NFT

Neuroelectromagnetic Forward Head Modeling Toolbox

Zeynep AKALIN ACAR

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NFT

- A complete framework for accurate forward problem solution.
- Easy-to-use MATLAB environment with GUI and command-line functions.
- Ability to use available subject information
  - T1-weighted 3D MR images
  - Digitized sensor (electrode) locations

Comparison with Dipfit

- The realistic model in Dipfit is a three-layer MNI head model represented with 3000 vertices.
  - The forward matrices are pre-calculated, so there is no need for FP calculations.
- NFT generates subject-specific models.
  - NFT does model generation and forward problem calculations.
  - More accurate.

Starting NFT

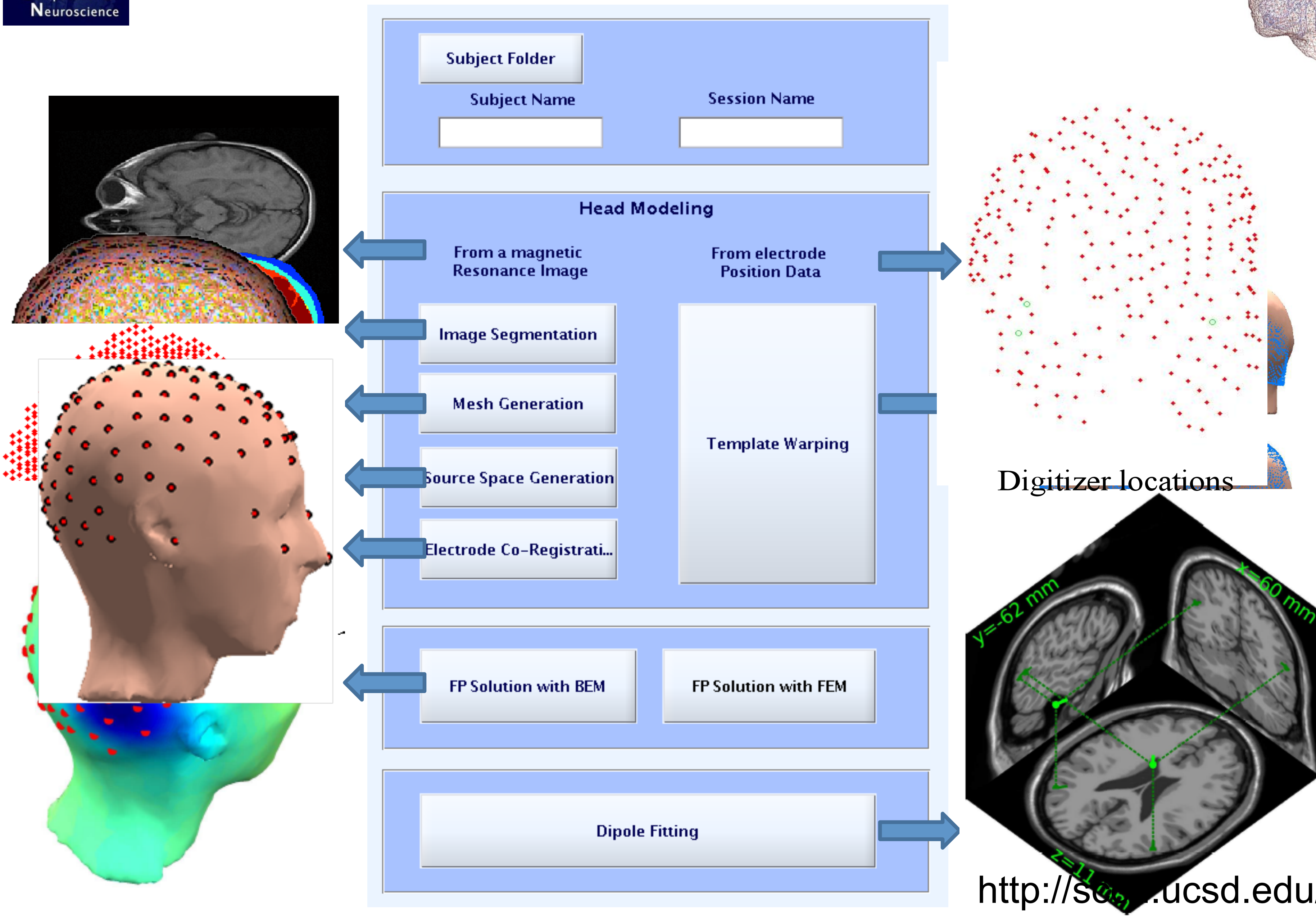
- To start from EEGLAB

  EEGLAB -> Tools -> NFT

- To start as a standalone toolbox

  addpath NFT directory

  Type ‘NFT’ in Matlab

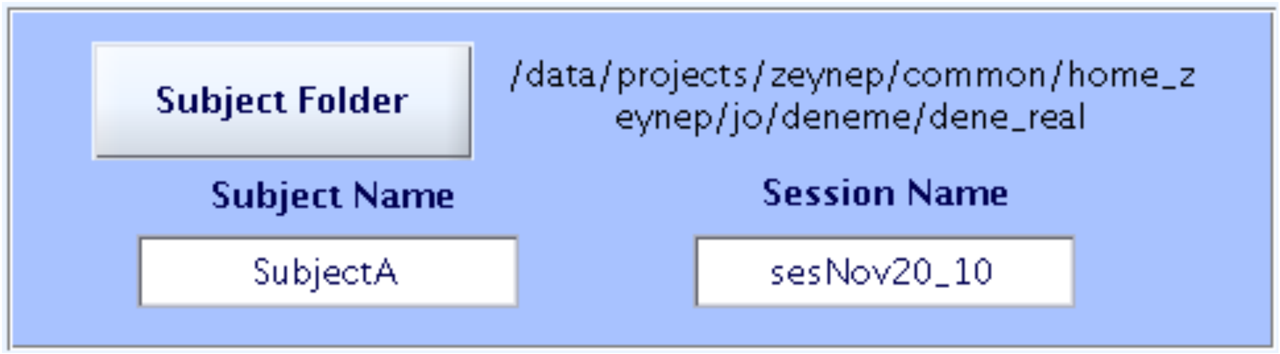


Subject Folder
Subject Name
Session Name
Head Modeling
From a magnetic Resonance Image
From electrode Position Data
Image Segmentation
Mesh Generation
Source Space Generation
Electrode Co-Registrati...
Template Warping
FP Solution with BEM
FP Solution with FEM
Dipole Fitting
Digitizer locations
y=-62 mm
x=60 mm
http://sc
.ucsd.edu/nft

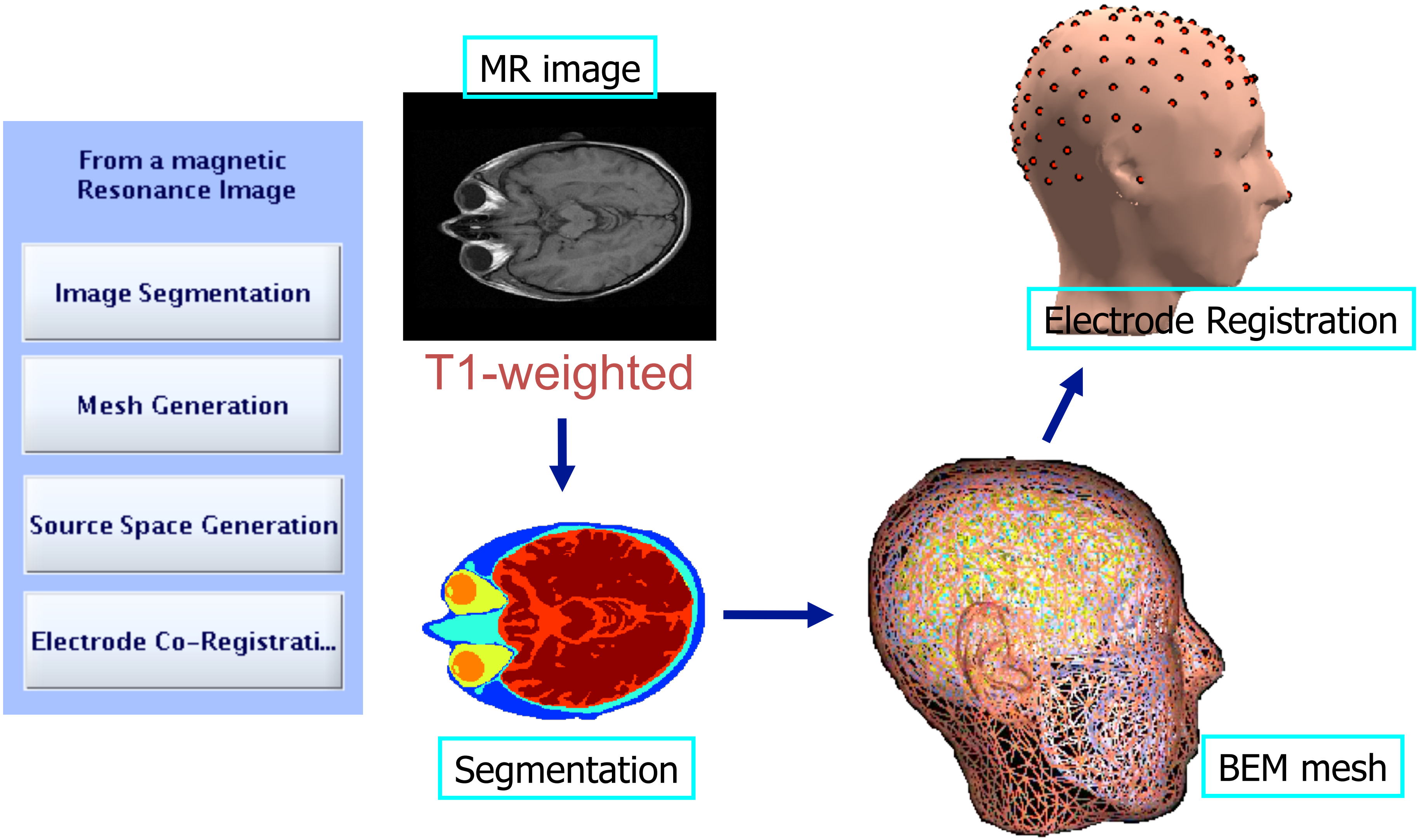
Subject Selection

- Select subject folder
- Specify subject name
- Specify session name

Subject Selection



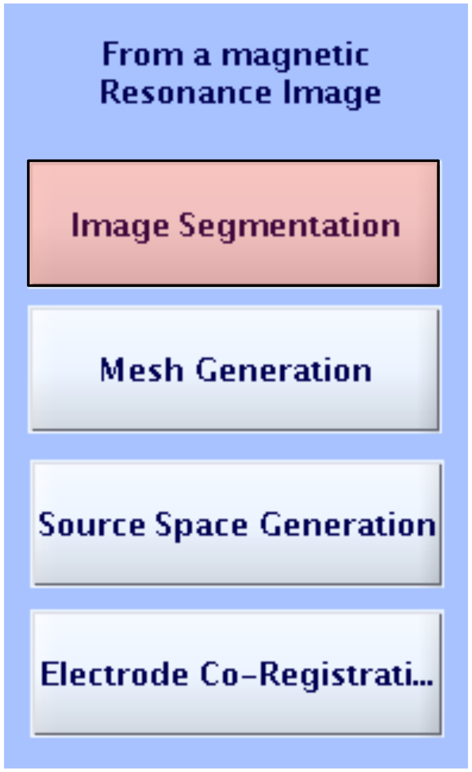
Head modeling from MR images

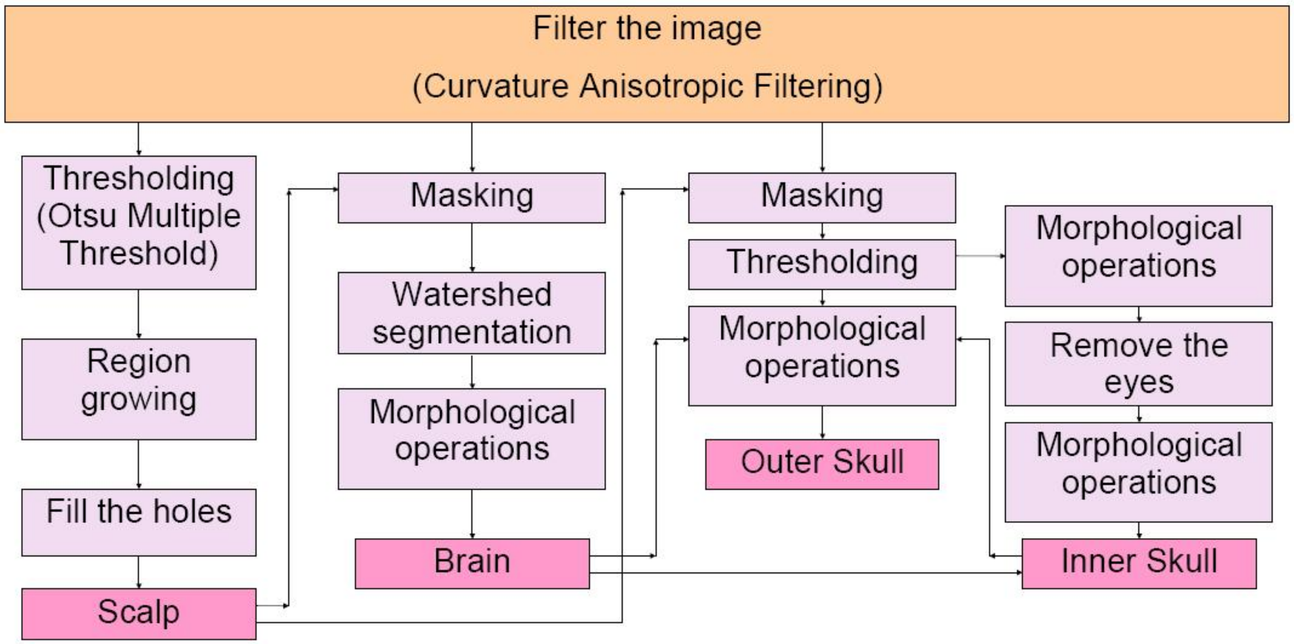


Preparing the MR Image

- Using FreeSurfer
  - Inhomogeneity correction
  - Convert to 1x1x1 volume
  - Arrange direction of the image
  - Save in analyze format

Image Segmentation





Classifies four tissues from T1-weighted images
Scalp, Skull, CSF and Brain

Image Segmentation

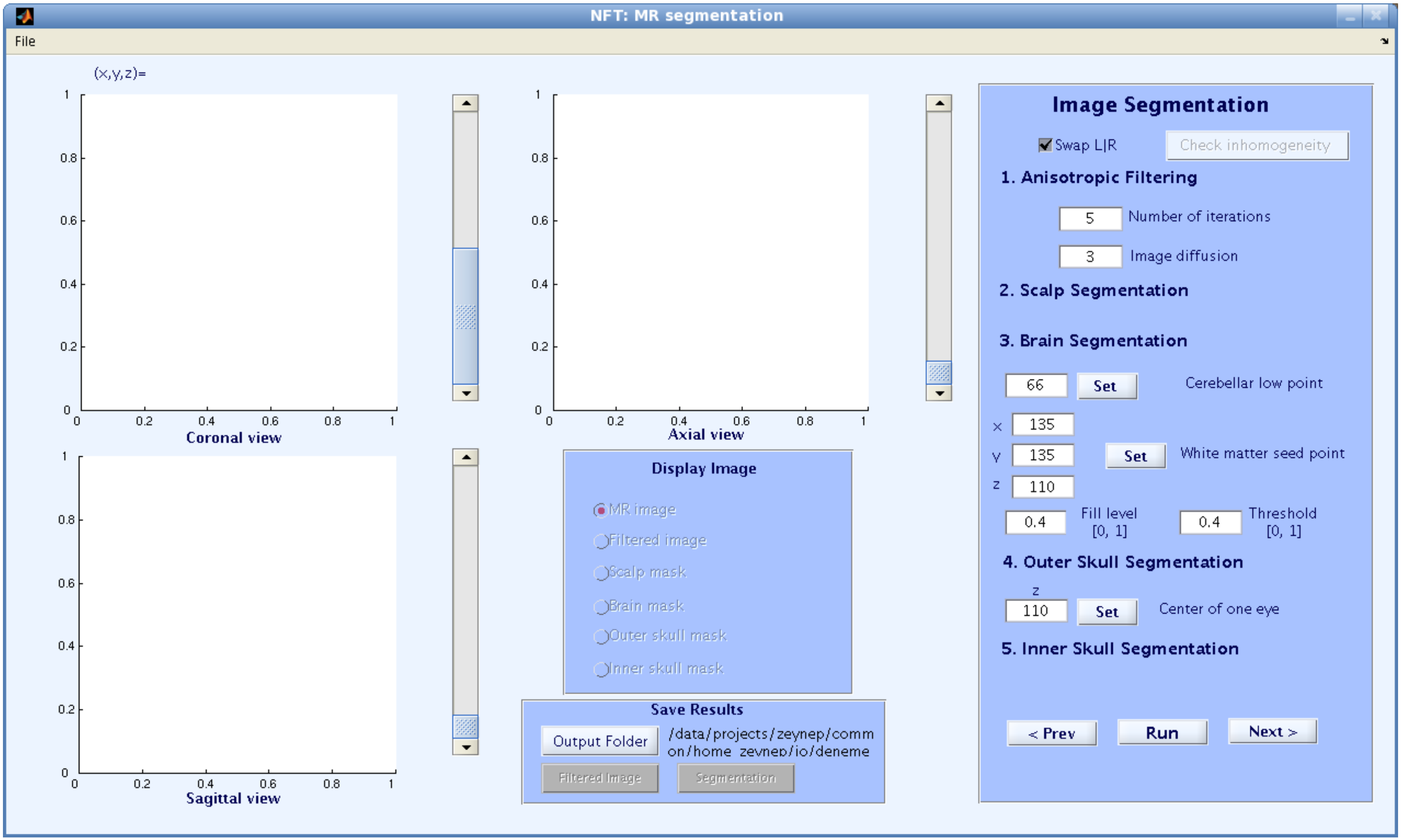
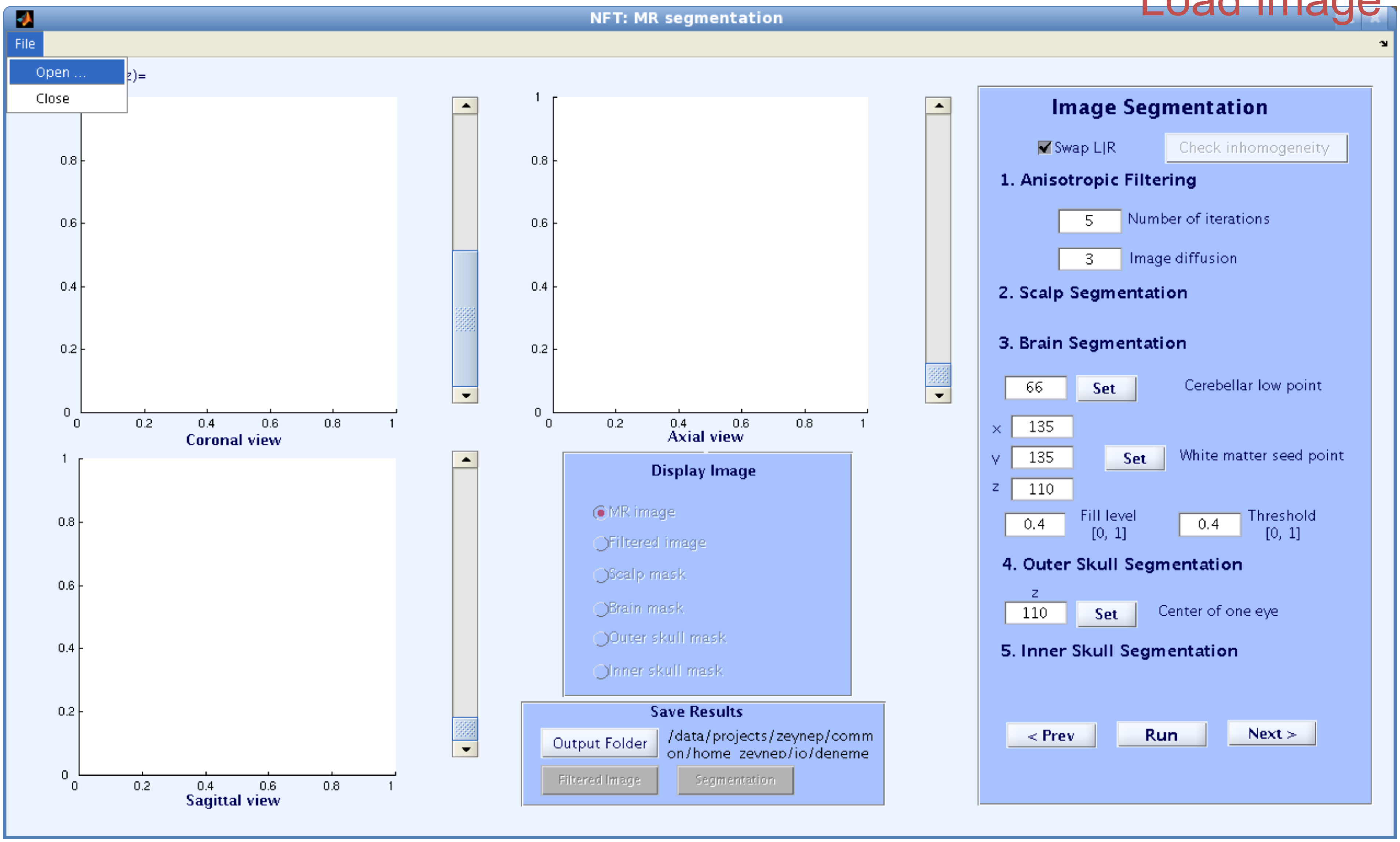


