INTERNATIONAL EDITION

Research

IMR NEWS KINKEN

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[RESEARCH CENTER INTRODUCTION]

Aiming for mutual development of the neutron community and materials science

Center of Neutron Science for Advanced Materials

SPECIAL INTERVIEW

IMR's New Internationalization Initiative
—GIMRT: Global Institute for Materials Research Tohoku—

Koki TAKANASHI

Director of Institute for Materials Research, Tohoku University

Gerrit E.W. BAUER

Head of International Collaboration Center (ICC-IMR)

SPECIAL INTERVIEW

IMR's New Internationalization Initiative

GIMRT [Global Institute for Materials Research Tohoku]

Director of Institute for Materials Research,
Tohoku University

Koki Takanashi

Born in Tokyo in 1958. After obtaining his doctoral degree in Physics from the University of Tokyo (1986), he became assistant professor, associate professor, Alexander-von-Humboldt Research Fellow at Jülich Research Center. Since 2000, he has been professor at IMR where he is the Director since 2014. Concurrently serves as Vice President of Tohoku University since 2018. His research field is Magnetic Materials. (Researcher ID F-8273-A-9488-2011).

In November 2018, the Institute for Materials Research (IMR) was certified as an "International Joint Usage / Research Center" newly established by the Ministry of Education, Culture, Sports, Science, and Technology (MEXT). The IMR called the project "GIMRT: Global Institute for Materials Research Tohoku", which aims to share materials development and research among leading institutions around the world, and will establish a diverse range of programs to support and promote international collaborative research. How will the IMR respond to the expectation of strengthening Japan's research capabilities? Professor Koki Takanashi, Director of IMR and Professor Gerrit E. W. Bauer, Head of the International Collaboration Center (ICC-IMR) discussed the current situation of internationalization in Japan and the role played by IMR.

International Collaboration Center (ICC-IMR)
Head: Professor

Gerrit E. W. Bauer

Born in Gronau/Westfalen in 1956. He holds a Doctoral Degree in Physics from the Technical University Berlin (1984). After a postdoc at the Institute for Solid State Physics of the University of Tokyo (1984-86), he became a member of the Scientific Staff of the Philips Research Laboratories (1986-92). He has been appointed professor at Delft University of Technology in 1992 and professor of Tohoku University at the IMR in 2011, serving concurrently as head of the International Collaboration Center (ICC-IMR) since 2015. His research addresses theoretical condensed matter physics and spintronics (Researcher ID F-8273-2010).

To be a core for materials science research connecting Japan and the world

—— Why was the IMR certified as an International Joint Usage/Research Center[*1]?

Takanashi: The certification is a testament to the IMR's global cutting-edge research and previous efforts toward internationalization. Frankly, I am happy to accept it as a challenge to strengthen materials science in Japan.

Bauer: We established the International Collaboration Center (ICC-IMR) as an independent system in 2008. Since then, it has provided various pillars of support related to international collaborative research and exchange. In the past decade, 571 overseas researchers including Ph.D. students from 37 countries visited the IMR with ICC support, contributing greatly to the internationalization of our Institute and the promotion of materials research. The recent certification will enhance our options to stimulate international collaborative research even more and integrate it better with national partners.

Takanashi: Our plans to enhance international joint-use/collaboration research as certified by the government are now realized in a new system that we call "GIMRT: Global Institute for Materials Research Tohoku". GIMRT provides support for various international collaborative research programs building on the foundations laid by the ICC. We intend to contribute to the internationalization of Japan as a whole by accelerating the internationalization of the IMR together with our national partners in materials science research.

—— What are the international strengths and characteristics of the IMR?

Takanashi: Since its inception, the IMR has been engaged in research from basic to applied materials science, which is rare even from a global perspective. This broad range of efforts is the strength of the IMR and has led in the past to numerous world-leading research results.

