

Imaging the Adsorption of Methane and Hydrogen in Corncob Carbon

Eylon Winterstein

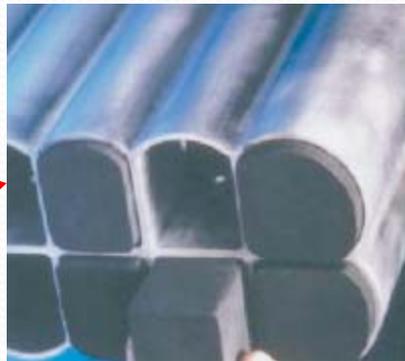
SUNY at Binghamton

Dr. Craig Brown

NIST Center for Neutron Research

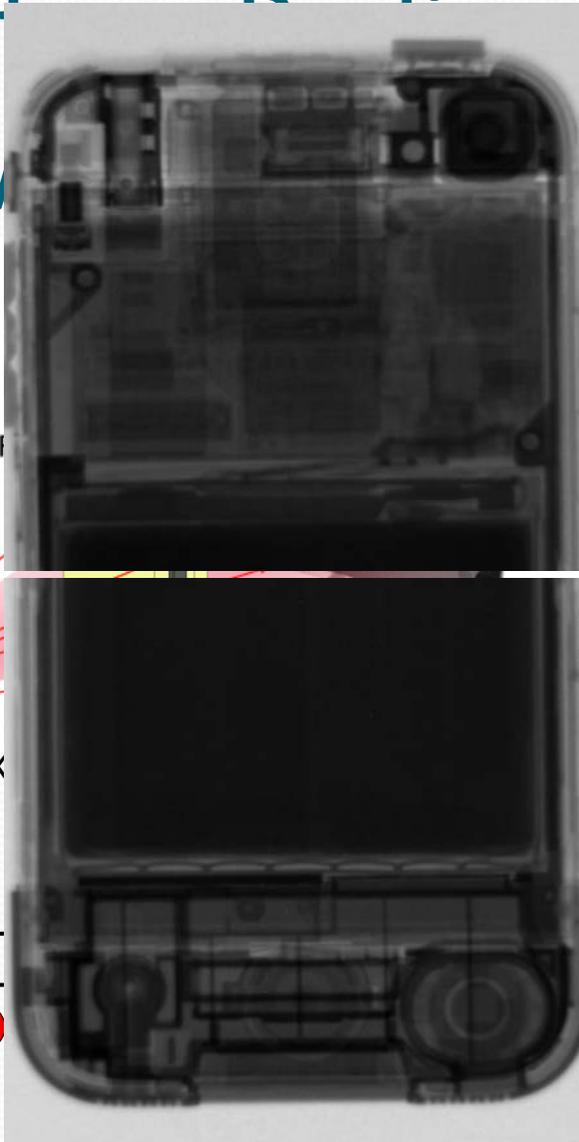


Driving Force: Why do we care?



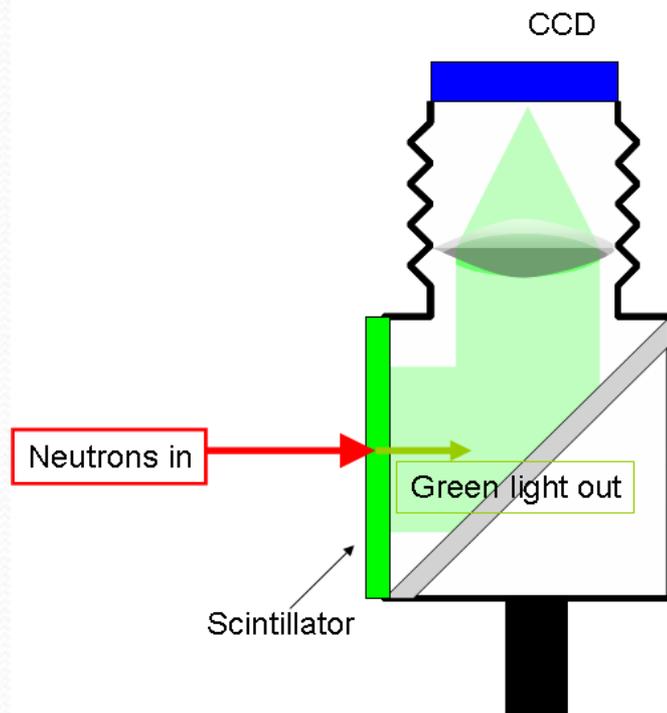
- The need to find a practical method for low pressure – high capacity gas storage for CH_4 and H_2 .
- Your next car might well run on clean natural gas and be ready for hydrogen when it comes along.

Neutron Radiography: How does it work?



