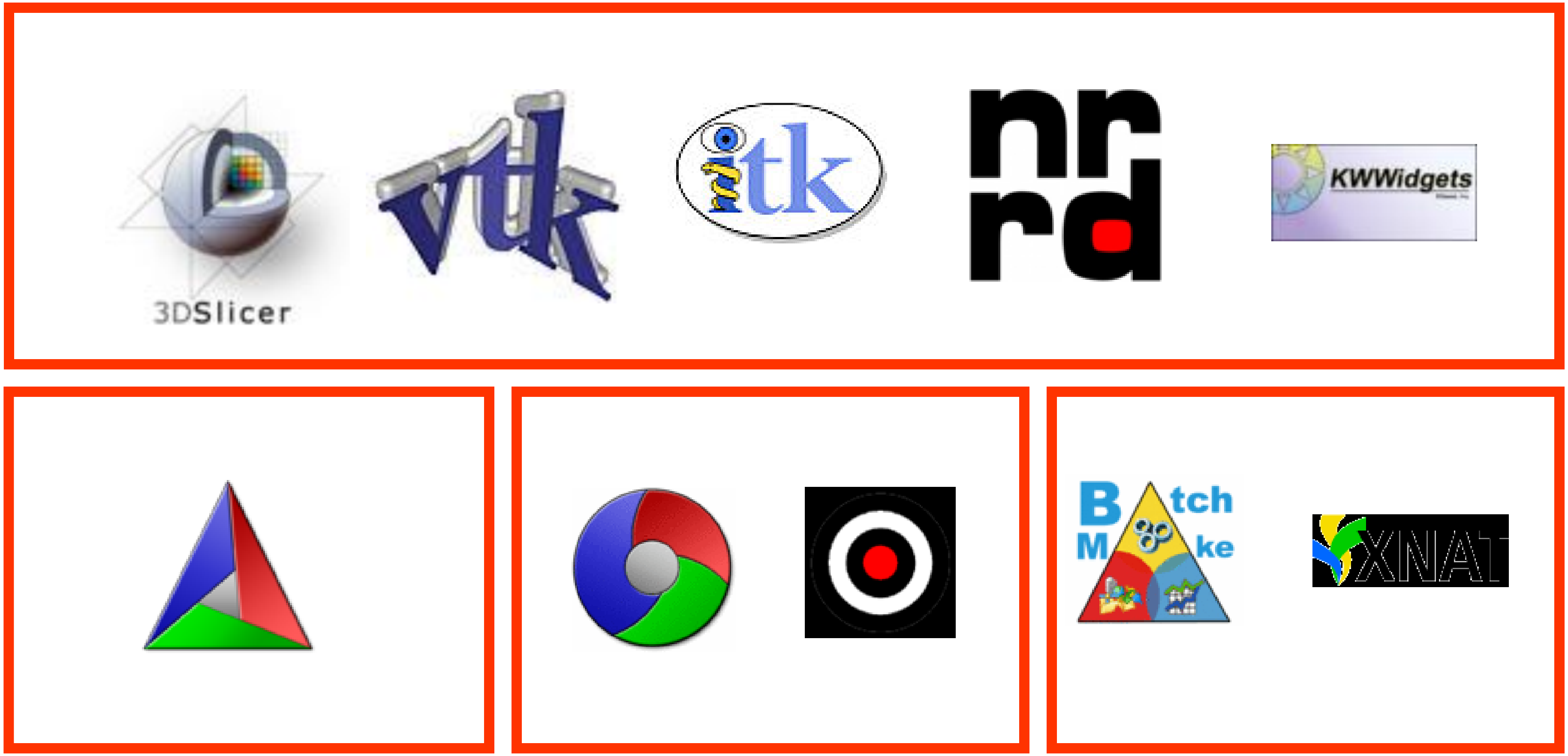
Paul Cézanne, *Moulin sur la Couleuvre à Pontoise, 1881,*
Staatliche Museen zu Berlin, Nationalgalerie

Programming into Slicer3

Sonia Pujol, Ph.D.

Surgical Planning Laboratory
Harvard University

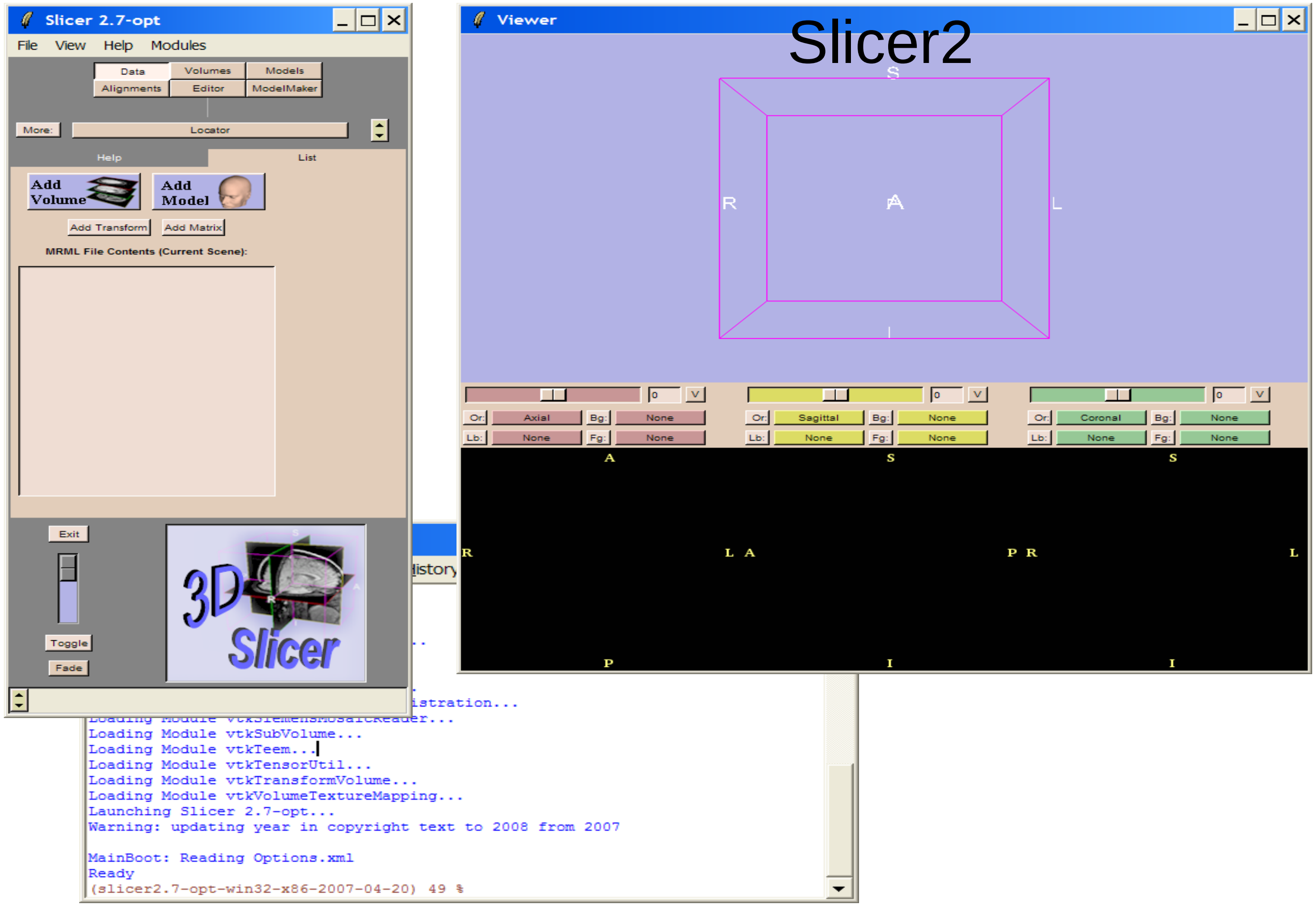
The NA-MIC Kit



Slicer3

- An end-user application for image analysis
- An open-source environment for software development
- A software platform that is both easy to use for clinical researchers and easy to extend for programmers

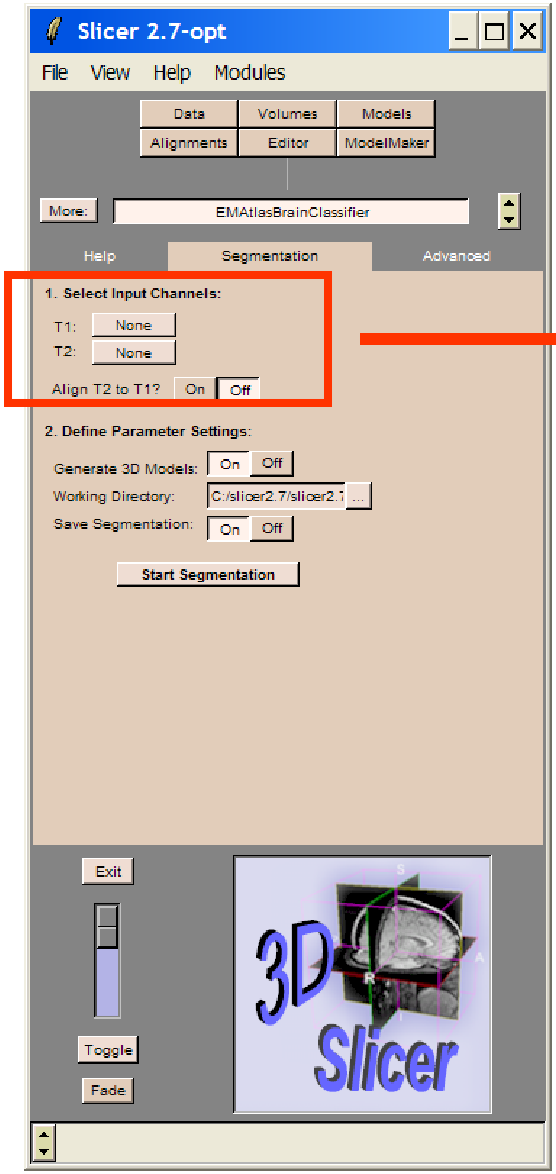
Before Slicer3



Slicer2

```
istration...
Loading Module vtkSiemensMosaicReader...
Loading Module vtkSubVolume...
Loading Module vtkTeem...
Loading Module vtkTensorUtil...
Loading Module vtkTransformVolume...
Loading Module vtkVolumeTextureMapping...
Launching Slicer 2.7-opt...
Warning: updating year in copyright text to 2008 from 2007

MainBoot: Reading Options.xml
Ready
(slicer2.7-opt-win32-x86-2007-04-20) 49 %
```

Programming into Slicer2



1. Select Input Channels:

T1: None

T2: None

Align T2 to T1? On Off

2. Define Parameter Settings:

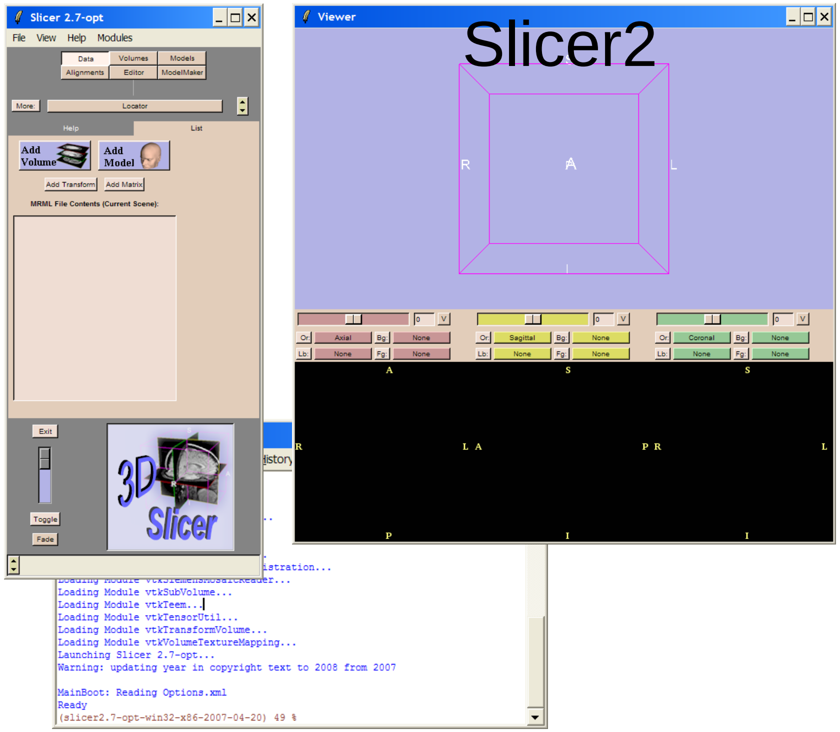
Generate 3D Models: On Off

Working Directory: C:/slicer2.7/slicer2.7

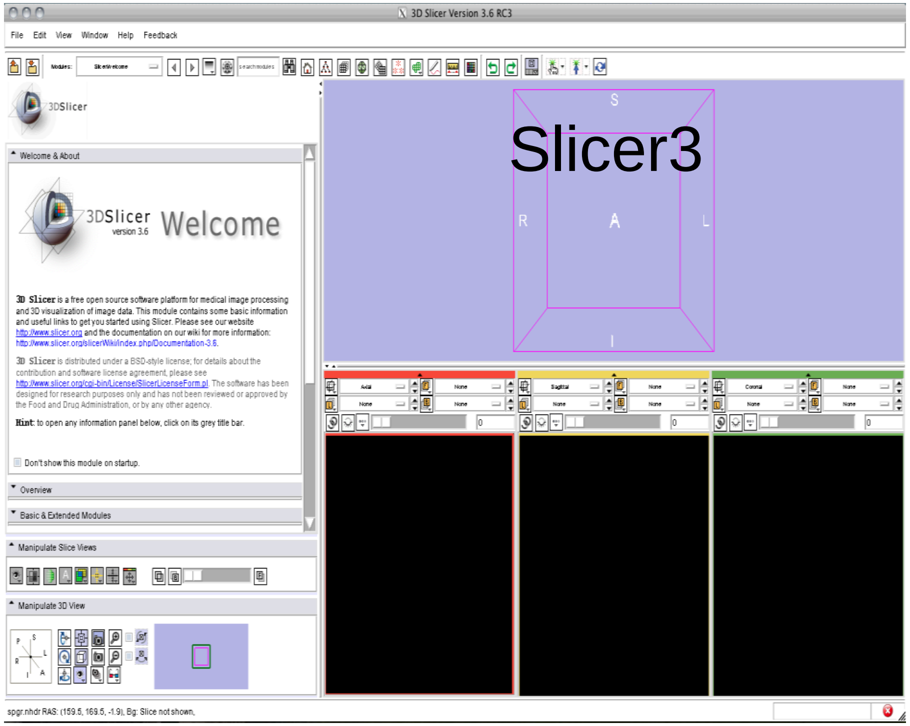
Save Segmentation: On Off

```
#--------------------------------------------
 # 1. Step
 #--------------------------------------------
 set f $fSeg.fStep1
 DevAddLabel $f.lTitle "1. Select Input Channels: " WTA
 pack $f.lTitle -side top -padx $Gui(pad) -pady 1 -anchor w
 frame $f.fInput -bg $Gui(activeWorkspace)
 pack $f.fInput -side top -padx 0 -pady 0  -anchor w
foreach frame "Left Right" {
    frame $f.fInput.f$frame -bg $Gui(activeWorkspace)
    pack $f.fInput.f$frame -side left -padx 0 -pady $Gui(pad) }
 foreach LABEL "T1 T2" Input "SPGR T2W" {
    DevAddLabel $f.fInput.fLeft.l$Input "  ${LABEL}:"
    pack $f.fInput.fLeft.l$Input -side top -padx $Gui(pad) -pady 1 -anchor w
    set menubutton   $f.fInput.fRight.m${Input}Select
    set menu       $f.fInput.fRight.m${Input}Select.m
eval {menubutton $menubutton -text [Volume($EMAtlasBrainClassifier(Volume,${Input}),node) GetName] -
relief raised -bd 2 -width 9 -menu $menu} $Gui(WMBA)
    eval {menu $menu} $Gui(WMA)
    TooltipAdd $menubutton "Select Volume defining ${Input}"
    set EMAtlasBrainClassifier(mbSeg-${Input}Select) $menubutton
    set EMAtlasBrainClassifier(mSeg-${Input}Select) $menu
    # Have to update at UpdateMRML too
    DevUpdateNodeSelectButton Volume EMAtlasBrainClassifier Seg-${Input}Select Volume,$Input
    pack $menubutton -side top  -padx $Gui(pad) -pady 1 -anchor w }
frame $f.fAlign -bg $Gui(activeWorkspace)
 TooltipAdd  $f.fAlign "If the input T1 and T2 are not aligned with each other set flag here"
 pack $f.fAlign -side top -padx 0 -pady 2  -padx $Gui(pad) -anchor w
 DevAddLabel $f.fAlign.lAlign "Align T2 to T1? "
 pack $f.fAlign.lAlign -side left -padx $Gui(pad) -pady 1 -anchor w
 foreach value "1 0" text "On Off" width "4 4" {
    eval {radiobutton $f.fAlign.r$value -width $width -indicatoron 0\
             -text "$text" -value "$value" -variable EMAtlasBrainClassifier(AlignInput) } $Gui(WCA)
    pack $f.fAlign.r$value -side left -padx 0 -pady 0  }
```

From Slicer2 to Slicer3



```
istration...
Loading Module vtkSiemensMosaicReader...
Loading Module vtkSubVolume...
Loading Module vtkTeem...
Loading Module vtkTensorUtil...
Loading Module vtkTransformVolume...
Loading Module vtkVolumeTextureMapping...
Launching Slicer 2.7-opt...
Warning: updating year in copyright text to 2008 from 2007

MainBoot: Reading Options.xml
Ready
(slicer2.7-opt-win32-x86-2007-04-20) 49 %
```



3D Slicer is a free open source software platform for medical image processing and 3D visualization of image data. This module contains some basic information and useful links to get you started using Slicer. Please see our website http://www.slicer.org and the documentation on our wiki for more information: http://www.slicer.org/slicerWiki/index.php/Documentation-3.6.

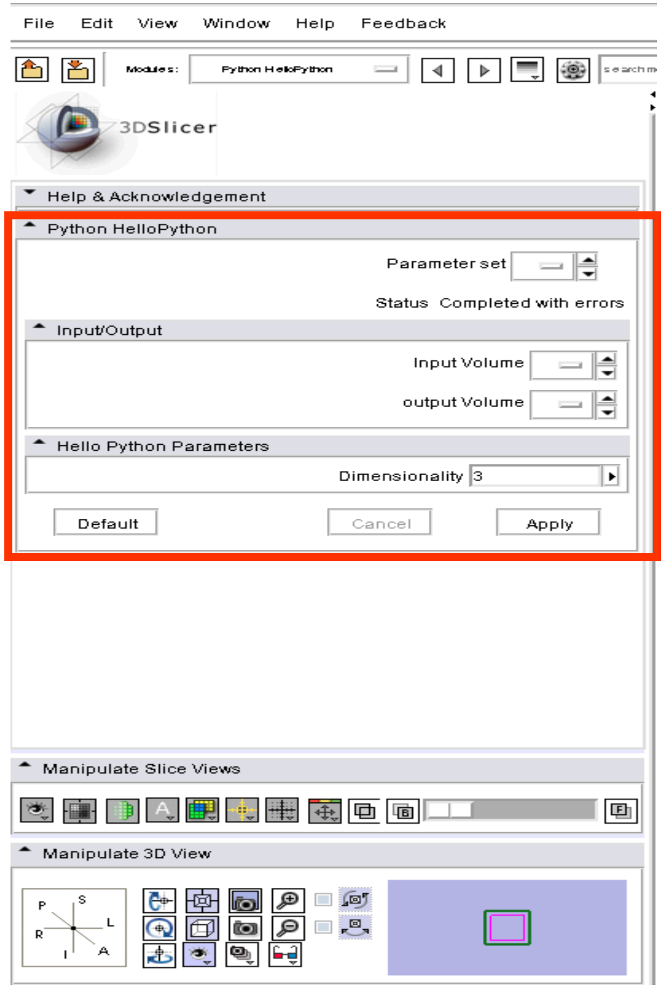
3D Slicer is distributed under a BSD-style license; for details about the contribution and software license agreement, please see http://www.slicer.org/cgi-bin/License/SlicerLicenseForm.pl. The software has been designed for research purposes only and has not been reviewed or approved by the Food and Drug Administration, or by any other agency.