Bauer: World-class researchers around the world, including those at the IMR, have similar qualities and values. The uniqueness of the IMR and Japan is the kindness, hospitality, and work ethic of the Japanese people. Students are motivated and diligent, and the support of administrative departments and secretaries is outstanding. Since the leaders of our organization are leading scientists themselves, I believe that our environment is indeed very research-friendly.

Takanashi: The IMR offers to share some of the world's top experimental devices. These include a "hot lab" that can handle radioactive materials, a 25T cryogen-free superconducting magnet that operates continuously for months, a supercomputer specializing in materials science, and a neutron scattering spectrometer at J-PARC, the world's highest intensity neutron source. Even before GIMRT's certification, researchers from around the globe visited IMR to use these facilities.

Improving internationalization in Japan is an urgent task

—— What are your views on the current state of internationalization in Japan?

Takanashi: Unfortunately, in spite of in general strong recognition of research contributions, Japan's influence in the international science community is still rather weak. Perhaps due to an island mentality, many Japanese people, including researchers, are not eager to leave their country for a longer period; in addition, Japan is geographically far from both the USA and Europe. These are barriers to collaborative research. Japan's number of papers and international co-authorship rates are relatively low, so in order to realize its full research potential, I believe that concerted efforts to increase international awareness are necessary.

Bauer: From my perspective, internationalization of Japan has not progressed much over the past decades. Language remains the biggest obstacle. Taking care of overseas researchers who do not understand the Japanese language and culture is labor-intensive. Japanese students are not very eager to study and work abroad. Therefore, while the simple presence

*1 A large program in which MEXT prioritizes universities and research institutes with internationally useful and high-quality research resources as international research bases. It aims to improve Japan's international presence and strengthen basic science capabilities by preparing systems that makes optimal use of Japan's extensive research resources.

By strengthening its role as a core base connecting Japanese and overseas research institutions, IMR will fulfill its duty to lead internationalization in order to improve Japan's research capabilities through GIMRT programs.

—— Koki Takanashi

of overseas researchers at Japanese laboratories is a burden, but will not only increase the human resource adapted to Japan but also contribute to the development of an international awareness and ultimately Japan's research competence.

Takanashi: That is why GIMRT offers programs for overseas researchers to visit the IMR via financial support for travel and subsistence. In addition, I believe that it is important to establish a system that makes it easier for the organization to accept overseas researchers by reducing administrative hurdles.

—— GIMRT has another program to encourage young IMR researchers to carry out research overseas. What are the significance and current situation for young researchers who would like to expand their horizon?

Bauer: In recent years, I strongly feel that young Japanese researchers have become more introvert. The number of students studying abroad has decreased drastically compared to the peak period. This is not a favorable situation, but the government has recognized the problem and we intend to do our part.

Takanashi: I agree that the situation is critical. I think that our social structure is a contributing factor. Being constantly pushed to achieve results, young researchers in Japan put less efforts into planning career paths than in other countries. They struggle with the tasks in front of them and fear set-backs when studying abroad. Actually, a study abroad used to be a requirement to become a faculty member of a university, but this is not the case anymore.

Bauer: Conversely, the ability of Japanese researchers to conduct world-class research may contribute to the lack of interest in overseas exchange programs. However, research is always fluid. Fields that are receiving much attention now, may loose their flair in a few years. Having domestic as well as foreign experiences allows young researchers to choose from more options for their future activities. I believe that studying abroad is really the best choice, and GIMRT provides additional opportunities for Japanese and overseas researchers to gain a broader international perspective.

Development of global materials science through internationalization

—— Finally, what are your expectations and enthusiasm for GIMRT?

Takanashi: The IMR was one of the first to be certified as a nationwide collaborative research institute*2. We made IMR's equipment available to universities and research institutions throughout Japan. GIMRT not only provides and supports hardware usage, but also extends the existing collaborative research (Bridge Research for Multi-Core Collaboration) to include overseas research institutions through the IMR. The government has tasked us with this role because of our long experience in interacting with foreign researchers and their institutions since the foundation of the IMR, as well as the existing national network in material science. It gives us the responsibility to help raising the research power and international awareness of Japan as a whole.

