Real-time Elemental Analysis for Prompt Process Control

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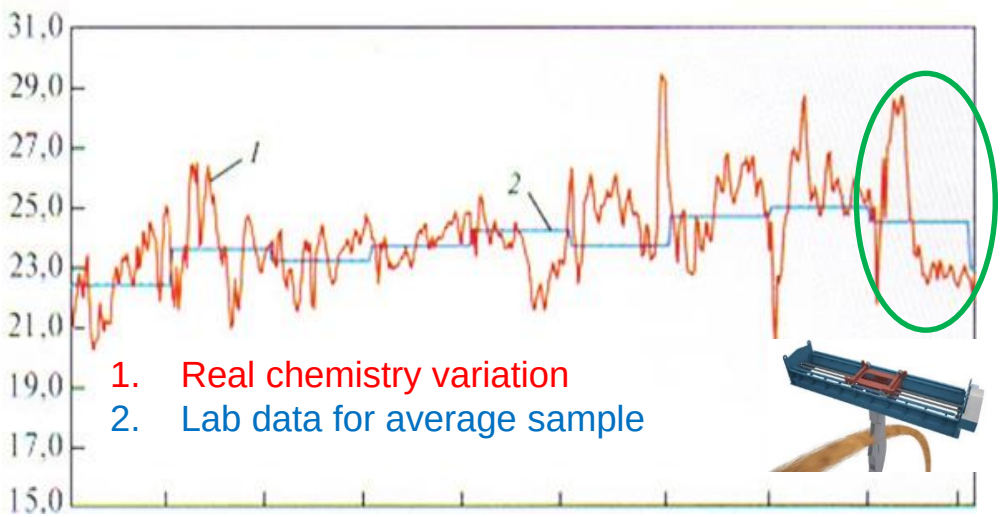
Online analysis for process control

LYNCIS presents

Industrial online LIBS analysers

- **continuous process control**
- **real-time analysis without sampling**
- **absolutely safe laser spectroscopy**

Why online?



Sampling and collection | **Sample preparation** | **Delivery to lab** | **Lab analysis**

Some hours delay between sampling and lab

It is already late to influence on production process

Periodic laboratory measurements

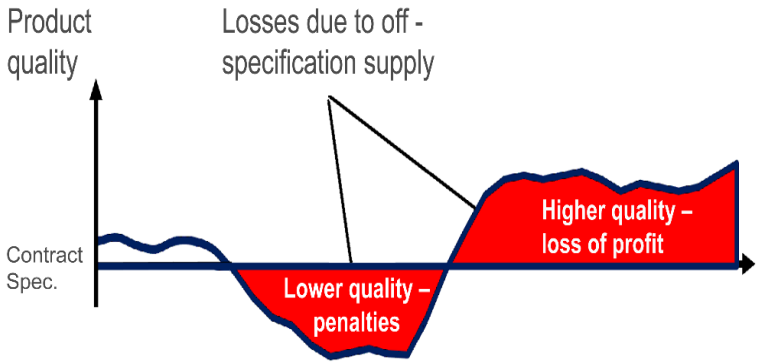
of averaged samples

miss real strong quality variations

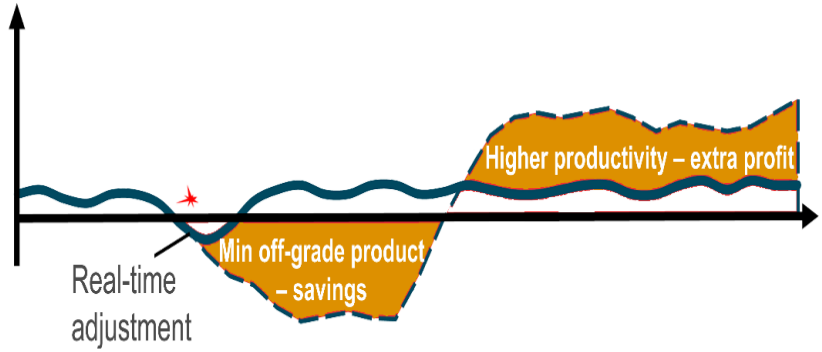
in material streams

Why online?

WITHOUT ONLINE ANALYSIS



WITH ONLINE ANALYSIS



YOUR BENEFITS WITH ONLINE ANALYSIS

Stable technological process

- Optimal raw material supply
- Optimal blending and add-ons
- Stable raw mix and product quality

Stable product quality

- Savings in fuel, energy and reagent consumption
- Higher profits for higher grade products
- Reduced off-grade product penalties

Prompt process control based on real-time elemental analysis enhances process and prevents economic losses

Our company

LYNCIS is the leading specialist with proven installations in online industrial analysis based on Laser Spectroscopy (LIBS)

- First MAYA LIBS analyser in operation **since 2008** (USA).
- **Worldwide installations**: USA, Canada, Russia, Ukraine. On-going projects in Austria, Spain and Turkey.
- **24/7 operation in different industries**

Our installations

Ironmaking

Fertilizers

Slurry, brines

Limestone

Refractories

Coal

Our expertise

LYNCIS offers a full solution for online analysis

- **Definition of technical requirements and installation site with customers**
- **Customer's materials research and In-factory calibration**
- **Optimal configuration of LIBS system**
- **Production**
- **Commissioning and on-site calibration**
- **Integration with SCADA**
- **Prompt service & support**

LIBS online technology

Pulsed laser beam is focused on the material surface

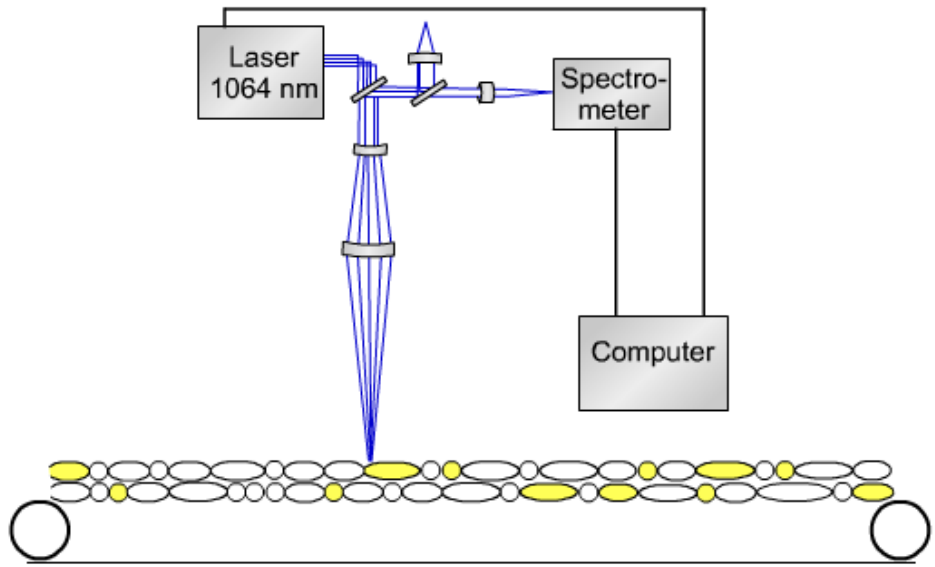
Solid / liquid material transforms to plasma around the focus point

