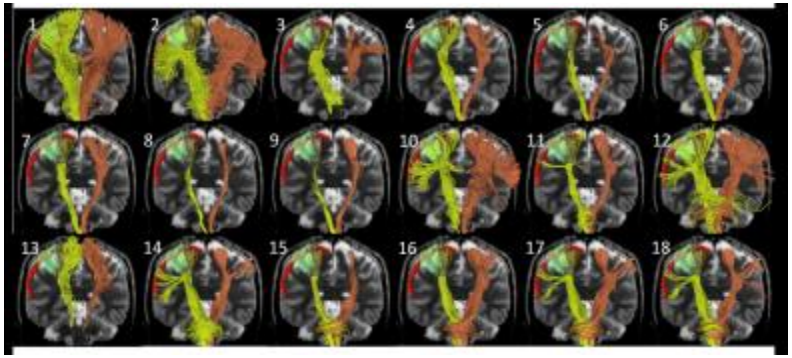
Training & Validation Update

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

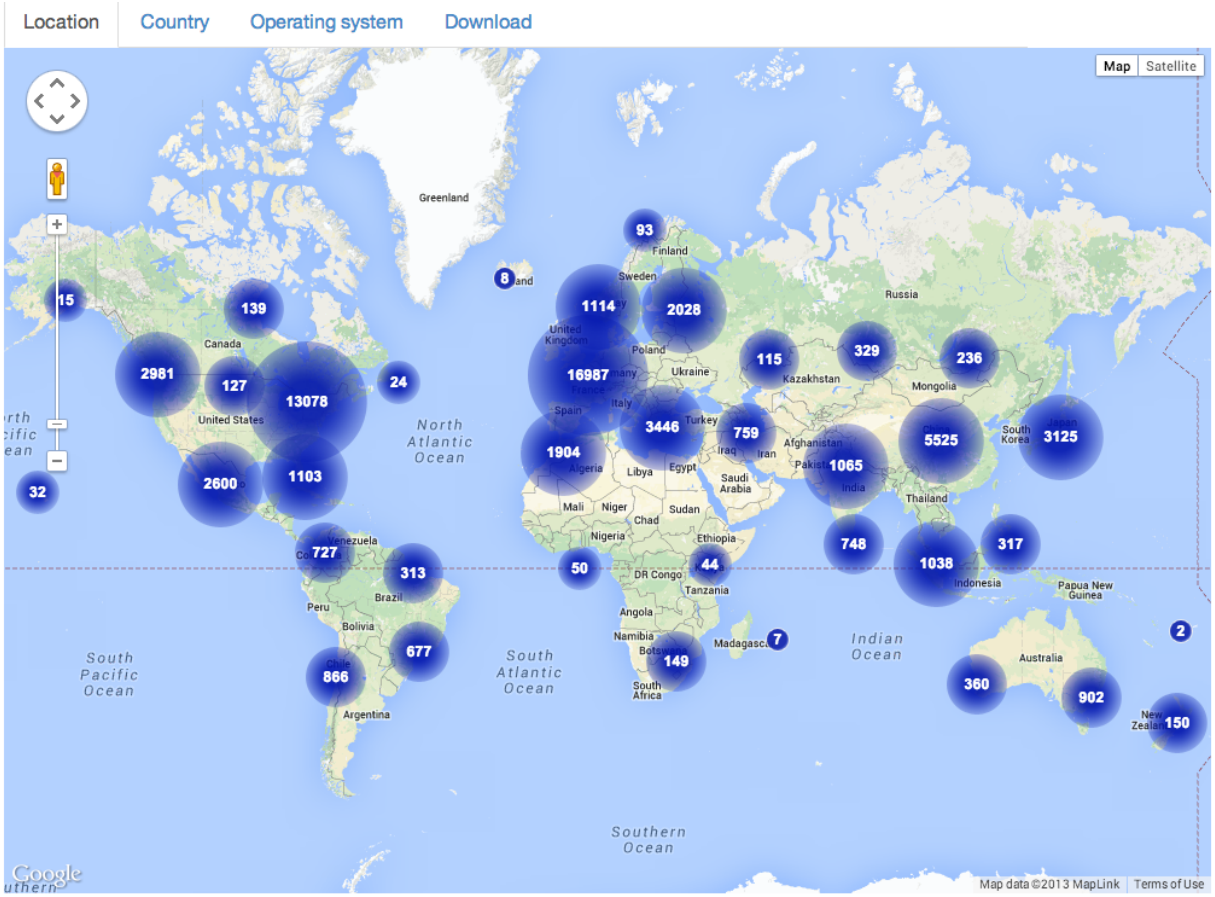
forever

release type

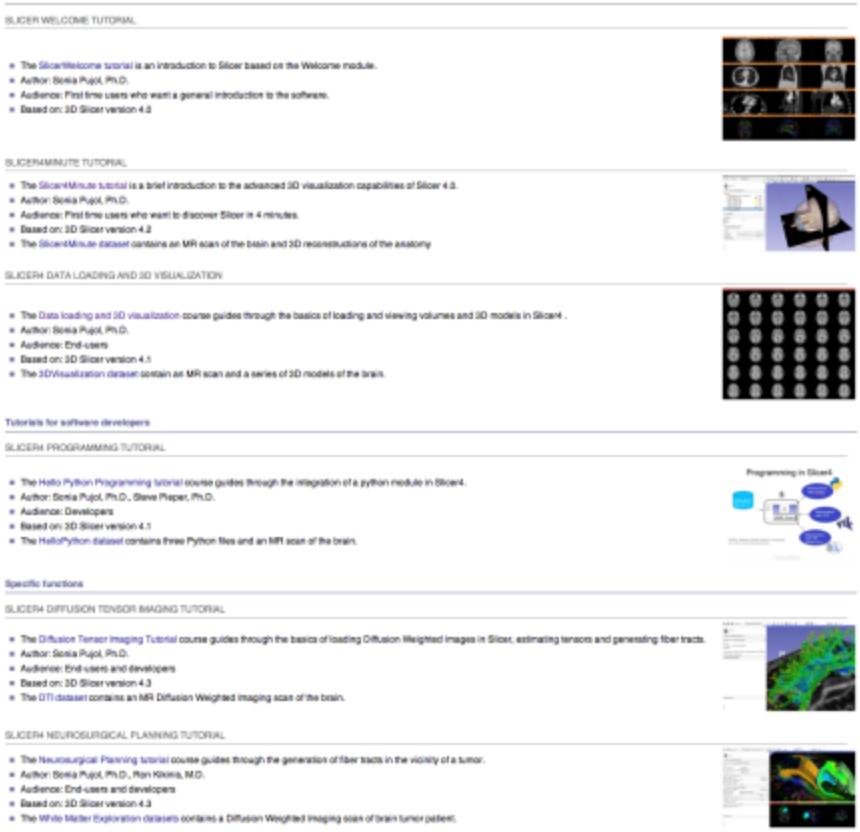
any

version

any

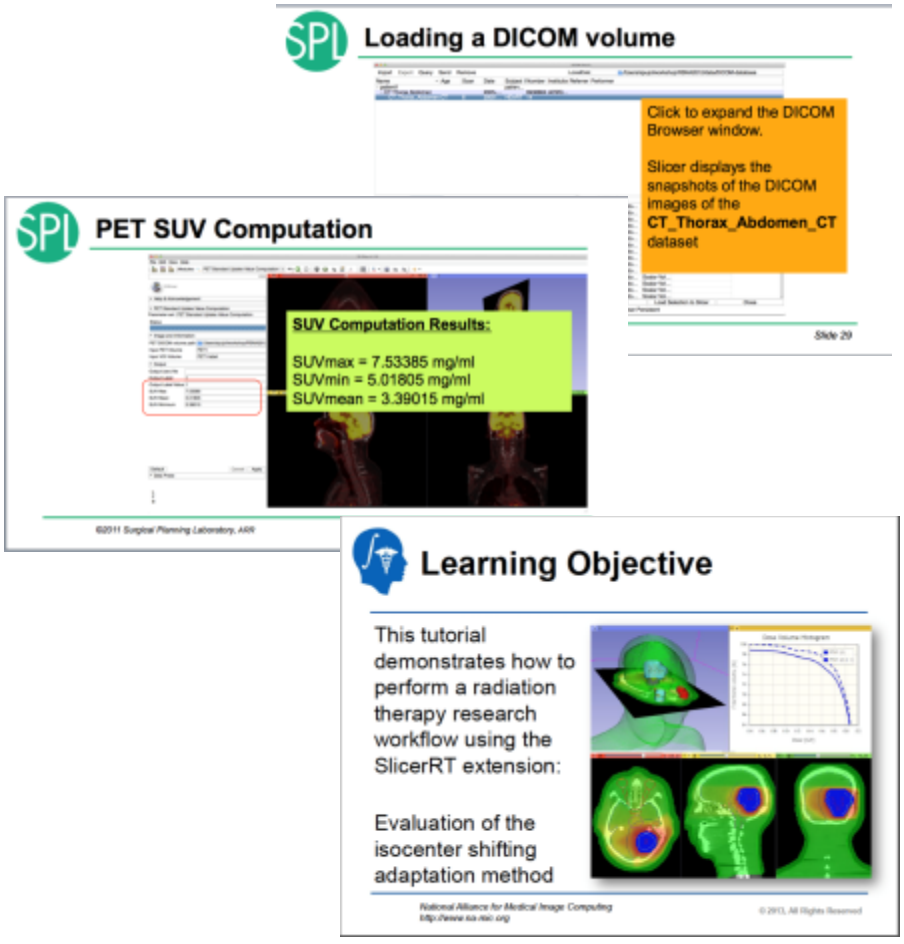


NA-MIC Tutorials



- 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



- **Modernization of training portfolio:**

- Drag & Drop feature
- DICOM viewer
- new Markups module

- **New tutorials**

-Cardiac MRI Toolkit (Utah)

-HelloCLI (MGH)

-DTI Prep (IOWA)

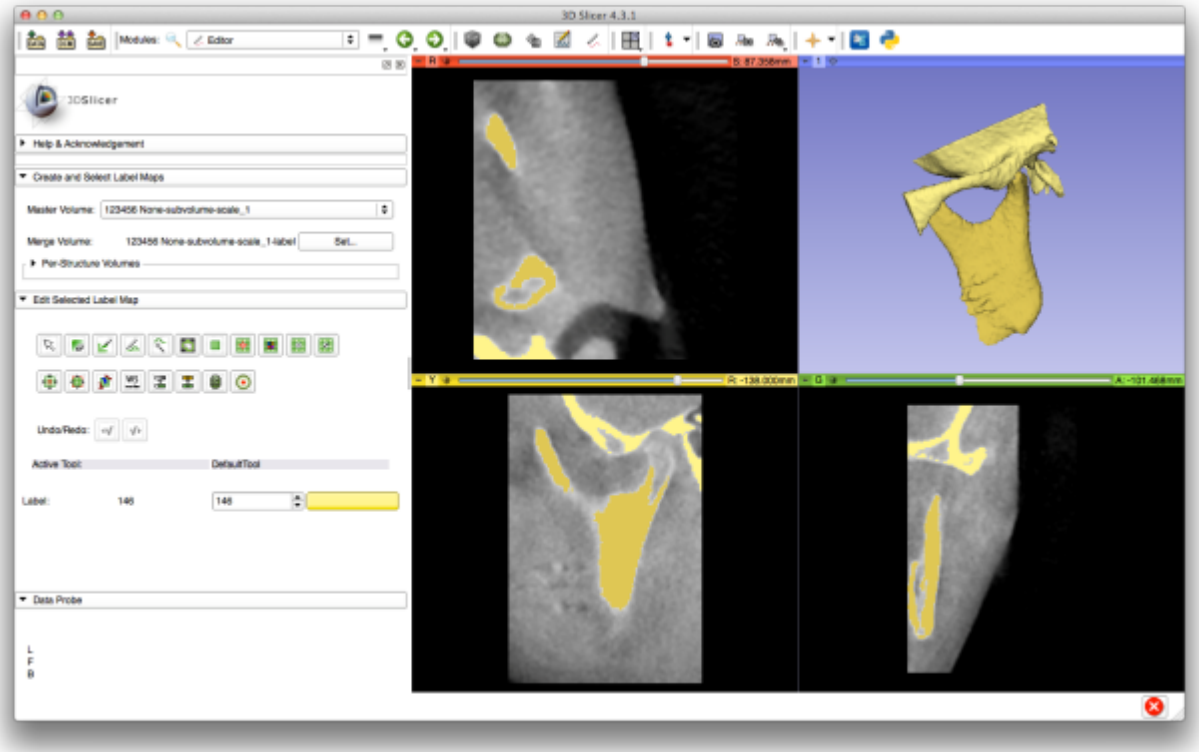
-SlicerRT (Queen's University)

-3D Printing (BHW)

Preparing Data for 3D Printing

Cone Beam CT: Skull

3D Printed Models:
Temporal Bone and Mandible

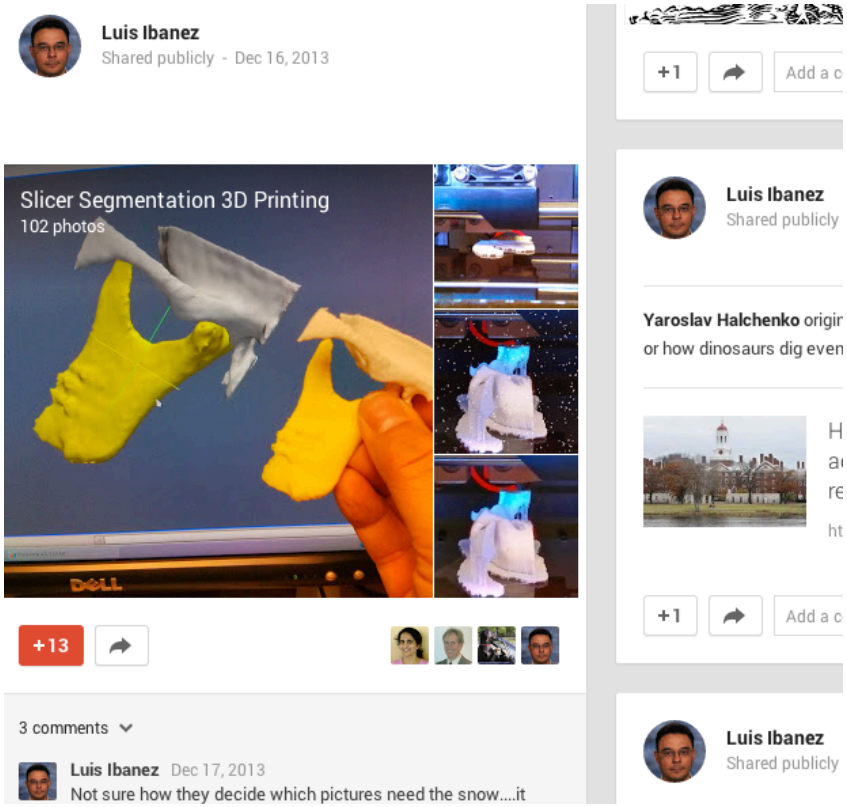


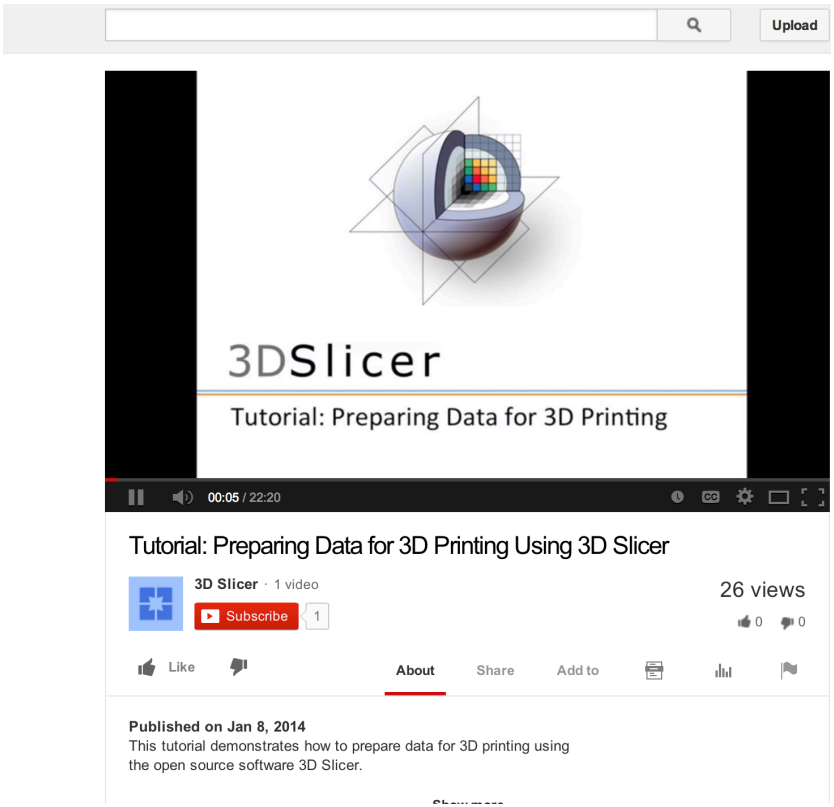
Download Tutorial:
http://wiki.na-mic.org/Wiki/index.php/File:Slicer_3D_Printing_Tutorial.mov

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

Acknowledgements: P41EB015898, P41EB015902, U54EB005149

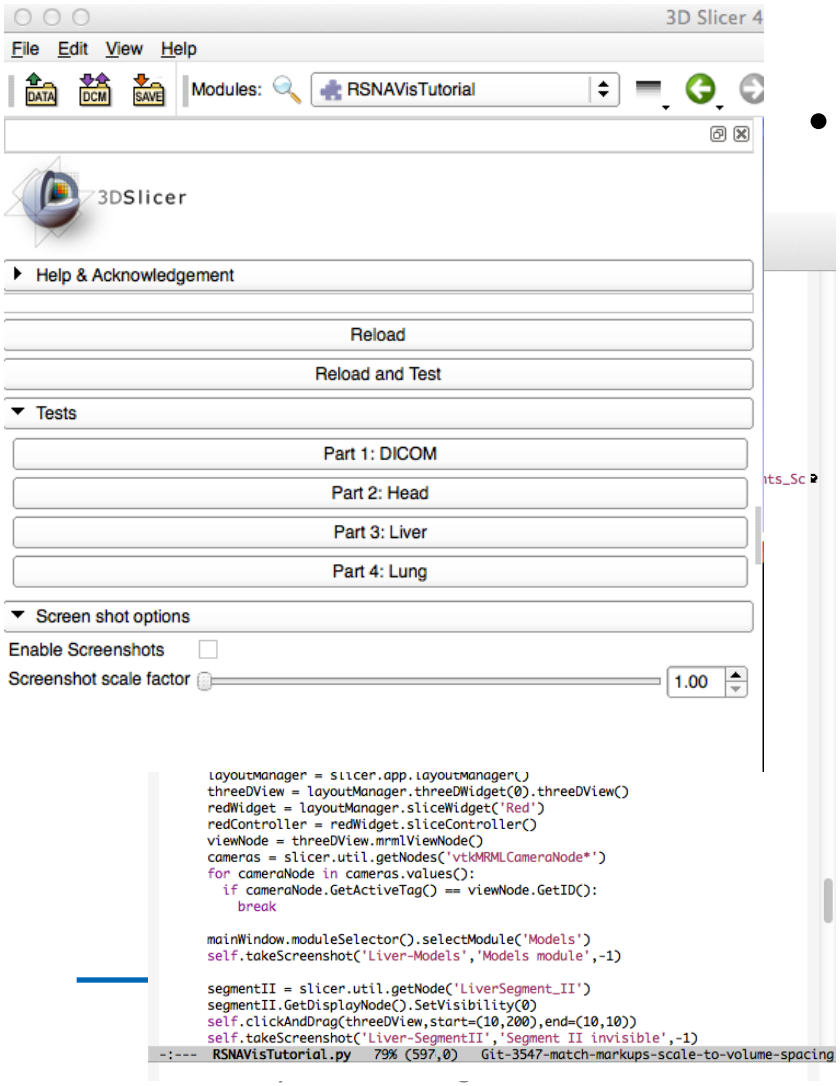
3D Printing Tutorial on YouTube and Google+





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

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, Czec 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

