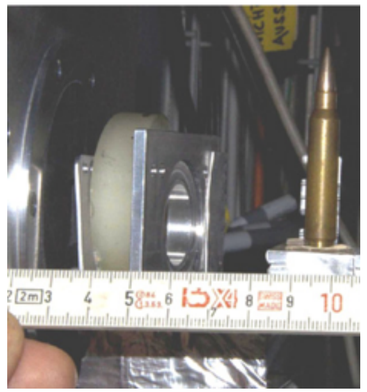
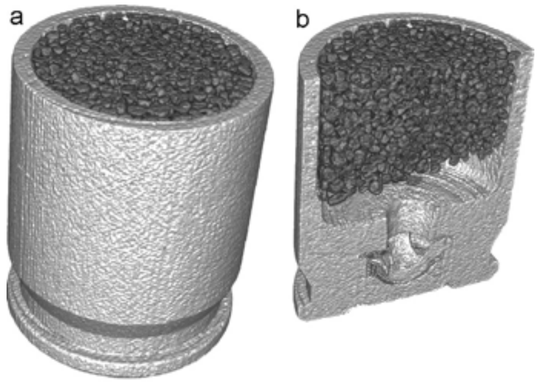
ImageJ: binary files and HDF5 files exploration of the bullet volume





cartridge

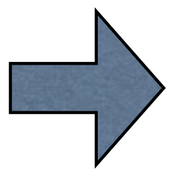
To prepare:

1) Moodle: download Week 1/bullet dataset (binary, 26.8 MB)
2) Moodle: download Week 2/bullet dataset (HDF5, 107 MB)
3) Launch your ImageJ. Does Plugins/HDF5 exist? If not, double check Week 0/Installing ImageJ (NIH)/Download the HDF5 plugin instructions.

filenames and file sizes

volume_bullet_p134_uint16.bin, 26,808,246 bytes
volume_bullet_p134.h5, 107,235,032 bytes

```
In[24]:= listOfFilenames = FileNames["volume*", NotebookDirectory[]]
         Map[ FileByteCount, listOfFilenames]

Out[24]= {/Users/lesbutler/Documents/h4581/volume_bullet_p134.h5,
          /Users/lesbutler/Documents/h4581/volume_bullet_p134_uint16.bin}

Out[25]= {107 235 032, 26 808 246}

In[33]:= volume = Import[listOfFilenames[[1]], {"Datasets", "/volume"} ];
         {rows, columns, slices} = Dimensions[volume]

Out[34]= {243, 243, 227}

In[35]:= 243 × 243 × 227 × 2

Out[35]= 26 808 246

In[39]:= 243 × 243 × 227 × 8

Out[39]= 107 232 984

In[40]:= 107 235 032 - %

Out[40]= 2048
```



volume_bullet_p134_uint16.bin
is stored with 2 bytes per number

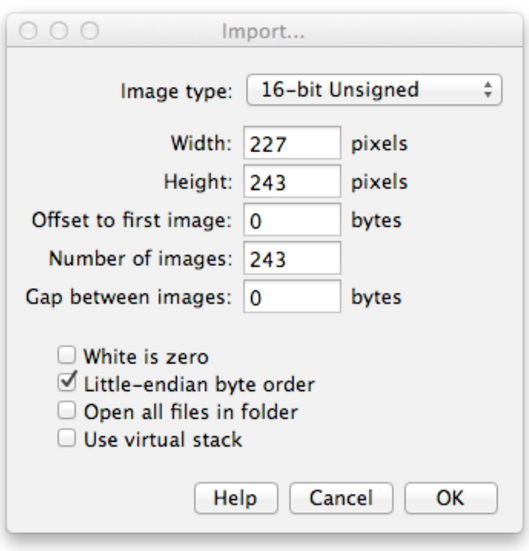
volume_bullet_p134.h5
is stored with 8 bytes per number plus a header
that is 2048 bytes long

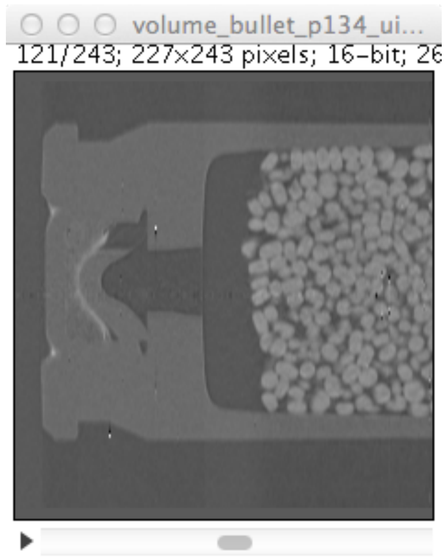
Use ImageJ to inspect the binary file

volume_bullet_p134_uint16.bin, 26,808,246 bytes

```
In[24]:= listOfFilenames = FileNames["volume*", NotebookDirectory[]]
         Map[ FileByteCount, listOfFilenames]

Out[24]= {/Users/lesbutler/Documents/h4581/volume_bullet_p134.h5,
          /Users/lesbutler/Documents/h4581/volume_bullet_p134_uint16.bin}

Out[25]= {107 235 032, 26 808 246}

In[33]:= volume = Import[listOfFilenames[[1]], {"Datasets", "/volume"} ];
         {rows, columns, slices} = Dimensions[volume]

Out[34]= {243, 243, 227}
```

Use ImageJ File/Import/Raw





Use ImageJ to inspect the HDF5 file

volume_bullet_p134.h5, 107,235,032 bytes

In[24]:=
```
listOfFilenames = FileNames["volume*", NotebookDirectory[]]
Map[ FileByteCount, listOfFilenames]
```

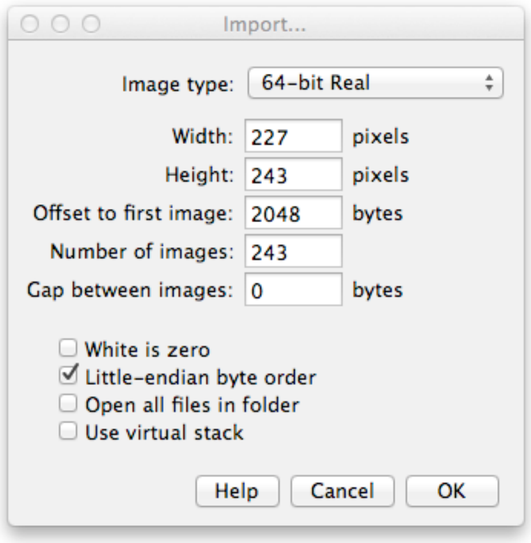
Out[24]=
```
{/Users/lesbutler/Documents/h4581/volume_bullet_p134.h5,
 /Users/lesbutler/Documents/h4581/volume_bullet_p134_uint16.bin}
```

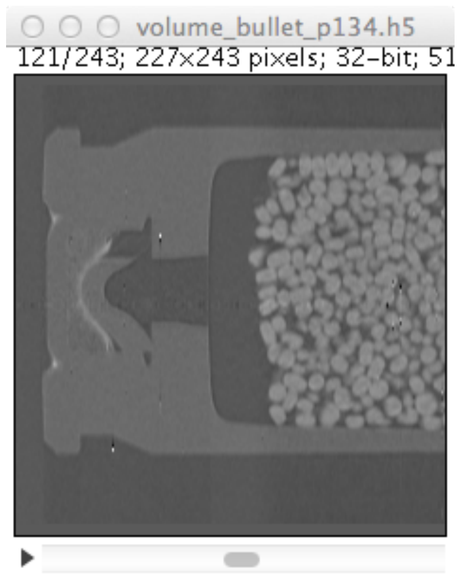
Out[25]=
```
{107 235 032, 26 808 246}
```

