LYNXEYE XE-T

● High-Resolution Position Sensitive Detector with Superb Energy Resolution

The LYNXEYE XE-T is the next generation "Compound Silicon Strip" detector with superb energy resolution for ultrafast 0D, 1D, and 2D X-ray diffraction.

The LYNXEYE XE-T is particularly optimized to meet the increasing demands in X-ray diffraction of highest count rate capabilities, best angular resolution (peak widths), and best energy resolution.

The unique combination of sensor chip and front-end electronics as realized in the LYNXEYE XE-T makes it the highest performing detector on the market in terms of both data and manufacturing quality.

- High-speed data acquisition up to 450 times faster than a conventional point detector system
- Superior energy resolution better than 380 eV Cu radiation making Kß filters and secondary monochromators redundant
- Operation with all common characteristic X-ray emission lines (Cr, Co, Cu, Mo, and Ag radiation)
- Outstanding angular resolution (peak widths) and perfect line profile shapes
- Outstanding peak-to-background ratio for highest sensitivity and data quality
- No defective channels at delivery time – guaranteed

LYNXEYE XE-T

Specimen fluorescence? You don't need any mirrors or monochromators!

Fundamentally, sample fluorescence is generated by the incident beam and can only be effectively reduced by choosing an appropriate wavelength. When fluorescence is present, it can only be filtered using suitable diffracted beam path components such as mirrors, monochromators, and energy discriminating / dispersive detectors.

Mirrors and monochromators are critical to alignment, and are usually tailored for a single wavelength. While mirrors always compromise the instrument resolution achievable in the traditional Bragg-Brentano geometry, diffracted beam monochromators are intensity killers. Typical intensity losses range from more than 70% for point detectors up to more than 90% for one-dimensional detectors, compared to unfiltered radiation. At such losses, a one-dimensional detector loses all its advantages and operates at intensity levels close to traditional point detectors. Counting statistics are poor, resulting in noisy patterns and thus very poor lower limits of detection. Furthermore, present diffracted beam mirrors or monochromators cannot be used for two-dimensional diffraction, leaving an important gap for a huge range of applications where two-dimensional diffraction is of advantage.

The LYNXEYE XE-T overcomes these issues thanks to its unprecedented filtering of fluorescence and Kß radiation, utilizable for both one- as well as two-dimensional diffraction applications.

This is demonstrated in Figures 1-2 for a natural hematite specimen (Fe-fluorescence with Cu-radiation) by comparing data acquired with the LYNXEYE XE-T and a scintillation counter with secondary monochromator. Figure 1 demonstrates the superb filtering of Fe-fluorescence without any loss of peak intensity versus unfiltered radiation. Remarkable is the huge intensity gain by a factor of 450 by comparison to the secondary monochromator data. As a consequence, the LYNXEYE XE-T has an enormous advantage in terms of intensity and counting statistics and thus lower limits of detection. This is demonstrated in Figure 2. A second phase, calcite, is easily detected using the LYNXEYE XE-T, but is far below the detection limit in the secondary monochromator data.

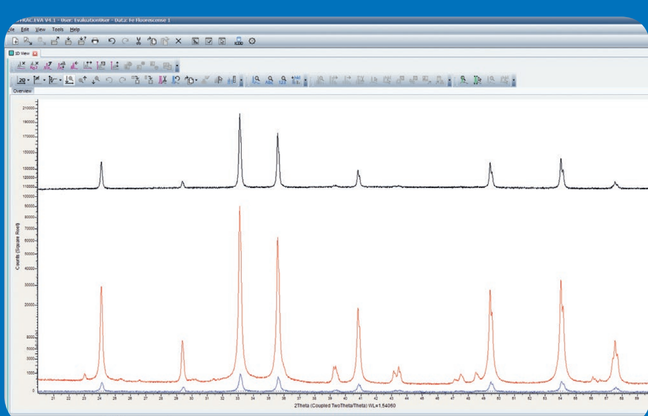


Figure 1: Unfiltered (black line) and filtered (red line) data demonstrating the superb filtering of fluorescence radiation by the LYNXEYE XE-T. The intensity gain over the secondary monochromator data (blue line) amounts to a factor of about 450.