Biomedical engineers

Radiologists

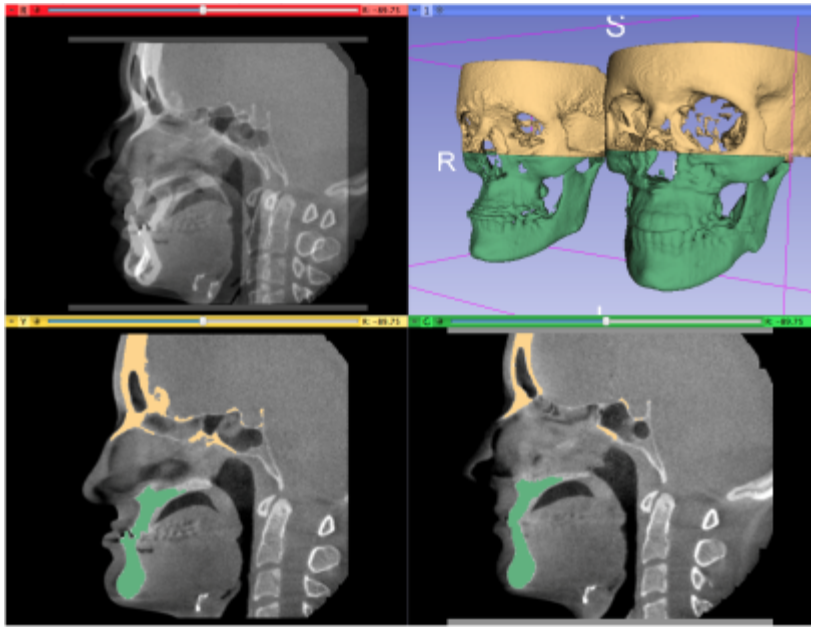
Medical Physicists

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

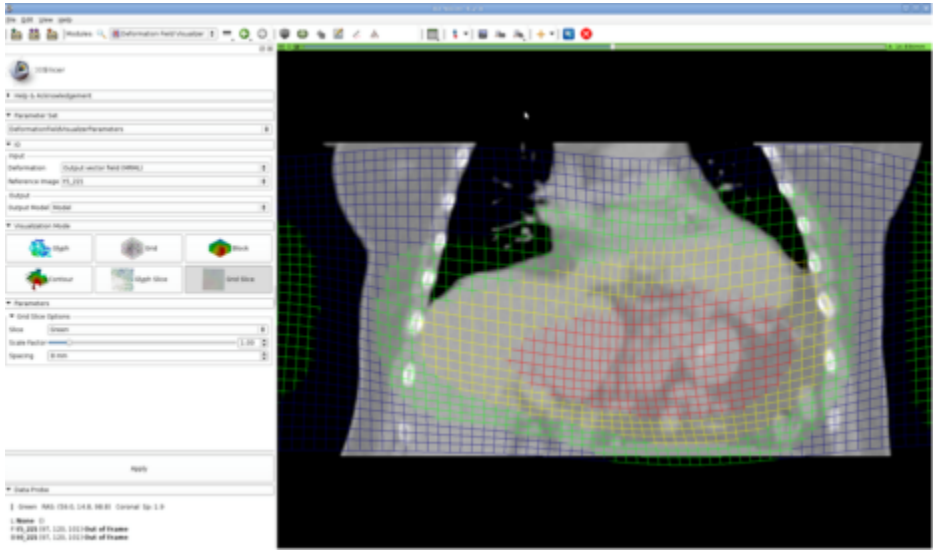
MGH, Boston

BRAINS Camp 2013, Iowa City

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

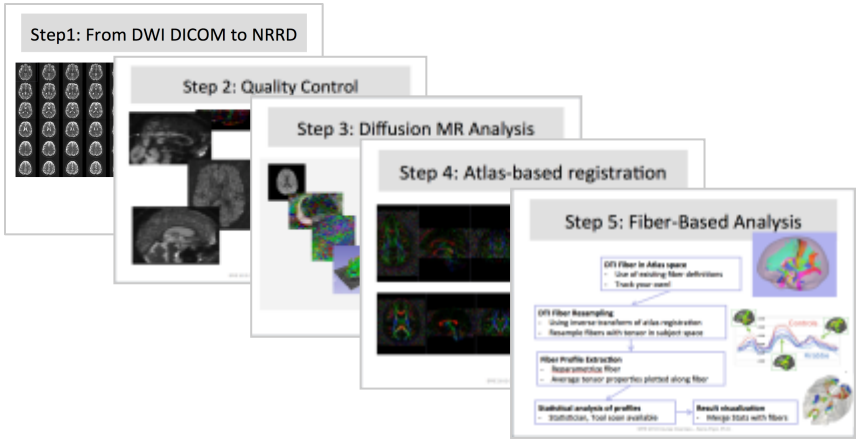
- Workshop Faculty:
- Hans Johnson, Vince Calhoun, Vince Magnotta

AAPM 2013, Indianapolis



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

SPIE 2013 DTI Course, Orlando



SPIE Medical Imaging

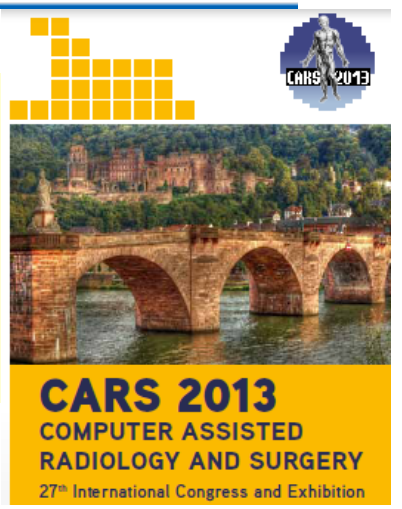
- 4-hour course on the fundamentals of the acquisition, analysis and validation of Diffusion Tensor Imaging (DTI) data (Pujol, Styner, Gerig)
- End-to-end medical image processing solution using Slicer4

NA-MIC Outreach events at International conferences

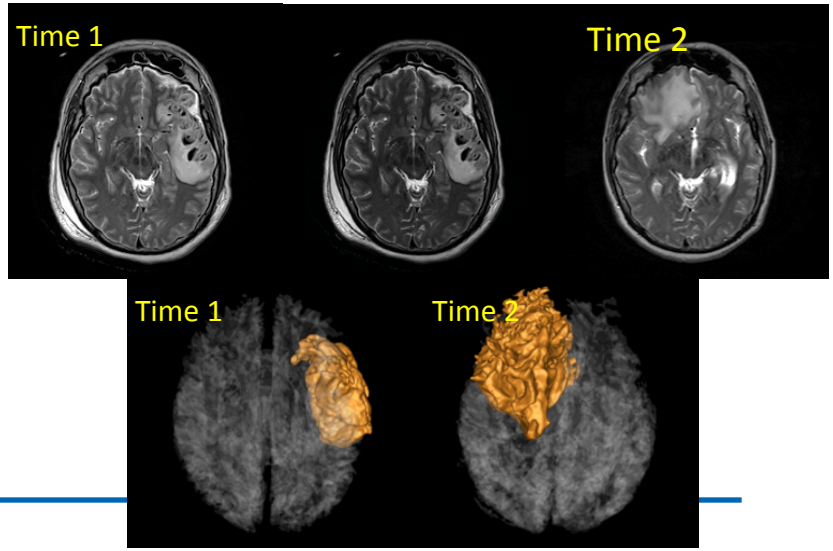
TBI Workshop, CARS 2013, Germany

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

M. Vannier: Diffusion MRI in Traumatic Brain Injury



- 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.)



THE UNIVERSITY OF UTAH

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 (Sas
- 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 an
- 16:15-17:00 Extending the MITK Workbench: CTK Plugin generator
  (Sascha Zelzer)

Joint MITK-Slicer event

NA-MIC Workshop Faculty:

- Sonia Pujol
- Steve Pieper
- Gabor Fichtinger

June 26–29, 2013
Heidelberg, Germany

CARS 2013
Computer Assisted Radiology and Surgery
27th International Congress and Exhibition

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

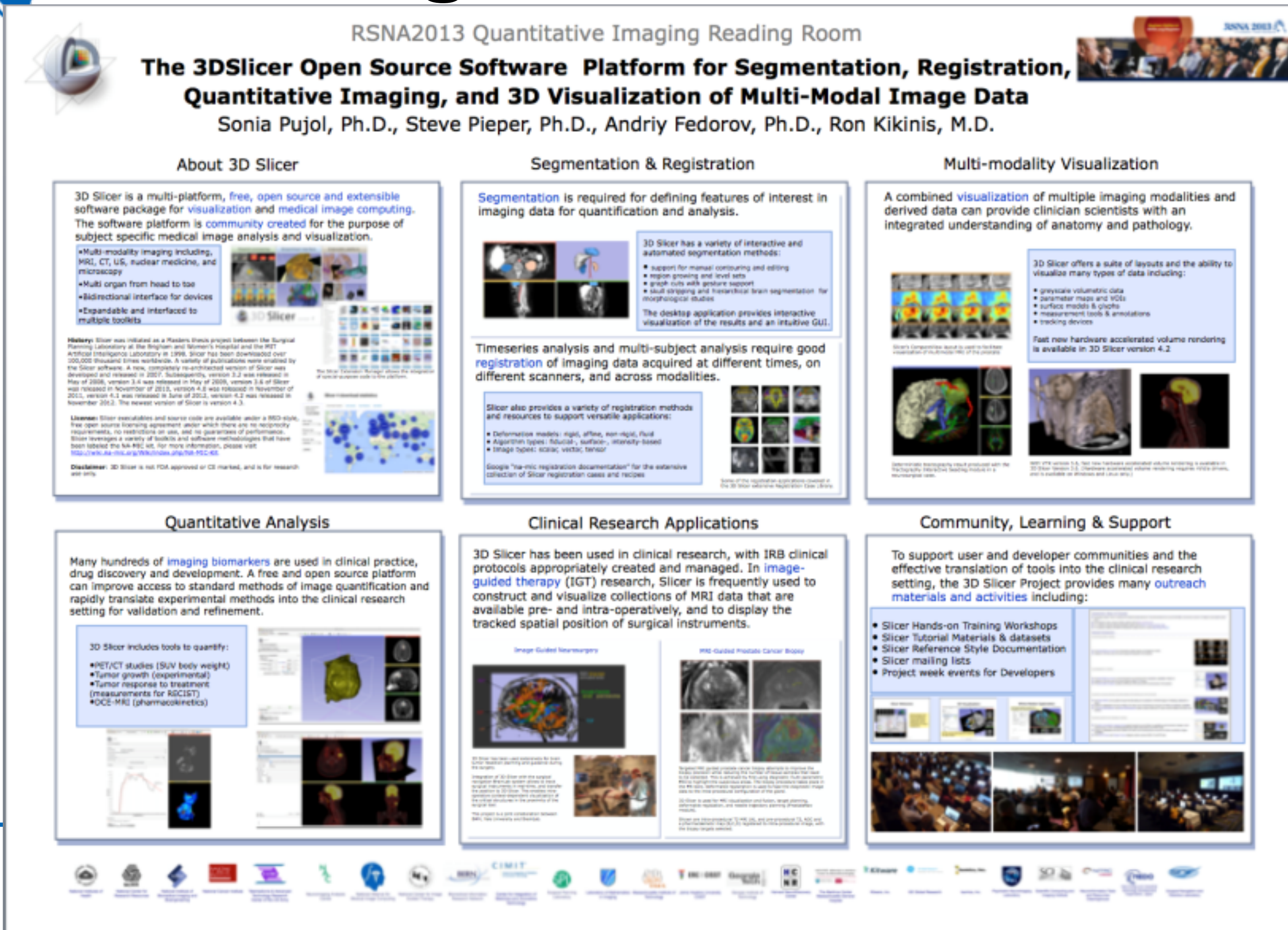
- RSNA 2013: 75,000 participants
- Joint NA-MIC/NAC/ NCIGT week- long series of events

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
8:00am-11:00am: 3D Slicer Exhibit: **Quantitative Imaging Reading Room.** Lakeside Learning Center Hall E, Exhibit LL-QRR3007.	**8:00am-11:00am:** 3D Slicer Exhibit: **Quantitative Imaging Reading Room.** Lakeside Learning Center Hall E, Exhibit LL-QRR3007.	**8:00am-11:00am:** 3D Slicer Exhibit: **Quantitative Imaging Reading Room.** Lakeside Learning Center Hall E, Exhibit LL-QRR3007.	**8:00am-12:15pm:** 3D Slicer Exhibit: **Quantitative Imaging Reading Room.** Lakeside Learning Center Hall E, Exhibit LL-QRR3007.	**8:00am-12:15pm:** 3D Slicer Exhibit: **Quantitative Imaging Reading Room.** Lakeside Learning Center Hall E, Exhibit LL-QRR3007.	**8:00am-12:45pm:** 3D Slicer Exhibit: **Quantitative Imaging Reading Room.** Lakeside Learning Center Hall E, Exhibit LL-QRR3007.
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.	**12:15pm-1:15pm:** Meet-The-Experts Session, 3D Slicer Exhibit: **Quantitative Imaging Reading Room.** Lakeside Learning Center Hall E, Exhibit LL-QRR3007.	**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.	**12:15pm-1:15pm:** Meet-The-Experts Session, 3D Slicer Exhibit: **Quantitative Imaging Reading Room.** Lakeside Learning Center Hall E, Exhibit LL-QRR3007.	**12:15pm-1:15pm:** 3D Slicer Exhibit: **Quantitative Imaging Reading Room.** Lakeside Learning Center Hall E, Exhibit LL-QRR3007.	
12:30pm-1:30pm: 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.	**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.	**1:15pm-6:00pm:** 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.	
1:30pm-6:00pm: 3D Slicer Exhibit: **Quantitative Imaging Reading Room.** Lakeside Learning Center Hall E, Exhibit LL-QRR3007.					

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

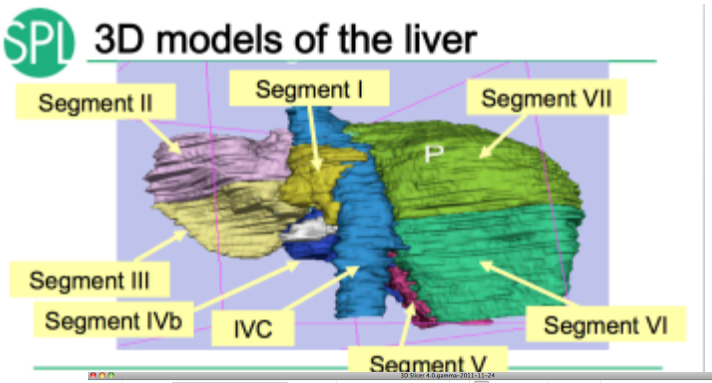
Quantitative Imaging Reading Room Exhibit

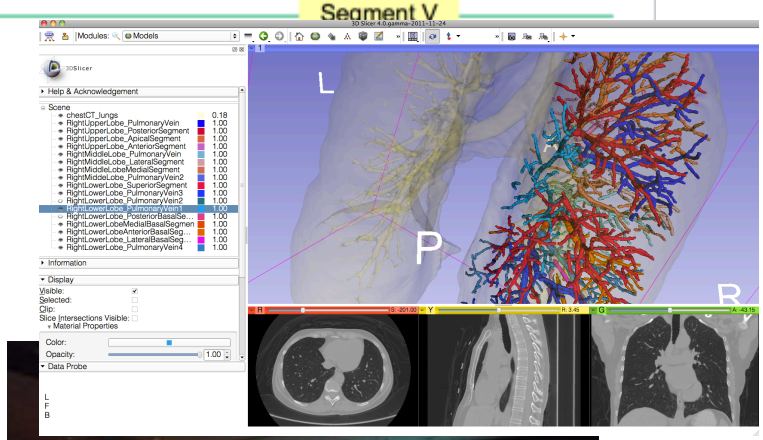


RSNA 3DVisualization Course

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

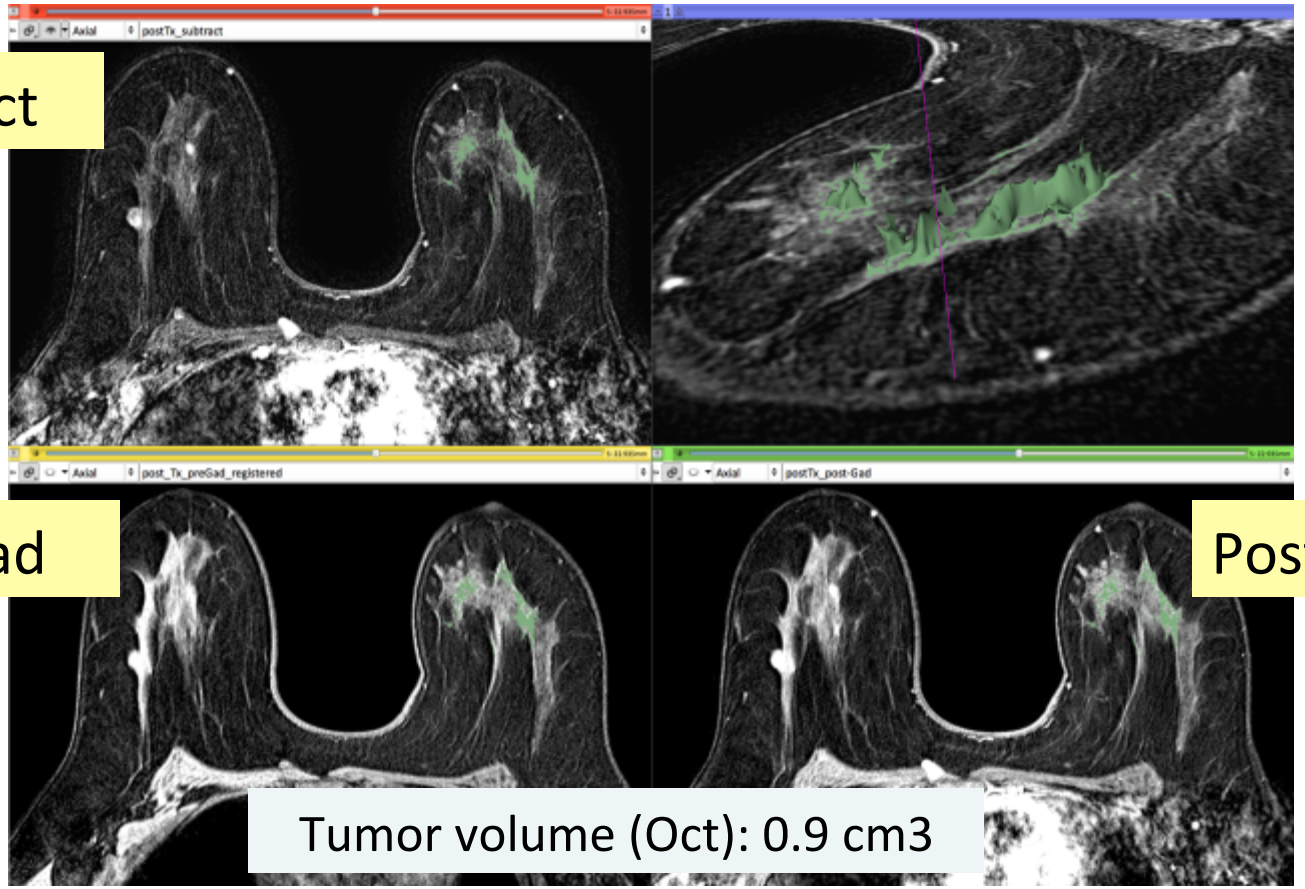
RSNA Quantitative Imaging Course

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



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**''

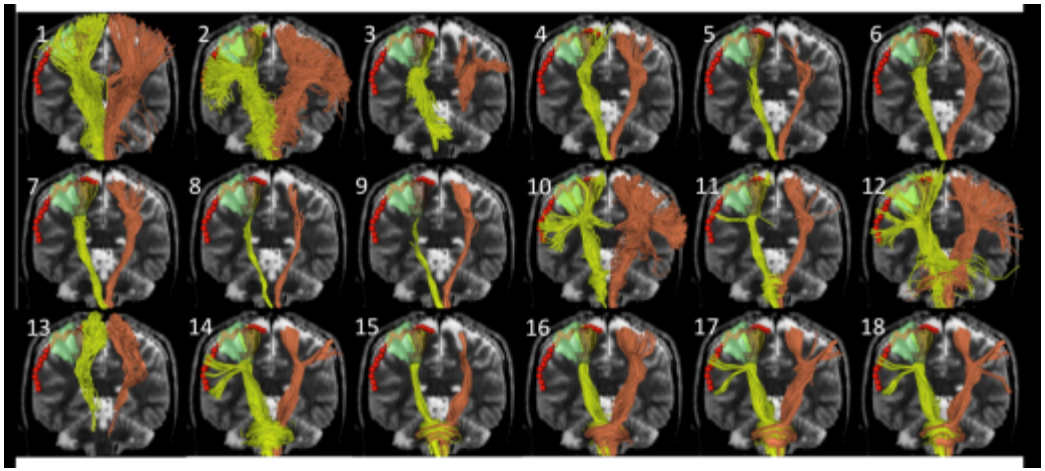
Radiology Today Citation

RSNA 2013

Slicer Course on RSNA 2013 postcard

World Congress of Neurosurgery 2013

WFNS 2013
XV WFNS World Congress of Neurosurgery
Seoul, Korea - 2013

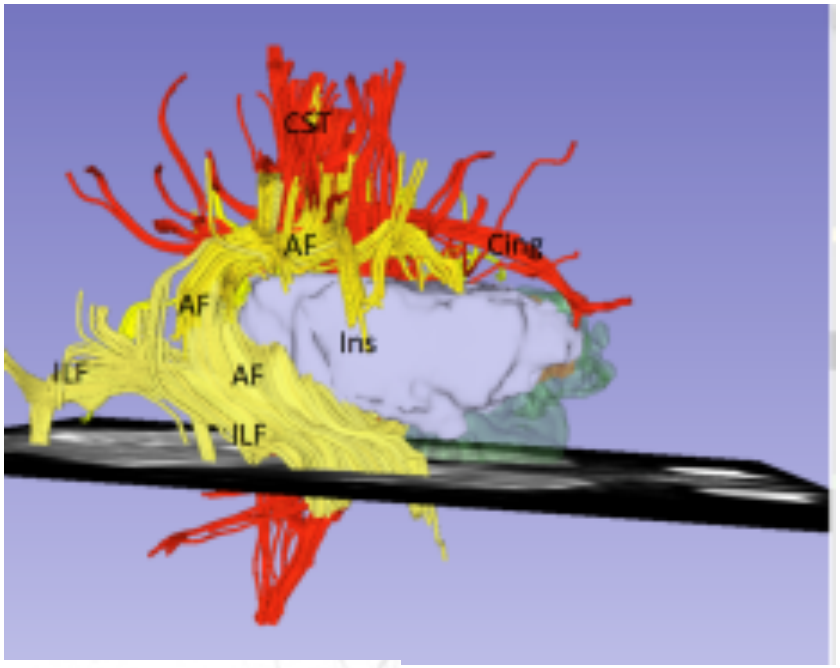


Towards Validation of DiffusionTensor Imaging Tractography for Neurosurgical Planning: The MICCAI DTI Tractography Challenge,