Hint: to open any information panel below, click on its grey title bar.

□ Don't show this module on startup.

spgr.nhdr RAS: (159.5, 169.5, -1.9), Bg: Slice not shown,

The New Execution Model



Modules: Python HelloPython

Parameter set

Status Completed with errors

Input Volume

output Volume

Dimensionality 3

```
<?xml version="1.0" encoding="utf-8"?>
<executable>
 <category> Demonstration </category>
 <title> Python HelloPython </title>
 <description> Slicer Developer Course </description>
 <version>  1.0    </version>
 <documentation-url>  </documentation-url>
 <license></license>
 <contributor>
        Sonia Pujol, Ph.D., Surgical Planning Laboratory, Harvard Medical School
</contributor>
 <acknowledgements> National Alliance for Medical Image Computing (NAMIC), Grant
U54 EB005149. </acknowledgements>
 <parameters>
  <label>Input/Output</label>
  <description>Input/output parameters</description>
  <image>
   <name>helloPython</name>
   <label>Input Volume</label>
   <channel>input</channel>
   <index>0</index>
   <default>None</default>
   <description>Input volume</description>
  </image>
  <image>
   <name>helloPythonOutputVolume</name>
   <label>Output Volume</label>
   <channel>output</channel>
   <index>1</index>
   <default>None</default>
   <description>Output filtered</description>
  </image>
</parameters>
</executable>
```

Slicer3 Execution Model

- This course is based on the Execution Model which provides a mechanism for incorporating command line programs as Slicer modules.

- Jim Miller, Dan Blezek, Bill Lorensen (GE)

- This course uses the Python interpreter that has been integrated to Slicer.

Material

This course requires the following material

- Slicer3-3.6.3-2011-06-07

http://www.slicer.org/pages/Special:SlicerDownloads

- HelloPython.zip

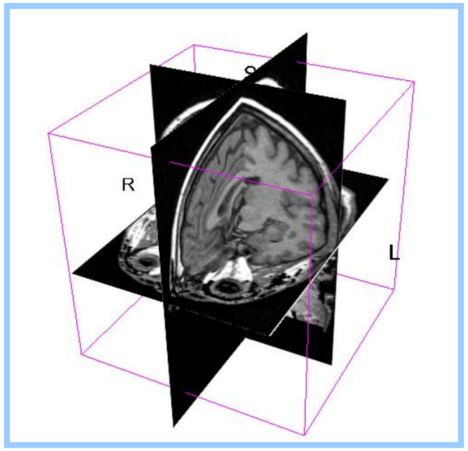
http://www.slicer.org/slicerWiki/index.php/Slicer3.6:TrainingSoftware_tutorials

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.

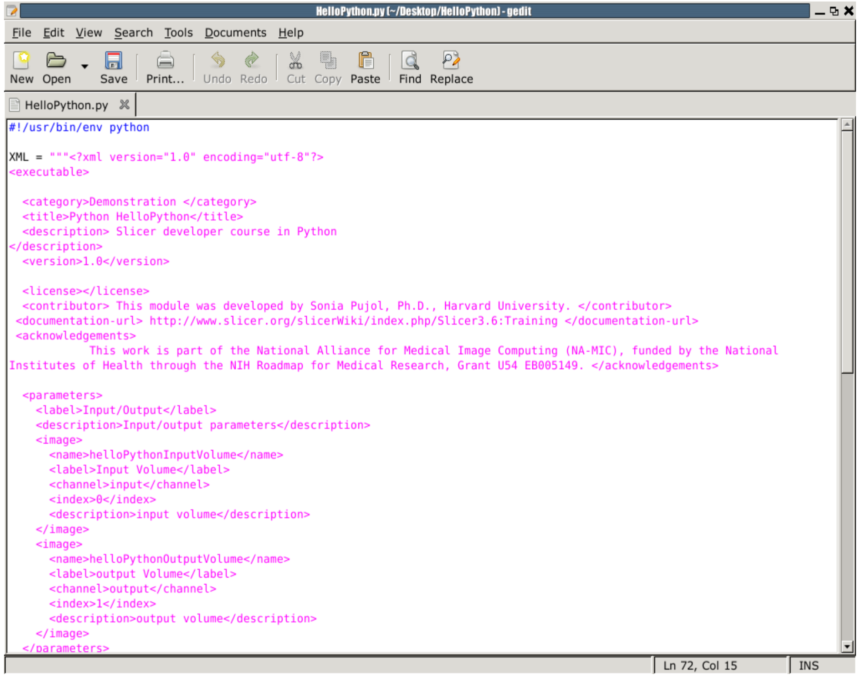
HelloPython Course Material

Unzip the HelloPython.zip archive



spgr.nhdr spgr.raw.gz

(124 SPGR images)


HelloPython.py (~/Desktop/HelloPython) - gedit
File Edit View Search Tools Documents Help
New Open Save Print... Undo Redo Cut Copy Paste Find Replace
HelloPython.py
Ln 72, Col 15
INS

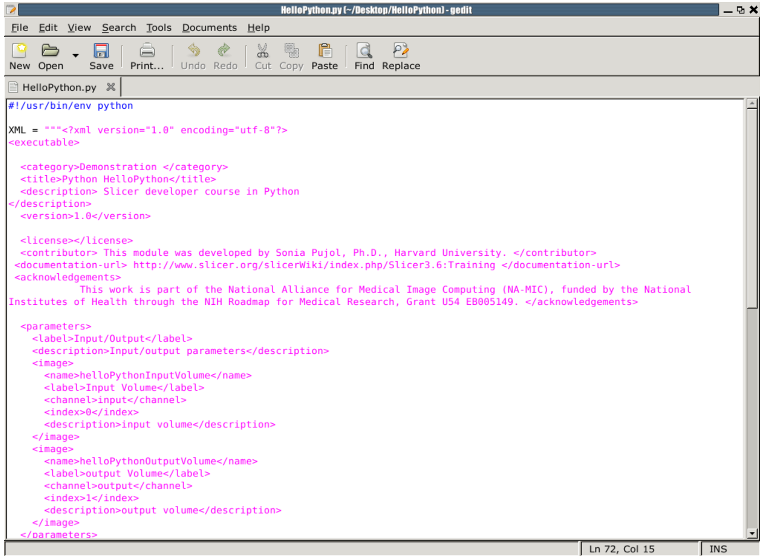
```
#!/usr/bin/env python

XML = """<?xml version="1.0" encoding="utf-8"?>
<executable>

  <category>Demonstration </category>
  <title>Python HelloPython</title>
  <description> Slicer developer course in Python
</description>
  <version>1.0</version>

  <license></license>
  <contributor> This module was developed by Sonia Pujol, Ph.D., Harvard University. </contributor>
 <documentation-url> http://www.slicer.org/slicerWiki/index.php/Slicer3.6:Training </documentation-url>
 <acknowledgements>
            This work is part of the National Alliance for Medical Image Computing (NA-MIC), funded by the National
Institutes of Health through the NIH Roadmap for Medical Research, Grant U54 EB005149. </acknowledgements>

  <parameters>
    <label>Input/Output</label>
    <description>Input/output parameters</description>
    <image>
      <name>helloPythonInputVolume</name>
      <label>Input Volume</label>
      <channel>input</channel>
      <index>0</index>
      <description>input volume</description>
    </image>
    <image>
      <name>helloPythonOutputVolume</name>
      <label>output Volume</label>
      <channel>output</channel>
      <index>1</index>
      <description>output volume</description>
    </image>
  </parameters>
```

HelloPython.py

Overview

- Part A: Integration of the HelloPython.py program into Slicer3
- Part B: Implementation of the Laplace operator in the HelloPython module
- Part C: Image Sharpening using the Laplace operator

Part A:
Integrating HelloPython into Slicer3



HelloPython.py (~/Desktop/HelloPython) - gedit
File Edit View Search Tools Documents Help
New Open Save Print... Undo Redo Cut Copy Paste Find Replace
HelloPython.py
Ln 72, Col 15
INS

```
#!/usr/bin/env python

XML = """<?xml version="1.0" encoding="utf-8"?>
<executable>

  <category>Demonstration </category>
  <title>Python HelloPython</title>
  <description> Slicer developer course in Python
</description>
  <version>1.0</version>

  <license></license>
  <contributor> This module was developed by Sonia Pujol, Ph.D., Harvard University. </contributor>
 <documentation-url> http://www.slicer.org/slicerWiki/index.php/Slicer3.6:Training </documentation-url>
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Institutes of Health through the NIH Roadmap for Medical Research, Grant U54 EB005149. </acknowledgements>

  <parameters>
    <label>Input/Output</label>
    <description>Input/output parameters</description>
    <image>
      <name>helloPythonInputVolume</name>
      <label>Input Volume</label>
      <channel>input</channel>
      <index>0</index>
      <description>input volume</description>
    </image>
    <image>
      <name>helloPythonOutputVolume</name>
      <label>output Volume</label>
      <channel>output</channel>
      <index>1</index>
      <description>output volume</description>
    </image>
  </parameters>
```
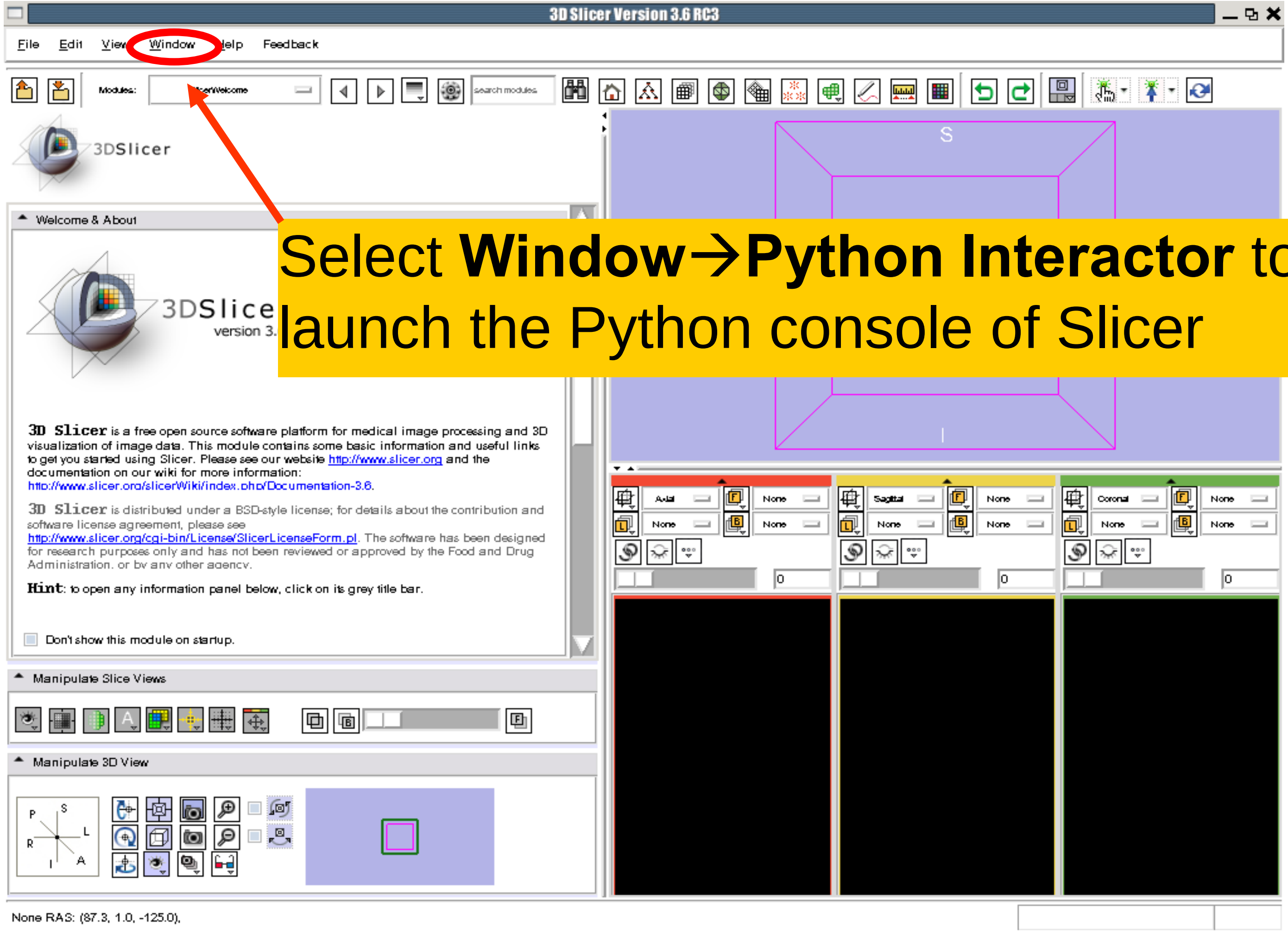

Python Console



3D Slicer is a free open source software platform for medical image processing and 3D visualization of image data. This module contains some basic information and useful links to get you started using Slicer. Please see our website http://www.slicer.org and the documentation on our wiki for more information: http://www.slicer.org/slicerWiki/index.php/Documentation-3.6.

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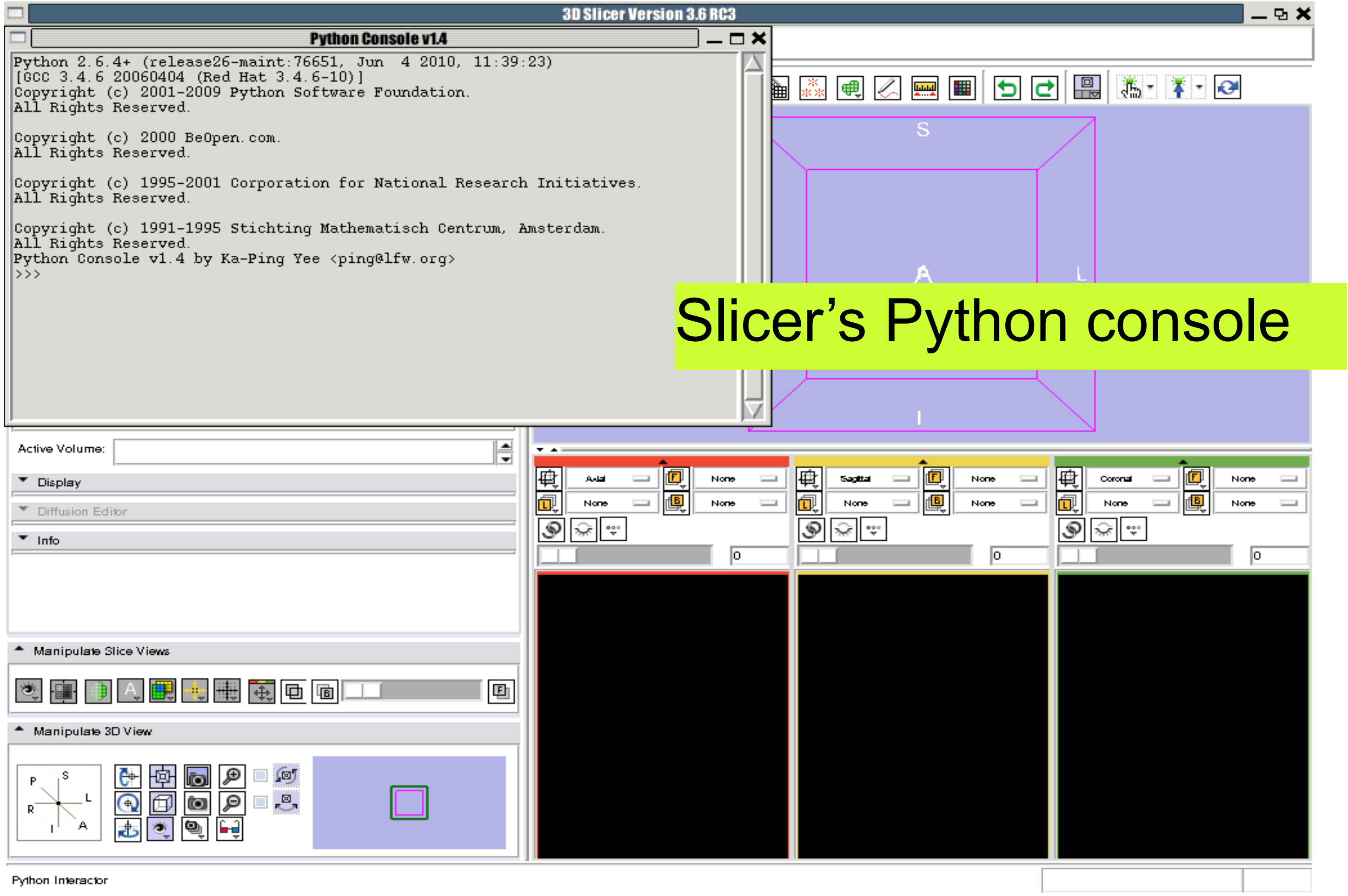
Hint: to open any information panel below, click on its grey title bar.

□ Don't show this module on startup.

