L18, 16 April: Independent Projects

1) Launch these programs on your computer (lab or labtop)

FileZilla or Fugu

ImageJ

2) Connect to tezpur and /project/lbutler/data_materials

Objective: Is there a data set in this folder that has interest to you for a final project?

3) Connect to tezpur and /project/lbutler/biology

Objective: Is there a data set in this folder that has interest to you for a final project?

Note: These data sets are from Prof. Homberger's anatomy lab.

4) Medical data sets: http://www.osirix-viewer.com/datasets/

Note: OsiriX is a DICOM viewer available for free (Mac only, 32-bit version) and for $369 (Mac only, 64-bit version). There are free ImageJ DICOM plugins (http://www.iftm.de/telemedizin/dcmimex.htm) and Mathematica can read uncompressed DICOM files.

5) NIH Visible Human Project: http://www.nlm.nih.gov/research/visible/getting_data.html   Paperwork for data access is in progress.

Fabricated devices: (a) cartridge and (b) NMR MAS rotor

Filename: volume_bullet_p134_uint16.bin
volume = {243, 243, 227} pixel size = 55 μm, file size = 0.27 MB
neutron tomography at Paul Scherrer Institute
Bullet type unknown (probably Soviet or East German)
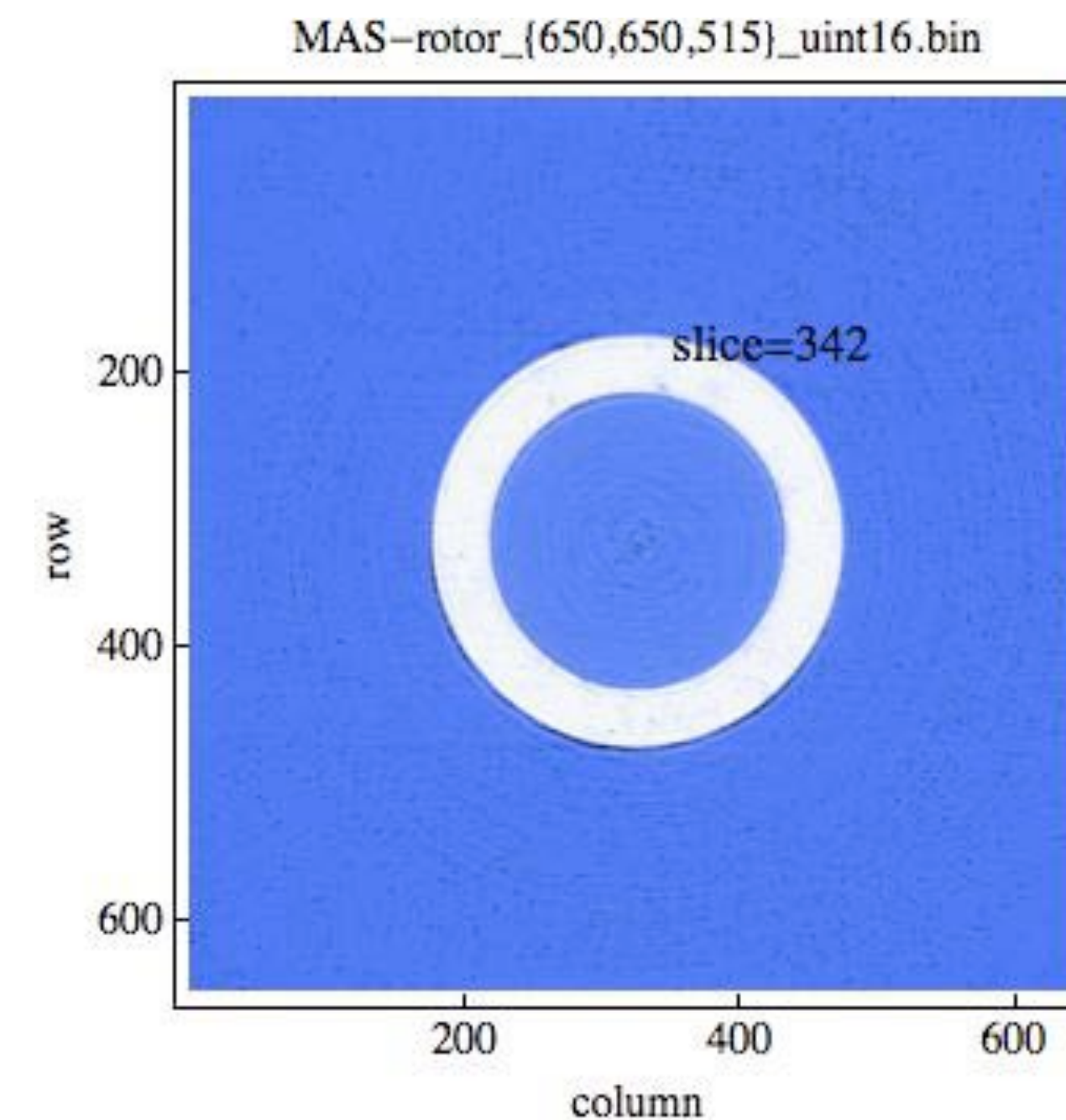
Filename: MAS-rotor_{650,650,515}_uint16.bin
volume = {650, 650, 515}, pixel size = 5.67 μm, file size = 0.43 GB
X-ray tomography at the Advanced Photon Source, 13BM
Precision fabricated Kel-F cap and zirconia cylinder. Used for high-speed MAS NMR at the National High Magnetic Field Lab until broken (break outside field of view).
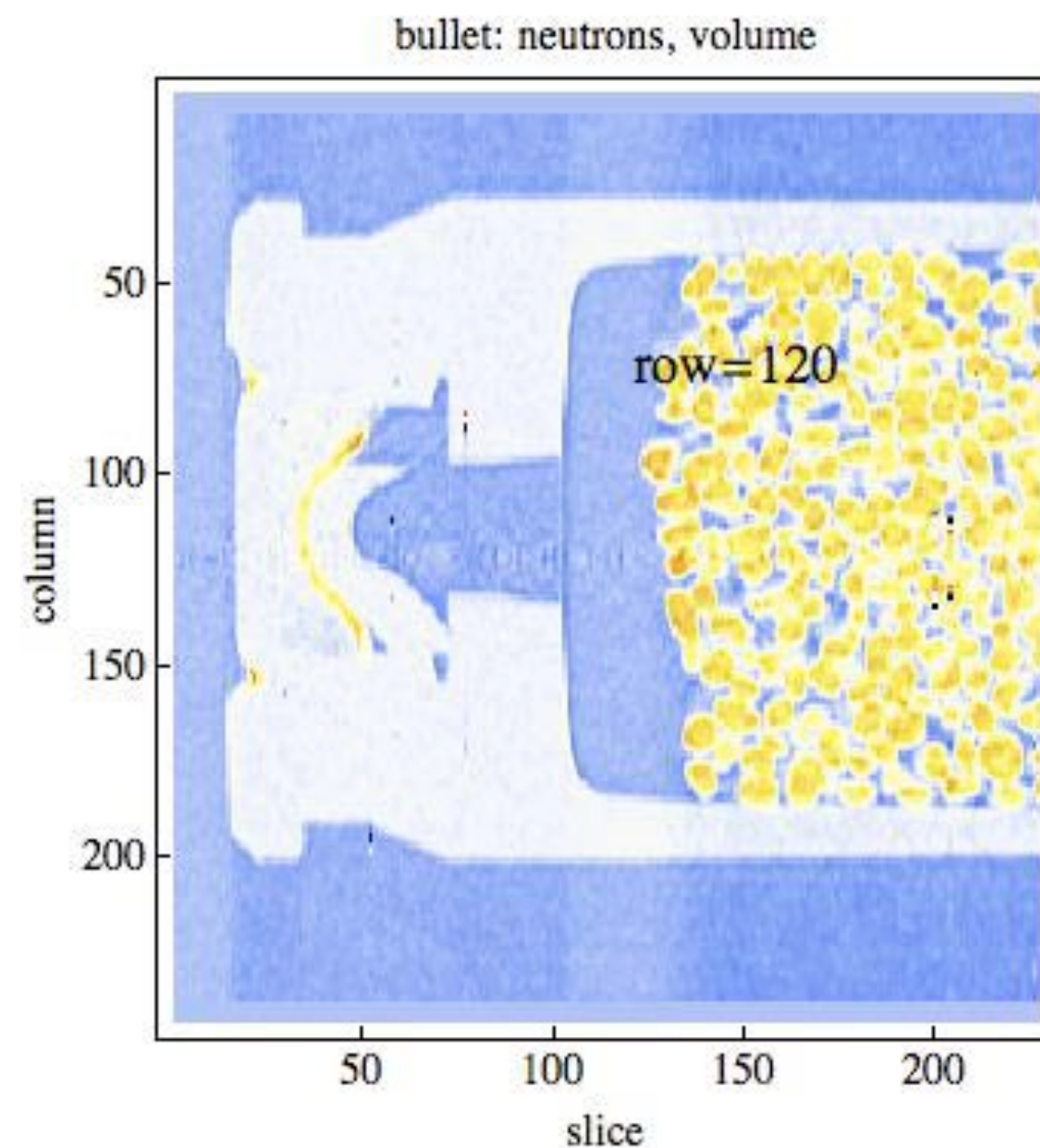
3035_bullet_neutron_volume.mov

