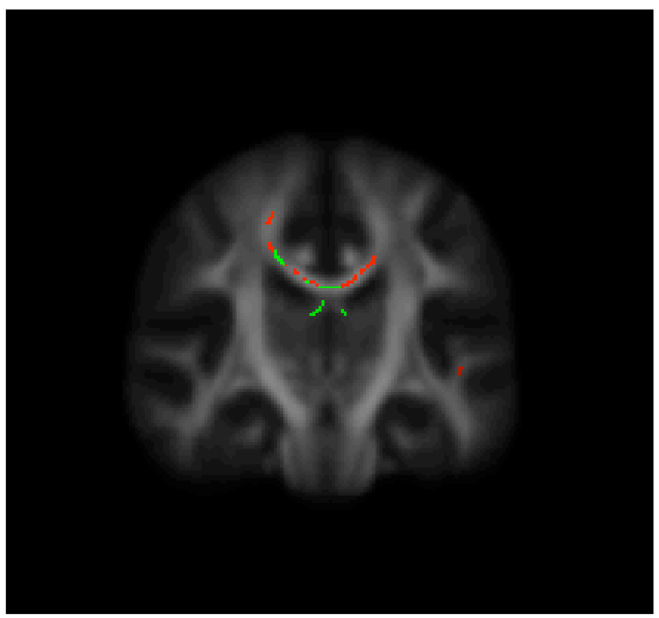
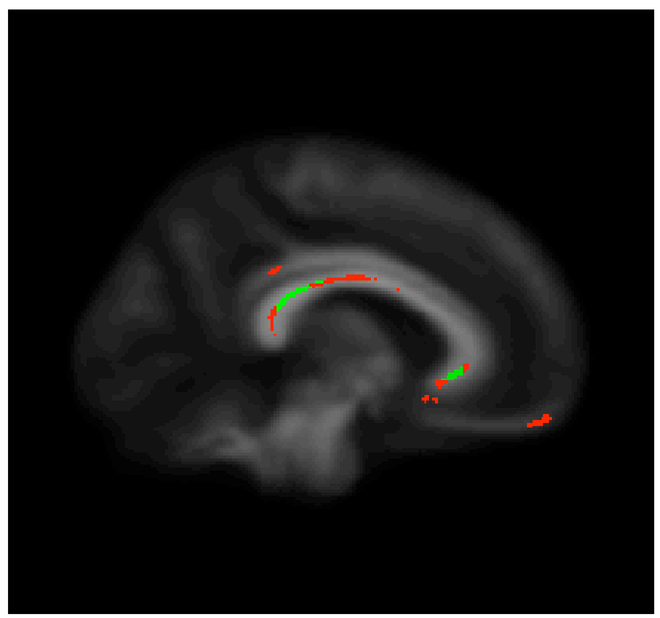
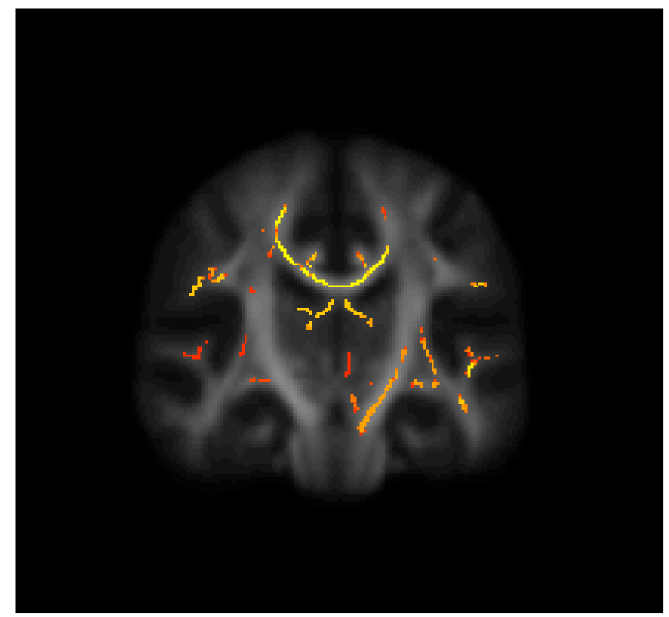
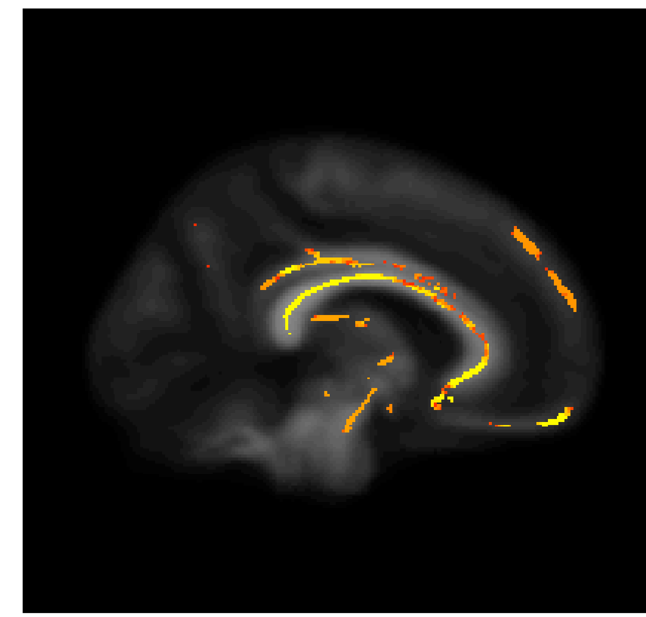
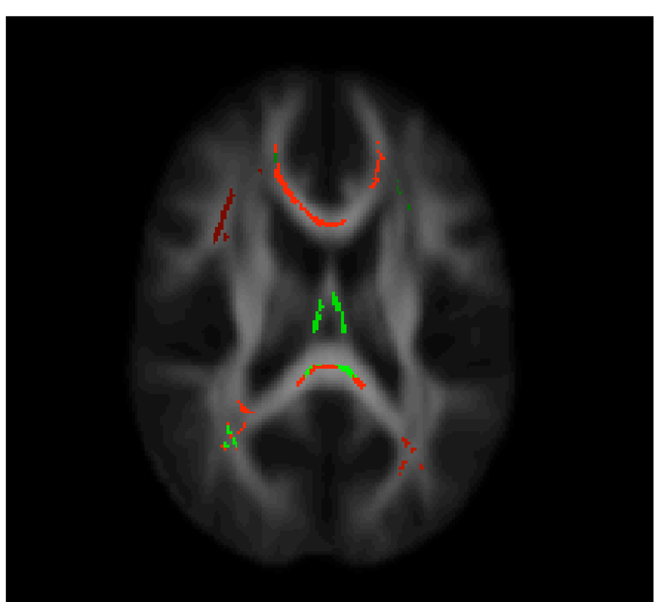
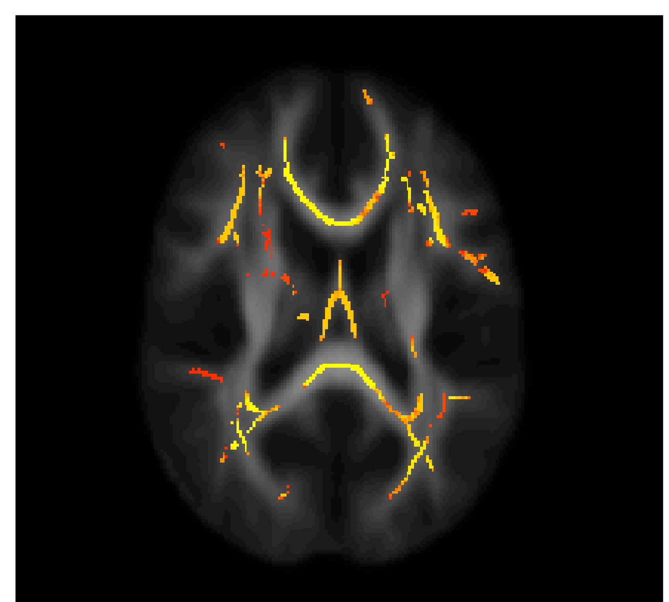
TFCE for TBSS

controls > schizophrenics
p<0.05 corrected for multiple comparisons across space,
using randomise

