FOSS

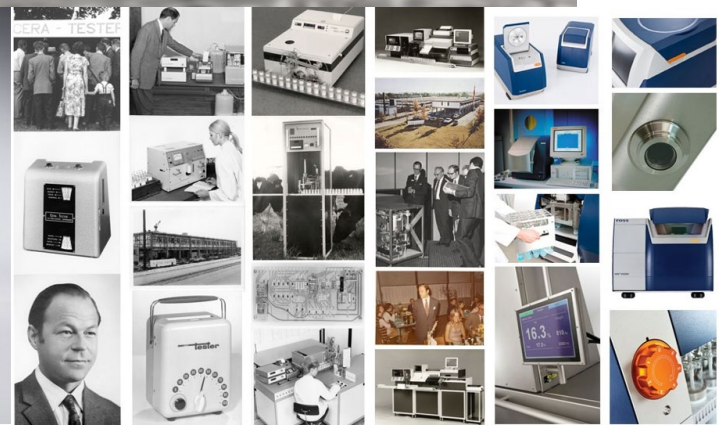
25th Annual Grain Distillers Symposium
October 25, 2021

NIR Instrumentation for Corn to Ethanol & CoProducts

Paul Dawson, FOSS North America
Industry Sales Manager – Grain & Feed

ANALYTICS BEYOND MEASURE

Discussion Agenda



- WHAT
  - Analytical “Whats”
  - NIR Method Strengths
- WHERE & WHO
- HOW
  - NIR Technology Approaches & Examples
- Innovation

A HISTORY OF PIONEERING INVENTIONS

In 1956, Nils Foss identified the need for a portable moisture analyser

Fast, easy-to-use and dedicated, the Cera-Tester was the first FOSS innovation

Matching innovative technology to the demands of particular industries has been the foundation of FOSS ever since

1956

Cera Tester monitors moisture content in grain. The instrument is a highly popular world first.

1963

Milk becomes a major business area, and the Pro Milk helps to speed-up the analysis of fat content in milk.

1973

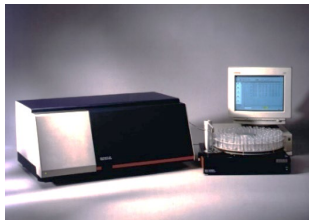
The Tecator Kjeltec™ paves the road for simpler, safer, less timeconsuming and more cost efficient Kjeldahl analysis.

1980

Analysis of individual bacteria or somatic cells leads to dramatic improvements in raw milk quality.

1997

FOSS acquires Perstorp Analytical and improves consistency of analysis results throughout the grain industry via NIR.



1999

WineScan introduces FTIR analysis as an effective way of improving quality throughout the wine making process.

2003

Introduction of X-ray analysis of meat allows entire batches of meat to be checked for fat

2014

First commercial use of EyeFoss for quality assessment of grain using image analysis to replace the age-old method of visual inspection.

2015

MilkoScan Mars makes screening for milk adulteration available to any size of business, along with other quality tests.

2016

FOSS achieves record growth with revenue of 285 million EUR.

ANALYTICAL METHOD “WHATS”

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Precision is key for proper data usage.

SPEED

Testing is first founded on targets of best accuracy.

PRECISION

Speed is one of the biggest boosts technology brings toward ROI.

ACCURACY

ANALYTICS BEYOND MEASURE

ANALYTICAL METHOD “WHATS”

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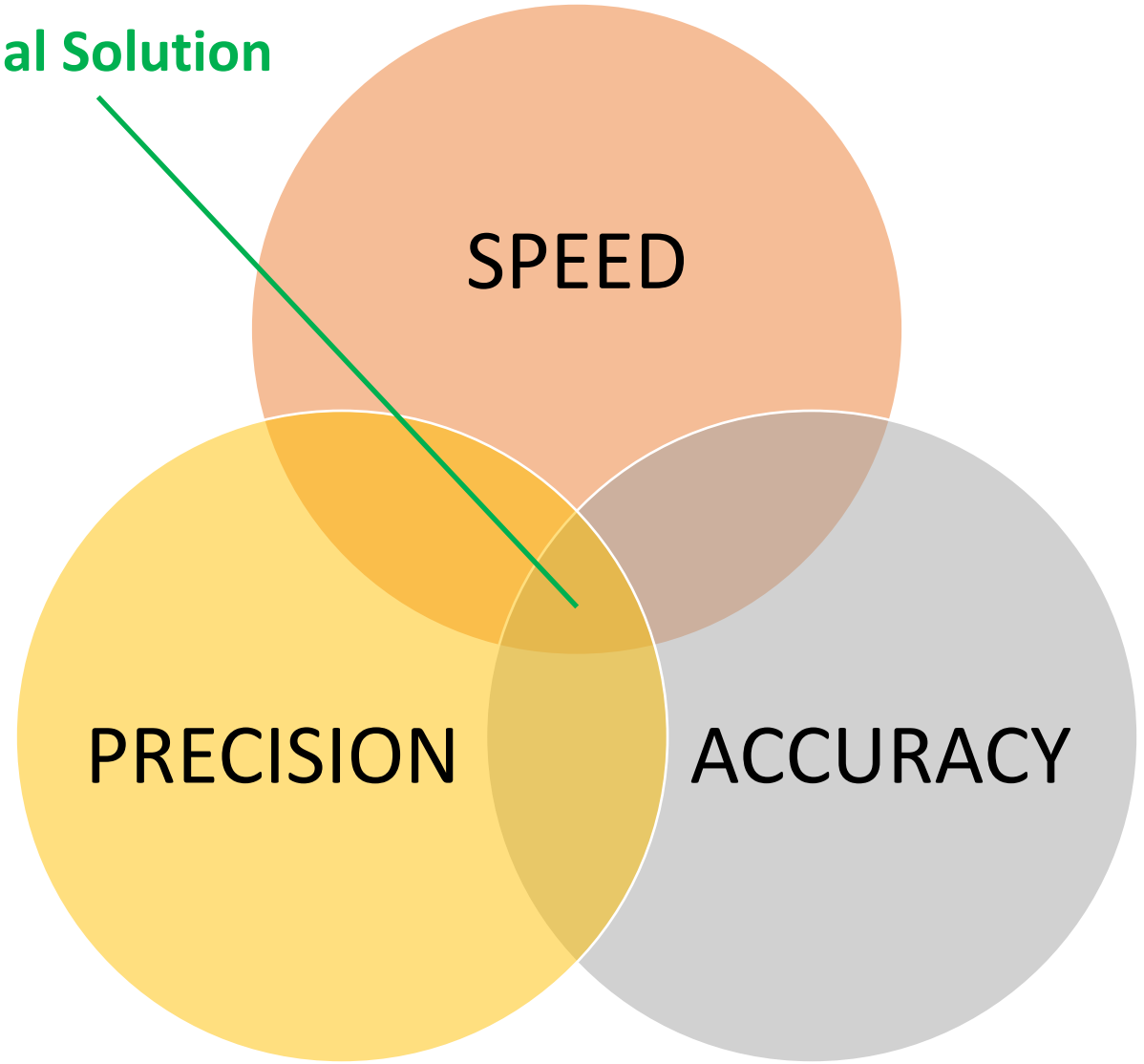
Any given analytical method has varying levels of these targets.



