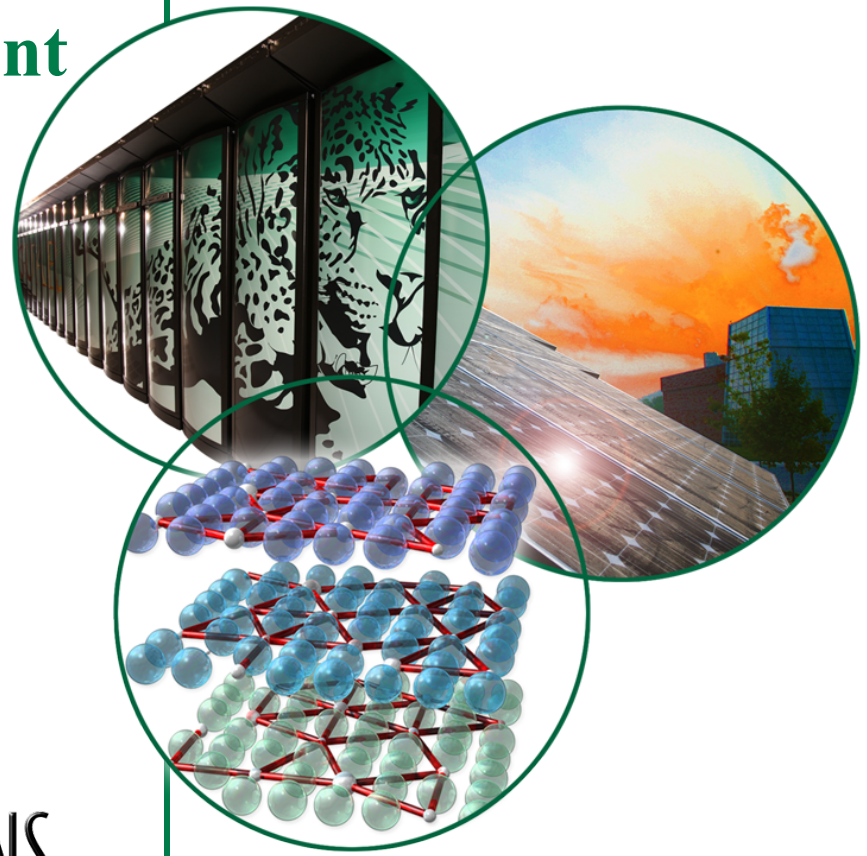
Initial Measurements at the CG1 Instrument Development Station at the High Flux Isotope Reactor

Lowell Crow

TRTR/IGORR 2010

September 22, 2010



Neutron Sciences

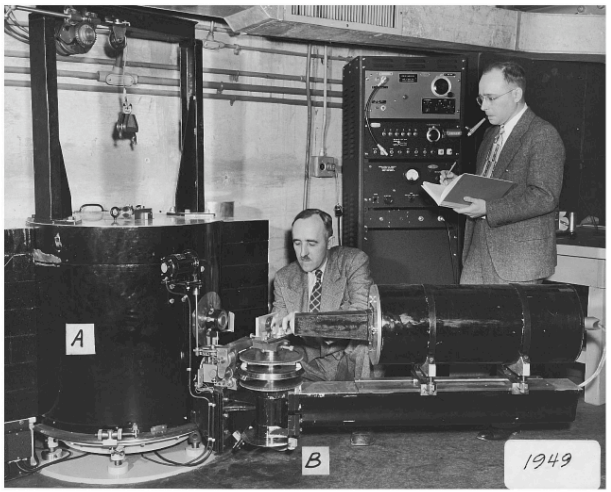
HFIR

SNS
SPALLATION NEUTRON SOURCE

U.S. DEPARTMENT OF ENERGY

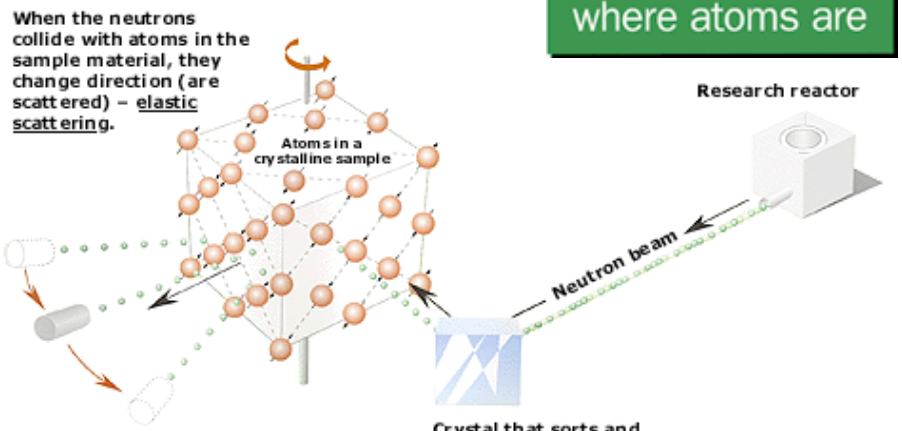
OAK RIDGE NATIONAL LABORATORY
MANAGED BY UT-BATTELLE FOR THE DEPARTMENT OF ENERGY

What do we do with neutron scattering?

