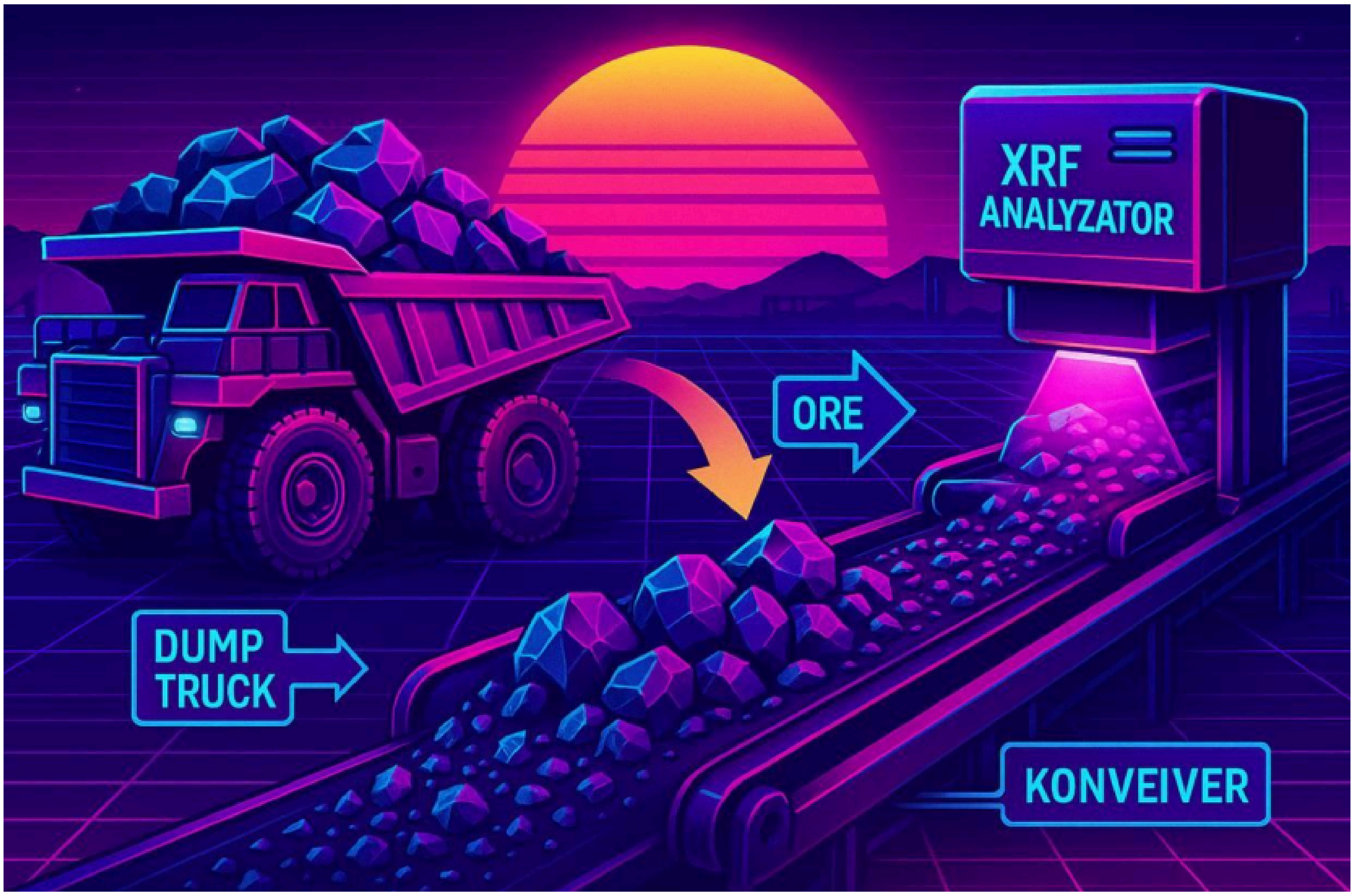
Labsystematic
Your partner in high end instrumentation

@labsis.id

On-Belt XRF Analysis of Run-of-Mine
Ore with Lump Size up to 300 mm



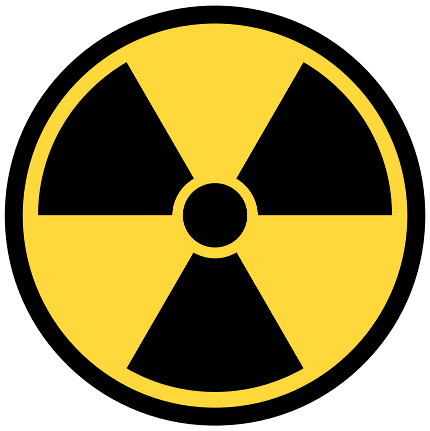
www.labsystematic.com

PART 1

“This belt analyzer is useless — it can’t see inside the rocks. What’s the point?”

