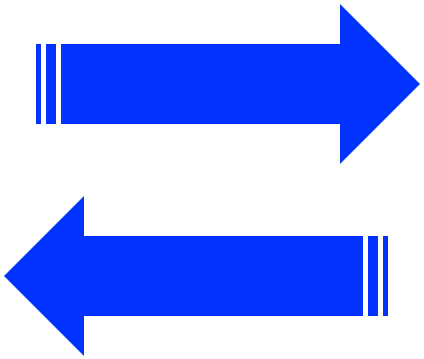
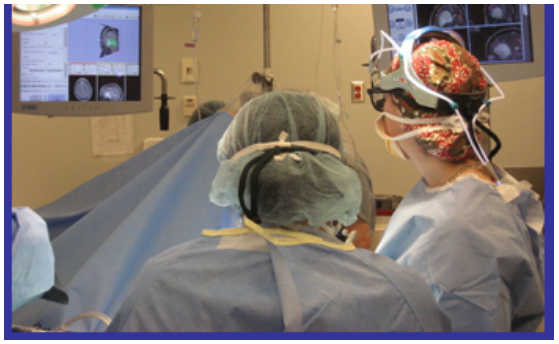
Training & DTI Validation

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

Training Core Mission





→**Teaching effort** to accelerate the transfer of NA-MIC technology to the community

→**Technology sharing effort** to enable interoperability between open-source software

→ **Validation effort** to investigate the comparative performances of algorithms

2012 NA-MIC Training Workshops

17 workshops at national & international venues

1. SPIE Medical Imaging, San Diego, CA, February 2012
2. Iowa Training Workshop, Iowa City, Iowa. March 2012
3. ISBI 2012, Barcelona, Spain, April 2012
4. Slicer Workshop, Sydney Australia, April 2012
5. Slicer Master Class, Perth, Australia, May
6. Slicer Master Classe, Darlinghurst, Austra
7. Madrid-MIT Mvision, Madrid, Spain. May 2
8. CARS 2012, Pisa, Italy. June 2012
9. AAPM 2012 meeting, Charlotte, NC. July
10. BU Slicer Training Session, Boston, MA. A
11. Slicer invited lecture, Mexico City, Mexico. September 2012.
12. HST.583 neuroimage analysis lab, September 2012.
13. MICCAI 2012 DTI Challenge, Nice, France. October 2012
14. Cranio-Maxillo Facial workshop, Cleveland. November. 2011
15. RSNA 2012, Chicago, Il. December 2012
16. HST.583 Diffusion Tensor Imaging Lab, December 2012
17. PNL Training workshop, Boston, MA. December 2012

In 2012, 704 clinical researchers and scientists participated in NA-MIC Workshops

Multi-disciplinary teaching

- Radiotherapy: AAPM 2012
- Radiology: RSNA 2012
- Neuroscience: SPIE 2012
- Cephalometry: CMF Cleveland 2012
- Image-Guided therapy: CARS 2012

NA-MIC workshops reach diverse audiences

Medical students

Software developers

Computer scientists

Residents

Biomedical engineers

Radiologists

Medical Physicists

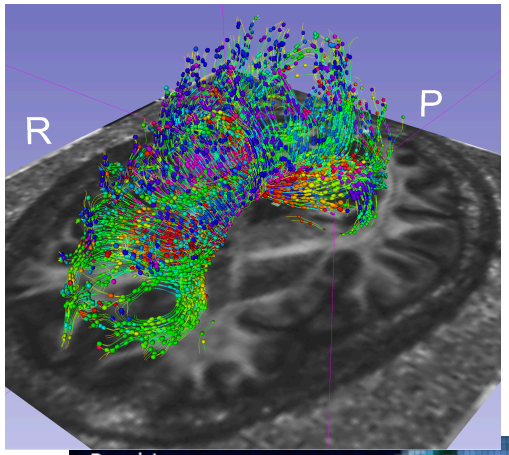
Neurosurgeons

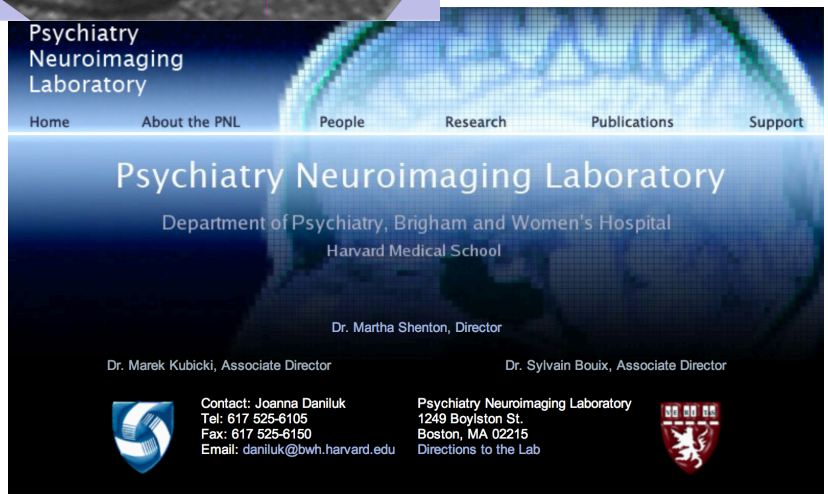
NA-MIC Workshops

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

NA-MIC Training Workshops: National Venues

Psychiatry Neuroimaging Lab, Boston



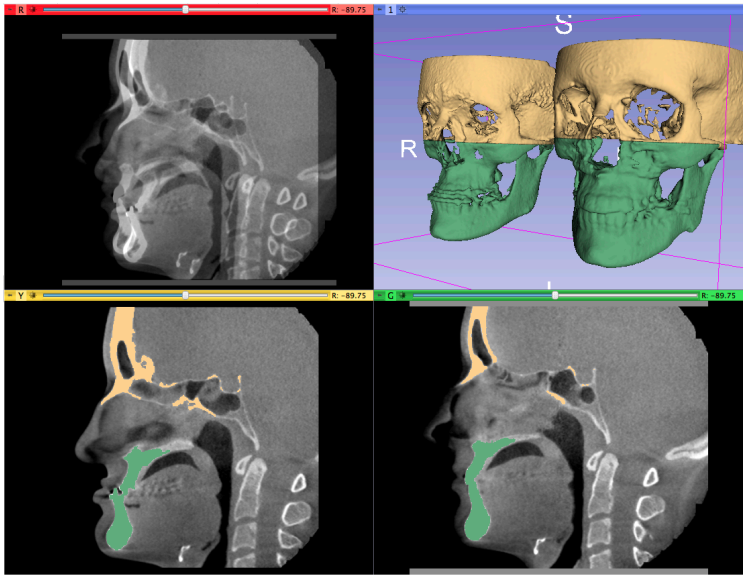


- Theme: An introduction to DTI analysis in Slicer4
- Local Organizer: Zora Kikinis, Ph.D.
- Workshop Faculty: Sonia Pujol, BWH
- 20 participants

Cranio-Maxillo Facial Workshop, Cleveland

- Theme: Open-source 3D image analysis in dentistry

- Workshop Faculty
  Beatriz Paniagua, UNC
  Tung Nguyen, UNC
  Lucia Cevidanes, U.Michigan



- 11 participants

- Dental dataset

University of Iowa, Iowa City

Agenda

Time	Tuesday, March 20, 2012
9:00-9:10 AM	3D Slicer, a Platform for Medical Image Computing (Ron Kikinis)
9:10-9:55 AM	Data Loading and 3D Visualization (Sonia Pujol)
9:55-10:45 AM	DTI Tutorial: From DWI images to tracts (Sonia Pujol)
10:45-11:00 AM	Coffee Break
11:00-12:15 PM	Neurosurgical Workflow (Sonia Pujol)
12:15-1:30 PM	Lunch
1:30-3:00 PM	XNAT, Registration (Hans Johnson)
3:00-3:30 PM	Coffee Break
3:30-5:00 PM	BWH QIN project: Quantitative MRI of prostate cancer as a biomarker and guide for treatment: Presentation and Slicer demo (Andrey Fedorov)
Time	Wednesday, March 21, 2012
09:00-10:30 AM	Programming in Slicer4 (Sonia Pujol) (Andriy Fedorov,Demian Wassermann)
10:30-10:45 AM	(
10:30 AM-11:30 AM	SimpleITK w
11:30-12:00 PM	Concluding
1:00-5:00 PM	DWI Discussion (Demian Wassermann) (By invitation or

http://na-mic

THE UNIVERSITY OF IOWA

Two-day Slicer4 user and developer training workshop

- Local organizer:

Hans Johnson, Univ. of Iowa

David Welch, Univ. of Iowa

- Workshop Faculty:

Sonia Pujol, BHW

Ron Kikinis, BWH

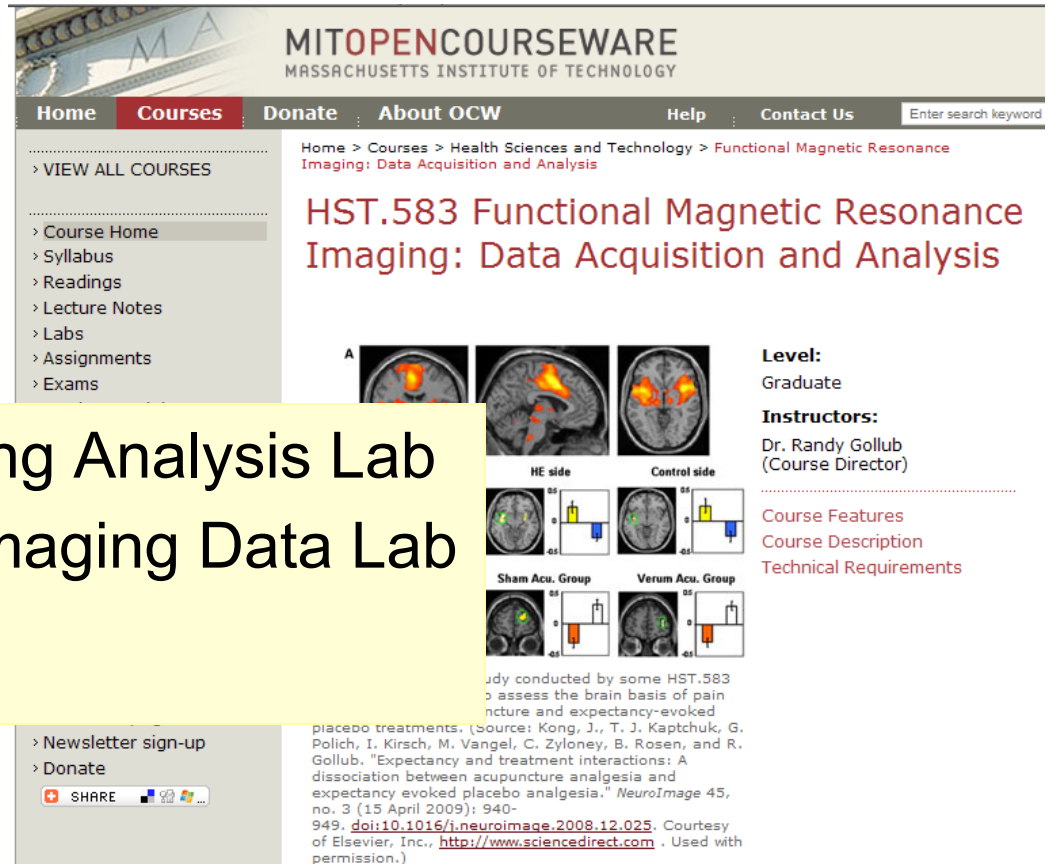
Demian Wasserman, BWH

Andriy Fedorov, BWH

- Audience: 36 scientists and clinical researchers

HST.583 Course, Boston

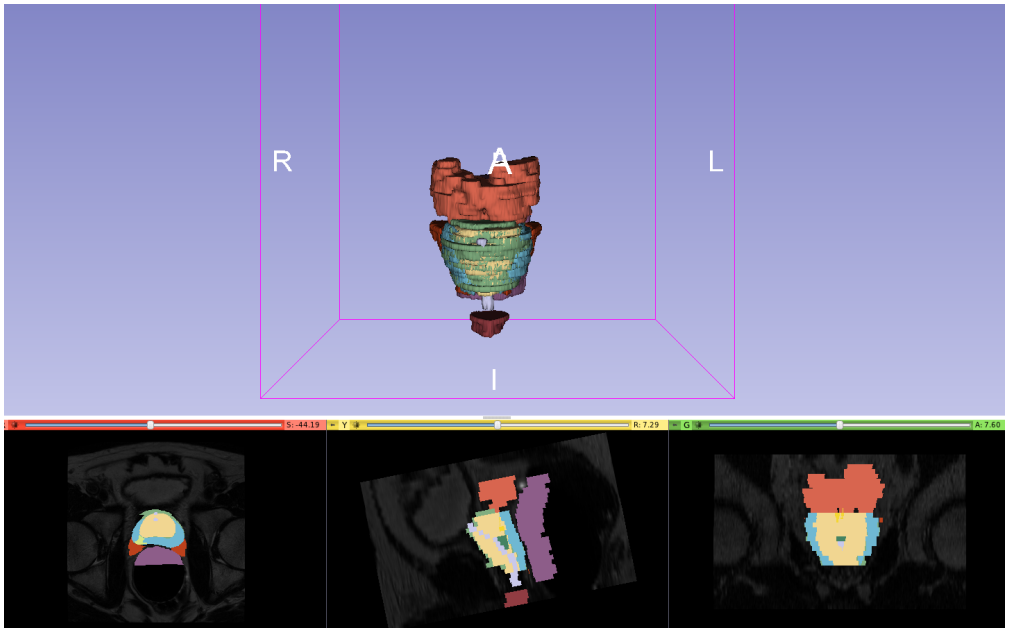
- Harvard-MIT Health Science and Technology



- Diffusion Tensor Imaging Analysis Lab
- Life Cycle of Medical Imaging Data Lab

(S.Pujol)

Boston University, Boston



- Basics of data loading and 3D visualization of prostate models in Slicer4
- Introduction to label map, MRML file, and Slicer scene
- Tutorial organizer:

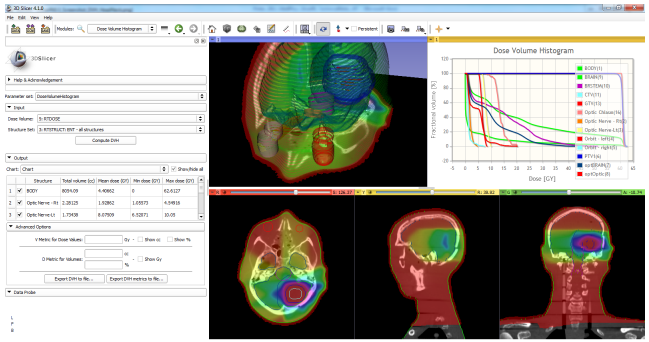
  Carl Jaffe, BU
- Tutorial faculty:

  Sonia Pujol, BWH
- Audience: BU Radiology residents

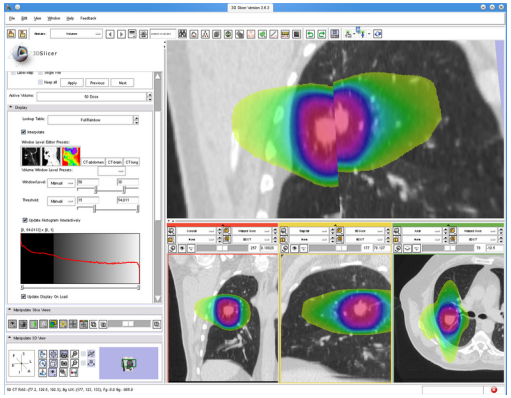
NA-MIC Training Workshops: International Conferences

AAPM 2012, Charlotte, NC

- Theme: 3DSlicer for radiation therapy research



- Gregory Sharp, Nadya Shusharina, James Shackleford,, MGH
- 25 participants



Joint meeting of the American Association of Physicists in Medicine (**AAPM**) and the Canadian Organization of Medical Physicists (**COMP**)

SPIE 2012, San Diego

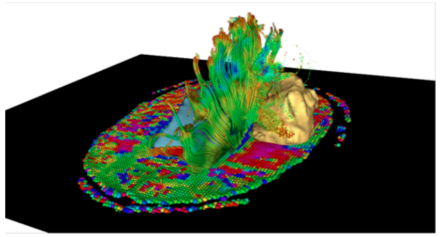
SPIE Medical Imaging

NAC

Contents [show]

Exploring Brain Connectivity in-vivo: from Theory to Practice - A hands-on analysis workshop on Diffusion MRI by the National Alliance for Medical Image Computing (NA-MIC)

Course Description:



The development of Diffusion Tensor Magnetic Resonance Imaging (DT-MRI) has opened up the possibility of studying the complex organization of the brain's white matter in-vivo. By measuring the diffusion of water molecules in tissues, the technique gives insights into the structure and orientation of major white matter pathways, and DT-MRI findings have the potential to play a critical role in the extraction of meaningful information for diagnosis, prognosis and following of treatment response. The course will guide participants through the fundamental aspects of DT-MRI data analysis, as well as the challenges of transferring cutting-edge DT-MRI techniques to clinical routine. The format will include a series of hands-on sessions with the participants running DT-MRI analysis on their own laptops, to provide a practical experience of extracting useful clinical information from Diffusion MR images. The hands-on sessions will use DT-MRI tools from the NA-MIC toolkit, which include the 3DSlicer software, an open-source platform for medical image processing and 3D visualization used in biomedical and clinical research. Participants will be guided through an integrated workflow for exploring the brain white matter in a series of datasets that will be provided as part of the course. This event is part of the on-going effort of the NIH-funded National Alliance for Medical Image Computing (NA-MIC) to transfer the latest advances in biomedical image analysis to the scientific and clinical community.

http://www.na-mic.org/Wiki/index.php/SPIE_2012_DTI_Workshop

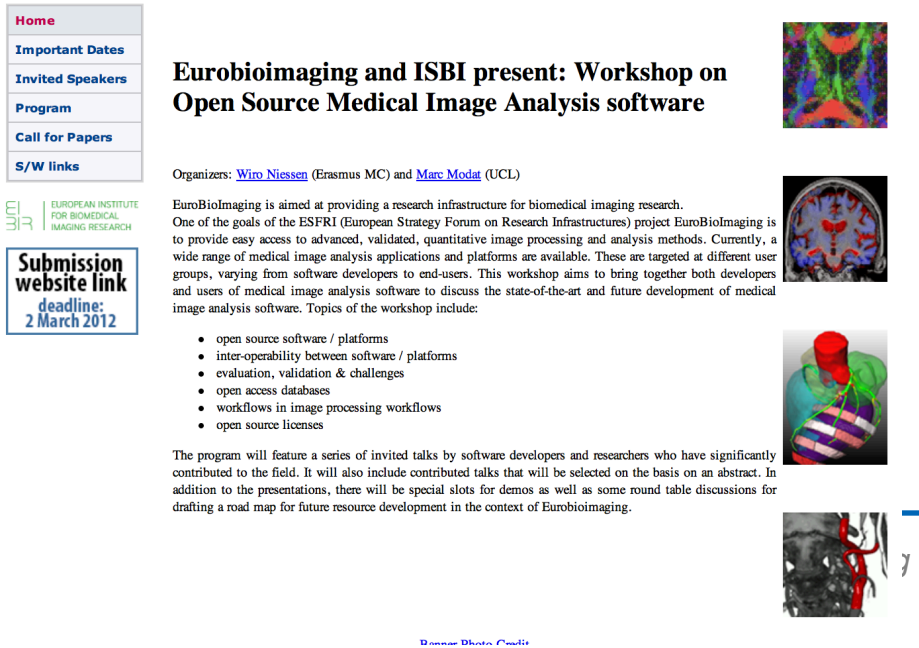
SPIE 2012 Course: “Exploring Brain Connectivity in vivo: from Theory to Practice”