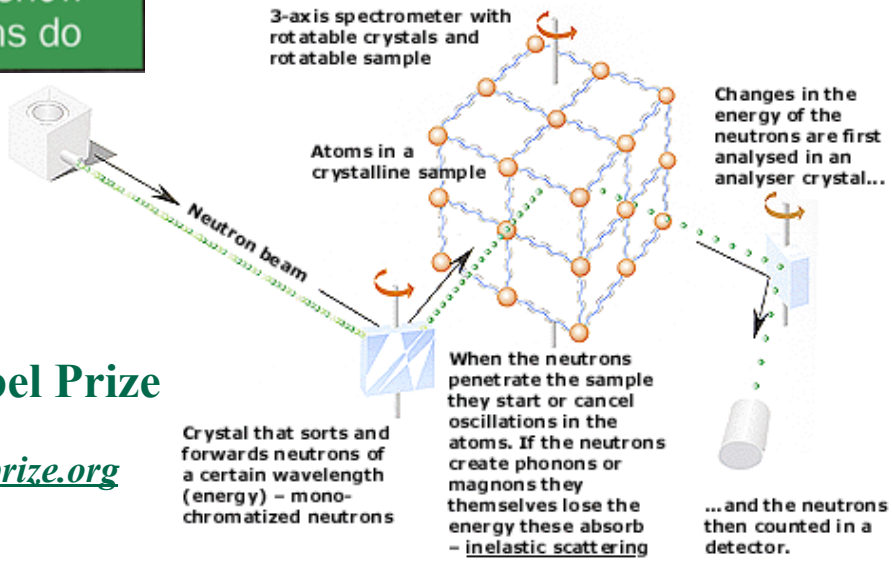


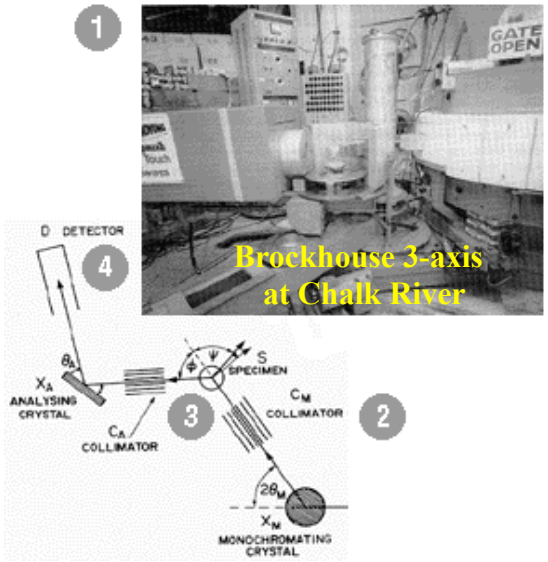
E.O. Wollan and C. G. Shull, X-10, 1949

Neutrons show where atoms are



Neutrons show what atoms do





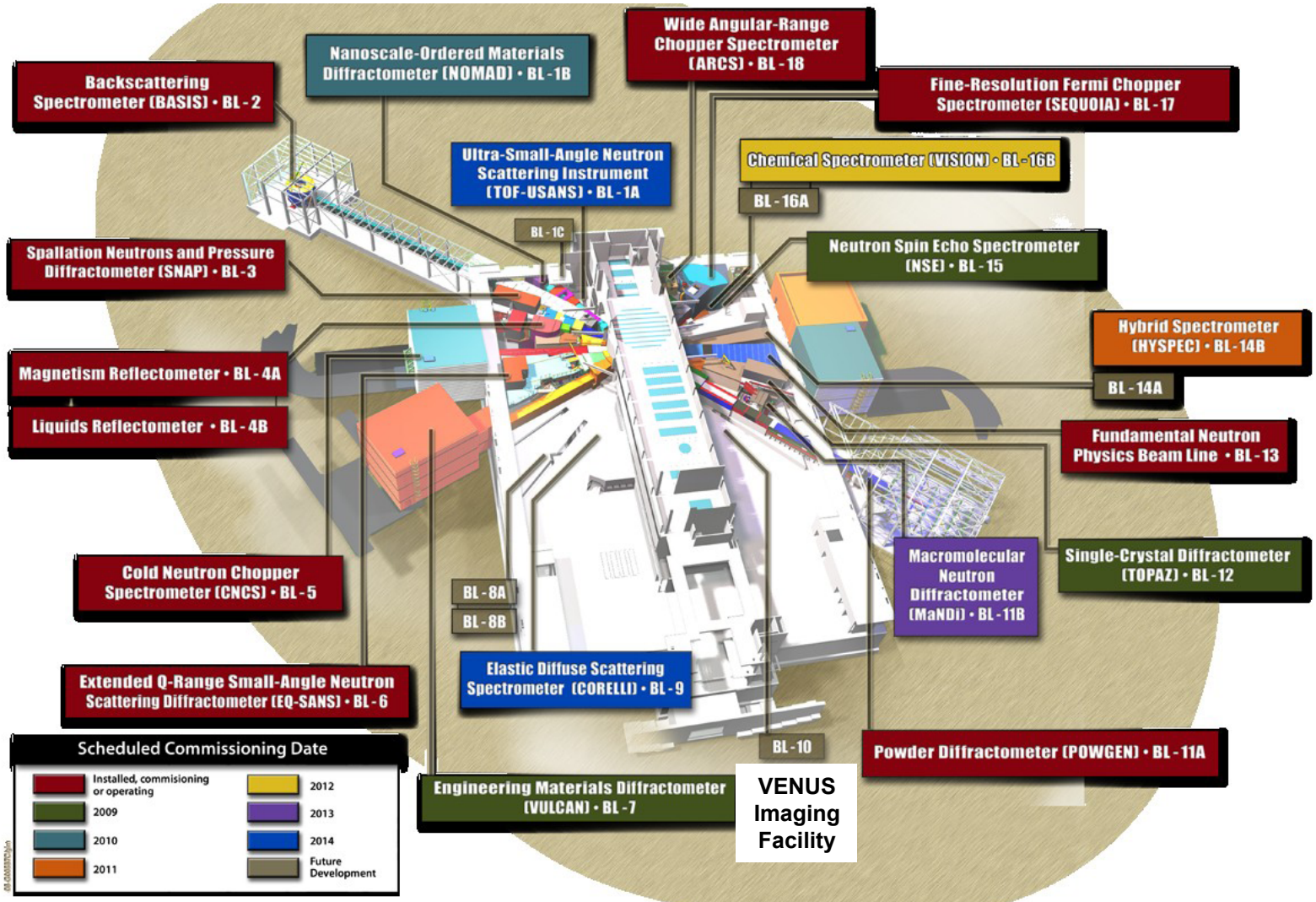
Brockhouse 3-axis at Chalk River

1994 Nobel Prize

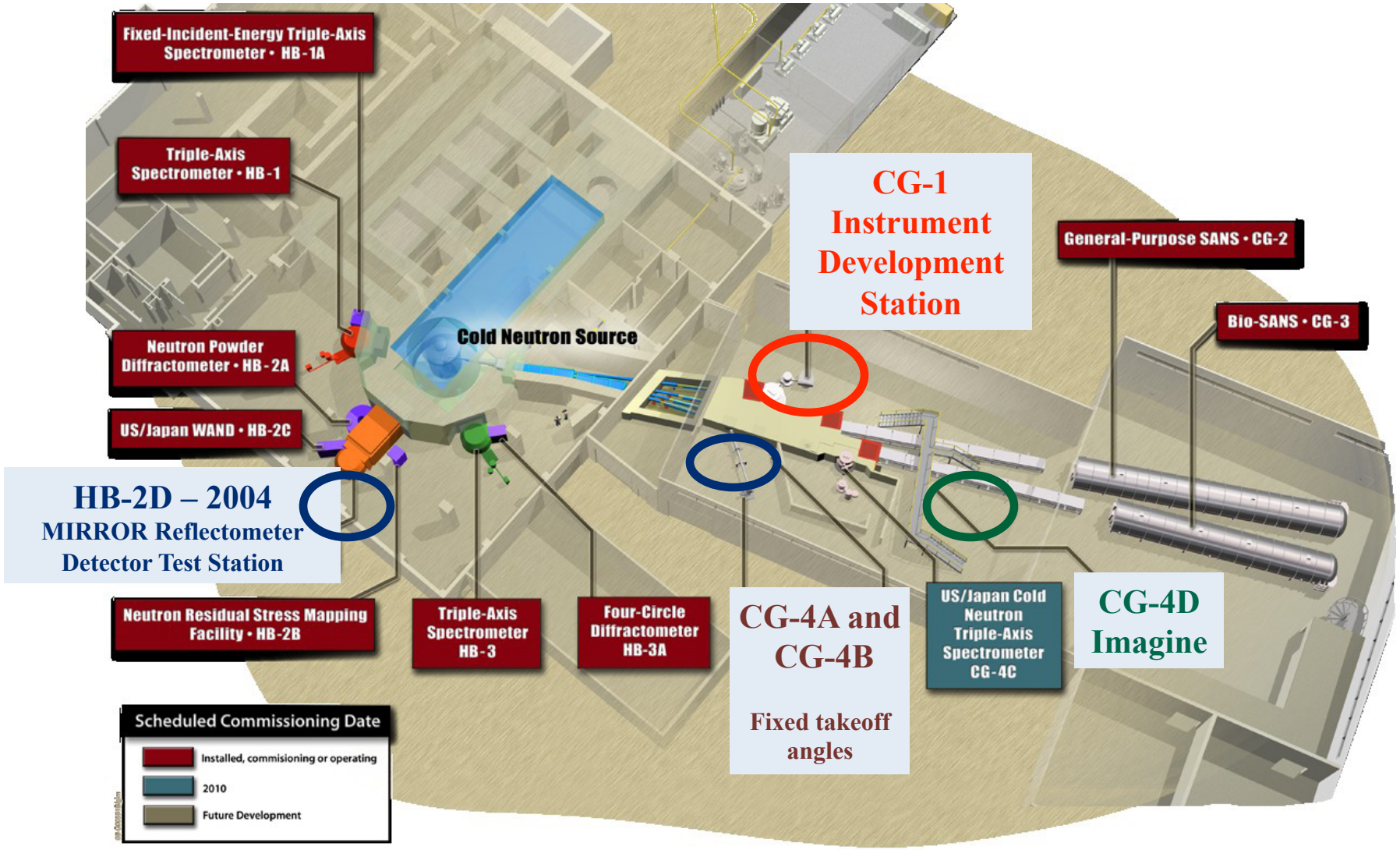
from nobelprize.org

ORNL operates two major Neutron Scattering Facilities – we are continuing to develop instrumentation at both

Instruments at the *Spallation Neutron Source*:



High Flux Isotope Reactor Instruments:



Neutron Facilities Development Division – Instrument Development Group

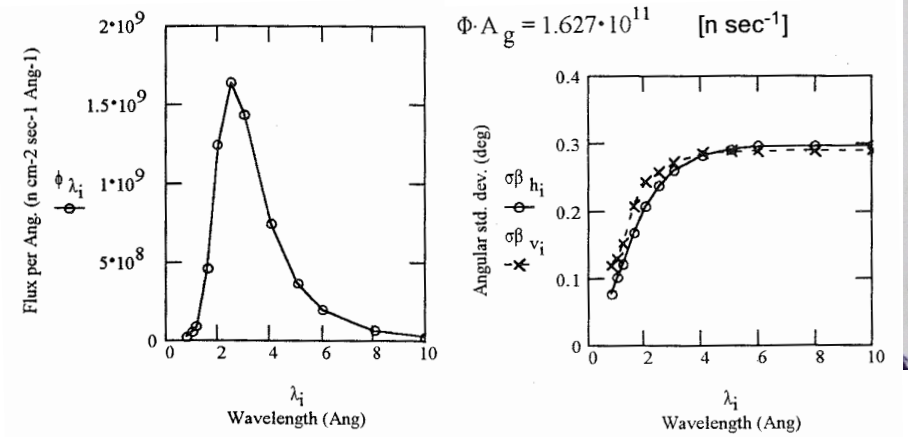
Lee Robertson, Lead
Lowell Crow
Hassina Bilheux (powder diffraction group) – Imaging development
Tony Tong – ^{3}He polarization
Mike Fleenor
Ducu Stoica (powder diffraction group)
Kevin Berry (detector group)
Students: Daniel Brown, Nicholas Thomas

