

Realistic Head Models for Cortical Source Analysis in Infant Participants

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<http://erlab.psych.sc.edu/pdf/srcdreal-2007.pdf>

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Background

Cortical source analysis can identify cortical areas that are active during infant cognitive processing. This analysis uses high-density EEG recording and quantitative models that identify dipole sources inside the head to account for the EEG data. These sources can be related to the EEG activity in the time domain, to the experimental procedures, and to the cognitive processes occurring during the task. Cortical source analysis with infant participants has used adult models for the electrical and spatial characteristics of the head. The current poster will overview a method for using infant MRIs to develop realistic head models for infant participants for cortical source analysis.

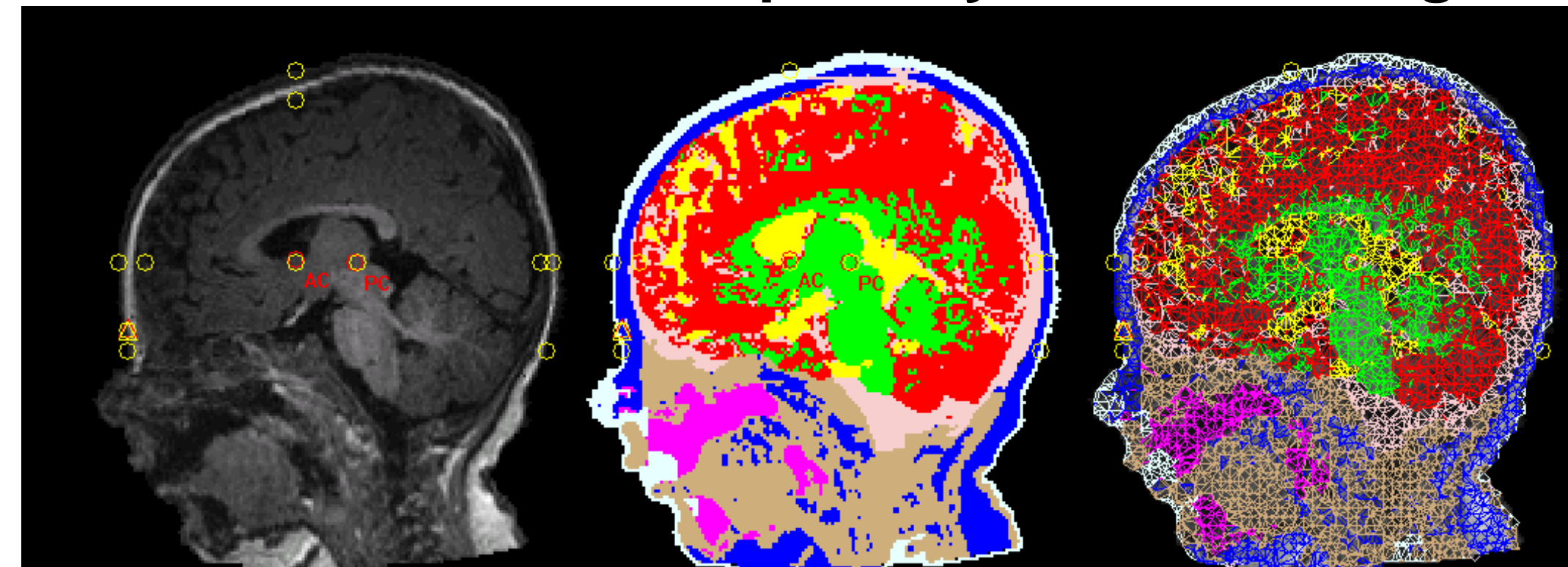
Infant Anatomical MRI

Infant anatomical MRI must be obtained. This could come from a database of infant MRIs, e.g., NIH MRI study of normal brain development, 1.5 T T1W – PD/T2W, 0, 3, 6, 9, 12, Evans 2006. Use a single MRI selected on basis of age and head size, or use normalized MRI for age. OR, do MRI of individual infant participant (e.g., 3.0T of normal, unselected infants; Gilmore, 2004; Richards, in progress; Paterson et al, ISIS 2004).