- Guido Gerig, Utah
- Martin Styner, UNC
- Sonia Pujol, BWH

Full pipeline on the fundamentals of DTI

Lectures & hands-on sessions on acquisition, analysis and interpretation of DT-MRI data

ISBI 2012, Barcelona



- Two-day ISBI 2012 workshop on Open-source medical image analysis software
- Invited lecture on 3D Slicer
- Interoperability of 3D Slicer with open-source packages
- Workshop organizers: Wiro Niessen, Erasmus NC, Marc Modat, UCL

CARS 2012, Pisa

Hands-on Workshop on Image-guided therapy

Saturday June 30, 2012
9:00 am – 4:30 pm
Palazzo dei Congressi, Pisa, Italy

Faculty

Sonia Pujol, Ph.D., Harvard University, Boston, USA
Gabor Fichtinger, Ph.D., Queen's University, Kingston, Canada
Nobuhiko Hata, Ph.D., Harvard University, Boston, USA
Junichi Tokuda, Ph.D., Harvard University, Boston, USA

A joint event of the National Alliance for Medical Image Computing (NA-MIC),
the Neuroimage Analysis Center (NAC),
and the National Center for Image-Guided Therapy (NCIGT)
funded through the National Institutes of Health.

http://www.na-mic.org/Wiki/index.php/CARS_2012

contact: spujol@bwh.harvard.edu

RSNA 2012

- RSNA 2012: 75,000 participants
- NA-MIC 1-week long series of events

  - Refresher courses:

3 hours hands-on courses (>100 attendees)

  - Quantitative Imaging Reading Room: 54 hours demos

One-week long series of events at RSNA

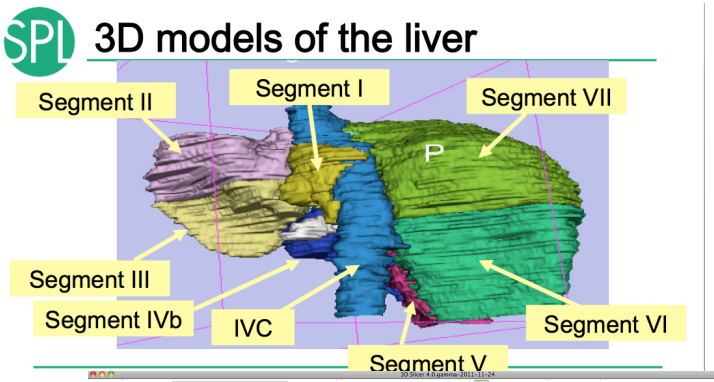
Sunday, November 25	Monday, November 26	Tuesday, November 27	Wednesday, November 28	Thursday, November 29	Friday, November 30
8:00am-11:00am. 3D Slicer Exhibit, Quantitative Imaging Reading Room, Lakeside Learning Center, Hall E, LL-QRR3007 --- - **11:00am-12:30pm**. RSNA Refresher Course: **"Quantitative Medical Imaging for Clinical Research and Practice" Katarzyna Macura, Sonia Pujol, Ron Kikinis**. Room S401CD --- - **12:30pm-6:00 pm**. 3D Slicer Exhibit Quantitative Imaging, Lakeside Learning Center, Hall E	**8:00am-11:00am**. 3D Slicer Exhibit,, Quantitative Imaging Reading Room, Lakeside Learning Center, Hall E --- - **12:15pm-1:15pm**. Meet-The-Experts Session, Quantitative Imaging Reading Room, Lakeside Learning Center, Hall E --- - **1:15pm-6:00 pm**. 3D Slicer Exhibit, Quantitative Imaging, Lakeside Learning Center, Hall E	**8:00am-11:00am**. 3D Slicer Exhibit, Quantitative Imaging Reading Room, Lakeside Learning Center, Hall E --- - **12:30pm-2:00pm**. RSNA Refresher Course: **"3D Visualization of DICOM images for Radiology Applications" Sonia Pujol, Kitt Shaffer, Ron Kikinis**. Room S401CD --- - **12:30pm-6:00 pm**. 3D Slicer Exhibit, Quantitative Imaging, Lakeside Learning Center, Hall E	**8:00am-12:15pm**. 3D Slicer Exhibit Quantitative Imaging Reading Room, Lakeside Learning Center, Hall E --- - **12:15pm-1:15pm**. Meet-The-Experts Session, Quantitative Imaging Reading Room, Lakeside Learning Center, Hall E --- - **1:15pm-6:00 pm**. 3D Slicer Exhibit, Lakeside Learning Center, Hall E --- -	**8:00am-12:15pm**. 3D Slicer Exhibit, Quantitative Imaging Reading Room, Lakeside Learning Center, Hall E --- - **12:15pm-1:15pm**. Meet-The-Experts Session, Quantitative Imaging Reading Room, Lakeside Learning Center, Hall E --- - **1:15pm-6:00pm**. 3D Slicer Exhibit, Quantitative Imaging Reading Room, Lakeside Learning Center, Hall E	**8:00am-12:45pm**. 3D Slicer Exhibit,, Quantitative Imaging Reading Room, Lakeside Learning Center, Hall E

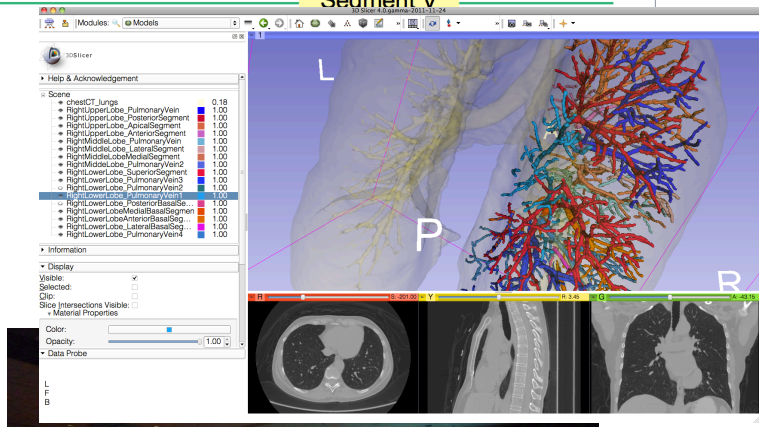
Thanks to Slicer developer team

RSNA 3DVisualization Course

3D interactive visualization of liver & lung segments

5th edition (RSNA 2008, 2009, 2010, 2011, 2012)





Course Instructors:

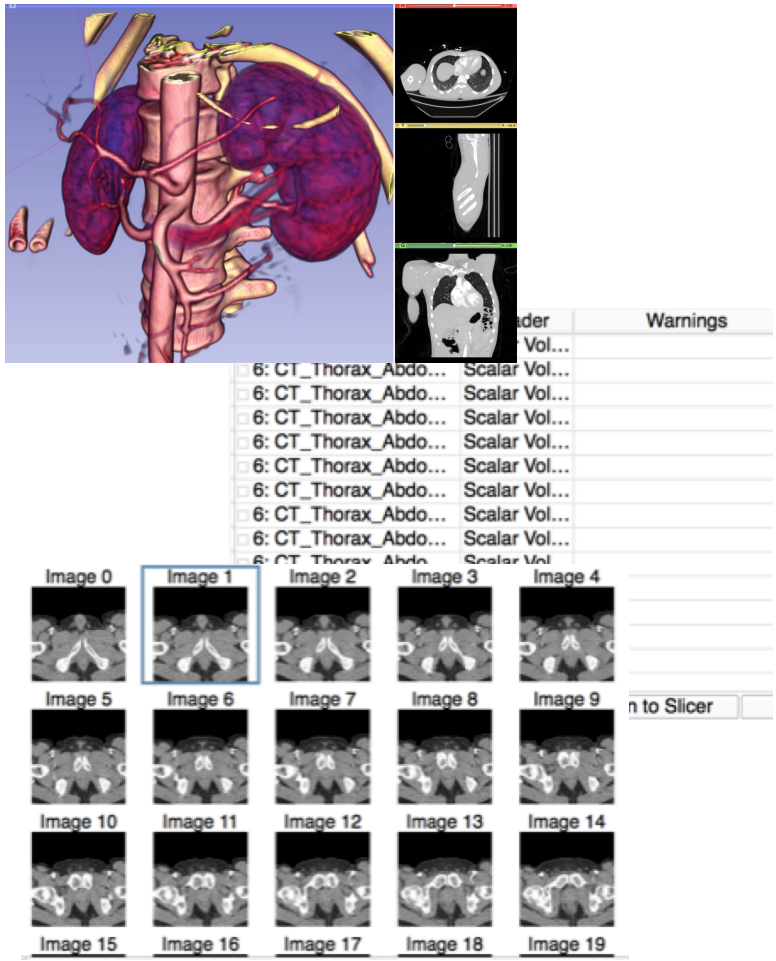
- Kitt Shaffer, MD, PhD,

Vice Chairman for Radiology Research, BU Medical Center

- Sonia Pujol, Ph.D., BWH

- 105 international attendees

3D Visualization course: New Additions



- DICOM data loading in Slicer 4
- GPU-based Volume rendering

RSNA Quantitative Imaging Course

Measurements of small volumetric changes in slow growing tumors, and quantitative imaging analysis of FDG-PET/CT data

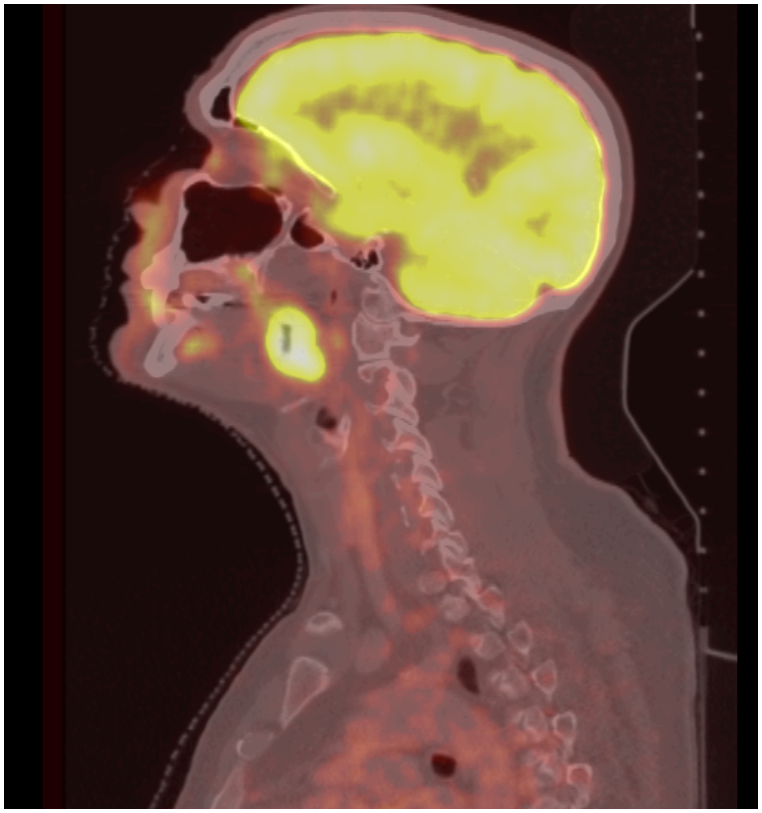
4th edition (RSNA 2009, 2010, 2011, 2012)

Course Instructors:

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

- 105 international attendees

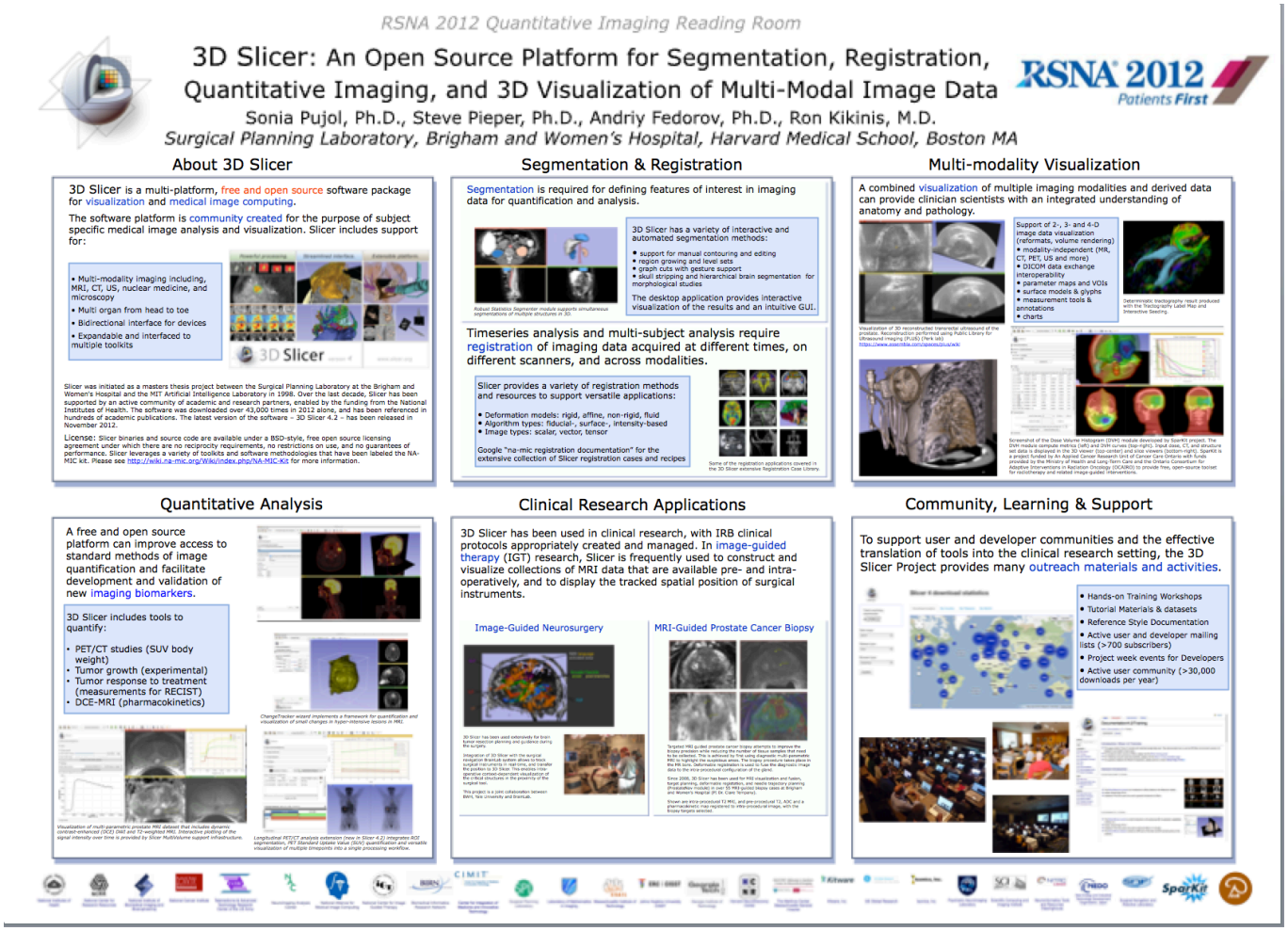
Quantitative Image Analysis Course: New Addition



New Clinical case:

→ Measurement Metabolic Activity in squamous cell carcinoma using the FDG-PET/CT Standard Uptake Value Computation module in Slicer4

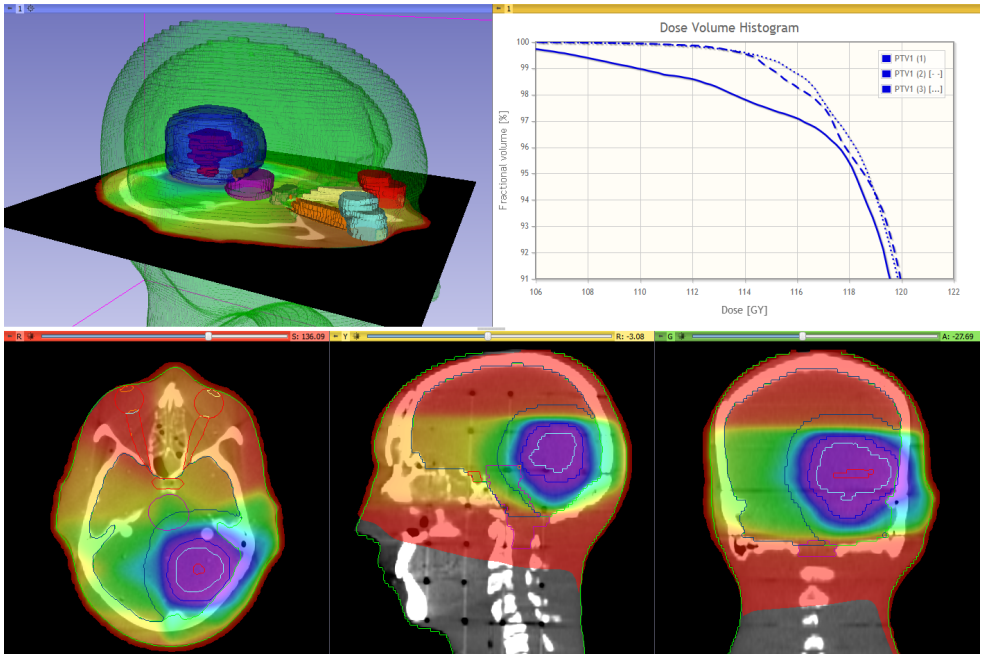
Quantitative Imaging Reading Room Exhibit



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

QIRR New Addition: SlicerRT

- SlicerRT Extension
  - DICOM-RT import
  - RT-specific analysis:
    Dose Accumulation
    Dose Comparison (gamma)
    Isodose contours / surfaces
    Contour Comparison
    Contour Morphology
  - Plastimatch
    BSpline registration
    Landwarp registration



- Csaba Pinter, Andras Lasso, An Wang, David Jaffray, and Gabor Fichtinger, “SlicerRT: Radiation therapy research toolkit for 3D Slicer”, Med. Phys. 39 (10), October 2012
- https://www.assembla.com/spaces/slicerrt/

Slide courtesy of Csaba Pinter

NA-MIC International Outreach

NA-MIC Outreach: Australia

Creating Tools for Medical Image Computing

a presentation by

Dr Ron Kikinis, Director, Surgical Planning Laboratory, Brigham and Women's Hospital, Harvard Medical School, Boston, USA

sponsored by

HARVARD CLUB OF AUSTRALIA

When: 2nd May 2012, 5:30 - 7:30 PM

Where: Conference Room 4, Ground Floor, Aikenhead Wing, St Vincent's Hospital, 41 Victoria Parade, Fitzroy, VIC 3065, click here to download campus map.

Entry: HISA members are invited to attend free of charge. Non-members $25.

Professor Kikinis investigates how to extract information and knowledge out of biomedical imaging data and use the knowledge to help diagnosis and treatment. Medicine is primarily an empiric field of science with relatively little theory. The engineering sciences, on the other hand, have a solid theoretical foundation, which allows easy hypothesis formation and extrapolation. This results in very different scientific cultures and how the scientific method is used in each field. Working as a translator between medical doctors, computer scientists and physicists is both a great privilege and an enormous challenge. Surprisingly few concepts are shared among these fields of science, which makes successful interdisciplinary work difficult to accomplish.

The fields of Radiology and Surgery are undergoing a quiet revolution, which started several decades ago. Capabilities of imaging devices have evolved in leaps and bounds, producing a larger quantity of more complex data. In order to take advantage of these novel capabilities in diagnostics and treatment, it is necessary to research, develop and deploy new image processing capabilities and, for treatments, to link them to devices.

