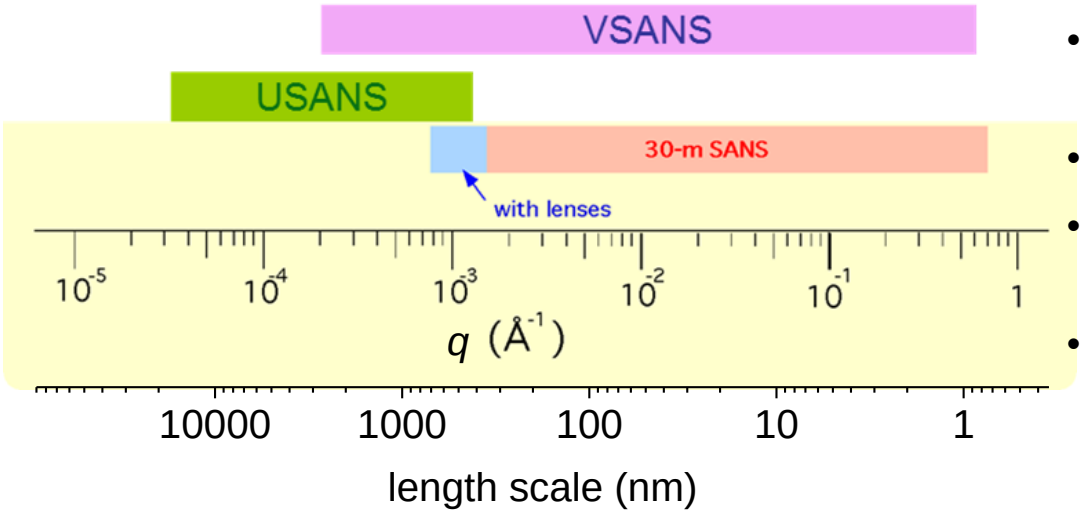
A virtual tour of vSANS: Very Small-Angle Neutron Scattering Diffractometer

(https://www.nist.gov/ncnr/chrns-vsans-very-small-angle-neutron-scattering)

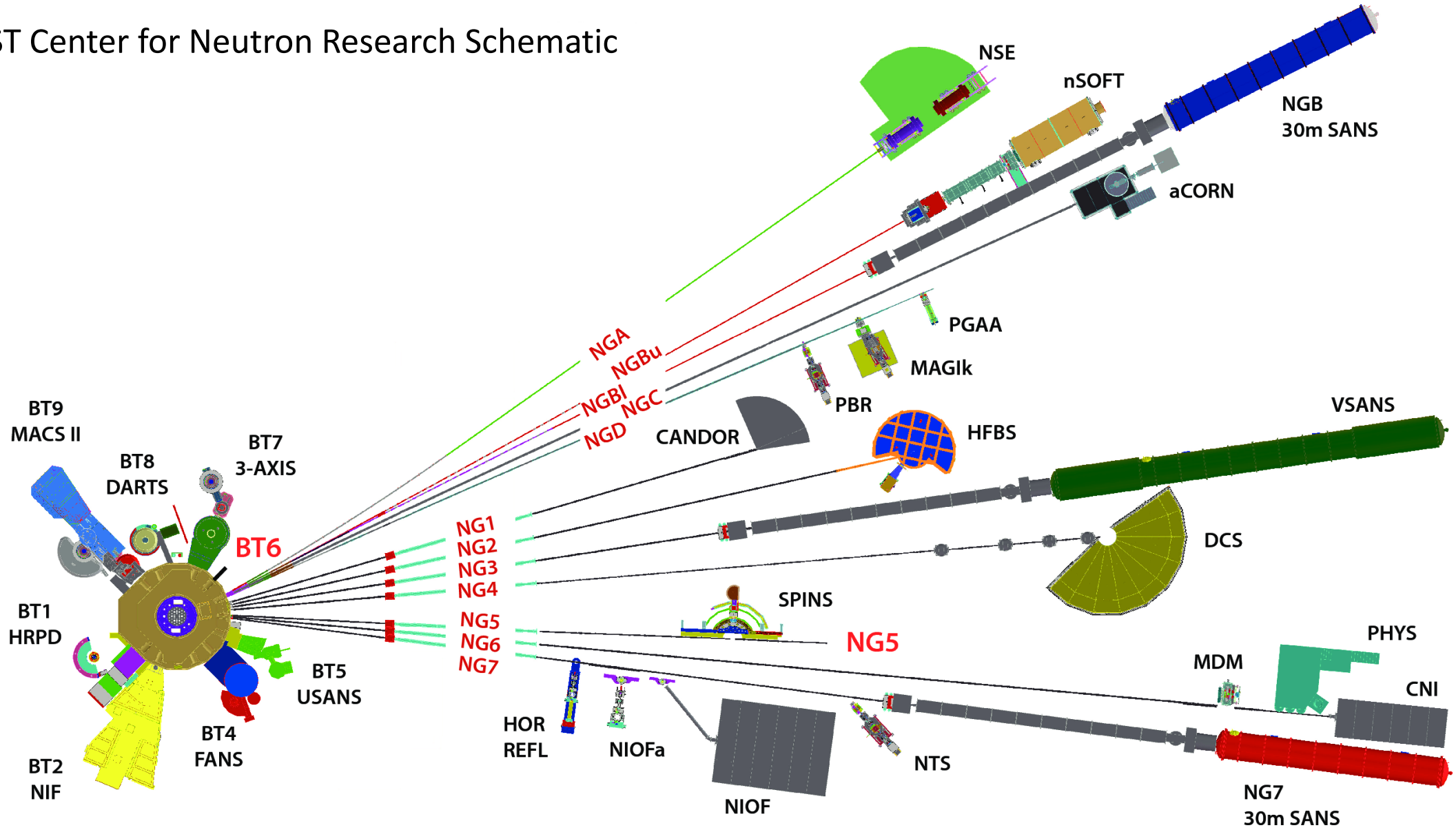
Flexibility, *q* range, and flux

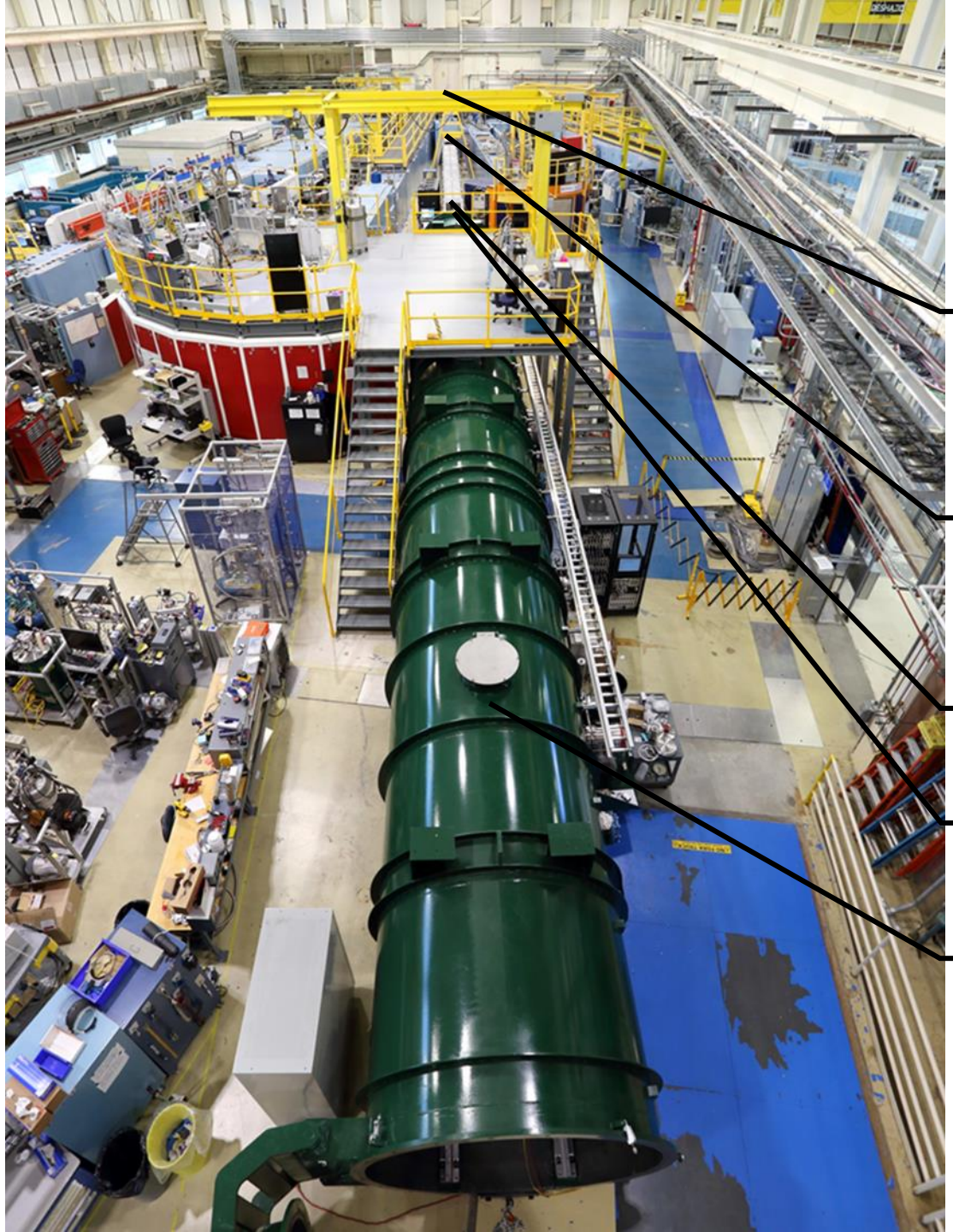


- **Higher neutron flux with new collimation choices**
- **Smaller scattering angles**
- **Wider *angle* range captured in one detector configuration**
- **1,000 x faster then USANS**

Courtesy of John Barker

NIST Center for Neutron Research Schematic





- **Higher neutron flux**
- **Lower scattering angles (low *q*)**
- **Polarized beam**

Wavelength options:
White beam, velocity selector, or HOPG graphite polarized

Beam collimation options:
Vertical slit, pinhole, converging apertures, guide field

Lenses and prisms

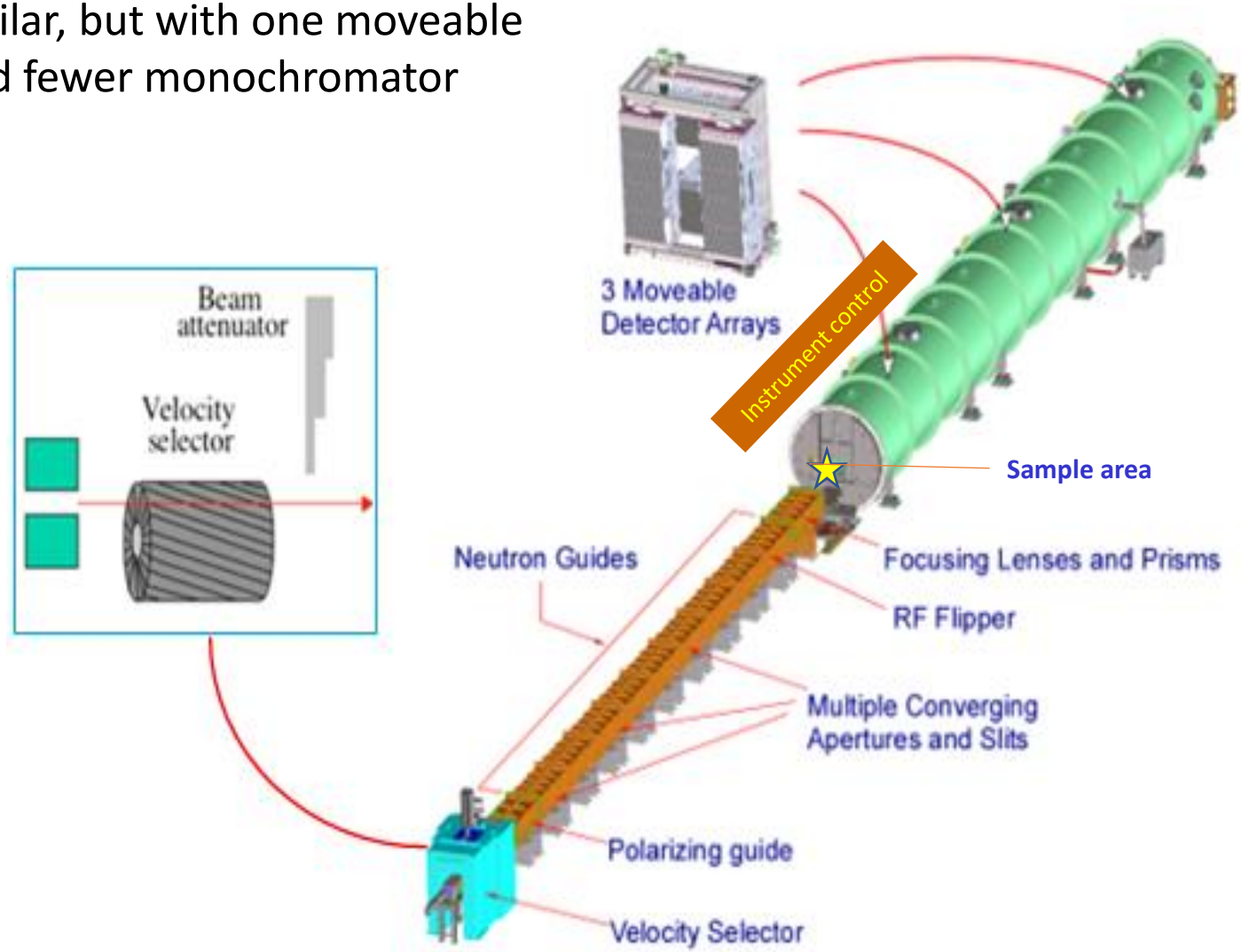
Larger (2m) sample area

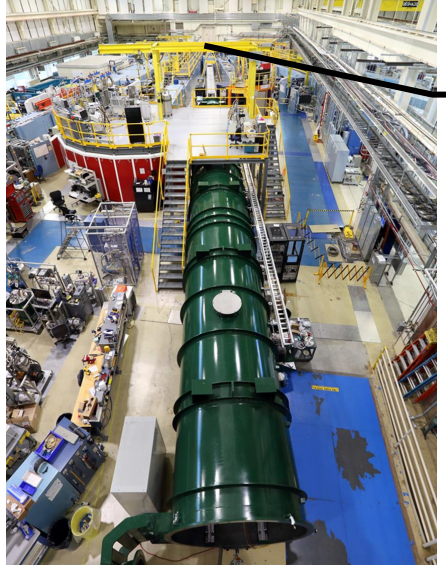
Three movable detector carriages; Two w. ^{3}He tube panels, one high resolution