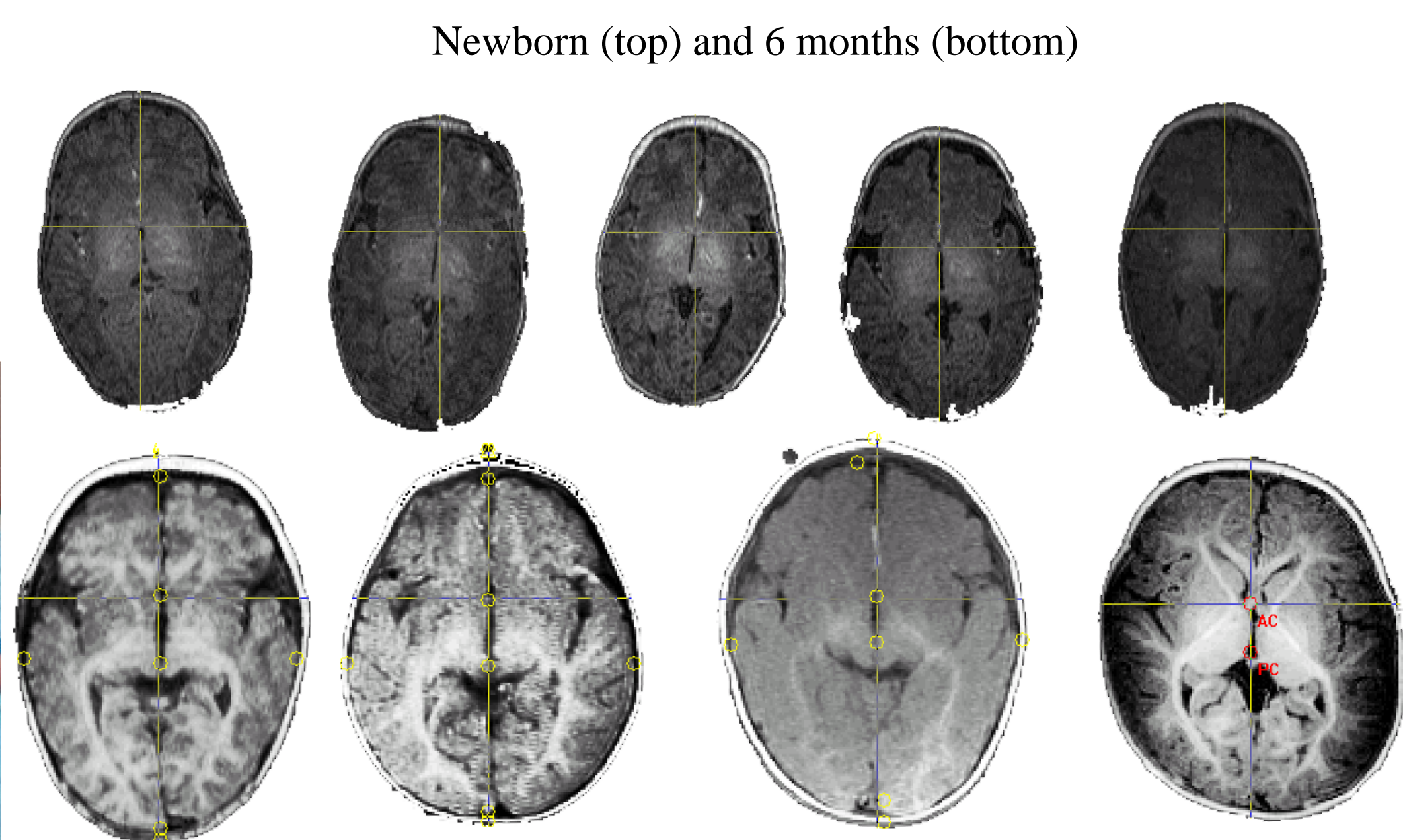


Semented "Wireframe" File

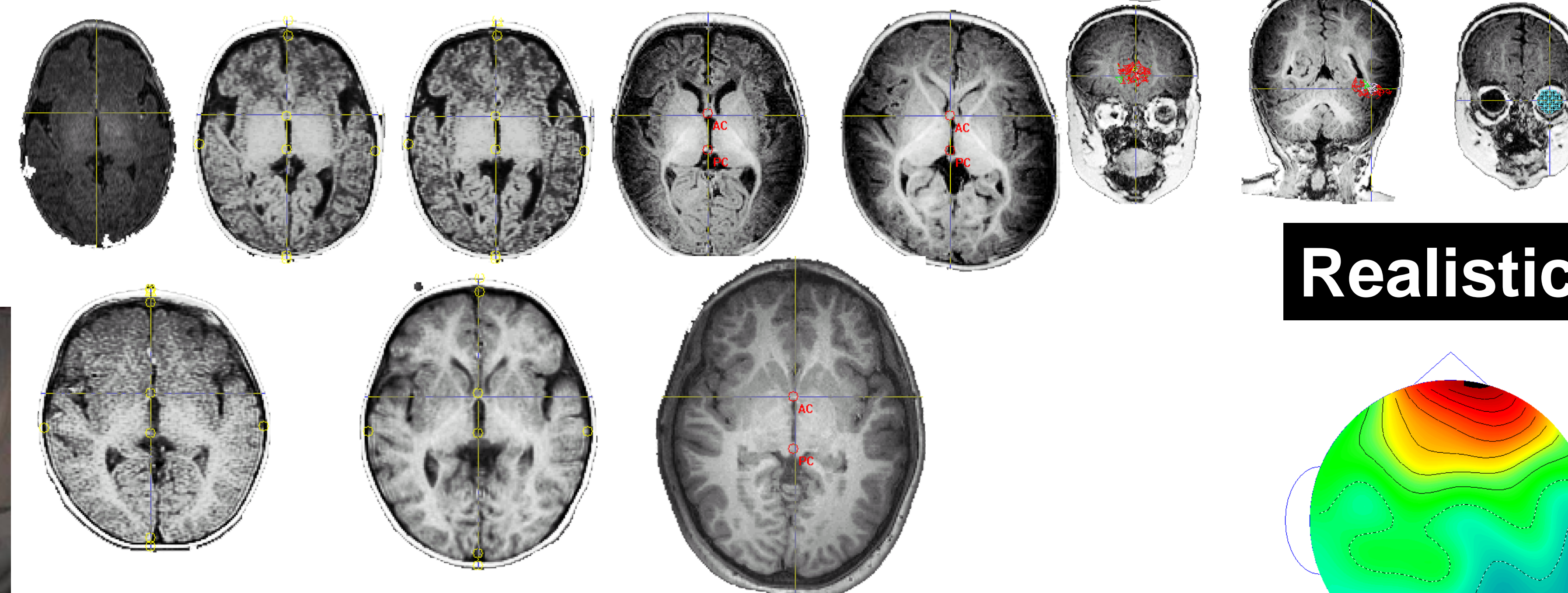
The segmented MRI is made into a 3-D "wireframe". The wireframe has tetrahedral elements, each which has four vertices (corners) and an associated media type (skull, scalp, etc). The wireframe may be stored as a series of numbers for use with topographical and cortical source model programs. The conductivity of each tissue type may be incorporated into the wireframe or stored separately for different ages.



What is Under the Bumps ?