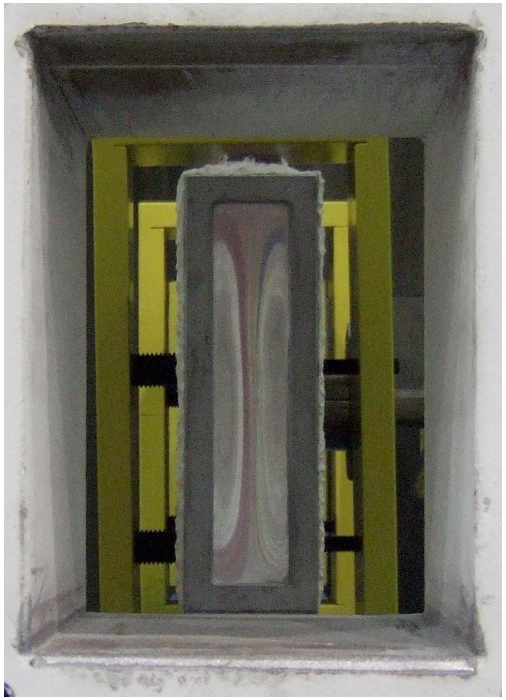
Support from HFIR upgrades, instrument support, engineering, neutronics, detectors, data acquisition

A closer look at CG1:

CG1 guide on the HFIR Cold Source:
large area (25 mm wide × 150 mm tall)
high flux (> 10^9 n/cm^2 s)
cutoff of about 1.6 Å.

Guide Calculations by Ralph Moon (2001)

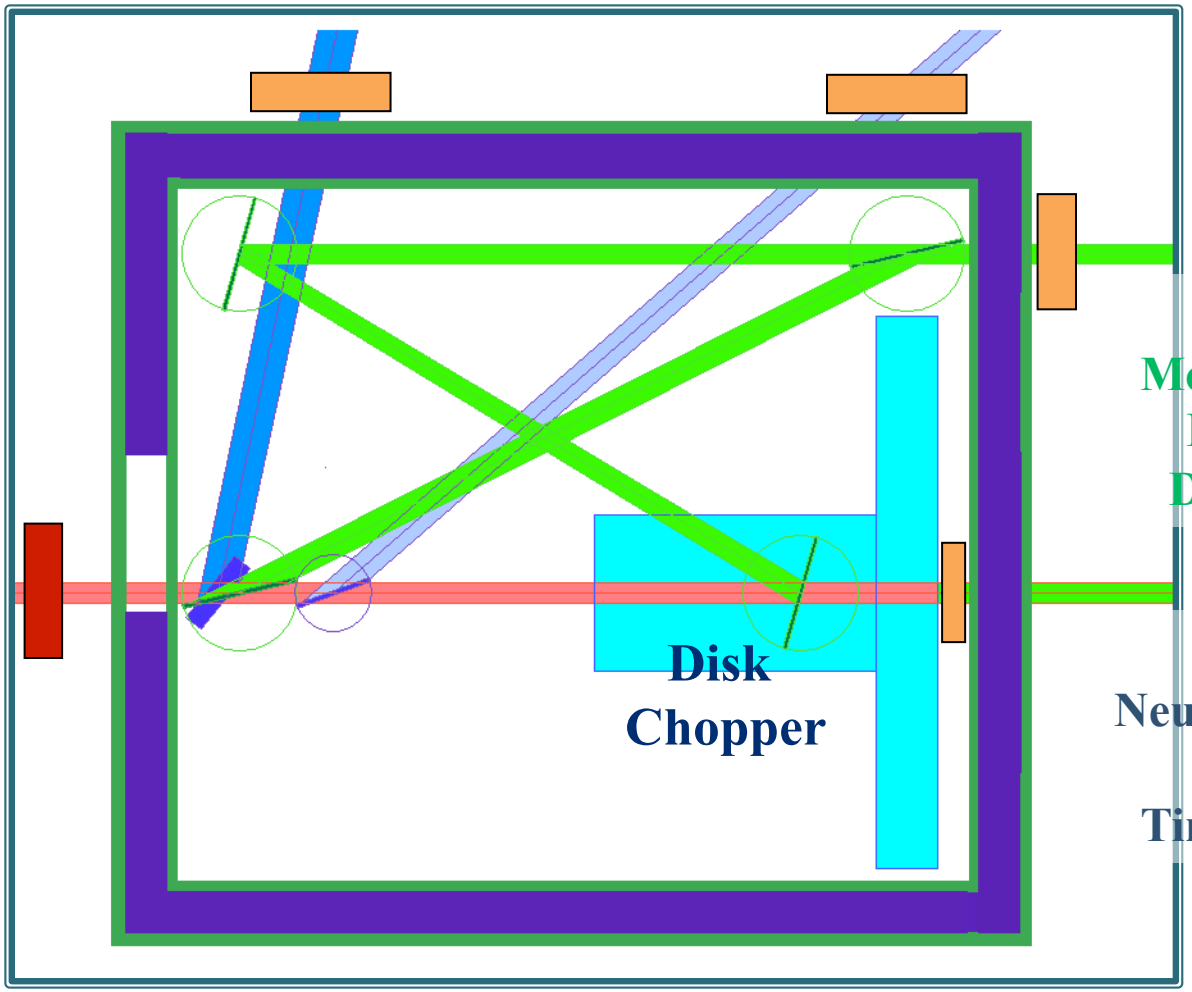




1 Guide
4 Beamlines

CG1A
SERGIS

CG1B
Utility Diffractometer



CG1
Main
Beam

CG1C
Monochromatic
Imaging &
Development

CG1D
Neutron Optics /
Imaging
Time-of-Flight

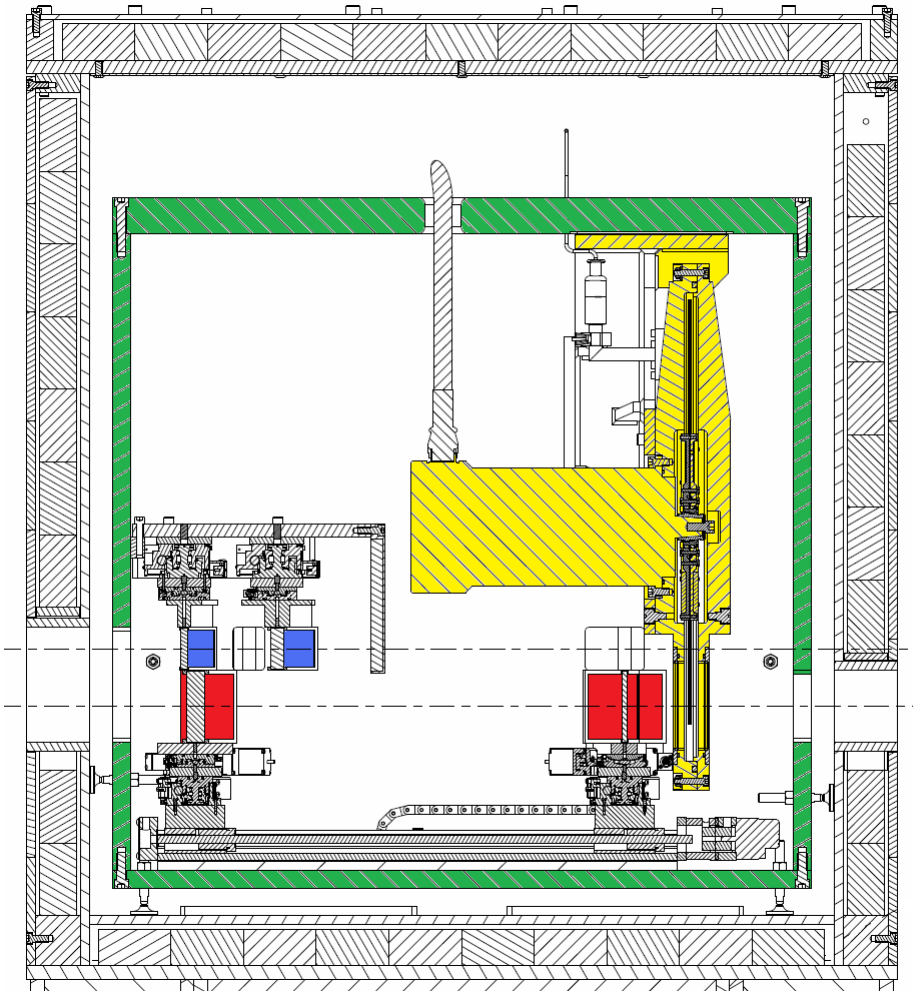
Monochromator / Chopper Shielding Enclosure