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



(Thanks to Nikos Makris, MD)

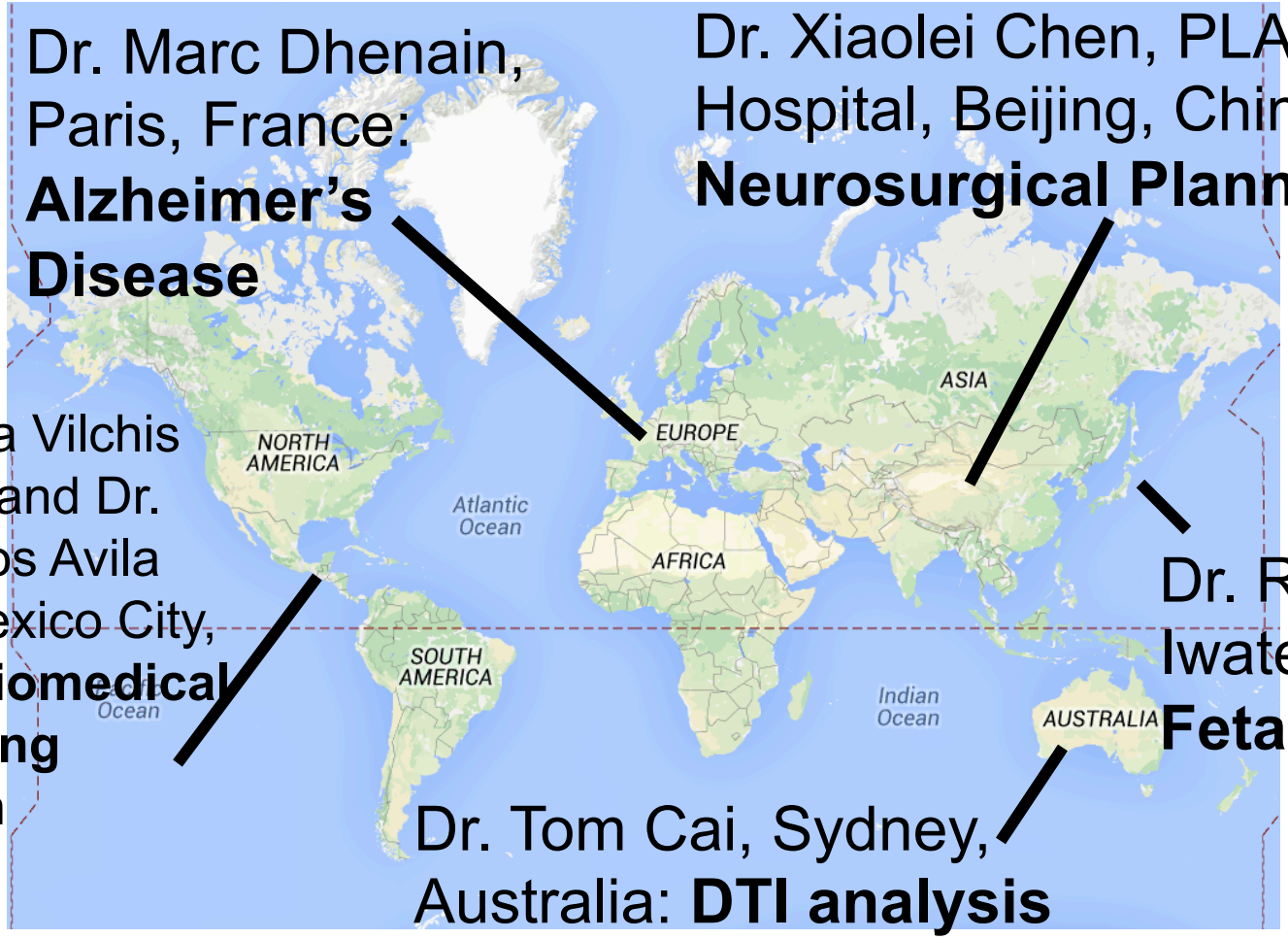
Invited lectures:

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

WFNS 2013
XV WFNS World Congress of Neurosurgery
Seoul, Korea - 2013

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

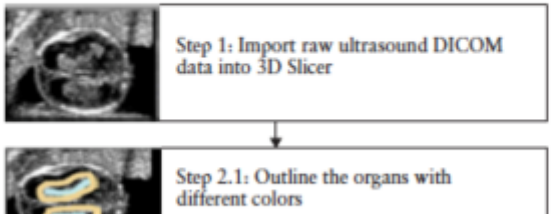
Picture of the Month

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, Morioa, 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.



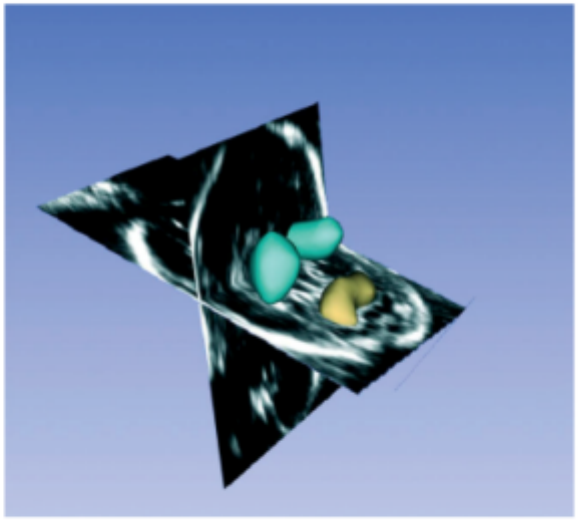


Figure 2 Result of 'Grow Cut Segmentation' of the fetal brain using

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らっています。

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

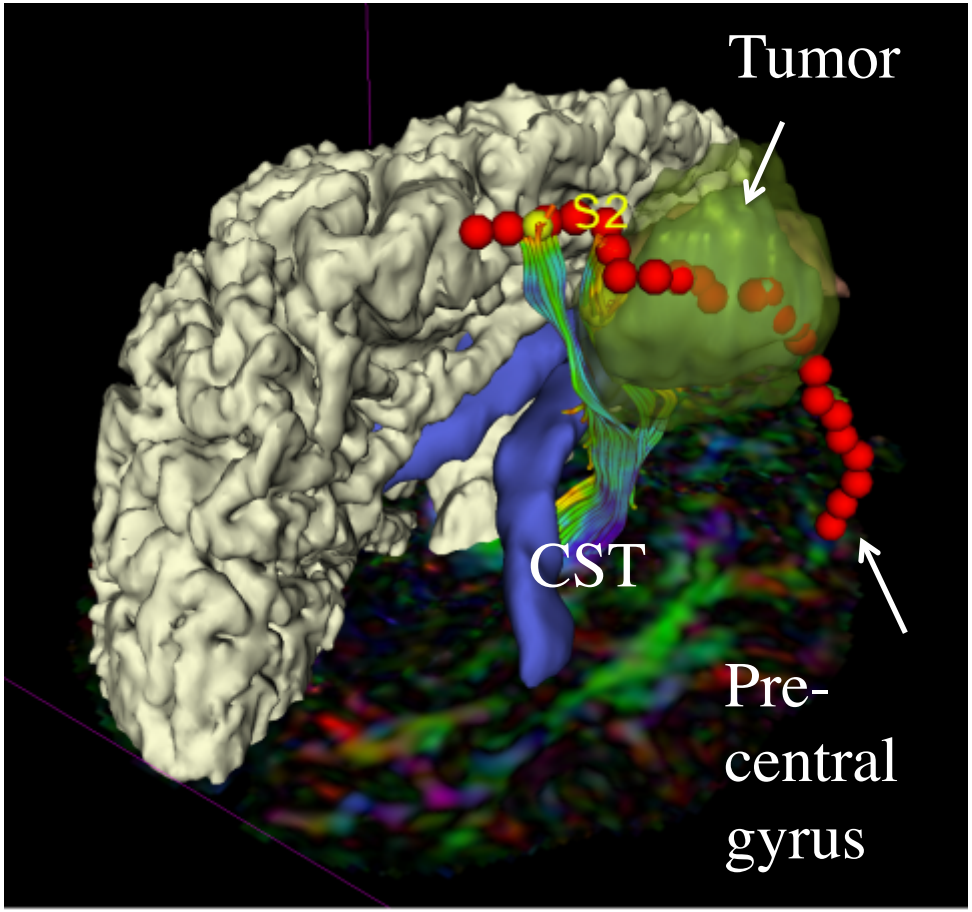
17th Project Week: MIT, Summer June 2013

- 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

Tina Kapur, Ph.D., Co-PI
Steve Pieper, Ph.D., Co-PI

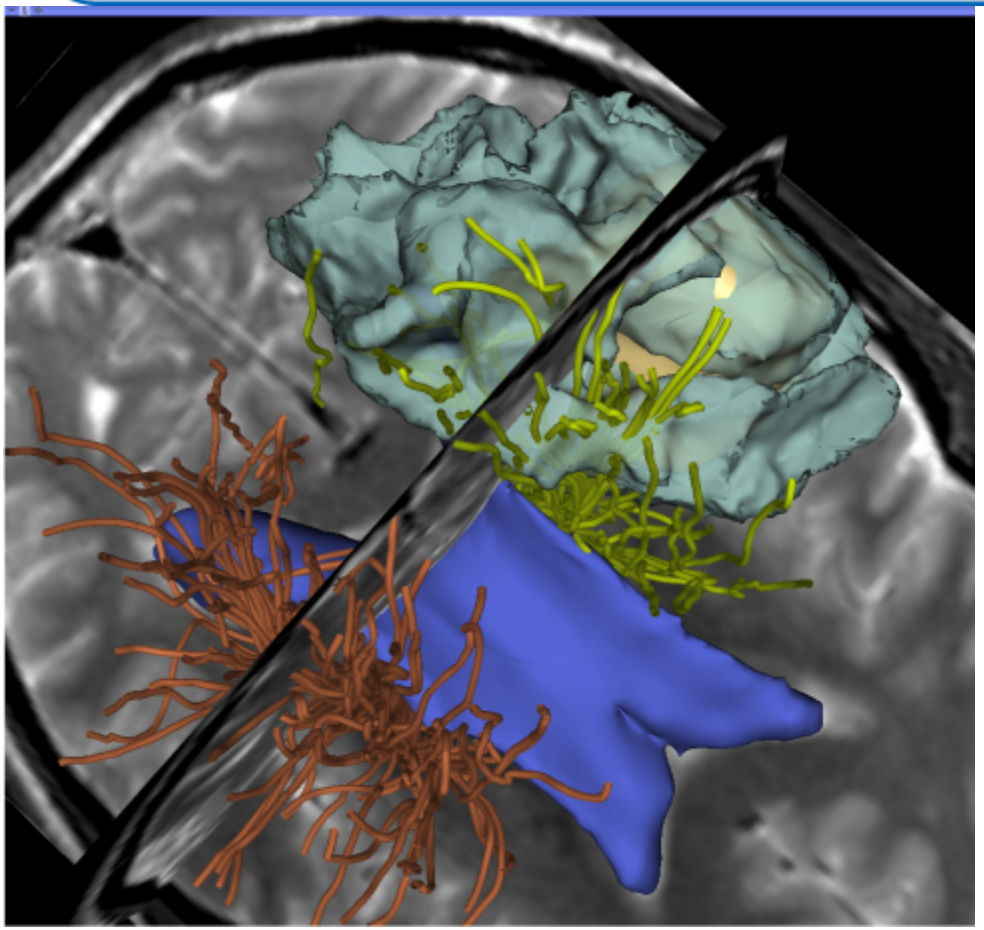
Validation Update Effort: the MICCAI DTI Challenge

DTI for Neurosurgery: Capabilities



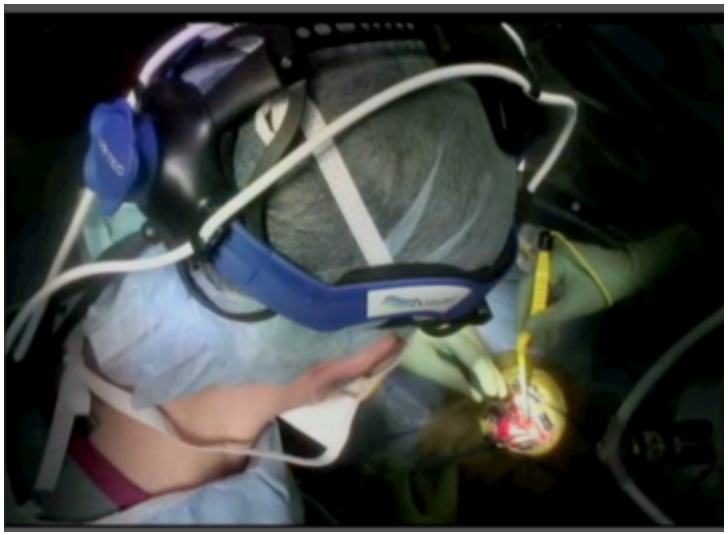
- Non-invasive 3D visualization of peritumoral white matter pathways
- Spatial relationship of a tumor with tracts involved in motor, visual or language function
- Spatial relationship between the tracts and eloquent cortex

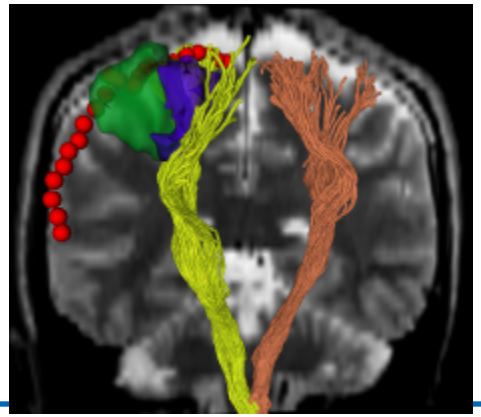
DTI Tractography for neurosurgery: Current Limitations



- 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

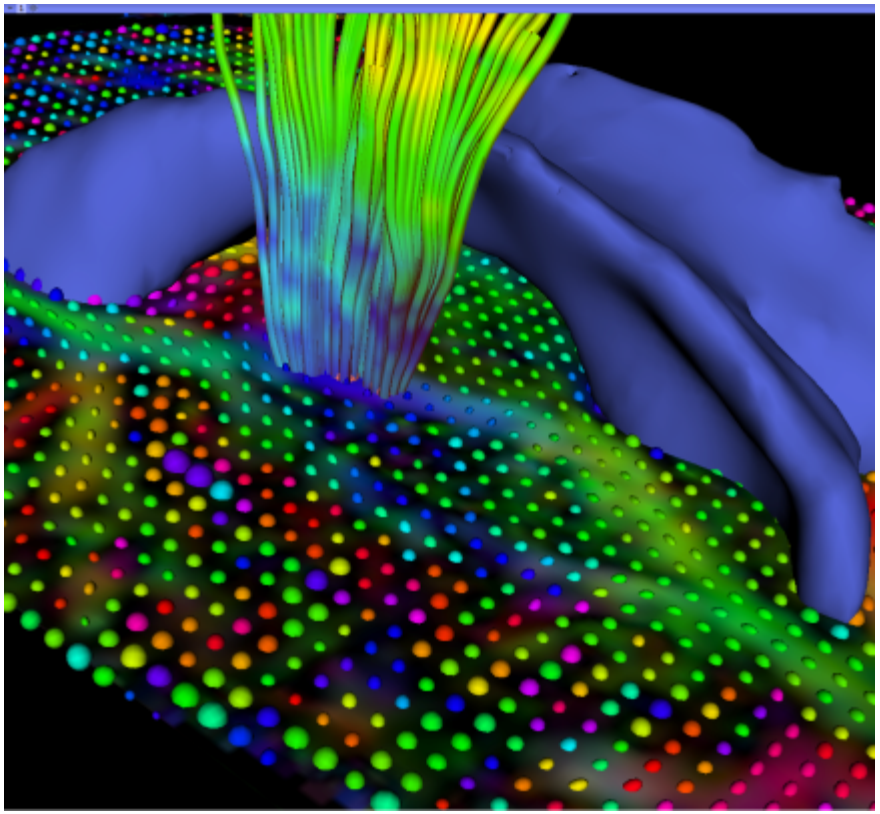
False-positive tracts

→risk of incomplete resection

True positive tracts but not essential tracts:

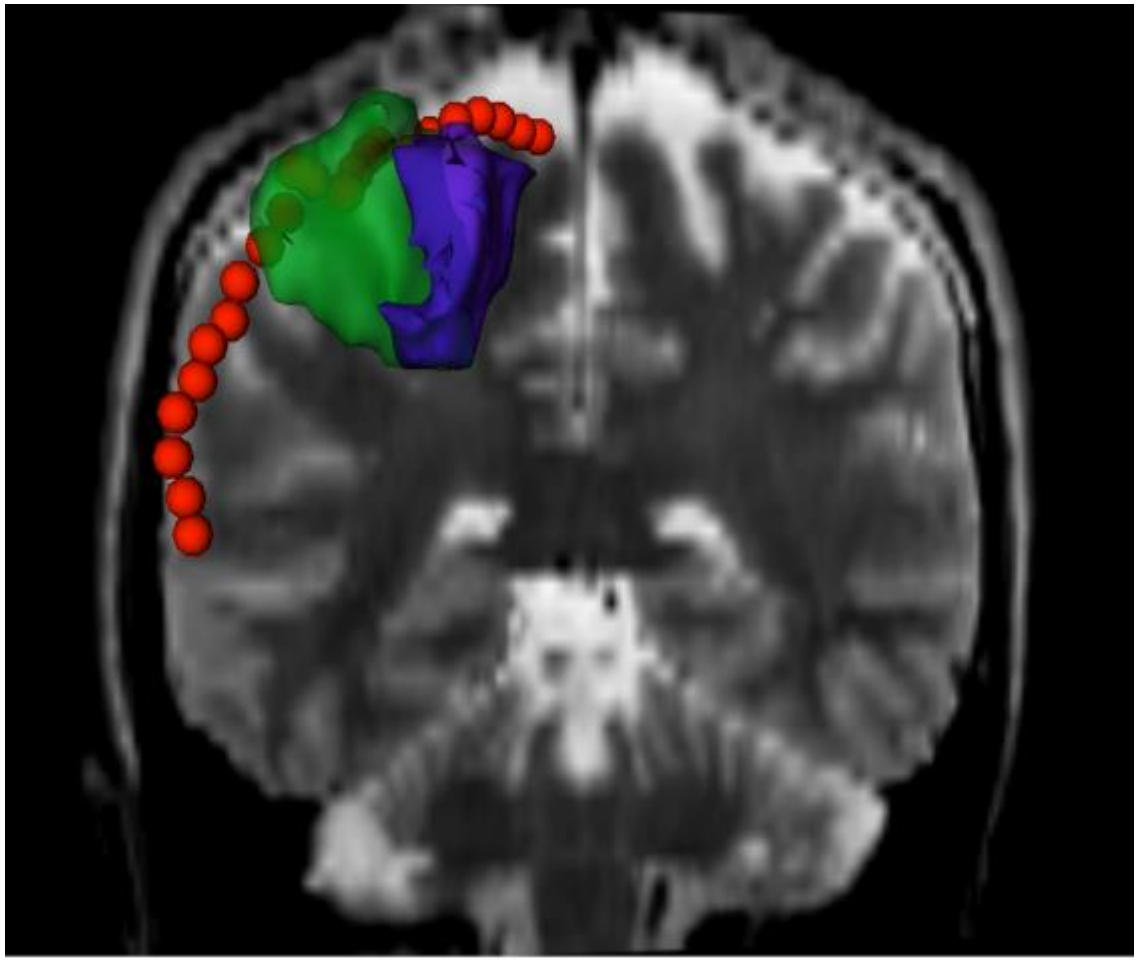
→risk of incomplete resection

DTI Tractography research

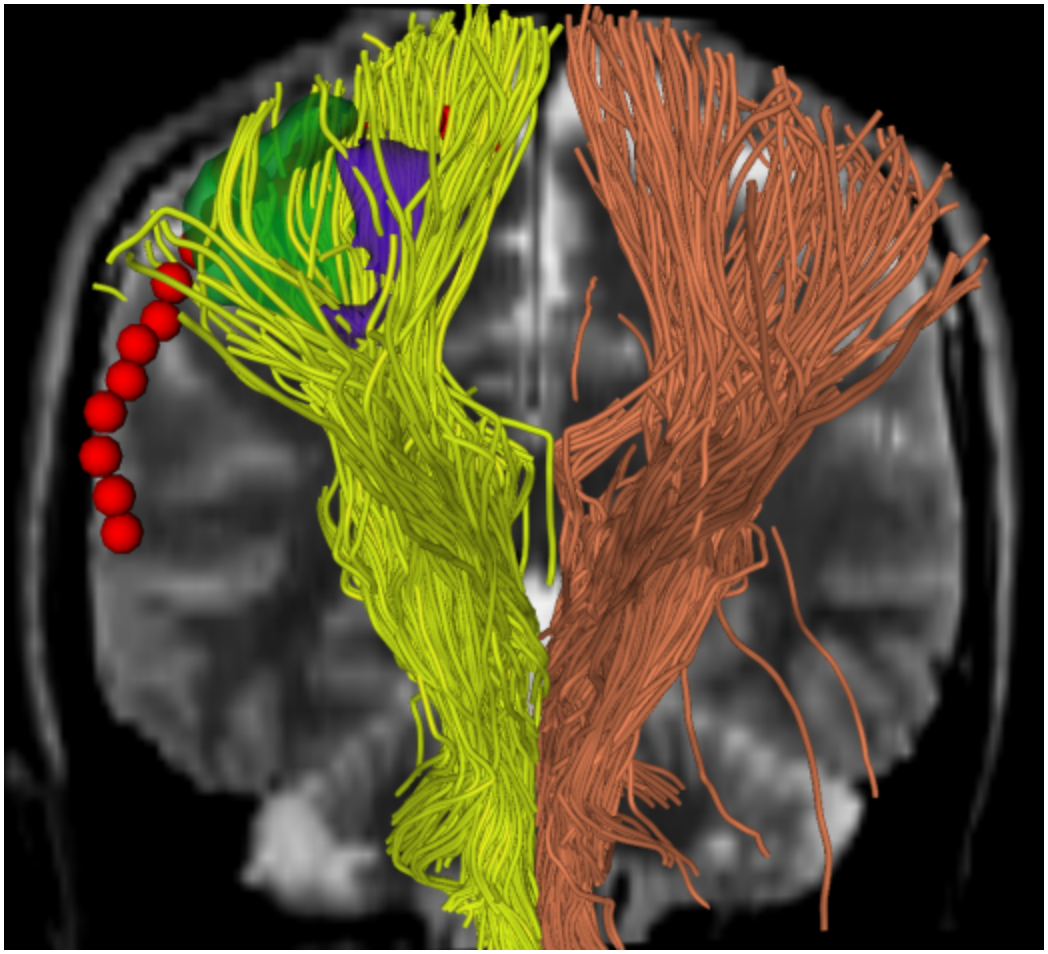


The complexity of DTI data has fostered many exploratory activities in new computational approaches for tracing white matter pathways.