3035_MAS_rotor_Xray.mov

Migmatite: (a) neutron and (b) X-ray data sets

Filename (neutron): N_600_601_651_uint16.bin
volume = {601, 651, 600} pixel size = 37 μm, file size = 0.47 GB
neutron tomography at FRM-II

Filename (X-ray, original data): X_901_901_1200_uint16.bin
volume = {601, 651, 600} pixel size = 24.41 x 24.41 x 26.48 μm, file size = 1.95 GB
Filename (X-ray, after affine transformation and cropping): X_600_601_651_uint16.bin
volume = {601, 651, 600} pixel size = 37 μm, file size = 0.47 GB
X-ray tomography on X-radia lab system at U. Texas, Dept. of Geology

3035_migmatite_neutron-Xray.mov
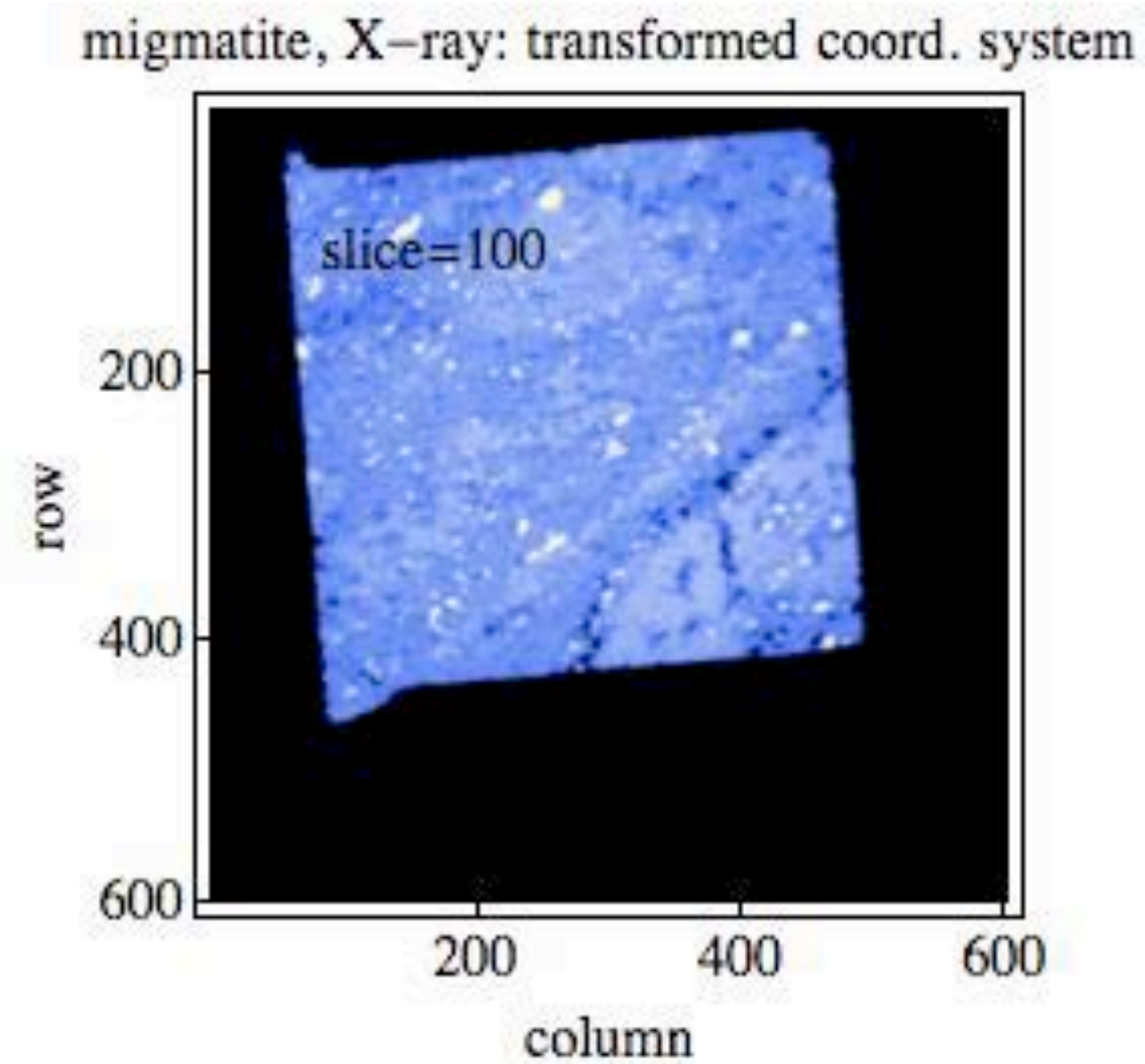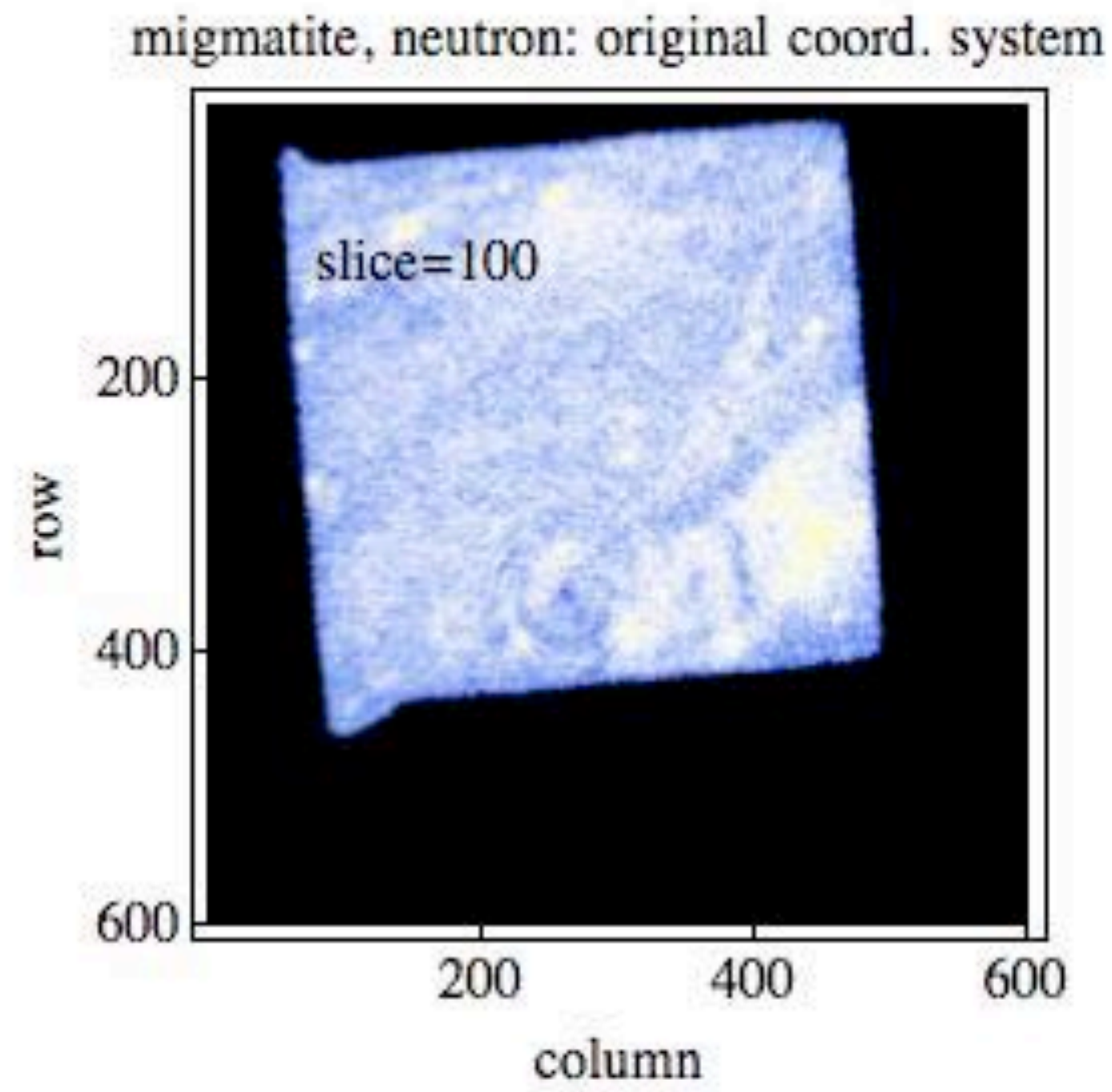
Polymer blends: (a) traditional and (b) Greek golden ratio data acquisition

Filename (traditional): FR2_B05_{900,1150,1700}_200k_int16.bin (first of six time steps)
volume = {900, 1150, 1700} pixel size = 1.85 μm, file size = 3.52 GB
X-ray tomography at APS 2-BM

