

cancer-sim

Ivar Thokle Hovden

<https://github.com/ivartz/cancer-sim>

47615c3dae92771e3b552bc809f2e9b139b7b388

Motivation

- Generate synthetic displacements for each voxel in anatomical images to get warped anatomical images
- The displacements are supposed to mimic displacement of tissue caused by progression of cancer in the brain
- Ground truth for testing voxel tracking algorithms

python3 cancer-displacement.py -h

usage: cancer-displacement.py [-h] [--ref REF] [--tumormask TUMORMASK]

 [--brainmask BRAINMASK]

 [--displacement DISPLACEMENT]

 [--gaussian_range_one_sided GAUSSIAN_RANGE_ONE_SIDED]

 [--max_radial_displacement_to_brainmask_fraction

MAX_RADIAL_DISPLACEMENT_TO_BRAINMASK_FRACTION]

 [--max_radial_displacement_to_outer_ellipsoid_mask_fraction

MAX_RADIAL_DISPLACEMENT_TO_OUTER_ELLIPSOID_MASK_FRACTION]

 [--num_vecs NUM_VECS] [--angle_thr ANGLE_THR]

 [--num_splits NUM_SPLITS]

 [--spline_order SPLINE_ORDER]

 [--smoothing_std SMOOTHING_STD]

 [--perlin_noise_res PERLIN_NOISE_RES]

 [--perlin_noise_abs_max PERLIN_NOISE_ABS_MAX]

 [--eout EOUT] [--fout FOUT]

optional arguments:

-h, --help show this help message and exit

--ref REF input 3D nifti for reference, can be a normal static scan

--tumormask TUMORMASK

A binary mask with 1=tumor tissue, 0=healthy (outside of tumor) tissue

--brainmask BRAINMASK

A binary mask with 1=brain tissue, 0=outside of the brain

--displacement DISPLACEMENT

The maximum amount of radial displacement (in isotropic units according to --ref) to add

--gaussian_range_one_sided GAUSSIAN_RANGE_ONE_SIDED

The one-sided range x used for $x=[-x,x]$ on a normal (gaussian) symmetric distribution to model tumor expansion

--max_radial_displacement_to_brainmask_fraction MAX_RADIAL_DISPLACEMENT_TO_BRAINMASK_FRACTION

<0=interpolated radial displacement is very local close to the tumor ellipsoid model inflection surface, 1=the maximum interpolated radial displacement will reach or overreach the end of the brain mask along its path. Displacements will cover most of the brain]

--max_radial_displacement_to_outer_ellipsoid_mask_fraction
MAX_RADIAL_DISPLACEMENT_TO_OUTER_ELLIPSOID_MASK_FRACTION
 <0=almost no radial data to interpolate, stretching out
 first (largest) values near inflection surface (0),
 1=no cut, entire gaussian_range_one_sided will be used
 for interpolation, starting from inflection surface]

--num_vecs NUM_VECS The number of normal vectors used to simulate the
explosive spread of tissue displacement

--angle_thr ANGLE_THR
 The maximum angle (in degrees) between a normal vector
 on the model ellipsoid surface and field vectors
 allowed when determining a directional binary mask

--num_splits NUM_SPLITS
 How many splits to perform of the displacement vector
 array before calculating directional binary masks.
 Internal parameter, increase if memory error

--spline_order SPLINE_ORDER
 Order of interpolation in
 scipy.ndimage.map_coordinates. 0=kNN, 1=trilinear,
 2=quadratic, 3=cubic, 4 and 5

--smoothing_std SMOOTHING_STD
 Standard deviation of smoothing of the final
 interpolated x, y and z displacement

`--perlin_noise_res PERLIN_NOISE_RES`

The number of periods of noise to generate along each axis for Perlin noise. The noise is added to the final interpolated Gaussian and x, y and z displacement (before scaling displacements to specified max displacement, and before scaling displacements that went outside of the brain)

`--perlin_noise_abs_max PERLIN_NOISE_ABS_MAX`

The absolute value of maximum Perlin noise to add. The noise is added to the final interpolated Gaussian and x, y and z displacement (before scaling displacements to specified max displacement, and before scaling displacements that went outside of the brain)

`--eout EOUT` Base name of files saved containing binary masks of model ellipsoids

`--fout FOUT` Base name of generated 4D output fields, needs to be converted to ANTs transform before used in ANTs `antsApplyTransforms`

Method

- Define a range of parameter settings to use for generating a dataset of synthetic displacements

Parameter	Description	Values	radial growth from volumetric change
1. displacement : Maximum displacement	The maximum absolute value of the displacement field	2, 5, 8 [mm]	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC478579/
2. gaussian_range_one_sided : Gaussian half max width	Half width of the Gaussian used to create displacements	5, 6, 7	
3. max_radial_displacement_to_brainmask_fraction : Fraction of maximum radial displacement to skull, starting from tumor geometric center	The coverage of displacements in the brain (<0,1]; 1=whole brain)	0.3, 0.6, 1	
4. max_radial_displacement_to_outer_ellipsoid_mask_fraction : Fraction of maximum radial displacements to the outer ellipsoid mask, before interpolation, -"-	Outer cut of maximum radial displacement (<0,1]; 1=no cut)	1	Always 1?
5. num_vecs : Number of vectors for computing radial displacements	Increased accuracy of ellipsoid-based displacement with higher number	18, 36, 54	Always largest?
6. angle_thr : Maximum angle	Maximum accepted deviation in degrees between displacement vectors for approximate same direction	5, 7, 8 [degrees]	
7. smoothing_std : Gaussian smoothing standard deviation		4	Fixed at 4?
8. perlin_noise_res : Perlin noise granularity fraction	~ Granularity of Perlin (continuous) additive noise (<0,1], 1 lowest)	0.05, 0.1, 0.2	
9. perlin_noise_abs_max : Perlin noise maximum magnitude fraction	[0,1], 0=no noise; 1=SNR=1	0, 0.25, 0.5	

displacement=8

```
python3 cancer-displacement.py --ref 2-T1c.nii.gz \  
    --tumormask 2-Tumormask.nii.gz \  
    --brainmask 2-BrainExtractionMask.nii.gz \  
    --displacement $displacement \  
    --gaussian_range_one_sided 6 \  
    --max_radial_displacement_to_brainmask_fraction 1 \  
    --max_radial_displacement_to_outer_ellipsoid_mask_fraction 1 \  
    --num_vecs 54 \  
    --angle_thr 21 \  
    --num_splits 4 \  
    --spline_order 1 \  
    --smoothing_std 4 \  
    --perlin_noise_res 0.05 \  
    --perlin_noise_abs_max 0 \  
    --eout ellipsoid-mask.nii.gz \  
    --fout field.nii.gz
```

ITK-SNAP Toolbox

Main Toolbar



Cursor Inspector



Cursor position (x,y,z):

47 115 58

Intensity under cursor:

Layer	intensity
2-T1c	20...
warped	21...
3-T1c	20.3
directional-bin...	1
neg-field-8mm...	1.4...
interp-neg-fiel...	1.0...

Label under cursor:

0 Clear Label

Segmentation Labels

Active label:

Label 1

Paint over:

All labels

Overall label opacity:

50

3D Toolbar

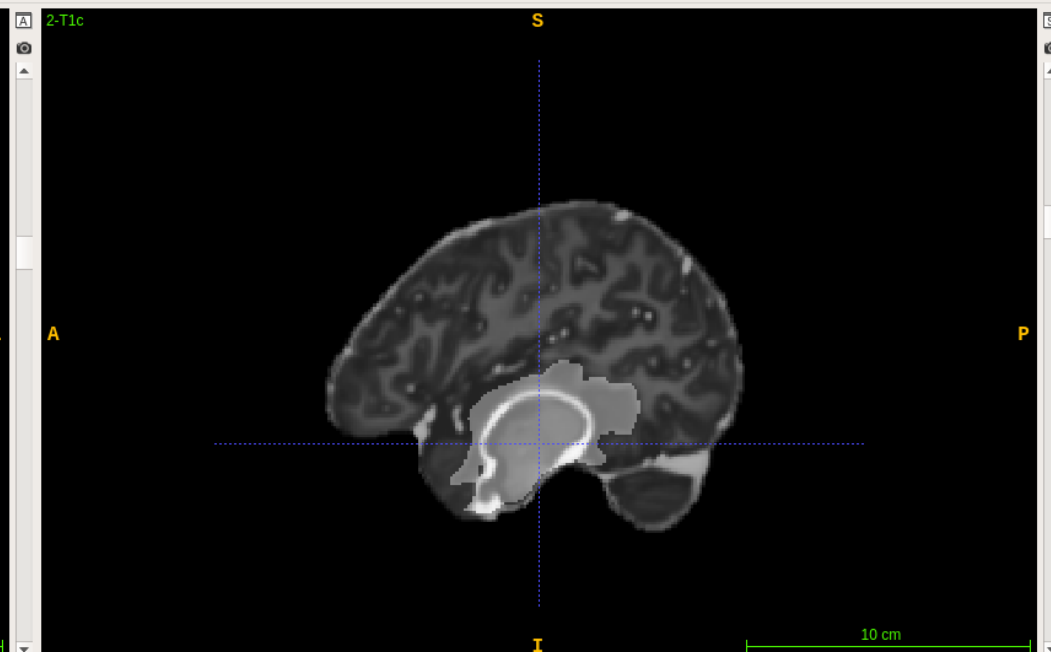
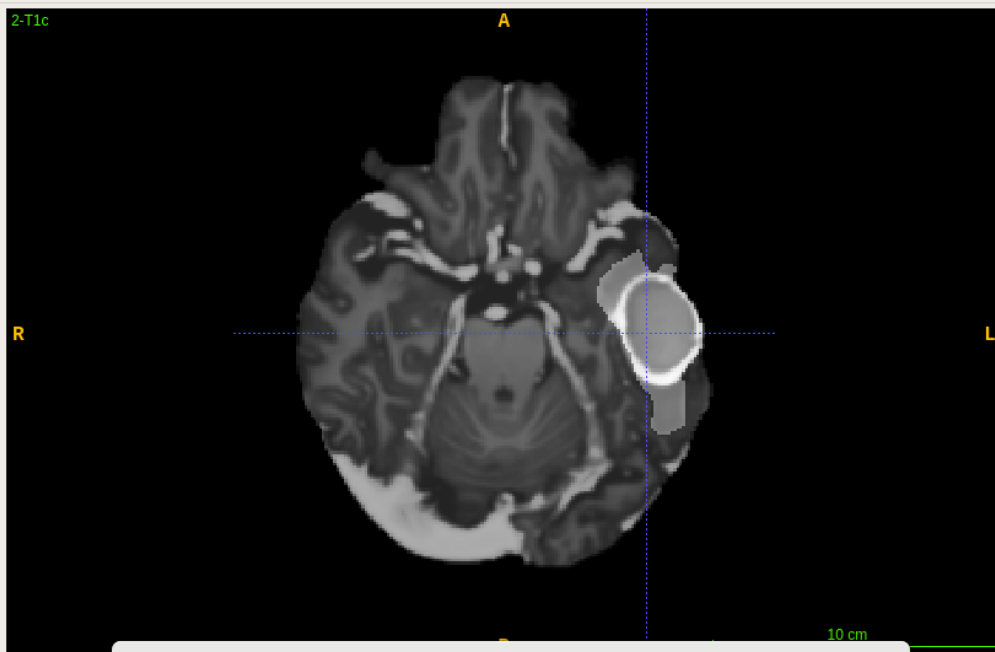


Image Layer Inspector - ITK-SNAP



Main Image

2-T1c

Additional Images

warped

3-T1c

directional-binary-masks-r

neg-field-8mm-ants

interp-neg-field-8mm-ants

2-Tumormask

gaussian

interp-gaussian

ellipsoid-mask

outer-ellipsoid-mask

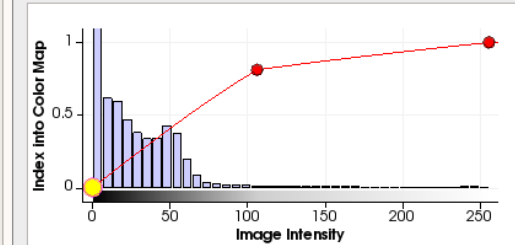
General Contrast Color Map Info Metadata

Linear Contrast Adjustment:

Minimum: 0,00 Level: 127,50 Reset

Maximum: 255,00 Window: 255,00 Auto

Curve-Based Contrast Adjustment:



Selected control point:

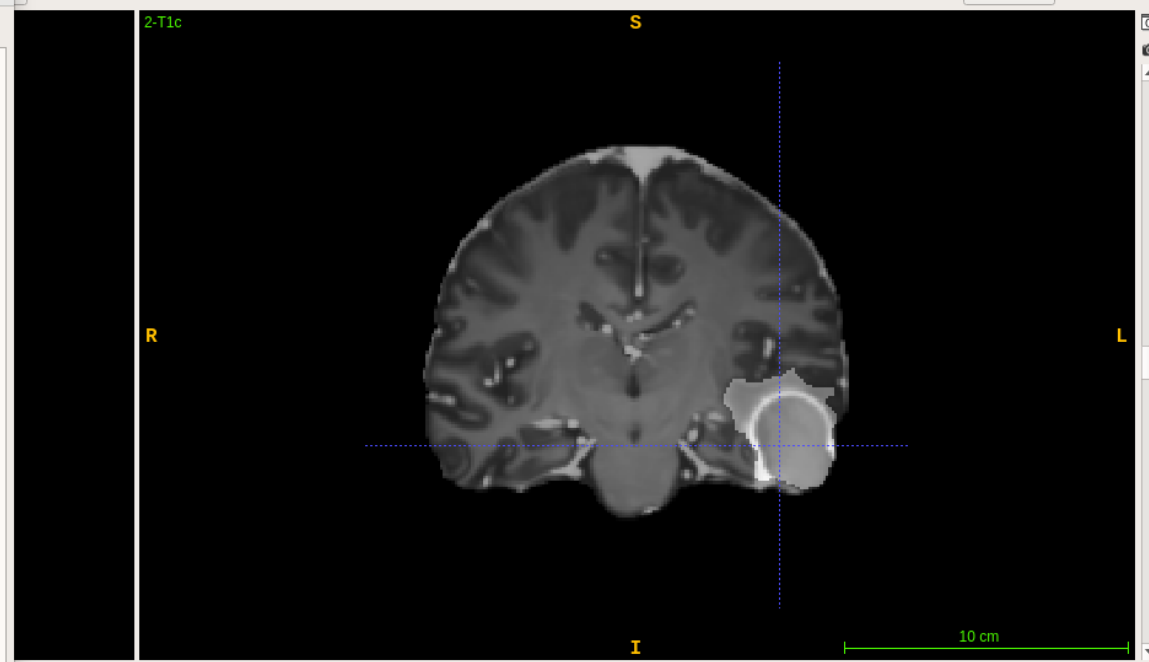
Id: 1 x: 0,00 y: 0,000 + -

Histogram Display Options:

Bin size: 10 Cutoff: 7,0 % Log scale

Close

58 of 193



zoom to fit

47 of 193

10 cm

zoom to fit

115 of 229

ITK-SNAP Toolbox

Main Toolbar



Cursor Inspector



Cursor position (x,y,z):

47 115 58

Intensity under cursor:

Layer	intensity
2-T1c	20...
warped	21...
3-T1c	20.3
directional-bin...	1
neg-field-8mm...	1.4...
interp-neg-fiel...	1.0...

Label under cursor:

0 Clear Label

Segmentation Labels

Active label:

Label 1

Paint over:

All labels

Overall label opacity:

50

3D Toolbar

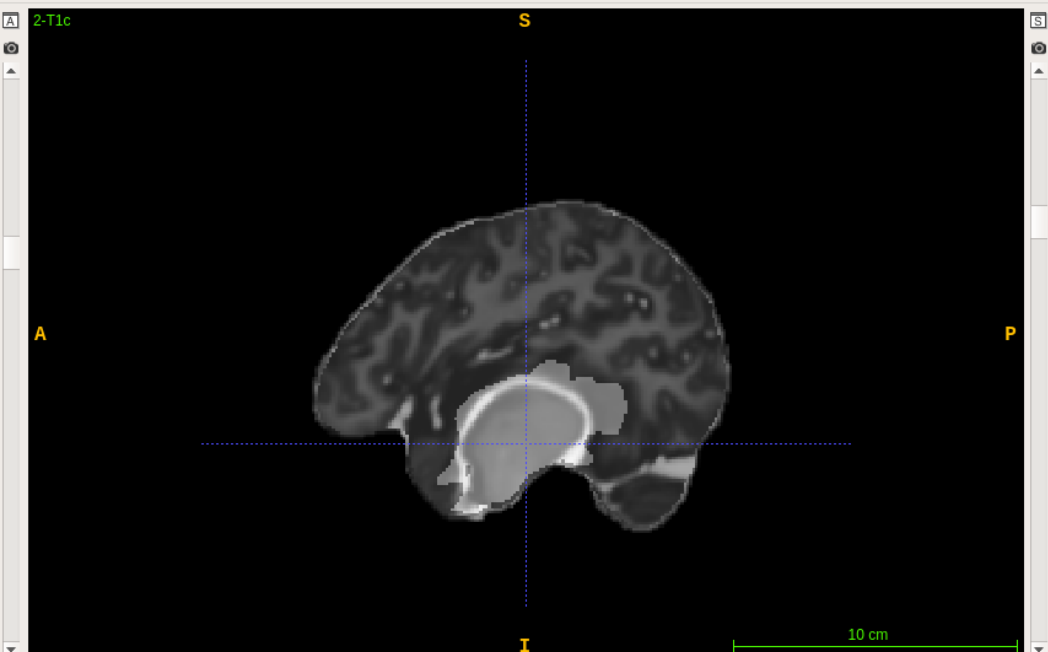
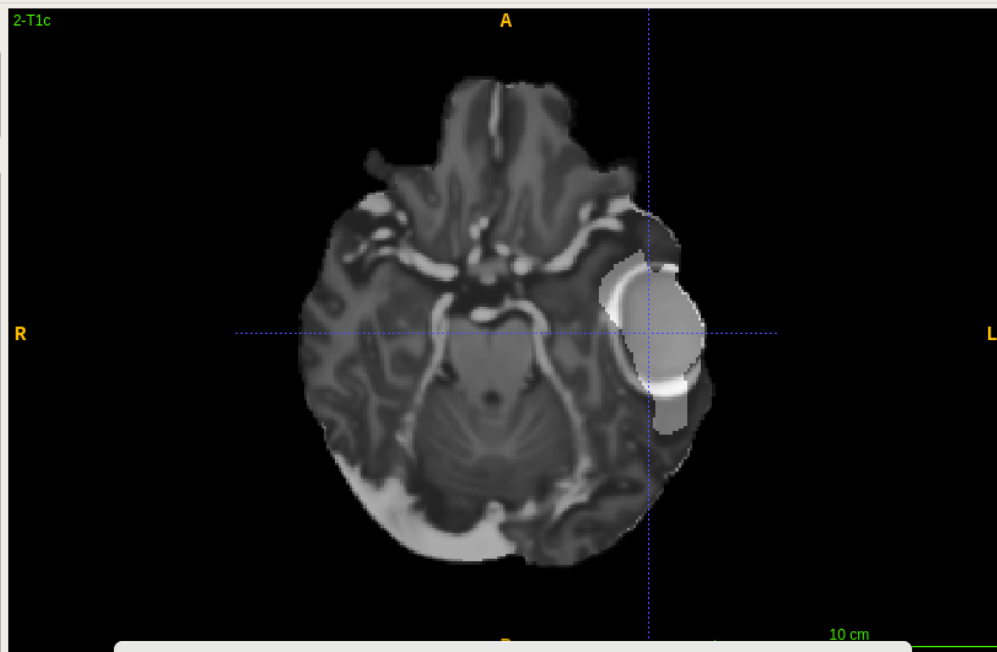


