APP4-1

Solenoidal Magnet for Multi-Purpose Detector at NICA

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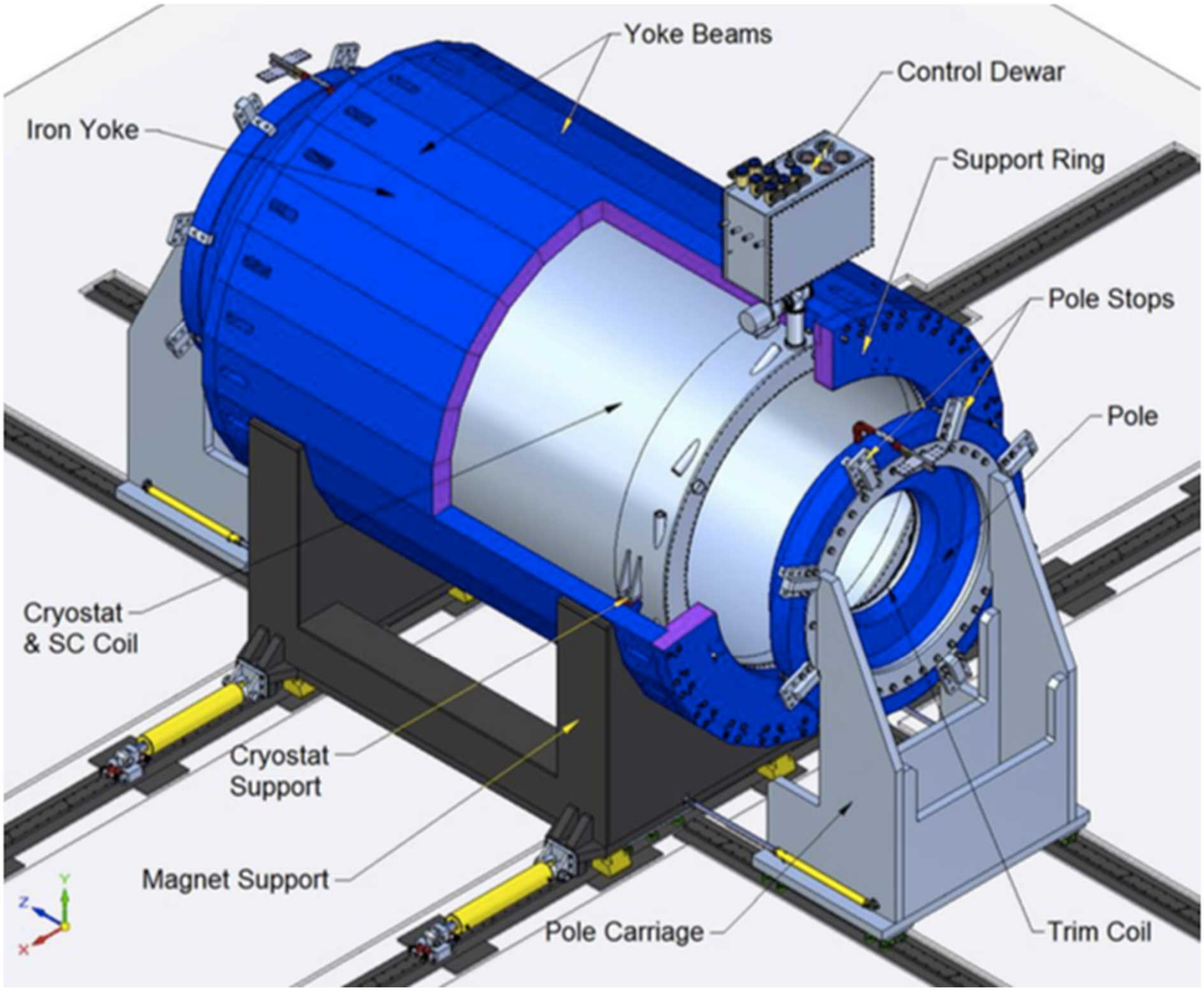
The multipurpose detector (MPD) is a 4π spectrometer to be used for studying charged hadrons, electrons, and photons generated in heavy ion collisions at energies provided by the NICA collider of the Joint Institute for Nuclear Research (Dubna). A constituent part of the MPD is a superconducting solenoid magnet with a superconducting NbTi coil and a steel flux return yoke. The superconducting magnet of MPD is intended for providing a highly homogeneous magnetic field of 0.5 T in an aperture 4596 mm in diameter to ensure the transverse momentum resolution within the range of 0.1–3 GeV/c at NICA. Paper describes a main parameters, general view and the production status of the SC solenoidal magnet for MPD.



