CLS Run Winter 2021 Logbook

December 20-22, 2021

Participants: Richard Jones, Zisis Papandreou, Aram Teymurazyan, and Mehran Talebitaher

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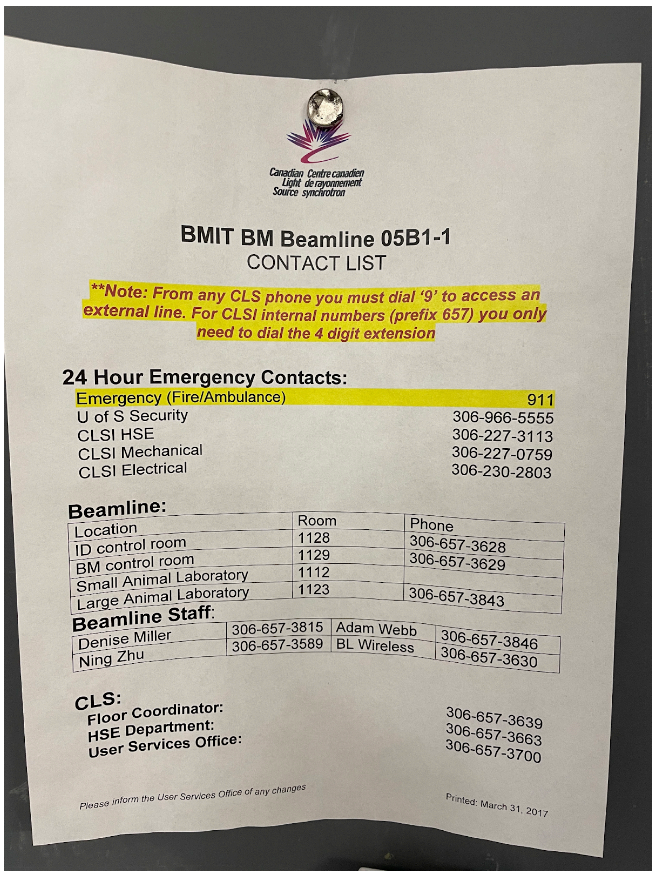
Contact Information

- Phone numbers
    a. Richard Jones, richard.t.jones@uconn.edu, (860) 377-5224 (cell)
    b. Zisis Papandreou, zisis@uregina.ca, (306) 596-7775 (cell)
    c. Aram Teymurazyan, Aram.Teymurazyan@uregina.ca, (306) 450-5387 (cell)
    d. Alireza (Mehran) Talebitaher, Alireza.Talebitaher@uregina.ca, (306) 541-3848 (cell)
    e. Adam Webb, BMIT Science Associate, office: 306-657-3846, cell: 306-372-8304
    f. BMIT and other CLS phone numbers are listed in the two images below.

New image below replaced on Dec 20, 2021. Please note that it is out of date: Denise is no longer at CLS; Adam is our contact for both hardware and software.



Canadian Light Source / Centre canadien de rayonnement synchrotron

BMIT BM Beamline 05B1-1
CONTACT LIST

***Note: From any CLS phone you must dial '9' to access an external line. For CLSI internal numbers (prefix 657) you only need to dial the 4 digit extension**

24 Hour Emergency Contacts:

Emergency (Fire/Ambulance)	911
U of S Security	306-966-5555
CLSI HSE	306-227-3113
CLSI Mechanical	306-227-0759
CLSI Electrical	306-230-2803

Beamline:

Location	Room	Phone
ID control room	1128	306-657-3628
BM control room	1129	306-657-3629
Small Animal Laboratory	1112	
Large Animal Laboratory	1123	306-657-3843

Beamline Staff:

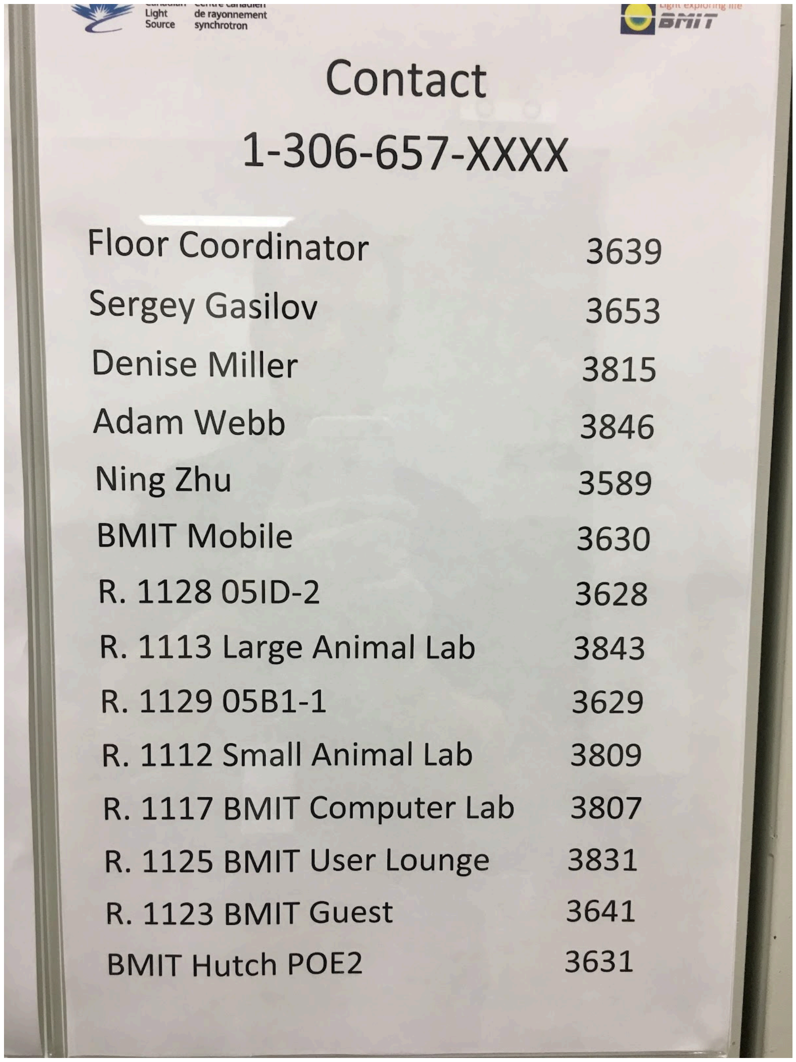
Denise Miller	306-657-3815	Adam Webb	306-657-3846
Ning Zhu	306-657-3589	BL Wireless	306-657-3630

CLS:

Floor Coordinator:	306-657-3639
HSE Department:	306-657-3663
User Services Office:	306-657-3700

Please inform the User Services Office of any changes

Printed: March 31, 2017


Contact
1-306-657-XXXX
Floor Coordinator 3639
Sergey Gasilov 3653
Denise Miller 3815
Adam Webb 3846
Ning Zhu 3589
BMIT Mobile 3630
R. 1128 05ID-2 3628
R. 1113 Large Animal Lab 3843
R. 1129 05B1-1 3629
R. 1112 Small Animal Lab 3809
R. 1117 BMIT Computer Lab 3807
R. 1125 BMIT User Lounge 3831
R. 1123 BMIT Guest 3641
BMIT Hutch POE2 3631

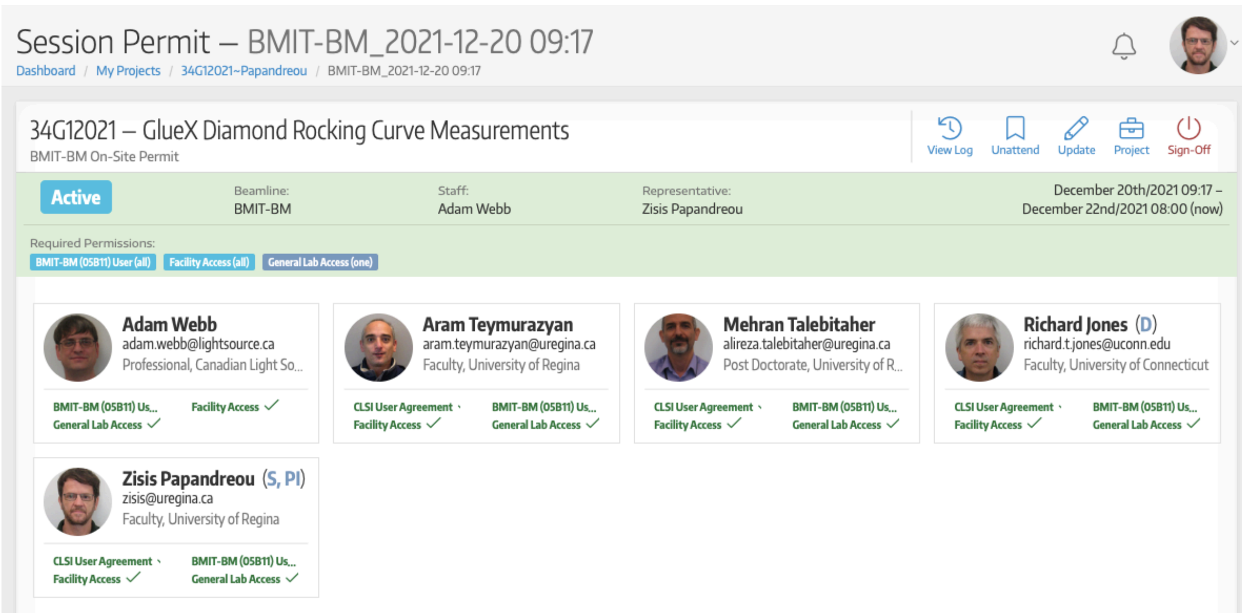
Pre-experimental run dinner (Richard missed his flight)

Goals for this run

1. Check out beamline optics and verify camera focus
2. Verify that the diamonds case arrived intact
3. Mount JD80-1 on holder and install in beamline
4. Take rocking curves of JD80-1 in 4 orientations
5. Transfer data from JD80-1 to UConn, verify data quality
6. Dismount JD80-1 and return to packaging
7. Mount JD80-100 on holder and install in beamline
8. Take rocking curves of JD80-100 in 4 orientations
9. Transfer data from JD80-100 to UConn, verify data quality
10. Dismount JD80-100 and return to packaging
11. Mount JD80-200 on holder and install in beamline
12. Take rocking curves of JD80-200 in 4 orientations
13. Transfer data from JD80-200 to UConn, verify data quality
14. Dismount JD80-200 and return to packaging
15. Mount JD80-300 on holder and install in beamline
16. Take rocking curves of JD80-300 in 4 orientations

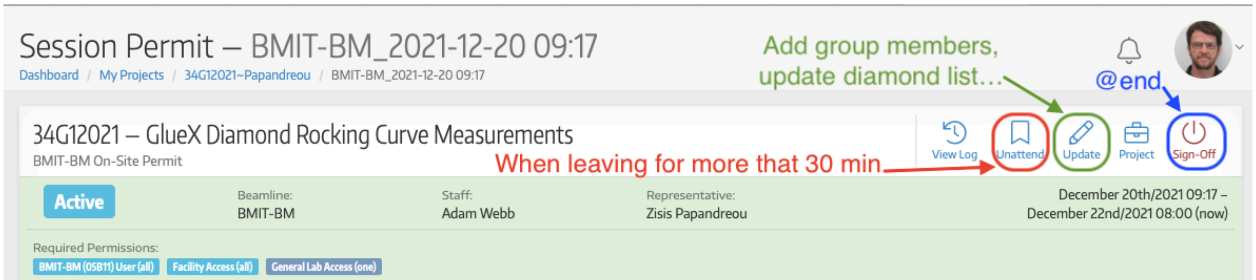
17. Transfer data from JD80-300 to UConn, verify data quality
18. Dismount JD80-300 and return to packaging
19. Transfer all remaining data, photos, and software tools to UConn
20. Clean up and check out

Session Permit document

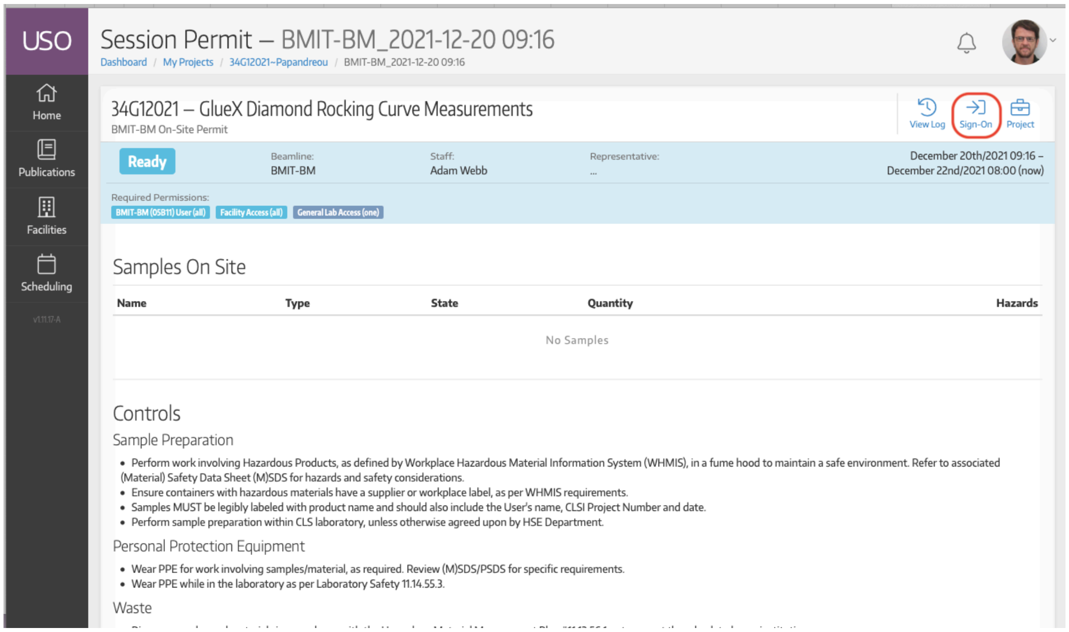


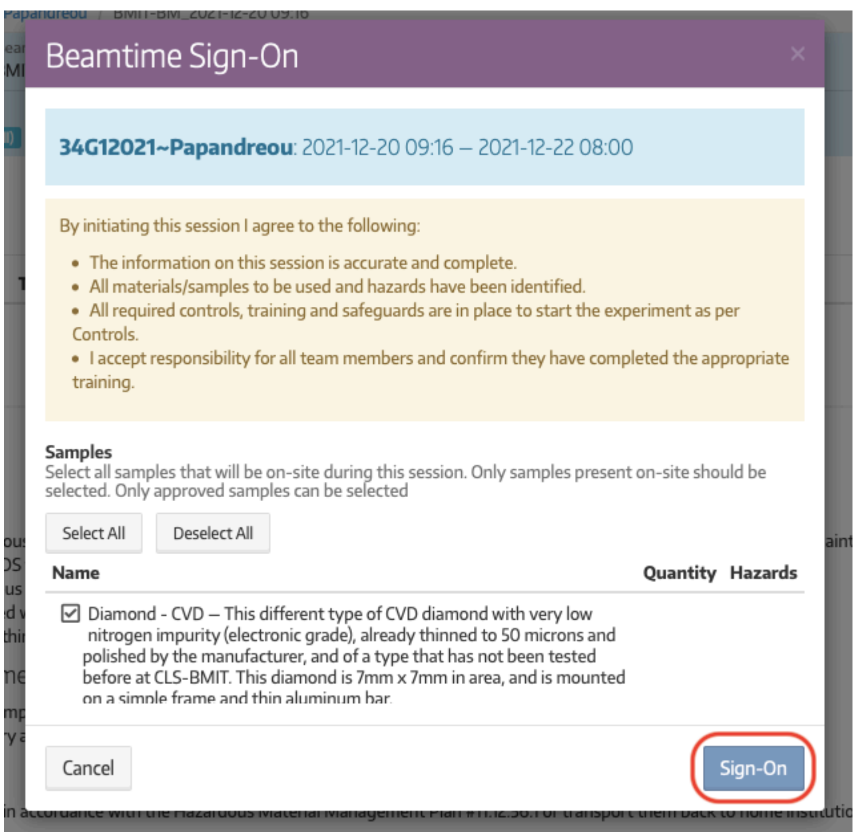
Experimental Sign-in

Once the crew received its BSO (Beam Safety Operations) training, Adam Webb credited each member with the completion of the course. Then, each member had to log into their CLS account and accept the completion before the PI (ZP) could Sign in and take control of the experiment. At the end of the beam time, ZP will sign off. Also, if the experiment is to be left unattended, this can be indicated. All actions can be carried out by clicking on the respective button at the top right of the PI's account.


Session Permit — BMIT-BM_2021-12-20 09:17
Dashboard / My Projects / 34G12021~Papandreou / BMIT-BM_2021-12-20 09:17
Add group members, update diamond list…
@end
34G12021 — GlueX Diamond Rocking Curve Measurements
BMIT-BM On-Site Permit
When leaving for more that 30 min
View Log
Unattend
Update
Project
Sign-Off
Active
Beamline: BMIT-BM
Staff: Adam Webb
Representative: Zisis Papandreou
December 20th/2021 09:17 – December 22nd/2021 08:00 (now)
Required Permissions:
BMIT-BM (05B11) User (all)
Facility Access (all)
General Lab Access (one)

Beamtime Sign-on





Info from previous runs

The logbooks from the August, 2016 run is a valuable store of useful information for how to carry out these rocking curve measurements at CLS. Use the link below to obtain read-only access.

- Logbook from GlueX CLS summer run 2019
- Link to photos taken during summer run 2019
- Logbook from GlueX CLS summer run 2016
- Link to photos taken during summer run 2016
- Logbook from CLS run in September, 2016
- Link to photo directory from September, 2016
- Logbook from GlueX CLS fall run 2017
- Link to photo directory from November, 2017

Shift schedule

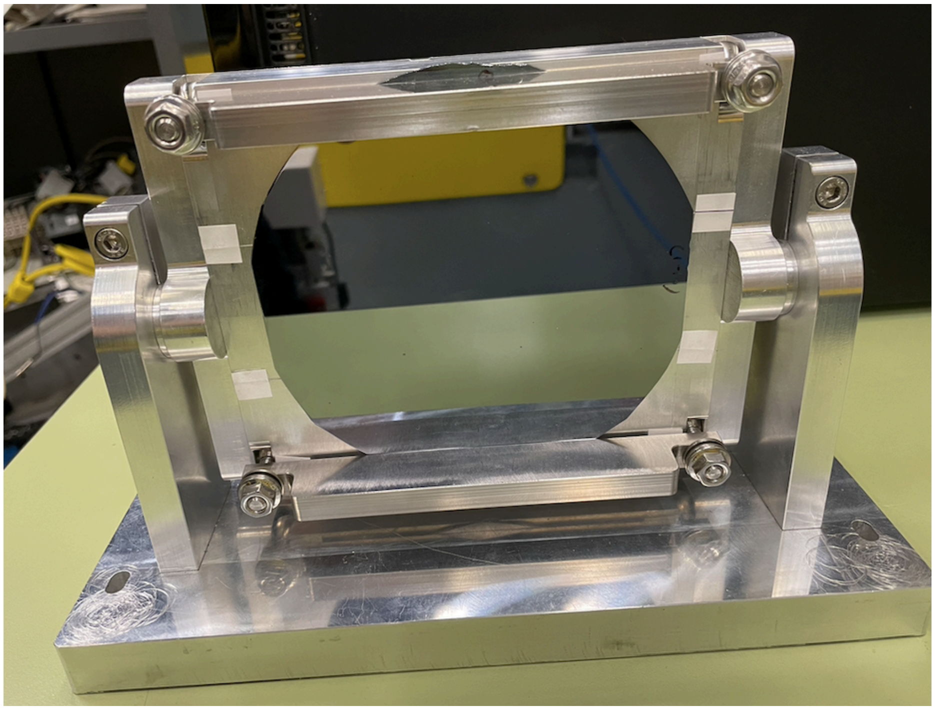
December 20, 2021 [rtj, zp, at, mt]
To be set later, after Richard arrives. The pairs will be Aram/Mehran and Richard/Z\isis.

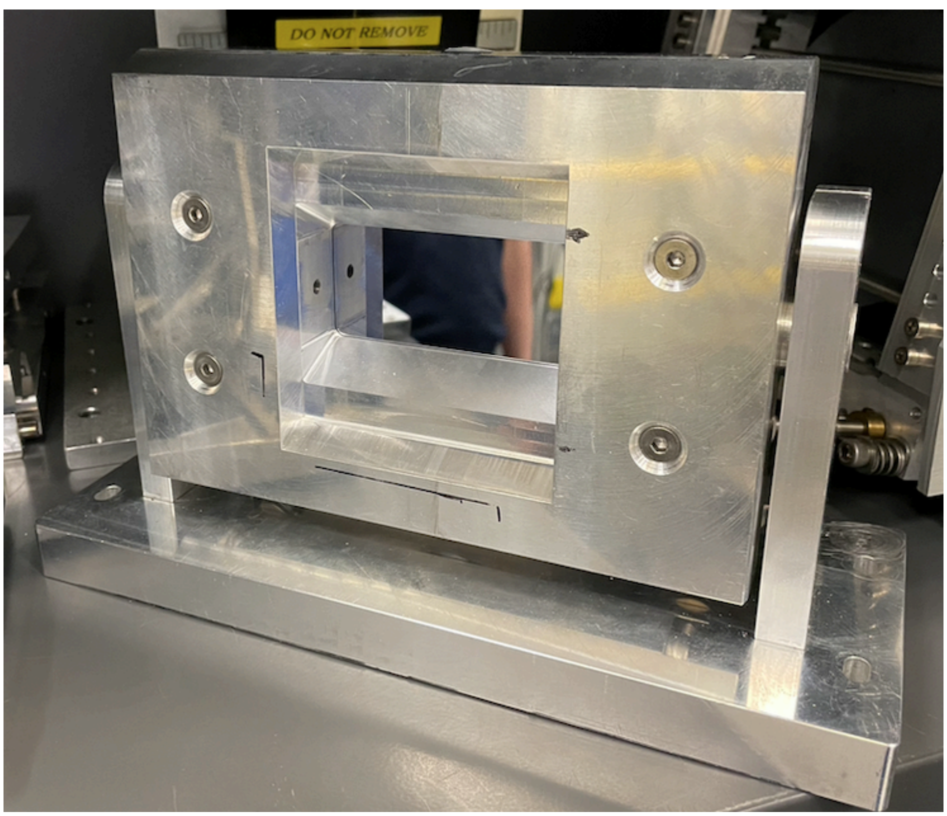
Accelerator

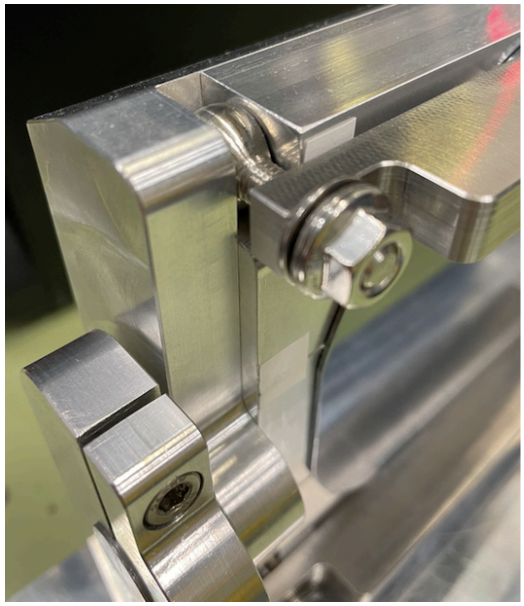
Beam used to be refilled every 8 hours but now is in top up mode: injection every 2 minutes.

Setting up the goniometer, camera

The aluminum frame that holds the diamonds was located in Dean Chapman's cabinet, inside the detector hutch. We received permission from Dean to unmount a Si wafer/crystal that was on it. Photos before unmounting the Si were taken and sent to Dean and some are shown below.

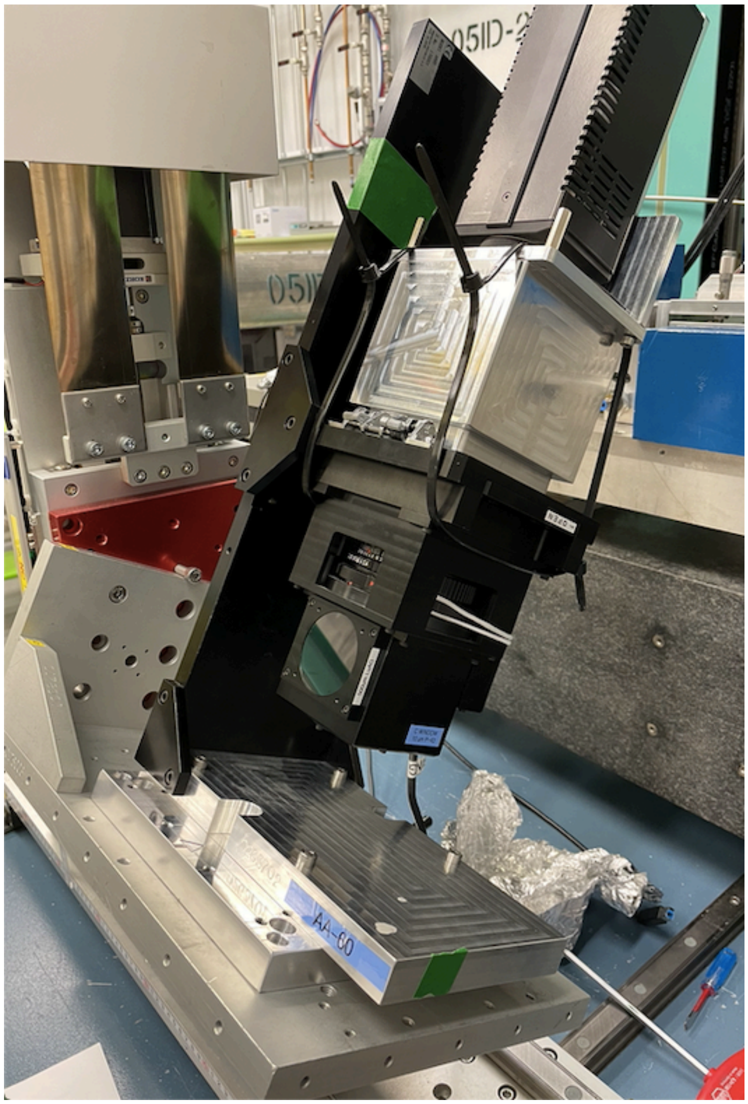


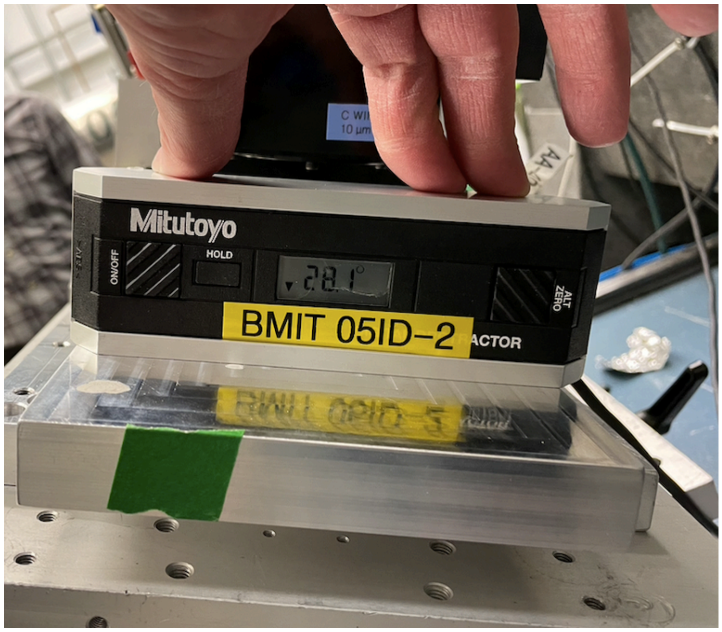

DO NOT REMOVE



Note on lasers: The wall-mounted vertical laser (behind the camera, and on the wall) is shown below. The one mounted on the side wall had a lock-tight bolt on the top, which once loosened allows the laser beam to reach the diamond. Previously it was ending about 50 cm upstream of the diamond, because it was striking the hole in the laser housing. For leveling purposes ensure that both horizontal lasers are set to the “MONO” setting.

The camera and its tilt are shown in the next two photos. Note that the detector’s scintillator is LuAG-500um, which is one thick crystal (4000x2000 pixels approximately, 32 mm wide). Last time we had GADOX-20um but this is formed out of powder so it is not necessarily uniform everywhere. LuAG-500um should be better, as it has better signal to noise ratio according to Adam.

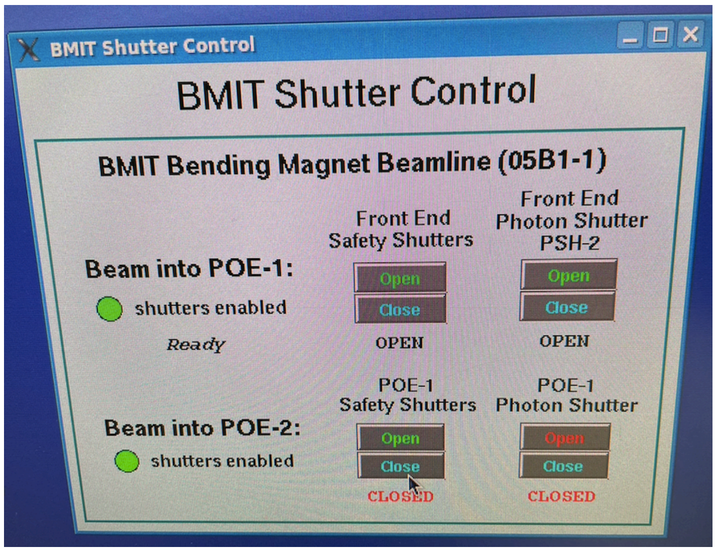

AA-60

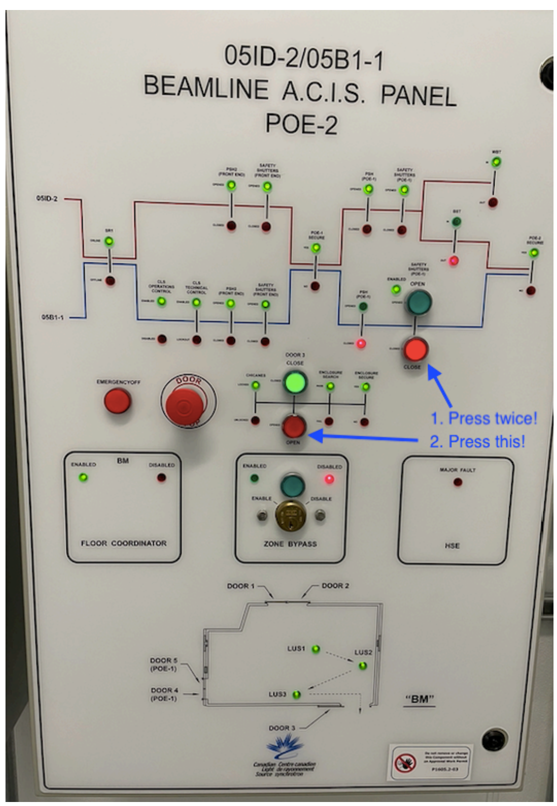


The IP to the computer that controls the detector is 10.52.15.216; note that the IP does not match its name according to Adam. Here is a photo of that computer, located in the experimental hutch, on the floor, left side of beamline (as photons travel). The Camware software connects to this IP (see image under DAQ section).

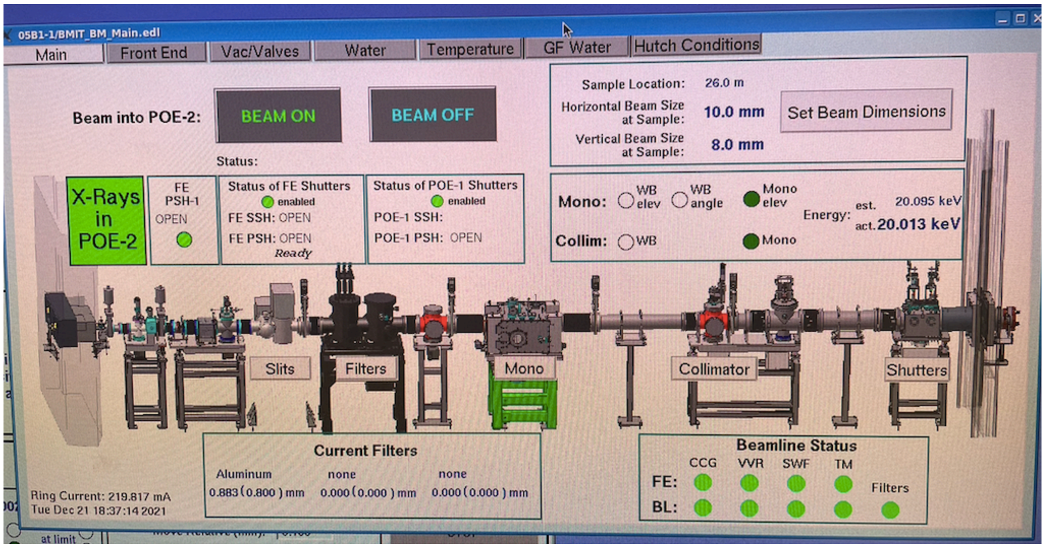
Beamline optics

The Safety and Photon Shutters are controls from the counting house computer. In locking up the area, Safety Shutter is turned on first, then Photon Shutter (POE-2), and the reverse when going to Controlled Access, although the latter step is usually controlled at the door interlock. Note that the monochromator (POE-1) stays with shutters enabled (in) to stay warm.





BMIT uses a double crystal bragg 2,2,0 monochromator. Adam tuned the monochromator to 20 kV (monochromator - click on diagram, type 20 kV) and we are using a 0.8mm Al filter. Screenshot is below.



Goniometer and Camera controls

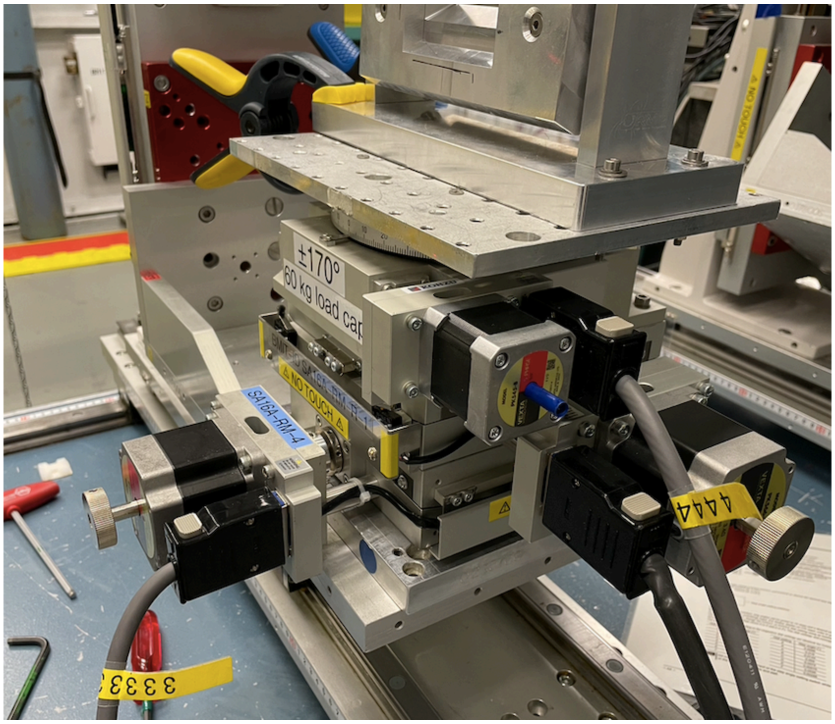
Five (5) motors have been connected to the goniometer, labeled with yellow streamers with the numbers 1111, 2222, 3333, etc. See nomenclature and pictures below.

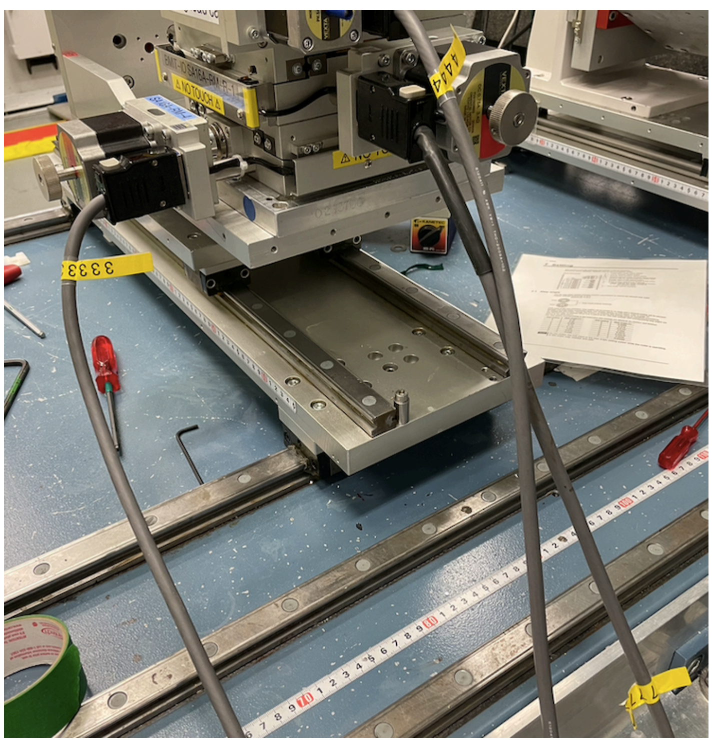
- 1 vertical - camera
- 2 vertical - goniometer
- 3 pitch - goniometer
- 4 roll - goniometer
- 7 yaw - goniometer

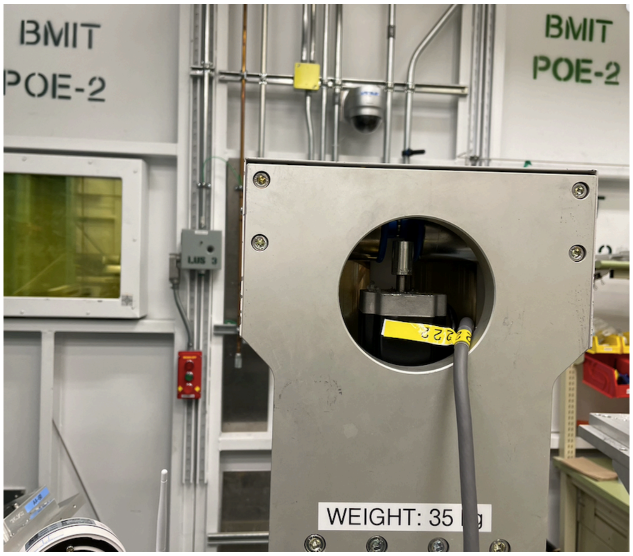
Copied over from 2019 logbook: The motor assignments are as follows:

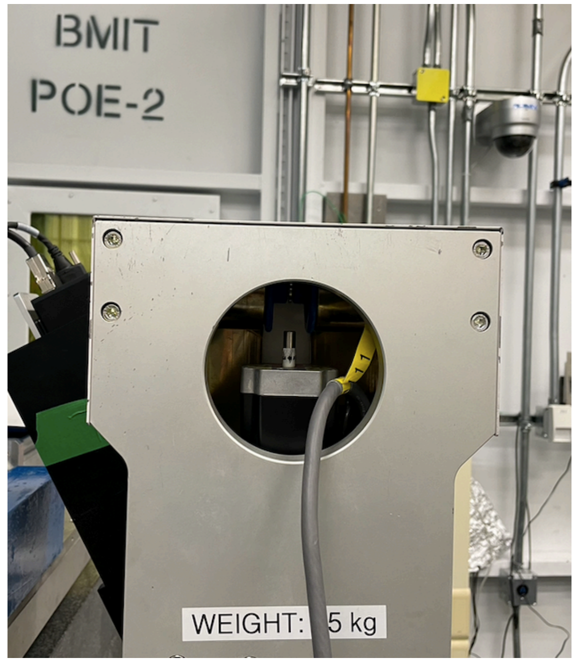
- Cable 1 - vertical motion stage on the target
- Cable 2 - vertical motion stage on the camera
- Cable 3 - target chi angle
- Cable 4 - target theta (Bragg) angle
- Cable 7 - target phi angle

Note that cables 1 and 2 look to be reversed from the 2019 run.

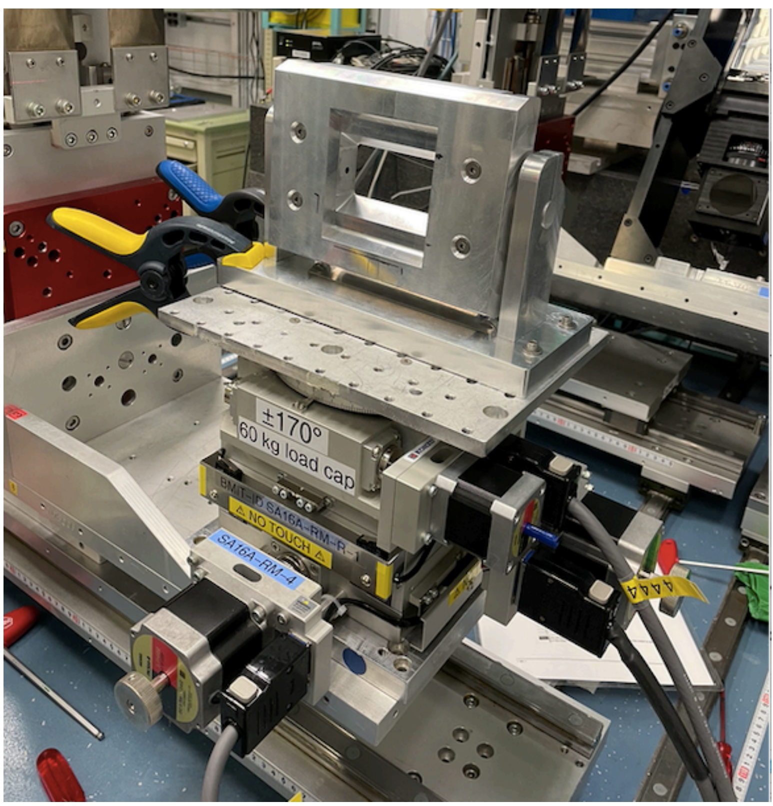

±170°
60 kg load cap
SA16A-RM-4
NO TOUCH


NO TOUCH





The complete goniometer setup is below as well as the webcam that looks at the goniometer.



Note: The stepping motor resolution has changed from 2019 to 2020. The spec sheets for both old and new motors are shown below.

12/21/21, 2:14 PM Motorized Swivel Stage

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- Precision X/XY Stage
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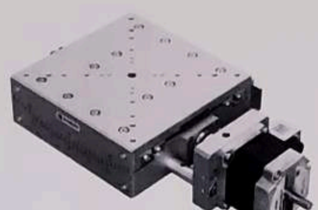
- Motorized X/XY Stage
- Precision Z Stage
- Precision Rotation Stage
- Precision Swivel (Tilt) Stage
- Manual Swivel Stage
- Motorized Swivel Stage
- Manual Alignment Station
- Heavy Duty Goniometer
- Old model Lineup
- Vacuum Stages
- Compact 6-Axes Manipulator
- Laser measurement system
- Blur Vibration Simulator
- System Products / Experimental
- Product Comparing
- Control Electronics
- Accessories

RoHS

SA16A-RT01



Catalog Data PDF Browse

Price(JPY)

¥

Quote

Quantity 0

Information

Link to Technical informaiton of motorized Swivel(Tilt) Stage

Drawings file: 2D JPEG

Drawing For Download: 2D CAD DXF | 3D CAD STEP | 3D CAD PARASOLID

Connect Fig File: Wiring Diagram | Mirror Wiring

Remarks and Features

Please, prepare the cable for 5 lead motor.
2 phase stepper motor is available. [Model] SA16A-RT01-BM (Additional Cost ¥40,000)
Note: 2 phase stepper motor specifications change connector.

メカ仕様

Model Number	SA16A-RT01
Mirror Model Number	SA16A-RT01-R
Table Size	160mm×160mm
Guide Mechanism	Cross-Roller Guide
Angular Range	±10°
Lead Mechanism	Worm & Worm Wheel
Resolution Full/Half Step	0.001412° / 0.000706°
Resolution Micro Step (1/20 div)	0.0000706° ← old one (2019)
Maximum Speed	7.06°/sec
Repeatability	≦±0.001° (AVE.±0.0001°)
Work Distance	220mm±0.5mm
Rotation Center Play	φ0.5mm/±10°
Lost Motion	≦0.005° (AVE. 0.0006°)
Backlash	≦0.001° (AVE. 0.0001°)
Moment Load Stiffness	0.02 arcsec/N · cm (AVE. 0.008 arcsec/N·cm)
Load Capacity	196N (20kgf)
Material	Aluminum Alloy
Finishing	Clear-Matt Anodizing
Weight	6.2kg

電気仕様

Standard Motor	5 phase stepper motor (Oriental Motor: C087Q-9215P) 2 phase stepper motor (Oriental Motor: PK264JDB) Motor Shaft Diameter:Φ8mm Conformance option handle: B type
Standard Connector	5 phase stepper motor： 20Pin Round (Hirose: RP13A-12RA-20PC) 2 phase stepper motor： 20Pin Rectangular (Hirose: PC-1620, P-1620A-STA)
Sensor Model	F-101(HOME, LIMIT)

Overhaul Price

~

*Additional parts cost is not included on Overhaul Price

Lubricant Change Option

Clean Room Lubricant Change Price ("-C" at the end of model number)

https://www.kohzuprecision.com/products/positioning-stages/swivel-tilt-stage/motorized-swivel-stage/product/538/5%2C20/SA16A-RT01/1770/ 1

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Precision Positioning Stages

- Precision X/XY Stage
- Manual X/XY Stage
- Motorized X/XY Stage
- Precision Z Stage
- Precision Rotation Stage
- Precision Swivel (Tilt) Stage
- Manual Swivel Stage
- Motorized Swivel Stage
- Manual Alignment Station
- Heavy Duty Goniometer
- Old model Lineup
- Vacuum Stages
- Compact 6-Axes Manipulator
- Laser measurement system
- Blur Vibration Simulator
- System Products / Experimental
- Product Comparing
- Control Electronics
- Accessories

RoHS

SA16A-RM

Catalog Data PDF Browse

Price(JPY)

¥ 480,000

Quote

Quantity 0

Information

Link to Technical informaiton of motorized Swivel(Tilt) Stage

Drawings file: 2D JPEG

Drawing For Download: 2D CAD DXF | 3D CAD STEP | 3D CAD PARASOLID

Connect Fig File: Wiring Diagram | Mirror Wiring

Remarks and Features

Please, prepare the cable for 10 lead motor.
2 phase stepper motor is available. [Model] SA16A-RM-BM (Additional Cost ¥ 40,000)

メカ仕様

Model Number	SA16A-RM
Mirror Model Number	SA16A-RM-R
Table Size	160mm×160mm
Guide Mechanism	Cross-Roller Guide
Angular Range	±10°
Lead Mechanism	Worm & Worm Wheel
Resolution Full/Half Step	0.0012°/0.0006°
Resolution Micro Step (1/20 div)	0.00006°
Maximum Speed	6°/sec
Repeatability	±0.001°
Work Distance	280mm±0.5mm
Rotation Center Play	φ0.5mm/±10°
Lost Motion	≦0.005°
Backlash	≦0.003°
Moment Load Stiffness	0.02 arcsec/N·cm
Load Capacity	196N (20kgf)
Material	Aluminum Alloy
Finishing	Clear-Matt Anodizing
Weight	5.5kg

← new one (2021)
we use 2 μstep = 0.00012 ≅ 2.09 μrad

電気仕様

Standard Motor	5 phase stepper motor (Oriental Motor: PK566-B) 2 phase stepper motor (Oriental Motor: PK264JDB) Motor Shaft Diameter:Φ8mm Conformance option handle: B type
Standard Connector	20Pin Rectangular (Hirose: PC-1620, P-1620A-STA)
Sensor Model	F-101(HOME, LIMIT), F-107(INDEX)

Overhaul Price

¥ 48,000~

*Additional parts cost is not included on Overhaul Price

Lubricant Change Option

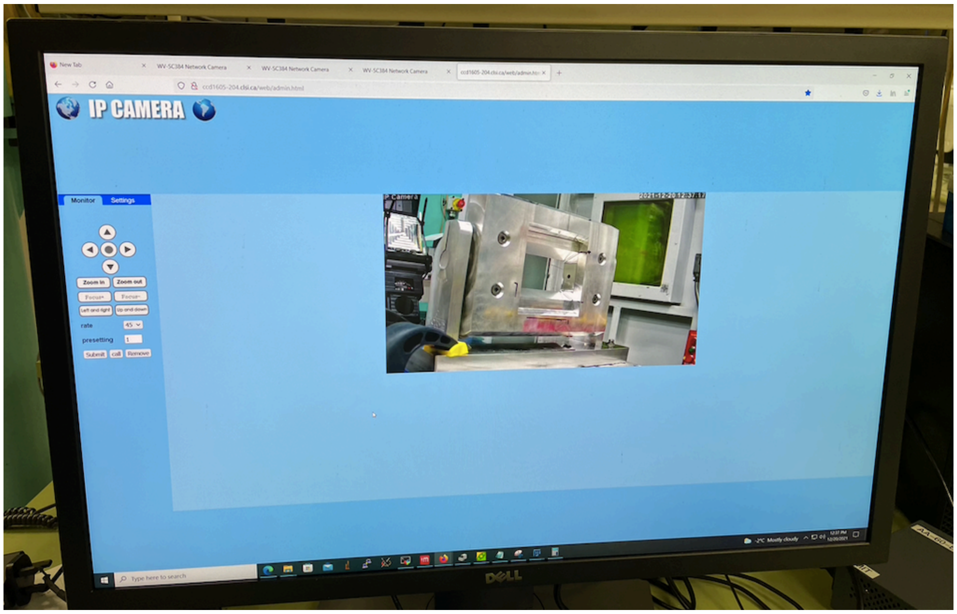
Clean Room Lubricant Change Price ("-C" at the end of model number)	¥ 36,000
Vacuum Lubricant Change Price ("-V" at the end of model number)	¥ 36,000

Motor Change Option

Same Size Motor Change Price	¥ 15,000~
Different Size Motor Change Price	¥ 36,000~

*The Motor cost is not included on Motor Change Price

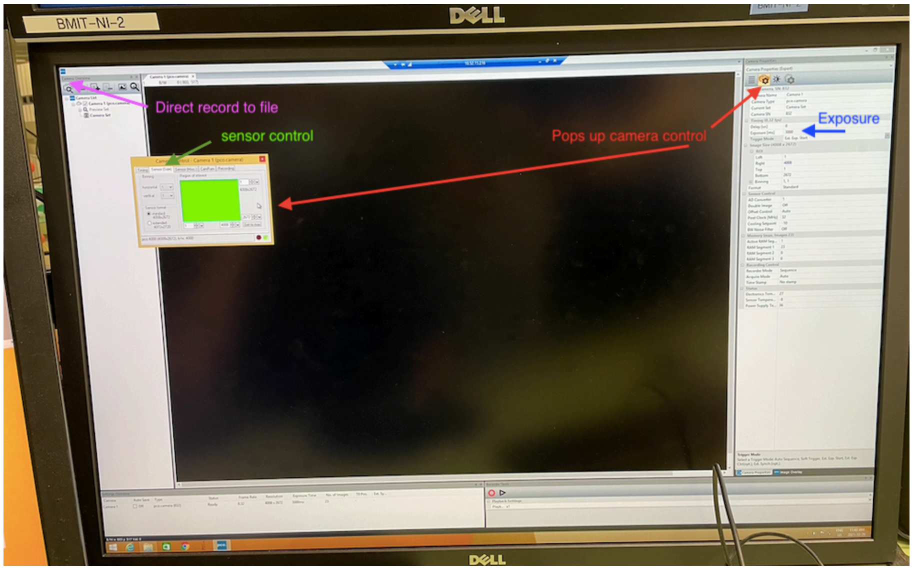
The webcam view on the computer screen.



Data Acquisition System

There is new software for the camera, called Camware 64 PCO (https://www.pco.de/software/camera-control-software/pcocamware/). A screen shot is shown below. Match its exposure to Multi View CT exposure; File/Direct Record to16bit tiff

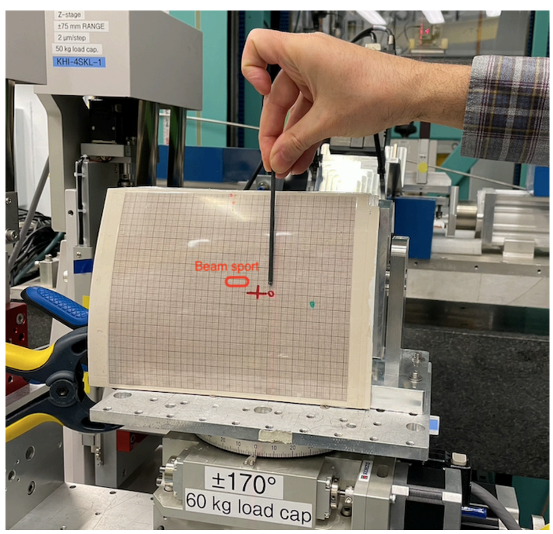
Connection is done via WIndows Remote Desktop Connection: Computer: 10.52.15.216. Username: CLSI\bmituser1 Password: bmituser1_1129



Scanning Silicon

We installed a piece of Si that Adam found on the aluminum frame, and roughly aligned it with the lasers and by eye. It is quite large; it is half of an oval, capable of filling the hole in the middle of the frame (as shown above). See photo on the right below.

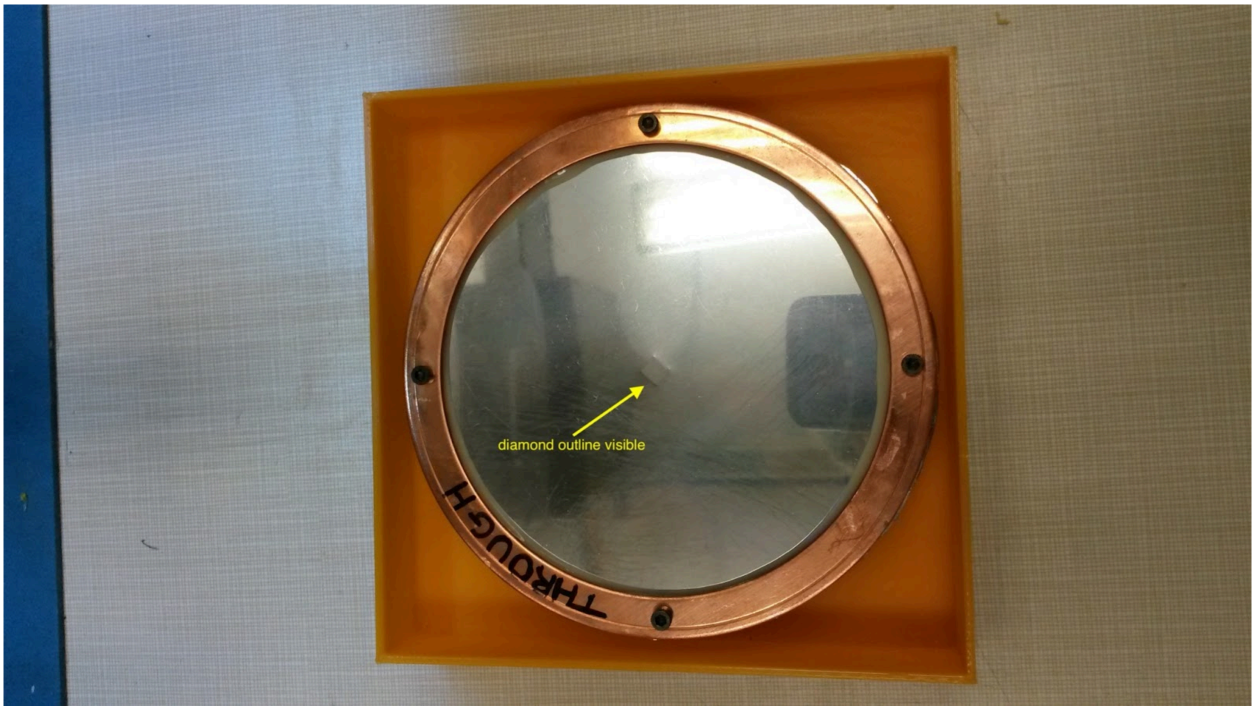
We used fluorescent paper and were able to see the X-ray beam spot (sort of rectangular in shape). See photo of the setup below, with Mehran's hand holding a thin Allen wrench showing where the vertical laser beam is.



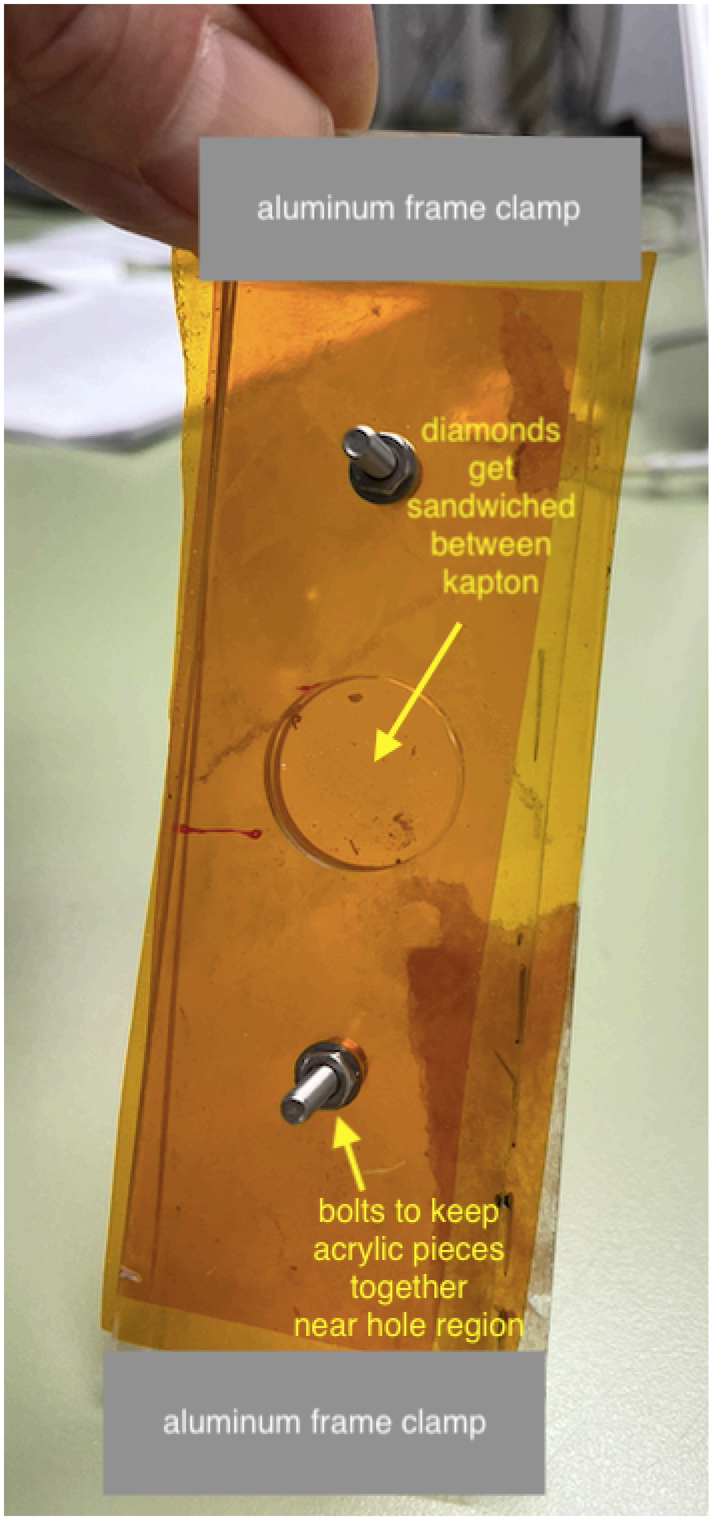
Trying to find the X-ray spot in the camera was not successful. We really do not know what kind of Si wafer we have, so we were scanning in the dark, pun intended.

Constructing a diamond holder

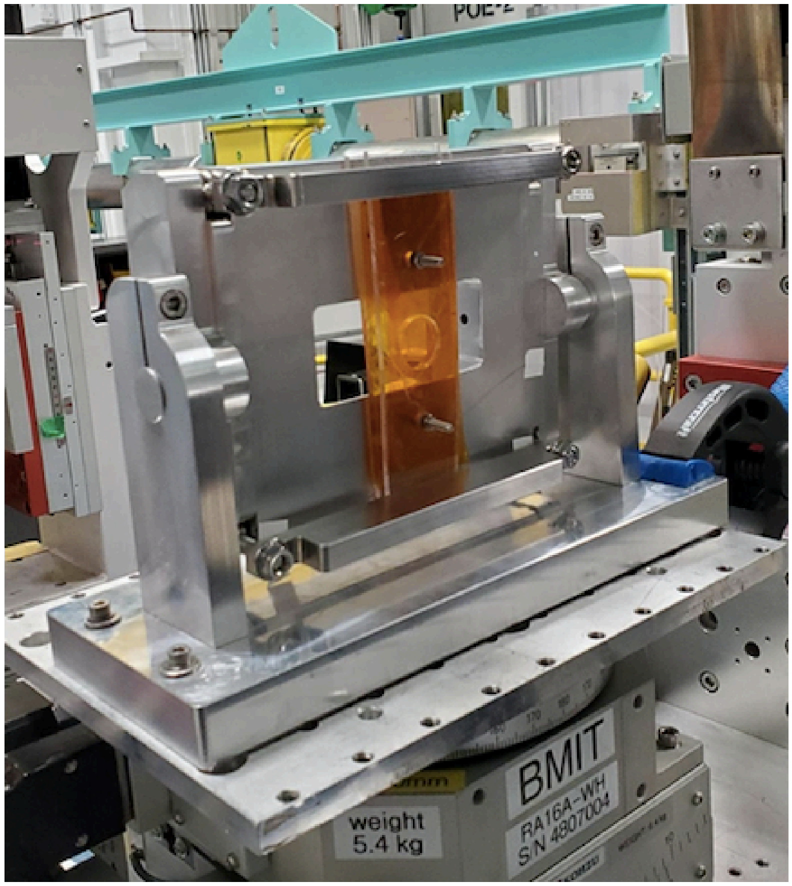
The diamonds for the run are thick and uncut, which means they cannot be mounted on the aluminum target strips/ladder. In the past, we used a copper ring with a 5” inner diameter as shown in the picture below, to sandwich and suspend the diamonds between two mylar sheets. That ring was misplaced and could not be recovered for this run.



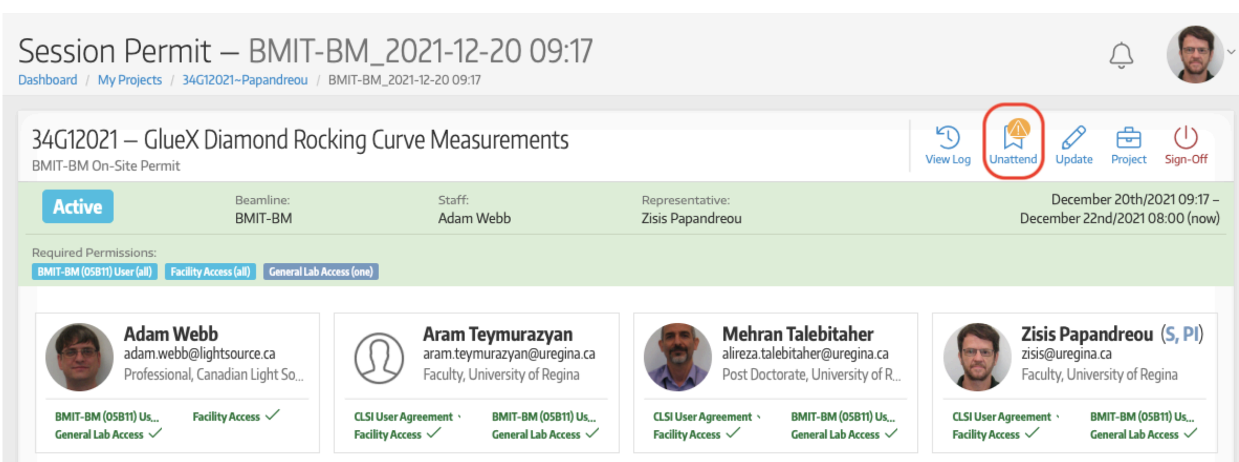
After scavenging the facility and considering several options to “trap” the diamonds in a similar fashion (acrylic sheets, zip lock bags, washers, etc) we settled on cutting two pieces of acrylic, boring a 2cm-diameter hole, aligned, in both, and adding two screws above and below the hole, to keep the acrylic pieces close together. The non-sticky side of kapton tape is used to hold the diamond in place with friction, while the sticky side is applied on the acrylic pieces. This construction should hold the diamonds in place in the beam, and also is easy to take apart to install a new diamond. See photo below.


aluminum frame clamp
diamonds get sandwiched between kapton
bolts to keep acrylic pieces together near hole region
aluminum frame clamp

Finally, this is what it looked installed and clamped on the Aluminum frame of the goniometer setup. See photo below.



At this point, Aram, Mehran and Zisis left the lab at around 7pm. The Unattended button was activated online, on the Experimental Permit. See screen shot.



Diamond Arrival

After many “adventures” by the airlines, Richard arrived in Saskatoon at 1am on December 21 (24 hours late) without the diamond suitcase. Fortunately, the suitcase arrived early in the morning while Zisis was driving him to the airport. We should be up and running scans before 11am or so. Aram and Mehran will come between 11am-12pm to check in and we will then set up shifts for the remaining 22 hours.

Unpacking the diamonds

The diamonds were hand-carried to CLS by Richard in a locked carrying case. Here is a picture showing the inside of the case when it was opened, and the contents of the samples container.

Diamond Scans

Bragg Law Spreadsheet for C and Si.

beamline optics

File Edit View Insert Format Data Tools Extensions Help Last edit

D10 fx =2*degrees(asin(B10/(2*A10)))

	A	B	C	D	E
1	lattice constant	0.357	nm at 300K	diamond	
2		0.5431	nm at 300K	silicon	
3					
4	energy (keV)	qreflection (keV)	wavelength (nm)	2thetaBragg (deg)	thetaBragg (deg)
5	diamond (2,2,0)				
6	10	9.820	0.12395	58.81	29.41
7	20	9.820	0.061975	28.42	14.212
8	Si(2,2,0)				
9	10	6.455	0.12395	37.66	18.83
10	20	6.455	0.061975	18.57	9.29
11	Si(3,3,1)				
12	10	9.948	0.12395	59.66	29.83
13	20	9.948	0.061975	28.80	14.40
14					
15	angle from 2,2,0 to 3,3,1 directions			13.26	deg
16	angle from 1,1,1 to 3,3,1 directions			37.37	deg
17	angle from 1,0,0 to 3,3,1 directions			46.51	deg
18	angle from 3,1,1 to 3,3,1 directions			25.94	deg
19					

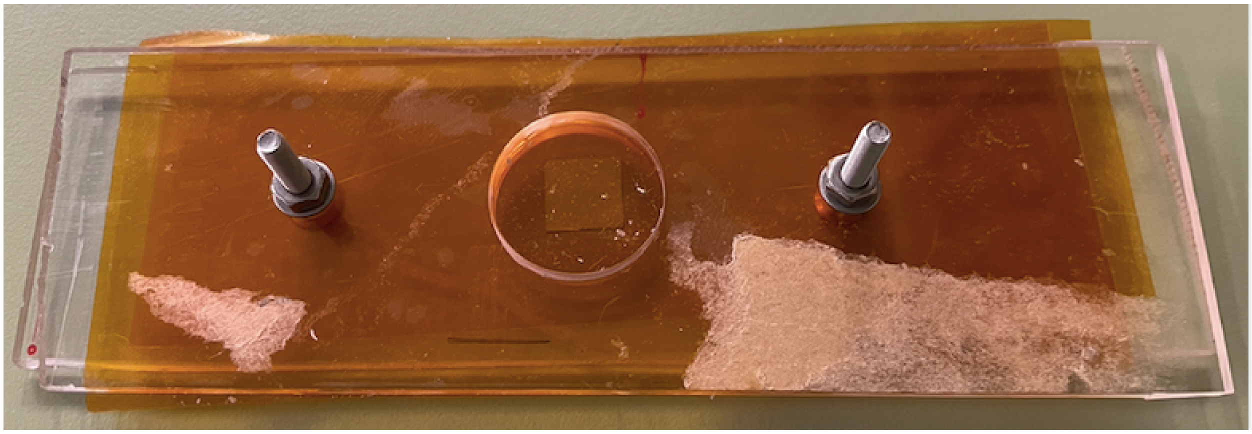
Directory structure where our raw data is initially written to:

This PC › beamlinedata (\\loki) (Z:) › BMIT › projects › prj34G12021 › raw › 2021.12.20 › JD80-1

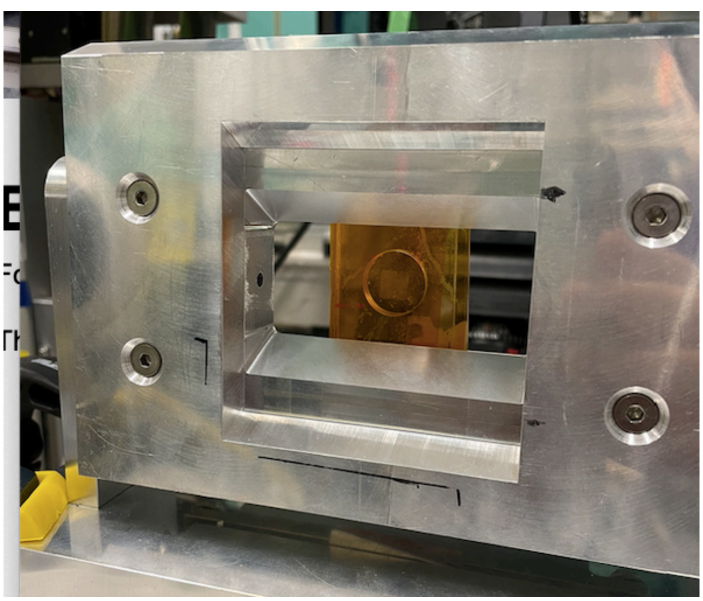
This PC\beamlinedata (\\loki) (Z:)\BMIT\projects\prj34G12021\raw\2021.12.20\JD80-1

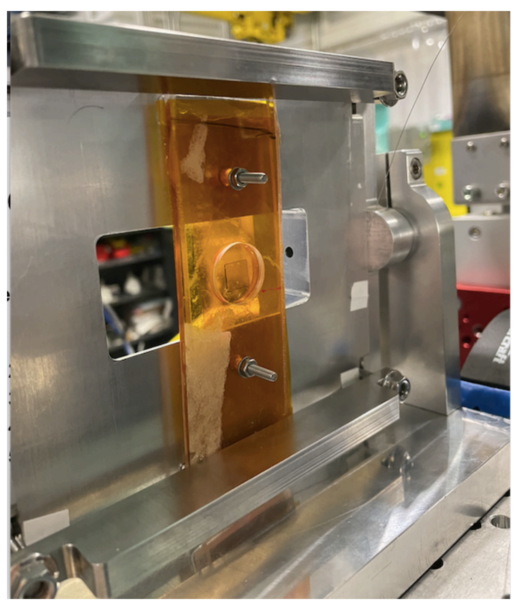
mounting in the new diamond holder

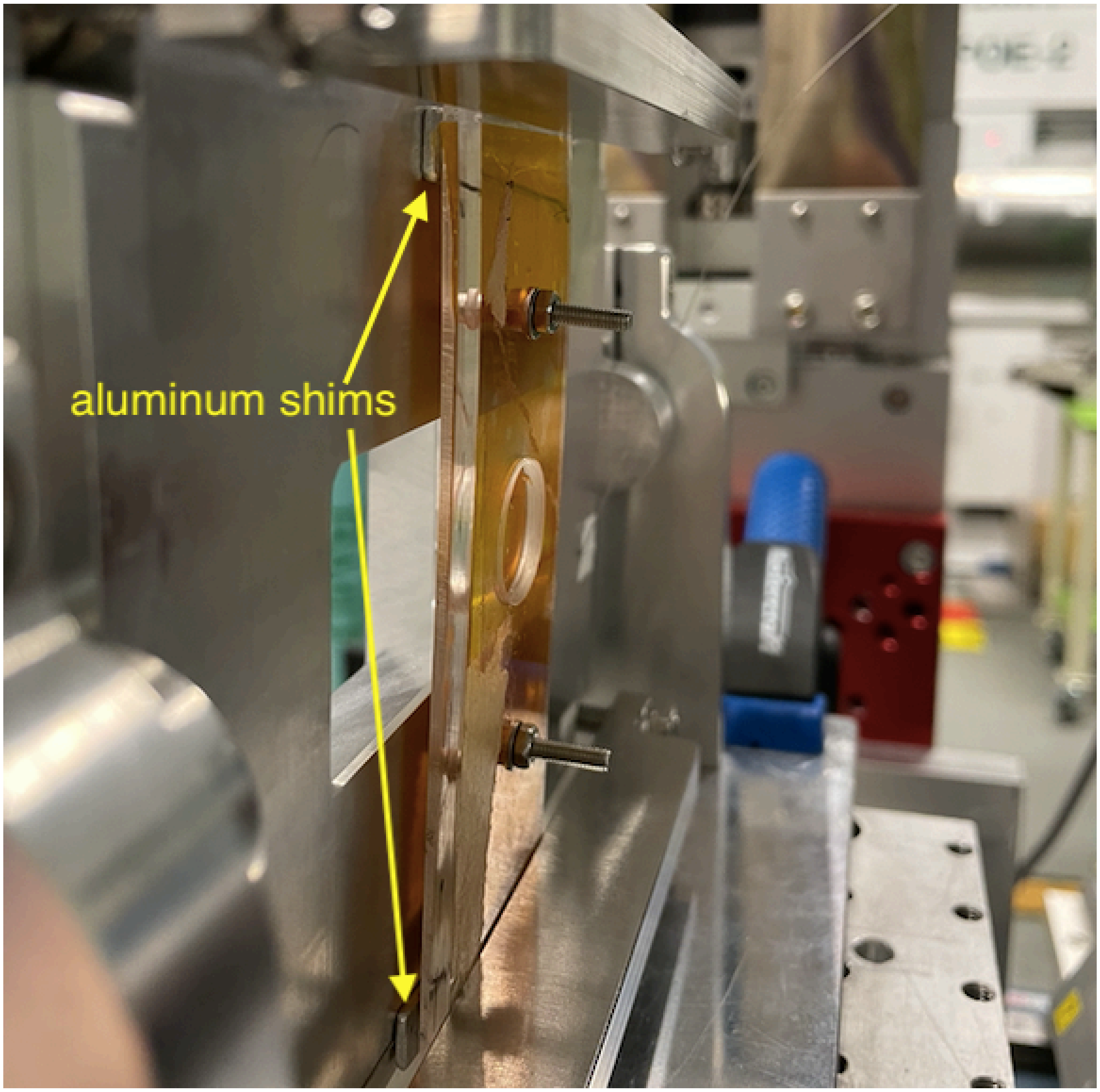
It was a piece of cake to put the diamond in the hole of the acrylic diamond holder (a.k.a. “Orange Cookie”). Richard took it out of its wrapping, lifted it with a piece of paper, placed over the hold of one of the acrylic sheets, nudged with the paper at the center, and then Zisis placed the oher acrylic sheet on top and bolted the two sheets together. Here is a photo:



When Richard and Zisis installed the acrylic holder and clamped it on the goniometer aluminum frame, the holder bowed a bit, and the worry was that it would strain the diamond and cause it to curl. The holder was removed, 2 thin aluminum shims were made in the machine shop and crazy-glued to the edges of one of the acrylic pieces. The holder was remounted. No (or at least much less) bowing now. The thickness of acrylic pieces and aluminum shims just allows for a few turns on the nuts of the aluminum frame, to finger-tightness, and it is keeping the holder in place. The acrylic holder was rotated so that the diamond would be parallel to the floor, and was aligned using the lasers in the hutch. Photos below, including a detailed look at the shims.

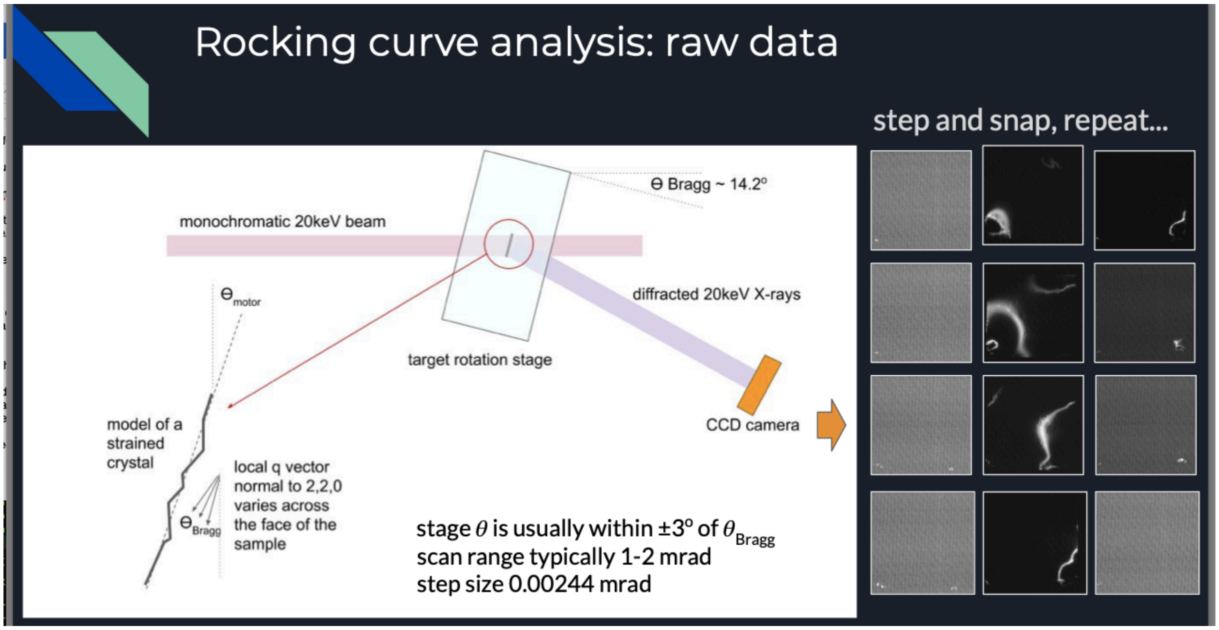






review of rocking curve methodology

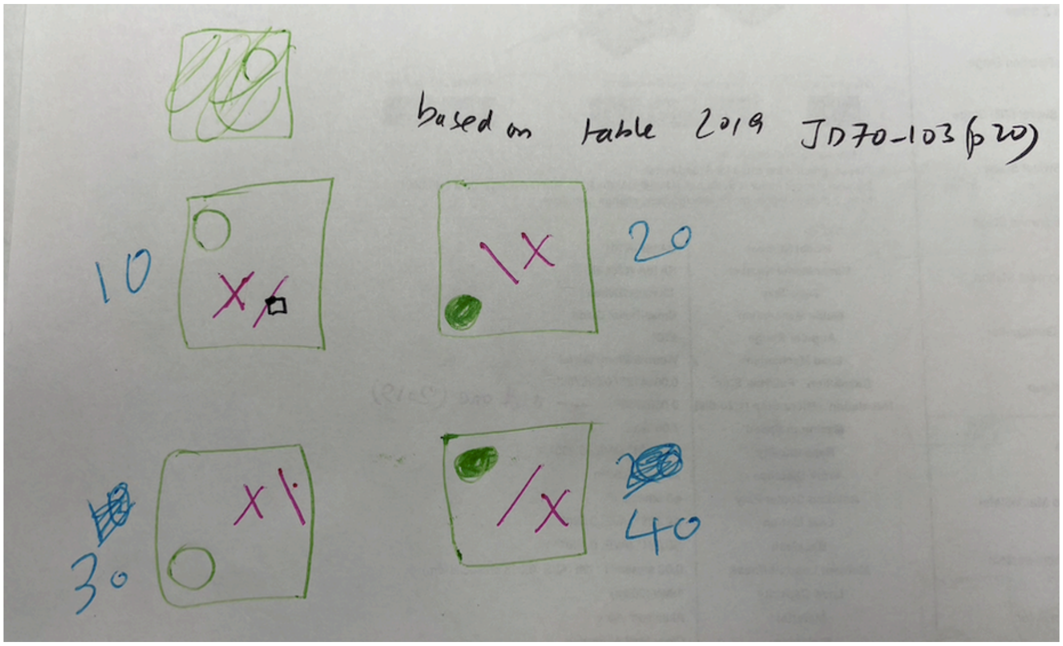
See document GlueX-doc-4505 on the GlueX document dataserver. A slide from that talk is shown below.



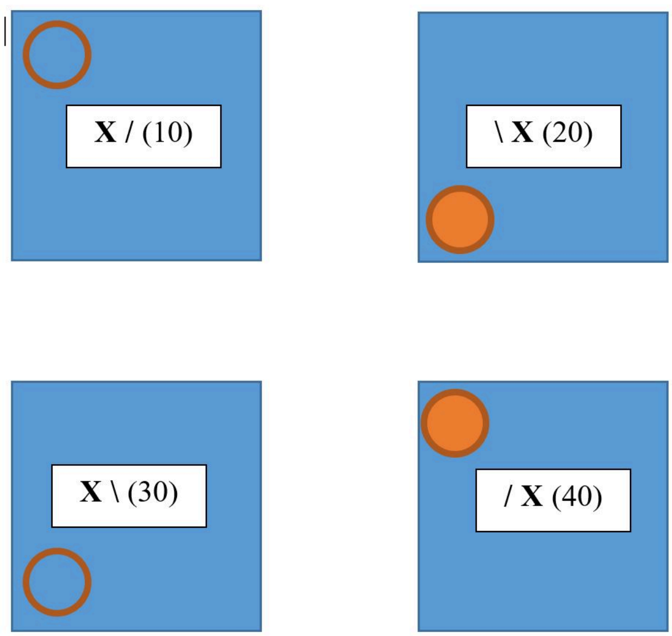
nomenclature for diamond orientations

The diamond orientation schematics are shown in the figure below. We plan to put markings on the backs of the diamonds (backs according to the photon beam). In the sketches below, the dot represents the virtual diamond “wet spot” (where it would have normally been glued to the aluminum bar. A solid circle means that that spot is in the front of the diamond and an open circle means it is on the back of the diamond. The 10-40 represent the scan numbers.

$$1\ urad\ = 0.000057\ degree$$

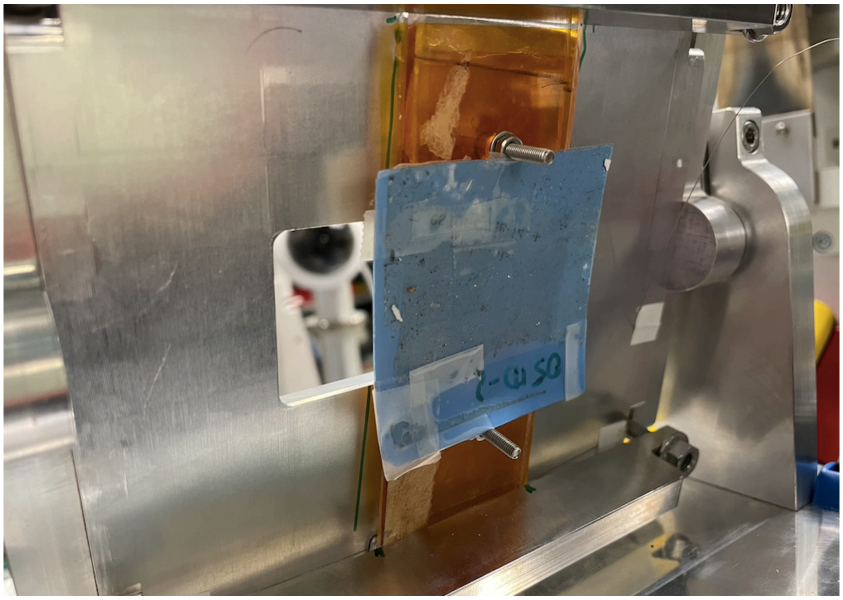


And a fancier drawing:



scanning for beam spot

We placed a fluorescent paper behind the diamond and turned off the lights in the hall. The diamonds line up very well with the 10mm x 20 mm beam spot. Another useful method was to put the fluorescent paper in front of the camera and rapidly scan the angle to see the x-ray spot on the camera, and thereby find out the pitch relative position.



December 21, 14:00 [rtj,at,mt]
Centering the diamond on the X-ray beam spot was somewhat complicated by the fact that the vertical cross-hair laser line appears to be nearly 10mm to the beam-right of the beam spot. The camera was viewing the beam spot on fluorescent paper just behind the diamond, from a position upstream and beam-left. Parallax would make the beam spot appear to be right of the diamond under conditions of good alignment, but only by a 1-2 mm, if my estimate of the viewing angle is correct, so the large offset between the vertical laser and the beam spot is real. We used the beam spot imaged on fluorescent paper to center the diamond in the horizontal direction. We then set the diamond thetaBragg to 15 degrees using a digital protractor, and made sure rocking the theta stage by +/- 2^{o} will not result in a collision with the camera mount stage.

We then placed a large fluorescent screen in front of the camera aperture and did a fast scan.

- fast scan parameters:
  - theta scan range: 13^{o}-17^{o}
  - bright blip was seen on the fluorescent screen 15.7^{o}
  - rocking back and forth we were able to find the approximate center of the diffraction peak

Visually, the fast scan gives the impression that this diamond is going to have a very large whole-crystal rocking curve. This is a good start, we are on our way to taking rocking curves!

To provide a fixed reference for the diamond orientation, I marked the corner with a black dot in one corner.

finding the right camera scintillator

After mounting the first crystal JD80-1, we were able to quickly find the 2,2,0 reflection in the first orientation and take some camera images. Even at the peak of the rocking curve, the brightness of the image was quite low, such that the background pixels looked grey-speckled instead of black the way they did during previous scans. This is a new camera (to us), so I inquired with Adam about what might have changed, and I learned about 2 factors that might be costing us diffracted beam intensity: the type of scintillator, and the width of the slits.

There are two scintillators available for this camera.

1. Lutetium Aluminum Garnet activated by cerium ($Lu_3Al_5O_{12}$:Ce, LuAG:Ce) are fast and bright scintillation materials. The decay time is 70-100 ns. Detailed characteristics from the manufacturer are shown in the graphic below.
2. Gadolinium oxysulfide (Gd_2O_2S), also called gadolinium sulfoxylate, GOS or Gadox, is an inorganic compound, a mixed oxide-sulfide of gadolinium.

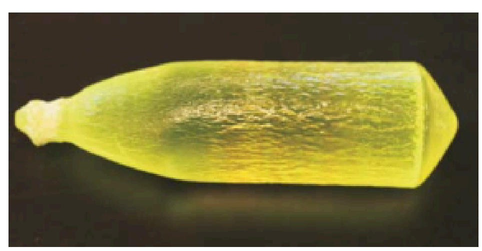
crytur

LuAG:Ce Scintillation Material

LuAG:Ce, Lutetium Aluminum Garnet activated by cerium (chemical formula $Lu_3Al_5O_{12}$), is a relatively dense and fast scintillation material. Its density of 6.73 g/cm3 is about 94% of the density of BGO (7.13 g/cm3). Its decay time is much faster (70 ns) than that of BGO (300 ns). This is of advantage in time dependent and coincidence measurements. The wavelength of scintillation emission is about 535 nm, which is ideal for photodiode and avalanche diode readout. The material can also be used for imaging screens, similarly to YAG:Ce. A particular advantage of LuAG:Ce is its higher density resulting in thinner screens with higher spatial resolution. The material is mechanically and chemically stable,

Advantage

- High density and fast decay time
- Fast decay time
- Suited for photodiode and avalanche diode readout
- Very good machining properties
- Chemical, mechanical and temperature resistance



Main usage

- High energy gamma and charged particle detection
- PET matrixes
- High spatial resolution imaging screens for X ray, gamma and beta

The material can be machined into a variety of shapes and sizes including prisms, spheres and very thin plates.

Table of physical parameters

	NaI:Tl	BGO	YAG:Ce	YAP:Ce	CRY-019	LuAG:Ce	CRY-018
Density [g/cm^3]	3.67	7.13	4.55	5.37	7.4	6.76	4.50
Hardness [Mho]	2	5	8.5	8.6	5.8	8.5	5.8
Index of refraction	1.85	2.15	1.82	1.95	1.82	1.84	1.79
Crystal structure	cubic	cubic	cubic	rhombic	monoclinic	cubic	monoclinic
Hygroscopic	yes	no	no	no	no	no	no
Cleavage	yes	no	no	no	yes	no	yes
Light output [% NaI:Tl]	100	15 - 20	40	60	40 - 75	20	80
Emmision [nm]	415	480	550	370	415 - 420	535	425
Decay Time [ns]	230	300	70	25	46	70	45
Energy Resolution [% at 661 keV]	7.2	12	7.2	6.7	8.5	-	7
Radiation length x_0 [cm]	2.9	1.1	3.5	2.7	1.2	-	2.74
Photon yield @300K [10^3 Ph/MeV]	38	8 - 10	35	25	28	20	32

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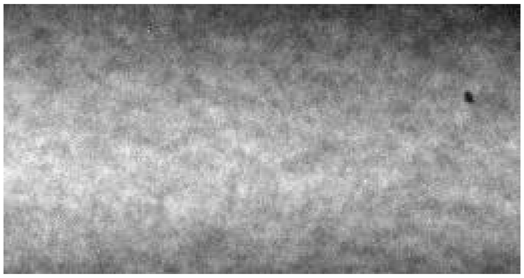
E-mail: crytur@crytur.cz

The emission spectra for both should be good for the CCD to detect. I would have to search a bit to find specific yields vs x-ray energy. I looked at some notes I have from January. Attached are small pieces of images from the two scintillators we used (best area imaged). The count rates are actually quite close at 34 KeV with 2800 counts in 2 s for luag vs 2500 counts in 2 s for gadox. The main disadvantage of the gadox for imaging is the structure in the image. This is due to material being a fine powder. This can be mostly subtracted but not entirely and increases ring artifacts in CT reconstructions.



However, I did note in January that the LuAG was not as good at lower energies. Performance of the scintillator (LuAG) gets better as the energy increases. For your application, the background may not be so important. In imaging, we are comparing areas of sample and areas with only beam. In your measurements, on the other hand, the difference is between x-rays and no x-rays.

We default to using YAG and LuAG scintillators for CT imaging but in retrospect I think I simply picked the incorrect scintillator for the application.

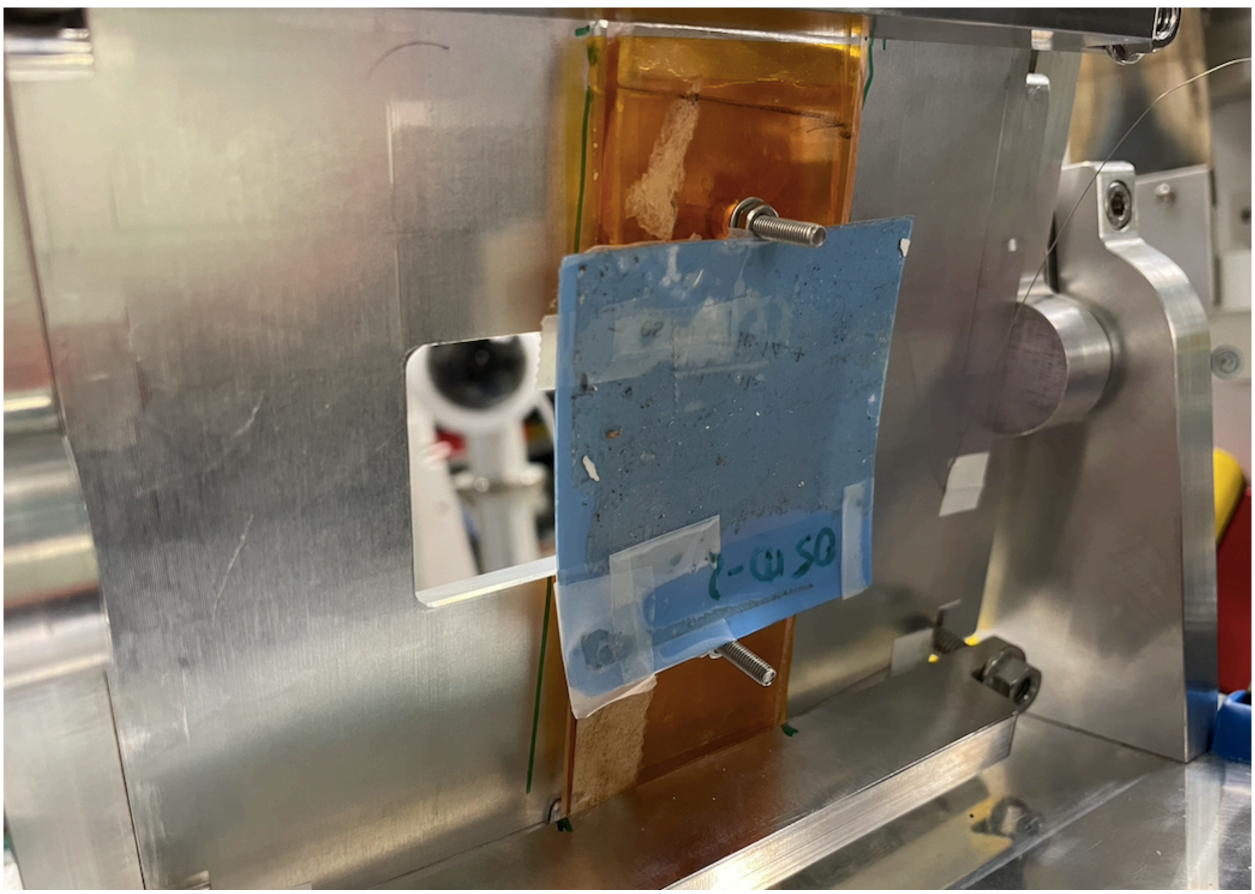
The second factor for intensity was opening the aperture on the lens which was not fully open. I noticed this while I was switching the scintillator. The previous person had used a different f-stop with a smaller aperture which decreases the amount of light getting to the camera. This would have been changed to adjust the depth of field and aberration of the lens. This is a trade off of sharper focus across the image versus loss of count rate. This becomes important when rotating the object during the CT scan.

After swapping out scintillator #1 for scintillator #2 and opening the slits (called f-stop above) we found the images looked like they did with the previous camera, with very fine features of just a few pixels popping out clearly from the dark background in the image.

adjusting the focus on the camera

We focused the beam using the device below and the diffraction pattern (instead of a sharp point like we did last time).

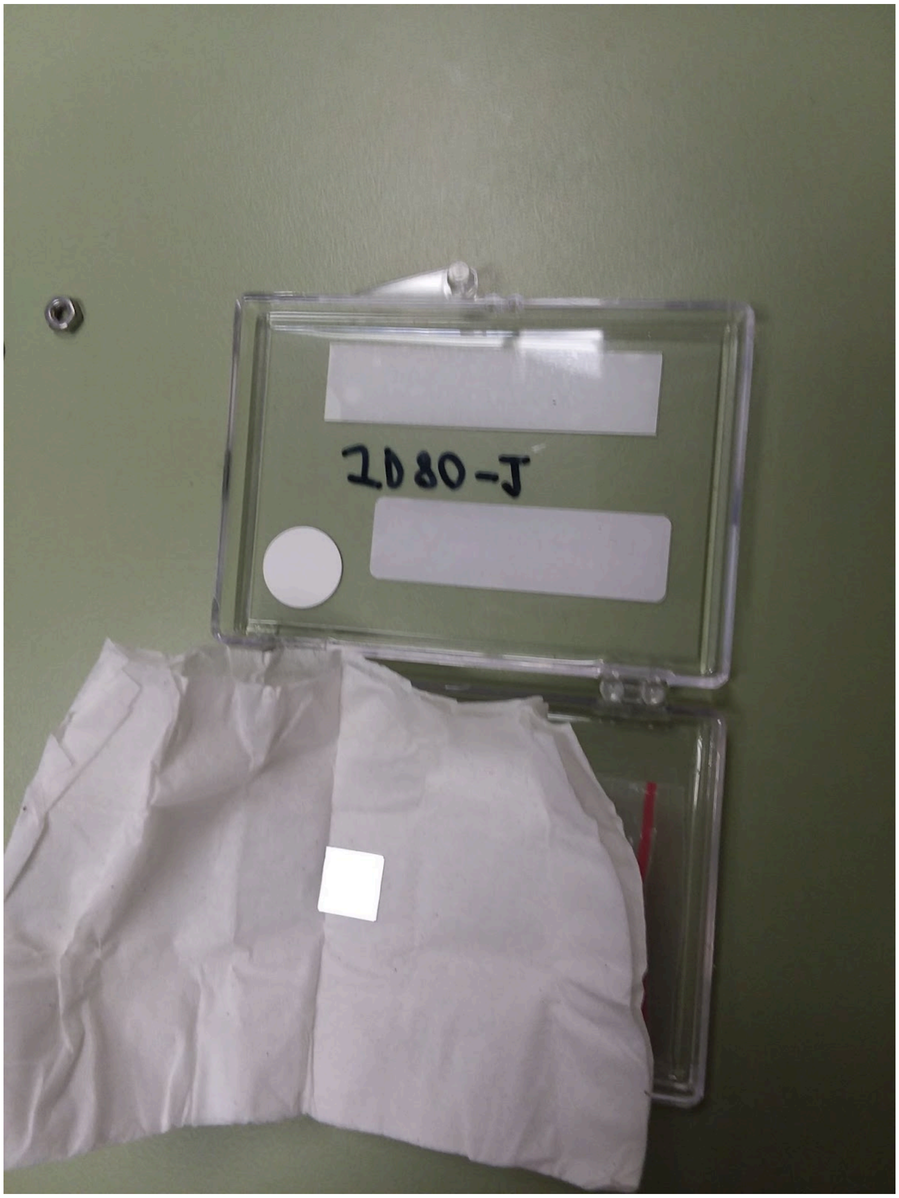
December 21, 16:45 [zp,at,mt]
Added alignment reference lines on the Aluminum frame so that we can position the acrylic holder quickly and (roughly) reproducibly each time. See photo (green lines):



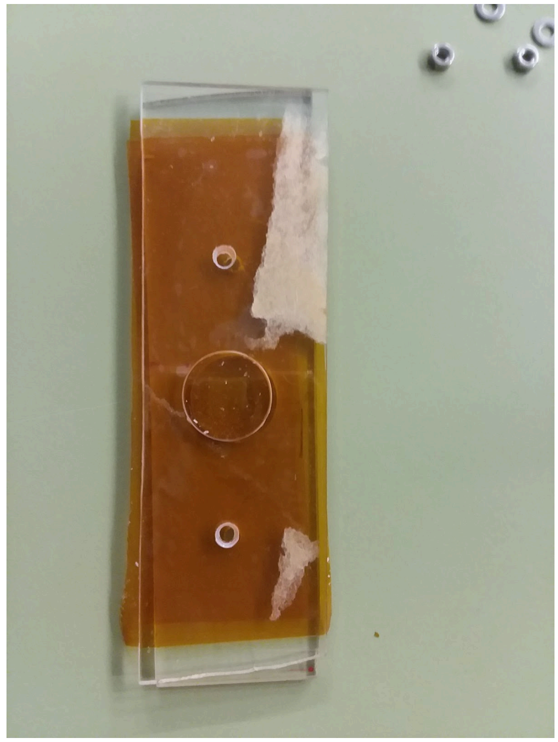
Mount JD80-1, install in beamline

December 21, 11:50am [rj,zp]

With the training completed, we unpacked the first diamond JD80-1 from the case. JD-80-1 has a black dot on it that marks the corner of reference for indicating the orientations.



Here is JD80-1 mounted inside the BMIT-diamond sample holder that was made for this run.

Take rocking curves (4) of JD80-1

scan	orientation	theta range (deg)	no. steps	step size (urad/deg)	image prefix
10*	X/	(0.7000,0.7660)	550	2.09 / 0.00012	JD80-1-10
20*	\X	(16.5915,16.6658)	584	“	JD80-1-20
22†	\X	(16.5315, 16.6115)	667	“	JD80-1-20-2
30*	X\	(-0.1503, -0.0743)	633	“	JD80-1-30
40	/X	(16.5000, 16.5800)	667	“	JD80-1-40

*The camera captured half of the images. It has enough information. The reason was that the gui parameter “write file delay” was too short (100ms). We increased it to 1000 ms. and the reason is that the new camera needs a longer time to capture the image.
†This scan was originally called 20-2, renamed later to 22 to adhere to scans being integers.

Transfer data from JD80-1 to UConn

With less than 12 hours left in our beam time, we did not want to take the time to transfer the data right away. Instead we went ahead with the next sample, and left the data transfer and quality checks to the end of the run.

Verify data quality

Postponed to the end of the run.

Dismount JD80-1, repackage

December 22, 2021 [rtj, mt]
The JD80-1 diamond was returned to its tight wrapping paper and stuffed back into the little baggie taped to the bottom of its individual-sample plastic box. The box was returned to the carrying case.

Mount JD80-100, install in beamline

JD-80-100 has a red dot on it that marks the corner of reference for indicating the orientations. We took it from the paper wrapper where it was originally shipped together in the same wrap with JD80-200 and JD80-300, and used a red pen to place a tiny red dot in one corner. That dot serves to uniquely identify the orientations of the following scans.

Take rocking curves (4) of JD80-100

scan	orientation	theta range (deg)	no. steps	step size (urad/deg)	image prefix
10	X/	(13.401,13.412)	92	2.09 / 0.00012	JD80-100-10
12†	X/	(13.389,13.400)	92	“	JD80-100-10-2
20	\X	(13.689,13.709)	167	“	JD80-100-20
30	X\	(13.054,13.069)	125	“	JD80-100-30
40	/X	(12.944,12.959)	125	“	JD80-100-40

†This scan was originally called 10-2, changed later to 12 to adhere to scans being integers.

Transfer data, verify data quality

Postponed to the end of the run.

Dismount JD80-100, repackage

Between scans 20 and 30, we moved JD80-100 temporarily to a storage container, and went ahead with JD80-200, hoping we would have enough beam time to come back and make the remaining two scans. We did, so the last two scans in the above table were done after we had finished all four scans of JD80-300. When we were done, we returned JD80-100 to the leftmost cell in the middle row of sample carrier Sleeve 1. Photos showing all three JD80-(100,200,300) in the sample carrier are included at the end.

Mount JD80-200, install in beamline

JD-80-200 has a green dot on it that marks the corner of reference for indicating the orientations.

Take rocking curves (4) of JD80-200

scan	orientation	theta range (deg)	no. steps	step size (urad/deg)	image prefix
10	X/	(13.769,13.789)	167	2.09 / 0.00012	JD80-200-10
20	\X	(13.734,13.754)	167	“	JD80-200-20
30	X\	(12.890,12.905)	125	“	JD80-200-30
40	/X	*ran out of time*		“	

Transfer data, verify data quality

Postponed to the end of the run.

Dismount JD80-200, repackage

We returned JD80-200 to the second from left cell in the middle row of sample carrier Sleeve 1. Photos showing all three JD80-(100,200,300) in the sample carrier are included at the end.

Mount JD80-300, install in beamline

JD-80-300 has a black dot on it that marks the corner of reference for indicating the orientations.

Take rocking curves (4) of JD80-300

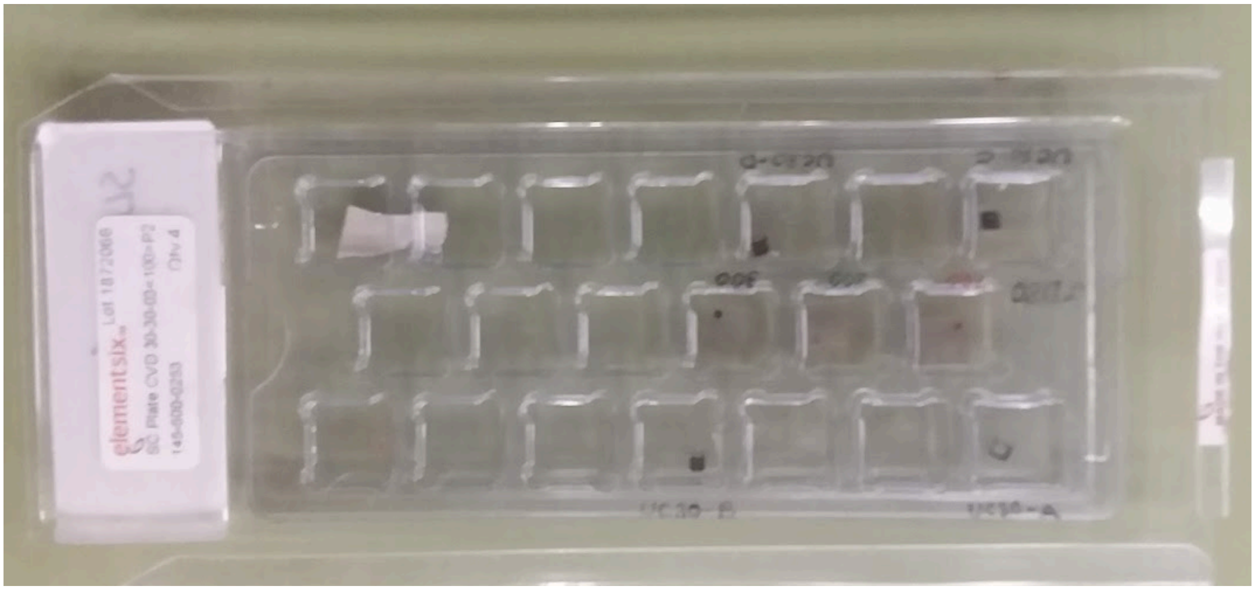
scan	orientation	theta range (deg)	no. steps	step size (urad/deg)	image prefix
10	X/	(13.159,13.179)	167	2.09 / 0.00012	JD80-300-10
20	\X	(13.269,13.289)	167	“	JD80-300-20
30	X\	(14.204,14.224)	167	“	JD80-300-30
40	/X	(14.384,14.404)	167	“	JD80-300-40

Transfer data, verify data quality

Postponed until after the run, for lack of time.

Dismount JD80-300, repackage

We returned JD80-300 to the third from left cell in the middle row of sample carrier Sleeve 1. The photos below show all three JD80-(100,200,300) packaged in sample carrier 1 and returned to the carrying case for transport after the run was finished.



December 22, 2021 [rtj, zp, mt]
Last few minutes of beamtime (see accelerator screen) and last scan (see photo of Richard and Mehran).

Experiment Session End

Beam off at 8:01. Session ends automatically by system, at the end of our assigned beam time. See screenshot summary below, sent by email by the system..

CLS User Office 12/22/2021, 08:00 AM

Canadian Light Source: Session Ended

to: <zisis@uregina.ca>

Dear Zisis Papandreou,

This email is to inform you that your session on BMIT-BM has ended. The details of the session can be found below.

Additionally, we would greatly appreciate you taking a minute to complete a short questionnaire to help us improve our services to you and future users. Comments received are shared with beamline staff and CLS management. Please let us know about your most recent session:

https://user-portal.lightsource.ca/surveys/session/24493

If you have any questions, please contact the User Services Office at clsuo@lightsource.ca or 1-306-657-3700.

Sincerely,
CLSI User Services Office

Session Details:

Start Time: 2021-12-20 09:17
End Time: 2021-12-22 08:00
Staff Responsible: Adam Webb
User Responsible:
Project: [34G12021](https://user-portal.lightsource.ca/projects/6848/)
Beamline: BMIT-BM

History:

- Hand over by Adam Webb for BMIT-BM at Mon Dec 20 2021, 09:16.

- Sign-On updated by Zisis Papandreou on Mon Dec 20 2021, 09:17; Added samples: 'Diamond - Type II (3)', 'Diamond - CVD (1)';; Added team: 'Zisis Papandreou', 'Aram Teymurazyan', 'Adam Webb', 'Mehran Talebitaher';

- Beamline unattendance (BMIT-BM_2021-12-20 09:17 unattended from Mon Dec 20 2021, 18:49 - Mon Dec 20 2021, 19:47 (expected)) is submitted by Zisis Papandreou on Mon Dec 20 2021, 18:49

- Beamline unattendance (BMIT-BM_2021-12-20 09:17 unattended from Mon Dec 20 2021, 18:49 - Tue Dec 21 2021, 09:10) is closed by Zisis Papandreou on Tue Dec 21 2021, 09:10

- Sign-On updated by Zisis Papandreou on Tue Dec 21 2021, 10:29; Added team: 'Richard Jones';

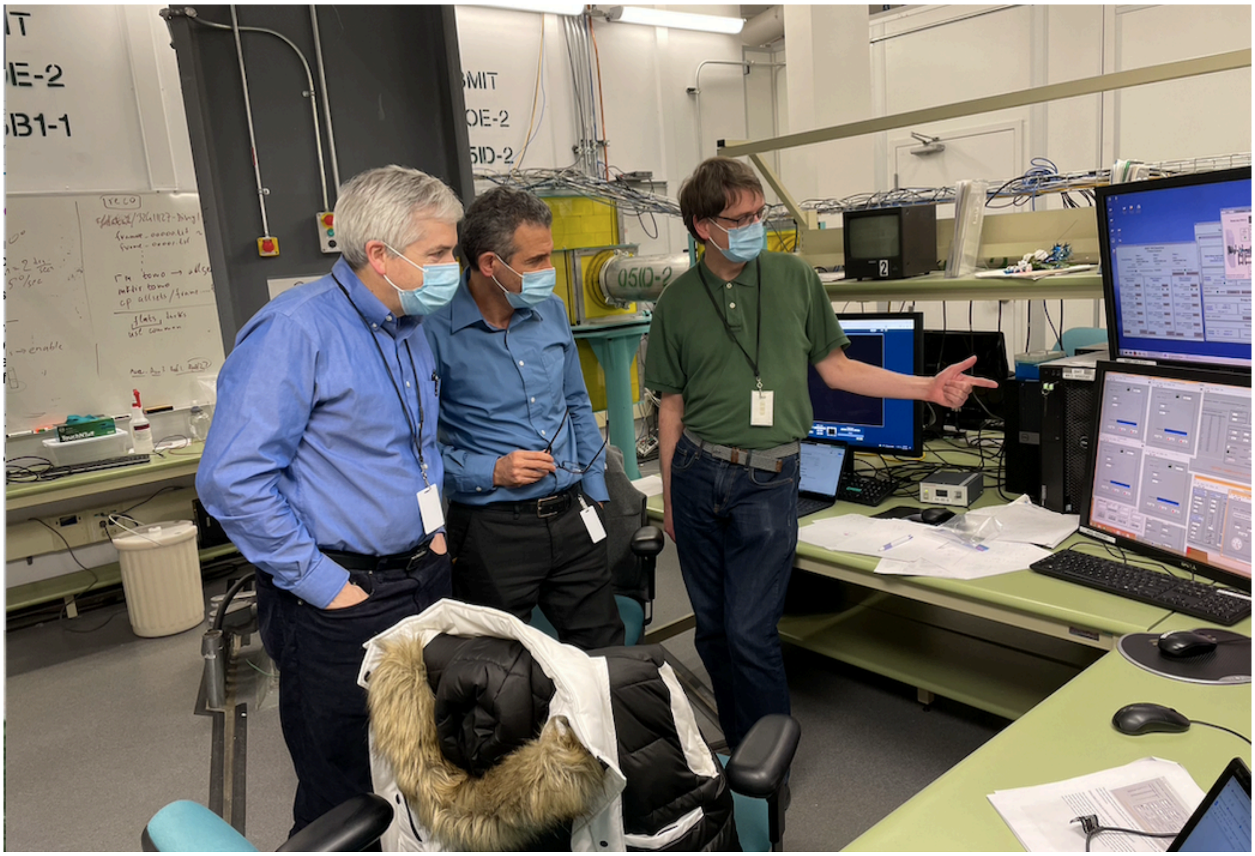
- Areas in use sanitized: False

- Personal items removed: False

- Auto Sign-Off on Wed Dec 22 2021, 08:00. Manual Sign-Off Overdue.

Clean up and Sign Out

December 22, 2021 [rtj,tm,am,zp]
A few end-of-run photos. Aram came a few minutes afterwards. (COVID restrictions had a maximum of 3 shift workers in the counting house, not counting Adam.




POE-3
05ID-2


POE-3
05ID-2

Thank you to Adam, and everyone at CLS for your help!

Transfer data to UConn

December 22, 2021 [rtj]
We used globus to transfer all of the rocking curve data to UConn. Adam uploaded the folder containing all of our data to the CLS-BMIT globus endpoint, where Richard was able to find it and transfer it to the UConn storage system. These data are remotely accessible to anyone with the URL to where the data are stored. The URLs for all of the rocking curve measurements ever performed for GlueX radiators are saved in the GlueX Diamond Inventory Spreadsheet that is linked from the GlueX wiki.

Photos taken throughout the run by Zisis and Richard were all copied to a single shared google drive dedicated to this run. The drive is owned by Richard and will be maintained for the duration of the GlueX experiment.

Photos from run CLS-12-2021

Rocking curve data analysis

December 23, 2021 [rtj]

With the data now archived successfully at UConn, I need to go back and recall the specific steps that are needed to turn these raw data into rocking curve topographic images. I found these steps described in the logbook from the June, 2019 CLS run, which I transcribe below with changes to reflect the specifics of the new run.

1. Use globus online to transfer the folder containing all of the images taken in the previous scan to jonesrt#grinch. These data should land in grinch.phys.uconn.edu:/export/data0.

2. Create a data analysis area on /nfs/direct/jonesrt, e.g. /nfs/direct/jonesrt/cls-12-2021 and create a work directory for this sample, eg. /nfs/direct/jonesrt/cls-12-2021/JD80-1, then use rsync to copy image files from grinch to this work area. This separation between directories used for transfer and analysis is useful so that one can rename files in the analysis area without having them overwritten by the next globus transfer. This renaming happens whenever someone mistypes the image prefix or sequence numbering options during image acquisition, and lets the names be rewritten into canonical form before attempting to run the analysis. Canonical form for images is **<sample>-<scan>_<N>.tif** where step number N ranges from 1 to the number of steps and has leading zeros to make the total number of digits equal to 5.

3. Go to /home/www/docs/halld/diamonds on gluey.phys.uconn.edu and make a new directory for this run, e.g. cls-12-2021. Inside this directory, create a symlink called "data" to the work area on /nfs/direct/jonesrt/<run> created in step 2 above. Make another

folder next to “data" called “photos” where photographs from the run will be stored. Then cd into data and add a symlink back to /home/www/docs/halld/diamonds/Analysis called Analysis. Finally, from within Analysis, create a symlink to the same destination as /home/www/docs/halld/diamonds/<run>/data, and name it <run>. This completes the directory linkage structure assumed in the code and in these instructions.

4. Make a local copy of rcmaker.C (one can be found in the Analysis directory) in the sample directory under /home/www/docs/halld/diamonds/<run>/data/<sample>. Open a new terminal window and cd into this directory where the copy of rcmaker.C is found.

5. Start root in this window, and initialize the root session as follows:

    a. .L /usr/lib64/libtiff.so
    b. .L rcmaker.C+O

6. Each time a new scan is made and the data are pushed into the analysis area through globus + rsync steps, a new root command illustrated below must be issued to convert the raw image files into root histograms.

    a. rcmaker(“<sample>”,<scan>,<steps>,1)

7. When this completes, use uberftp to push the output root file that contains all of the raw data from this scan to pnfs. The file is named <sample>-<scan>_rocking_curves.root and should be found in the same directory as the tiff files that were used to create it. Ignore the warnings from the tiff conversion library about unexpected tags in the tiff header, as these do not cause any real problems. The destination directory on pnfs should be /pnfs/phys.uconn.edu/data/Gluex/beamline/diamonds/<run>/results. If this directory does not exist yet, it should be created and owned by the gluexuser user. Copying into this directory requires that the person doing the transfer have a valid voms proxy issued by the Gluex vo.

8. Create a plain text file <sample>.info in the same directory where the image files are stored, and edit it to add the information from the logbook regarding the number of steps in each scan, the size of each step, and the range of Bragg angles covered by the scan. To get the right format for this file, copy one from an image directory from a previous run period and then overwrite the original values using an editor.

9. As soon as the X_rocking_curves.root file is uploaded to pnfs, the root process that fits the rocking curves to a gaussian peak over a constant background can be started. I use proof for this step, although if you are patient you can just run it in a regular root client session. The configuration of the proof service at UConn makes using this pretty straight-forward. Use the UConn-proof web interface to start your own private proof service, and then connect to that service to do your analysis. All of this is automated by the dofits.C script found in Analysis. The following session illustrates how to use it, from a root session started in the Analysis directory. Before you start this, edit the dofits.C file

to make sure it points to your private proof service, and that the appropriate set of lines have been commented out so that only the scans that you want to fit are processed. All you need to do as the run progresses is just add a single line in the appropriate function within dofits.C for each scan you want to process, and comment them out as you finish each one.

a. .L Map2D.cc+O
b. .L rcfitter.C+O
c. .L rcpicker.C+O
d. .L run_rcfitter.C+O
e. .x dofits.C

10. The above step creates a new root output file <sample>-<scan>_results.root in the Analysis directory. Use uberftp to copy it to the same area on pnfs where you stored the X_rocking_curves.root file in one of the previous steps.

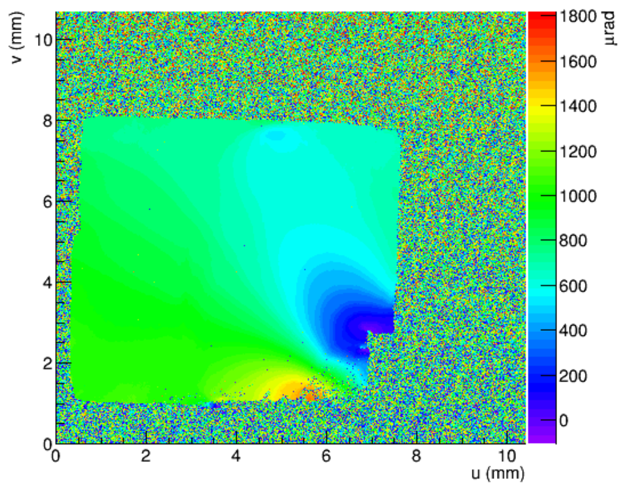
11. Edit the python script plotgen.py and follow the examples in the code to add a line to generate rocking curve topograph images for each scan with a X_results.root file that has been uploaded to pnfs, as described in the previous step. Run this file within a python session as follows.

a. import plotgen

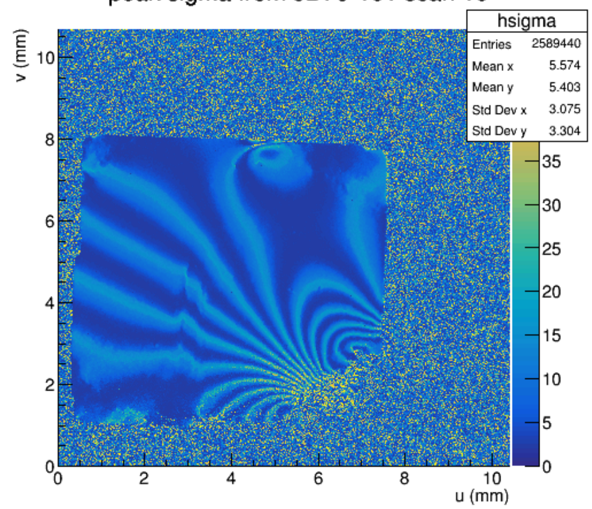
12. Move the *.png files created in the last step into <run>/<sample>. Eventually at the end of the run, you will back up these <sample> directories containing all of the raw image files into a compressed archive and then remove the tiff files, leaving behind only these png images. These are the final results from this analysis.

13. Delete the .root files created in the above steps after they have been copied into pnfs. This leaves behind a very small data footprint in the /home/www and /nfs/direct/jonesrt nfs areas, containing only a few png images and text files from each scan. The raw data and fitting results are stored in the root files that are archived on pnfs.

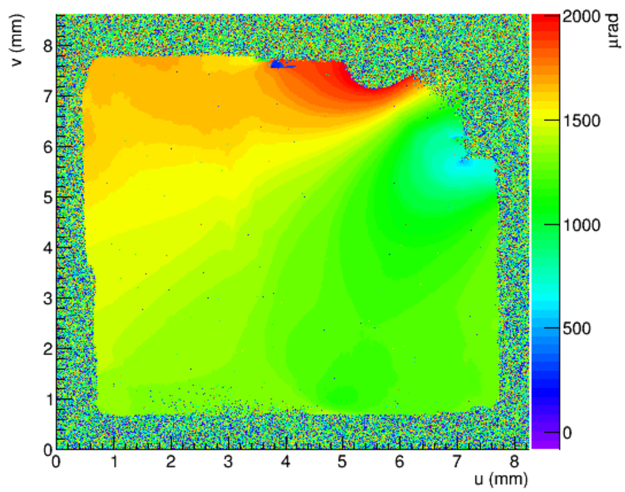
peak centroid from JD70-101 scan 10



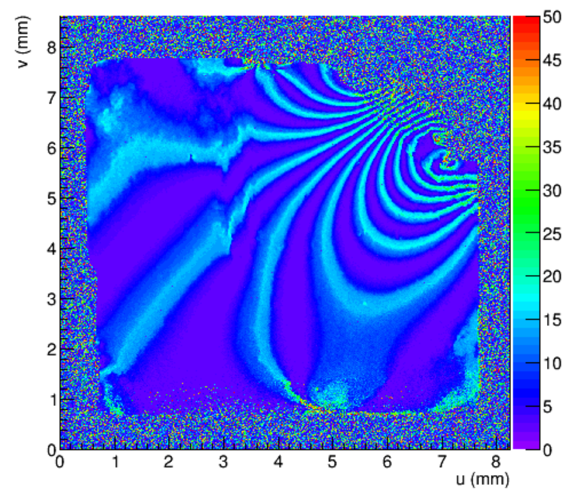
peak sigma from JD70-101 scan 10



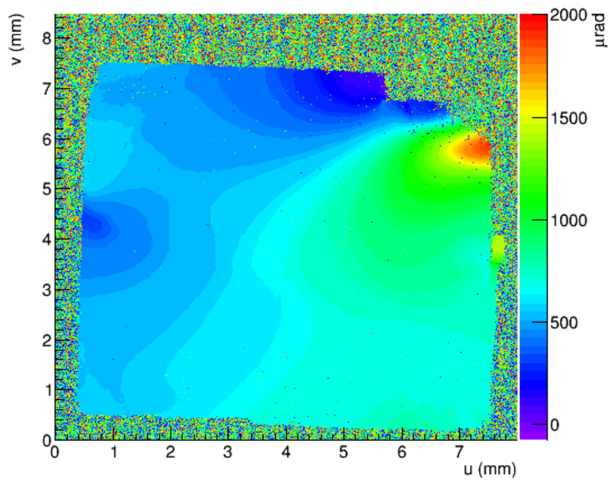
peak centroid from JD70-101 scan 30



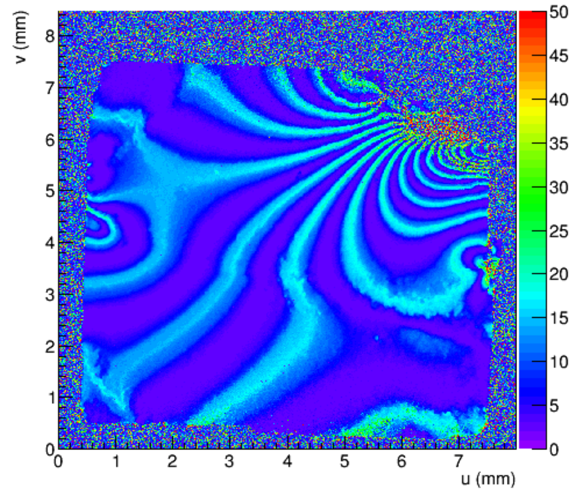
peak sigma from JD70-101 scan 30



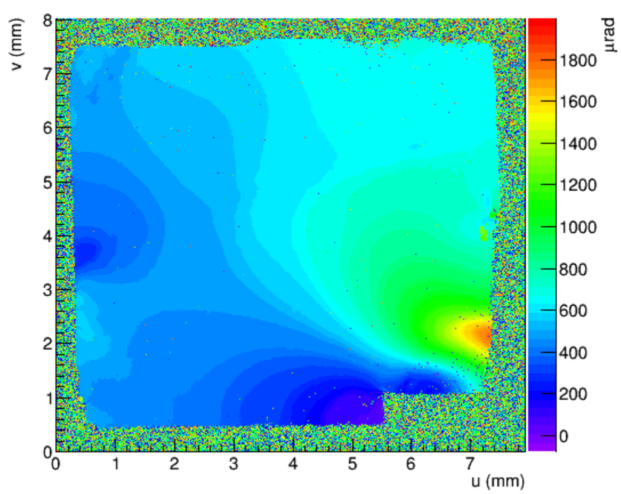
peak centroid from JD70-101 scan 40



peak sigma from JD70-101 scan 40



peak centroid from JD70-101 scan 50



peak sigma from JD70-101 scan 50