In[33]:=
```
volume = Import[listOfFilenames[[1]], {"Datasets", "/volume"} ];
{rows, columns, slices} = Dimensions[volume]
```

Out[34]=
```
{243, 243, 227}
```

Use ImageJ File/Import/Raw



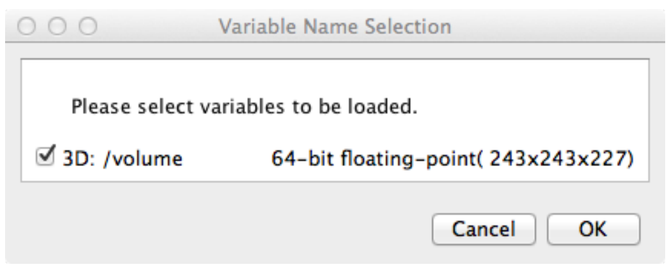


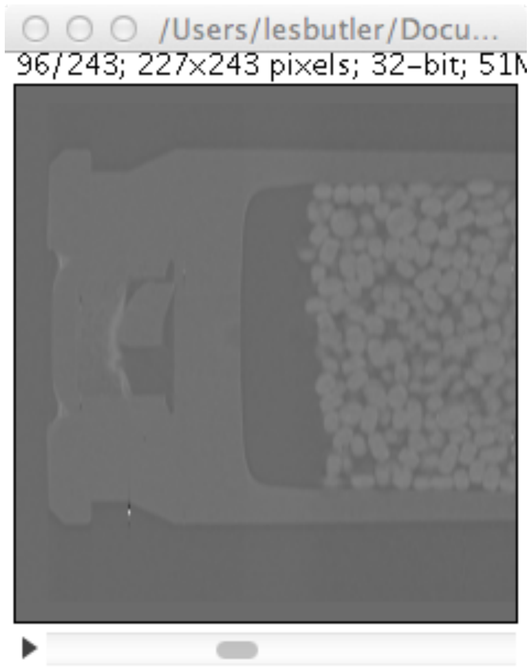
Use ImageJ to inspect the HDF5 file

volume_bullet_p134.h5, 107,235,032 bytes

```
In[24]:= listOfFilenames = FileNames["volume*", NotebookDirectory[]]
         Map[ FileByteCount, listOfFilenames]

Out[24]= {/Users/lesbutler/Documents/h4581/volume_bullet_p134.h5,
          /Users/lesbutler/Documents/h4581/volume_bullet_p134_uint16.bin}

Out[25]= {107 235 032, 26 808 246}

In[33]:= volume = Import[listOfFilenames[[1]], {"Datasets", "/volume"} ];
         {rows, columns, slices} = Dimensions[volume]

Out[34]= {243, 243, 227}
```

Use ImageJ Plugins/HDF5/Load HDF5



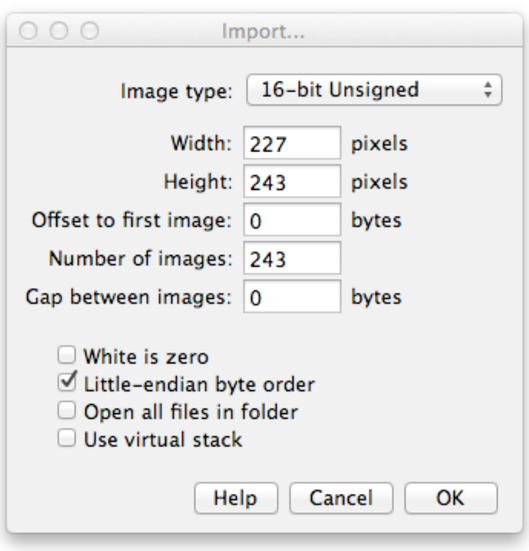


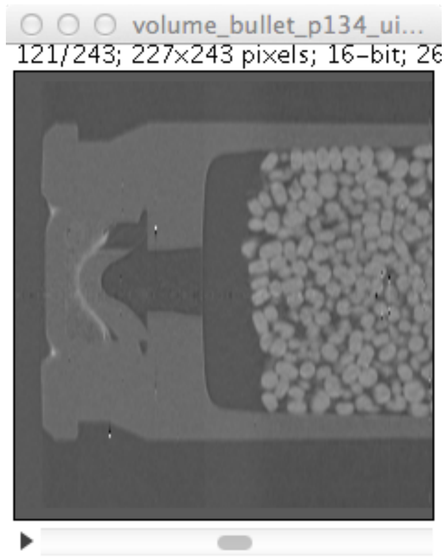
Use ImageJ to inspect the binary file

volume_bullet_p134_uint16.bin, 26,808,246 bytes

```
In[24]:= listOfFilenames = FileNames["volume*", NotebookDirectory[]]
         Map[ FileByteCount, listOfFilenames]

Out[24]= {/Users/lesbutler/Documents/h4581/volume_bullet_p134.h5,
          /Users/lesbutler/Documents/h4581/volume_bullet_p134_uint16.bin}

Out[25]= {107 235 032, 26 808 246}

In[33]:= volume = Import[listOfFilenames[[1]], {"Datasets", "/volume"} ];
         {rows, columns, slices} = Dimensions[volume]

Out[34]= {243, 243, 227}
```