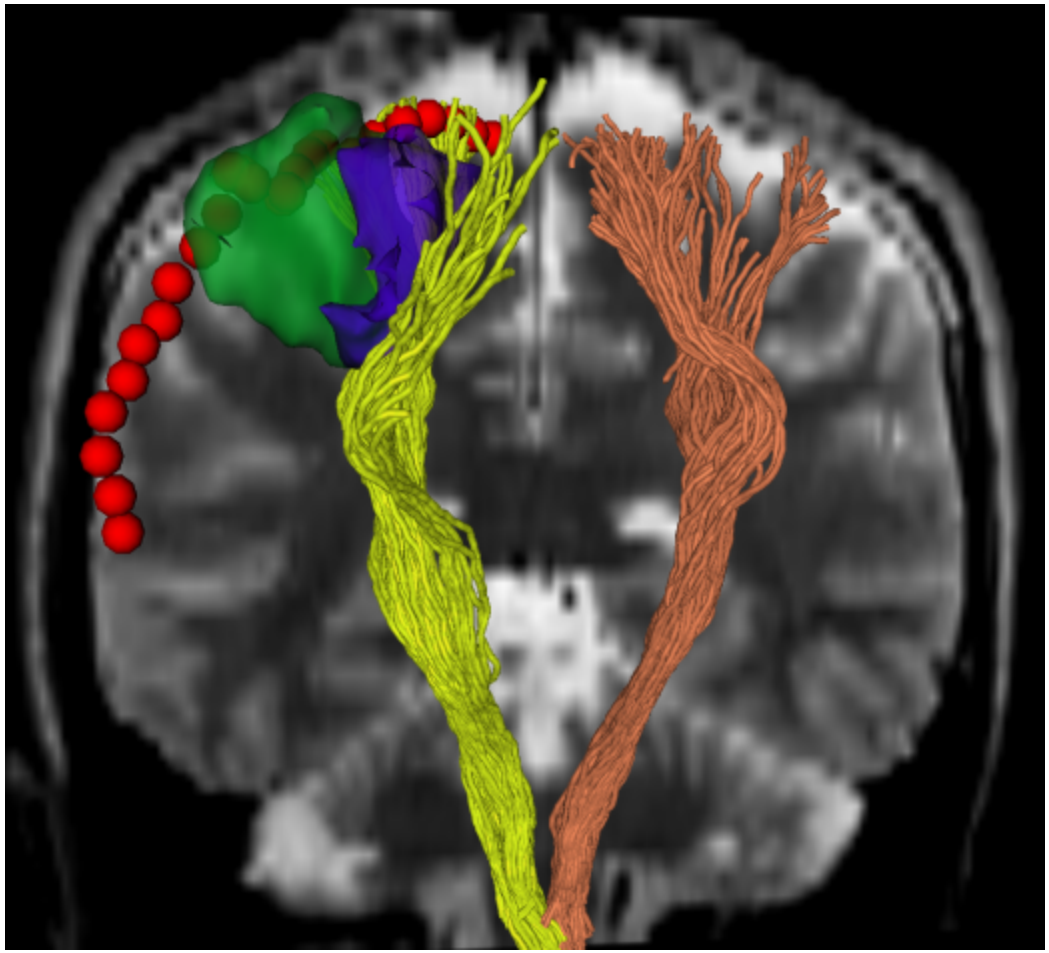
Clinical Case: 47 yo professionnal golfer



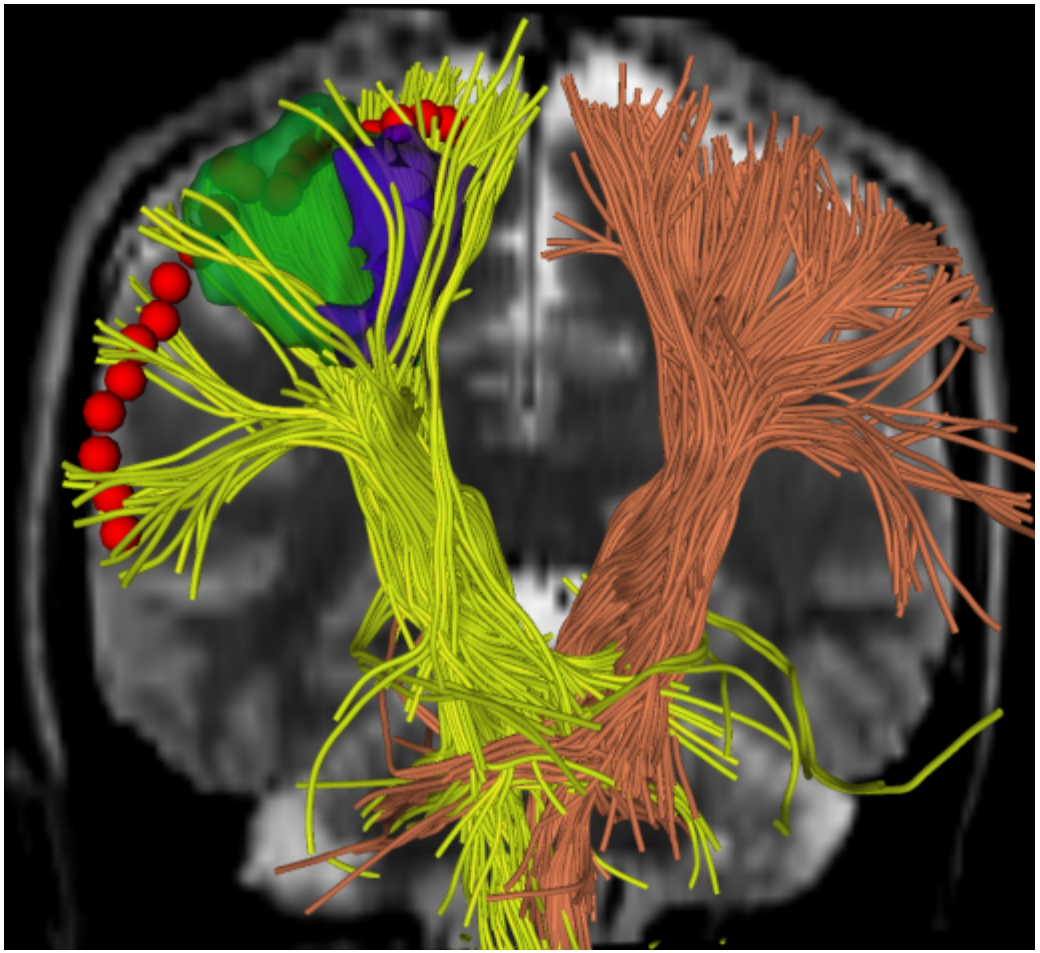
CST Reconstruction: Method #1



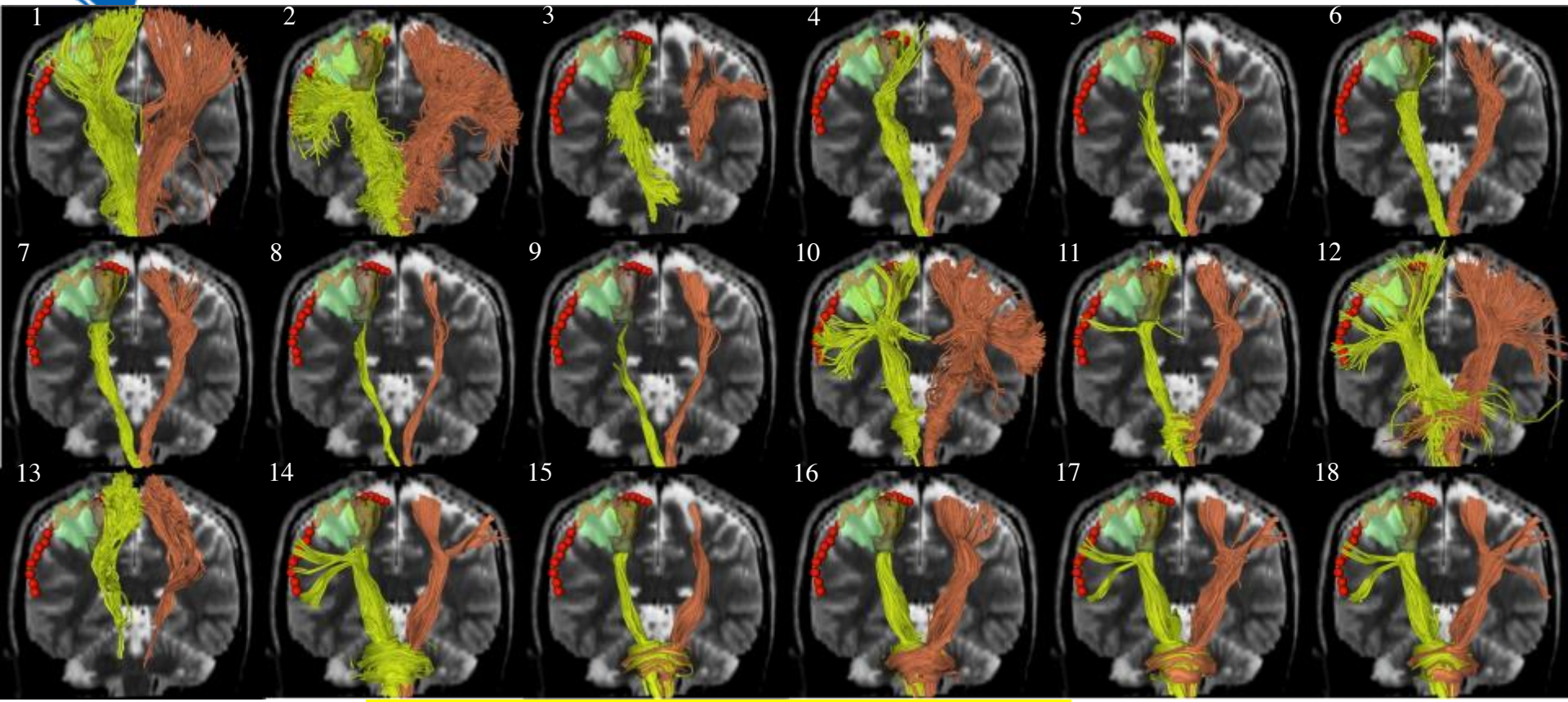
CST Reconstruction: Method #2



CST Reconstruction: Method #3



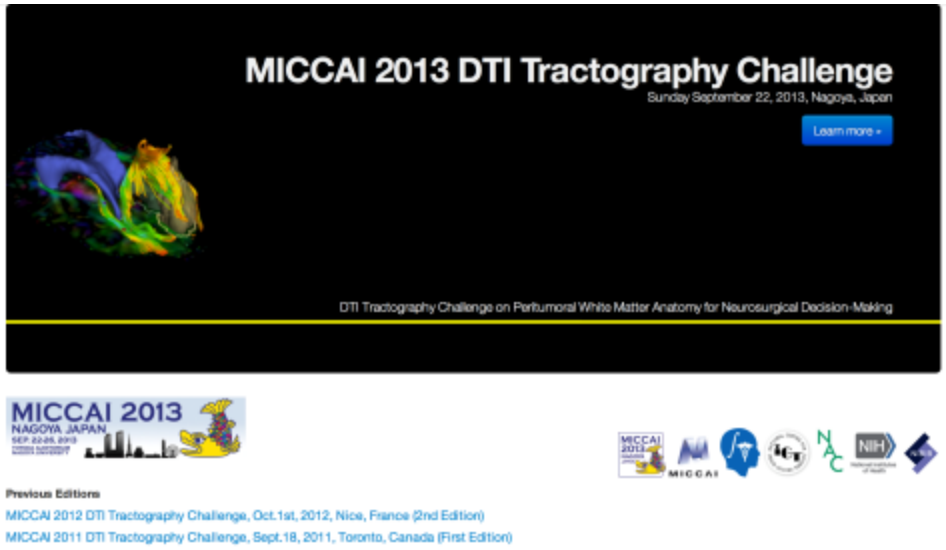
Corticospinal Tract 18 methods



Need for validation of DTI tractography findings

MICCAI 2012 DTI Challenge

DTI Challenge Project



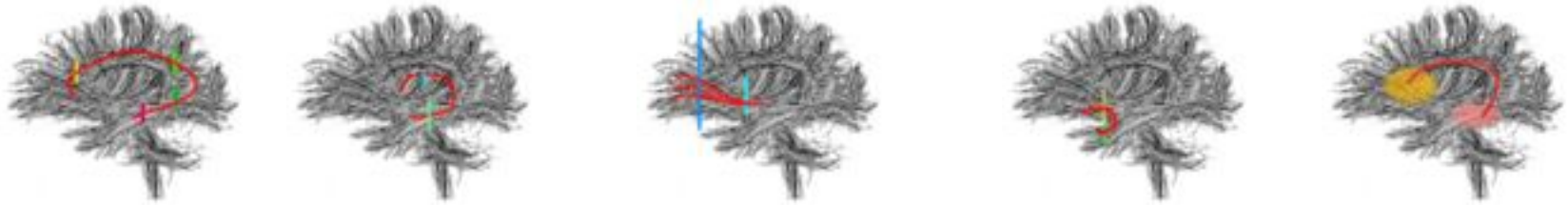
Goal:

- 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

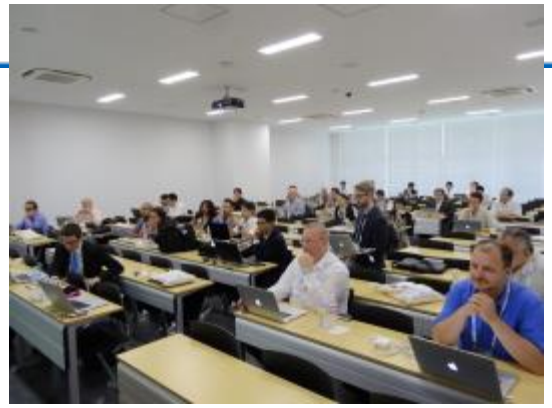
Dr. Alexandra Golby, Boston, USA
Dr. Arya Nabavi, Kiel, Germany
Dr. Sandrine De Ribaupierre, London, Ontario, Canada
Dr. David Fortin, Sherbrooke, Canada
Dr. Francesco Cardinale, Milan, Italy
Dr. Xiaolei Chen, Beijing, China
Dr. Ye Li, Beijing, China
Dr. Hugues Duffau, Montpellier Hospital, France
Dr. Yoshihiro Muragaki, Tokyo, Japan
Dr. Luke Maczyn, Philadelphia, USA
Dr. Yasukazu Kajita, Nagoya, Japan

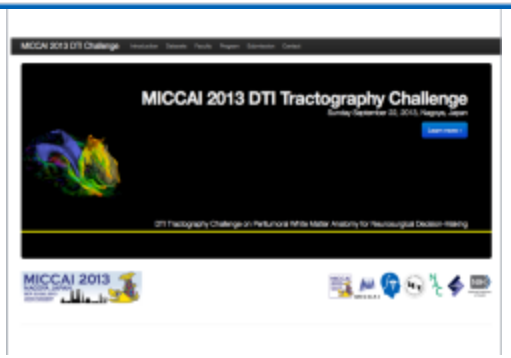
19 Tractography Groups

1. A. Khan. Robarts Research Institute, Toronto, Canada
2. C.Brun, UPenn, Philadelphia, USA
3. H.Jonhson, University of Iowa, USA
4. O.Commonwick, 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 Chapell 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

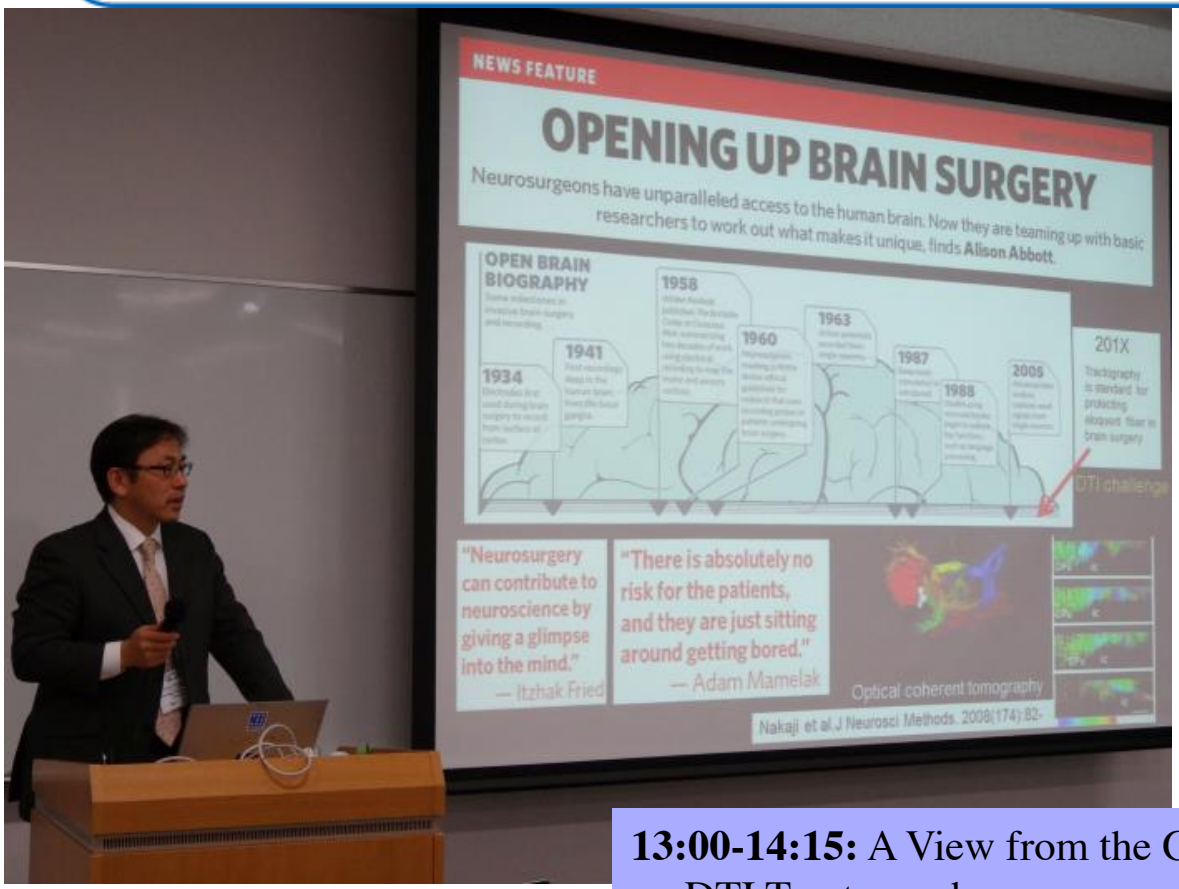
DTI Challenge 2nd Edition
MICCAI 2012
Nice, France

