NIR Process Analyzers in Action: Driving Quality and Efficiency in the Grain (Flour) Industries

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For the Better

Agenda:

1. Drivers behind successful adoption of NIR process analyzers in the grain & feed industries
2. Installation examples and technology integration into existing process lines (Case Studies)
3. Factors to consider when choosing an NIR process analyzer for specific applications

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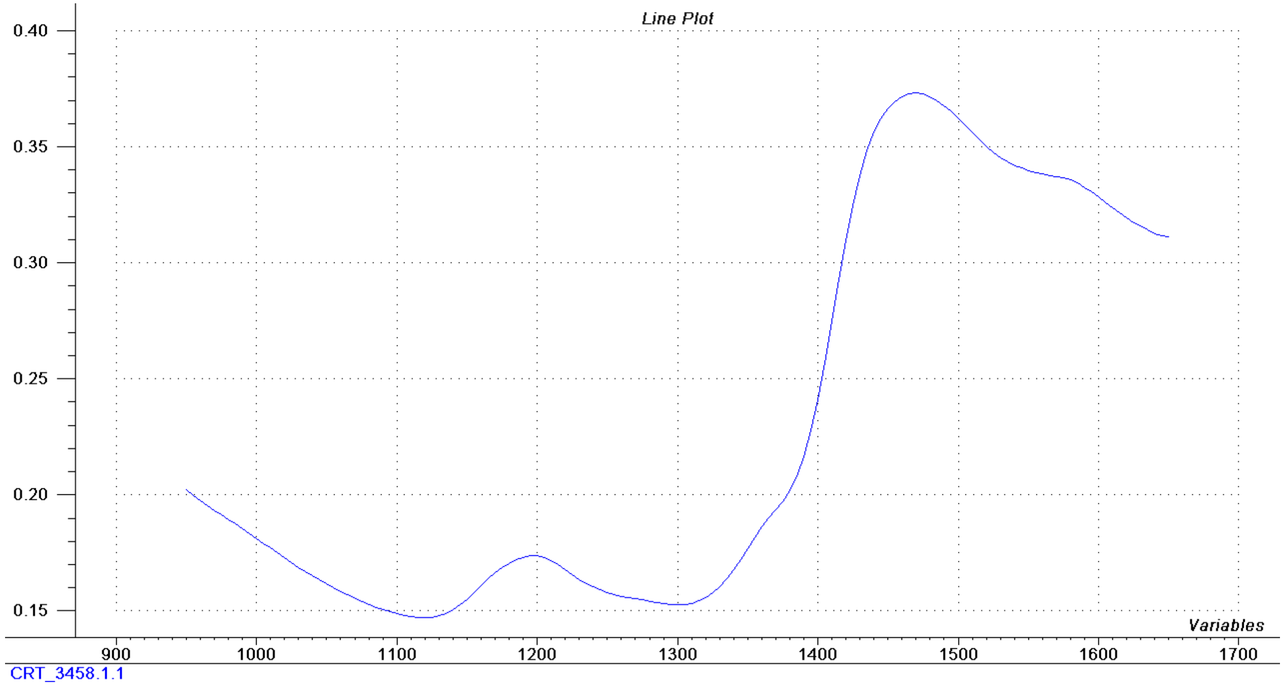
What is NIR?

- **N**ear **I**nfra**R**ed light used to determine composition
- Can measure proximates (moisture, protein, fat,...)
- Can not measure very low concentrations or minerals



Evolution of NIR use

1970s
In lab by scientists

1990s
In lab by anyone

2010s
In the process

What motivates organizations to embrace process NIR?

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Drivers behind increased use of process NIR analyzers

➢ The Natural Next Step

Lab NIR Experience

- Most process NIR users have started with Lab NIR and want to get more benefits

General Automation Drive

- Increased automation of production processes enables full benefits of process NIR implementation

Drivers behind increased use of process NIR analyzers

➢ Efficient Use of Skilled Labor

Skilled Labor Challenges

- More and more difficult/expensive to find skilled labor

Testing Frequency

- Higher frequency of testing today means more time spent on manual sampling and analysis

