

4-ID-C Beamline Manual

4IDC Beamline

Storage Ring: 0.0 mA, 0.0 hrs

Insertion Devices: 3.3cm ID, 13.222 keV, -3216.576 mm, CPU: 3.606 keV

Beam Position Monitors:

	Vertical	Horizontal
1st:	0.343	1.723
2nd:	-1.014	-1.032
Angle:	-357.1 -724.2	

4IDA: L2-90, M3C, ENS, SGM, EXS, Diag, KB Mirrors, Experiment

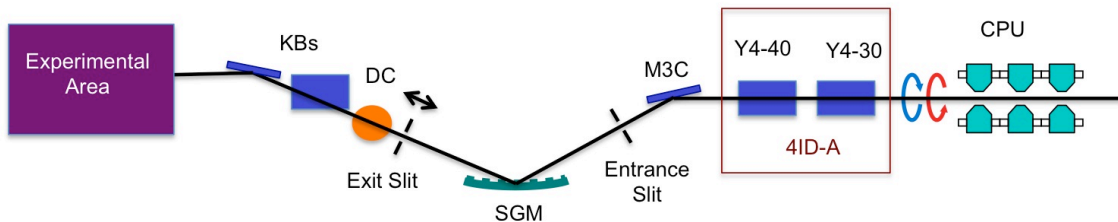
Motors: Motors, EPS, PSS, Bunch

Scans: Scans, Scan Control, Displays

Detectors: Scaler, Preamps, DAC/ADC, 4 Step, JY Spec, MCA

User: Calculations, I/O, Sequences, Tools, InterpTable, FuncGen

BURT Save/Restore: BURT Result, Save, Restore (0), RESET, All Stop, Beamline Manual



Last Updated 01/2/2018

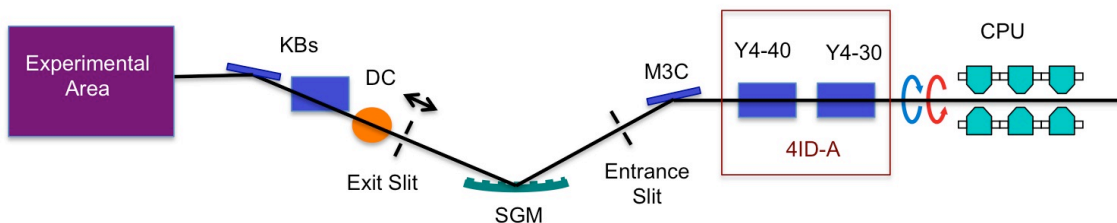


1. INTRODUCTION TO THE BEAMLINE	4
Beamline Layout	4
Experimental Area.....	4
Key Components	4
Tour of the Beamline.....	6
2. THE CONTROL SYSTEM.....	8
Workspace 1	8
Workspace 2	9
Workspace 3	10
Workspace 4	11
Workspace 5	12
Workspace 6	13
Workspace 7	15
Workspace 8	15
3. Beamline Operation.....	16
Getting Started.....	16
Aligning the M3C.....	17
Unix Commands	17
Using the current amplifiers	18
4. DATA ACQUISITION AND MANIPULATION.....	19
Setting up data files	19
Setting up a scan	19
Python Commands	19
• Sample Environment.....	19
• Beamline Control	20
• Normal Scans	20
• Find Sample Scans.....	21
• XMCD Scans in Polarization Switching Mode.....	22
• XPS Scans and Control.....	22
• Diagnostic Scans.....	23
Automated Scan Control with Python Scripting	23
Exporting and Transferring Data For Retrieval	27
Data File Structure	29
5. Reference Data	33
Flux and Resolution Data.....	33
Energy Calibration Spectra	34
Reference XMCD Spectra.....	35
Lanthanide x-ray absorption.....	36
Oxygen 1s x-ray-absorption edges of transition-metal oxides.....	39
Mn, Fe, Ni, Zn, Mg, Al oxides	40
6. Trouble Shooting	44
Aligning SGM if position is lost:	44
Control Problems	44

7.	APS 4-ID-C Octupole End Station	46
	Description.....	46
	Starting up the octupole magnet.....	47
	Checking Magnet Status	48
	Setting Current Offsets.....	49
	Advanced Control.....	49
8.	APS 4-ID-C 7T Magnet End Station:	50
	Description.....	50
	Operation.....	51
	Topping up the He Dewar:.....	52
	Procedure for changing samples on the 7 T magnet.....	54
9.	APS 4-ID-C XPS end station	56
10.	APS 4-ID-C X-ray Photoemission Electron Microscopy (X-PEEM)	57
11.	4-ID-C Personnel	58

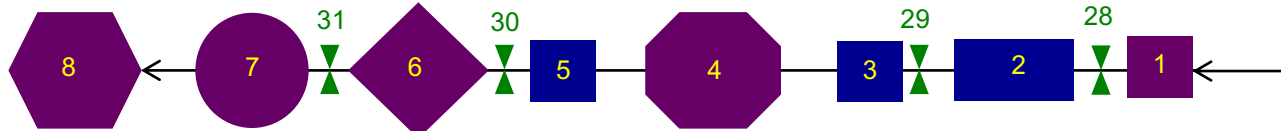
1. INTRODUCTION TO THE BEAMLINE

Beamline Layout



Beamline 4-ID-C is based on a spherical grating monochromator, designed to operate in the 400 - 3000 eV range through the use of several gratings. The enables the capability to achieve high resolving powers over this entire energy range. The basic components consist of the circularly polarizing undulator (CPU), two horizontally deflecting mirrors (Y4-30 & Y4-40), vertically focusing mirror (M3C), entrance slit, grating (SGM), movable exit slit, diagnostic chamber (DC) and Kirkpatrick-Baez (KB) refocusing mirrors.

Experimental Area

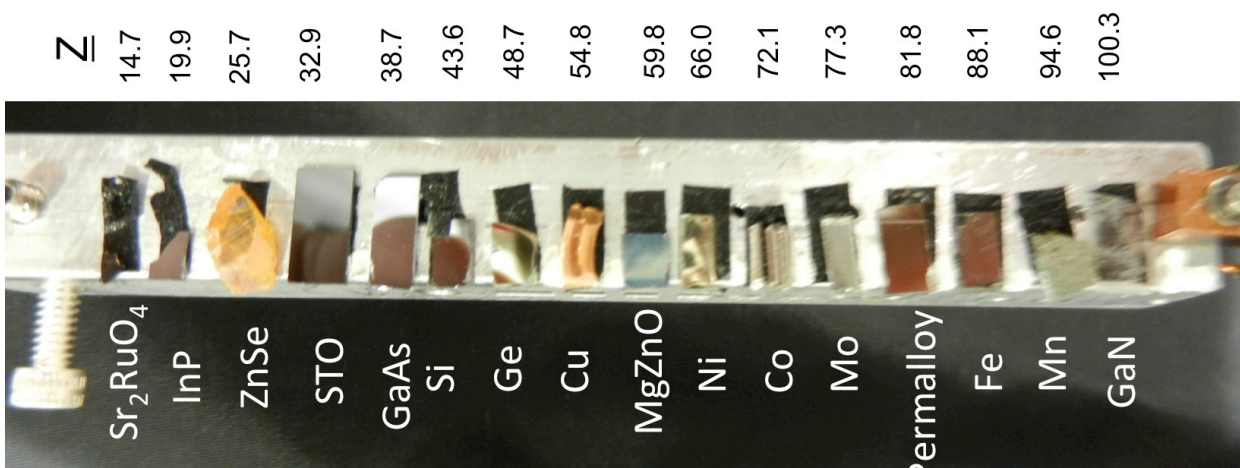
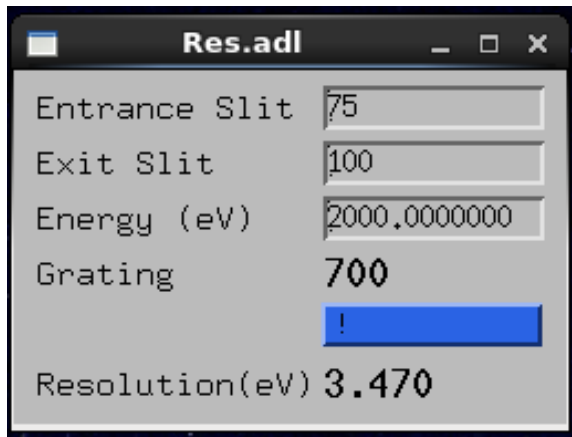


(1) IO grid with Au evaporator. (2) Differential pump. (3) Apertures. (4) Octupole end station. (5) Movable phosphor screen. (6) 7 T end station. (7) Low field (<100 G) magnet station with low temperature (>8 K) cryostat and optics for XEOL measurements. (8) Movable end station (PEEM, XPS, User). Items in green are the beamline isolation valves.

Key Components

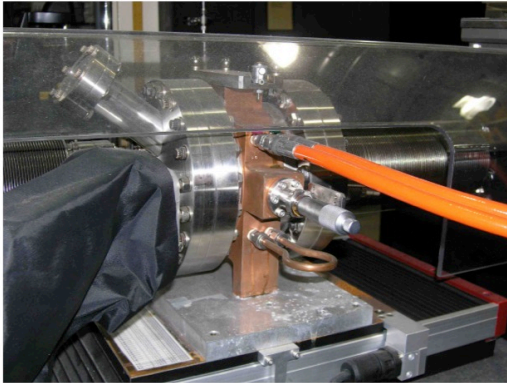
- Vertically deflecting mirror (M3C): This vertically deflecting mirror focuses the beam on the entrance slit of the monochromator. Over time it sometimes requires adjustment. This can be done automatically via the command: scm3c().
- SGM gratings: There are three gratings mounted in the grating tank: 700, 400 and 1200 l/mm. The 400 and 700 are used for most measurements, but the 1200 may be beneficial for higher energy experiments. See the flux and resolution data in the Reference Data section

- Entrance and exit slits. The slit sizes determine the photon energy resolution and can be adjusted over the range of 5-200 μm . Normally the entrance slit is set to 75 μm and the exit slit is varied. To calculate the resolution, use the resolution calculator. To adjust the slit size, adjust the micrometer according to the table posted nearby.
- Diagnostic chamber (DC). The DC contains a number of standards mounted on motorized manipulator. The standards may be positioned by command (see environmental controls). The “Z” position for the various standards is found on the following diagram, which can be set with the commands shown below.

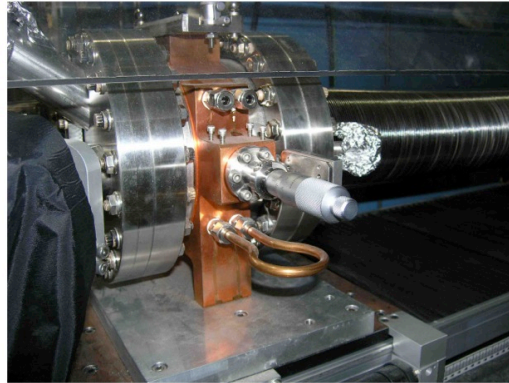


- I0 monitor. The I0 monitor consists of an electrically isolated, 70% transmission Au grid that is inserted into the beam. The restoring current (20 pA to 10 nA) is converted into a voltage and then into a frequency and read by a scaler. It is possible to evaporate a fresh layer of Au, *in situ*, but this is only necessary on rare occasions when the grid has been exposed to air and for measurements at the O K edge. Contact staff to perform evaporation.
- The KB mirrors may be used to focus and steer (within limits) the beam. See staff before adjusting.
- Apertures. There are three pin-hole apertures mounted in a translator that may be used to aperture the beam. From bottom to top their sizes are 20, 700, and 50 μm .
- Movable phosphor screen. This is located between the Octupole and 7 T end stations. It may be manually inserted in order to view the beam fluorescence through the adjacent viewport.

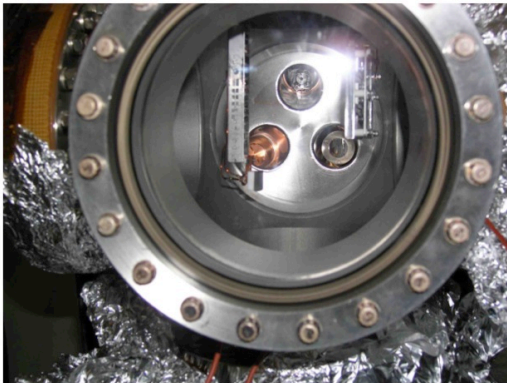
Tour of the Beamline



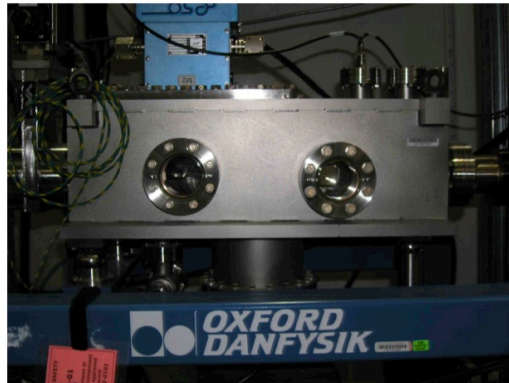
ENTRANCE SLIT



EXIT SLIT



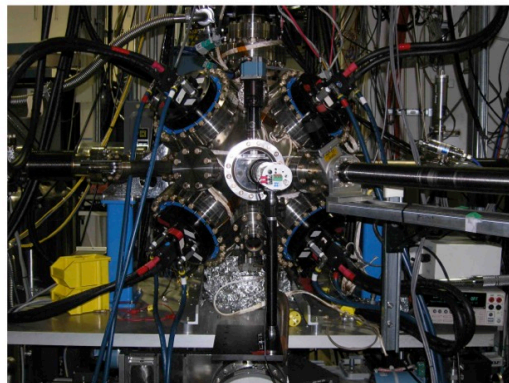
DIAGNOSTIC CHAMBER



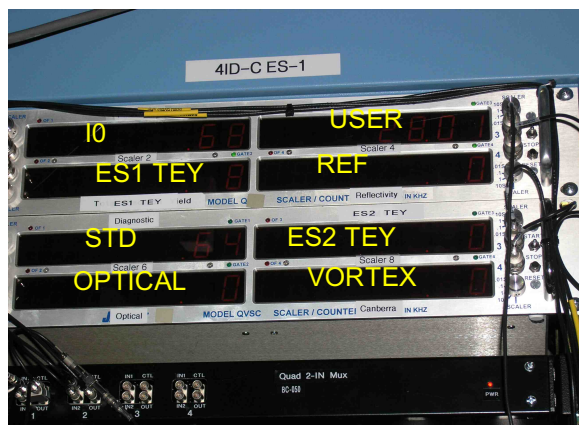
KB MIRRORS



OCTUPOLE POWER SUPPLIES



OCTUPOLE CHAMBER



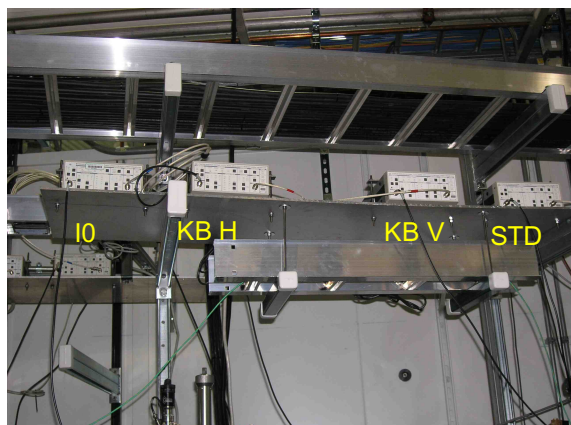
SCALERS



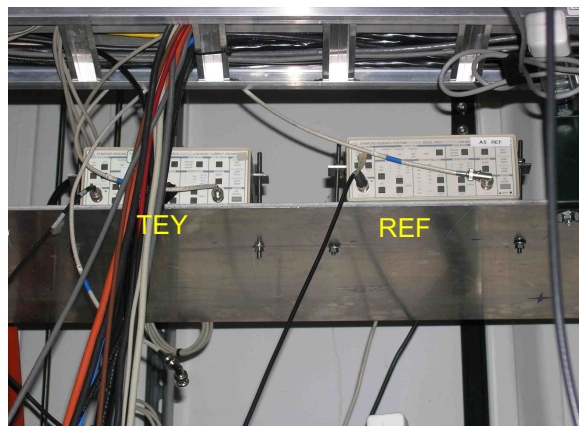
LAKESHORE CONTROLLERS



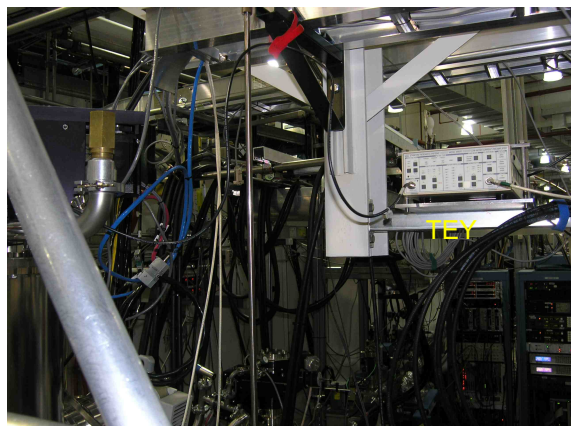
VACUUM CONTROLLERS



DIAGNOSTIC PREAMPS



ES1 (OCTUPOLE) PREAMPS



ES2 (7T) PREAMP

2. THE CONTROL SYSTEM

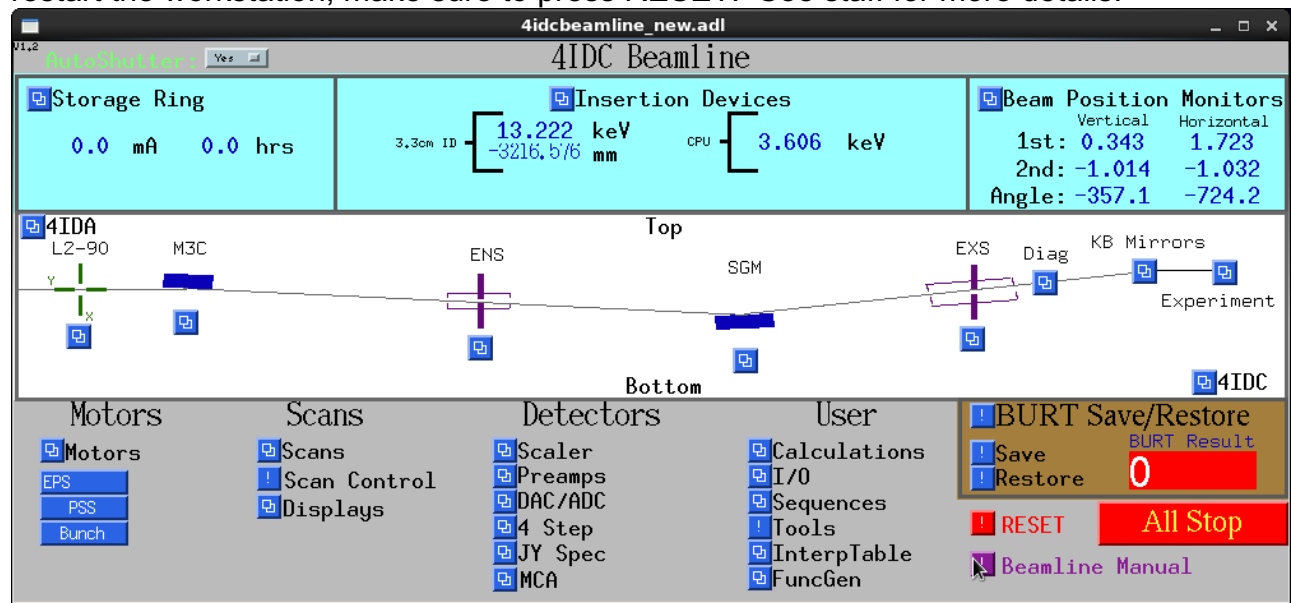
There are 4 computer monitors (center, left, right, top) that perform different functions depending on the workspace.

