Analyse case7 npgamma 29-11-2016

November 29, 2016

Use npgamma to compare HN Case 7 dose data. See https://github.com/SimonBiggs/npgamma/blob/master/Module%20usage%203D.ipynb

In [1]:
```
import dicom
import numpy as np
import matplotlib.pyplot as plt
%matplotlib inline

from npgamma import calc_gamma
```

In [2]:
```
dcm_ref = dicom.read_file("Case7_dose_AAA.dcm")
dcm_evl = dicom.read_file("Case7_dose_Dm.dcm")
```

In [3]:
```
# The x, y, and z defined here have not been sufficiently verified
# They do not necessarily match either what is within Dicom nor what is wit
# TPS. Please verify these and see if they are what you expect them to be.

# If these functions are incorrect or there is a better choice of dimensior
# please contact me by creating an issue within the github repository:
#   https://github.com/SimonBiggs/npgamma/issues

# If you are able to validate these functions please contact me in the same


# Imports the dose in matplotlib format, with the following index mapping:
#   i = y
#   j = x
#   k = z

# Therefore w
def load_dose_from_dicom(dcm):
    """Imports the dose in matplotlib format, with the following index mapp
        i = y
        j = x
        k = z

    Therefore when using this function to have the coords match the same or
    ie. coords_reference = (y, x, z)
```

```
    """
    pixels = np.transpose(
        dcm.pixel_array, (1, 2, 0))
    dose = pixels * dcm.DoseGridScaling

    return dose


def load_xyz_from_dicom(dcm):
    """Although this coordinate pull from Dicom works in the scenarios test
    this is not an official x, y, z pull. It needs further confirmation.
    """
    resolution = np.array(
        dcm.PixelSpacing).astype(float)
    # Does the first index match x?
    # Haven't tested with differing grid sizes in x and y directions.
    dx = resolution[0]

    # The use of dcm.Columns here is under question
    x = (
        dcm.ImagePositionPatient[0] +
        np.arange(0, dcm.Columns * dx, dx))

    # Does the second index match y?
    # Haven't tested with differing grid sizes in x and y directions.
    dy = resolution[1]

    # The use of dcm.Rows here is under question
    y = (
        dcm.ImagePositionPatient[1] +
        np.arange(0, dcm.Rows * dy, dy))

    # Is this correct?
    z = (
        np.array(dcm.GridFrameOffsetVector) +
        dcm.ImagePositionPatient[2])

    return x, y, z


dose_reference = load_dose_from_dicom(dcm_ref)
dose_evaluation = load_dose_from_dicom(dcm_evl)

x_reference, y_reference, z_reference = load_xyz_from_dicom(dcm_ref)
x_evaluation, y_evaluation, z_evaluation = load_xyz_from_dicom(dcm_evl)
```

In [7]:
```
# Input coordinates need to match the same order as the dose grid in
# index reference order.
```

```
        coords_reference = (
            y_reference, x_reference, z_reference)

        coords_evaluation = (
            y_evaluation, x_evaluation, z_evaluation)
```

In [8]:
```
distance_threshold = 3
distance_step_size = distance_threshold / 10

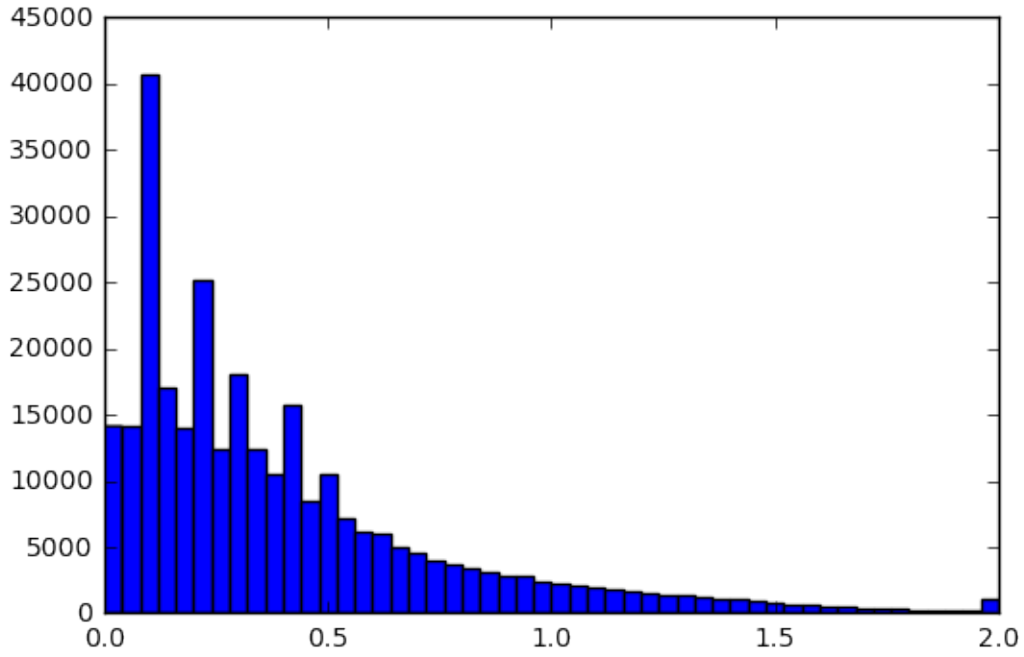
dose_threshold = 0.03 * np.max(dose_reference)
lower_dose_cutoff = np.max(dose_reference) * 0.2
maximum_test_distance = distance_threshold * 2
max_concurrent_calc_points = 10000000
```

In [9]:
```
gamma = calc_gamma(
    coords_reference, dose_reference,
    coords_evaluation, dose_evaluation,
    distance_threshold, dose_threshold,
    lower_dose_cutoff=lower_dose_cutoff,
    distance_step_size=distance_step_size,
    maximum_test_distance=maximum_test_distance,
    max_concurrent_calc_points=max_concurrent_calc_points)
```

In [10]:
```
valid_gamma = gamma[~np.isnan(gamma)]
valid_gamma[valid_gamma > 2] = 2
```

In [11]:
```
plt.hist(valid_gamma, 50);
plt.xlim([0,2])
```

Out[11]: (0, 2)



```
In [12]: np.sum(valid_gamma <= 1) / len(valid_gamma)

Out[12]: 0.9152553510103717

In [13]: relevant_slice = (
             np.max(dose_evaluation, axis=(0, 1)) >
             lower_dose_cutoff)
         slice_start = np.max([
                 np.where(relevant_slice)[0][0],
                 0])
         slice_end = np.min([
                 np.where(relevant_slice)[0][-1],
                 len(z_evaluation)])

In [17]: max_ref_dose = np.max(dose_reference)

         cut_off_gamma = gamma.copy()
         greater_than_2_ref = (cut_off_gamma > 2) & ~np.isinf(cut_off_gamma)
         cut_off_gamma[greater_than_2_ref] = 2

         for z_i in z_evaluation[slice_start:slice_end:5]:
             i = np.where(z_i == z_evaluation)[0][0]
             j = np.where(z_i == z_reference)[0][0]
             print("================================================================
             print("Slice = {0}".format(z_i))

             plt.contourf(
                 x_evaluation, y_evaluation, dose_evaluation[:, :, j], 30,
                 vmin=0, vmax=max_ref_dose, cmap=plt.get_cmap('gist_heat'))
             plt.title("AXB Dm")  # Evaluation -
             plt.colorbar()
             plt.show()

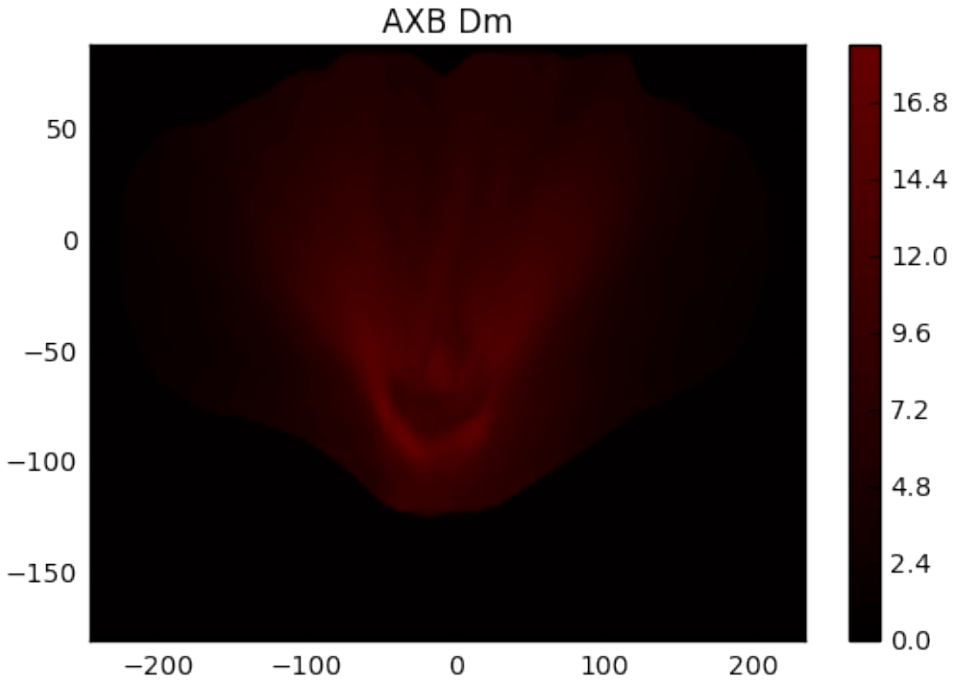
             plt.contourf(
                 x_reference, y_reference, dose_reference[:, :, j], 30,
                 vmin=0, vmax=max_ref_dose, cmap=plt.get_cmap('gist_heat'))
             plt.title("AAA")  # Reference -
             plt.colorbar()
             plt.show()

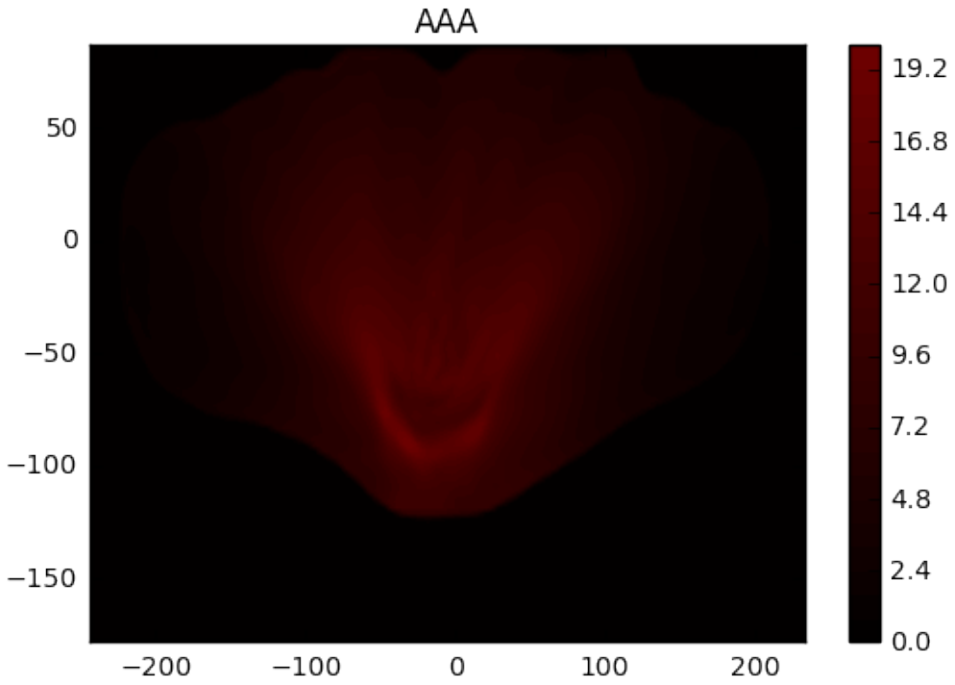
             plt.contourf(
                 x_evaluation, y_evaluation, cut_off_gamma[:, :, i], 30,
                 vmin=0, vmax=2, cmap=plt.get_cmap('bwr'))
             plt.title("Gamma 3%/3mm")
             plt.colorbar()
             plt.show()
```

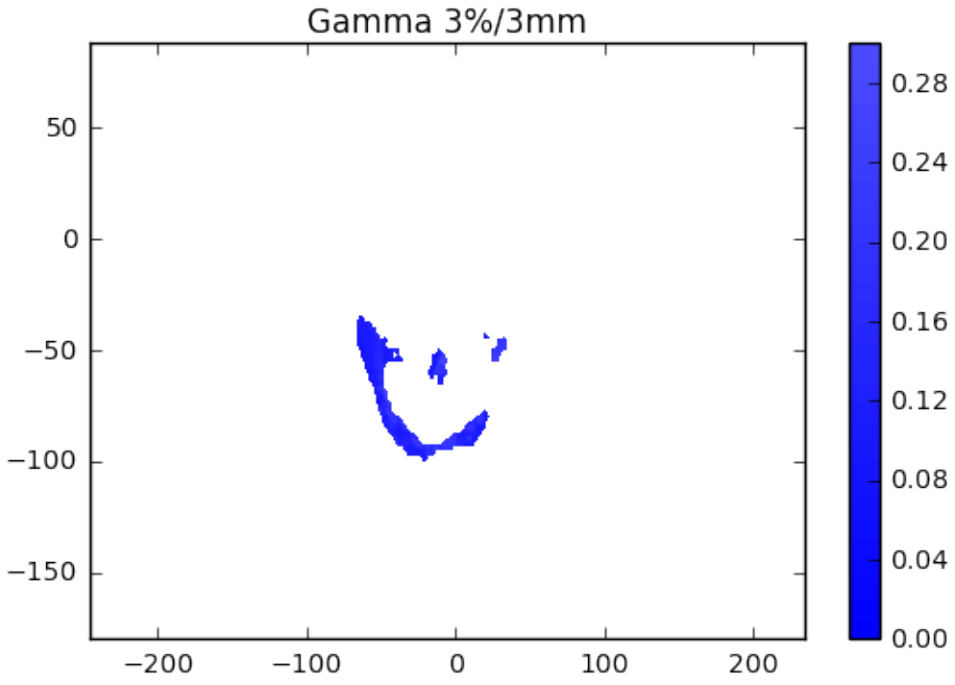
```
            print("\n")
```

```
C:\Users\RCole02.ROYALSURREY\AppData\Local\Continuum\Anaconda3\lib\site-packages\ip
```

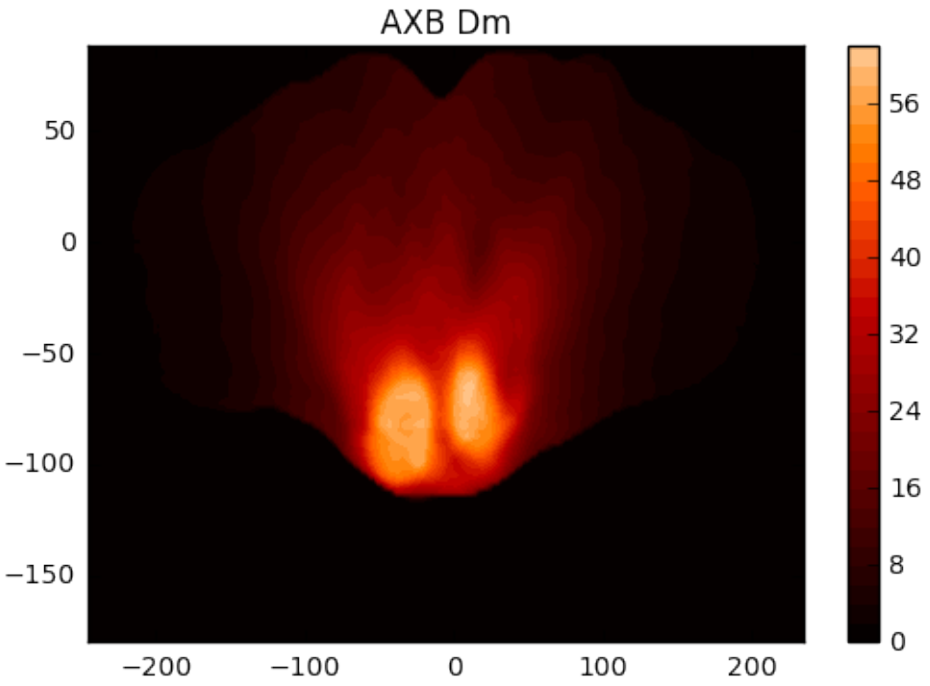
```
========================================================================
Slice = -141.25
```

