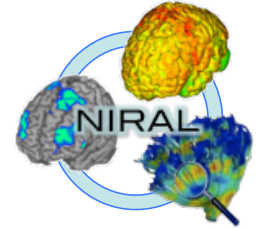




NA-MIC

*National Alliance for Medical Image Computing*

*<http://na-mic.org>*



# Diffusion Imaging Quality Control with DTIPrep

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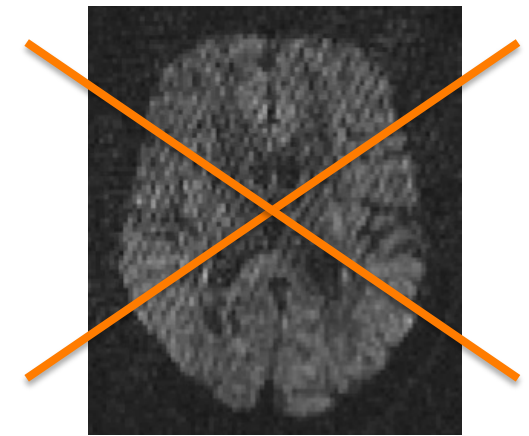




# DWI/DTI QC



- This tutorial teaches you how to do quality control (QC) of diffusion images both for DTI as well as other diffusion models (such as HARDI)
- DWI/DTI QC is performed with the NA-MIC tool **DTIPrep**
  - Can be called within Slicer
  - Also stand-alone tool





# Dataset

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For this tutorial you will need some DWI/DTI data files that can be found on this link :  
<http://hdl.handle.net/1926/1759>



