

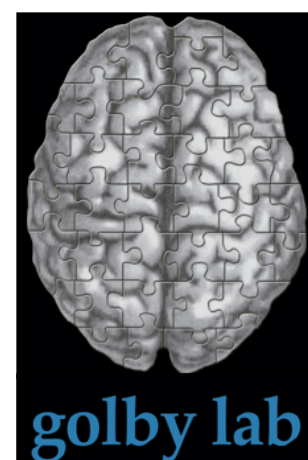


Open-Source Diffusion MRI Software for Brain Cancer Research

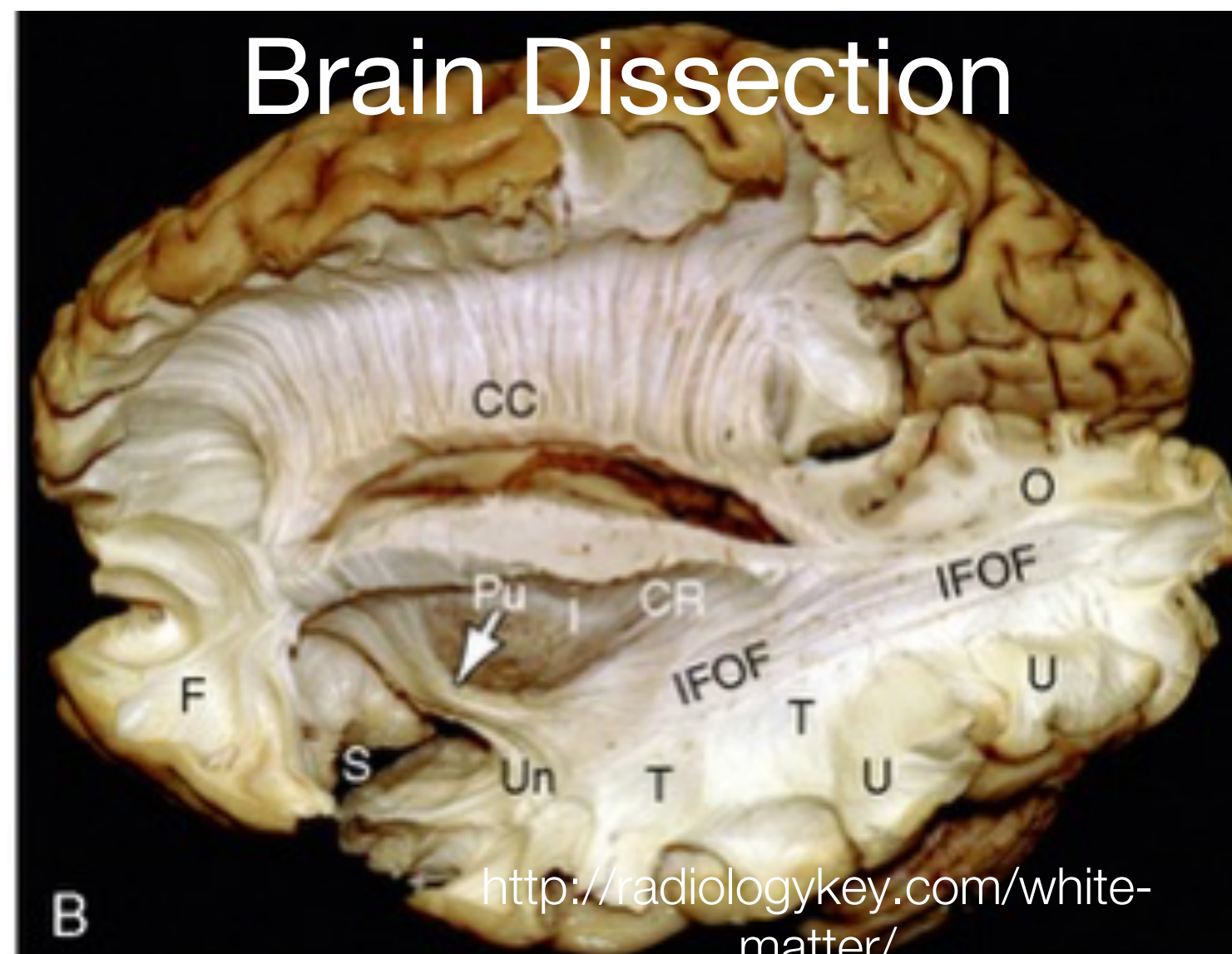
Lauren J. O'Donnell, Ph.D.

Assistant Professor of Radiology

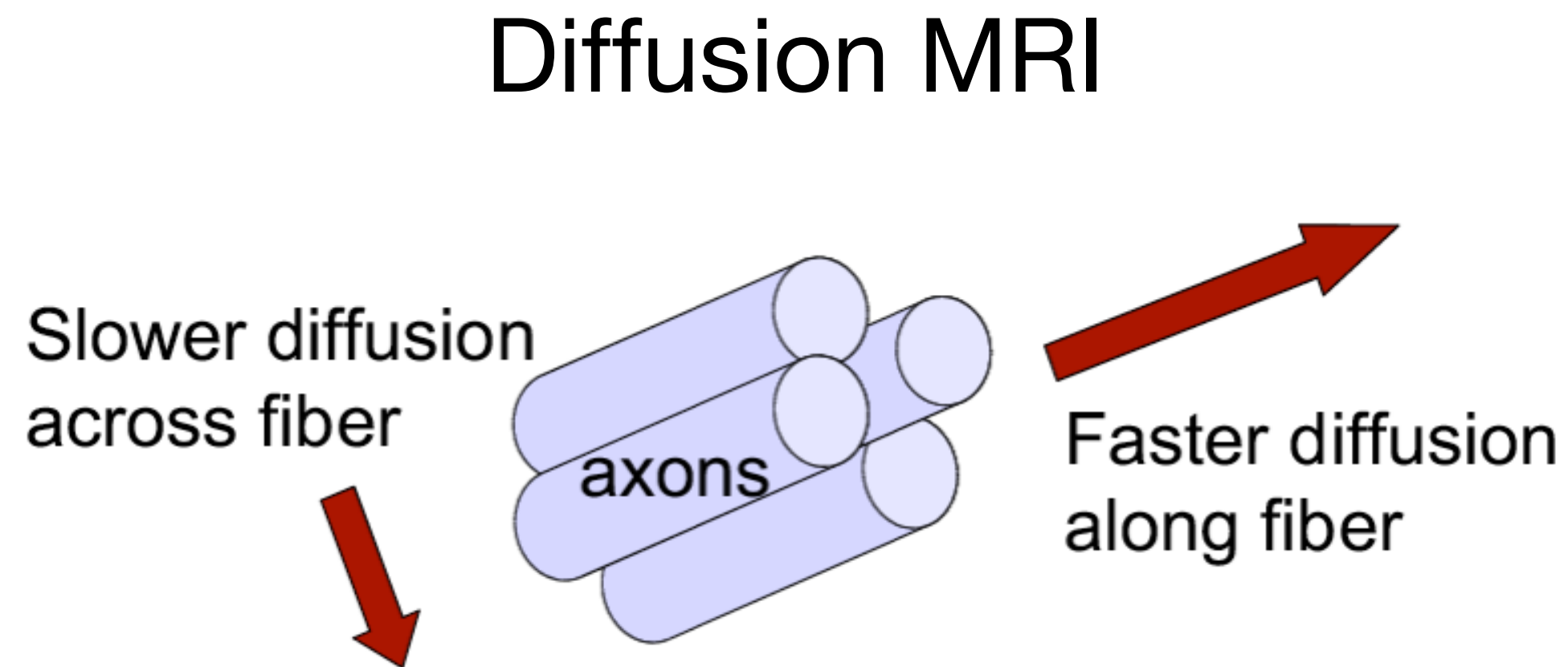
Harvard Medical School and Brigham and Women's Hospital



