

Residual Magnetism in an MR Suite after Field-Rampdown of an 8T superconducting magnet

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Introduction

After rampdown of a superconducting magnet of an Magnetic Resonance Imaging (MRI) system in a hospital environment it was predicted that the residual magnetism could remain throughout the entire structure of an MRI suite and lead to costs of degaussing in the range of 100,000 US dollars before the use of computer or diagnostic imaging would be possible again [1]. This study evaluates the residual magnetization at different points of interest in the MRI suite at several time points after field-rampdown of an 8 Tesla superconducting whole-body MR-scanner.

Material and Methods

The hospital based 8 Tesla superconducting magnet has a bore diameter of 0.8 m prior to the inclusion of shim and gradient coils, a weight of about 30 tons and a length of 3.26 m. The magnet is housed in a shielded room 7.6 m in length, 4.7 m in width, and 4 m in height. This room provides RF shielding and contains the stray magnetic field by using 240 tons of annealed low carbon steel. The magnet achieved the 8 T field in February 10, 1998 which required a current of 199 A. The magnet was ramped down on August 21, 2006. Residual magnetism was measured in the 8T MRI suite with two different gaussmeters (410- and 420-Gaussmeter, Lake Shore Cryotronics, Westerville, OH) in DC mode. The residual magnetic field at 34 respective points of interests (Figure 1) was determined with both gaussmeters at 2, 9, 17 and 40 days after rampdown.

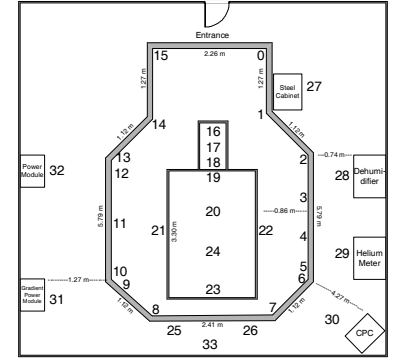


Figure 1 Measurement points (0-33) of residual magnetism in an MR suite after rampdown of an 8T magnet.

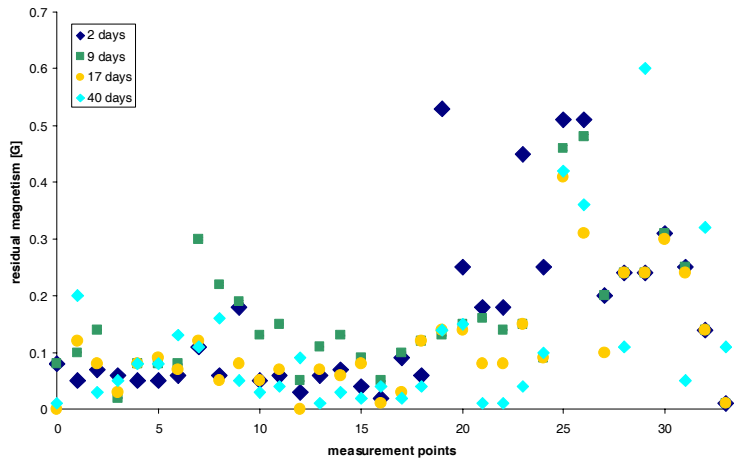


Figure 2 Residual magnetism at 34 different measurement points in an MR suite shown in Figure 1 at 2, 9, 17 and 40 days after rampdown of an 8T magnet.

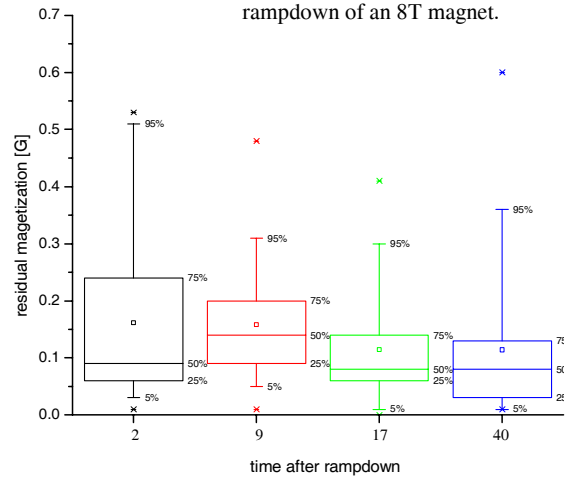


Figure 3 Whisker box plots (with mean, median, minimum, maximum, 5/95 percentiles at the whiskers and 25/75 percentiles at the box) of the residual magnetism in an MR suite at different time points: 2, 9, 17 and 40 days after rampdown of an 8T magnet.

Results

The measured residual magnetism in the MRI suite after rampdown of an 8T superconducting magnet was not significantly elevated compared to magnetic fields observed in the environment. An elevation of 0.53 Gauss ($5.3 \cdot 10^{-5}$ Tesla) compared to the magnetic field of the earth [2] was determined inside the bore of the magnet (measurement points # 19, 20, 23, 24 in Figure 2). Other areas that showed elevated magnetism were those near the steel cabinets (# 27-30) and penetration panel (# 25, 26). Around the magnet the carbon steel walls of the iron shield did not show elevated magnetism of more than 0.35 Gauss (# 0-15). During a period of 40 days no further significant changes in magnetism at any of the points of interest could be seen in comparison to initial measurements directly after rampdown (Figure 3). These measurements were consistent with both gaussmeters used in this study.

Discussion

After rampdown of a superconducting magnet there is no need of degaussing the MRI suite when an appropriate steel composition has been used in the iron shield of the magnet to avoid residual magnetism. Even the rampdown of an ultrahigh field 8T MR scanner allows the immediate further use of the MRI suite in a hospital environment.

Literature

- [1] Robb M: Magnetic Contamination: The Ghost of MRI Past. Radiology Today Vol. 5 No. 21 Page 22 (2004)
- [2] Whalery KA and Holmez RT: The Earth's main magnetic Field. Phys. Educ. 34(4) 180-184 (1999)