



NA-MIC

National Alliance for Medical Image Computing

<http://na-mic.org>

Training & Validation Update

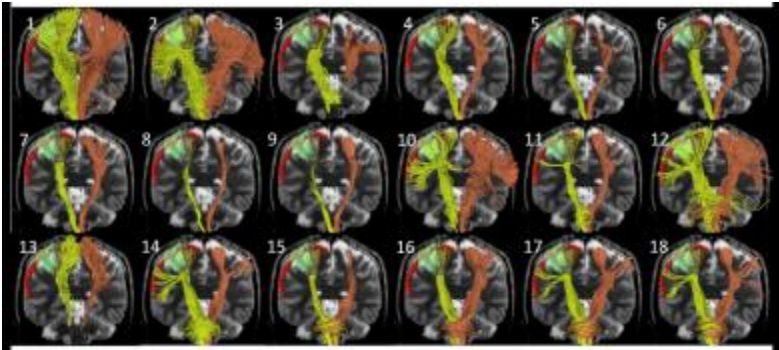
Sonia Pujol, PhD
NA-MIC Training Core P.I.



NA-MIC Training Core Mission



RSNA Course



MICCAI DTI
Challenge

- **Training effort** to transfer NA-MIC technology for subject-specific image analysis to clinical researchers
- **Translational research effort** to investigate the comparative performance of different algorithms



TRAINING UPDATE



3DSlicer: a technology delivery platform



An **open-source environment**
for software developers



An **end-user application**
for clinical researchers

A software platform that is both

- easy to use for clinical researchers
- easy to extend for programmers



3DSlicer: worldwide impact (2011-2013)

Slicer downloads

Matching downloads:

63183

date range

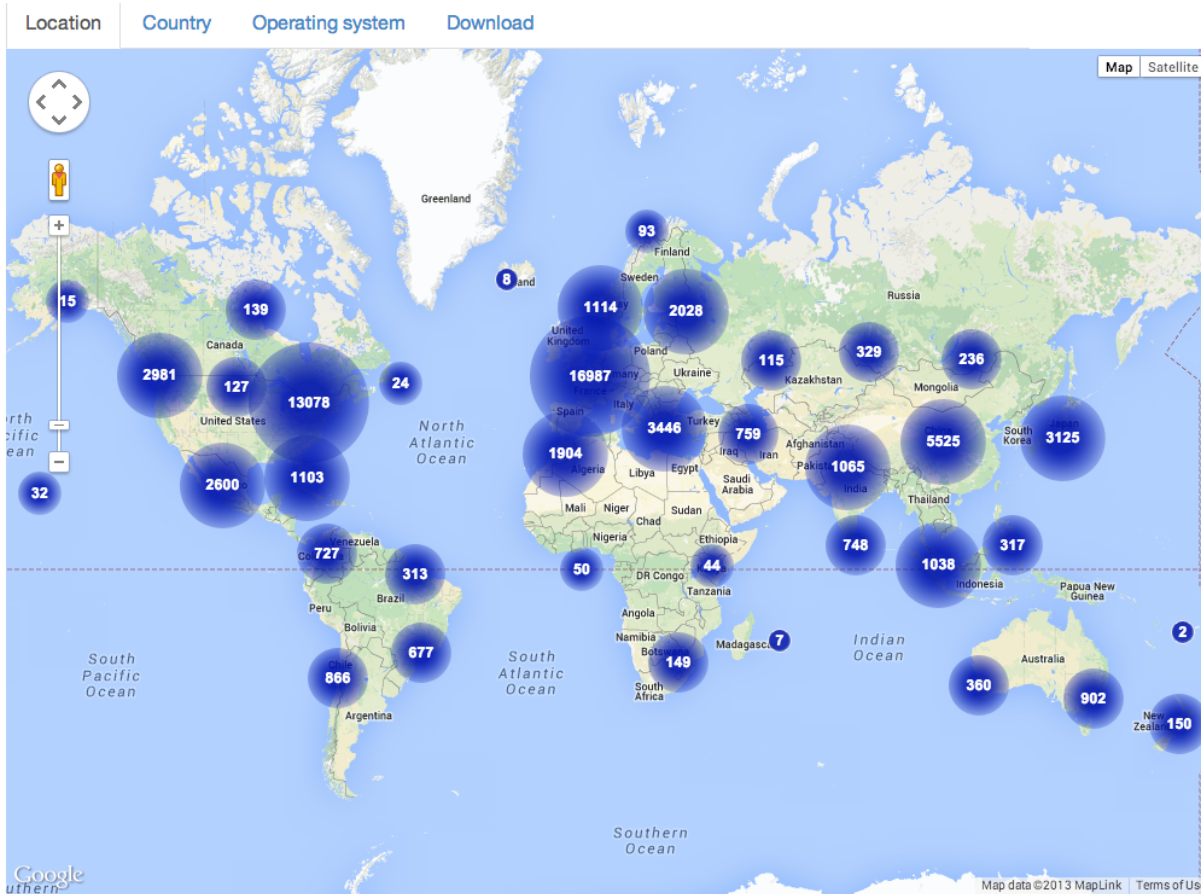
forever

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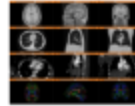




NA-MIC Tutorials

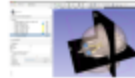
SLICER WELCOME TUTORIAL

- The *Slicer>Welcome tutorial* is an introduction to Slicer based on the Welcome module.
- Author: Sonia Pujol, Ph.D.
- Audience: First time users who want a general introduction to the software.
- Based on: 3D Slicer version 4.8



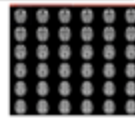
SLICERMINUTE TUTORIAL

- The *Slicer/Minute tutorial* is a brief introduction to the advanced 3D visualization capabilities of Slicer 4.8.
- Author: Sonia Pujol, Ph.D.
- Audience: First time users who want to discover Slicer in 4 minutes.
- Based on: 3D Slicer version 4.2
- The *Slicer/Minute dataset* contains an MR scan of the brain and 3D reconstructions of the anatomy



SLICERH DATA LOADING AND 3D VISUALIZATION

- The *Data loading and 3D visualization* course guides through the basics of loading and viewing volumes and 3D models in Slicer.
- Author: Sonia Pujol, Ph.D.
- Audience: End-users
- Based on: 3D Slicer version 4.1
- The *3DVisualization dataset* contain an MR scan and a series of 3D models of the brain.



Tutorials for software developers

SLICERH PROGRAMMING TUTORIAL

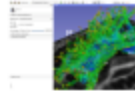
- The *Hello Python Programming tutorial* course guides through the integration of a python module in Slicer.
- Author: Sonia Pujol, Ph.D., Steve Pieper, Ph.D.
- Audience: Developers
- Based on: 3D Slicer version 4.1
- The *HelloPython dataset* contains three Python files and an MR scan of the brain.



Specific functions

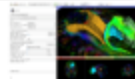
SLICERH DIFFUSION TENSOR IMAGING TUTORIAL

- The *Diffusion Tensor Imaging Tutorial* course guides through the basics of loading Diffusion Weighted images in Slicer, estimating tensors and generating fiber tracts.
- Author: Sonia Pujol, Ph.D.
- Audience: End-users and developers
- Based on: 3D Slicer version 4.3
- The *DTI dataset* contains an MR Diffusion Weighted imaging scan of the brain.



SLICERH NEUROSURGICAL PLANNING TUTORIAL

- The *Neurosurgical Planning tutorial* course guides through the generation of fiber tracts in the vicinity of a tumor.
- Author: Sonia Pujol, Ph.D., Ran Xie, M.D.
- Audience: End-users and developers
- Based on: 3D Slicer version 4.3
- The *White Matter Exploration dataset* contains a Diffusion Weighted imaging scan of brain tumor patient.



- Modular multi-level training for expert and non-expert community
- Tutorials and anonymized datasets for end-users and developers
- Cross platform testing for quality control



New Additions

SPI Loading a DICOM volume

Click to expand the DICOM Browser window.
Slicer displays the snapshots of the DICOM images of the CT_Thorax_Abdomen_CT dataset

Slide 29

SPI PET SUV Computation

SUV Computation Results:
SUVmax = 7.53385 mg/ml
SUVmin = 5.01805 mg/ml
SUVmean = 3.39015 mg/ml

©2011 Surgical Planning Laboratory, AOR

Learning Objective

This tutorial demonstrates how to perform a radiation therapy research workflow using the SlicerRT extension:

Evaluation of the isocenter shifting adaptation method

National Alliance for Medical Image Computing
<http://www.na-mic.org>

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- **Modernization of training portfolio:**
 - Drag & Drop feature
 - DICOM viewer
 - new Markups module
- **New tutorials**
 - Cardiac MRI Toolkit (Utah)
 - HelloCLI (MGH)
 - DTI Prep (IOWA)
 - SlicerRT (Queen's University)
 - 3D Printing (BHW)

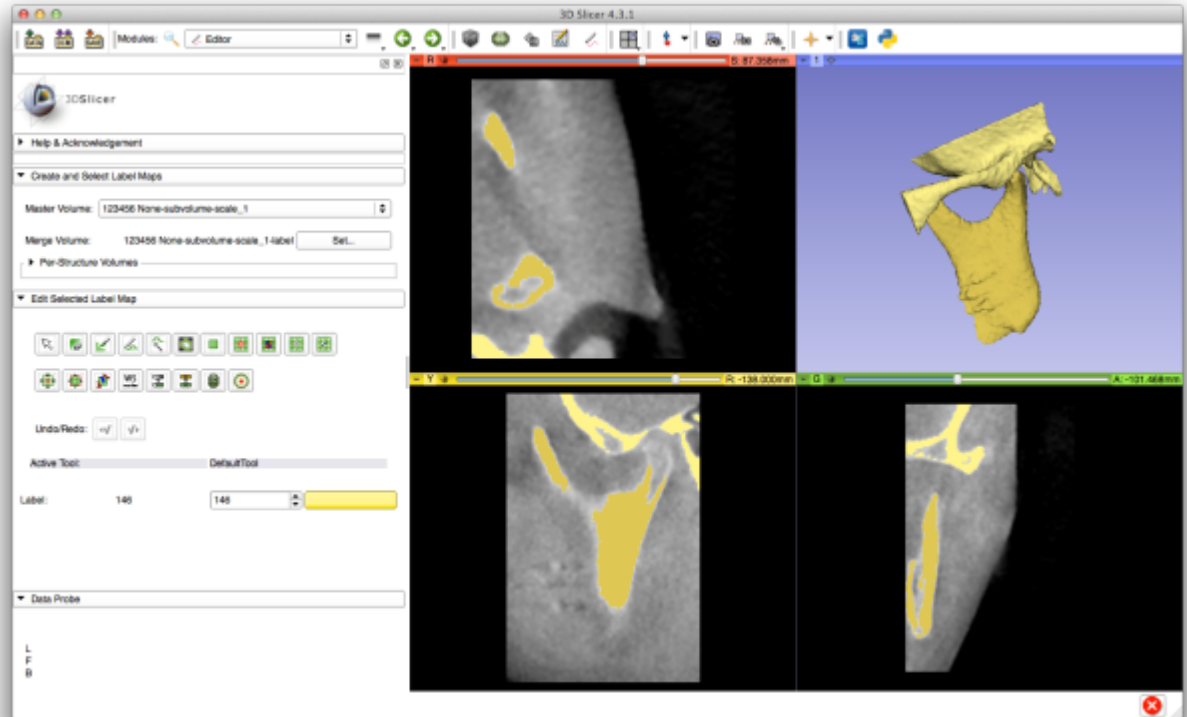


Cone Beam CT: Skull

Preparing Data for 3D Printing



3D Printed Models:
Temporal Bone and Mandible



Download Tutorial:

http://wiki.na-mic.org/Wiki/index.php/File:Slicer_3D_Printing_Tutorial.mov

Tutorial and Slide courtesy of Nabgha Farhat, Brigham and Women's Hospital

Acknowledgements: P41EB015898, P41EB015902, U54EB005149



3D Printing Tutorial on YouTube and Google+

Luis Ibanez
Shared publicly - Dec 16, 2013

Slicer Segmentation 3D Printing
102 photos

+13

3 comments

Luis Ibanez Dec 17, 2013
Not sure how they decide which pictures need the snow....it

+1

Luis Ibanez
Shared publicly

Yaroslav Halchenko origir
or how dinosaurs dig even

H
a
r
e
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Luis Ibanez
Shared publicly

3DSlicer
Tutorial: Preparing Data for 3D Printing

00:05 / 22:20

Tutorial: Preparing Data for 3D Printing Using 3D Slicer

3D Slicer · 1 video

26 views

Like About Share Add to

Published on Jan 8, 2014
This tutorial demonstrates how to prepare data for 3D printing using the open source software 3D Slicer.

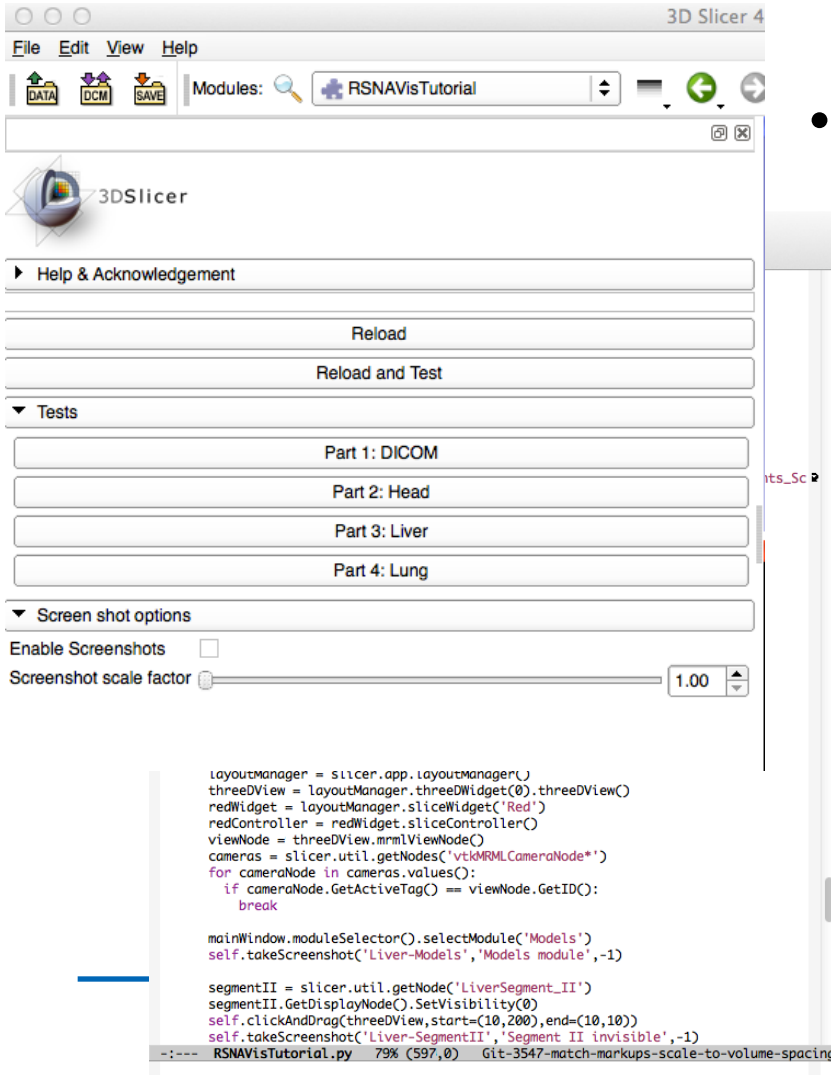
Tutorial and Slide courtesy
Nabgha Farhat
Brigham and Women's Hsp

National Alliance for Medical Image Computing
<http://na-mic.org>

P.S. 4 Luis



Training Portfolio: Quality Control



- Self-test infrastructure in Slicer can be used to run nightly tests of the functionality used in tutorials.

A python script is created with commands that automate the steps of the tutorial.

The tests are integrated into Slicer and can be run by users.

The tests are run each night and can be monitored for failure as the code changes.

(slide courtesy of Nicole Aucoin)



NA-MIC Workshops



RSNA 2013

Hands-on workshops tailored for clinicians, clinical researchers, and scientists at national events, invited seminars, and international conferences



2013: 32 outreach events

21 workshops at national & international venues

Jan-June 2013:

598 participants

1. DTI Hands-on course, SPIE 2013, Orlando, Florida (Feb.5)
2. 3D Slicer demos, IMAGINE session, European Congress of Radiology, ECR 2013, Vienna, Austria (March 7-11)
3. Automatic Segmentation Algorithm workshop (March 8)
4. SlicerRT workshop, Medical University Vienna (March 11)
5. Imaging in Neuroscience hands-on course, Harvard Catalyst (April 8)
6. 3D Slicer hands-on workshop, Tokyo, Japan (April 9)
7. 3D Slicer hands-on workshop, Iwate, Japan (April 10)
8. AAPM Slicer User meeting Summer meeting, Indianapolis, NH (May 31)
9. 3D Slicer Hands-on workshop, BWH, Boston, (June 14)
10. DTI In traumatic Brain Injuries, CARS 2013, Heidelberg, Germany (June 26)
11. Image-Guided Therapy Workshop, CARS 2013, Heidelberg, Germany (June 30)



2013: 33 outreach events

22 workshops at national & international venues

June-Sept 2013

598 participants

12. BRAINSCamp hands-on workshop, Iowa City (August 1st)
13. 3D Slicer user group AAPM 2013 meeting, Indianapolis, (August 5)
14. MICCAI 2013 DTI Tractography Challenge, Nagoya, Japan (Sept.22)
15. MICCAI 2013 CTK Programming Tutorial, Nagoya, Japan (Sept.26)
16. 3D Slicer Neurosurgery workshop, PLA General Hospital, Beijing, China (Sept.29)
17. 3D Slicer Seminar, Changchun, China (Sept.30)
18. 3D visualization of the anatomy using Slicer, Harvard Medical School Gross Anatomy course, (ct.15)
19. 3D Slicer Workshop, Brno, Czech Republic (Oct 17)
20. 3D Cranio-Maxillo Facial workshop, CWRU Cleveland (Nov 20)
21. 3D Visualization of DICOM images for Radiology Applications, Hands-on course, RSNA 2013, Chicago (Dec.1)
22. Quantitative Medical Imaging for Research and Practice, Hands-on course, RSNA 2013, Chicago, (Dec.3)



2013: 33 outreach events

11 presentations and invited lectures

1. 3D Slicer lecture, European Congress of Radiology, ECR 2013, Vienna, Austria (March 7)
2. 3D Slicer invited lecture, Medical University of Vienna, Austria, (March 11)
3. DTI Challenge Poster Presentation, Sonia Pujol, P41 Directors Meeting, Washington DC (March 18-19)
4. The MICCAI DTI Challenge, invited lecture, Tokyo Women's University, Tokyo, Japan (April 8)
5. The MICCAI DTI Challenge, invited lecture, Jutendo University, Tokyo, Japan (April 8)
6. 3D Slicer invited lecture, AAPM New England Chapter Summer meeting, Portsmouth, NH (May 31)
7. 3D Slicer Summer Contest (June 28)
8. Invited lecture, Brain Mapping for Neurosurgery, 15th World Congress of Neurosurgery, Seoul, Korea (Sept. 11)
9. Invited lecture, Insular Gliomas, 15th World Congress of Neurosurgery, Seoul, Korea (Sept.12)
10. NA-MIC/NAC Invited Seminar, The 1st Hospital of Jilin University, Changchun, China (Sept.30)
11. 3D Slicer Booth, Quantitative Imaging Reading Room, RSNA 2013, Chicago (Dec.1-6)



Multi-disciplinary teaching

- Radiotherapy: AAPM 2013
- Radiology: RSNA 2013
- Neuroscience: SPIE 2013
- Cephalometry: CMF Cleveland 2013
- Image-Guided therapy: CARS 2013



NA-MIC workshops reach diverse audiences

Medical students

Dentists

Software
developers

Computer
scientists

Residents



3DSlicer

Radiologists

Biomedical
engineers

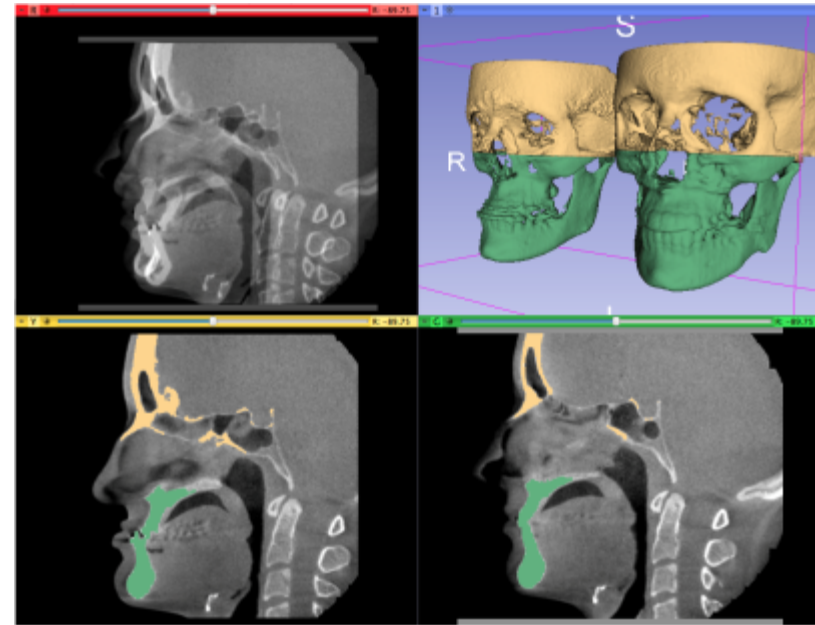
Medical Physicists

Neurosurgeons



Cranio Maxillo Facial Workshop

- Theme: Open-source 3D image analysis in dentistry
- Workshop Faculty
Beatriz Paniagua, UNC
Tung Nguyen, UNC
Lucia Cevidanes, U.Michigan
Vinicius Boen, U.Michigan





