

# EEGpal: Main windows

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The EEGpal toolbox is developed by Michael DePretto ([contact info](#)) and Michaël Mouthon (University of Fribourg, [michael.mouthon@unifr.ch](mailto:michael.mouthon@unifr.ch)).

EEGpal is an open-source Matlab-based software for automated/semi-automated EEG data pre-processing and analyses. It proposes Graphical User Interfaces (GUIs) that allow EEG pre-processing to be batched across participants with a high degree of flexibility in processing parameters.

The purpose is to offer a complement to the free software Cartool developed by Denis Brunet (University of Geneva, reference: Brunet D., Murray M., Michel C. (2011) Spatiotemporal analysis of multichannel EEG: CARTOOL. *Computational intelligence and neuroscience*, vol. 2011, 813870. DOI : [10.1155/2011/813870](https://doi.org/10.1155/2011/813870)). It is also an alternative to the original EEGLAB GUI (reference: Delorme, A., & Makeig, S. (2004). EEGLAB: an open-source toolbox for analysis of single-trial EEG dynamics. *Journal of Neuroscience Methods*, 134(1), 9-21. DOI: [10.1016/j.jneumeth.2003.10.009](https://doi.org/10.1016/j.jneumeth.2003.10.009)).

In summary, the authors propose the EEGpal graphical interface (GUI) as a more practical solution than the EEGLAB and Cartool GUIs for automating preprocessing. The authors recommend the use of Cartool software for the visualisation of EEG traces.

## Minimum requirement

Matlab 2018b or later

## License

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## Before to start

This section reminds the import terminology and concept to know before to use this toolbox.

### **What is a Time Frame (TF)?**

The abbreviation TF (or tf) used in the toolbox stands for Time Frame. It corresponds to one sampling point the EEG files. This is the smallest unit of time. Its duration depends on the sampling frequency. For example, if the sampling frequency is 2048 Hz, then  $1\text{ TF} = 1/2048 = 0.000488\text{s} = 0.488\text{ ms}$ .

### **File types**

One of the advantages of the EEGpal toolbox is that it works with a serval EEG file format. For example:

- .bdf : Raw Biosemi files
- .eph : Text file format (with tab column as separator) used in Cartool. The first line is an header which contains info about the number of channel, number of time point and sampling rate
- .ep: Text file format (with tab as column separator) used in Cartool and RAGU software (Koenig, T., Kottlow, M., Stein, M., & Melie-García, L. (2011). Ragu: A Free Tool for the Analysis of EEG and MEG Event-Related Scalp Field Data Using Global Randomization Statistics. Computational Intelligence and Neuroscience, 2011, 1-14. DOI: 10.1155/2011/938925.). Contains only data without any temporal information in it
- .sef: Binary EEG file used in Cartool that contains the data and temporal information. It is the default option proposed in EEGpal because this solution uses the least disk space.
- .set/.fdt: File format used by EEGLAB
- .ris: Inverse solution file used in Cartool
- .freq: Frequency analysis file used in Cartool

The EEGpal toolbox offers the possibility to easily switch from one file format to the other, thanks to the export tool or the choice of output file format within each module.

