes.

TOP is the TOF cold polarized neutron spectrometer installed also at the exit of a guide tube C_1. The incident pulsed white beam of neutrons polarized by means of total reflection from a Soller slit package composed of thin films of an Fe-Co alloy on a polymer support. The polarization direction is reversed by a Drapkin type spin flipper and a flipping ratio of 11 has been achieved as monitored by the 111 Bragg reflection from a Cu Heusler alloy. The spectrometer is currently being used to study the interface magnetism in the bilayer crystals of FePd or FeZr.

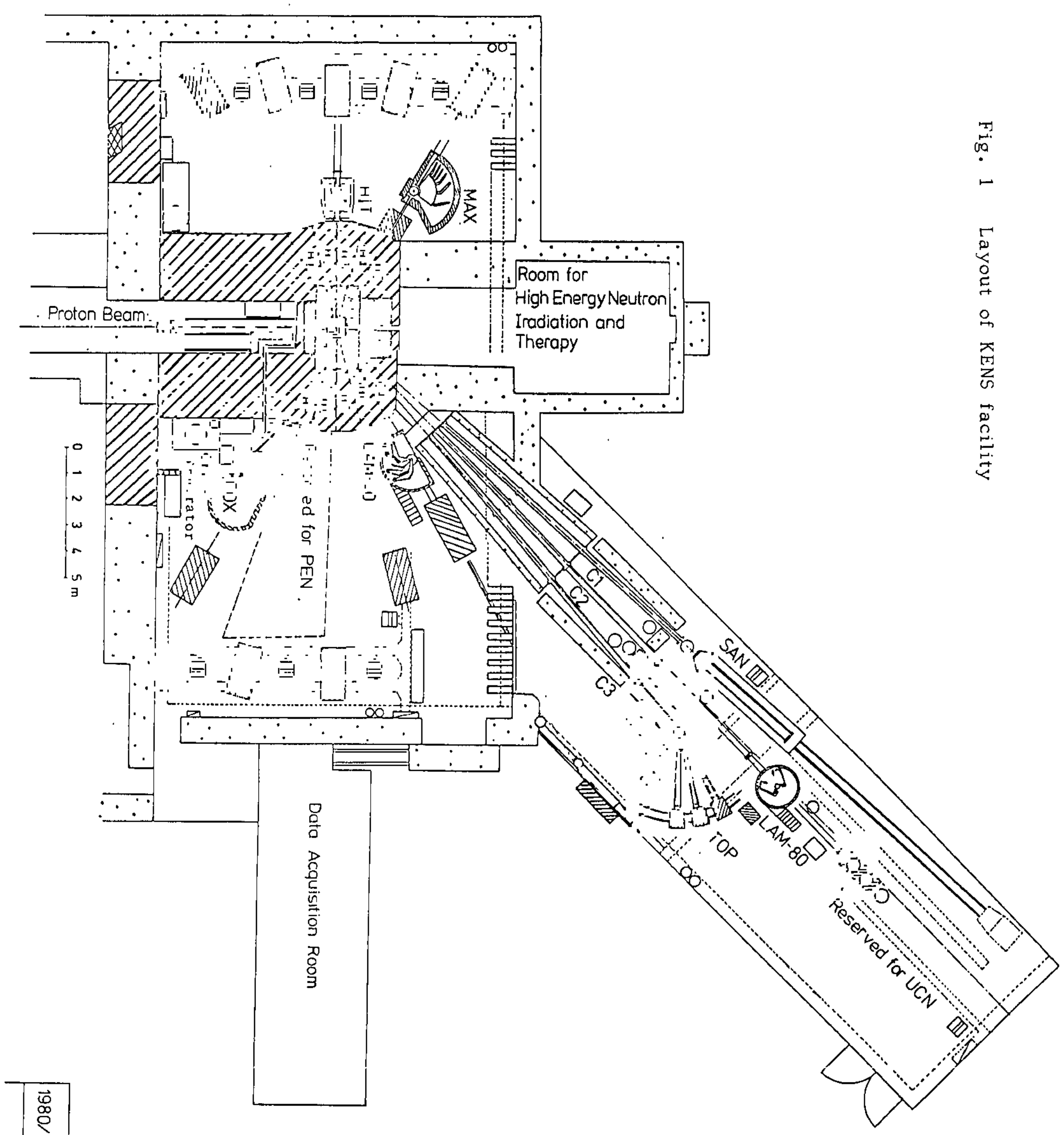
Two further spectrometers called FOX and PEN are at a late stage of design and will be installed in early 1981. The former is a conventional four cycle single crystal diffractometer, while the latter is a polarized epithermal neutron spectrometer in which polarization is achieved by transmission of the neutron beam through a dynamically polarized proton filter.

