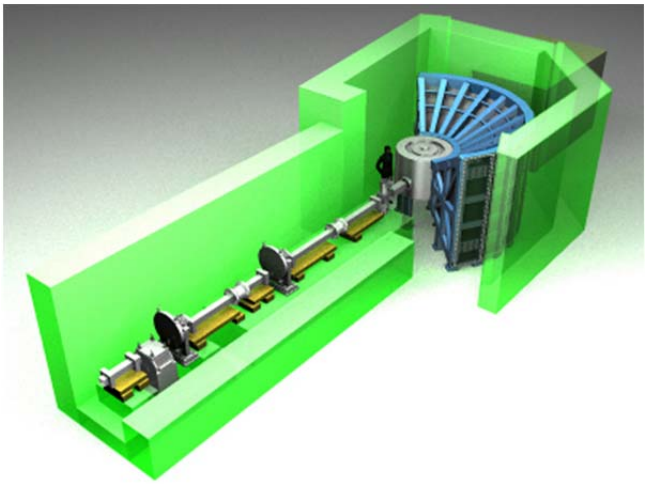
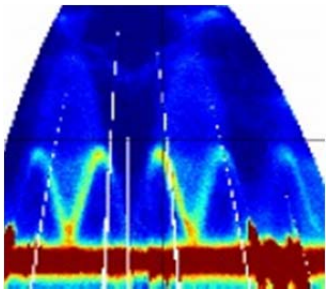
BL01: 4D Space Access Neutron Spectrometer—4SEASONS(四季)—



Overview

4SEASONS is a high-intensity Fermi-chopper spectrometer. It is intended to provide high counting rate up to 300 meV neutron energy with medium resolution ($\Delta E/E_i$ > 5% at E = 0) to efficiently collect weak inelastic signals from novel spin and lattice dynamics especially in high-T_c superconductors and related materials. To achieve this goal, the spectrometer equips advanced instrumental design such as an elliptic-shaped converging neutron guide coated with high-Q_c (m = 3–4) supermirror, and long-length (2.5 m) ^{3}He position sensitive detectors arranged cylindrically inside the vacuum scattering chamber. Furthermore, the spectrometer is ready for multi-incident-energy measurements by the repetition rate multiplication method.



The construction of 4SEASONS was a part of the project "Development of the 4D Space Access Neutron Spectrometer (4SEASONS) and Elucidation of the Mechanism of Oxide High-T_c Superconductivity" supported by Grant-in-Aid for Specially Promoted Research, MEXT (No. 17001001). 4SEASONS became one of the *Public Beamlines* since the 2011B term.

Specifications

Beamline	BL01
Moderator	Coupled
Neutron guides	Elliptically converging shape with m = 3.2–4 supermirrors
Incident energy	10–300 meV
Energy resolution	$\Delta E/E_i$ > 5% FWHM at E = 0 when $\Delta t_{ch} = \Delta t_m$
Flight paths	Moderator-sample = 18.03 m, Sample-detector = 2.5 m
Fermi chopper	At 1.71 m upstream of the sample, rotating at 25–600 Hz, at 25-Hz intervals
Band definition choppers	Two disk choppers at 9 m and 12 m, rotating at 25 or 12.5 Hz Aperture = 77° (at 9 m) and 103° (at 12 m)
Background (T0) chopper	At 8.5 m, rotating in 25 or 50 Hz
Detectors	Position-sensitive ^{3}He tubes cylindrically arranged at 2.5 m from the sample position Horizontal coverage: −35° to 55° (−35° to 130° in the future) Vertical coverage: −25° to 27°

Sample Environment

Sample environment of 4SEASONS conforms to the MLF standard for sample environment. A sample environment device is attached to the flange of the vacuum chamber. 4SEASONS has the standard 400 mm and 800 mm flanges, which are 600 mm above the beam center. 4SEASONS also has a non-standard 1000 mm flange for a larger device.

Available devices

Closed-cycle refrigerator (top-loading)

The available temperature range is 5–300 K. With a high-temperature option, the maximum temperature reaches 600 K. The sample room is 100 mm in diameter, which is almost similar to the one of a MAXI Orange. The sample is attached to the end of the sample stick. The end of the sample stick is a male M8 screw. Usually, an attachment is attached to the end of the stick, which provides the MLF standard sample attachment surface. Its sample attachment surface is 50 mm above the beam, and has eight M4 screw holes with PCD = 44 mm. Alternatively, users may use the original M8 screw directly.