Drawing showing monochromators and chopper in enclosure

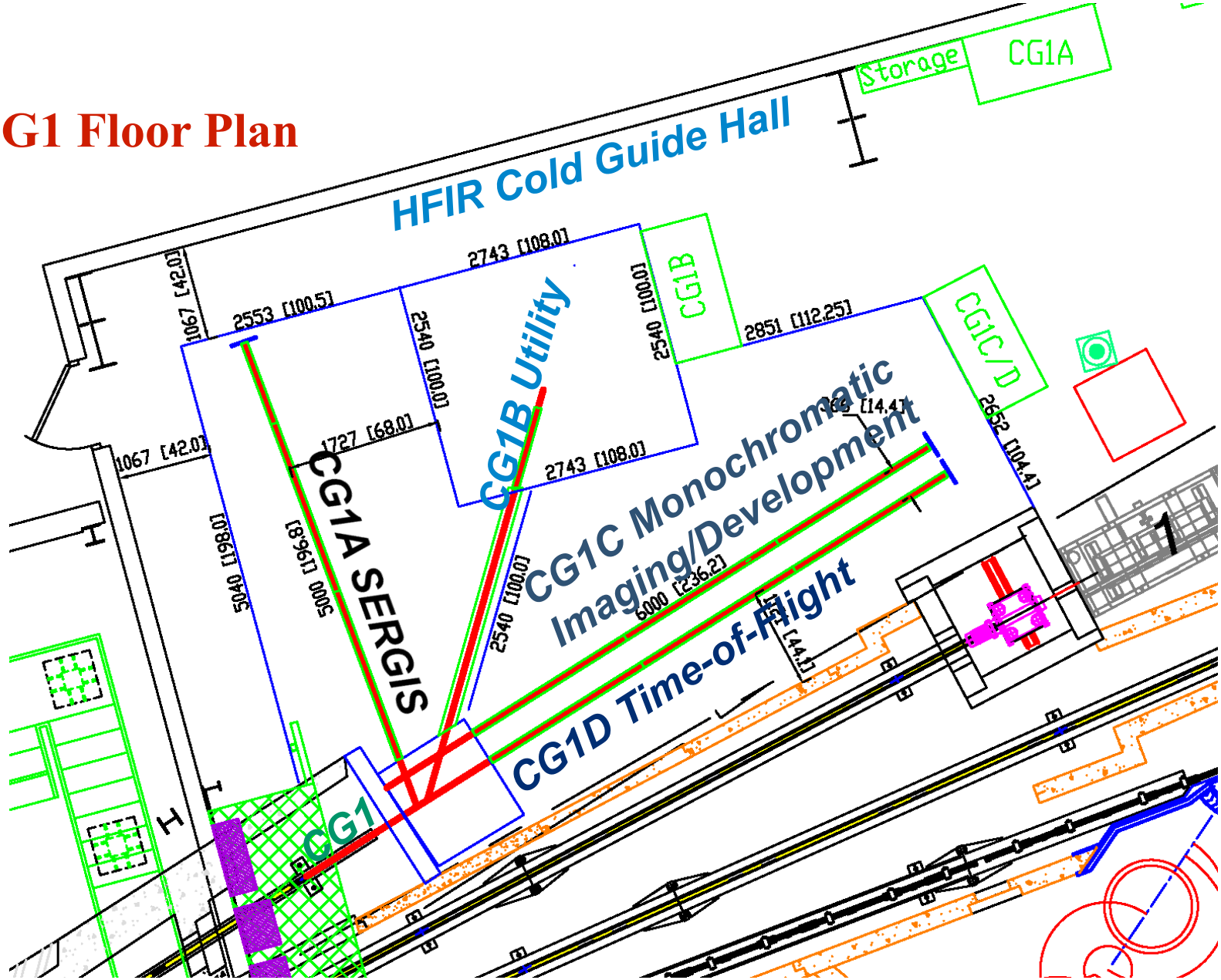
Upper 60 mm – graphite monochromators for SERGIS and Utility Diffractometer

Lower 90 mm – double bounce plastically deformed Si (111) crystals for variable monochromatic beam

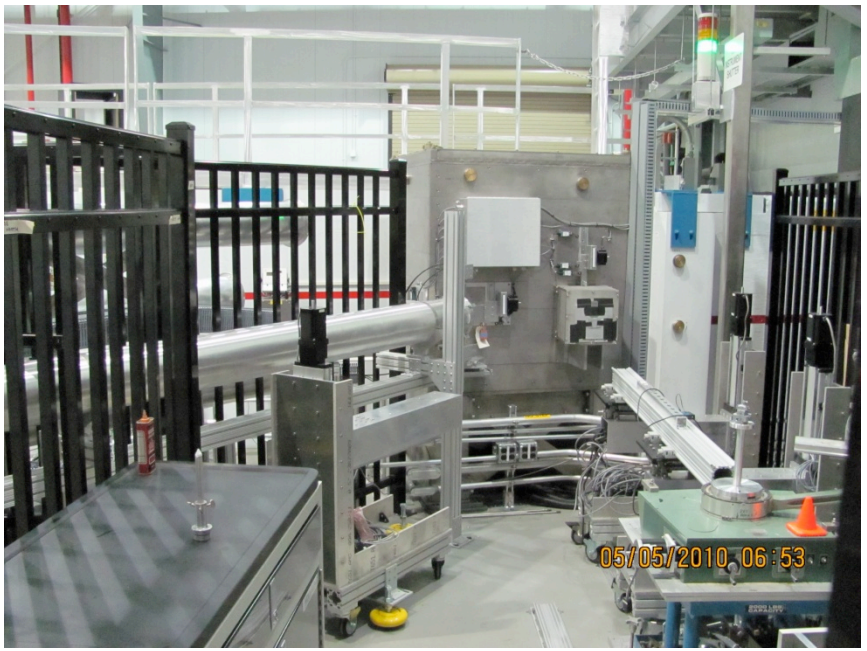
Chopper (formerly used at GPPD at IPNS) for cold time-of-flight beam



CG1 Floor Plan



CG1A – 4.22 Å beam in commissioning, so far used in analyzer alignment, irradiation, and detector tests



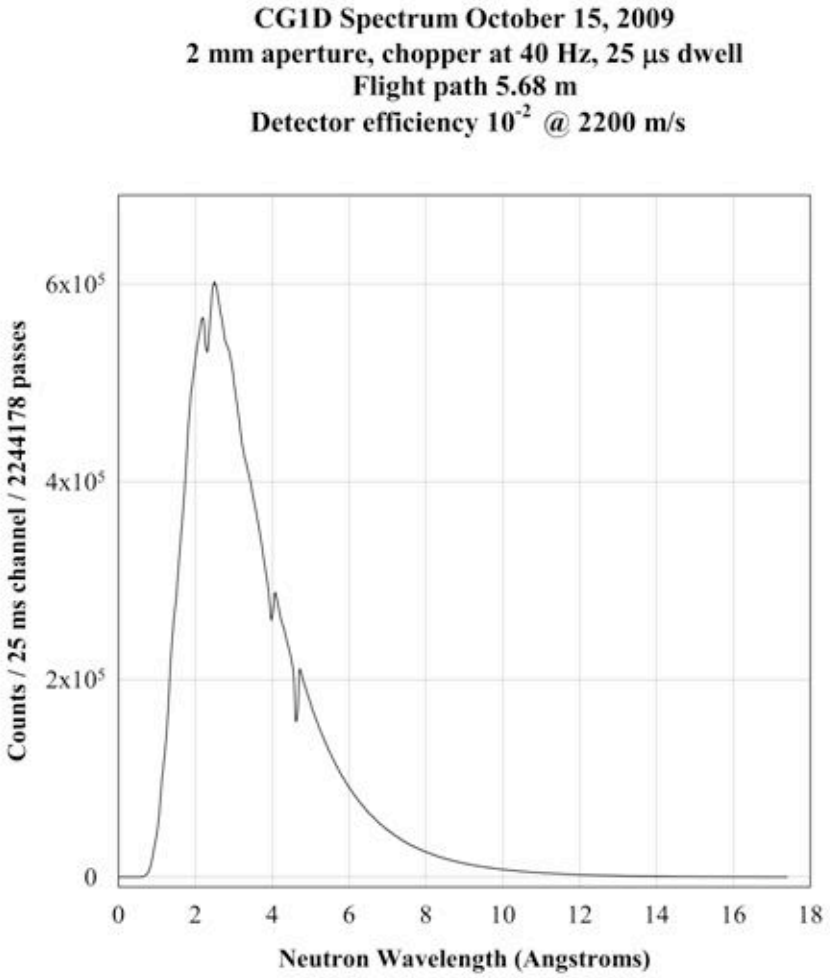
Goal is to build a SERGIS (Spin Echo Resolved Grazing Incidence Scattering) prototype, using polarized neutrons to build a high rate, high resolution reflectometer

CG1B – Utility Diffractometer began Summer 2010, now in full operation

CG1C – "double bounce" monochromator will be made with two pressed silicon single crystals. This will provide a large variable wavelength beam for instrument and imaging development.