None RAS: (87.3, 1.0, -125.0),

Select **Window→Python Interactor** to launch the Python console of Slicer

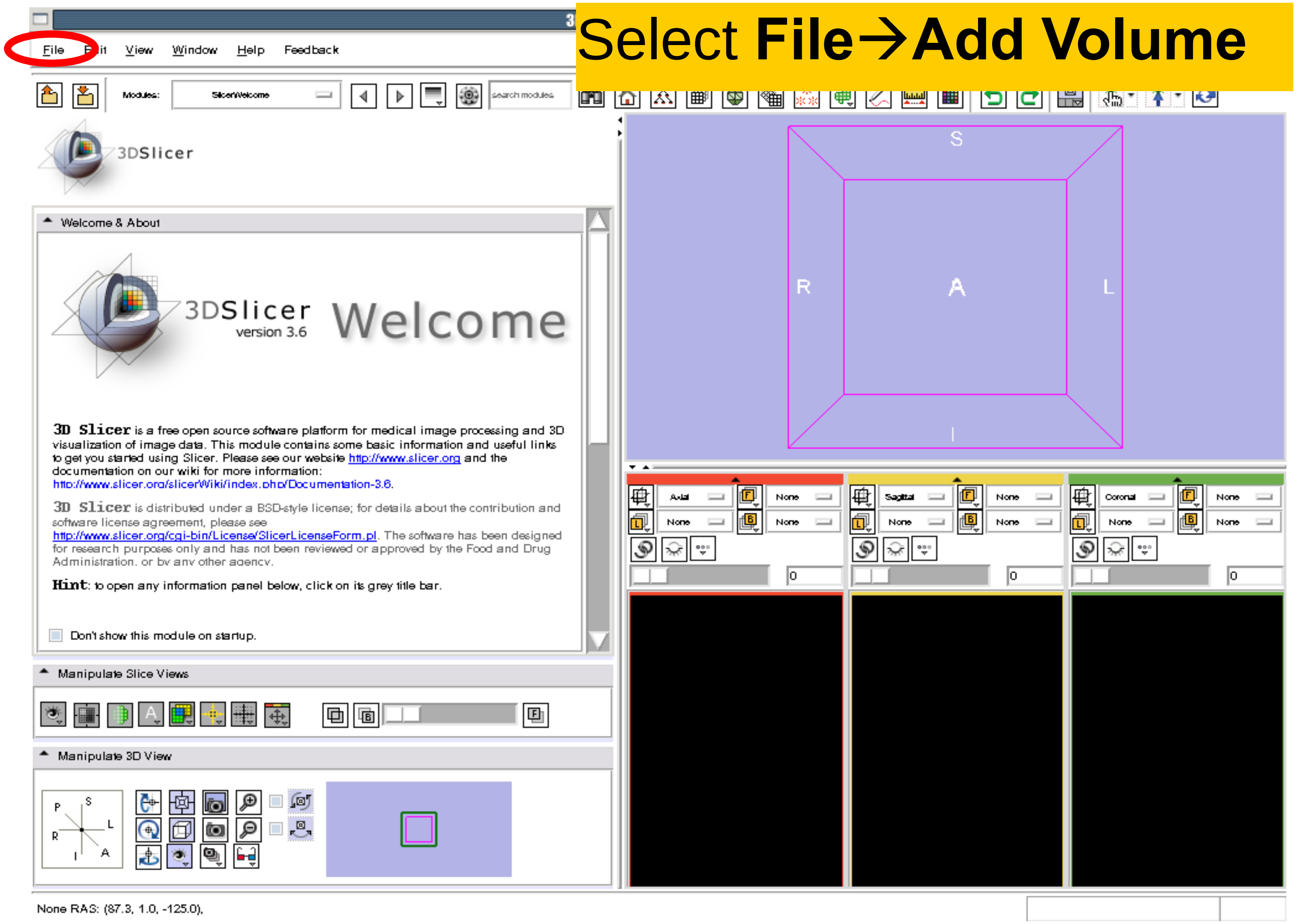
Python Console



```
Python 2.6.4+ (release26-maint:76651, Jun  4 2010, 11:39:23)
[GCC 3.4.6 20060404 (Red Hat 3.4.6-10)]
Copyright (c) 2001-2009 Python Software Foundation.
All Rights Reserved.

Copyright (c) 2000 BeOpen.com.
All Rights Reserved.

Copyright (c) 1995-2001 Corporation for National Research Initiatives.
All Rights Reserved.

Copyright (c) 1991-1995 Stichting Mathematisch Centrum, Amsterdam.
All Rights Reserved.
Python Console v1.4 by Ka-Ping Yee <ping@lfw.org>
>>>
```

Slicer’s Python console

Python Console



Select **File→Add Volume**

3D Slicer is a free open source software platform for medical image processing and 3D visualization of image data. This module contains some basic information and useful links to get you started using Slicer. Please see our website http://www.slicer.org and the documentation on our wiki for more information: http://www.slicer.org/slicerWiki/index.php/Documentation-3.6.

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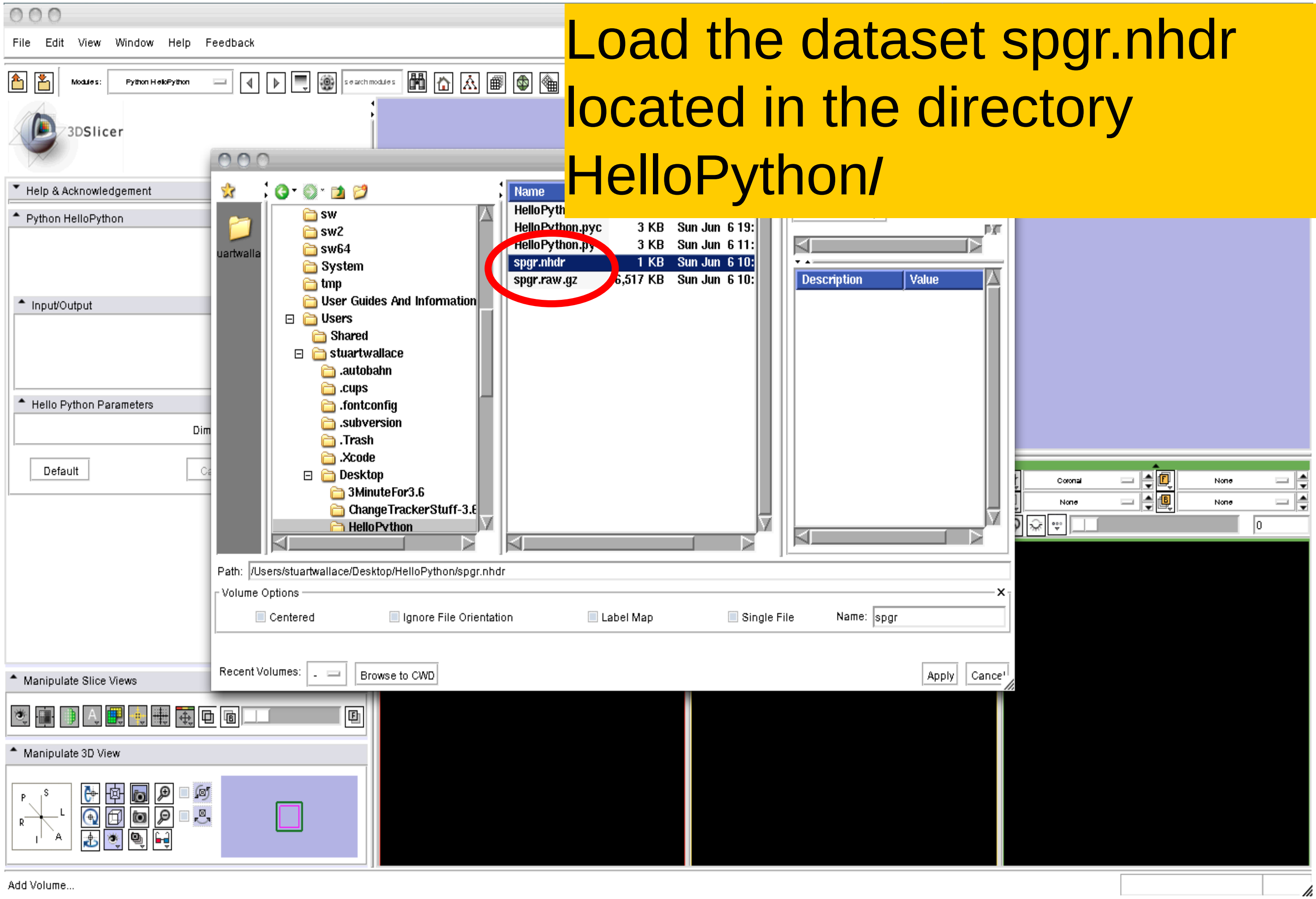
Hint: to open any information panel below, click on its grey title bar.

□ Don't show this module on startup.

None RAS: (87.3, 1.0, -125.0),

Python Console

Load the dataset spgr.nhdr located in the directory HelloPython/



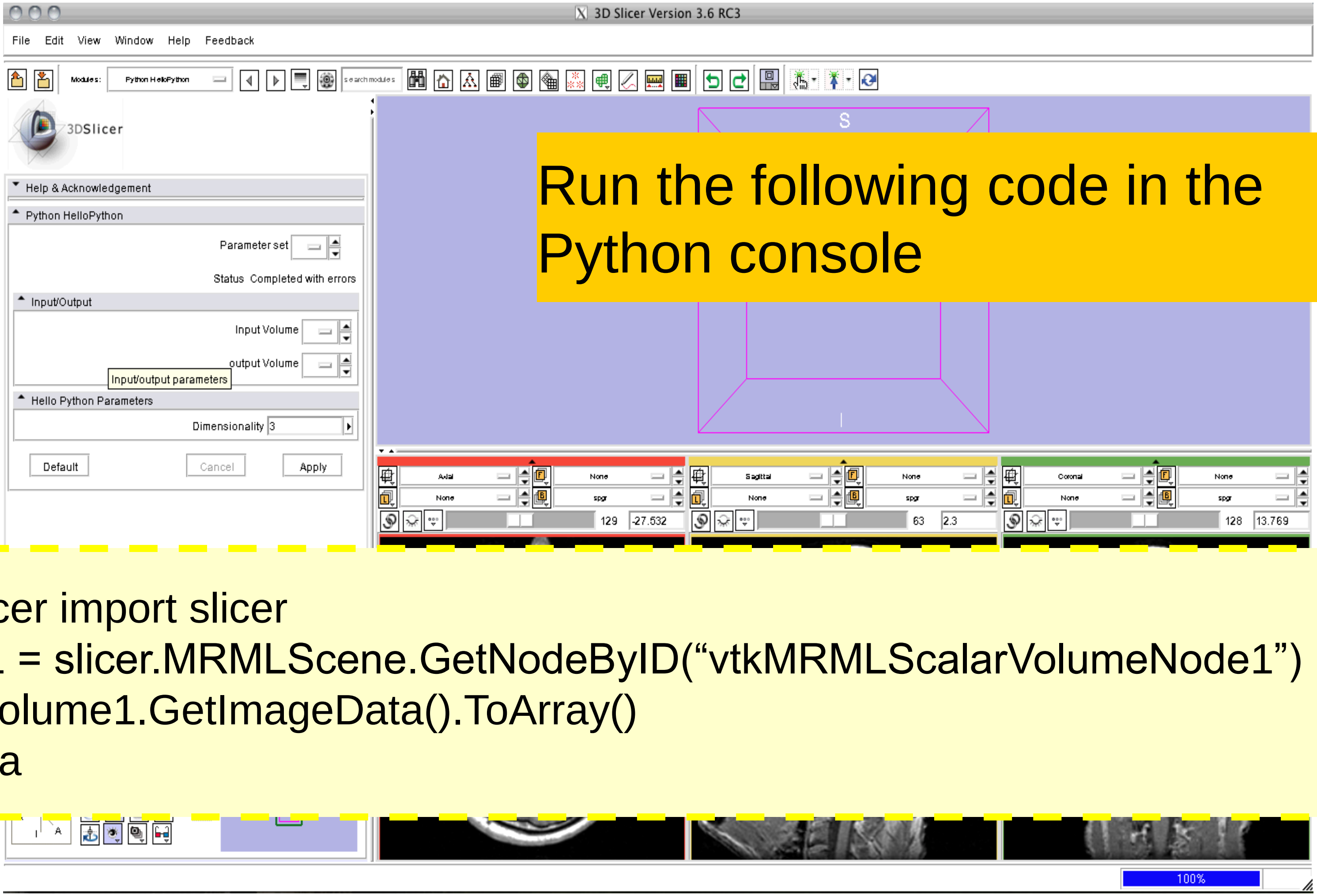
Name		
HelloPyth		
HelloPython.pyc	3 KB	Sun Jun 6 19:
HelloPython.py	3 KB	Sun Jun 6 11:
spgr.nhdr	1 KB	Sun Jun 6 10:
spgr.raw.gz	6,517 KB	Sun Jun 6 10:

Path: /Users/stuartwallace/Desktop/HelloPython/spgr.nhdr

Volume Options

□ Centered □ Ignore File Orientation □ Label Map □ Single File Name: spgr

Python Console



Parameter set

Status Completed with errors

Input Volume

output Volume

Dimensionality 3

Axial: 129, -27.532

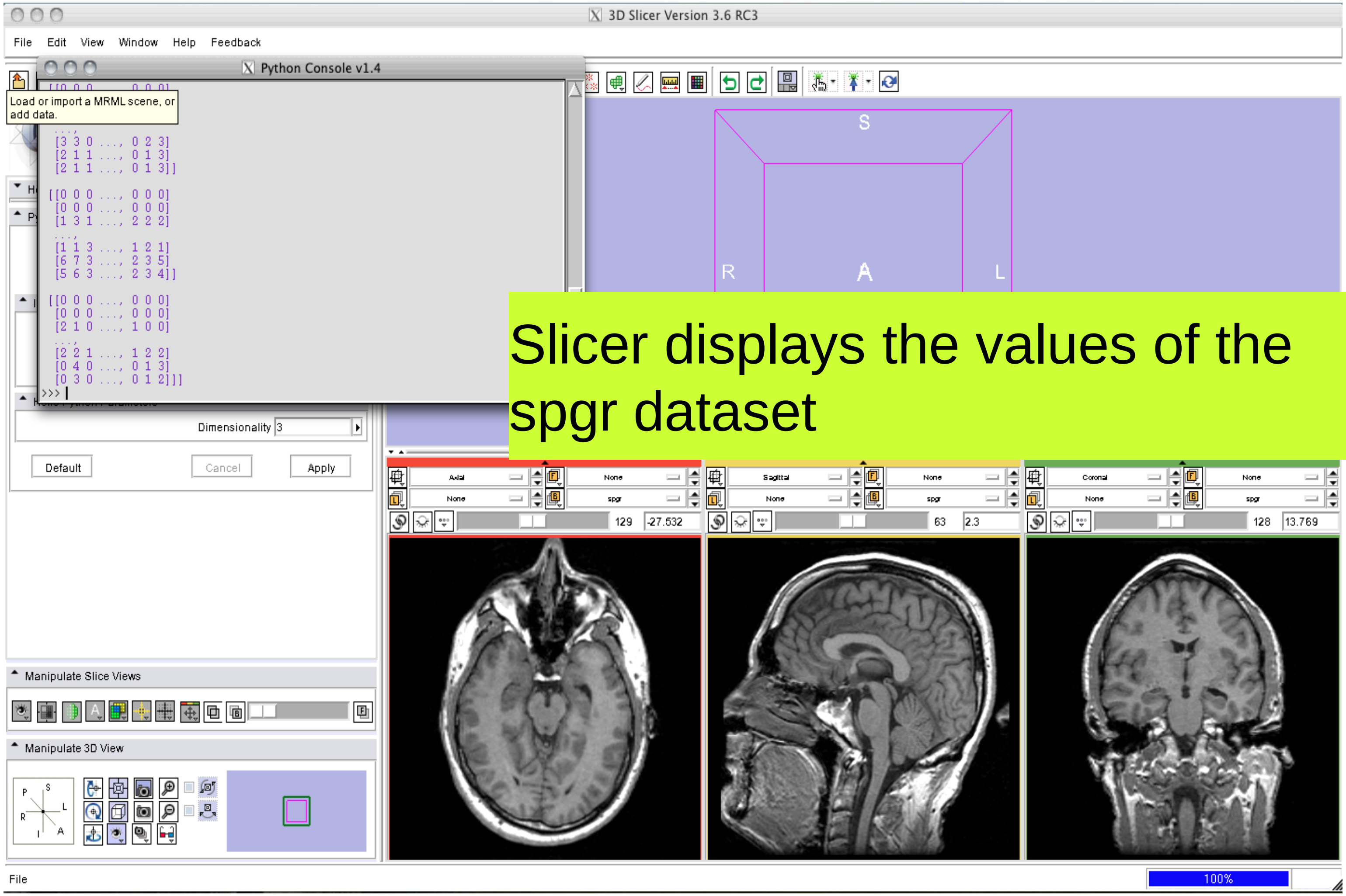
Sagittal: 63, 2.3

Coronal: 128, 13.769

Run the following code in the Python console

```
from Slicer import slicer
volume1 = slicer.MRMLScene.GetNodeByID(“vtkMRMLScalarVolumeNode1”)
data = volume1.GetImageData().ToArray()
print data
```

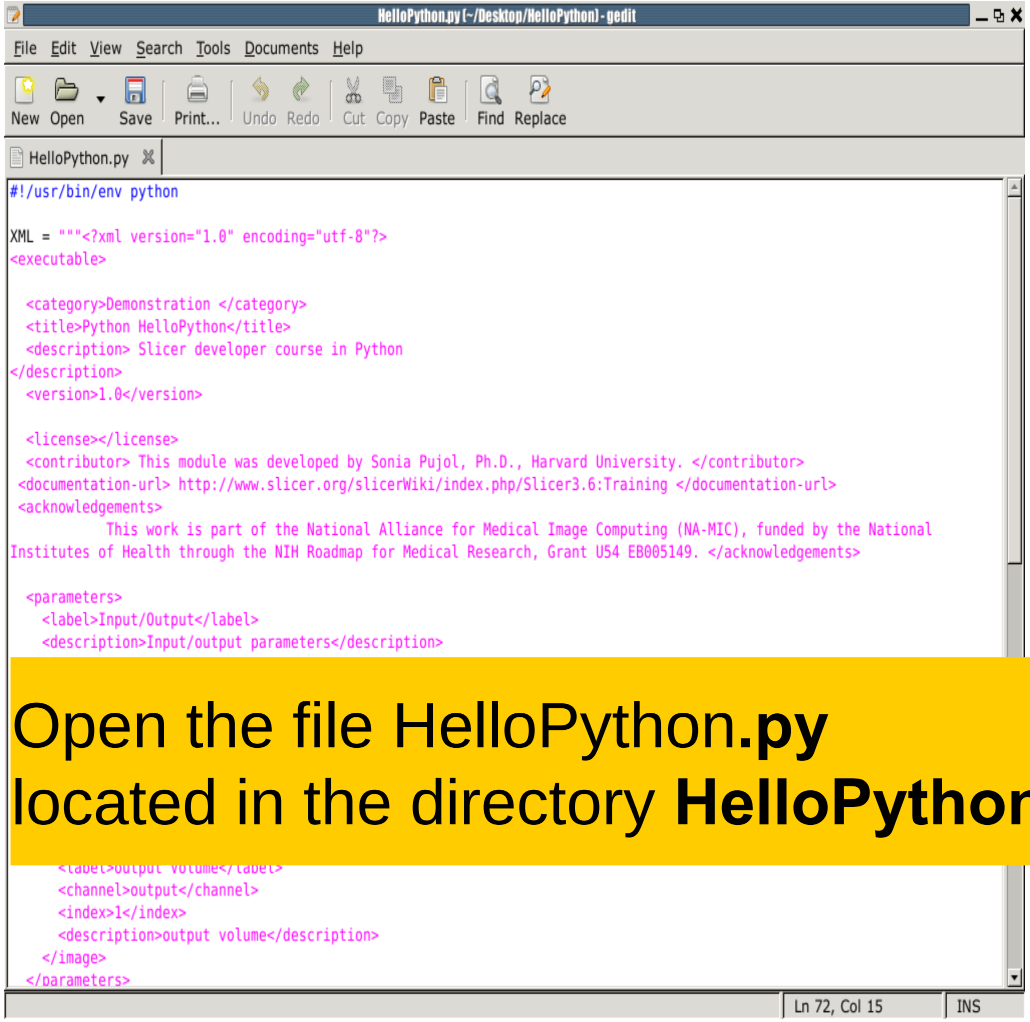
Python Console



```
[[0 0 0 ..., 0 0 0]
 ...,
 [3 3 0 ..., 0 2 3]
 [2 1 1 ..., 0 1 3]
 [2 1 1 ..., 0 1 3]]

[[0 0 0 ..., 0 0 0]
 [0 0 0 ..., 0 0 0]
 [1 3 1 ..., 2 2 2]
 ...,
 [1 1 3 ..., 1 2 1]
 [6 7 3 ..., 2 3 5]
 [5 6 3 ..., 2 3 4]]

[[0 0 0 ..., 0 0 0]
 [0 0 0 ..., 0 0 0]
 [2 1 0 ..., 1 0 0]
 ...,
 [2 2 1 ..., 1 2 2]
 [0 4 0 ..., 0 1 3]
 [0 3 0 ..., 0 1 2]]]
>>>
```

