

Surgical Planning Laboratory Brigham and Women's Hospital Boston, Massachusetts USA

a teaching affiliate of Harvard Medical School

### 3D VISUALIZATION OF DICOM IMAGES FOR RADIOLOGICAL APPLICATIONS

#### Sonia Pujol, PhD, Harvard Medical School Surgical Planning Laboratory, Brigham and Women's Hospital

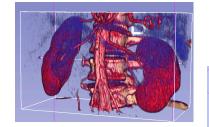
#### Kitt Shaffer, MD, PhD, Boston University Vice-Chairman for Education, Boston University School of Medicine

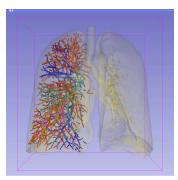
Ron Kikinis, MD, Harvard Medical School Surgical Planning Laboratory, Brigham and Women's Hospital

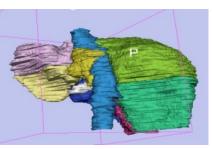


### **3D Visualization of DICOM images for Radiological applications**

Following this tutorial, you will be able to load and visualize DICOM volumes with 3D Slicer, and to interact in 3D with structural images and models of the anatomy.





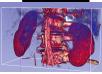




### **Overview**



Part I: Introduction to the 3DSlicer software



Part II: 3D Data Loading and visualization of DICOM images

- Volume Rendering of thoraco-abdominal CT data
- Surface Rendering of MR head data



Part III: 3D interactive exploration of the anatomy

- Exploration of the Segments of the liver
- Exploration of the Segments of the lung





### **Overview**



### Part I: Introduction to the 3DSlicer software



Part II: 3D Data Loading and visualization of DICOM images

- Volume Rendering of thoraco-abdominal CT data
- Surface Rendering of MR head data



Part III: 3D interactive exploration of the anatomyExploration of the Segments of the liver

- Exploration of the Segments of the lung

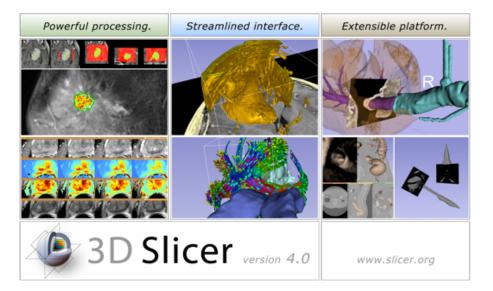




# *Introduction to the 3DSlicer software*



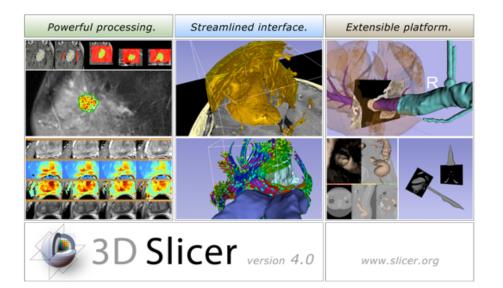




3DSlicer is a freely available opensource platform for segmentation, registration and 3D visualization of medical imaging data.

3DSlicer is a multi-institutional effort supported by the National Institute of Health.





- 3DSlicer version 4.3 is a multiplatform software running on Windows, Linux, and Mac OSX
- Slicer is distributed under a BSD license with no restriction on use
- Slicer is a tool for research, and is not FDA approved

**Disclaimer** 

It is the responsibility of the user of 3DSlicer to comply with both the terms of the license and with the applicable laws, regulations and rules.

## An interdisciplinary platform



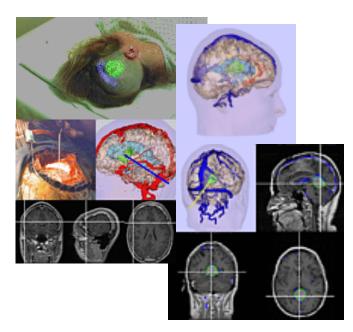


An open-source environment for software developers

An end-user application for clinical investigators and scientists

A software platform that is both easy to use for clinical researchers and easy to extend for programmers





 1997: Slicer started as a research project between the Surgical Planning Lab (Harvard) and the CSAIL (MIT)

Image Courtesy of the CSAIL, MIT



### **3DSlicer History**



Total matching downloads: 97702 Date range: forever ¢ Release type:

÷

¢

Browser type: desktop

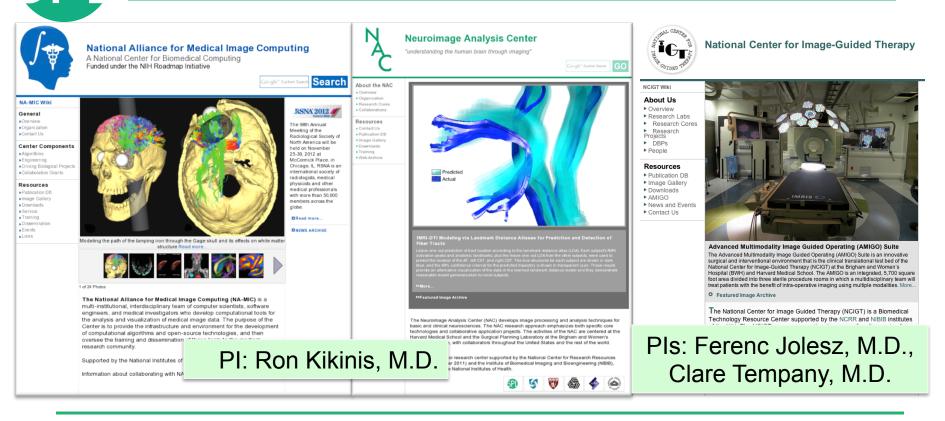
Update





- 1997: Slicer started as a research project between the Surgical Planning Lab (Harvard) and the CSAIL (MIT)
- 2013: Multi-institution effort to share the latest advances in image analysis with the clinical and scientific community

### A multi-institution: NA-MIC, NAC, NCIGT



### **Slicer: Behind the scenes**

00		CDash	- Slicer4							4	-
+ http://www.cdash.org/slicer4/	index.php?project=Slicer4						¢	Q. Google	e		
C III namic Google weather Slicer Co	untway Yahoo! eCommons dti_review										
RSNA 2011 - NAMIC	CDash - Slicer4							_			
Login All Dashboards											
S S	licer4						C	lia	or.	in huilt	$\Delta v $
	evious Current Project						$\mathbf{O}$		н	is built	eve
									<b>U</b> .		
	WARNING: This CDash instance is running the bleed	ling edge svn t	runk CDash	code, and is	updated fro	equently. Yo				x a 71	
1 file changed by 1 author as of Sunday, Nove	ember 27 2011 - 22:00 EST						ni	ah	st /	nn 10/in	dow
Nightly-Packages							111	u	ΠU	on Win	UUW
		Update	Con	figure		Build		3			
Site	Build Name	Files	Error	Warn	Error	Warn					
factory-win7.kitware	Windows7-VS2010-32bits-QT4.7.1-PythonQt-With-TcI-CLI-	0	0	0	2.2	107	ЛЛ	20		ndlin	
	Release @						IVI	a	<b>D</b>	nd Lini	UX
factory-mac-64bits.kitware	SnowLeopard-g++4.2.1-64bits-QT4.7-PythonQt-With-TcI-CLI Release 92	1	0	0	0	14.0					
factory-ubuntu-64bits.kitware	Linux-g++4.4.3-64bits-QT4.7-PythonQt-With-TcI-CLI-Release	° 1	0	0	0	13 <sup>a</sup> .	n	ot.	for	mo	
factory-win7.kitware	Windows7-VS2008-64bits-QT4.7.1-PythonQt-With-TcI-CLI- Release 🚱 🖓	0	0	0	0.34	1000 m	μ	αι	101	ms	
factory-win7.kitware	Windows7-VS2008-32bits-QT4.7.1-PythonQt-With-TcI-CLI- Release 🗇 Q	1	0	0	0.,	1000 <sup>-di</sup> -2w	•				
Nightly											
Site	Build Name	Update	Con	figure	1	Build		Test		Build Time	
U.U		Files	Error	Warn	Error	Warn	Not Run	Fại	Pass	Dung Third	
whitecube.kitware	SnowLeopard-gcc4.2.1-Qt4.7.0-PythonQt-With-Tcl-Relea	<sup>350</sup> 1	0	0	27	190	0	96	391	11 hours ago	
youpi.sci.utah.edu	OpenSuse-c++4.5.0-64bits-QT4.6.3-PythonQt-With-TcI-NoCl Release	u- 0	0	0	0	15	0	304	6	11 hours ago	
eris.kitware	Linux-g++4.4-QT4.6.3-PythonQt-CLI-Release @	1.0	0	0	0	15.2	0	36.2	451	3 hours ago	
factory-ubuntu-64bits.kitware	Linux-g++4.4.3-QT4.7-PythonQt-With-Tcl-CLI-Valgrind-Relea	<sup>150</sup> 0	0	0	0	13.0	0	27 <sup>10</sup>	460.4	11 hours ago	
factory-ubuntu-64bits.kitware	Linux-g++4.4.3-64bits-QT4.7-PythonQt-With-Tcl-NoCLI- Coverage-Release	0	0	0	0	12 <sup>.0</sup>	0	23"	287.,	11 hours ago	
sagarmatha.kitware	Linux-g++4.3.3-QT4.7-PythonQt-With-Tcl-NoCLI-Release	0	0	0	0	12.2	0	22	288	12 hours ago	
Continuous											
Site	Build Name	Update	Con	figure		Build		Test		Build Time	
-9110	Build Name	Files	Error	Warn	Error	Warn	Not Run	Fail	Pass		
	OpenSuse-c++4.5.0-64bits-QT4.6.3-PythonQt-With-Tcl-NoC										

## **P** Slicer Training events



- Hands-on training workshops at national and international venues
- More than 2,700 clinicians, clinical researchers and scientists trained since 2005

# Slicer Training events



#### Major international conferences

- **RSNA** 2008, 2009, 2010, 2011, 2012,2013
- MICCAI 2008, 2009, 2011, 2012,2013
- **SfN** 2009, 2011
- **SPIE** 2012, 2013
- **CAOS** 2010
- **CARS** 2010, 2012, 2013



Hands-on refresher courses

- 3D Visualization of DICOM images for Radiology Applications
- Quantitative Imaging for Clinical Research and Practice

#### **Quantitative Imaging Reading Room Exhibit**

 3DSlicer: An Open Source Platform for Segmentation, Registration, Quantitative Imaging, and 3D Visualization of Multi-Modal Image Data.



### **Overview**



Part I: Introduction to the 3DSlicer software



### Part II: 3D Data Loading and visualization of DICOM images

- Volume Rendering of thoraco-abdominal CT data
- Surface Rendering of MR head data



- Part III: 3D interactive exploration of the anatomyExploration of the Segments of the liver
  - Exploration of the Segments of the lung



### Welcome to Slicer4

000			cer 4.3.1			
Modules: 🔍 💽 Welcome to Slicer			+ -   🖪 🏓			
Welcome	80	8 1 *		S		
Load DICOM Data	Load Data					
Feedback						
We are always interested in improving 3D Slicer, and every See more at http:			R			
> About	//goo.gi/68vcHm.					
The Main Window     Loading and Saving						
<ul> <li>Display</li> </ul>						
Mouse & Keyboard     Documentation & Tutorials						
Acknowledgment		• R ¥ .	S: 0.000mm ~ Y 🕸		R: 0.000mm ~ G 🗰 B	A: 0.0

### To start Slicer, select Start $\rightarrow$ Programs $\rightarrow$ Slicer4-3.1-1 (win64)

8



### **Navigating the Application GUI**

The Graphic User Interface (GUI) of Slicer4 integrates **four components:** 

- the Menu Toolbar
- the Module GUI Panel
- the 3D Viewer
- the Slice Viewer

Elle Edit View Help	
Desireer     Welcome     Coad DicOM Data     Costomize Silicer     Costomize Silicer     Onu     Costomize Silicer     The Main Window     Loading and Saving     Display     Mouse & Keyboard     Documentation & Tutorials     Acknowledgment	s 3D Viewer
Module GUI Panel	Slice Viewers

Welcome to Slicer4.3.1.1



ACPC Transform Add Scalar Volumes Affine Registration Annotations AtlasTests **BSpline Deformable Registration** BSpline to deformation field Cameras Cast Scalar Volume ChangeTracker Charting CheckerBoard Filter Colors Create a DICOM Series Crop Volume Curvature Anisotropic Diffusion Data DataProbe Demon Registration (BRAINS) 👪 DICOM DICOM to NBBD Converter Diffusion Tensor Scalar Measurements Diffusion Weighted Volume Masking DTlexport DTlimport DWI Joint Rician LMMSE Filter DWI Bician I MMSE Filter DWI to DTI Estimation DWI to Full Brain Tractography DWI Unbiased Non Local Means Filter Editor EMSegment Command-line EMSegmenter with Atlas EMSegmenter without Atlas

Histogram Matching Image Label Combine Intensity Difference Change Detection (FAST) Label Map Smoothing Label Statistics labelToggleBug2049 Linear Registration Mask Scalar Volume Median Image Filter Merge Models Model Maker Model To Label Map Models Multiply Scalar Volumes MultiVolumeExplorer MultiVolumeImporter N4ITK MRI Bias correction ℜ OpenIGTLinkIF **Orient Scalar Volume** Otsu Threshold Image Filter Otsu Threshold Segmentation Performance Tests PET Standard Uptake Value Computation Probe Volume With Model Reformat Resample DTI Volume Besample Image (BRAINS) Resample Scalar Volume Resample Scalar/Vector/DWI Volume **Rigid Registration** Robust Multiresolution Affine Registration Robust Statistics Segmenter RSNA2012Quant RSNA2012Vis Sample Data t (Issue 2428)

on Growing Segmentation

rashBug2590 lar Volumes alar Volume Display Interactive Seeding

Label Map Seeding

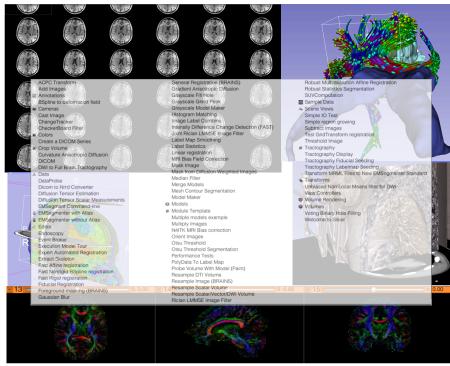
RML Files to New EMSegmenter Standard

# Transforms Vector Demon Registration (BRAINS) Vector to Scalar Volume View Controllers View Controllers Slice Interpolation Bug 1926 Volume Rendering Volumes Voting Binary Hole Filling Image Filter WebGL Export

Welcome to Slicer

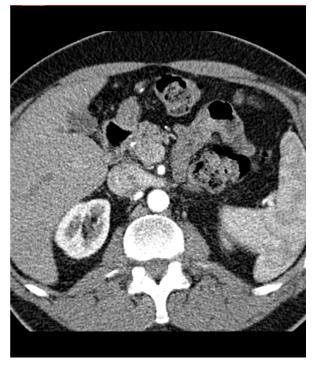
Click on **Welcome to Slicer** to display the list of modules of Slicer in the Modules menu SPI