Successful research in this field requires interdisciplinary teams with effective communications and shared values. While prototypes are sufficient for algorithm research, translation into biomedical research requires the creation of tools that can be used by physicians. Industrial involvement in this process only occurs after the value of a new capability has been demonstrated in translational research.

For the last decade, Professor Kikinis has focused on creating a software platform to make it easier to translate engineering prototypes for image post-processing into diagnostics and surgical treatment.

In his talk, Professor Kikinis will discuss current state-of-the-art tools and recent progress from a personal perspective.

Open Source Image Processing Software for Translational Clinical Research.

Master Class and Public Lecture, May 14-16, 2012, The University of Western Australia, Perth, AU

Creating Tools for Medical Image Computing.

May 2, 2012: St Vincent's Hospital, Melbourne

April 26, 2012: St Vincent's Hospital, Darlinghurst

NA-MIC Outreach: Spain

Madrid–MIT m+VISIÓN CONSORTIUM
Innovation, Leadership, Impact

Universidad Rey Juan Carlos

Invited 2-day event:

- DTI analysis
- Neurosurgical Planning
- Programming in Slicer

Workshops Faculty

- Pollina Golland, MIT
- Ron Kikinis, BWH
- Sonia Pujol, BWH

NA-MIC Outreach: Mexico

Invited Lecture:

« The 3DSlicer open-source platform for medical image computing and image-guided therapy. »
Sonia Pujol, BWH

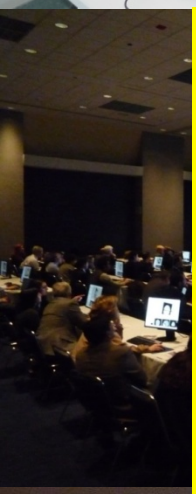
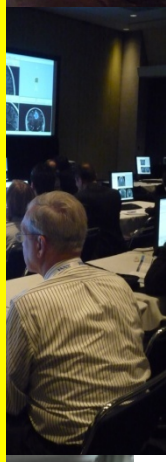
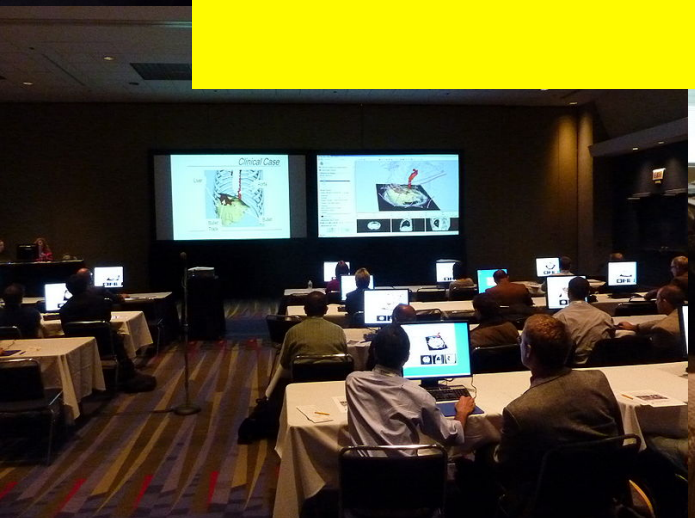
Audience: 200 biomedical engineering students

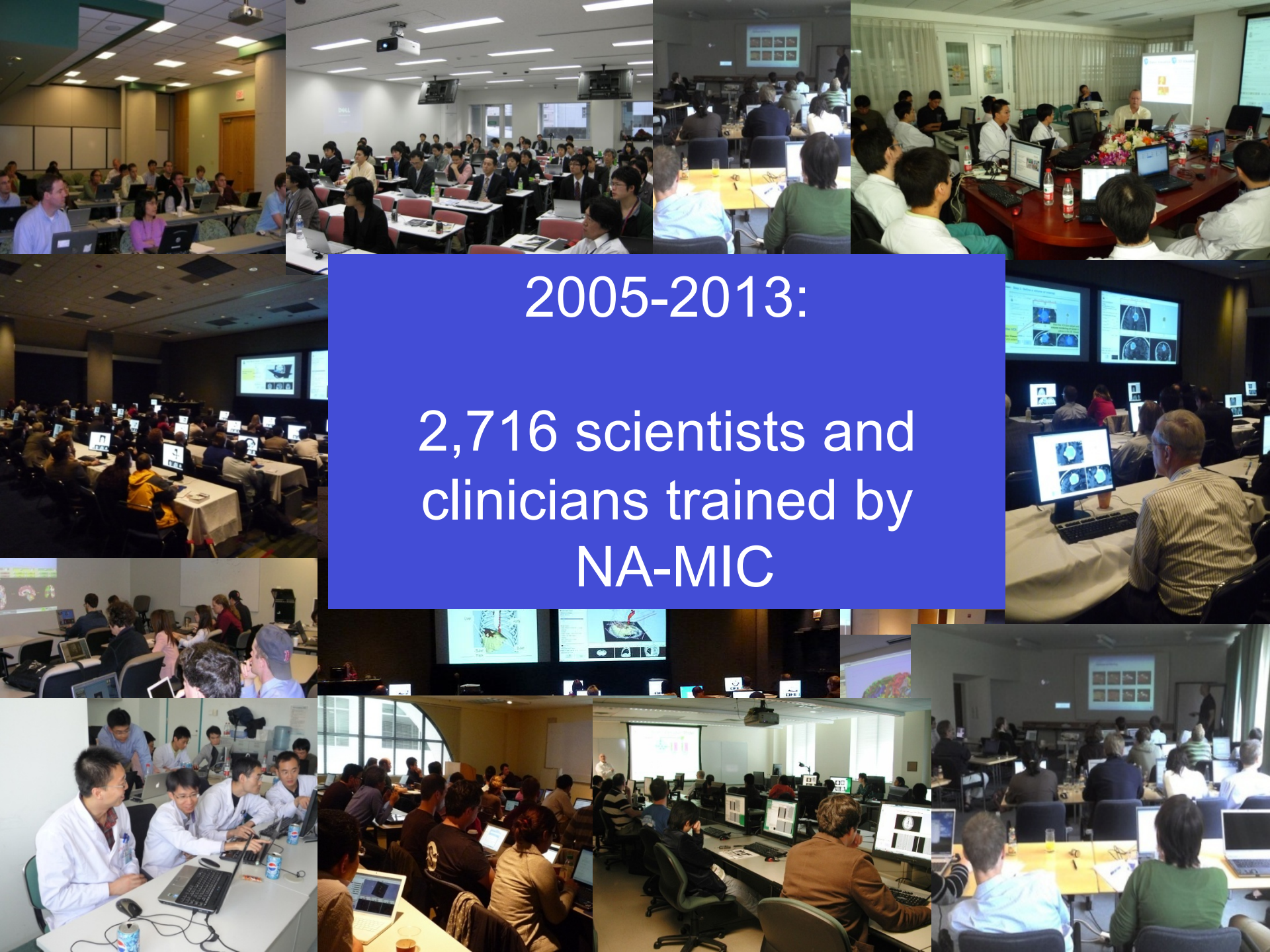


2013 training events:

17 workshops

704 NA-MIC training workshop participants

2005-2013:

2,716 scientists and clinicians trained by NA-MIC

Dissemination Update

14th Project Week: Salt Lake City, Utah, January 2012

- 104 attendees: 19 academic institutions, 6 companies
- 57 Projects: Segmentation, Registration, IGT, Radiotherapy, Informatics, DTI, Engineering

15th Project Week: MIT, Summer June 2012

- 88 attendees: 20 academic institutions, 8 companies
- 62 Projects: TBI, Radiation Therapy, Huntington's Disease, Atrial Fibrillation, IGT, Segmentation, Registration, Tractography, Vessels, Engineering

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

NA-MIC standard methodology for technology sharing

Sonia Pujol, Ph.D. – Steve Pieper, Ph.D.

Slicer Execution Model

NA-MIC AHM 2006

Slicer3:Execution Model

Home < Slicer3:Execution Model

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Abstract

The purpose of the Slicer3 Execution Model is to facilitate a "run-everywhere" philosophy for algorithm writers. NAMIC has adopted a standard for algorithm "self-description" that is followed when command line executables are written. Slicer, the grid, clusters, etc... will be able to use the executables directly in their environment.

Status

The Slicer3 execution model contains three components:

1. Module Description Parser - This is a C++ library that parses an xml description of a module and creates C++ classes that can be accessed in applications.
2. Command Line Processing - This is a C++ program that uses the Module Description Parser to generate C++ code that parses the command line arguments specified in the xml module description. This code can be included in the command line module to access the command line arguments at run-time.
3. Slicer3 GUI - This GUI and related MRML and Logic classes uses the Module Description Parser to create GUI, MRML and Logic classes for each module "discovered" at run-time.

Currently, an initial implementation of all three components is complete.

Here is a discussion page on how to deal with reference systems in the Execution Model.

Documentation

Look at the Execution Model Documentation for details.

Background

The initial implementation of the Slicer3 Execution Model followed a Wiki discusion of requirements and implementation options. Refer to the Execution Model Discussion for background and motivation.

Slicer Execution Model

NA-MIC AHM 2006

NA-MIC Training Workshop 2008

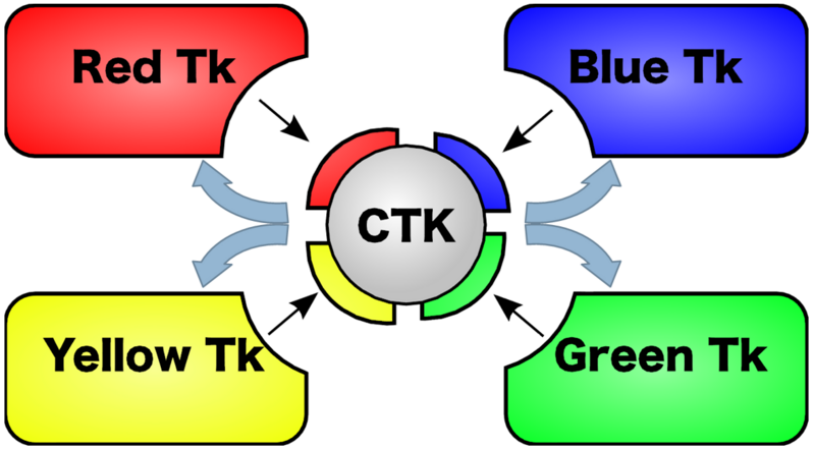
MITK presentation by Ivo Wolf, Marco Nolden, Sascha Zelzer

Slicer Execution Model

NA-MIC AHM 2006

NA-MIC Training Workshop 2008

CTK 2009



Slicer Execution Model

NA-MIC AHM 2006

NA-MIC Training Workshop 2008

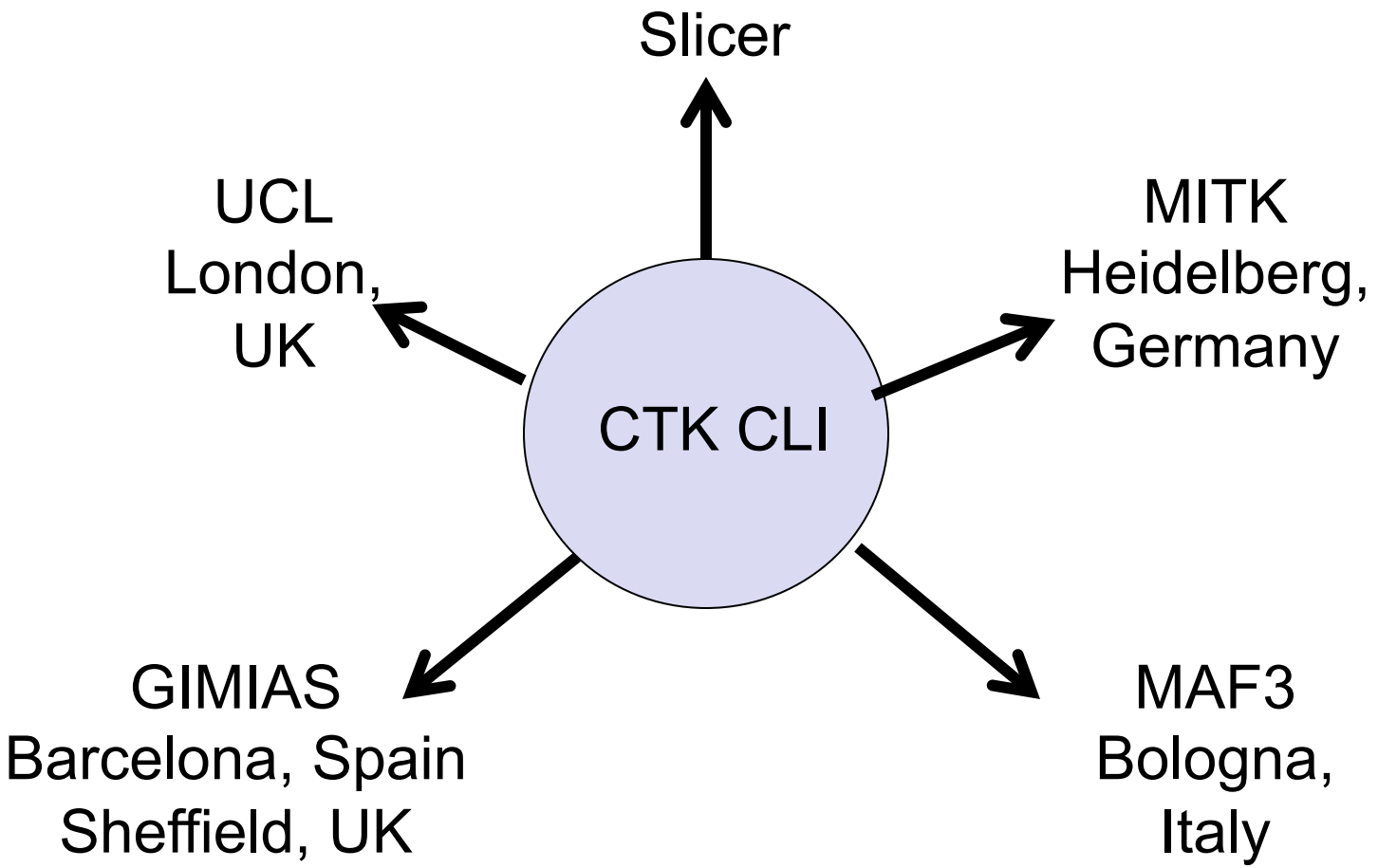
CTK 2009

CTK CLI 2012

CTK Hackfest, Boston, 2012

→ CTK adoption of Slicer Execution model

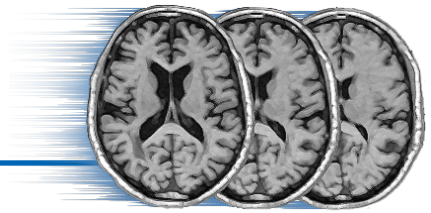
CTK CLI


Slicer
UCL
London,
UK
MITK
Heidelberg,
Germany
CTK CLI
GIMIAS
Barcelona, Spain
Sheffield, UK
MAF3
Bologna,
Italy