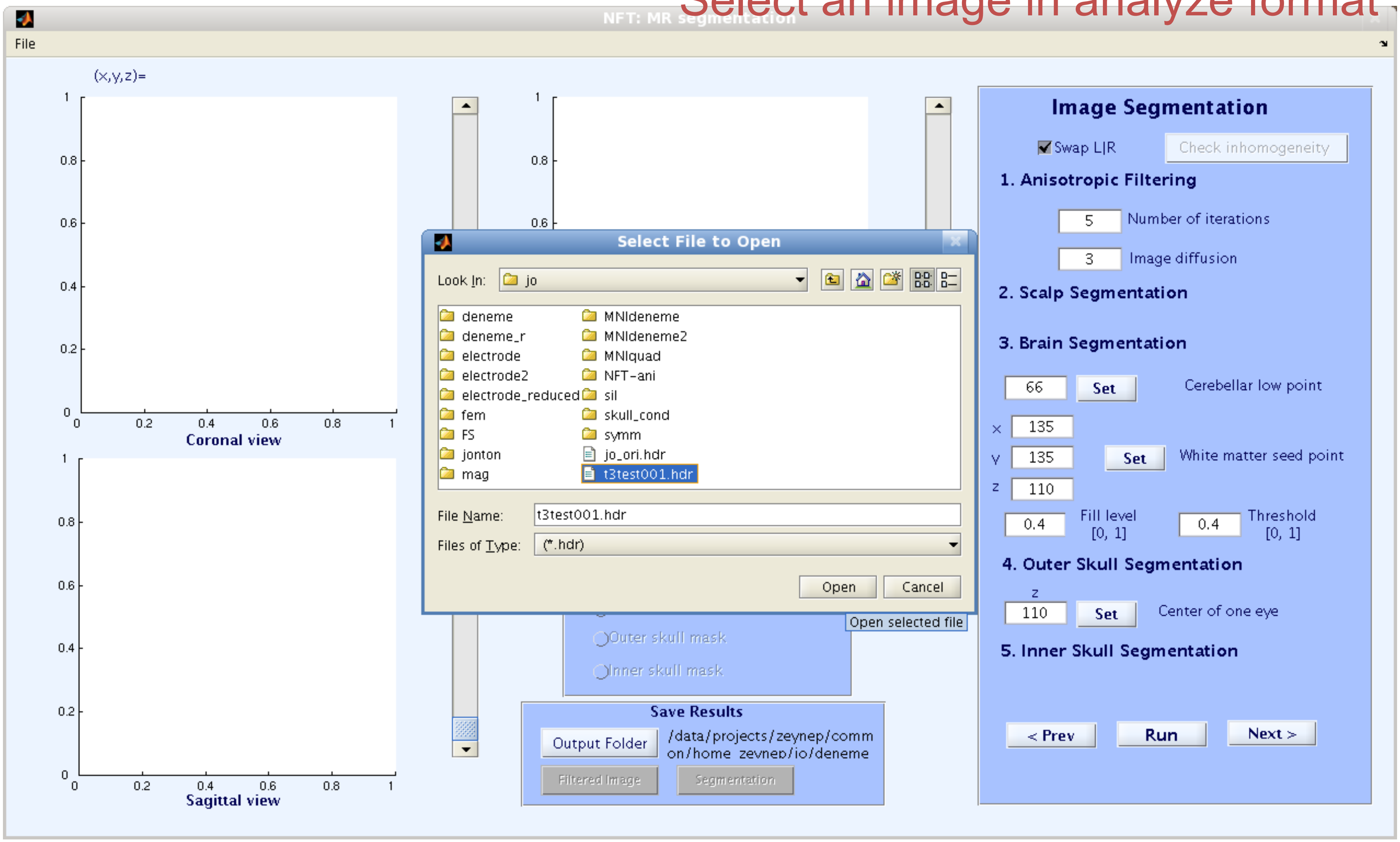
Image Segmentation

Load image



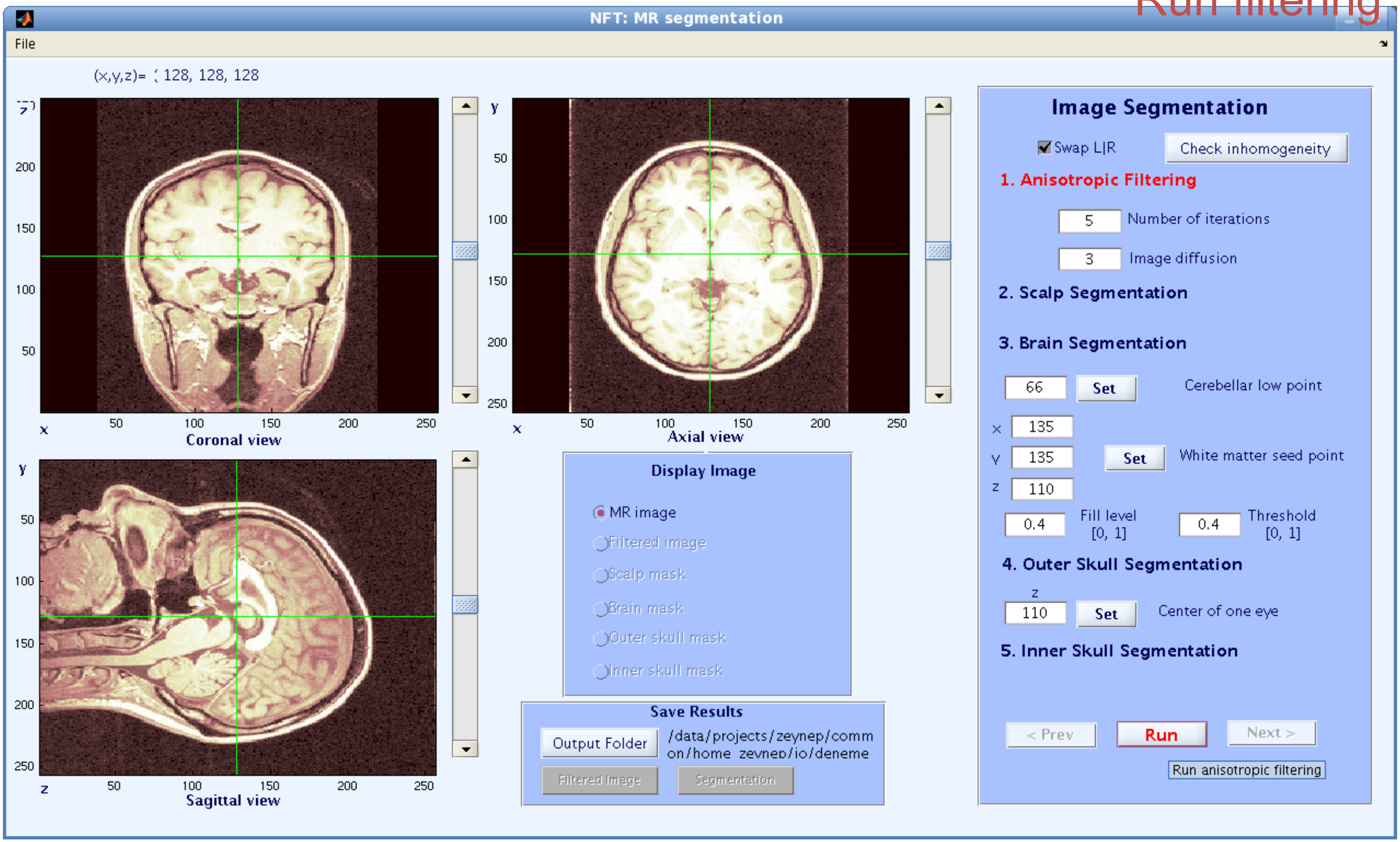
Segmentation

Select an image in analyze format

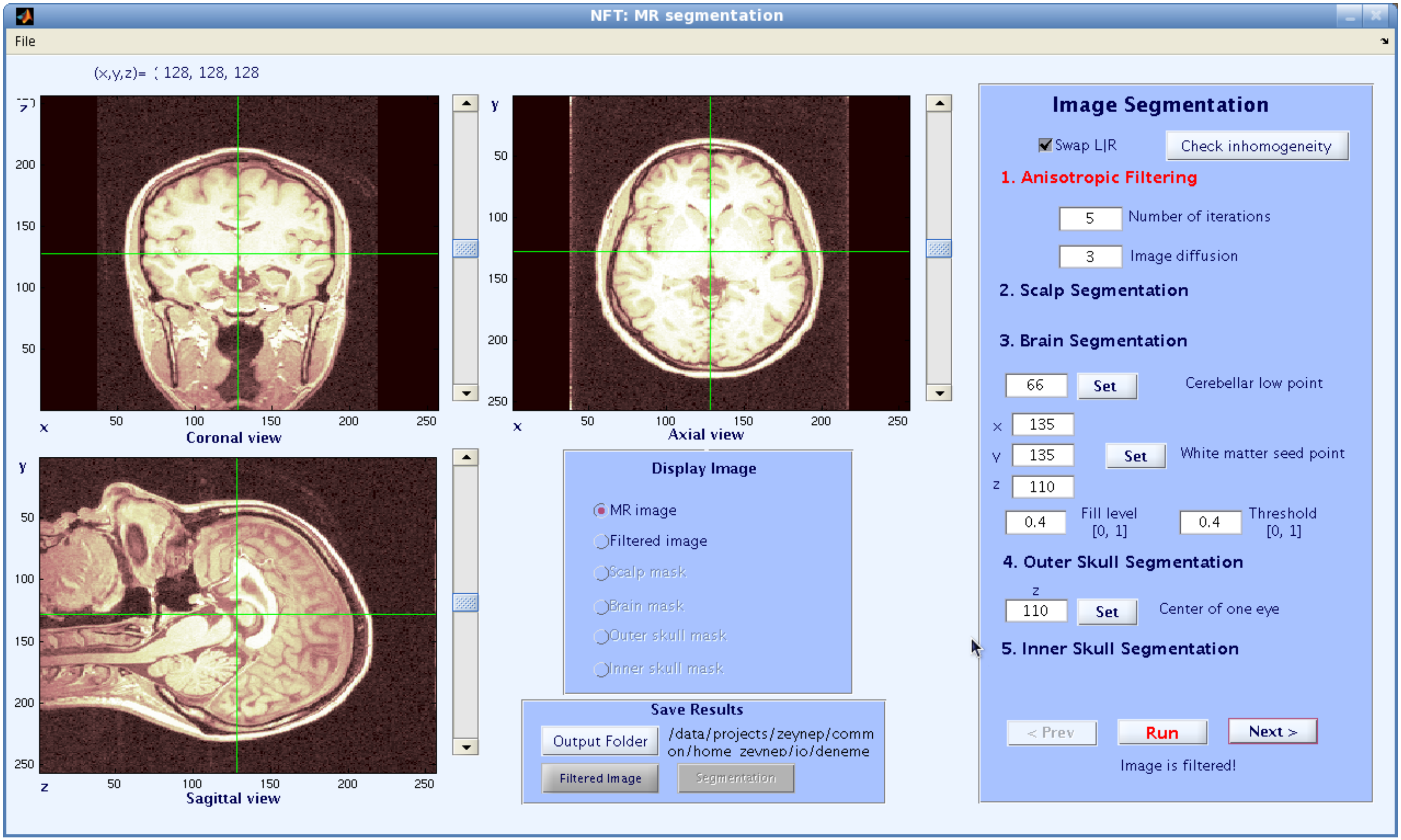


Segmentation

Run filtering

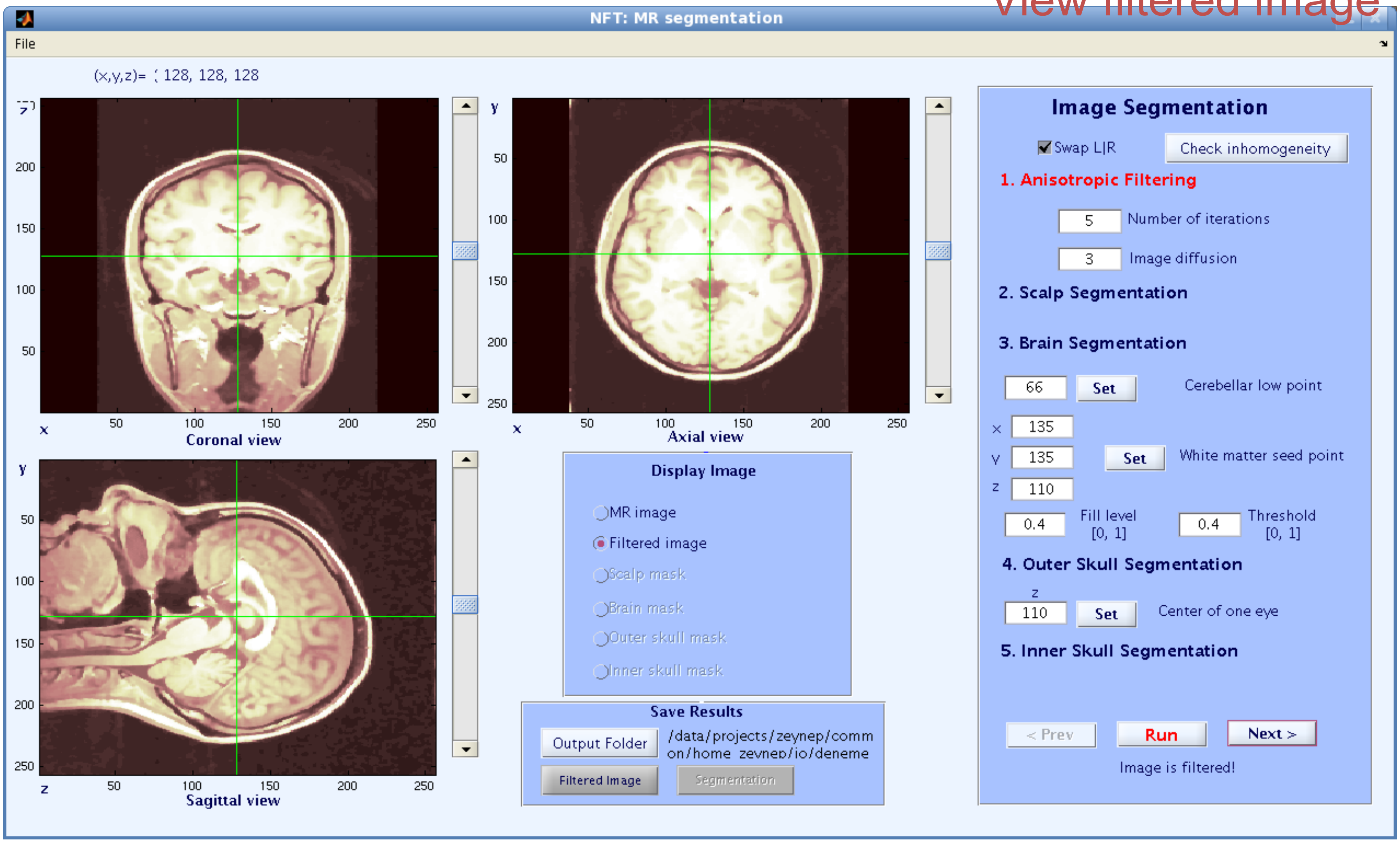


Segmentation



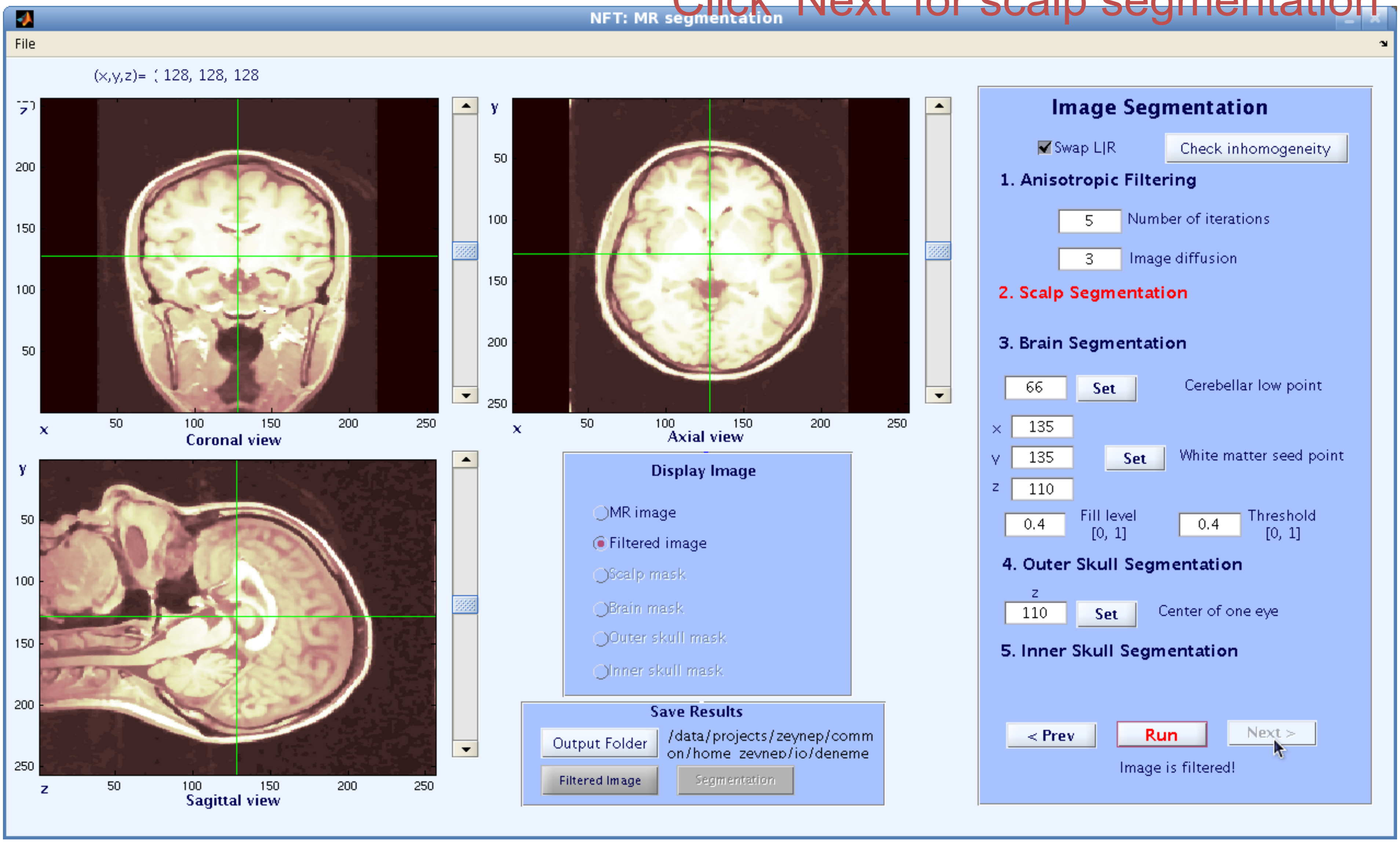
Segmentation

View filtered image



Segmentation

Click ‘Next’ for scalp segmentation



Segmentation

Click ‘Run’ for scalp segmentation

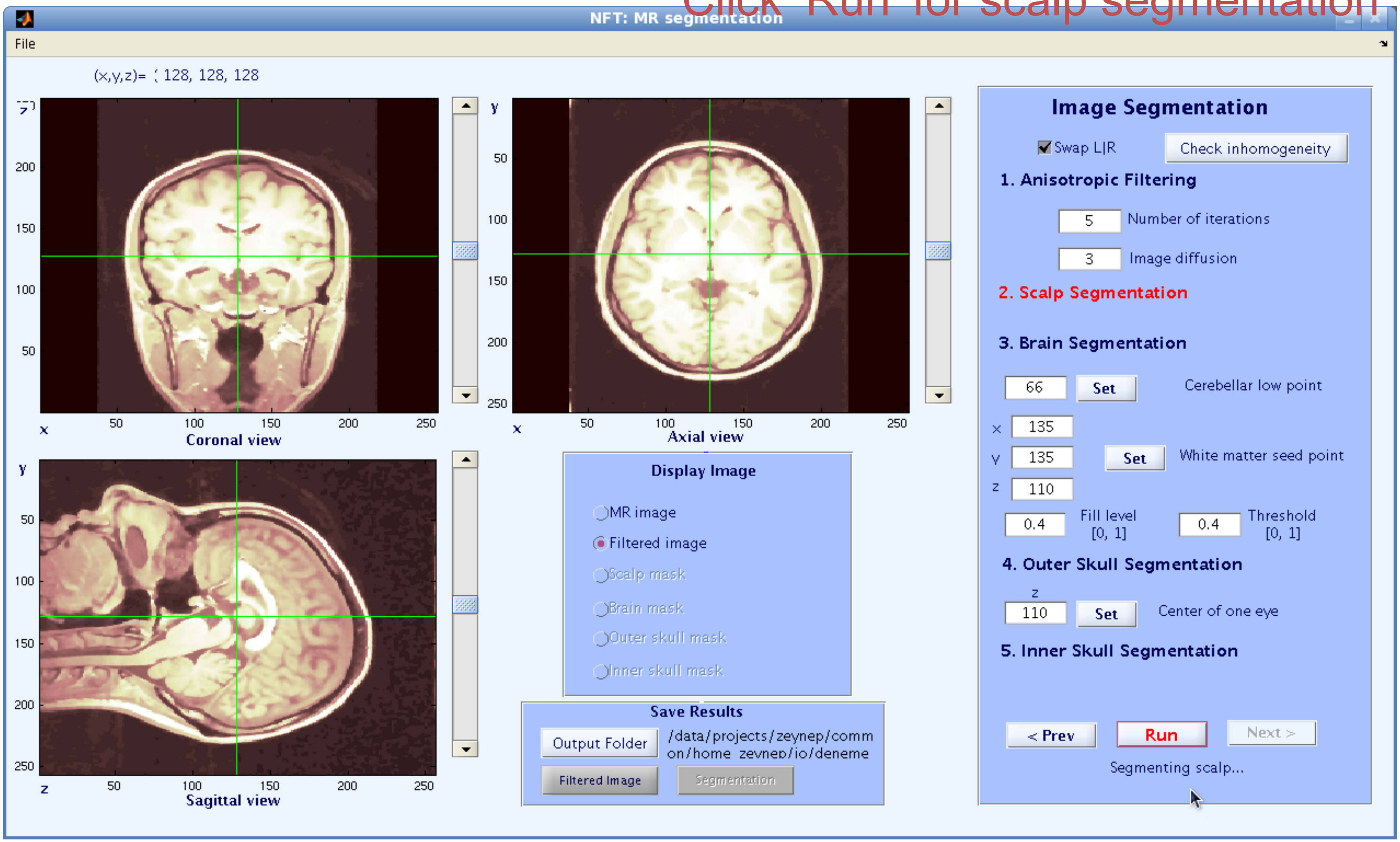
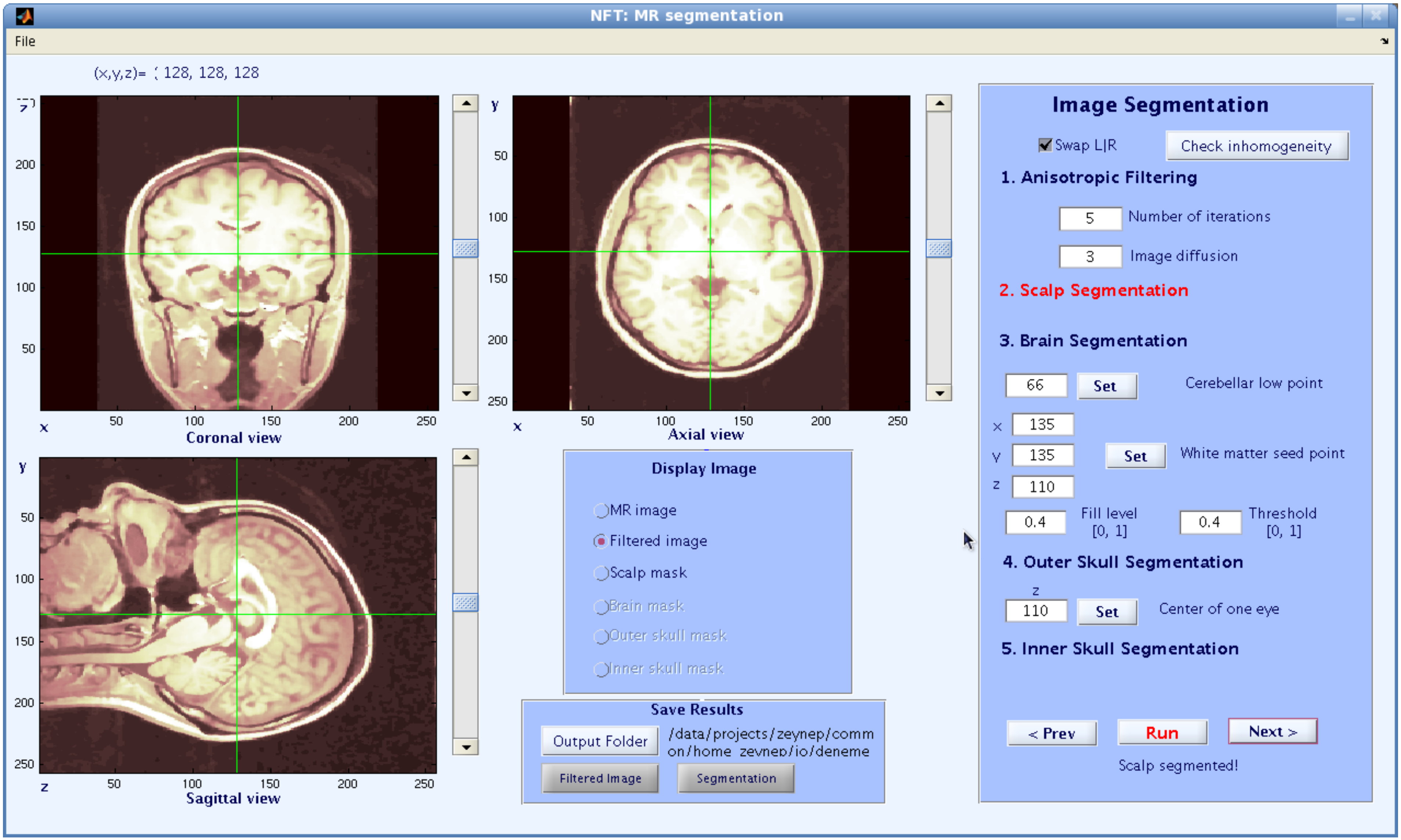
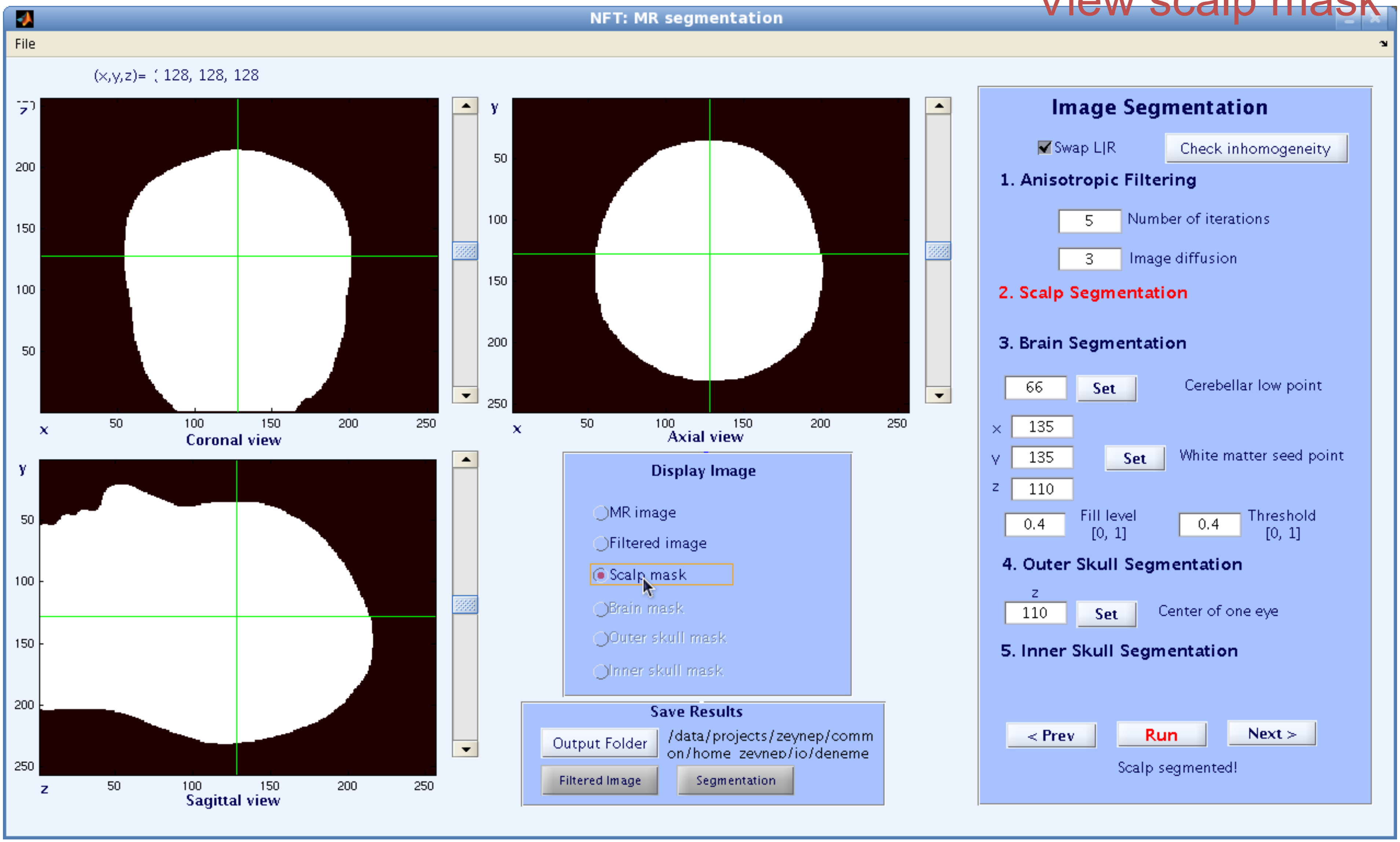


Image Segmentation



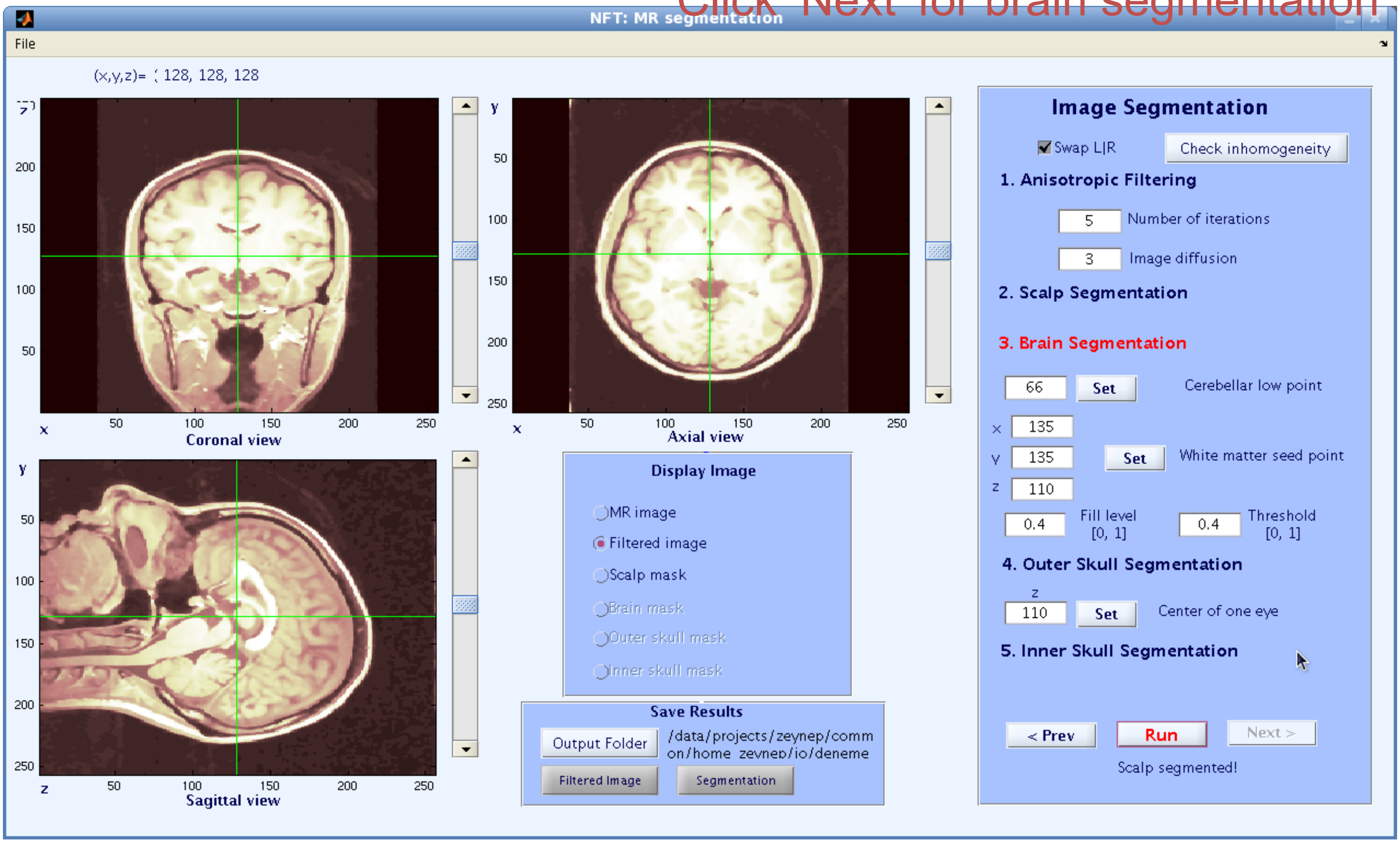
Segmentation

View scalp mask



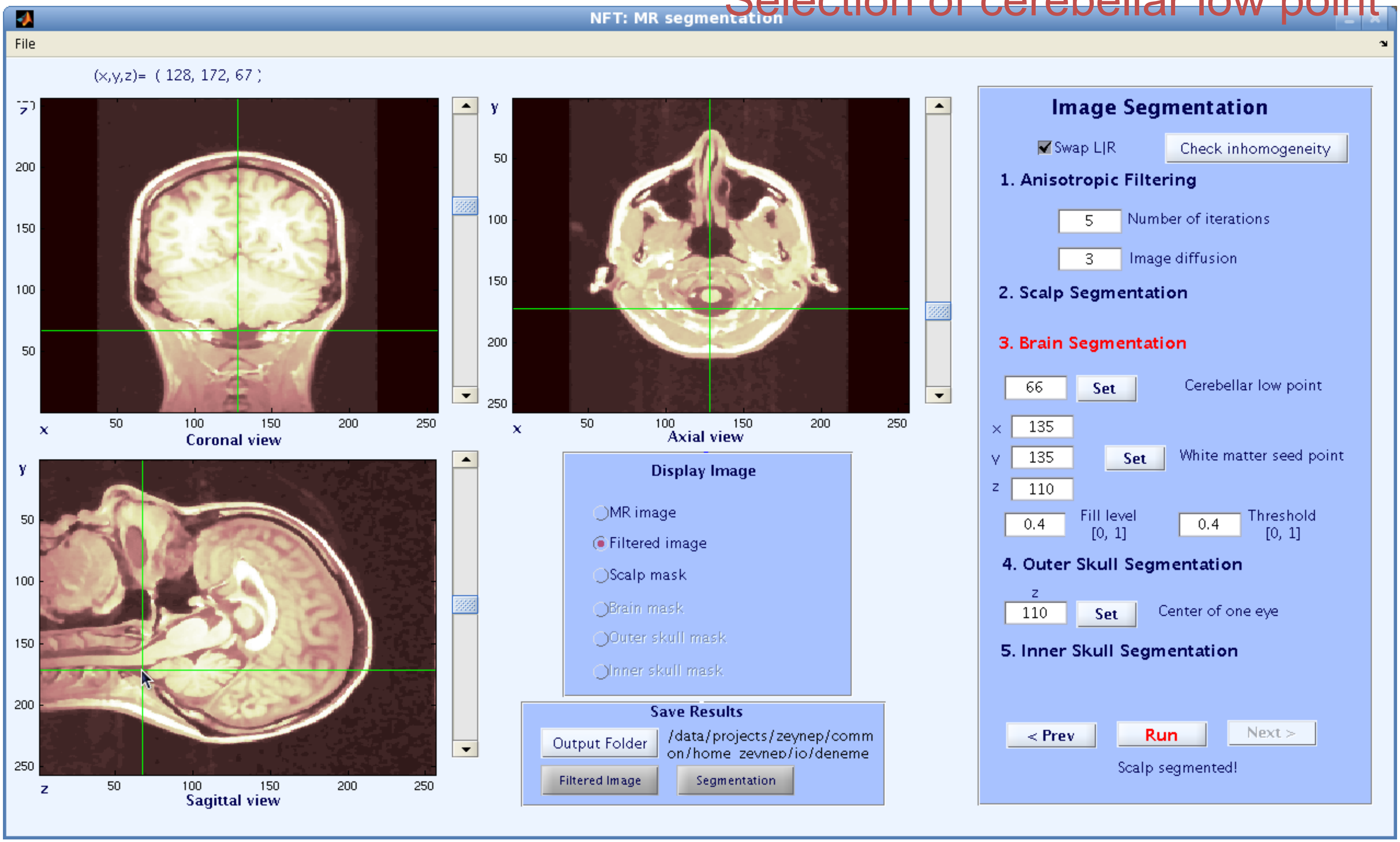
Segmentation

Click 'Next' for brain segmentation



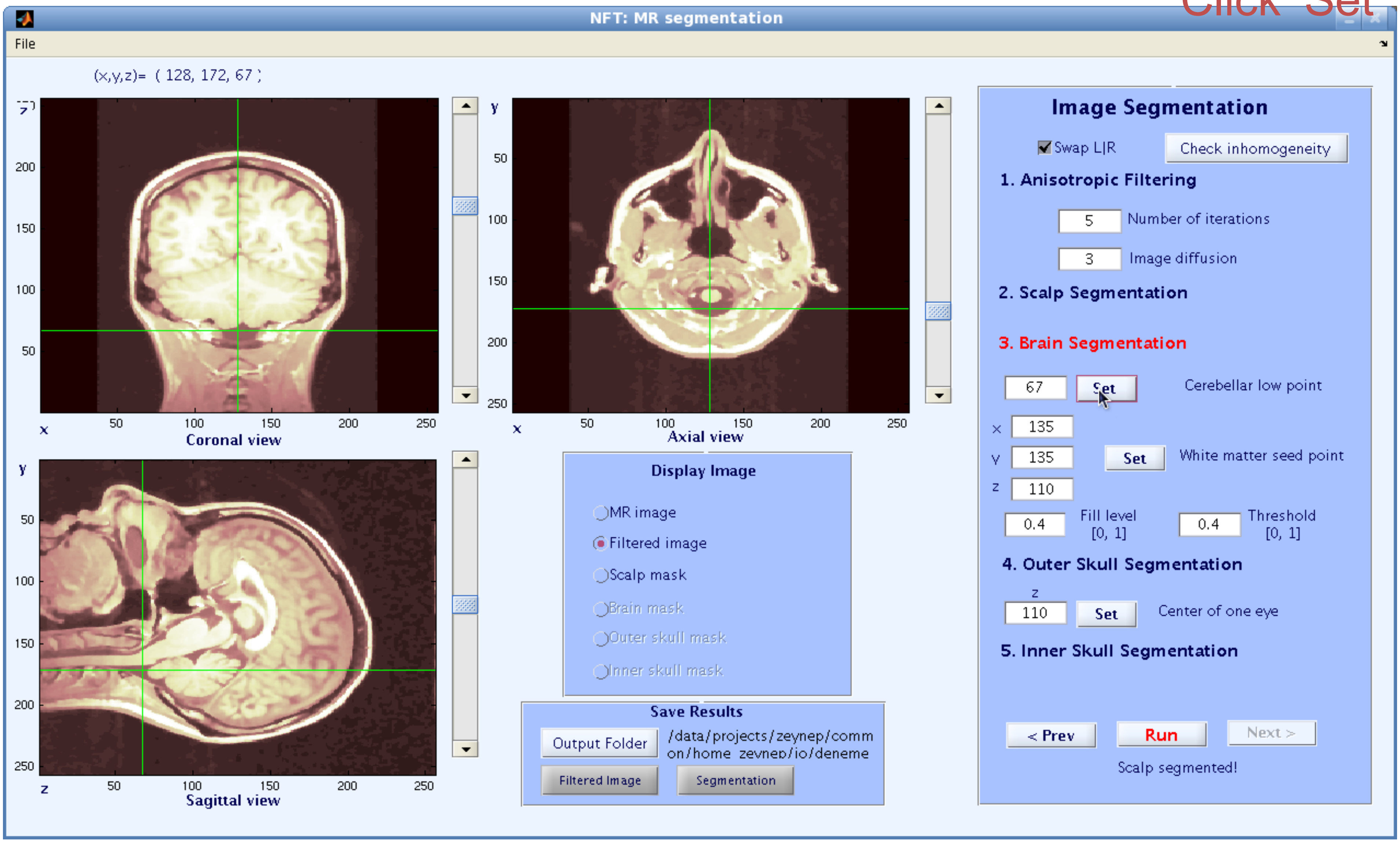
Segmentation

Selection of cerebellar low point



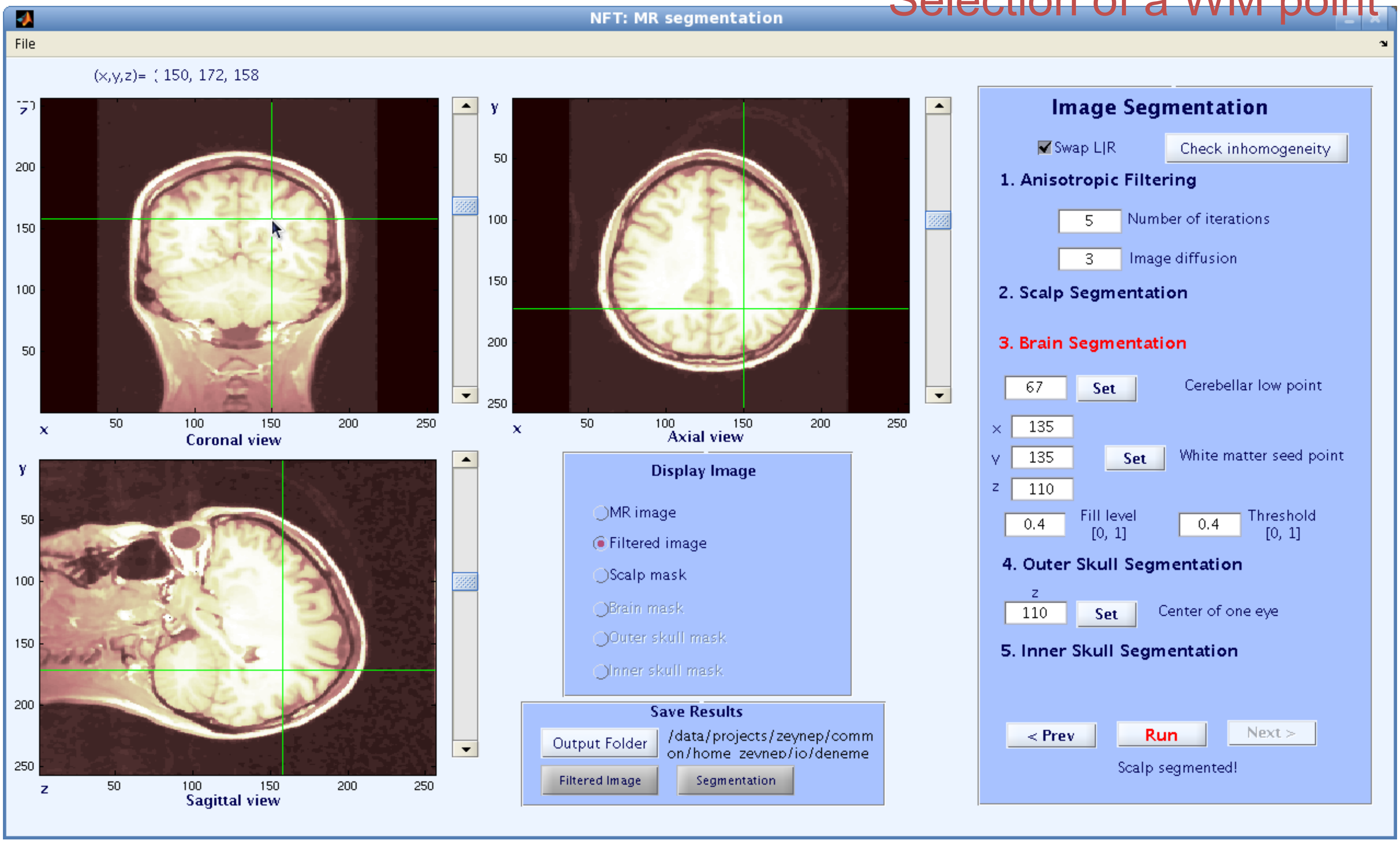
Segmentation

Click 'Set'