### **Welcome to Slicer4**



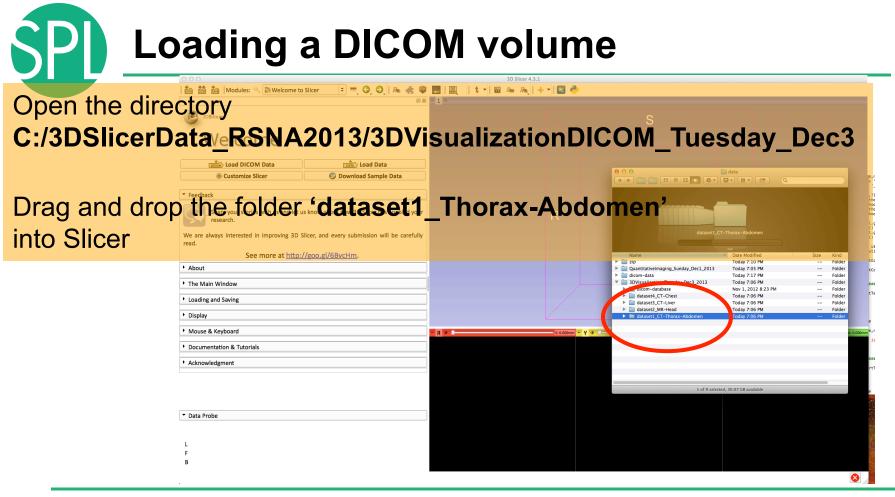
Slicer4.3.1 contains more than 100 modules for image segmentation, registration and 3D visualization of medical imaging data

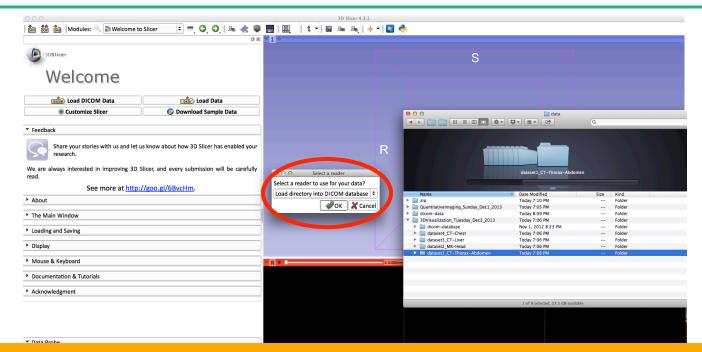




### Part 1:

### Loading a DICOM Volume





### A pop-up window appears: Select Load directory into DICOM database and click on OK

©2012-2013 Surgical Planning Laboratory, ARR

Slide 23

	i 🚵 🚵 🐜 Module		Query Send Remove	LocalDatabası	/Users/spujol/workshop/R	SNA2013/data/dicom-da	ata	1	
	3DSlicer								
	Help & Acknowledger	ſ							
	✓ Servers	-							
	Start Listener when S	- I							
	▼ DICOM Database and	1							
	Recent DICOM Activi	1						L	
	0 series added to datab	i					•		
		orax Abc		DICOM Data	Reader Scalar Volume	Warnings			
			000	6: CT Thorax Abdomen for o					
			/Users/spujol/workshop/R	SNA2013/data/3DV isualization_Tuesd	ay_Dec3_2013/dataset1_CT-T	horax-Abdomen/IM-00	01-0262.dcm		
		-					89%		
			_	6: CT_Thorax_Abdomen for the second s	cont Scalar Volume	_	Calleer		
				6: CT_Thorax_Abdomen for a	cont Scalar Volume			R: 0.000mm - G & C	A: 0.6
		•	81	Uncheck All	Load Selection to Slicer	Close			
		· · · · · · · · · · · · · · · · · · ·		Make DICOM Browser Persiste					
cer sta	arts In	adir	na the	DICOM	limag	AS			
		aan	ig uic		innag	00			

000	1000	3D Slicer 4.3.1	
🕅 🕅 🐜 Moo		DICOM Details	
	Import Export Query Send Remove	Local Databası 👘 /Users/spujol/workshop/RSNA20	13/data/dicom-data
3DSlicer	Name ^ Age Scan D	Date Subject ID Number Institution Referrer Perf	former
Just the state	patient1	patient1_ID	S
Help & Acknowled			
Theip & Heknowled			
<ul> <li>Servers</li> </ul>	_		
Start Listener when	1		
DICOM Database :			
<ul> <li>Recent DICOM Act</li> </ul>			
0 series added to dat	4	III	
		DICOM Data Doador	Warnings
	orax Abc	G: CT Th	
		6: CT_Th Directory import completed.	
		G: CT_Th     1 New Patients     G: CT_Th     1 New Studies	
		6: CT_Th 1 New Series	
		291 New Instances	
	-		
			R: 0.000mm + G + G
	( I III )	Uncheck All Load Selection to Slicer	Click on OK once the
	[ <del></del>	Make DICOM Browser Persistent	
			diractory import is
			directory import is
<ul> <li>Data Probe</li> </ul>			
			completed
В			
-			

Slide 25

📩 📸 🐜 Modu				er 4.3.1			
	le Import Export Query Send	Pamaya	DICOM Details	iol/workshop/RSNA2013/data/dicom-dat			
	Name ^ Age	Scan Date		tution Referrer Performer			
3DSlicer	⊨ patient1		patient1_ID				
Help & Acknowledge	CT Thorax Abdomen	2005-0 6 2005-0	-01 6936864 oEfZ -01 HEART 14	QhRfY			
✓ Servers	-						
Start Listener when S	SI						
<ul> <li>DICOM Database an</li> </ul>	nd						
<ul> <li>Recent DICOM Activ</li> </ul>	4						
0 series added to data	1						
				ay the file ax_Abdon		y, Select	
				/-1	-	-	
			,	tion to Slicer Close			
	C	Make	Uncheck All Load Selec	tion to Slicer Close			
	(	The second secon	,	tion to Slicer Close			
		) Make	,	tion to Slicer Close			
▼ Data Probe	(	D Make	,	tion to Slicer Close			
▼ Data Probe		() Make	,	tion to Slicer Close			
▼ Data Probe	I	) Make	,	tion to Slicer Close			
▼ Data Probe L F B	r	) Make	,	tion to Slicer Close			

SPL

Name patient1 CT Thorax CT_Thora	rt Query Se ^ A Abdomen ax_Abdomen C	lge Scan			splays the s [_ <b>Thorax</b> _	•		
Image 0	Image 1	Image 2	Image 3	Image 4	6: CT_Thorax_Abdo	Reader Scalar Vol Scalar Vol Scalar Vol Scalar Vol	Warnings	i -
	Image 6	Image 7	Image 8	Image 9	6: CT_Thorax_Abdo 6: CT_Thorax_Abdo	Scalar Vol Scalar Vol Scalar Vol Scalar Vol		
Image 5	Image 11	Image 12	Image 13	Image 14	6: CT_Thorax_Abdo			

SPL

Import Export Query Send Remove Name ^ Age Scan Date Subject I Num e patient1	Click on Load Selection to Slicer to load the DICOM volume into Slicer (note: this may take a few minutes)
Image 0       Image 1       Image 2       Image 3       Image 4         Image 5       Image 6       Image 7       Image 8       Image 9         Image 10       Image 11       Image 12       Image 13       Image 14         Image 6       Image 12       Image 13       Image 14	* 6: CT_Thorax_Abdo       Scalar Vol         6: CT_Thorax_Abdo       Scalar Vol
Image 15 Image 16 Image 17 Image 18 Image 19	9 Uncheck All Load Selection to Slicer Close

SPI

00	3D Slicer 4.3.1			
🖮 🛗 🕍   Modules: 🔍 🛗 DICOM 🔅 =, 🔾 🔍   🌆 🐇 🖤 🔜	🖳   <b>t</b> •   🖬 🗛 🗛   🔶 •   🔩	3 👶		
3DSlicer		S		
Help & Acknowledgement				
▼ Servers				
Start Listener				
Start Listener when Slicer Starts				
▼ DICOM Database and Networking				
Show DICOM Browser				
Recent DICOM Activity	D			
0 series added to database in the past hour	R		L	
Refresh			8735em 6	k (B 10e
▼ Data Probe		and a second		

Slicer displays the axial, coronal and sagittal slices of the DICOM dataset

**S**PI

8

<b>0</b> 0	3D Slicer 4.2.0-	rc1-2012-10-28			
<u>File</u> <u>E</u> dit <u>V</u> iew <u>H</u> elp					
🚵 🚵 Modules: 🔍 🕍 DICOM	= O, O, I 🕸 🚳 🐁 📈	🖳   🕯 🕶 🗟   🖬 🙈	+ <b>-</b>		
.4	e e 1 +				
3DSlicer			S		
Help & Acknowledgement					
- Servers					
Start Listener					
Start Listener when Slicer Starts					
<ul> <li>DICOM Database and Networking</li> </ul>		R			
Show DICOM Browser					
Select the <b>Volumes</b>					
ociect the volumes					
in a duil a tin the a					
module in the					
	- R ••	S: -188.50 - Y +		R: 7.00 - G +	A: 169.
modules menu			LONA A		ACCENT GEOR
moduleo menu					
	-				
		Sec. 1	TAV ES		A LIN A LINE
		A	1 - 1		AND AND
		-			and and
		,	120		1 Bernard
		and a state of the			1 all the
<ul> <li>Data Probe</li> </ul>				5	
		ST /	0163		
Red RAS: (-79.4, 290.2, -188.5) Axial Sp: 2.0		-	1101.50	0	4-12-12-12-11 ST
L None () F None ()	<u>)</u>		1 Carrow Carl		1000
B <b>6: CT_Thorax_Abdomen</b> (426, 17, 145) <b>-956</b>				1	

SPL

Loading a DIC	OM volume
Select the Active Volume 6:CT_Thorax_Abdomen	Slicer has a series of window/level presets available
Lookup Table: Interpolate: Window Level editor preserve W: 350 (Manual W/L + L: 40 ) Threshold: Off +	

3480

Click on the Window Level Preset **CT-abdomen**, or adjust manually the Window and Level using the Manual W/L slider

-1434

Histogram



over the red banner in the Red Viewer to display the slice menu. Click on the Links icon () to link the slice controls across all Slice Viewers. Click on the Eye icon to display the three anatomical	0.0.0	3D Slicer 4.2.0-rc1-2012-10-28
Position the mouse cursor over the red banner in the Red Viewer to display the slice menu. Click on the Links icon S to link the slice controls across all Slice Viewers. Click on the Eye icon to display the three anatomical		
<ul> <li>Where Volume is CT_Thorax_Abdomen</li> <li>Where Volume</li></ul>	🚵 🚵 🕍  Modules: 🔍 🔍 Volumes	
Position the mouse cursor over the red banner in the Red Viewer to display the slice menu. Click on the Links icon S to link the slice controls across all Slice Viewers. Click on the Eye icon to display the three anatomical	Help & Acknowledgement     Active Volume 6: CT_Thorax_Abdomen	S S
	Position the mouse cursor over the red banner in the Red Viewer to display the slice menu. Click on the <b>Links icon</b> S. to link the slice controls across all Slice Viewers. Click on the <b>Eye icon</b> to	Solution in the slice controls (except in the slice controls (

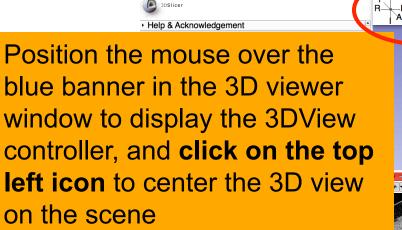
000	3D Slicer 4.2.0-rc1-2012-10-28
<u>F</u> ile <u>E</u> dit <u>V</u> iew <u>H</u> elp	
🛍 🛗 Modules: 🔍 🛡 Volumes 💠 =	3 0   🕸 📾 🐁 🛛 🗶   🖬 🖡 📥   + -
© 8 3DSIIcer	
Help & Acknowledgement	
Active Volume 6: CT_Thorax_Abdomen +	
Volume Information	
- Display	
Lookup Table: 📗 Grey 🗧	
Interpolate:  Window Level editor presets:	
W: 350 🗘 Manual W/L 🔹 L: 40 🗘	
Threshold: Off +	
-1434 🖕 🖂 3480 🗼	R:7.00 - G - A:169.00
anatomical ear in the 3D	Axial + 6: CTdomen +

The three anatomical slices appear in the 3D viewer. Use the rightmouse button in the 3D Viewer to zoom in and out



	e o o Filo, Edit View, Holp	3D Sli	ter 4.2.0-rc1-2012-10-28	
	File Edit View Help			
	🚵 🛗 🚵 Modules: 🔍 🔍 Volumes		≪   🖳   \$ ▼   60 № №   + ▼	
	.4			
	3DSIIcer			
	<ul> <li>Help &amp; Acknowledgement</li> </ul>	A		
	Active Volume 6: CT_Thorax_Abdomen	÷		
	<ul> <li>Volume Information</li> </ul>			
	- Display			
	Lookup Table: Marey	÷		
	Interpolate: Window Level editor presets:			
	🕅 🕅 🧖	L: 40 =		
	Threshold: Off			
	-1434	- 3480 ÷	S: 188.50 - Y +	R: 7.00 - G * A: 169.00
Lloo th	e left-mouse bu		5: CTdomen ÷	The N
Use in	e leit-mouse bu			
· . ()		AP-6		
in the .	3D Viewer to rot	ate		
tha 2D	volume			
	volume			A A A A A A A A A A A A A A A A A A A

L F B



File Edit View Help

🚵 🚵 🐜 Modules: 🔍 🛛 Volumes



由 👂 陆 fps

Center the 3D view on the scene 🎍 🕶 🐻 📠 📥 🔸 🕶

D

R

ወ

Note: a shortcut to this functionality is available through the icon next to the number '1' in the blue banner

Q

**H** 

-向-

Data Probe

.@'

, 🖸 ,

<del>.</del>

đ

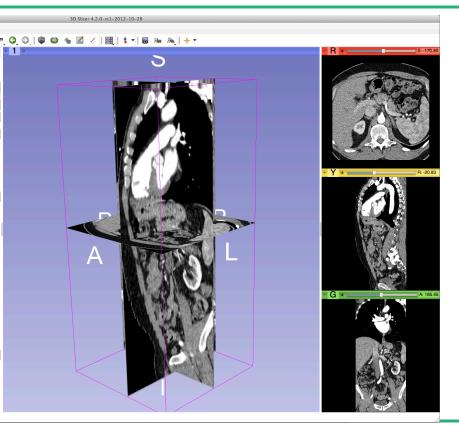
	00	3D Slicer 4.:	2.0-rc1-2012-10-28		
	<u>F</u> ile <u>E</u> dit <u>V</u> iew <u>H</u> elp				
	🚵 🚵 Modules: 🔍 🔍 Volumes	🗈 =. G. O. I 🕸 🚳 🐁 🗹 🌔	1 🗐 😫 🕶 📾 🙈 🕂 🛨		
		0 x 1 +	Conventional		
	3DSlicer		Co ventional Widescreen		
			Conventional Quantitative		
	<ul> <li>Help &amp; Acknowledgement</li> </ul>		I Frur-Up		
	Active Volume 6: CT_Thorax_Abdomen	•	Dual 3D		
	Volume Information	<u> </u>	Triple 3D		
			i 3D only	1	
	- Display		Red slice only	P	
	Lookup Table: Grey		Yellow slice only		
	Interpolate:  Window Level editor presets:		Green slice only	Š.	
			Tabbed 3D	2	
			Tabbed slice		
Click on	the Slicer layout		Compare		
	and choor hayout		Compare Widescreen		
•	1 1 1 1 1		E Compare Grid		
menuic	on, and select the	<u>e                                    </u>		R: 7.00 - G	A: 169.00
	on, and coroot th		Four over four		
			Two over Two		
Conver	ntional Widescre	en se		<u>.</u>	and the second
				NIT: C	A
layout		1 A A A A A A A A A A A A A A A A A A A	and and	The A	
layout		r ~ 4 3		1 million	
					A martin
					ALL LAF
	✓ Data Probe		The second second		
	L	1-7 P	Mar and		C Stand
	F				1 mg
	В		all	100	

