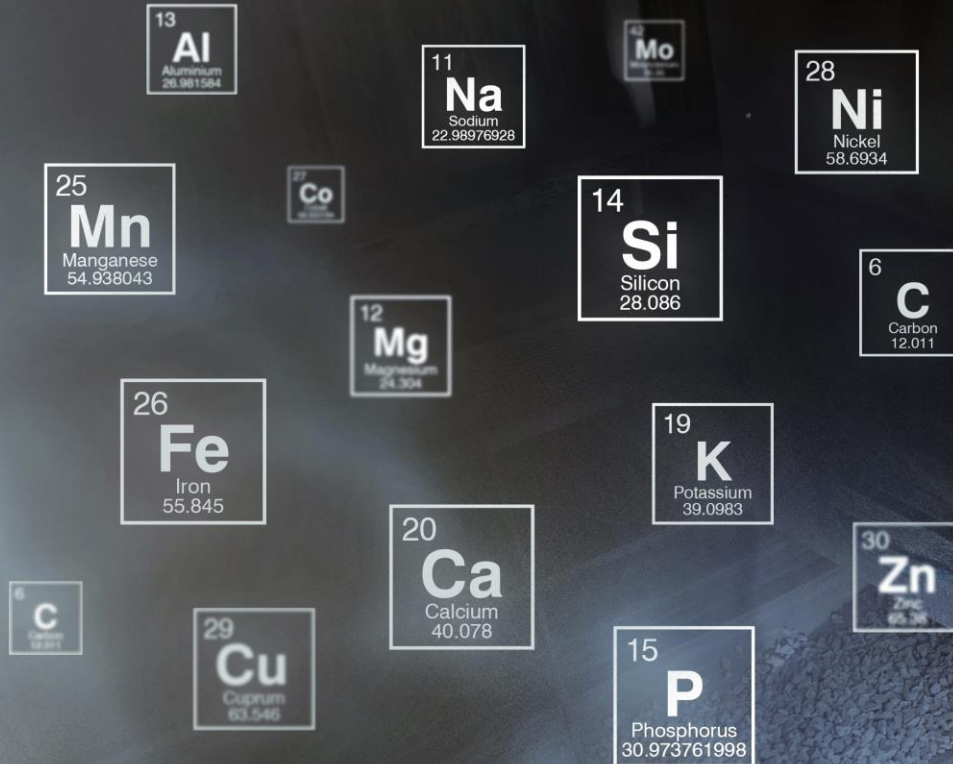


# LYNCIS

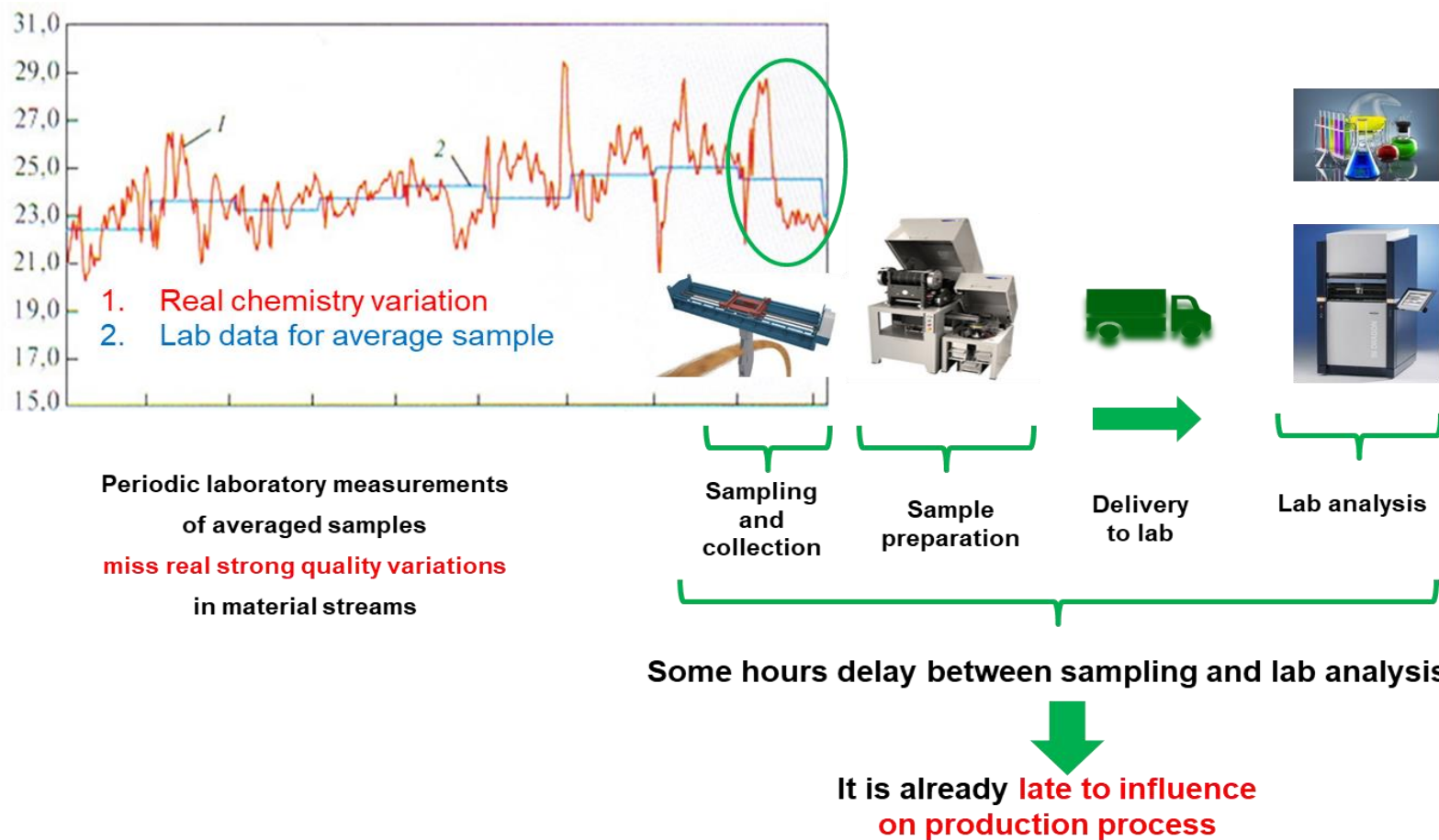
Real-time process optimization  
in Fertilizers Industry

## Radiation-Free Online Elemental Analyzer

Continues and safe online chemical analysis  
of material streams for real time process  
optimization and Industry 4.0 solutions