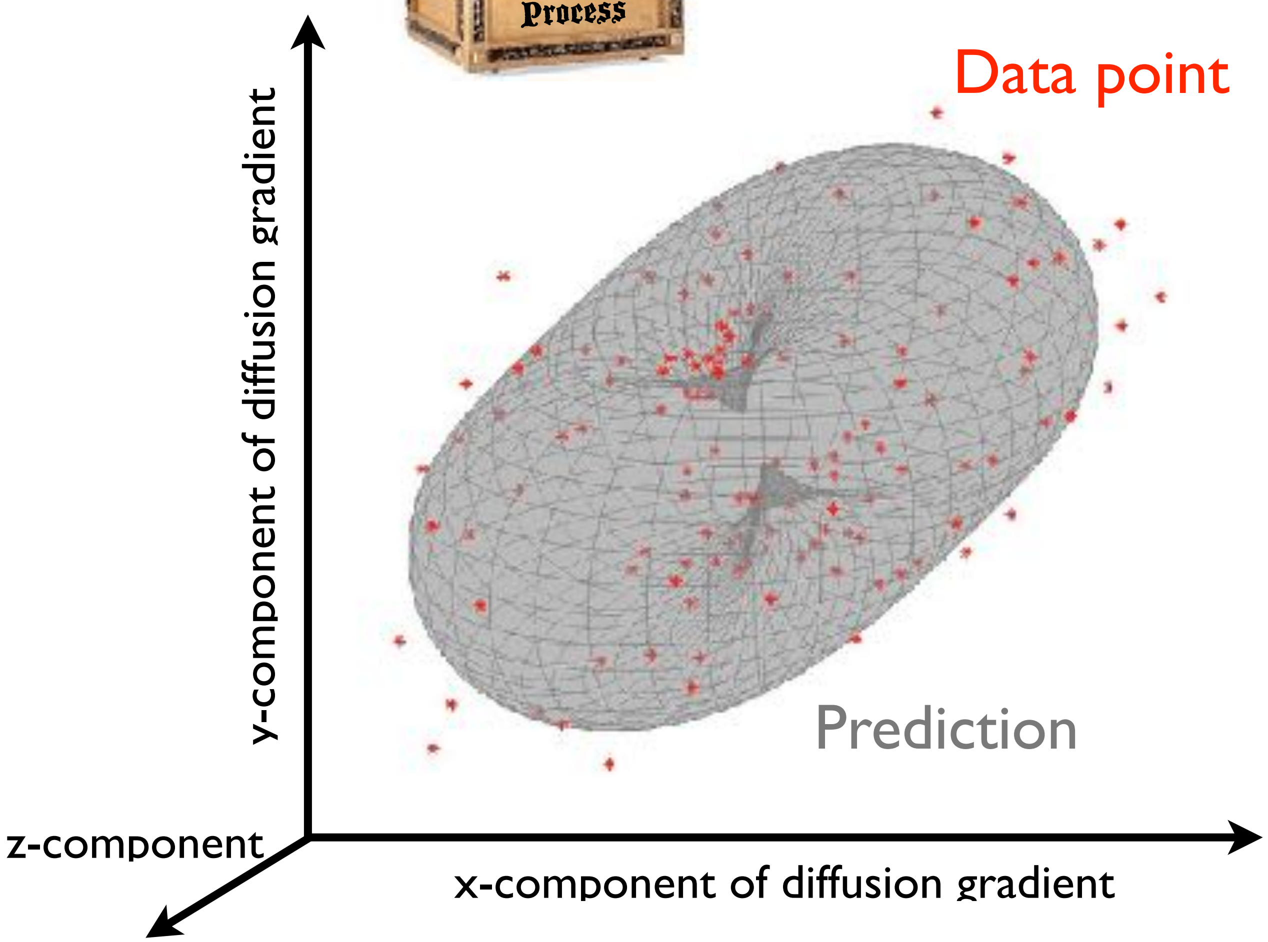


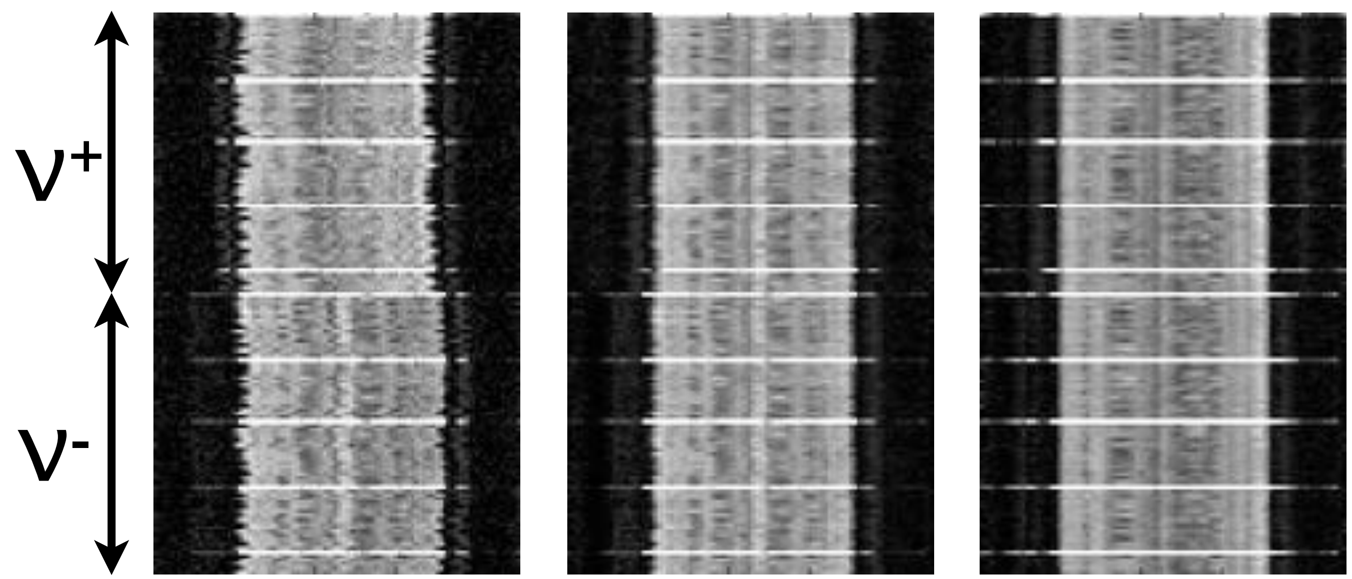
cluster-based:
cluster-forming
threshold =
2 or 3

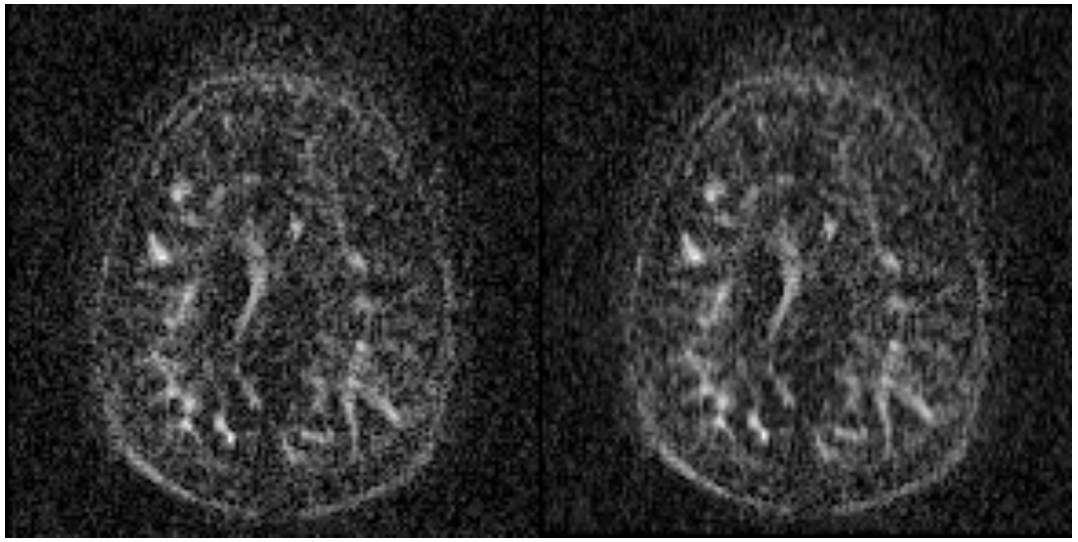


TFCE

eddy and topup - tools for processing of diffusion data

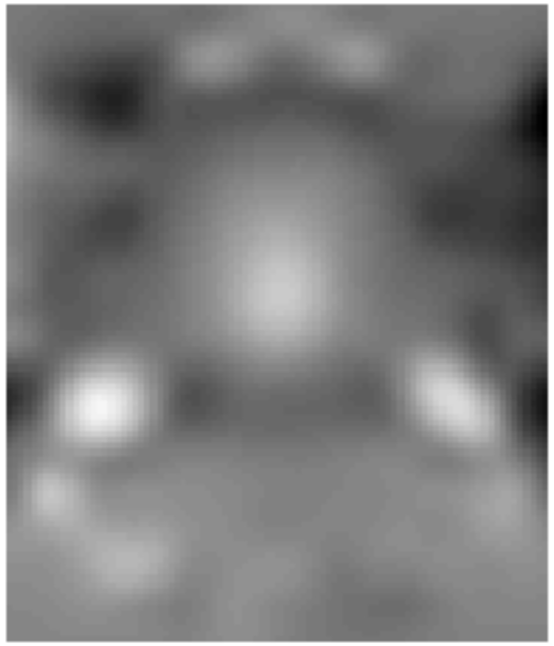






Separate estimation of susceptibility- and eddy current-fields

So, what we need to estimate is

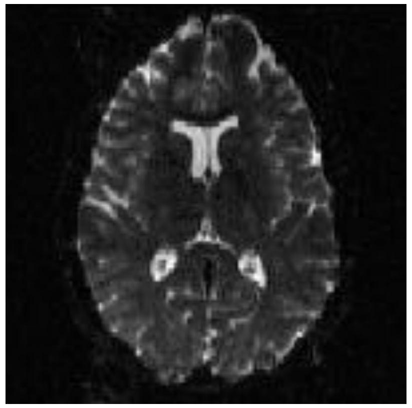
One of these per subject	One of these per volume
	
topup	eddy

FSL-tools:

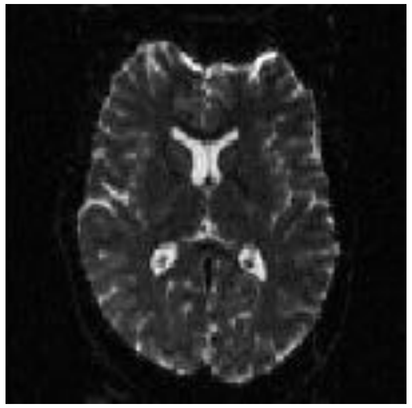
Outline of the talk

- What is the problem with diffusion data?
- Off-resonance field
  - How does it cause distortions?
  - Where does it come from?
- Registering diffusion data
  - How topup works
  - How eddy works
- Practicalities
- Some results
- Quality control
- “Advanced” eddy features

How topup works (very briefly)



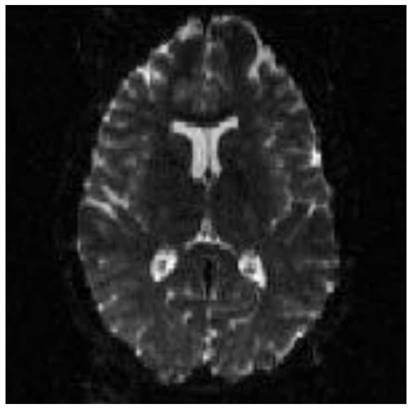
p=[0 1 0]



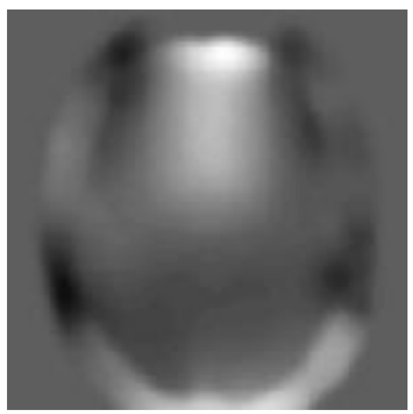
p=[0 -1 0]

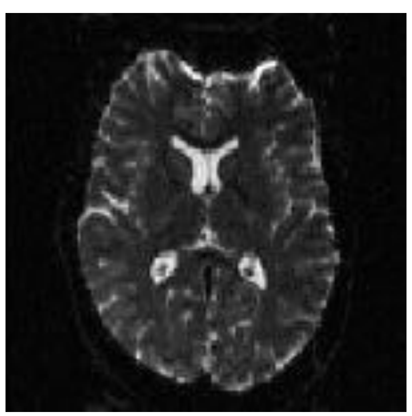
Given two images acquired with different phase-encoding

How topup works (very briefly)



p=[0 1 0]

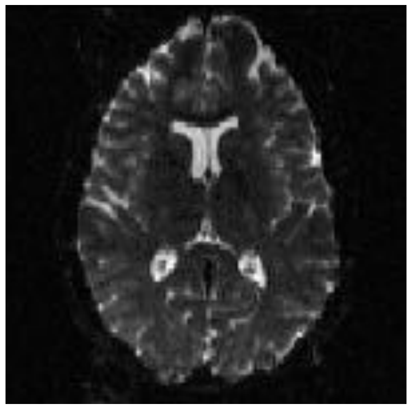




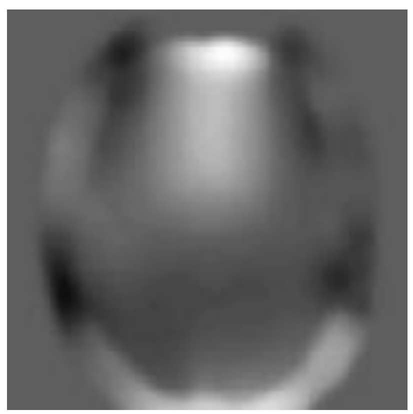
p=[0 -1 0]