Image Layer Inspector - ITK-SNAP



Main Image

2-T1c

Additional Images

warped

3-T1c

directional-binary-masks-r

neg-field-8mm-ants

interp-neg-field-8mm-ants

2-Tumormask

gaussian

interp-gaussian

ellipsoid-mask

outer-ellipsoid-mask

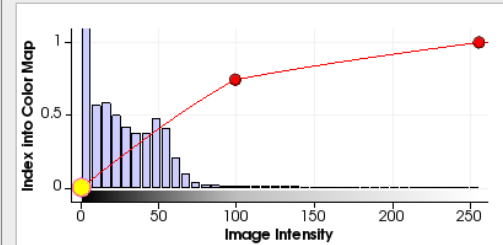
General Contrast Color Map Info Metadata

Linear Contrast Adjustment:

Minimum: 0,00 Level: 127,50 Reset

Maximum: 255,00 Window: 255,00 Auto

Curve-Based Contrast Adjustment:



Selected control point:

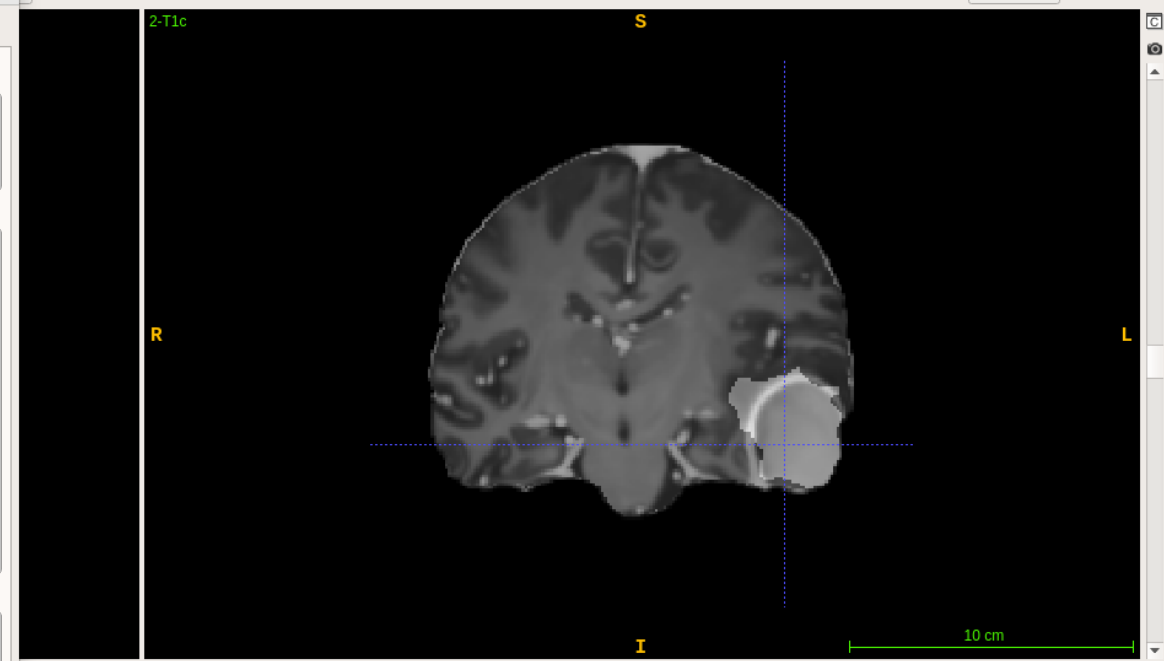
Id: 1 x: 0,00 y: 0,000 + -

Histogram Display Options:

Bin size: 10 Cutoff: 7,0 % Log scale

Close

58 of 193



zoom to fit

47 of 193

10 cm

zoom to fit

115 of 229

ITK-SNAP Toolbox

Main Toolbar



Cursor Inspector



Cursor position (x,y,z):

47 115 58

Intensity under cursor:

Layer	Intensity
2-T1c	20.000
warped	21.000
3-T1c	20.300
directional-bin...	1.000
neg-field-8mm...	1.400
interp-neg-fiel...	1.000

Label under cursor:

0 Clear Label

Segmentation Labels

Active label:

Label 1

Paint over:

All labels

Overall label opacity:

50

3D Toolbar

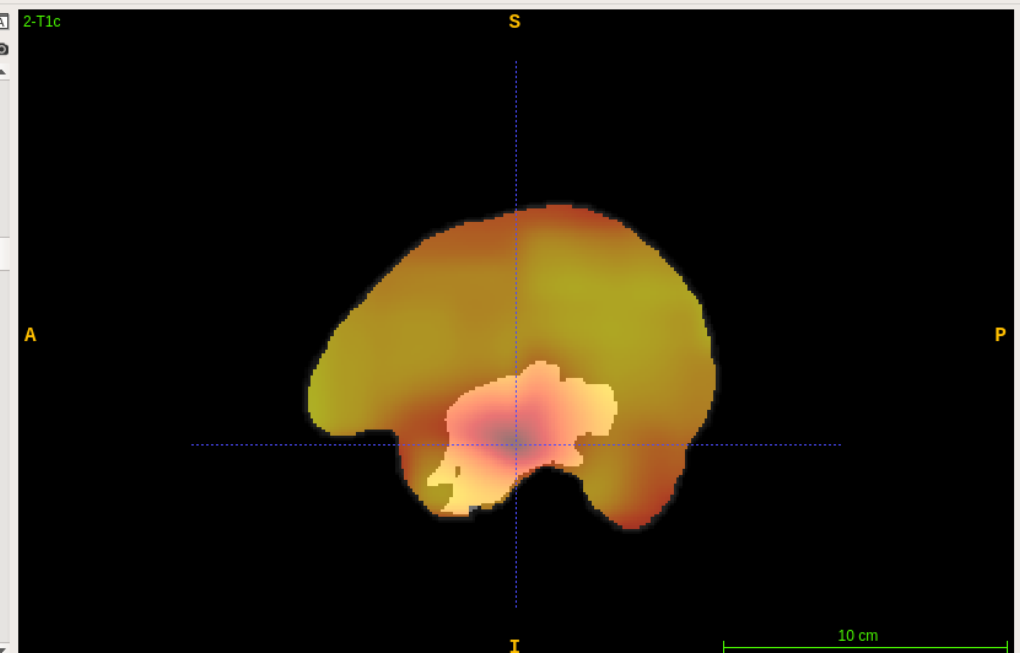
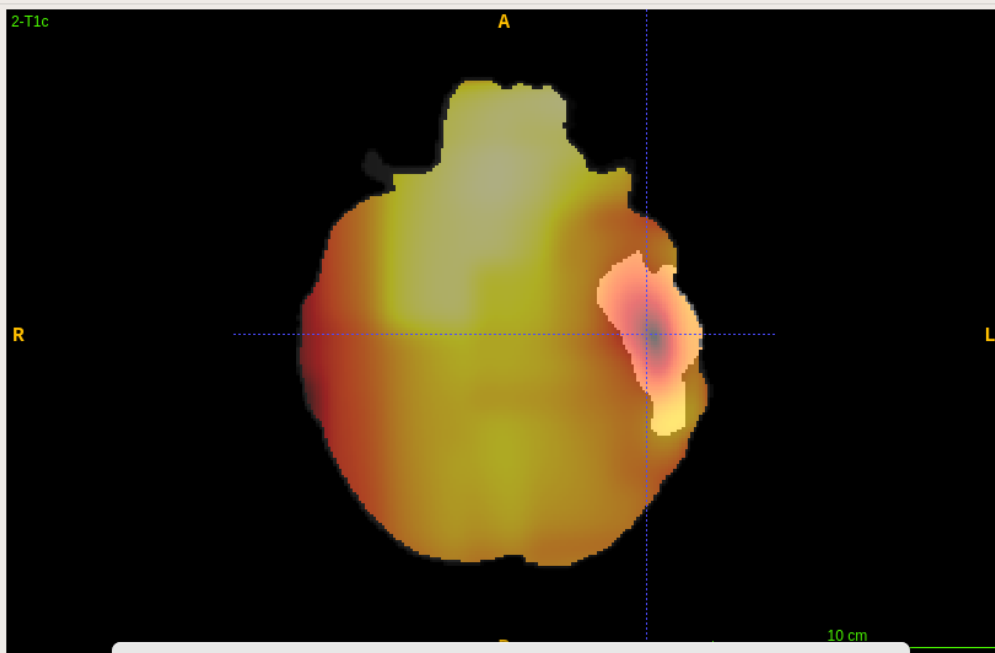


Image Layer Inspector - ITK-SNAP



Main Image

2-T1c

Additional Images

warped

3-T1c

directional-binary-masks-r

neg-field-8mm-ants

interp-neg-field-8mm-ants

2-Tumormask

gaussian

interp-gaussian

ellipsoid-mask

outer-ellipsoid-mask

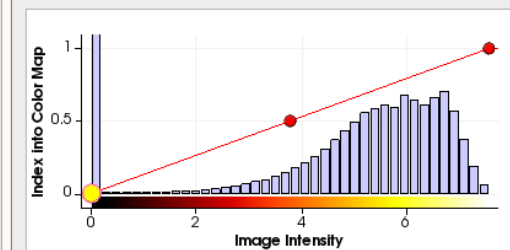
General Contrast Color Map Info Metadata

Linear Contrast Adjustment:

Minimum: 0,000 Level: 3,775 Reset

Maximum: 7,549 Window: 7,549 Auto

Curve-Based Contrast Adjustment:



Selected control point:

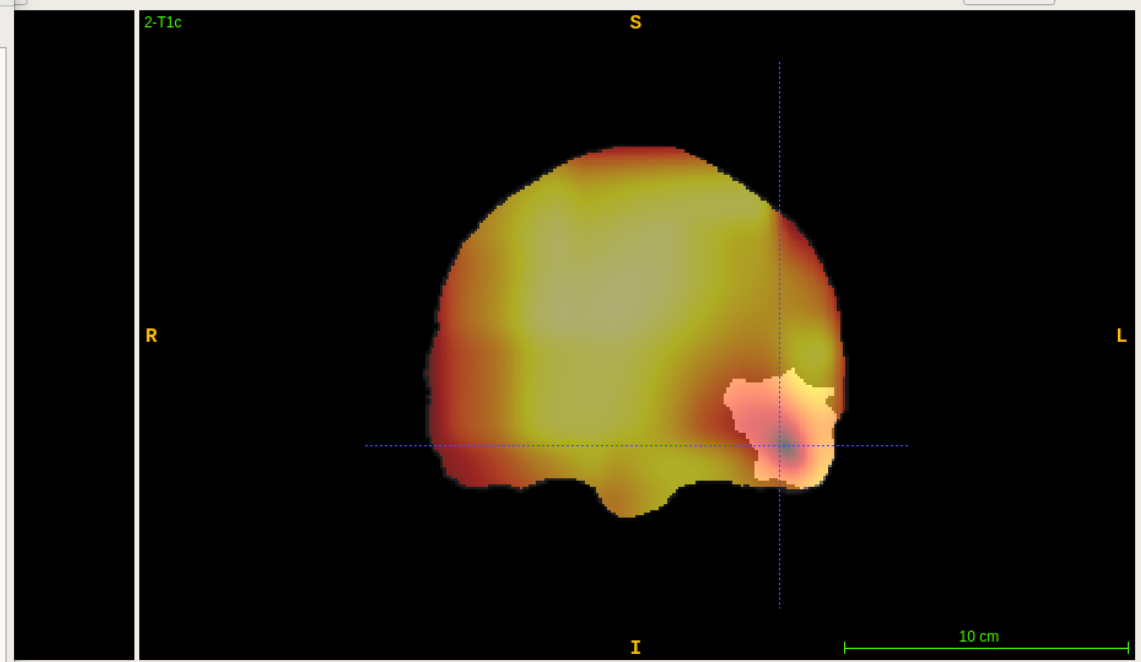
Id: 1 x: 0,000 y: 0,000

Histogram Display Options:

Bin size: 10 Cutoff: 3,0 % Log scale

Close

58 of 193



zoom to fit

47 of 193

10 cm

zoom to fit

115 of 229

ITK-SNAP Toolbox

Main Toolbar



Cursor Inspector



Cursor position (x,y,z):

47 115 58

Intensity under cursor:

Layer	intensity
2-T1c	20...
warped	21...
3-T1c	20.3
directional-bin...	1
neg-field-8mm...	1.4...
interp-neg-fiel...	-1...

Label under cursor:

0 Clear Label

Segmentation Labels

Active label:

Label 1

Paint over:

All labels

Overall label opacity:

50

3D Toolbar

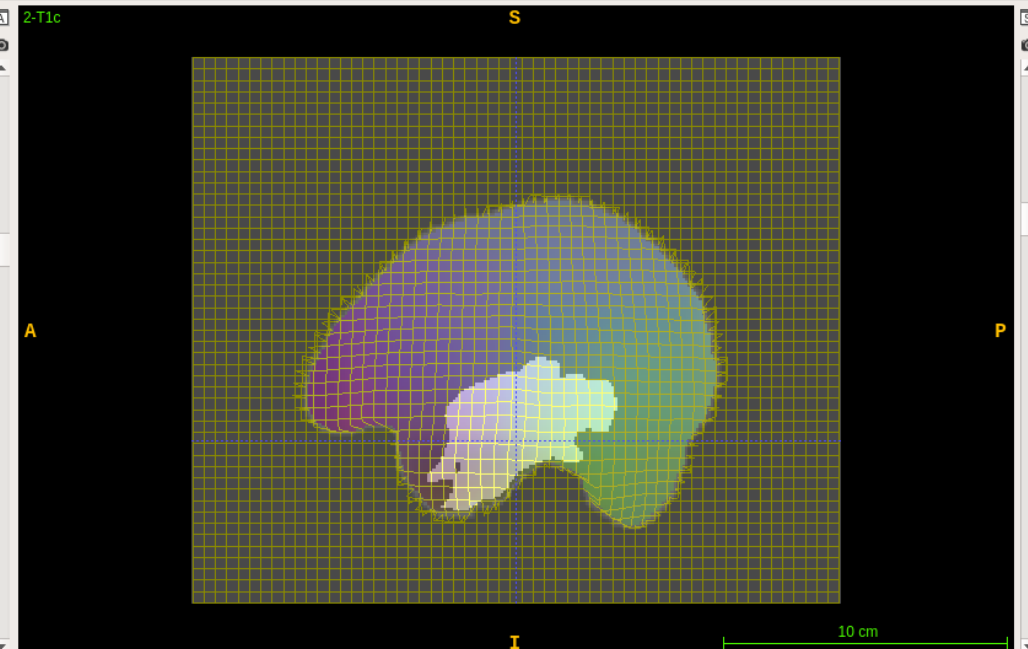
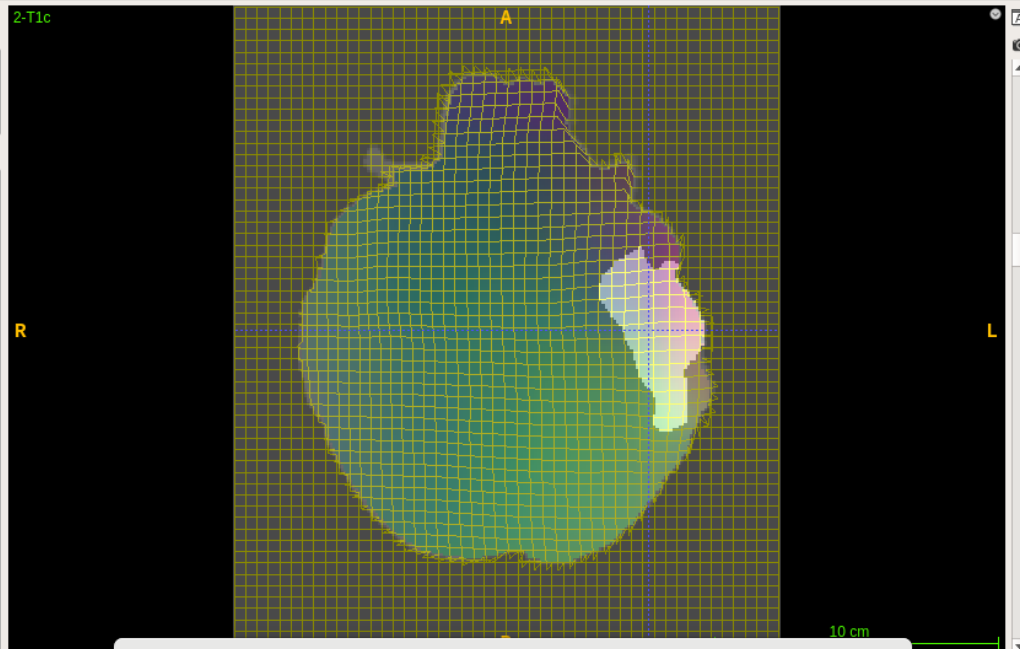


Image Layer Inspector - ITK-SNAP



Main Image

2-T1c

Additional Images

warped

3-T1c

directional-binary-masks-r

neg-field-8mm-ants

interp-neg-field-8mm-ants

2-Tumormask

gaussian

interp-gaussian

ellipsoid-mask

outer-ellipsoid-mask

General Contrast Color Map Info Metadata

General Image Layer Properties:

Filename: interp-neg-field-8mm-ants.nii.gz

Nickname:

Tags:

How to Display this Image Layer:

Display as: ☒ Separate image ☒ Semi-transparent overlay

Overlay

opacity:

100%

Display order:



Move up



Move down

How to Visualize Multiple Image Components:

Display mode: Deformation Grid Display

Component:

update

Close

58 of 193

zoom to fit

47 of 193

58 of 193

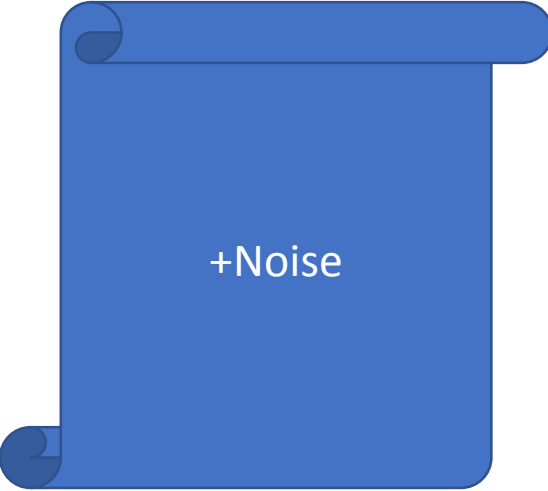
10 cm

zoom to fit

115 of 229

displacement=8

```
python3 cancer-displacement.py --ref 2-T1c.nii.gz \  
    --tumormask 2-Tumormask.nii.gz \  
    --brainmask 2-BrainExtractionMask.nii.gz \  
    --displacement $displacement \  
    --gaussian_range_one_sided 6 \  
    --max_radial_displacement_to_brainmask_fraction 1 \  
    --max_radial_displacement_to_outer_ellipsoid_mask_fraction 1 \  
    --num_vecs 54 \  
    --angle_thr 21 \  
    --num_splits 4 \  
    --spline_order 1 \  
    --smoothing_std 4 \  
    --perlin_noise_res 0.05 \  
    --perlin_noise_abs_max 0.25 \  
    --eout ellipsoid-mask.nii.gz \  
    --fout field.nii.gz
```



+Noise

ITK-SNAP Toolbox

Main Toolbar



Cursor Inspector



Cursor position (x,y,z):

47 115 58

Intensity under cursor:

Layer	intensity
2-T1c	20...
warped	22...
3-T1c	20.3
directional-bin...	1
neg-field-8mm...	-1.09
interp-neg-fiel...	1.3...