Slicer displays the values of the spgr dataset

HelloPython.py

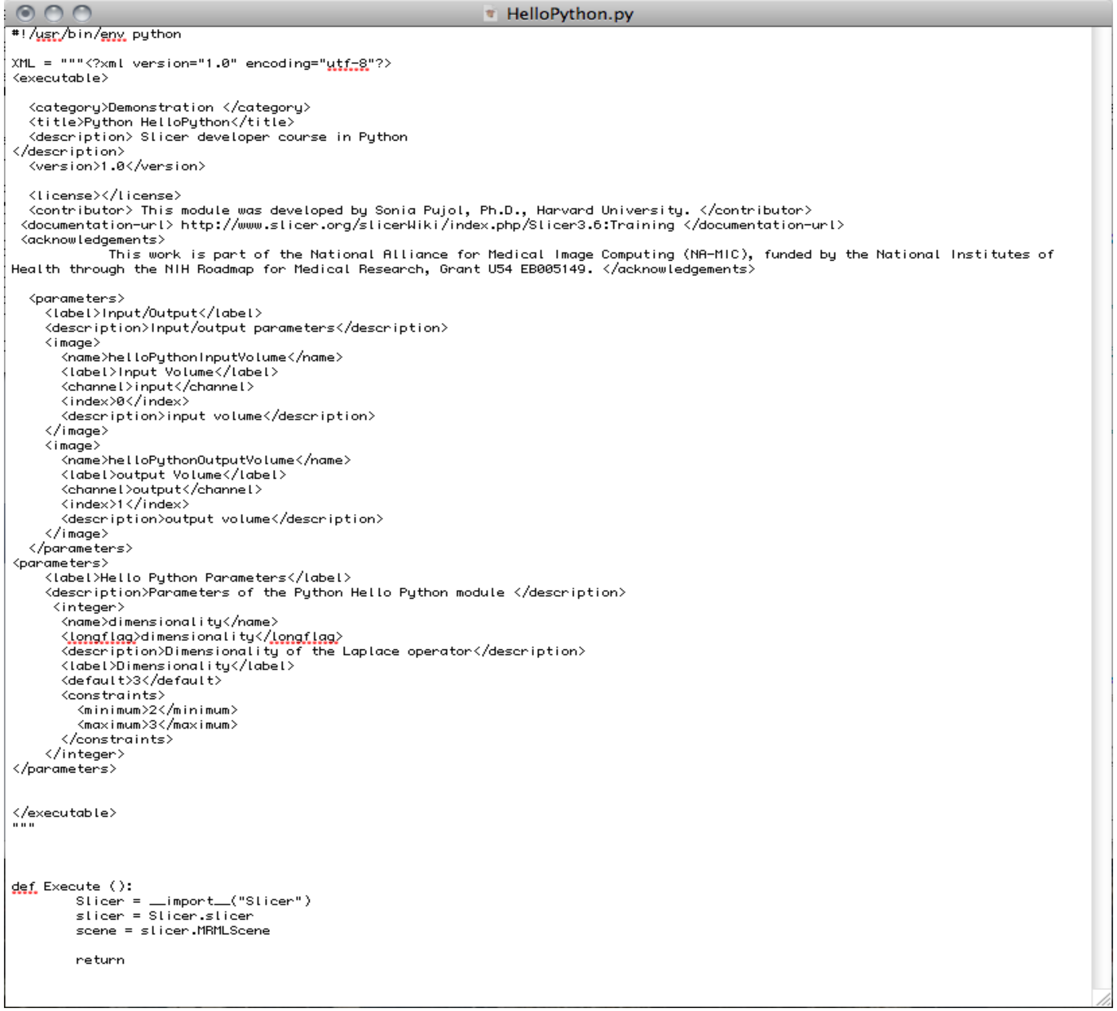

HelloPython.py (~/Desktop/HelloPython) - gedit
File Edit View Search Tools Documents Help
New Open Save Print... Undo Redo Cut Copy Paste Find Replace
HelloPython.py
Ln 72, Col 15
INS

```
#!/usr/bin/env python

XML = """<?xml version="1.0" encoding="utf-8"?>
<executable>

  <category>Demonstration </category>
  <title>Python HelloPython</title>
  <description> Slicer developer course in Python
</description>
  <version>1.0</version>

  <license></license>
  <contributor> This module was developed by Sonia Pujol, Ph.D., Harvard University. </contributor>
 <documentation-url> http://www.slicer.org/slicerWiki/index.php/Slicer3.6:Training </documentation-url>
 <acknowledgements>
            This work is part of the National Alliance for Medical Image Computing (NA-MIC), funded by the National
Institutes of Health through the NIH Roadmap for Medical Research, Grant U54 EB005149. </acknowledgements>

  <parameters>
    <label>Input/Output</label>
    <description>Input/output parameters</description>
```

Open the file HelloPython**.py**
located in the directory **HelloPython**

```
      <label>Output Volume</label>
      <channel>output</channel>
      <index>1</index>
      <description>output volume</description>
    </image>
  </parameters>
```

HelloPython.py



HelloPython.py

```
#!/usr/bin/env python

XML = """<?xml version="1.0" encoding="utf-8"?>
<executable>

  <category>Demonstration </category>
  <title>Python HelloPython</title>
  <description> Slicer developer course in Python
</description>
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Health through the NIH Roadmap for Medical Research, Grant U54 EB005149. </acknowledgements>

  <parameters>
    <label>Input/Output</label>
    <description>Input/output parameters</description>
    <image>
      <name>helloPythonInputVolume</name>
      <label>Input Volume</label>
      <channel>input</channel>
      <index>0</index>
      <description>input volume</description>
    </image>
    <image>
      <name>helloPythonOutputVolume</name>
      <label>output Volume</label>
      <channel>output</channel>
      <index>1</index>
      <description>output volume</description>
    </image>
  </parameters>
<parameters>
    <label>Hello Python Parameters</label>
    <description>Parameters of the Python Hello Python module </description>
     <integer>
      <name>dimensionality</name>
      <longflag>dimensionality</longflag>
      <description>Dimensionality of the Laplace operator</description>
      <label>Dimensionality</label>
      <default>3</default>
      <constraints>
        <minimum>2</minimum>
        <maximum>3</maximum>
      </constraints>
    </integer>
</parameters>


</executable>
"""



def Execute ():
        Slicer = __import__("Slicer")
        slicer = Slicer.slicer
        scene = slicer.MRMLScene

        return
```

Module Description

Module Parameters

Execute function

Module Description

```
#!/usr/bin/env python
XML = """<?xml version="1.0" encoding="utf-8"?>
<executable>
<category>Demonstration </category>
 <title>Python HelloPython</title>
 <description> Slicer developer course in Python </description>
  <version>1.0</version>
  <license></license>
  <contributor> This module was developed by Sonia Pujol, Ph.D., Harvard University. </contributor>
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 <acknowledgements>
          This work is part of the National Alliance for Medical Image Computing (NA-MIC),
          funded by the National Institutes of Health through the NIH Roadmap for Medical Research,
          Grant U54 EB005149.
 </acknowledgements>
```
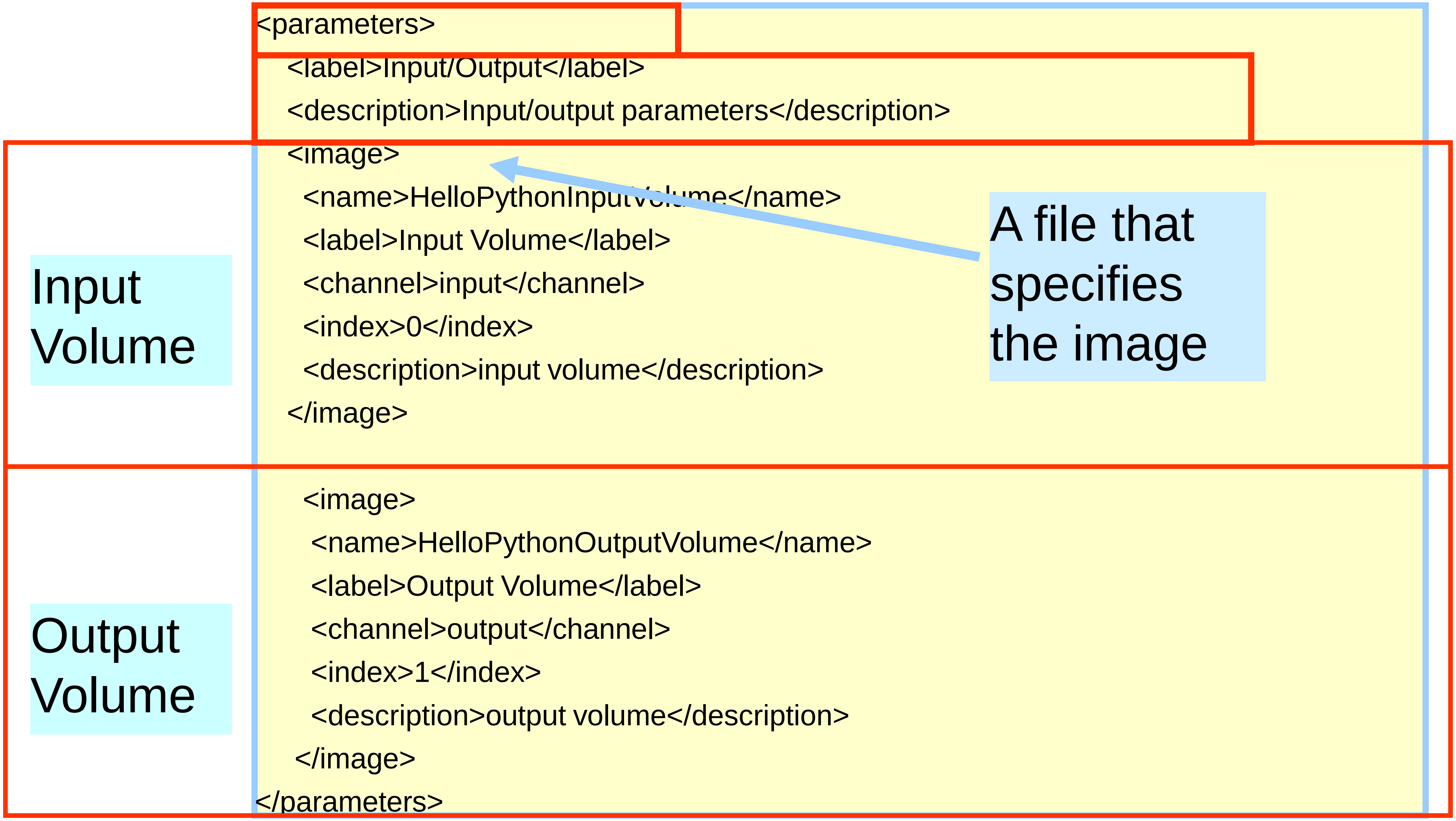

Module Parameters



```
<parameters>
   <label>Input/Output</label>
   <description>Input/output parameters</description>
   <image>
     <name>HelloPythonInputVolume</name>
     <label>Input Volume</label>
     <channel>input</channel>
     <index>0</index>
     <description>input volume</description>
   </image>

     <image>
      <name>HelloPythonOutputVolume</name>
      <label>Output Volume</label>
      <channel>output</channel>
      <index>1</index>
      <description>output volume</description>
    </image>
</parameters>
```

Input Volume

A file that specifies the image

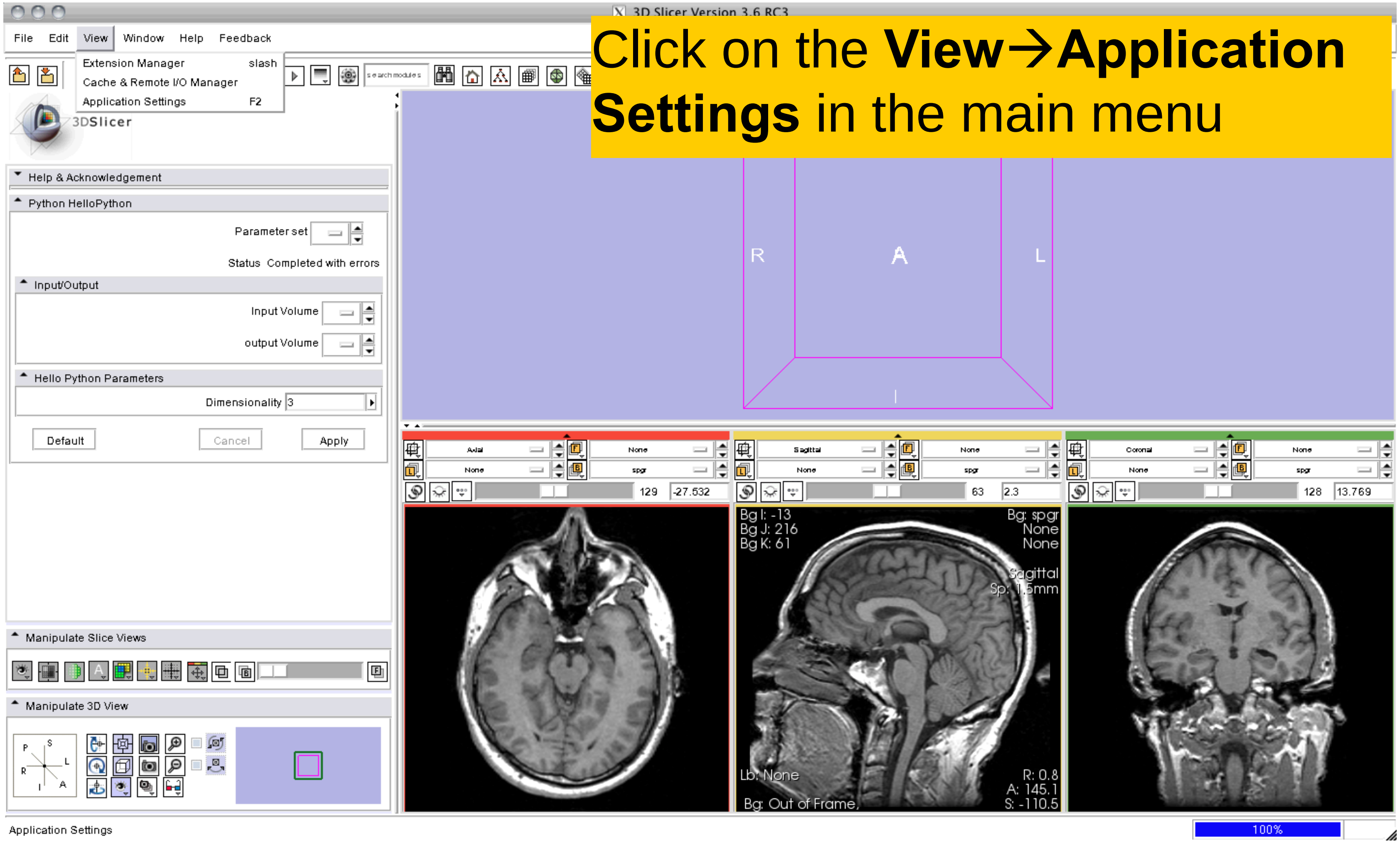
Output Volume

Execute Function

```
def Execute ():

Slicer = __import__("Slicer")
slicer = Slicer.slicer
scene = slicer.MRMLScene


return
```

The Slicer object will be the main interface to Slicer as a whole. s

Integrating HelloPython to Slicer3



Parameter set

Status Completed with errors

Input Volume

output Volume

Dimensionality 3

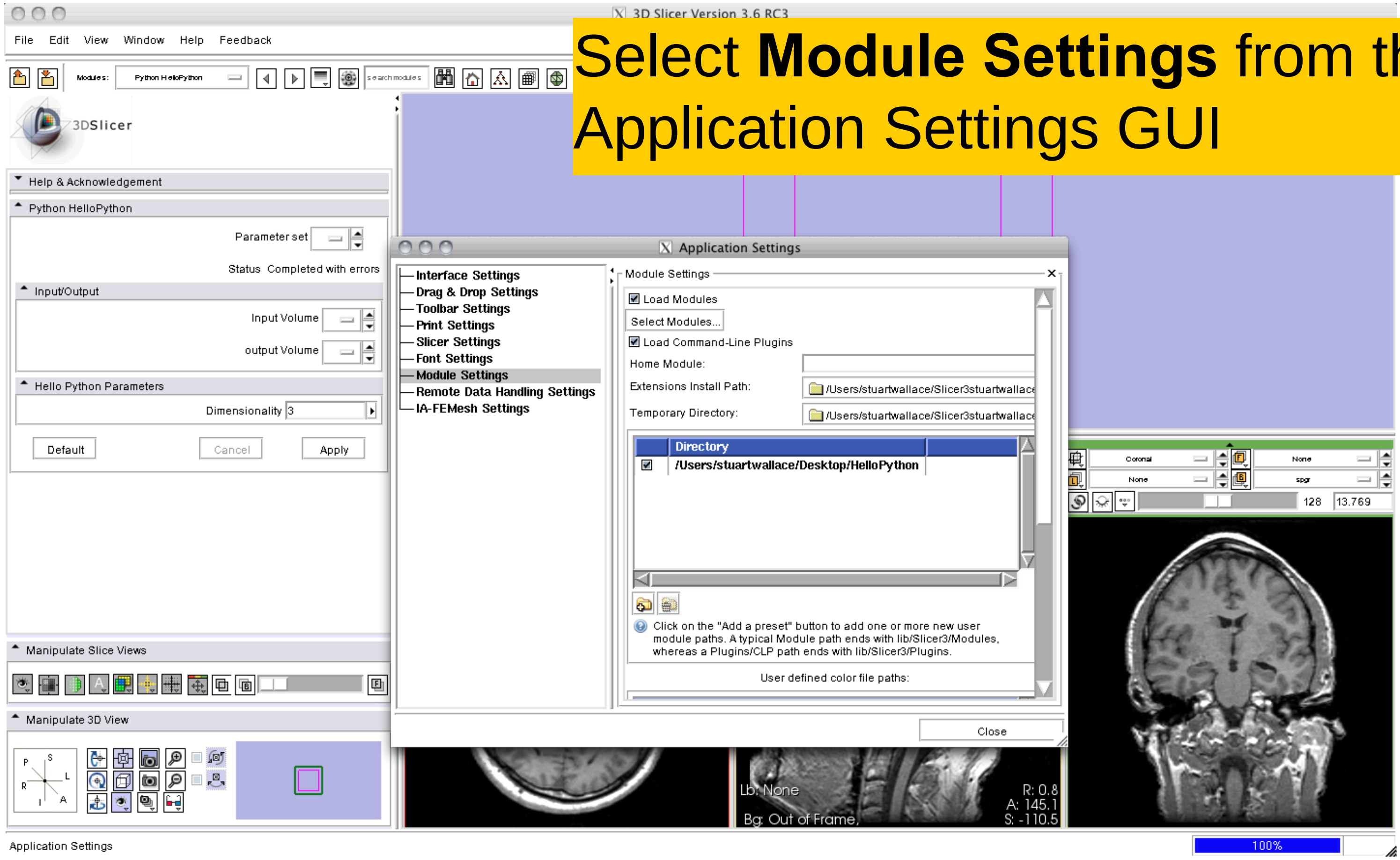
Click on the **View→Application Settings** in the main menu

Programming into Slicer3. Sonia Pujol, Ph.D., Harvard Medical School
National Alliance for Medical Image Computing

http://na-mic.org © 2010, ARR

Integrating HelloPython to Slicer3

Select **Module Settings** from the Application Settings GUI



Parameter set

Status Completed with errors

Input Volume

output Volume

Dimensionality 3

Module Settings

☑ Load Modules

☑ Load Command-Line Plugins

Home Module:

Extensions Install Path: /Users/stuartwallace/Slicer3stuartwallace

Temporary Directory: /Users/stuartwallace/Slicer3stuartwallace

	Directory
☑	/Users/stuartwallace/Desktop/HelloPython

Click on the "Add a preset" button to add one or more new user module paths. A typical Module path ends with lib/Slicer3/Modules, whereas a Plugins/CLP path ends with lib/Slicer3/Plugins.