Filename (Greek): TEST_5_CONSTANT_HEAT_H1.h5 (first of eleven time steps)
volume = {12, 471, 471} pixel size = 7.42 μm, file size = 63 MBB
X-ray tomography at CAMD
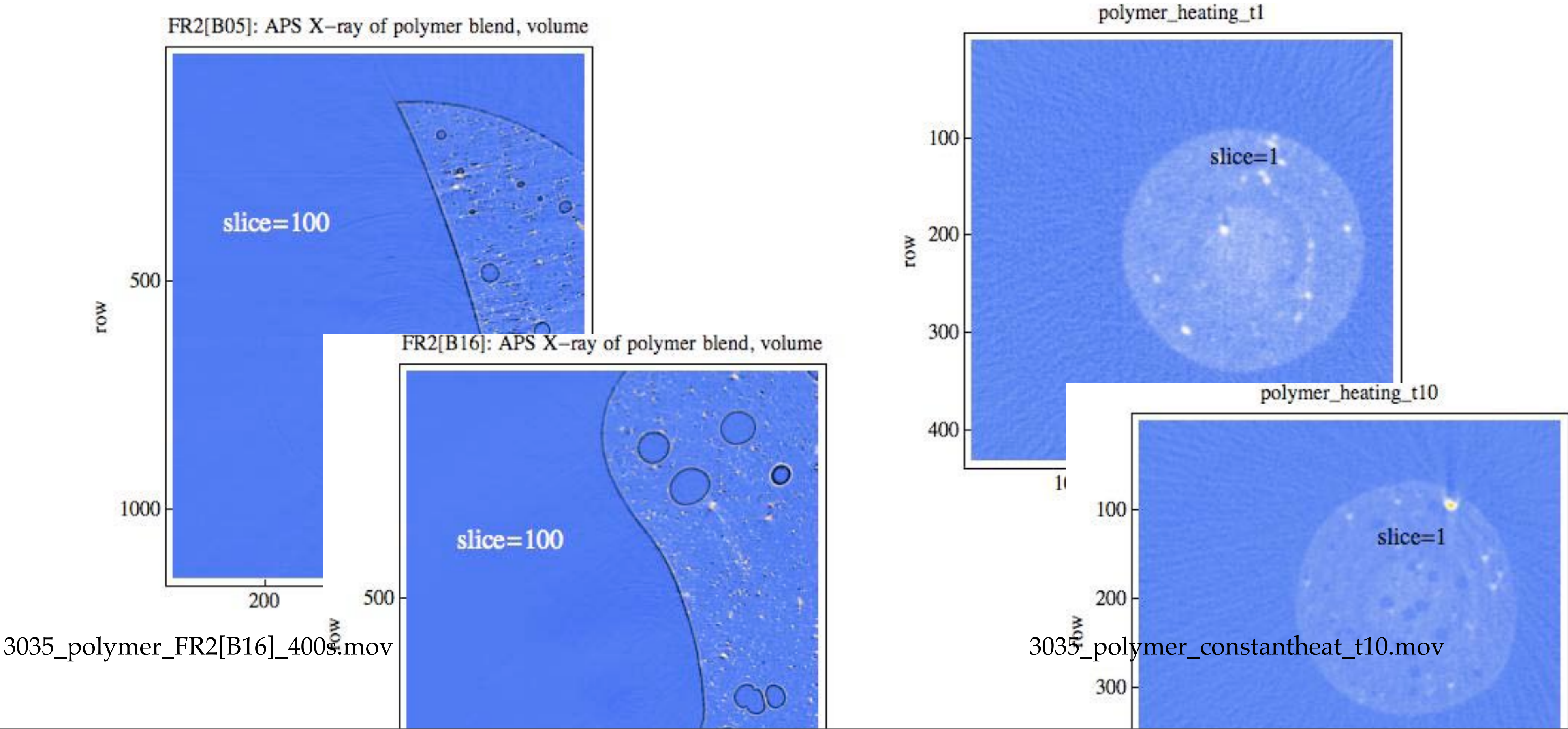
Volcanic basalts: (a) 28 keV and (b) 38 keV

Filename: GL01_5_28k_{650,650,515}_uint16.bin (one of six datasets: 3 samples and two X-ray energies)

volume = {650, 650, 515} pixel size = 5.67 μm, file size = 0.44 GB

X-ray tomography Advanced Photon Source 13-BM

- GL-01-5: Mid-Atlantic Ridge, Basalt glass 417D 29-4-33, Pillow margin, sea water deposit, about 100 Myr old
- GL-01-6: Columbia River Basalt, Basalt glass DSTW 78-226G, Pillow margin, fresh water deposit, about 100 Myr old
- GL-01-7: Columbia River, Basalt glass "Frenchman Springs Mbr", Pillow margin, fresh water deposit, about 15 Myr old
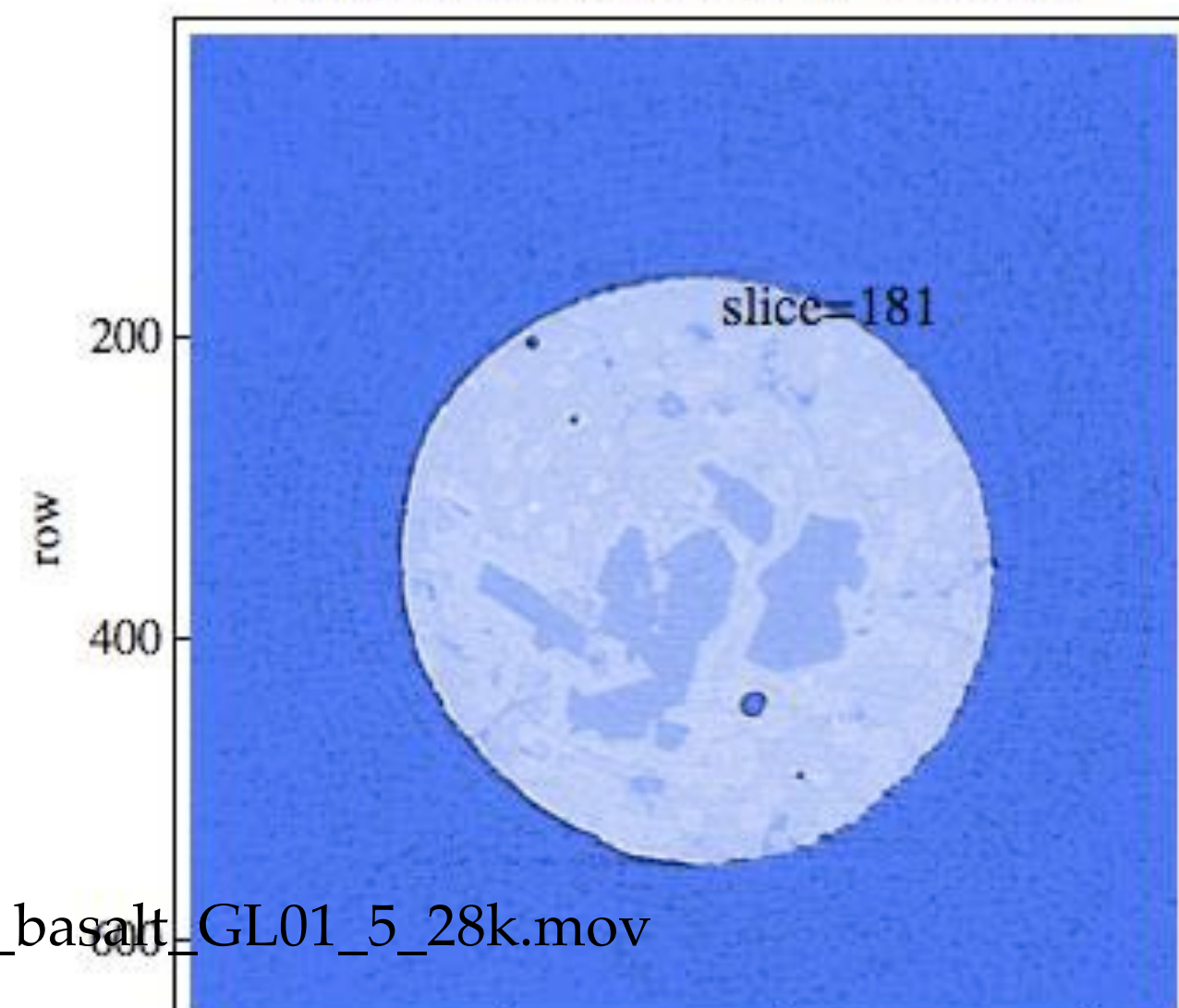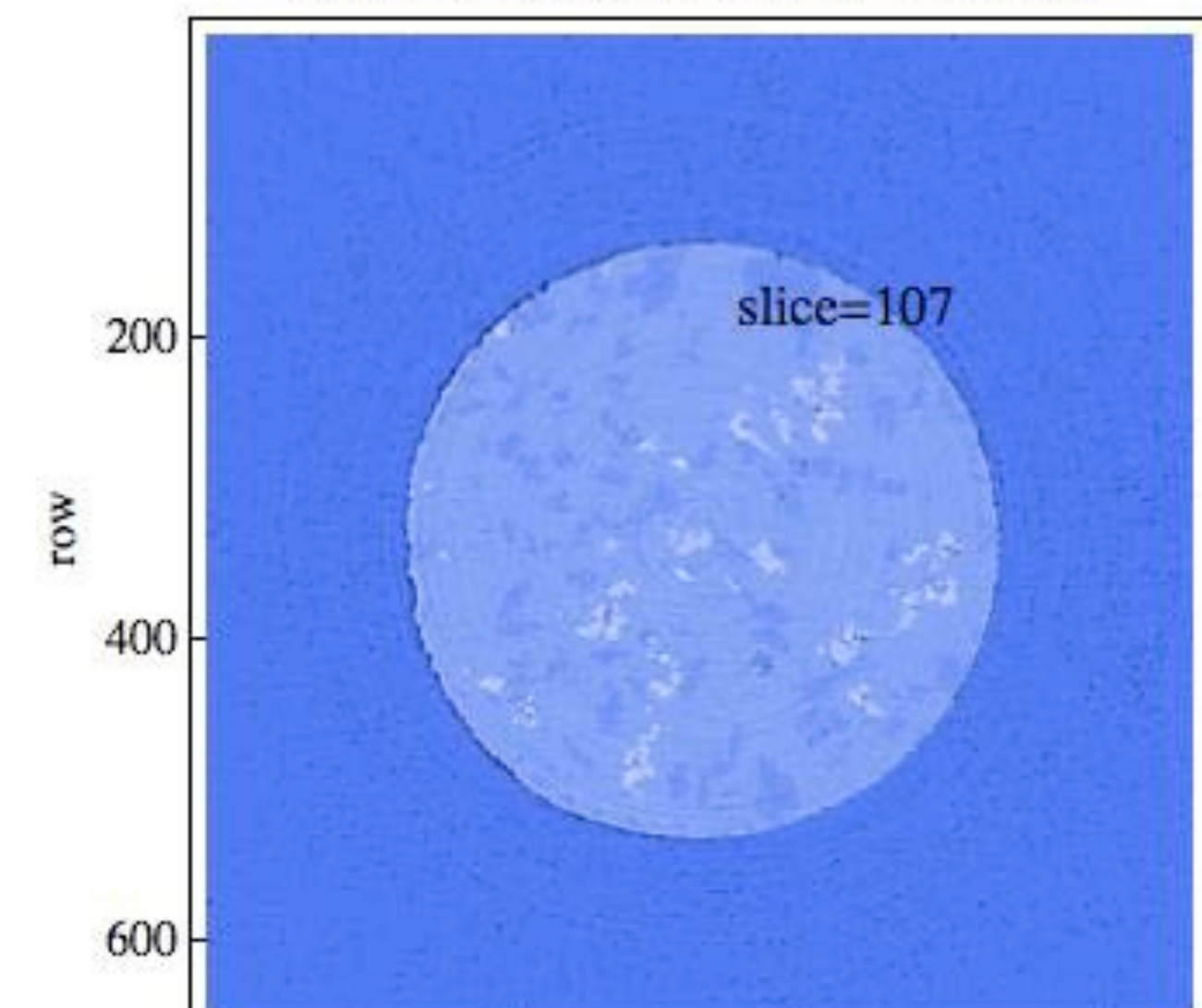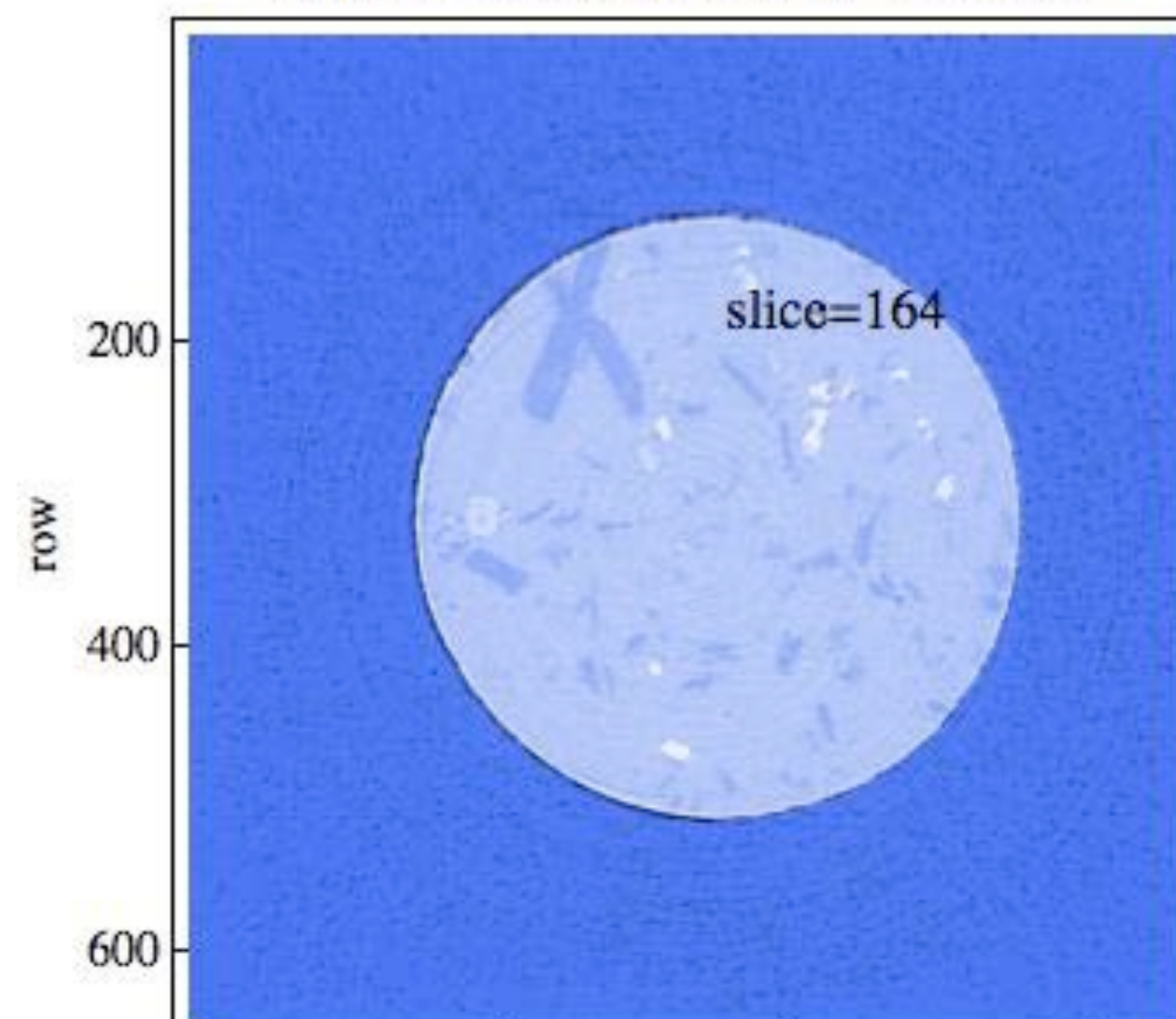

