



Contribution ID: 402

Type: Poster Presentation of 1h45m

A Tabletop Liquid-Helium-Free, Persistent-Mode 1.5-T/70-mm MgB₂ Osteoporosis MRI: Two Magnet Design Options

Thursday, August 31, 2017 1:45 PM (1h 45m)

In this paper we present two design options for a tabletop liquid-helium-free, persistent-mode 1.5-T/70-mm MgB₂ "finger" MRI for osteoporosis screening. Both designs, one with and the other without an iron yoke, satisfy the following criteria: 1) 1.5-T center field with a 70-mm room-temperature bore for a finger to be placed at the magnet center; 2) spatial field homogeneity of <5 ppm over a 20-mm diameter of spherical volume (DSV); 3) persistent-mode operation with temporal stability of <0.1 ppm/hr; 4) liquid-helium-free operation; 5) 5-gauss fringe field radius of <50 cm from the magnet center; and 6) small and light enough to use on an exam table. Although the magnet is designed to operate nominally at 14 K, maintained by a cryocooler, it has a temperature margin of 6 K to keep its 1.5-T persistent field over the 14-20 K operating temperature range. The magnet is immersed in a volume of solid nitrogen (SN₂) that provides additional thermal mass when the cryocooler is switched off to produce a vibration-free measurement environment. The SN₂ enables the magnet to maintain its persistent field over a period of time sufficient for quiescent measurement, while still limiting the magnet operating temperature to no higher than 20 K. We discuss first pros and cons of each design, and then technical challenges and further studies of our proposed MgB₂ MRI magnet.

Acknowledgement: Research reported in this publication was supported by the National Institute of General Medical Sciences of the National Institutes of Health

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Session Classification: Thu-Af-Po4.04

Track Classification: D2 - Magnets for MRI