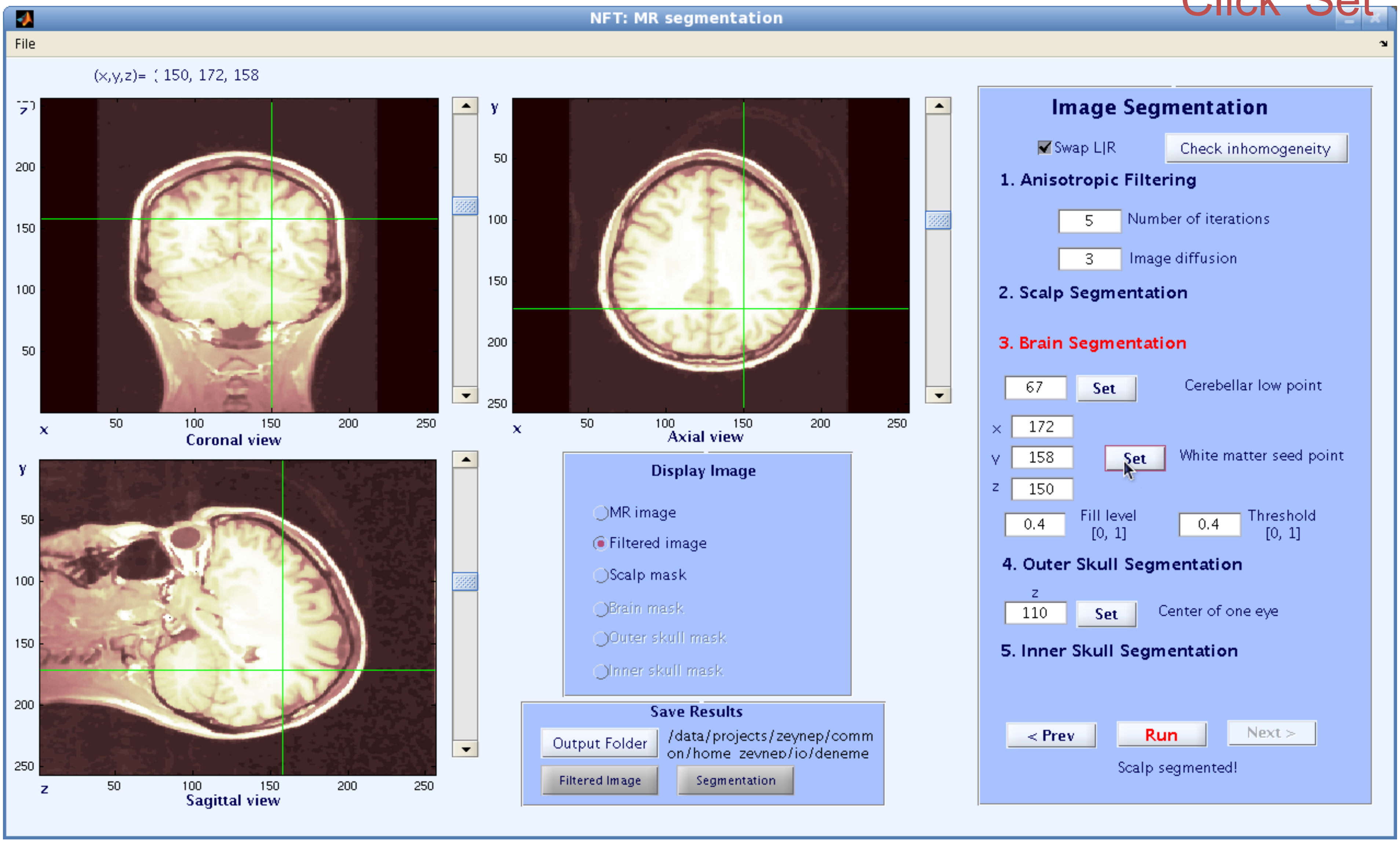
Segmentation

Selection of a WM point



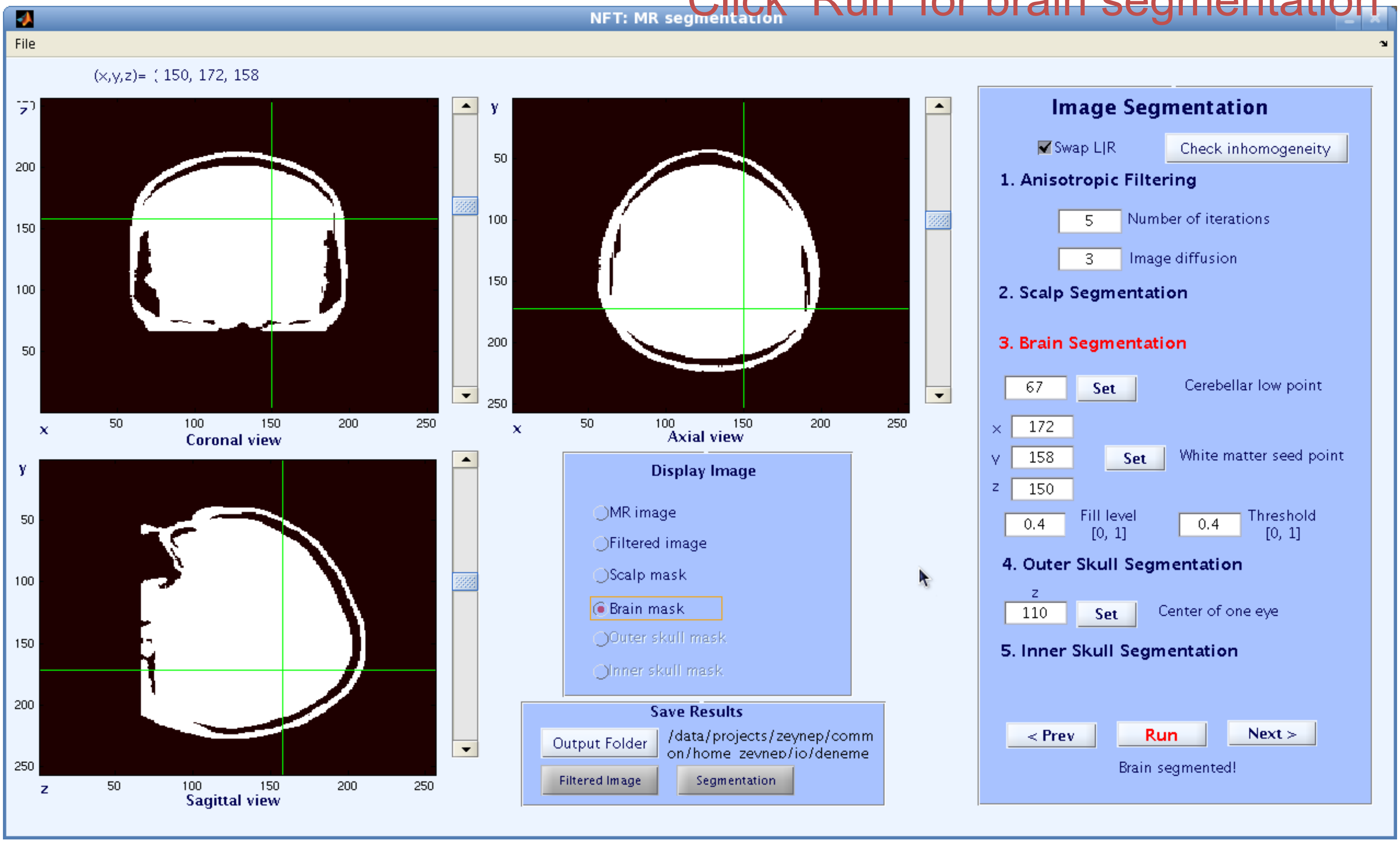
Segmentation

Click 'Set'



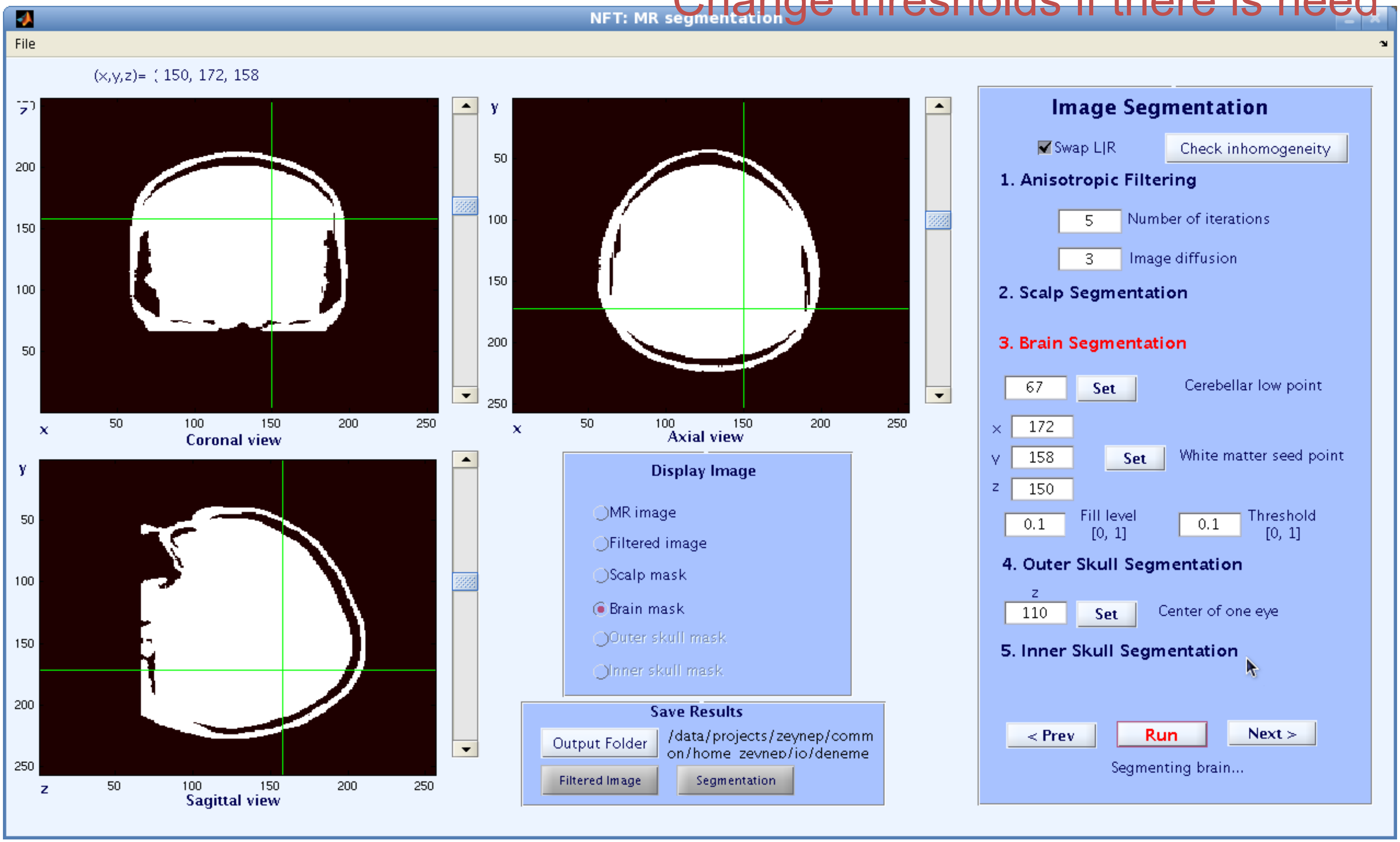
Segmentation

Click 'Run' for brain segmentation



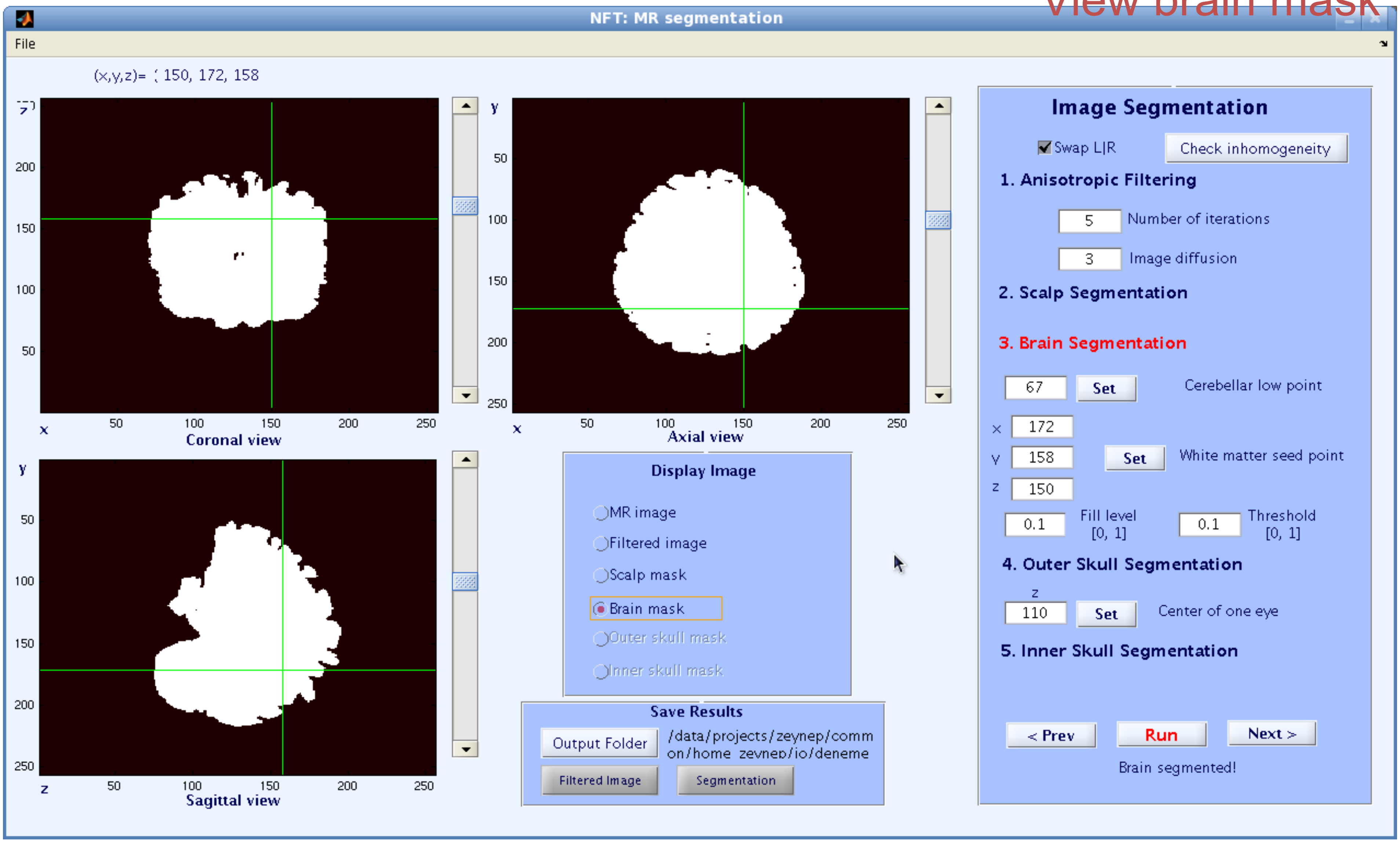
Segmentation

Change thresholds if there is need



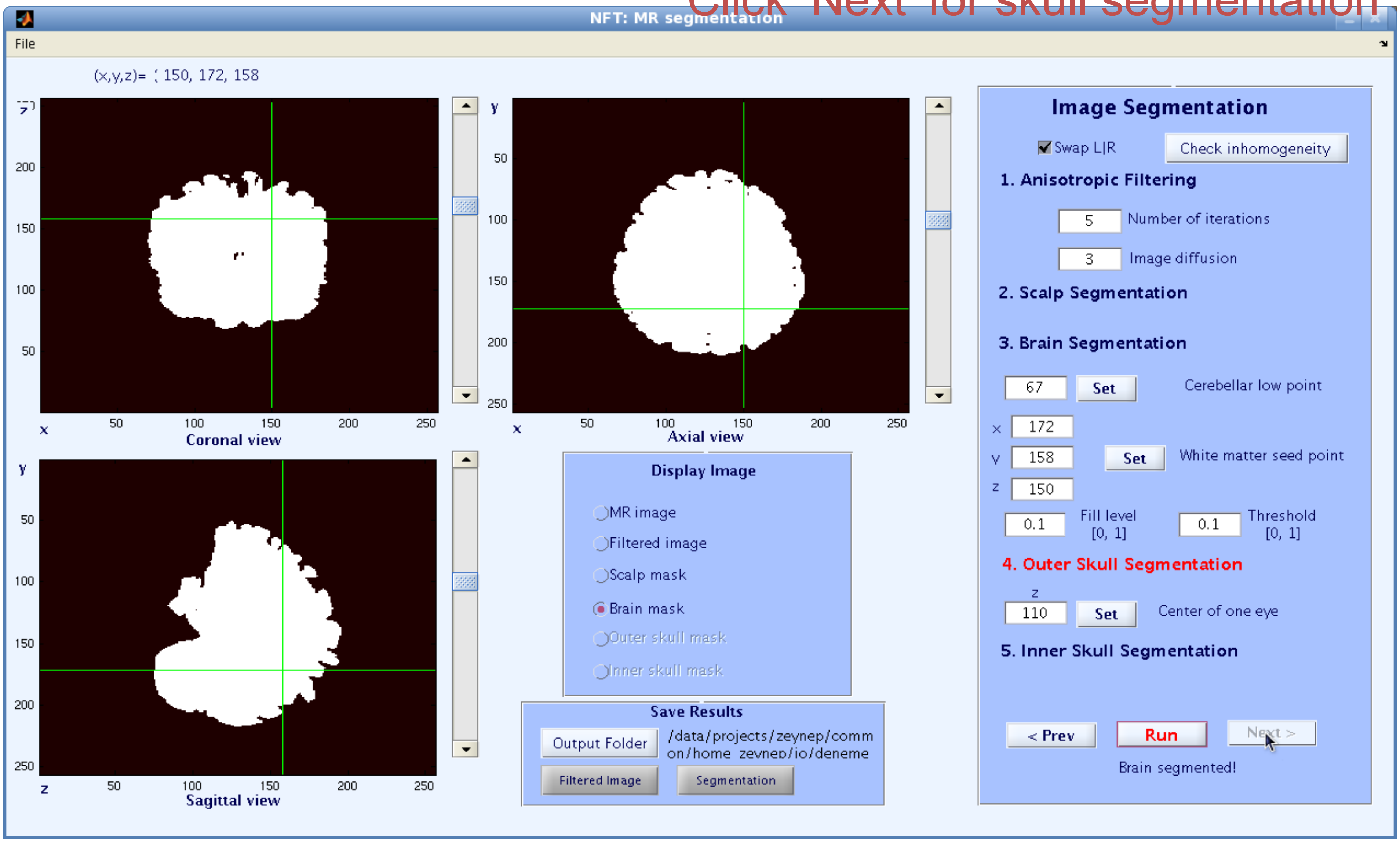
Segmentation

View brain mask



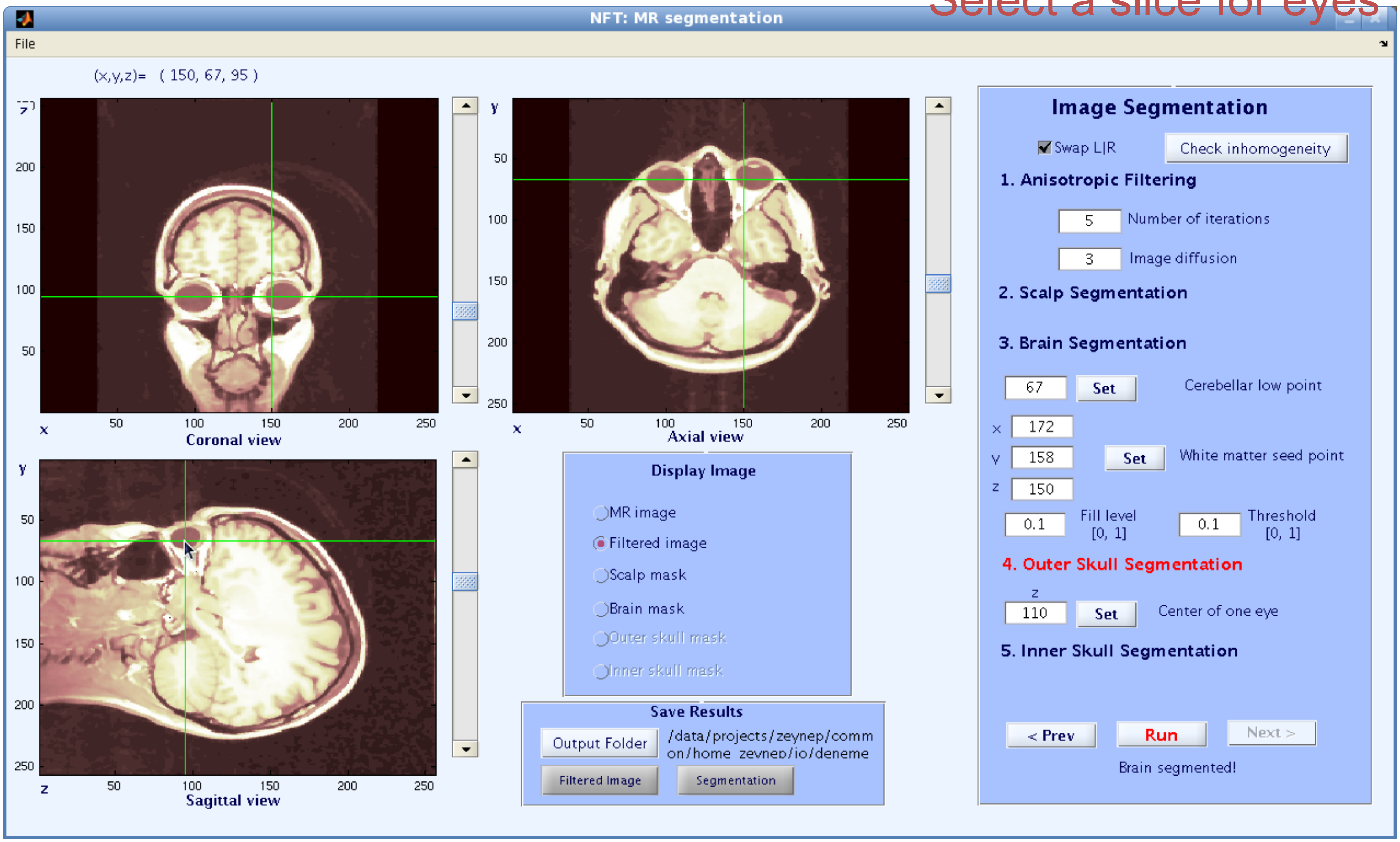
Segmentation

Click 'Next' for skull segmentation



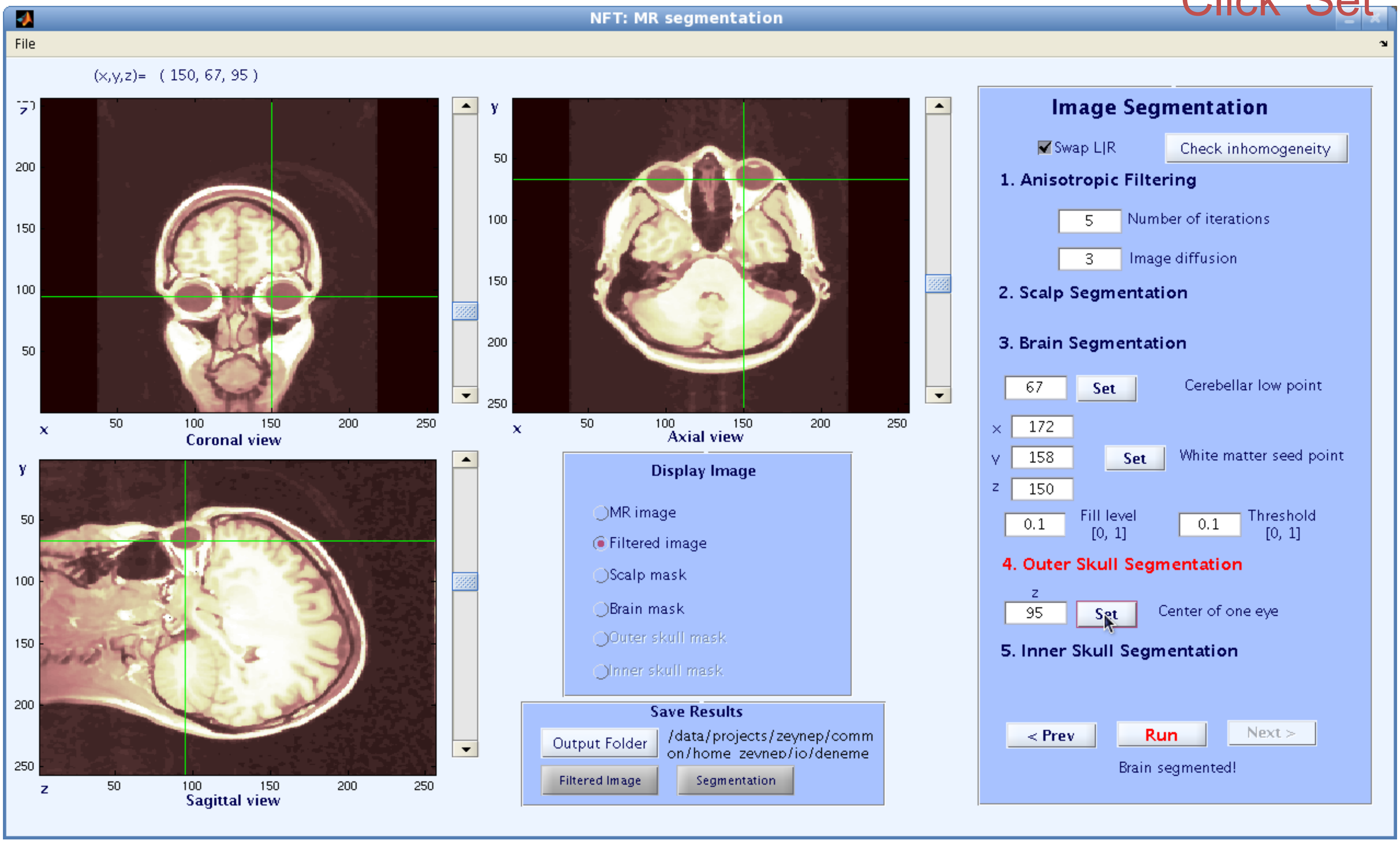
Segmentation

Select a slice for eyes



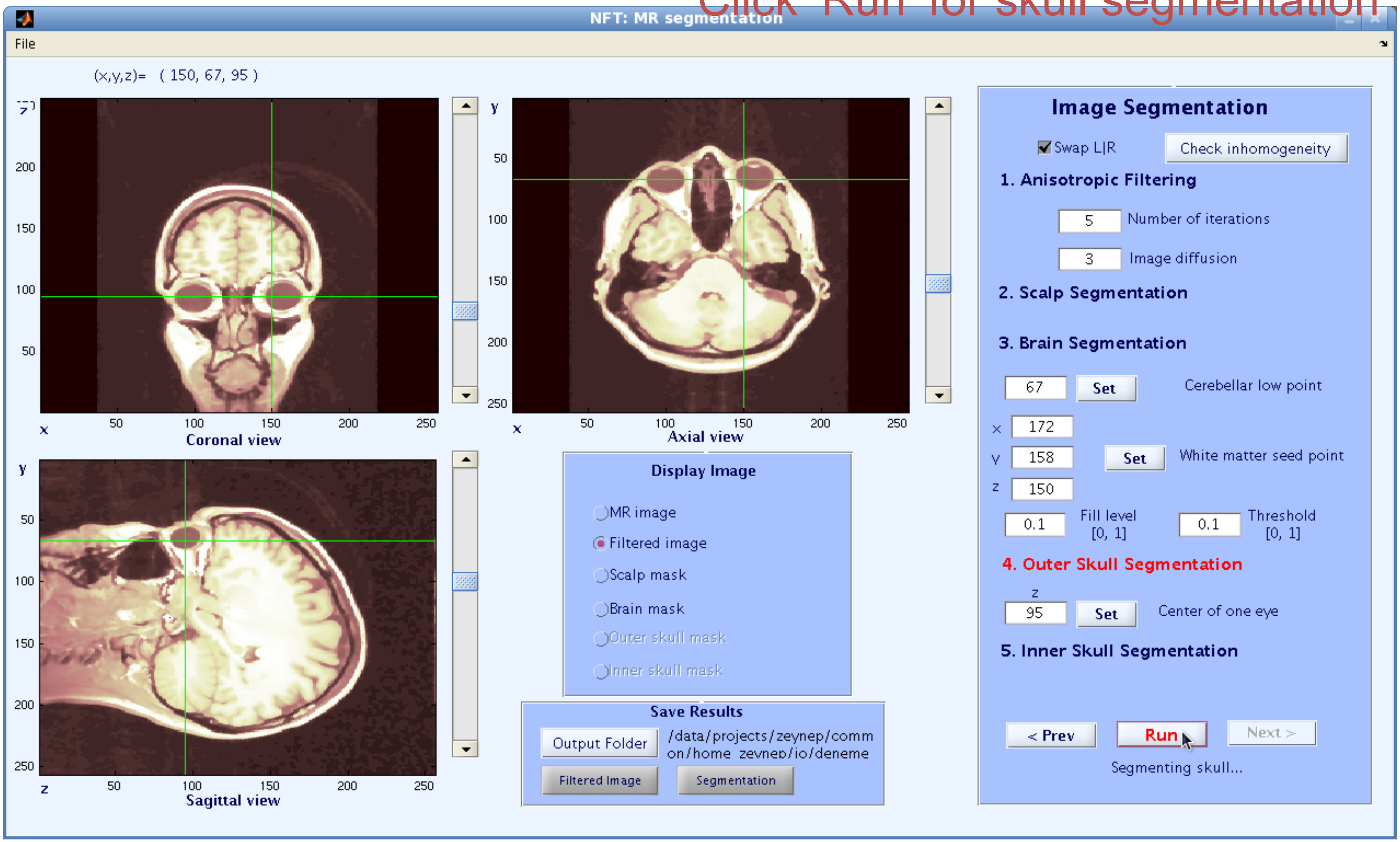
Segmentation

Click 'Set'