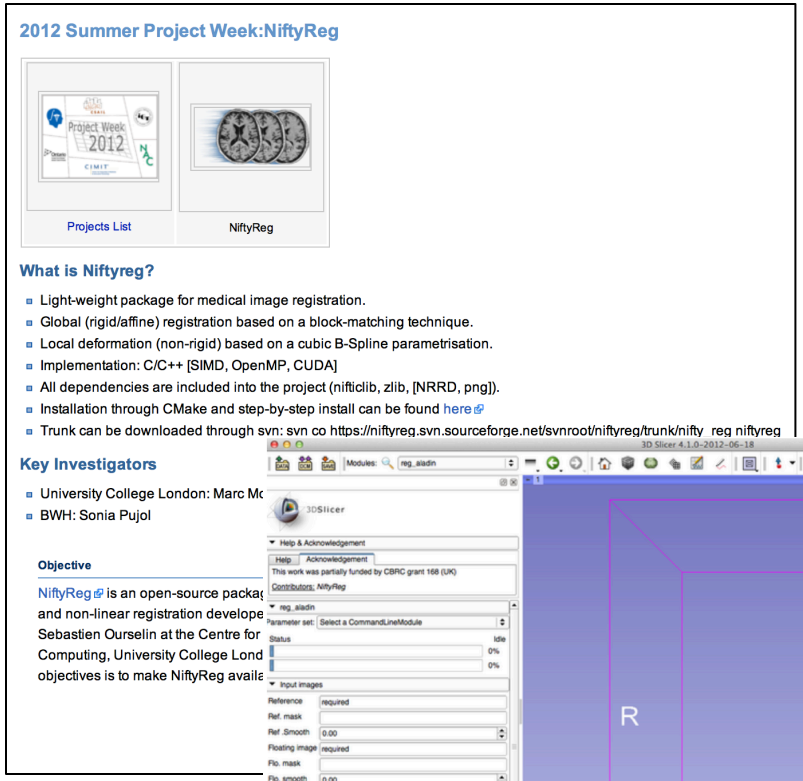
ISBI 2012 Open-source workshop

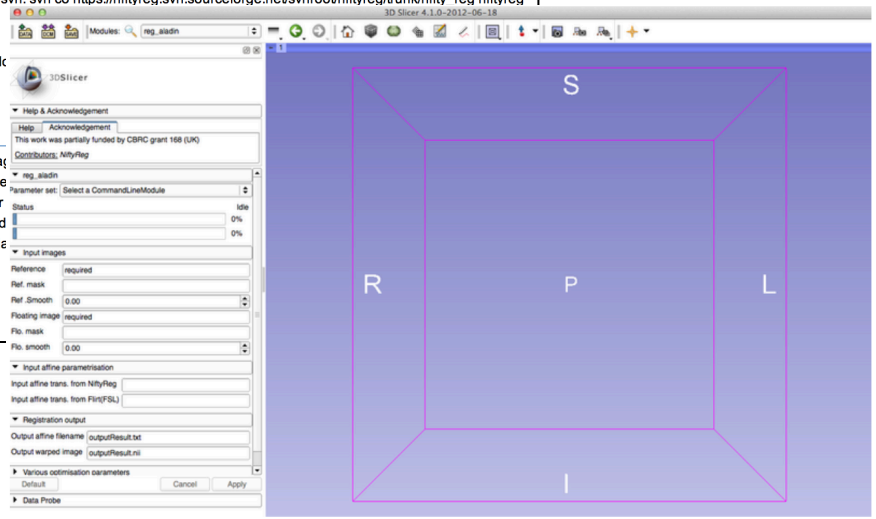
- 3DSlicer presentation

- NiftyReg (UCL, London) presentation



NA-MIC Summer Project week

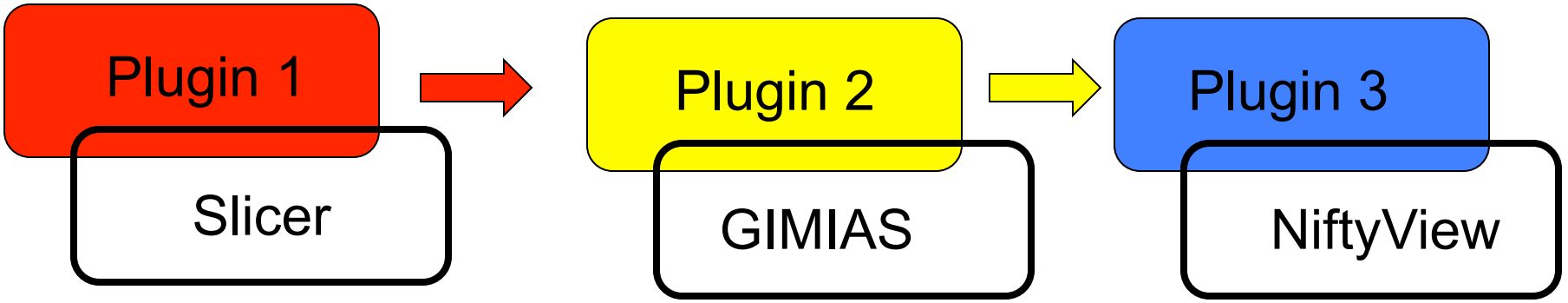




- Integration of NiftyReg library as Slicer CLI Extension

Marc Modat, UCL
Sonia Pujol, BHW

NiftyReg integration



http://www.commontk.org/index.php/Documentation/CLI_In_Context

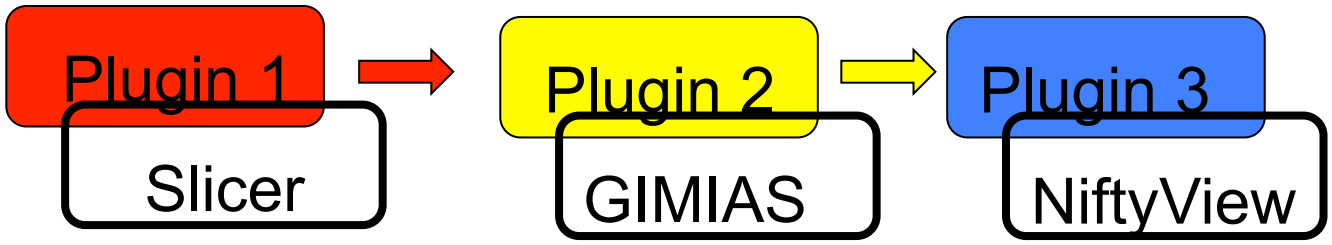
Slicer Execution Model

NA-MIC AHM 2006

NA-MIC Training Workshop 2008

CTK 2009

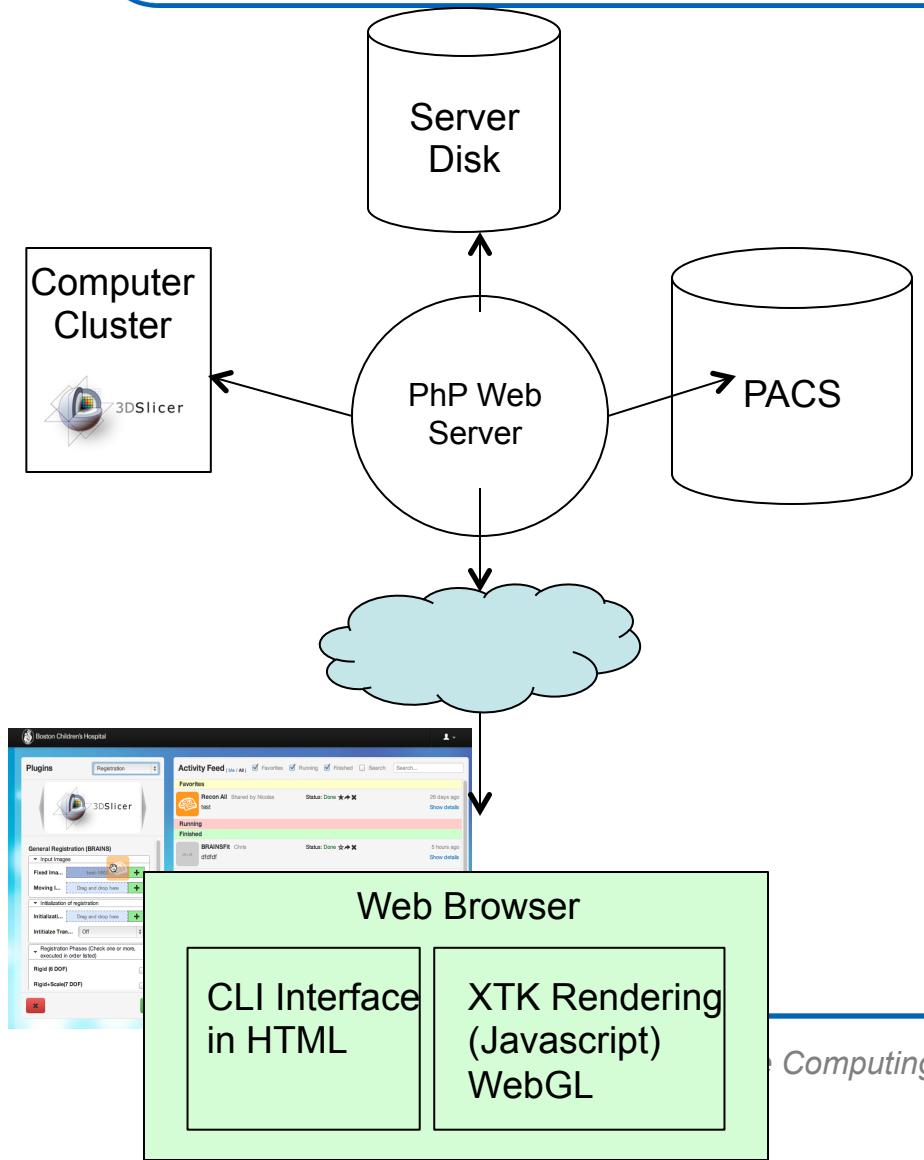
CTK CLI 2012



http://www.commontk.org/index.php/Documentation/CLI_In_Context

Slicer SEM leverages interoperability between packages

Open-source platform “ChRIS”



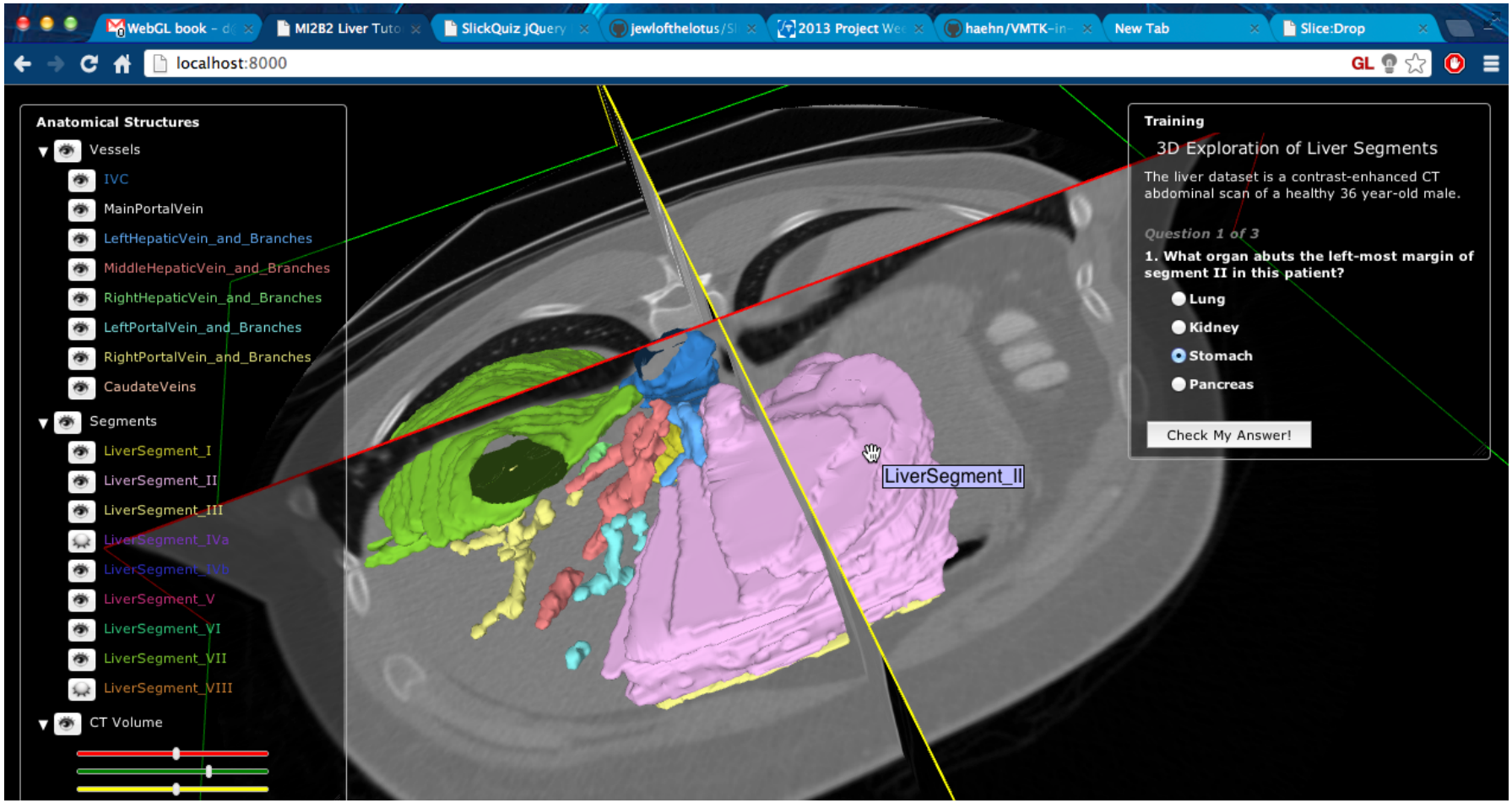
Slicer CLI modules accessible via the web

Client/Server application for Slicer remote execution on PACS data

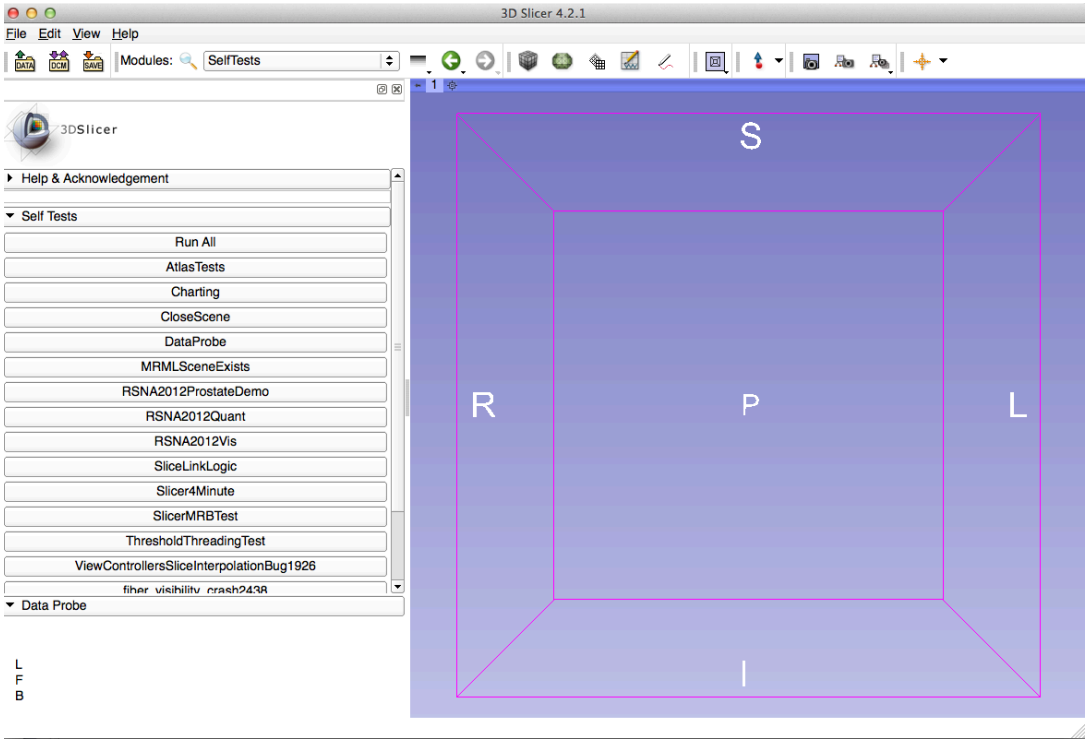
Dr. Rudolph Pienaar
Dr. Ellen Grant
Nicolas Rannou

Children’s Hospital, Boston, MA

RSNA Liver tutorial



Slicer Automated testing: done!

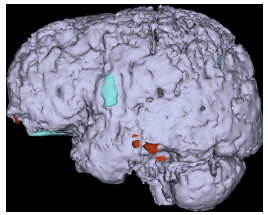


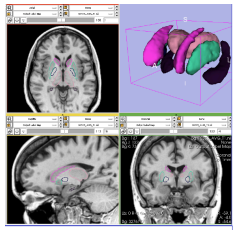
- Python implementation (**Steve Pieper**) for self-tests of tutorials integrated to Slicer distribution
- Users can confirm correct execution of a module based on the tests
- First use at RSNA 2012

Summer 2012 Tutorial Contest

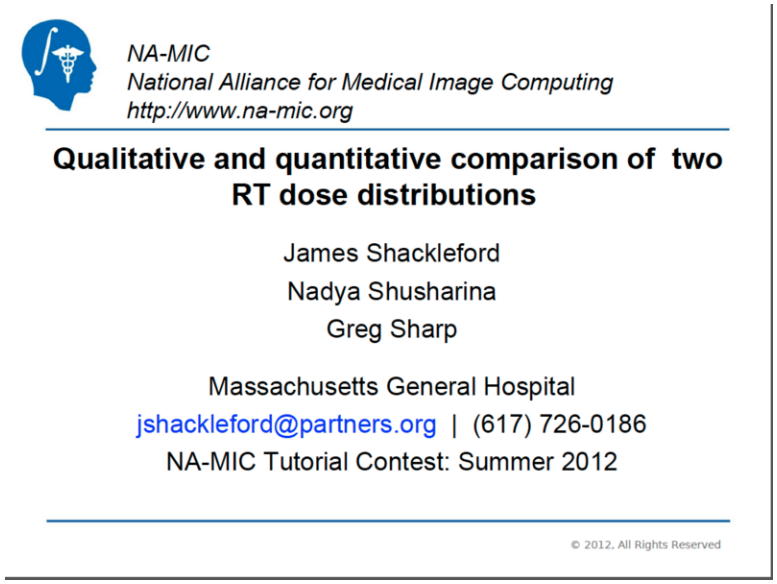
- 5 tutorial submissions

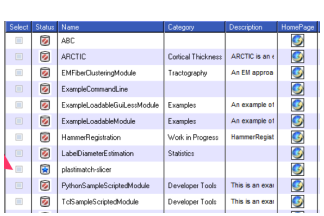
First prize winner:

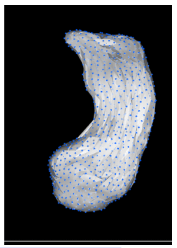


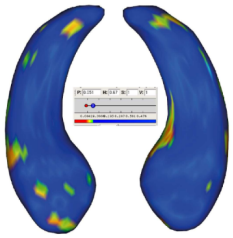


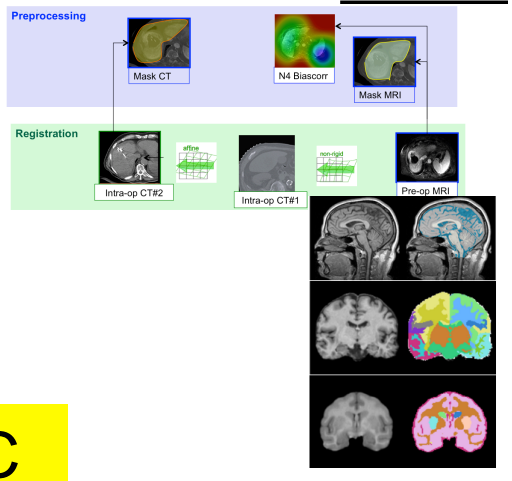
BRAINSCut Output example for sub-cortical structures

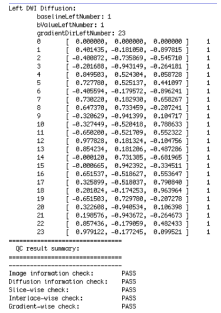












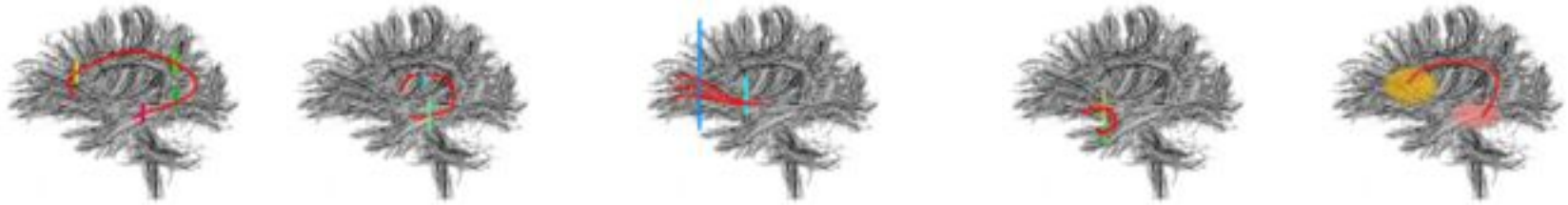
→ Next Tutorial Contest: NA-MIC Summer Project Week 2012

DTI Tractography Validation Update

NA-MIC pilot initiative

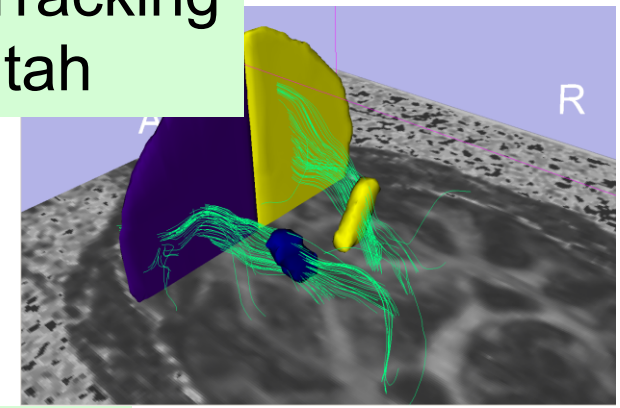
- Exploratory work on validation of DTI tractography

