# Reducing noise artifacts in intracranial EEG within high field MRI

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**INTRODUCTION**. The use of intra-operative MRI-guidance during surgery for brain tumors provides the surgeon with a powerful tool to define the structural anatomy of the patient's brain and tumor and can help to maximize resection of the tumor. Knowledge about the patient's functional anatomy may be acquired through subdural electrocortical recordings and stimulation. Electrocortical recording in the MRI environment could be an important adjunct when operating in or near functionally important brain areas in order to avoid causing a neurologic deficit. However, artifacts introduced by the static magnetic field in both the electrophysiological and MRI signals have prevented the use of such techniques in MRI-guided surgeries. In this work we introduce and a new type of MRI compatible intracranial electrode based on Polymer Thick Film (PTF) to reduce the Faraday's induced noise based on our previous EEG/fMRI research [1].

**METHODS**. A polyester film of dimensions of 10 × 12.5 cm and thickness of 0.075mm was used as substrate for the electrode set placed in a Siemens 3T TIM Trio scanner as in **top left**. The recordings were performed using the Open Hardware Open Software architecture, High-Field One (HF-1) [2]. The same channel was displayed (**bottom**) after decimation ×100 to show only the motion component. The following PTF materials (Creative Materials Inc., Tyngsboro, MA) were used: 118-43 (silver, conductivity = 400 S/m), 119-28 (carbon, conductivity = 0.08 S/m) and 118-02 (dielectric, conductivity = $9.1\ 10^{-17}$ S/m). Two separate but geometrically identical electrode sets were built, the first (**top, middle**) consisted of silver electrodes and carbon leads isolated by a dielectric and the second (**top, right**) was made entirely of silver with leads that were also isolated by a dielectric. The electrodes were immersed in a container with water, which was moved parallel to the $\mathbf{B_0}$ field (red arrow, **top left**) using a MRI compatible shifter [3] adapted to a 2Hz period. The first stage of the HF-1 was steadily mounted and immobilized to the bed, the electrodes were connected to this stage with carbon wires for the proposed electrode set (**top, middle**) or copper wires for the silver electrode set (**top, right**) with identical length (i.e., 9 cm) via a bipolar adapter/amplifier.

**RESULTS**. We observed (**bottom**) a decrease in the amplitude of the motion-induced noise by a factor of 4 ($std_{118-43}$ = 15.4 µV Vs. $std_{119-28}$ = 4.1 µV) with carbon vs. silver leads.

**DISCUSSION AND CONCLUSIONS**. The results show a reduction in Faraday induced noise that was predicted by simulations [4]. The factor of four reduction in the amplitude of the noise observed was smaller than the one predicted by the simulations. However, the proposed new leads may have a rather substantial effect in reducing the motion induced currents and thus the noise that thus far has impeded our subdural recordings on the patient's pial surface inside large magnetic fields.

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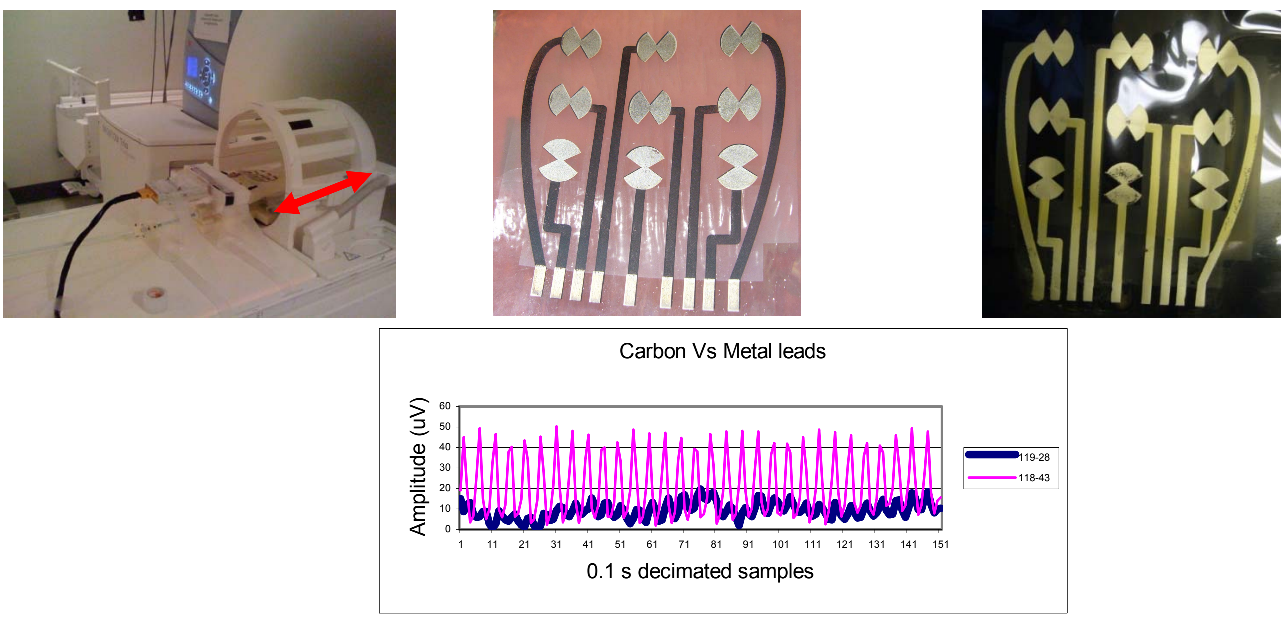


**Figure:** ***(Top-left)*** *First stage of our HF-1 system with bipolar adapter attached to either carbon and 119-28 leads or copper and 118-43 leads.* ***(Top-middle)*** *The proposed PTF electrode set with carbon (i.e., 119-28) leads.* ***(Top-right)*** *A test set with metal PTF leads (i.e., 118-43) used for comparison.* ***(Bottom)*** *Motion induced traces collected using the carbon based (blue) and silver based leads.*