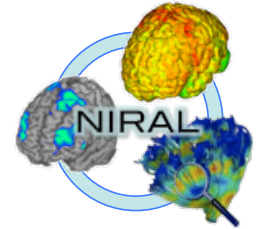




NA-MIC

National Alliance for Medical Image Computing

<http://na-mic.org>



Diffusion Imaging Quality Control with DTIPrep

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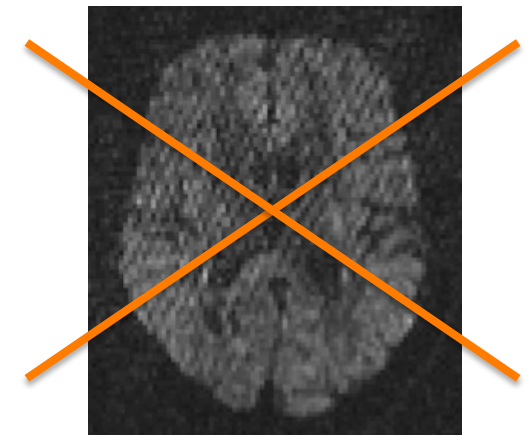




DWI/DTI QC



- 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



For this tutorial you will need some DWI/DTI data files that can be found on this link :
<http://wiki.na-mic.org/Wiki/images/7/78/SlicerWorkshop-UNC-20150611.tar.gz>