When cooling, plasma emits light

Spectrometer collects this light and produce wavelength-based spectrum

This process repeats with frequency

up to 100 Hz



As process engineers need data on chemistry during short period, usually within

30 sec to 10 min

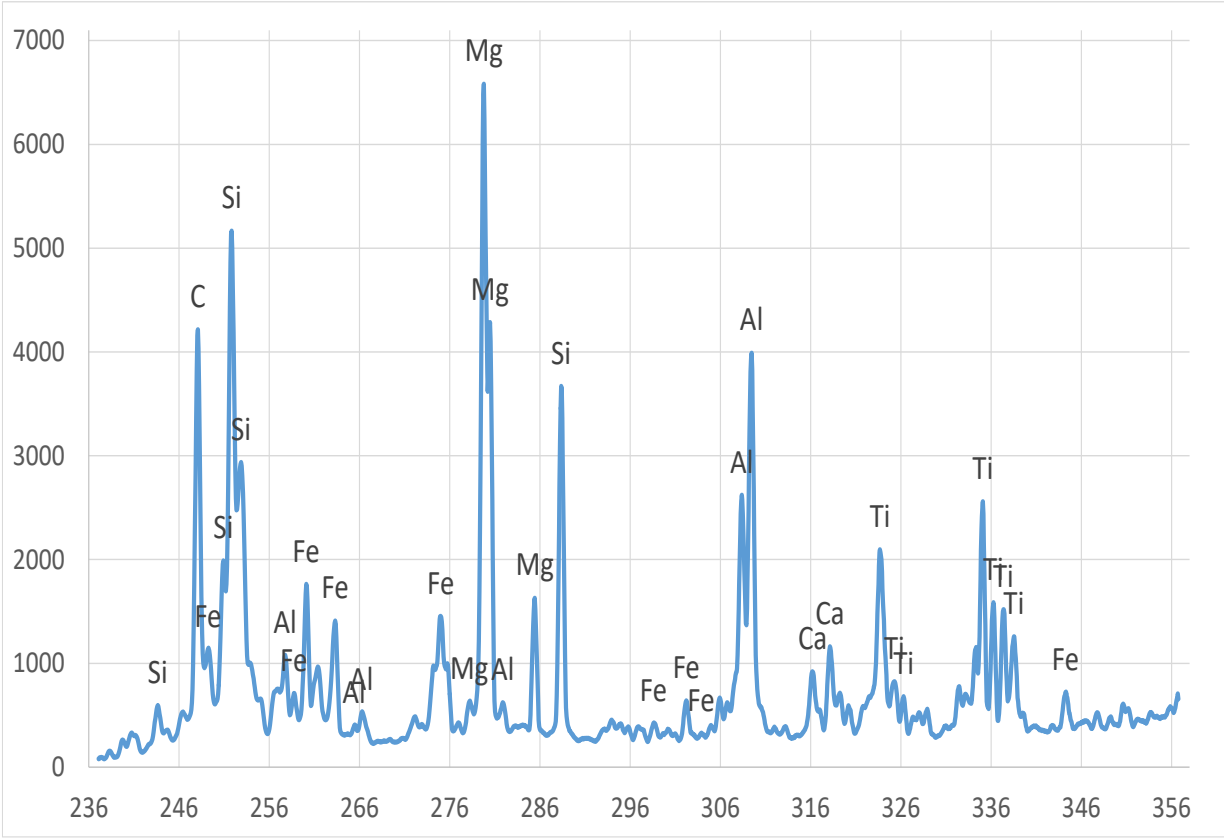
we collect some hundreds or thousands spectra

for representative statistics

LIBS spectra

All element has it's own spectral lines in optical wavelength range

Spectral lines intensity corresponds to concentration of appropriate elements



Simultaneous detection of all necessary elements, including light ones

(H, Li, B, C, Al, Si, Mg, Ca, Fe, Ti etc)

LIBS safety

Absolutely safe

LIBS uses only optical wavelength range during excitation and emission

NO hazardous

neutron, Gamma and X-ray ionized radiation

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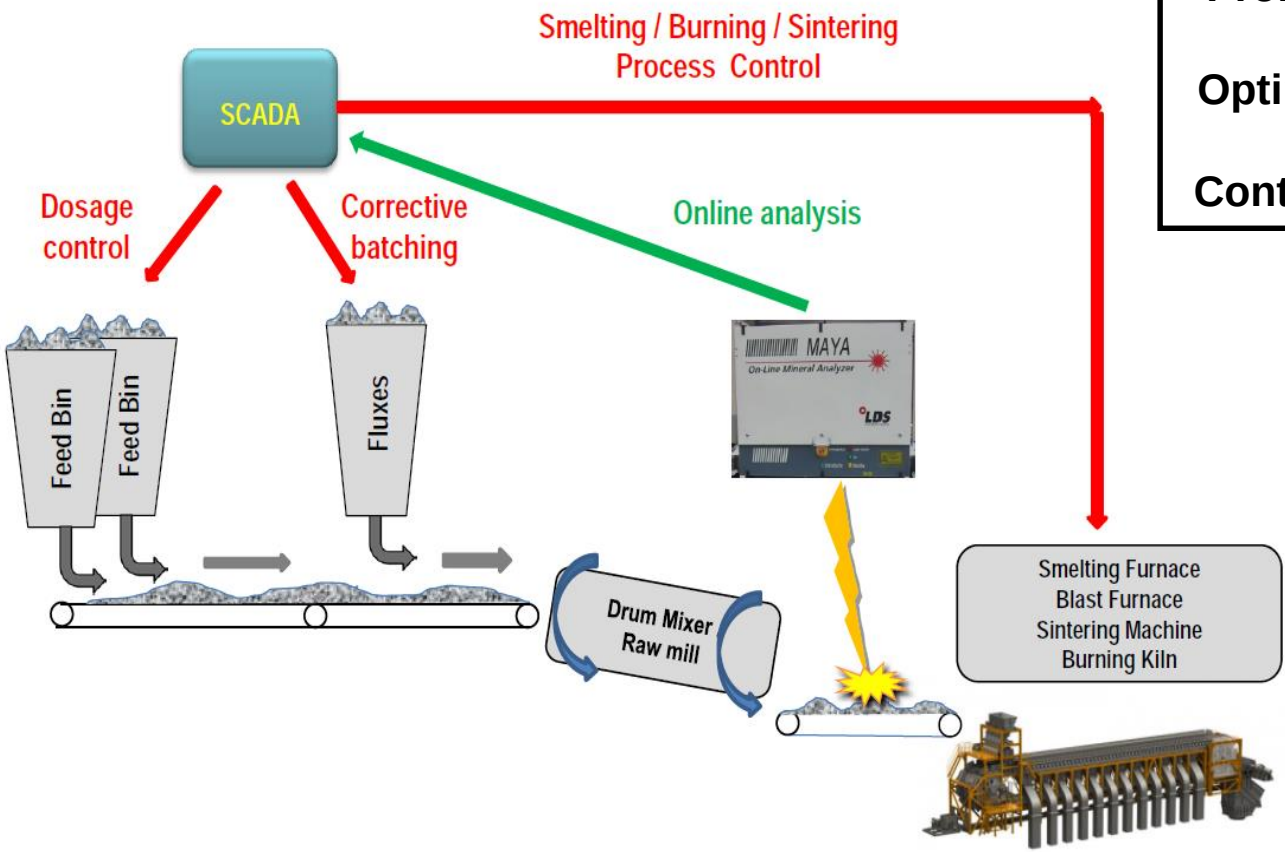
Case studies