Drivers behind increased use of process NIR analyzers

➢ Technical Development

More Robust

- No moving parts, suited for industrial environments

Lower Price

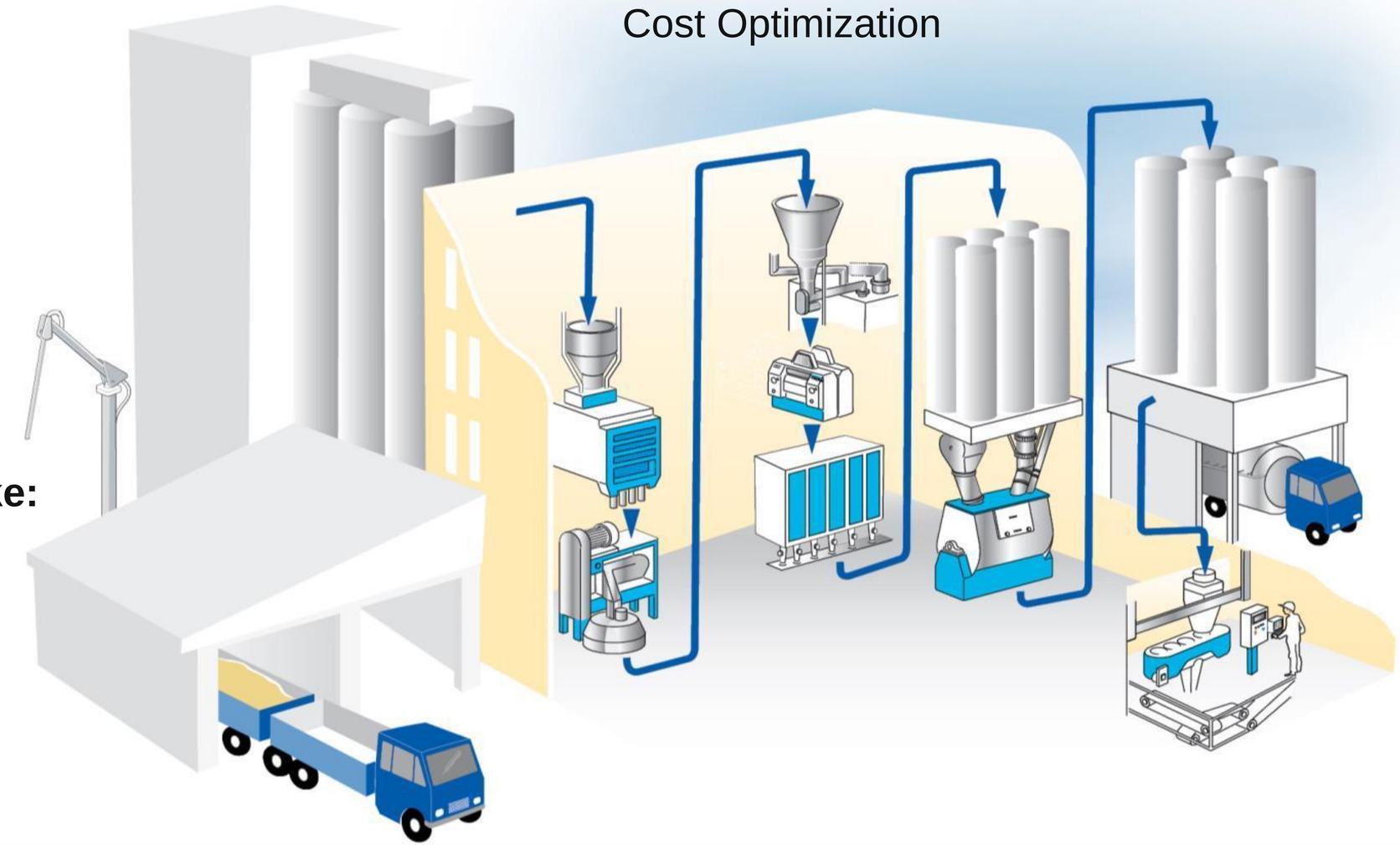
- Affordable high performance

Easier to Implement

- Mature software, factory calibrated for many applications

Case study: flour milling

Blending and tempering:
Cost Optimization



Wheat intake:
Segregation
Rejection

Final QC:
Confirmation

Grain blending for increased profitability

➢ Reducing Safety Margins to Targets

Wheat blending control loops

- Measure protein content of blend before tempering
- Change blend ratio continuously to keep protein content of blend constant
- More consistent flour

Optimized blending

- Millers often aim above the targets, to ensure that they never go below.
- Reducing this ‘safety margin’ is possible when continuous measurement and control is implemented

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Grain blending for increased profitability

➢ Optimizing *Grain* Blending

Estimated market prices:

- Wheat: (12%): € 230/t
- Wheat: (13.5%): € 245/t

	Without Process NIR	"Safe" Blend Ratio	With Process NIR	"Safe" Blend Ratio
Total volume = 400 ton/day (Target = 13% Protein) -Wheat, 12% protein -Wheat, 13.5% protein	80 tons 320 tons	(13.2%) 20% 80%	107 tons 293 tons	(13.1%) 27% 72%
Cost per day: -Wheat, 12% protein -Wheat, 13.5% protein **Total**	€ 18 400 € 78 400 **€ 96 800**		€ 24 610 € 71 785 **€ 96 395**	**- € 405**
			Annual Savings= **(330 x € 405 / day)**	**€ 133 650**

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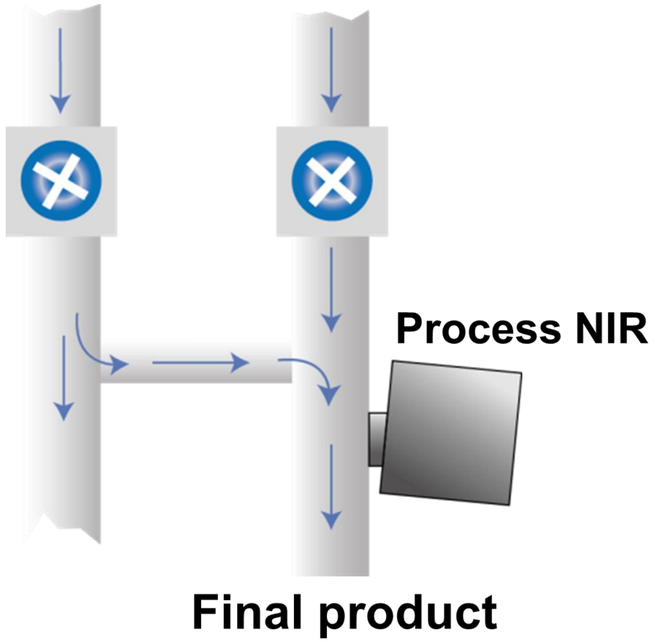
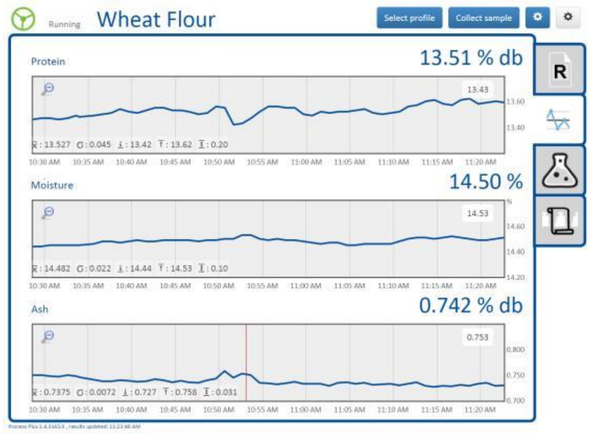
Grain blending for increased profitability