Use ImageJ File/Import/Raw

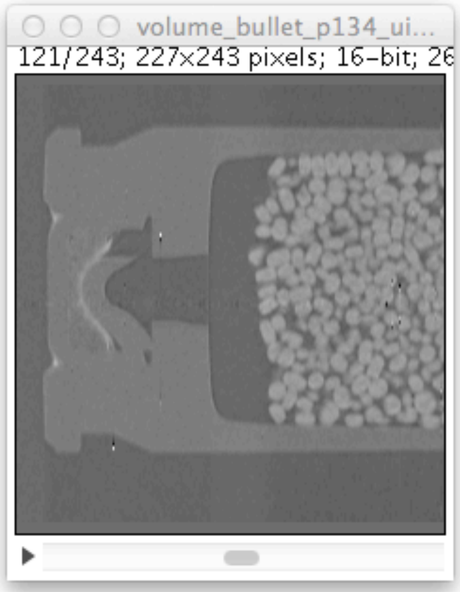


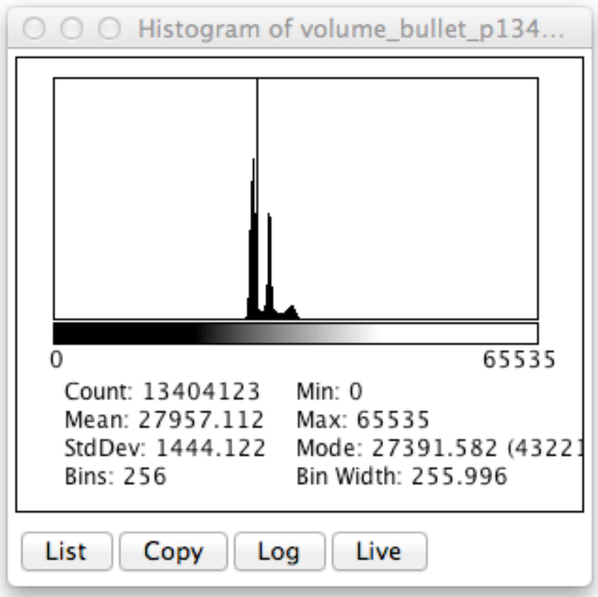


volume_bullet_p134_uint16.bin

volume_bullet_p134.h5

Make histogram with Analyze/Histogram

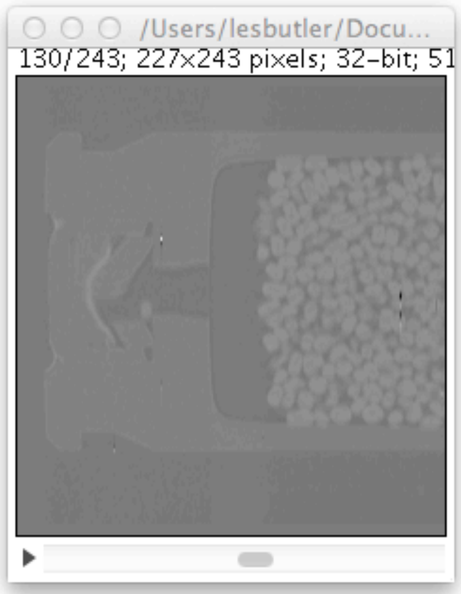


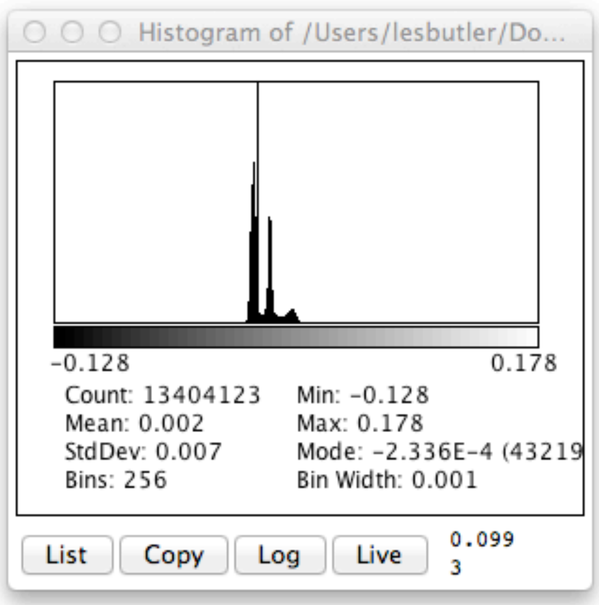


<u>unsigned integer-16</u>

- smaller files
- for ImageJ and Avizo, less memory needed
- made from expt. data by rescaling
- Note: 0=black and 65535=white.

These are {min,max} values in the data.





<u>real-64</u>

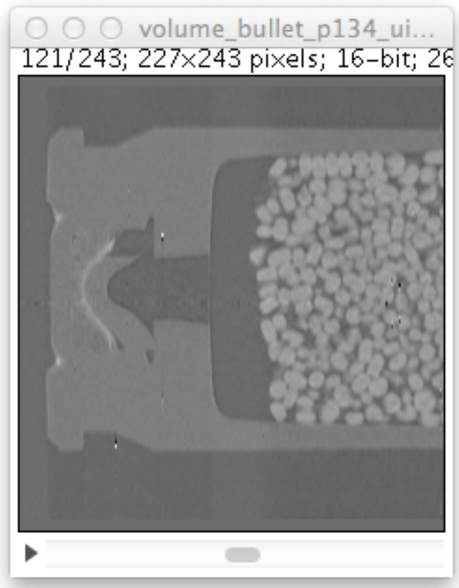
- this is original data
- numbers can be related back to neutron attenuation values. For example, the values for air should be very close to zero.
- Note: -0.128=black and 0.178=white.

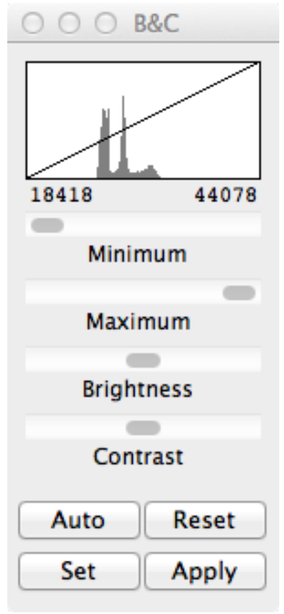
These are {min,max} values in the data.

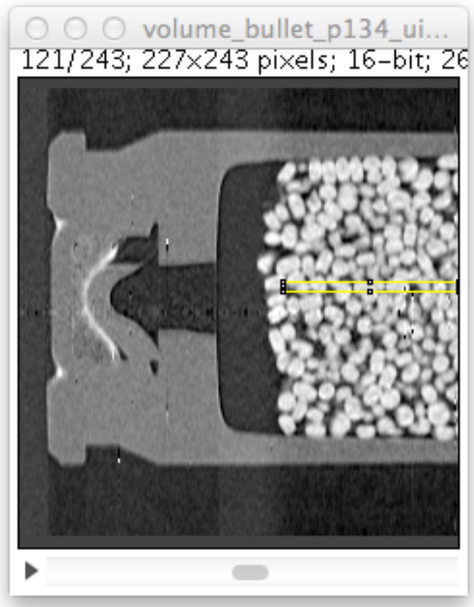
volume_bullet_p134_uint16.bin

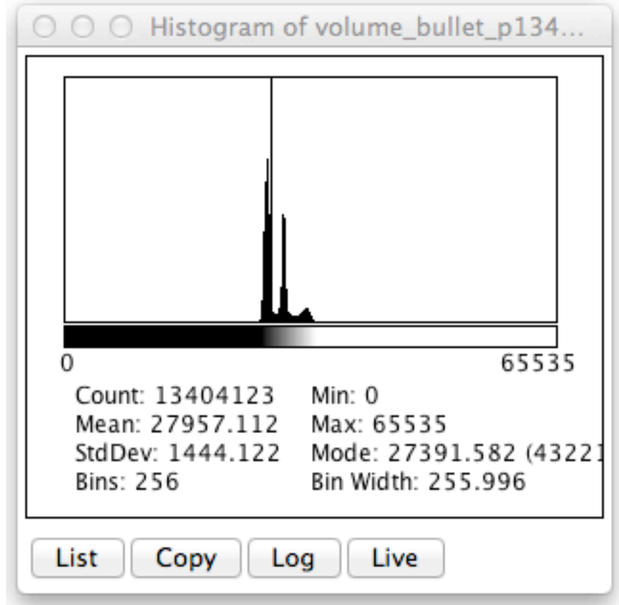
volume_bullet_p134.h5

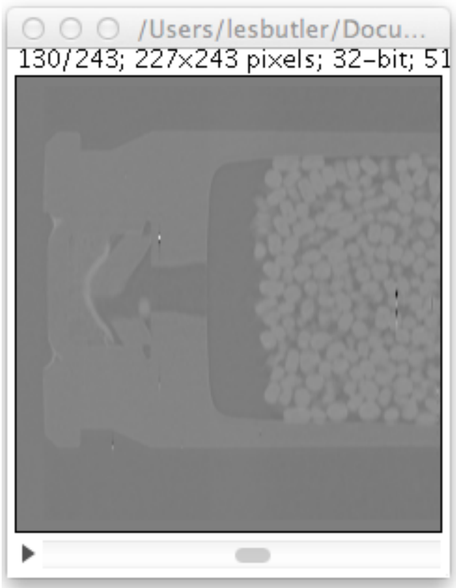
Adjust limits of colormap with Image/Adjust/BrightnessContrast...
and select "Auto". According to histograms, data values are not changed.
Why has the appearance the of image change?

