

X-ray Diffractometer

# XRD-7000



# New Concept in Multifunction X-Ray Diffractometry for the 21st Century

Shimadzu X-ray Diffractometer

## XRD-7000



# Handles extra-large samples and liquid samples

## Features a high-precision vertical $\theta$ - $\theta$ goniometer

The new XRD-7000 Series X-ray diffractometers feature a high-precision vertical  $\theta$ - $\theta$  goniometer and are able to handle huge samples than conventional instruments - up to W400 × D550 × H400mm.

In addition to basic qualitative and quantitative analysis, the XRD-7000 Series handles residual austenite quantitation, environmental quantitative analysis, precise lattice constant determination, degree of crystallinity calculations, crystallite size and crystal strain calculations, crystal system determination, as well as Rietveld analysis and other software-based crystal structure analysis. The addition of attachments permits stress measurements, measurements on non-ambient condition, and the measurement of thin-film samples. The newly developed large R- $\theta$  stage permits automatic stress mapping of an entire sample up to 350 mm diameter. The strong parallel beam optical system with built-in polycapillary unit is available to further expand the range of application.

### Feature

#### High-precision vertical $\theta$ - $\theta$ goniometer

The high-precision vertical  $\theta$ - $\theta$  goniometers used in the XRD-7000 Series boast a minimum step size of 0.0001°. Select from the L model to analyze large samples or the general-purpose S model. Both models feature a variable goniometer radius to handle the analysis of any sample.

#### Comprehensive range of options expand the system

To match the aim of the analysis, options for the measurement of thin films, stress, or heated samples can be combined with the new strong parallel beam optical system with built-in polycapillary unit.

#### WINDOWS 7-compatible

The system uses the stable WINDOWS 7 software platform, resulting in excellent multitasking and networkability. The unit control and data processing software is based on the highly regarded XRD-6100 software with enhancements to improve ease of operation.

#### Safety-first design

The casing incorporates the same door lock mechanism as the XRD-6100 and was designed with safety from X-ray exposure in mind.

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# Applications of X-Ray Diffractometry



## Ferrous metals

### Steel

Qualitative analysis of steel sheet, measurement of residual austenite and residual stress, analysis of friction and wear test samples, measurement of iron oxide films and nitride layers, evaluation of plating and texture.

### Cast iron

Qualitative analysis of precipitates and additives in cast iron.

### Surface-treated steel

Evaluation of characteristics of surface-treated areas, quality control, residual stress measurement.



## Non-ferrous metals

### Copper and zinc

Qualitative analysis of alloys, orientation measurements of foil samples, evaluation of texture, qualitative analysis of plated areas.

### Aluminum

Qualitative analysis of aluminum and aluminum alloys, oxides and nitrides, evaluation of texture in rolled material.

### Other metals

Qualitative analysis of metal alloys, oxides and nitrides, evaluation of characteristics of surface-treated areas, residual stress measurement.



## Machinery, automobiles, shipbuilding

### Machinery

Qualitative analysis of tool steels, surface analysis of machined parts, analysis of austenite layers, qualitative analysis of surface plating, residual stress measurement.

### Automobiles and shipbuilding

Qualitative analysis of structural parts, quantitative analysis of austenite, residual stress measurement.

Qualitative analysis of exhaust gas catalyts.



## Chemicals and catalysts

### Chemicals

Qualitative analysis of organic and inorganic chemicals, analysis of impurities.

### Catalysts

Qualitative analysis and degree of crystallinity measurements, measurement of crystallite size to check final product.



Model S vertical  $\theta$ - $\theta$  goniometer



## Ceramics

### Porcelain and ceramics

Qualitative analysis of raw materials, final product evaluation, analysis of crystal structures during heating (crystal system, crystallite size, lattice constant).

### Cement and glass

Qualitative and quantitative analysis of clinker and cement (free lime, etc.), qualitative analysis of raw materials. Qualitative analysis and orientation measurements of thin film layers formed at the glass surface.



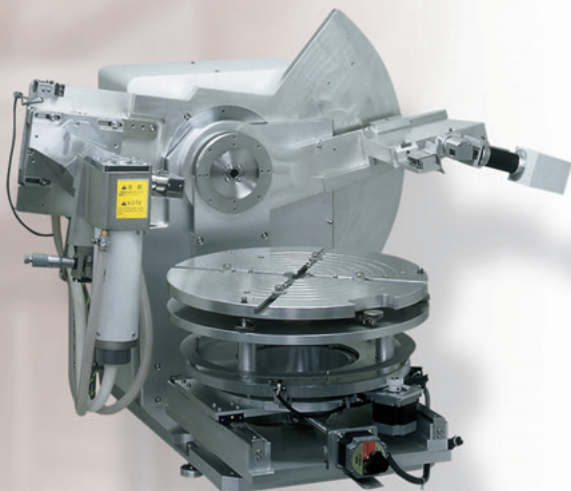
## Pharmaceuticals and medical treatment

### Pharmaceuticals

Qualitative analysis of raw materials, identification of impurities. Crystal polymorphism analysis and degree of crystallinity measurements, quality control during pharmaceutical manufacture using crystallite size measurement. Product final quality check and crystal polymorphism analysis related to patents.

### Dental materials

Qualitative analysis of dental materials such as apatite.



Model L vertical  $\theta$ - $\theta$  goniometer



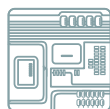
## Resources and energy

### Coal, oil, natural gas

Plant-scale qualitative analysis, evaluation of carbon materials, evaluation of catalysts during petroleum refining .

### Rocks and minerals

Qualitative analysis of raw materials and identification of impurities. Qualitative/quantitative analysis of asbestos minerals (compatible with PRTR method).



## Electrical and electronic materials

### Electrical components

Qualitative analysis of corrosion and adhering matter on electrical contacts. Stress measurements in structural parts, qualitative analysis of plated parts.

### Electronic components

Qualitative analysis and orientation measurements of thin-film electronic materials. Measurement of substrate crystal orientation for magnetic heads and electronic elements.

### Superconductors

Crystal structure analysis of superconducting materials using the Rietveld method.



## Construction and civil engineering

Qualitative/quantitative analysis of asbestos in construction materials. Qualitative analysis of construction materials such as tiles and bricks.



## Environment and industrial wastes

### Environment

Qualitative/quantitative analysis of asbestos in the work environment. Qualitative analysis of dust.

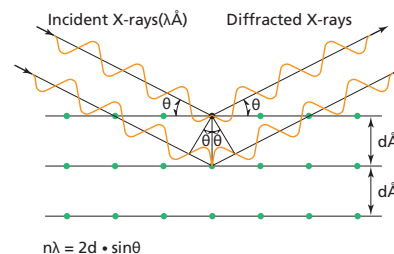
### Industrial waste

Qualitative analysis of residual matter in plating liquids, combustion ash, coal ash, and furnace slag.

# Basic Construction is Corresponded with a Wide Range of Applications

## Principle of operation

The XRD-7000, an X-ray diffractometer analyze crystalline states under normal atmospheric conditions. This method is non destructive. X-rays focused on a sample fixed on the axis of the spectrometer (goniometer) are diffracted by the sample. The changes in the diffracted X-ray intensities are measured, recorded and plotted against the rotation angles of the sample. The result is referred to as the X-ray diffraction pattern of the sample. Computer analysis of the peak positions and intensities associated with this pattern enables qualitative analysis, lattice constant determination and/or stress determination of the sample. Qualitative analysis may be conducted on the basis of peak height or peak area. The peak angles and profiles may be used to determine particle diameters and degree of crystallization, and are useful in conducting precise X-ray structural analysis.



## Fields of application

Steel, non-ferrous metals, machinery, shipbuilding, welding, automobiles, ceramics, cement, glass, catalysts, electric components, electronic materials, magnetic materials, superconductors, textiles, paper and pulp, foods, chemicals, pesticides, dyes, pigments, paints and ink, pharmaceuticals, dental materials, biological materials, oil and coal, electrical power, gas, ores, soil and rocks, clays, minerals, construction and civil engineering, environment, industrial waste products.

## Construction

### X-ray-protected housing

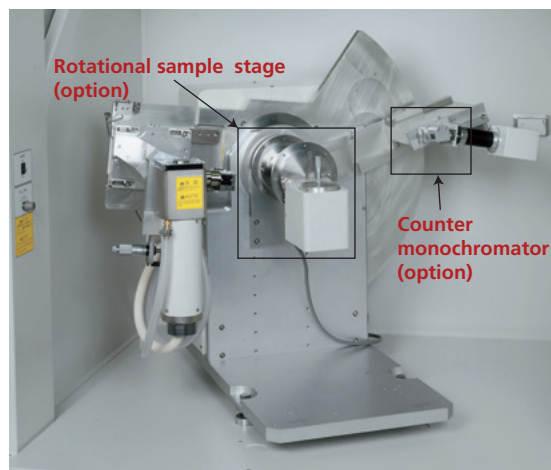
The front door is mounted on guide rollers to enable extremely light-touch and smooth door opening for facilitative installation/exchange of samples and attachments. A magnet latch assures certain door closing, and to further ensure safety, a door interlock mechanism is automatically activated whenever X-rays are generated.

### High-precision, vertical goniometer

High-speed rate (1000°/min) and high-precision angle reproducibility (0.0002°) provide fast measurement and highly reliable data. The  $\theta$ - $\theta$  goniometer unit allows analysis of samples in various states, substantially widening the application range. The drive mechanism features an independent dual axis  $\theta$ - $2\theta$  linkage drive, and independent  $2\theta$  and  $\theta$  axis drives, freely selectable for efficient thin film and various other types of analysis.

### High voltage transformer for high output X-ray tube

The high voltage transformer supports either the 2.2kW high output fine focus X-ray tube or 2.7kW high output broad focus X-ray tube.



High-precision  $\theta$ - $\theta$  Goniometer

## Construction

### X-ray tubes

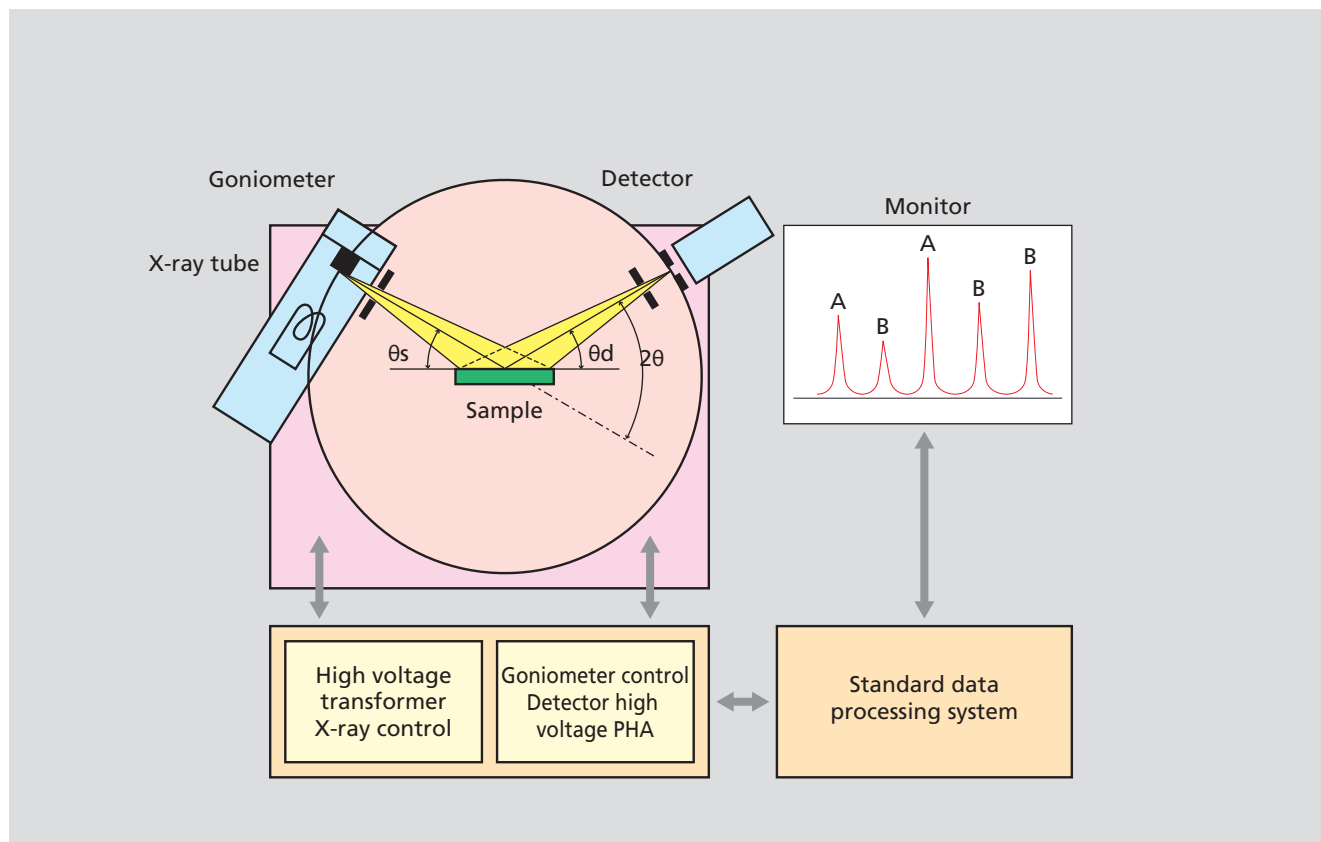
The XRD-7000 will accept various types of X-ray tubes, including the normal focus (NF) 2kW type and broad focus (BF) 2.7kW type, which are standard accessories, as well as the optional long fine focus (LFF) 2.2kW type. By attaching the optional counter monochromator, all types of samples, including Fe samples can be analyzed using the standard Cu X-ray tube.

