

rTMS – Stimulation

TARGETS INSERTION IN THE PATIENT MRI

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1. Purpose: neuronavigated targeting

1) DLPFC targeting

Insert the validated DLPFC targets inside the MRI of the patient before a neuronavigated rTMS. Targets will be presented as small white spheres.

Targets available with the batch:

GR_cytoTARGET_MNI

Talairach coordinates: $|X|=45$; $Y=45$; $Z=35$

MNI coordinates: $|X|=46$; $Y=45$; $Z=38$

Anatomical location : middle frontal gyrus

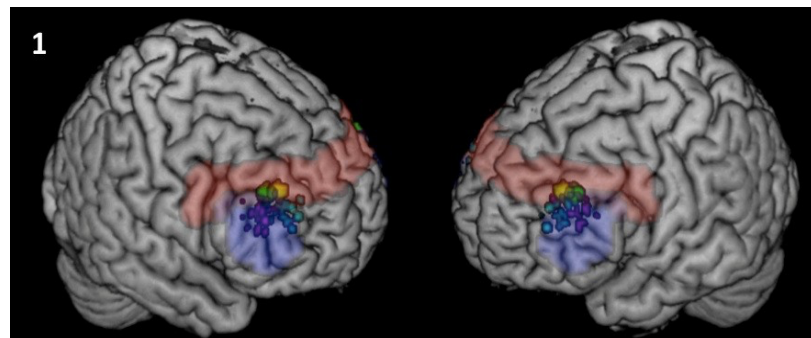
Cytoarchitectonic definition : between BA 46 and BA 9 Yellow on

the figure

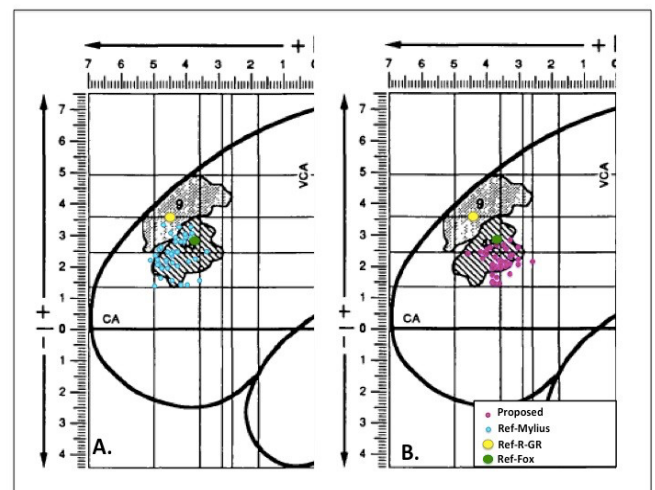
References:

- Rajkowska, G., Goldman-Rakic, P.S., 1995. Cytoarchitectonic definition of prefrontal areas in the normal human cortex: II. Variability in locations of areas 9 and 46 and relationship to the Talairach Coordinate System. *Cereb. Cortex* N. Y. N 1991 5, 323–337.
- Fitzgerald, P.B., Hoy, K., McQueen, S., Maller, J.J., Herring, S., Segrave, R., Bailey, M., Been, G., Kulkarni, J., Daskalakis, Z.J., 2009a. A randomized trial of rTMS targeted with MRI based neuro-navigation in treatment-resistant depression. *Neuropsychopharmacology* 34, 1255–1262.

DLPFC-targets represented on a MNI-template, with superimposition of BA9 (red) and 46 (blue). Yellow: GR_cytoTARGET; Cyan: VM_anatTARGET; Purple: BP_anatTARGET



2



BP_anatTARGET_MNI

Talairach coordinates: $|X|=48$; $Y=37$; $Z=21$

MNI coordinates: $|X|=48$; $Y=37$; $Z=25$ Anatomical location : middle frontal gyrus Cytoarchitectonic definition : BA 46

Purple on the figure

Reference:

B. Pommier, F. Vassal, C. Boutet, S. Jeannin, R. Peyron, I. Faillenot. *Neurophysiologie Clinique/Clinical Neurophysiology* (2017) 47, 35—46

https://hal.science/NEUROPAIN_CRNL/hal-02138815v1

Fox_funcTARGET_MNI

Talairach coordinates: |X|=44; Y =38; Z = 29

MNI coordinates: |X|= 44 ; Y = 38; Z = 34 Anatomical location :
middle frontal gyrus Cytoarchitectonic definition : BA 46/9

green on the figure

Reference:

Fox MD, Buckner RL, White MP, Greicius MD, Pascual-Leone A. Efficacy of Transcranial Magnetic Stimulation Targets for Depression Is Related to Intrinsic Functional Connectivity with the Subgenual Cingulate. *Biol Psychiatry* 2012;72:595–603. doi:10.1016/j.biopsych.2012.04.028.

