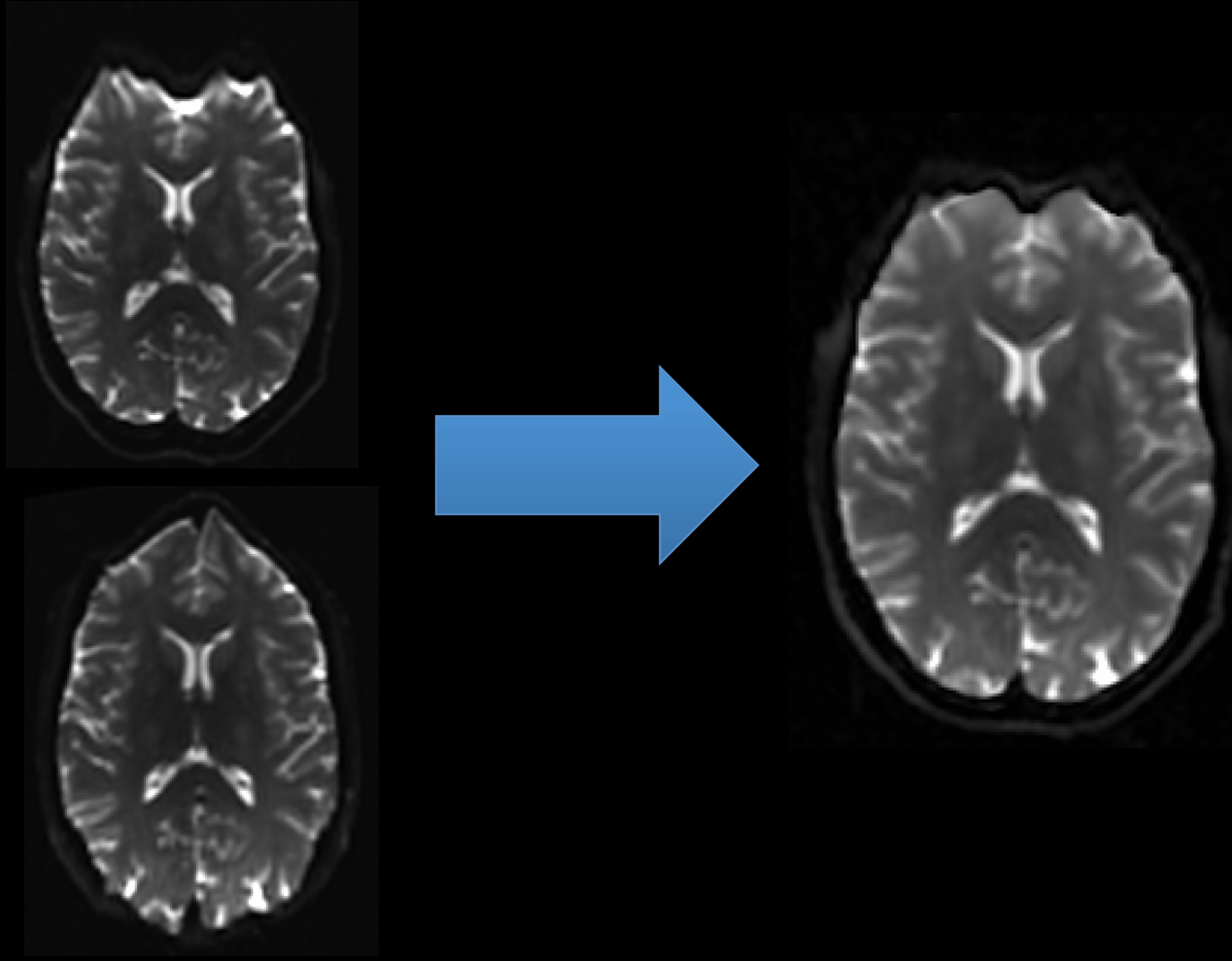


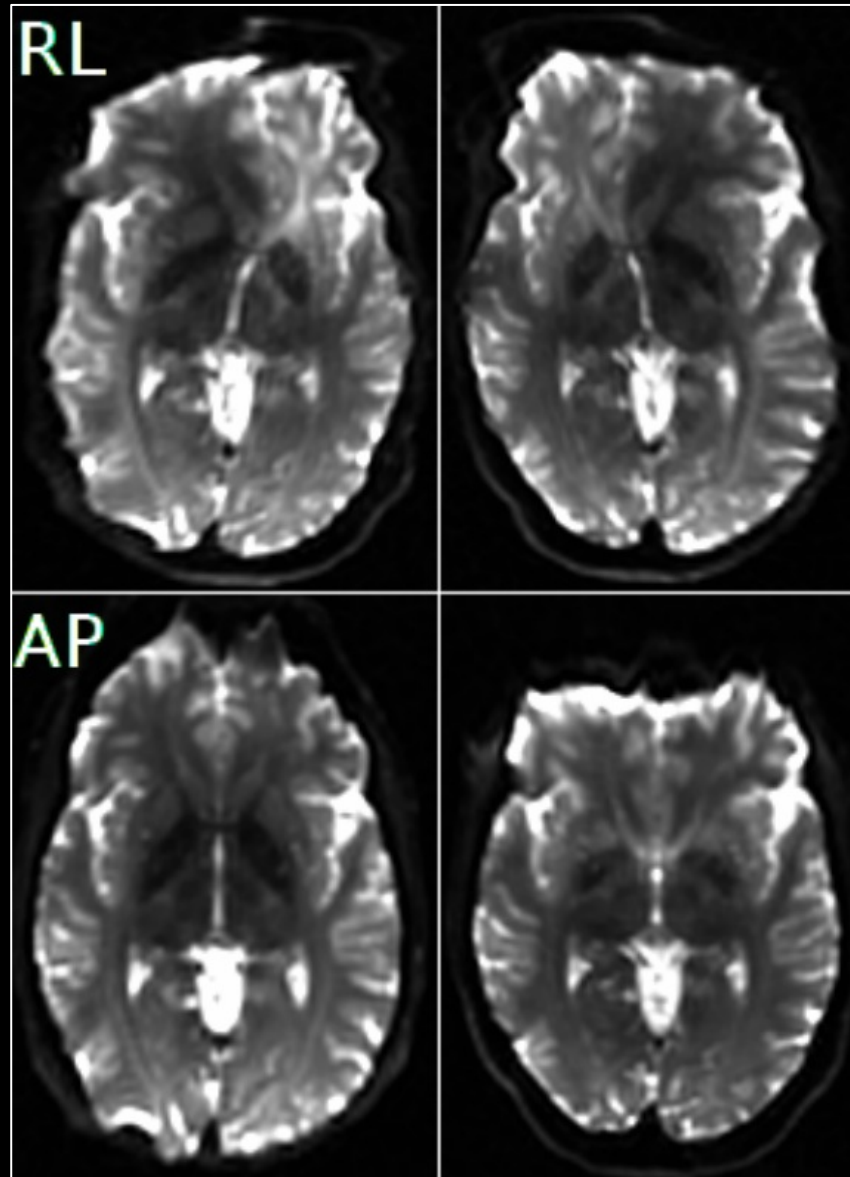
**DR-BUDDI**  
**Blip-up Blip-down Correction of**  
**EPI images with TORTOISE**