Keywords: magnet, accelerator, solenoid

APP4-2

Effect of electromagnetic force on the hydraulic characteristics of a quad-pancake coil wound with a Nb_3Sn CIC conductor

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The superconducting magnet system for the JT-60 super advanced (JT-60SA) comprises a central solenoid (CS) coil, six equilibrium field coils, and 18 toroidal field (TF) coils [1]. With regards to the CS coil, a model coil was developed to verify the CS coil manufacturing and fabrication jig [2-4]. The configuration of the model coil is a quad-pancake coil wound with cable-in-conduit (CIC) conductors composed of Nb_3Sn strands. The model coil was tested using the coil test facility of the National Institute for Fusion Science, which can accommodate testing of a forced-cooled superconducting coil. The test results of critical current, joint resistance, and pressure drop in the model coil have already been described in Refs [2,4]. In this paper, the hydraulic characteristics of the model coil are described. In addition, the relations between the coil current operation and hydraulic characteristics are discussed while comparing several superconducting coils wound CIC conductors.

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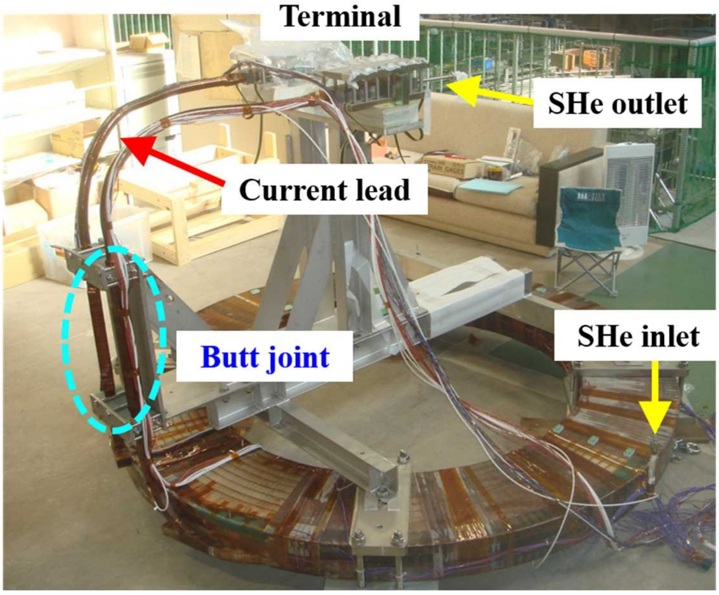
[4] H. Murakami, et al., Development and Test of JT-60SA Central Solenoid Model coil, IEEE Transactions on Applied Superconductivity, 24 (3) (2014) 4200205.



Keywords: Hydraulic characteristics, Nb3Sn Cable-in-conduit (CIC) conductor, JT-60SA central solenoid (CS)

APP4-3

Thermal Properties of Heat Pipes for Conduction Cooled HTS Coils

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High-Temperature Superconducting (HTS) coils can generate high magnetic fields with low loss, so the HTS coils are expected to be applied to various fields. Recently, a liquid hydrogen storage system using an HTS levitation coils has been proposed. This system is high efficiency because low heat invention. In addition, it has robustness against earthquake by controlling HTS levitation coil to suppress the tank motion corresponding to the ground shaking. In order to apply the HTS coil to such applications, conduction cooling type are required for the coils. And, in this case of cooling pass by solid thermal conduction, heat generation in the coil cannot be sufficiently removed. Therefore, we have proposed an HTS coils with conduction cooling by using a self-oscillation-type heat pipes (OHP), which have excellent thermal transport properties. We fabricated a dummy coil without HTS winding and cooling tests on the dummy coil were carried out in order to clarify the good conditions of OHPs for cooling the HTS coils. And then a test coils wound with Bi-2223 tapes were fabricated and tested. We report the details of these coils and results of experiments.