Diffusion MRI: the only method that can measure our brain connections in vivo

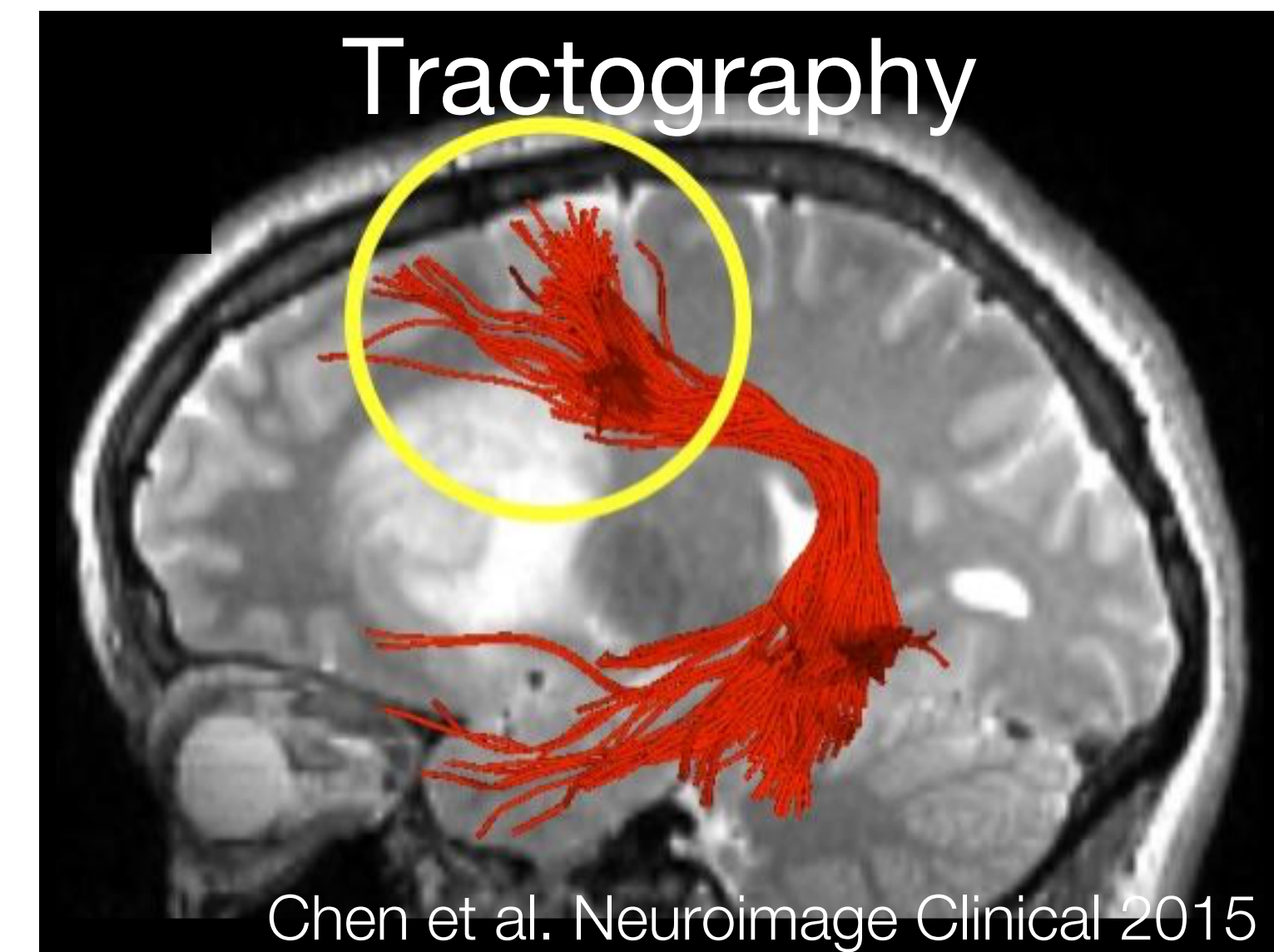


“What we are interested in”