Autoseg workshop, Boston



- One-day workshop on the design of algorithms for automatic segmentation of medical images.
- Greg Sharp
MGH, Boston



BRAINS Camp 2013, Iowa City



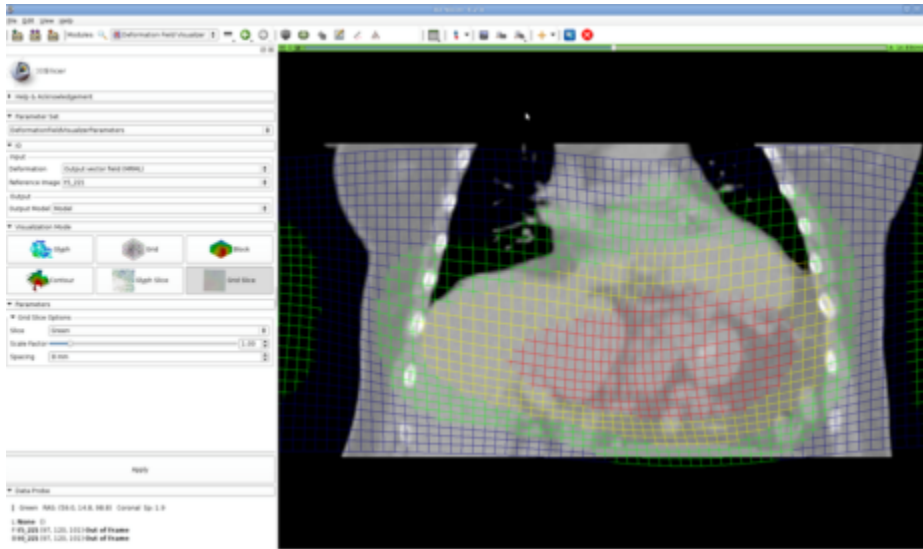
- Two-day BRAINSCamp workshop at the Iowa Institute for Biomedical Imaging



- Workshop Faculty:
 - Hans Johnson, Vince Calhoun, Vince Magnotta
-



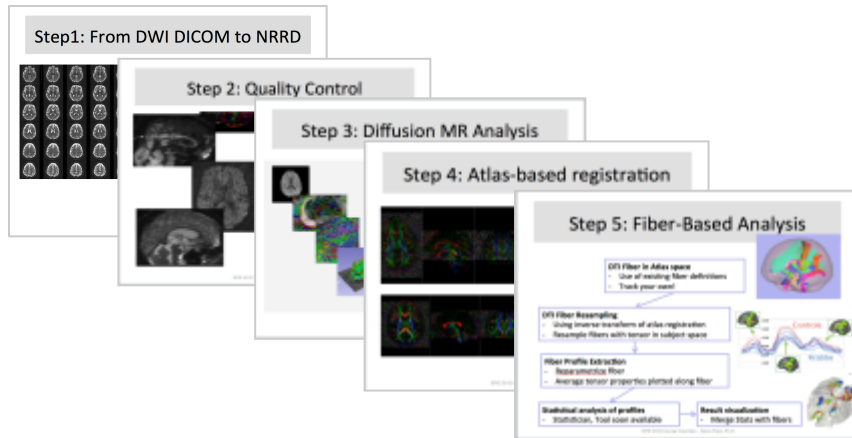
AAPM 2013, Indianapolis



- Theme: 3DSlicer for radiation therapy research
- Gregory Sharp, Nadya Shusharina, James Shackelford, MGH



SPIE 2013 DTI Course, Orlando



- 4-hour course on the fundamentals of the acquisition, analysis and validation of Diffusion Tensor Imaging (DTI) data (Pujol, Styner, Gerig)
- End-to-end medical image processing solution using Slicer4



NA-MIC Outreach events at International conferences



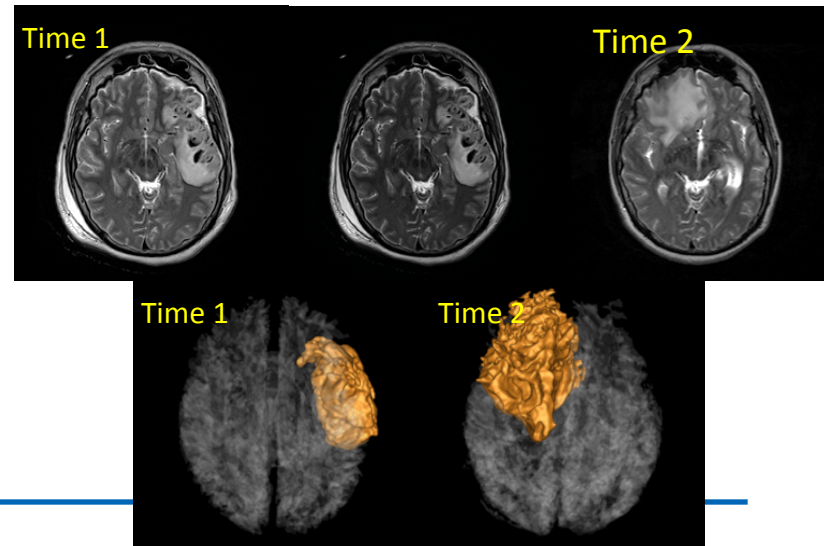
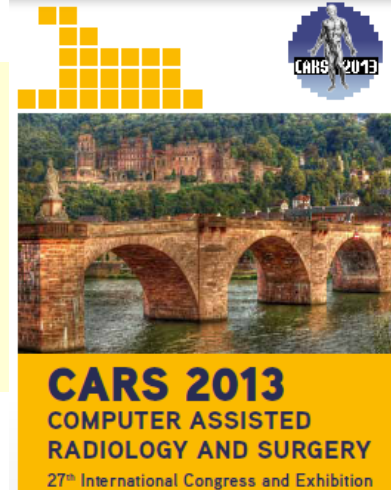
TBI Workshop, CARS 2013, Germany

Modeling brain injury and trajectory of brain changes from longitudinal multimodal imaging

- Guido Gerig
- U of Utah, SCI Institute and School of Computing &
- UCLA LONI (Jack Van Horn, Andrei Irimia, Arthur Toga, Vespa) &
- NA-MIC Research Team (Kikinis et al.)



M. Vannier: Diffusion MRI in Traumatic Brain Injury





CARS 2013 IGT Workshop, Germany

CARS 2013 IGT workshop

- 8:30-8:35 Opening remarks and Introduction
- 8:35-8:45 Presentation of the NA-MIC (Sonia Pujol)
- 8:45-9:15 Open-source software for Medical Image Computing and Computer Assisted Interventions (Steve Pieper): An introduction to CTK
- 9:15-9:45 Rapid prototyping of US-guided needle placement applications (Gabor Fichtinger)
- 9:45-10:15 Device integration for Image-Guided Therapy (Noby Hata)
- 10:15-10:30 Coffee-Break
- 10:30-11:45 Hands-on 3D Slicer session: Neurosurgical Planning Tutorial (Sonia Pujol)
- 11:45-12:00 The DTI Tractography Challenge for Neurosurgery (Sonia Pujol)
- 12:00-13:00 Lunch break
- 13:00-13:30 Introduction to the Medical Imaging Interaction Toolkit (Marco Nolden)
- 13:30-14:00 Demonstration of the MITK Workbench (Andreas Fetzer)
- 14:00-14:20 Interoperability and extension mechanisms in CTK (Sascha Zelzer)
- 14:20-15:00 Image-guided therapy within MITK: Tracking-based app imaging support and ultrasound navigation (Alexander Seitel)
- 15:00-15:30 Coffee break
- 15:30-16:15 Demonstration of IGT applications (Alexander Seitel and Gabor Fichtinger)
- 16:15-17:00 Extending the MITK Workbench: CTK Plugin generator (Sascha Zelzer)



June 26-29, 2013
Heidelberg, Germany

CARS 2013

Computer Assisted Radiology and Surgery
27th International Congress and Exhibition



Joint MITK-Slicer event

NA-MIC Workshop Faculty:

- Sonia Pujol
- Steve Pieper
- Gabor Fichtinger



European Congress of Radiology (ECR 2013, Vienna)



- Oral sessions & IMAGINE session Demos
- « The 3DSlicer open-source platform for segmentation, registration, quantitative imaging and 3D visualization of biomedical image data. » Sonia Pujol, Ph.D
- « SlicerRT – 3D Slicer based open-source toolkit for radiation therapy research ». Csaba Pinter, M.Sc.



RSNA 2013, Chicago



- RSNA 2013: 75,000 participants
- Joint NA-MIC/NAC/NCIGT week-long series of events





1-week long series of events at RSNA 2013

Sunday, December 1	Monday, December 2	Tuesday, December 3	Wednesday, December 4	Thursday, December 5	Friday, December 6
<p>8:00am-11:00am: 3D Slicer Exhibit: Quantitative Imaging Reading Room. ☞ Lakeside Learning Center Hall E, Exhibit LL-QRR3007.</p>	<p>8:00am-11:00am: 3D Slicer Exhibit: Quantitative Imaging Reading Room. ☞ Lakeside Learning Center Hall E, Exhibit LL-QRR3007.</p>	<p>8:00am-11:00am: 3D Slicer Exhibit: Quantitative Imaging Reading Room. ☞ Lakeside Learning Center Hall E, Exhibit LL-QRR3007.</p>	<p>8:00am-12:15pm: 3D Slicer Exhibit: Quantitative Imaging Reading Room. ☞ Lakeside Learning Center Hall E, Exhibit LL-QRR3007.</p>	<p>8:00am-12:15pm: 3D Slicer Exhibit: Quantitative Imaging Reading Room. ☞ Lakeside Learning Center Hall E, Exhibit LL-QRR3007.</p>	
<p>11:00am-12:30pm: RSNA Refresher Course: "Quantitative Medical Imaging for Clinical Research and Practice: Hands-on Workshop." ☞ Sonia Pujol, Katarzyna Macura, Ron Kikinis Room S401CD.</p>	<p>12:15pm-1:15pm: Meet-The-Experts Session ☞, 3D Slicer Exhibit: Quantitative Imaging Reading Room. ☞ Lakeside Learning Center Hall E, Exhibit LL-QRR3007.</p>	<p>12:30pm-2:00pm: RSNA Refresher Course: "3D Interactive Visualization of DICOM Images for Radiology Applications: Hands-on Workshop." ☞ Sonia Pujol, Kitt Shaffer, Ron Kikinis Room S401CD.</p>	<p>12:15pm-1:15pm: Meet-The-Experts Session ☞, 3D Slicer Exhibit: Quantitative Imaging Reading Room. ☞ Lakeside Learning Center Hall E, Exhibit LL-QRR3007.</p>	<p>12:15pm-1:15pm: 3D Slicer Exhibit: Quantitative Imaging Reading Room. ☞ Lakeside Learning Center Hall E, Exhibit LL-QRR3007.</p>	<p>8:00am-12:45pm: 3D Slicer Exhibit: Quantitative Imaging Reading Room. ☞ Lakeside Learning Center Hall E, Exhibit LL-QRR3007.</p>
<p>12:30pm-1:30pm: Meet-The-Experts Session ☞, 3D Slicer Exhibit: Quantitative Imaging Reading Room. ☞ Lakeside Learning Center Hall E, Exhibit LL-QRR3007.</p>	<p>1:15pm-6:00pm: 3D Slicer Exhibit: Quantitative Imaging Reading Room. ☞ Lakeside Learning Center Hall E, Exhibit LL-QRR3007.</p>	<p>12:15pm-1:15pm: Meet-The-Experts Session ☞, 3D Slicer Exhibit: Quantitative Imaging Reading Room. ☞ Lakeside Learning Center Hall E, Exhibit LL-QRR3007. -- 1:15pm-6:00pm: 3D Slicer Exhibit: Quantitative Imaging Reading Room. ☞ Lakeside Learning Center Hall E, Exhibit LL-QRR3007.</p>	<p>1:15pm-6:00pm: 3D Slicer Exhibit: Quantitative Imaging Reading Room. ☞ Lakeside Learning Center Hall E, Exhibit LL-QRR3007.</p>	<p>1:15pm-6:00pm: 3D Slicer Exhibit: Quantitative Imaging Reading Room. ☞ Lakeside Learning Center Hall E, Exhibit LL-QRR3007.</p>	
<p>1:30pm-6:00pm: 3D Slicer Exhibit: Quantitative Imaging Reading Room. ☞ Lakeside Learning Center Hall E, Exhibit LL-QRR3007.</p>					



Quantitative Imaging Reading Room Exhibit

RSNA2013 Quantitative Imaging Reading Room



The 3D Slicer Open Source Software Platform for Segmentation, Registration, Quantitative Imaging, and 3D Visualization of Multi-Modal Image Data

Sonia Pujol, Ph.D., Steve Pieper, Ph.D., Andriy Fedorov, Ph.D., Ron Kikinis, M.D.



About 3D Slicer

3D Slicer is a multi-platform, free, open source and extensible software package for visualization and medical image computing. The software platform is community created for the purpose of subject specific medical image analysis and visualization.

- Multi-modality imaging including, MRI, CT, US, nuclear medicine, and microscopy
- Multi organ from head to toe
- Bidirectional interface for devices
- Expandable and interfaced to multiple toolkits



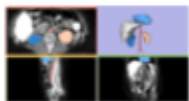
History: Slicer was initiated as a Readers thesis project between the Surgical Planning Laboratory at the Brigham and Women's Hospital and the MIT Artificial Intelligence Laboratory in 1996. Slicer has been downloaded over 100,000 thousand times worldwide. A variety of publications were authored by the Slicer authors. A new, completely re-architected version of Slicer was developed and released in 2007. Subsequently, version 3.2 was released in May of 2008, version 3.4 was released in May of 2009, version 3.6 of Slicer was released in November of 2010, version 4.0 was released in November of 2011, version 4.1 was released in June of 2012, version 4.2 was released in November 2012. The newest version of Slicer is version 4.3.

Licensing: Slicer executables and source code are available under a BSD-style, free open source licensing agreement under which there are no reciprocity requirements, no restrictions on use, and no guarantees of performance. Slicer leverages a variety of toolkits and software mechanisms that have been licensed under the MIT license. For more information, please visit http://www.slicer.org/wiki/About_Slicer

Disclaimer: 3D Slicer is not FDA approved or CE marked, and is for research use only.

Segmentation & Registration

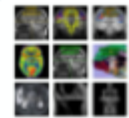
Segmentation is required for defining features of interest in imaging data for quantification and analysis.



- 3D Slicer has a variety of interactive and automated segmentation methods:
- support for manual contouring and editing
 - region growing and level sets
 - graph cuts with gesture support
 - skull stripping and hierarchical brain segmentation for morphological studies
- The desktop application provides interactive visualization of the results and an intuitive GUI.

Timeseries analysis and multi-subject analysis require good registration of imaging data acquired at different times, on different scanners, and across modalities.

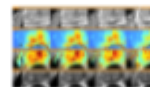
- Slicer also provides a variety of registration methods and resources to support versatile applications:
- Deformation models: rigid, affine, non-rigid, fluid
 - Algorithm types: fiducial, surface-, intensity-based
 - Image types: scalar, vector, tensor



For more information, please visit <http://www.slicer.org/wiki/Registration>

Multi-modality Visualization

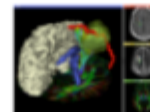
A combined visualization of multiple imaging modalities and derived data can provide clinician scientists with an integrated understanding of anatomy and pathology.



3D Slicer offers a suite of layouts and the ability to visualize many types of data including:

- grayscale volumetric data
- parametric maps and VQEs
- surface models & plots
- measurement tools & annotations
- tracking devices

Fast raw hardware accelerated volume rendering is available in 3D Slicer version 4.2



Advanced visualization capabilities are available in 3D Slicer version 4.2. Hardware accelerated volume rendering requires video drivers, and is available on Windows and Linux only.



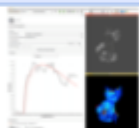
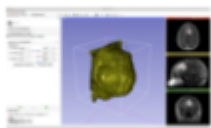
3D Slicer version 4.2. New raw hardware accelerated volume rendering is available in 3D Slicer version 4.2. Hardware accelerated volume rendering requires video drivers, and is available on Windows and Linux only.

Quantitative Analysis

Many hundreds of imaging biomarkers are used in clinical practice, drug discovery and development. A free and open source platform can improve access to standard methods of image quantification and rapidly translate experimental methods into the clinical research setting for validation and refinement.

3D Slicer includes tools to quantify:

- PET/CT studies (SUV body weight)
- Tumor growth (experimental)
- Tumor response to treatment (measurements for ADC/DT)
- DCE-MRI (pharmacokinetics)



Clinical Research Applications

3D Slicer has been used in clinical research, with IRB clinical protocols appropriately created and managed. In image-guided therapy (IGT) research, Slicer is frequently used to construct and visualize collections of MRI data that are available pre- and intra-operatively, and to display the tracked spatial position of surgical instruments.

Image Guided Neurosurgery

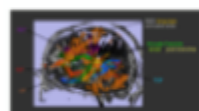
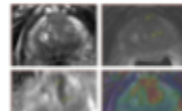


Image Guided Neurosurgery (IGNS) is a minimally-invasive approach to brain surgery. It involves the use of pre-operative imaging to plan and guide the surgical approach. Slicer is used to visualize the patient's anatomy and the surgical instruments in real-time.

MRI-Guided Prostate Cancer Biopsy



MRI-Guided Prostate Cancer Biopsy (MPCB) is a minimally-invasive approach to prostate cancer diagnosis. It involves the use of pre-operative MRI to plan and guide the biopsy approach. Slicer is used to visualize the patient's anatomy and the biopsy instruments in real-time.