GL01_5_28k_{650,650,515}_uint16.bin

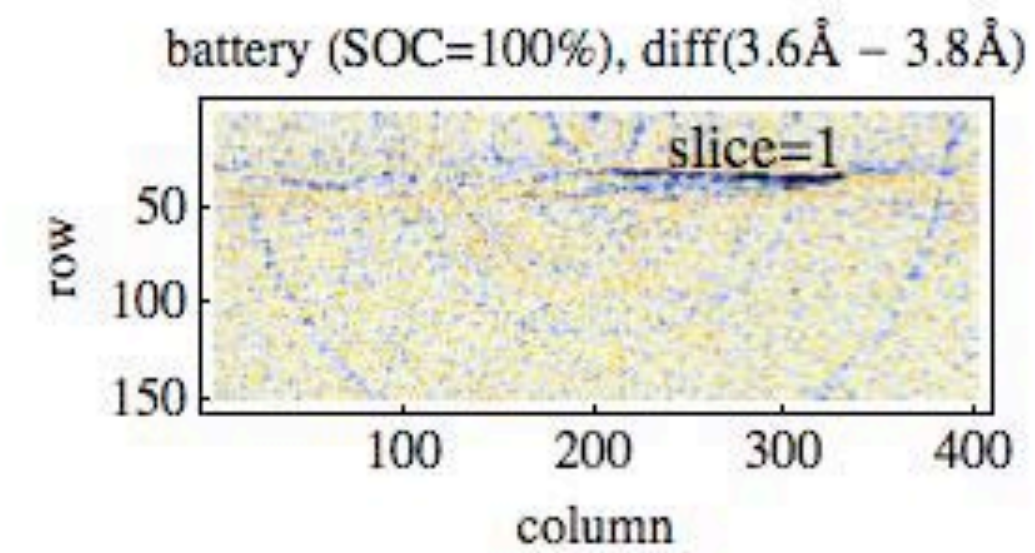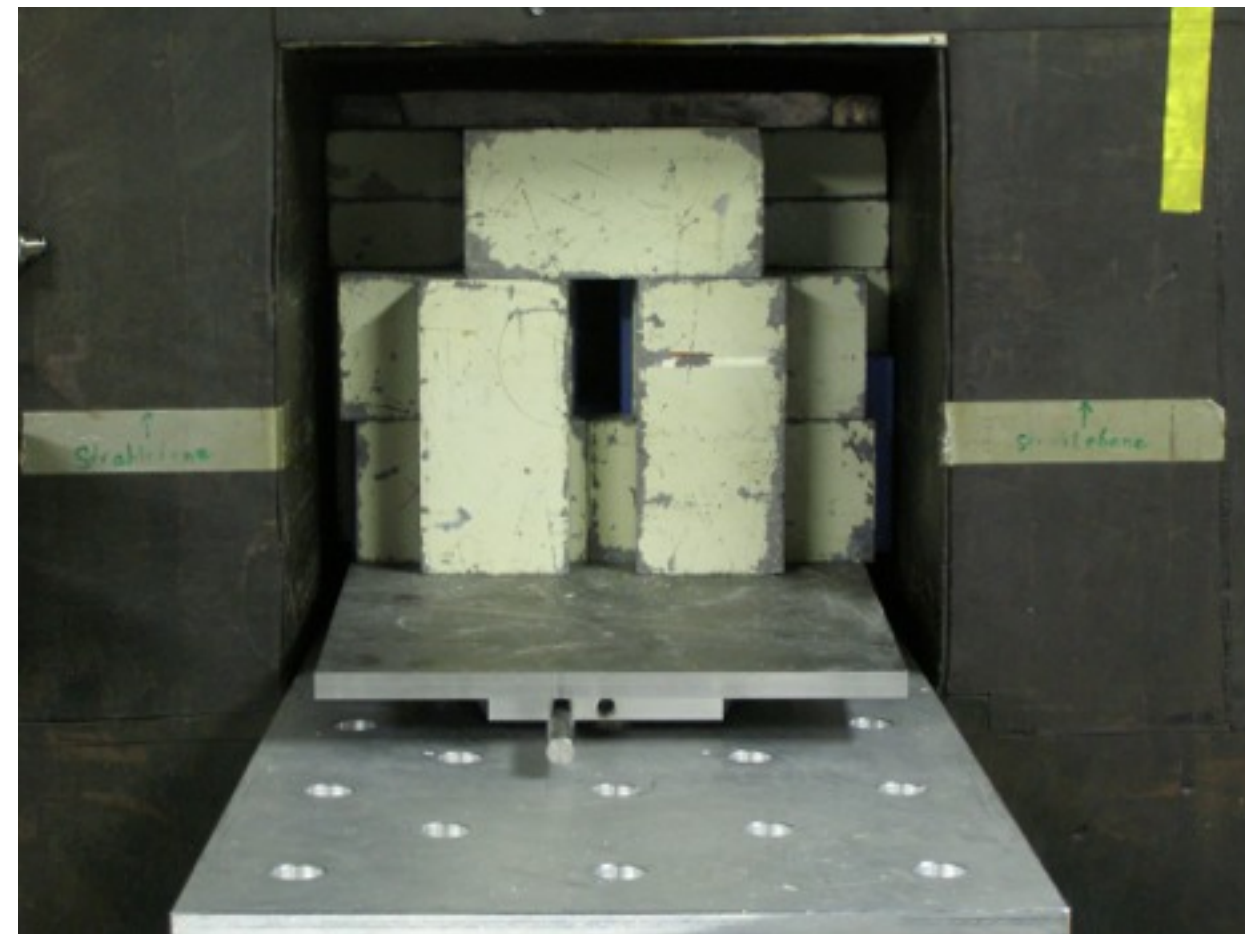GL01_6_28k_{650,650,515}_uint16.bin