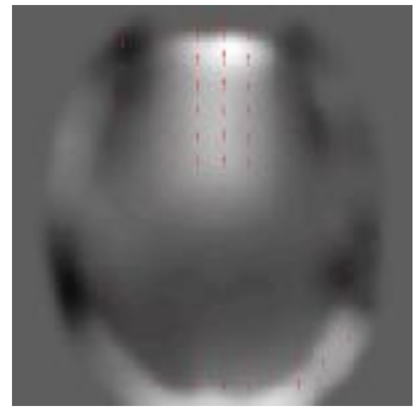
And we know what the off-resonance field is

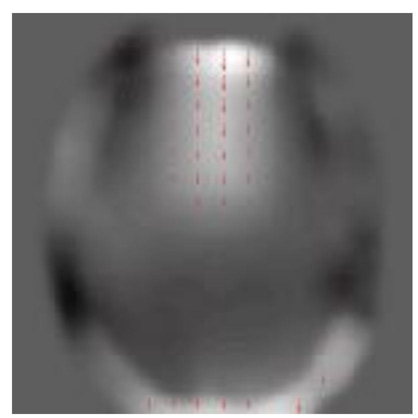
How topup works (very briefly)

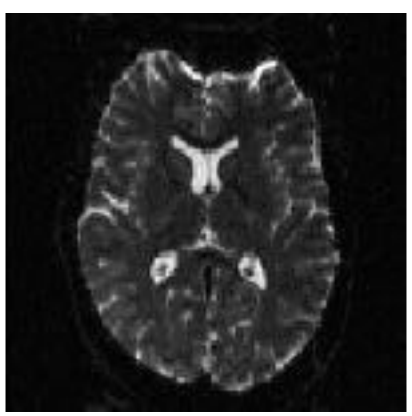


p=[0 1 0]





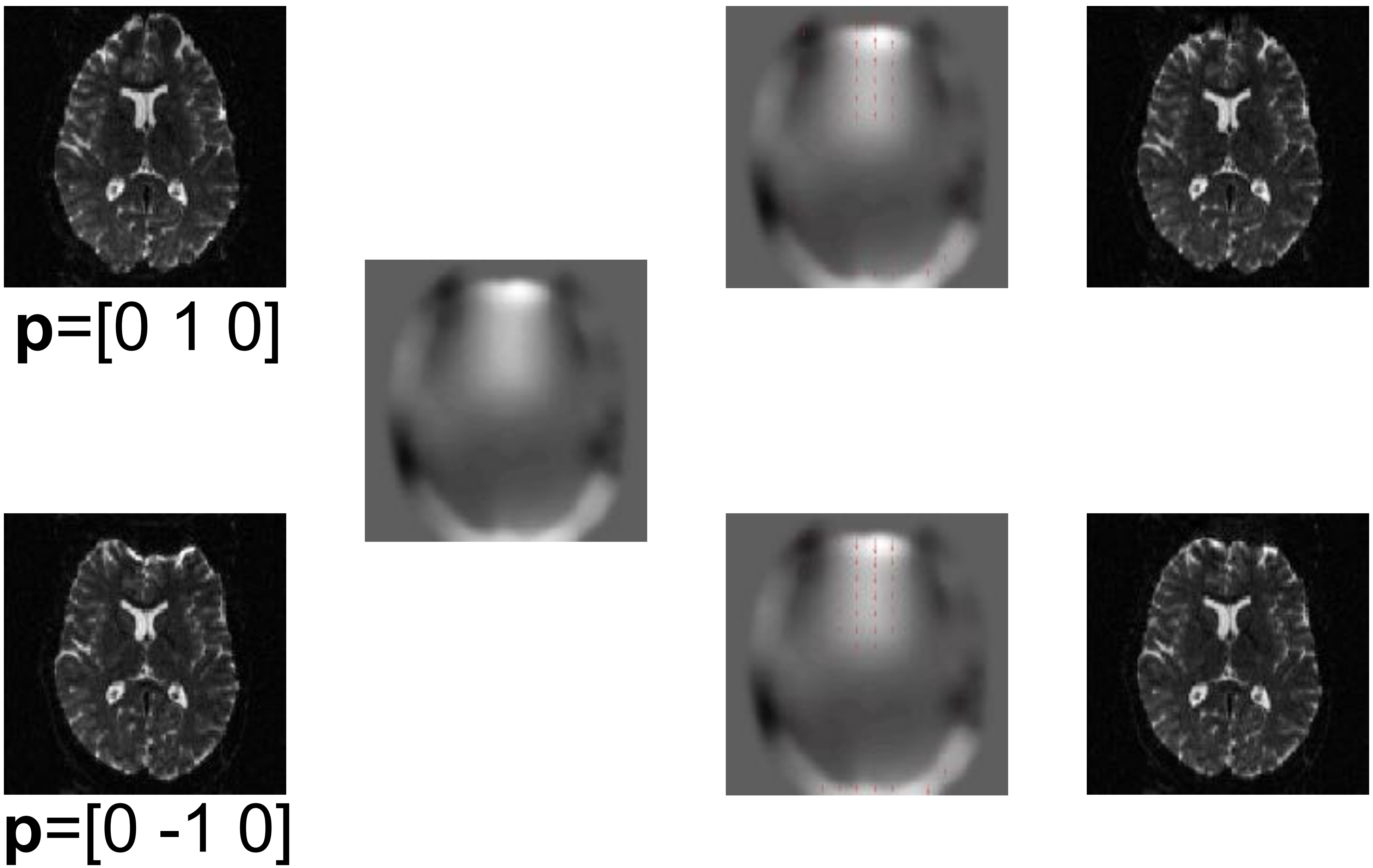




p=[0 -1 0]

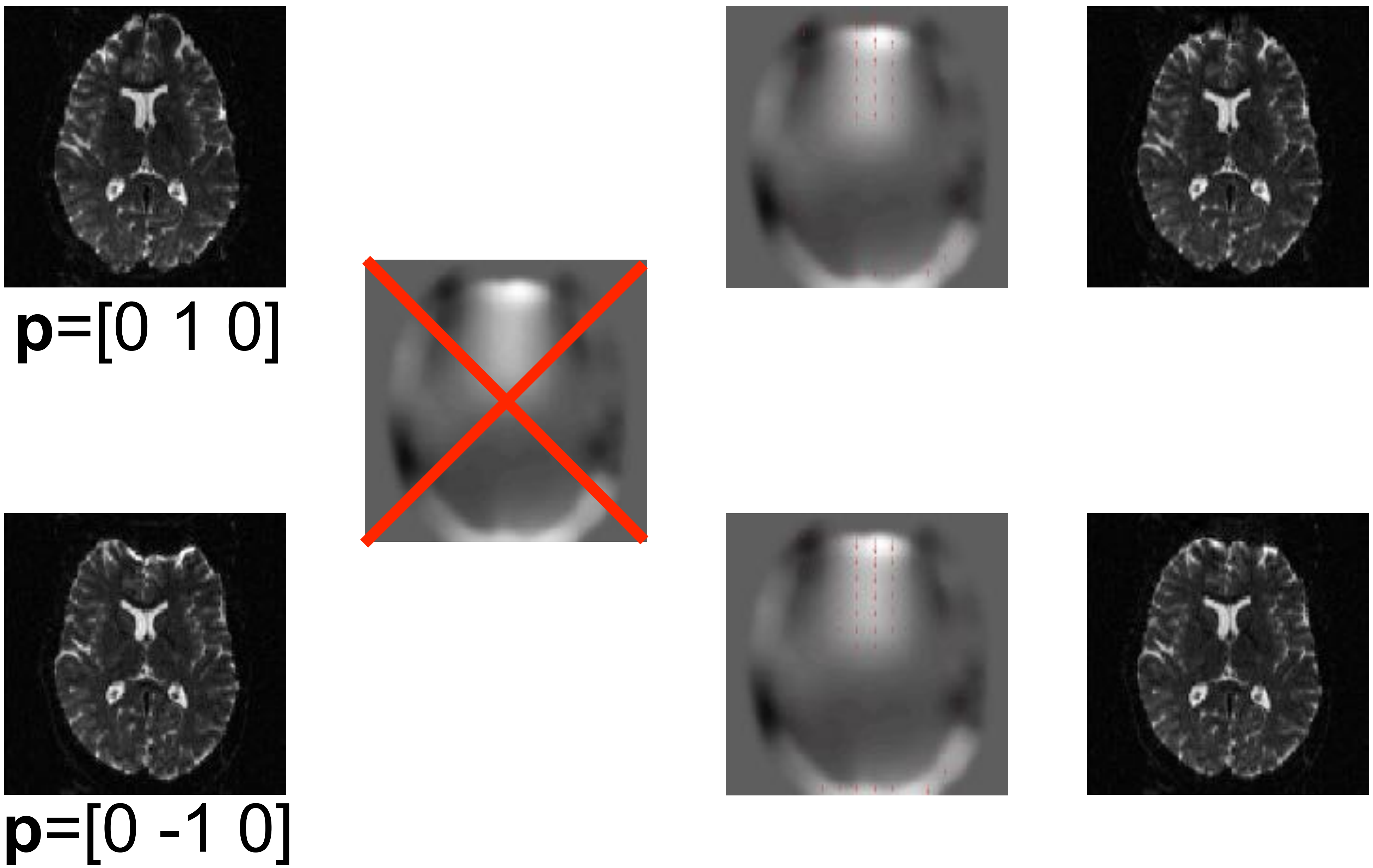
We can combine this with the PE information to get displacement maps

How topup works (very briefly)



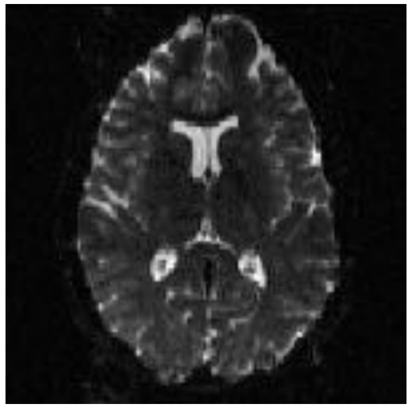
And use that to correct the distortions

How topup works (very briefly)

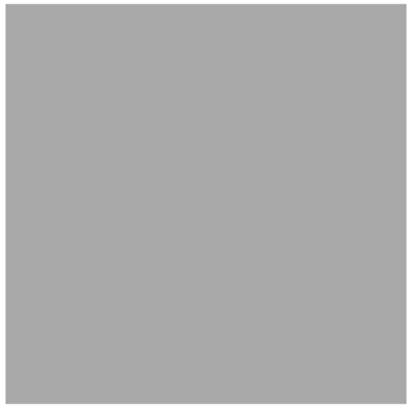


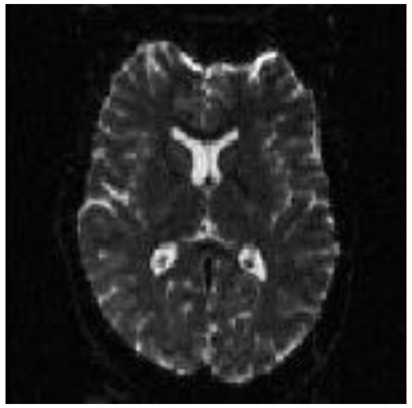
BUT we don’t know the field. That is what we want topup to calculate.