VM_anatTARGET_MNI

This target is not inserted in the MRI by default.

Talairach Coordinates: |X|= 41 ; Y = 43 ; Z = 29

MNI coordinates: |X|= 41 ; Y = 43 ; Z = 29

Anatomical location : middle frontal gyrus Cytoarchitectonic
definition : between BA 46 and BA 9

cyan on the figure References:

- Mylius, V., Ayache, S.S., Ahdab, R., Farhat, W.H., Zouari, H.G., Belke, M., Brugières, P., Wehrmann, E., Krakow, K., Timmesfeld, N., Schmidt, S., Oertel, W.H., Knake, S., Lefaucheur, J.P., 2013. Definition of DLPFC and M1 according to anatomical landmarks for navigated brain stimulation: Inter-rater reliability, accuracy, and influence of gender and age. *NeuroImage* 78, 224–232. doi:10.1016/j.neuroimage.2013.03.061
- Coordinates from : B. Pommier, F. Vassal, C. Boutet, S. Jeannin, R. Peyron, I. Faillenot. *Neurophysiologie Clinique/Clinical Neurophysiology* (2017) **47**, 35—46

2) Operculo-insular targeting

Insert the SII or insular targets inside the MRI of the patient before a neuronavigated rTMS.

Targets will be presented as small white spheres.

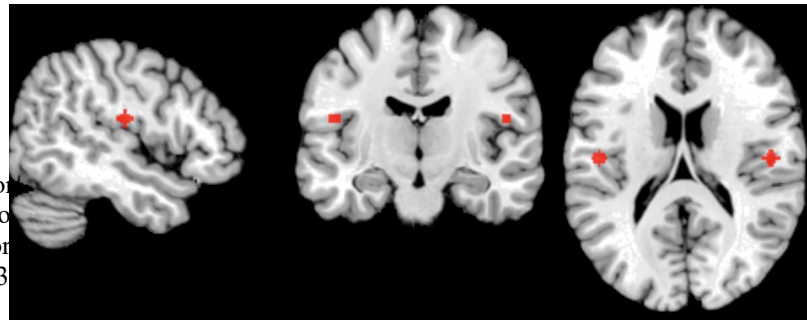
Targets available with the batch:

SII_LR

Located in the center of SII.

How it was created ?

On a template MNI, the 4 ROI OP of Eichkoff (Anatomical Atlas of the Human Brain, 1997).
In the dimension z, I would like to see the 4 ROIs, choose the slice where I can see 3 ROIs.
In the dimension y, I choose the slice between anterior and posterior.



coordinates

MNI coordinates: (-48, -16, 16) or (50, -16, 16)

InsulaPOST_Ig_ALG_LR

Targeting the posterior and superior insula near the peri-insular sulcus.

How it was created ?

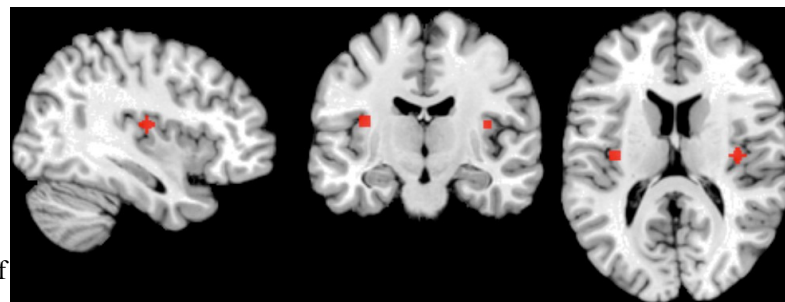
- Ig of HCP atlas in MNI
- ALG of Faillenot et al 17.