User defined color file paths:

128 13.769

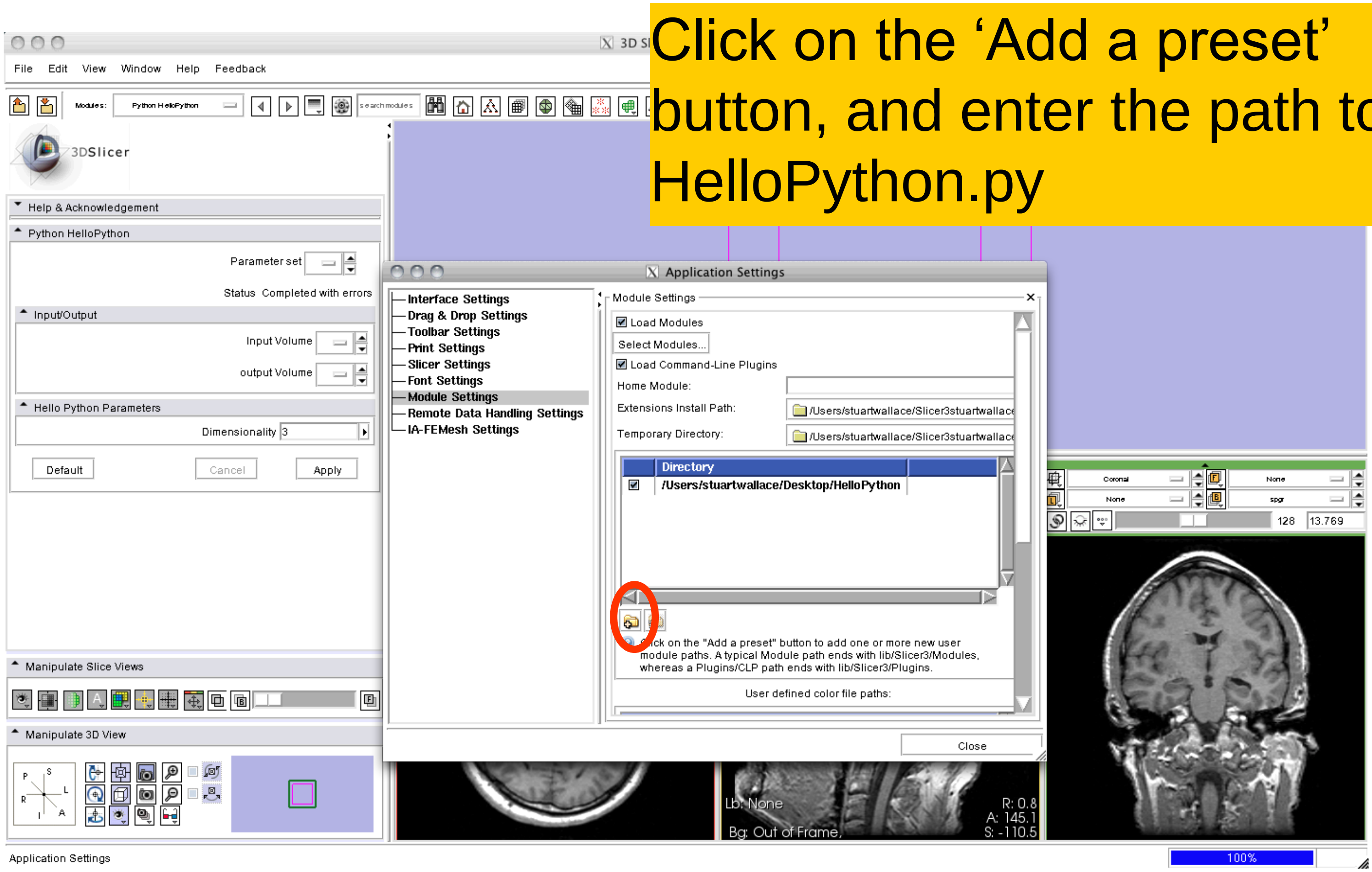
Lb: None
Bg: Out of Frame

R: 0.8
A: 145.1
S: -110.5

Application Settings

Integrating HelloPython to Slicer3

Click on the ‘Add a preset’ button, and enter the path to HelloPython.py



Parameter set

Status Completed with errors

Input Volume

output Volume

Dimensionality 3

Module Settings

☑ Load Modules

☑ Load Command-Line Plugins

Home Module:

Extensions Install Path: /Users/stuartwallace/Slicer3stuartwallace

Temporary Directory: /Users/stuartwallace/Slicer3stuartwallace

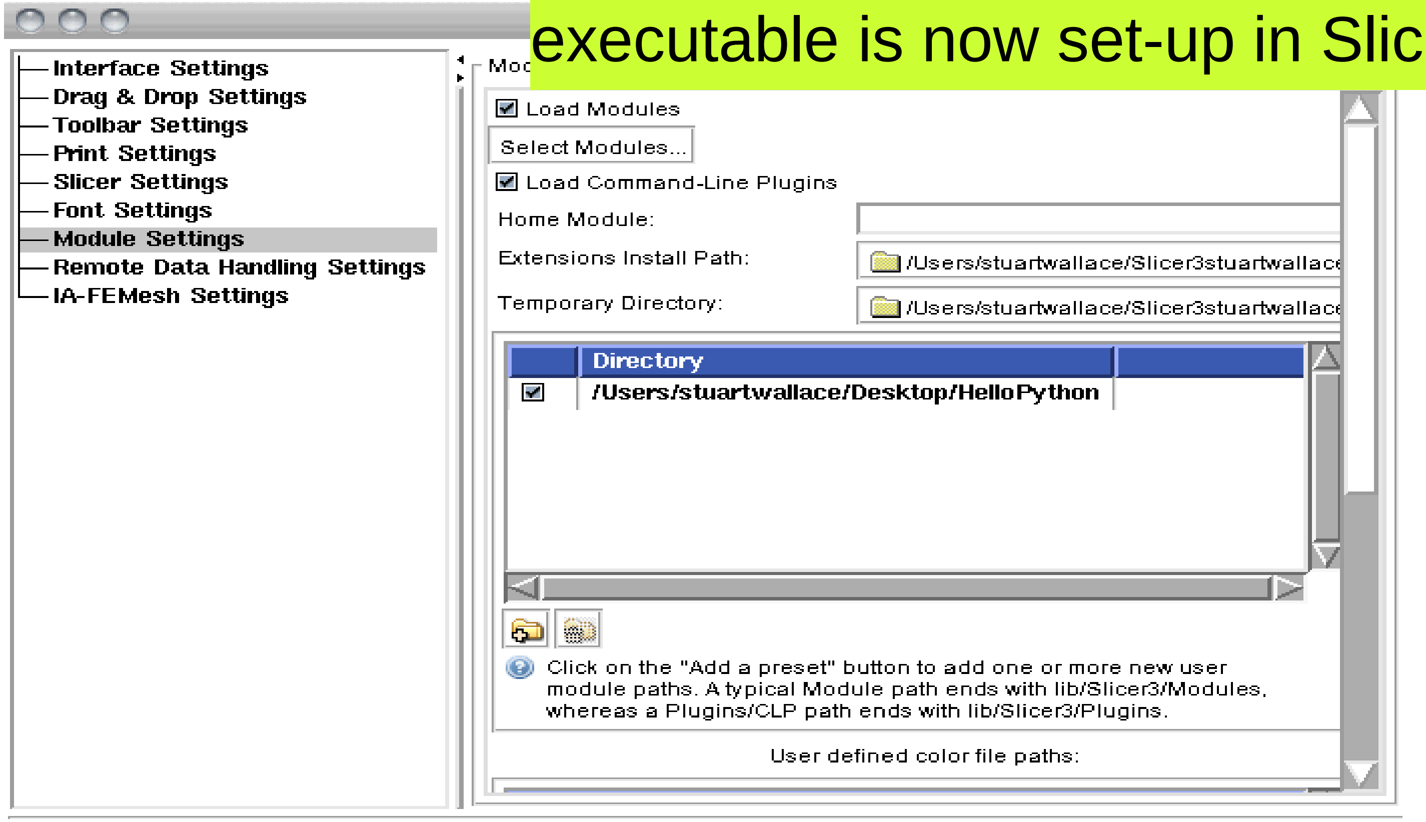
	Directory
☑	/Users/stuartwallace/Desktop/HelloPython

ck on the "Add a preset" button to add one or more new user module paths. A typical Module path ends with lib/Slicer3/Modules, whereas a Plugins/CLP path ends with lib/Slicer3/Plugins.

User defined color file paths:

Integrating HelloPython to Slicer3

The path to the HelloPython.py executable is now set-up in Slicer3.



☑ Load Modules

☑ Load Command-Line Plugins

Home Module:

Extensions Install Path: /Users/stuartwallace/Slicer3stuartwallace

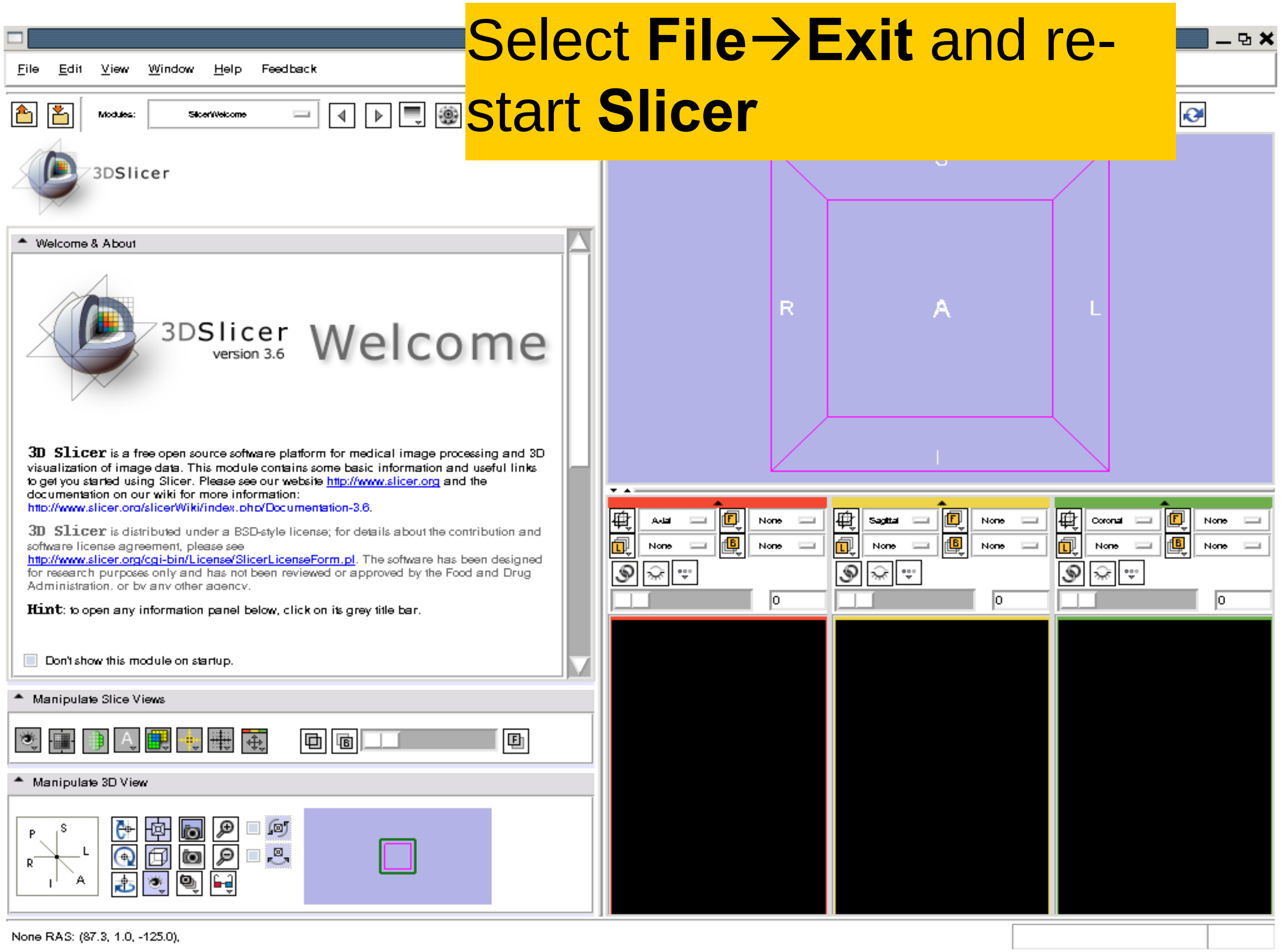
Temporary Directory: /Users/stuartwallace/Slicer3stuartwallace

	Directory
☑	/Users/stuartwallace/Desktop/HelloPython

Click on the "Add a preset" button to add one or more new user module paths. A typical Module path ends with lib/Slicer3/Modules, whereas a Plugins/CLP path ends with lib/Slicer3/Plugins.

Click on the **Close** to exit the Application Settings window.

Integrating HelloPython to Slicer3



Select **File→Exit** and re-start **Slicer**

3D Slicer is a free open source software platform for medical image processing and 3D visualization of image data. This module contains some basic information and useful links to get you started using Slicer. Please see our website http://www.slicer.org and the documentation on our wiki for more information: http://www.slicer.org/slicerWiki/index.php/Documentation-3.6.

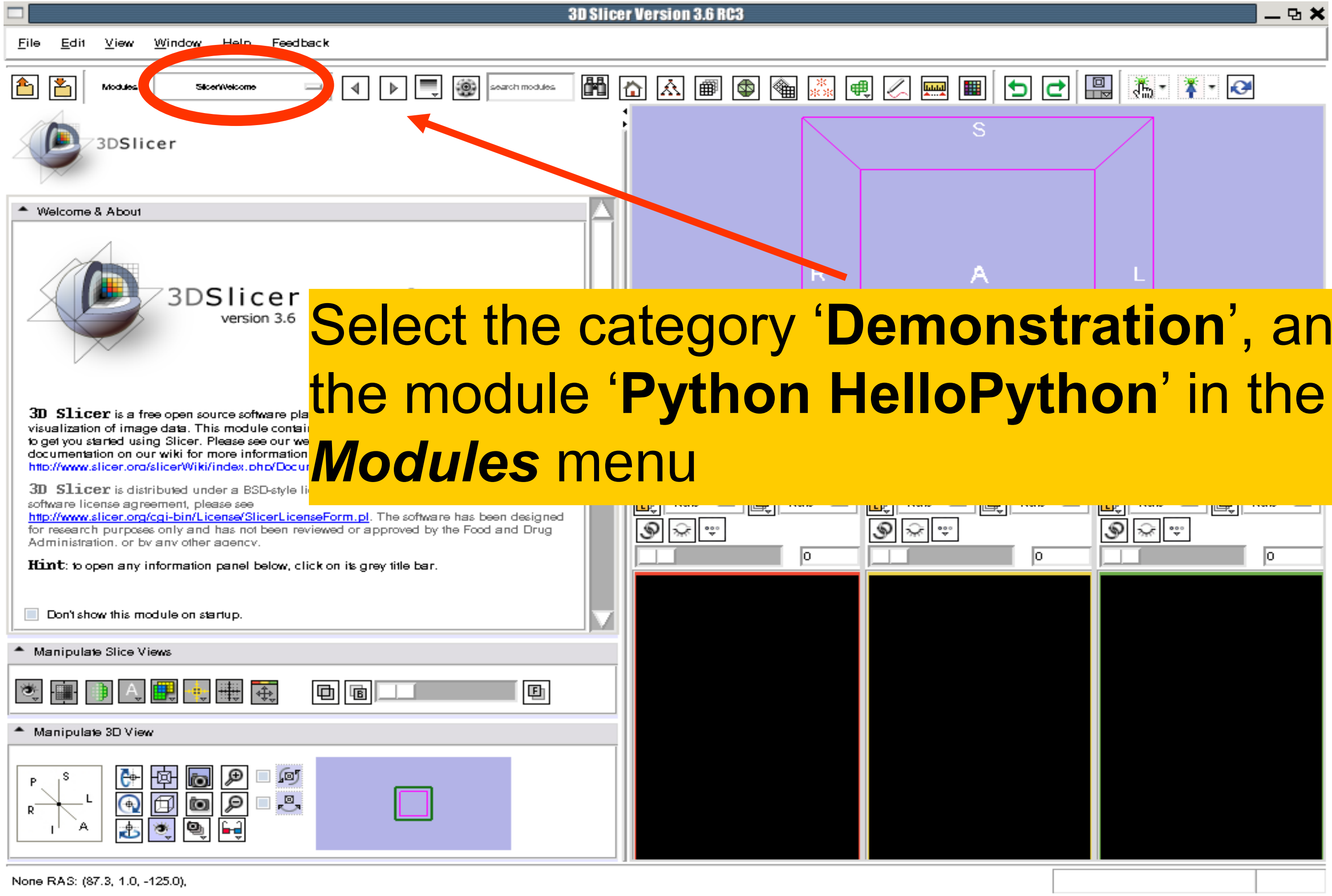
3D Slicer is distributed under a BSD-style license; for details about the contribution and software license agreement, please see http://www.slicer.org/cgi-bin/License/SlicerLicenseForm.pl. The software has been designed for research purposes only and has not been reviewed or approved by the Food and Drug Administration, or by any other agency.

Hint: to open any information panel below, click on its grey title bar.

□ Don't show this module on startup.

None RAS: (87.3, 1.0, -125.0),

HelloPython module



3D Slicer is a free open source software pla
visualization of image data. This module contai
to get you started using Slicer. Please see our we
documentation on our wiki for more information
http://www.slicer.org/slicerWiki/index.php/Docu

3D Slicer is distributed under a BSD-style li
software license agreement, please see
http://www.slicer.org/cgi-bin/License/SlicerLicenseForm.pl. The software has been designed for research purposes only and has not been reviewed or approved by the Food and Drug Administration, or by any other agency.