- Optimizing *Flour* Blending

Use in-line process NIR for automated blending of streams based on ash content





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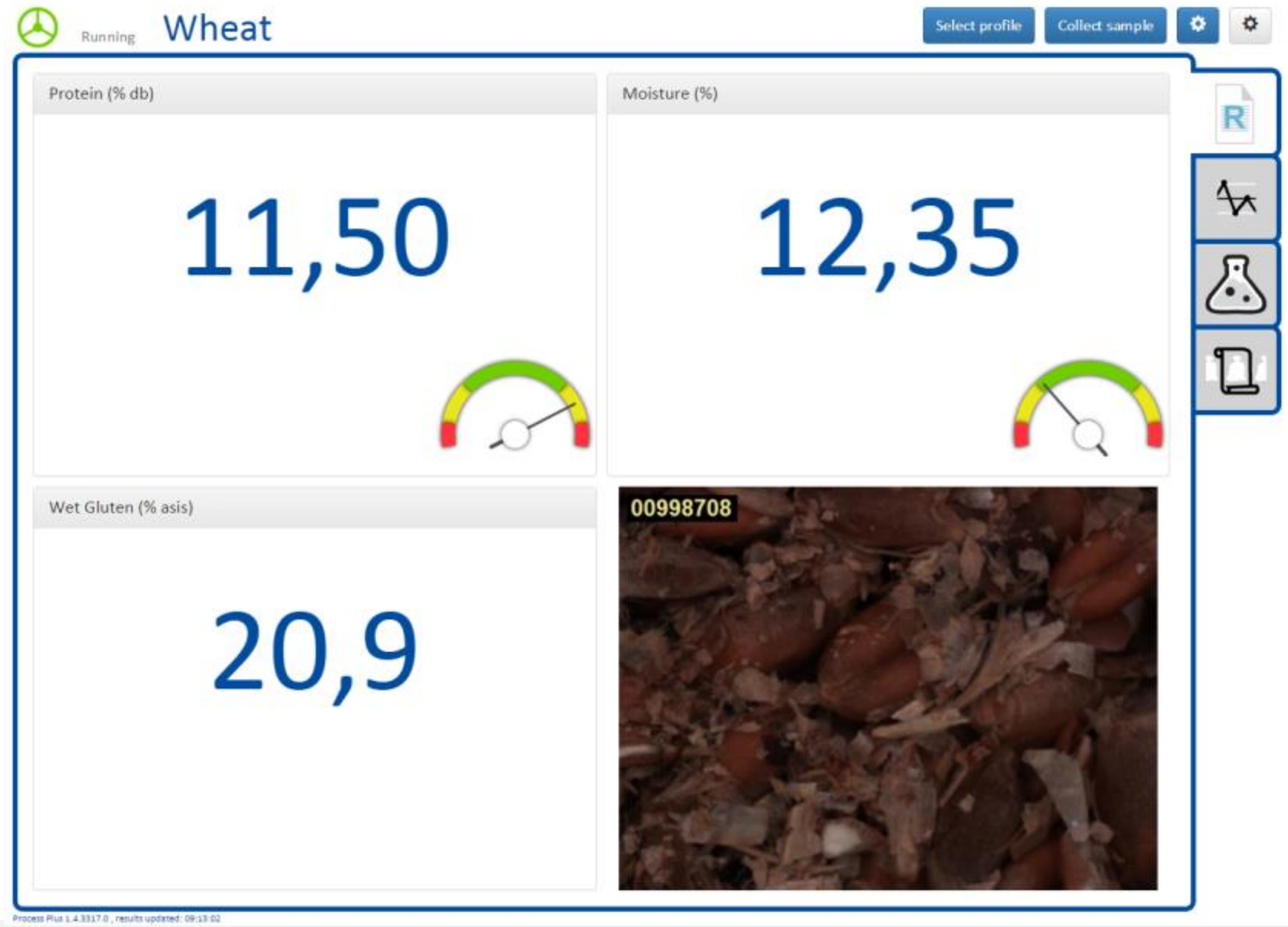
What do we see?