It is important to weigh the investment of resources toward any given application’s strengths and weaknesses.

ANALYTICS BEYOND MEASURE

ANALYTICAL METHOD “WHATS”

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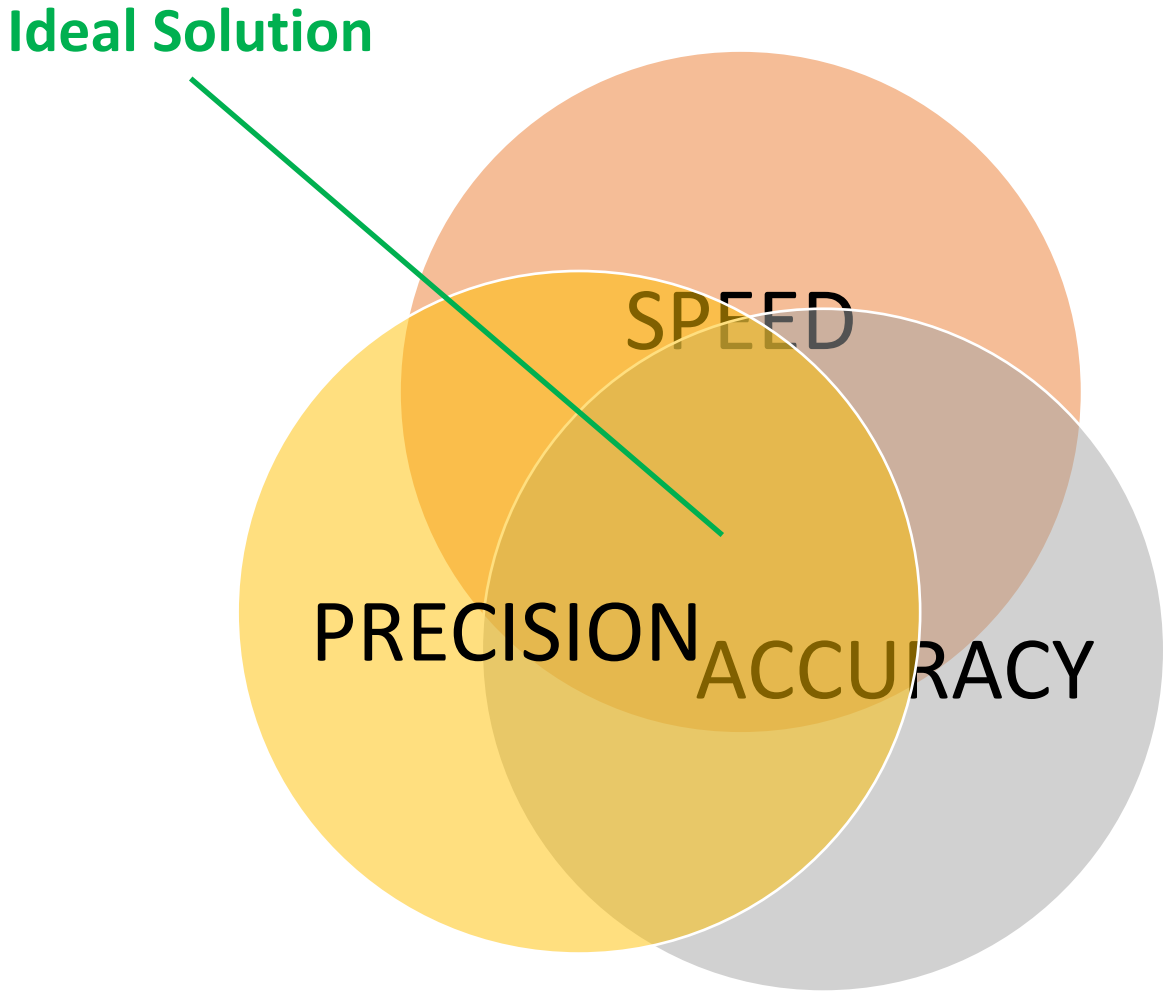

It is important to weigh the investment of resources toward any given application’s strengths and weaknesses.

ANALYTICS BEYOND MEASURE

ANALYTICAL METHOD “WHATS”

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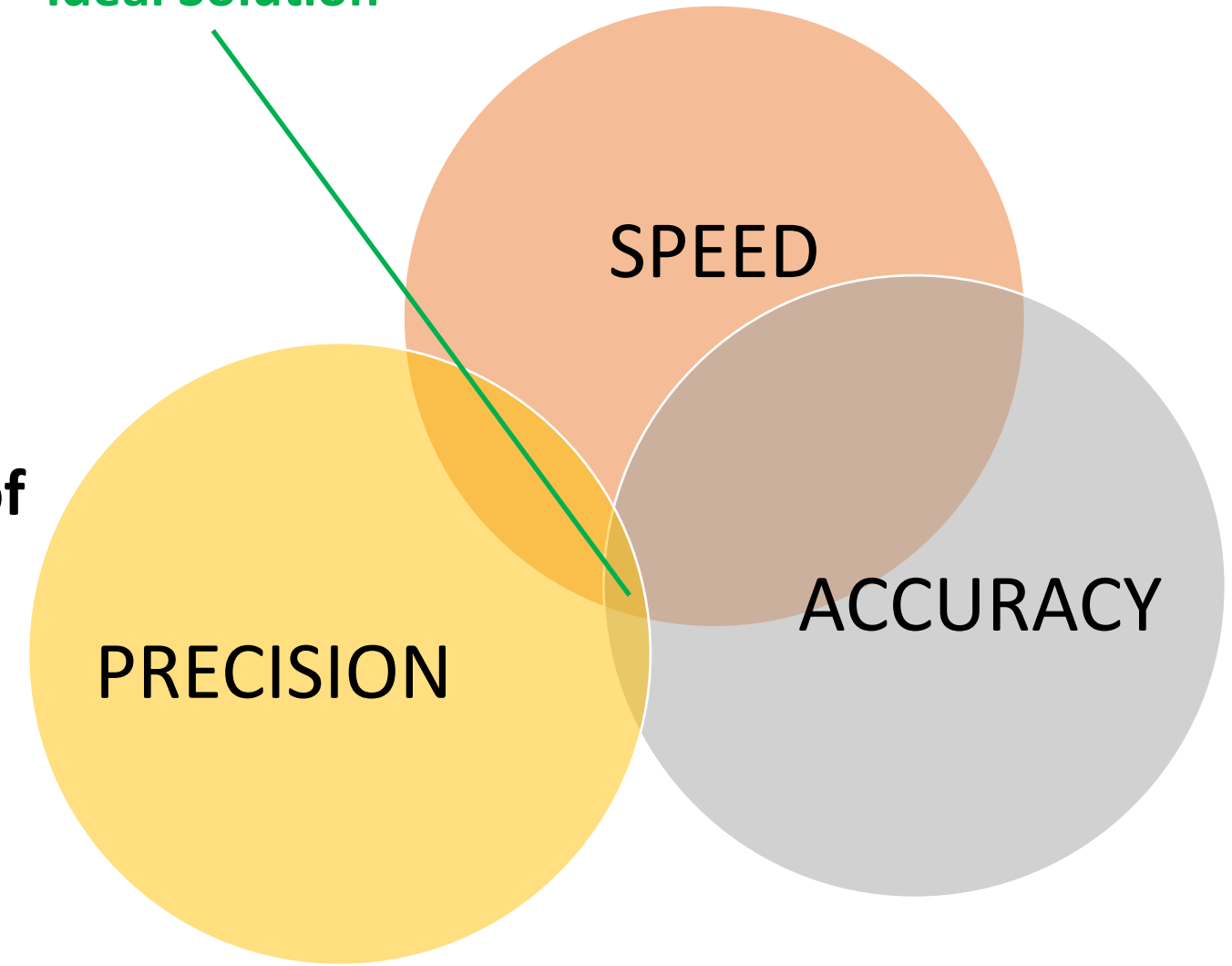
Ideal Solution

Any given analytical method has varying levels of these targets.