# Why Online?



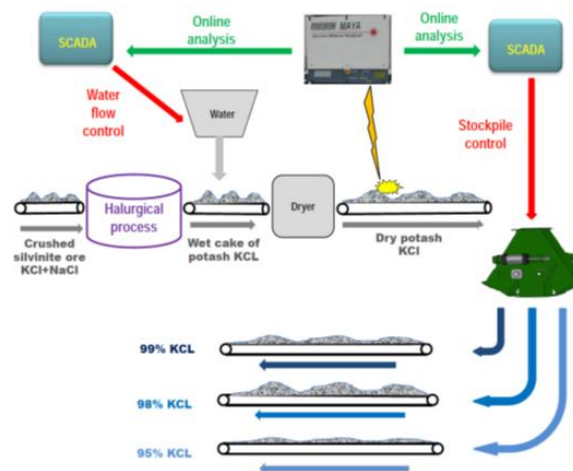
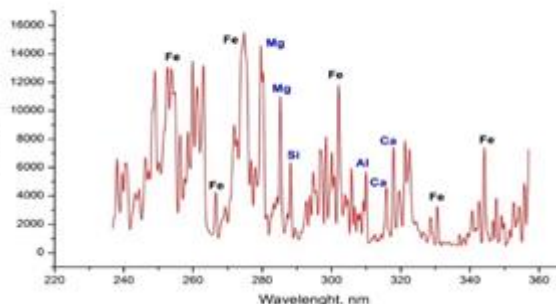
# How you will benefit from online analysis?

Access to real-time elemental analysis enables you to make better decisions in the production process

Online chemical analysis

Real-time process control

Improved KPIs



- Higher recovery of fertilizer minerals
- Additional earnings from high-grade fertilizers
- Reduced consumption of water and energy
- Elimination of quality claims

# Online Analyzer for Fertilizer Industry

## Phosphates

- Analysis of MgO, Fe<sub>2</sub>O<sub>3</sub>, Al<sub>2</sub>O<sub>3</sub>, CaO, P<sub>2</sub>O<sub>5</sub>, BPL
- Quality control and rejection of waste rocks at earlier stages

## Potash

- Analysis of KCl, NaCl, insolubles
- Analysis of solids and brine solution
- Final product quality control

## NPK

- Analysis of N, P, K, moisture, etc.
- Final product quality control



## Customers



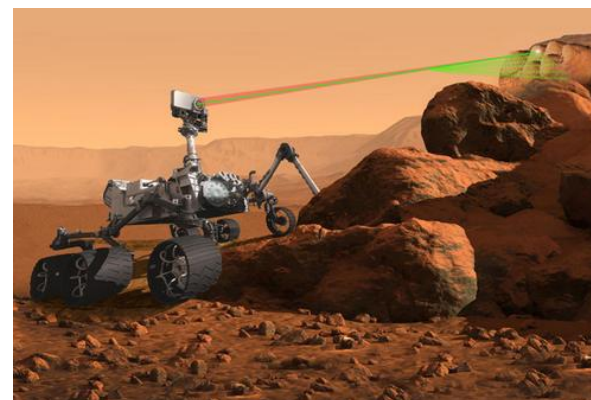
# Technology

[https://spinoff.nasa.gov/Spinoff2020/ip\\_9.html](https://spinoff.nasa.gov/Spinoff2020/ip_9.html)

## Laser Induced Breakdown Spectroscopy (LIBS)

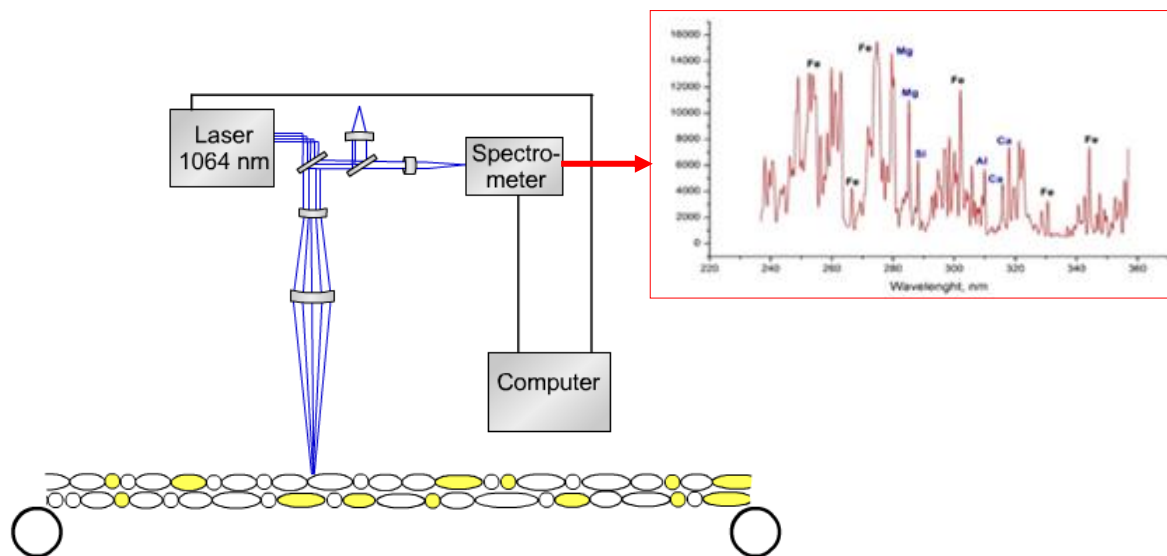
LIBS technology use laser-based optical emission spectrometry to analyze elemental composition of various materials. First practical application was developed in 1980 and now it used in Military, Industrial and Medical applications.

NASA Curiosity rovers are equipped with LIBS instrument for chemical analysis of rocks in Mars.



### Operation Principles:

1. Pulsed laser beam is focused on the material on conveyor
2. Solid / liquid material transforms to plasma around the focus point
3. When cooling, plasma emits light
4. Spectrometer collects this light and produce wavelength-based spectrum
5. This process repeats with frequency up to 100 Hz