Courtesy of John Barker

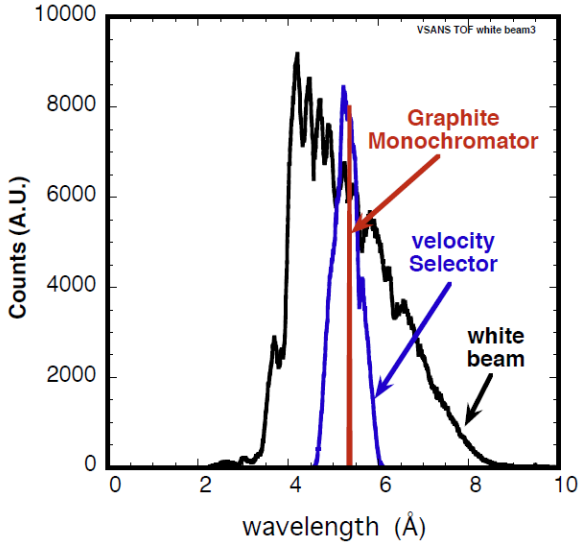
vSANS

(SANS is similar, but with one moveable detector and fewer monochromator options)

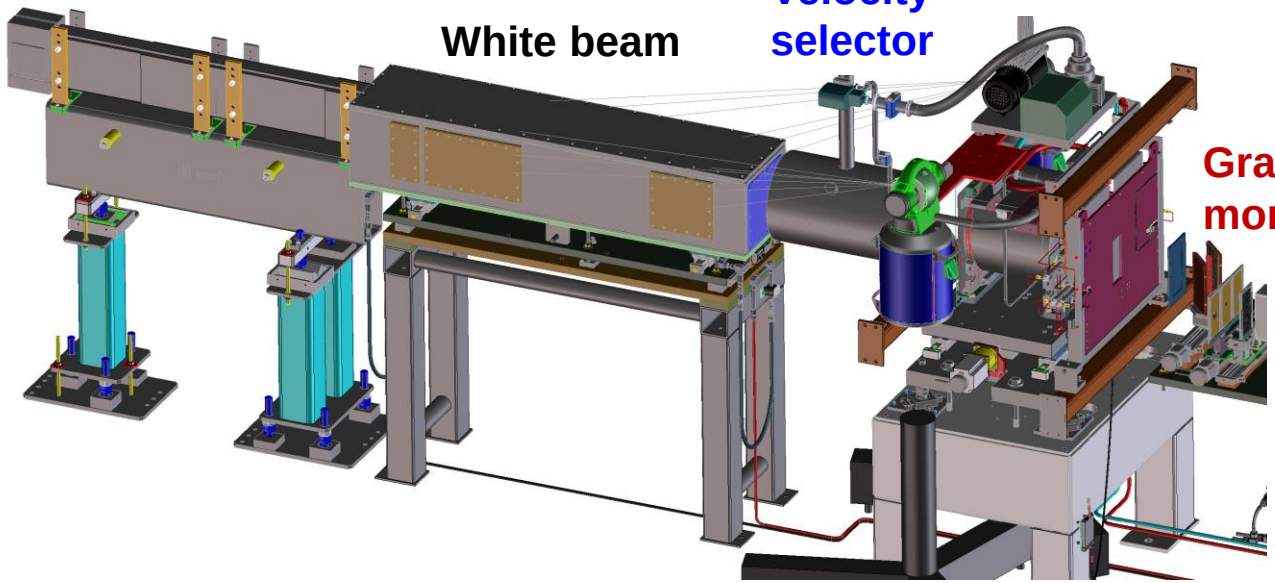




White beam, velocity selector or HOPG Graphite:



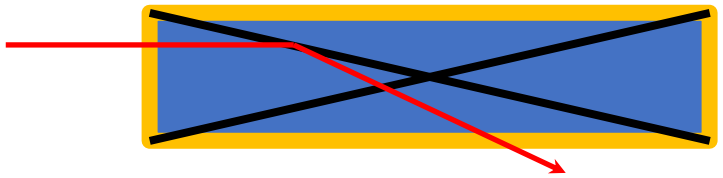
Type	Intensity
"White"	4x
Selector	1
Graphite	1/12 x



Courtesy of John Barker

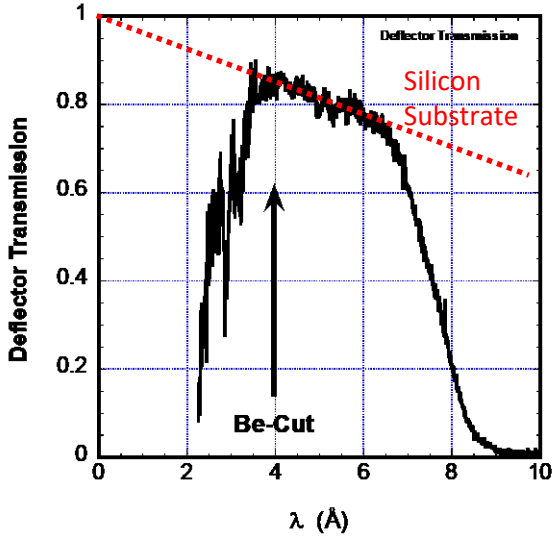
Monochromator options:

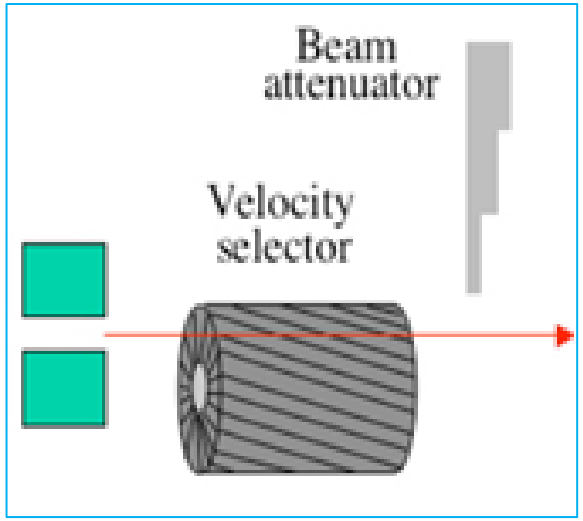
White Beam: Be filter (not shown) & “X” Mirror Deflector



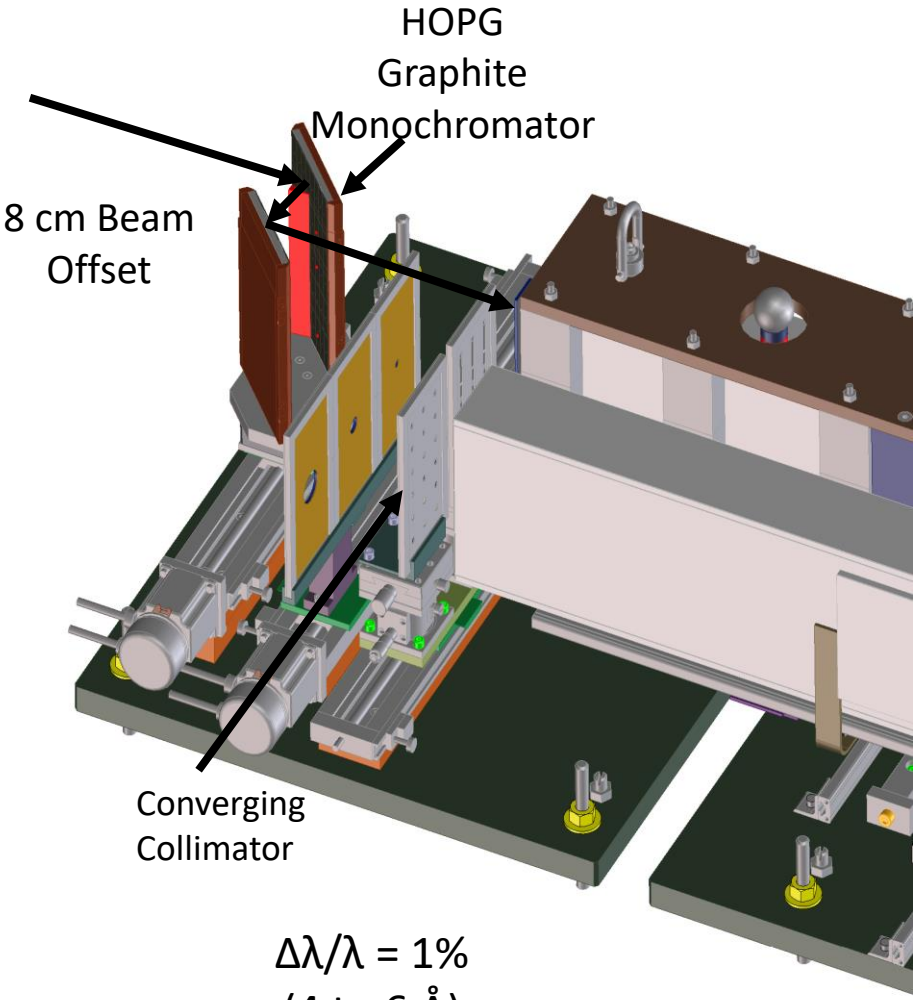
<λ> = 5.3 Å, $\frac{\Delta\lambda}{\lambda} = 40\%$

Gain = 4





Δλ/λ = 12%
(4.5 to 12 Å)



Δλ/λ = 1%
(4 to 6 Å)

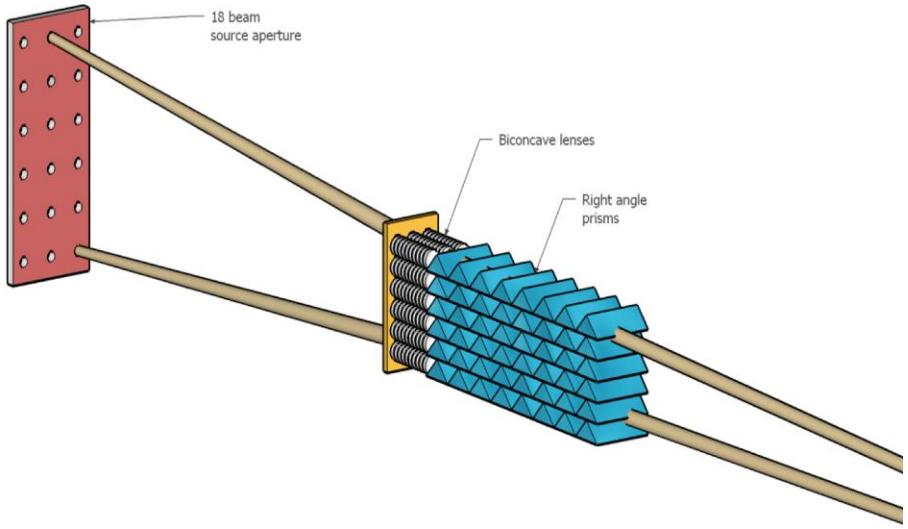
Images courtesy of John Barker

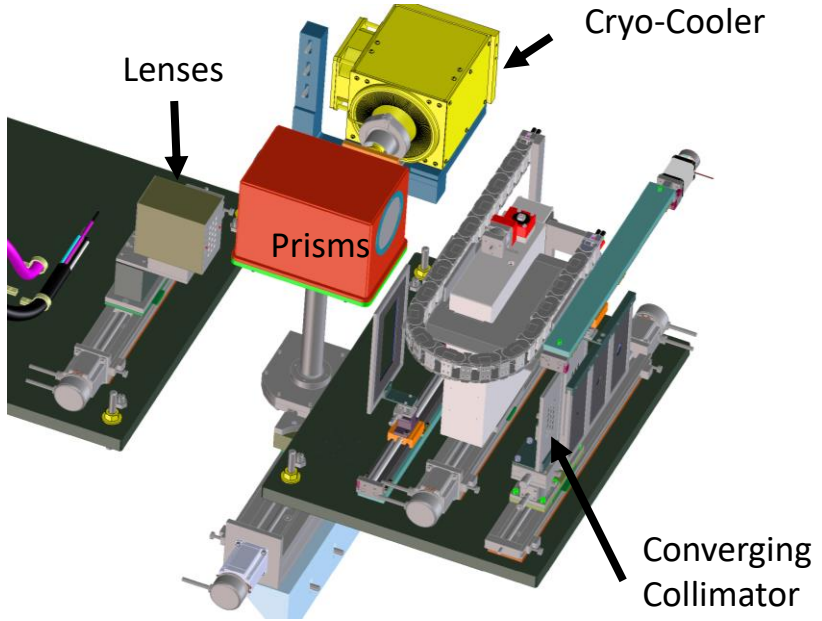
Collimation: circular pinhole, slits, or converging beams (shown here for use with High-Resolution CCD Camera):

Q_{min} = 2e-4 Å^{-1}, $\lambda = 6.7$ Å

(Q_{min} 3e-4 Å^{-1} for polarized)

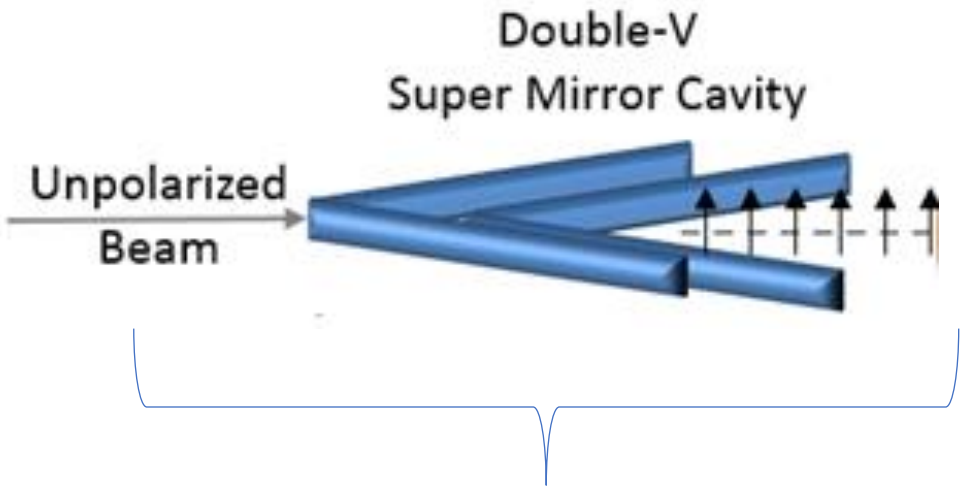
- 18 converging beams
- 13 apertures (cross-talk)
- 14 Lenses / beam
- 9 Prisms / beam (gravity)



