BESA Research
Quick Guide
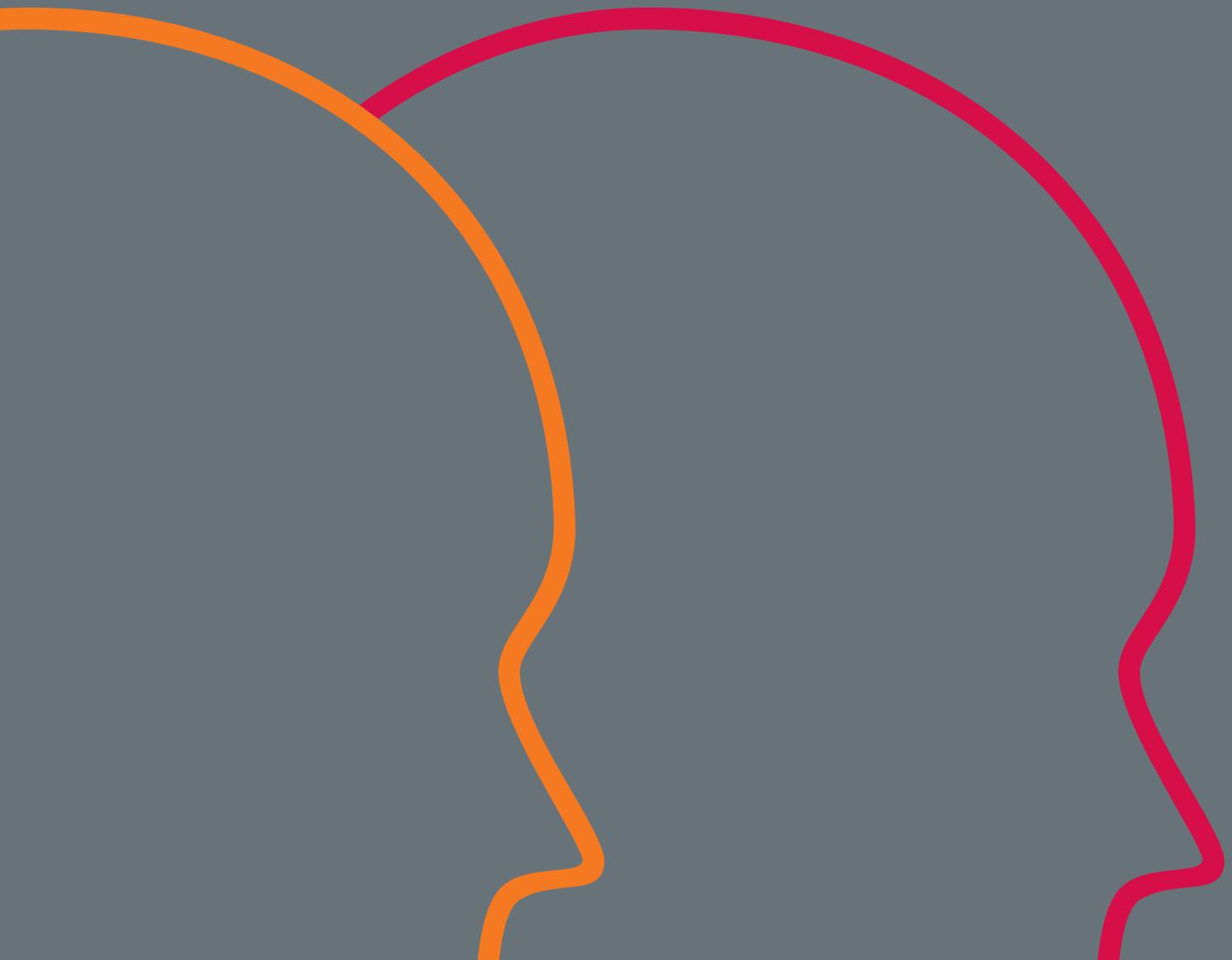
BESA®

Research 6.0

Quick Guide for EEG-MEG coregistration using BESA Research 6.0 and MRI 2.0

Copyright and Trademarks

The BESA Research product and its documentation are copyrighted © 2012 by BESA GmbH. All rights reserved.