“What we have” *

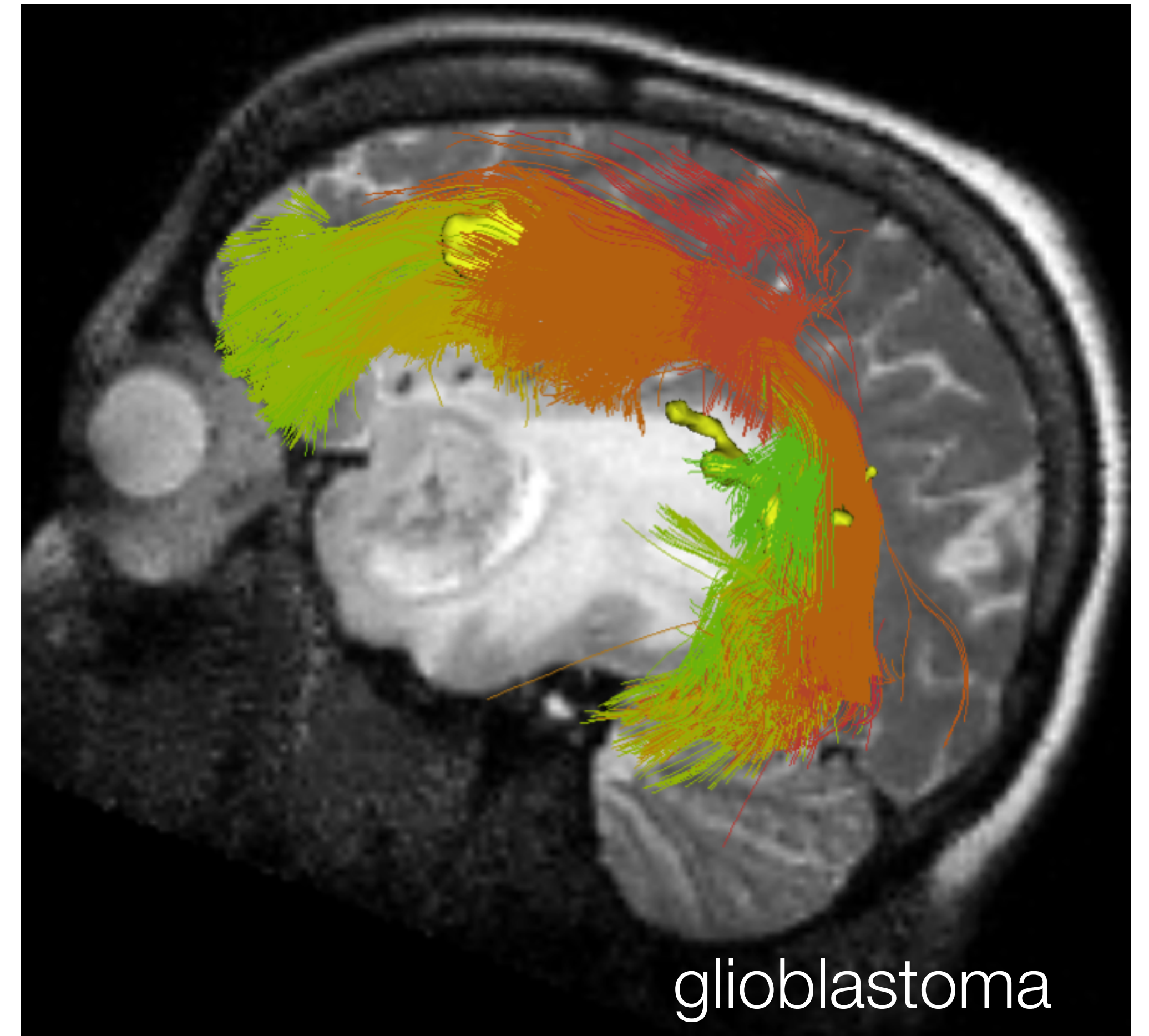
* Beaulieu C. NMR in Biomedicine. 2002

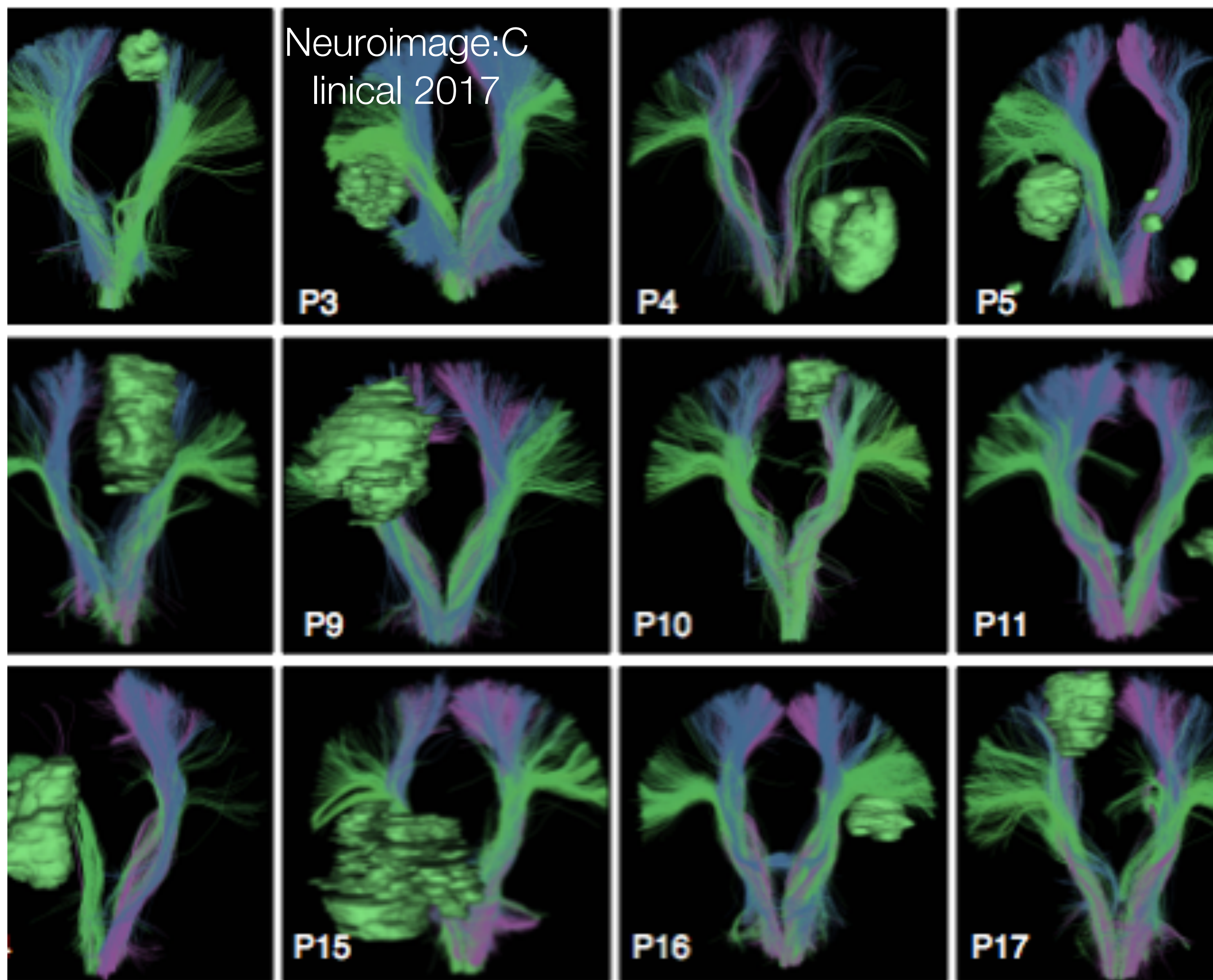


“What we try to do with it”

Neurosurgery for Brain Tumors

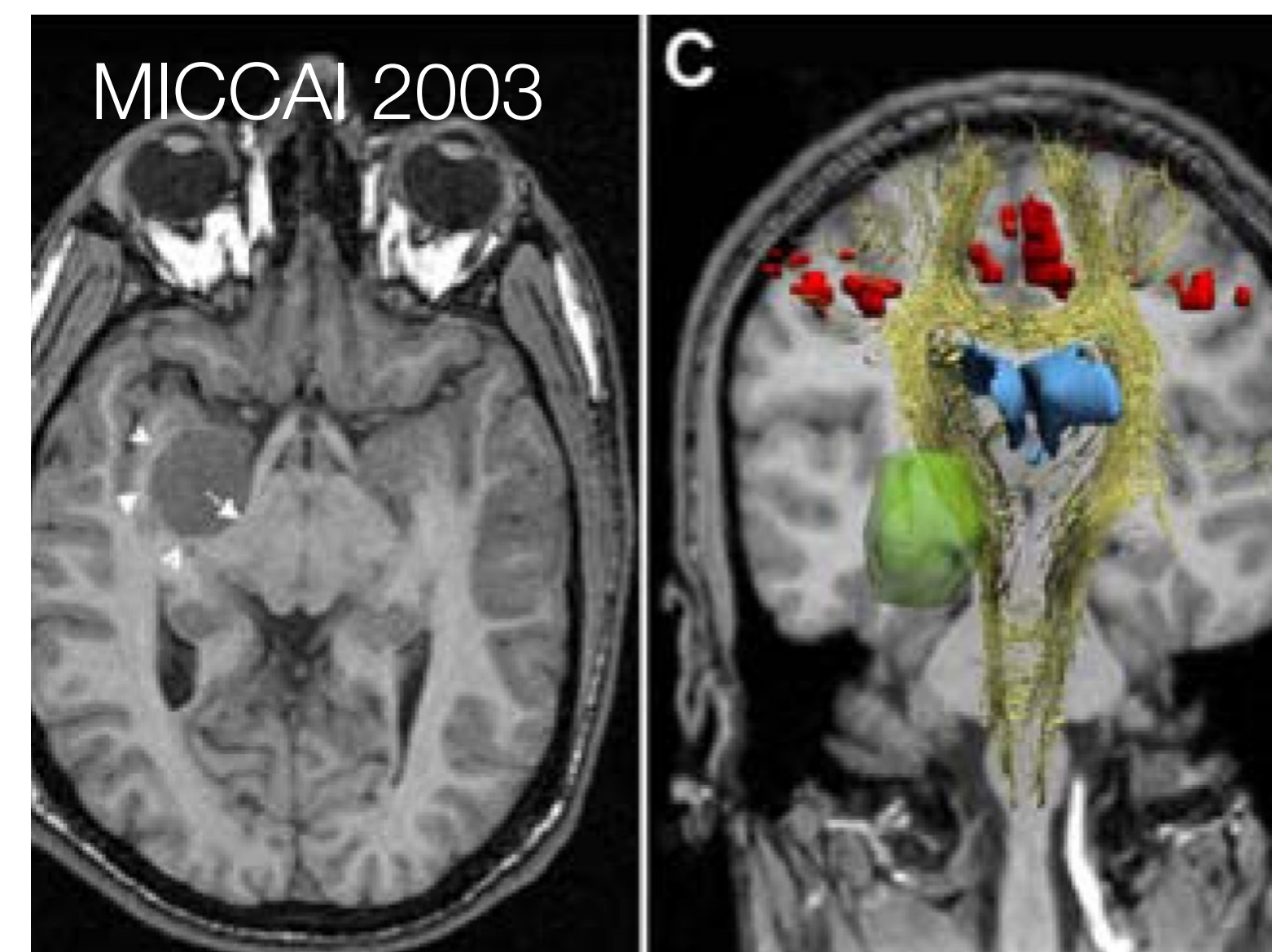
- Maximal tumor resection improves patient outcome
- dMRI: Map white matter tracts
- dMRI: Map brain microstructure
- dMRI is used for surgical planning and neuronavigation during surgery.