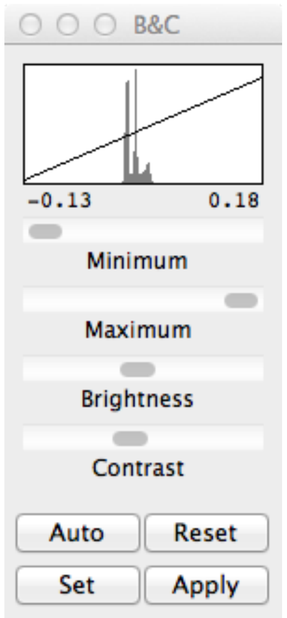


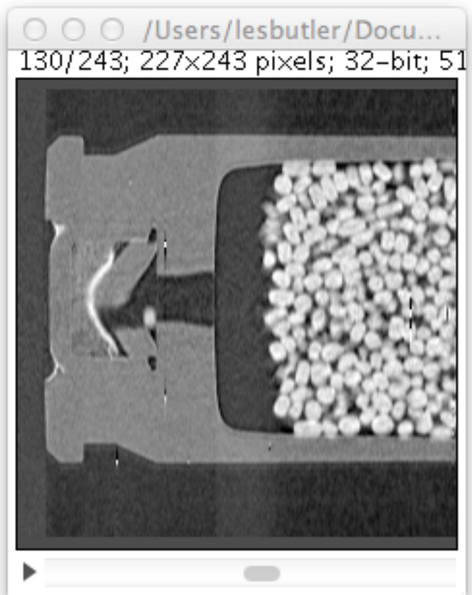


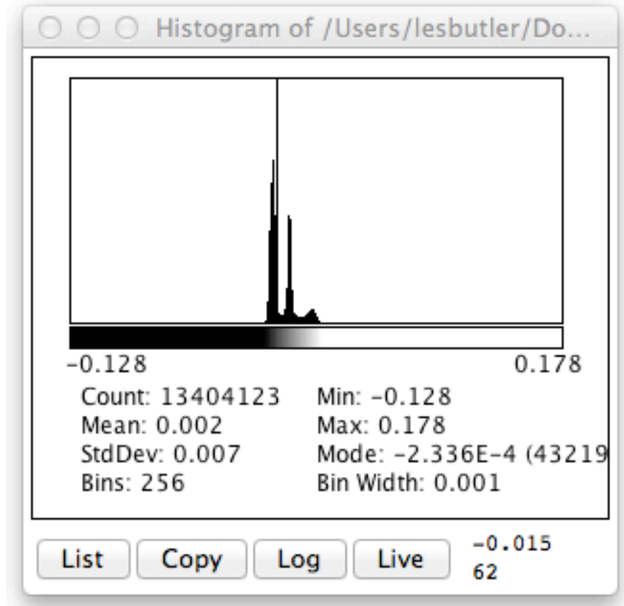






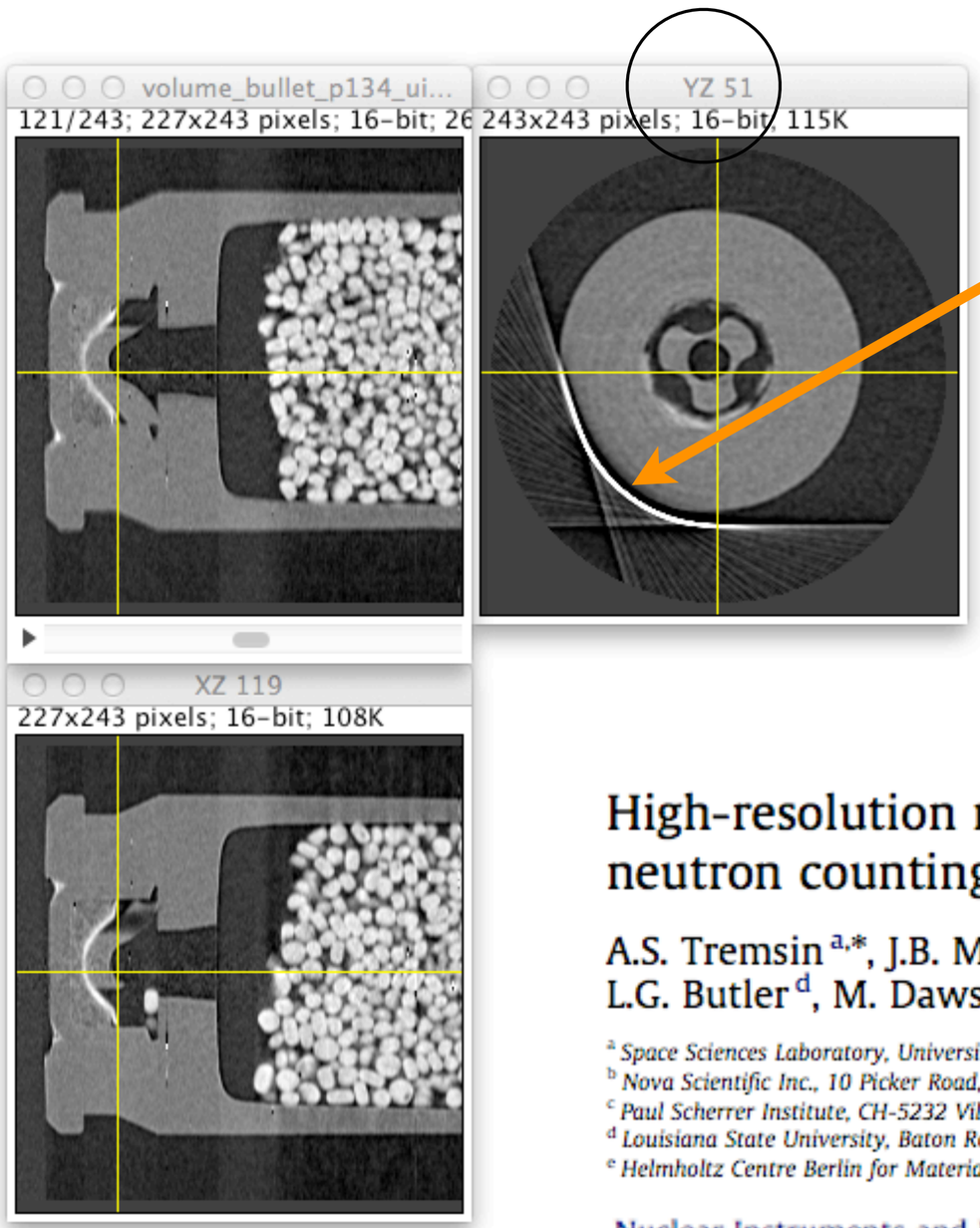






volume_bullet_p134_uint16.bin

Select the smaller file (....uint16.bin) and Image/Stacks/Orthogonal Views
Navigate to YZ 51



The bright arc is a flaw in the detector.
Please don't try to enhance this flaw in your Avizo work.

High-resolution neutron microtomography with noiseless neutron counting detector

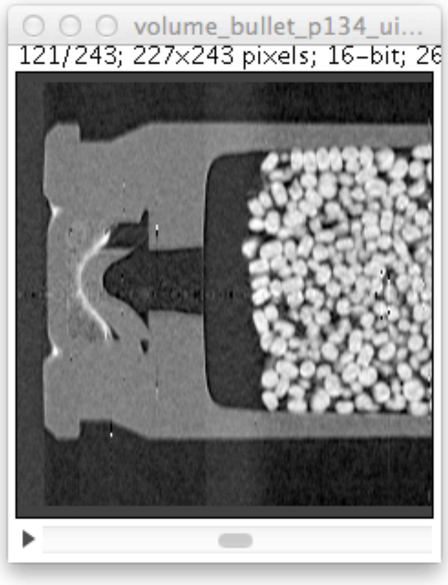
A.S. Tremsin [a,*], J.B. McPhate [a], J.V. Vallerga [a], O.H.W. Siegmund [a], W.B. Feller [b], E. Lehmann [c], L.G. Butler [d], M. Dawson [e]