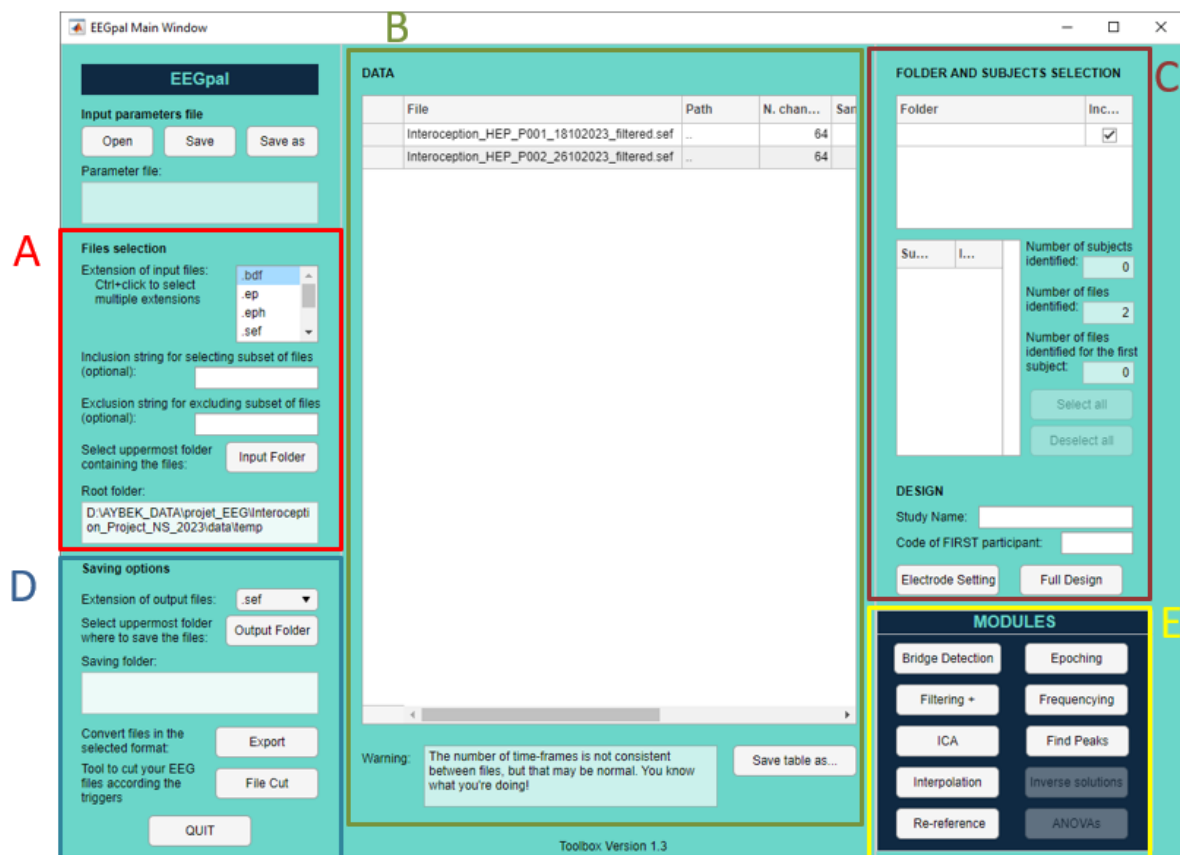
### **What is the difference between Triggers and Markers?**

Usually, we add a tag to the EEG recording to mark the position of an event. This is the function of triggers/markers. The difference is that the triggers are included in the EEG file (this is the case for .bdf and .set file formats), while the markers are recorded in a separate text file named eeg\_file.mrk (this is the case for .eph, .ep, .sef file formats). EEGpal automatically detects these two cases and can handle them.

### **Processing Information File (PIF)**

Each time you perform a processing step with an EEGpal tool or module, a Processing Information File (PIF) is created. This is a text file containing a summary of all input and output files and processing parameters. It allows you to keep track of the steps you have performed.