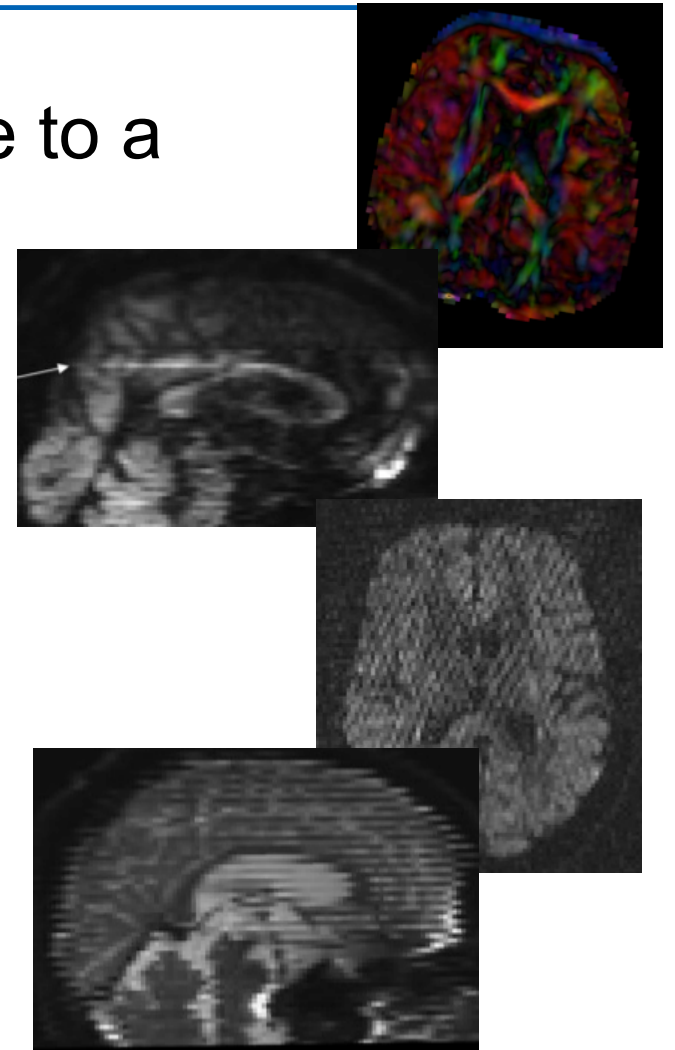
Diffusion Artifacts



Diffusion images are sensitive to a number of artifacts

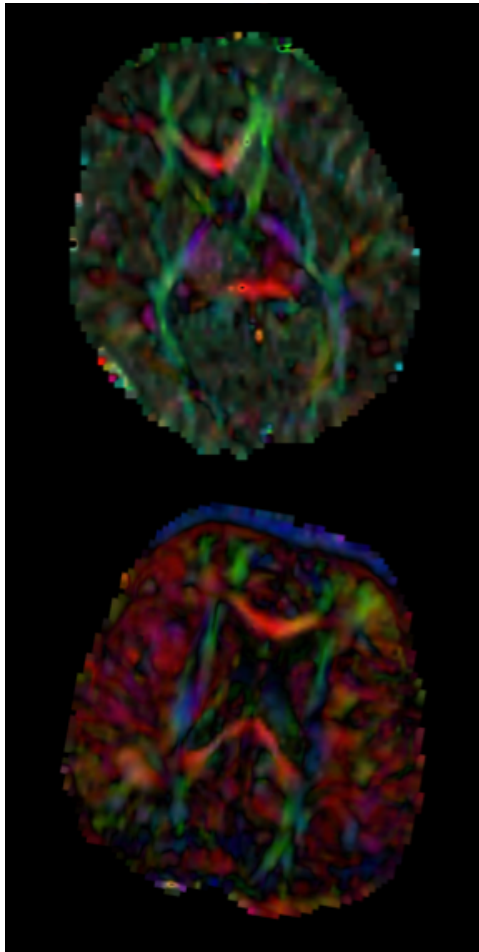
- Motion
- Eddy-current distortions
- Noise/SNR issues
- Vibrational artifacts
- Venetian blind artifacts
- “unknown” ...