SPL

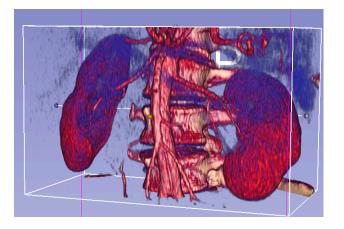
### Loading a DICOM volume

Use the red slice, yellow slice and green slice sliders to slice through the volume in all three anatomical directions

Data Probe





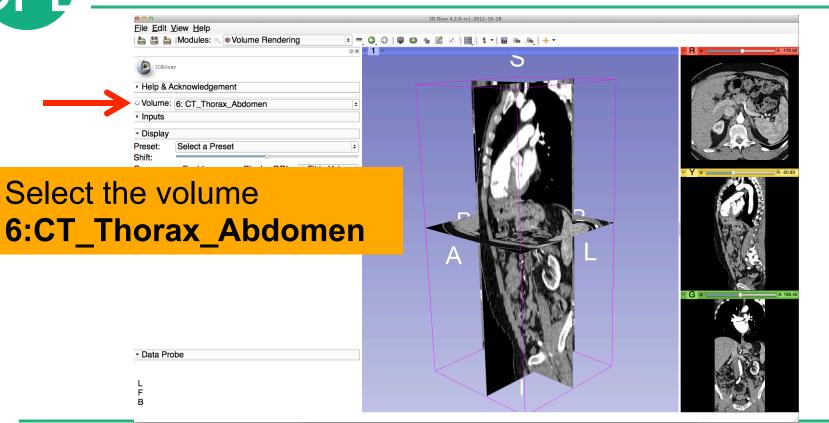


3D Interactive exploration of thoraco-abdominal CT data using Volume Rendering

SPL

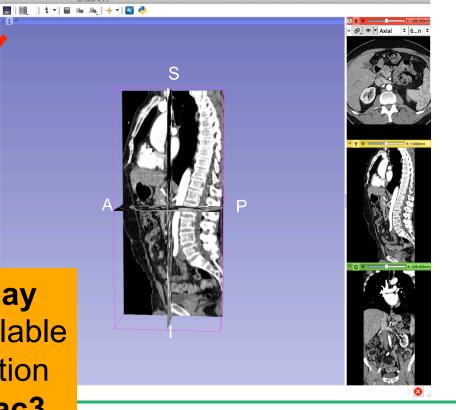
	00	3D Slicer 4.2.0-rc1-2012-10-28	
	<u>F</u> ile <u>E</u> dit <u>V</u> iew <u>H</u> elp		
	🚵 🛗 Modules: 🔍 🔍 Volume Rendering 🛛 💠 💻 🤤 🔘 🛛 🖤	🚳 🍓 📶 🏑   📴   💲 🕇 🐻 🐜 🤼   🔶 ד	
	Ø 8 - <b>1</b> +		- R + S: -170.50
	3DSlicer	3	
	<ul> <li>Help &amp; Acknowledgement</li> </ul>		
	Volume: 6: CT_Thorax_Abdomen		
	Inputs		and the second second
	- Display		Jak"
	Preset: Select a Preset +		
	Shift:		
	e module <b>Volume</b> ng in the modules		R-2093
menu			
	- Data Probe		A 185.45

L F B



								ତ୍ ତ୍	
ma									
	3DSI	icer							
Help	& Ac	knowled	Igement						
			Bennenit						
😔 Vol	ume:	6: CT -	Thorax_Al	odomen					
Inpu	ts		and the second s				1150		
▼ Disp	lau	1000	1765	100		1910	100		155
· Disp	lay					100			
Preset:		100				00			- 89
Shift:		100	1	1	1				
Crop:		1915	12.1			Con-	· stars	6	-
		<i></i>	C.S.	1 100 M		62	199	82	Carlo
	ng:	TR OF C	nuy cust	5					
Kender									

Click on **Preset** in the **Display** tab to display the list of available presets for the transfer function Select the Preset **CT-Cardiac3** 



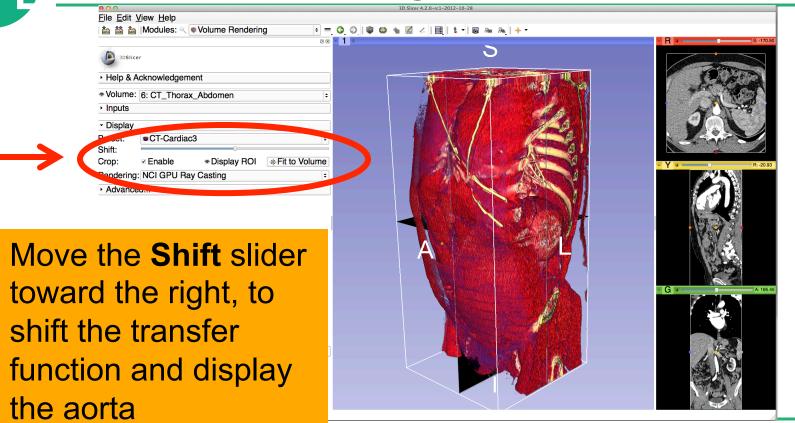
000	3D Slicer 4.2.0-rc1-2012-10-28
File <u>E</u> dit <u>V</u> iew <u>H</u> elp	
	. G. O.   ♥ ♥ ♠ Z <
3DSIIcer	5
Help & Acknowledgement	
○ Volume: 6: CT_Thorax_Abdomen +	
Inputs	
<ul> <li>Display</li> <li>Preset:</li> <li>CT-Cardiac3</li> <li>\$</li> <li>Shift:</li> <li>Crop:</li> <li>Enable</li> <li>&gt; Display ROI</li> <li></li></ul>	
Select the Rendering VTK CPU Ray Casting, and click on the eye icon in the	
<b>Volume</b> tab to display the	
Volume rendered volume	
in the 3D viewer	

S: -170.50

R: -20.93

165.45

	0.0.0	3D Slicer 4.2.0-rc1-2012-10-28	
	<u>File Edit View Help</u>		
	🊵 🚵   Modules: <     ♥ Volume Rendering     ♥ =     O     Ø     I     Ø       Ø     <	❀ ☑ ∠   ☑   \$ *   ☑ An An   + *	R
	3DSIlicer	5	
	Help & Acknowledgement		Series .
	* Volume: 6: CT_Thorax_Abdomen +		
	Inputs		A DEAR
	· Display		
	Preset: CT-Cardiac3		
	Crop: Enable Display ROI I Fit to Volume		- Y + R:-20.93
	Rendering: NCI GPU Ray Casting +		
	Advanced		
			No.7
			ALS.
			in the second
			- G - A: 185.45
<b>.</b>			
Slicer disr	plays the 3D		
	-		150
rendered	volume of the		
rendered			
CT Thore	x Abdomon datasat		
	ax Abdomen dataset		



SPI

	00		3D Slicer 4.2.0	
	Eile Edit View Help	G. O. 🔍 🖤 😂 🐁	📈 🖉 I 📴 I 🕇 🗝 1 🐻 💀 .	
	3DSlicer      Help & Acknowledgement      Volume: 6: CT_Thorax_Abdomen      Inputs      Display  Preset:     CT-Cardiac3     CT-Cardiac3     Shit:     Crop:     Enable     Display ROI     Display ROI     Prist to Volume  Rendering: VTK CPU Ray Casting     C     Advanced			R: 7.00
of the a	lume rendered in orta and rib cag s in the 3D viewe	e		A 189.00

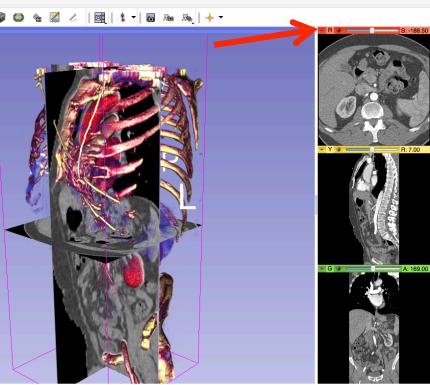


3D Slicer 4.2.0

Click on the eye icon in the red viewer to turn off the visibility of the anatomical slices in the 3D viewer

Data Probe

F



# SPI

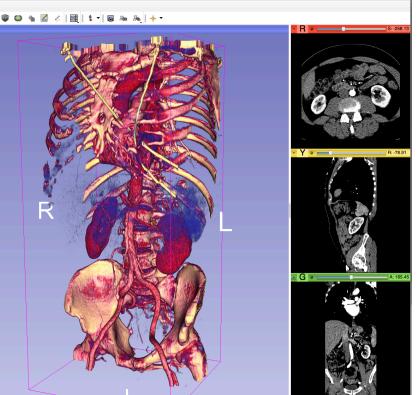
### **Volume Rendering**

• • **0** • **1** 

File Edit View Help a a a local Modules: ♥ ♥ Volume Rendering D Slicer 4.2.0-rc1-2012-10-28

Use the mouse in the 3D window to rotate the volume rendered image

3DSlicer



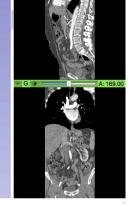


в

000	3D Slicer 4.2.0-rc1-2012-10-28
<u>File</u> <u>E</u> dit <u>V</u> iew <u>H</u> elp	
i 🛍 🛗 🕍 IModules: 🔍 🔍 Volume Rendering	
	88 • 1 ♦8:-258.13
3DSlicer	
<ul> <li>Help &amp; Acknowledgement</li> </ul>	
* Volume: 6: CT_Thorax_Abdomen	
Inputs	
<ul> <li>✓ Display</li> <li>Preset: ●CT-Cardiac3</li> </ul>	
Shift:	
Crop: Display ROI Fit to	Volume Pi-76.91
Rendering: NCI GPU Ray Casting	
<ul> <li>Advanced</li> </ul>	
Click on the eye icon	
Choix off the oyo looff	
in the velume	
in the volume	
rendering panel to	G A 165.45
rendering parter to	
remove the volume	
rendered image from	
Tenuereu inage Itom	
the 3D viewer	

Elle Edit View Help		3D Slicer 4.2.0	
bin	÷ =, (3, (2)) (1) (1)	) 🕯 🖾 🖉 🛛 🔤 🔤 🛓 🕇	<b>.</b>
	Ø 🗙 🎽 1 💠	S	► R 🛊 - S: -188
3DSlicer			RO.
Help & Acknowledgement			No.
Q: Volume: 6: CT_Thorax_Abdomen     Inputs	<b> </b> ♦		005
▼ Display			
Preset: CT-Cardiac3	<b>*</b>		- Y - R: 7.00
Crop: ✓ Enable , Display ROI + Hr Rendering: VTK CPU Ray Casting	to Volume	R P	
Advanced			S S

Click on **Display ROI** to display a region of interest that we will use for cropping the dataset, and check the option **Enabled** 



DPI

000	3D Slicer 4.2.0	
<u>File</u> <u>Edit</u> <u>View</u> <u>H</u> elp		
📩 🧰 km Modules: 🔍 🔍 Volume Rendering 💠	् 🔾 🔍 🚳 🌰 📶 🕢 । 📴 । 🕯 - । 🐻 👞 🙈 । 🔶 -	
Ø Ø	► 1 Φ	
3DSlicer	S	
Help & Acknowledgement		
Volume: 6: CT_Thorax_Abdomen		
► Inputs	Start C	
▼ Display		
Preset: CT-Cardiac3 🗘	- Y 🛊	
Shift: Crop: マ Echo 参 Display ROI 使于it to Volume		
Bender un CP nay Casting ♦		
► Advanced		
	G 🛊 — A: 169.00	
The region of interest		
annears in the 3DV/iew	lor line line line line line line line line	
appears in the 3DView		
F B		
в		



000

File Edit View Help

DSlicer

Help & Acknowledgement

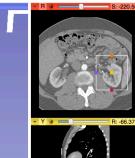
#### **Volume Rendering**

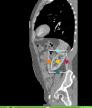
3

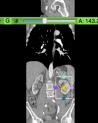
BD Slicer 4.2.0

- Volume: 6: CT\_Thorax\_Abdomen Turn on the visibility of the grayscale images in to the 3D Viewer, and position the ROI around the left and right kidneys using the ROI controls in the 2D anatomical views and in the **3D** viewer

Modules: 🔍 🔘 Volume Rendering





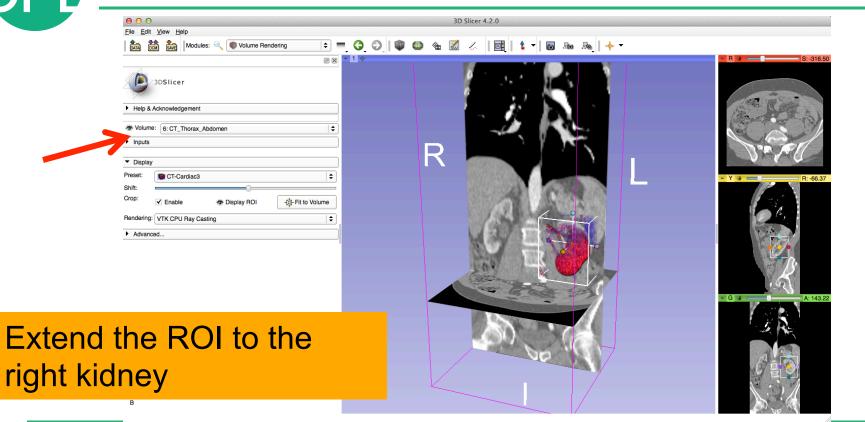




000	3D Slicer 4.2.0	
<u>Eile Edit View H</u> elp		
📩 🧰 🐜 Modules: 🔍 🕼 Volume Rendering 🔷 🖛	000   00 m Z ×   00 h + -	
Solicer      Help & Acknowledgement      Volume:      CT_Thorax_Abdomen      Proset:     OrGardiac3     Shift:     Crop:     V Enable     ** Display PRIset:     Therefore and the second		-220.50
Click on the eye icon to display the volume rendered image of the kidney		: 143.22
L F B		



00	3D Slicer 4.2.0		
<u>File Edit View H</u> elp			
Modules: 🔍 🕼 Volume Rendering	🔾 🔍 I 🖤 🚇 🐐 📈 🖉 I		
B     B     B     B     B     B     B     B     B     B     B     B     CT_Thorax_Abdomen     C     Display     Preset     CT-Cardiac3     C     C     C     Cardiac3     C	1 •		R:-66.37
plays the volum image of the lef			G A 143.22
▼ Data Probe	No.		Ges
L F B	Bolt of	CONTRACT OF	





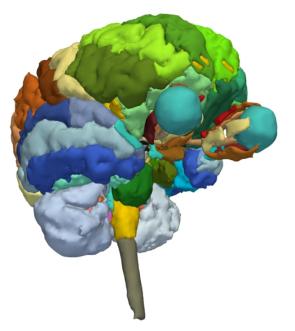
00	3D Slicer 4.2.0-rc1-2012-10-28	
<u>F</u> ile <u>E</u> dit <u>V</u> iew <u>H</u> elp		
	🖤 😂 🐐 📶 🙏   📴   💲 🕶 🖪   🔶 I 😽	
88 <mark>- 1</mark> 0		R * S: -258.13
DoSlicer		
Help & Acknowledgement		A State
Volume: 6: CT_Thorax_Abdomen		AND THE OWNER
Inputs		
- Diaplay		
Pisplay Preset: CT-Cardiac3		
Preset: CT-Cardiac3 +		
Crop: ✓ Enable		- Y - R: 94.82
Rendering: NCI GPU Ray Casting		
Advanced		
snlavs the		b a G
splays the		
· · · · · · ·		Carlos Carlos