BESA® is a registered trademark of BESA GmbH, Graefelfing, Germany.

All other trademarks, brands and product names used in this guide are trademarks of the respective owners.

Author(s):	Michael Scherg
Document name:	BESA Research 6.0 - Quick Guide for EEG-MEG coregistration
Revision number:	002
Revision date:	06 November 2012

Table of Contents

1. Introduction

With the release of BESA MRI 2.0, it is now possible to segment MRI data, create individual 4-layer FEM models for EEG source analysis, and to coregister MRI data with EEG / MEG in an easy and most intuitive way. Source localizations performed in BESA Research can be performed with a realistic individual head model and instantly projected onto the individual anatomy of the subject within the source analysis module.

Coregistration can be performed for the following types of electrode / sensors:

- Digitized electrodes, fiducials and surface points, including MEG sensors if available.

- Standard 10-10 electrodes and standard electrode caps, e.g. Easy Cap without digitization. (Coordinate files for standard 10-10 electrodes including special inferior temporal electrodes are provided;

- Coordinate files for special caps upon request to http://besa.de/contact/support/form.php.

2. EEG-MEG coregistration with MRI data using <u>digitized</u> electrodes

2.1. Setting BESA MRI as your default MRI program

1. In BESA Research click on **File → MRI Coregistration** menu item. This will prompt you to save an ***.sfh** file with the current coordinates for coregistration. If you have used BrainVoyager before, it will open automatically. Please quit Brain Voyager when you are offered to or close it after starting.
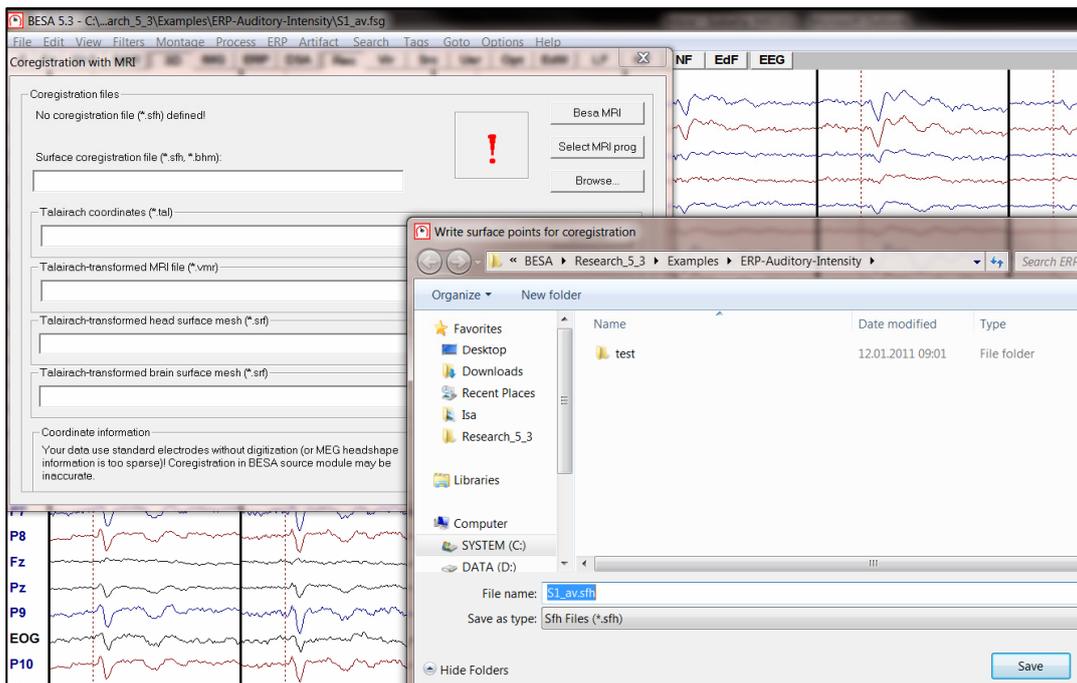
2. Click the **Select MRI program** button and browse for the installed **BESA MRI.exe** program. This will prompt BESA MRI to open and sets BESA MRI as your default MRI program. Leave BESA Research open and continue working in BESA MRI.

