



# DICOM and Slicer: A Tutorial

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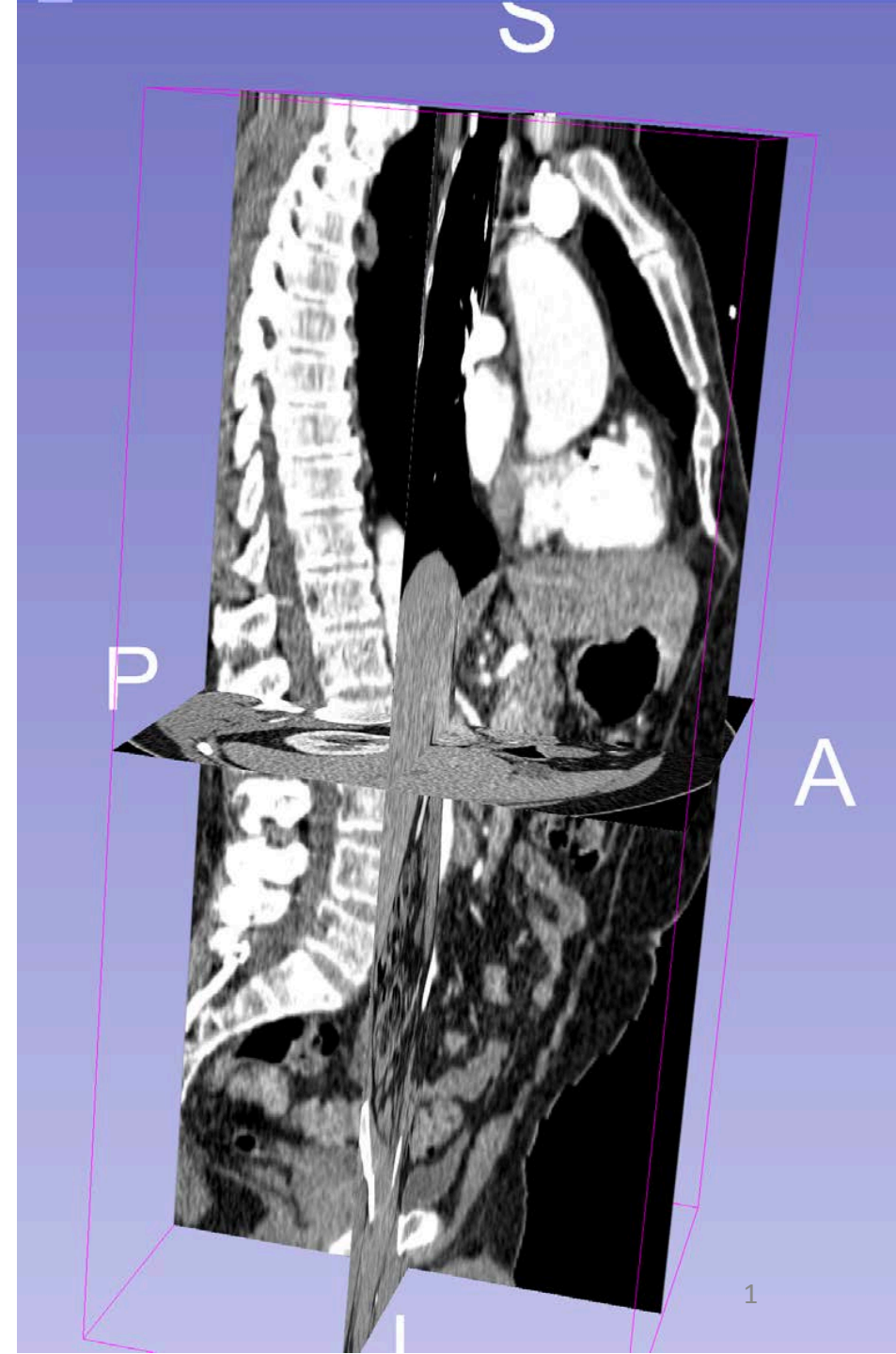
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# Objective

This tutorial provides a basic introduction to the DICOM standard, and shows how to visualize DICOM images in 3D Slicer version 5.0



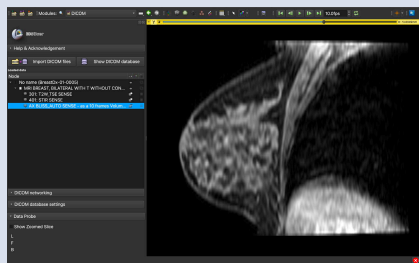
# Tutorial Outline



Part 1: Introduction to DICOM



Part 2: DICOM and Slicer



Part 3: Loading and Visualizing DICOM data in Slicer

# Tutorial material

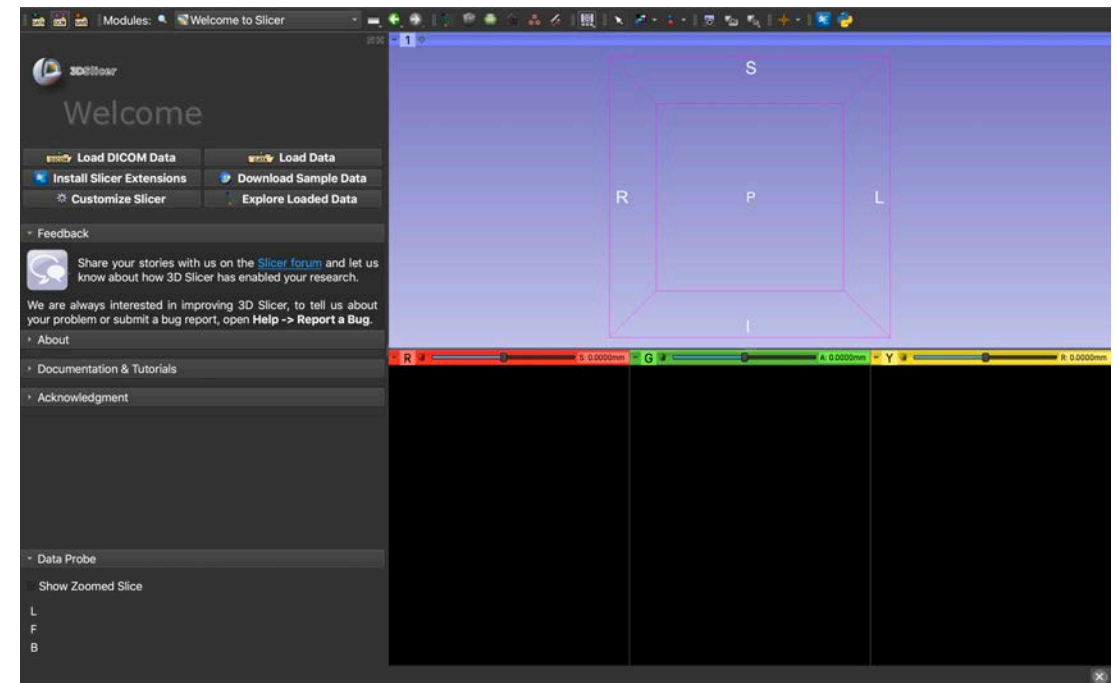
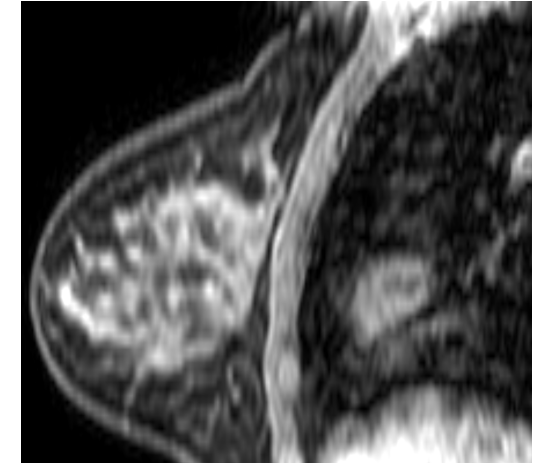
3D Slicer version 5.0

<https://download.slicer.org>

SlicerDICOMTutorialData

DICOM Torso CT

DICOM Breast MRI



# Disclaimer

- 3D Slicer is a free open source software application distributed under a BSD style license
- The software is not FDA approved or CE marked, and is for research use only



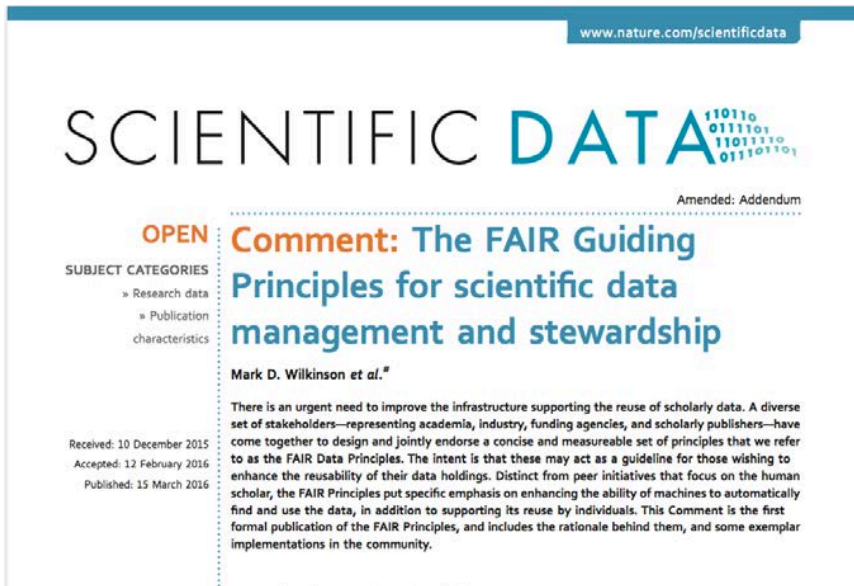
# Part 1: Introduction to DICOM

# Reproducible Science

- Reproducible science is critical to drive research and accelerate discoveries
- Open-source software tools such as 3D Slicer and data standards such as DICOM contribute to the reproducibility of scientific results in biomedical research



# F.A.I.R. Principles



- **Findable:** Data are easily findable
- **Accessible:** Users know how to access the data, including authentication and authorization
- **Interoperable:** Data can be integrated with other data and can interoperate with applications for storage and analysis
- **Reusable:** Data can be replicated or combined for new research

*The FAIR Guiding Principles for scientific data management and stewardship.*

Wilkinson et al. *Sci. Data* 2016

<http://go-fair.org/fair-principles>



# The DICOM standard

- DICOM (Digital Imaging and Communications in Medicine) is the international standard for handling, storing, printing and transmitting medical imaging data
- Clinical imaging equipment (CT scanners, MR scanners, X-Ray and ultrasound machines) generate DICOM files



# DICOM History

- 1982: The American College of Radiology (ACR) and the National Electrical Manufacturers Association (NEMA) initiate standards for the interconnection of medical imaging devices
- 1985: Publication of the ACR-NEMA Digital Imaging and Communications Standards version 1.0
- 1988: Publication of the ACR-NEMA Digital Imaging and Communications Standards version 2.0
- 1993: Publication of the ACR-NEMA Standards version 3.0 also referred to as the Digital Imaging and Communications in Medicine (DICOM) standard

# DICOM Today

- The DICOM standard is continuously being refined to address new community needs through multiple releases every year
- As of 2020/07/06, the DICOM standard is DICOM PS3 2020c and contains 4,000 pages
- DICOM Working Groups are established to expand the capabilities of the standard given the continuous evolution of imaging modalities (e.g. WG-16 Magnetic Resonance)  
<https://www.dicomstandard.org/wgs>

# FAIR Data and the DICOM Standard

www.nature.com/scientificdata

## SCIENTIFIC DATA

Amended: Addendum

**OPEN** **Comment: The FAIR Guiding Principles for scientific data management and stewardship**

**SUBJECT CATEGORIES**

- » Research data
- » Publication characteristics

Received: 10 December 2015  
Accepted: 12 February 2016  
Published: 15 March 2016

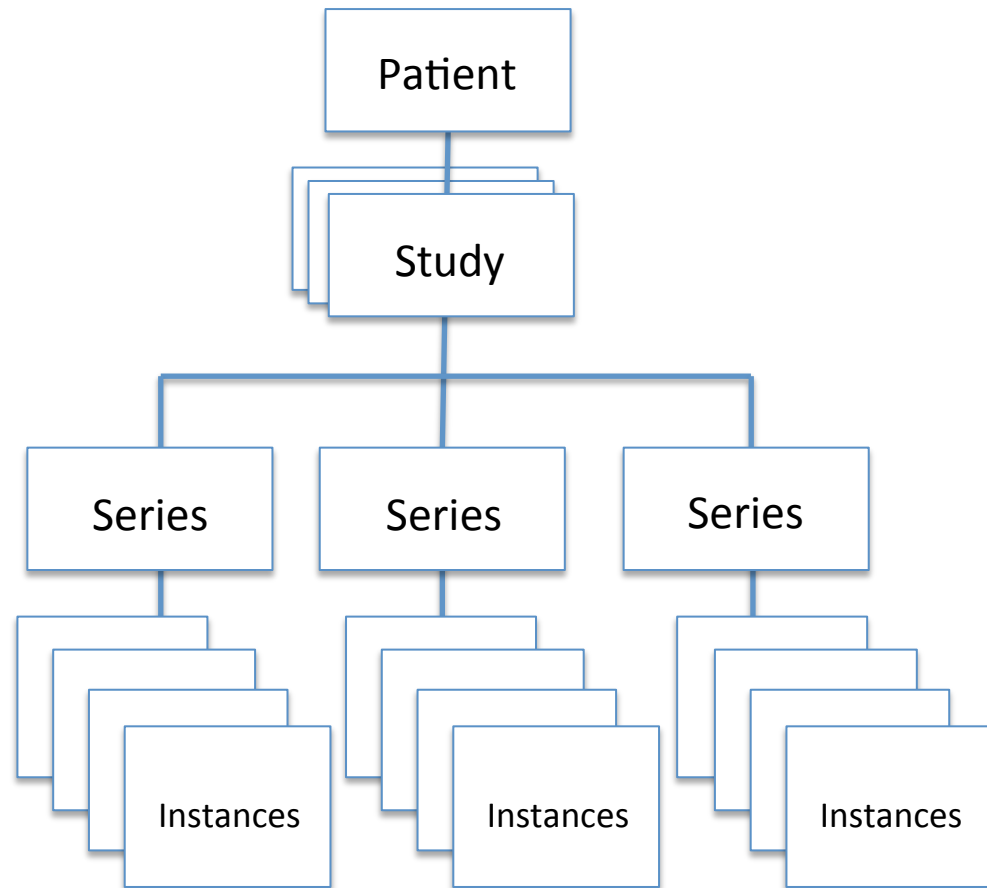
Mark D. Wilkinson *et al.*<sup>\*</sup>

There is an urgent need to improve the infrastructure supporting the reuse of scholarly data. A diverse set of stakeholders—representing academia, industry, funding agencies, and scholarly publishers—have come together to design and jointly endorse a concise and measurable set of principles that we refer to as the FAIR Data Principles. The intent is that these may act as a guideline for those wishing to enhance the reusability of their data holdings. Distinct from peer initiatives that focus on the human scholar, the FAIR Principles put specific emphasis on enhancing the ability of machines to automatically find and use the data, in addition to supporting its reuse by individuals. This Comment is the first formal publication of the FAIR Principles, and includes the rationale behind them, and some exemplar implementations in the community.



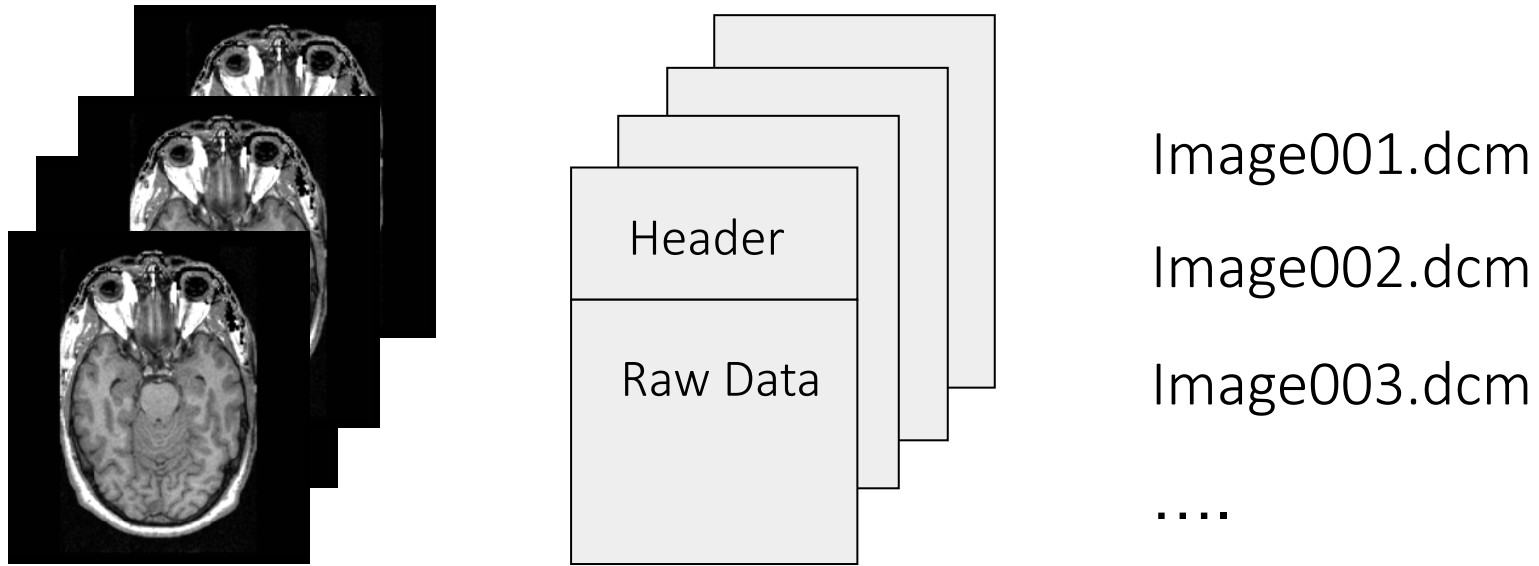
The DICOM Standard facilitates compliance of imaging data with FAIR principles

# DICOM Data Model



- In the DICOM data model, a **DICOM Study** consists of several **DICOM Series**, and each DICOM Series contains **DICOM Instances**
- Each of the DICOM Studies, Series and Instances are assigned a Unique Identifier (UID)

# Example of DICOM instances: DICOM MRI Image data

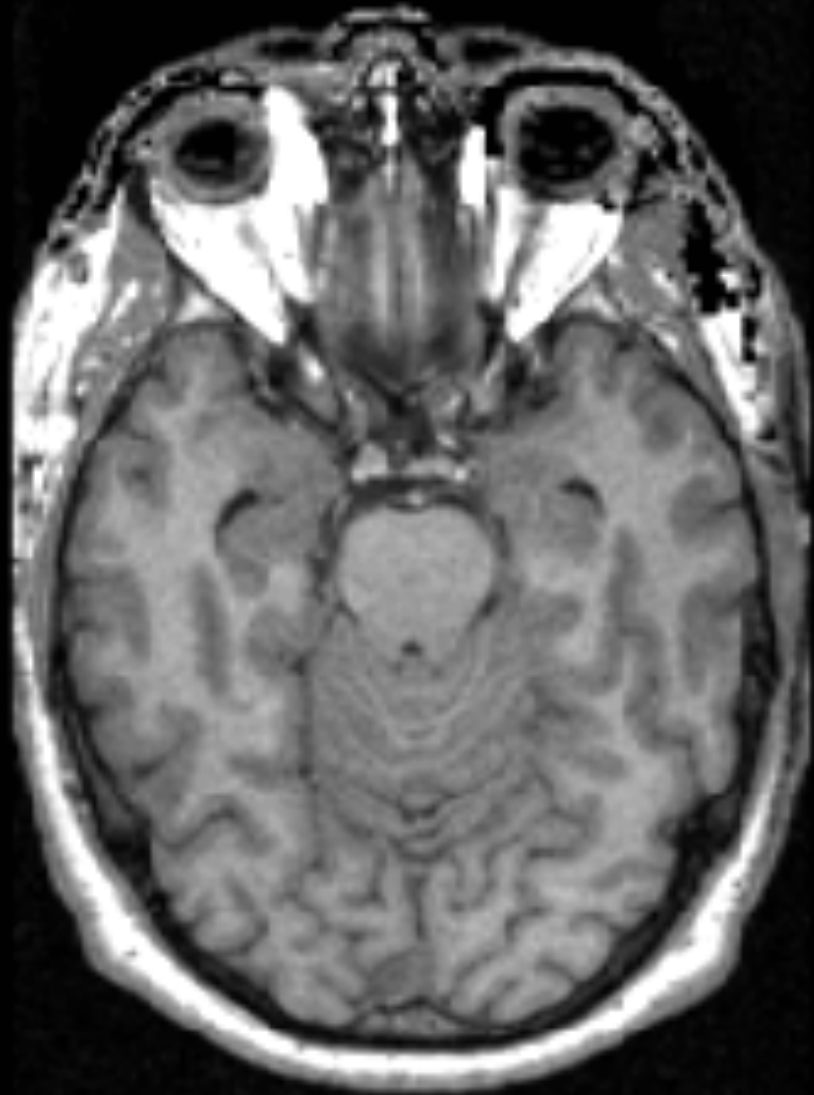


An MRI image is an example of DICOM instance that consists of a DICOM header and an image dataset

```
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0008,0070,Manufacturer=GE MEDICAL SYSTEMS
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0008,0081,City Name=1852796513
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0008,0201,?=-0500
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0008,1040,Institutional Dept. Name=1852796513
0008,1050,Performing Physician's Name=1852796513
0008,1060,Name Phys(s) Read Study=1852796513
0008,1070,Operator's Name=anon
0008,1080,Admitting Diagnosis Description=1852796513
0008,1090,Manufacturer's Model Name=GENESIS.SIGNA .....
0010,0010,Patient's Name=anon
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0010,0032,Patient Birth Time=000000
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0010,1010,Patient Age=000Y
.....
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0028,0102,High Bit=15
0028,0103,Pixel Representation=1
.....
7FE0,0010,Pixel Data=131072
```

