Comparison Between CCMI and CAHM for design Shielded gradient coils for MRI.

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Introduction
One of the most important concepts for obtaining an image using MRI is the use of magnetic field gradients. There have been different techniques to improve the quality of the magnetic field gradients that allow high strength gradient fields that can be rapidly switched on and off for fast imaging modalities, large homogeneous-gradient-volume or minimum inductance. This work is focused on a comparison between two methods based in the target field method proposed by Turner[1,2] to build shielded gradient coils. The main problem of the target field method is that a current of infinite extent is designed with a set of constraints but the current is modified, and in consequence the final coil might not have the desired characteristics. Carlson[3] proposed a current distribution using a Fourier Series for a coil of finite length. Another solution was proposed by Chronik[4] that adds a set of current constraints forcing the current to lie over a certain length. Another important issue to consider is the interaction of the rapidly switched gradient fields with other conducting structures in the MRI system that generates the eddy currents. To avoid problems in imaging due to these eddy currents shielded gradient coils were proposed by Morich[5] et al. and Van Vaals Bergman et al.[6]

Method
Most gradient coils that are used in MRI consist of wire arrangements on the surface of a cylindrical former. Carlson approach with harmonics minimisation (CAHM) allows a restricted length to be included at the beginning of the design process [3]. Considering the current distribution on the inner cylinder to be limited to the region r < L, the inner coil current distribution is defined as a weighted harmonic series an of finite axial extent (2l), Eq (1). A functional is minimized in terms of the coefficients an over a mesh of N points defining the region of a desired uniform gradient in Eq (2), where L is the inductance. The current density for the shield coil, both coils gradient and shield are designed with the same length property that helps to save physical space in the bore, avoiding claustrophobia.

Results and Discussion
A transverse head gradient coil for imaging application has been implemented in the MATLAB software language and used to create a shielded gradient coil using the CCMI and CAHM methods. It is important to mention that the gradient coil and the shield coil have the same length. The CAHM approach with minimization allows a flexible method of coil design in which the trade off between of gradient uniformity and the inductance, can be made in a more intuitive and direct method of coil design in which the trade off between of gradient uniformity and the inductance, can be made in a more intuitive and direct.