2.2. Coregister, if channels labels and surface point coordinate files have already been assigned

3. In BESA Research click on **File → MRI Coregistration** menu item this will prompt you to save an ***.sfh** file with the current coordinates for coregistration as shown under 1.

2.3. If not yet assigned, define the digitized electrode and channel definition files

4. In BESA Research select menu item **File → Head surface points and sensors → Load coordinate files** (Hotkey: **Ctrl-L**).

5. If electrode labels are not yet assigned correctly, browse to your channel definition file (***.ela**, ***.elp**) under **Channel configuration**.

6. Under **Digitized head surface points**, browse to your digitized electrode file (***.sfp**) and choose the according electrode thickness (mm) in the input field.

2.4. Start Coregistration from the Channel and digitized head surface point information box

7. Press the **Edit/Coreg.** button in the **Coregistration file** section.
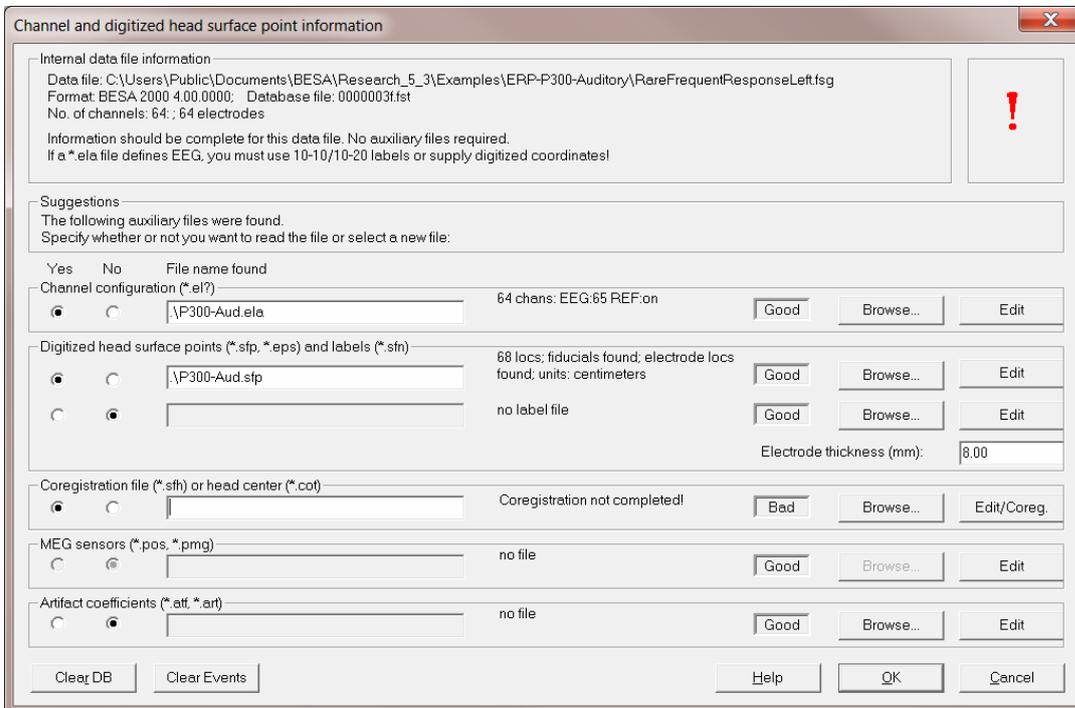
8. The dialog for the saving of the coregistration file opens as shown above under 1. Continue as shown there and BESA MRI opens.