Slicer displays the cropped volume rendered images showing the left and right kidney

	00	3D Slicer 4	4.2.0-rc1-2012-10-28	
	<u>File E</u> dit <u>V</u> iew <u>H</u> elp			
		G O 🗐 🚇 🎕 🗹 🤞	∠      \$ ▼   @ № №   + ▼	
		- <b>1</b> *		- R + S: -258.13
-	Basilicer     Help & Acknowledgement			
	Volume: 6: CT Thorax Abdomen			
	Inputs			
	,			
	Display Preset:     OCT-Cardiac3     Shift:			
	Crop:   ✓ Enable			- Y *R:94.82
	Rendering: NCI GPU Ray Casting			
	Advanced			
Click on File close the sce				
Click on Slic	er→Exit to		( TANKAK	G A 124.10
quit Slicer				0 S
	L F B			

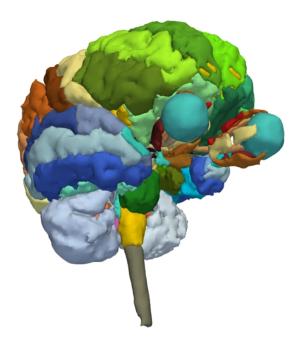
> Help & Acknowledgement	
	Y       Some data have been modified. Do you want to save them before ext?       Save     Exit (discard modifications)       Cancel exit
← Data Probe L F B	





# 3D visualization of surface models of the brain

## **3D** Data Loading and Visualization



- This tutorial is a short introduction to the advanced 3D visualization capabilities Slicer
- The Slicer4 Minute dataset is composed of an MR scan of the brain and 3D surface reconstructions of anatomical structures.
- The data are part of the SPL-PNL Brain Atlas developed by Talos, Jakab, Kikinis *et al.* The atlas is available at:

http://www.spl.harvard.edu/publications/item/view/2037

### Welcome to Slicer4

00		3D Slice				
Modules: 🔍 💽 Welcome to Slicer		🖳   \$ ▼   🖬 № №   + a - 1 *	- 1 🖪 🤚			
Welcome	C 23 8	- IV		S		
DICOM Data	Data Load Data					
Customize Slicer	🕑 Download Sample Data					
<ul> <li>Feedback</li> </ul>		)				
Share your stories with us and let us kn	- Share your stories with us and let us know about how 3D Slicer has enabled your research.		R			
We are always interested in improving 3D Slicer, and every s See more at <u>http://</u>						
About		1				
▶ The Main Window						
Loading and Saving						
Display						
Mouse & Keyboard						
Documentation & Tutorials						
Acknowledgment		- R 🕸 C	S: 0.000mm + Y 🔅		R: 0.000mm - G 🕸 🕒	A: 0.000m
		ĺ.				

#### To start Slicer, select Start $\rightarrow$ Programs $\rightarrow$ Slicer4-3.1 (win64)

8



#### **Slicer4 Minute Tutorial: Viewing the Scene**

000			er 4.3.1				
🛍 🛗 Modules: 🔍 🖾 Models 🗘 🗘	=, Q, Q, I 🕾 🚓 🖤 🛛	🐻 🛛 🚺 👌 🕶 🖓 🖓 🖓	هر   🔶 🔪 🔁 🕹				
	0 🗙 🗝	1 *				* *	\$: 0.000
3DSlicer			S				
Help & Acknowledgement	<u> </u>		0				
					/		
nclude Fibers 🗌 🔍 Scroll to	<i>♀</i> *						
Scene							
			000	🚞 data			
					Q		
	=						
Internet							R: 0.0
<ul> <li>Information</li> </ul>				zip			
urface Area: 0.00mm^2				_			
olume: 0.00mm^3	* *		Name	<ul> <li>Date Modified</li> <li>Today 7:10 PM</li> </ul>	Size	Kind Folder	
lumber of Points:			QuantitativeImaging_Sunday_Dec1_2013	Today 7:05 PM		Folder	
			dicom-data	Today 9:25 PM		Folder	
umber of Cells: 0		R	DVisualization_Tuesday_Dec3_2013	Today 7:06 PM		Folder	
×			dicom-database	Nov 1, 2012 8:23 PM		Folder	
umber of Points Scalars: 0			dataset4_CT-Chest	Today 7:06 PM		Folder	
			dataset3_CT-Liver	Today 7:06 PM		Folder	
lumber of Cells Scalars: 0			dataset2_MR-Head	Today 9:52 PM		Folder	
			MRHead_Scene.mrb dataset1_CT-Thorax-Abdomen	Today 9:52 PM Today 7:06 PM	21.5 MB	Document Folder	
ilename:			dataset1_c1=Inorax-Abdomen	10day 7:00 PM		Folder	
Display							
Visibility							A: 0.0
				1 of 10 selected, 27.13 GB available			
<u>+</u> 13101C.							
Zuh.							
Slice Intersections Visible:							
Slice Intersections Thickness: 1 px	*						

Open the directory dataset2\_Head located in C:/3DSlicerData\_RSNA2013/3DVisualizationDICOM\_Tuesday\_Dec3 Drag and drop the file Head\_Scene.mrb into Slicer

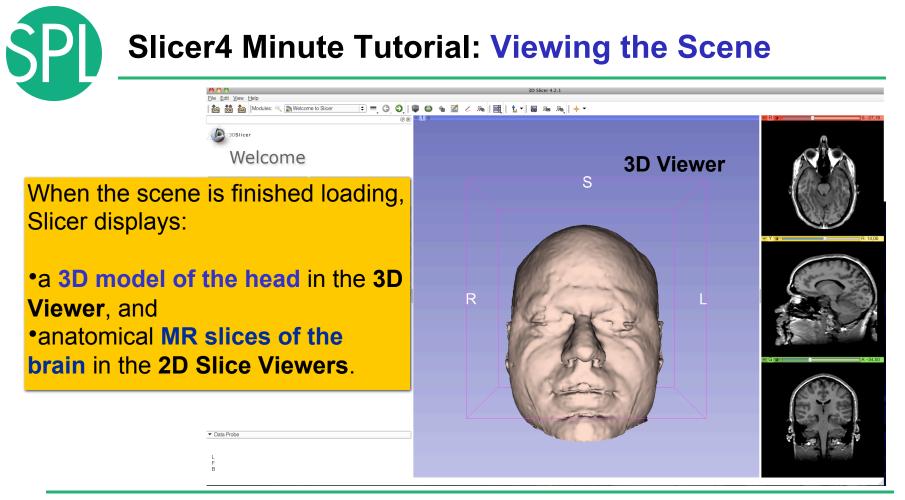


#### **Slicer4 Minute Tutorial: Viewing the Scene**

000							3D Slicer	4.3.1						
🚵 📸 🚵 Modules:	Models		: = 🔾	🕤   🔈 🥡	ė 🔍 🖪		• 🖬 🗛 🗛	🔶 🗝 🔤	<b>e</b>					
				•	08 -			•					· · ·	S: 0
3DSlicer						- 								
<ul> <li>Help &amp; Acknowledgeme</li> </ul>	nt				-				U					
nclude Fibers		Scroll to	:0	Q	*									
Scene														
								00	1	<b></b>	data			
	00		Add	data into the s	scene				) 💼 💼 📰 🔳 🖬 🖬	** ** =*	2	Q		
		tory to Add Choo					Show Options			-				
	~		File			Desc	ription							
	✓ Tuesday	_Dec3_2013/dat	taset2 MR-He	ead/MRHead	Scene.mr	MRB Slicer I	Data Bundle 🗢							R: 0
<ul> <li>Information</li> </ul>			_		_					MRHead	Scene.mrb			
Surface Area:	0													
Surface Area:	0.										-			i i i i i i i i i i i i i i i i i i i
/olume:	0.							► 🗐 z	ame	T Date Me		Size		
the states	-								p uantitativeImaging_Sunday_Dec1_2	Today 2 2013 Today 2				
Number of Points:	0								com-data	Today S				
Number of Cells:	0								DVisualization_Tuesday_Dec3_2013					
tumber of cells.									dicom-database		2012 8:23 PM			
Number of Points Scalars:	0								dataset4_CT-Chest	Today 1				
wumper of Points Scalars:	0								dataset3_CT-Liver	Today				
Number of Cells Scalars:	0							<b>T</b>	dataset2_MR-Head	Today 9				
									MRHead_Scene.mrb	Today 9		21.5 MB		
Filename:	🛓 Reset					<i>4</i> 0	K 🗶 Cancel		dataset1_CT-Thorax-Abdomen	Today 2	:06 PM		Folder	
<ul> <li>Display</li> </ul>	1													
Visibility														A: C
										1 of 10 selected,	27.13 GB available			
Visible:	14°													

#### Click on **OK** to load the file **MRHead\_Scene.mrb** into Slicer

L



©2012-2013 Surgical Planning Laboratory, ARR

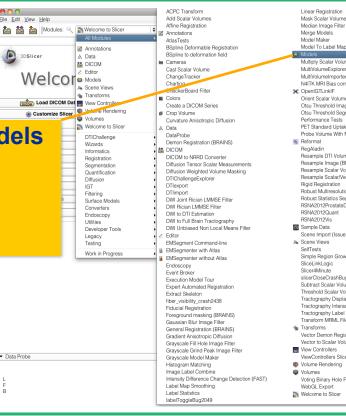
#### Slicer4 Minute Tutorial: Exploring Slicer's functionality

To access the **Models** module, browse through the list of modules.

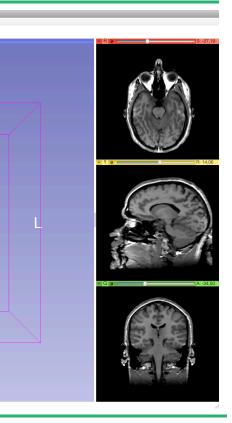
00

File Edit View Help

3DSlicer



Merge Models Model Maker Model To Label Map Multiply Scalar Volumes MultiVolumeExplorer MultiVolumeImporter N4ITK MRI Bias correction ★ OpenIGTLinkIF Orient Scalar Volume Otsu Threshold Image Filter Otsu Threshold Segmentation Performance Tests PET Standard Uptake Value Computation Probe Volume With Model Reformat RegAladin Resample DTI Volume Resample Image (BRAINS) Resample Scalar Volume Resample Scalar/Vector/DWI Volume Rigid Registration Robust Multiresolution Affine Registration Robust Statistics Segmenter BSNA2012ProstateDemo RSNA2012Quant BSNA2012Vis Sample Data Scene Import (Issue 2428) A Scene Views SelfTests Simple Region Growing Segmentation SliceLinkLogic Slicer4Minute slicerCloseCrashBug2590 Subtract Scalar Volumes Threshold Scalar Volume Tractography Display Tractography Interactive Seeding Tractography Label Map Seeding Transform MRML Files to New EMSegmenter Standard Transforms Vector Demon Registration (BRAINS) Vector to Scalar Volume View Controllers ViewControllers Slice Interpolation Bug 1926 Volume Rendering Volumes Voting Binary Hole Filling Image Filter WebGL Export Twelcome to Slicer



Data Probe

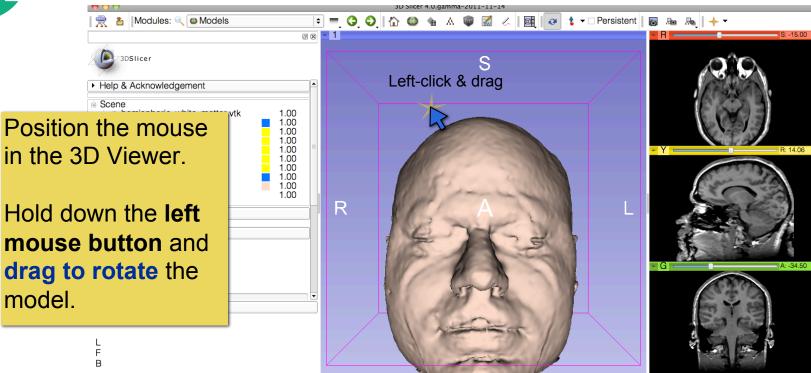


#### **Slicer4 Minute Tutorial: Switching to the Models Module**

3D Slicer 4.0.gamma-2011-11-14 指 🕶 🗆 Persistent 🛛 🐻 🛛 🗛 🛛 💠 🕶 Modules: Models 🖻 💻 🤤 😜 🗎 🏠 🚳 🐁 « ø ~ A Ø 🗙 🗧 1 R = S: -15.00 3DSlicer S Help & Acknowledgement Scene hemispheric\_white\_matter.vtk 1.00 left\_eyeball.vtk 1.00 optic chiasm.vtk 1.00 øptic nerve L.vtk 1.00 optic nerve R.vtk 1.00 - Y -----R: 14.06 optic\_tract\_L.vtk
 optic\_tract\_R.vtk
 right\_eyeball.vtk 1.00 1.00 1.00 Skin.vtk 1.00 skull bone.vtk 1.00 R Information Display Visible: Selected: Clip: - G — A: -34.50 Slice Intersections Visible: Material Properties Data Probe F В

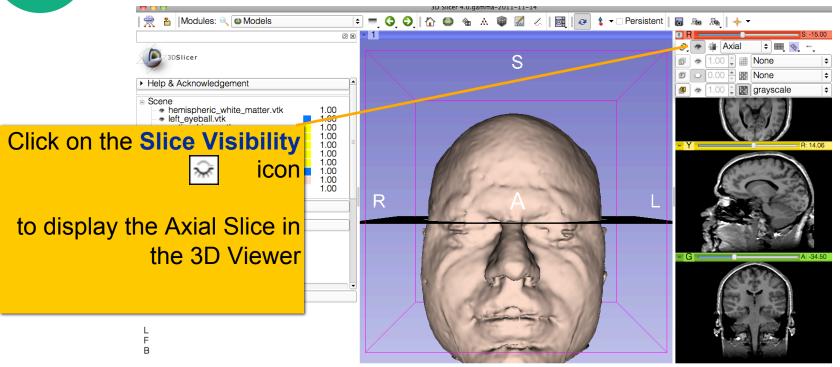


#### **Slicer4 Minute Tutorial: Basic 3D Interaction**





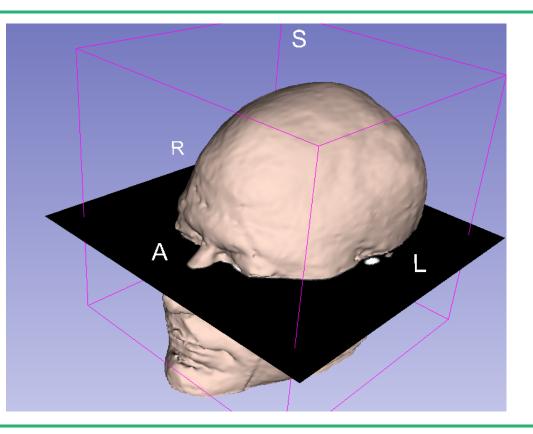
#### **Slicer4 Minute Tutorial: Viewing Slices in the 3D Viewer**





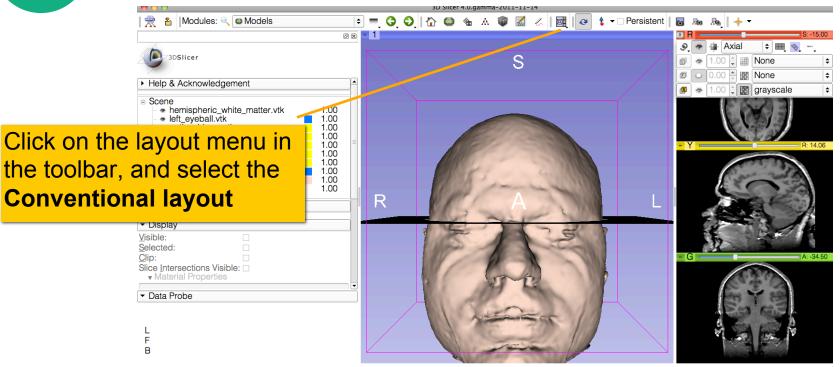
#### Slicer4 Minute Tutorial: 3D Visualization

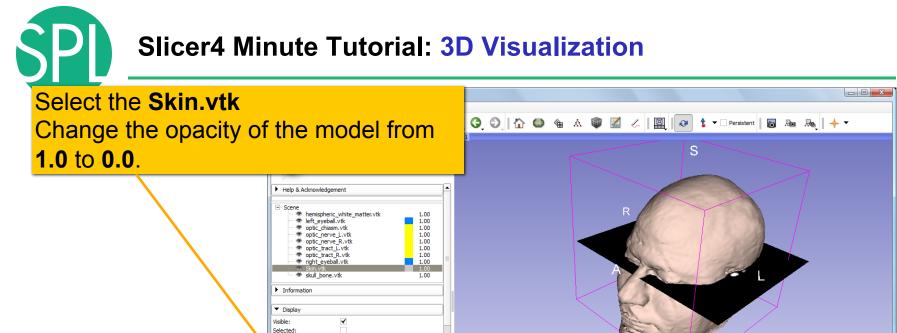
Slicer adds a view of the **Axial slice** in the 3D View.