[a] *Space Sciences Laboratory, University of California, Berkeley, CA 94720, USA*
[b] *Nova Scientific Inc., 10 Picker Road, Sturbridge, MA 01566, USA*
[c] *Paul Scherrer Institute, CH-5232 Villigen, Switzerland*
[d] *Louisiana State University, Baton Rouge, LA 70803, USA*
[e] *Helmholtz Centre Berlin for Materials and Energy, Germany*

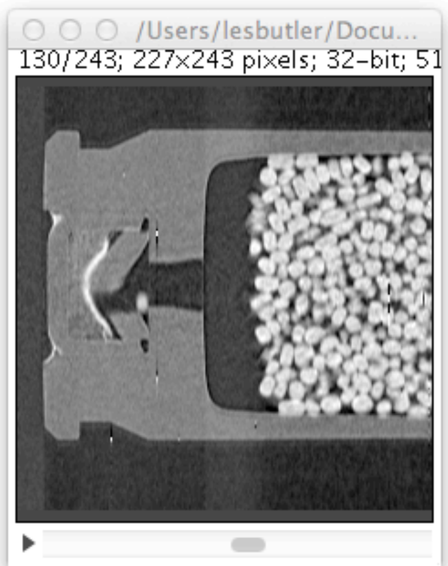
Nuclear Instruments and Methods in Physics Research A 652 (2011) 400–403

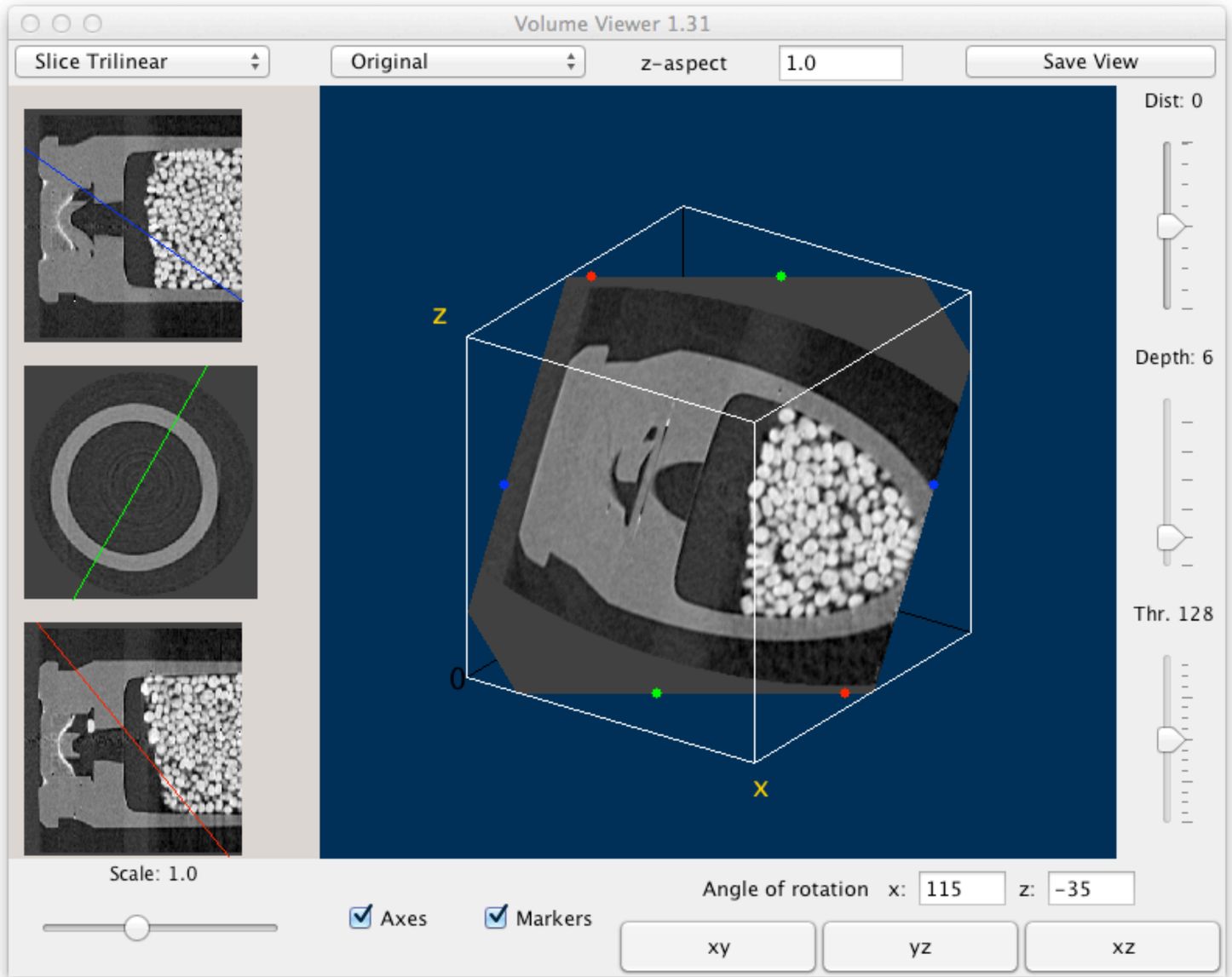
Select the smaller file (....uint16.bin) and Plugins/3D/Volume Viewer

