BESA Connectivity 1.0

The comprehensive toolbox for state-of-the-art brain connectivity analysis in sensor space and source space

Welcome to BESA Connectivity

We recommend that you read this document carefully before installing, configuring, and using the product. The document contains Safety Instructions, which are followed by Installation Instructions. The workflow concept, described in the next chapter, is designed to make the interaction with the program as simple as possible.

Finally, the Quick Reference and User Guidance explains the user journey and the data flow through the program, and how to get your experimental data into the program.

We strive to bring you the latest methods for advanced EEG and MEG analysis in a user-friendly and optimized implementation.

Dr. Tobias Scherg
CEO / General Manager

Table of Contents

Safety Instructions

Intended Use

- BESA Connectivity 1.0 is intended for the Use (MDD 93/42/EEC)

  – For Human Beings
  – And NOT for Animal Beings

- BESA Connectivity is a stand-alone software product compatible with personal computers running under a Windows operating system.

- The purpose of BESA Connectivity 1.0 is to assist in the analysis of EEG and MEG data by providing tools for the following analysis steps:

  – Time-frequency analysis
  – Brain connectivity analysis

- BESA Connectivity 1.0 software is licensed for research use only. It is not allowed to use the BESA Connectivity software directly or indirectly for medical diagnosis and/or treatment of humans.

- BESA Connectivity 1.0 is intended to be run independently of the EEG and MEG acquisition and review programs of other manufacturers.

BESA GmbH is not liable for the use of the software beyond the intended purpose.

Intended User

The intended user is a neuroscience professional with a reasonable knowledge about frequency data generated in neurophysiological recordings of human brain activity. He or she is expected to be literate in the usage of computer programs in the Windows environment.

BESA Connectivity 1.0 is only to be used by appropriate trained specialist personnel who also have an understanding of English sufficient to enable them to read the User Manual and operate the software.

The BESA GmbH assumes no liability for unauthorized access to this product or unauthorized use. Children, layman and patients shall not use the product.

System Requirements

BESA Connectivity 1.0 is designed to be used for the following hardware / OS:

- Windows® 10 – 64 bit (Touch not supported)
- Windows® 8.1 – 64 bit (Touch not supported)
- Windows® 7 – 64 bit (Touch not supported)
- Processor: minimum 2 GHz
- RAM: minimum 4 GB
- Display resolution: minimum 1280 × 1024 pixels
- Graphics card supporting OpenGL 2.0 with 16 MB RAM or more

Disposal Information

When disposing of the BESA license key and the box, national guidelines on environmental protection must be followed.

Installation Instructions

The installation and initial setup of BESA Connectivity 1.0 must be carried out by an administrator or an experienced technician.

Installation

1. Please insert the installation USB stick into your computer. Browse to the Setups folder. If you have downloaded BESA Connectivity 1.0 from our website, browse to the Download folder.
2. Run **BESA_Connectivity_1_0_April_2018_Setup_Win_x64.exe**

3. Please follow the on-screen instructions.
4. Once the installation is complete, proceed with the initial setup as explained in the following chapter.

Specifying the BESA Connectivity Data Folder

As initial configuration step, the BESA Connectivity Data Folder needs to be specified. This is the folder where BESA Connectivity stores all project and result data.

When starting the program for the first time, the following dialog box appears:
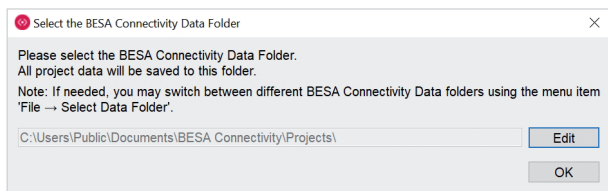
By default, the folder is pre-selected to the **Public Documents** folder on your PC. If you use BESA Connectivity in a network, it is recommended to change the folder to a network location. Use the **Edit** button to change the location. Press the **OK** button to keep the default selection. You can also change the project data folder at a later time (see user manual for details).

Workflows and Screen Elements

BESA Connectivity uses a modern workflow concept that guides you through all the worksteps needed to complete a project. Two workflows are provided in BESA Connectivity:

• Time-Frequency Analysis, and
• Connectivity Analysis

Time-Frequency Analysis

The first workflow, Time-Frequency Analysis, is a pre-requisite for the Connectivity Analysis workflow. In this workflow, the epoched data are read along with a channel description file, where channels can be defined on the scalp (sensor space) or inside the brain (source space). It is also possible to add additional channels, e.g. with signals from peripheral nerves.

