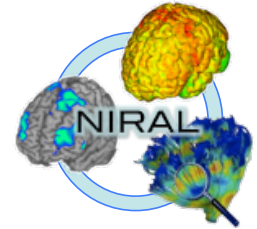




NA-MIC

*National Alliance for Medical Image Computing*

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



# DTI Atlas Registration via 3D Slicer and DTI-Reg

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# DTI Registration

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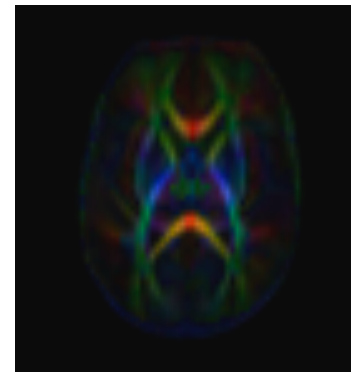
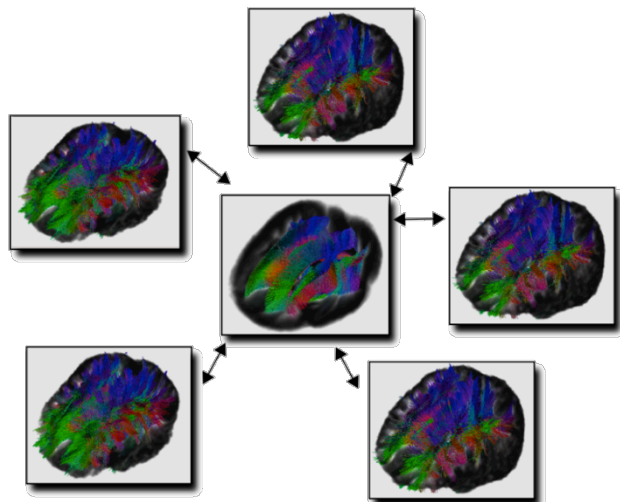
- This tutorial teaches you how
  - Load DTI datasets & masks
  - Perform a pair-wise registration to a prior atlas via DTI-Reg
    - Affine transform and deformable transform
  - Save the transformed images and the deformable transform



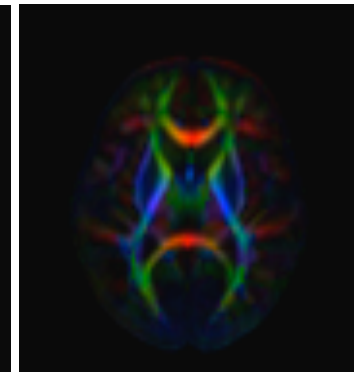
# DTI Population Atlases



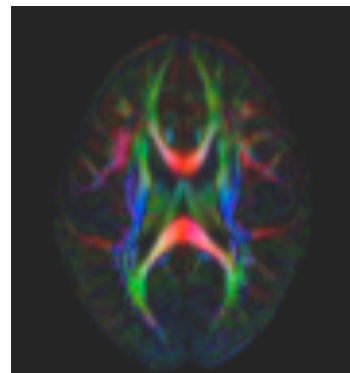
- Definition of standard space
- SNR increase
- Better tractography



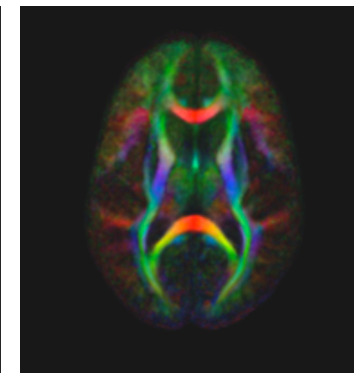
Neonate



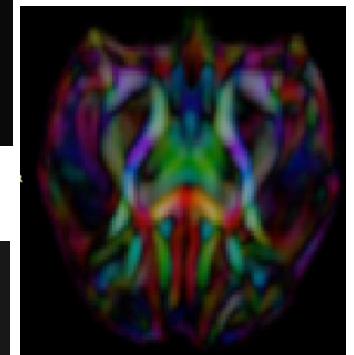
1 year



2 year



Adult



Rhesus (15mo)



