Avaliação do Software CASToR para reconstrução de imagens a partir de simulação com 131I no código GATE

João Henrique Martins Castelo

Graduando em Física Médica pela UFRJ

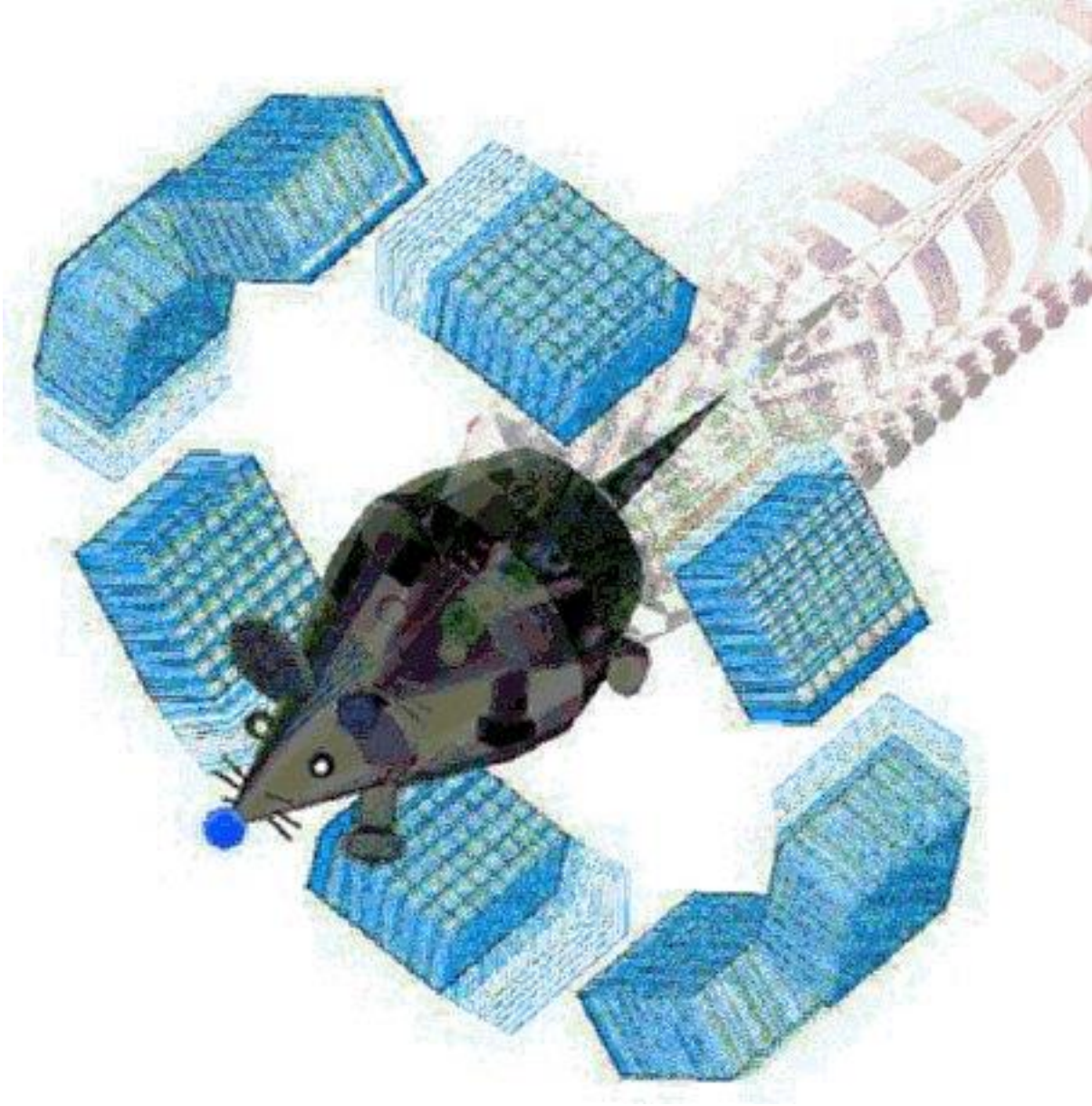
Bolsista PIBIC pelo IRD

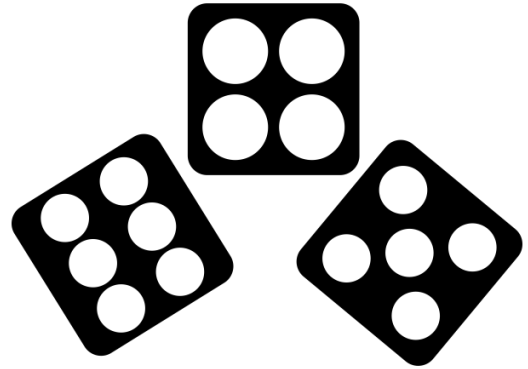
UFRJ

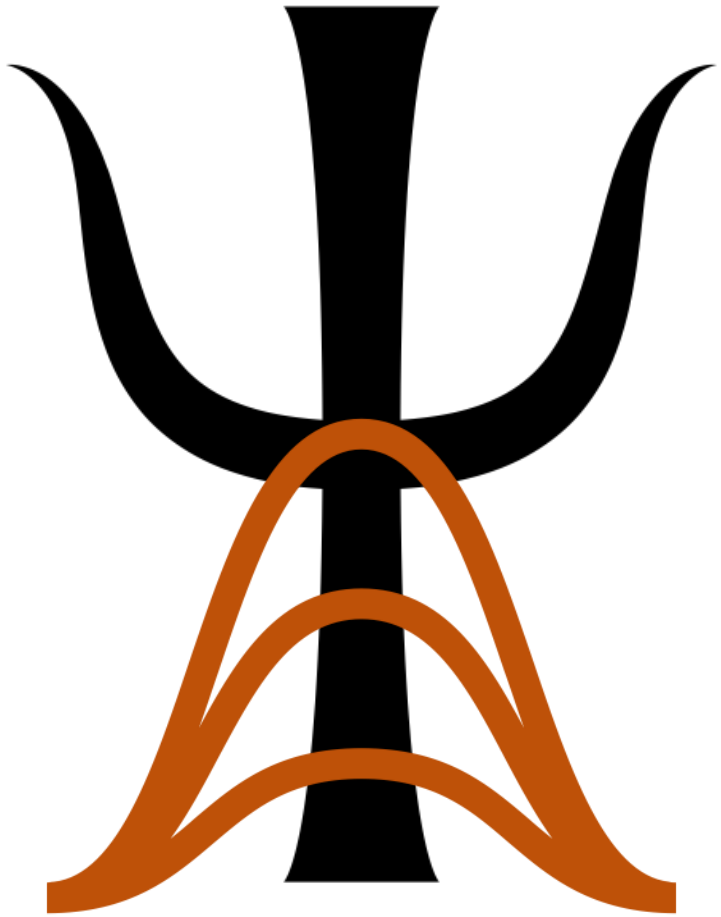
Como reconstruir imagens a partir de uma simulação SPECT Monte Carlo?

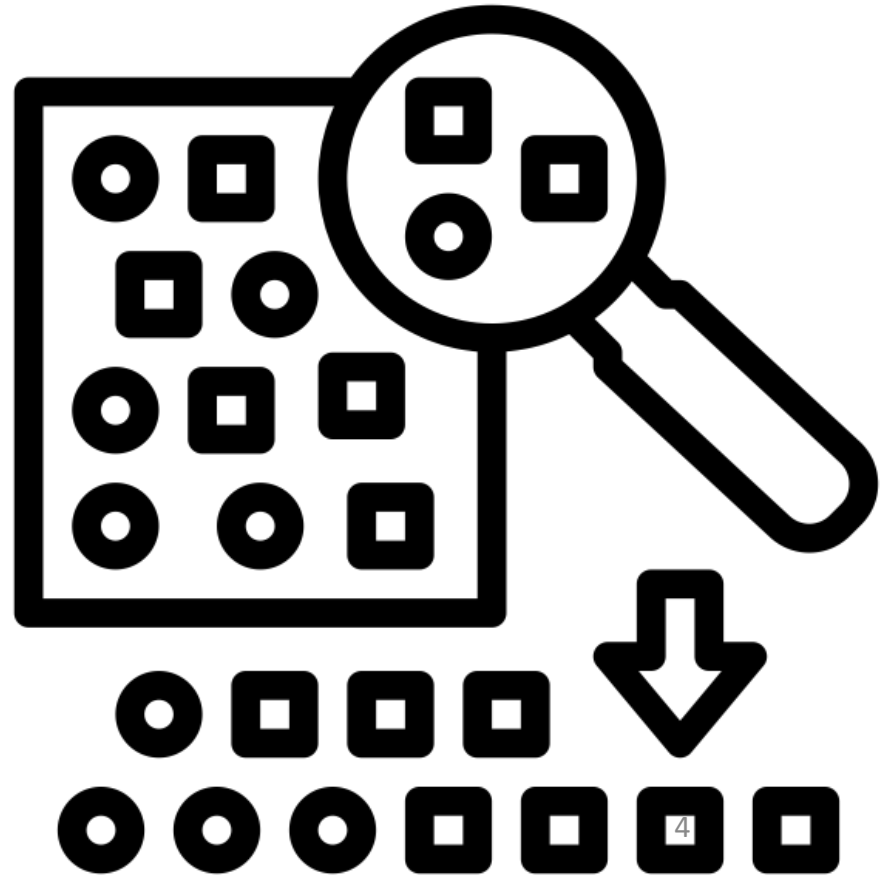
GEANT4 APP FOR TE

GATE





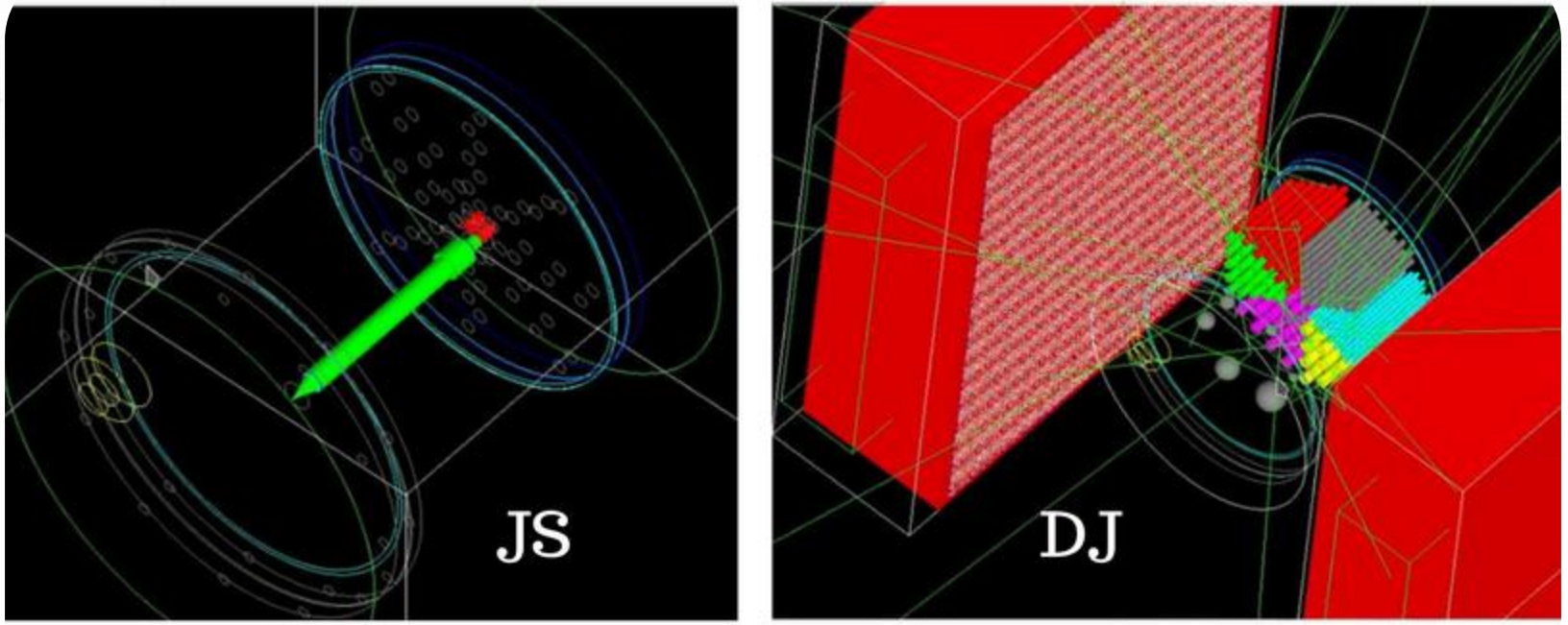




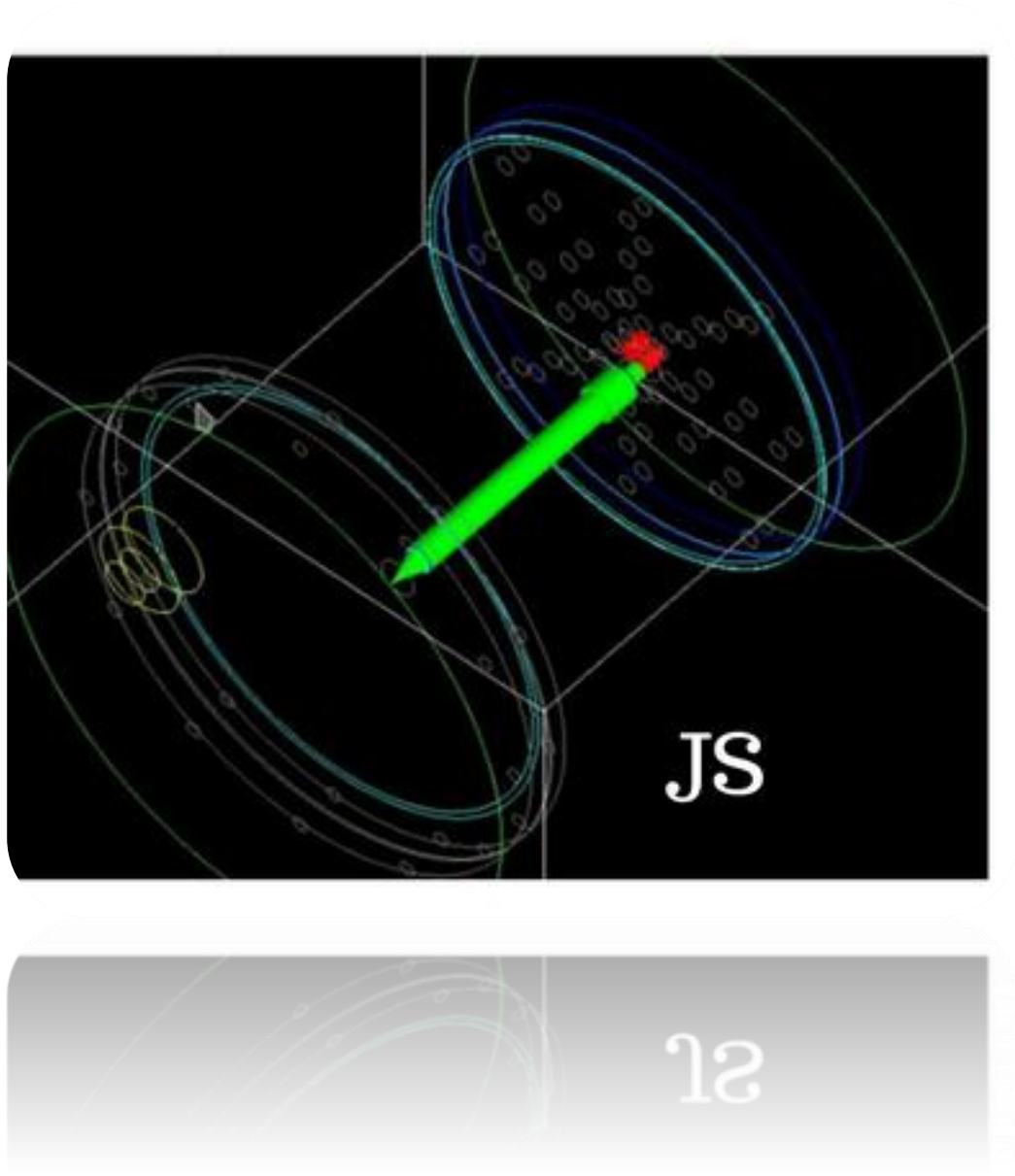
IMPLEMENTATION OF THE JASZCZAK PHANTOM AT THE GATE RADIATION TRANSPORT CODE FOR SPECT SIMULATION

