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ACTIVITY/PROJECT SPECIFIC PROCEDURE

SP 12-8
USE AND MAINTENANCE OF BRUKER ANALYTICAL X-RAY SYSTEMS
D8 ADVANCE X-RAY DIFFRACTOMETER
Revision 4

Effective Date: March 27, 2020

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	(printed name)	(signature)	(date)

1.0 Purpose and Scope

This procedure prescribes the Sandia National Laboratories (SNL) Waste Isolation Pilot Plant (WIPP) process for the operation and maintenance of the Bruker Analytical X-Ray Systems D8 Advance X-Ray Diffractometer (XRD), as part of the laboratory geochemistry research activities in the support of WIPP projects.

This procedure is applicable only for the Bruker Analytical X-Ray Systems D8 Advance X-Ray Diffractometer. This document is concise and is not meant to substitute for or be a reproduction of the manufacturer's instruction manuals for the XRD. The user is responsible for reading and understanding these manuals (see references).

Acronyms and definitions for terms used in this procedure may be found in the Glossary located at the Sandia National Laboratories (SNL) WIPP Online Documents web site.

2.0 Implementation Actions

2.1 Responsibility

The Principal Investigator (PI), or designee, whose activities warrant the use of this procedure is responsible for implementing the requirements of this procedure.

The Project Scientist, or designee, is responsible for performing the measurements, following the requirements of this procedure, documenting the results, and assuring that the use of the latest revisions of this document are followed.

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2.2 Safety

The activities described in this SP shall conform with SNL Environmental Safety and Health programs (ES&H). This document does not address ES&H issues. Laboratory ES&H procedures described in the TWDs/SOPs of the laboratory in which the equipment is used shall be adhered to.

Additional Safety Information: In case of an instrument malfunction or emergency, turn the instrument off by pressing one of the red emergency shut-off buttons shown in Figure 1. For a description of all the display options and indicator lights for the X-Ray generator and Enclosure Display, see the D8 Series, User Manual, D8 Advance/D8 Discover (BRUKER, 2018).

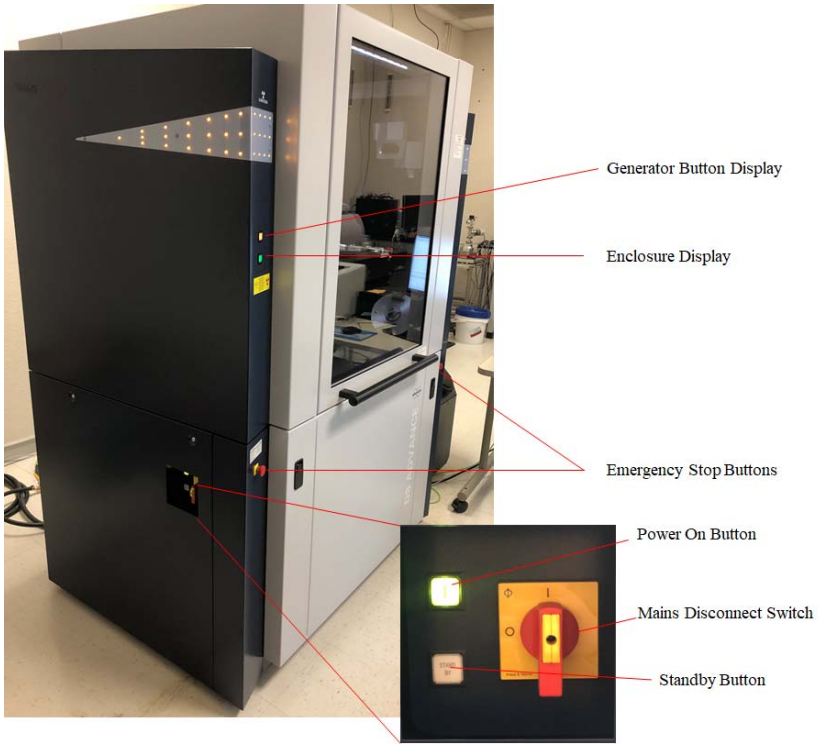

Figure 1. Picture of the D8 ADVANCE and Location of Emergency and Operating Buttons

2.3 Qualified Users

RAD 102 is the required minimum training for use of the computer and analysis software for the XRD.

RAD 214 Radiation-Generating Device Training and/or RAD 210 is the required minimum training for XRD operation (e.g. loading samples and unloading samples)

2.4 Quality Control

2.4.1 Alignment

Annual alignment of the diffractometer will be completed by a qualified technician from Bruker AXS, Inc. The annual alignment is necessary to ensure best performance of the diffractometer system. If the operator needs to perform the alignment before the annual alignment is due, detailed instructions in section 6.6.7 of the D8 Series, User Manual: D8 Advance/D8 Discover (BRUKER, 2018) should be strictly followed to avoid any potential damage to the detector. The annual alignment will be documented in the Bruker AXS D8 X-Ray Diffractometer Log Book.

2.4.2 Standard(s)

A quartz or corundum standard with no expiration date supplied by the manufacturer, Bruker AXS, Inc., will be used for annual alignment, and the quarterly verification (Section 2.4.3).

2.4.3 Frequency

The instrument will be realigned annually (Section 2.4.1), by a qualified technician from Bruker AXS, Inc. The instrument's alignment shall be verified quarterly (every 3 months) with a performance test, using one of the approved standards (corundum or quartz) supplied by the manufacturer. If the system is not available for analyzing samples because of the need for repair, or because of the repair in process, the time of verification may deviate from the quarterly schedule. The quarterly verification will be documented in the Bruker AXS D8 X-Ray Diffractometer Log Book.

2.4.4 Quarterly Performance Test Criteria

The performance test for the XRD involves measuring the position of the main/highest peak (Quartz = 26.64° degrees, Corundum=35.149° degrees). Suggested starting parameters for the quarterly performance test are scanning from 20-40 degrees, at a step size of 0.01 and 0.1 seconds/step. If this measurement is off by more than 0.2 degrees, then the instrument must be realigned. If realignment is required, a performance test will be done immediately after realignment. For more information on the alignment and quarterly performance checks see the Instrument Performance Verification Booklet (BRUKER 2019)

2.4.5 Sample Preparation

Various types of sample holders are available for use in the SNL laboratory. Figure 2 and Figure 3 below show the most common types (Front load powder holder and Si Low background holder) used. For smaller sample sizes the Si Low background holder is recommended. An “anoxic” type holder, equipped with a protectant dome and gasket is also available for both of these types of sample holders for use with samples that are sensitive to oxygen exposure.