Bauer: "Internationalization" is in my opinion a means for research development, not a purpose in itself. Further globalization is essential to advance Japanese research by the influx of new ideas and cultures of getting things done. Stimulation of international collaborative research will improve Japan's international recognition and research power. GIMRT will help attracting leading researchers from around the world to the IMR. We hope that top institutes and universities abroad will reciprocally invite Japanese researchers, ultimately leading to a better integration into the global research community.

Takanashi: To maintain and develop materials science research, which is Japan's specialty, we must engage in cutting-edge research while being mindful of existing traditions. Promotion of international collaborative research via GIMRT will be the key to realize a new era of Japan's materials science research in support of the world's future economy and ecology.

*2 A system unique to Japan that provides opportunities for universities and research institutions to share large equipment and technology throughout Japan. IMR was certified as member of this program in 1978.

Thanks to the kindness and dedication of the Japanese and the state-of-the-art equipment owned by IMR, I think IMR is an environment in which it is easy for researchers coming from abroad to concentrate on research.

—— *Gerrit E. W. Bauer*

What is GIMRT?

Global Institute for Materials Research Tohoku

Vision

Our vision is to share IMR's advanced research platform with global researchers to bring forth advances in the materials sciences.

As one of the world's leading institutes for materials science, IMR opens its advanced facilities, instruments, knowledge base, and technologies to the world-wide materials science community.

Research

IMRT

5 reasons to join GIMRT

1 **Access to world-class advanced facilities**
such as the hot laboratory and the world's highest cryogen free superconducting magnet.

2 Work together with
IMR's world-leading material scientists.

3 **Strong and comprehensive support**
from skilled technicians and researchers.

4 **Join IMR's global partnerships in materials research,**
developed since its founding in 1916.

5 **Enjoy Sendai, the "Forest City"**
—the center of science, culture, and more, in north-eastern Japan.

GIMRT Programs

Use IMR Resources for Materials Science

Research visit for several weeks
- Single Research Visit

Staying at IMR for few months
- Visiting Guest Professor
- Research Fellowship Student

Bridge Domestic, Overseas and IMR Researchers

Multi-core research collaboration
- Bridge Proposal

Research at overseas institutes
- Travel Support for Young Scientist

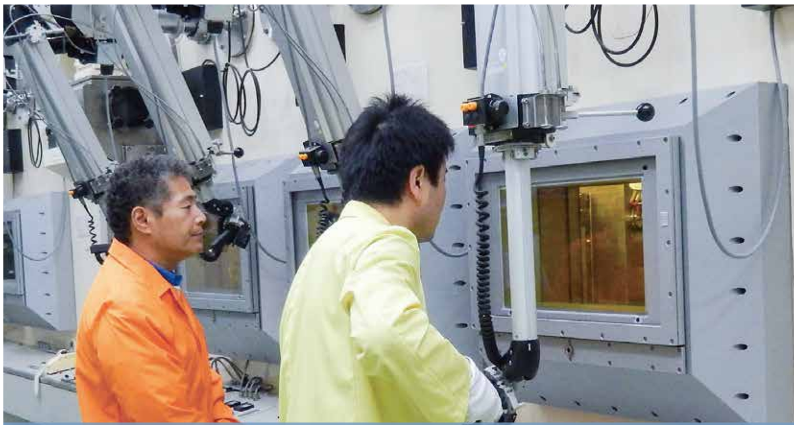
Exchange between research communities
- International Workshop

