

Elemental Analysis by Wavelength Dispersive X-ray Fluorescence (WDXRF) Spectrometry

What is XRF?

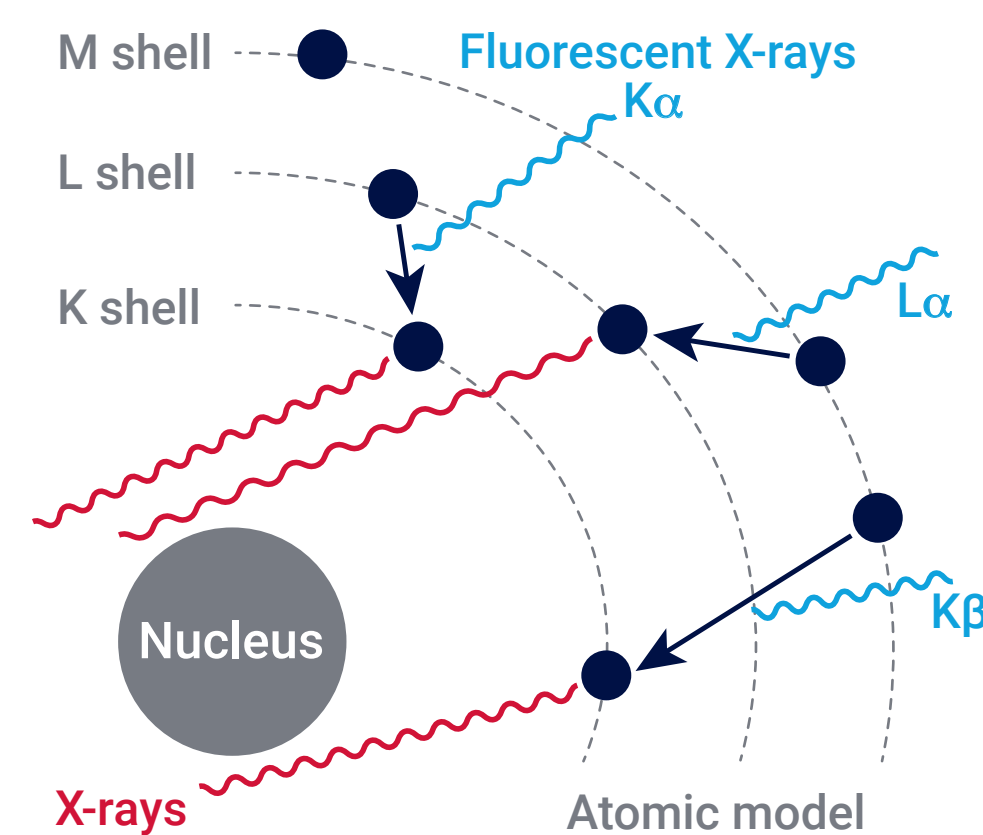
X-ray fluorescence analysis is a method that uses characteristic X-rays (fluorescent X-rays) generated when X-rays irradiate a substance. This poster shows the principles of generation of fluorescent X-rays using an atomic Bohr model diagram.

In WDXRF, a sample is irradiated with X-rays causing emission of fluorescent X-rays from the material. The fluorescent X-rays are then diffracted with a crystal and observed with a detector. The wavelength (energy) of fluorescent X-ray is specific to an element and the X-ray intensity correlates with the element concentration. This allows qualitative and quantitative analysis.

The Rh/Pd target X-ray tube on the instrument irradiates the sample. The emitted fluorescent X-rays from the sample are then diffracted by a crystal (LiF200, PET, RX26, Ge) to select X-rays by wavelength. The intensity of the diffracted X-rays is then measured with a detector. P-10 gas is used for the flow proportional counter (F-PC) to detect X-rays with longer wavelengths (lighter elements). The scintillation detector is used for heavy elements.

The instrument is equipped with a vacuum pump since measurements of solid samples are performed in vacuum atmosphere. Liquid samples are measured in Helium.

- 1 Primary X-ray photon strikes an inner shell electron.
- 2 An inner shell electron is ejected as a photo electron.
- 3 An electron shifts from outer shell.
- 4 Fluorescent x-ray photon is produced.