Bad DWI's are removed





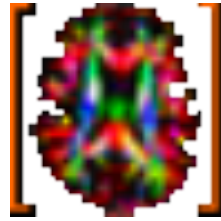
Outline



- 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

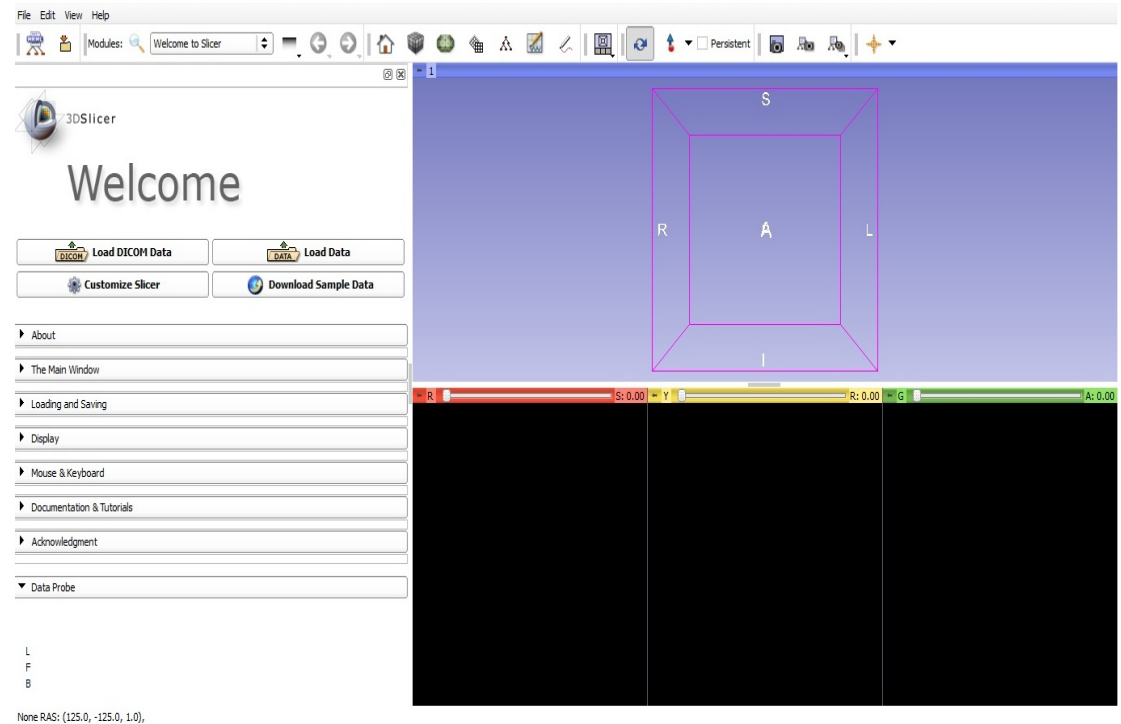


Start Slicer 4



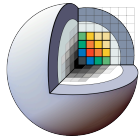
Linux/Mac users :
Launch the Slicer executable located in the Slicer4 directory