Long-term collaboration
- Integrated Joint Project
- Joint Laboratory

IMR's facilities and laboratories open for your research

1 RDG

24 Individual Research Divisions and Groups

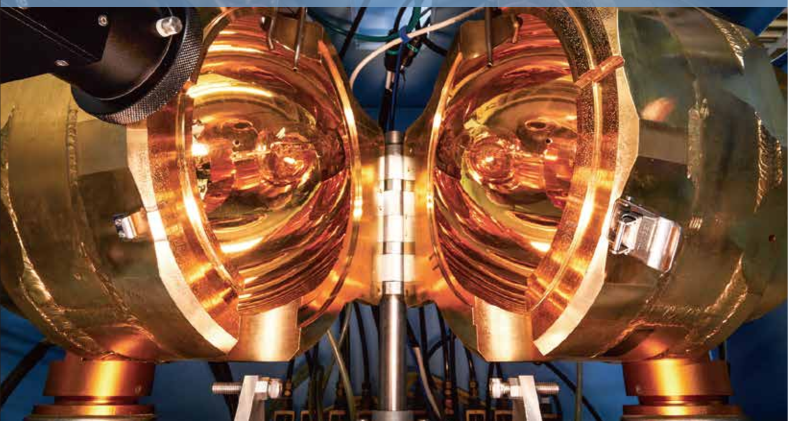


2 IRCNMS (Oarai)

International Research Center for Nuclear Materials Science

3 CRDAM

Cooperative Research and Development Center for Advanced Materials



4 HFLSM

High Field Laboratory for Superconducting Materials

5 CCMS

Center for Computational Materials Science

6 CNSAM

Center of Neutron Science for Advanced Materials

Aiming for mutual development of the neutron community and materials science

Numerous large-scale research facilities are gathered on a large site at Tokai-mura, Ibaraki Prefecture. Neutron beams from the large research reactor and accelerator on this site are utilized by researchers nationwide as a powerful method capable of precisely clarifying the structure of substances. The Center of Neutron Science for Advanced Materials (CNSAM) is an organization that manages and operates four pieces of neutron experiment equipment owned by IMR. We interviewed Professor Masaki Fujita, Head of the Center, who is working to organically collaborate with rare-equipment groups worldwide and to expand the neutron community.

Pioneering neutron research

The Center of Neutron Science for Advanced Materials (CNSAM) was established in April 2010 to manage the neutron experiment equipment owned by IMR and to promote advanced materials science research using neutrons. Neutron experiments can only be performed at limited facilities around the world. IMR is one of the few laboratories which operates different types of neutron scattering instruments, and has contributed to the community of neutron science even before the establishment of the Center.

In the background of establishment of CNSAM, there increases the movement to strategically use of neutrons for various materials science in Japan and overseas. We therefore transferred the instruments, which have been managed by a laboratory, to CNSAM, in order to unify their management with expanding user support. Furthermore, in 2012, we started the construction of a new polarized neutron spectrometer (POLANO) at the Materials and Life Science Experimental Facility (MLF) at the Japan Proton Accelerator Research Complex (J-PARC), which supplies high-intensity neutron beams. The user program of POLANO will start in April 2019, and we are now preparing for full-scale operations.

Aiming for mutual development with materials science

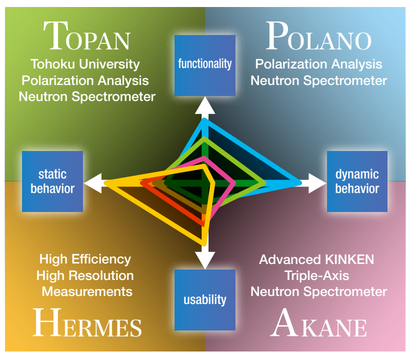
Neutron scattering measurements give precise information on the microstructures and dynamism of atoms, molecules, and spins; therefore, neutron scattering is quite a powerful tool for materials science. In fact, one-third of neutron experiments conducted in a large facility such as MLF are classified into the field of materials science. CNSAM aims to realize the continuous and mutual development of neutron science and materials science with the following objectives:

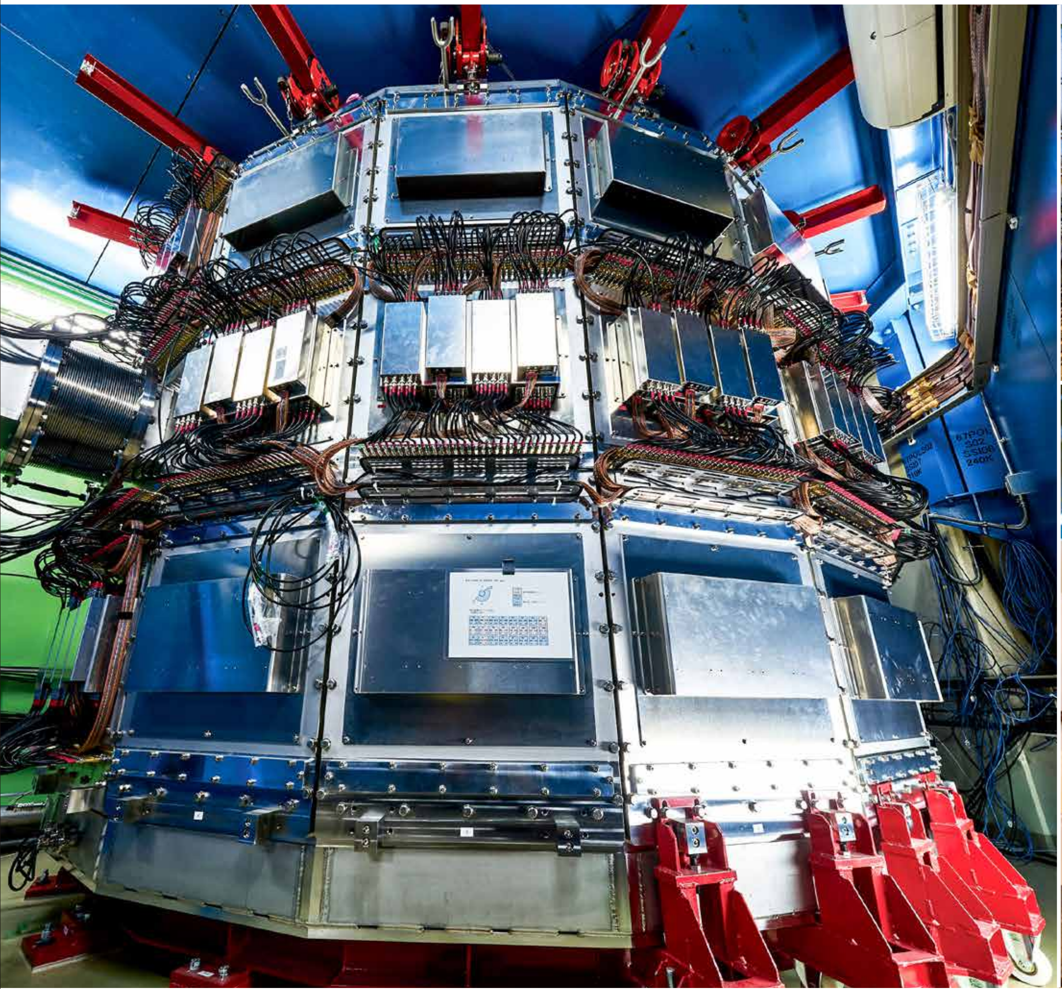
1. Construction of a platform for neutron utilization and contribution to materials science.
2. Support of young researchers and human resources production in the field of neutron science.
3. Promotion of exchange and collaborations between neutron users and facility research groups.

Neutron scattering instruments (PATH) rich in variations

Our approach toward constructing a platform is to characterize individual neutron scattering instruments clearly and to utilize these instruments complementary.