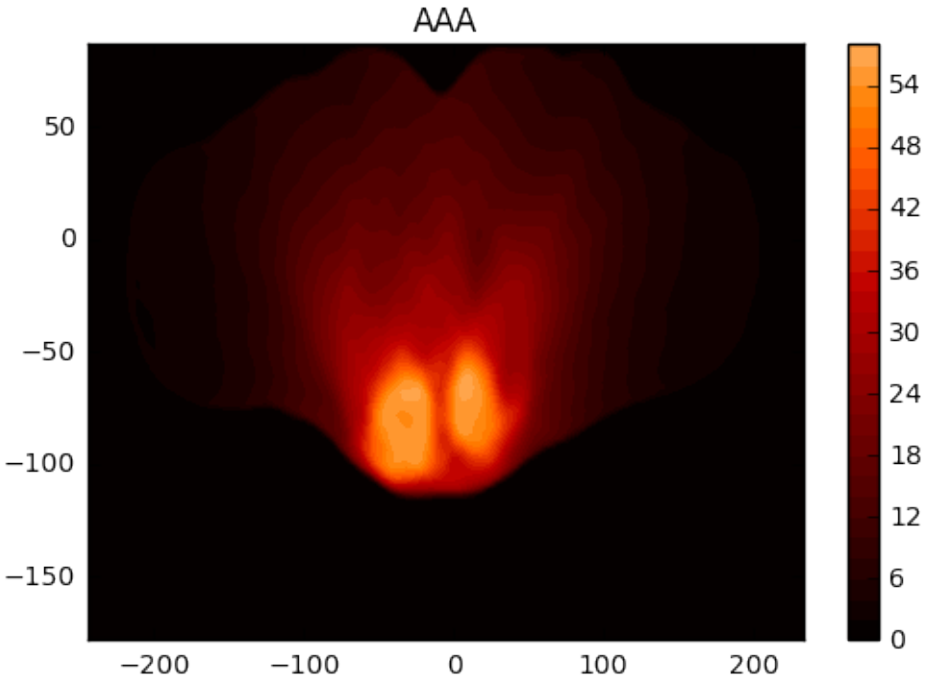



AAA
50
0
−50
−100
−150
−200
−100
0
100
200
19.2
16.8
14.4
12.0
9.6
7.2
4.8
2.4
0.0


Gamma 3%/3mm
50
0
−50
−100
−150
−200
−100
0
100
200
0.28
0.24
0.20
0.16
0.12
0.08
0.04
0.00

```
======================================================================
Slice = -128.75
```


AXB Dm
50
0
−50
−100
−150
−200
−100
0
100
200
56
48
40
32
24
16
8
0


AAA
50
0
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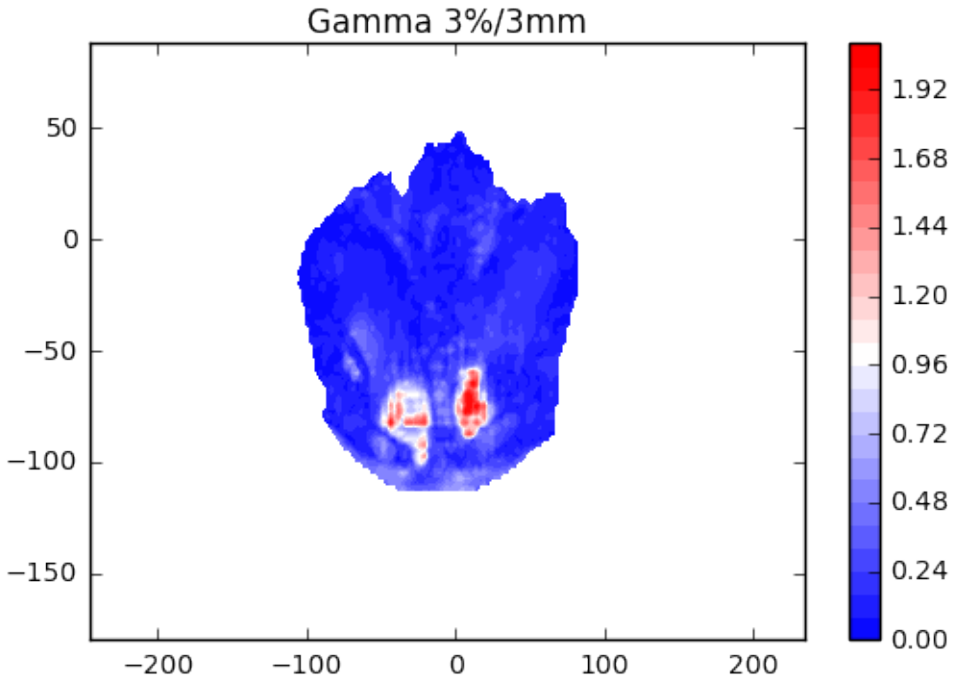
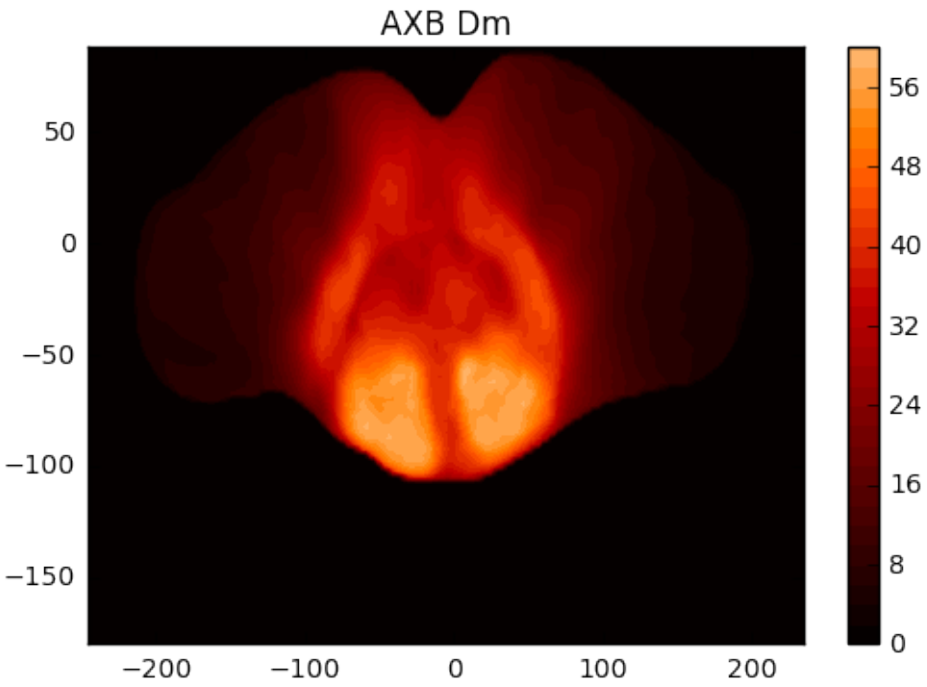
−150
−200
−100
0
100
200
54
48
42
36
30
24
18
12
6
0


Gamma 3%/3mm
50
0
−50
−100
−150
−200
−100
0
100
200
1.92
1.68
1.44
1.20
0.96
0.72
0.48
0.24
0.00

==========

Slice = -116.25


AXB Dm
50
0
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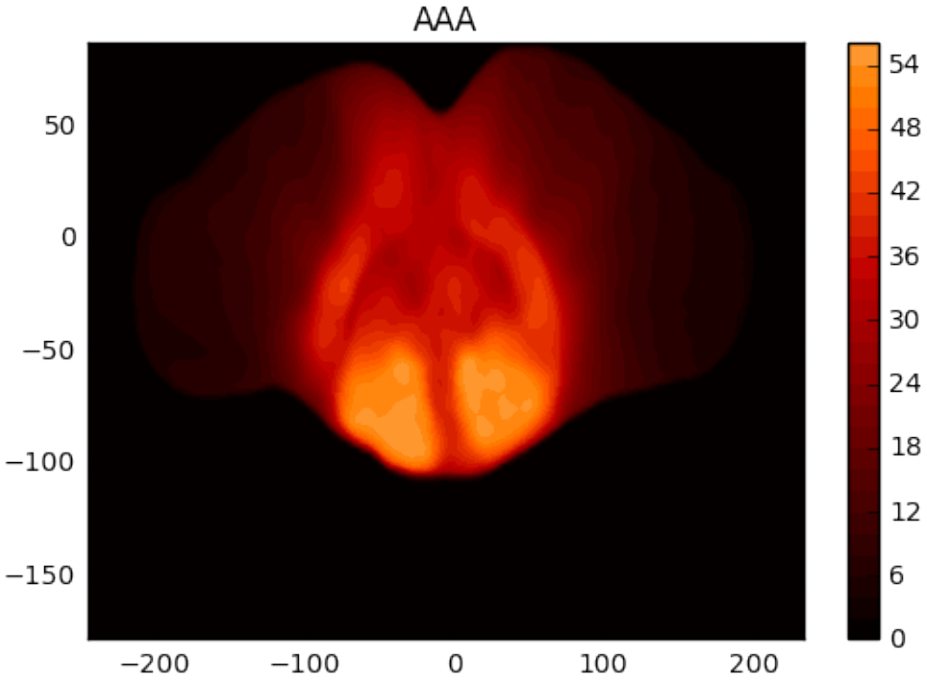
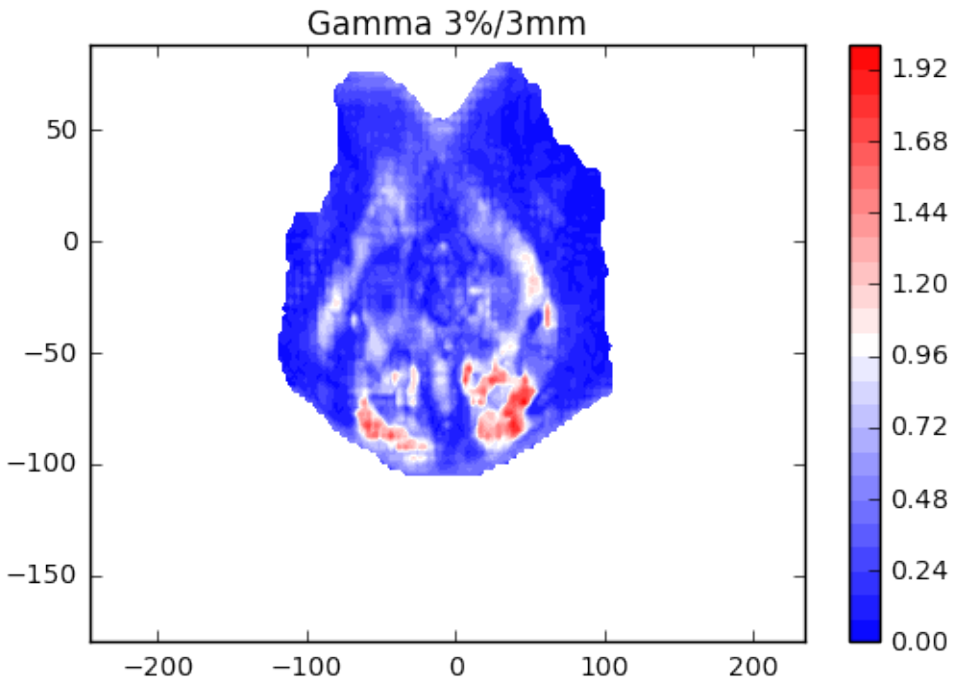
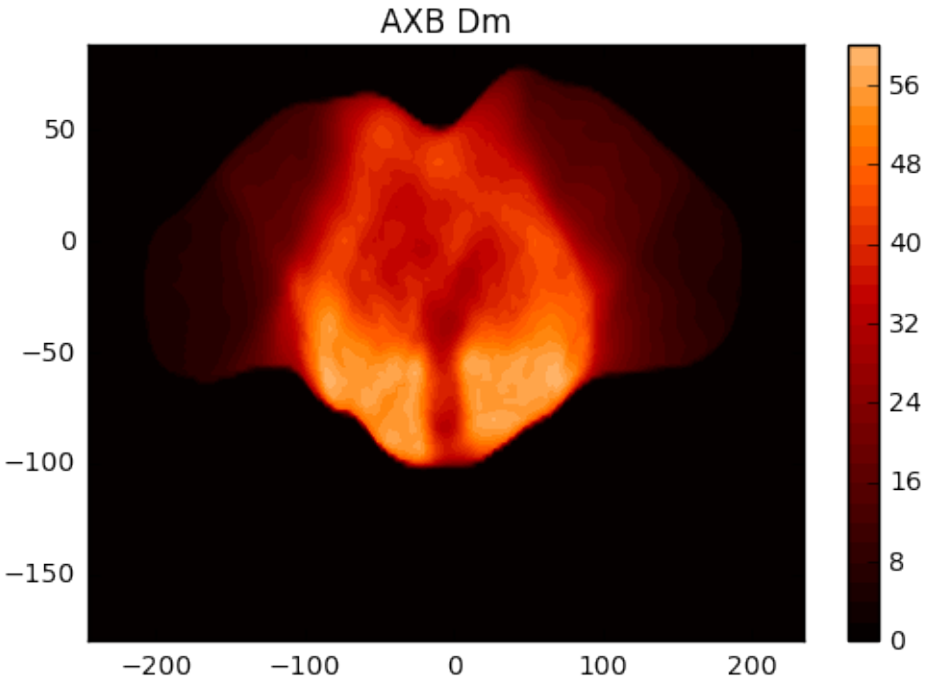
−100
−150
−200
−100
0
100
200
56
48
40
32
24
16
8
0