# Dataset

---



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

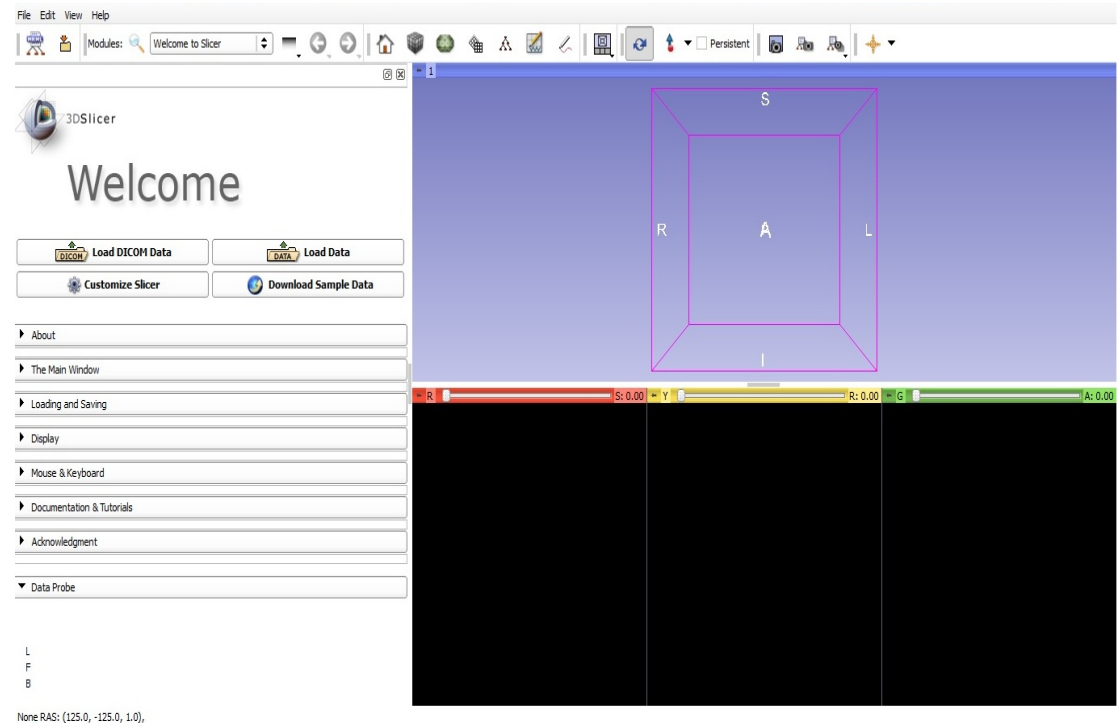


# Start Slicer 4



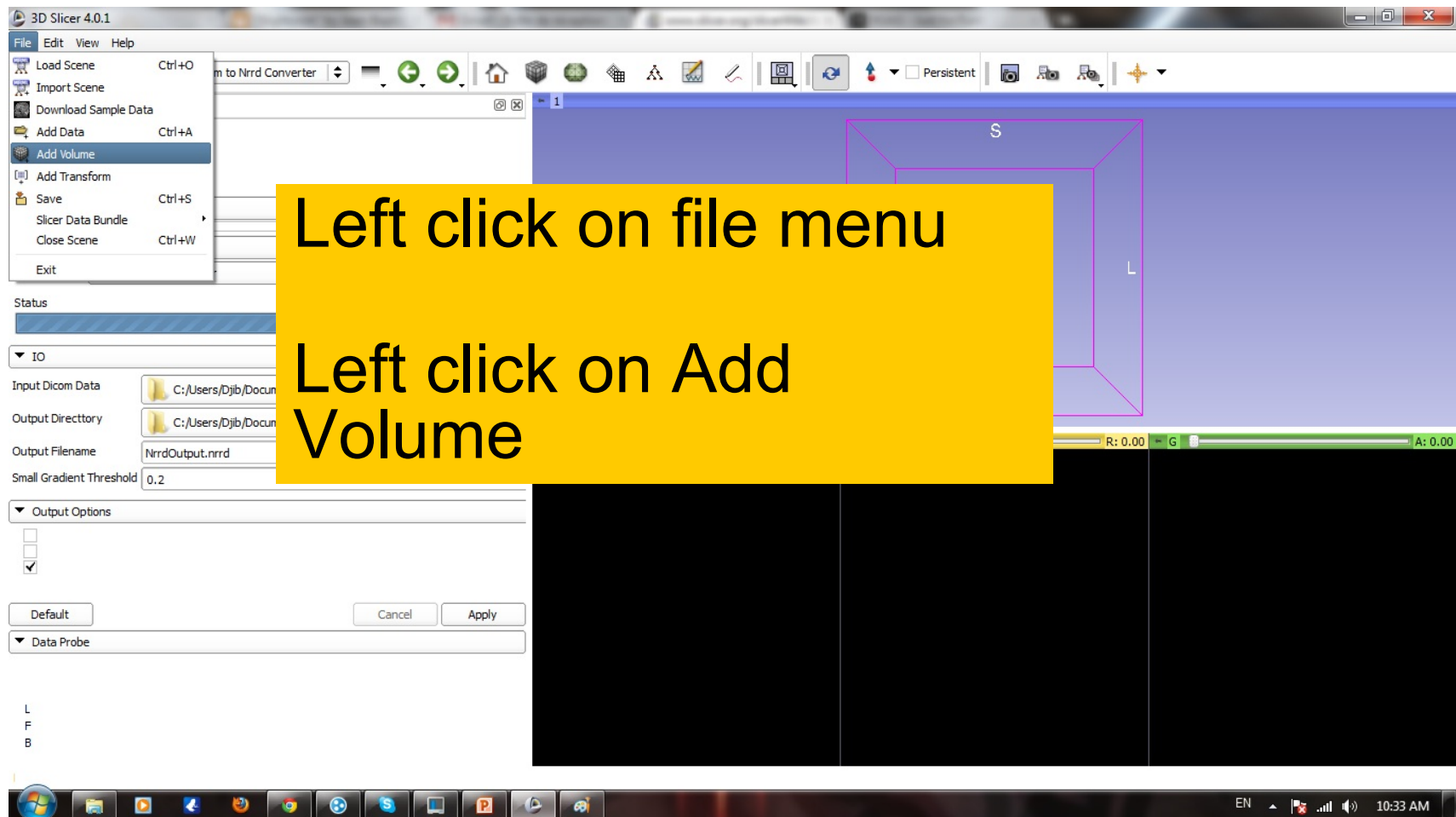
Linux/Mac users :  
Launch the Slicer executable located in the Slicer4 directory