- ***Dosage of fluxes for sinter mixture basicity stabilization***
- ***Incoming control of iron ore, sludge, iron concentrate and flux mixture at sinter plant***
- ***Off-grade ore rejection***

Case study - Iron sinter basicity stabilization
Flux dosage into sinter mix



Prompt flux dosage control

Optimal blending of iron ore

Control of gas consumption

Stable sinter basicity

High sinter strength

Sinter return reduction

Gas economy

Reduced coke consumption in blast furnace

Case study - Iron sinter basicity stabilization
Flux dosage into sinter mix

Payback – 6-12 months

Early information about sinter basicity

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Optimal dosage of fluxes and coke into blast furnace

Blast furnace smelting process control

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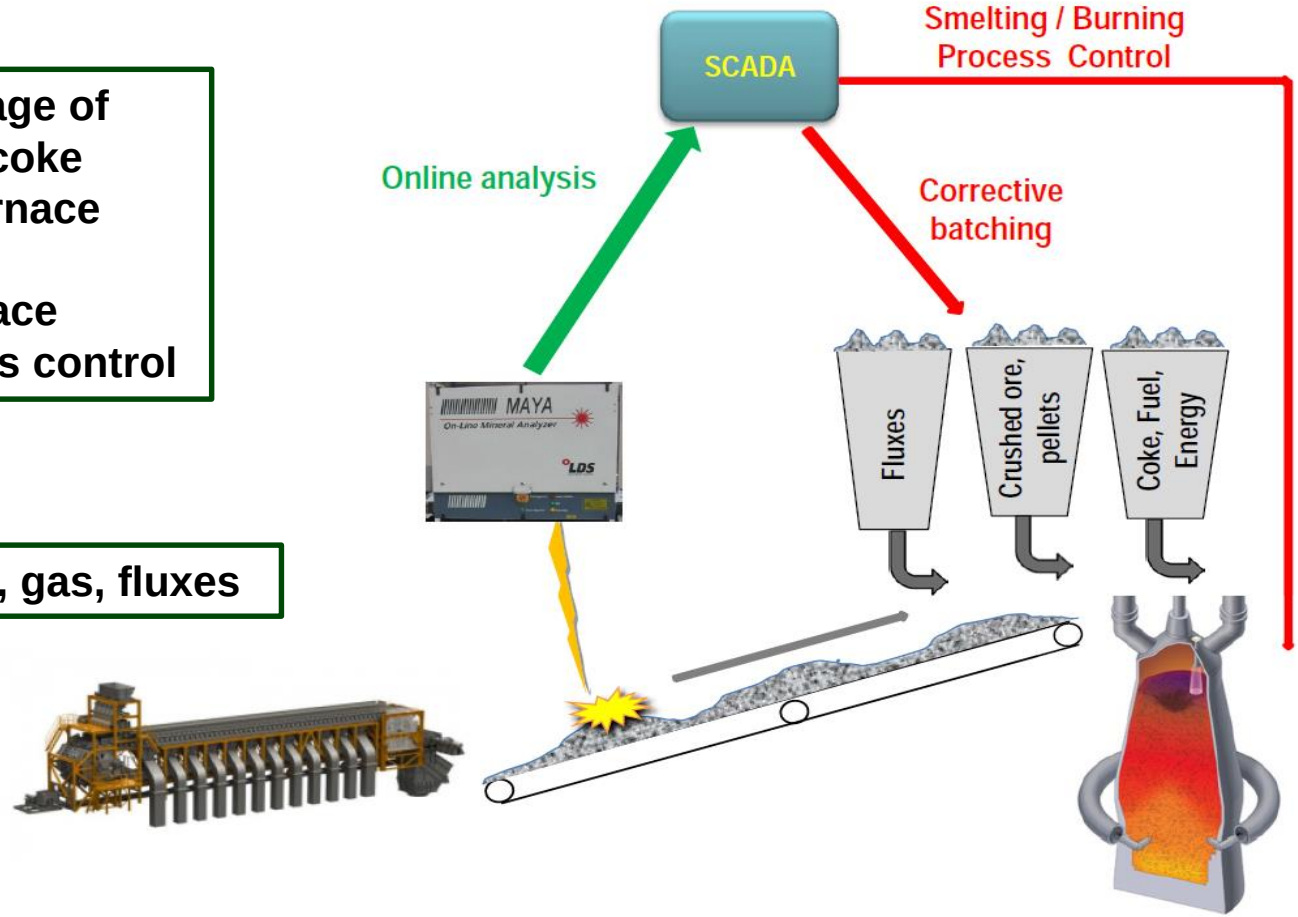
Savings in coke, gas, fluxes



Case study - Iron sinter basicity stabilization
Flux dosage to sinter mix

Task

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

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
Flux dosage into sinter mix

- **Sinter mix – iron concentrate, crushed iron ore, lime, coal**
- **Particle size – from 74 micron to 50 mm**
- **Each grain of limestone and iron ore are coated by iron concentrate**
- **Extremely dusty environment**
- **Environment temperature: -10^0C - $+30^0$C**

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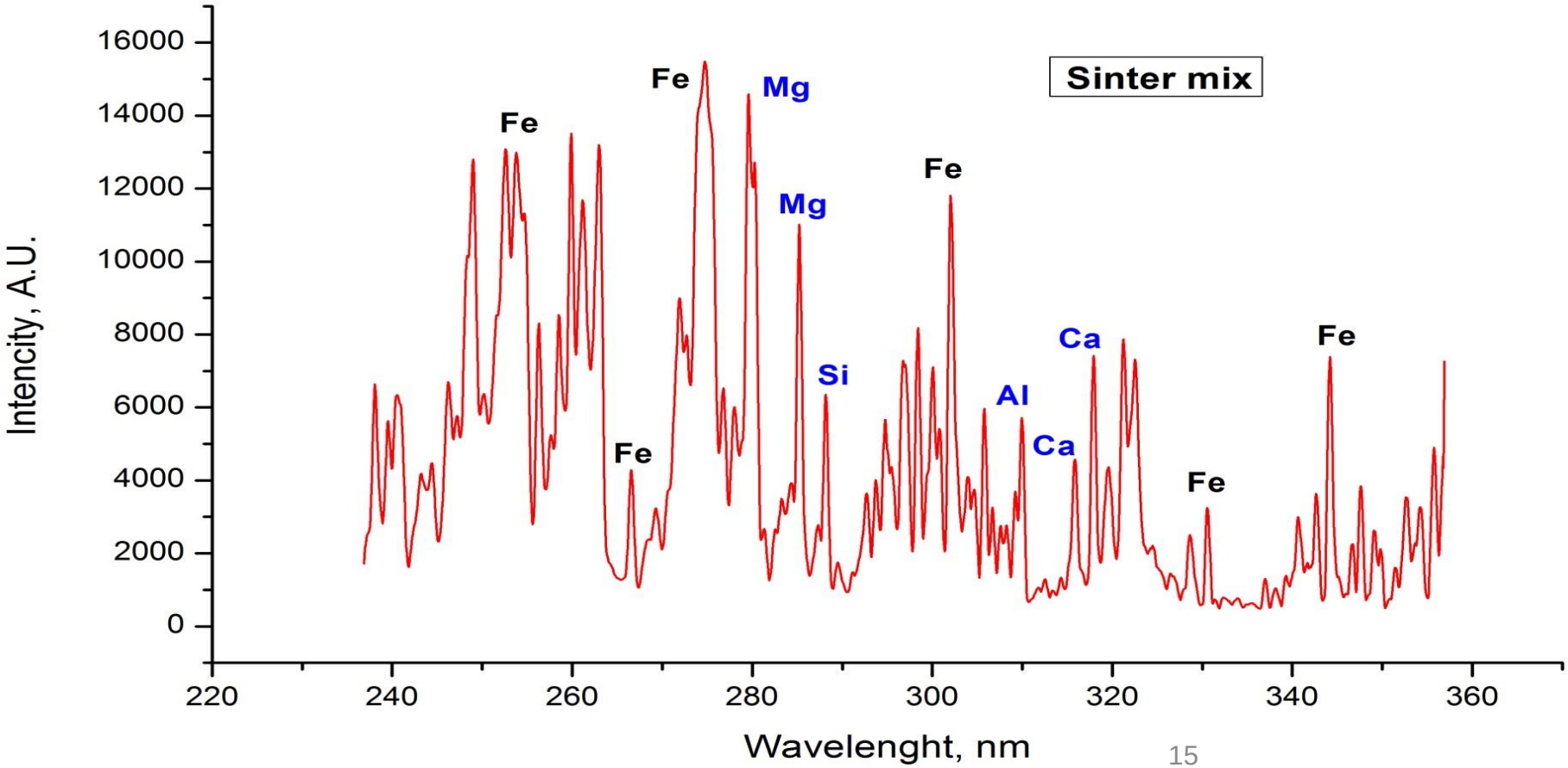
Case study - Iron sinter basicity stabilization
Flux dosage into sinter mix