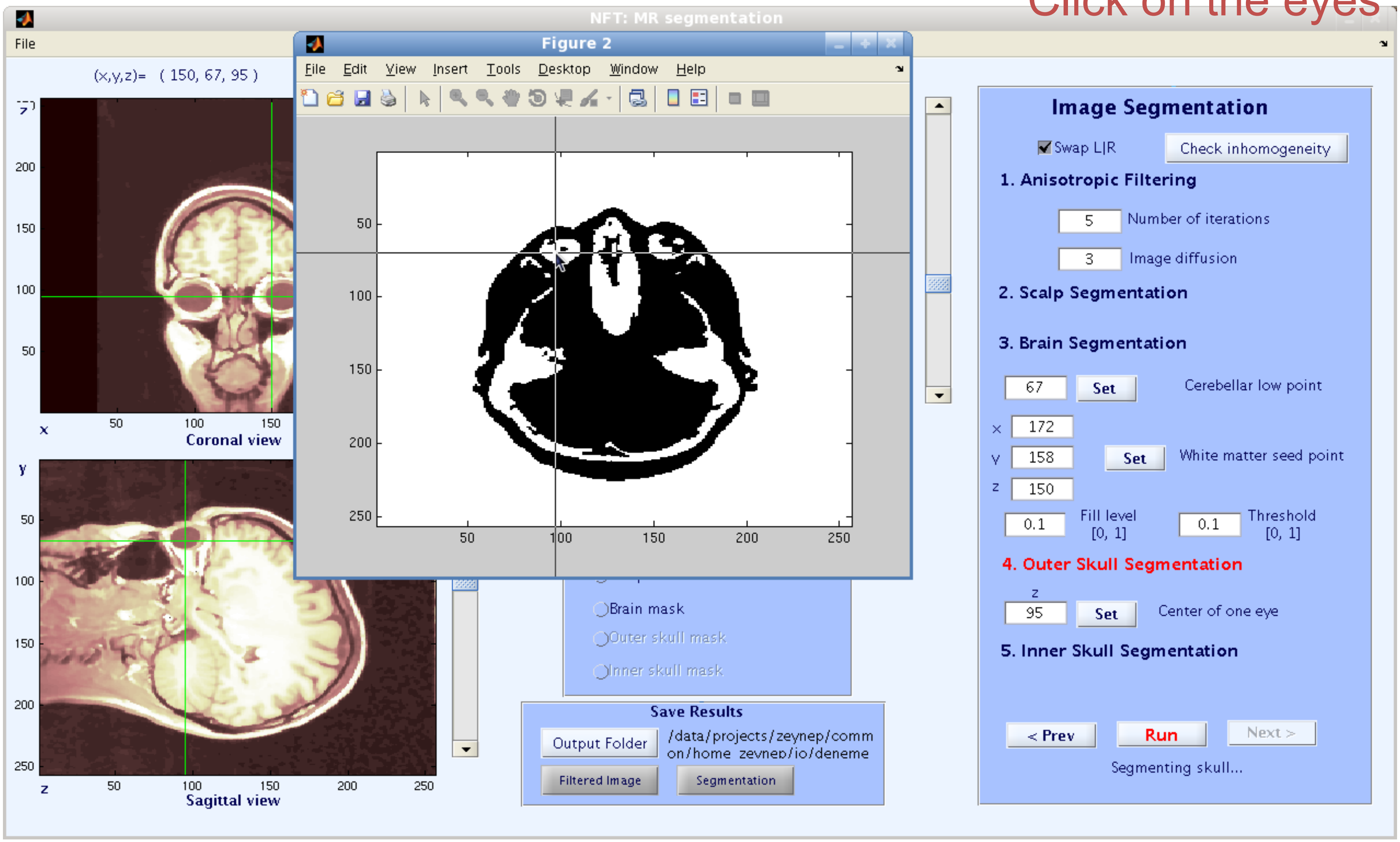
Segmentation

Click 'Run' for skull segmentation

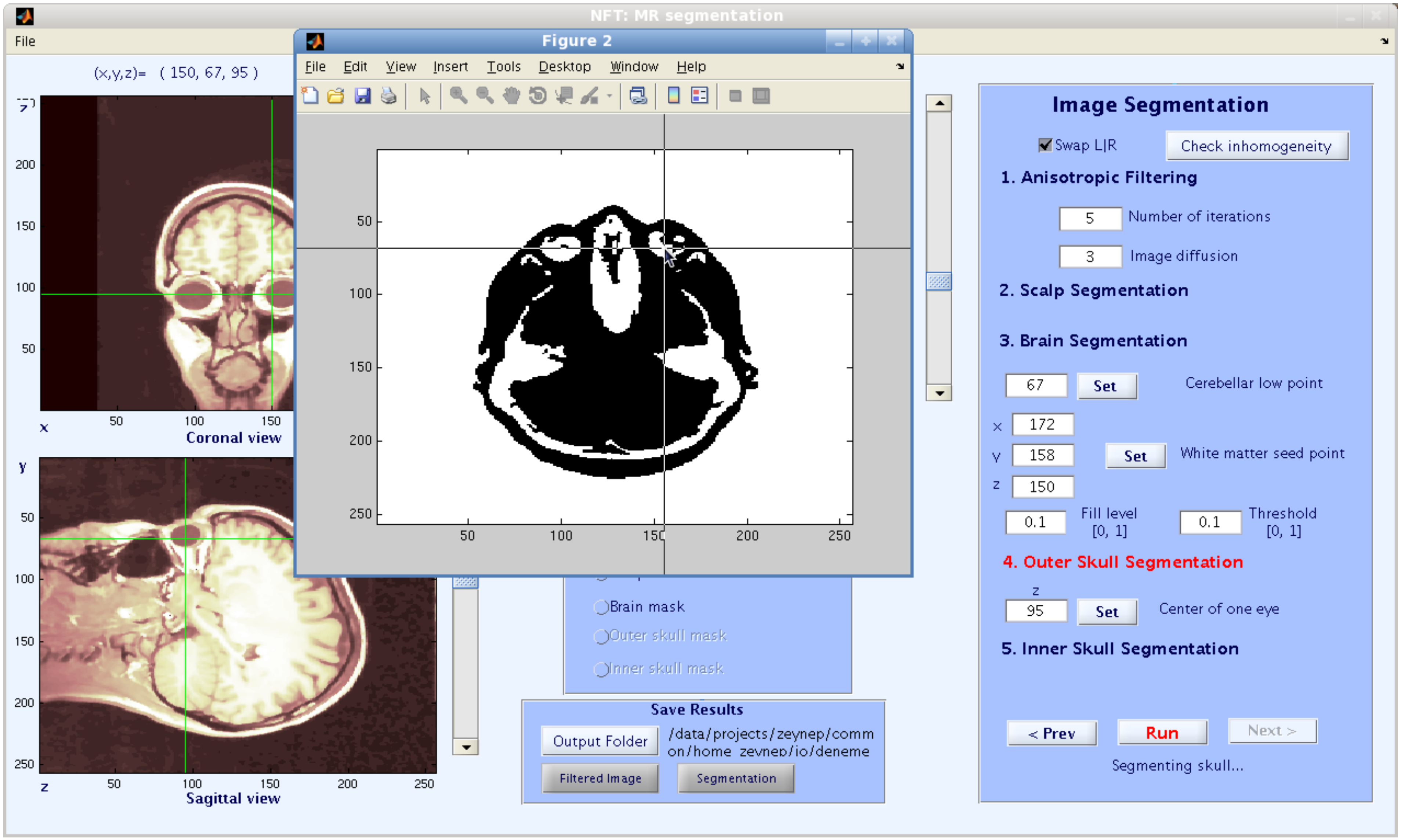


Segmentation

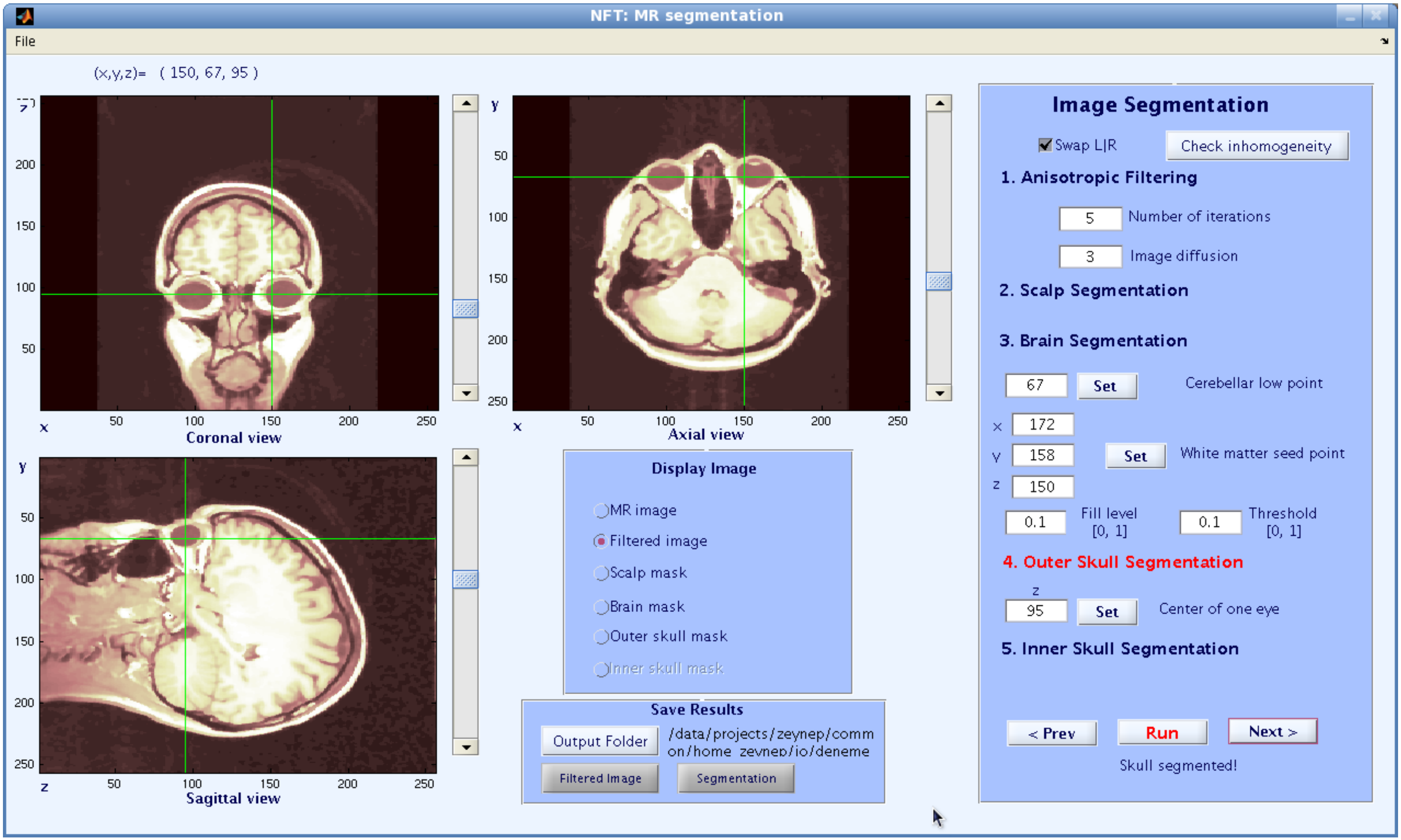
Click on the eyes



Segmentation

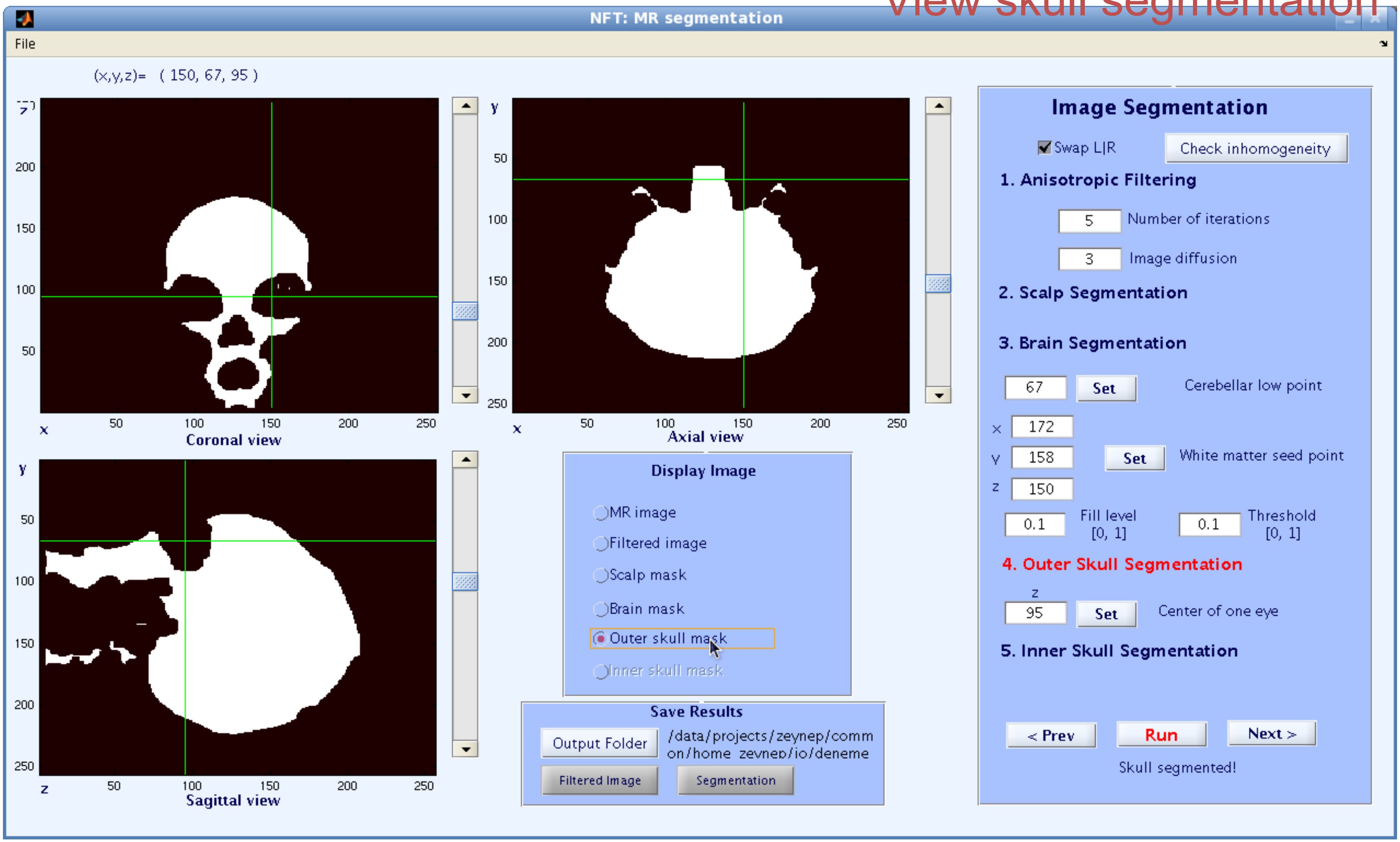


Segmentation



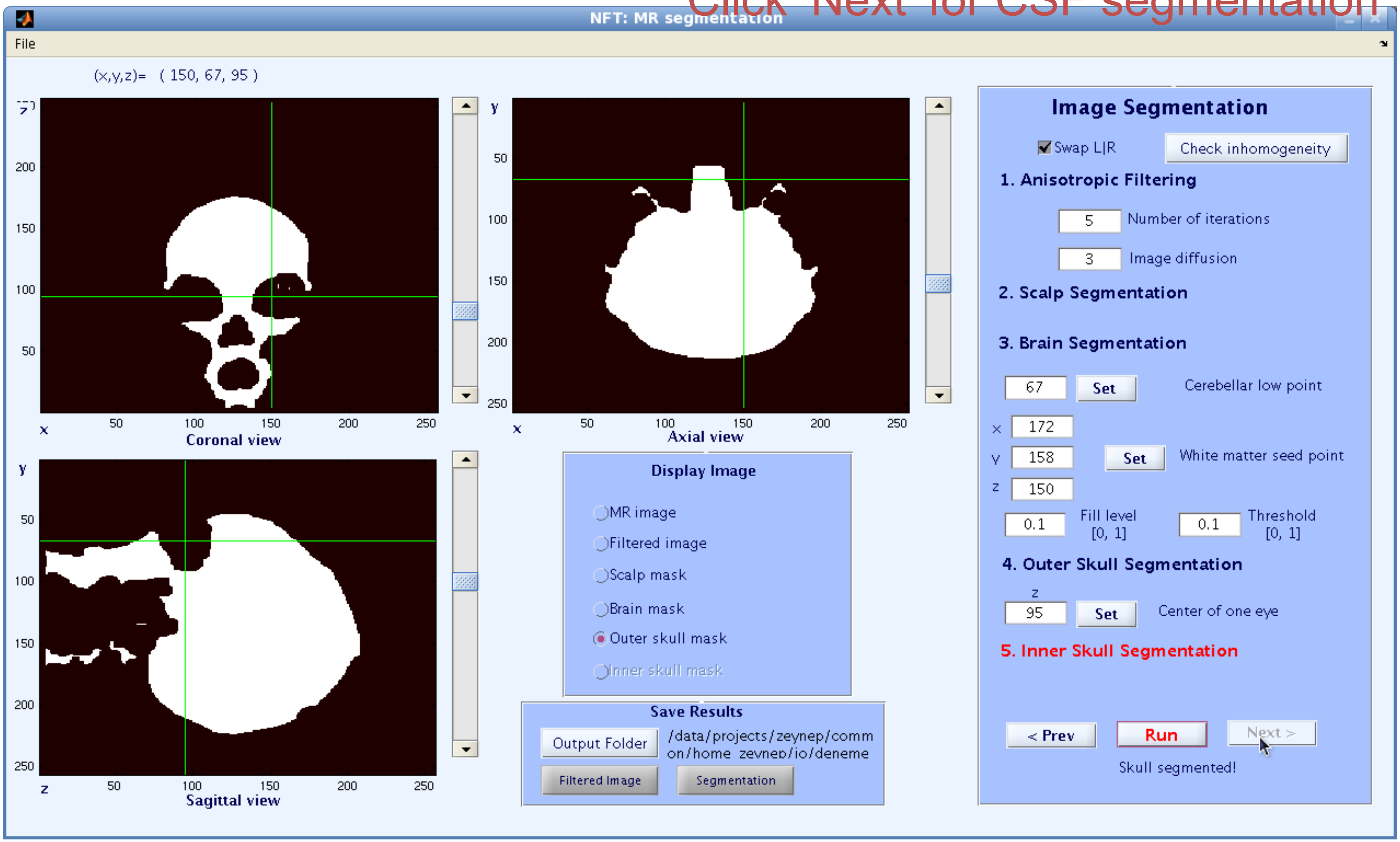
Segmentation

View skull segmentation



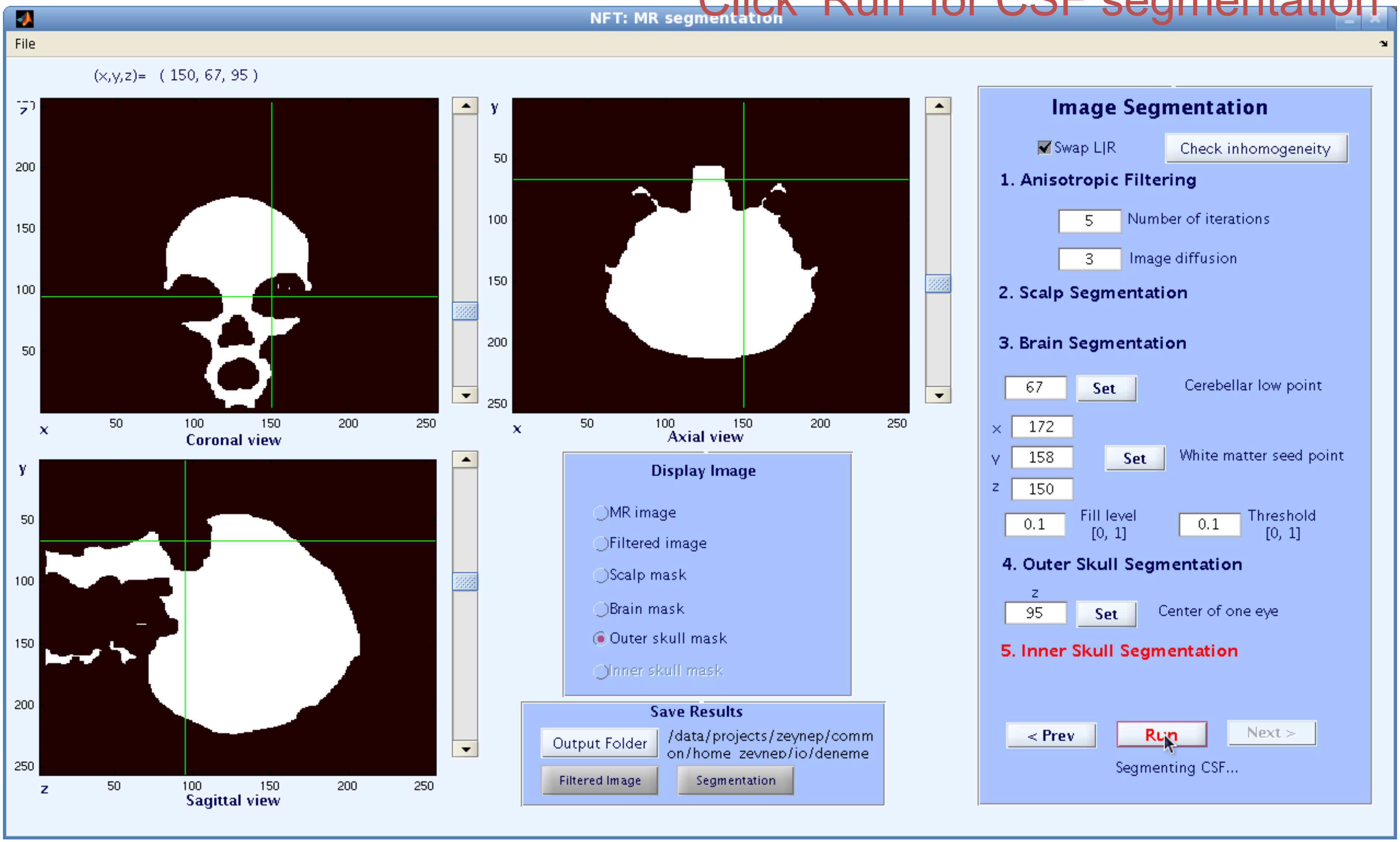
Segmentation

Click ‘Next’ for CSF segmentation

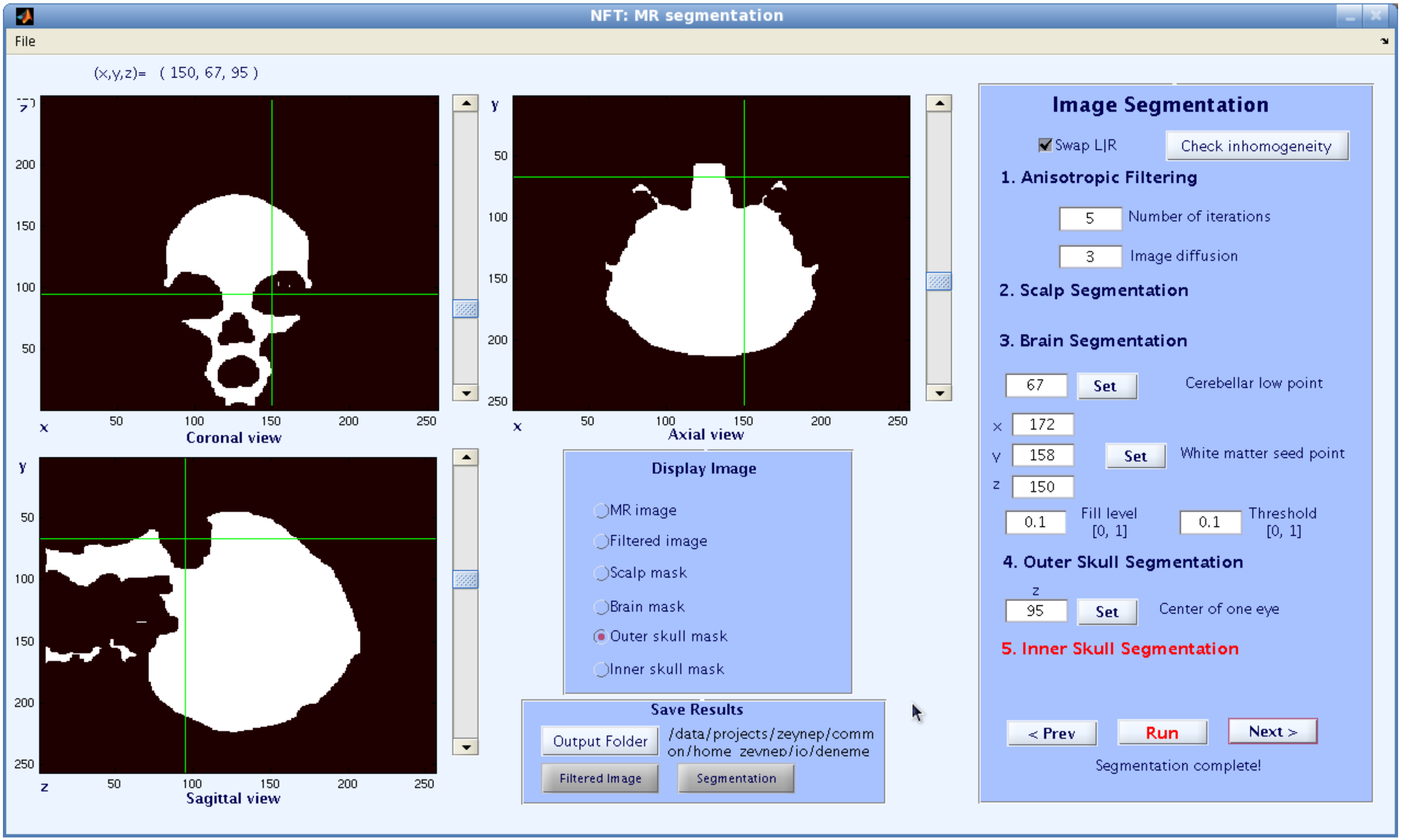


Segmentation

Click ‘Run’ for CSF segmentation

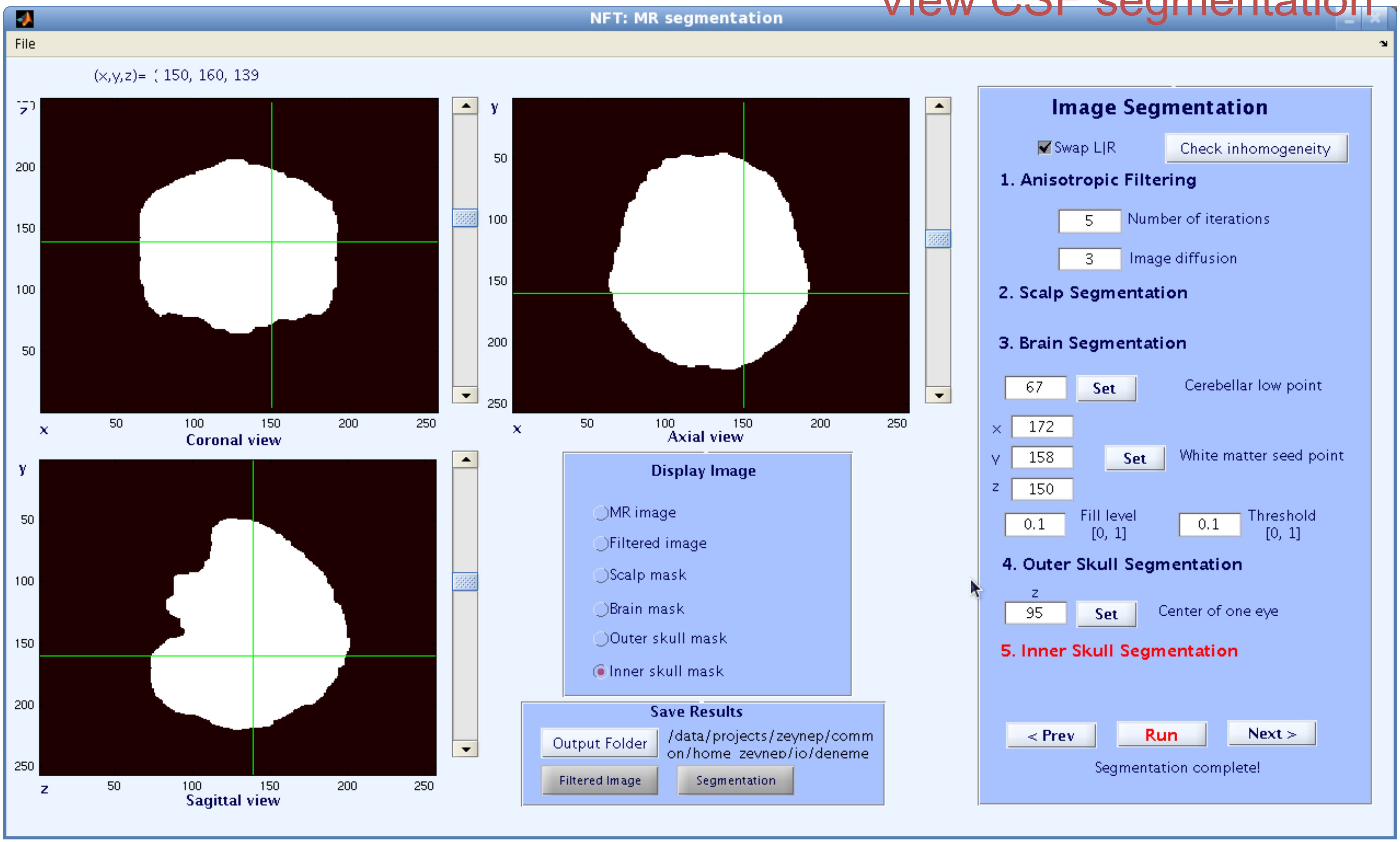


Segmentation



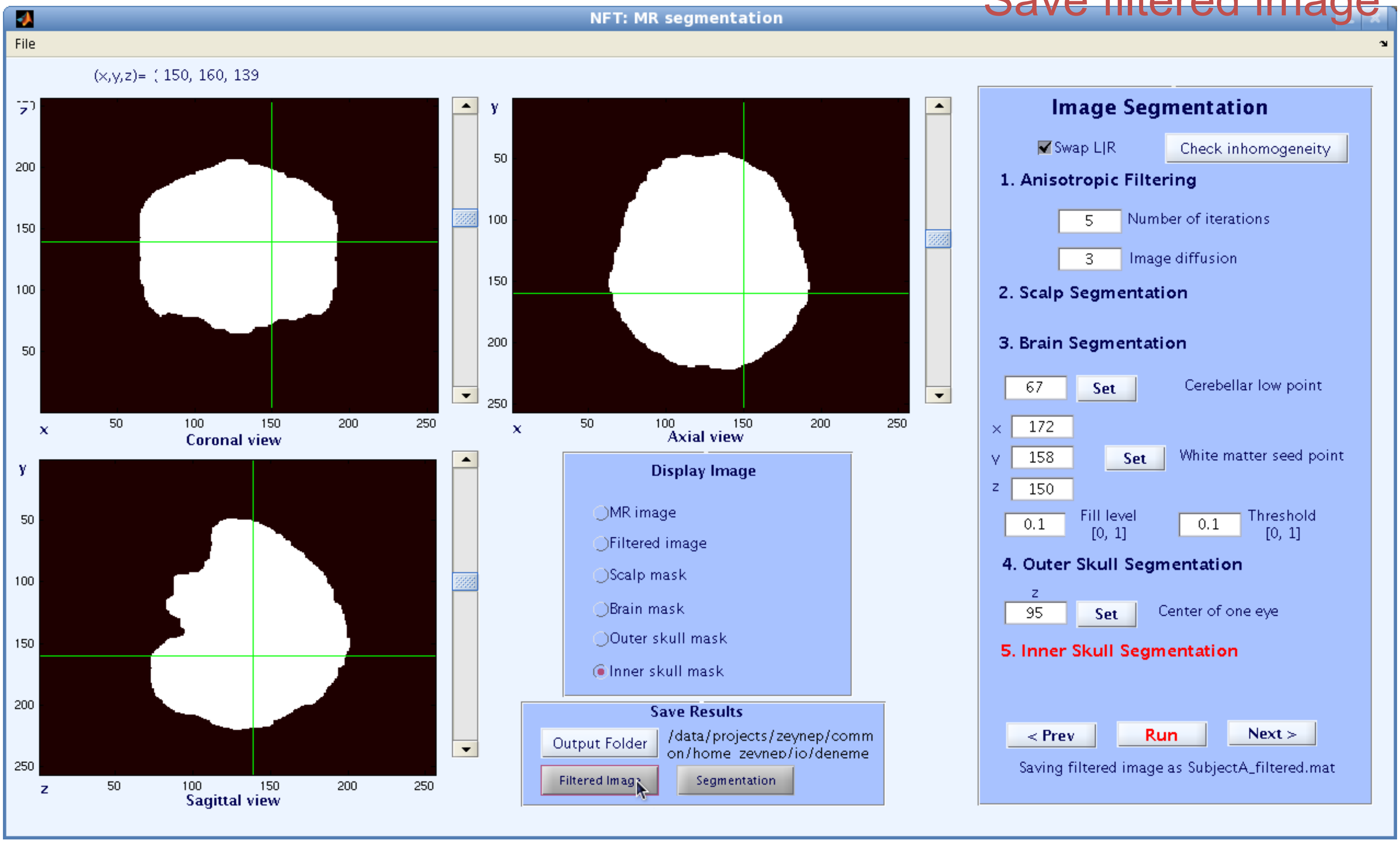
Segmentation

View CSF segmentation

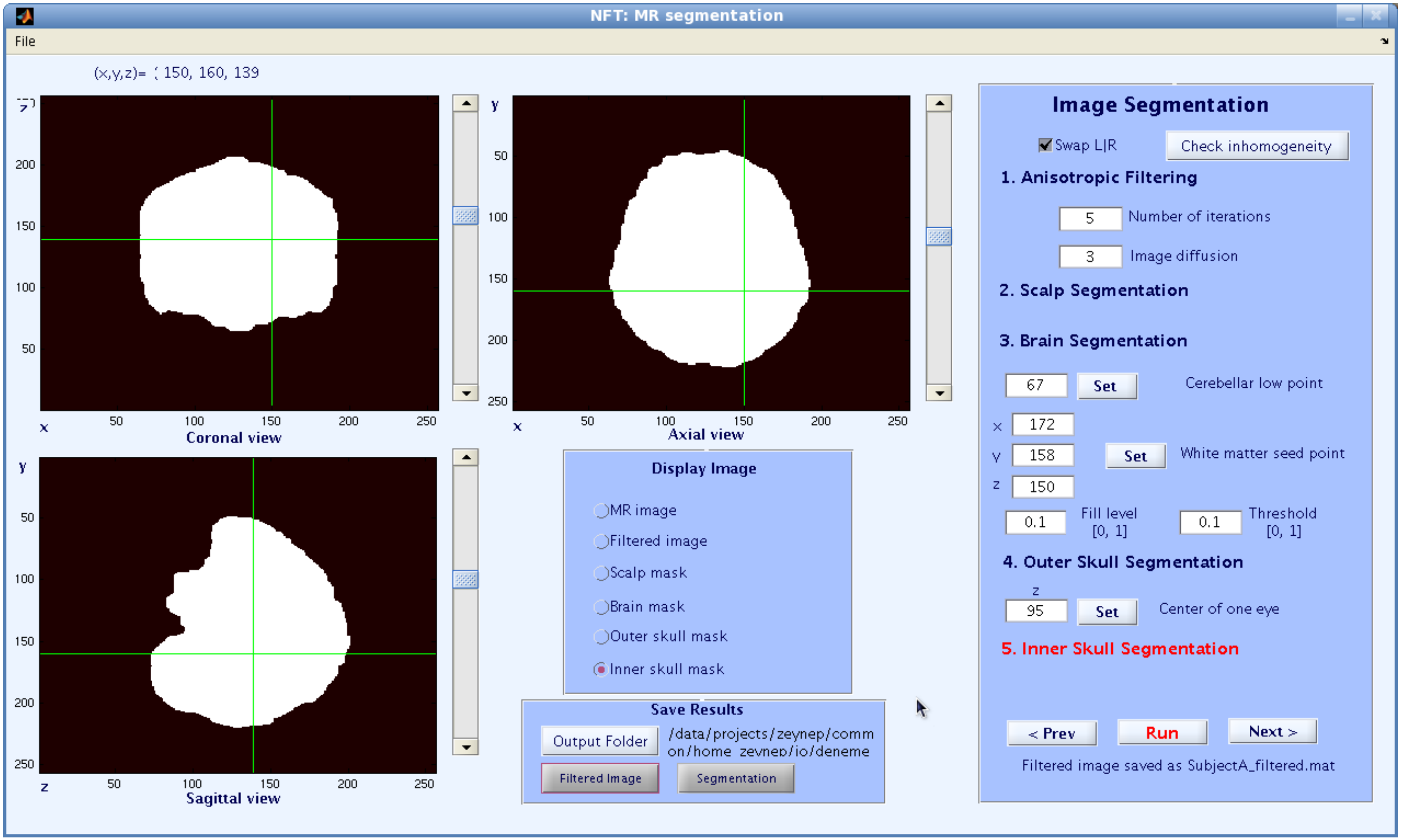


Segmentation

Save filtered image

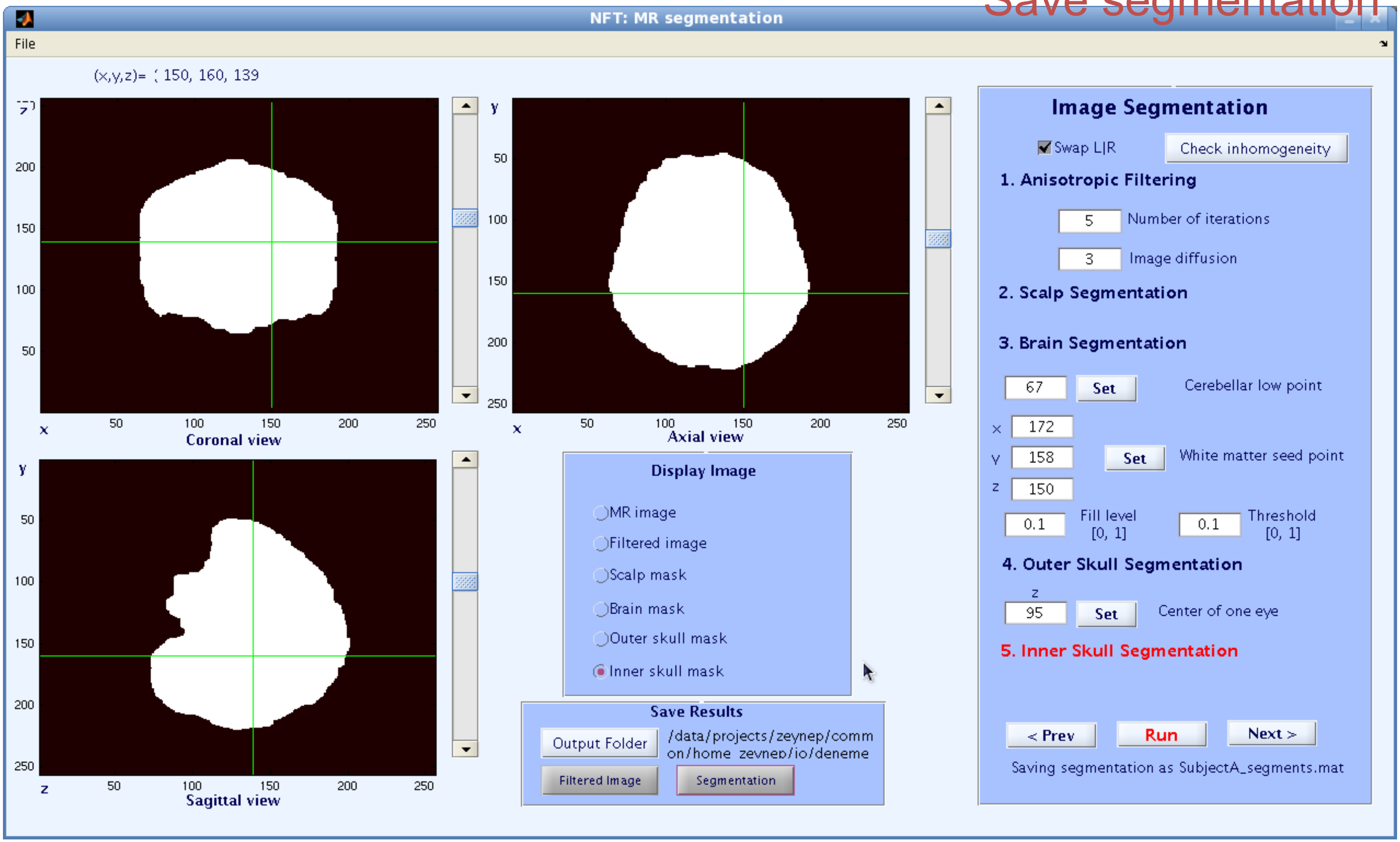


Segmentation



Segmentation

Save segmentation



Segmentation

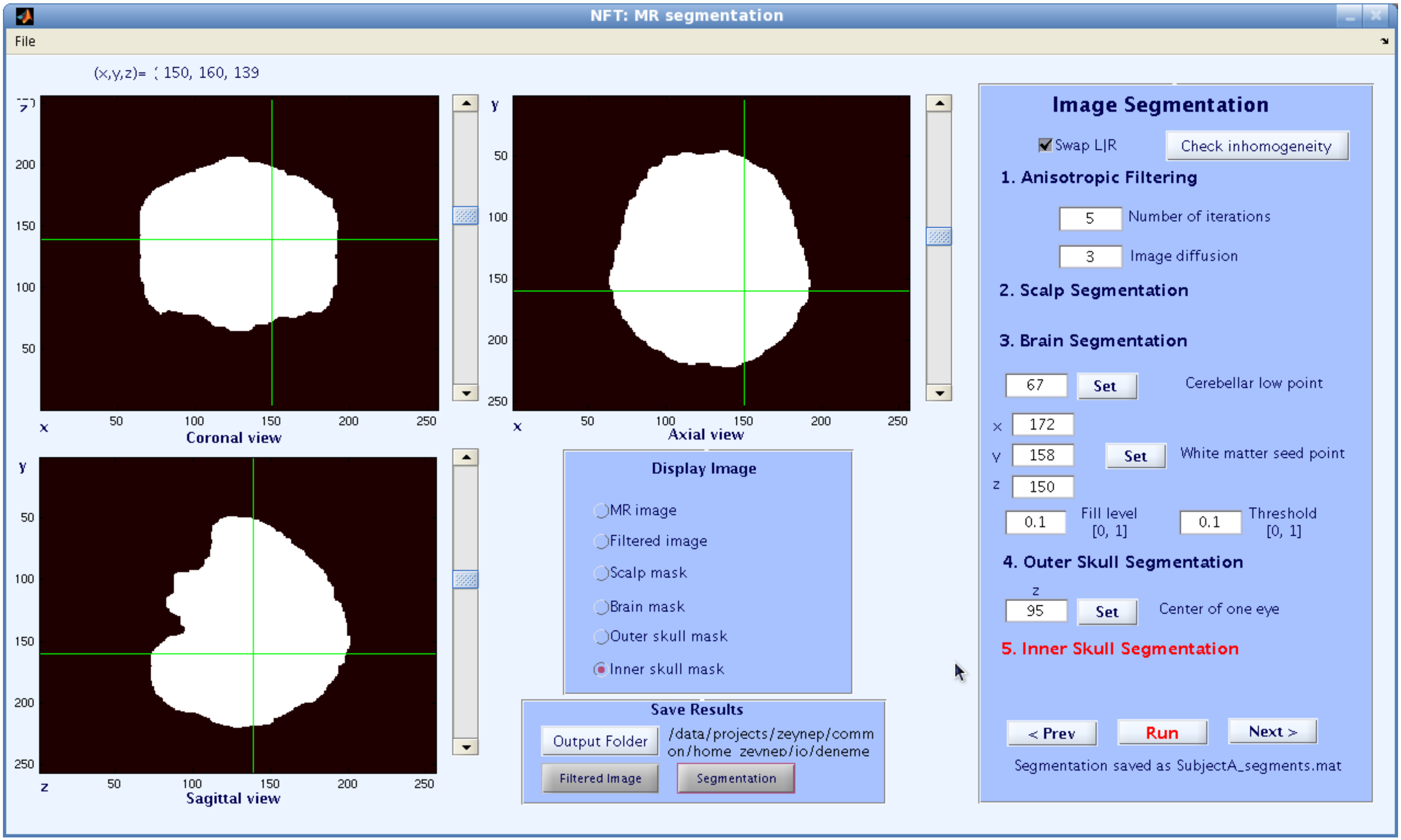
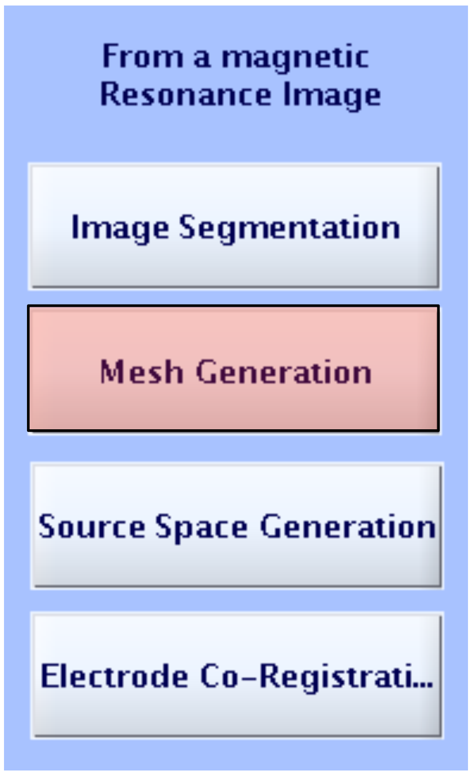
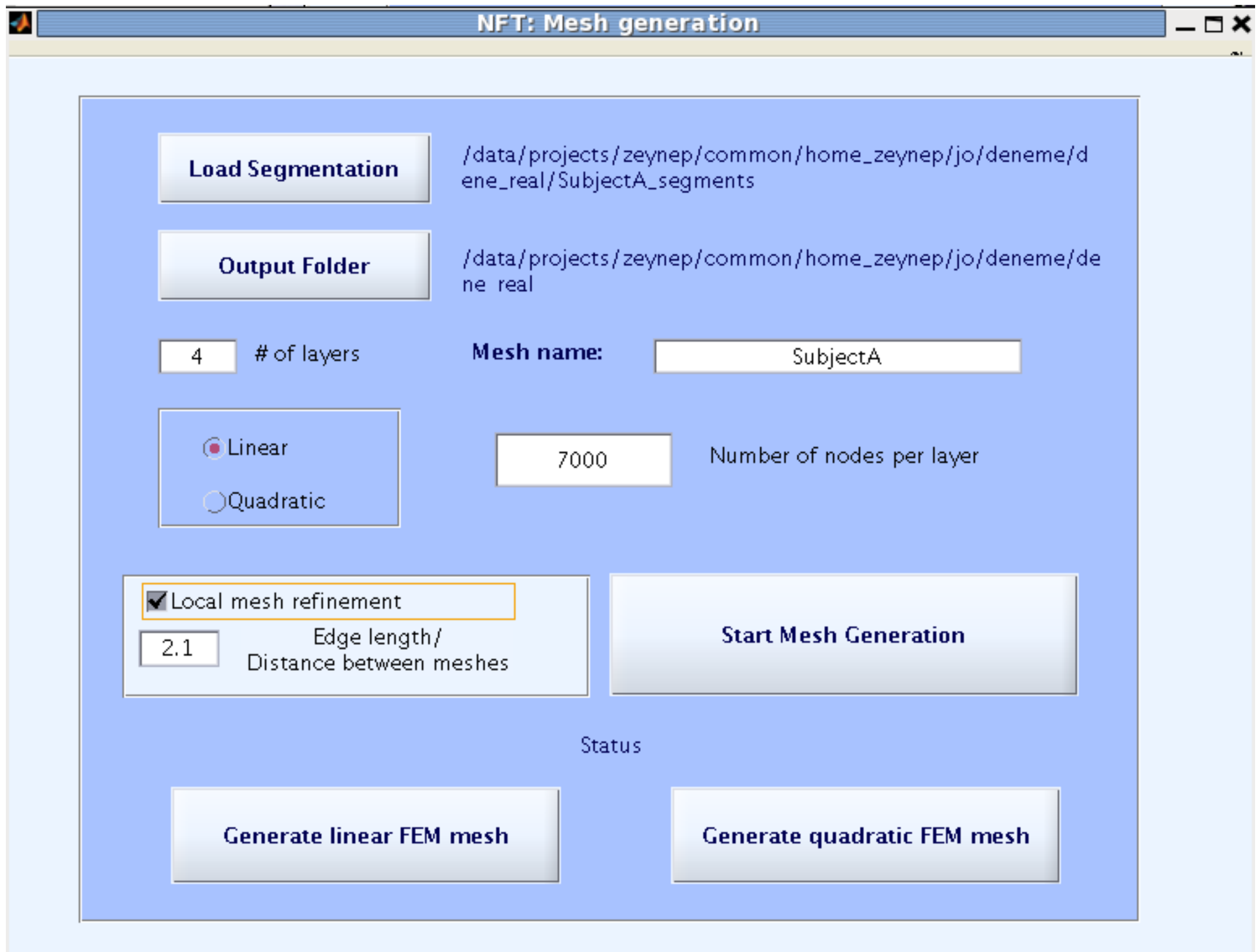


Image Segmentation

```