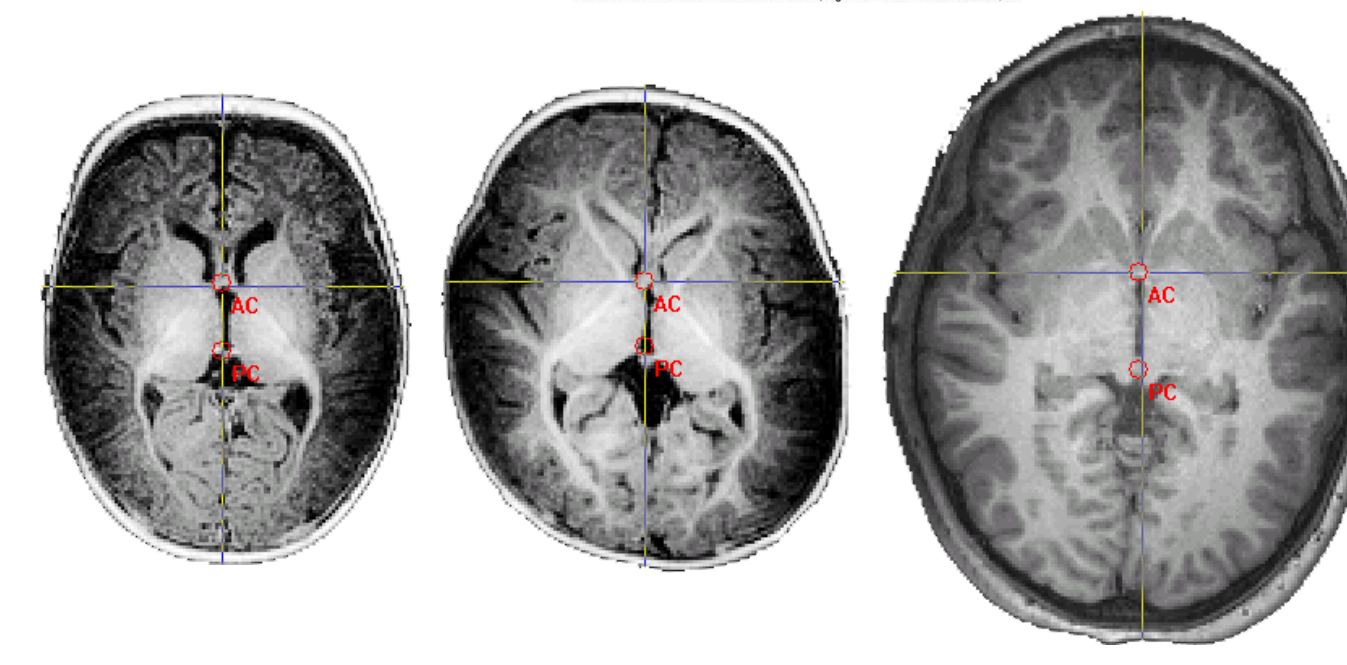
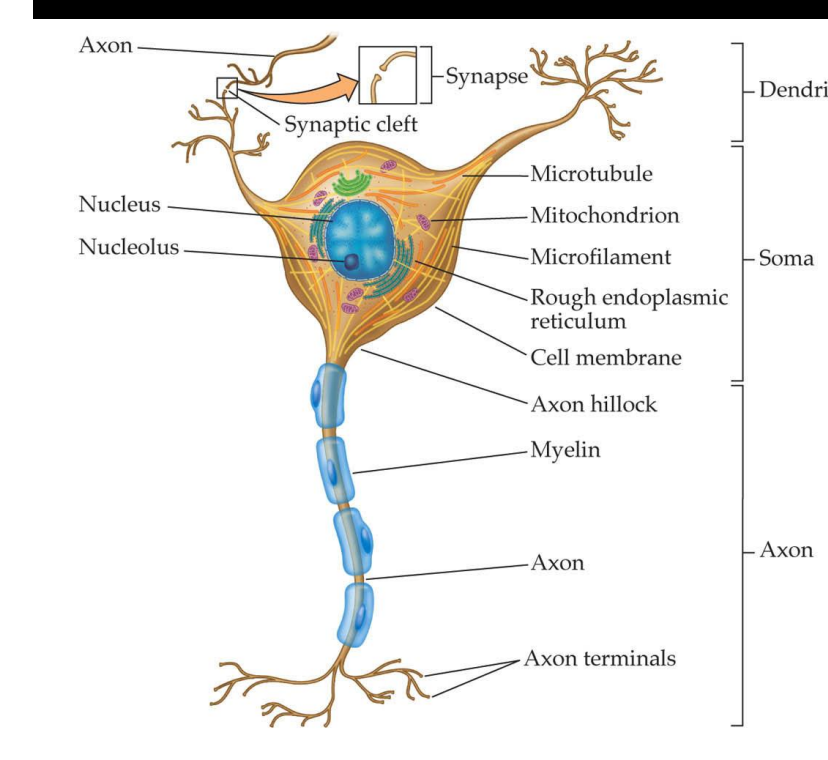


Newborn (3.0T), 1 & 3 Months (N-1.5T), 3.5 & 6.5 Months (JR-3.0T)