Example of DICOM header content

- The **DICOM header** contains metadata which include information on the patient, study and imaging data.
- DICOM provides a standardized way to present metadata which makes it searchable
- The metadata information is accessible through **DICOM tags**
- DICOM tags uniquely identify DICOM attributes
- Original data from the scanner tell users important elements about the acquisition



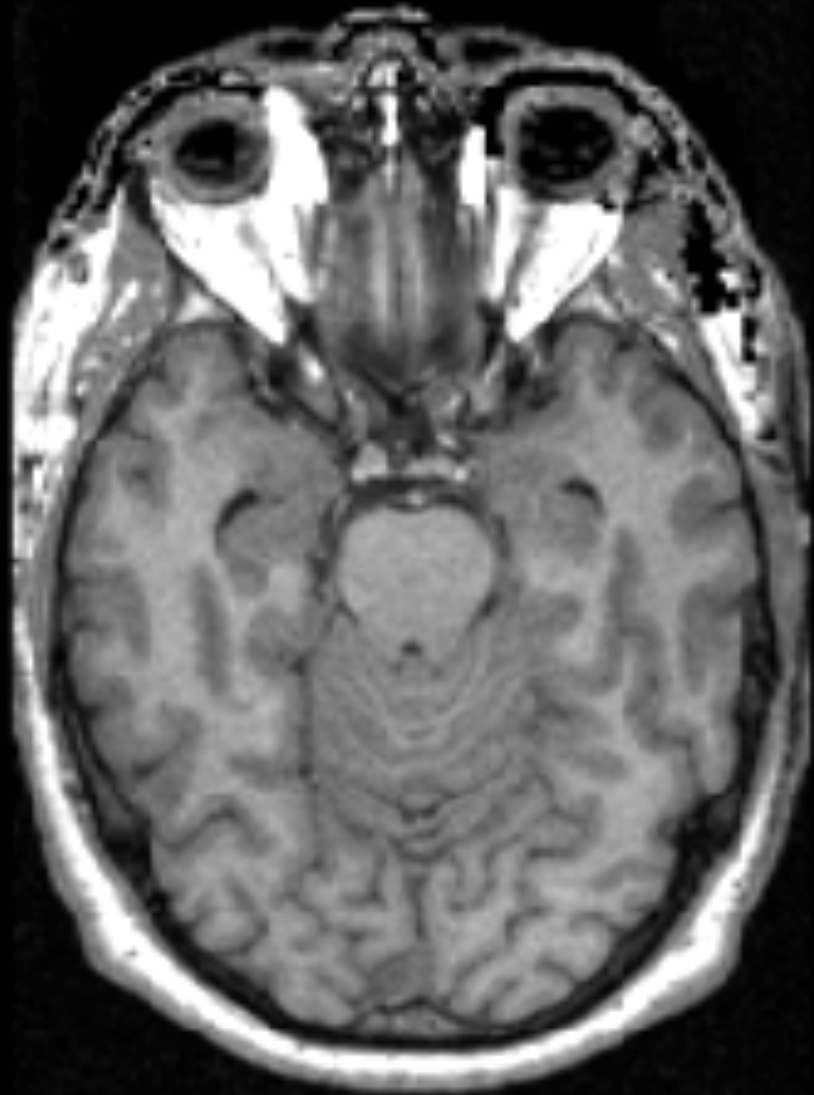
## Physician and Study Information

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0002  
0002  
0002  
0002  
0002

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0008,1080,Admitting Diagnosis Description=1852796513  
0008,1090,Manufacturer's Model Name=GENESIS.SIGNA .....

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0010,0020,Patient ID=anon  
0010,0030,Patient Date of Birth=00000000  
0010,0032,Patient Birth Time=000000  
0010,0040,Patient Sex=O  
0010,1010,Patient Age=000Y  
.....  
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.....  
7FE0,0010,Pixel Data=131072





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```
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```

## Patient Information

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```

```
.....
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0028,0100,Bits Allocated=16
0028,0101,Bits Stored=16
0028,0102,High Bit=15
0028,0103,Pixel Representation=1
.....
7FE0,0010,Pixel Data=131072
```

# HIPPA Patient privacy

The Health Insurance Portability and Accountability Act of 1996 (HIPAA) protects the privacy and security of certain health information

<http://www.hhs.gov/hipaa/index.html>

```
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```

...

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0008,0092,?=1852796513
0008,0201,?=-0500
```

```
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```

```
0008,1085,Study Description=anon
```

```
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```

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0008,
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```
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```

```
0008,1090,Manufacturer's Model Name=GENESIS.SIGNA.....
```

```
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```
0010,0020,Patient ID=anon
```

```
0010,0030,Patient Date of Birth=00000000
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```
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```
0010,0040,Patient Sex=O
```

```
0010,1010,Patient Age=000Y
```

```
.....
```

```
0028,0010,Rows=256
```

```
0028,0011,Columns=256
```

```
0028,0030,Pixel Spacing=0.937500 0.937500
```

```
0028,0100,Bits Allocated=16
```

```
0028,0101,Bits Stored=16
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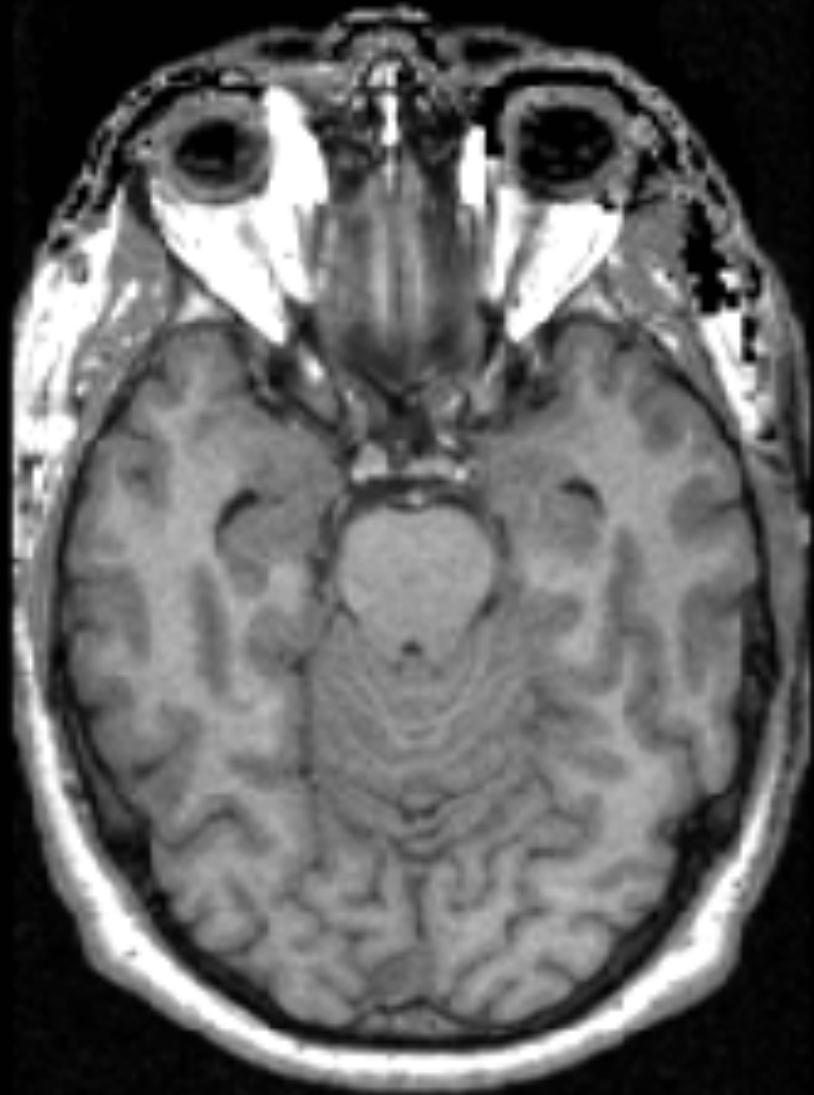
```
0028,0102,High Bit=15
```

```
0028,0103,Pixel Representation=1
```

```
.....
```

```
7FE0,0010,Pixel Data=131072
```

Patient Information

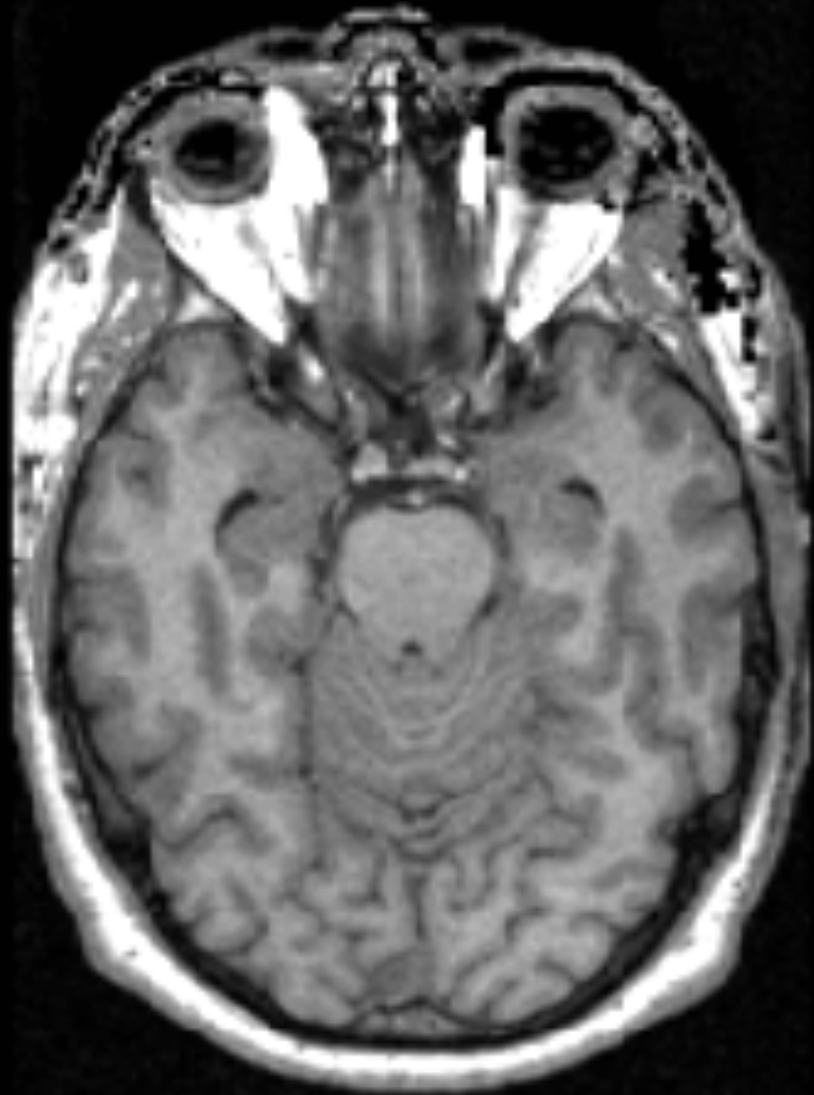


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## Image Information

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```
7FE0,0010,Pixel Data=131072
```