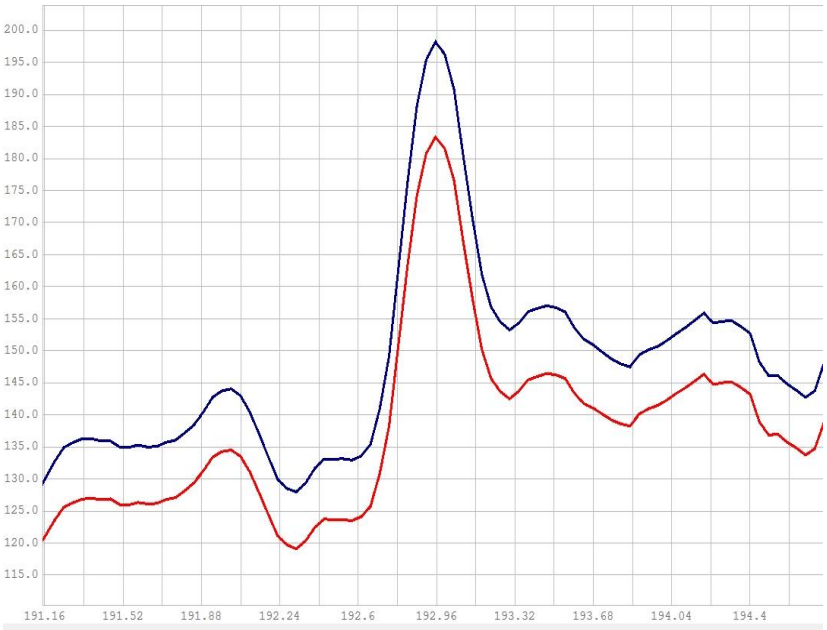
Typical sinter mix spectra
Clean lines of Ca, Si, Mg, Al between intensive Fe lines



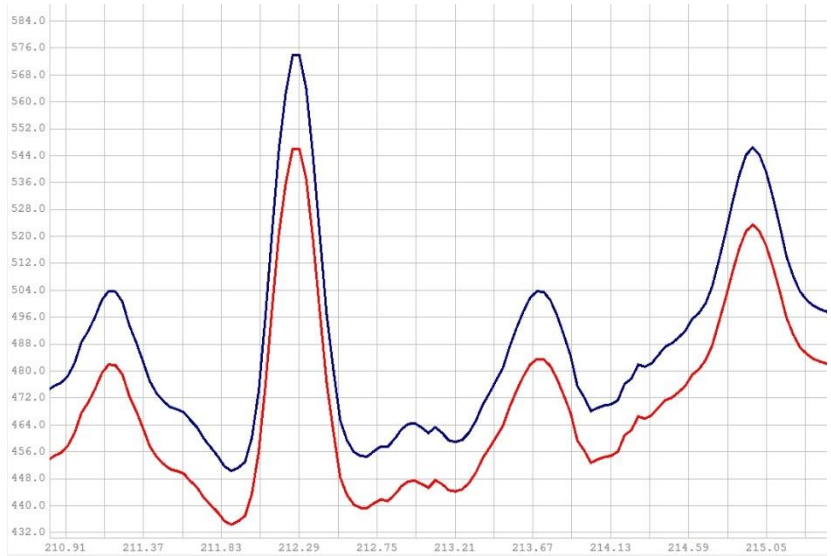
Case study - Iron sinter basicity stabilization
Flux dosage into sinter mix

Typical sinter mix spectra
Clear lines of C 193nm and Si 212nm in Deep UV range
without intensive Fe lines

