

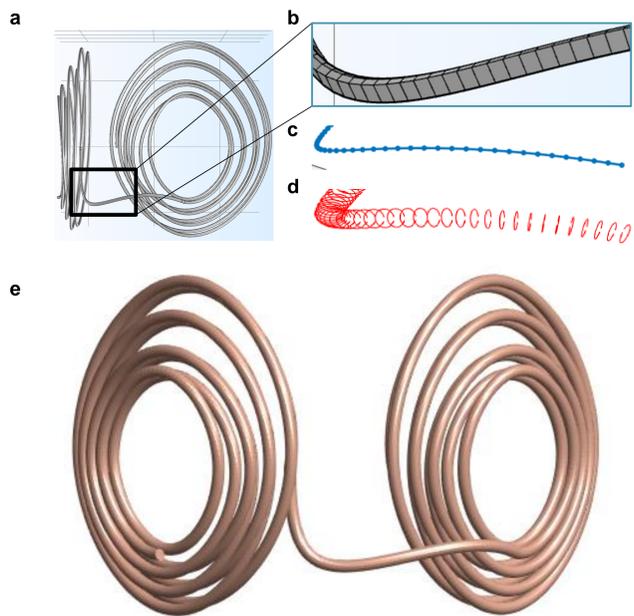
## Introduction

Precise, biophysical modeling of the stimulation field of transcranial magnetic stimulation (TMS) coils on realistic head models is essential for understanding the affects of stimulation on brain activity and determining exact brain targets for clinical applications. This perhaps is even more essential for coils with complex geometries whose resulting electric fields interact with the variable brain anatomy of subjects in highly nontrivial ways. However, while several toolboxes are available for TMS simulation, the challenge of coil generation and proper positioning makes some of them less adaptable for complex coil geometries.

Here we present the integration of two FDA approved coils from BrainsWay's H-Coil Family, the H1 Coil and the H7 Coil, into an existing software toolkit for TMS electric-field modeling with a boundary element fast multipole method (BEM-FMM)<sup>1</sup>. Along with complex geometries, these coils have flexible bases that allow the coils to conform to the curvature of the scalp of the individual patient for maximal magnetic coupling. We describe novel procedures used for the generation of the coil meshes and how they were positioned and oriented on the scalp of the head models.

<sup>1</sup>Makarov, Sergey N., et al. "A software toolkit for TMS electric-field modeling with boundary element fast multipole method: An efficient MATLAB implementation." *Journal of neural engineering* 17.4 (2020):.

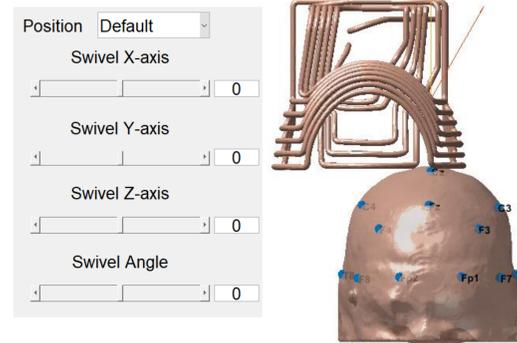
## 1. Coil Generation from CAD Model



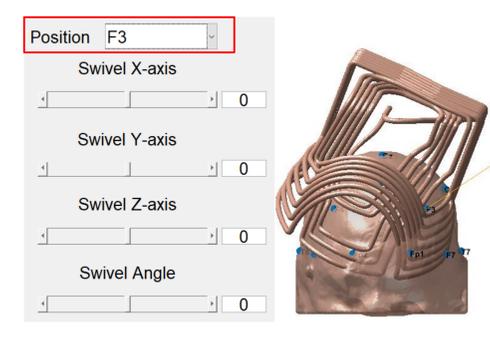
A complex geometric coil is inputted from a CAD file (a) and meshed as a grid (b). From the mesh, the center line of the coil path is calculated (c) and cross sections of the coil are arranged along that path (d). Mesh and current paths are created by linking the cross sections.

## 2. Coil Positioning (H1 Coil)

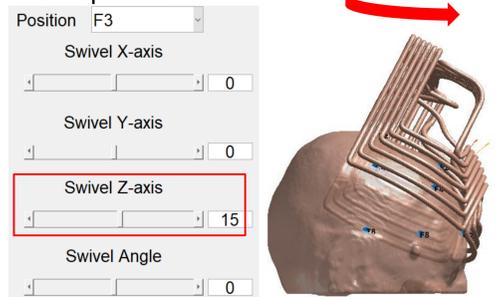
I. Coil is placed over head model labeled with EEG positions



