

PHYSICS

CHEMISTRY
BIOLOGY

ENGINEERING



NEW

X-RAY APPARATUS



- Image sensor for high-resolution CT and digital Laue images
- Sharp Bragg spectra with new HD set
- Highest possible intensity with the new gold tube
- Plenty of space for accessories: new, practical drawer

LEYBOLD®

THE X-RAY SYSTEM

MODULAR CONCEPT FOR PHYSICS, CHEMISTRY, BIOLOGY, MEDICAL AND ENGINEERING SCIENCES

With the LEYBOLD X-ray Apparatus and the Computed Tomography accessories a wide range of topics on high schools and universities can be covered.

PRINCIPLES

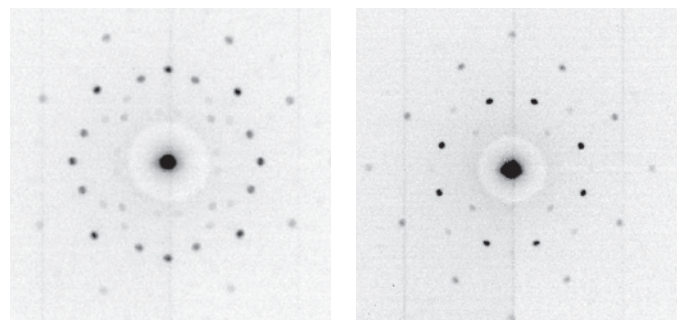
- Radiation imaging
- X-ray photography
- Ionisation and Dosimetry
- Attenuation of X-rays

SOLID STATE PHYSICS

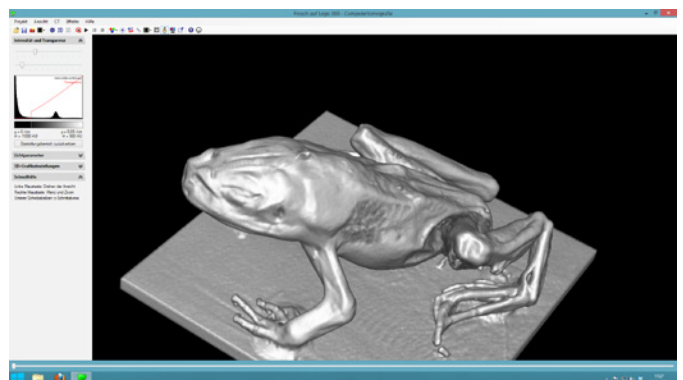
- Bragg: Determining the lattice constants of monocrystals
- Laue: Investigating the lattice structure of monocrystals
- Debye-Scherrer: Determining the lattice plane spacings of polycrystalline powder samples

ATOMIC PHYSICS

- Bragg: Diffraction of X-rays at a monocrystal
- Investigating the energy spectrum of an X-ray tube
- Duane-Hunt: Determination of h from the limit wavelength
- Energy-dependent absorption, K- and L-edges
- Moseley's law and determination of the Rydberg constant
- Fine structure of X-ray spectra
- Determining the binding energy of individual subshells by selective excitation
- X-ray fluorescence
- Compton effect on X-rays



Digital Laue images of NaCl and LiF (exposure time < 1 min)



3D reconstruction of a frog with the LEYBOLD Computed Tomography software

TECHNICAL APPLICATIONS

- Radiology
- Mineralogy
- Radiation protection
- X-ray fluorescence analysis
- Non-destructive material analysis
- Non-destructive testing
- Computed tomography also in 3D

1. BASIC DEVICE

- X-ray Apparatus
- Tubes
- Goniometer
- Drawer for storage



X-ray apparatus (554 800) with Bragg crystal and counter tube in operation.

Further information on the website under cat. no. 554 800

2. INDIVIDUAL ACCESSORY

PLEASE ASSEMBLE YOUR INDIVIDUAL SYSTEM AND PAY ONLY FOR WHAT YOU REALLY NEED.

- Crystals
- HD Accessory
- Absorber
- X-ray films

3. X-RAY ENERGY DETECTOR



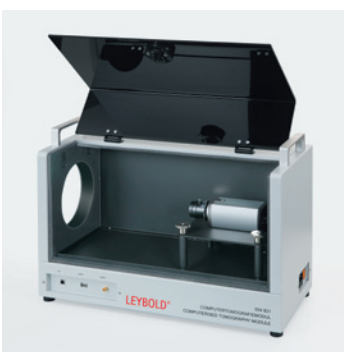
X-ray energy detector (559 938) for recording of energy resolved X-ray spectra.