Community, Learning & Support

To support user and developer communities and the effective translation of tools into the clinical research setting, the 3D Slicer Project provides many outreach materials and activities including:

- Slicer Hands-on Training Workshops
- Slicer Tutorial Materials & datasets
- Slicer Reference Style Documentation
- Slicer mailing lists
- Project week events for Developers





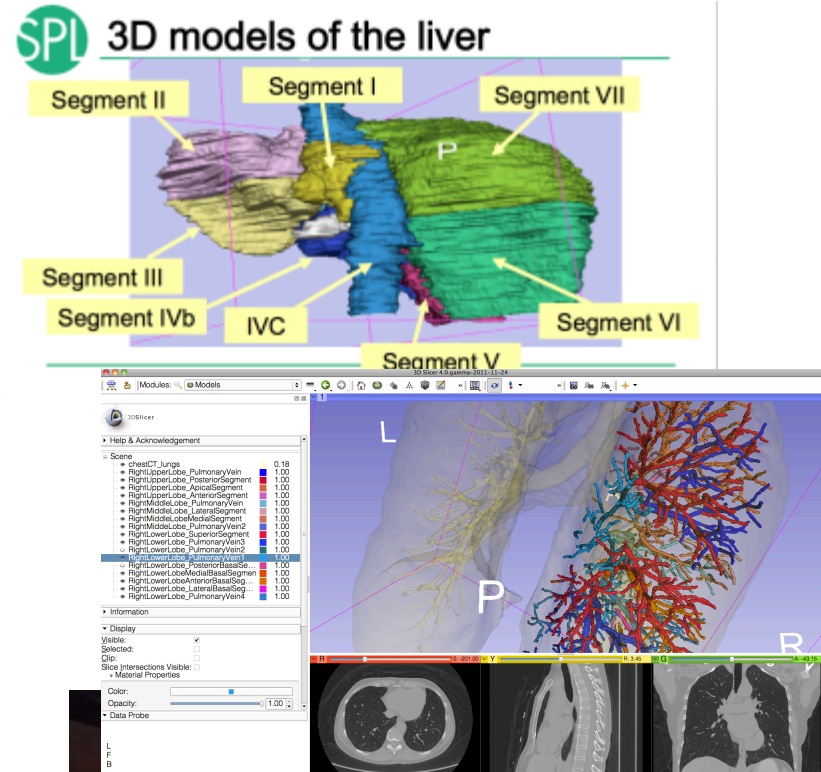
RSNA 3D Visualization Course

3D interactive visualization of liver & lung segments

6th edition (RSNA 2008, 2009, 2010, 2011, 2012, 2013)

Course Instructors:

- Dr. Kitt Shaffer, MD, PhD, Vice Chairman for Radiology Research, BU Medical Center
- Sonia Pujol, Ph.D., BWH





RSNA Quantitative Imaging Course

Measurements of small volumetric changes in slow growing tumors, and quantitative imaging analysis of FDG-PET/CT data *5th edition (RSNA 2009, 2010, 2011, 2012, 2013)*

Course Instructors:

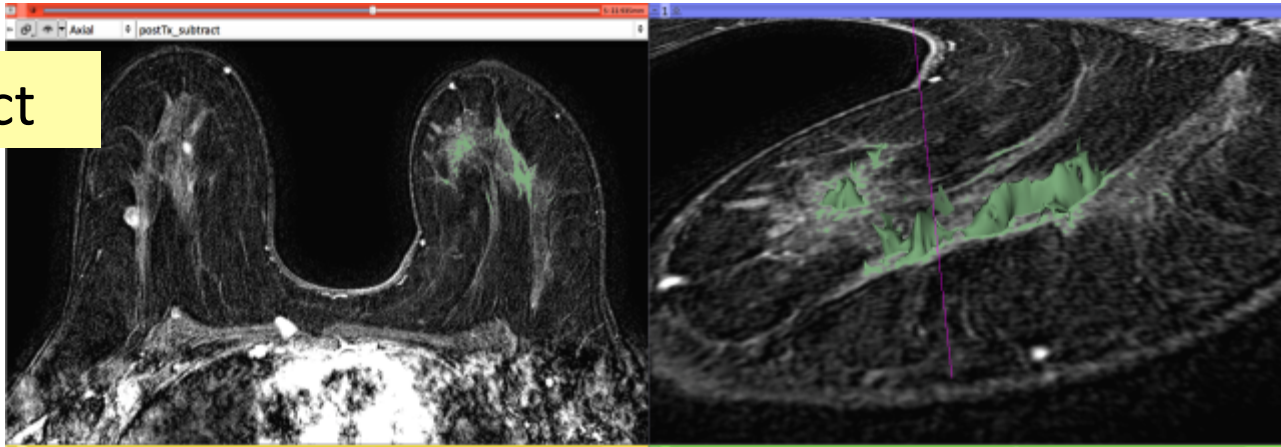
- Katarzyna Macura, MD, PhD, JHU
- Sonia Pujol, Ph.D., BWH



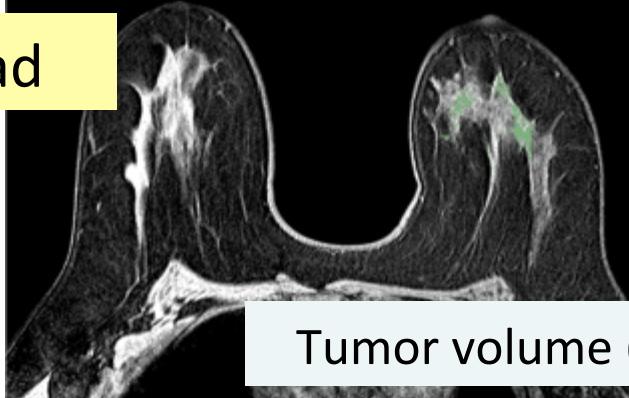


RSNA Quantitative Imaging Course: Breast Tumor Case

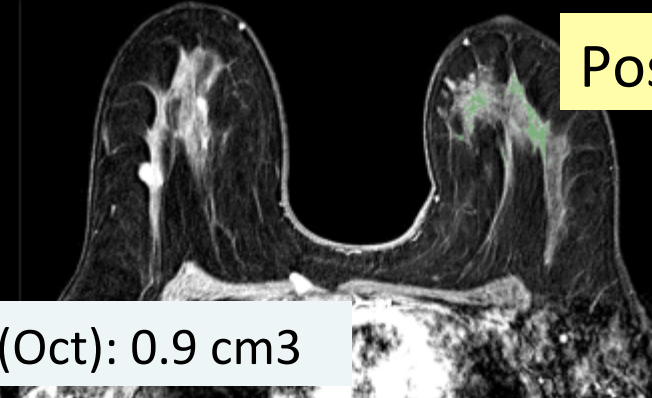
Subtract



Pre-Gad



Post-Gad



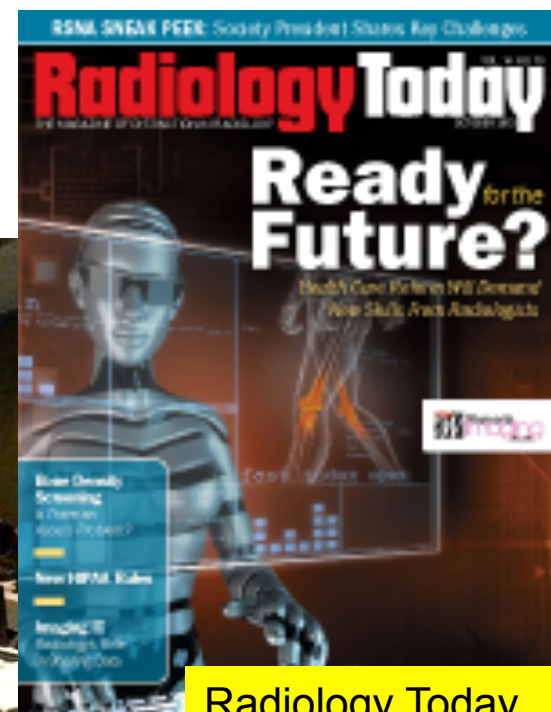
Tumor volume (Oct): 0.9 cm³



RSNA Quantitative Imaging Course

The "Quantitative Medical Imaging for Clinical Research and Practice" course (Pujol, Macura, Kikinis) has been selected by Radiology Today in [*"Challenges and Opportunities - A Sneak Peek at RSNA 2013 With Views From President Sarah S. Donaldson, MD" Radiology Today Vol. 14 No. 10 P. 24 »*](#)

Categories: **Finance and Support Research in Radiologic Science'** and **'Promote and Advance Precision Radiology without Increasing Costs'**



Radiology Today
Citation



RSNA 2013

Register Online at
RSNA.org/Register

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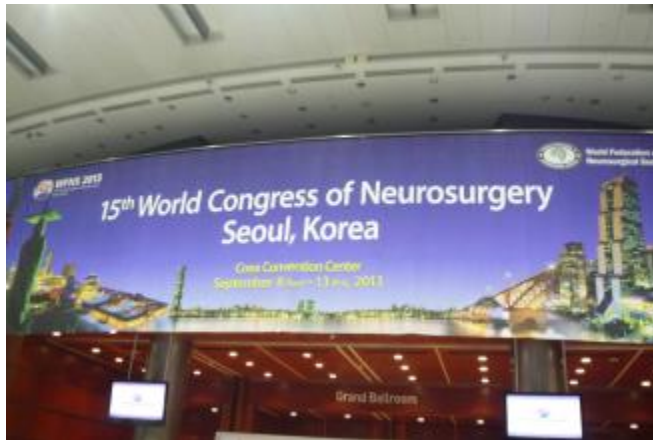


National Alliance for Medical Image Computing
<http://na-mic.org>

**Slicer Course on RSNA
2013 postcard**



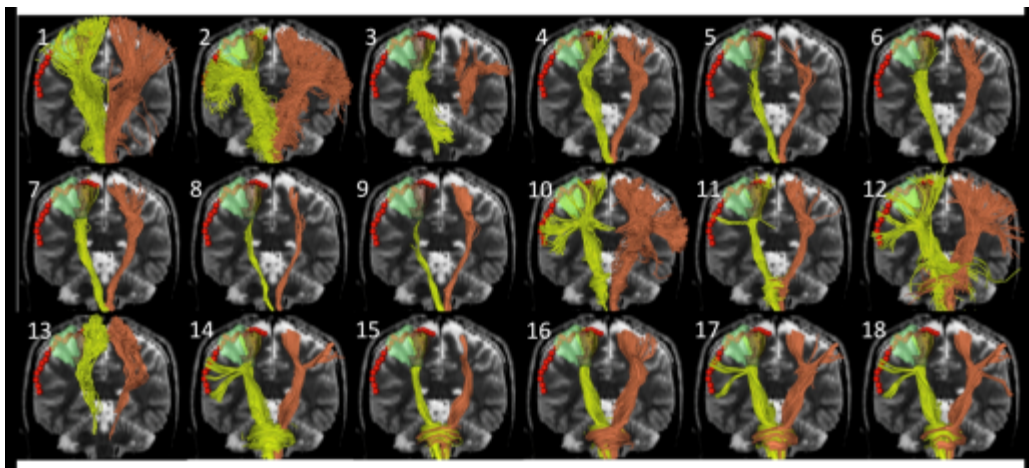
World Congress of Neurosurgery 2013



Towards Validation of DiffusionTensor Imaging Tractography for Neurosurgical Planning: The MICCAI DTI Tractography Challenge,

Sonia Pujol, Alexandra Golby, Guido Gerig, Carl-Fredrik Westin, Martin Styner, William Wells, Sylvain Gouttard, Carlo Pierpaoli, Arya Nabavi, Ron Kikinis

Brain Mapping and Intraoperative Imaging II, Sept.11, WFNS 2013, Oral presentation





World Congress of Neurosurgery 2013

Invited lectures:

Non-invasive Brain Mapping using Diffusion MRI Tractography, Sonia Pujol

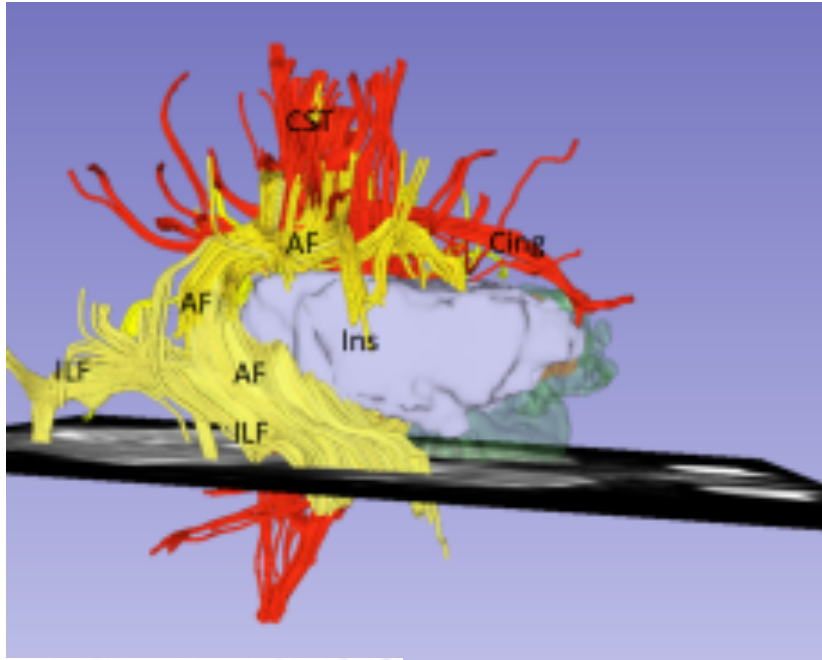
Role of Brain Mapping for Neurosurgery, Sept.11

WFNS 2013, Invited lecture

Preoperative Planning of Insular Gliomas Resection Using Multimodal MRI, Sonia Pujol

Insular Gliomas: From Anatomy to Management,

WFNS 2013, Invited lecture



*(Thanks to
Nikos Makris,
MD)*



WFNS 2013

XV WFNS World Congress of Neurosurgery
Seoul, Korea - 2013

alliance for Medical Image Computing

<http://na-mic.org>



NA-MIC Training Core International Collaborations

Dr. Marc Dhenain,
Paris, France:
**Alzheimer's
Disease**

Dr. Xiaolei Chen, PLA General
Hospital, Beijing, China:
Neurosurgical Planning

Dr. Adriana Vilchis
Gonzales and Dr.
Juan Carlos Avila
Vilchis, Mexico City,
Mexico: **Biomedical
Engineering
education**

Dr. Rie Oyama,
Iwate, Japan:
Fetal Imaging

Dr. Tom Cai, Sydney,
Australia: **DTI analysis**



NA-MIC Invited Workshop in Iwate



Invited 2-day event:
**Image-Guided Therapy
Research using Open
Source Free Software
3D Slicer**



Workshops Faculty

- Sonia Pujol, BWH
- Ron Kikinis, BWH
- Noby Hata, BWH
- Rie Oyama, Iwate University



NA-MIC Collaboration with Iwate University, Japan

Ultrasound Obstet Gynecol 2013; 42: 609–610
Published online 2 October 2013 in Wiley Online Library (wileyonlinelibrary.com). DOI: 10.1002/uog.12484

Picture of the Month

Towards improved ultrasound-based analysis and 3D visualization of the fetal brain using the 3D Slicer

R. OYAMA*, M. JAKAB†, A. KIKUCHI*, T. SUGIYAMA*, R. KIKINIS† and S. PUJOL†

*Iwate Medical University, Department of Obstetrics and Gynecology, Morioka, Japan; †Harvard Medical School, Brigham and Women's Hospital, Department of Radiology, Boston, MA, USA

Magnetic resonance imaging (MRI) provides useful three-dimensional (3D) information; however, there are some restrictions on its use during pregnancy due to safety concerns. In addition, fetal movements can create artifacts on MR images, as image quality depends on position of the fetus and placenta. In the past decade, 3D ultrasound imaging has been used in clinical practice to investigate the formation and volumetric size of critical anatomical structures of the fetus. However, current techniques rely mainly on analysis of sections of interest that do not integrate anatomical information concerning the shape of these structures.



Step 1: Import raw ultrasound DICOM data into 3D Slicer



Step 2.1: Outline the organs with different colors

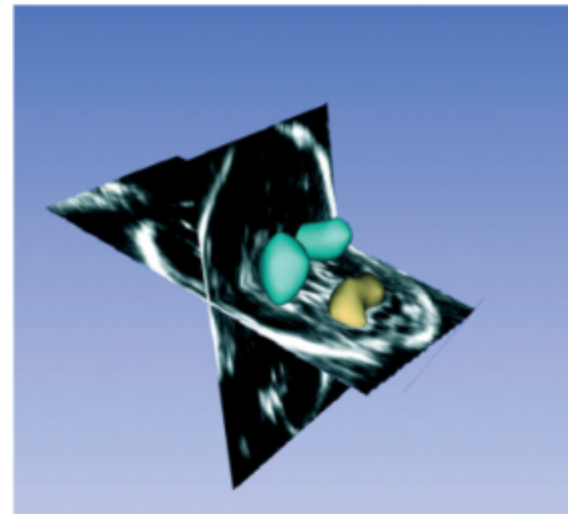


Figure 2 Result of 'Grow Cut Segmentation' of the fetal brain using the 3D Slicer. The blue structure represents the choroid plexus, and



Rie Oyama, MD

- 2010: Slicer RSNA Course
- 2012-2013: One-Year research visit at SPL
- 2013: *Ultrasound in Obstetrics and Gynecology* Journal Paper
- 2013: Iwate Workshop



NA-MIC Invited Workshop in Tokyo

Tokyo 2013 Training

Contents [show]

English Page

Objective:

The purpose of this workshop is to introduce Slicer 4 in Japanese image processing community and invited them to participate in Open Source software effort within medical image processing community. The learning objective of the workshop is to 1) understand the basic usage of 3D Slicer version 4, (2) perform image segmentation in Slicer 4, (3) learn how to use Slicer in image-guided therapies. The targetted audience is scientists and graduate students in medical image processing and image guided surgery.

Dates and Location:

- Date: Tuesday 4/9/2013
- Location: AZE, Tokyo Office

日本語ページ

目的

このコースは、オープンソースソフトウェア3D Slicer のバージョン4について国内で始めて行うチュートリアルです。新しいSlicerを活用して画像誘導手術シミュレーション、ナビゲーション、医用画像処理について体験講義を行うことを目的としています。通常の講義とは異なり、実際に自分のパソコンにソフトウェアをダウンロードして、臨床で用いられている画像データを使いながら、直接「手」で先端研究を感じてもらうことがコースの目的です。コースで使用するソフトウェアは無償でプログラムソースコードが公開されており、コース終了後はこのソフトウェアを中心に研究を展開することができます。この展開方法についてもコース内で触れます。ハンズオンセミナーの質をあげるため、受講者の人数を制限し受講者に対する講師陣の人数を限りなく多くするようにとりはかっています。

Invited Workshop:

Faculty:

- Sonia Pujol, BWH
- Ron Kikinis, BWH
- Noby Hata, BWH
- AZE R&D Boston Karl Diedrich, PhD
- AZE R&D Boston

Audience: 31 engineers



Neurosurgeons: PLA General Hospital



One-day hand-on slicer training workshop on neurosurgical planning

Faculty:

Sonia Pujol, Ph.D.

Ron Kikinis, MD

Steve Pieper, PhD



Invited NA-MIC seminar First Hospital of Jilin University, Changchun, China



NA-MIC Faculty:
Ron Kikinis, MD
Sonia Pujol, Ph.D.
Steve Pieper, PhD



Dissemination Update

16th Project Week: Salt Lake City, Utah, January 2013

- 80 attendees: 17 academic institutions, 4 companies
- 54 Projects: TBI, Atrial Fibrillation, Slicer 4 Extensions, Huntington's Disease, Head and Neck Cancer, Stroke, IGT, Radiation Therapy, Medical Robotics, Infrastructure Engineering

17th Project Week: MIT, Summer June 2013

- 104 attendees: 22 academic institutions, 13 companies
- 75 Projects: Huntington's Disease, TBI, Atrial Fibrillation and Cardiac Image Analysis, Radiation Therapy, IGT and Device Integration with 3D Slicer, COPD, and Infrastructure Engineering

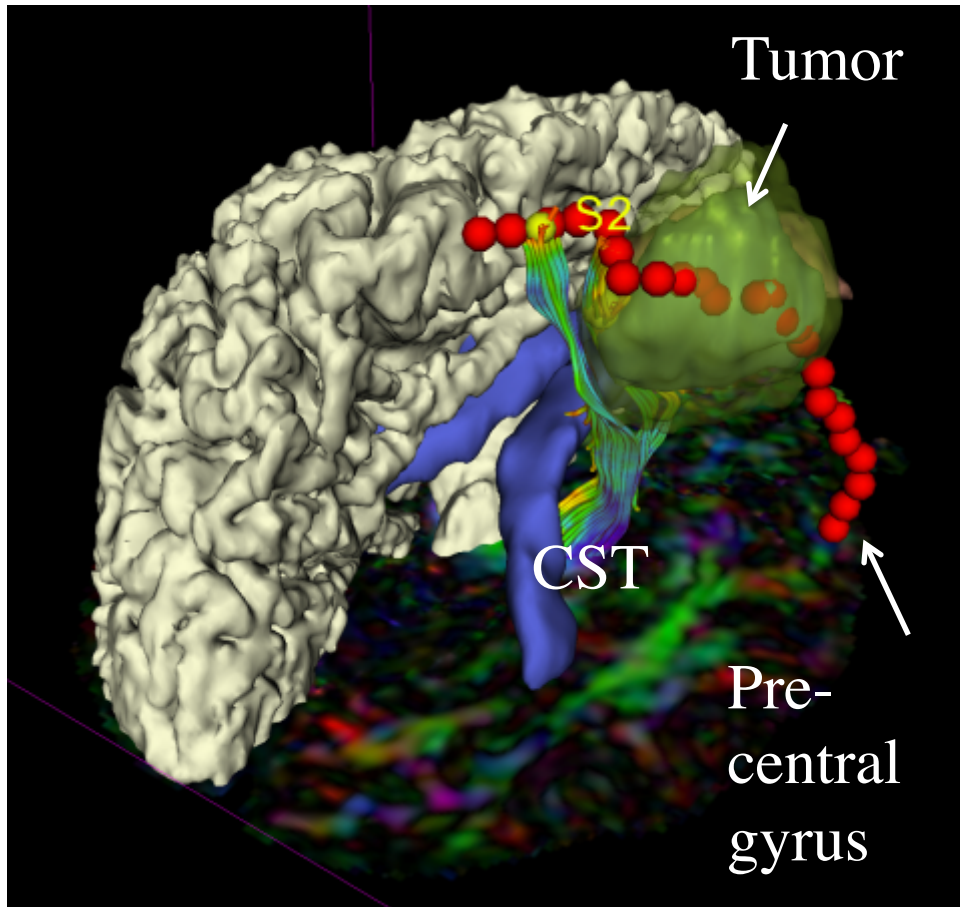




Validation Update Effort: the MICCAI DTI Challenge



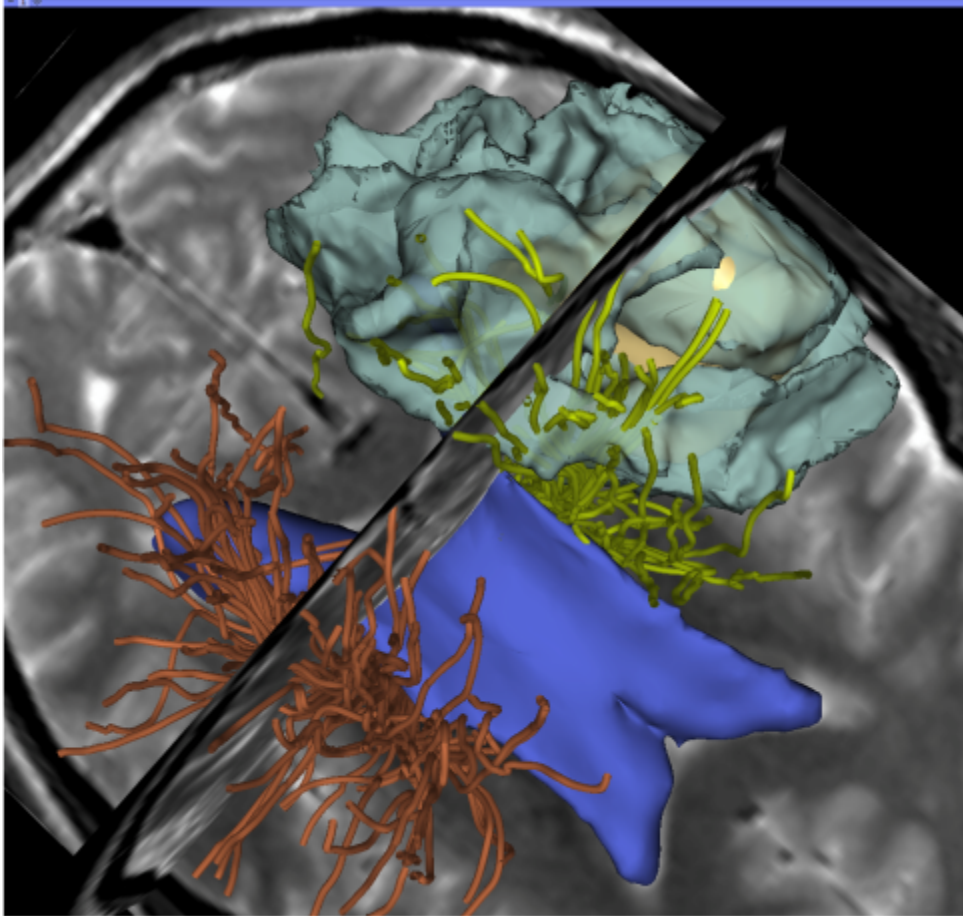
DTI for Neurosurgery: Capabilities



- Non-invasive 3D visualization of peritumoral white matter pathways
- Spatial relationship of a tumor with tracts involved in motor, visual or language function
- Spatial relationship between the tracts and eloquent cortex