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



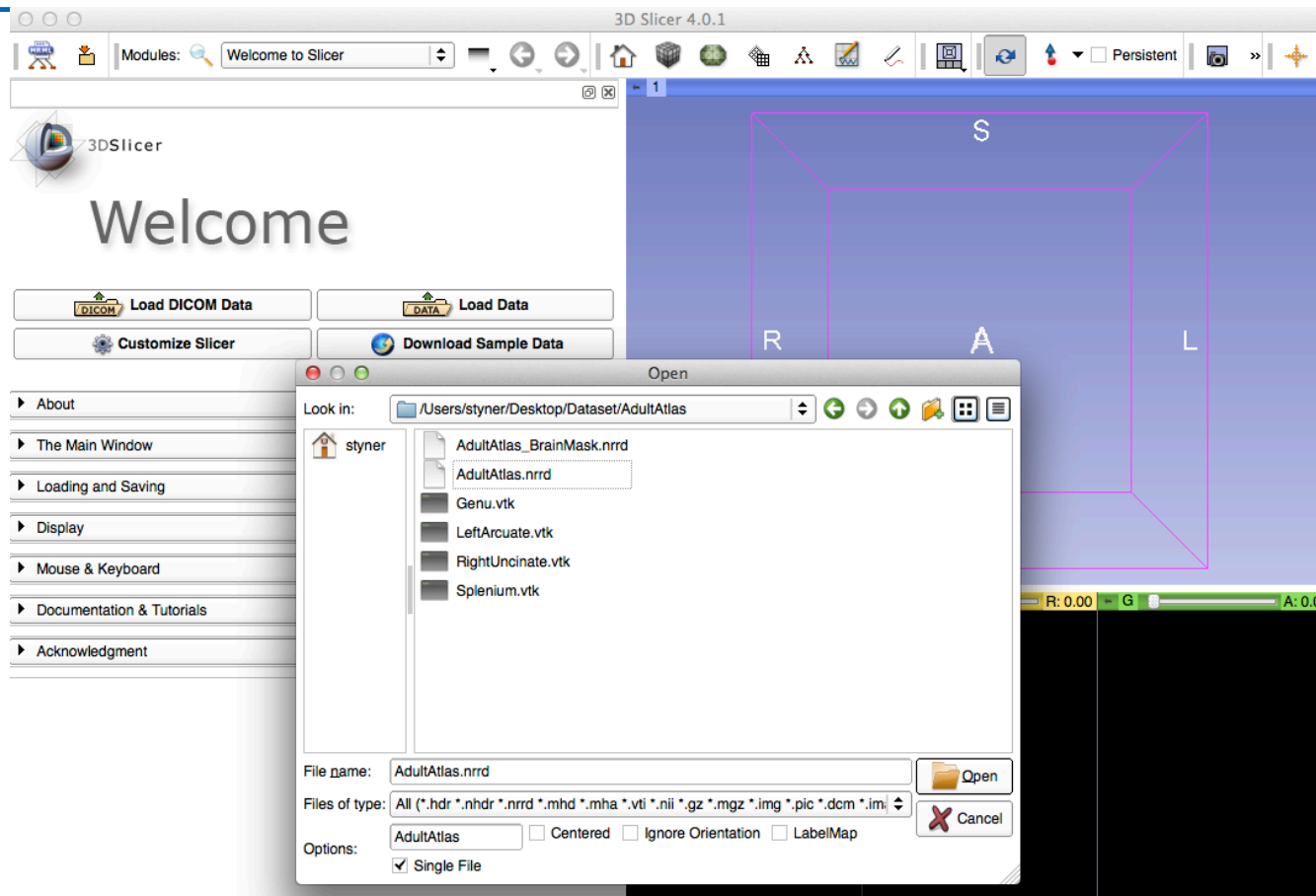


# Loading DTI Atlas





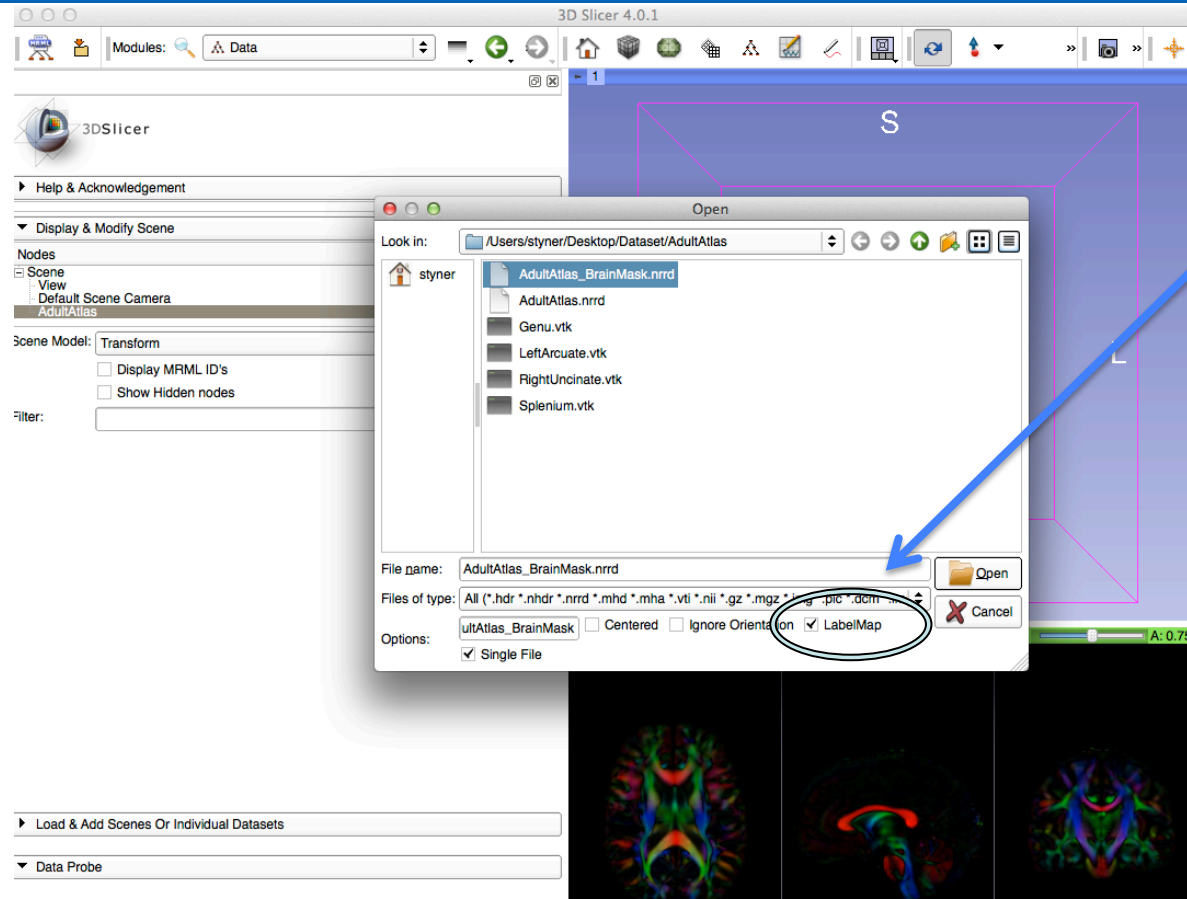
# Loading DTI Atlas



Select the AdultAtlas.nrrd volume



# Loading DTI Atlas **Mask**



Load AdultAtlas\_BrainMask.nrrd label map

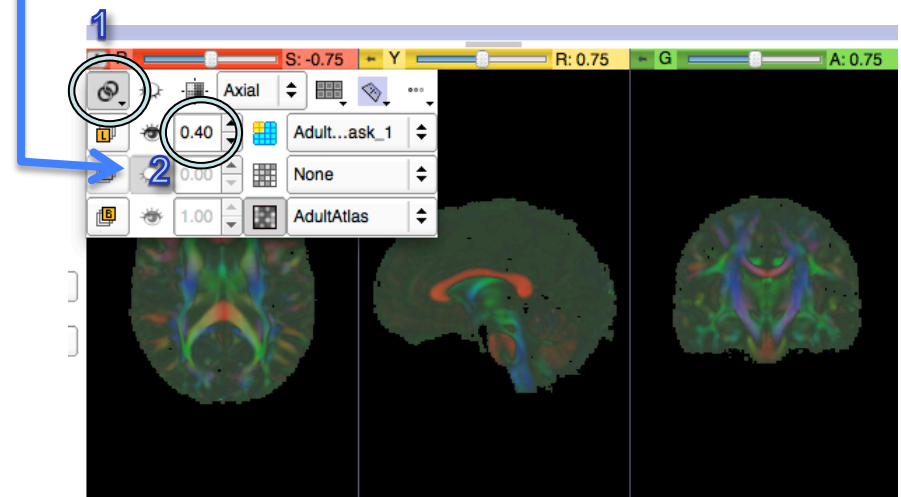