GL01_7_38k_{650,650,515}_uint16.bin

slice=181
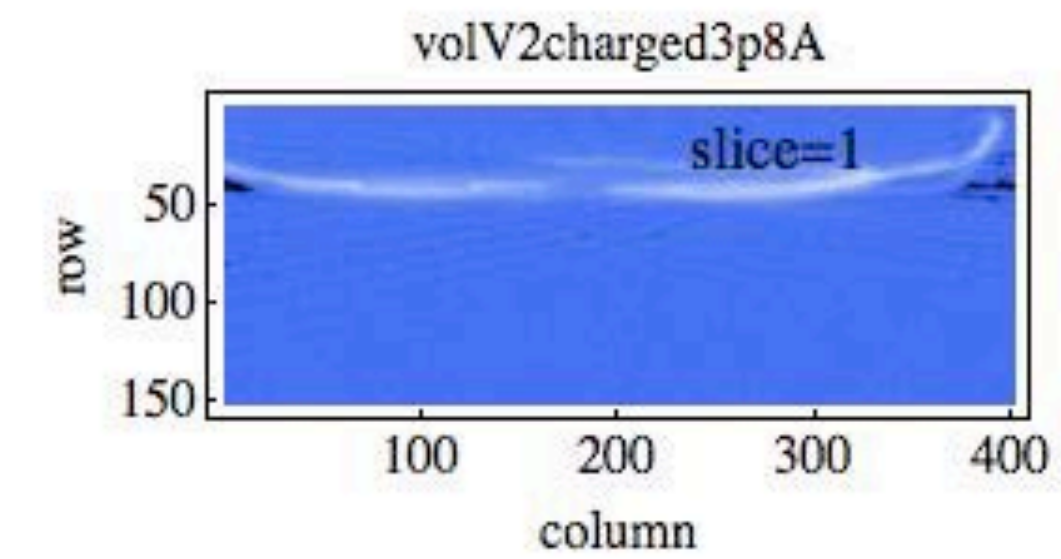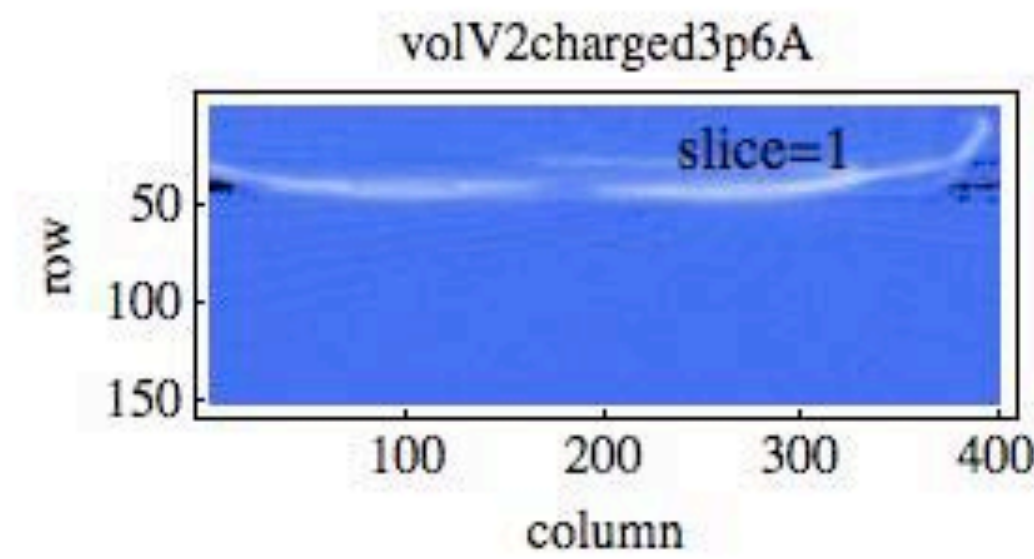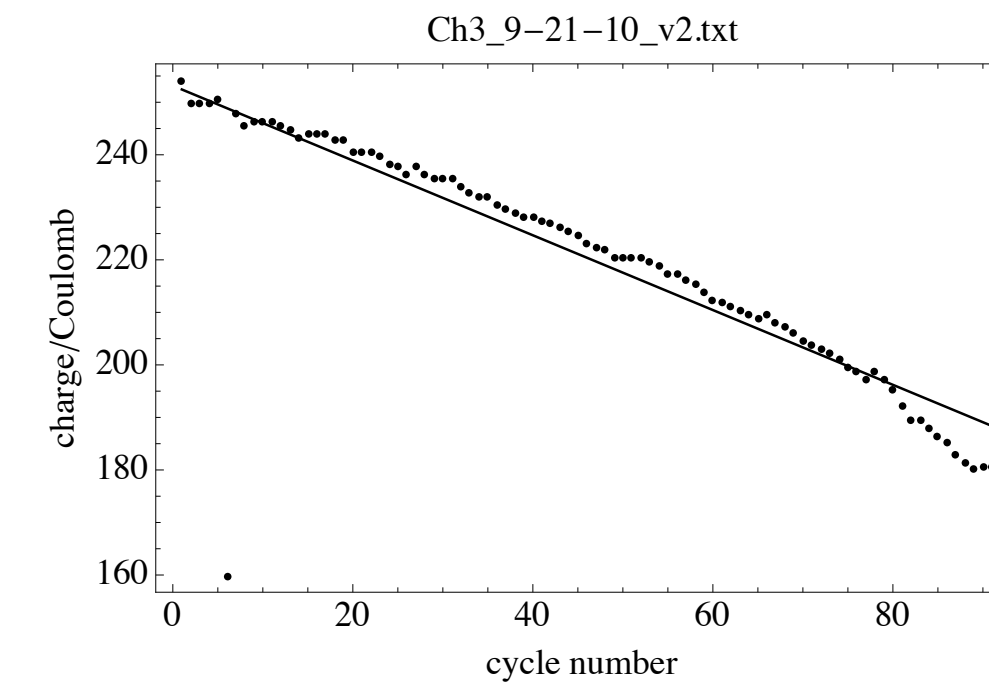
slice=164

slice=107

3035_basalt_GL01_5_28k.mov

Energy: (a) lithium-ion battery

Battery: filename: volV2charged3p6A.h5 (one of seven datasets: 4 state-of-charge and 2 neutron wavelengths)
volume = {151, 401, 238} pixel size = 4x54 μm, file size = 0.12 GB, neutron tomography at FRM II, Sept 2010

