fMRI Preprocessing

"RCW"

spm8Batch

methodology

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What you need:

- spm8Batch system
- spm8 with at least revision 4290
- FSL 4.1.7 or FSL 4.1.8

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spm8Batch processing tools:

Standard Directory Structure

bash commands from unix shell

launches to background

email/txt msg notification

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Expected directory structure

```
/diskdrive/
   [experiment]/
      Subjects/
         [subject]/
            anatomy/
               ht1overlay.nii
               htspgr.nii
            func/
               run_XX/
                  run_XX.nii
            connect/func/
               func/
                  run_XX/
                     run_XX.nii
```


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Auxiliary Commands

- getfMRI
- UNNIFTI
- tarBET

Main Processing Commands

- [next page]

```
/diskdrive/
   [experiment]/
      matlabScripts/
         spm8batch/
            [command]/
               YYYY_MM/

   warpfMRI_XXXXX_...sh
   warpfMRI_XXXXX_...log
   warpfMRI_XXXXX_...m
```

Login

Launch command

(automatically builds components goes into background)

Logout (if you wish)

Check email, check the log for any errors.

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[*physioCorr*]
sliceTime
realignfMRI
 bestBET
 fslCheck
 mvBestBET
 tarBET
coregOverlay
coregHiRes
warpHiRes - *DARTEL option*
warpfMRI
smoothfMRI

all commands have built-in help

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Command Options

```
-A                all runs present
-a [directory]    anatomy directory e.g. anatomy/BET
-b                also put best BET one picked
-D                super debug flag
-d                debug flag
-F [TR]           fMRI TR
-f [directory]    functional directory e.g. connect/func
-g [gradient]     gradient value to pass to 'bet'
-h [name]         high resolution image
-i [run number]   include this run number
-M [directory]    master subject directory
-m ["options"]    mcflirt options
-n [name]         name prepend
-O [name]         other object to drag into process
-o [name]         overlay image name
-R                reslice flag set to 2
-r                reslice flag set to 1
-S [#]            standard volume number for mcflirt
-s [directory]    sub-directory name to search for images
-T [name]         template image name
-t                test flag
-U [unique]       user email name/txt msg address
-u [#]            BET threshold override value
-v [name]         volume to use for coregistration
-w [directory]    coregistration output directory
-z [#]            voxel reslice size
-# [#-#]          inclusive run list
```


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Expected data:

overlay image in the same rough space as the functional data

hi resolution image needed for warping

time-series data

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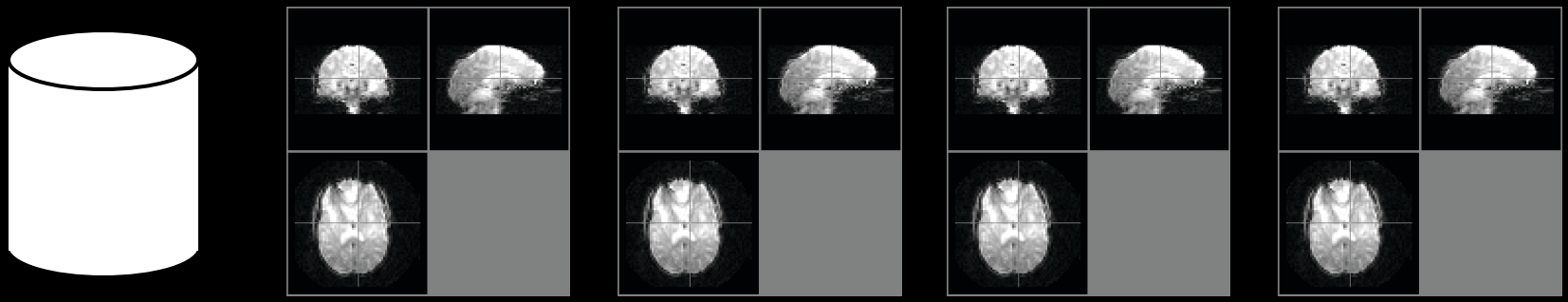
Pre-processing done at fMRI Lab



p-file
(k-space)

run

prun

aprun

raprun

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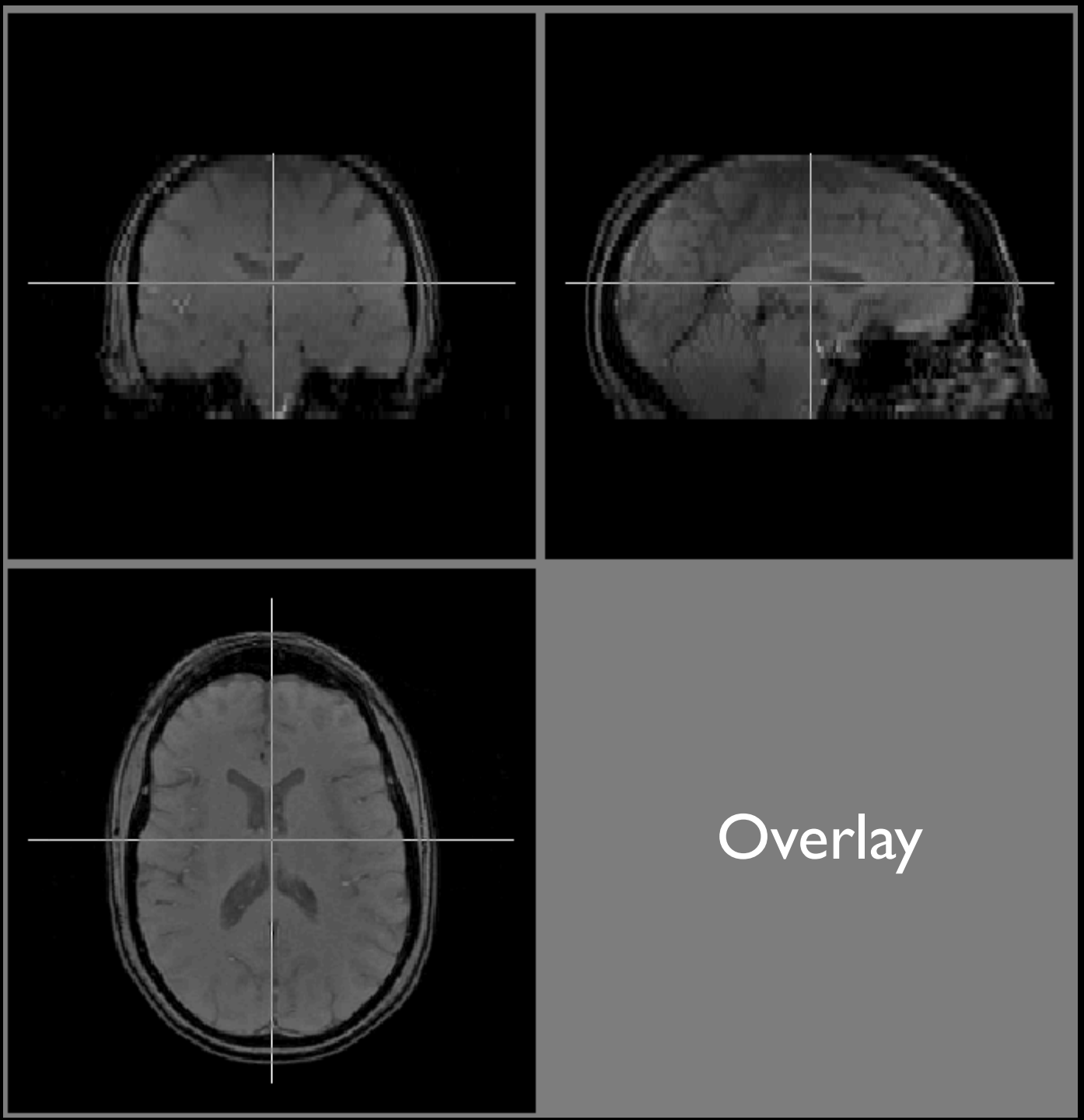

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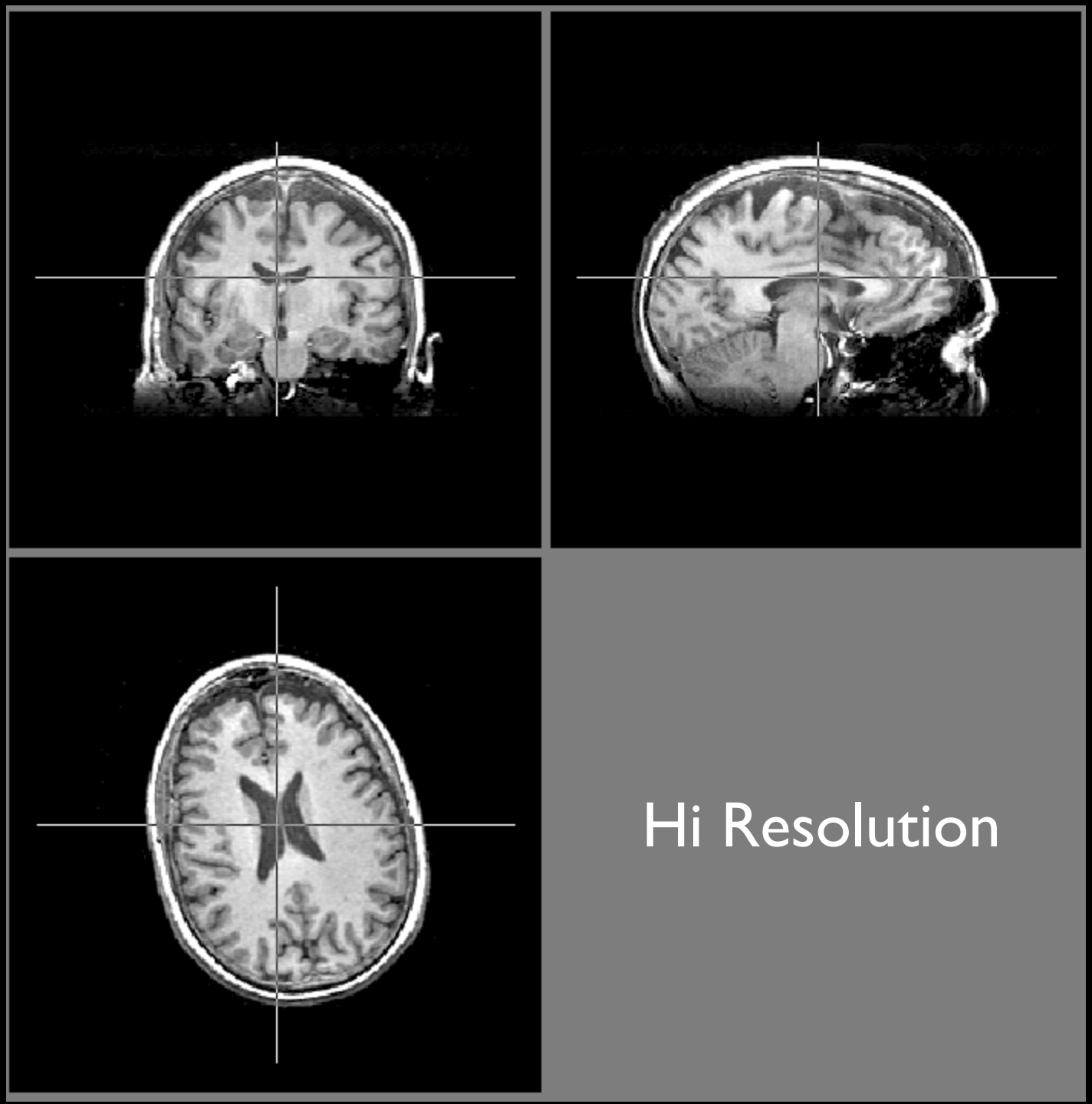