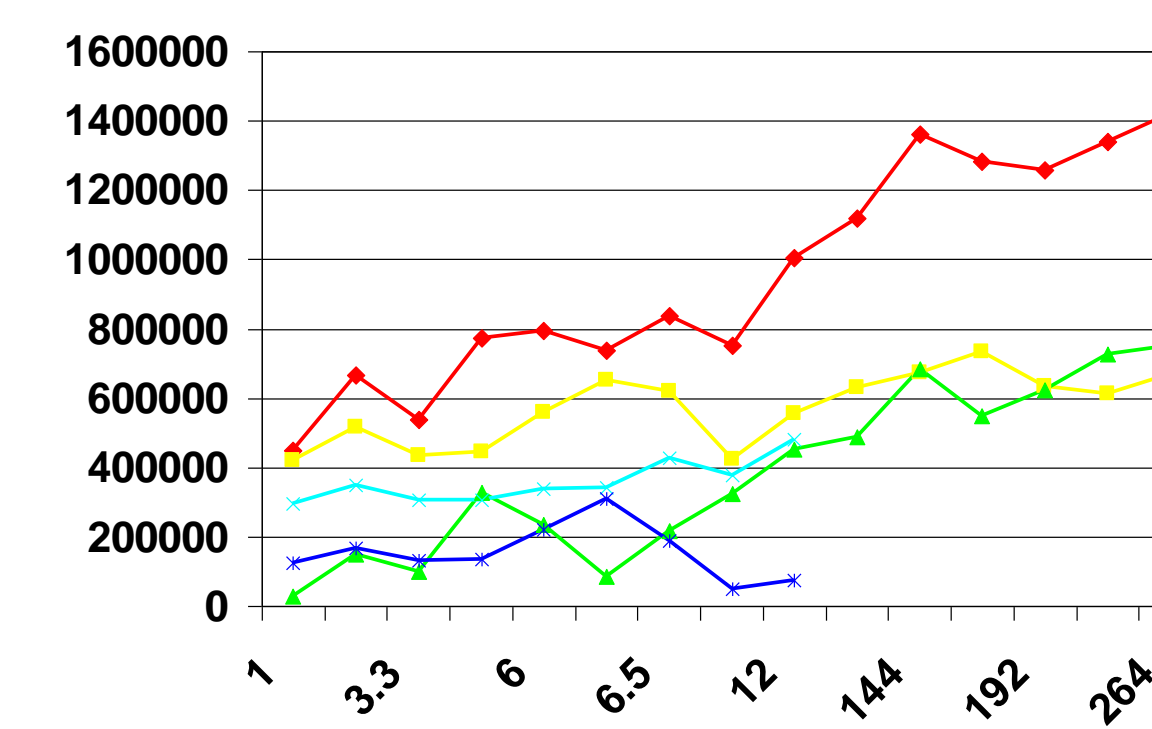


9 Months & 12 Months (N-1.5T), 12 Years (JER-3.0T)

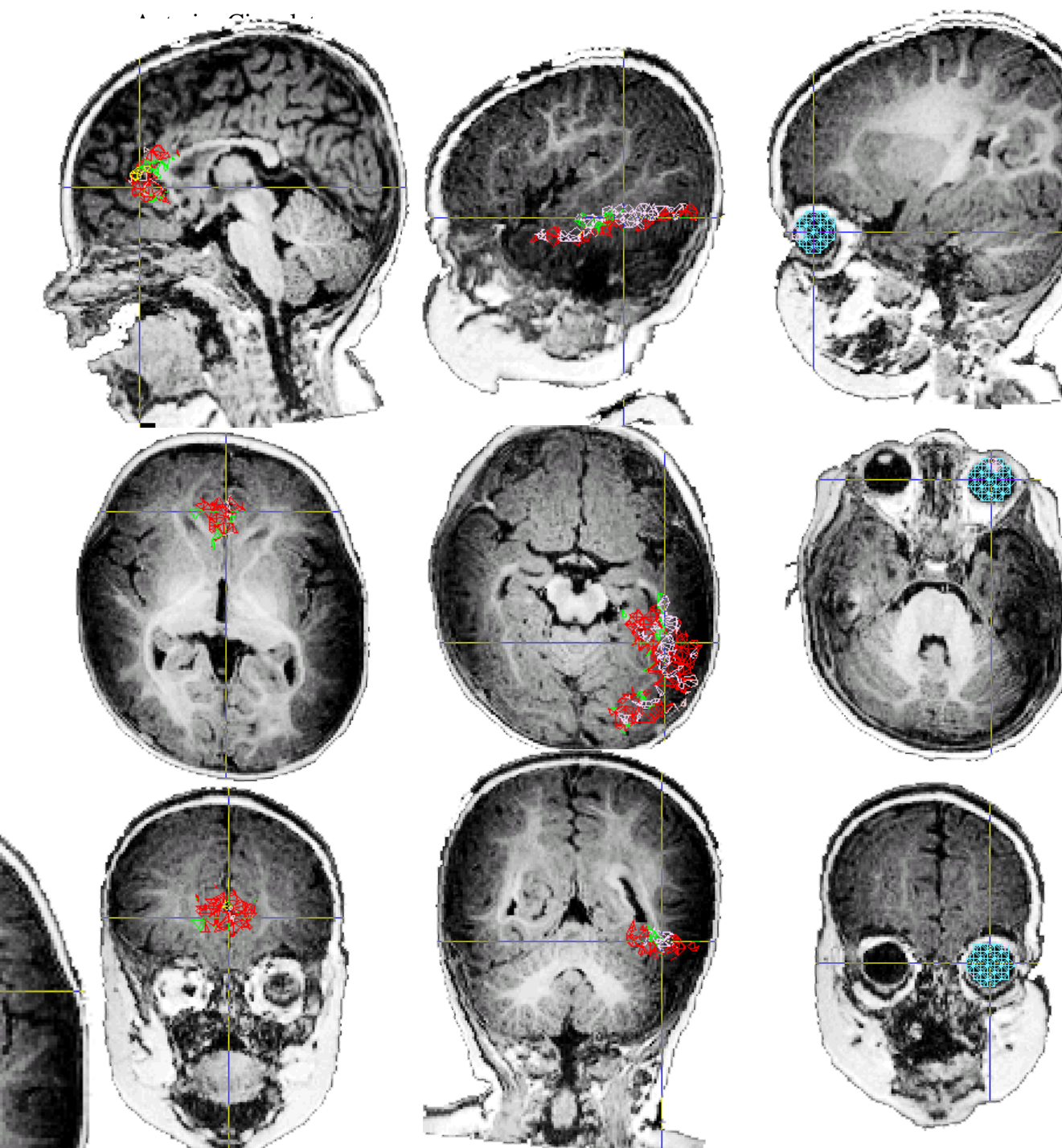
Myelination



Volume: Total (Red), GM (Yellow), WM (Green)
Calculated Cell Bodies (Aqua), Non-Myelinated Axons (Blue)



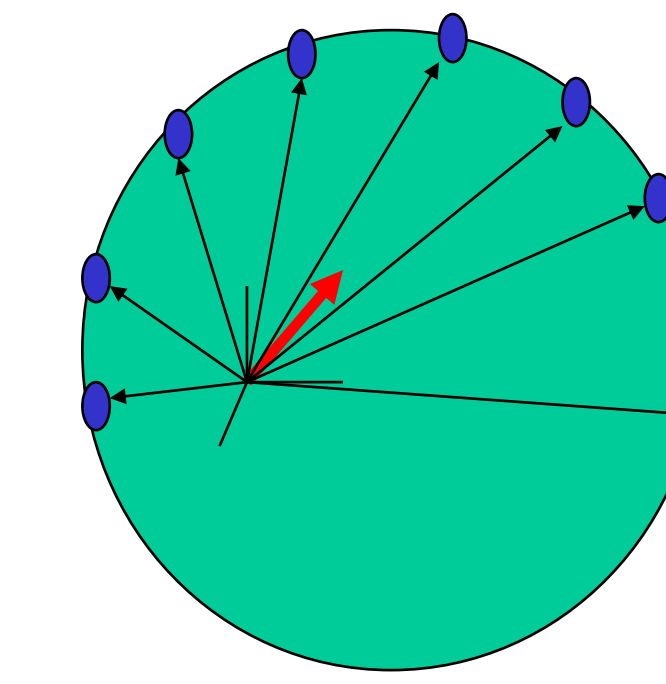
Realistic Locations (e.g., Talairach Space)



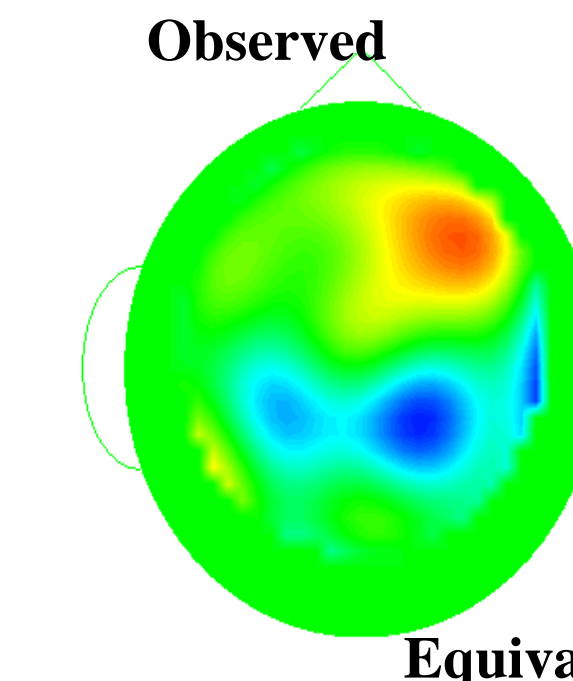
Cortical Source Analysis

Cortical source analysis ("Brain electrical source analysis"; equivalent current dipole (ECD) analysis) is used to identify putative electrical source inside the head of electrical activity occurring on the scalp. Dipole source analysis hypothesizes a (a set of) dipole (s) that generates an electrical current on the scalp. This forward solution may be compared with the scalp EEG map, and the dipole location and magnitude is modified to minimize the difference between the generated map and the scalp electrical map.