João H. M. Castelo[1] , [1]Daniel A. B. Bonifácio

[1]Instituto de Radioproteção e Dosimetria - IRD/CNEN - Rio de Janeiro, RJ



Cores meramente ilustrativas


JS

Journal of Radiological Protection

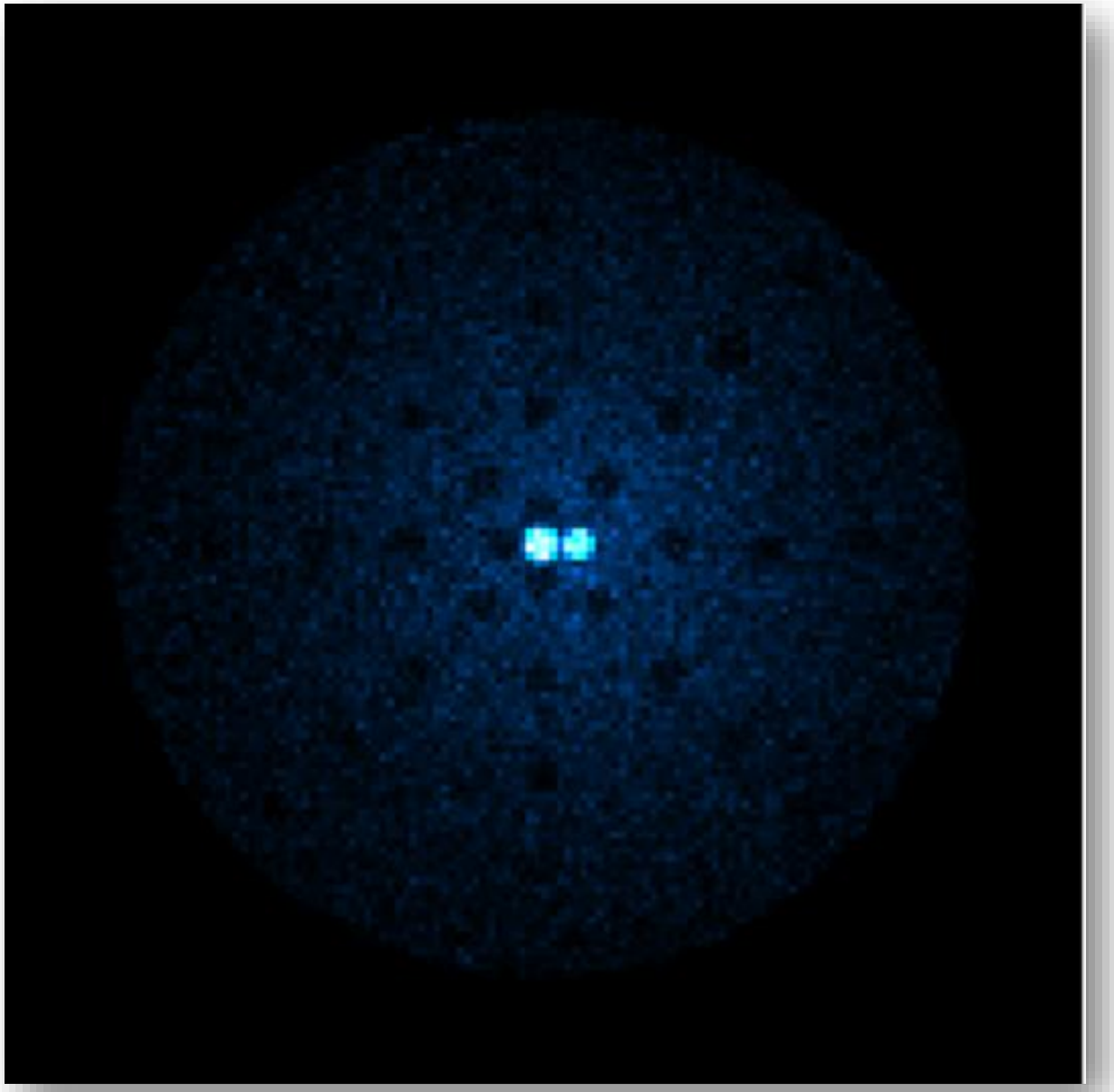
ACCEPTED MANUSCRIPT

Influence of the SPECT calibration source position on the absorbed dose calculation for ¹³¹I-NaI therapy using GATE simulations

Samira Marques de Carvalho[1], Ana Paula Marques Costa[2], Celso D Ramos[3], João H. M. Castelo[4], Sérgio Querino Brunetto[5] and D A B Bonifacio[6]

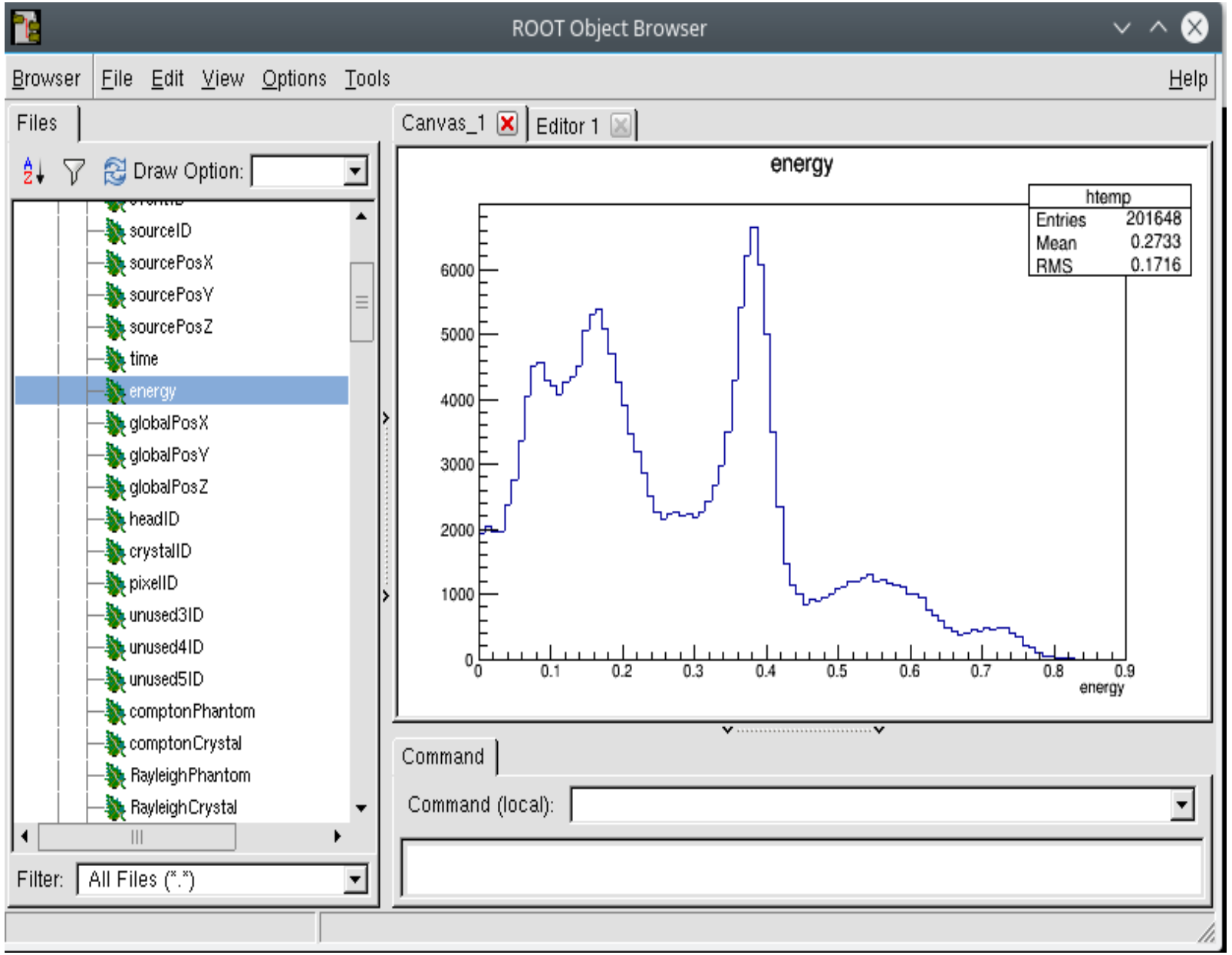
Accepted Manuscript online 18 July 2018 •

Mapa 3D de Dose

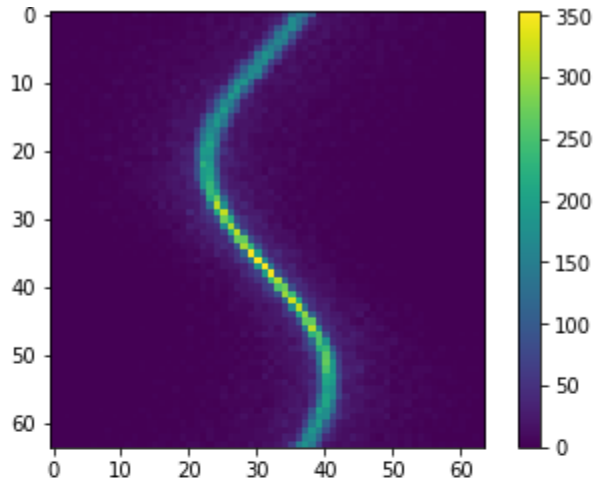


ROOT

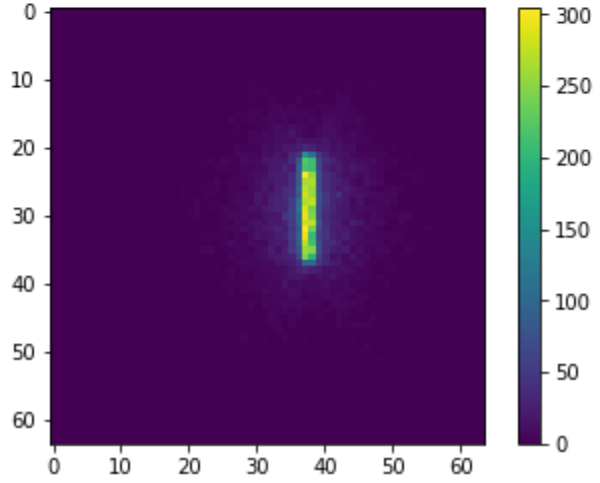
Data Analysis Framework



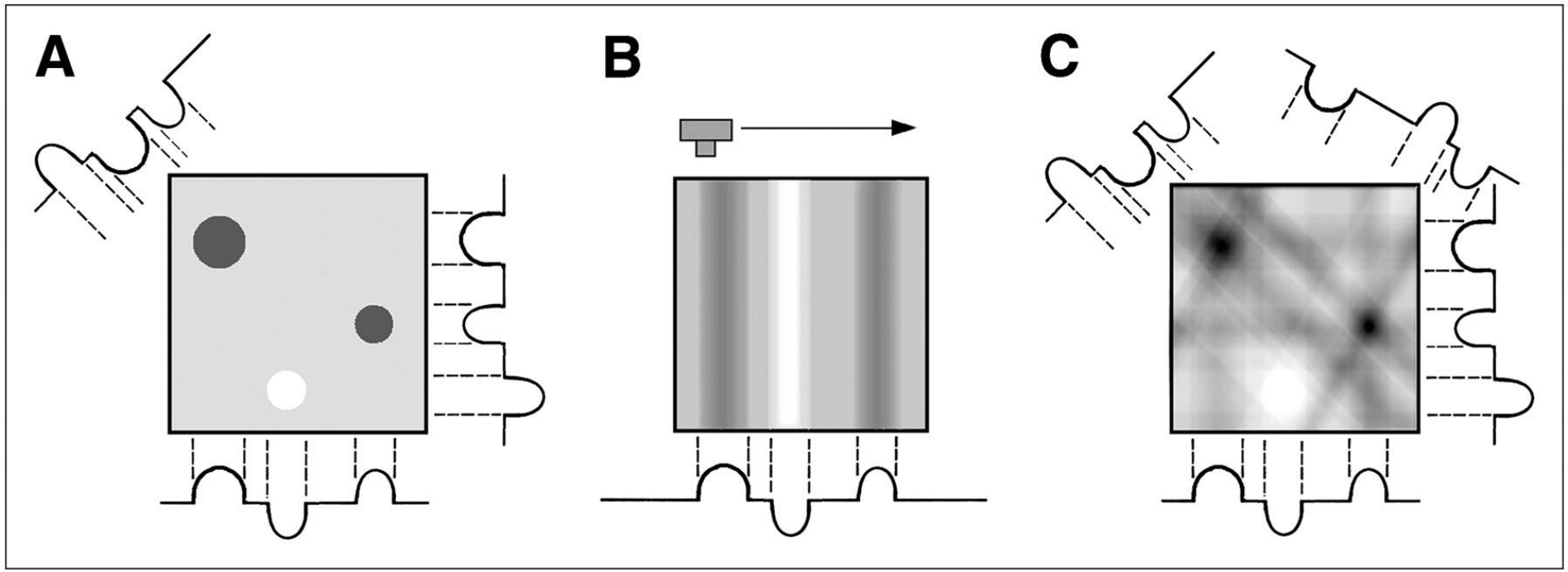
Projeções

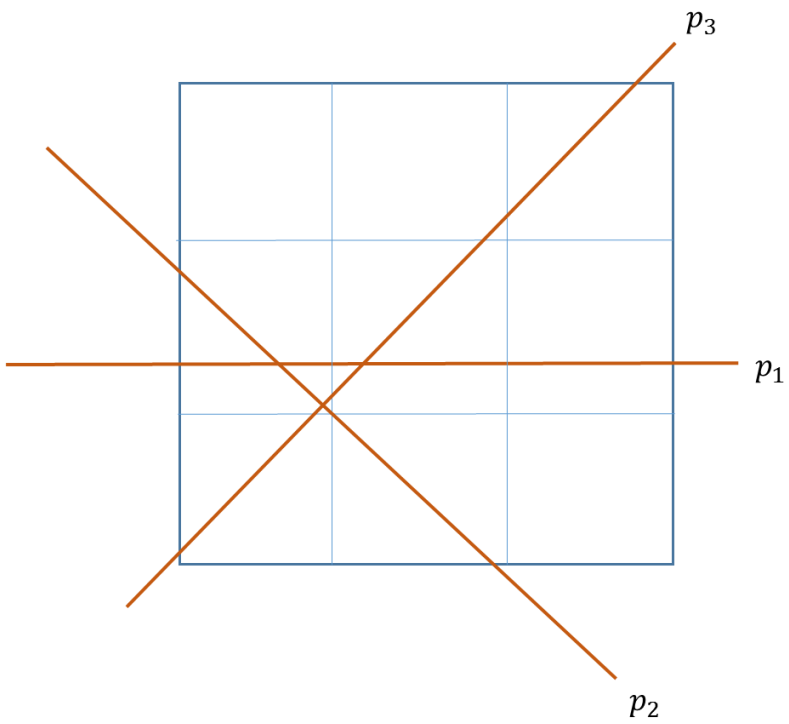


Out[3]: <matplotlib.colorbar.Colorbar at 0x7f981079c550>



Caminhos possíveis?