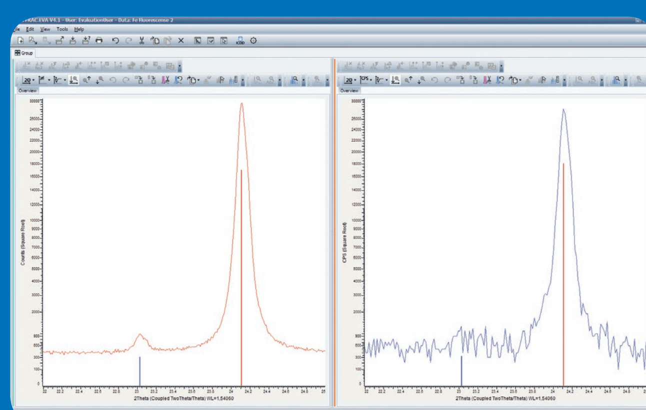


Figure 2: Zoomed region from Fig. 1 (21° - 27° 2θ) illustrating the unparalleled lower limits of detection capabilities of the LYNXEYE XE-T. Secondary monochromator data (blue line) scaled to the same maximum peak intensity as the LYNXEYE XE-T data (red line). Calcite (blue stick) is clearly below the detection limit for the secondary monochromator data.

LYNXEYE XE-T

No more Kß filter artefacts in your data!

There is almost no greater nuisance in diffraction data than artefacts introduced by the Kß filter, specifically absorption edges at the high energy tails of Kα diffraction peaks. Nevertheless, Kß filters are the most frequently used devices for monochromatization, as secondary monochromators do not represent a true alternative due to the very high intensity losses discussed earlier. As a consequence, absorption edges frequently prevent accurate profile fitting of peak tail regions and the background, and thus often represent a major part of the remaining misfit to the data, specifically for high intense peaks at low angles 2θ.

With the LYNXEYE XE-T this is no longer the case. This is demonstrated in Figure 3 for the 104 reflection of corundum, NIST SRM 1976a, using Cu radiation. In the left scan window, a Ni-filtered diffraction pattern is compared to an unfiltered pattern, clearly exhibiting significant absorption edges, accompanied by remnant Kß peaks.
In the right scan window, a "LYNXEYE XE-T filtered" pattern is compared to the same unfiltered pattern. The LYNXEYE XE-T data is completely free of absorption edges, furthermore Kß is filtered below the detection limit. In addition the total background is significantly reduced due to improved filtering of white radiation (Bremsstrahlung), resulting in improved peak to background ratios and thus lower limits of detection.

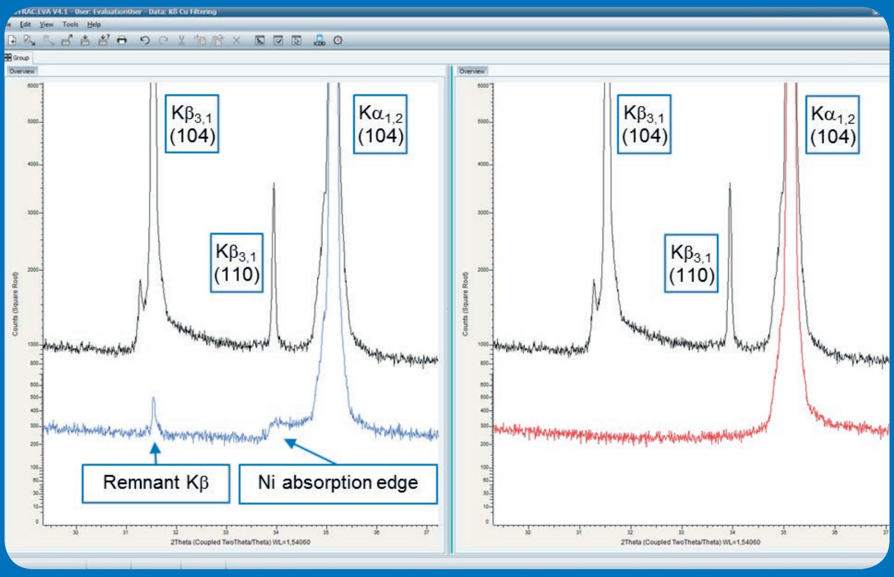


Figure 3: Comparison of corundum data (NIST SRM 1976a) obtained with the LYNXEYE XE-T detector.
Black line: filter mode disabled.
Blue line: filter mode disabled plus Ni-filter.
Red line: filter mode enabled.