2.5. Performing the Coregistration in BESA MRI

After the surface head point information has been written (**.sfh** file, see 1), BESA Research sends a message to BESA MRI with the information on the folder where this file is located and initiates a new coregistration project (for details see the user manual of BESA MRI).

9. Assuming you have already performed the segmentation of your MRI data, simply follow the workflow in BESA MRI by pressing the **Next** button in the bottom right corner of BESA MRI.

10. Press the **Select input project** button in the top right corner of BESA MRI to choose the MRI segmentation data of the appropriate subject.

11. Follow the workflow to define the nasion and the preauricular points:
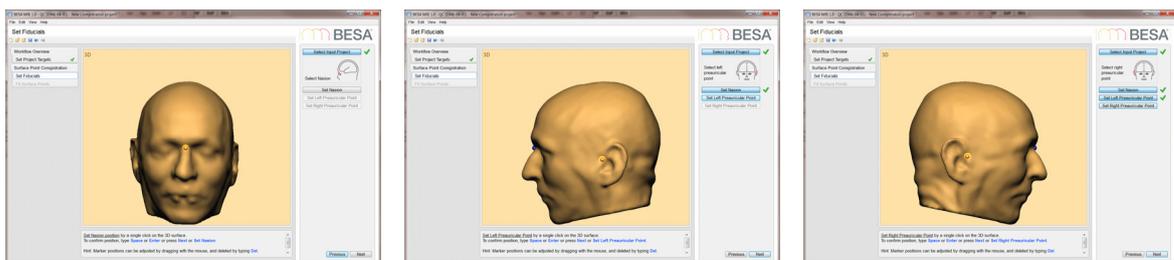
12. Press the **Next** or **Select Coregistration File** button to select the coregistration file (***.sfh**) previously saved by BESA Research (see step 1). The folder information has been passed to BESA MRI. After automatic loading, the digitized electrodes are displayed along with the segmented skin.

13. Press the **Run Surface Point Fit** button to coregister the digitized electrodes with the MRI data. You can manually influence the fit by determining the maximum distance the electrodes are allowed to have from the skin or by increasing the weight of the fiducials. This can be done either before or after the automatic surface point fit. After modifying the **Advanced Settings**, surface points are refitted automatically, when proceeding by pressing **<Space>** or the **Next** button.
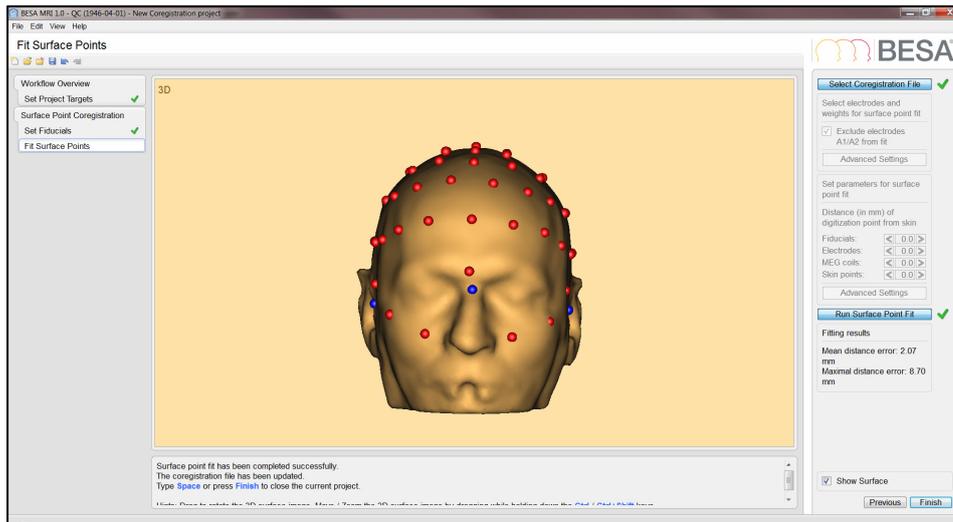
14. In case the option **Generate FEM Leadfields** was checked, BESA MRI will calculate lead fields for the given electrode layout. Please note that this step can take a while to compute, depending on the number of electrodes in the electrode layout. The electrode, for which the lead fields are currently computed, is highlighted in orange. The electrodes that are already finished are displayed in blue.

