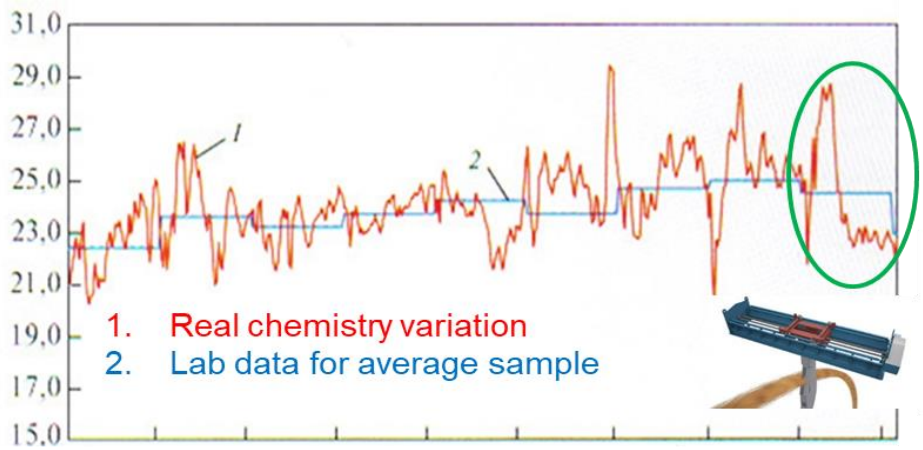
# Radiation-Free Online Elemental Analyzer

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

LYNCIS

*Real-time process optimization in Iron and Steel*

# Why Online?




Periodic laboratory measurements
of averaged samples
miss real strong quality variations
in material streams

Sampling and collection

Sample preparation

Delivery to lab

Lab analysis

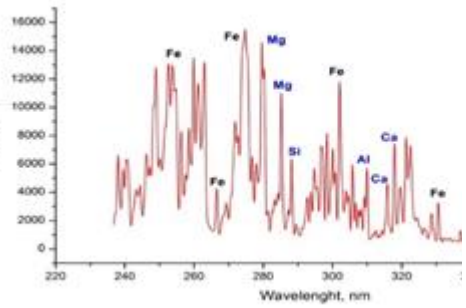
Some hours delay between sampling and lab analysis

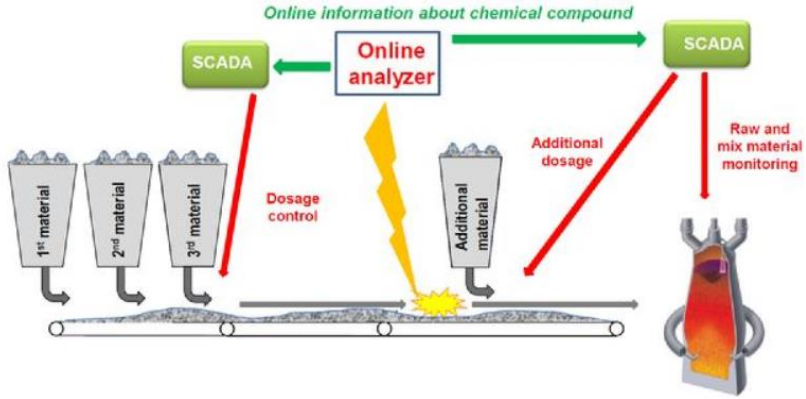
It is already late to influence
on production process

# 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




- **Reduced production costs** in saving fluxes, coke and energy
- Increased efficiency and **stability of blast furnace**
- **• Higher quality of sinter, ore concentrate, pellets and iron**

# Online Analyzer for Iron And Steel Industry

## Applications:

- **Crushed Ore Quality Control**

Automated stockpile, ore sorting and impurities rejection solutions

- **Sinter Mix Control**

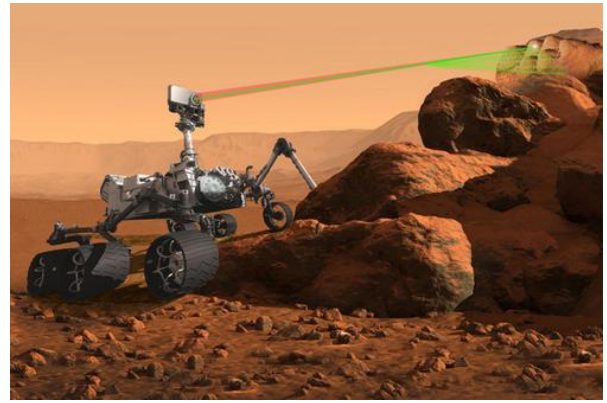
Optimum dosage of fluxes and raw material in sinter basicity control