# LIBS Spectrum

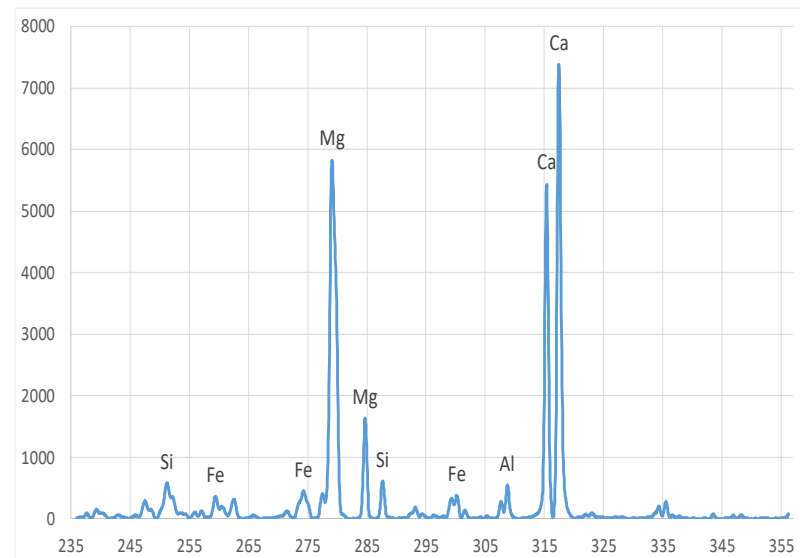
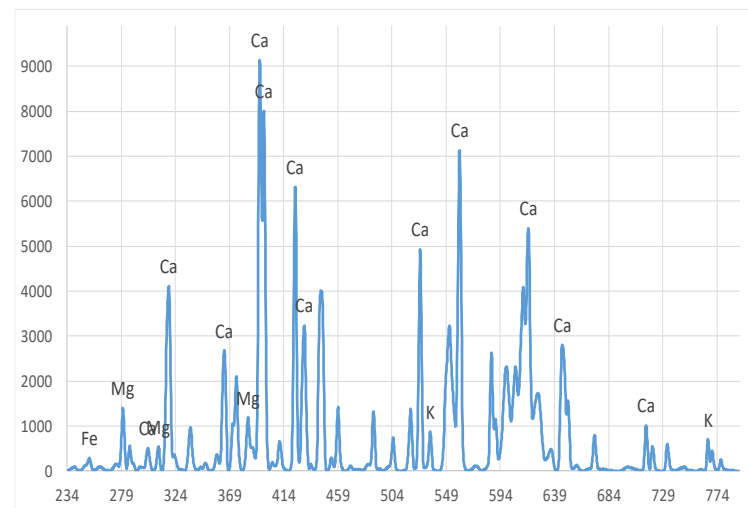
## LIBS Signal Features:

- Clear analytical lines of Ca, K, P, N, Mg, Al, Fe other elements of interest with no interference
- High signal/background ration

## Ability to perform:

- Bulk and fine materials analysis
- Brine, slurry and liquor analysis

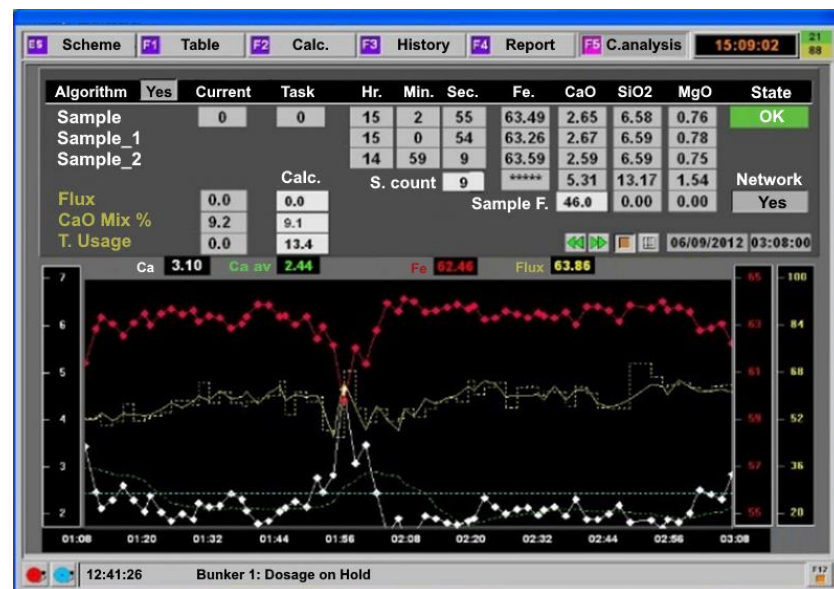
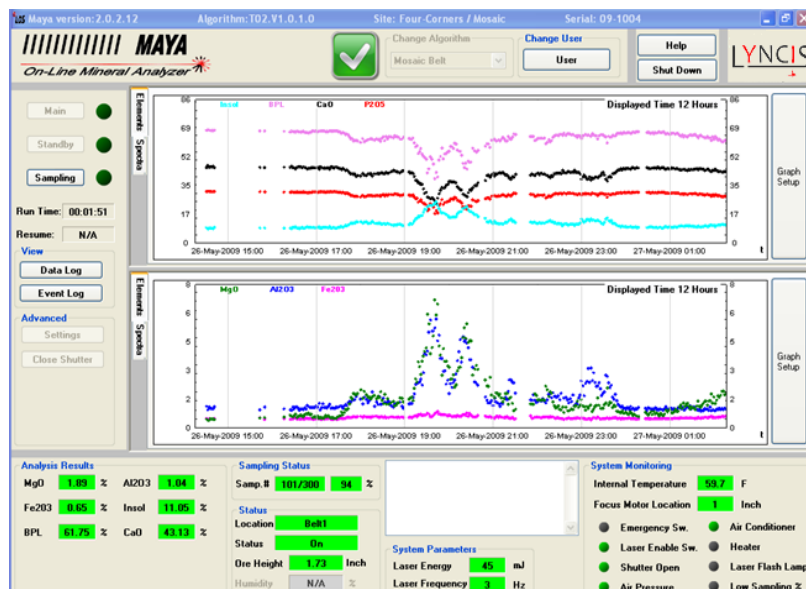
## LIBS spectra



# Long term stable continuous automatic operation

Fully automatic 24/7 operation provides real-time chemistry of material streams without sampling and sample preparation

Integration with customer's SCADA for prompt process control



# Case Study – Phosphate

## Rejection of dolomite impurities in phosphate ore

MAYA online analyzer was installed on conveyor belt to control the quality of the raw ore feed before the beneficiation.

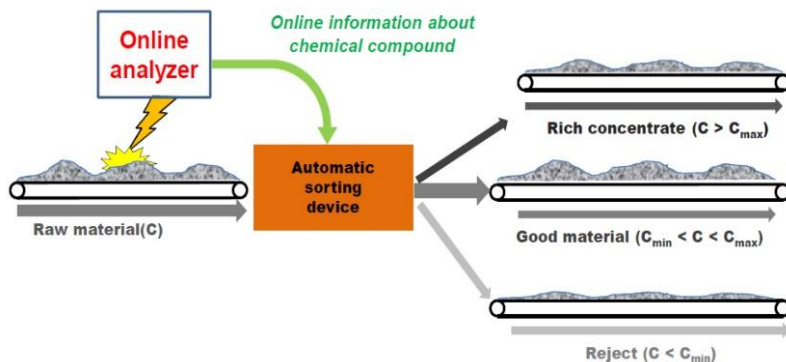
It allowed to reject off-grade raw materials (too high MgO concentration) and sort the product based on the concentrations.