15. Press the **Finish** button to finalize and save the coregistration project.

16. Now **return to BESA Research** by selecting the icon of the BESA Main window in the Windows status bar. There will be a green tick mark in the **Coregistration with MRI** dialog window and all necessary Talairach-transformed MRI files will automatically be loaded.

17. In case lead fields were computed for an individual FEM model, the **Coregistration with MRI** dialog window will state **Individual FEM found** at the bottom.

18. Press the **OK** button twice to return to the main window for BESA Research to start source analysis.

2.6. Using individual FEMs for source analysis

19. If FEM lead fields were computed during coregistration the individual FEM will be available in the Head Model drop-down menu of the source analysis module in BESA Research. Choosing it will cause all inverse solutions to be based on the individual forward model. Thereby, a higher localization precision can be achieved.

2.7. Displaying source analysis results using individual anatomy

20. Once you have computed a source reconstruction, right-click into the solution-frame of the source analysis window and choose **Display MRI** or type **A** (anatomy). This will show the source reconstruction overlaid on the individual anatomy of your subject.
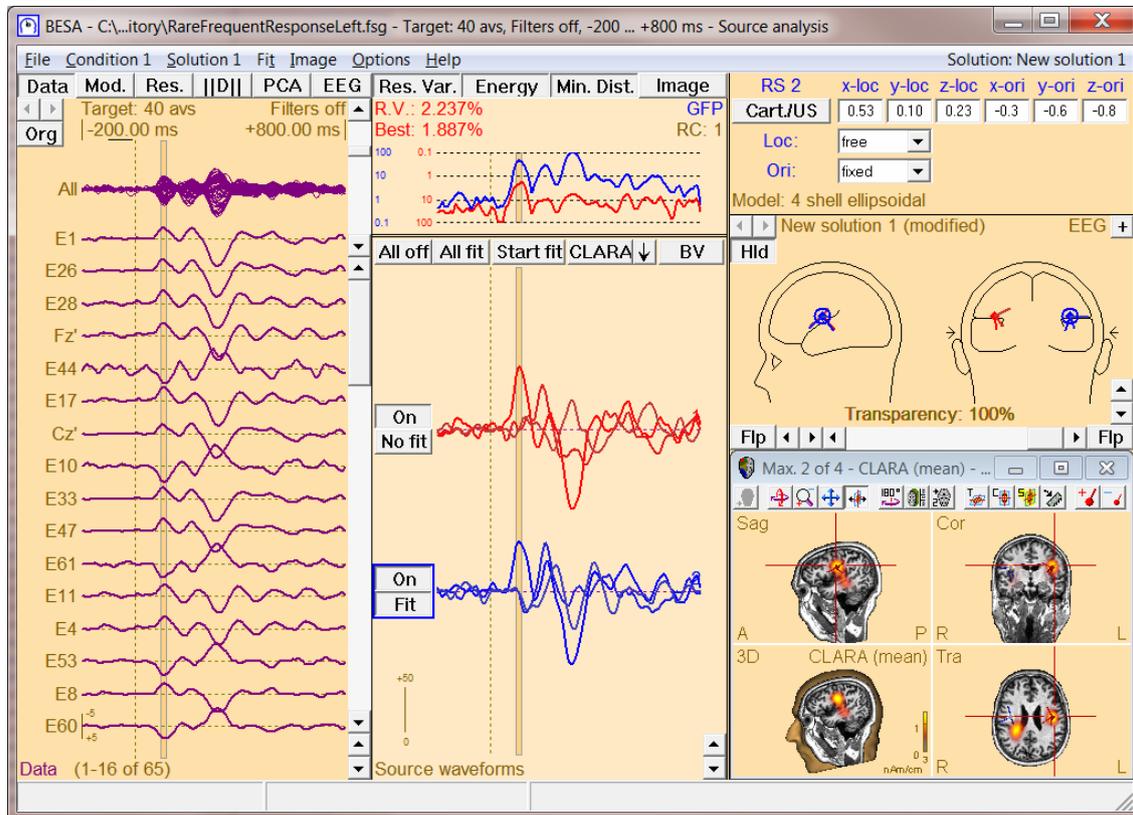
3. EEG-MEG coregistration with MRI data using <u>standard</u> electrodes