Our neutron scattering instruments are installed at the research reactor JRR-3 of the Japan Atomic Energy Agency (JAEA) and J-PARC MLF in Tokai, Ibaraki. They are collectively referred to as PATH, which is an acronym for the following devices: POLANO, which successfully began operation in 2017; AKANE and TOPAN, which can investigate





(Left) An overall picture of POLANO spectrometer which can measure the spin and lattice dynamics with polarized neutron beam. (Right) Advanced KINKEN Triple-Axis Neutron Spectrometer (AKANE).

the motion of atoms (phonon) and spins (magnon) in detail; and HERMES, which can examine the arrangements of nuclei and spins in substances with high precision.

AKANE and HERMES are introductory instruments that can be used even by beginners for neutron scattering experiments. Before the unexpected shutdown of JRR-3 by the Great East Japan Earthquake, we received more than 70 proposals a year for HERMES. This was the largest number of users of JRR-3, demonstrating the high demand for neutrons in the research fields of hydrogen storage compounds, lithium batteries, fuel cells, magnetic materials, and so on. TOPAN and POLANO are suitable for more specialized research. With these instruments, a polarized neutron beam*, which provides information about spins and atoms separately, can be generated. Therefore, these arrangements and motions can be examined in detail. These instruments can be used to clarify the mechanism of high-transition-temperature superconductivity and to understand the novel magnetism of metallic magnets. We plan to contribute on materials science research by exploiting the advantages of each instrument.

How to foster the next-generation

The education of young researchers is one of the important issues in the community of neutron science. To perform neutron scattering experiments, a certain level of skill is required, and sufficient machine time for the practical use of instruments is indispensable to improve these skills. Unfortunately, the operation of JRR-3 has been suspended for the past eight years owing to the Great East Japan Earthquake of March 2011. We have continued to provide opportunities for experiments using the instruments in J-PARC MLF, and in overseas research facilities. However, because the availability of neutrons is limited, the accumulation of experience and development of skills are difficult for young researchers.

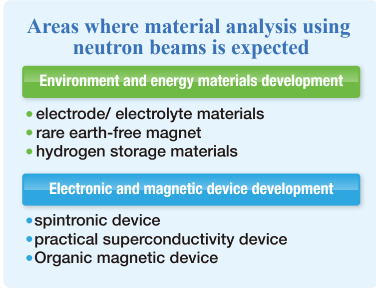
Considering these situations, CNSAM is promoting support for the education of students and training of young researchers. Seminars and facility tours for students and young researchers are held accordingly. In addition, we are constructing a compact

Center of Neutron Science for Advanced Materials

Head/Prof. **Masaki FUJITA**

Masaki Fujita obtained his doctoral degree in physics (1998) from Kobe University. He became Assistant professor at ICR Kyoto University (1998), IMR Tohoku University (2003), Associate professor (2009), Professor (2014) at IMR. Since 2014, he has been Head of Center of Neutron Science for Advanced Materials, IMR. Research fields and tools are Superconducting materials and Quantum beam spectroscopies. (Researcher ID D-8430-2013).

High Efficiency High Resolution Measurements (HERMES).



diffractometer (HERMES-E) at JRR-3, which is suitable for practical training and introductory experiments. HERMES-E will start operating after JRR-3 is restarted in 2020.

Exchange of users with various backgrounds is key

For the future of neutron science, it will be imperative to expand the field through exchange and cooperation with various users. With the world's highest intensity and quality of neutron beams being generated at J-PARC MLF, research on neutrons is expected to expand significantly. Moreover, the conventional versatile instruments at JRR-3 have been improved to enable researchers to easily conduct experiments, opening the door to many new users.