- **Pelletizing and Final Product Control**

Precise fluxes, coal and moisture adjustment for higher product quality

# Technology

https://spinoff.nasa.gov/Spinoff2020/ip_9.html



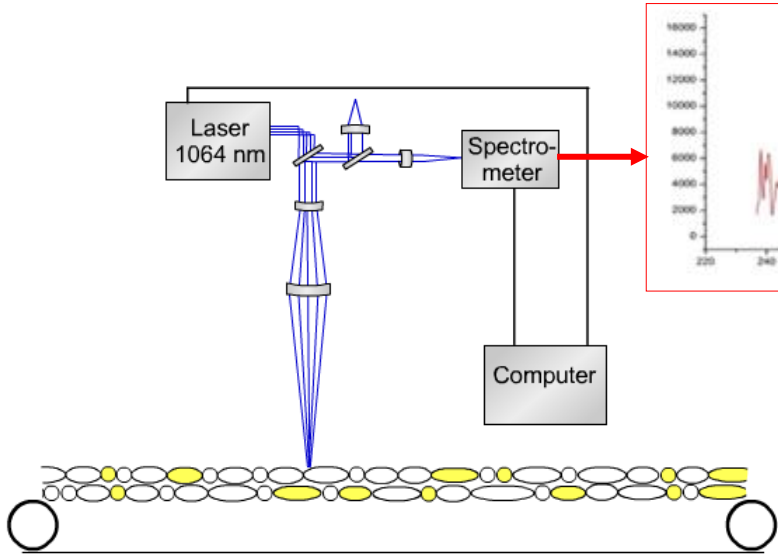
**Laser Induced Breakdown Spectroscopy (LIBS)**

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

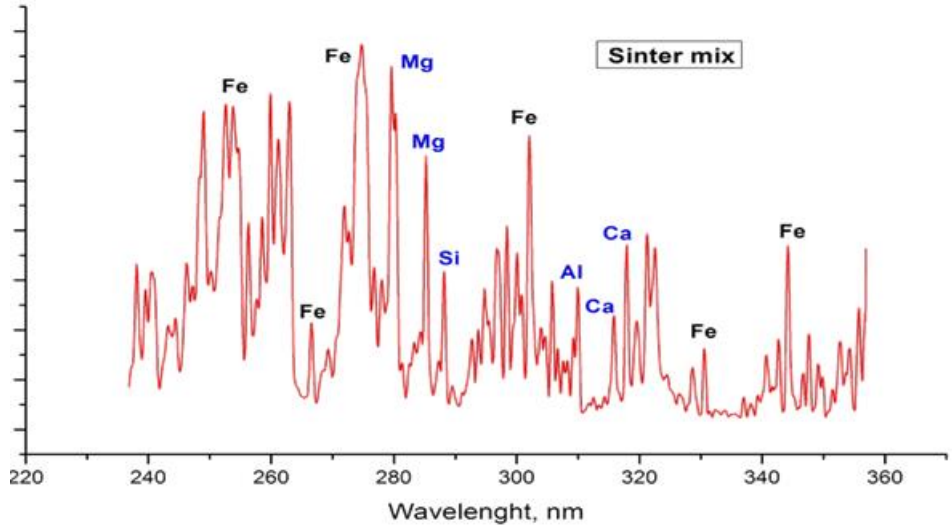
**LIBS spectra**

LIBS Signal Features:

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

Ability to perform:

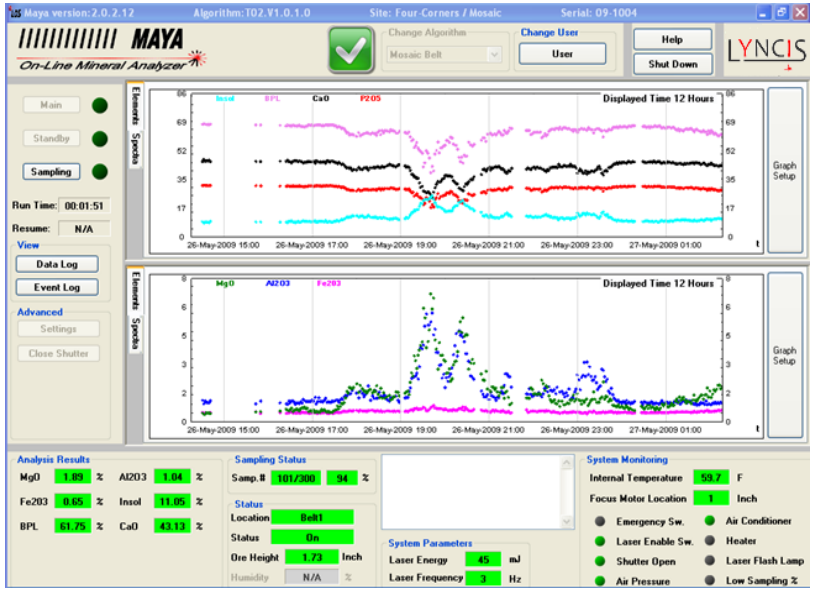
- Bulk and fine materials analysis
- Slurry and pulp analysis

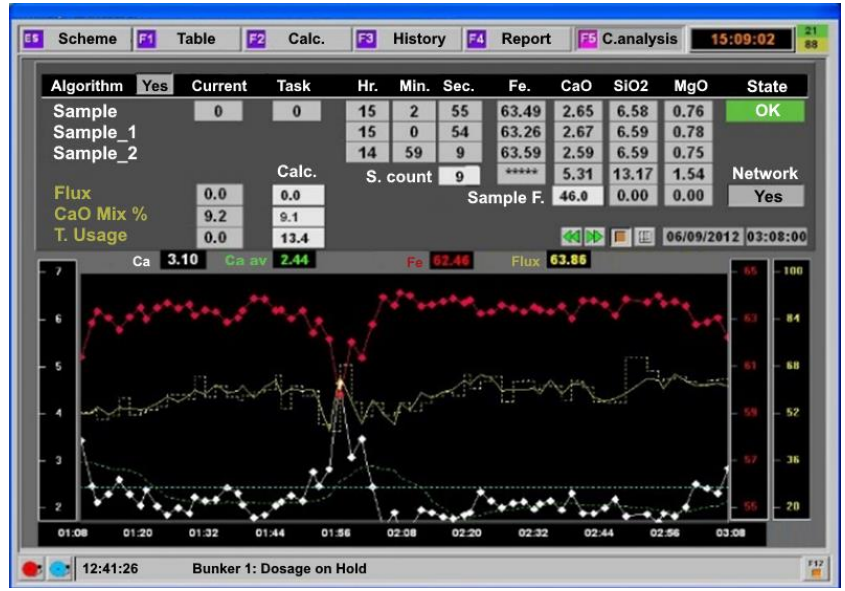


# Long term stable continuous automatic operation

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



# Safety

**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.

# Case study
## Iron sinter basicity stabilization

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### Task

Online analysis of Fe and CaO for automatic dosage of fluxes before sinter machine