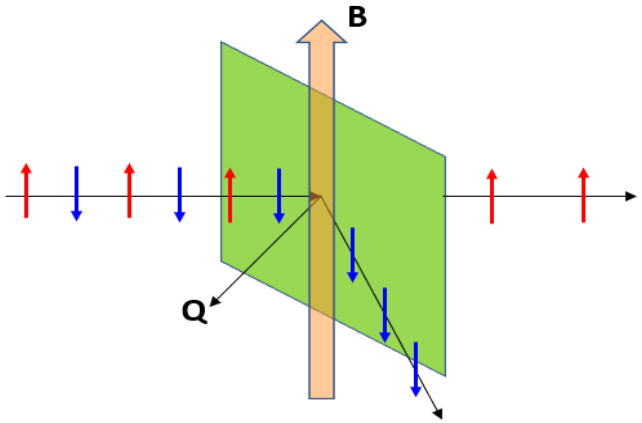


Courtesy of John Barker

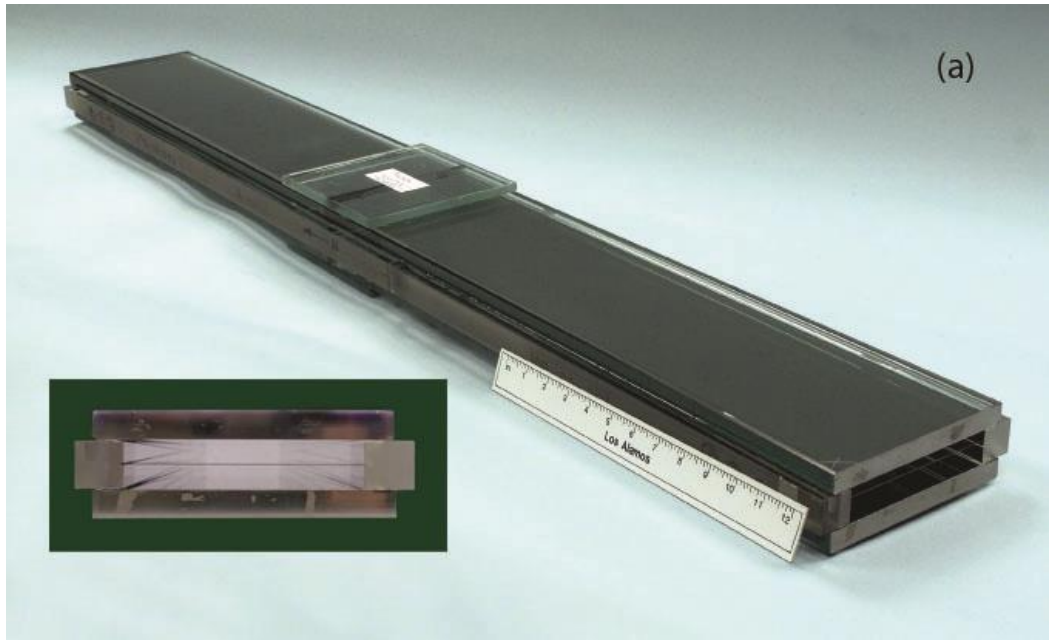
Neutron Spin Polarizer (neutron spin precess about +/- neutron polarization axis)



SLD for $n^{\uparrow}$, $n^{\downarrow}$ = $b_{nuclear}$ -,+ $b_{magnetic}$

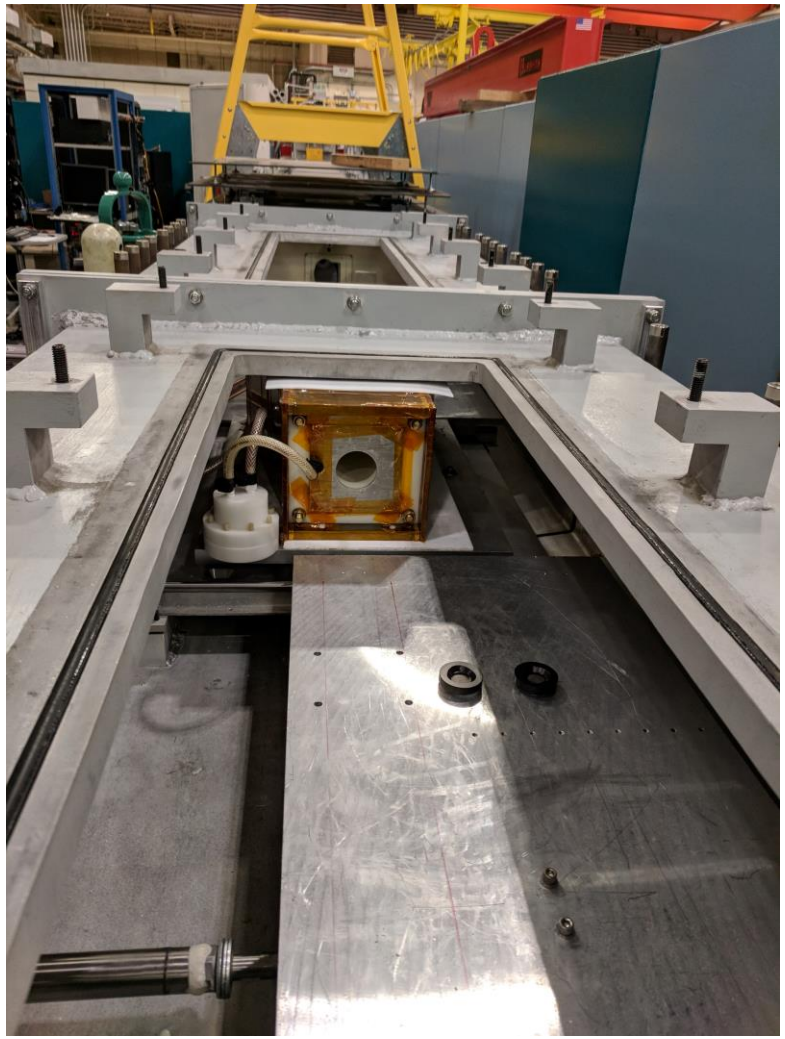


FeSi super mirror



$P \equiv (n^{\uparrow} - n^{\downarrow})/(n^{\uparrow} + n^{\downarrow}) >= 99.85\ \%$

Multiple guide boxes (with magnetic guide field)



- Multiple guide boxes contain neutron guides and focusing optics
- At VSANS and NG7 SANS, these guides are fit with magnets and steel plates which create a uniform, vertical magnetic field from the neutron spin polarizing supermirror to the RF spin flipper. The vertical field extends beyond the last guide, into the sample area.
- Here a section of guide is shown with the top removed. The exiting edge of the RF flipper (NG7 SANS) is shown.
- The whole series of guide boxes are evacuated for experiments in order to reduce air scattering.

RF Flipper for Polarized Beam (translates with beam offset)

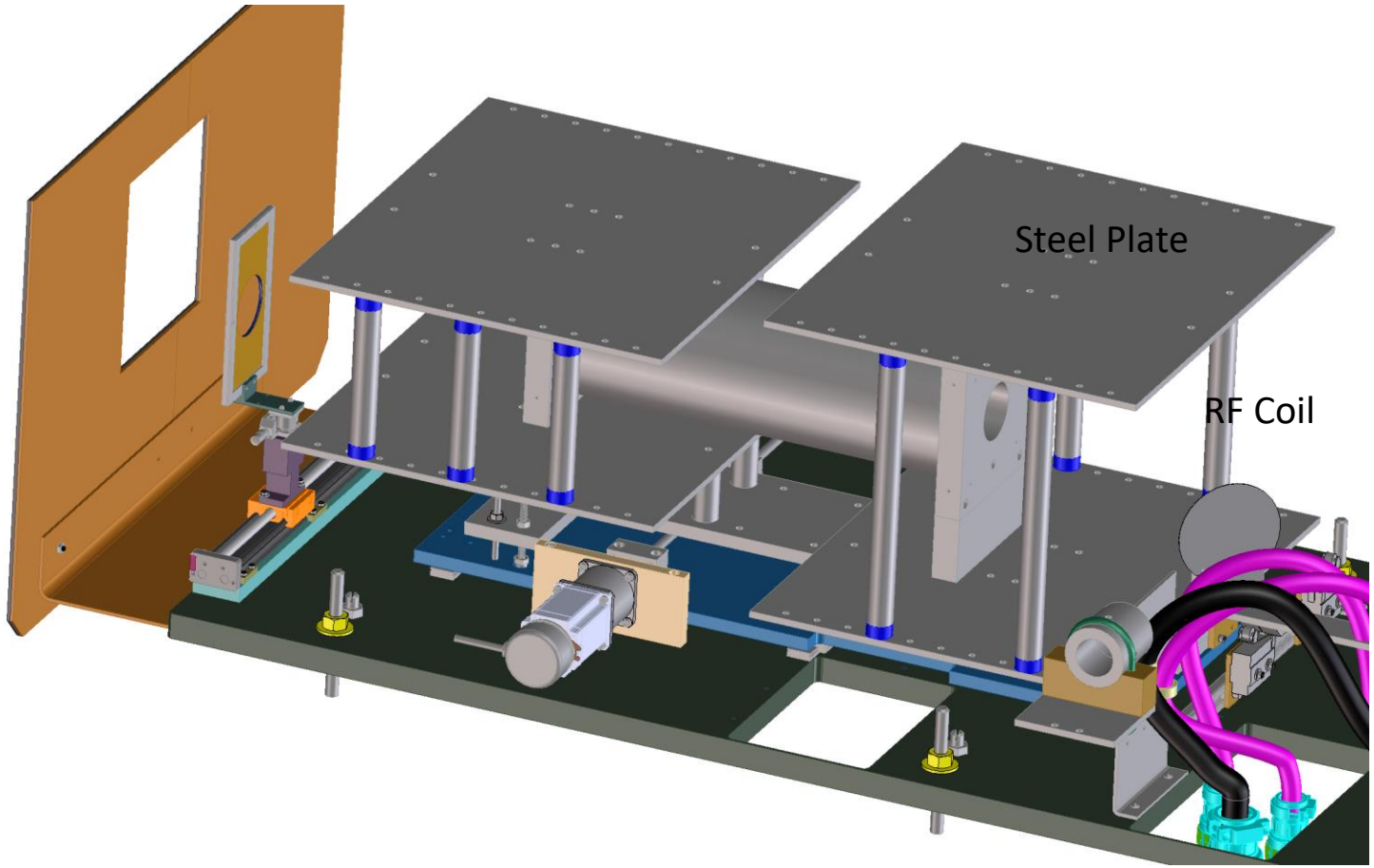
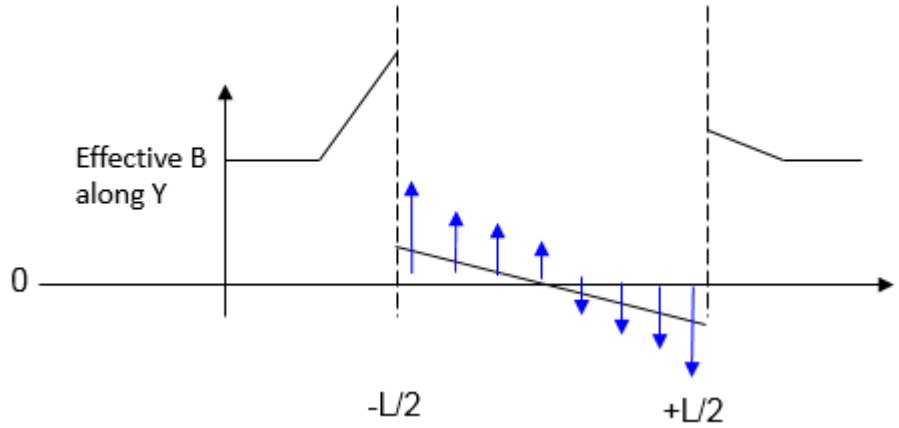
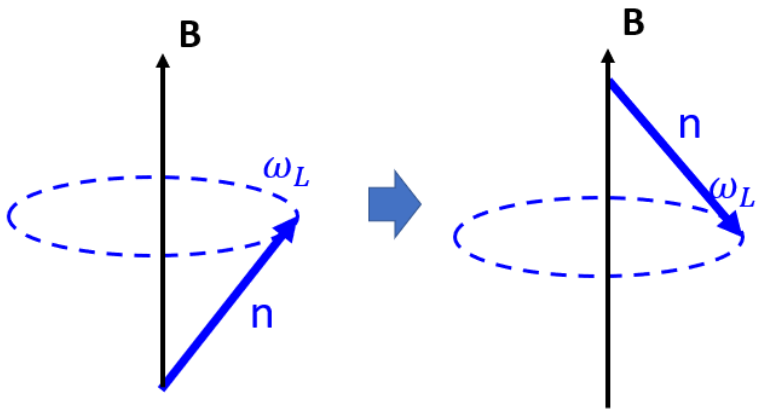


Image courtesy of John Barker

$$B_{Y,\,effective} = B_Y - \omega_{RF} / \gamma$$



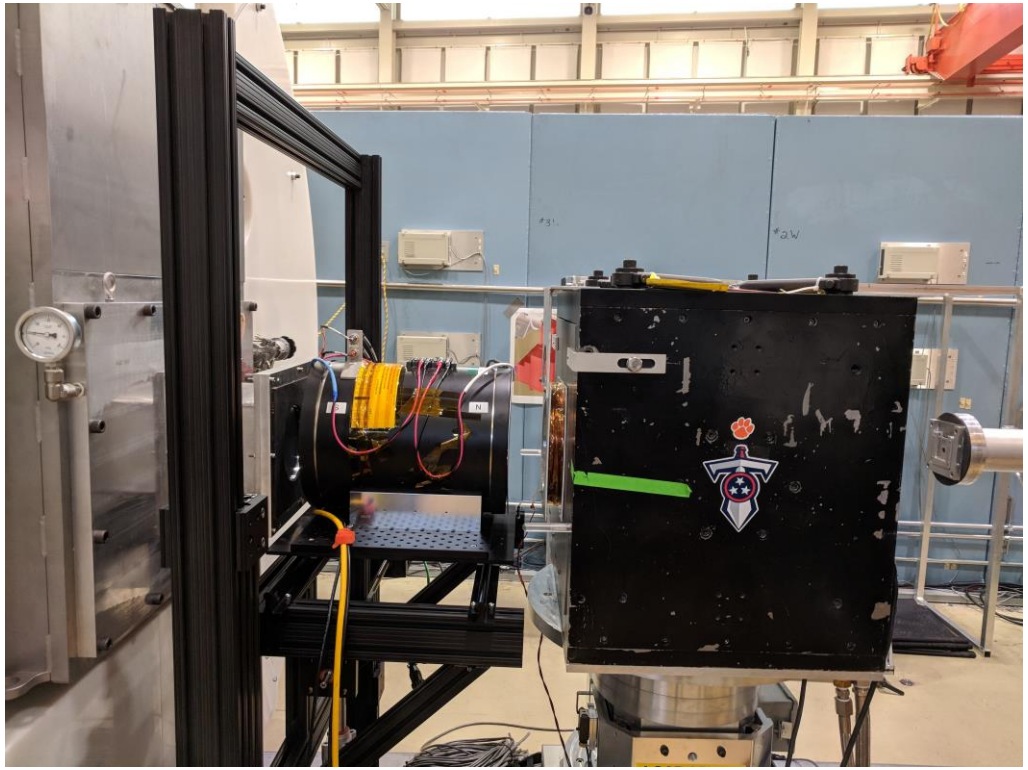


C.P. Slicther, Principles of Magnetic Resonance, (Springer Verlag, Berlin 1980).