CG1D – Chopper Time-of-flight beamline for instrument and imaging development, operating since Fall 2009

Initial Commissioning of CG1D September 2009



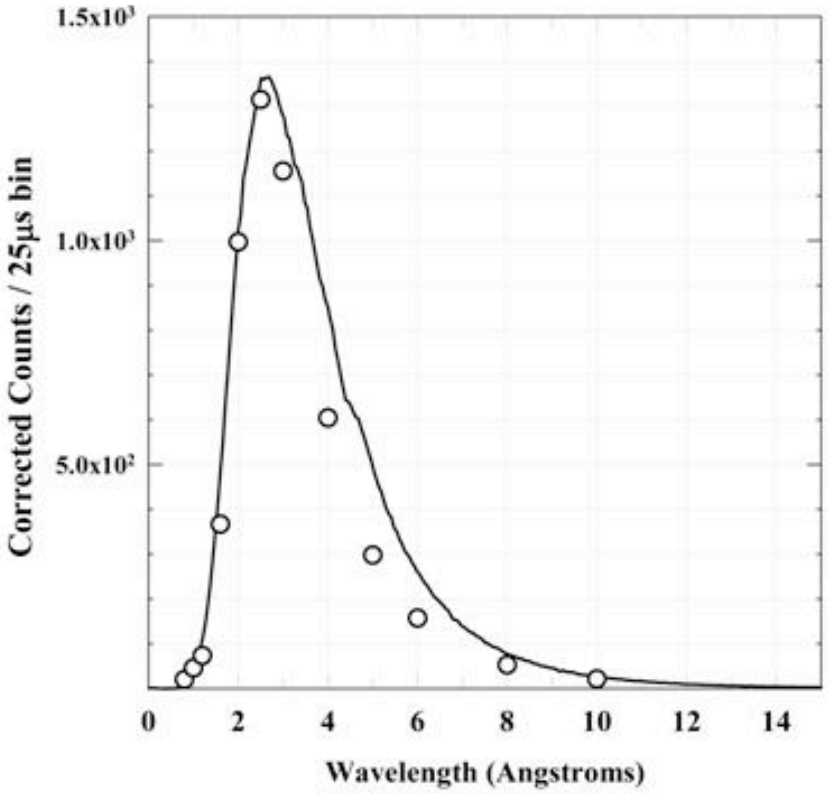
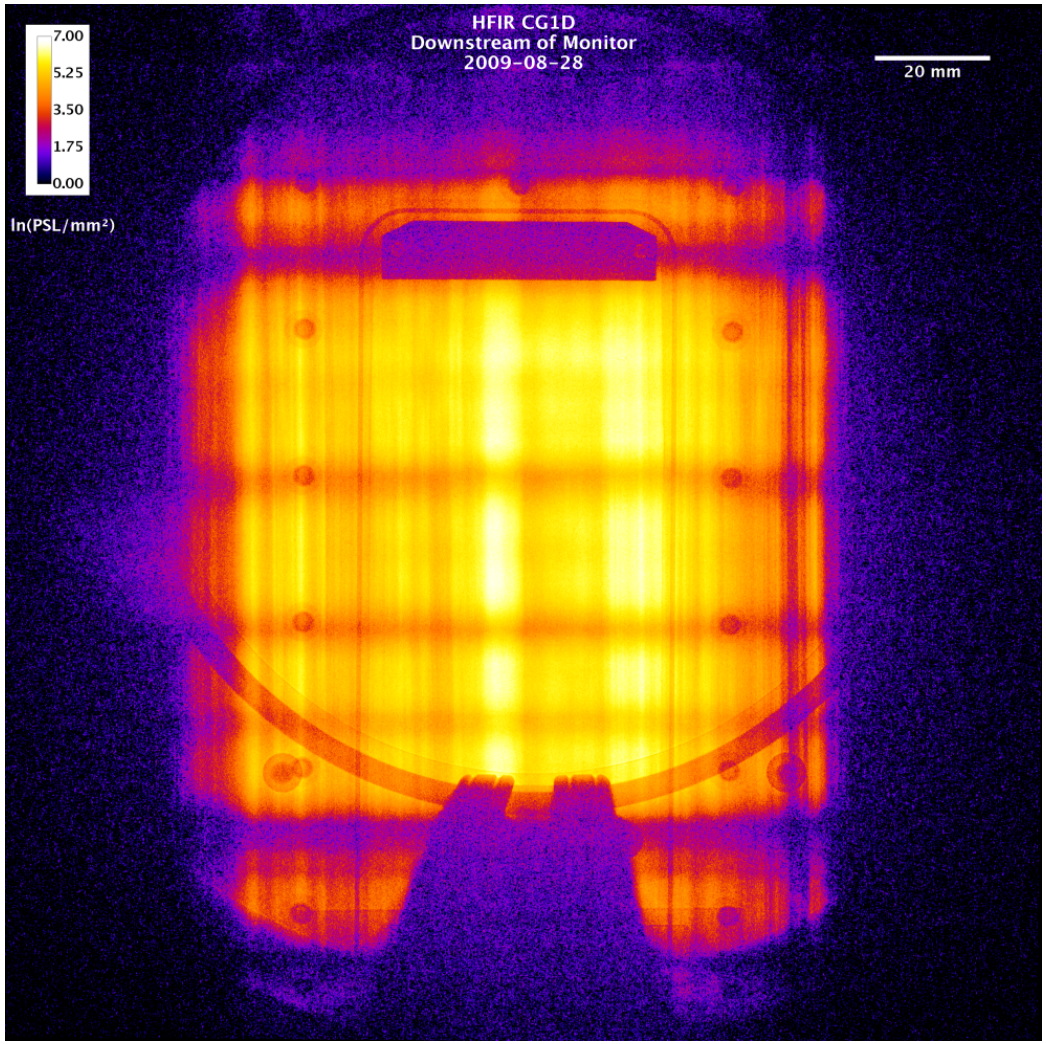


Image plate view at 5.5 m from chopper (with chopper at 20 Hz) – the image shows the neutron monitor detector, flight path O-ring, and internal mounting rail, in addition to the beam divergence structure (Erik Iverson)



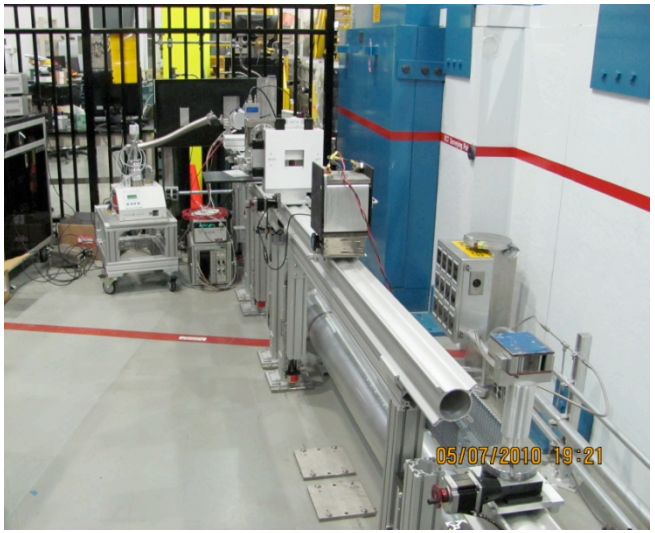
Instrument Development Test Station at the High Flux Isotope Reactor at ORNL

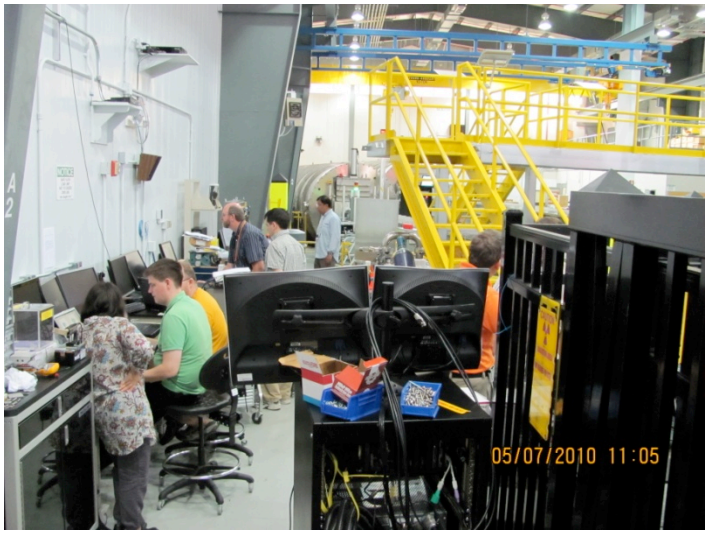
Current activities May 2010

Four neutron beams for development and support of neutron scattering

Instruments designed for frequent changes in configuration to address new development needs and ideas

CG1D, for example, will be run with 4 different component arrangements in the present cycle