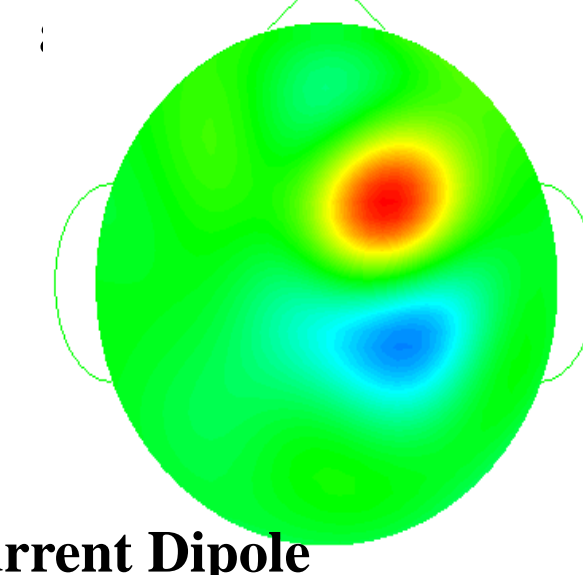
Equivalent Current Dipole Analysis



- 1) Current flow on scalp (EEG / ERP)
- 2) Hypothesize cortical source
- 3) Calculate forward solution
- 4) Compare against scalp current
- 5) Change simulated (3)