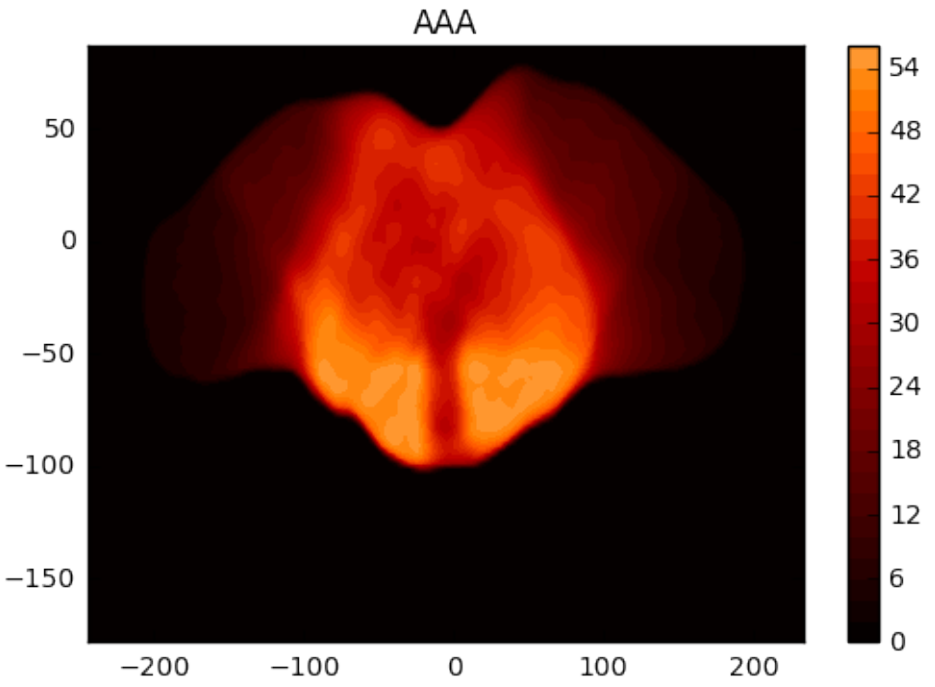

AAA
50
0
−50
−100
−150
−200
−100
0
100
200
54
48
42
36
30
24
18
12
6
0

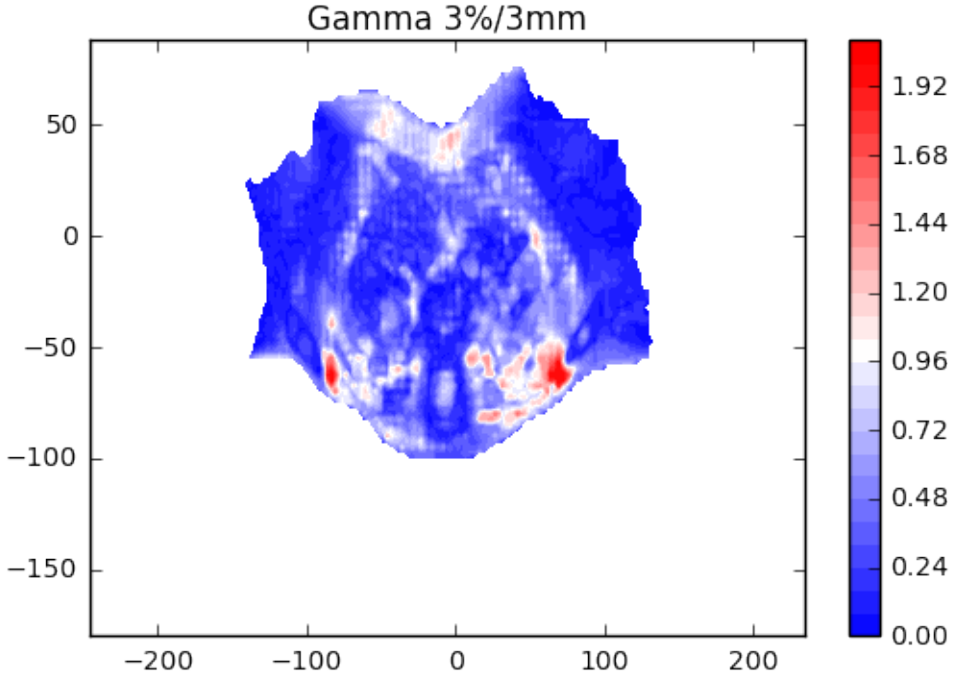

Gamma 3%/3mm
50
0
−50
−100
−150
−200
−100
0
100
200
1.92
1.68
1.44
1.20
0.96
0.72
0.48
0.24
0.00

==========

Slice = -103.75

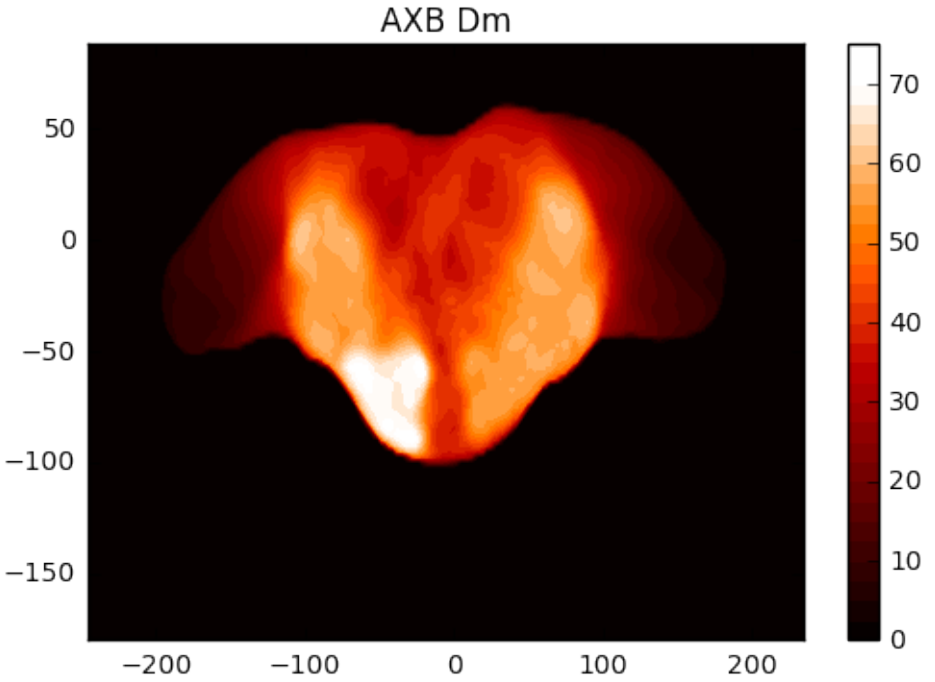

AXB Dm
50
0
−50
−100
−150
−200
−100
0
100
200
56
48
40
32
24
16
8
0


AAA
50
0
−50
−100
−150
−200
−100
0
100
200
54
48
42
36
30
24
18
12
6
0


Gamma 3%/3mm
50
0
−50
−100
−150
−200
−100
0
100
200
1.92
1.68
1.44
1.20
0.96
0.72
0.48
0.24
0.00

==========

Slice = -91.25


AXB Dm
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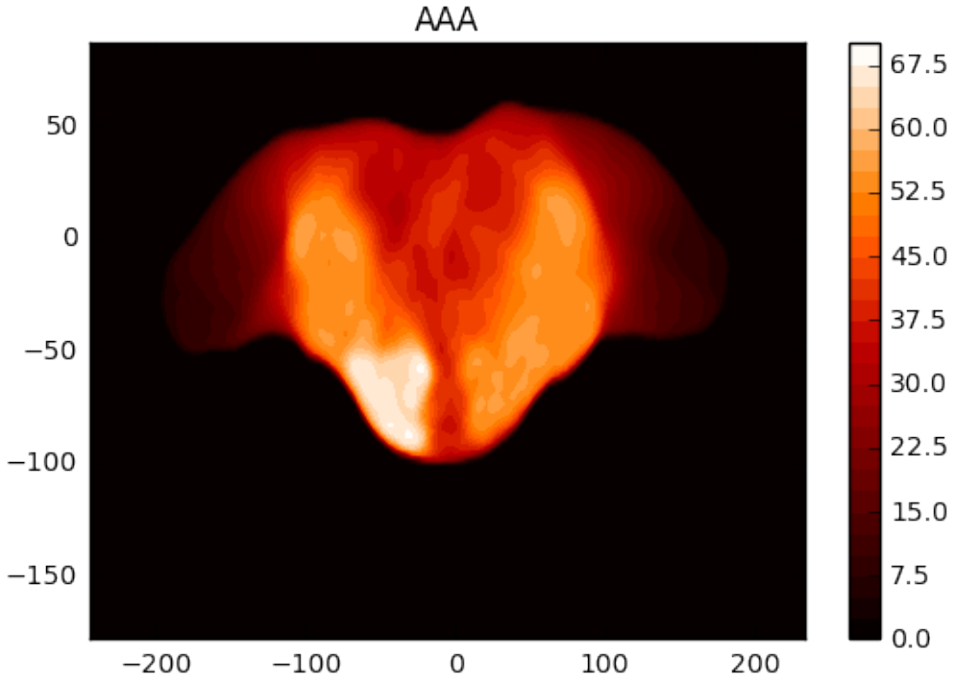
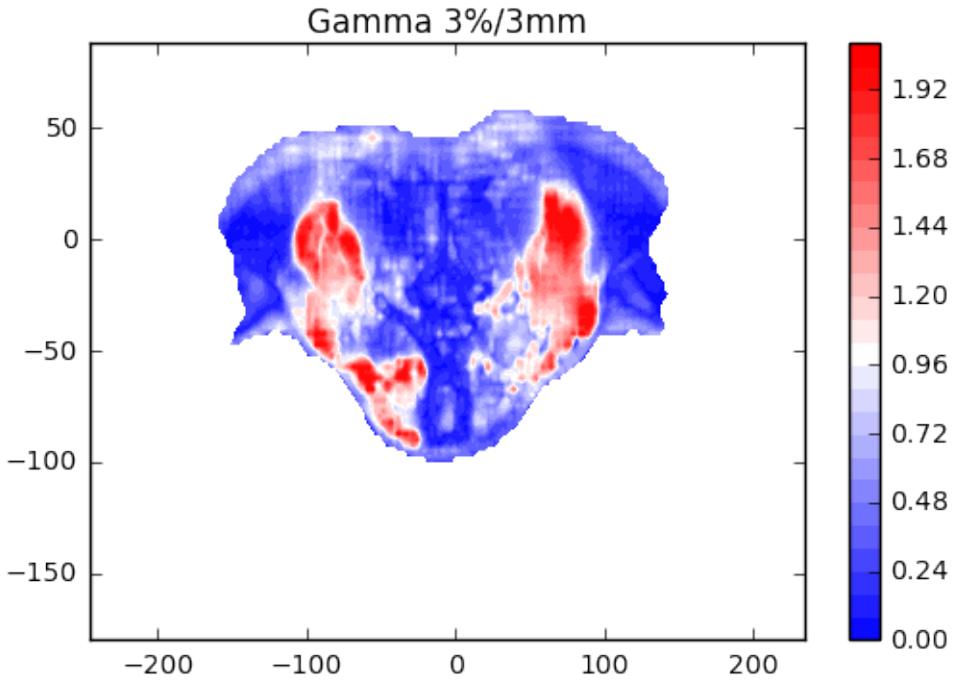
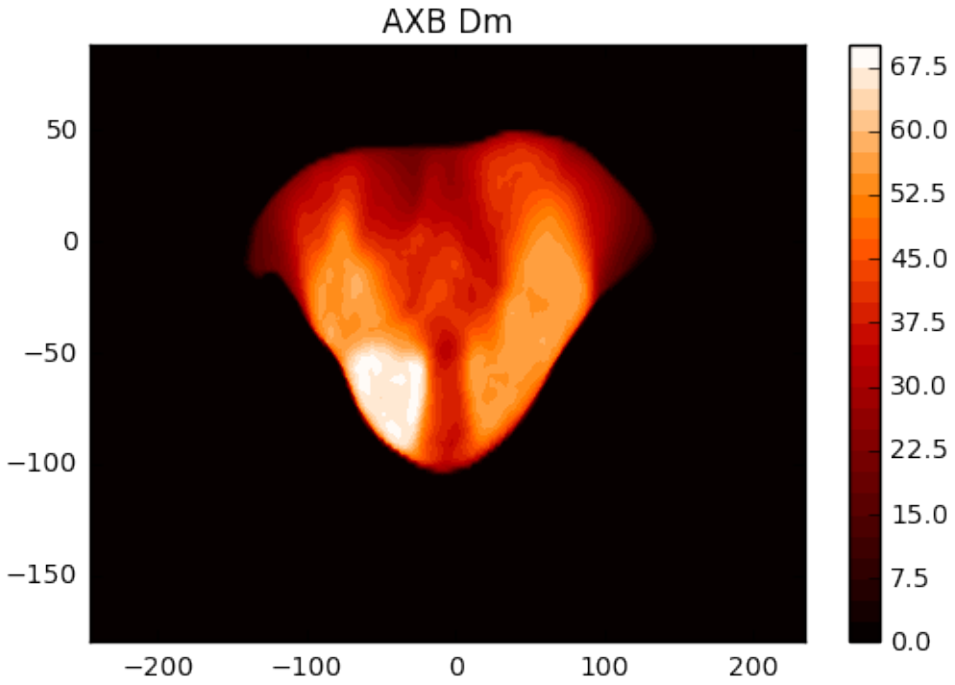
−100
0
100
200
70
60
50
40
30
20
10
0

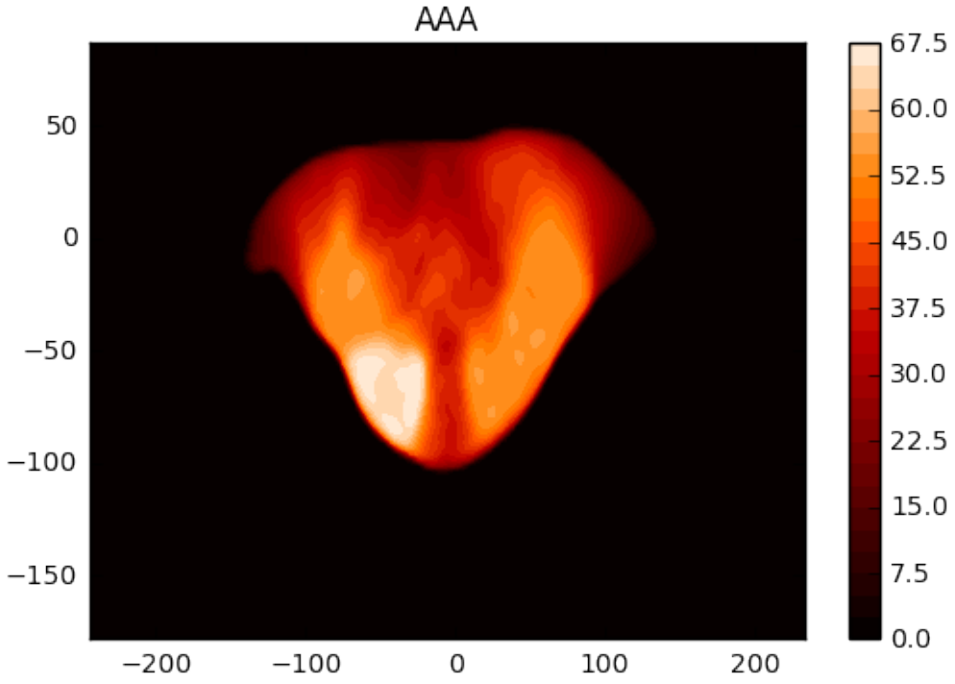

AAA
50
0
−50
−100
−150
−200
−100
0
100
200
67.5
60.0
52.5
45.0
37.5
30.0
22.5
15.0
7.5
0.0

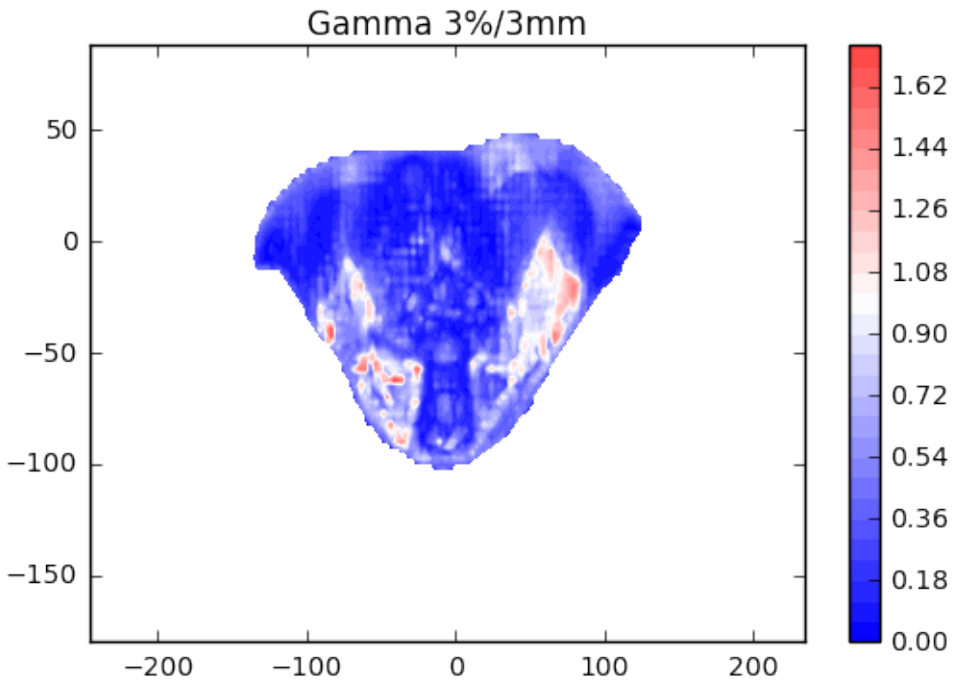

Gamma 3%/3mm
50
0
−50
−100
−150
−200
−100
0
100
200
1.92
1.68
1.44
1.20
0.96
0.72
0.48
0.24
0.00