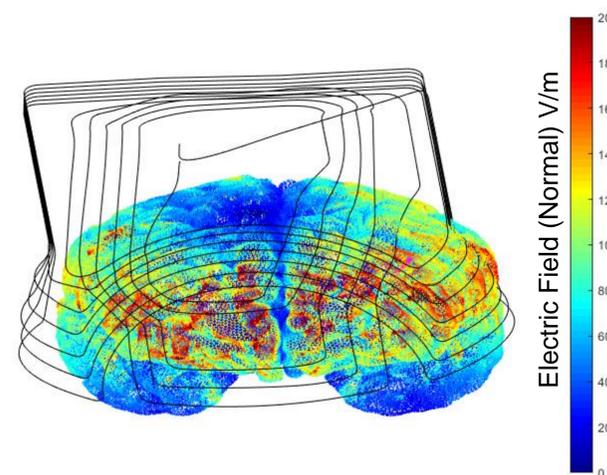
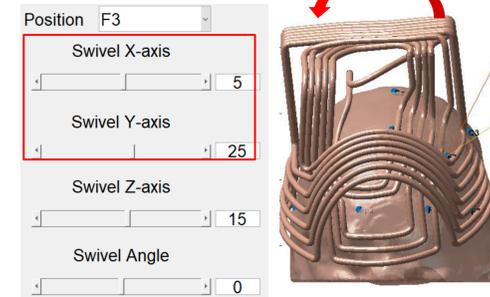
II. Coil is positioned over target, rotated so normal of coil hotspot matches normal of target



III. Coil is rotated along Z-axis until symmetric over hemispheres

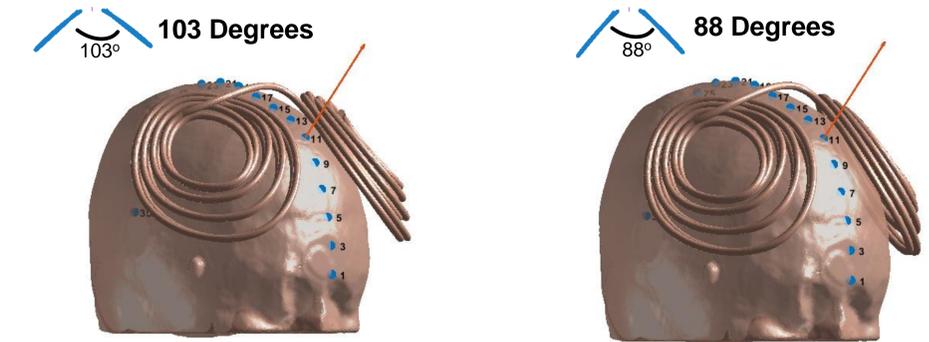


IV. Coil is rotated along X and Y-axes until sitting tightly over head

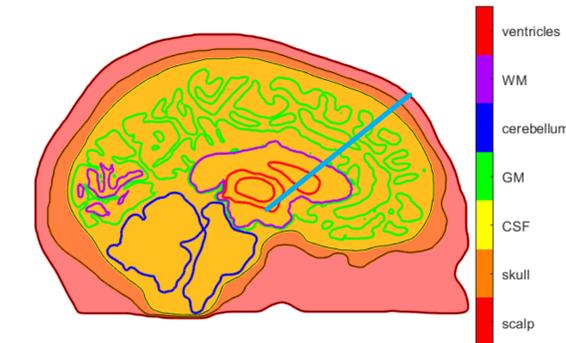


## 3. Coil Fitting (H7 Coil)

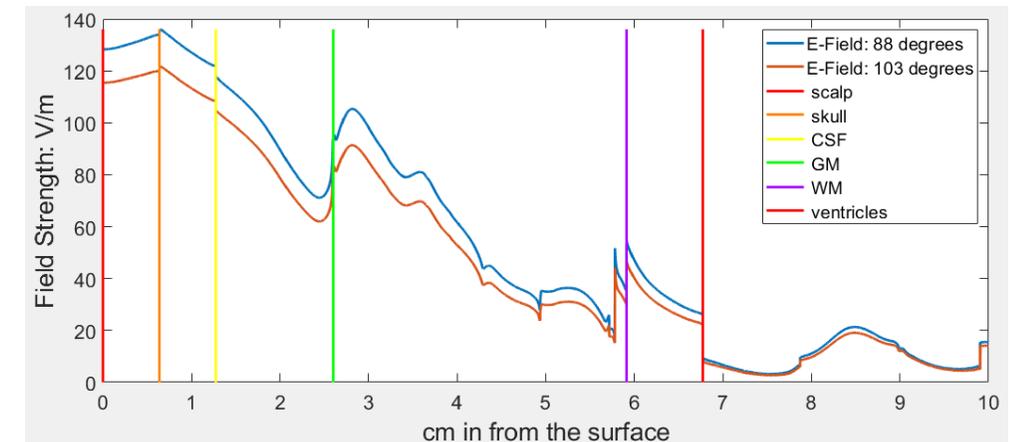
H-Coils are flexible coils which change shape to conform to the head



The path of the coil wings can be rotated to change the angle between the two wings of the coil and then remeshed accordingly



Electrical field is calculated along the line normal to the coil into the head (blue line)



Coil angle significantly changes the strength of the resulting electric field