Each workspace may be accessed by a selection button located in the bottom right corner of the monitor.

Each workspace is dedicated to a specific instrument or purpose described as follows:

Workspace 1

By selecting various options from the window below in the center monitor it is possible to bring up any possible beamline control screen. Note the RESET button. If you start or restart the workstation, make sure to press RESET. See staff for more details.

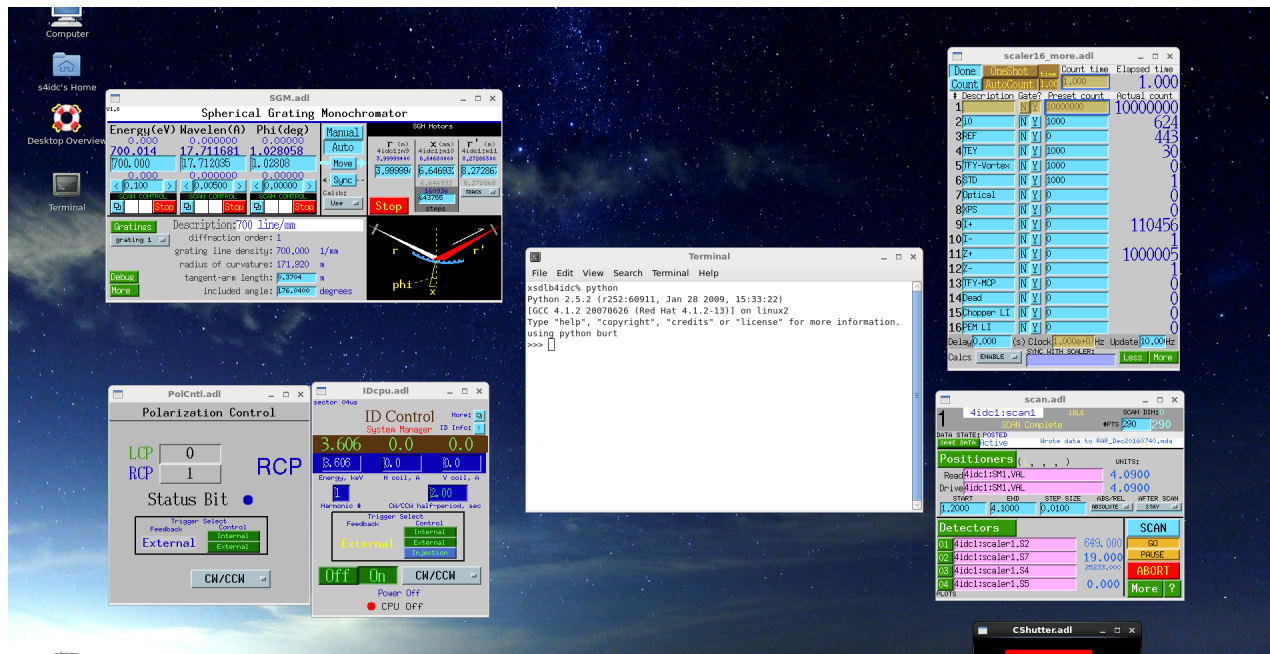


The left and right monitors are available for additional displays, controls or terminals and the top monitor contains ID/beamline information.

Workspace 2

The left and right monitors contain data plots and the top monitor contains ID/beamline information.

The center monitor contains the principal beamline control and data acquisition windows,



- Scalers (upper right): Displays the names and count rates of the various scalars.
- Scan Control (lower right): Used for setting up a data file. Click on the green SaveData button near the top of the screen, which will open a new window. Edit the last part subdirectory field to the name of your choice. See that the change is reflected in the readout below this field. Then change the Next Scan Number to 1.
- Shutter control (lower right): User for opening and closing the C shutter.
- Python terminal window (lower middle): This is terminal window used to control scanning and sample environment via python commands. In this window there will be a prompt for the Python programming language (>>>). In the even the scan window is not present simply go to the Scan area, open a Terminal and type python at the prompt. All scans and much of the sample control can be accessed here.
- ID Control (lower middle-left): Controls the energy of the CPU (keV).
- Polarization control (lower left): Controls the polarization mode (H,V,CW,CCW) of the CPU. For XMCD scans the mode must be CW/CCW and the trigger select must be in "External."
- Spherical Grating Monochromator (upper left): Sets the energy (eV) of the SGM and controls the associated motors.

Workspace 3

The left and right monitors contain data plots and the top monitor contains ID/beamline information.

The center monitor contains the interfaces necessary to control the Octupole end station.

The main screens are:

- XMCD Sample Control: Enables the positioning of the sample over 4 degrees of freedom. Ability to set the two theta angle of the reflected beam detector. Ability to set the field vector of the Octupole magnet.
- Ability to read and set the sample temperature (bottom middle).
- Control of the A3 (TEY) and A5 (REF) preamps. The A4 preamp is currently inactive.
- Ability to monitor the MCA output whose input is normally the Vortex detector (lower right).

The screenshot displays the following windows and their content:

- SampleCntl_Oct.adl (XMCD Sample Control):**
 - Energy SGM (eV): 700.003
 - Energy CPU (KeV): 3.606
 - Polarization: CW/CCW
 - Electron Yield (TEY) (#A3): Raw: 1, Norm: 0.001
 - Detector Angle: Current Angle: 19.9950, Set Angle: 20.00000
 - Fluorescence (TFY) (#A4): Raw: 0, Norm: 0.000
 - Reflectivity (REF) (#A5): Raw: 1, Norm: 0.001
 - Sample X: 5.66875, Sample Y: -1.30000, Sample Z: 48.00023, Rotation: 9.927000
 - Temperature Control: T(K) = 1.00, T(K) set: 300.00
- SRS70.adl (SR570 CURRENT PREAMPLIFIER #03 TEY):**
 - BIPAS VOLTAGE: 3000 nV
 - FILTER: 12 dB lowpass, lowpass 3dB freq. 10 Hz, highpass 3dB freq. 0.03 Hz
 - GAIN MODE: LOW NOISE
 - INVERT: OFF
 - INPUT OFFSET: 0 nA
 - SENSITIVITY: 2 nA/V
- SRS70.adl (SR570 CURRENT PREAMPLIFIER #04):**
 - BIPAS VOLTAGE: 20 nV
 - FILTER: 6 dB lowpass, lowpass 3dB freq. 10 Hz, highpass 3dB freq. 0.03 Hz
 - GAIN MODE: LOW NOISE
 - INVERT: ON
 - INPUT OFFSET: 0 nA
 - SENSITIVITY: 1 nA/V
- SRS70.adl (SR570 CURRENT PREAMPLIFIER #05 REF):**
 - BIPAS VOLTAGE: -1 nV
 - FILTER: 12 dB lowpass, lowpass 3dB freq. 10 Hz, highpass 3dB freq. 300 Hz
 - GAIN MODE: LOW NOISE
 - INVERT: OFF
 - INPUT OFFSET: 1 nA
 - SENSITIVITY: 10 nA/V
- LakeShore340lp1.adl (LakeShore 340):**
 - Temperature Parameters: READ 1 second
 - Loop Set: 300.00 °K
 - Control Sensor: 1.00 °K
 - Sample Sensor: 1.00 °K
 - Heater Power: 0.0 %
 - Range: OFF
- mca.adl (asynMCA (41d1:mca1)):**
 - LiveTime: 0.93
 - ResultTime: 1.00
 - DeadTime: 9.09
 - Legend: background (use Y axis on right)
 - ROI Table:

ROI Label	Co La	Elastic	0,00	0,00	0,00
Sum	3124,00	4718,00	0,00	0,00	0,00
Net	-3,15e+04	208,00	0,00	0,00	0,00
Low	800	855	1195	-1	-1
High	8555	1185	1485	-1	-1
nAvg	0	0	0	0	0
PRESET?	N	Y	N	Y	N
PRESET?	0,00	0,00	0,00	0,00	0,00

Workspace 4

The left and right monitors contain data plots and the top monitor contains ID/beamline information.

The center monitor contains the interfaces necessary to control the 7 T end station. The main screens are:

- 7T Sample Control: Enables the positioning of the sample over Z and Phi coordinates. Also provides the ability to position the magnet chamber in the Y, Z, Theta directions. Ability to read the field of the 7 T magnet. Setting of the field is done through python commands
- Ability to read and set the sample temperature (bottom right).
- Control of the A6 (TEY) preamp .

The screenshot displays a multi-panel control interface for a 7 T magnet system. The main panel, titled '7T Sample Control', shows various parameters and controls:

- Energy SGM (eV):** 700.003
- Energy CPU (KeV):** 3.606
- Polarization:** CW/CCW
- Electron Yield (TEY):** Raw: 1, Norm: 0.001
- LHe:** dewar and sample gauges showing -18.0% and 0.0% respectively.
- Field:** -0.000 T
- PSH:** Off
- Fluorescence (TFY):** Raw: 0, Norm: 0.000
- Temperature Control:** T(K) = 287.60, T(K) set: 300.00
- Sample Positioning:**
 - Sample Z: -0.03175
 - Sample Phi: -40.55625
- Magnet Positioning:**
 - Magnet Y: 3.08018
 - Magnet Z: 7.99994
 - Magnet Theta: 105.57800

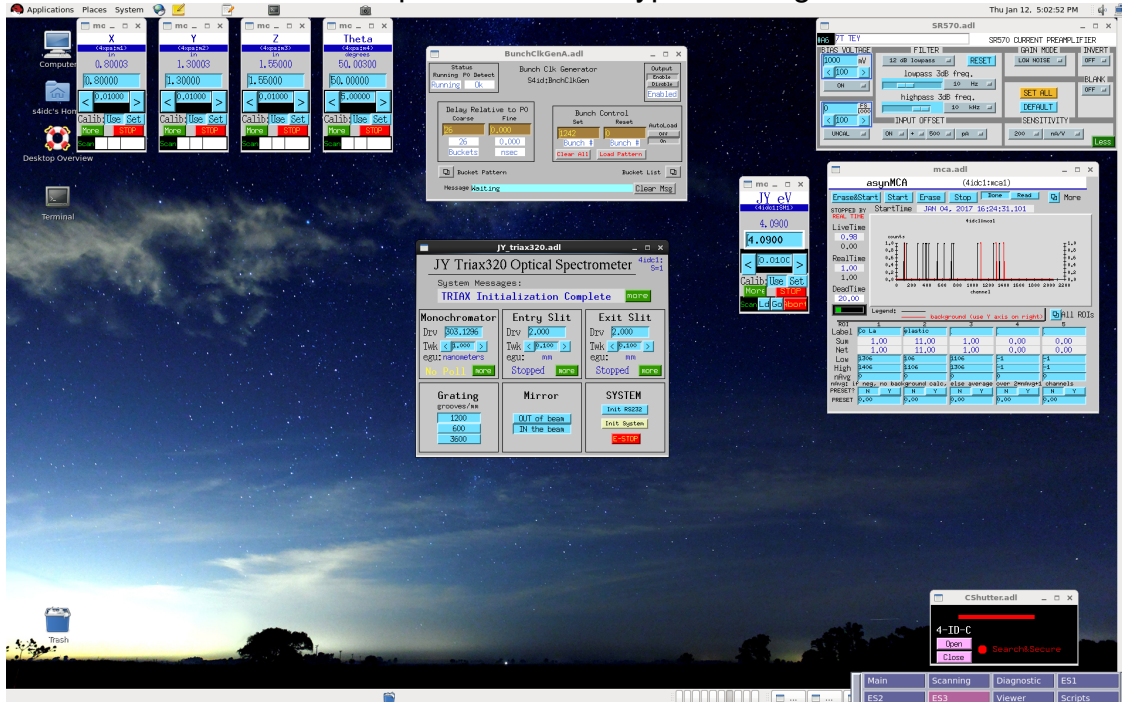
Other panels include:

- SR570.adl:** SR570 CURRENT PREAMPLIFIER controls including BIAS VOLTAGE, FILTER, GAIN MODE, and SENSITIVITY.
- AMI430.adl:** AMI430 Magnetic Field Controller showing Magnet Status (8 At Zero), Field (7.178 T), Voltage (2.000 V), Current (75.000 A), and Target field (0.000 T).
- LakeShore340lp1.adl:** LakeShore 340 temperature controller showing Temperature Parameters (Loop Set 300.00, Point 50.00 °K), Control Sensor (287.60 °K), and Sample Sensor (287.60 °K).

Workspace 5

The left and right monitors contain data plots and the top monitor contains ID/beamline information.

The center monitor is user configurable. It is typically used for control of the XPS end station and control of the XEOL spectrometer. A typical configuration is shown below.

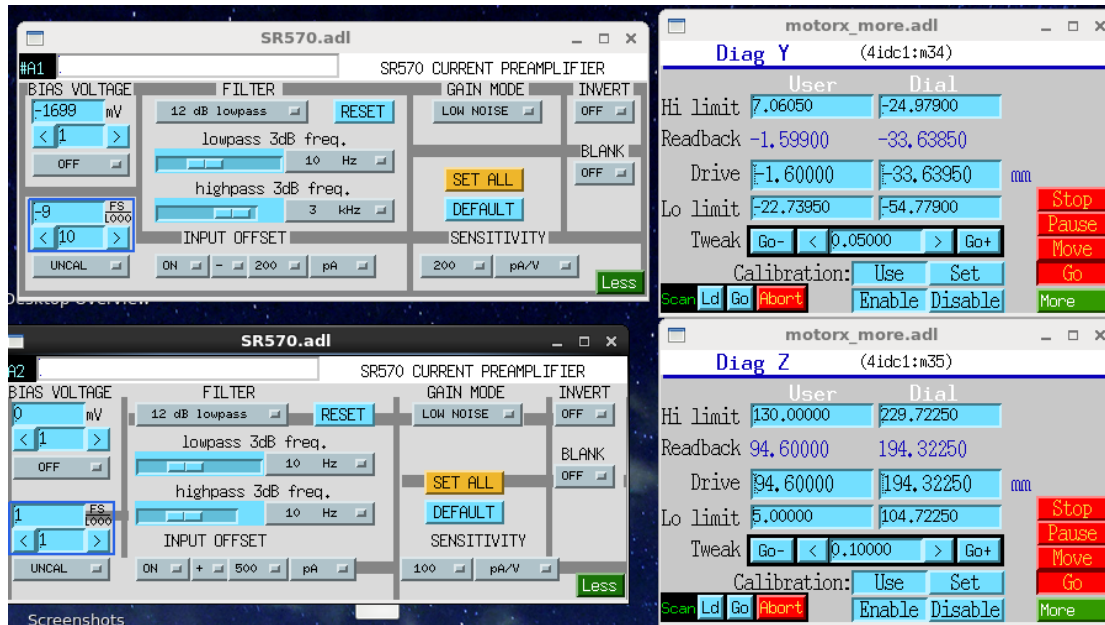


Workspace 6

Top monitor: A-Hutch: Control of two horizontal focusing mirrors in 4IDA (staff only).

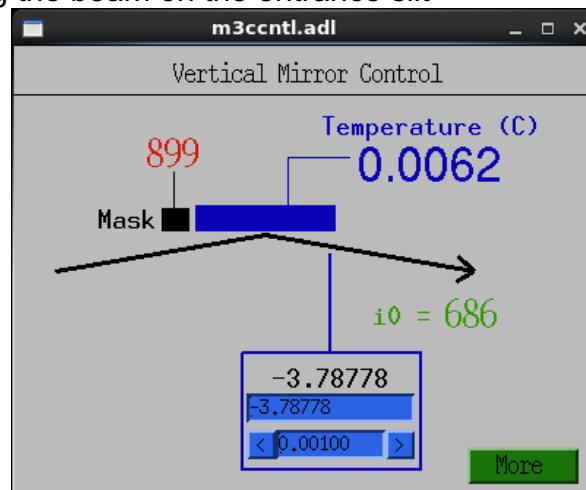
Right monitor: Slits for beam size control (staff only).

Left monitor: This workspace contains the screens for the I0 (A1) and standards (A2) preamps as well as the motor drivers that control the positions of the standards. See below.