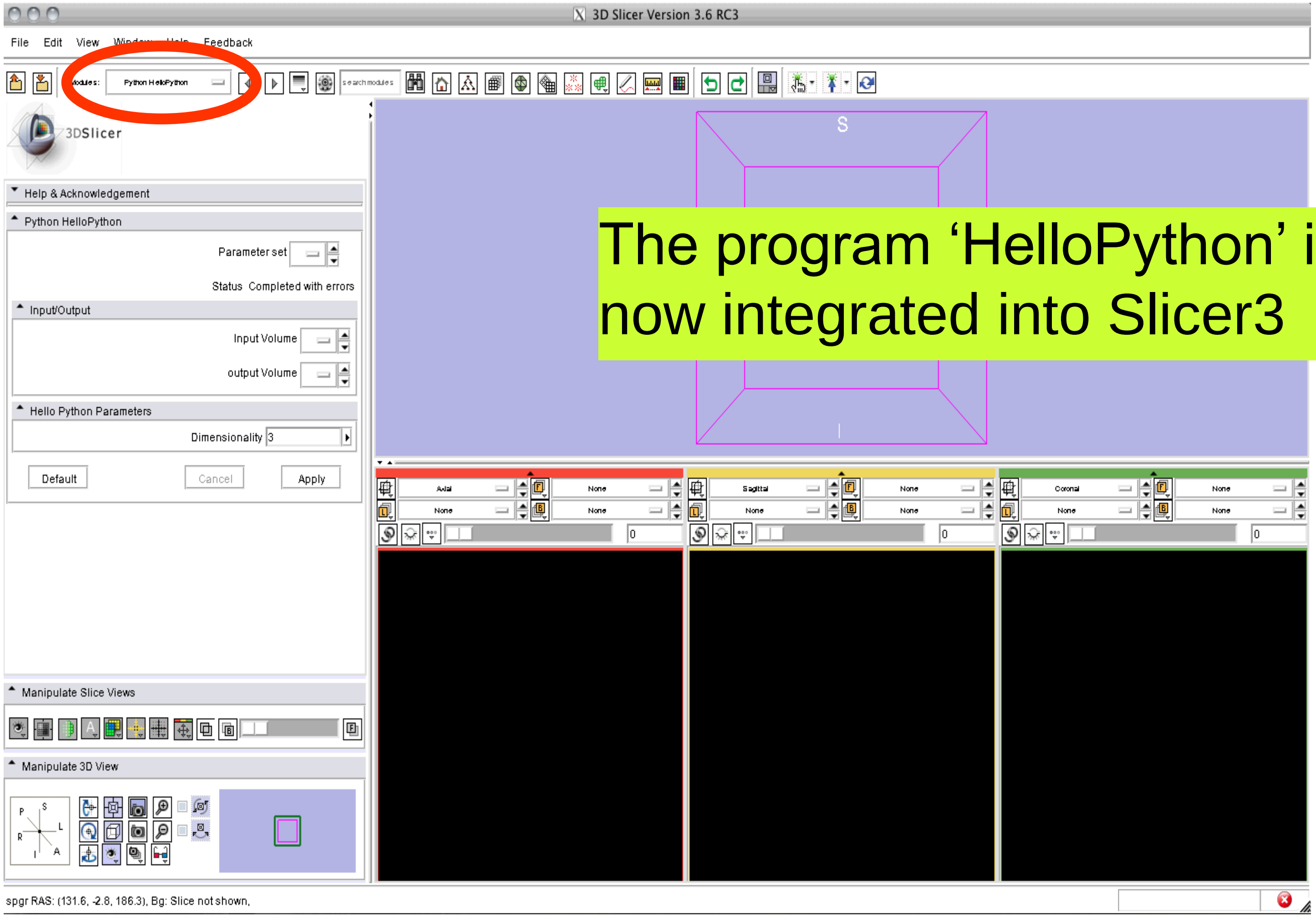
Hint: to open any information panel below, click on its grey title bar.

□ Don't show this module on startup.

None RAS: (87.3, 1.0, -125.0).

Select the category ‘**Demonstration**’, and the module ‘**Python HelloPython**’ in the ***Modules*** menu

HelloPython Module



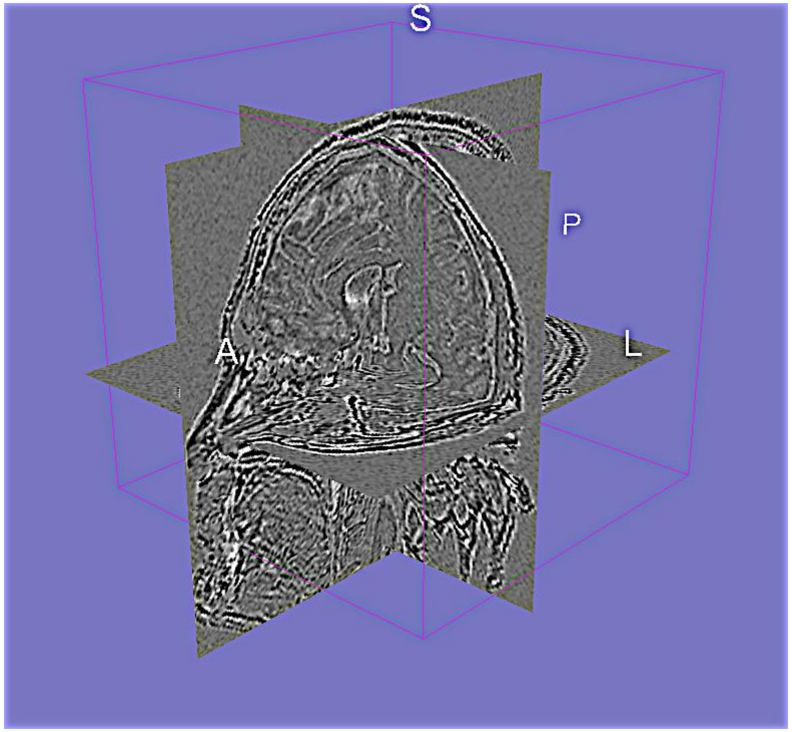
Modules: Python HelloPython

Status Completed with errors

Dimensionality 3

spgr RAS: (131.6, -2.8, 186.3), Bg: Slice not shown,

The program 'HelloPython' is now integrated into Slicer3



Part B: Implementing the Laplace* Operator

*named after Pierre-Simon, Marquis de Laplace (1749-1827)

Execute Function

```
def Execute (HelloPythonInputVolume, HelloPythonOutputVolume):

Slicer = __import__("Slicer")
slicer = Slicer.slicer
scene = slicer.MRMLScene
inputVolume = scene.GetNodeByID(HelloPythonInputVolume)
outputVolume = scene.GetNodeByID(HelloPythonOutputVolume)

return
```

Add the I/O code

Laplace Operator

```
def Execute (HelloPythonInputVolume, HelloPythonOutputVolume):


Slicer = __import__("Slicer")
slicer = Slicer.slicer
scene = slicer.MRMLScene
inputVolume = scene.GetNodeByID(HelloPythonInputVolume)
outputVolume = scene.GetNodeByID(HelloPythonOutputVolume)
laplacian = slicer.vtkImageLaplacian()
laplacian.SetInput(inputVolume.GetImageData())


return
```

Add the Laplace operator

Laplace Operator

```
<parameters>
    <label>Input/Output</label>
    <description>Input/output parameters</description>
    <image>
      <name>HelloPythonInputVolume</name>
      <label>Input Volume</label>
      <channel>input</channel>
      <index>0</index>
      <description>input volume</description>
     </image>
     <image>
       <name>HelloPythonOutputVolume</name>
       <label>Output Volume</label>
       <channel>output</channel>
       <index>1</index>
       <description>output volume</description>
      </image>
</parameters>
<parameters>
    <label>Hello Python Parameters</label>
    <description> Parameters of the Python Hello Python module </description>
</parameters>
```

Add a new parameter group for the Laplace operator

Laplace Operator

```
<parameters>
  <label>Hello Python Parameters</label>
  <description>Parameters of the Python Hello Python module </description>
   <integer>
    <name>dimensionality</name>
    <longflag>dimensionality</longflag>
    <description>Dimensionality of the Laplace operator</description>
    <label>Dimensionality</label>
    <default>3</default>
    <constraints>
      <minimum>2</minimum>
      <maximum>3</maximum>
    </constraints>
  </integer>
 </parameters>
```

Add the Laplace operator’s dimensionality

Laplace Operator

```
def Execute (HelloPythonInputVolume, HelloPythonOutputVolume,
dimensionality=3):
Slicer = __import__("Slicer")
slicer = Slicer.slicer
scene = slicer.MRMLScene
inputVolume = scene.GetNodeByID(HelloPythonInputVolume)
outputVolume = scene.GetNodeByID(HelloPythonOutputVolume)
laplacian = slicer.vtkImageLaplacian()
laplacian.SetInput(inputVolume.GetImageData())
laplacian.SetDimensionality(dimensionality)

return
```

Set-up the corresponding dimensionality parameter in the Python code

Laplace Operator

```
def Execute (HelloPythonInputVolume, HelloPythonOutputVolume,
dimensionality=3):
Slicer = __import__("Slicer")
slicer = Slicer.slicer
scene = slicer.MRMLScene
inputVolume = scene.GetNodeByID(HelloPythonInputVolume)
outputVolume = scene.GetNodeByID(HelloPythonOutputVolume)
laplacian = slicer.vtkImageLaplacian()
laplacian.SetInput(inputVolume.GetImageData())
laplacian.SetDimensionality(dimensionality)
laplacian.Update()
outputVolume.SetAndObserveImageData(laplacian.GetOutput())
return
```

Add code to get the output of the Laplace operator

Laplace Operator

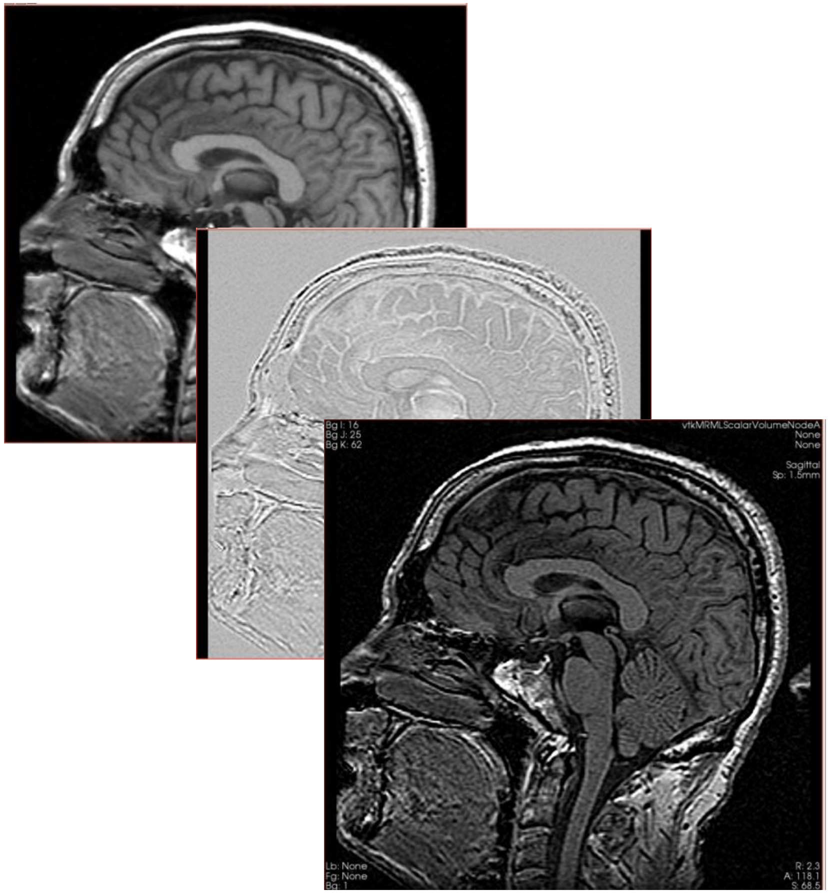
```
def Execute (HelloPythonInputVolume, HelloPythonOutputVolume, dimensionality=3):
Slicer = __import__("Slicer")
slicer = Slicer.slicer
scene = slicer.MRMLScene
inputVolume = scene.GetNodeByID(HelloPythonInputVolume)
outputVolume = scene.GetNodeByID(HelloPythonOutputVolume)
laplacian = slicer.vtkImageLaplacian()
laplacian.SetInput(inputVolume.GetImageData())
laplacian.SetDimensionality(dimensionality)
laplacian.Update()
outputVolume.SetAndObserveImageData(laplacian.GetOutput())
matrix = slicer.vtkMatrix4x4()
inputVolume.GetIJKToRASMatrix(matrix)
 outputVolume.SetIJKToRASMatrix(matrix)
return
```

Place back the Laplacian of the image in the RAS reference system.

Integrating HelloPython to Slicer3

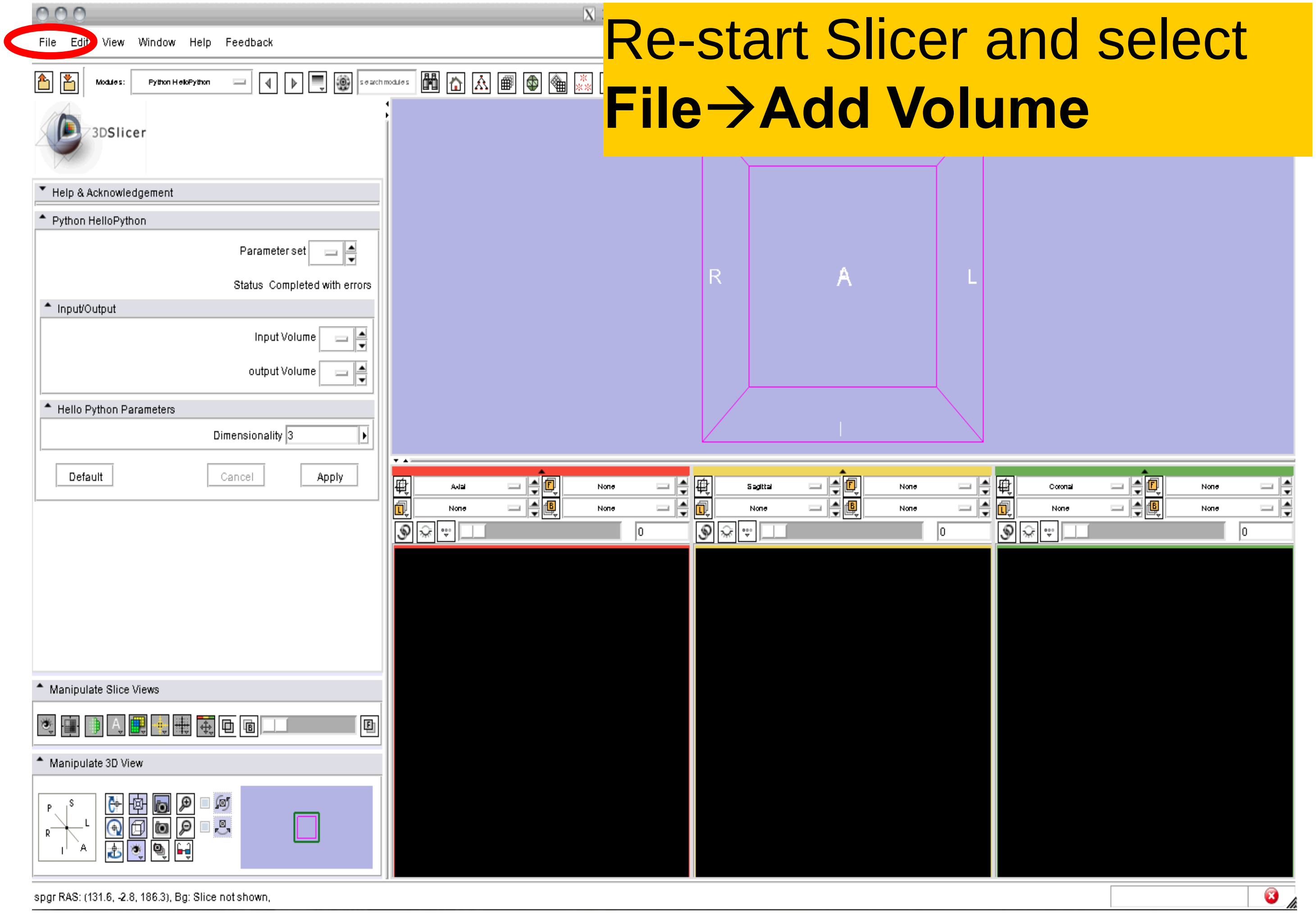
```
def Execute (HelloPythonInputVolume, HelloPythonOutputVolume,
dimensionality=3):
Slicer = __import__("Slicer")
slicer = Slicer.slicer
scene = slicer.MRMLScene
inputVolume = scene.GetNodeByID(HelloPythonInputVolume)
outputVolume = scene.GetNodeByID(HelloPythonOutputVolume)
laplacian = slicer.vtkImageLaplacian()
laplacian.SetInput(inputVolume.GetImageData())
laplacian.SetDimensionality(dimensionality)
laplacian.Update()
outputVolume.SetAndObserveImageData(laplacian.GetOutput())
matrix = slicer.vtkMatrix4x4()
inputVolume.GetIJKToRASMatrix(matrix)
outputVolume.SetIJKToRASMatrix(matrix)
return
```

Save the HelloPython.py file and exit Slicer.