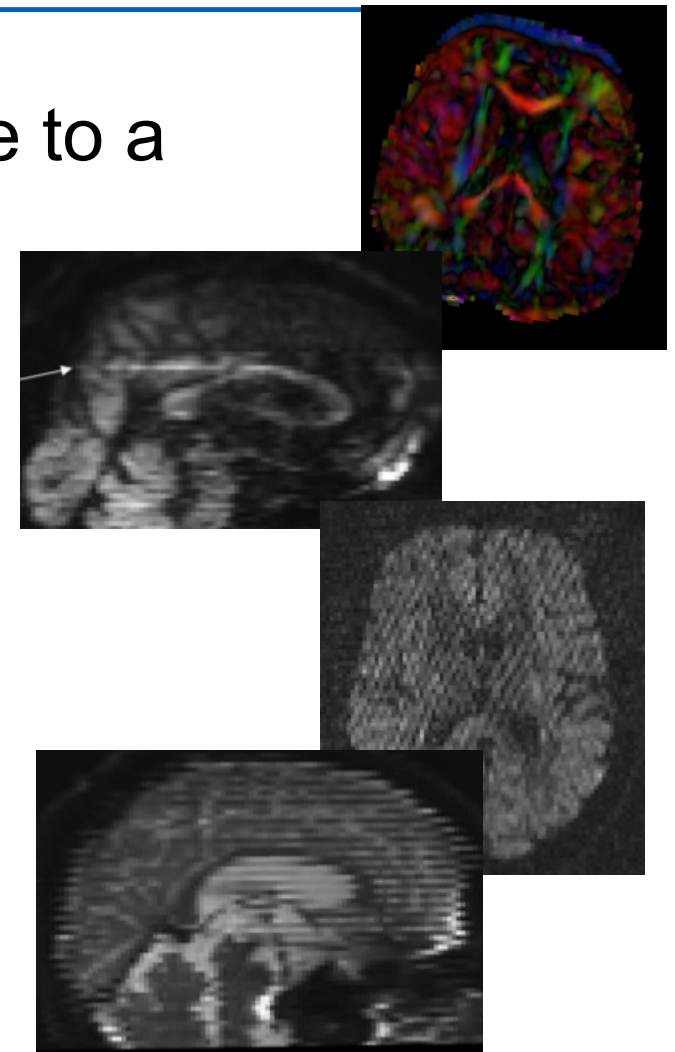
# Diffusion Artifacts



Diffusion images are sensitive to a number of artifacts

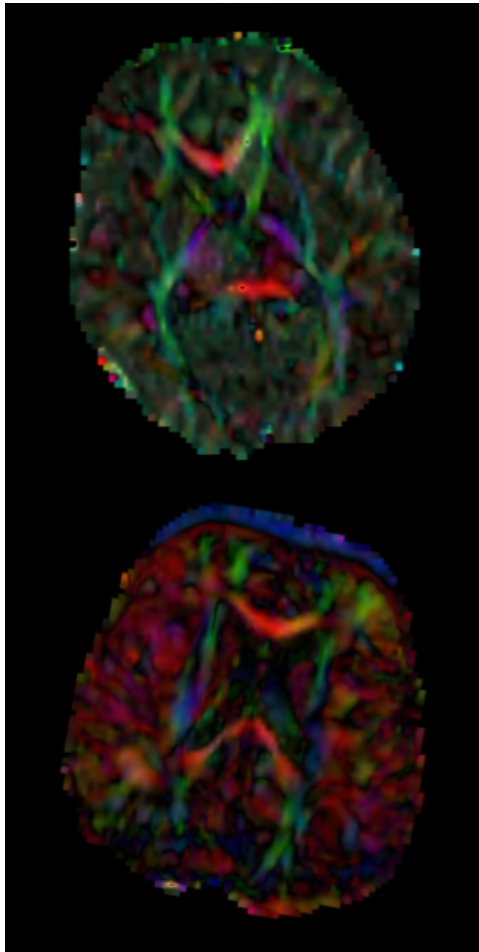
- Motion
- Eddy-current distortions
- Noise/SNR issues
- Vibrational artifacts
- Venetian blind artifacts
- “unknown” ...

**Bad DWI's are removed**





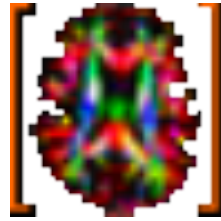
# Outline



- DTI QC pipeline
  1. Start DTIPrep
  2. Load DWI dataset
    - Check DWI & gradient info
  3. Protocol for Automatic QC
  4. Run Automatic QC on DWI
  5. Final Visual QC
  6. Check DTI glyphs in Slicer



# DTIPrep



- Stand alone/Slicer module
- NITRC page: <http://www.nitrc.org/projects/dtiprep/>
  - Additional manual on NITRC page
- Protocol based QC
  - Protocol defines all the parameters
- Automatic report creation
- Embed/Cropping of DWI data
  - Same size images => simplifies processing
- Visualization of gradient scheme