How topup works (very briefly)



p=[0 1 0]

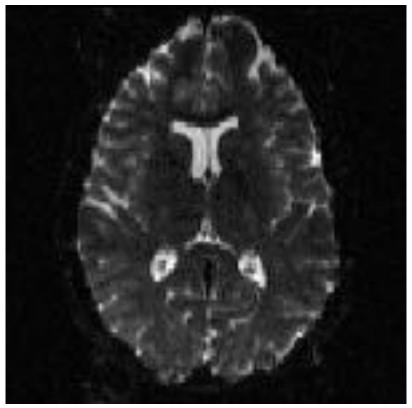




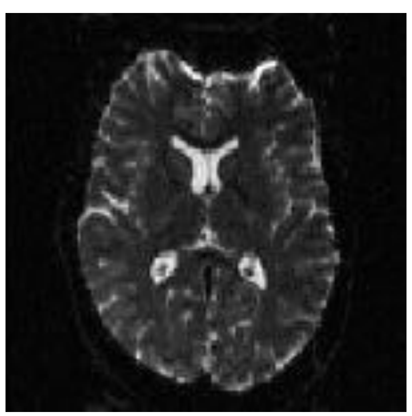
p=[0 -1 0]

topup “guesses” a field...

How topup works (very briefly)



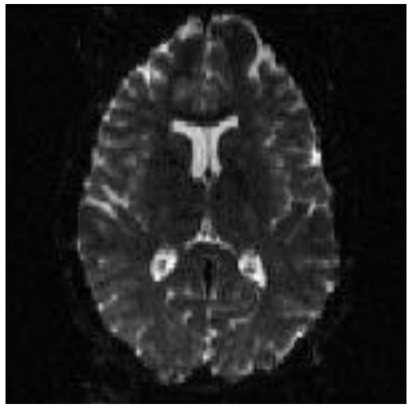
p=[0 1 0]

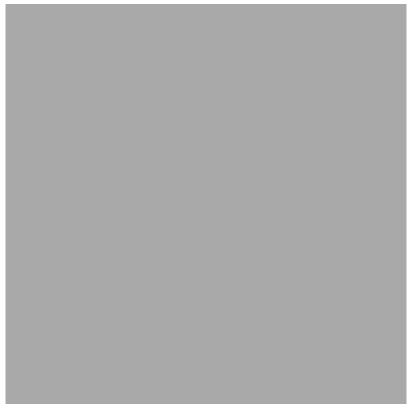


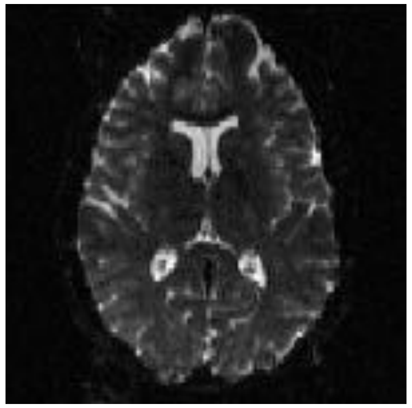
p=[0 -1 0]

...calculates the displacement maps...

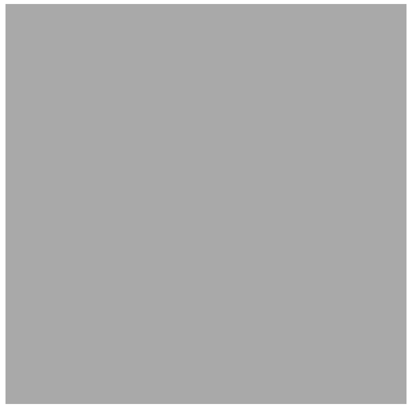
How topup works (very briefly)

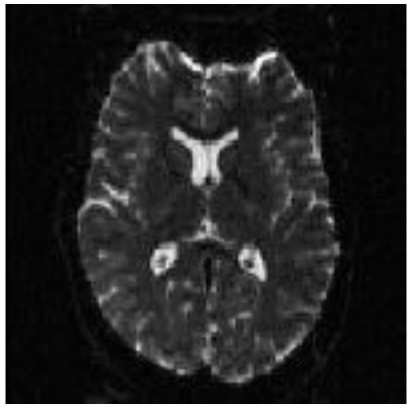


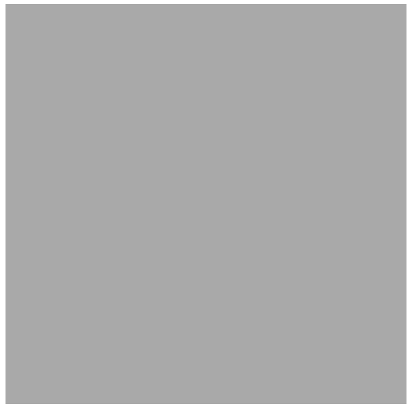


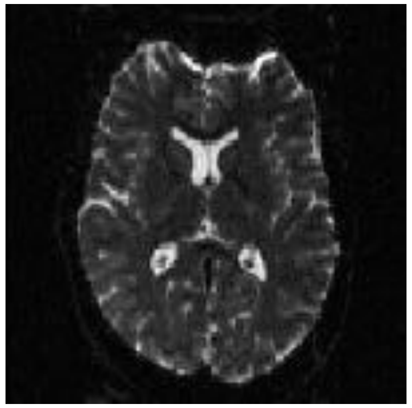


p=[0 1 0]





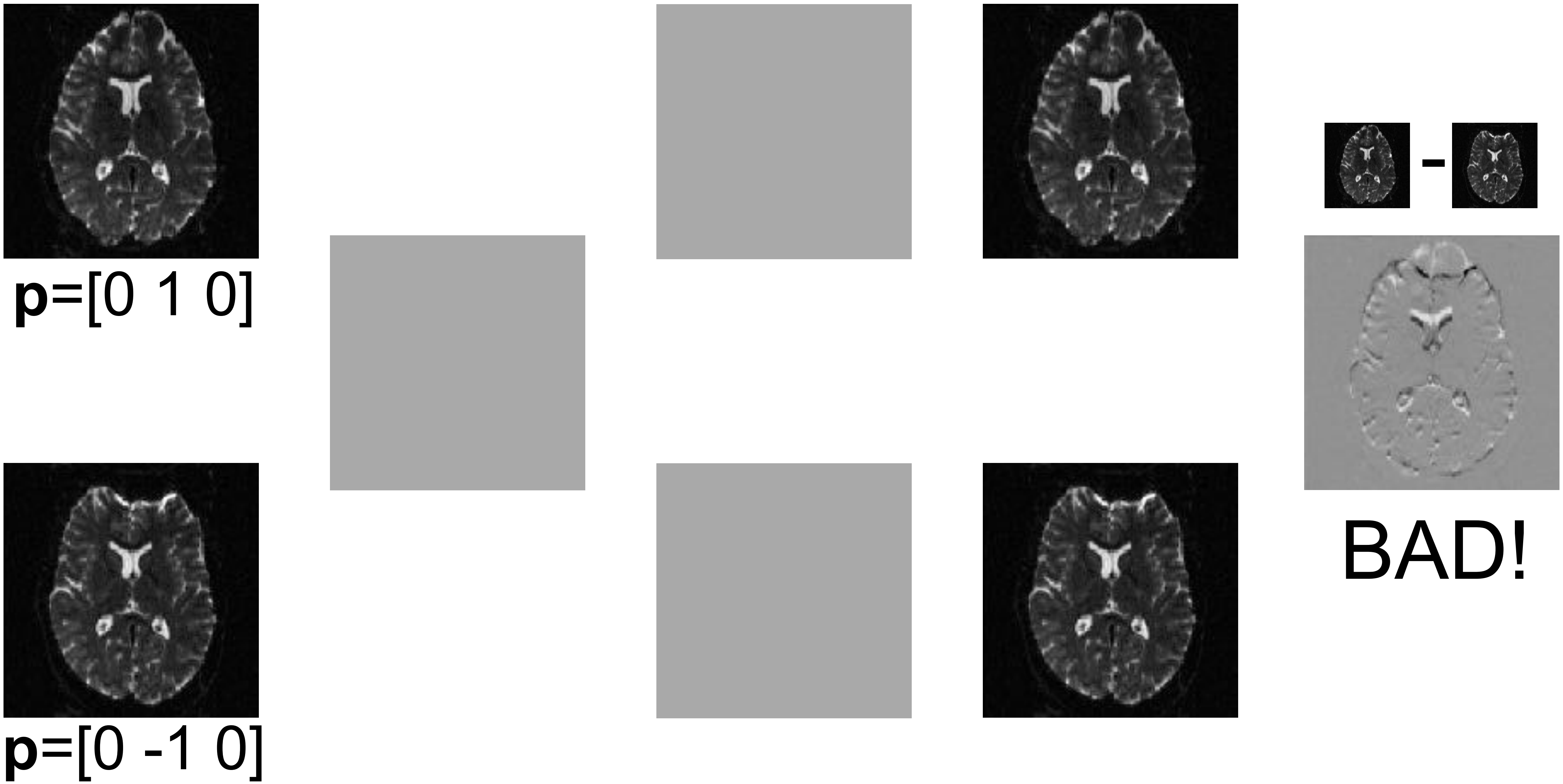




p=[0 -1 0]

..."corrects" the images...

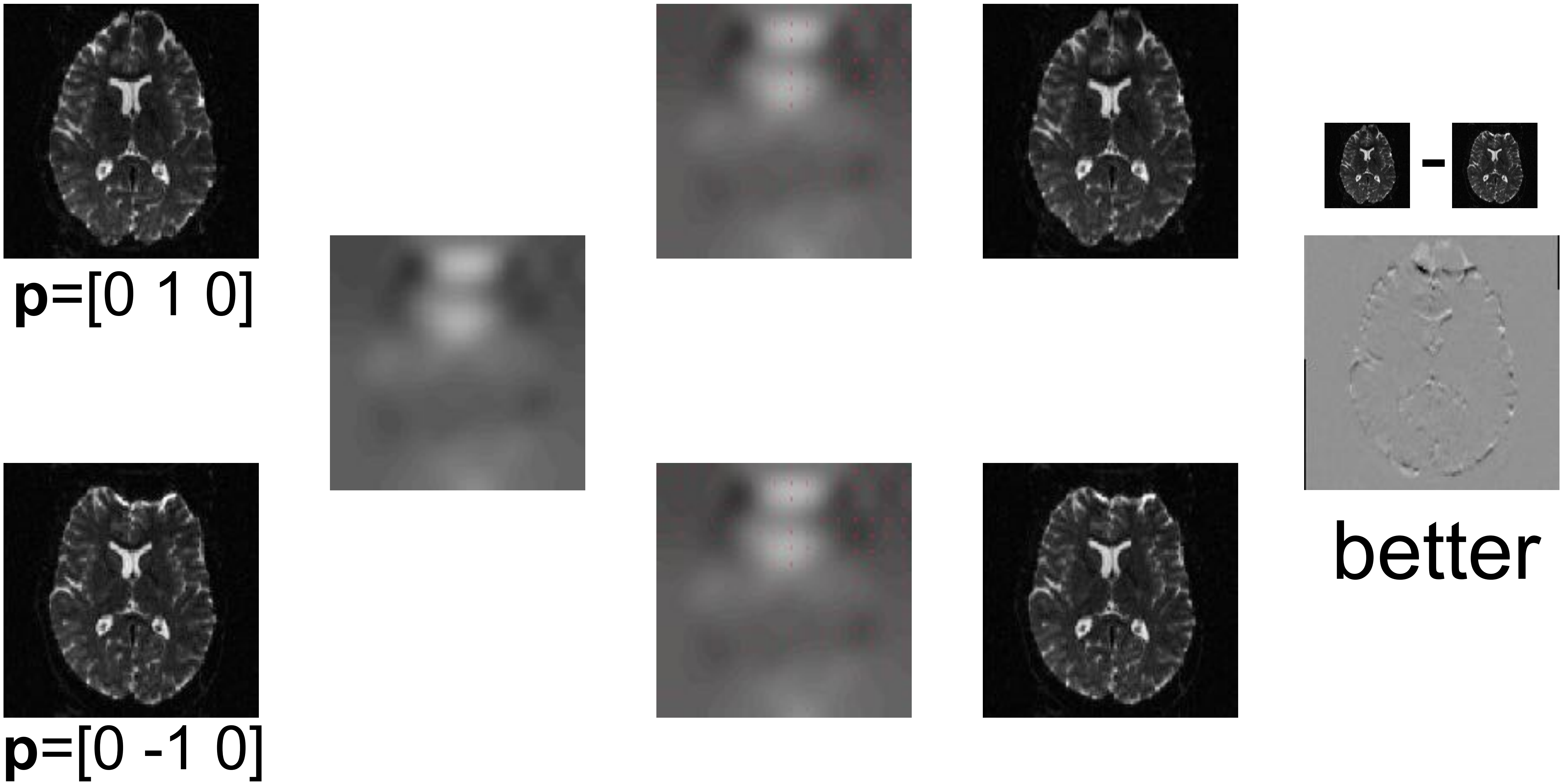
How topup works (very briefly)