On the other hand, to expand neutron science, we need to advertise advantages of neutrons and research results, while grasping the issues and needs of each field. In the neutron community, which requires large facilities for the research, a deviation between instrument scientists and users may occur. In this respect, CNSAM has the advantage of understanding both views since IMR is promoting its own science and is supporting users by operating four instruments. IMR can become an ideal model as it can gather users' opinions to introduce easier-to-use systems on a trial basis, and feedforward successful trials to the community. We believe that exchanges with various users will surely revitalize the bright community. The strengths of IMR will help develop materials research from new perspectives. With exchanging domestic and overseas users and instrument scientists in the facility, new developments in materials science by advanced usages of neutron can be expected. CNSAM will bridge the gap between scientists in different research fields and contribute to the advancement of both neutron research and materials science.

*Beams where the spin orientations of neutrons are aligned in one direction.

Researcher introduction

CROSS
Researcher
Masato Matsuura

Masato Matsuura (*1972) holds a Doctor Degree of in physics (2000) from Tohoku University. He was an assistant professor at ISSP The Univ of Tokyo (2004), Osaka Univ (2008), IMR Tohoku Univ (2010). He joined Research and Development Division of CROSS in 2013. His research focuses on lattice and spin dynamics in condensed matter and functional materials (Researcher ID C-2827-2013).

CROSS: Bridging J-PARC MLF, Users, and IMR

We interviewed Dr. Masato Matsuura, Deputy Chief Researcher of the Comprehensive Research Organization for Science and Society (CROSS), which is deeply involved in the joint use of the Center of Neutron Science for Advanced Materials, Tohoku University.

What is CROSS?

CROSS is an organization that manages proposal selection process and provides user support on the public beam lines (BL) at the Materials and Life Science Experimental Facility (MLF). MLF is located in the Japan Proton Accelerator Research Complex (J-PARC). In addition, CROSS manages the assessment of applications to build BLs like the Polarized Neutron Spectrometer POLANO constructed by IMR.

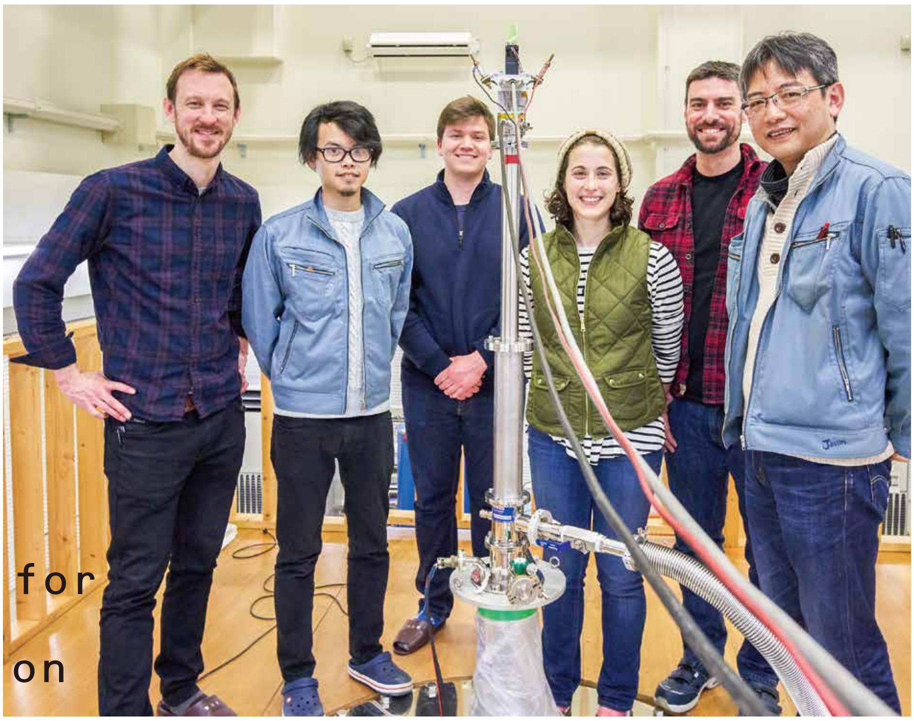
What research topics are you tackling?