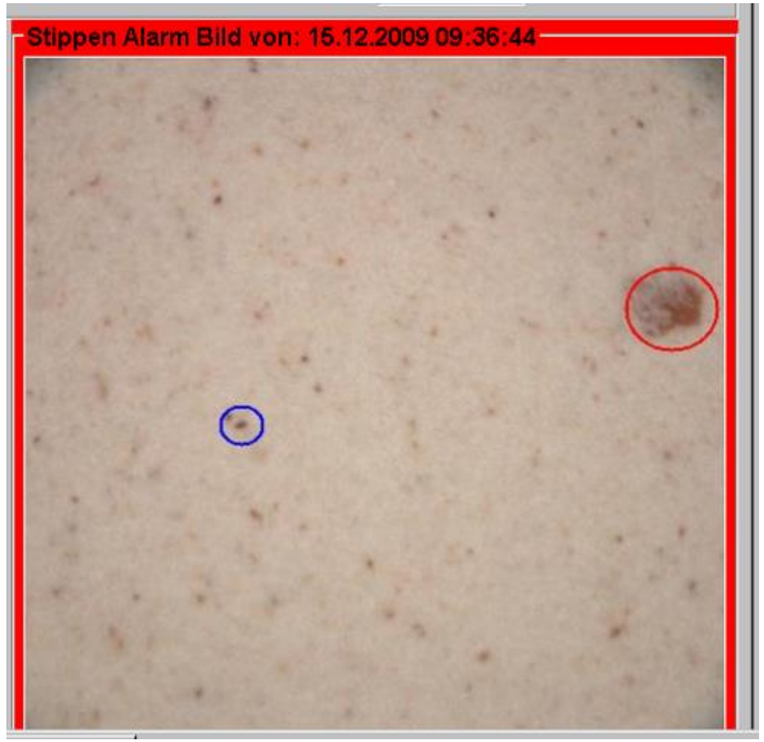


Camera

Product view gives a unique insight in to the processing

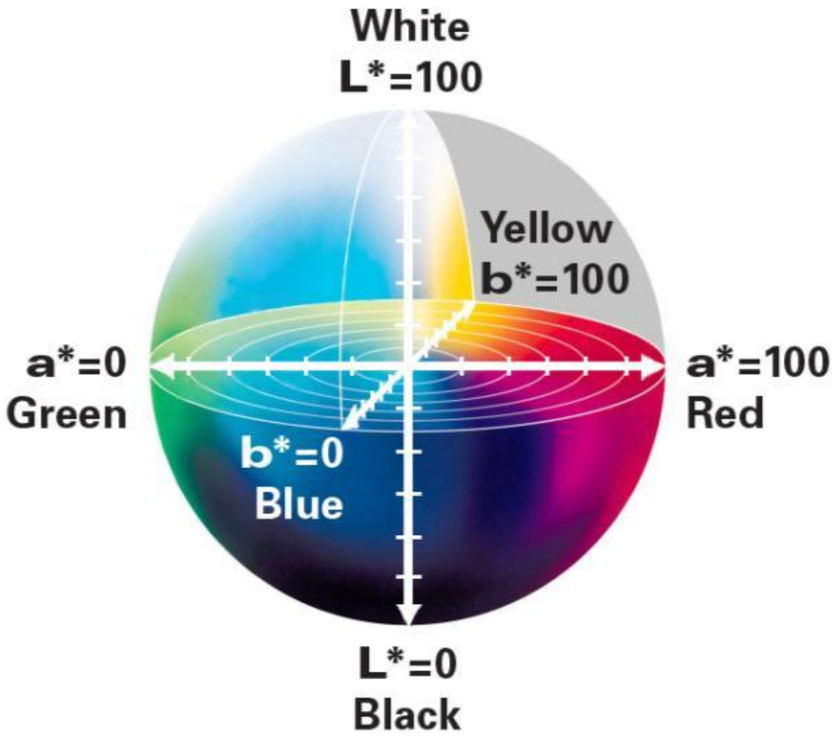
Camera

- Detection
- Size
- Counting
- Triggering alarm



Colour

Product view gives a unique insight in to the processing

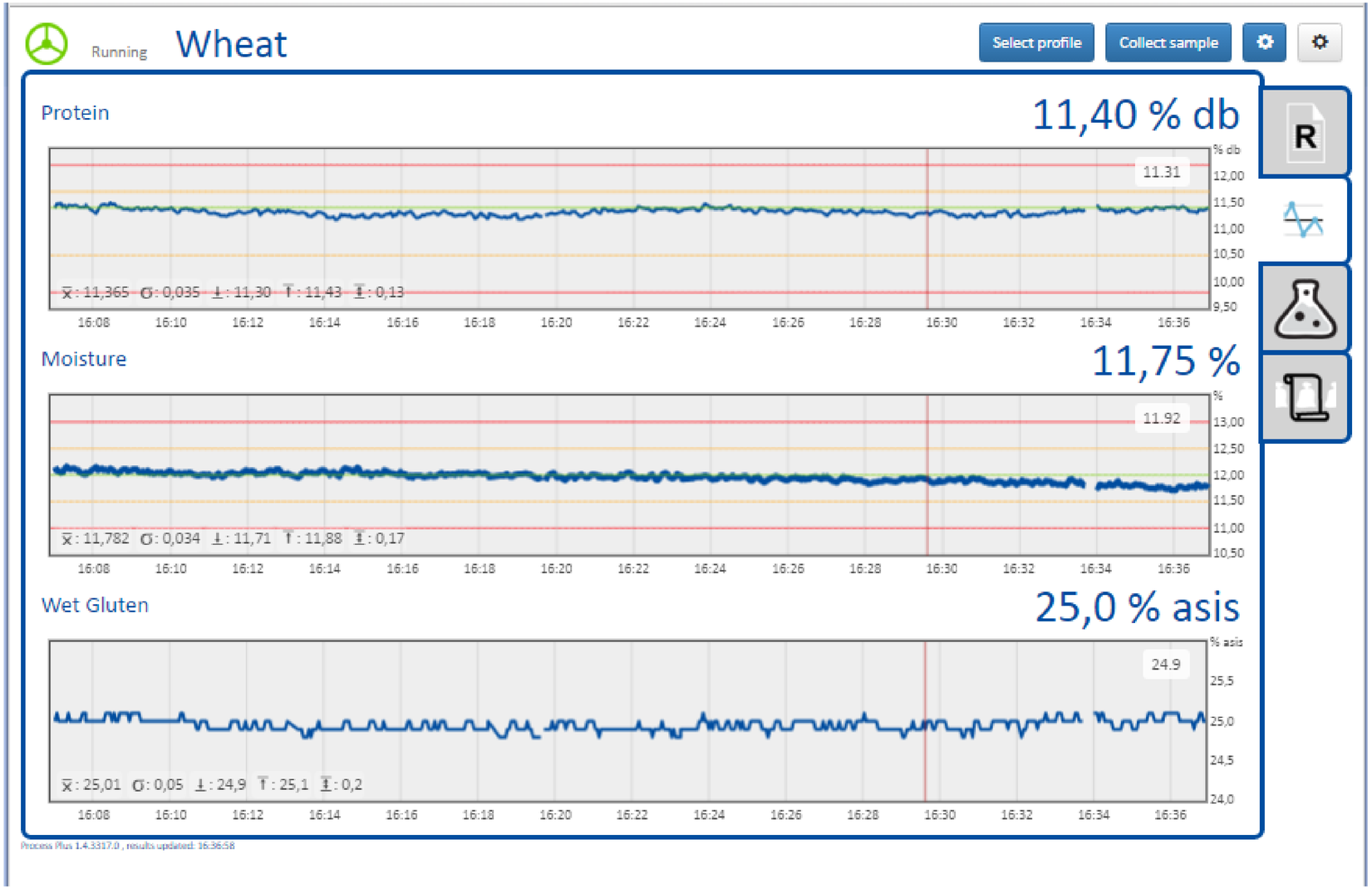


L=89 a=1 b=9

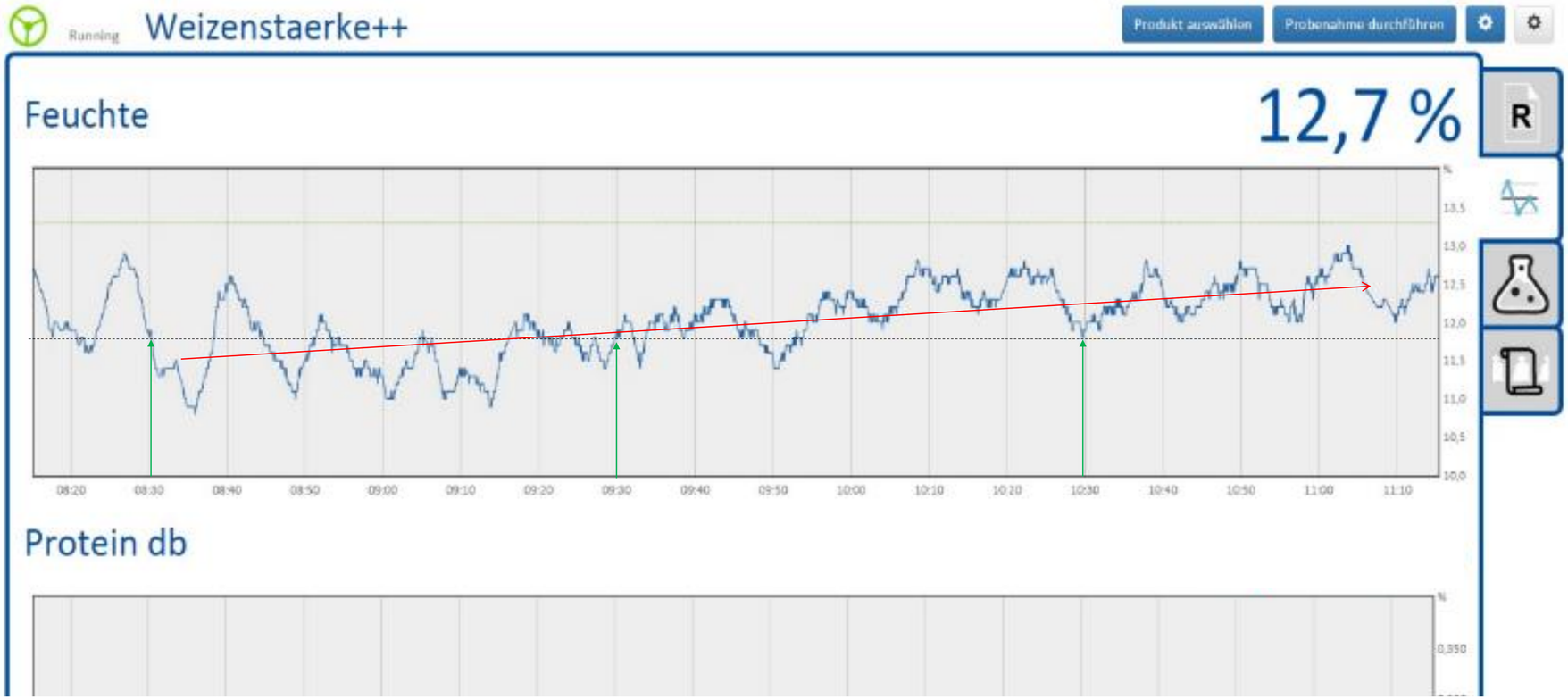
L=84 a=1.5 b=20

L=81 a=2.5 b=30

What we see


Running
Wheat
Select profile
Collect sample
Protein
11,40 % db
% db
12,00
11,50
11,00
10,50
10,00
9,50
11.31
x̄: 11,365 σ: 0,035 ⊥: 11,30 ⊤: 11,43 ↕: 0,13