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

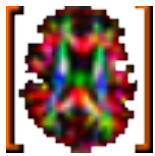




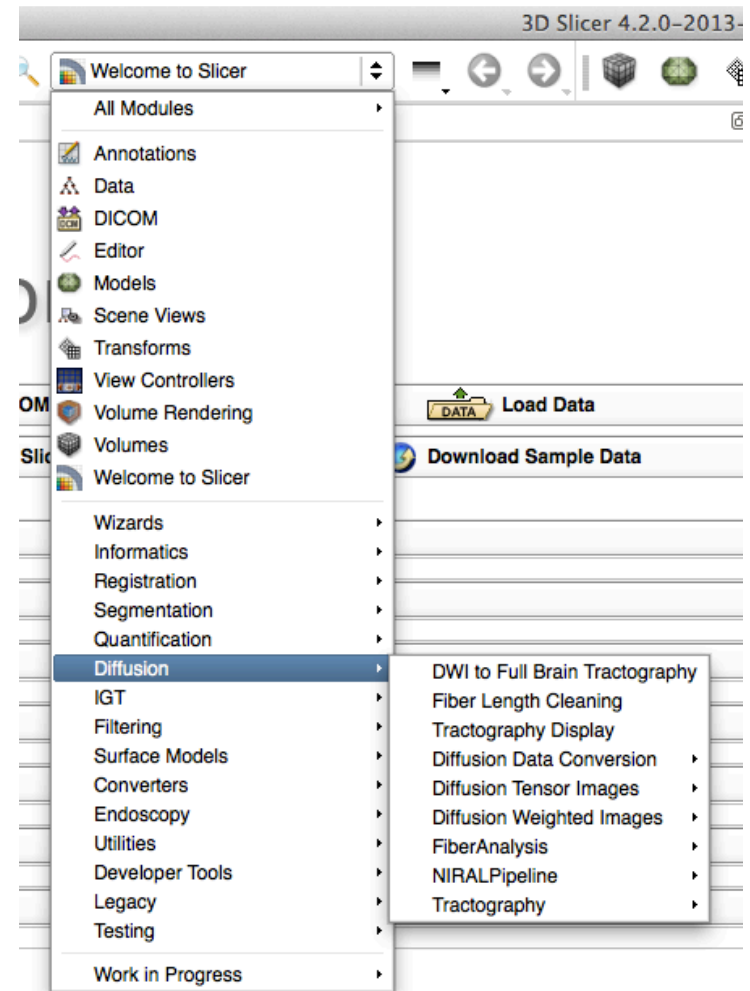
Start DTIPrep within Slicer



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



If it is not installed, then do so via extension browser





Workaround on Mac



Show Package Contents on Slicer

Go to Extensions =>
DTIPrep => cli-modules =>
DTIPrep

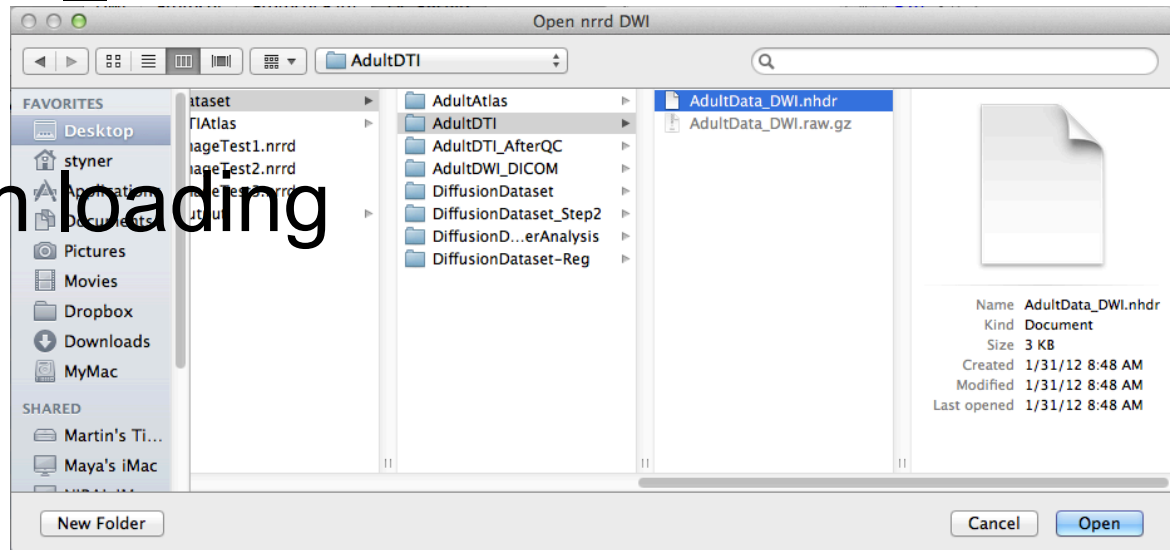
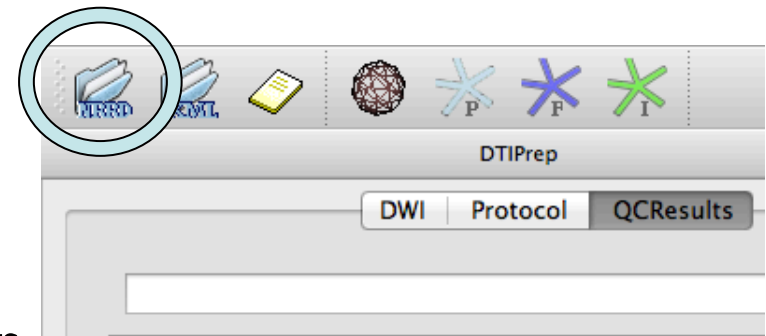
The screenshot illustrates the process of navigating to the DTIPrep extension's CLI modules on a Mac. The file browser window shows the path: Applications > Imaging > Slicer_4.2.N.02.05 > Contents > Extensions-21665 > DTIPrep > cli-modules. A context menu is open over the 'cli-modules' folder, with the 'Show Package Contents' option highlighted. A blue arrow points from the text 'Show Package Contents on Slicer' to this option. The context menu also shows other options like 'Move to Trash', 'Get Info', 'Compress "Slicer_4.2.N.02.05"', 'Burn "Slicer_4.2.N.02.05" to Disc...', 'Duplicate', 'Make Alias', 'Quick Look "Slicer_4.2.N.02.05"', 'Copy "Slicer_4.2.N.02.05"', 'Show View Options', and 'Label:'. The file browser window also shows the contents of the 'cli-modules' folder, including subfolders like 'ABC', 'DTIAtlasBuilder', 'DTIAtlasFiberAnalyzer', 'DTIAtlasFiberAnalyzer.s4ext', 'DTIPrep', 'DTIPrep.s4ext', 'DTIProcess', 'DTIProcess.s4ext', 'FiberViewerLight', 'FiberViewerLight.s4ext', 'SkullStripper', and 'SkullStripper.s4ext'.