The individual epochs can be reviewed along with an average of the epochs, and epochs discarded from further analysis if needed. The next step is to select the method for time-frequency decomposition. The user can choose between the methods:

• Complex Deconvolution
• Morlet Wavelet transform
• Mexican Hat Wavelet transform

It is possible to select several methods simultaneously. Transformed data can be reviewed at the end of the workflow.
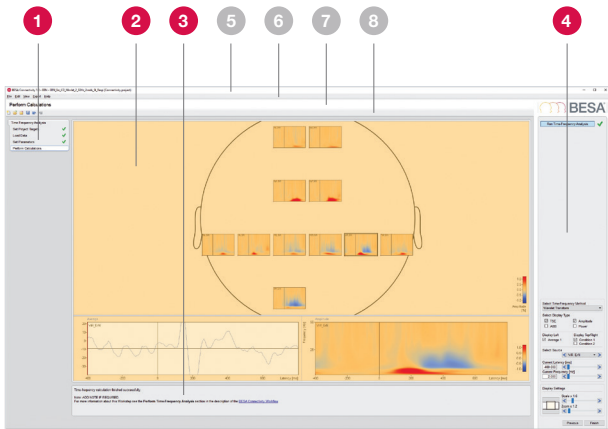
1. Workflow Window   **5.** Title bar
2. Main Window   **6.** Menu bar
3. Information Window   **7.** Captions
4. Interaction Window   **8.** Tool bar

The **Workflow Window** shows an overview of the workflow, and the current work step. The **Main Window** displays results (in the above example, calculation of TSE in an error-related negativity paradigm, in the Time-Frequency workflow).

The **Information Window** provides current status and additional information. The **Interaction Window** is where the user performs the tasks of the current work step.

Connectivity Analysis

In this workflow, Time-Frequency decomposed data can be analysed for their connectivity, using one or several of the following methods:

- Granger Causality
- Partial Directed Coherence
- Coherence
- Directed Transfer Function
- Imaginary Part of Coherence
- Phase Locking Value

Results are displayed either in a grid view to show all connectivities in one view (see top figure on next page), or in a 3D view of the brain or skin surface, with connection strength encoded in thickness of connecting arrows (see bottom figure on next page).

The displays are highly interactive and also support additional analysis options:

- Sum of inflow / outflow
- Average over time
- Average over frequency
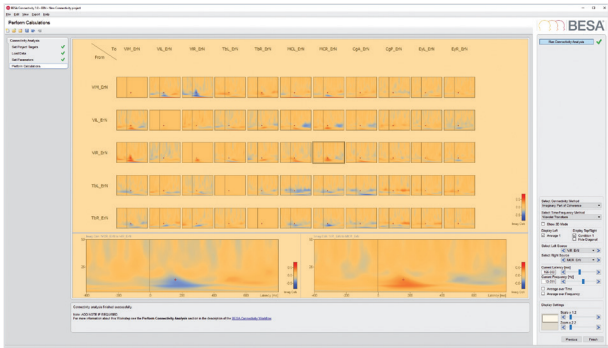
Imaginary part of coherence between all channels in a source montage applied to an ERN experiment. The selected channel pair is shown in the detail windows below the matrix display.

3D visualization of Granger causality between source channels in an ERN experiment at 13.4 Hz and 140 ms after stimulus.

Quick Reference / User Guidance

Data Input

Epoched raw data are provided in a simple binary format, accompanied by an ASCII header file describing the data. In addition, a montage description file needs to be provided (either *.elp for surface data, or *.bsa for source montages or virtual sensor data). The formats are described in the BESA Wiki. Simply visit http://wiki.besa.de and type your question, or browse through the content.

Data Export

BESA Connectivity exports all results in open ASCII formats. Matlab readers are available to continue the analysis down-stream. High-resolution image export and video export options are also provided.

Support and Help

The User Manual can be downloaded from the BESA website in the Downloads section. All features are also described in the program help. It can be started from the menu item Help → BESA Connectivity Help. You can request the User Manual in printed paper form at no additional cost.

Our Support is available via our web-interface here: https://besa.de/contact/support/form.php

User Journey and Data Flow

Epoched raw data in any montage are read into BESA Connectivity in the Time-Frequency workflow.