NLMK

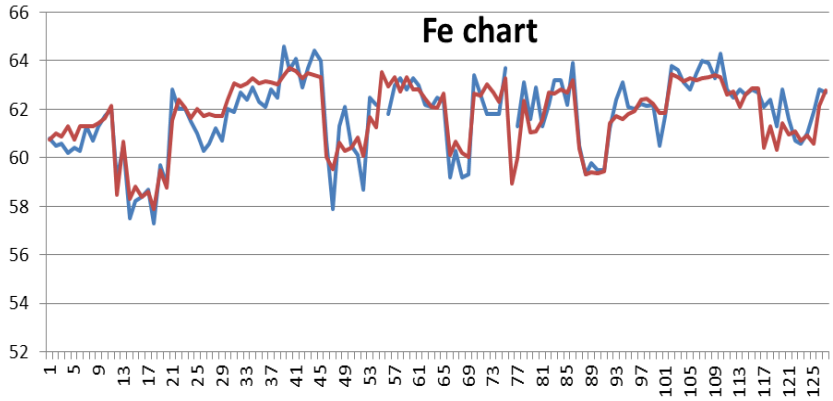
### Economic benefits

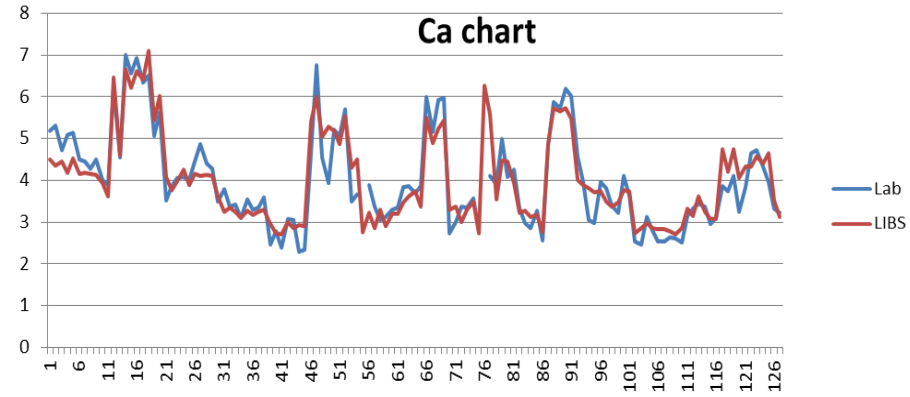
- Off-grade sinter (basicity deviation > 0.05) decreased from ~8% to ~4%
- Average basicity deviation reduced by 20% (from 0.05 to 0.04)
- Coke consumption in blast furnace decreased by (1000g coke)/(MT of iron)

Payback ~ 3-4 months

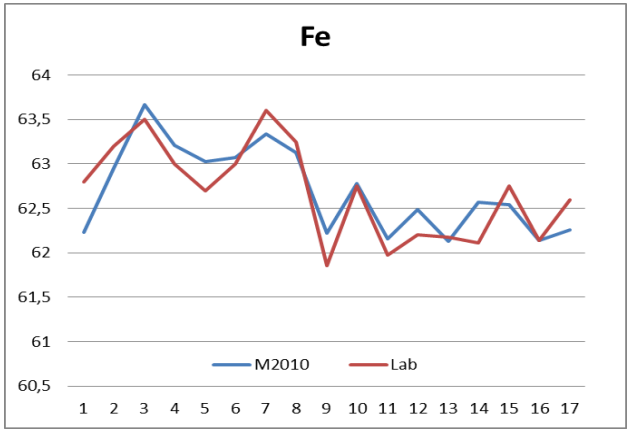
# Case study
## Iron sinter basicity stabilization

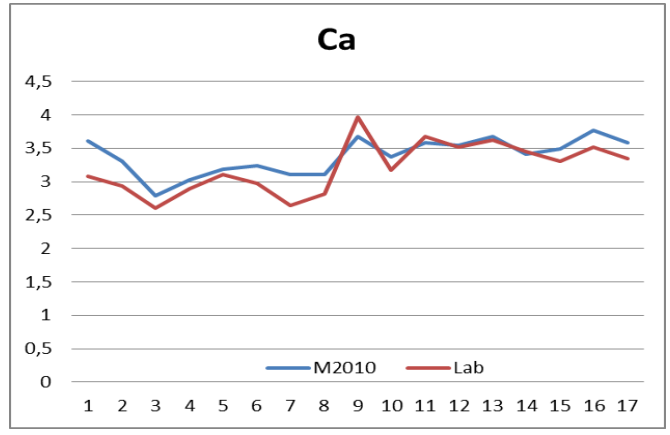
### Long term Fe & CaO monitoring




### MAYA Online and Lab mesurment comparison after one year operation




At the customer Plant , MAYA is permanently working from March 2011, 24/7/365 in the real industrial environment – high dust level, vibrations, wide temperature and moisture range – without recalibration!