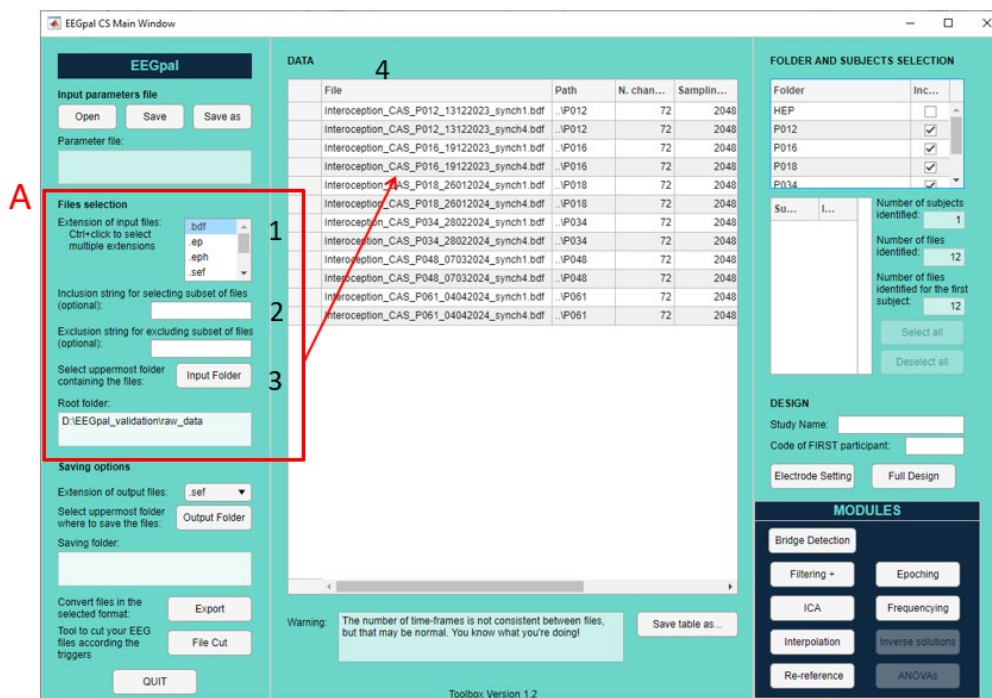
## Main window



There is five important section in the EEGpal main window:

- Importation section:** Tool to import/Select the EEG file in the Data table B (see below for details)
- Data table:** Contains the list of files which will be used for the next processing step. It contains characteristic info about files like the number of channels, sampling rate, number of time frame, subject and condition
- Selection and update info about files listed in Data table:** Specify subject and condition information, sub-selection and electrode localization settings (see below for details)
- Saving options and Tools:** Permit to define the default format of file saving as well as export the file of the Data Table in another format. You can also found here the File Cut tool to cut your EEG files
- Modules section:** List of preprocessing modules (first columns) and analysis modules (second columns). A help file is provided for each of them.

## Import Data



1. Select the raw data format.
2. optional: If you want to filter a part of the files, you can write in a character string that is common to the files you want to select (for example, if you write 'normal', then the toolbox will select only the files with the word normal in their name).  
At the opposite, you can exclude file which contains a specific pattern.
3. Press the Input Folder button and select the directory containing all the EEG files you wish to import. These files can be placed in sub-directories. The toolbox will select all files corresponding to the search criteria defined in 1 and 2, whether they are in the main folder or in sub-folders. It takes some time to fill the list in the central panel. Give Matlab time to complete this list before doing anything.
4. The main panel lists all the files that the toolbox has found. It informs us in order: file name, location on disk, sampling frequency, total number of electrodes recorded in the file, and the number of TFs contained in the file.

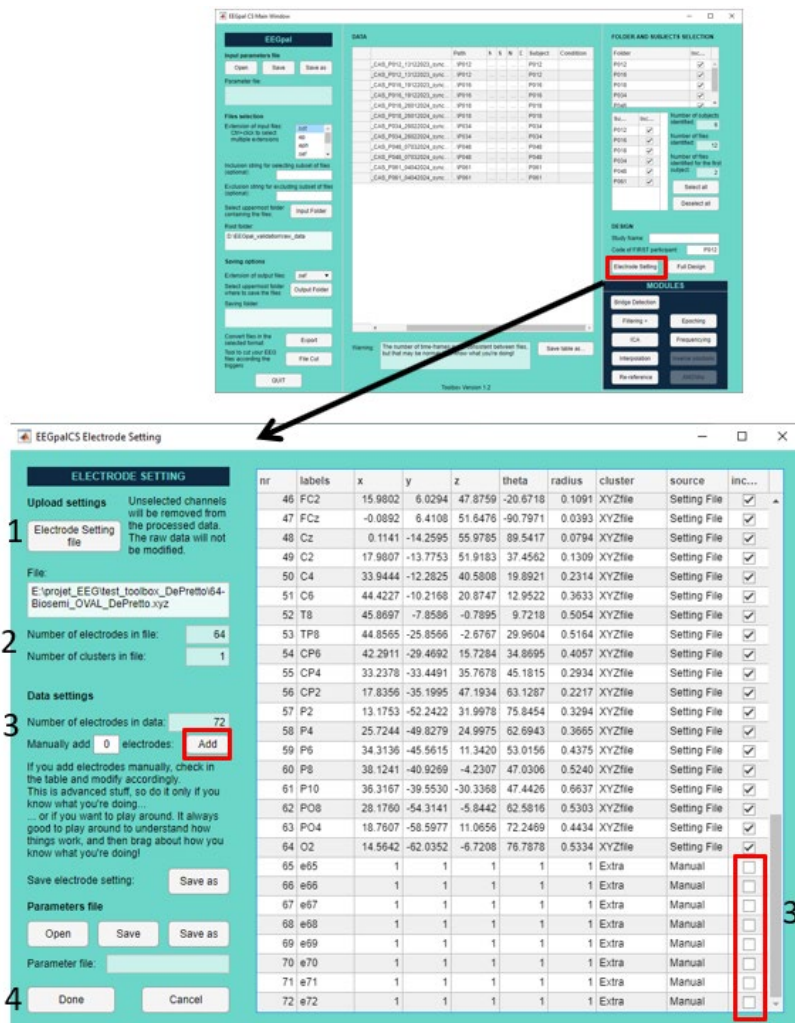
## Define participant and adjust the selection