Center monitor:

M3C: mirror for focusing the beam on the entrance slit



KB Mirrors: Horizontal and vertical refocusing and steering mirror control

The screenshot shows the 'KB Mirror Control' window with the following parameters and controls:

- Reset KB Bender:** A red button with a warning icon.
- M2 Focus:** A control box with a 'More' button, a value of -0.43003 , a slider at -0.43000 , and a step of 0.01000 . A red line labeled '572' connects it to the 'Vertical' label.
- M1 Focus:** A control box with a 'More' button, a value of -0.28002 , a slider at -0.28000 , and a step of 0.01000 . A red line labeled '660' connects it to the 'Horizontal' label.
- Vertical:** A grey label with a left-pointing arrow and a red vertical line labeled $i0 = 684$.
- Horizontal:** A grey label with a right-pointing arrow.
- M2 Z:** A control box with a value of -2.60005 , a slider at -2.600 , and a step of 0.010 . A 'Mirror' button is below it.
- M2 Angle:** A control box with a value of 30.24914 , a slider at 30.249 , and a step of 0.020 . A 'Mirror' button is below it.
- M1 Y:** A control box with a value of 2.85000 , a slider at 2.850 , and a step of 0.020 . A 'Mirror' button is below it.
- M1 Angle:** A control box with a value of 11.49028 , a slider at 11.490 , and a step of 0.020 . A 'Mirror' button is below it.
- TEY: 1**
TFY: 0
REF: 1
- © Negative Angle**

Workspace 7

This workspace contains the Pymca viewer (below right), which is used to view previous data while data acquisition is active. It also contains the mda to ascii GUI (below left), which converts data from mda to ascii formats and stores the latter in directories that are indirectly accessible via ftp or directly via the ancillary PC.

Convert 4idc mda to ascii (Jan2014:yc)

Directory for *.mda *.mda

/home/sector4/4idc/vx4idc/2013_1

Directory for *.asc *.asc

/home/sector4/4idc/data/2013_1

raw mda files

*.mda

command line for mda2ascii

/home/sector4/mda2ascii_linux64 -1 -d

prefix for ascii

YZ0313

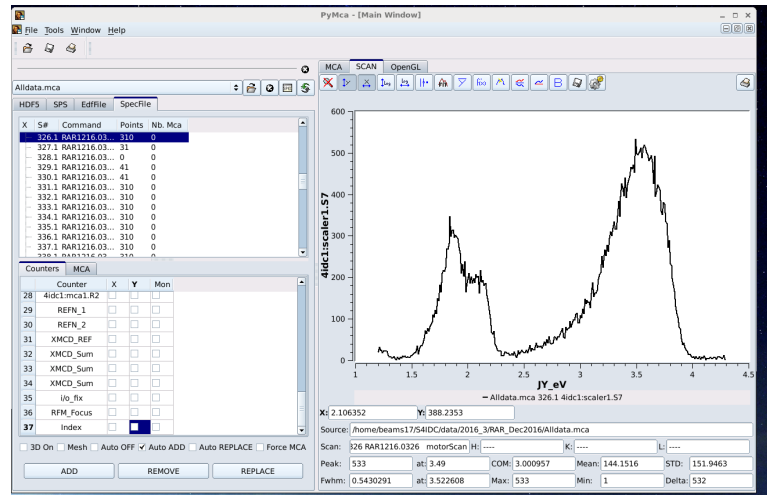
Convert *.mda to *.asc, rename to *.0001

convert

Automatic update Set Time (minutes) Time Left (min:sec)

Off 2.0 0:00

7T chamber? Yes Make simpler ascii **Simpler ascii**



Workspace 8

This workspace is used for editing and running python scripts.

3. Beamline Operation

Getting Started

To enable the beamline at the start of the run:

- 1.) Be sure safety approval form is posted and has all the relevant information. Note that only sector staff can sign the ESAF form.
- 2.) Confirm beamline vacuum status and then Open all necessary CLOSED beamline valves from the EPS panel.
- 3.) Open the Station C shutter from the PSS panel or control screen.

It will take approximately 30 min for optics to warm up. Visually check that there is beam on the M3C mirror, entrance slit, and grating using the video monitor.

Beamline control and data acquisition is done through a distributed control system called EPICS. Movement of beamline components is accomplished by talking to VME crates that are resident on the TCP/IP network. Access is accomplished via a linux workstation.

Starting and Setting Up Computer Control

Usually the control screens are already present, but if not proceed with the following steps as necessary. In the case of 4-ID-C, the computer is xsdlb4idc. To log on type:

Username: **s4idc**
Password: **See staff**

Then to start the control systems go to the workspace 1, center monitor, open a Terminal from the control strip at the top of the screen, and type **start4idc** at the xsdlb4idc% prompt. Wait while the software launches and sets up the control screens. The launch will switch between different workspaces and monitors on the desktop. Don't touch anything until it finishes in the EPS/Vacuum workspace of the top monitor as it will affect the screen layout. Each workspace has a name corresponding to the types of controls available in that area. If you have a problem with any of the displays, you can always execute **restart4idc** in order to close all the windows and redo the window layout. Make sure to press the **RESET** button in Workspace 1.

Aligning the M3C

From time to time it is necessary to check the alignment of the beam on the entrance slit. This is done by tweaking the M3C motor in the workspace 6. Simply tweak in 0.001 mm steps until the i0 counts are maximized. Note this in the Logbook as it can cause small energy shifts. Another option is to type scm3c() at the scan control line, which will scan the mirror and set it to the peak.

Unix Commands

Environment Control

Command	Description
cd <i>d</i>	Change to directory <i>d</i>
mkdir <i>d</i>	Create new directory <i>d</i>
rmdir <i>d</i>	Remove directory <i>d</i>
mv <i>f1</i> [<i>f2...</i>] <i>d</i>	Move file <i>f</i> to directory <i>d</i>
mv <i>d1</i> <i>d2</i>	Rename directory <i>d1</i> as <i>d2</i>
passwd	Change password
alias <i>name1</i> <i>name2</i>	Create command alias
unalias <i>name1</i>	Remove command alias <i>name1</i>
rlogin <i>nd</i>	Login to remote node
logout	End terminal session
setenv <i>name</i> <i>v</i>	Set env var to value <i>v</i>
unsetenv <i>name1</i> <i>name2...</i>	remove environment variable

Output, Communication, & Help

Command	Description
lpr -P <i>printer</i> <i>f</i>	Output file <i>f</i> to line printer
script [<i>f</i>]	Save terminal session to <i>f</i>
exit	Stop saving terminal
session	
mail <i>username</i>	Send mail to user
biff [<i>yn</i>]	Instant notification of mail
man <i>name</i>	UNIX manual entry for <i>name</i>
learn	Online tutorial

Process Control

Command	Description
Ctrl/c *	Interrupt processes
Ctrl/s *	Stop screen scrolling
Ctrl/q *	Resume screen output
sleep <i>n</i>	Sleep for <i>n</i> seconds
jobs	Print list of jobs
kill [% <i>n</i>]	Kill job <i>n</i>
ps	Print process status stats
kill -9 <i>n</i>	Remove process <i>n</i>
Ctrl/z *	Suspend current process
stop % <i>n</i>	Suspend background job <i>n</i>
command&	Run command in background
bg [% <i>n</i>]	Resume background job <i>n</i>
fg [% <i>n</i>]	Resume foreground job <i>n</i>
exit	Exit from shell

Abbreviations used in this pamphlet

Ctrl/x	hold down control key and press x
d	directory
env	environment
f	filename
n	number
nd	computer node
var	variable
[y/n]	yes or no
[]	optional arg
...	list

Environment Status

Command	Description
ls [<i>d</i>] [<i>f...</i>]	List files in directory
ls -l [<i>f...</i>]	List files in detail
alias [<i>name</i>]	Display command aliases
printenv [<i>name</i>]	Print environment values
quota	Display disk quota
date	Print date & time
who	List logged in users
whoami	Display current user
finger [<i>username</i>]	Output user information
chfn	Change finger information
pwd	Print working directory
history	Display recent commands
! <i>n</i>	Submit recent command <i>n</i>

File Manipulation

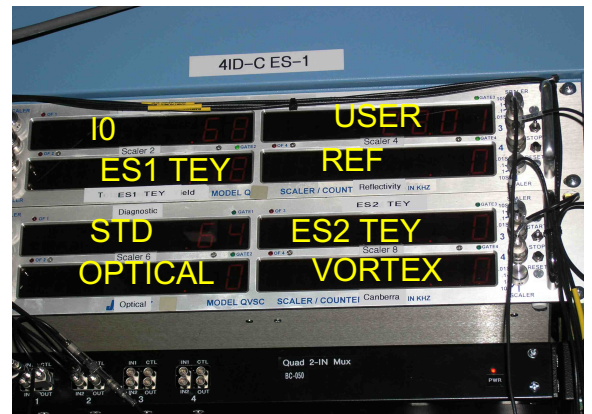
Command	Description
vi [<i>f</i>]	Vi fullscreen editor
emacs [<i>f</i>]	Emacs fullscreen editor
ed [<i>f</i>]	Text editor
we <i>f</i>	Line, word, & char count
cat <i>f</i>	List contents of file
more <i>f</i>	List file contents by screen
cat <i>f1</i> <i>f2</i> > <i>f3</i>	Concatenates <i>f1</i> & <i>f2</i> into <i>f3</i>
chmod <i>mode</i> <i>f</i>	Change protection mode of <i>f</i>
cmp <i>f1</i> <i>f2</i>	Compare two files
cp <i>f1</i> <i>f2</i>	Copy file <i>f1</i> into <i>f2</i>
sort <i>f</i>	Alphabetically sort <i>f</i>
split [- <i>n</i>] <i>f</i>	Split <i>f</i> into <i>n</i> -line pieces
mv <i>f1</i> <i>f2</i>	Rename file <i>f1</i> as <i>f2</i>
rm <i>f</i>	Delete (remove) file <i>f</i>
grep 'ptn' <i>f</i>	Outputs lines that match ptn
diff <i>f1</i> <i>f2</i>	Lists file differences
head <i>f</i>	Output beginning of <i>f</i>
tail <i>f</i>	Output end of <i>f</i>

Compiler

Command	Description
cc [-o <i>f1</i>] <i>f2</i>	C compiler
lint <i>f</i>	Check C code for errors
f77 [-o <i>f1</i>] <i>f2</i>	Fortran77 compiler
pc [-o <i>f1</i>] <i>f2</i>	Pascal compiler

Using the current amplifiers

There are SRS current amplifiers that are used for TEY and REF measurements (see beamline tour section). The sensitivity determines their output. The preamp shown below will output 1 V for every 200 pA of current. The voltage is converted into a frequency (100,000 cps per volt), which is then read by a scaler. The scaler reading may be viewed either on the work station or on the scaler displays on the top of the left hand control rack (see diagram below). There are two settings that need monitoring and adjustment during the experiment: the zero offset and the current range. To adjust the zero offset, close the shutter and adjust the input offset (red arrow) until the output is slightly positive (scaler displays read ~0.5 (500 cps)). The sensitivity will depend on the signal level, which is material and photon energy dependent. It should be set so that the output level is in the range ~1-3 V (100-300 kcps). If the signal level is too low (<0.4 V) increase the sensitivity; if it is too high (>5 V) decrease the sensitivity (black arrow). **If the sensitivity is too high the amplifiers may saturate (~6V output and red warning light visible on the amplifier).** The sensitivity may also be adjusted by python command.



4. DATA ACQUISITION AND MANIPULATION

Setting up data files

Go to the Scanning area in workspace 2 and locate the Scan Control in the lower right part of the screen. Click on the green SaveData button near the top of the screen, which will open a new window. Edit the last part subdirectory field to a name of your choice. See that the change is reflected in the readout below this field. Then change the Next Scan Number to 1.

Setting up a scan

All scan control is performed from a Python terminal window. In this window there will be a prompt for the Python programming language (>>>). In the event the scan window is not present, open a Terminal and type python at the prompt. All scans and much of the sample control can be accessed. The following list contains the commands used for Python data acquisition.

Python Commands

- **Sample Environment**

Command	Function
x(x)	Set Octupole sample x (mm)
y(y)	Set Octupole sample y (mm)
z(z)	Set Octupole sample z (mm)
th(theta)	Set Octupole sample angle (degrees)
tth(2theta)	Set Octupole detector angle (degrees)
pos()	List Octupole sample y, z, and theta
tempr()	Read Octupole chamber sample temperature
temps(temp)	Set and stabilize Octupole chamber sample temperature (K)
field(A)	Set Octupole chamber horizontal field (power supply amps)
y7(z)	Set 7T chamber magnet y (mm)
z7(z)	Set 7T chamber sample z (mm)
th7(theta)	Set 7T sample angle (degrees)
tempr7()	Read 7T chamber sample temperature
temps7(temp)	Set and stabilize 7T chamber sample temperature (K)
hfa(field)	Set 7T field (T) (see notes on this command for info on persistent mode, etc.)*
xxps(x)	Set XPS sample x (in)

y(xpsy)	Set XPS sample y (in)
zxps(z)	Set XPS sample z (in)
thxps(theta)	Set XPS sample angle (degrees)
ystd(y)	Set standard sample y (mm)
zstd(z)	Set standard sample z (mm)
zxelm(z)	Set XELM/Low field magnet sample z (mm)

*The hfa() macro will check the operating mode of the SC magnet and leave it in that state after changing field. If the Switch Heater is off, macro will assume operation in persistent mode. The macro will match the power supply current to the coils, turn on the switch heater, ramp to the new field, turn off the heater, and ramp down the supply. If the switch heater is on, it will assume non-persistent mode and ramp immediately to the new field.

• Beamline Control

Command	Function
eng(energy)	Tune SGM and undulator to certain energy (eV)
lcp(energy)	Tune SGM and undulator to energy and polarization (LCP) (eV)
rcp(energy)	Tune SGM and undulator to energy and polarization (RCP) (eV)
h(energy)	Tune SGM and undulator to energy and polarization (H) (eV)
v(energy)	Tune SGM and undulator to energy and polarization (V) (eV)
cwccw(energy)	Tune SGM and undulator to energy and polarization (CW/CCW) (eV)
jy(wavelength)	Set optical monochromator to wavelength (nm)
jyev(energy)	Set optical monochromator to energy (eV)
acon()	Turn on scan accumulation (i.e. sum data in series of scans)
acoff()	Turn off scan accumulation
opc()	Open C shutter
clc()	Close C shutter
lock()	Lock exit slit motion
track()	Unlock exit slit motion
sca(V)	For Vortex: Set SCA window using DAC channel (V)
jyent(size)	Set size of JY spectrometer entrance slit (mm)
jyexit(size)	Set size of JY spectrometer exit slit (mm)
set_amp(amp#, value, unit)	Sets a given amplifier number to a given range. Example: set_amp('A2', 10, 'nA/V'). Sets amp A2 to 10 nA/V.

• Normal Scans

Normal scans consist of scanning energy, position, etc... and measuring one value at each point of the scan. The input to all these scans are the same: start, finish, step size, and count time. For example, the command for an energy scan from 630 to 660 eV in a 0.1 eV step and 0.5 sec counting time is: sceng(660,630,.1,.5). Note that it is more efficient to scan from high to low energy.

Command	Function
scx(s,f,st,t)	Scan sample x position on front chamber (mm)
scy(...)	Scan sample y position on front chamber (mm)
scz(...)	Scan sample z position on front chamber (mm)
scr(...)	Scan sample angle on front chamber (degree)
scy7(...)	Scan sample y position on 7T magnet (mm)
scz7(...)	Scan sample z position on 7T magnet (mm)
scr7(...)	Scan sample z angle on 7T magnet (degree)
scxxps(...)	Scan sample x position on XPS chamber (in)
scyxps(...)	Scan sample y position on XPS chamber (in)
sczxps(...)	Scan sample z position on XPS chamber (in)
scrthxps(...)	Scan sample angle on XPS chamber (degree)
sch(...)	Hysteresis scan of Octupole horizontal field along the beam direction (scans loop from start to finish and then back to start). NOTE: Start must be < Finish or will not work. Field range values in power supply amps.
sceng(...)	Scan incident photon energy for absorption measurement (eV)
scengld(...)	Scan monochromator without moving undulator (keV)
sc2th(...)	Theta-2Theta scan on front chamber (input is theta scan range) (degree)
scjy(...)	Scan JY spectrometer (input is wavelength range in nm)
scjyev(...)	Scan JY spectrometer (input is energy range in eV)
scengjy(...)	Scan incident photon energy with JY input time gated. (eV)
scan()	Run last scan again
mscan(N)	Run last scan N times in a row

• Find Sample Scans

Find sample scans consist of scanning the position of a particular dimension and measuring one value at each point of the scan. At the end of the scan it will go to the maximum value measured by the Reference Detector (see scan.adl screen). The input to all these scans are the same: start,finish,step size, and count time. For example, the command for a x position scan of the Octupole manipulator from 10 to 20 mm in a 0.1 mm step and 0.5 sec counting time is: scx(10,20,.1,.5).

Command	Function
FindSamplex(st,f,st,t)	Scan sample x position on Octupole chamber (mm) and go to peak position after scan
FindSampley(...)	Scan sample y position on Octupole chamber (mm) and go to peak position after scan

FindSamplez(...)	Scan sample z position on Octupole chamber (mm) and go to peak position after scan
FindSampleY7(...)	Scan 7 T magnet table y position (mm) and go to peak position after scan
FindSampleZ7(...)	Scan 7 T sample Z position (mm) and go to peak position after scan

• XMCD Scans in Polarization Switching Mode

These scans involve toggling of the undulator polarization. Before starting a scan make sure the CPU is set to the AC or "CW/CCW" mode. This can be done at the command line by typing "cwccw(energy)". We have control of the polarization via a TTL trigger signal. Make sure Trigger Select is set to External on the CPU screen in the Scan area. For these scans the magnetic field must be set manually beforehand. The input to all these scans are the same: start, finish, step size, and count time. For example, the command for an energy scan from 630 to 660 eV in a 0.1 eV step and 1 sec counting time is: scxmcdcp(630,660,.1,.1). NOTE: Count time must be >= 1 sec!

Command	Function
scxmcdcp(s,f,st,t)	XMCD scan vs energy
scxmcdcpr(...)	XMCD scan vs. front chamber sample angle
scxmcdcpy (...)	XMCD scan vs. front chamber sample y position
scxmcdcpz (...)	XMCD scan vs. front chamber sample z position
scxmcd2thcp(...)	XMCD scan vs. theta-2theta
scxmcdcpz7 (...)	XMCD scan vs. 7T chamber sample z position
scxmcdcpr7 (...)	XMCD scan vs. 7T chamber sample angle
scxmcdcph(...)	XMCD scan vs. 7T chamber field (scans loop from start to finish and then back to start). NOTE: Start must be < Finish or will not work.

• XPS Scans and Control

Command	Function
scArgus(st,f,st.t,PE)	XPS binding energy scan (eV) for Argus analyzer. Will set pass energy to PE if a value is present.
scArgusI0(st,f,st.t,PE)	Same as above, but also takes a dummy EPICS scan which can be subsequently used for I0 and sample current extraction. This file also stores beamline parameters.
ArgusWF(value)	Set work function of Argus analyzer (eV)
ArgusPE(value)	Set pass energy of Argus analyzer (eV)

- **Diagnostic Scans**

These scans are used for beamline diagnostics and testing.

