

Cryo-free multisection superconducting magnetic system with MgB₂ coil

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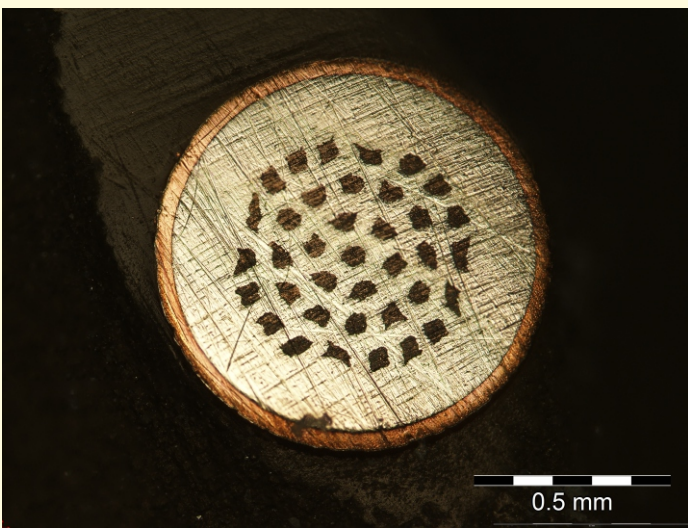
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Abstract

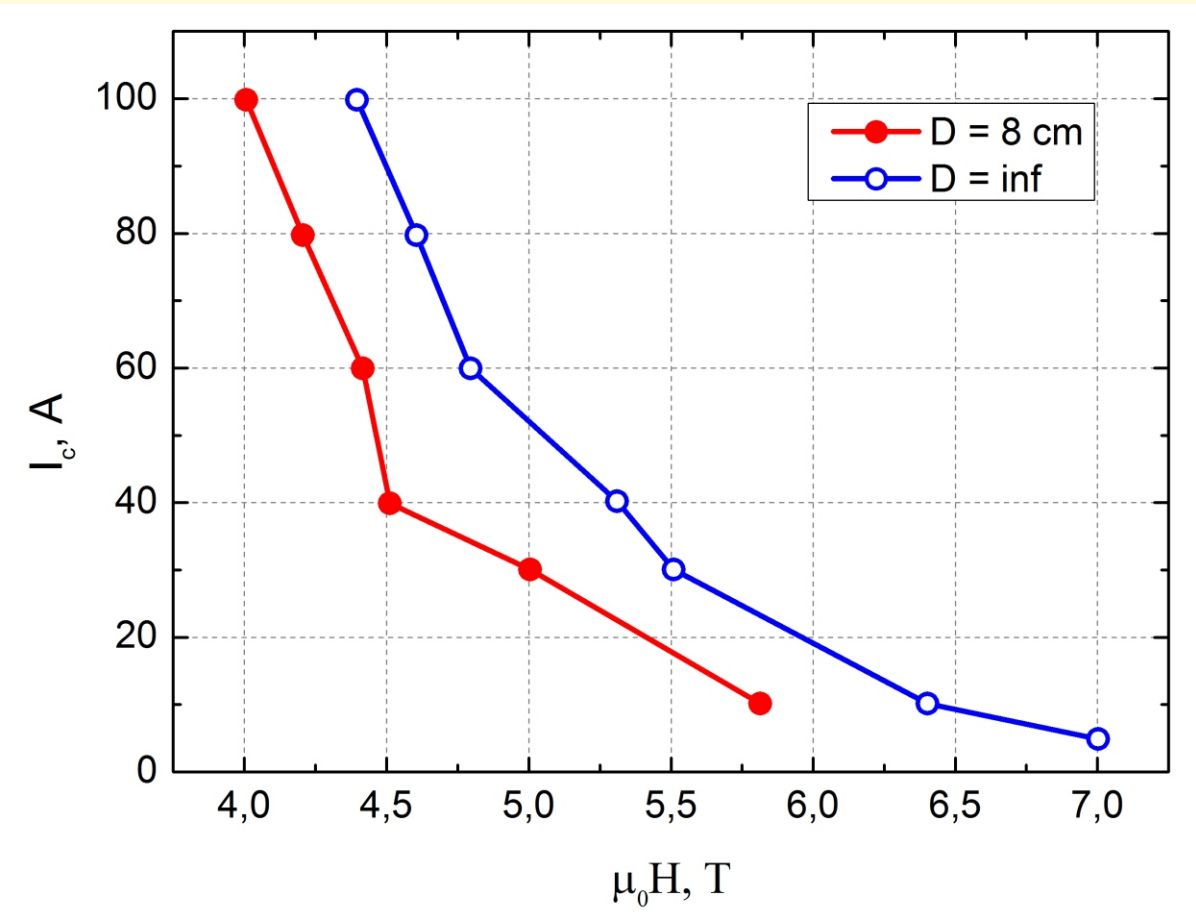
Comprehensive studies of the transport and the magnetic properties of MgB₂ wires were carried out at temperatures 4.2-20 K and magnetic field up to 8 T. Cryomagnetic system with MgB₂ coil was designed and constructed based on the received data. Cryomagnetic system is designed to create a permanent magnetic field of up to 5 T in the warm bore of 40 mm in diameter. The operating current of the system is 100 A. The magnetic field is created by a system of three concentric solenoids. The inner coil is composed of a 10 double pancakes wound with the 2nd generation HTS tape produced by SuperOx. Middle coil is made of multifilament MgB₂ wire with a diameter of 1 mm produced by Columbus Superconductors. Middle coil has height of 120 mm, an inner diameter of 80 mm and an outer diameter of 88 mm. The inner and middle coils are connected in series, what allows both sections to operate at temperature range from 4.2 K to 20 K. The external coil of background field is wound of NbTi. It is powered by a separate pair of current leads. The solenoids are cooled by cryocooler though copper bar. The present report describes the design and the manufacture of the cryomagnetic system.