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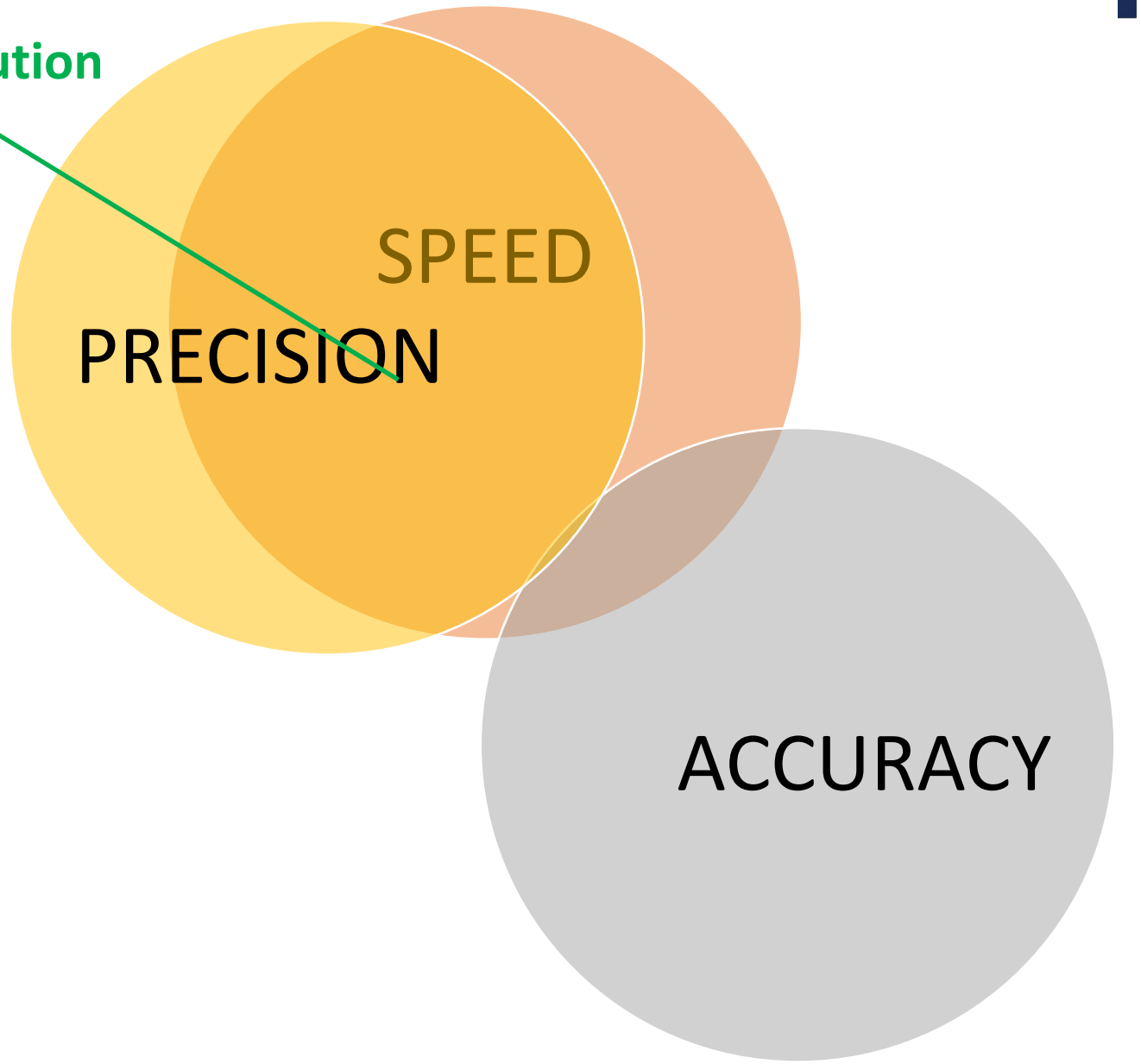

ANALYTICS BEYOND MEASURE

NIR “WHATS”

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Typical NIR Solution:

- Provides a 100% ROI within 6-12 months
- Deletes need for chemicals & most Lab Space Requirements
- Implements robust calibration(s) supporting daily production
- Removes need for highly trained personnel for daily operation
- Reduces need for traditional analytical testing methods by 95%

ANALYTICS BEYOND MEASURE

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“Typical NIR Solution”:

- Provides a 100% ROI within 6-12 months
- NonDestructive Testing, Deletes need for chemicals
- Implements **robust performance** supporting daily production
- Removes need for highly trained personnel for daily operation
- Reduces need for traditional analytical testing methods by 95%

NIR Robust Performance:

- Reduces Down Time
- Calibration(s) specific to any/all products
- Ultra-High rate of data production (10-100+ rate increase)

ANALYTICS BEYOND MEASURE

WHERE: NIR SERVES FUNCTIONS ACROSS A MULTITUDE OF INDUSTRIES

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RAW MILK TESTING

mpr, NML national milk laboratories, valacta, eurofins, Qlip

DAIRY

Fonterra, Groupe Lactalis, Nestlé, Danone, glanbia, Kraft, FrieslandCampina, Arla

GRAIN, MILLING & OILS

Barilla, CBH Group, ADM, DCOOP, SGS, LDC Louis Dreyfus Company

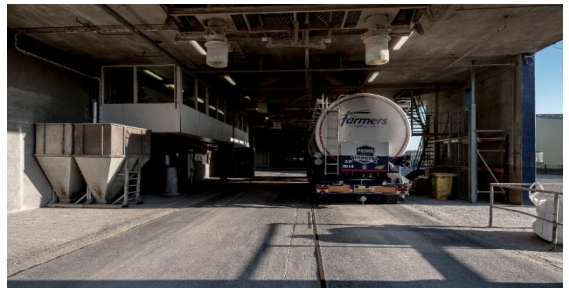
WINE

Concha y Toro, Chateau Latour, Val d'Oca, Dominio de Pingus, Antinori, indevin New Zealand, Hochschule Geisenheim University

MEAT

Tyson, VION Food Group, OSI, Danish Crown, JBS, Cargill

FEED & FORAGE

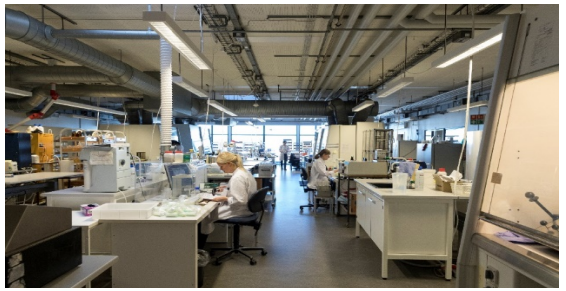


Cargill, inVivo, nutreco, Evonik Industries, CPF, Adisseo A Bluestar Company Adding Difference

OTHER INDUSTRIES

Olam, Cargill, Hershey's, Mondelēz International, raízen, MARS

LABORATORIES



eurofins, MERIEUX NutriSciences, SGS, AGROLAB GROUP

ANALYTICS BEYOND MEASURE

WHERE: NIR SERVES FUNCTIONS ACROSS A MULTITUDE OF INDUSTRIES

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Thousands of NIR units are in use across the globe including a wide range of conditions and analytical functions.