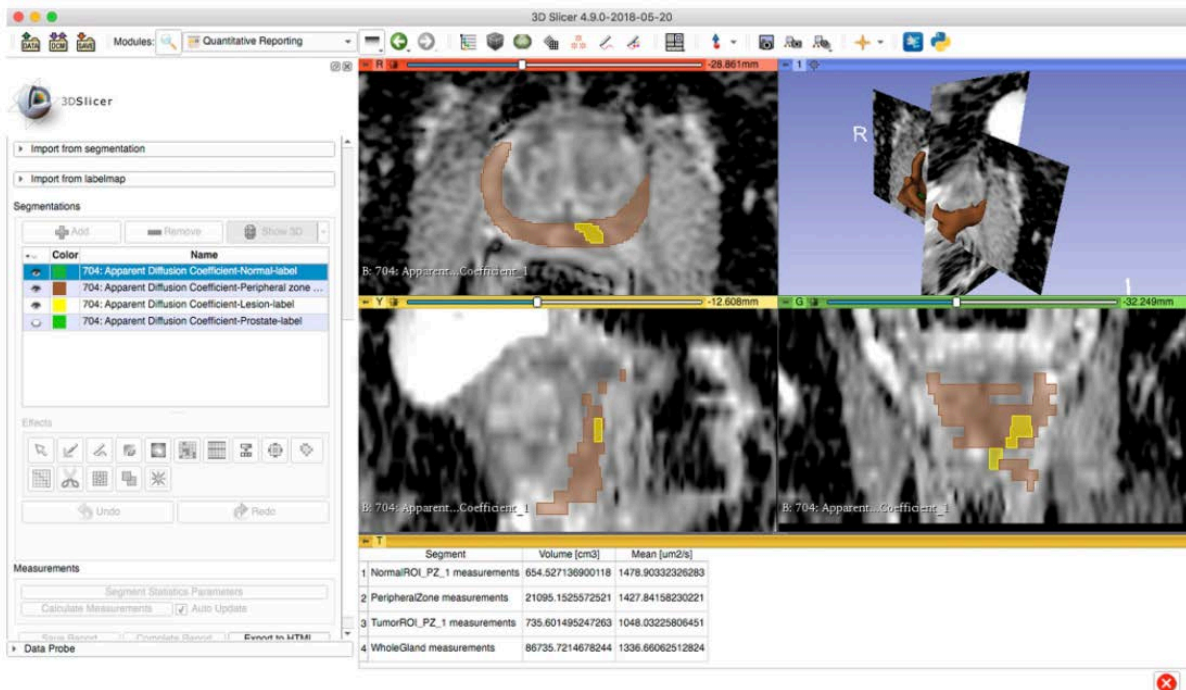
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0028,0013,Pixel Representation=1
.....
```

Pixel Data

7FE0,0010,Pixel Data=131072

## Examples of Standard DICOM Instances

- **DICOM images** produced by imaging equipment: single X-Ray slice , DICOM CT or DICOM MR volume, DICOM multi-frame object (e.g. fMRI experiment, diffusion MRI, DCE)
- **DICOM Segmentation Object (SEG):** voxels labelled in regions of interest (ROIs)
- **DICOM Structured Report (SR):** clinical information (e.g. diagnosis, pathology, surgery, etc.), measurements computed from segmented ROIs



# Examples of Standard DICOM Instances

DICOM Images

Prostate MRI Images

DICOM Segmented Structures

Prostate gland, peripheral zone, lesion, normal tissue

Measurements

Volumes of prostate gland, peripheral zone, lesion, normal tissue

Segmented structure	SegmentedPropertyCategoryCodeSequence	SegmentedPropertyTypeCodeSequence	AnatomicRegionSequence
Prostate gland	("T-D000A", "SRT", "Anatomical Structure")	("T-9200B", "SRT", "Prostate")	NA
Peripheral zone of the prostate gland	("T-D000A", "SRT", "Anatomical Structure")	("T-D05E4", "SRT", "Peripheral zone of the prostate")	NA
Lesion in the peripheral zone of the prostate gland	("M-01000", "SRT", "Morphologically Altered Structure")	("M-01100", "SRT", "Lesion")	("T-D05E4", "SRT", "Peripheral zone of the prostate")
Normal tissue in the peripheral zone of the prostate gland	("T-D0050", "SRT", "Tissue")	("G-A460", "SRT", "Normal")	("T-D05E4", "SRT", "Peripheral zone of the prostate")

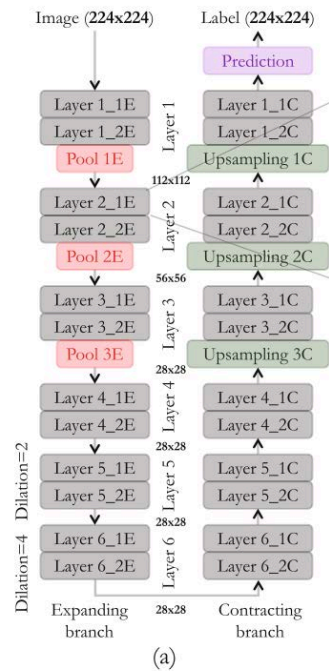
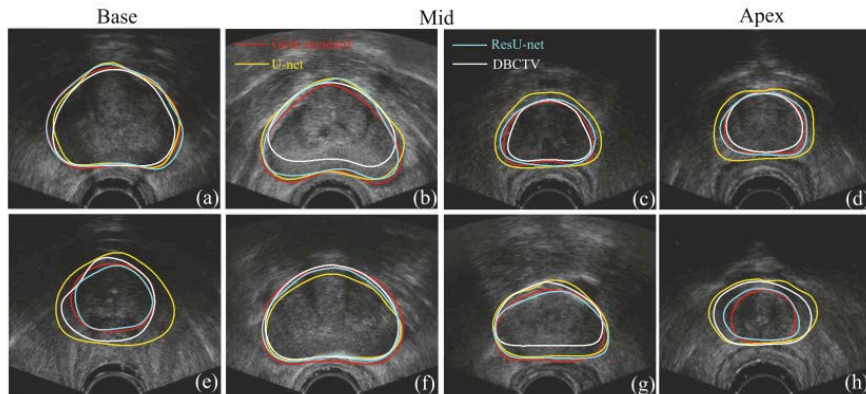
Measured structure	Finding	Finding Site
Prostate gland *	(T-F6078, SRT, "Entire Gland")	("T-9200B", "SRT", "Prostate")
Peripheral zone of the prostate gland	(R-404A4, SRT, "Entire")	("T-D05E4", "SRT", "Peripheral zone of the prostate")
Lesion in the peripheral zone of the prostate gland	(R-42037, SRT, "Abnormal")	("T-D05E4", "SRT", "Peripheral zone of the prostate")
Normal tissue of peripheral zone of the prostate gland	("G-A460", "SRT", "Normal")	("T-D05E4", "SRT", "Peripheral zone of the prostate")

## DICOM Terminology

- DICOM provides support for segmentation objects and annotations
- DICOM Structured Reports enable provenance tracking
- DICOM derived data can be stored on a DICOM server or on other archive (e.g. TCIA) with permission, and is compliant with FAIR principles

# DICOM for Artificial Intelligence Studies

- DICOM defines **syntax rules** and **vocabularies** that enable easy extraction of knowledge from the data
- The DICOM framework for medical imaging data management enables the **automation of cohort formation** and maximizes the **interoperability of the data for AI studies**



Anas et al. MICCAI 2017

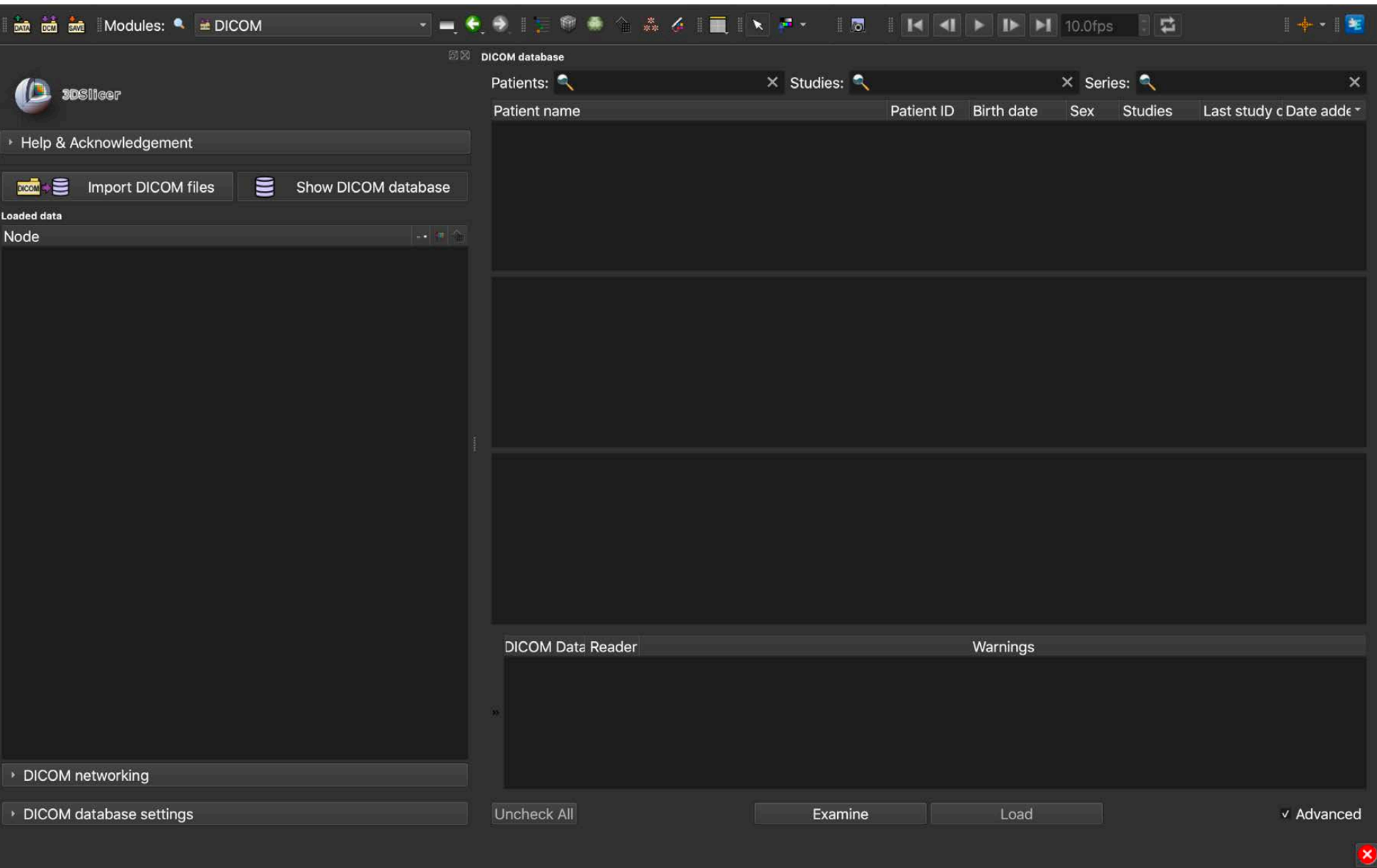




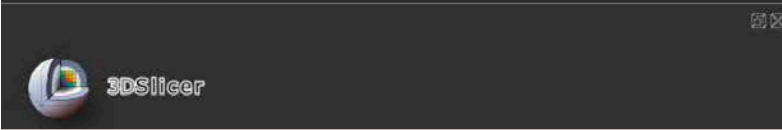
## Part 2: DICOM and Slicer

## Slicer DICOM module

- The **Slicer DICOM module** provides the infrastructure for storing, loading and exporting DICOM data
- Slicer supports CT, MRI, PET, X-Ray and ultrasound DICOM data
- Dedicated **Slicer Extensions** can be added to Slicer for importing additional DICOM instances (e.g. DICOM RT Dose, DICOM Segmentation Object, Diffusion Weighted MRI, etc.)



# Slicer DICOM module



Help & Acknowledgement  
Import DICOM files Show DICOM database

Loaded data  
Node  
DICOM data loaded into Slicer

DICOM networking  
DICOM database settings

DICOM database

Patients: Studies: Series:

Patient name	Patient ID	Birth date	Sex	Studies	Last study c Date added
DICOM database					

DICOM Data Reader Warnings

Uncheck All Examine Load

Advanced 28



Help & Acknowledgement

Import DICOM files Show DICOM database

Loaded data

Node

DICOM networking

DICOM database settings

Patient name Patient ID Birth date Sex Studies Last study c Date added

Table with 6 columns: Patient name, Patient ID, Birth date, Sex, Studies, Last study c Date added. The table is currently empty.