Cross-section of the MgB₂ wire



Number of filaments $N_f = 37$
Wire diameter $D_w = 1$ mm
Filament diameter $D_f = 56$ mkm
Fill factor 11,4%
Monel matrix
External copper layer

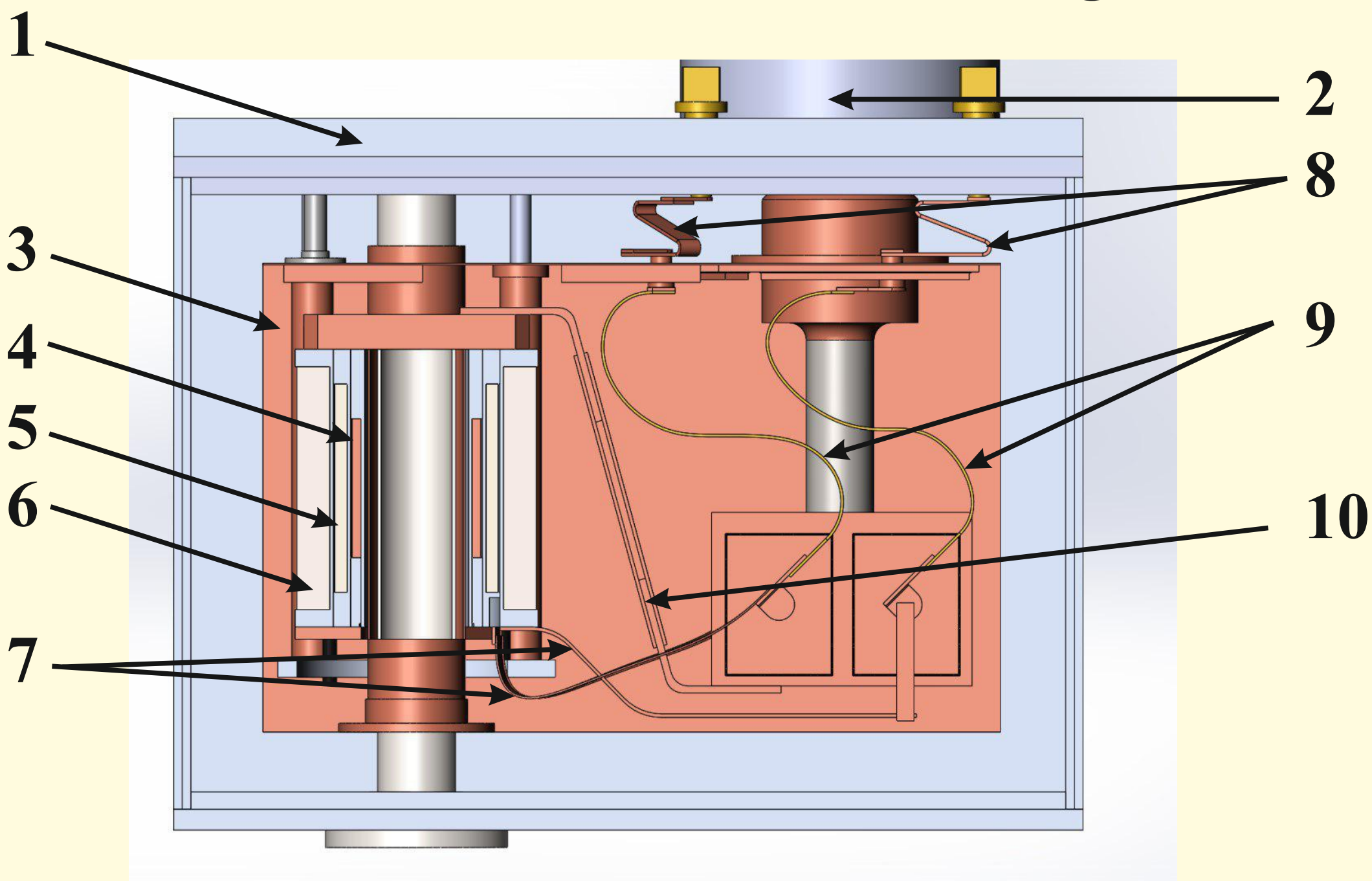
Critical current in perpendicular magnetic field