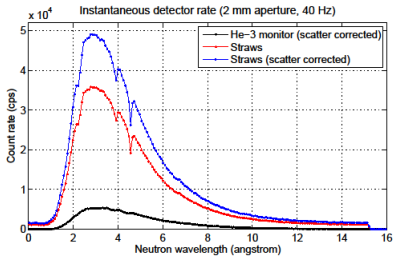
MISANS (modulated intensity small angle neutron scattering) prototype test in progress

HFIR Cycle 428 (May2010):

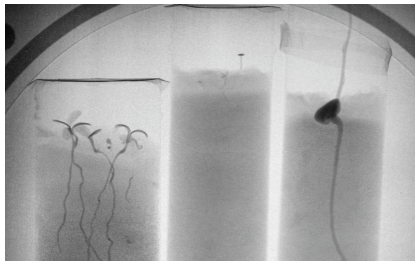
CG1D: MISANS prototype testing (with Argonne/Munich/Delft)
Straw tube detector test (Proportional Technologies)
Imaging system tests
United Technologies Plasma jet imaging

CG1A: Alignment of samples for ARCS and Sequoia at SNS
Testing of analyzers for Vision at SNS

CG1B: Completion and initial commissioning



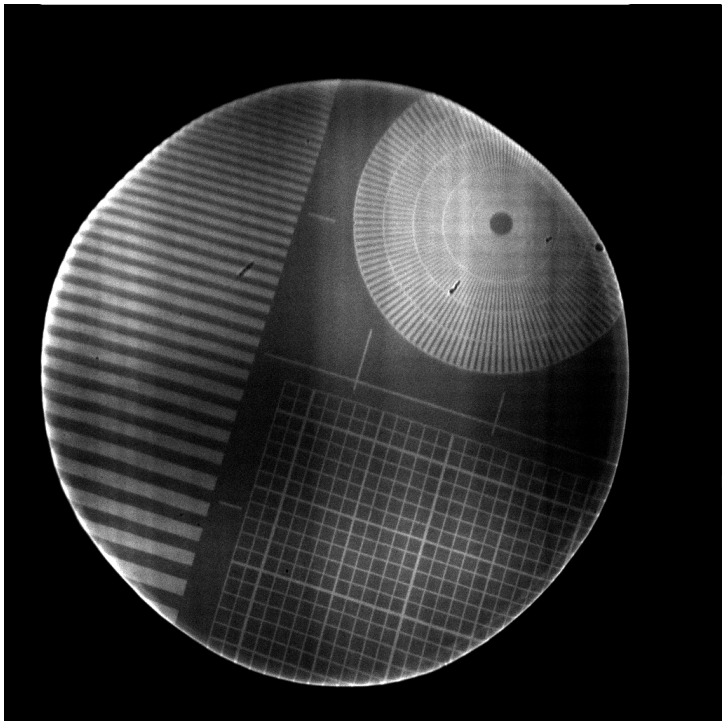
Straw tube spectra
(Proportional Technologies, taken on CG1D)



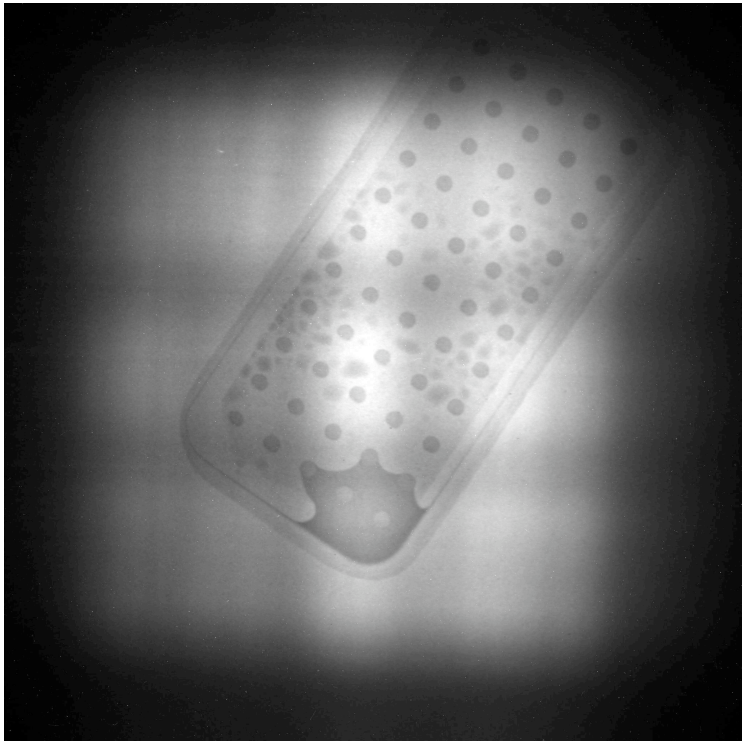
Neutron plant image

Operated by the Instrument Development Group: **Lee Robertson (Group Leader), Lowell Crow, Xin (Tony) Tong, Michael Fleenor, Ducu Stoica, Hassina Bilheux, Daniel R. Brown, Nicholas G. Thomas , Erik Iverson, Kevin Berry**

Imaging (Hassina Bilheux, collaborators from U. of Tennessee, several other ORNL divisions)



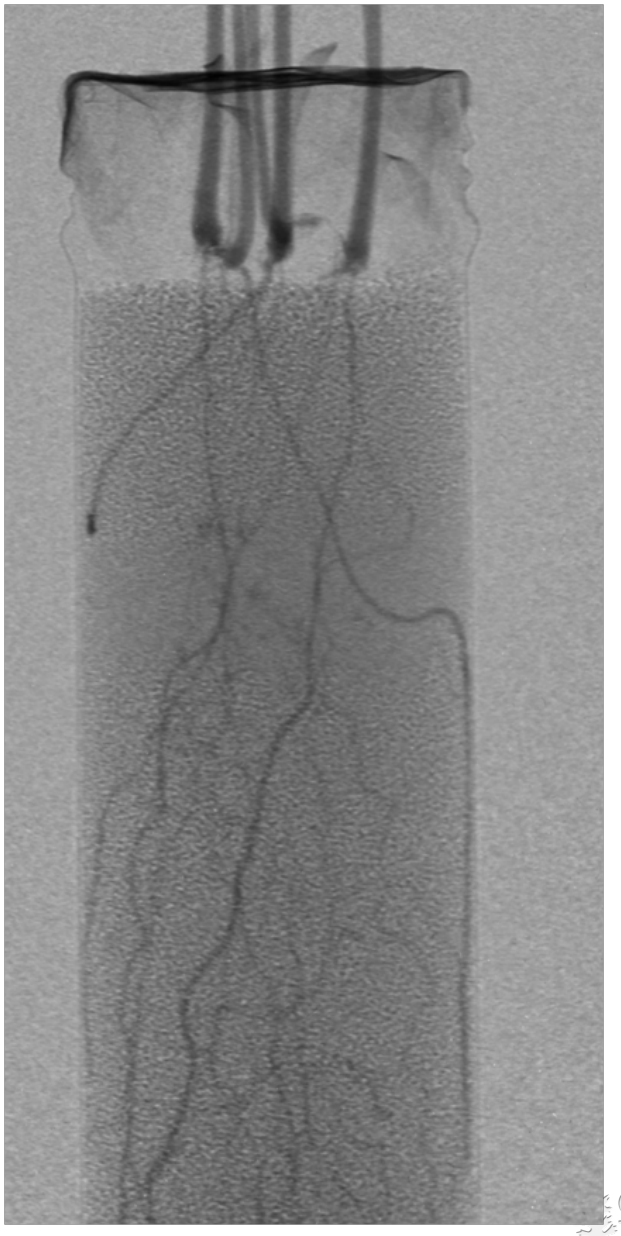
Resolution mask with microchannel plate detector indicates resolution smaller than 100 µm



Water is visible in this heat exchanger image using a scintillator/CCD camera. A graphite diffuser has softened the sharp features in the incident spectrum (H. Bilheux, R. Hale, R. Childs)