Load DWI image



- Click NRRD icon
- File Dialog
 - Select your DWI
 - AdultData_DWI.nhdr
- “Open”
- Done with loading





DWI info



DTIPrep Tools(Qt4) - /Users/styner/Data/DTIWorkshopDataset/DTI/DTIPrep_JB.nhdr

DTIPrep

DWI Protocol QCResults

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

Dicom2Nrrd DTIPrep

MPR 3D view

Image2DView 1

DWI 0

Axia 47

None 1 0 0 W/L Vis I>

Image2DView 2

DWI 0

Sagit 64

None 1 0 0 W/L Vis I>

Image2DView 3

DWI 0

Coro 64

None 1 0 0 W/L Vis I>

Detailed
DWI
Info

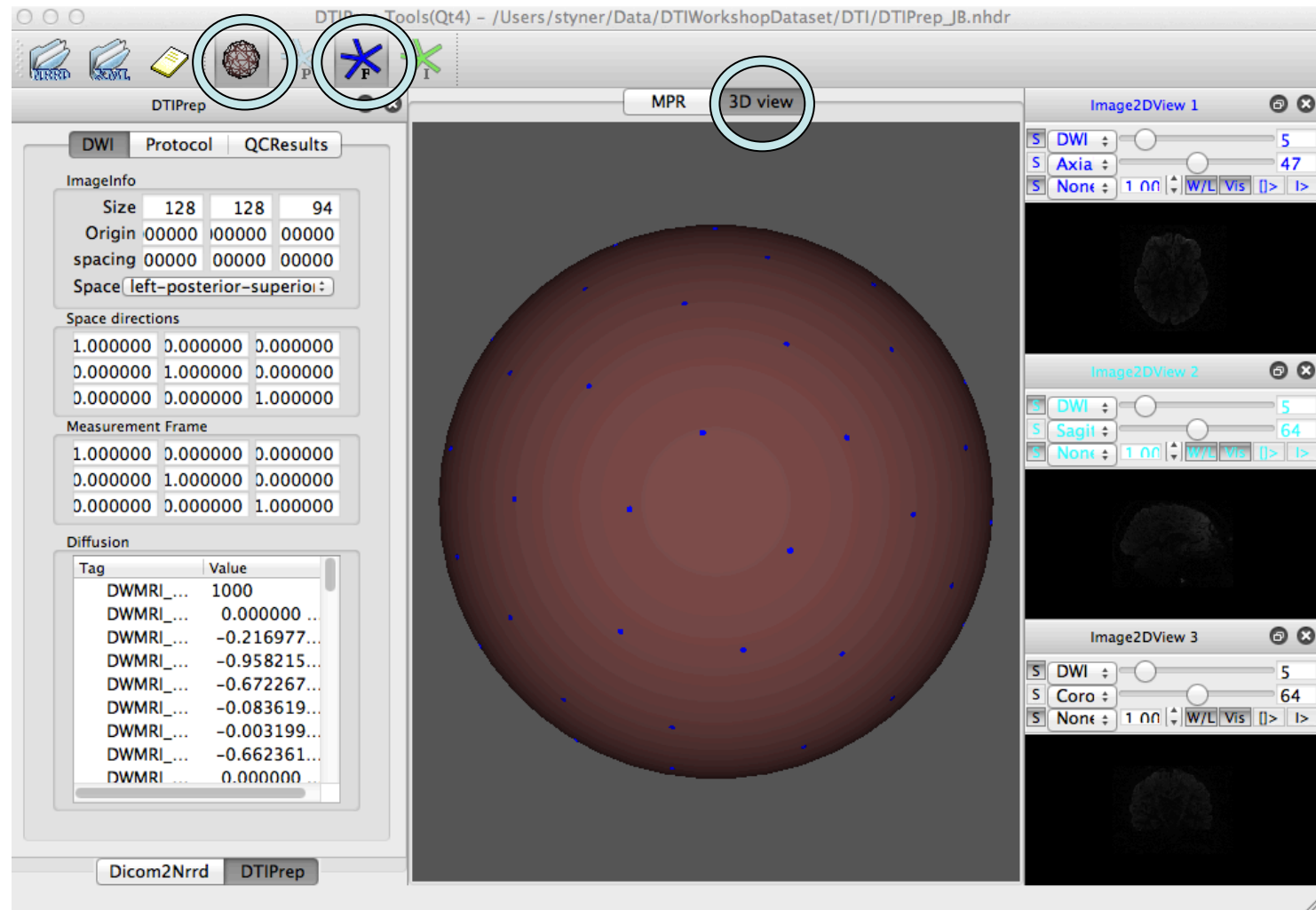


Gradient info in 3D



Displays gradient scheme on unit sphere (F = File)