The screenshot shows the EEGpal CS Main Window with the following components:

- Left Sidebar (Input parameters file):** Includes buttons for 'Open', 'Save', and 'Save as'. It also has sections for 'Files selection' (with file type dropdowns), 'Inclusion string for selecting subset of files (optional):', 'Exclusion string for excluding subset of files (optional):', 'Select uppermost folder containing the files:' (with 'Input Folder' button), 'Root folder:' (with text input), 'Saving options' (with 'Extension of output files:' dropdown, 'Select uppermost folder where to save the files:' button, and 'Saving folder:' text input), and 'Convert files in the selected format:' (with 'Export' and 'File Cut' buttons). A 'QUIT' button is at the bottom.
- Central Data Table:** Titled 'DATA', it has columns for 'Path', 'A', 'S', 'N', 'C', 'Subject', and 'Condition'. The first row is highlighted with a red box (1). The 'Subject' column is highlighted with a green box (3). A warning message at the bottom states: 'Warning: The number of time-frames is not consistent between files, but that may be normal. You know what you're doing!'. A 'Save table as...' button is also present.
- Right Sidebar (FOLDER AND SUBJECTS SELECTION):** Contains a table for selecting folders and subjects. It has a 'Folder' column and an 'Inc...' column. The first row is highlighted with a red box (5). Below this table, there are statistics: 'Number of subjects identified: 6' and 'Number of files identified for the first subject: 2'. There are 'Select all' and 'Deselect all' buttons. Below this is the 'DESIGN' section with 'Study Name:' and 'Code of FIRST participant:' (with a dropdown showing 'P012' and a red box (2)). There are 'Electrode Setting' and 'Full Design' buttons. At the bottom is the 'MODULES' section with buttons for 'Bridge Detection', 'Filtering +', 'ICA', 'Interpolation', 'Re-reference', 'Epoching', 'Frequencying', 'Inverse solutions', and 'ANOVAs'.

1. In order to specify the different subject to the EEGpal toolbox, identify the participant code in the EEG name for the first entry in data table.
2. Enter the code for the first participant (determined in point 1).
3. The Toolbox will then automatically identify which participant the files belong to. The participant codes are added to the Subject column. Check that the values are correct.
4. You can then deselect specific participants to remove them from the data list.
5. You can also deselect files according the sub-folder from the input folder