Command	Function
scm3c()	Scan and optimize M3C position (NOTE: no inputs!)
sczero(s,f,st,t)	Scan of SGM x motor for alignment
scsgmeng(s,f,st,t,id_energy_keV)	Scan SGM energy at a given ID energy

Automated Scan Control with Python Scripting

There are many types of scan sequences that can be automated with a script. All scripts should be put in the /home/beams17/S4IDC/python2.5/scripts/. There are two sample script files called ychoi_sample.py and XMCD7T_T_sample.py. The first is a fairly complex script written by Yong Choi that performs XMCD and hysteresis scans in the 7 T chamber. The second is a relatively simple script that performs XMCD as a function of temperature in the 7 T chamber. To create a file use the Editor in the Scripts area. It is usually easier to open a previously created file or one of the sample files. The two sample files are shown below.

ychoi_sample.py

```
#!/usr/bin/env python

from ca_util import *
from time import sleep
import commands
from ScanFunc_pyBurt import *
# The above is important header stuff DO NOT REMOVE!

#-----
#       define functions for 7Tesla chamber
#-----

def Escans3():
    sceng(700, 735, 0.2, 0.5)
    sceng(770, 807, 0.2, 0.5)
    sceng(1065, 1122, 0.2, 0.5)

def TwoHalfLoops():
    # field sweeping, switch heater needs to be on.      37min/each
    eng(642.2)
    scm3c()
    scxmcdcpshhalf( 2., -2., -0.04, 3., 15.)
    scxmcdcpshhalf(-2., 2., 0.04, 3., 15.)
    # scxmcdcpshhalf(-6., 6., 0.1, 3., 28.)
```

```

def xmcd_scans(elem = 'SmCo'):
    # Co, Sm xmcd scans
    if elem == 'SmCo':
        scxmcdcp(1065, 1115, 0.25, 0.5) # Sm edge
        scxmcdcp(770, 807, 0.25, 0.5) # Co edge
    if elem == 'CuSmCo':
        scxmcdcp(920, 960, 0.25, 0.5) # Cu edge
        scxmcdcp(1065, 1115, 0.25, 0.5) # Sm edge
        scxmcdcp(770, 807, 0.25, 0.5) # Co edge
    if elem == 'Sm':
        scxmcdcp(1065, 1115, 0.25, 0.5) # Sm edge
    if elem == 'Co':
        scxmcdcp(770, 807, 0.25, 0.5) # Co edge
    if elem == 'Cu':
        scxmcdcp(920, 960, 0.25, 0.5)

def loop_scans():
    h_list = [6,3,0,-3,-6]
    xmcd_scans()
    for h0 in h_list:
        He_level=level()
        print scan_number()
        print "Field is %.1f and He is at %.1f" % (h0, He_level)
        hfa(h0)
        scm3c()
        xmcd_scans('Cu')

def meas_part1(eV):
    hfa(6)
    scm3c()
    xmcd_scans('CuSmCo') # 3 energy scans at +6T
    scm3c()
    eng(eV)
    scxmcdcp(6., -6., -0.1, 3., 28.)
    scm3c()
    xmcd_scans('CuSmCo') # energy scans at -6T

def do_it():
    # turn switch heater ON at zero field before hysteresis
    #hfa(0)
    #strPV = "4idc2:AMI430:PSOnOff"
    #caput(strPV, 1)
    #-----
    #hfa(6)
    eng(1081.2)
    scm3c()
    scxmcdcp(6., -6., -0.1, 3., 50.) #321
    scm3c()
    scxmcdcp(-6., 6., 0.1, 3., 50.) #323
    eng(776.5)
    scm3c()
    scxmcdcp(6., -6., -0.1, 3., 50.) #325
    scm3c()
    scxmcdcp(-6., 6., 0.1, 3., 50.) #327

```



```

        hfa(0)
        xmcd_scans('SmCo')          #328, 329

#-----
#          call functions below
#-----
scm3c()
xmcd_scans('SmCo') #331, 332
xmcd_scans('SmCo')   #333, 334

# ----- End -----

```

XMCD7T_T_sample.py

```

#!/usr/bin/env python

from ca_util import *
from time import sleep
import commands
from ScanFunc_pyBurt import *
# The above is important header stuff DO NOT REMOVE!

hfa(3)
temps7(8)
scm3c()
a=0
while a < 30:
    temps7(8+a*5)
    eng(709)
    FindSampleZ7(25,28,.1,.5)
    scxmcdcp(715,705,-.1,1)
    eng(709)
    FindSampleZ7(28,33,.1,.5)
    scxmcdcp(715,705,-.1,1)
    a=a+1

a=0
scm3c()
while a < 6:
    temps7(160+a*10)
    eng(709)
    FindSampleZ7(25,28,.1,.5)
    scxmcdcp(715,705,-.1,1)
    eng(709)
    FindSampleZ7(28,33,.1,.5)
    scxmcdcp(715,705,-.1,1)
    a=a+1

hfa(0)
temps7(290)

```

Once the file is ready, save to a name.py. The .py tells us it is a python file. To run the script open a terminal window and change into the directory where the script is located, i.e. /home/beams17/S4IDC/python2.5/scripts//2014/2014_3. At the prompt type:

```
python name.py &
```

The output of the python script will be written to the terminal window. DON'T CLOSE IT B/C IT WILL KILL THE SCRIPT! If for some reason you have to stop the script, go to the terminal window and hit CTRL C.

Exporting and Transferring Data For Retrieval

Data can be exported to ASCII files using the following procedure. Go to workspace 7 and open a terminal. At the prompt type “convert”. The following screen will appear

Convert 4idc mda to ascii (Jan2014:yc)

Directory for *.mda

Directory for *.asc

raw mda files

command line for mda2ascii

prefix for ascii

Convert *.mda to *.asc, rename to *.0001

Automatic update Set Time (minutes) Time Left (min:sec)

7T chamber? Make simpler ascii

Hit the *.mda button and locate the directory where the mda files are stored. This will be the directory entered when the experiment was started. Next hit the *.asc button and locate the directory where the converted ascii files will be stored. You may have to create this directory, but this is part of the dialog. Next type in the prefix for the ascii files. In the example the ascii files will be stored as RAR1014.xxxx, where xxxx is the file number (0001 to 9999).

The data is automatically copied over to an anonymous FTP site every 20 minutes. If you need to transfer the data by hand, open a terminal window and copy the files onto the XOR anonymous ftp server. At the prompt type cd data and this will put you into the data directory. cd into the asciimdafiles subdirectory in your data directory and use the following command

```
cp * /home/xor-ftp/pub/sector4/4idc/data/2014_3/MyExpt/asciimdafiles/
```

The * will copy all files with that name.

You could also copy over an entire directory, using the following command

```
cp -R dirname /home/xor-ftp/pub/sector4
```

Step 2. The data can be retrieved using an ftp program, a web browser or the ancillary PC.

Using an ftp program:

1. Connect to ftp.xor.aps.anl.gov
2. When it prompts you for a user type “anonymous” and use your e-mail as a password
3. Change to directory “pub/sector4”.
4. Get file copied over in step 2.

Using a web browser:

1. Go to <http://ftp.xor.aps.anl.gov/pub/sector4>
2. Click on file to download onto your computer.

Using the ancillary PC.

1. Locate the directory where the files are stored. For instance:
[sector4\(\\s4dserv\)\(Z:\)/4idc/data/2014_3/RAR_Oct14](#)
2. Copy the files to a USB drive.

Data File Structure

The first part of the ascii data files contains numerous lines containing values for the process variables (PVs) that were active during the scan. Every important parameter should be able to be extracted from this list. An example follows:

```
# Extra PV 1: 4idcl:saveData_scanNumber, , "6",
# Extra PV 2: 4idcl:scaler1.TP, scaler time preset, "1",
# Extra PV 3: 4idcl:saveData_fileSystem, filesystem,
  "//s4dserv/export/sector4/4idc/vx4idc"
# Extra PV 4: 4idcl:saveData_subDir, subdirectory, "2014_3/TO_Oct14"
# Extra PV 5: 4idcl:saveData_comment1, , ""
# Extra PV 6: 4idcl:saveData_comment2, , ""
# Extra PV 7: 4idcl:scan1.PlSM, scan mode, "LINEAR"
# Extra PV 8: 4idcl:scan1.PlAR, scan abs/rel positions, "ABSOLUTE"
# Extra PV 9: 4idcl:scan1.ACQM, scan acquire mode, "NORMAL"
# Extra PV 10: 4idcl:userStringCalc1.AA, Comment:, ""
# Extra PV 11: ID04b:energy.VAL, CPU Energy (keV), "0.948976278",
# Extra PV 12: ID04b:mode.VAL, CPU mode, "CW/CCW"
# Extra PV 13: ID04b:TriggerSelect.VAL, CPU trigger, "External"
# Extra PV 14: ID04b:H_coil.VAL, CPU H Current, "756.953767",
# Extra PV 15: ID04b:V_coil.VAL, CPU V Current, "223.044175",
# Extra PV 16: 4ida:m9.RBV, Y4-30 In-out (mm), "1.382", mm
# Extra PV 17: 4ida:m10.RBV, Y4-30 Vertical (mm), "0", mm
# Extra PV 18: 4ida:m11.RBV, Y4-30 Rotation (mm), "-3.1099125", mm
# Extra PV 19: 4ida:m12.RBV, Y4-40 In-out (mm), "-0.081", mm
# Extra PV 20: 4ida:m13.RBV, Y4-40 Vertical (mm), "0", mm
# Extra PV 21: 4ida:m14.RBV, Y4-40 Rotation (mm), "-42.827575", mm
# Extra PV 22: 4idcl:m21.RBV, L2-90 Bottom position (mm), "-1.2", mm
# Extra PV 23: 4idcl:m22.RBV, L2-90 Left position (mm), "5.8", mm
# Extra PV 24: 4idcl:m23.RBV, L2-90 Top position (mm), "5.9", mm
# Extra PV 25: 4idcl:m24.RBV, L2-90 Right position (mm), "3", mm
# Extra PV 26: 4idcl:m3.RBV, M3C US Y (mm), "10.77341", mm
# Extra PV 27: 4idcl:m4.RBV, M3C DS Y (mm), "-3.78841", mm
# Extra PV 28: 4idcl:m2.RBV, M3C Z (mm), "-0.36195", mm
# Extra PV 29: 4idcl:scaler2.S6, M3C mask, "1",
# Extra PV 30: 4idcl:D2Dmm_raw.VAL, M3C Temp (deg. C), "0.00625672922",
# Extra PV 31: 4idcl:SGM1:EnergyRBV, SGM Energy (eV), "924.984413", eV
# Extra PV 32: 4idcl:SGM1:LambdaRBV, SGM Lambda (A), "13.4039279", Angstro
# Extra PV 33: 4idcl:SGM1:phiRBV, SGM phi (deg), "0.778000713", degrees
# Extra PV 34: 4idcl:m9.RBV, Entrance arm (m), "3.999991", m
# Extra PV 35: 4idcl:m10.RBV, Grating Tangent arm (mm), "5.02985", mm
# Extra PV 36: 4idcl:m11.RBV, Exit arm (m), "7.932114", m
# Extra PV 37: 4idcl:SGM1:grating, SGM Grating, "grating 1"
# Extra PV 38: 4idcl:m31.RBV, Ver RFM1, "-0.550002", mm
# Extra PV 39: 4idcl:m29.RBV, Hor RFM1, "-0.31992", mm
# Extra PV 40: 4idcl:M1t2.D, RFM Y height, "2.68999995",
# Extra PV 41: 4idcl:M1t2.C, RFM Y Angle (mrad), "10.5203795",
# Extra PV 42: 4idcl:M2t2.D, RFM Z height, "-1.72994973",
# Extra PV 43: 4idcl:M2t2.C, RFM Z Angle (mrad), "30.0902857",
# Extra PV 44: 4idcl:Alsens_num.VAL, i0 SR570, "1"
# Extra PV 45: 4idcl:Alsens_unit.VAL, i0 SR570, "nA/V"
```

```

# Extra PV 46: 4idcl:A2sens_num.VAL, Diag SR570, "1"
# Extra PV 47: 4idcl:A2sens_unit.VAL, Diag SR570, "nA/V"
# Extra PV 48: 4idcl:A3sens_num.VAL, TEY SR570, "1"
# Extra PV 49: 4idcl:A3sens_unit.VAL, TEY SR570, "nA/V"
# Extra PV 50: 4idcl:A4sens_num.VAL, TFY SR570, "1"
# Extra PV 51: 4idcl:A4sens_unit.VAL, TFY SR570, "nA/V"
# Extra PV 52: 4idcl:A5sens_num.VAL, REF SR570, "1"
# Extra PV 53: 4idcl:A5sens_unit.VAL, REF SR570, "nA/V"
# Extra PV 54: 4idcl:A6sens_num.VAL, 7TTEY SR570, "2"
# Extra PV 55: 4idcl:A6sens_unit.VAL, 7TTEY SR570, "nA/V"
# Extra PV 56: 4idcl:userTran2.C, Entrance Slit (um), "75",
# Extra PV 57: 4idcl:userTran2.D, Exit Slit (um), "150",
# Extra PV 58: 4idcl:4step:Aseq.DLY1, step A actions, "0",
# Extra PV 59: 4idcl:4step:Aseq.DO1, step A actions, "1",
# Extra PV 60: 4idcl:4step:Aseq.LNK1, step A actions, "4idcl:userTran16.A PP
NMS"
# Extra PV 61: 4idcl:4step:Aseq.DLY2, step A actions, "0.25",
# Extra PV 62: 4idcl:4step:Aseq.DO2, step A actions, "1",
# Extra PV 63: 4idcl:4step:Aseq.LNK2, step A actions, "4idcl:userTran16.A PP
NMS"
# Extra PV 64: 4idcl:4step:Aseq.DLY3, step A actions, "0",
# Extra PV 65: 4idcl:4step:Aseq.DO3, step A actions, "0",
# Extra PV 66: 4idcl:4step:Aseq.LNK3, step A actions, ""
# Extra PV 67: 4idcl:4step:Aseq.DLY4, step A actions, "0",
# Extra PV 68: 4idcl:4step:Aseq.DO4, step A actions, "0",
# Extra PV 69: 4idcl:4step:Aseq.LNK4, step A actions, ""
# Extra PV 70: 4idcl:4step:Bseq.DLY1, step B actions, "0",
# Extra PV 71: 4idcl:4step:Bseq.DO1, step B actions, "0",
# Extra PV 72: 4idcl:4step:Bseq.LNK1, step B actions, "4idcl:userTran16.A PP
NMS"
# Extra PV 73: 4idcl:4step:Bseq.DLY2, step B actions, "0.25",
# Extra PV 74: 4idcl:4step:Bseq.DO2, step B actions, "0",
# Extra PV 75: 4idcl:4step:Bseq.LNK2, step B actions, "4idcl:userTran16.A PP
NMS"
# Extra PV 76: 4idcl:4step:Bseq.DLY3, step B actions, "0",
# Extra PV 77: 4idcl:4step:Bseq.DO3, step B actions, "0",
# Extra PV 78: 4idcl:4step:Bseq.LNK3, step B actions, ""
# Extra PV 79: 4idcl:4step:Bseq.DLY4, step B actions, "0",
# Extra PV 80: 4idcl:4step:Bseq.DO4, step B actions, "0",
# Extra PV 81: 4idcl:4step:Bseq.LNK4, step B actions, ""
# Extra PV 82: 4idcl:m20.RBV, 8-pole sample x position, "3.509375", mm
# Extra PV 83: 4idcl:m15.RBV, 8-pole sample y position, "2.071875", mm
# Extra PV 84: 4idcl:m17.RBV, 8-pole sample z position, "9.4999125", mm
# Extra PV 85: 4idcl:m14.RBV, 8-pole sample angle, "15.003", deg
# Extra PV 86: 4idcl:m13.RBV, 7T Z pos (in), "-0.0635", mm
# Extra PV 87: 4idcl:m19.RBV, 7T Sample Angle, "70", degrees
# Extra PV 88: 4idcl:m37.RBV, 7T Magnet Table Y, "0.4996025", mm
# Extra PV 89: 4idcl:m38.RBV, 7T Magnet Table Z, "7.60006", mm
# Extra PV 90: 4idcl:m39.RBV, 7T Magnet Table Theta, "97.577", mm
# Extra PV 91: 4idcl:LS340:TC1:SP1, Front T setpoint, "0",
# Extra PV 92: 4idcl:LS340:TC1:Sample, Front T sample, "0",
# Extra PV 93: 4idcl:LS340:TC2:SP1, 7T T setpoint, "300",
# Extra PV 94: 4idcl:LS340:TC2:Sample, 7T T sample, "3.0827",
# Extra PV 95: 4idcl:LM500:S1:level, 7T magnet level, "-16.4", percent
# Extra PV 96: 4idcl:userTran7.G, 2Theta, "29.9925",

```

```

# Extra PV 97: 4idc1:userTran7.L, q_z at 2Theta, "0.242587219",
# Extra PV 98: 4idc2:AMI430:Field, 7T field (T), "0",
# Extra PV 99: 4idc2:AMI430:Current, 7T current (A), "0",
# Extra PV 100: 4idc2:8p:Axis1Current, 8-pole Axis 1 Current(A),
"0.0366210938", A
# Extra PV 101: 4idc2:8p:FRB1, 8-pole Axis 1 Field (T), "1.80260899", Oe
# Extra PV 102: 4idc2:8p:Axis2Current, 8-pole Axis 2 Current(A), "-
0.164794922", A
# Extra PV 103: 4idc2:8p:FRB2, 8-pole Axis 2 Field (T), "-7.89164036", Oe
# Extra PV 104: 4idc2:8p:Axis3Current, 8-pole Axis 3 Current(A), "-
0.0381469727", A
# Extra PV 105: 4idc2:8p:FRB3, 8-pole Axis 3 Field (T), "1.87772532", Oe
# Extra PV 106: 4idc2:8p:Axis4Current, 8-pole Axis 4 Current(A), "-
0.173950195", A
# Extra PV 107: 4idc2:8p:FRB4, 8-pole Axis 4 Field (T), "-8.33006009", Oe