C 193 nm



Si 212 nm



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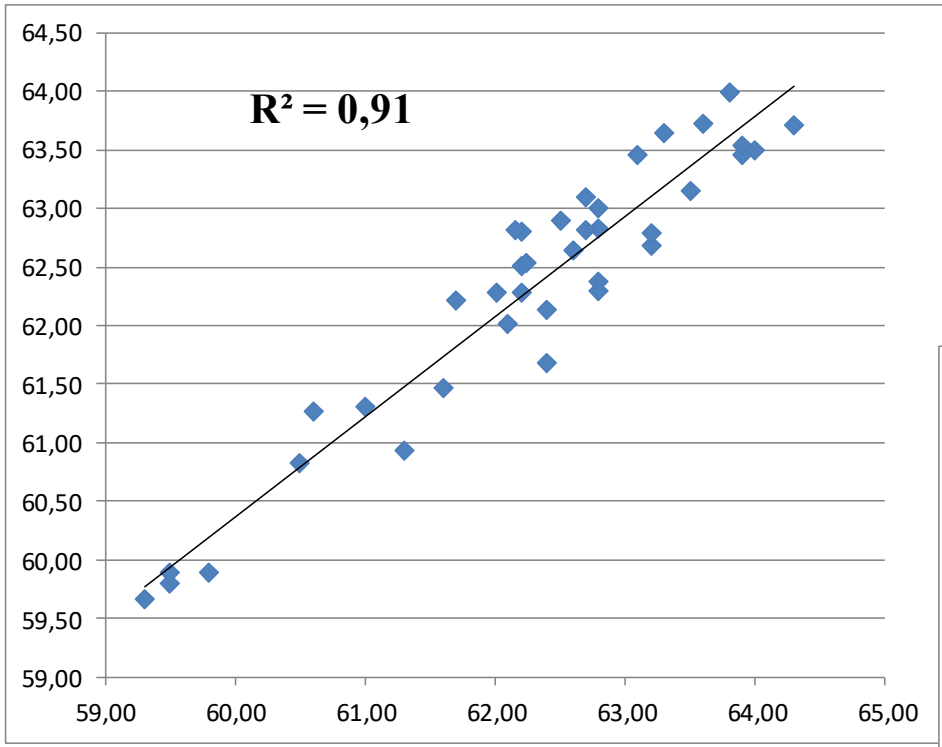
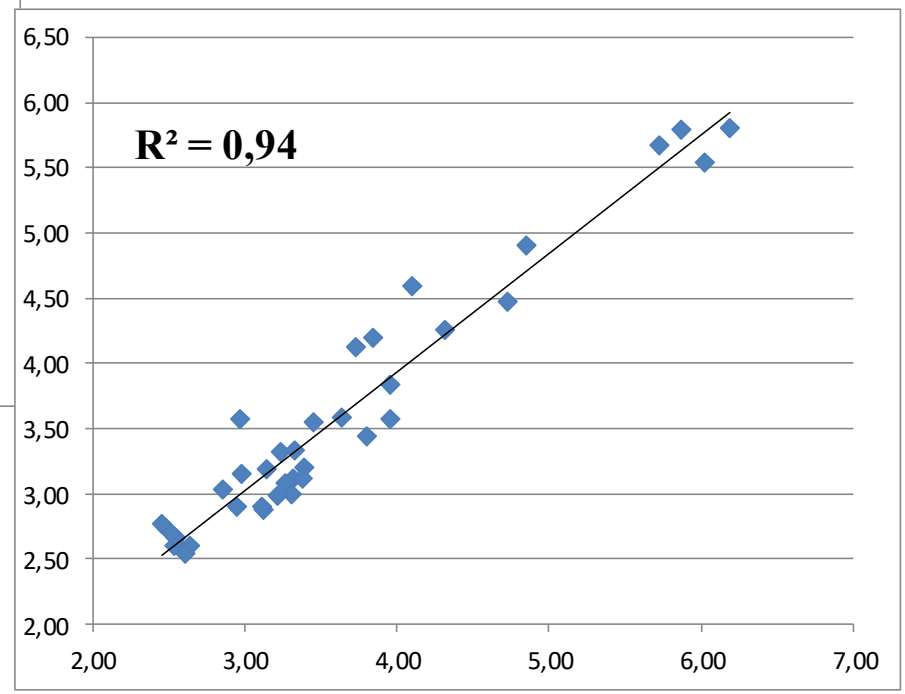
Case study - Iron sinter basicity stabilization
Flux dosage into sinter mix

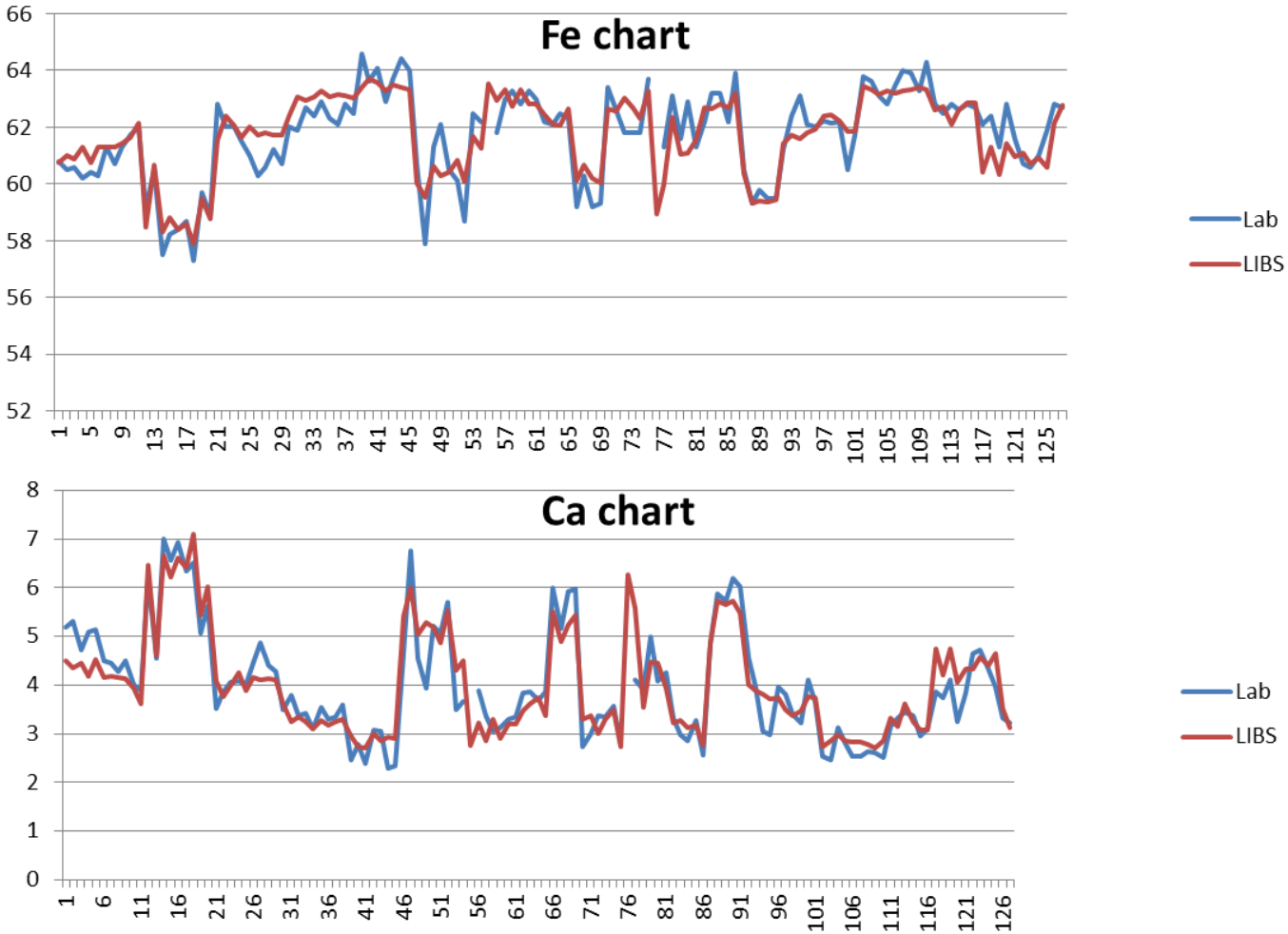


Static calibration Fe & CaO



Case study - Iron sinter basicity stabilization
Flux dosage into sinter mix

Novolipetsk plant. Long term Fe & CaO monitoring



Case study - Iron sinter basicity stabilization
Flux dosage into sinter mix

Operator screen

SCADA interface

Concentration of Fe, CaO during 2-5 min varies much more than average 4 hour's data from laboratory

