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MEG and Pico-Tesla TMS in Multiple Sclerosis

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Magnetoencephlography (MEG) is considered as a non-invasive method that records the magnetic fields produced by the neuronal brain activity. In our lab, using a whole-head 122-channel gradiometer device (Neuromag-122, Neuromag Ltd, Helsinki, Finland) we performed such biomagnetic measurements in an electrically shielded room (Figure 1A). Our MEG recordings were taken with sampling frequency rate of 256Hz and associated Nyquist frequency of 128Hz, which was well above the constituent frequency components of interest in our MEG recordings and avoid aliasing artifacts. The MEG filtered with cut-off frequencies at 0.3 and 40Hz.

Biomagnetic measurements were also performed in our lab using a one channel second order gradiometer MEG system (model 601 of the Biomagnetic Technologies Inc) located in the same shielded room (Figure 1B). The MEG recordings were performed after positioning the MEG sensor 3 mm above the scalp of the patient, with the use of an optic positioning system, which was based on the International 10 - 20 Electrode Placement System. This system uses any one of the standard EEG recording positions as its origin. We used the P3, P4, T3, T4, F3 and F4 recording positions. The reference system was devised to retrieve maximal information from a specified area of the skull given that the gradiometer coil is theoretically equally sensitive to all magnetic flux lines perpendicular to a circular area of the brain. The MEG signal was band-pass filtered with cut-off frequencies of 0.1 and 60 Hz. The MEG recordings were digitized using a 12 bit precision analog to digital converter with a sampling frequency of 256 Hz, and were stored in a PC peripheral memory for off-line Fourier statistical analysis.

In addition using pico Tesla Transcranial Magnetic Stimulation (pT-TMS), ($1pT=10^{-12}$ T) which is a non-invasive easy to perform method, we investigated a variety of clinical conditions. Therefore, using the electronic device invented by Professors Anninos and Tsagas [1] it was found that we can increased the (2 - 7Hz) abnormal frequencies of the recorded MEG for each Multiple Sclerosis (MS) patient towards frequencies of less or equal to its frequencies of the alpha frequency range (8 - 13Hz) [2-6]. The electronic device consists of one generator to produce alternative low voltage of frequencies from 2 - 7 Hz, and supplies a number of selected coils of one group which consists of alike rows of coils, or a plurality of groups of similar coils arranged in rows. The pico-Tesla (pT-TMS) electronic device is a modified helmet containing up to 122 coils that cover the 7 brain regions: Frontal, Vertex, Occipital, right-left Temporal and right-left Parietal. The pT-TMS electronic device produces modulations of the magnetic flux (intensity: 1 - 7.5pT) in the alpha frequency range (8 - 13 Hz) of each MS patient (Figure 1C). The pT-TMS device was constructed for each MS patient to generate a square wave (so that to look like the firing activity of neurons in the brain [2-6]. Using the electronic device in the MS patients with abnormal MEG activity and symptoms we have demonstrated that most of the patients were shown quantifiable benefit. In conclusion using the external weak pT-TMS we were able successfully to attenuate most of the symptoms in MS patients [2-6]. This research protocol was approved by the Research Committee of our Democritus University of Thrace. Funding for this work was provided by a collaboration of General Secretariat of Research and Technology, GR and the ERGO AEBE, INC, GR under a research program (Grant Number: 80623).

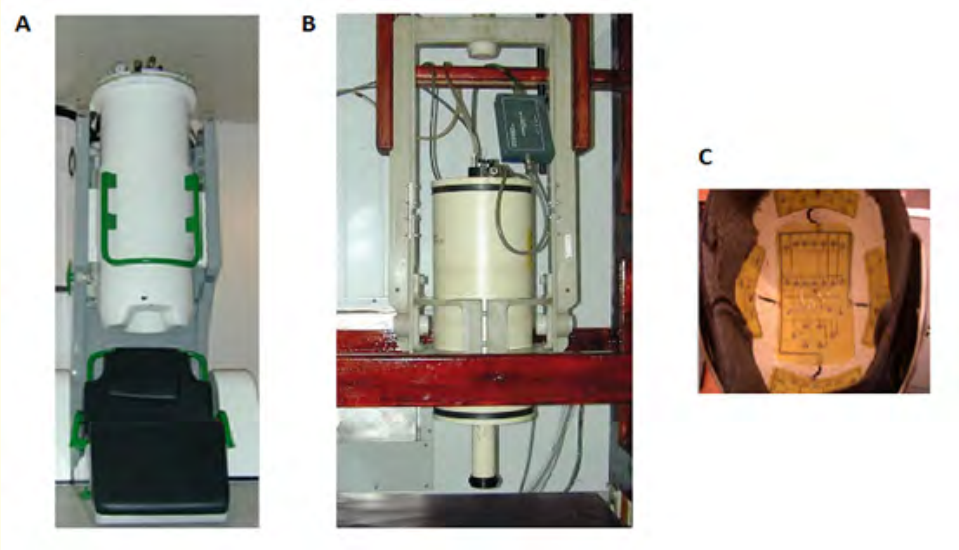

Figure 1: *A) The 122 channel MEG system inside the shielded room B) The one channel MEG system inside the shielded room. C) the configuration of the stimulation coils within the helmet of the electronic device.*

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