==========

Slice = -78.75

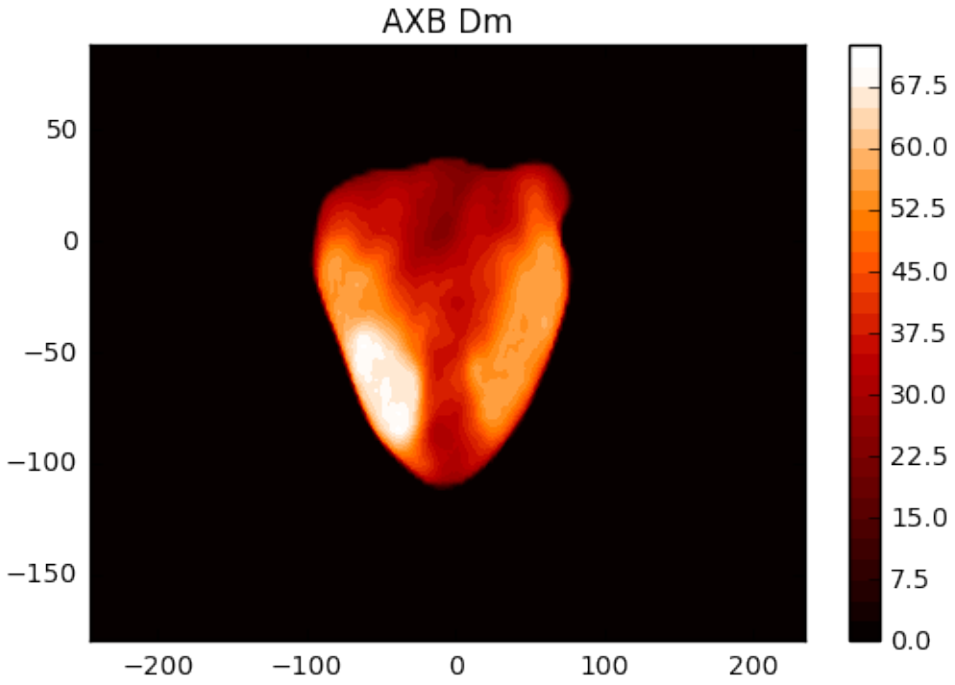

AXB Dm
50
0
−50
−100
−150
−200
−100
0
100
200
67.5
60.0
52.5
45.0
37.5
30.0
22.5
15.0
7.5
0.0


AAA
50
0
−50
−100
−150
−200
−100
0
100
200
67.5
60.0
52.5
45.0
37.5
30.0
22.5
15.0
7.5
0.0


Gamma 3%/3mm
50
0
−50
−100
−150
−200
−100
0
100
200
1.62
1.44
1.26
1.08
0.90
0.72
0.54
0.36
0.18
0.00

==========

Slice = -66.25


AXB Dm
50
0
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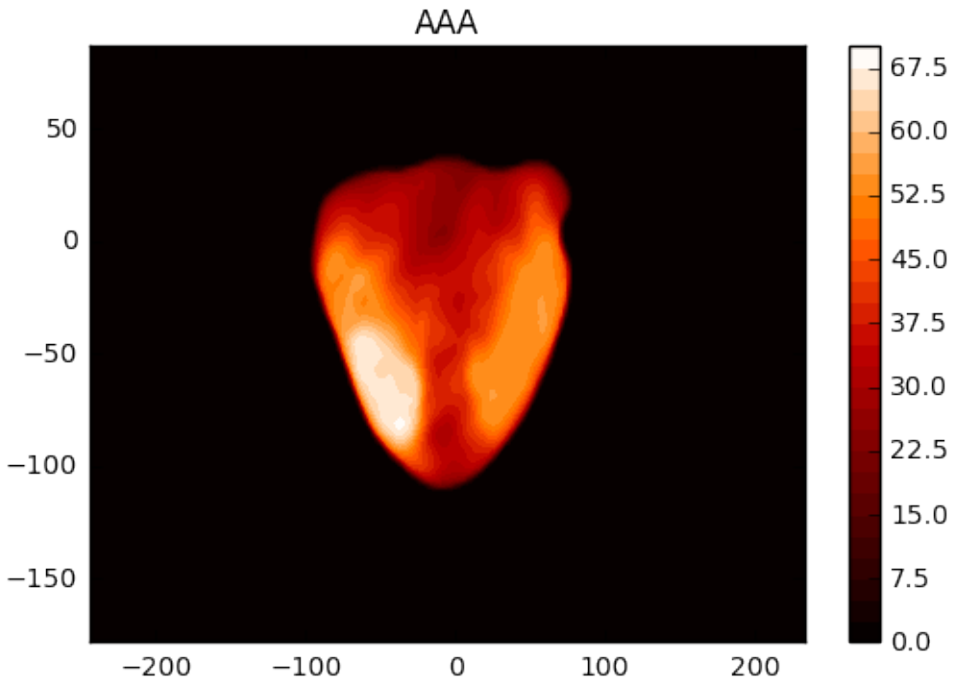
−100
−150
−200
−100
0
100
200
67.5
60.0
52.5
45.0
37.5
30.0
22.5
15.0
7.5
0.0


AAA
50
0
−50
−100
−150
−200
−100
0
100
200
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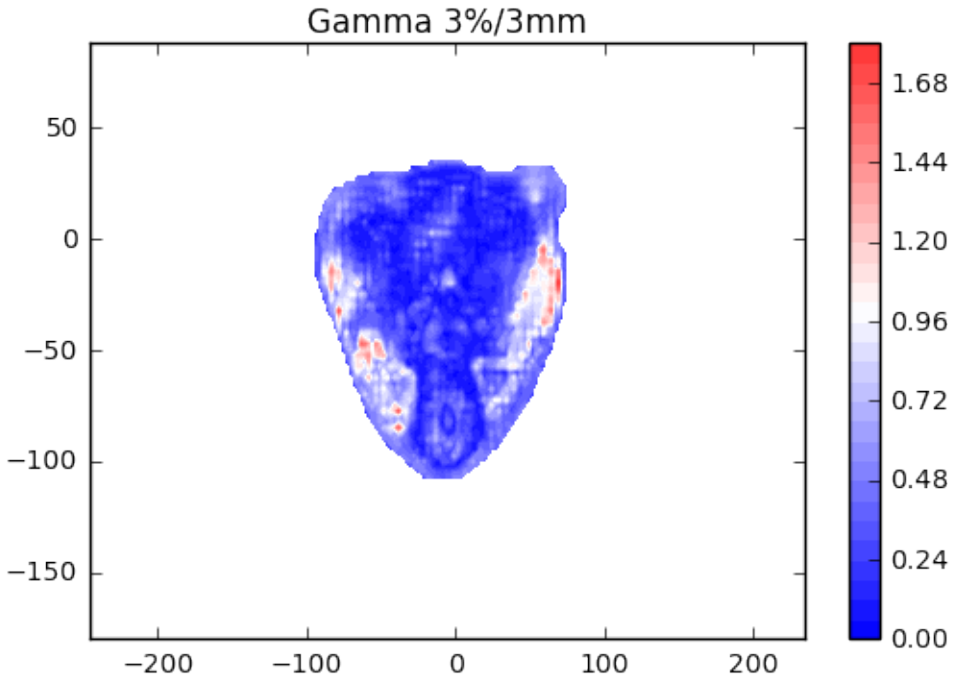
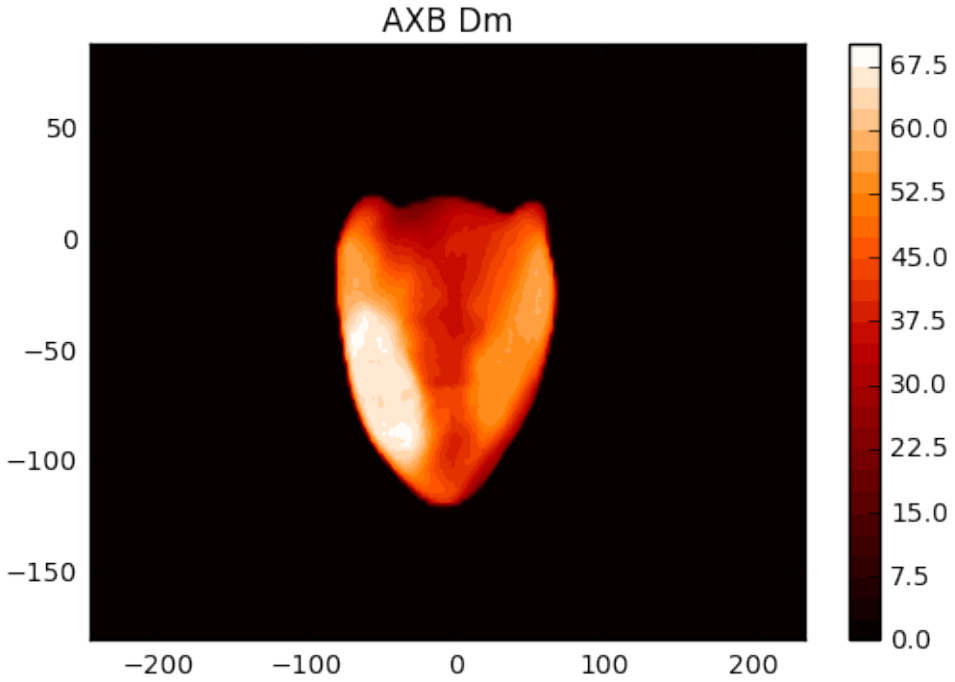
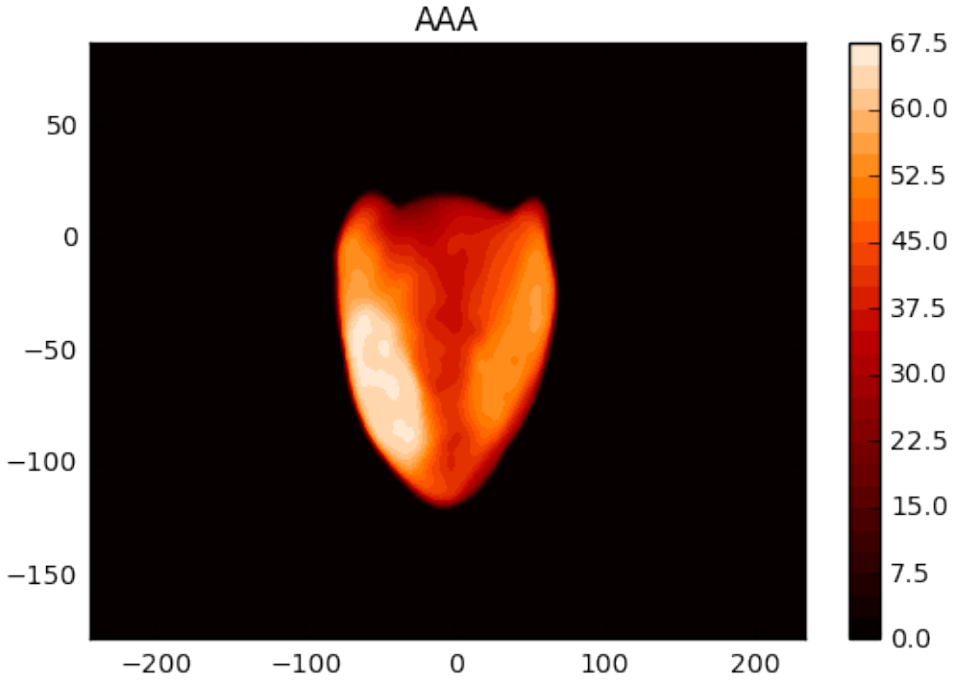
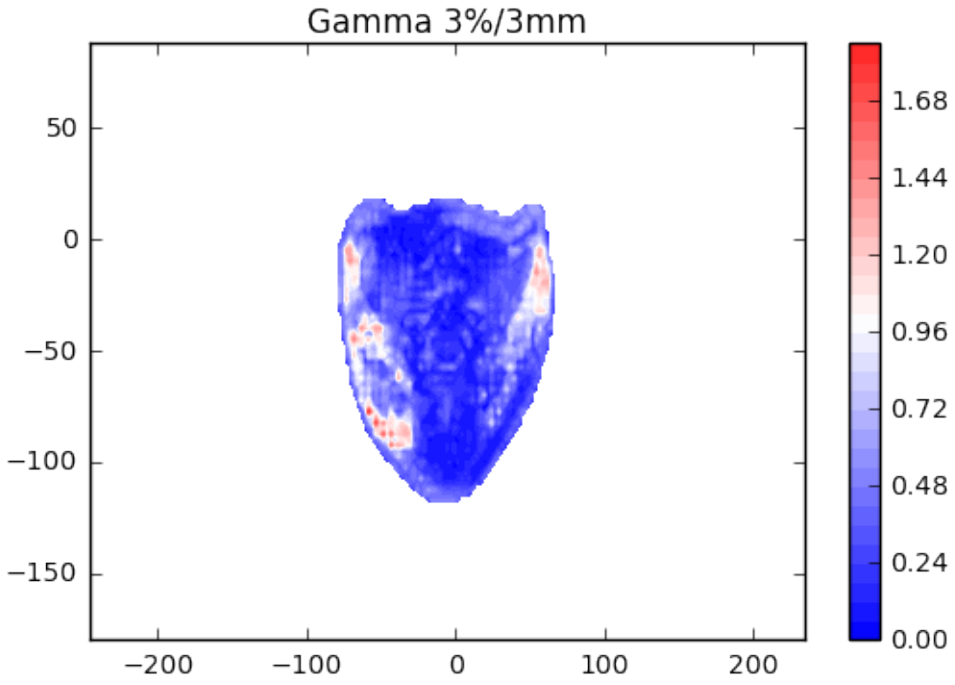
60.0
52.5
45.0
37.5
30.0
22.5
15.0
7.5
0.0


Gamma 3%/3mm
50
0
−50
−100
−150
−200
−100
0
100
200
1.68
1.44
1.20
0.96
0.72
0.48
0.24
0.00

```
==========================================================================
Slice = -53.75
```