NIR provides one of the most rapid ROIs available from any analytical technique.

ANALYTICS BEYOND MEASURE

WHERE & HOW NIR…

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HOW NIR HELPS CUSTOMERS INCREASE QUALITY AND DECREASE COSTS

RAW MATERIAL
Ensure incoming production product meets specifications

PROCESSING
Control of manufacturing process by reducing variability and making more consistent product

FINISHED GOODS
Ensure safe products and compliance with regulatory requirements

Crude Fiber
Moisture
Ash
Starch
Protein
Amino Acids
Color
More…

On-farm | Receiving points | At-line/In-line production | Quality Control Laboratories | Finished products

ANALYTICS BEYOND MEASURE

NIR TECHNOLOGY: HOW

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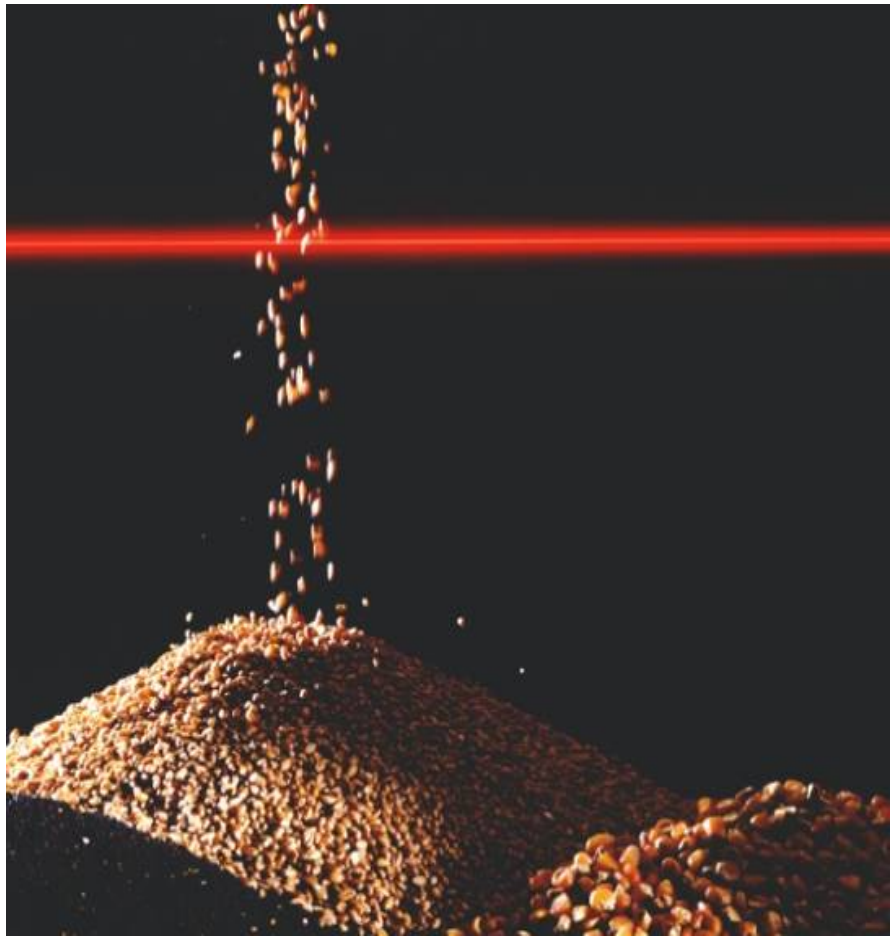
HOW DOES IT WORK?

- Near Infrared Technology is based on a combination of spectrometry and powerful mathematics
- Near Infrared light is directed onto a sample
- Detected light is modified according to the composition of the sample
- The spectral modifications are converted to information regarding the composition of the sample
- These conversion algorithms are called ”calibrations”



ANALYTICS BEYOND MEASURE

NEAR-INFRARED SPECTROSCOPY

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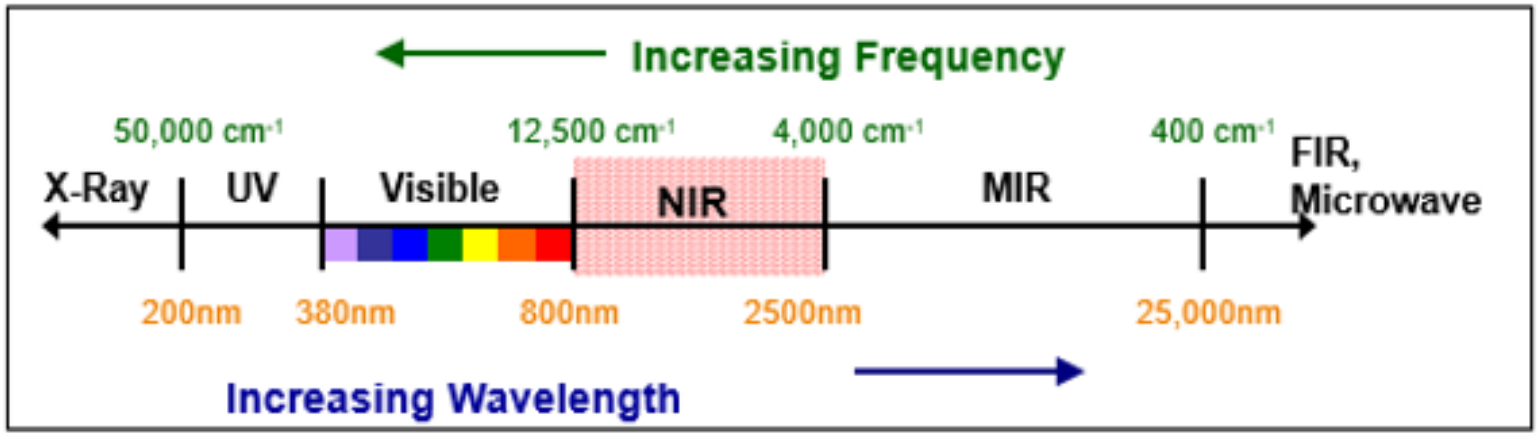
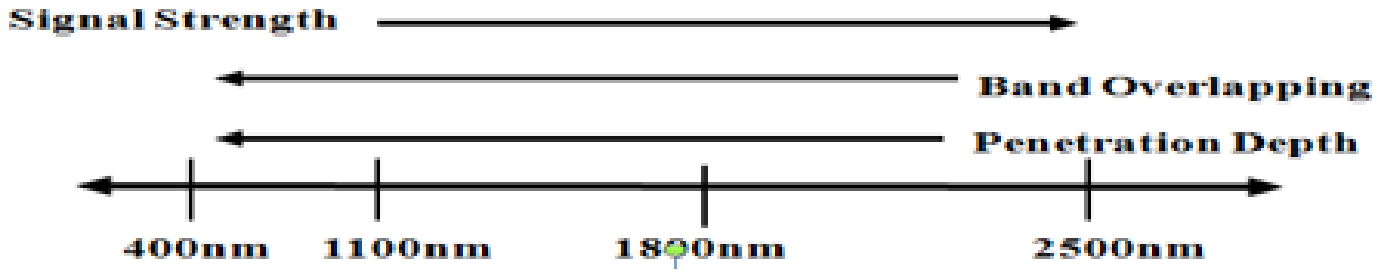
NIR is the spectrum of light just next to Visible Light.