# Case study
## Flux dosage into sinter mix

LYNCIS

### Complex task

2 analyzers for 3 conveyors

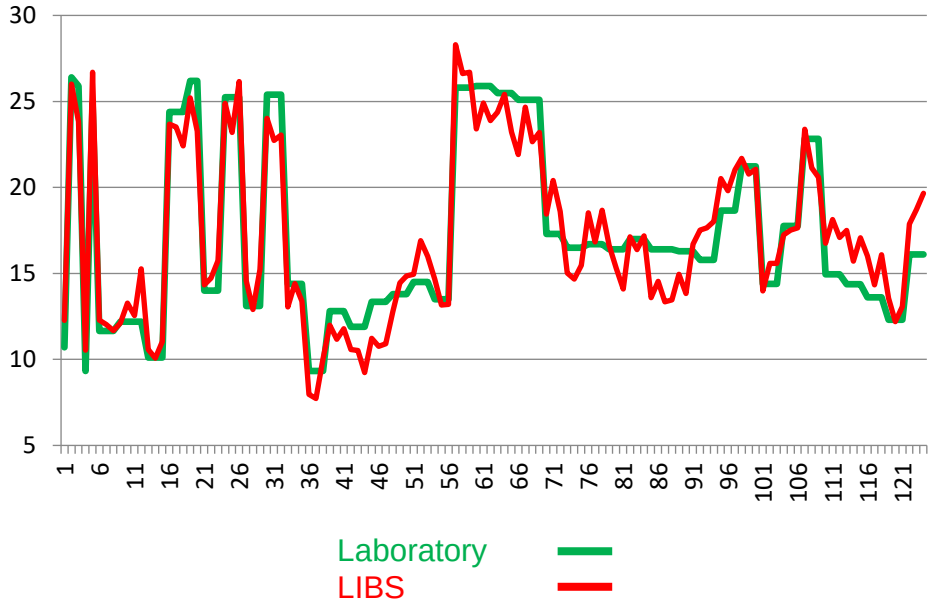
2-3 different materials on each belt:

- Iron ore concentrate *(throughput 1600 MT/hour)*
- Iron ore
- Slag
- Flux mix – limestone + dolomite + shelly ground

Analytical tasks:
- $Fe_{total}$
- CaO
- $SiO_2$
- MgO
- Moisture

# Case study
## Flux dosage into sinter mix

Long term accurate and stable analysis of SiO2 in iron ore mix




- 5 kinds of the iron ores
- Mixtures with different ratio
- Different deposits
- Different mineralogical composition
- Strong chemistry variation

# Technical specifications

Operation temperatures from -20 $^{o}$C to +50 $^{o}$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

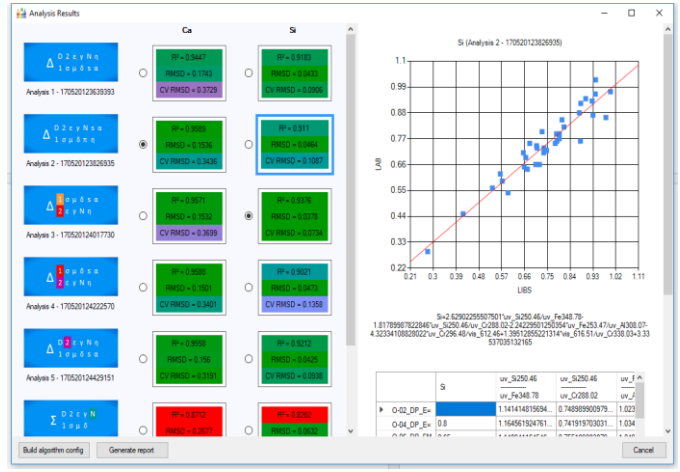
Fully safe LIBS technology generates only optical wave range during excitation and emission