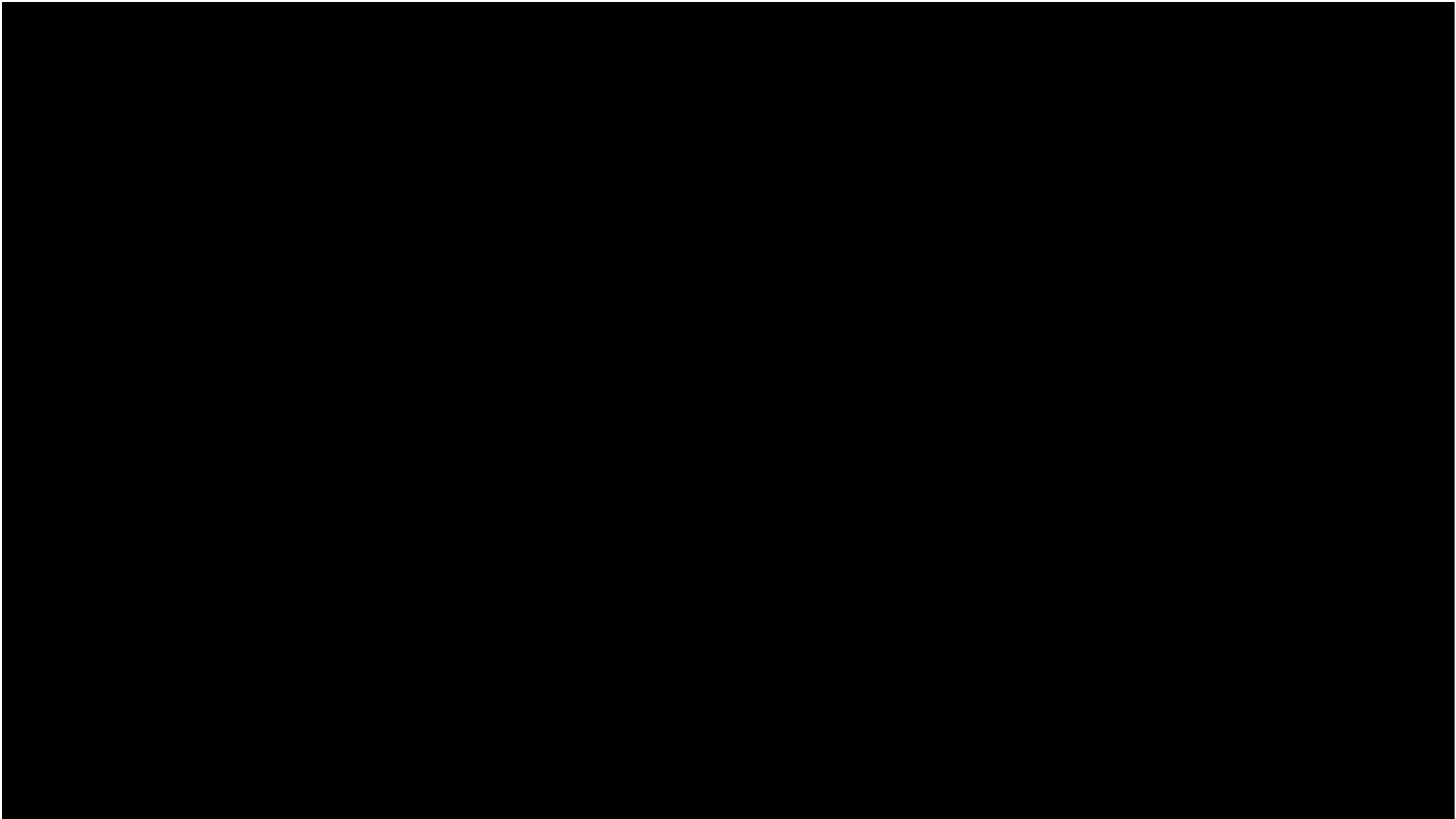




dSlicer **dmRI**

NIH NCI ITCR U01CA199459: Open Source
Diffusion MRI Technology For Brain Cancer
Research





SlicerDMRI U01

- Create state-of-the-art dMRI workflows for brain cancer research.

- Latest improvements are available:

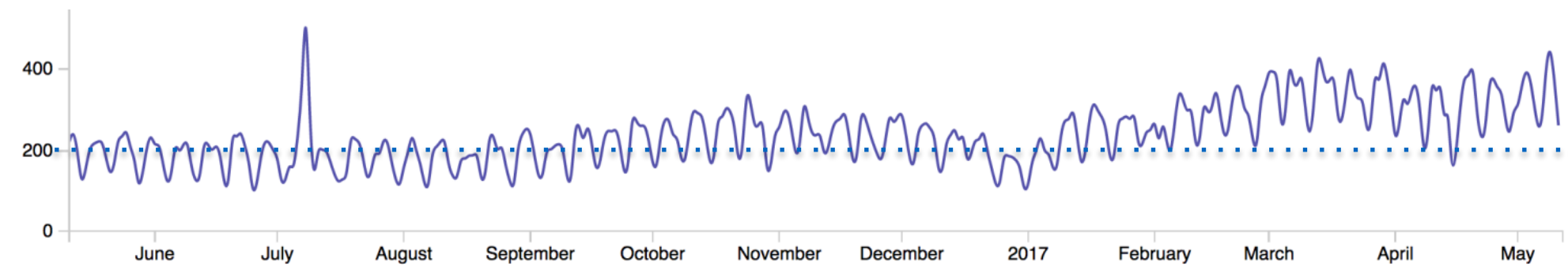
- dmri.slicer.org

- <https://github.com/SlicerDMRI>




3D Slicer: a platform for software dissemination

Downloads per day



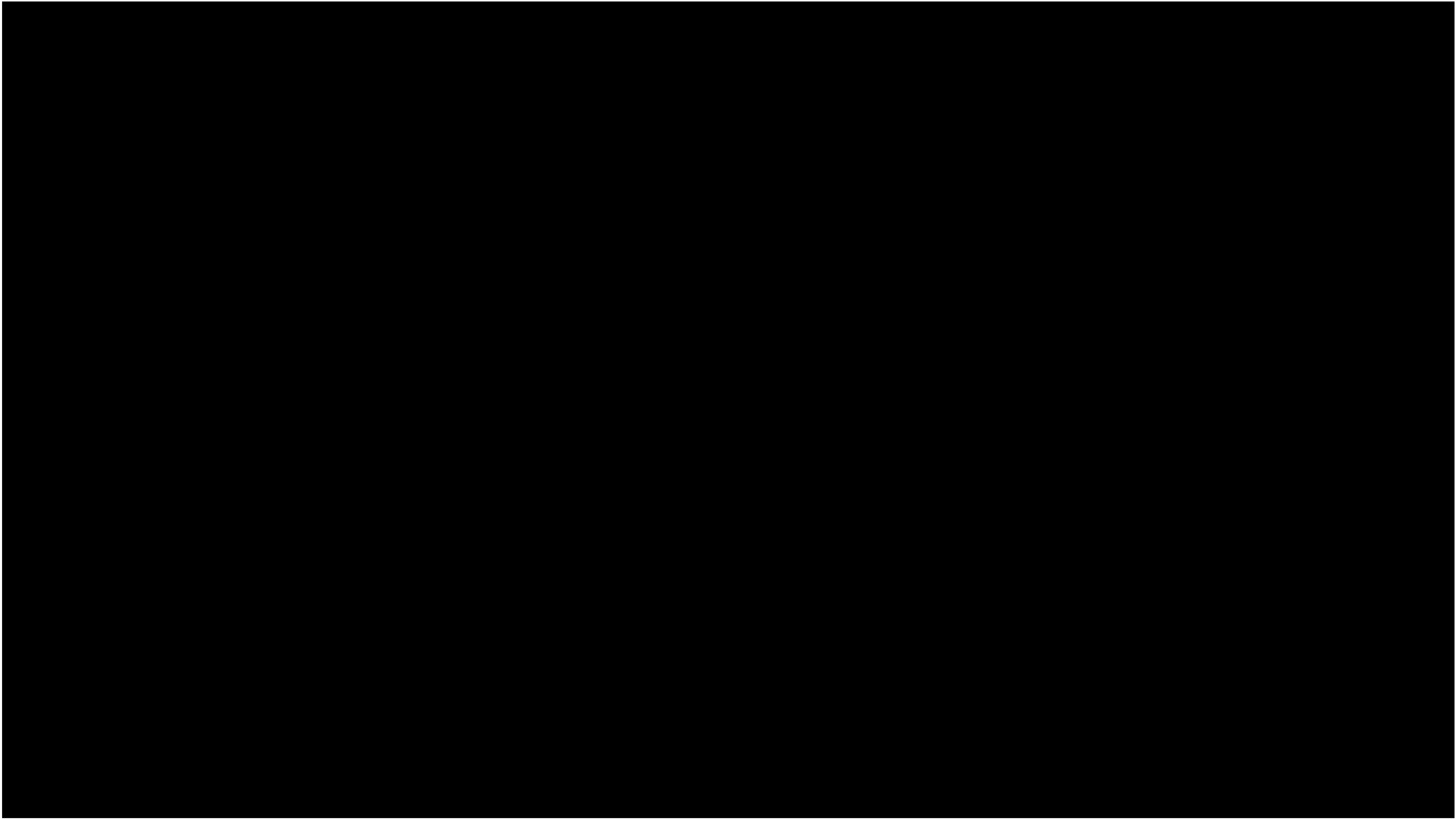
Extension Manager “App Store”

 PerkTutor Tamas Ungi, Matthew ... ★★★★★ (0) INSTALL	 Sobolev Segmenter Arie Nakhmani (UAB), ... ★★★★★ (0) INSTALL	 PETTumorSegmentat... Christian Bauer (Univer.. ★★★★★ (0) INSTALL	 PetSpectAnalysis Martin Bertran, Natalia.. ★★★★★ (0) INSTALL	 DebuggingTools Andras Lasso (PerkLab.. ★★★★★ (0) INSTALL
 PET-IndiC Ethan Ulrich (University.. ★★★★★ (0) INSTALL	 PBNRR Fotis Drakopoulos (CR... ★★★★★ (0) INSTALL	 ModelToModelDistan.. Francois Budin (UNC), ... ★★★★★ (0) INSTALL	 CurveMaker Junichi Tokuda (BWH) ★★★★★ (0) INSTALL	 Slicer-Wasp Thomas Lawson (MRC ... ★★★★★ (0) INSTALL
 ResectionPlanner Matt Lougheed (Queen.. ★★★★★ (0) INSTALL	 Scoliosis Franklin King (PerkLab.. ★★★★★ (0) INSTALL	 SlicerToKiwiExporter Jean-Christophe Fillion.. ★★★★★ (0) INSTALL	 PickAndPaintExtensi... Lucie Macron (Universi... ★★★★★ (0) INSTALL	 DeveloperToolsForEx... Francois Budin (UNC), ... ★★★★★ (0) UNINSTALL

SlicerDMRI released as extension

- Separate SlicerDMRI from core code for faster developments
- Available to users as extension in Slicer4.6 (Oct 2016)
- We can update independently of Slicer versioning
- Easy install process (video)





New user forum

New forum for user support
discourse.slicer.org



Support

The Support category is for all usage questions and general discussion of Slicer and extensions.

■ Feature requests

Development

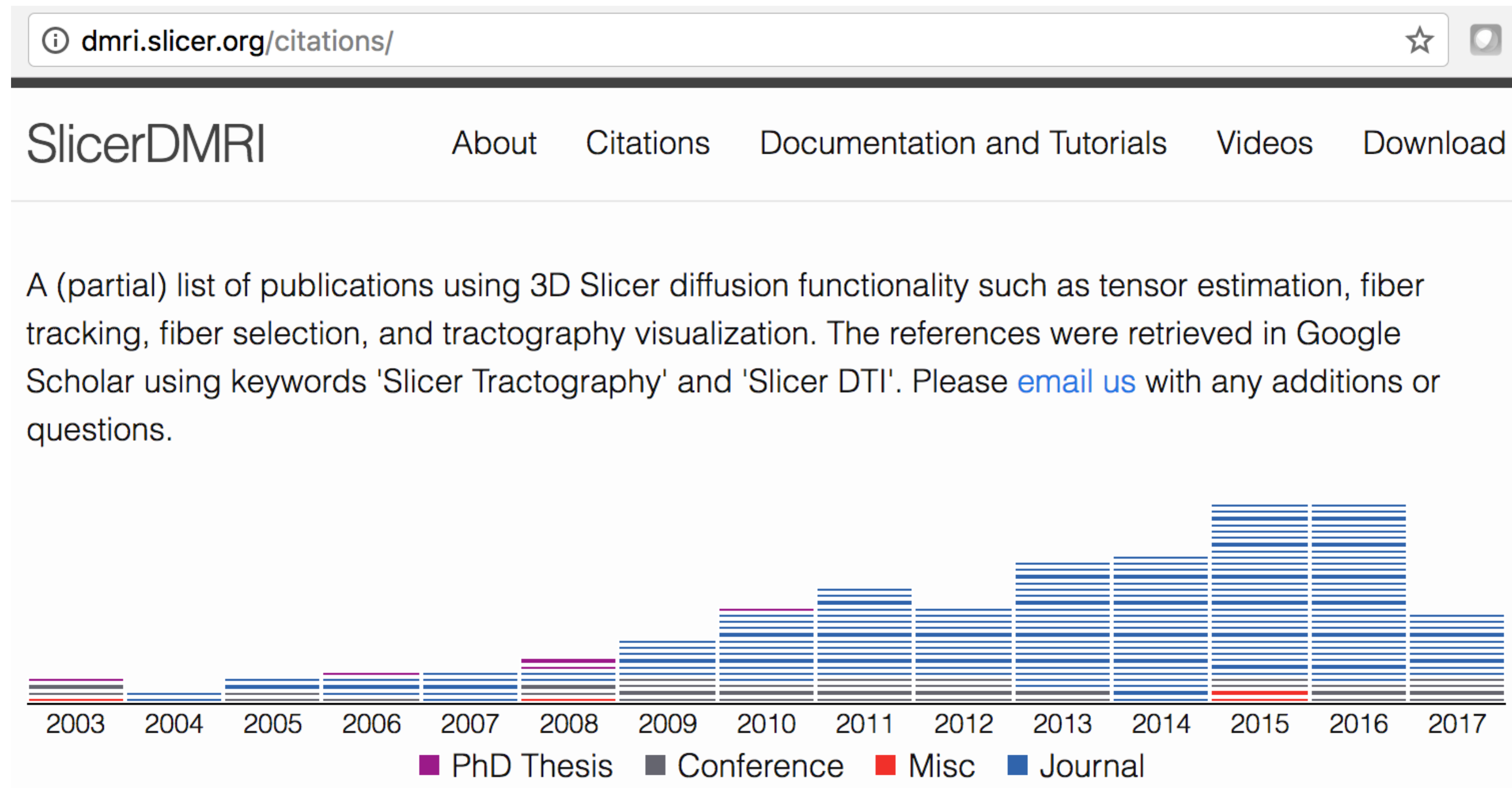
The Development category is for discussion of Slicer application and extension programming, software testing, and related topics - similarly to the former slicer-devel mailing list.