- Cross-comparison of tractography algorithms on major white matter fascicles

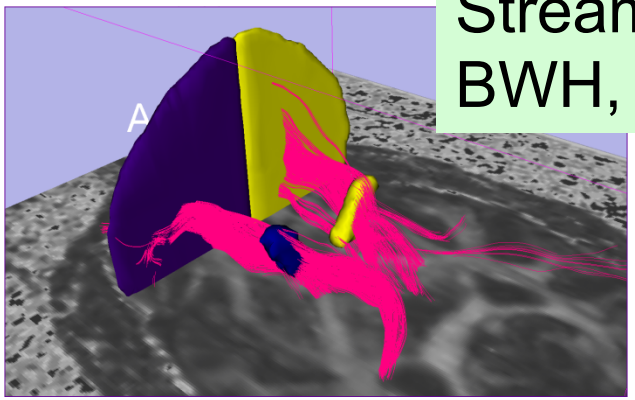


Early Implementation

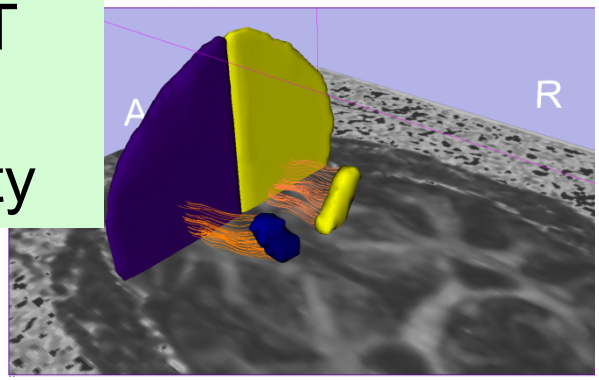
Fiber Tracking
SCI, Utah



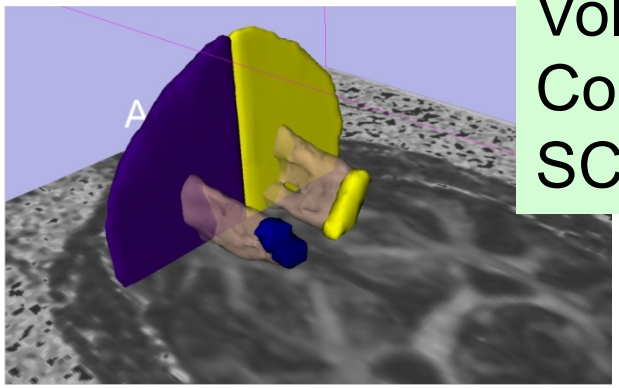
Streamline
BWH, Harvard



GTRACT
Iowa
University

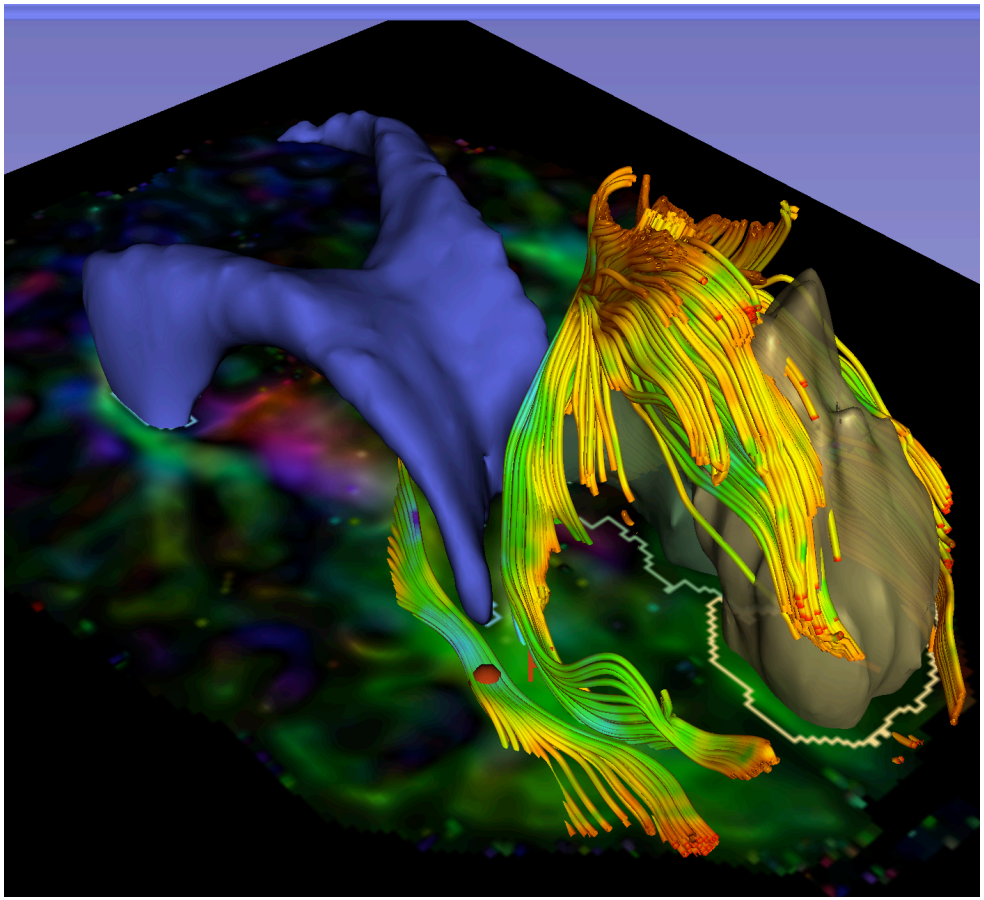


Volumetric
Connectivity
SCI, Utah



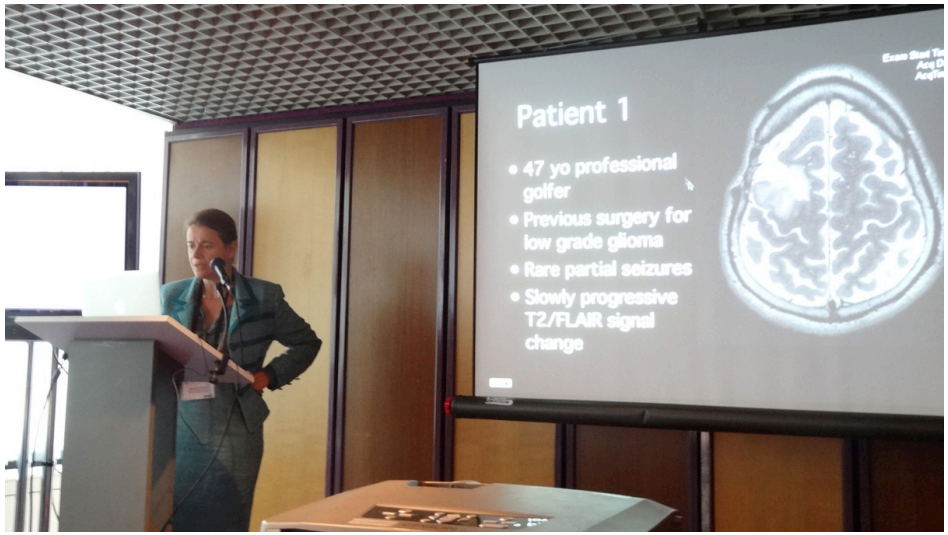
Pujol et al. ISMRM 2009

DTI for Neurosurgery



Pre-operative assessment of white matter anatomy for tumors located in eloquent areas where motor, sensory, speech and cognitive function reside.

What does the clinician want to see?

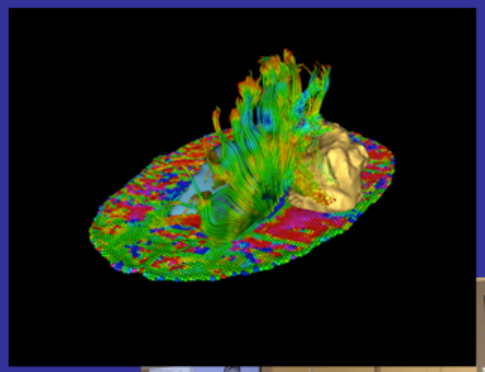


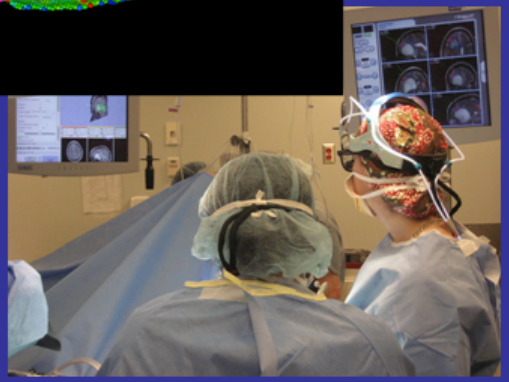
Dr. Alexandra Golby

- Where is the tract?
- Is it normal?
- Is it symmetric?
- Is anything missing?
- Is it functional?

MICCAI 2011 DTI Challenge, 1st Edition

14th International Conference on Medical Image Computing and Computer Assisted Intervention





DTI Tractography for Neurosurgical Planning: A Grand Challenge

MICCAI 2011 Workshop
Sunday September 18, 9am-6pm
Westin Harbour Castle
Toronto, Canada

Workshop Faculty

Sonia Pujol, PhD, Surgical Planning Laboratory, Harvard Medical School
Ron Kikinis, MD, Surgical Planning Laboratory, Harvard Medical School
Alexandra Golby, MD, Brigham and Women's Hospital, Harvard Medical School
Guido Gerig, PhD, The Scientific Computing and Imaging Institute, University of Utah
Martin Styner, PhD, Neuroimage Research and Analysis Laboratory, University of North Carolina
William Wells, PhD, Surgical Planning Laboratory, Harvard Medical School
Carl-Fredrik Westin, PhD, Laboratory of Mathematics in Imaging, Harvard Medical School
Sylvain Gouttard, MSc, The Scientific Computing and Imaging Institute, University of Utah

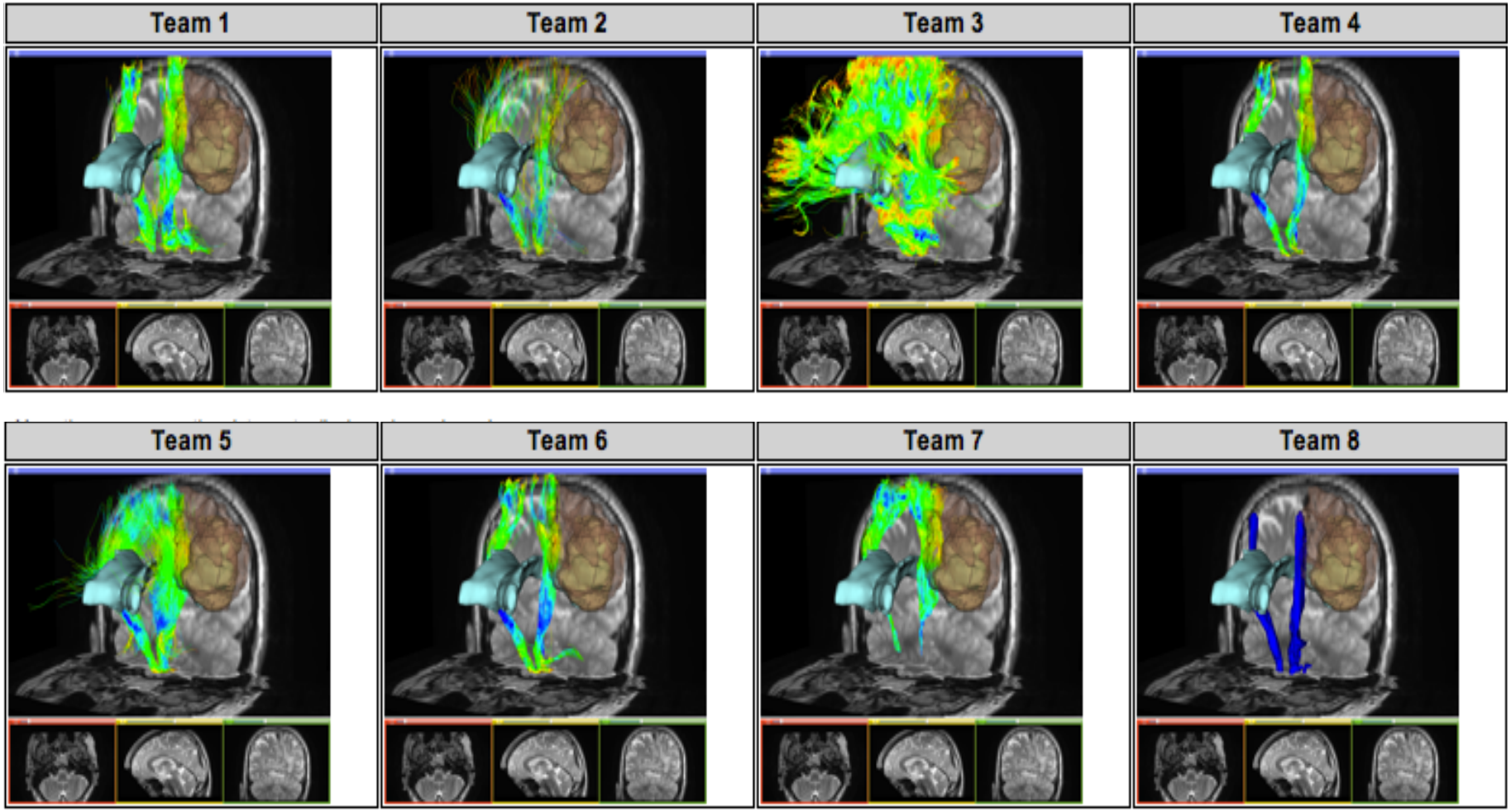
National Alliance for Medical Image Computing

http://www.na-mic.org/Wiki/index.php/Events:_DTI_Tractography_Challenge_MICCAI_2011

MICCAI 2011 Workshop

- 8 tractography teams
- 2 practicising neurosurgeons
- 23 international participants

MICCAI 2012 DTI Challenge, 1st Edition



MICCAI 2012 DTI Challenge, 2nd Edition

MICCAI 2012 DTI Tractography Challenge

Second Edition

INTRODUCTION THE CHALLENGE FACULTY KEYNOTE SPEAKER DATA REGISTRATION CONTACT

Welcome to the 2nd edition of the MICCAI DTI Tractography Challenge. The workshop will be held on Monday October 1st, 2012 as part of the 15th International Conference on Medical Image Computing and Computer Assisted Intervention (MICCAI 2012).

http://dti-challenge.org

MICCAI 2012 DTI Challenge

- 10 tractography teams
- 5 practicising neurosurgeons
- 36 international participants

Faculty

- Sonia Pujol, BWH
- Ron Kikinis, BWH
- Alexandra Golby, BWH
- Arya Nabavi, Kiel Hospital, Germany
- Guido Gerig, SCI Utah
- Martin Styner, UNC
- William Wells, BWH
- CF Westin, BWH
- Laurent Chauvin, BWH

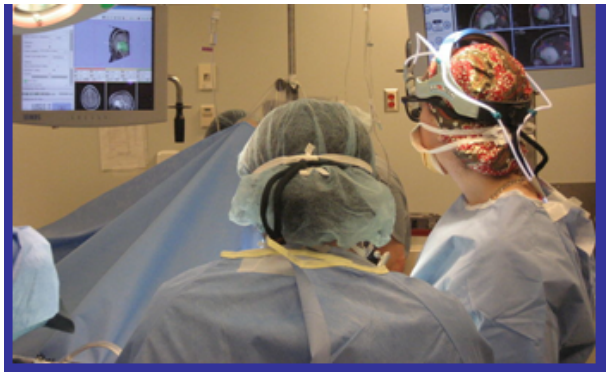
Keynote Speaker

- Dr. Carlo Pierpaoli, NIH

Considerations on the use of Diffusion MRI tractography to investigate brain connectivity

Tractography: The Good, The Bad and the Ugly

Neurosurgeons



- **Dr. Alexandra Golby**, Brigham and Women's Hospital, Harvard Medical School, Boston, USA
- **Dr. Arya Nabavi**, University Hospital Schleswig-Holstein, Kiel, Germany
- **Dr. Sandrine De Ribaupierre**, Western University, London, Ontario, Canada
- **Dr. David Fortin**, Sherbrooke University, Sherbrooke, Canada
- **Dr. Francesco Cardinale**, Epilepsy and Parkinson Surgery Centre "Claudio Munari", Milan, Italy

10 international teams

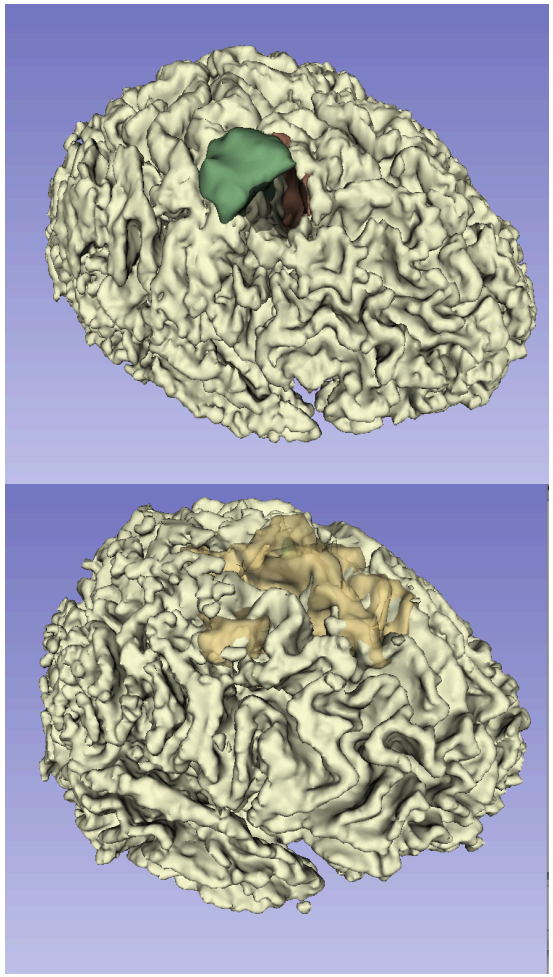
- USA (3)
- Canada (2)
- France
- Italy
- Germany
- Turkey
- Spain

→ 19 tractography methods represented

10 international teams

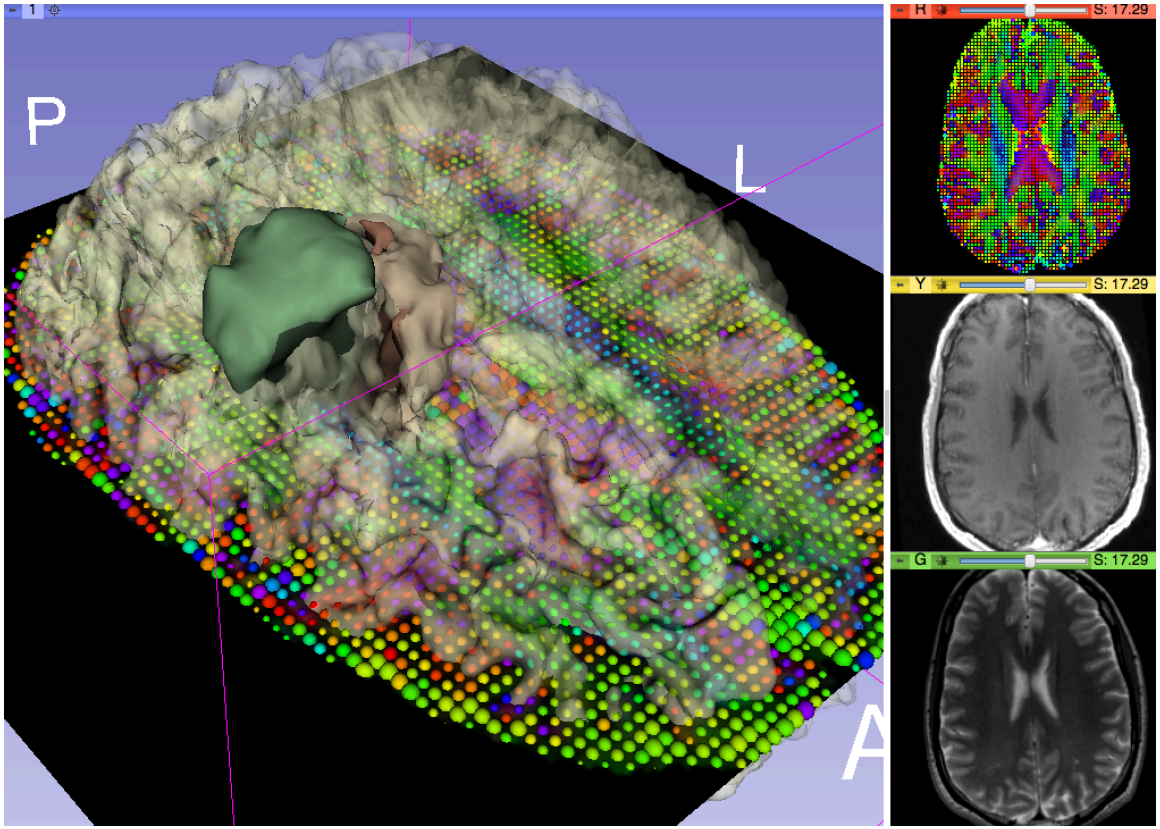
1. *Ali R. Khan, Maged Goubran, Jonathan C. Lau, Roy Eagleson, Terry M. Peters, and Sandrine de Ribaupierre. Robarts Research Institute, London, Canada*
2. *Aymeric Stamm, Olivier Commowick, Patrick Perez, and Christian Barillot. INSERM U746-CNRS UMR6074-INRIA University of Rennes I, Rennes, France*
3. *-Peter F. Neher, Bram Stieltjes, Marco Reisert, Hans-Peter Meinzer, and Klaus H. Fritzsche. German Cancer Research Center, Heidelberg, Germany*
4. *.Antonio Tristan-Vega, Santiago Aja-Fernandez, and Carl-Fredrik Westin. University of Valladolid, Valladolid, Spain*
5. *Riza Alp Guler, Ali Demir, and Gozde Unal. Sabanci University, Istanbul, Turkey*
6. *Alessio Moscato, and Francesco Cardinale, Niguarda Hospital, Milan, Italy*
7. *Gabriel Girard, Maxime Chamberland, Jean-Christophe Houde, David Fortin, and Maxime Descoteaux. Sherbrooke University,Sherbrooke, Canada*
8. *Joy Matsui, Eun Young Kim, Vincent Magnotta, and Hans Jonhson. University of Iowa, Iowa City, USA*
9. *Sudhir K Pathak, Deepa Krishnaswamy, and Walter Schneider, University of Pittsburgh, Pittsburgh, USA*
10. *Hesamoddin Salehian, Guang Cheng, Jiaqui Sun, and Baba Vemuri. University of Florida, Gainesville, USA*