Hi Resolution

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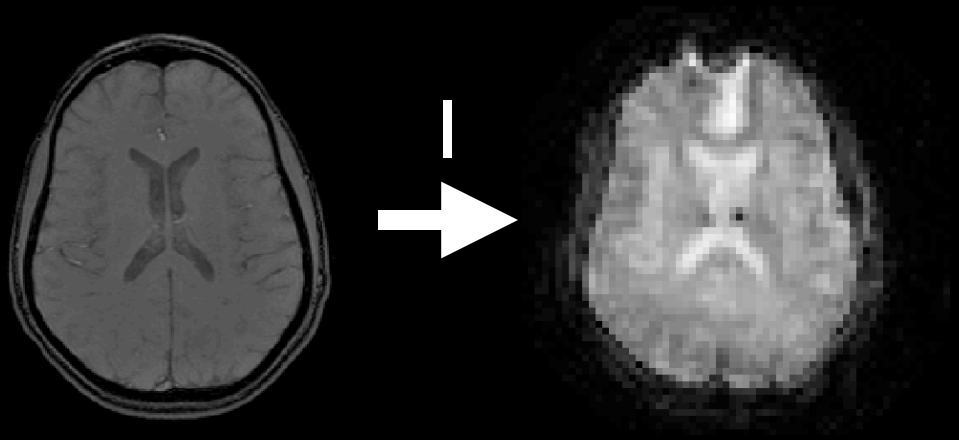
Strategy for normalization of functionals



1 - coregOverlay
2 - coregHiRes
3 - warpHiRes
4 - warpfMRI

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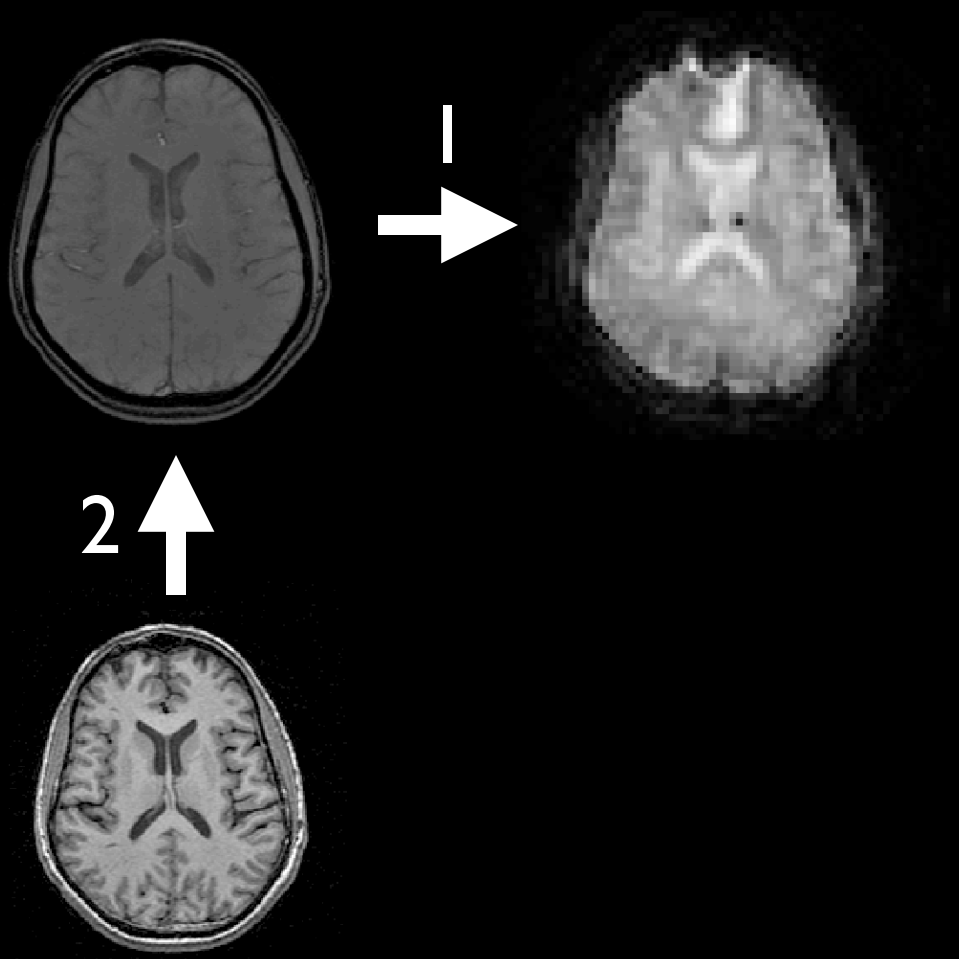
Strategy for normalization of functionals



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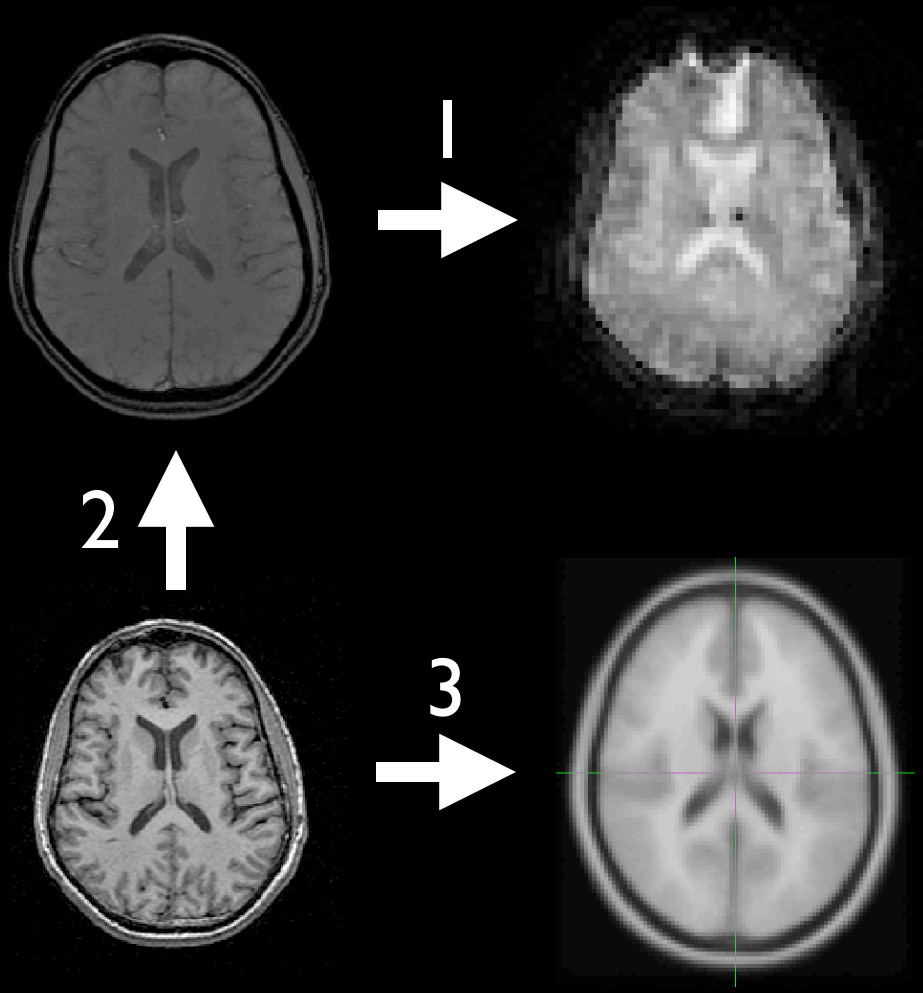
Strategy for normalization of functionals



1 - coregOverlay
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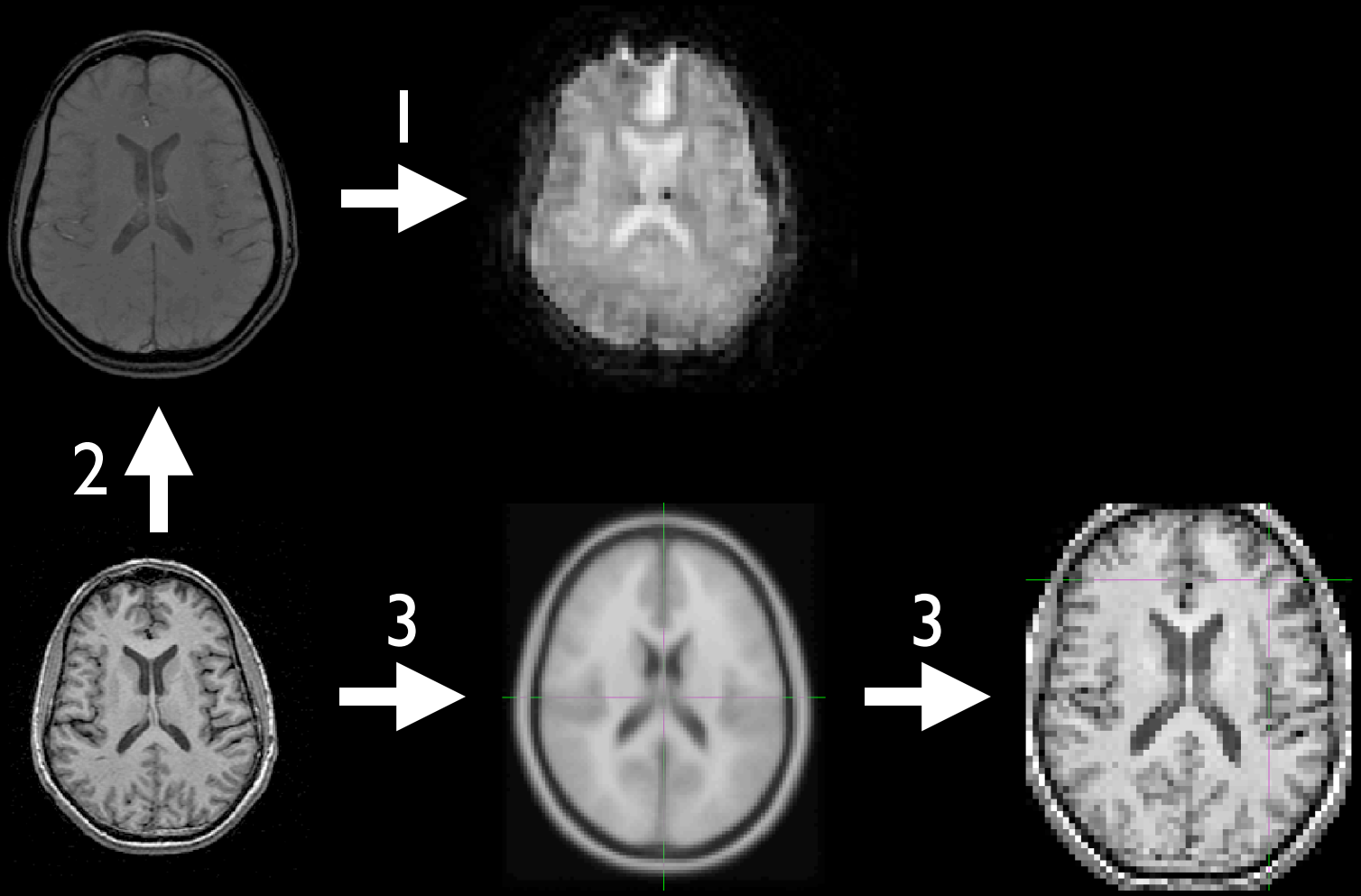
Strategy for normalization of functionals