Large (2m) Sample Area

Courtesy of John Barker, Julie Borchers

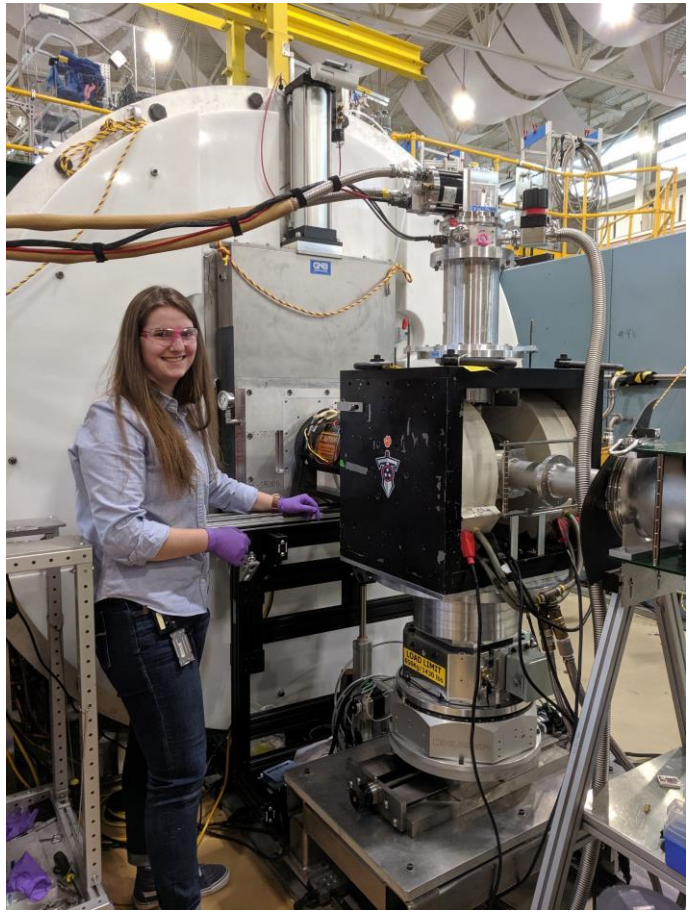
Sample area with Titan Magnet (0 to 1.6 Tesla) and ^{3}He Solenoid Analyzer Installed

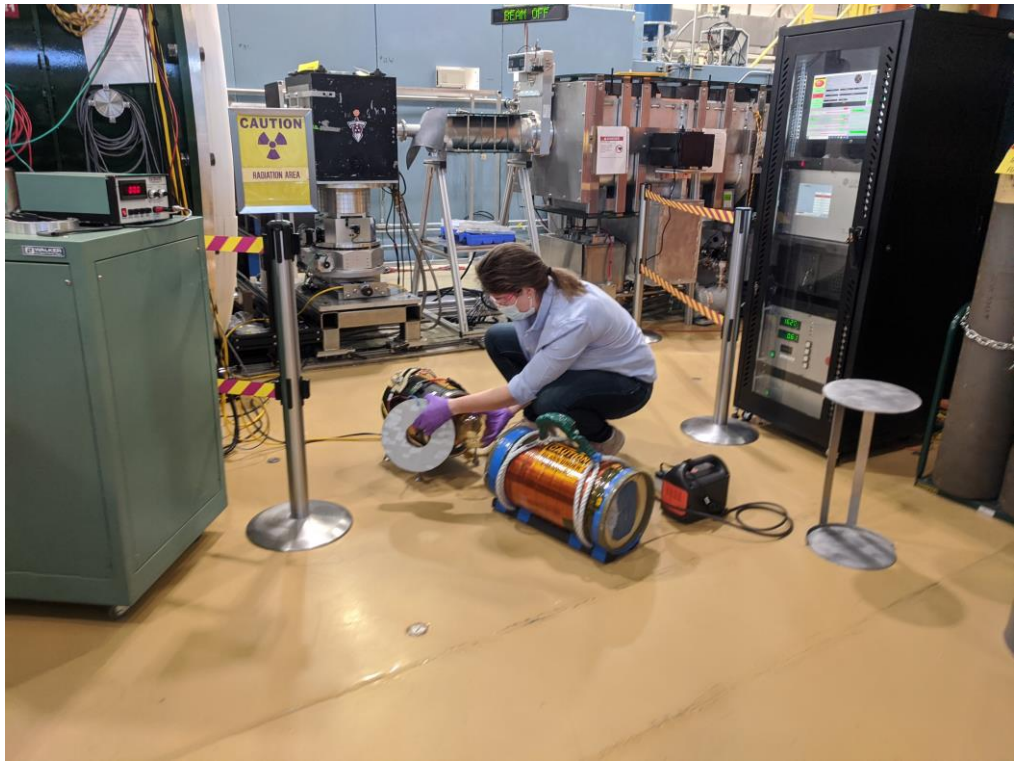


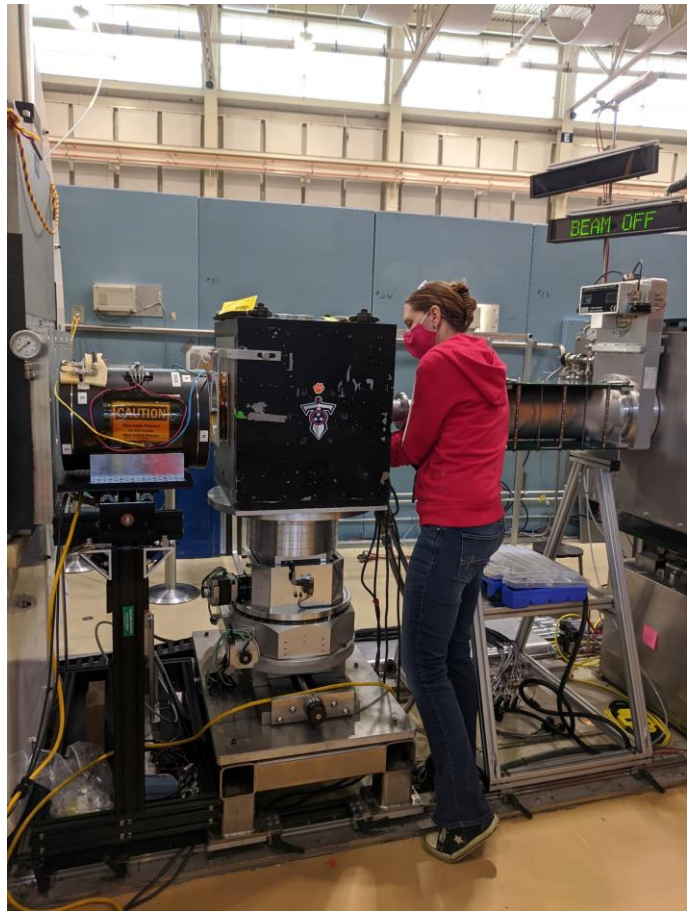
Side view of magnet

Top view into magnet

Sample area set-up for a polarized beam experiment, including Titan magnet, CCR, and ^{3}He spin filter.

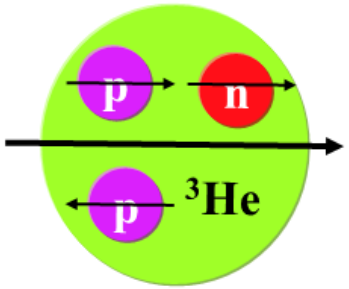




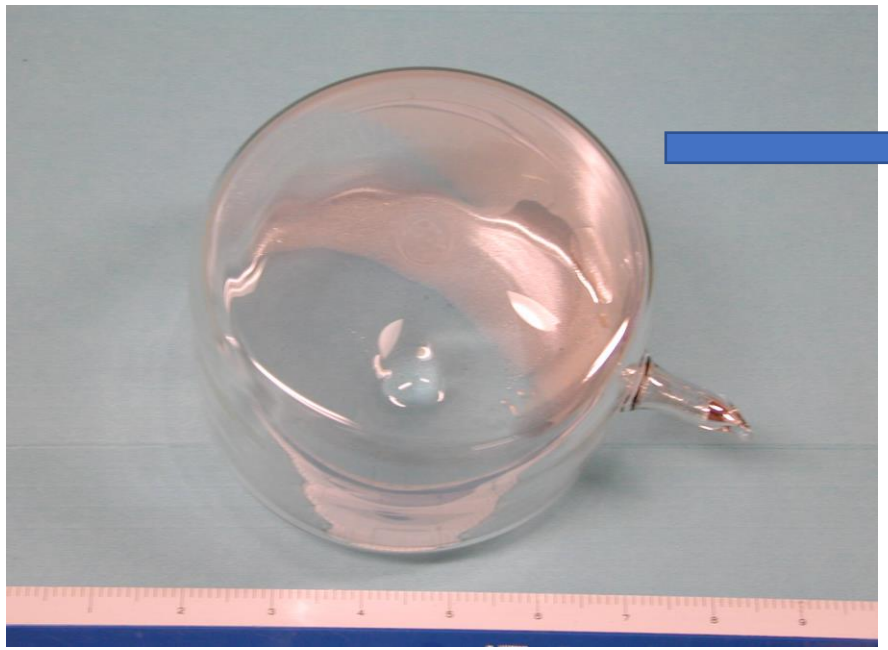


Courtesy of Julie Borchers

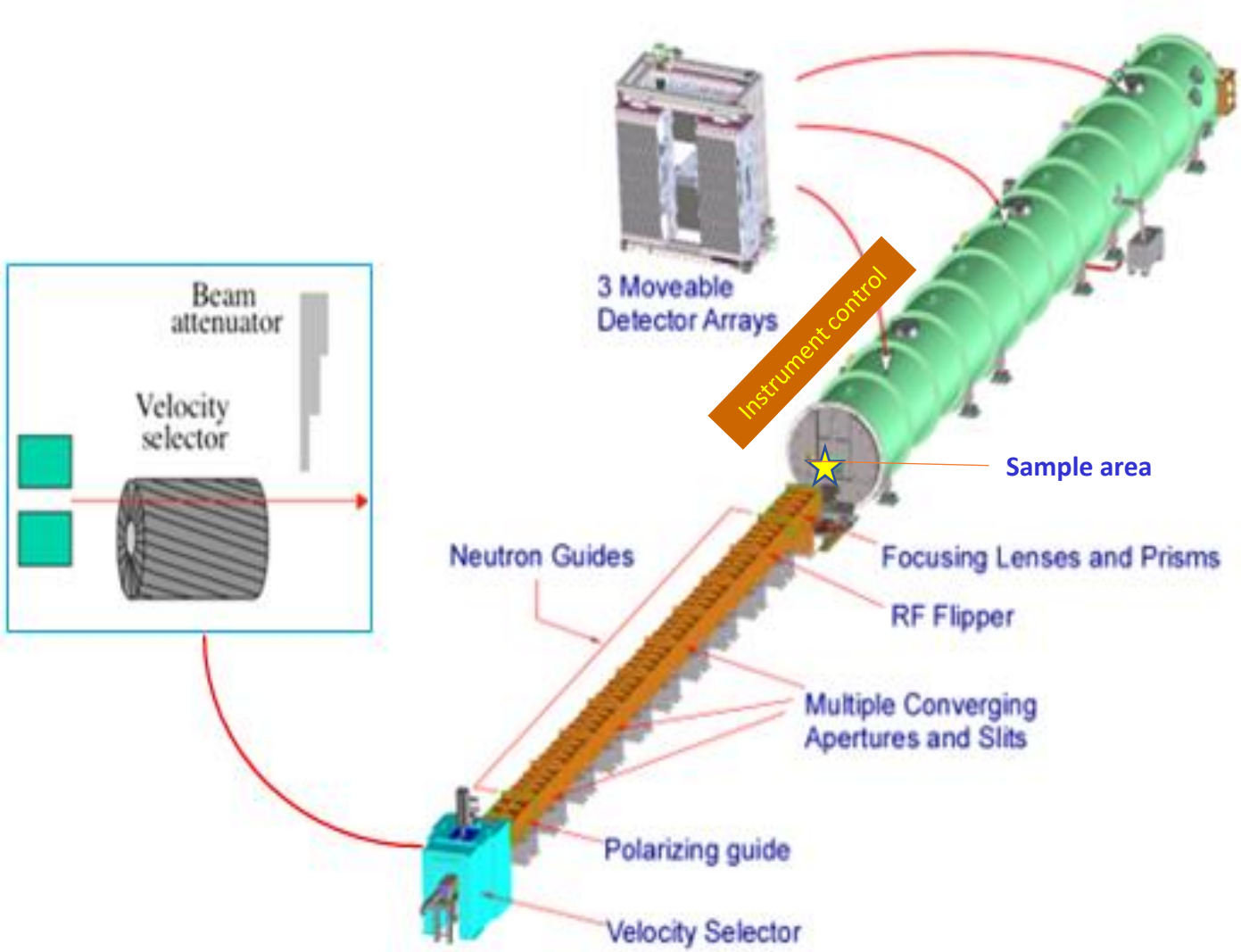
^{3}He filled spin filters as SANS/VSANS sit just beyond the sample. The current SANS cells are named from a list of wines and top gun characters.



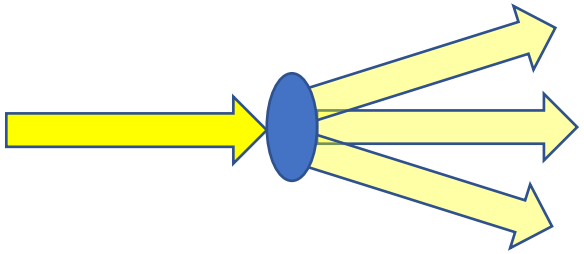
Neurons aligned with ^{3}He pass; otherwise absorbed



Courtesy of Wangchun Chen and Shannon Watson.