...and evaluates the results...

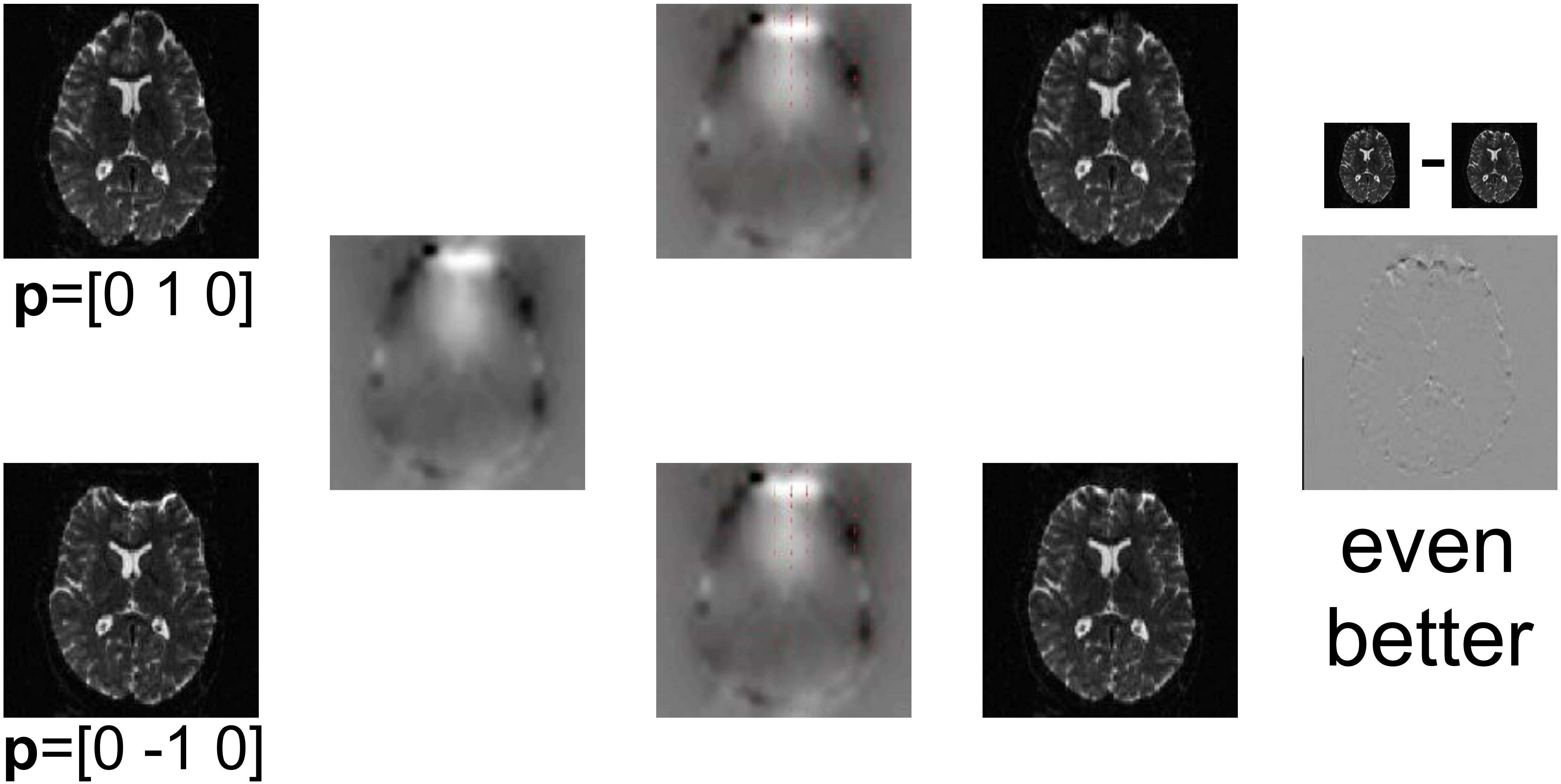
And **this** is the crucial bit.

How topup works (very briefly)



Because topup can then “guess” another field

How topup works (very briefly)