#### **Slicer4 Minute Tutorial: Viewing Slices in the 3D Viewer**





1.00 🌲

0.00

F

Clip:

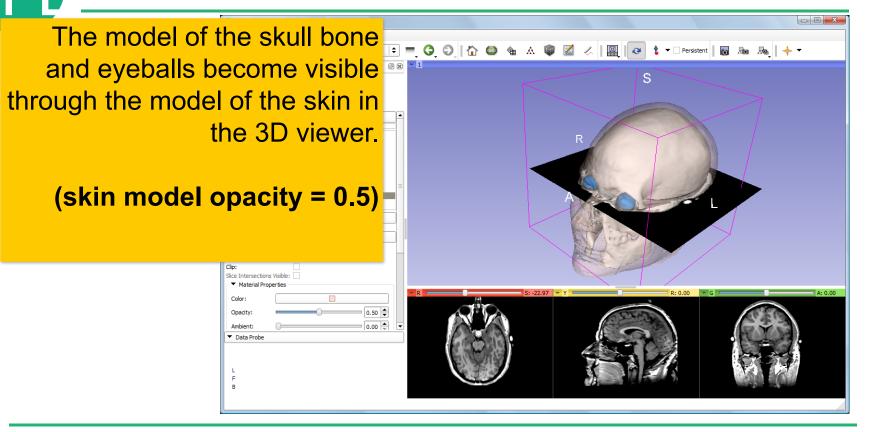
olor:

Doacity:

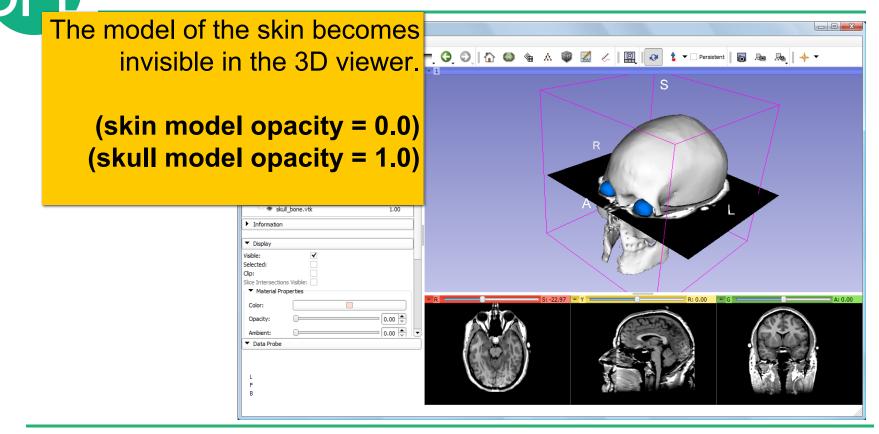
mbient:

Slice Intersections Visible:

#### Slicer4 Minute Tutorial: 3D Visualization



#### **Slicer4 Minute Tutorial: 3D Visualization**





Click on the Slice Visibility icon in the Green Slice Viewer to display the Coronal Slice in the 3D Viewer.

Display
 Visible:

Selected: Clip:

Opacity:

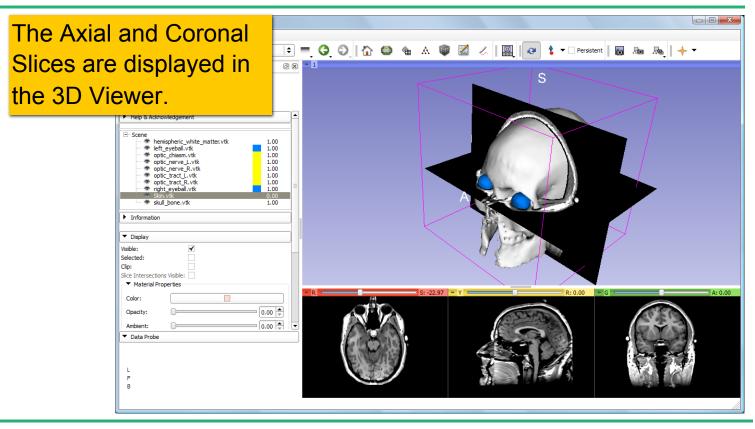
Ambient: Data Probe

Slice Intersections Visible: Material Properties Color:

~

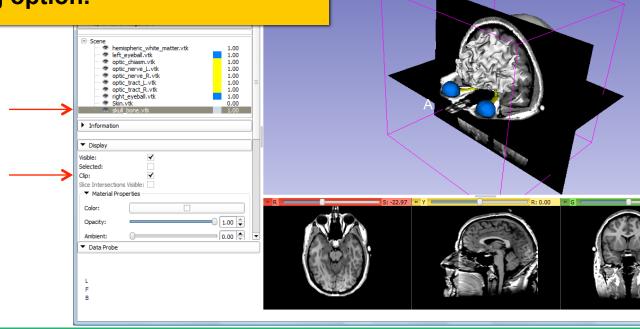
- • · × 🖻 💳 🤤 🕼 🌑 🎕 🛦 🖤 📶 🖉 📗 🤕 👌 🕶 🖸 Persistent 🛛 🐻 🔬 🕂 🕶 0 🗙 🐂 1 S ≑ 🔠 📎 Coronal 0.00 0.00 grayscale







# Select the 3D model **skull\_bone.vtk** in the Model Hierarchy and turn on the **Clipping option.**



A

~

ø

1

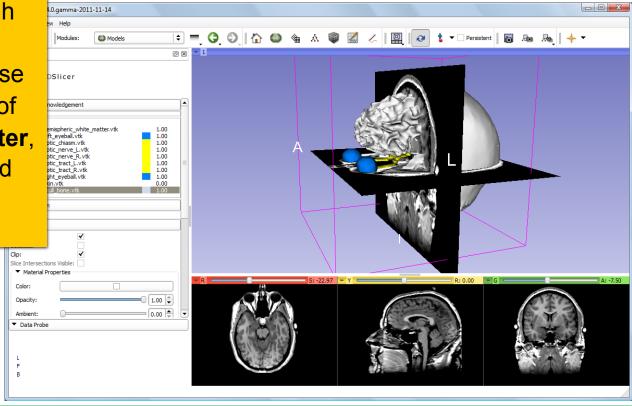
S

©2012-2013 Surgical Planning Laboratory, ARR

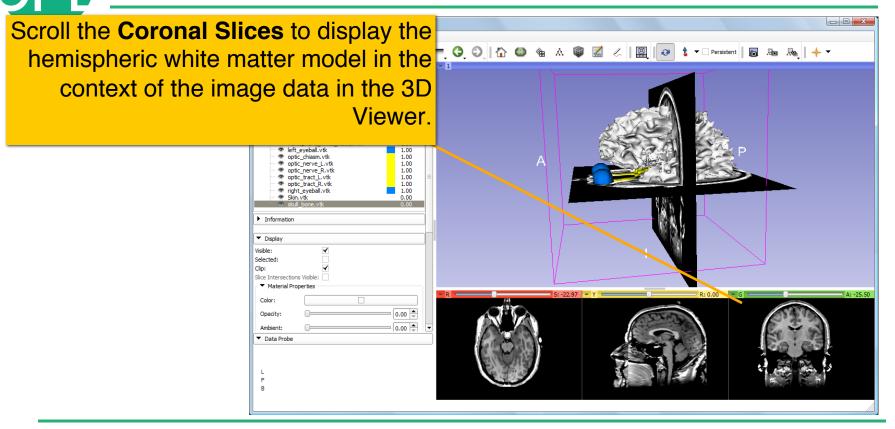
A: 0.00

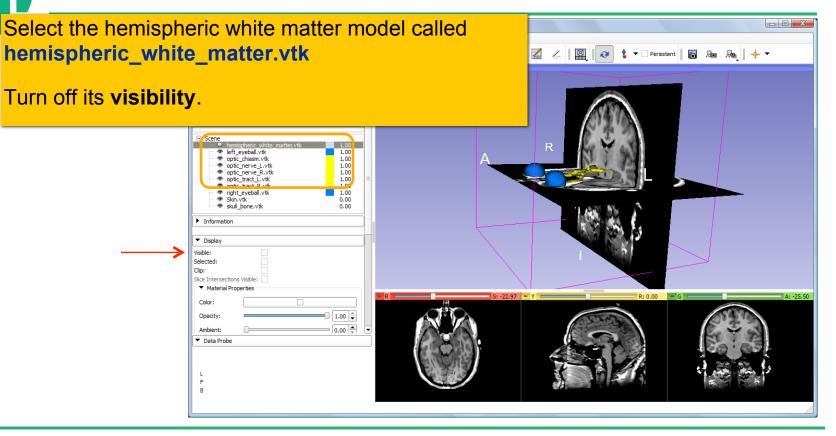
🕶 🛛 Persistent 🛛 🐻 🛝 🔸 🖛

Browse through the coronal slices to expose the 3D model of the white matter, and the left and right optic nerves.



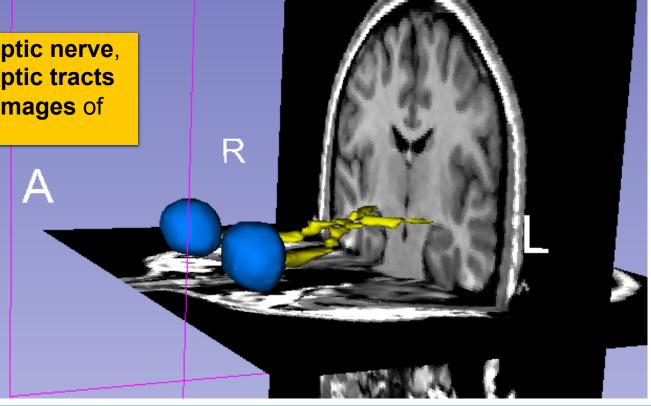
Now make the skull invisible. - 0 -X-🖻 💳 👶 🕥 | 🏠 🚳 🍇 🆓 🔣 🥢 | 🏦 | 🐼 💲 🖛 Persistent | 🐻 🐜 🙈 | 🔶 🔻 Modules: Models 0 🗙 🐂 1 3DSlicer Help & Acknowledgement - Scene hemispheric\_white\_matter.vtk 1.00 1.00 left\_eyeball.vtk optic\_chiasm.vtk 1.00 optic\_nerve\_L.vtk 1.00 optic\_nerve\_R.vtk 1.00 1.00 optic tract L.vtk 1.00 optic\_tract\_R.vtk right\_eyeball.vtk 1.00 Skin.vtk 0.00 1.00 Information R: 0.00 A: -18.00 Display Visible: Selected: Clip: ~ Slice Intersections Visible: Material Properties Color: 1.00 🌲 Opacity: 0.00 🚔 👻 Ambient: Data Probe F в







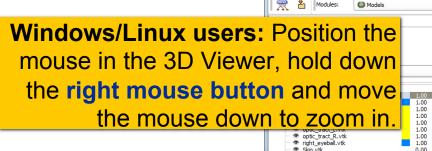
Slicer displays the **optic nerve**, **optic chiasm** and **optic tracts** overlaid on the **MR images** of the brain.





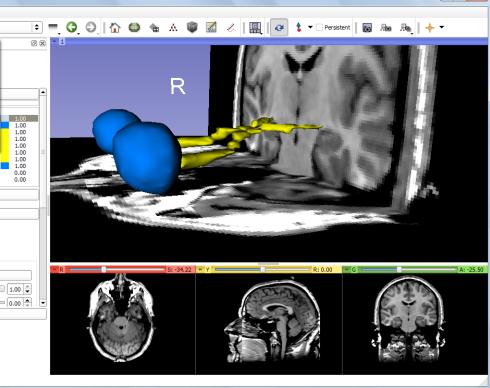
#### Slicer4 Minute Tutorial: 3D Visualization: Zoom the view

0.00



3D Slicer 4.0.gamma-2011-11-14

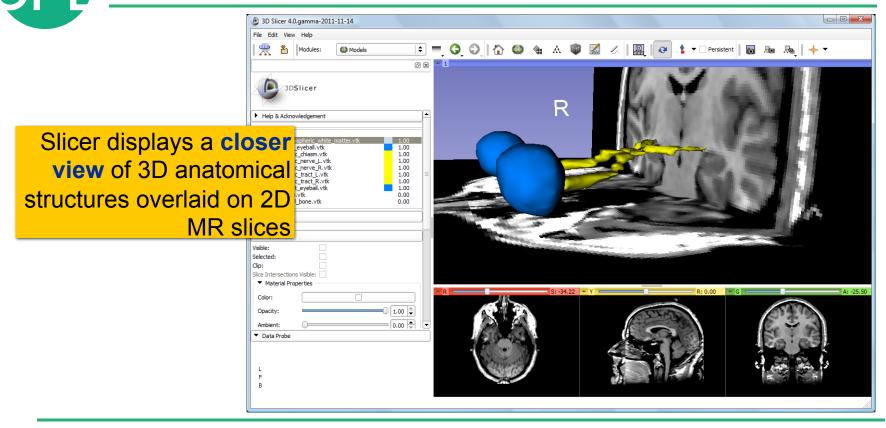
Mac users: Position the mouse in the 3D Viewer, hold down the apple button and the mouse button and move the mouse down to zoom in (or use two fingers on the touch pad)



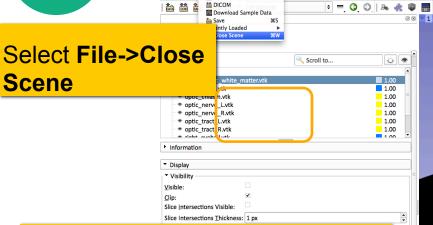
в



#### **Slicer4 Minute Tutorial: 3D Visualization: Zoom the view**



### Close the existing scene and all its data

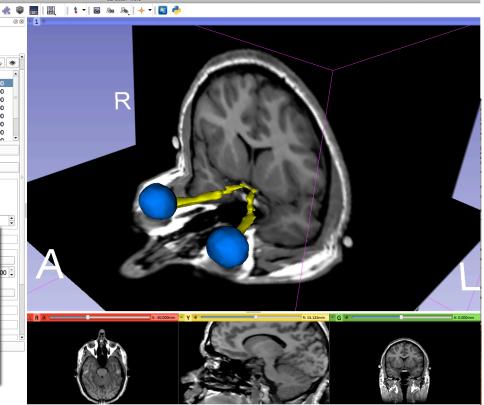


a Add Data

This removes any dataset previously loaded into Slicer.

