Intention Letter for a scientific collaboration between your lab and the Functional Brain Mapping Lab of Geneva University Hospital.

The Goal: Development of a MatLAb environment (e.g. GUI based) or equivalent for the Analysis of EEG data on realistic head models based on MRI subject or the average head model.

In particular that comprises the construction of electromagnetic tomographic images describing the neuronal activity all over the gray matter in the brain. The EEG data can be from normal subjects (Evoked potentials, Sleep, Control subjects, etc.) or patients (epilepsy, stroke, etc). The final step of this analysis is the construction of Non parametric Maps for the comparison of groups or subjects under different conditions.

To achieve that Goal we need to fulfill the following steps:

1) Construction of the forward model based on the MRI subject (or average head) including:

a) Segmentation of MRI images to determine the external surface, the brain surface and the gray and the white matter.

b) Selection of solution points in the gray matter.

c) Co-registration and Alignment (landing) of the EEG sensors on the MRI for both: theoretical electrodes location * and sensor position indicator measurements **.

d) Computation of the lead field matrix associated to the electrode and solution points configuration previously selected**.

2) Computation of the inverse solution matrix associated to the head model and the type data*. For example, use EPIFOCUS for epilepsy and LAURA or ELECTRA for spontaneous or evoked EEG.

3) Statistical analysis of the inverse solution images for the following non-parametric tests:

a) Paired and non-paired differences of a single subject on 2 conditions based on randomized distributions**.
b) Comparison of EEG or inverse solution maps corresponding to multiple conditions (Randomized One way MANOVA)*.

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* Already done
** Partially done or at least one alternative available.

4) Preprocessing of the EEG data to restrict the inverse solution analysis to important sections data as described by*:

a) Periods or segments of stability in the data (e.g. microstates, correlation matrix, etc.).

b) Time frequency maps characterizing brain processes as obtained by the Non stationary isolation technique.

Current state of development

Many of the tasks described in points 1-4 have already a clear solutions and many of them count with at least a partial solution, however the existence of a computing and open environment to do all this analysis is missing. All the alternatives available today suffer from at least one of the following limitations:

1) While the methods are really simple and do not need big resources to be implemented if you want professional software you need to pay a significant amount of money.
2) Almost all the environments (cost free or commercial) impose you the use of some pre-selected tools and give you no opportunity to include new updated methods to compare with the ones offered.
3) In many cases that you find free software it is very complex to use or it is incomplete.

Work to be done: The proposal.

As stated before we have developed or implemented solution in Matlab for many of those problems. In addition the MatLab community have posted a grant amount of code that can be easily transformed / incorporated to solve some of these problems. What is missing is the development of a cost free, flexible and user-friendly environment containing the available solutions and allowing a fast and easy incorporation of possible new developments.

For that reason we look for partners interested in the development of such environment and willing to invest some local resources in such task, having in mind that joining this project can put your lab at the level of the current state of research in one of the most promising and cheap technique, that is, the analysis of brain functional images produced from the EEG.

What we offer: We will provide our expertise in the development of methods and implementation of numerical methods to solve all these tasks. As well as the MatLab code already developed at our place during last 7 years.

What we need from the partners: The minimum resource required is a MatLab programmer with a computer to work mainly in the design and implementation of the environment.

What are the benefits for the partners: At the end of the first period the partners will have a professional and flexible environment available for the analysis of the EEG able to

compute realistic head models, several and different type of inverse solutions and the Statistical analysis of the tomographic images computed from the EEG. The continuous development of the environment will warrant the updated state research for all the participants.

If you feel interested in this collaboration or would like to have more information about it, please contact:

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The bibliography presented here, intends only to illustrate the experience of our group and should be considered by no means a review of these topics.

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