### Highly stable X-ray generator

Shimadzu's long experience in producing high-performance X-ray generators has provided an X-ray generator of high stability, with tube voltage and tube current both stable to within  $\pm 0.01\%$ . This stability is unaffected during fluctuation of source voltage or ambient temperature, ensuring high reliability of data even during prolonged periods of data acquisition.

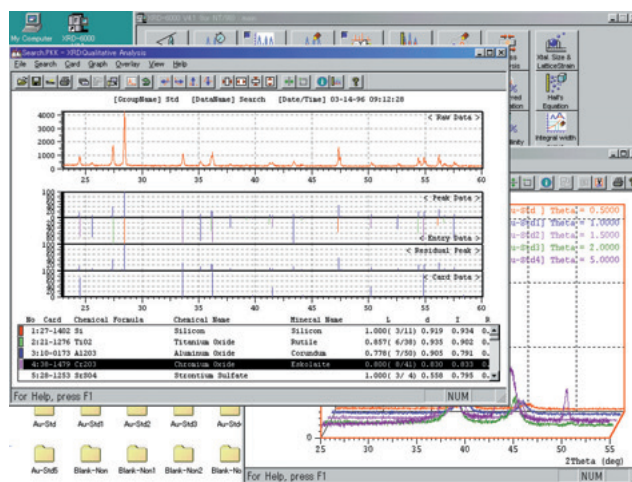
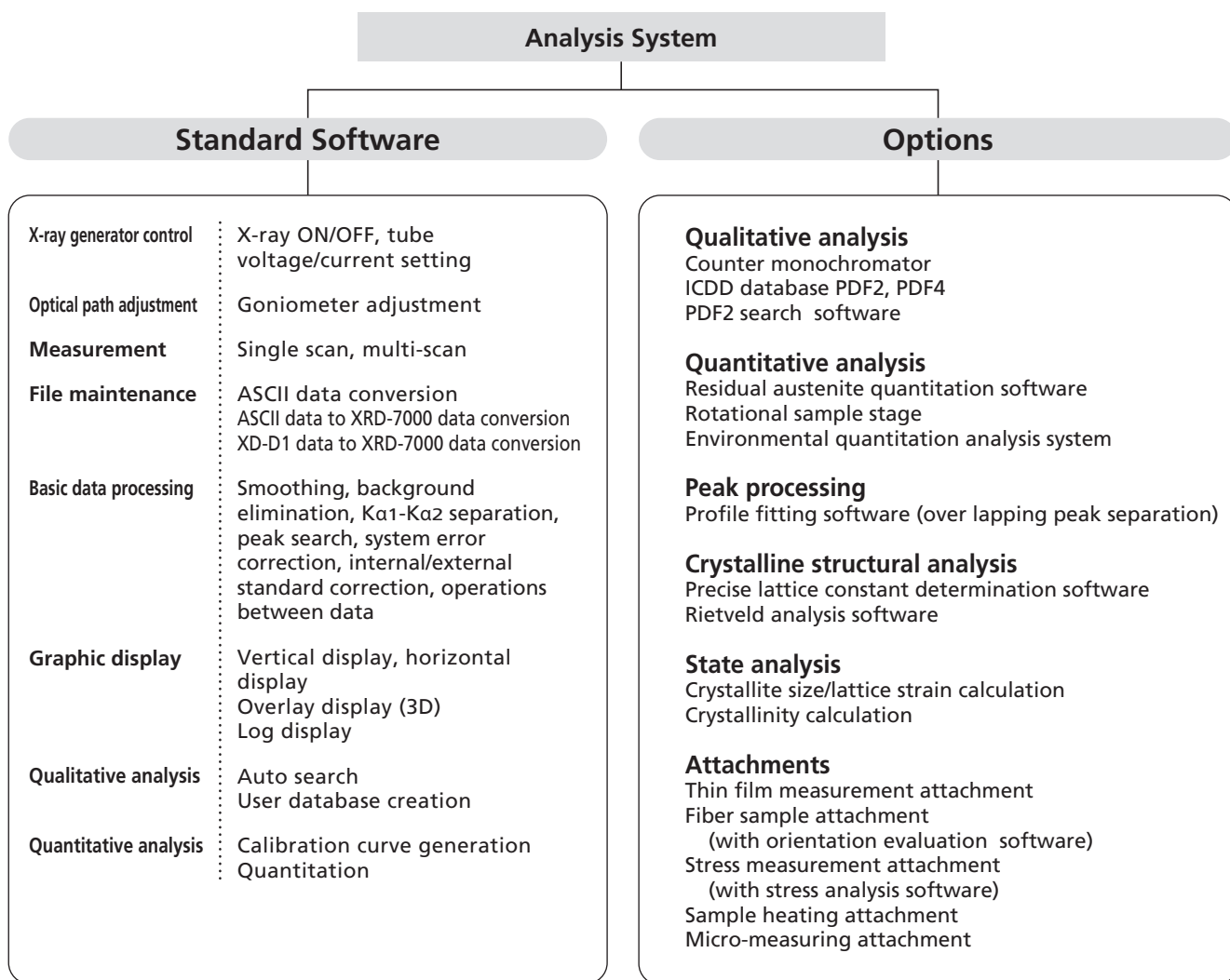
### Data Processing System

Instrument control and data processing are handled by a IBM PC/AT compatible PC, provided with abundant operation software pre-loaded on a large capacity hard disk drive, enabling high-speed analytical calculations in a user-friendly Windows environment. Windows 7 compatibility further enhances stability.



XRD-7000 Relational Diagram

# Providing a Complete Analysis System



Auto search results and thin film sample overlay display



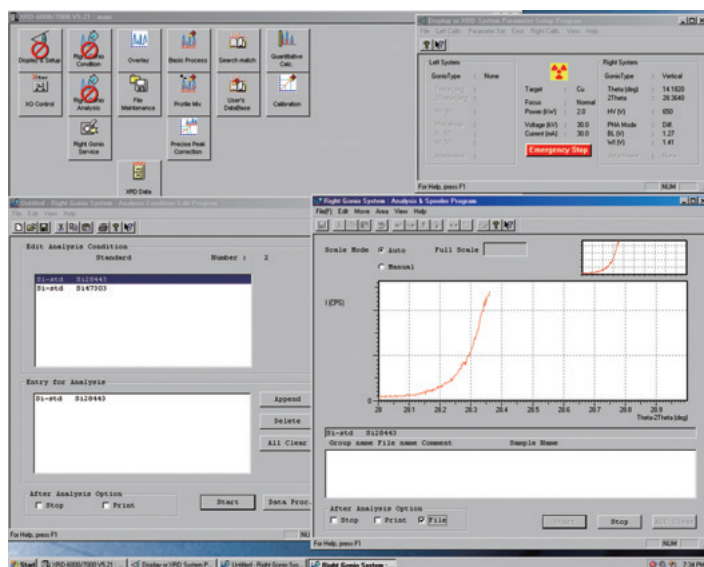
# Automatic Measurement, Easy Operation

[ Fully automatic goniometer optical system adjustment with automatic saving of adjustment data ]

## Measurement Display

Sample measurement condition can be set by easy operation.

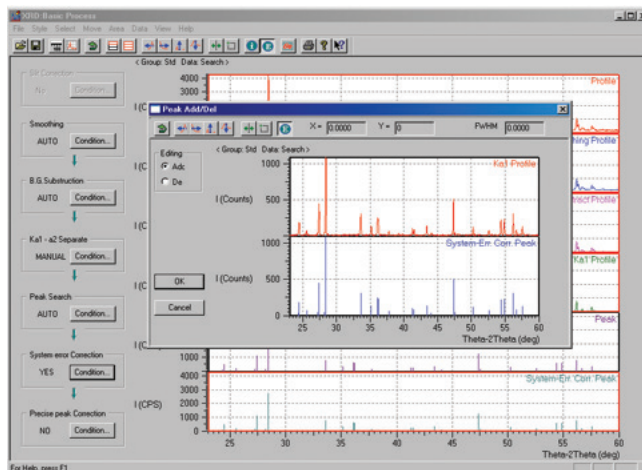
The scheduling and the progress condition of the measurement can be confirmed at one view by the analysis spooler.



# Multitasking Enhances Analysis Efficiency

## Basic Data Processing

The multitasking capability provided with the Windows 7 operating environment allows measurement and data processing to be conducted simultaneously, enhancing the efficiency of analysis operations.

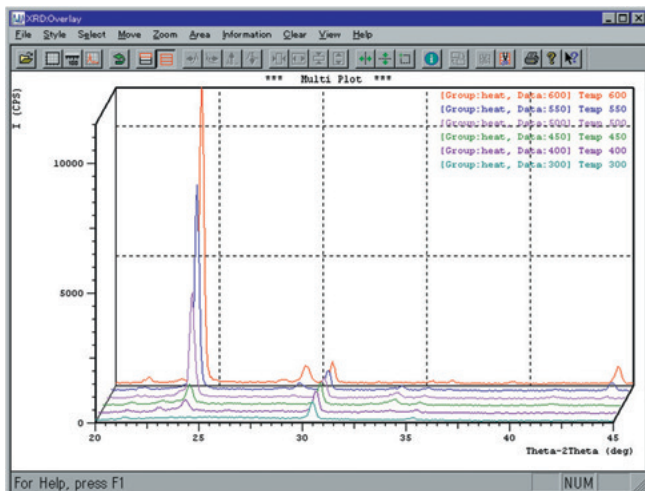


Basic Data Processing Screen

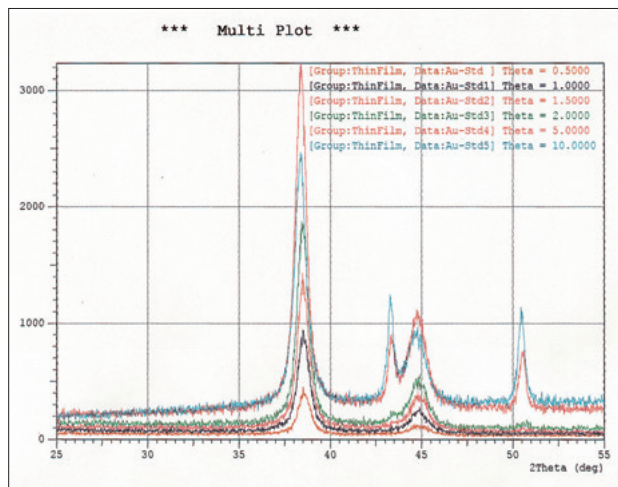
# Pleasant Data Processing Environment

## Graphic Display

Data can be freely zoomed with a click of the mouse, so profile comparison of thin film data or heating measurement data etc. is easily accomplished using combined 2-dimensional or 3-dimensional display. The software also features a variety of other useful graphic functions, such as intensity Log conversion display and hidden-line processing on the 3-dimensional display, among others. Each type of data can be output to the color printer, so differences between samples can be recognized at a glance.



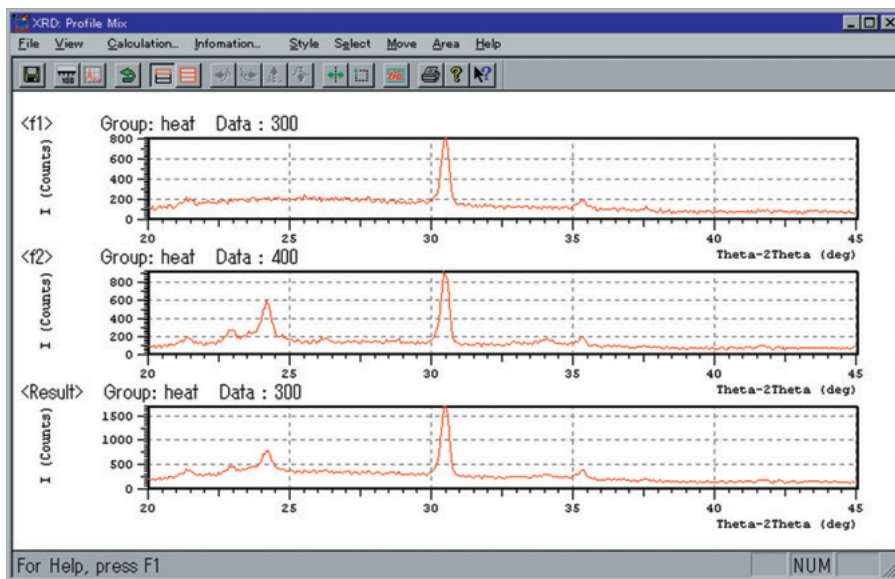
3-Dimensional Screen of Thin Film Sample



2-Dimensional Output of Thin Film Sample

## Adding/Subtraction operations

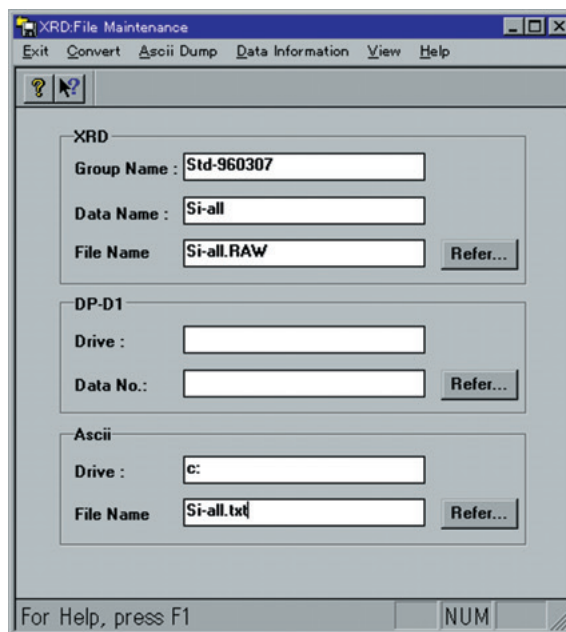
Data manipulation functions such as deletion of unnecessary peak profiles and addition of re-analyzed data to obtain a summed profile are some of the invaluable tools available for conducting efficient data analysis. Spectral calculations are conducted in the window displayed at right.



Spectral Calculation Window

## File Maintenance –Data Format Conversion–

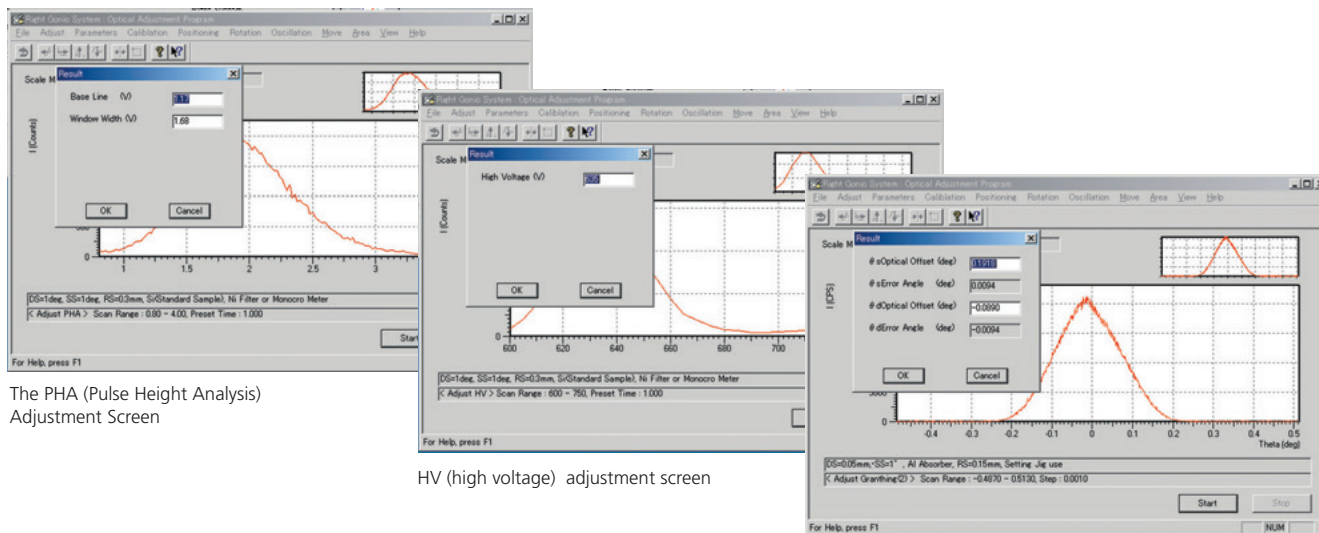
With the XRD-7000, digital data measured by other x-ray diffractometers can be converted into files to enable analysis using this data processing software. The data from Shimadzu's x-ray diffractometers XRD-6000/6100 can be used without alteration and a dedicated file conversion window has been made available for the XD-D1 and XD-610 models. In the case of other x-ray diffraction data,  $2\theta$  angle and x-ray intensity text files (ASCII data) can be converted into XRD-7000 data format. In reverse, raw data measured by the XRD-7000 also can be converted into text files or files formatted to enable Rietveld analysis. Furthermore, processed data including peak data, as well as raw data, can be converted to text format, facilitating data processing in customized format.



File Conversion Window

## Optical System Adjustment

The XRD-7000 allows fully automatic adjustment of the goniometer optical system (including optional attachments) from the computer screen. The zero adjustment of the  $qs$  and  $qd$  axes, X-ray detector high voltage setting, PHA baseline setting, and window width setting are conducted automatically and the associated adjustment data is saved automatically. These functions are useful for daily maintenance operations.



The PHA (Pulse Height Analysis) Adjustment Screen

HV (high voltage) adjustment screen

$\theta_s/\theta_d$ -axis adjustment Screen

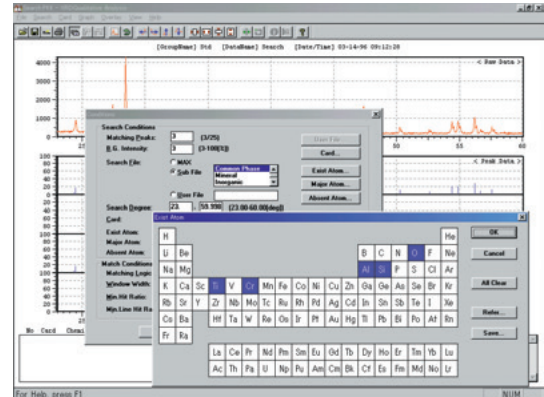
# Enhanced Auto Search System

[ Auto Search, General Quantitation Software Provided as Standard ]

Identification work can be performed efficiently on screen.

## Detailed search parameters can be set.

To obtain correct results with automatic search/match, search parameters that conform to each sample must be set. The XRD-7000 enables the setting of detailed search parameters such as selection of files to be used in the search and three levels of element data input.



Search Parameter Setting Screen

## Replete with second search function for authoritative identification of small amount of components.

Identifying small amount of components with a primary search is difficult, a second search is needed after the major components have been identified. The XRD-7000 comes replete with a second search function to provide an environment for easy identification of small amount of components.

## Various search result data can be displayed.

Search results can be stack-displayed with each standard data display over raw data. Also, for easy comparison, standard substance names, chemical equations, ore names, Miller indices, and ICDD numbers can be displayed on each peak. Furthermore, an easy quantitative calculation function using a corundum ratio for candidate substances (Intensity ratio for the  $\alpha$ -Al<sub>2</sub>O<sub>3</sub> strongest peak) is included in the equipment. If your system has a PDF 2 or PDF 4 database, PDF 2 or PDF 4 detailed data for candidate substances can be displayed on a separate window.



Search Result Screen

## Dedicated user database can be created.

The user's very own database file - separate from the sub-file supplied by ICDD (International Center for Diffraction Data) - can be created. Selected ICDD standard data and substance data not registered with ICDD can be input into this file. And data obtained through measurements by the XRD-7000 can be registered as they are in the database file, which means that the user's basic samples can be registered, and comparisons made with those substances to provide an extra dimension to quality control.

No.	JCPDS #	Chemical Formula	Mineral Name	3-Strongest lines...d(Å)	q.m.
1	10-0173	Al <sub>2</sub> O <sub>3</sub>	Corundum, syn	2.07(100) 1.18(20) 1.45(14)	*
2	33-0628	AlFe	Aluminum, syn [	2.34(100) 2.02(47) 1.22(24)	*
3	04-0787	Al	Aluminum, syn [	2.36(100) 2.04(52) 1.23(26)	*
4	04-0784	Au	Gold, syn	2.36(100) 2.04(48) 1.23(26)	*
5	04-0783	Ag	Silver-31T(100)	2.12(100) 2.45(72) 1.50(45)	*
6	38-1420	TiN	Snbomite, syn	2.12(100) 2.45(72) 1.50(45)	*
7	06-0696	Fe	Iron, syn	2.03(100) 1.17(30) 1.43(20)	*
8	35-0819	(Fe,C)		2.04(100) 1.00(00) 1.00(00)	o
9	26-1879	C	Graphite-31TR\	3.35(100) 2.00(11) 1.96(9)	o
10	11-0865	CeB	Caalborzite, s	2.07(100) 2.39(80) 1.46(80)	b
11	05-0694	Cr	Chromium	2.04(100) 1.10(30) 0.91(20)	*
12	05-0727	Co	Chromium, syn	1.93(100) 1.25(00) 1.13(00)	b
13	04-0836	Cu	Copper, syn	2.09(100) 1.01(46) 1.20(20)	*
14	35-0821	Mg		2.45(100) 2.61(36) 2.70(25)	*
15	38-0784	HgI <sub>2</sub>		3.05(100) 2.04(100) 1.17(100)	o

User Database Creation Screen

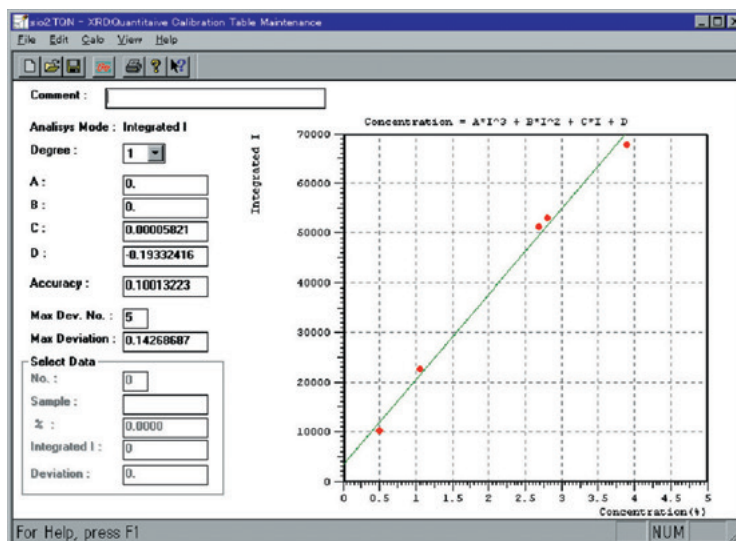
# Polished Quantitation Software

[ Satisfies your analysis objectives ]

## Calibration Curves

Calibration curves can be generated for intensity, integrated intensity or intensity ratio.

Intensity and integrated intensity calculations are used for the internal standard and standard addition methods.

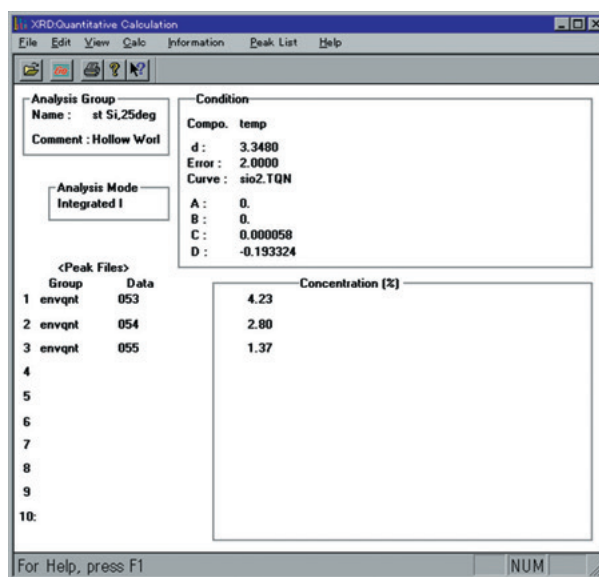


Calibration Curve Screen for Integrated Intensity

## Quantitative Analysis

The internal standard method and 2 intensity methods are available to satisfy most of the application needs.

Further, up to 5 peaks may be specified for quantitation and up to 10 sets of data may be calculated simultaneously.



Integrated Intensity Quantitation Results Screen

Note: Residual austenite quantitation and environmental quantitation software packages are optional.

# Range of Attachments

## Qualitative analysis

### ■ Counter monochromator

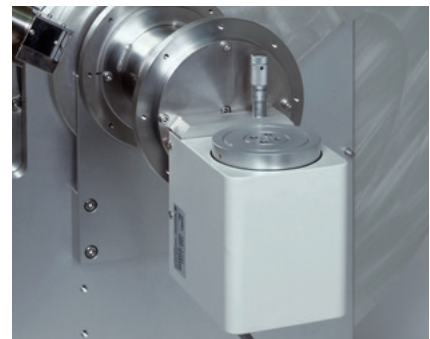
Qualitative analysis (identification) is the most common analysis conducted with X-ray diffractometers. The counter monochromator is an attachment that enhances the accuracy of qualitative analysis. The counter monochromator obtains data with a good S/N ratio. A combination of Cu X-ray tube and Cu tube monochromator can cut the fluorescent X-rays from Mn, Fe, Co, and Ni samples and is applicable to a wide range of sample types.



## Thin-film measurements

### ■ Thin-film measurement attachment

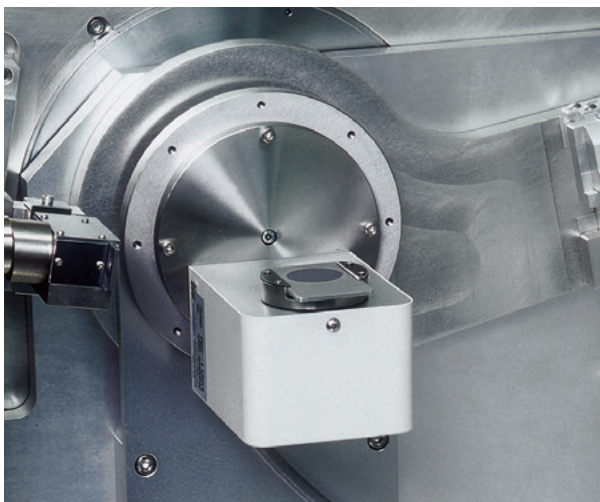
This attachment is effective for the measurement of samples with sub-micron thickness. Conducting parallel beam diffractometry at low angles of incidence restricts the penetration of incident X-rays into the underlying substrate to achieve high-sensitivity X-ray analysis of the surface layer only. In addition, by conducting measurements while changing the angle of X-ray incidence, the thin film thickness can be approximately determined by detecting the angle at which diffracted X-rays from the substrate are detected. The sample stage incorporates a rotation mechanism that permits orientation measurement of the thin-film layer.



## Quantitative analysis

### ■ Rotational sample stage/environmental measurement stage

Rotational sample stage is effective for the quantitative measurement precisely because the X-Ray diffraction from the sample can be detected more efficiently and the influence of orientation when loading the sample can be reduced by rotation of stage. Environment measurement stage can measure the quantitative analysis which is complied with "work environment quantification method" for measurement of asbestos and free silicic acid in work environment.



Rotational sample stage



Environmental measurement stage

## Heated sample measurement

### ■ Sample heating attachment

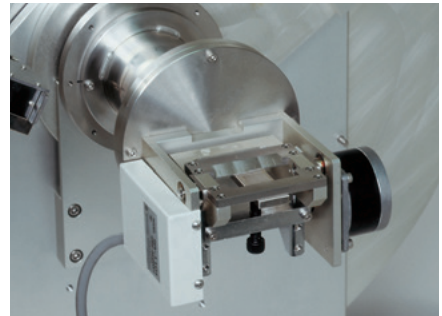
The sample heating attachment allows analysis of samples at various temperatures. Versions of this attachment are available for low-, medium-, and high-temperature ranges to suit the analyzed sample and analysis temperature range.



## Stress measurement

### ■ Stress measurement attachment

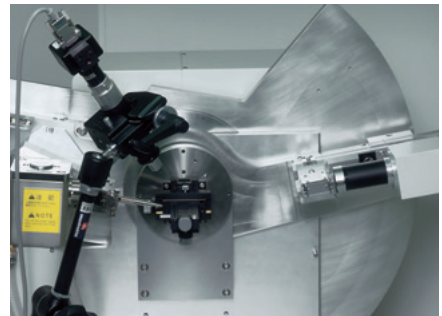
Stress measurement using X-ray diffraction is non-destructive and permits the measurement of residual stresses, making it a widely used method for the performance evaluation and quality control of mechanical parts. The stress measurement attachment permits measurement by both the side-inclination and iso-inclination methods to achieve stress measurements in mutually perpendicular directions at a same position. The side-inclination method permits measurements in depressions in a sample, such as at the root of gear teeth.



## Small area measurements

### ■ Micro measurement attachment

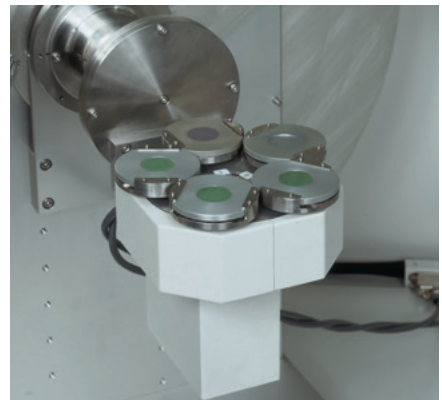
The micro measurement attachment is used to measure minute areas of the sample. The attachment comprises a pinhole slit to control the incident X-ray beam, an analysis position setting stage, and a microscope with a CCD camera to determine the measurement position. Determination of the measurement position is simple. The video capture function allows a photograph of the measurement position to be saved with the measured data.



## Automatic analysis

### ■ Auto Sample Changer for 5 samples

This stage automatically changes samples for measurement. Up to five samples can be loaded for fully automatic qualitative analysis or other measurements.



# Large-sample stage (R- $\theta$ stage)

## Load samples up to 350 mm diameter.

Large samples up to 350 mm diameter and 190 mm thickness can be directly mounted on the R- $\theta$  stage. Any point on the sample can be selected for measurement.

Setting the measurement range permits fully automatic mapping (stress, quantitative analysis, etc.) of measurement results.

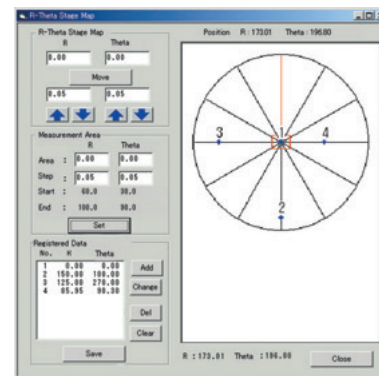


## Automatic stress mapping system

After loading the sample, confirm the measurement position while moving the R- $\theta$  stage using the R- $\theta$  stage map screen (right) and set the R and  $\theta$  start point, end point, and steps.

The optional CCD camera kit permits the measurement position to be confirmed on the screen.

After setting the positions, simply press start to conduct fully automatic mapping and automatically calculate the stress analysis results. Results of separate measurements can be superimposed.

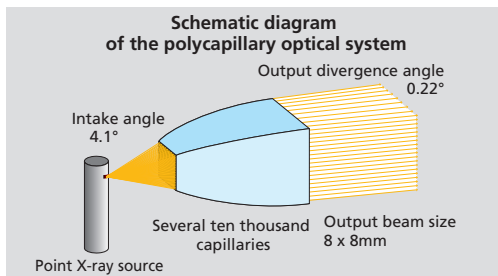


R- $\theta$  stage setting screen

# Polycapillary optical system

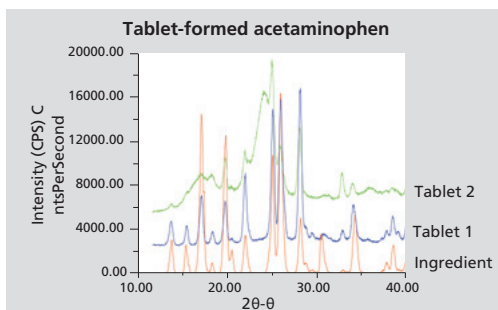
## Principle of the polycapillary optical system

The fine glass capillaries in the order of several microns are arranged in a solid as guides to multiple X rays. The X-rays pass along each capillary while repeating total internal reflection and exit from the opposite end of the polycapillary system. The capillaries are curved to that repeated total internal reflection is allowed, and the X-rays from the point X-ray source exit the unit as a parallel beam with a large solid angle.



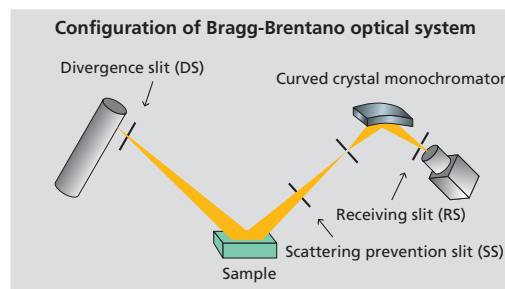
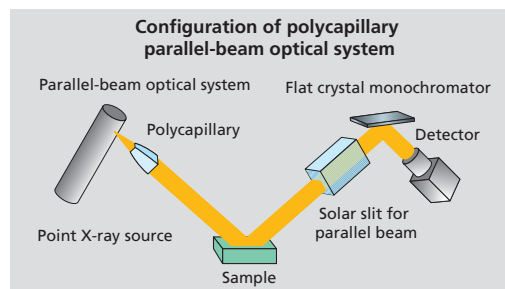
## Sample measurement using the polycapillary optical system

This example shows measurements of the raw drug acetaminophen and its tablets during the process of manufacturing. Tablets can be directly analyzed to evaluate the degree of crystallinity and crystal polymorphism. The XRD-7000 is able to perform accurate, highly sensitive measurements on irregular surfaces or curved surfaces like this.



## Features of the polycapillary optical system

Compared with the conventional focused beam system and the normal parallel-beam system, the polycapillary optical system more efficiently exploits the beam from the X-ray tube, resulting in higher diffraction X-ray intensity. A displacement of the sample in a Bragg-Brentano optical system can move it outside the focus, causing a significant displacement in diffraction angle and a dramatic drop-off in diffraction X-ray intensity. Conversely, a displacement of a few millimeters in a parallel-beam system has no effect on the diffraction angle and a few decrease on the diffraction X-ray intensity. Consequently, incorrect loading of the upper and lower sample faces or an uneven sample surface causes no angular displacement and accurate measurement is possible. The parallel-beam system also allows analysis of curved surfaces, something not possible with conventional optical systems.

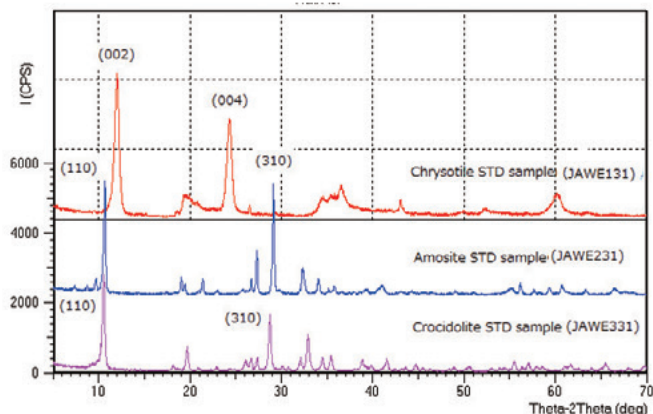




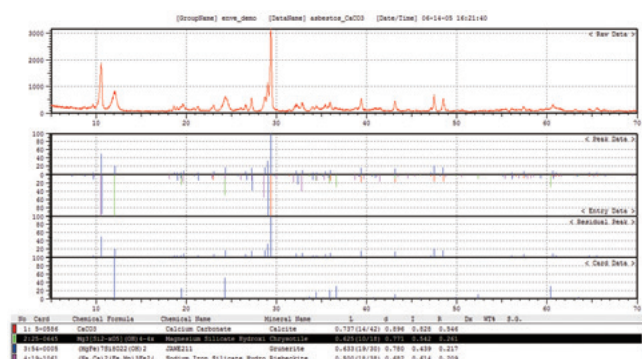
# Qualitative and quantitative analysis of asbestos and free silicic acids

The concentration of asbestos in construction materials is measured using phase contrast dispersion staining microscopes and X-ray diffractometers. After pulverizing the sample acquired from the site in a pulverizer, a phase contrast dispersion staining microscope and X-ray diffractometer are used respectively to qualitatively analyze the sample. If the sample is determined to contain asbestos at this stage, then it is quantitatively analyzed using the X-ray diffractometer. In actual practice, asbestos analysis (JIS A 1481) requires sensitivity sufficient to determine 0.1 % content by weight in 100 mg of acquired sample. To increase sensitivity so that such trace asbestos levels can be detected, formic acid is used to dissolve matrix components in the pulverized sample. Then the residue after formic acid treatment is recovered in a fluorocarbon polymer binder filter using a suction filtration system for use in quantitative analysis. In this case, the quantitative analysis is performed using an X-ray diffractometer, where the absorption of diffracted X-rays must be corrected to compensate for the asbestos itself and the undissolved matrix components. This correction process (base standard absorption correction method) involves first measuring the metal plate (base plate) for a blank filter, placing the filter with the formic acid-treated asbestos in the diffractometer, and measuring the asbestos together with the metal base plate to determine a correction factor from the diffraction intensity ratio of the metal plate. Then that correction factor is used to determine the corrected asbestos diffraction intensity. Note that this method was originally developed for measuring the free silicic acid content in mineral particulates during work environment measurements. The XRD-7000 X-ray diffractometer environmental measurement package includes a user database for environmental samples, which is effective for increasing the accuracy of qualitative analysis, a filter holder and rotational sample stage for use in the base standard absorption correction method, and environmental quantitation software for performing quantitative calculations that correct for absorption. This environmental quantitation software incorporates Shimadzu's proprietary measurement expertise cultivated from many years in this field, which is especially valuable when quantitating particularly trace levels of asbestos.

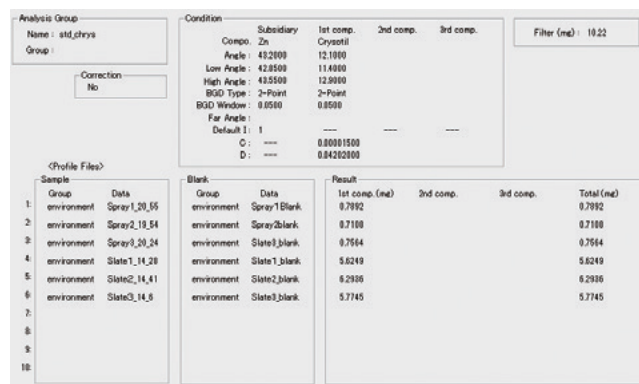
In addition, this XRD-7000 X-ray diffractometer environmental measurement package is compliant with methods specified in the Notification No. 0828001 by the Director of the Chemical Hazards Control Division, Industrial Safety and Health Department, Labour Standards Bureau, Ministry of Health, Labour and Welfare of Japan, such as for analyzing asbestos in natural minerals or measuring the free silicic acid content in mineral particulates during work environment measurements.



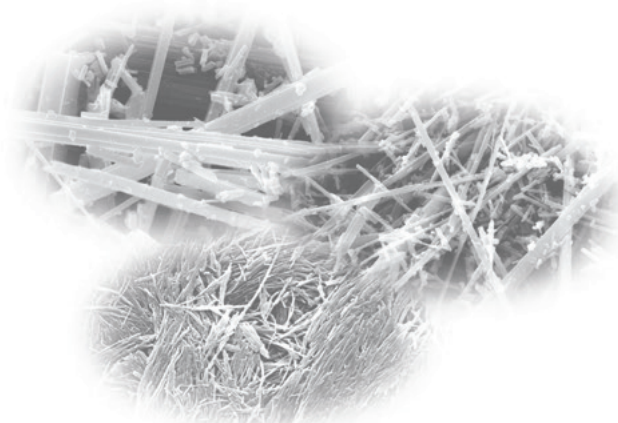
The major types of asbestos are serpentine asbestos (chrysotile) and amphibole asbestos (amosite and crocidolite). The characteristic peaks of these types can be quantitatively analyzed by X-ray diffractometry.



Qualitative analysis results for asbestos



Screenshot of environmental quantitation software



# Accessories

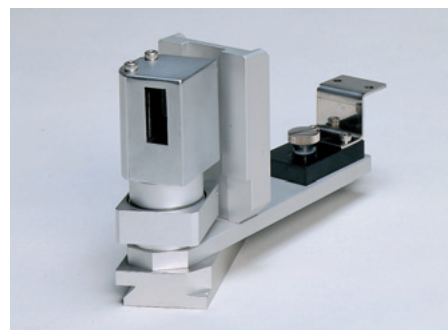
## Qualitative Analysis

### Counter monochromator

Installed in the X-ray detector unit, the counter monochromator transforms X-rays which have passed through the entrance slit into monochromatic X-rays, allowing only the characteristic X-rays (K $\alpha$  rays) to be detected. Exclusion of all other X-rays from the sample, including continuous rays and K $\beta$  rays as well as fluorescent X-rays, ensures diffraction patterns with a high signal-to-noise ratio.

Part Description	Application	P/N
Counter monochromator CM-3121	Cu X-ray tube	215-22360-02
Counter monochromator CM-3131	Co X-ray tube	215-22360-03
Counter monochromator CM-3141	Fe X-ray tube	215-22360-04
Counter monochromator CM-3151	Cr X-ray tube	215-22360-05

Note: Cannot be used together with OneSight wide-range high-speed detector.



### ICDD PDF2 / PDF4

This is the powder X-ray diffraction database provided by ICDD. PDF2 is provided on CD-ROM, and contains, in addition to substance name, chemical formula and d-I data, miller indices, lattice constants, space groups and other crystallographic information. Using additional PDF2 Automatic Search Software, unknown substances may be easily identified via the registered crystallographic information.

ICDD PDF2	P/N for Educational institutions	P/N for Other uses
Single license	239-50002-12	239-50002-11

Note: The license is valid for five years. It can be extended for five more years for free at the time of the license period ends.

In addition to the functions of PDF2, database PDF4 has the functions of data searching software (DDView+), the display of 2D, 3D structural chart, various lattice parameters, and the simulation wave form by the calculation, and the import of the measurement data. There are two kinds of databases of PDF4+ (for general) and PDF4/Organics (for organics).

ICDD PDF4+	P/N for Educational institutions	P/N for Other uses
Single license (New, 1years license)	239-50015-02	239-50015-01
Single license (Renewal, 1years license)	239-50015-04	239-50015-03
Single license (Renewal, 3years license)	239-50015-06	239-50015-05
Single license (Renewal, 5years license)	239-50015-08	239-50015-07

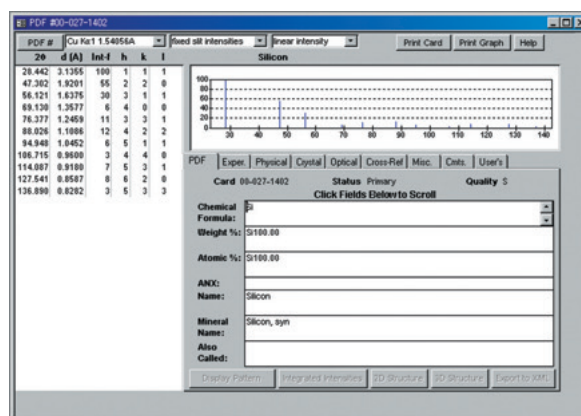
ICDD PDF4 / Organics	P/N for Educational institutions	P/N for Other uses
Single license (New, 1years license)	239-50015-22	239-50015-21
Single license (Renewal, 1years license)	239-50015-24	239-50015-23
Single license (Renewal, 3years license)	239-50015-26	239-50015-25
Single license (Renewal, 5years license)	239-50015-28	239-50015-27

### PDF2 Search Software

Searches can be performed from the card No., as well as based on multiple elements using "AND" or "OR" conditions, with analyte identification and crystalline structure obtained simultaneously.

PDF2 Search Software (DDView)  
Single license

Note: DDView is included in PDF2 Database.



## Quantitative Analysis

### Rotational Sample Stage RS-1001

The RS-1001 performs in-plane rotation of the sample in combination with oscillation around the goniometer sample axis ( $\theta$ ) to minimize the scatter in diffraction pattern intensities attributable to the sample crystalline orientation, and thereby enhance the precision in most types of quantitative analysis.

#### Main specifications

- Rotation  $\beta$  axis (sample in-plane)
- Rotation speed 1 to 60rpm
- Minimum step width 0.1 degree
- Operation modes Constant speed rotation, oscillation sample in-plane rotation scan (continuous, step)
- Measuring angle range  $2\theta$  5° to 163°

Part Description	P/N
Rotational sample stage (without option driver)	215-21766-01

Note: Please arrange optional additional ASSY with optional driver ASSY at the same time. Please refer to the paragraph of a special accessory on page 28.



## Quantitative Analysis

### Environmental Measurement Stage RS-2001

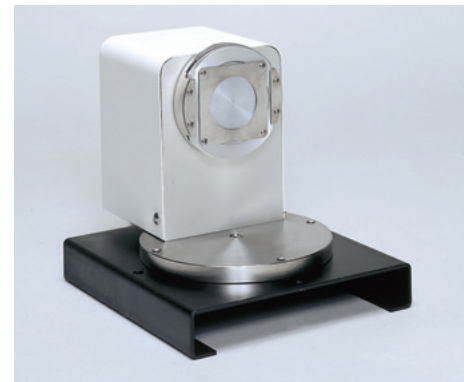
A complete environmental analysis system, this comprises a special environmental quantitative analysis stage, filter holder and quantitation software. A special filter holder is provided which allows measurement using an asbestos-imbedded filter just as it is. The main specifications of the environmental stage are the same as those of the general purpose rotational sample stage. The calibration curve correction is based on Zn, however, when the diffraction line of the sample overlaps with that of Zn, an Al sample holder (optional) is also available. The sample stage option driver can also be used with the rotational sample stage.

#### Main specifications

- Measuring angle range  $2\theta$  5° to 163°

Part Description	P/N
Environmental Analysis Stage (with S/W)	215-21767-03
Al filter holder ( $\phi$ 25)	215-23765-92
Aluminum sample holder (5PC)	215-22507-06
Aluminum sample holder with penetration-hole (5pc)	215-22507-10

Note: Please arrange optional additional ASSY with optional driver ASSY at the same time. Please refer to the paragraph of a special accessory on page 28.



### Environmental Quantitation Software (P/N 215-00421-92)

Environment samples as suspended dust particles, in very small quantity, collected on filter present an analytical challenge. XRD-7000 allows a reliable analysis. The software eliminates the effect X-ray absorption by the filter, providing a calibration curve having good linearity and high accuracy. The software associated with the use of a special sample holder allows the application of a very efficient filter absorption correction. Three compositions can be calculated simultaneously.

Sample Name	Substrate	Comp	1st comp	2nd comp	3rd comp	File Ingt
Condition	Comp	Zn	1st comp	2nd comp	3rd comp	10.22
Angle	43.1900	12.1000	20.0000	20.0000	20.1200	
Low Angle	42.8000	12.0000	20.0000	20.0000	20.0000	
High Angle	43.5800	12.2000	20.0000	20.0000	20.2400	
RD Type	2Phase	2Phase	2Phase	2Phase	2Phase	
RD Index	0.0000	0.0000	0.0000	0.0000	0.0000	
Far Angle	123.0000	---	---	---	---	
Calcd I	C	0.0000000	0.0000000	0.0000000	0.0000000	
Obs I	C	0.0700000	0.2000000	0.1000000	0.1000000	

iPhase (%)	Sample	Comp	Status	1st comp	2nd comp	3rd comp	4th comp	Total
1	Calc	alpha=0	Calc	20+1	0.0000	0.2000	0.1000	0.3000
2	Calc	alpha=1	Calc	20+1	0.0000	0.2000	0.1000	0.3000
3	Calc	alpha=2	Calc	20+1	0.0019	0.2004	0.1004	0.3027

Quantitation Results Screen

# Accessories

## Automatic Analysis

### Auto 5 Position Sample Changer (ASC-1001)

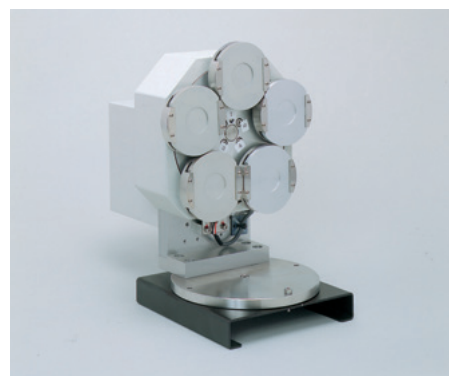
This stage is used in order to automatically measure maximum 5 samples. The ASC-1001 performs in-plane rotation of the sample in combination with oscillation around the goniometer sample axis ( $\theta$ ) to minimize the scatter in diffraction pattern intensities attributable to the sample crystalline orientation. Also it is possible to avail filter holder (option) for Environmental Measurement Stage RS-2001.

#### Main specifications

- Sample position 5
- Sample Size Powder: 25mm  $\phi$   
Filter: 25mm or 47mm  $\phi$  (option)
- Rotation speed 1 to 60rpm
- Measuring angle range 2 $\theta$  7° to 163°

Part Description	P/N
Auto 5 position sample changer (with a option driver unit)	215-23175-01
Zn filter holder (25mm $\phi$ ) 5pc/set	215-23760-91
Al filter holder (25mm $\phi$ ) 5pc/set	215-23760-92

Note: Please arrange optional additional ASSY with optional driver ASSY at the same time. Please refer to the paragraph of a special accessory on page 28.



## Automatic Analysis

### Sample plates for RS-2001 and ASC-1001

This stage is used in order to automatically measure maximum 5 samples. The ASC-1001 performs in-plane rotation of the sample in combination with oscillation around the goniometer sample axis ( $\theta$ ) to minimize the scatter in diffraction pattern intensities attributable to the sample crystalline orientation.

Also it is possible to avail filter holder (option) for Environmental Measurement Stage RS-2001.

Part Description	P/N
Aluminum sample holder (5pc)	215-22507-06
Glass sample holder (5pc)	215-22507-07
Glass Micro sample holder (5pc)	215-22507-08
Non-reflcttive sample holder (2pc)	215-22507-09

## Attachments

### Thin Film Analysis using Attachment THA-1101

This is a specialized thin film analysis system, including the thin film sample stage, monochromator and suction pump.

Employing the fixed incidence angle, parallel X-ray diffractometry method, penetration of incident X-rays into the substrate sample is limited as much as possible, providing low background, thin film X- ray diffraction patterns. Specimens are easily set in place using the suction pump.

The sample stage option driver can also be used with the rotational sample stage.

#### Main specifications

- Rotation  $\beta$  axis (sample in-plane)
- Rotation speed 1 to 60rpm
- Minimum incidence angle 0.1degree
- Sample suction pump AC100V, 10W (1 pump)
- Operation modes Constant speed rotation, oscillation, sample in-plane rotation scan, (continuous, step)

Part Description	P/N
Thin film analysis attachment (without option driver)	215-21765-01

Note1: Please arrange optional additional ASSY with optional driver ASSY at the same time. Refer to the paragraph of a special accessory on page 28.

Note2: Cannot be used together with OneSight wide-range high-speed detector.



## Fiber Sample Attachment

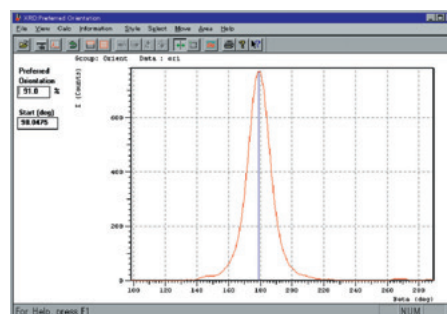
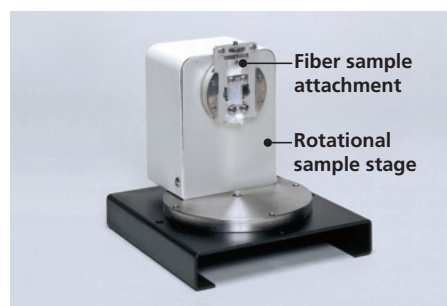
Used in combination with the Rotational Sample Stage (RS-1001), this system measures the degree of orientation for fibers. The acquired data is then processed using the provided fiber sample attachment software to calculate degree of orientation.

Part Description	P/N
Fiber sample attachment (with S/W)	215-22624

Note: Cannot be used together with OneSight wide-range high-speed detector.

### Fiber orientation software (P/N215-00428-92)

- This software evaluates the degree of orientation for fiber samples, using the data of peak width at half height acquired from orientation measurement (sample in-plane  $\beta$  axis measurement).



Degree of Orientation Evaluation Screen

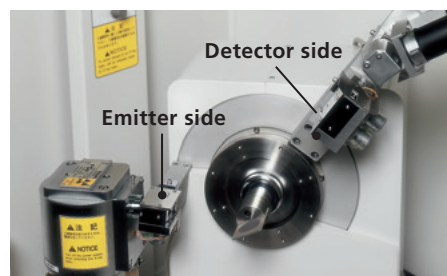
## AVS-1101 Automatic Variable Slit System

This mechanism automatically sets the DS, SS and RS slit widths according to the measurement mode selected on the screen.

- Fixed Irradiation Width Mode:**  
The emission slit is adjusted so that all sample surfaces are irradiated with the x-ray of the same width. The detector slits (SS and RS) are also adjusted in accordance with the irradiation width
- Fixed Irradiation Width Mode:**  
The DS, SS and RS slit widths are fixed at the set values.

Part Description	P/N
AVS-1101 Automatic Variable Slit System	215-23950

Note: Cannot be used together with OneSight wide-range high-speed detector.



Degree of Orientation Evaluation Screen

## MDA-1101/1201 Micro Area Measurement Attachment

The Micro Area Measurement Attachment uses a pinhole slit for emission, allowing the measurement of micro regions. Measured surfaces are observed via a CCD camera, so observation images can be loaded onto a computer, saved and edited. The product line includes two models: the MDA-1101 that uses an optical microscope and the MDA-1201 that uses a zoom (8 - 80 mm) camera lens.

### Key Specifications

- Pinhole Emitter Slit 0.1, 0.2, 0.3, 0.5, 1, or 2 mm diameters
- XYZ Movement  $\pm 7.5$  mm
- Sample Surface Observation Method CCD camera image viewed on computer screen

Part Description	P/N
Micro Area Measurement Attachment (MDA-1101)	215-23180-93
Micro Area Measurement Attachment (MDA-1201)	215-23180-94

Note: Cannot be used together with OneSight wide-range high-speed detector.



# Accessories

## Stress Analysis Attachment SA-1101

This specialized stress analysis system using the side-inclination method include the stress analysis sample stand, X-ray tube and stress analysis software. X-ray stress analysis is widely used to measure the level of stress in substances. In the X-ray diffractometry of stress extremely small changes in the lattice space are measured from the X-ray diffraction pattern profile. The use of the special stress analysis stand associated with the side-inclination method allows the precise measurement of the residual stress. This technique is free of absorption error. The software includes following functions, as measurement, width at half height, peak position calculation and stress calculation. Depending the type of sample and reflective plane, either the Cr X-ray tube or Co tube is necessary. The sample stand option driver can also be used with the rotational sample stage.

### Main specifications

- Inclined axis  $\alpha$  axis
- Inclined angle range 0 to 50 degrees
- Operation modes Oscillating, fixed

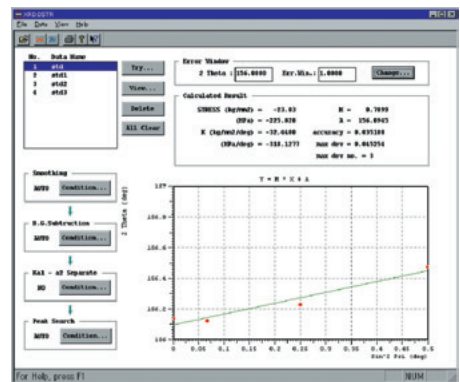
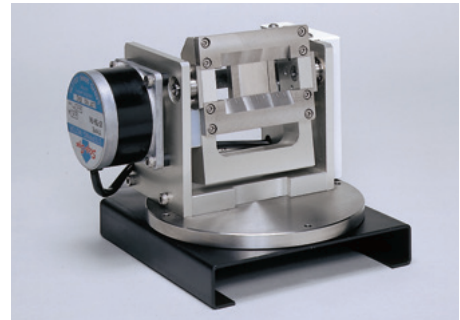
Part Description	P/N
Stress analysis attachment (with Cr tube, S/W)	215-21769-01
Stress analysis attachment (with Co tube, S/W)	215-21769-03

Note1: Please arrange optional additional ASSY with optional driver ASSY at the same time. Refer to the paragraph of a special accessory on page 28.

Note2: Cannot be used together with OneSight wide-range high-speed detector.

### Stress Analysis Software (P/N 215-00429-92)

- This software can perform analysis using data from either the iso-inclination method ( $\psi$  - fixed method,  $\psi_0$  - fixed method) or the side-inclination method.



Residual Stress Analysis Result Screen

## PCL-1002 Polycapillary Unit

The polycapillary unit is a new optical X-ray element that splits a single X-ray beam emitted from a point light source into multiple X-ray beams using three-dimensionally arranged capillary optics to create a powerful parallel beam output that covers a large area.

- 1) Compared to conventional methods, this unit uses the X-ray more effectively and increases the intensity of the diffracted X-ray, allowing more sensitive analysis.
- 2) With conventional methods, variations in sample surface height are directly translated into variations in X-ray diffraction angles. This polycapillary unit uses parallel beams, so it is not affected by variations in sample surfaces.

Part Description	P/N
PCL-1002 Polycapillary Unit	215-24375-91
CM-4121 Counter Monochromator Assembly (for parallel beams)	215-22360-06
X-Ray Tube (Long fine focus, with Cu target)	210-24100-11

Note: Cannot be used together with OneSight wide-range high-speed detector.



## Sample Heating Attachment HA-1001

This system, consisting of a special sample heating furnace and temperature controller, is used to heat the sample during X-ray diffractometry to study the influence of heat on the crystalline structure. The atmosphere in the furnace, consisting of air, an inert gas or a vacuum, may be heated to 1500°C during measurement. The measurement results are output in multiple data format to enable comparison of X-ray diffraction patterns obtained at various temperatures.

### Main Specifications

	HA-1001
Thermocouple	Pt-Pt/Rh
Measurement temperature	1500C max. in vacuum, air 1200C max. using inert gas (N2)
Control functions	PID value setting, fixed temperature control (temperature increase, decrease, hold, stop)
Power supply	Single phase 200/220V±10% 10A

Note: Cannot be used together with OneSight wide-range high-speed detector.



Part Description	P/N
Sample heating attachment for XRD-7000 (with temperature controller)	215-23000-01

## Heating attachment TTK-450

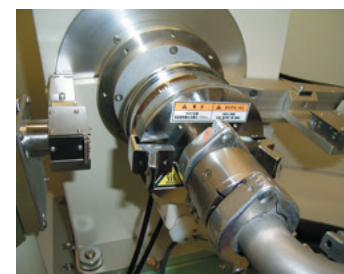
This system, consisting of a special sample heating furnace and temperature controller, is used to heat the sample during X-ray diffractometry to study the influence of heat on the crystal structure. The atmosphere in the furnace, consisting of air, an inert gas or vacuum, may be heated to 450°C during measurement at TTK-450.

The measurement results are output in multiple data format to enable comparison of X-ray diffraction patterns obtained at various temperature.

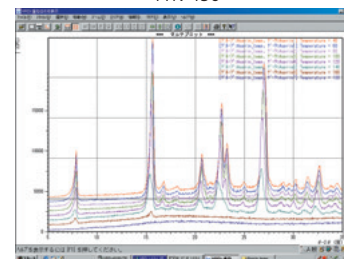
### Main Specifications

	TTK-450
Thermocouple	PT100 resister
Power supply	RT to 300°C (in the air, or an inert gas)
Temperature	RT to 450°C (in vacuum)
Control functions	PID value setting fixed temperature control (increase, decrease, hold, stop)
Power supply	single phase 200/220V±10% 5A

Note: Cannot be used together with OneSight wide-range high-speed detector.



TTK-450



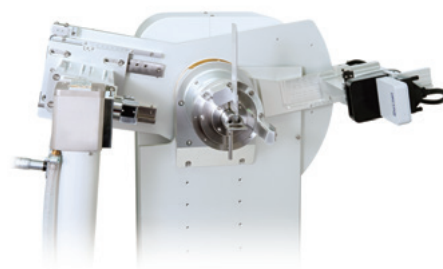
Sample Heating Measurement

Part name	P/N
Heating attachment TTK-450	215-24030-93
Vacuum kit for TTK-450 for XRD-7000	215-24034-92

## Wide-Range High-Speed Detector OneSight

This is a wide-range high-speed detector, which can be mounted on XRD-7000. The OneSight has 1280 channels on a wide-range array. It achieves an intensity approximately 100 times higher than that obtained by a scintillation detector. The OneSight is equipped with a horizontal-sample-type goniometer, which allows extremely large samples to be accommodated.

Number of Channels	1280
Strip width	50 μm
Active area	64 × 8 mm
Dimensions	W72 × H100 × D24 mm



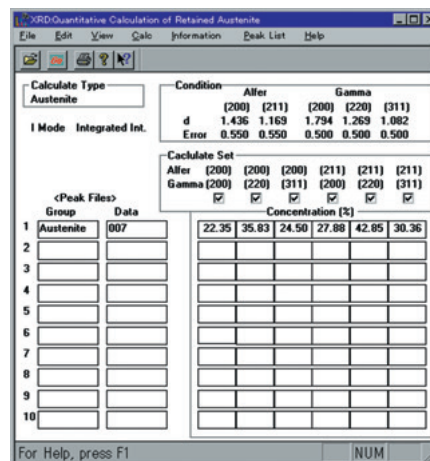
# Comprehensive Optional Software

## Quantitative Analysis

### Residual Austenite Quantitation (P/N 215-00430-92)

Common method to quantify the residual austenite is to apply the method for samples consisting of 2 components such as tempered copper  $\alpha$ -iron and  $\gamma$ -iron. The special software allows the determination without the need of standard sample.

The software directly uses the intensity ratio of the measured X-ray peaks of the  $\alpha$ -iron and  $\gamma$ -iron components to theoretically perform the calculation. The five-peak average method is used to make the determination, so scattering due to the matrix effect is reduced to enhance the reliability of the results. Using the rotational sample stage (P/N 215-21766) for measurement even further helps to overcome data scattering.



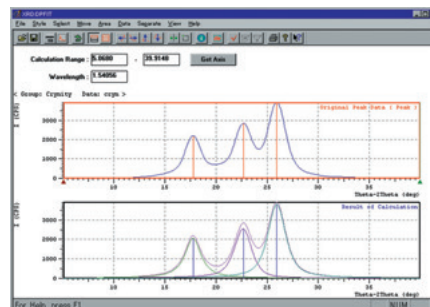
Quantitation Results Screen

## Peak Processing

### Overlapping Profile Fitting Software (P/N 215-00423-92)

Using the Gauss and Lorentz models, overlapping peaks are separated one by one, with information including position, intensity, width at half height and integrated intensity calculated for each diffraction peak.

These are then utilized to conduct quantitative analysis and crystalline structure analysis.



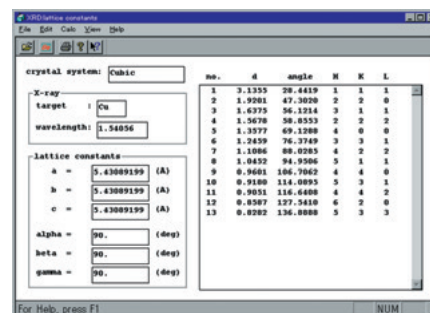
Peak Separation Screen

## Crystalline Structural Analysis

### Precise lattice constant determination software (P/N 215-00424-92)

In X-ray diffractometry, a higher accuracy is often required to determine the lattice constant, which is a fundamental parameter for determining a substance's crystalline structure. This is most often used for quantitating solid solution content.

This software corrects the raw diffraction angle data calculated via basic data processing to determine enhanced precision lattice constants for up to 7 crystals concurrently, employing the least squares method to even further minimize error in diffraction angles. In addition, the miller index is applied to each peak.



Precise lattice constant determination calculation Result Screen



# Lineup

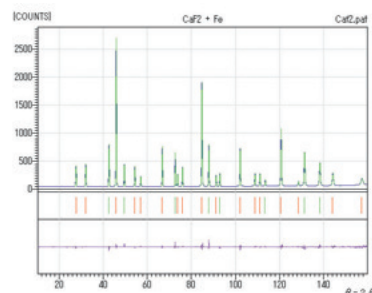
## Rietveld Analysis Software (P/N 215-00433-92)

The Rietveld method is a crystal structure analysis method applicable to overall powder X-ray and neutron diffraction patterns for the direct determination of structural parameters and lattice constants.

It fits the diffraction pattern calculated for assumed structural models to an actual pattern and determines the parameters using the non-linear least square method.

The Rietveld analysis software used is the RIETAN program developed by F.Izumi (National Institute for Materials Science).

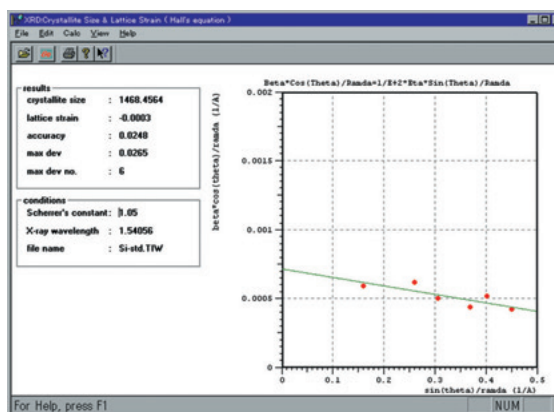
Part Description	P/N
Rietveld analysis software RIETAN	215-00433-92



## State Analysis

### Crystallite Size & Lattice Strain Software (P/N 215-00426-92)

Samples normally consist of crystallites ranging in size from several  $\mu\text{m}$  to tens of  $\mu\text{m}$ . However, in the case of catalyst crystallites, which may measure several hundred  $\text{\AA}$ , X-ray diffraction is insufficient, resulting in diffraction peak spreading. This software quantitatively determines that spread, and applies that Scherrer's equation to calculate the crystallite size. When there is involvement of lattice strain, the diffraction spread is determined for a number of diffraction peaks, and from the resultant line slope and intercepts, the size of each of the crystallites and the lattice strain are calculated. (Hall's Method)

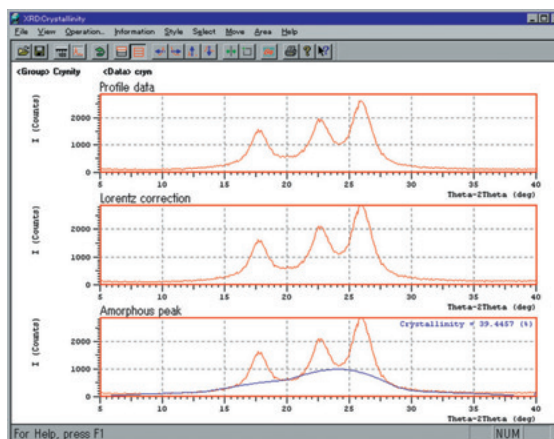


Hall's Equation Calculation Result Screen

### Crystallinity Calculation Software (P/N 215-00427-92)

The degree of crystallization of a mixture of crystalline and amorphous substance, such as found in high polymer samples, is an important parameter of substance characterization.

This software automatically or manually separate the measured diffraction patterns into those of crystalline components and those of amorphous components. Then, it calculate the integrated intensity of the two types of substance, called degree of crystallization using the peak area ratio of the two classes of components.

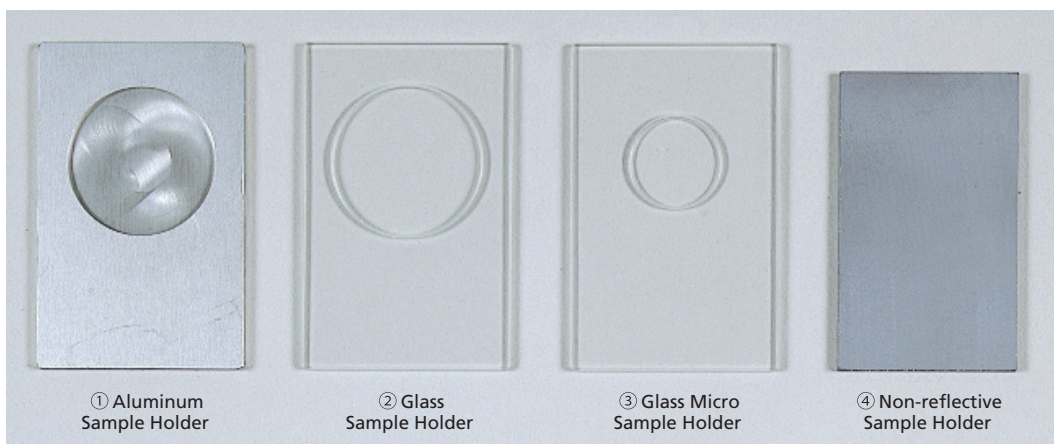


Crystallinity Calculation Result Screen

# Other Accessories

## Sample Holders

The following sample holders are available to allow different application, including the aluminum sample holder, which is supplied as standard with the diffractometer.



Part Description	Sample area	Application	Remarks	P/N
Aluminum Sample Holder	ø25 (dia.) x 1mm (d)	General purpose	Made of aluminum, 5pc	215-22507-01
Glass Sample Holder	ø25 (dia.) x 1mm (d)	Lattice constant	Made of glass, 5pc	215-22507-02
Glass Micro Sample Holder	ø15 (dia.) x 0.5mm (d)	Micro samples	Made of glass, 5pc	215-22507-03
Non-reflective Sample Holder		Ultramicro samples	Made of silicon, 2pc	215-22507-05

## X-ray Tubes and X-ray Filters

Focus Type	Type NF	Type BF	Type LFF
Focus Size	1 x 10mm	2 x 12mm	0.4 x 12mm
Tube voltage, current	60kV, 50mA	60kV, 60mA	60kV, 55mA
Target	X-ray Tube Maximum Load & P/N		
Cu	2.0kW (239-24014-01)*1	2.7kW (210-24016-21)	2.2kW (210-24100-11)
Co	1.8kW (062-40003-04)	2.7kW (210-24016-24)	1.8kW (210-24100-14)
Fe	1.5kW (062-40003-05)	2.2kW (210-24016-25)	1.0kW (210-24100-15)
Cr	2.0kW (062-40003-06)	2.7kW (210-24016-26)	1.9kW (210-24100-16)

X-Ray Filter	
Part Description	P/N
Ni filter (for Cu)	(215-22500-02)
Fe filter (for Co)	(215-22500-03)
V filter (for Cr)	(215-22500-05)

\*1 When using it as a point focus, combine a X-ray tube and a point focus head of following P/N.

- 1) X-ray tube (Cu target, 2.0kW, NF) P/N 210-24016-11
- 2) Point focus head P/N 239-16047

\*When using the polycapillary system, use LFF type.

## ■ Cooling Water Circulator

### RKE1500B-V-G2-SP (for 3kW X-ray tube)

With its built-in cooler, the Cooling Water Circulator cools the X-ray tube and X-ray generator by circulating cooled, pure or clean water. The unit is recommended when no tap water is available or the available water is of poor quality.

#### Main specifications

- Power supply Three phase 200V  $\pm$  10% 10A (RKE1500B-V-G2-SP)
- Ambient temperature 5 to 40°C
- Cooling capacity 5.3kw/h (50/60Hz) (RKE1500B-V-G2-SP)

Part Description	P/N
RKE1500B-V-G2-SP	239-15049-02



RKE1500B-V-G2-SP

# Accessories

## Special Accessories

◎: Absolutely required   ○: Required   ●: Required depending on objective

Analysis Objective	Part Description	Part Number	Iron and steel related	Non-ferrous metals, precious metals	Metallurgy, automotive, shipbuilding, welding	Brickmaking, ceramics	Cement and glass	Electrical, electronic materials	Foodstuffs, textiles, paper, pulp	Chemicals, catalysts, dyes, paints	Medical, dental materials, biological organisms	Natural resources, energy	Construction, engineering	Environment, industrial waste	Environment (Asbestos)
1 BG reduction, especially iron samples	Counter Monochromator CM-3121	P/N 215-22360-02	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎
2 Qualitative analysis PDF2 Search	ICDD PDF2 file (CD-ROM)	P/N 239-50002-11,12	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎
	PDF2 Search S/W (DDVIEW)	P/N 239-50002-21,22													
3 Qualitative analysis PDF4 Search	ICDD PDF4 + (CD-ROM)	P/N 239-50015-01,02	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎
4 General purpose quantitative analysis	*Rotational Sample Stage RS-1001 <sup>Note1</sup>	P/N 215-21766-01	○	○	○	○	○	○	○	○	○	○	○	○	○
	Auto 5 position sample changer ASC-1001 <sup>Note1,2</sup>	P/N 215-23175-02													
5 Residual austenite quantitation	*Residual austenite quantitation S/W	P/N 215-00430-92	○	○											
	*Rotational Sample Stage RS-1001 <sup>Note1</sup>	P/N 215-21766-01	○	○											
6 Environmental quantitative analysis system	*Environmental Quantitative Analysis Stage RS-2001 <sup>Note1</sup> (Filter holders Zn, with S/W)	P/N 215-21767-01												◎	◎
	Filter holder Al (ø 25mm)	P/N 215-23765-92												◎	◎
7 Multiple peak separation	Profile fitting S/W	P/N 215-00423-92	●	●	●	●	●	●	●	●	●	●	●	●	●
8 Precise lattice constant determination	Precise lattice constant determination S/W	P/N 215-00424-92	●	●	●	●	●	●		●					
9 Crystal structure analysis	Rietveld analysis, RIETAN software	P/N 215-00433-92	●	●	●	●	●	●		●					
10 Crystallite size / lattice stress	Crystallite Size / Lattice Stress S/W	P/N 215-00426-92						○	○	○					
11 Degree of crystallization	Degree of Crystallization S/W	P/N 215-00427-92	●					○	○	○					
12 Heating analysis	Sample Heating Attachment HA-1001	P/N 215-23000-01	●	●	●	●	●	●		●	●				
13 Thin film analysis	*Thin Film Analysis Attachment THA-1101 <sup>Note1</sup> (stage, monochromator, suction pump)	P/N 215-21765-01	●	●	●	●	●	●							
14 Fiber degree of orientation analysis	Rotational Sample Stage RS-1001 <sup>1)</sup>	P/N 215-21766-01	●	●	●	●	●	○	●						
	Fiber Sample Attachment (with S/W)	P/N 215-22624	●					○	●						
15 Residual stress analysis	*Stress Analysis Attachment SA-1101 <sup>Note1</sup> (with Cr X-ray tube, S/W)	P/N 215-21769-01	○	○	○	●	●	●							
16 Micro Measurement with microscope	Micro-Measuring Attachment MDA-1101	P/N 215-23180-93	●	●	●	●		●		●					
17 Micro Measurement with CCD camera	Micro-Measuring Attachment MDA-1201	P/N 215-23180-94	●	●	●	●		●		●					
18 Auto Mapping (stress, quantitative analysis)	R-θstage for large sample		●	●	●	●	●	●	●	●	●	●	●	●	●
19 Strong parallel beam X-ray source	poly-capillary unit PCL-1002	P/N 215-24375-91	●	●	●	●	●	●	●	●	●	●	●	●	●

1) Can be used together with general purpose rotational sample stage

Note1: Please arrange optional additional ASSY(P/N215-23705) with optional driver ASSY(P/N215-21764) at the same time when you arrange the accessories of the asterisk. Moreover, even when two or more accessories are arranged, the option driver ASSY and optional additional ASSY can use it combinedly with one unit.

Note2: When I arrange an auto 5 position sample changer, please arrange two optional additional ASSY.

# Specifications

## XRD-7000

Item	XRD-7000L		XRD-7000S
X-ray generator	Max. output	3kW	
	Tube voltage/tube current stability	±0.01% (for 10% power fluctuations)	
	Max. tube voltage	60kV <sup>*1</sup>	
	Max. tube current	80mA <sup>*1</sup>	
	Tube voltage step width	1kV	
	Tube current step width	1mA	
	Overload limit setting	Change setting to suit tube type.	
	Tube protection	Overload, overvoltage, overcurrent, cooling water abnormalities	
Goniometer	Safety mechanisms	Door interlock mechanism (X rays generated after confirming door closed.)	
	Type	Vertical $\theta$ - $\theta$	
	Goniometer radius	275mm standard (variable from 200 to 275 mm)	200mm standard (variable from 200 to 275 mm)
	X-ray beam to attachment base distance	220mm	85mm
	Min. step angle	0.0001° ( $\theta$ ), 0.0002° (2 $\theta$ )	
	Angular reproducibility	0.0002°	
	Operation angle range	-12 to 163° (2 $\theta$ ), -6 to 82° ( $\theta$ s), -6 to 132° ( $\theta$ d)	
	Operation system	$\theta$ s- $\theta$ d linked; $\theta$ , 2 $\theta$ individual	
	Operation mode	Continuous scan measurement, step scan measurement, calibration, positioning	
	Slewing speed	1000°/minute (2 $\theta$ )	
	Operating speed	0.1 to 50°/minute ( $\theta$ s, $\theta$ d), 0.1 to 100° (2 $\theta$ )	
	Divergence slit (DS)	0.5°, 1°, 2°, 0.05mm	
	Scattering prevention slit (SS)	0.5°, 1°, 2°	
	Receiving slit (RS)	0.15mm, 0.3mm	
Casing	Dimensions	W1120 × D1049 × H1790 mm	
		Weight	530kg
		Leakage X-rays	Less than 2.55v/h (at maximum output)

\*1 When using OneSight wide-range high-speed detector.

## X-ray Tubes and X-ray Filters

Focus Type	Type NF	Type BF	Type LFF
Focus Size	1 x 10mm	2 x 12mm	0.4 x 12mm
Tube voltage, current	60kV, 50mA	60kV, 60mA	60kV, 55mA
Target	X-ray Tube Maximum Load & P/N		
Cu	2.0kW (239-24014-01)*2	2.7kW (210-24016-21)	2.2kW (210-24100-11)
Co	1.8kW (062-40003-04)	2.7kW (210-24016-24)	1.8kW (210-24100-14)
Fe	1.5kW (062-40003-05)	2.2kW (210-24016-25)	1.0kW (210-24100-15)
Cr	2.0kW (062-40003-06)	2.7kW (210-24016-26)	1.9kW (210-24100-16)

X-Ray Filter	
Part Description	P/N
Ni filter (for Cu)	(215-22500-02)
Fe filter (for Co)	(215-22500-03)
V filter (for Cr)	(215-22500-05)

\*2 When using it as a point focus, combine a X-ray tube and a point focus head of following P/N.

- 1) X-ray tube (Cu target, 2.0kW, NF) P/N 210-24016-11
- 2) Point focus head P/N 239-16047

\*When using the polycapillary system, use LFF type.

## Detectors

### OneSight Wide-Range High-Speed Detector

(FD-1001 1D High-Speed Detector P/N 215-24320-91)

Scan range	0-159° : Radius of Goniometer 275 mm 0-150° : Radius of Goniometer 200 mm 0-148° : Radius of Goniometer 185 mm
Operation mode	Step-scan mode, One-shot mode
Sensor	Reverse biased pn-junction array
Detection principle	Single photon counting
Weight	280 g
Active area	64 × 8 mm
Number of channels	1280
Width of one channel	50 $\mu$ m

### Scintillation Detector

SC-1003 P/N 215-24385-92

Scintillator	Na I
Scaler	Preset time: 0.1 to 1000s; digits: 7
HV/PHA	500 to 1200 V high-voltage power supply, baseline and window auto-controlled

## Data Processing Unit

OS	Windows 7
Controlled elements	Goniometer, X-ray generation, tube voltage, tube current, detector high voltage, PHA, scaler
Basic data processing	Smoothing, BG elimination, K $\alpha$ 1-K $\alpha$ 2 separation, peak searching, peak width at half height, integrated intensity, systematic error correction, internal/external standard correction, operations between data, graphic display
Qualitative analysis	Database generation, automatic searching (ICDD PDF2/PDF4 optional)
Quantitative analysis	Calibration curve generation, quantitative analysis

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# Installation Requirements

## Installation Site

This instrument uses X-rays for measurement and analysis. Accordingly, before installing the instrument, be sure to consult local regulations regarding measures associated with X-ray generation, and comply with all necessary regulatory procedures.

## Power requirements

For main unit	Single phase 200/220V $\pm 10\%$ 2kW type: 30A 3kW type: 50A
Data processing unit	Single phase 100V $\pm 10\%$ 10A
Ground	Independent, at least 100 $\Omega$ resistance

Power supply voltage fluctuation must not exceed 10%.

If the sample heating attachment, cooling water pump or cooling water circulator is used, a separate power supply is required.

## Installation site environment

The following ambient temperature and humidity are required.

Temperature	23°C $\pm 5^\circ\text{C}$
Humidity	Less than 75%

Avoid any sudden changes in temperature, which might cause condensation to form on the surfaces of internal parts.

Heat generated from the instrument is approximately 1kW/h. When the cooling water circulator is installed in the same room, this is increased by 3.2kW/h for the 2kW X-ray tube and 5.3kW/h for the 3kW X-ray tube.

## Cooling water supplied to instrument

When cooling water supplied to the instrument becomes dirty due to piping corrosion, etc., this causes clogging of the X-ray tube filters. Cooling water should be supplied using the following conditions.

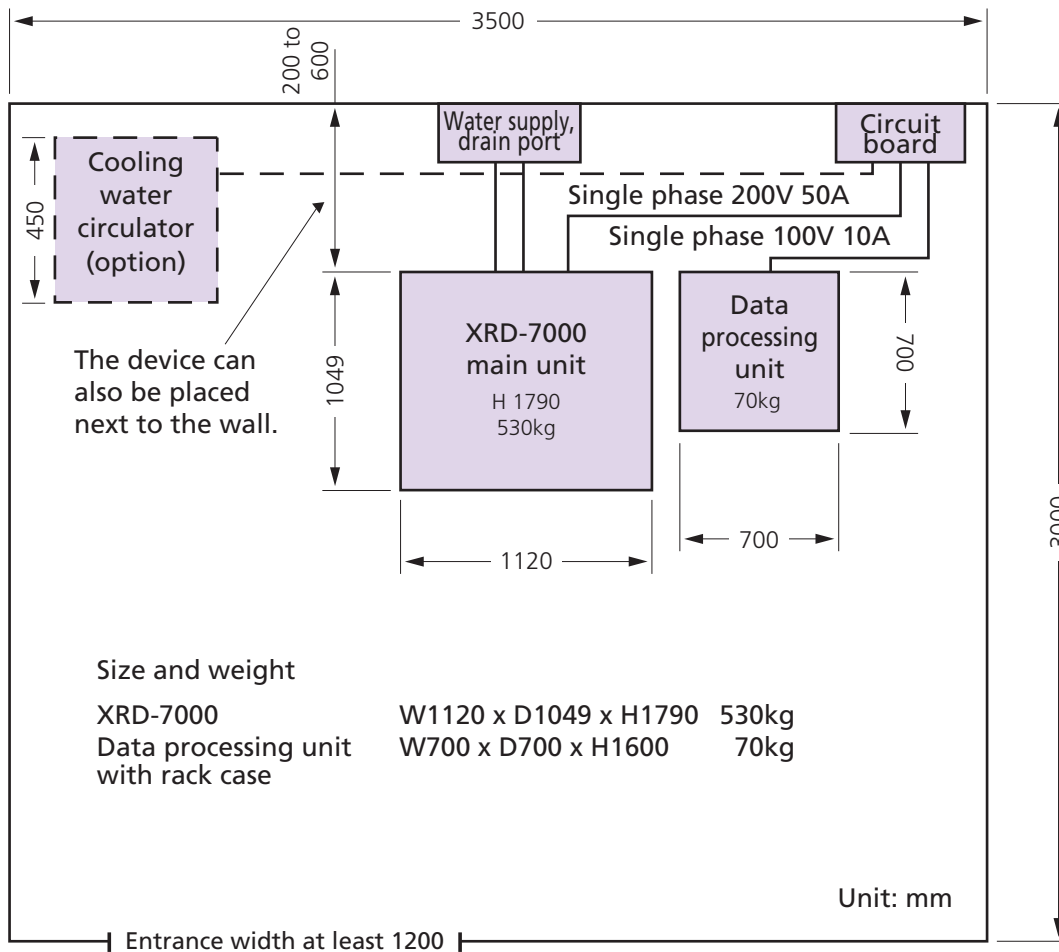
Temperature	23°C $\pm 5^\circ\text{C}$
Humidity	60% $\pm 5\%$

Avoid any sudden changes in temperature, which might cause condensation to form on the surfaces of internal parts.

Heat generated from the instrument is approximately 860cal/h. When the cooling water circulator is installed in the same room, this is increased by 3.2kW/h for the 2kW X-ray tube and 5.3kW/h for the 3kW X-ray tube.

Flow rate	at least 4.0L/min
Water pressure	3-5kgf/cm <sup>2</sup>
Water quality	pH6-8, hardness less than 80ppm
Particulates	less than 0.1mm
Supply water port diameter	12.7mm $\varnothing$
Drain water port	Natural drainage

If the flow rate is lower than 4.0L/min, the safety circuit for protection of the X-ray tube is active, disabling the X-ray generation circuit. When minimum conditions of flow-rate could not be fulfilled, use the cooling water circulator, available as an option.



**XRD-7000 Floor Plan Example**



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