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)

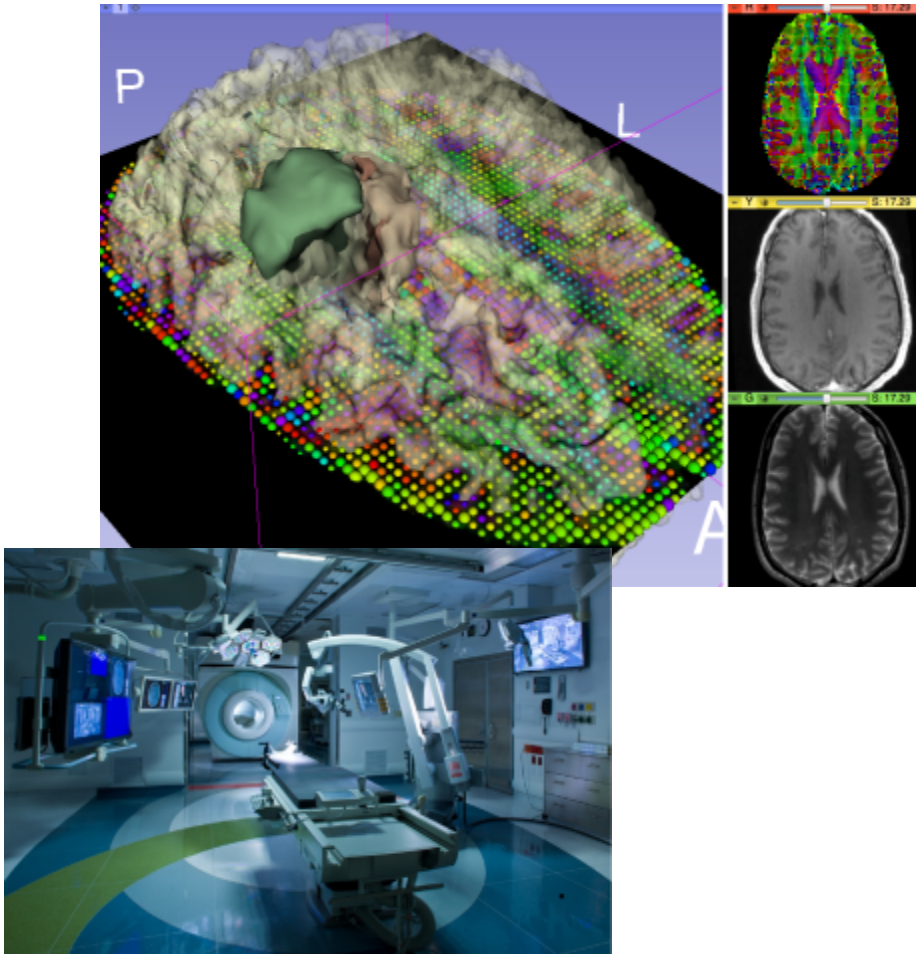


10 neurosurgeons
10 tractography teams

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

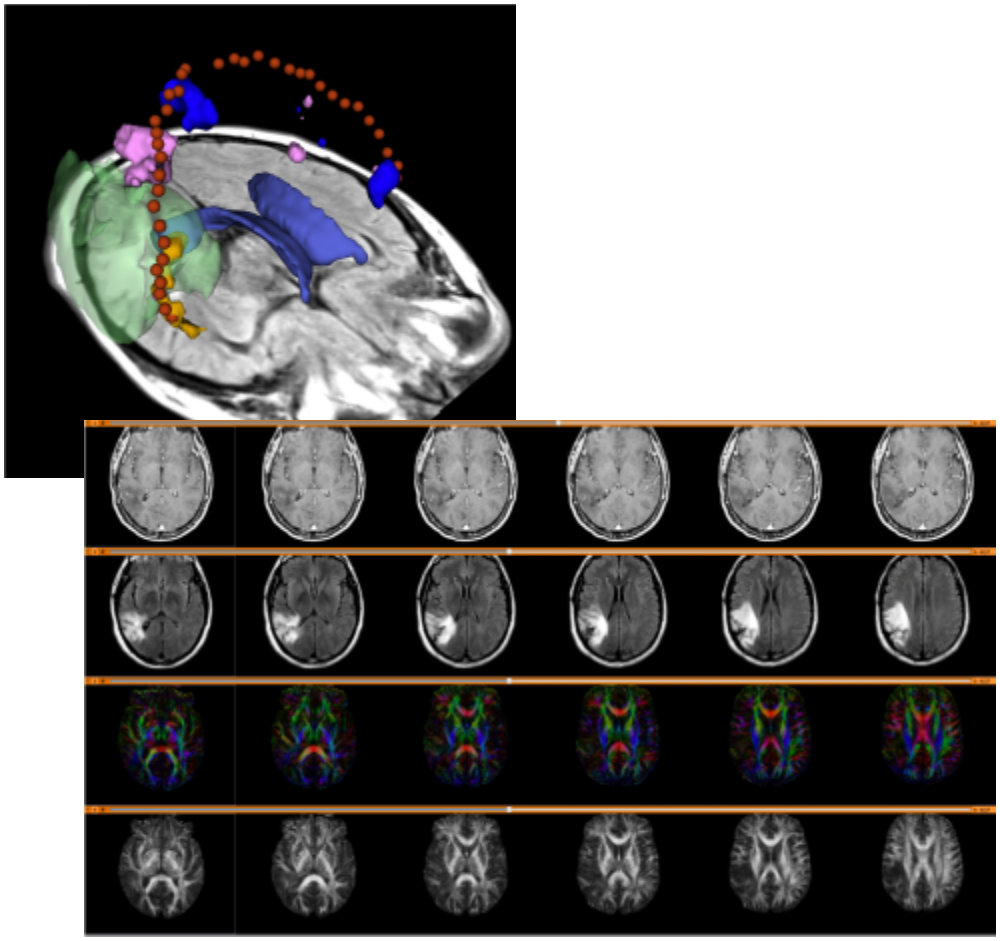
- *Arya Nabavi M.D.,Kiel, Germany*
- *Yoshihiro Muragaki M.D., Ph.D., Tokyo, Japan*
- *Luke Macyszyn, M.D. Philadephia, USA*
- *Sandrine de Ribaupierre, M.D., London Ontario, Canada*

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

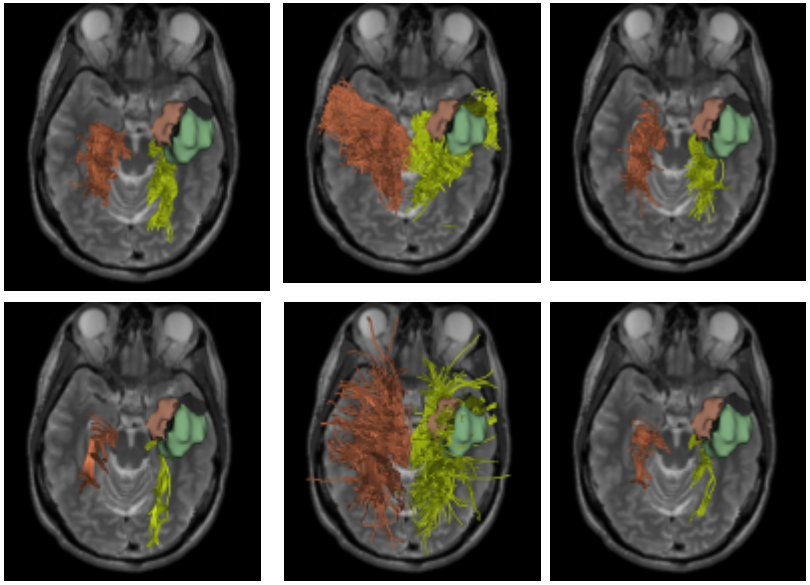
Standardization effort using 3D Slicer



MICCAI 2013 DTI Challenge

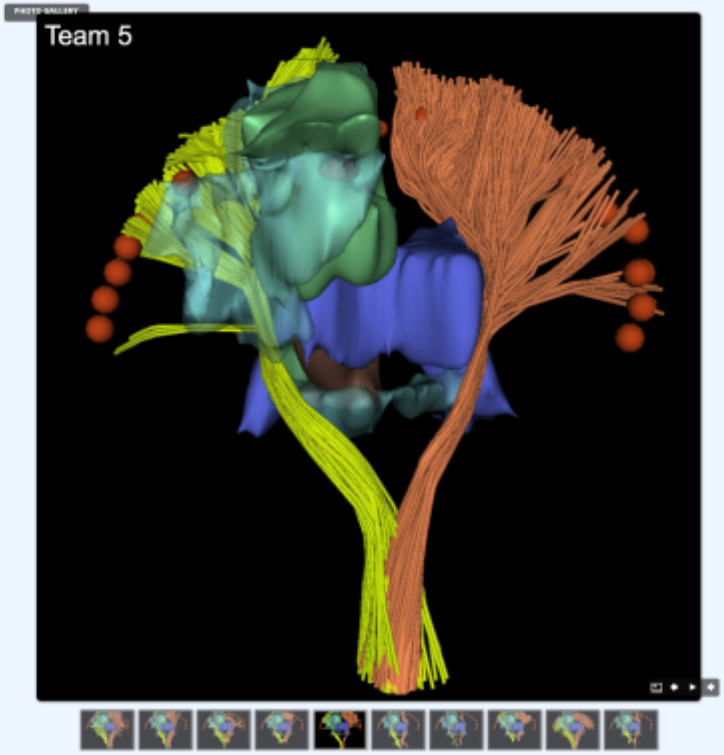
3D Slicer as a platform for technology comparison

Evaluation of Tractography Results



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

Standardized review questionaire



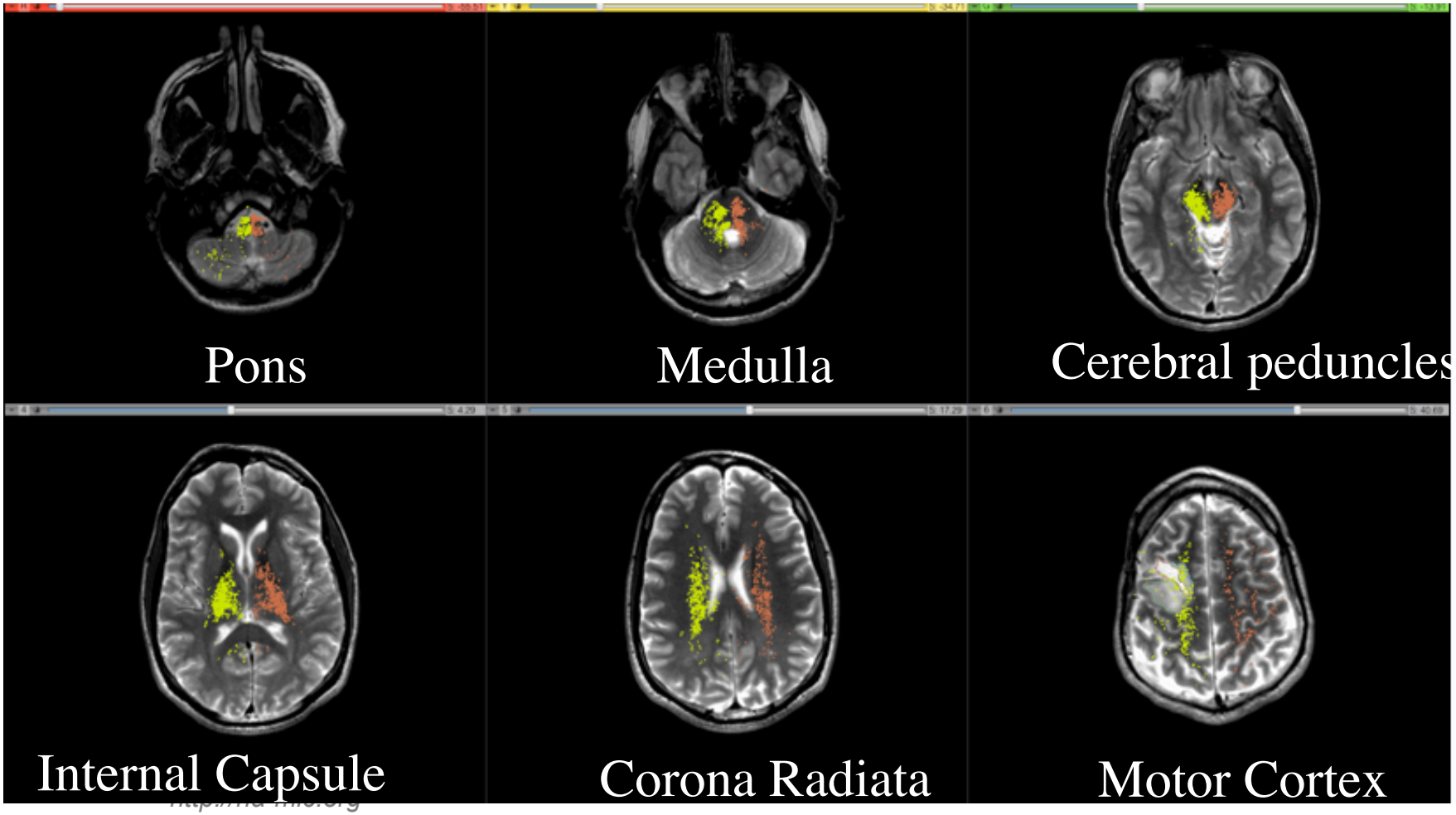
Question 1: Please rate the anatomical correctness of the tractography reconstruction in the motor cortex area using a 1 to 5 answer.

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

	1	2	3	4	5
Team1	○	○	○	○	○
Team2	○	○	○	○	○
Team3	○	○	○	○	○
Team4	○	○	○	○	○
Team5	○	○	○	○	○
Team6	○	○	○	○	○
Team7	○	○	○	○	○
Team8	○	○	○	○	○
Team9	○	○	○	○	○
Team10	○	○	○	○	○