Keywords: Heat Pipes, HTS, Hydrogen, Levitation

APP4-4

Effect of Surface-treated Carbon Nanotube (CNT) Fillers in Epoxy Composites on Thermal and Electrical Stabilities of Superconducting Coils

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This study investigates the thermal and electrical stabilities of superconducting coils impregnated with an epoxy/acid-treated carbon nanotube (CNT) composite evaluated using cool-down, over-current, and repetitive-cooling tests. Carboxylic acid groups, which facilitate uniform CNT dispersal within the epoxy resin, successfully attached at the CNT surfaces using acid treatment, and formed preferential paths for heat conduction. The coil impregnated with epoxy containing acid-treated CNTs exhibited superior cooling performance and thermal/electrical stabilities compared to untreated CNTs; it effectively facilitated heat transfer between the coil and liquid nitrogen owing to its higher thermal conductivity. Moreover, the proposed epoxy composite reduced the thermal contraction difference between the superconducting tape and epoxy composite. This epoxy composite containing acid-treated CNTs is highly recommended for developing a mechanically dense superconducting coil with enhanced thermal and electrical stabilities.

Keywords: Carbon Nanotube, Epoxy, Thermal and electrical stabilities, Superconducting coil

APP4-5

Ac Loss Measurements of High Current HTS Cables

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High current HTS cables are promising for the HTS applications such as magnets and electric machines because of their larger current capacities than those of single coated conductors. High current HTS cables of various architectures have been proposed: Roebel cable, conductor on round core (CORC) cable, twisted stacked-tape cable (TSTC), etc. The reduction of ac losses is one of the major issues for the applications of high current HTS cables, because many of them are operated in a pulse or ac modes. Subsequently, the understanding of their ac loss characteristics is substantially important for their practical applications.
We measure the ac losses of high current HTS cables under the conditions which they carry an ac transport current and/or are exposed to an ac external magnetic field. This experimental condition simulates the actual situation at which high current HTS cables are used. The dissipated power due to an ac transport current is called transport loss, and that due to an ac external magnetic field is called magnetization loss. The former is measured by four probe method, and the latter is measured using a linked pick-up coil (LPC). We measure the amplitude dependencies of the transport losses and the magnetization losses at a couple of frequencies and the frequency dependences of the magnetization losses at a small amplitude.

Acknowledgement
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Keywords: ac loss, high current HTS cables, CORC, Roebel cable

APP4-6

Ac Loss Analyses of Twisted Stacked-Tape Cables

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Various types of high current cables are proposed by using coated conductors. Among them, we focus on twisted sacked-tape cables and examine the ac loss characteristics of coated conductors composing the cables through electromagnetic field analyses. In these types of cables, because the direction of a tape-shaped coated conductor in a cable varies along the cable axis, the critical current of the tape varies along it as well under a transverse magnetic field. This variation in the critical current naturally influence its ac loss characteristic. Moreover, due to complex three-dimensional structures of twisted tape, the current distribution becomes complicated and affect the ac loss characteristic. We also examine the effect of striating coated conductors to reduce ac losses in the twisted tapes in the cables. We use striated and copper-plated coated conductors, in which filaments are not insulated electrically in order to allow current sharing, and the electromagnetic coupling between filaments are studied. The parameters representing cable geometry such as number of stacks, separation between tapes, cabling pitches are varied to study their influence on ac loss characteristics.

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Keywords: ac loss, coated conductor, high current cable, twisted stacked-tape cable