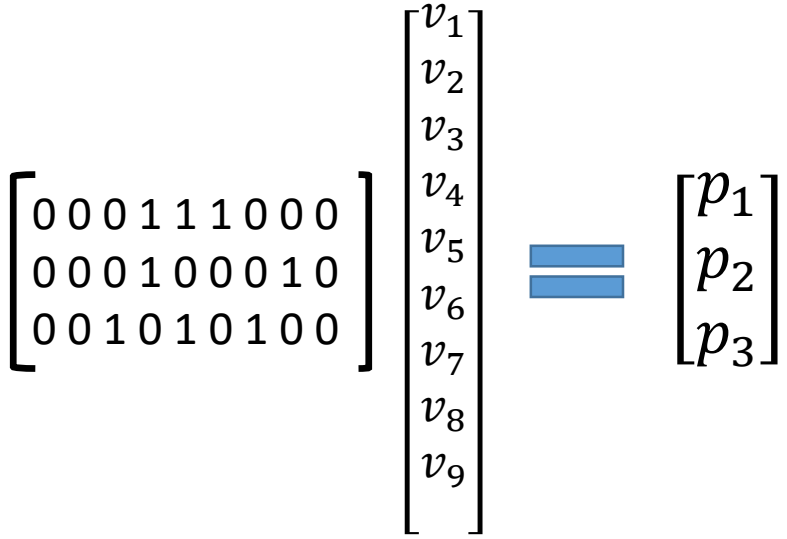




$$p_1 = v4 + v5 + v6$$

$$p_2 = v4 + v8$$

$$p_3 = v7 + v5 + v3$$


0 0 0 1 1 1 0 0 0
0 0 0 1 0 0 0 1 0
0 0 1 0 1 0 1 0 0
v_1
v_2
v_3
v_4
v_5
v_6
v_7
v_8
v_9
p_1
p_2
p_3

Projection #1

$$q \leftarrow \begin{bmatrix}0\\0\\0\\0\end{bmatrix} + \frac{(6-0)}{2}\begin{bmatrix}1\\1\\0\\0\end{bmatrix} = \begin{bmatrix}3\\3\\0\\0\end{bmatrix}$$

$$q \leftarrow \begin{bmatrix}3\\3\\0\\0\end{bmatrix} + \left(\frac{14-0}{2}\right)\begin{bmatrix}0\\0\\1\\1\end{bmatrix} = \begin{bmatrix}3\\3\\7\\7\end{bmatrix}$$

$$\sum_j A_{ij} = \begin{bmatrix}1\\1\\0\\0\end{bmatrix} + \begin{bmatrix}0\\0\\1\\1\end{bmatrix} = \begin{bmatrix}1\\1\\1\\1\end{bmatrix}$$

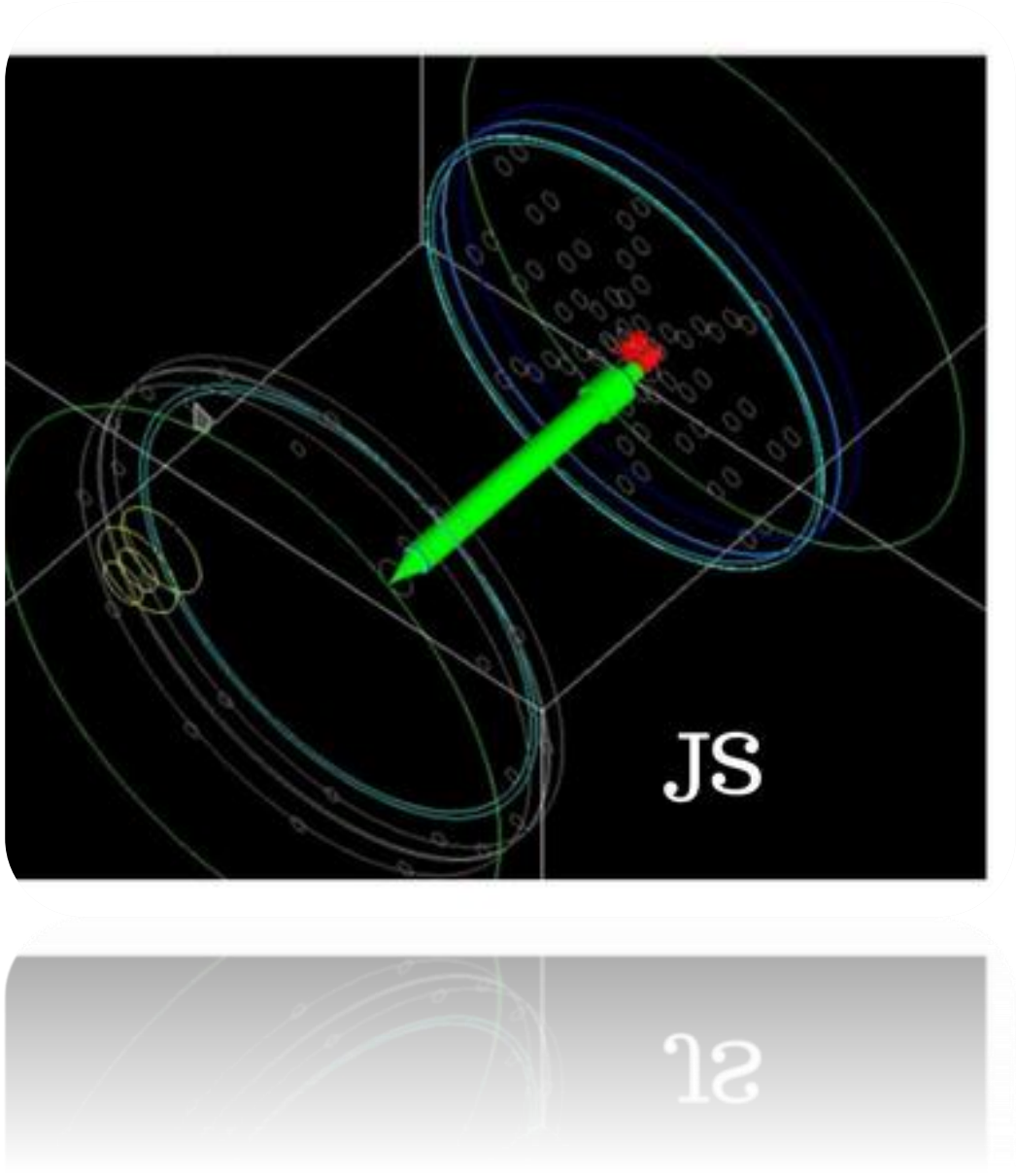
$$q \,/ \sum_j A_{ij} = \begin{bmatrix}3\\3\\7\\7\end{bmatrix}$$

$$a_3^T p = \begin{bmatrix}1&0&1&0\end{bmatrix}\begin{bmatrix}3\\3\\7\\7\end{bmatrix} = 10$$

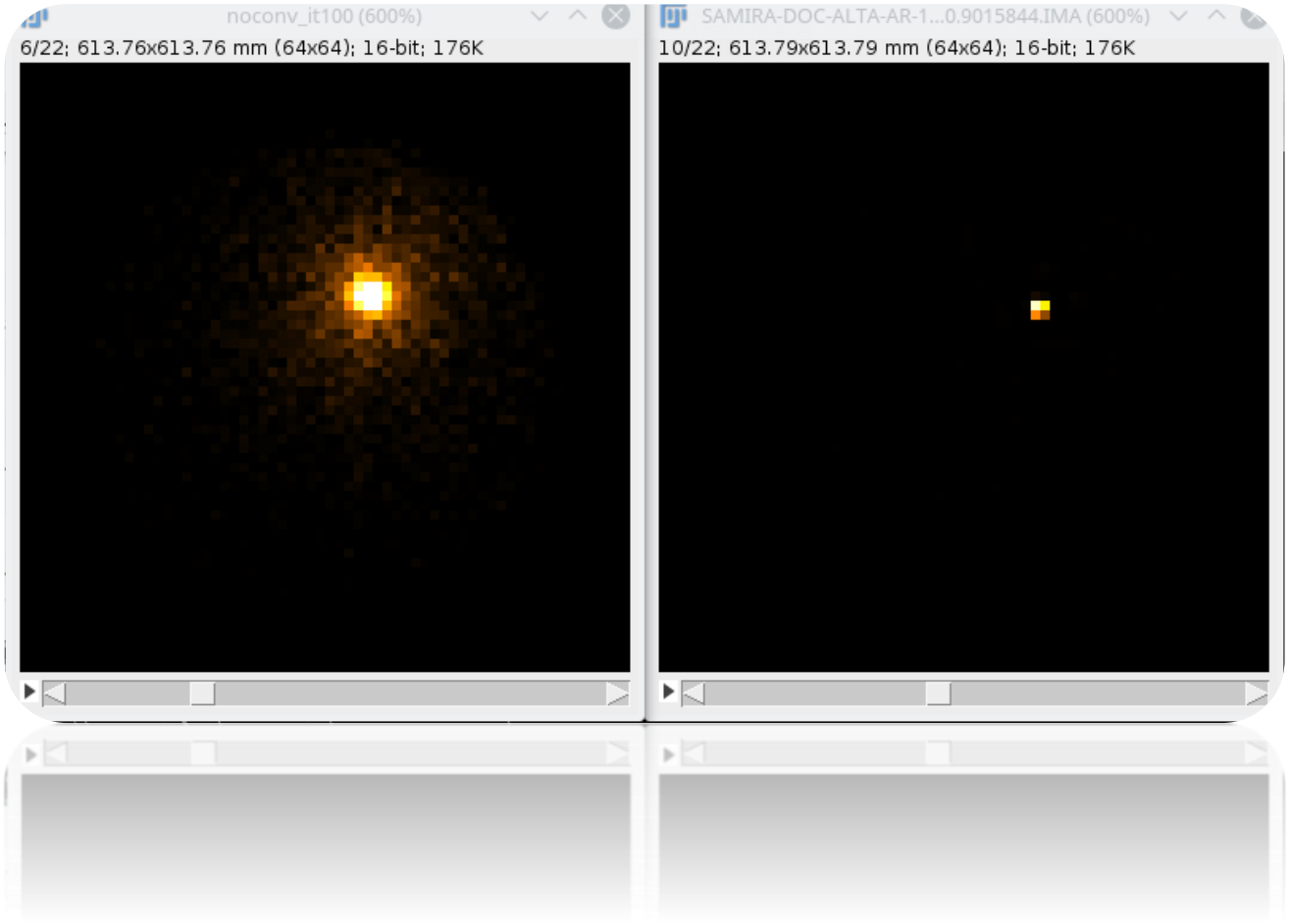
$$q \leftarrow \begin{bmatrix}0\\0\\0\\0\end{bmatrix} + \left(\frac{8-10}{2}\right)\begin{bmatrix}1\\0\\1\\0\end{bmatrix} = \begin{bmatrix}-1\\0\\-1\\0\end{bmatrix}$$

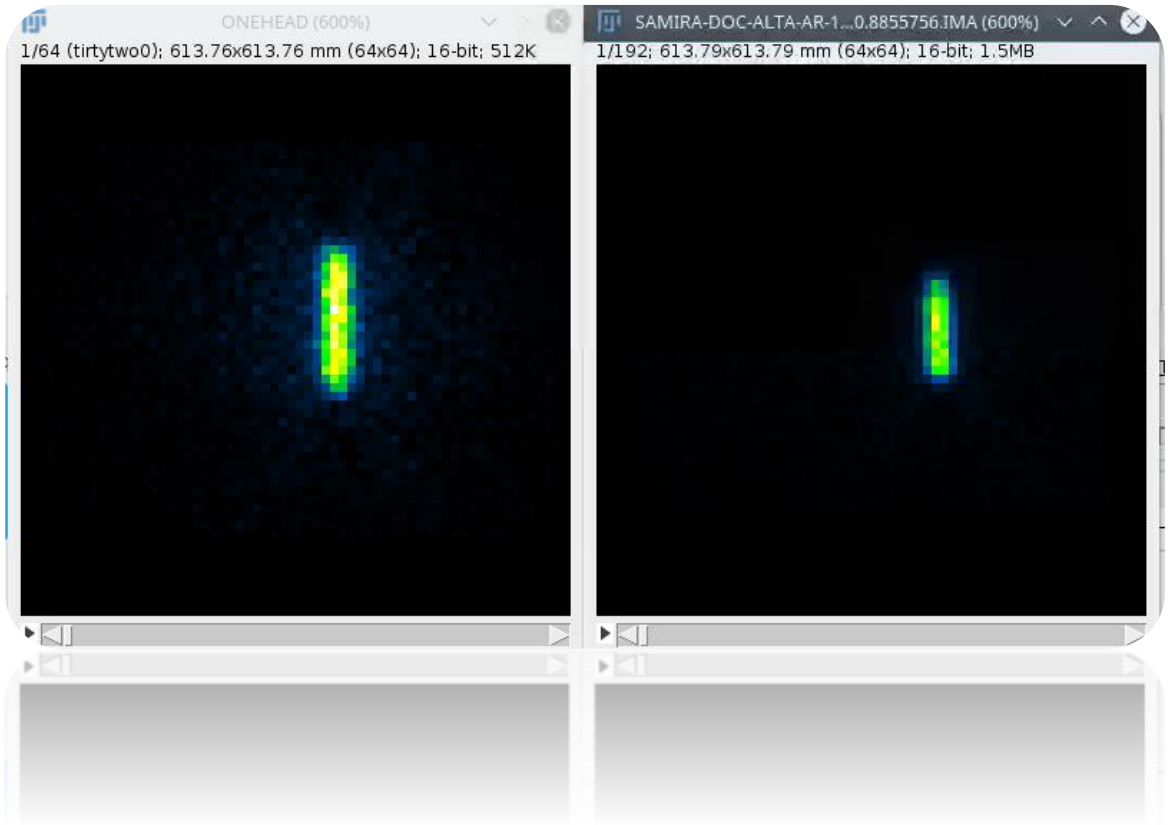
$$a_4^T p = \begin{bmatrix}0&1&0&1\end{bmatrix}\begin{bmatrix}3\\3\\7\\7\end{bmatrix} = 10$$

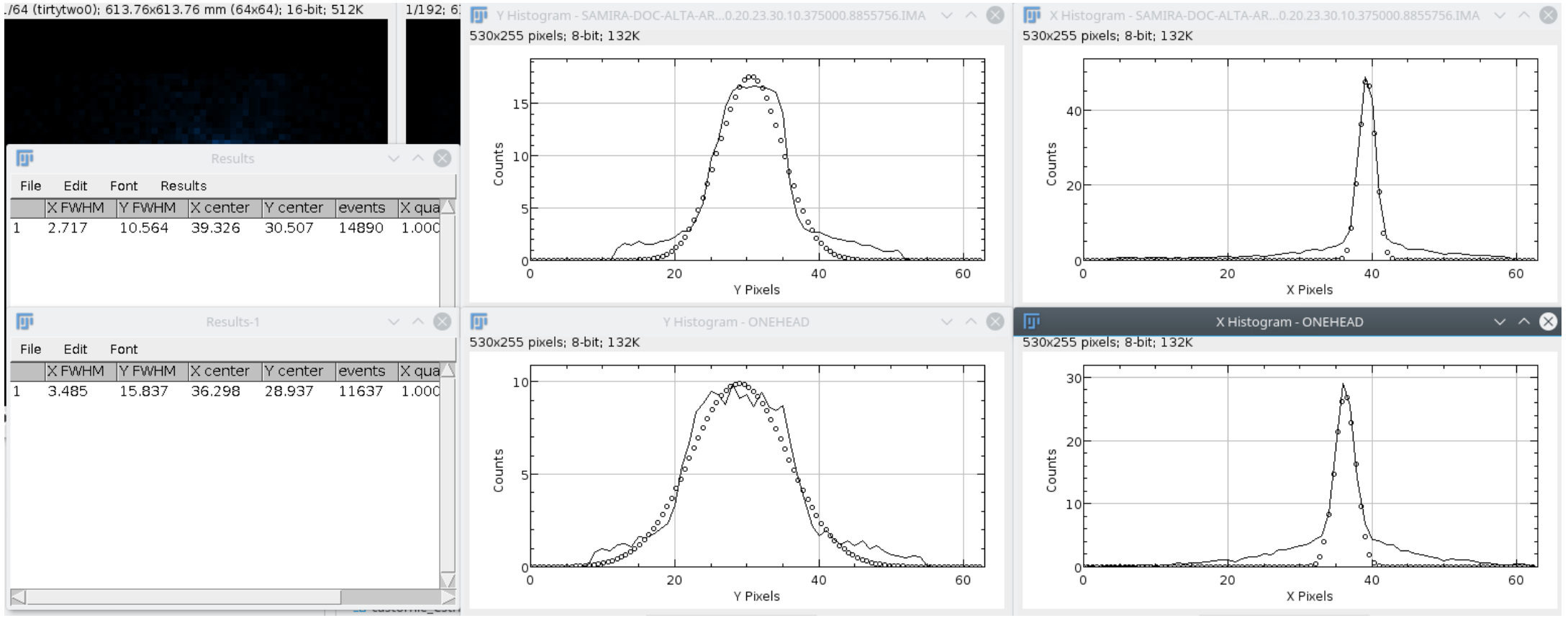
$$q \leftarrow \begin{bmatrix}-1\\0\\-1\\0\end{bmatrix} + \left(\frac{12-10}{2}\right)\begin{bmatrix}0\\1\\0\\1\end{bmatrix} = \begin{bmatrix}-1\\1\\-1\\1\end{bmatrix}$$