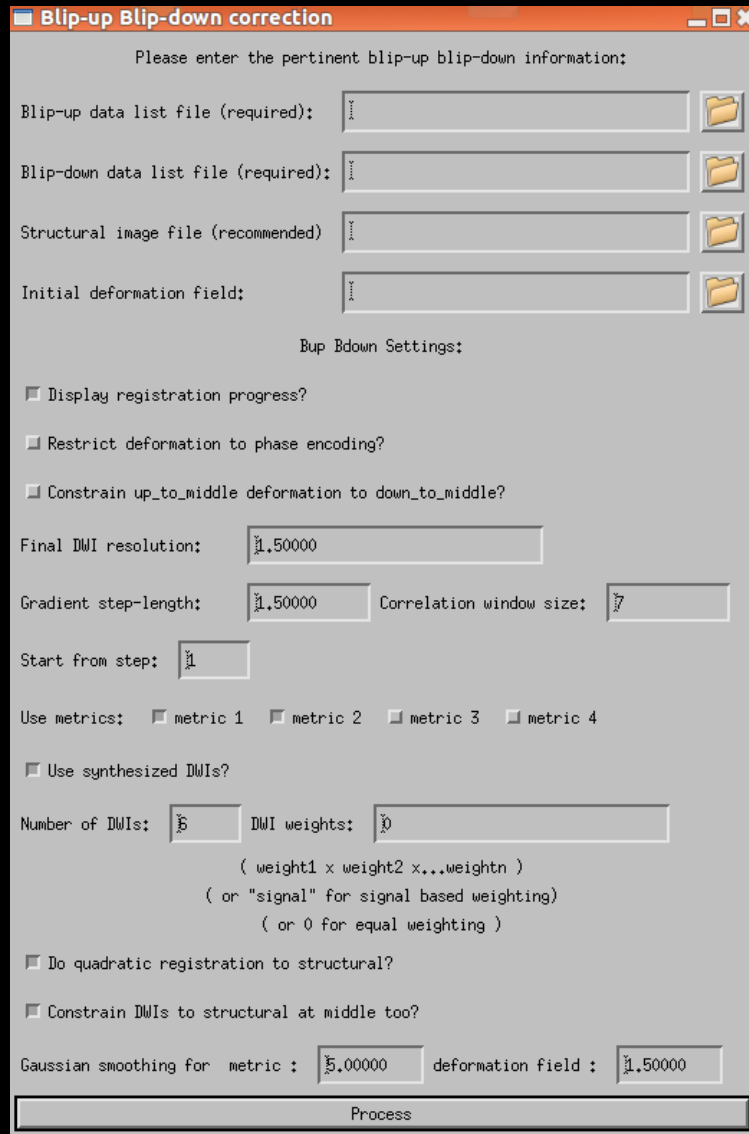
# Blip-up Blip-down correction

- Acquire the entire diffusion dataset with identical parameters except
  - Reversed phase encoding directions.
  - Anterior and Posterior or Right and Left.
- Assuming no motion and changes in the B0 field,
  - Amount of EPI distortions should be theoretically identical.
  - EPI distortions should be in opposite directions.
- DR-BUDDI (Diffeomorphic Registration of Blip-Up blip-Down Diffusion Imaging) uses this information to correct for :
  - Geometrical displacements.
  - Signal pile-ups and expansions.

# Blip-up Blip-down correction





# The GUI





Blip-up Blip-down correction

Please enter the pertinent blip-up blip-down information:

Blip-up data list file (required):  

Blip-down data list file (required):  

Structural image file (recommended)  

Initial deformation field:  

Bup Bdown Settings:

Display registration progress?

Restrict deformation to phase encoding?

Constrain up\_to\_middle deformation to down\_to\_middle?

Final DWI resolution:

Gradient step-length:  Correlation window size:

Start from step:

Use metrics:  metric 1  metric 2  metric 3  metric 4

Use synthesized DWIs?

Number of DWIs:  DWI weights:   
( weight1 x weight2 x...weightn )  
( or "signal" for signal based weighting )  
( or 0 for equal weighting )

Do quadratic registration to structural?

Constrain DWIs to structural at middle too?

Gaussian smoothing for metric :  deformation field :

Process

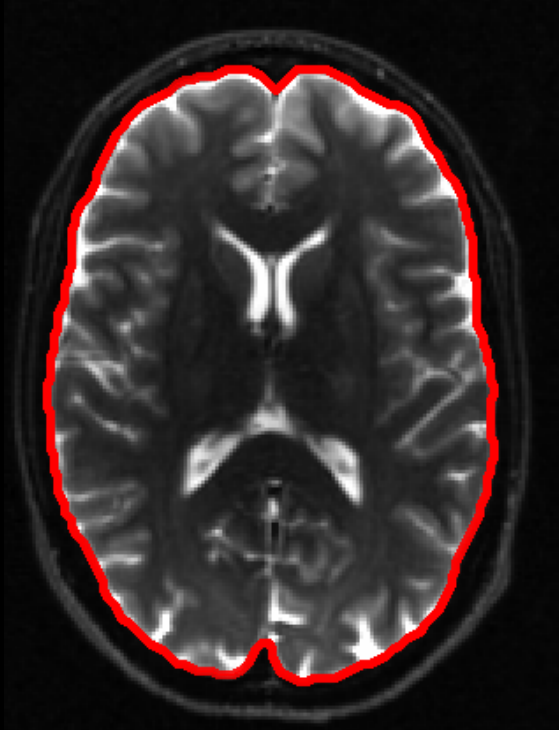
- Descriptions of each parameter and setting can be found at (under v2.1.0) :