Label under cursor:

0 Clear Label

Segmentation Labels

Active label:

Label 1

Paint over:

All labels

Overall label opacity:

50

3D Toolbar

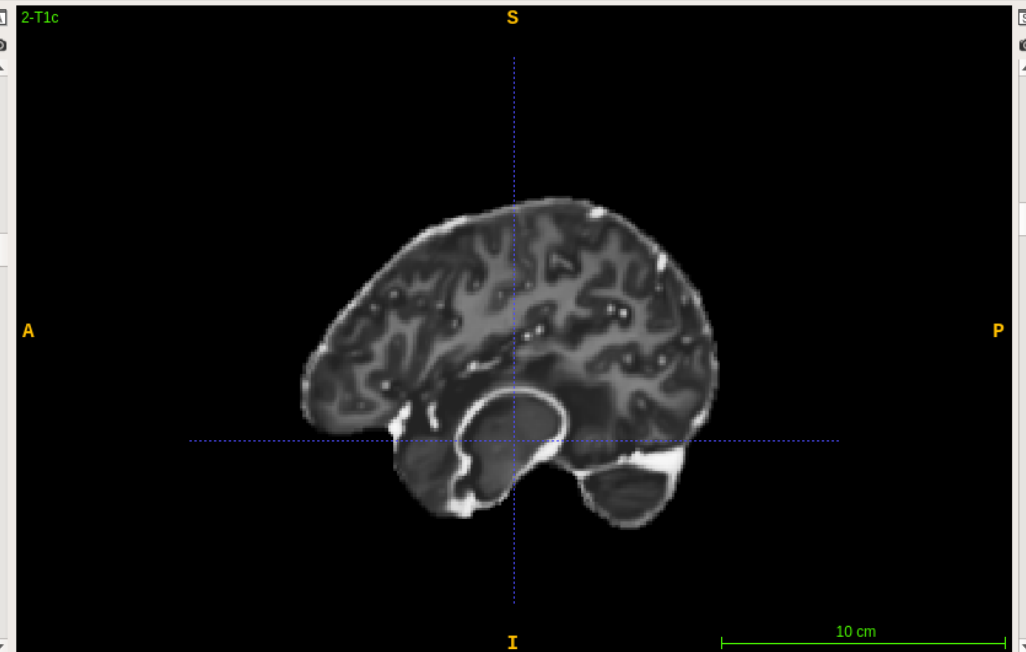
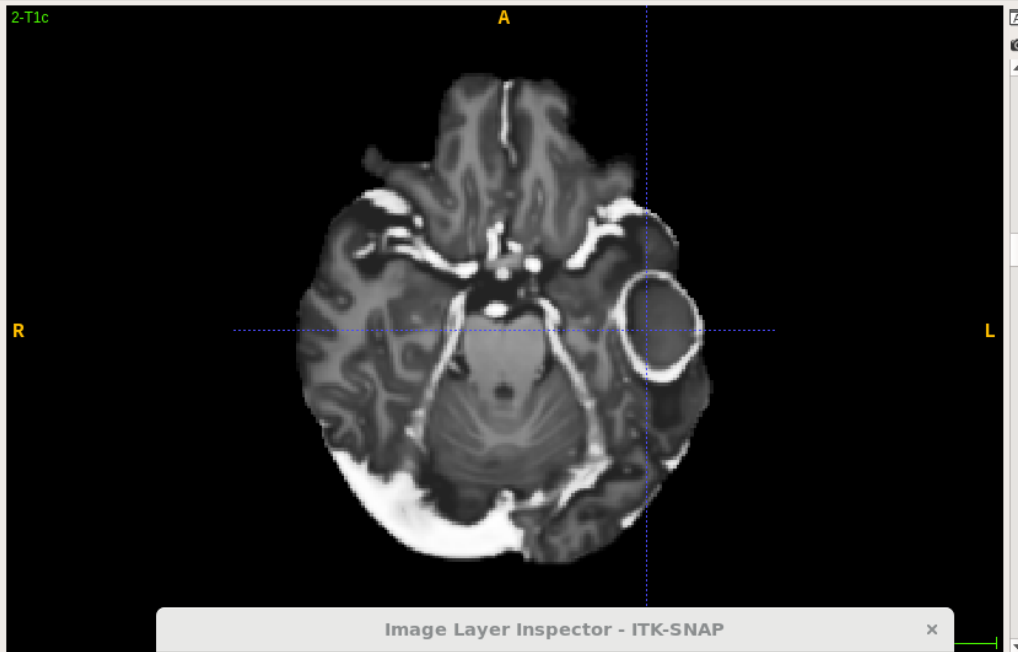


Image Layer Inspector - ITK-SNAP



- Main Image
2-T1c
- Additional Images
- warped
 - 3-T1c
 - directional-binary-masks-r
 - neg-field-8mm-ants
 - interp-neg-field-8mm-ants
 - 2-Tumormask
 - gaussian
 - perlin-noise
 - interp-gaussian
 - ellipsoid-mask

Close

General Contrast Color Map Info Metadata

Linear Contrast Adjustment:

Minimum: 0,00

Level: 127,50

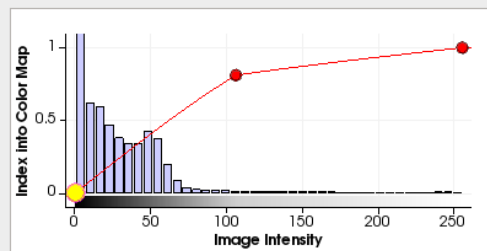
Reset

Maximum: 255,00

Window: 255,00

Auto

Curve-Based Contrast Adjustment:



Selected control point:

Id: 1

x: 0,00

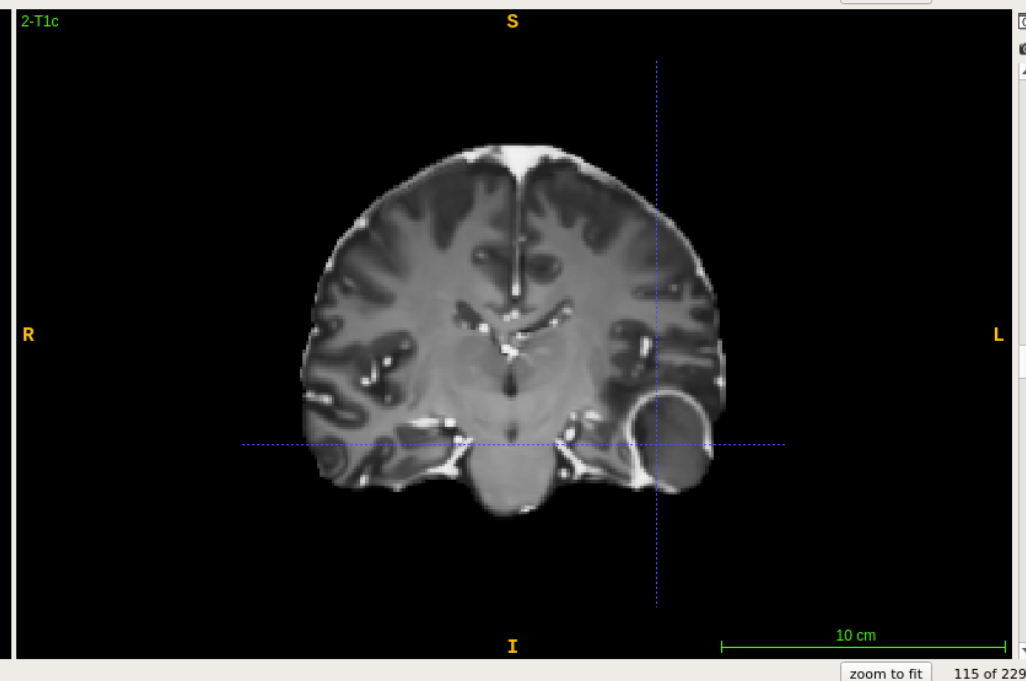
y: 0,000

+ -

Histogram Display Options:

Bin size: 10

Cutoff: 7,0 %

☐ Log scale

ITK-SNAP Toolbox

Main Toolbar



Cursor Inspector



Cursor position (x,y,z):

47 115 58

Intensity under cursor:

Layer	intensity
2-T1c	20...
warped	22...
3-T1c	20.3
directional-bin...	1
neg-field-8mm...	-1.09
interp-neg-fiel...	1.3...

Label under cursor:

0 Clear Label

Segmentation Labels

Active label:

Label 1

Paint over:

All labels

Overall label opacity:

50

3D Toolbar

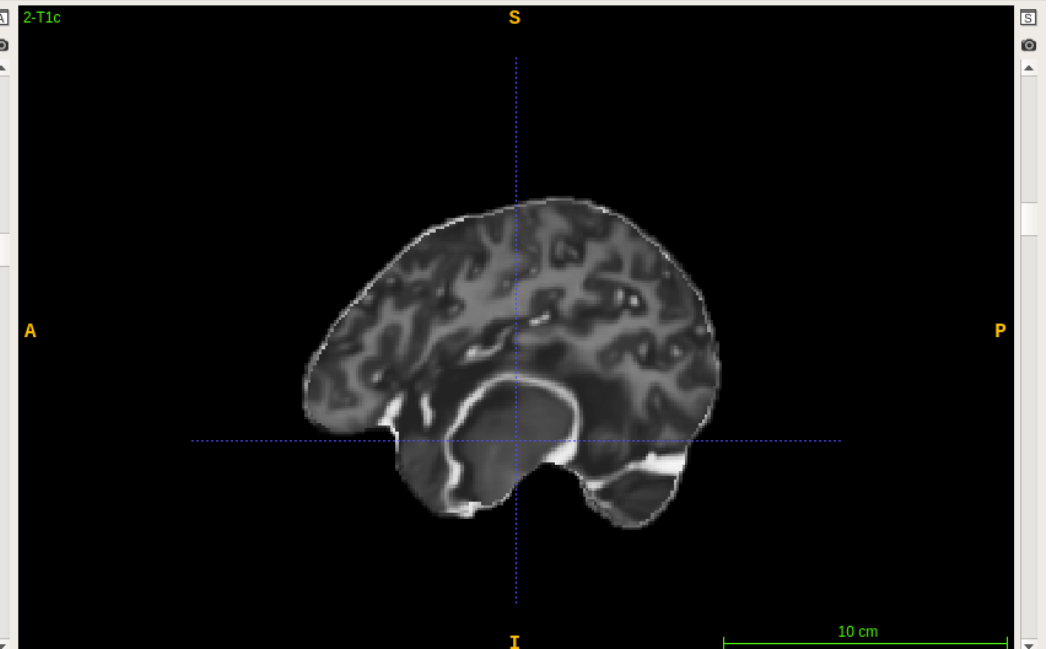


Image Layer Inspector - ITK-SNAP



Main Image

2-T1c

Additional Images

warped

3-T1c

directional-binary-masks-r

neg-field-8mm-ants

interp-neg-field-8mm-ants

2-Tumormask

gaussian

perlin-noise

interp-gaussian

ellipsoid-mask

Close

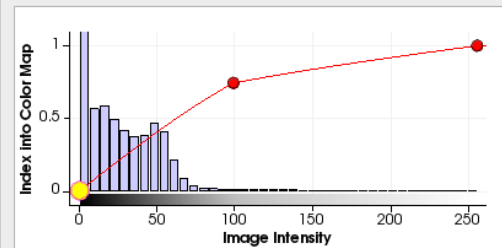
General Contrast Color Map Info Metadata

Linear Contrast Adjustment:

Minimum: 0,00 Level: 127,50 Reset

Maximum: 255,00 Window: 255,00 Auto

Curve-Based Contrast Adjustment:



Selected control point:

Id: 1 x: 0,00 y: 0,000 + -

Histogram Display Options:

Bin size: 10 Cutoff: 7,0 % Log scale

update

58 of 193

zoom to fit

47 of 193

10 cm

zoom to fit

115 of 229

ITK-SNAP Toolbox

Main Toolbar



Cursor Inspector



Cursor position (x,y,z):

47 115 58

Intensity under cursor:

Layer	intensity
2-T1c	20...
warped	22...
3-T1c	20.3
directional-bin...	1
neg-field-8mm...	-1.09
interp-neg-fiel...	1.3...

Label under cursor:

0 Clear Label

Segmentation Labels

Active label:

Label 1

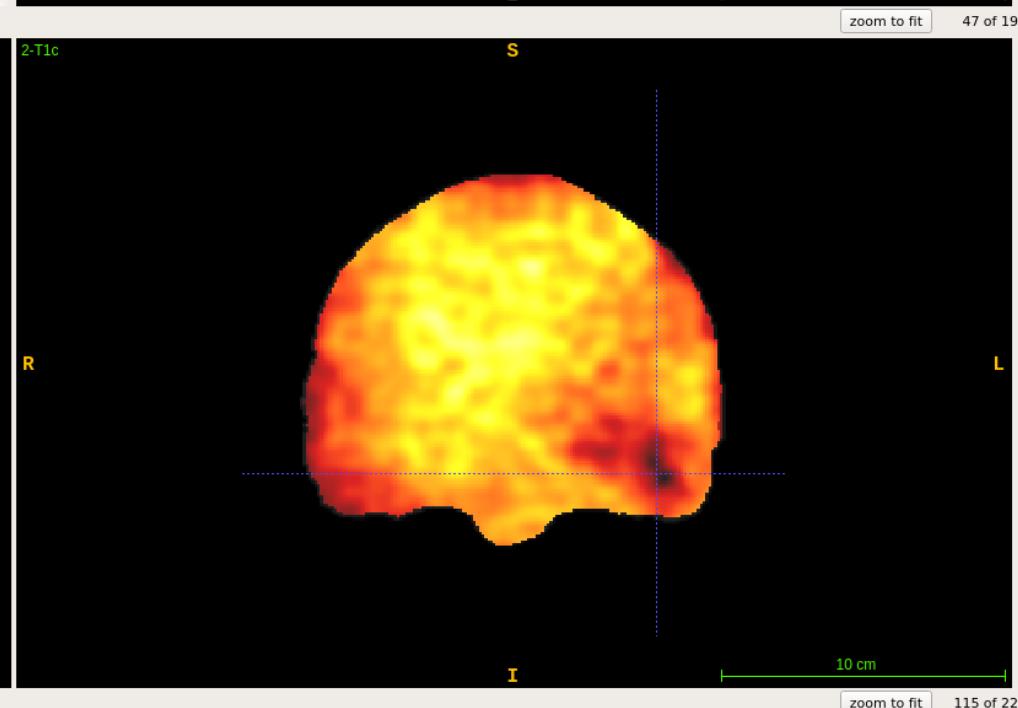
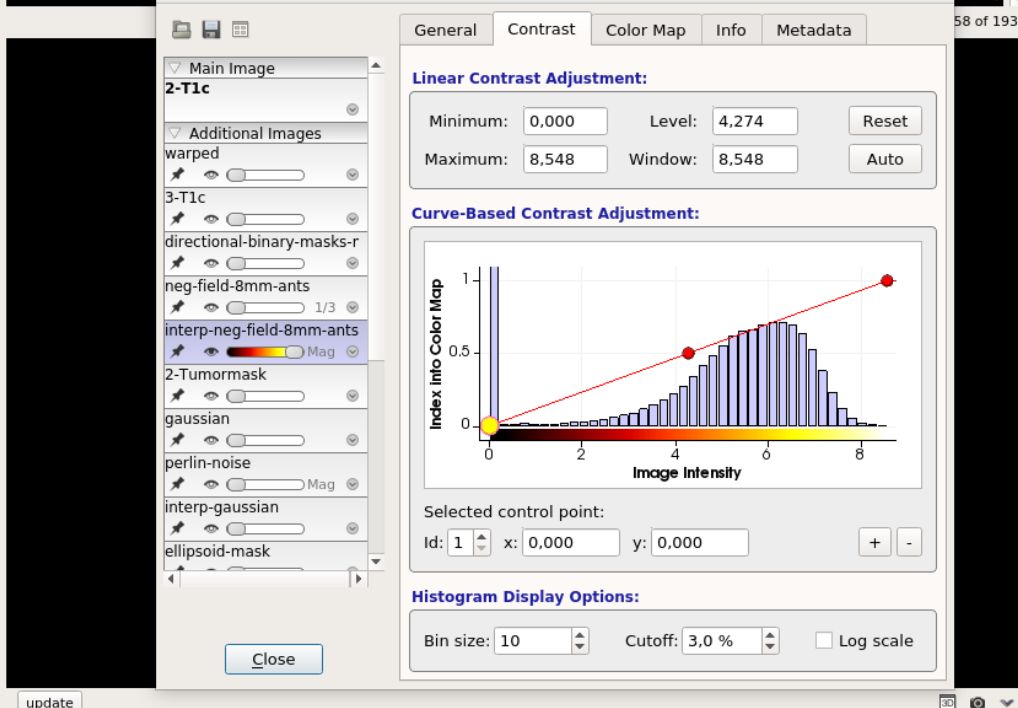
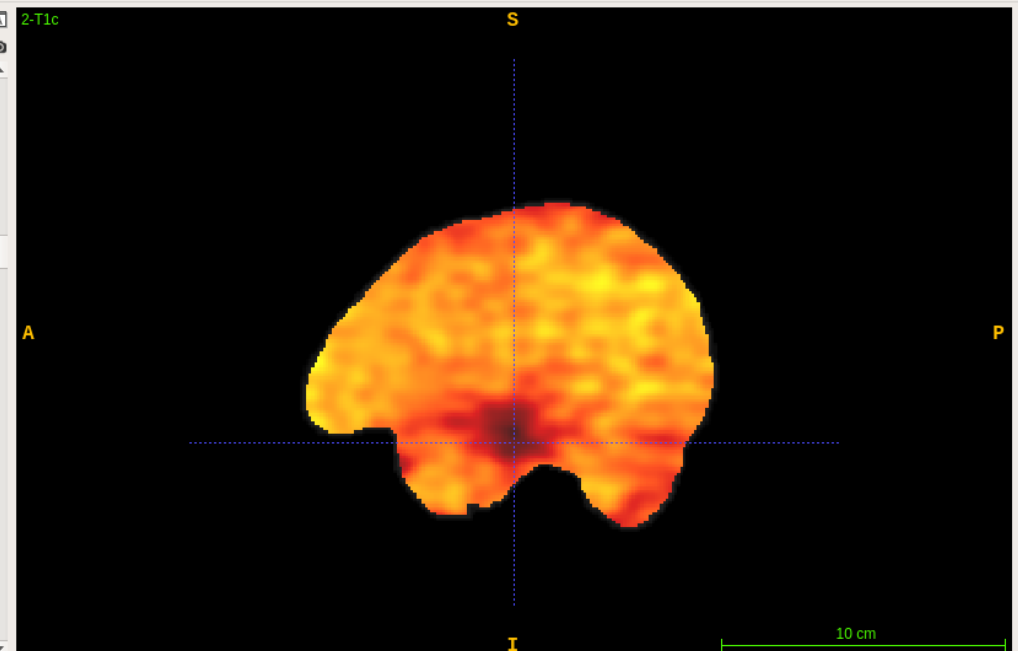
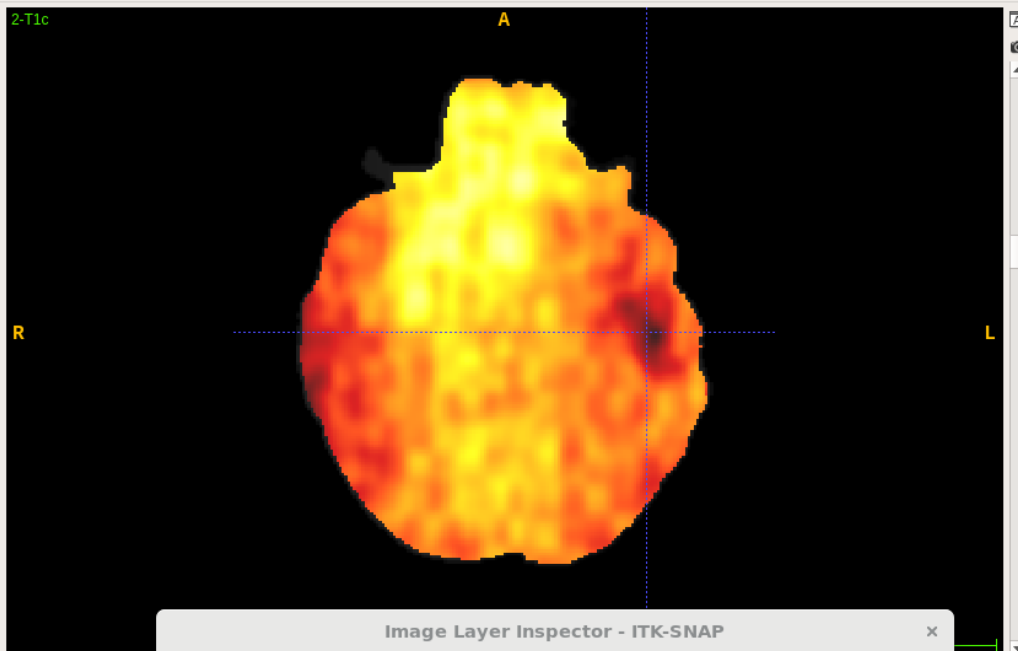
Paint over:

All labels

Overall label opacity:

50

3D Toolbar



ITK-SNAP Toolbox

Main Toolbar



Cursor Inspector



Cursor position (x,y,z):

47 115 58

Intensity under cursor:

Layer	intensity
2-T1c	20.00
warped	22.00
3-T1c	20.3
directional-bin...	1
neg-field-8mm...	-1.09
interp-neg-fiel...	-1.00

Label under cursor:

0 Clear Label

Segmentation Labels

Active label:

Label 1

Paint over:

All labels

Overall label opacity:

50

3D Toolbar

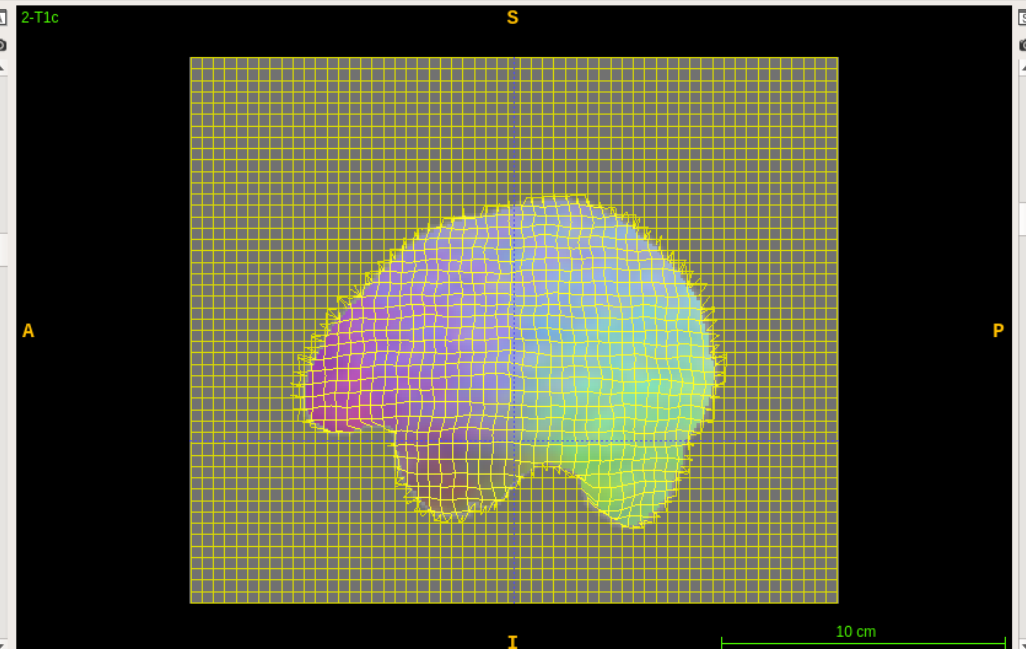
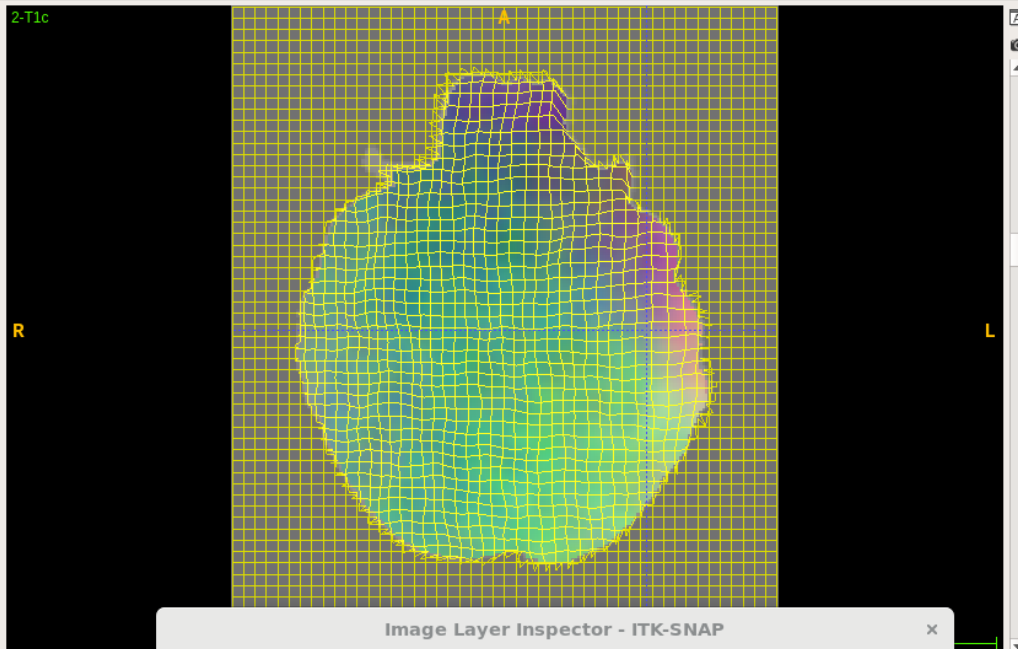


Image Layer Inspector - ITK-SNAP



Main Image

2-T1c

Additional Images

warped

3-T1c

directional-binary-masks-r

neg-field-8mm-ants

interp-neg-field-8mm-ants

2-Tumormask

gaussian

perlin-noise

interp-gaussian

ellipsoid-mask

General Contrast Color Map Info Metadata

General Image Layer Properties:

Filename: interp-neg-field-8mm-ants.nii.gz

Nickname:

Tags:

How to Display this Image Layer:

Display as: ☒ Separate image ☒ Semi-transparent overlay

Overlay

opacity:

100%

Display order:

Move up

Move down

How to Visualize Multiple Image Components:

Display mode: Deformation Grid Display

Component:

Close

update

58 of 193

zoom to fit

47 of 193

10 cm

zoom to fit

115 of 229

ITK-SNAP Toolbox

Main Toolbar



Cursor Inspector



Cursor position (x,y,z):

47 115 59

Intensity under cursor:

Layer	Intensity
2-T1c	18.000
warped	21.700
3-T1c	21.000
directional-bin...	1
neg-field-8mm...	1.900
interp-neg-fiel...	-1.000

Label under cursor:

0 Clear Label

Segmentation Labels

Active label:

Label 1

Paint over:

All labels

Overall label opacity:

50

3D Toolbar

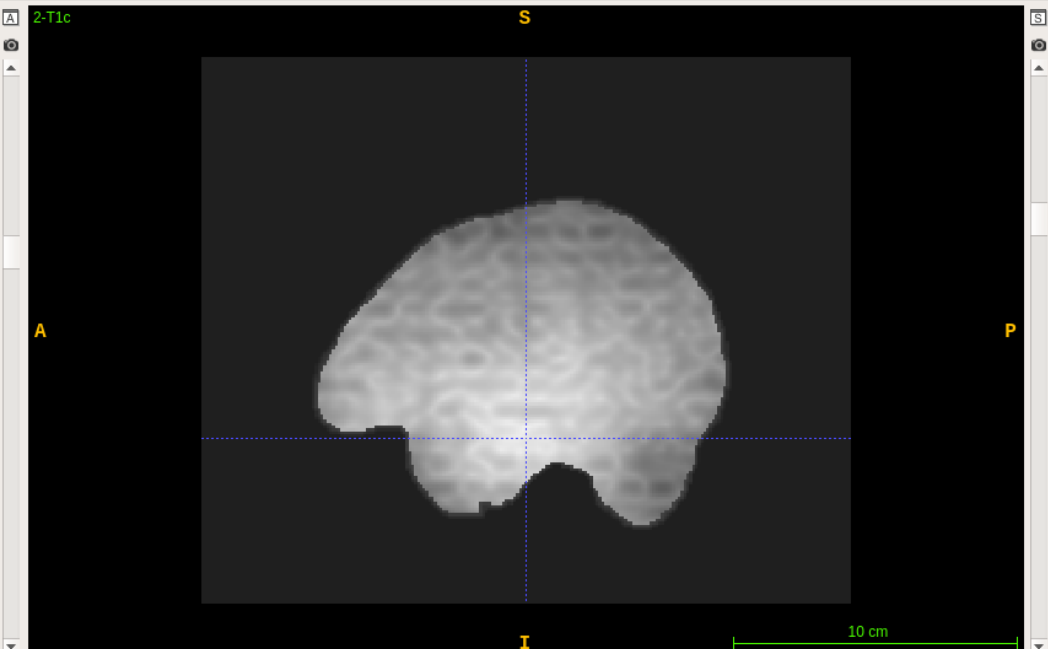
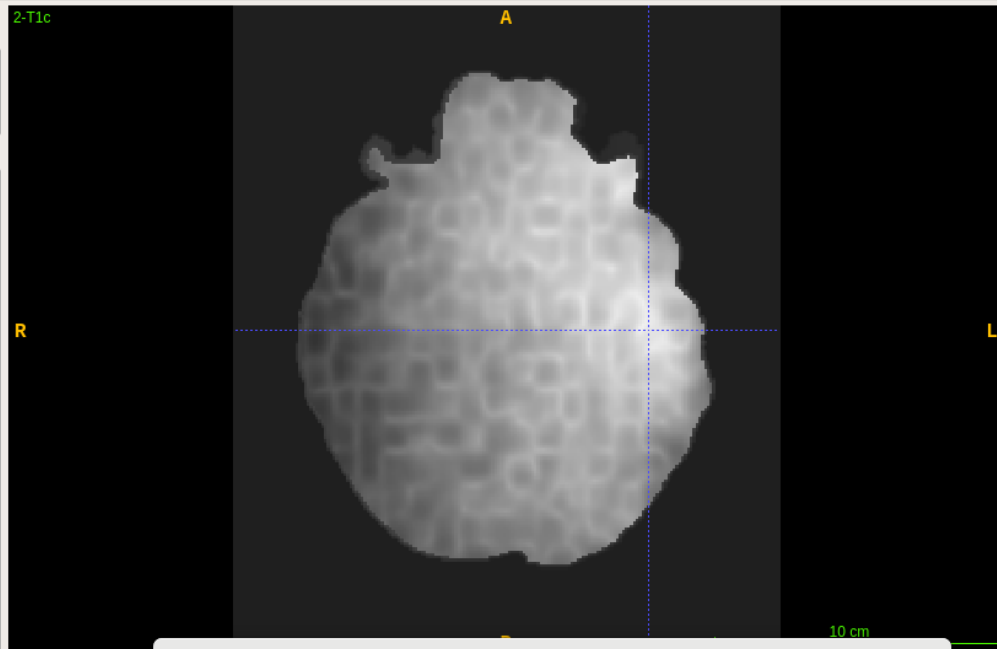


Image Layer Inspector - ITK-SNAP



Main Image

2-T1c

Additional Images

warped

3-T1c

directional-binary-masks-r

neg-field-8mm-ants

interp-neg-field-8mm-ants

2-Tumormask

gaussian

perlin-noise

interp-gaussian

ellipsoid-mask

General Contrast Color Map Info Metadata

Presets:

Select a colormap:

Grayscale

Color Map Editor:



Selected Control Point Properties:

Index: 1

Style: Continuous

Position: 1

Discontinuous

Opacity: 1

Side: Left Right

Color: Choose...

Close

update

59 of 193

zoom to fit

47 of 193

59 of 193

zoom to fit

115 of 229



0.832

0.198

Level

Window

ITK-SNAP Toolbox

Main Toolbar



Cursor Inspector



Cursor position (x,y,z):

47 115 58

Intensity under cursor:

Layer	intensity
2-T1c	20....
warped	22....
3-T1c	20.3
directional-bin...	1
neg-field-8mm...	-1.09
interp-neg-fiel...	-1....

Label under cursor:

0 Clear Label

Segmentation Labels

Active label:

Label 1

Paint over:

All labels

Overall label opacity:

50

3D Toolbar

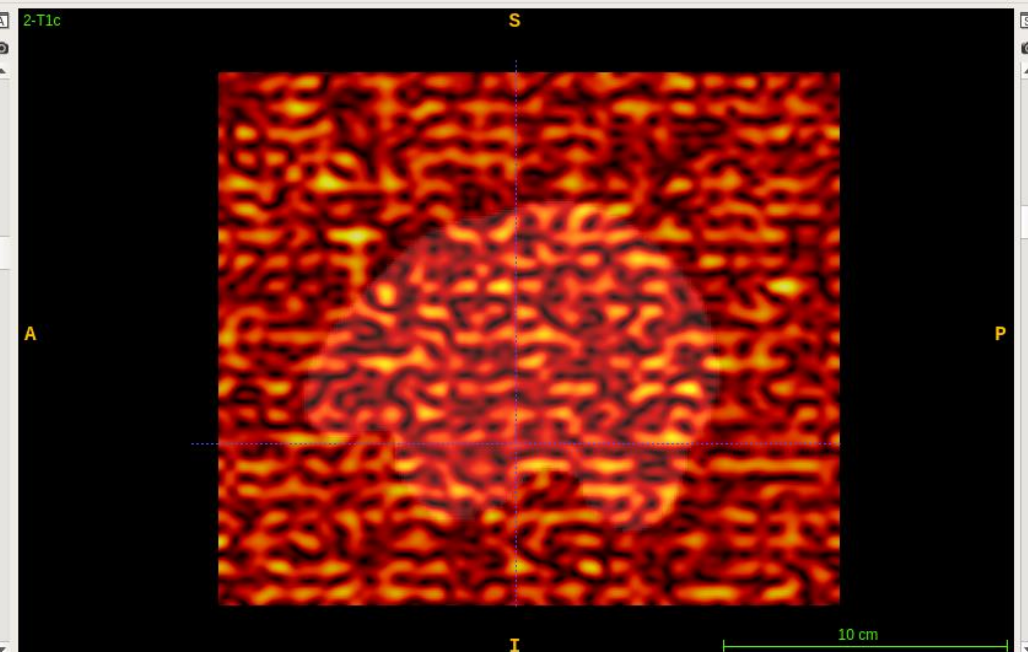
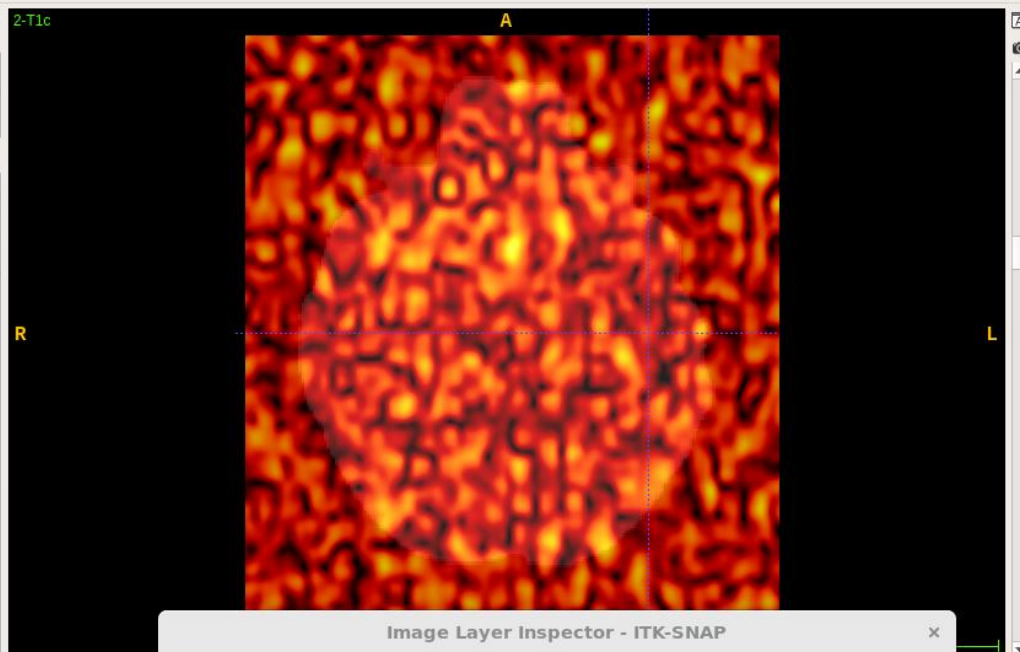


Image Layer Inspector - ITK-SNAP



Main Image

2-T1c

Additional Images

warped

3-T1c

directional-binary-masks-r

neg-field-8mm-ants

interp-neg-field-8mm-ants

2-Tumormask

gaussian

perlin-noise

interp-gaussian

ellipsoid-mask

General Contrast Color Map Info Metadata

Linear Contrast Adjustment:

Minimum: 0,00000

Level: 0,11653

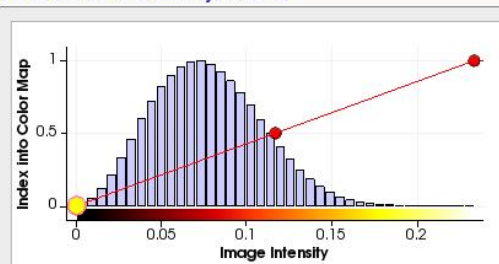
Reset

Maximum: 0,23307

Window: 0,23307

Auto

Curve-Based Contrast Adjustment:



Selected control point:

Id: 1

x: 0,00000

y: 0,00000

+ -

Histogram Display Options:

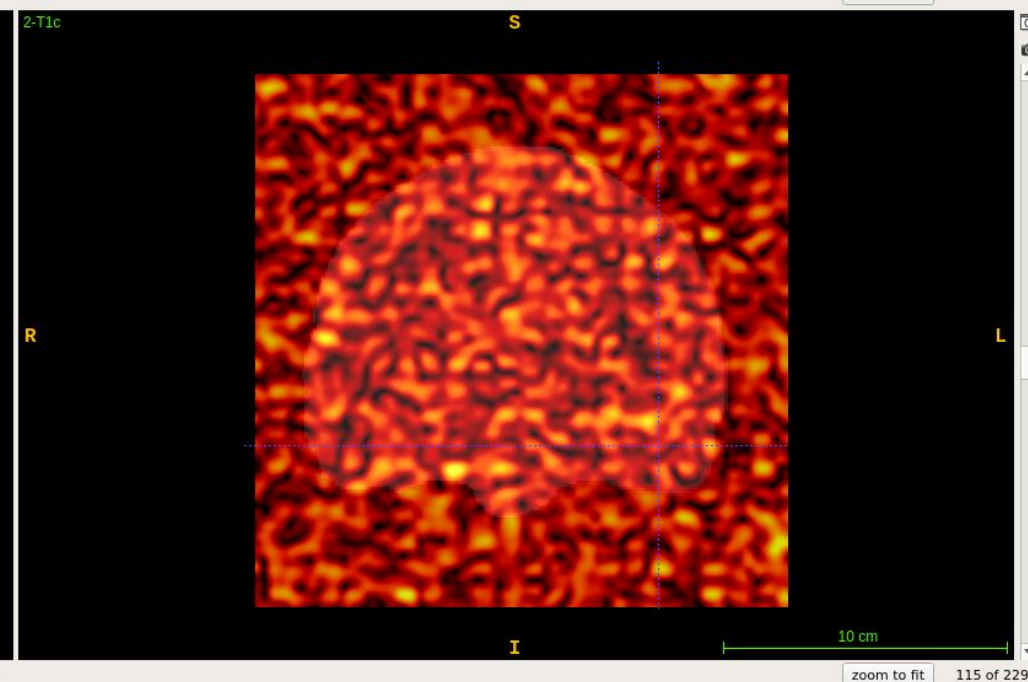
Bin size: 10

Cutoff: 100,0 %

☐ Log scale

Close

58 of 193



update

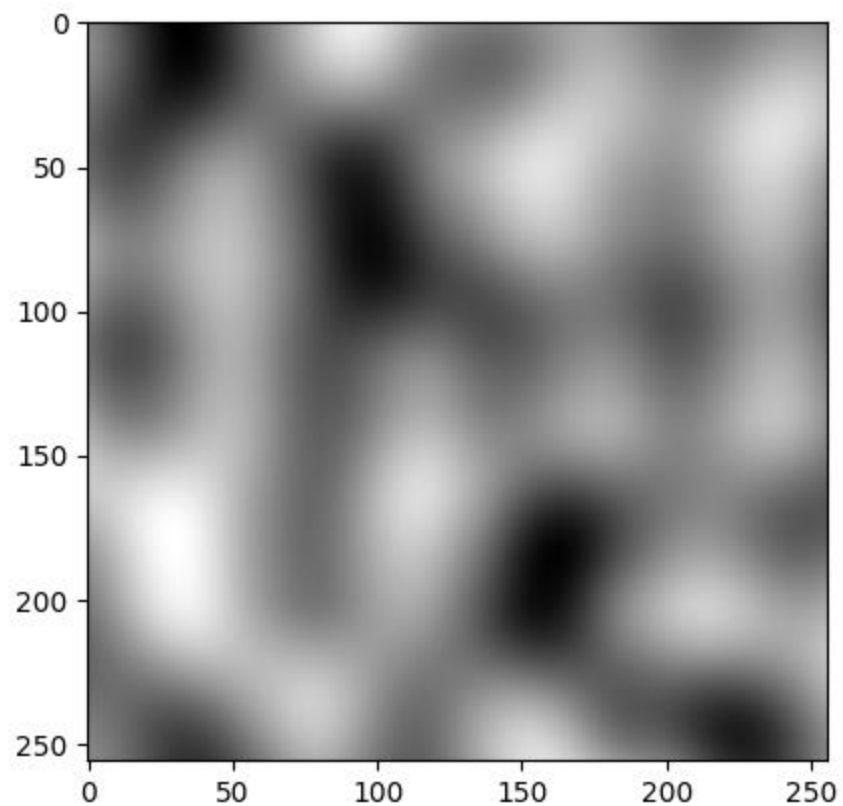
58 of 193

zoom to fit

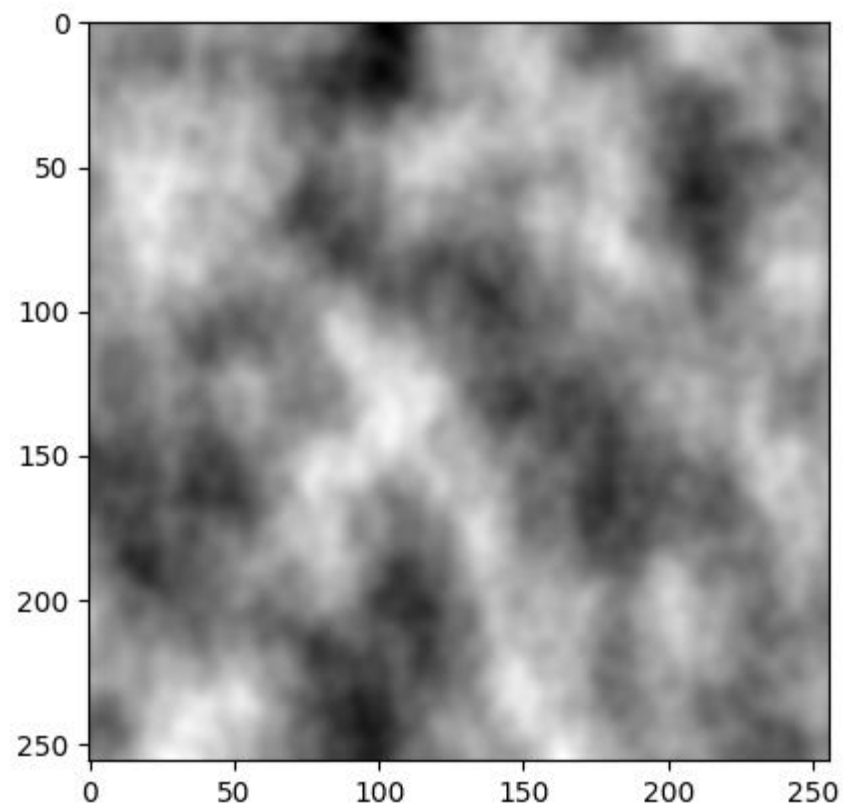
115 of 229

Gradient-based (continuous) noise

Perlin noise



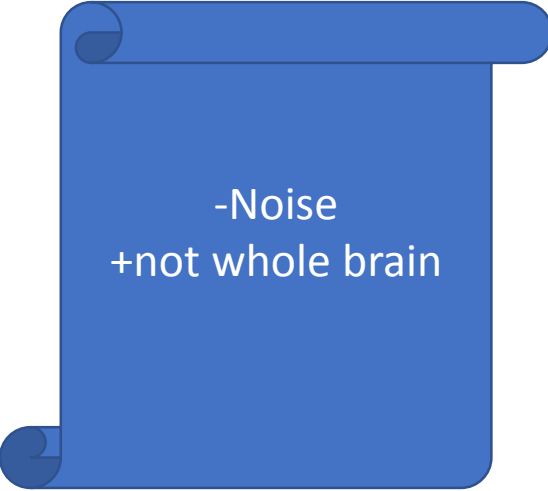
Fractal noise



<https://github.com/pvigier/perlin-numpy>

displacement=8

```
python3 cancer-displacement.py --ref 2-T1c.nii.gz \  
    --tumormask 2-Tumormask.nii.gz \  
    --brainmask 2-BrainExtractionMask.nii.gz \  
    --displacement $displacement \  
    --gaussian_range_one_sided 6 \  
    --max_radial_displacement_to_brainmask_fraction 0.3 \  
    --max_radial_displacement_to_outer_ellipsoid_mask_fraction 1 \  
    --num_vecs 54 \  
    --angle_thr 21 \  
    --num_splits 4 \  
    --spline_order 1 \  
    --smoothing_std 4 \  
    --perlin_noise_res 0.05 \  
    --perlin_noise_abs_max 0 \  
    --eout ellipsoid-mask.nii.gz \  
    --fout field.nii.gz
```



-Noise
+not whole brain

ITK-SNAP Toolbox

Main Toolbar



Cursor Inspector



Cursor position (x,y,z):

46 115 58

Intensity under cursor:

Layer	intensity
2-T1c	21...
warped	23
3-T1c	21...
directional-bin...	1
neg-field-8mm...	1.4...
interp-neg-fiel...	0.7...

Label under cursor:

0 Clear Label

Segmentation Labels

Active label:

Label 1

Paint over:

All labels

Overall label opacity:

50

3D Toolbar

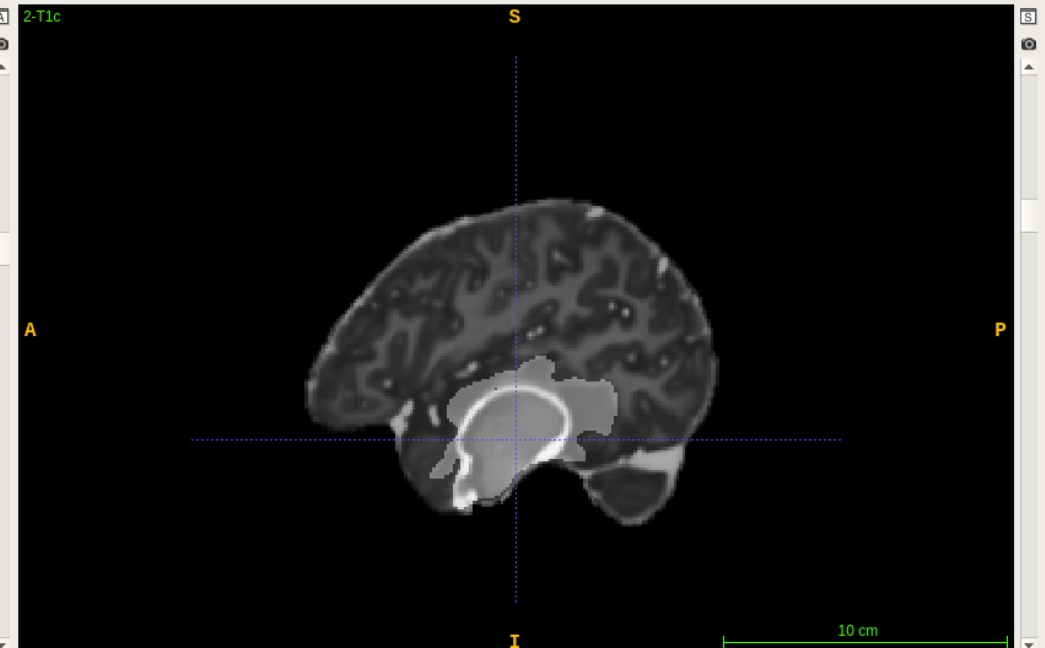


Image Layer Inspector - ITK-SNAP

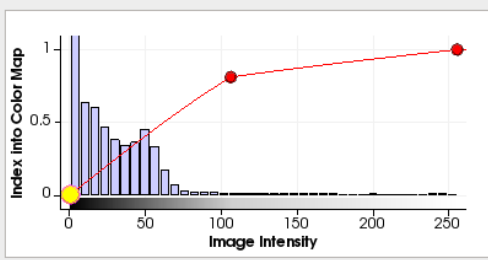
General Contrast Color Map Info Metadata

Linear Contrast Adjustment:

Minimum: 0,00 Level: 127,50 Reset

Maximum: 255,00 Window: 255,00 Auto

Curve-Based Contrast Adjustment:



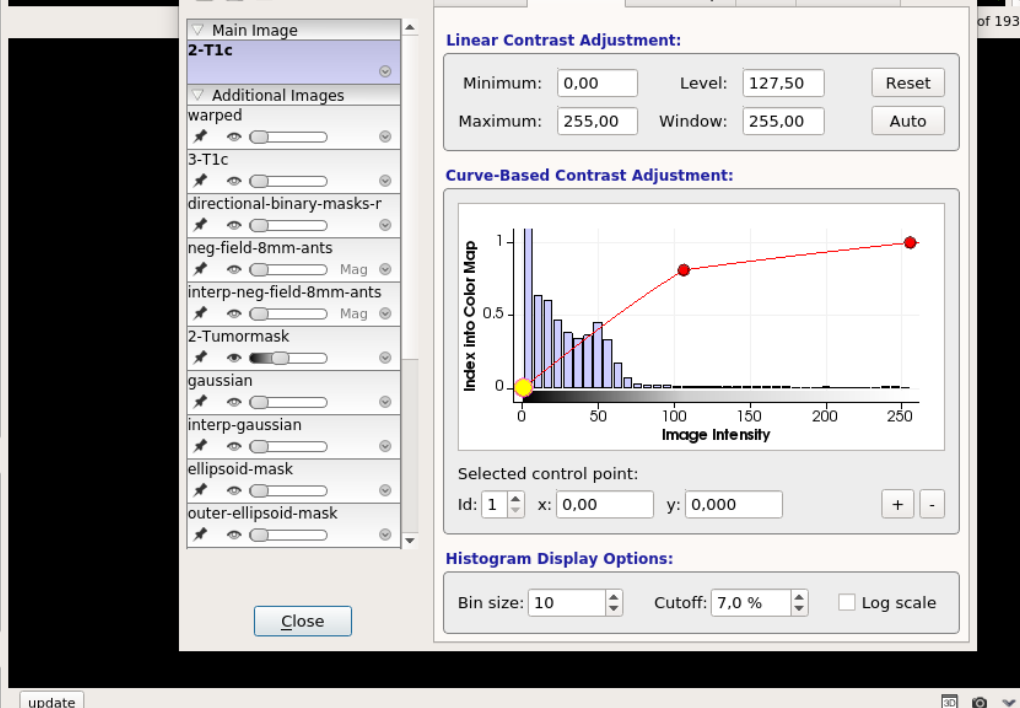
Selected control point:

Id: 1 x: 0,00 y: 0,000 + -

Histogram Display Options:

Bin size: 10 Cutoff: 7,0 % Log scale

Close



ITK-SNAP Toolbox

Main Toolbar



Cursor Inspector



Cursor position (x,y,z):

46 115 58

Intensity under cursor:

Layer	Intensity
2-T1c	21...
warped	23
3-T1c	21...
directional-bin...	1
neg-field-8mm...	1.4...
interp-neg-fiel...	0.7...

Label under cursor:

0 Clear Label

Segmentation Labels

Active label:

Label 1

Paint over:

All labels

Overall label opacity:

50

3D Toolbar

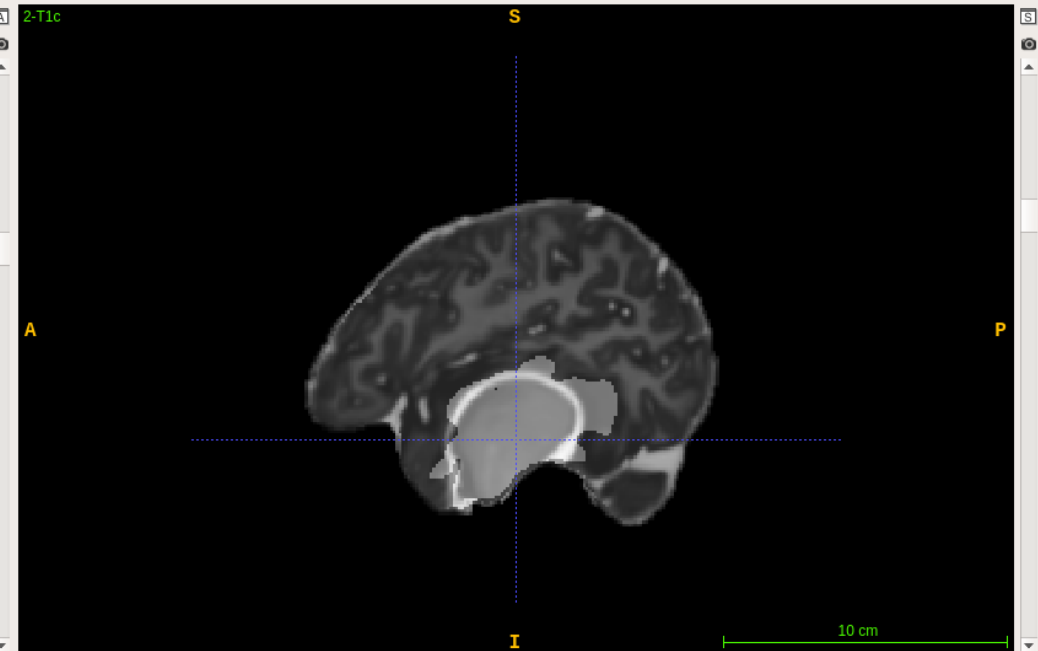
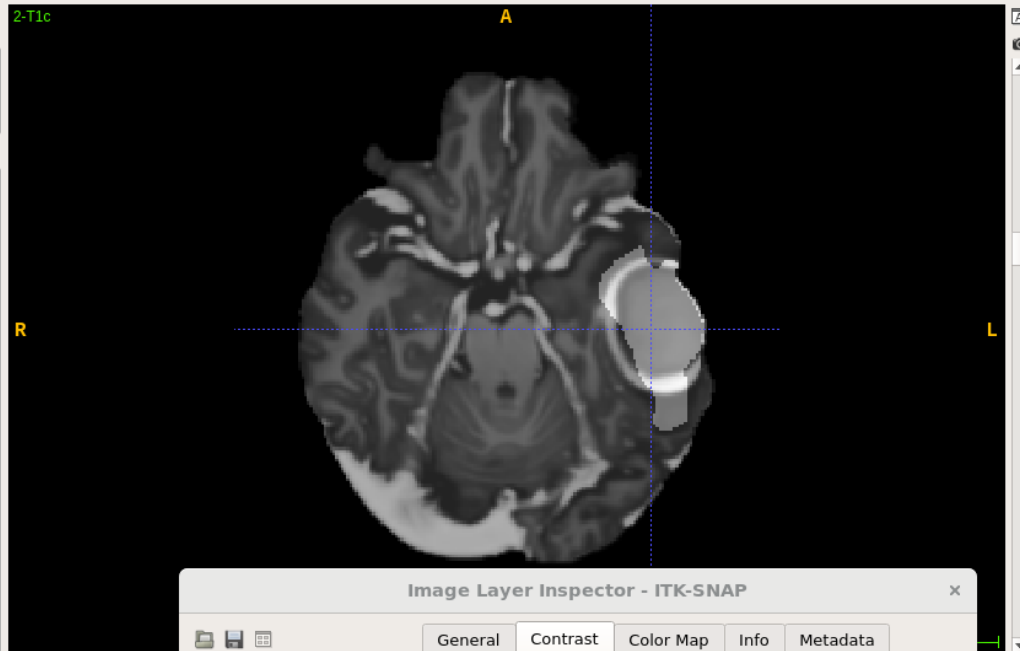


Image Layer Inspector - ITK-SNAP

General Contrast Color Map Info Metadata

Linear Contrast Adjustment:

Minimum: 0,00 Level: 127,50 Reset

Maximum: 255,00 Window: 255,00 Auto

Curve-Based Contrast Adjustment:

Index into Color Map

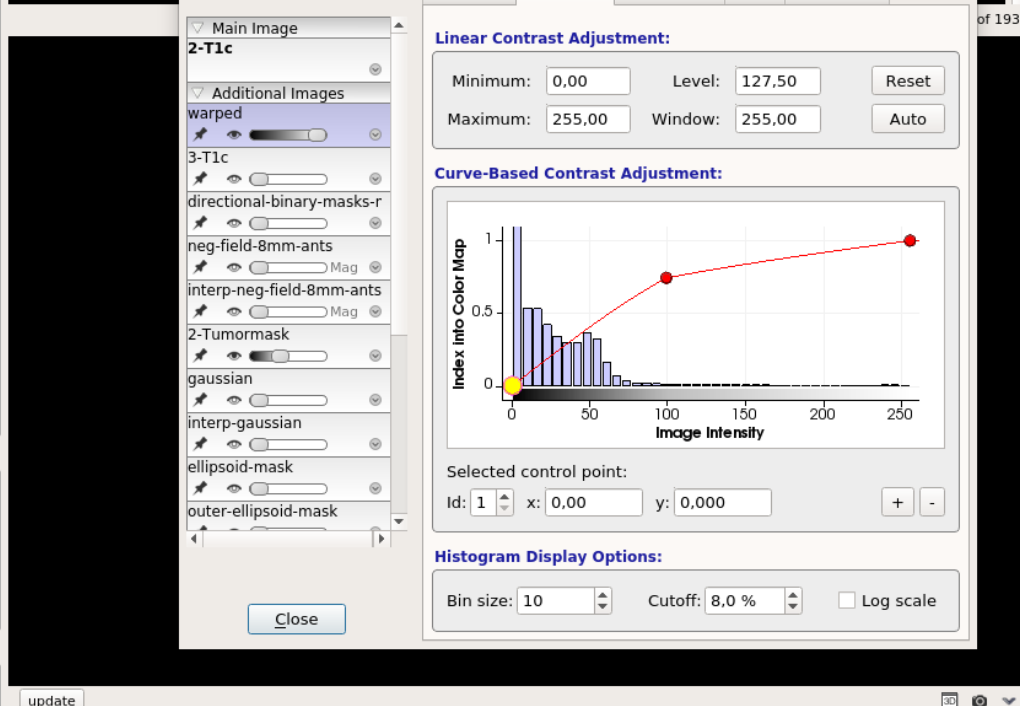
Selected control point:

Id: 1 x: 0,00 y: 0,000 + -

Histogram Display Options:

Bin size: 10 Cutoff: 8,0 % Log scale

Close



ITK-SNAP Toolbox

Main Toolbar



Cursor Inspector



Cursor position (x,y,z):

46 115 58

Intensity under cursor:

Layer	Intensity
2-T1c	21...
warped	23
3-T1c	21...
directional-bin...	1
neg-field-8mm...	1.4...
interp-neg-fiel...	0.7...