...and another...until it is happy, and then it "knows" the field

Outline of the talk

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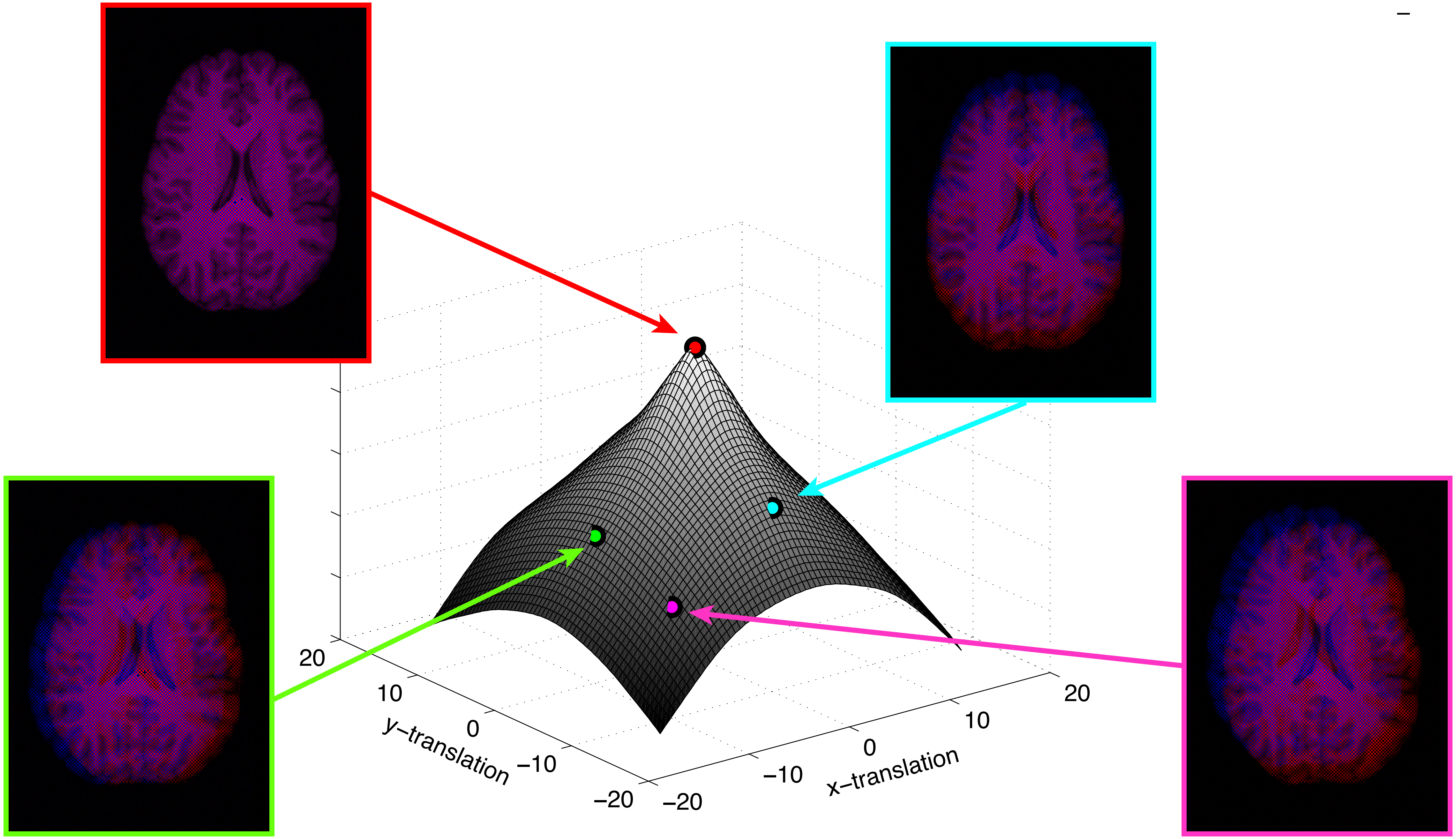
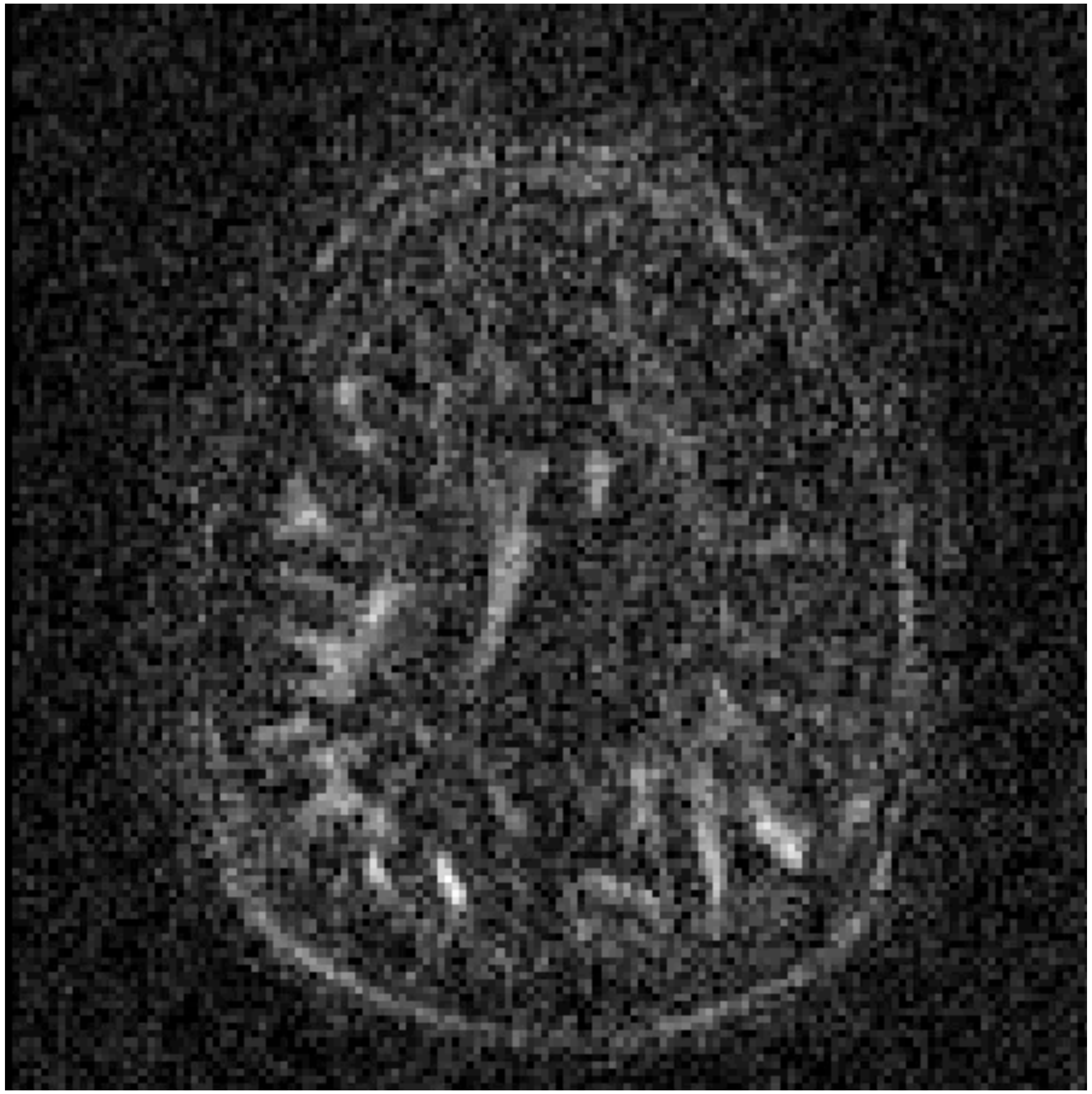
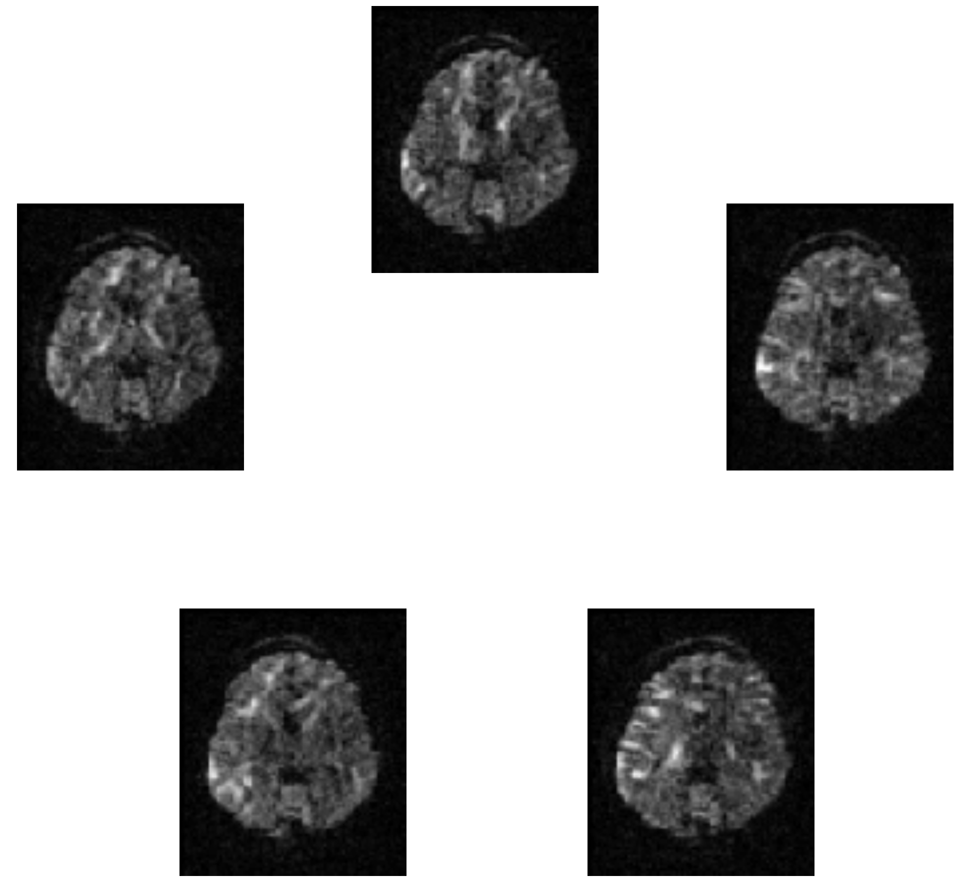
Worlds shortest course on image registration



Maximising/minimising an objective/cost-function

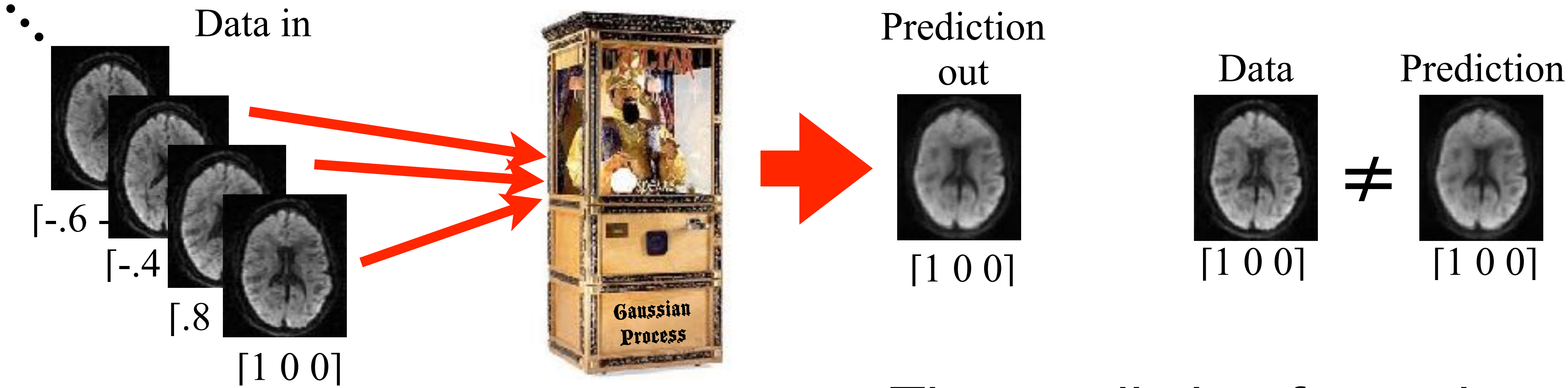
But it is not easy to register diffusion weighted images





- Each image has different distortions -> non-linear registration
- What is the reference image?

Zoltar -- The prediction maker



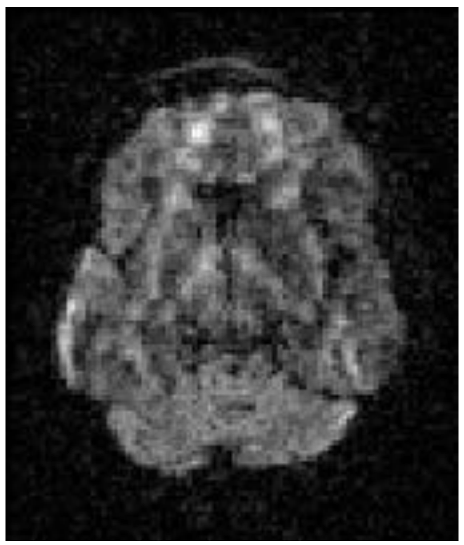
Given some data in, Zoltar will make a prediction what the data "should" be.

The prediction for a given dwi will not be identical to the "input" for that dwi

I know this sounds crazy, but please trust me on this.
(Zoltar is actually a Gaussian Process)