### Technological tasks:

- Grade Sorting

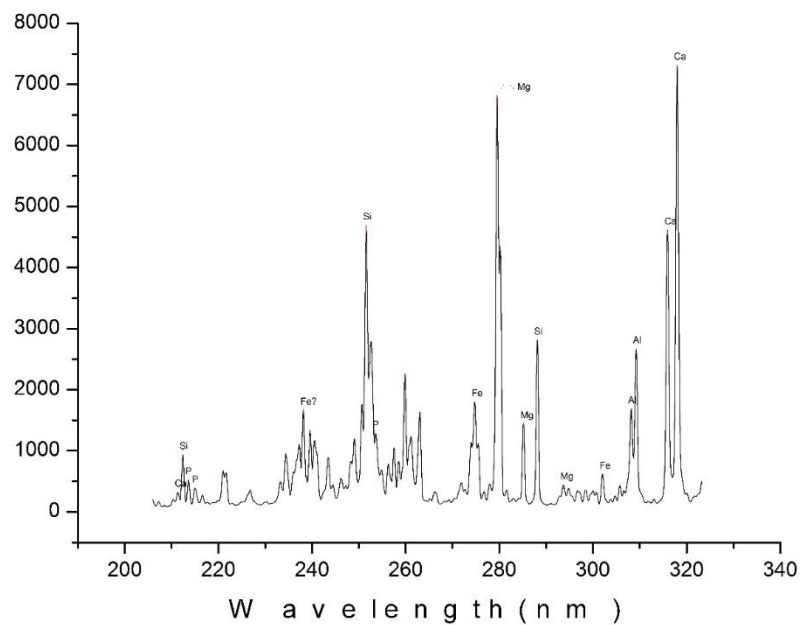
### Source of economic benefits:

- Additional earnings from high grade phosphate ore

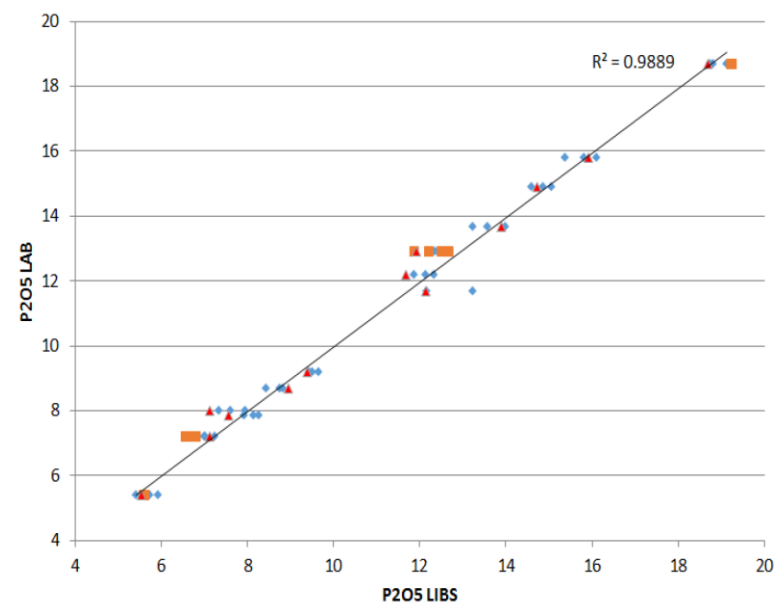


# Measurements

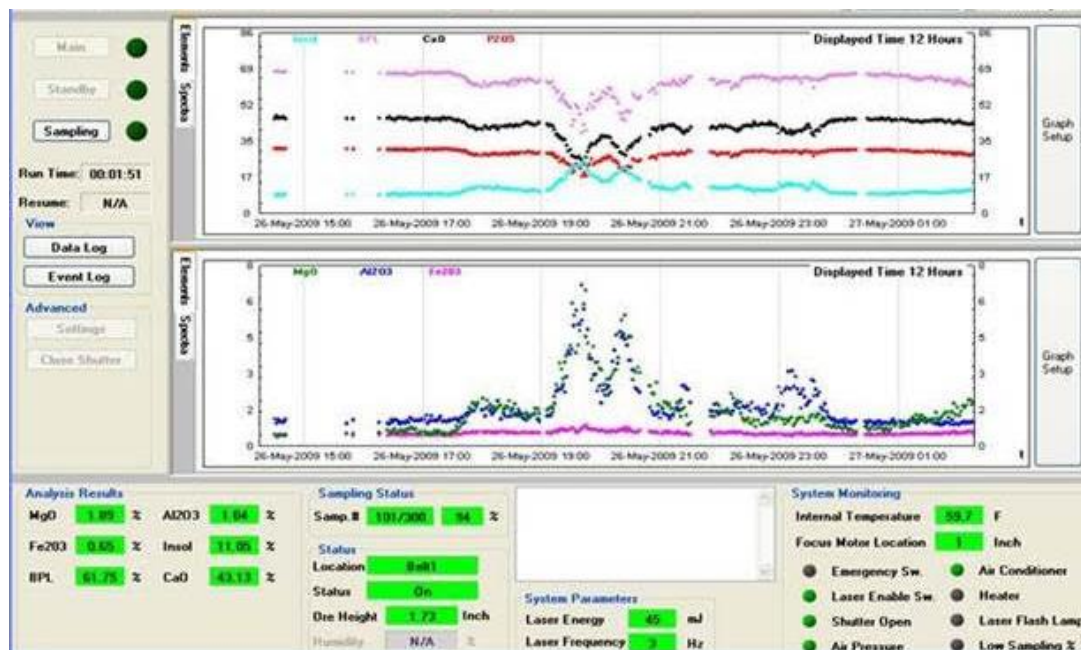
## Apatite – nepheline ore spectra



## Calibration curve with blind samples (red)



# Process Control



Measurement of P2O5, Mg, Fe, Al, Bone Phosphate Lime (BPL), Insoluble phase and Metal Impurity Ratio (MER).

Two percent MgO pebble content was decided to be considered as a decision point for "bad," high MgO % rock discarding for crushed ore quality improvement.