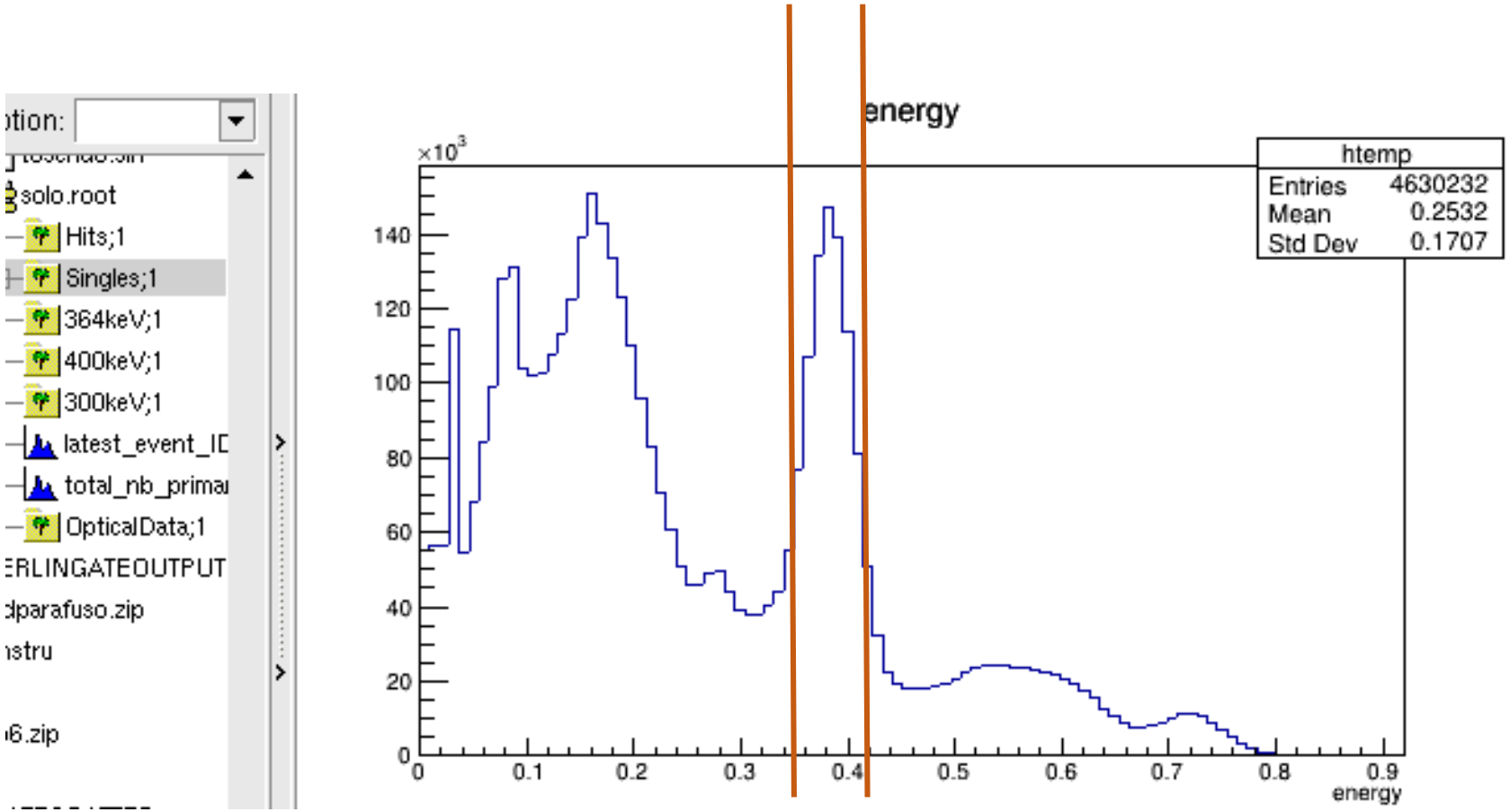

JS

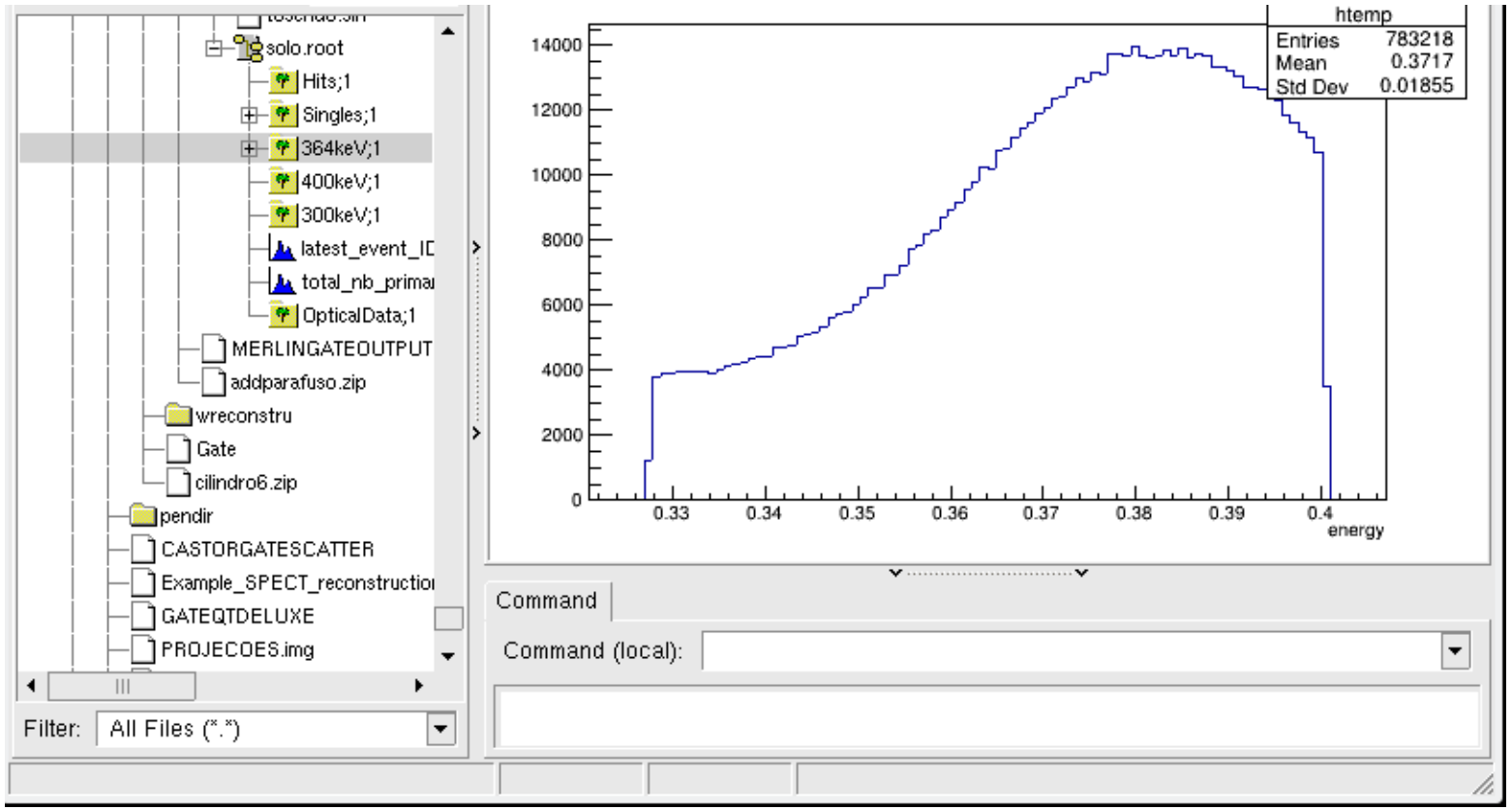
Customizable and Advanced Software for Tomographic Reconstruction (CASToR)


noconv_it100 (600%)
6/22; 613.76x613.76 mm (64x64); 16-bit; 176K
SAMIRA-DOC-ALTA-AR-1...0.9015844.IMA (600%)
10/22; 613.79x613.79 mm (64x64); 16-bit; 176K

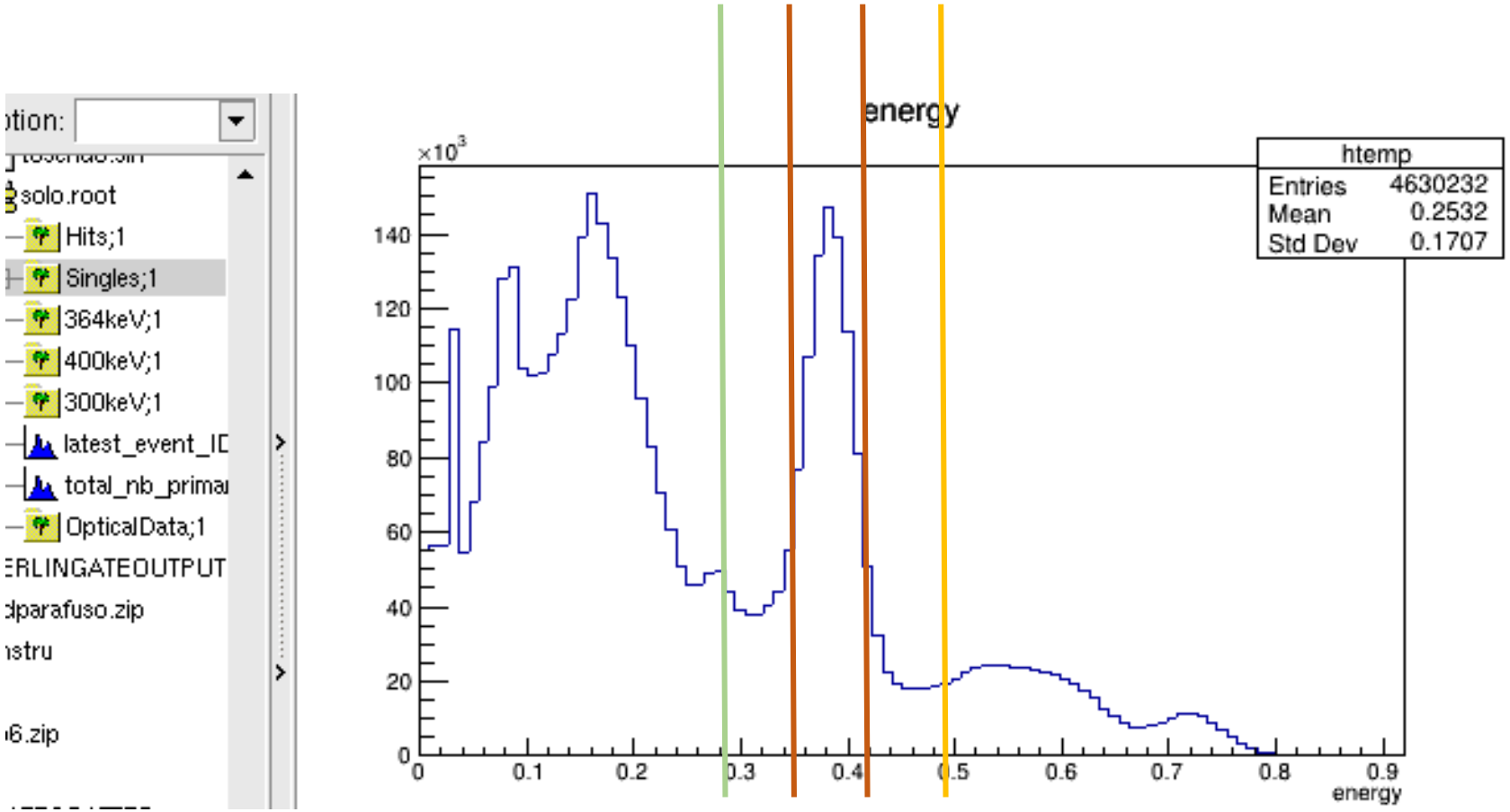

ONEHEAD (600%)
1/64 (tirtytwo0); 613.76x613.76 mm (64x64); 16-bit; 512K
SAMIRA-DOC-ALTA-AR-1....0.8855756.IMA (600%)
1/192; 613.79x613.79 mm (64x64); 16-bit; 1.5MB


./64 (tirtytwo0); 613.76x613.76 mm (64x64); 16-bit; 512K
1/192; 6
Results
File Edit Font Results
X FWHM Y FWHM X center Y center events X qua
1 2.717 10.564 39.326 30.507 14890 1.000
Results-1
File Edit Font
X FWHM Y FWHM X center Y center events X qua
1 3.485 15.837 36.298 28.937 11637 1.000
Y Histogram - SAMIRA-DOC-ALTA-AR...0.20.23.30.10.375000.8855756.IMA
530x255 pixels; 8-bit; 132K
Counts
Y Pixels
X Histogram - SAMIRA-DOC-ALTA-AR...0.20.23.30.10.375000.8855756.IMA
530x255 pixels; 8-bit; 132K
Counts
X Pixels
Y Histogram - ONEHEAD
530x255 pixels; 8-bit; 132K
Counts
Y Pixels
X Histogram - ONEHEAD
530x255 pixels; 8-bit; 132K
Counts
X Pixels


ption:
solo.root
Hits;1
Singles;1
364keV;1
400keV;1
300keV;1
latest_event_ID
total_nb_primar
OpticalData;1
ERLINGATEOUTPUT
dparafuso.zip
nstru
6.zip
energy
htemp
Entries 4630232
Mean 0.2532
Std Dev 0.1707
×10^3
140
120
100
80
60
40
20
0
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9
energy


solo.root
Hits;1
Singles;1
364keV;1
400keV;1
300keV;1
latest_event_ID
total_nb_primai
OpticalData;1
MERLINGATEOUTPUT
addparafuso.zip
wreconstru
Gate
cilindro6.zip
pendir
CASTORGATESCATTER
Example_SPECT_reconstructio
GATEQTDELUXE
PROJECOES.img
Filter:
All Files (*.*)
htemp
Entries 783218
Mean 0.3717
Std Dev 0.01855
14000
12000
10000
8000
6000
4000
2000
0
0.33
0.34
0.35
0.36
0.37
0.38
0.39
0.4
energy
Command
Command (local):

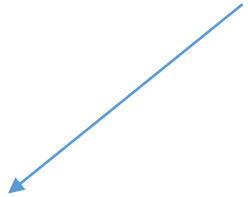
```
TFile *f = new TFile("./solo.root","OPEN");
TTree *singles364 = (TTree*)gDirectory->Get("364keV");
nSingles364  = singles364->GetEntries();
TTree *singles400 = (TTree*)gDirectory->Get("400keV");
nSingles400  = singles400->GetEntries();
TTree *singles300 = (TTree*)gDirectory->Get("300keV");
nSingles300  = singles300->GetEntries();

TFile *f364 = new TFile("./wto364.root","RECREATE");
TTree *newtree364 = singles364->CloneTree();
newtree364->SetName("Singles");
newtree364->Print();
f364->Write();
f364->Close();

TFile *f300 = new TFile("./wto300.root","RECREATE");
TTree *newtree300 = singles300->CloneTree();
newtree300->SetName("Singles");
newtree300->Print();
f300->Write();
f300->Close();
```


ption:
solo.root
Hits;1
Singles;1
364keV;1
400keV;1
300keV;1
latest_event_ID
total_nb_primar
OpticalData;1
ERLINGATEOUTPUT
dparafuso.zip
nstru
6.zip
energy
htemp
Entries 4630232
Mean 0.2532
Std Dev 0.1707
×10^3
140
120
100
80
60
40
20
0
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9
energy

mac

data

output



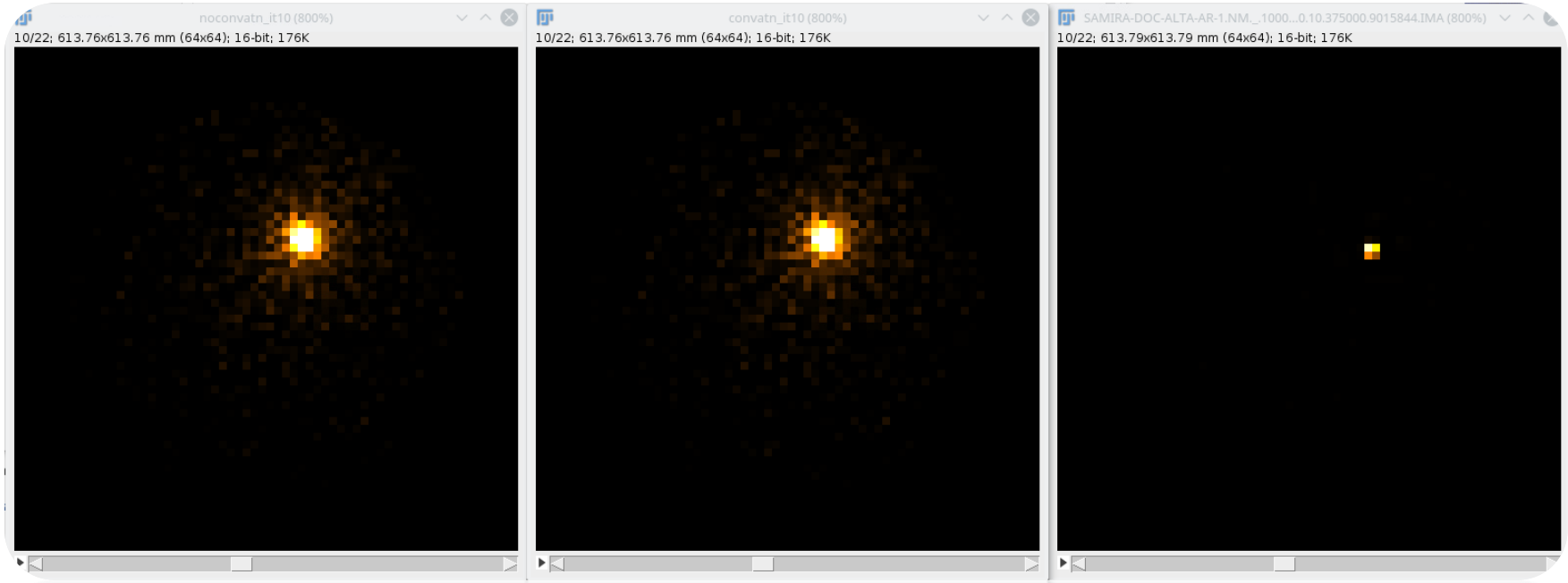
```
castor-GATEMacToGeom -m ../mac/flipedSymbia_T2_HE.mac -o hecol
castor-GATERootToCastor -m ../mac/flipedSymbia_T2_HE.mac  -o castorfile -i wto364.root  -s hecol  -sp_bins 180,128
```

Se o último comando não funcionar devido a falta do **time slice**, adicione as linhas na macro do SPECT.