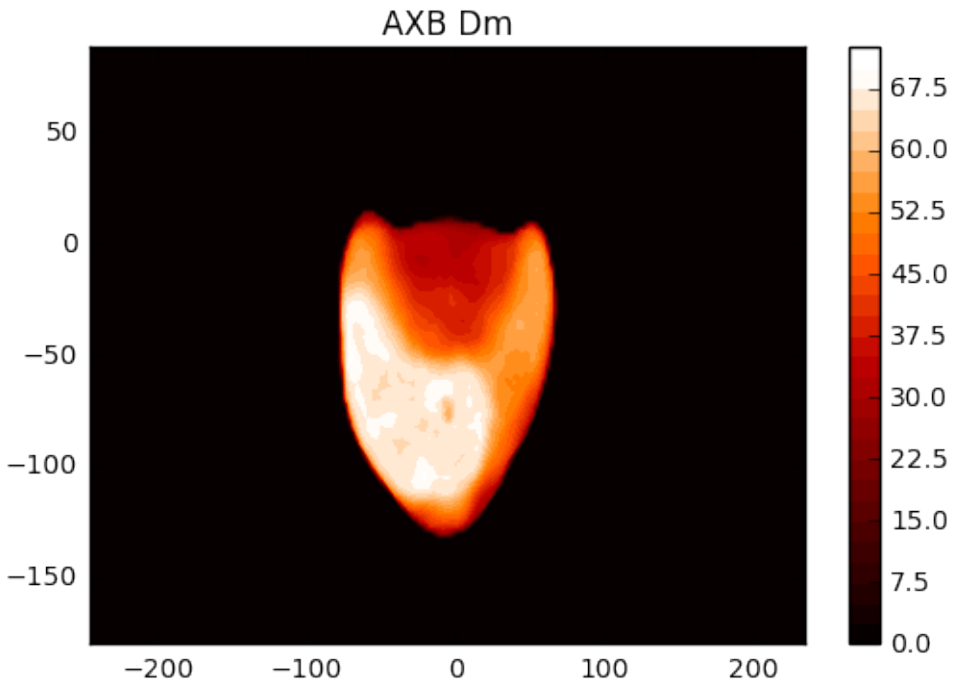

AXB Dm
50
0
−50
−100
−150
−200
−100
0
100
200
67.5
60.0
52.5
45.0
37.5
30.0
22.5
15.0
7.5
0.0


AAA
50
0
−50
−100
−150
−200
−100
0
100
200
67.5
60.0
52.5
45.0
37.5
30.0
22.5
15.0
7.5
0.0


Gamma 3%/3mm
50
0
−50
−100
−150
−200
−100
0
100
200
1.68
1.44
1.20
0.96
0.72
0.48
0.24
0.00

==========

Slice = -41.25


AXB Dm
50
0
−50
−100
−150
−200
−100
0
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60.0
52.5
45.0
37.5
30.0
22.5
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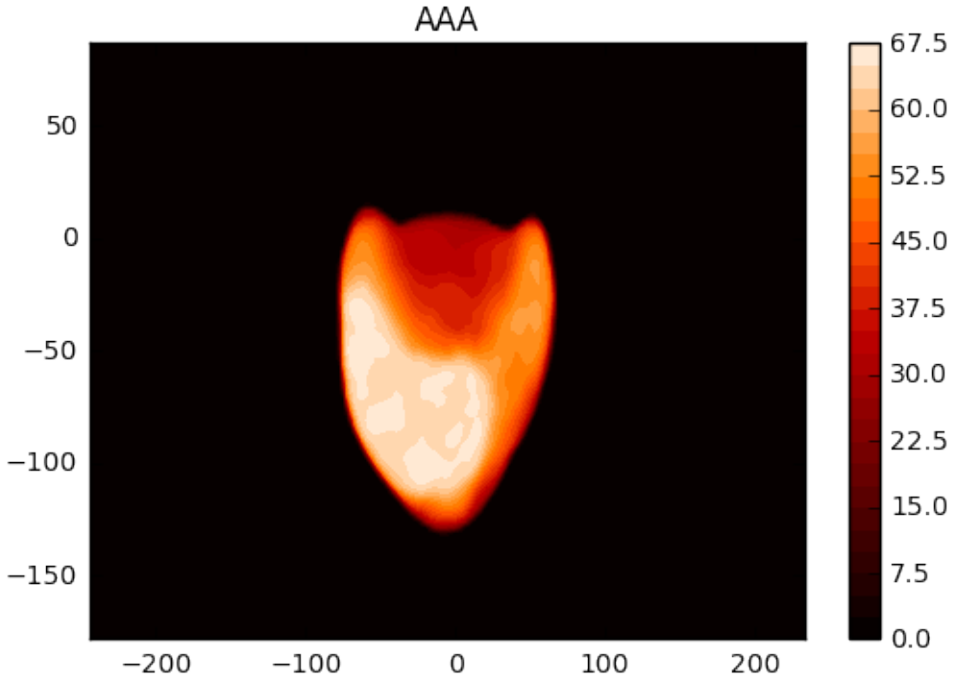
0.0


AAA
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−200
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60.0
52.5
45.0
37.5
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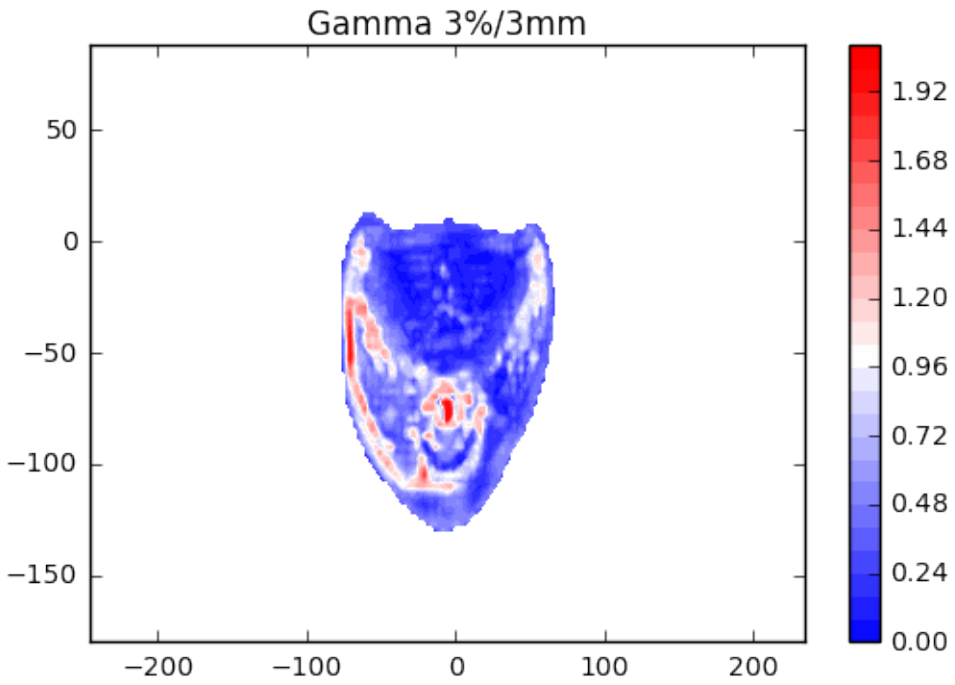
7.5
0.0


Gamma 3%/3mm
50
0
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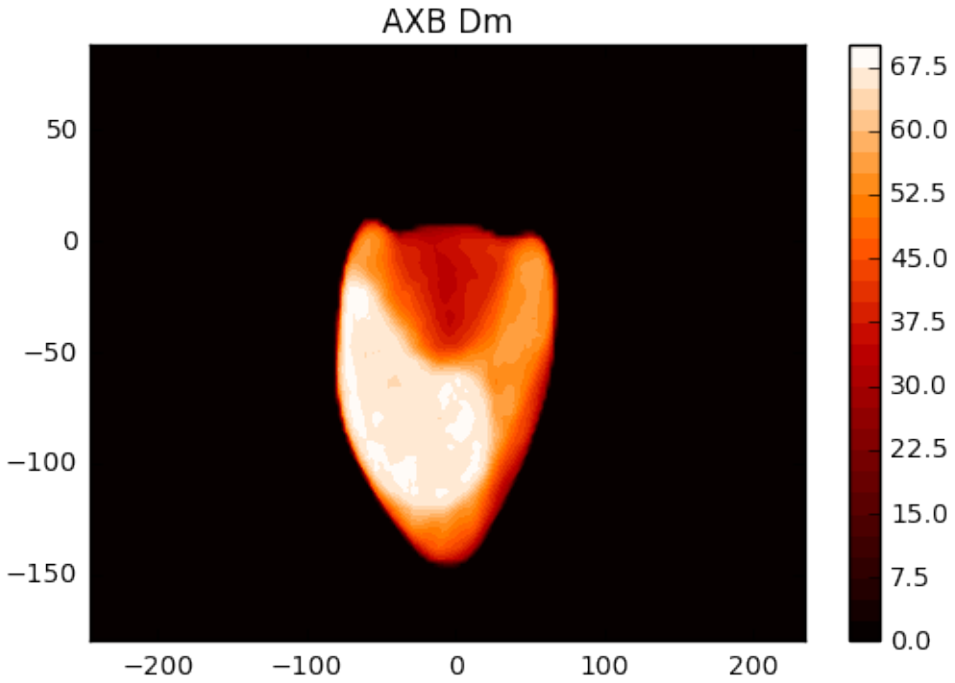
−100
−150
−200
−100
0
100
200
1.92
1.68
1.44
1.20
0.96
0.72
0.48
0.24
0.00

==========

Slice = -28.75


AXB Dm
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0
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−100
−150
−200
−100
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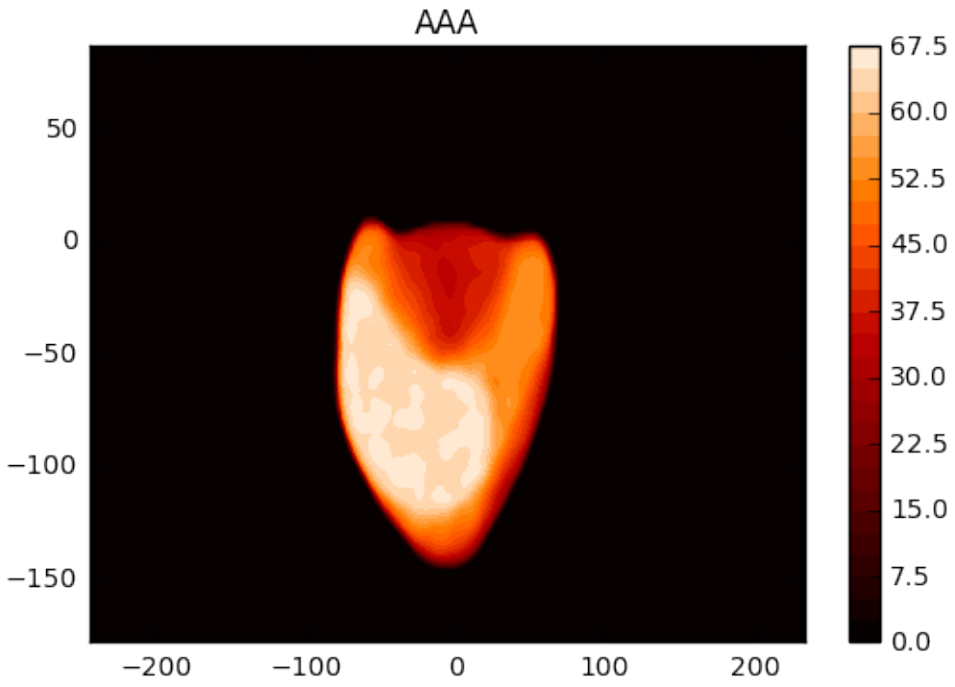
100
200
67.5
60.0
52.5
45.0
37.5
30.0
22.5
15.0
7.5
0.0


AAA
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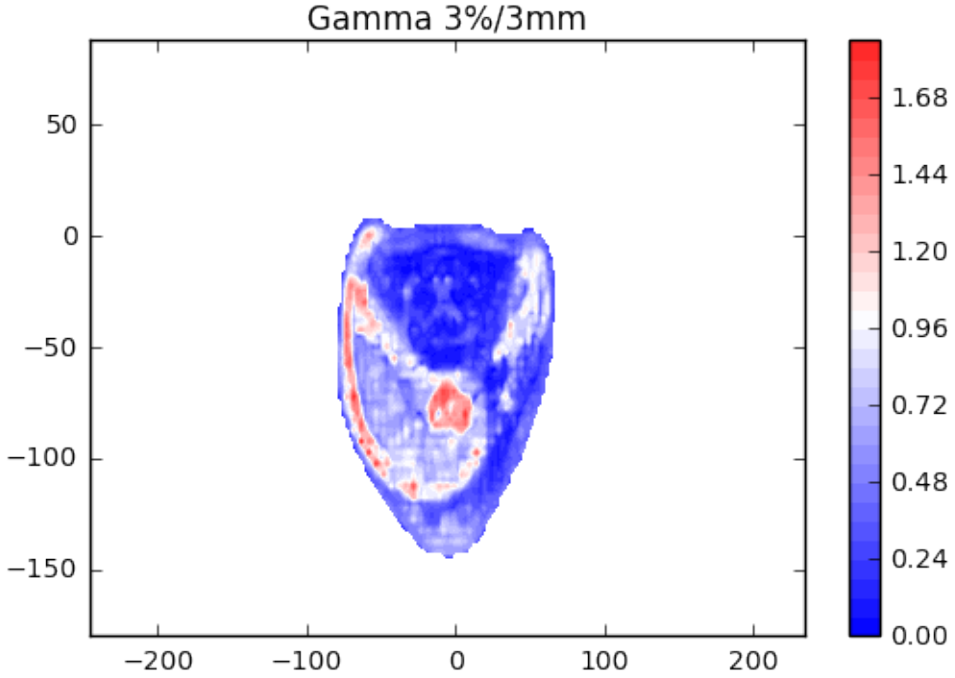
52.5
45.0
37.5
30.0
22.5
15.0
7.5
0.0