- X-ray energy detector
- MCA box for CASSY
- Targets
- Alloys

The new X-ray image sensor is inserted in the X-ray apparatus.



4. COMPUTED TOMOGRAPHY SOLUTIONS FOR HIGH SCHOOLS AND UNIVERSITIES



- Computed Tomography module
- Computed Tomography Pro

The Computed Tomography Module captures the visible X-ray images from the fluorescent screen.

HIGH RESOLUTION CT SCANS

WITH THE NEW
IMAGE SENSOR

X-RAY IMAGE SENSOR

554 828

Compact high-resolution sensor head with USB module for capturing X-ray images with an X-ray apparatus at daylight conditions (without X-ray film). Together with the precision slide (554 829) the X-ray image sensor is a high performance camera for X-ray photographie, radiology, material testing, crystallography and computer tomography for use in practical trainings and demonstrations at universities.

The X-ray images can be saved as grayscale image in full resolution or they can be used for 3D reconstruction of the irradiated object with the computed tomography software. Such reconstruction is done live while capturing the images within minutes.

The sensor head is inserted with the precision slide (554 829) in the experiment chamber of the X-ray apparatus. The X-ray image is captured indirectly, as the radiation is first converted with a scintillator foil into a visual analog intermediate image and then with two large CMOS sensors into electrical voltage. This analog video signal of the sensor head is transmitted via a dual-link DVI cable to the digitalizing USB module and finally as grayscale image to the PC. The USB module is located outside of the X-ray apparatus to enable a compact as possible experimental set up within the X-ray apparatus.

The used CMOS sensors have proven themselves thousands of times and for over 10 years in industrial applications, e.g. in non-destructive material testing, production control and in medical engineering. Used in an X-ray apparatus they also provide there high-resolution radiography images up to CT scans.

Technical data of the analog sensor head

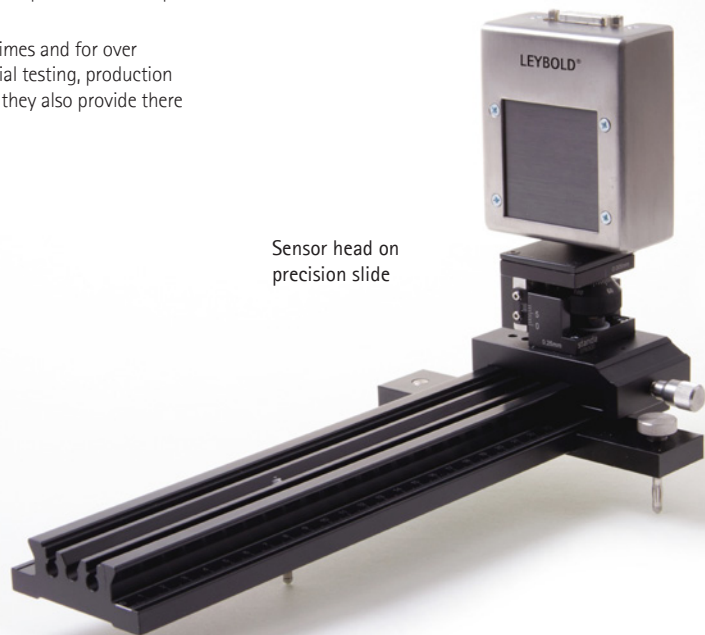
- Sensor without pixel line defects (Premium Grade)
- Sensor area : 49.2 mm x 48.0 mm
(CMOS, shielded for increased durability)
- Resolution: 1024 pixel x 1000 pixel
- Pixel size: 48 μm x 48 μm
- Video output: analog (0.5 μV /electron)
- Connection: Dual-Link DVI socket
- Housing: Special steel

Technical data of the digitalizing USB module

- Resolution AD converter: 12 bit grayscale



Analog sensor head with digitalizing USB module



Sensor head on
precision slide

PRECISION SLIDE X-RAY IMAGE SENSOR

554 829

For precise positioning and adjustment of the X-ray image sensor (554 828) in the X-ray apparatus (554 800 or 554 81USB). The optical bench offers a free positioning of the X-ray image sensor in the experiment chamber of the X-ray machine.

Directly behind the collimator, Laue images or at the other end of the optical bench computer tomography scans can be captured. If the center of the image sensor is accurately positioned behind the rotation axis of the goniometer with the high quality fine drive, there are optimum conditions for high-resolution CT scans.

The included demo version of the software Computed tomography displays high-resolution X-ray images, saves them in high-quality (16 bit grayscale) and is suitable for the use in X-ray photography, radiology, material testing and crystallography (Laue). For use in computed tomography the Pro-version of the software (554 820) is used.

ACCESSORY COMPUTED TOMOGRAPHY

554 826



For mounting of objects on the goniometer for computed tomography including multiple objects. The set of Lego bricks is chosen so that it can also serve as a slide. By gluing small objects, replaceable objects of study can be fixed easily.

SOFTWARE COMPUTED TOMOGRAPHY PRO

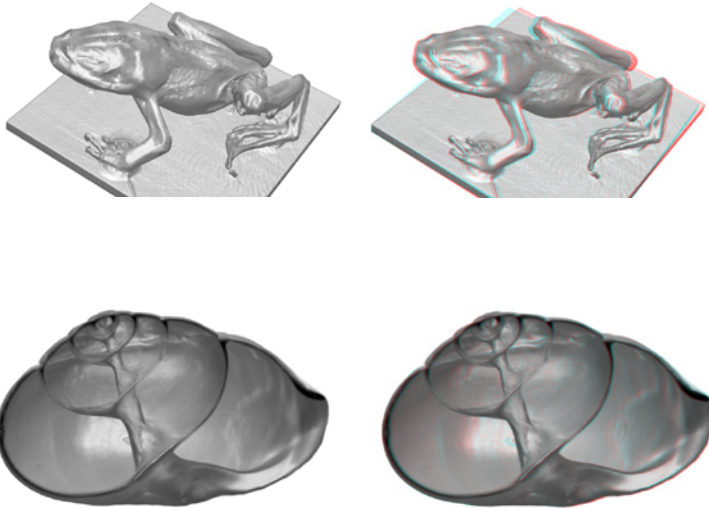
554 820

For calculation of CT scans with the Computed tomography module (554 821) or the X-ray image sensor (554 828) and the X-ray apparatus (554 801 or 554 811USB).

The X-ray apparatus is controlled in selectable angular steps to capture the X-ray images. During the capture the back-projection process is selectively visualized in two or three dimensions. There are already sectional views and 3D images of the unfinished 3D object with all viewing tools (rotate, zoom, transparency effects, cuts, stereoscopic display, illumination similar to the Heidelberg ray tracing model) available. The back-projection process completes with each additional step the finally finished 3D object.

Despite the low X-ray energy of 35 keV of a school X-ray apparatus, good resolution CT scans of different objects can be captured and also be analysed qualitatively and quantitatively. The focus is on the didactic preparation of the capturing process and the analysis.

A license of this software limited to Computed tomography module (554 821) is already included there.



High-resolution CT scans of a frog and a snail.
3D display also stereoscopic for red-cyan glasses (right hand).

RED-CYAN GLASSES (3D)

554 827

For viewing of stereoscopic 3D image as i.e. generated from the Computed Tomography Pro software (554 820).



PACKAGE COMPUTED TOMOGRAPHY PRO

554 820P

Extension of the X-ray apparatus (554 801) with the X-ray image sensor (554 828) and all accessories for high-resolution computed tomography.

Consisting of

554 820	Software Computed Tomography Pro
554 826	Accessory Computed Tomography
554 827	Red-Cyan Glasses (3D)
554 828	X-ray image sensor
554 829	Precision slide X-ray image sensor

	COMPUTED TOMOGRAPHY MODULE	COMPUTED TOMOGRAPHY PRO
Task group	High schools/universities	Universities
X-ray image	observable on fluorescent screen	not observable inside image sensor
Image sensor	photosensitive camera	analog CMOS image sensor
Resolution	640 pixel x 480 pixel	1024 pixel x 1000 pixel
Bit depth (grayscale)	8 bit	12 bit
Sensitivity	high	very high (also for Laue)
max. object size	approx. 8 cm x 8 cm x 8 cm	approx. 4 cm x 4 cm x 4 cm
max. object resolution	approx. 0.25 mm	approx. 0.05 mm
Connection to PC	USB	USB

AT LAST - SHARP BRAGG SPECTRA

NEW,
PRACTICAL
DRAWER

Up to now, the resolution available from school X-ray apparatuses could only record the characteristic lines in a Bragg spectrum with low sharpness. This meant that they became too wide and could only be measured with too small intensity in comparison with the continuum. Using the HD accessory X-ray, which consists of a high-resolution collimator and Geiger counter holder with narrow slits in addition to new software, the maximum possible angular resolution of your goniometer increases to 0.01° . Together with the narrow slits, Bragg spectra with 4-fold resolution are possible. This means that not only the lines are sharper by a factor of 4, but also that the contrast between sharper lines and wide continuum is correspondingly increased.