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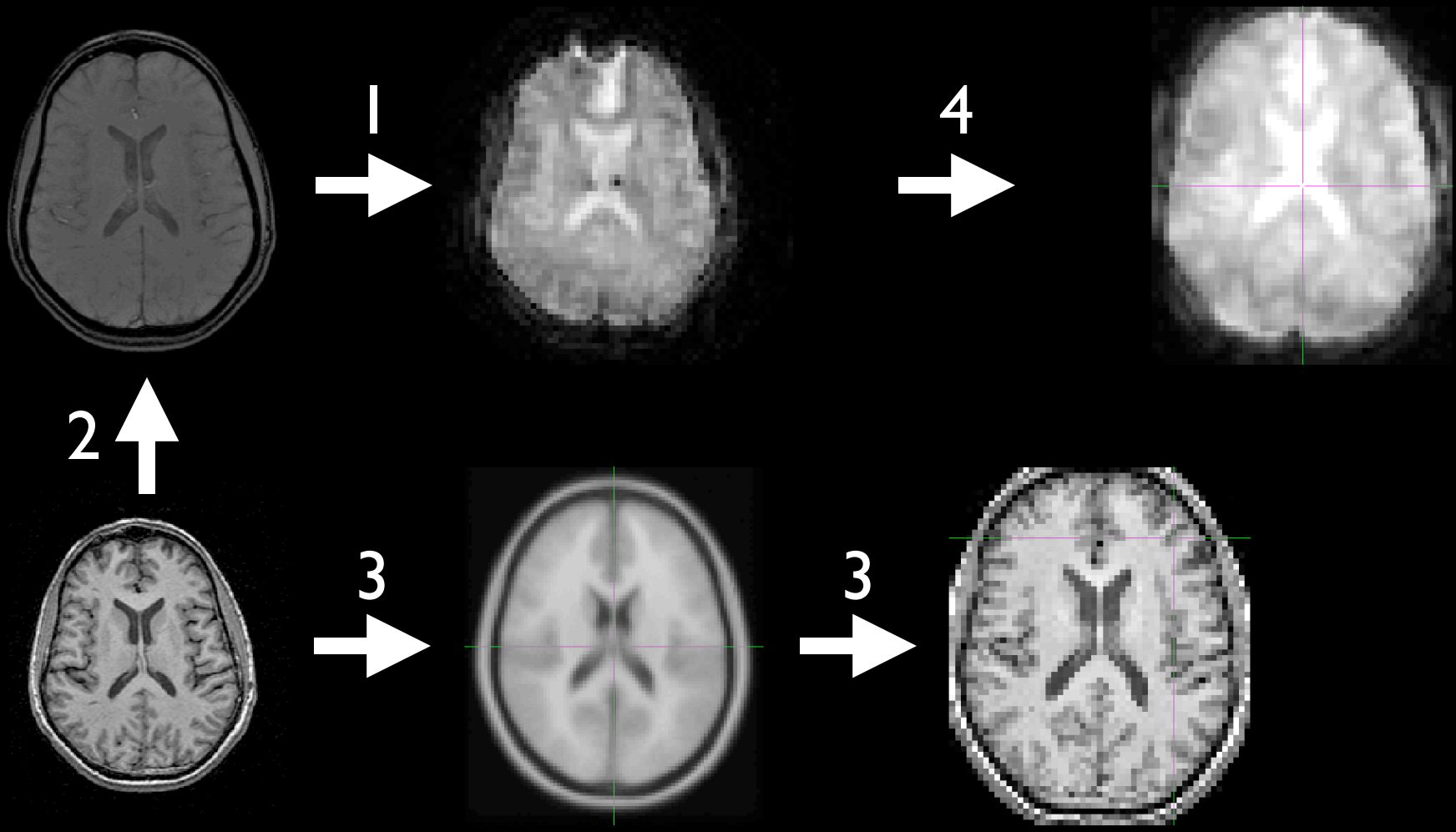
Strategy for normalization of functionals



1 - coregOverlay
2 - coregHiRes
3 - warpHiRes
4 - warpfMRI

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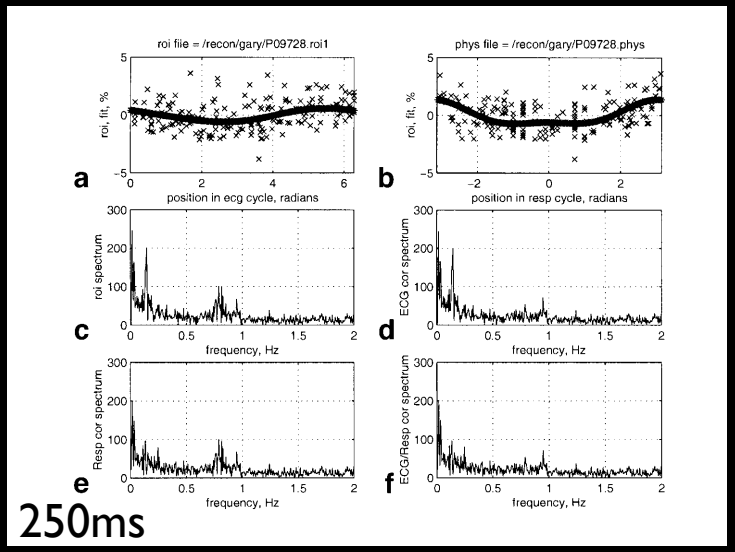
physioCorr [subject]

physiological correction:

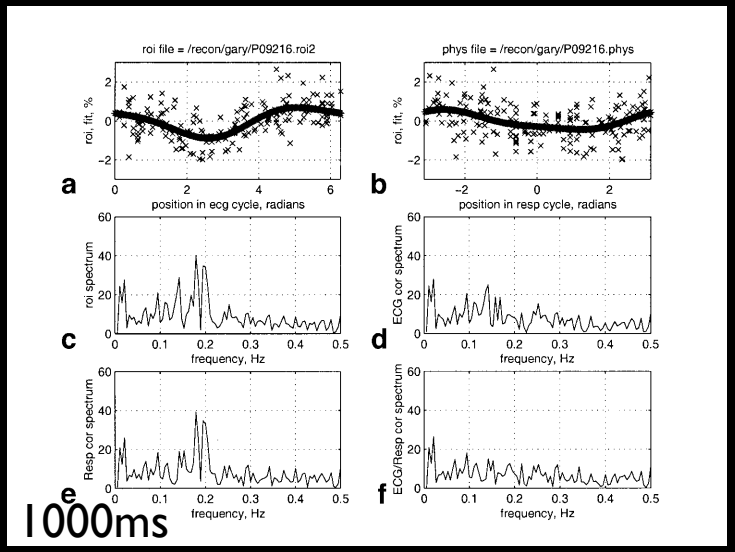
In the current paper, we have shown that the NVR model composed of a comprehensive set of nuisance regressors substantially reduces the structured noise in fMRI residuals. The NVR model is based on a number of effects which are known to contribute to the non-white noise in fMRI (hardware drift, residual movement artefacts, respiration and cardiac pulsation). In fact, the proposed NVR model is only new in the sense that we for the first time have used a combination of several already published models in the same analysis.

It was furthermore found that our approach, in general, was superior to the covariance estimation currently imp emented in SPM2. In particular, we found the global AR(1) model of SPM to be inadequate near larger arteries which is not surprising given the inability of a first-order AR model to account for oscillatory noise. -- Lund, Neuroimage 29, 2006