*<https://science.nichd.nih.gov/confluence/display/nihpd/Version+Update+Notes>*

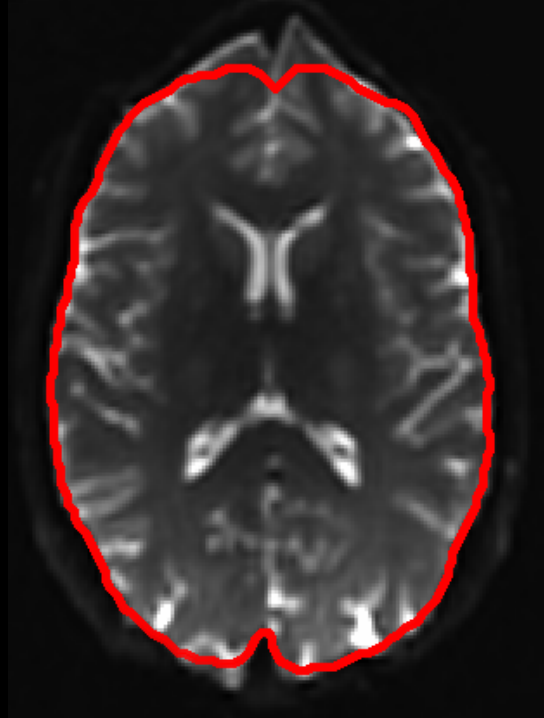
# Blip-up Blip-down correction

- DR-BUDDI is programmed in C++ with OpenMP for parallelization.
- It can directly be called from command line.
- The IDL GUI is only used to generate the correct syntax for command line.
- DR-BUDDI supports OSX and Linux flavors (v6 required for CentOS).
- Progression of correction can be checked real time within the progress window with the arrow keys.
  
- DIFFPREP needs to be run on both the up and down datasets beforehand.
- As the up and down listfiles, the upsampled versions of original, unprocessed listfiles need to be provided, (i.e. original\_updata\_up.list and original\_downdata\_up.list)

