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| **LORETA, sLORETA, eLORETA and swLORETA.** |

**The goal is to link symptoms to functional hubs and modules in the brain.**

1. **Software for analysis**:

LORETA-KEY software (LORETA, sLORETA & eLORETA) available at [www.uzh.ch/keyinst/loreta.htm](http://www.uzh.ch/keyinst/loreta.htm).

LORETA AND sLORETA have been replaced by eLORETA and swLORETA.

swLORETA now available at Applied Neuroscience ([www.appliedneuroscience.com](http://www.appliedneuroscience.com))

Other: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Full Brain Volume  Partial Brain Volume (portion to be examined if using other source analysis software): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. **Exported time series** from qEEG data (see CDEs for qEEG)

EEG artifact-free data with > .90 reliability estimates exported to text files with each column devoted to one electrode.

2-second EEG segments windowing function (to control for spectral leakage):

\_\_\_\_% cosine taper window

other taper window function (% overlap) \_\_\_\_\_\_\_\_\_\_

Hanning (Hamming) window function (% overlap) \_\_\_\_\_\_\_

Non-overlapping (successive) window function

1. **Define Frequency Bands** as follows within LORETA.

**Conventional band settings**: delta = 1-3 Hz; theta = 4-7 Hz; alpha = 8-12 Hz; beta-1 = 13-18 Hz; beta-2 = 19-21 Hz; beta 3 = 22-30 Hz; omega = 1-30 Hz.

**Researcher-defined bands**, such as 1Hz bands--1Hz, 2Hz, 3Hz, etc. (name bands) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. **Electrode Coordinates**: Head model of eLORETA & electrode coordinates are based on the Montreal Neurological Institute average MNI brain map (MNI152) (Mazziota et al., 2001).

Number of electrodes (from qEEG data, min 19 electrodes): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* Use of  10/20 system of placement, or  other system (define) \_\_\_\_\_\_\_\_\_\_\_

1. **State analysis type**:

|  |  |  |  |
| --- | --- | --- | --- |
| Current density power time series | Total nonlinear connectivity | Lagged coherence | Microstate segmentation |
| Current density power XYZ time series | Instantaneous nonlinear connectivity | Total phase synchronization | Global connectivity |
| Total linear connectivity | Lagged nonlinear connectivity | Lagged phase synchronization | Independent Component Analysis |
| Instantaneous linear connectivity | Total coherence | Instantaneous phase synchronization | Isolated Effective Coherence |
| Lagged linear connectivity | Instantaneous coherence | Cross Frequency Analysis | Other:\_\_\_\_\_\_\_\_\_\_\_\_ |

**Specify ROIs** (regions of interest) within solution space: cortical gray matter—6239 5 mm3. voxels, check one:

MNI coordinates used to define significantly active regions

Single Nearest Voxel method (each ROI has a single voxel

All-Voxels-Within-A-Radius

1. **Sampling Rate:**

128 Hz

256 Hz

512 Hz

1024 Hz

Other: \_\_\_\_\_\_\_\_\_\_\_

1. Matlab Scripts Used:
2. Comparison Parameters:  Normative Database or  Controls. If database used, name database \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Typical parameters analyzed in qEEG data collection:**

* EEG Auto Artifact Rejection without Phase Distortion (ICA distorts phase information if used for de-artifacting).
* Test Re-test Reliability > 0.95
* EEG JTFA (joint time-frequency analysis) & FFT (fast fourier transform) Analyses
* EEG Auto & Cross-Spectral Analyses
* Normative Data Base Comparisons should be built into software.
* Discriminant and Multiple Regression Functions
* Bi-Spectral Analyses
* EEG 3-Dimensional Neuroimaging in Time and Frequency
* Symptom Checklist and Neural Network Protocol Generation
* Produce Color Topographic Maps of ANOVA & t-tests
* Produce real time z-scored Phase Shift and Lock Duration and Graph Metrics

**Important note: All elements on this CRF are considered Supplemental – Highly Recommended and should be collected as part of a qEEG source localization study.**

**Specific Instructions**

**\***The intent of this form is to provide minimal data elements to perform **qEEG source localization** to estimate cortical sources of qEEG measures, including connectivity. These linear inverse solutions are distinguished from other measures of brain science such as EEG, qEEG, fMRI, PET, SPECT, etc. through their use of localization techniques following qEEG voltage measures. The common goal of all qEEG source localization models is to discover solutions which illustrate the brain regions that produce observed scalp electrical potentials. Low Resolution Electromagnetic Tomography (LORETA) and its derivatives, standardized LORETA (sLORETA), exact LORETA (eLORETA) and standardized weighted LORETA (swLORETA), all provide accurate localization of all sources at once to find source generators in the human brain. The software is freely available for research, and has been shown to provide the least localization error of all the source analysis platforms available (Grech et al., 2008) as well as providing the most efficient for estimation of current density sources with 19 electrodes (Congedo et al., 2004).

**References**

Congedo, M., Lubar, J., & Joffe, D. (2004). Low resolution electromagnetic tomography

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Grech, R., Cassar, T., Muscat, J., Camilleri, K.P., Zervakis, M., Xanthopoulos, P. (2008). Review on solving the inverse problem in EEG source analysis. *J Neuroeng Rehabil 7*(5): 25. Doi: 10.1186/1743-0003-5-25.

Pascual-Marqui, R. D., Lehmann, D., Koukkou, M., Kochi, K, Anderer, P., Saletu, B. et al. (2011). Assessing interactions in the braini with exact low-resolution electromagnetic tomography. *Phil., Trans. R. Soc,* 306: 3768-3784. Doi:10.1098/rsta.2011.0081