- Sample is placed in a neutron beam.
- Neutrons either pass through or are scattered/absorbed by a sample.
- Pixel intensity depends on the number of neutrons that pass through a sample point.
- 2-D grayscale images that are produced provide information about interior structure of a sample.

Neutron Radiography: Continued



- Neutrons are converted to light by the scintillator (${}^6\text{LiF}/\text{ZnS}:\text{Cu,Al,Au}$).
- Neutron to light conversion efficiency is 20%.
- The light is then captured by a CCD camera producing an image.
- CCD image acquisition rate is 0.2 Hz, pixel pitch of $57\ \mu\text{m}$

ALL-CRAFT:

The corncob carbon sample

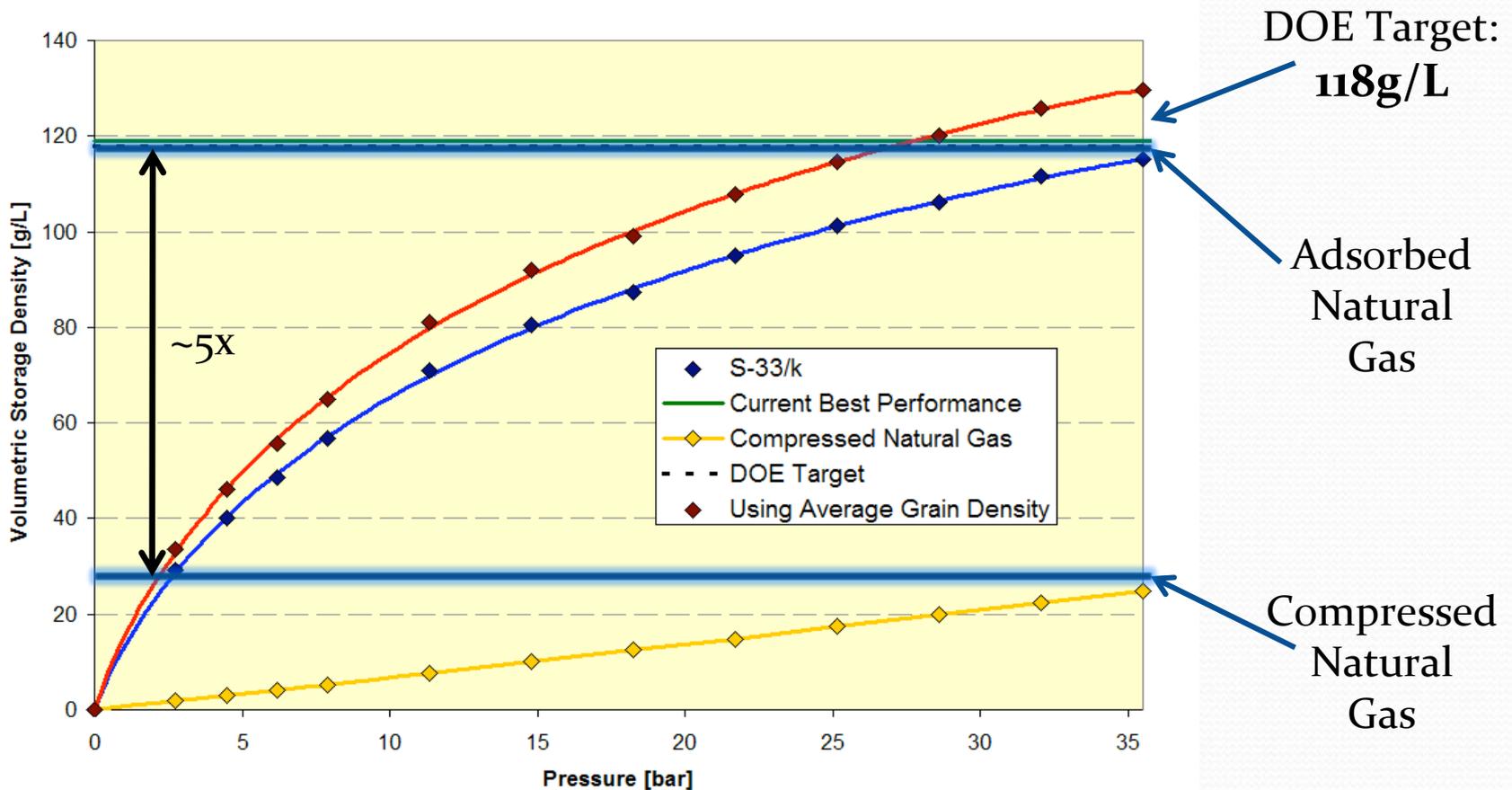


- Developed by the University of Missouri
- Porous Carbon adsorbs gas.