```

Following this section is a list describing the headings of the columns of the actual data file. An example follows:

```

# Column Descriptions:
#   1 [      Index      ]
#   2 [1-D Positioner 1] 4idc1:SGM1:Energy, SGM1:Energy, LINEAR, eV,
4idc1:SGM1:EnergyRBV, Energy readback, eV
#   3 [1-D Positioner 2] ID04b:set_energy.VAL, , LINEAR, ,
ID04b:energy.VAL, ,
#   4 [1-D Detector   1] 4idc1:scaler1.S2, ,
#   5 [1-D Detector   2] 4idc1:scaler1.S3, ,
#   6 [1-D Detector   3] 4idc1:scaler1.S4, ,
#   7 [1-D Detector   4] 4idc1:scaler1.S5, ,
#   8 [1-D Detector   5] 4idc1:scaler1.S6, ,
#   9 [1-D Detector   6] 4idc1:scaler1.S7, ,
#  10 [1-D Detector   7] 4idc1:scaler1.S8, ,
#  11 [1-D Detector   8] 4idc1:scaler1_calc3.VAL, ,
#  12 [1-D Detector   9] 4idc1:scaler1_calc4.VAL, ,
#  13 [1-D Detector  10] 4idc1:scaler1_calc5.VAL, ,
#  14 [1-D Detector  11] 4idc1:scaler1_calc6.VAL, ,
#  15 [1-D Detector  12] 4idc1:scaler1_calc7.VAL, ,
#  16 [1-D Detector  13] 4idc1:scaler1_calc8.VAL, ,
#  17 [1-D Detector  14] 4idc1:D2Dmm_raw.VAL, Dmm raw desc,
#  18 [1-D Detector  15] 4idc1:scaler1.T, ,
#  19 [1-D Detector  16] 4idc1:scaler1.S7, ,
#  20 [1-D Detector  17] 4idc1:scaler2.S7, ,
#  21 [1-D Detector  18] 4idc1:scaler2.S8, ,
#  22 [1-D Detector  19] 4idc1:scaler1.S15, ,
#  23 [1-D Detector  20] 4idc1:scaler1.S16, ,
#  24 [1-D Detector  21] 4idc1:scaler1_calc3.VAL, ,
#  25 [1-D Detector  22] 4idc1:scaler1_calc4.VAL, ,
#  26 [1-D Detector  23] 4idc1:scaler1_calc5.VAL, ,
#  27 [1-D Detector  24] 4idc1:scaler1_calc6.VAL, ,
#  28 [1-D Detector  25] 4idc1:scaler1_calc7.VAL, ,
#  29 [1-D Detector  26] 4idc1:scaler1_calc8.VAL, ,
#  30 [1-D Detector  27] 4idc1:userCalc1.VAL, REFN_1,
#  31 [1-D Detector  28] 4idc1:userCalc2.VAL, REFN_2,
#  32 [1-D Detector  29] 4idc1:userCalc9.VAL, XMCD_REF,
#  33 [1-D Detector  30] 4idc1:userTran4.C, XMCD Sum,

```

```

# 34 [1-D Detector 31] 4idcl:userTran4.F, XMCD Sum,
# 35 [1-D Detector 32] 4idcl:userTran4.I, XMCD Sum,
# 36 [1-D Detector 33] 4idcl:userTran1.E, LI Signal Norm,
# 37 [1-D Detector

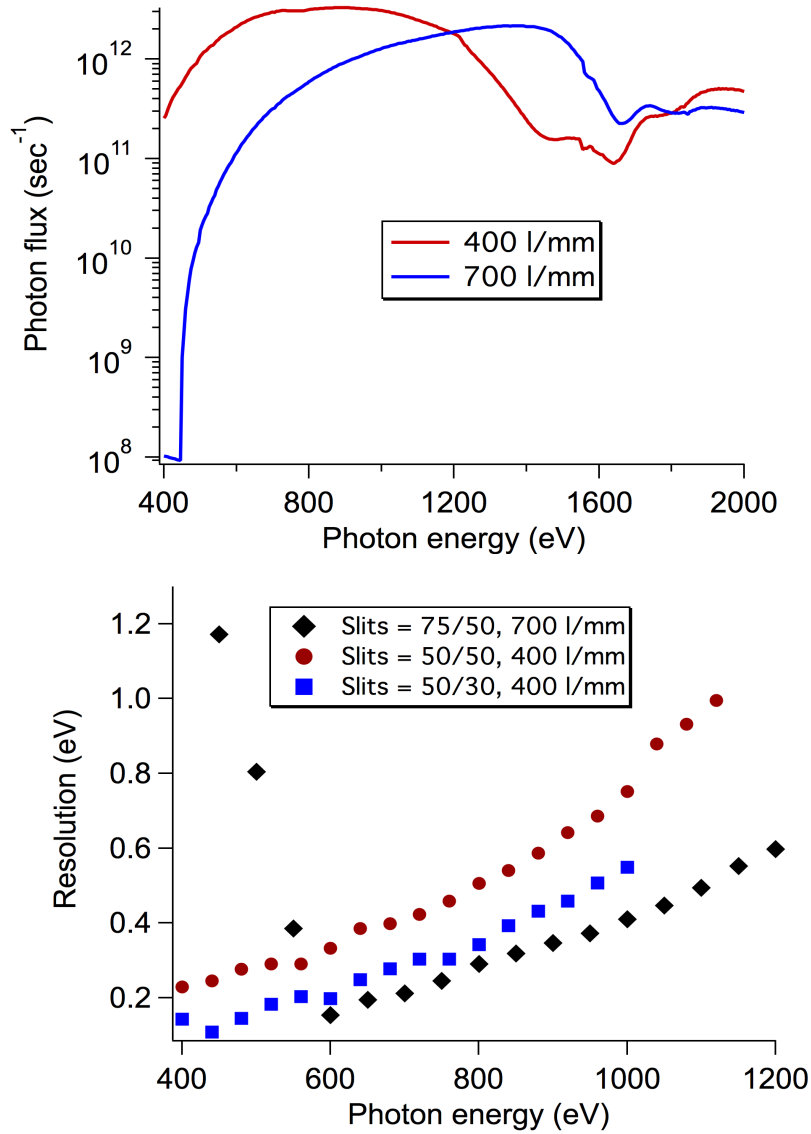
```

Since it isn't obvious what these descriptions mean, the heading for the columns of some of the more common scans are found in the following table.

Col.	XAS	XMCD	x,y,z	Hyst Oct	Hyst 7 T
01	Point #	Point #	Point #	Point #	Point #
02	SGM E (eV)	SGM E (eV)	Position	Field	Field
03	ID E (keV)	ID E (keV)	I0	I0	I0 RCP
04	I0	I0 RCP	REF RAW	REF RAW	TEY RCP
05	REF RAW	TEY RCP	TEY RAW	TEY RAW	TFY RCP
06	TEY RAW	TFY RCP	TFY RAW	TFY RAW	REF RCP
07	TFY RAW	REF RCP	STD	STD	I0 LCP
08	STD	I0 LCP	OPT	OPT	TEY LCP
09	OPT	TEY LCP	XPS	XPS	TFY LCP
10	XPS	TFY LCP	REF NORM	REF NORM	REF LCP
11	REF NORM	REF LCP	TEY NORM	TEY NORM	TEY SUM
12	TEY NORM	TEY SUM	TFY NORM	TFY NORM	TFY SUM
13	TFY NORM	TFY SUM	STD NORM	STD NORM	REF SUM
14	STD NORM	REF SUM			TEY XMCD
15		TEY XMCD			TFY XMCD
16		TFY XMCD			REF XMCD
17		REF XMCD			
18		STD NORM			

5. Reference Data

Flux and Resolution Data

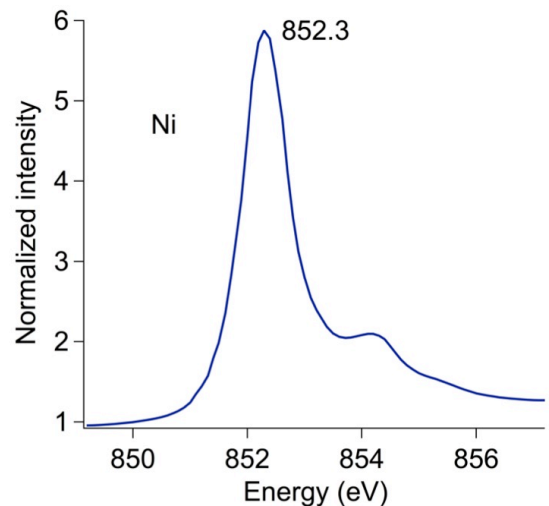
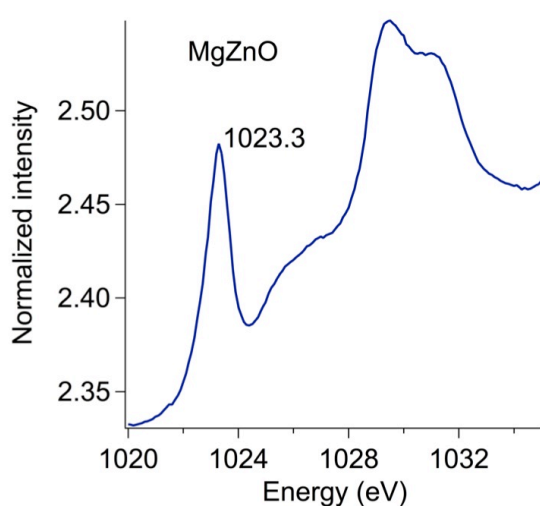
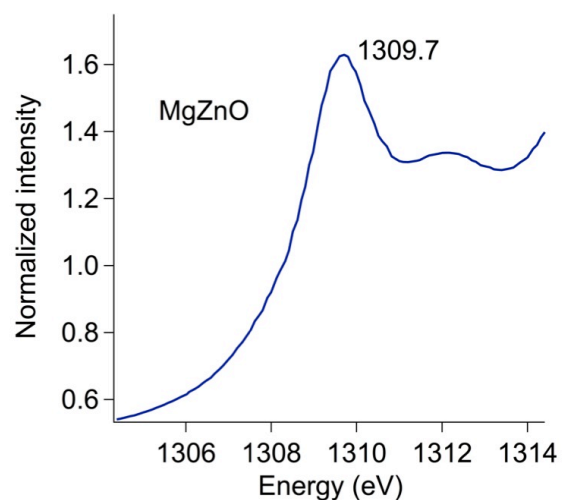
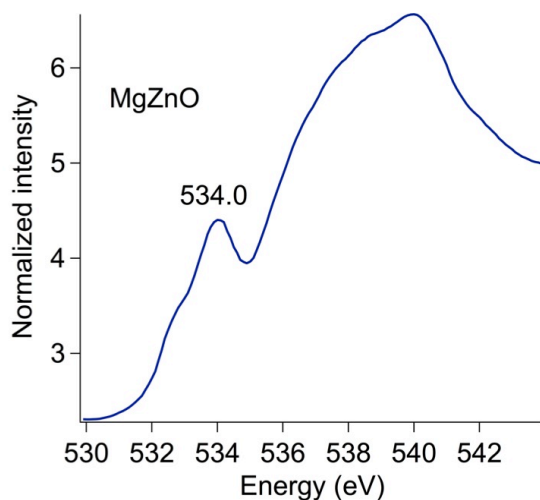


Top: Measured X-ray flux of the 400 and 700 l/mm gratings with a 75 μm entrance slit and a 50 μm exit slit.

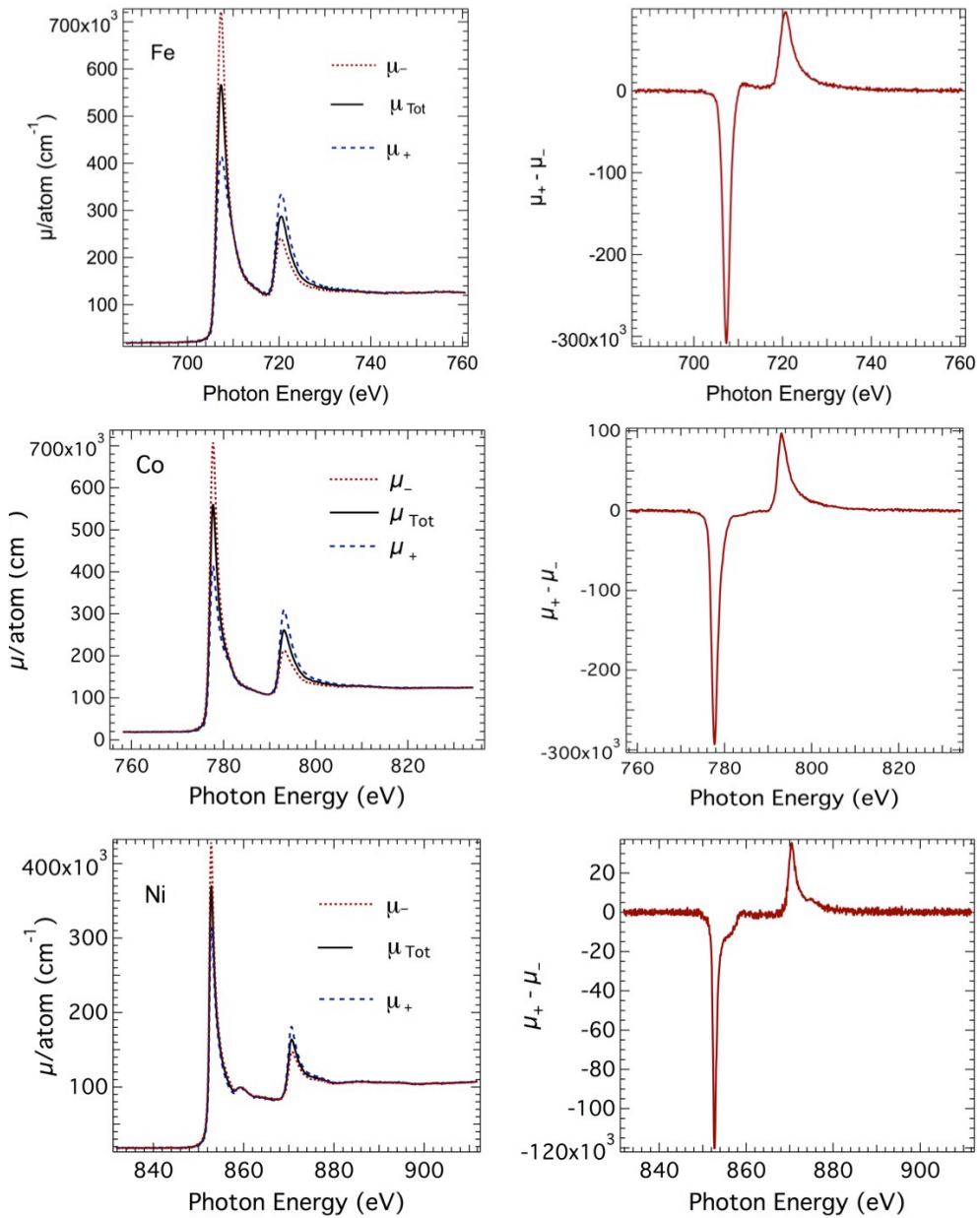
Bottom: Experimental resolution of the two gratings obtained by the analysis of the C 1s XPS data from HOPG.

Energy Calibration Spectra

The following scans of two of the standard samples were taken following energy calibration of the beamline using gas phase samples. The energies of the features should be accurate to ± 0.2 eV.



Reference XMCD Spectra



REFERENCES

C. T. Chen, Y. U. Idzerda, H. J. Lin, N. V. Smith, G. Meigs, E. Chaban, G. H. Ho, E. Pellegrin and F. Sette, *Physical Review Letters* **75** (1), 152-155 (1995).

V. Chakarian, Y. U. Idzerda and C. T. Chen, *Phys. Rev. B* **57** (9), 5312-5315 (1998).

Lanthanide x-ray absorption

Physical Review B 32, 5107 (1985)

32

LANTHANIDE 3d X-RAY ABSORPTION

5111

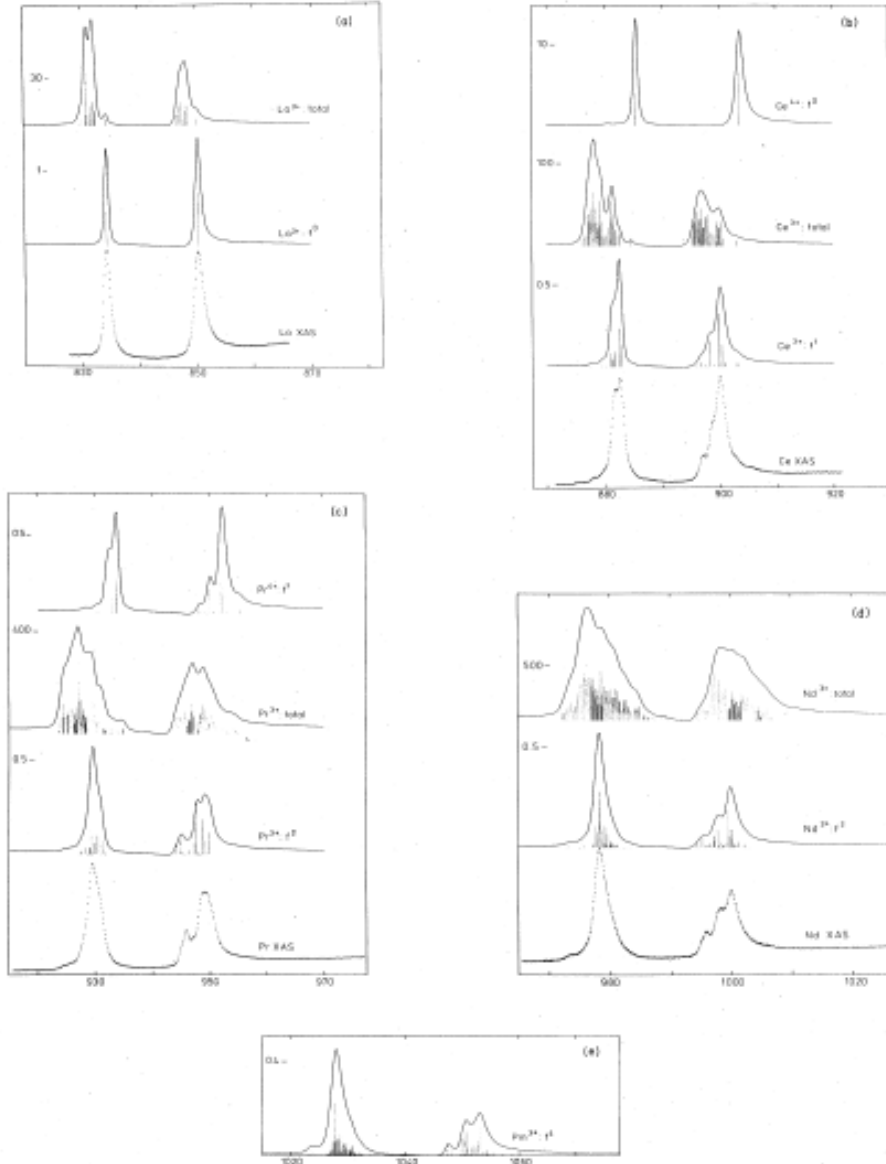


FIG. 1. Spectra of the rare-earth metals. The spectra labeled XAS are the experimental curves. The label f^n denotes the theoretical dipole excitation spectrum from the Hund's rule ground level of the configuration f^n to the levels of d^2f^{n+1} . The spectrum labeled "total" gives each level of d^2f^{n+1} with weight $2J+1$. The horizontal axes gives the excitation energy in eV. The experimental spectra have an unknown vertical scale. The scale of the theoretical spectra is indicated at the left. The dipole spectra give the absorption cross section σ in \AA^2 , the "total" spectra give the density of states in numbers of atomic levels per eV for the curves. The vertical lines have been normalized; close lying lines have been added.