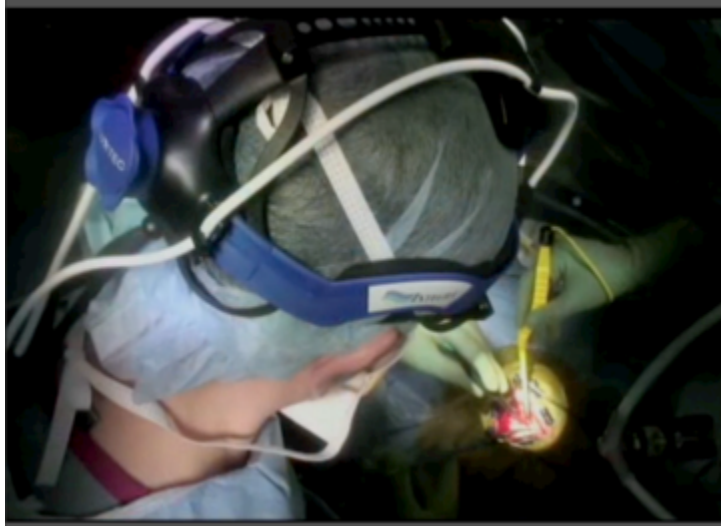
DTI Tractography for neurosurgery: Current Limitations



- Diffusion properties can be affected by the presence of a lesion or edema
- Crossing fibers areas are challenging (e.g. centrum semi-ovale)
- Brain shift issue as with any pre-op imaging modality



Potential impact of tractography errors on neurosurgical outcomes



False-negative tracts:

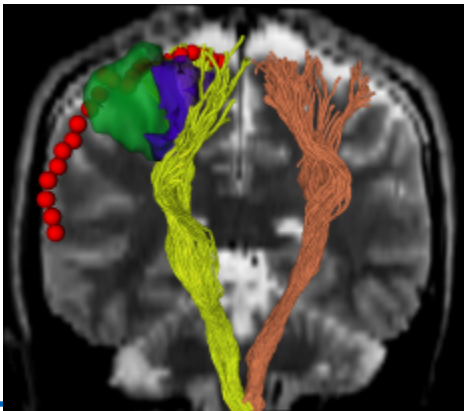
→ risk of postoperative neurological deficit

False-positive tracts

→ risk of incomplete resection

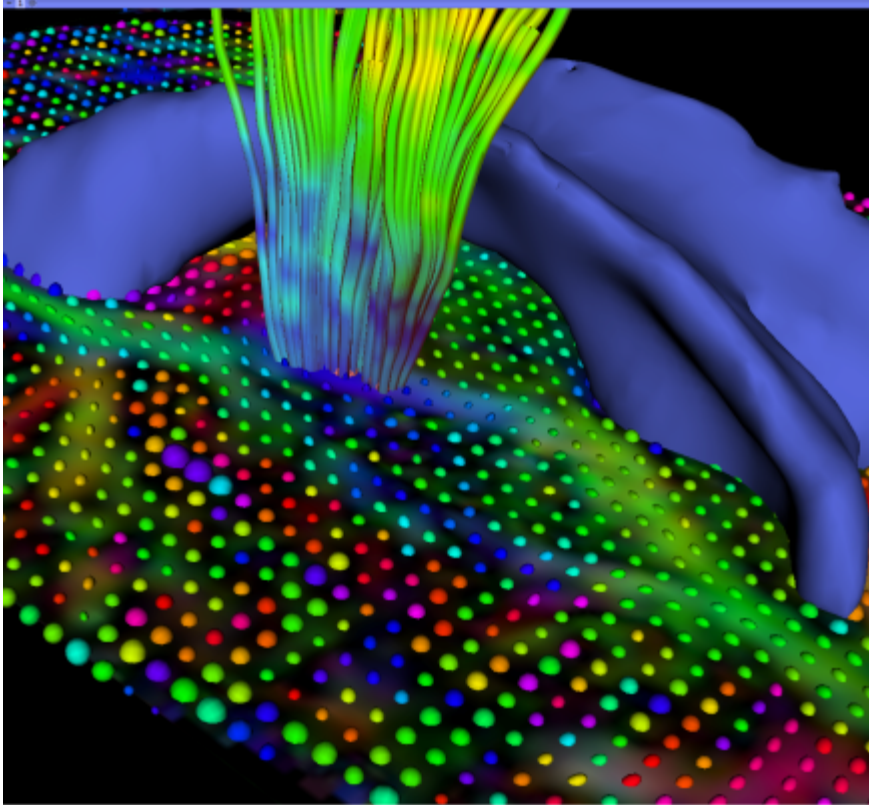
True positive tracts but not essential tracts:

→ risk of incomplete resection





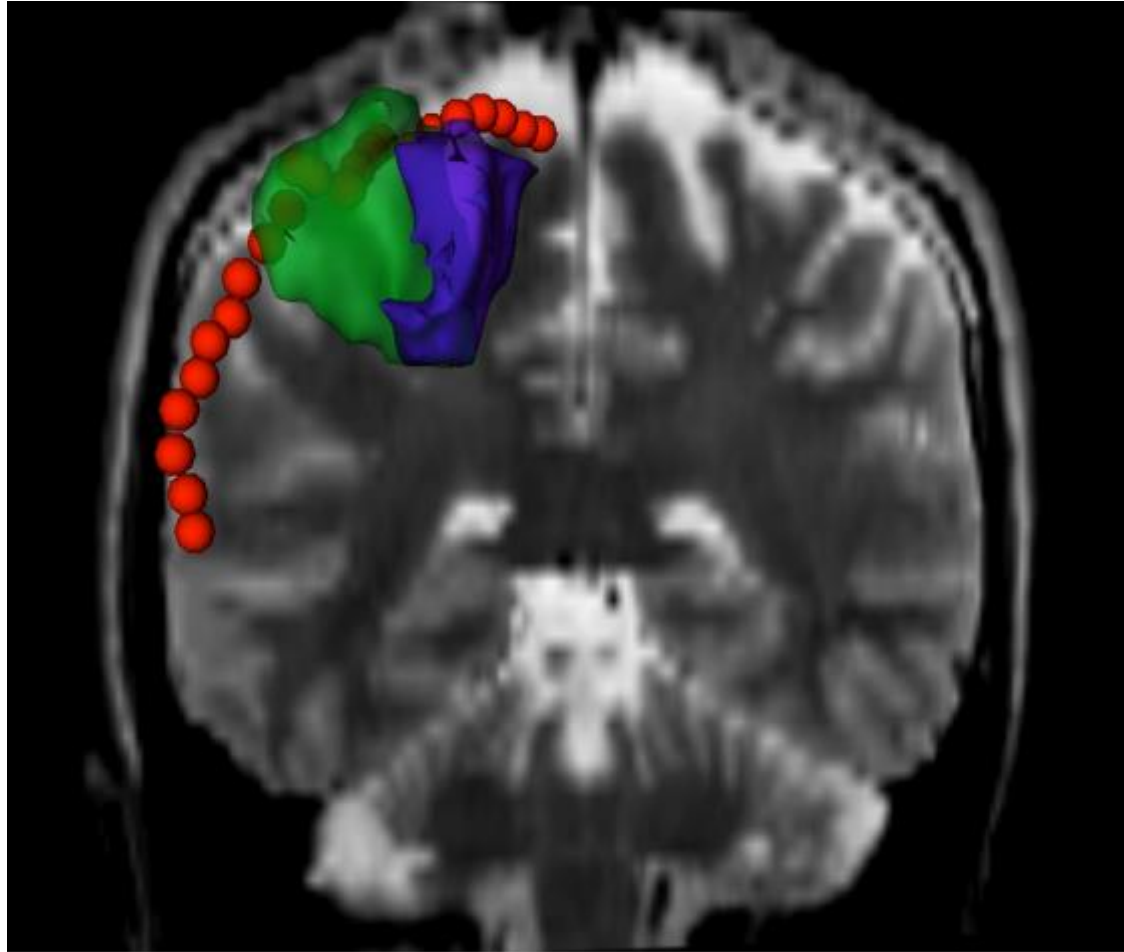
DTI Tractography research



The complexity of DTI data has fostered many exploratory activities in new computational approaches for tracing white matter pathways.

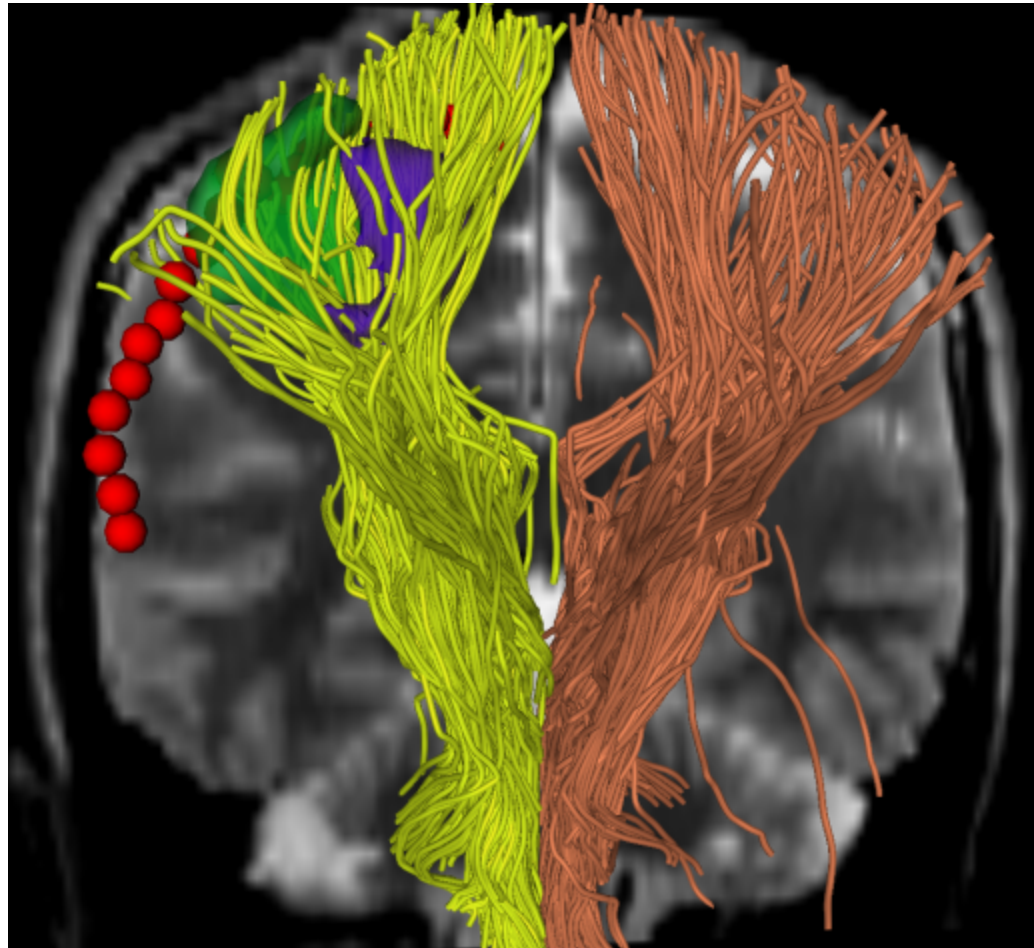


Clinical Case: 47 yo professional golfer



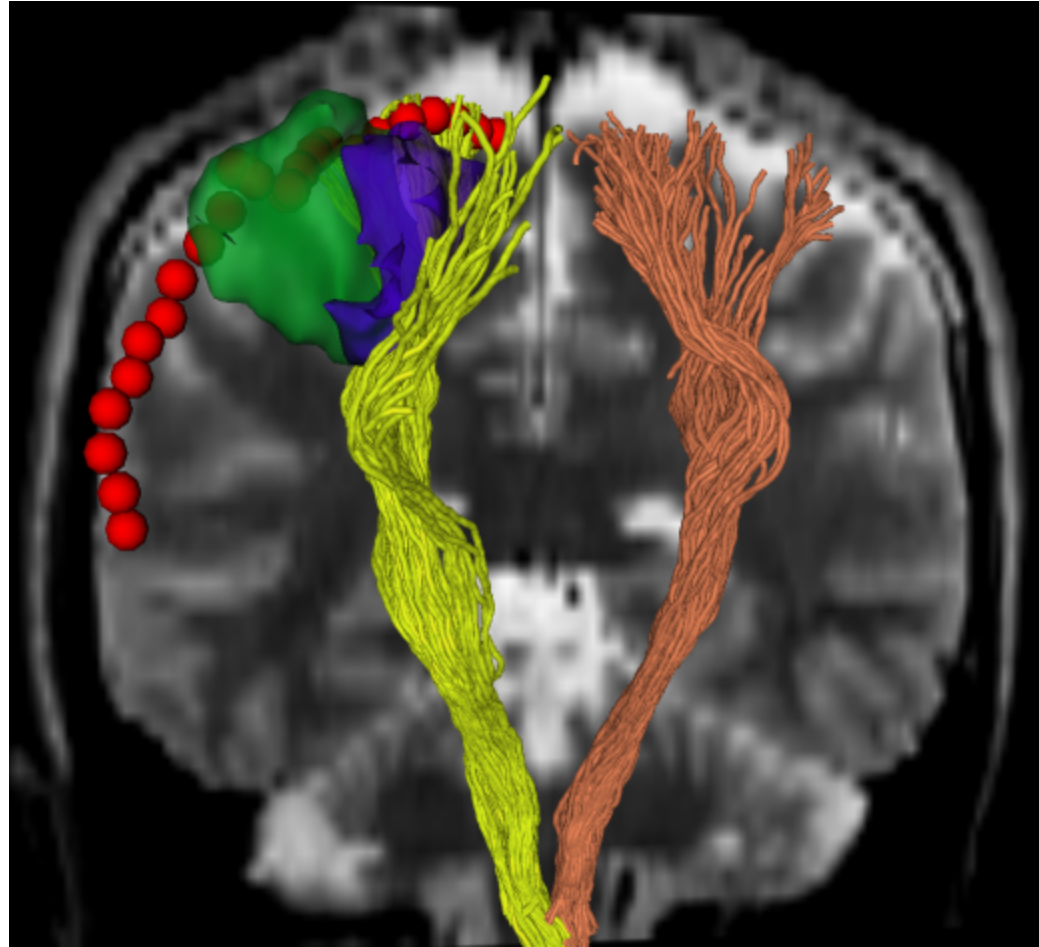


CST Reconstruction: Method #1



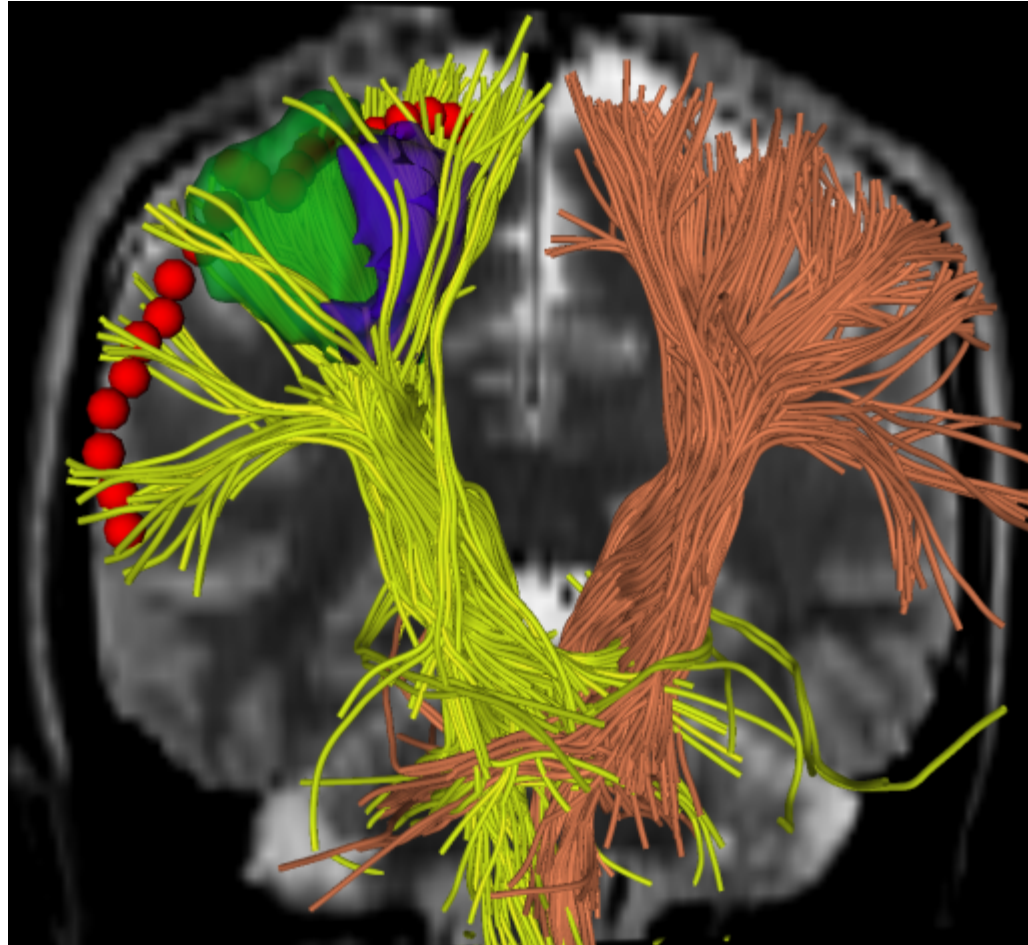


CST Reconstruction: Method #2



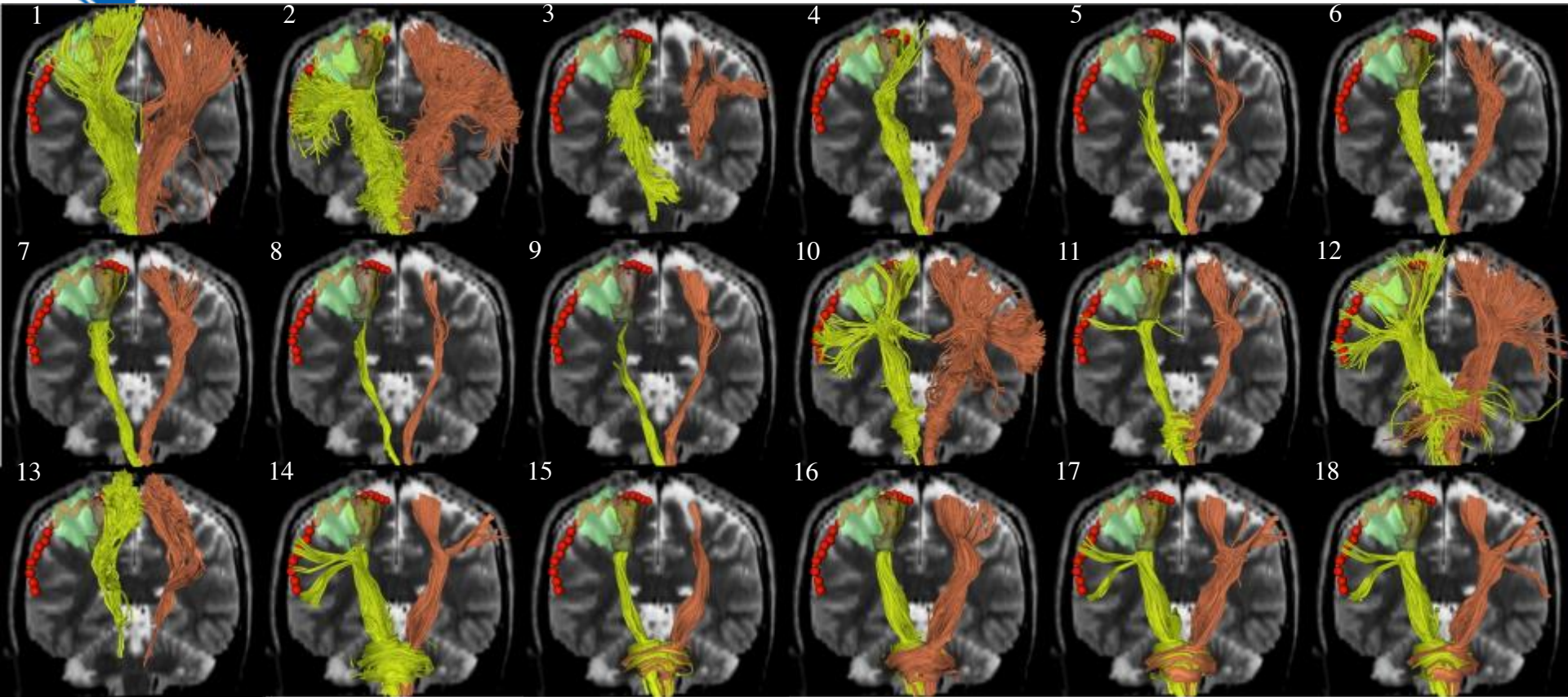


CST Reconstruction: Method #3





Corticospinal Tract 18 methods



Need for validation of DTI tractography findings

MICCAI 2012 DTI Challenge



DTI Challenge Project



Previous Editions

MICCAI 2012 DTI Tractography Challenge, Oct.1st, 2012, Nice, France (2nd Edition)

MICCAI 2011 DTI Tractography Challenge, Sept.18, 2011, Toronto, Canada (First Edition)



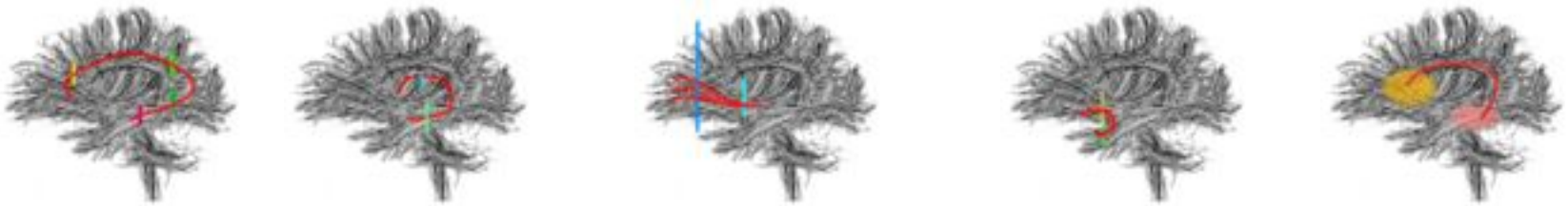
Goal:

- To define **standards** to evaluate tractography methods for **subject-specific analysis** and ascertain **quality features** for surgical guidance.



