AP4-1-INV

Conductor for MRI magnets

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Magnetic Resonance Imaging, MRI, is a powerful medical diagnostic tool and the largest commercial application of superconductivity. MRI magnet design is determined by competing requirements including functional performance, patient comfort, ease of siting in a hospital, minimum acquisition and lifecycle cost. The increased center field, maximized uniformity volume, minimized field decay and stray field, magnet compactness, optimized refrigeration, improved manufacturability, reliability and serviceability drive the magnet requirements. We consider the conductor requirements for commercial MRI magnets while avoiding links to a specific magnet configuration. MgB2, ReBCO and BSCCO conductors are evaluated. From a technical point of view, none of the HTS or MgB2 conductors meet all of the requirements to commercial MRI magnets at the moment. The following conductor features shall be developed or improved:

· Conductors specifically designed for MRI applications, with form-fit-and-function which can be readily integrated into present MRI topology with minimum modifications
· Conductors with improved quench characteristics, i.e. the conductor ability to carry significant currents without damage in the resistive state
· Insulation which is compatible with manufacturing and refrigeration technologies
· A dramatic increase in production and long-length quality control, including large-volume conductor manufacturing technology.

The in-situ MgB2 conductor is, perhaps, the closest to commercial requirements while still needs significant and lengthy developments including development of a stabilized conductor, conductor that does not require processing after winding, reliable long-length conductor.

Conductor technology is not the only issue in introduction of HTS / MgB2 conductor in commercial MRI magnets. Volume-production technologies shall be developed including efficient winding, reliable quench protection, superconducting joints, thermal switches that are compatible with HTS / MgB2 and can operate at elevated temperature, refrigeration technologies.

Keywords: MRI, Magnetic Resonance Imaging, NbTi conductor

AP4-2-INV

Development of A Half Size 3T REBCO Superconducting Magnet for MRI

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Research and development for the practical application of a medical-use magnetic resonance imaging system (MRI) superconducting magnet that requires without liquid helium started as the New Energy and Industrial Technology Development Organization's (NEDO) supported project in fiscal 2016. Development of a liquid helium-free medical MRI superconducting magnet is desired. Another purpose is to reduce the size and weight of high magnetic field magnets. By using the high temperature superconducting coil, it is possible to make the 3T magnet as shape, weight, leakage magnetic field as 1.5T magnet. In this project, we are developing a half size active shield-type 3T REBCO coil for MRI. This magnet has active shield coils with a maximum diameter of 1200 mm, and the room bore diameter is 480 mm. This magnet is one of the largest in the world as a magnet using a REBCO wire with an accumulated energy of 1.6 MJ at the rated magnetic field. It is a magnet system with magnetic field uniformity and magnetic field stability necessary for imaging. In this paper, we report the half-size active shield-type 3T coil and the cooling system that can reduce the initial cooling time.

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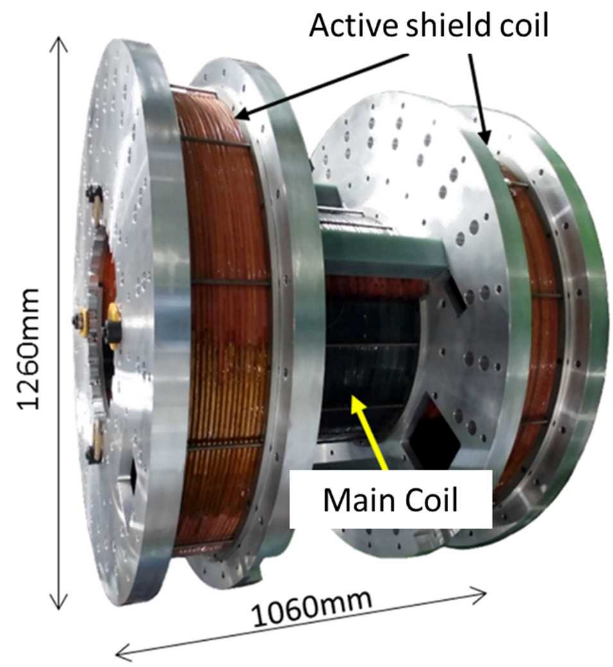

Fig.1 Photograph of half-size REBCO superconducting coil for MRI with active shield coils.

Keywords: Superconducting magnet, MRI, Liquid helium free, REBCO coil, field stability, field uniformity

AP4-3-INV

A Quench of an 800-MHz HTS Insert (H800)

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An 800-MHz HTS insert (H800), together with a 500-MHz LTS NMR magnet (L500), constitutes the MIT 1.3-GHz high-resolution LTS/HTS NMR magnet (1.3G). The H800, composed of 3-nested coils, each a stack of no-insulation REBCO double-pancake coils, was designed to generate at 4.2 K and 251.3 A a center field of 18.3 T (= 18.8 T -0.5 T), where 0.5 T is an estimated field by screening current. In 2018, we operated H800 in a bath of liquid helium at 4.2 K: ~5 min after its power supply had reached 251.3 A, H800 quenched. When it quenched, its measured center field was 17.9 T, corresponding to a computed (from 18.3 T and 17.9 T) azimuthal (field-generating) current of 245.8 A. This talk begins with a brief history of the MIT 1.3G program that began in 2000, and then proceeds to focus on H800. Topics include: 1) the H800's charging history when it quenched; 2) a likely quench cause; 3) consequences seen in H800 after quench. The talk concludes with a brief description of key design features in H800N, a new 800-MHz insert, introduced in light of lessons learned from the H800.

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Keywords: High-temperature superconducting magnet, REBCO double-pancake coils, 1.3-GHz high-resolution LTS/HTS NMR magn, Magnet quench