RETROICOR - implemented at fMRI BIRB



250ms



1000ms

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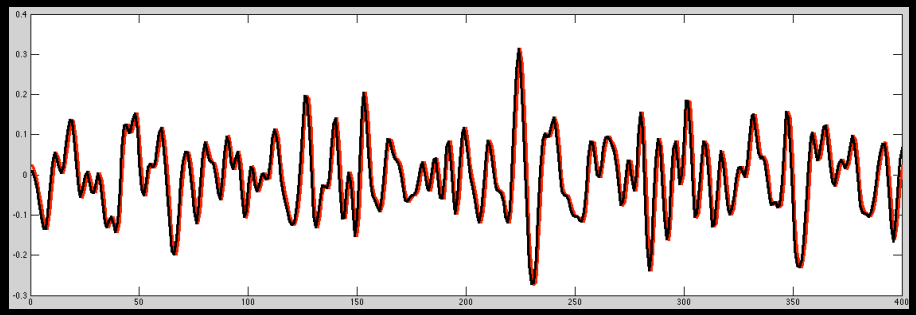
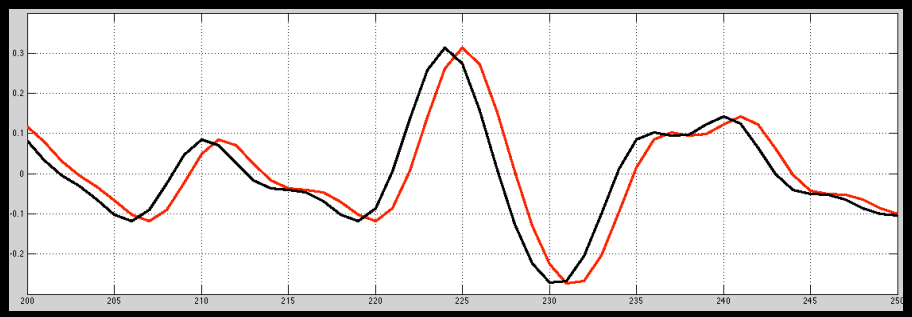
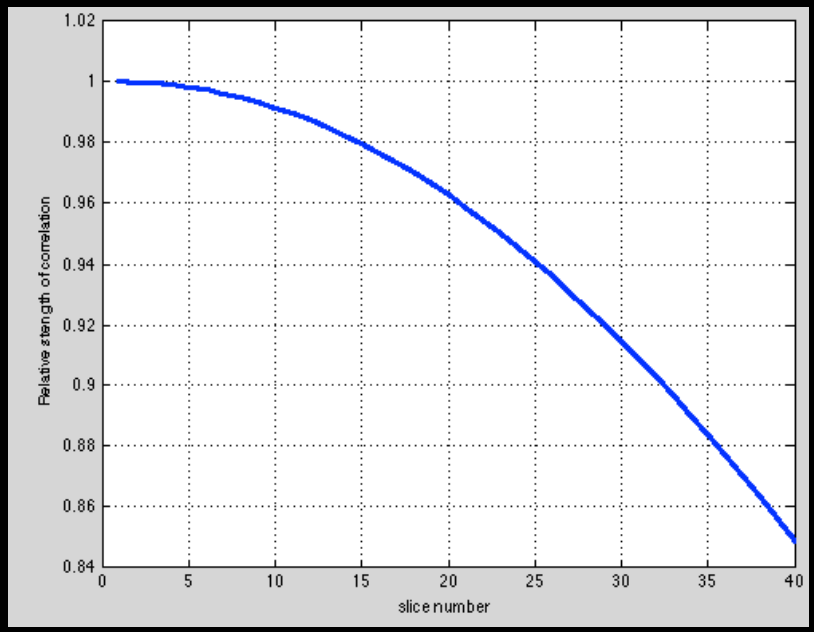
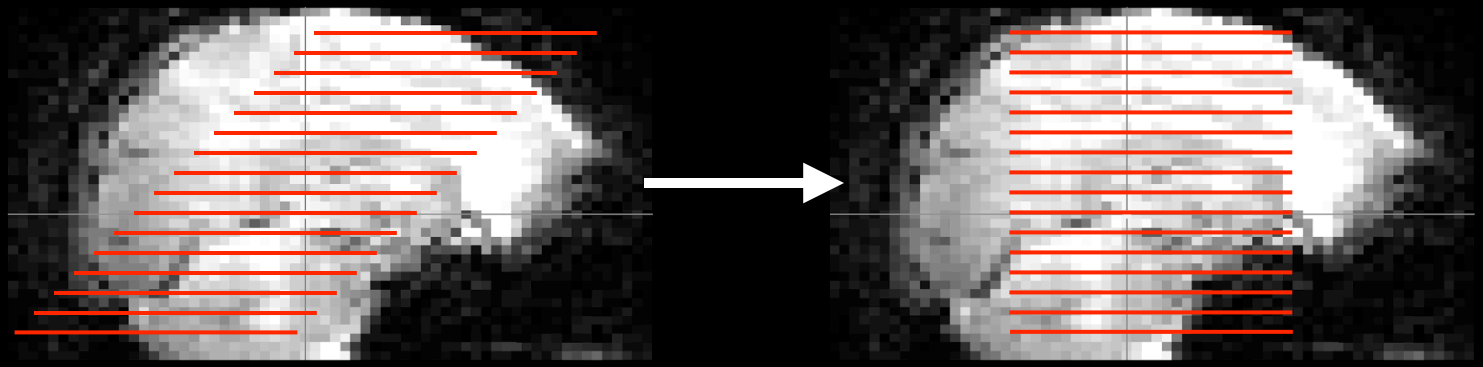
sliceTime [subject]









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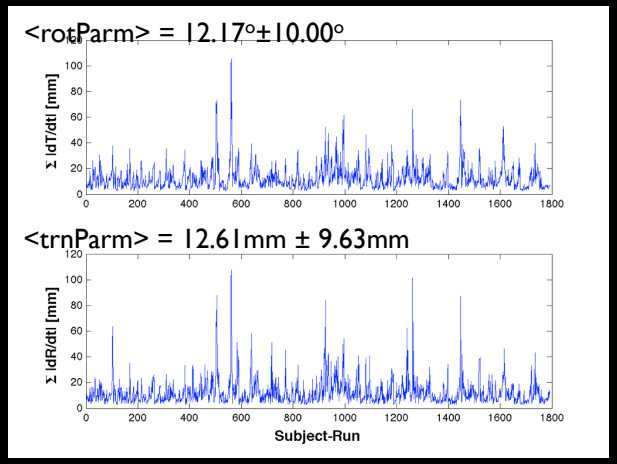
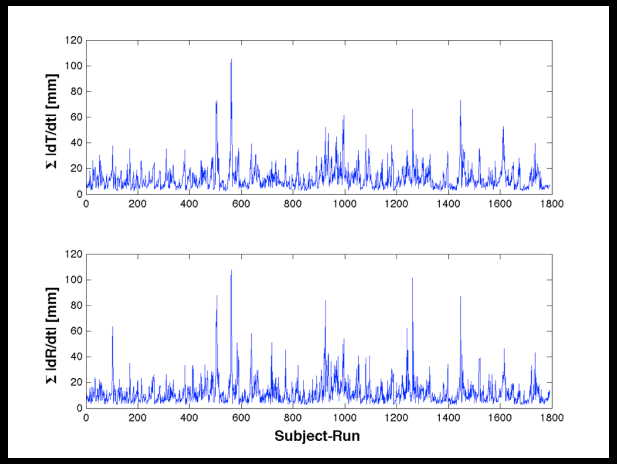
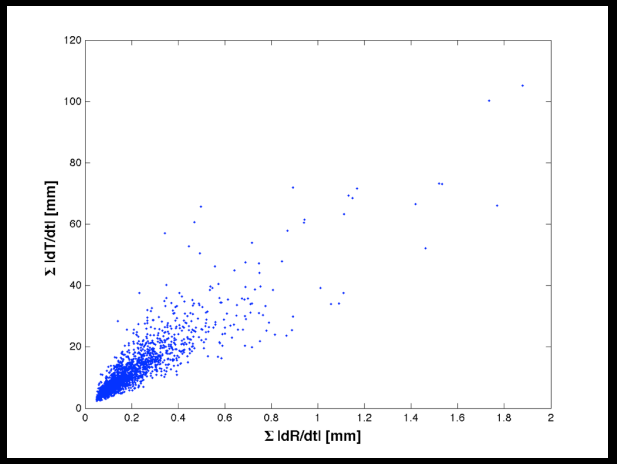
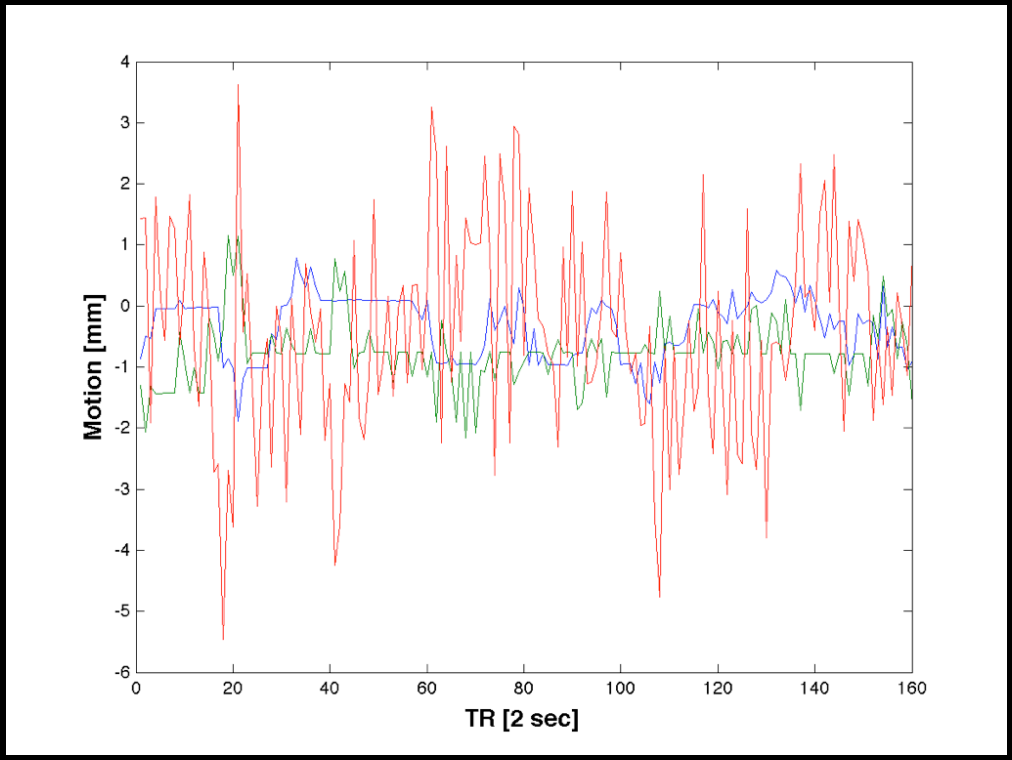
realignfMRI [subject]