NA-MIC pilot initiative

- Exploratory work on validation of DTI tractography
- Cross-comparison of tractography algorithms on major white matter fascicles





DTI Challenge Working Group (MICCAI 2011, 2012 & 2013)

9 Research Scientists

Sonia Pujol, BWH (P.I)

Ron Kikinis, BWH

Guido Gerig, SCI Utah

Laurent Chauvin, BWH

Isaiah Norton, BWH

Martin Styner, UNC

CF Westin, BWH

William Wells, BWH

Carlo Pierpaoli, NIH

11 Neurosurgeons

Dr. Alexandra Golby, Boston, USA

Dr. Arya Nabavi, Kiel, Germany

Dr. Sandrine De Ribaupierre, London, Ontario, Canada

Dr. David Fortin, Sherbrooke, Canada

Dr. Francesco Cardinale, Milan, Italy

Dr. Xiaolei Chen, Beijing, China

Dr. Ye Li, Beijing, China

Dr. Hugues Duffau, Montpellier Hospital, France

Dr. Yoshihiro Muragaki, Tokyo, Japan

Dr. Luke Maczryn, Philadelphia, USA

Dr. Yasukazu Kajita, Nagoya, Japan

19 Tractography Groups

1. A. Khan, Robarts Research Institute, Toronto, Canada

2. C. Brun, UPenn, Philadelphia, USA

3. H. Johnson, University of Iowa, USA

4. O. Commonick, A. Stamm, INRIA Rennes, France

5. B. Vemuri, University of Florida, USA

6. G. Veni, SCI Institute, SLC, USA

7. A. Tristan-Vega, BWH-LMI, Boston, USA

8. P. Neher, German Cancer Research Centre, Germany

9. Y. Shi, UNC Chapel Hill, USA

10. X. Chen, PLA General Hospital, China

11. M. Tamura, Tokyo Women's Med. University, Japan

12. N. Gajawelli, Children's Hospital, Los Angeles, USA

13. Y. Masutani, The University of Tokyo Hospital, Japan

14. F. Cardinale, Hospitale Niguarda, Italy

15. G. Unal, Sabanci University, Turkey

16. S. Pathak, University of Pittsburgh, USA

17. M. Descoteaux, Sherbrooke University, Canada

18. R. Verma, Upenn, USA

19. J. Klein, Fraunhofer MEVIS, Germany



DTI Challenge Working Group (2011-2013)

Special thanks to Junichi Tokuda for help with website design



DTI Challenge 3rd Edition
MICCAI 2013
Nagoya, Japan



DTI Challenge 2nd Edition
MICCAI 2012
Nice, France



DTI Challenge 1st Edition
MICCAI 2011
Toronto, Canada

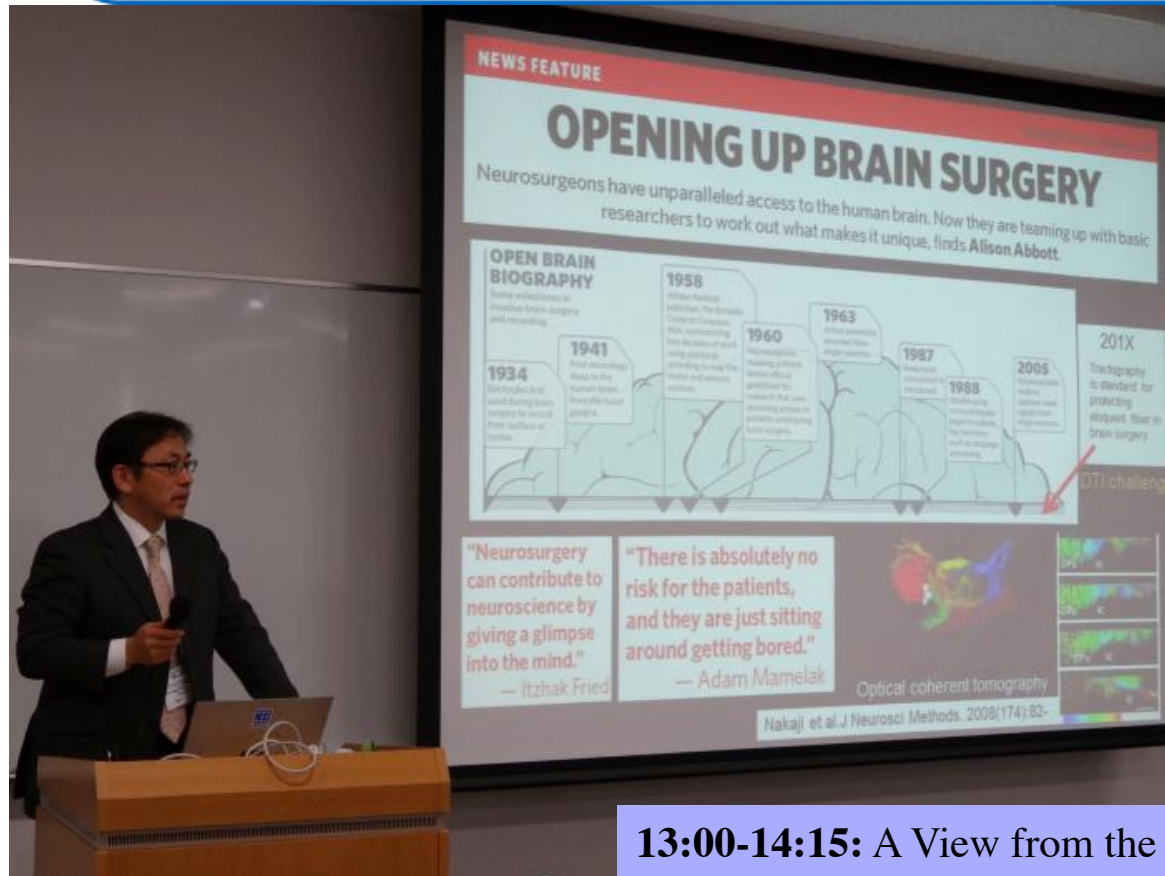
DTI Challenge 3rd Edition (MICCAI 2013, Nagoya, Japan, Sept. 22, 2013)



10 teams – 10 neurosurgeons



DTI Challenge 3rd Edition (MICCAI 2013, Nagoya, Japan, Sept. 22, 2013)



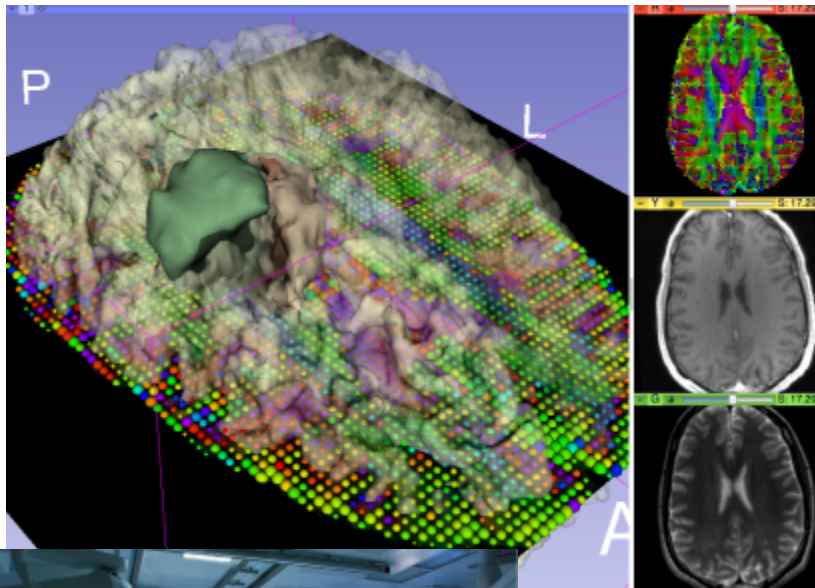
**10 neurosurgeons
10 tractography teams**

13:00-14:15: A View from the Clinic: The Neurosurgeon's Perspective on DTI Tractography

- *Arya Nabavi M.D., Kiel, Germany*
- *Yoshihiro Muragaki M.D., Ph.D., Tokyo, Japan*
- *Luke Macyszyn, M.D. Philadelphia, USA*
- *Sandrine de Ribaupierre, M.D., London Ontario, Canada*



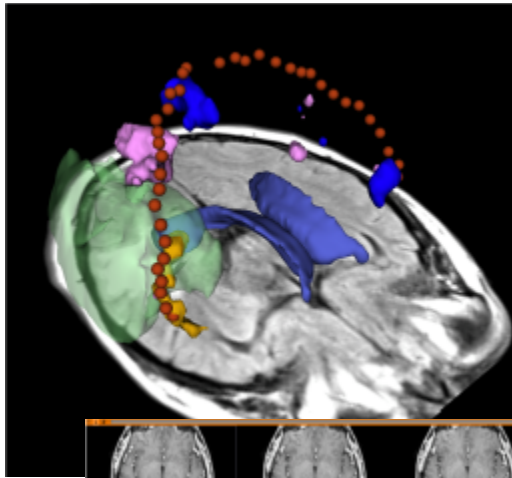
DTI Challenge Datasets



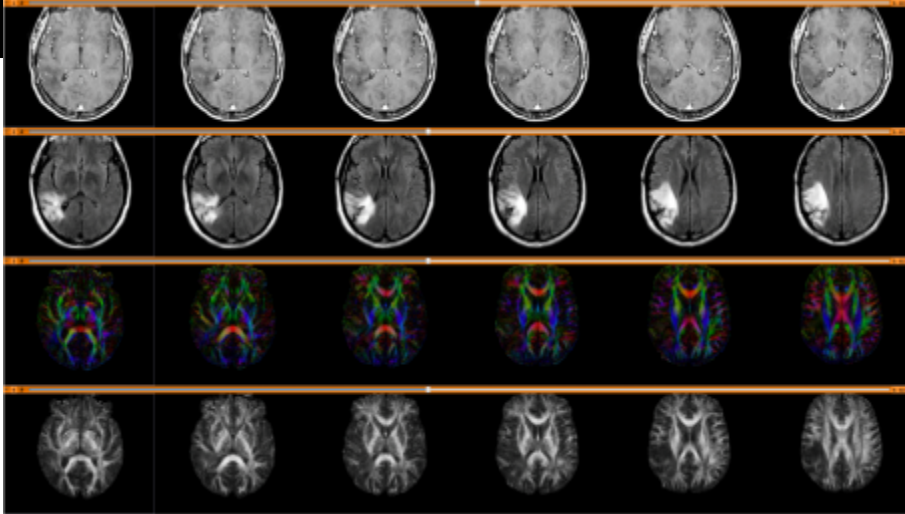
- Collaboration with NAC DBP4/NCIGT (LGG & HGG cases)
- T1, T2, pre-op and intra-op DWI anonymized scans from brain tumor patients operated on in the AMIGO suite
- Registration, manual segmentation and 3D modeling of tumor regions



Standardization effort using 3D Slicer



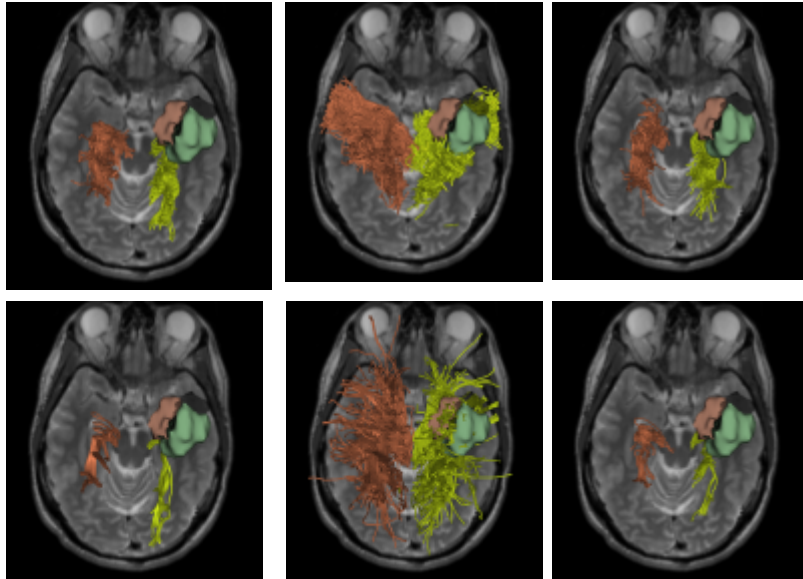
3D Slicer as a platform for technology comparison



MICCAI 2013 DTI Challenge



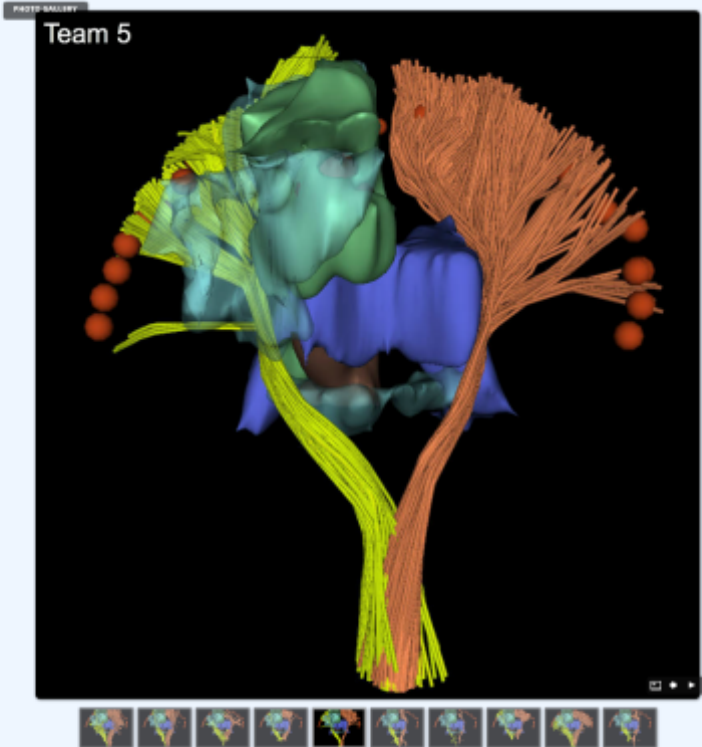
Evaluation of Tractography Results



- Standardized review by a panel of neurosurgeons and DTI experts
- Quantitative assessment of variability among methods



Standardized review questionnaire



Question 1: Please rate the anatomical correctness of the tractography reconstruction in the motor cortex area using a 1 to 5 answer.

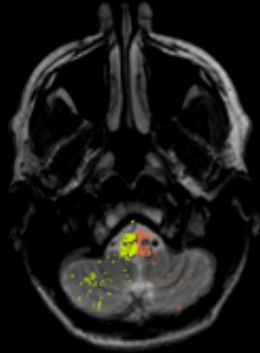
(1=Poor, 2=Fair, 3=Good, 4=Very Good, 5=Excellent)

	1	2	3	4	5
Team1	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Team2	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Team3	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Team4	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Team5	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Team6	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Team7	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Team8	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Team9	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Team10	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