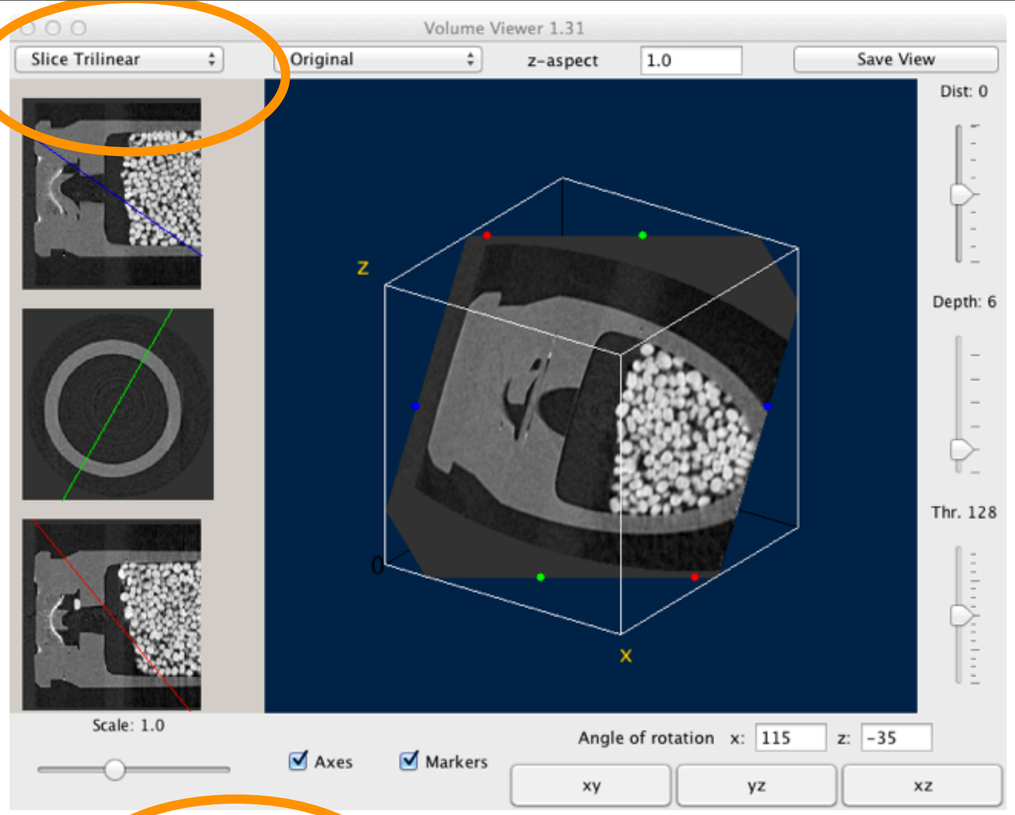
volume_bullet_p134_uint16.bin

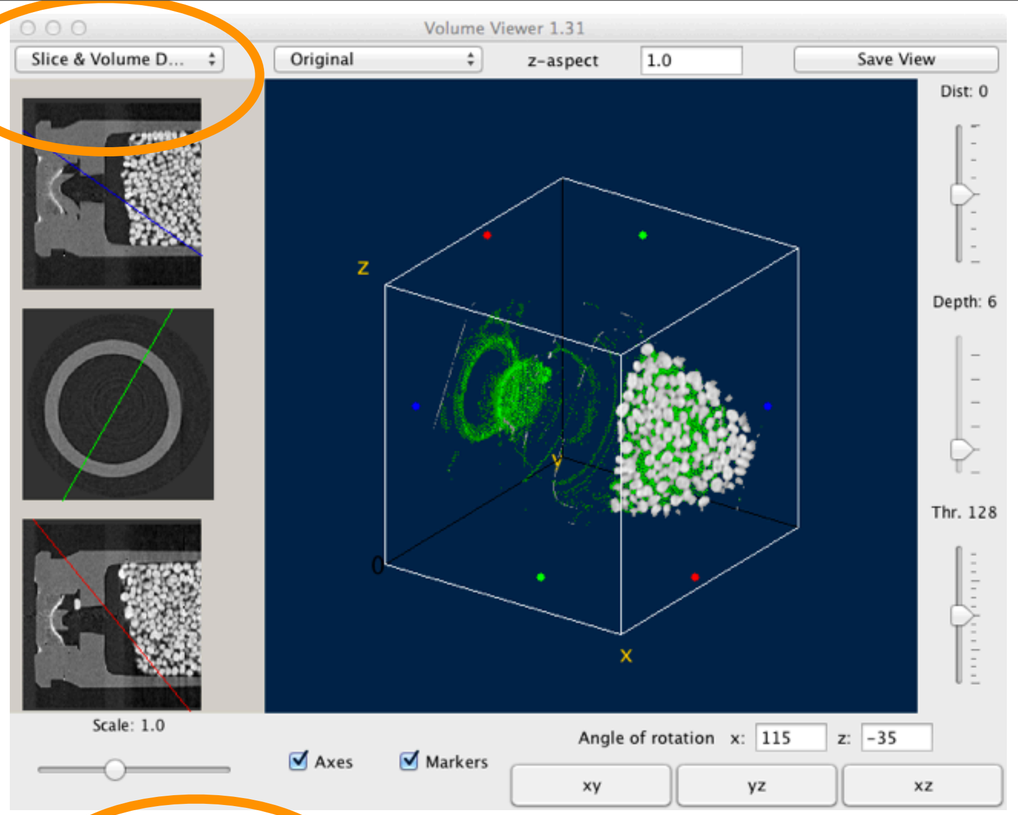


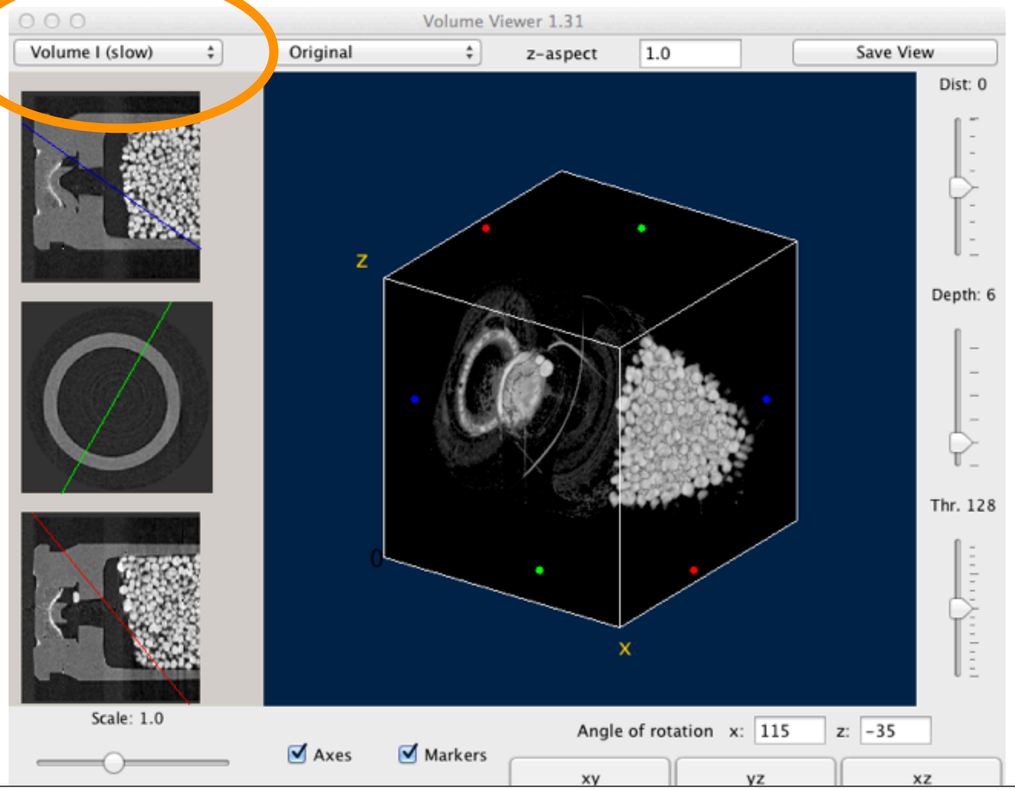
volume_bullet_p134.h5

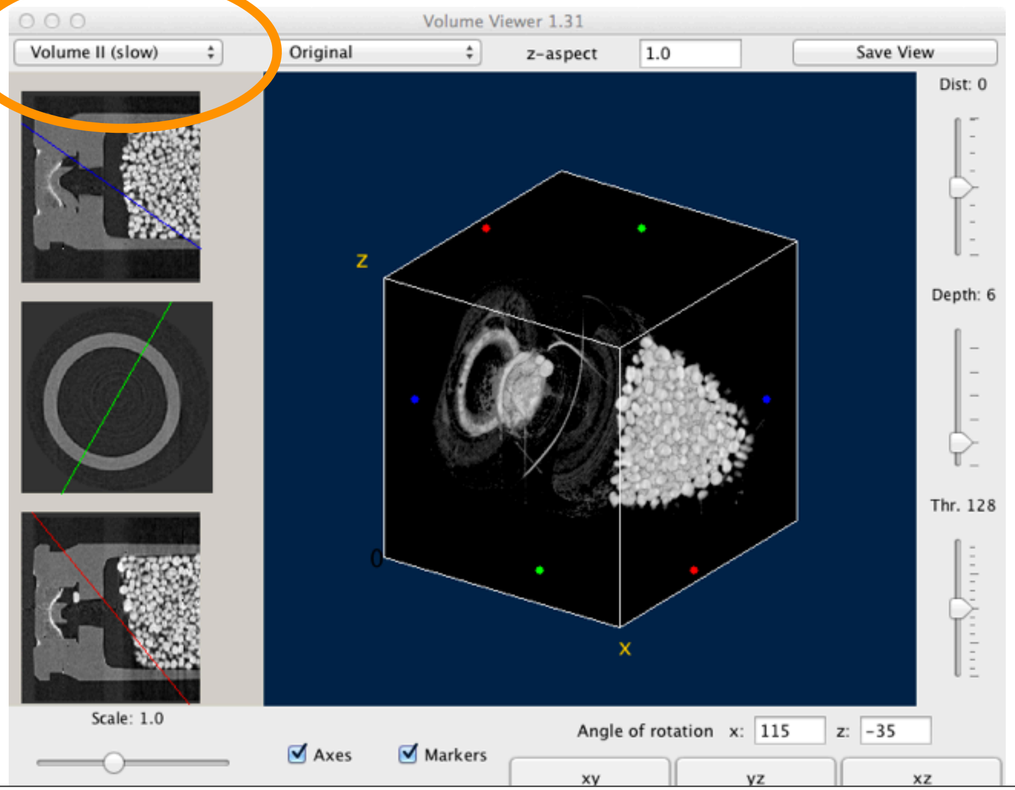





Volume Viewer 1.31
Slice Trilinear
Original
z-aspect
1.0
Save View
Dist: 0
Depth: 6
Thr. 128
Z
0
X
Scale: 1.0
Axes
Markers
Angle of rotation x: 115 z: -35
xy
yz
xz