# Adjust View



- Adjust view to see both mask and atlas
  1. Link all 3 viewers
  2. Opacity change

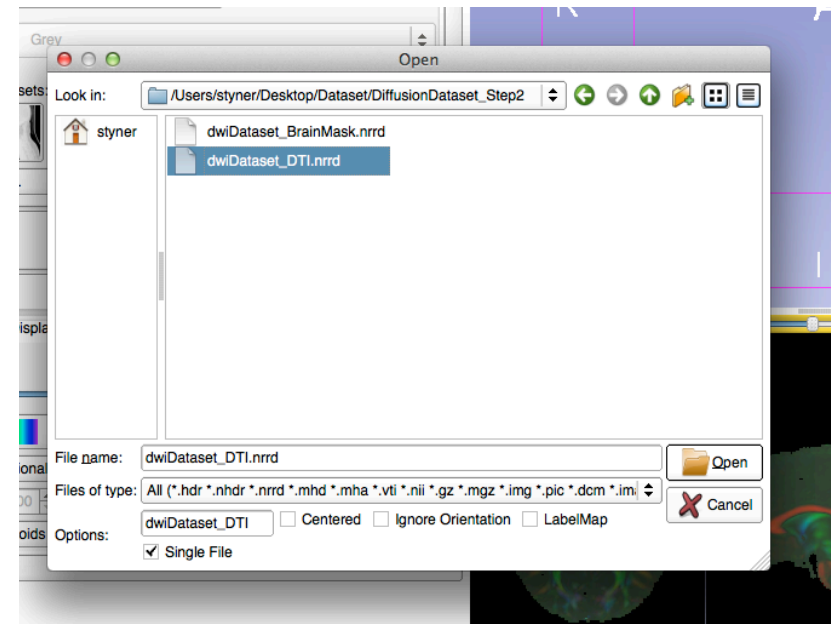




# Loading DTI dataset



- File Menu =>Add Volume (or use from previous tutorial)
- DiffusionDataset\_Step2
- Load DTI NRRD

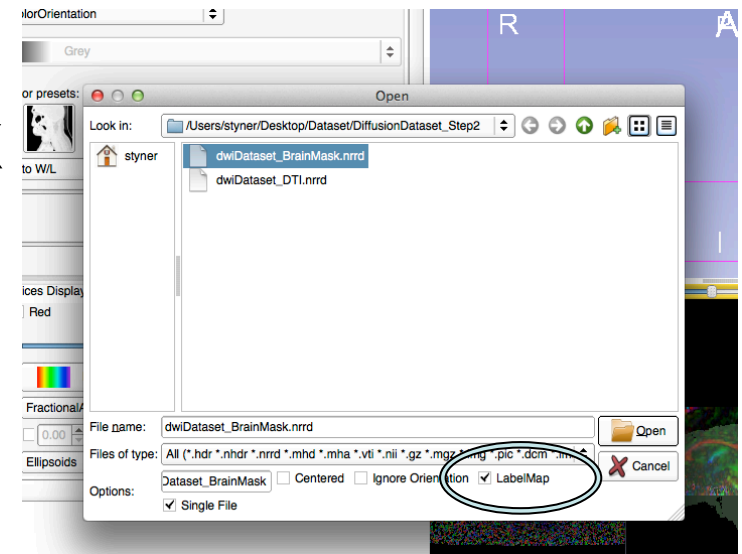
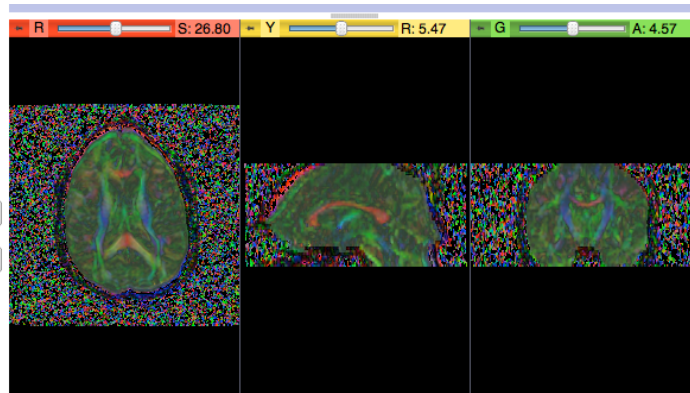