DICOM Data Reader Warnings

Empty area for DICOM Data Reader and Warnings.

Uncheck All

Examine

Load

Advanced 29

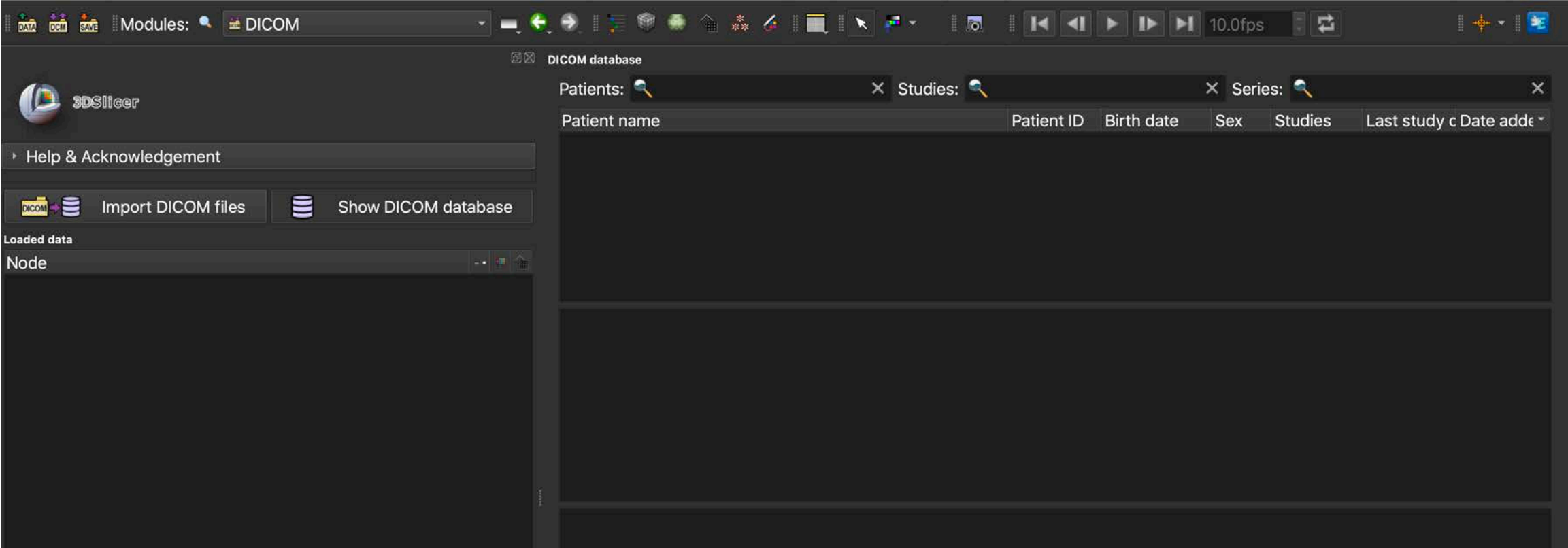
DICOM data can be imported into the Slicer DICOM database using the **Import DICOM files** button or via Drag&Drop



3DSlicer  
Help & Acknowledgement  
Import DICOM files Show DICOM database  
Loaded data  
Node  
DICOM networking  
DICOM database settings

The DICOM database follows the DICOM model hierarchy organized in patients, studies and series

DICOM database  
Patients: Studies: Series:  
Patient name Patient ID Birth date Sex Studies Last study c Date added  
Patients  
Studies  
Series  
DICOM Data Reader Warnings  
Uncheck All Examine Load Advanced



The DICOM database settings panel lets the user choose the location of the database and enables database maintenance



▶ DICOM networking

▼ DICOM database settings

Database location:

Auto-hide browser window:

Maintenance:

- 
- 

DICOM Data Reader

Warnings

Uncheck All

Examine

Load

Advanced



3DSlicer

Help & Acknowledgement

Import DICOM files Show DICOM database

Loaded data Node

The DICOM networking pannel gives access to the DICOM Listener and DICOM Query/Retrieve functionalities of Slicer (Advanced users)



DICOM networking

Pull data from remote server:  Query and retrieve

Storage listener:  not started

Start storage listener on startup:

DICOM database settings

Patient name	Patient ID	Birth date	Sex	Studies	Last study c Date added

DICOM Data Reader Warnings

Uncheck All Examine Load Advanced

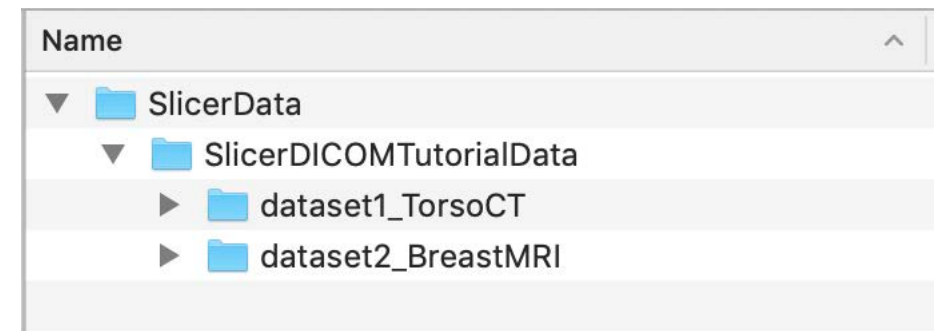


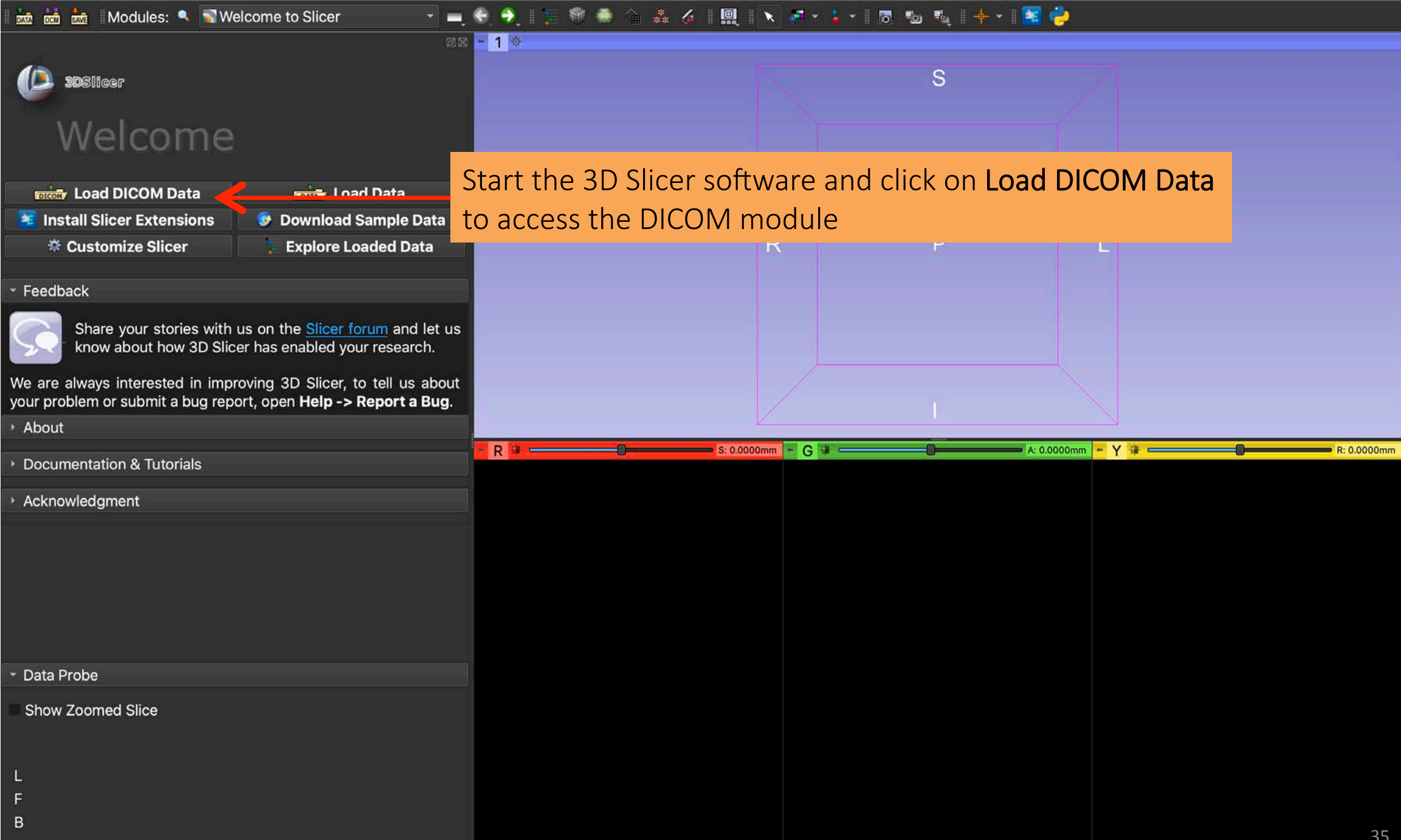




# Tutorial Dataset

- Download the **SlicerDICOMTutorialData.zip** file to your computer
- Create a **SlicerData** folder on your computer and move the SlicerDICOMTutorialData.zip file to the SlicerData folder
- Unzip the SlicerDICOMTutorialData.zip





Start the 3D Slicer software and click on **Load DICOM Data** to access the DICOM module

L  
F  
B

3DSlicer

DICOM database

Patients: Studies: Series:

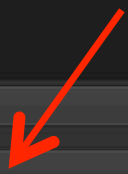
Patient name	Patient ID	Birth date	Sex	Studies	Last study c Date added

Import DICOM files Show DICOM database

Loaded data

Node

Click on DICOM database settings



- ▶ DICOM networking
- ▶ DICOM database settings

Warnings

Uncheck All Examine Load

Advanced 36

3DSlicer

Help & Acknowledgement

Import DICOM files Show DICOM database

Loaded data

Node

Slicer displays the path to the default DICOM database location

DICOM networking

DICOM database settings

Database location: /Users/smp36/Documents/SlicerDICOMDatabase\_1

Auto-hide browser window:

Maintenance: Remove unavailable data sets Remove all data sets

DICOM database

Patients: Studies: Series:

Patient name	Patient ID	Birth date	Sex	Studies	Last study c Date added

DICOM Data Reader Warnings

3DSlicer

Help & Acknowledgement

Import DICOM files Show DICOM database

Loaded data

Node

DICOM networking

DICOM database settings

Database location: /Users/smp36/data/SlicerData

Auto-hide browser window:

Maintenance: Remove unavailable data sets

Remove all data sets

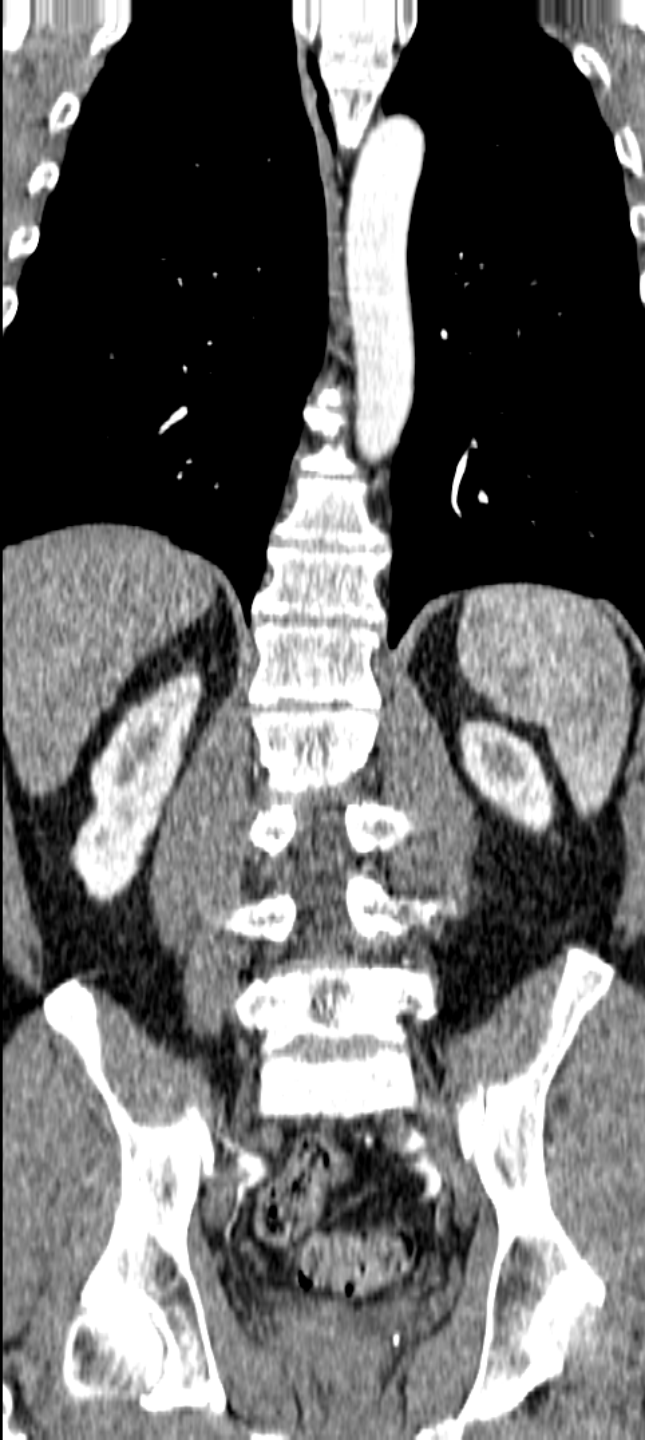
DICOM database

Patients: Studies: Series:

Patient name	Patient ID	Birth date	Sex	Studies	Last study c Date added

DICOM Data Reader Warnings

Click on the default path and change it to the path of the SlicerData directory that you created

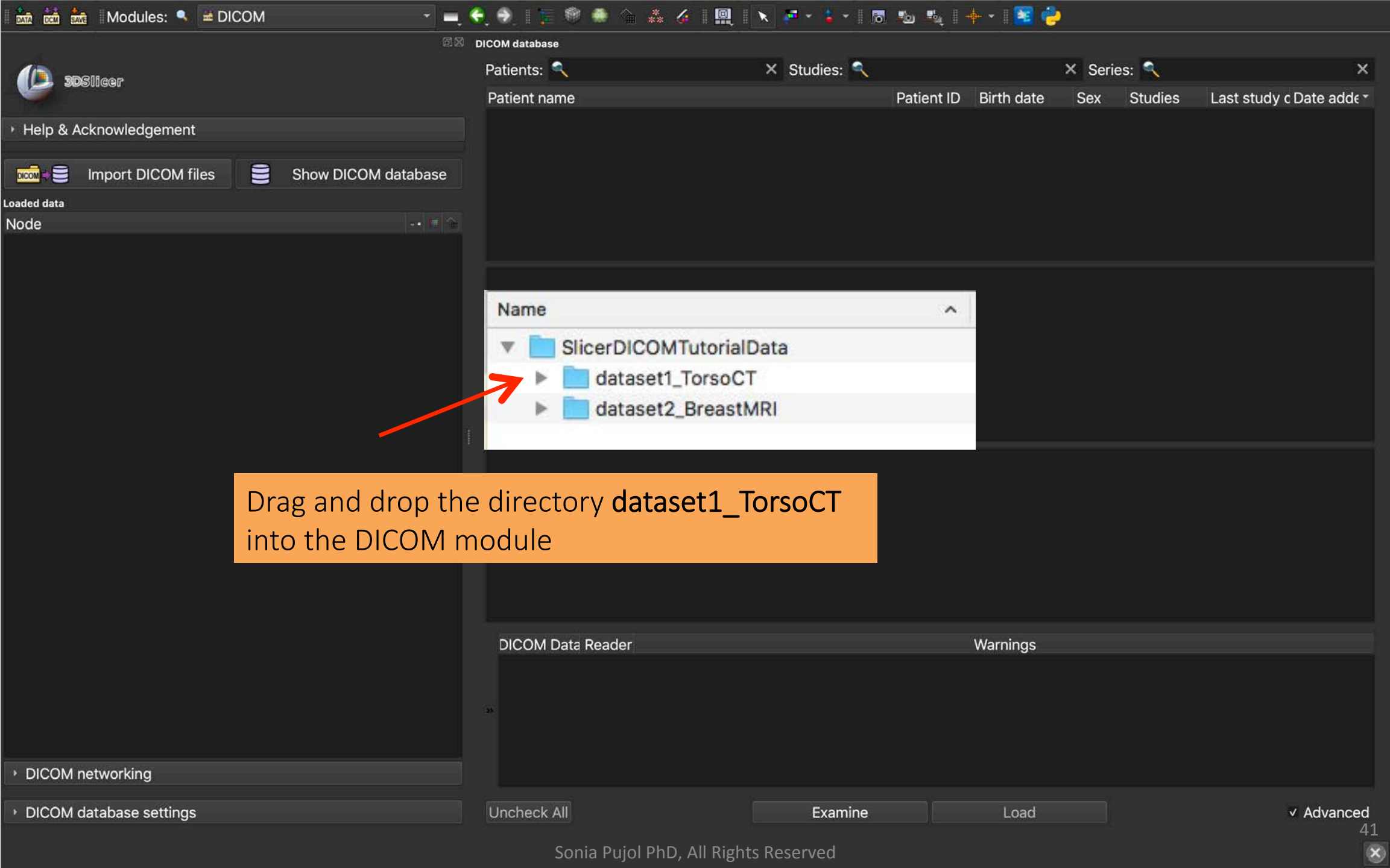


# Dataset #1

## Torso CT

# Loading a DICOM dataset in Slicer





Drag and drop the directory dataset1\_TorsoCT into the DICOM module



Click on patient1 in the list of patients



Patients: Studies: Series:

Patient name	Patient ID	Birth date	Sex	Studies	Last study	Date add
patient1	patient1_ID			1	Wed Jun 1 2005	2020...842

Slicer displays the corresponding study and series



Study date	Study ID	Study description	Series	Date added
20050601	6936864	CT Thorax Abdomen	1	202...843



Series #	Series description	Modality	Size	Count	Date added