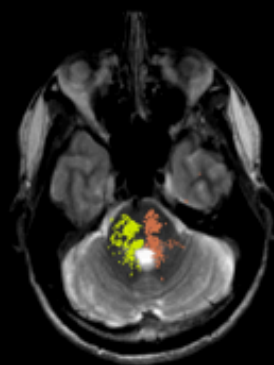


Clinical evaluation criteria

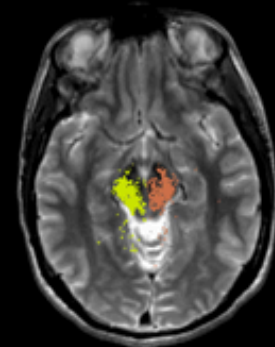
C1. Anatomical Correctness



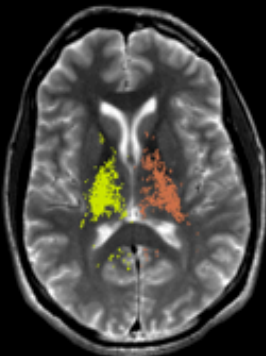
Pons



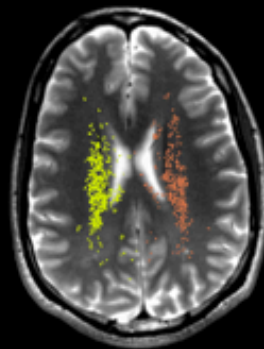
Medulla



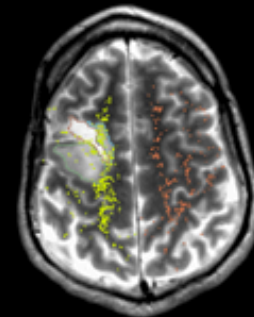
Cerebral peduncles



Internal Capsule



Corona Radiata

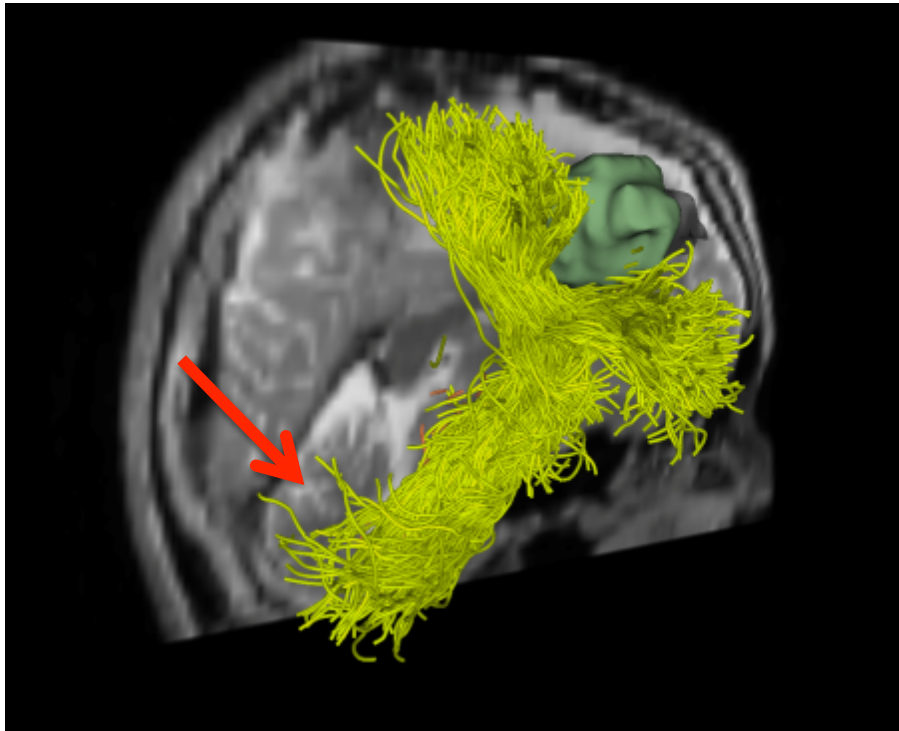


Motor Cortex

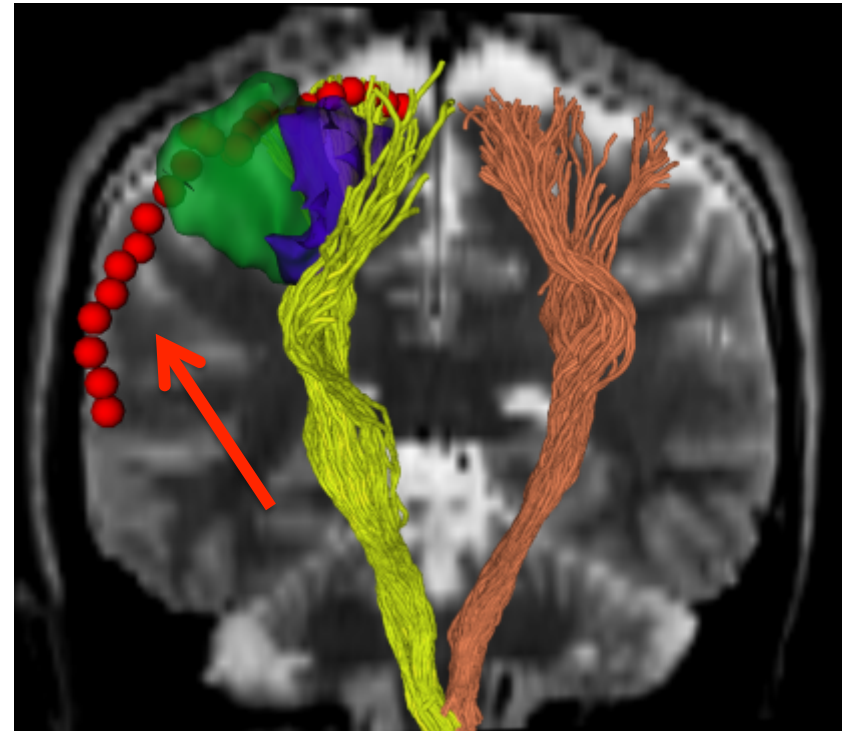


Clinical evaluation criteria

C2. False-positive tracts



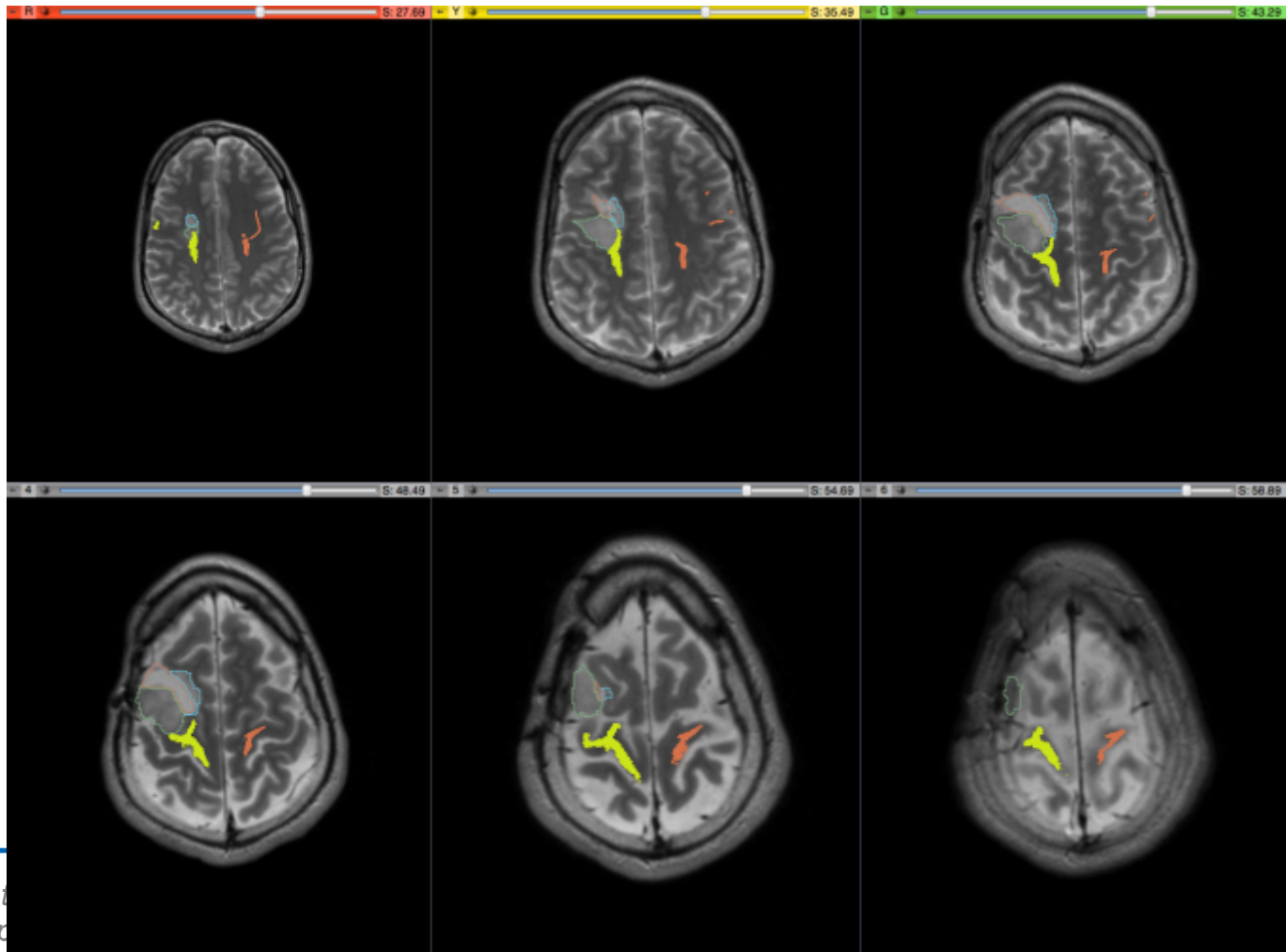
C3. False-negative tracts





Clinical evaluation criteria

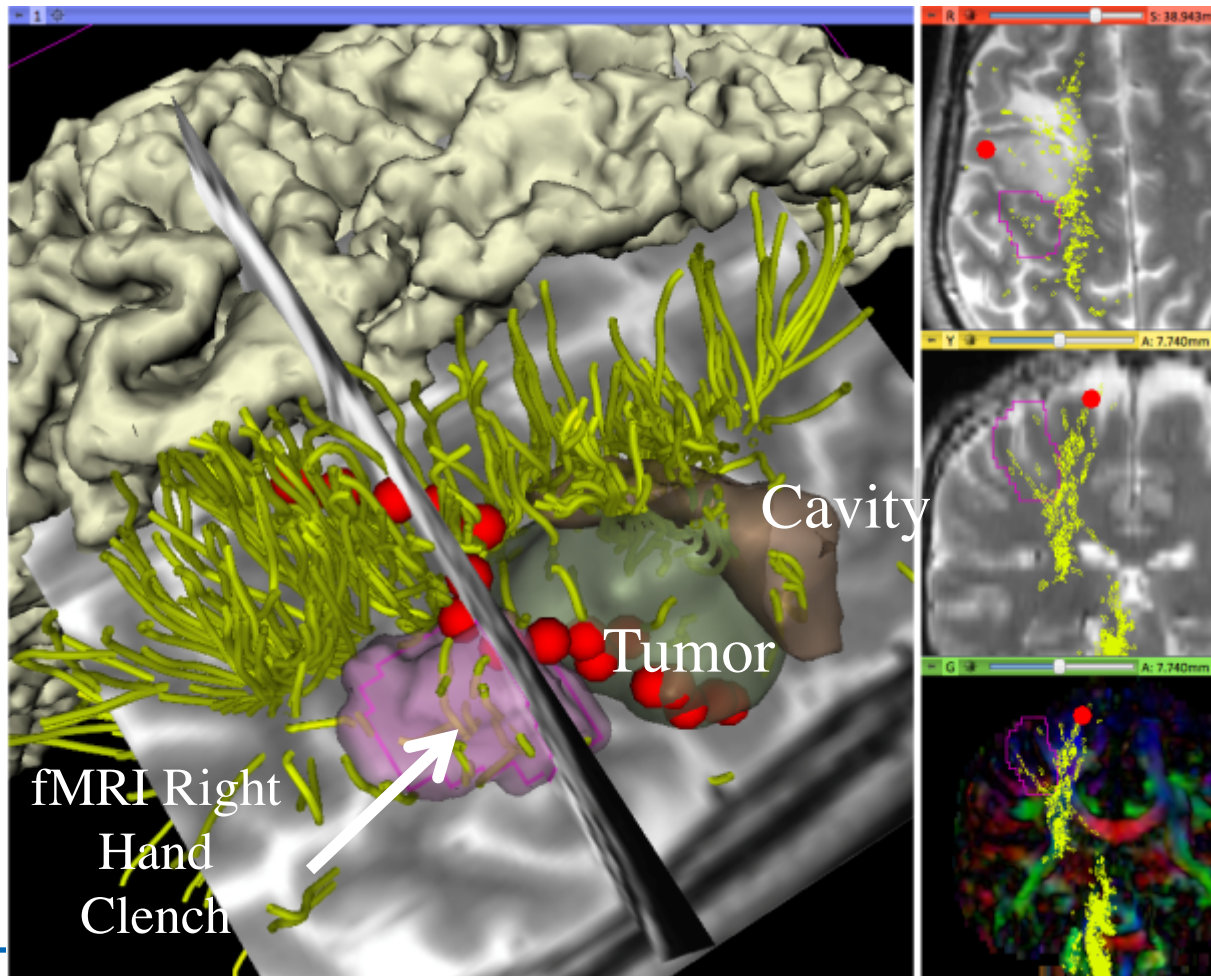
C4. Peritumoral Tracts





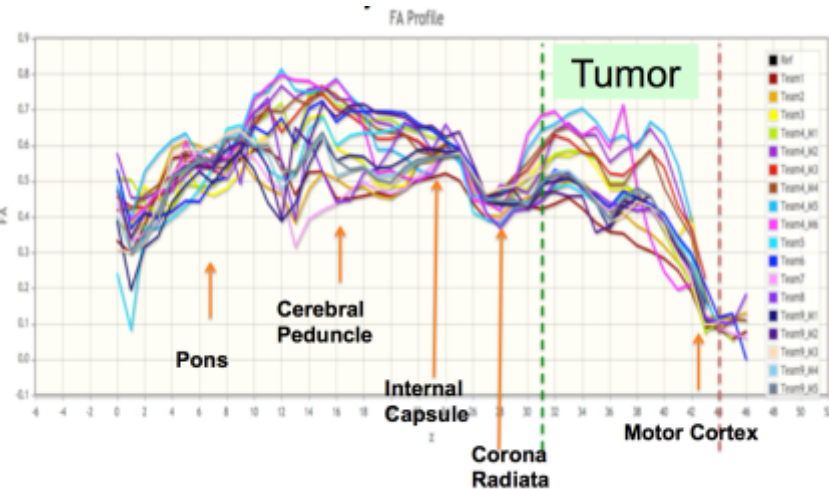
Clinical evaluation criteria

C5. Anatomico-functional correlation





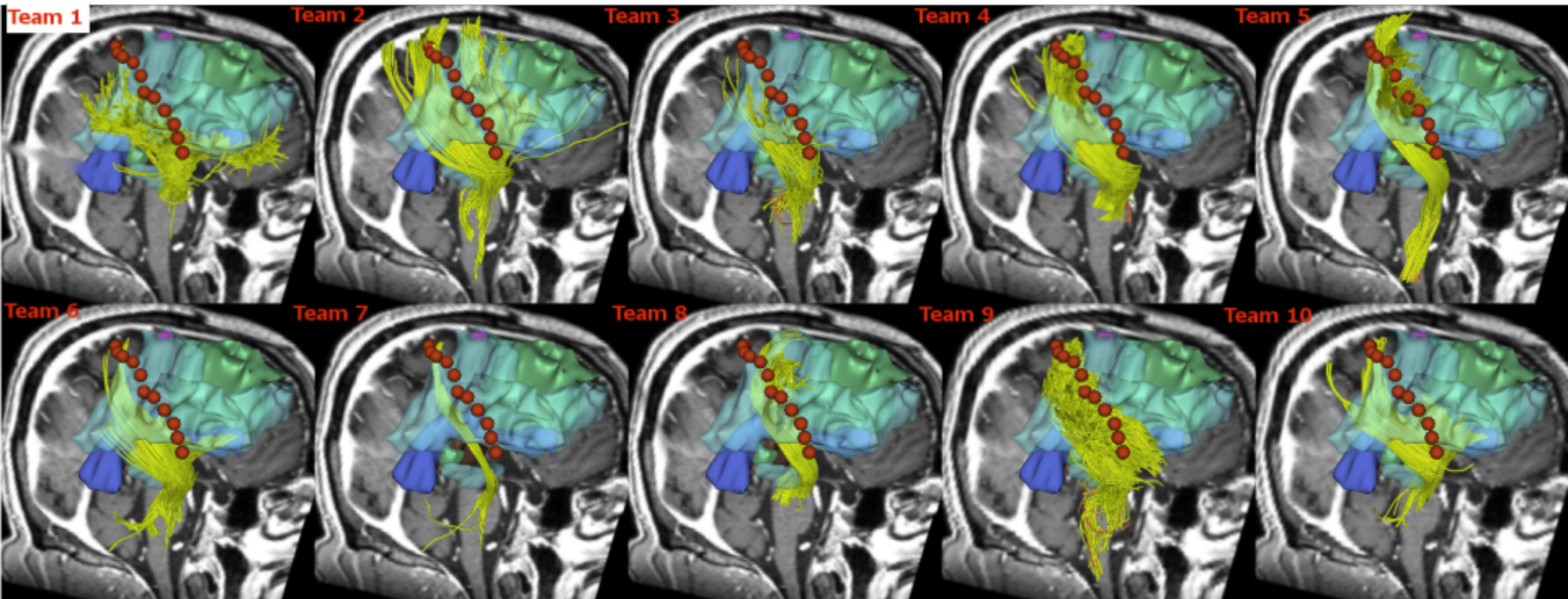
Quantitative Evaluation



- Metric 1: Degree of bundle overlap
- Metric 2: Distance between tracts
- Metric 3: Bundle Profile of Fractional Anisotropy



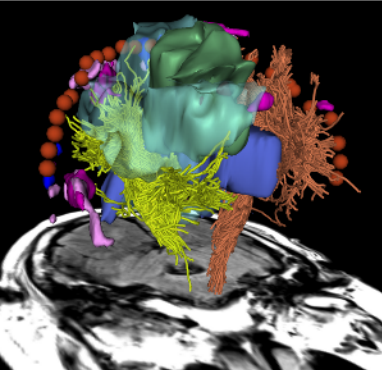
MICCAI 2013 Results



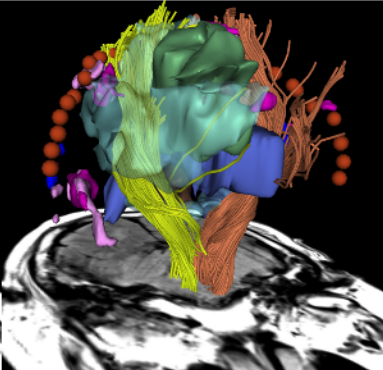


MICCAI 2013 Results

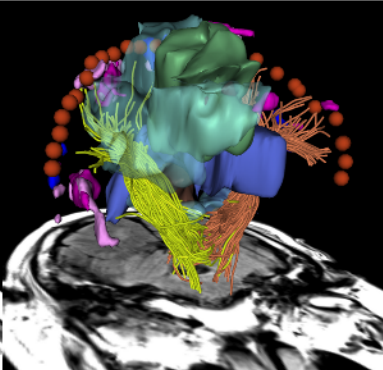
Team1



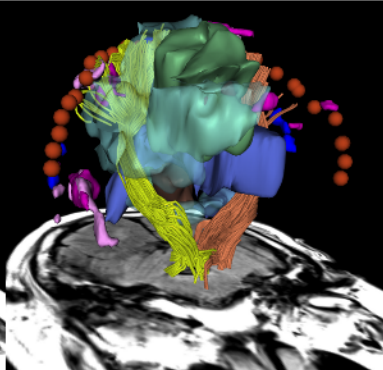
Team2



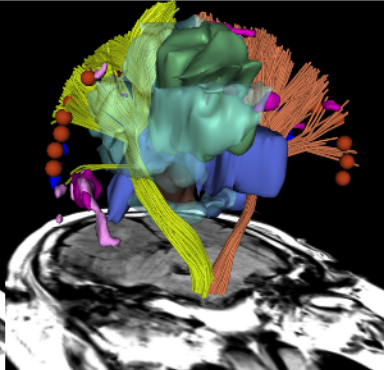
Team3



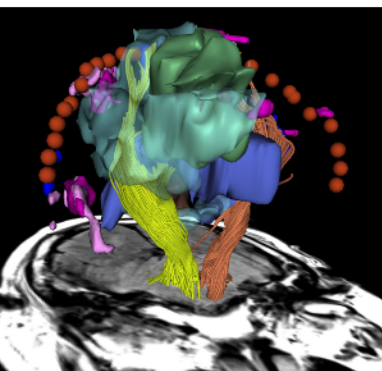
Team4



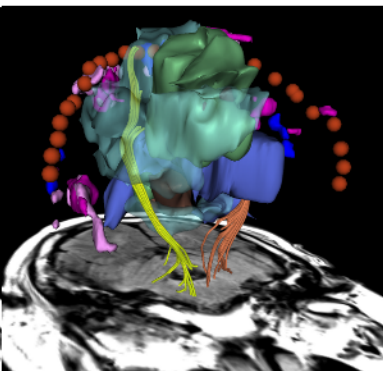
Team5



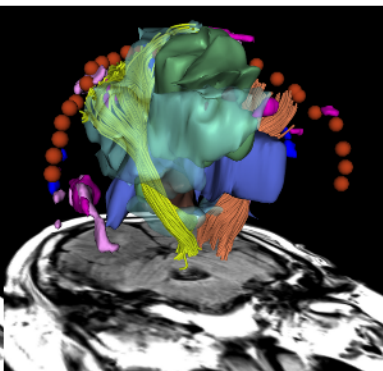
Team6



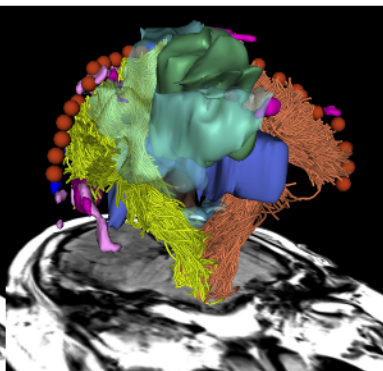
Team7



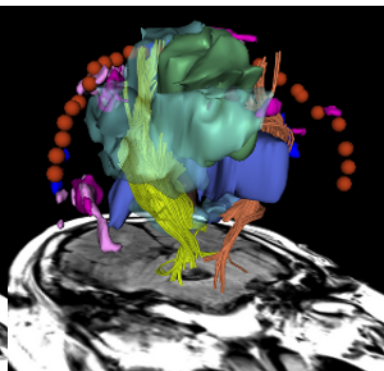
Team8



Team9



Team10





**Q1: Do the different tracts
overlap ?**

**Dice Coefficient of Bundle
Overlap**



Dice coefficient of bundle overlap

Tumor Side	Patient 1 (Tumor Side)	Patient 2 (Tumor Side)	Patient 3-20dir (Tumor Side)	Patient 3-30dir (Tumor Side)
Max	0.427	0.403	0.365	0.465
Min	0.083	0.027	0.011	0.035
Mean	0.245	0.190	Similar (weak) overlap values tumor vs. healthy side	
STD	0.08	0.095	Similar (weak) overlap values tumor vs. healthy side	
Healthy Side	Patient 1 (Healthy side)	Patient 2 (Healthy side)	Patient 3-20dir (Healthy side)	Patient 3-30dir (Healthy side)
Max	0.393	0.411	0.570	0.47
Min	0.064	0.048	0.0284	0.04
Mean	0.24	0.216	0.212	0.217
STD	0.99	0.099	0.127	0.103

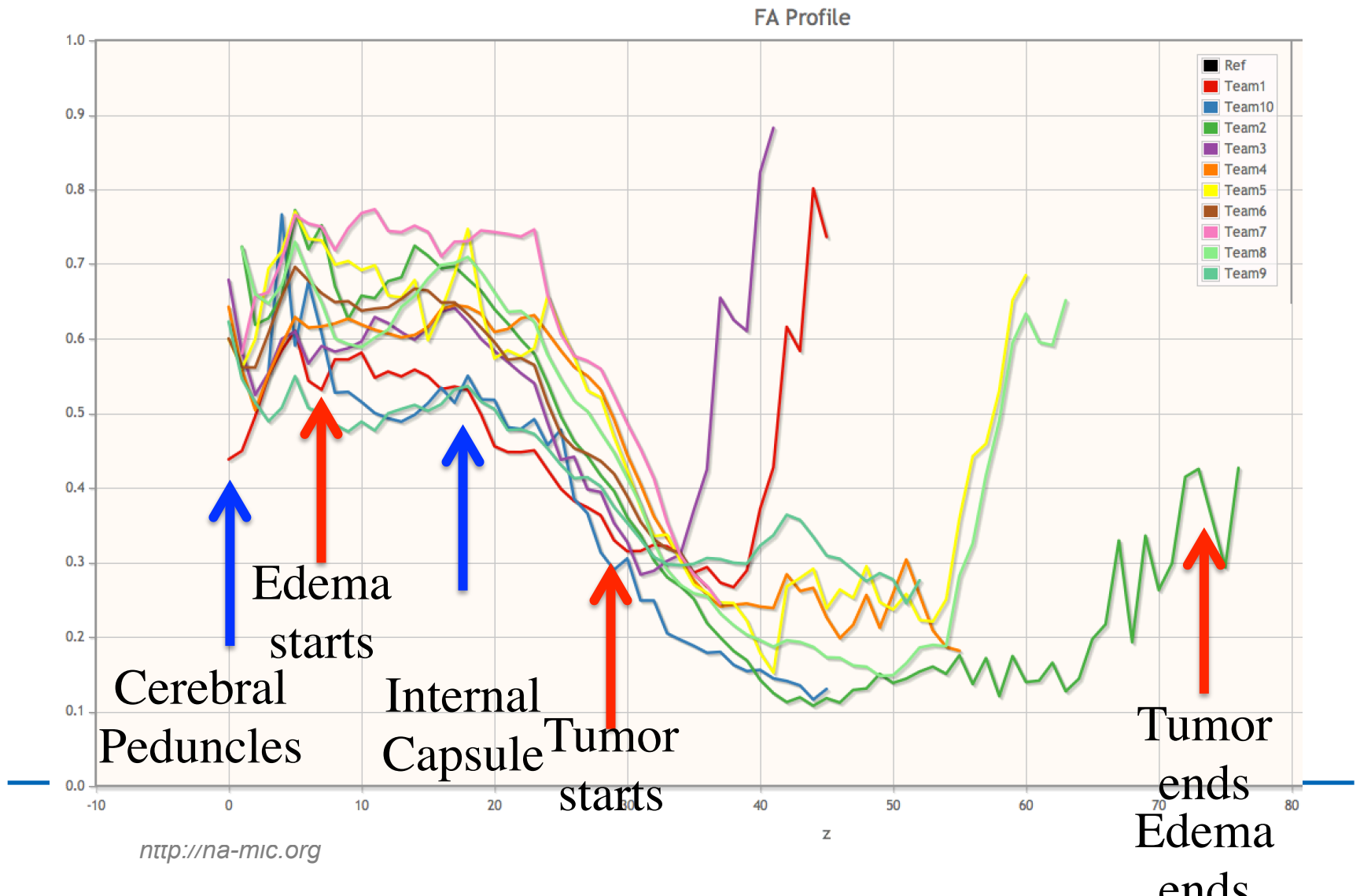


Q2: Does the variability among methods depend on the anatomical location ?