# Correction with BSplines



Structural image



Original Distorted image with  
the same outline

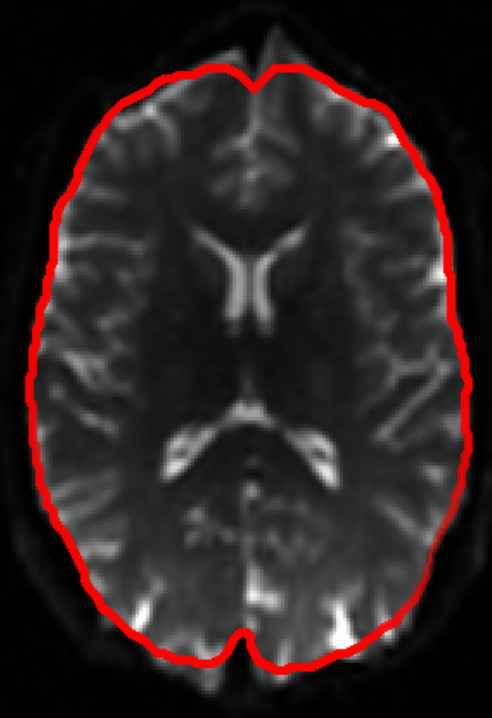
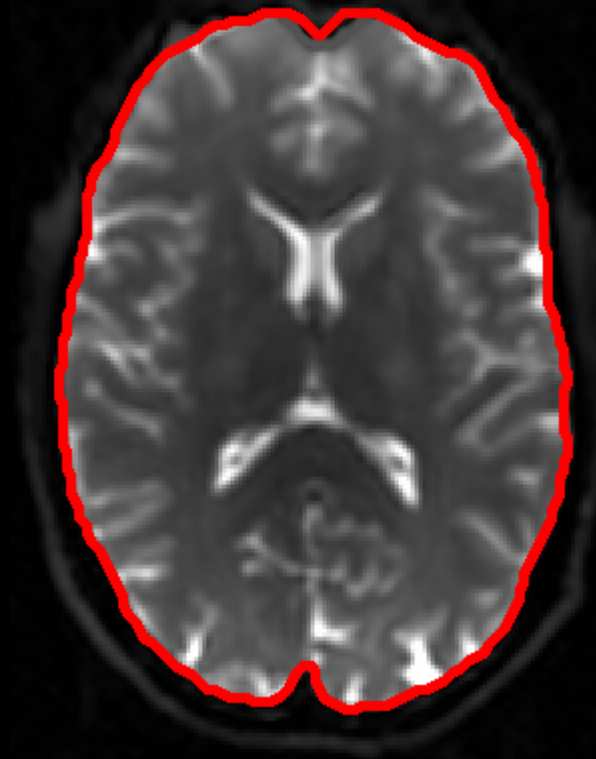
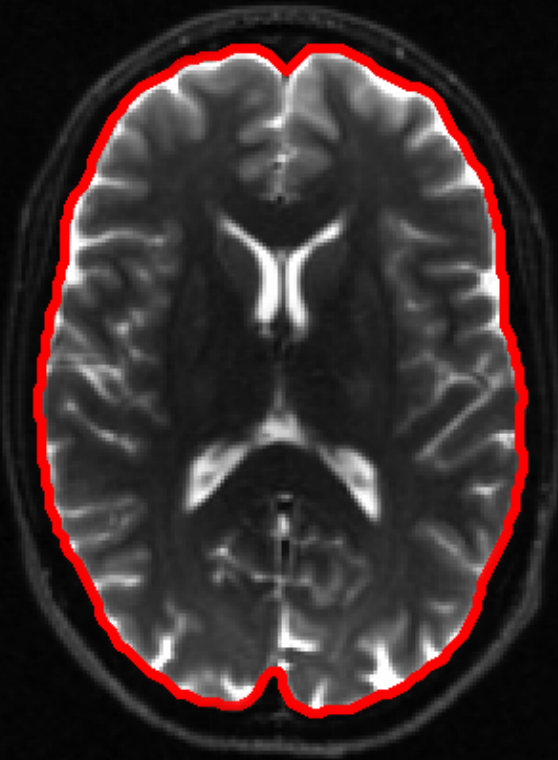


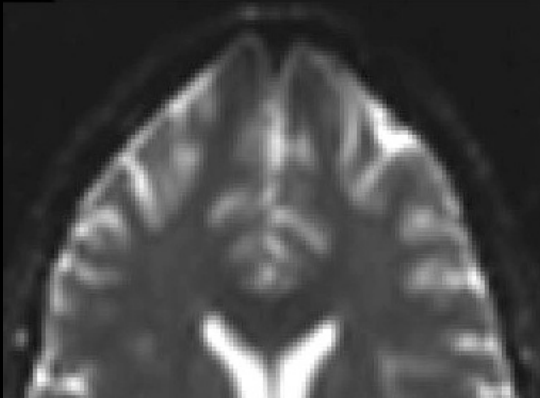
Image corrected with  
Bsplines registration

# Bup-bdown correction

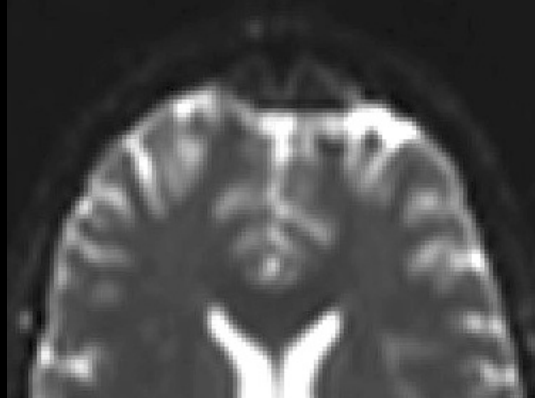


Blip-up blip-down correction is significantly superior to corrections employing only one data with single phase encoding direction.