6	CT_Thorax_Abdomen	CT	512x512	291	202...843

DICOM Data Reader Warnings

✓ 6: ... Scalar Volume

Uncheck All

Examine

Load

Advanced



3DSlicer

Help & Acknowledgement

Import DICOM files Show DICOM database

Loaded data

Node

DICOM networking

DICOM database settings

DICOM database

Patients: Studies: Series:

Patient name	Patient ID	Birth date	Sex	Studies	Last study	Date add
patient1	patient1_ID			1	Wed Jun 1 2005	2020...842

Study date	Study ID	Study description	Series	Date added
20050601	6936864	CT Thorax Abdomen	1	202...843

Series #	Series description	Modality	Size	Count	Date added
6	CT_Thorax_Abdomen	CT	512x512	291	202...843

DICOM Data Reader Warnings

✓ 6: ... Scalar Volume

Click on Examine

Uncheck All Examine Load Advanced 43

3DSlicer

Help & Acknowledgement

Import DICOM files Show DICOM database

Loaded data

Node

DICOM networking

DICOM database settings

DICOM database

Patients: Studies: Series:

Patient name	Patient ID	Birth date	Sex	Studies	Last study	Date add
patient1	patient1_ID			1	Wed Jun 1 2005	2020...842

Study date	Study ID	Study description	Series	Date added
20050601	6936864	CT Thorax Abdomen	1	202...843

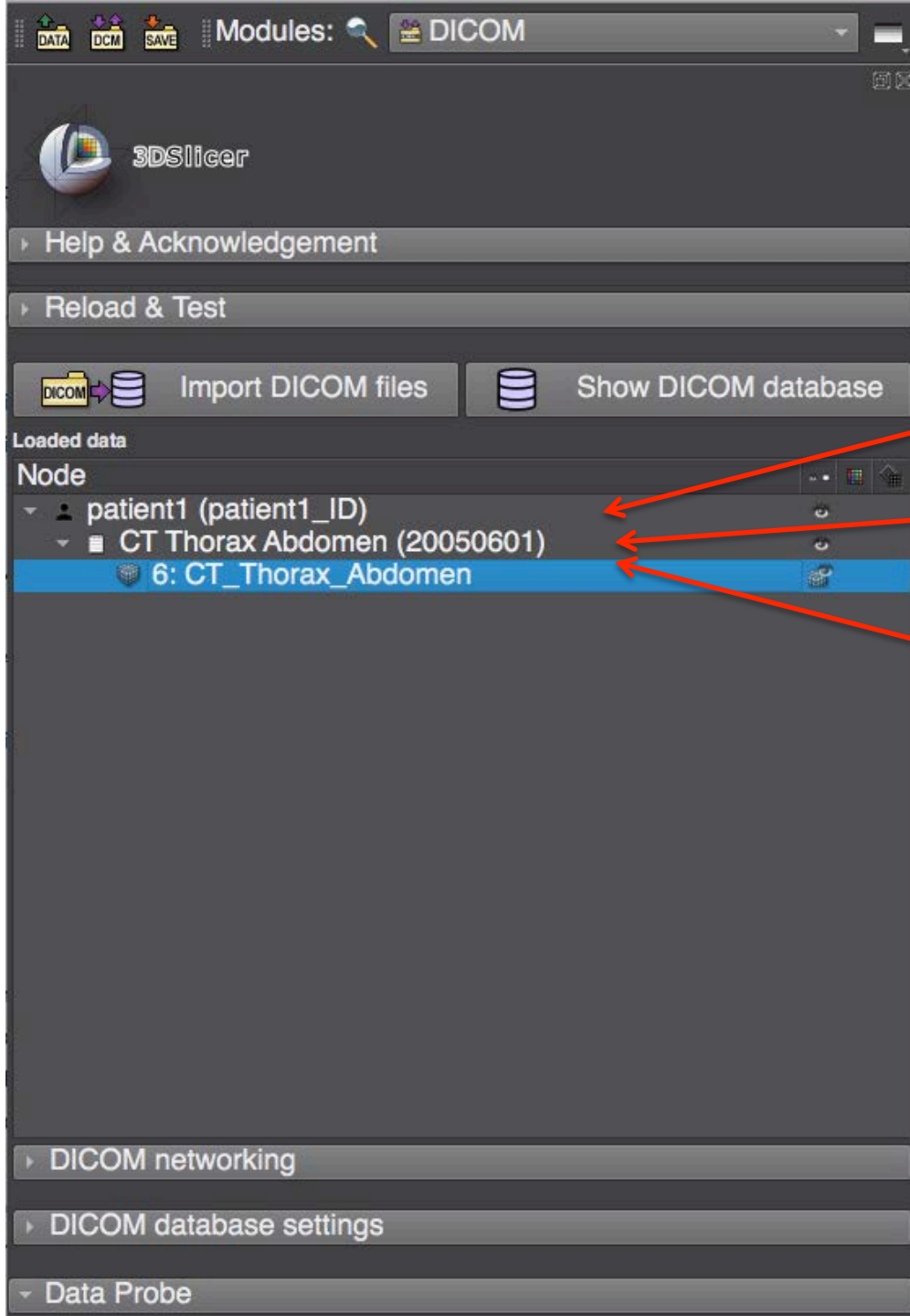
Series #	Series description	Modality	Size	Count	Date added
6	CT_Thorax_Abdomen	CT	512x512	291	202...843

DICOM Data Reader Warnings

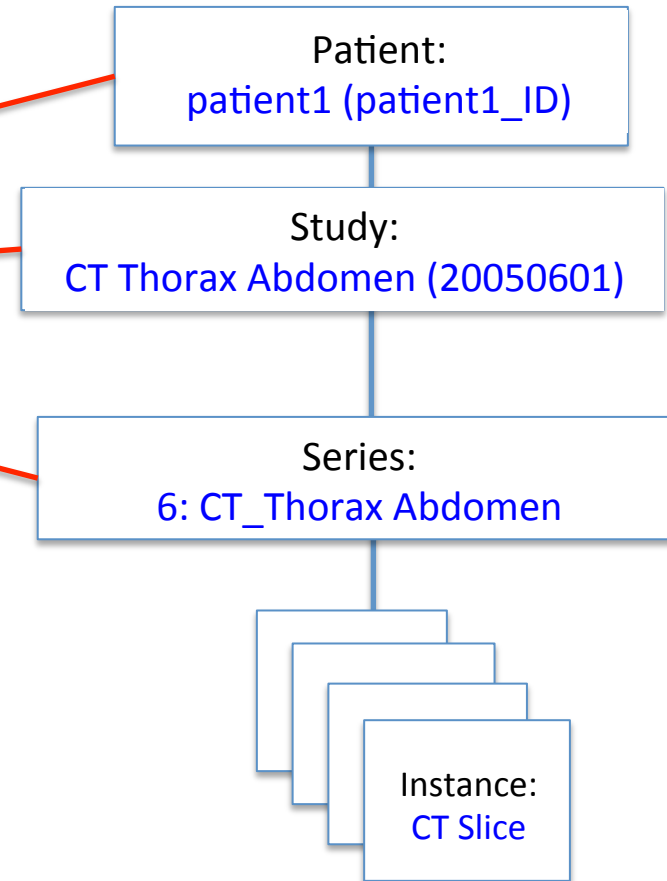
✓ 6: ... Scalar Volume

Click on Load

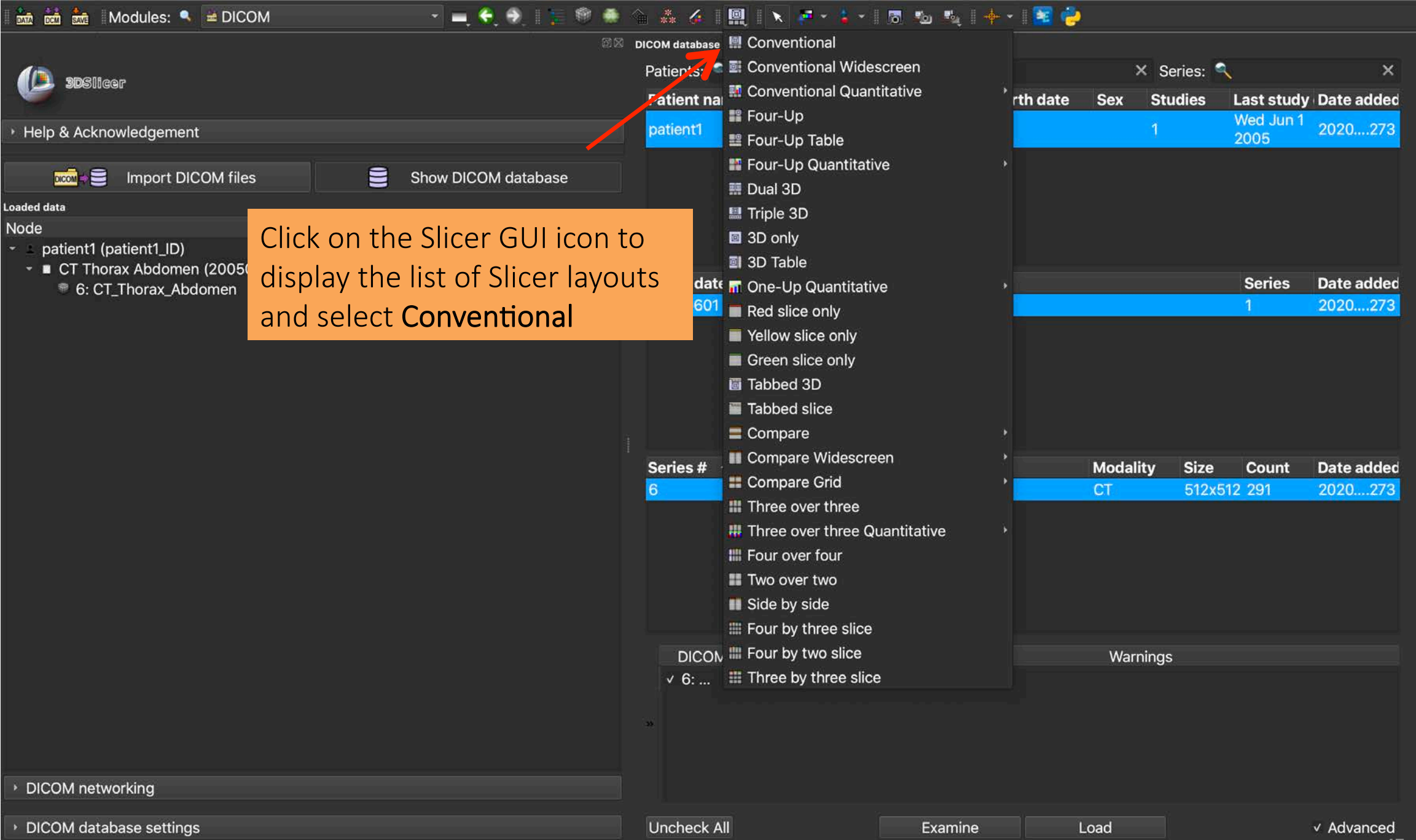
Uncheck All Examine Load Advanced 44



The DICOM dataset is loaded into Slicer as a patient-study-series DICOM hierarchy



# Visualizing a DICOM dataset in Slicer



Click on the Slicer GUI icon to display the list of Slicer layouts and select Conventional

Series #  
6

Birth date	Sex	Studies	Last study	Date added
		1	Wed Jun 1 2005	2020....273

	Series	Date added
	1	2020....273

Modality	Size	Count	Date added
CT	512x512	291	2020....273

3DSlicer

Help & Acknowledgement

Import DICOM files Show DICOM database

Loaded data

Node

- patient1 (patient1\_ID)
  - CT Thorax Abdomen (20050601)
    - 6: CT\_Thorax\_Abdomen

DICOM networking

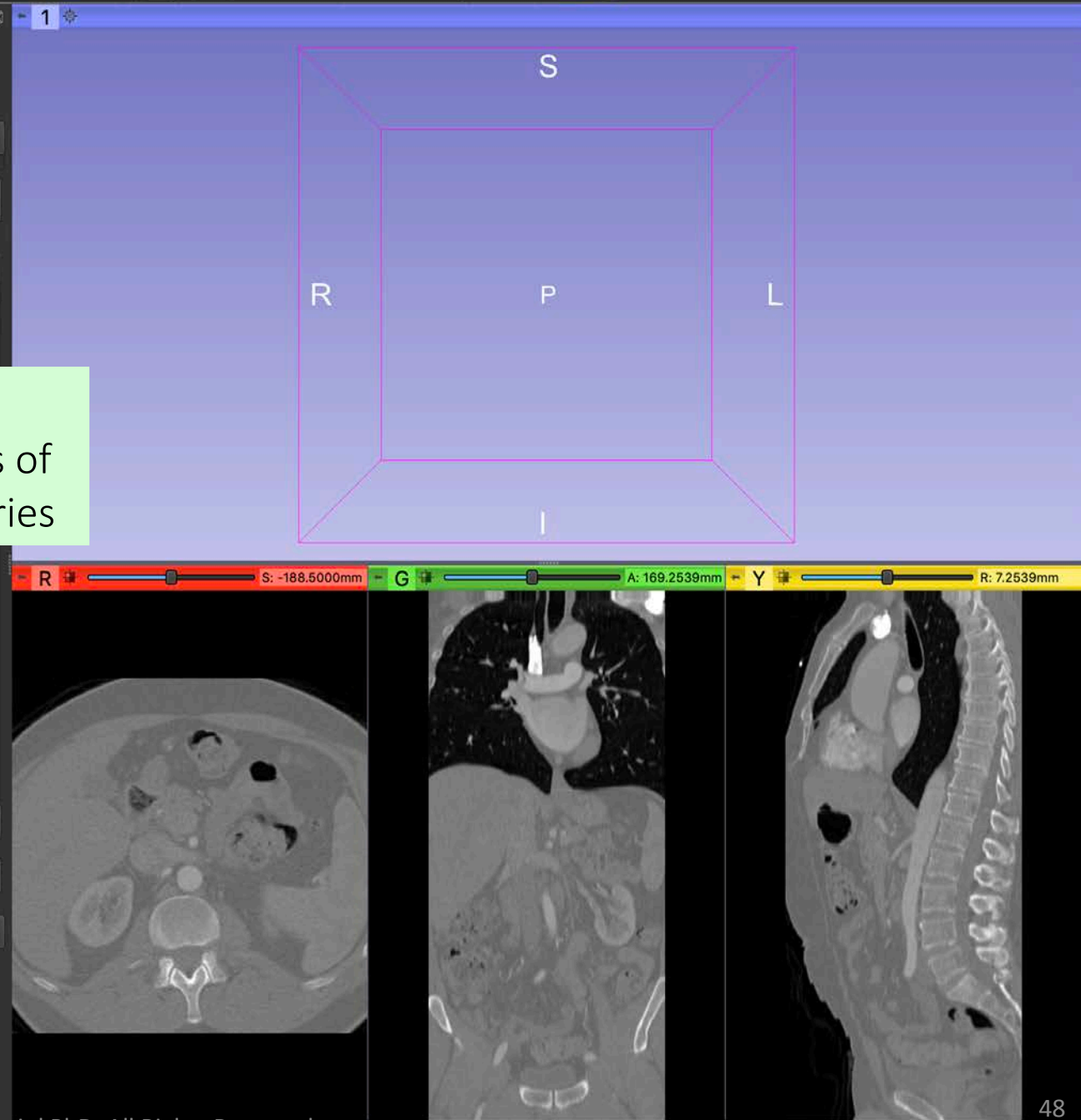
DICOM database settings

Data Probe

Show Zoomed Slice

L  
F  
B

Slicer displays the axial, coronal and sagittal images of 6:CT\_Thorax\_Abdomen series





3DSlicer

Help & Acknowledgement

Import DICOM files Show DICOM database

Loaded data

Node

- patient1 (patient1\_ID)
  - CT Thorax Abdomen (20050601)
    - 6: CT\_Thorax\_Abdomen**

Rename  
Delete  
**Edit properties...**  
Create child folder  
Clone  
Register this...  
Convert to RT dose volume...  
Export to DICOM...  
Segment this...

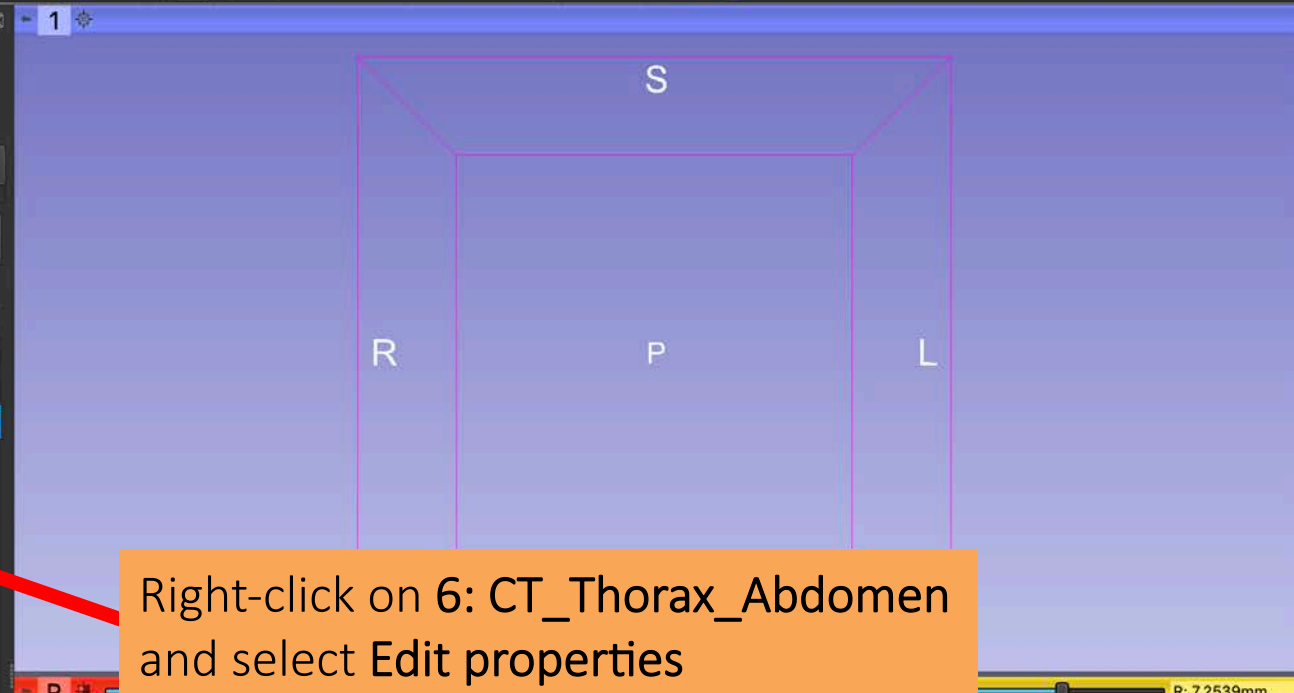
DICOM networking

DICOM database settings

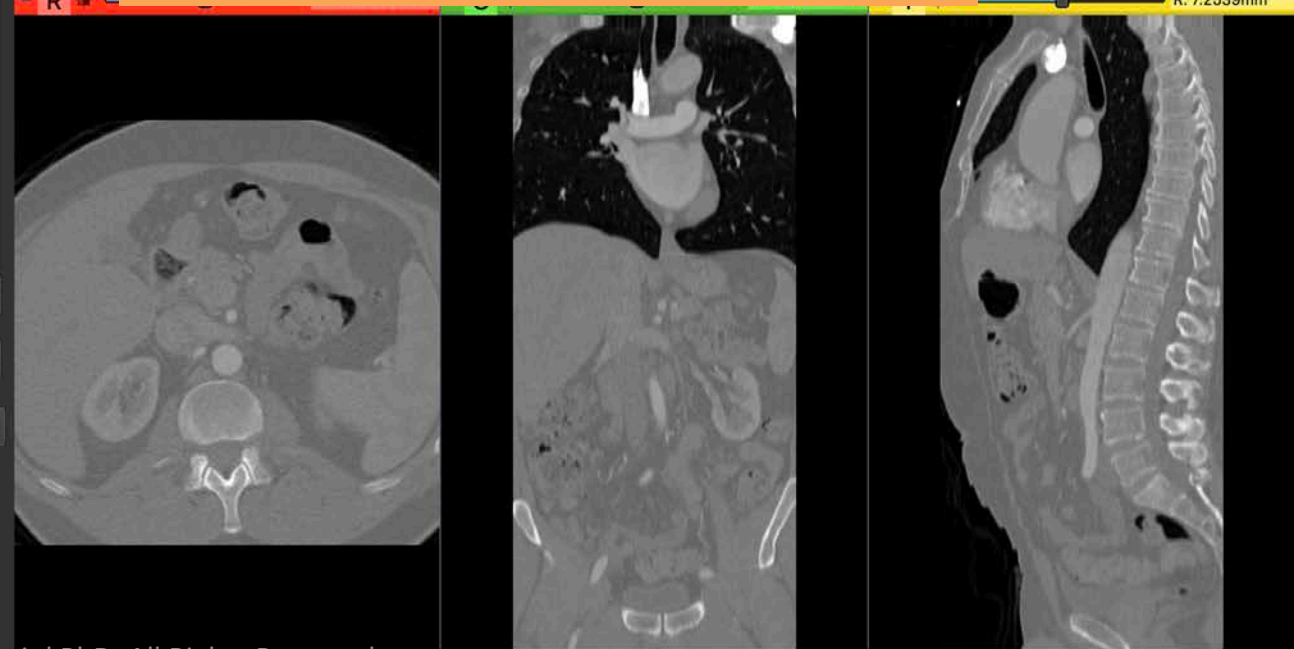
Data Probe

Show Zoomed Slice

L  
F  
B



Right-click on 6: CT\_Thorax\_Abdomen and select Edit properties



3DSlicer

Help & Acknowledgement

Active Volume 6: CT\_Thorax\_Abdomen

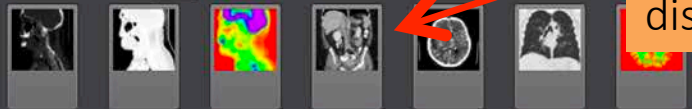
Volume Information

Display

Lookup Table: Grey

Interpolate:

Window/Level:



W: 350 Manual W/L L: 40

Threshold: Off

-1434 3481

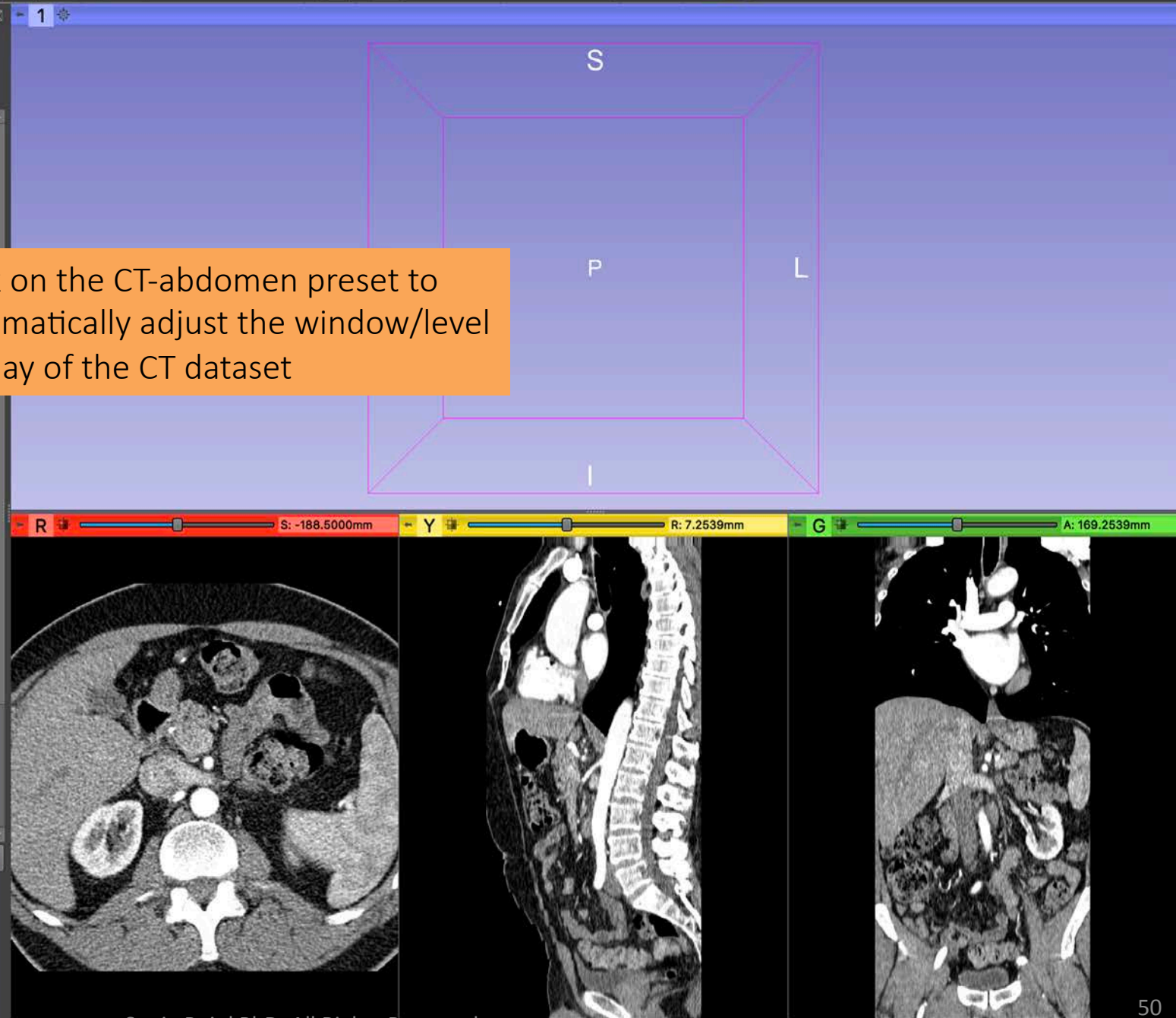
Histogram

Data Probe

Show Zoomed Slice

L  
F  
B

Click on the CT-abdomen preset to automatically adjust the window/level display of the CT dataset



3DSlicer

Help & Acknowledgement

Active Volume 6: CT\_Thorax\_Abdomen

Volume Information

Display

Lookup Table: Grey

Interpolate:

Window/Level:  L: 40

W: 350 L: 40

Threshold: Off

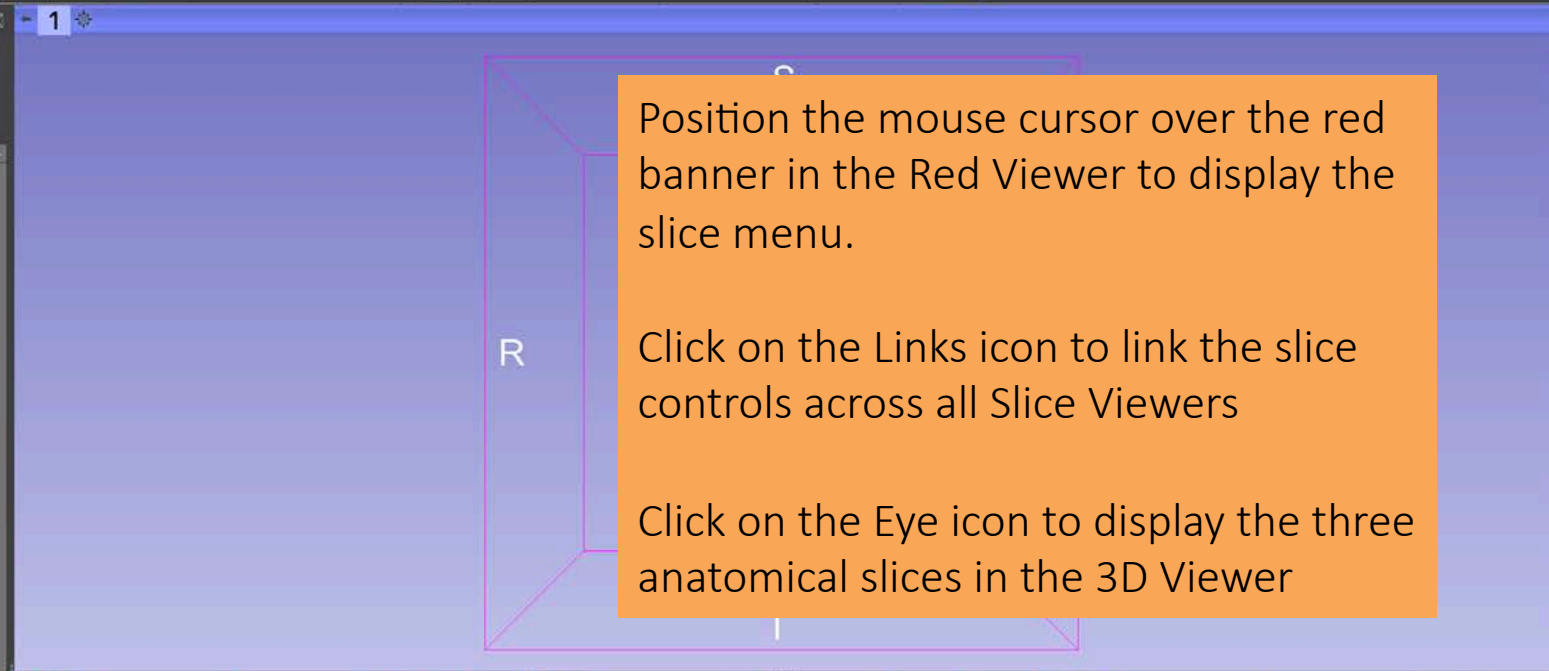
-1434 3481

Histogram

Data Probe

Show Zoomed Slice

L  
F  
B



R S: -188.5000mm Y R: 7.2539mm G A: 169.2539mm

Axial 6: CT\_Tho...x\_Abdomen

3DSlicer

Help & Acknowledgement

Active Volume 6: CT\_Thorax\_Abdomen

Volume Information

Display

Lookup Table: Grey

Interpolate:

Window/Level:  W: 350 L: 40

Threshold: Off

-1434 3481

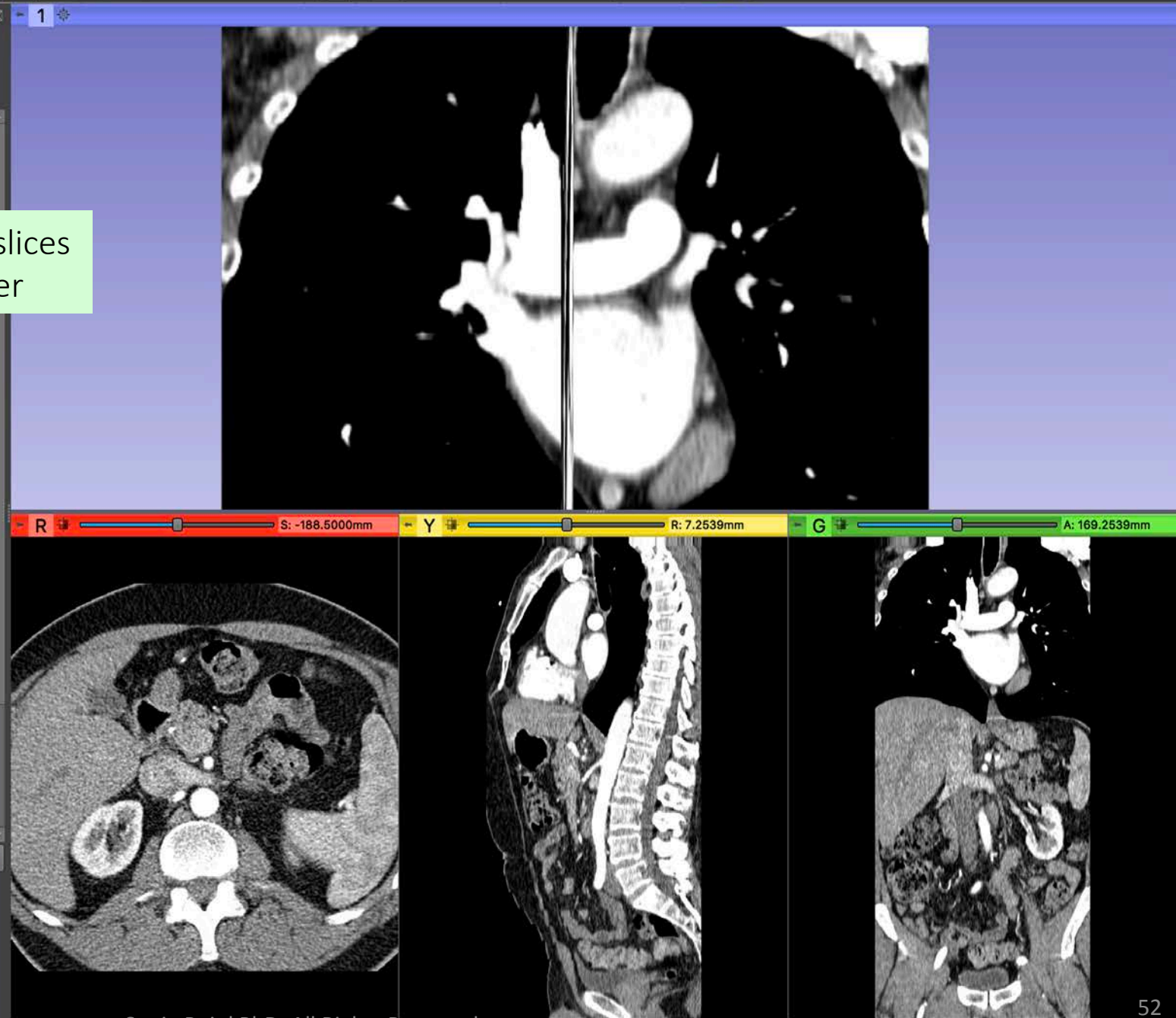
Histogram

Data Probe

Show Zoomed Slice

L  
F  
B

