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Performance test of 1.5 T cryogen free orthopedic MRI magnet

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A 1.5 T cryogen free superconducting magnet for a dedicated orthopedic MRI of human extremities was developed and tested. The magnet has a compact cryostat cooled by a pulse tube coldhead with cooling power of 1 W at 4.2 K. The warm bore of a cryostat is 325 mm in diameter, 600 mm in length. Cost effective NbTi wire was used for making superconducting coils. The magnet is actively shielded. 0.5 mT stray field located at 1.7 / 2.5 m from the magnet center in radial / axial directions correspondingly. A novel approach has been implemented to decrease the cool down time of the magnet. According to it, the coldhead was placed in the separate sleeve filled with the gaseous helium. It was shown experimentally that the convection of helium gas in the coldhead sleeve speeds up the cool down significantly, more than by 40% in this case. Cooling down the magnet from ambient to operating temperature takes about 100 hours. The magnet operates in persistent mode with magnetic field stability of better than 0.01 ppm/hour. Special tests have been performed to investigate the magnet behavior in case the coldhead is switched off. Quenches in the range from near 5 to more than 6 minutes after the coldhead was stopped were observed. The magnet has shown steady operation at 1.5 T in case the coldhead was switched off for four minutes or even longer. At the same time the slight decay of the persistent field of less than 100 ppm was observed.

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