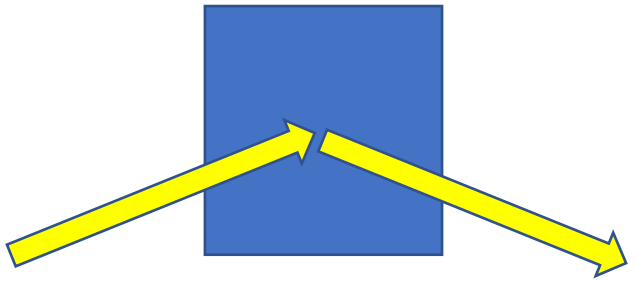


SANS transmission geometry:
Variation transverse to beam

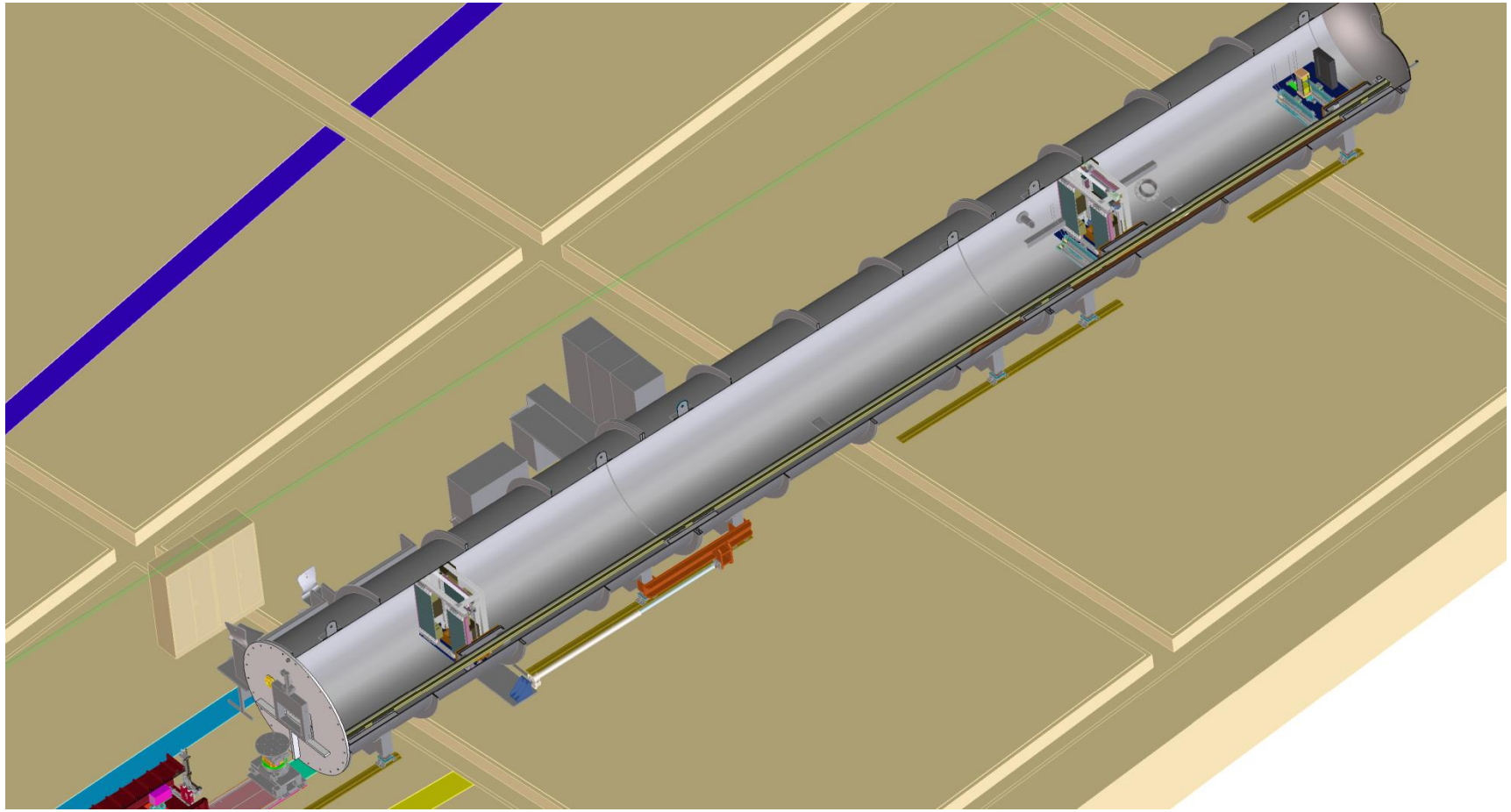


vs.

Reflection geometry:
depth dependence



Cutaway view of detector vessel showing **three** movable detector carriages



Courtesy of John Barker

Inside the detector tank

Courtesy of Julie Borchers

Inside the detector tank

Movable 2D Detector Panels to form a Picture Frame:

- **4 Side Panels 384 mm x 1000 mm**
- **4 Top/bottom 500 mm x 384 mm**
- **8 mm dia. He(3) Tubes, one layer**

Extends Q-range by factor of 30x

Rear CCD

- **1 of 220 mm x 500 mm tall (0.2 mm resolution)**

Other Multiple Carriage Instruments:

- **D33, ILL Grenoble France**
- **BILBY, ANSTO, Australia**

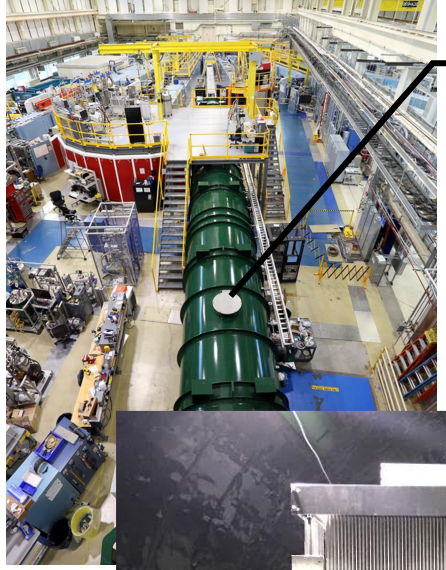
Panel distances:

Front 0.6 m to 10 m

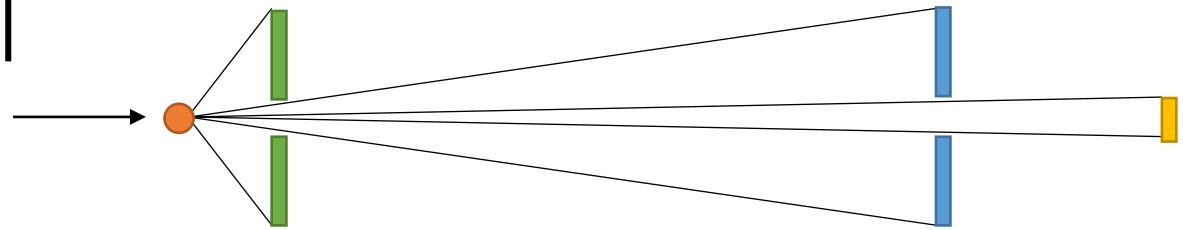
Middle 2.5 m to 18 m

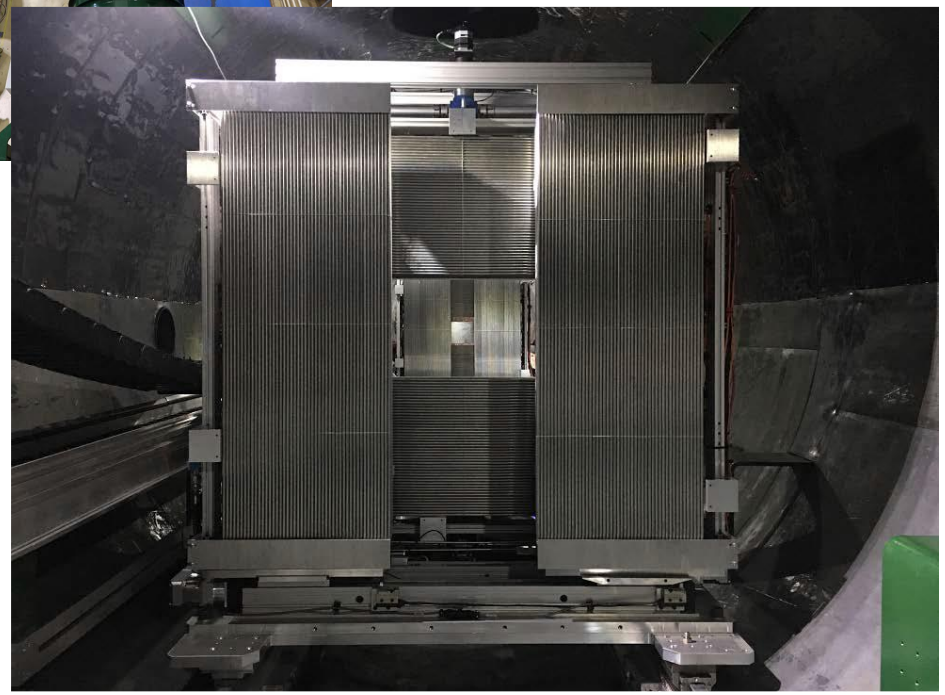
Rear 10 m to 22 m

Courtesy of John Barker

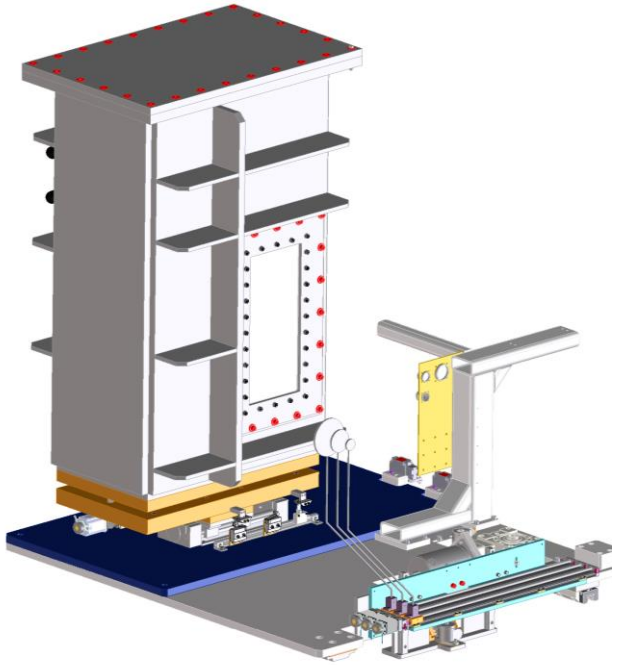


Detectors





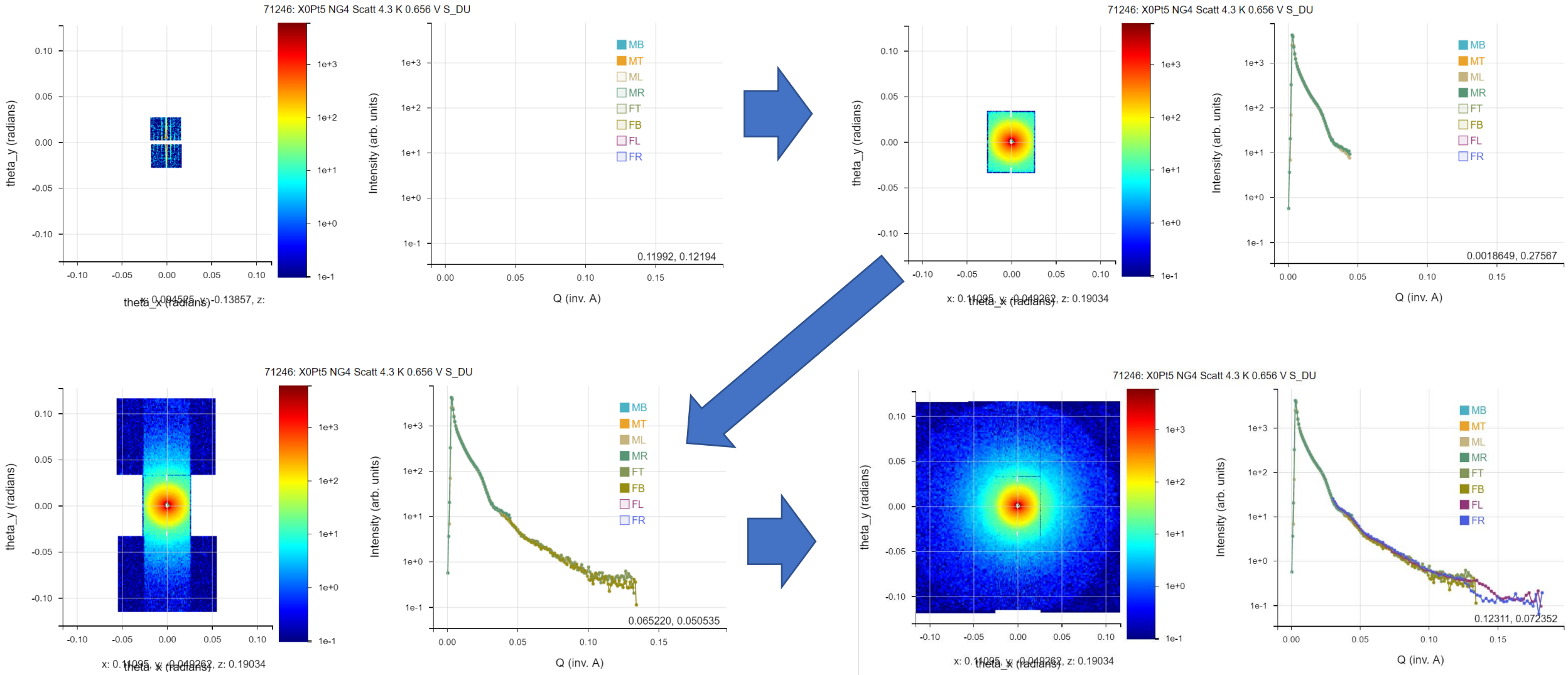
Two carriages with ^{3}He tube panels,
8 mm fwhm → “Picture Frames”