If standard electrodes have been used for the recorded EEG without electrode digitization, you can still coregister the EEG data with the individual MRI. Coregistration is initiated in BESA Research by loading a predefined standard set of 3D electrode positions based on the 10-10 / 10-20 electrodes. Then you start coregistration as in the case of digitized electrodes and BESA MRI will morph the standard 3D electrode cloud together with the 3 fiducials (nasion, PAL=T9, PAR=T10) to the individual scalp surface. Using the coordinate transformations in the **.sfh** file as modified by BESA MRI, BESA Research internally recalculates the spherical coordinates of all electrodes (labels change, e.g. from T9 -> T9'), thus allowing the use of the standard realistic head model approximations as well as the multi-shell ellipsoidal head models.

In order to coregister your EEG data with an individual MRI using virtual electrodes, please load the following files:

3.1. Defining the standard electrode positions by loading a standard surface point file (.sfp).

1. Open your EEG file in BESA Research with standard electrodes according to the 10-10 / 10-20 conventions (or specific cap electrodes for which a standard electrode position file is available).

2. Select menu item **File → Head surface points and sensors → Load coordinate files** (**Ctrl-L**).

3. Under **Digitized head surface points** press the **Browse** button.

4. At the bottom of the **Load Surface Points** box, select the **Standard Electrode Folder** under directories:
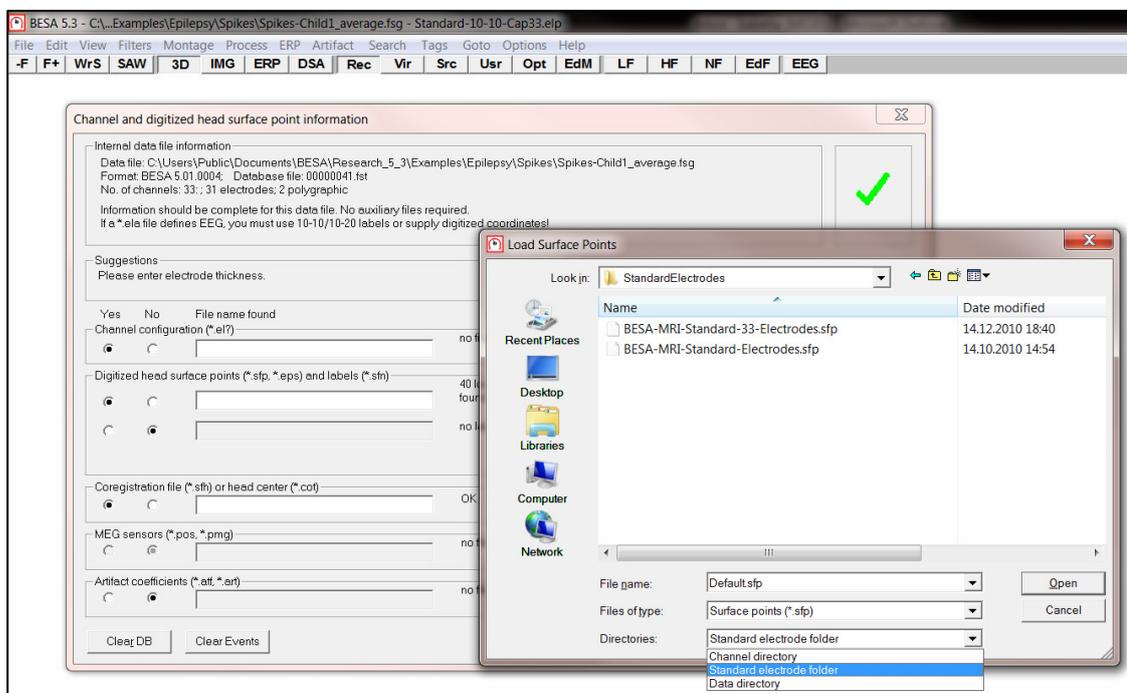
5. Select the file **BESA-MRI-Standard-33-Electrodes** if your electrodes are equal to or a subset of the 33 standard electrodes (standard 10-20 incl. A1/A2, F9,T9,P9 / F10/F10/P10; FC1,2,5,6, CP1,2,5,6).

