• Start up of KENS & History of Pulsed neutron scattering activities in Japan

• Quick survey of research activity of KENS at KEK/BSF which was a milestone of J PARC/MLF.

Yasuo Endoh (Tohoku University & CEMS.RIKEN)

The history started from the institute of Nuclear Science Facility, Tohoku University located at Mikamine, Sendai
Electron Lineac Facility in Tohoku University
1967

Motoharu Kimura
Construction of Electron Lineac Facility
at Laboratory of Nuclear Science, Tohoku University

$300 \text{ MeV EL :}$

multi purpose or Interdisciplinary research fields

Nuclear Physics & Condensed Matters Science
( Giant Electron Resonance, Neutron Scattering, Dense excitons etc)

Challenge : Novel Way how to utilize the large facility

粉末回折装置 （木村スプートニク）

Powder Diffractometer （Kimura Sputnik）
Kimura Sputnik
(Debye Scherrer camera)

SuperHRPD at MLF

100m Flight path with short pulses (high resolution): \( \Delta d/d \geq 0.035\% \)
Production & extraction of pulsed cold neutrons besides development of high resolution spectroscopic methods

- Neutron production by developing of solid methane neutron moderator installed at the side of neutron production solid target and neutron guide tubes with new supermirrors.
- Contribution of KENS facility
- New proposal scheme of collaboration programs has been established in the research field of condensed matter science which had been well organized among the accelerator based large sciences of high energy physics.
- Under the established collaboration program, the construction of BSF facility has been completed.
- Rapid growth of neutron users in Japan which has been also applied to reactor based neutron science collaboration at JRR3.
- International collaborations such as UK – Japan, US – Japan, ICANS have been organized.
1980

1980 KENS 完成
Completion of KENS

世界初のスパレーショングパルス中性子施設
The first spallation pulsed neutron facility in the world

初めての冷中性子
The first cold neutrons

Every Neutron is Good Neutron!
Every Neutron is Good Neutron!

1980  KENS 完成  Completion of KENS
世界初のスパレーショングパルス中性子施設  The first spallation pulsed neutron facility in the world

1986  石川義和教授・逝去  Prof. Yoshikazu Ishikawa’s decease
LAM & Low Energy INS
(using pulsed cold neutrons)

Original Idea & Device

Prof. Kazuhiko Inoue

Mica Analyser Xstal
Back Scattering

→ IRIS at ISIS
Quantum Rotational Tunneling spectroscopy
(CH₃ molecule in γ picoline)

LAM80 at KENS vs DNA at MLF/JPARC

\[ S(Q, \epsilon) \]

\[ \begin{align*}
\epsilon &= -400 \\
\epsilon &= -200 \\
\epsilon &= 0 \\
\epsilon &= 200 \\
\epsilon &= 400 \\
\end{align*} \]

\[ \begin{align*}
\epsilon_4 &= 60 \mu eV \\
\epsilon_3 &= 115 \mu eV \\
\epsilon_2 &= 190 \mu eV \\
\epsilon_1 &= 274 \mu eV \\
\end{align*} \]

\[ \text{Intensity (arb. unit)} \]

Eenrgy (meV)

DNA
Analysis of Quantum tunneling Spectrum

Fig. 11. $Q$-dependencies of inelastic scattering from N-oxy γ-picoline at $\varepsilon_i$ ($i=1 \cdots 4$). (○), (×), (●) and (□) denote peak intensities observed at $\varepsilon_i$ ($i=1 \cdots 4$), respectively. Calculated values are shown by a solid line.

Fig. 13. $Q$-dependencies of $S_i$ ($i=1 \cdots 4$) and $T_i$. $S_i$ and $T_i/2$ are displayed by solid lines and a dotted line, respectively.

Six-fold potential

Three-fold potential

(a) (b)
SUPER INTENSE PULSED NEUTRON (100/ KENS) PROJECT PLANNED AT 1985 UNDER THE LEADERSHIP BY PROF. ISHIKAWA

- GEMINI(KENS-II) proposal

Expansion of $Q$-$\omega$ space
$10^2 > \omega > 10^{-3}$ meV, $10^2 > Q > 10^{-4}$ Å$^{-1}$

New research field
- materials engineering and sciences
- bioscience and engineering
- polymer and chemical sciences

Contributions of interdisciplinary fields
- Radiation protection engineering
- Safety analytical engineering
- Accelerator physics and engineering
Structure Determination at KENS

Determined Crystal Structure of YBCO
&
‘Hot News’ in the Paper

KEK Symposium 5.19.'0
Japan-UK international collaboration & installation of nearly developed the chopper spectrometer MARI

Japanese participation of research activities at ISIS

Alan Leadbetter
(1934 – 2019)
spin wave spectrum of 1D AF

= outcomes of researches at MARI =

CsVCl$_3$

one-dimensional antiferromagnet
Observations of spin excitations in high Tc Cu superconductors. Robust two-dimensional (incommensurate) spin fluctuations exist in superconducting phase for Cu oxides probed by neutron scattering and X-ray photo emission measurements.
**Development of Neutron Brillouin Scattering Method & Installation of HRC at MLF in JPARC**

HRC (High Resolution Chopper Spectrometer)

- Low angle down to 0.6°
- High energy $E_i = 0.1 - 0.3$ eV
- High resolution $\Delta E/E_i = 2\%$

**polycrystal**

- Spin waves and phonons near (000) in polycrystals, amorphous materials, liquids
Spin dynamics of Weyl Fermions in Metallic Ferromagnet of SrRuO$_3$


Magnetic Field produced by Berry phase (Berry curvature) is shown to be an observable of inelastic neutron scattering: magnetic field acting to spin fluctuations is proportional to local anisotropic spin wave energy.
TO CONCLUDE

• KENS HAS CONTRIBUTED AS THE BASIS OF MLF/J-PARC: which constitutes the realization of the dream of KENS-II mandatory in future activities in MLF/J-PARC

• Simplify by change of organization from Troika (KEK, JAEA, CROSS) system to a new single one

• Introduce multiple user programs (long term, short term projects) to separate casual users and acted users

• A new system to train young researchers, engineers and to educate PhD students (Change current SOKENDAI to new program)

• Constant activities for instrumentations, engineering, and search for new comers to expand users

• Relation of PF and MLF in KEK research organization (Revolutionary change of BUKKOKEN)

MLF user program will be reconsidered to more flexible utilization of the facility
End of presentation as an introductory talk

• Thank you all for listening   Yasuo Endoh