**Benefits – improved product quality/price**

**Payback ~ 2 months**

# Case Study – Potash Grade Sorting

MAYA is installed above the conveyor with final product – KCl

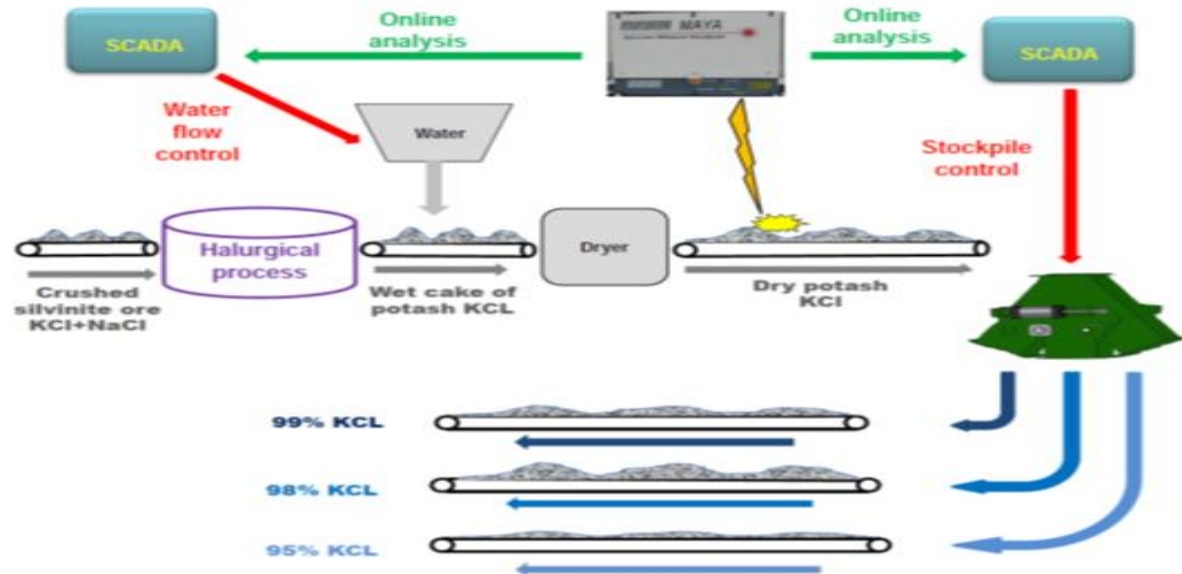
## Technological tasks:

- Final product grade sorting (95%, 98% and 99% of KCl)
- Grade Sorting



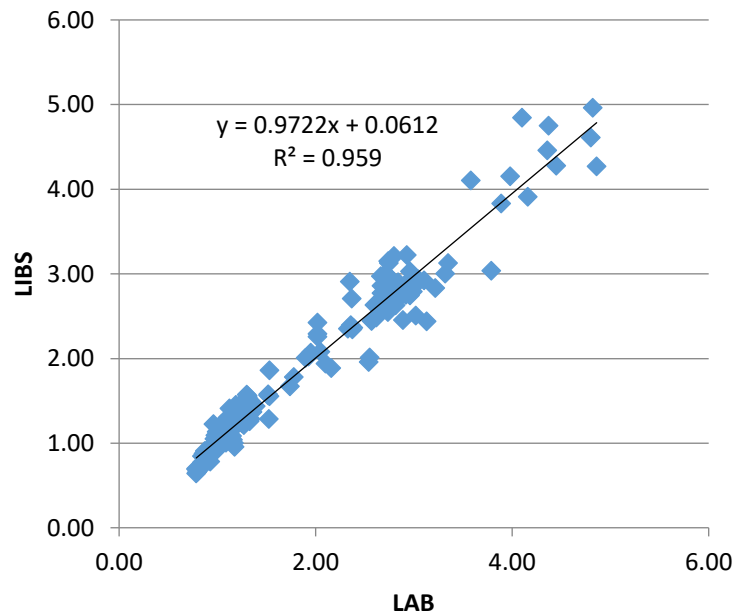
## Operating environment:

- Extremely corrosion environment
- Temperature of material ~ up to 200C
- Ambient temperature ~ - 10C... +30 C
- Ambient humidity up to 100%

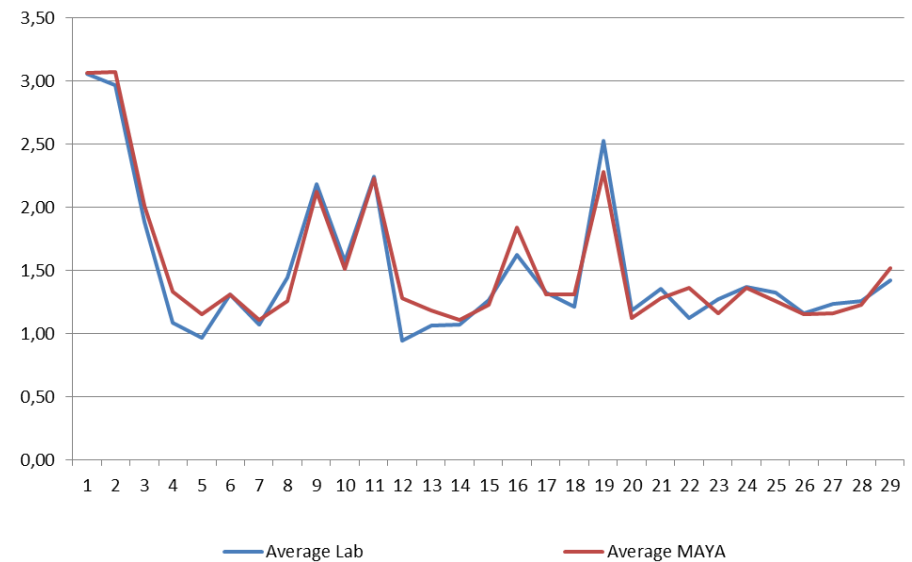


# Measurements

## Dynamic on-site calibration

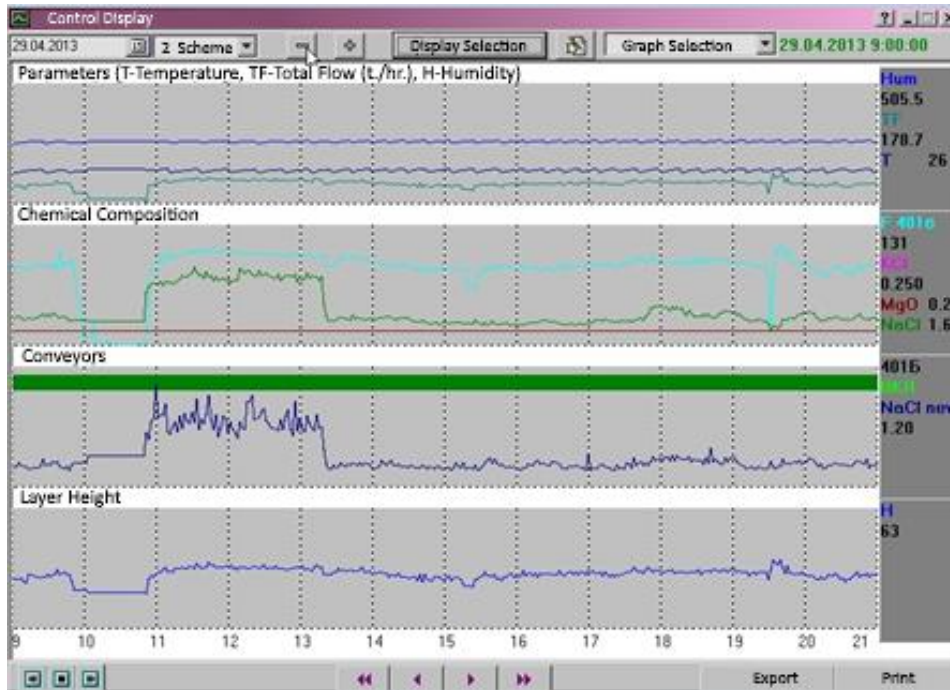


## LIBS vs Lab long-term comparison



# Automatic Process Control

## SCADA interface



## Source of economic benefits

- reduced reagents/water/energy consumption
- final product quality control
- reduction of product overload
- reduced losses of potassium in the tails

**Payback – 3 months**

# Case Study – Potash

## Water dosage for crystallization process control

MAYA online analyzer was installed on a production conveyor after hot leaching and crystallization process for feedforward control to monitor incoming product quality.