The three anatomical slices appear in the 3D viewer





Click on the Slicer layout menu icon, and select Conventional Widescreen layout

Help & Acknowledgements

Active Volume 6: CT\_Thorax\_Abdomen

Volume Information

Display

Lookup Table: Grey

Interpolate:

Window/Level: Manual W/L

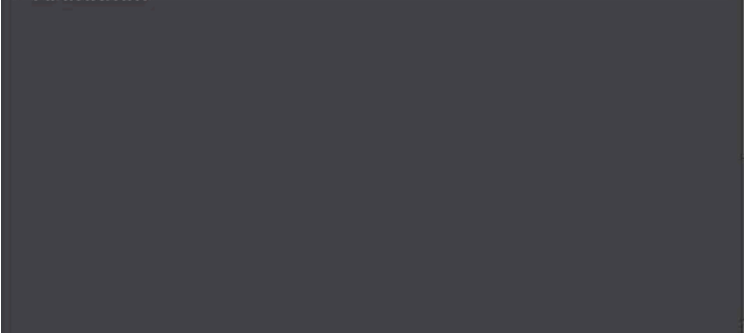


W: 350 L: 40

Threshold: Off

-1434 3481

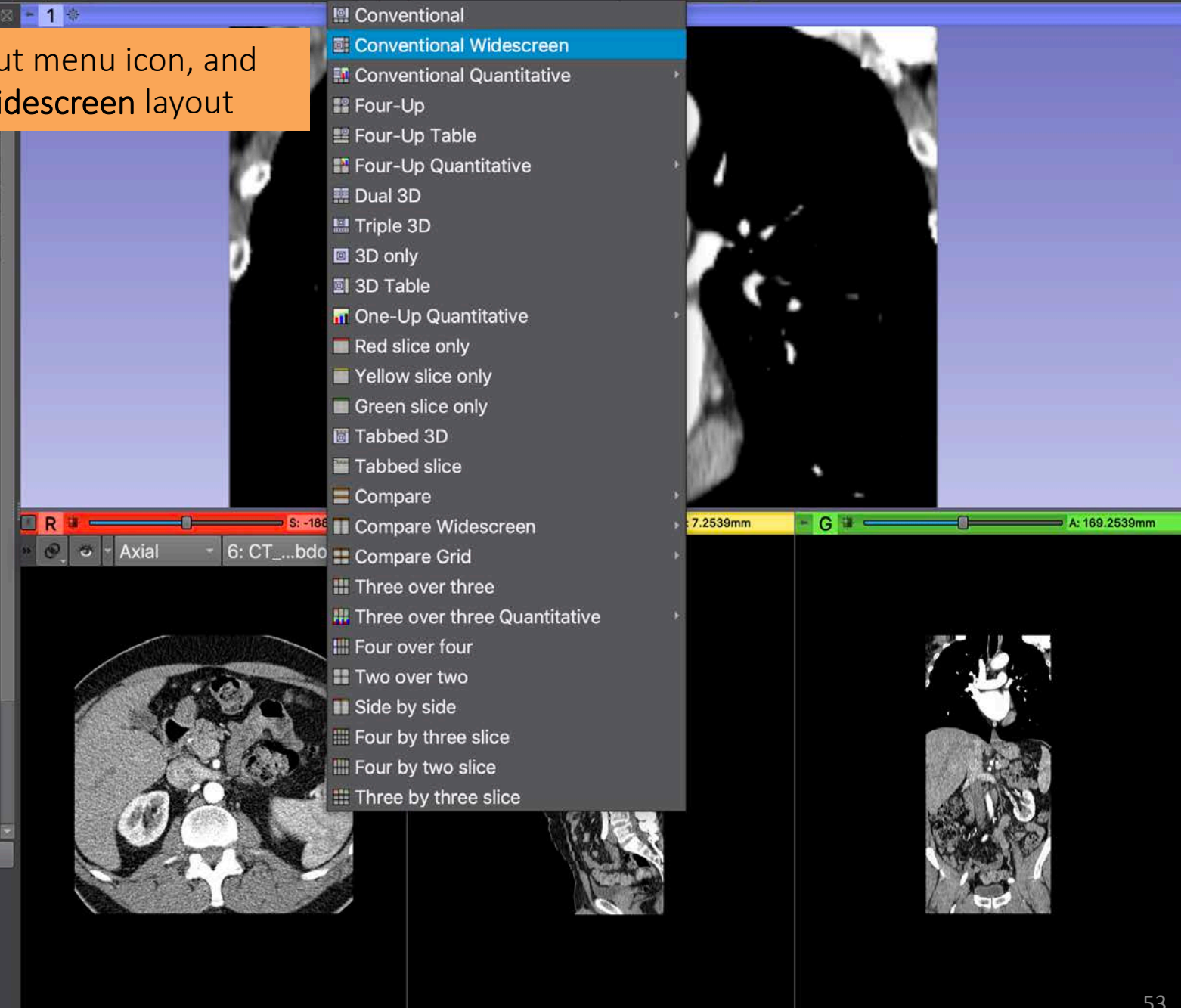
Histogram



Data Probe

Show Zoomed Slice

L F B

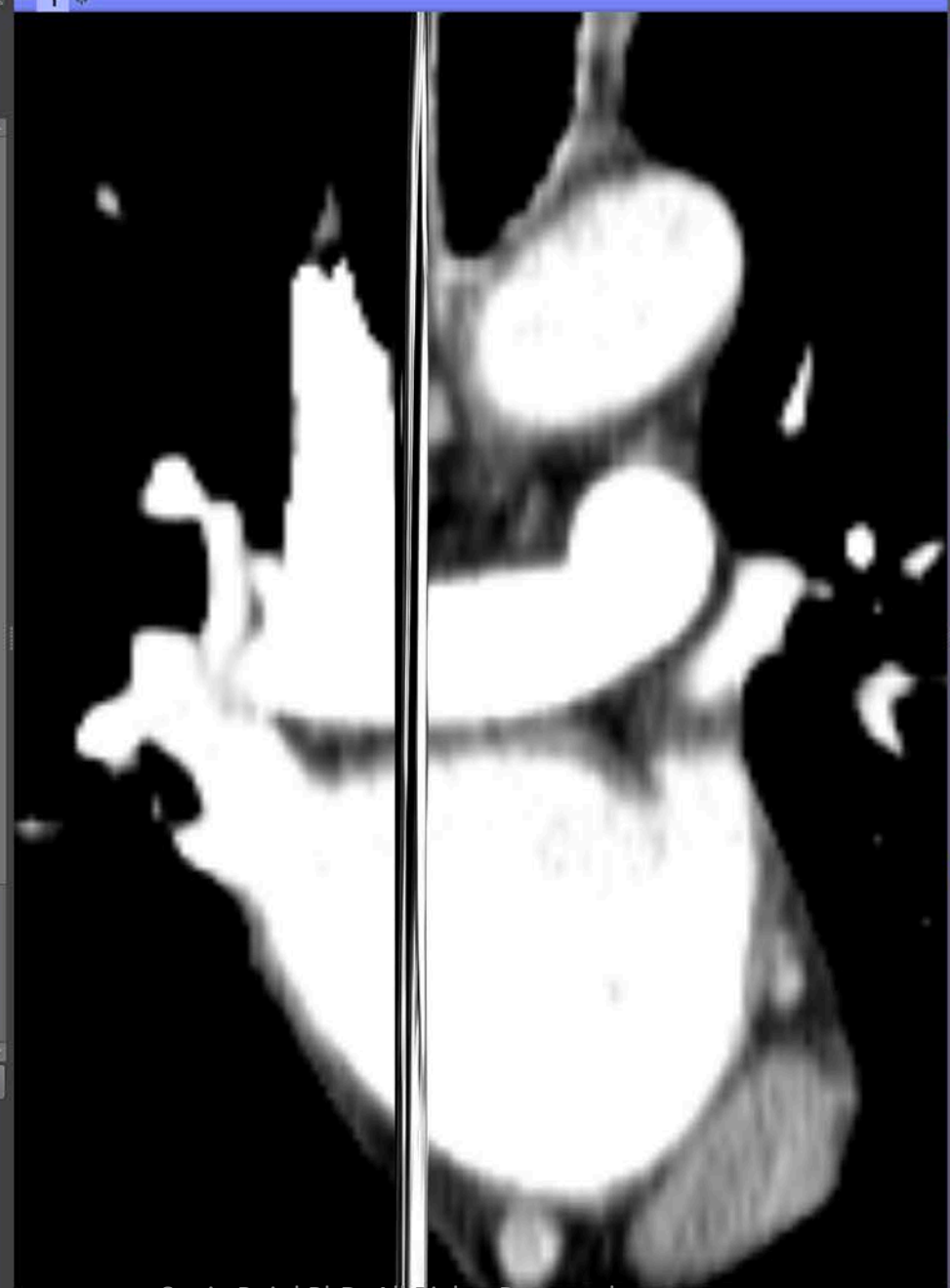


- Conventional
- Conventional Widescreen**
- Conventional Quantitative
- Four-Up
- Four-Up Table
- Four-Up Quantitative
- Dual 3D
- Triple 3D
- 3D only
- 3D Table
- One-Up Quantitative
- Red slice only
- Yellow slice only
- Green slice only
- Tabbed 3D
- Tabbed slice
- Compare
- Compare Widescreen
- Compare Grid
- Three over three
- Three over three Quantitative
- Four over four
- Two over two
- Side by side
- Four by three slice
- Four by two slice
- Three by three slice

3DSlicer

- Help & Acknowledgement
- Active Volume: 6: CT\_Thorax\_Abdomen
- Volume Information
- Display
  - Lookup Table: Grey
  - Interp
  - Window
- W: 350 Manual W/L L: 40
- Threshold: Off
- 1434 3481
- Histogram
- Data Probe
  - Show Zoomed Slice
  - L
  - F
  - B

Slicer switches the layout to Conventional Widescreen layout



R S: -188.5000mm

Axial 6: CT\_Thorax\_Abdomen

Y R: 7.2539mm

G A: 169.2539mm

3DSlicer

Help & Acknowledgement

Active Volume 6: CT\_Thorax\_Abdomen

Volume Information

Display

Lookup Table: Grey

In

W: 350 Manual W/L L: 40

Threshold: Off

-1434 3481

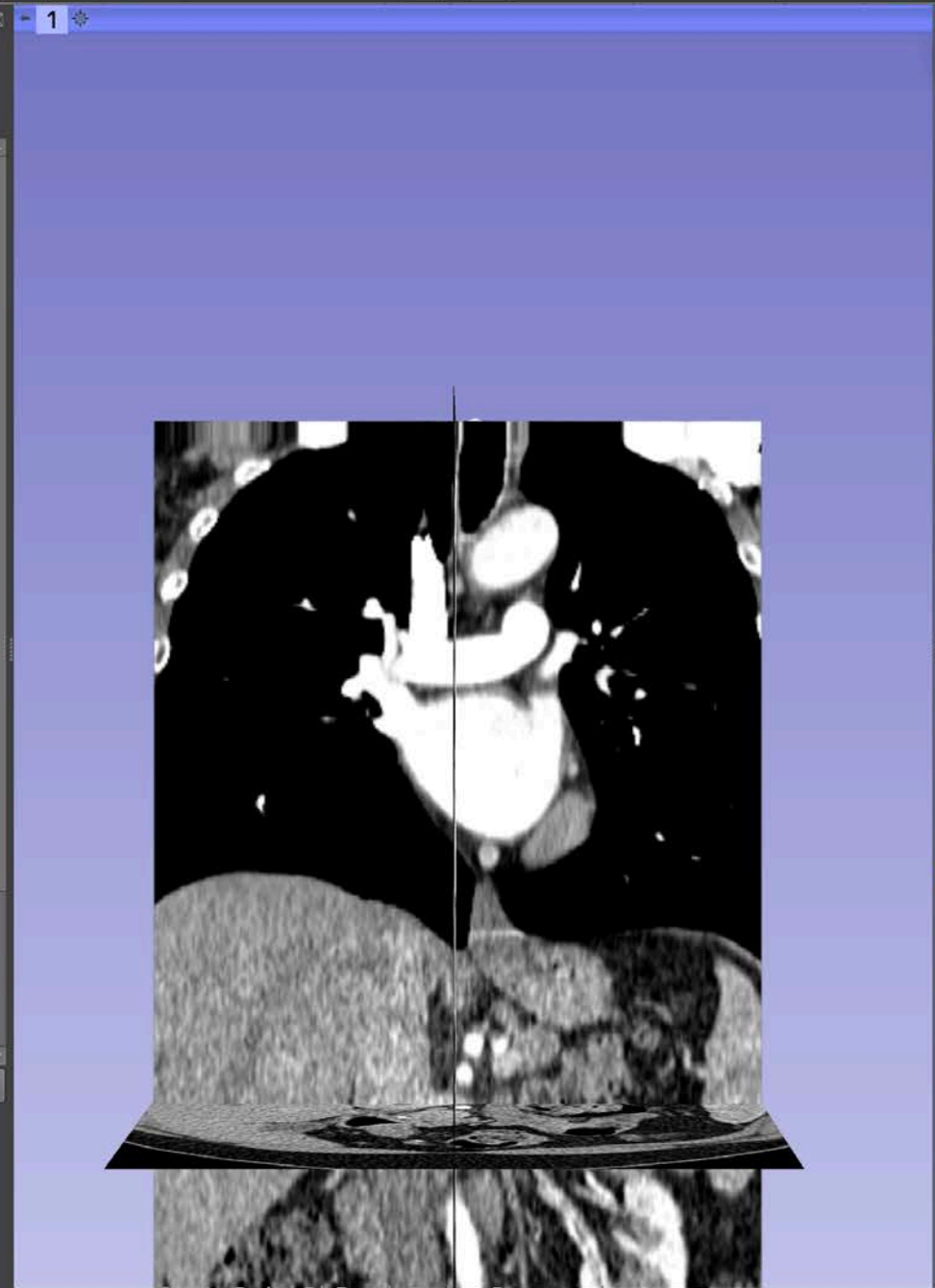
Histogram

Data Probe

Show Zoomed Slice

L  
F  
B

Use the right mouse button in the 3D Viewer to zoom out



R S: -188.5000mm

Axial 6: CT\_Thorax\_Abdomen

Y R: 7.2539mm

G A: 169.2539mm

Windows taskbar with icons for DATA, DCM, SAVE, Modules, and Volumes.

3DSlicer

Help & Acknowledgement

Active Volume 6: CT\_Thorax\_Abdomen

Volume Information

Display

Lookup Table: Grey

W: 350 Manual W/L L: 40

Threshold: Off

-1434 3481

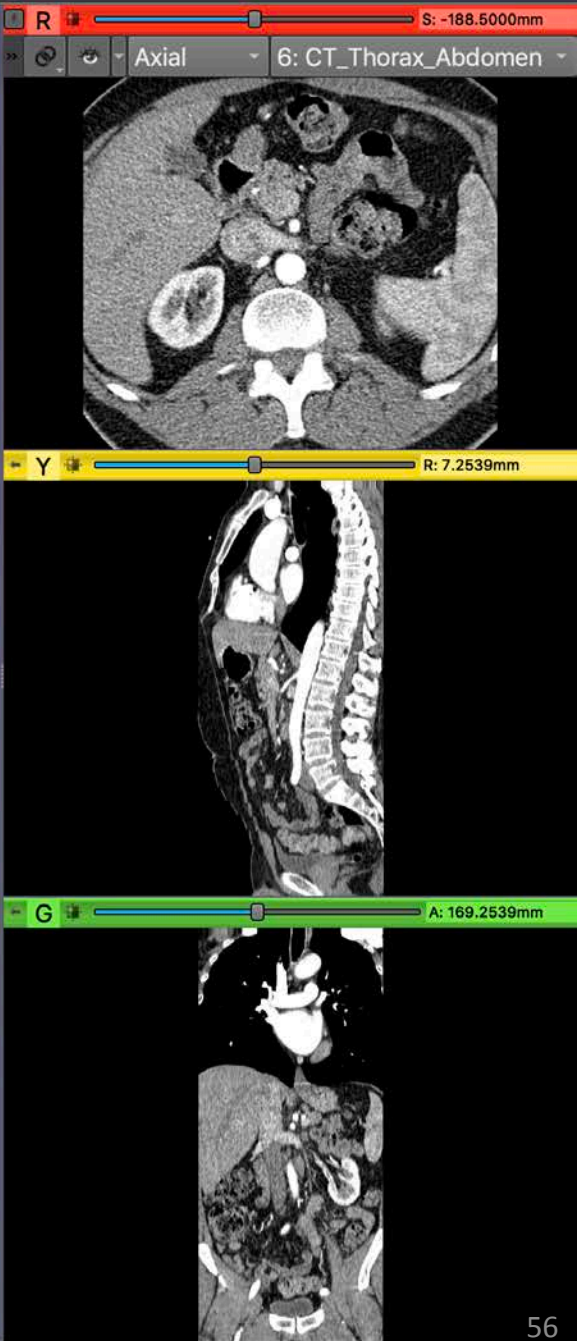
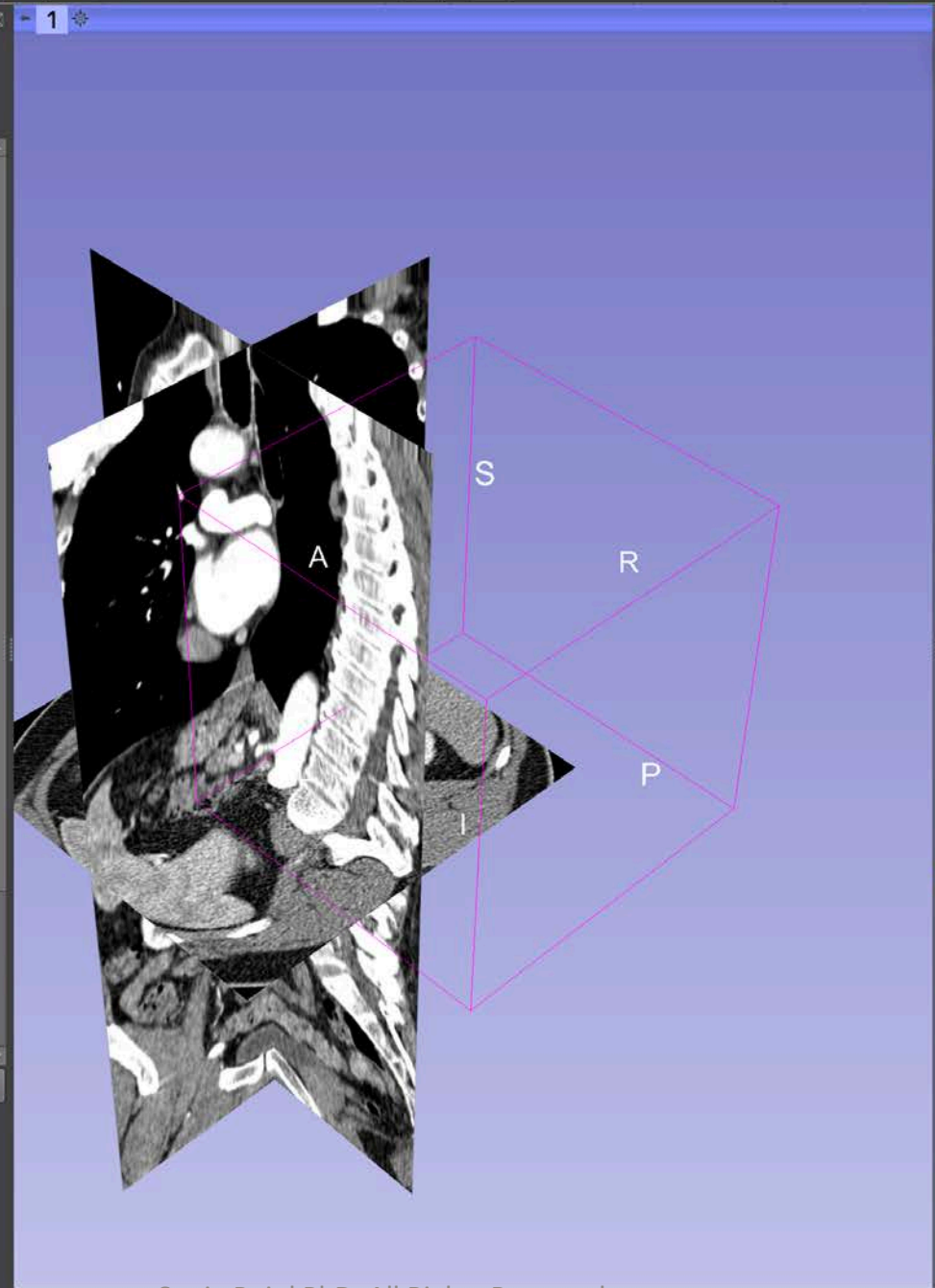
Histogram

Data Probe

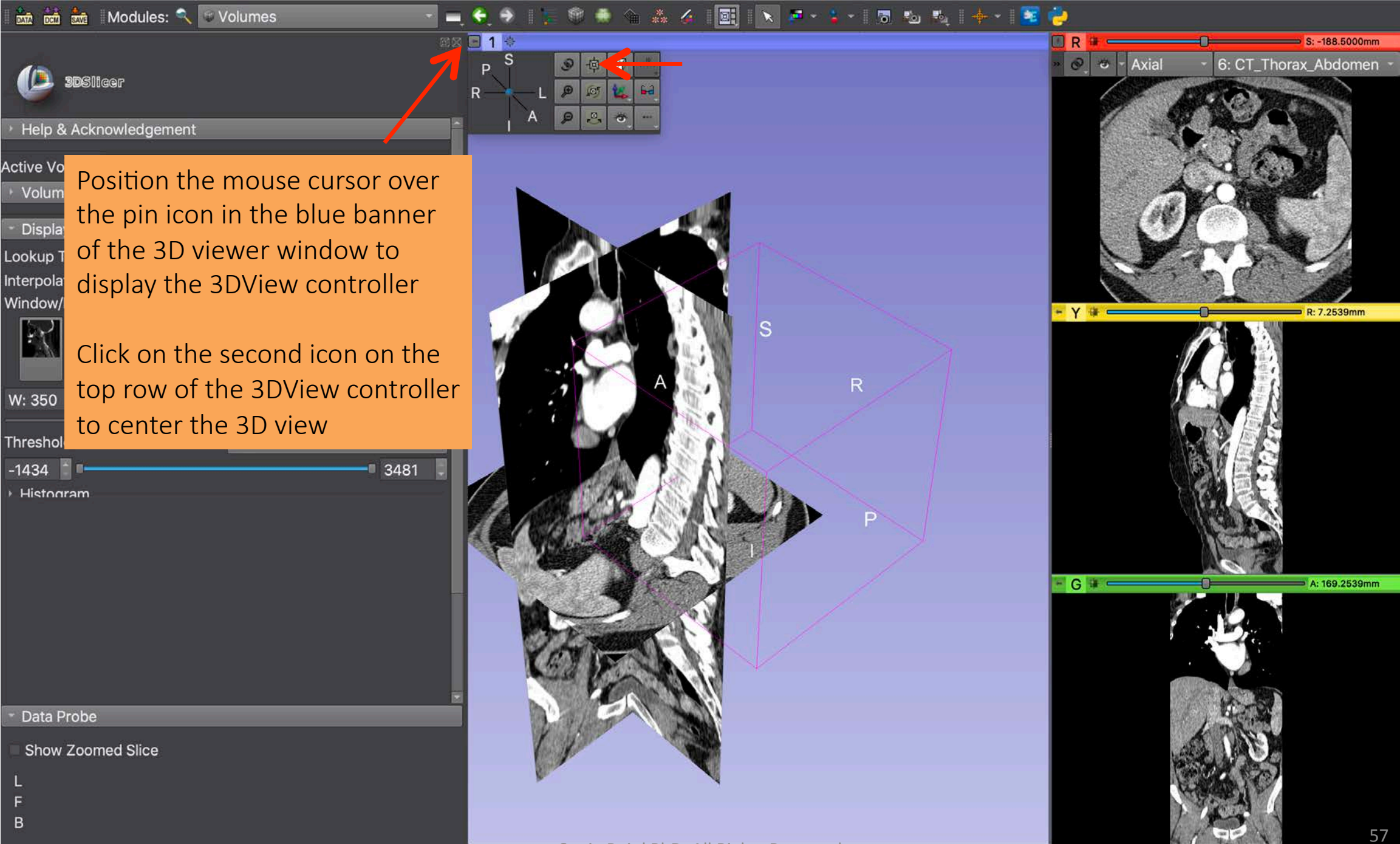
Show Zoomed Slice

L  
F  
B

Use the left mouse button in the 3D Viewer to rotate the images







Position the mouse cursor over the pin icon in the blue banner of the 3D viewer window to display the 3DView controller

Click on the second icon on the top row of the 3DView controller to center the 3D view

3DSlicer

Help & Acknowledgement

Active Volume 6: CT\_Thorax\_Abdomen

Volume Information

Display

Lookup Table: Grey

Interpolate:

Window/Level:

W: 350 Manual W/L L: 40

Threshold: Off

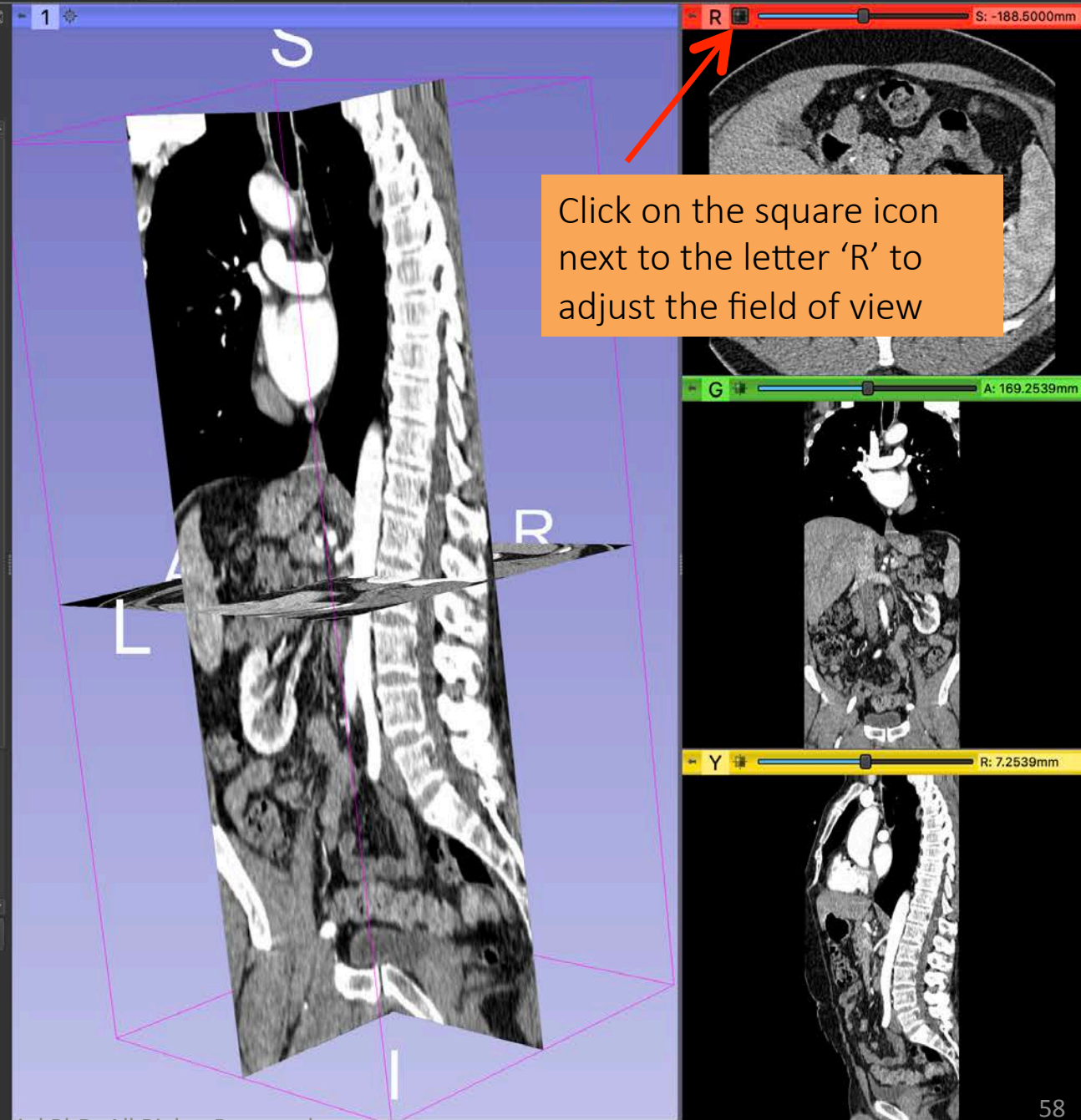
-1434 3481

Histogram

Data Probe

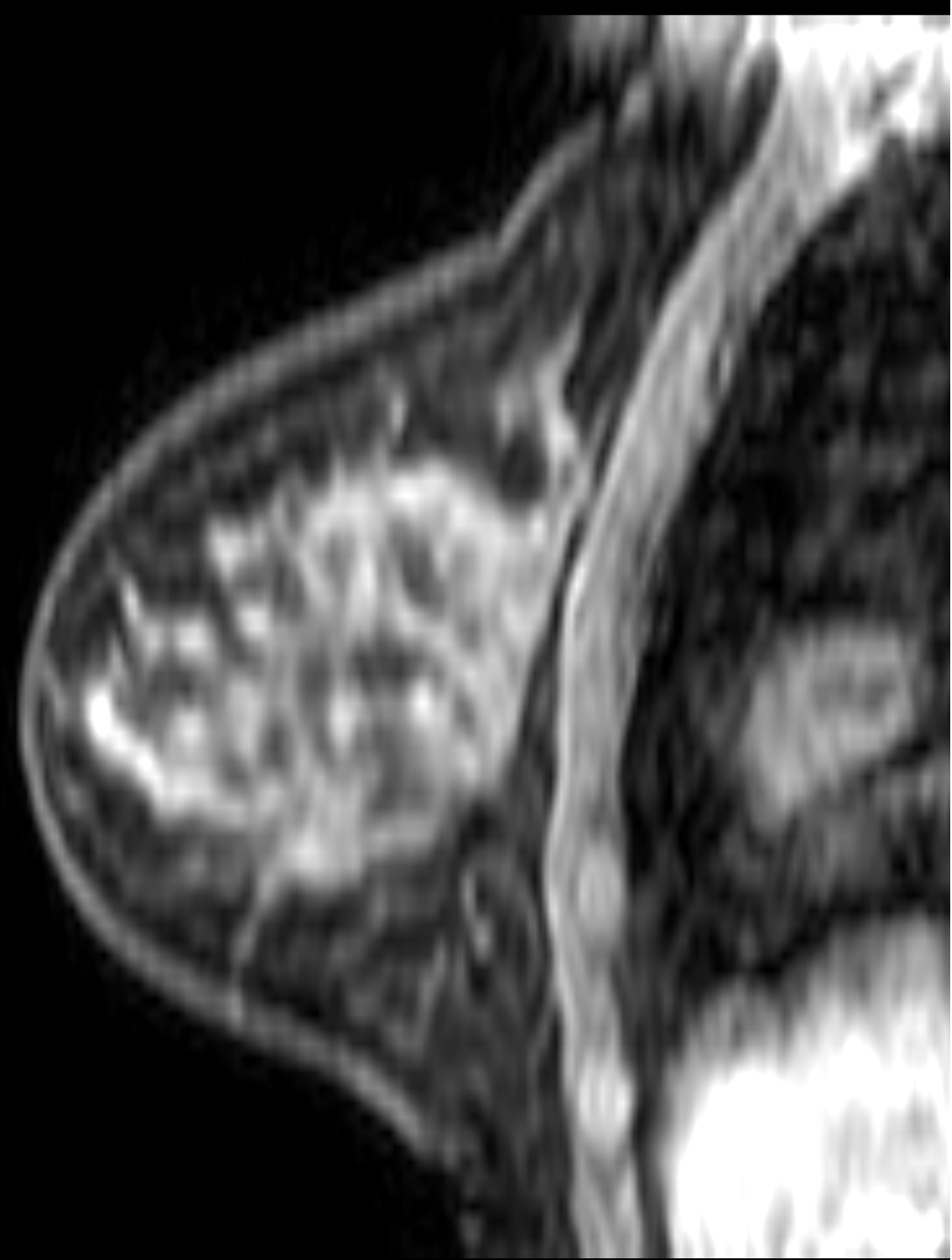
Show Zoomed Slice

L  
F  
B



Click on the square icon next to the letter 'R' to adjust the field of view





# Dataset #2

## Breast MRI

# Breast MRI Dataset

- The Breast MRI dataset is part of the BREAST-DIAGNOSIS collection of The Cancer Imaging Archive (TCIA) of the National Cancer Institute
- The dataset was acquired on patient with right breast infiltrating ductal carcinoma
- The DICOM images consist of one study and three series: T2, STIR and BLISS
- BLISS is an MRI sequence for breast MRI studies. BLISS provides the measurement of two bilateral volumes in a single acquisition.

Bloch, B. Nicolas, Jain, Ashali, & Jaffe, C. Carl. (2015). Data From BREAST-DIAGNOSIS. The Cancer Imaging Archive. <http://doi.org/10.7937/K9/TCIA.2015.SDNRQXXR>

Patient name	Patient ID	Birth date	Sex	Studies	Last study c Date added
patient1	patient1_ID			1	Wed Jun 1 2020...858

Help & Acknowledgement

Import DICOM files Show DICOM database

Loaded data Node

Name

- ▼ SlicerDICOMTutorialData
  - ▶ dataset1\_TorsoCT
  - ▶ dataset2\_BreastMRI

Drag and drop the directory dataset2\_BreastMRI into the DICOM module

DICOM Data Reader Warnings

DICOM networking