6. Select the file **BESA-MRI-Standard-Electrodes** if you electrodes use additional positions of the 10-10 system, and/or e.g. T1/T2, Sp1/Sp2 or other inferior electrodes.

7. After loading the standard electrode position file, a green tick mark must show. If <u>not</u>, you may have to create a copy of the standard file and add the electrodes positions of your specific electrodes in the head coordinate system. After loading press **V** to view and check the electrodes in the BESA main window. Location of the standard files:

- Windows 7:
  C:\Users\Public\Documents\BESA\Research_6_0\Montages\Channels\StandardElectrodes

- Windows XP:

  Shared Documents\BESA\Research_6_0\Montages\Channels\StandardElectrodes

8. If you are using an electrode cap, e.g. from EGI, select the **Channel Directory** at the bottom of the **Load Surface Points** dialog window and browse to the adequate folder. Currently, standard positions for EGI and BioSemi caps are available.

   For others, please request to http://besa.de/contact/support/form.php.
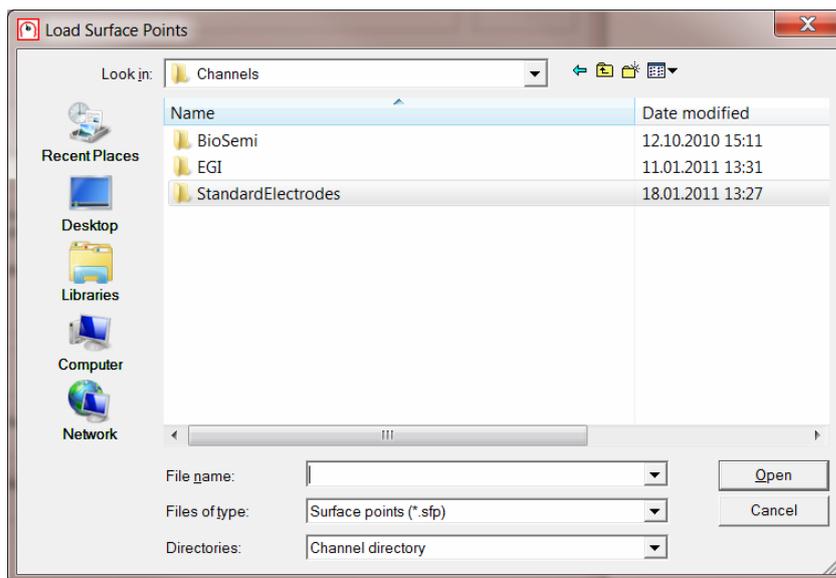
3.2. Start the Coregistration in BESA MRI

Continue with step 4 as described above.

In BESA MRI, you may adjust the fiducials, give higher weights (e.g. 10) to the fiducials using the **Advanced Settings** menu, or restrain the solution more around the fiducials - using the **Advanced Settings** in the **Distance** section - in order to match standard electrodes better to the fiducial positions and the midline.