Command Window
New to MATLAB? Watch this Video, see Demos, or read Getting Started.

>> dir SubjectA*

SubjectA_mri.mat       SubjectA_segments.mat

>> load SubjectA_mri
>> mri

mri =

          dim: [256 256 256]
        xgrid: [1x256 double]
        ygrid: [1x256 double]
        zgrid: [1x256 double]
      anatomy: [256x256x256 double]
    transform: [4x4 double]
          hdr: []

>> load SubjectA_segments
>> Segm

Segm =

         scalpmask: [256x256x256 logical]
         brainmask: [256x256x256 logical]
    outerskullmask: [256x256x256 logical]
    innerskullmask: [256x256x256 logical]

>> 
```

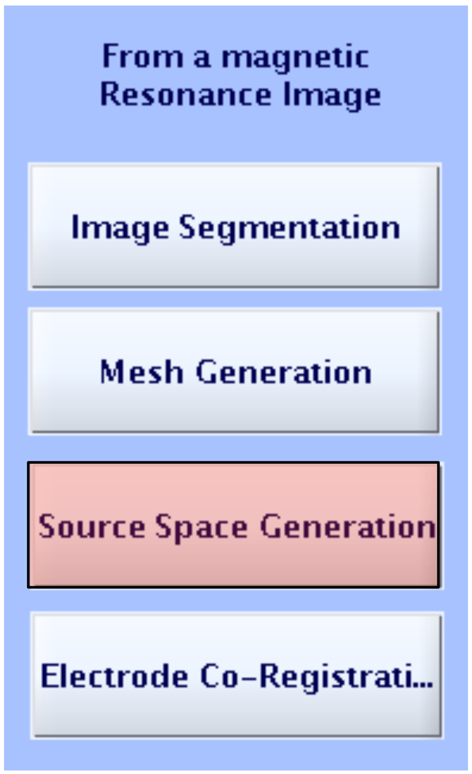
Mesh Generation

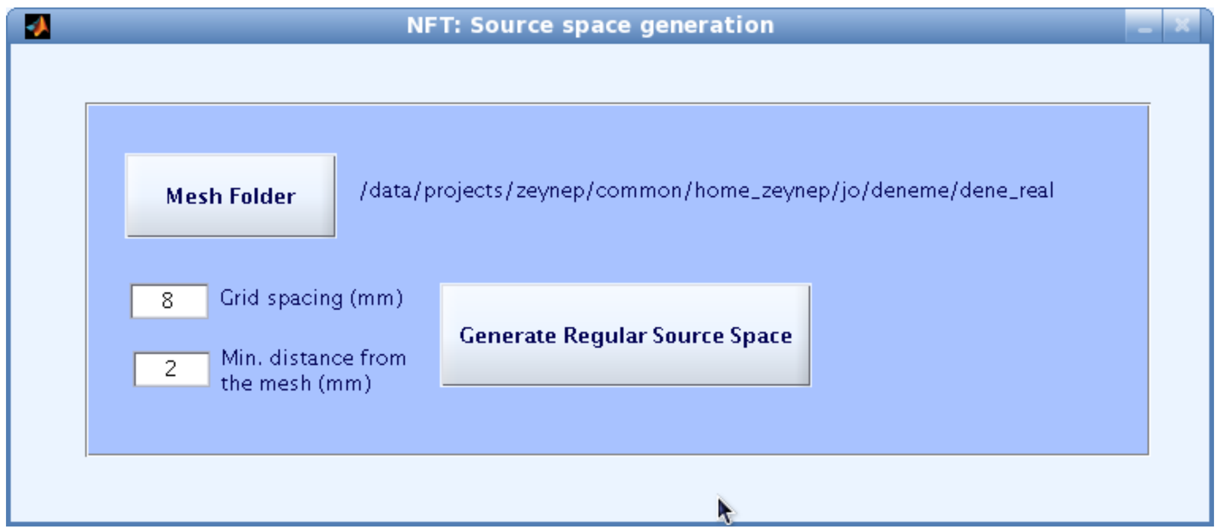




Generate Mesh for a 3 or 4 layer head model

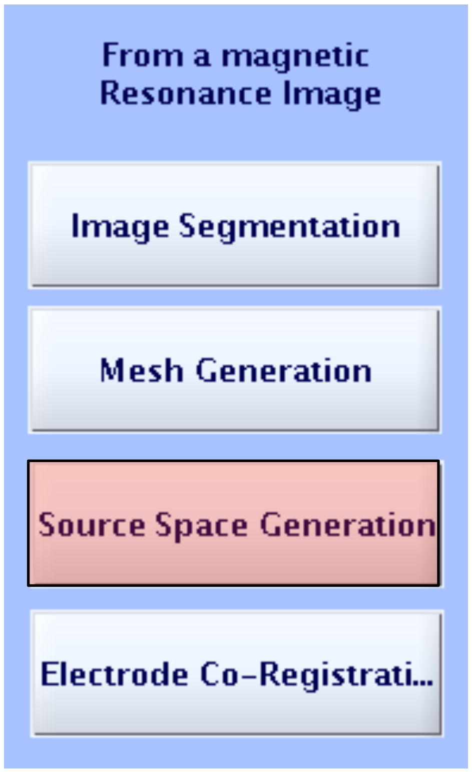
Source Space Generation

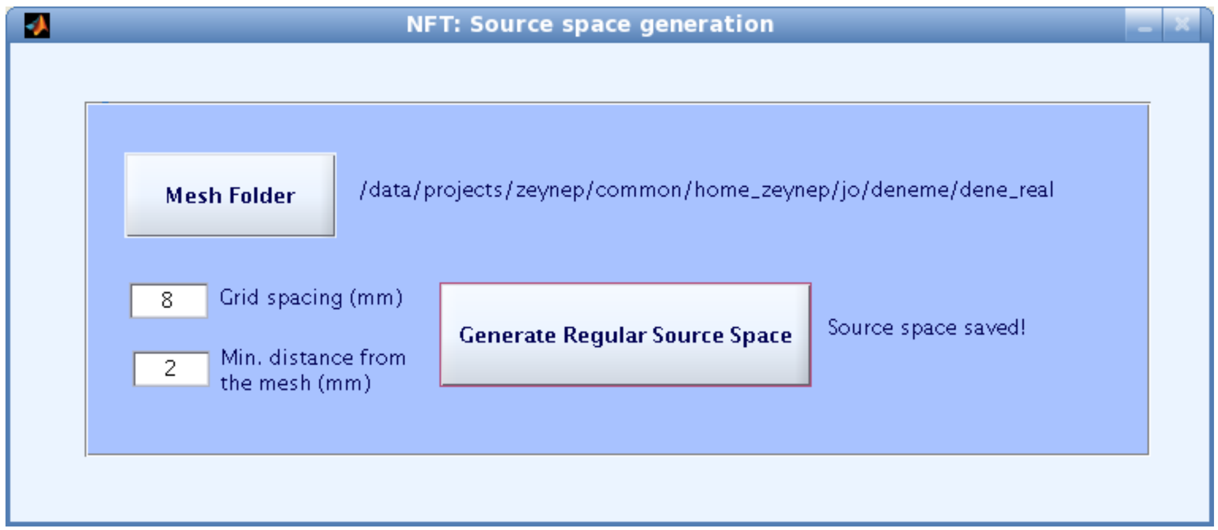




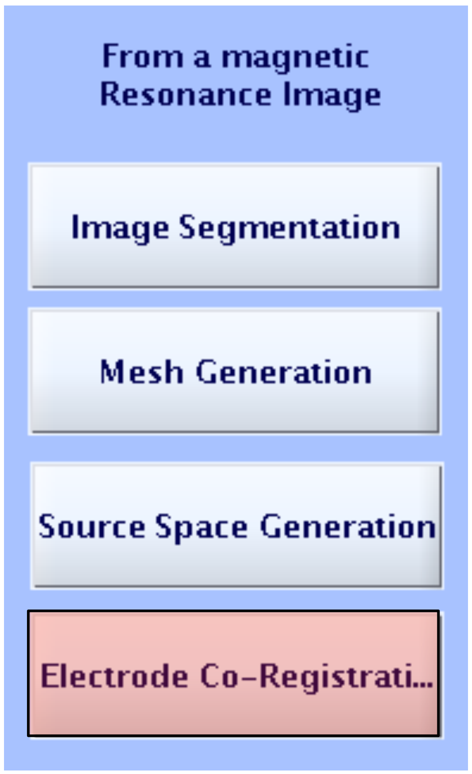
Generates a simple source space:
Regular Grid inside the brain
With a given spacing and distance to the mesh