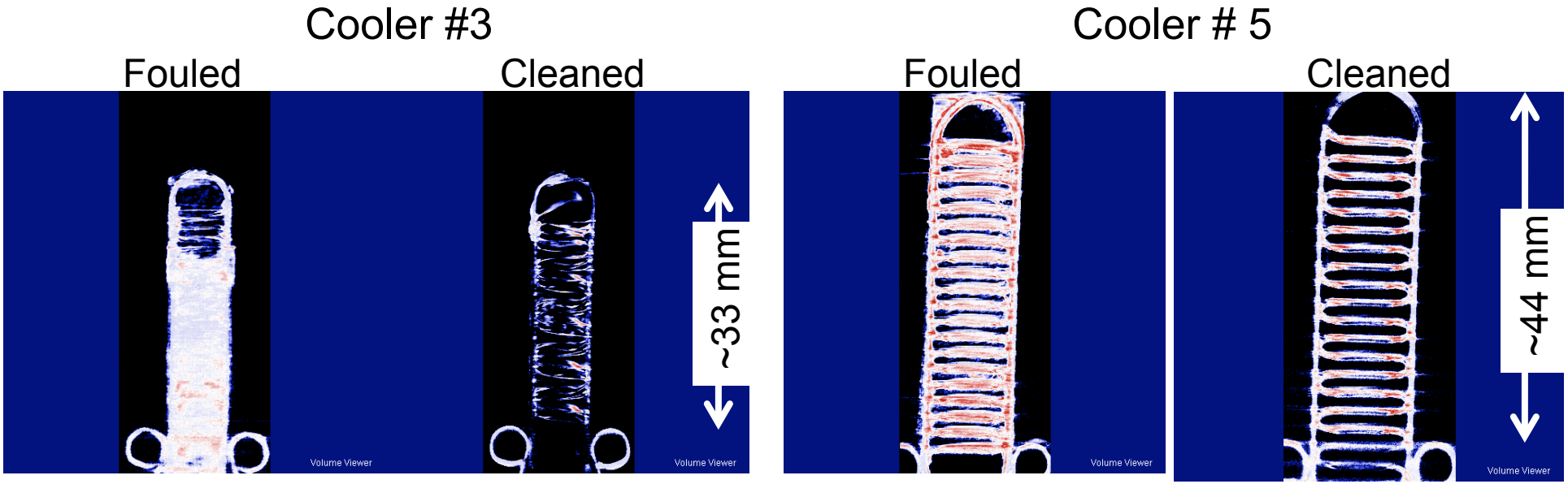
Switchgrass

(H. Bilheux, J. Warren, (ORNL), Misun Kang (UT/ORNL))



Neutron Tomography: Industry-Provided Diesel EGR Cooler Tube Sections

Michael Lance, Hassina Bilheux, Keely Willis (ORNL), Andrea Strzelec (ORNL/PNNL)

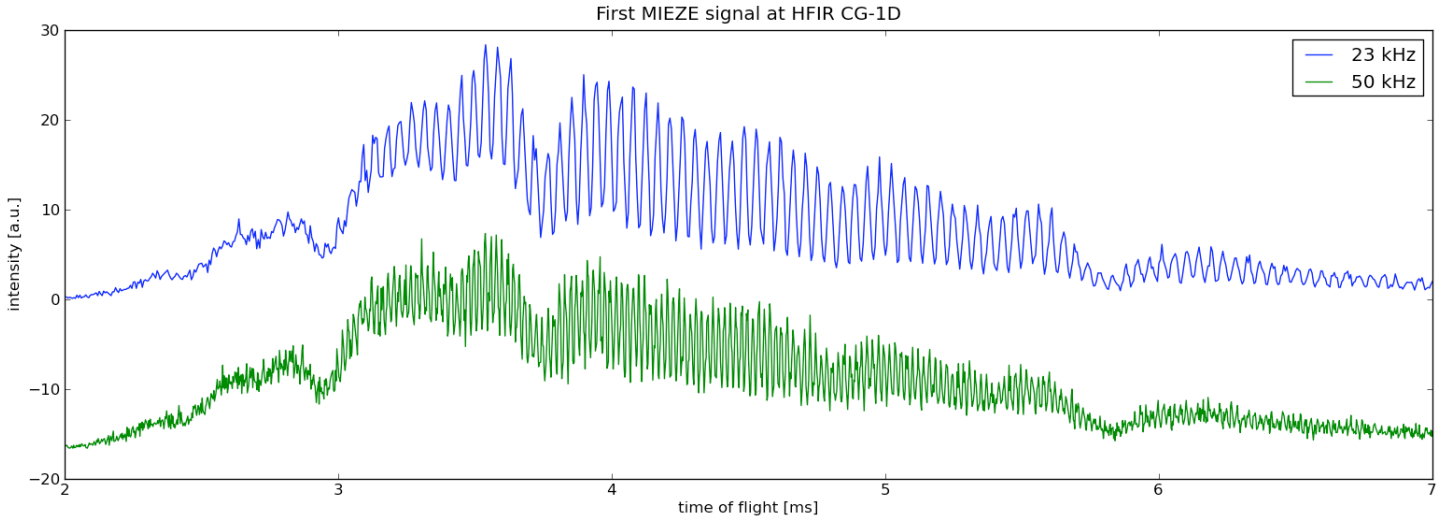


- **Neutrons are strongly attenuated by hydrogen which allows for non-destructive imaging of the deposit through the metal.**
- **The two coolers with the most HC were selected for neutron tomography.**
- **Tomographs were collected by rotating the samples and acquiring 720 radiographs. (~14 hours for all 4 coolers, with the CG1D "white beam")**

Polarized neutron prototype:

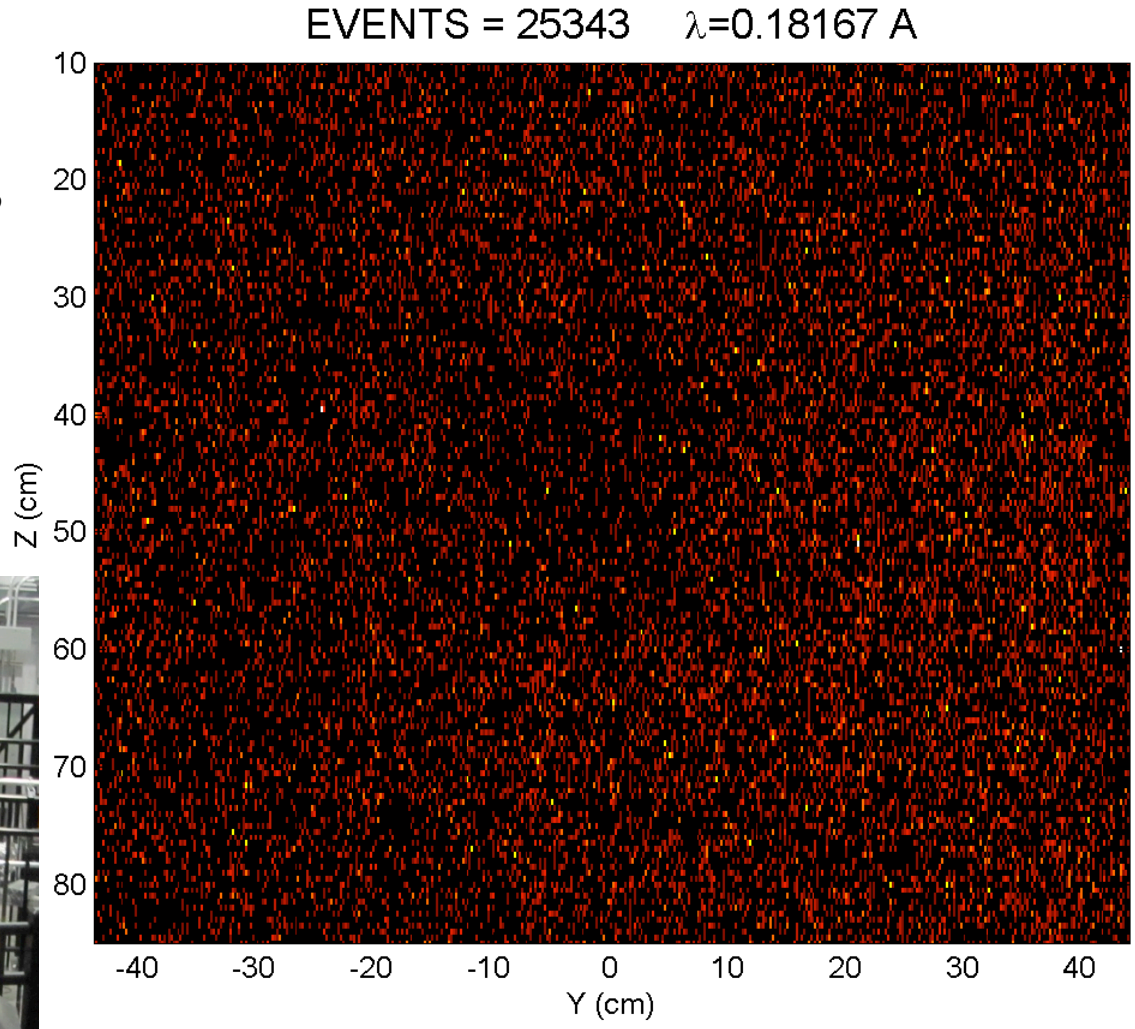
MISANS (Modulated Intensity Small Angle Neutron Scattering)