How eddy works: Loading step

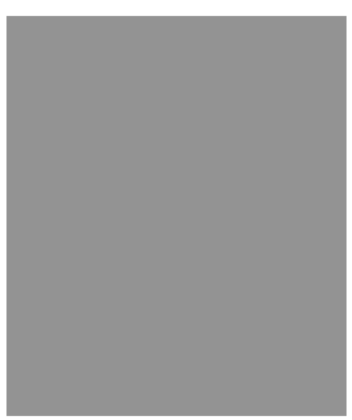
Pick the first dwi



Use current estimates of

Susc

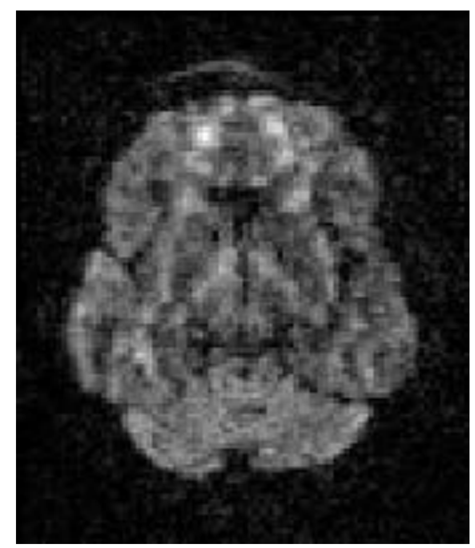
EC



MP

$$\begin{bmatrix} 0 \\ 0 \\ \vdots \\ 0 \end{bmatrix}$$

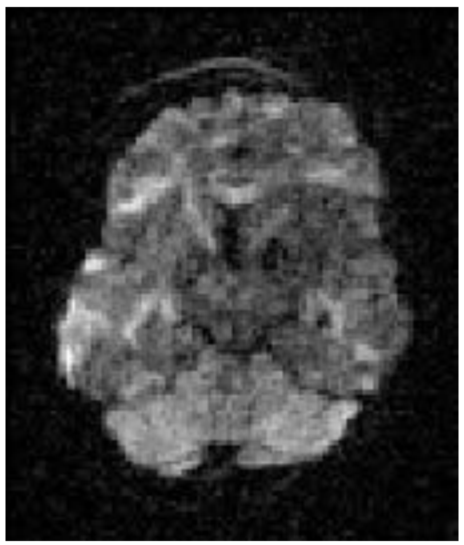
To correct image



And load into prediction maker

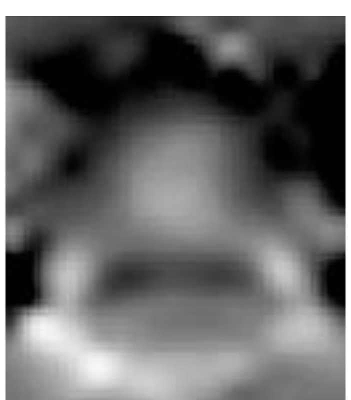
How eddy works: Loading step

then the 2nd dwi

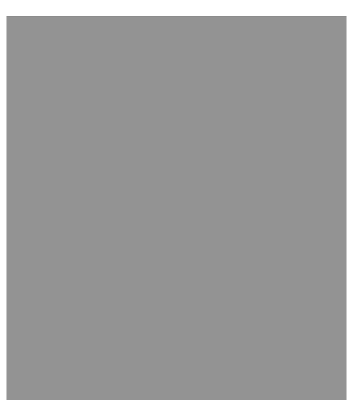


Use current estimates of

Susc



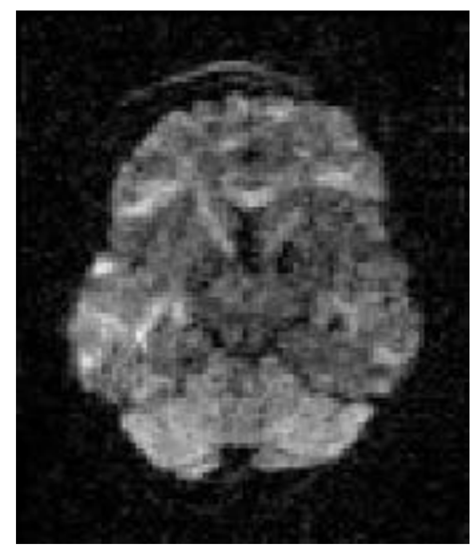
EC



MP

$$\begin{bmatrix}0\\0\\\vdots\\0\end{bmatrix}$$

To correct 2nd image

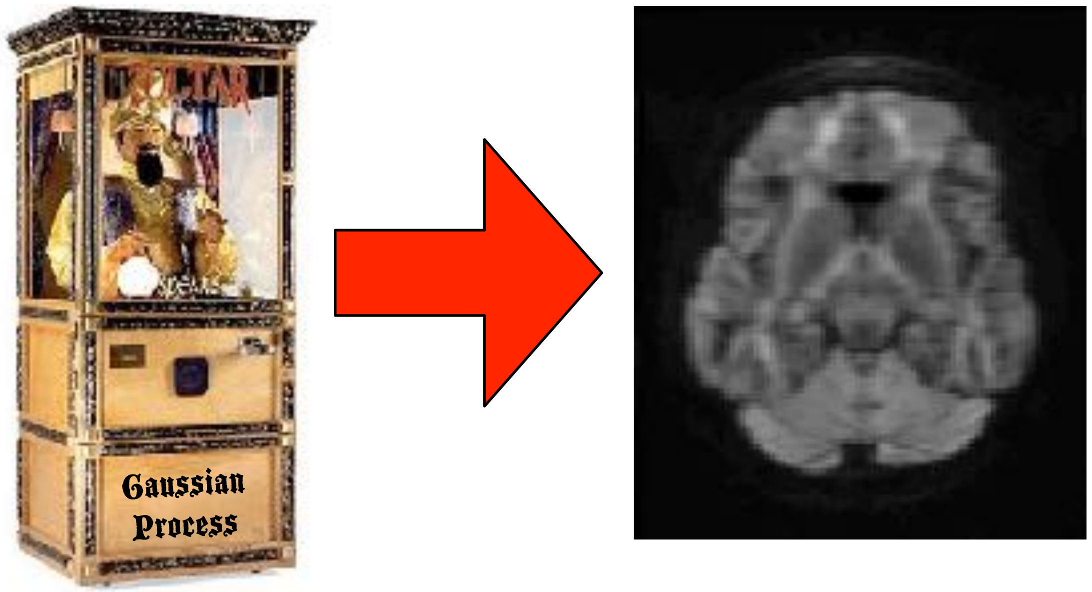


And load into prediction maker

Until we have loaded all dwis

How eddy works: Estimation step

Draw a prediction
for first dwi

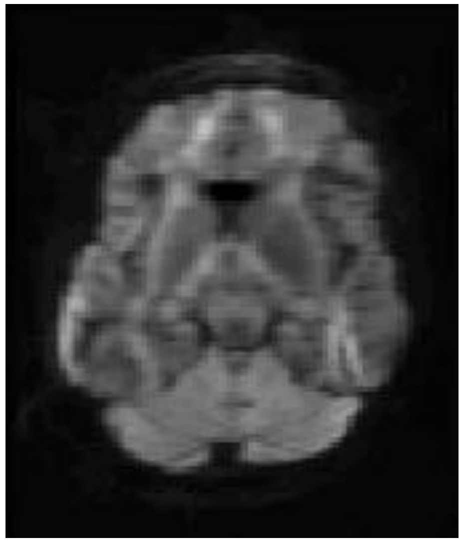


Use current estimates of

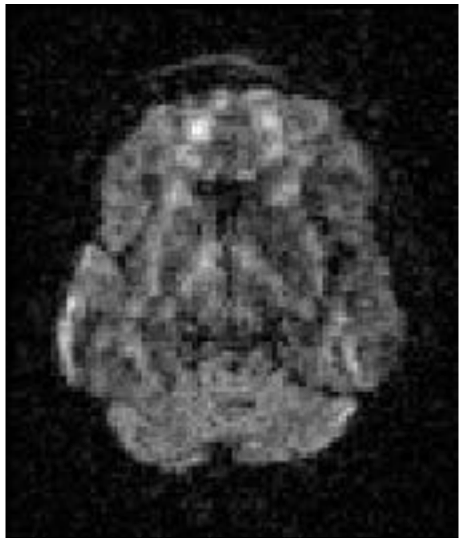
Susc EC MP

$$\begin{bmatrix} 0 \\ 0 \\ \vdots \\ 0 \end{bmatrix}$$

Invert



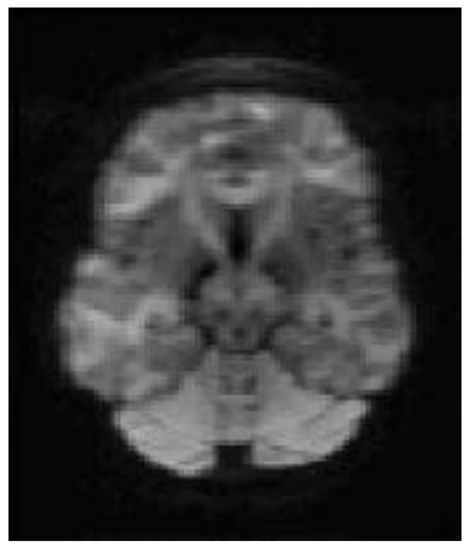
To get prediction in "observation space"