Label under cursor:

0 Clear Label

Shutter

Segmentation Labels

Active label:

Label 1

Paint over:

All labels

Overall label opacity:

50

3D Toolbar

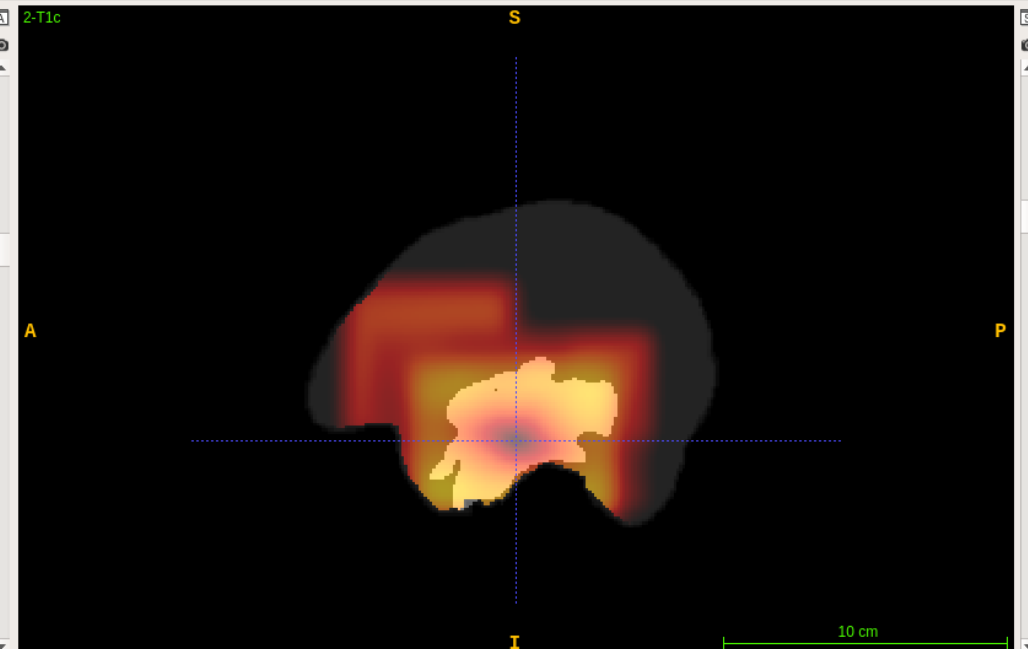
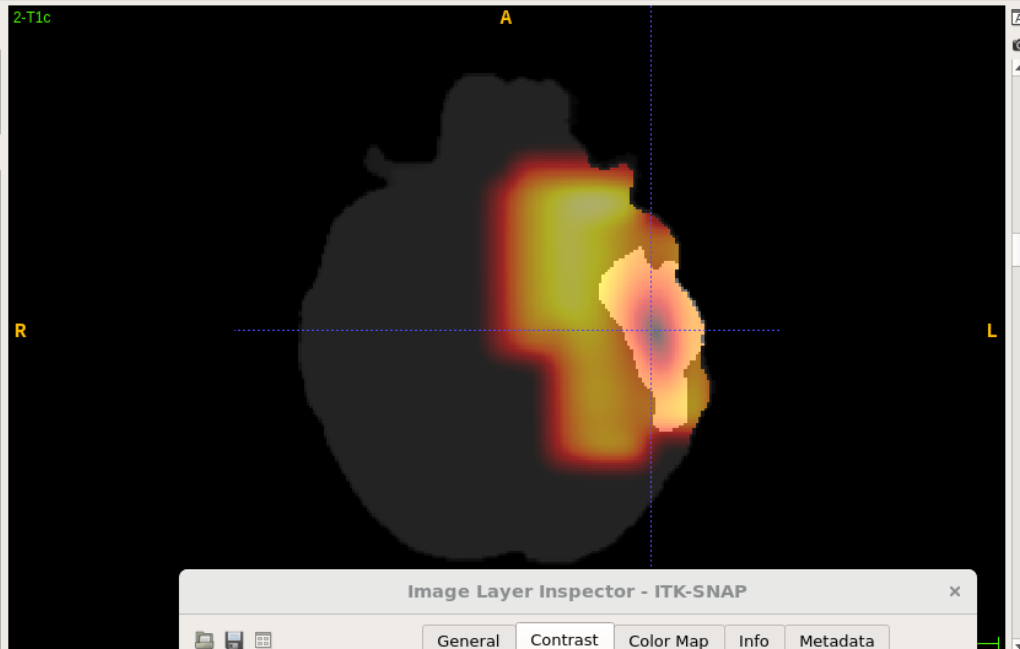


Image Layer Inspector - ITK-SNAP

General Contrast Color Map Info Metadata

Linear Contrast Adjustment:

Minimum: 0,000 Level: 3,848 Reset
Maximum: 7,696 Window: 7,696 Auto

Curve-Based Contrast Adjustment:

Index into Color Map

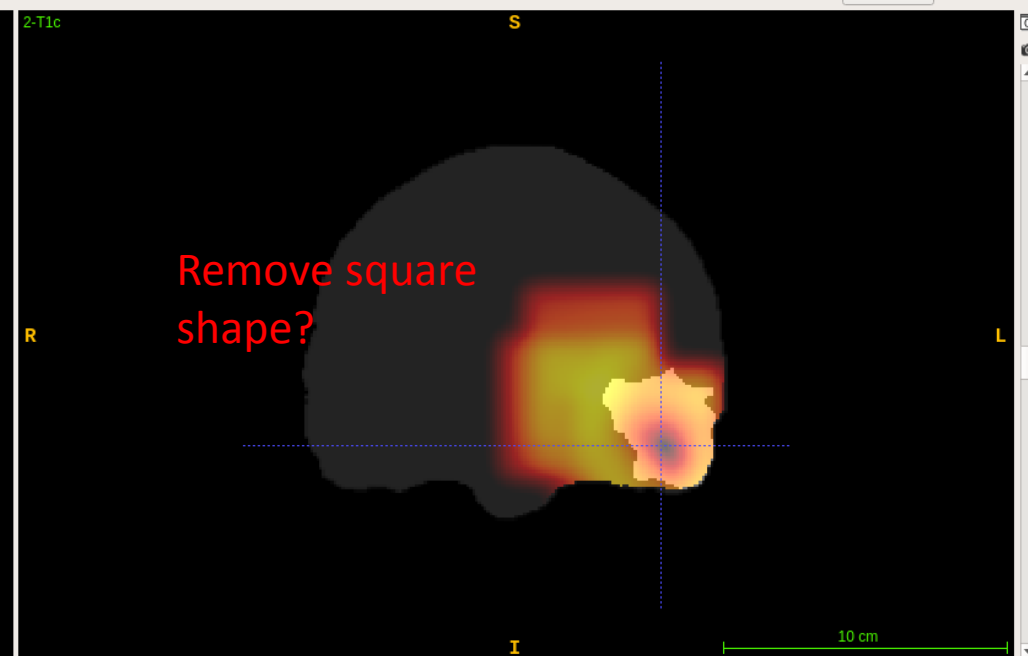
Selected control point:
Id: 1 x: 0,000 y: 0,000 + -

Histogram Display Options:

Bin size: 10 Cutoff: 0,8 % Log scale

Close

of 193



update

100 115 of 229

zoom to fit

115 of 229

ITK-SNAP Toolbox

Main Toolbar



Cursor Inspector



Cursor position (x,y,z):

46 115 58

Intensity under cursor:

Layer	intensity
2-T1c	21...
warped	23
3-T1c	21...
directional-bin...	1
neg-field-8mm...	1.4...
interp-neg-fiel...	-0...

Label under cursor:

0 Clear Label

Segmentation Labels

Active label:

Label 1

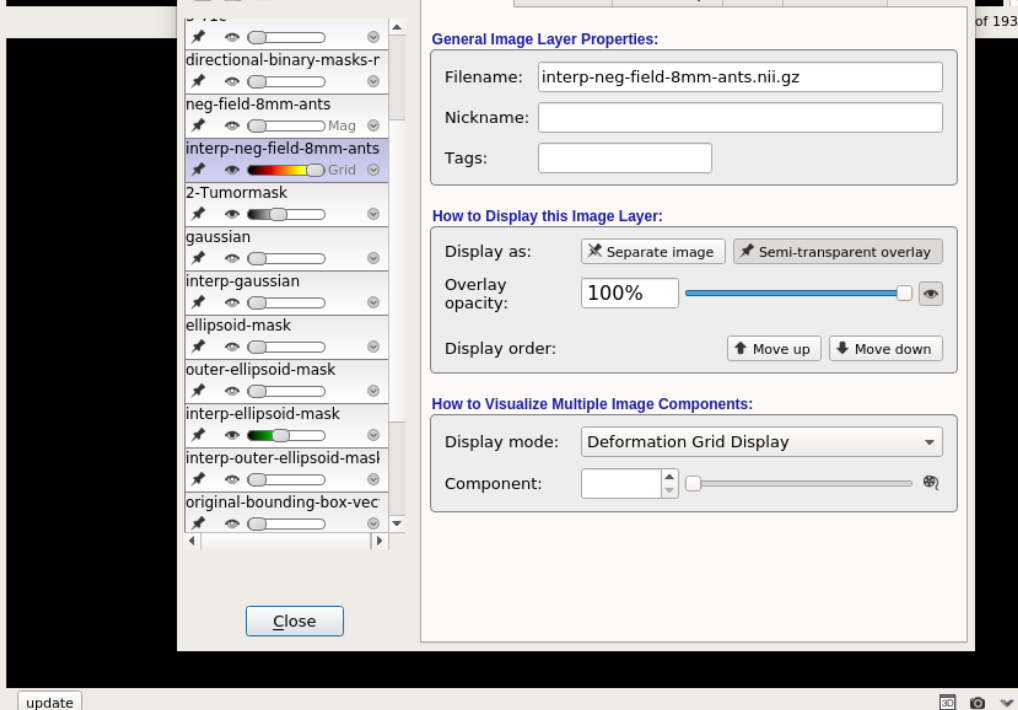
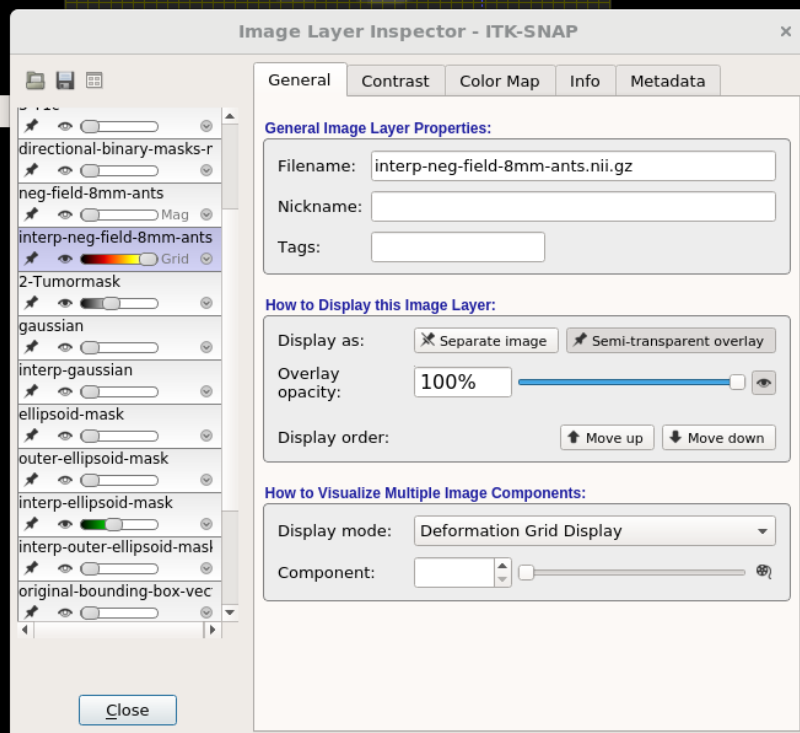
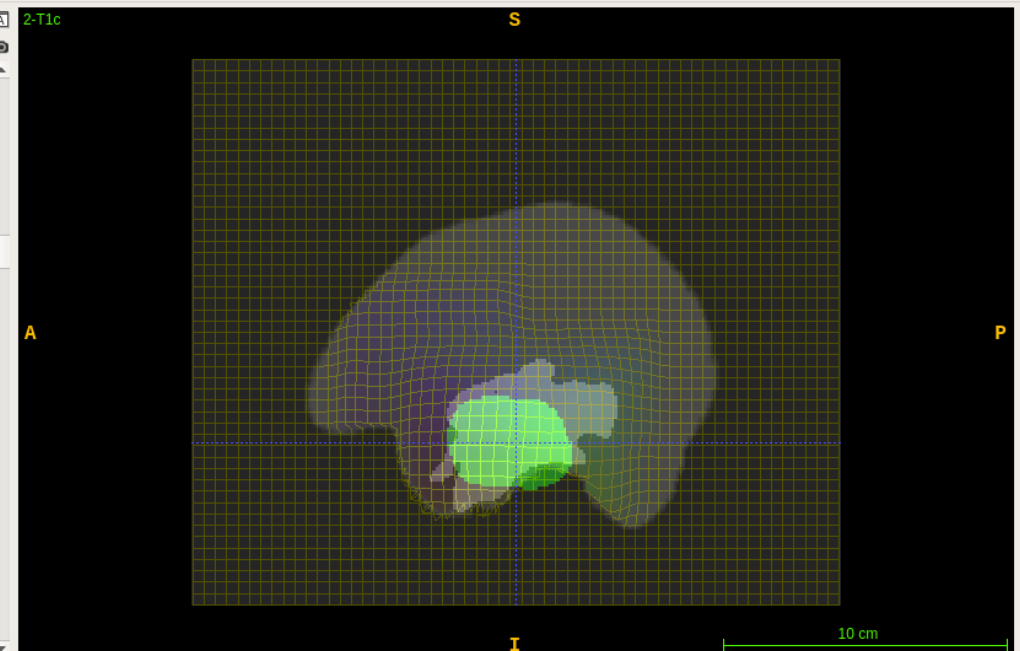
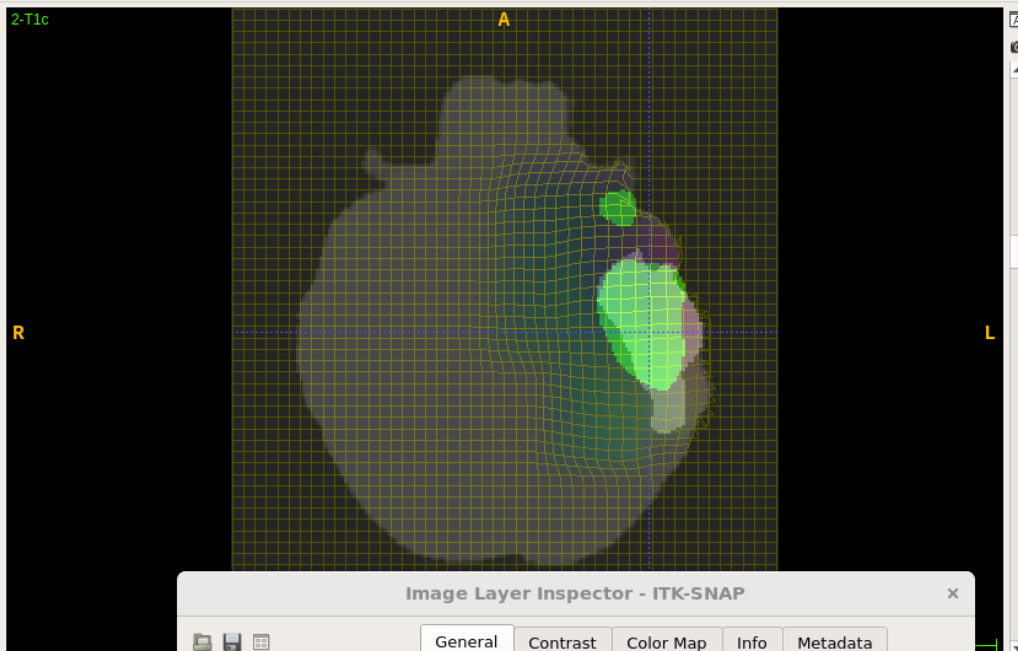
Paint over:

All labels

Overall label opacity:

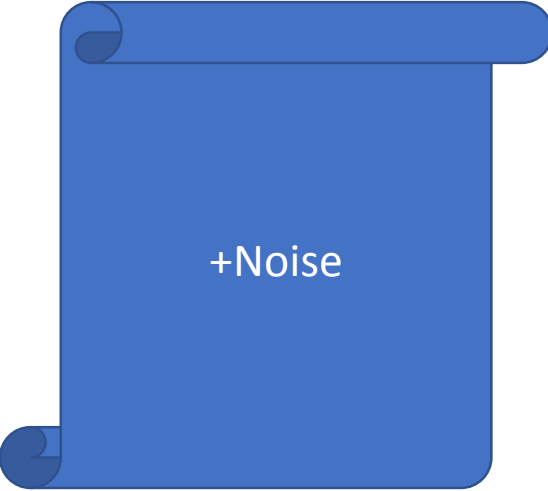
50

3D Toolbar



displacement=8

```
python3 cancer-displacement.py --ref 2-T1c.nii.gz \  
    --tumormask 2-Tumormask.nii.gz \  
    --brainmask 2-BrainExtractionMask.nii.gz \  
    --displacement $displacement \  
    --gaussian_range_one_sided 6 \  
    --max_radial_displacement_to_brainmask_fraction 0.3 \  
    --max_radial_displacement_to_outer_ellipsoid_mask_fraction 1 \  
    --num_vecs 54 \  
    --angle_thr 21 \  
    --num_splits 4 \  
    --spline_order 1 \  
    --smoothing_std 4 \  
    --perlin_noise_res 0.05 \  
    --perlin_noise_abs_max 0.25 \  
    --eout ellipsoid-mask.nii.gz \  
    --fout field.nii.gz
```



+Noise

ITK-SNAP Toolbox

Main Toolbar



Cursor Inspector



Cursor position (x,y,z):

46 115 58

Intensity under cursor:

Layer	intensity
2-T1c	21...
warped	22...
3-T1c	21...
directional-bin...	1
neg-field-8mm...	1.8...
interp-neg-fiel...	-0...