Based on a sample reflecting or absorbing NIR light energy, a reference set of data is made and a calibration is developed.





ANALYTICS BEYOND MEASURE

NEAR-INFRARED SPECTROSCOPY TECHNIQUES

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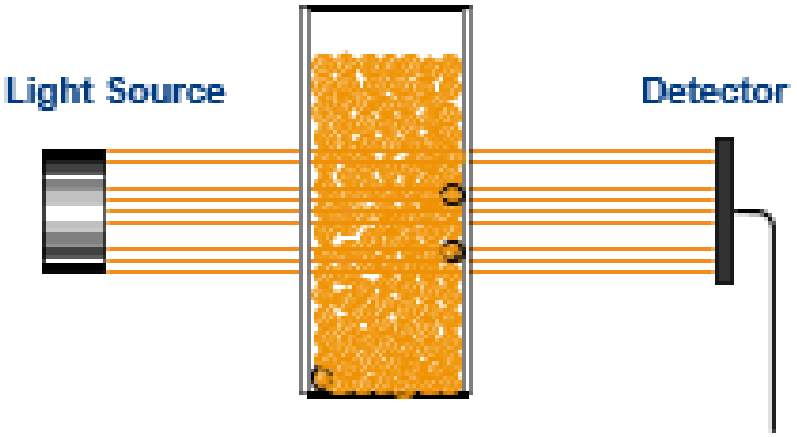
ANALYTICS BEYOND MEASURE

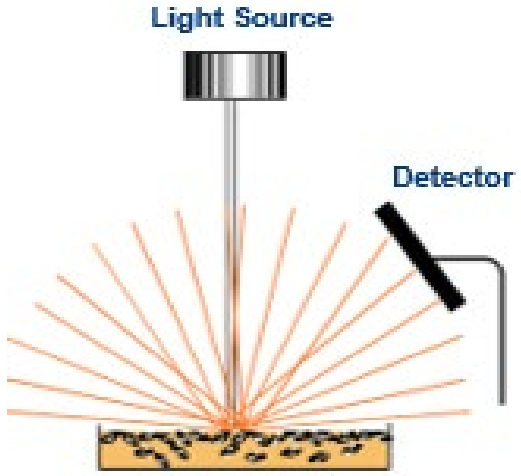
TRANSMITTANCE



- Higher Energy Light = Shorter Wavelengths
- Sample penetration up to 30mm
- Less Homogeneous sample like whole grains
- Disadvantages (Provides less parameters)

+

REFLECTANCE



- Lower Energy Light = Longer Wavelengths
- Sample penetration .1-1mm
- Need a Homogeneous sample
- Test more parameters (F,M,P,S,A,F, Amino/Fatty Acids)

=

TRANSFLECTANCE

- Combination of Transmittance and Reflectance
- Light Source penetrates sample and reflects off gold reflector cup that is placed on sample

NIR HOW: ABSORBANCE BANDS

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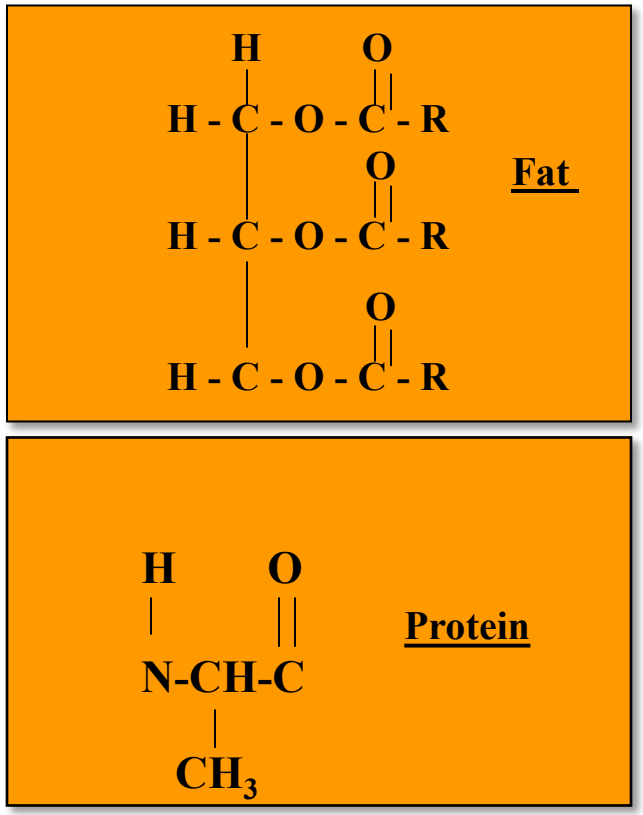
The absorbance bands observed in the Near Infrared region arise mainly from vibrations of molecules with bound hydrogen atoms.