Community

Community information and project/topic sub-forums.

■ SlicerCMF ■ SlicerSALT ■ SlicerDMRI

Document SlicerDMRI research use



> 200 downloads/month
(Nov 2016-May 2017)

Released DICOM Tractography

- First implementation of the new international standard
- DCMTK: Open-source DICOM library
- SlicerDMRI DICOM I/O module
- Soon: interoperability with commercial neurosurgical neuronavigation and hospital PACS systems
- Interoperability challenge: RSNA 2017

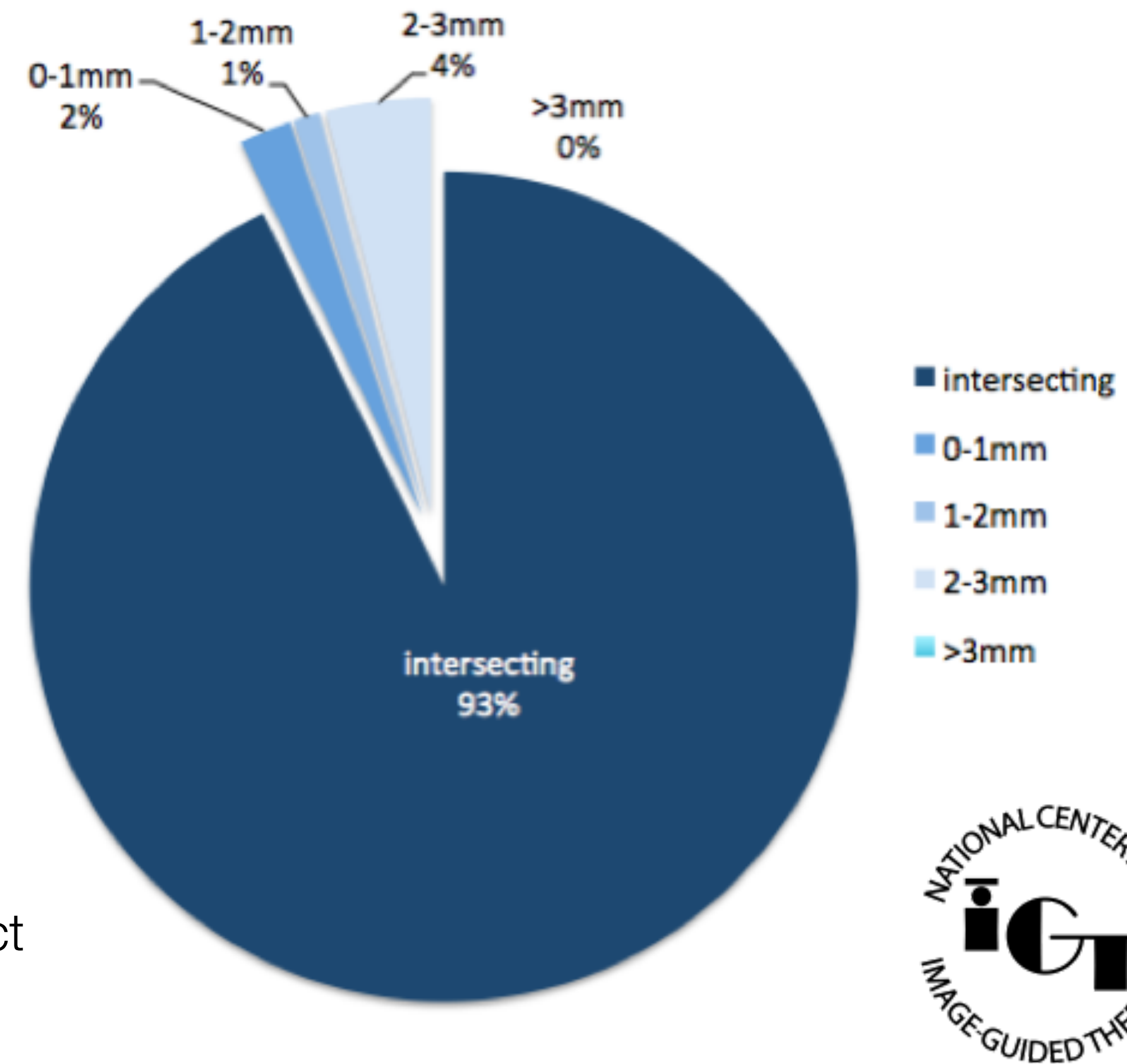
Table C.8.X-2
TRACTOGRAPHY RESULTS MODULE ATTRIBUTES

Attribute Name	Tag	Type	Attribute Description
Include Table 10-12 "Content Identification Macro Attributes"			
Content Date	(0008,0023)	1	The date the content creation started.
Content Time	(0008,0033)	1	The time the content creation started.
Track Set Sequence	(0066,0101)	1	Describes the track sets that are contained within the data. One or more Items shall be included in this sequence.
>Track Set Number	(0066,0105)	1	Identification number of the Track Set. Uniquely identifies a track set within this SOP instance. Shall start at a value of 1, and increase monotonically by 1.