At the end of this workflow, the user can export high-resolution images and results, and / or continue to the connectivity workflow, where the results computed in the Time-Frequency workflow are re-loaded.

After the last work step, results and images or videos can be exported. All project data are stored in the program database.
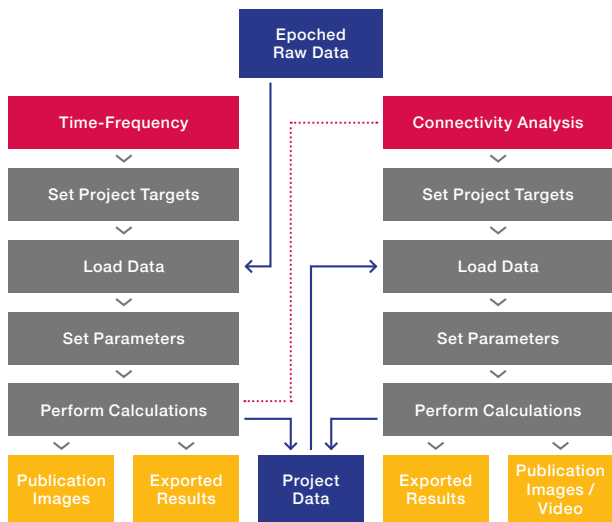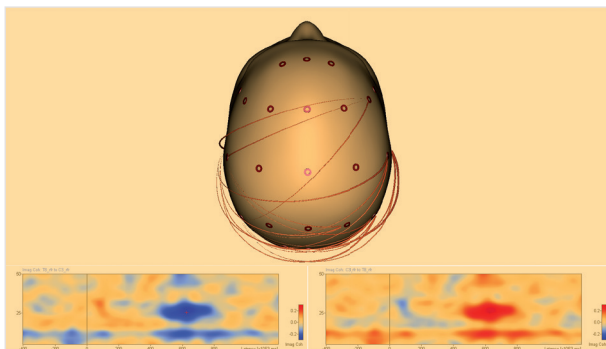
Interaction with BESA Research

Definition of epoched data for connectivity analysis is performed in the ERP module of BESA Research.

When launching BESA Connectivity, epoched data are auto-saved in the current montage, and the workflow for time-frequency analysis in BESA Connectivity is started.
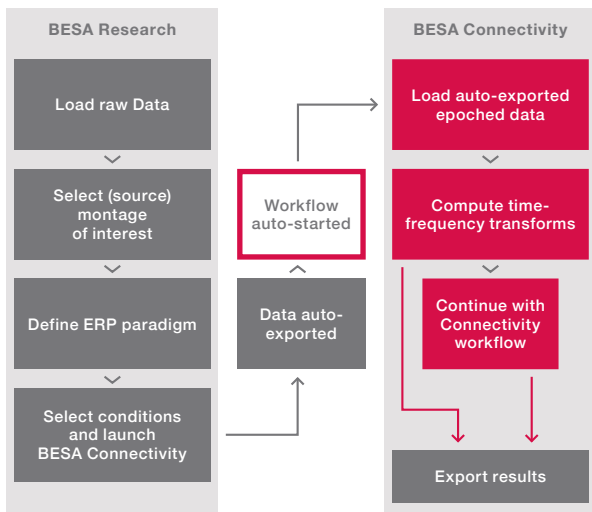
3D sensor-level display of Imaginary Part of Coherence in a 27-channel reference-free montage
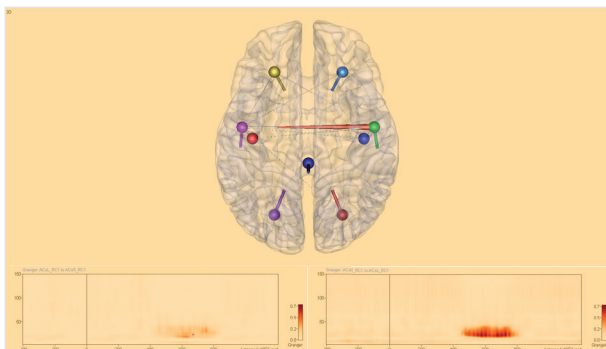
3D source-level display of Granger causality in a 9-channel source montage

$C\,E$

The CE marking certifies that this product fulfills the essential requirements of the Medical Devices Directive MDD 93/42/EEC.