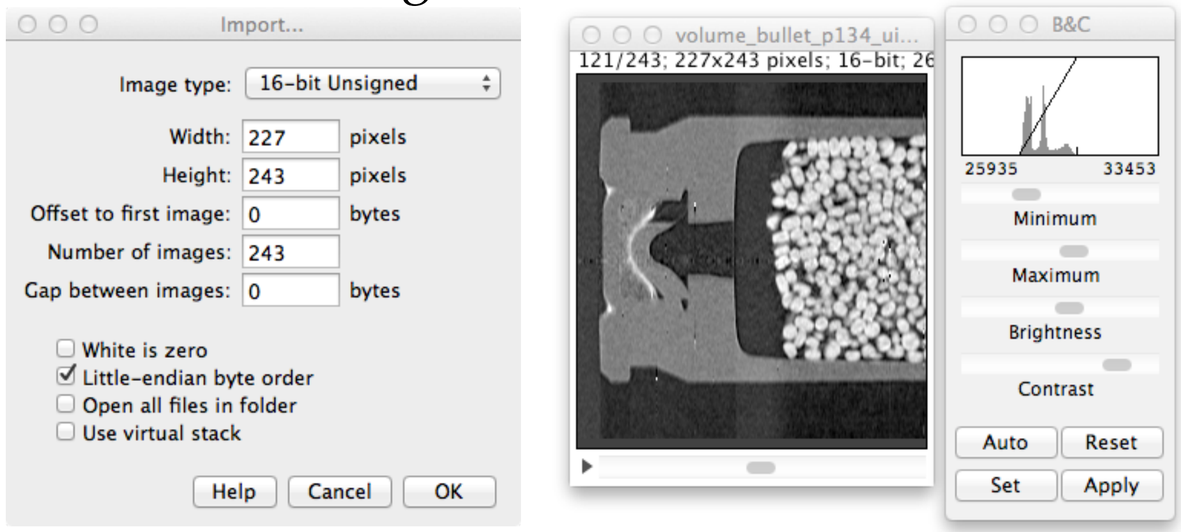

Volume Viewer 1.31
Slice & Volume D...
Original
z-aspect
1.0
Save View
Dist: 0
Depth: 6
Thr. 128
Z
Y
0
X
Scale: 1.0
Axes
Markers
Angle of rotation x: 115 z: -35
xy
yz
xz


Volume Viewer 1.31
Volume I (slow)
Original
z-aspect
1.0
Save View
Dist: 0
Depth: 6
Thr. 128
Z
0
X
Scale: 1.0
Axes
Markers
Angle of rotation x: 115 z: -35
xy
yz
xz

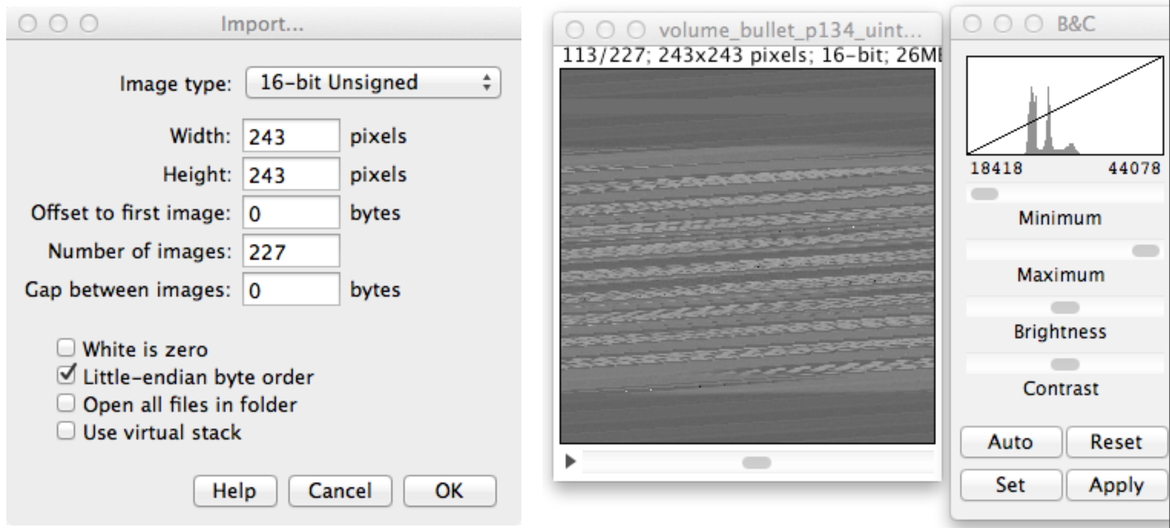

Volume Viewer 1.31
Volume II (slow)
Original
z-aspect
1.0
Save View
Dist: 0
Depth: 6
Thr. 128
Z
0
X
Scale: 1.0
Axes
Markers
Angle of rotation x: 115 z: -35
xy
yz
xz