Published automated tractography

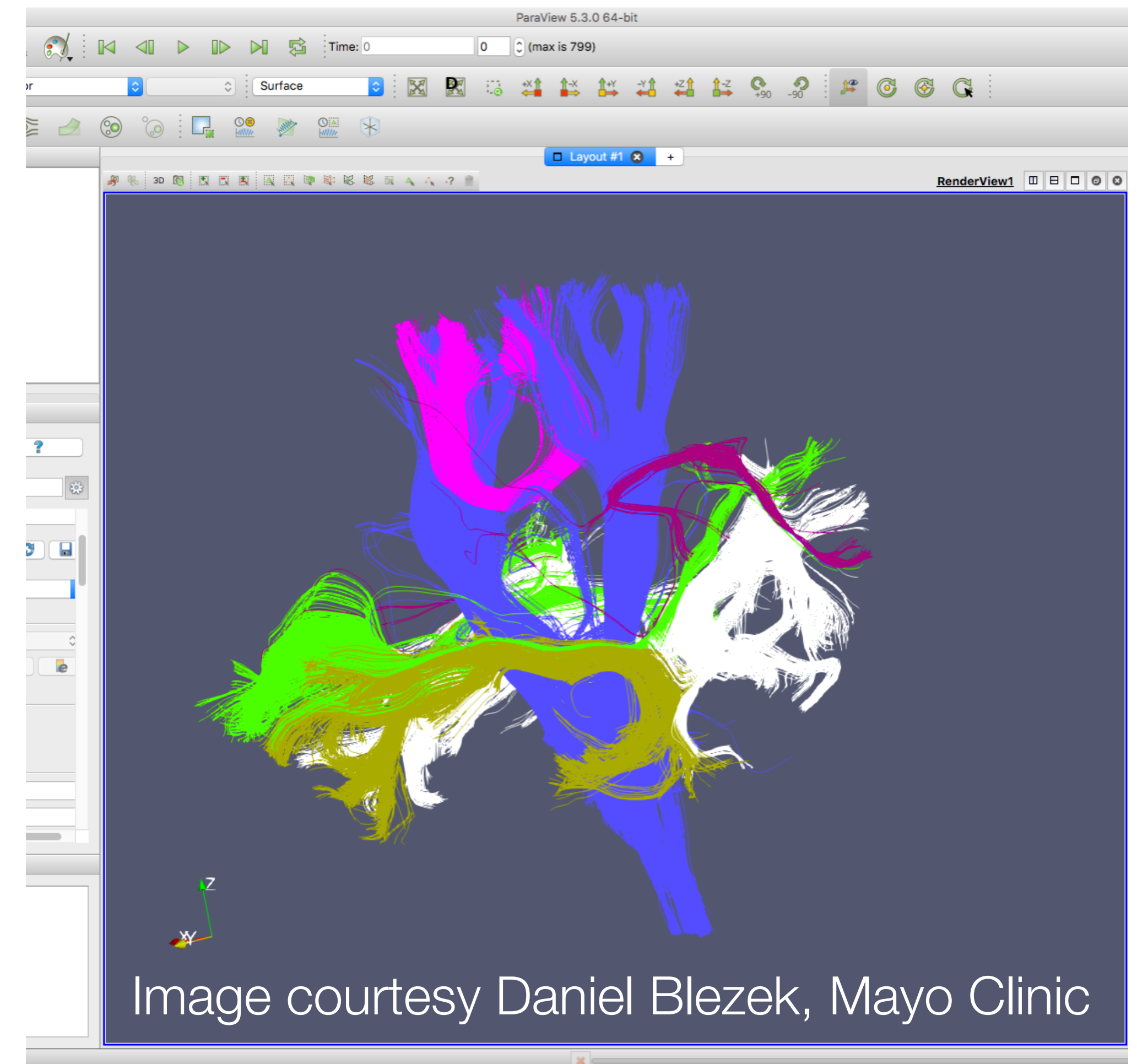
- 18 consecutive retrospective brain tumor patients
- Anatomically expected result:
 - 89 of 95 language and motor activations intersected by the corresponding tract
- Higher intersection than prior work (e.g. Diehl et al. Epilepsy research 2010 considered < 10 mm good)

O'Donnell LJ, et al. Automated white matter fiber tract identification in patients with brain tumors. NeuroImage: Clinical. 2017



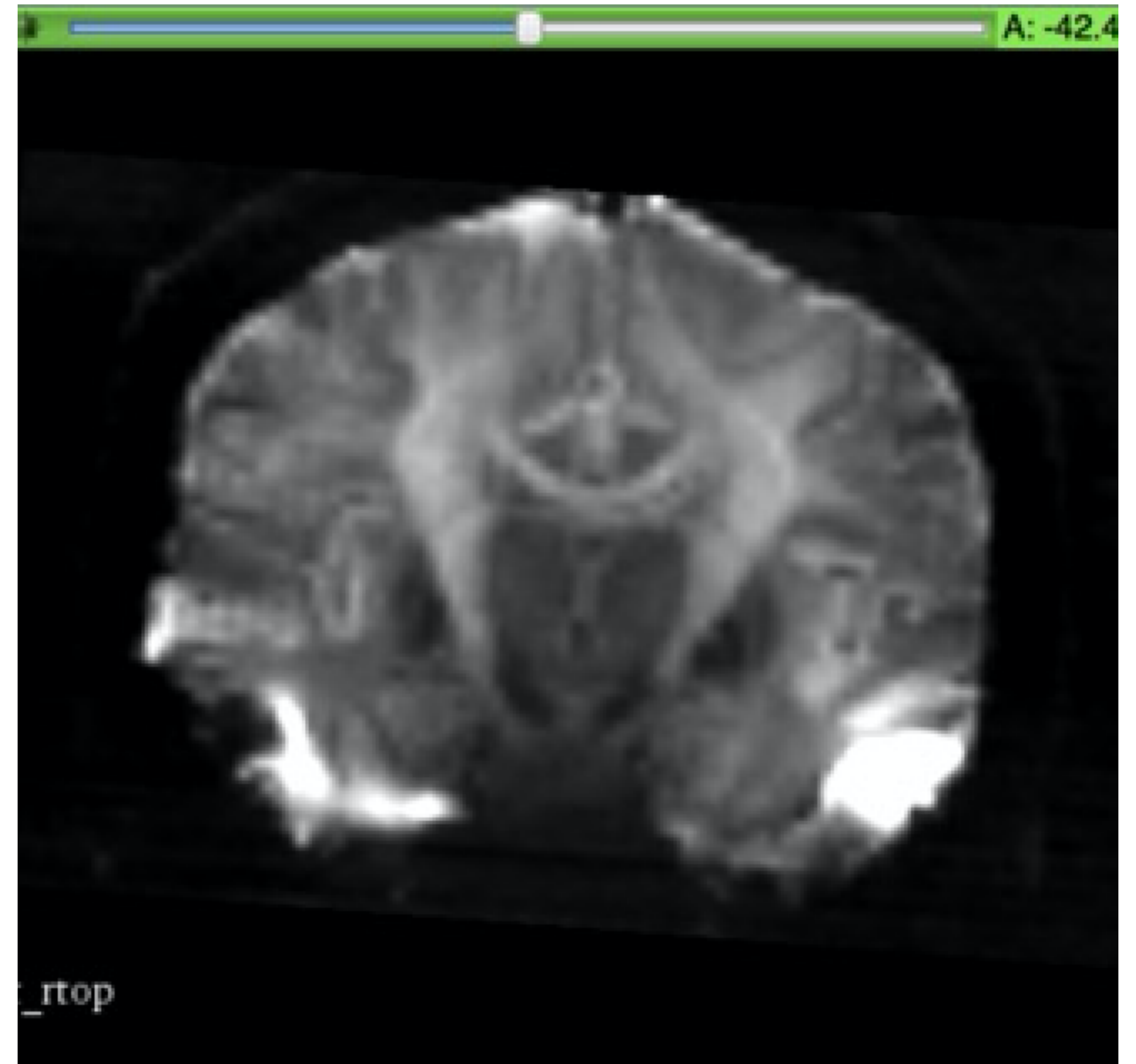
New open-source community interactions

- Automatic tract identification is now in testing at Mayo Clinic
- Interoperability Challenge RSNA (led by Andrey Federov)
- Discussion started to combine DICOM code with community software TractConverter
- Investigating diffusion imaging in python (dipy) integration into SlicerDMRI