- Check for uniformity

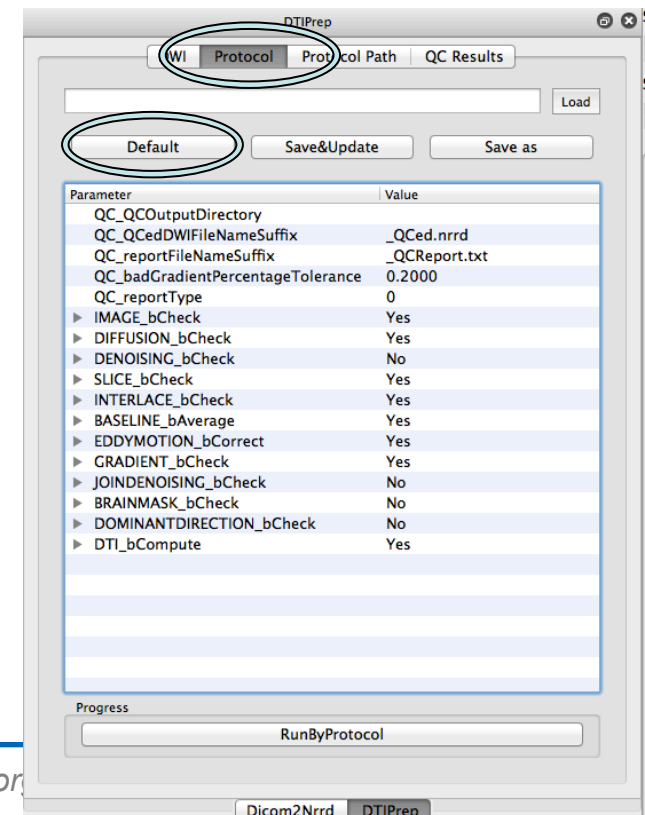




Protocol in DTIPrep



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

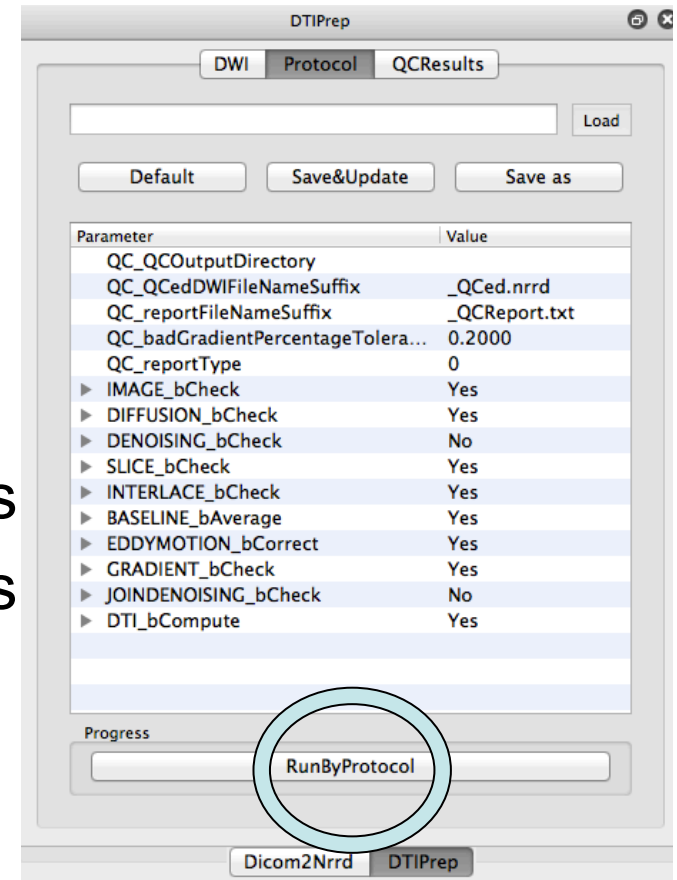




Run QC



- 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

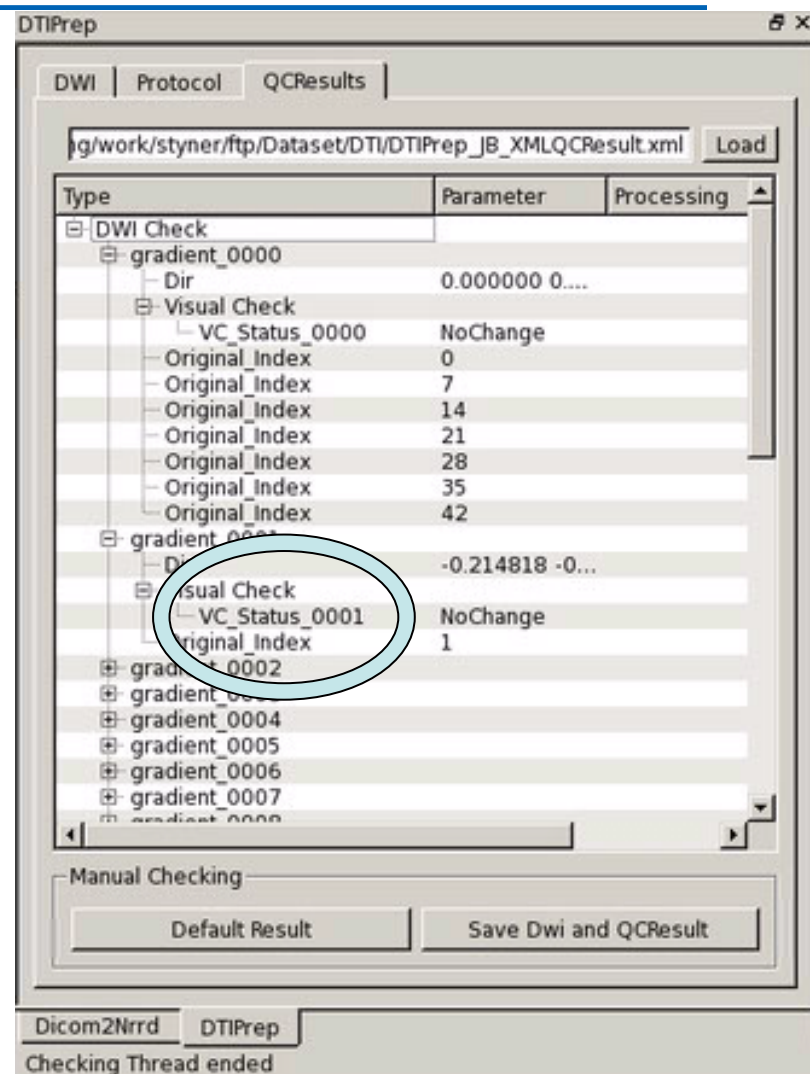
Checking Thread ended



Visual QC & Save



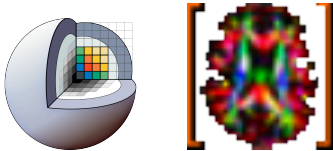
- Double click on “VC_Status”
- Option to include or exclude
- Often unnecessary





Conclusion



- DTI QC is a must
- DTIPrep & Slicer provide comprehensive QC 
- This tutorial guided you through the “default” use of DTIPrep
- Soon v1.2: Better Slicer integration, directional artifacts detection, and residual error estimation



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- Utah: Guido Gerig, Sylvain Gouttard
- Iowa: Hans Johnson, Joy Matsui