And compare to actual observation

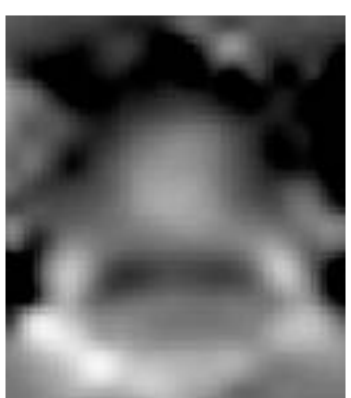
How eddy works: Estimation step

Draw a prediction
for 2nd dwi



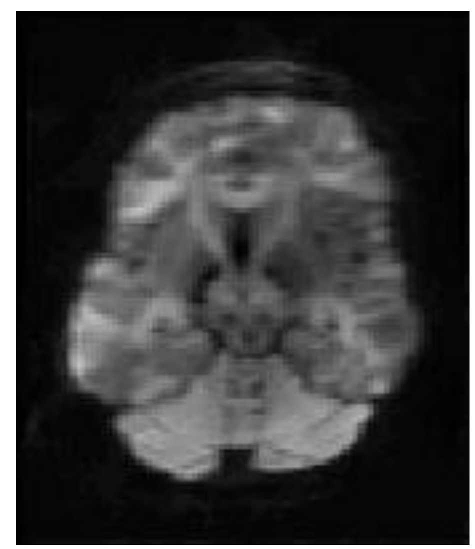
Use current estimates of

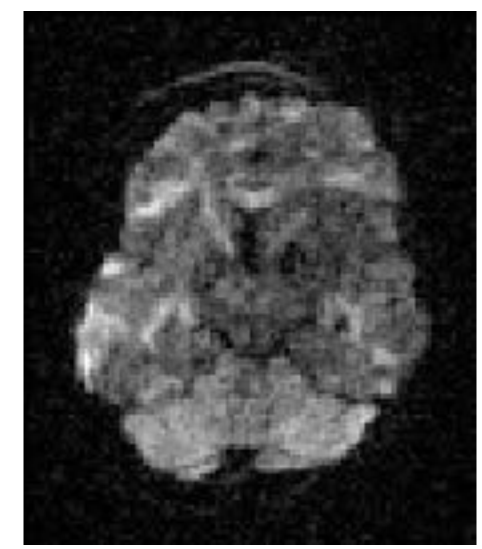
Susc EC MP



$$\begin{bmatrix} 0 \\ 0 \\ \vdots \\ 0 \end{bmatrix}$$

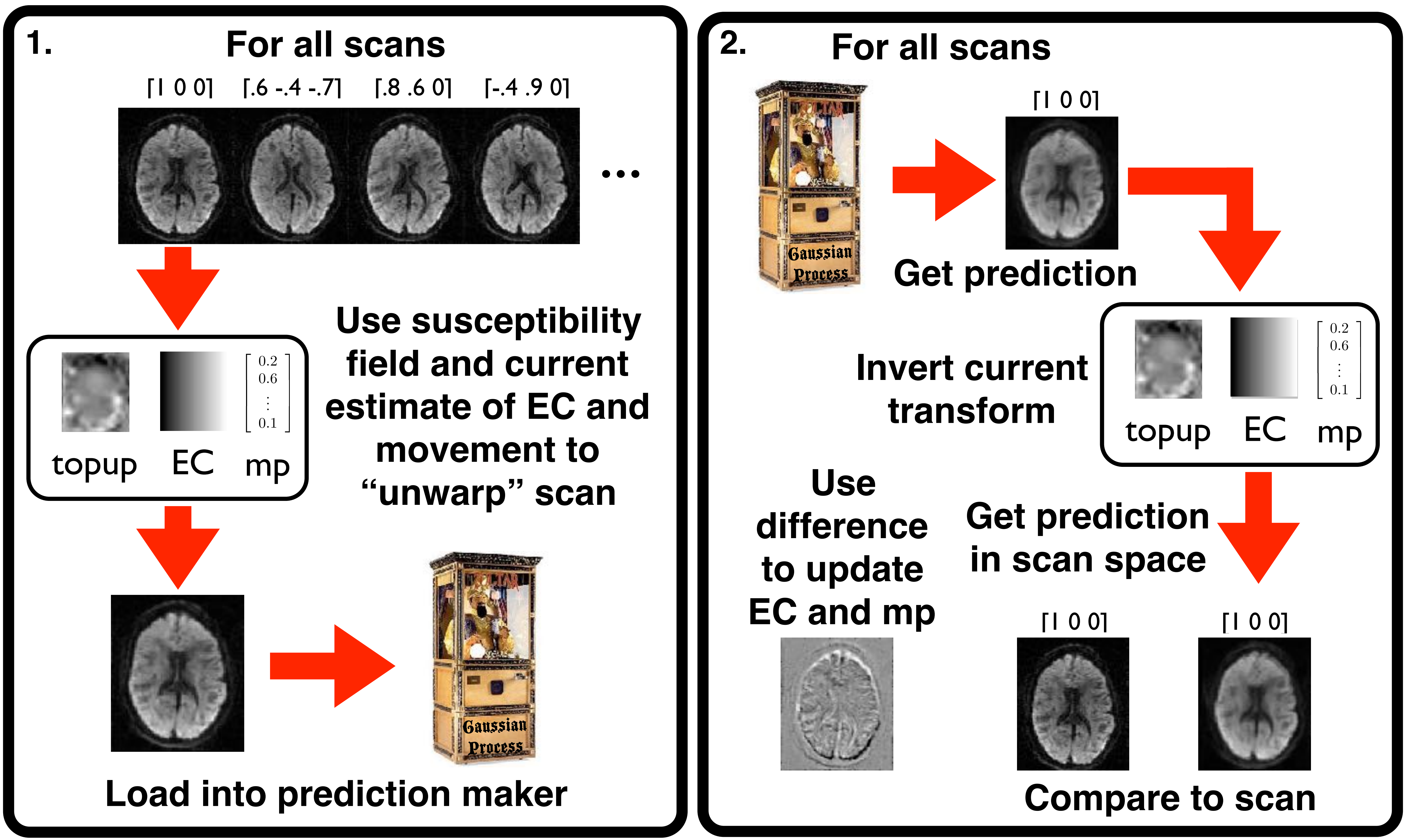
Invert



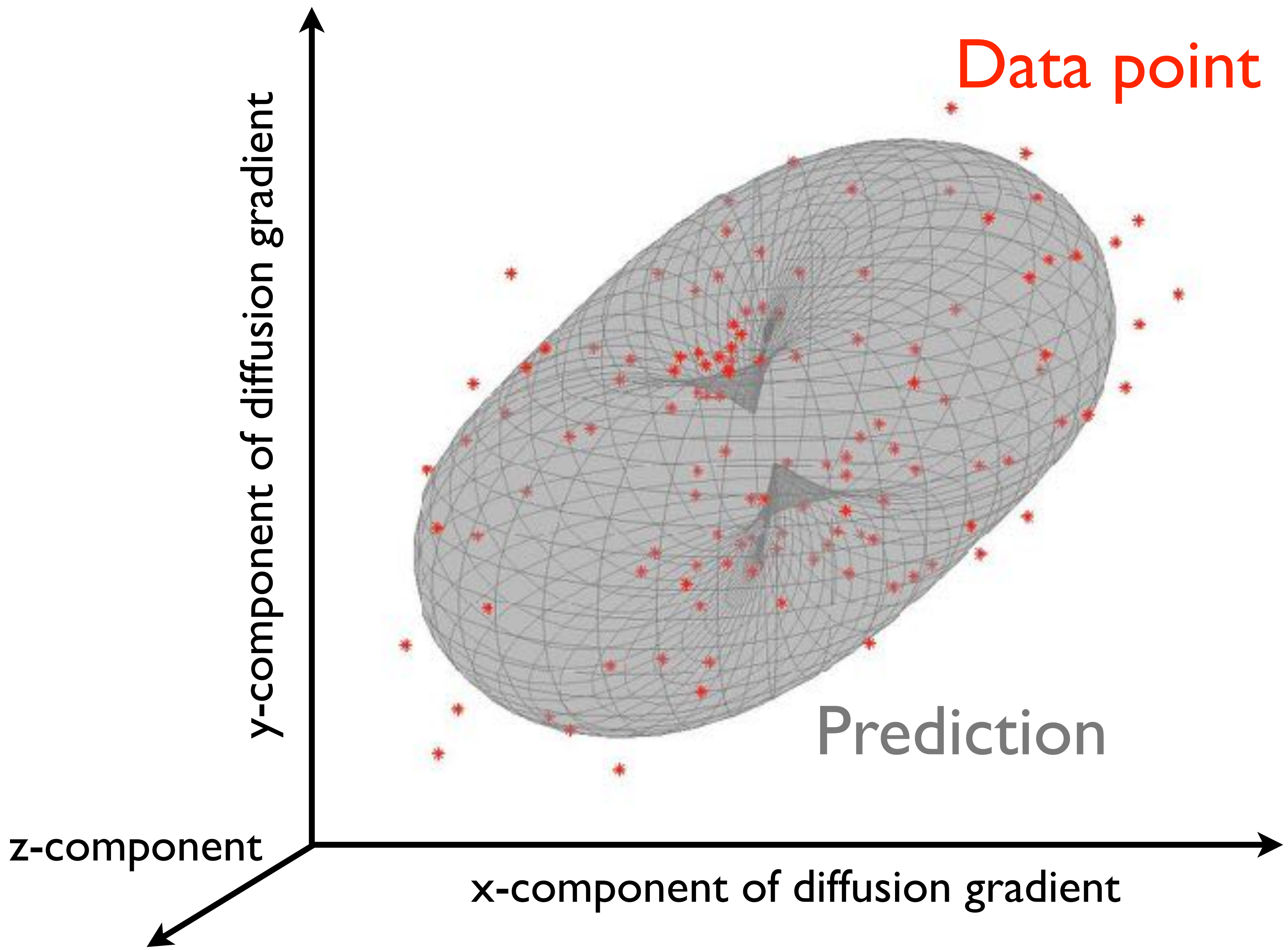


And then we repeat
the procedure for the
next dwi ...

How eddy works



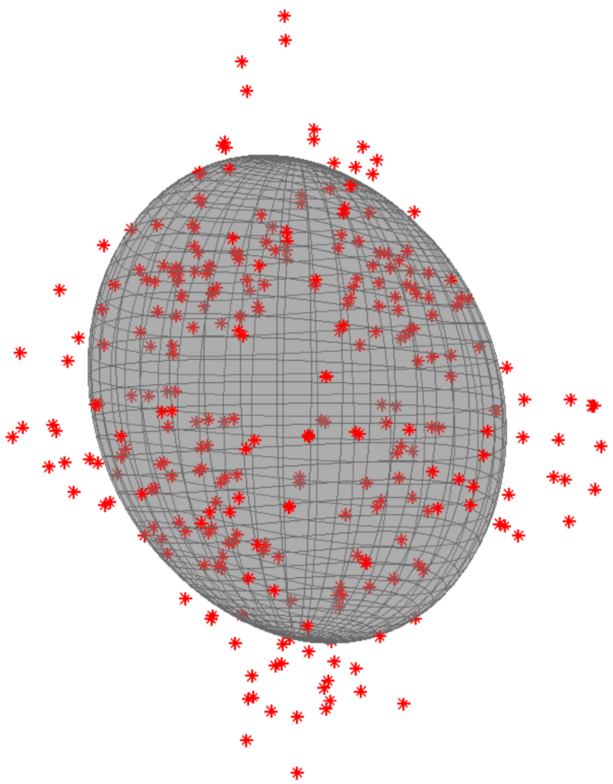
Under the hood of Zoltar



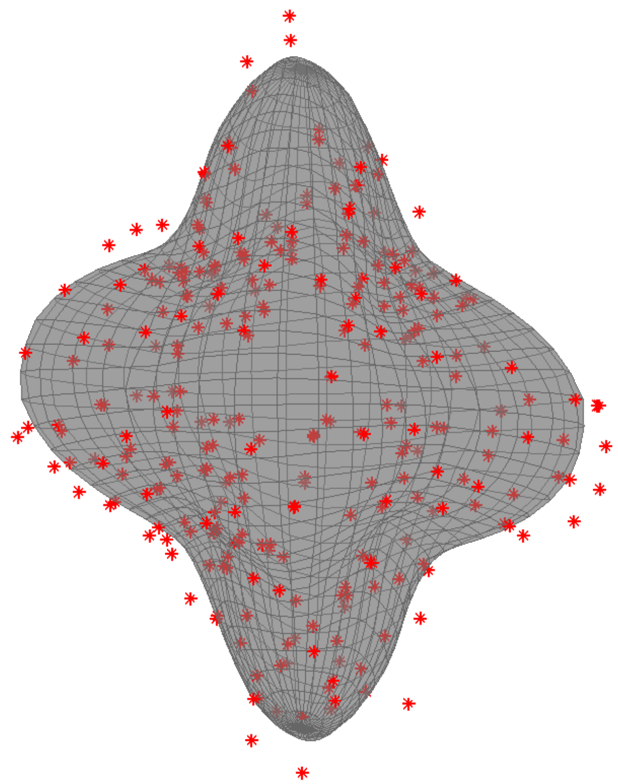
The signal is “modelled” in a data-driven fashion assuming that points close together on the unit sphere have similar signal.

Under the hood of Zoltar

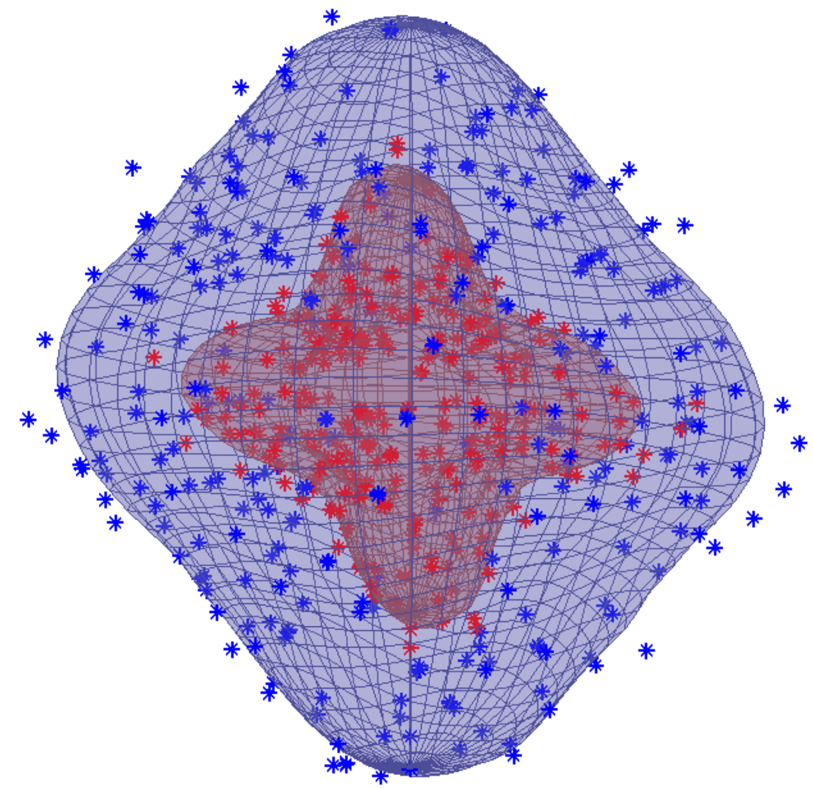
Tensor



Gaussian Process



Multi-shell predictions



The GP can model voxels with complicated anatomy while still being computationally convenient.

Shells with strong signal can help inform predictions in shells with poor signal