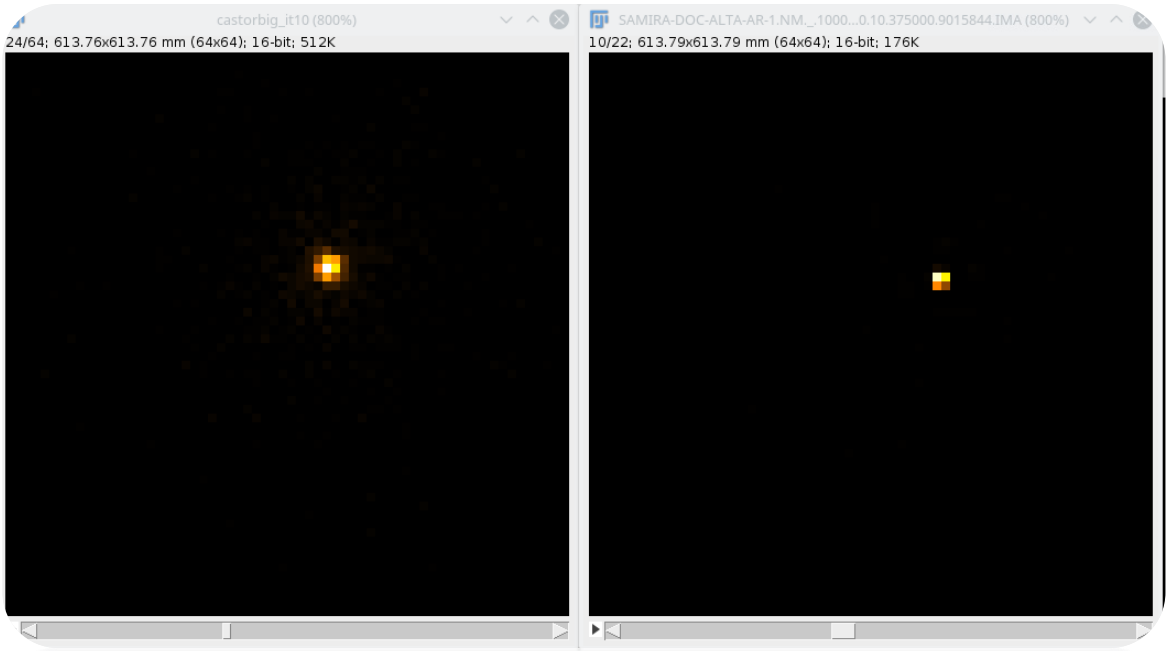
```
Data filename: castorfile_CstrProj.Cdf
Number of events: 1474560
Data mode: histogram
Data type: SPECT
Start time (s): 0
Duration (s): 4160
Scanner name: hecol
Number of bins: 180, 128
Number of projections: 64
Projection angles: 0, 5.6225, 11.245, 16.8675, 22.49, 28.1125, 33.735, 39.3575, 44.98, 50.6025, 56.225, 61.8475, 67.47, 73.0925, 78.715,
84.3375, 89.96, 95.5825, 101.205, 106.827, 112.45, 118.073, 123.695, 129.318, 134.94, 140.562, 146.185, 151.807, 157.43, 163.053,
168.675, 174.298, 179.92, 185.542, 191.165, 196.787, 202.41, 208.033, 213.655, 219.277, 224.9, 230.522, 236.145, 241.768, 247.39,
253.012, 258.635, 264.258, 269.88, 275.503, 281.125, 286.747, 292.37, 297.992, 303.615, 309.237, 314.86, 320.482, 326.105, 331.728,
337.35, 342.973, 348.595, 354.217
Distance camera surface to COR: 234.5
Calibration factor: 1
Isotope: unknown
Normalization correction flag: 0
Scatter correction flag: 0
Head rotation direction: CW
```

Global distance camera to surface to COR : 234.5

```
castor-recon -df castorfile_CstrProj.Cdh -opti MLEM -dim 64,64,64 -vox 9.59,9.59,9.59 -fout convatnBih -it 10:10 -proj incrementalSiddon
-fov-out 78 -oit -1 -conv gaussian,4.5,4.5,3::psf
```


noconvatn_it10 (800%)
10/22; 613.76x613.76 mm (64x64); 16-bit; 176K
convatn_it10 (800%)
10/22; 613.76x613.76 mm (64x64); 16-bit; 176K
SAMIRA-DOC-ALTA-AR-1.NM...1000...0.10.375000.9015844.IMA (800%)
10/22; 613.79x613.79 mm (64x64); 16-bit; 176K

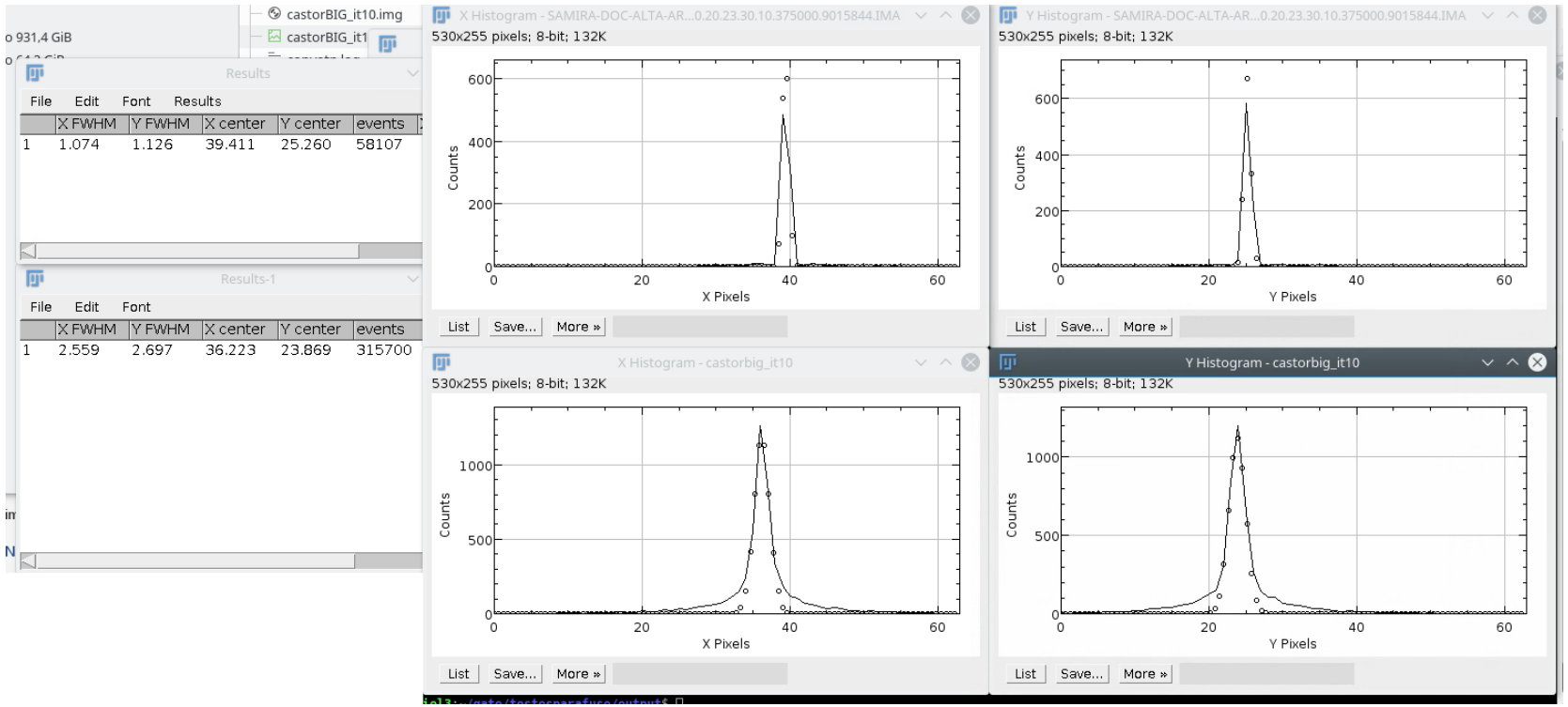
22 CORTES

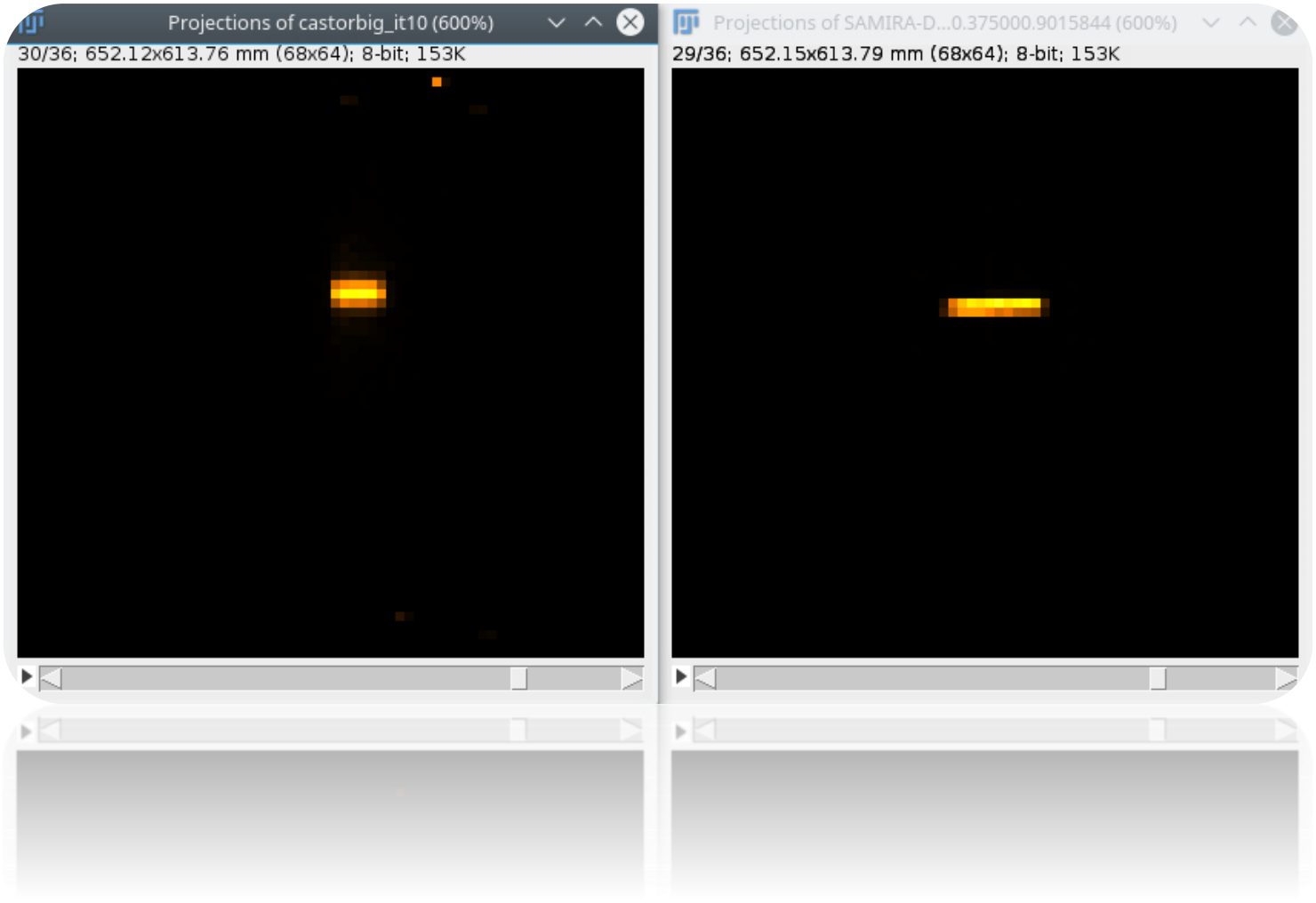

castorbig_it10 (800%)
24/64; 613.76x613.76 mm (64x64); 16-bit; 512K
SAMIRA-DOC-ALTA-AR-1.NM._.1000...0.10.375000.9015844.IMA (800%)
10/22; 613.79x613.79 mm (64x64); 16-bit; 176K

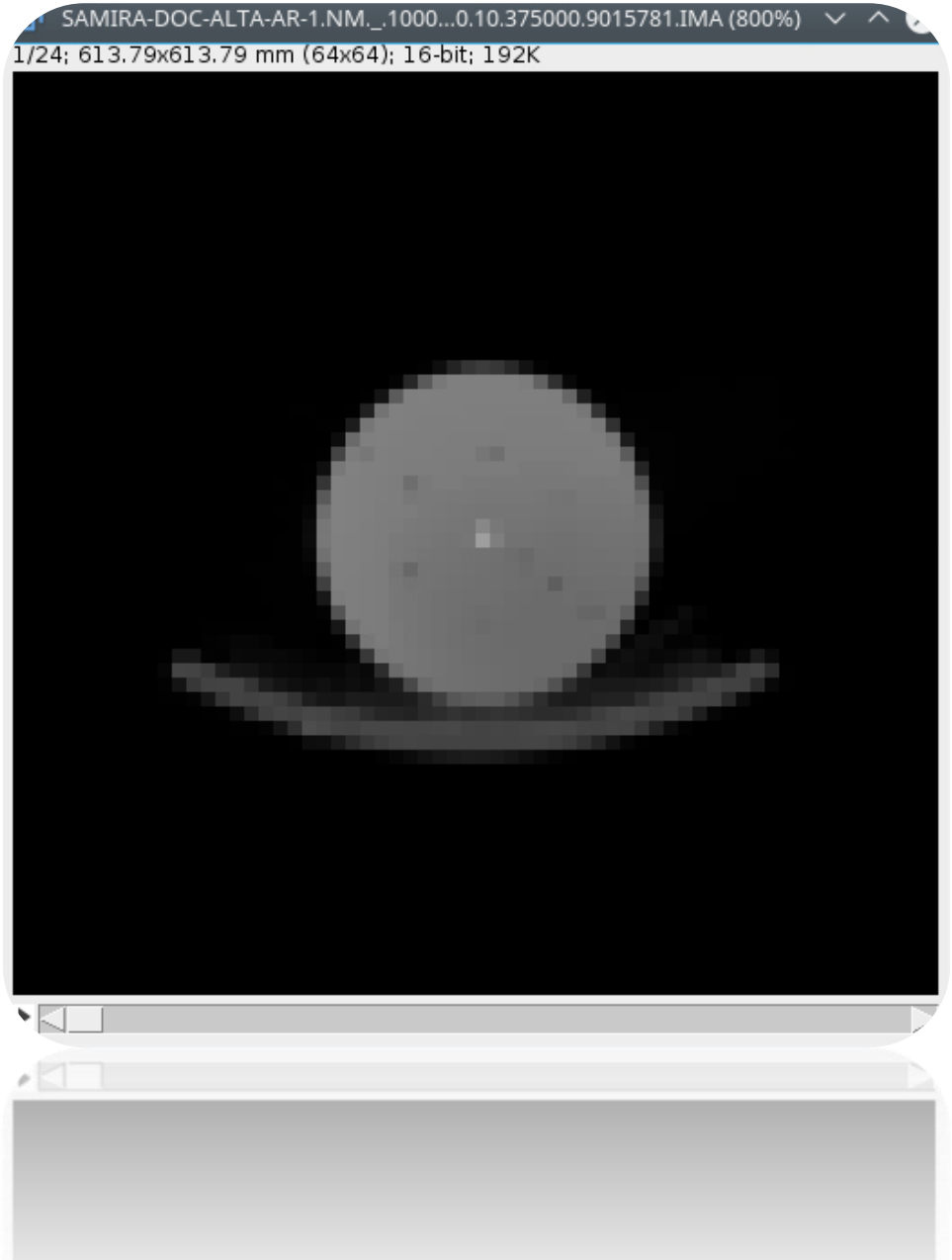
64 CORTES

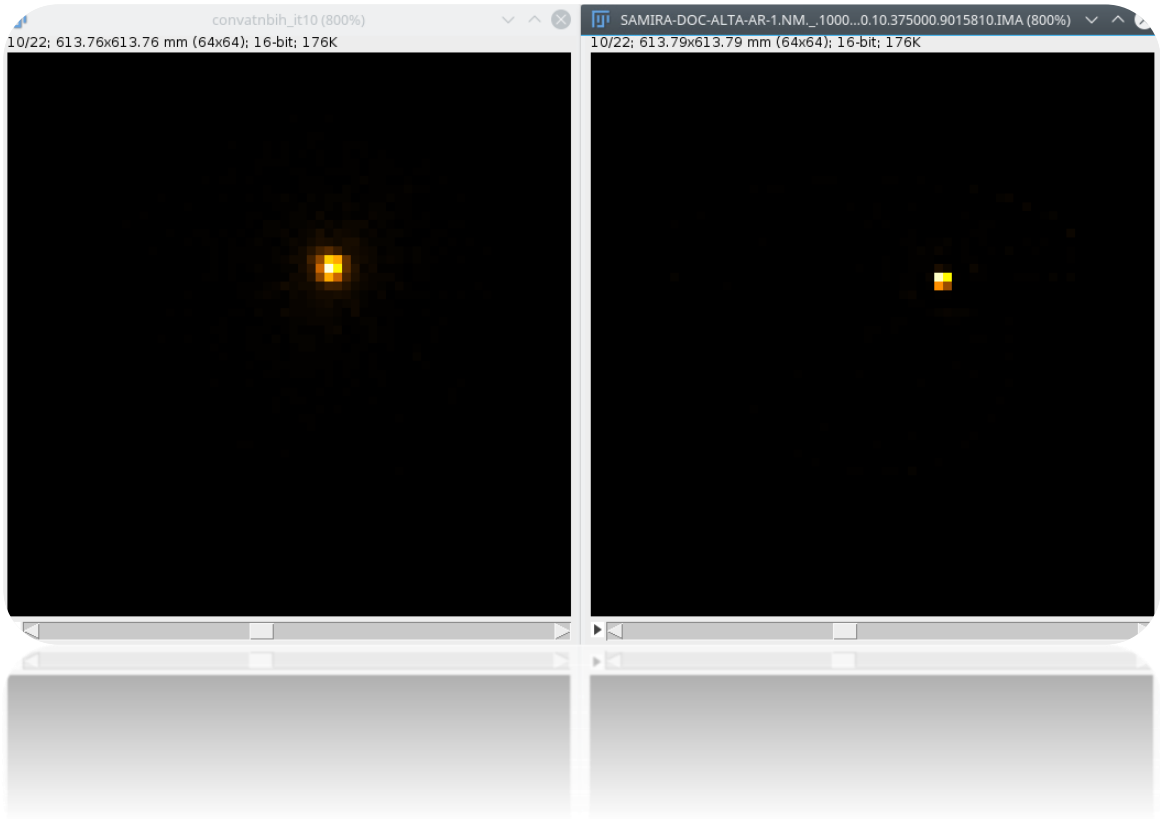
E agora?