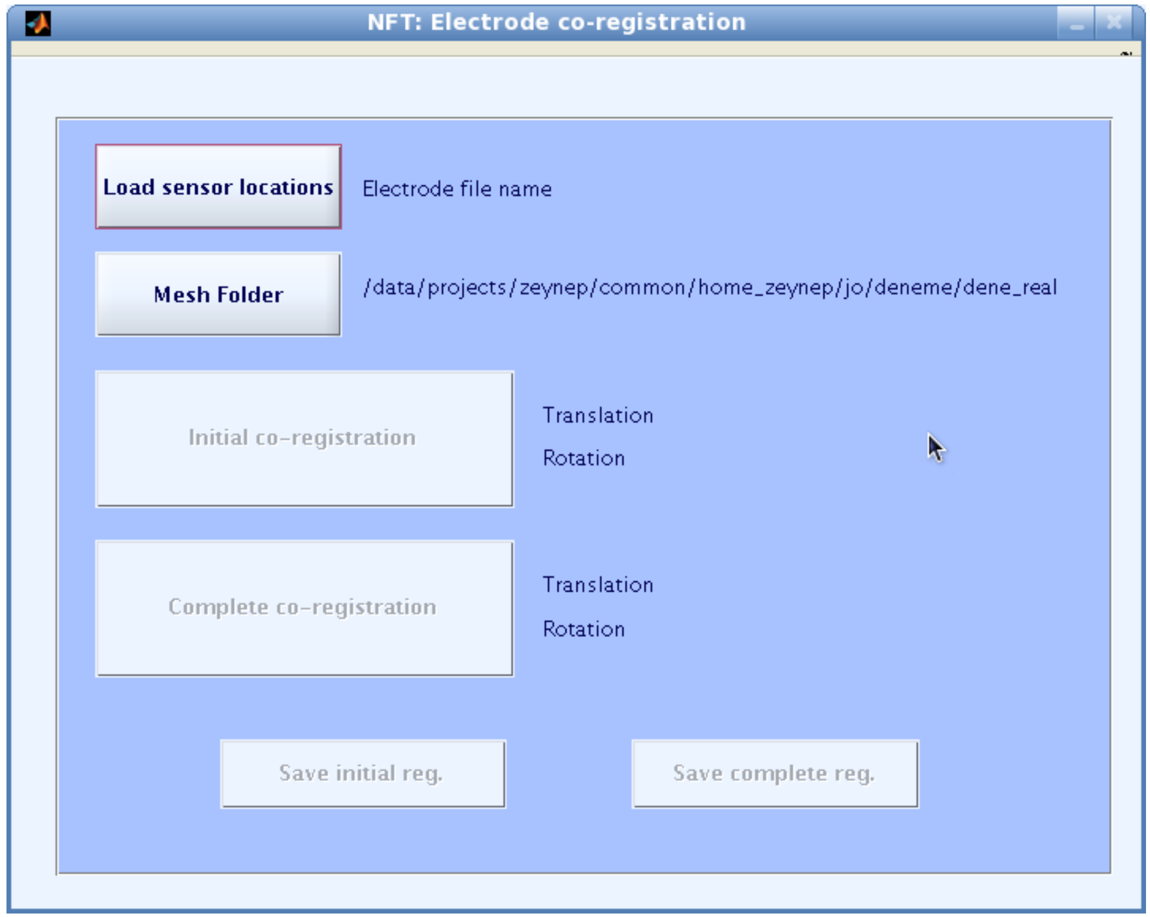
Source Space Generation



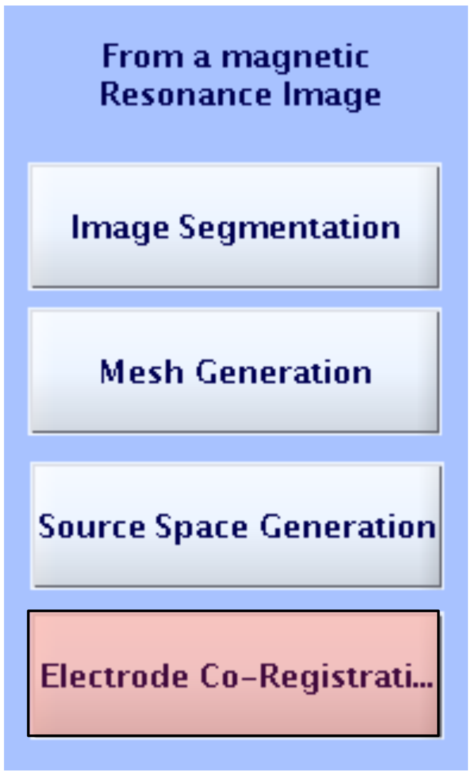


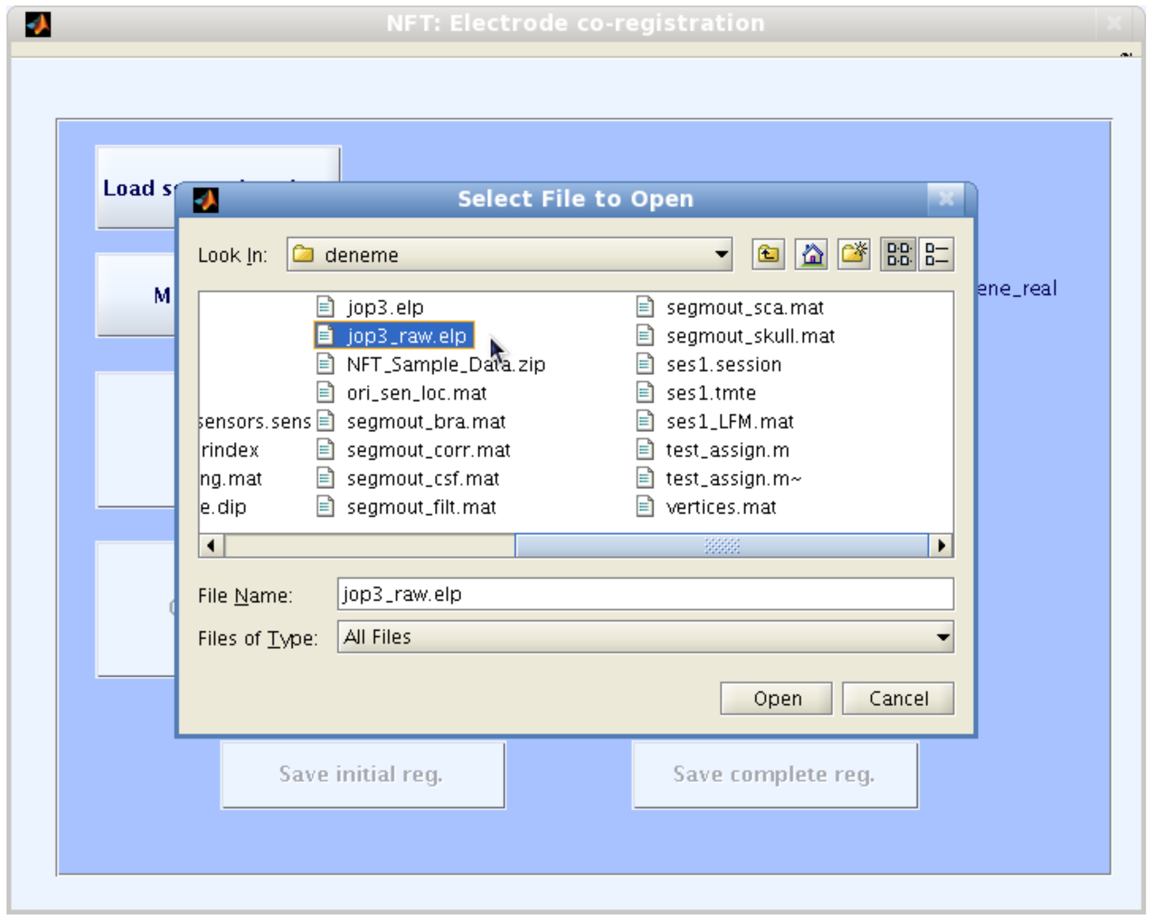
Electrode Co-registration



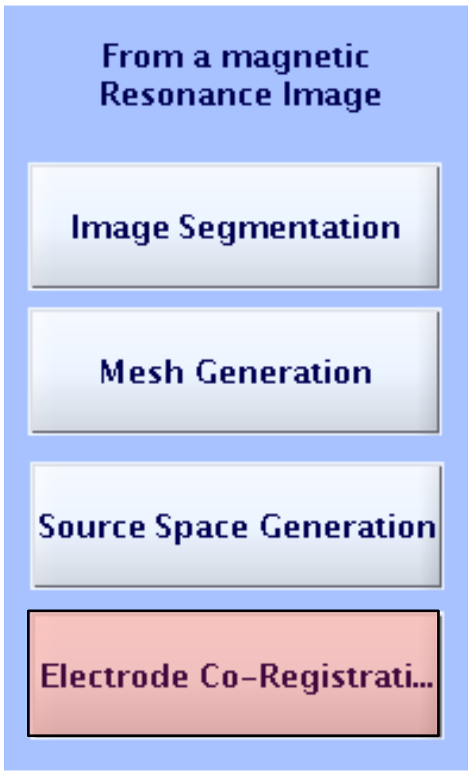


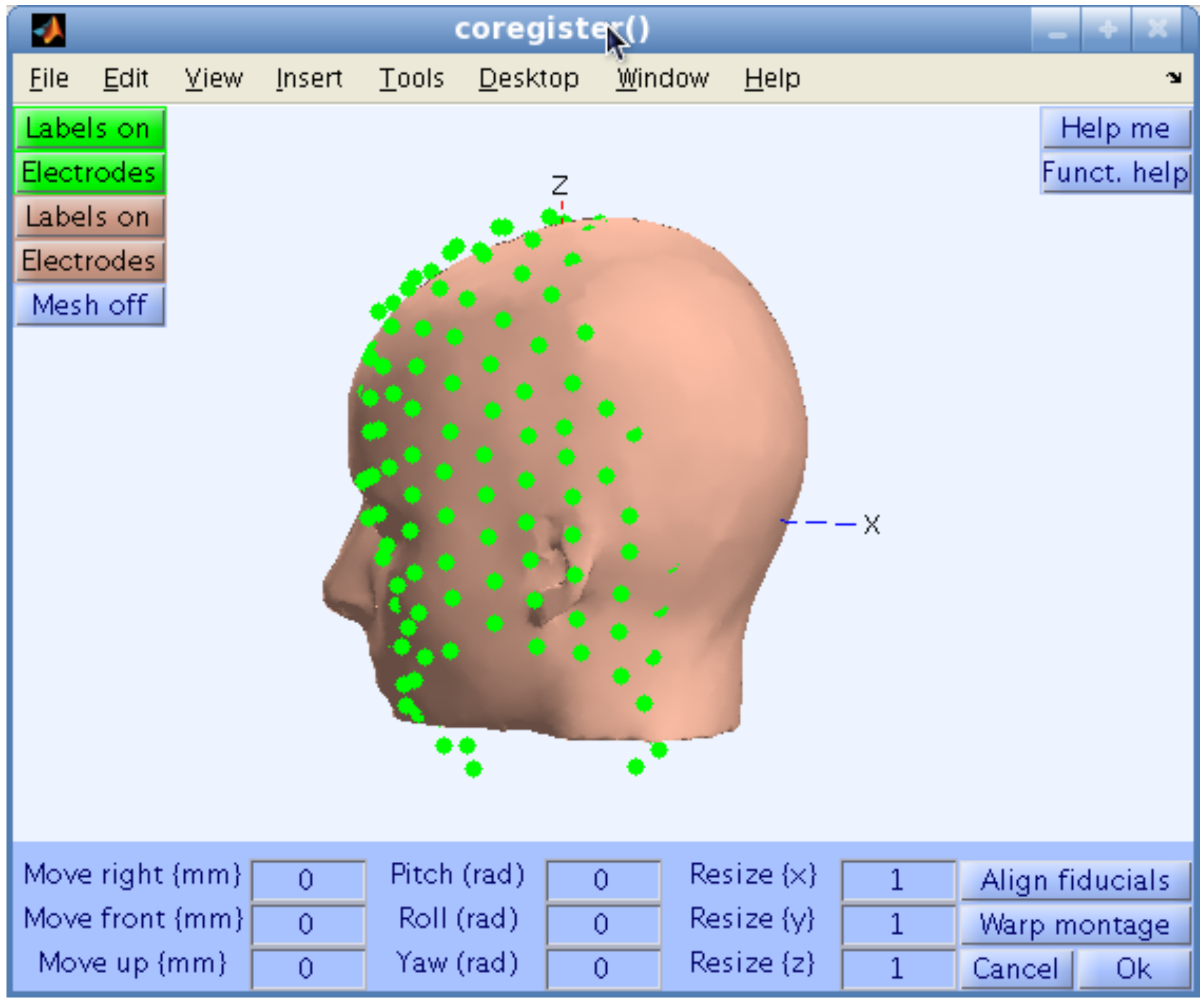
Electrode Co-registration



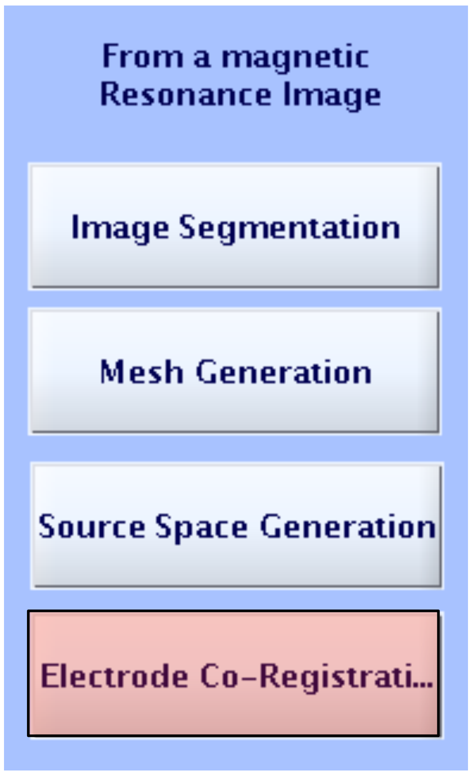


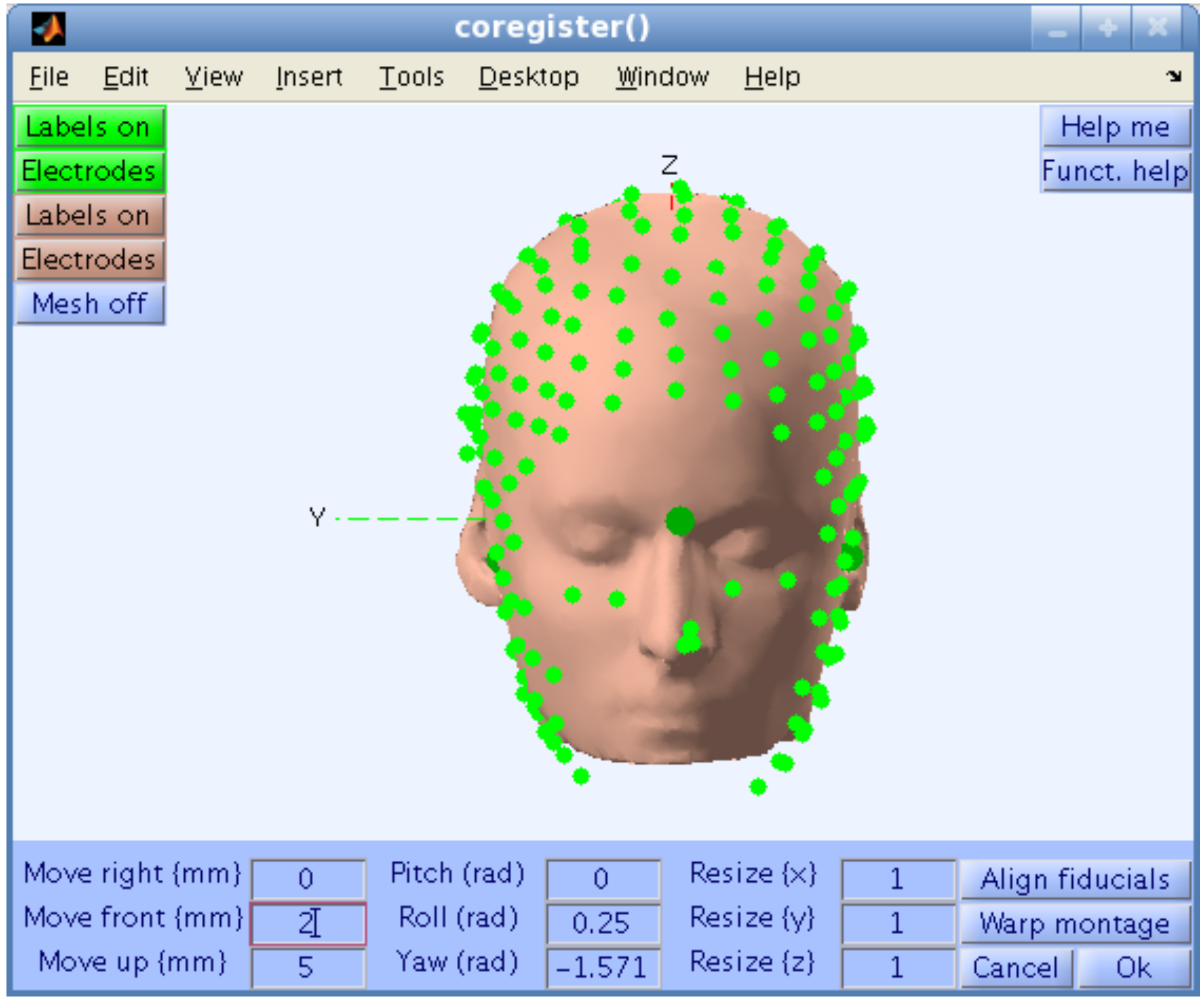
Electrode Co-registration



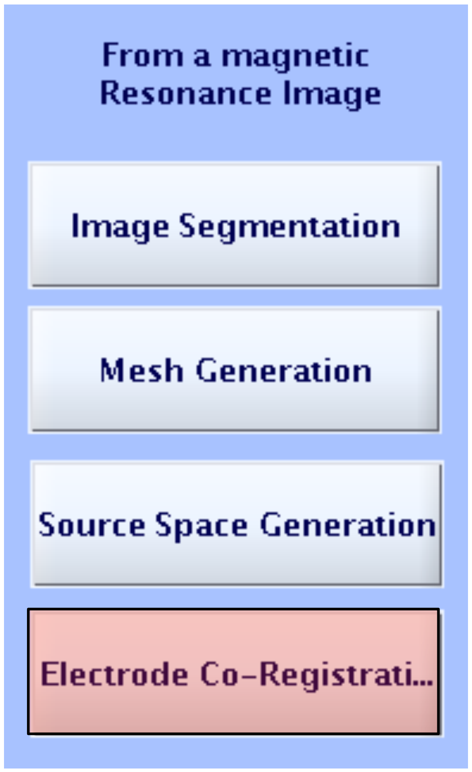


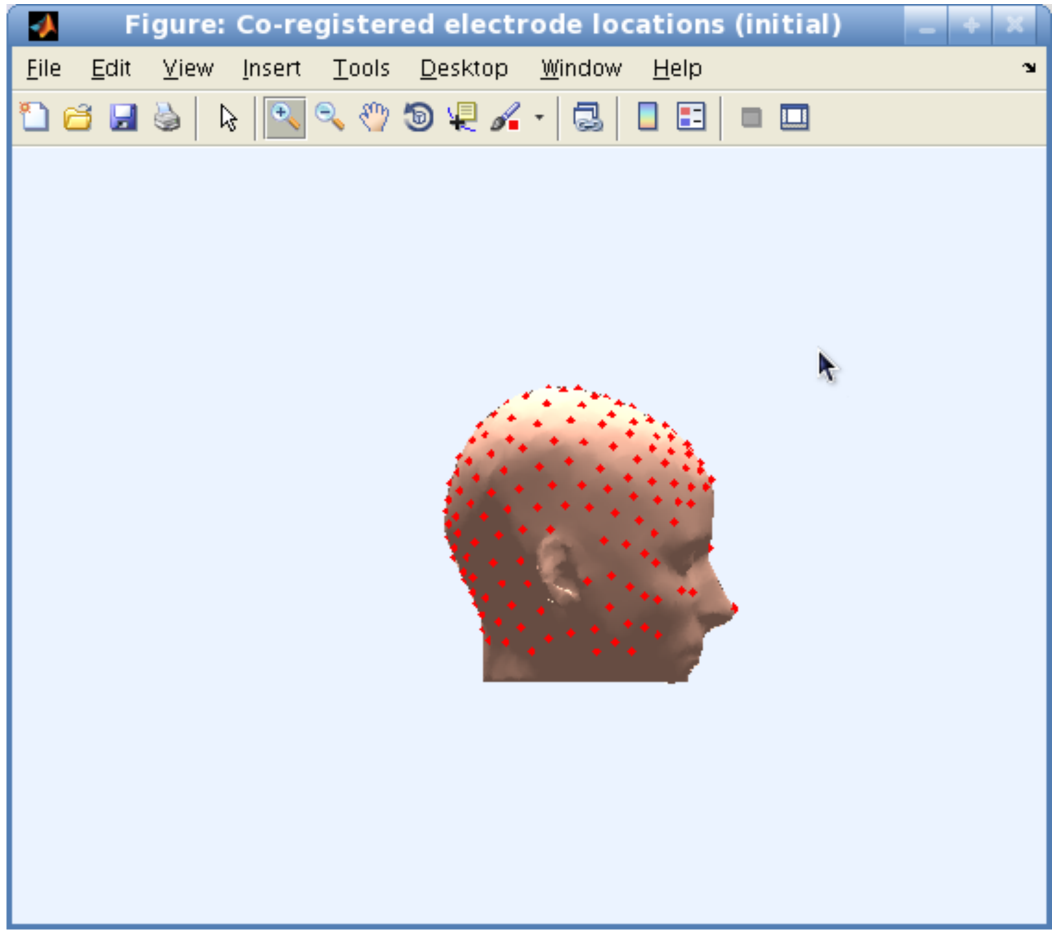
Electrode Co-registration



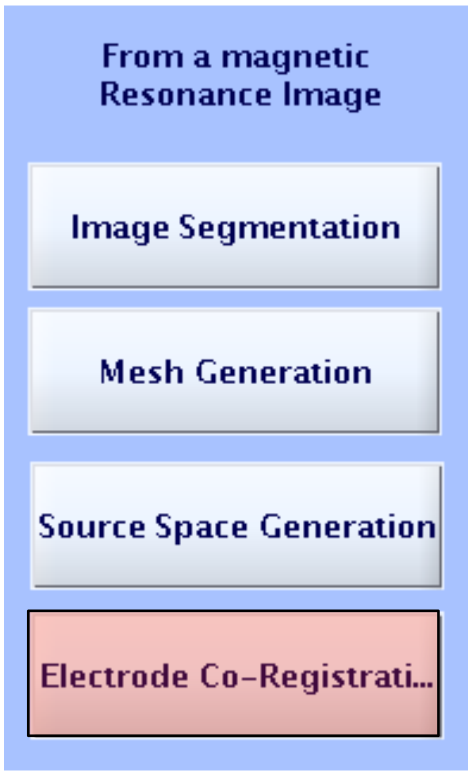


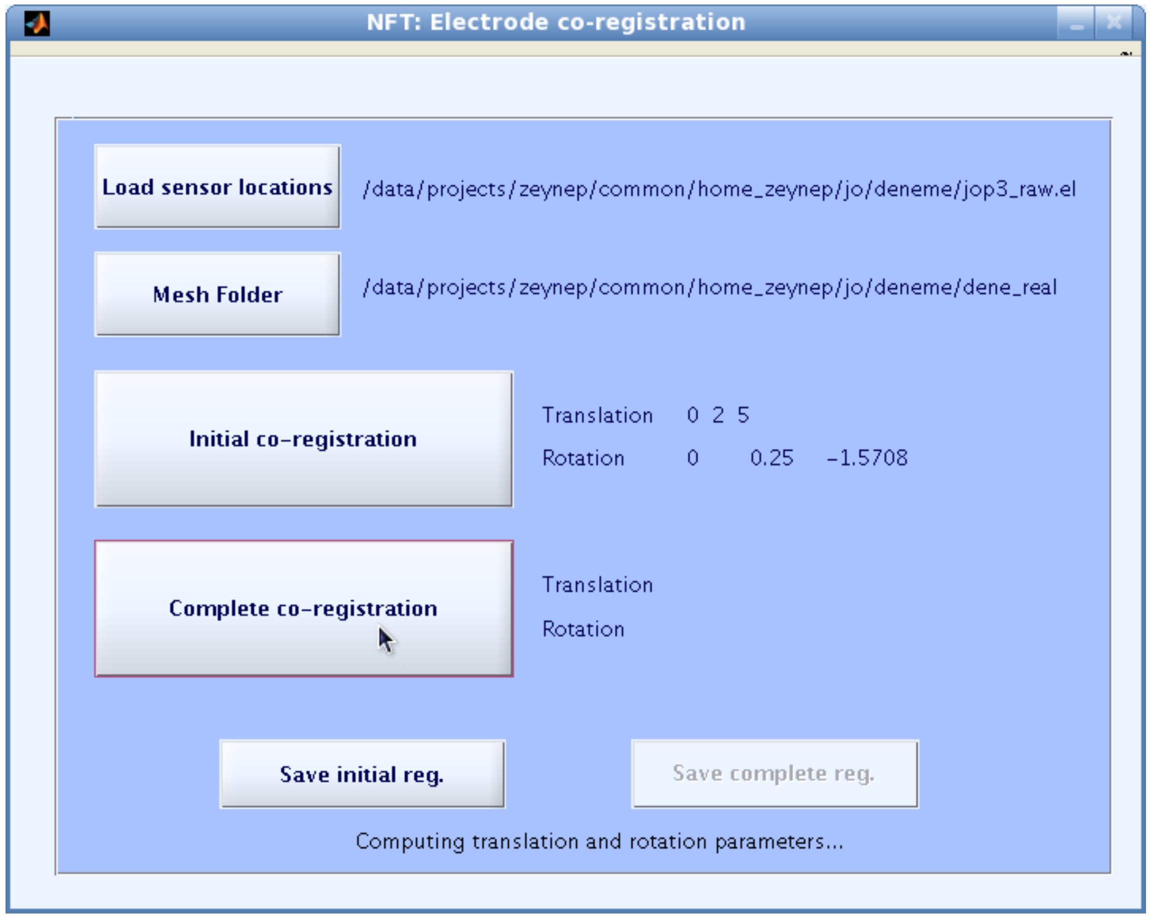
Electrode Co-registration



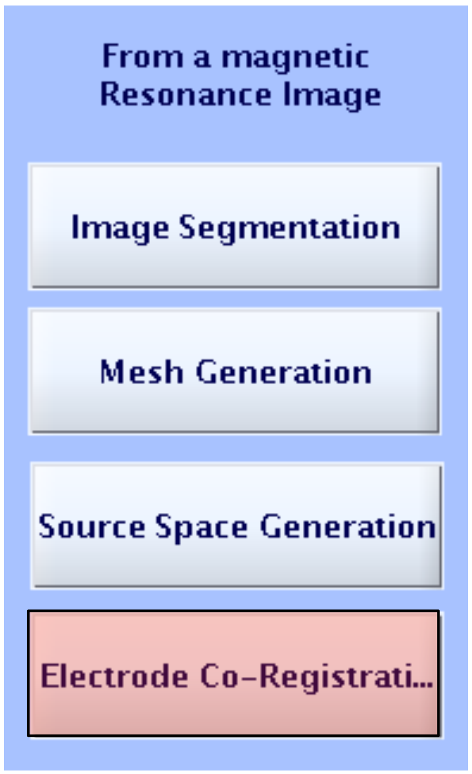


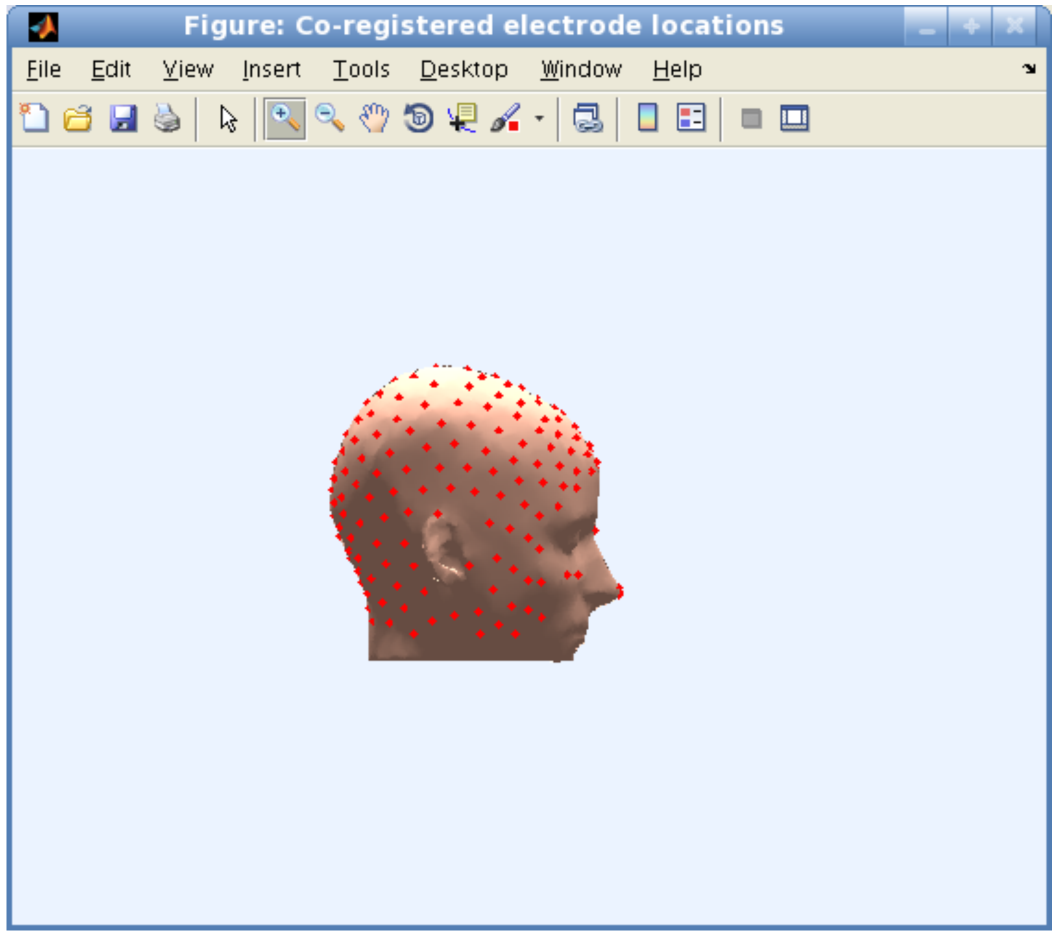
Electrode Co-registration



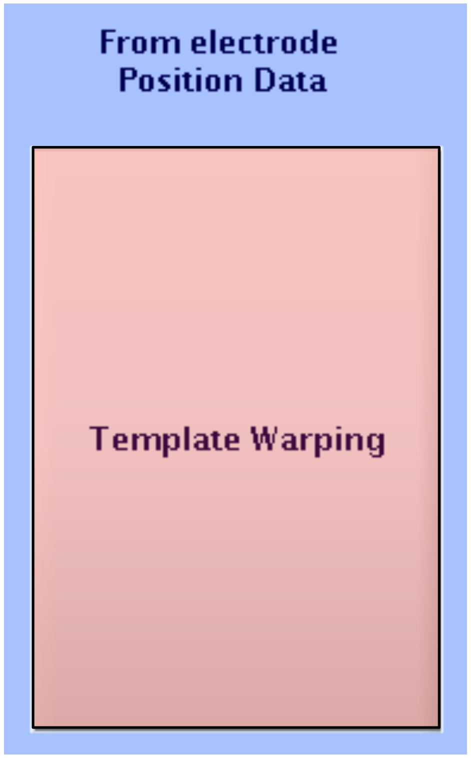


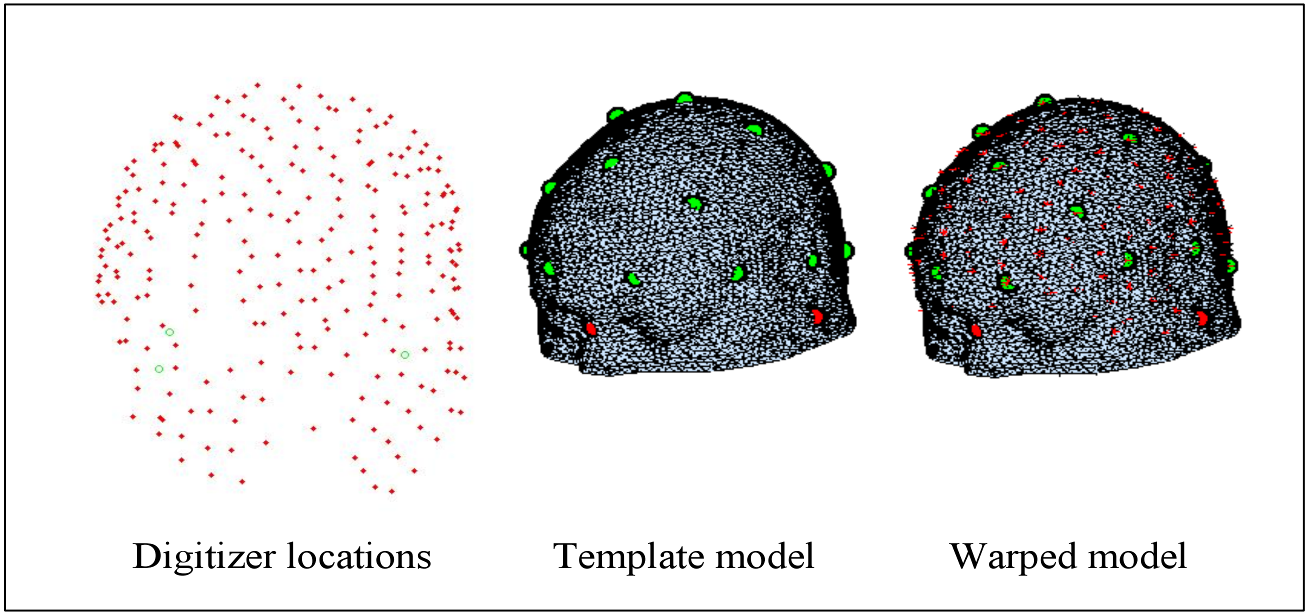