J. Lal, J. Carpenter, Argonne
R. Georgii, Georg Brandl, TU Munich
M. Bleuel, TU Delft



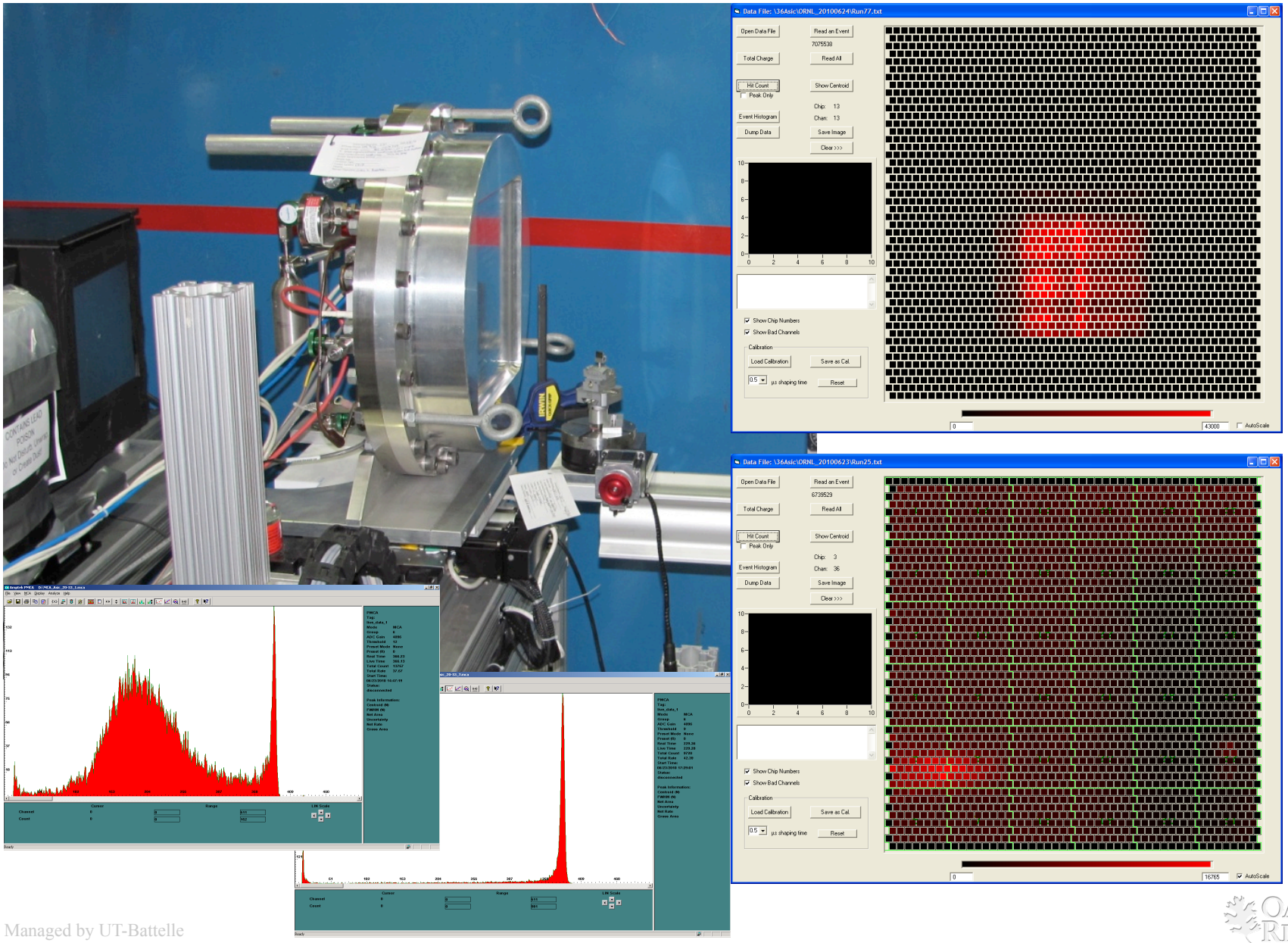
Boron Straw Tube Detectors

SBIR project by Proportional Technologies, Inc, Houston
Array of 1100 4 mm diameter 1 m long boron straw tube detectors



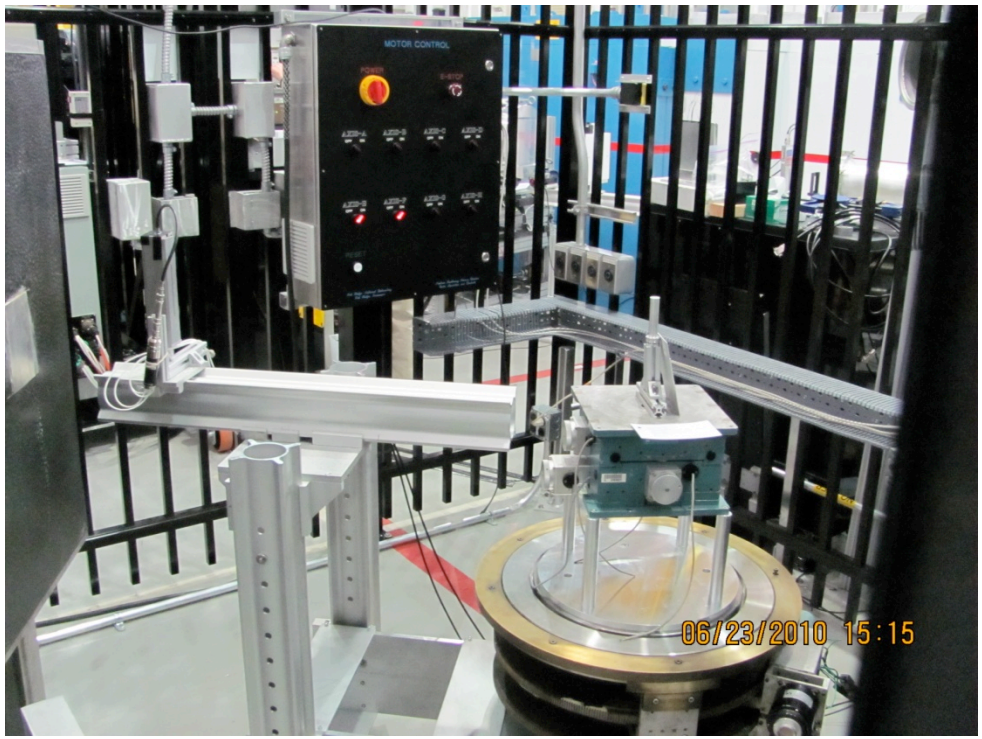
Time-of-flight SANS detector demonstration

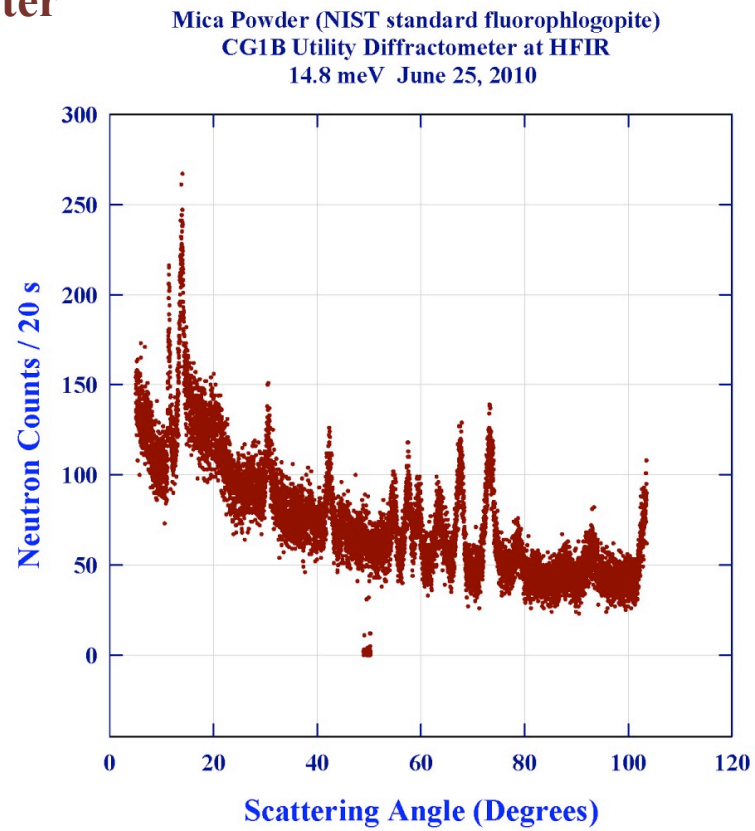
Brookhaven Ionization Mode "Pad" detector (BNL/ORNL collaboration)



CG1 Instrument Development Test Station at HFIR

Initial Commissioning of CG1B Utility Diffractometer
Started June 18, 2010 (HFIR cycle 429)
Initial calibration scans
2.417 Å, 14.0 meV





Monochromator/analyzer tests
Sample alignment (saves time on user instruments)
Optics and components tests (*e.g.* sample cans)

Flux is about 1.4 x 10^6 n/cm^2 s
Beam is up to 8 × 8 cm^2 at about 4 m from the flat graphite monochromator

August: Cycle 430 – 8 measurements
October: Cycle 431 – 16 measurements planned