## Loading the electrode coordinate file

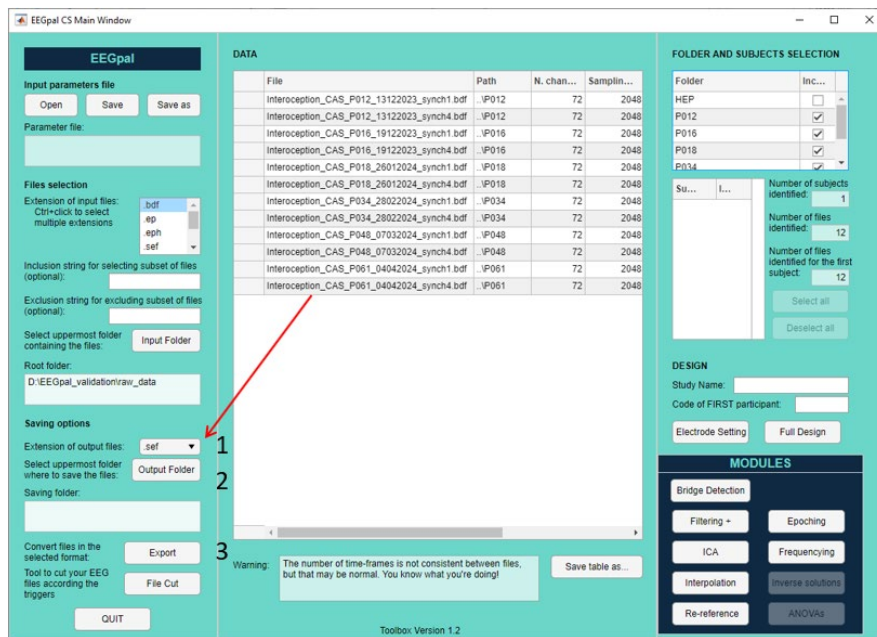


1. Load the .xyz, .els or .locs file containing the spatial coordinates for locating the electrode position on the EEG cap.  
In the current situation there are already two coordinate files for a 64 channel Biosemi configuration in the *Resource* sub-folder of the EEGpal. The *biosemi64\_officialAB\_update.locs* file contains the coordinates found on the official Biosemi website with a spherical distribution of electrodes. The file *64-Biosemi\_OVAL\_AB.xyz* is an oval distribution of the electrodes after coregistration with the MNI template in Cartool (more physiologically accurate).  
You can add your own coordinate file directly in the Resource sub-folder of EEGpal to gain time.
2. The toolbox informs you of the number of electrodes present in this coordinate file, as well as the number of clusters. A cluster is a group of electrodes that can be specified within an .els file (e.g. to separate EEG electrodes from external channels).
3. Optional: To remove supplementary channel of non-interest: The toolbox compares with the number of electrodes in the EEG files.

In our case, the EEG files contain 8 more electrodes than the coordinate file (ECG channels). Click on the Add button to manually add these 8 channels to the table on the right. Make sure that these new electrodes are deselected (the default setting) so that they are ignored/deleted (and not interpolated) in the analysis.

4. Click on Done

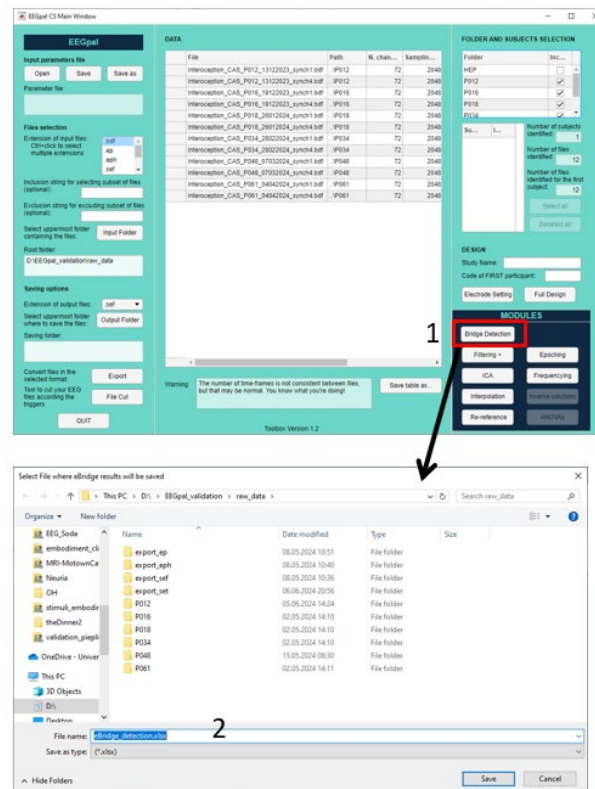
## Export to another EEG file format



1. Select the output format (.sef, .eph, .ep for Cartool or .set for eeglab)
2. Choice the folder where the files will be stored
3. Click on the Export button



## Bridge Detection



1. Press on the “Bridge Detection” button.
2. Select the location of the .xlsx output file

This module calls the eeglab script eBridge which automatically detect if two or more channels are bridged (same signal). Open the .xlsx output file to check if there is any. We will need this info for the ICA and interpolation step.

3. Check the excel file on the C column (percentage of channels that are bridged; if 0 = good to go, no bridge detected, if there is a number we have to delete one of the bridged channels)

**Other tools and modules have their own manuals.**