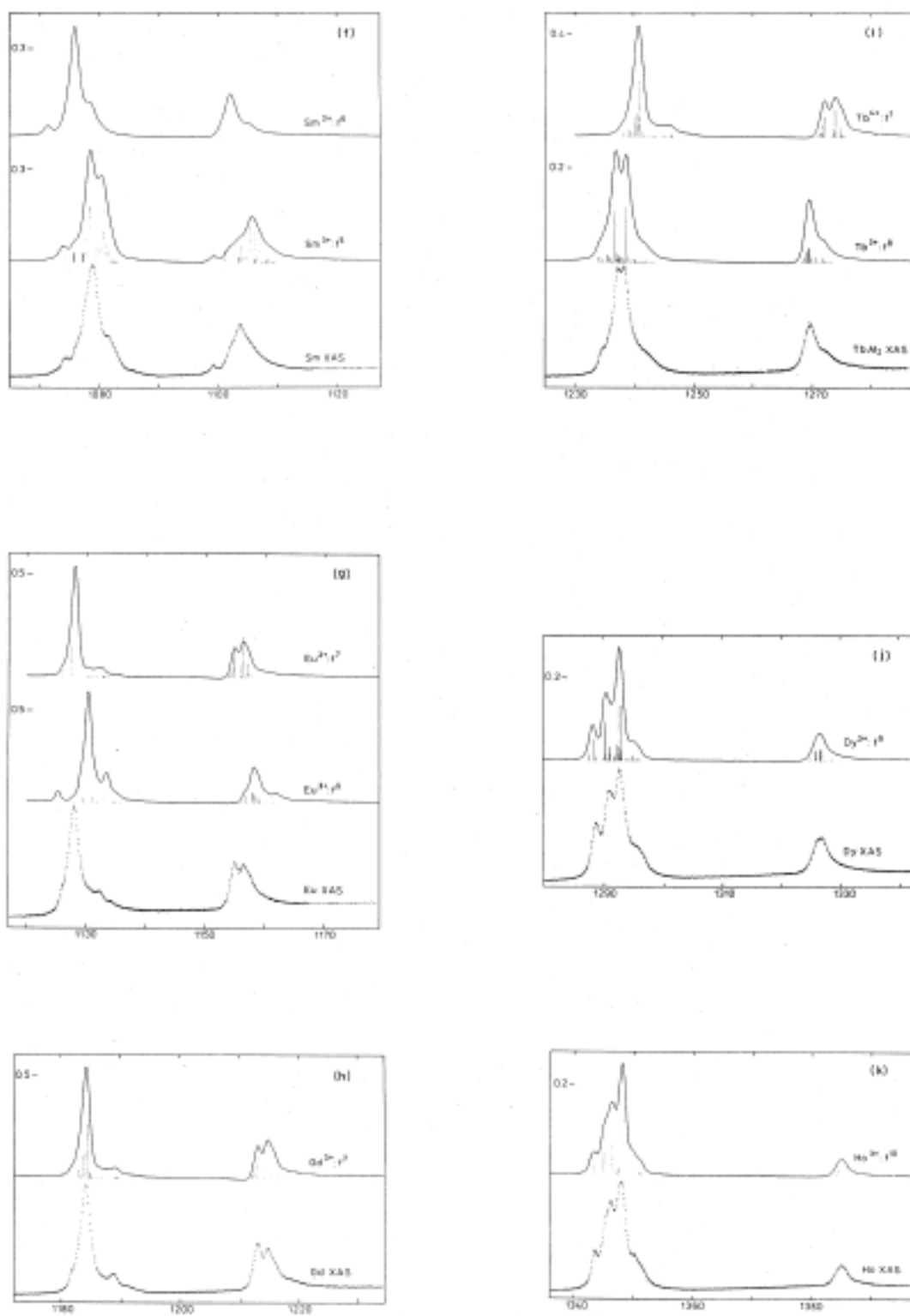


FIG. 1. (Continued).

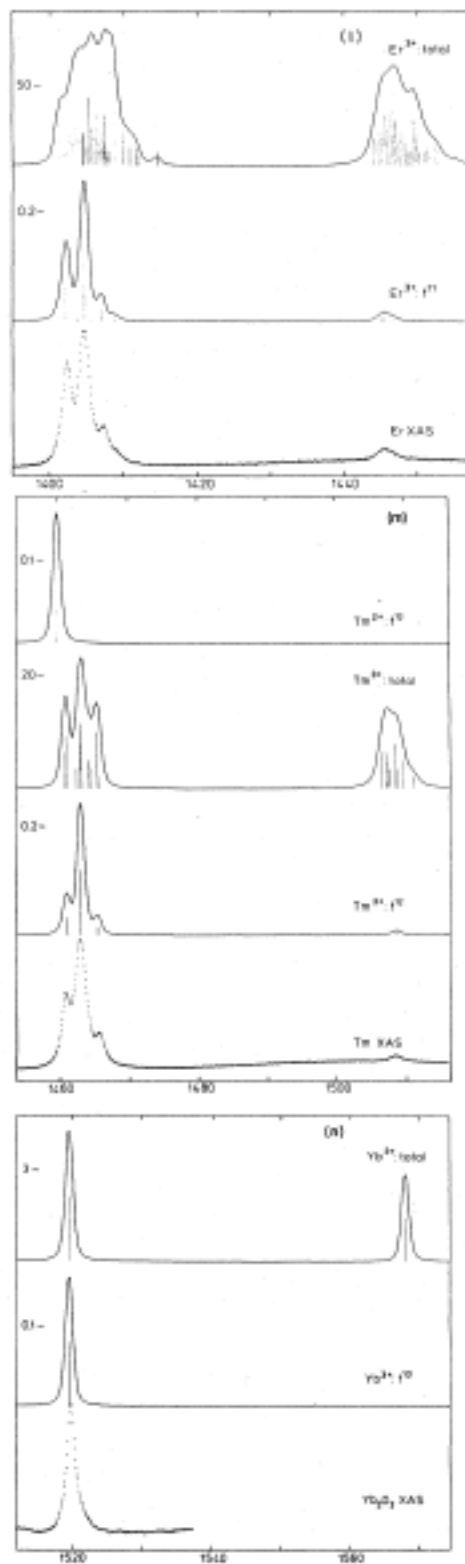


FIG. 1. (Continued).

Oxygen 1s x-ray-absorption edges of transition-metal oxides

Physical Review B **40**, 5715 (1989)

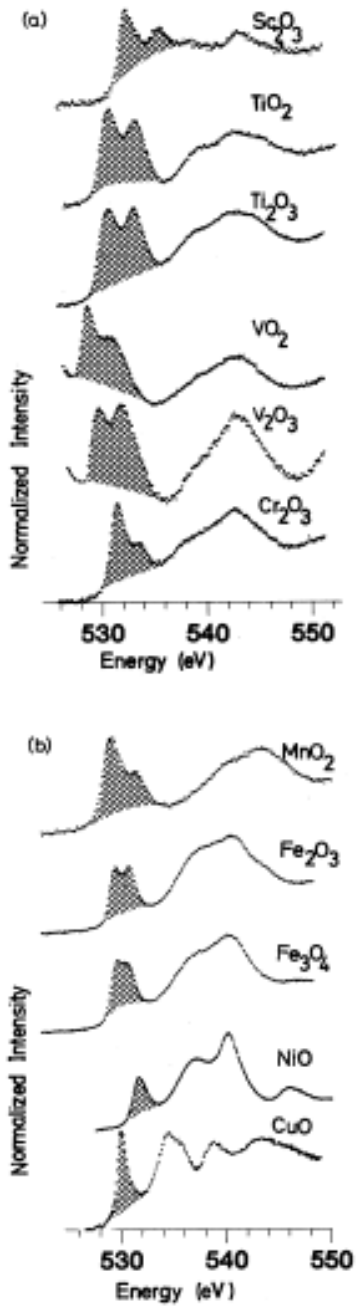


FIG. 1. (a) and (b) Oxygen 1s x-ray-absorption spectra: the shaded area is assigned to oxygen *p* character in the transition-metal 3*d* band. The broader structure above is assigned to oxygen *p* character in the metal 4*s* and 4*p* bands. The vanadium edges are distorted by the tail of the vanadium *L*₂ edge.

Mn, Fe, Ni, Zn, Mg, Al oxides

J. Amer. Ceram. Soc. 88, 2013 (2005)

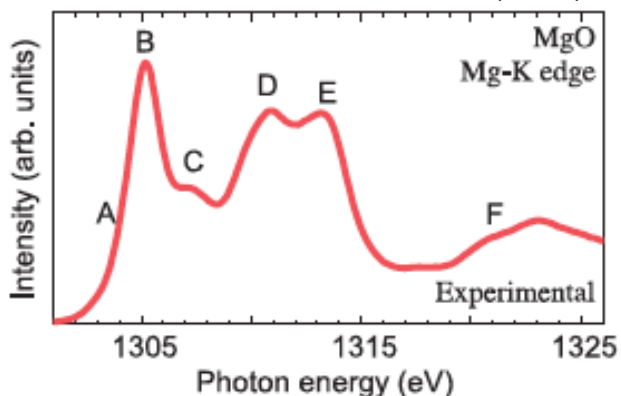


Fig. 3. (Bottom) Experimental MgK X-ray absorption near edge structures of MgO. (Middle) Theoretical spectra obtained using different supercell sizes, i.e., 2, 16, 54, 128 atoms with a core-hole. (Top) Theoretical spectrum without including a core-hole, i.e., for the ground state.

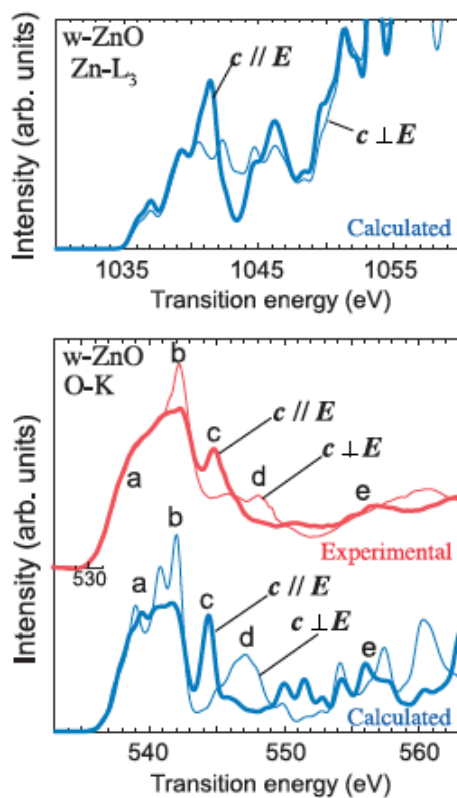


Fig. 7. Orientation dependence of X-ray absorption near edge structures (XANES) by experiment and theory for wurzite-ZnO at three different edges.²³ Experimental O-K XANES is obtained from Guo *et al.*⁵².

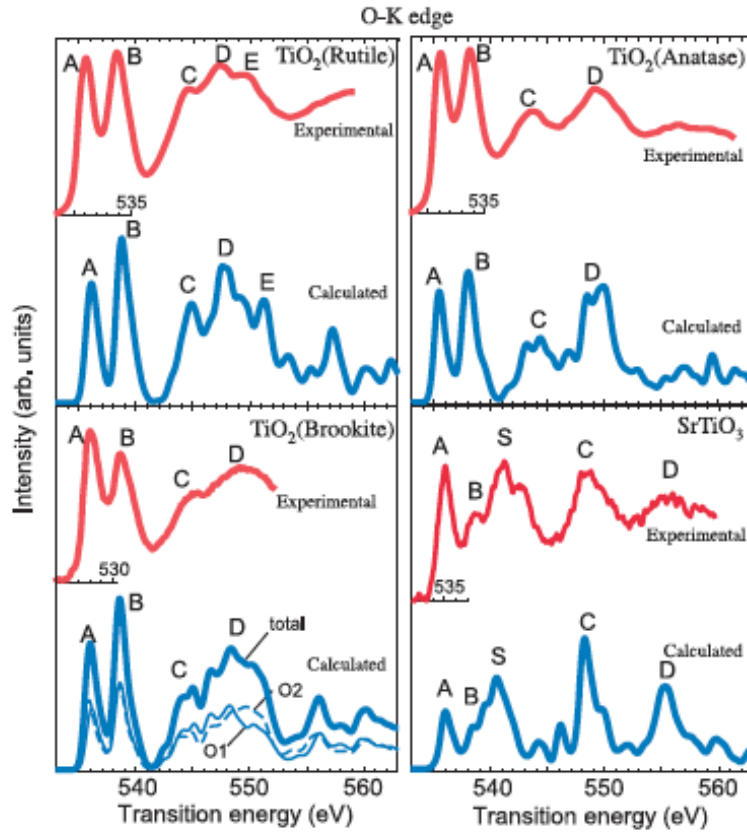
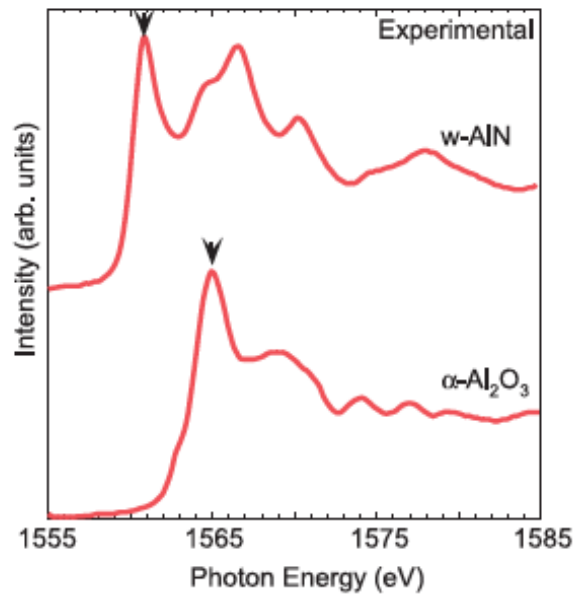
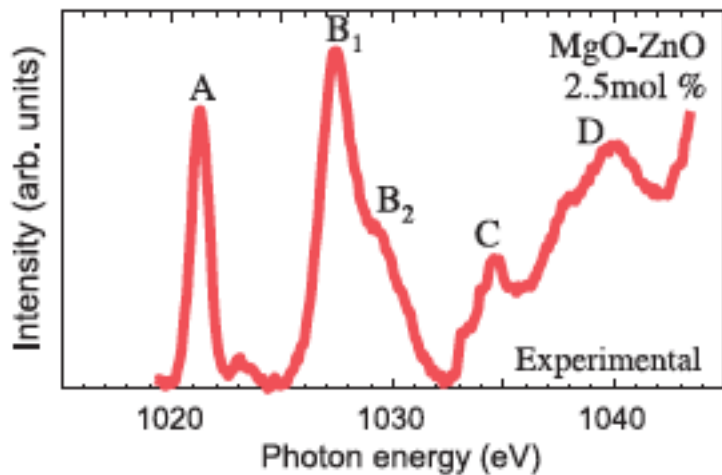


Fig. 14. O-K electron energy loss near edge structure of four Ti(IV) compounds by experiment and theory.²³





Experiment

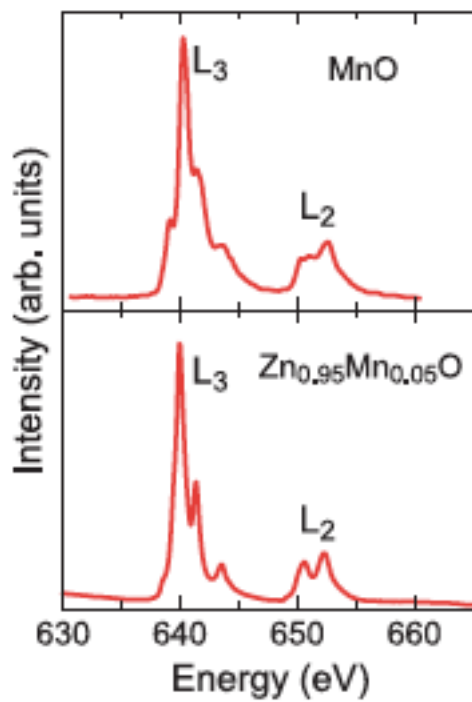


Fig. 24. (Left) Experimental MnL_2 features of $Zn_{0.95}Mn_{0.05}O$ and MnO if absorption near edge structures by experimental spectrum of MnO is o

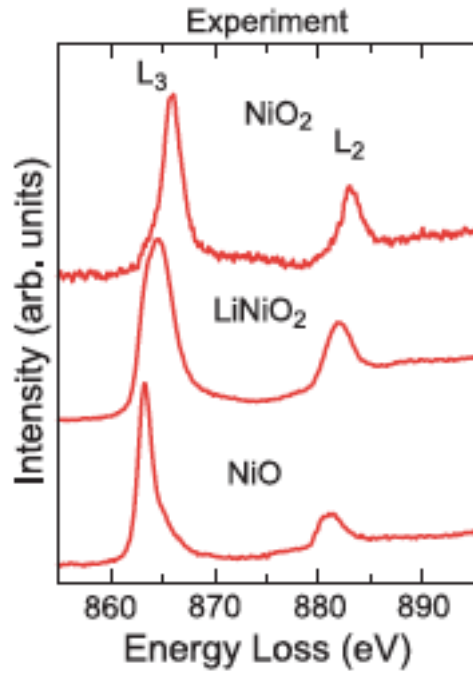
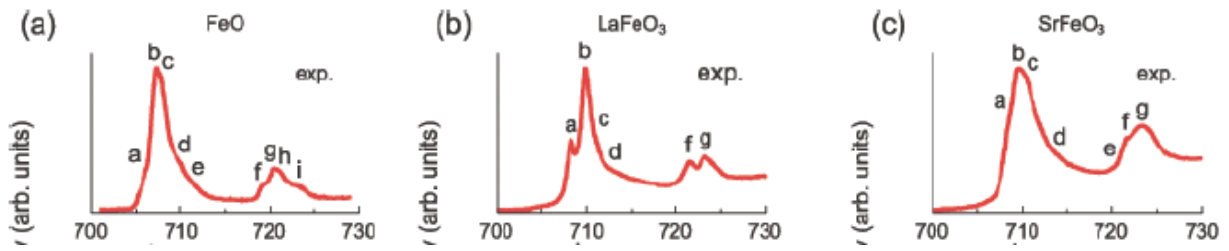


Fig. 26. (Left) Experimental NiL_{2,3} structure (ELNES) of three Ni oxide multi-electron calculations.^{50,51}



6. Trouble Shooting

Aligning SGM if position is lost:

(CALL BEAMLINE STAFF BEFORE DOING THIS!!!)

If the grating position is lost, use the following procedure to recalibrate:

- 1.) Close the C shutter
- 2.) Open x motor (m10) control screen from the MORE menu on the SGM control screen. Set the Dial to +18 and drive the motor to the positive limit. Then move back by 18 mm and set the Dial value to 0.0 mm. At the same position, reset the readout under the SGM to zero by depressing the x0 button. If the Exit slit position is also wrong, open the control screen from the same MORE menu, drive it to the negative limit, then move positive by 0.1 m, and set this value to 8 m.
- 3.) Set the slits to Entrance/Exit = 20/10 μm , set the i0 amp to 20 nA/V, move the sample out of the beam and open the shutter. Then set the ID to 1keV.
- 4.) Move to ~ -0.6 mm on the Dial and use the offset to set the User value to zero. Offset is located in the setup screen, which can be accessed from the more menu on the motor control. Check that the zero order spot can be seen on the exit slit. If not it may be necessary to try searching by hand by changing the dial value.
- 5.) Once the zero order beam is near the exit slit opening for a user value close to zero, type `sczero(-.1,.1,.01,.5)`.
- 6.) Use the offset to set the peak position to zero on the user field and then move off zero order.

Control Problems

FIELDS GO BLANK AND WHITE:

(CALL BEAMLINE STAFF BEFORE DOING THIS!!!)

This happens when the workstation loses connection to the VME crates. For this beamline there are 3 crates that are involved: 1.) Insertion device 2.) 4IDA and 3.) 4IDC. To determine which crate is the culprit examine the windows with the problem and look for the prefix of: 1.) ID04b: 2.) 4ida: or 3.) 4idc1:. If this happens first wait for 5-10 minutes to see if the connection returns. If not do the following.

For case 1.) call the floor coordinator and tell them you lost connection to the insertion device control for ID04.

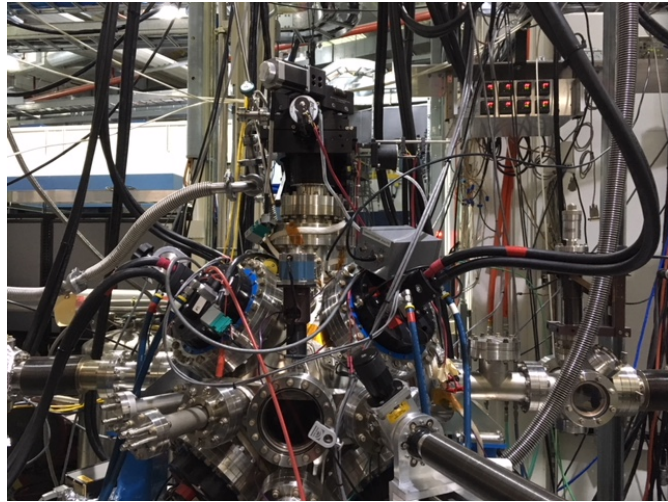
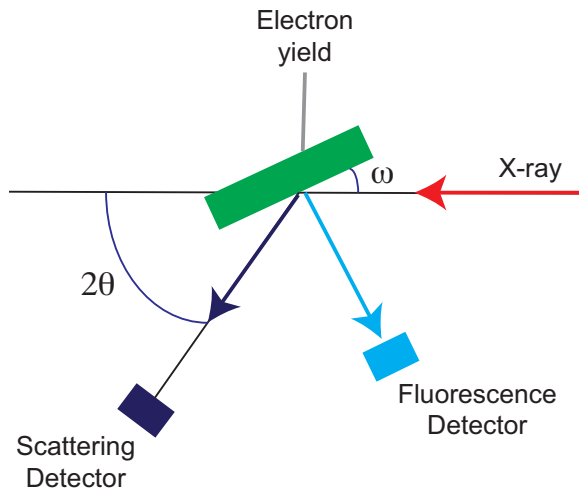
For case 2.) This will only effect the 4IDA mirror screens. The 4IDA crate is on top of the 4IDA station.. Then press the Green RESET button on the crate at the front of the station and wait until the displays return to normal.

For case 3.) first go to the RING workspace on the far right monitor and look for the CRATE DIAGNOSTICS terminal. Click on this window and then press return and the ioc2idc> prompt should appear or an error will flash by on the screen. Note the error in the logbook and any comments related to the event. Then type CTRL-X to reboot the crate and wait until the displays return to normal. The progress can also be monitored in the terminal window. After the displays return to normal it is necessary to go the 4IDC area and select RESET from the red button at the lower right of the beamline screen. It will also be necessary to quit the python program (window with >>> prompt) in the Scan area by typing Ctrl-D. Then restart by typing "python" at the xor4idc% prompt. If for some reason the screens stay blank and white, try typing "restart4idc" at the xor4idc% prompt.

7. APS 4-ID-C Octupole End Station

Description

This endstation is a vector electromagnet that can apply a field in any direction with a magnitude of 0.4-0.5 T depending on the field direction. This chamber has 3 primary detection modes: surface sensitive electron yield via sample current, fluorescence using a Vortex energy discriminating detector, or scattering with a photodiode. The scattering angular range is a 2θ of 0-100 deg. and ω is freely variable from 0-360 deg. **NOTE:** while we have control of the angular range, the detector reproducibility is not good enough to measure wide angle reflectivity scans as a function of angle. The geometry is shown below:



The sample temperature is variable from 500 K down to ~30 K. For sample mounting we have two options. One option has 3 sample holders (left in figure) that interface with a sample load lock. Samples need to be less than ~7mm diameter for this case. This option also allows coarse control of the sample azimuthal angle. In the second option (right in figure), there is an open space ~1 cm wide and 40 mm in length on which samples can be mounted. Additional samples can be loaded on the opposite face. Note that for the first option there is a sample load lock that can handle 8 additional samples that can be exchanged rapidly (~15 mins). For the second option, the entire chamber needs to be vented and pump down time ranges from 3 hours for measurements above 150K to 12-24 hours for the pressure to recover enough for low temperature measurements without rapid ice formation. Samples can be mounted using either Carbon tape or Silver paint/paste. In addition, the cryostat has 4 additional wires available for in-situ device measurements.



Starting up the octupole magnet.

1.) On the back side of the octupole chamber on the downstream end of the 4-ID-B hutch wall facing 4-ID-C, there are two pairs of right angle valves labeled as #1 and #2. To turn on, start with #1 first rotate the valves in the open direction by ~ 10-15 degs. (until you start to hear the flow of water) then immediately turn on the associated pump using the switch at the back. After the pump is on, immediately open the valves to the full open position. Repeat the same for #2. To shut off the pumps, reverse follow the same procedure of closing the water valves most of the way and then immediately shutting off the pump. Be sure though when shutting off the water to turn off the raw supplies first or they will alarm.

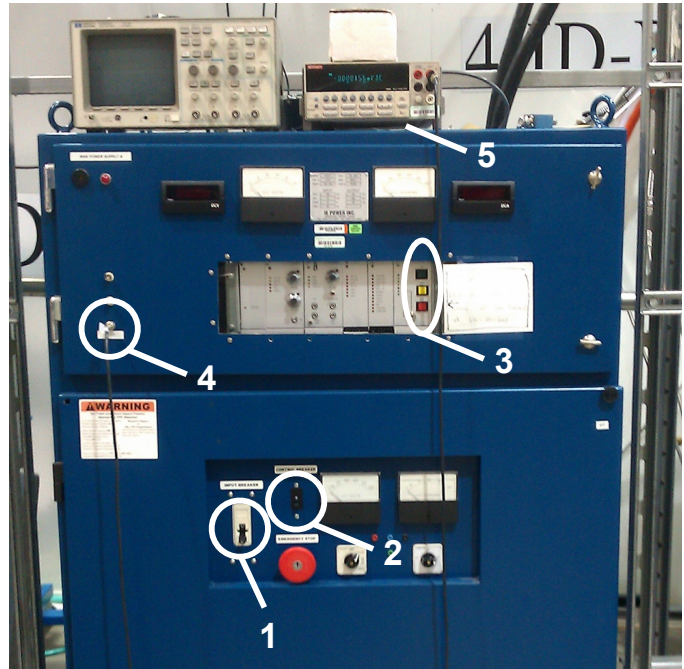


Figure 1 Raw power supply

2.) Once the water is on, the next step is to turn on the two raw supplies (see Figure 1). In order to start the supply, first turn on breaker labeled 1 in the figure followed by breaker 2. The two read LED displays at the top will run through a quick startup and then read 0. Go to the section labeled 3, press the YELLOW button, wait 10 secs and then press the GREEN button. If any alarms sound, you can shut the supply and alarms off with the RED button. This supply is connected to two interlocks: water flow (requires both water pumps on) and current leakage to ground. The BNC labeled 4 can be used to monitor the ground current and if connect to the DMM (5), can be seen on the ES1 display in the computer. The supply will fault when this reads -3.0 V, which corresponds to 60 mA. Both supplies turn on the same way.

3.) After the two raw supplies are on, go to the screen on the computer and find the workspace 3 area where you will see the screen in Fig. 2 below. This is the main screen for the endstation number 1 (octupole). The magnet status and some control is shown on the screen. To turn on the converters, go to the python screen in Scanning and type:

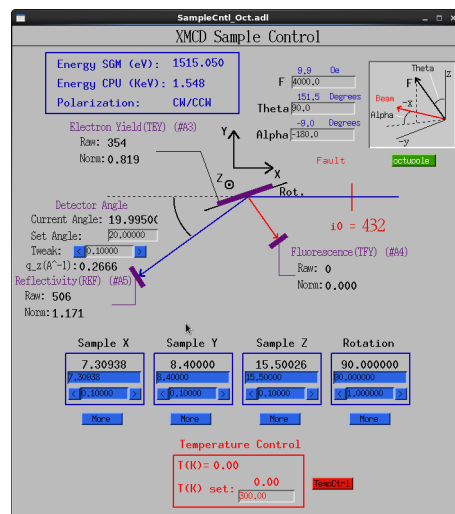


Figure 2 Octupole sample control screen

```
>>>unclamp()
```

Then check on the workspace 3 screen (see Fig. 2) that the Fault below the magnetic field settings has disappeared. Then check everything is working by typing:

```
>>>field8p(1000,90,0)
```

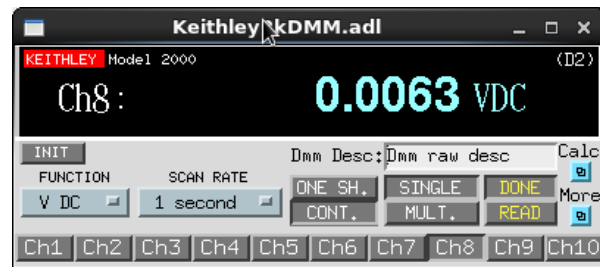
This will set a field of 1000 Oe along a theta = 90 and alpha = 0 (see field diagram in Fig. 2 or on ES1 screen). Note that this command will always start by setting the field to zero before setting the field in a new direction. In order to turn the magnetic off, set the field to zero and type:

```
>>>clamp()
```

Then follow the steps above in reverse.

Checking Magnet Status

In order to make sure everything is in working order, it is possible to monitor the leakage current to ground through the BNC labeled by #4 in Figure 1. This is read as a voltage and -3V is the trip point. This is the DC leakage current to ground measured as a voltage across a 50 Ohm resistor (ie. 1V = 20 mA). Note that this has to be checked separately for poles 1-4 and 5-8 by changing the BNC cable to the connector on the appropriate supply. The reading can be seen on the DMM (D2) in the workspace 3 area. Note the values at the start of the experiment with a current of 50A, which is the maximum current level. If the level is greater than -0.5V, notify one of the beamline staff.

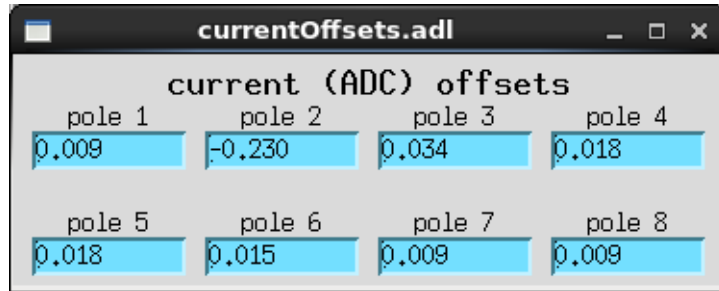


In case of a ground fault trip

In the event that the leakage current exceeds the maximum, the power supplies will shutdown and alarm. To stop the alarm, go to the raw supplies and press the RED off button (See #3 in Fig. 1). Notify beamline staff. To diagnose the problem, connect the meter above to the appropriate supply and turn on the poles one by one using the 8pole screen accessible by the Green button on the workspace 3 screen.

Setting Current Offsets

The current is measured by sensors on each of the eight supplies. Occasionally the zero level drifts and needs to be adjusted. To do so, go to the workspace 3 screen (Fig. 2) and open the **8 pole** screen (see Fig. 4 below). In the lower right, click on More and select current offsets, which will open the following screen. Set the field to zero and then tweak the offsets so that the current reading on the ADC reading is zero.



Advanced Control

To control the poles individually, click on the green button in the upper right of the workspace 3 screen (Fig. 2) and select the **8 pole**, which will open the screen shown below in Figure 3.

This system has eight separate poles that are each supplied by a dedicated converter unit. Here on this screen, you see the status of each of the eight poles. It will start with them all listing a fault. This is due to the fact that they are all **Clamped** to output zero current by the software. The first step is to select **Use** for all of the eight poles and then in the lower left, click the **clear faults** button. If things are functioning properly, at this point all of the faults will disappear and the magnet is now ready to use. Using the screen in Figure 2, enter 1000 into the F box and hit return or type field(Amps) at the command line. You will see all the power supplies on the 8 pole screen start to ramp the currents for the appropriate field magnitude and direction as noted on the screen in Fig. 2. At this point, when it reaches the target field check that the SET and ADC currents are close to one another. Otherwise, click on the **Run** button at the lower left and select **calibrate**. If they continue to read differently, adjust the current offsets.

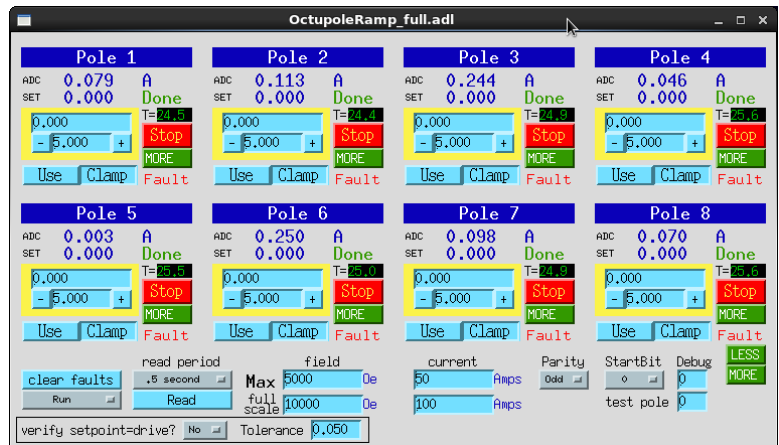


Figure 3 8 pole control screen

8. APS 4-ID-C 7T Magnet End Station:

Description

The 7 T magnet end station is a split-coil horizontal field windowless superconducting solenoid, equipped with a liquid Helium (LHe) variable temperature insert (VTI, ~5 to 325 K) on which samples are mounted. The VTI is mounted on a positioner stage which allows ~40 mm of vertical travel for multiple samples and ~340° of sample polar angle (ϕ). Presently the accessible field range is -6 to +6 T. The field is in the same direction as the X-ray propagation vector. Two principal methods of detection are available: total electron yield which is performed by measuring the restoring current to the electrically isolated sample and X-ray fluorescence yield using a Vortex detector mounted perpendicular to the X-ray beam. It is also possible to measure reflectivity at a fixed angle of ~12 degrees grazing.

Samples are mounted on a transferable sample holder, which is then positioned in the sample mount carrier (Fig. 1). The samples can occupy the bottom 35-40 mm of the holder. For thin film samples, double sided carbon tape is used for mounting the samples. However, for bulk samples it is necessary to secure them more securely since the high magnetic field may be strong enough to pull the samples off the tape. The tapped holes on the holder may be used for this purpose. The sample holder/carrier is then mounted on a magnetic linear rotary drive in the introduction chamber (Fig. 2). It typically takes 15 minutes to transfer samples after mounting them in the intro chamber.



Figure 1.