Patients



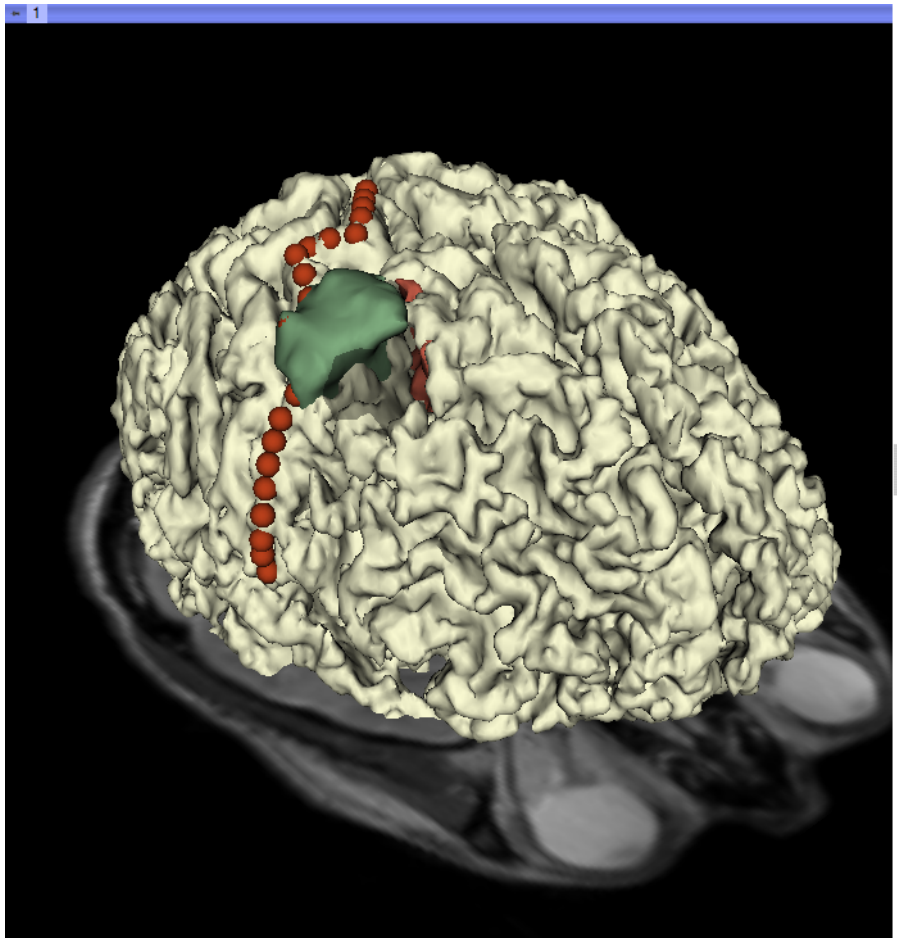
- Patient 1: Recurrent/residual anaplastic astrocytoma Grade III
- Patient 2 : Oligodendroglioma grade II
- Patient 3: Oligodendroglioma Grade II
- Patient 4: Anaplastic astrocytoma Grade III

Challenge Datasets



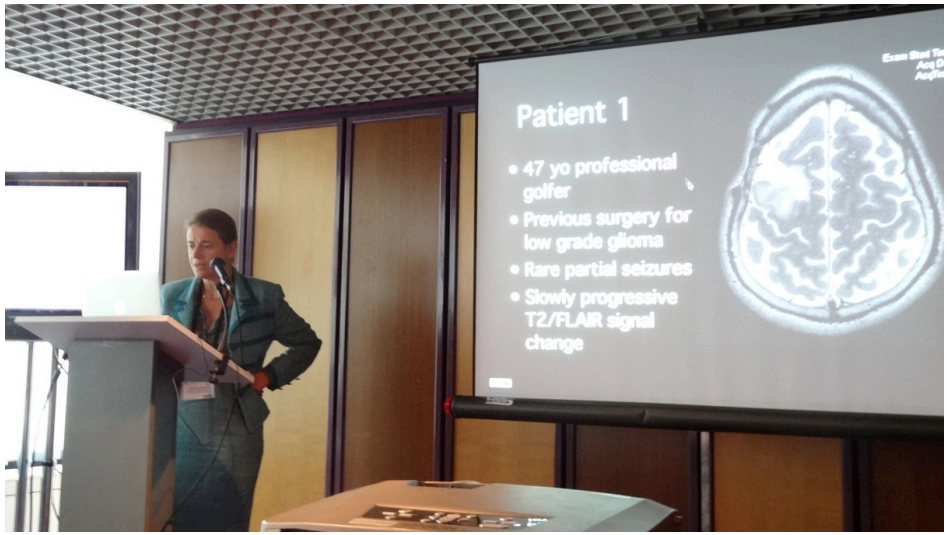
- T1,T2, DWI, DTI
- Pre-segmented tumor regions
- 3D White Matter Surface

Challenge Datasets (new)



- Delineation of pre-central gyrus (expected motor cortex location)

What does the clinician want to see?



Dr. Alexandra Golby, MICCAI 2012

- Where is the tract?
- Is it normal?
- Is it symmetric?
- Is anything missing?
- Is it functional?

DTI Challenge Evaluation

- Quantitative assessment (STAPLE, DICE, FA Profile)
- Qualitative evaluation by clinicians and DTI experts

- 2nd Edition: Standardization effort
- Web-based questionaire for review

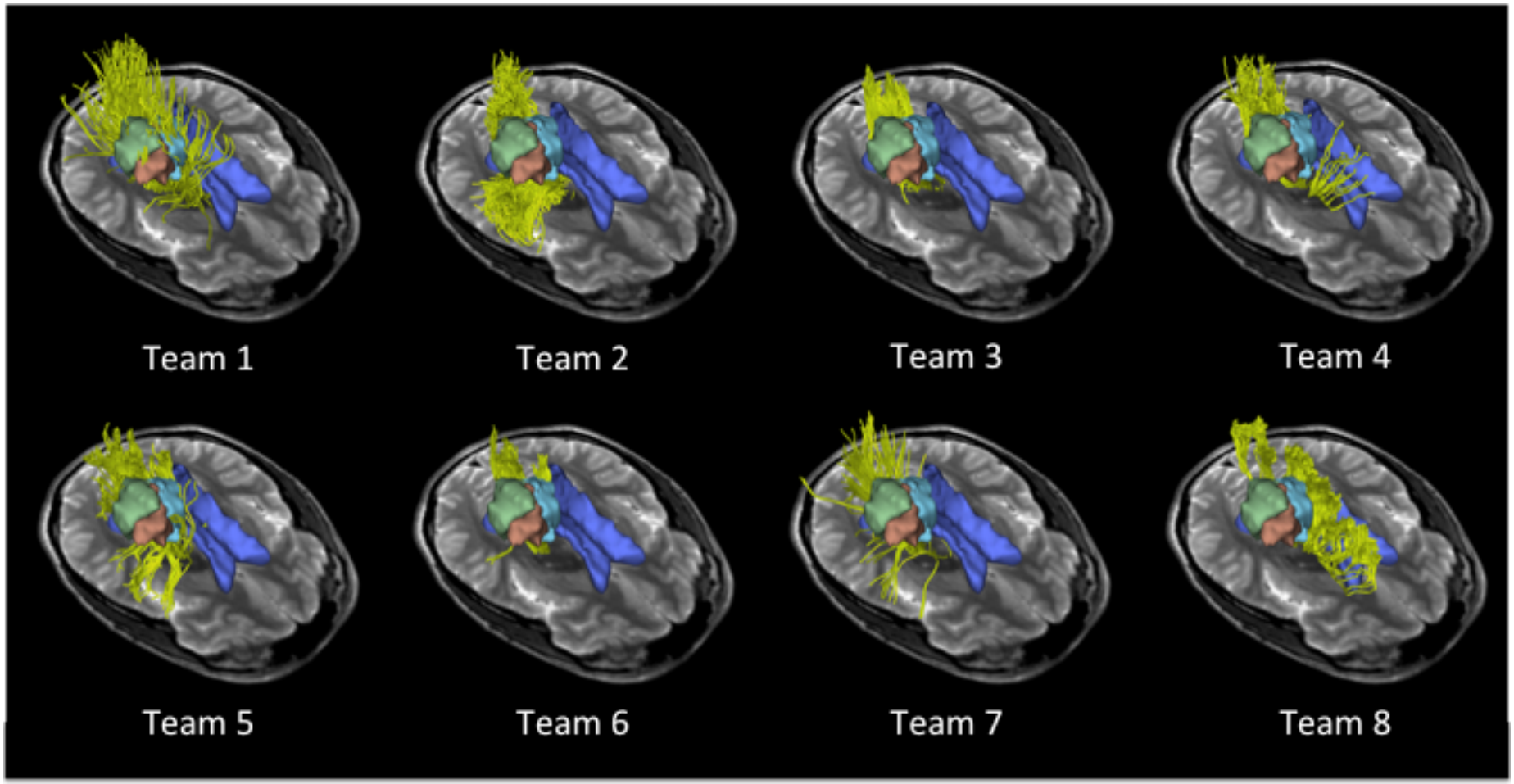
Panel of reviewers

Practicing neurosurgeons and DTI experts:

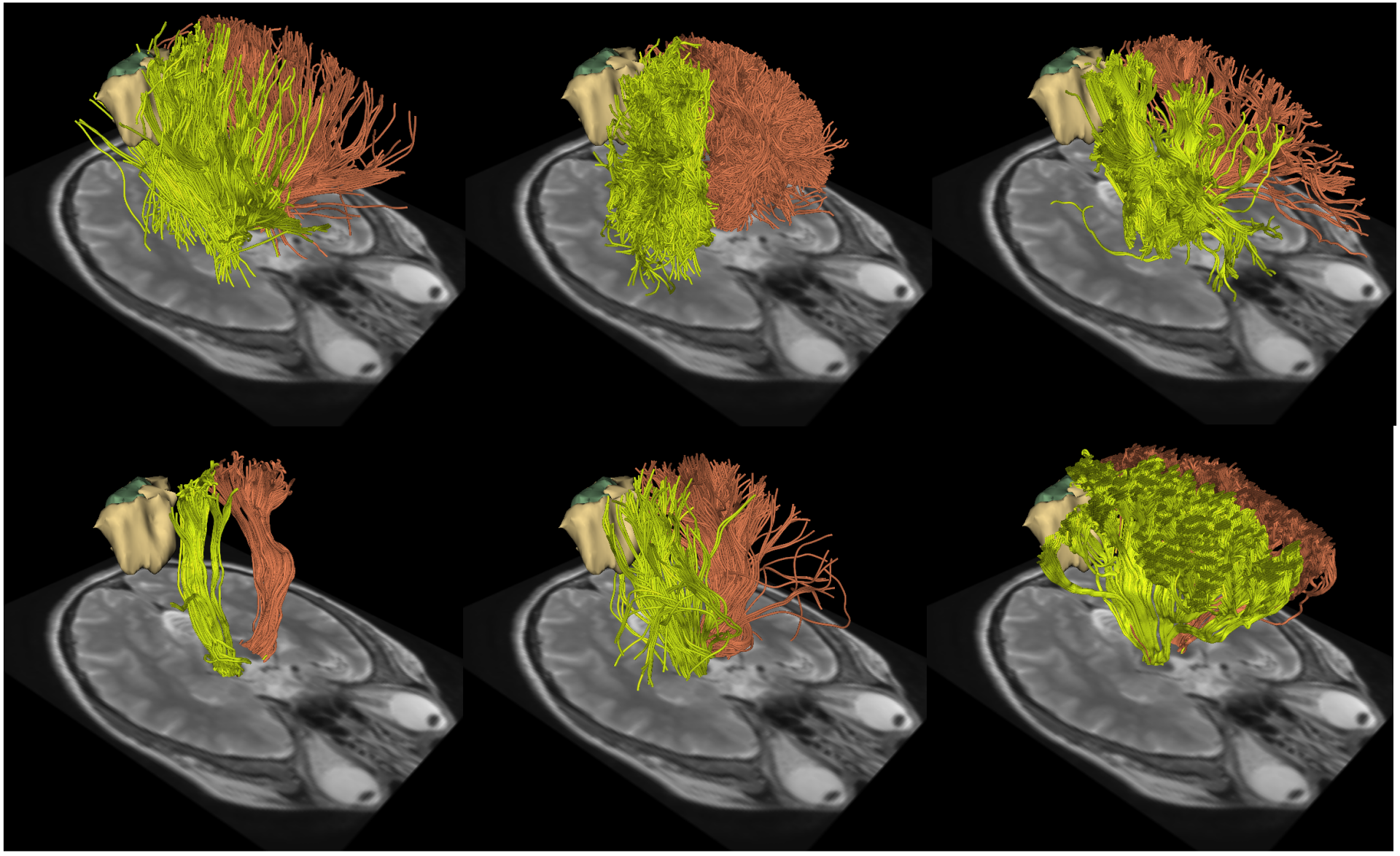
1. Dr. Alexandra Golby
2. Dr. Arya Nabavi
3. Dr. Ron Kikinis
4. Dr. Carlo Pierpaoli
5. Dr. Carl-Fredrik Westin

DTI Tractography Challenge
Preliminary Results

Patient1 (pre-workshop)



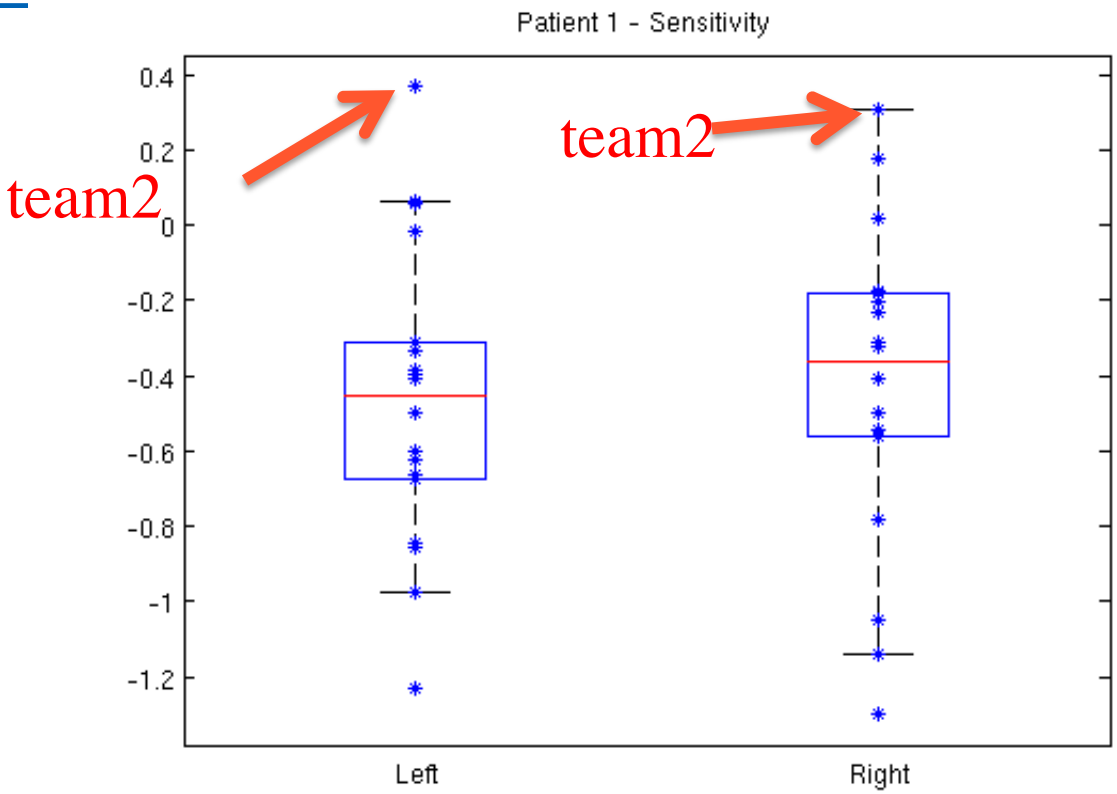
Patient 3 (5-hour on-site challenge)



Quantitative evaluation

- Metric 1: STAPLE sensitivity score
- Metric 2: Dice coefficient of overlap
- Metric 3: Fiber FA profile along tract