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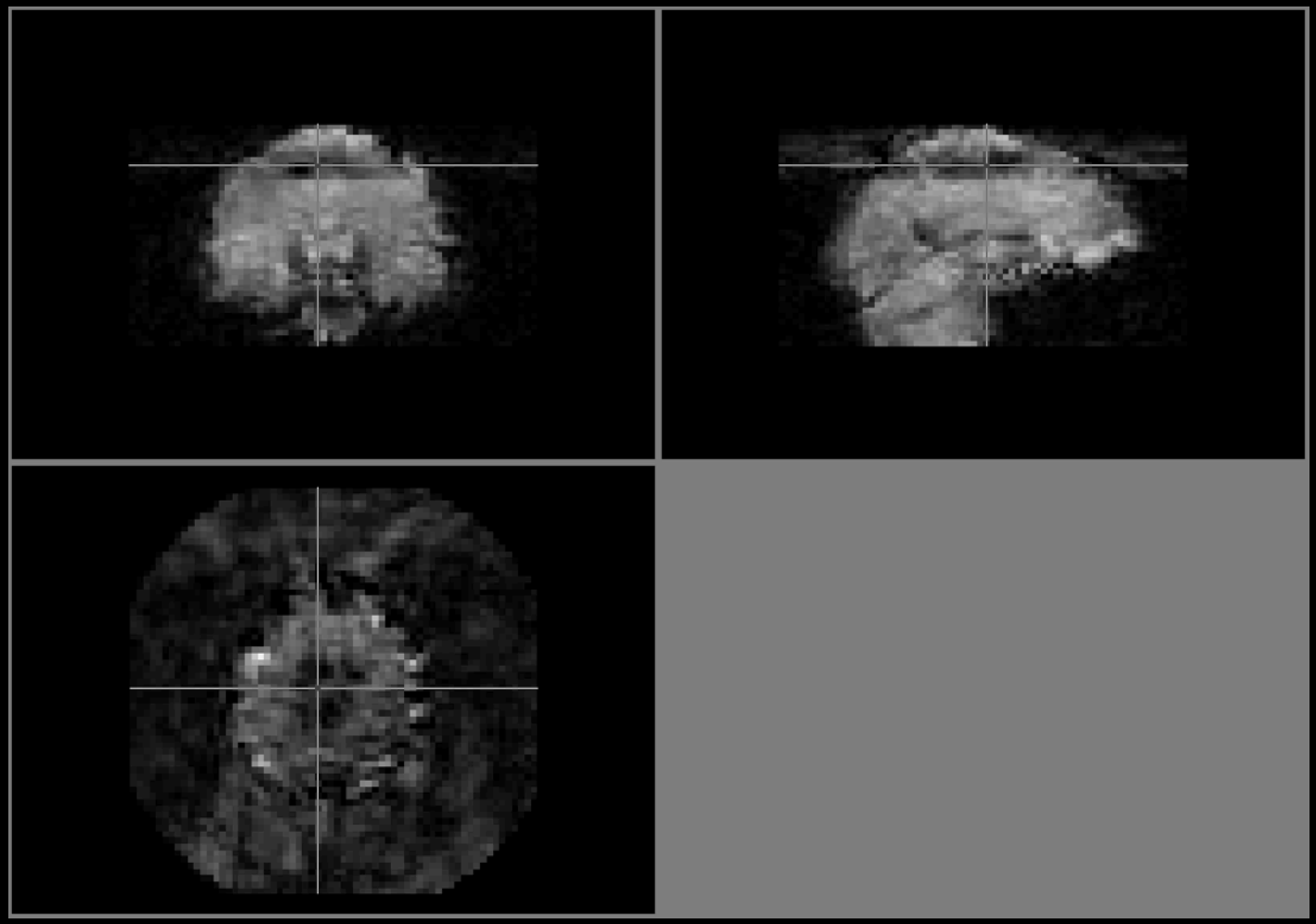
Always check for bad data. Arduous task but critical.



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physioCorr [subject]

run_XX.nii ⟶ ***prun_XX.nii***

sliceTime [subject]

prun_XX.nii ⟶ **aprun_XX.nii**

realignfMRI [subject]

aprun_XX.nii ⟶ **raprun_XX.nii**

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Getting the best brain extraction

`bestBET, fslCheck, mvBestBET`

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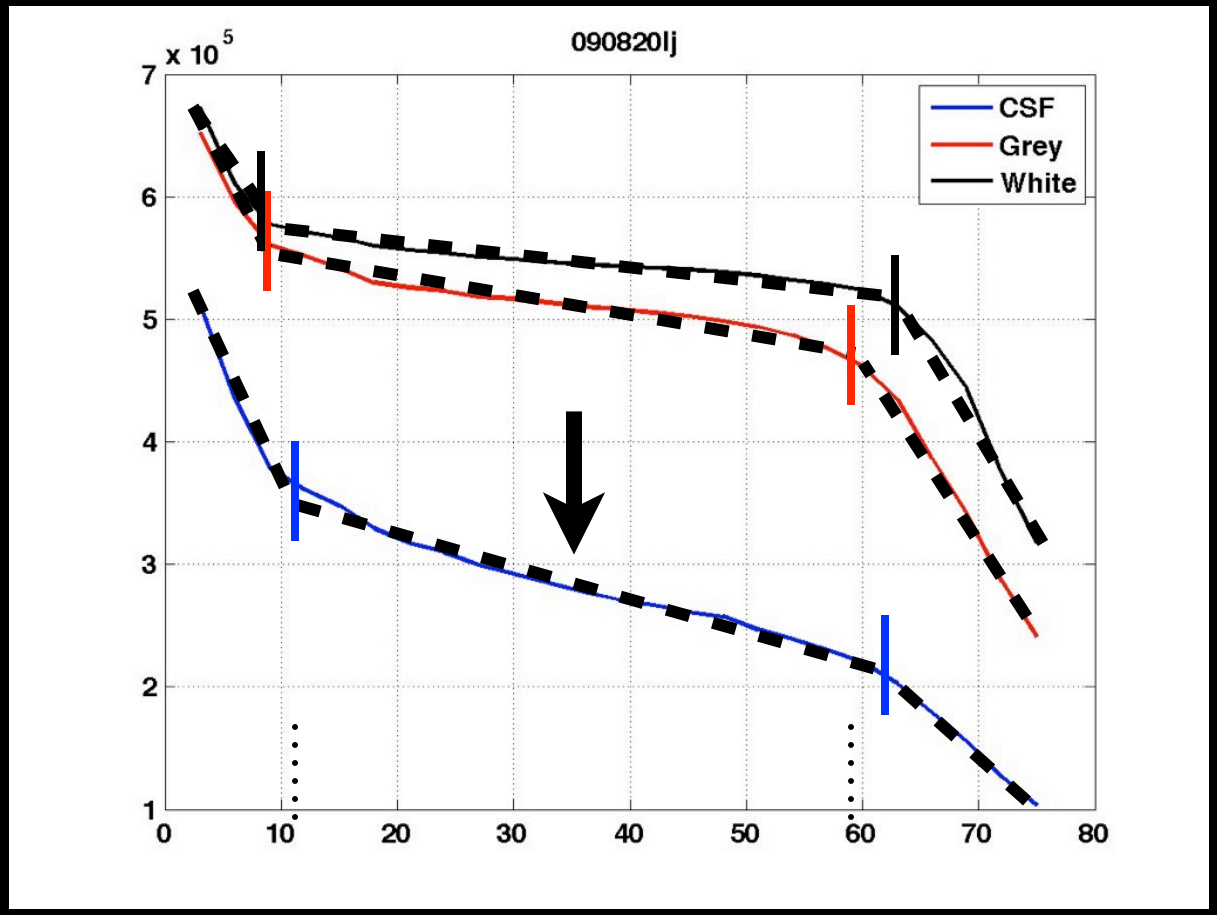
bestBET [subject]



voxel count

extraction fraction

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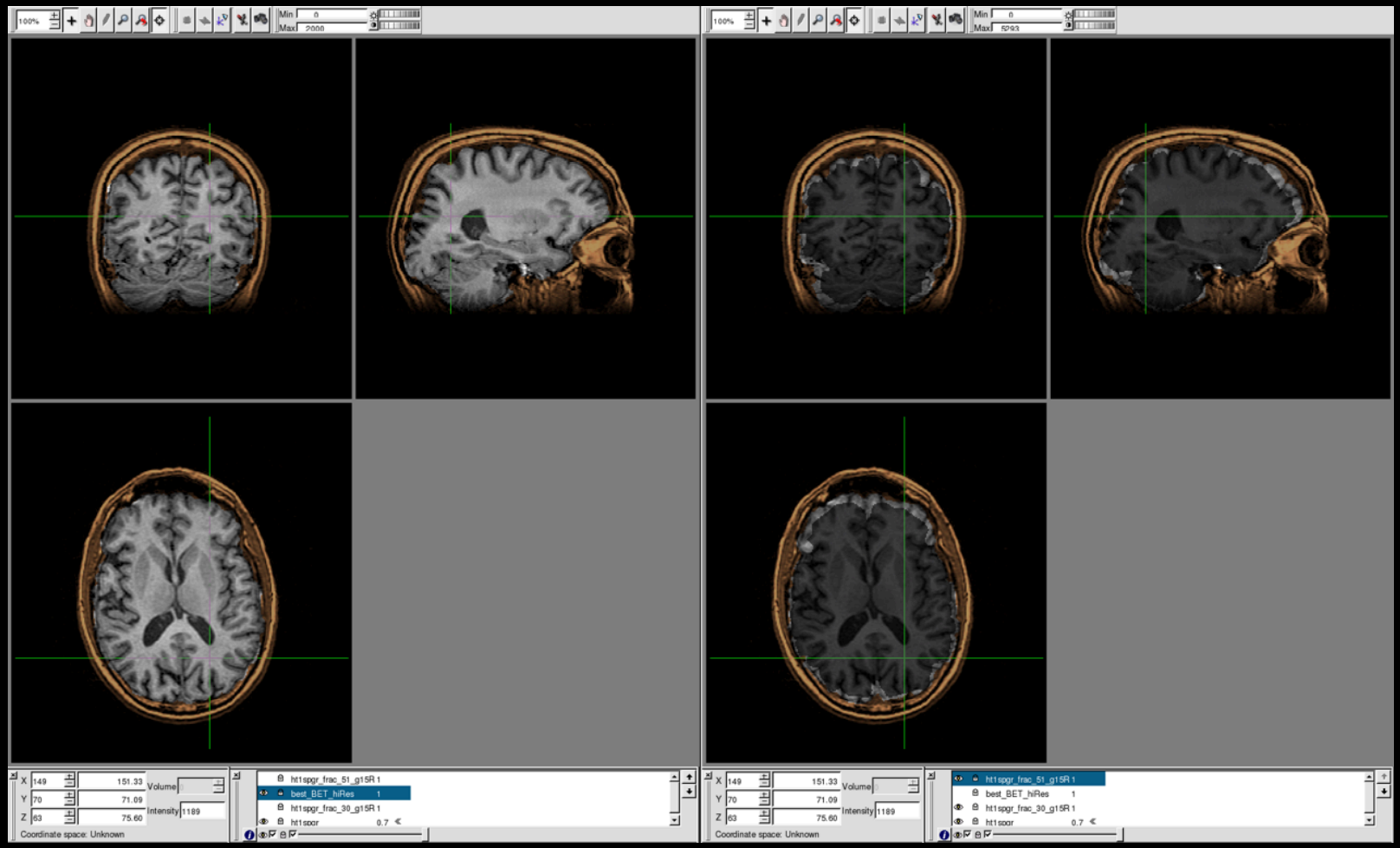
`fslCheck -h ht1spgr [subject][-b]`



mvBestBET -h ht1spgr [subject] [-u value]