Find a point :

- at the border between OP and Ig of Eichkoff
- **AND** on Ig (HCP)
- **AND** on ALG (Faillenot)

coordinates

MNI coordinates: (-36, -16, 14) or (38, -16, 12)

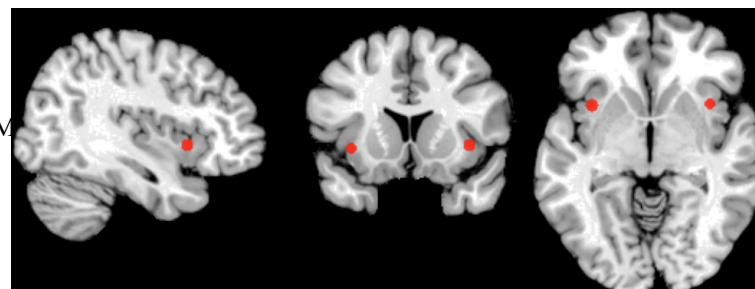


InsulaANT_SIS_LR

How it was created ?

On the template MNI SPM8_grey, overlay the ROIs ASG, MNI, and SIS.
Find a point at the limits of these 3 ROIs.

coordinates



3) OTHER target

If you have your own target in MNI space, or if you want to use a third target :

- go to ../InsertTARGETintoMRI/targets
- copy your image in the 'targets' directory
- insert 'OTHER' in the name
- Don't forget: remove 'OTHER' in the name of all other files.

2. Installation

Requirements

SPM installed.

If not, [install](#) the standalone version if you don't have a Matlab licence

See : <http://en.wikibooks.org/wiki/SPM/Standalone>.

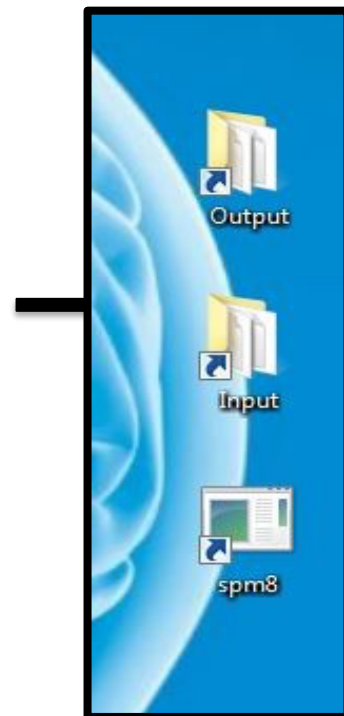
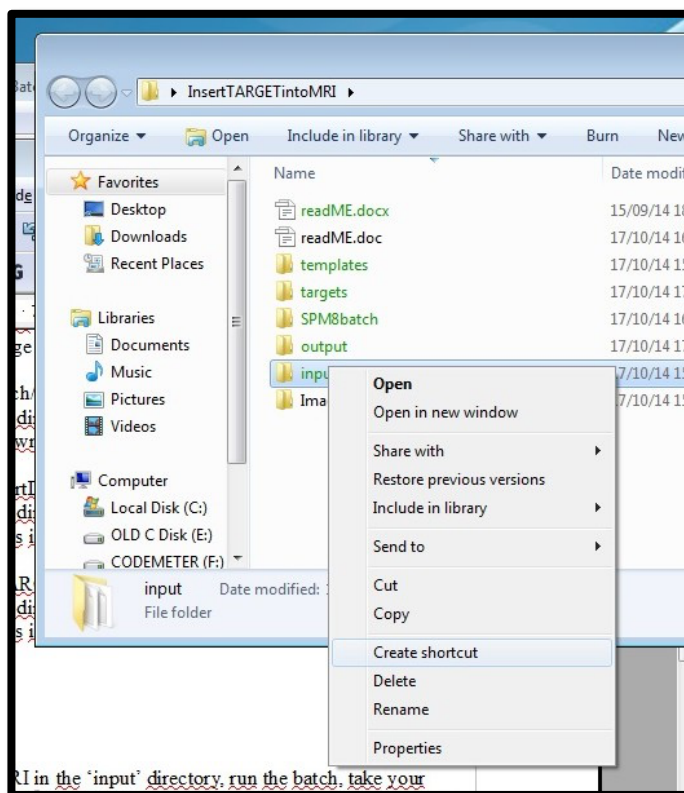
I suggest to create shortcut to start spm12 on the desktop and to start the batch into /insertTARGET_v4/SPM12batch

Download

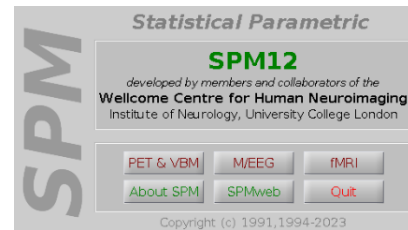
- download the files from: <https://github.com/crn1-lab/>
- Folder: InsertTARGETintoMRI_v4
- Copy the folder where you want (eg: /Documents)