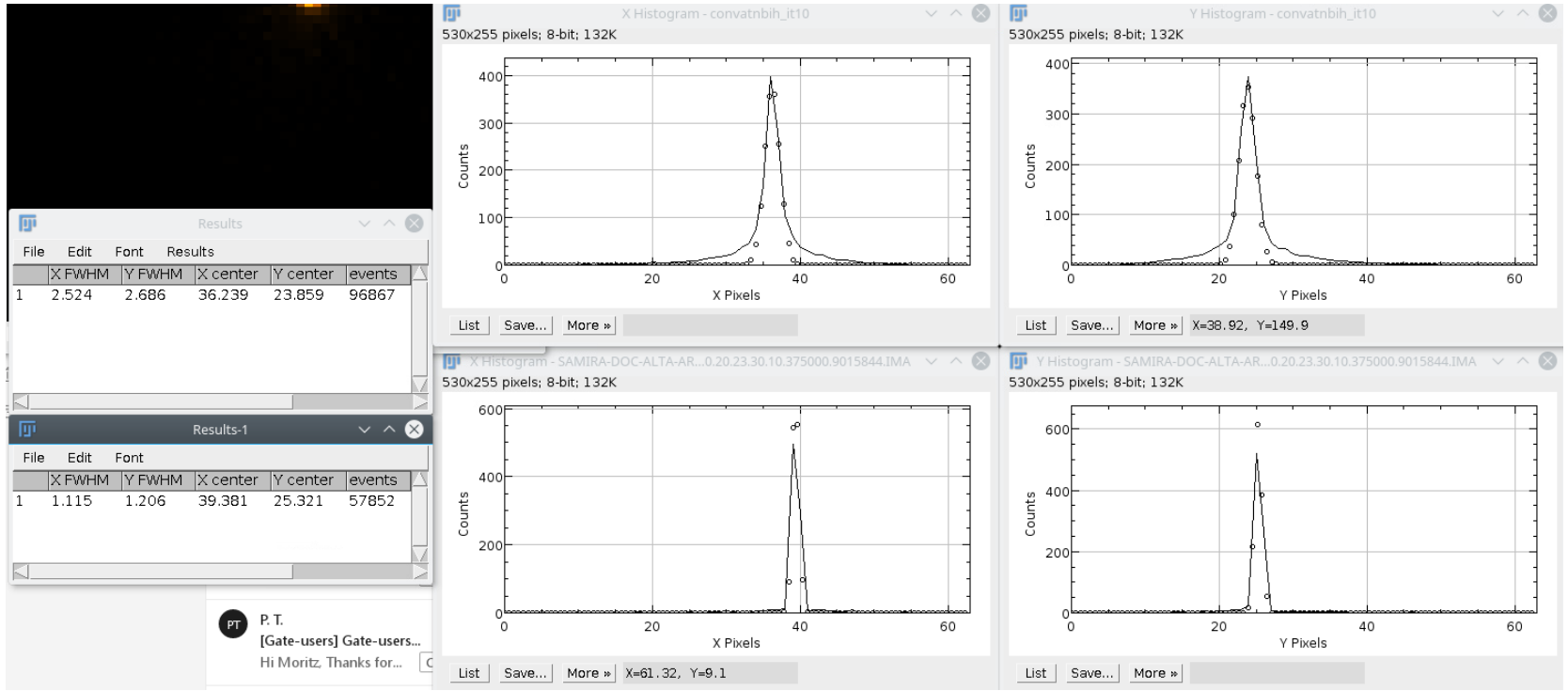
Volume de Reconstrução altera significativamente a qualidade da imagem!

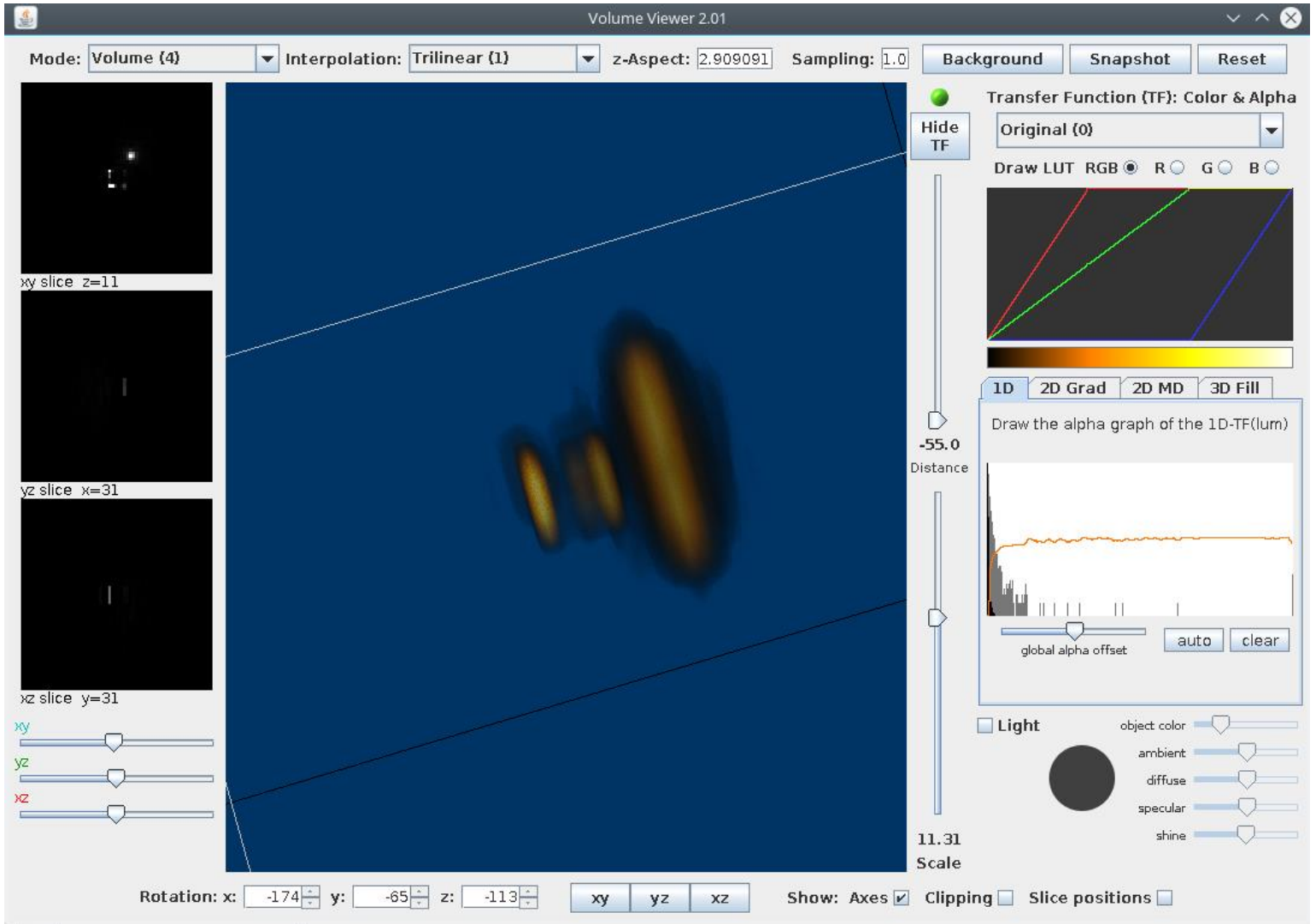

castorBIG_it10.img
castorBIG_it1
o 931,4 GiB
Results
File Edit Font Results
X FWHM Y FWHM X center Y center events
1 1.074 1.126 39.411 25.260 58107
Results-1
File Edit Font
X FWHM Y FWHM X center Y center events
1 2.559 2.697 36.223 23.869 315700
X Histogram - SAMIRA-DOC-ALTA-AR...0.20.23.30.10.375000.9015844.IMA
530x255 pixels; 8-bit; 132K
Counts
X Pixels
List Save... More »
Y Histogram - SAMIRA-DOC-ALTA-AR...0.20.23.30.10.375000.9015844.IMA
530x255 pixels; 8-bit; 132K
Counts
Y Pixels
List Save... More »
X Histogram - castorbig_it10
530x255 pixels; 8-bit; 132K
Counts
X Pixels
List Save... More »
Y Histogram - castorbig_it10
530x255 pixels; 8-bit; 132K
Counts
Y Pixels
List Save... More »


Projections of castorbig_it10 (600%)
30/36; 652.12x613.76 mm (68x64); 8-bit; 153K
Projections of SAMIRA-D...0.375000.9015844 (600%)
29/36; 652.15x613.79 mm (68x64); 8-bit; 153K


SAMIRA-DOC-ALTA-AR-1.NM._.1000...0.10.375000.9015781.IMA (800%)
1/24; 613.79x613.79 mm (64x64); 16-bit; 192K


convatnbih_it10 (800%)
10/22; 613.76x613.76 mm (64x64); 16-bit; 176K
SAMIRA-DOC-ALTA-AR-1.NM._1000...0.10.375000.9015810.IMA (800%)
10/22; 613.79x613.79 mm (64x64); 16-bit; 176K


Results
File Edit Font Results
X FWHM Y FWHM X center Y center events
1 2.524 2.686 36.239 23.859 96867
Results-1
File Edit Font
X FWHM Y FWHM X center Y center events
1 1.115 1.206 39.381 25.321 57852
P. T.
[Gate-users] Gate-users...
Hi Moritz, Thanks for...
X Histogram - convatnbih_it10
530x255 pixels; 8-bit; 132K
Counts
X Pixels
List Save... More »
Y Histogram - convatnbih_it10
530x255 pixels; 8-bit; 132K
Counts
Y Pixels
List Save... More » X=38.92, Y=149.9
X Histogram - SAMIRA-DOC-ALTA-AR...0.20.23.30.10.375000.9015844.IMA
530x255 pixels; 8-bit; 132K
Counts
X Pixels
List Save... More » X=61.32, Y=9.1
Y Histogram - SAMIRA-DOC-ALTA-AR...0.20.23.30.10.375000.9015844.IMA
530x255 pixels; 8-bit; 132K
Counts
Y Pixels
List Save... More »


Volume Viewer 2.01
Mode: Volume (4)
Interpolation: Trilinear (1)
z-Aspect: 2.909091
Sampling: 1.0
Background
Snapshot
Reset
xy slice z=11
yz slice x=31
xz slice y=31
xy
yz
xz
Hide TF
-55.0
Distance
11.31
Scale
Transfer Function (TF): Color & Alpha
Original (0)
Draw LUT RGB R G B
1D
2D Grad
2D MD
3D Fill
Draw the alpha graph of the 1D-TF(lum)
global alpha offset
auto
clear
Light
object color
ambient
diffuse
specular
shine
Rotation: x: -174 y: -65 z: -113
xy
yz
xz
Show: Axes
Clipping
Slice positions

Ann Nucl Med. 1992 Aug;6(3):153-8.

Correction of scattered photons in Tc-99m imaging by means of a photopeak dual-energy window acquisition.

Kojima A[1], Tsuji A, Takaki Y, Tomiguchi S, Hara M, Matsumoto M, Takahashi M.

Quantitative 131I SPECT with triple energy window Compton scatter correction

Article (PDF Available) *in* IEEE Transactions on Nuclear Science 45(6):3109 - 3114 · January 1999 *with* 135 Reads

DOI: 10.1109/23.737672 · Source: IEEE Xplore

O problema da janela tripla

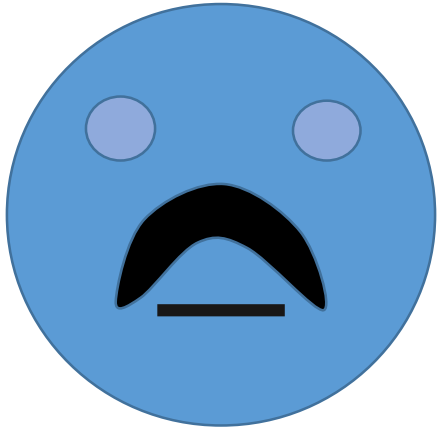
$$C_{sc} = \left(\frac{C_{high}}{W_{high}} + \frac{C_{low}}{W_{low}}\right)\frac{W_{main}}{2}$$

Matriz de Projeção

ou

Projeções

O CASToR não possui espaço para informação de espalhamento quando convertido do ROOT.

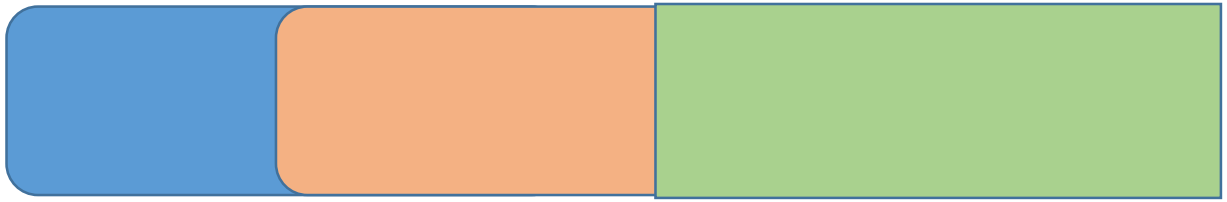


Porém ele existe na conversão direta para arquivos cdF e cdH.

```
###### 364, 300, 400
/gate/output/projection/enable
/gate/output/projection/setInputDataName 364keV
/gate/output/projection/addInputDataName 300keV
/gate/output/projection/addInputDataName 400keV
#/gate/output/projection/setFileName ../output/{testNumber}
/gate/output/projection/setFileName ../output/ONEHEADEW{i}
/gate/output/projection/pixelSizeX 9.59 mm
/gate/output/projection/pixelSizeY 9.59 mm
/gate/output/projection/pixelNumberX 64
/gate/output/projection/pixelNumberY 64
/gate/output/projection/projectionPlane YZ
```

Como eu economizo tempo de simulação

```
#set -x
nohup Gate -a [i,1][act,650000][source,131IGamas] main.mac > flowlogi1.txt &
nohup Gate -a [i,2][act,650000][source,131IGamas] main.mac > flowlogi2.txt &
nohup Gate -a [i,3][act,650000][source,131IGamas] main.mac > flowlogi3.txt &
nohup Gate -a [i,4][act,650000][source,131IGamas] main.mac > flowlogi4.txt &
nohup Gate -a [i,5][act,650000][source,131IGamas] main.mac > flowlogi5.txt &
nohup Gate -a [i,6][act,650000][source,131IGamas] main.mac > flowlogi6.txt &
```



hadd full.root split1.root split2.root splitn.root

É muito mais fácil operar em projeções do que nos arquivos do ROOT.