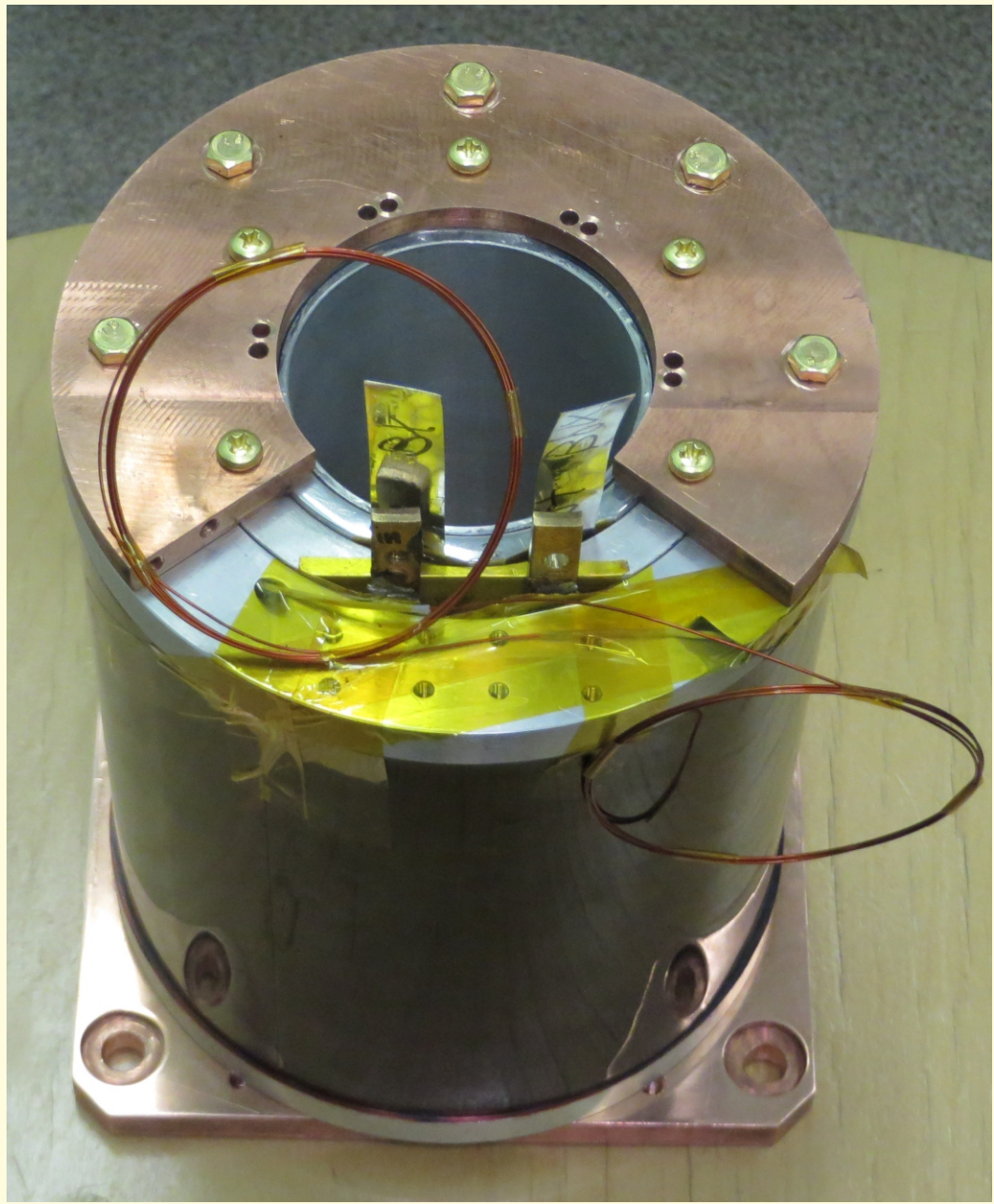
T=4,2 K

Open circles - no bending strain
Closed circles - deformation at former with diameter D=8 cm