FA Profile along the CST

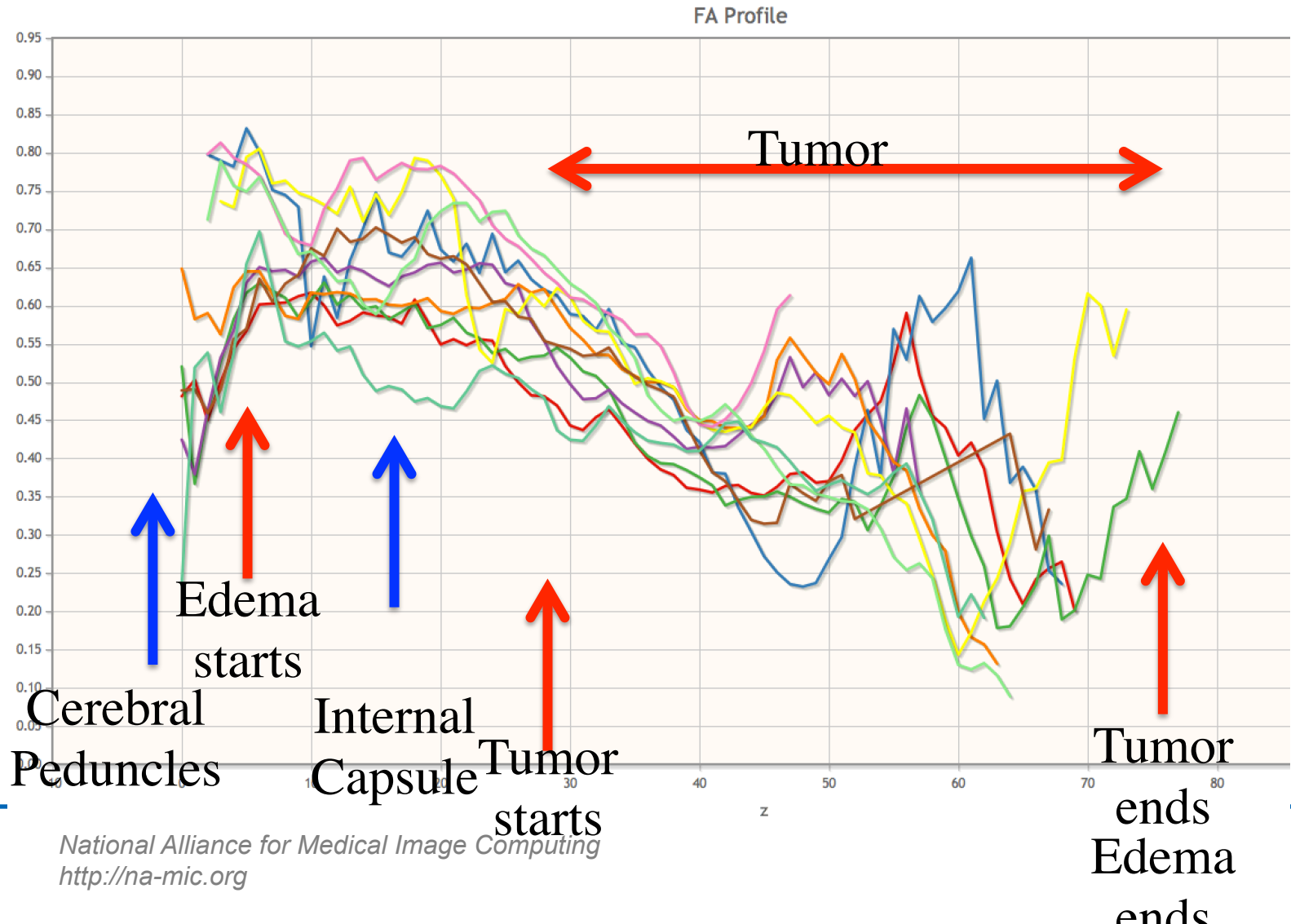


FA profile (tumor side)





FA profile (contralateral side)

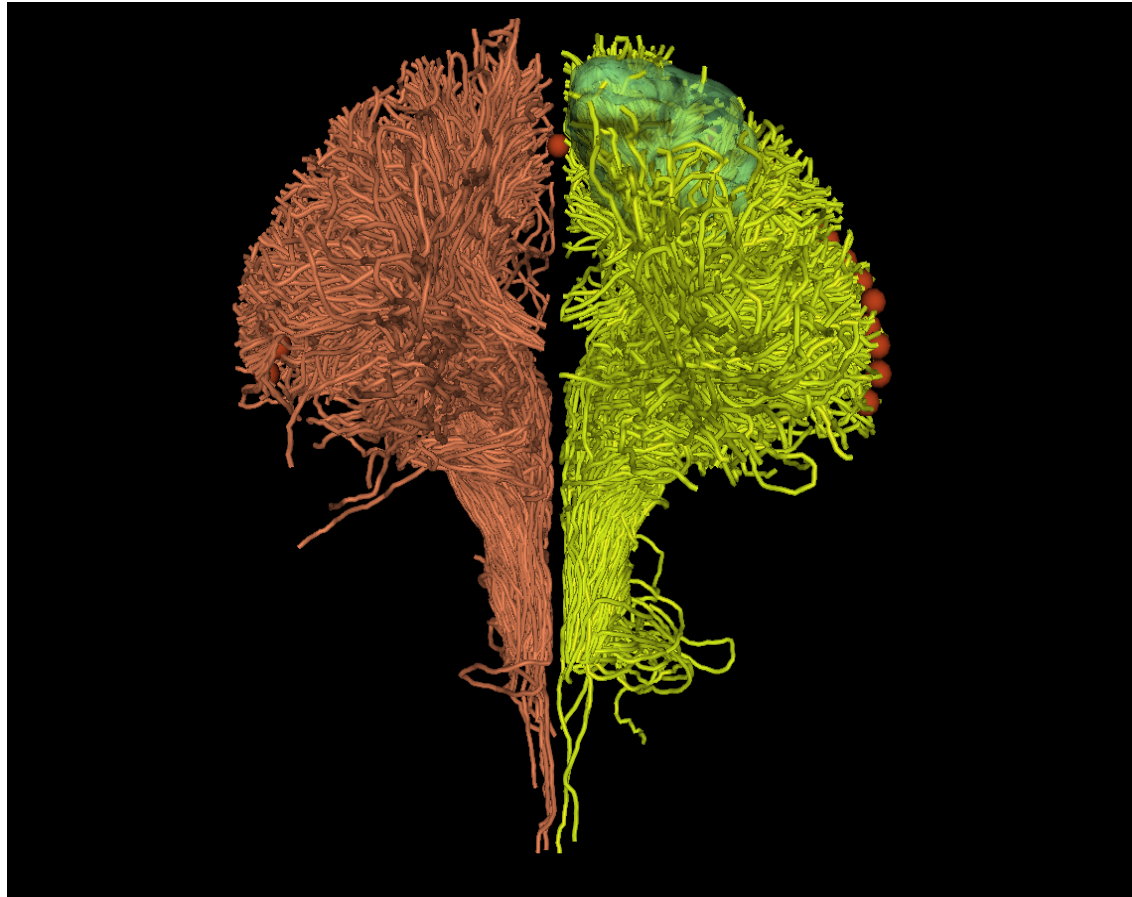




Q3: Are the different methods in agreement in the lateral projections of the CST ?

