Contribution ID: **947** Type: **Contributed Oral Presentation**

M2Or1C-05: Thermal conductivity test of innovative insulation materials for the cryostats of FCC detector solenoids

Tuesday, July 23, 2019 11:15 AM (15 minutes)

The Future Circular Collider study (FCC) includes the design of detector magnets for the FCC-ee (electron-positron), covering the energy range 90 to 400 GeV and requiring a 2 T solenoid for particle spectrometry, and for the FCC-hh (proton-proton) with 100 TeV collision energy and a 4 T detector solenoid. For both solenoids and their cryostats, CERN is developing an innovative and challenging design by which the solenoids are positioned inside the calorimeters, directly surrounding the inner tracker. For this purpose the cryostat must be optimized to achieve minimum radiation length. It is structured as a sandwich of thinnest possible metallic shells for achieving vacuum tightness, supported by layers of lowest density and radiation transparent insulation material providing sufficient mechanical resistance and lowest thermal conductivity.
In this respect, thermal and mechanical analysis of innovative insulation materials are currently being carried out. The first material of interest, Cryogel Z, is a flexible composite blanket, which combines silica aerogel with reinforcing fibers and has a density of 160 kg/m3. It allows a 4 m bore, 6 m long FCC-ee detector solenoid cryostat with a total thickness of 250 mm, a heat load less than 400 W on the cold mass and 10 kW on the thermal shield.
An alternative would be using glass spheres dispersed in between the thin-walls of the vacuum vessel providing support. An option is type K1 with a 65 μm diameter glass spheres manufactured by 3M with a density of 125 kg/m3. It is crucial to investigate the low temperature mechanical and thermal properties of these materials, some of which have not been thoroughly examined yet. CERN has designed and manufactured a large-sample setup for testing the materials' thermal conductivity and compressive behavior under vacuum. We outline the setup and present the first cryogenic test results on these materials.

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Session Classification: M2Or1C - Thermal Properties, Radiation Effects & Degradation