Some common errors with Import/Raw

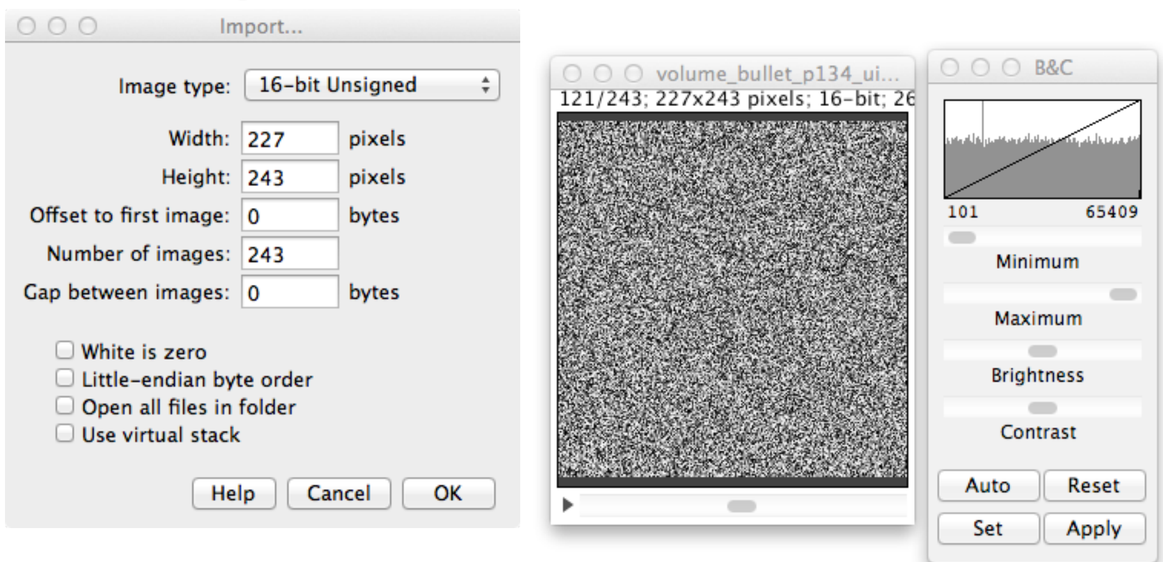
correct settings



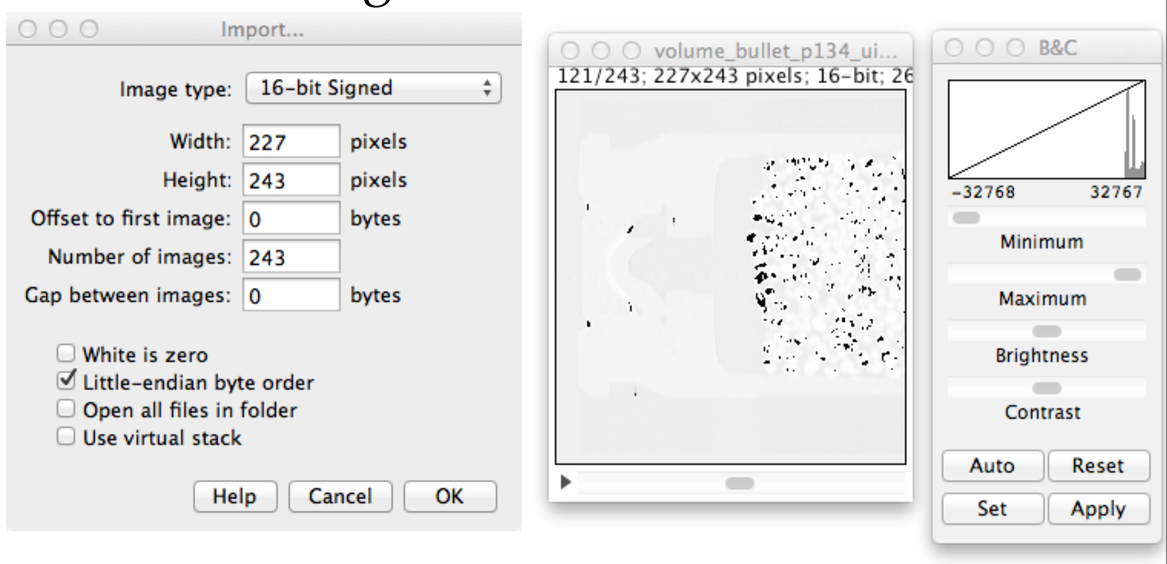
wrong dimension order



wrong endian

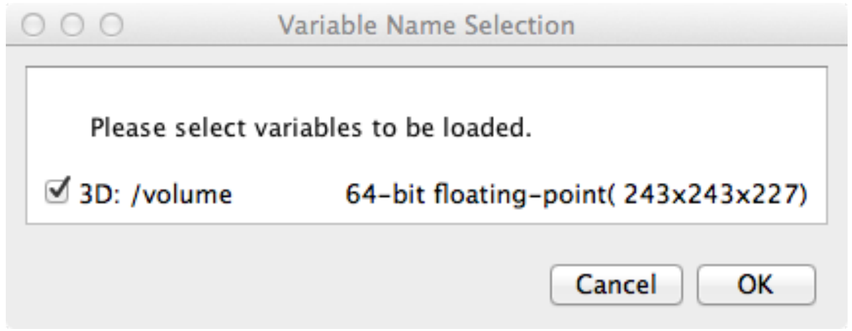


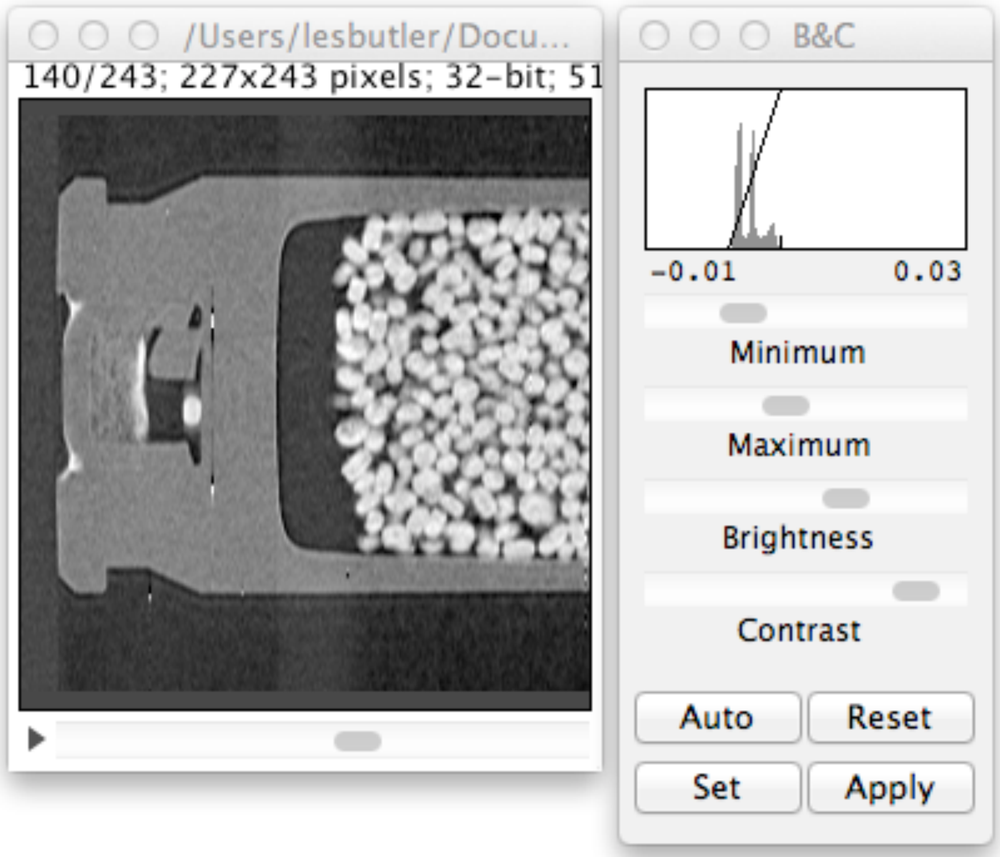
wrong number format



Some common errors with Plugins/HDF5/Load HDF5

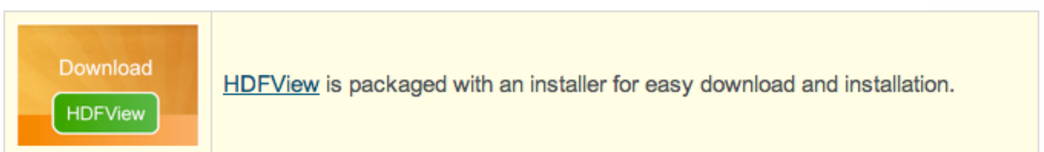
correct settings





HDF5 is a "self-describing" file format and is largely free of data import problems.
"HDFView" is a free Java program for inspecting HDF5 files. Good for validating files.

The HDF Group http://www.hdfgroup.org/HDF5/



http://www.vsg3d.com/avizo®-faqs-and-user-documentation

Avizo® FAQs and User documentation

Data input/output, printing

33. **What are the supported data formats (input and output)?**
A list of supported file formats is contained in the index section of the user's guide.

As yet, Avizo does not support HDF5.

HW 1: ImageJ

due Monday, 30 Jan

reproduce the common binary import errors.

Suggestion: try the errors from class and make up
some of your own errors.

Wednesday: Mathematica and data import.