High resolution detector,
scintillator + CCDs

Courtesy Dr. John Barker

A view of how the detectors overlap



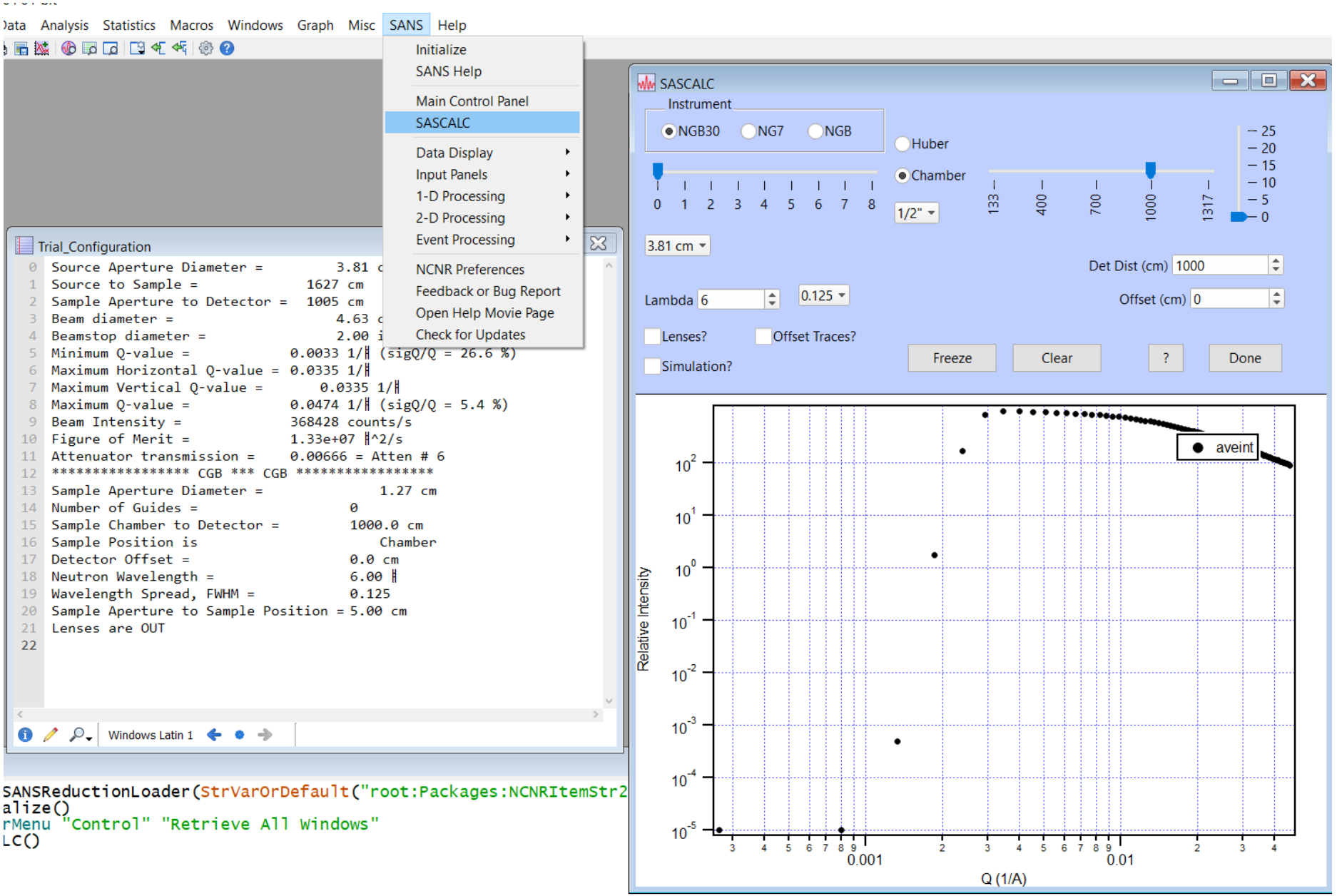
Courtesy of Brian Maranville

To view any data: https://ncnr.nist.gov/ncnrdata/view/vsansbrowser.html

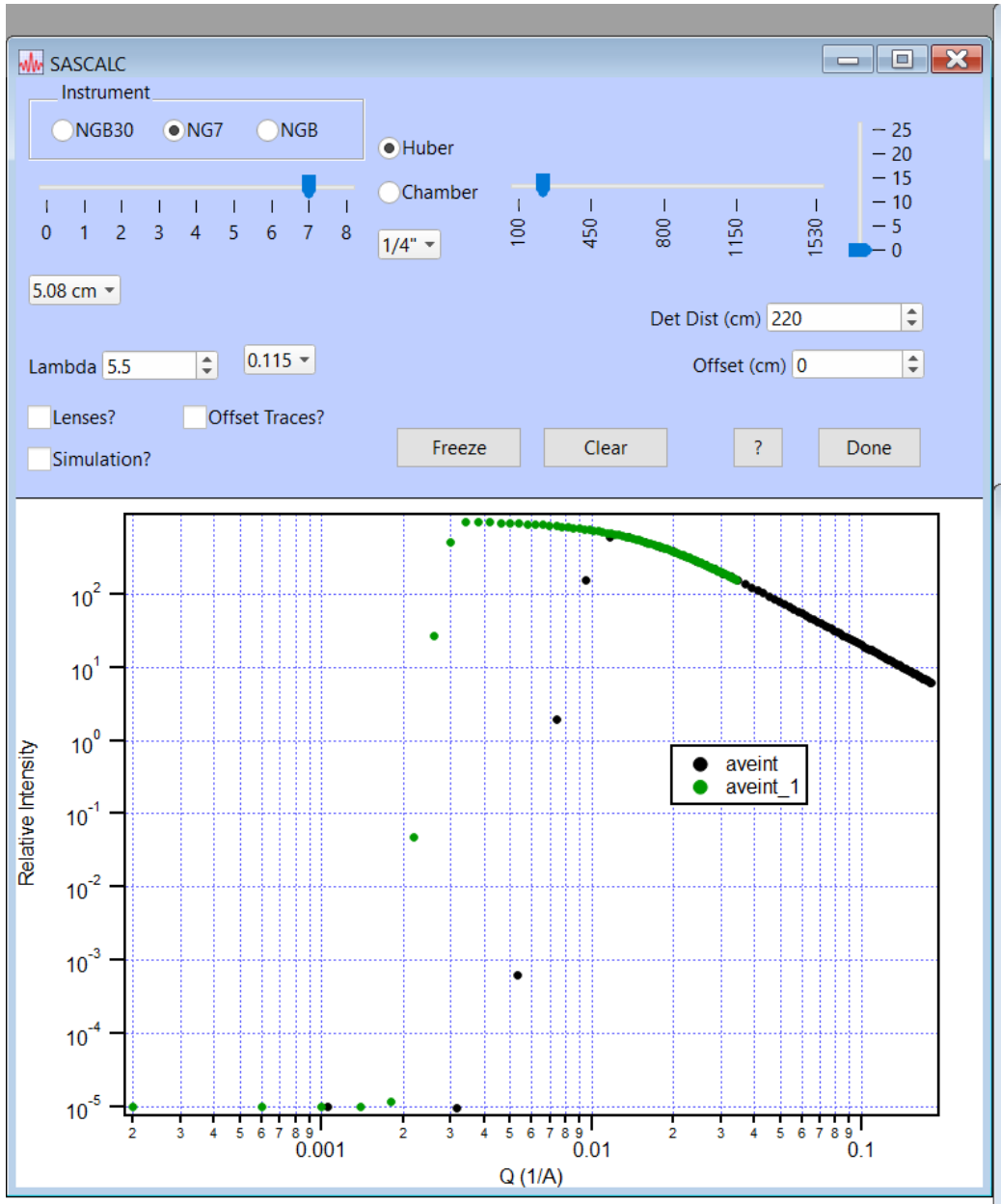
Controlling the Instrument

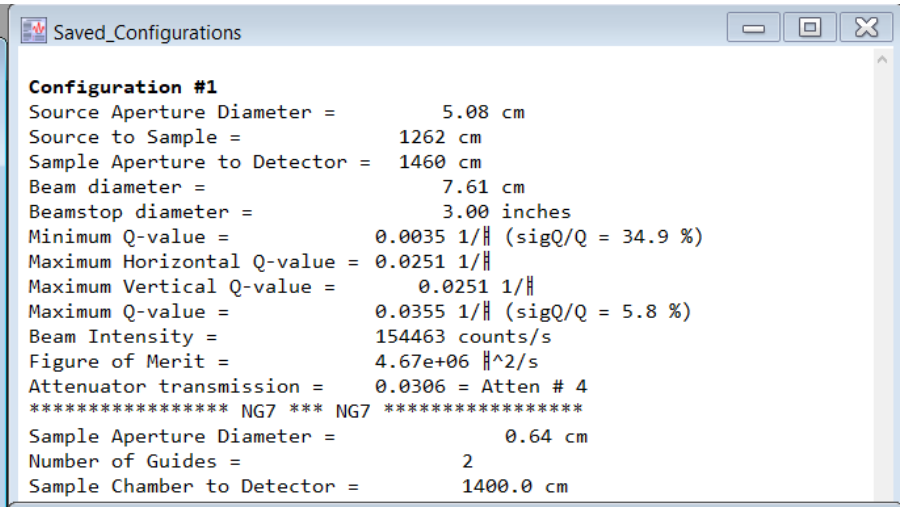
Courtesy of Julie Borchers

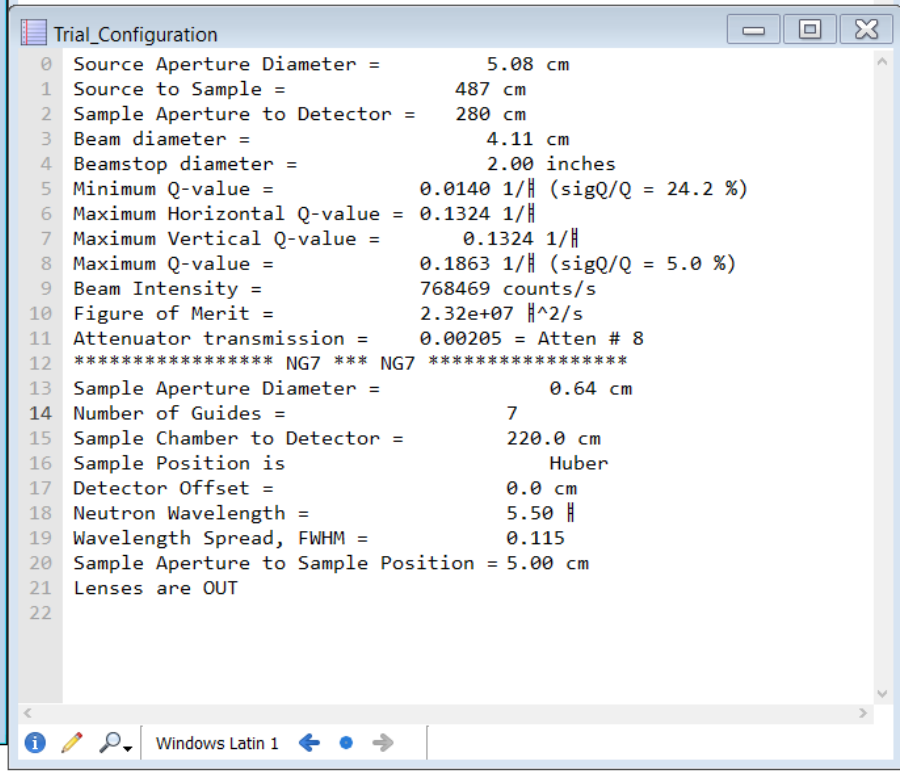
SASCALC (from IGOR, SANS Reduction) – starting screen



SASCALC (from IGOR, SANS Reduction) – a configuration set







Online VCALC (for VSANS): http://nicedata.ncnr.nist.gov/niceweb/nicejs/VCALC/

Beam

λ (Å) 5.5 | Δλ/λ 0.12 | Frontend Trans. = 1.0 | Flux Φ = 1.575e+11 | Beam Current (1/s) = 2.884e+5 | I_0 (1/s/cm^2) = 9.106e+5

Collimation

Num. guides 4 | Source aperture (mm) 60.0 | Source distance (cm) = 1582 | T_filter = 0.5245418835981687 | T_guide = 0.8852928099999999

Ext. Sample aperture (mm) 6.35 | Sample ap. to GV (cm) 75 | Sample to GV (cm) 75

L_1 (cm) = 1507 | A_1A_2/L_1 = 0.000003943

Middle Carriage

SDD input (cm) 1450 | SDD (cm) = 1525 | L_2 (cm) = 1525 | Beam drop (cm) = 0.4384 | Beamstop Required (inch) = 2.976 | Beamstop (inch) 3

$2\theta_{min}$ (rad) = 0.002498 | **Q_{min} (1/Å) = 0.002854** | $(\Delta Q/Q_{min})_x$ = 0.4147 | $(\Delta Q/Q_{min})_y$ = 0.4149 | Q_{max} (1/Å) = 0.05000 | $(\Delta Q/Q_{max})_x$ = 0.05434 | $(\Delta Q/Q_{max})_y$ = 0.05434

Ref Beam Ctr_x (cm) 0 | Ref Beam Ctr_y (cm) 0 | From file

Left Panel Lateral Offset (cm) -1.5 | Q_{right} (1/Å) = -0.001854 | **Q_{left} (1/Å) = -0.03142**

Right Panel Lateral Offset (cm) 0.5 | Q_{left} (1/Å) = 0.0009102 | **Q_{right} (1/Å) = 0.03048** | Q_{bottom} (1/Å) = -0.03901 | Q_{top} (1/Å) = 0.03840

Front Carriage

Q_{min} (1/Å) = 0.03048 | $(\Delta Q/Q_{min})_x$ = 0.06235 | $(\Delta Q/Q_{min})_y$ = 0.06236 | Q_{max} (1/Å) = 0.1881 | $(\Delta Q/Q_{max})_x$ = 0.04939 | $(\Delta Q/Q_{max})_y$ = 0.04939

SDD input (cm) 370 | SDD (cm) = 445 | Ref Beam Ctr_x (cm) 0 | Ref Beam Ctr_y (cm) 0 | From file

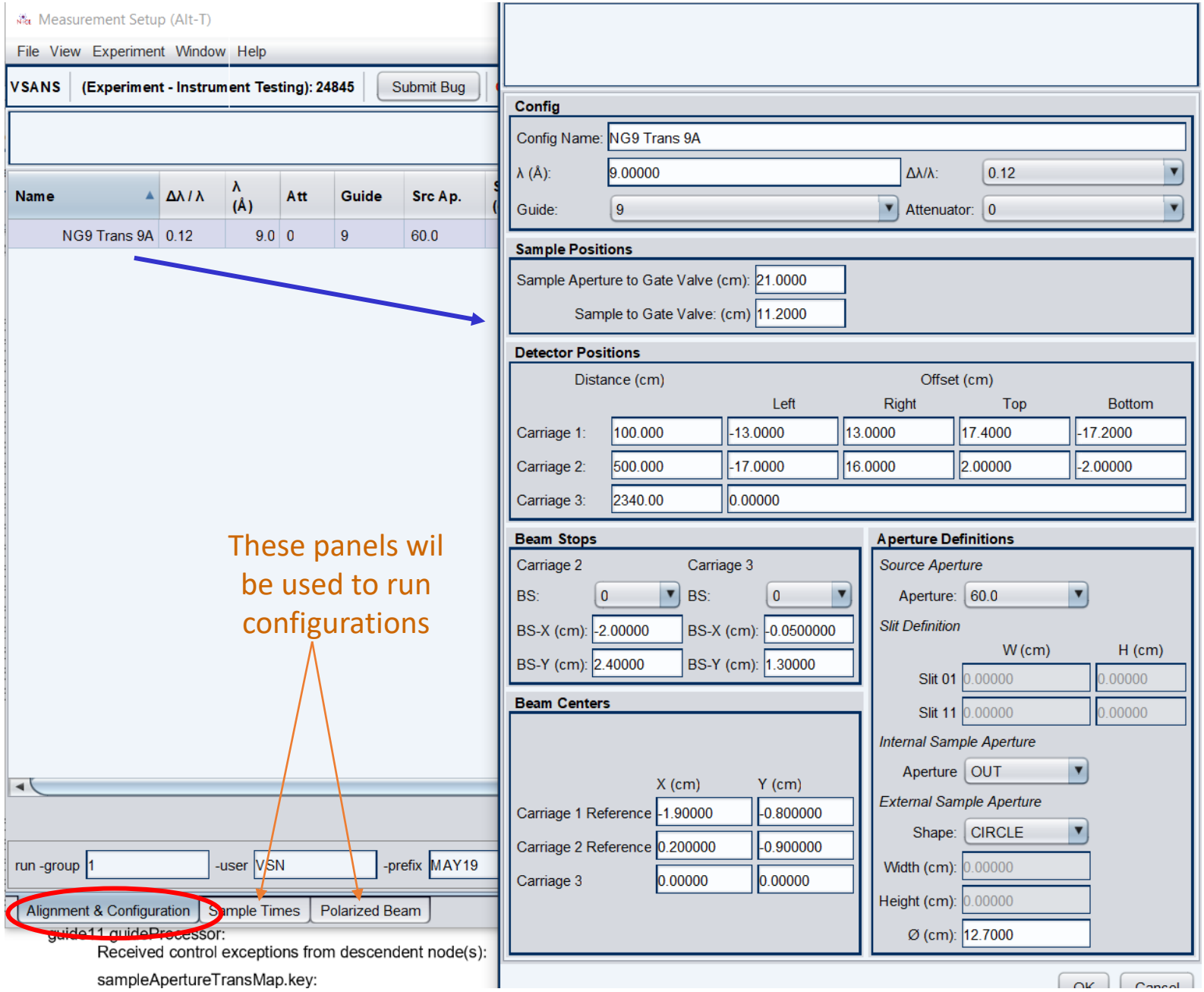
Left Panel Lateral Offset (cm) -11.5176 | Q_{right} (1/Å) = -0.03142 | **Q_{left} (1/Å) = -0.1321** | Match to left edge of ML