Gamma 3%/3mm
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0
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−100
−150
−200
−100
0
100
200
1.68
1.44
1.20
0.96
0.72
0.48
0.24
0.00

```
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Slice = -16.25
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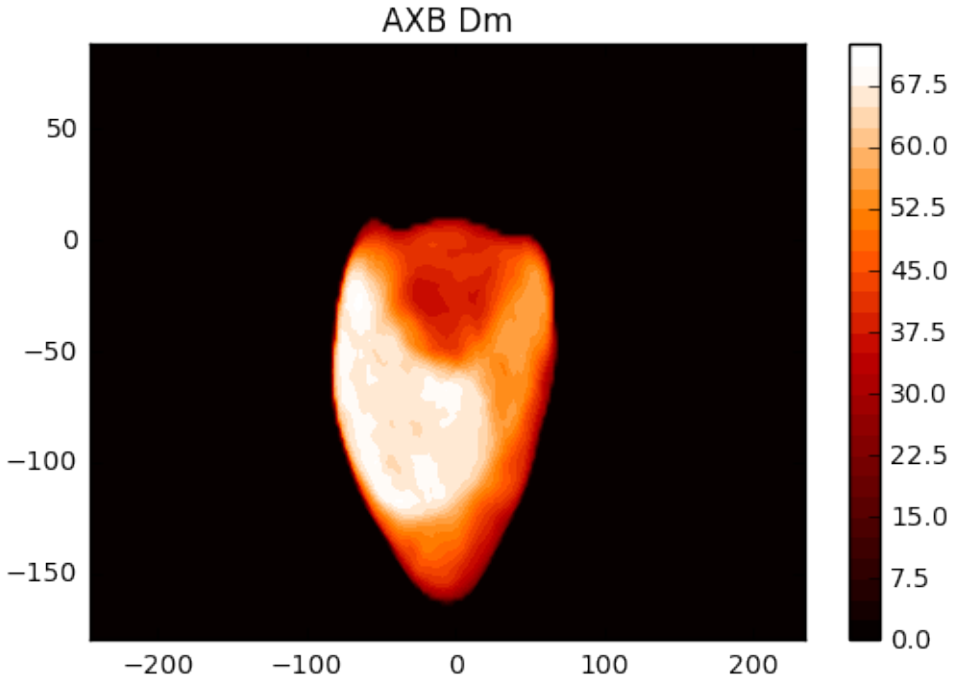
AXB Dm
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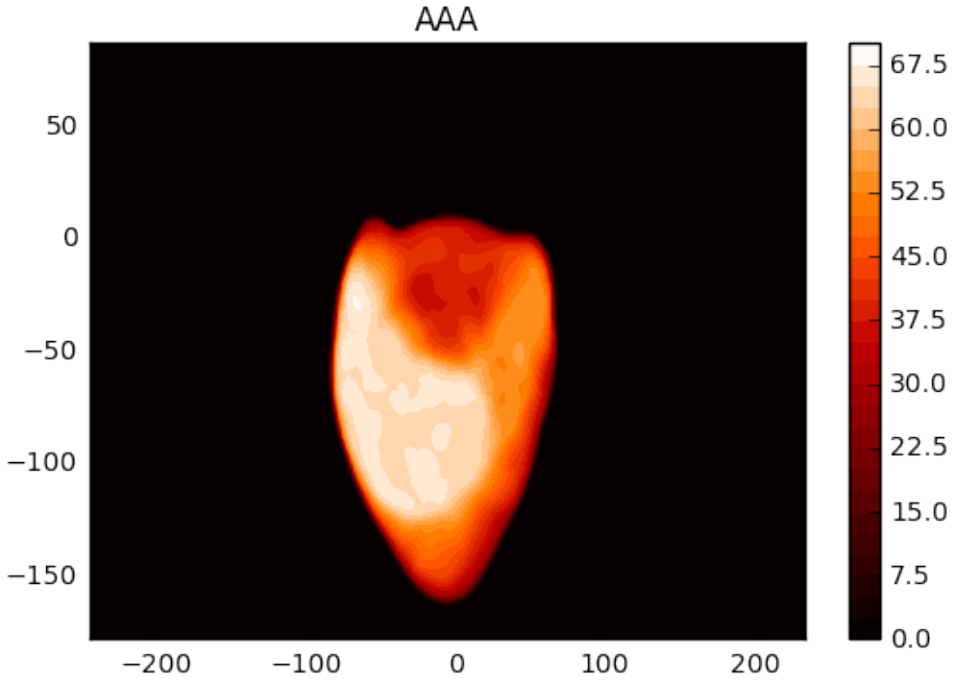
0
−50
−100
−150
−200
−100
0
100
200
67.5
60.0
52.5
45.0
37.5
30.0
22.5
15.0
7.5
0.0


AAA
50
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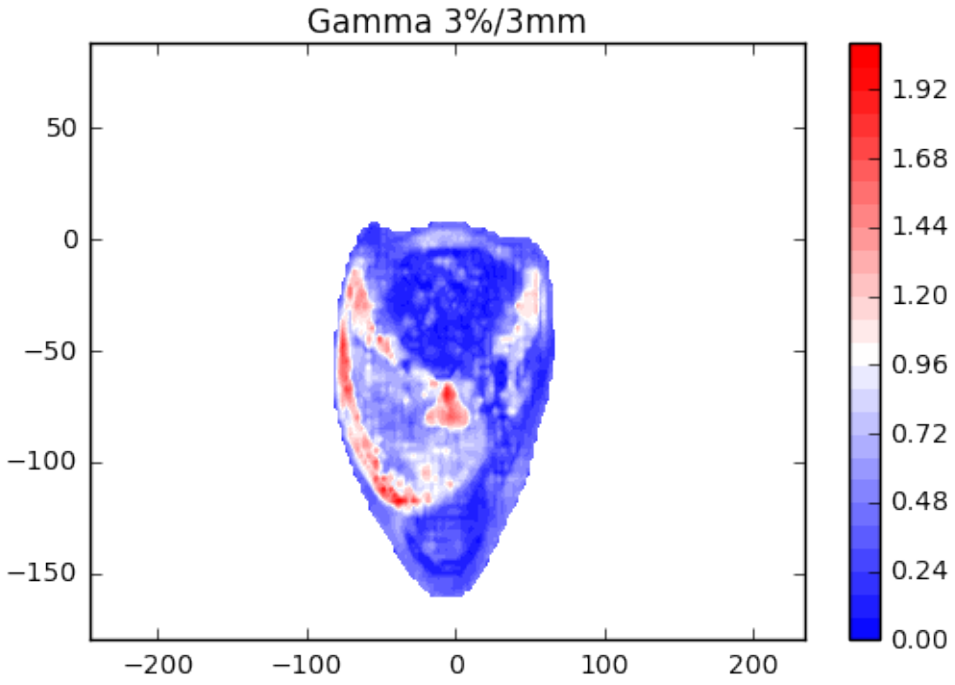
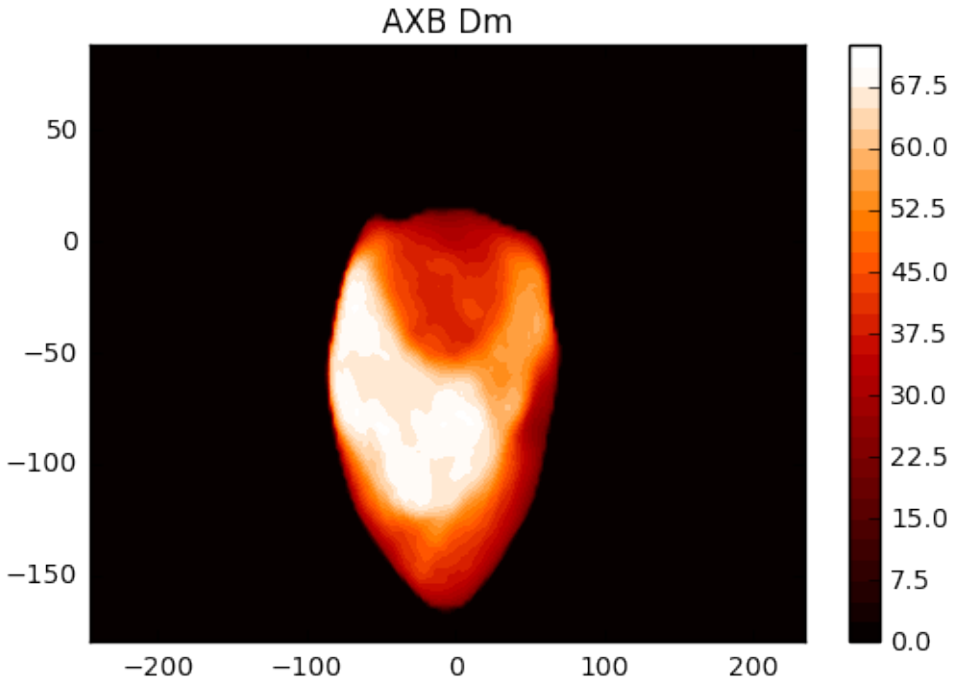
−100
−150
−200
−100
0
100
200
67.5
60.0
52.5
45.0
37.5
30.0
22.5
15.0
7.5
0.0


Gamma 3%/3mm
50
0
−50
−100
−150
−200
−100
0
100
200
1.92
1.68
1.44
1.20
0.96
0.72
0.48
0.24
0.00

==========

Slice = -3.75


AXB Dm
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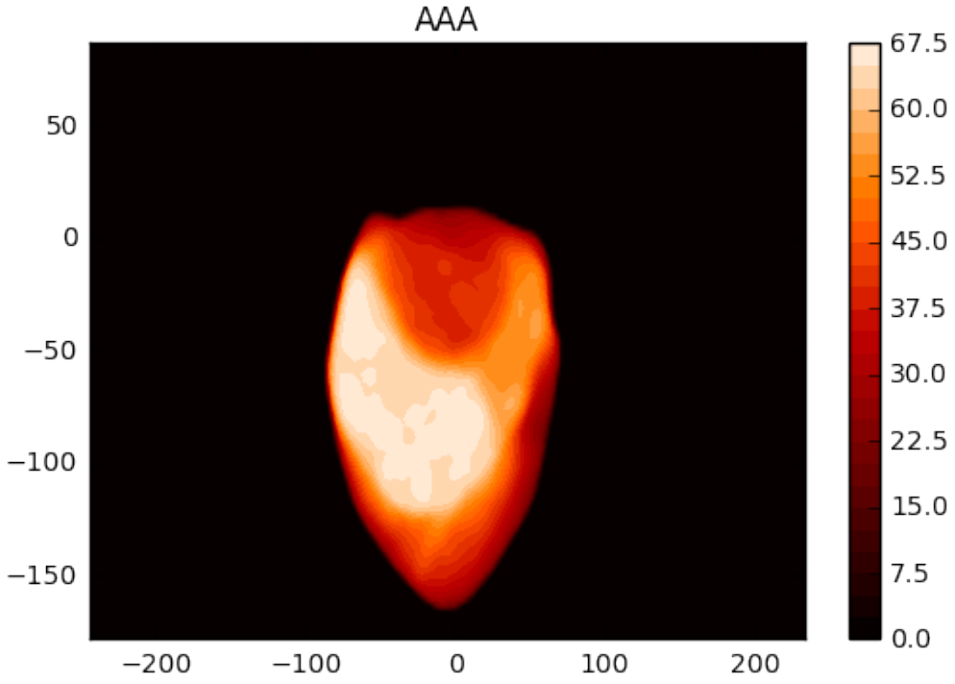
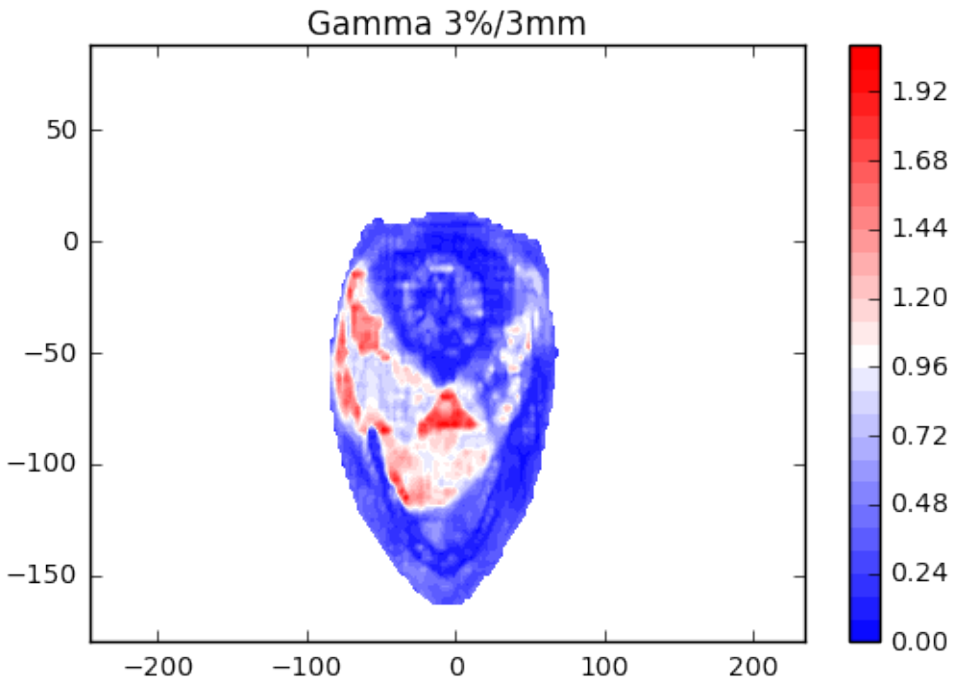
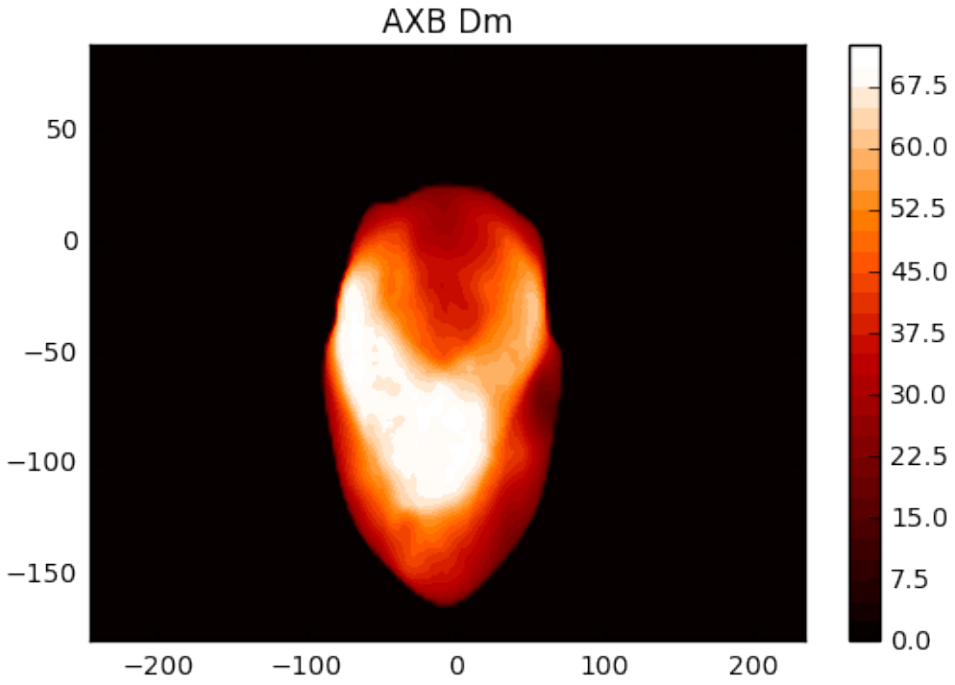
0
−50
−100
−150
−200
−100
0
100
200
67.5
60.0
52.5
45.0
37.5
30.0
22.5
15.0
7.5
0.0

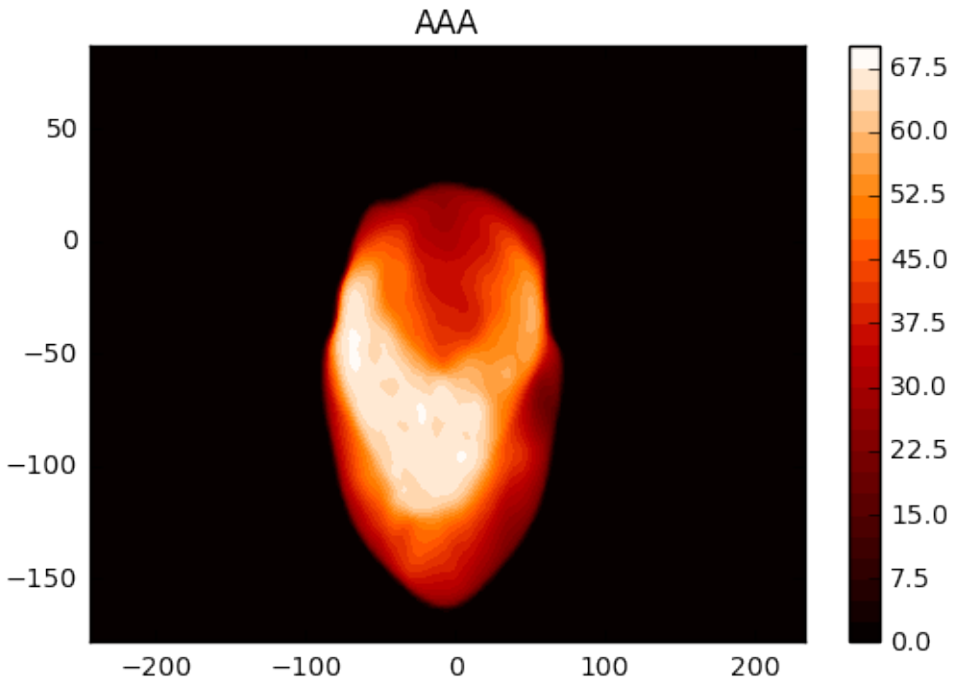

AAA
50
0
−50
−100
−150
−200
−100
0
100
200
67.5
60.0
52.5
45.0
37.5
30.0
22.5
15.0
7.5
0.0

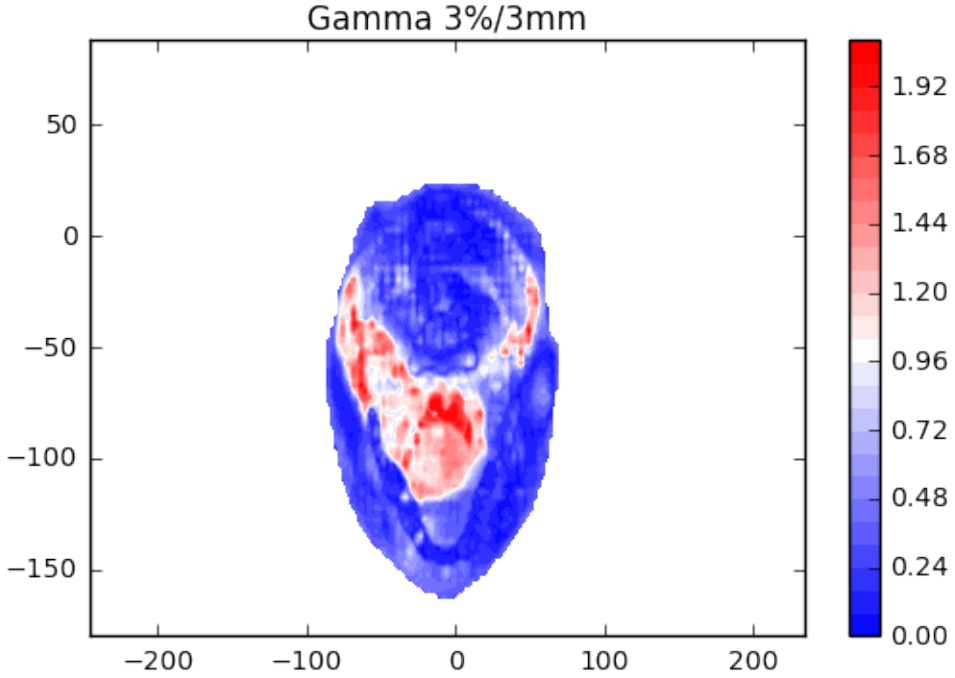

Gamma 3%/3mm
50
0
−50
−100
−150
−200
−100
0
100
200
1.92
1.68
1.44
1.20
0.96
0.72
0.48
0.24
0.00

==========

Slice = 8.75

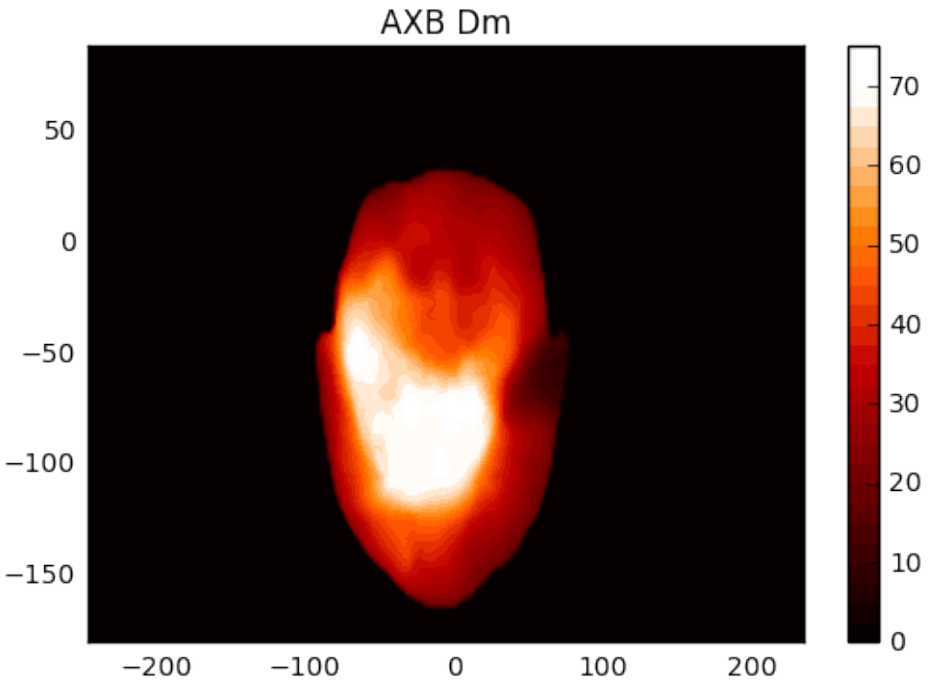

AXB Dm
50
0
−50
−100
−150
−200
−100
0
100
200
67.5
60.0
52.5
45.0
37.5
30.0
22.5
15.0
7.5
0.0


AAA
50
0
−50
−100
−150
−200
−100
0
100
200
67.5
60.0
52.5
45.0
37.5
30.0
22.5
15.0
7.5