Publications

Instrumentation

1. "High intensity chopper spectrometer 4SEASONS at J-PARC",
   R. Kajimoto, T. Yokoo, K. Nakajima, M. Nakamura, K. Soyama, T. Ino, S. Shamoto, M. Fujita, K. Ohoyama, H. Hiraka, K. Yamada, and M. Arai,
   J. Neutron Research **15**, 5–12 (2007).
2. "Conceptual design of MAGIC chopper used for 4SEASONS at J-PARC",
   M. Nakamura, M. Arai, R. Kajimoto, T. Yokoo, K. Nakajima, and Th. Krist,
   J. Neutron Research **16**, 87–92 (2008).
3. "Study of the Neutron Guide Design of the 4SEASONS Spectrometer at J-PARC",
   R. Kajimoto, K. Nakajima, M. Nakamura, K. Soyama, T. Yokoo, K. Oikawa, and M. Arai,
   Nucl. Instr. and Meth. A **600**, 185–188 (2009).
4. "First Demonstration of Novel Method for Inelastic Neutron Scattering Measurement Utilizing Multiple Incident Energies",
   M. Nakamura, R. Kajimoto, Y. Inamura, F. Mizuno, M. Fujita, T. Yokoo, and M. Arai,
   J. Phys. Soc. Jpn. **78**, 093002-1–4 (2009).
5. "New Technique for Inelastic Scattering Measurement Is in Practical Use at J-PARC",
   R. Kajimoto, M. Nakamura, and M. Arai,
   Neutron News. **21**, 55–56 (2010).
6. "4D Space Access Neutron Spectrometer 4SEASONS (SIKI)（4 次元空間中性子探査装置「四季」）",
   R. Kajimoto and M. Nakamura,
   Hamon（波紋）**20**, 8−12 (2010). (in Japanese)
7. "New technique for inelastic neutron scattering measurement demonstrated on the chopper spectrometer 4SEASONS at J-PARC（動き出した J-PARC 中性子非弾性散乱装置「四季」―中性子非弾性散乱実験の新規手法の実証―）",

R. Kajimoto, M. Nakamura, Y. Inamura, F. Mizuno, T. Yokoo, T. Nakatani, M. Arai, and M. Fujita,
Solid State Physics（**固体物理**）**45**, 79-89 (2010). (in Japanese)

8. "Comissioning of the Fermi-Chopper Spectrometer 4SEASONS at J-PARC - Background Study",
R. Kajimoto, M. Nakamura, Y. Inamura, F. Mizuno, K. Nakajima, N. Takahashi, S. Ohira-Kawamura, T. Yokoo, R. Maruyama, K. Soyama, K. Shibata, K. Suzuya, T. Nakatani, S. Sato, S. Wakimoto, Y. Ito, T. Iwahashi, W. Kambara, H. Tanaka, N. Yoshida, A. Katabira, K. Aizawa, and M. Arai,
Proceedings of ICANS XIX.
9. "The Fermi Chopper Spectrometer 4SEASONS at J-PARC",
R. Kajimoto, M. Nakamura, Y. Inamura, F. Mizuno, K. Nakajima, S. Ohira-Kawamura, T. Yokoo, T. Nakatani, R. Maruyama, K. Soyama, K. Shibata, K. Suzuya, S. Sato, K. Aizawa, M. Arai, S. Wakimoto, M. Ishikado, S. Shamoto, M. Fujita, H. Hiraka, K. Ohoyama, K. Yamada, and C.-H. Lee,
to be published in J. Phys. Soc. Jpn. Suppl. B (proceedings of NASCES11).

Scientific Results

1. "Observation of $s\pm$-like spin resonance in iron-based nodal superconductor $BaFe_2(As_{0.65}P_{0.35})_2$ using inelastic neutron scattering",
M. Ishikado, Y. Nagai, K. Kodama, R. Kajimoto, M. Nakamura, Y. Inamura, S. Wakimoto, H. Nakamura, M. Machida, K. Suzuki, H. Usui, K. Kuroki, A. Iyo, H. Eisaki, M. Arai, and S. Shamoto,
to be published in Phys. Rev. B (arXiv:1011.3191).
2. "Inelastic neutron scattering on iron-based superconductor $BaFe_2(As,P)_2$",
M. Ishikado, K. Kodama, R. Kajimoto, M. Nakamura, Y. Inamura, S. Wakimoto, A. Iyo, H. Eisaki, M. Arai, S. Shamoto,
to be published in Physica C (Proceedings of ISS2010).
3. "Inelastic neutron scattering study of the magnetic fluctuations in Sr_2RuO_4",
K. Iida, M. Kofu, N. Katayama, J. Lee, R. Kajimoto, Y. Inamura, M. Nakamura, M. Arai, Y. Yoshida, M. Fujita, K. Yamada, and S.-H. Lee,
to be published in Phys. Rev. B (arXiv:1105.3352).
4. "Magnetic Excitation Spectra of Superconducting Ca-Fe-Pt-As System",
M. Sato, T. Kawamata, Y. Kobayashi, Y. Yasui, T. Iida, K. Suzuki, M. Itoh, T. Moyoshi, K. Motoya, R. Kajimoto, M. Nakamura, Y. Inamura, and M. Arai,
to be published in J. Phys. Soc. Jpn.

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