- CH	FAT
- OH	Moisture
- NH	Protein



ACCURACY VERSUS PRECISION

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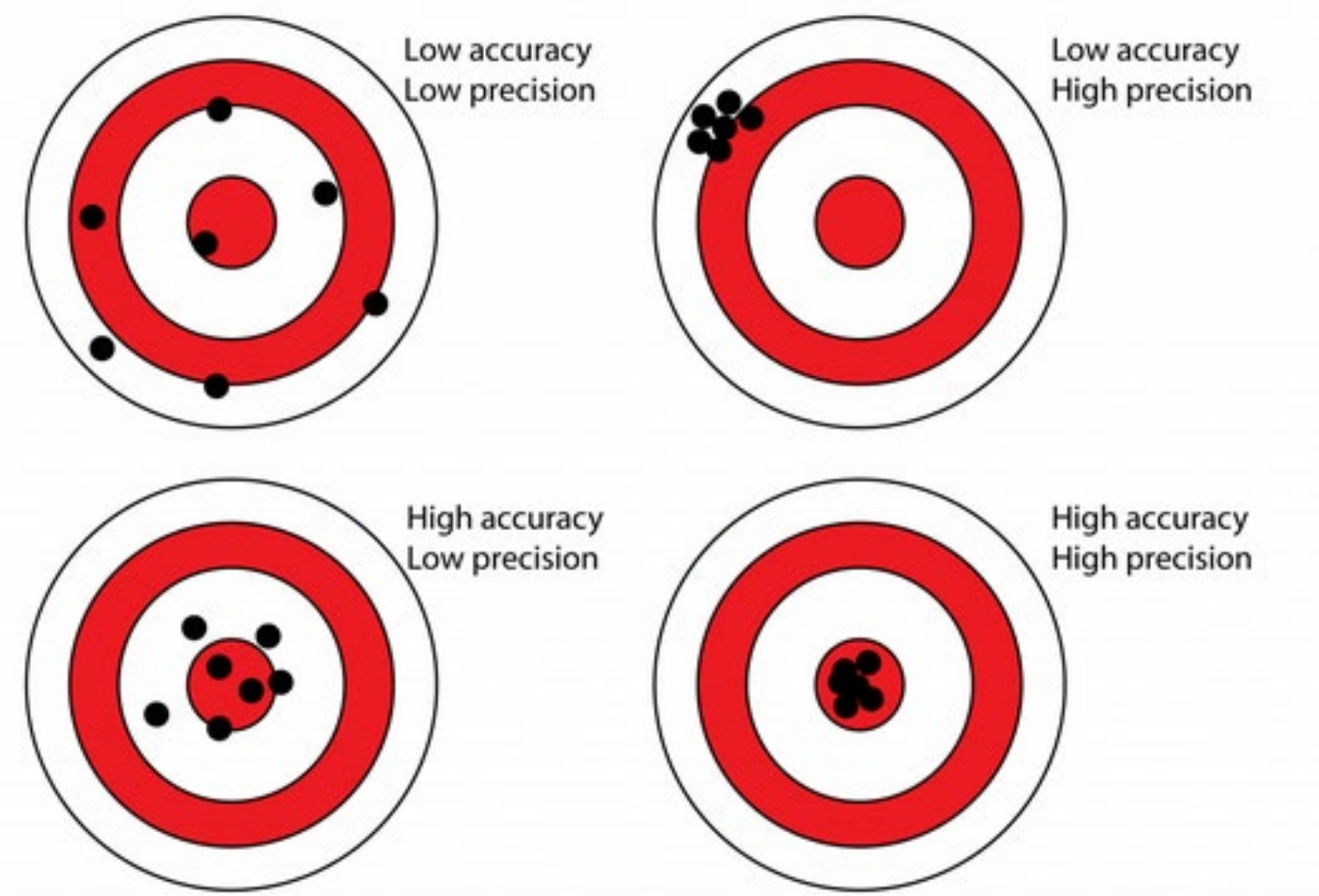
- **NIR is Highly Precise**
- **AOAC Approved Primary Method is Accurate and Precise**
- **Accuracy comes from the Primary Reference Method**
- **General Rule NIR will be within 1.5X to 2X the Error in the Reference Method**



ANALYTICS BEYOND MEASURE

HOW: NIR SPEED CAN HELP EVERYTHING

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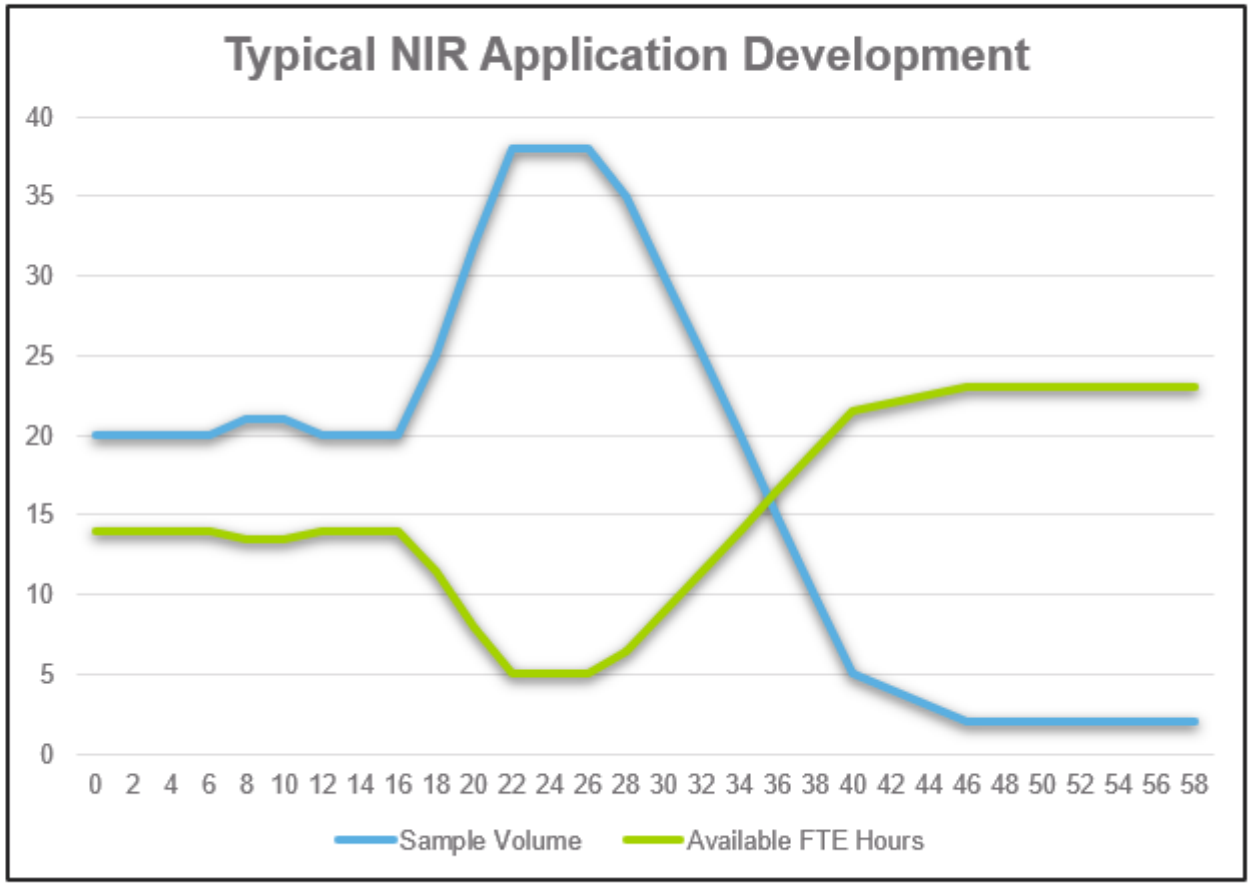
NIR Development times & savings vary per application and conditions.

The benefits of NIR provide:

- Faster Results
- Less Cost
- Less Labor
- No Chemicals/Prep
- Non-Destructive

Robust calibrations can be developed from scratch.