# Loading DTI dataset mask



- File Menu =>Add Volume (or use from previous tutorial)
- DiffusionDataset\_Step2
- Load BrainMask
- “LabelMap” checkbox



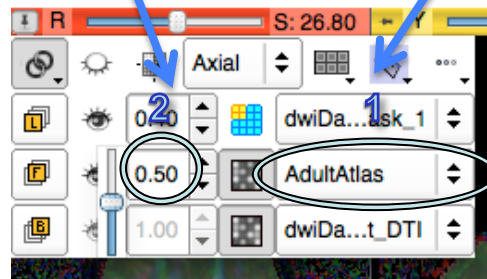


# Overlay DTI datasets



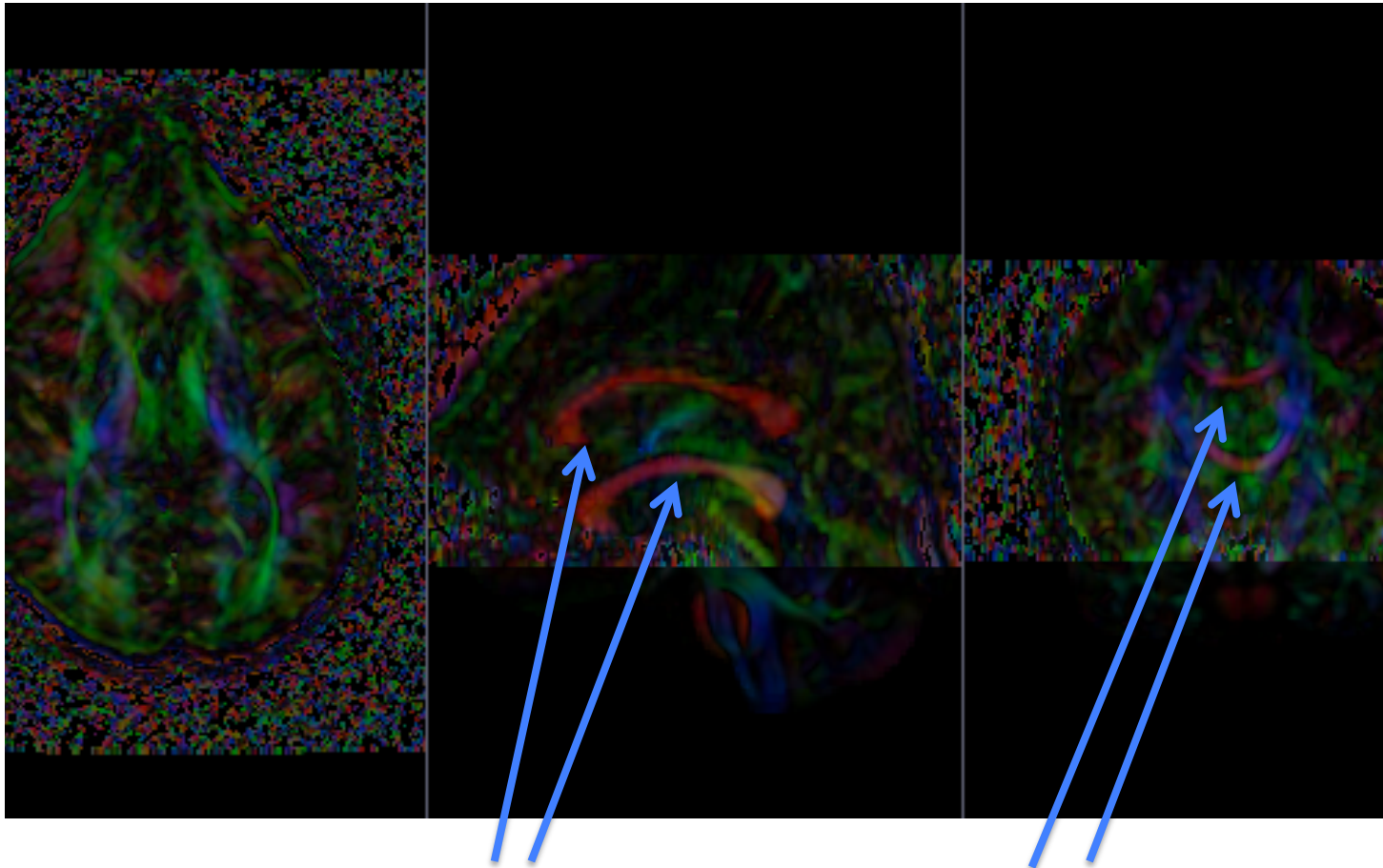
- How can we check alignment?
- Overlay the DTI images!

1. Select AdultAtlas for Foreground
2. Set Opacity to 0.5





# Overlay



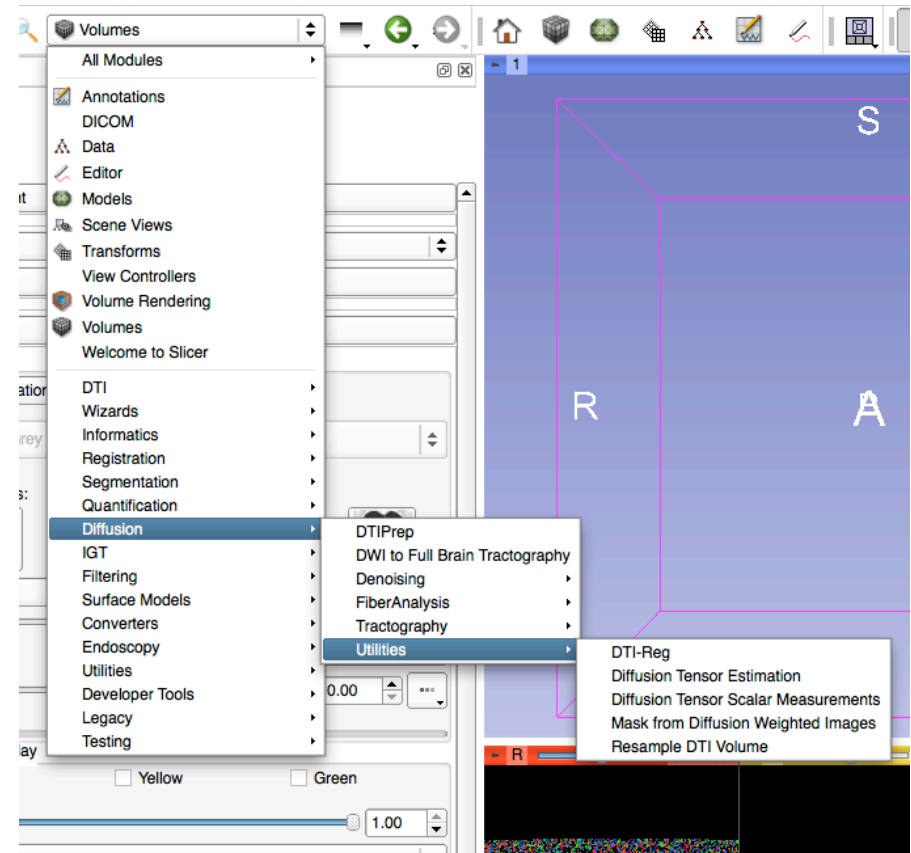
Bad alignment: 2 separate corpus callosum



