



XRD-DP220

X-RAY DIFFRACTOMETER



<https://m.insize.com/XRD-DP220.html>



EN -- Please scan the QR code or visit the website for operation manual.

IT --- Scansiona il codice QR oppure visita il sito web per il manuale d'uso.

CZ -- Pro návod prosím naskenujte QR kód nebo navštivte webovou stránku.

ES -- Por favor, escanee el código QR o visite la página web para ver el manual de instrucciones.

FR -- Veuillez scanner le QR Code ou visiter notre site web pour accéder aux manuels d'utilisation.

DE -- Bitte scannen Sie den QR-Code oder besuchen Sie die Website für die Bedienungsanleitung.

PT -- Para aceder ao manual de instruções, por favor, faça a leitura do código QR ou visite o nosso site.

SECURITY WARNING

X-ray diffraction instruments involve ionizing radiation during operation, and improper handling may pose hazards to human health. To ensure safety, please strictly comply with the following warnings and precautions:

RADIATION SAFETY

Warning:X-ray diffraction instruments generate ionizing radiation. Operators must be trained and strictly comply with radiation safety operating procedures.

preventive measure:

- a. Wear a radiation dosimeter and check the radiation dose regularly.
- b. Ensure the instrument shielding device is intact to avoid direct exposure to X-rays.
- c. Do not place any part of your body in the X-ray beam path while the machine is in operation.
- d. Do not start X-ray when the instrument door is not fully closed.

emergency handling :

In the event of radiation leakage or accidental exposure, immediately shut down the equipment and evacuate the area, and contact professional personnel for handling.

If anyone is exposed to radiation, seek medical attention immediately and report to the relevant authorities.

ELECTRICAL SAFETY

Warning:The instrument uses high-voltage power supply. Improper operation may cause electric shock or fire.

preventive measure :

- a. Ensure the power supply voltage matches the instrument requirements and use a properly grounded power outlet.
- b. Do not open the electrical control box while the instrument is in operation.
- c. Regularly inspect power cords and connectors. If any damage is found, stop using them immediately and contact the maintenance team.

MECHANICAL SAFETY

Warning:The instrument contains moving parts. Improper operation may cause pinch or collision.

preventive measure :

- a. Do not place your hands or other objects near moving parts while the instrument is in operation.
- b. Before replacing samples or adjusting components, turn off the instrument and wait for all moving parts to stop completely.

OTHER SAFETY PRECAUTIONS

- a. The instrument should be placed in a well-ventilated, dry, and dust-free environment.
- b. Do not store flammable or explosive materials near the instrument.
- c. Operators should wear appropriate protective equipment, such as lab coats and gloves.

The instrument is for use by trained professionals only. Unauthorized personnel are prohibited from using it.

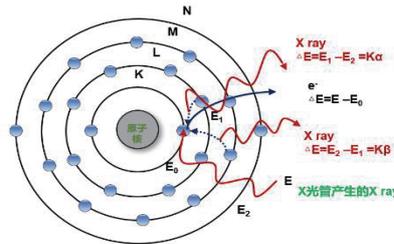
Symbol Description

Symbol	Meaning	Explain
	Warn	Operations that may cause personal injury or equipment damage.
	High risk	Indicates high-voltage operations. Exercise special caution.
	Radiation risk	Indicates that operations involving ionizing radiation require protective measures.
	Operation Prompt	Indicates steps or precautions. Read carefully and follow.
	Matters need attention	Indicates key information or restrictions that require special attention.

1. Instrument Introduction

1.1. operational principle

X-rays are produced by the collision of high-energy electrons with metal targets (such as copper or molybdenum). When electrons strike the target, the inner electrons are excited and displaced, while the outer electrons transition to the inner electrons, releasing energy in the process. X-rays are emitted in the form of radiation.



When incident X-rays interact with a crystal, diffraction occurs. The crystal lattice structure determines the diffraction angles and intensity distribution of the incident X-rays. Diffraction experiments analyze structural information of crystals by observing the diffraction patterns. Bragg's Law describes the X-ray diffraction phenomenon:

$$\lambda = 2d \sin \theta$$

n: diffraction order

λ : X-ray wavelength

d: interplanar spacing ,

θ : half of the incident angle and diffraction angle

When Bragg's law is satisfied, X-rays produce enhanced diffraction signals at specific angles. These amplified signals can be detected by the detector. By measuring the diffraction angle and the known wavelength of the incident X-rays, the unit cell spacing d can be determined. X-ray diffraction (XRD) provides critical information about the material's lattice type, unit cell parameters, phase composition, grain size, crystallinity, and internal stress by projecting X-rays onto the sample and analyzing the diffraction patterns generated by the atomic arrangement in the crystal.

1.2. instrument structure

The X-ray diffractometer is a high-precision analytical instrument based on the principle of X-ray diffraction, widely applied in fields such as materials science, mineralogy, chemistry, and physics. This instrument measures diffraction angles and intensities through the interaction between X-rays and the crystal structure of samples, thereby providing critical information on the phase composition, crystal structure, and grain size of materials.

This product is primarily composed of the following components:

1. Radiation-proof main cabinet;
2. X-ray tube;
3. External automatic sampling;
4. Cooling system;
5. Angler;
6. Detector;
7. Optical system;
8. Sample stage system;
9. Control system, etc.



This article introduces the main structure and function of X-ray diffraction instrument, and helps users to understand the parts and functions of the instrument.

Anti-Radiation Main Cabinet

The radiation-shielding cabinet is a critical component of the X-ray diffraction system, primarily designed to block X-ray radiation and ensure the safety of both operators and the surrounding environment. Its main functions include:

Radiation shielding: Absorbing and blocking X-rays through high-density materials (such as lead plates) to prevent radiation leakage.

Equipment protection: Provide a stable operating environment for core components such as X-ray generators and angle meters.

Safety interlock: Equipped with an interlock device to ensure automatic shutdown of the X-ray generator if the cabinet door is not closed or in an abnormal condition.

X Ray Tube

Characteristic X-rays (e.g., Cu K α radiation) are generated by accelerating electrons through a high-voltage electric field to bombard metal targets (such as copper or molybdenum). The target material can be replaced according to experimental requirements. Regular inspection of target wear is necessary to ensure timely replacement. To maintain normal experimental operation and prevent overheating of the X-ray tube, these measures should be implemented.

External Automatic Sampling

The external automated sampling system is primarily divided into a sample loading area and a sample unloading area. In later stages, it can be integrated with robotic arms and conveyor belts to achieve AI-powered intelligent laboratory operations.

Coolant Passage

The X-ray tube is cooled by water to ensure stable operation. Regularly check the coolant level and circulation status.

Angle Dekko

The angle meter is the core component for controlling the angle position of the sample and detector, ensuring the accuracy of the diffraction experiment. The angle meter mainly consists of the following parts: sample stage, angle meter arm, and encoder.

Sample Stage Placement: For sample placement, it can be adjusted horizontally, vertically, and rotated to ensure accurate positioning. The sample stage supports various sample types (powder, film, block, etc.) and is equipped with a sample height adjustment device to ensure the sample is centered on the beam.

Angle-measuring arm: Equipped with an X-ray detector and X-ray source, it rotates around the sample to receive diffraction signals. The scanning radius is 150 mm, with an angle range of -3° to 152° , meeting most experimental requirements. It features a precision stepper motor, achieving an angle repeatability of 0.0001° .

Encoder: Real-time measurement of the sample stage and detector angles to ensure measurement accuracy. The high-precision optical encoder achieves an angular resolution of 0.0001° .

Prober

The X-ray detector captures X-ray signals diffused by the sample and converts them into electrical signals for subsequent processing. The XRD-DP220 can be equipped with detectors according to user requirements, including one-dimensional array detectors and zero-dimensional detectors.

Zero-dimensional detector: single-channel point detector with high signal-to-noise ratio and good measurement accuracy, especially suitable for conventional powder diffraction experiments with high signal quality requirements.

One-dimensional array detector: Absorbs X-ray photons directly through semiconductor materials and generates electrical signals. It offers high energy resolution, making it suitable for complex sample analysis while significantly improving testing efficiency.

Optical System

The optical system adjusts the intensity, direction, and focus of the X-ray beam to ensure experimental precision. The XRD-DP220 selects different optical systems based on the test type.

Narrow slit: It is mainly used to control the divergence angle of the light source, reduce the scattering of the sample, and control the range of the incident angle of the detector.

Collimator: Limits the divergence angle of X-ray beams and improves beam parallelism. Different collimators with varying apertures can be replaced to meet different experimental requirements.

Monochromator: Filters out non-characteristic X-rays to improve the signal-to-noise ratio of the diffraction signal. Uses crystal or multilayer film technology for high energy resolution. Adjustable angle for selecting specific wavelength X-rays.

Focusing lens: Converts divergent X-ray beams into collimated parallel beams by optimizing the propagation direction of X-rays, thereby enhancing the resolution and sensitivity of diffraction peaks. It is suitable for various XRD applications such as powder diffraction, film analysis, and stress testing.

Sample Holder System

The sample stage system is a critical component of X-ray diffraction instruments, serving to secure and position samples to ensure their precise alignment within the X-ray beam. Depending on the sample type and experimental requirements, the sample stage system can be categorized into various types.

Powder sample table: Powder sample table is a special device for fixing powder samples, suitable for various powder samples, such as metal powder, ceramic powder, drug powder, etc.

Film sample stage: Film sample stage is a special device for fixing film samples, suitable for various film samples, such as metal film, semiconductor film, polymer film, etc.

High and low temperature sample stage: The high temperature sample stage is a special device for diffraction experiments under high temperature conditions, which is suitable for the study of high temperature performance of materials.

Navar

The control system is used to control the instrument's running state and realize the data acquisition and processing.

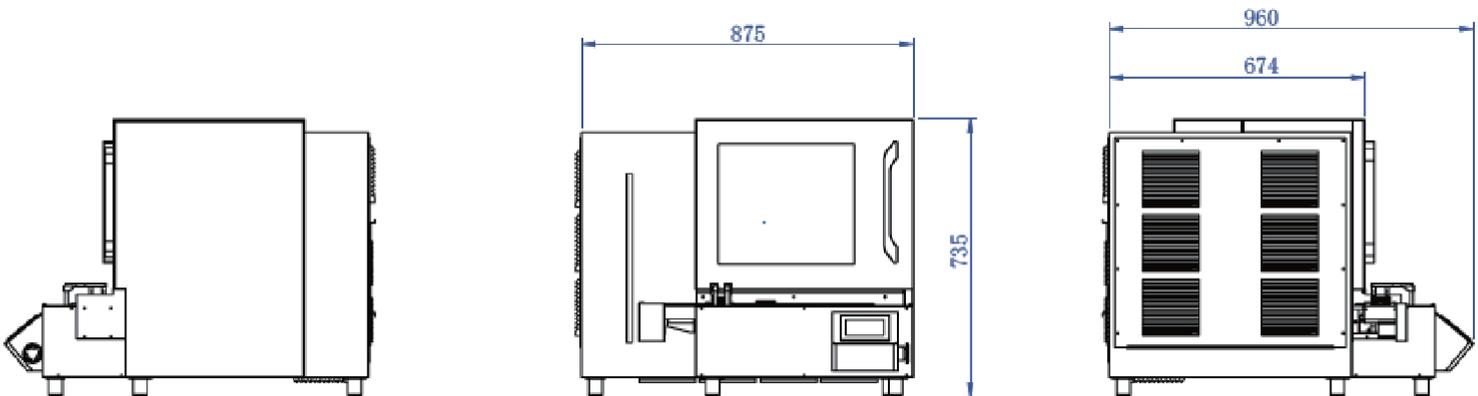
matters need attention :

1. All instrument components require regular maintenance and calibration to ensure measurement accuracy and operational safety.
2. Before operating the equipment, please read this manual carefully and complete the required training.
3. Unauthorized personnel are not allowed to disassemble or modify the instrument components.

1.3 SPECIFICATION

Goniometer	structure	θ/θ linkage-type goniometer
	diffraction circle radius	150mm
	2 θ angle range	-3°~152°
	2 θ angle indication error	$\leq \pm 0.02^\circ$
	2 θ angle repeatability	<0.002°
	2 θ angular resolution	full width at half maximum (FWHM)<0.05°
	scanning speed	0.01-120°/min
1D array detector	sub-detector	no less than 640
	effective area	32mm×8mm
	maximum linear count rate	6.4×10 ⁸ cps (noise-free)
X-ray tube	maximum output power	2.2kW
	focal spot	elongated focal spot: 12 mm×0.4 mm, point focal spot: 1.2 mm×0.4 mm
	target	Cu
	maximum tube voltage	40kV
	maximum tube current	30mA
Optical path		automatic divergence slit anti-scatter device
Heat dissipation method		built-in circulating cooling water system
Sample stage		fixed sample stage (for reflection measurements without sample rotation)
Power supply		AC220V, 50Hz
Dimensions (L×W×H)		880mm×705mm×735mm
Net weight		180kg

1.4. Instrument operating environment requirements



To ensure the proper operation and measurement accuracy of the X-ray diffraction instrument, the device must be installed in a location that meets the following environmental requirements

A site with specific conditions. Please read and strictly follow the instructions before installation and use.

Ambient temperature

Requirements: 15 °C to 30 °C

explain :

The instrument shall operate in a constant temperature environment to avoid excessive temperature fluctuations.

High temperatures may cause instrument overheating, affecting performance; low temperatures may lead to component shrinkage or poor lubrication.

Humidity requirements

Requirements: 20% to 80% relative humidity (no condensation)

explain :

High humidity may cause short circuit or corrosion of the internal circuit of the instrument.

Low humidity may cause the accumulation of static electricity, which may affect the stability of electronic components.

Power requirement

ask :

Single-phase AC 220-230 V \pm 10%, 50/60 Hz, 40A

explain :

The unstable power supply voltage may cause instrument damage or measurement error.

Grounding failure may cause electrostatic interference or electrical safety hazards.

Ventilation and Scattering

Ventilation and Heat Dissipation

ask :

Leave at least 50 cm of space around the instrument to ensure air circulation.
Good ventilation of the environment to avoid heat accumulation.

explain :

X-ray generators and other electronic components generate heat, requiring effective thermal dissipation.

Poor ventilation may cause overheating of the instrument, which may affect its performance and lifespan.

Earthquake and dustproof

ask:

The instrument should be placed on a stable laboratory bench to avoid vibration.
The environment should be kept clean and free of dust accumulation.

explain :

Vibration may cause loosening of instrument components or measurement errors.

Dust may enter the instrument and affect the performance of optical and electronic components.

Radiation protection

ask:

The laboratory should comply with local radiation safety regulations to ensure that the radiation dose is below the safety standard (typically $\leq 1 \mu\text{Sv/h}$).
Radiation warning signs should be clearly displayed around the instrument.

explain :

X-ray diffraction instruments emit ionizing radiation, requiring appropriate protective measures.

Space requirement

ask :

The laboratory area should be sufficient to accommodate the instruments and their accessories, typically recommended to be no less than 10 square meters.
Sufficient operating space should be reserved around the instrument to facilitate maintenance and sample replacement.

explain:

Insufficient space may cause operational inconvenience or safety risks.

Other requirements

electromagnetic interference :

The instrument should be kept away from strong electromagnetic interference sources (such as large motors and radio equipment).

Light conditions:

The laboratory should avoid direct exposure to strong light to prevent affecting the performance of optical components.

maintenance prevention:

The laboratory should be equipped with safety facilities such as fire extinguishers and first aid kits to ensure timely handling in emergency situations.

Matters Need Attention:

1. If the laboratory environment does not meet the requirements, take appropriate measures to improve it. Otherwise, it may cause instrument damage or measurement errors.
2. Regularly check the laboratory environment to ensure that the instruments are always operating in a suitable environment.
3. If you have any questions, contact technical support or a professional engineer.

←INSIZE→

2. Installation and Debugging

2.1. OOBA

Before installing the instrument, perform the unpacking inspection strictly according to the following steps to ensure the equipment and accessories are intact and complete. If any issues are found, contact the supplier or after-sales service department immediately.

2.1.1. OOBA

Ensure the unpacking environment maintains temperatures between 15°C and 30°C with relative humidity ranging from 20% to 80%. Avoid high humidity to prevent equipment moisture or low humidity to avoid static electricity. The unpacking area should be spacious and tidy, with a flat floor free of debris for easy operation and equipment placement. Prepare unpacking tools such as gloves and wrenches. At least four people should collaborate to avoid equipment tipping or damage caused by single-person operation. Operators must wear protective gloves to prevent direct contact with sharp packaging materials.

2.1.2. scope of examination

a. **Check the packing list:** According to the contents of the packing list provided with the goods. If the actual items do not match the packing list, take a photo and contact the supplier immediately.

b. **Equipment Inspection:** Check the main unit housing for scratches, dents, or rust; inspect critical components like radiation shielding doors and sample chambers for deformation or looseness; verify the X-ray tube glass housing is crackfree; ensure the sample platform surface is smooth with flexible moving parts; inspect power cables and data lines for damage or breaks; confirm connectors are intact without deformation or rust.

2.2. Installation steps

a. angle meter installation

Place the angle meter: Mount the angle meter on a stable workbench. Typically, angle meters come with a dedicated mounting base. Secure it to the bench with

- bolts, then adjust the level to ensure the instrument is perfectly level.

Connect the drive motor and encoder: Connect the cables of the angle meter's drive motor and encoder to their respective interfaces to ensure proper signal

- transmission.

Install sample holders: Mount standard, film, or other specialized sample holders on the goniometer as required, ensuring secure installation with flexible

- rotation and movement capabilities.

b. Installation of X-ray tube and tube sleeve

Fixation of the tube sleeve: Align the dovetail groove on the side of the tube sleeve with the left rotating arm of the protractor, rotate the lower knob to

- allow it to slide along the left arm of the protractor, and insert the pin into the appropriate radius of the protractor (standard is in the pin hole at the 245mm position, move the tube sleeve to the correct position and tighten the lower knob.

- X-ray Tube Installation: When installing the X-ray tube, align the water inlet and outlet ports of the tube with those of the tube sleeve. The tube's focal spot should be aligned with the sleeve's window. Place a sealing rubber gasket, gently insert the tube into the sleeve, and alternately tighten the two fastening screws of the X-ray tube base. Conduct a water test to check for leaks and verify the accuracy of the water circuit connection.

c. optical path system installation

- Installation of the slit system: Install the slit system at the designated position in the optical path. Select the appropriate slit width based on experimental requirements, and adjust the position and angle of the slit to precisely control the size and direction of the X-ray beam.
- Installation of optical components: such as monochromators, mirrors, etc., should be installed and adjusted according to the instructions to ensure positional accuracy and optical performance of the components, thereby guaranteeing the quality and resolution of X-rays.
- Optical path components: Connect all optical components using dedicated connectors to form a complete optical system. Ensure tight and accurate connections to prevent light leakage or misalignment.

d. detector installation

- Fixed Detector: Align the dovetail slot of the detector bracket with the right rotating arm of the angle meter. Rotate the lower knob to enable sliding on the left arm. Insert the pin into the pin hole at the appropriate angle meter radius (standard position at 245mm). After positioning the detector bracket, secure the lower knob.
- Connect the signal and power lines: Connect the signal line of the detector to the instrument host and the power line to the power socket to ensure the detector operates normally and transmits data.

e. Cable installation

- Remove the rear door panel, insert the cleaned cable into the plug socket of the high-voltage transformer, then connect the high-voltage cable to the X-ray tube and tighten the screw cap. Note that extreme care must be taken during installation to avoid damaging the tube.

f. Installation of water-cooled machine equipment

- Connecting cooling water pipes: If the equipment requires an external cooling water circulation system, properly connect the cooling water pipes (the left water-cooled pipe facing the angle meter is the inlet, and the right is the outlet. First connect the outlet pipe to the flow meter inlet, then connect the flow meter outlet to the water-cooled machine). Connect the pipes to the X-ray generator and other components requiring cooling, ensuring secure connections with no leakage.
- Add cooling medium: Add an appropriate amount of deionized water (approximately 70-80L) or a dedicated coolant to the cooling tank as required by the cooling system.
- Start the cooling system: Turn on the cooling circulation pump, check if the cooling water flow is normal, and observe the flow meter.

Check if the flow rate is stable (typically 3.8-4.3L/min), verify pressure stability, and inspect for any leaks.

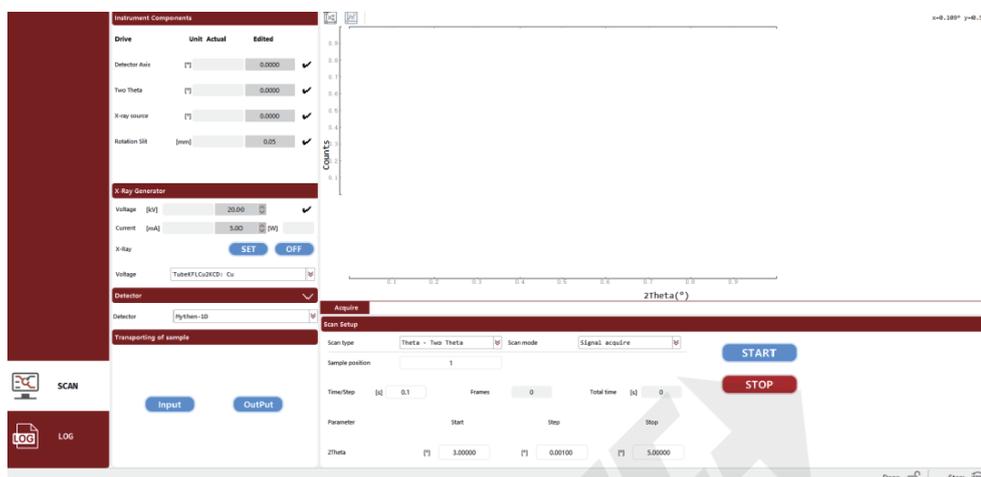
! matters need attention :

1. During installation, strictly follow safety protocols to avoid electric shock or radiation exposure.
2. If you encounter installation difficulties or issues, stop the installation immediately and contact technical support.
3. After installation, perform initial debugging to ensure the instrument operates normally.

←INSIZE→

3. Software function

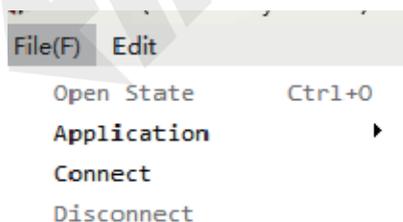
XRD is a specialized data acquisition and analysis software for XRD-DP220, offering functions including instrument control, data collection, analysis, and result output. It is widely used in scientific research, material analysis, and other fields. After double-clicking to start the software, the interface will appear as follows:



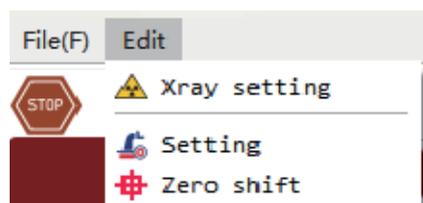
The XRD software primarily features a file menu bar at the top and a function switch bar on the left. The function switch bar includes SCAN and LOG functions.

3.1 menu bar

The menu bar includes File and Edit. File contains mode settings and allows you to connect devices through the file menu bar.



Click "Edit" to include X-Ray settings, Setting, and Zero shift.



Edit is designed for engineers and includes advanced settings for technical personnel. It is used for device calibration, system parameter adjustment, hardware diagnosis, and software maintenance. This mode allows you to modify and debug core device parameters to ensure stable and accurate system performance.

The engineer mode involves the underlying control and key parameters of the equipment. If the operation is not proper, it may lead to abnormal operation of the equipment, data distortion, and even damage to the hardware.

! matters need attention :

Users are advised not to enter or modify any settings in engineer mode.

If needed, please contact our technical support or have a professional engineer perform the operation and adjustment.

3.2 keyboard shortcuts

The software shortcut keys are located below the menu bar, from left to right: Stop, High Voltage Off.

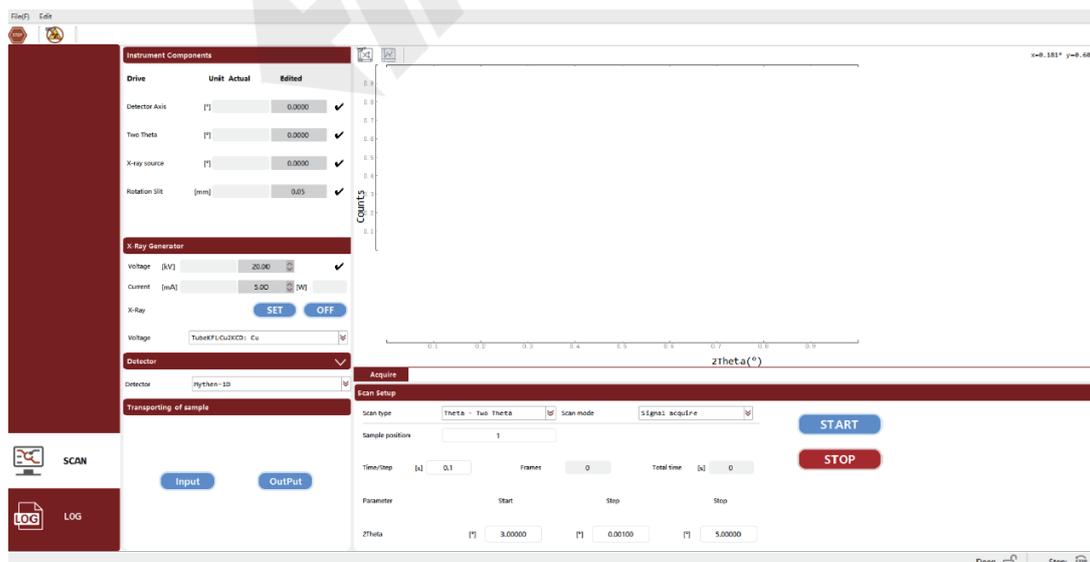


Emergency stop: Click to stop all axes in case of an emergency.

High-pressure shutdown: Directly shut down the high-pressure system

3.3 SCAN function

Click the SCAN button in the right-side function switch bar to access the main experimental control interface. This interface primarily includes the following functional modules: Instrument Components, X-Ray Generator, Detector, Sample Transport, and Scan Setup, which are used for equipment control, light source management, detector selection, sample loading/unloading operations, and experimental parameter settings.



Instrument Components:The system includes detectors, light sources, and rotating slits for motion control. Users can control the movement of these components by clicking corresponding hardware icons and monitor their real-time status. The parameters displayed on the interface vary depending on the specific configuration of the equipment.

X-Ray Generator:Controls the X-ray source in the device. Parameters and buttons allow setting the source's operating voltage, current, and activation. For multiple sources, the Voltage button switches between different target materials.

Detector:If the instrument is equipped with multiple detectors, the type of detector is automatically selected from the dropdown box. If the detector is not recognized, it cannot be selected.

Sample transfer:This module controls the sample loading and unloading process. When the device is not equipped with a third-party robotic arm, the Input button enables loading and the Output button enables unloading. The system automatically completes sample transfer and positioning.

Scan Setup:This module is used for setting experimental parameters. Users can customize test parameters based on sample conditions, including: Scan type:

Scan mode: Scan mode

Sample position

Time/Step: Detector exposure time

Frames: Number of frames collected

Total time: Total test time

Additionally, the Parameter section allows users to set the starting angle and step size, enabling adjustments to suit specific testing requirements and accommodate various experimental setups.

3.4 LOG function

Number	Date	Time	Grade	Information
1	2025-10-17	11:01:15,335	ERROR	Failed to connect to Xray server
2	2025-10-17	11:01:15,443	ERROR	Failed to connect to Xray server
3	2025-10-17	11:01:33,774	INFO	Server initialization completed
4	2025-10-17	11:01:33,775	INFO	The DCU XRD detector service has been started and monitored at 0.0.0.0/6001
5	2025-10-17	11:01:33,831	INFO	Server initialization completed
6	2025-10-17	11:01:33,832	INFO	Server startup failed: [WinError 10048] 请尝试每个套接字地址(协议/网络地址/端口)只允许使用一次。
7	2025-10-17	11:01:33,833	ERROR	DCU Server startup failed
8	2025-10-17	11:02:31,220	INFO	Stop XRD DCU service...

LOGs record critical operational data, system status, and anomalies during software or device operation, enabling users to trace steps, troubleshoot, and perform data backup and analysis. The system automatically logs content in real-time without manual intervention. Each record includes timestamps, user, operation type, and details. Abnormalities or errors are highlighted with clear labels (e.g., "[ERROR]") for rapid troubleshooting.

4. Operation Declaration

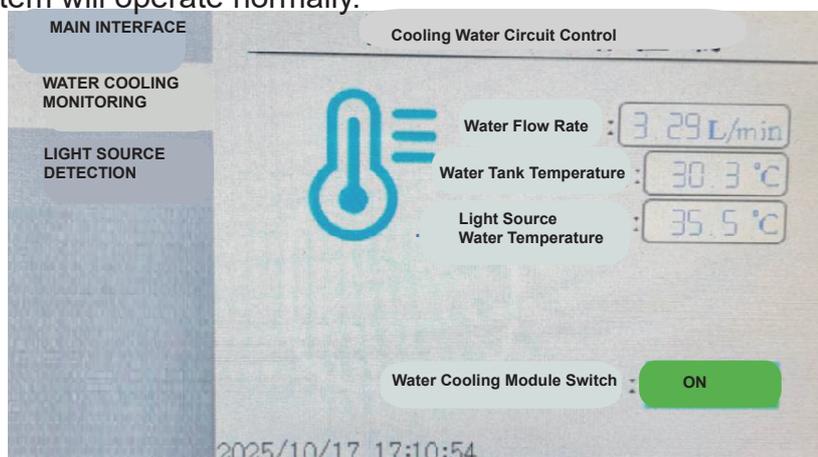
4.1. Boot preparation

4.1.1 Before formal testing, ensure the laboratory temperature and humidity meet the equipment requirements.

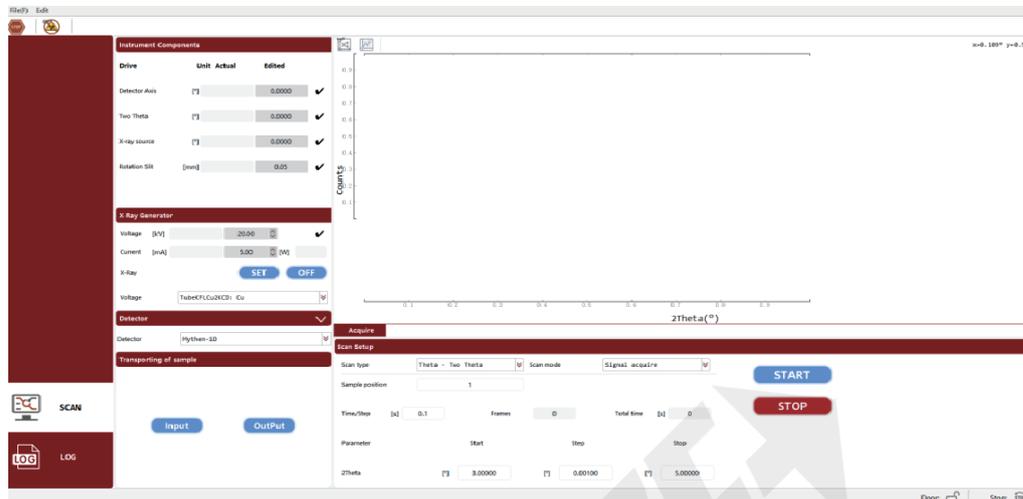
4.1.2 Turn on the power switch by pressing the red button in the upper right corner of the diffraction instrument's back panel. The machine will then power on and perform a self-check. After startup, verify that the emergency stop switch is activated. Next, tap the button on the touchscreen interface at the lower right of the front panel to confirm the safety door interlock and lighting are functioning properly. Once confirmed, turn off the safety door interlock.



4.1.3 Tap the water cooling monitoring interface on the touchscreen, then press the button at the bottom right to activate the cooling water circulation system. When the water flow rate exceeds 2.8L/min and the temperature reads room temperature, the system will operate normally.



4.1.4 Double-click the desktop shortcut to launch the XRD control software. The system will automatically establish a connection with the device hardware. After opening the software, check if the \checkmark symbols next to all components in the Instrument Components section are lit to confirm proper communication. If not lit, check the network or device connection. Wait until communication is restored before proceeding.

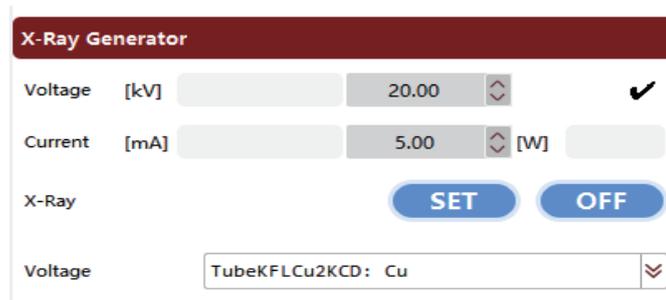


Drive	Unit	Actual	Edited
Detector Axis	[°]	0.0000	<input checked="" type="checkbox"/>
Two Theta	[°]	0.0000	<input checked="" type="checkbox"/>
X-ray source	[°]	0.0000	<input checked="" type="checkbox"/>
Rotation Slit	[mm]	0.05	<input checked="" type="checkbox"/>

4.1.5 Click the SET button in the X-Ray Generator interface to initiate the automatic preheating process. The system automatically selects the preheating procedure based on the equipment's shutdown duration. During the presetting process, a preheating prompt will appear in the lower left corner of the software. When the interface displays "The preheating is completed, and the high-pressure start-up is successful", the preheating is complete. While the equipment is preheating, sample preparation can be performed.

! matters need attention :

- Do not turn off the software or power off the device during preheating.
- During the preheating phase, users can simultaneously prepare samples to enhance experimental efficiency.
- If an error occurs during the warm-up process, pause the operation and contact technical support.



4.1.6 The machine is ready for testing.

4.2. sample preparation

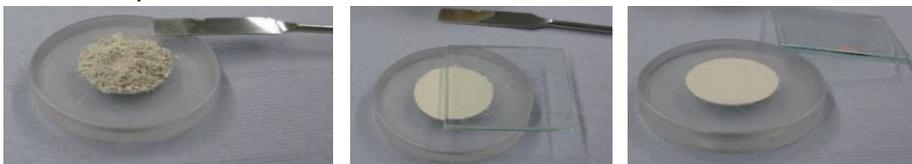
During the preheating of the equipment, sample preparation can be performed.

The preparation of powder samples is a critical step for obtaining accurate X-ray diffraction data.

To obtain high-quality XRD data, the sample must meet the following requirements:

- Moderate particle size: It is recommended to use particles smaller than 10 μm to minimize particle effects.
- Uniform distribution: The sample must be evenly distributed on the sample stage to avoid orientation effects.
- No contaminants: The sample must not contain moisture, oils, or organic contaminants, as these may affect measurement accuracy.
- Optimal sample thickness: The sample thickness should typically range from 0.2 to 1 mm. Excessively thick samples may cause excessive X-ray absorption, while excessively thin samples may result in insufficient signal.

Place the sample holder on a flat surface. Use a spatula to fill the sample well with an appropriate amount of powder. Gently press the powder with a slide to ensure a smooth, crack-free surface. Remove any excess powder from the edges of the sample well to avoid interference with measurements. Note that over-compaction should be avoided to prevent preferential orientation (e.g., sheet-like or needle-like crystal alignment). The surface of the loaded sample should be flush with the edges of the sample well. For thin-film samples, use clay or kapton tape to secure them within the sample holder.

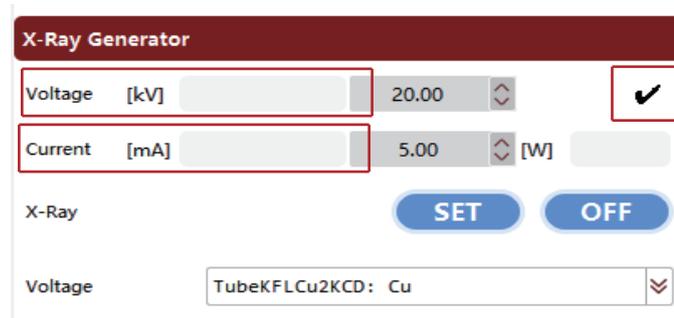


Question	Cause	Solve the problem
Diffraction peak is too broad	Excessive particle size	Grinding and sieving to remove large particles
Low diffraction peak intensity	The sample is too thin or unevenly loaded.	Increase the sample filling amount to ensure a smooth surface.
Peak shift	The sample is not aligned with the reference plane	The height of the sample was adjusted.
Background noise is high	The sample surface is uneven or contaminated	Recharge and clean the sample tank.

4.3. parameter setting

4.3.1.X-Ray Generator

After the device is preheated, find the X-Ray Generator in the SCAN module and raise the light source to the target working power.



4.3.1.1 Voltage: The output voltage of the light source, typically recommended at 40kV with a maximum limit of 40 kV. Prolonged exposure to high voltage may cause damage to the optical tube.

4.3.1.2 Current: The output current of the light source, typically recommended at 30mA with a maximum limit of 30mA. Prolonged operation at high current levels may damage the power supply.

After entering the voltage and current parameters, click the ✓ button to automatically switch to the set high-voltage operating state. Do not close the software or operate other modules during the voltage increase process.

4.3.1.3 Voltage: The device is equipped with a Cu target light source by default. If multiple target light sources are available, you can switch targets using Voltage. Note: After switching the target material, reconfirm the voltage and current parameters to avoid exceeding the recommended range.

4.3.2. Detector

In the Detector section, select the detector model from the dropdown menu (e.g., Mythen). Check if the detector is connected and confirm that data acquisition is ready.



4.3.3. Transporting of sample

This device supports two sample loading methods:

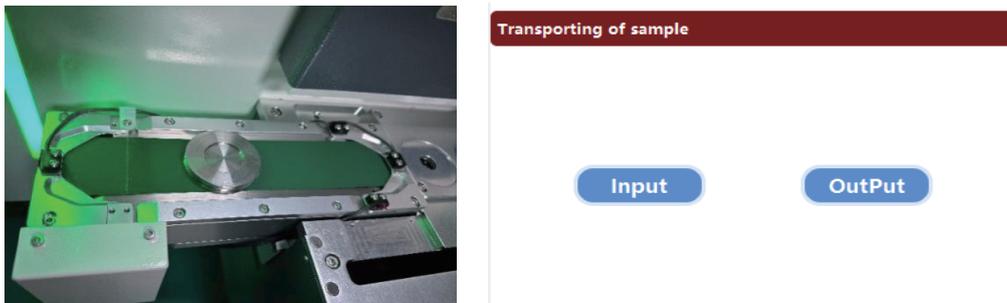
- Method 1: Automatic sample loading and unloading through a third-party intelligent system;
- Method 2: Automatic sample loading and unloading through the local control software XRD-DP220.

If the device lacks a third-party smart system, use the XRD control software to load and unload samples.

Click the Input button to start sample delivery. Place the prepared samples at the conveyor belt entrance.

The device will automatically clamp the sample mechanically and deliver it to the testing area.

If no sample is in the device, it will be directly transferred to the test area, and the user can initiate the test after completing parameter settings. If the device is currently testing, the mechanical gripper will temporarily store the new sample in the pending test area. Once the current sample completes testing, the system will automatically transfer the new sample to the test area to continue the testing process. If the test needs to be terminated during sample processing, click the Output button to safely return the sample to the conveyor belt exit.

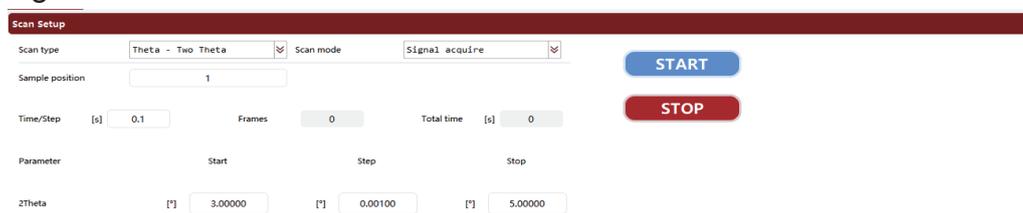


For devices equipped with third-party intelligent systems, this software provides comprehensive API documentation to enable seamless sample control. Developed by our engineers, the API documentation includes interface specifications, invocation methods, and parameter configuration examples, ensuring secure and reliable integration between third-party systems and the device.

Note: Ensure the sample is placed correctly and securely to avoid abnormal clamping. Manual intervention during loading or unloading is not recommended. If the sample gets stuck or not fully captured, pause the operation and contact technical support.

4.3.4. Scan type

The Acquire module serves as the core functional area in instrument testing, primarily used to configure parameters such as scan type, scanning mode, step size, integration time, and test angle range. Proper parameter settings not only affect testing duration but also directly influence data resolution and signal-to-noise ratio. Through this interface, users can flexibly control experimental workflows to perform routine diffraction analysis, high-precision structure determination, or rapid screening tests.



4.3.4.1 Scan type: Select different scan types from the dropdown.

Different scanning modes can be selected based on sample and test requirements. Theta-TwoTheta (default): The most commonly used scanning mode, suitable for most powder samples, bulk materials, and coated materials.

4.3.4.2 Scan mode: Select a different scan mode from the dropdown. The default is signal acquire mode, which is suitable for most test scenarios. Continuous acquisition enables continuous scanning.

The mode is suitable for batch scanning of multiple samples with conveyor belt, and can continuously collect data during automatic loading/unloading process to improve testing efficiency.

4.3.4.3 Time/Step: Sets the integration time for the detector at each step size. With consistent step sizes, longer integration time extends the total test duration but improves the signal-to-noise ratio. Conversely, shorter integration time may result in insufficient diffraction peak intensity, compromising data quality. The system defaults to 0.1s.

4.3.4.4 Step: Sets the angular step size during testing. With the same integration time, a smaller step size increases the testing time but improves resolution, while a larger step size reduces data accuracy.

A smaller step size (e.g., 0.005°) enhances peak resolution, making it suitable for precise structural analysis or Rietveld refinement.

A larger step size (e.g. 0.02°) can significantly reduce testing time and is suitable for rapid screening and routine testing. The system recommends a default step size of 0.005° , which can be flexibly adjusted according to actual needs.

4.3.4.5 2Theta: Sets the starting and ending angles of the sample, with a scanning range of 2° to 160° .

If the position of the characteristic peak of the sample is clear, the scanning range can be narrowed to shorten the test time.

For unknown samples or when obtaining complete diffraction spectra, it is recommended to set a wider range (e.g., 10° - 80°).

For thin films or special materials, angle optimization can be performed in combination with grazing incidence mode. Properly setting the scanning range helps improve efficiency and ensures complete recording of target peaks.

4.3.4.6 After setting the parameters, click START to automatically launch the scanning program.

During the testing process, the diffraction curve changes can be observed in real time in the spectrum window on the right side of the interface to confirm whether the target peak appears and whether the signal intensity meets the requirements.

To adjust parameters, click the STOP button to terminate the current test. The system will safely stop scanning and save collected data to prevent loss.

We recommend performing a short-range pre-scan before the official test to verify the parameter settings.

4.3.4.7 After completing the test, right-click the atlas window to display a floating box. Click the Save Date button to open the Windows file save dialog, where users can customize the file name and save location.

 **Original Size**

 **Open File**

 **Delete Line**

 **Save Data**

4.3.4.8 When the device lacks a third-party smart system, the externally tested samples must be manually removed after testing.

4.4. Device is off

4.4.1 Take the completed test samples;

4.4.2 To turn off high voltage: First, set the voltage to 20kV and current to 5mA via the X-Ray Generator interface. Click the ✓ button on the right side of the interface. Once the high voltage automatically drops to the specified value, click OFF to disable it.

X-Ray Generator

Voltage [kV] 20.00 ✓

Current [mA] 5.00 [W]

X-Ray SET OFF

Voltage TubeKFLCu2KCD: Cu

4.4.3 Close all software;

4.4.4 After ten minutes of high-voltage operation, turn off the power switch on the back of the instrument.

4.4.5 Turn off the computer.

5. Daily Maintenance and Care

To ensure the long-term stable operation and extended service life of X-ray diffraction instruments, regular daily maintenance and care are required. The following content provides a detailed introduction to maintenance cycles, operational procedures, and precautions.

5.1. Maintenance cycle

Project	Period	Remarks
Clean the instrument surface	Weekly	Keep the instrument clean to prevent dust accumulation.
Check the cooling system	Weekly	Ensure the cooling water flows smoothly without leakage.
Check the X-ray tube condition	Monthly	Observe the appearance and confirm there are no cracks or damages.
Calibration goniometer	Every quarter	The angle precision was calibrated by using standard sample.
Inspection of radiation shielding device	Semiannually	Ensure that the lead plate or lead glass is not damaged or deformed
Comprehensive inspection and maintenance	Annually	Comprehensive inspection and maintenance shall be performed by professional technicians.

5.2. Maintenance steps

5.2.1 Clean the instrument surface

- Turn off the instrument and unplug the power cord.
- Wipe the instrument surface with a clean soft cloth to remove dust and stains.
- For stubborn stains, a small amount of neutral detergent can be used, and corrosive detergents should be avoided.
- After completing the step cleaning, wipe the instrument surface with a dry cloth to ensure no residual cleaning agent remains.

5.2.2 Check the cooling system

- Check whether the cooling water pipe connection is secure and leak-free.
- Check the coolant tank level and ensure it is within the normal range.
- Clean the filter of the cooling system to prevent dust clogging.

5.2.3 Check the X-ray tube.

- Turn off the instrument and unplug the power cord.
- Open the X-ray tube installation cover and inspect the exterior of the X-ray tube to confirm there are no cracks or damages.
- Check whether the X-ray tube connector is securely fastened without any looseness.
- Contact technical support if you notice any issues.

5.2.4 calibration goniometer

- Place the standard sample (e.g., silicon powder) on the sample stage.
- Set the calibration program in the software and run the angle scan.
- Compare test results with standard values to verify angular accuracy.
- If there is a deviation, adjust the angle meter parameters or contact technical support

5.2.5 radiation shielding device

- a. Check whether the lead plate or lead glass is intact, without damage or deformation.
- b. Check if the platform screen door's sealing strip is aged or detached to ensure proper sealing.
- c. Contact technical support if you notice any issues.

5.2.6 Comprehensive inspection and maintenance

- a. A comprehensive inspection shall be conducted by professional technicians, including the electrical system, mechanical system, optical system, etc.
- b. Replace worn-out components such as sealing strips and cooling water pipes.
- c. Perform a full calibration to ensure the instrument operates at peak performance.

! matters need attention:

1. Always turn off the instrument power and unplug the power cord before maintenance.
2. Always turn off the instrument power and unplug the power cord before maintenance.

6. Fault Description

This chapter details common faults and solutions for X-ray diffraction systems. Users can quickly identify and resolve issues based on symptoms. If unable to resolve the issue, contact technical support promptly.

6.1. light source failure

Phenomenon	Possible reasons	Resolvent
No light emission	<ol style="list-style-type: none">1. X-ray tube damage2. High-voltage power supply failure3. cooling system failure	<ol style="list-style-type: none">1. Examine the appearance of the X-ray tube to ensure there are no cracks or damages.2. Check the high-voltage power supply connection and ensure the voltage and current settings are correct.3. Check the cooling system to ensure smooth water flow.
The stability is not strong.	<ol style="list-style-type: none">1. X-ray tube aging2. High-voltage power supply is unstable3. Insufficient cooling system	<ol style="list-style-type: none">1. Replace the X-ray tube.2. Check the high-voltage power supply to ensure stable voltage and current.3. Check the cooling system to ensure proper cooling.
Optical tube overheating	<ol style="list-style-type: none">1. cooling system failure2. Insufficient cooling water3. cooling water pipe blockage	<ol style="list-style-type: none">1. Check the cooling system to ensure smooth water flow.2. Replenish the cooling water to the normal level.3. Clean the cooling water pipes to prevent blockages.

6.2. angle meter malfunction

Phenomenon	Possible reasons	Resolvent
Cannot rotate	<ol style="list-style-type: none">1. Motor failure2. mechanical lock3. control signal loss	<ol style="list-style-type: none">1. Check the motor connection and ensure the power supply is normal.2. Clean the mechanical parts to ensure smooth operation.3. Check the control signal line to ensure a secure connection
Cannot rotate prevent loosening	<ol style="list-style-type: none">1. angle encoder fault2. Mechanical looseness3. Calibration is inaccurate	<ol style="list-style-type: none">1. Check the angle encoder to ensure the signal is normal.2. Tighten mechanical components to prevent loosening.3. recalibrate the theodolite
Abnormal noise of the goniometer	<ol style="list-style-type: none">1. Mechanical component wear2. Insufficient lubrication3. Foreign body entry	<ol style="list-style-type: none">1. Inspect mechanical components2. Add appropriate amount of lubricating oil.3. Clean mechanical components and remove foreign objects

6.3. detector failure

Phenomenon	Possible reasons	Resolvent
No signal	<ol style="list-style-type: none">1. Motor failure2. mechanical lock3. control signal loss	<ol style="list-style-type: none">1. Check the detector for damage.2. Check the signal line connection and ensure it is secure.3. Check the power connection to ensure it is working properly.
Weak signal	<ol style="list-style-type: none">1. angle encoder fault2. mechanical loosening3. Calibration is inaccurate	<ol style="list-style-type: none">1. Check the detector for damage.2. Check the signal line connection and ensure it is secure.3. Check the power connection to ensure it is working properly.
High noise	<ol style="list-style-type: none">1. wear of mechanical parts2. Lack of lubrication3. Foreign body intrusion	<ol style="list-style-type: none">1. Replace the detector.2. Check the environment and eliminate interference sources.3. Check the grounding system to ensure proper grounding.

6.4. software fault

Phenomenon	Possible reasons	Resolvent
Cannot start	<ol style="list-style-type: none">1. Software damage2. System incompatibility3. License expired	<ol style="list-style-type: none">1. Check the detector for damage.2. Check the signal line connection and ensure it is secure.3. Check the power connection to ensure it is working properly.
Cannot connect to the device	<ol style="list-style-type: none">1. Connection line fault2. The driver is not installed3. The device is not on	<ol style="list-style-type: none">1. Check the detector for damage.2. Check the signal line connection and ensure it is secure.3. Check the power connection to ensure it is working properly.
Slow	<ol style="list-style-type: none">1. Insufficient computer performance2. Software configuration is incorrect3. The data volume is too large	<ol style="list-style-type: none">1. Replace the detector.2. Check the environment and eliminate interference sources.3. Check the grounding system to ensure proper grounding.

The above content provides a detailed troubleshooting guide for X-ray diffraction instruments. Users may adjust the details based on their specific issues.



www.insize.com