Select Slicer→Quit to exit the software

в







### **Overview**

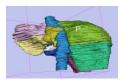


Part I: Introduction to the 3DSlicer software



Part II: 3D Data Loading and visualization of DICOM images

- Volume Rendering of thoraco-abdominal CT data
- Surface Rendering of MR head data

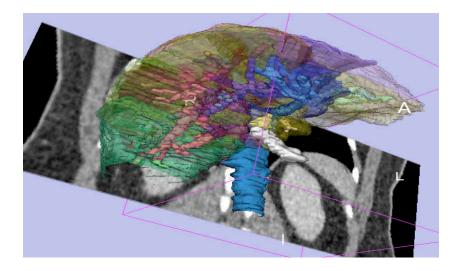


Part III: 3D interactive exploration of the anatomy

- Exploration of the Segments of the liver
- Exploration of the Segments of the lung





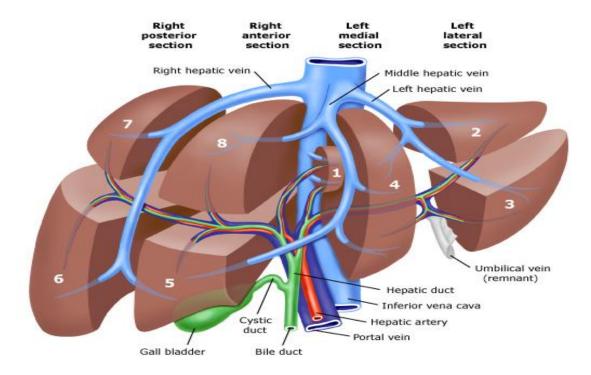


### Part II:

## Interactive 3D Visualization of the segments of the liver



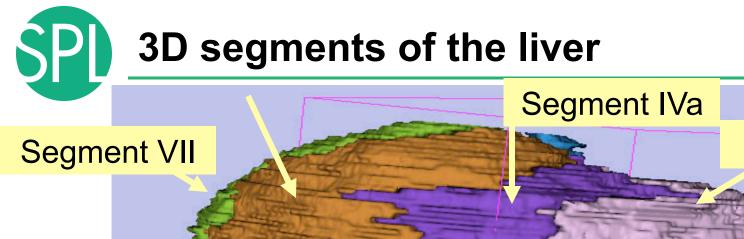
### Anatomy of the liver







The liver dataset is a contrast-enhanced CT abdominal scan of a healthy 36 year-old male.



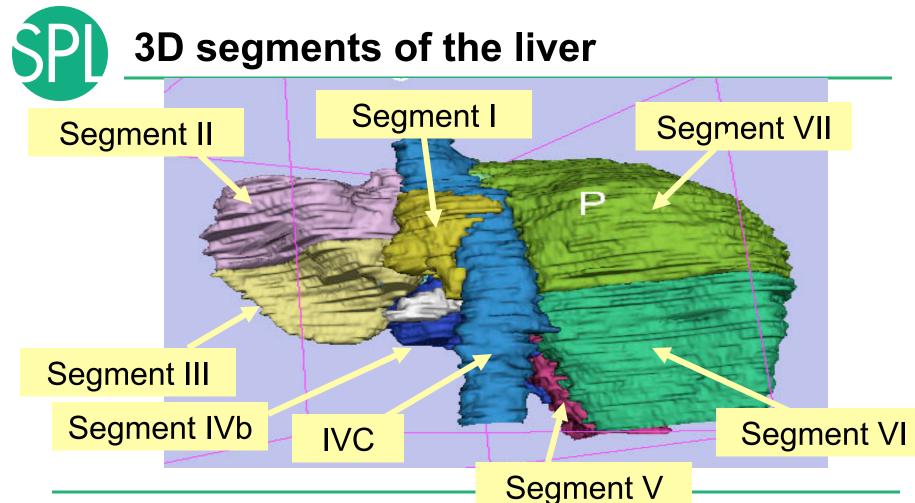


### Segment IVb

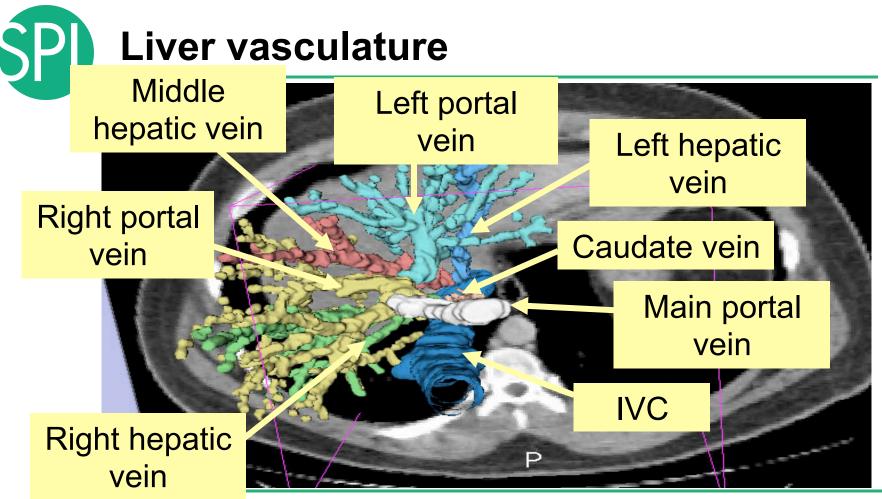
Segment V

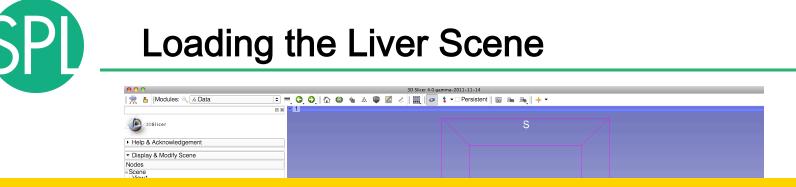
Segment II

Segment III



©2012-2013 Surgical Planning Laboratory, ARR





### Browse to the directory

- C:\3DSlicerData\_RSNA2013\3DVisualizationDICOM\_Tuesday\_Dec3
- Select the directory dataset3\_Liver

Drag and drop the file LiverSegments\_Scene.mrb into Slicer

Click on OK to load the scene into Slicer

### Loading the Liver Scene

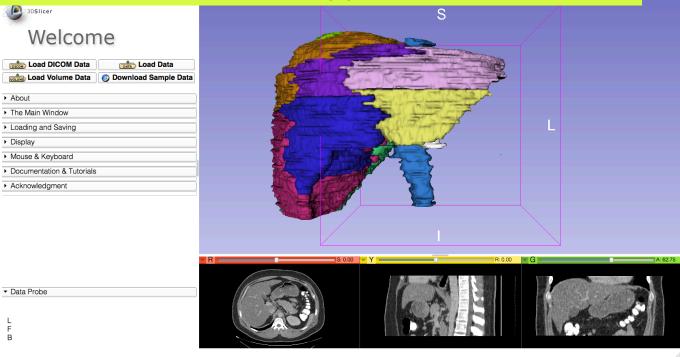
000			3D Slicer 4.3.1		
				<b>A</b> .	
🚵 🚵 🀜 Modules: 🔍 🛎 Mo	dels	) O   🌬 🤹 🖉 📠	<u> </u>	2 7	
		Ø 🗷 🗖 🔍			
3DSlicer				-	
				S	
nclude Fibers	Scroll to	<u>↔</u> 🕗			
Scene					
		000	Add data into the scene		
		Choose Directory to Ar	dd Choose File(s) to Add	Show Options	
Information		✓	File	Description	
		✓ation_Tuesday_De	c3_2013/dataset3_CT-Liver/LiverSegmer	nts_Scene.mrml MRML Scene 🗧	
<ul> <li>Display</li> </ul>					
Visibility					
Visible:					
Clip:					
Slice Intersections Visible:					
Slice Intersections Thickness: 1 px					
Representation					
▼ Color					
Color:		- Reset		Grancel	
Opacity:					
Edge Visibility:			<u>k</u>		×
Edge Color:	#000000	- 4	B	0.000mm + 4	R: 0.000mm + 4 0-
▶ Lighting					
Material					
Scalars					
<ul> <li>Data Probe: /Users/spujol/worksho</li> </ul>					· · · · · · · · · · · · · · · · · · ·
	Click	r on $O$	K to loo	the cool	ne into Slicer
L					
F					

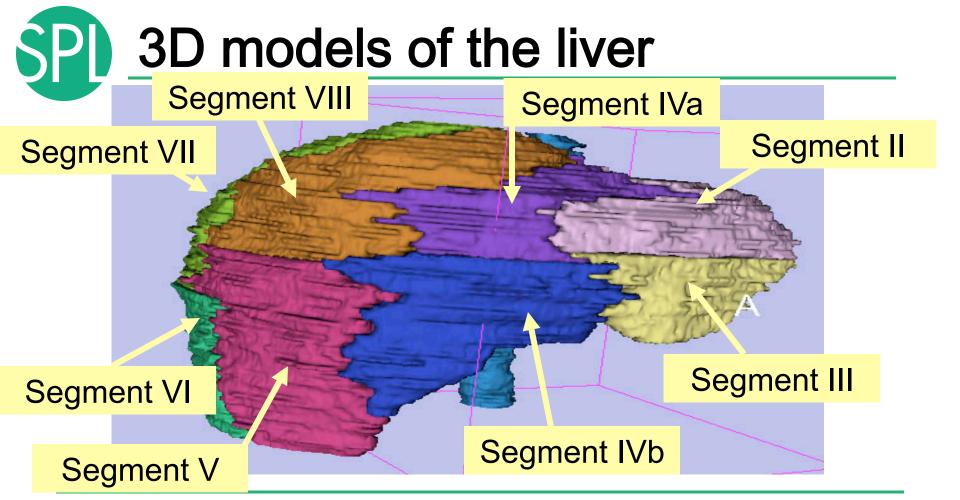
SPL

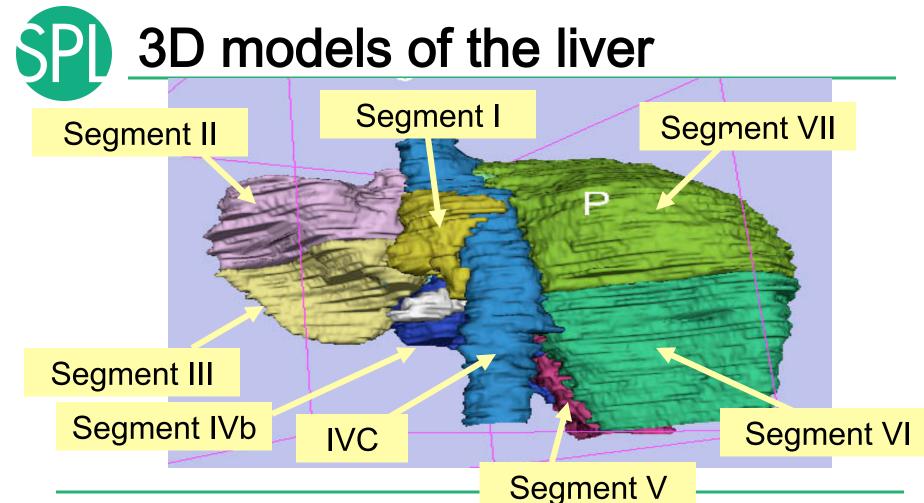
Side 92

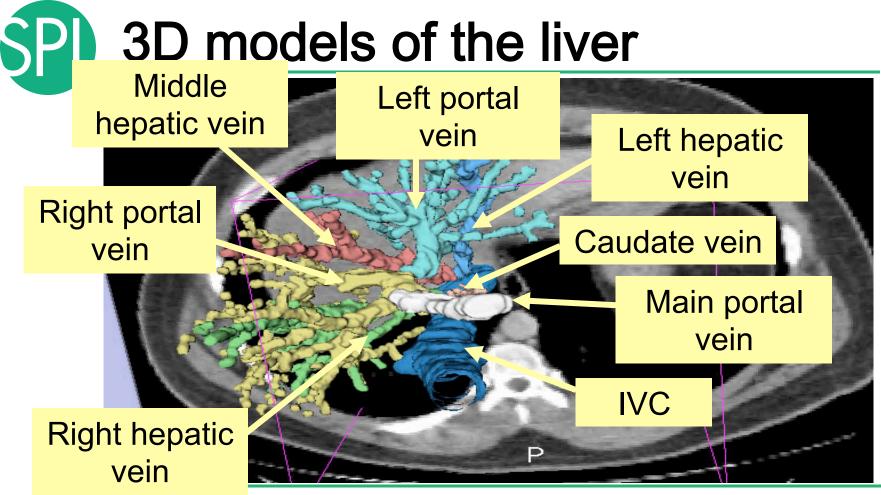
### **Liver Segments Scene**

#### The elements of the scene appear in the Viewer

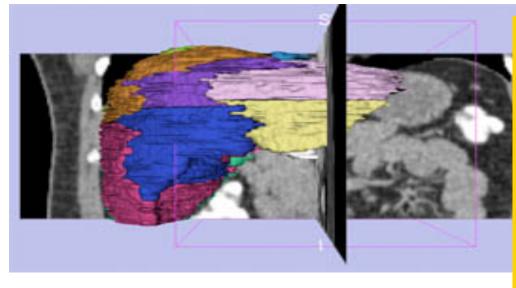




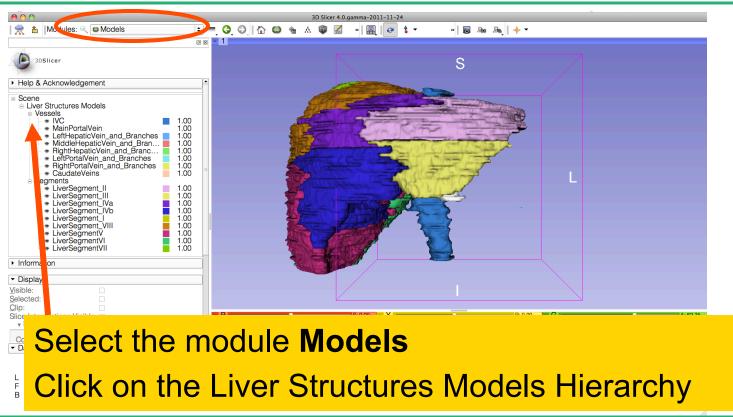


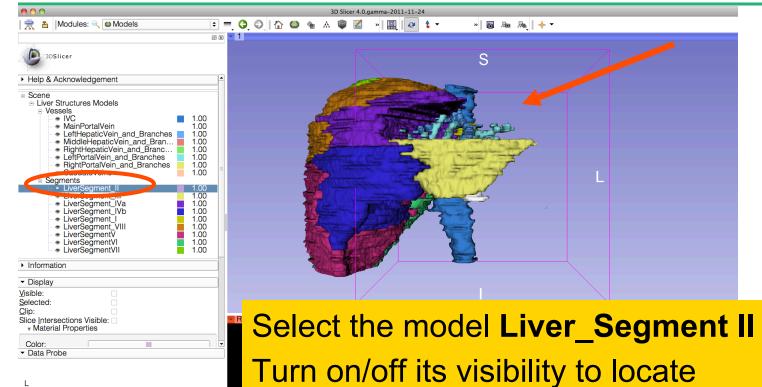






Example: What organ abuts the left-most margin of segment II in this patient ?





it in the 3D viewer.