ANALYTICS BEYOND MEASURE

HOW: REGRESSION METHODS

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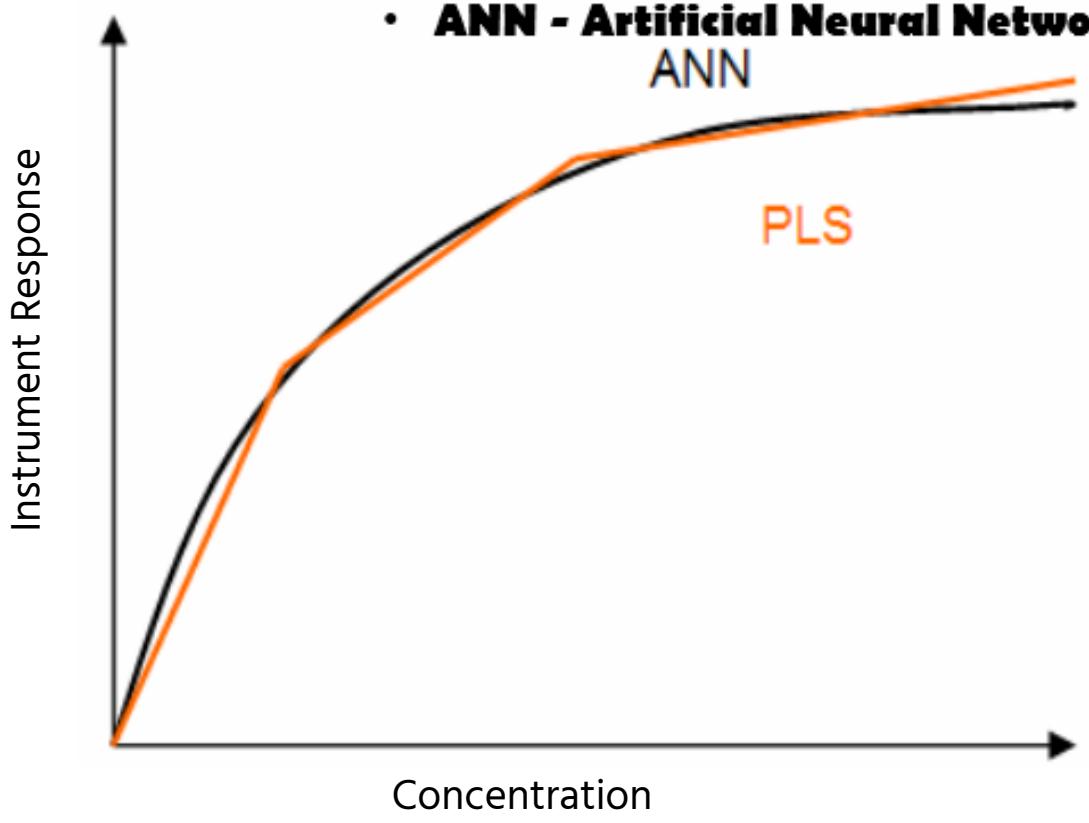
- **PLS - Partial Least Square and**
- *** MPLS - Modified form of PLS**

- **LOCAL**

- **ANN - Artificial Neural Network**



Commonly used method for NIR/FT-NIR

+ Good for medium sized individual calibrations
- One calibration per product
- Limited range per calibration

+ Commonly used for large related datasets
- Needs large data base to work

+ Ability to solve non-linearity problems
+ Ability to handle larger concentration ranges, i.e. fewer calibrations needed
+ A higher degree of transferability
+ Increased robustness and less work in adjusting and up dating the calibration
- Needs large data base to work

Costs associated with building a calibration

1. Calibration development
2. Validation
3. Calibration Maintenance

FOSS NIR SOLUTION EVOLUTION

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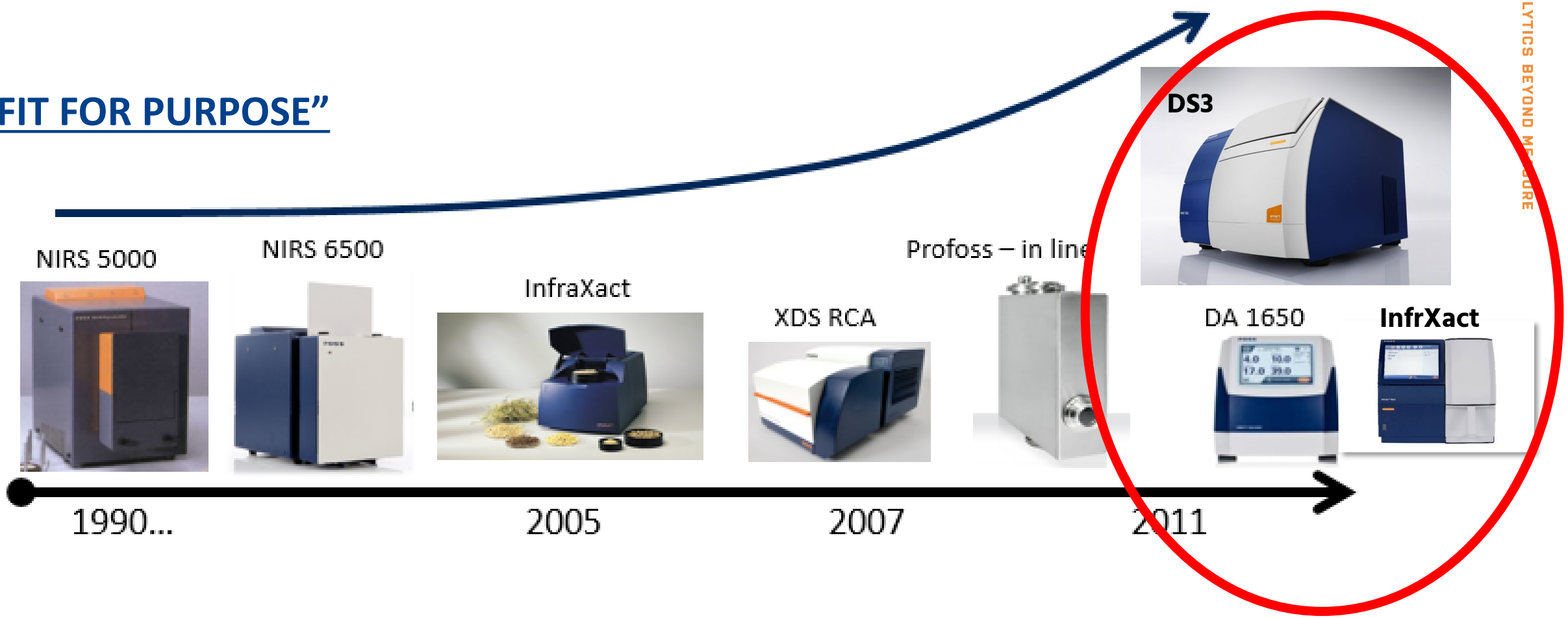
ALWAYS EVOLVING TO MEET INDUSTRY NEEDS

“FIT FOR PURPOSE”