§7. System for Operation and Research

The KENS facility is unique in that it was constructed without there being permanent staffs for the project in KEK. Even now the number of permanent staff is limited to be three so that the neutron source, cold neutron source and the five spectrometers must be maintained by the KENS research group which consists mainly of outside people. Seven spectrometer groups have been organized corresponding to the seven existing spectrometers and those belonging to each group have an obligation both to maintain and improve their spectrometer as well as acting as a 'local contact' when persons outside the group wish to use the machine. Because of this arrangement about 70% of the total machine time is allocated to the spectrometer group. Further subdivision of the machine time within the group is made by group leader, which makes research scheduling somewhat flexible. In each year all proposals including those from each spectrometer group are presented to KEK before the end of February. These proposals were examined by the Neutron Scattering Committee composed of eight specialists from different fields and following their decision final approval may be given by Advisory Council for Scientific Policy and Management via Committee for the Utilization of BSF.

References

1) Y. Ishikawa and N. Watanabe, KEK Report 78-19 (1978)
2) H. Sasaki, N. Watanabe and Y. Ishikawa, KENS Report I (1980) 1
3) Y. Ishikawa and S. Ikeda, KENS Report I (1980) 19
4) N. Watanabe, K. Yamada, M. Misawa and T. Mizoguchi, KENS Report I (1980) 73
5) K. Tajima, Y. Ishikawa and S. Tomiyoshi, ibid. 86
6) K. Inoue, Y. Kiyanagi, M. Kohgi and Y. Ishikawa, ibid. 127
7) Y. Ishikawa, S. Ikeda, M. Furusaka and N. Niimura, ibid. 101
8) Y. Endoh and Y. Ishikawa, ibid. 149