Label under cursor:

0 Clear Label

Segmentation Labels

Active label:

Label 1

Paint over:

All labels

Overall label opacity:

50

3D Toolbar

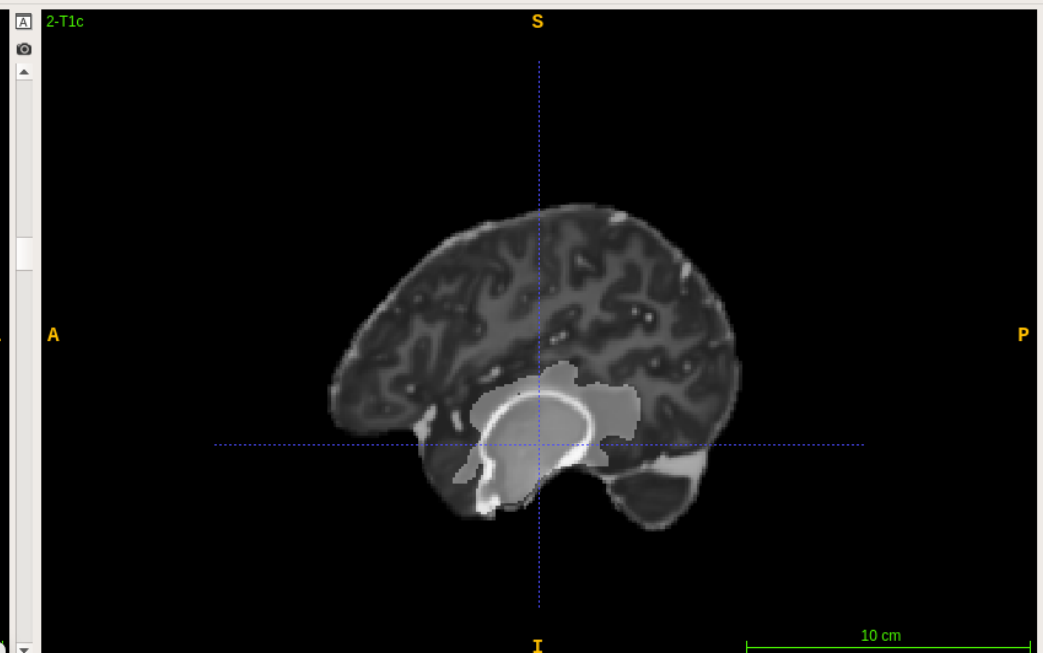
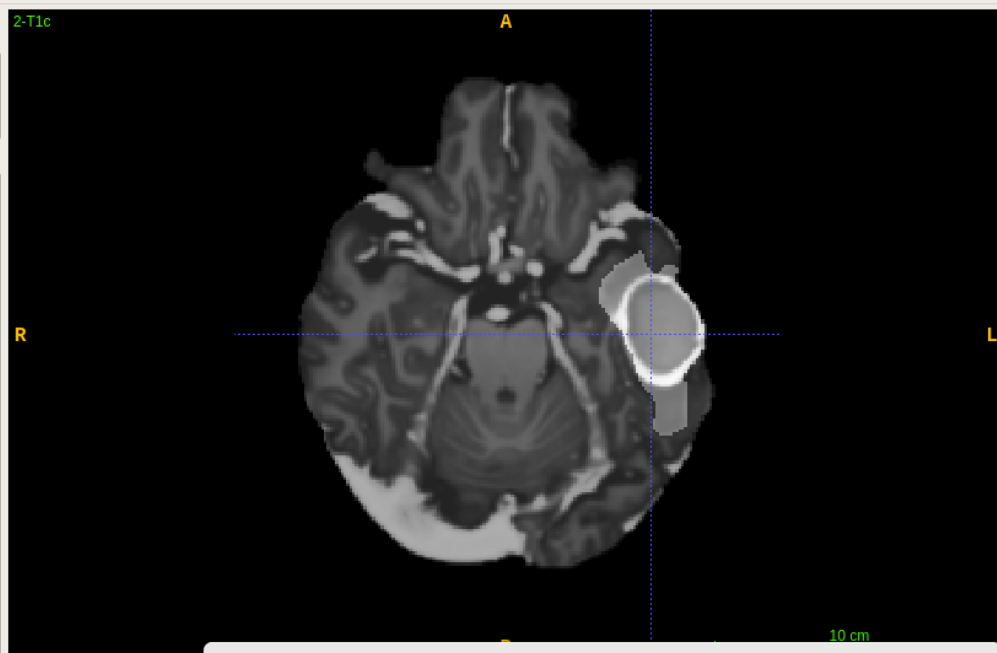


Image Layer Inspector - ITK-SNAP



Main Image

2-T1c

Additional Images

warped

3-T1c

directional-binary-masks-r

neg-field-8mm-ants

interp-neg-field-8mm-ants

2-Tumormask

gaussian

perlin-noise

interp-gaussian

ellipsoid-mask

General Contrast Color Map Info Metadata

Linear Contrast Adjustment:

Minimum: 0,00

Level: 127,50

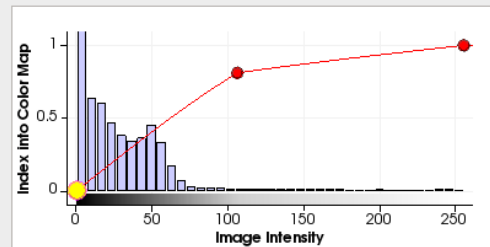
Reset

Maximum: 255,00

Window: 255,00

Auto

Curve-Based Contrast Adjustment:



Selected control point:

Id: 1 x: 0,00 y: 0,000

+ -

Histogram Display Options:

Bin size: 10

Cutoff: 7,0 %

☐ Log scale

Close

update

93



zoom to fit

46 of 193

10 cm

zoom to fit

115 of 229

ITK-SNAP Toolbox

Main Toolbar



Cursor Inspector



Cursor position (x,y,z):

46 115 58

Intensity under cursor:

Layer	intensity
2-T1c	21...
warped	22...
3-T1c	21...
directional-bin...	1
neg-field-8mm...	1.8...
interp-neg-fiel...	-0...

Label under cursor:

0 Clear Label

Segmentation Labels

Active label:

Label 1

Paint over:

All labels

Overall label opacity:

50

3D Toolbar

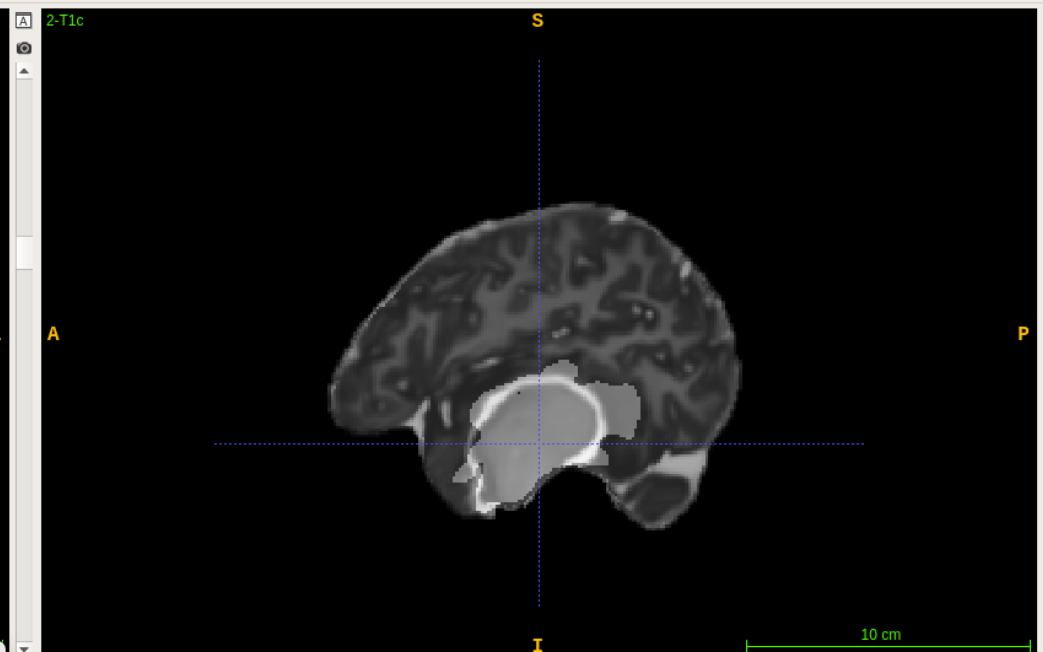
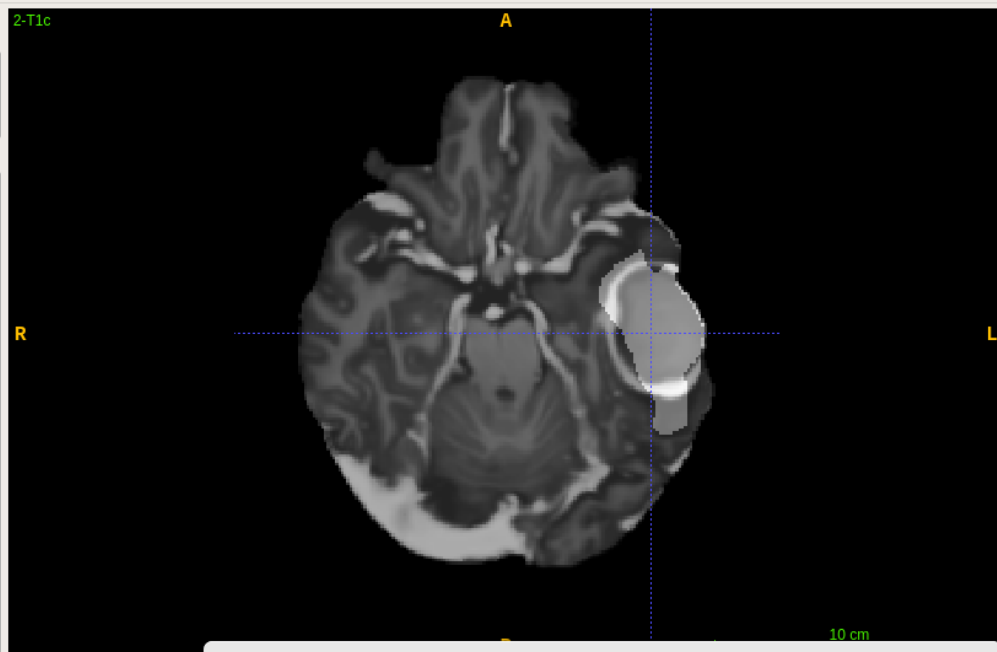
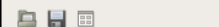


Image Layer Inspector - ITK-SNAP



Main Image

2-T1c

Additional Images

warped

3-T1c

directional-binary-masks-r

neg-field-8mm-ants

interp-neg-field-8mm-ants

2-Tumormask

gaussian

perlin-noise

interp-gaussian

ellipsoid-mask

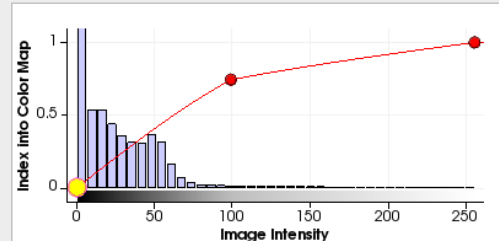
General Contrast Color Map Info Metadata

Linear Contrast Adjustment:

Minimum: 0,00 Level: 127,50 Reset

Maximum: 255,00 Window: 255,00 Auto

Curve-Based Contrast Adjustment:



Selected control point:

Id: 1 x: 0,00 y: 0,000

Histogram Display Options:

Bin size: 10 Cutoff: 8,0 % Log scale

93 zoom to fit 46 of 193



zoom to fit 115 of 229

ITK-SNAP Toolbox

Main Toolbar



Cursor Inspector



Cursor position (x,y,z):

46 115 58

Intensity under cursor:

Layer	Intensity
2-T1c	21...
warped	22...
3-T1c	21...
directional-bin...	1
neg-field-8mm...	1.8...
interp-neg-fiel...	0.9...

Label under cursor:

0 Clear Label

Segmentation Labels

Active label:

Label 1

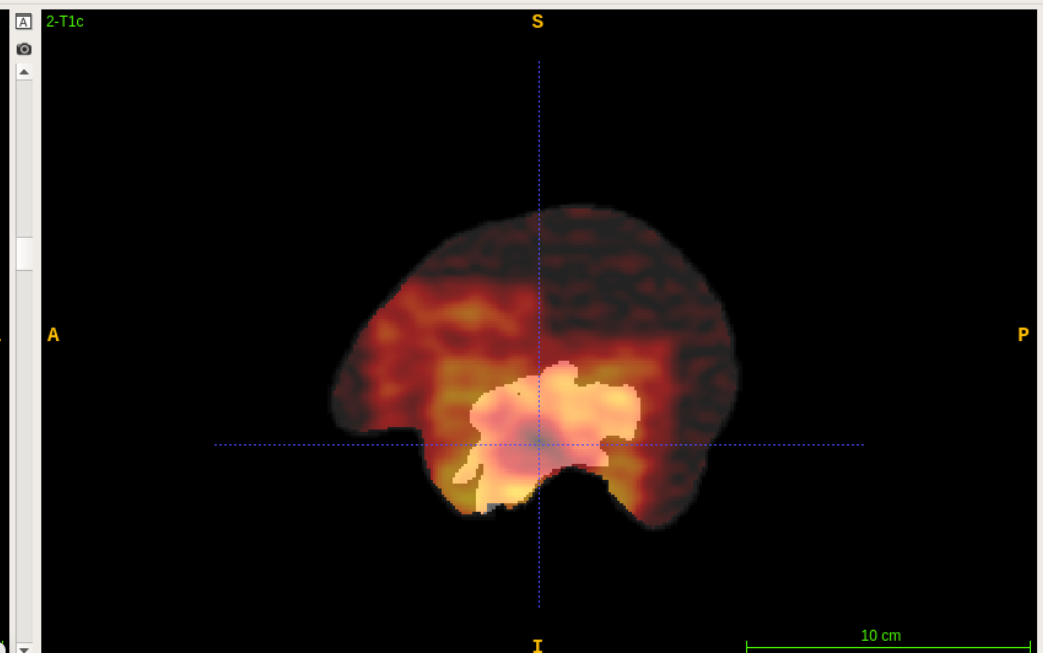
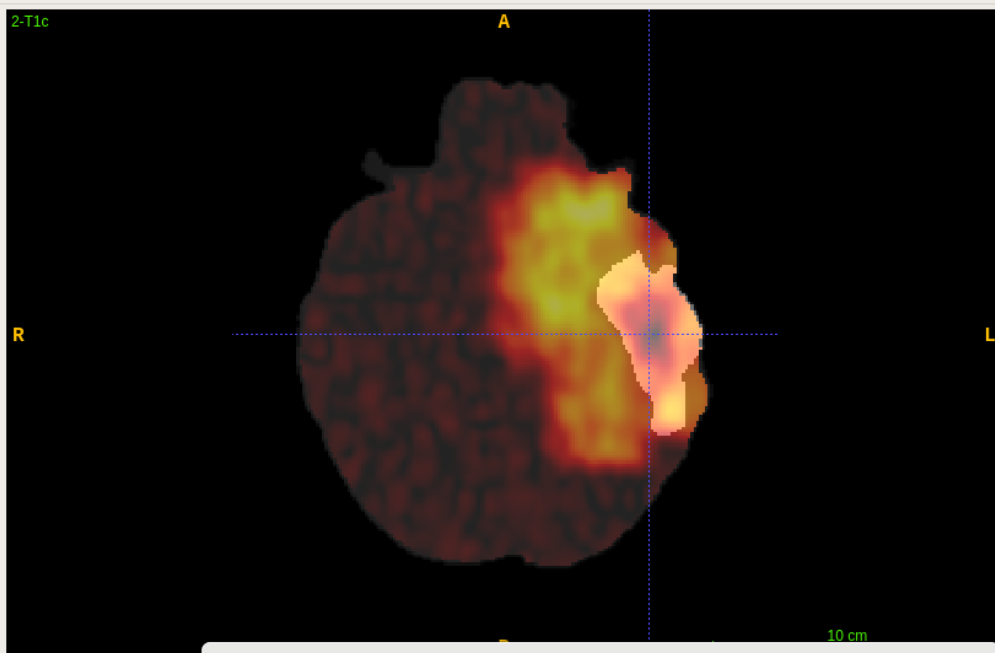
Paint over:

All labels

Overall label opacity:

50

3D Toolbar



zoom to fit

46 of 193

Image Layer Inspector - ITK-SNAP



Main Image

2-T1c

Additional Images

warped

3-T1c

directional-binary-masks-r

neg-field-8mm-ants

interp-neg-field-8mm-ants

2-Tumormask

gaussian

perlin-noise

interp-gaussian

ellipsoid-mask

General Contrast Color Map Info Metadata

Linear Contrast Adjustment:

Minimum: 0,000

Level: 4,237

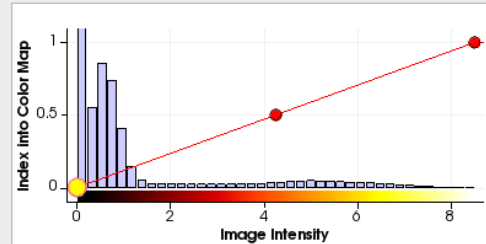
Reset

Maximum: 8,473

Window: 8,473

Auto

Curve-Based Contrast Adjustment:



Selected control point:

Id: 1 x: 0,000 y: 0,000

+ -

Histogram Display Options:

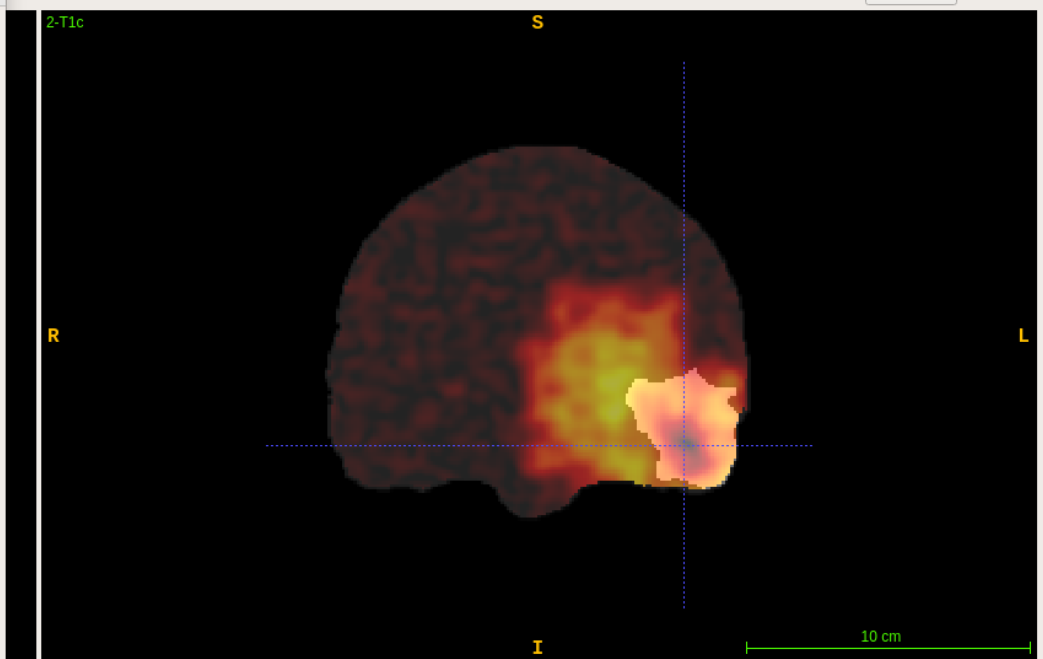
Bin size: 10

Cutoff: 8,0 %

☐ Log scale

Close

update



zoom to fit

115 of 229

ITK-SNAP Toolbox

Main Toolbar



Cursor Inspector



Cursor position (x,y,z):

46 115 58

Intensity under cursor:

Layer	intensity
2-T1c	21...
warped	22...
3-T1c	21...
directional-bin...	1
neg-field-8mm...	1.8...
interp-neg-fiel...	-0...