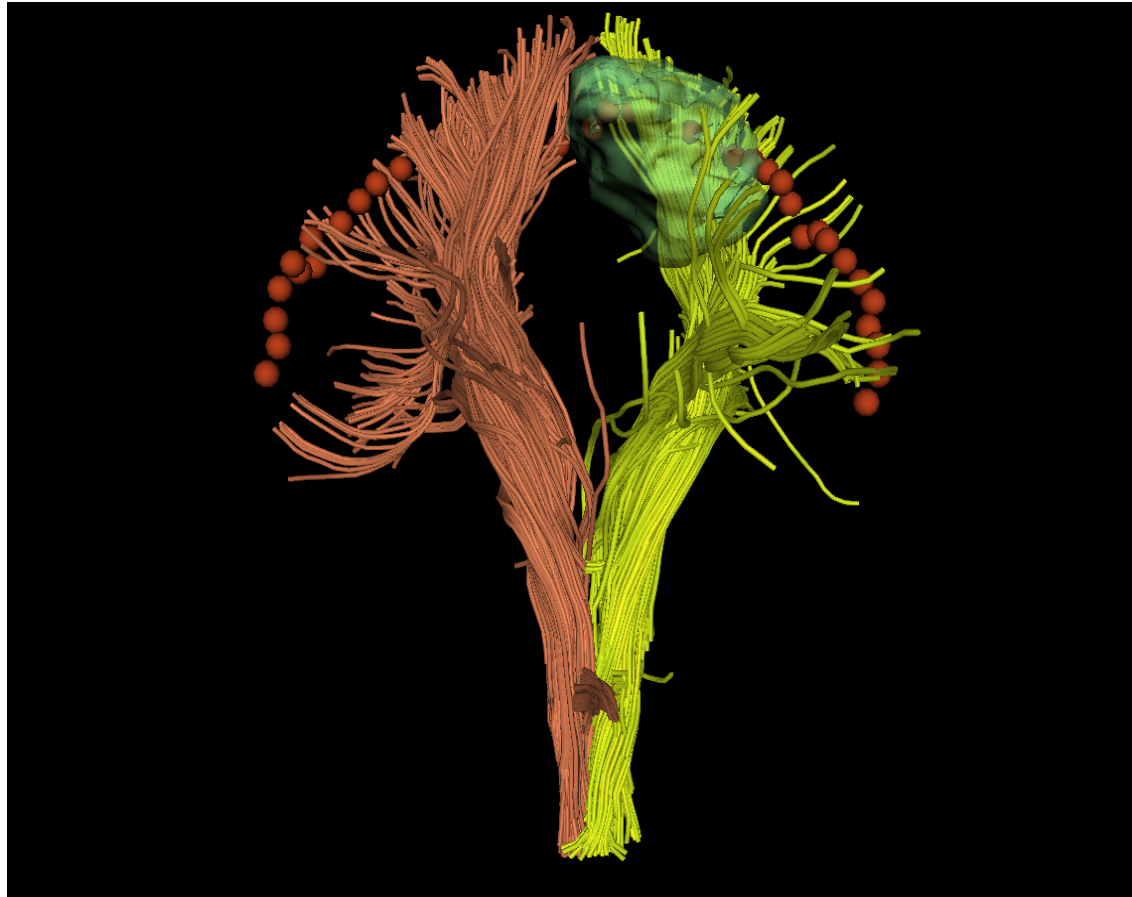


Team1



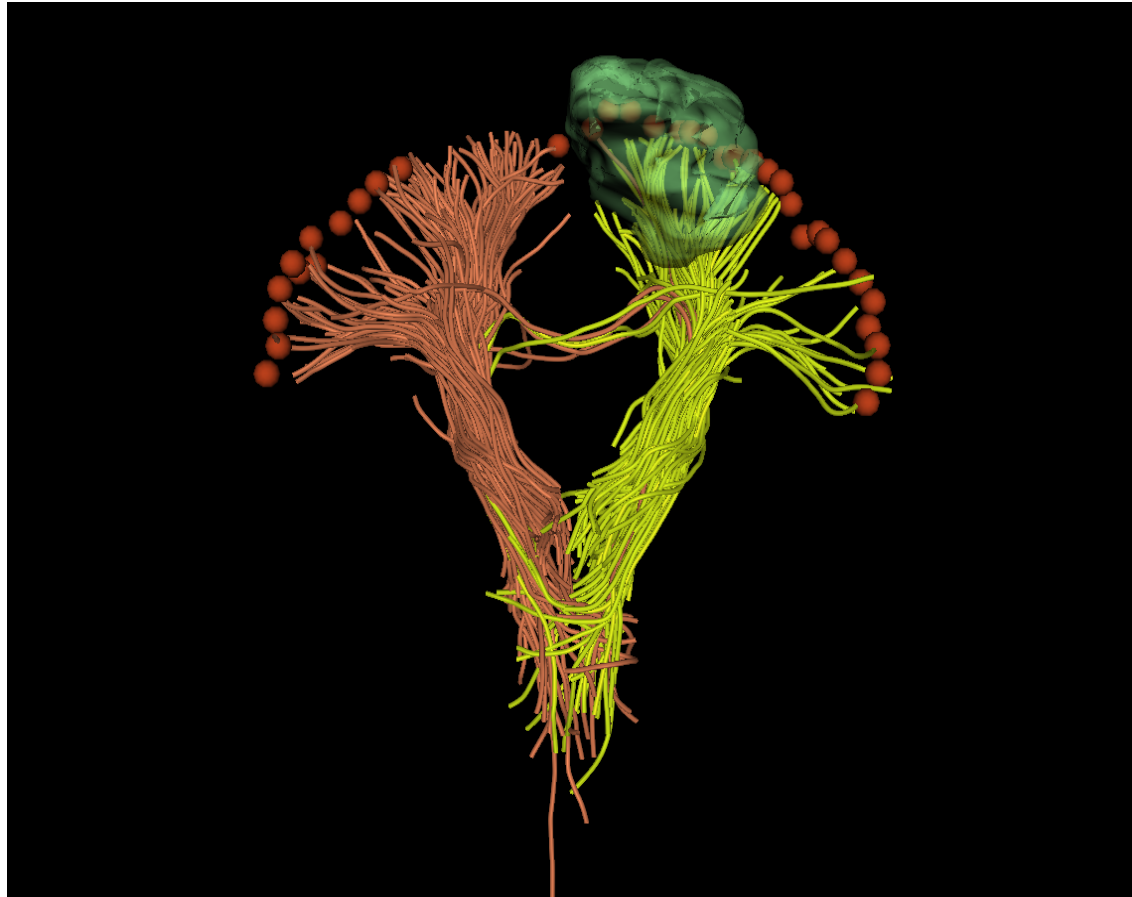


Team2



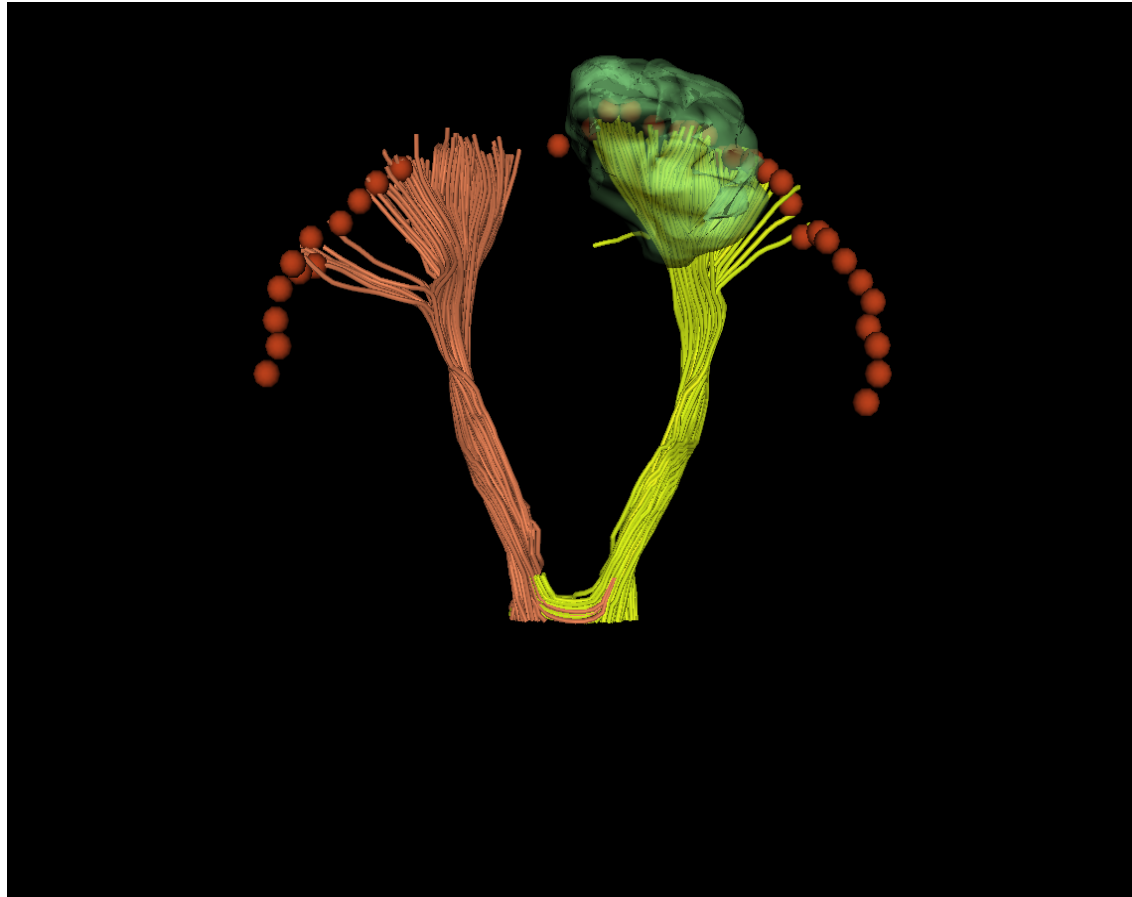


Team3



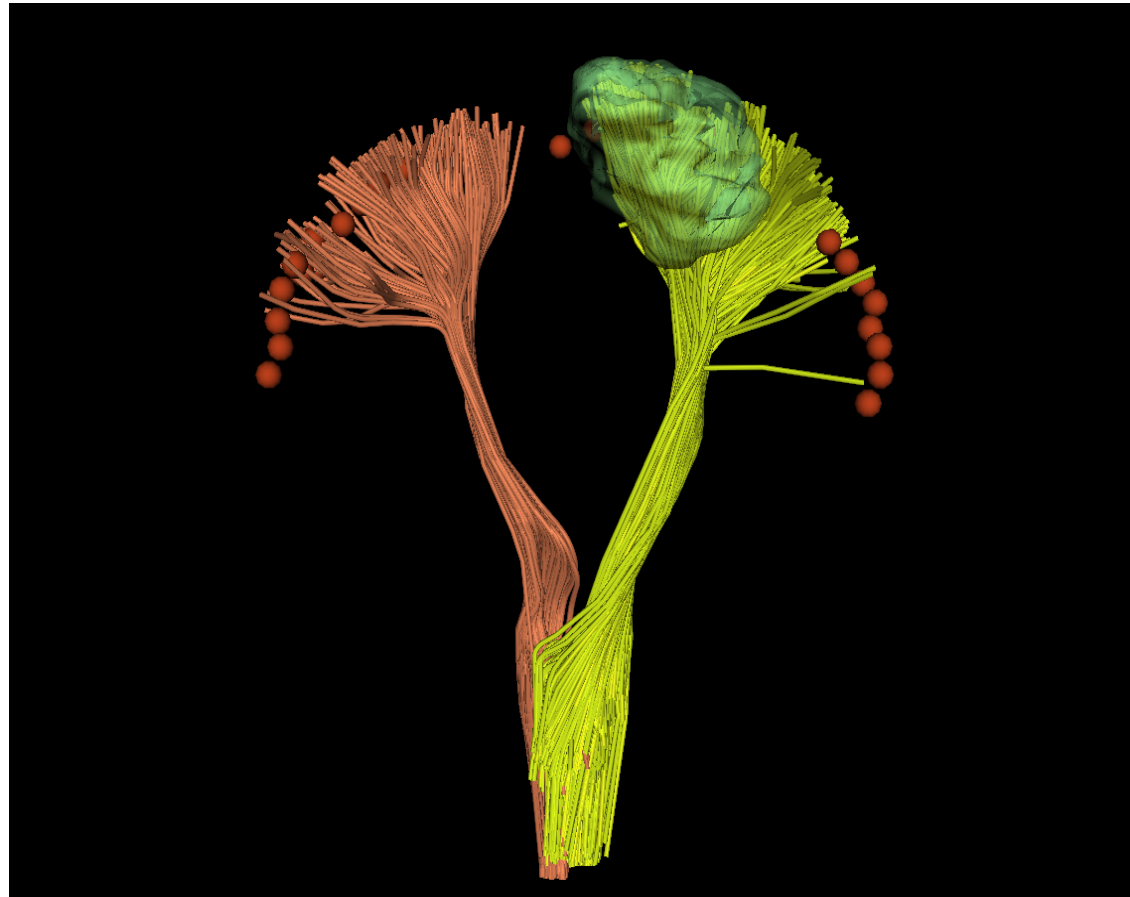


Team4



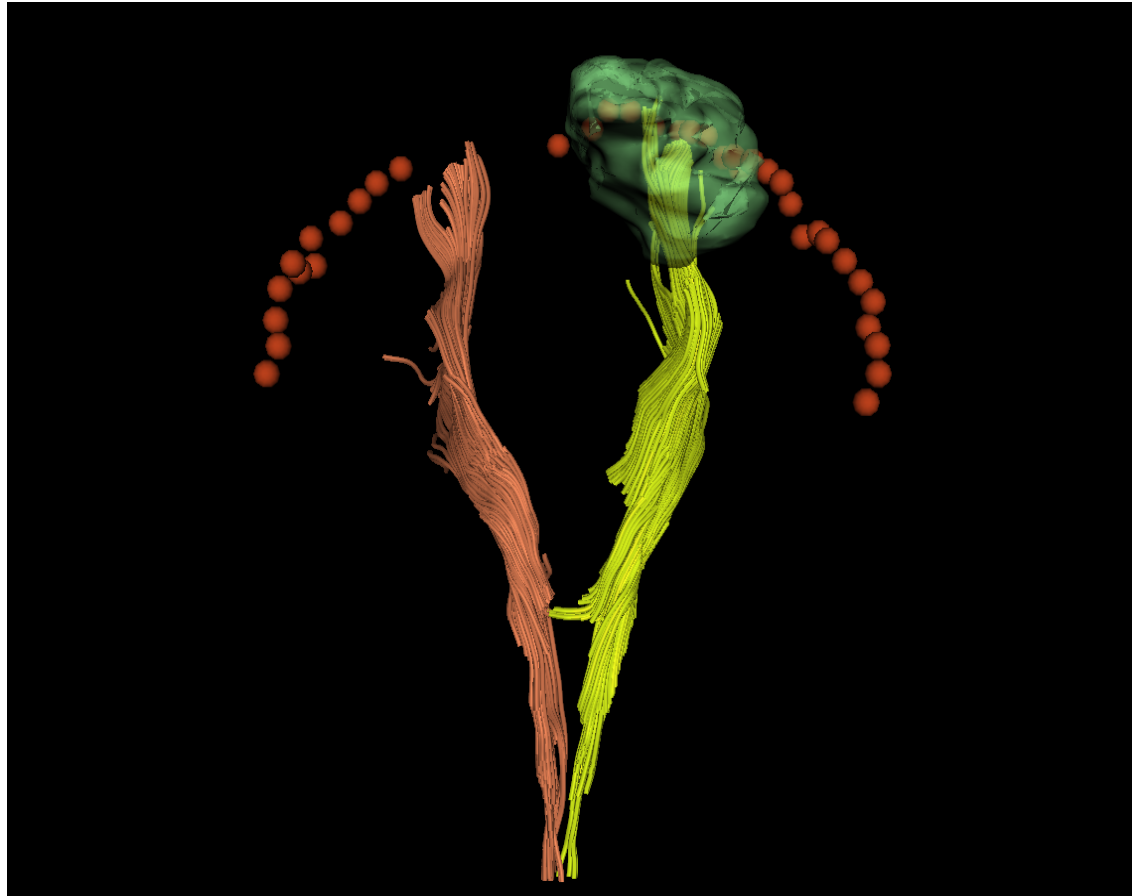


Team5





Team6



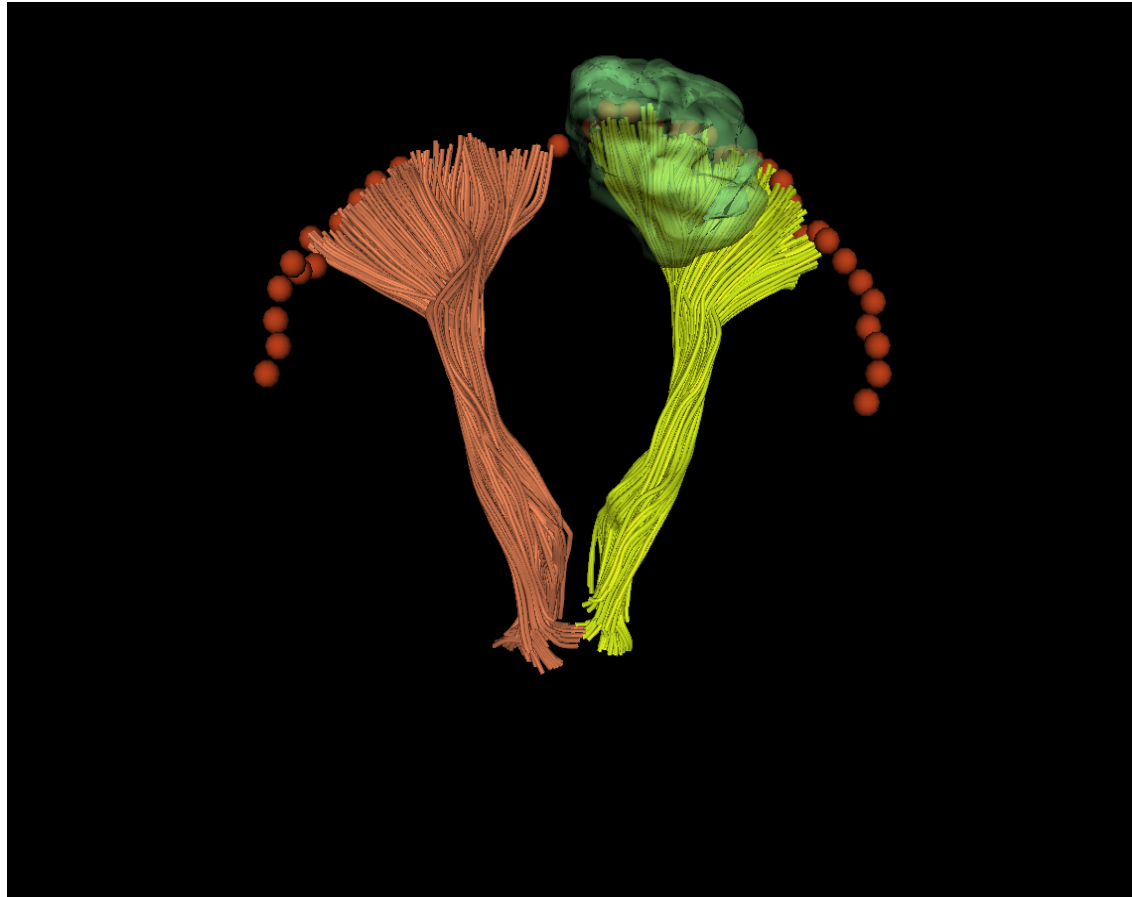


Team7



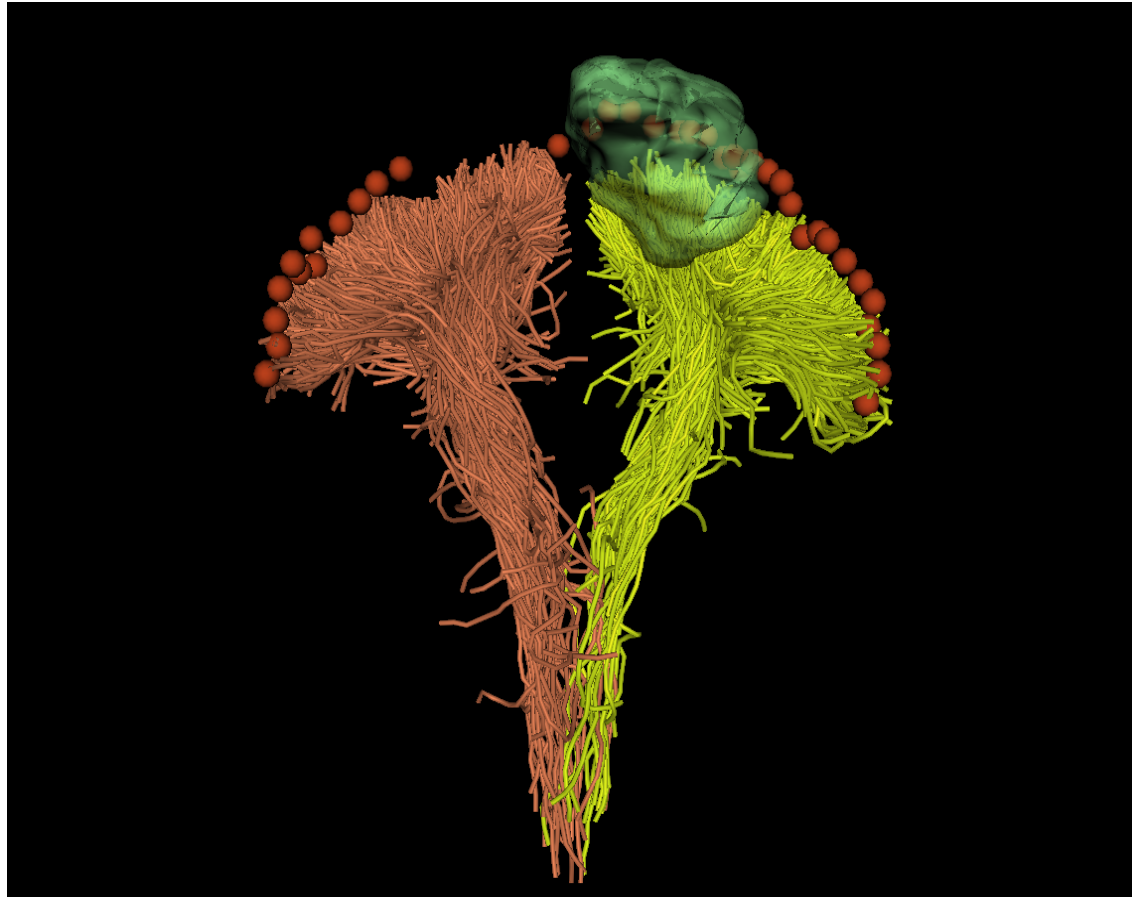


Team8



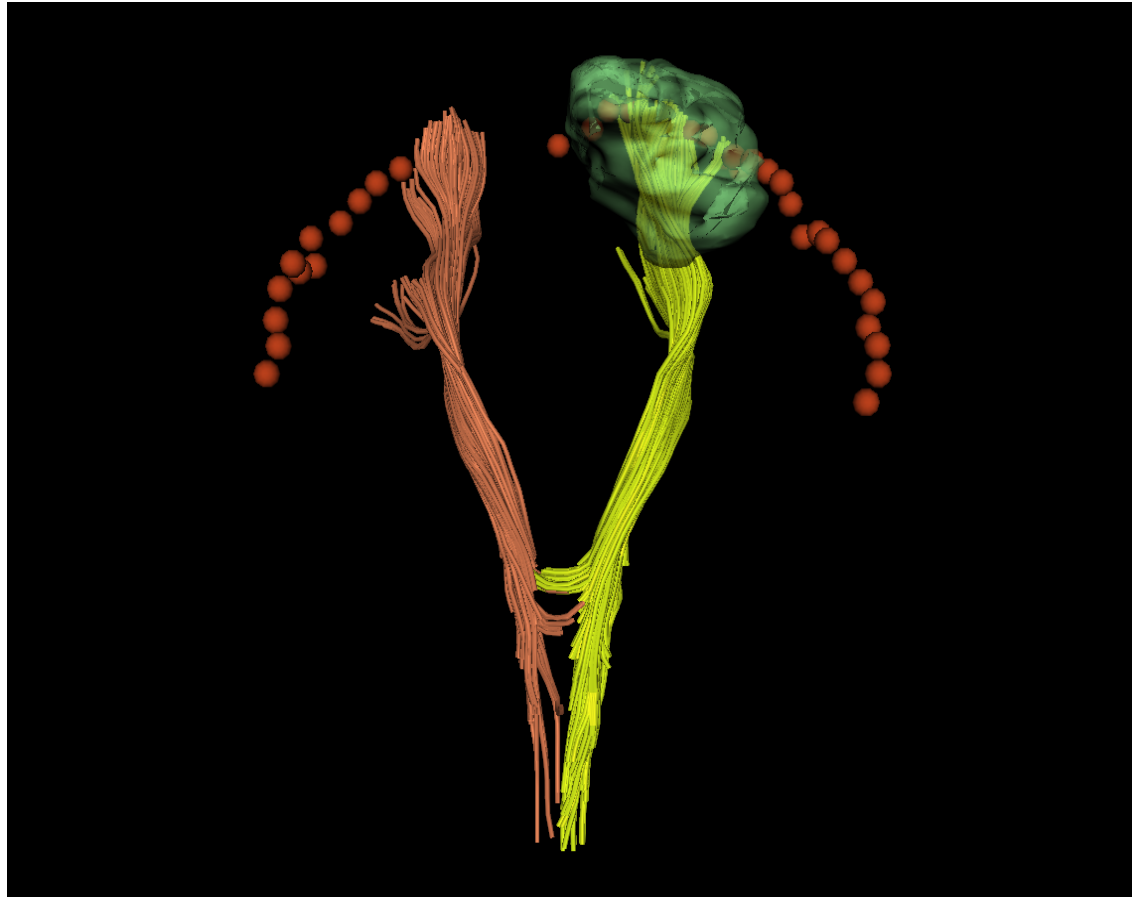


Team9





Team10



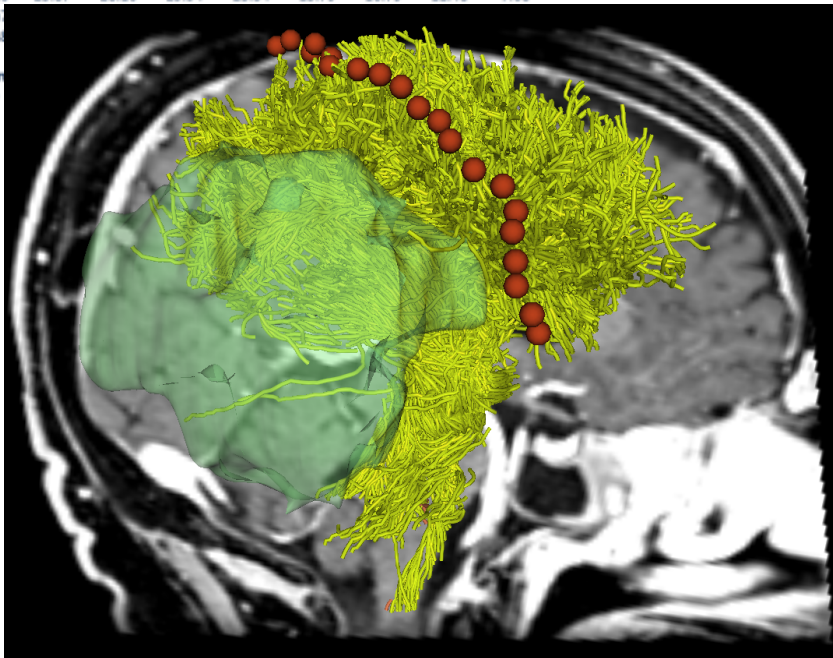


DTI Challenge Workshop findings

Table 1: Dice Coefficient for volumetric overlap between tracts (DTI Challenge'12)

Team	Patient1		Patient2		Patient3		Patient4	
	Left	Right	Left	Right	Left	Right	Left	Right
Team1	27.32	20.7	24.58	22.6	N/A	N/A	N/A	N/A
Team2	19.00	19.76	20.09	17.81	20.38	25.13	22.01	22.89
Team3	21.07	17.84	24.63	19.81	20.44	23.7	26.19	27.2
Team4	28.58	23.93	23.74	17.04	21.6	25.77	19.99	23.53
Team5	27.64	25.19	30.3	26.78	25.43	29.68	26.51	26.89
Team6	25.87	28.16	29.94	25.34	13.79	16.79	11.48	7.68

- Large variability among tractography methods
- Improved results for some of teams from year 1 to year 3
- Learning experience and Service to the community
- Neurosurgery in itself represents a unique opportunity for validation of DTI tractography





NA-MIC Training Core 2005-2014



NA-MIC Training Core

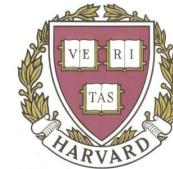


- Randy Gollub, M.D., Ph.D., MGH



National Venues

- Harvard,
- MIT,
- UCSF,
- UCLA,
- UCSD,
- Stanford,
- Dartmouth,
- NIH,
- University of New Mexico,
- University of Iowa,
- St Louis University,
- Duke University,
- UNC,
- NCI,
- NLM,
- MIND,





International venues

- Montreal, Canada
- Munich, Germany
- London, UK
- Dundee, UK
- London, Canada
- Sydney, Australia
- Melbourne, Australia
- Madrid, Spain
- Pisa, Italy
- Paris, France
- Tokyo, Japan
- Iwate, Japan
- Nagoya, Japan
- Changchun, China
- Geneva Switzerland...and many more!





Tutorials and Slides in a 10 year span

Slicer2: 11 tutorials and 764 slides
Slicer3.2: 18 tutorials and 907 slides
Slicer3.4: 24 tutorials and 1,527 slides
Slicer3.6: 25 tutorials and 1,217 slides
Slicer4.0: 17 tutorials and 822 slides
Slicer4.3: 17 tutorials and 857 slides



Tutorials and Slides in a 10 year span





Dartmouth Medical Center

May 26-27, 2005





RSNA 2013, Chicago

Dec. 1st , 2013





NA-MIC Training 2005-2014:



Participants:

2006: 235

2007: 370

2008: 250

2009: 270

2010: 635

2011: 457

2012: 704

2013: 585





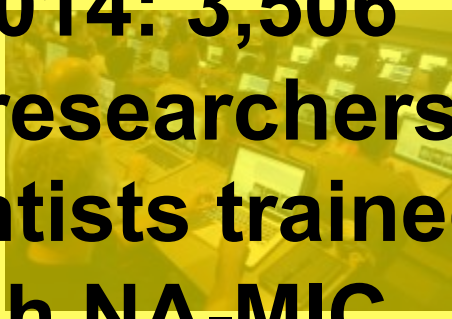
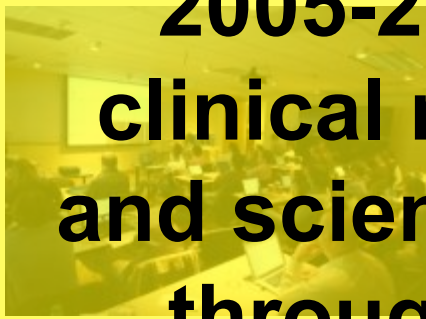
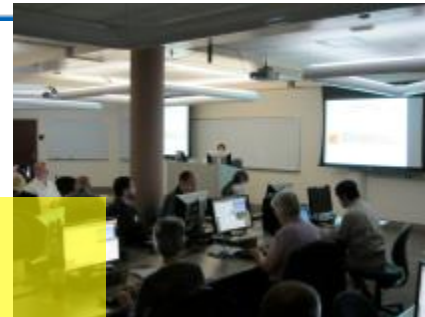
NA-MIC Training 2005-2014:

**3,506 NA-MIC Trainees in
116 Outreach events in 14
different countries**





2014 Update



**2005-2014: 3,506
clinical researchers
and scientists trained
through NA-MIC
Training Core Effort**