1980/12 KENS FACILITY

Fig. 1 Layout of KENS facility

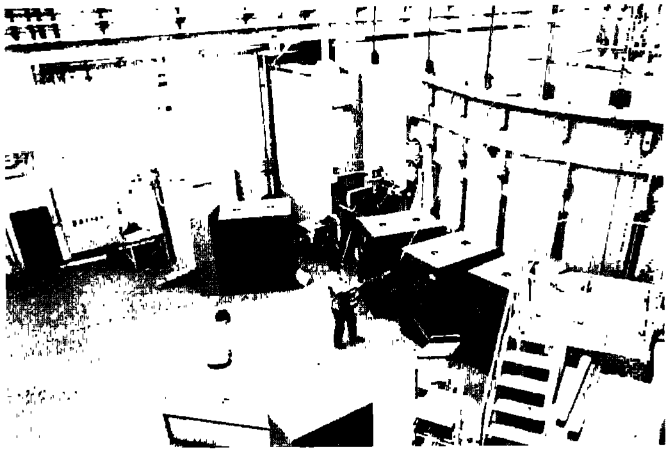


Fig. 2 Photograph of main experimental area A with LAM on the right hand side

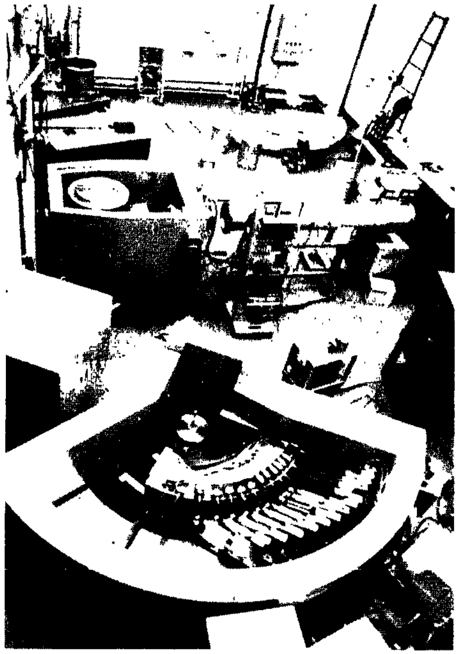


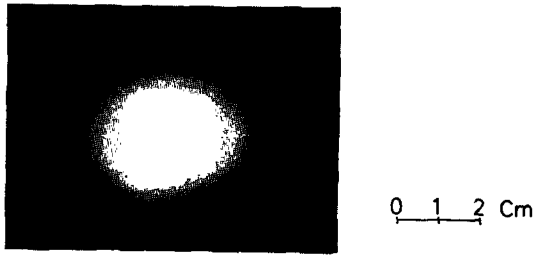
Fig. 3 Photograph of main experimental area B with HIT and MAX (below)

Fig. 4 Photograph of cold neutron experimental area with SAN (left) and TOP (right)

Fig. 5 Photograph of data acquisition room

Proton Beam Size at Target

Observed Beam Size



Beam Intensity Profile

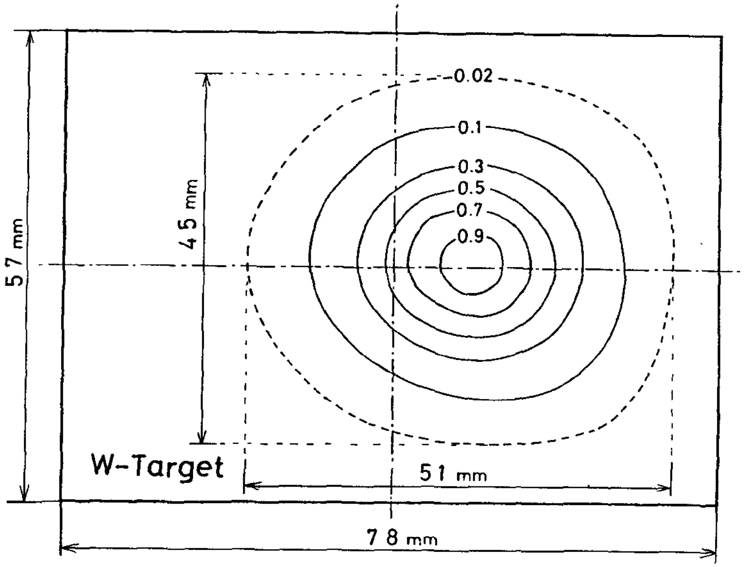
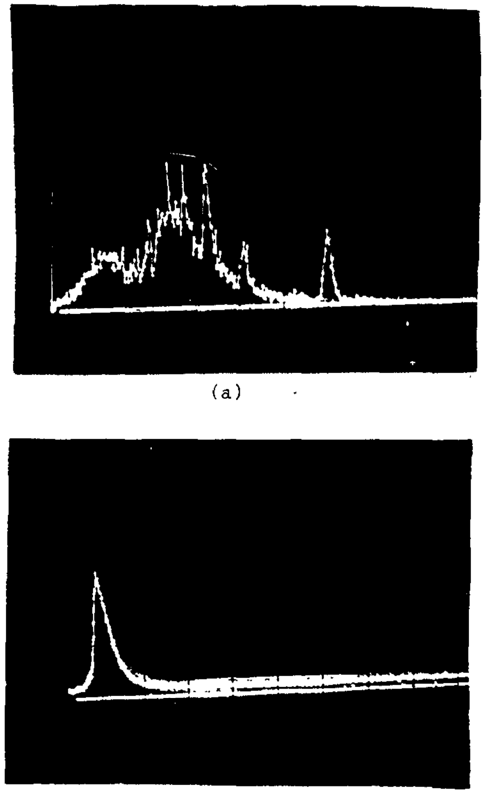


Fig. 6 Proton beam size on the neutron target (above) and beam intensity profile (below)



(a)

(b)

Fig. 7 First neutron scattering data from the KENS facility measured on June 18, 1980
(a) iron block (b) polyethylene plate