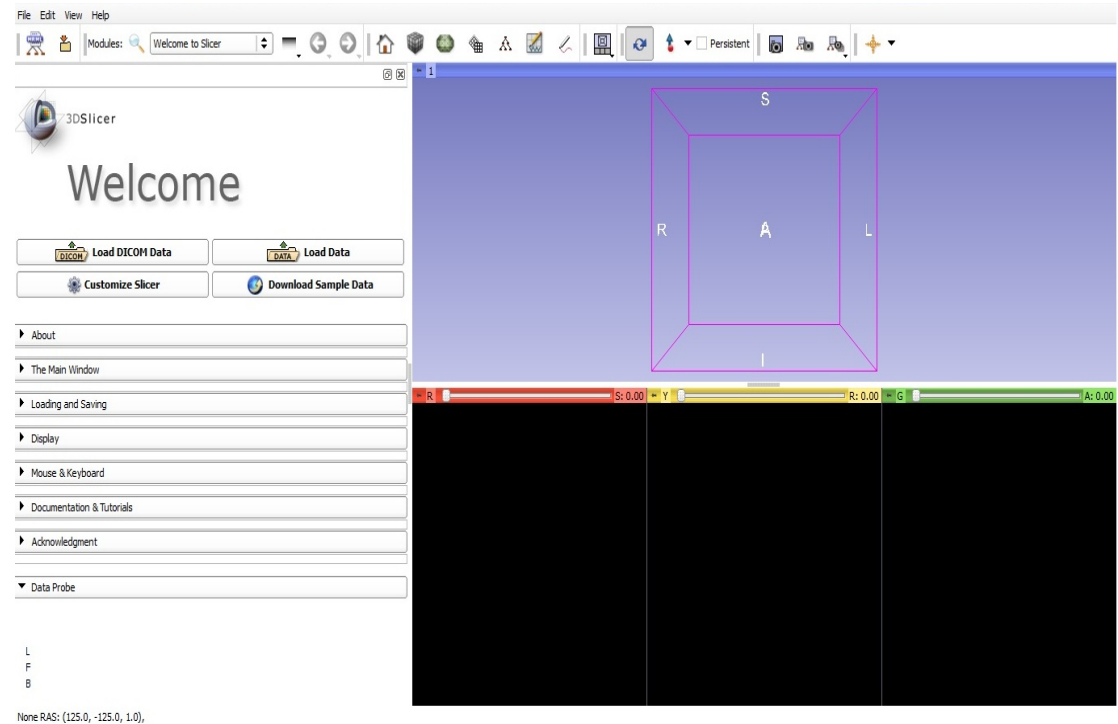


# Start Slicer 4



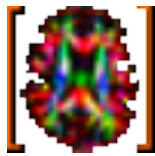
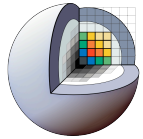
Linux/Mac users :  
Launch the Slicer executable located in the Slicer4 directory

Windows users :  
Select Start→All Programs→Slicer4.0.1→Slicer  
Or launch the Slicer executable from Slicer4 directory

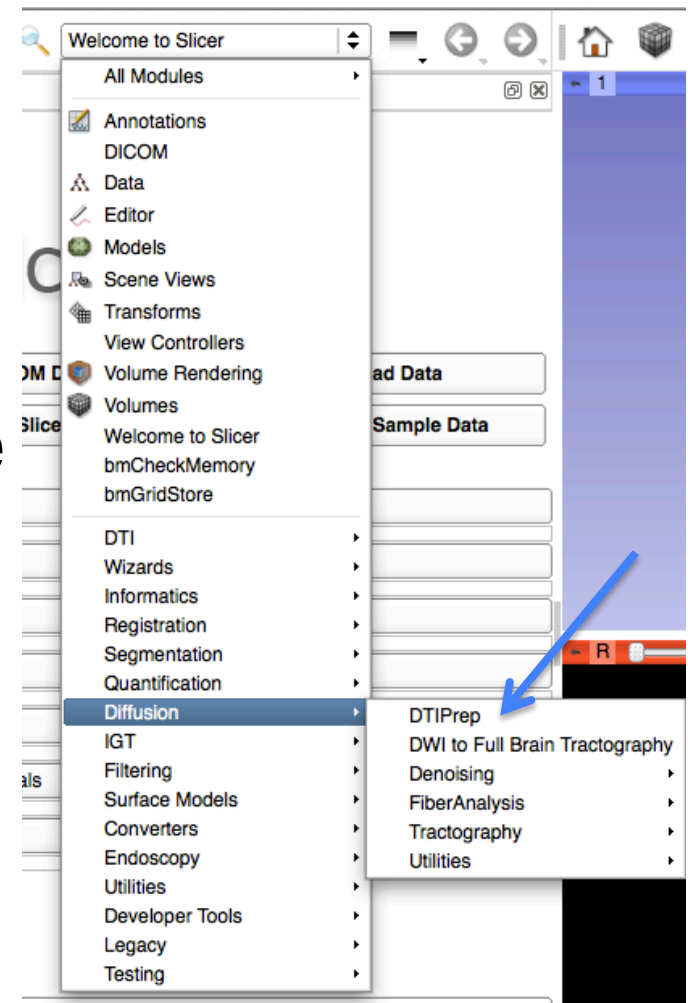




# Start DTIPrep within Slicer



1. Select DTIPrep
  - Diffusion category
2. Create new Commandline module
3. Click “Apply”
4. DTIPrep starts up







# DTIPrep Main Window



The screenshot shows the DTIPrep main window with several key components labeled:

- Toolbar:** Located at the top left, containing icons for file operations (Open, Save, Print) and processing (P, F, I).
- Info Window:** A large table in the center-left area with columns for Type, Parameter, Processing, and Result. It is currently empty.
- DWI Viewers:** Three stacked windows on the right side, each showing DWI data with controls for DWI, Axia, and None parameters, along with W/L, Vis, and I> buttons.
- 3D Viewer:** A central vertical window displaying a 3D view of the data.