Electrode Co-registration





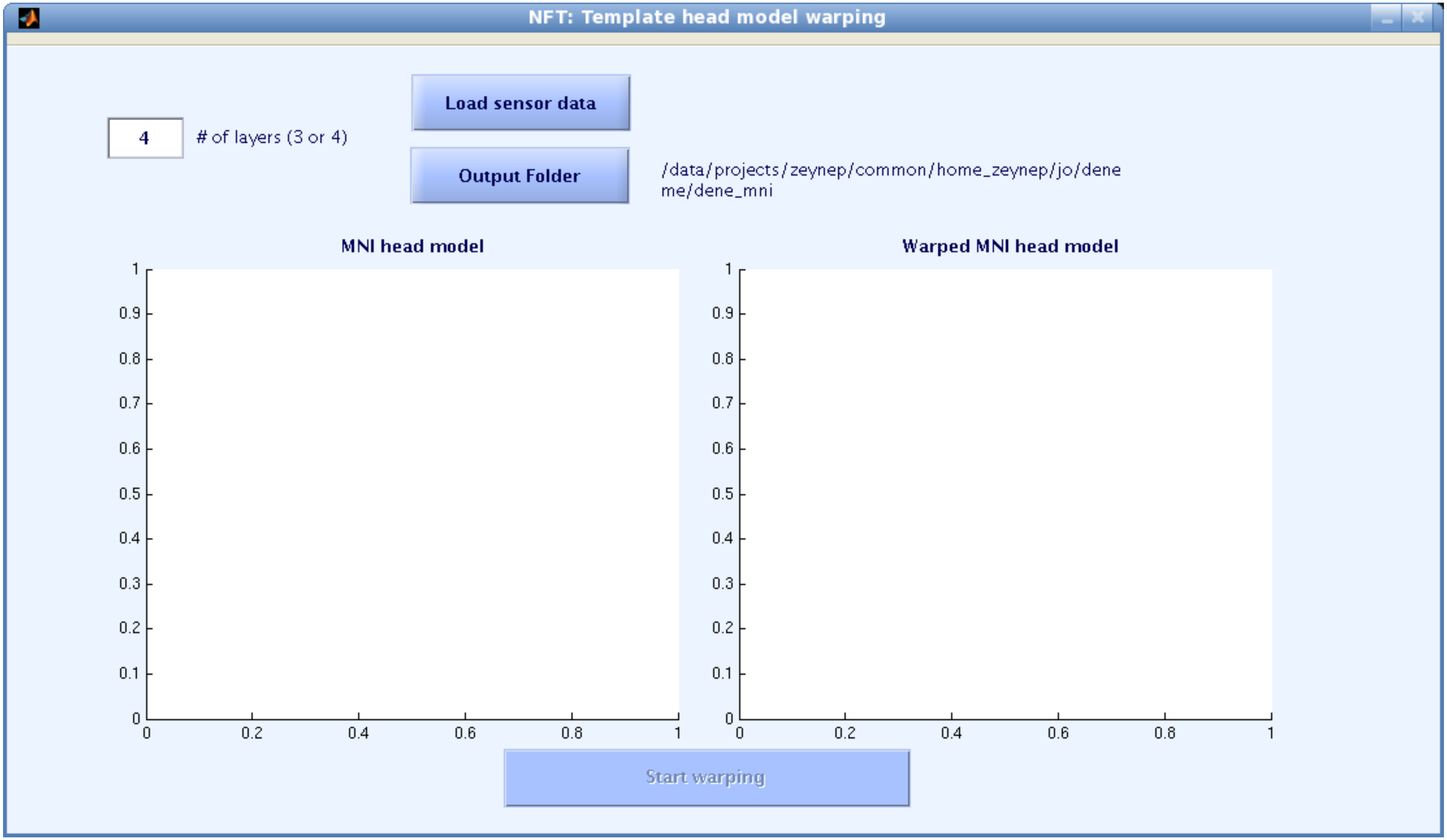
Head Modeling from Electrode Position Data



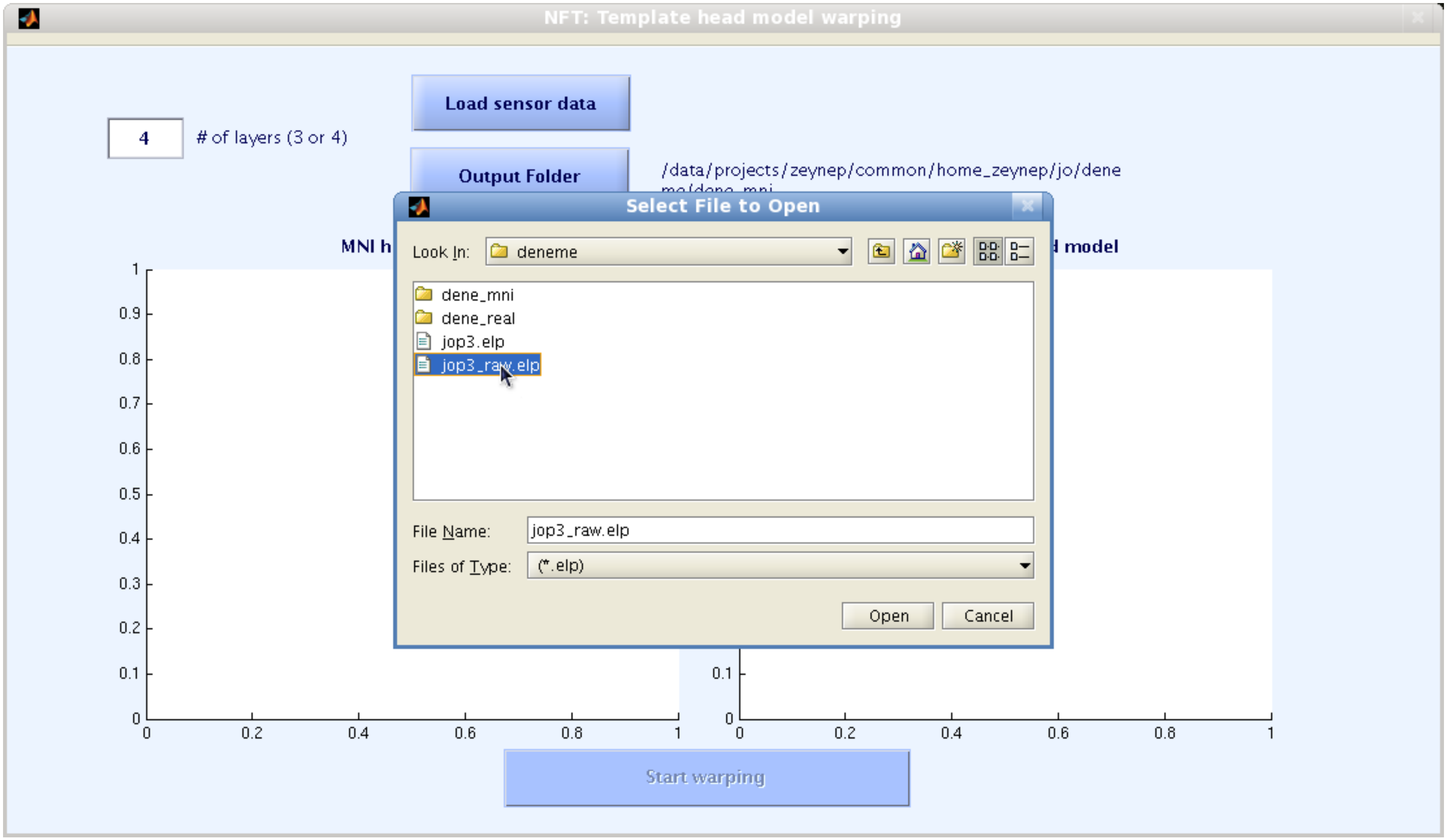


- Warp a template mesh to electrode positions
  - When no MR images are available
  - Non-rigid thin-plate spline warping

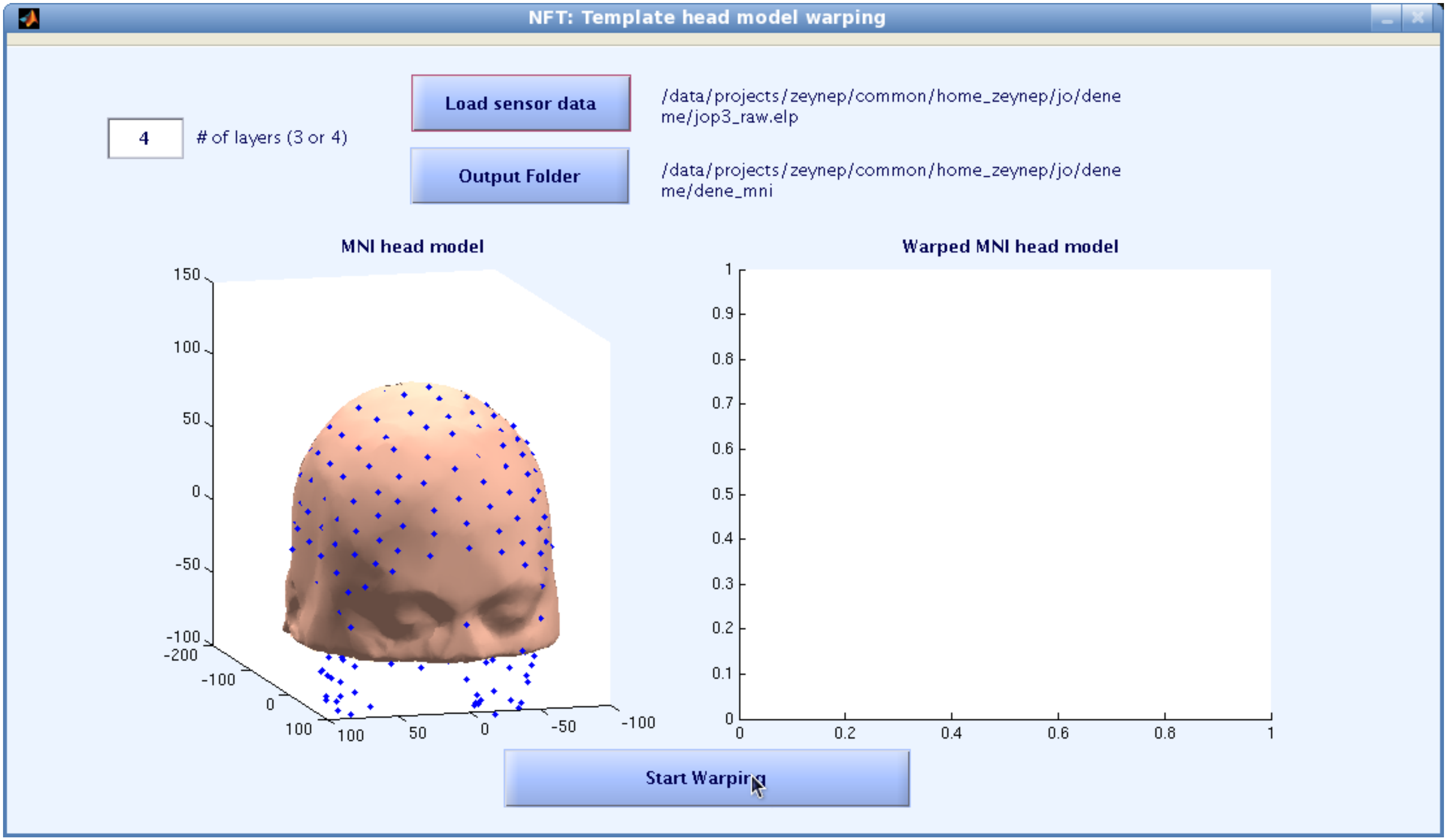
Template Warping



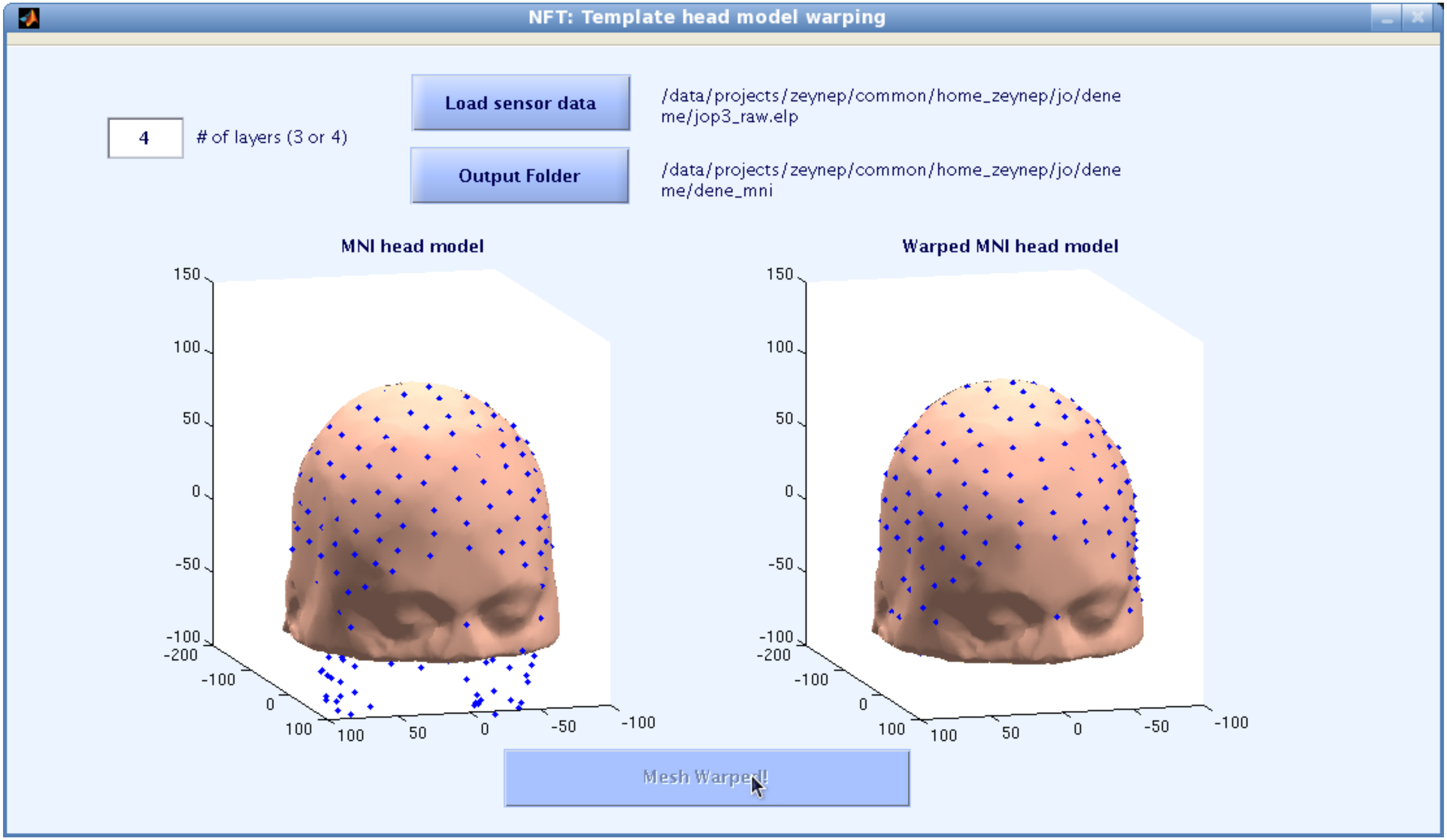
Template Warping



Template Warping



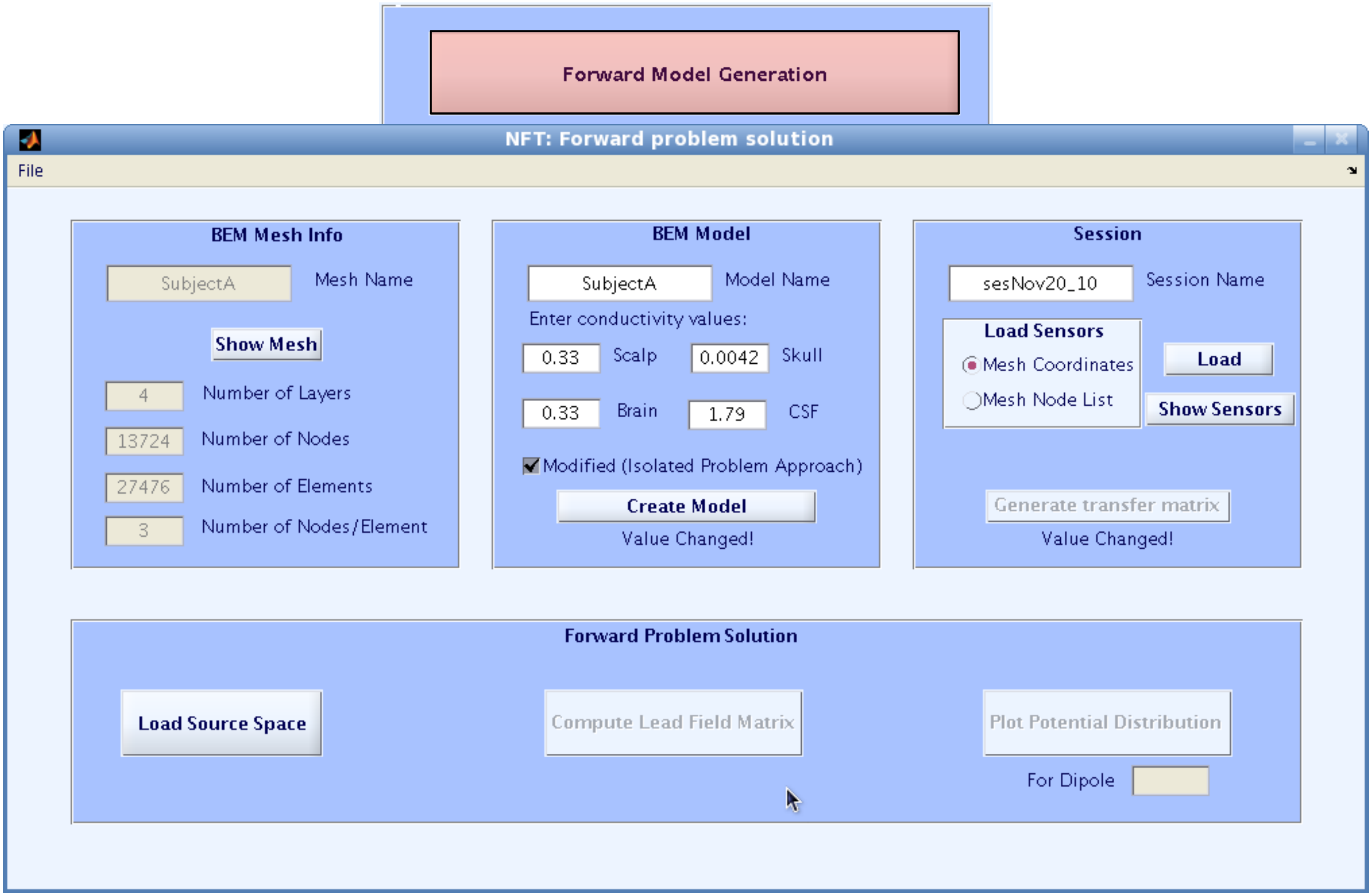
Template Warping



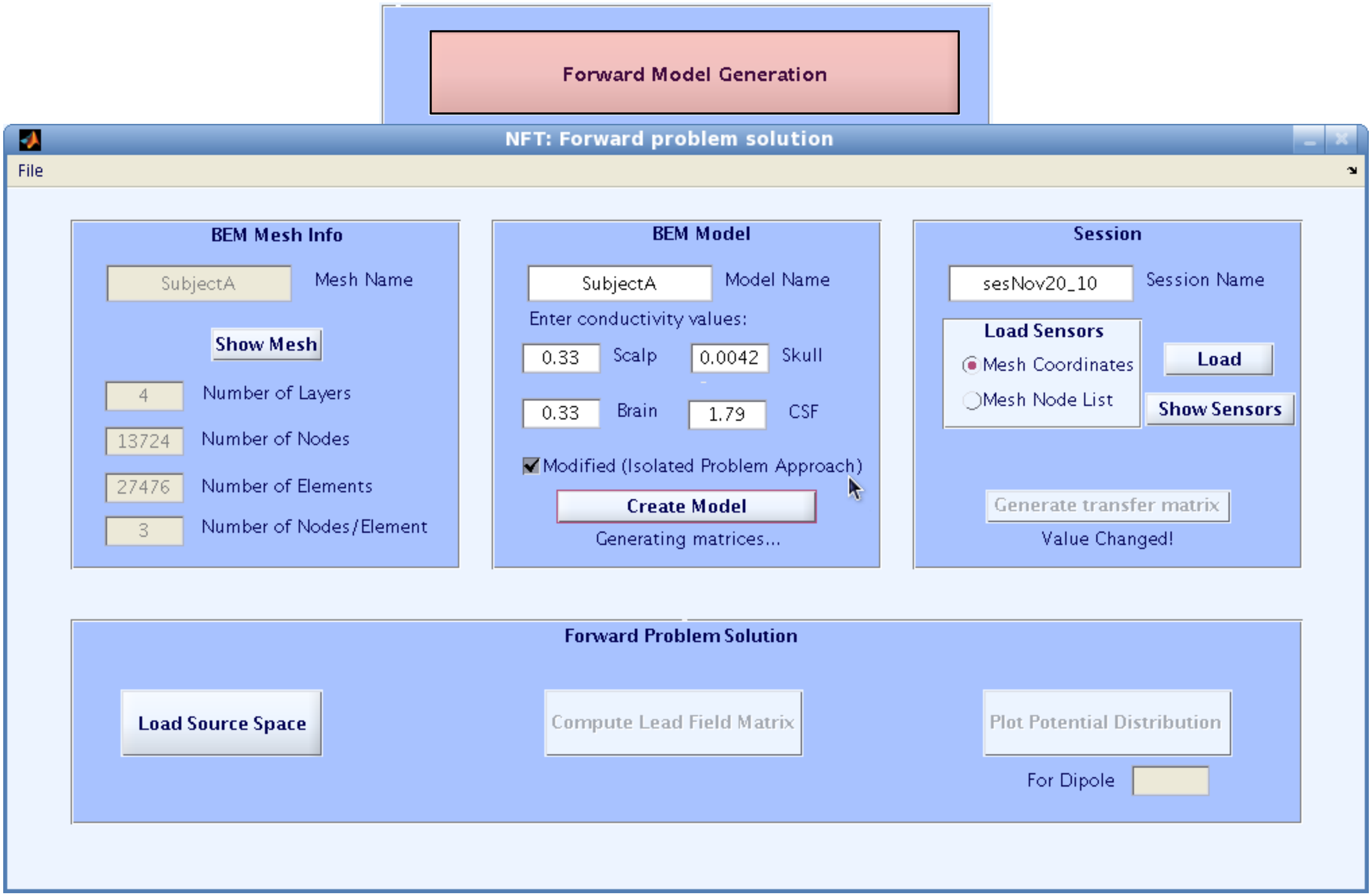
Forward Problem Solver

- MATLAB interface to numerical solvers
- Boundary Element Method or Finite Element Method
  - EEG Only (for now)
  - Interfaces to the Matrix generator executable written in C++
- Other computation done in MATLAB
- Generated matrices are stored on disk for future use.

