New Technologies in the Fight Against Falsified Medical Products:

X-ray Powder Diffraction - Possibilities and Drawbacks

M.Sc. David Kočović,
Head of Laboratory CInMED

CInMED

14.10.2025.
Belgrade, Serbia

Falsified Medical Products

Deadly new drugs found in fake medicines in the UK

29 October 2024

Alex Homer Shared Data Unit
Navtej Johal BBC News, Midlands correspondent

UCLA Health — Find Care | Patient Resources | Treatment Options | Locations | Discover

News & Insights

Counterfeit pills sold in Mexican pharmacies found to contain fentanyl, heroin, and methamphetamine

Global State

Prior data (IMPACT report) estimated ≥30%
Current information (WHO) ≥10%

Contaminated cough syrups death toll passes 300 in four months

BY SANJAY KUMAR | 14 FEBRUARY 2023

Inconsist
on the sc
USP

Half a million lives lost to fake medicines in sub-Saharan Africa: UN

UN says 605 tons of trafficked medical products were seized in West Africa alone between 2017 and December 2021

SOUTH DAKOTA DEPARTMENT OF HEALTH — Topics | Programs

News

Fake Pills Kill: The Increasing Danger of Fentanyl

Screening Technologies for Detection – handheld devices

TLC (testing kits)

Raman spectroscopy

NIR spectroscopy

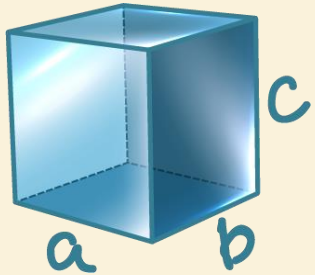
PADs (paper analytical devices)

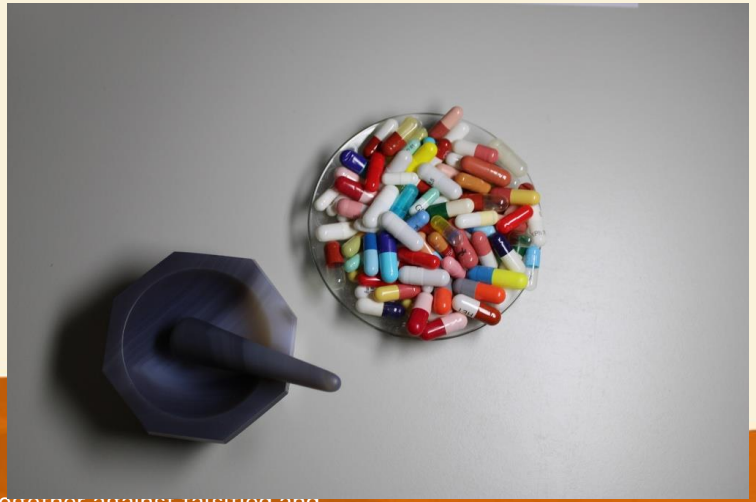
Screening Technologies for Detection – handheld devices

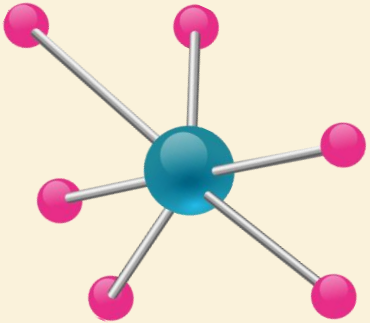
Laboratory of the Institute for Medicines and Medical Devices of Montenegro

The laboratory instruments were funded through the EU Instrument for Pre-Accession Assistance (IPA II, 2014–2020) under Negotiation Chapter 1 – Free Movement of Goods, and were delivered in December 2020.

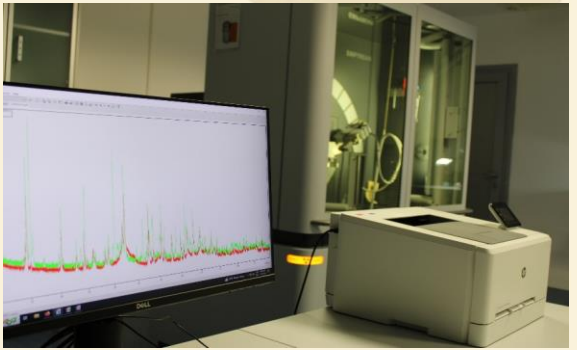
The equipment is intended for the detection of substandard and falsified medicines on the Montenegrin market using X-ray powder diffraction (XRPD) and X-ray fluorescence (XRF) techniques.