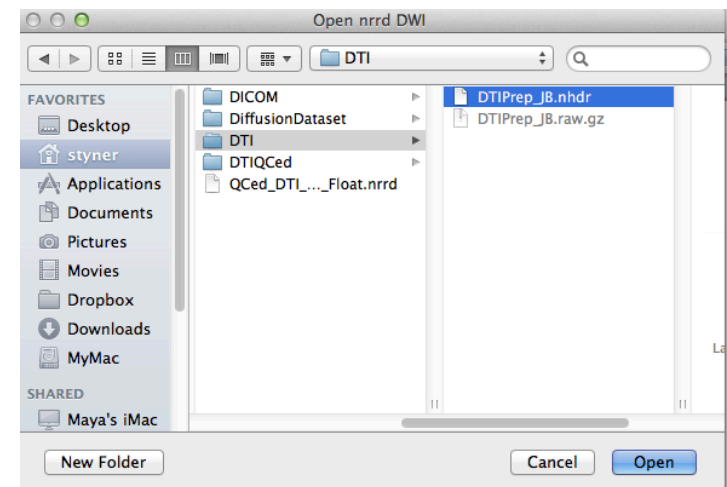
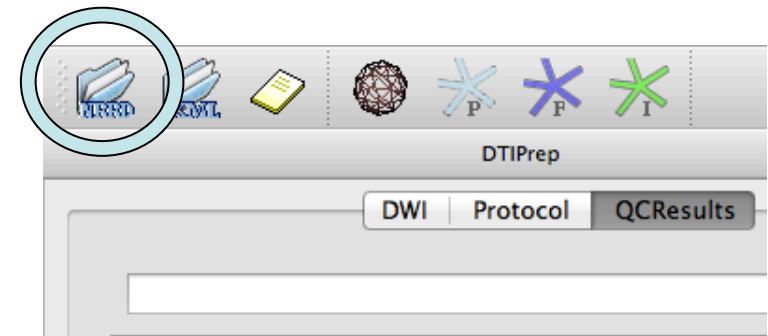
At the bottom of the window, there are buttons for 'Manual Checking', 'Default Result', and 'Save Dwi and QCResult', along with a status bar showing 'Dicom2Nrrd' and 'DTIPrep'.



# Load DWI image



- Click NRRD icon
- File Dialog
  - Select your DWI
  - DTI/DTIPrep\_JB.nhdr
- “Open”
- Done with loading





# DWI info



The screenshot shows the DTIPrep Tools (Qt4) interface. The main window displays DWI information in a table format. A blue arrow points from the text 'Detailed DWI Info' to the 'Space directions' table. The interface also includes a 3D view of the brain and three 2D image views (Image2DView 1, 2, and 3) showing different slices of the brain.

**ImageInfo**

Size	128	128	94
Origin	-96.000000	-96.000000	-70.500000
spacing	1.500000	1.500000	1.500000
Space	left-posterior-superior		

**Space directions**

1.000000	0.000000	0.000000
0.000000	1.000000	0.000000
0.000000	0.000000	1.000000

**Measurement Frame**

1.000000	0.000000	0.000000
0.000000	1.000000	0.000000
0.000000	0.000000	1.000000

**Diffusion**

Tag	Value
DWMRI_...	1000
DWMRI_...	0.000000 0.000000 0.000000
DWMRI_...	-0.216977 -0.485676 -0.846782
DWMRI_...	-0.958215 0.073066 -0.276559
DWMRI_...	-0.672267 0.739094 -0.042394
DWMRI_...	-0.083619 0.451844 -0.888169
DWMRI_...	-0.003199 0.939470 0.342616
DWMRI_...	-0.662361 -0.373398 0.649501
DWMRI_...	0.000000 0.000000 0.000000
DWMRI_...	0.404212 -0.841875 -0.216706