16:08 16:10 16:12 16:14 16:16 16:18 16:20 16:22 16:24 16:26 16:28 16:30 16:32 16:34 16:36
Moisture
11,75 %
%
13,00
12,50
12,00
11,50
11,00
10,50
11.92
x̄: 11,782 σ: 0,034 ⊥: 11,71 ⊤: 11,88 ↕: 0,17
16:08 16:10 16:12 16:14 16:16 16:18 16:20 16:22 16:24 16:26 16:28 16:30 16:32 16:34 16:36
Wet Gluten
25,0 % asis
% asis
25,5
25,0
24,5
24,0
24.9
x̄: 25,01 σ: 0,05 ⊥: 24,9 ⊤: 25,1 ↕: 0,2
16:08 16:10 16:12 16:14 16:16 16:18 16:20 16:22 16:24 16:26 16:28 16:30 16:32 16:34 16:36
Process Plus 1.4.3317.0 , results updated: 16:36:58

What laboratory could be missing



Factors to consider when choosing an NIR process analyzer

➢ Product Access / Variability and System Configuration

Product access

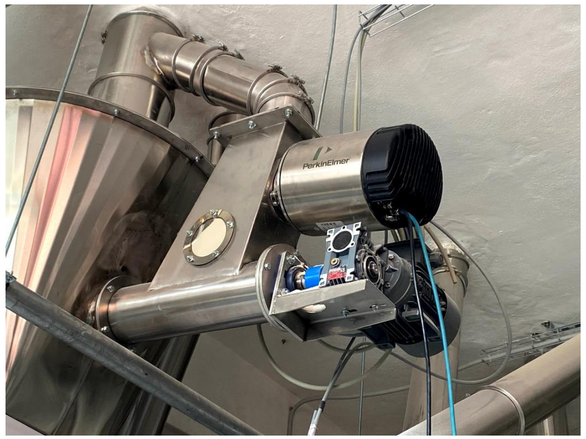
- Non-contact:
  - Belt, auger or conveyor
- In contact:
  - In pipe, Redler, hopper, shute etc.
- Sampling

Product variability

- Natural products
- Sort/Species
- Temperature variation
- Heterogeneity
- Product flow

System configuration

- Technology
  - Filter NIR or Full Spectrum NIR?
  - Multiple measuring points?
    - Fiber Optics or Ethernet?