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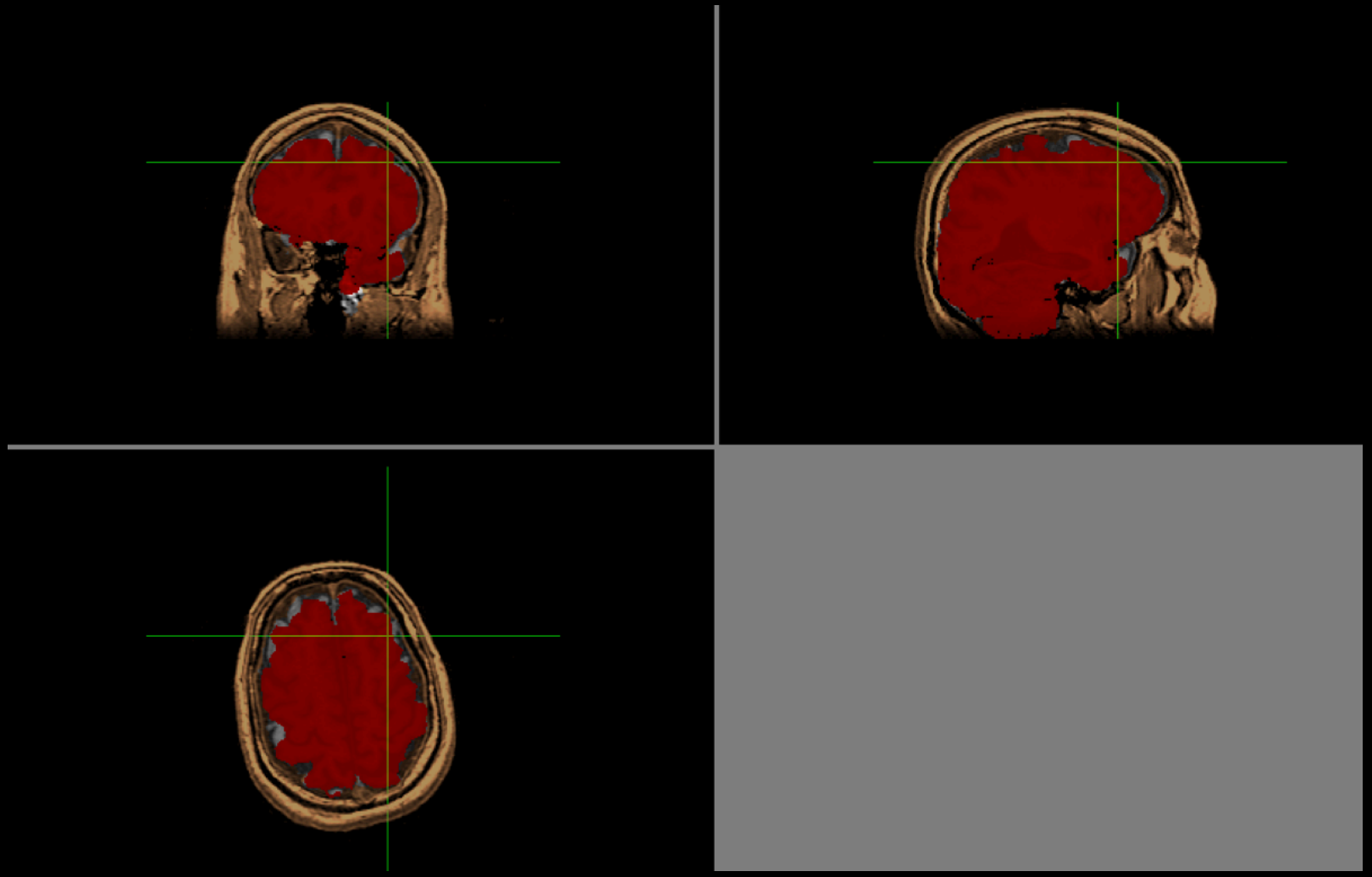
Example of different thresholds.
Red is not great.



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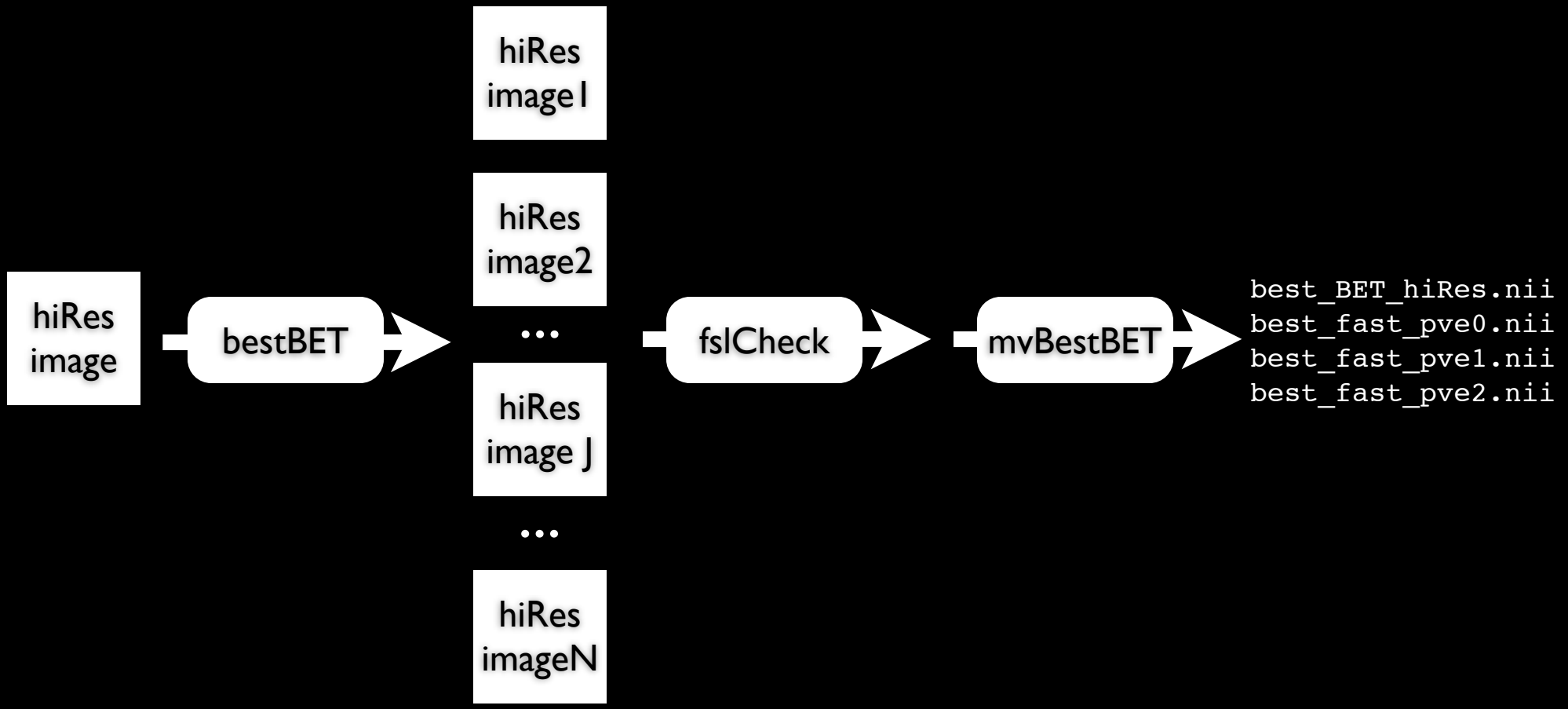
As part of bestBET, different tissue segments are created. The mvBestBET command will automatically label the ones you choose for further processing.