©2012-2013 Surgical Planning Laboratory, Акк

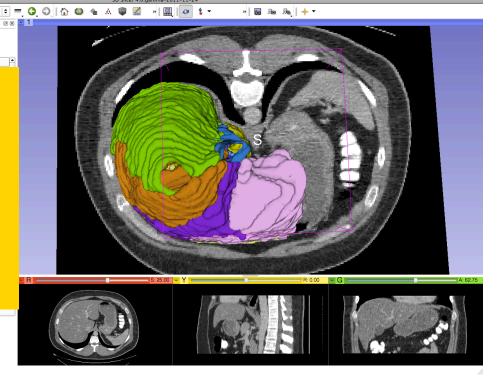
F B

Position the mouse in the 3D Viewer, hold down the left mouse button and drag to orient the 3D model to a superior view.

Modules:

Borna Street
 Solution
 Sector Street
 Sector Street

Models



National Alliance for Medical Image Computing Slide 10 http://na-mic.org © 2010, ARR

00		3D Slicer 4.0.g	amma-2011-11-24		
👷 🏝 Modules: 🔍 🚳 Models		h 🚇 🎕 🛦 🧊 📶	» 🖳 🐼 🕇 🔻	»   🐻 🗛 🥾   🔶 🔻	
3DSIlcer	@ 8 - 1		and the second		
<ul> <li>Help &amp; Acknowledgement</li> </ul>	<u> </u>				
Scene     Liver Structures Models     Vessels     MainPortalVein     MainPortalVein and Branches     MiddleHepaticVein_and Branches     MiddleHepaticVein_and Branches     MiddleHepaticVein_and Branches     RightPortalVein_and Branches     RightPortalVein_and Branches     ScaudateVeins     ScaudateVeins     ScaudateVeins     LiverSegment_II     LiverSegment_II     LiverSegment_II     LiverSegment_Va     LiverSegment_Va     LiverSegmentVI     LiverSegmentVI     LiverSegmentVI	1.00 1.00			s Seg/l	
Information		10			
<ul> <li>▼ Display</li> <li>Visible:</li> </ul>			ALC: NOT THE OWNER.		
Selected:  Clip: Slice Intersections Visible: * Material Properties	R		<u>s 25.00</u> Q	uestion 1:	
Color:					
L			W	hat organ abut	<mark>s the lef</mark>
В				a at many in af a	
			m	ost margin of s	egment

in Patient 1?

©2012-2013 Surgical Planning Laboratory, ARR

#### 3D Slicer 4.0.gamma-2011-11-24 کے [Modules: ﴿ Models : ﴿ Models : ﴿ اِللَّ اِللَّهِ اِللَّهِ اِللَّهِ اِللَّهِ اِللَّهِ اِللَّهِ اللَّهِ اللَّ اللَّ اللَّ اللَّ اللَّ اللَّ اللَّهُ ال

### **Question 1:**

What organ abuts the leftmost margin of segment II in this patient?

> Selected Clip:

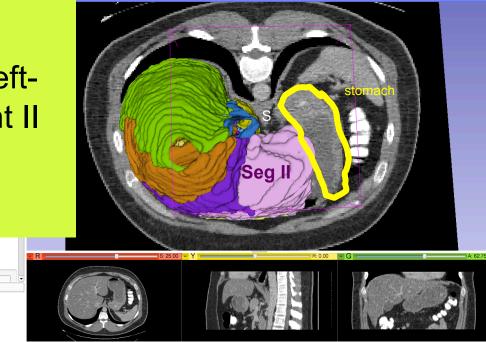
> > Color: Data Probe

F B

Slice Intersections Visible:

-

### Answer 1: Stomach



G 🗙 🗝 1

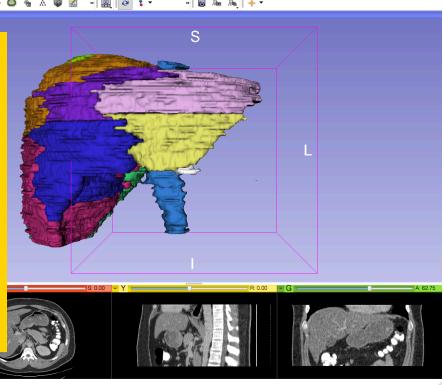
👷 🎽 Modules: 🔍 🙆 Models

= ♀ ♀ ♪ ☆ ⇔ ▲ ☆ ₩ 🖾 » 🖩 🐼 \$ - >> 🐻 🐜 🔶 + -

### **Question 2:**

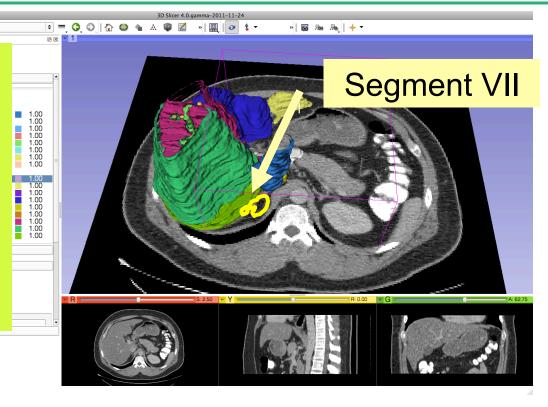
F B

Which segment would most likely be affected by an aggressive tumor invading locally from the right adrenal gland ?



#### **Question 2:**

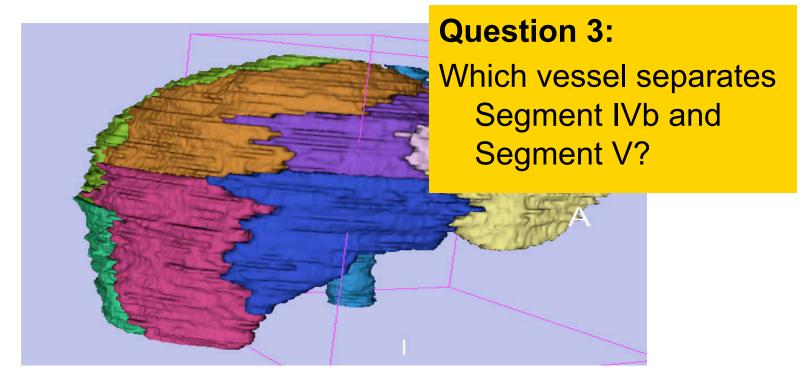
Which segment would most likely be affected by an aggressive tumor invading locally from the right adrenal gland ? Answer 2: <u>Segment VII</u>



Data LIUDI

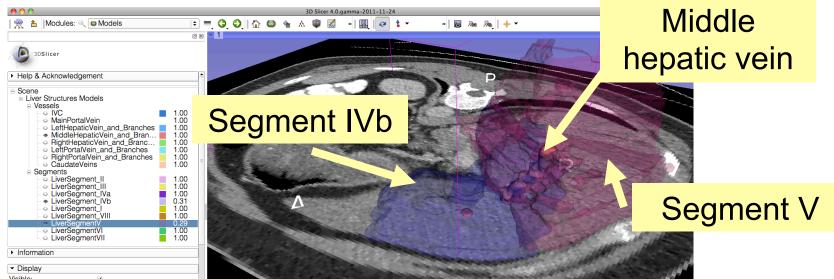
F

👾 🎽 Modules: 🔍 🚇 Models





### **Middle Hepatic Vein**



### **Question 3:**

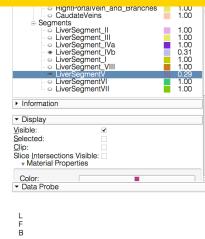
Which vessel separates Segment IVb and Segment V? Answer 3: <u>The middle hepatic vein</u>

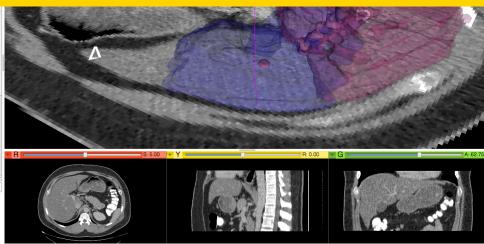


### **Closing the Liver Scene**

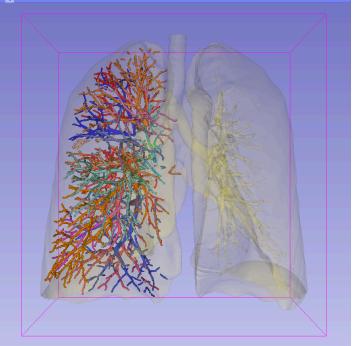


#### Select **Slicer** → **Exit** to close the Liver Scene and exit Slicer



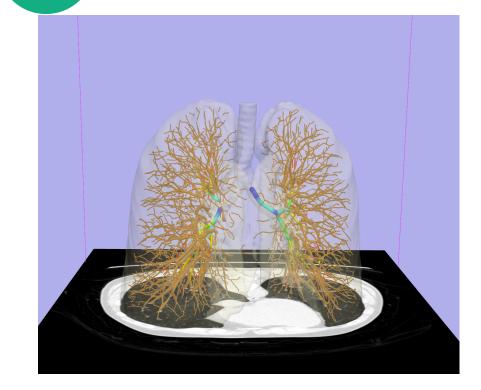






## Interactive 3D Visualization of the segments of the lungs

### Segments of the lung

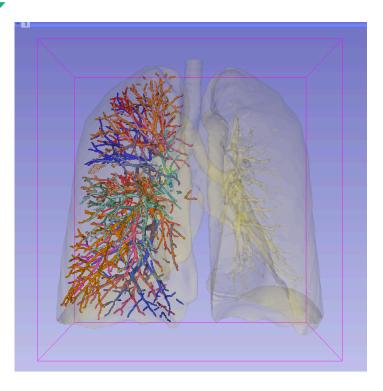


Segmentation and 3D surface reconstruction of the lung and pulmonary vessels

Acknowledgment:

Segmentation of the lung surface and vasculature: Raul San Jose Estepar, Ph.D., George Washko, M.D., Ed Silverman, M.D. and James Ross, MSc. Brigham and Women's Hospital (K25 HL104085) and COPDGene (01 HL089897 and U01 HL089856)

### Segments of the lung



3D parcellation of arteries and veins from original model of pulmonary vessels (Kitt Shaffer, M.D., Ph.D. - Sonia Pujol, Ph.D.)

- Right Upper Lobe (RUL)
  - RUL Pulmonary Vein
  - RUL Anterior Segment
  - RUL Apical Segment
  - RUL Posterior Segment
- Right Middle Lobe (RML)
  - RML Pulmonary Vein 1 & 2
  - RML Lateral Segment
  - RML Medial Segment
- Right Lower Lobe (RLL)
  - RLL Pulmonary Vein 1,2,3
  - RLL Anterior Basal Segment
  - RLL Medial Basal Segment
  - RLL Lateral Basal Segment
  - RLL Posterior Basal Segment

#### Loading the Chest Data Scene

		Ø 🕱 🗝 1 🗇					
3DSlicer							
			000	<u> </u>			
				b 🗐	lata		
Help & Acknowledg	ement	<b></b>				Q	
clude Fibers	Scroll to	<b>₽</b> ♥					
-				ARRAND.			
Scene							
					and the second second		
				LungSegment	ts_Scene.mrb		
			Name	Date Modified	Size	Kind	
			▶ 📄 zip	Today 7:10 PM	5126	Folder	
		=	QuantitativeImaging Sunday Dec1 2013	Today 7:05 PM		Folder	
	No. of Contract of		dicom-data	Today 9:25 PM		Folder	
Information			Test Strategy Strategy Test Strategy	Today 7:06 PM		Folder	
			dicom-database	Nov 1, 2012 8:23 PM		Folder	
urface Area:	0.00mm^2	÷.	dataset4_CT-Chest	Today 9:58 PM		Folder	
			LungSegments_Scene.mrb	Today 9:57 PM	151.9 MB	Document	
olume:	0.00mm^3		dataset3_CT-Liver	Today 7:06 PM		Folder	
umber of Points:	0	A .	dataset2_MR-Head	Today 9:52 PM		Folder	
	С		MRHead_Scene.mrb CT-Thorax-Abdomen	Today 9:52 PM Today 7:06 PM	21.5 MB	Document Folder	
imper of Points:	0	<u>*</u>	dataset1_C1=Inorax=Abdomen	Today 7:06 PM		rolder	
imber of Cells:	*			1 of 11 selected, 2	6 97 CR available		

Open the directory

C:\3DSlicerData\_RSNA2013\3DVisualizationDICOM\_Tuesday\_Dec3

Select the subdirectory dataset4\_Chest

Drag and drop the file LungSegments\_Scene.mrb into Slicer

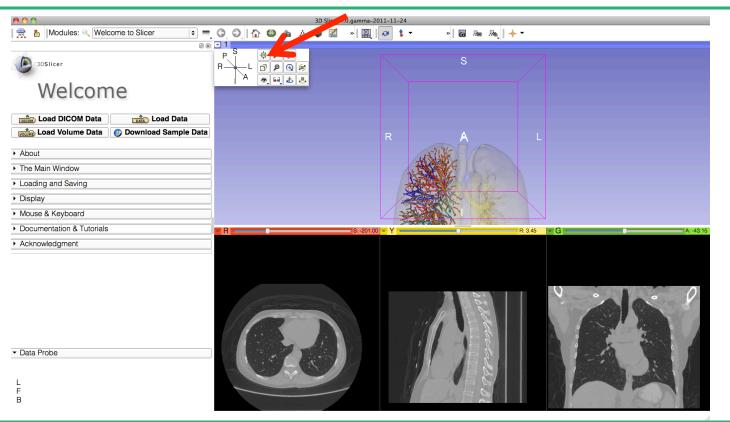
#### Loading the Lung Scene

1

С

	[]		3D Slice					
🚵 🚵 🐜  Modules: 🔍	Models 🗘	= 3 9   🕾 🚓 🔍 📕		&, + ▼ E	I 🥐			
		0 8 🛌 1	¢					
3DSlicer					S			
Help & Acknowledgement		A			_	/		
						data	۹.	
clude Fibers	Scroll to	☆ 🐲					4	
Scene								
	00	Add data into the scene						
C	hoose Directory to Add Choose Fi	e(s) to Add	Show Options					
	• •					LungSegments_Scene.mrb		
<b>~</b>		le	Description					
×	sday_Dec3_2013/dataset4_CT-	Chest/LungSegments_Scene.mrb	MRB Slicer Data Bundle	_	Name	<ul> <li>Date Modified</li> </ul>	Size Kind	
				R	▶ 🛄 zip	Today 7:10 PM	Folder	
Information					<ul> <li>QuantitativeImaging_Sunday_Dec1_2013</li> <li>dicom-data</li> </ul>	Today 7:05 PM Today 9:25 PM	Folder Folder	
rface Area:					all	Today 7:06 PM	Folder	
					dicom-database	Nov 1, 2012 8:23 PM	Folder	_
lume: 0					dataset4_CT-Chest	Today 9:58 PM	Folder	
					LungSegments_Scene.mrb	Today 9:57 PM	151.9 MB Document	
umber of Points: 0					dataset3_CT-Liver	Today 7:06 PM	Folder	
umber of Cells:					dataset2_MR-Head	Today 9:52 PM	Folder	
					MRHead_Scene.mrb	Today 9:52 PM	21.5 MB Document	_
umber of Points Scalars:					dataset1_CT-Thorax-Abdomen	Today 7:06 PM	Folder	
2					1	of 11 selected, 26.97 GB available		
lumber of Cells Scalars:								
ilename:	Reset		Scancel					
lename.								
Display								
<ul> <li>Visibility</li> </ul>								
landle.	V	-	9	S: 0	200mm + 🕸 🕒	R: 0.000mm		A
Clip:								
Slice Intersections Thickness:	1 px	×						
		1 1 1	<b>C'I</b>	1				
k on (		nad th		ntr	Slicer			
В								