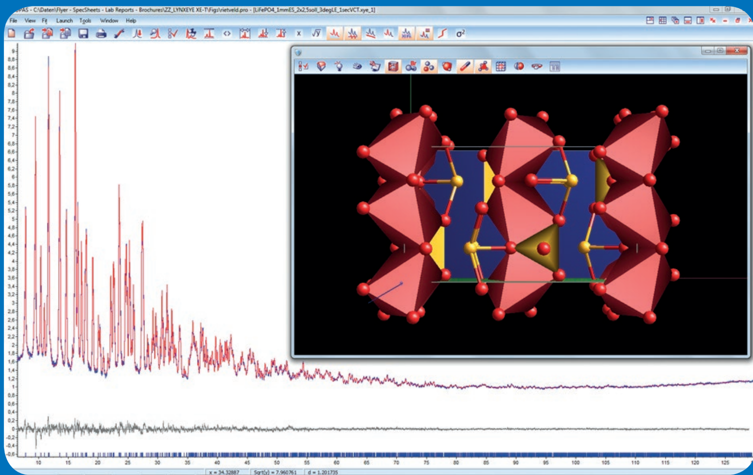


Figure 4: Structure determination and refinement of $LiFePO_4$ using $MoK\alpha_1$ data. Capillary transmission, d_{min} = 0.4Å.

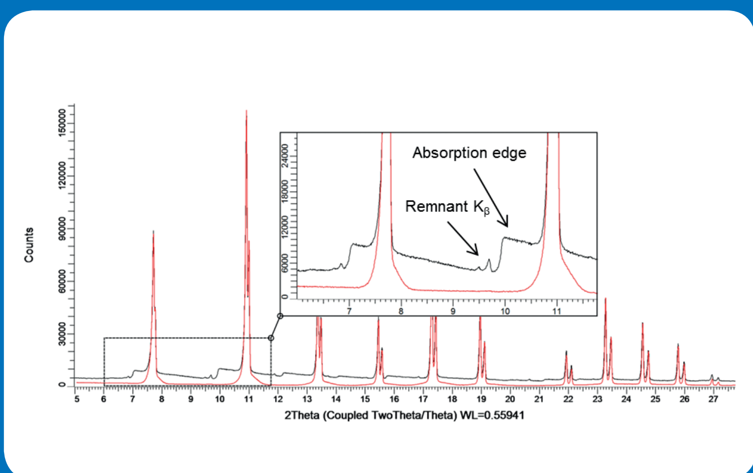


Figure 5: Comparison between Kß-filtered (black) and LYNXEYE XE-T filtered LaB_6 (NIST SRM660a) data using Ag radiation demonstrating superb filtering of K-beta and white radiation also for applications requiring high-energy X-rays such as Mo and Ag. Capillary transmission.

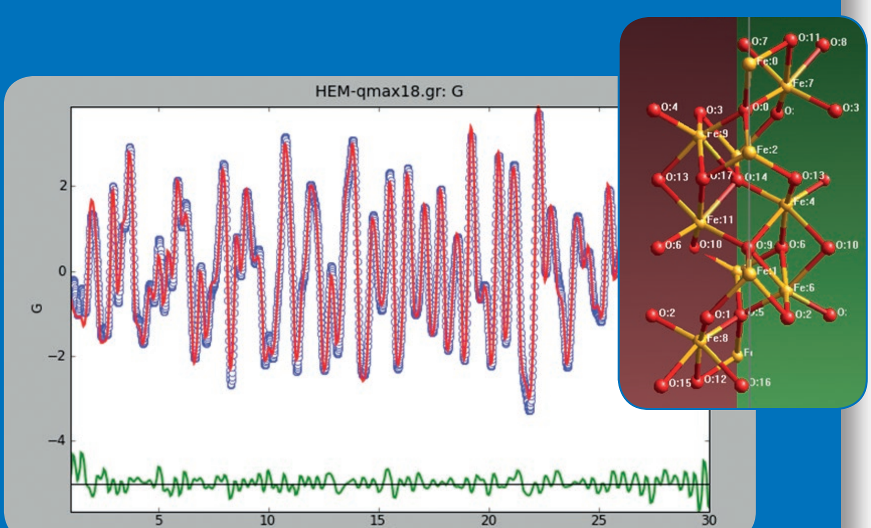


Figure 6: Structure refinement of strongly absorbing hematite using pair distribution function (PDF) analysis. Ag data, capillary transmission.

LYNXEYE XE-T

Highest durability

The LYNXEYE XE-T detector is radiation-hard by design. Unlike other traditional detectors, including pixel detectors, the LYNXEYE XE-T electronics are separated from the sensor and so are protected from radiation damage.

As a consequence, the detector can be equally operated with all common characteristic X-ray emission lines, including, but not limited to Cr, Co, Cu, Mo, and Ag radiation. Detector degradation due to radiation damage is thus of no concern even for higher energies such as Mo and Ag radiation.

Both excellent durability and superb energy resolution position the LYNXEYE XE-T as the Nr. 1 detector choice for applications benefitting from higher X-ray energies, most notably for structure determination and refinement as well as pair distribution function (PDF) analysis a shown in Figures 4-6.

LYNXEYE XE-T

Quality by Design

The LYNXEYE XE-T detector is a paradigm changer in all X-ray powder diffraction application areas. It is not only unique in terms of functionality and versatility, but also in terms of manufacturing quality. Quality by design – the LYNXEYE XE-T detector is guaranteed to be free of defective channels or even dead areas at delivery time. This unique guarantee, together with a factory-made calibration, makes it particularly suited for one- and two dimensional fixed mode measurements. Reliable and complete data sets are obtained with the LYNXEYE XE-T, without any missing data points and thus any need for data interpolation.

- No defective channels at delivery time
  - Covered by instrument warranty
- Data acquisition without missing or interpolated data points
- Highly uniform active area, highest data quality

LYNXEYE XE-T

Lowest background

Data acquisition at low angles smaller than ~20° 2θ requires some sophisticated beam conditioning to minimize instrument background (mostly air scatter), which otherwise is the most prominent contribution to the data. This is of particular concern at very low angles smaller than ~5° 2θ, the small angle X-ray scattering (SAXS) regime, where background suppression is of highest importance.

The unique Variable Active Detector Window™ feature of the LYNXEYE XE-T virtually eliminates low angle background scattering. This is achieved by the fully automatic, software-controlled change of the active detector window size as a function of 2θ: At 0° 2θ, the active detector window is closed, and gradually opens as the detector moves to higher angles 2θ, without any user-intervention. As a consequence, the use of beamstops becomes obsolete, and high quality data with virtually no instrument background can be collected starting at angles as low as 0.15° 2θ as shown in Figures 7 and 8.

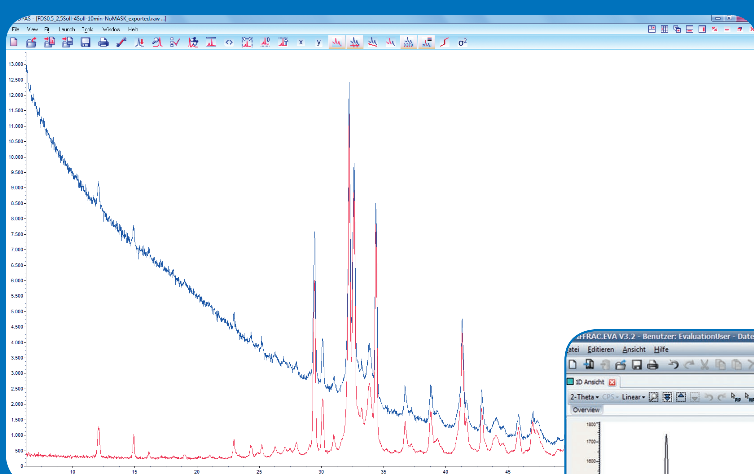


Figure 7: NIST SRM 8486 (Ordinary Portland Clinker) without (blue scan) and with Motorized Anti-Scatter Screen (red scan). All other measurement conditions left identical.

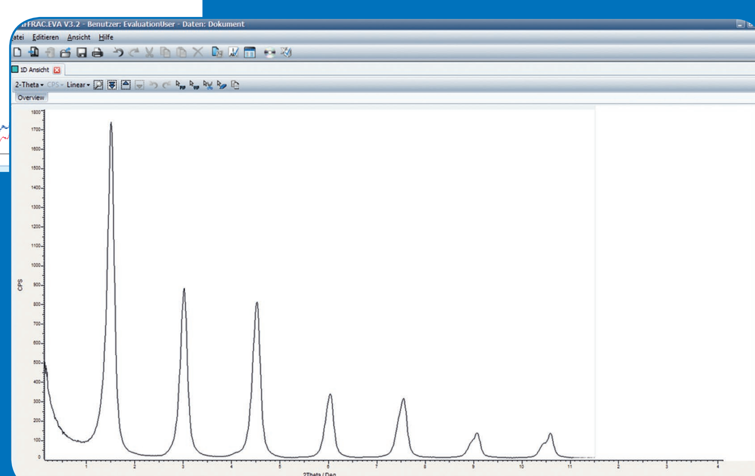


Figure 8: Low angle data collected on silver behenate. Thanks to the Motorized Anti-Scatter Screen and the Variable Active Detector Window™ of the LYNXEYE XE-T the instrument background is extremely low.

LYNXEYE XE-T

Scanning two-dimensional diffraction

Equipped with Bruker's patented 0°/90° mount, the LYNXEYE XE-T can be used for 0D and 1D data collection (0° orientation), as well as 2D data collection (90° orientation). The principle is explained in Figure 9.

Employing the LYNXEYE XE-T detector for 2D diffraction applications allows one to take advantage of every single detector property also available for 0D- and 1D data collection, resulting in superior data quality not available with any other two-dimensional detector currently on the market:

1. Energy resolution

Collection of 2D diffraction data at better than 380 eV energy resolution, taking advantage of the same filtering capabilities as for 0D and 1D data collection. Superb filtering of fluorescence and white radiation, best peak to background without the need for filters or monochromators.

2. Operation with all common characteristic X-ray emission lines

In addition to commonly employed Cr, Co, and Cu radiation, 2D data collection is also explicitely supported for Mo and Ag radiation, thanks to the radiation hardness of the detector.

3. Highest data quality

The absence of any defective channels or dead areas leads to the most uniform active detector area available on the market. The obtained diffraction data are not affected by any data interpolation.

4. Versatility

Variable sample to detector distance to optimize 2θ- and γ-coverage and peak resolution.

5. Software integration

Full integration into the DIFFRAC.SUITE software package for both 2D data acquisition and evaluation, see Figures 10 to 12.

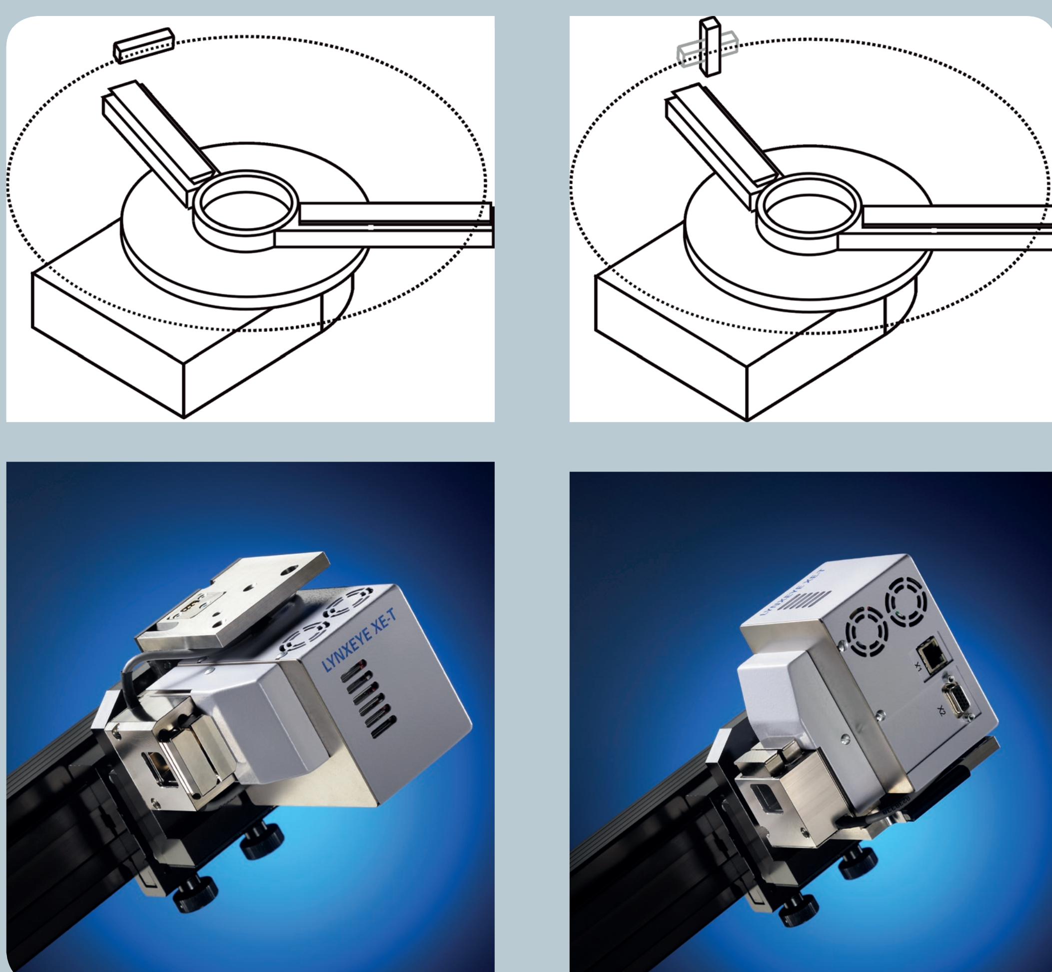
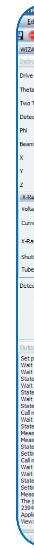