### Technological tasks:

- Crystallization process control by water dosage

### Source of economic benefits:

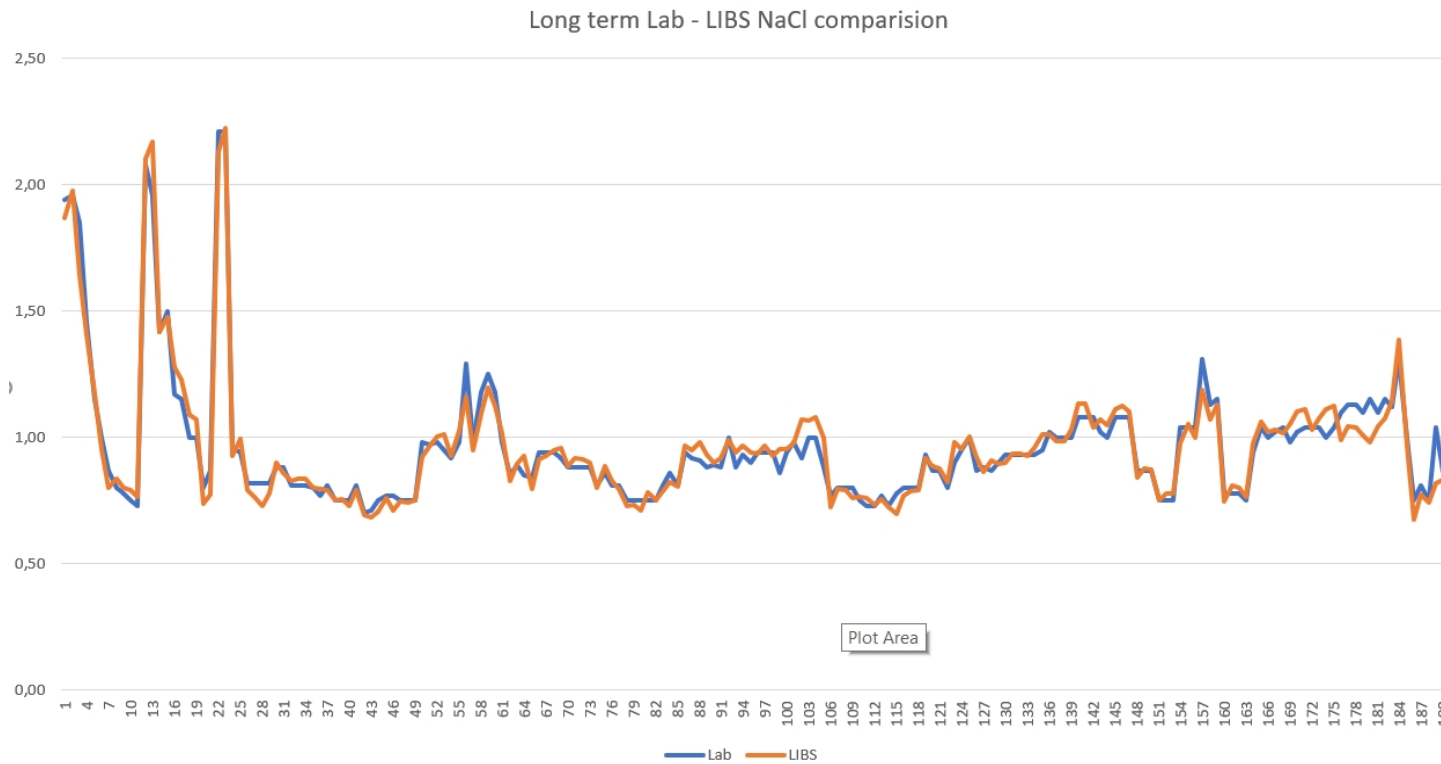
- Higher utilization of potassium
- Additional earnings from high grade fertilizers
- Elimination of quality claims
- Reduced consumption of water and energy



**Payback – 12 months**

# Accurate real time measurements

Long lasting good correlation with laboratory analysis in real time conditions with materials on conveyor belt



# Automated Process Control

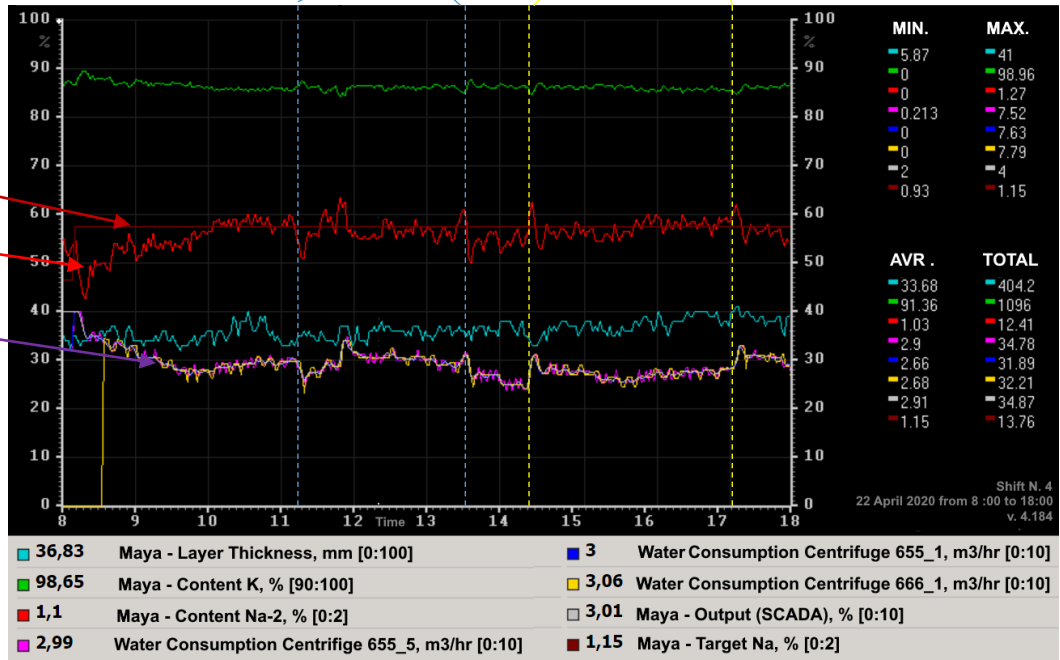
At these points NaCl becomes higher than desired. Water supply is increased automatically to drive NaCl concentration down.