Detailed  
DWI  
Info

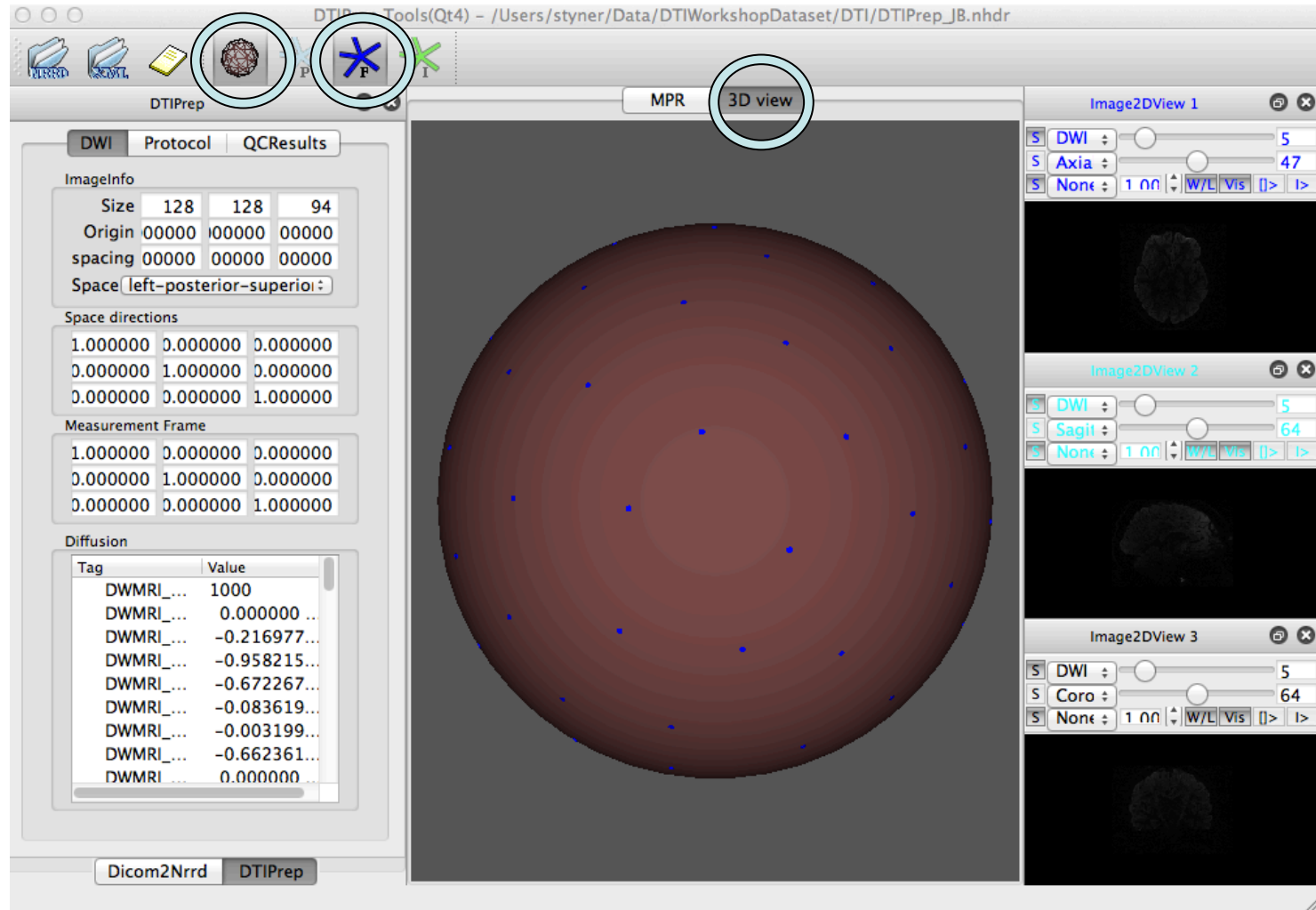


# Gradient info in 3D



Displays gradient scheme on unit sphere (F = File)