Figure 9: Left - 0° orientation for 0D and 1D data collection, Right - 90° orientation for 2D data collection



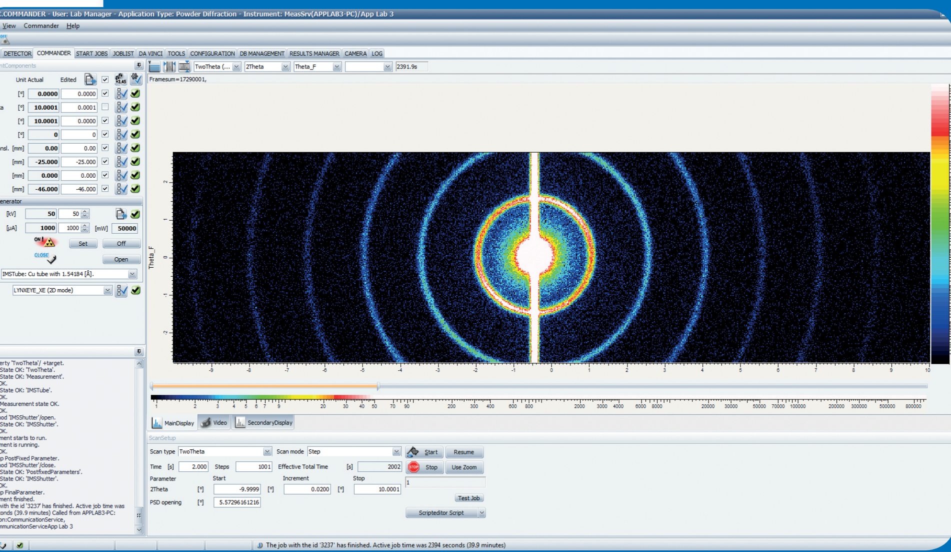


Figure 10: 2D SAXS data collection with DIFFRAC.COMMANDER

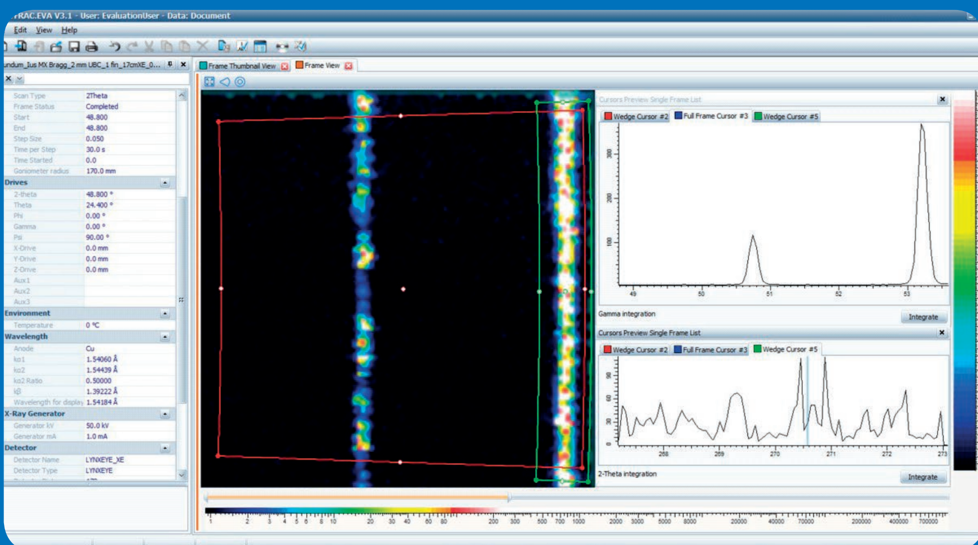


Figure 11: Data integration in DIFFRAC.EVA

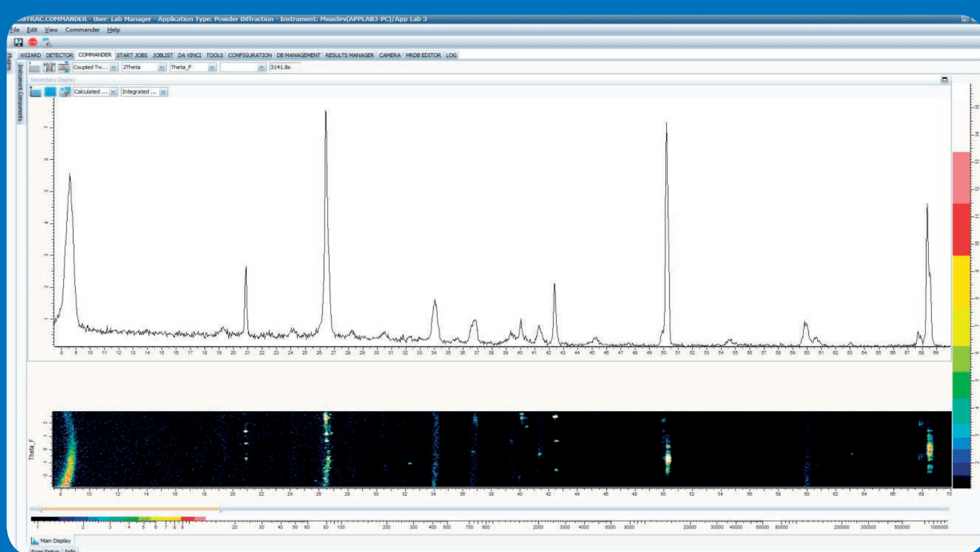


Figure 12: Real-time 2D and integrated 1D data view in DIFFRAC.COMMANDER during measurement

LYNXEYE XE-T

The highest performance detector for X-ray powder diffraction

Technical data
"Compound silicon strip" detector with 192 channels Up to 15 steps sub-sampling, giving 2880 (15x192) apparent channels
Active window: 14.4 mm x 16 mm
Spatial resolution (pitch): 75 micrometer
Maximum global count rate: >100,000,000 cps (fast shaping time)
Cr, Co, Cu, Mo, and Ag radiation
Sensor thickness: 500 µm
Radiation-hard front end electronics Proprietary charge-sharing elimination technology
Energy resolution <380 eV at 8 keV (Cu radiation) at 298K (energy resolution invariably depends on environmental laboratory temperature)
No maintenance
No counting gas, cooling water or liquid nitrogen

The LYNXEYE detector family is developed in collaboration with the AGH University of Science and Technology, Faculty of Physics and Applied Computer Science, Krakow, Poland.

LYNXEYE turned 90°: EP 1 647 840 A2 patent; EP 1 510 811 B1 patent

Bruker AXS GmbH

Karlsruhe · Germany
Phone +49 721 50997-0
Fax +49 721 50997-5654
info.baxs@bruker.com

www.bruker.com