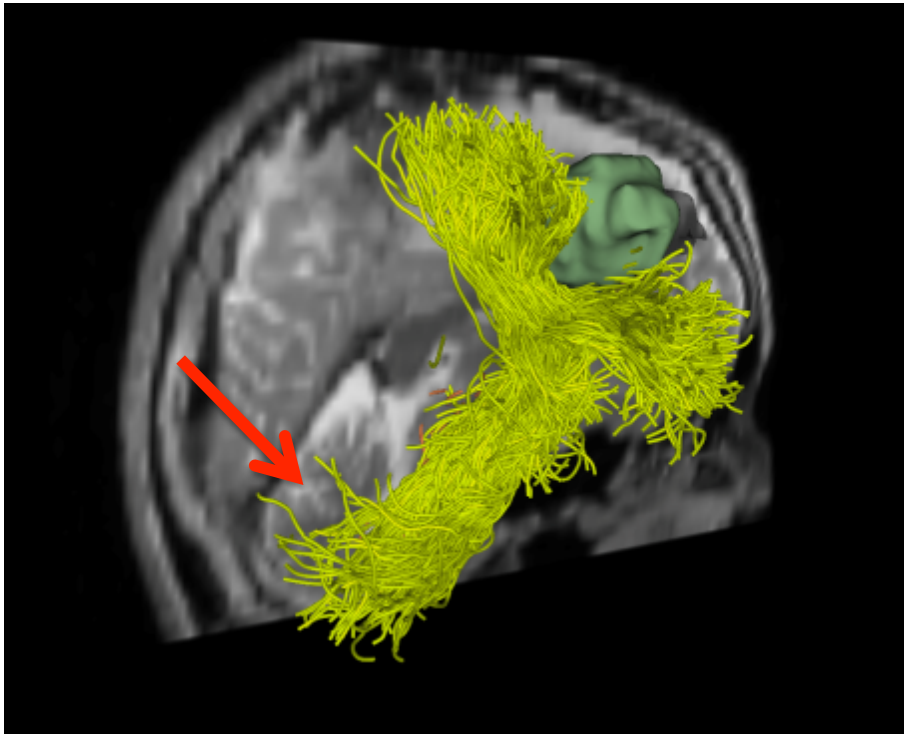
Clinical evaluation criteria

C1. Anatomical Correctness

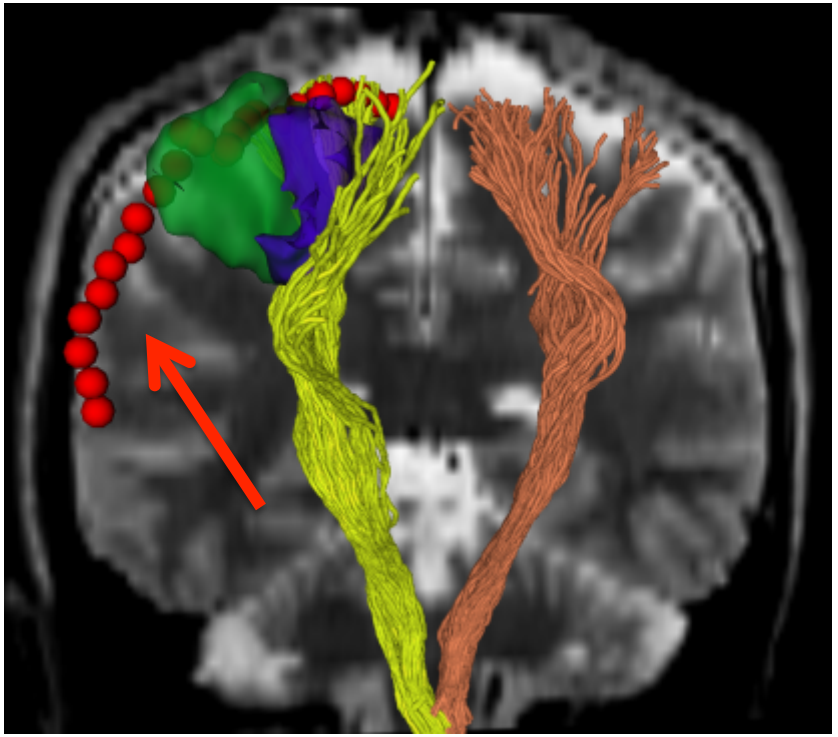


Clinical evaluation criteria

C2. False-positive tracts

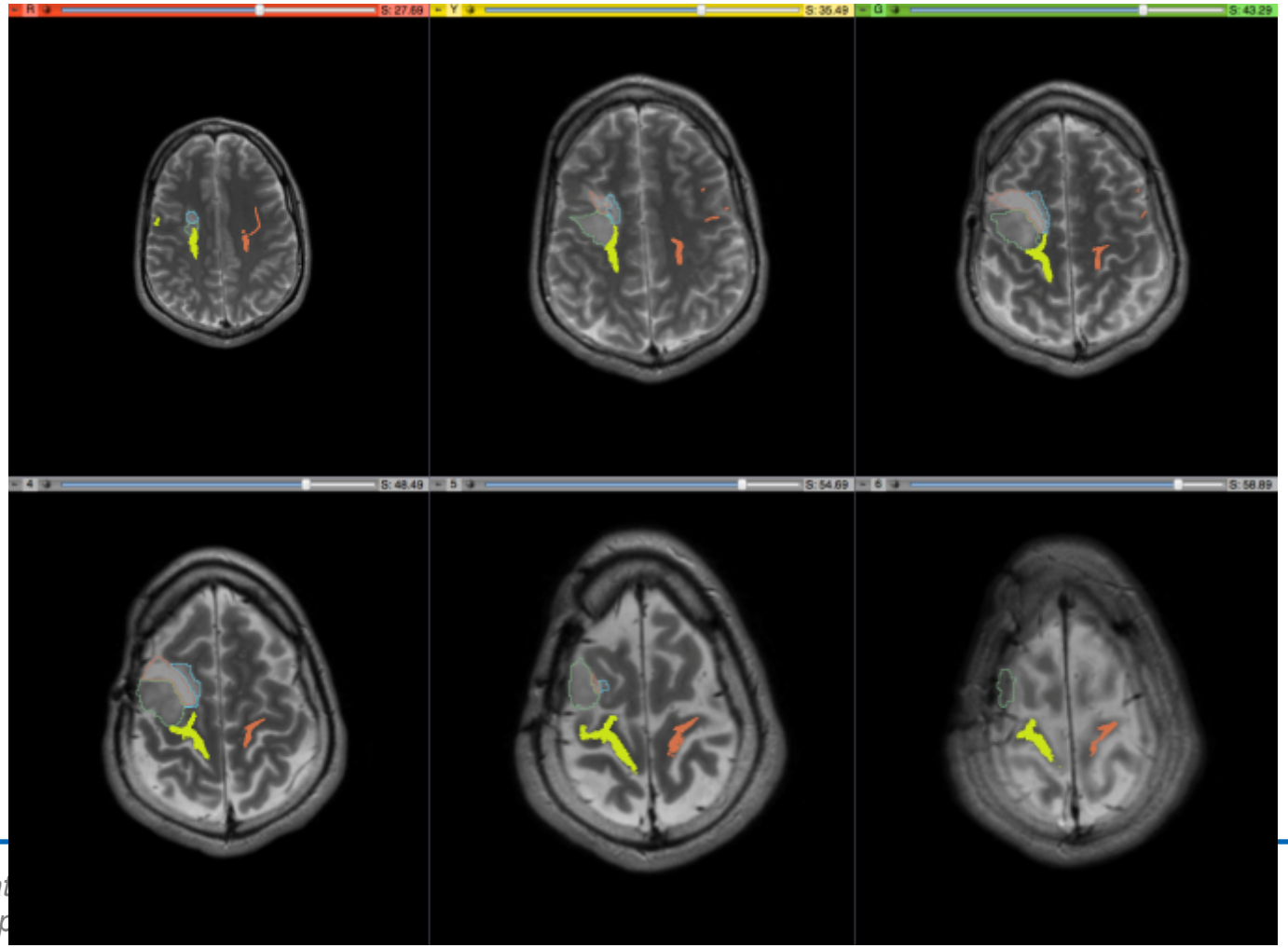


C3. False-negative tracts



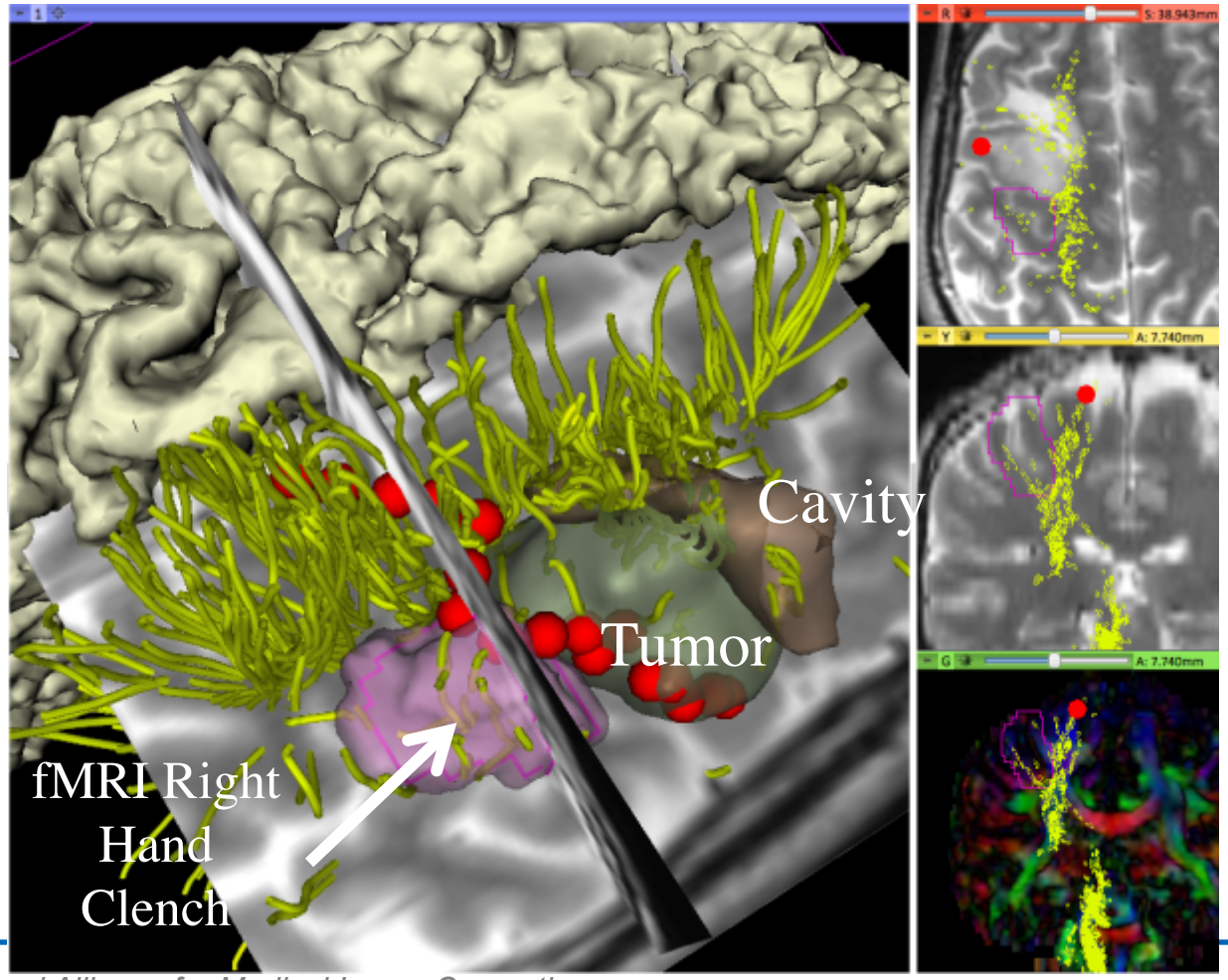
Clinical evaluation criteria

C4. Peritumoral Tracts

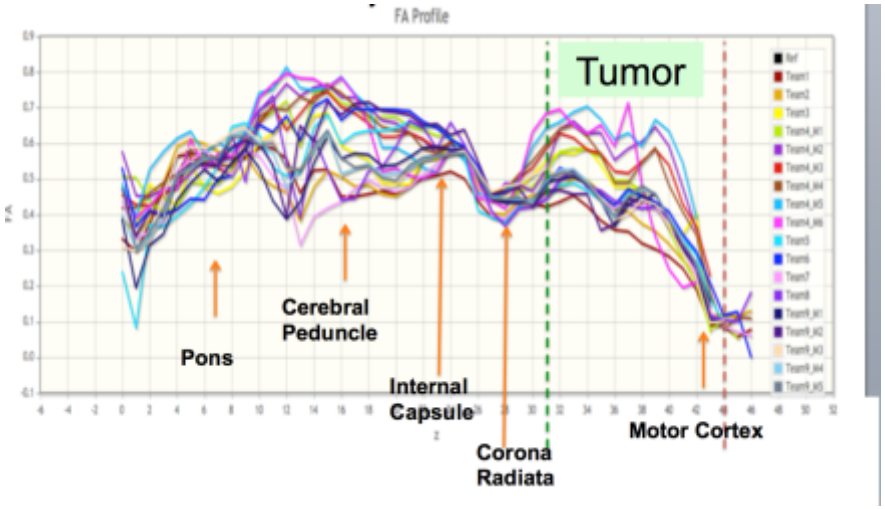


Clinical evaluation criteria

C5. Anatomico-functional correlation

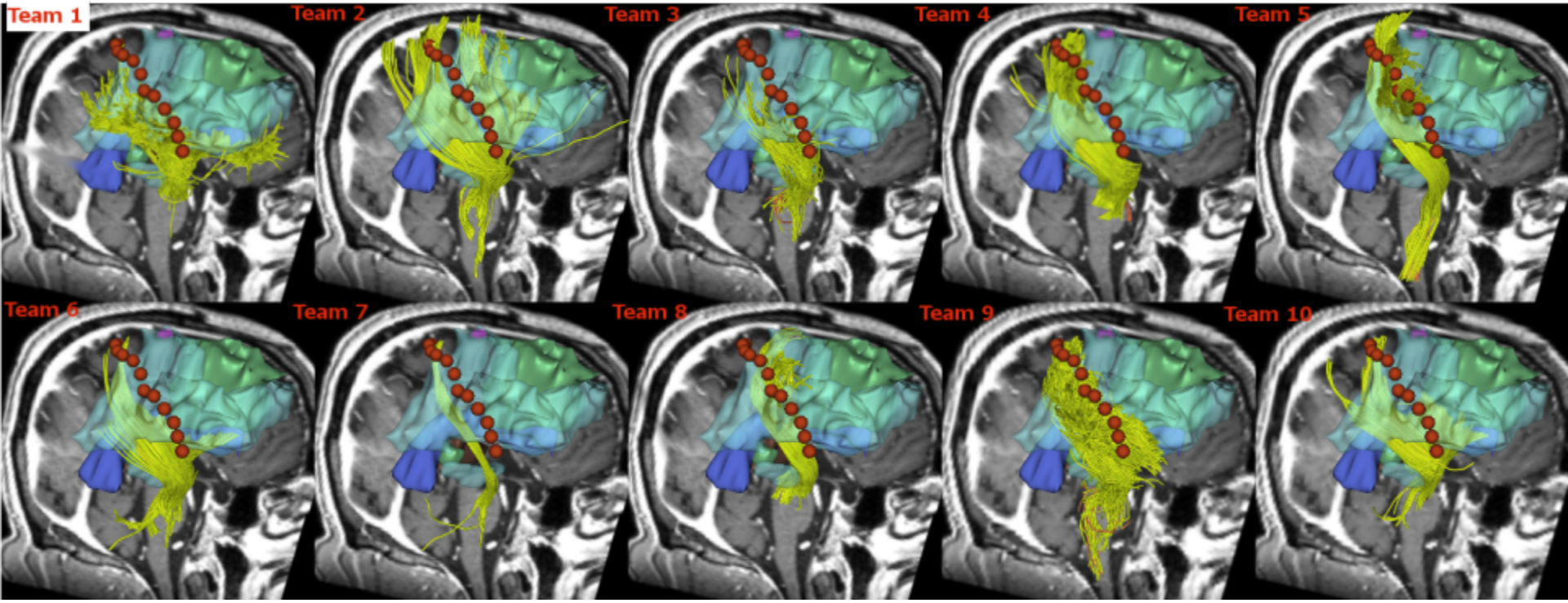


Quantitative Evaluation

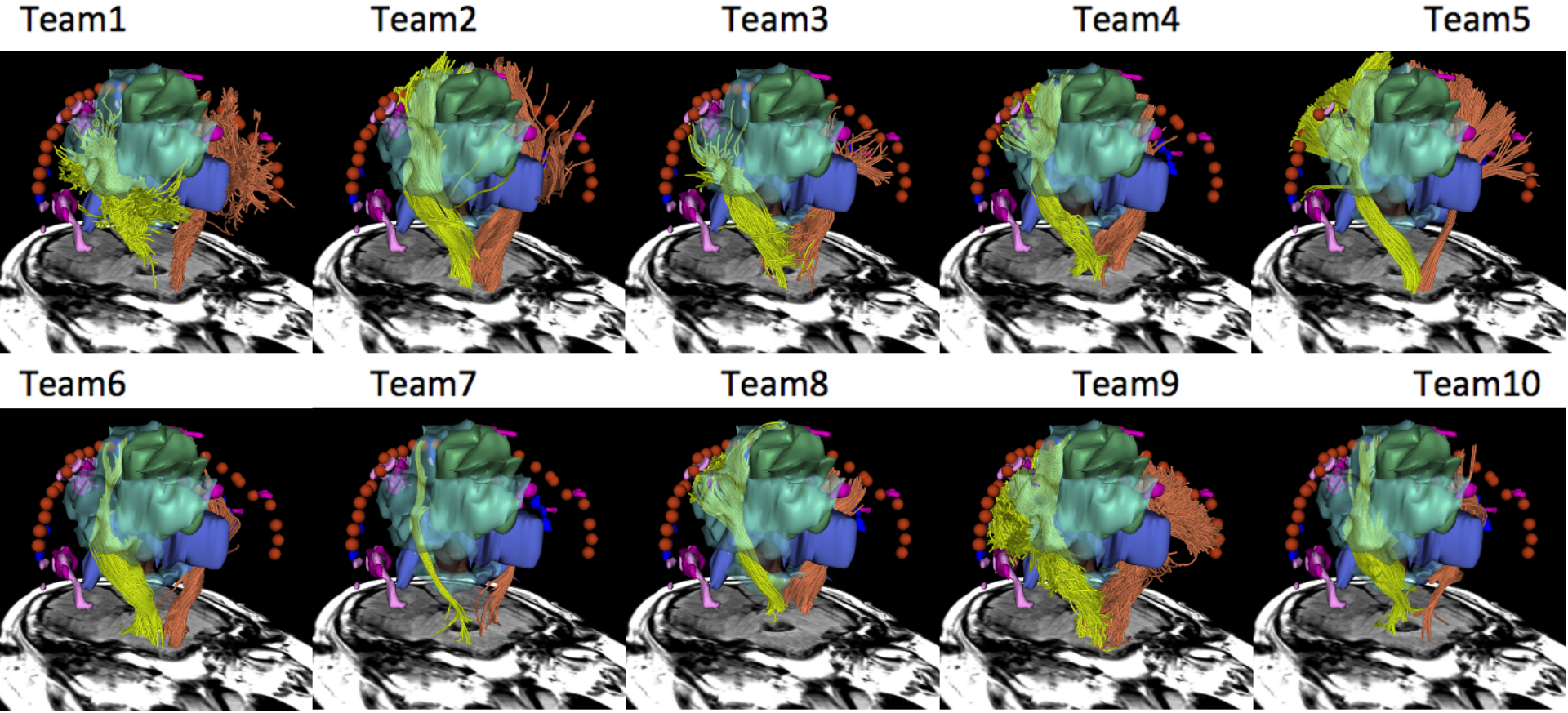


- Metric 1: Degree of bundle overlap
- Metric 2: Distance between tracts
- Metric 3: Bundle Profile of Fractional Anisotropy

MICCAI 2013 Results



MICCAI 2013 Results



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)	Patient3-20dir (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		
STD	0.08	0.095		

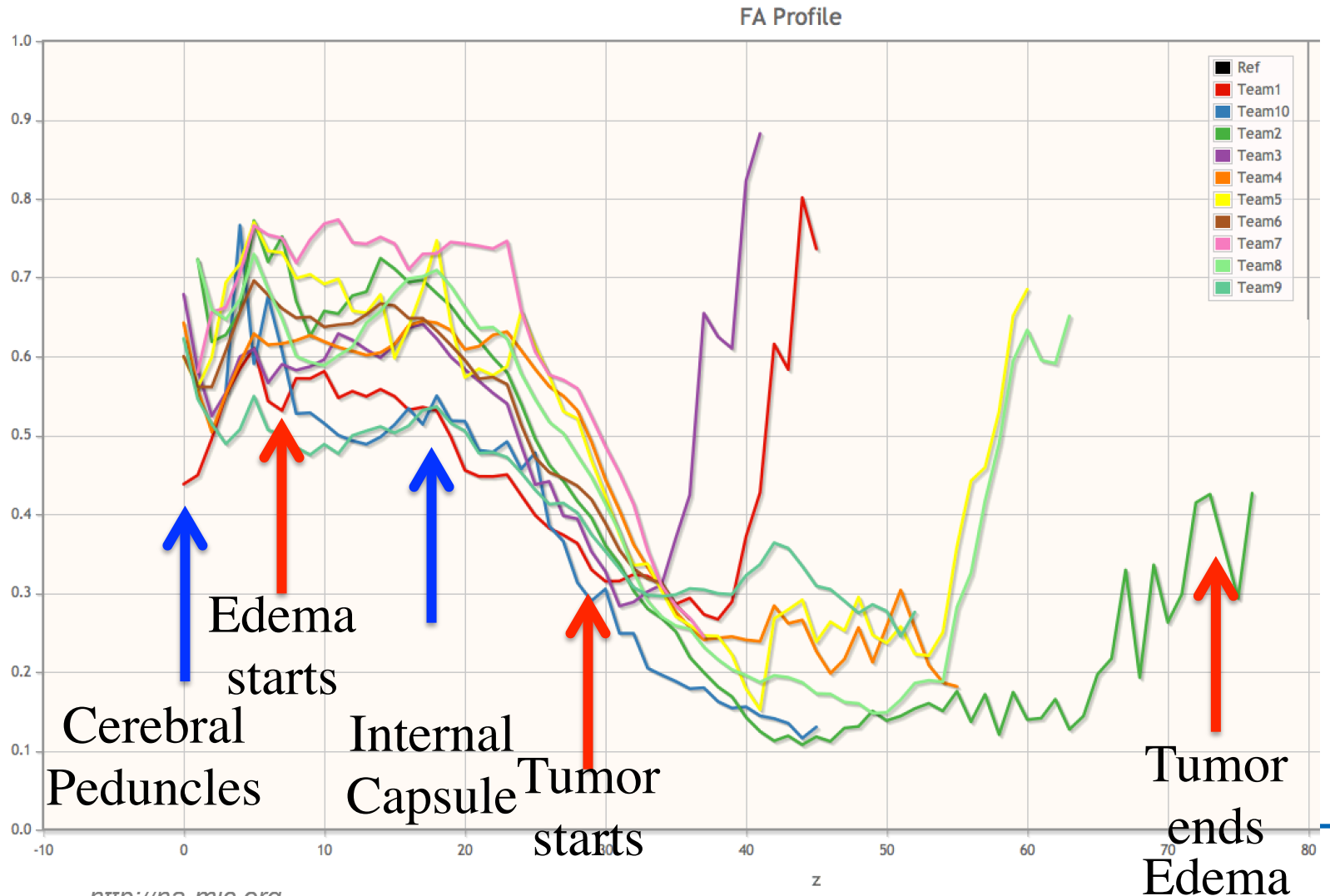
Similar (weak) overlap values tumor vs. healthy side

Healthy Side	Patient 1 (Healthy side)	Patient 2 (Healthy side)	Patient 3-20 dir (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

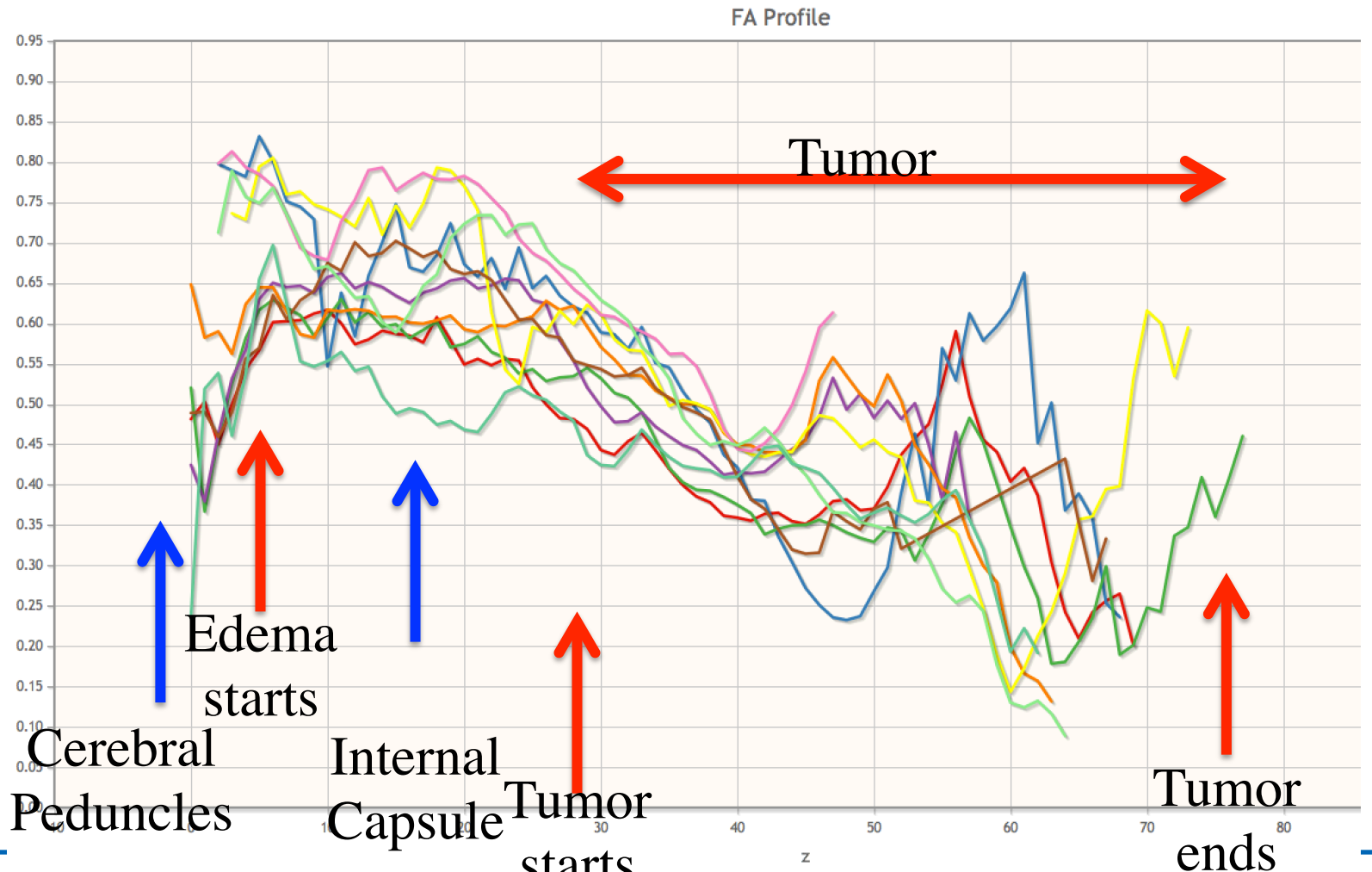
Q2: Does the variability among methods depend on the anatomical location ?

