Tri-axial Square Helmholtz Coils System to Generate Uniform Magnetic Field Volume

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Introduction: The study of the effects of magnetic field stimulation in biological systems require devices capable of generating homogenous magnetic fields and further guarantee a controlled and repeatable exposure to different samples involved in the experiment [1]. This work presents analysis and validation of a tri-axial Square Helmholtz Coils (SHC) system (Figure 1), commonly used to generate highly uniform magnetic field on a specific volume.

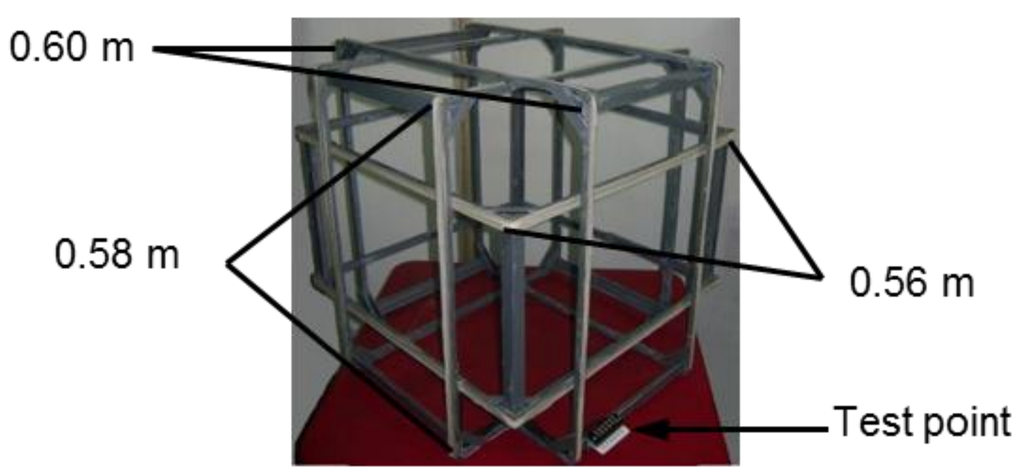

Figure 1. Tri-axial square Helmholtz coils system

Computational Methods: The analysis of square Helmholtz coil is based on the Bio-Savart law [3]. In order to verify the distribution and uniformity of each component of the magnetic field B_z, B_y and B_x on workloads, a 3D computational model was designed in COMSOL®. This model is composed by three pairs of square Helmholtz coils and a sufficiently large cube which is assigned zero potential for electromagnetic analysis [2].

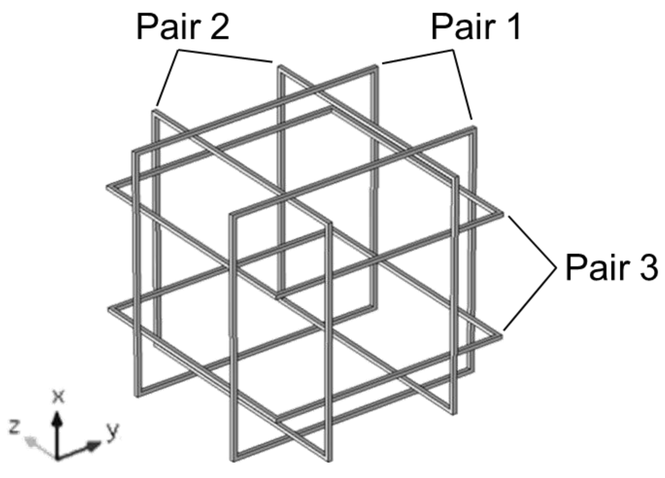

Figure 2. Computational model of the coils system

Results: The simulation results show the contour maps of magnetic flux density for each pair of coils (Figure 3), these results allow to verify uniformity of the static magnetic field of 190 µT applying a constant current of 1.5 A, 1.45 A and 1.4 A respectively.