Part C: Image Sharpening with the Laplace Operator

Running the Laplace Operator



Modules: Python HelloPython

Parameter set

Status Completed with errors

Input Volume

output Volume

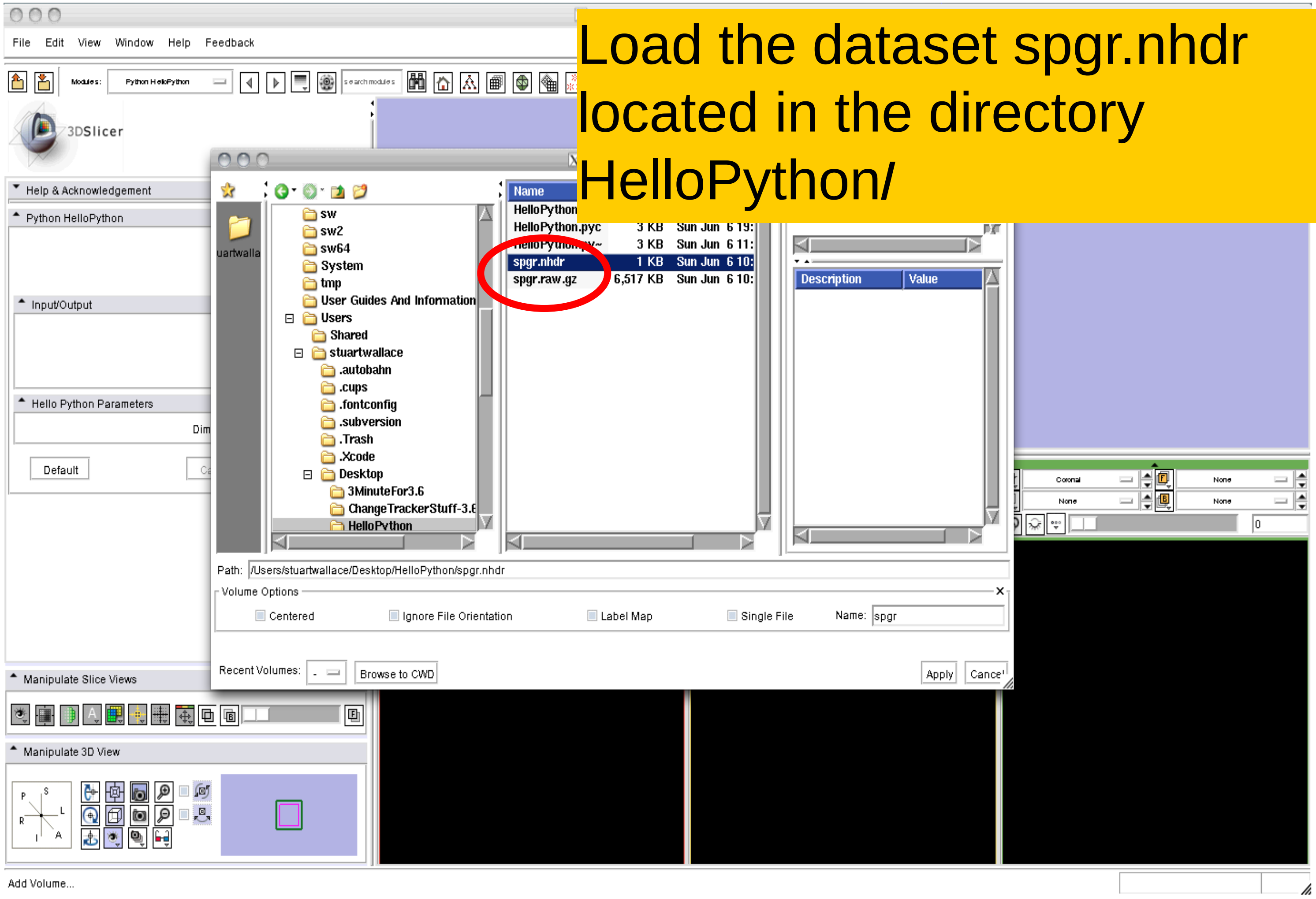
Dimensionality 3

spgr RAS: (131.6, -2.8, 186.3), Bg: Slice not shown,

Re-start Slicer and select

File→Add Volume

Running the Laplace Operator



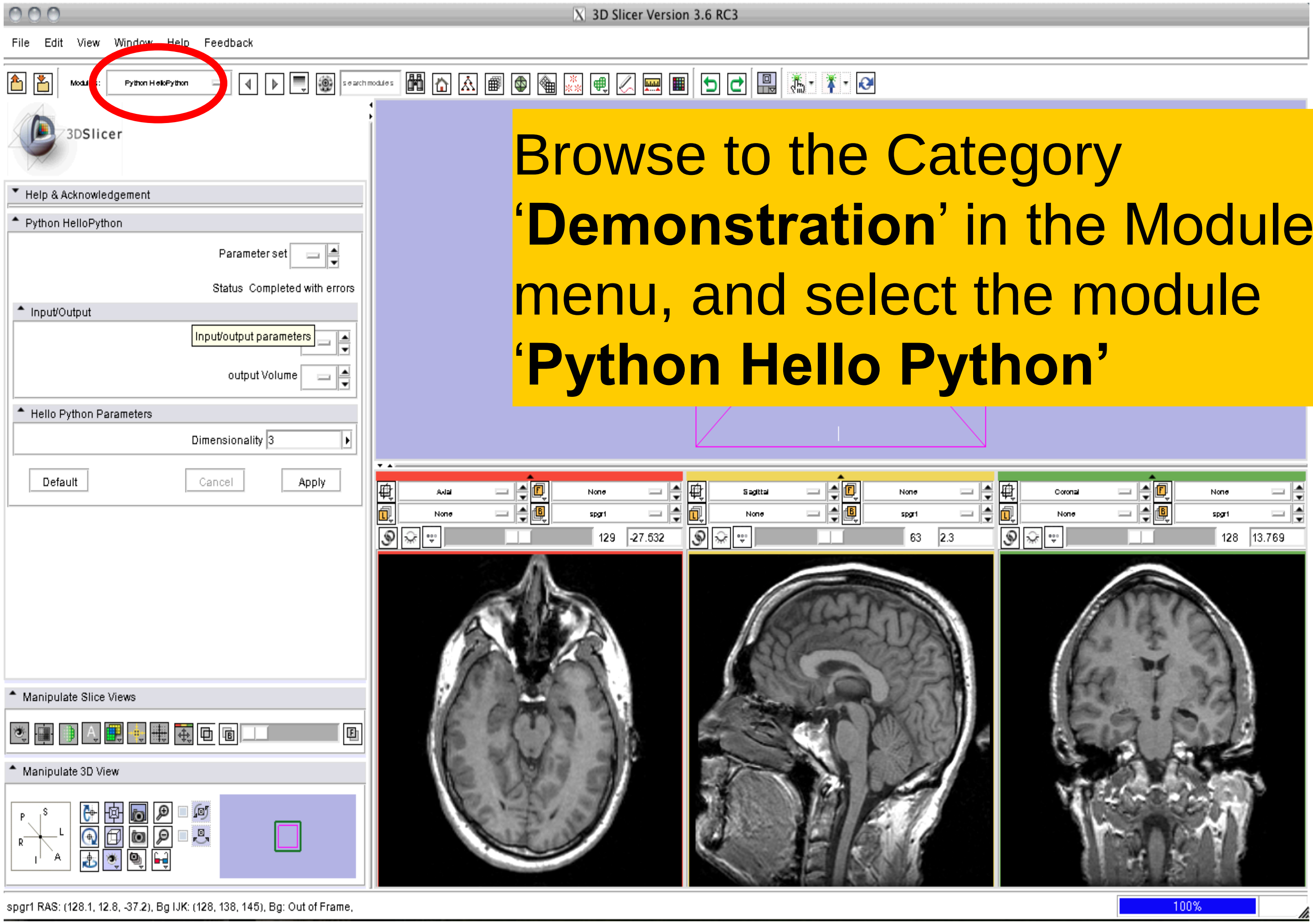
HelloPython
HelloPython.pyc 3 KB Sun Jun 6 19:
HelloPython.py~ 3 KB Sun Jun 6 11:
spgr.nhdr 1 KB Sun Jun 6 10:
spgr.raw.gz 6,517 KB Sun Jun 6 10:

Path: /Users/stuartwallace/Desktop/HelloPython/spgr.nhdr

□ Centered □ Ignore File Orientation □ Label Map □ Single File Name: spgr

Load the dataset spgr.nhdr located in the directory HelloPython/

Running the Laplace Operator



Parameter set

Status Completed with errors

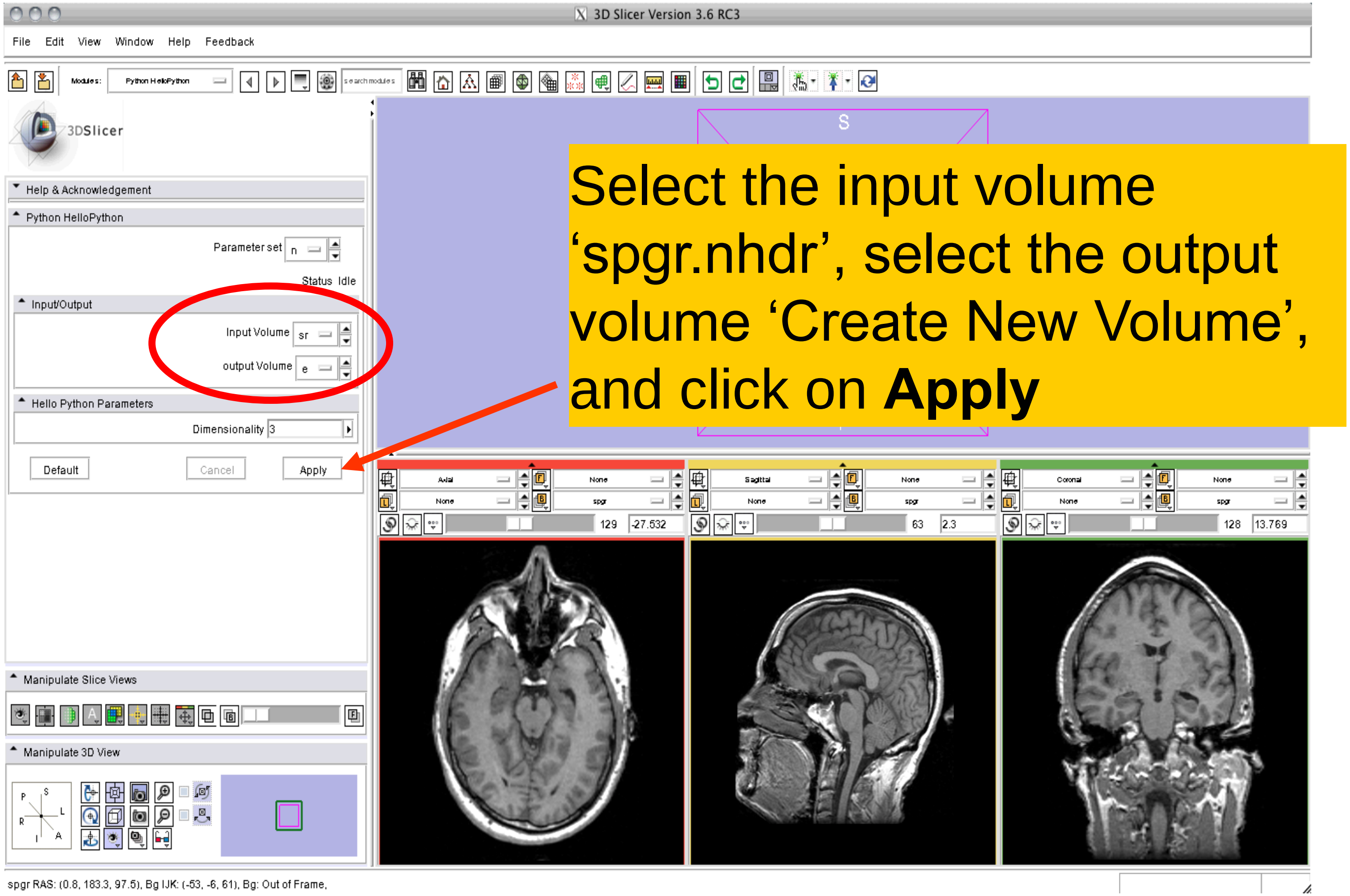
output Volume

Dimensionality 3

spgr1 RAS: (128.1, 12.8, -37.2), Bg IJK: (128, 138, 145), Bg: Out of Frame,

Browse to the Category ‘**Demonstration**’ in the Modules menu, and select the module ‘**Python Hello Python**’

Running the Laplace Operator



3D Slicer Version 3.6 RC3

Parameter set n

Status Idle

Input/Output

Input Volume sr

output Volume e

Hello Python Parameters

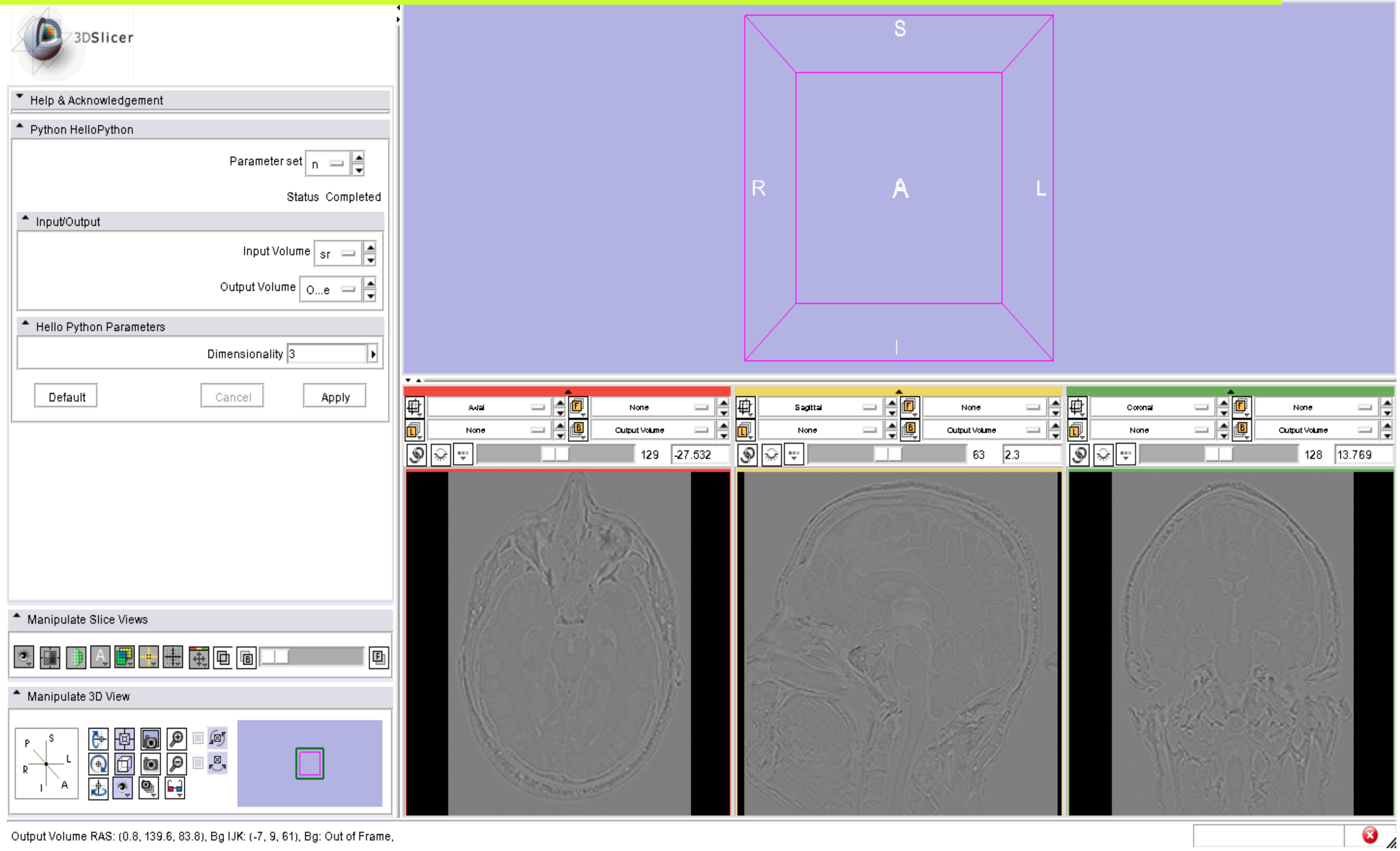
Dimensionality 3

spgr RAS: (0.8, 183.3, 97.5), Bg IJK: (-53, -6, 61), Bg: Out of Frame,

Select the input volume ‘spgr.nhdr’, select the output volume ‘Create New Volume’, and click on **Apply**

Running the Laplace Operator

Slicer displays the Laplacian of the spgr image.



Parameter set n

Status Completed

Input Volume sr

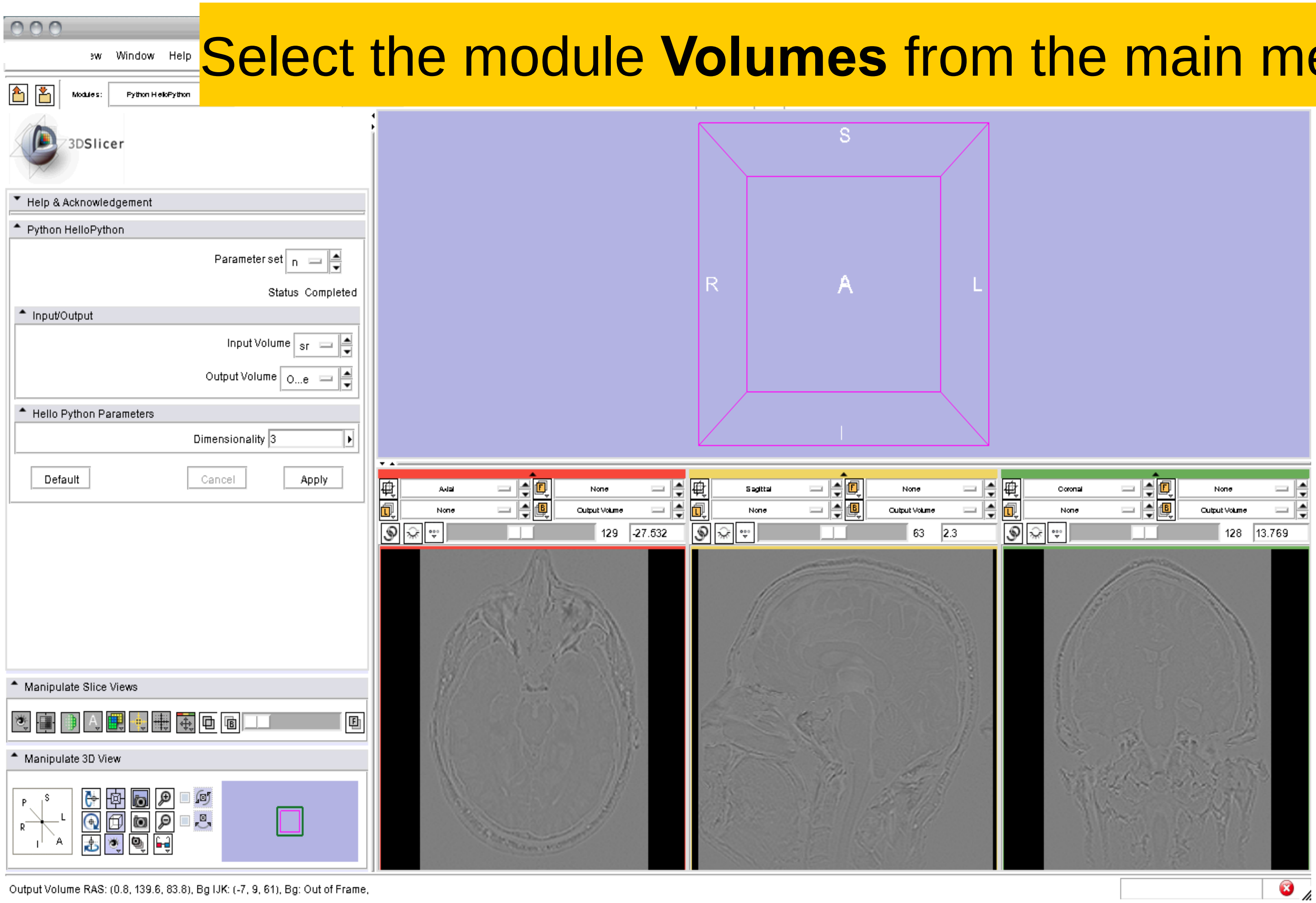
Output Volume O...e

Dimensionality 3

Output Volume RAS: (0.8, 139.6, 83.8), Bg IJK: (-7, 9, 61), Bg: Out of Frame,

Laplacian of the image

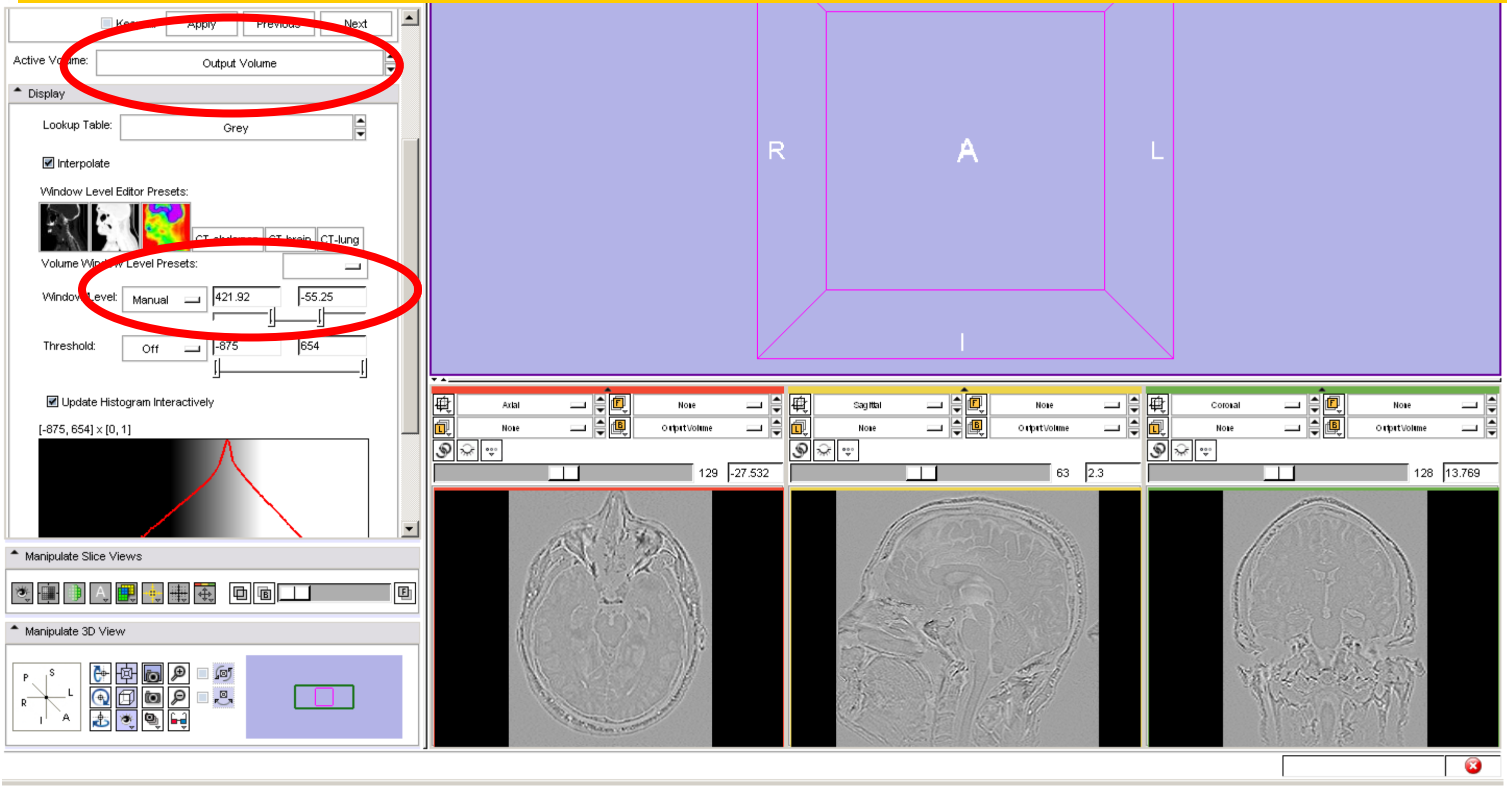
Select the module **Volumes** from the main menu