DICOM database settings



3DSlicer

Help & Acknowledgement

Import DICOM files Show DICOM database

Loaded data

Node

DICOM networking

DICOM database settings

DICOM database

Patients: Studies: Series:

Patient name	Patient ID	Birth date	Sex	Studies	Last study c Date added
Bre...005			F	1	Tue Nov 11 2008 2020...622
patient1	patient1_ID			1	Wed Jun 1 2005 2020...858

Slicer imports the dataset2\_BreastMRI directory into the DICOM database

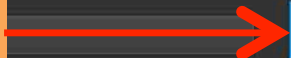
The directory contains 1 patient, 1 study and 3 series



Import completed: added 1 patients, 1 studies, 3 series, 1008 instances. OK

DICOM Data Reader Warnings

Click on the PatientID  
BreastDx-01-0005 to display  
the study and the three  
T2W, STIR and BLISS series



DICOM database

Patients:  Studies:  Series:

Patient name	Patient ID	Birth date	Sex	Studies	Last study	Date added
BreastDx-01-0005	BreastDx-01-0005		F	1	Tue Nov 11 2008	2020....583
patient1	patient1_ID			1	Wed Jun 1 2005	2020....273

Study date	Study ID	Study description	Series	Date added
20081111		MRI BREAST, BILATERAL WITH T WITHOUT CONTRAST	3	2020....583

Series #	Series description	Modality	Size	Count	Date added
301	T2W_TSE SENSE	MR	528x528	84	2020....583
401	STIR SENSE	MR	528x528	84	2020....221
801	AX BLISS_AUTO SENSE	MR	528x528	840	202....646

Click on the double  
arrow to display the  
list of DICOM readers



DICOM Data Reader Warnings

»



Help & Acknowledgement

Import DICOM files

Show DICOM database

Loaded data

Node  
DICOM networking  
DICOM database settings

DICOM database

Patients: Studies: Series:

Patient name	Patient ID	Birth date	Sex	Studies	Last study c	Date added
Bre...005			F	1	Tue Nov 11 2008	2020...622
patient1	patient1_ID			1	Wed Jun 1 2005	2020...858

Study date	Study ID	Study description	Series	Date added
20081111		MRI BREAST, BILATERAL WITH T WITHOUT CONTRAST	3	2020...622

Series #	Series description	Modality	Size	Count	Date added
301	T2W_TSE SENSE	MR	528x528	84	2020...622
401	STIR SENSE	MR	528x528	84	2020...126
801	AX BLISS_AUTO SENSE	MR	528x528	840	2020...672

The list of DICOM plugins appear

- DICOMScalarVolumePlugin
- DICOMSlicerDataBundlePlugin
- DICOMVolumeSequencePlugin
- MultiVolumeImporterPlugin

DICOM Data Reader Warnings

Uncheck All

Examine

Load

Advanced





# Slicer DICOM Plugins

- ✓ DICOMScalarVolumePlugin
- ✓ DICOMSlicerDataBundlePlugin
- ✓ DICOMVolumeSequencePlugin
- ✓ MultiVolumeImporterPlugin

- Slicer implements a list of DICOM plugins to handle a diverse set of DICOM data objects
- These plugins need to be enabled in order to read specific DICOM data objects such DICOM RT data or DICOM DWI data



Help & Acknowledgement

Import DICOM files

Show DICOM database

Loaded data

Node

DICOM networking

DICOM database settings

DICOM database

Patients: Studies: Series:

Patient name	Patient ID	Birth date	Sex	Studies	Last study c Date added
	Bre...005		F	1	Tue Nov 11 2008 2020...622
patient1	patient1_ID			1	Wed Jun 1 2005 2020...858

Study date	Study ID	Study description	Series	Date added
20081111		MRI BREAST, BILATERAL WITH T WITHOUT CONTRAST	3	2020...622

Series #	Series description	Modality	Size	Count	Date added
301	T2W_TSE SENSE	MR	528x528	84	2020...622
401	STIR SENSE	MR	528x528	84	2020...126
801	AX BLISS_AUTO SENSE	MR	528x528	840	2020...672

- DICOMScalarVolumePlugin
- DICOMSlicerDataBundlePlugin
- DICOMVolumeSequencePlugin
- MultiVolumeImporterPlugin

DICOM Data Reader Warnings

Uncheck All

Examine

Click on Examine

Advanced





Help & Acknowledgement

Import DICOM files

Show DICOM database

Loaded data

Node

DICOM database

Patients: Studies: Series:

Patient name	Patient ID	Birth date	Sex	Studies	Last study c	Date added
	Bre...005		F	1	Tue Nov 11 2008	2020...622
patient1	patient1_ID			1	Wed Jun 1 2005	2020...858

Study date	Study ID	Study description	Series	Date added
20081111		MRI BREAST, BILATERAL WITH T WITHOUT CONTRAST	3	2020...622

Series #	Series description	Modality	Size	Count	Date added
301	T2W_TSE SENSE	MR	528x528	84	2020...622