- Check for uniformity

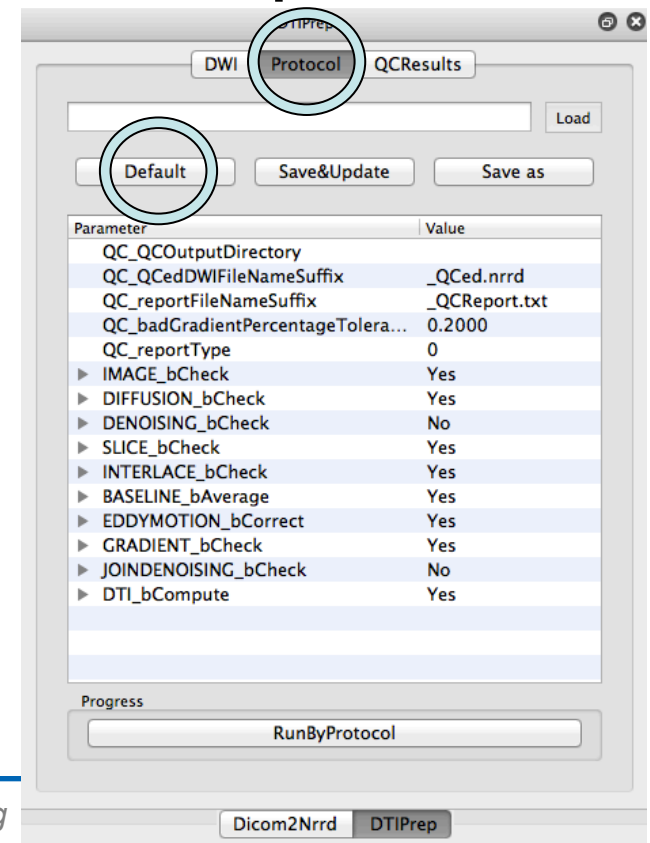




# Protocol in DTIPrep



- Protocol defines parameters
- Use default parameters or load prior parameter set
- Select “Protocol” tab
- Select “Default”
- Detailed parameters
  - See manual on NITRC

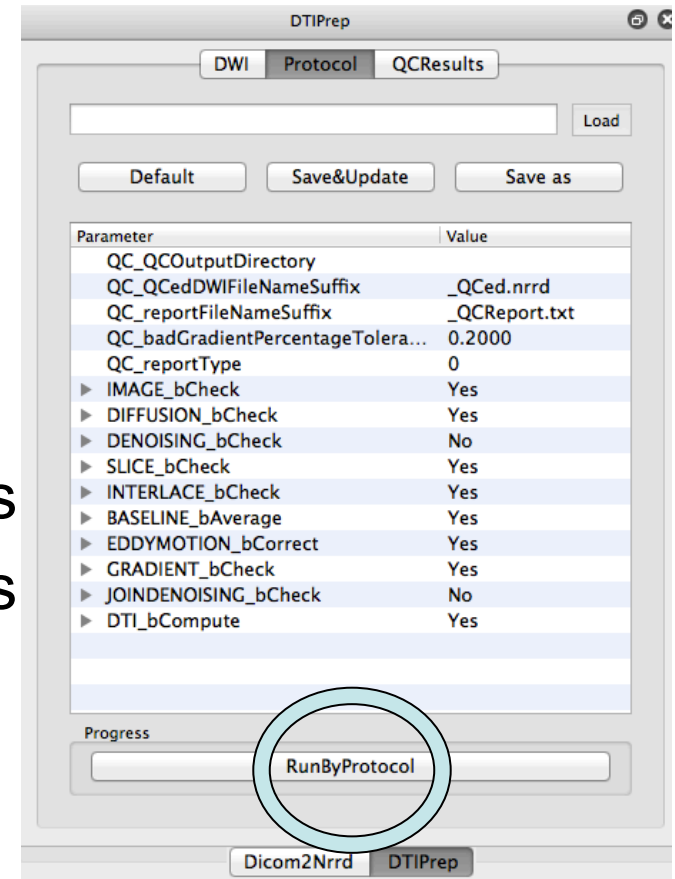




# Run QC



- Select “RunByProtocol”
  - Runs for a few minutes (5-15)
- Checks:
  1. Image dimensions
  2. Gradients directions
  3. Intensity changes across slices
  4. Excessive motion across slices
  5. motion and eddy current correction
  6. Residual motion detection
  7. Optional noise removal





# QC Result



- Loads QC'ed DWI when finished
- Detailed reporting
- Directions after motion correction
- Reasons for exclusion

DTIPrep

DWI | Protocol | QCResults

g:/work/styner/ftp/Dataset/DTI/DTIPrep\_JB\_XMLQCResult.xml Load

Type	Parameter	Processing
[-] DWI Check		
[-] gradient_0000		
Dir	0.000000 0...	
[-] Visual Check		
VC_Status_0000	NoChange	
Original_Index	0	
Original_Index	7	
Original_Index	14	
Original_Index	21	
Original_Index	28	
Original_Index	35	
Original_Index	42	
[-] gradient_0001		
Dir	-0.214818 -0...	
[-] Visual Check		
VC_Status_0001	NoChange	
Original_Index	1	
[-] gradient_0002		
[-] gradient_0003		
[-] gradient_0004		
[-] gradient_0005		
[-] gradient_0006		
[-] gradient_0007		
[-] gradient_0008		