Configuration

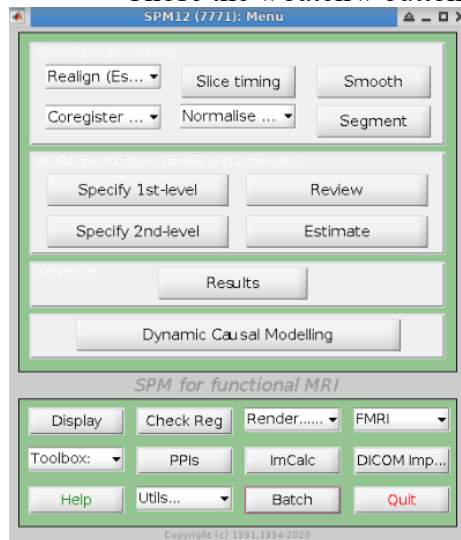
- This is done once. Don't forget to save the changed batches!
- You should have a folder 'InsertTARGETintoMRI_v4' with 4 directories:
 - 'input' (empty),
 - 'output' (empty), 'SPM12batch' (5 files),
 - 'targets' (7 files)
- We suggest to create shortcuts from 'input' and 'output' on the desktop:



- Open SPM12 and chose the fMRI button:

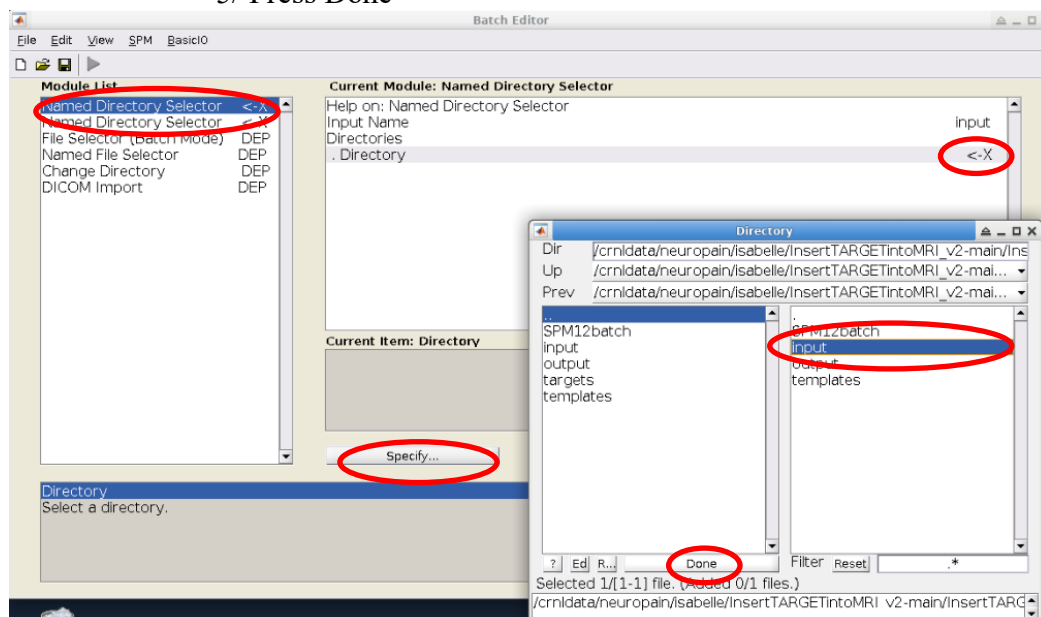


- Chose the « batch » button



- Load the first batch: /SPM12batch/convertDICOM
 - 1/ file : load batch
 - 2/ In the left part of the window chose the directory 'SPM12batch'.
 - 3/ On the right window, select 'convertDICOM'
 - 4/ Press 'Done'
- **2 modules, both called 'named directory selector', have to be changed:** the input and output directories as defined in the downloaded directory should be selected.