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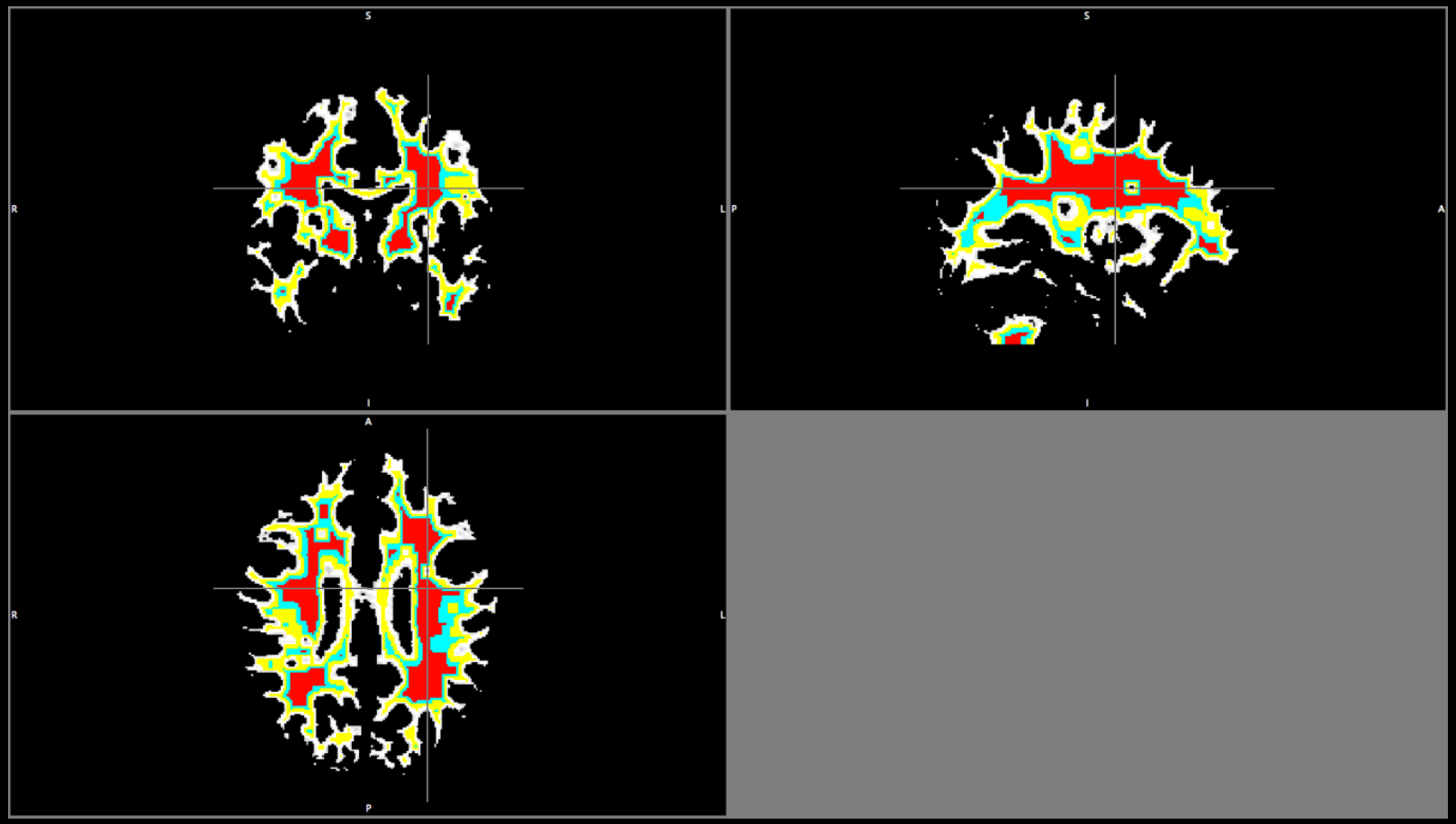
White matter segment with various erosions.



```
anatomy/BET/best_BET_hiRes.nii
anatomy/BET/best_fast_pve0.nii
anatomy/BET/best_fast_pve1.nii
anatomy/BET/best_fast_pve2.nii
```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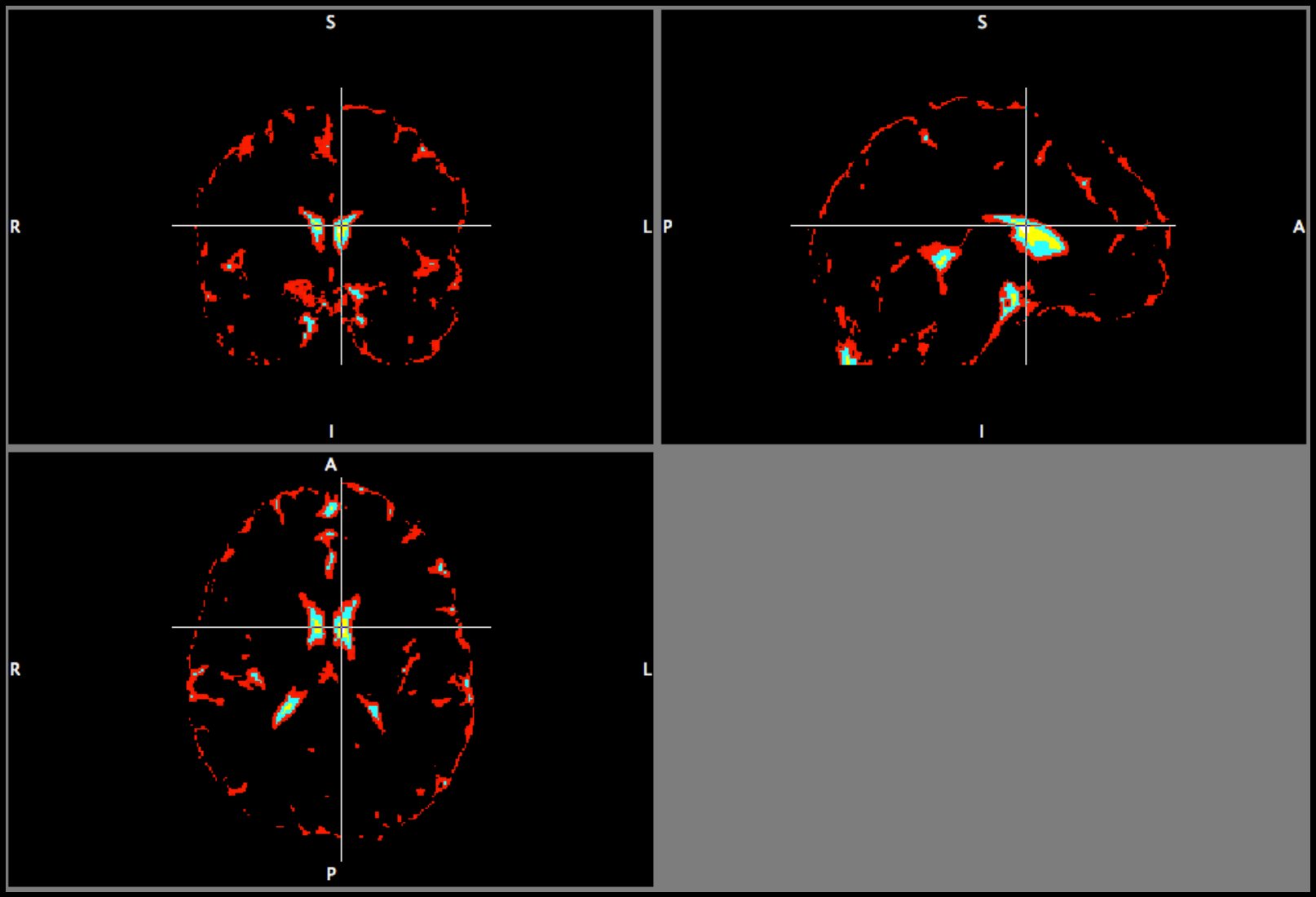
CSF segment with various erosions.



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coregOverlay [subject]

Prior → After

```
[subject]/
  anatomy/
     ht1overlay.nii
     htspgr.nii
  func/
    run_XX/
      run_XX.nii
      raprun_XX.nii
```

```
[subject]/
  anatomy/
     ht1overlay.nii
     htspgr.nii
  func/
    run_XX/
      run_XX.nii
      raprun_XX.nii
    coReg/
       ht1overlay.nii
```


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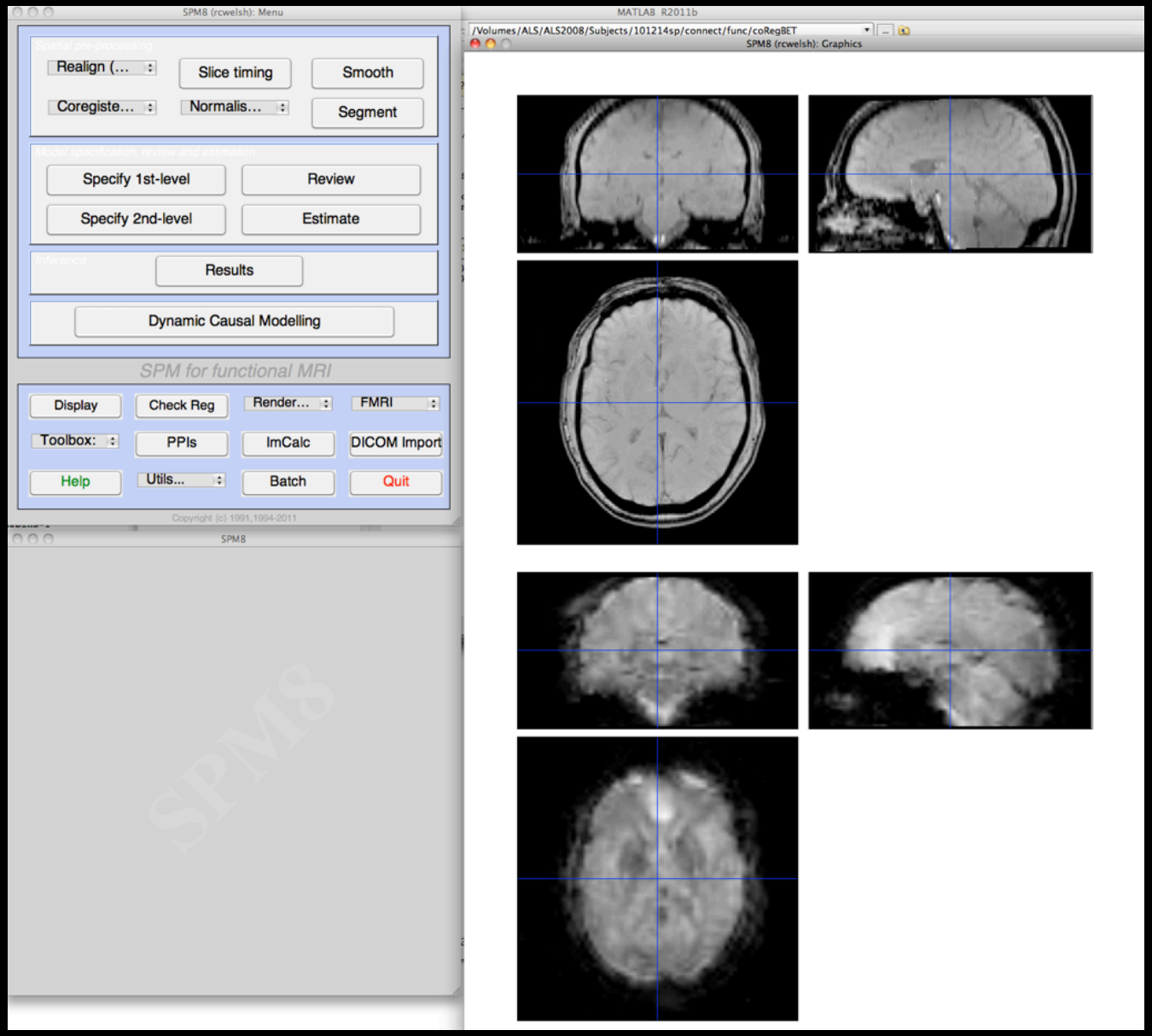
Check registration



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coregHiRes [subject]

Prior → After

```
[subject]/
  anatomy/
     ht1overlay.nii
     htspgr.nii
     BET/
        best_BET_hiRes.nii
  func/
    run_XX/
      run_XX.nii
      raprun_XX.nii
```

```
[subject]/
  anatomy/
     ht1overlay.nii
     htspgr.nii
  func/
    run_XX/
      run_XX.nii
      raprun_XX.nii
    coReg/
       ht1overlay.nii
       best_BET_hiRes.nii
       best_fast_pve0.nii
       best_fast_pve1.nii
       best_fast_pve2.nii
```


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warpHiRes [subject]

After

```
[subject]/
  anatomy/
    ...
  func/
    run_XX/
    ...
    coReg/
      w1mm_best_BET_hiRes.nii
      w1mm_best_fast_pve0.nii
      w1mm_best_fast_pve1.nii
      w1mm_best_fast_pve2.nii
      best_BET_hiRes_sn.mat
```