Label under cursor:

0 Clear Label

Shutter

Segmentation Labels

Active label:

Label 1

Paint over:

All labels

Overall label opacity:

50

3D Toolbar

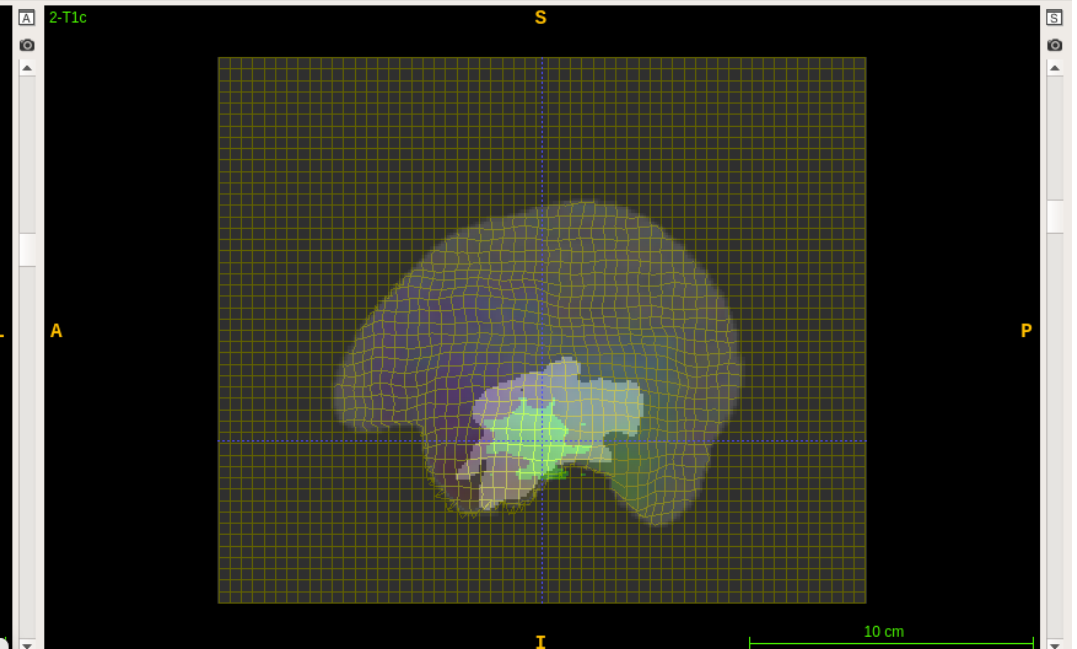
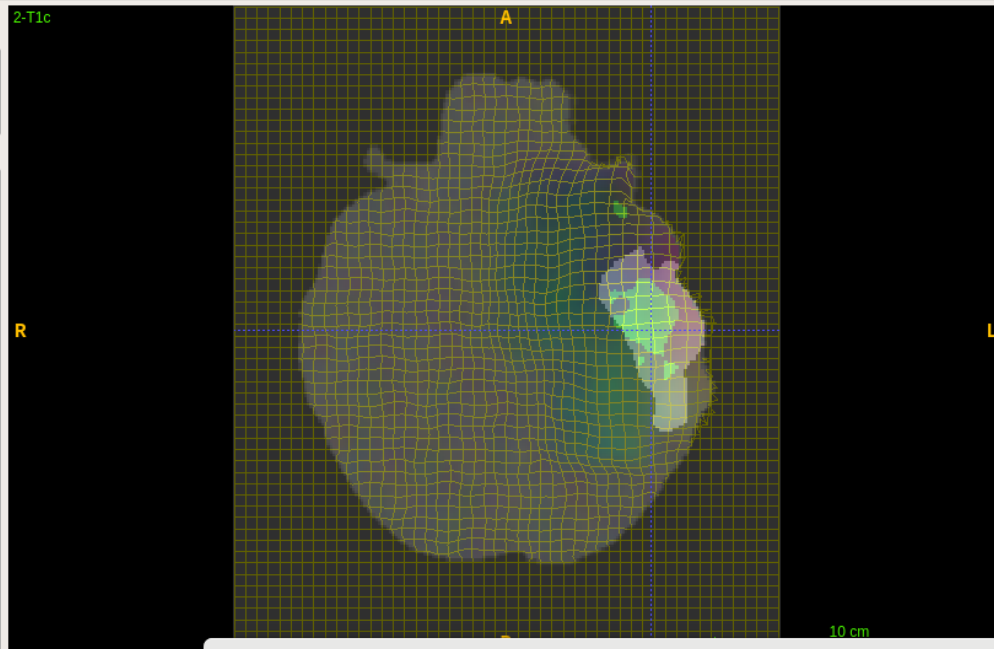
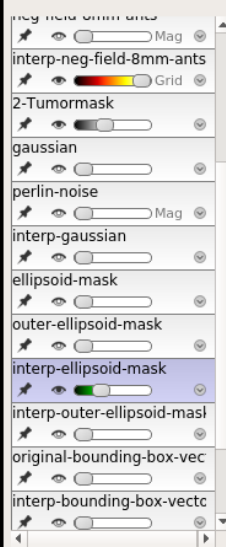
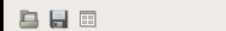


Image Layer Inspector - ITK-SNAP



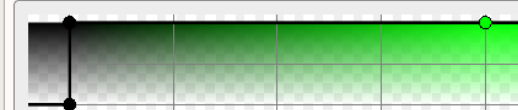
General Contrast Color Map Info Metadata

Presets:

Select a colormap:

Black to green

Color Map Editor:



Selected Control Point Properties:

Index: 1

Style: Continuous

Position: 1

Discontinuous

Opacity: 1

Side: Left Right

Color: Choose...

Close

update

zoom to fit 46 of 193

zoom to fit 115 of 229

ITK-SNAP Toolbox

Main Toolbar



Cursor Inspector



Cursor position (x,y,z):

46 115 58

Intensity under cursor:

Layer	intensity
2-T1c	21...
warped	22...
3-T1c	21...
directional-bin...	1
neg-field-8mm...	1.8...
interp-neg-fiel...	-0...

Label under cursor:

0 Clear Label

Segmentation Labels

Active label:

Label 1

Paint over:

All labels

Overall label opacity:

50

3D Toolbar

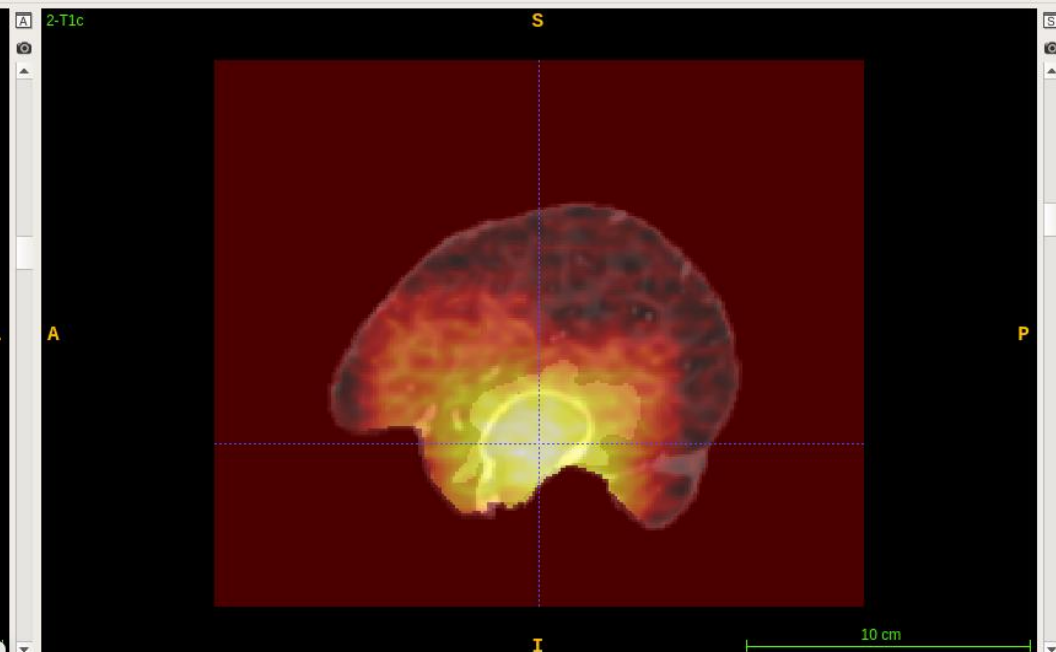
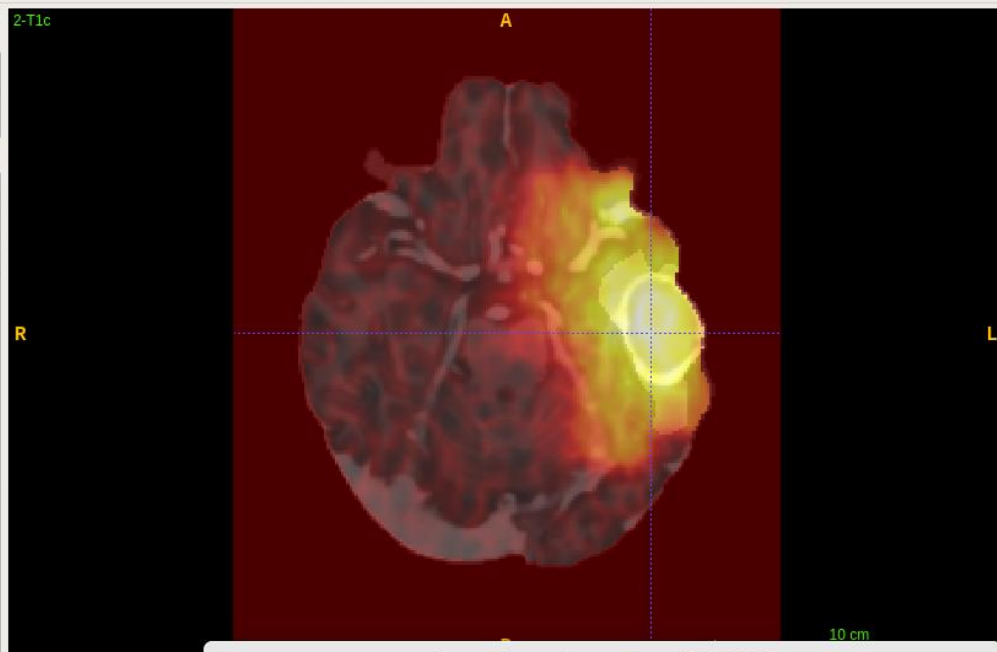


Image Layer Inspector - ITK-SNAP



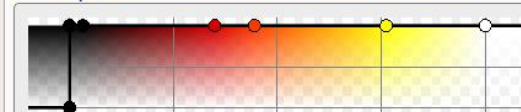
General Contrast Color Map Info Metadata

Presets:

Select a colormap:

Hot

Color Map Editor:



Selected Control Point Properties:

Index: 1

Style: Continuous

Position: 100

Discontinuous

Opacity: 100

Side: Left Right

Color: Choose...

Close

update

zoom to fit 46 of 193

zoom to fit 115 of 229

ITK-SNAP Toolbox

Main Toolbar



Cursor Inspector



Cursor position (x,y,z):

46 115 58

Intensity under cursor:

Layer	intensity
2-T1c	21....
warped	22....
3-T1c	21....
directional-bin...	1
neg-field-8mm...	1.8...
interp-neg-fiel...	-0....

Label under cursor:

0 Clear Label

Segmentation Labels

Active label:

Label 1

Paint over:

All labels

Overall label opacity:

50

3D Toolbar

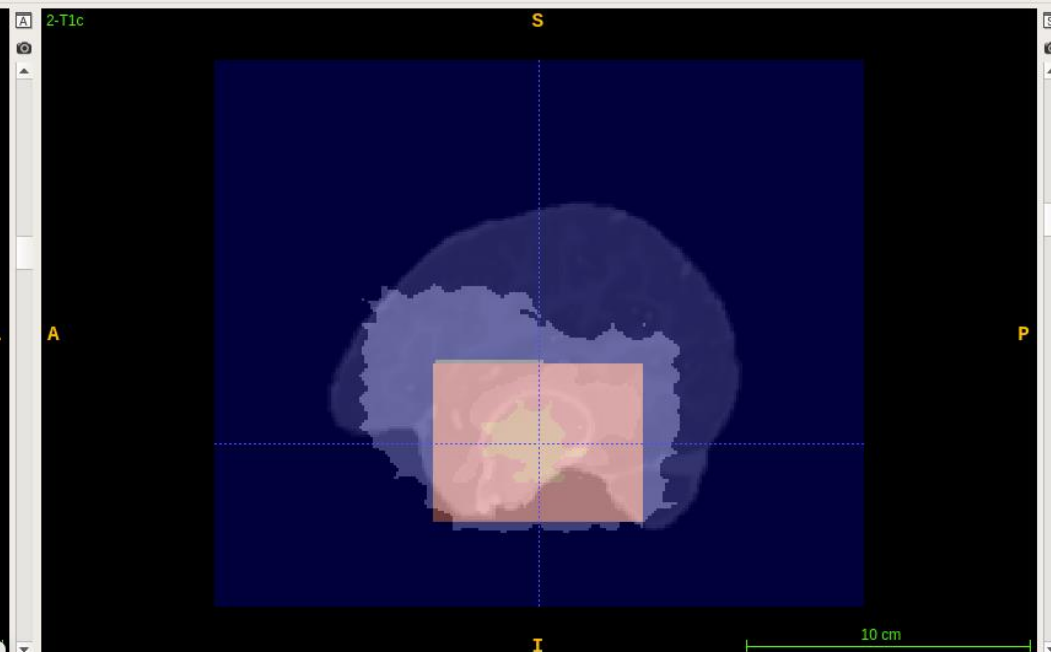
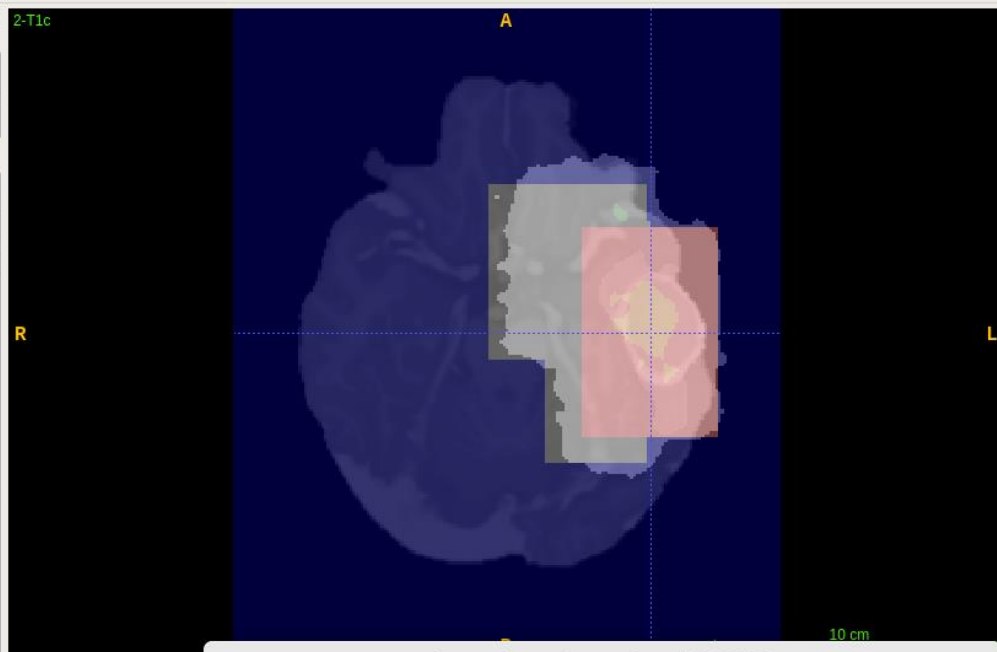
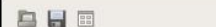


Image Layer Inspector - ITK-SNAP



General Contrast Color Map Info Metadata

Presets:

Select a colormap:

Black to green

Color Map Editor:



Selected Control Point Properties:

Index: 1

Style: Continuous

Position: 100

Discontinuous

Opacity: 100

Side: Left Right

Color: Choose...

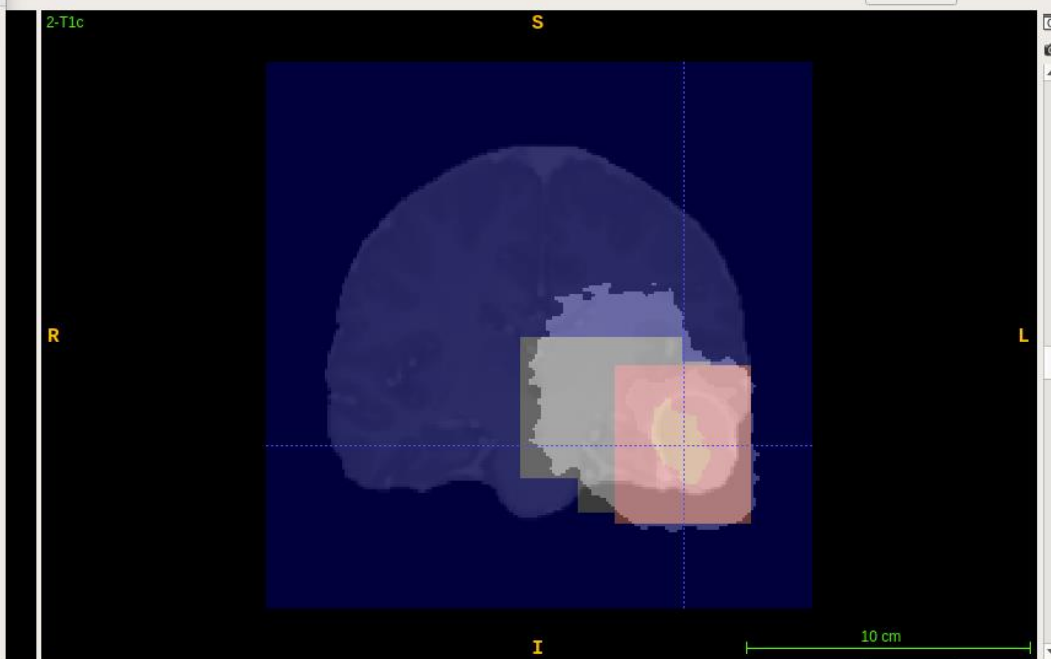
Close

update

93

zoom to fit

46 of 193



10 cm

zoom to fit

115 of 229