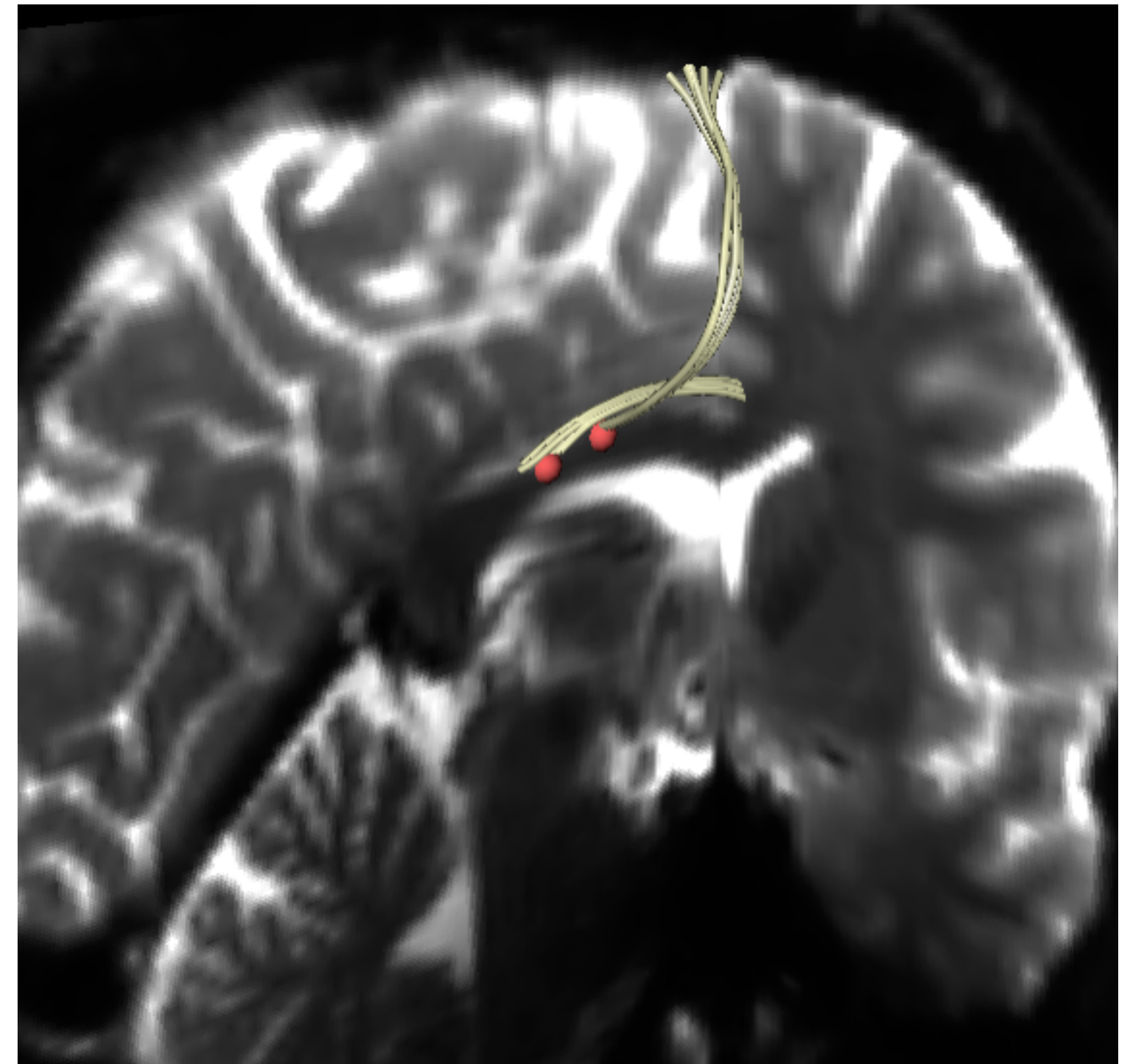
Including Community Library

- Dipy: python toolbox for analysis of MR diffusion imaging (dipy.org)
 - Very popular in dMRI research, but no or limited user interface
- Goal: access dipy functionality in Slicer
 - Initial integration: separate full python installation needed for dipy
- Computation of new microstructure measures (significant additional functionality is possible)



New Functionality in SlicerDMRI

- Summer 2017 release in Slicer-nightly extension
 - Initial dipy integration module
 - Multishell microstructure measures
 - Interactive multi-fiber tractography
- New website, new tutorials, new videos, many improvements to code
- Looking forward: new functionality via integration of and compatibility with community libraries

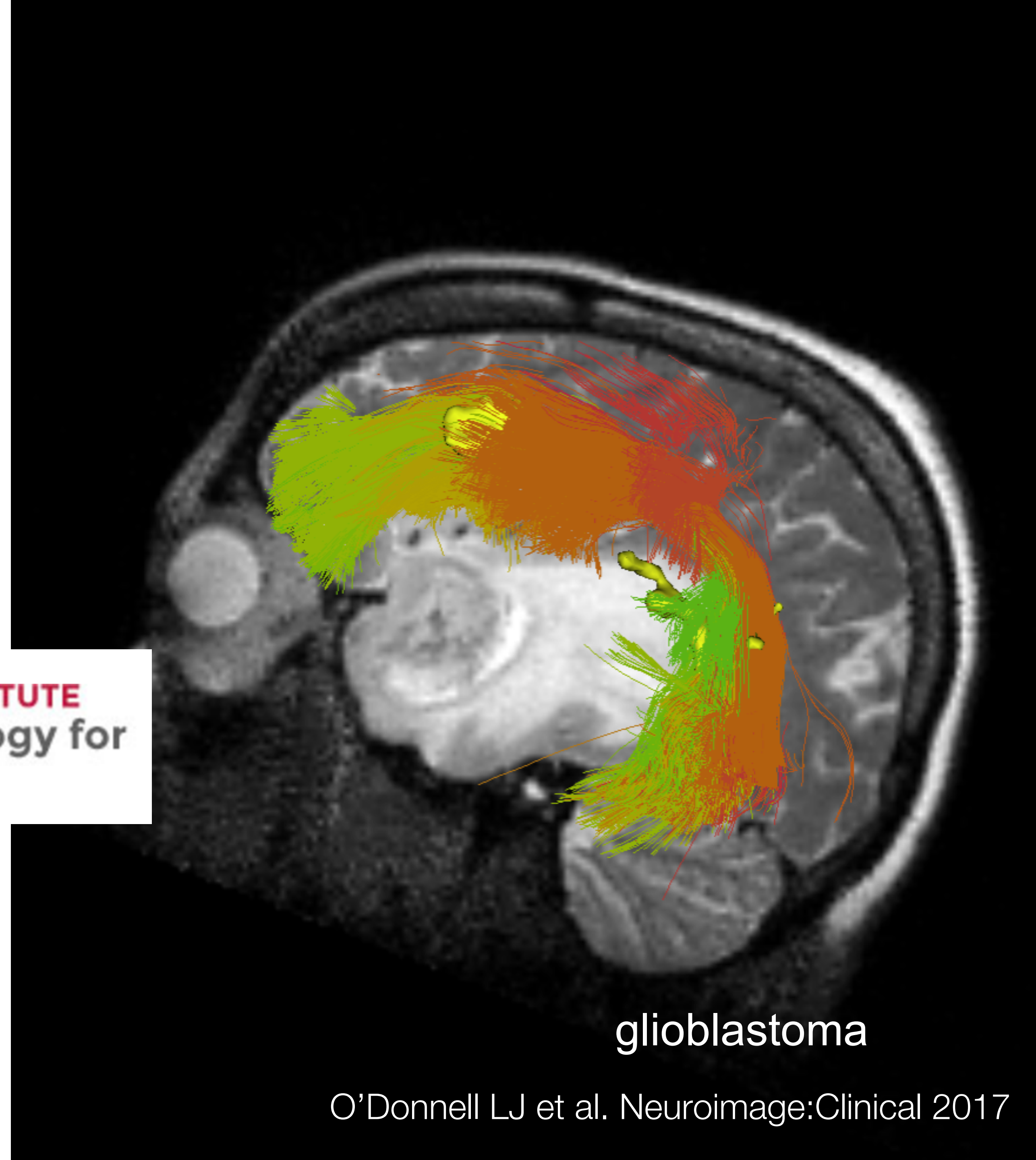


Thank you

- Alexandra J. Golby, NCIGT
- Fan Zhang, postdoc NCIGT/LMI
- Isaiah Norton, software engineer U01
- Laura Rigolo, Golby Lab
- Walid Ibn Essayed, M.D
- Prashin Unadkat, M.D.
- Yogesh Rathi
- Sandy Wells
- Steve Pieper
- Carl-Fredrik Westin
- Ron Kikinis, NAC
- NCI ITCR U01CA199459



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glioblastoma

O'Donnell LJ et al. Neuroimage: Clinical 2017