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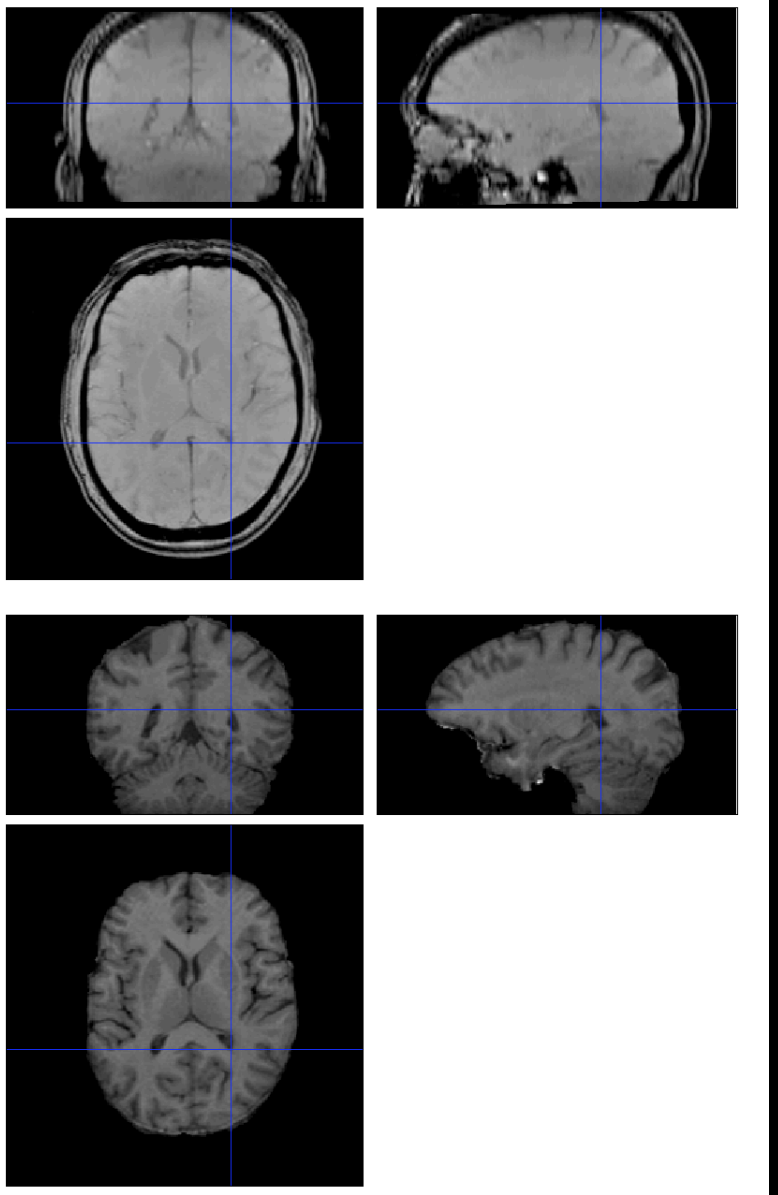
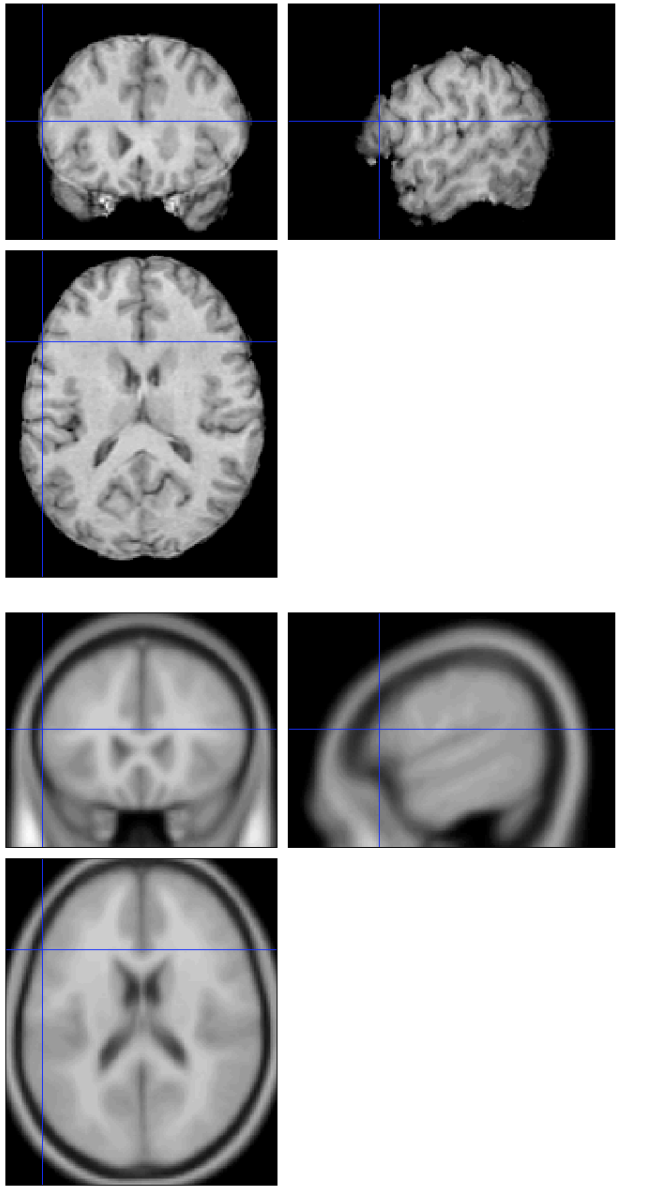
Overlay to hires



Warped HiRes



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warpfMRI [subject]

Prior → After

```
[subject]/
  anatomy/
     ht1overlay.nii
     htspgr.nii
  func/
    run_XX/
      run_XX.nii
      raprun_XX.nii
```

```
[subject]/
  anatomy/
     ht1overlay.nii
     htspgr.nii
  func/
    run_XX/
      run_XX.nii
      raprun_XX.nii
      w3mm_raprun_XX.nii
```


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smoothfMRI [subject]

Prior → After

```
[subject]/
  anatomy/
     ht1overlay.nii
     htspgr.nii
  func/
    run_XX/
      run_XX.nii
      raprun_XX.nii
```

```
[subject]/
  anatomy/
     ht1overlay.nii
     htspgr.nii
  func/
    run_XX/
      run_XX.nii
      raprun_XX.nii
      w3mm_raprun_XX.nii
      s5mm_w3mm_raprun_XX.nii
```


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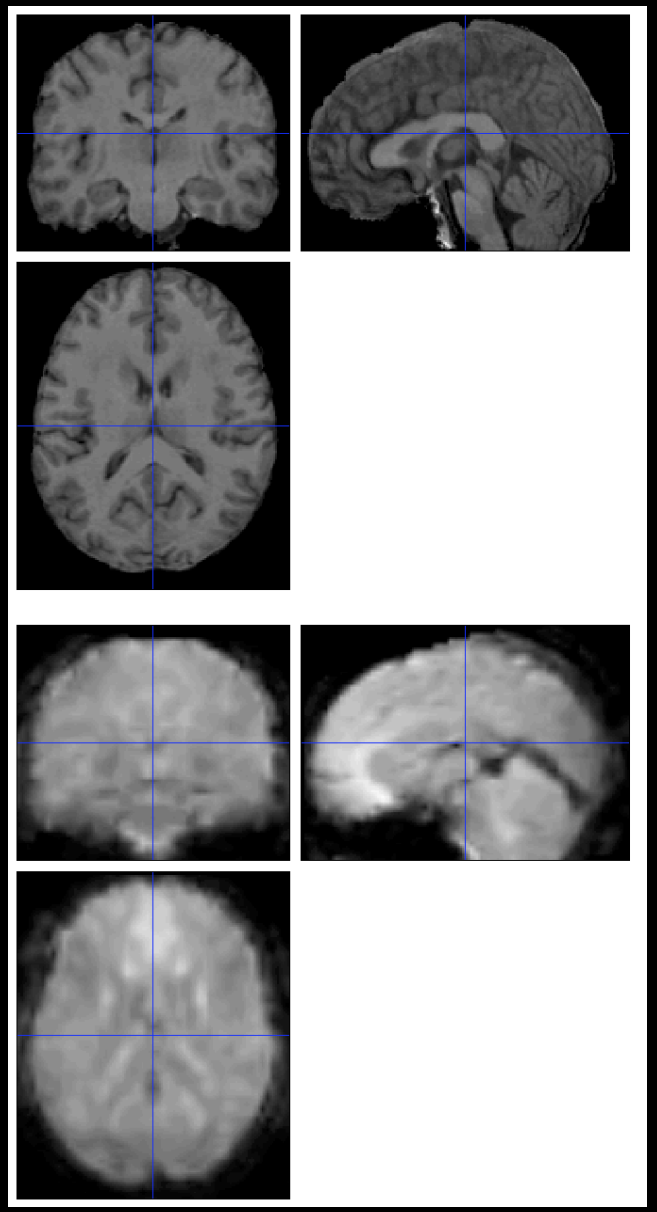
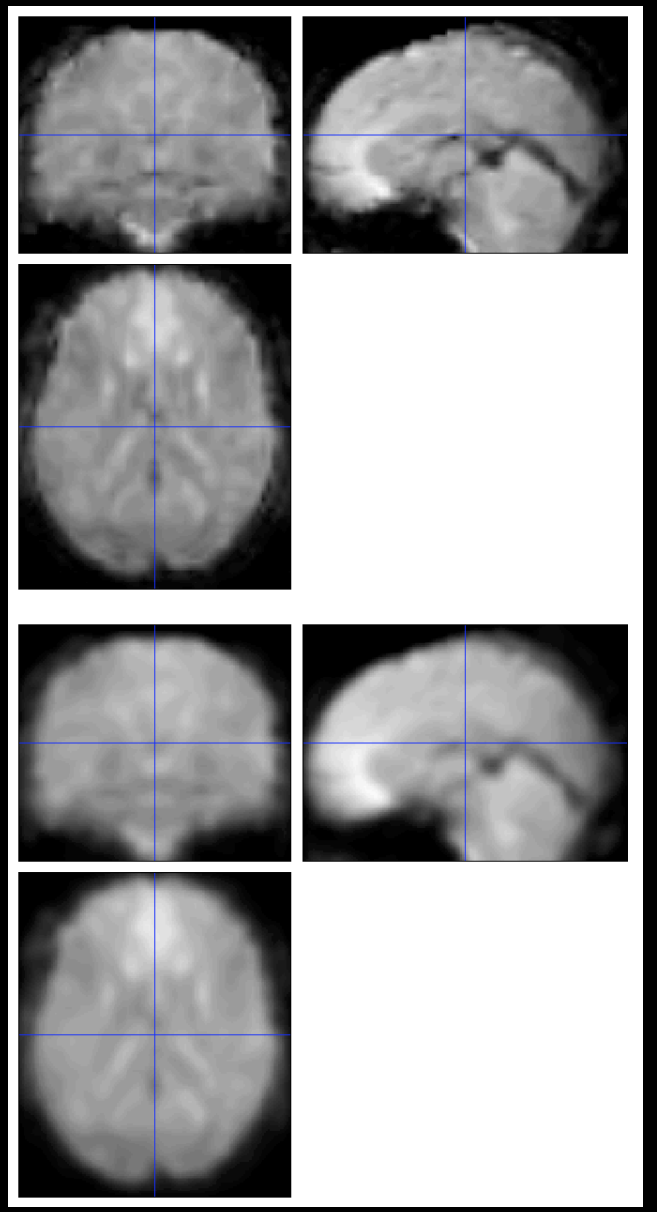
Warped functionals Smoothed functionals





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