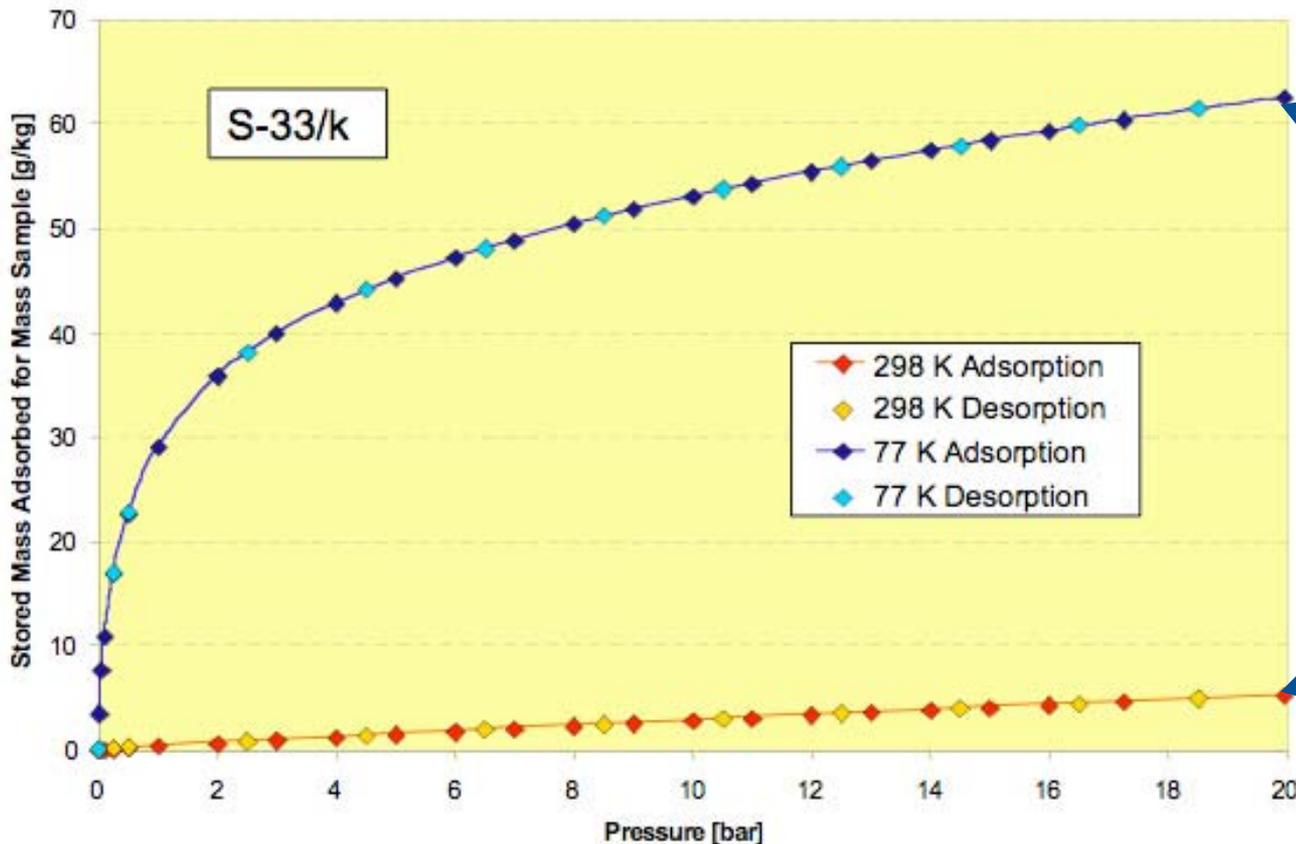
ALL-CRAFT:

The corncob sample's performance



ALL-CRAFT:

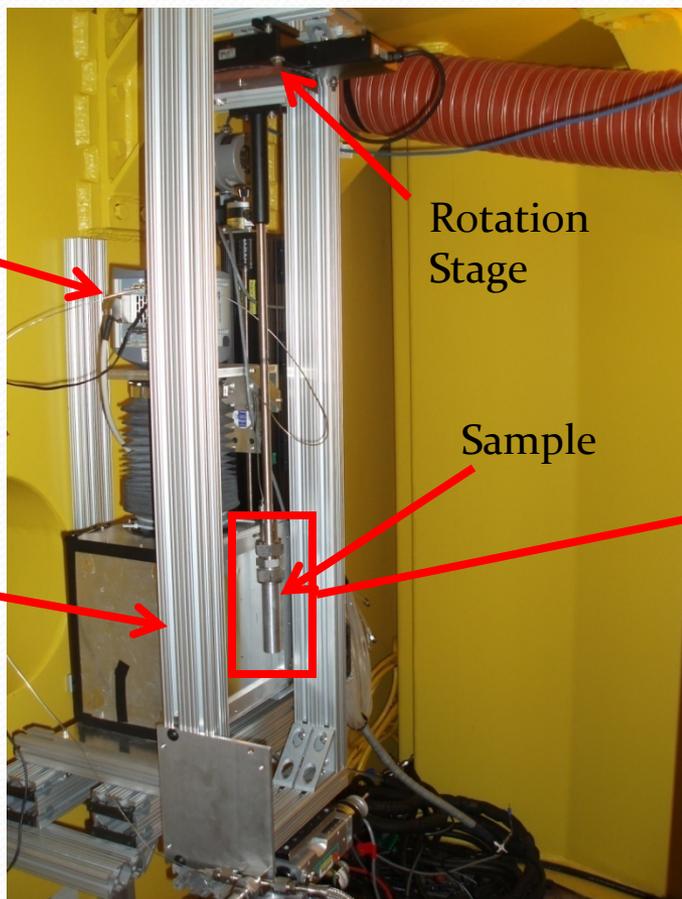
The corncob sample's performance



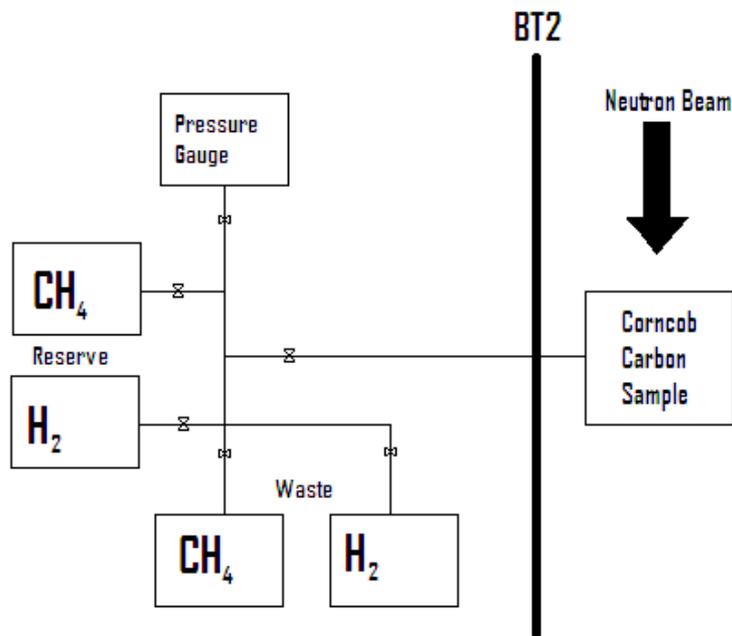
Hydrogen
@ 77 K
6.2 mass%

Hydrogen
@ 298 K
0.5 mass%

Experiment: Preparation



Experiment: Adsorption of CH_4 and H_2



- Collected radiography and tomography data.
- Wanted to know how the gases distributed within the carbon with time.
- Varied pressure in between data collection.

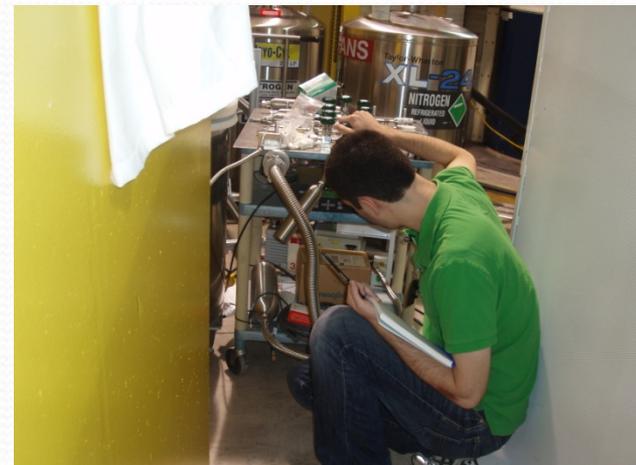
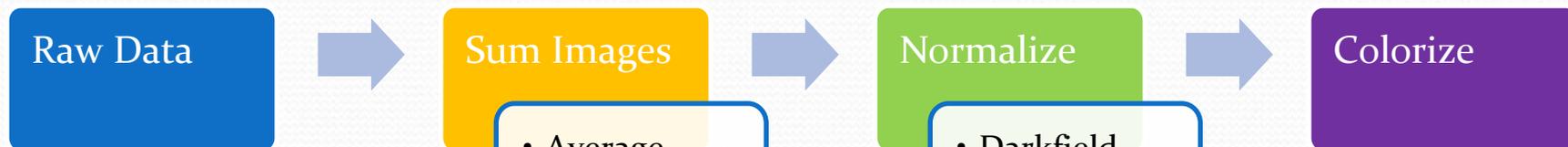


Image Processing: How does it work?