401	STIR SENSE	MR	528x528	84	2020...126
801	AX BLISS_AUTO SENSE	MR	528x528	840	2020...672

- DICOMScalarVolumePlugin
- DICOMSlicerDataBundlePlugin
- DICOMVolumeSequencePlugin
- MultiVolumeImporterPlugin

DICOM Data	Reader
<input checked="" type="checkbox"/> 301: ...	Scalar Volume
<input checked="" type="checkbox"/> 401: ...	Scalar Volume
<input checked="" type="checkbox"/> AX ...	MultiVolume
801: A...	Scalar Volume Images are not equally spaced (a difference of 2 v...
AX ...	MultiVolume

Click on Load to load the data into Slicer

DICOM networking

DICOM database settings

Uncheck All

Examine

Load

Advanced

3DSlicer

Help & Acknowledgement

Import DICOM files Show DICOM database

Loaded data

Node

- patient1 (patient1\_ID)
  - CT Thorax Abdomen (20050601)
    - 6: CT\_Thorax\_Abdomen
  - No name (BreastDx-01-0005)
    - MRI BREAST, BILATERAL WITH T WITHOUT CON...
      - 301: T2W\_TSE SENSE
      - 401: STIR SENSE
      - AX BLISS\_AUTO SENSE - as a 10 frames Volum...

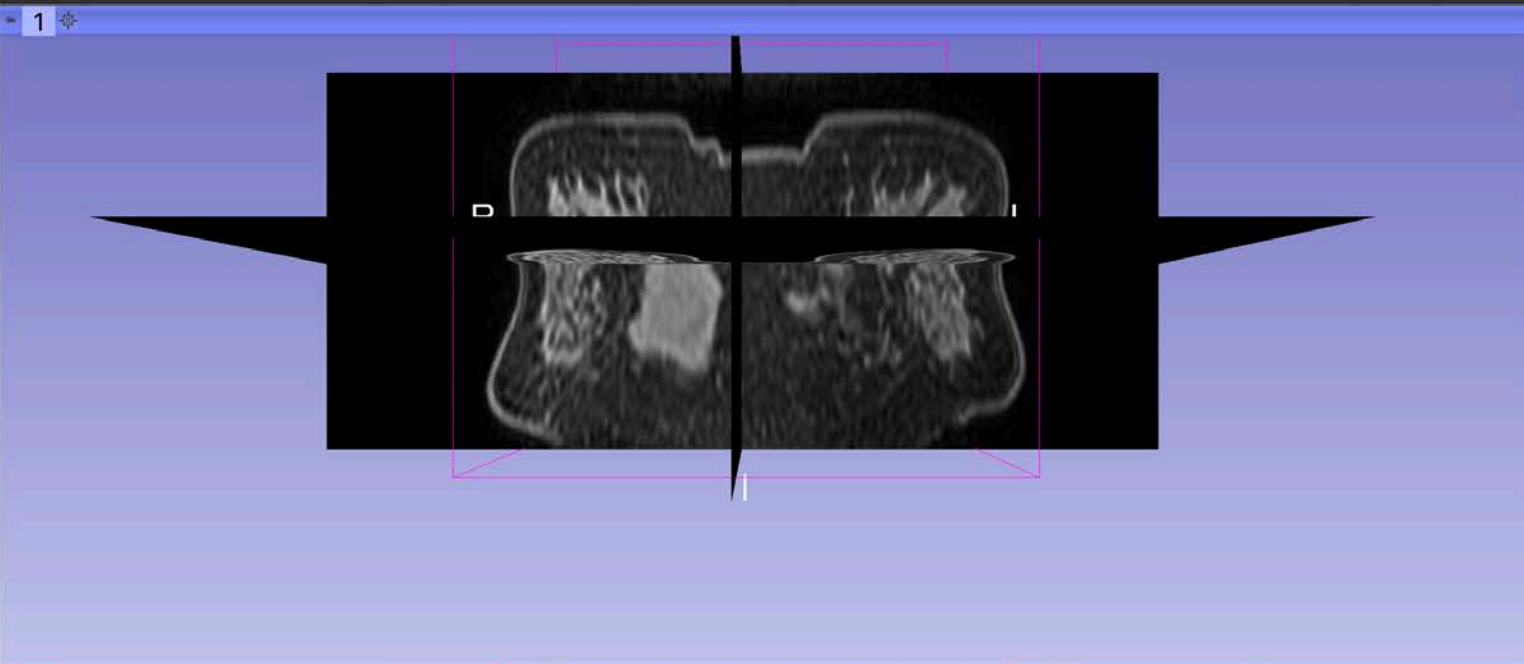
DICOM networking

DICOM database settings

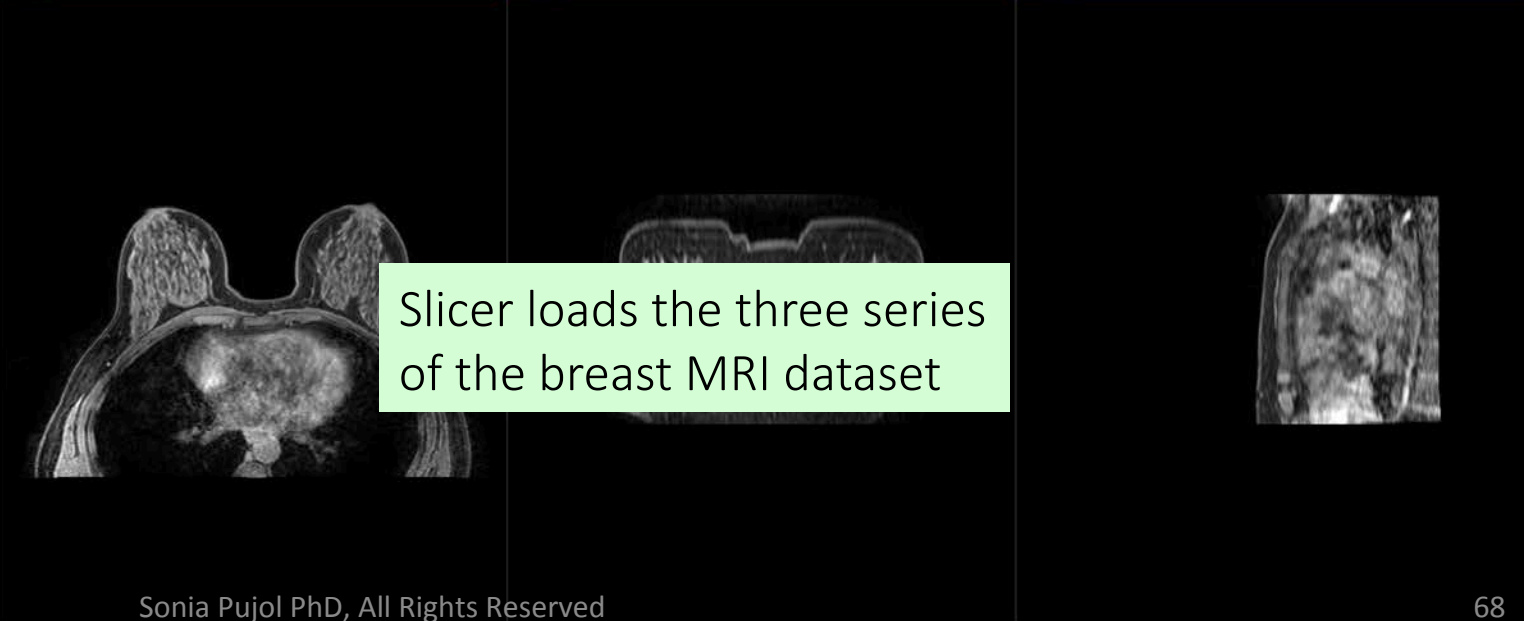
Data Probe

Show Zoomed Slice

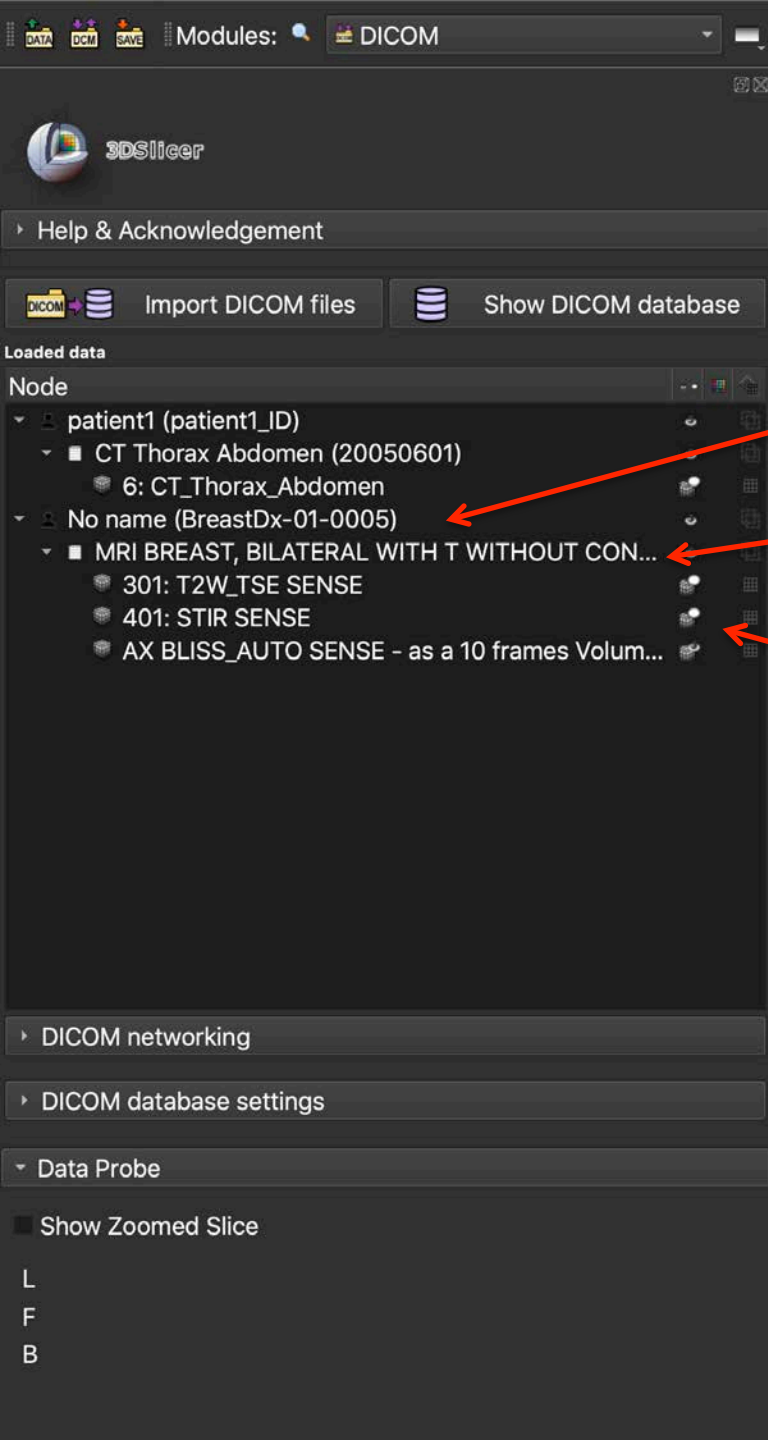
L  
F  
B



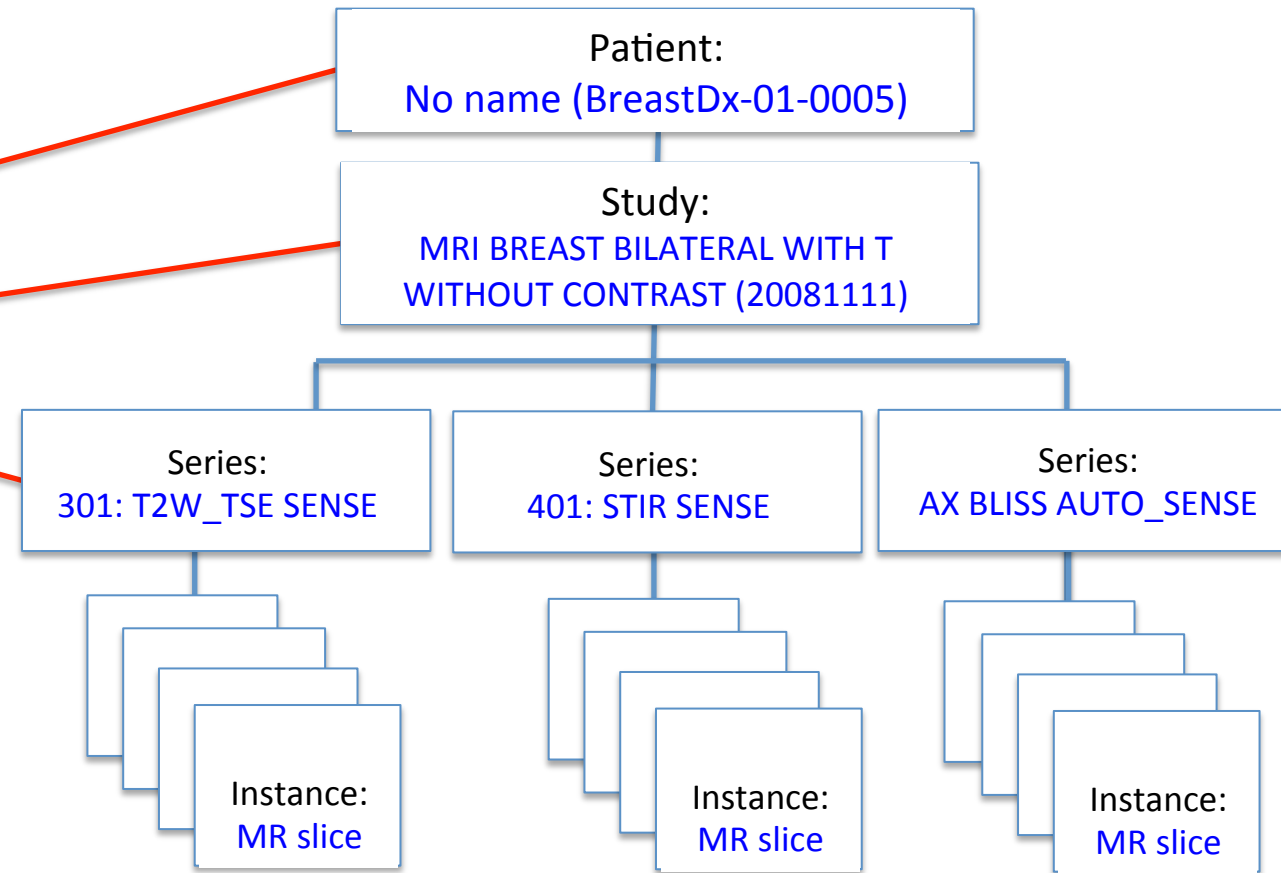
R S: -18.1139mm G A: -22.7503mm Y R: 3.6702mm



Slicer loads the three series of the breast MRI dataset



DICOM data are loaded into Slicer as a patient-study-series hierarchy



3DSlicer

Help & Acknowledgement

Import DICOM files Show DICOM database

Loaded data

Node

- No name (BreastDx-01-0005)
  - MRI BREAST, BILATERAL WITH T WITHOUT CON...
    - 301: T2W\_TSE SEI
    - 401: STIR SENSE
    - AX BLISS\_AUTO S

DICOM networking

DICOM database settings

Data Probe

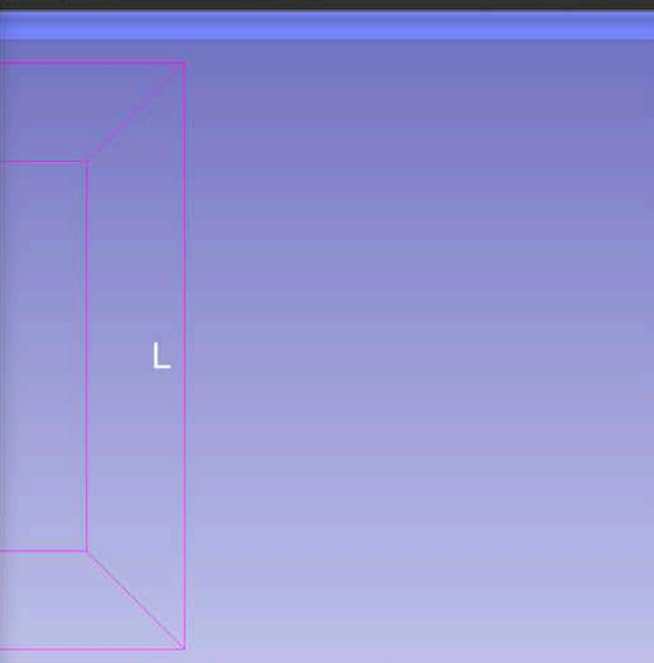
Show Zoomed Slice

L  
F  
B

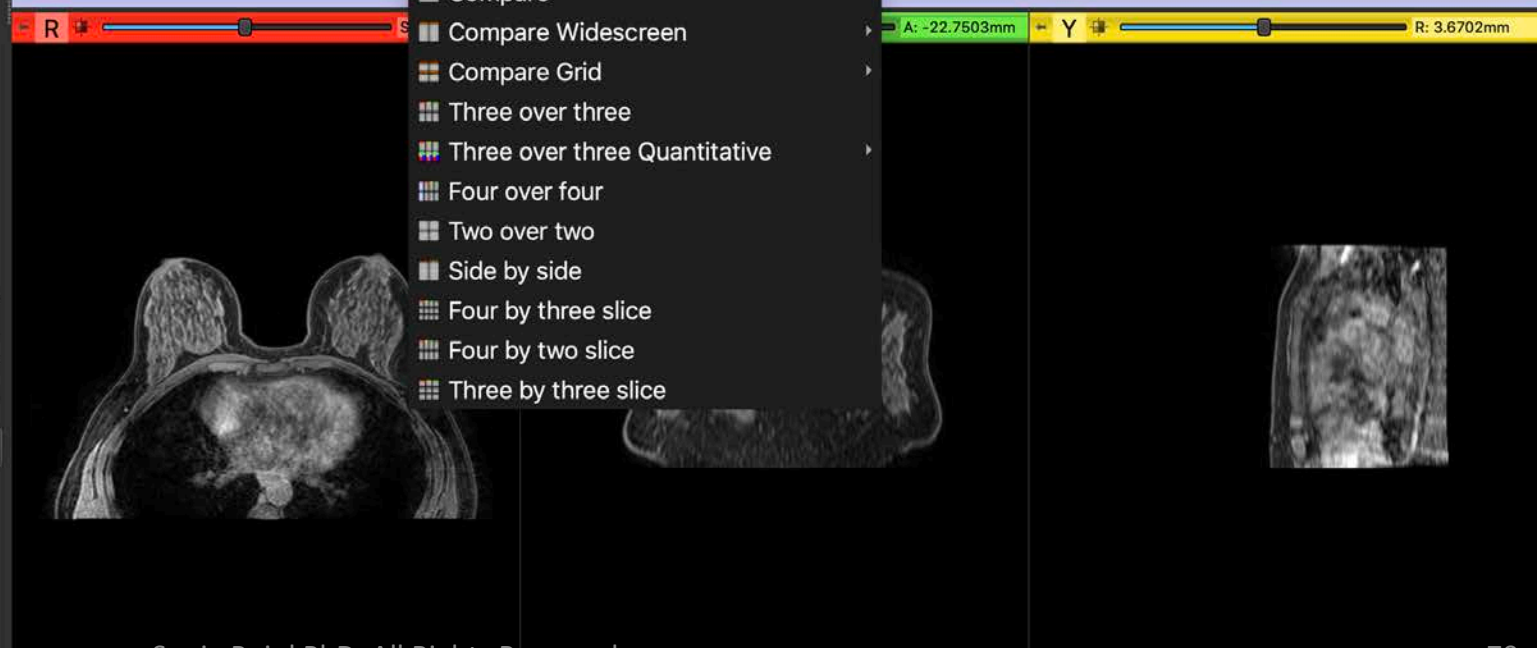
Click on the layout menu and select Yellow slice only

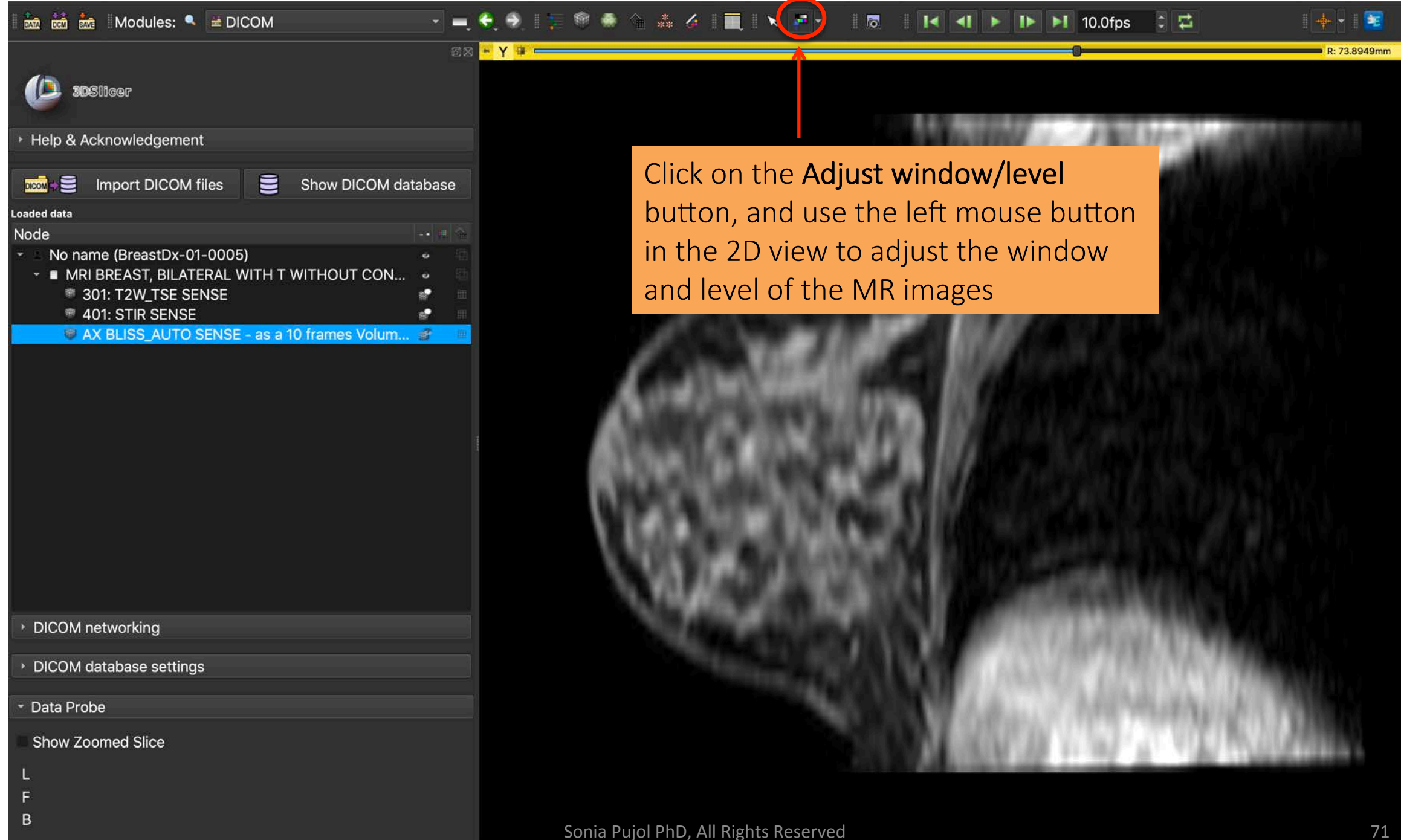


- Conventional
- Conventional Widescreen
- Conventional Quantitative
- Four-Up
- Four-Up Table
- Four-Up Quantitative
- Dual 3D
- Triple 3D
- 3D only
- 3D Table
- One-Up Quantitative
- Red slice only
- Yellow slice only**
- Green slice only
- Tabbed 3D
- Tabbed slice
- Compare
- Compare Widescreen
- Compare Grid
- Three over three
- Three over three Quantitative
- Four over four
- Two over two
- Side by side
- Four by three slice
- Four by two slice
- Three by three slice



A: -22.7503mm Y R: 3.6702mm





Click on the **Adjust window/level** button, and use the left mouse button in the 2D view to adjust the window and level of the MR images

3DSlicer

Help & Acknowledgement

Import DICOM files Show DICOM database

Loaded data

Node

- No name (BreastDx-01-0005)
  - MRI BREAST, BILATERAL WITH T WITHOUT CON...
    - 301: T2W\_TSE SENSE
    - 401: STIR SENSE
    - AX BLISS\_AUTO SENSE - as a 10 frames Volum...**

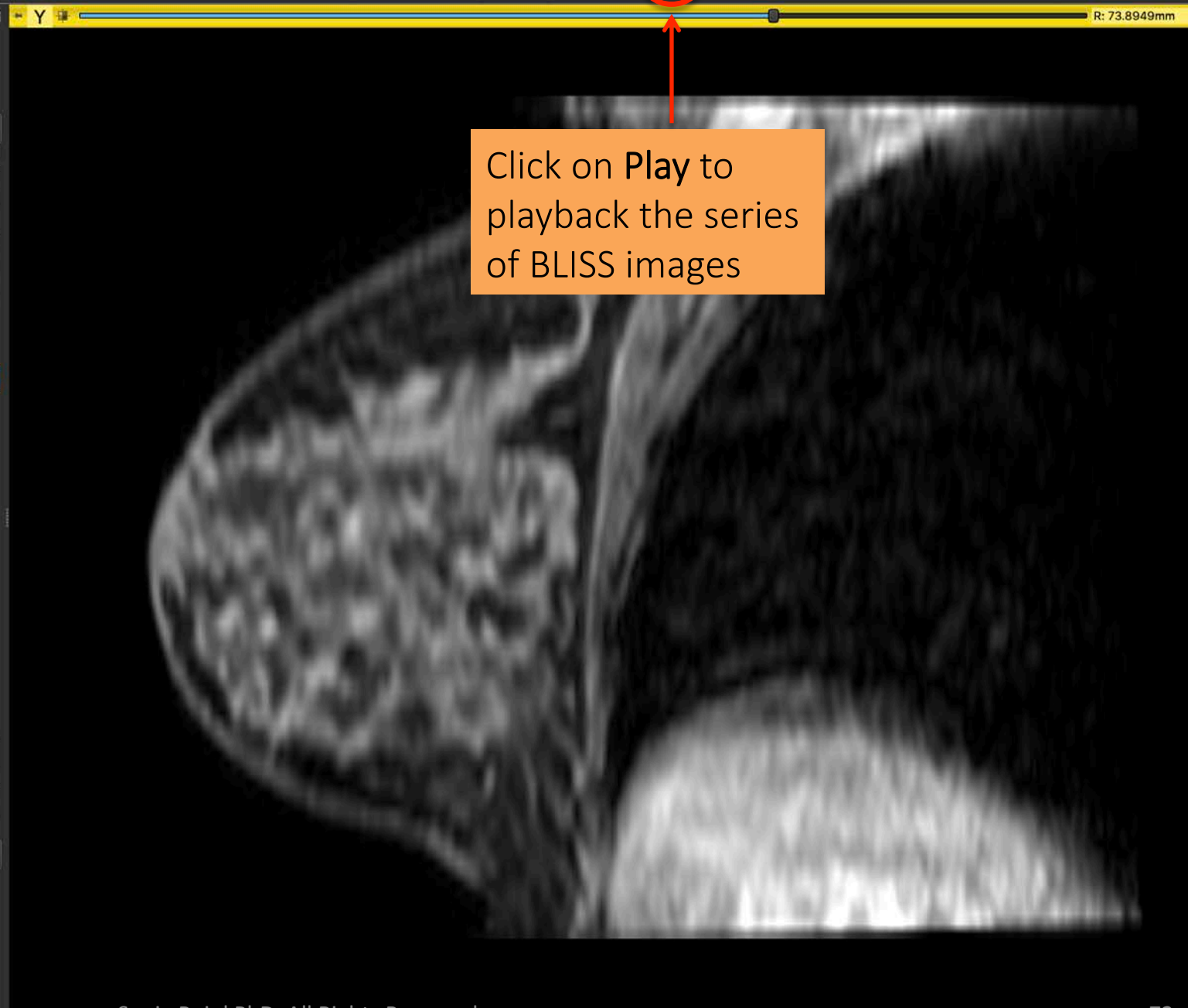
DICOM networking

DICOM database settings

Data Probe

Show Zoomed Slice

L  
F  
B



Click on **Play** to playback the series of BLISS images







Help & Acknowledgement

Import DICOM files Show DICOM database

Loaded data

- Node
- No name (BreastDx-01-0005)
  - MRI BREAST, BILATERAL WITH T WITHOUT CON...
    - 301: T2W\_TSE SENSE
    - 401: STIR SENSE
    - AX BLISS\_AUTO SENSE - as a 10 frames Volum...**

Slicer starts playing the BLISS sequence

DICOM networking

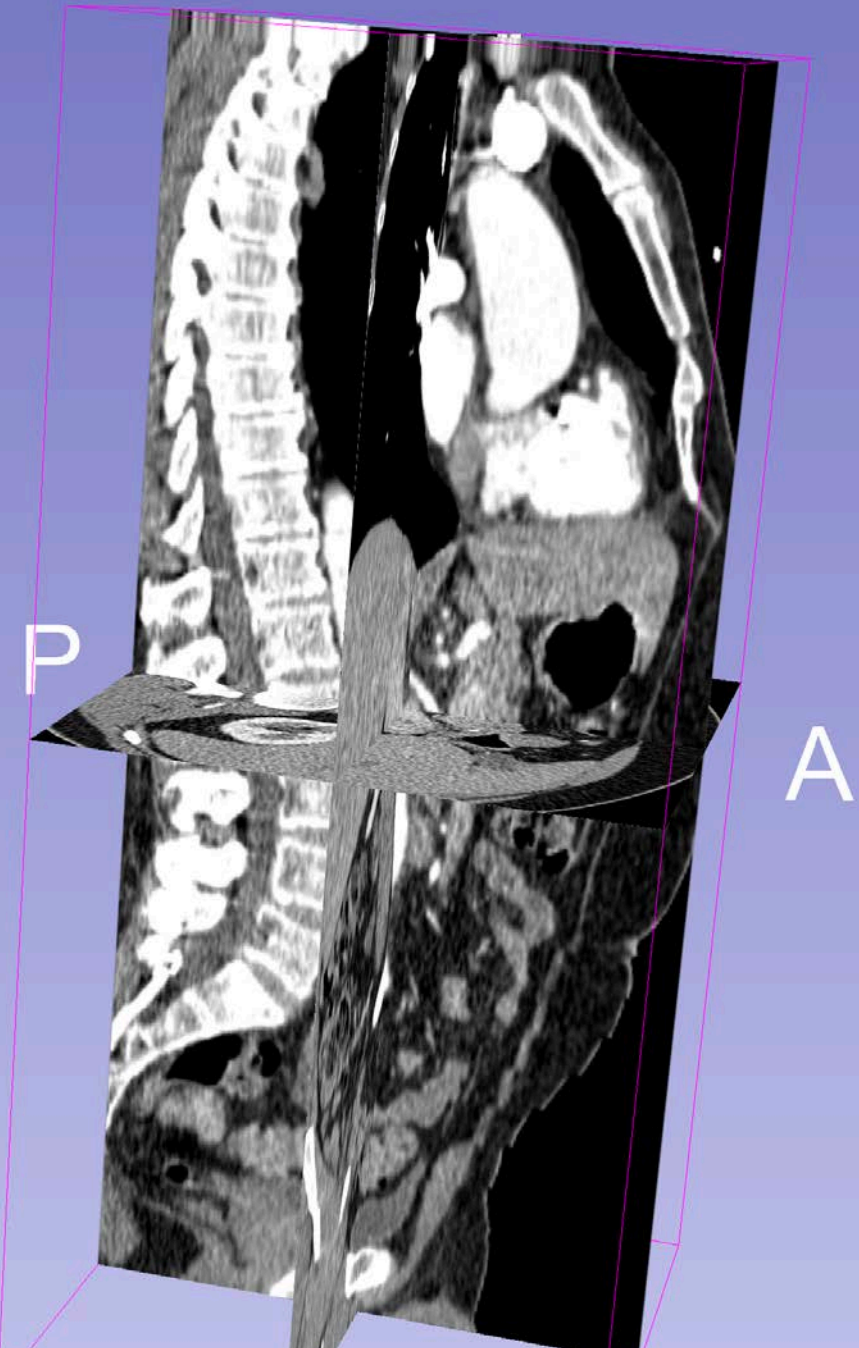
DICOM database settings

Data Probe

Show Zoomed Slice

L  
F  
B





# Conclusion

---

- This tutorial introduced the DICOM standard and showed how to load and visualize DICOM CT and MR images in Slicer
- 3D Slicer and the DICOM standard enable compliance with the FAIR principles for biomedical research
- By enabling interoperability between research and clinical environments, 3D Slicer and the DICOM standard lower the inherent barriers to the translation of research advances to patient care



Acknowledgments

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