0.0


Gamma 3%/3mm
50
0
−50
−100
−150
−200
−100
0
100
200
1.92
1.68
1.44
1.20
0.96
0.72
0.48
0.24
0.00

==========

Slice = 21.25


AXB Dm
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0
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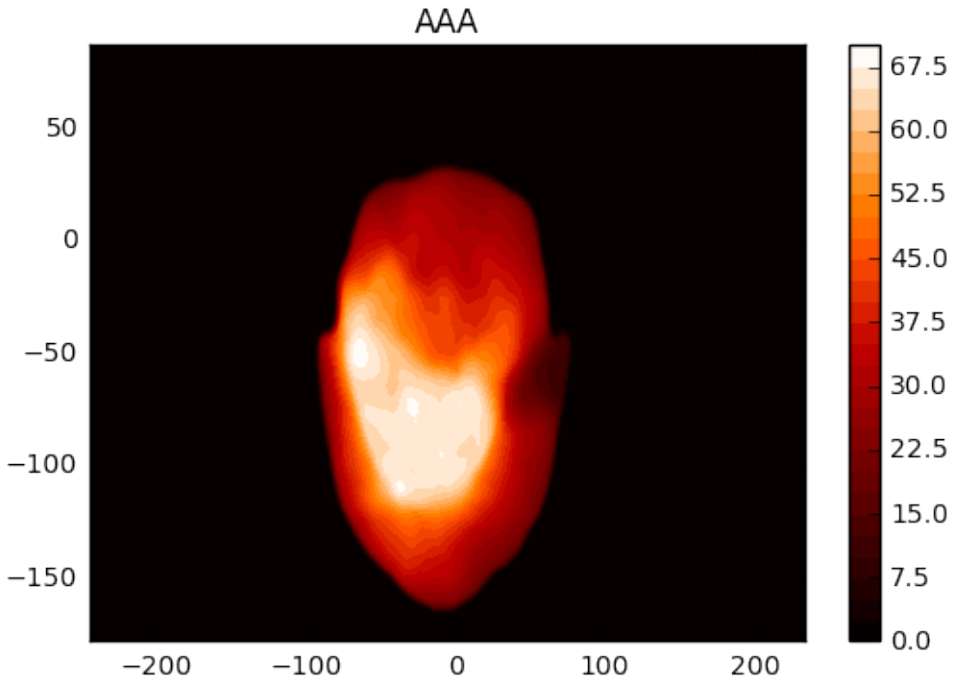
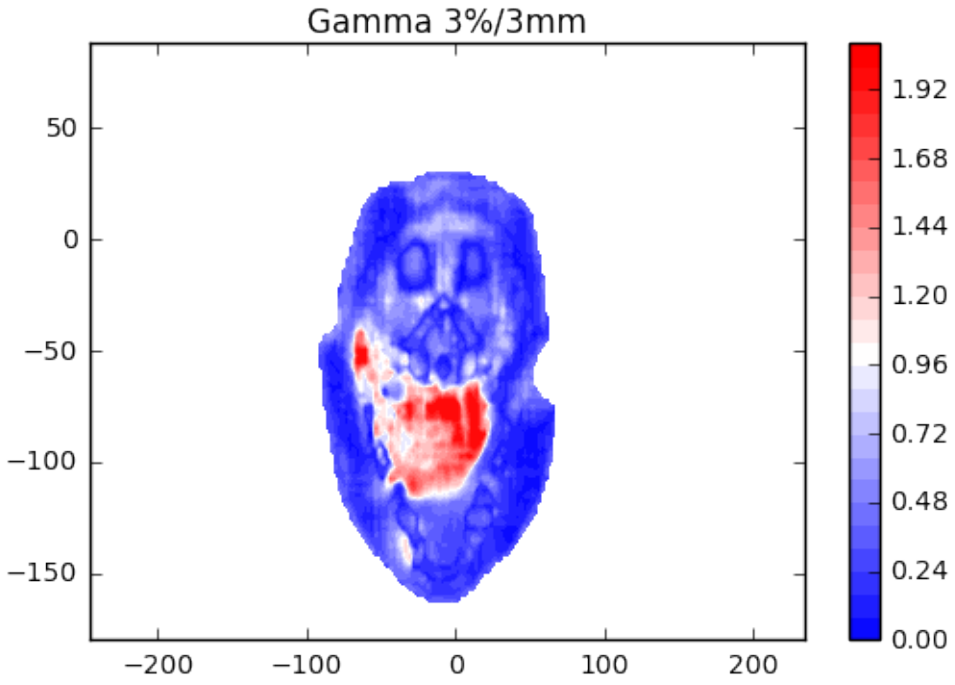
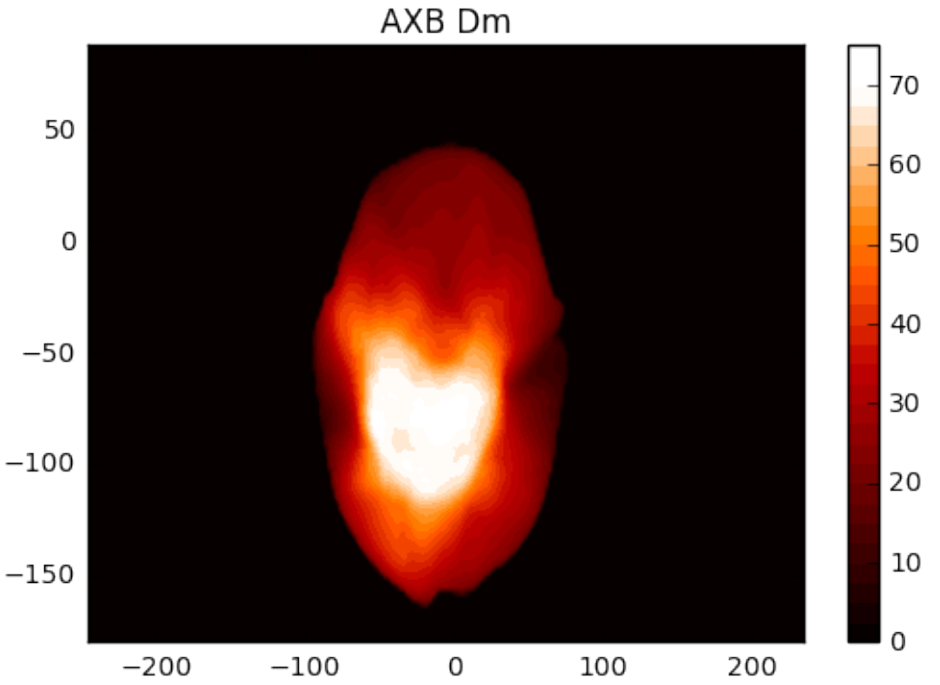
−200
−100
0
100
200
70
60
50
40
30
20
10
0


AAA
50
0
−50
−100
−150
−200
−100
0
100
200
67.5
60.0
52.5
45.0
37.5
30.0
22.5
15.0
7.5
0.0


Gamma 3%/3mm
50
0
−50
−100
−150
−200
−100
0
100
200
1.92
1.68
1.44
1.20
0.96
0.72
0.48
0.24
0.00

==========

Slice = 33.75


AXB Dm
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0
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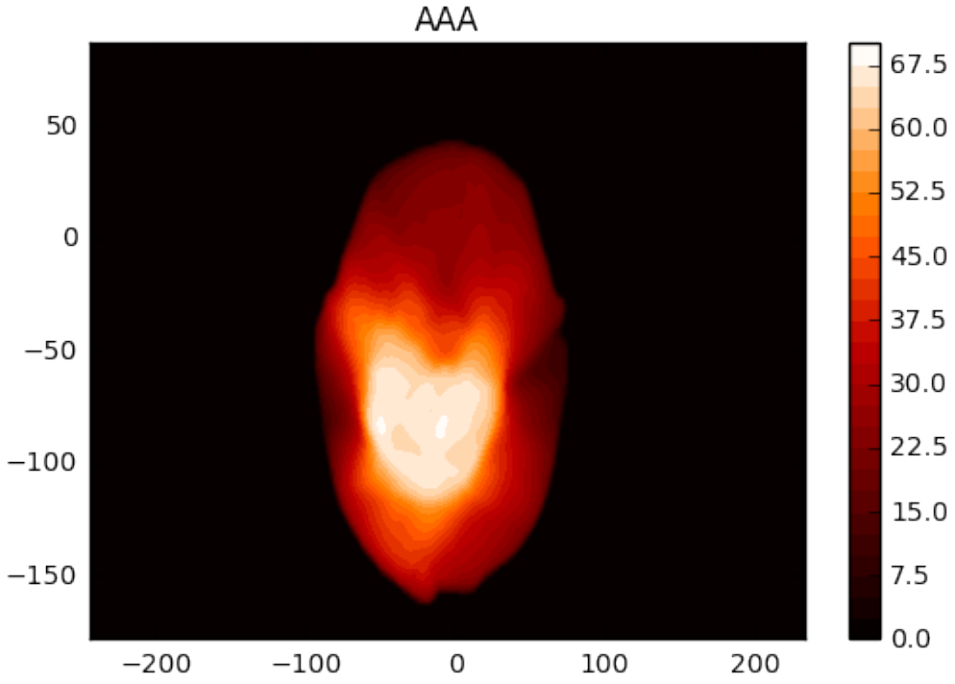
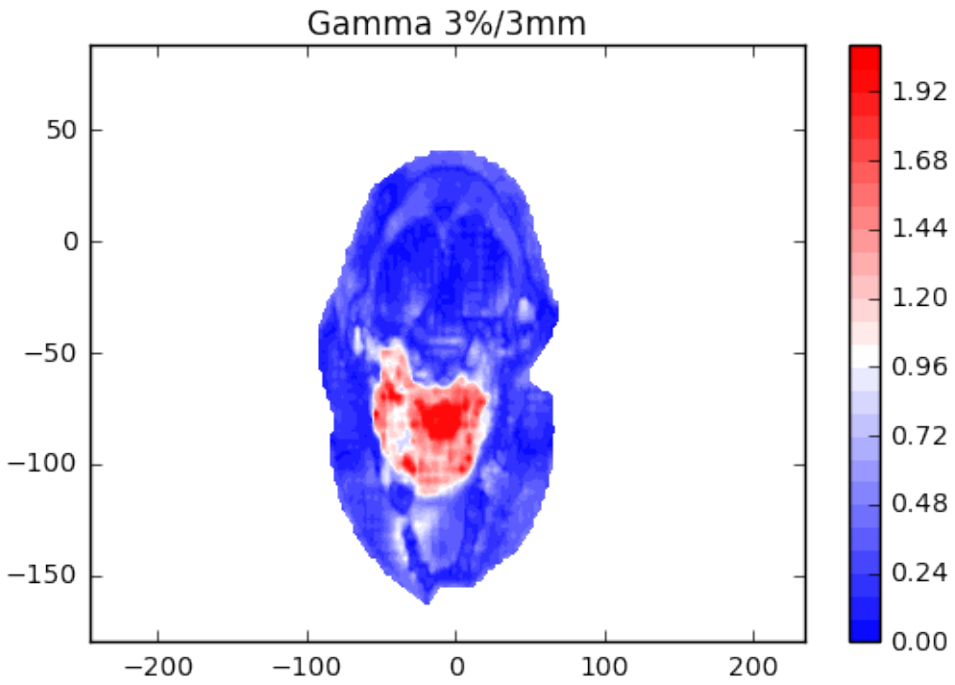
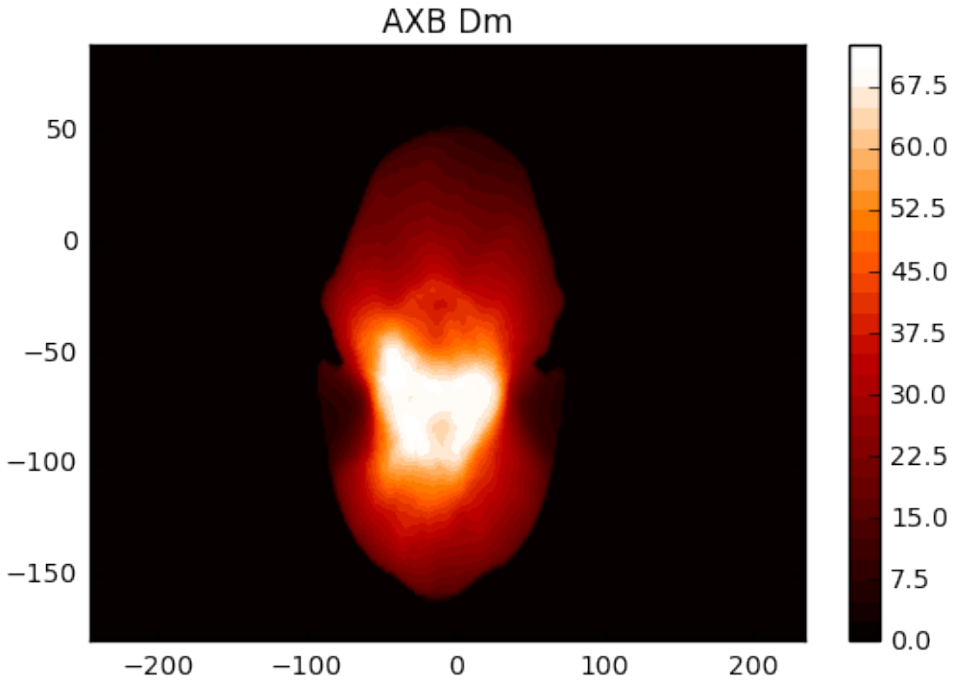
−200
−100
0
100
200
70
60
50
40
30
20
10
0


AAA
50
0
−50
−100
−150
−200
−100
0
100
200
67.5
60.0
52.5
45.0
37.5
30.0
22.5
15.0
7.5
0.0


Gamma 3%/3mm
50
0
−50
−100
−150
−200
−100
0
100
200
1.92
1.68
1.44
1.20
0.96
0.72
0.48
0.24
0.00

==========

Slice = 46.25


AXB Dm
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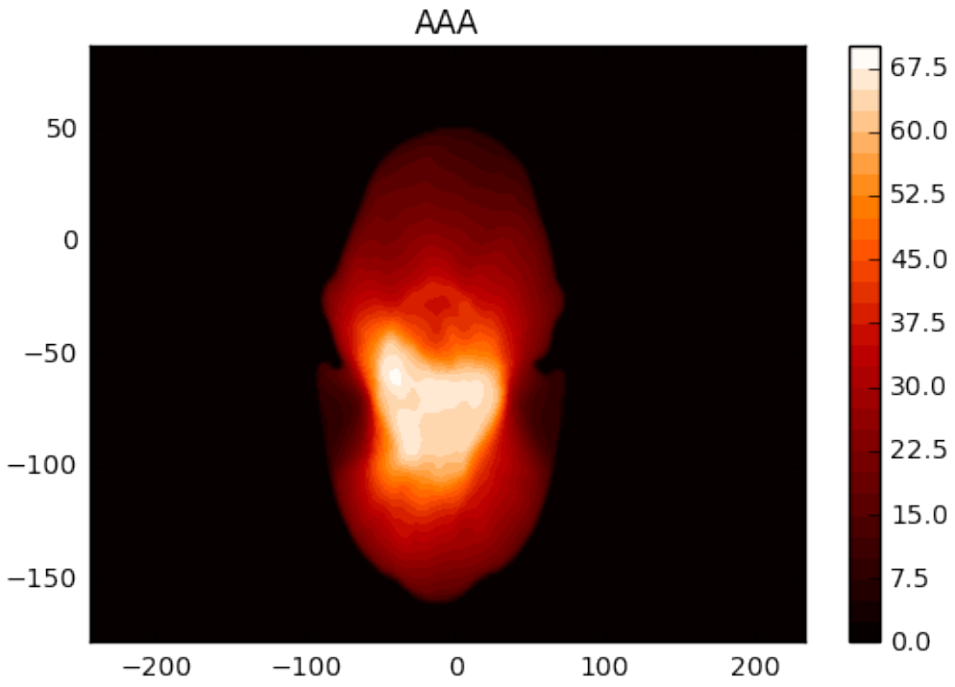
0
−50
−100
−150
−200
−100
0
100
200
67.5
60.0
52.5
45.0
37.5
30.0
22.5
15.0
7.5
0.0


AAA
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−150
−200
−100
0
100
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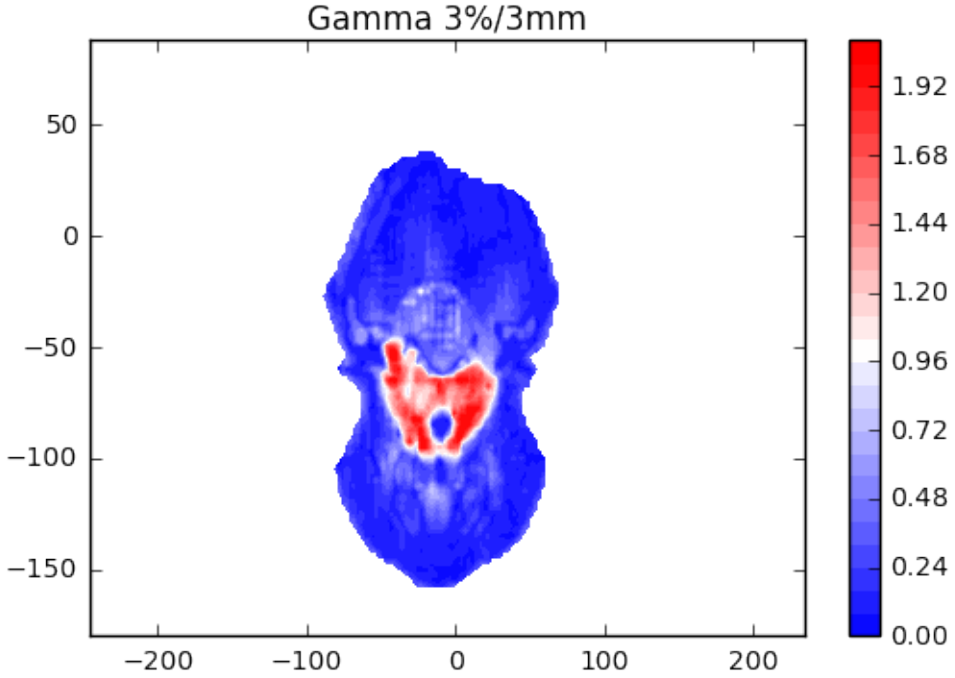
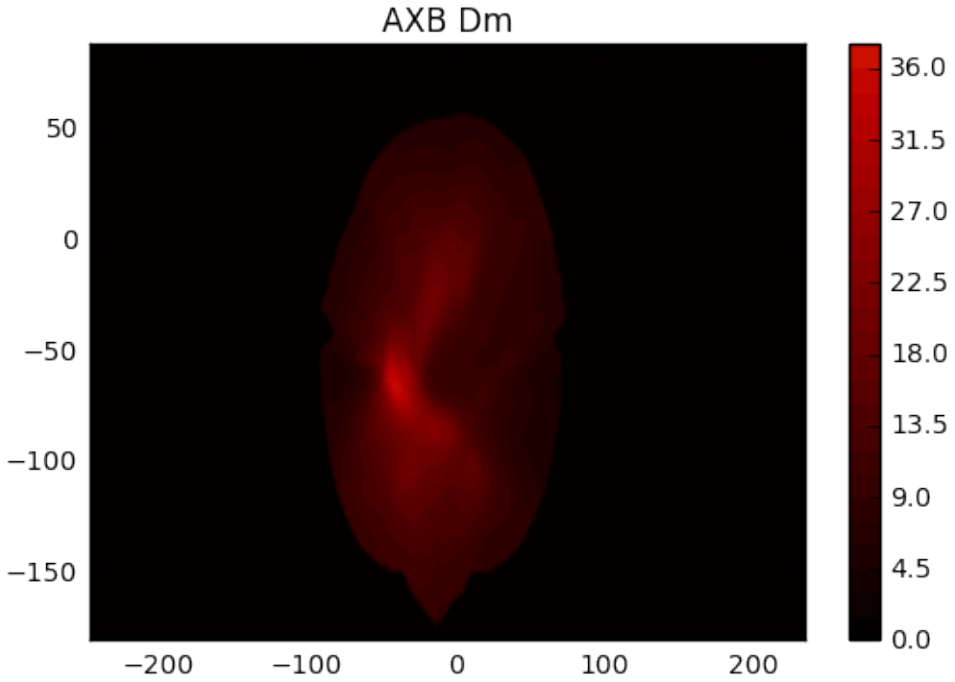
67.5
60.0
52.5
45.0
37.5
30.0
22.5
15.0
7.5
0.0


Gamma 3%/3mm
50
0
−50
−100
−150
−200
−100
0
100
200
1.92
1.68
1.44
1.20
0.96
0.72
0.48
0.24
0.00