Ch2_9−23−10_v2.txt

Ch3_9−21−10_v2.txt

volV2charged3p6A

volV2charged3p8A

battery (SOC=100%), diff(3.6Å − 3.8Å)
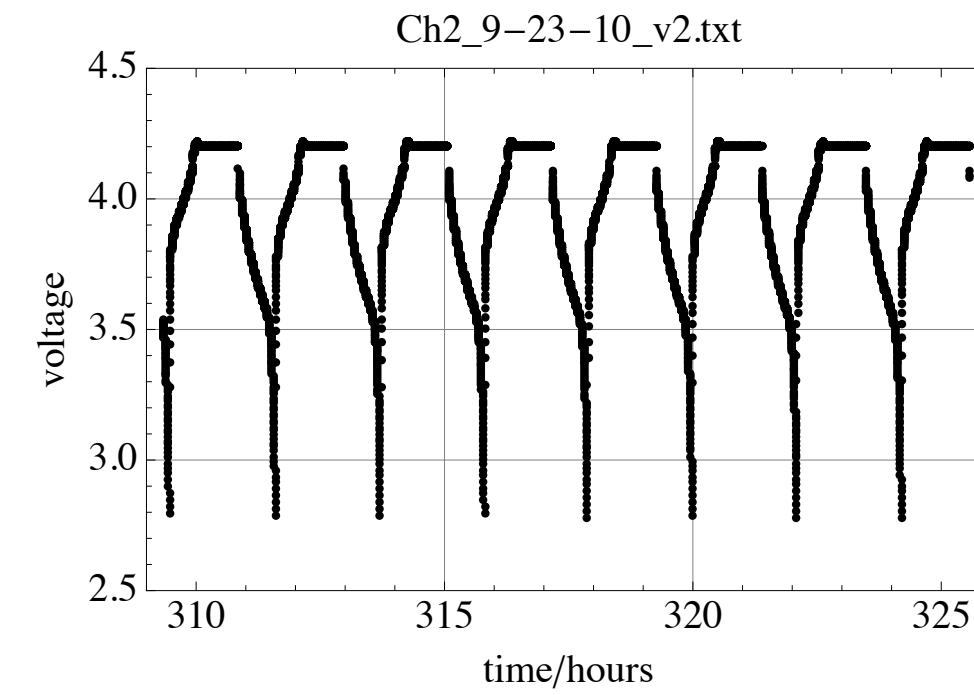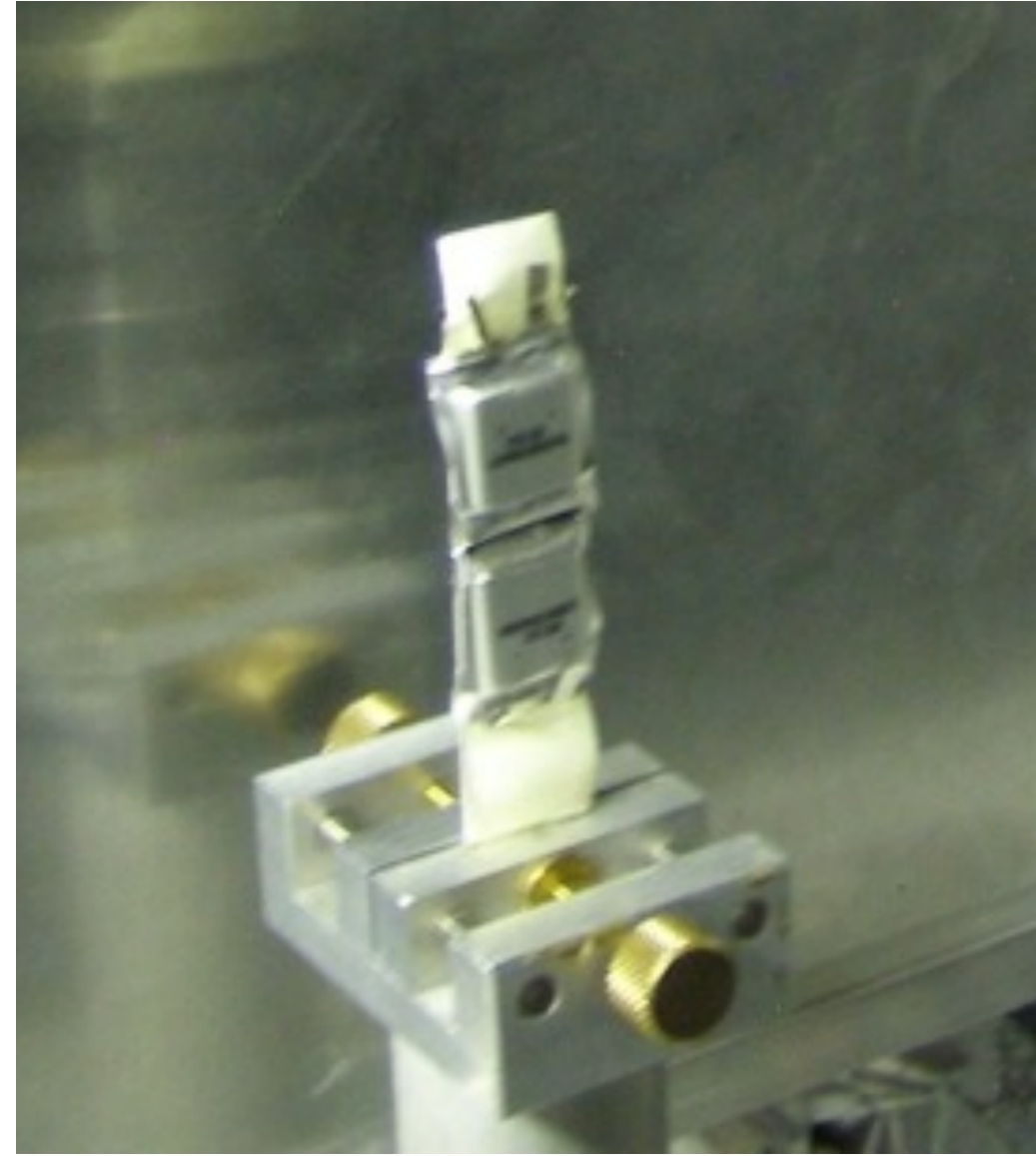
3035_battery_SOC100.mov

First results are published in "Neutron Imaging of a Commercial Li-Ion Battery During Discharge: Application of Monochromatic Imaging and Polychromatic Dynamic Tomography", NIMB, Butler, *et al.*, (2011)