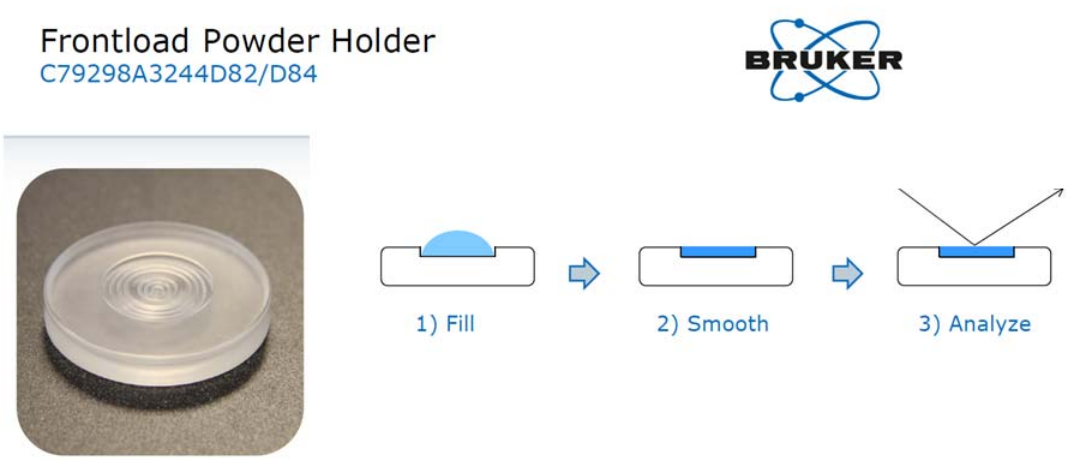

Figure 2. Front Load Powder Holder Preparation

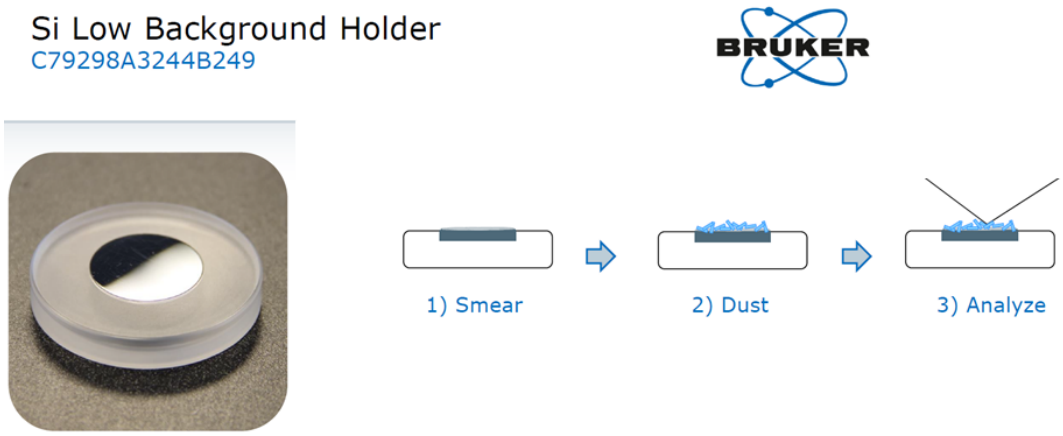

Figure 3. Si Low Background Holder

Basic Sample Preparation Steps:

1. Sample height is critical. Ensure that the sample height is perfectly level with the top of the holder. A sample height that is too high or too low will cause peak shifting.
2. Make the powder sample smooth. <45 micron or -325 mesh is recommended.
3. Use as much sample as possible in order to cover the sample holder. (Note: If enough sample is available, a front load powder sample holder is preferred over a Si low background holder, because over-all intensities will be higher and a greater resolution can be obtained).

Sample preparation procedures (i.e. collection times, mechanism of grinding and sample holder type) should be recorded in the scientific notebook.

Tips:

- Use vacuum grease or other silicon-based grease to smear on Si low background holder to "hold" the sample in place.
- Pushing the sample too hard into the holder can cause preferred orientation and erroneous phase identification.
- Coarse or Grainy samples can cause "artifact peaks" that could lead to erroneous phase identification. See Figure 4, showing an "artifact peak" for the unground sample (Green).

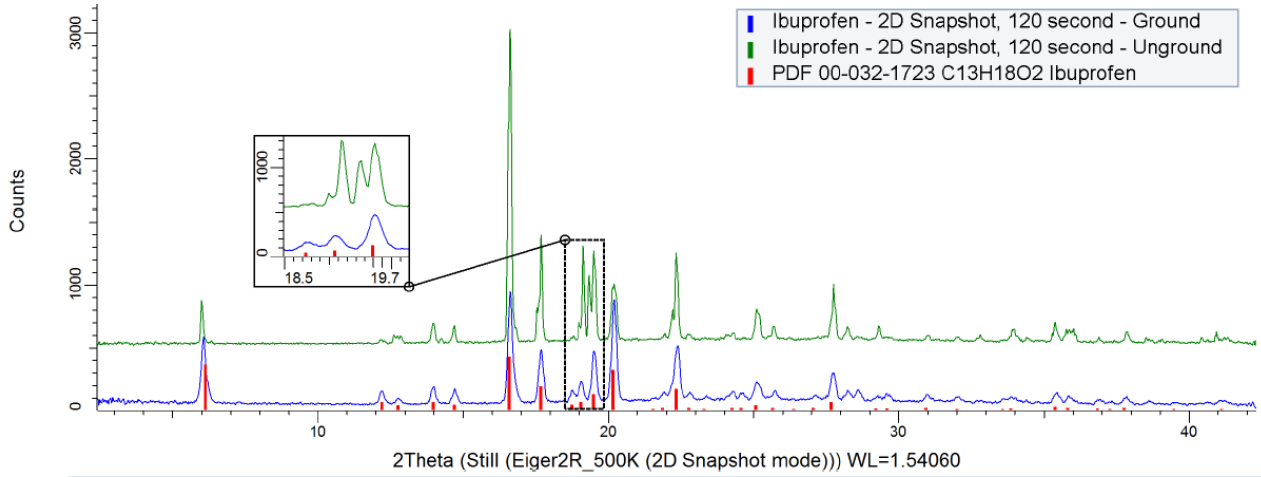

Figure 4. Ground vs Unground sample

- Samples with platy or rod-like structures (e.g. organics such as citrate solids) are more likely to have preferred orientation. If a sample is pre-disposed to preferred orientation, alternate analysis strategies may be necessary, such as using the capillary tube analysis or numerous sample preps and analysis for a single solid to compare variation between preparations (See Appendix C).

2.5 Operating the Bruker D8 Advance X-Ray Diffractometer

2.5.1 Start-Up

1. For daily start-up the instrument will be in stand-by mode.
2. Ensure the chiller is on
3. Click on the "DIFFRAC.COMMANDER" icon
4. If there is a communication error with the software, click the Measurement server icon and press the Enclosure Display Button on the instrument.
5. When a good connection has been established between the instrument and software the Enclosure Display Button will turn green.
6. Select "Lab Manager" from the drop-down box presented upon software initiation
7. Leave the password field blank and press enter
8. Click on the Commander tab at the left of the screen
9. Figure 5 shows the set-up of the opened window, with a description of each area

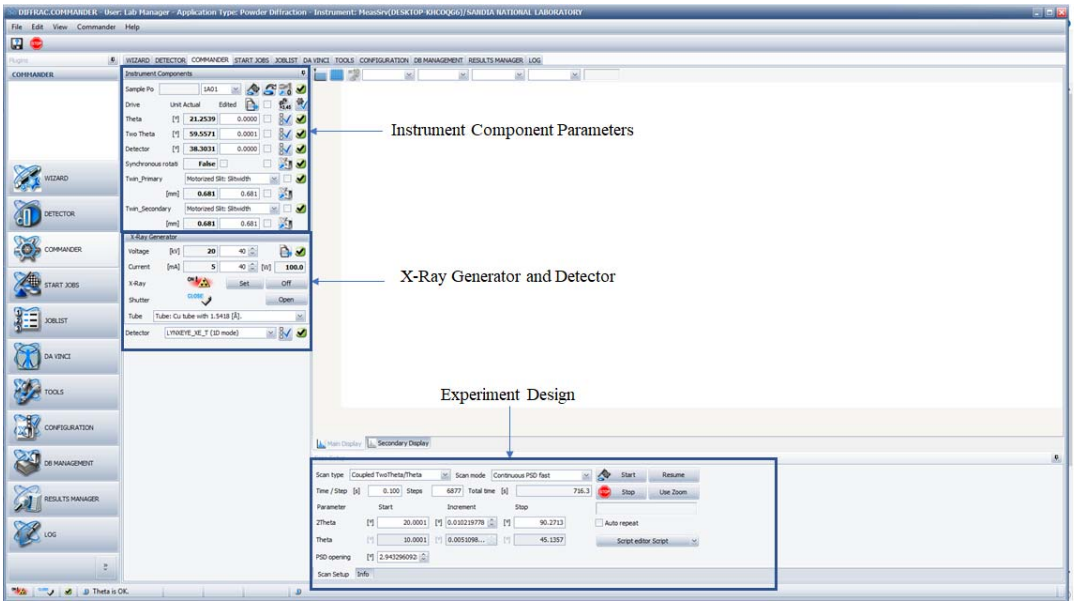

Figure 5. Commander Program Layout

10. Before the instrument can be used, the instrument control drives must be initialized. To initialize drives, put a check mark next to Theta and Detector, in the Instrument Component Parameters box indicated in Figure 6.
11. Then click the "Initialize selected drives" icon to move the drives to the desired positions and initialize them. All drives should now be initialized and ready for use, as indicated by a green check mark. If a Yellow exclamation mark is still present at any of the drives, initialize the drives with the indicated error.