Manual Checking

Default Result Save Dwi and QCResult

Dicom2Nrrd DTIPrep

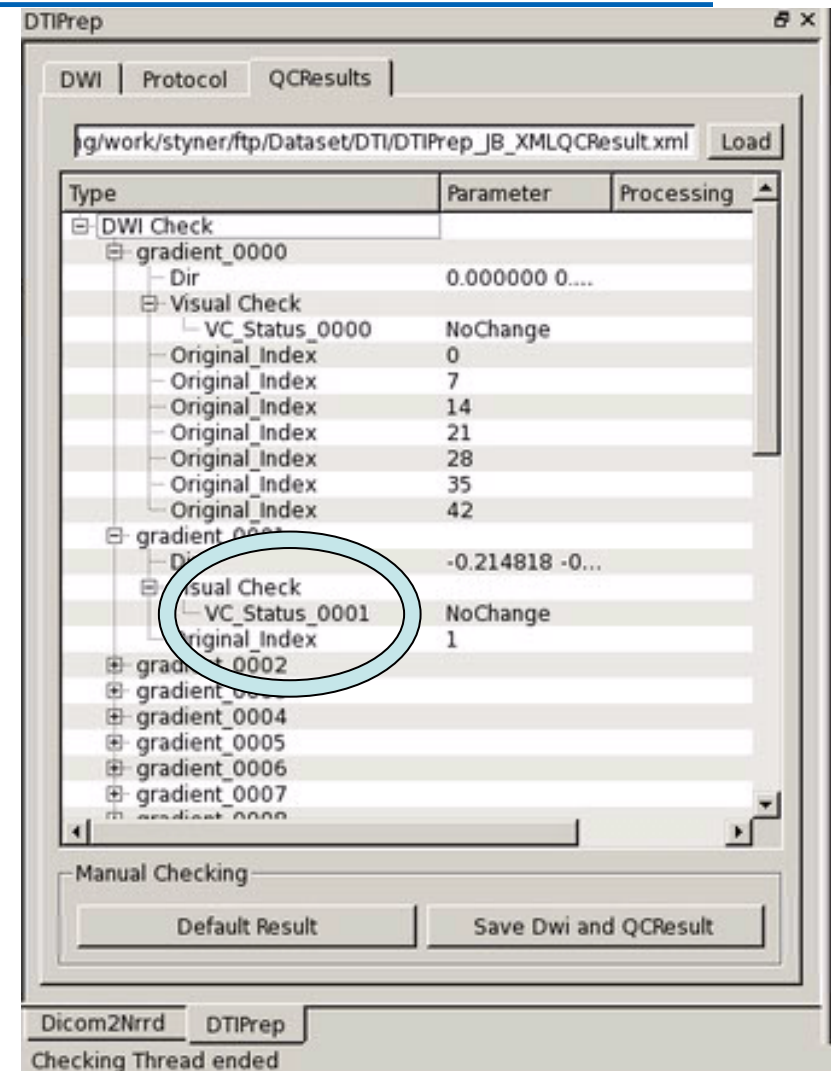
Checking Thread ended



# Visual QC & Save



- Double click on “VC\_Status”
- Option to include or exclude
- Often unnecessary

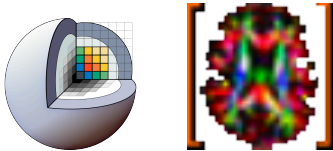






# Conclusion



- DTI QC is a must
- DTIPrep & Slicer provide comprehensive QC 
- This tutorial guided you through the “default” use of DTIPrep
- Future: Better Slicer integration, directional artifacts detection & correction (Farzinfar et al, ISBI 2012)



# Acknowledgment



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- Utah: Guido Gerig, Sylvain Gouttard
- Iowa: Hans Johnson, Joy Matsui
- Liu, Z., et al. (2010). Quality control of diffusion weighted images. *Proceedings of SPIE*, 7628(1), 76280J.