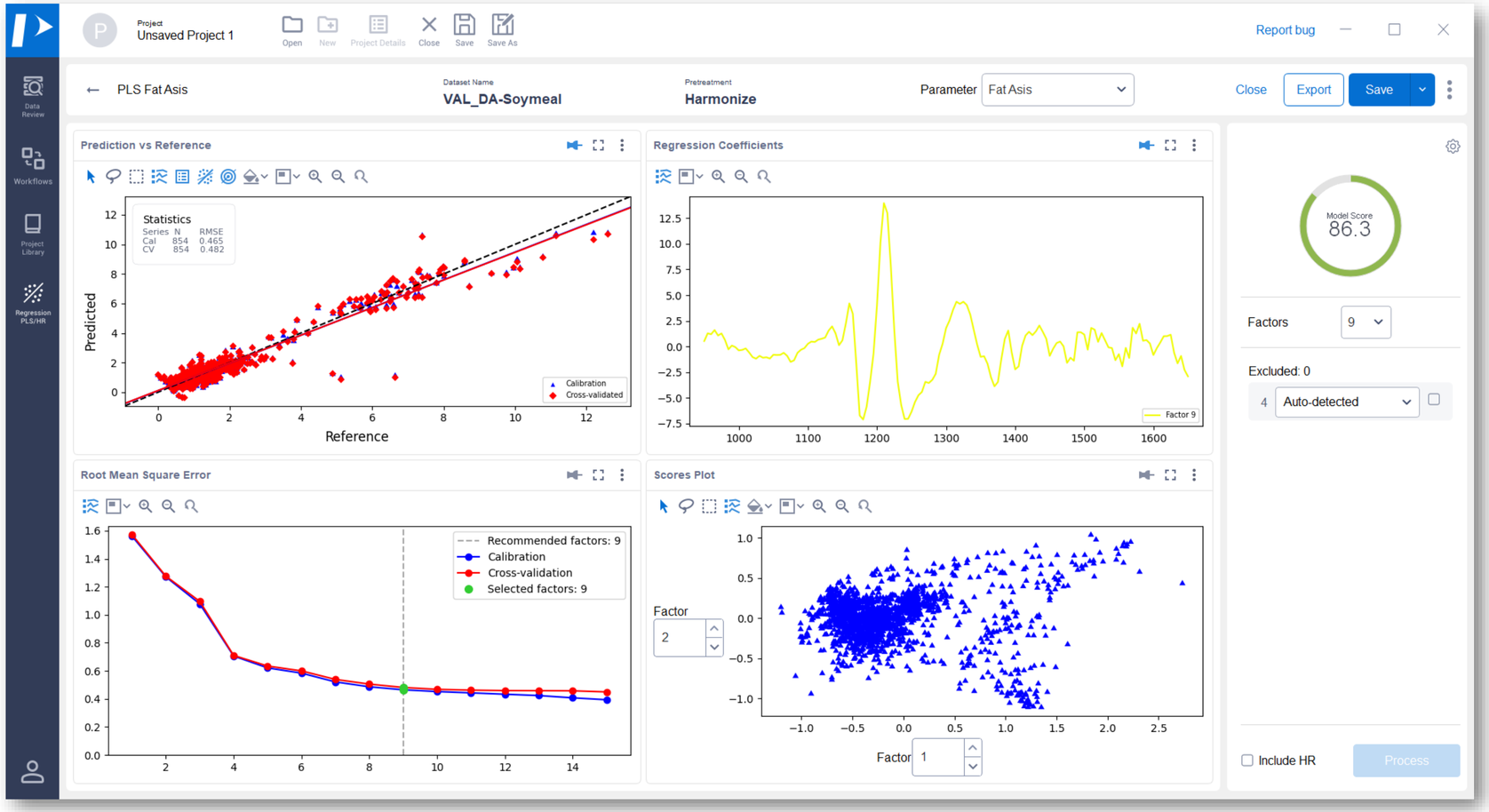


Factors to consider when choosing an NIR process analyzer

- Calibration and chemometrics

Influencing factors

- Understanding of NIR
- Lab reference
- Regression techniques (Chemometrics)

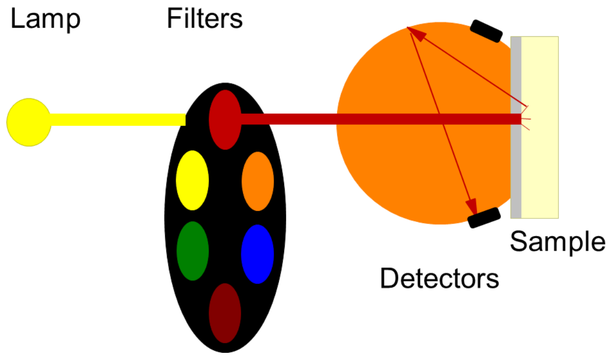


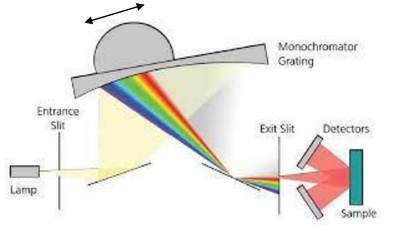
Factors to consider when choosing an NIR process analyzer

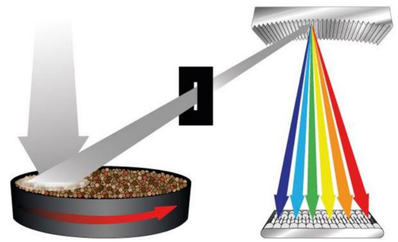
➢ Filter vs Full Spectrum Technology

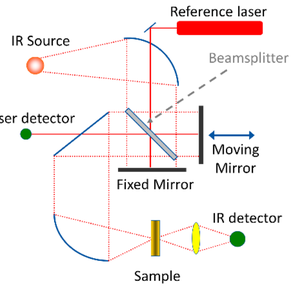
Influencing factors

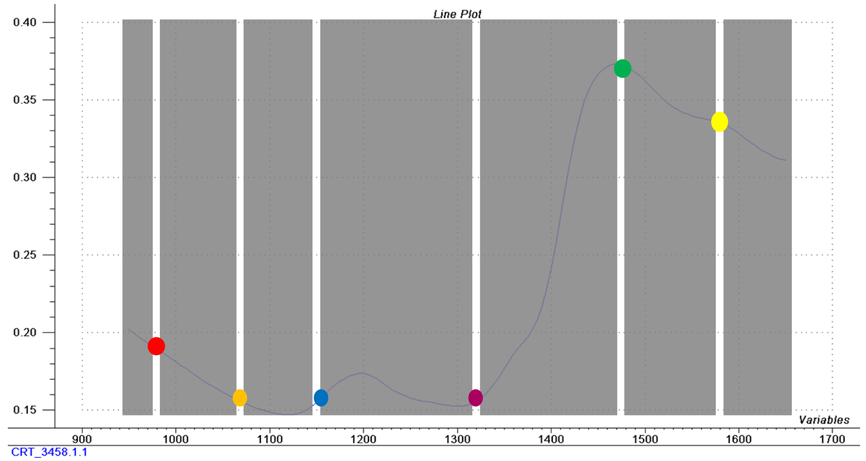
- Target analytes
- Matrix variation
  - Density
  - Color
  - Shapes
- Regression techniques (Chemometrics)