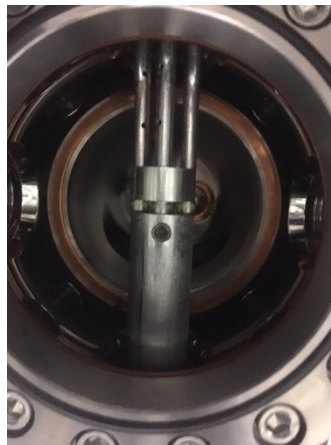


Figure 2.

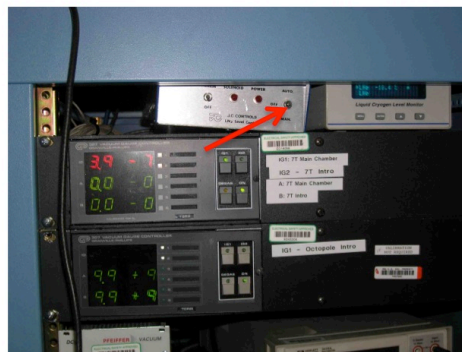
Operation

Safety:

The magnet station produces significant stray magnetic fields. Within 1 meter of the coil, the field may be strong enough to pull objects out of your hands. Therefore, exercise caution when working with tools around the magnet and be aware of the field value. Don't leave tools on the table even when the magnet is off. The black and yellow tape line on the floor is the 5 Gauss line. People with pacemakers or other devices should be aware of it. Use cryogloves, aprons and face shields when filling the magnet Dewars.

General:

During normal operation the outer LN2 jacket should be filled twice per day. To do this, simply flip the switch on the controller (see picture). When LN2 starts to shoot out the top of the magnet, turn the switch off. This should not be performed during data collection as it will introduce noise. The LHe dewar typically lasts 24 hours, depending on the experiment. The dewar should boil-off at a rate of ~2.5%/hr or less with the magnet in persistent mode and the sample below 150K. Ramping the magnet and heating the sample significantly increase the boil-off rate. The persistent switch is at 37.5% on the He level indicator, thus the magnet can be operated safely provided the level is higher than that. Care must be taken, however, to ensure sufficient ramp-down time before the level reaches 37.5%. As a rule, we refill when the level reaches 45-50%.



He usage:

The initial fill from warm typically requires 1 100-l dewar. Subsequent fills from 50% usually require about 30 l.

Setting the field:

The magnet is equipped with persistent switch heater (PSH), and can be operated in either persistent mode or non-persistent mode, depending on the type of scan needed. While in persistent mode, care must be taken to match the current in the leads to the coil current before connecting the power supply via the PSH. This is accomplished using the python macro:

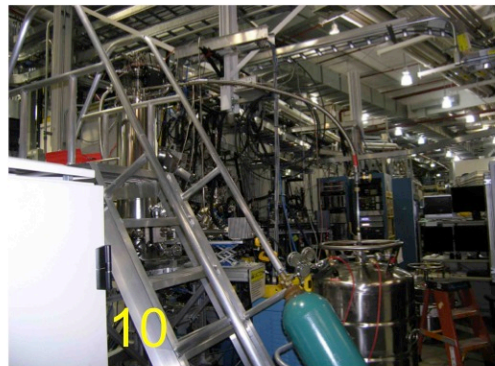
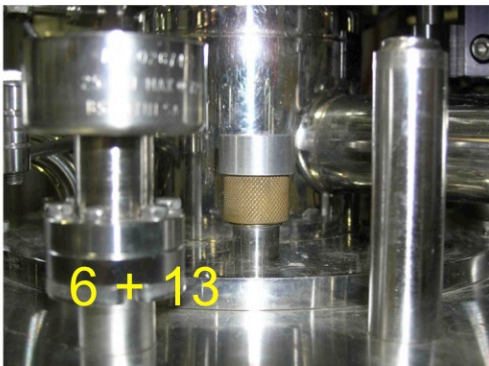
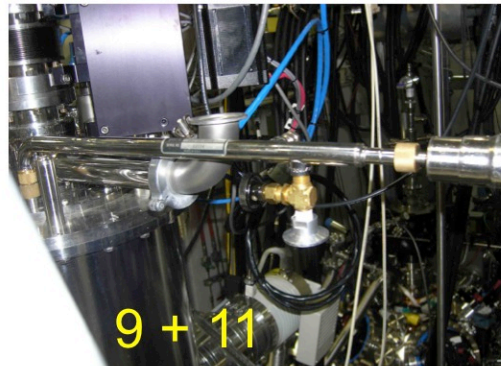
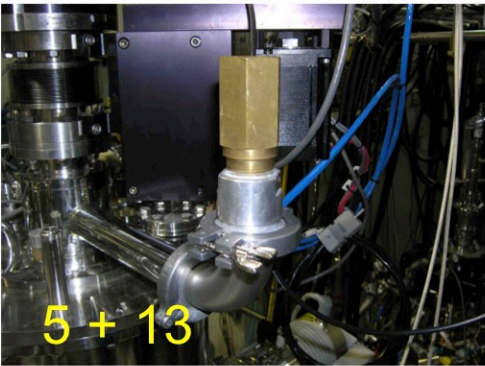
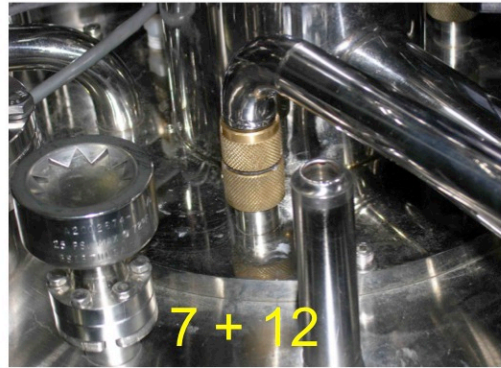
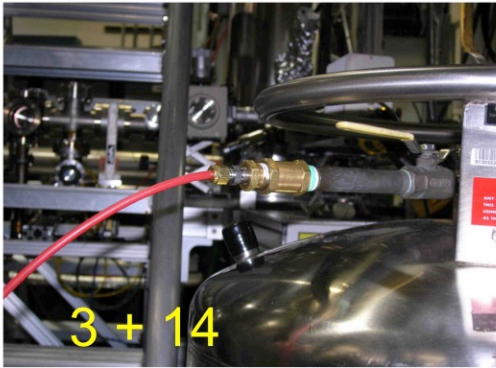
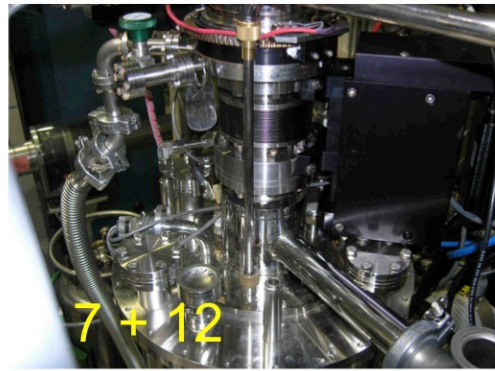
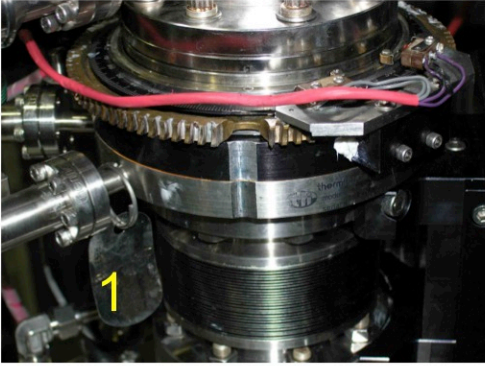
```
hfa(H),
```

where H is the desired field in Tesla. The macro checks the magnet state, matches the current and operates the PSH if necessary, and returns the magnet to its initial state after ramping to the desired field.

Topping up the He Dewar:

During fill operations appropriated PPE (face shield and cryogenic gloves) should be worn. On the following page are pictures associated with the steps listed below.

1. Stop data collection and move the Sample Phi so that the notch in the brass gear lines up with the He Fill Port (~115 deg.).
2. Close the beamline valve VC17.
3. Ramp the field to zero
4. Obtain a LHe supply Dewar and insert the transfer line. Attach a He gas bottle to the Dewar to maintain pressure while filling.
5. Remove the exhaust relief valve from the Exhaust Port
6. Remove the Al cap from the He Fill Port.
7. Using a 1/2" to 3/8" LHe fitting adapter, place the right-angle adapter into the He Fill Port.
8. Precool the transfer line by opening the needle valve a turn and waiting until the gas coming out is cold enough to cause heavy condensation.
9. Once the transfer line is cold, connect it to the right-angle adapter using an O-ring and brass connector.
10. The level may drop initially. Once it starts to go up again, transfer speed may be increased.
11. Transfer to the 99.9% level and then 5-7 minutes longer to completely top-off the Dewar. Then, close the needle valve and disconnect the transfer line
12. Remove the right-angle adapter.
13. Replace the Al cap (first) and then the exhaust valve
14. Close the valves between the He gas bottle and the Dewar and remove the connecting tube from the Dewar.



Procedure for changing samples on the 7 T magnet

Samples are mounted on a transferable sample holder, which is then positioned in the sample mount carrier (Fig. 1). The samples can occupy the bottom 35 mm of the holder. For thin film samples, double sided carbon tape is used for mounting the samples. However, for bulk samples it is necessary to secure them more securely since the high magnetic field may be strong enough to pull the samples off the tape. The tapped holes on the holder may be used for this purpose. The sample holder/carrier is then mounted on a magnetic linear rotary drive in the introduction chamber (Fig. 2). The following procedure is used to load and unload the samples.

LOADING SAMPLES

1. Make sure the VTI is near room temperature (>290 K), the sample Z is minimum ($z=0$), the field is zero and the TEY BNC cable is disconnected..
2. Put sample stage and carrier in load lock and tighten set screw to secure carrier to transfer arm. (Fig. 2)
3. Turn on diaphragm pump. Turn on turbo pump.
4. Wait 10 to 15 min – make sure that turbo is at full speed, $P < 10^{-6}$ torr.
5. Open gate valve (Fig. 3). Raise up transfer arm. Screw on sample mount.
6. Retract transfer arm and close gate valve.
7. Reconnect TEY signal cable. Cover windows and turn on Vortex detector

REMOVING SAMPLES

1. Set temps7(290). Wait for ~10 min after the controller indicates that the temperature has been reached.
2. Set hfa(0)
3. Close VALVE 30.
4. Set sample position $z=0$ or minimum reached at limit switch.
5. Turn off the Vortex XRF detector.
6. Disconnect TEY BNC cable.
7. Take the Al foil off the 4.5" viewport, and position lamp to illuminate window and turn on the lamp, making the sample stage visible at the monitor.
8. Make sure the load-lock chamber is pumped down - the turbo pump should be on and operating at 1000 Hz, $P < 10^{-6}$ torr.
9. Open the gate valve (Fig. 3) between the load-lock chamber and main chamber.
10. Lift the magnet (metal cylinder) (Fig. 4) on the transfer arm up, when resistance is felt, turn around to find proper angle, then continue to lift up by watching through the monitor or the viewport, from bottom, counter clockwise direction rotate the sample holder until it is loose and sitting on the frame.
11. Lower the magnet on the transfer arm, bringing the samples and sample holder into the load-lock chamber.
12. Close the gate valve between load-lock chamber and main chamber securely.

13. Turn off intro chamber ion gauge.
14. Turn off the diaphragm pump that backs the turbo and the turbo pump (near the LN2 refilling control), the switch button is at the back, right-top part.
15. Wait for a few minutes until you hear the valve open automatically for venting.
16. Open the load-lock window, using a screwdriver to lever it open as there is still some residual vacuum.
17. Loosen the set screw on the transfer arm.
18. Lift the sample set (including samples and sample holder) up, then tilt slightly to remove.
19. Close the window of the load-lock chamber and tighten knob.
20. Turn on the diaphragm pump because the gate valve leaks a little.
21. Work on the sample holder to change the samples. Use the same sample holder if you want the same range of angular motion as different holders have different orientations.



Figure 1.



Figure 2.

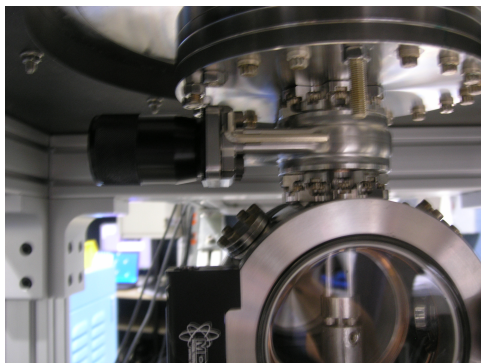


Figure 3.

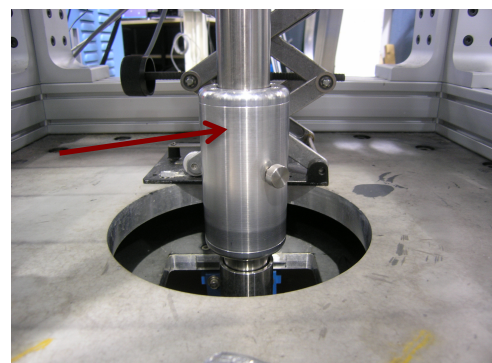
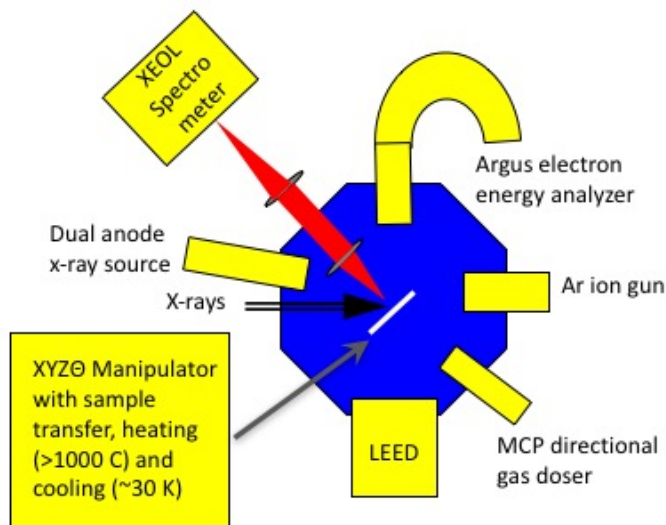


Figure 4.

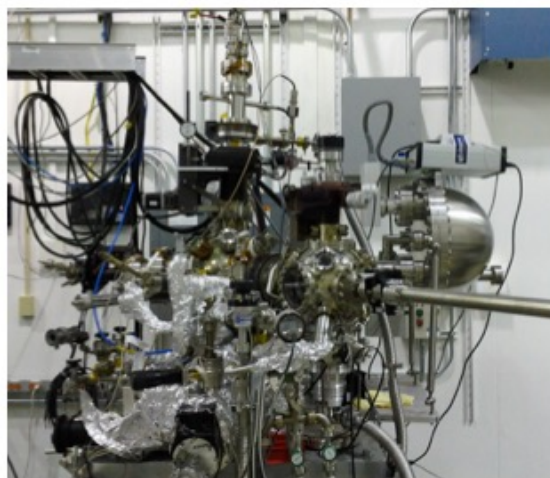
9. APS 4-ID-C XPS end station

The XPS end station is a UHV chamber (base pressure $\sim 1 \times 10^{-10}$ Torr) equipped with a load lock chamber and a variety of surface analysis components. A schematic diagram and picture of the end station is shown below.

Schematic diagram of the XPS chamber setup



Picture of the XPS chamber (off line). The Argus analyzer is on the right and is located at 90 degrees from the direction of the x-ray beam.



Available Omicron style sample holders, from left to right: Standard; Integrated thermocouple; Integrated thermocouple with hole; Biasing across surface or from surface to ground. All are made from molybdenum.

In addition to the electron energy analyzer the end station is equipped with an Ar ion sputter gun, LEED, a microchannel plate directional gas doser, a lens system for extracting visible light to be analyzed by an x-ray excited optical luminescence (XEOL) spectrometer, an Ir filament that can be used to crack oxygen (and perform crude charge compensation for insulating materials), and a dual anode Mg/Al x-ray source. The sample transfer system is based on Omicron style sample holders. Four samples may be mounted in the introduction chamber at one time.

10. APS 4-ID-C X-ray Photoemission Electron Microscopy (X-PEEM)

Elmitec PEEM with integrated sample stage

Specifications:

Accelerating Voltage: -20 kV on the sample

X-ray Beam Incidence Angle: 16°

Minimum Spot Size at Sample: 100 μm vertical, 350 μm horizontal (includes incidence angle effect)

Working Distance: 1-2 mm

Spatial Resolution: Up to 50 nm, dependent on sample roughness

Maximum Field of View: 500 μm

Acceptable Sample Dimensions: Must fit into a circular cavity of approximate 8 mm diameter, maximum wafer thickness ~1 mm

Acceptable Sample Conductivity: Must be capable of supporting a nanoamp range photocurrent without charging. Metallic or semiconducting sample usually work well, insulators do not.

Sample Temperature: Room Temperature

Sample Positioning: Micron resolution with indexing, not motorized

Typical Image Acquisition Time: 1 sec – 10 min

Typical Time to Align Beam to Sample: 1-8 hours (needed at most once per experiment)

Typical Time to Align PEEM Optics: 1 hour (needed for each sample)

Typical Sample Interchange Time: 1 hour

11. 4-ID-C Personnel



Daniel Haskel
MM Group Leader
431/E008
(630) 252-7758
haskel@aps.anl.gov



Becki Gagnon
Secretary
431/E001
(630) 252-5406
gagnon@aps.anl.gov



Mike McDowell
Scientific Associate
431/E009
(630) 252-0111
mwm@aps.anl.gov



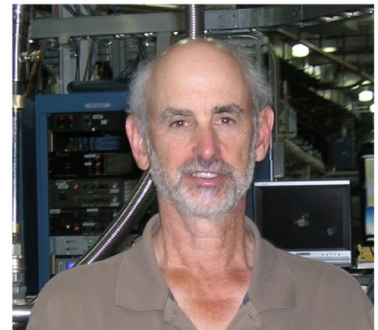
Dave Gagliano
Beamline Technician
431/E020
(630) 252-1137
davegag@aps.anl.gov



John Freeland
4-ID-C Beamline Scientist
431/E003
(630) 252-9614



David Keavney
4-ID-C Beamline Scientist
431/E002
(630) 252-7893



Richard Rosenberg
4-ID-C Beamline Scientist
431/E005
(630) 252-6112