TCP/IP – CSV/XLS file transfer

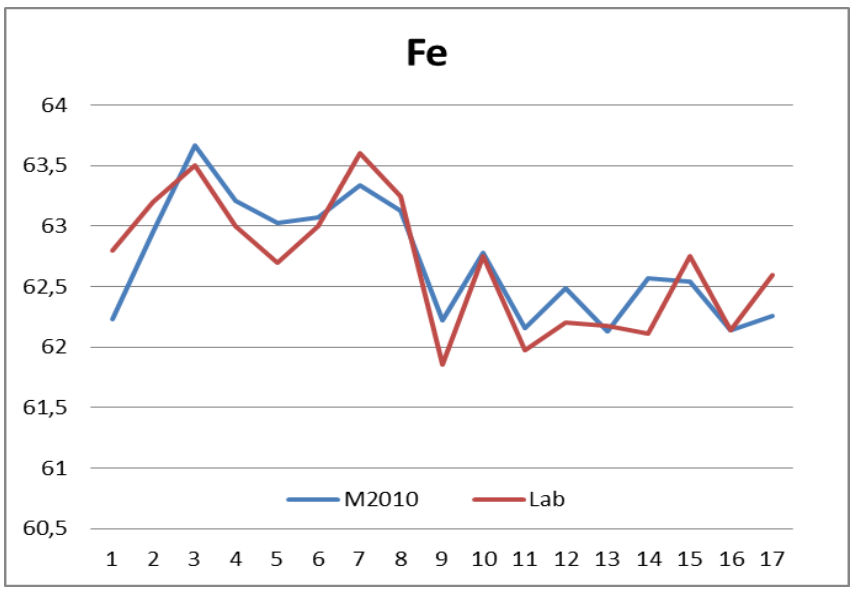
MS SQL / My SQL, OPC Server

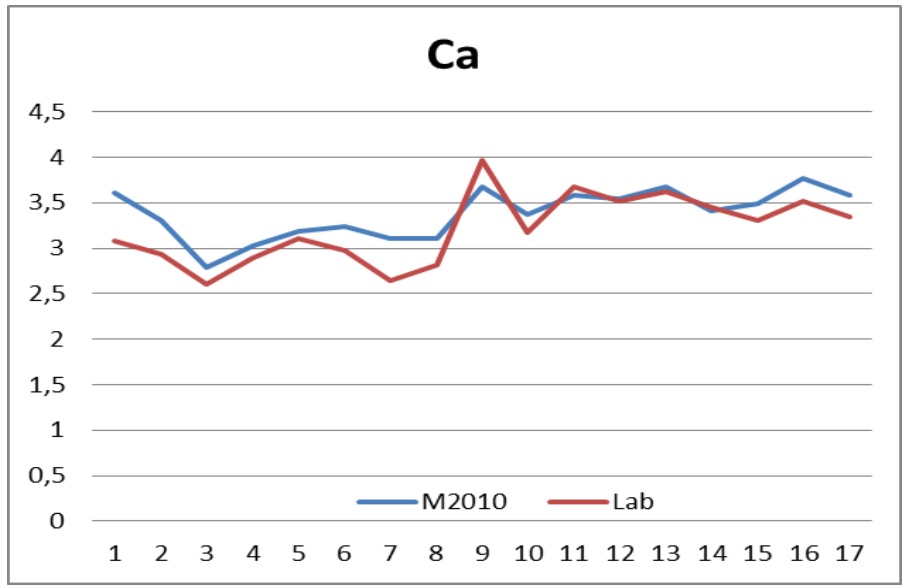
Modbus/Profibus

Case study - Iron sinter basicity stabilization
Flux dosage into sinter mix

At the Novolipetsk Plant (Russia), 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!

Calibration curves after one year operation





Case study - Iron sinter basicity stabilization
Flux dosage into sinter mix

ArcelorMittal

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**

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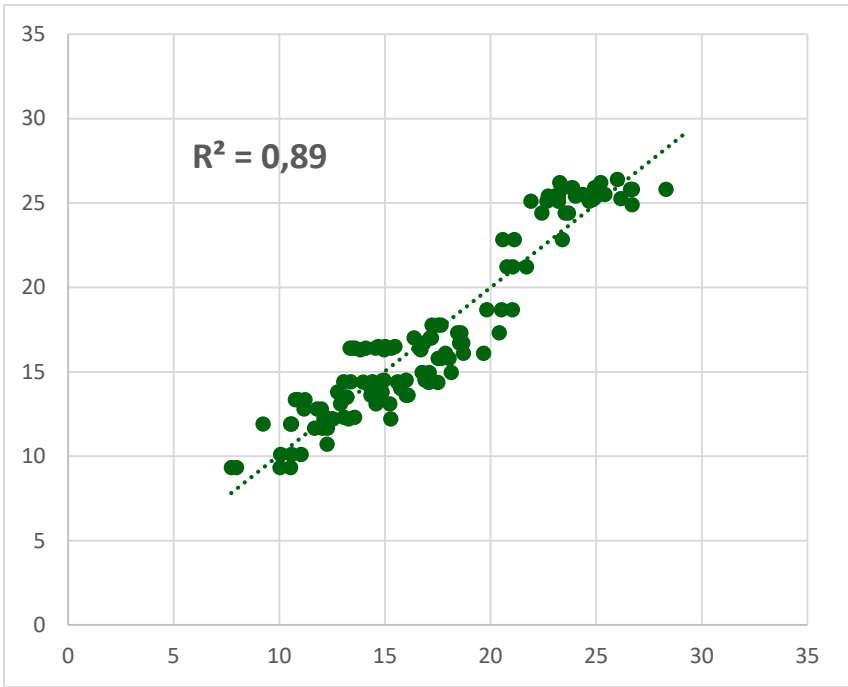
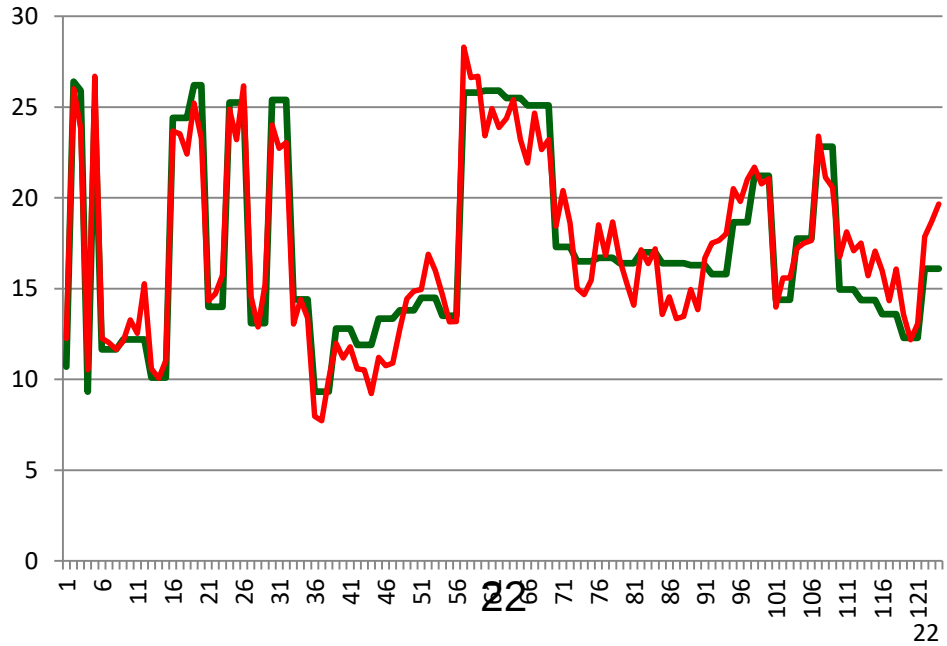
Case study - Iron sinter basicity stabilization
Flux dosage into sinter mix