FA Profile along the CST

FA profile (tumor side)

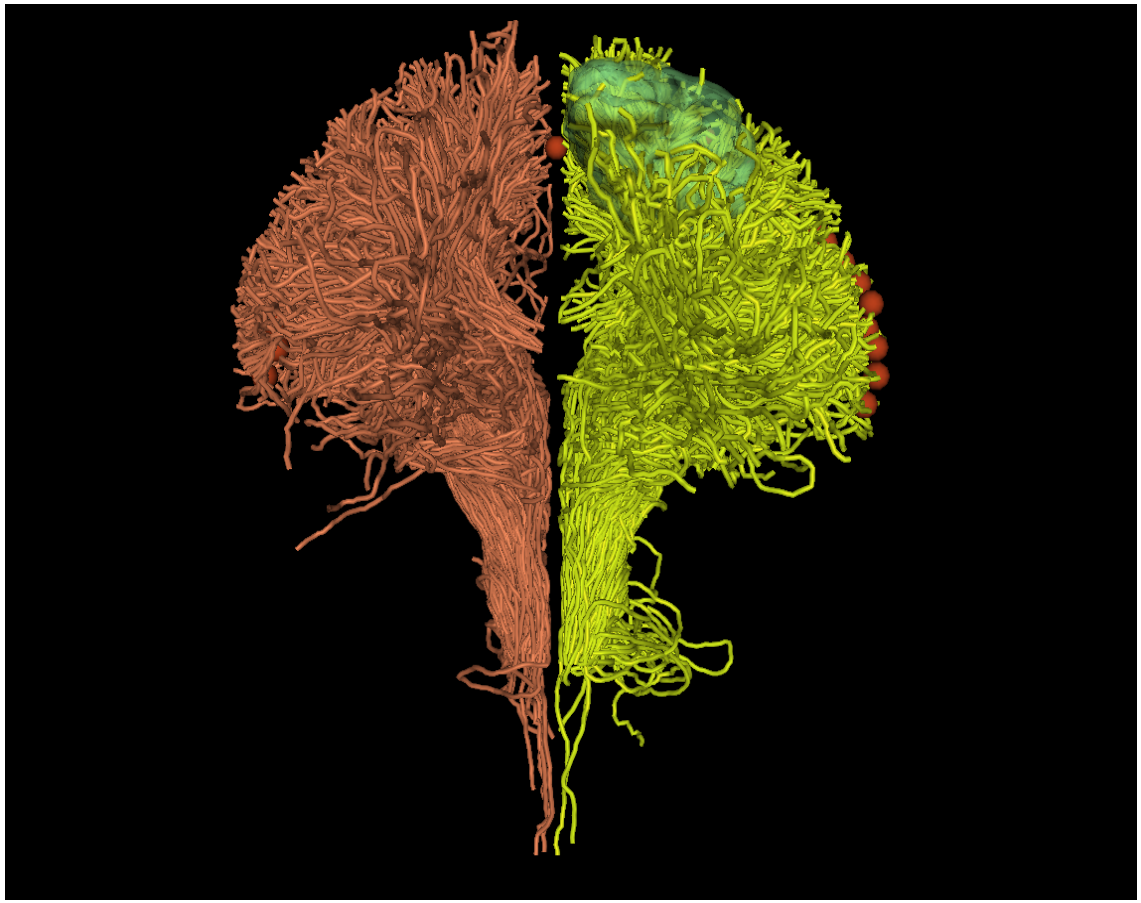


FA profile (contralateral side)

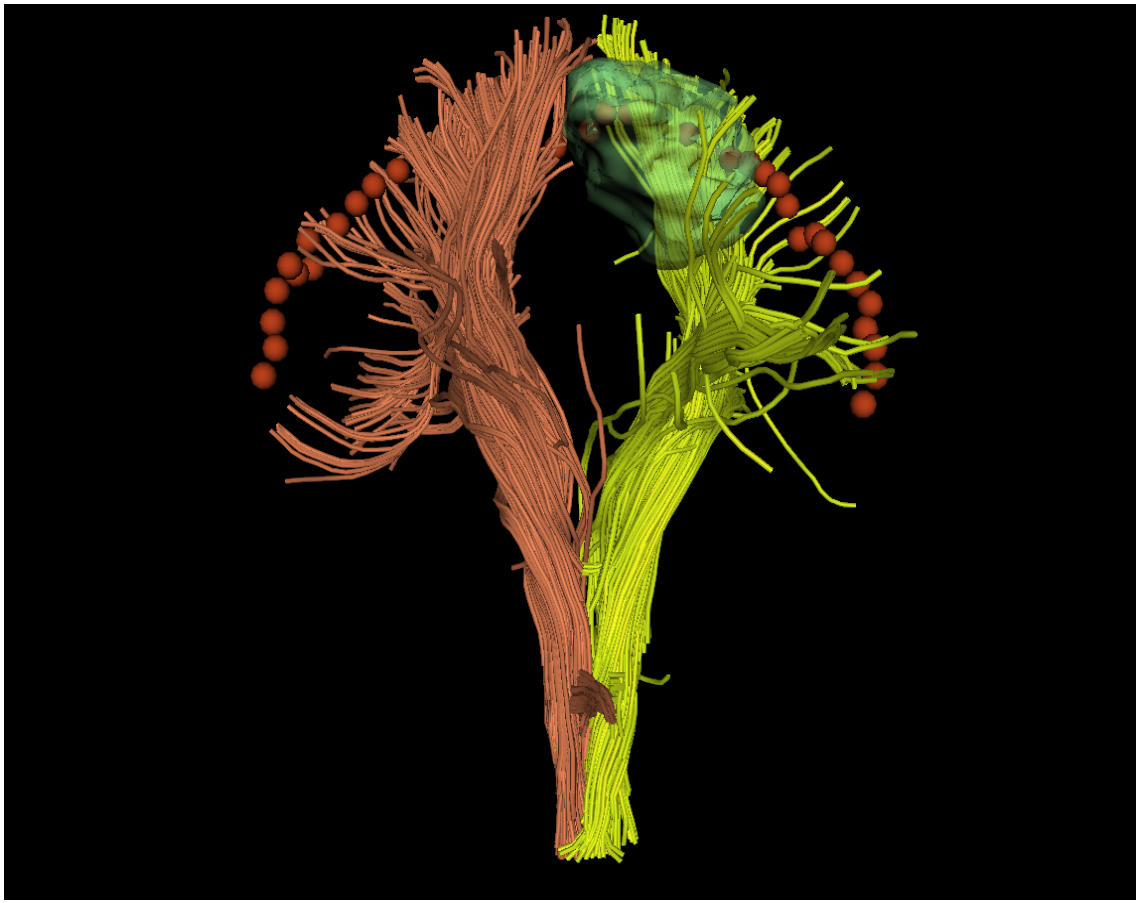


Q3: Are the different methods in agreement in the lateral projections of the CST ?