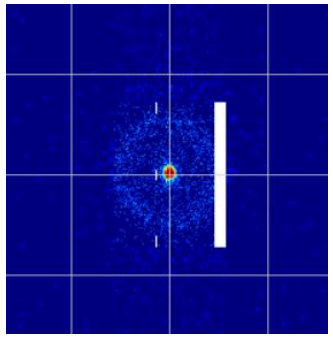
Right Panel Lateral Offset (cm) 11.2799 | Q_{left} (1/Å) = 0.03048 | **Q_{right} (1/Å) = 0.1312** | Match to right edge of MR

Top Panel Vertical Offset (cm) 15.8467 | Q_{bottom} (1/Å) = 0.03840 | Q_{top} (1/Å) = 0.1306 | Match to top edge of MR

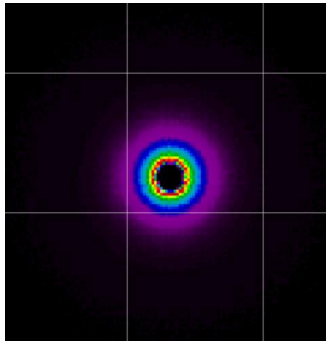
Bottom Panel Vertical Offset (cm) -15.2487 | Q_{top} (1/Å) = -0.03901 | Q_{bottom} (1/Å) = -0.1312 | Match to bottom edge of MR

NICE Aligning the Instrument



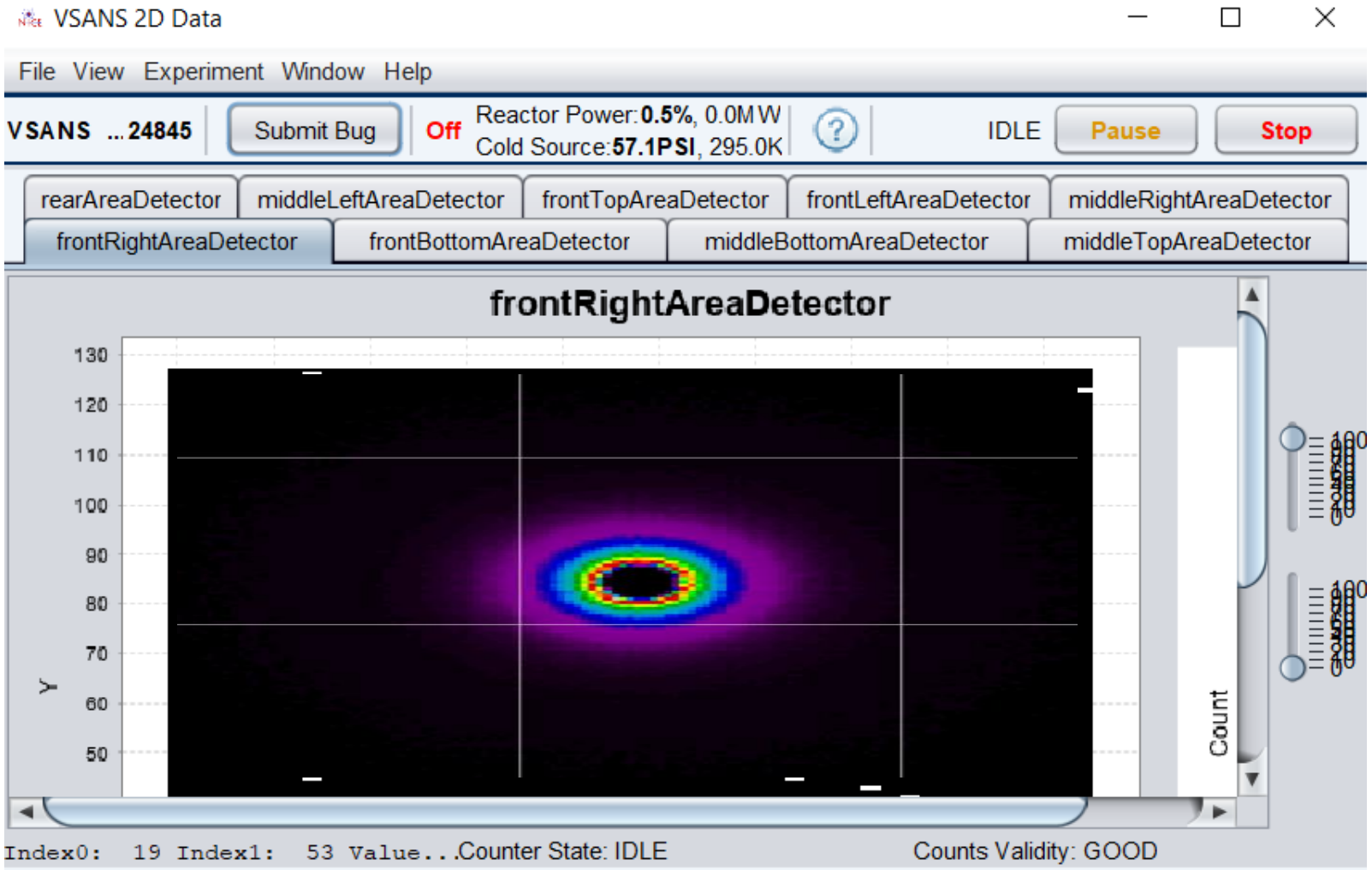


Transmissions are used o set beam center (the middle right detector panel is translates to left to place beam away from edges for measurement)



Scattering files to align beam stop

NICE 2D Data Viewer

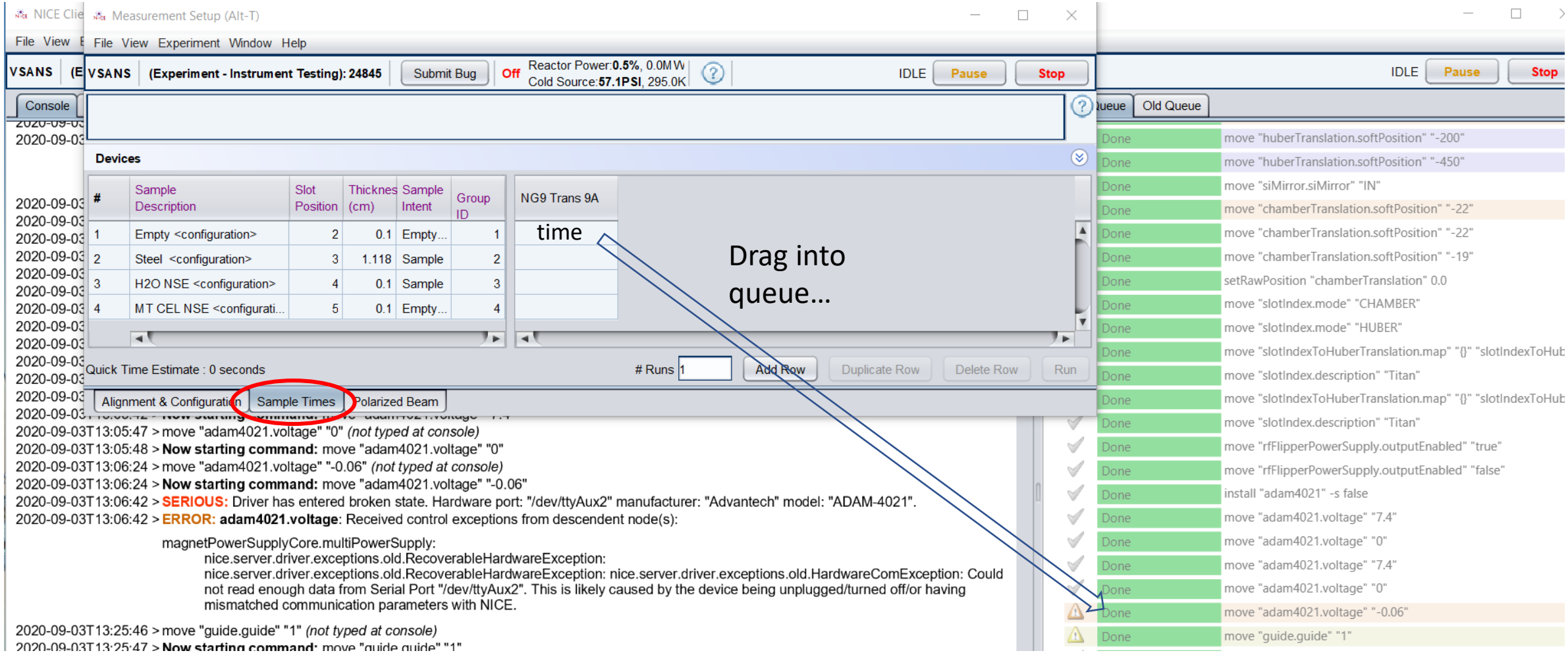


Hold the 'H' key and drag over the display for the histogram window.

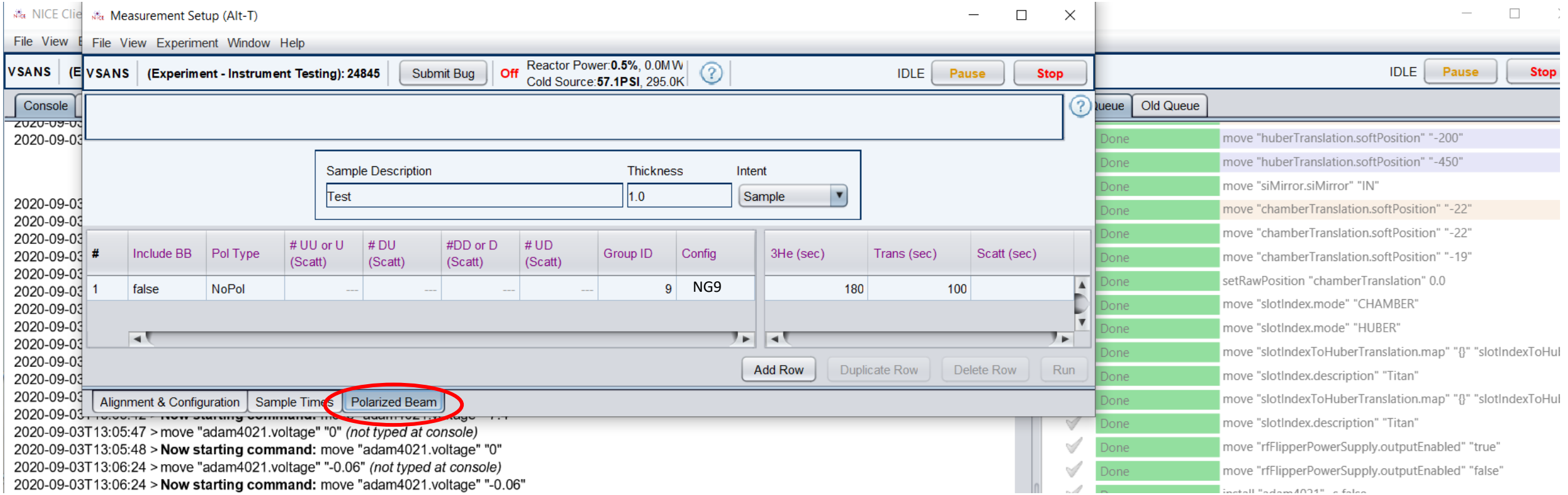
Hold the 'C' key and click/drag the display for the beam center window. Beam centers (in centimeters) for front and middle detectors can only be calculated by dragging on the respective left and right detector displays. The rear detector has its beam centers calculated in pixels.

This does **NOT** work in logarithmic mode.

NICE Running Configurations (collecting data)



NICE Running Polarized Configurations (starting point)



Running Polarized Configurations (more options shown)

Units of cm

Sample, open, empty, blocked beam

Sample Description	Thickness	Intent
CoFe2O4 Nanoparticles <configuration>	1.0	Sample

Pol Type	#UU or U Scatt	#DU or -- Scatt	#DD or D Scatt	#UD or -- Scatt	Group ID	Temp	Adam 4021	Config	3He (sec)	Trans (sec)	Scatt (sec)
SMFrontHe 3Back	1	2	1	2	1	300	7.4	NG4	100	100	3600
HalfPol SMFront	1		1		2	200	7.4	NG4		100	1800
Unpol					3	100	0	NG4		100	900

Select polarization type

Number of scattering files to repeat; 1 is assumed for unpolarized.

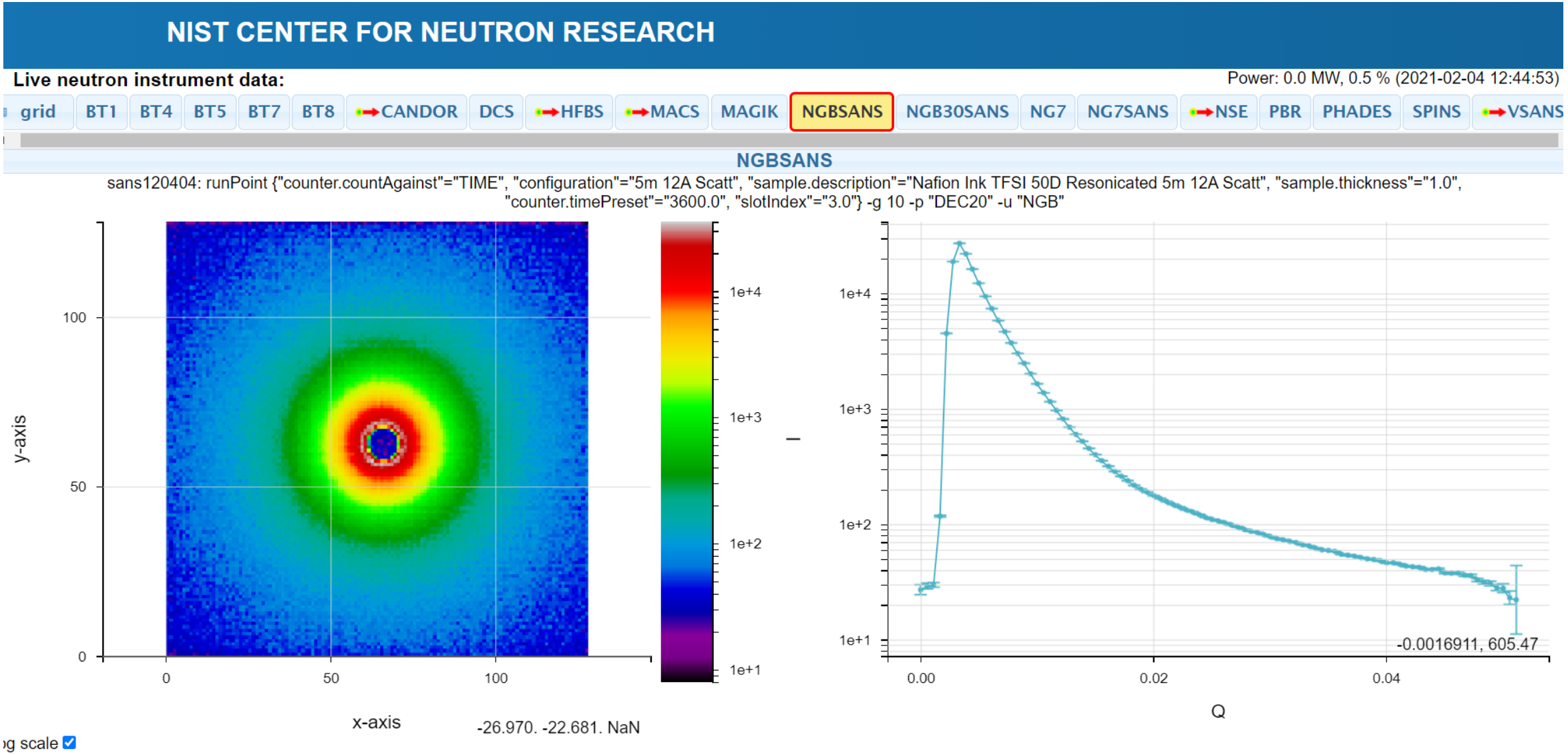
Temperature in K

Electro-magnet voltage

Drag and drop (into queue) files to be run. **3He** runs unpolarized transmissions of ^{3}He OUT, IN beam. **Trans** runs UU, DU, DD, UD, supermirror-only (or D and U or Unpolarized) transmissions. **Scatt** runs the number and type of scattering files listed to the left.