Design of the magnetic system

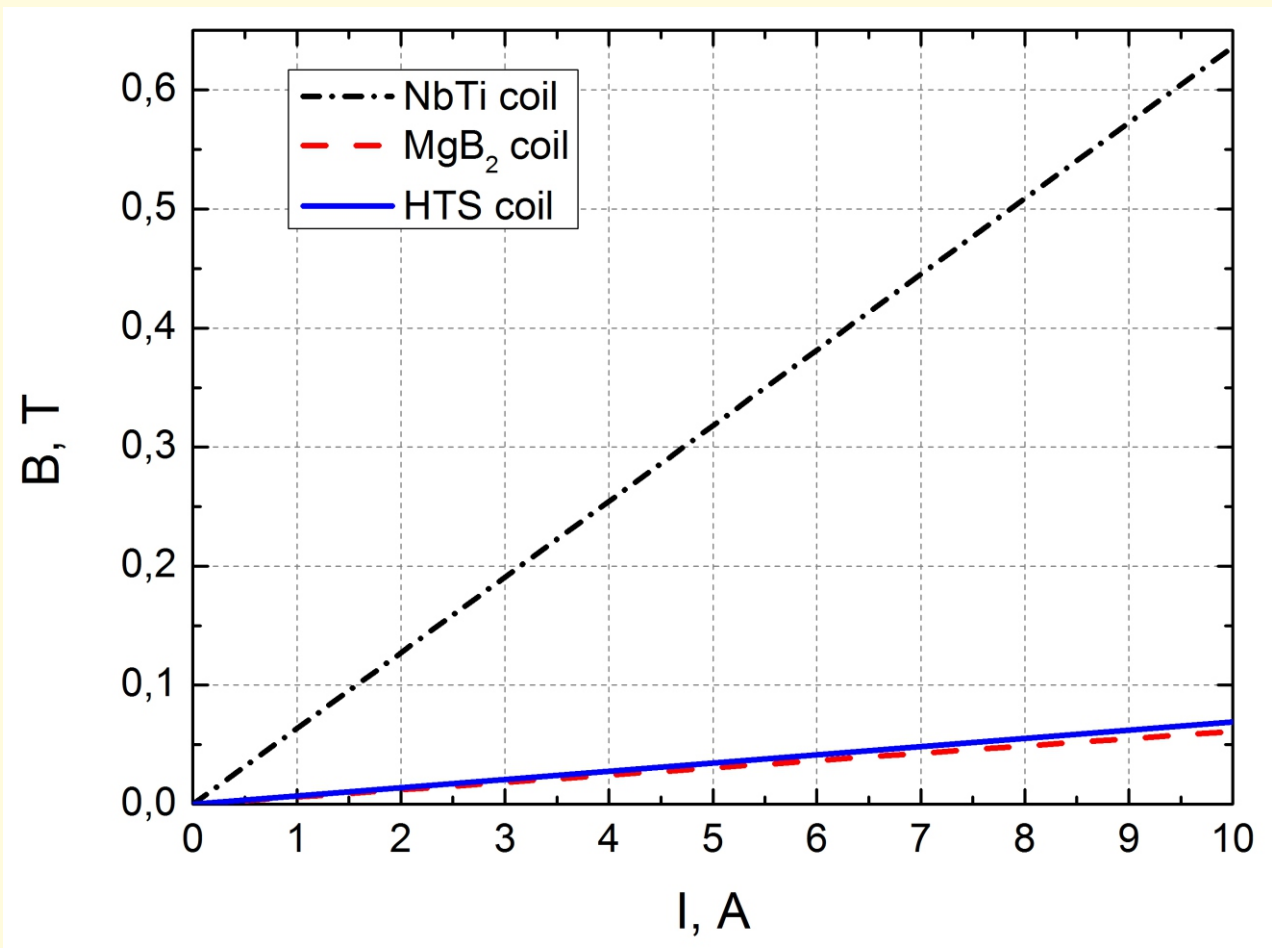


- 1 - Cryostat of the magnetic system
- 2 - Cryocooler
- 3 - Copper radiation shield
- 4 - HTS double pancake coil
- 5 - MgB₂ coil
- 6 - NbTi coil
- 7 - Current leads between the 2nd cryocooler stage and the magnet (HTS tape + NbTi+copper for the external coil and HTS tape + copper for the inner and middle coils)
- 8 - Current leads (copper)
- 9 - Current leads between the 1st and the 2nd cryocooler stages (HTS tape + brass)
- 10 - Copper bus



The system of three concentric solenoids

	HTS	MgB ₂	NbTi
Diameter of wire (mm)	tape 4 mm	1	0.5
Inner diameter (mm)	64	80	100
External diameter (mm)	76	93	138
Height (mm)	80	120	140
Total length of wire (m)		195	3473,7
Total number of turns	482	714	19684
Average number of turns in the layer		119	259



Lines - the calculated values of the load curves for manufactured coils