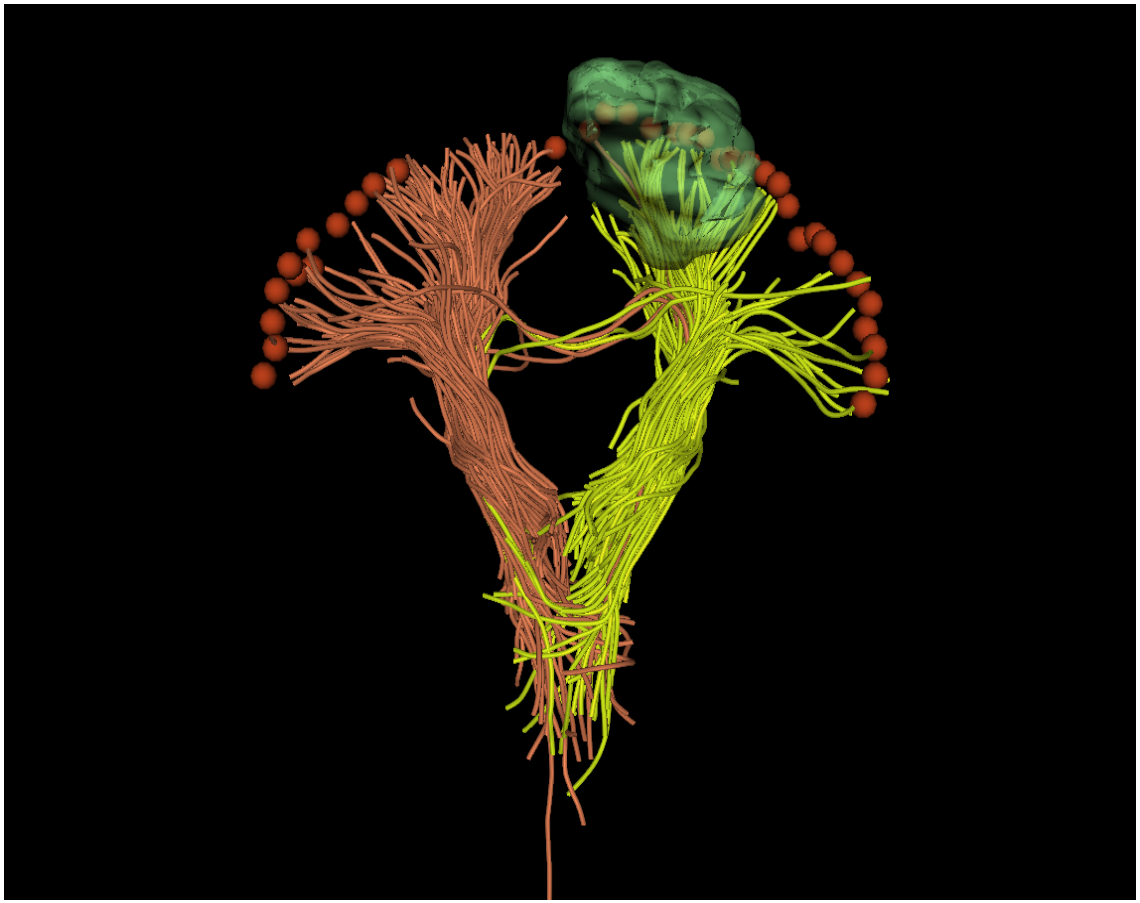
Team1



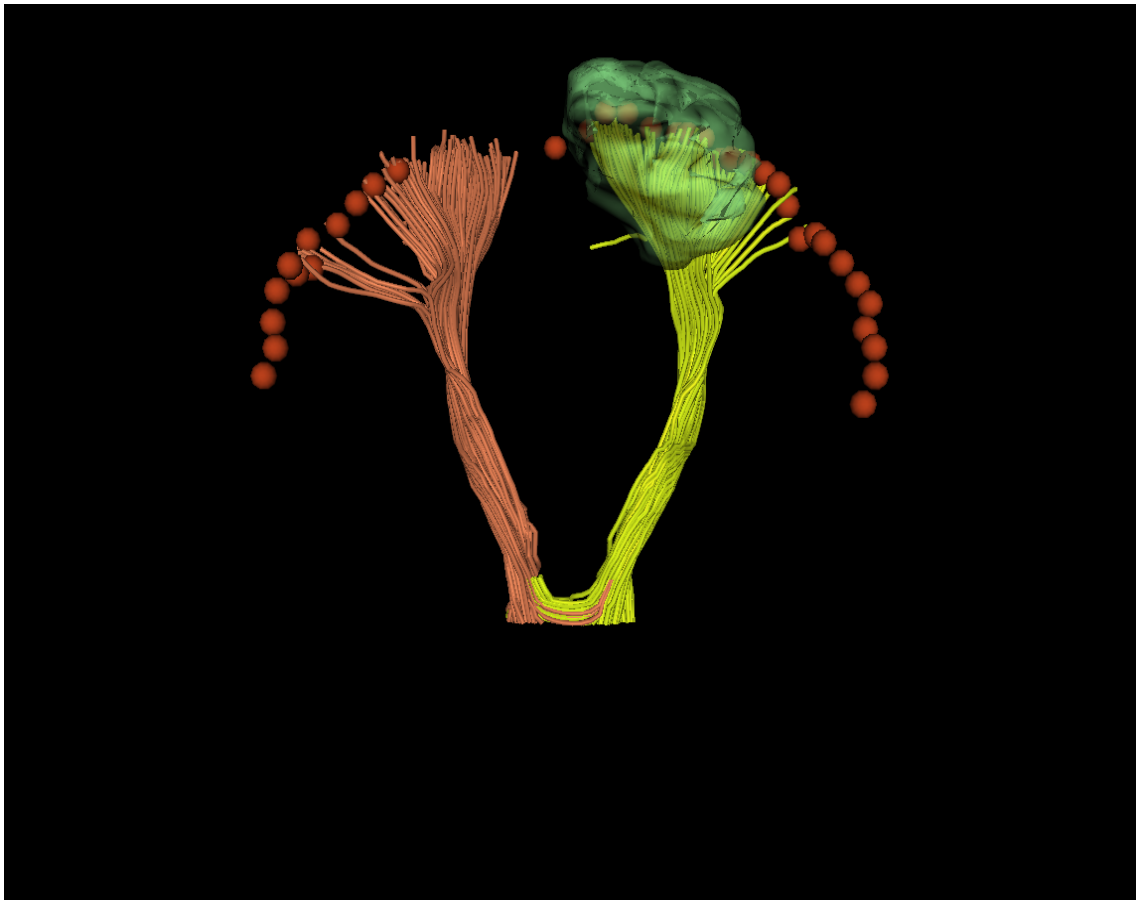
Team2



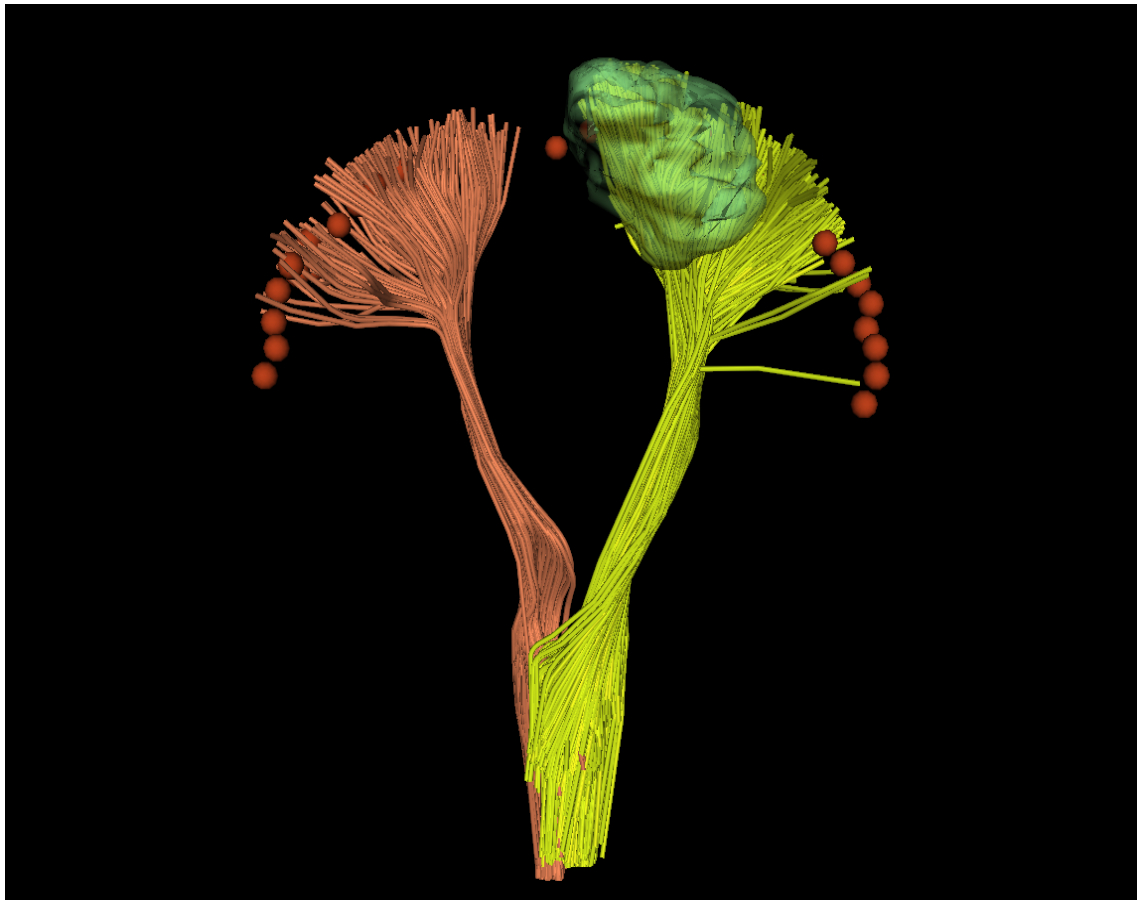
Team3



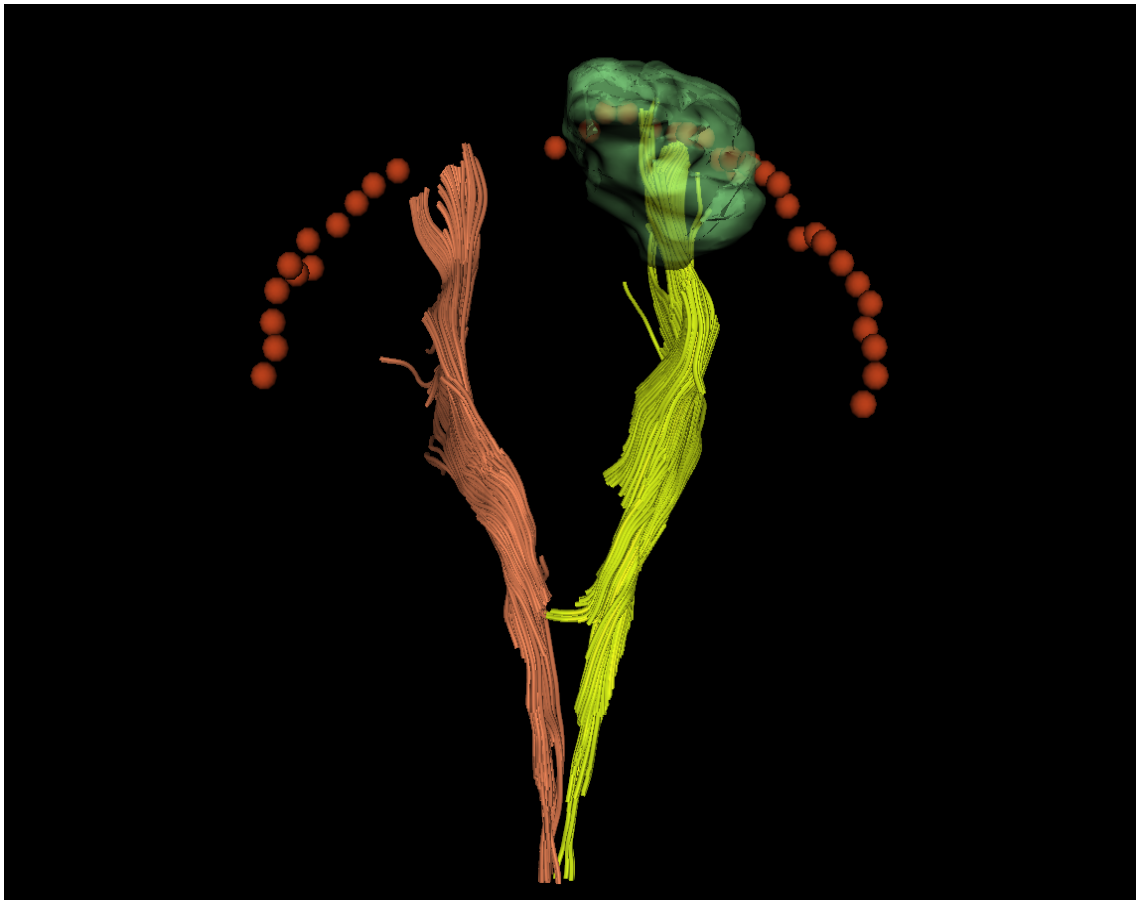
Team4



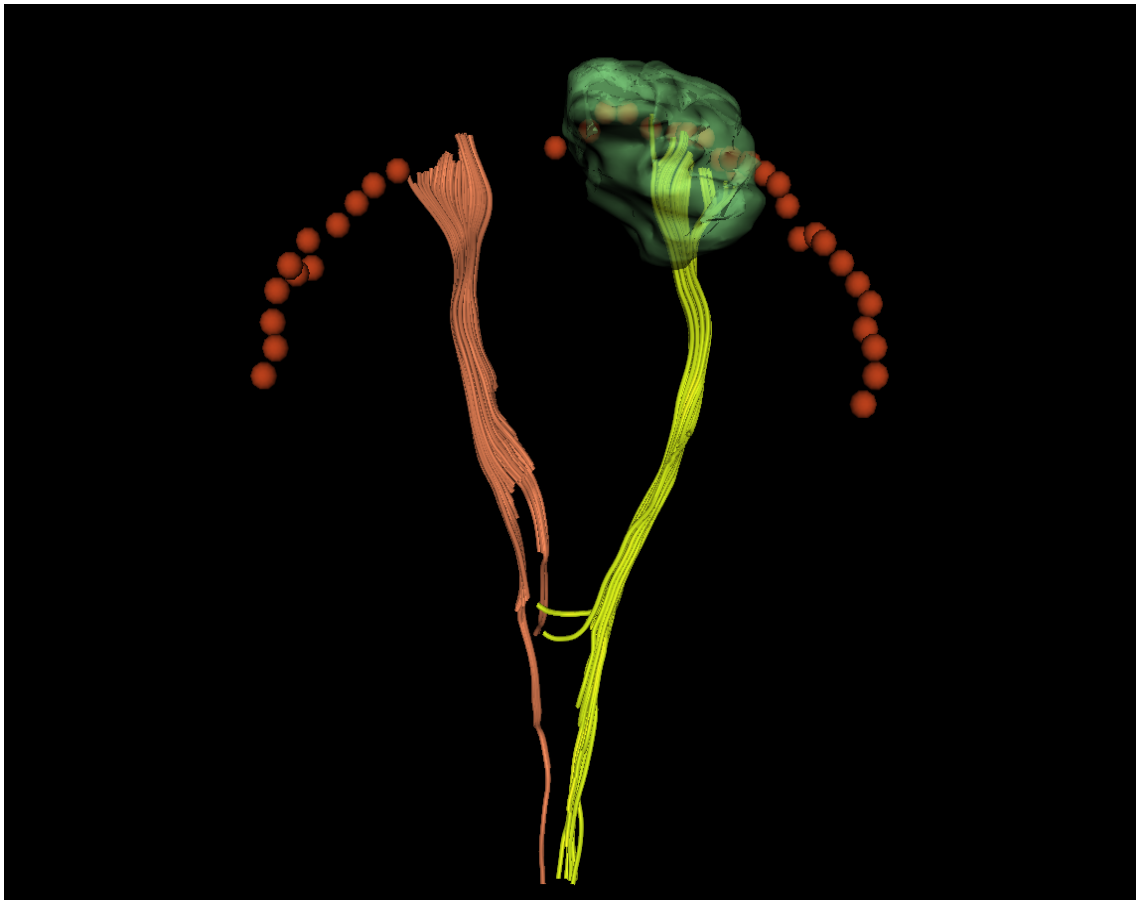
Team5



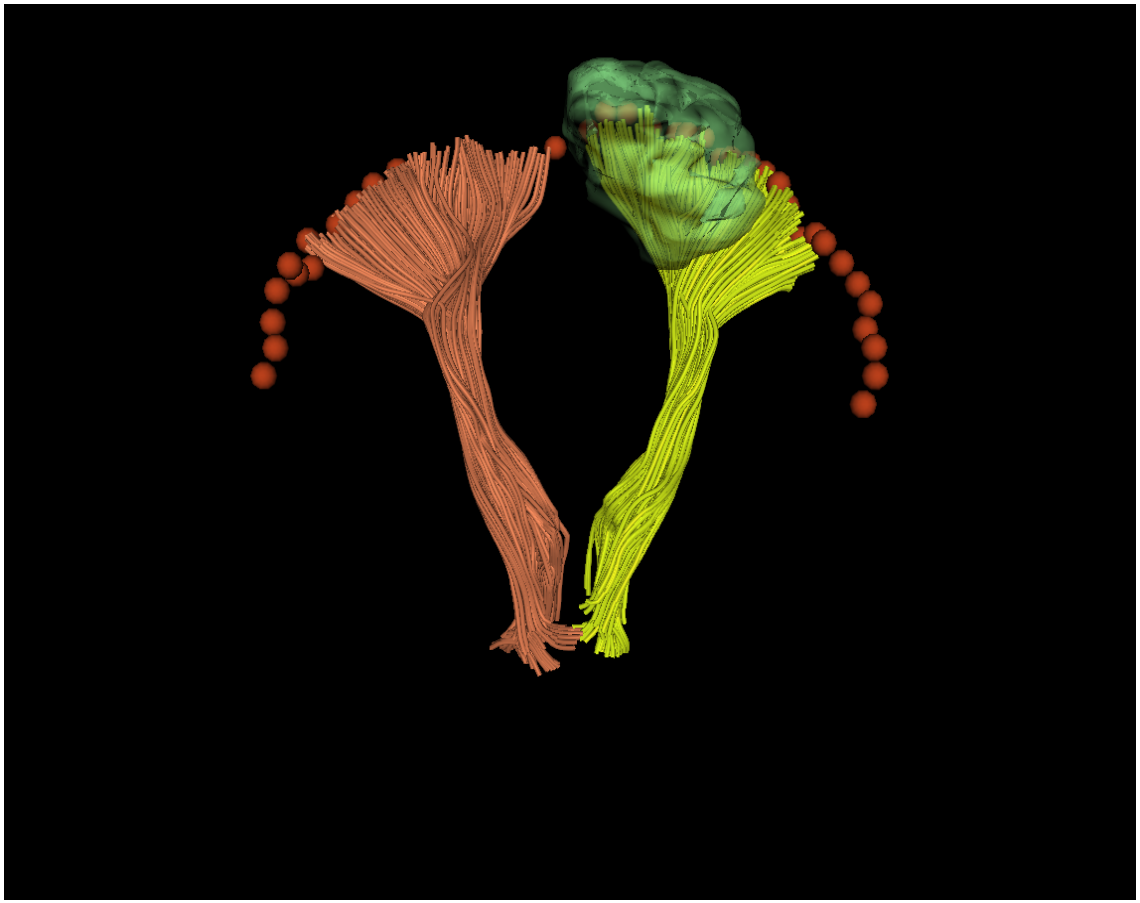
Team6



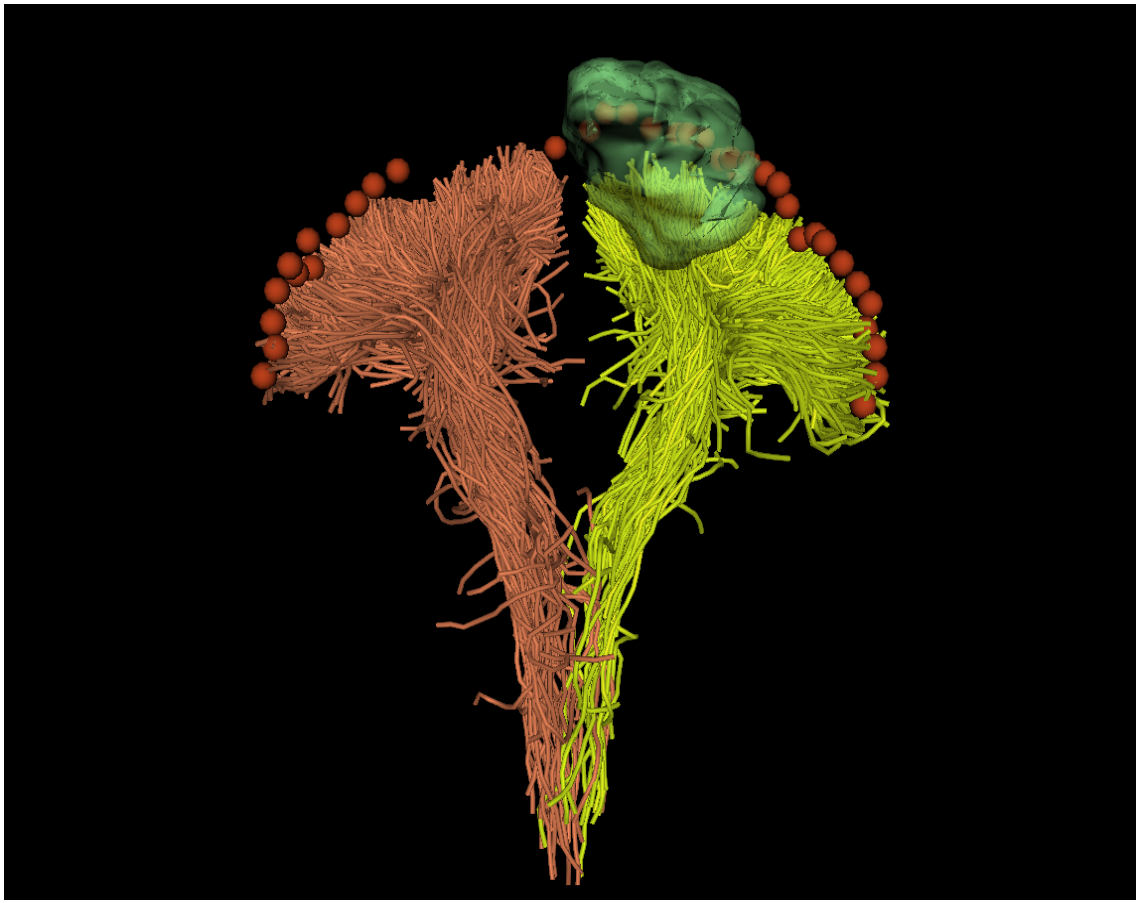
Team7



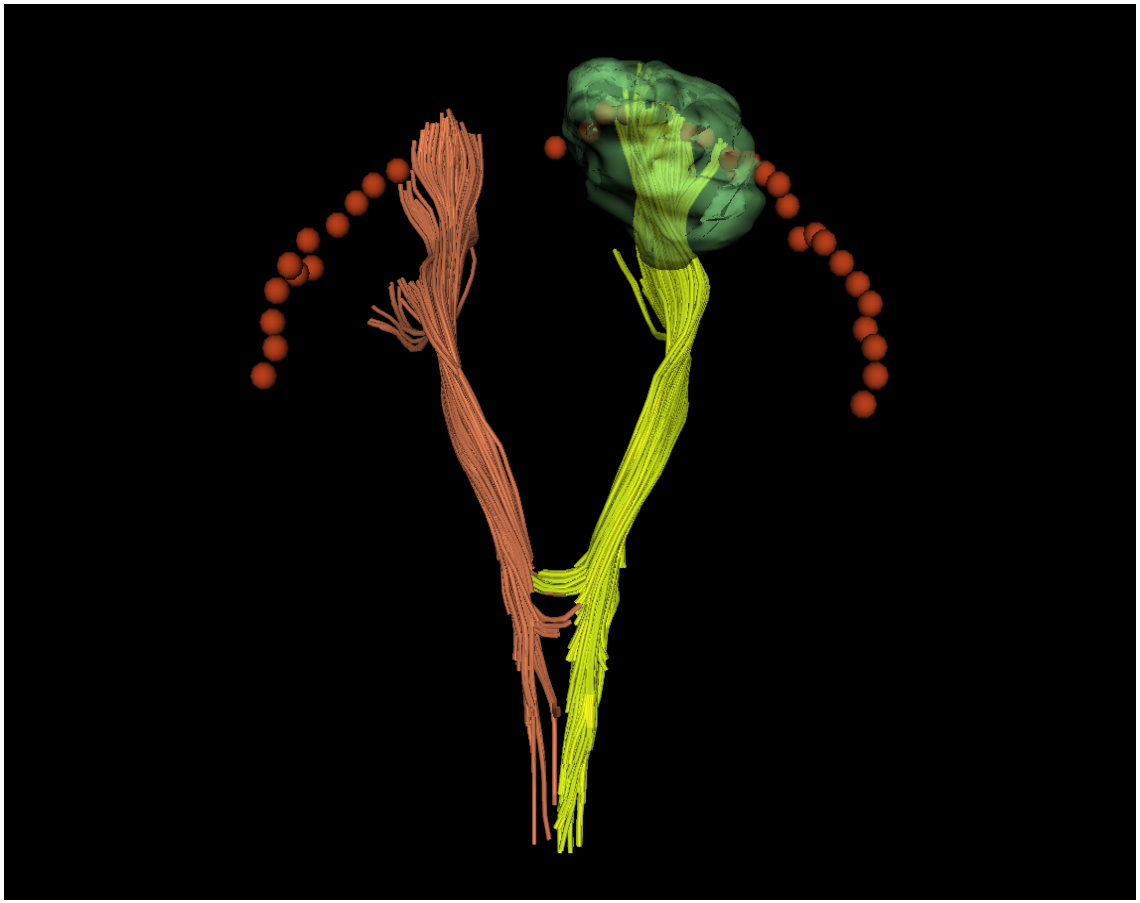
Team8



Team9



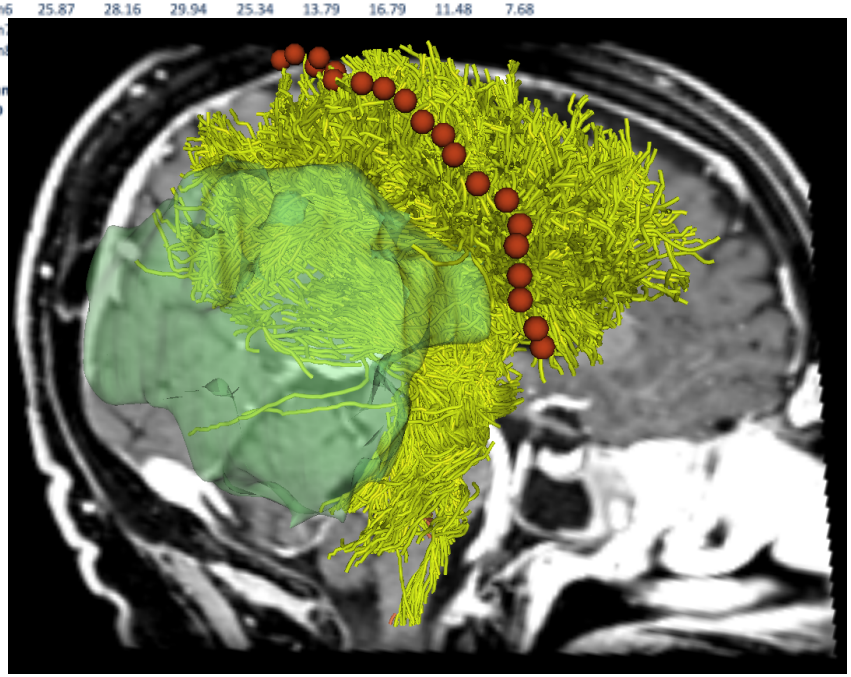
Team10



DTI Challenge Workshop findings

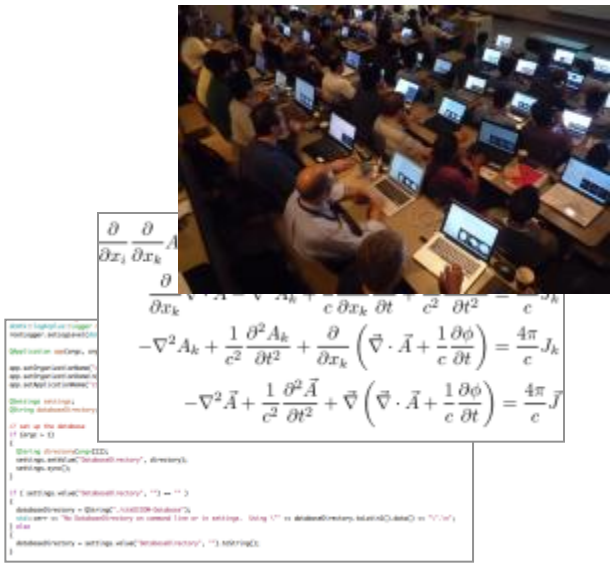
Table 1: Dice Coefficient for volumetric overlap between tracts (DTI Challenge'12)

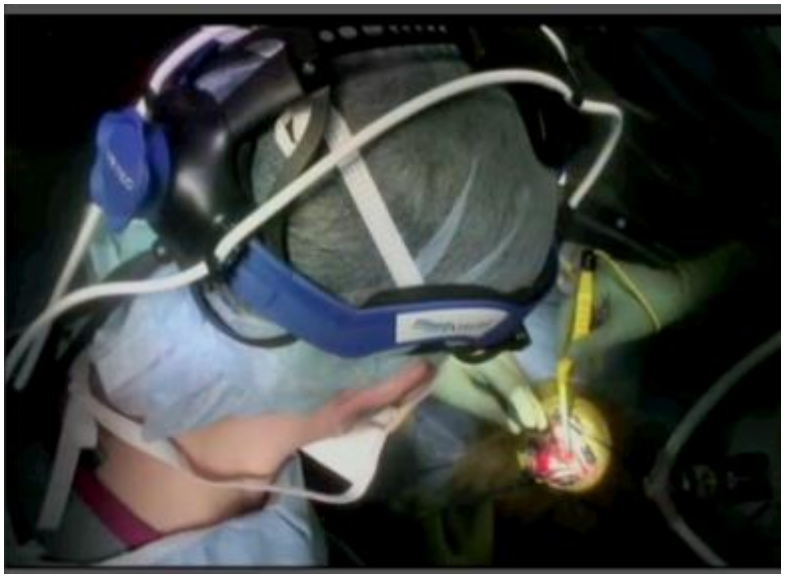
	Patient1		Patient2		Patient3		Patient4	
Team	Left	Right	Left	Right	Left	Right	Left	Right
Team1	27.32	20.7	24.58	22.6	N/A	N/A	N/A	N/A
Team2	19.00	19.76	20.09	17.81	20.38	25.13	22.01	22.89
Team3	21.07	17.84	24.63	19.81	20.44	23.7	26.19	27.2
Team4	28.58	23.93	23.74	17.04	21.6	25.77	19.99	23.53
Team5	27.64	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
Team								
Team								
Mean								
STD								



- 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

On-going work by DTI Challenge Group





- Two-way exchange between the scientists who create the tools and the neurosurgeons who will use the tools in the clinics.
- Multidisciplinary effort (Neuranatomy, Neurosurgery, Radiology, Mathematics, Computer Science, Statistics) that requires collaborative work
- Fourth Edition DTI Challenge Workshop, MICCAI 2014

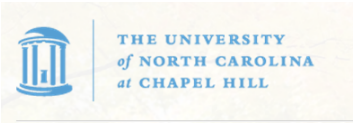
NA-MIC Training Core 2005-2014

NA-MIC Training Core

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

National Venues

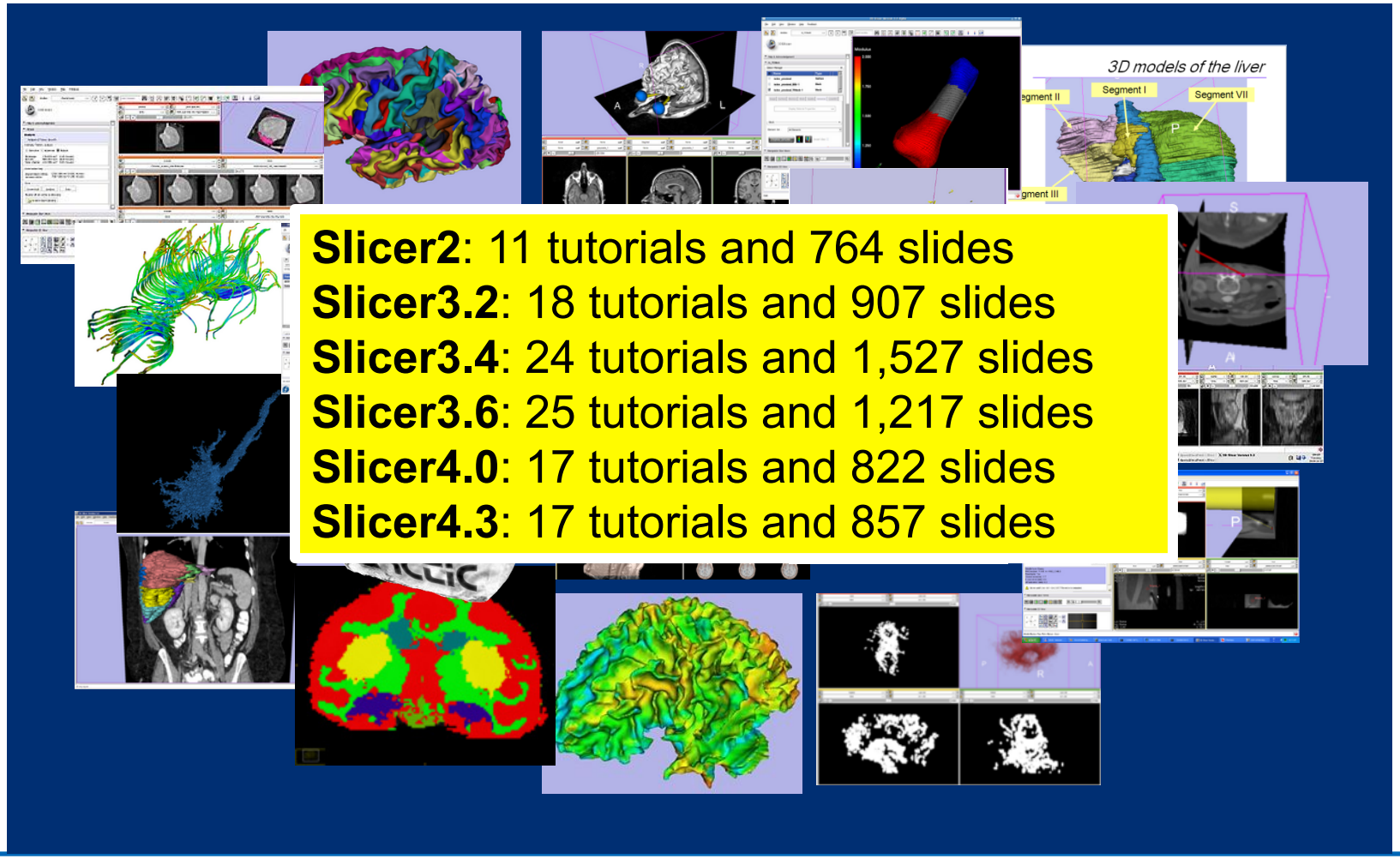
- Harvard,
- MIT,
- UCSF,
- UCLA,
- UCSD,
- Stanford,
- Dartmouth,
- NIH,
- University of New Mexico,
- University of Iowa,
- St Louis University,
- Duke University,
- UNC,
- NCI,
- NLM,
- MIND,



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

Darmouth 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:

2014 Update

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