# Select DTI-Reg Module



- Slicer modules
  1. Diffusion
  2. Utilities
  3. DTI-Reg
- Pairwise DTI registration module

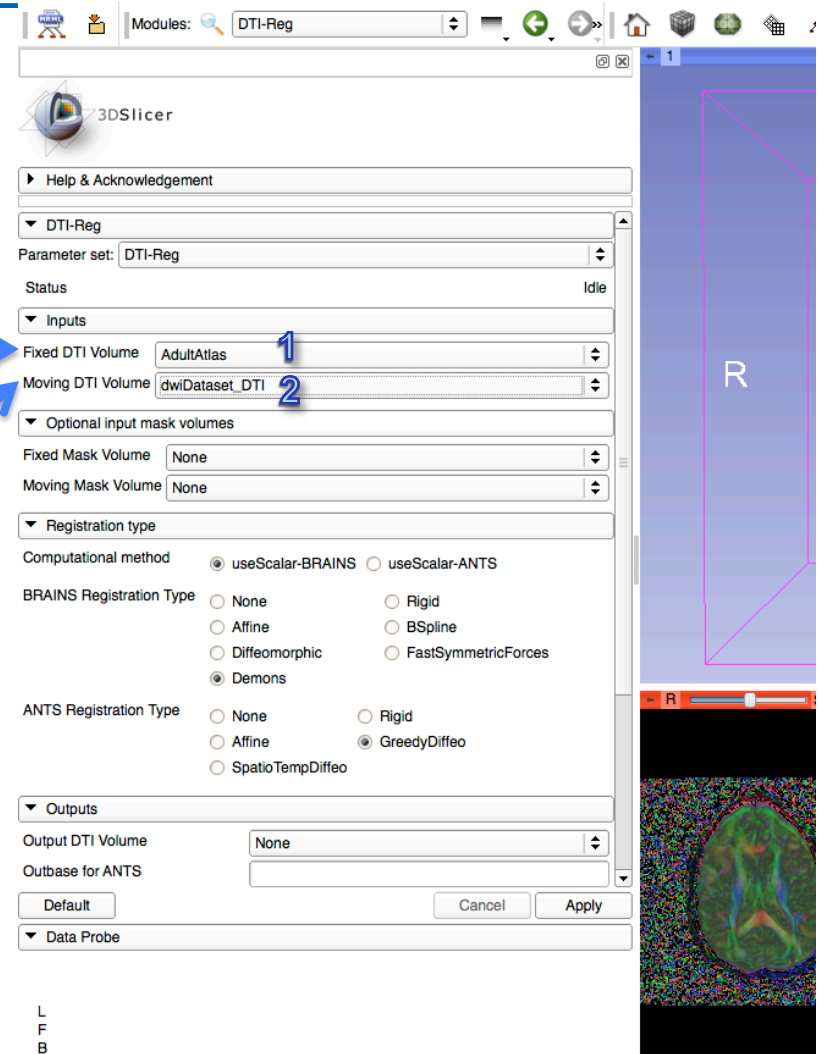




# Volumes for Registration



1. Fixed Volume = Target of registration = Atlas DTI
2. Moving Volume = DTI dataset





# Set Masks for Registration



1. Set Fixed Mask to Atlas Mask
2. Set Moving Mask to dwiDataset Mask

DTI-Reg

Parameter set: DTI-Reg

Status: Idle

Inputs

Fixed DTI Volume: AdultAtlas

Moving DTI Volume: dwiDataset\_DTI

Optional input mask volumes

Fixed Mask Volume: AdultAtlas\_BrainMask **1**

Moving Mask Volume: dwiDataset\_BrainMask **2**

Registration type

Computational method:  useScalar-BRAINS  useScalar-ANTS

BRAINS Registration Type:  None  Rigid  Affine  BSpline  Diffeomorphic  FastSymmetricForces  Demons

ANTS Registration Type:  None  Rigid  Affine  GreedyDiffeo  SpatioTempDiffeo

Outputs

Output DTI Volume: None

Outbase for ANTS: [Empty field]





# Set Transform to Affine



- Set registration transform to Affine
- Registration is performed in 2 steps
- Future versions: all in 1 step
- If you have ANTS pre-installed => select it!

The screenshot shows the DTI-Reg software interface. The 'Registration type' section is expanded, showing the following options:

- Computational method:  useScalar-BRAINS,  useScalar-ANTS
- BRAINS Registration Type:  None,  Affine,  Diffeomorphic,  Demons,  Rigid,  BSpline,  FastSymmetricForces
- ANTS Registration Type:  None,  Affine,  SpatioTempDiffeo,  GreedyDiffeo

The 'Affine' option under BRAINS Registration Type is circled in red. The 'GreedyDiffeo' option under ANTS Registration Type is also selected. The 'Output DTI Volume' is set to 'None' and the 'Outbase for ANTS' is empty. The 'Status' is 'Idle'.