STAPLE

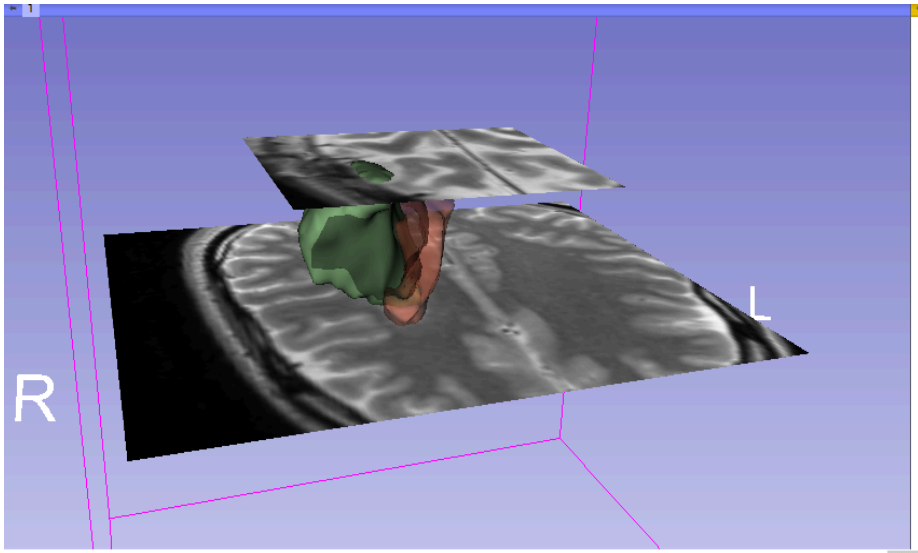


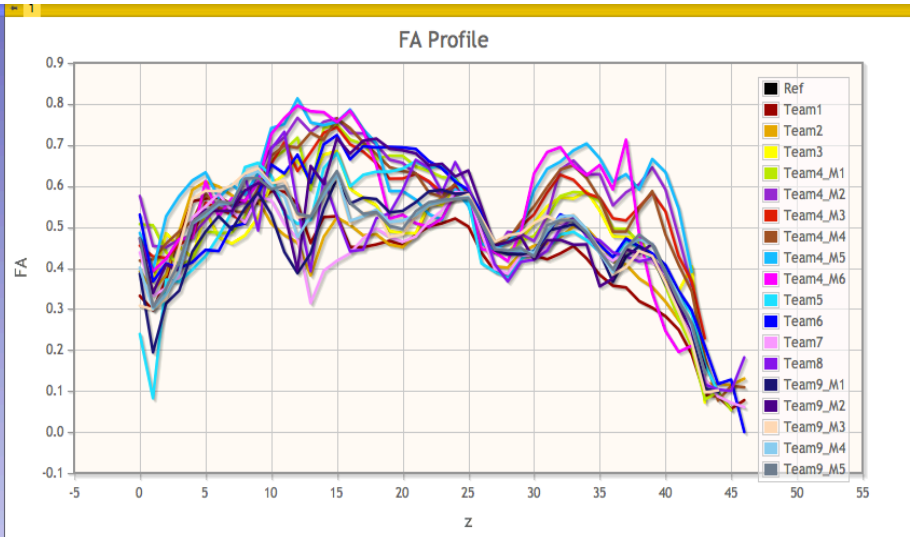
tumor

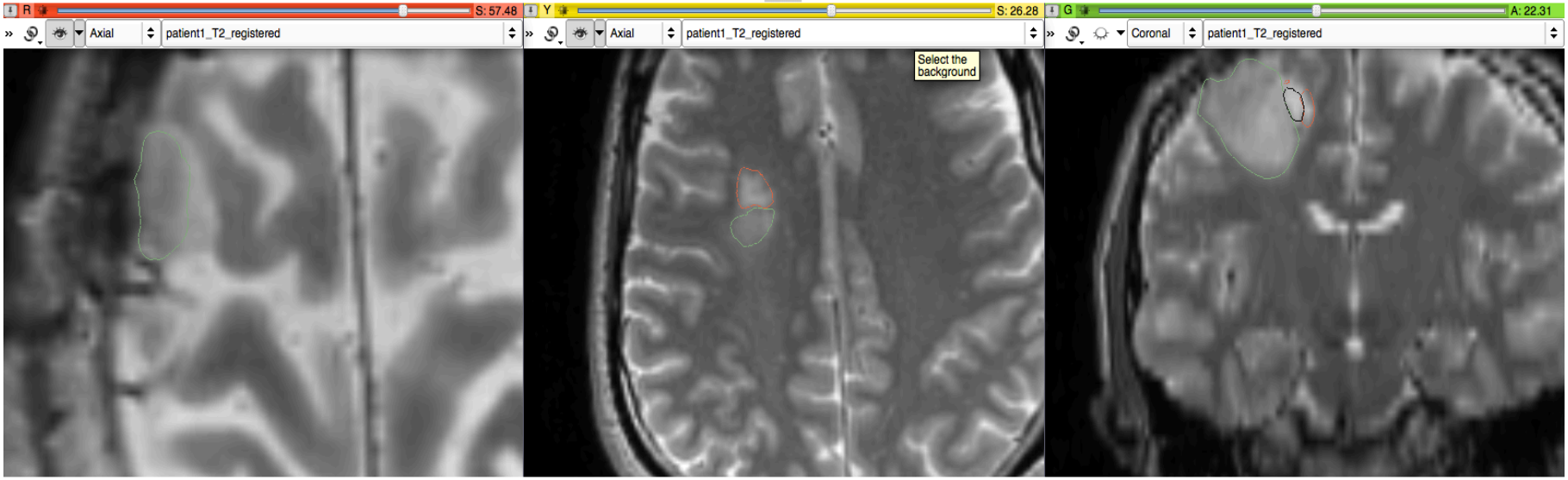
Dice coefficient of overlap

- Patient1:
  - mean: 25.81 % (left) / 26.48 % (right)
  - peritumoral mean: 36.37 %
- Patient2:
  - mean: 25.89 % (left) / 22.35 % (right)

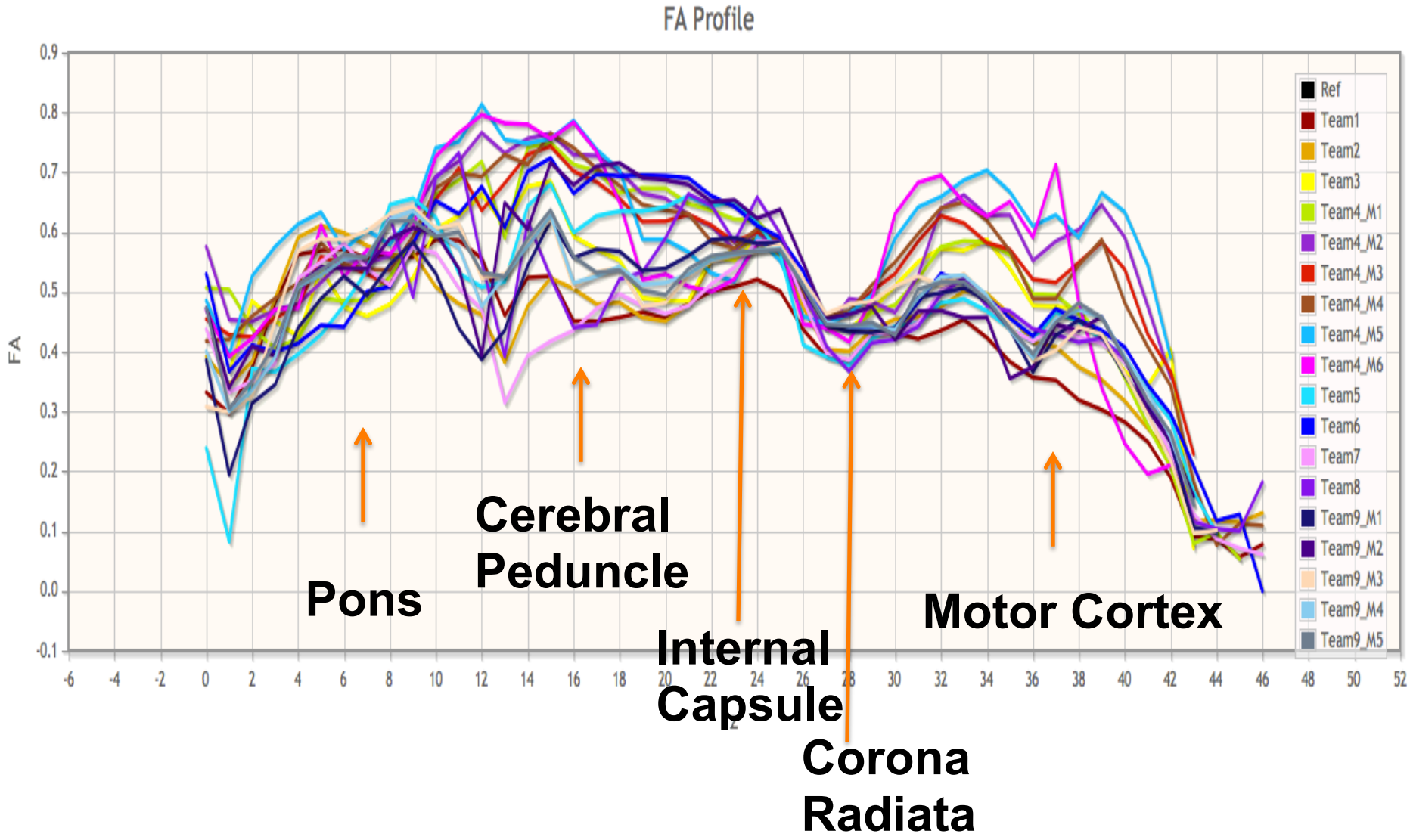
FA Profile


R
L

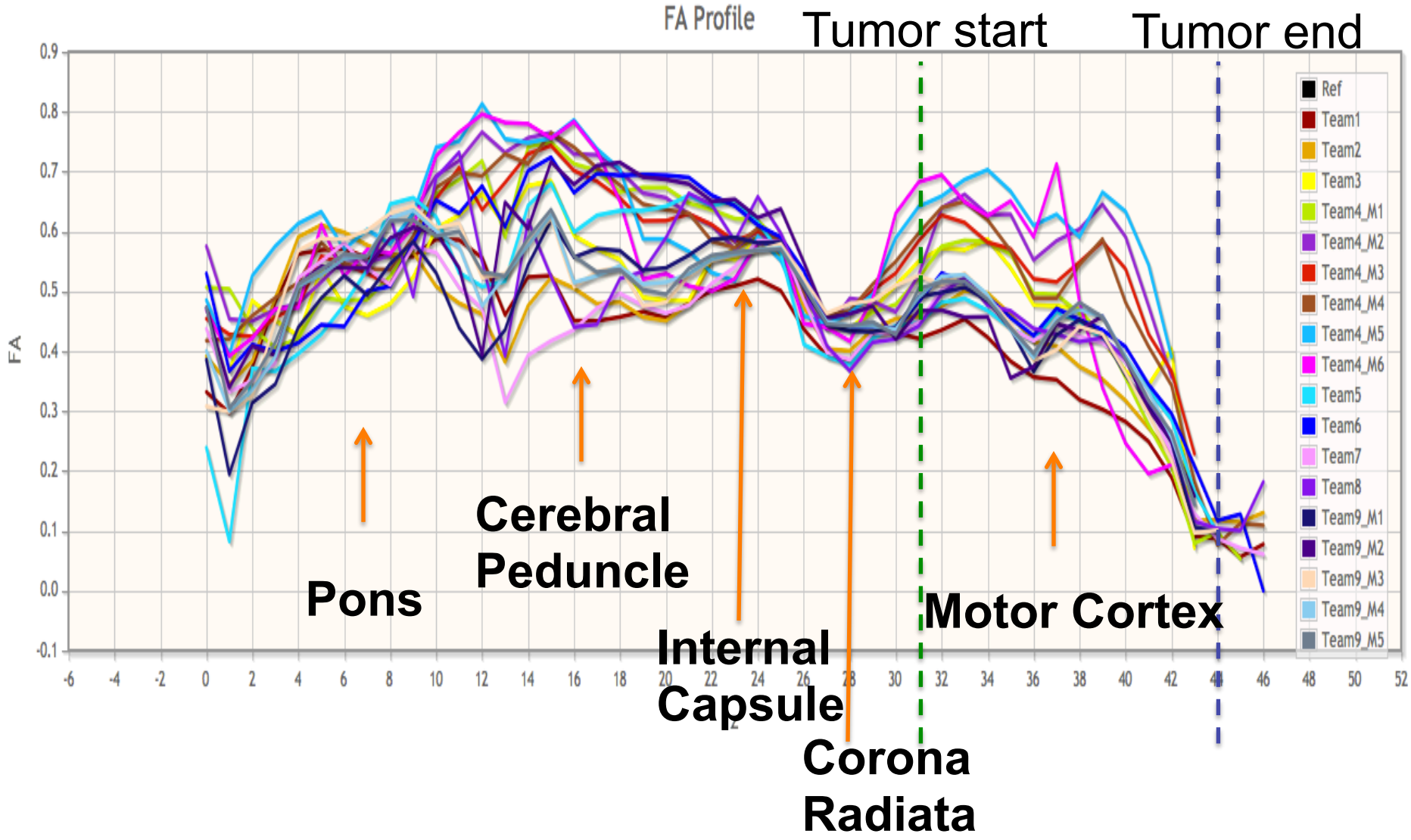

FA Profile
FA
z
Ref
Team1
Team2
Team3
Team4_M1
Team4_M2
Team4_M3
Team4_M4
Team4_M5
Team4_M6
Team5
Team6
Team7
Team8
Team9_M1
Team9_M2
Team9_M3
Team9_M4
Team9_M5


R
S: 57.48
Axial
patient1_T2_registered
Y
S: 26.28
Axial
patient1_T2_registered
Select the background
G
A: 22.31
Coronal
patient1_T2_registered

FA Profile


FA Profile
FA
Ref
Team1
Team2
Team3
Team4_M1
Team4_M2
Team4_M3
Team4_M4
Team4_M5
Team4_M6
Team5
Team6
Team7
Team8
Team9_M1
Team9_M2
Team9_M3
Team9_M4
Team9_M5
Pons
Cerebral Peduncle
Internal Capsule
Corona Radiata
Motor Cortex

FA Profile


FA Profile
Tumor start
Tumor end
FA
Pons
Cerebral Peduncle
Internal Capsule
Corona Radiata
Motor Cortex
Ref
Team1
Team2
Team3
Team4_M1
Team4_M2
Team4_M3
Team4_M4
Team4_M5
Team4_M6
Team5
Team6
Team7
Team8
Team9_M1
Team9_M2
Team9_M3
Team9_M4
Team9_M5

Clinical evaluation criteria

C1. Presence of False Negative Tracts

C2. Presence of False Positive Tracts

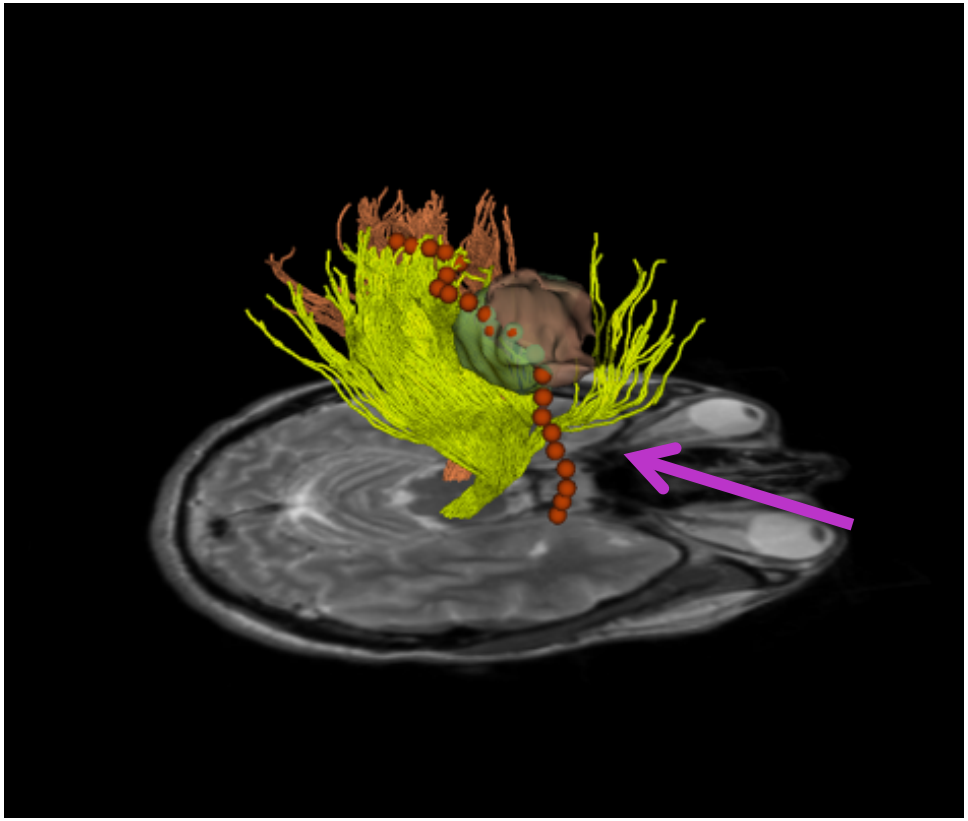
C3. Correct depiction of the CST in specific anatomical regions

C4. Correct depiction of the peritumoral tracts

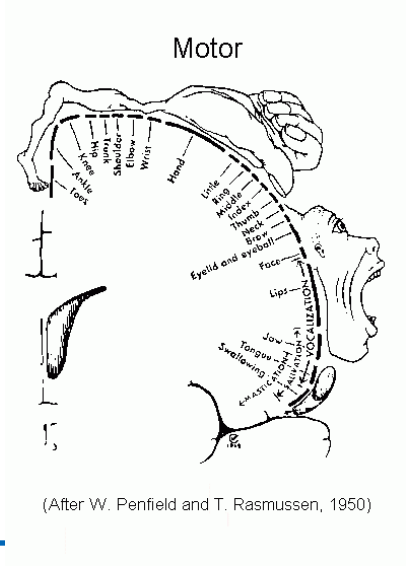
C5. Presence of implausible tracts

C6. Clinical relevance of the tractography reconstruction

C1. False Negative

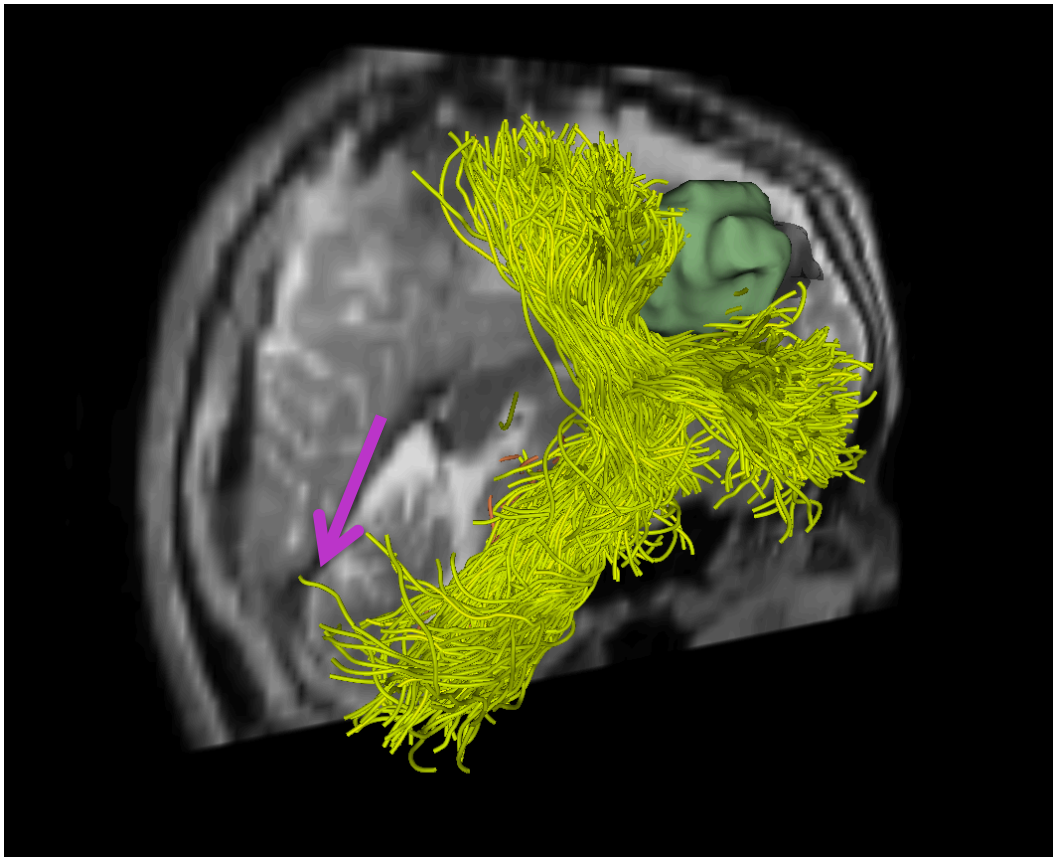


Which parts of the corticospinal tract are missing?