VAMOS PROGRAMAR!

jupyter Castor_Converter_joao Last Checkpoint: 19/08/2018 (autosaved)

Logout

File Edit View Insert Cell Kernel Widgets Help

Not Trusted | Python 3

Run Code

In [184]:

```
import matplotlib.pyplot as plt
import pandas as pd
import numpy as np
class Readinterfilefromgate:
    def __init__(self,filepath):
        df = pd.read_csv(filepath, sep = ":=", engine = 'python').rename(columns = {'Unnamed: 1' : 'Values'})
        self.showme  = df
        def find(name1):
            return df[df['!INTERFILE '].str.contains(name1)]['Values'].reset_index()['Values']
        self.data = find('data description')[0]
        bp = list(find('name of data file')[0].split('/')[2])
        bp.remove('1')
        self.binarypathfile = ''.join(bp)
        self.bptouse = ''.join(bp).split('.')[0]
        bpext = ''.join(bp).split('.')[1]
        self.bpext = '.{}'.format(bpext)
        totalnumberofimages = find('total number of images')
        self.totalnumberofimages = int(totalnumberofimages)
        byteorder = find('byte order')[0]
        if byteorder.upper() == ' LITTLEENDIAN':
            byteorder = '<'
        elif byteorder.upper() == ' BIGENDIAN' :
            byteorder = '>'
        self.byteorder = byteorder
        numberofEW = find('number of energy windows')
        EW = find('energy window')[find('energy window') != find('number of images/energy window').min()]
        self.EnergyWindows = []
        for item in (EW):
            self.EnergyWindows.append(item)
        self.directionofrotation = find('direction of rotation')[0][1:]
        self.startangle = float(find('start angle')[0])
        self.extentofrotation = float(find('extent of rotation')[0])
        bytesperpixel = find('number of bytes per pixel')[0]
        self.bytesperpixel = bytesperpixel[0]
```

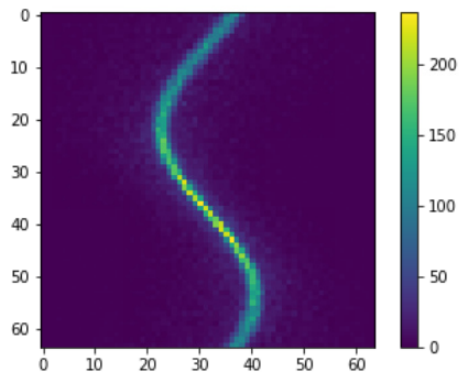
jupyter Castor_Converter_joao Last Checkpoint: 19/08/2018 (autosaved)

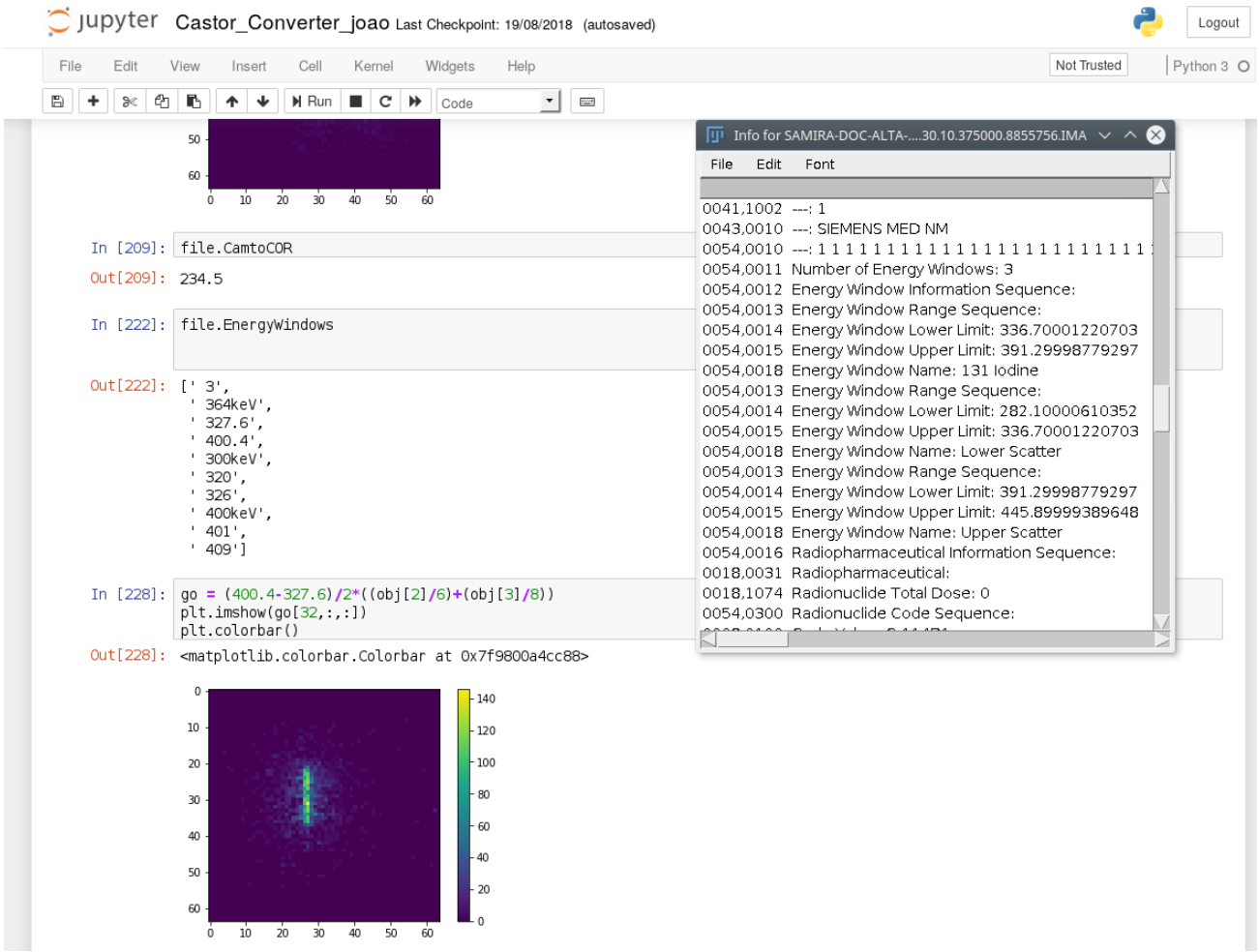
File Edit View Insert Cell Kernel Widgets Help Not Trusted

Run Code

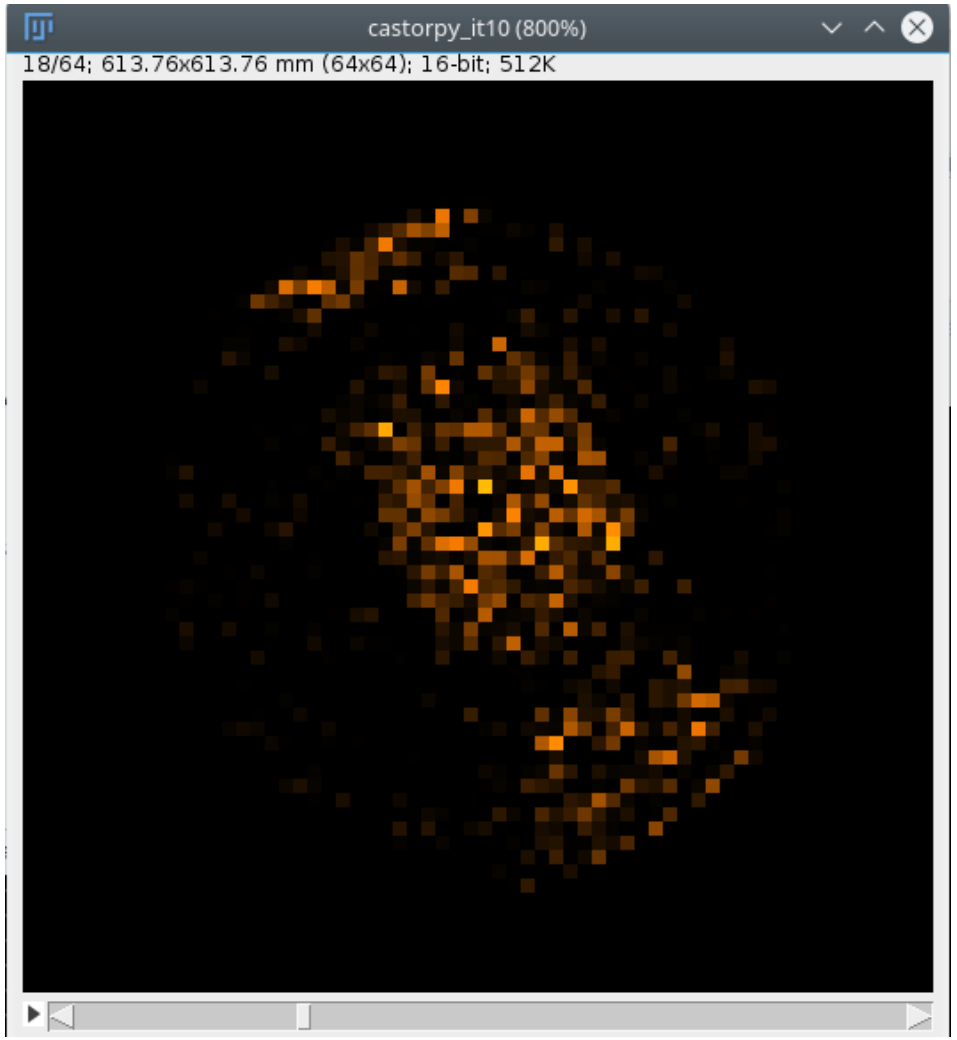
9	!GENERAL IMAGE DATA	NaN

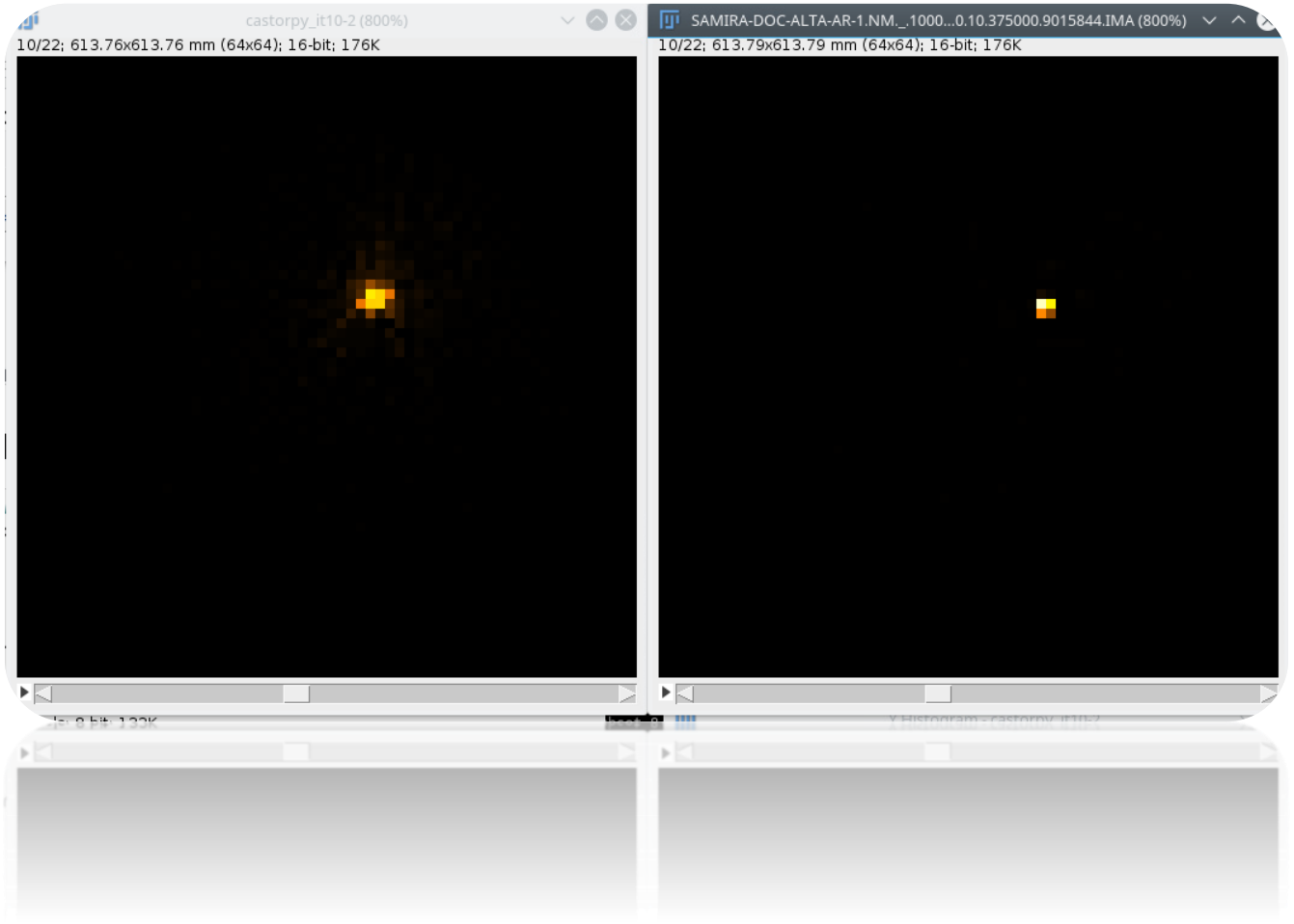
In [185]:
```
file = Readinterfilefromgate('ONEHEADEW1.hdr')# open the .hdr file
obj = file.tripleEW(6) # 12 splits
obj[0] # first object of the return is the central window
plt.imshow(obj[1][:,25,:]) #show slice 62, goes all way through 63
plt.colorbar()
plt.show()
file.dtype
obj[0].shape
plt.imshow(obj[0][45,:,:]) #show slice 62, goes all way through 63
plt.colorbar()
```