- Average
- Sum
- Integrate

- Darkfield
- Flatfield
- Bare Image

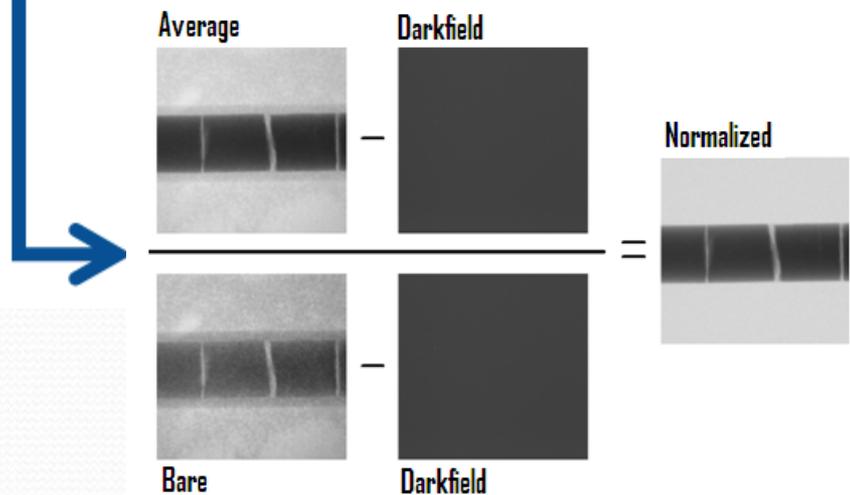
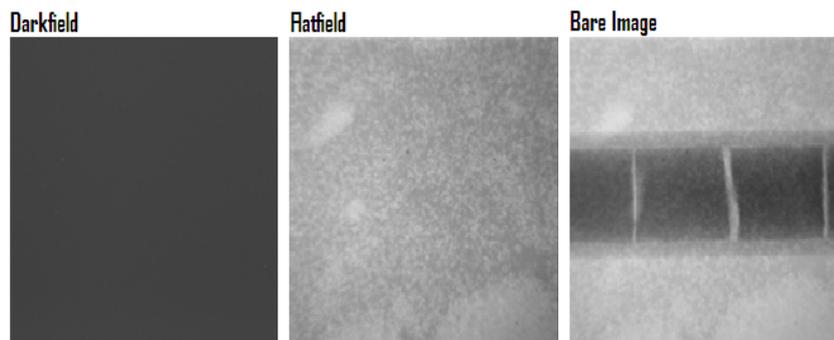
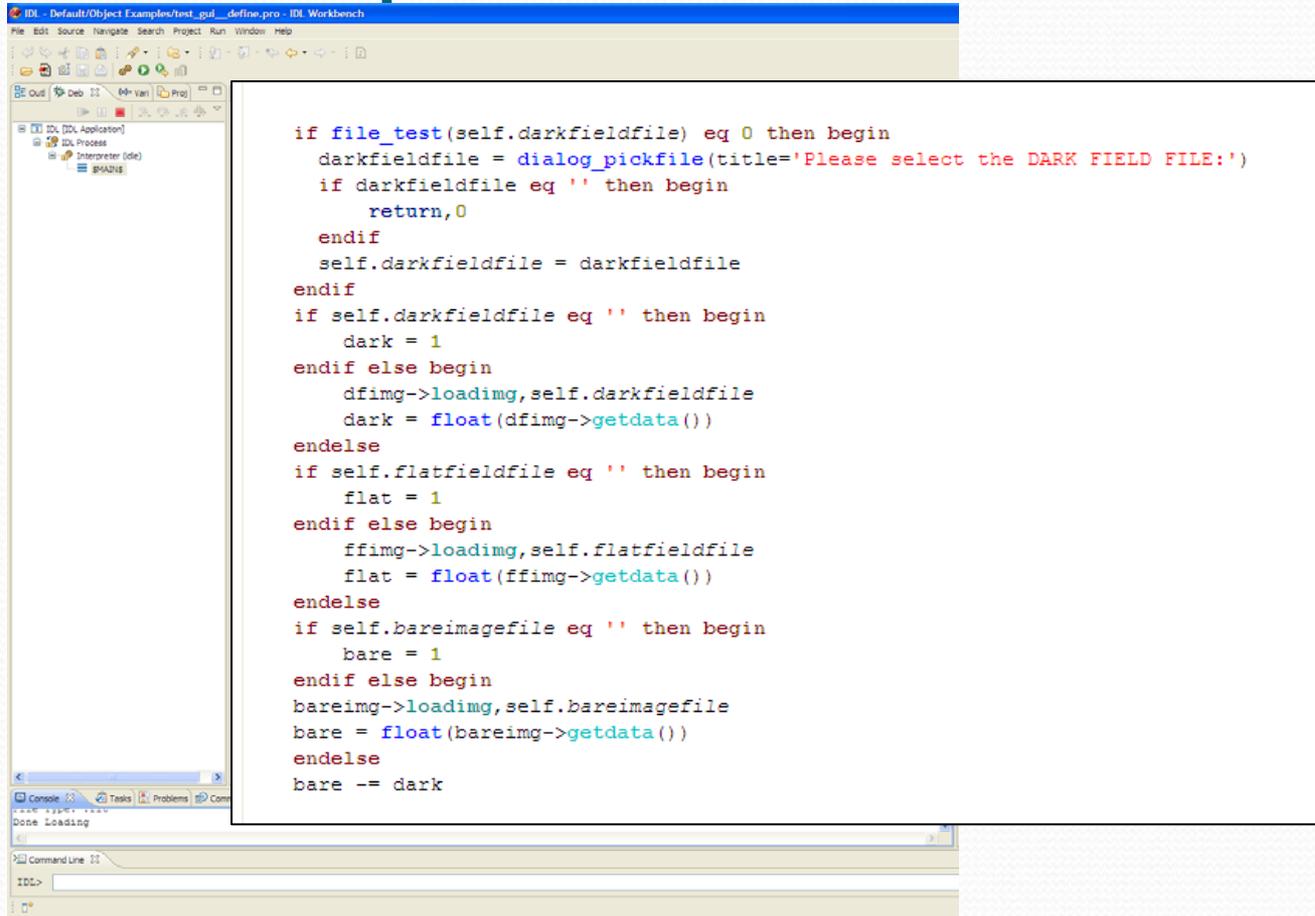