Energy: (b) hydrogen storage materials

H$_2$ storage material: filename: vol_A1_tw_001_.h5 (one of 23 datasets: 4 runs and 4 to 7 time windows)
volume = {260, 261, 701} pixel size = 122 μm, file size = 0.38 GB, neutron tomography at NIST
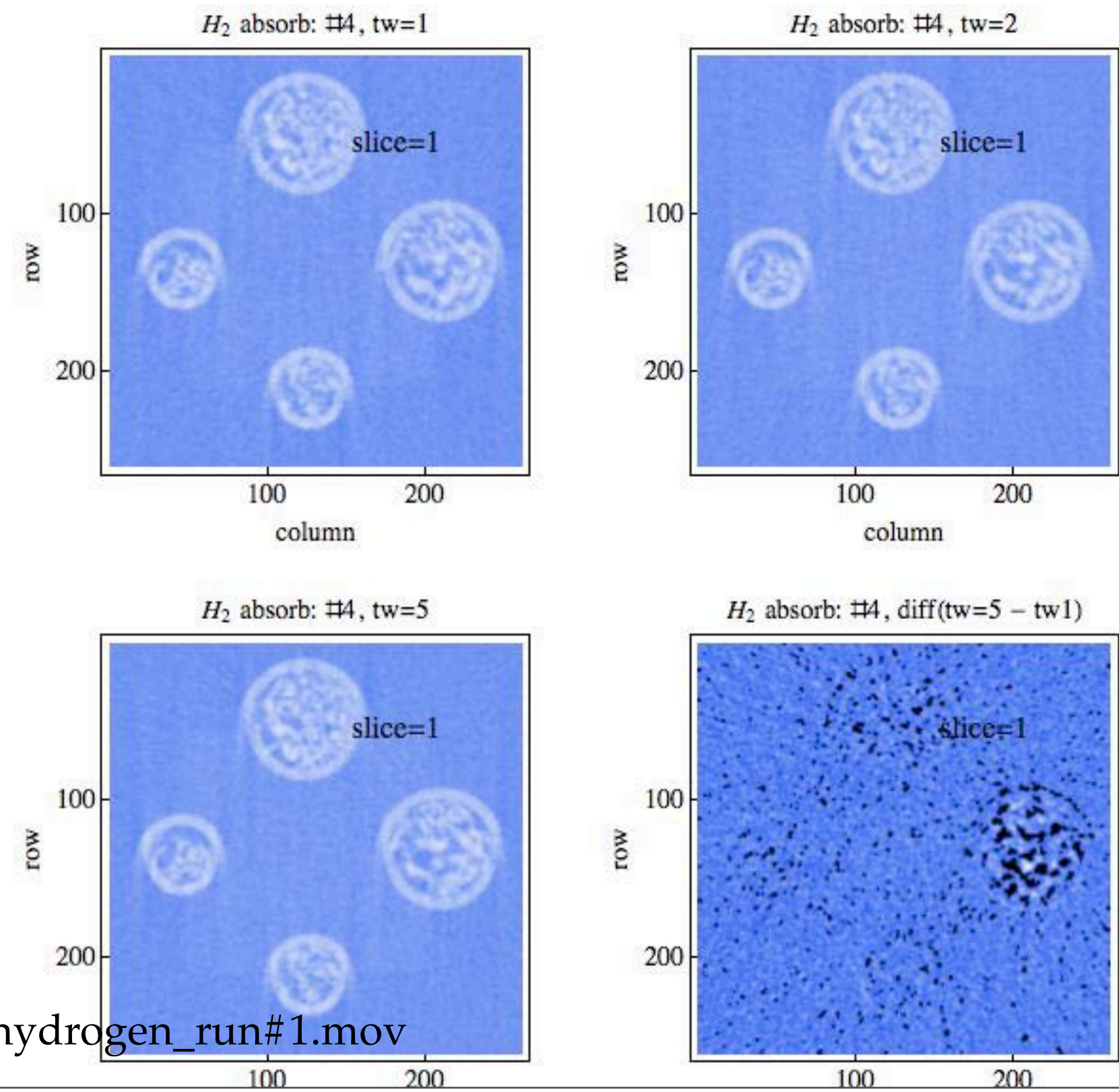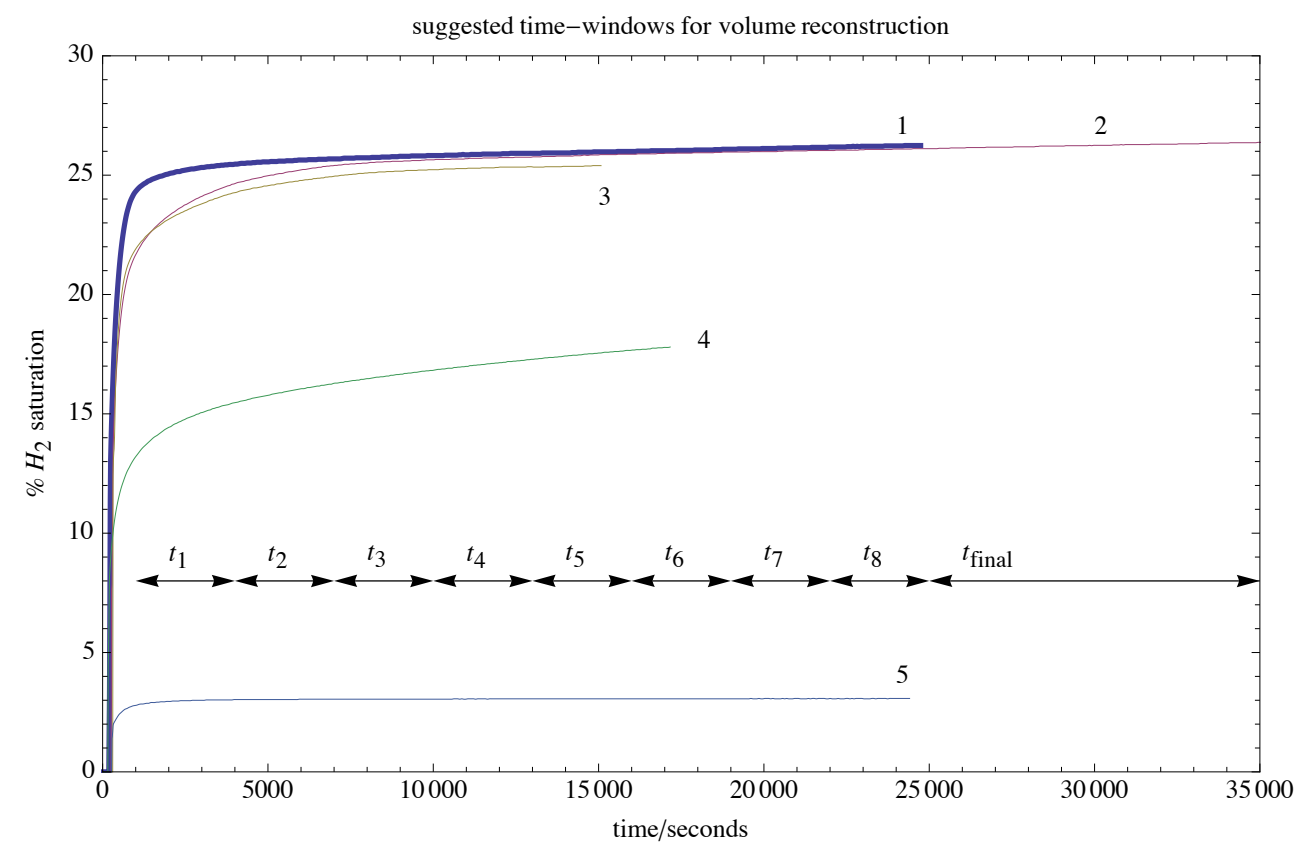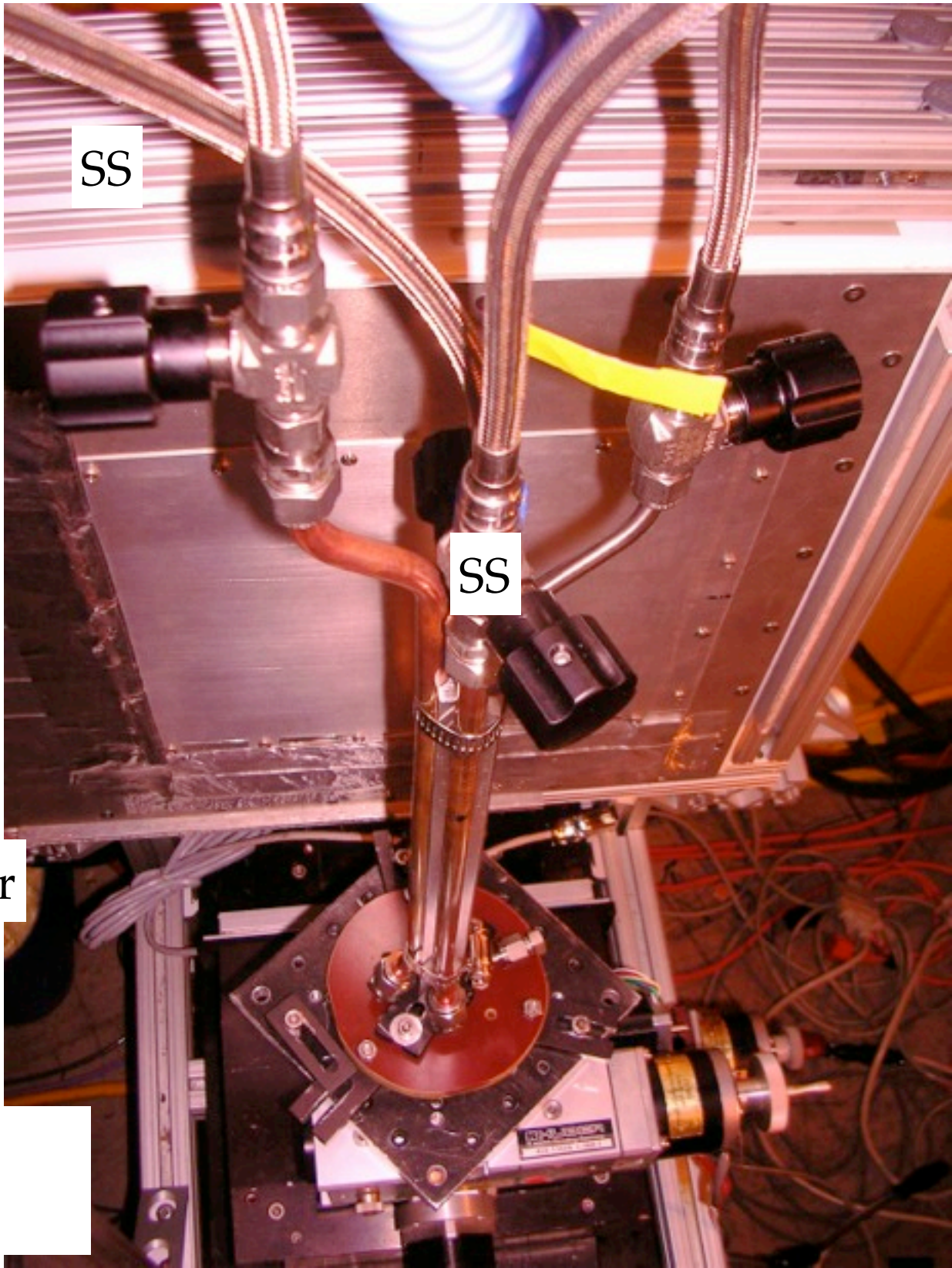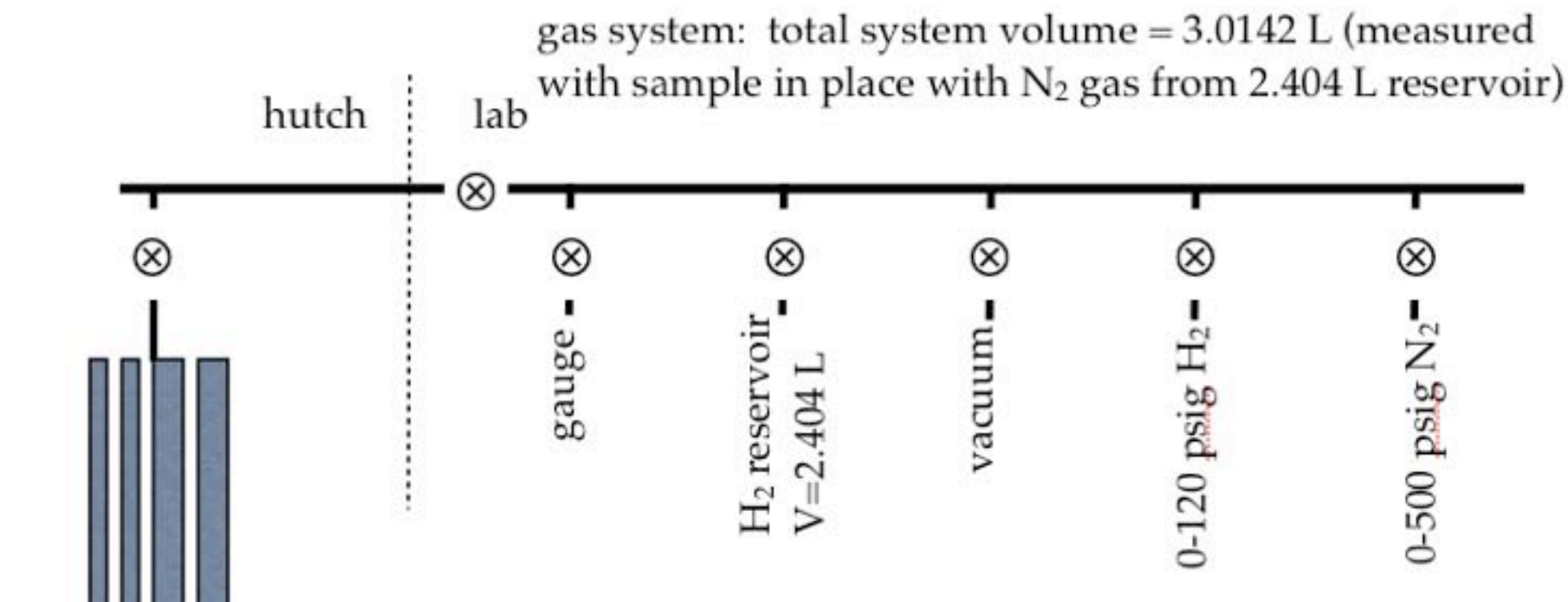
rotation angle = 0°
positive rotation is CCW