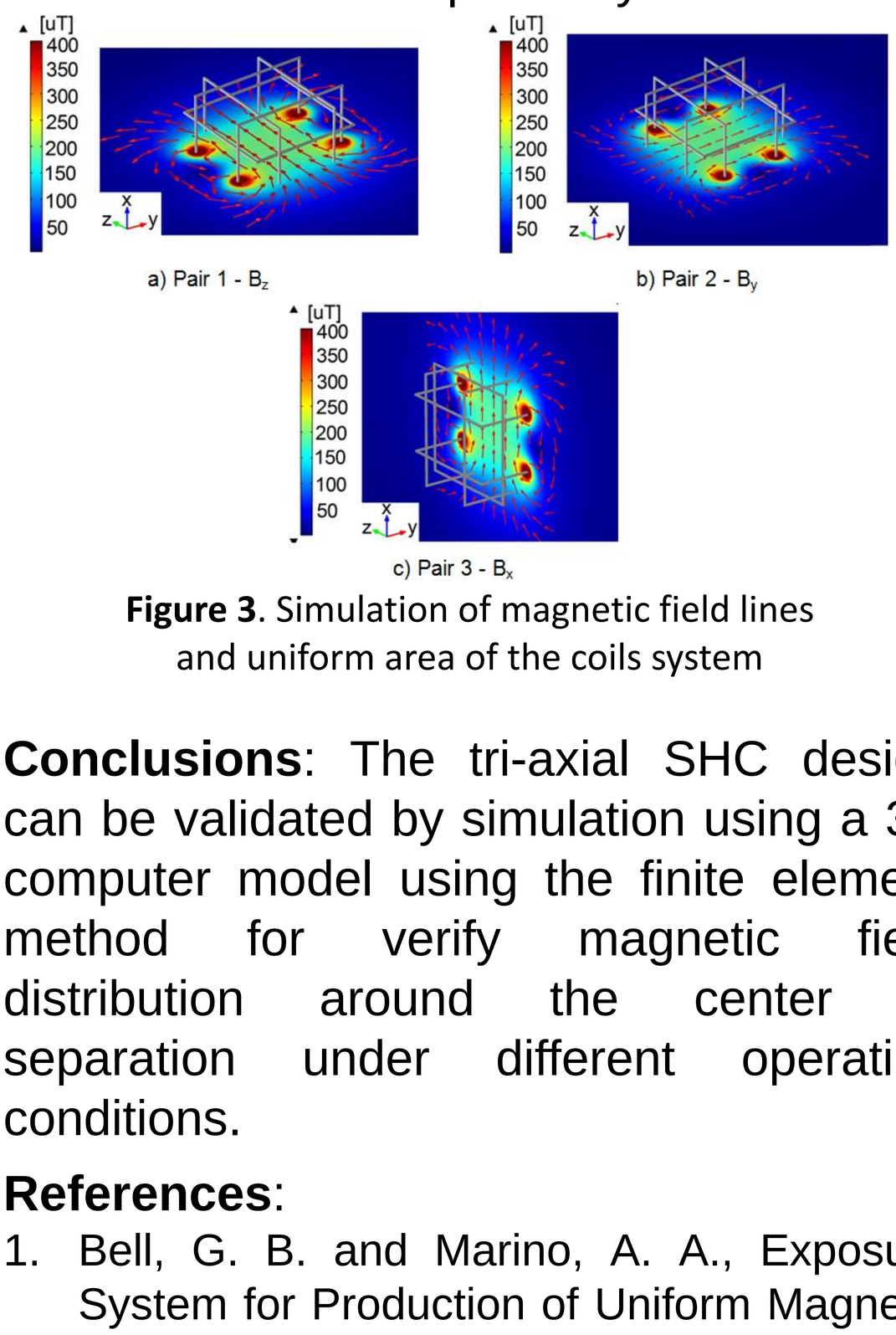

Figure 3. Simulation of magnetic field lines and uniform area of the coils system

Conclusions: The tri-axial SHC design can be validated by simulation using a 3D computer model using the finite element method for verify magnetic field distribution around the center of separation under different operating conditions.

References:

1. Bell, G. B. and Marino, A. A., Exposure System for Production of Uniform Magnetic Fields, Electromagnetic Biology and Medicine, 8(2), 147-158 (1989).
2. Olivares-Galvan et al., Coil Systems to Generate Uniform Magnetic Field Volumes, COMSOL Conference 2010, Boston-USA, 1-7 (2010).
3. Restrepo, A. F., Franco, E. and Pinedo, C. R., Metodología de diseño e implementación de un sistema para generación de campos magnéticos uniformes con bobinas Helmholtz Cuadrada Tri-Axial, Información Tecnológica, 25(2), 3-14 (2014).