Development and construction of an actively shielded zero boil-off 7T/700 bore magnet [ID:Tue-Mo-Po2.07-08]

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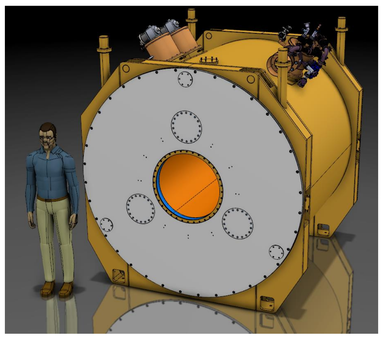
MT 26 International Conference on Magnet Technology
Vancouver, Canada | 2019

7T MRI Magnet

Since UHF MRI offers the possibility to study in a deeper way the brain functionality, these kind of magnets are becoming essential in neuroscience research.
ASG is involved in this sector with an active shielded, zero boil-off 7T/700mm bore magnet.

The magnet with stringent dimensional parameters has been designed and developed by ASG Superconductors team, in order to fulfil all the main characteristics but with a special address to respect the overall system height, length and weight.

ASG has been directly involved in the whole construction of the magnet, from the design to the production.



Main Parameters

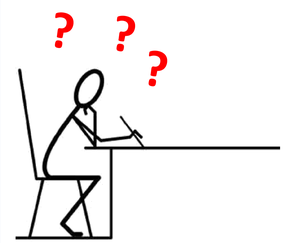
Mechanical Requirements
The magnet must fit within very stringent limits. It is small and light.

Maximum height	2850 mm
Service height	3000 mm
Width	2430 mm
Bore Diameter	700 mm
Length	2365 mm
Weight	< 25 tons

Magnetic Requirements
The magnet is self-shielded. The fringe field is very close to the magnet.

Central Field	7 T
Decay rate	< = 0.025 ppm/hr
5gauss Stray Field	6.0 m (axial)
	4.2 m (radial)
Field Homogeneity	< 5 ppm DSV 340 mm

Production



From Design To Production

Phase 1
Winding and Cable Insulation

Each coil has wounded on Al formers. A wire grading has been done in order to achieve the magnet requirements.

Phase 2
Cold Mass Assembly

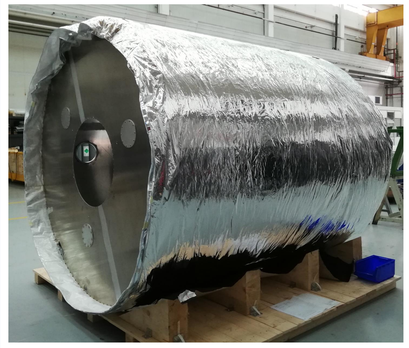
The magnetic system is composed by various coils nested one in the other, in order to reach a compact size and all the requirements.

Phase 3
Thermal Shield

The system must be zero boil-off.
In order to reduce the thermal load on the cold mass a thermal shield is installed around it.

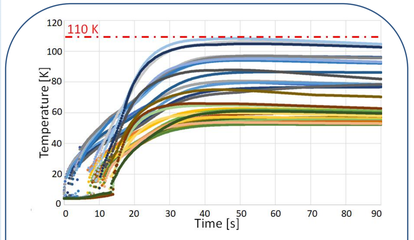
Phase 4
Cryostat Assembly

The whole cold mass and the thermal shield are anchored to the cryostat through a suspension system. All the cables, pump ports and signal wires exit from the magnet through a service turret.

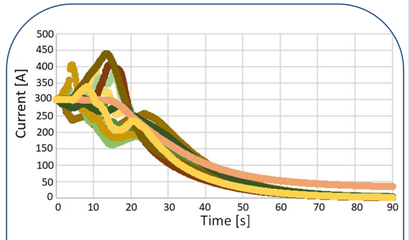


Protection System

As usual for MRI persistent magnets, the quench protection is made by coil subdivision and by means of diodes and protection resistances. The quench study has involved several possible cases depending on quench starting position in order to understand the worst case. The number of coil subdivisions and the protection resistance values have been chosen in order to minimize the interlayer voltage and the maximum temperature of the quenched coils.



Temperature Behaviour
The protection system has been developed in order to keep the maximum temperature below 120 K.



Current Behaviour
The protection system allows to discharge the magnet in less than 2 minutes.

Cryogenic

Cool-Down

- In order to save the liquid helium amount necessary for cool down, an additional cryocooler-based system has been studied.
- This cryocooler-based system allows to cool down the magnet from 70 K to 20 K.
- The 7T/700mm bore magnet is compatible with the use of an additional cryocooler-based system.
- A turret allows to house and to connect the additional cryocooler.
- The additional cryocooler can be demounted after cool down.

Zero boil-off system

A high efficient recondensing system has been implemented to allow to condensate the helium vapours.