3035_hydrogen_run#1.mov

■ Calculate images

transmission: a0/a0(ref)

differential phase: phase - phase(ref)

darkfield image: $\frac{a1/a1(ref)}{a0/a0(ref)}$

```
411]:= imageTransmission = allResultsSample[[All, All, 1]] / allResultsReference[[All, All, 1]];
       plotTextString = "transmission: min=" <> ToString[Min[imageTransmission]] <> ", mean=" <>
          ToString[Mean[Flatten[imageTransmission]]] <> ", max=" <> ToString[Max[imageTransmission]];
       image = Image[imageTransmission, "Real"] // ImageAdjust;
       image = ArrayPlot[imageTransmission, PlotRange -> {All, All, {0.8, 1.2}}];
       {gHistogramLinear, gHistogramLog} = funcPlotLinearLogHistogram[imageTransmission, "Real"];
       GraphicsRow[{image, gHistogramLinear, gHistogramLog}, ImageSize -> 800,
        Epilog -> Inset[Text[Style[plotTextString, 16, Background -> White]], Scaled[{0.3, 0.95}]] ]
```

[416]=

transmission: min=0.399818, mean=0.956627, max=2.4524
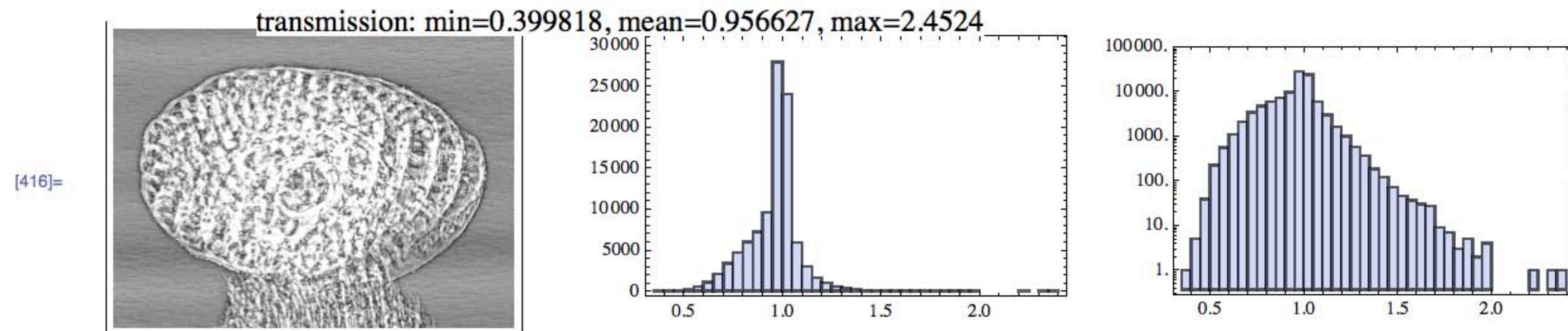

```
417]:= imageDifferentialPhase = allResultsSample[[All, All, 3]] - allResultsReference[[All, All, 3]];
       plotTextString = "differential phase: min=" <> ToString[Min[imageDifferentialPhase]] <> ", mean=" <>
          ToString[Mean[Flatten[imageDifferentialPhase]]] <> ", max=" <> ToString[Max[imageDifferentialPhase]];
       image = Image[imageDifferentialPhase, "Real"] // ImageAdjust;
       image = ArrayPlot[imageDifferentialPhase, PlotRange -> {All, All, {-Pi / 2, Pi / 2}}, ClippingStyle -> {Black, White}];
       {gHistogramLinear, gHistogramLog} = funcPlotLinearLogHistogram[imageDifferentialPhase, "Real"];
       GraphicsRow[{image, gHistogramLinear, gHistogramLog}, ImageSize -> 800,
        Epilog -> Inset[Text[Style[plotTextString, 16, Background -> White]], Scaled[{0.3, 0.95}]] ]
```

[422]=

differential phase: min=−5.84293, mean=−0.200924, max=6.11148
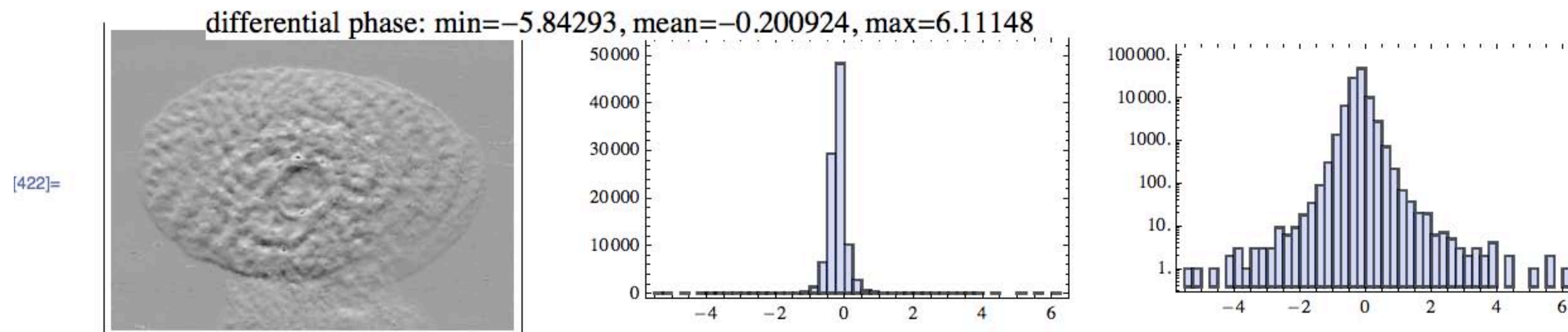
The materials science data sets: some leading questions.

1. Fabricated devices: (a) cartridge and (b) NMR MAS rotor

1. Cartridge: can this cartridge be identified based on its dimensions and the markings near the primer?
2. Cartridge: describe the propellant: average grain size, number grains/cm^3
3. MAS rotor: what are the variations of OD and ID versus the length of the zirconia cylinder? Any sign of wear?
4. MAS rotor: determine the end mill diameter used to machine the air drive flutes in the Kel-F cap.

2. Migmatite: (a) neutron and (b) X-ray data sets

1. Devise methods to compare and contrast neutron and X-ray data sets.
2. Explore the Avizo routines for affine data transformation.

3. Polymer blends: (a) traditional and (b) Greek golden ratio data acquisition

1. Traditional: how do the air bubble volumes track heating time and location?
2. Greek: Do the flame retardant particles show any sign of dissolution with time?
3. Greek: develop a method to track particle position with time and illustrate.

4. Volcanic basalts: (a) 28 keV and (b) 38 keV

1. Do segmentations of the 28 and 38 keV yield about the same mineral proportions? Can you develop a procedure to merge the segmentations?
2. One phase appears more needle-like in GL01-06. Can this characteristic be quantified and compared with the other samples?

5. Energy: (a) lithium-ion battery and (b) hydrogen storage materials

1. Battery: Can 3.6 Å and 3.8 Å volumes be aligned so as to yield an informative difference image?
2. H$_2$: Can extremely active grains be located? Are the active grains reproducibly active?

6. Phase Contrast Imaging: Foraminifera

1. Imaged twice: (a) standard X-ray tomography and (b) phase contrast tomography (generates transmission, phase, and dark-field images)
2. How are images similar? Different?

date: 16 April 2012

Project Checklist:

A. You must use all of these: ImageJ, Avizo, VisIt, and Mathematica. The ratio of Avizo to VisIt is up to you, and could be as skewed as 5% of one and 95% of the other. With VisIt, you must use, at least once, the HPC option.

B. You must generate:
   At least 3 movie "scenes".
   At least one pair of linear and log count histograms.
   An analyzed connected components report as appropriate for the data set.

C. You must work with your data set in at least two formats:
   Recommend *.bin and *.h5
   Also possible are stacked tiff, DICOM, and *.h5 (for VisIt).

D. Attendance at 11:40AM-12:30PM in 101 Middleton is highly, highly recommended. Jinghua and Les are here to answer questions. Access at other times is difficult.

E. Use your tezpur folders to store drafts and large (>100MB) final files. Smaller (<100MB) can be uploaded to Moodle.