CHRNS

Viewing Current Data (https://www.ncnr.nist.gov/ipeek/):

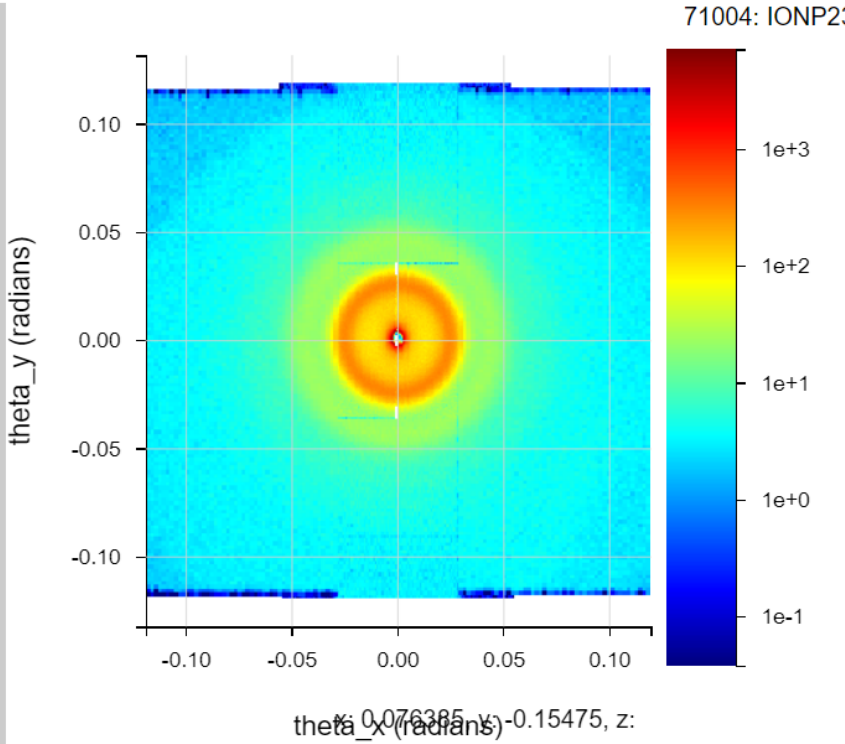


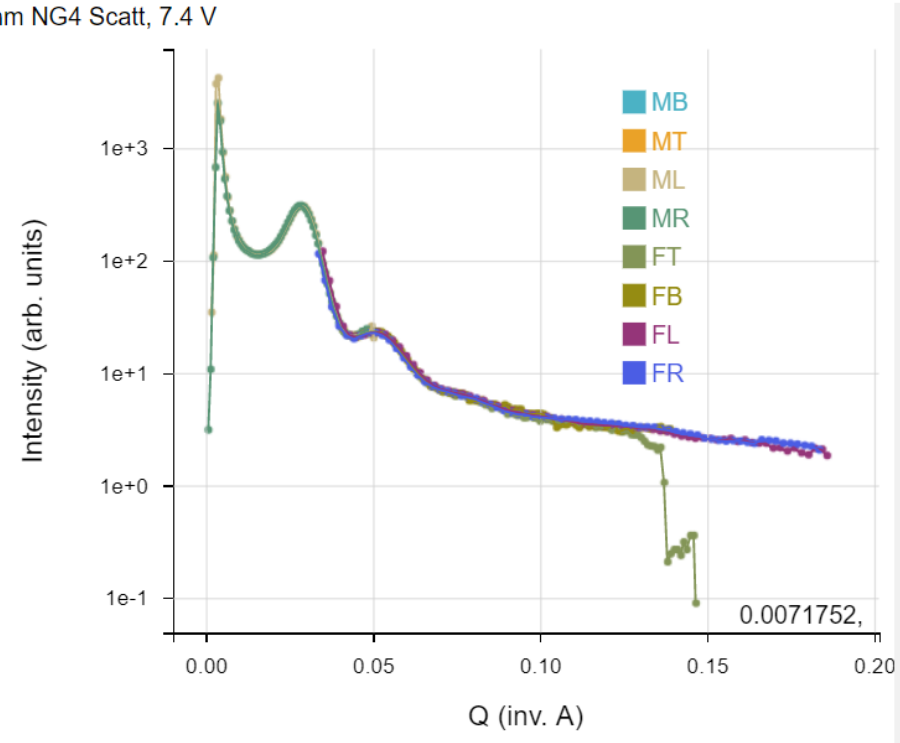
To view any data online: https://ncnr.nist.gov/ncnrdata/view/vsansbrowser.html

VSANS data

ncnrdata/vsans/202011/28007/data/

filename ▼	last-modified
sans71008.nxs.ngv	2020-12-07 09:33:23
sans71007.nxs.ngv	2020-12-07 08:51:06
sans71006.nxs.ngv	2020-12-07 08:48:22
sans71005.nxs.ngv	2020-12-07 07:57:16
sans71004.nxs.ngv	2020-12-07 07:54:32
sans71003.nxs.ngv	2020-12-07 07:03:26
sans71002.nxs.ngv	2020-12-07 07:00:41
sans71001.nxs.ngv	2020-12-07 06:09:37
sans71000.nxs.ngv	2020-12-07 06:06:52
sans70999.nxs.ngv	2020-12-07 05:15:47
sans70998.nxs.ngv	2020-12-07 05:13:02
sans70997.nxs.ngv	2020-12-07 04:21:58
sans70996.nxs.ngv	2020-12-07 04:19:13
sans70995.nxs.ngv	2020-12-07 03:28:08
sans70994.nxs.ngv	2020-12-07 03:25:23
sans70993.nxs.ngv	2020-12-07 02:34:19
sans70992.nxs.ngv	2020-12-07 02:31:34
sans70991.nxs.ngv	2020-12-07 01:40:29
sans70990.nxs.ngv	2020-12-07 01:37:44
sans70989.nxs.ngv	2020-12-07 00:46:40
sans70988.nxs.ngv	2020-12-07 00:43:56
sans70987.nxs.ngv	2020-12-06 23:52:50
sans70986.nxs.ngv	2020-12-06 23:50:05
sans70985.nxs.ngv	2020-12-06 22:59:00
sans70984.nxs.ngv	2020-12-06 22:56:15
sans70983.nxs.ngv	2020-12-06 22:05:10
sans70982.nxs.ngv	2020-12-06 22:02:25
sans70981.nxs.ngv	2020-12-06 21:11:20
sans70980.nxs.ngv	2020-12-06 21:08:36





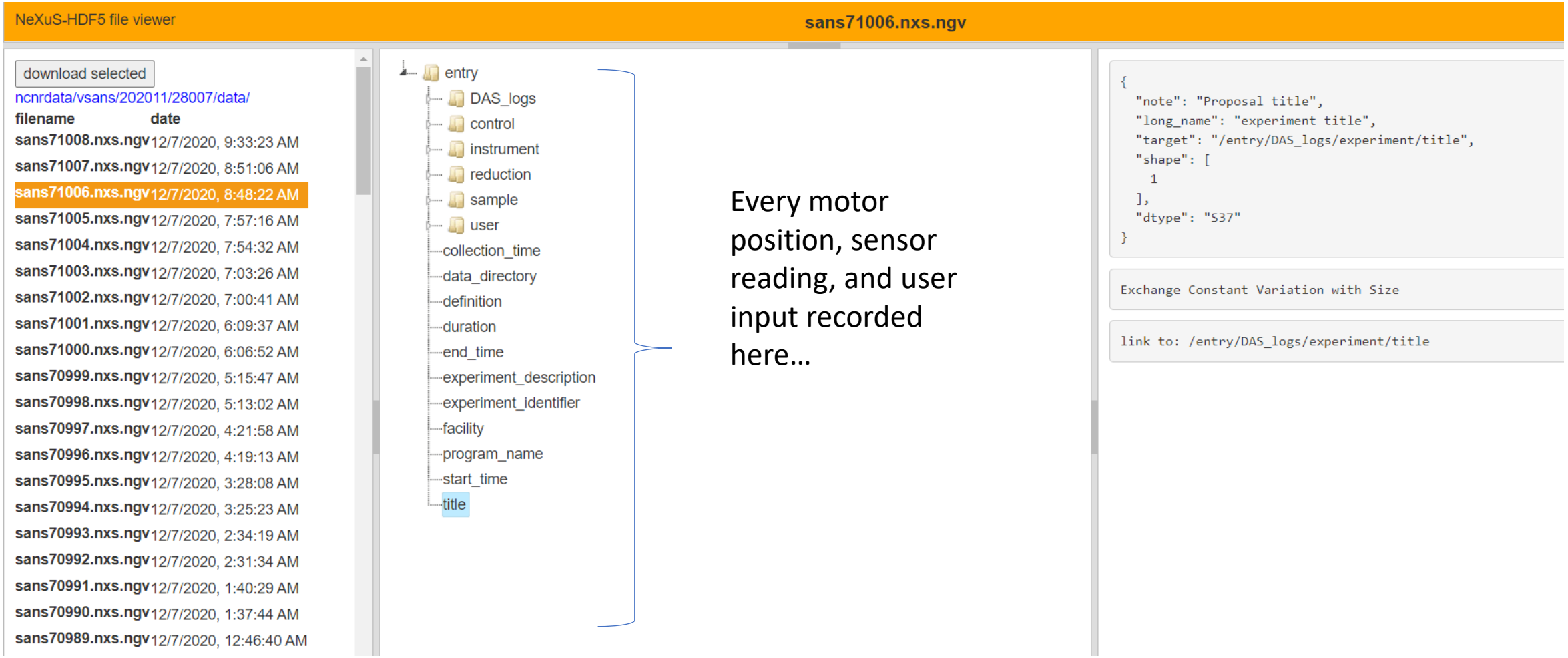
logZ ☑ show mask ☐ logX ☐ logy ☑

users: Kathryn Krycka;
title: Exchange Constant Variation with Size
elapsed: 3000
timePreset: 3000

description: IONP23nm NG4 Scatt, 7.4 V
local contact: Kathryn Krycka
wavelength: 5.50000
NeXus viewer: link

Website created by Brian Maranville

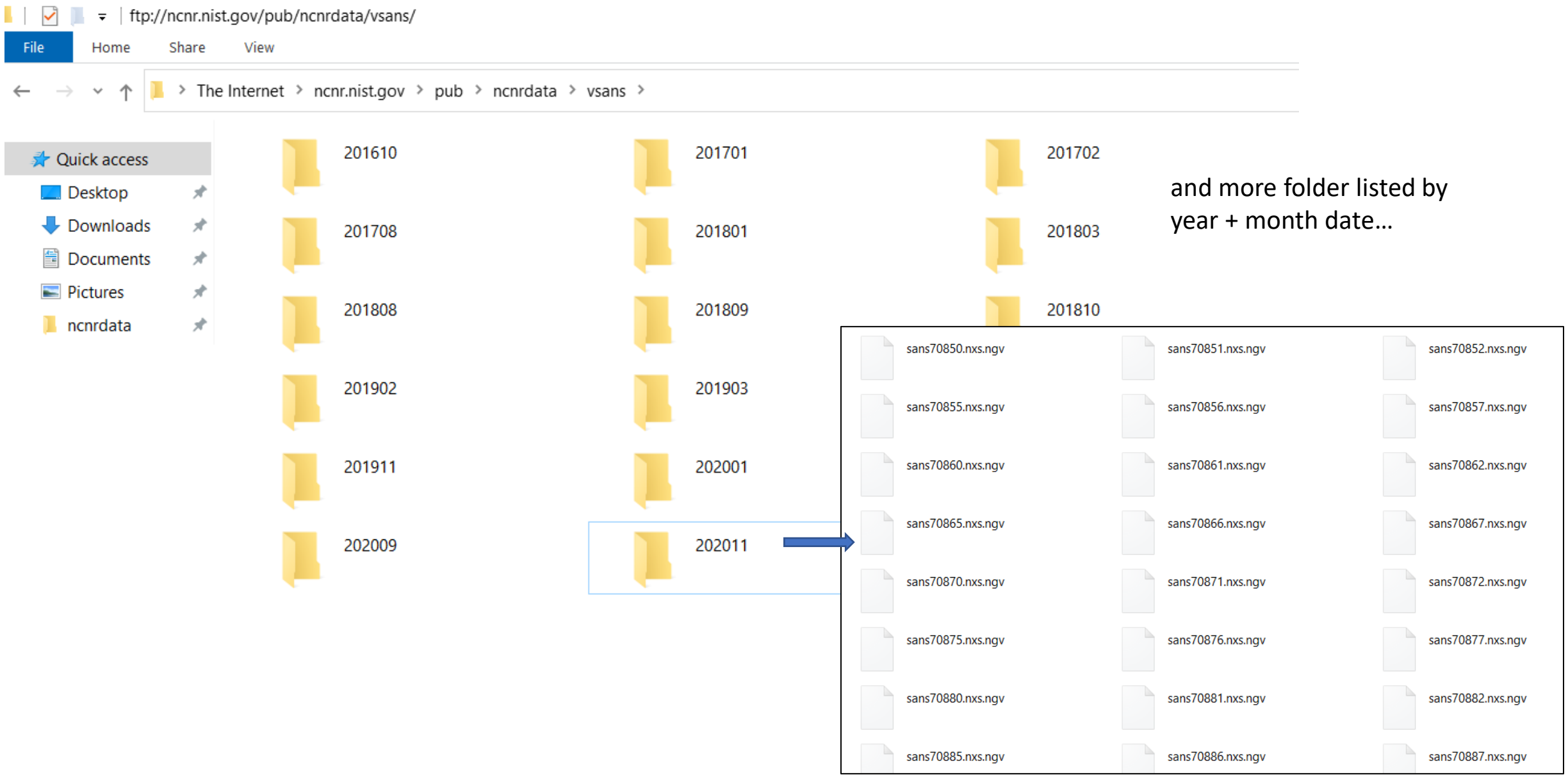
HDF Viewer: https://ncnr.nist.gov/ncnrdata/view/nexus-hdf-viewer.html?pathlist=ncnrdata+vsans



Every motor position, sensor reading, and user input recorded here…

Courtesy of Brian Maranville

Downloading Data (ftp://ncnr.nist.gov/pub/ncnrdata/vsans/):



and more folder listed by year + month date…

And this brings us to ***Data Reduction*** (IGOR, scripting, etc.) which we will work on at our next meeting.