- 1/ Left: select the first 'named Directory Selector'
- 2/ Up-right: Clic on ".Directory"
- 3/ Middle-right: specify
- 4/ Chose the directory that will contain the dicom images: "...input"
- 5/ Press Done



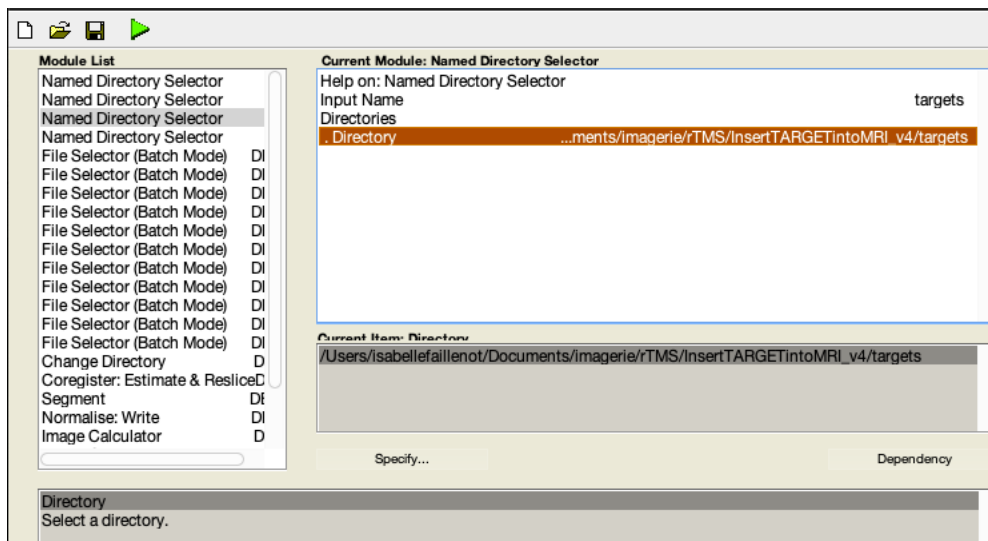
- 6/ repeat steps 1 to 5 for the second module 'Named Directory Selector' with the 'output' directory

- Save the batch



- Repeat these operations for the 4 other batches:

1. Load the second batch: '*convertDICOM_insertDLPFCintoMRI*'
2. 4 modules, both called 'named directory selector', have to be selected: 'input', 'output', 'templates' and 'targets' directories.
3. Save the batch with the same name : *convertDICOM_insertDLPFCintoMRI*
4. Do the same with '*convertDICOM_insertSIIintoMRI*'
5. Load the third batch: '*insertDLPFCintoMRI*'
6. 4 modules, both called 'named directory selector', have to be selected: input, output, and targets directories inside the download directory.
7. Save the batch
8. Do the same with '*insertSII_intoMRI*'

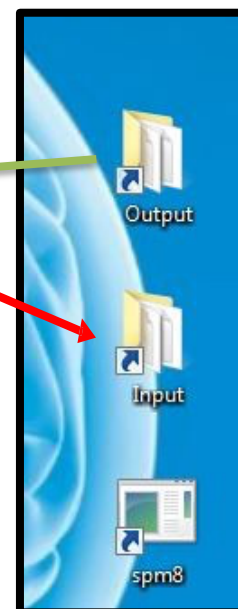


3. Use it!

- 1st. Put your MRI in the 'input' directory,
- 2nd. Run the batch,
- 3rd. Take your images in the 'output' directory
- 4th. Clean input and output directories before leaving

Details below...

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Choose the best batch for your images

There are 5 batches depending on the image format and the targets you want

If MRI is in nifti format:

- There are less than 10 files with a '.nii' extension.
- Chose only 1 file : the 3DT1 image (name often contain 'mprage' or 'anat' or '3DT1' or 'neuronav') and copy it in the 'input' directory
- Use the '*insertTARGETintoMRI*' batch

If MRI are in DICOM format:

- Usually images are in DICOM format;
- There are plenty of files (at least 150) often with a '.dcm' or '.ima' extention.
- When you know that there is only the 3DT1 image (more than 150 files): use the '*convertDICOM_insertTARGETintoMRI*' batch
- When you don't know and there are more than 200 files: I suggest to first run the batch '*convertDICOM*', delete the unwanted files inside 'output', keeping only the good one, empty 'input', move the 3DT1 file in 'input', and finally run the '*insertTARGETintoMRI*' batch.

The name of the batch includes the name of the target : DLPFC or SII.