SiO2 in the iron ore mix

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



Grain size – 0 (fine) - 30 mm
Moisture - 5-10%

Laboratory
LIBS

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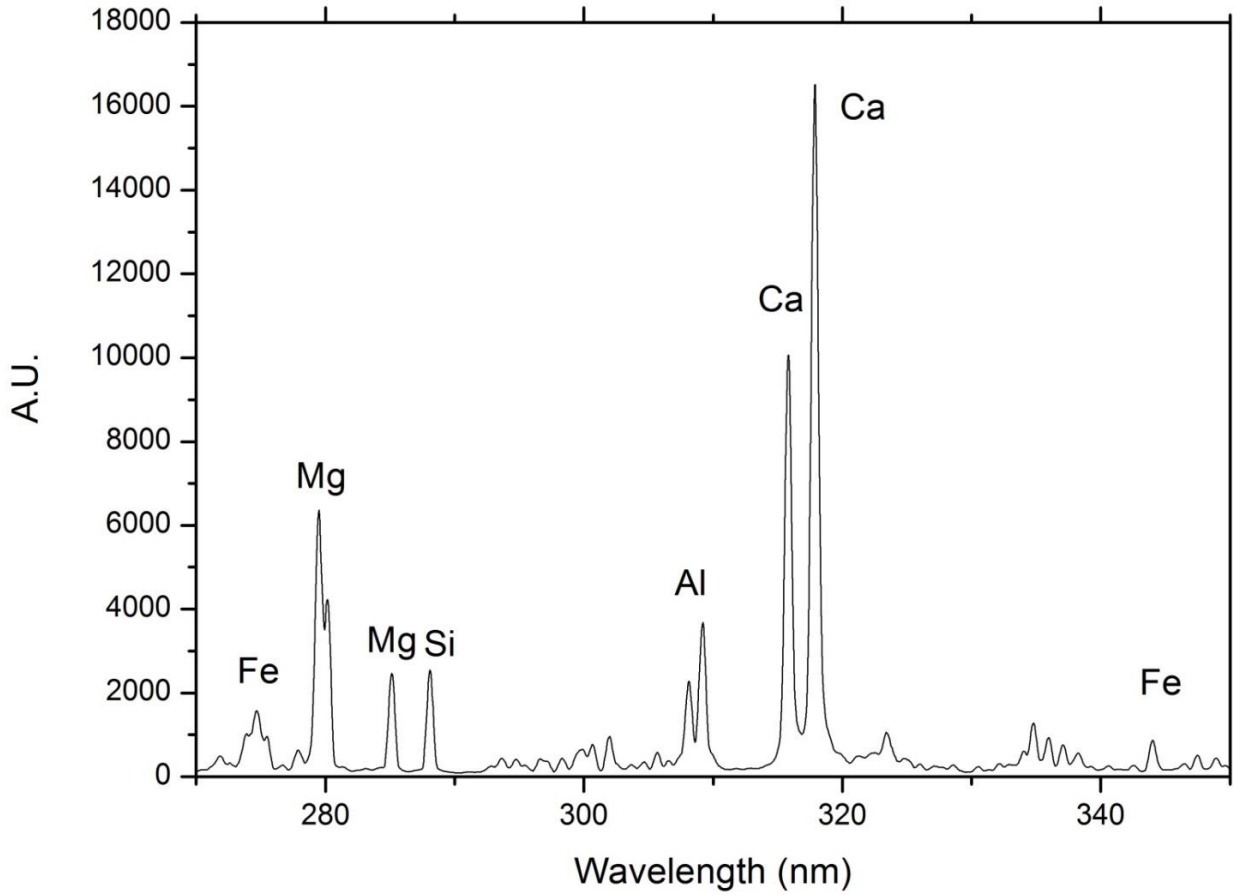
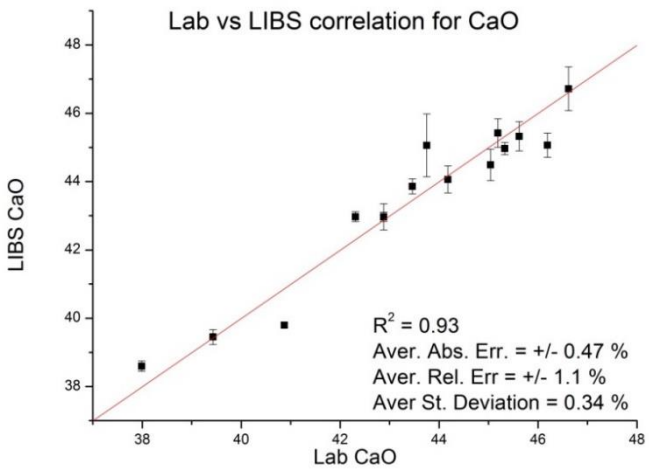
Case study - Iron sinter basicity stabilization
Flux dosage into sinter mix

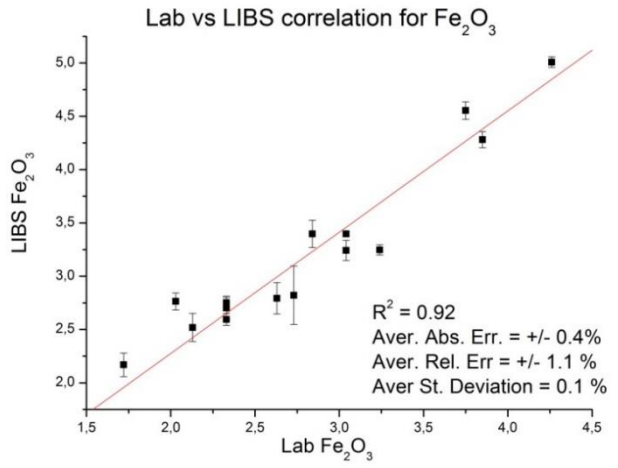
Limestone - Typical LIBS spectra

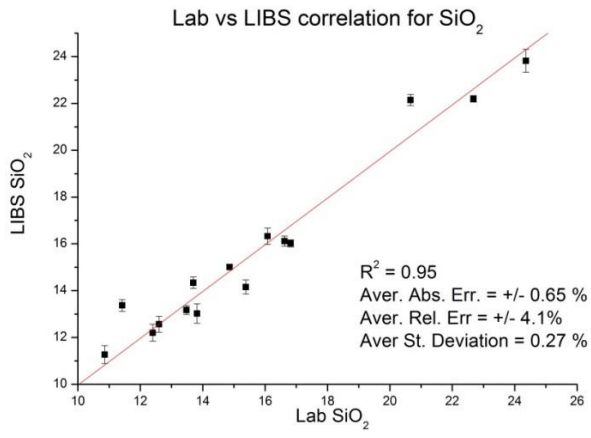


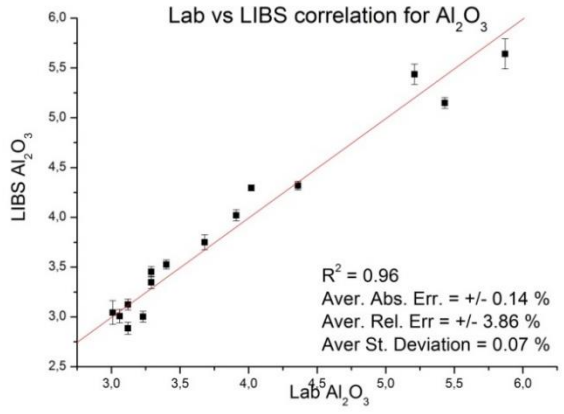
Case study - Iron sinter basicity stabilization
Flux dosage into sinter mix