# Select Outputs



- Create & rename volumes for output
  1. Affinely registered DTI dataset
  2. Affine transform
- Apply to run & wait

Registration type

Computational method  useScalar-BRAINS  useScalar-ANTS

BRAINS Registration Type  None  Rigid  
 Affine  BSpline  
 Diffeomorphic  FastSymmetricForces  
 Demons

ANTS Registration Type  None  Rigid  
 Affine  GreedyDiffeo  
 SpatioTempDiffeo

Outputs

Output DTI Volume Output DTI Volume 1

Outbase for ANTS

Output Transform File for BRAINS Output Transform File for BRAINS 2

Output Deformation Field Volume None

fixed FA Volume None

moving FA Volume None

Resampled FA Volume None

► BRAINS registration parameters

► ANTS registration parameters

Default Cancel Apply

None

AdultAtlas

dwiDataset\_DTI

Output DTI Volume

Rename current DiffusionTensorVolume

Create new DiffusionTensorVolume

Delete current DiffusionTensorVolume

none



# Registration



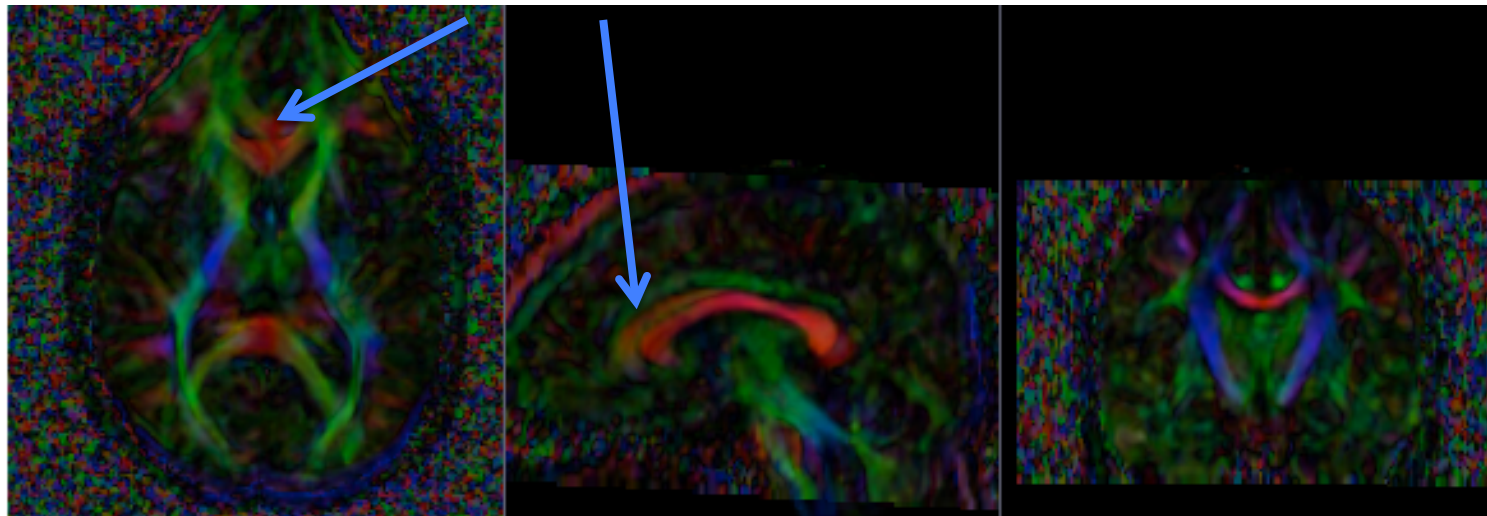
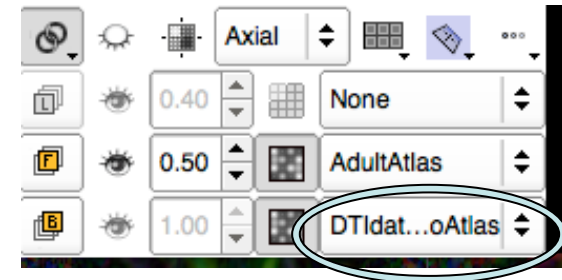
- Many pairwise methods exist
- DTI-Reg supports several registration methods based on calibrated FA image
  - Affine, B-spline, Demons-variants from within Slicer
  - ANTS as external call (necessitates ANTS installation)
- Future versions will also support DTI-TK
  - Registration based on full tensor



# Affine Results



- Select DTI-Reg result as background
- Result: single corpus callosum, but fuzzy, insufficient registration





# Deformable Registration



1. Change moving volume to affinely registered data
2. Change moving mask to atlas mask
3. Change registration to Diffeomorphic (Demons)
4. Add Deformation volume outputs

The screenshot shows the ANTs registration software interface with the following settings:

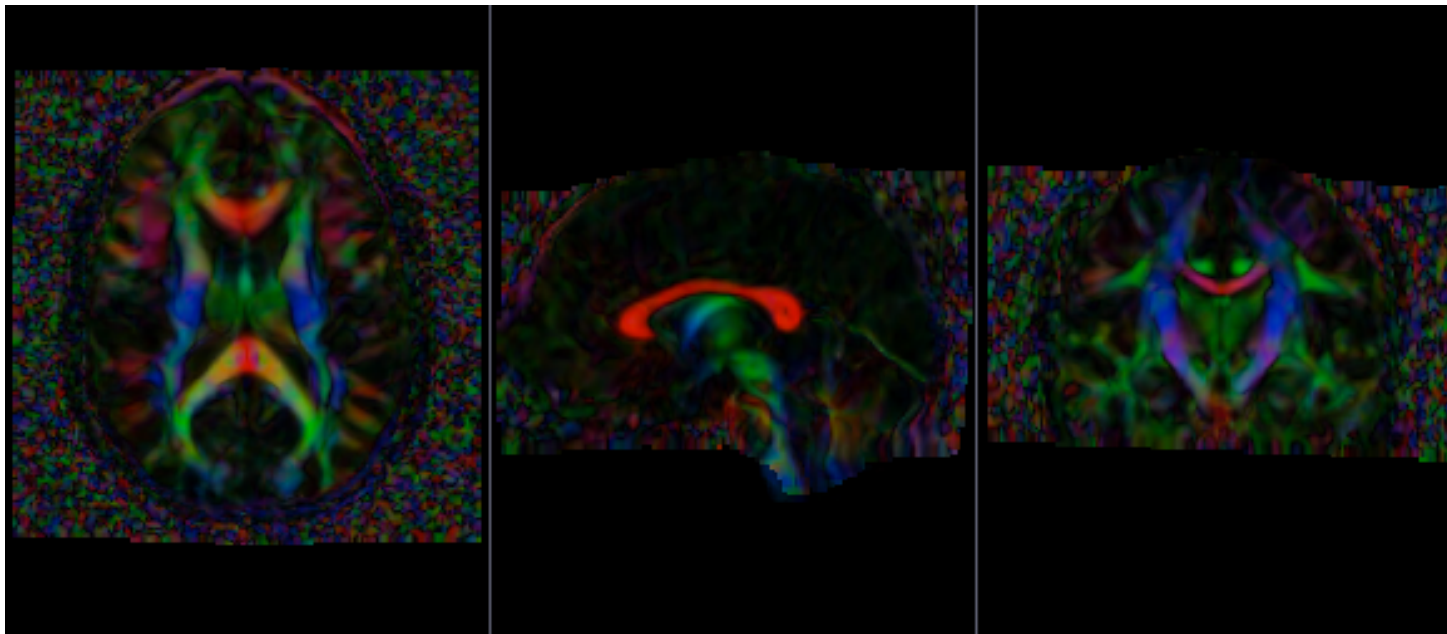
- Fixed DTI Volume: AdultAtlas
- Moving DTI Volume: DTIdata\_AffineRegAtlas (1)
- Optional input mask volumes:
  - Fixed Mask Volume: AdultAtlas\_BrainMask
  - Moving Mask Volume: AdultAtlas\_BrainMask (2)
- Registration type:
  - Computational method:  useScalar-BRAINS  useScalar-ANTS
  - BRAINS Registration Type:  None  Rigid  Affine  BSpline  Diffeomorphic (3)  Demons  FastSymmetricForces
  - ANTs Registration Type:  None  Rigid  Affine  GreedyDiffeo  SpatioTempDiffeo
- Outputs:
  - Output DTI Volume: DTIdata\_DeformToAtlas (4)
  - Outbase for ANTs: Output DTI image
  - Output Transform File for BRAINS: AffineTransform\_DTIdataRegAtlas
  - Output Deformation Field Volume: Deformation\_DTIdataAffineRegAtlas (5)
  - fixed FA Volume: None
  - moving FA Volume: None



# Deformable Results



- Select DTI-Reg deformable result as background
- Result: No longer fuzzy, great registration





# Save Outputs and Done



- Save all volumes and transform
  - Need: Affinely registered volume & Deformation field

	Node Name	Node Type	Node Status	File Format	File Name	Data Directory
1	<input type="checkbox"/> (Scene Description)	(SCENE)	Modified	MRML (.mrm)	Slicer4.0	/Users/styner/Desktop/Dataset/DiffusionDataset-Reg
2	<input type="checkbox"/> dwiDataset_DTI	DiffusionTensorVolume	Not Modified	NRRD (.nrrd)	dwiDataset_DTI.nrrd	/Users/styner/Desktop/Dataset/DiffusionDataset_Step
3	<input type="checkbox"/> dwiDataset_BrainMask	Volume	Modified	NRRD (.nrrd)	dwiDataset_BrainMask.nrrd	/Users/styner/Desktop/Dataset/DiffusionDataset-Reg
4	<input type="checkbox"/> AdultAtlas_BrainMask	Volume	Modified	NRRD (.nrrd)	AdultAtlas_BrainMask.nrrd	/Users/styner/Desktop/Dataset/DiffusionDataset-Reg
5	<input type="checkbox"/> AdultAtlas	DiffusionTensorVolume	Not Modified	NRRD (.nrrd)	AdultAtlas.nrrd	/Users/styner/Desktop/Dataset/AdultAtlas
6	<input checked="" type="checkbox"/> DTIdata_AffineRegAtlas	DiffusionTensorVolume	Modified	NRRD (.nrrd)	DTIdata_AffineRegAtlas.nrrd	/Users/styner/Desktop/Dataset/DiffusionDataset-Reg
7	<input checked="" type="checkbox"/> AffineTransform_DTIdataToAtlas	LinearTransform	Modified	Transform (.tfm)	AffineTransform_DTIdataToAtlas.tfm	/Users/styner/Desktop/Dataset/DiffusionDataset-Reg
8	<input checked="" type="checkbox"/> Deformation_DTIdataAffineToAtlas	VectorVolume	Modified	NRRD (.nrrd)	Deformation_DTIdataAffineToAtlas.nrrd	/Users/styner/Desktop/Dataset/DiffusionDataset-Reg
9	<input checked="" type="checkbox"/> DTIdata_DeformRegAtlas	DiffusionTensorVolume	Modified	NRRD (.nrrd)	DTIdata_DeformRegAtlas.nrrd	/Users/styner/Desktop/Dataset/DiffusionDataset-Reg

Destination for all selected: /Users/styner/Desktop/Dataset/DiffusionDataset-Reg

OK Cancel



# Conclusions

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- DTI registration is available in Slicer
- 2-step process currently, to be improved soon
- Brainmasks are needed (unless data is skull stripped already)
- This tutorial taught you how to register to an atlas
  - Next step: how to use the atlas for fiber base analysis





# Acknowledgment

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- **National Alliance for Medical Image Computing**  
NIH U54EB005149
- UNC: Jean-Baptiste Berger, Clement Vachet, Aditya Gupta
- Utah: Guido Gerig, Sylvain Gouttard
- Iowa: Hans Johnson, Joy Matsui