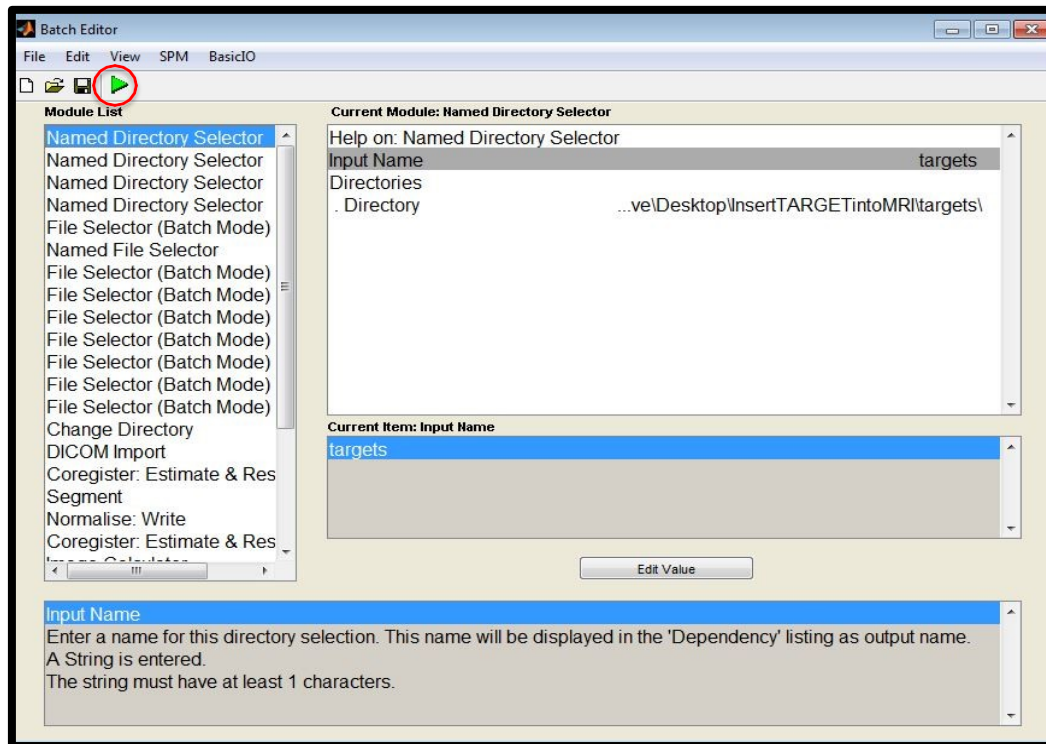
Eg : *convertDICOM_insertSIIintoMRI insertDLPFCintoMRI*

Copy files into 'input'

- Only one patient can be treated per run.
- Check that 'input' and 'output' directories are empty.
- Copy the chosen images of the patient directly in the directory 'input'

RUN batch of SPM12

- Open SPM12
- Clic on fMRI
- Clic on 'batch' button
- Load the batch adapted to your data: it is in .../InsertTARGETintoMRI/SPM12batch/
- Don't add anything!
- Run the batch (just clic on the green triangle)



- wait for few minutes...

Output

In the directory 'output' there are 4 images (NIFTI format):

- The original 3DT1 in nifti format (if you insert dicom images in the "input" folder) the filename starts with 'ms'
- subjORIG_otherTARGET.nii : MRI with the OTHER target

AND

- subjORIG_GRcytoTARGET.nii : MRI with the GR target (usually on the scalp)
- subjORIG_BPanatTARGET.nii : MRI with BP target (on MFG, BA 46)

OR (depending of the target chosen)

- subjORIG_SII_TARGET.nii : MRI with the SII target (center of OP)
- subjORIG_InsulaPost_TARGET.nii : MRI with Insula target (fundus of the periInsular sulcus, in Ig)

Clean

Copy the files you want in the patient's directory Empty input and output directories.

4. Cite it...

If you use the batch for research purpose, please cite the reference:

Easy methods to make the neuronavigated targeting of DLPFC accurate and routinely accessible for rTMS

Benjamin Pommier, François Vassal, Claire Boutet, Sophie Jeannin, Roland Peyron, Isabelle Faillenot
Clinical Neurophysiology (2017) 47, 35 - 46

Méthodes faciles pour rendre le ciblage neuronavigué du cortex préfrontal dorsolatéral précis et couramment accessible pour la pratique de la rTMS - *Neurophysiologie Clinique* (2017) 47, 35- 46
https://hal.science/NEUROPAIN_CRNL/hal-02138815v1

5. Trouble shooting

Problem:

the target is too light, not white

try:

in the batch : image calculator : $i1+i2*1000$ -> change to 2000

Otherwise :

If you have read this document and still have problem to install or to use the batch, contact:
isabelle.faillenot@univ-st-etienne.fr