Limestone static calibration - Correlation LIBS vs Lab





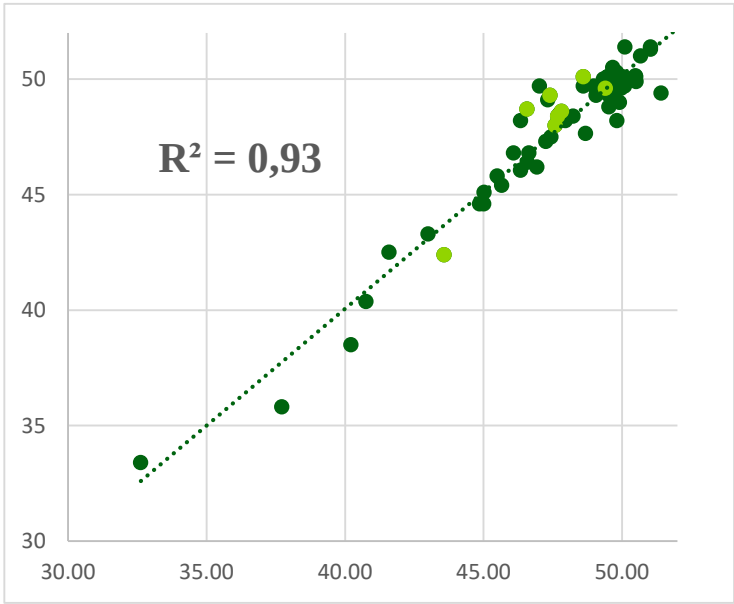




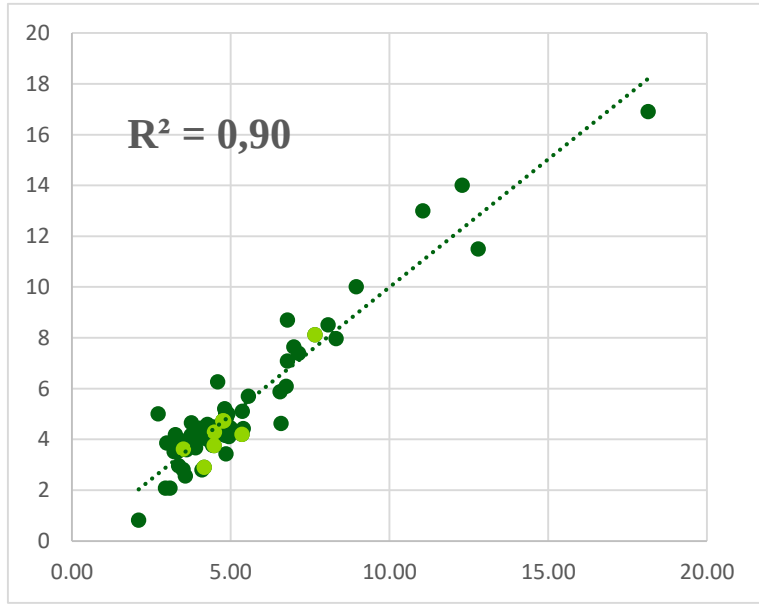
Case study - Iron sinter basicity stabilization
Flux dosage into sinter mix

Flux mix – *Limestone +Dolomite +Shelly ground*
Calibration on the conveyor belt

CaO



MgO



Calibration samples from conveyor belt

Blind samples from conveyor belt

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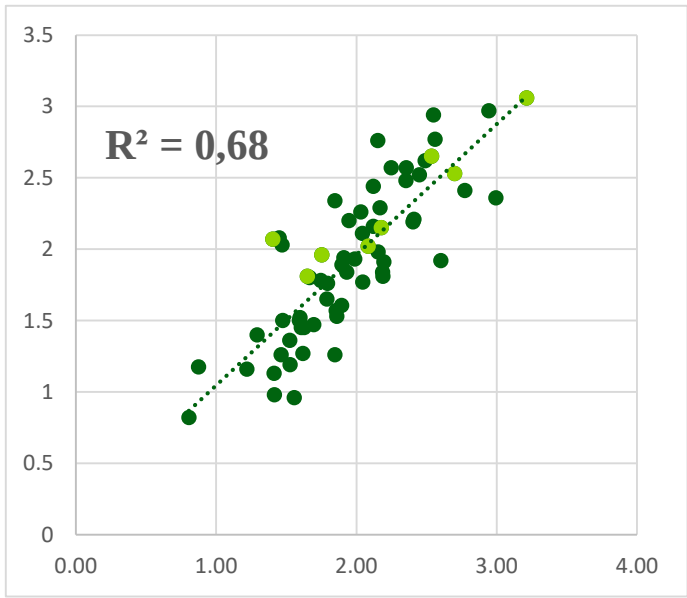
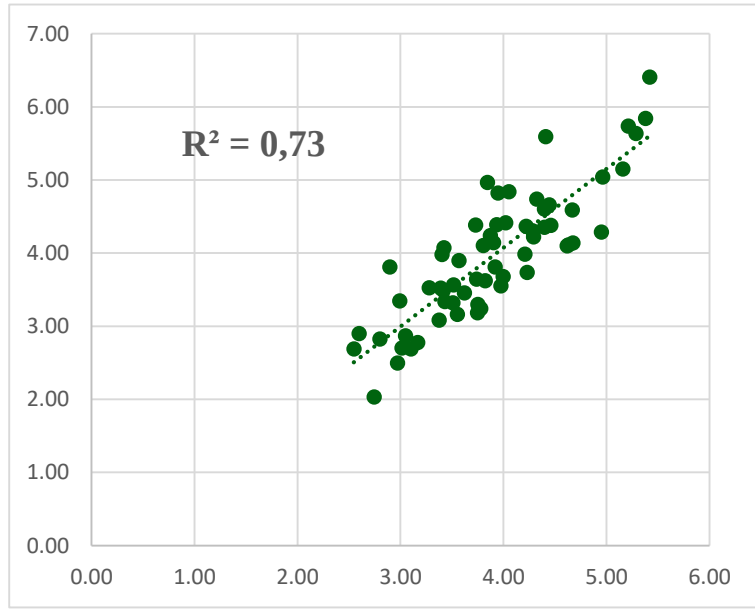
Case study - Iron sinter basicity stabilization
Flux dosage into sinter mix

Flux mix – *Limestone +Dolomite +Shelly ground*
Calibration on the conveyor belt

SiO2



Moisture



Calibration samples from conveyor belt

Blind samples from conveyor belt

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MAYA 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

- **Clean dry air** without oil for dusty environment – 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

MAYA technical specifications

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

Nd:YAG solid state impulse laser 1064 nm
Laser safety Class 1
Spectrometers detect 170 – 960 nm range

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

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

Integration with all SCADA types

Protection class - IP65

Corrosion, dustiness, vibration protection

Conclusions

Advantages of LYNCIS industrial analyzers

- **Proven operation in the industrial environment**
- **Fully automatic elemental analysis without sampling**
- **High accuracy and good correlation with laboratory data**
- **Protected from dustiness, humidity, vibrations, temperature variation**
- **Stable & reliable calibration**
- **Low cost installation and maintenance**
- **Fast ROI**

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Thank you

for your attention!

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