Output Volume RAS: (0.8, 139.6, 83.8), Bg IJK: (-7, 9, 61), Bg: Out of Frame,

Laplacian of the image

Set the Active Volume to **Output Volume** and adjust the Window/Level parameters



Active Volume: Output Volume

Display

Lookup Table: Grey

☑ Interpolate

Window Level Editor Presets:

Volume Window Level Presets:

Window/Level: Manual 421.92 -55.25

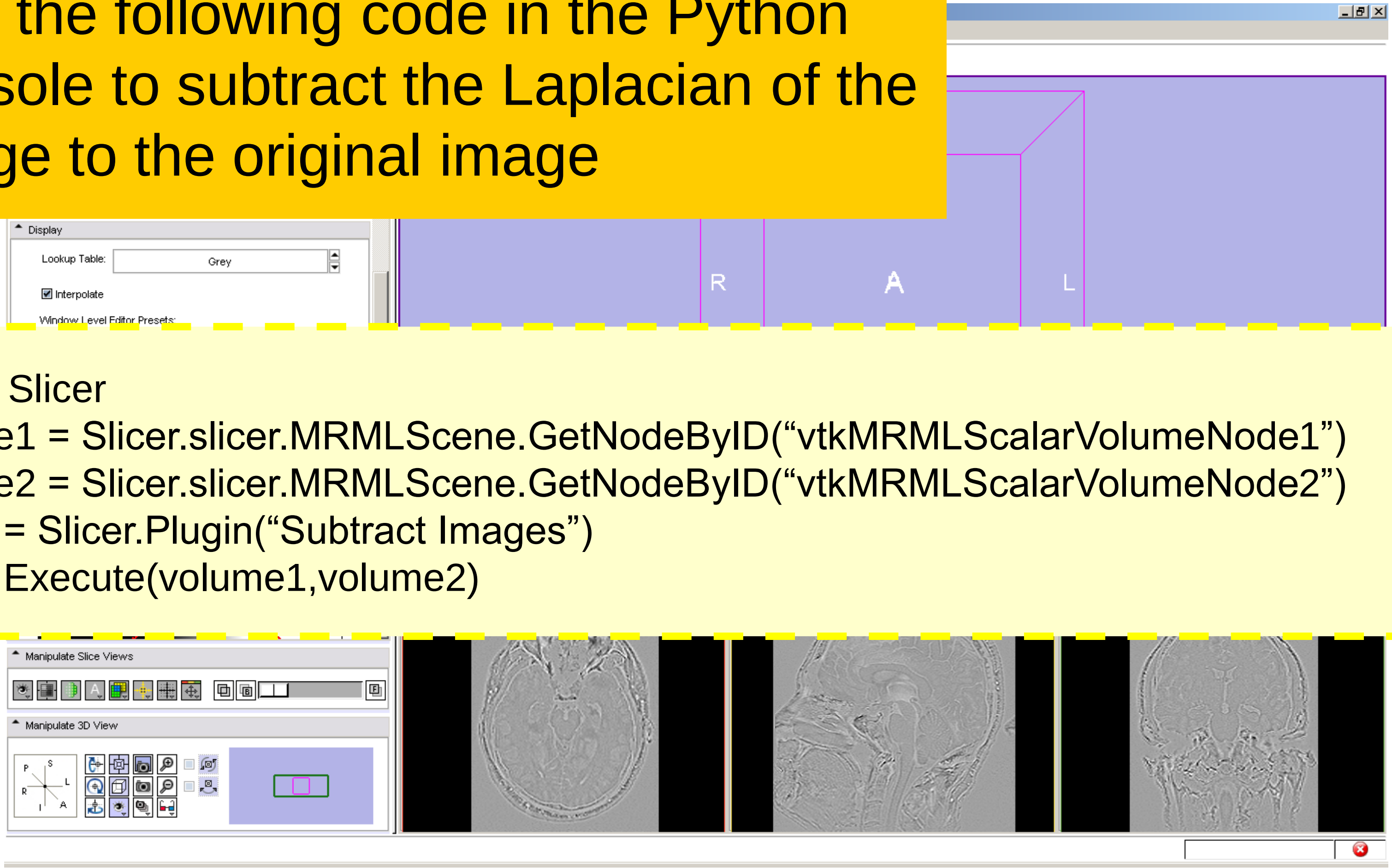
Threshold: Off -875 654

☑ Update Histogram Interactively

[-875, 654] x [0, 1]

Image Sharpening

Run the following code in the Python console to subtract the Laplacian of the image to the original image



Display

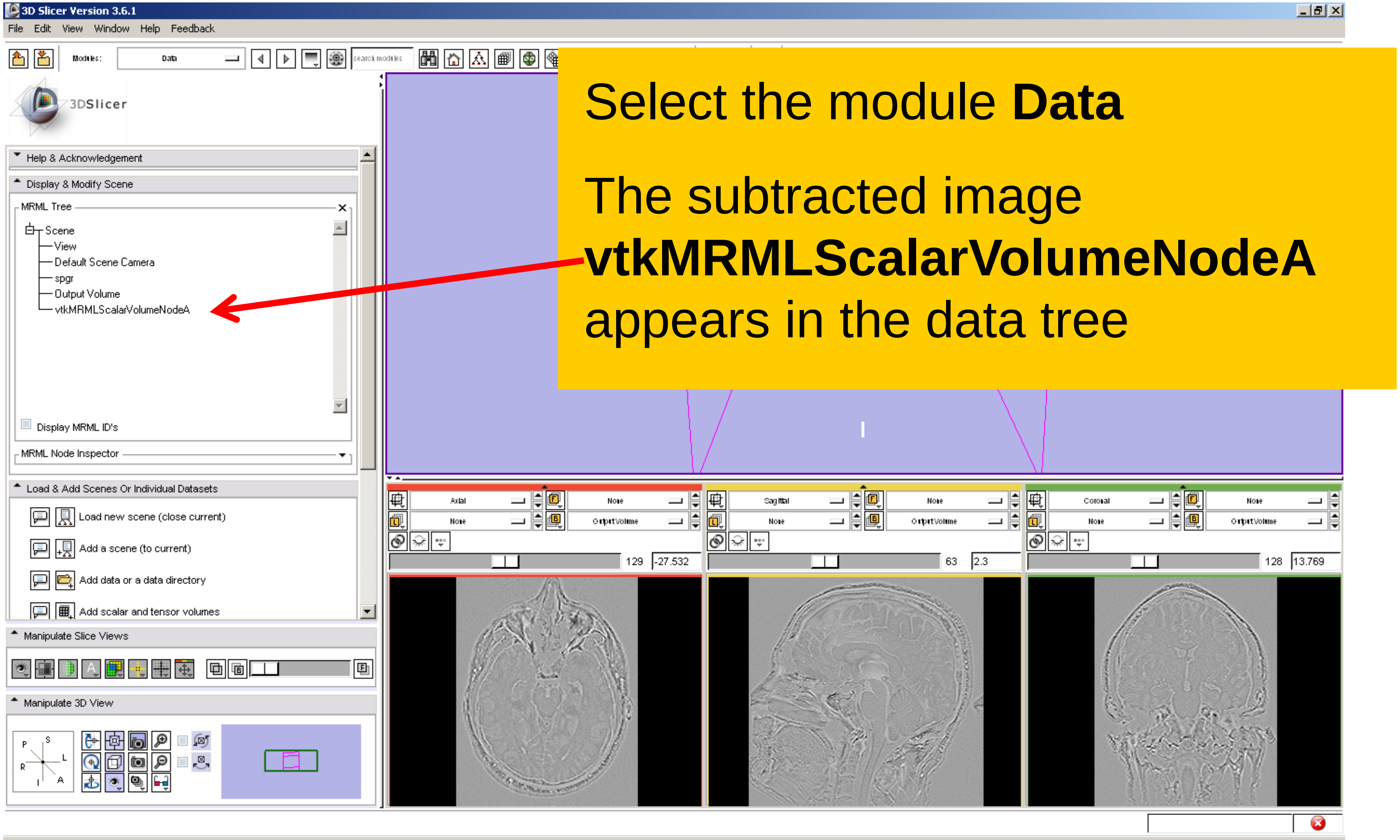
Lookup Table: Grey

☑ Interpolate

Window Level Editor Presets:

```
import Slicer
volume1 = Slicer.slicer.MRMLScene.GetNodeByID(“vtkMRMLScalarVolumeNode1”)
volume2 = Slicer.slicer.MRMLScene.GetNodeByID(“vtkMRMLScalarVolumeNode2”)
plugin = Slicer.Plugin(“Subtract Images”)
plugin.Execute(volume1,volume2)
```

Image Sharpening


3D Slicer Version 3.6.1

File Edit View Window Help Feedback

Modules: Data

Help & Acknowledgement

Display & Modify Scene

MRML Tree

- Scene
  - View
  - Default Scene Camera
  - spgr
  - Output Volume
  - vtkMRMLScalarVolumeNodeA

□ Display MRML ID's

MRML Node Inspector

Load & Add Scenes Or Individual Datasets

- Load new scene (close current)
- Add a scene (to current)
- Add data or a data directory
- Add scalar and tensor volumes

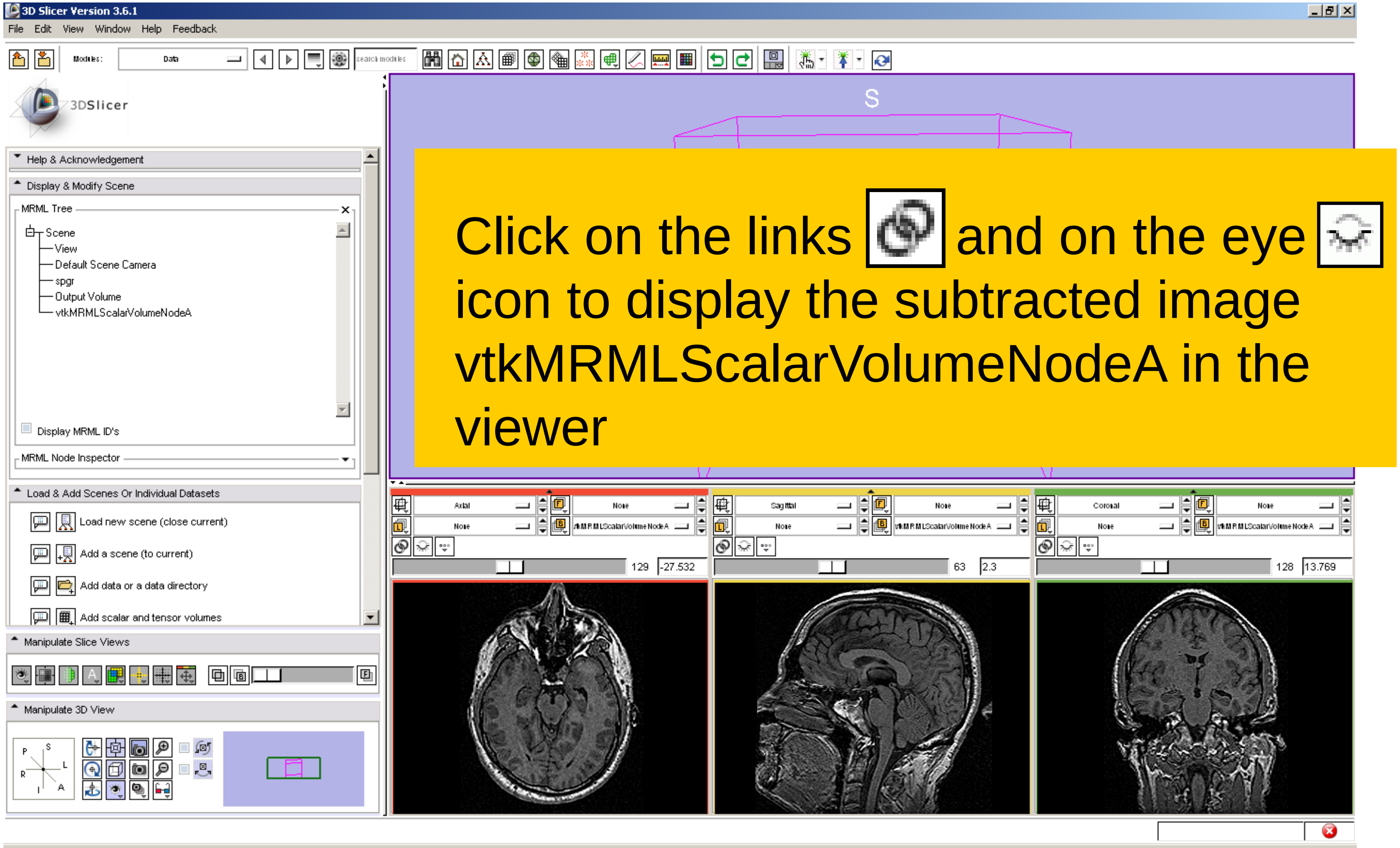
Manipulate Slice Views

Manipulate 3D View

Select the module **Data**

The subtracted image **vtkMRMLScalarVolumeNodeA** appears in the data tree

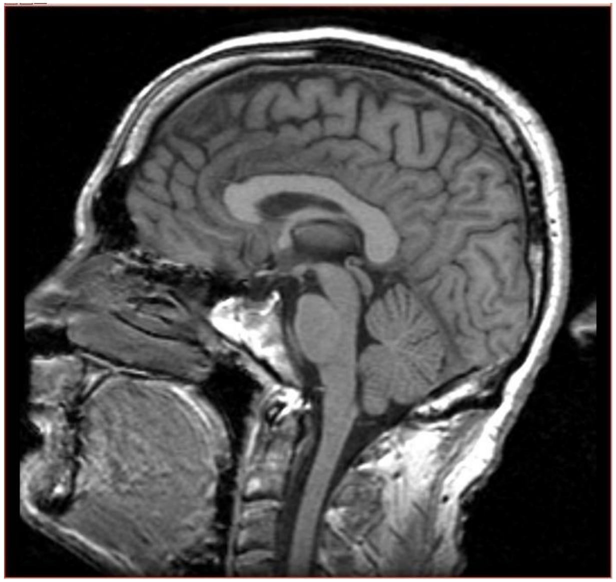
Image Sharpening



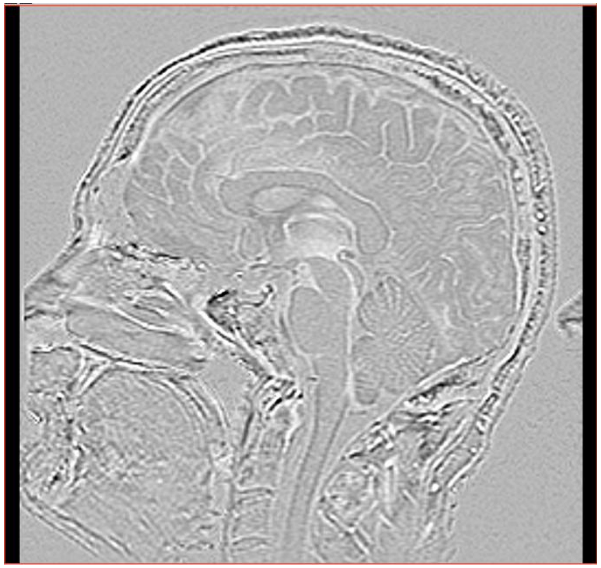
Click on the links 🔗 and on the eye 👁 icon to display the subtracted image vtkMRMLScalarVolumeNodeA in the viewer

Image Sharpening

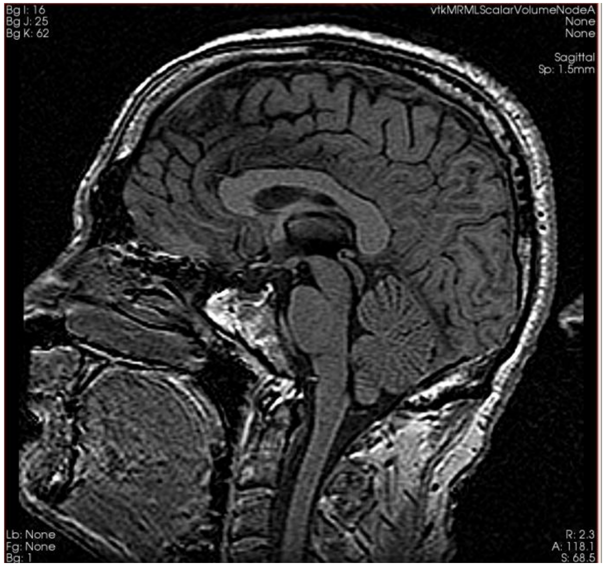
original



Laplacian



Laplacian filtered



Conclusion

- This course demonstrates how to integrate an external program in Python within Slicer3

- The Execution Model of Slicer3 provides a simple mechanism for incorporating command line programs as Slicer modules in Python.

Acknowledgments

National Alliance for Medical Image Computing

NIH U54EB005149

Neuroimage Analysis Center

NIH P41RR013218