This topic has sparked endless debate. Some say that on-stream X-ray fluorescence (XRF) analysis isn’t accurate enough; others doubt its representativity. Much of the skepticism stems from the fact that most classical literature on ore analysis and sample preparation is focused on laboratory methods — based on grams of finely ground material — not on tens of tons of raw ore in motion.

A systematic review explaining how on-belt XRF analysis fundamentally differs from laboratory techniques is nearly nonexistent. We aim to fill that gap.



Imagine the bed of a haul truck loaded with ore.

It can carry up to 500 tonnes. The rocks are the size of furniture, and the load is meters deep. Now imagine someone wants to “just mount an analyzer above the truck and measure composition.” That's a completely different story. In such conditions, the surface relief, loading density, and material depth make results unstable and raise serious questions about representativity.

What happens on a conveyor belt?

By the time ore is discharged onto the belt, it’s already partially crushed — there are no meter-sized boulders. As the belt moves, most lumps are scanned at the surface. The XRF analyzer doesn’t read the entire volume — only the top 1–3 mm — but it does so continuously, over time, and across the full width of the belt.

You can think of it as taking dozens of shallow cross-sections from every cubic meter of ore. Statistically, this approach can be even more reliable than a one-time laboratory assay of a small subsample taken from a “representative” sample. Field experience from sites where these analyzers have been used for years supports this.

Let’s talk methodology.

In laboratory practice, the representativity of a sample is often estimated using the Chechott formula:

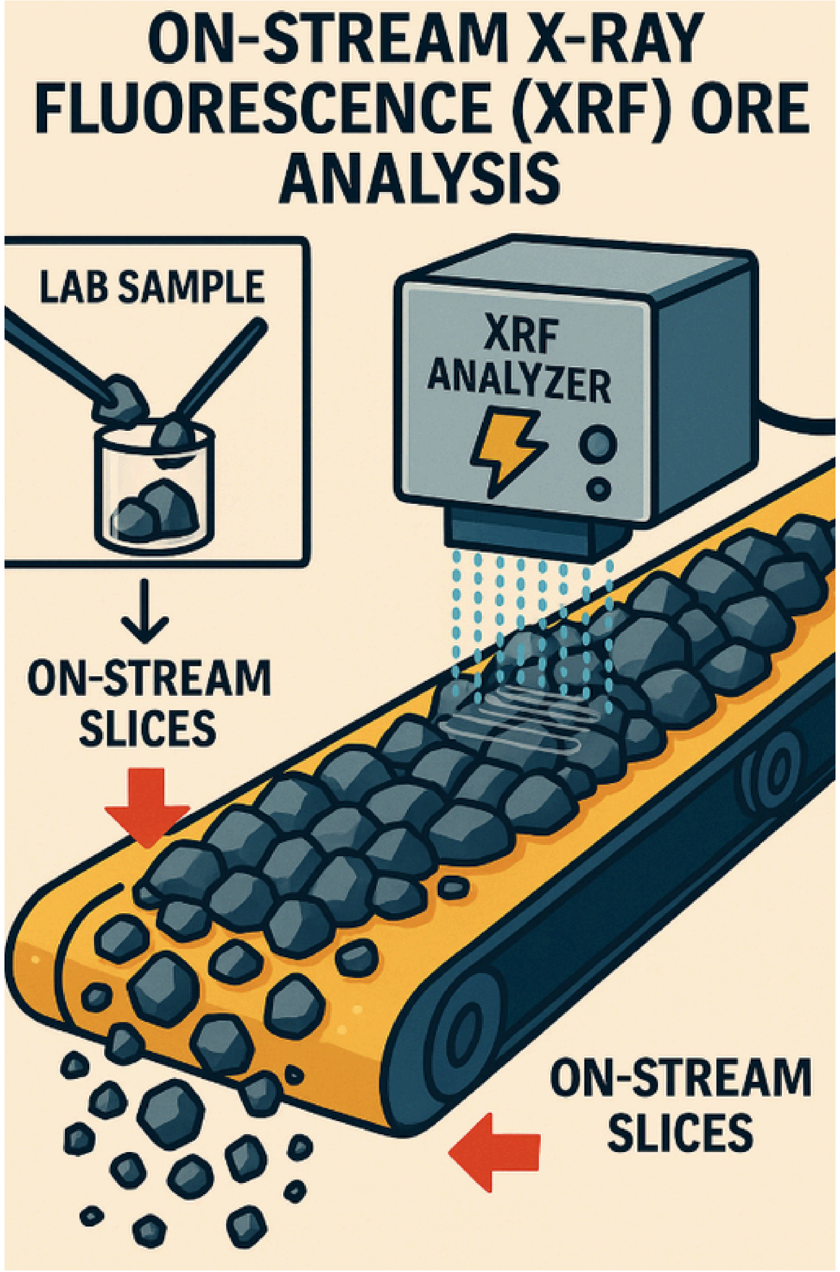
$Q = k \cdot d^2$

Where:

- Q = minimum representative sample mass, in kg
- d = maximum particle size, mm
- k = empirical coefficient (0.01–0.1), reflecting material heterogeneity

Example:

For $d = 300$ mm and $k = 0.05$:
$Q = 0.05 \times 300^2 = 4500$ kg = 4.5 tonnes
So, in theory, to obtain a representative sample at this particle size, you'd need 4.5 tonnes of
ore. This is nearly impossible to implement in practice — raising a valid question about the feasibility of truly “representative” sampling. Meanwhile, lab analysis is usually performed
on just a few dozen grams taken from those 4.5 tonnes.



PART 2

Why the Chechott Formula Doesn’t Work in Flowing Material

In Part 1, we highlighted a clear contradiction:

According to the Chechott formula, 4.5 tonnes are required for a representative sample at 300 mm particle size. In reality, laboratories work with a few grams. And on-stream analyzers? They only scan the surface — but continuously. So, is this representative or not?

The issue lies not with the formula, but with its applicability.

The Chechott equation Q = k · d^2 estimates the minimum required mass to capture all mineralogical inclusions and heterogeneity. It was developed in the context of one-time manual sampling: bucket, sample, subsample. The goal was to ensure that one sample accurately reflects the entire lot.

But on-stream XRF follows a different philosophy.

There is no single large sample. Instead, there are dozens, hundreds, or thousands of small “slices” that together form an averaged view of the entire flow. It’s like assembling a high-resolution mosaic rather than taking a single aerial photo.

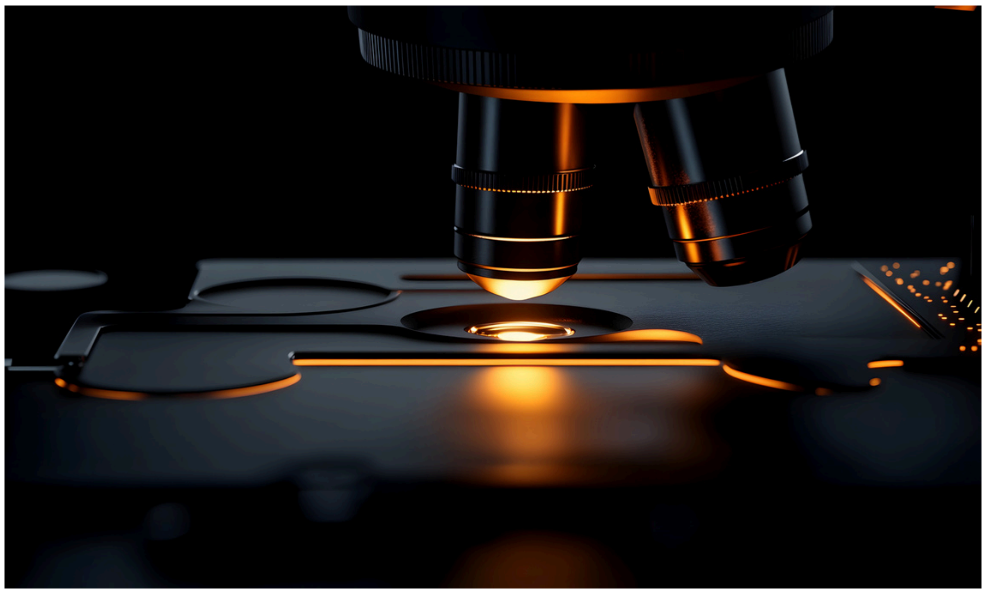
The Chechott formula simply doesn’t apply.

Why? Because it was designed for static, one-time measurements. But in a stream, you get many measurements. What isn’t captured in one spectrum is likely picked up in the next.
We're not sampling with a bucket — we're scanning the entire stream, layer by layer, over time.