At these points NaCl becomes lower than required and the event triggers decrease the water supply in leaching process to increase NaCl content in the production.

Target level of NaCl (1.15%)

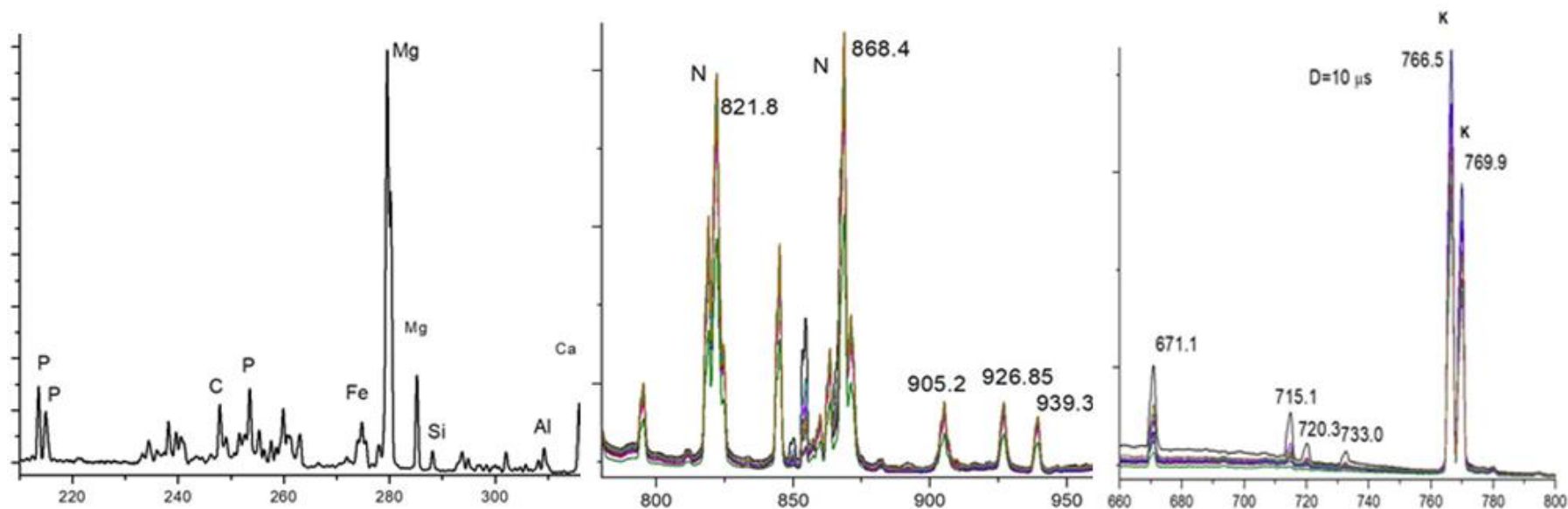
Actual (Measured by online MAYA analyzer) Concentration of NaCl in a product

Adjusted water supply level to control NaCl concentration in a product.  
Water supply is increased if NaCl levels are too high, and decreased if is too low.



# Analysis of NPK

Clear lines for all elements of interest with MAYA



## LIBS Technology

- **Environmentally and personal safe technology**
- No gamma-ray, neutron or X-ray radiation.  
No governmental permissions and licenses are needed for operating and transporting the equipment making it simpler and cheaper to manage the production.



**NO MORE RADIATION AT WORK PLACE**

# Technical specifications

Operation temperatures from -20 °C to +50 °C

Protection class - IP65

Corrosion, dust and vibration protection

Integration with all SCADA types; cloud and remote communication capabilities

Nd:YAG solid state impulse laser 1064 nm  
Laser safety Class 1

Spectrometers detect 170 – 960 nm range

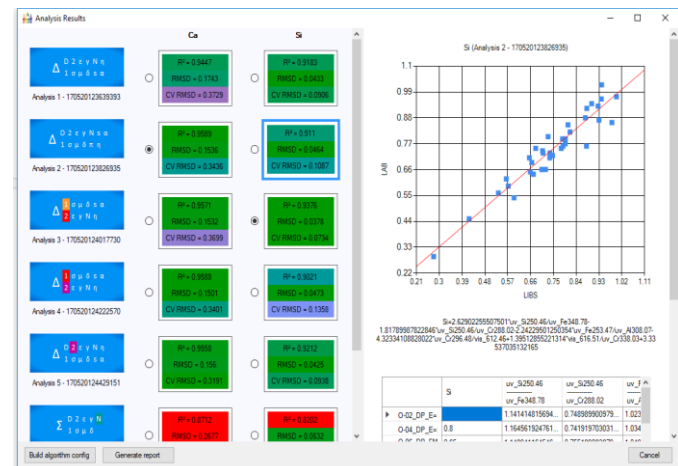
Fully safe LIBS technology generates only optical wave range during excitation and emission



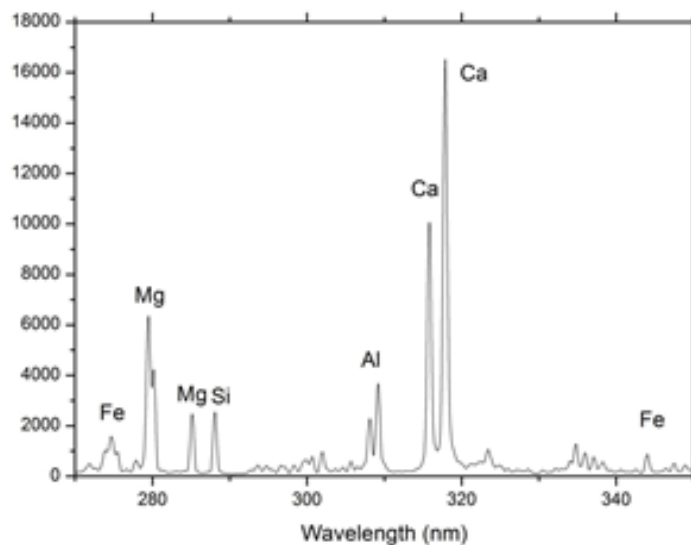
**24/7 continuous operation**  
**Direct on-belt / pipeline analysis**  
**NO sampling**  
**Designed for harsh industrial environment**