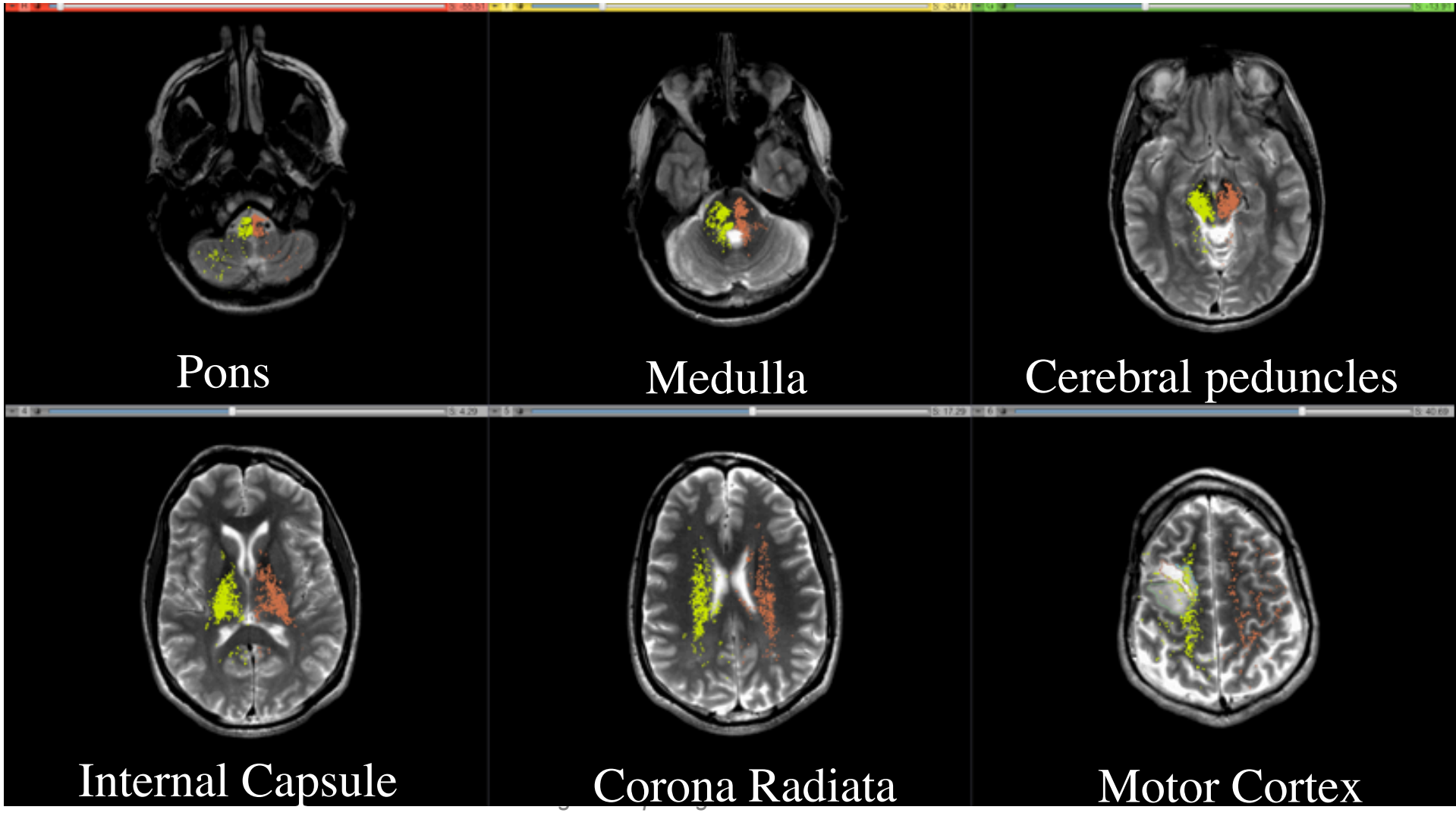
(After W. Penfield and T. Rasmussen, 1950)

C2. False Positive

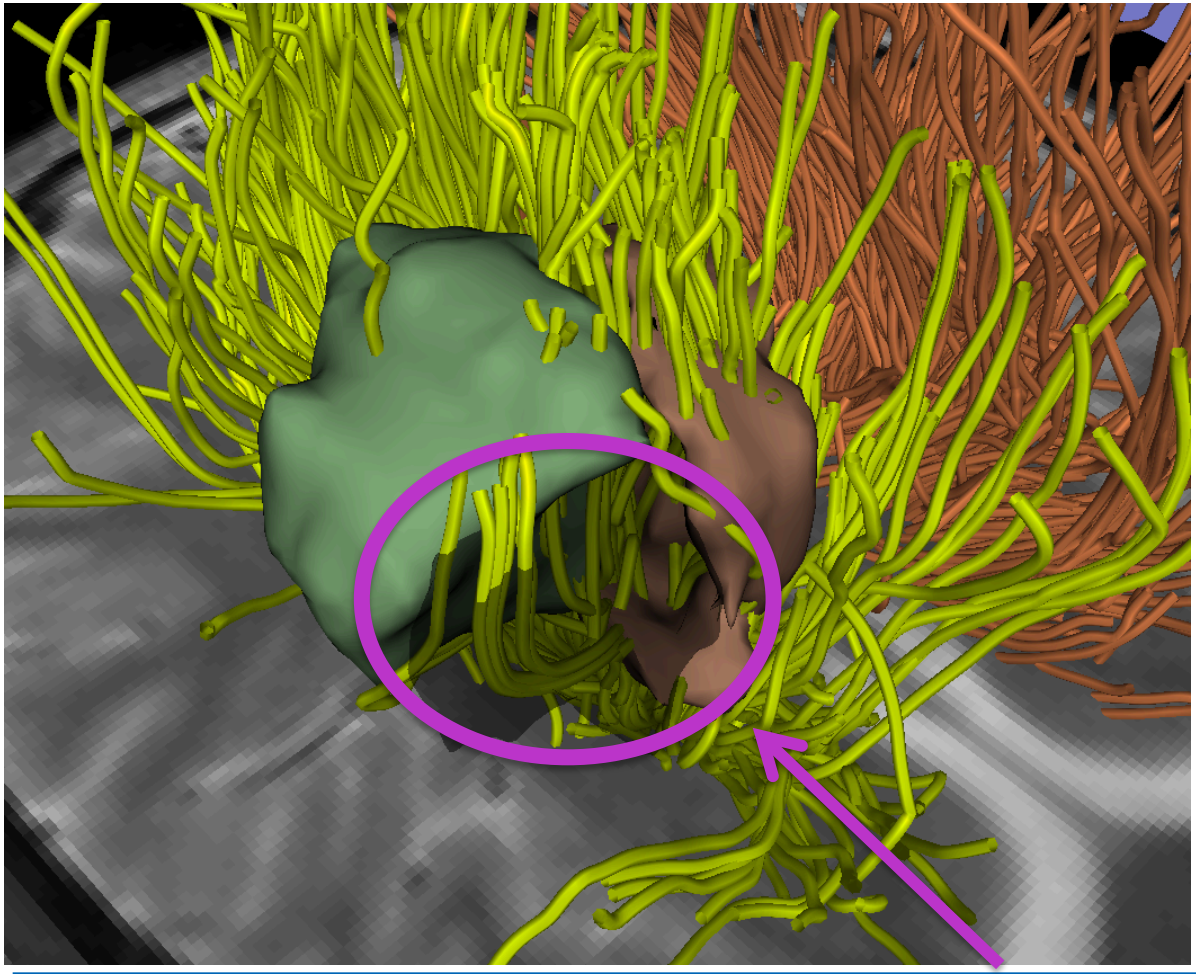


Did the tractography capture fiber bundles outside the corticospinal tract? If yes, where are the false positive tracts?

C3. Specific anatomical regions

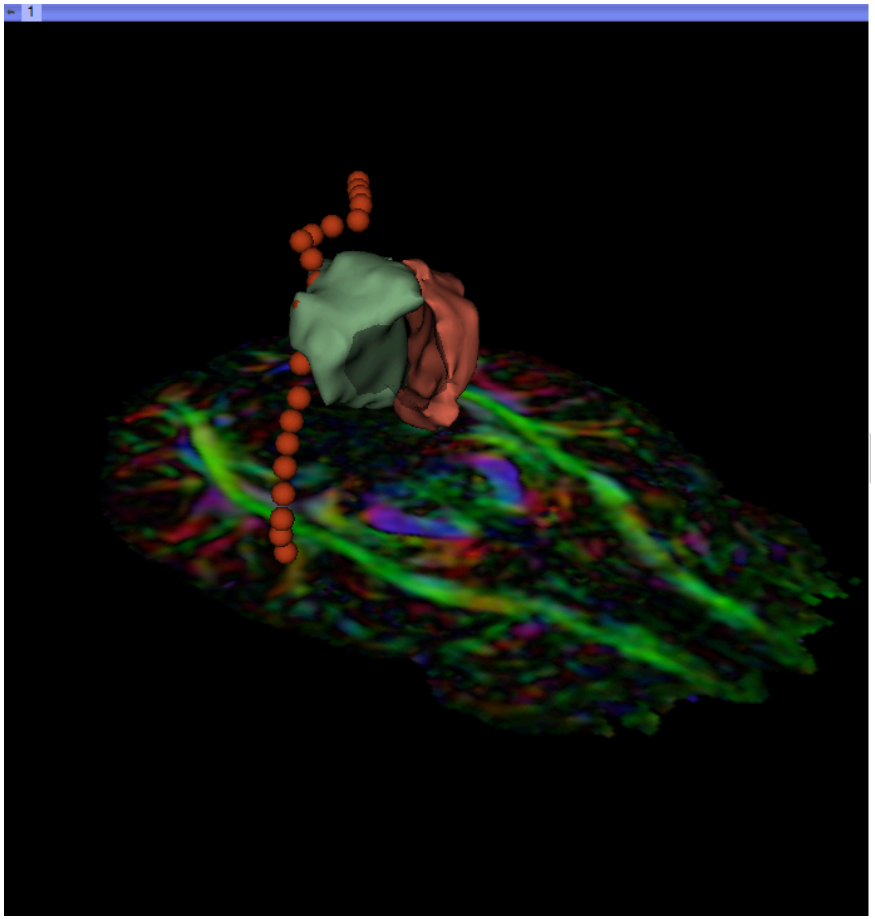


C5. Implausible Tracts



Are there tracts in place where they are implausible?

CST Lateral Projections



False Negative

1	2	3	4	5	6	7	8	9-1	9-5
3	**4.5**	2.25	2.25	3.25	2.25	2.5	1.75	3.5	2.5

False Positive

1	2	3	4	5	6	7	8	9-1	9-5
1.75	3.25	**4.0**	3.0	2.50	3.0	2.5	1.75	2.5	3.0

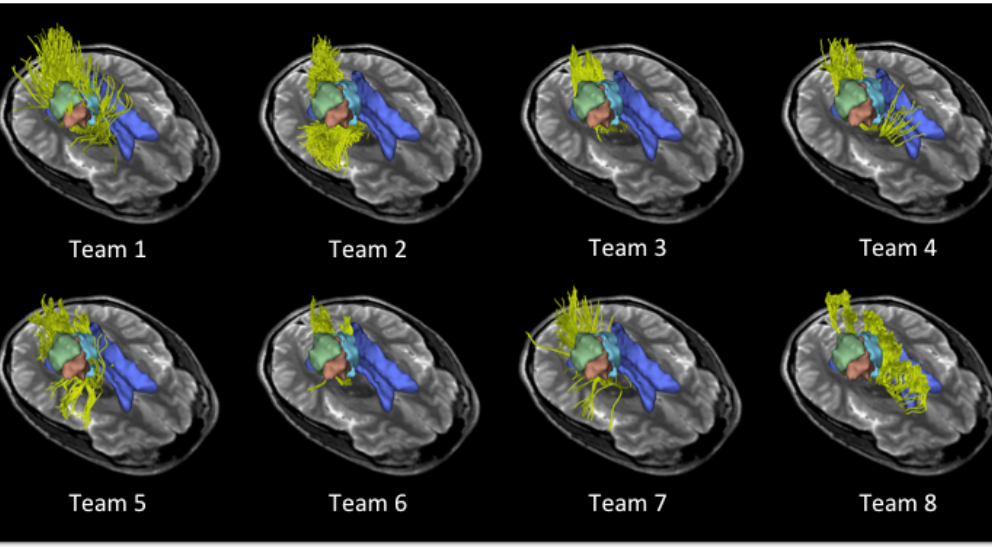
Anatomical regions

	1	2	3	4	5	6	7	8	9-1	9-5
CP	2.5	3	1.66	4	3	**3.33**	1.66	2	3	3
IC	2.5	3	2	3.5	2.66	**3.33**	2.66	2	2.5	2.5
MC	2	**3.5**	1.66	2.25	1.66	2.33	3.0	1.75	2.5	3.0

Overall Score [1-10]

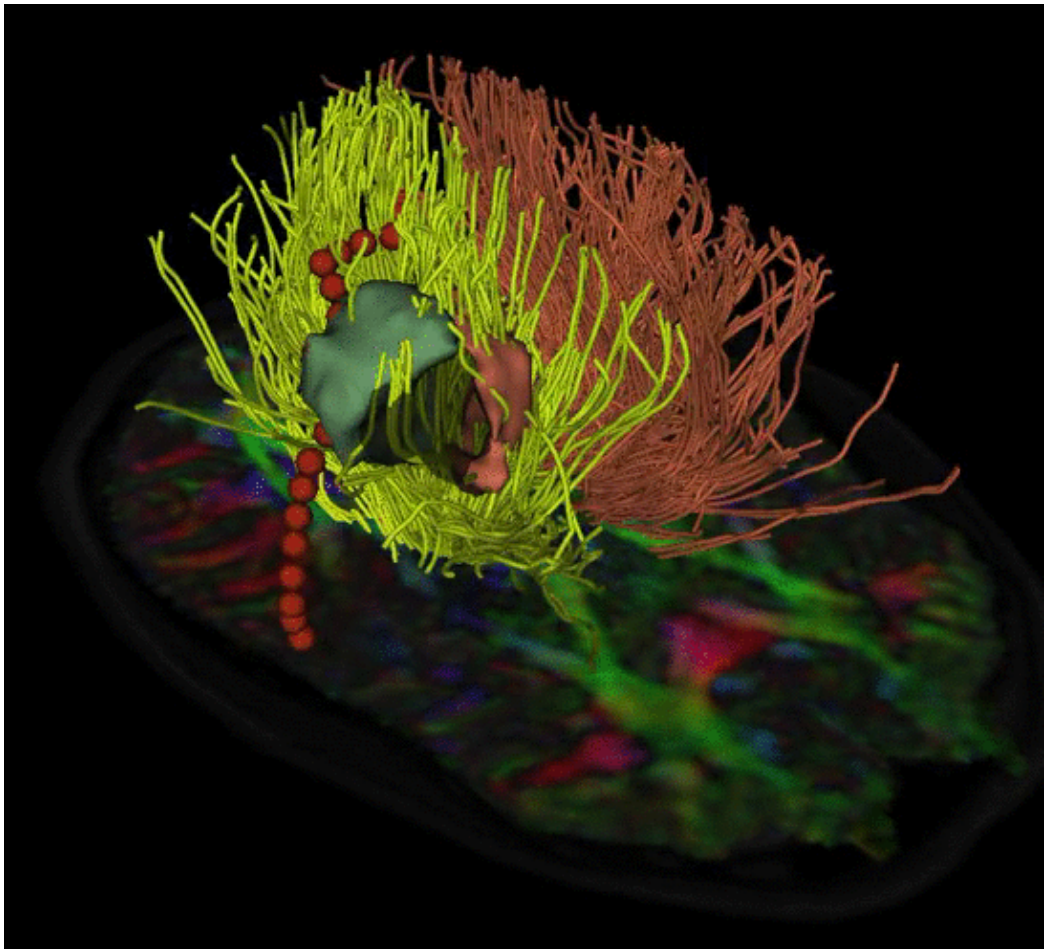
1	2	3	4	5	6	7	8	9-1	9-5
4	**7.66**	3.3	**4.75**	**4.75**	5	4.25	2.25	6	6

Workshops findings

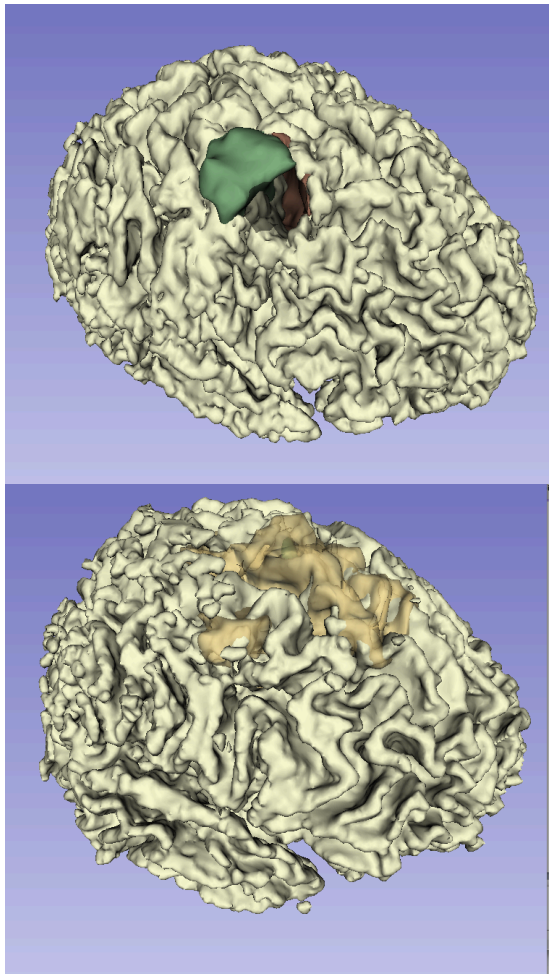


- Large intra- and inter-algorithm variability
- Reviewer variability
- Improved results for some of teams

CST Lateral Projections



Back to the Patients



Patient 1: 47 yo professional golfer

Patient 2 : 32 yo woman with recurrent seizures

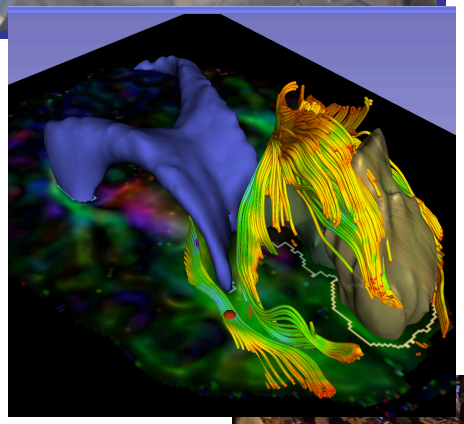
→ **Tractography needs to be used with caution**

MICCAI DTI Challenge: An international Effort

The two editions of the DTI Challenge gathered an international group representing 16 leading organizations

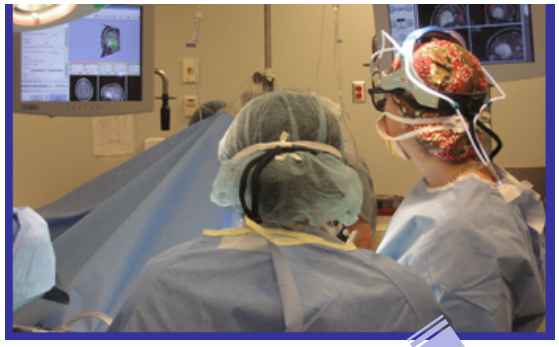
- DTI Experts
- Practicising neurosurgeons
- Tractography algorithms developers
- Neuroradiologists

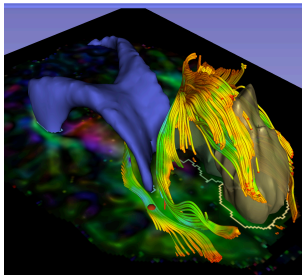
Working Group



- Long-term goal: Validation
- Short-term goal: Standardization effort:
  - Anatomy
  - Data
  - Evaluation

Working Group





Two-way bridge between the scientists who create the tractography tools, and the neurosurgeons who will use the tools in the clinics.

DTI Challenge: Conclusion

- Appropriate reflection of the current state of the art in the field
- Submission of an abstract to World Congress of Neurosurgery (WFNS 2013)
- Submission of new challenge proposal to MICCAI 2013
- On-going learning effort for the community