```
==========================================================================
Slice = 58.75
```


AXB Dm
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−100
−150
−200
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100
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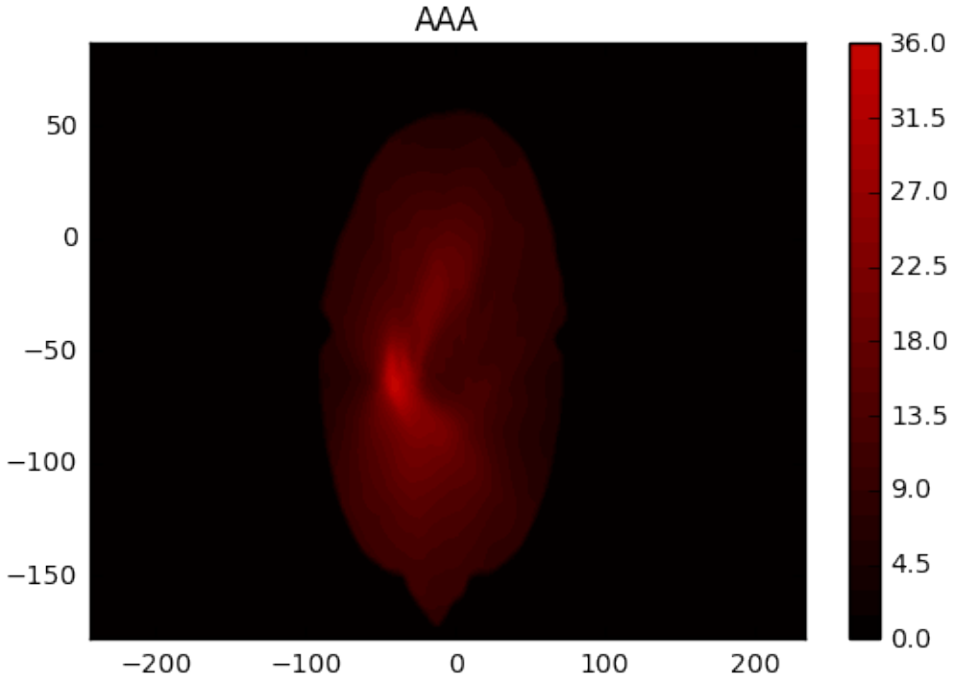
31.5
27.0
22.5
18.0
13.5
9.0
4.5
0.0


AAA
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−200
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200
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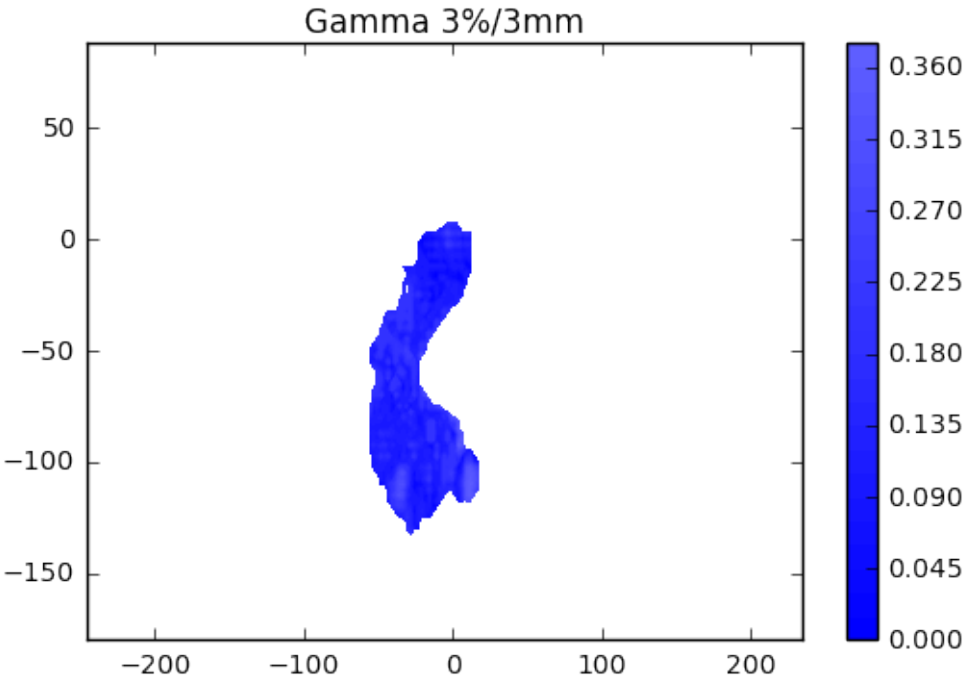
31.5
27.0
22.5
18.0
13.5
9.0
4.5
0.0


Gamma 3%/3mm
50
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−200
−100
0
100
200
0.360
0.315
0.270
0.225
0.180
0.135
0.090
0.045
0.000

In [ ]: