

## Automated multipurpose X-ray diffractometer

# SmartLab



### 1. Introduction

SmartLab, which was announced as a thin film sample X-ray diffractometer in 2005, is a high-precision goniometer with a high-intensity X-ray source based on an innovative ergonomic design, and is widely used by many users. SmartLab has been updated several times in the 13 years since its launch. This year, an even more sophisticated model of SmartLab was introduced.

In addition to the encoder-controlled-type high-precision horizontal sample mount goniometer featured in previous SmartLab models, this SmartLab offers many new features, including an advanced, safer cabinet; a longer-life high-intensity X-ray source; a multi-dimensional detector, the HyPix-3000, with improved sensitivity; an optical system supporting different types of measurement; and integrated software to control the system.

### 2. Major Features of New SmartLab

#### 2.1. Cabinet with both functionality and safety

The cabinet has four X-ray radiation enclosure doors that can be opened to make a 1.5-times-wider opening compared to the previous SmartLab while occupying almost the same installation area. The height of the top panel has been changed for easier placement of samples or attachments. With a high-intensity LED inside the unit and six observation windows provided on the X-ray radiation enclosure doors, users can see what is going on in the unit from the outside even during measurement.

Furthermore, several indicators including those for Power/X-ray On/Off and X-ray radiation enclosure doors locked status, are located on the front of the unit. The X-ray On/Off status is also indicated on the side of the unit, enabling users to easily identify the unit condition.



**Fig. 1.** Unit with X-ray radiation enclosure doors open.

## 2.2. Longer-life high-intensity X-ray tube

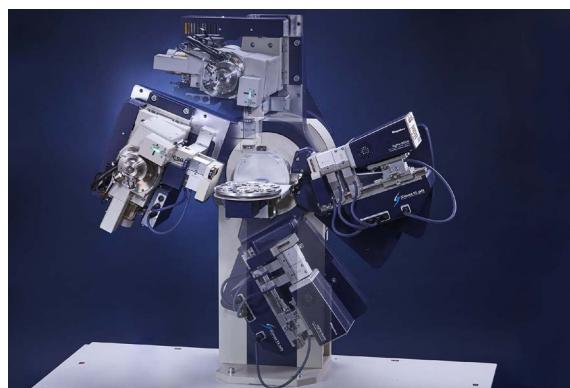
The brand new PhotonMax, a rotating anode X-ray tube, uses new mechanical seals to achieve approximately three times longer life than that of existing X-ray tubes. It has also been proven that maintenance costs can be reduced to a level equivalent to that of a sealed tube X-ray source.

## 2.3. Improved sensitivity of hybrid multi-dimensional detector HyPix-3000

HyPix-3000 is a multidimensional detector with a wide dynamic range and a high angular resolution that is capable of measuring in 0D, 1D and 2D modes. HyPix-3000 mounted on the new SmartLab has approximately 1.5 times higher energy resolution than the previous HyPix-3000, allowing it to significantly reduce background. Thanks to these features and the wide detection surface, measurement using a transmission WAXS (Wide Angle X-ray Scattering)/SAXS (Small Angle X-ray Scattering) optical system can evaluate even slight texture differences based on the circular measurement of Debye rings. For Out-of-Plane/In-Plane measurement in combination with grazing incidence optics (GI-WAXS), reciprocal space data, previously obtained through different measurement sessions, can be acquired at the same time.

## 2.4. CBO-Auto for automatic switching between reflection and transmission modes

SmartLab allows users to select multiple optical systems designed for different types of samples or for different measurement purposes. These optical systems can be selected through the integrated software SmartLab Studio II, and the position of the optics and samples are automatically adjusted. In the past, users could select appropriate optical elements for a particular measurement according to instructions by SmartLab Studio II, but had to change the elements himself/herself to carry out measurement with a different optical system. The newly developed CBO-Auto, based on Rigaku's unique mechanism, allows fully automatic switching between the reflection method with Bragg–Brentano optics and the transmission

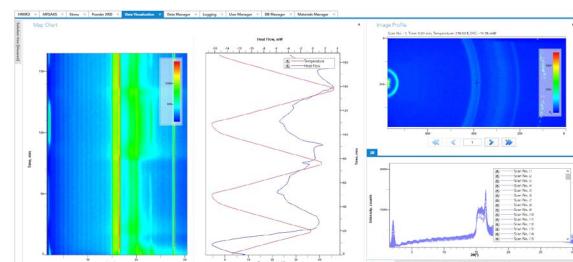


**Fig. 2.** Automatic switching between reflection and transmission modes.

method with convergent optics, which were originally different optical systems. By using both CBO-Auto and SmartLab Studio II, users no longer need to replace optical elements to switch between reflection mode and transmission mode using convergent beams. Since SmartLab Studio II automatically selects the condition for the highest intensity and resolution for each optical system, users can enjoy seamless measurement without the need to change optical systems.

## 2.5. Integrated software SmartLab Studio II

SmartLab Studio II, an integrated software platform covering all processes from measurement to analysis, not only has measurement guidance and optics adjustment mechanisms, which were part of the original SmartLab Guidance, but also provides analysis on the data obtained. In the past, control software existed independently from multiple analysis software programs. SmartLab Studio II now brings all these programs together as plug-ins. In addition, SmartLab Studio II, which controls SmartLab, also features new qualitative analysis using two-dimensional diffraction patterns, real-time analysis for simultaneous measurement and analysis and visualization of many two-dimensional diffraction patterns obtained through



**Fig. 3.** Visualization of 2D diffraction patterns.

*in-situ* measurement. For more information about real-time analysis, see the detailed instructions in the technical note on pages 17 to 20.

## 3. Conclusion

As stated above, the new SmartLab offers even higher functionality from its goniometer, X-ray source and detector compared to the previous model. It features convenient replacement of samples/attachments, automatic optics switching, data processing during measurement, visualization of 2D diffraction patterns and other functions. These enable the user to complete measurement/analysis tasks that would otherwise take a lot of time and effort more efficiently and in a shorter time than before. The new SmartLab can be used by anybody from X-ray diffractometer beginners to long-term users.