Image Processing: A new experience



The screenshot shows an IDE window titled "IDL - Default/Object Examples/test_gut_define.pro - IDL Workbench". The main editor displays the following IDL code:

```
if file_test(self.darkfieldfile) eq 0 then begin
    darkfieldfile = dialog_pickfile(title='Please select the DARK FIELD FILE:')
    if darkfieldfile eq '' then begin
        return,0
    endif
    self.darkfieldfile = darkfieldfile
endif
if self.darkfieldfile eq '' then begin
    dark = 1
endif else begin
    dfimg->loading,self.darkfieldfile
    dark = float(dfimg->getdata())
endif
if self.flatfieldfile eq '' then begin
    flat = 1
endif else begin
    ffimg->loading,self.flatfieldfile
    flat = float(ffimg->getdata())
endif
if self.bareimagefile eq '' then begin
    bare = 1
endif else begin
    bareimg->loading,self.bareimagefile
    bare = float(bareimg->getdata())
endif
bare -= dark
```

The IDE interface includes a menu bar (File, Edit, Source, Navigate, Search, Project, Run, Window, Help), a toolbar, a project browser on the left, a console at the bottom, and a command line at the very bottom.

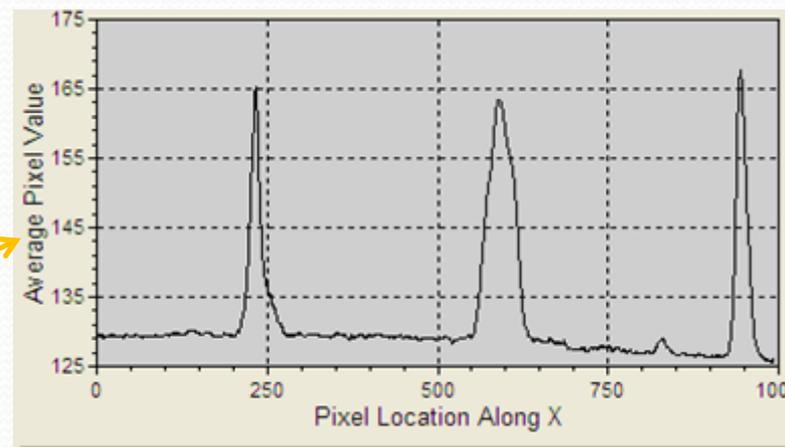
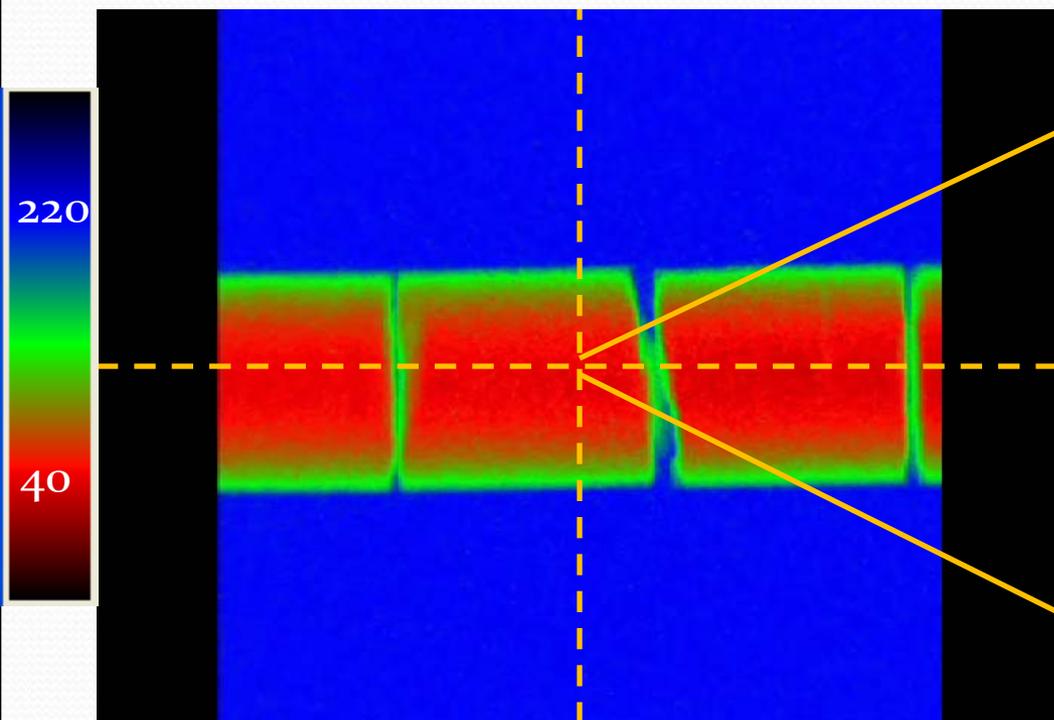
Image Processing: Faster than ever at the NCNR

The screenshot shows a Microsoft Excel spreadsheet with a large blue image processing window overlaid. The window contains a 'Object Widgets for the masses' dialog box with fields for 'File n:', 'Prefix:', 'First:', and 'Last:'. Below these fields is a black image area with the text 'I have no image data to zoom onto...'. The spreadsheet has columns A and H. Column A contains a list of parameters, and column H contains a list of output prefixes.

A	H
1 Name	Output Prefix List
2 SAV filename	0psi 1
3 Source Path	75psi 1
4 Out Path	100psi 1
5 Input Image Prefix	125psi 1
6 Output Prefix	150psi 1
7 Input Type	175psi 1
8 Output Type	200psi 1
9 Median filter	225psi 1
10 File Switch	250psi 1
11 first	275psi 1
12 last	300psi 1
13 Integrate	325psi 1
14 Sum Switch	350psi 1
15	375psi 1
16	400psi 1
17	425psi 1
18	bare
19	darkfield
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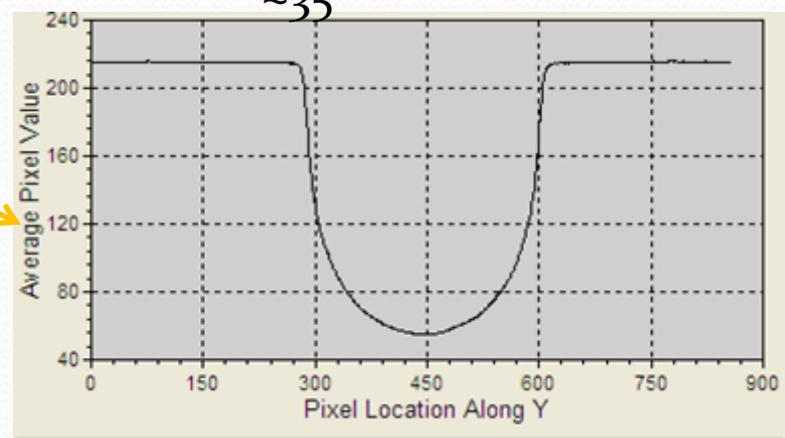
Results:

Distribution of Methane at varying pressures



Δ Pixel Value:

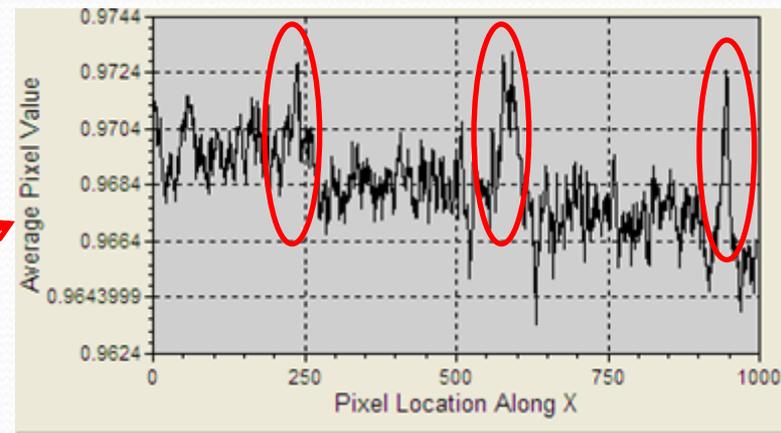
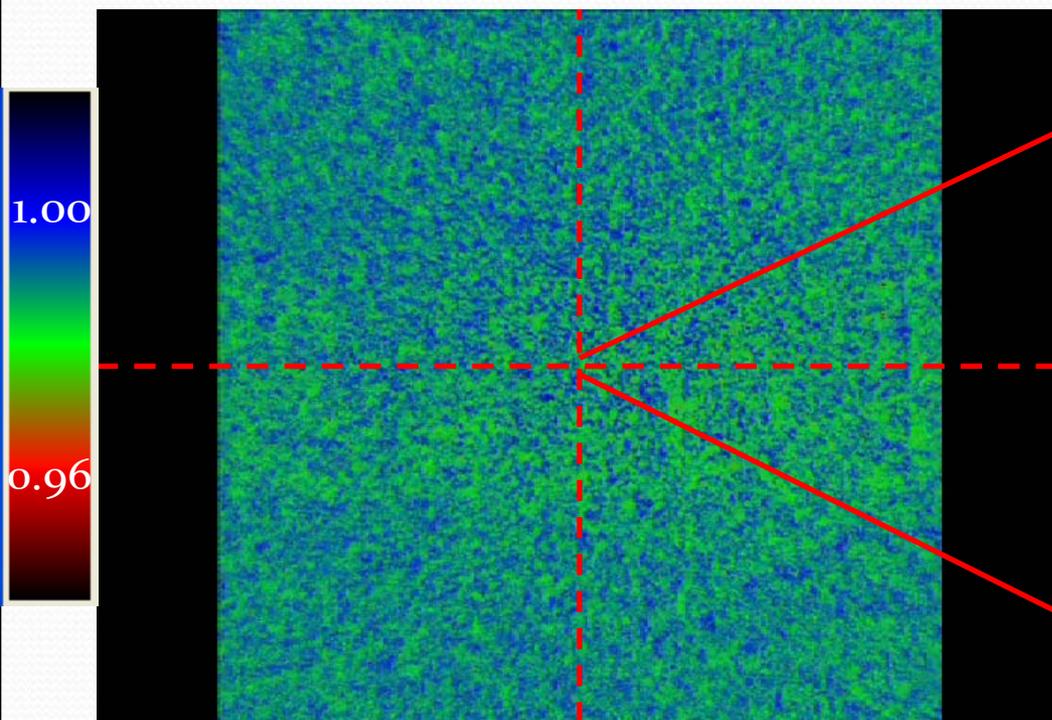
~35



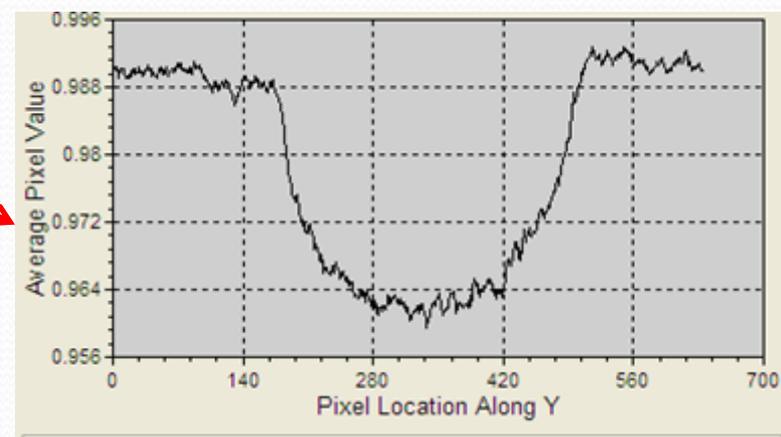
Δ Pixel Value: ~180

Results:

Distribution of Hydrogen at varying pressures



Δ Pixel Value: ~ 0.004



Δ Pixel Value: ~ 0.024

The Future

- Process the tomography data.
- Collect radiography and tomography data
 - At cryogenic temperatures,
 - Time resolved.
- Expand the capabilities of the image processing program.
 - Quantitative analysis,
 - Write movie files,
 - Inclusion into the DAVE platform.

Acknowledgements

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