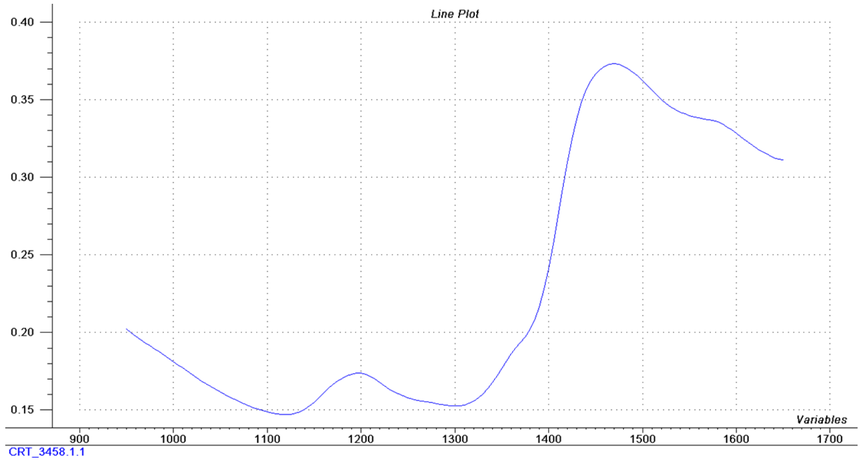












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Factors to consider when choosing an NIR process analyzer

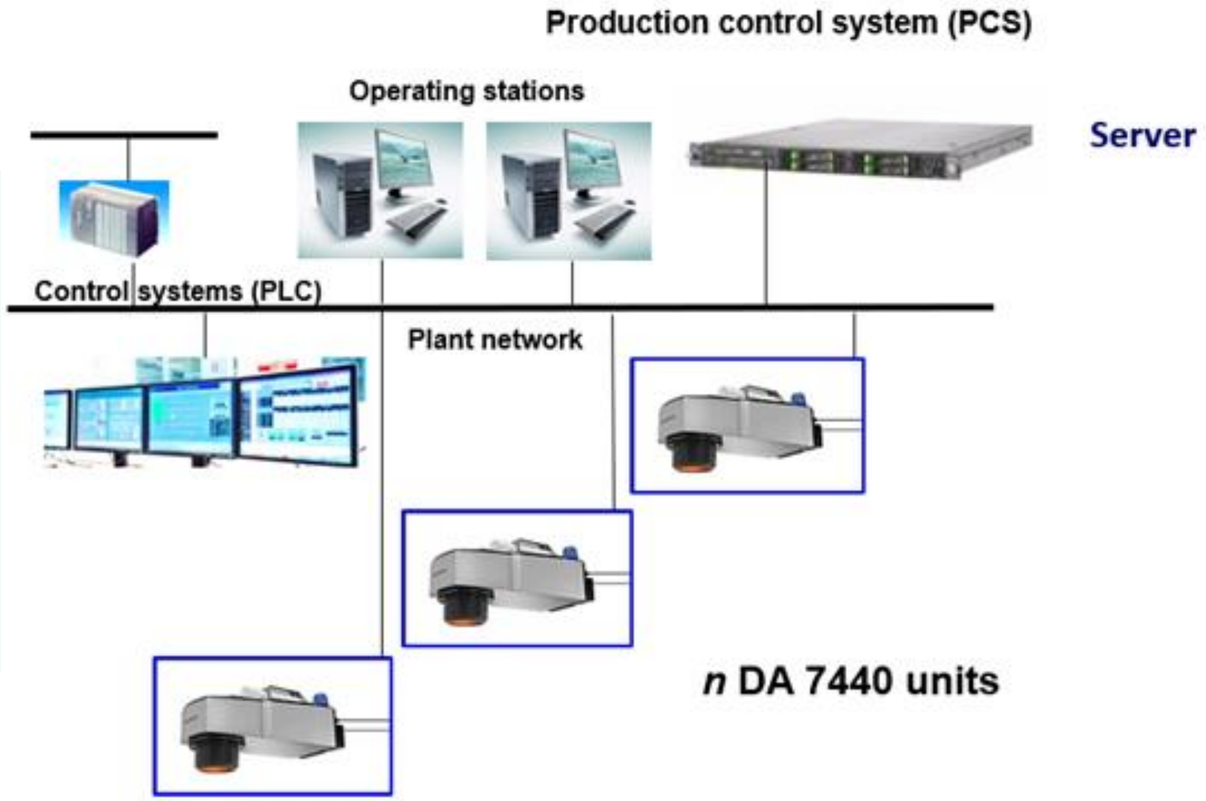
➢ Multiple Measuring Points

Fiber Optics

- Lower cost per measuring point?
  - Cost of optical fiber
  - Robustness of optical fibers
- Multiplexed channels
  - Sequential measurements
  - Multiplexed spectrometer goes down, all channels go down

Ethernet

- Higher cost per measuring point?
  - Cost of LAN cable
  - Robustness of LAN cable
- No multiplexing
  - Parallel measurements
  - Interchangeable sensors



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Lessons learned and best practices

➢ Thinking Ahead Gets it Right at The End

Vision and expectations

- What is the purpose?
  - What can I control?
- Define success criteria
- How will we measure success?
- Time-line

Dialogue with supplier

- Share your vision
- System configuration
- Chemometric models
- Connectivity
- Responsibilities
  - *Preparations for installation and commissioning*
  - *Agreed check-list*

Validation strategy

- Sampling
- Reference methods
  - Chemical methods
  - Benchtop NIR
- Calibration updates
- Economic model

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Thank you! Questions?

Connect with us!

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