3rd ICQMT 2025

3rd International Conference on Quantum Materials and Technologies

Isochronous Proton Cyclotron SC230 with a Cryogen-free Superconducting Magnet

Distinguished Professor
Yuta Ebara

Yuta Ebara is an engineer at the Technology Research Center of Sumitomo Heavy Industries (SHI), specializing in accelerator and superconducting technologies. He is an active member of the Cryogenics and Superconductivity Society of Japan and the Particle Accelerator Society of Japan. Additionally, he contributes internationally as a member of the International Electrotechnical Commission (IEC) TC45/WG20 (Nuclear Instrumentation/Charged Particle Accelerators). Before assuming his current position, he spent his academic years at Japanese universities (Tokyo Gakugei University and Tokyo Metropolitan University). His research focused on nuclear physics as well as atomic, molecular, and optical (AMO) physics. He participated in experiments such as the OROCHI (Optical Radioisotope-atom Observation in Condensed Helium as Ion-catcher) experiment at RIKEN. He also played a key role in the first detection of 'recurrent fluorescence' - an energy relaxation mechanism of interstellar molecules, using an electrostatic storage ring. His expertise spans laser spectroscopy, accelerator technology, and cryogenics.

Date and Time:
From 26 April to 3 May 2025, exact day&time will be announced later.

Lecture Room:
TBD

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10th ICSM 2025

10th International Conference on Superconductivity and Magnetism

Biography-continued

He has been with SHI since 2015. The company manufactures superconducting magnets for single-crystal silicon growth using the MCZ (magnetic-field-applied Czochralski) method, cryocoolers used in MRI (magnetic resonance imaging) systems and other cryogenic applications, and accelerators for research and medical purposes. He has been involved in the development of a compact superconducting isochronous cyclotron SC230 for proton therapy, a combination of accelerator, cryogenic, and superconducting technologies. In this project, he was responsible for magnetic field mapping, adjustments, and cyclotron commissioning. After successfully developing the SC230, he continues advancing research and development in accelerator and superconducting technologies.

Abstract

A superconducting isochronous cyclotron, SC230, was developed for proton therapy by Sumitomo Heavy Industries [1]. With a yoke diameter, height and weight of 2.8 m, 1.7 m and 65 t, respectively, it is currently the most compact isochronous cyclotron for proton therapy. Figure 1 shows a photo of the external appearance of the cyclotron. Size reduction was achieved by a high magnetic field using cryogen-free NbTi coils. An excitation test of the coils was conducted before installation in the cyclotron [2]. The coils are cryogen-free and cooled by conduction cooling using four 4 K-GM cryocoolers. The system is highly safe and easy to maintain, which reduces the effects of unstable helium supply. Thus, cryogen-free magnets have various advantages. However, in cyclotrons, the heat inputs to the coils during beam operation are larger owing to the leakage radio frequency (RF) and beam loss. The magnet was designed to have a temperature margin for stable operation. The coil temperature during the RF excitation and its dependence on the beam loss were measured to verify the stability of operations. Subsequently, it was confirmed that the coil cools sufficiently at the critical temperature [3].

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