Currently, there are seven the public BLs in MLF. I am working on the research and development of BL02 Near Backscattering Spectrometer DNA, which specializes in measuring atomic and molecular motions in soft materials, functional materials and spin motions in magnetic materials with high energy resolution (~μeV). Specifically, I am interested in the lattice dynamics of relaxer ferroelectrics and molecular organic conductors. Relaxer ferroelectrics are utilized for ultrasonic detectors in medical instruments for their extremely high piezoelectricity. The heterogeneous domain structures in the mesoscopic scale of a material greatly influence the expression of functional properties. Neutron scattering technique are excellent for analyzing dynamics in the mesoscopic scale. Currently, I am trying to clarify the origin of functionality by evaluating the lattice dynamics of relaxer dielectrics using spectrometers in J-PARC MLF.

What are the future developments for joint use with IMR?

A major objective of CROSS is to promote excellent research output at J-PARC MLF through comprehensive user support. As its name suggests, CROSS, which has connections with many research institutions through J-PARC's neutron experimental facility, can bridge these users and external research institutions. For example, in IMR, there are a lot of excellent researchers, equipment's, and knowledge about materials research. I expect that collaborative research between IMR, CROSS, and MLF users will realize many achievements and greatly contribute to the development of materials research.

Collaborative researcher interview



High-field measurements for next-generation fusion magnets

Name:

Zachary Hartwig

Affiliation and Position:

Massachusetts Institute of Technology (MIT)
Assistant Professor

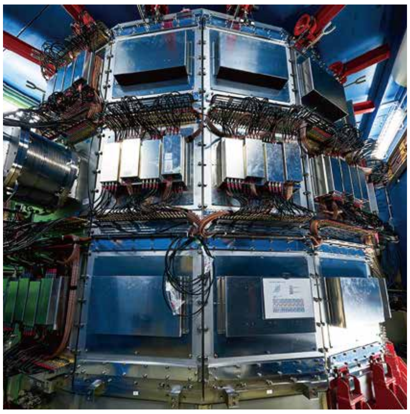
Research Proposal:

Characterization of commercial REBCO wires for high-field fusion magnets

Profile:

MIT, PhD, 2014
Boston University, BA, 2005
MIT PSFC researcher since 2007

My research focuses on utilizing high-temperature superconductors (HTS) to advance the performance of high-field, large bore superconducting magnets for fusion applications. Because of the wide variability in HTS obtained from different manufacturers, as well as strong critical current dependence on magnetic field, magnetic field angle, and temperature, it is essential to be able to fully characterize small samples of HTS over the entire potential design space of fusion magnets. This is especially important for the high-field fusion magnets being designed and fabricated at MIT, where peak fields will reach up to 25T. The incredible facilities at Tohoku University IMR, principally the 25T-CSM magnet and HTS critical current characterization system, provide perhaps the only place in the world where HTS samples can be fully characterized to our stringent requirements. Our 2 week measurement campaign on the 25T-CSM was an excellent success, giving us unprecedented HTS data to guide our magnet research and development. This success was primarily due to the expertise and guidance of Professors Satoshi Awaji, Tatsu Okada, and Arnaud Badel from IMR, who were gracious and patient hosts as we ran experiments late into the night for 2 weeks (Thank you!) Our entire team enjoyed our visit very much, particularly the students who helped lead the experiments and were in Japan for the first time. We enjoyed excellent technical discussion over lunch, and dinner, and we are eager to return to continue measurements and pursuing research opportunities with the scientists that we met during our time at IMR.



COVER

Polarization Analysis Neutron Spectrometer: POLANO

IMR's new neutron spectrometer, POLANO, is a high-intensity proton accelerator facility in Tokai-mura, Ibaraki Prefecture, which was constructed within J-PARC in collaboration with KEK over a period of about five years. In 2017, it succeeded in extracting a neutron beam and will be available to researchers worldwide from April 2019. Its most significant feature is that it can obtain separate information on the movement of spins and atoms, which have not been separable up to now.

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