THE NEW HD
ACCESSORY



HD ACCESSORY X-RAY

554 835

HD upgrade set for your X-ray apparatus consisting of a new collimator, geiger counter holder and the HD software.

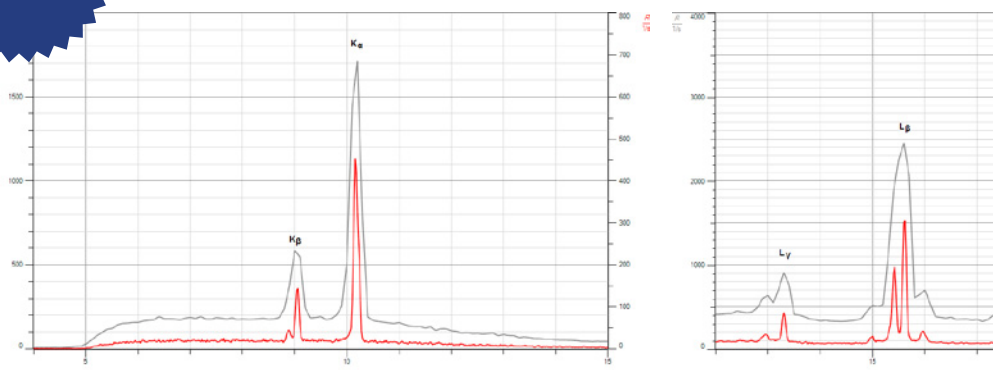
Simply fit the high-resolution collimator and geiger counter holder in the X-ray apparatus and start the new software – you can now record high-resolution Bragg spectra.

THE LEYBOLD TUBE
WITH THE HIGHEST
INTENSITY



IP
REGISTRATION

Mo spectrum with LiF in normal resolution (grey, left-hand scale) and high resolution (red, right-hand scale) each with 5 sec gate time/measuring point. In high resolution, the fine structure of the K_β line is visible even in the first order.





PLENTY OF
SPACE FOR
ACCESSORIES

The two drawers now offer you plenty of space for your accessories including X-ray tubes, crystals, absorbers, filters, Geiger counter with holder and target table, X-ray energy detector, MCA box and film holder, to match your X-ray apparatus and your computed tomography module. Thanks to the padded, device-shaped storage system, your accessories can be stored optimally, clearly and in just one place. The lockable drawer is made of stable steel and fits under the X-ray apparatus and also under a tabletop as an alternative.

DRAWER FOR X-RAY APPARATUS

554 804



X-RAY TUBE AU

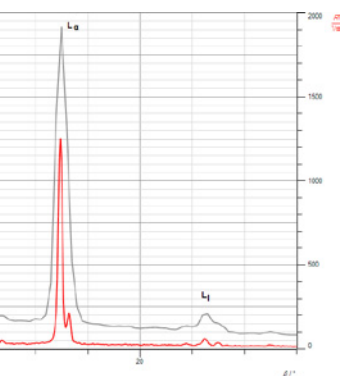
554 866

Ideal for radioscopy experiments and computed tomography
Shift of atomic energy of interest for atomic physics



DRAWER FOR COMPUTED TOMOGRAPHY MODULE

554 824



Au spectrum with LiF in normal resolution (grey, left-hand scale) and high resolution (red, right-hand scale) each with 5 sec gate time/measuring point. In high resolution, the fine structure of the L_{α} and L_{β} lines are visible even in the first order.

ALL NEWS AT A GLANCE

Cat. no.	Name
X-RAY APPARATUS	
554 835	HD Accessory X-ray
554 866	X-ray tube Au
554 804	Drawer for X-ray Apparatus
554 824	Drawer for Computer Tomography Modul
X-RAY IMAGE SENSOR AND ACCESSORY	
554 828	X-ray Image Sensor
554 829	Precision Slide X-ray Image Sensor
554 820	Software Computed Tomography Pro
554 826	Accessory Computed Tomography
554 827	Red-Cyan Glasses (3D)
PACKAGE COMPUTED TOMOGRAPHY PRO	
554 820P	Package Computed Tomography Pro

Further product information is available on our webpage under the particular catalogue no.



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