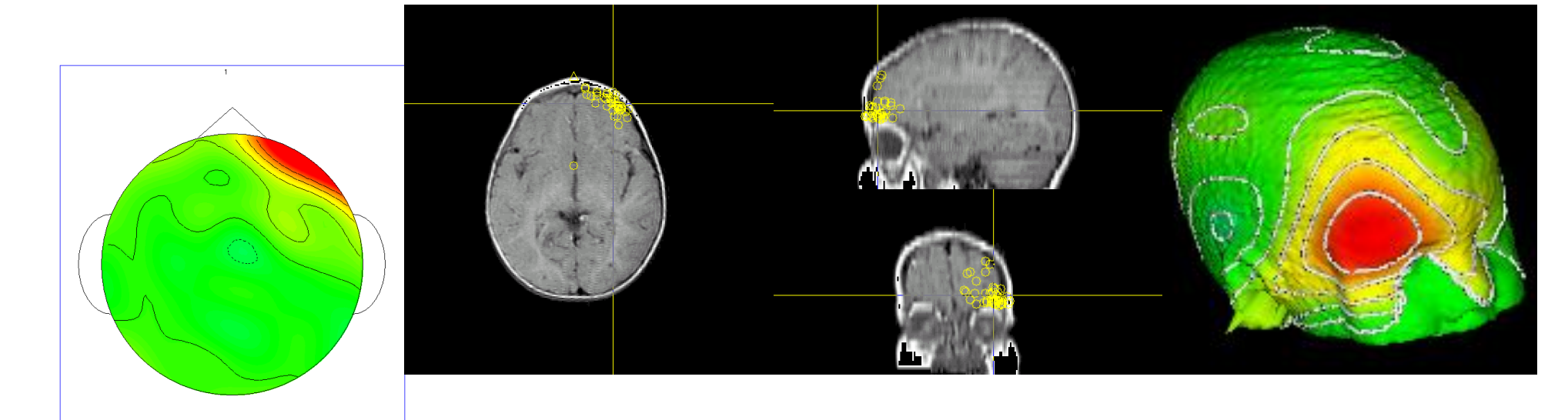
Observed



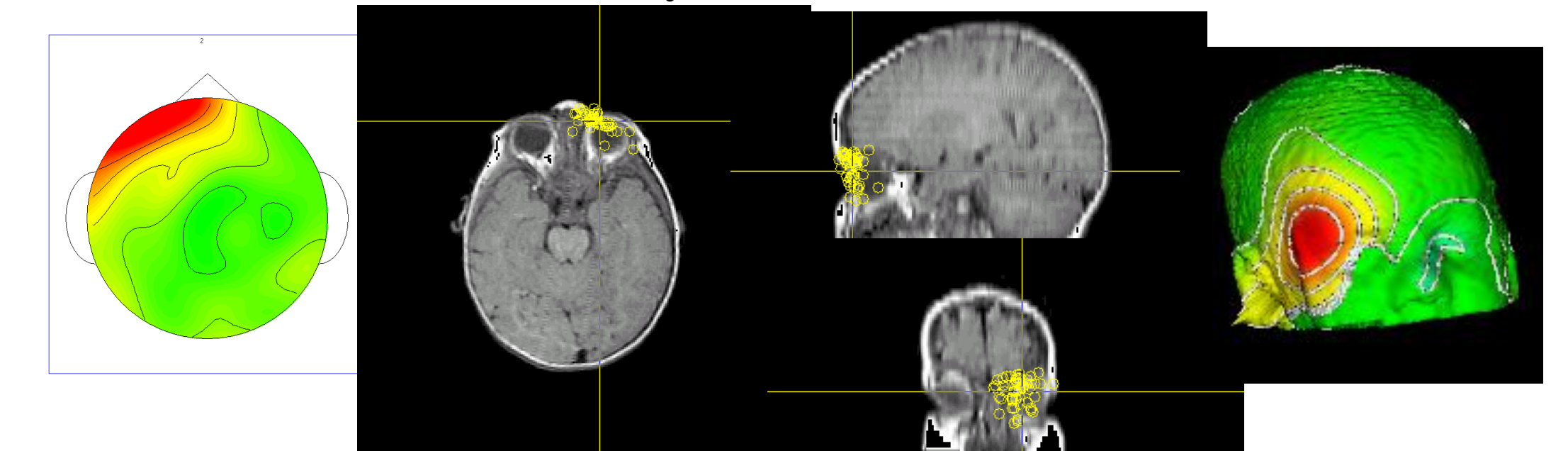
Equivalent Current Dipole

Richards, 2005 (3-Shell)

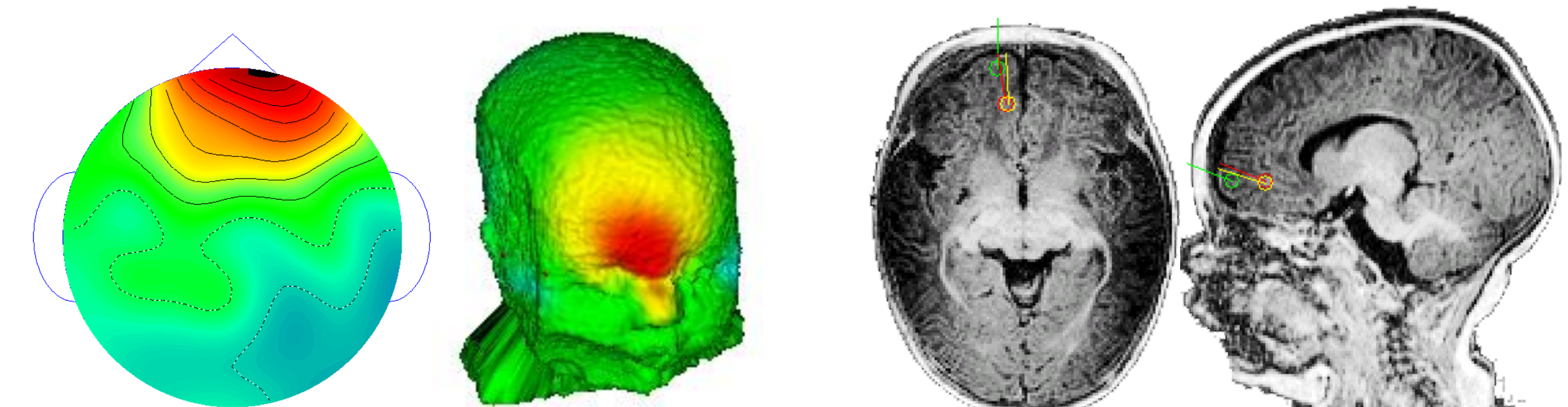
Lateral Frontal Component and Talairach Location
26, 55, 0, sup frontal gyrus (11)



Eye Socket ECDs



Realistic Model of Presaccadic ERP



- 3-Shell SV 3-Shell Model
- GM/Eyes SV FEM Model
- GM/NMA/Eyes SV FEM/Seams/NMA Model