# Software

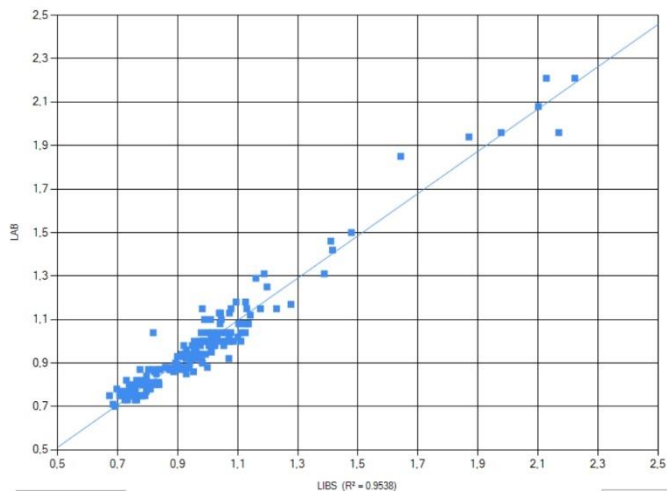
- Performance monitoring and auto notification if calibration fine tuning is recommended
- Easy addition of new sample points to calibration database
- Remote Control and assistance in monitoring and adjusting machine performance
- **Industry 4.0 integration**  
Full SCADA/PLC integration and networking capabilities allow the analyzers to be integrated in any Industry 4.0 and manufacturing ecosystem.



# Advanced Data Analytics



Na (Analysis 1.1.2.3 - 191118225254400)  
Trend:  $y = 0.972 \cdot x + 0.0269$



## Machine Learning and chemometrics

Online elemental analyzers are equipped with data processing modules and use advanced machine learning and chemometrics technics to monitor and learn the material changes during continuous processes.

This ensures accurate and stable measurements through the lifetime of the processing plant.

## We use for data reprocessing and optimal calibration:

- **PCA/PCR** - Principal Component Analysis/Regression)
- **Neural Networks**
- **SVM** - Support-vector machine)
- **PLS** - Partial least squares regression)
- **Classification algorithms**

# Surface Measurement – True Flow Measurement

LIBS provides accurate material flow measurement and is not affected by layer thickness, material load or conveyor construction and does not require measurement corrections based on additional sensors or assumed material distribution models.

To achieve representative measurement of the entire flow LIBS analyzer is installed at the location where material distribution has random nature. Locations after raw ore crusher, mill, discharge chute can be defined as having random material distribution and this can ensure that statistically accurate chemical composition of entire flow is measured.

If no random distribution exists at desired measurement point simple mechanical tools ( plunges, chains) are used to mix the material on a conveyor and ensure the surface measurement statistically represents an entire flow.



Examples of mechanical aid to ensure entire flow chemical composition analysis is delivered



# Installation and Maintenance

## Requirements for installation

- Simple frame:  
Installed **30 – 120 cm above the material**  
Dimensions ~1.5 (L) x 0.9 (D) x 1.3 (H) m  
Weight ~ 450 kg
- **Compressed Air** – 600-1200 l/min, 8 bar
- **Maintenance**
- Modern power diode laser source replacement  
**once in 5-10 years**
- Air filters – cleaning or replacement – depends on dustiness - **monthly**
- Protection window manual or air cleaning –**weekly**



**Low cost of ownership**

# Technology Advantages

## Main Features:

- **Stable analysis for process control with high accuracy measurement Ca, K, P, N, Mg, Al, Fe and other elements of interest**
- **Safe and environmentally friendly laser technology** with no gamma ray, neutron or X-ray radiation
- **Flexible installation option on a conveyor belt or airside with fully automatic 24/7 operation and SCADA integration**
- **Low cost of ownership and maintenance with remote support**



# Benefits

- **Higher recovery and utilization of fertilizer minerals**
- **Stable technology process with no product quality fluctuations**
- **High-grade product**
- **Reduced consumption of water and energy**
- **Reduced frequency and labor cost in lab testing and sample preparation**
- **Reduced concentration of scarce and useful minerals in tailings**



# About Company



- **LYNCIS** is a successor of Laser Distance Spectroscopy (LDS) in Industrial Applications with HQ in Lithuania – one of the biggest European centres of laser, optical and spectral technologies.
- **Strong analytical team** including PhD specialists in technology, physics and mathematics
- **Engineering team** - all technical personnel have Master or Bachelor degrees
- **HQ and production facilities in Lithuania.** Support Offices in Russia and Ukraine.
- Member of **Lithuanian Laser Association**



# Industries

## 10+ years of experience in various industries

Industry-proven technology, used by clients in N. America, Europe and Asia. First installation - in 2008 (USA)

We operate in the following industries:

- **Fertilizers** (phosphate, potassium, composite NPK – P, K, Na, moisture and others)
- **Iron and Steel** (iron ore and concentrate, sinter mix, limestone, coke -Fe, Si, Ca, Mg, Mn, C, moisture and others)
- **Cement** (limestone, raw meal – Ca, Si, Al, Fe...)
- **Refractories** ( Mg, Si, Ca, Fe, Al, Cr, B, Mn and others)
- **Coal** (C, ash content, volatiles, moisture – Fe, Al, Si, Mg, Ca...)
- **Industrial Minerals** (quartz, clays, nepheline...)
- **Base metals** (Cu, Al, Co, Mo, Zn and others)
- **Bauxite and Alumina**

and others

Examples of Installations:

Iron



Fertilizers



Limestone



Slurry, brines



Refractories

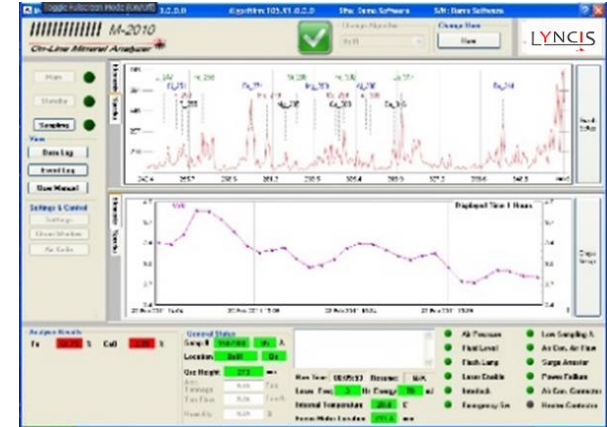


Coal



## Commissioning

- Initial technical requirements and site assessment
- Physical installation of equipment
- Dynamic on site calibration with existing material flow
- Guidance on lab sample preparation and chemical analysis quality standards
- Training
- Integration with SCADA and Industry 4.0 solutions



## Product Support

- Quality Management System  
Remote monitoring of operational parameters and identifying when additional points of calibrations are required to track material or production changes. Timely adjustments and finetuning for optimal operation.
- Regular Maintenance Service





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