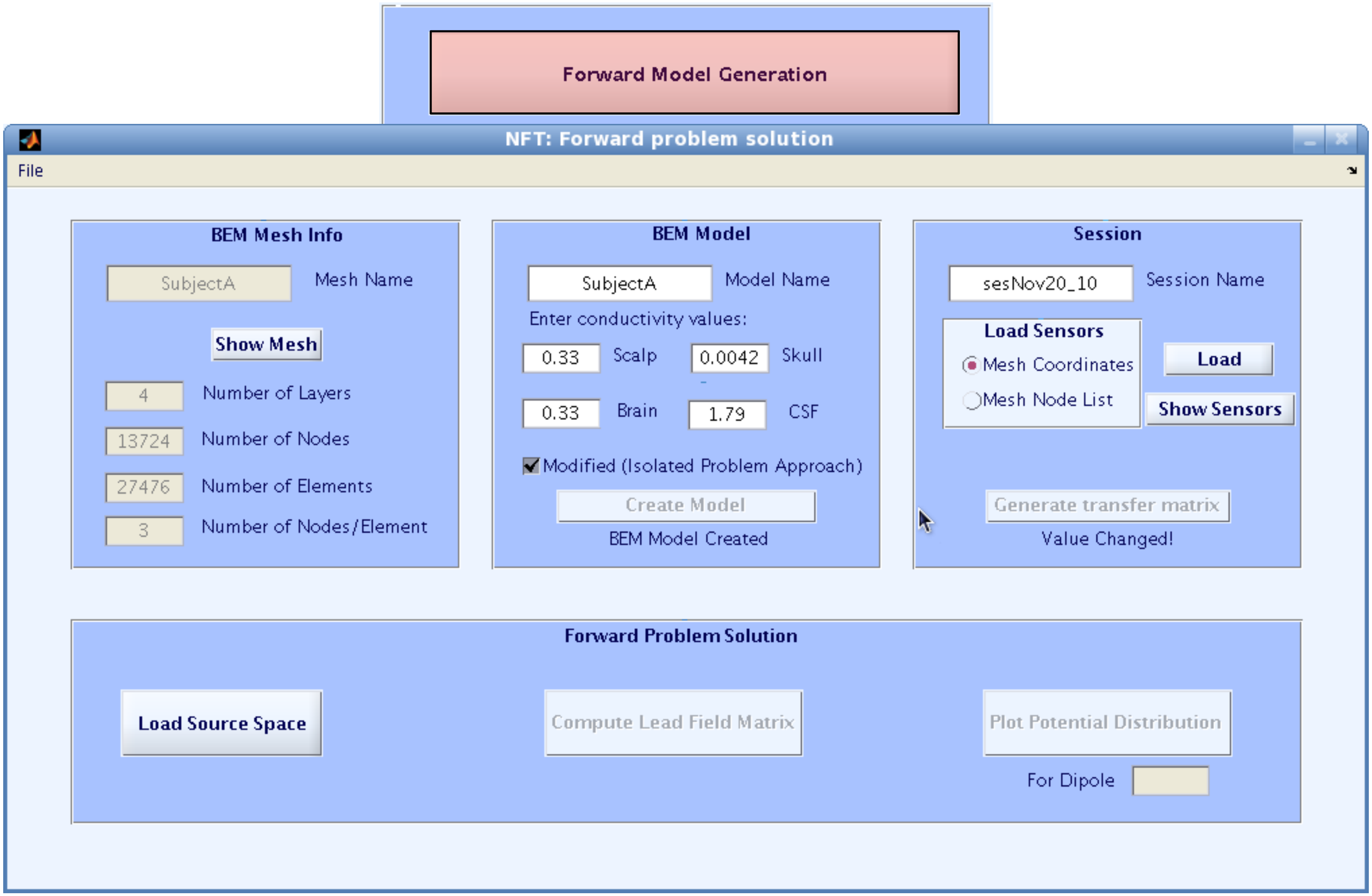
Forward Problem Solution with BEM



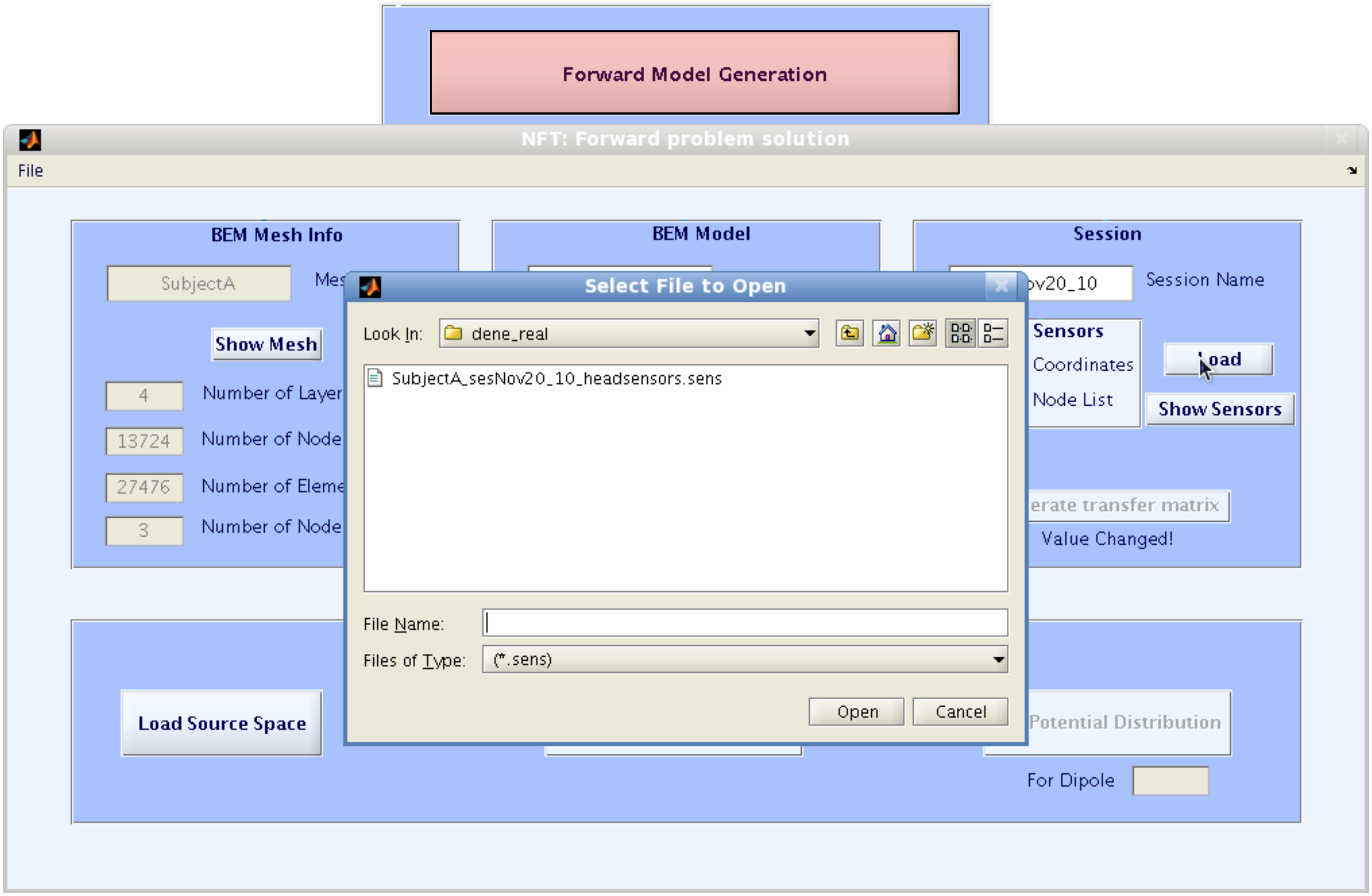
Forward Problem Solution with BEM



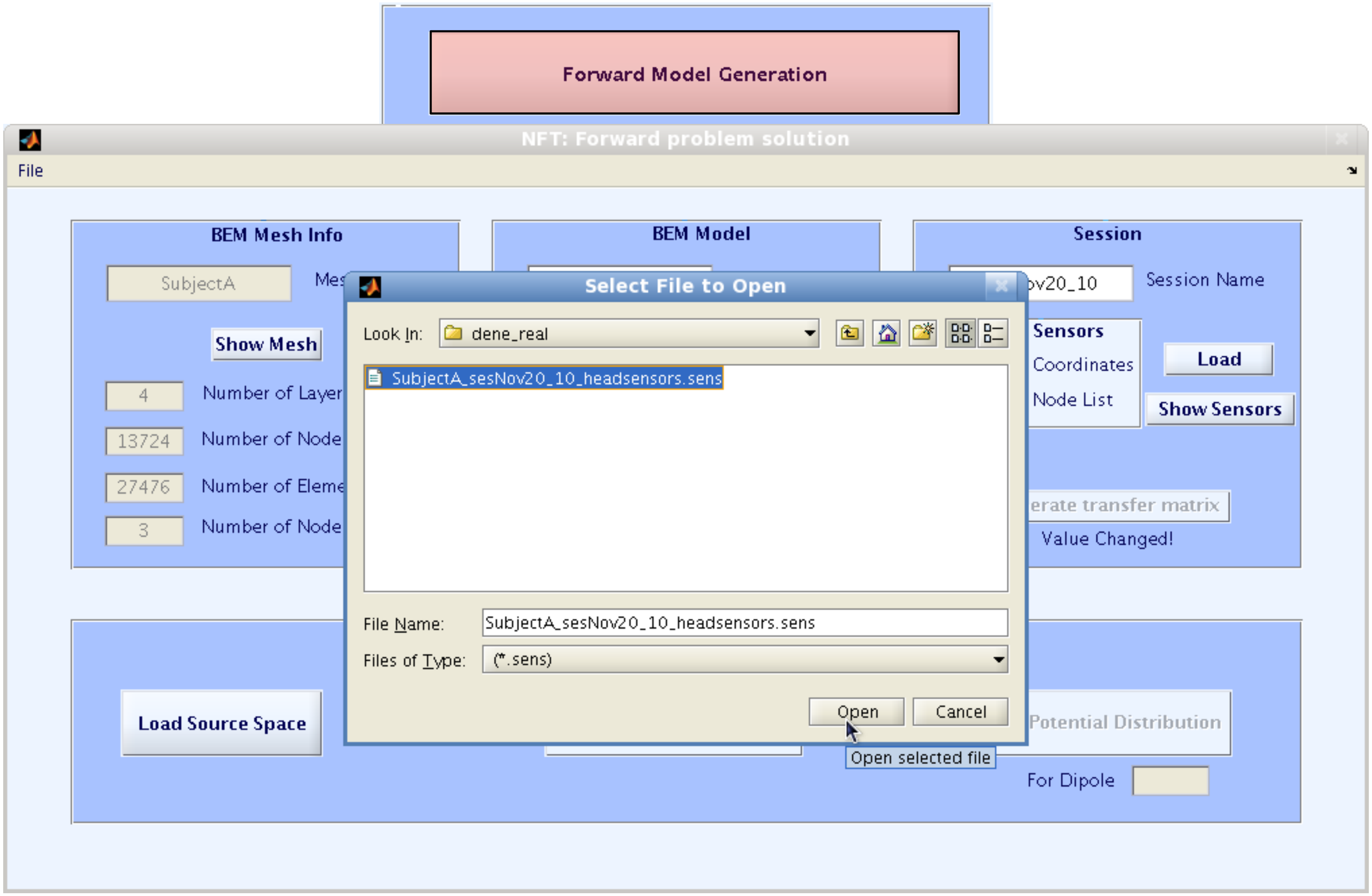
Forward Problem Solution with BEM



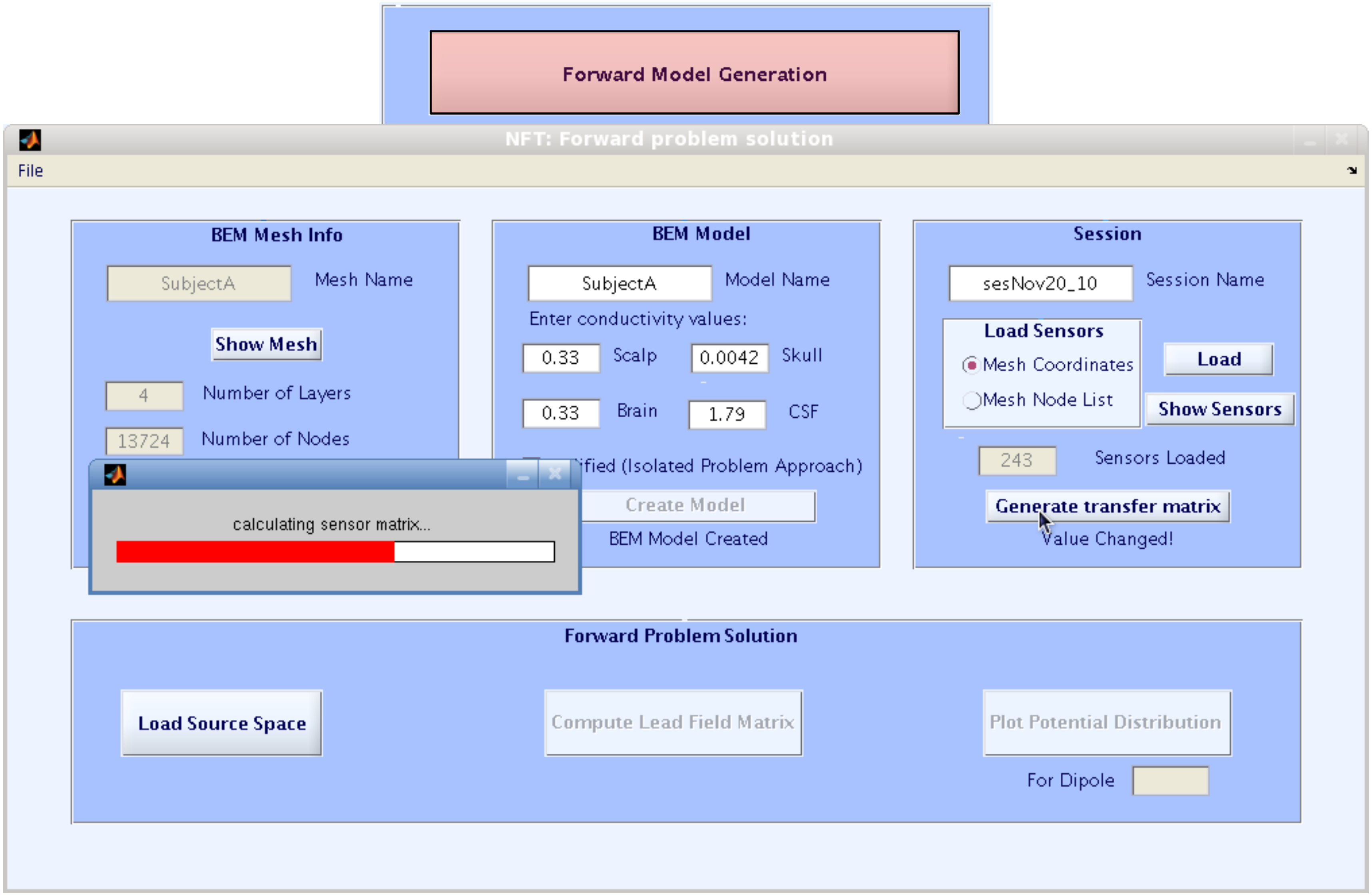
Forward Problem Solution with BEM



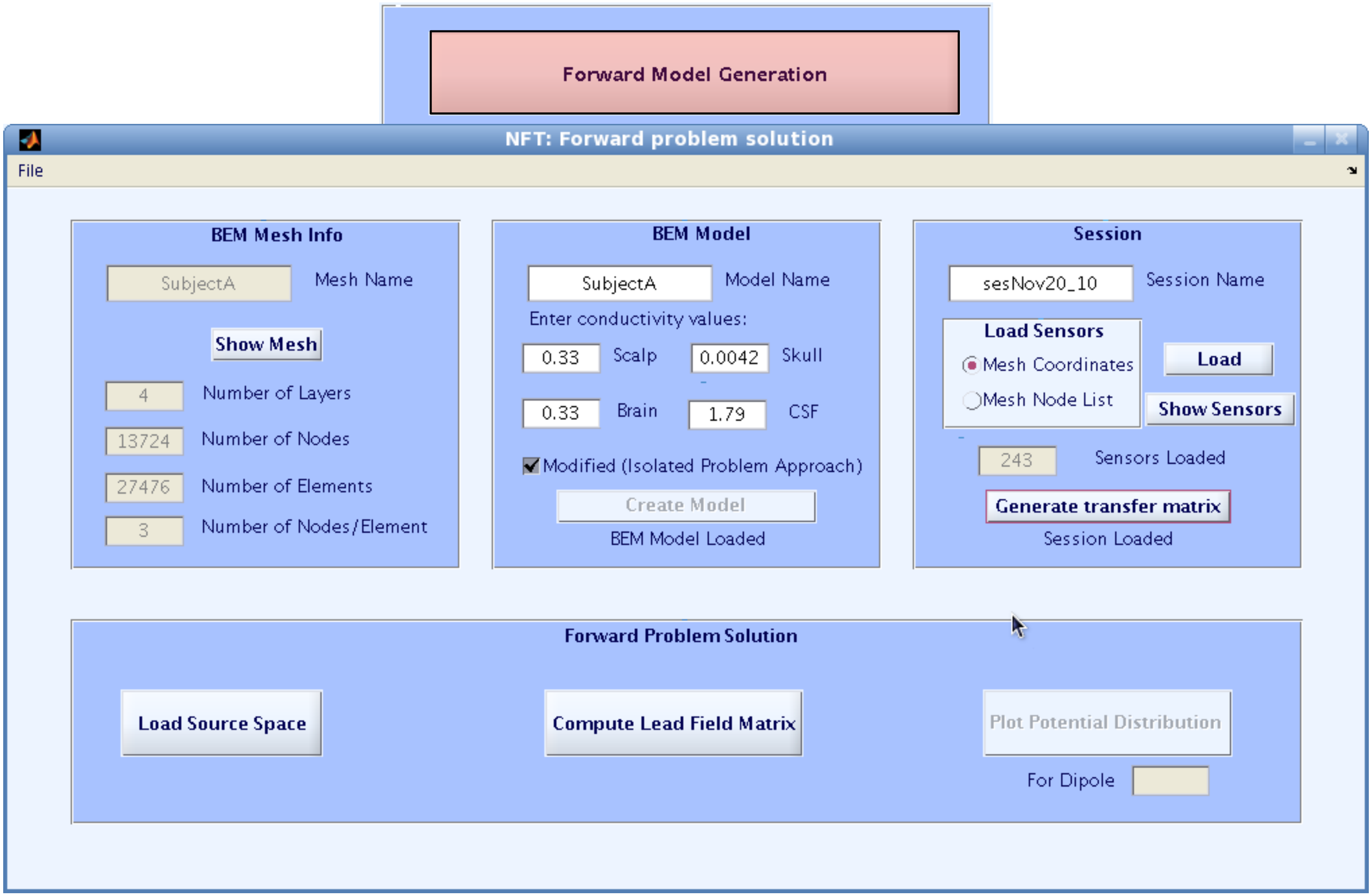
Forward Problem Solution with BEM



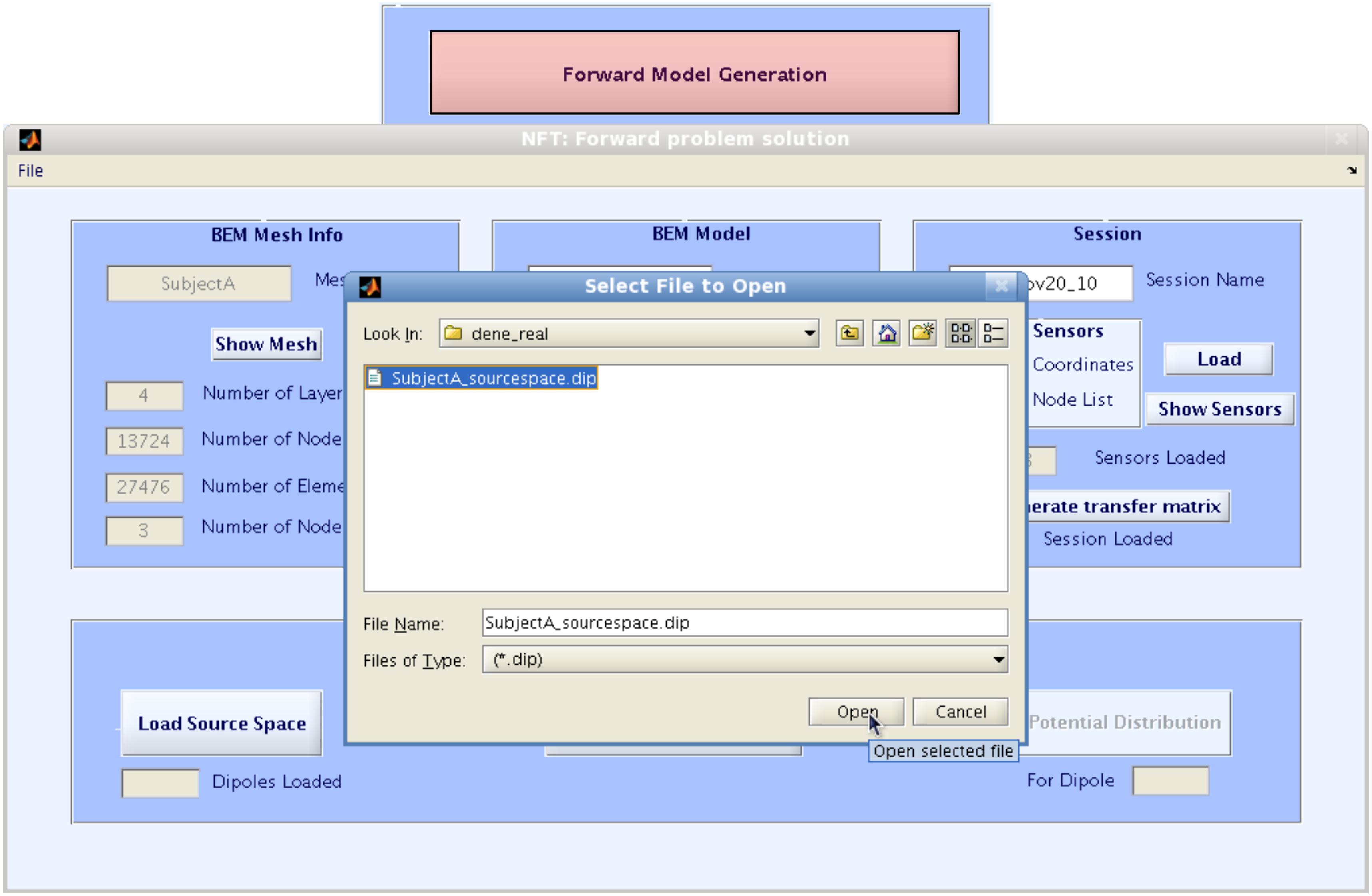
Forward Problem Solution with BEM



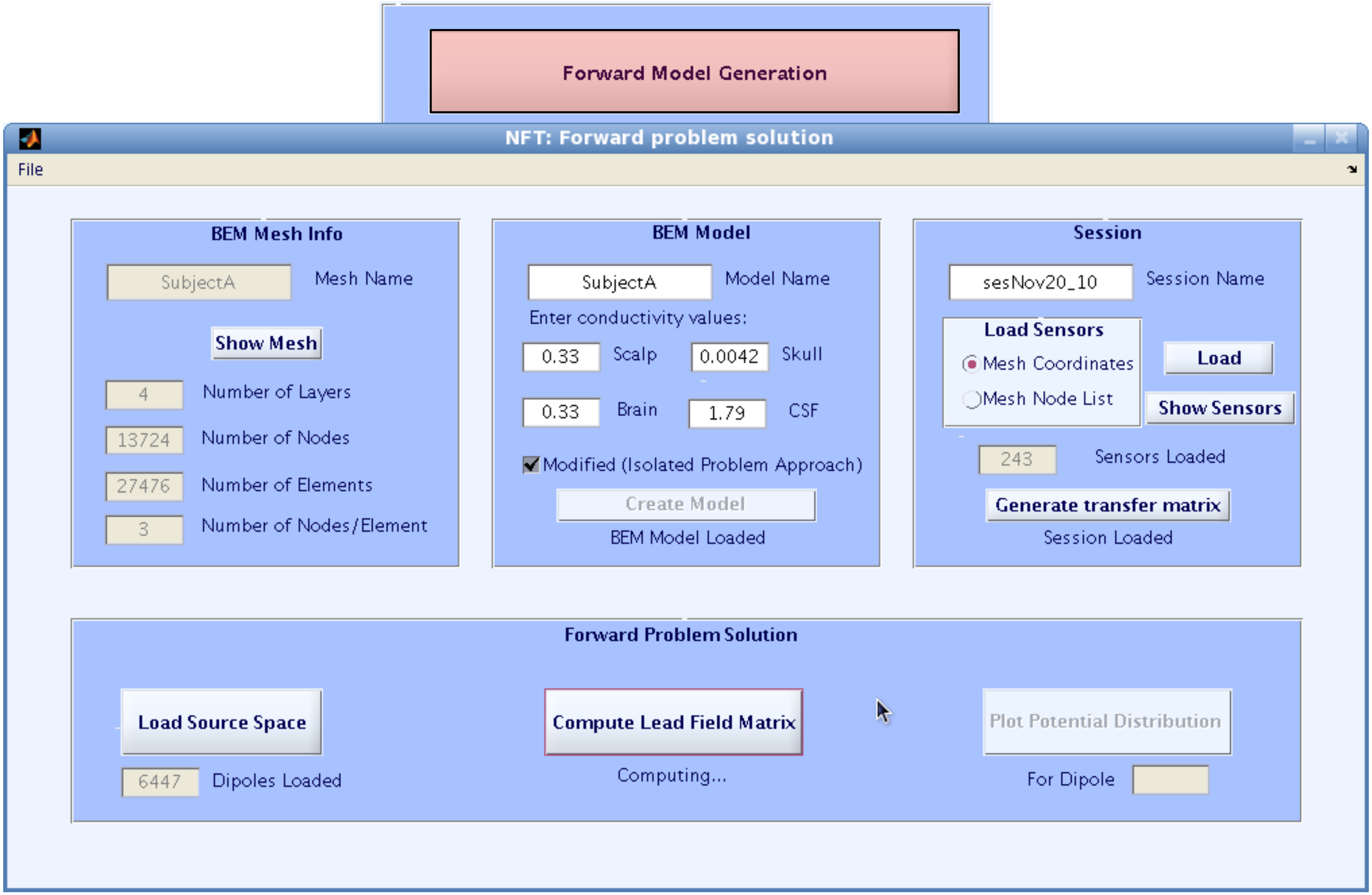
Forward Problem Solution with BEM



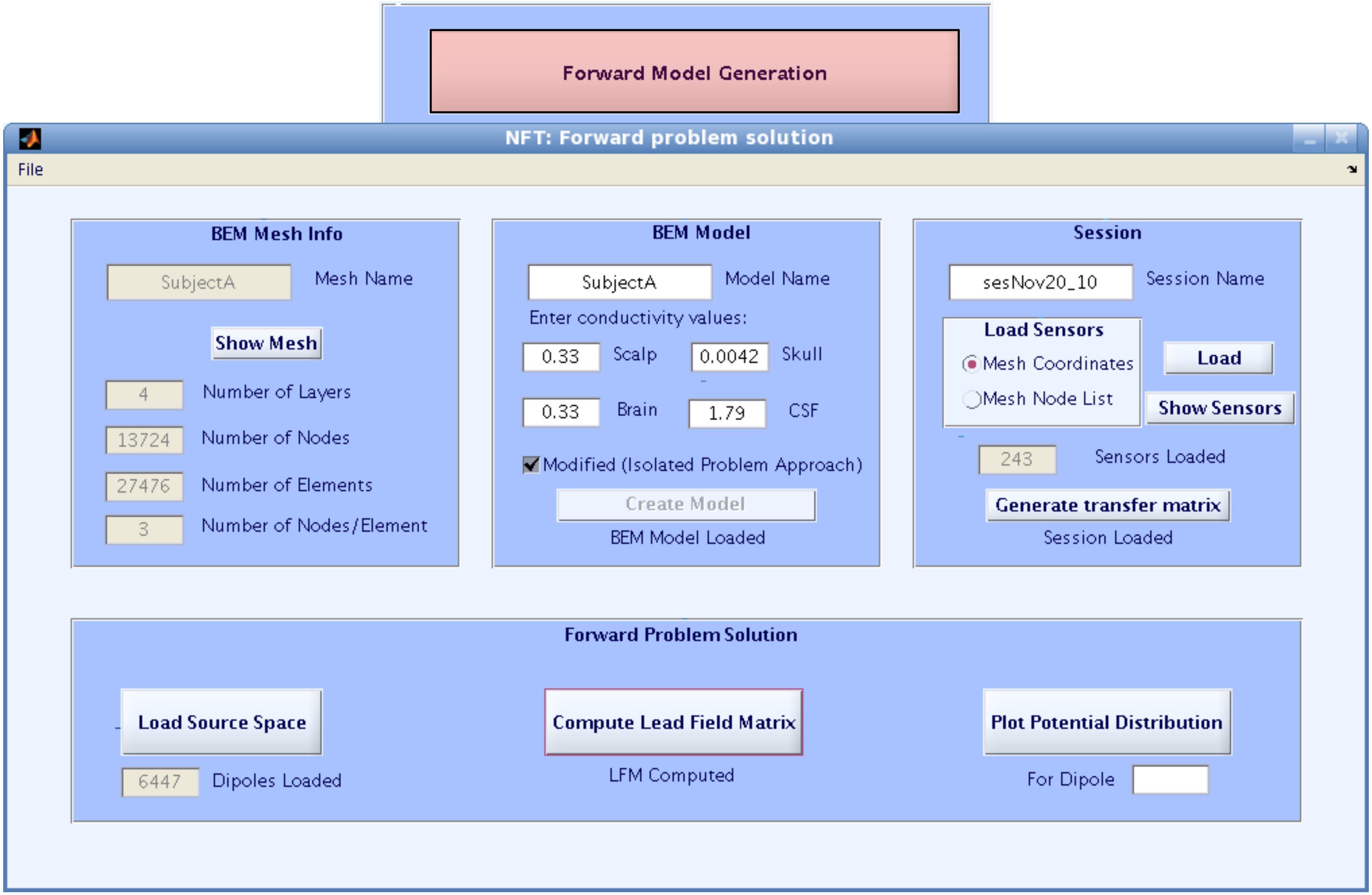
Forward Problem Solution with BEM



Forward Problem Solution with BEM



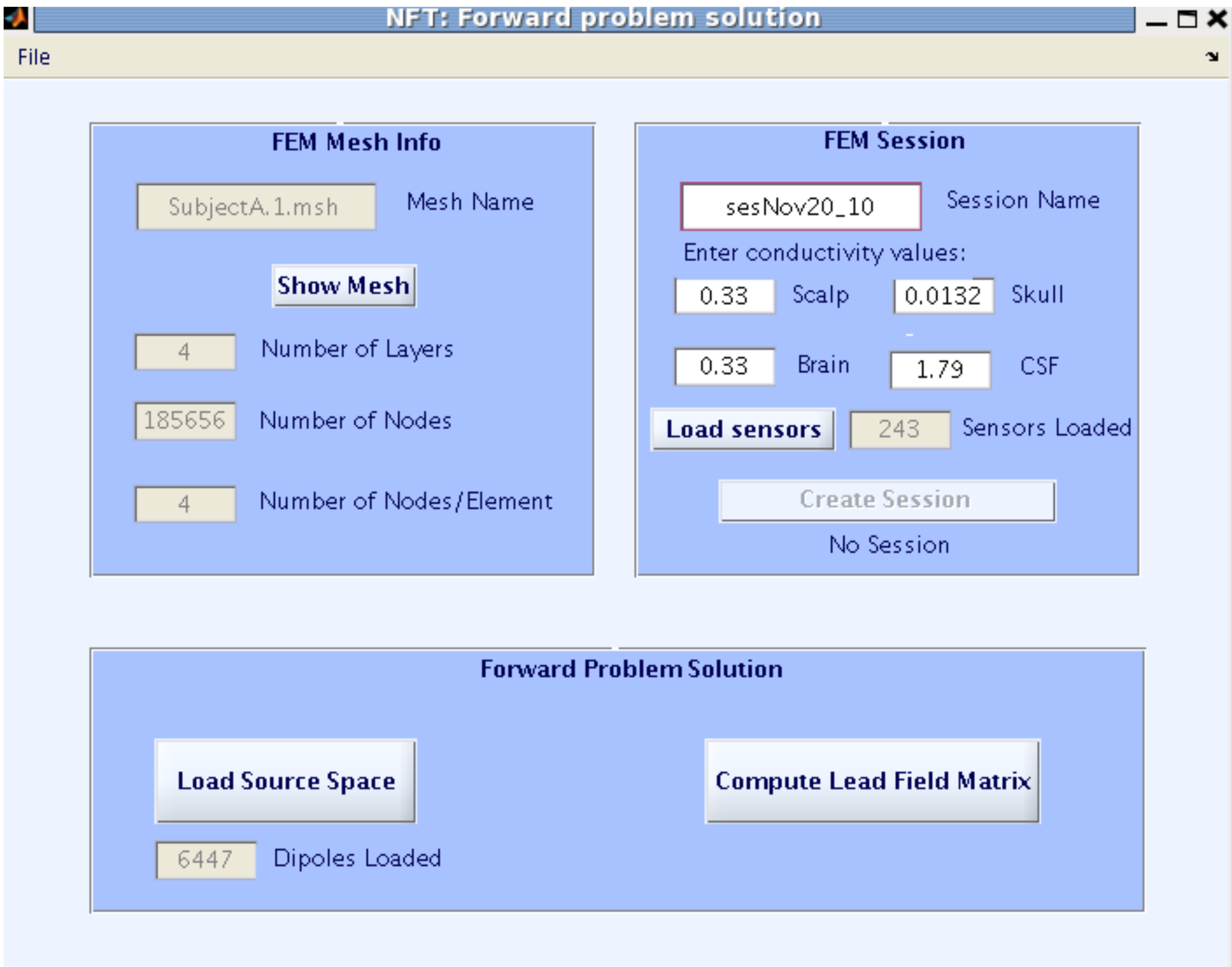
Forward Problem Solution with BEM



Forward Problem Solution with FEM

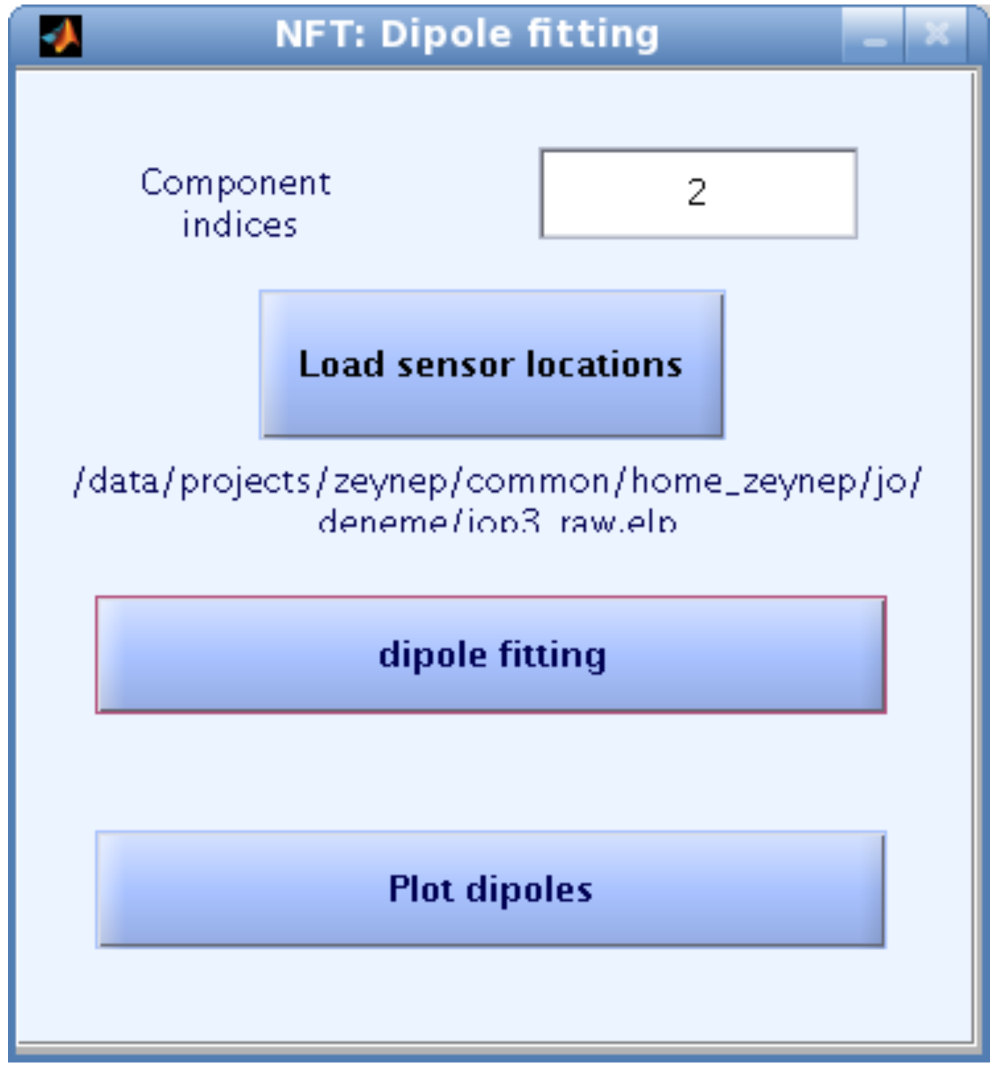
- Tetgen for mesh generation
  - Uses BEM meshes as boundaries
- METU-FEM to generate transfer matrix
  - Compiled from source
  - Requires PETSc for matrix operations
- metufem .mex file for forward solutions in MATLAB
- Instructions available under README.FEM file.

Forward Problem Solution with FEM



Dipole Fitting

- Requires EEGLAB integration to access Component indices.
- Uses FieldTrip in EEGLAB for dipole fitting.



Output

- Dipole source localization is saved in EEG structure, under EEG.etc.nft.
- After source localization with NFT, you can continue using EEGLAB;

EEG.dipfit.model = EEG.etc.nft.model;

NFT download and reference

- http://www.sccn.ucsd.edu/nft

- Akalin Acar Z, Makeig S, Neuroelectromagnetic Forward Head Modeling Toolbox, J. of Neuroscience Methods, vol 190(2), 258-270, 2010.