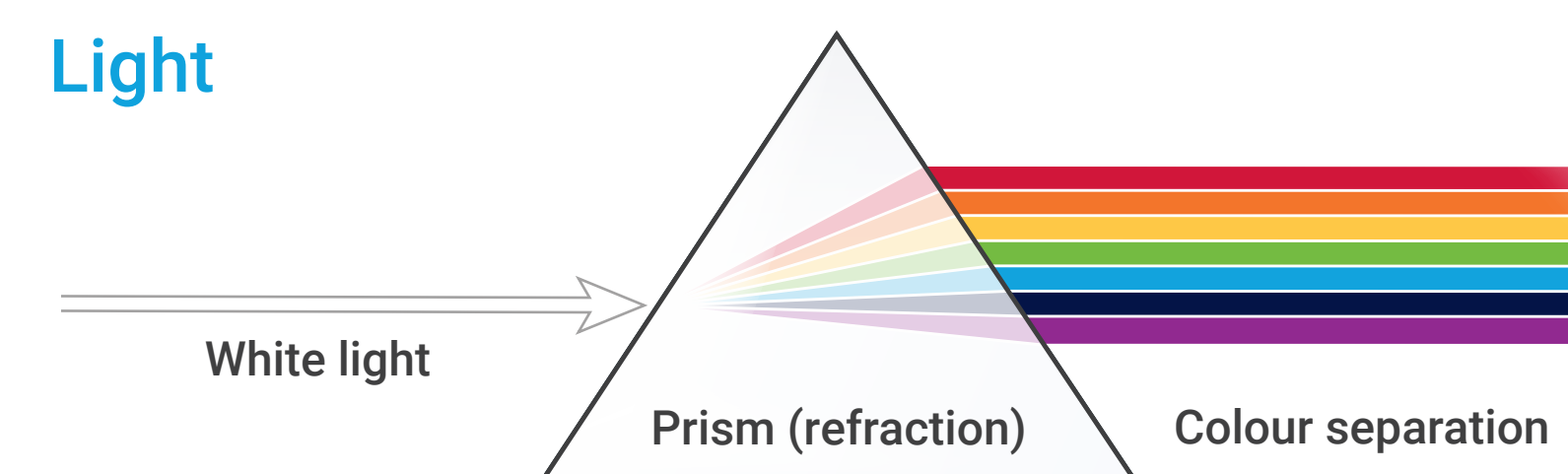


Point: Various types of fluorescent X-rays are generated from one atom.

How does WDXRF work?

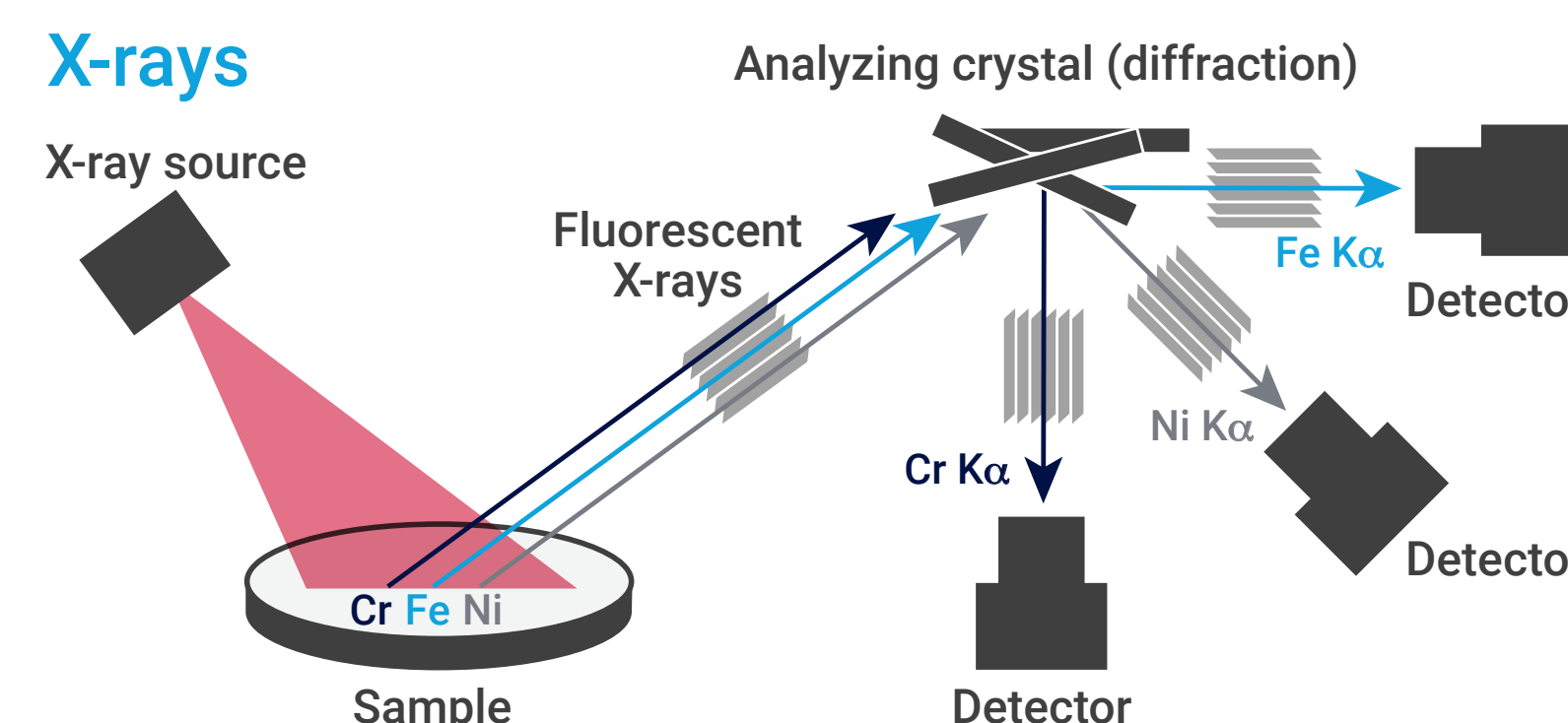
Wavelength dispersive X-ray fluorescence (WDXRF) spectrometry is a method used to separate and measure the characteristic fluorescent X-rays emitted from a sample. The technique employs an analyzing crystal to spatially spread the X-ray light, much like a prism spreads visible light into its component colours.

Light



The wavelength of the impinging X-ray and the crystal's lattice spacings are related by Bragg's law and produce constructive interference when they satisfy the Bragg equation. The X-rays emitted by the sample are collimated by parallel metal blades (collimator) and irradiate an automatically selected analyzing crystal at a precise angle. X-ray light diffracted by the analyzing crystal is spatially spread out, so that characteristic photons may be collected by a detector positioned at a precise angle to record a X-ray intensity of a specific element.

X-rays



Point: X-rays with various wavelengths are dispersed by diffraction phenomenon with analyzing crystal.

X-ray optics

In WDXRF, the sample, analyzing crystal and detector are all mounted on a variable angle drive optical mechanism called a goniometer. As illustrated (Fig 1 & Fig 2), the goniometer precisely varies the angles so that the detector can record X-ray fluorescence from any element of interest. The entire X-ray optical mechanism is contained within a vacuum chamber to eliminate absorption of soft radiation (low-energy photons) by the air.

The ZSX Primus series of spectrometers contain up to ten analyzing crystals, that can be automatically selected depending on the wavelength being analyzed, enabling elements from almost the entire periodic table to be analyzed.

Fig 1

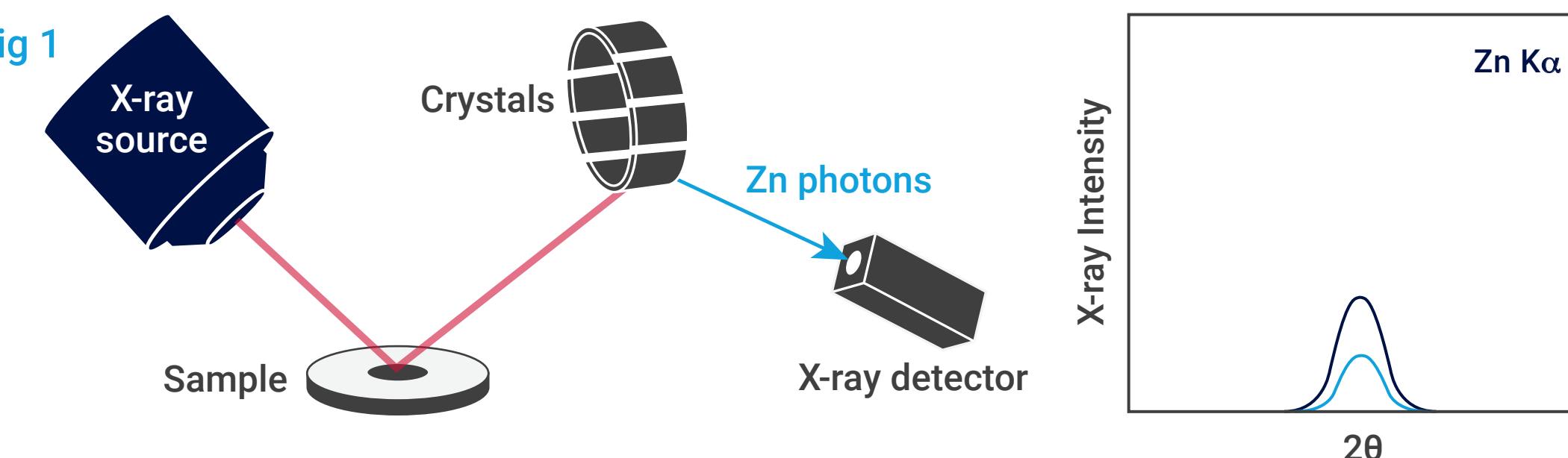
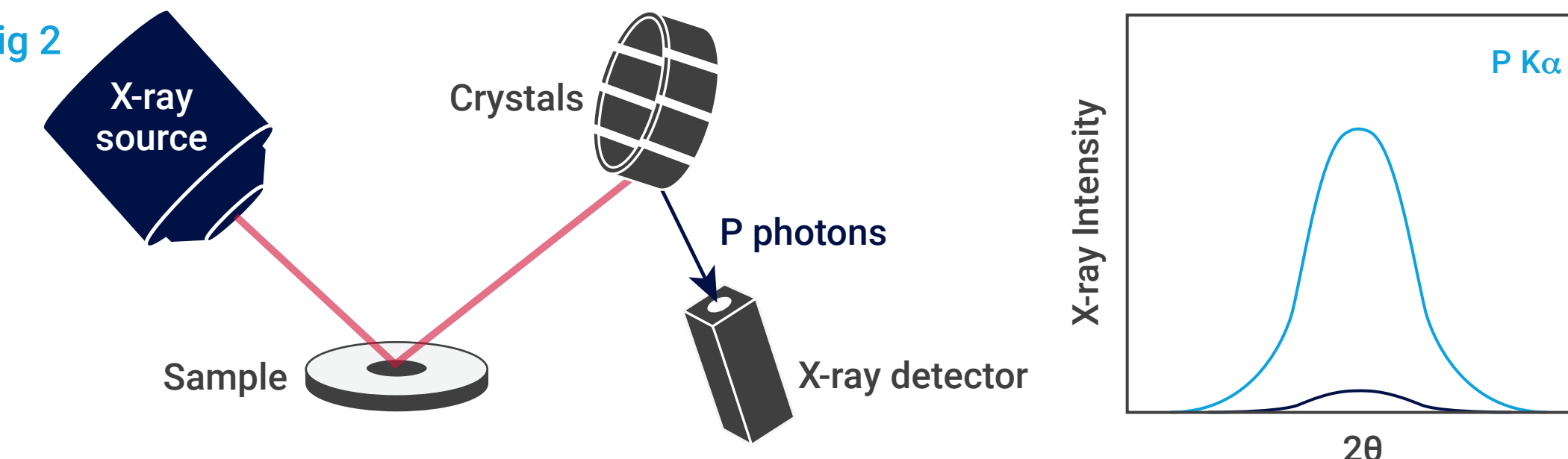
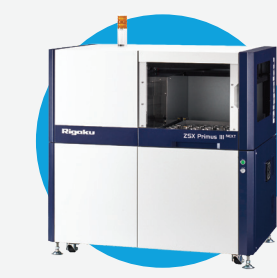
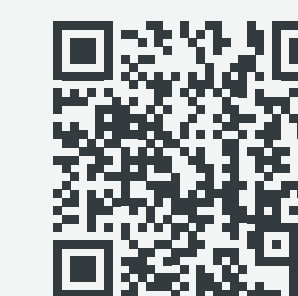


Fig 2



Rigaku's WDXRF Instruments

Sequential				Simultaneous
				
Supermini200 - Optimized as a benchtop WDXRF - Best Light element - Best for the determination of Cl, no spectral overlap	ZSX Primus III NEXT - Optimized for solids - Standard system - Normal sample throughput	ZSX Primus IV - Optimized for powder samples - Standard system - High sample throughput	ZSX Primus IVi - Optimized for liquid samples - Small Footprint - Normal to high sample throughput	Simultix 15 - Optimized for high speed - Most powerful system - High sample throughput



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