#### Loading the Lung Scene



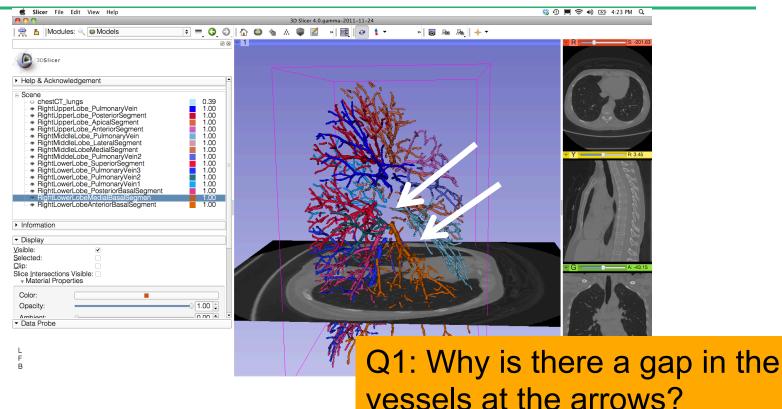
#### Loading the Lung Scene

<b>0</b> 0 0	3D Slicer 4.0.gamma-2011-11-24
। 👷 🏝 Modules: < Welcome to Slicer 💠 💻 🧿 🕘 🛛 🏠 🍩 🎕 🙏	A 📦 🖾 »   🖳   🕢 🛊 🕶 🛛 »   🐻 🗛 🗛   🔶 🕶
Image: Solution of the second state	
e module <b>Models</b> from les Menu.	
• Data Probe	

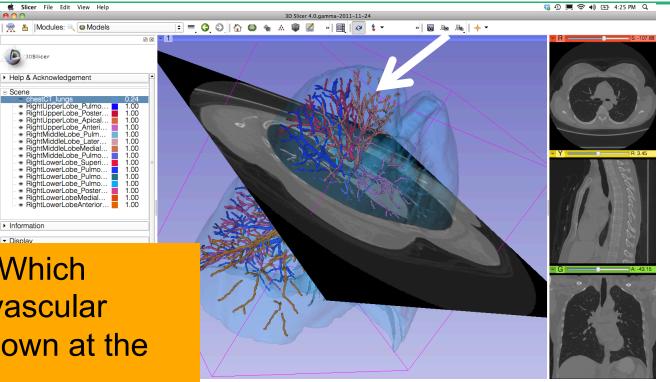


# Lung Segments

Slicer File Edit View Help	🍪 ① 🗐 🎅 🜒 🖭 5:48 PM Q
Modules: 🔍 🛛 Models 🕴 = 😋 🧉	3D Slicer 4.0.gamma-2011-11-24
	)   ☆ 😂 🛳 📽 📈 ⇒   🖳   🛩 \$ ▼ →   छ № №   + ▼ ■ 1
08	
3DSlicer	S
Help & Acknowledgement	
⊨ Scene	
chestCT_lungs     0.18     RightUpperLobe_PulmonaryVein     1.00	
= Bight Inport and BostoriarCogmont 100	
RightUpperLobe_ApicalSegment     I.00     RightUpperLobe_AnteriorSegment     I.00	Slicer displays the list of 15
RightMiddleLobe_PulmonaryVein 1.00	Slicer displays the list of 15
HightUpperLobe_ApicalSegment 1.00     HightUpperLobe_ApicalSegment 1.00     HightUpperLobe_ApicalSegment 1.00     HightUpperLobe_ApicalSegment 1.00     HightWiddleLobe_LeruinsoraryVein 1.00     HightWiddleLobeMedialSegment 1.00     HightWiddleLobeMedialSegment 1.00	
HighlikideLobe/Poliaisegment         1.00           RightLowerLobe_DulmonaryVein2         1.00           RightLowerLobe_PulmonaryVein3         1.00           RightLowerLobe_PulmonaryVein3         1.00           RightLowerLobe_PulmonaryVein3         1.00           RightLowerLobe_PulmonaryVein3         1.00           RightLowerLobe_PulmonaryVein3         1.00           RightLowerLobe_PulmonaryVein4         1.00           RightLowerLobe_PolmonaryVein5         1.00           RightLowerLobe_PolmonaryVein6         1.00           RightLowerLobePolmonaryVein7         1.00           RightLowerLobePolmonaryVein7         1.00           RightLowerLobePolmonaryVein7         1.00	surface models of pulmonary
RightLowerLobe_PulmonaryVein3     1.00	Surface models of pullionally
<ul> <li>RightLowerLobe_PulmonaryVein2</li> <li>RightLowerLobe_PulmonaryVein1</li> <li>1.00</li> </ul>	· · · · · · · · · · · · · · · · · · ·
RightLowerLobe_PosteriorBasalSegment     I.00     RightLowerLobeMedialBasalSegmen     I.00	
	structures.
RightLowerLobe_LateralBasalSegment 1.00 RightLowerLobe_PulmonaryVein4 1.00	
Information	
▼ Display	
Visible:	
Slice Intersections Visible:	R R: 3.45 G A: 43.15
Color:	
Opacity:	
▼ Data Probe	
L	
F	
В	

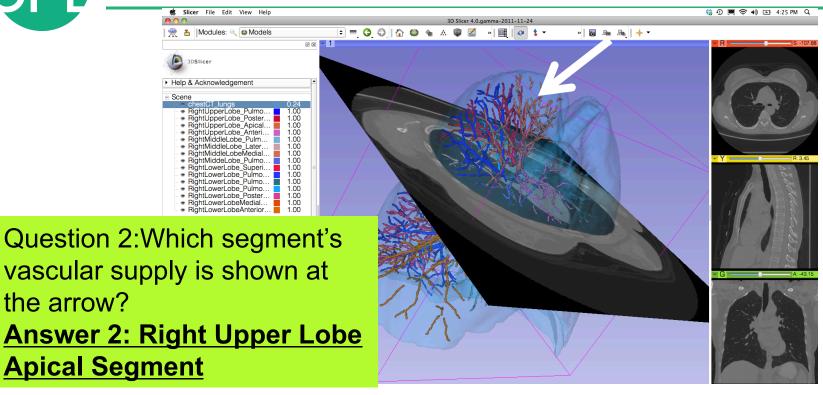


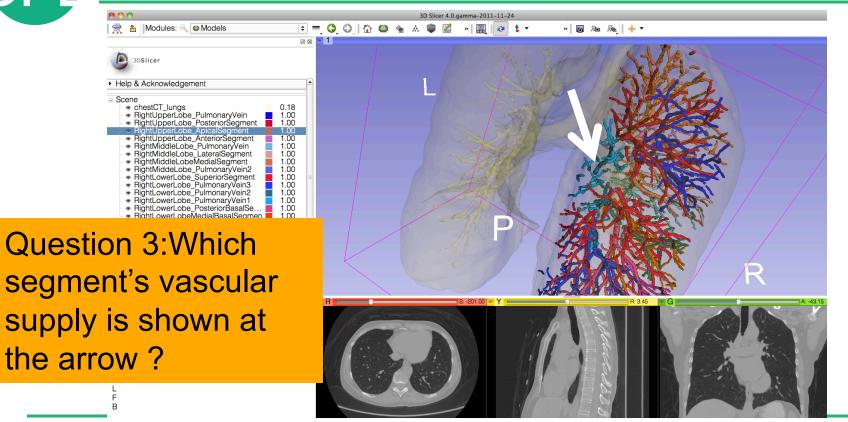
Slide 116



**Question 2:Which** segment's vascular supply is shown at the arrow?

00





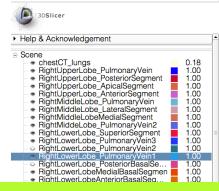
0 0

- Scene

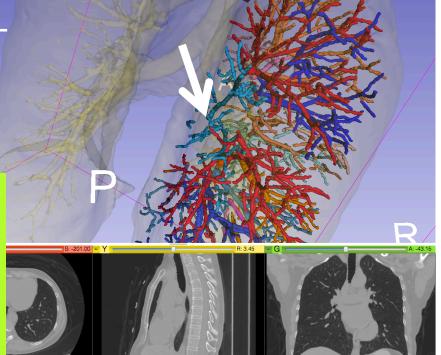


0 x - 1

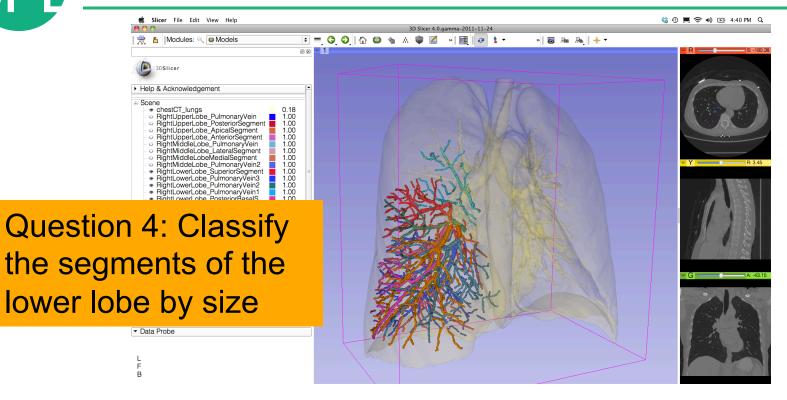
👷 皆 Modules: 🔍 🚳 Models

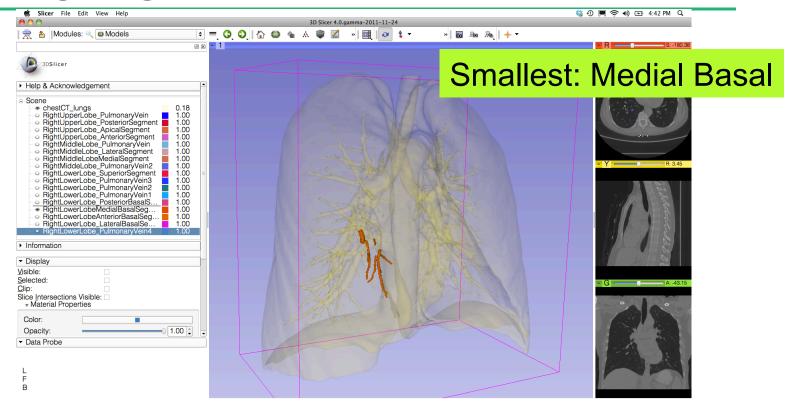


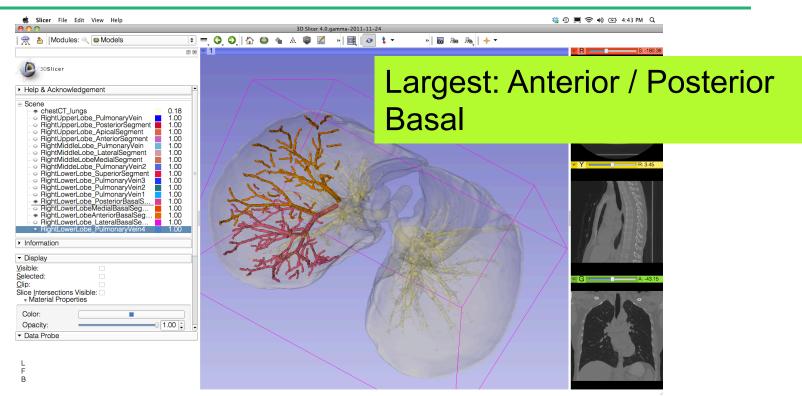
Question 3:Which segment's vascular supply is shown at the arrow? <u>Answer 3: Right Lower</u> Lobe Pulmonary Vein 1



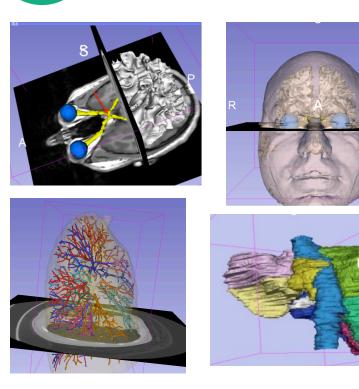
» 🐻 🜆 👧 🔶 🔻







## **3D Visualization of DICOM images**



- Interactive user-interface to load and manipulate greyscale volumes, labelmaps and 3D models.
- User-defined 3D view of the anatomy
- 3D Open-source platform for Linux, Mac and Windows

#### **3DSlicer website**



## 3DSlicer at RSNA 2013

#### **Quantitative Imaging Reading Room Exhibit QIRR 1028**

- Sun. Dec.1-Fri. Dec.6, 8:00-6:00
- 3DSlicer: An Open Source Platform for Segmentation, Registration, Quantitative Imaging, and 3D Visualization of Multi-Modal Image Data.
- Sonia Pujol, PhD, Steve Pieper, PhD, Andriy Fedorov, PhD, Ron Kikinis, MD,



#### **Additional Related Hands-on courses**

All courses are in this Advanced Imaging Classroom: S401CD (except Monday when it is in S401AB)

Sunday 11:00 am – Quantitative Imaging for Medical Research and Practice

**Sunday 4:00 pm** – Structured Annotation and Image Markup (AIM) Template and Toolsets (ICIW12)

Monday 4:30 pm – Clinical Trials Software for Clinical Trials and Research (ICIW24)

Wed 10:30 am – Open Access Imaging Data Resources: NIH Cancer Imaging Archive (ICIA41)

Wed 12:30 pm – Correlating Imaging with Human Genomics (ICIA42)



#### **3DSlicer at RSNA**

#### Questions: spujol@bwh.harvard.edu



#### Acknowledgments

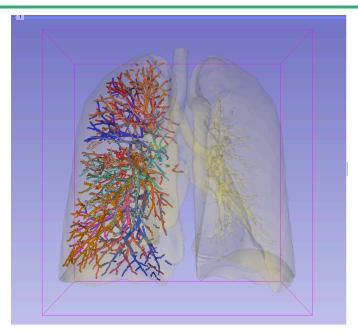
National Alliance for Medical Image Computing (NA-MIC) (NIH Grant U54EB005149)



Neuroimage Analysis Center (NAC) (NIH Grant P41 RR013218)

Marianna Jakab, Surgical Planning Laboratory, Brigham and Women's Hospital





www.slicer.org www.na-mic.org

Questions and comments: spujol@bwh.harvard.edu