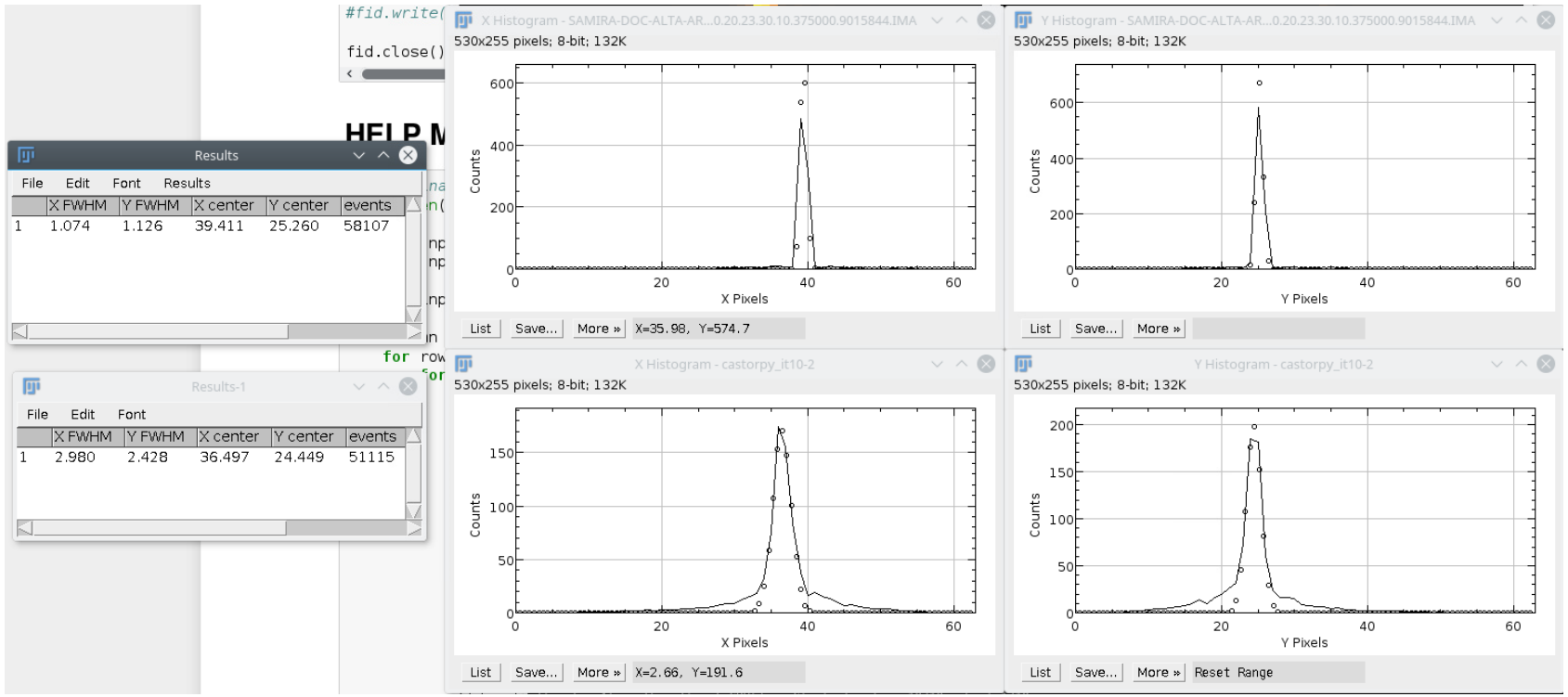


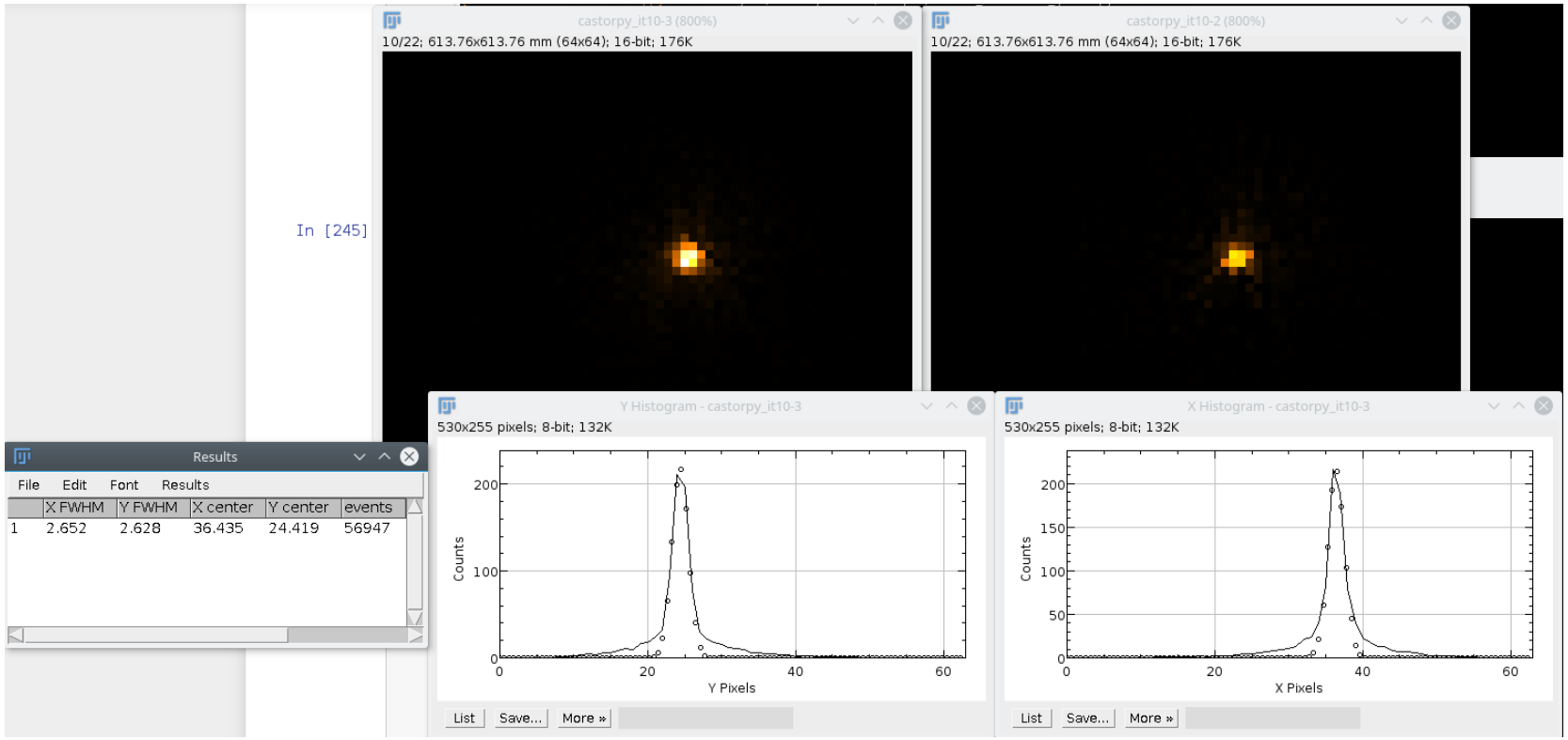

jupyter Castor_Converter_joao Last Checkpoint: 19/08/2018 (autosaved)
Logout
File Edit View Insert Cell Kernel Widgets Help
Not Trusted
Python 3
Run
Code
In [209]: file.CamtoCOR
Out[209]: 234.5
In [222]: file.EnergyWindows
Out[222]: [' 3',
' 364keV',
' 327.6',
' 400.4',
' 300keV',
' 320',
' 326',
' 400keV',
' 401',
' 409']
In [228]: go = (400.4-327.6)/2*((obj[2]/6)+(obj[3]/8))
plt.imshow(go[32,:,:])
plt.colorbar()
Out[228]: <matplotlib.colorbar.Colorbar at 0x7f9800a4cc88>
Info for SAMIRA-DOC-ALTA-....30.10.375000.8855756.IMA
File Edit Font
0041,1002 ---: 1
0043,0010 ---: SIEMENS MED NM
0054,0010 ---: 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0054,0011 Number of Energy Windows: 3
0054,0012 Energy Window Information Sequence:
0054,0013 Energy Window Range Sequence:
0054,0014 Energy Window Lower Limit: 336.70001220703
0054,0015 Energy Window Upper Limit: 391.29998779297
0054,0018 Energy Window Name: 131 Iodine
0054,0013 Energy Window Range Sequence:
0054,0014 Energy Window Lower Limit: 282.10000610352
0054,0015 Energy Window Upper Limit: 336.70001220703
0054,0018 Energy Window Name: Lower Scatter
0054,0013 Energy Window Range Sequence:
0054,0014 Energy Window Lower Limit: 391.29998779297
0054,0015 Energy Window Upper Limit: 445.89999389648
0054,0018 Energy Window Name: Upper Scatter
0054,0016 Radiopharmaceutical Information Sequence:
0018,0031 Radiopharmaceutical:
0018,1074 Radionuclide Total Dose: 0
0054,0300 Radionuclide Code Sequence:

Alternativa 1
Projeções para cdH e cdF

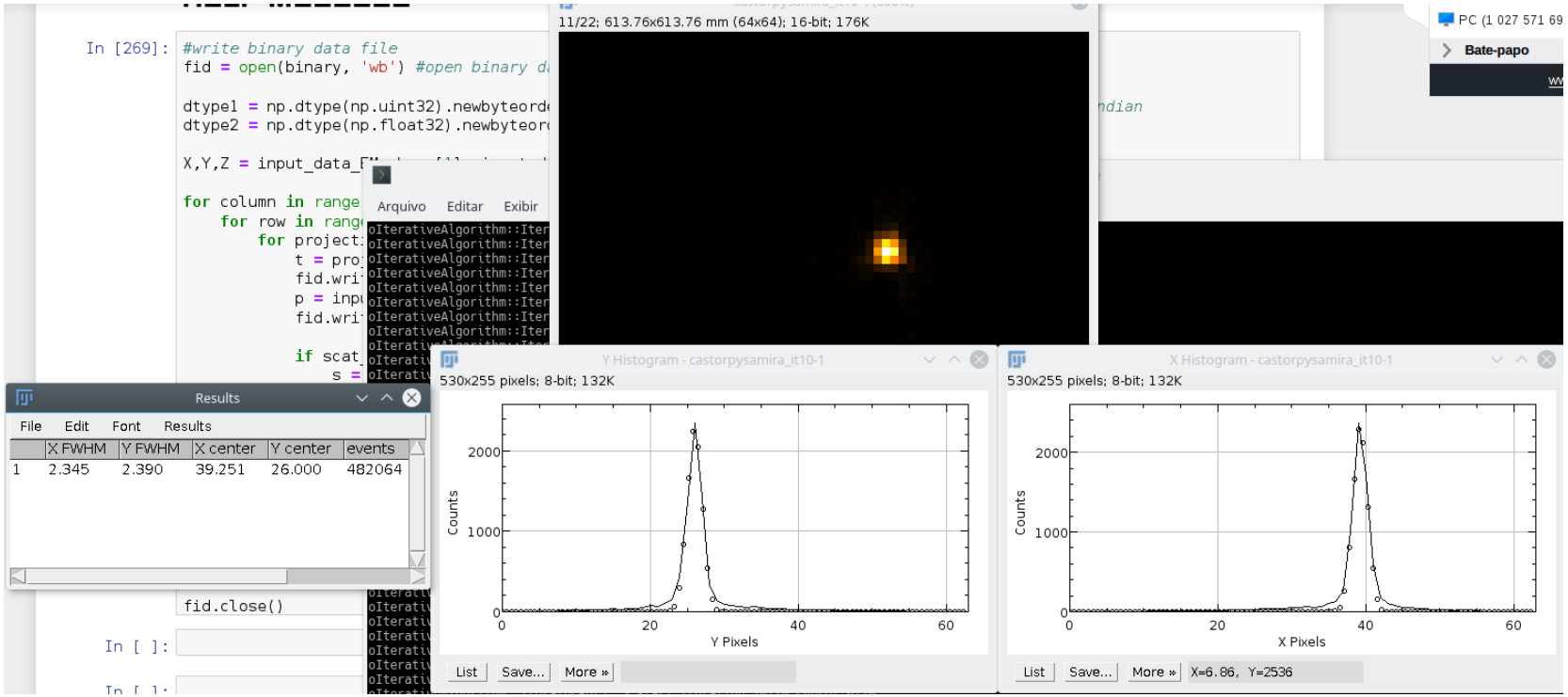

castorpy_it10 (800%)
18/64; 613.76x613.76 mm (64x64); 16-bit; 512K


castorpy_it10-2 (800%)
10/22; 613.76x613.76 mm (64x64); 16-bit; 176K
SAMIRA-DOC-ALTA-AR-1.NM._.1000...0.10.375000.9015844.IMA (800%)
10/22; 613.79x613.79 mm (64x64); 16-bit; 176K

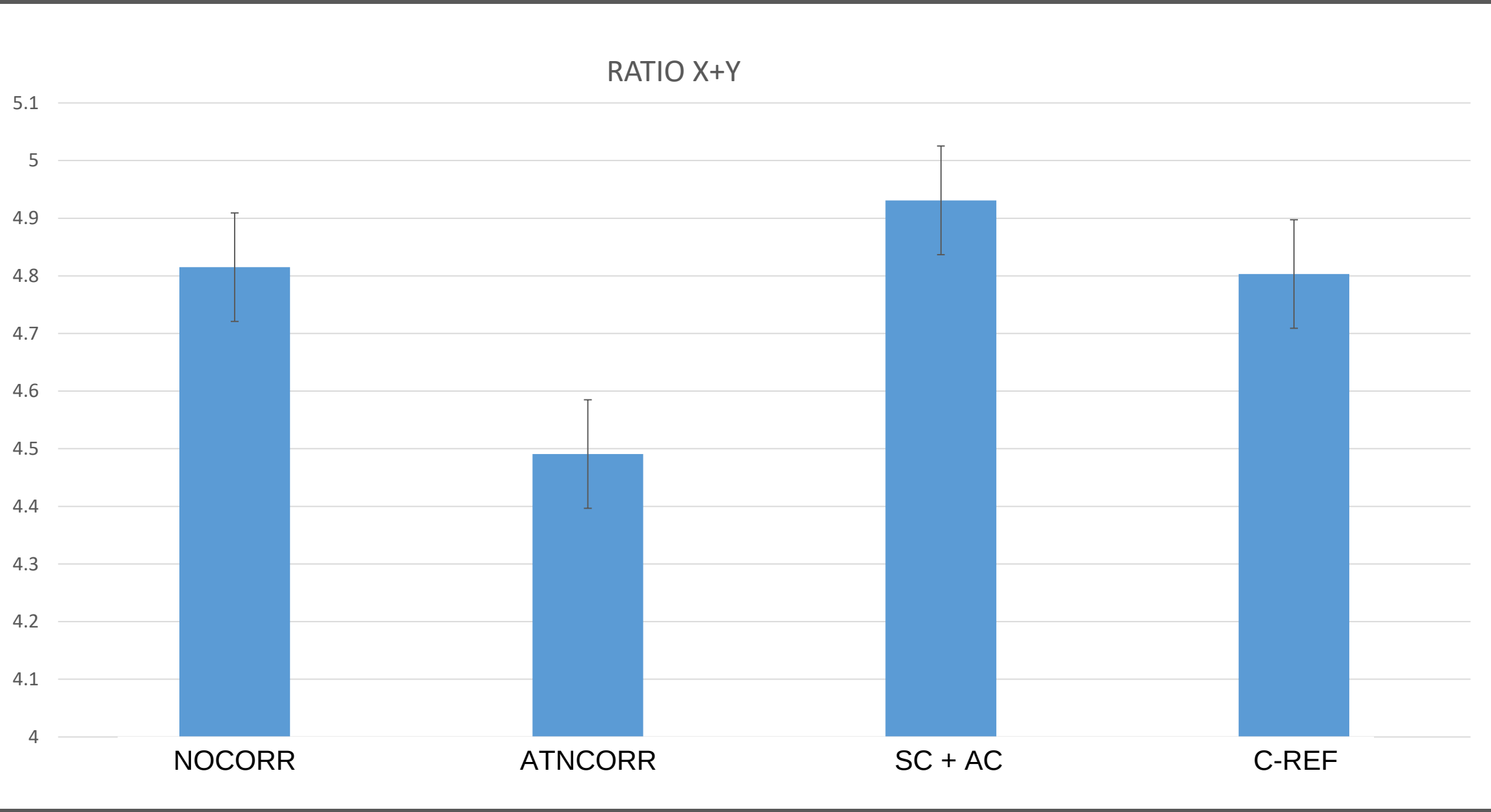

#fid.write(
fid.close()
HELP M
Results
File Edit Font Results
X FWHM Y FWHM X center Y center events
1 1.074 1.126 39.411 25.260 58107
Results-1
File Edit Font
X FWHM Y FWHM X center Y center events
1 2.980 2.428 36.497 24.449 51115
for row
for
X Histogram - SAMIRA-DOC-ALTA-AR...0.20.23.30.10.375000.9015844.IMA
530x255 pixels; 8-bit; 132K
Counts
X Pixels
List Save... More » X=35.98, Y=574.7
Y Histogram - SAMIRA-DOC-ALTA-AR...0.20.23.30.10.375000.9015844.IMA
530x255 pixels; 8-bit; 132K
Counts
Y Pixels
List Save... More »
X Histogram - castorpy_it10-2
530x255 pixels; 8-bit; 132K
Counts
X Pixels
List Save... More » X=2.66, Y=191.6
Y Histogram - castorpy_it10-2
530x255 pixels; 8-bit; 132K
Counts
Y Pixels
List Save... More » Reset Range


In [245]
castorpy_it10-3 (800%)
10/22; 613.76x613.76 mm (64x64); 16-bit; 176K
castorpy_it10-2 (800%)
10/22; 613.76x613.76 mm (64x64); 16-bit; 176K
Results
File Edit Font Results
X FWHM Y FWHM X center Y center events
1 2.652 2.628 36.435 24.419 56947
Y Histogram - castorpy_it10-3
530x255 pixels; 8-bit; 132K
Counts
Y Pixels
List Save... More »
X Histogram - castorpy_it10-3
530x255 pixels; 8-bit; 132K
Counts
X Pixels
List Save... More »

O método de reconstrução ainda é de grande influência


In [269]:
#write binary data file
fid = open(binary, 'wb') #open binary da
dtype1 = np.dtype(np.uint32).newbyteord
dtype2 = np.dtype(np.float32).newbyteor
X,Y,Z = input_data_F
for column in range
for row in rang
for project
t = pro
fid.wri
p = inpu
fid.wri
if scat
s =
fid.close()
In [ ]:
In [ ]:
11/22; 613.76x613.76 mm (64x64); 16-bit; 176K
Arquivo Editar Exibir
oIterativeAlgorithm::Iter
Results
File Edit Font Results
X FWHM Y FWHM X center Y center events
1 2.345 2.390 39.251 26.000 482064
Y Histogram - castorpysamira_it10-1
530x255 pixels; 8-bit; 132K
Counts
Y Pixels
List Save... More »
X Histogram - castorpysamira_it10-1
530x255 pixels; 8-bit; 132K
Counts
X Pixels
List Save... More »
X=6.86, Y=2536
PC (1 027 571 69
Bate-papo

DESCRICAO	FWHM X (GATE/REF)	FWHM Y (GATE/REF)	X+Y		X		Y	
PROJECAO	1.282664704	1.49914805			3.485	2.717	15.837	10.564
NOCORR	2.419925512	2.395204263	4.815129775		2.599	1.074	2.697	1.126
ATNCORR	2.26367713	2.227197347	4.490874477		2.524	1.115	2.686	1.206
SC + ATNCORR	2.774674115	2.156305506	4.930979622		2.98	1.074	2.428	1.126
CASToR REF	2.469273743	2.3339254	4.803199143		2.652	1.074	2.628	1.126


RATIO X+Y
5.1
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
NOCORR
ATNCORR
SC + AC
C-REF

https://github.com/SimpleITK/SimpleITK/blob/master/Examples/DicomSeriesFromArray/DicomSeriesFromArray.py

https://fiji.sc/

Adrian-FWHM

https://imagej.nih.gov/ij/plugins/fwhm/

NucMed

http://www.med.harvard.edu/JPNM/ij/plugins/NucMed.html

Agradecimentos especiais
Igor Vieira CRCN
James Scuffham
ROYAL SURREY COUNTY HOSPITAL NHS FOUNDATION TRUST
Daniel Bonifácio IRD
T. Merlin CASToR
Uwe Pietrzyk GATE