PART 2

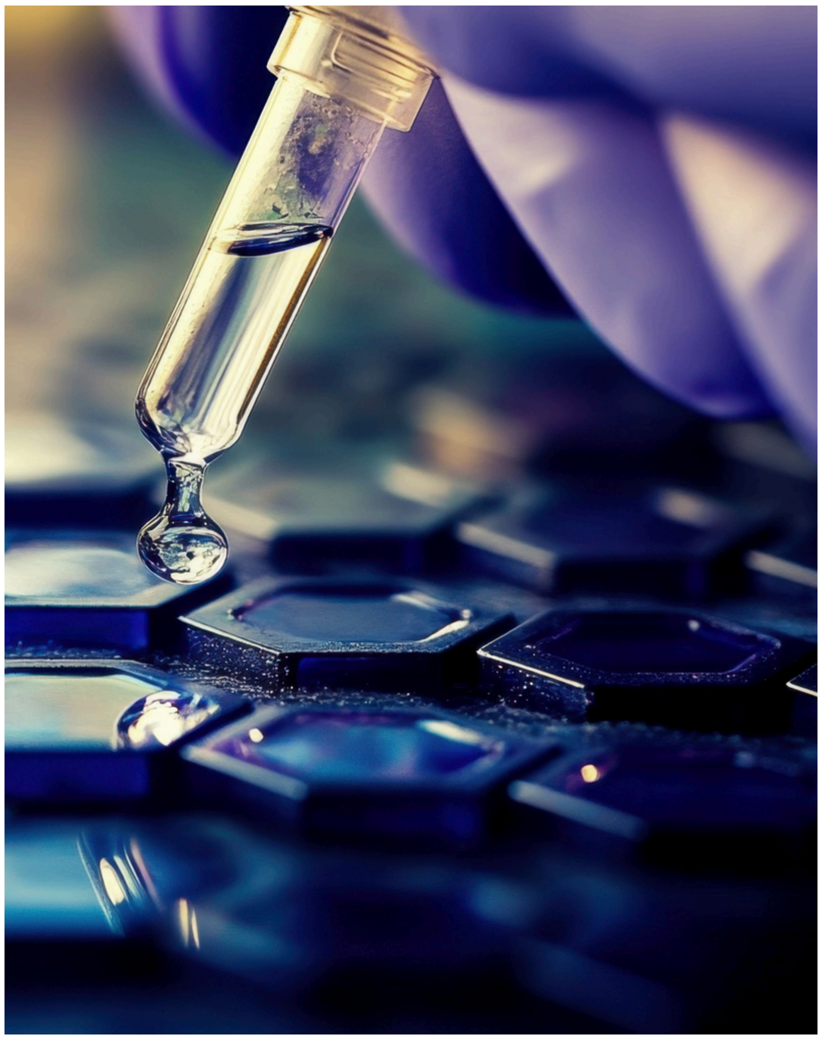
In place of mass, we use statistics.

The classical formula from sampling theory is:
$n = S^2 / \varepsilon^2$
Where:
- n = number of spectra required
- S = variance in composition between spectra
- ε = allowable error in the mean (e.g., 5%)



This is the new representativity — not volumetric, but statistical.

Instead of maximizing the mass of one lab sample, we control:
- integration time
- analyzed area
- X-ray tube current and voltage
- detector count rate
- averaging interval



PART 2

People often say:

“But you’re only scanning 1–3 mm of the surface!”
Yes. But across the full belt width. And all the time. This enables trend monitoring, detecting feed fluctuations, and ensuring real-time process control — without delays.
And remember: even in the lab, the full sample isn’t analyzed — just grams from tonnes.
In contrast, on-stream systems may analyze more total mass, albeit just the surface.

A final point: Laboratory methods are designed to eliminate two major error sources:

Micro-heterogeneity of the sample

The analytical spot in lab XRF is just a few mm². A large particle or inclusion in that spot can skew the result.
To avoid this, samples are pulverized, homogenized, and pressed to achieve maximum uniformity.
In contrast, on-stream systems average over areas of tens or hundreds of cm² — and do so repeatedly. No grinding required.
Averaging happens naturally across space and time.

Variable distance to the sample surface

XRF signal intensity depends strongly on geometry.
In the lab, this is controlled using fixed sample cells.
In on-stream systems, it's handled through engineering:

-A linear actuator maintains constant analyzer position
-Level sensors monitor layer height
-Real-time algorithms correct the signal for geometry changes

All of this is implemented and patented in the SOXRFA 4 on-stream analyzer, developed by SOXRF. These solutions compensate for key error sources and ensure stable results in real industrial conditions.

On-stream XRF is not a “simplified” lab method.

It is a distinct measurement system, where the goal is not to “penetrate deep,” but to
statistically cover the entire material flow.
And when implemented properly — from calibration to geometric stabilization — the
results can match or even exceed traditional lab sampling in reliability.