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

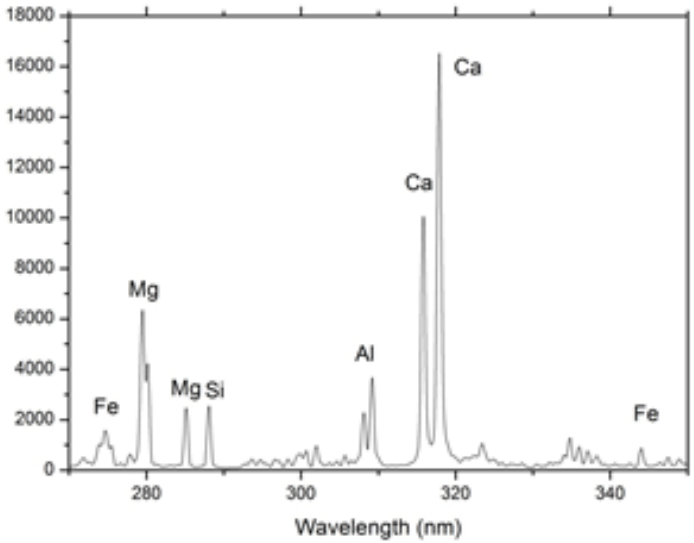
# Software

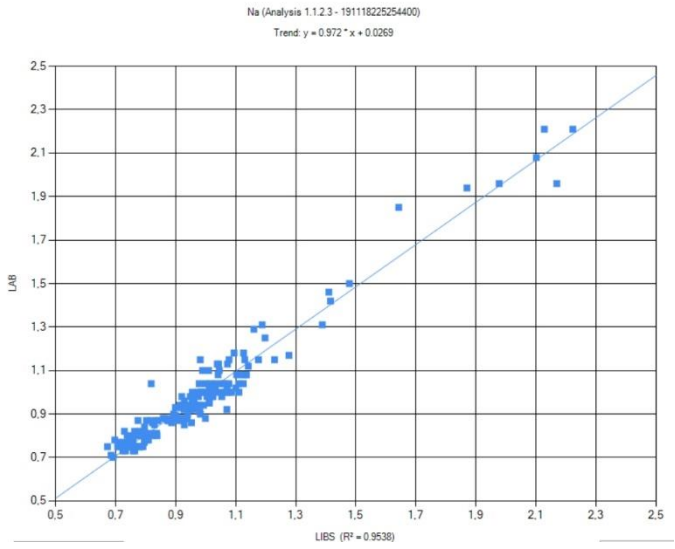
- **Performance monitoring and auto notification if calibration fine tuning is recommended**
- **Easy addition of new sample points to calibration database**
- **Remote Control and assistance in monitoring and adjusting machine performance**
- **Industry 4.0 integration**

  Full SCADA/PLC integration and networking capabilities allow the analyzers to be integrated in any Industry 4.0 and manufacturing ecosystem.



# Advanced Data Analytics




## 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

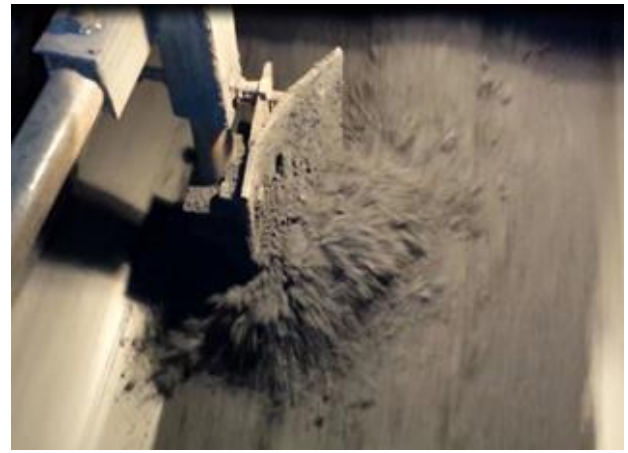
LIBS provides accurate material flow measurement and is not affected by layer thickness, material load or conveyor construction and does not require measurement corrections based on additional sensors or assumed material distribution models.

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.

Example of random distribution of raw ore on conveyor belt from installation site

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:

- **High accuracy and stable analysis** of $Fe_{tot}$,CaO, SiO2, MgO, C, Moisture and other elements of interest
- **No regular re-calibration requirements and Low maintenance cost**
- **Radiation Free,** environment and people safe technology
- Flexible installation option on a conveyor belt or slurry pipe with **fully automatic 24/7 operation and SCADA integration**

# Benefits

- **Reduced production cost by savings fluxes, coke and energy in sintering and pelletizing**
- **Higher quality of ore concentrate, sinter, ore pellets and iron**
- **Increased efficiency and stability of furnace**
- **Reduced frequency and labor cost in lab testing and sample preparation**

# 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 Steal** (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)
- **Coa**l (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

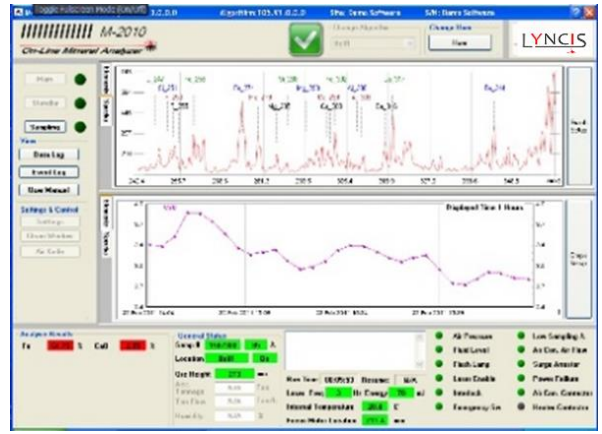
Refractories

Coal

# Service

## 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

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## 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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