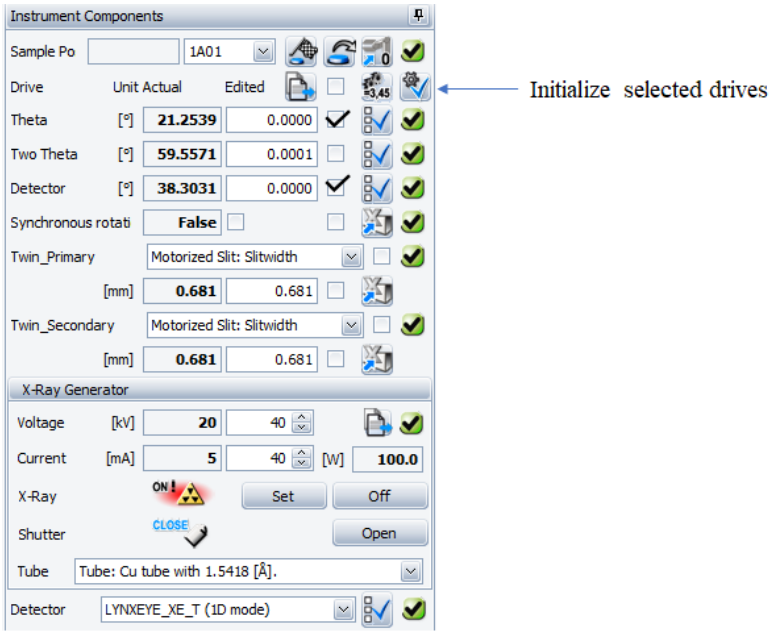

Figure 6. Initialize Selected Drives

2.5.2 Starting a Scan

1. Insert the prepared sample into the desired sample analysis location on the instrument. The sample may need to be initialized. If a yellow exclamation mark appears, initialize the drive by selecting the “Initialize Component” icon, as shown in Figure 7.

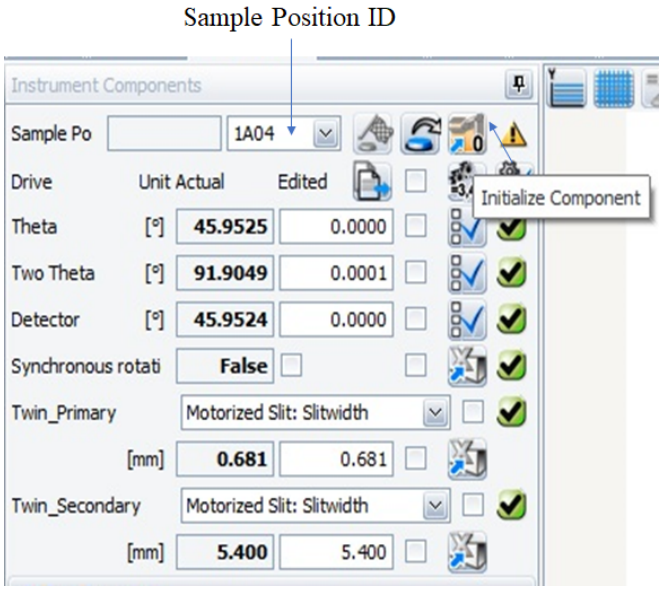

Figure 7. Initialize Sample Drives Icon

2. Set the generator to 40kV and 40mA in the X-Ray generator and detector box (Figure 5), by typing in the desired values in the editable fields and pressing the “Set” button.
3. Place desired slits into the instrument. Note: these are not required for operation but using different slits can improve analysis in some cases. For example, a small slit size may be necessary for resolving peaks at low angles. However, using smaller slit sizes reduces

the over-all intensity of the X-rays produced and a longer counting time may be necessary. A recommended setting for the Twin-Primary slit is 0.681 mm and 5.4 mm for the Twin-Secondary slit.
Relationships for Twin-Primary Slit: smaller slit size=>better resolution=>reduced intensity; larger slit size=>reduced resolution of peaks (not as sharp) =>higher intensity.

4. Click on the Da Vinci tab at the left side of the screen to check the instrument component set-up. Ensure there are no warnings.
5. Begin designing your experiment in the “Experiment Design” box .
6. Recommended starting settings are as follows: Scan from 20-40° Θ at 0.01 step size and 0.1 seconds /step.
7. Start the Scan by pushing “Start”.
8. Once the scan is complete make sure to save the scan before exiting the software.
9. Scans can also be started using the “Start Jobs" tab at the left of the screen.
10. When using the “Start Jobs” tab numerous samples can be started in sequence and the data will be automatically saved to the file name that is input into the editable fields. Figure 8 shows an example of the “Start Jobs” application.

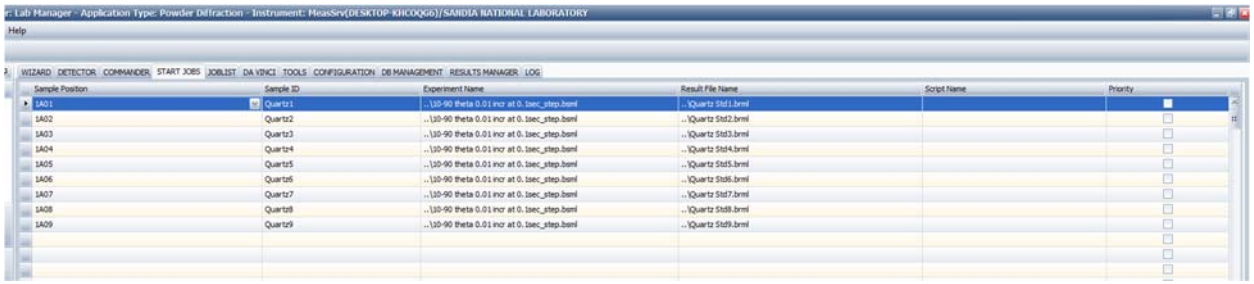

Figure 8. Example of Start Jobs Application

11. When analysis is complete, remove samples from the XRD sample holder, to ready the instrument for the next analysis.
12. Proceed to section 2.9.2 if long-term shut-down is necessary.

2.6 Phase Identification

When a scan is complete the spectrum will be saved as a .RAW file or a .BRML and stored in the folder C:\Results on the main computer.

To evaluate the phase(s) of the sample using the EVA software and PDF4+ database:

1. Open the “DIFFRAC.EVA” software by clicking on the icon.
2. Select File →Import from Files or click the “Import from Files” Icon

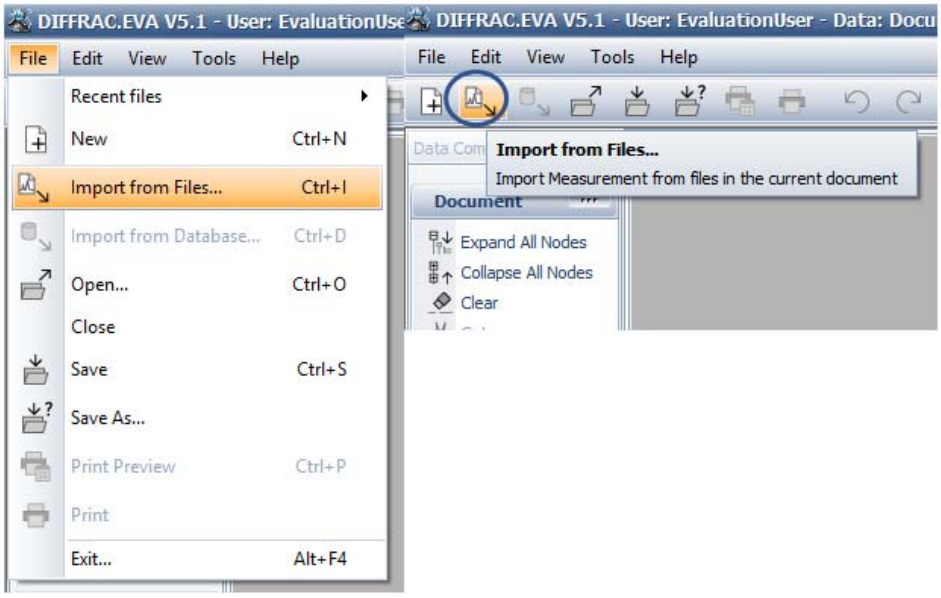

Figure 9. Import Files to DIFFRAC.EVA

3. Select the file to be imported (EXAMPLE: Corundum Standard). Either the .bmrl or .raw can be selected.

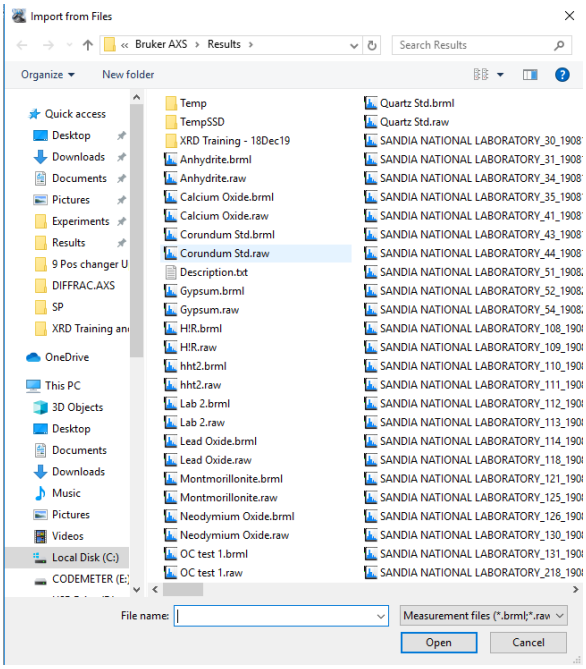

Figure 10. Select Import File

4. Click Search/Match (Scan) on the left side of the screen.

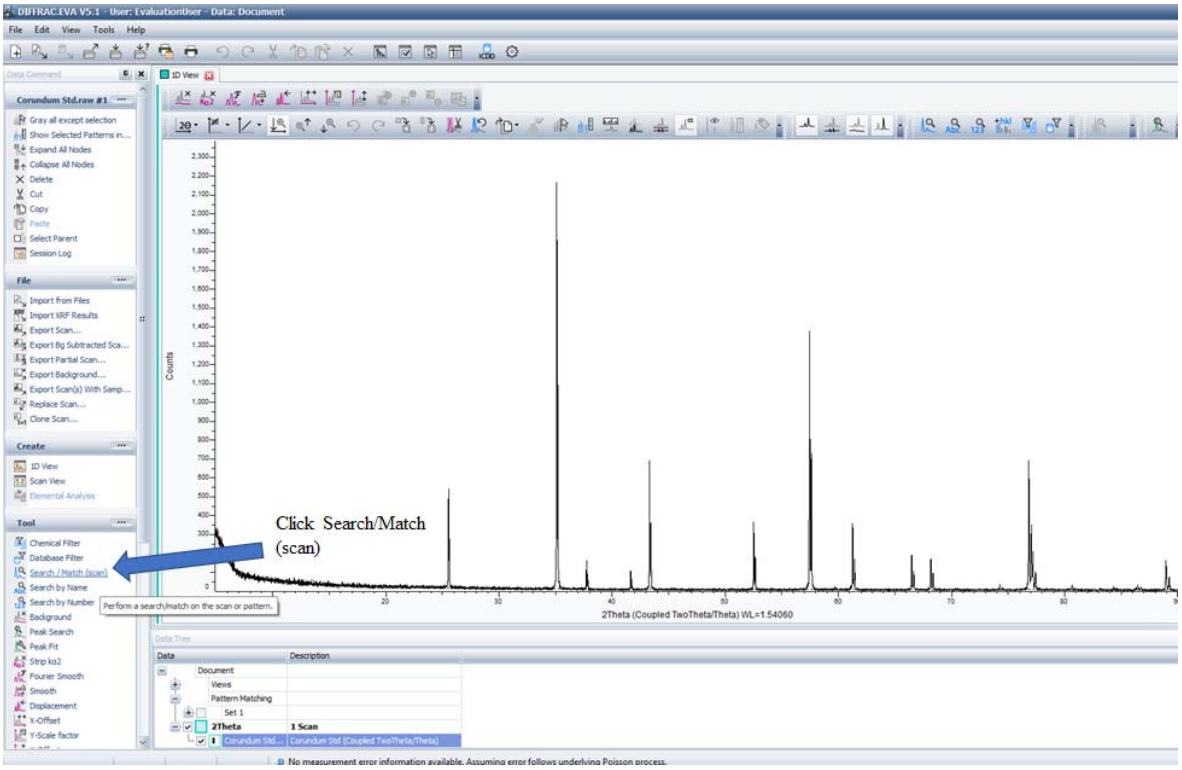

Figure 11. Search/Match

5. Click Search/Match after confirming that the correct database is selected. In this example the database PDF-4+ 2020 RDB is selected. (Figure 12)

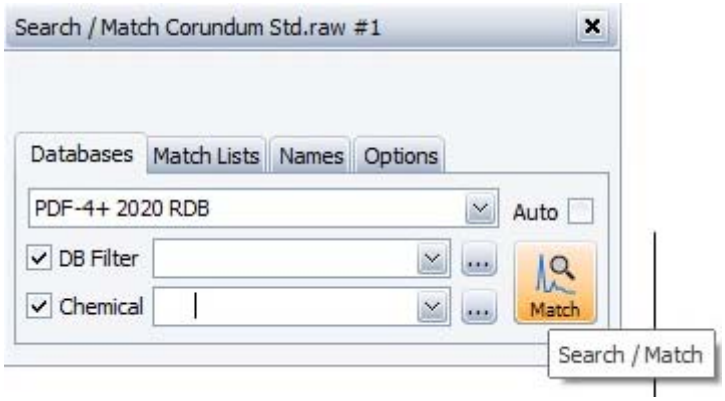

Figure 12. Search/Match #2

6. Select the pattern that matches with the highest accuracy (largest number of matching peaks) to the scan. When matching samples consider all available knowledge: i.e. what elements/solids should be present in the sample. Look up the sample matrix before trying to match the sample to the database (if it is available) (Figure 13).

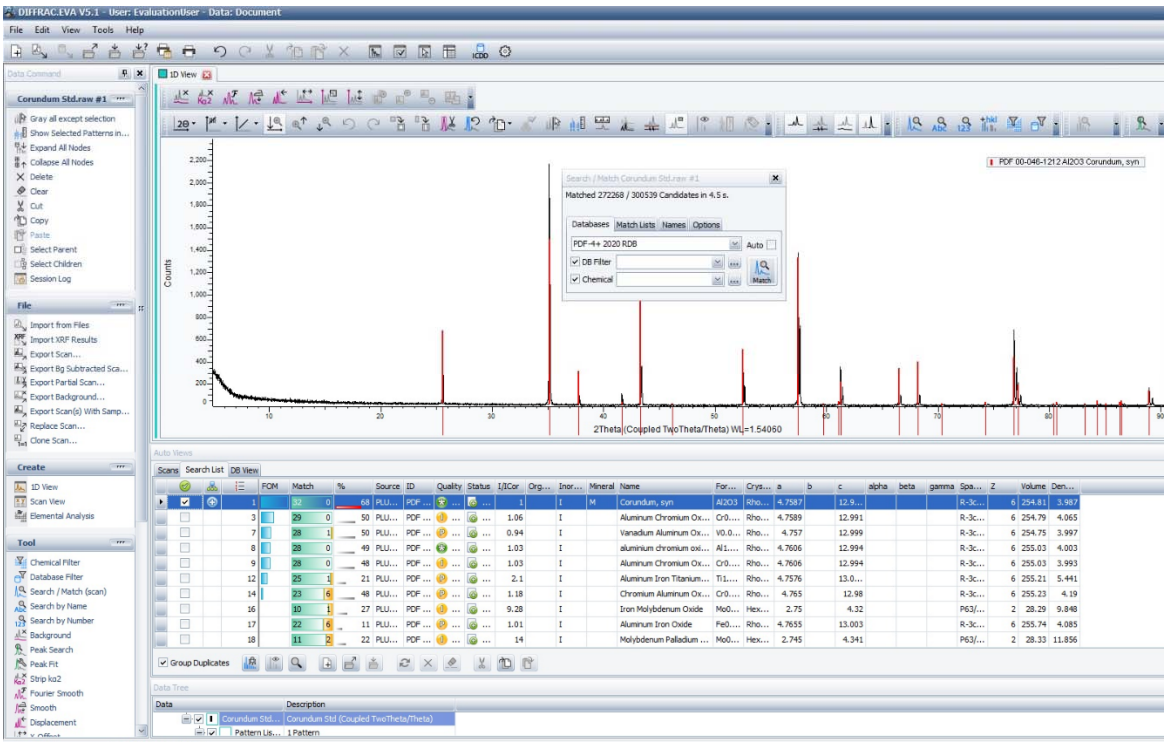

Figure 13. Select Best Match

7. Filters can also be used to help facilitate a more accurate match. To use a Chemical filter, select “Chemical Filter” from the left side of the screen (Figure 14).

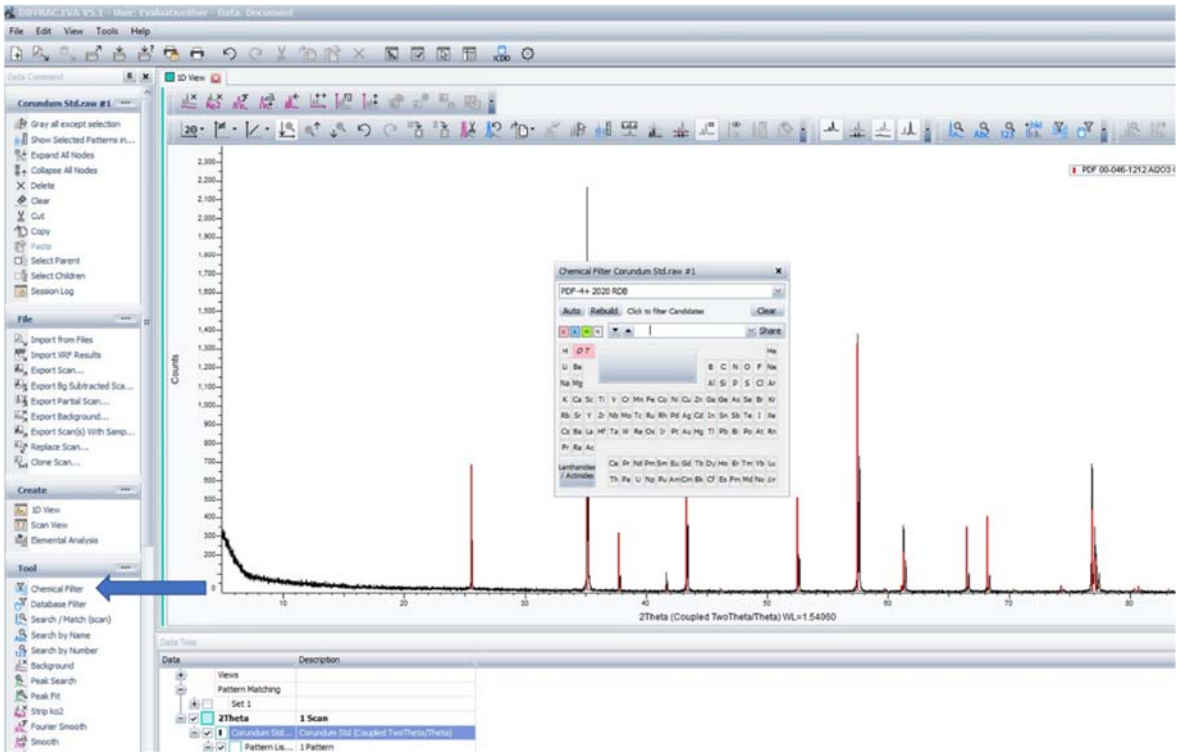

Figure 14. Chemical Filter

8. Highlight all elements that are not possible (based on chemical matrix knowledge) in Red by clicking 3 times in the element box. If any elements are mandatory matches for the sample, highlight those elements in Green by clicking twice on the element box. (Example for Corundum) (Figure 15). Note: D=Discard, A=Always Identified, M=Mandatory and N=Not Selected.

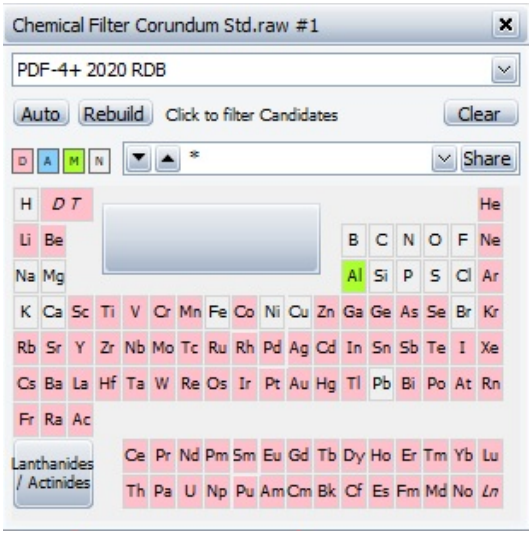

Figure 15. Chemical Filter #2

9. Once the chemical filter is set, click on Search/Match at the left side of the screen. Then click “Match”. The software will now filter the patterns to only match the criteria outlined in the Chemical Filter box.

Figure 16. Chemical Filter Match

10. Select the pattern that matches the scan with the highest accuracy (largest number of matching peaks). Note: When selecting matching scans, it is very important to consider the quality of the scan. Every scan in the database has a “Quality Mark” assigned to it. B=Blank, C=Calculated, H=Hypothetical, I=Indexed, O=Low precision, *=Star. Star and Indexed are the patterns with the highest accuracy and acceptance in the scientific community and should be chosen over other lower quality scans if available.

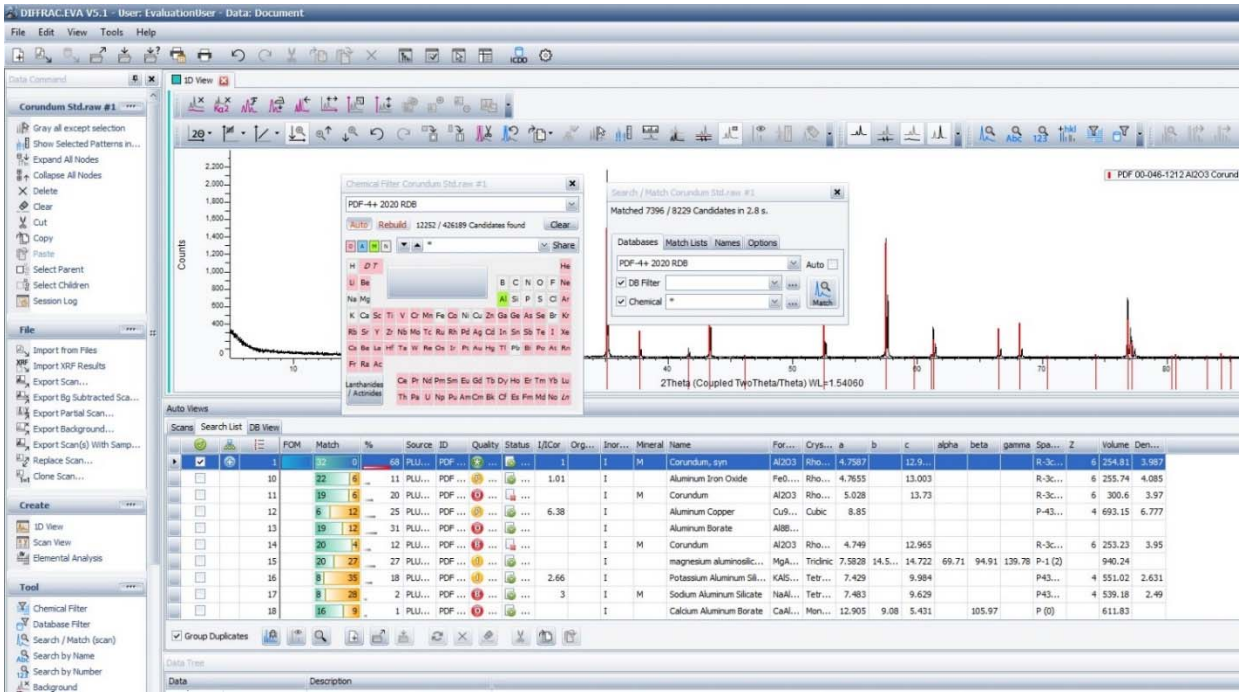

Figure 17. Chemical Filter Match #2

11. After the scan has been matched using the database, the matched file must be saved. Select File→Save As and give the file an appropriate name. (e.g. Corundum Standard "insert date")
12. The matched scan can either be printed to a PDF file and saved to a USB drive, or it can be printed using the printer attached to the XRD computer.
13. A hard-copy of the matched scan shall be placed in the scientific notebook or binder.
14. For more information on using the DIFFRAC.EVA software refer to the DIFFRAC.EVA tutorial guide Version 09.2017 (Bruker 2017).

2.7 Accessories

The Bruker D8 Advance XRD is equipped with numerous accessories including: a capillary stage, a heating stage, a Flip-Stick Sample stage and a single rotating sample stage. Before using or installing any of these accessories, consult the Appendices in this document and the respective users' manuals. After re-configuring/installing any of these stages the instrument alignment must be verified.

2.8 Maintenance

Annual maintenance will be performed on the instrument by the qualified technician from Bruker AXS, Inc. per the service contract of Sandia National Laboratories with Bruker AXS, Inc.

2.9 Long-term Start-up/Shut-down

2.9.1 Start-up after Long-term Shut-down

1. Check that neither of the large red Emergency Stop buttons are pressed.
2. Turn the Chiller power on (Figure 18). Note: The chiller can be left on during standby mode.

Figure 18. XRD Chiller On/Off switch

3. Turn the Mains Disconnect switch from to (Figure 18). The Mains Disconnect switch can also be used as a Lock Out Tag Out.
4. Press the Power On button (Figure 19).

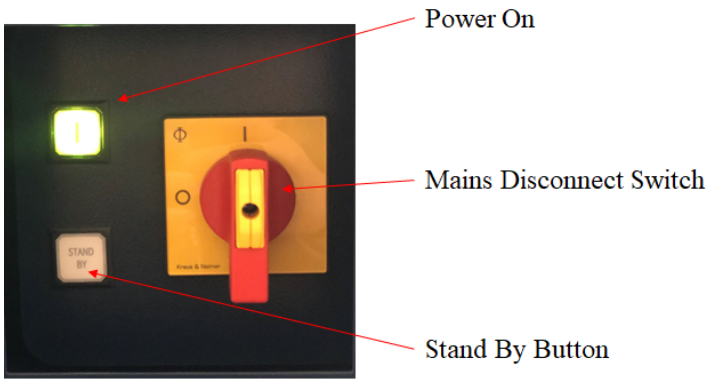

Figure 19. Power Buttons for XRD

5. Wait for a line to appear on the Generator Button Display (Figure 1).
6. Press the Generator button Display to turn on X-rays.

2.9.2 Long-Term Shutdown

1. Check that measurements are complete.
2. Ramp down the power of X-rays in DIFFRAC.COMMANDER by changing settings of voltage to 20kV and current to 5mA.
3. Press the Generator Display Button to turn off the X-rays (Figure 1).
4. Press the Standby Button (Figure 19). The Standby Button turns of all power except the lights.
5. Turn the Main Disconnect Switch from to (Figure 19).

2.10 References

BRUKER AXS, DIFFRAC.EVA. Tutorial. Version 09.2017. DOC-M88-EXX201. Karlsruhe, Germany.

BRUKER AXS, DIFFRAC.SUITE. User Manual. DIFFRAC.MEASUREMENT.SUITE. Karlsruhe, Germany. 2017

BRUKER AXS, D8 Series. User Manual. Instrument Performance Verification Booklet. D8 Advance/D8Discover/D8Endeavor. Karlsruhe, Germany. Installation Verification 2019.

BRUKER AXS, GmbH, 2018. D8 Series, User Manual. D8 Advance/D8 Discover. DOC-M88-EXX153 V6. Karlsruhe, Germany

BRUKER AXS, GmbH, 2020. Flip-Stick Maintenance. Guidelines for Performing Maintenance on the 9-position/flip-stick sample changer. DOC-16.03.200. Karlsruhe, Germany

3.0 Records

The following records, generated through implementation of this procedure, shall be prepared and submitted to the WIPP Records Center in accordance with NP 17-1 (Records):

QA Record

- Scientific Notebooks
- Annual Alignment
- Data Interpretation
- Data Printout

The PI shall be responsible to the preparation and submittal of Scientific Notebook, Data Interpretation, and Data Printouts. The custodian of the Bruker Analytical X-Ray Systems D8 Advance X-Ray Diffractometer (XRD) shall be responsible for the documentation of the Annual Alignment and Quarterly Performance Checks and their respective submittal and documentation.

4.0 Appendices

Appendix A: Rotating Sample Stage
Appendix B: FLIP-STICK Sample Stage
Appendix C: Capillary Stage and Alignment Microscope
Appendix D: HTK-1200N Oven Chamber Motorized Base
Appendix E: Motorized Anti-Scatter Screen

Appendix A
Rotating Sample Stage

The rotating sample stage is a computer-controlled stepper motor (Figure A-1). Angular ranges are 0-168° 2Theta in reflection mode, and -10° to 110° 2Theta in transmission mode. It is typically used to improve particle statistics and for the determination of crystal orientations via Phi scans. The Rotating Sample Stage can be used to determine the underlying structure, phase, and identification of a powder, thin film, or bulk polycrystalline material.

A.1.0 Installing the Rotating Sample Stage

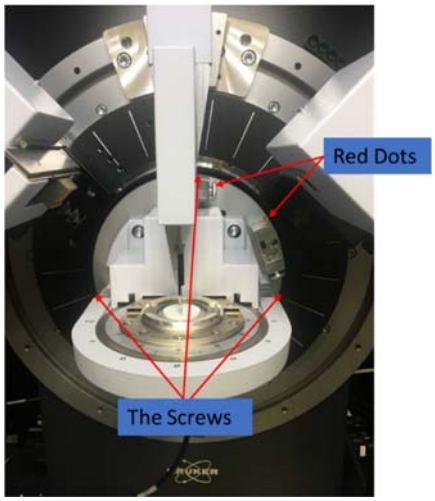

Figure A-1. Picture of the Rotating Sample Stage Screws

1. Turn off the power to the instrument as described in section 2.9.2
2. Plug in the cord to connect the device
3. Align the two red dots and rotate clockwise until the screw holes are aligned.
4. Tighten down the three screws located above and below the stage (Figure A-1) by using a T25 allen wrench tool. The longest screw will be located at the top of the attachment.
5. Turn the power to the instrument back on by following the instructions in section 2.9.1.
6. Turn on the computer.
7. Log in to the computer as Lab Manager (Section 2.5.1).
8. Open the Measurement Server program to initiate communication before starting the DIFFRA.COMMANDER program. Wait until X-rays are stable and then click reconnect.

A.1.1 Removing the Rotating Sample Stage

1. In the Commander Tab in DIFFRAC.COMMANDER program, move both the source (Theta) and the detector to 20°.
2. Exit out of the DIFFRAC.COMMANDER program.
3. Shut off the power to the instrument as described in Section 2.9.2
4. Take off the knife edge by unscrewing the knob located at the top of the attachment just enough until the knife edge can be removed.
5. Take out the three screws (Figure A-1).
6. Rotate the stage counter-clockwise until the two red dots are aligned and pull the stage out.

7. Unplug the cords connecting the Rotating Sample Stage to the instrument. Tuck cords back into instrument, but not too far as to push through to the other side of instrument.
8. Store Stage in safe configuration for next use (i.e. in instrument, or cabinets provided in room).

A.1.2 Loading a Sample on the Rotating Sample Stage

1. Using a circular sample holder, place a small amount of the sample on the holder. Make sure the height of the sample is level with the plastic outer ring of the holder by using a glass slide.
2. To measure the XRD pattern of a bulk material, place the material in the middle of the sample holder, and make sure the height of the sample is level with the sample holder's outer ring using a glass slide. The sample does not need to be adhered to the holder
3. Open the instrument door.
4. Make sure the knife edge is removed.
5. Place the sample on the stage by pushing down on the spring-loaded platform and slide the holder in.
6. On the diffractometer, it is usually not necessary to include a divergence slit, but Soller slits are necessary to help collect and collimate the scattered X-rays.

Appendix B
FLIP-STICK Sample Stage

The FLIP-STICK sample stage is a 9-position sample changer with sample rotation, which can be operated in both reflection and transmission mode.

Figure B-1. FLIP-STICK stage for using up to nine samples

B.1.0 Installing the FLIP-STICK Stage

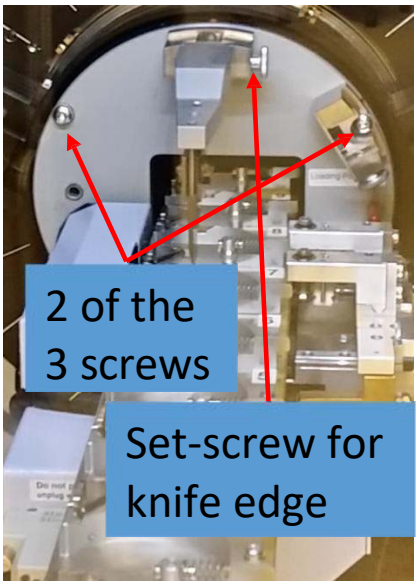

Figure B-2. FLIP-STICK stage. In the picture, 2 of the 3 screws can be seen. The third is below the sample holder.

1. Turn off the power to the X-ray source as described in section 2.9.2
2. Insert the FLIP-STICK stage with the two red dots aligned and rotate the stage clockwise until the three screw holes are aligned.

3. Tighten down the three screws (Figure B-2). The longest screw should be located at the top of attachment.
4. Connect the computer cords from the instrument to the FLIP-STICK attachments.
5. Turn the instrument power back on by following the instructions in section 2.9.1.
6. Open the Measurement Server program to initiate communication before starting the DIFFRAC.COMMANDER program.
7. Sample position IDs are shown/selected by clicking the drop-down, as shown in Figure 7.
8. If the spinning wheels in any sample holder (1-9) need cleaning and/or lubricating, refer to manufacturer's maintenance procedure, Flip-stick maintenance. (BRUKER, 2018).

B.1.1 Removing the FLIP-STICK Stage

1. In the Commander Tab in DIFFRAC.COMMANDER program, move both the source (Theta) and the detector to 20°. Initialize the component to sample (1A01).
2. Close down the program.
3. Shut off the instrument as described in section 2.9.2. Neither of the lights on the source should be on when removing or replacing a stage.
4. Take off the knife edge.
5. Remove the computer cords connecting the stage.
6. Take out the three screws (Figure B-2).
7. Rotate the stage counter-clockwise until the two red dots are aligned and pull the stage out.
8. Store the Flip-Stick stage in a safe place/box for next usage.

B.1.2 Loading a sample on the FLIP-STICK Stage

1. Using a circular sample holder, place a small amount of the sample on the holder. Make sure the height of the sample is level with the plastic outer ring of the holder by using a glass slide.
2. To measure the XRD pattern of a bulk material, place the material in the middle of the sample holder, and make sure the height of the sample is level with the sample holder's outer ring using a glass slide. The sample does not need to be adhered to the holder.
3. Open the instrument door.
5. Place the sample holder in one of the nine sample slots by pushing down on the spring-loaded platform and slide the holder in.
6. On the diffractometer, it is usually not necessary to include a divergence slit, but Soller slits are necessary to help collect and collimate the scattered X-rays.

Appendix C
Capillary Stage and Alignment Microscope

The Capillary Stage is designed for reflection XRD measurements for powder samples. The Capillary Stage is useful for spinning samples that have issues due to high-absorbances, texture effects, or when only a very small amount of sample can be measured. Also, sealed capillaries can be made for studying air-sensitive samples. The samples can be aligned using the included alignment microscope, which is fixed to the outer goniometer circle.

C.1.0 Capillary Sample Preparation and Alignment

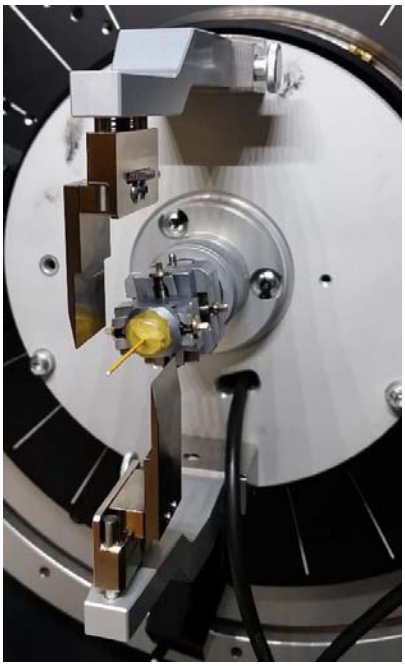

Figure C-1. Capillary Stage with Knife Edges

1. The Capillary Stage is shown in C-1.
2. Glass, quartz, and polyimide are common capillaries used and this procedure describes adding sample to a glass capillary. Other capillary materials can be used. Most capillaries range in size from 1 mm-0.1 mm. The default capillary size is normally 0.5 mm.
3. To the glass capillary, add a small quantity of sample at a time, tapping the capillary to push the sample down before adding more. No matter what the capillary is made of, pack it as densely as possible. Continue until about 3 cm of the capillary is filled. Close the end(s) using epoxy, wax, or clay. Make sure the sample does not move freely within the sealed capillary.
4. Insert the capillary into the goniometer (Figure C-2). The capillary can be inserted in the goniometer and wax added to make capillary stationary whilst on goniometer.

Figure C-2. Capillary on the Goniometer Inside the Case

5. The capillary on the goniometer needs to be aligned. Use the microscope shown in Figure C-3 to get a rough alignment. To align the capillary, use the twirler tool to make adjustments to the goniometer to move the capillary into the cross hairs in the microscope. (Note: The twirler tool must be inserted at a 90° angle to the microscope lens.) Then rotate the goniometer 90° and check that the capillary remains in the cross hairs. If not, use the twirler again to move the capillary back into the cross hairs. Then rotate 90° again. Continue until the capillary remains in the cross hairs while rotating the capillary.

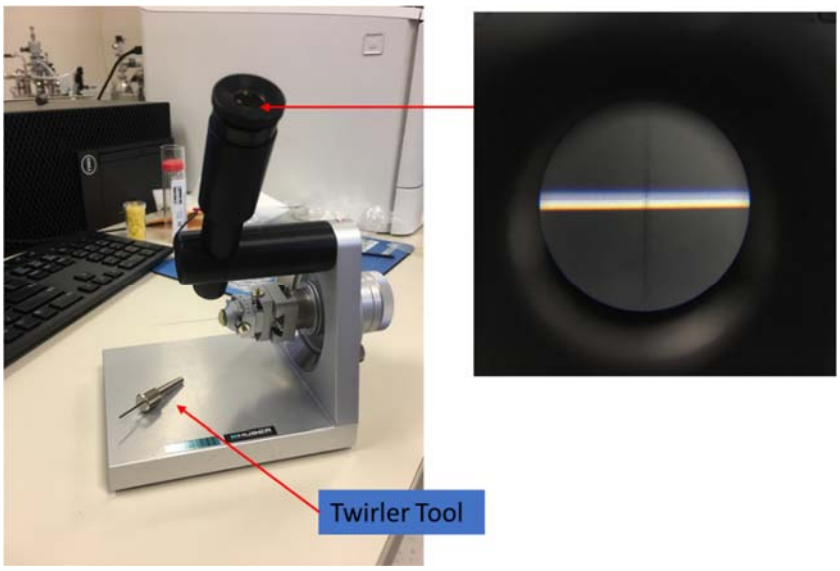

Figure C-3. Microscope and Twirler Tool Used to Roughly Align the Capillary Tube on the Goniometer Before Putting the Capillary onto the Instrument. Cross Hair View from Microscope Lens.

C.1.1 Installing the Capillary Stage

1. Make sure the power to the XRD is off as described in section 2.9.2.
2. Plug in the cords inside the instrument to the capillary stage.
3. Insert the Capillary Stage with the two red dots aligned and rotate the stage clockwise until the screws are aligned (Figure C-4).

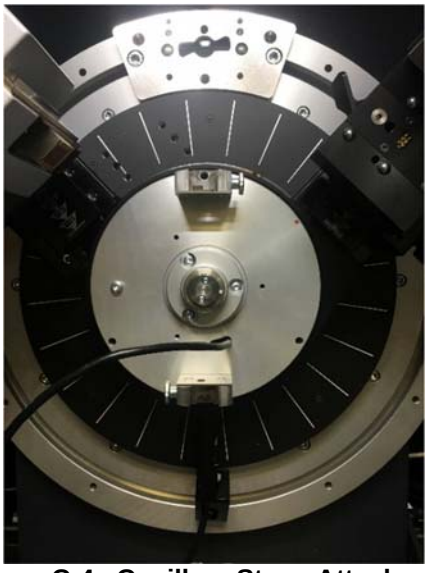

Figure C-4. Capillary Stage Attachment

4. Insert the capillary on the stage by screwing in the base of the goniometer to the stage.
5. After the rough alignment with the table microscope (Figure C-3), step 5 in this section, attach the other microscope onto the XRD goniometer (Figure C-5).

Figure C-5. Alignment Microscope on the XRD Instrument to Accurately Align the Capillary Stage

6. Make sure the capillary is in focus in the microscope.
7. Check the alignment by rotating the capillary by 90° and making sure the capillary remains in the cross hairs. If not, use the twirler to make adjustments to the capillary's goniometer. It is important that the capillary is aligned, otherwise the diffraction peaks may be shifted. Also, if unaligned, while rotating the capillary during a scan will create very broad diffraction peaks.

8. Once the capillary is aligned (while turning the goniometer, the capillary remains in the cross hairs of the microscopy), then remove the microscope and insert the two knife edges (Figure C-6).

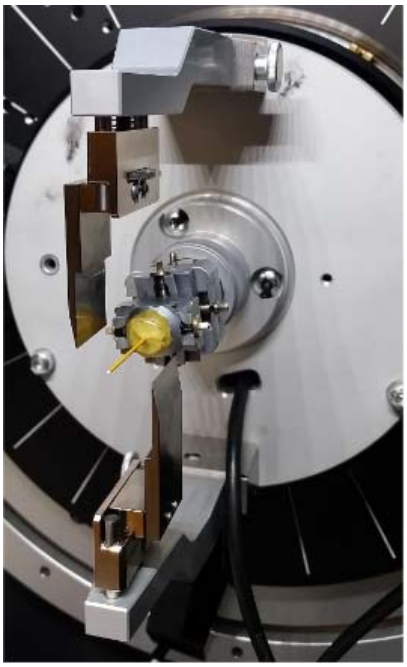

Figure C-6. Capillary Stage with Two Knife Edges

9. Turn the power to the instrument back on according to section 2.9.1.
10. Open the Measurement Server program to initiate communication before starting the DIFFRAC.COMMANDER program.

C.1.2 Removing the Capillary Stage

1. In the program, move both the source (Theta) and the detector to 20°.
2. Close down the program.
3. Shut off the instrument using the instructions from Section 2.9.2
4. Take off the two knife edges (Figure C-6).
5. Rotate the stage counter-clockwise until the two red dots are aligned and pull the stage out.
6. Unplug the cords connecting the capillary stage to the instrument.
7. Store the capillary stage in a safe place for next usage.

Appendix D
HTK-1200N Oven Chamber Motorized Base

The HTK 1200N is a nickel coated high-vacuum chamber designed for the use in the range from room temperature up to 1200°C. The chamber features a radiation heating similar to an oven. The HTK 1200N allows operation under high vacuum, inert atmosphere, or a number of oxidizing gases. The sample is mounted on an alumina sample holder and just below the sample the temperature sensor is located. For detailed instructions for installing the HTK-1200N Oven and its associated accessories, refer to the D8 Temperature Control User Manual, Installation and Operation starting on Page 2-9. The installation and operation of this accessory is very detailed and more extensive than this document can cover.

Appendix E
Motorized Anti-Scatter Screen

The Motorized Anti-Scatter Screen is a fully software-controlled device for effective suppression of instrument background, most importantly air-scatter at low angles 2q. In the Bragg-Brentano geometry, the Motorized Anti-Scatter Screen can be used in both fixed as well as automatic mode. The key feature in automatic mode is the fully software controlled, continuous retraction of the knife as a function of 2q to prevent any cropping of the beam at higher angles 2q.

DO NOT use the Anti-Scatter Screen with anoxic sample holders, as it could damage the holder and anti-scatter screen. It is also not recommended to use the Anti-scatter screen with the Flip-stick stage.

Figure E-1. A) Anti-air Scatter Screen installed on the instrument. B) Anti-air Scatter Screen stored on the rack on the inside right of the instrument.

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