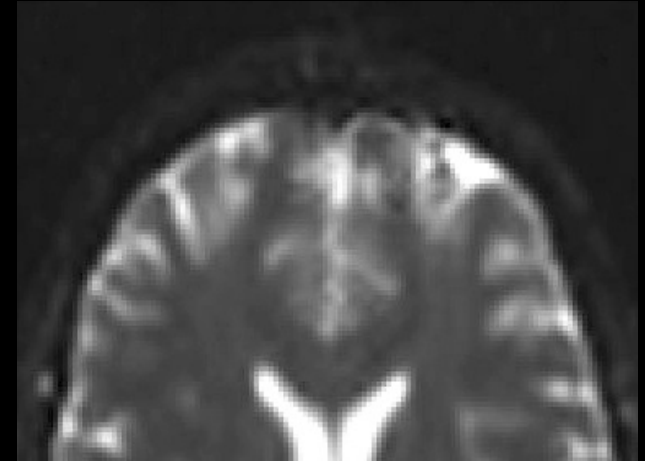
# Correction Comparison



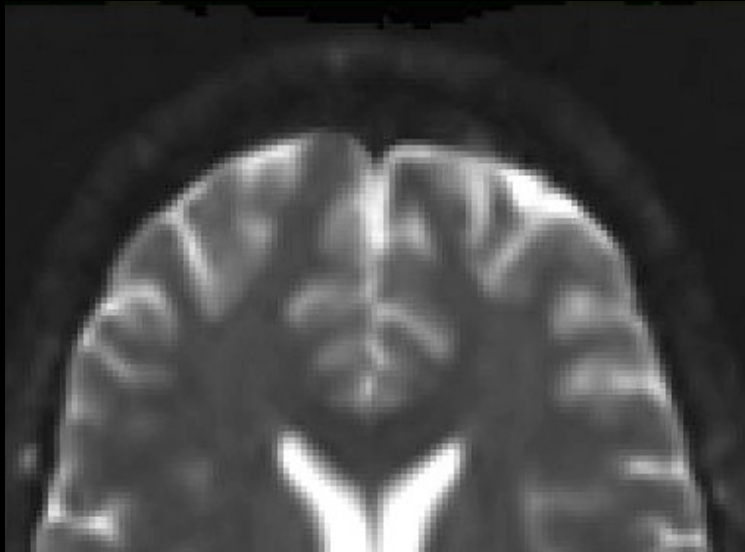
Original up image



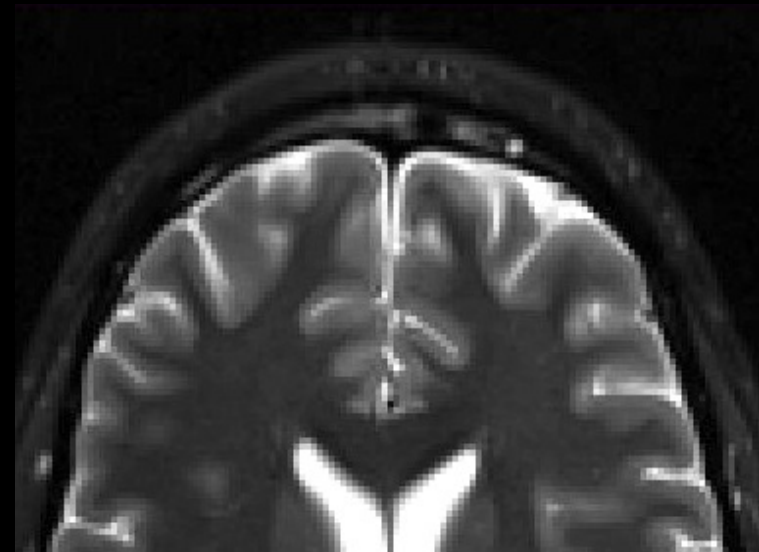
Correction 1



Correction 2



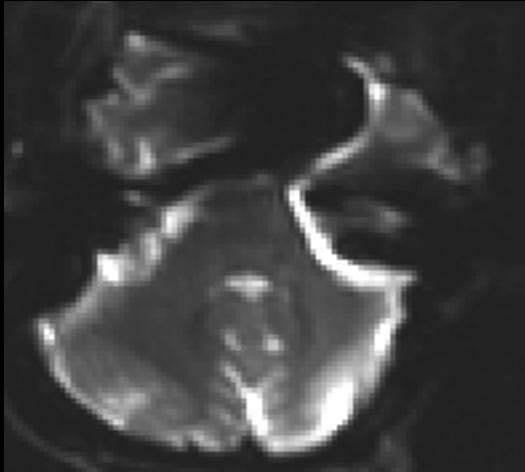
DR-BUDDI correction



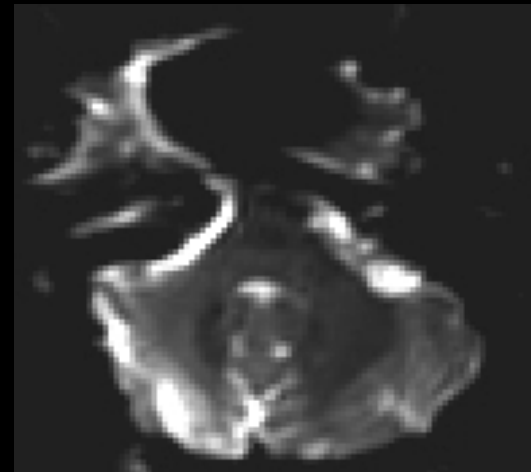
Structural image



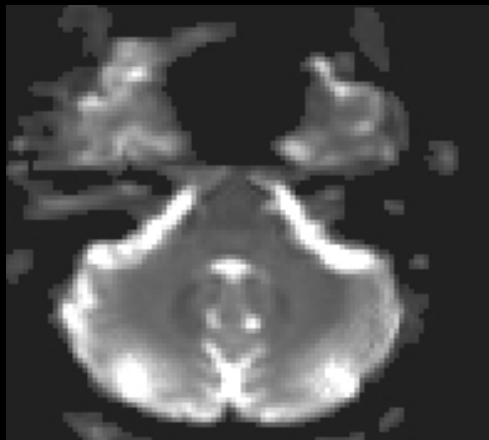
# Correction Comparison



Original up image



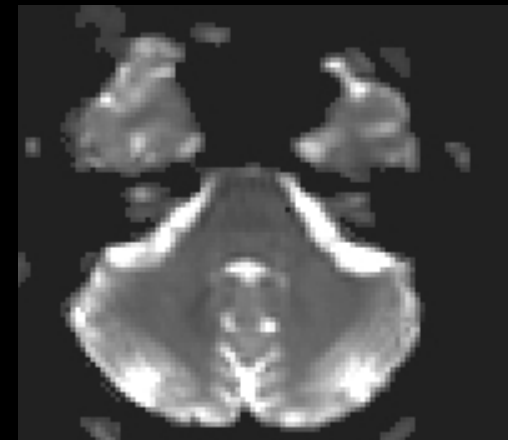
Original down image



Correction 1



Correction 2



Bup bdown correction

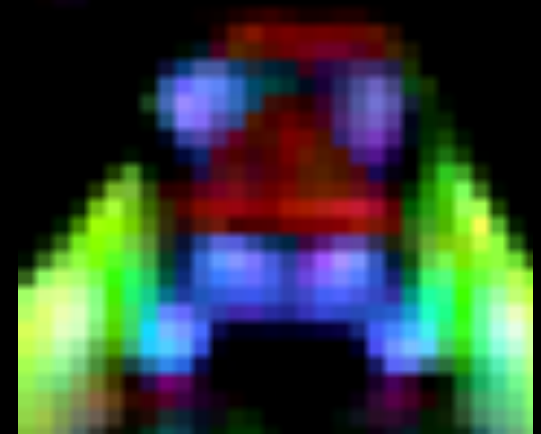
# Correction comparison



Correction 1



Correction 2



Bup bdown correction



# DR-BUDDI



- DR-BUDDI is out of beta state.
- It is still constantly being improved. Version 2 with new features, and more robust correction under very large distortions will be released soon.
- A detailed tutorial is available and the corresponding scientific paper is soon to be published (revision 2).
- We would like to hear your feedback and any problems that you might face.