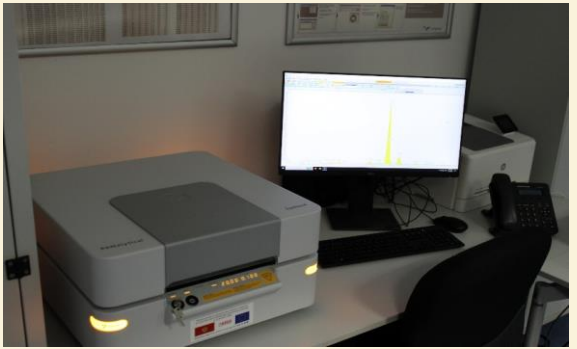




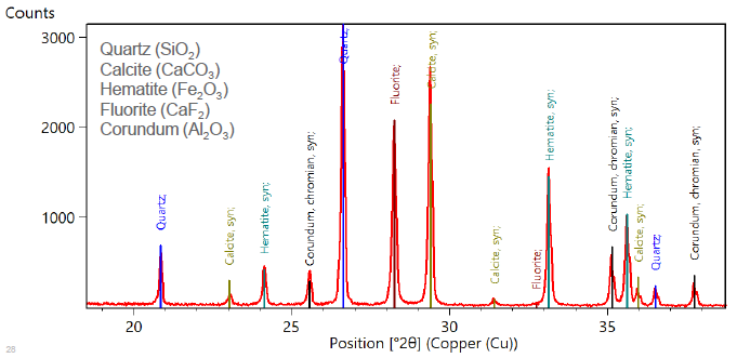


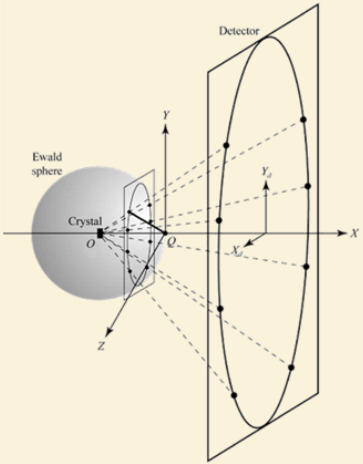
Laboratory of the Institute for Medicines and Medical Devices of Montenegro

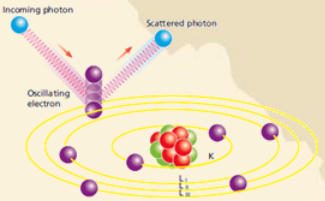


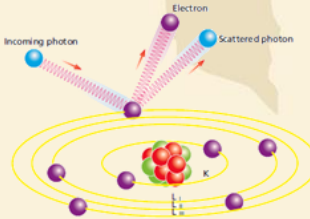


X-ray Powder Diffraction: The Fundamentals



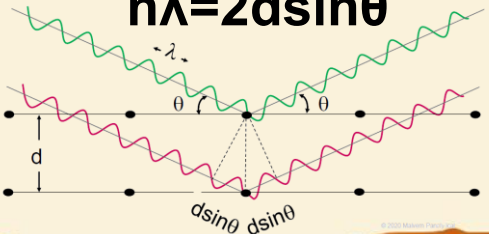


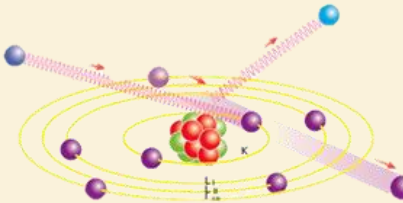




	X-Ray Diffraction	X-Ray Fluorescence
Atomic structure	Yes	No
Elemental composition	No (indirect)	Yes
Polymorph discrimination	Yes	No
Fingerprinting	Yes	Yes (for elements)
Database size	1,000,000+	Not applicable
Quantitative analysis	Yes	Yes
Speed	Minutes	Minutes

$$n\lambda=2d\sin\theta$$





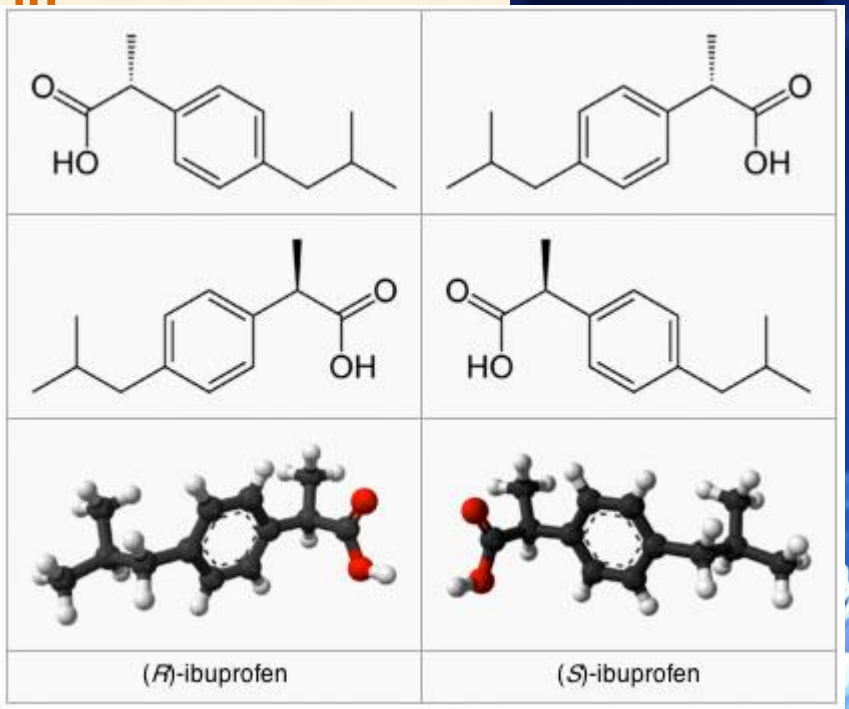
XRD Applications in Pharmaceutical A

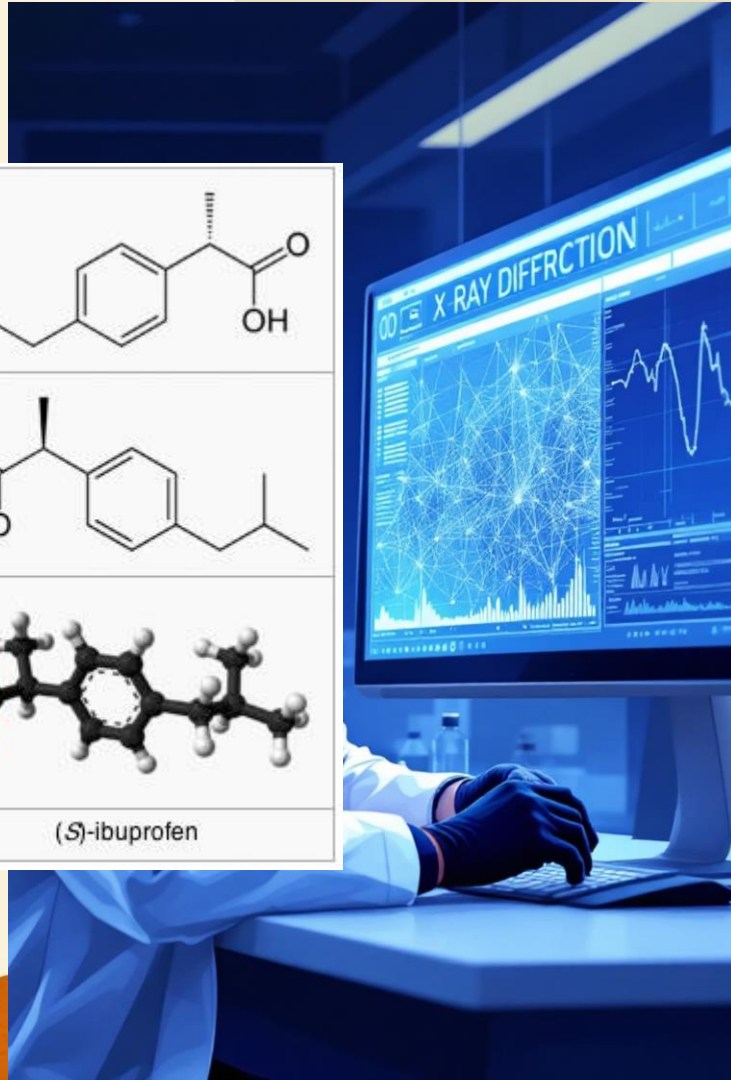
API identification
Confirms identity of crystal
patterns against reference d
adulterations

Polymorph screening
Distinguishes between diffe
molecule, which can drama
therapeutic efficacy

Excipient analysis
Identifies crystalline excipie
substitutions that may com
performance

Mixture characterization a
Analyzes multi-component
and detect undeclared ingre





XRD Technology: Possibilities and Drawbacks

Pros

Non-Destructive Analysis
Samples remain intact after analysis, enabling additional testing or evidence

Definitive Identification
Provides unambiguous crystalline phase identification with high specificity and

Minimal Sample Preparation
Requires simple grinding and mounting, reducing time and potential for

Quantitative Capability
Can estimate relative proportions of crystalline phases and total amorphous content in mixtures through Rietveld refinement

Solving crystal and molecular structure
The most advanced and challenging field of XRPD

No reference materials needed
The technique requires databases, that can be used to analyze samples without reference materials

Cons

Amorphous Materials
Cannot identify or characterize non-crystalline substances, limiting utility
for some formulations

Equipment Cost
High initial capital investment and maintenance requirements restrict accessibility in resource-limited settings

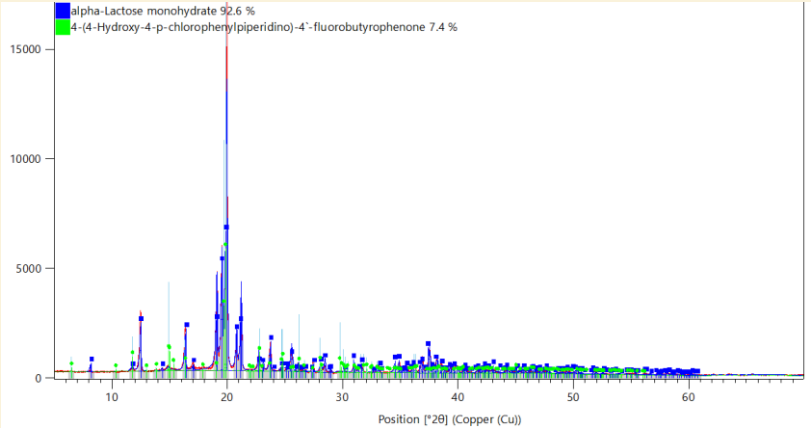
Expertise Required
Data interpretation demands specialized training and experience for accurate pattern analysis

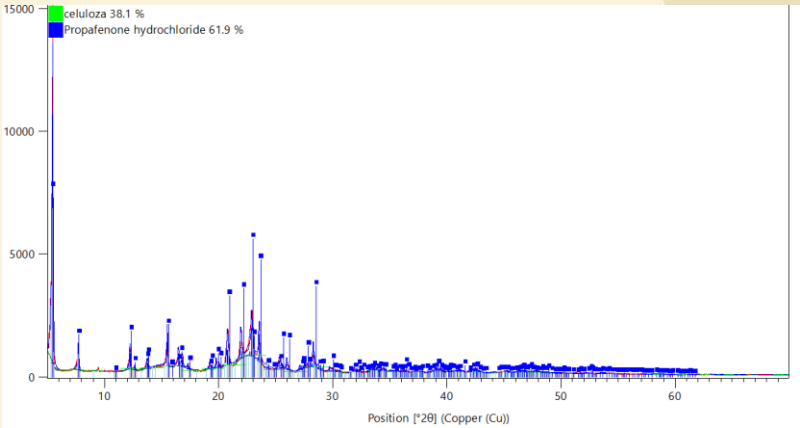
Interpretation Time
Measurements typically require 60 minutes per sample, and interpretations can be very lenghty

Safety concerns
Due to X-ray radiation, it is important to conduct regular checks for equipment and medical checks on personnel

Solid samples only
One of the biggest drawbacks, as liquid samples are not an option

XRD Technology: Possibilities and Drawbacks






Thank you for your attention
www.cinmed.