ANALYTICS BEYOND MEASURE

WHERE & HOW NIR…

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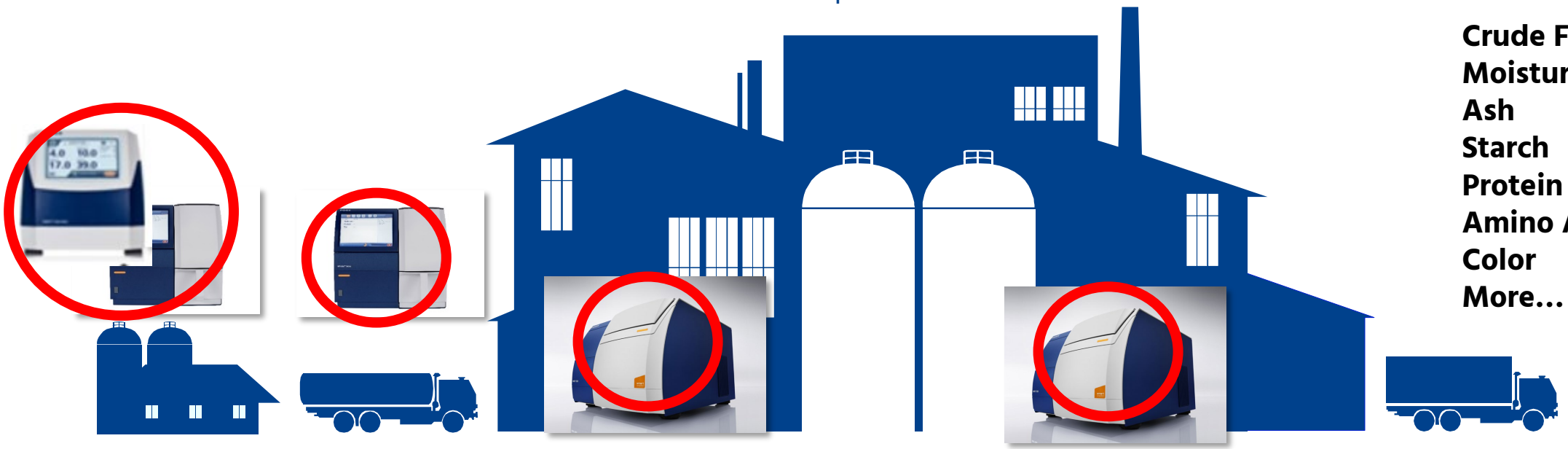
HOW NIR HELPS CUSTOMERS INCREASE QUALITY AND DECREASE COSTS

RAW MATERIAL
Ensure incoming production product meets specifications

PROCESSING
Control of manufacturing process by reducing variability and making more consistent product

FINISHED GOODS
Ensure safe products and compliance with regulatory requirements



Crude Fiber
Moisture
Ash
Starch
Protein
Amino Acids
Color
More…

On-farm | Receiving points | At-line/In-line production | Quality Control Laboratories | Finished products

ANALYTICS BEYOND MEASURE

FOSS NIRS DS2500 & DS3

FOSS

SAMPLE CUPS

ANALYTICS BEYOND MEASURE

FOSS NIRS DS2500

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SPECIFICATIONS

The best signal to noise ratio
The best wavelength range

- Scanning Monochrometer
- Wavelength range: 400- 2500 nm
- Spectral resolution: 0.5 nm
    - 4200 data points
- Wavelength accuracy: <0.05 nm
- Wavelength Precision: <0.005 nm

- Operating temperature: 41-104°F
- Humidity: <93% RH
- IP 65

ANALYTICS BEYOND MEASURE

NIR TECHNOLOGY

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WHY USE NIR VS. CHEMICAL ANALYSIS?

- No consumables/reagents
- Rapid Results
- Real time results to make adjustments during production
- Creates a more consistent end product
- Helps optimize raw material use
- Does not require trained lab tech to operate
- Does not degrade sample

ANALYTICS BEYOND MEASURE

FOSS NIR SOLUTION EVOLUTION

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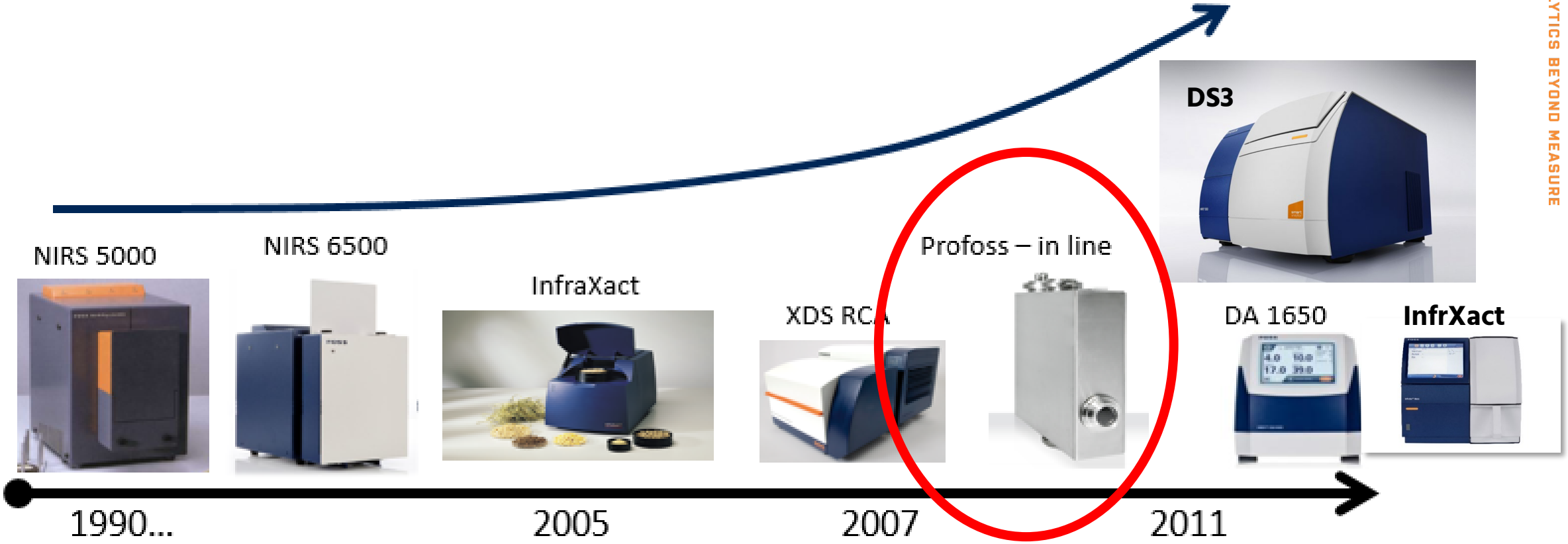
ANALYTICS BEYOND MEASURE

ALWAYS EVOLVING TO MEET INDUSTRY NEEDS



PROFOSS IN-LINE NIR

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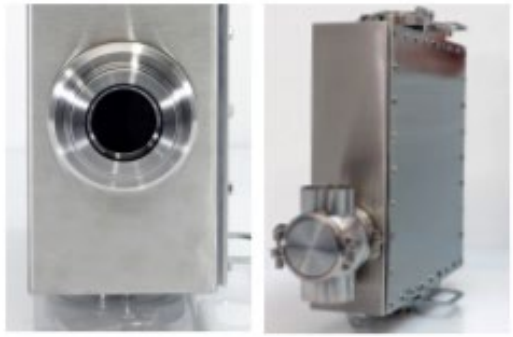
ANALYTICS BEYOND MEASURE

Dedicated sample interface

Window reflectance:

In-line analysis of paste, granulates, powdered products etc in pipes or transport systems without bypass can be performed. The products pass over the interface window. The window reflection interface can easily be installed into the production line using standard GEA Tuchenhagen flowcells or welding an interface flange into the wall of the pipe/transport system.



Temperature:	150°C (302°F)
Pressure:	Production pressure < 21 bar (< 305 PSI) Shock pressure < 50 bar (< 725 PSI)
Lens:	Sapphire; Diameter 45 mm, thickness 12 mm, w. food grade EPDM O-ring seal
Hygiene:	USDA, Dairy
Pipe flowcells:	Fits directly into GEA Tuchenhagen Varinline Access units Type N (DN40 to DN150) with 68 mm opening)
Transport system:	Stainless steel welding flange

ProFoss Complete Solutions

WHERE & HOW NIR…

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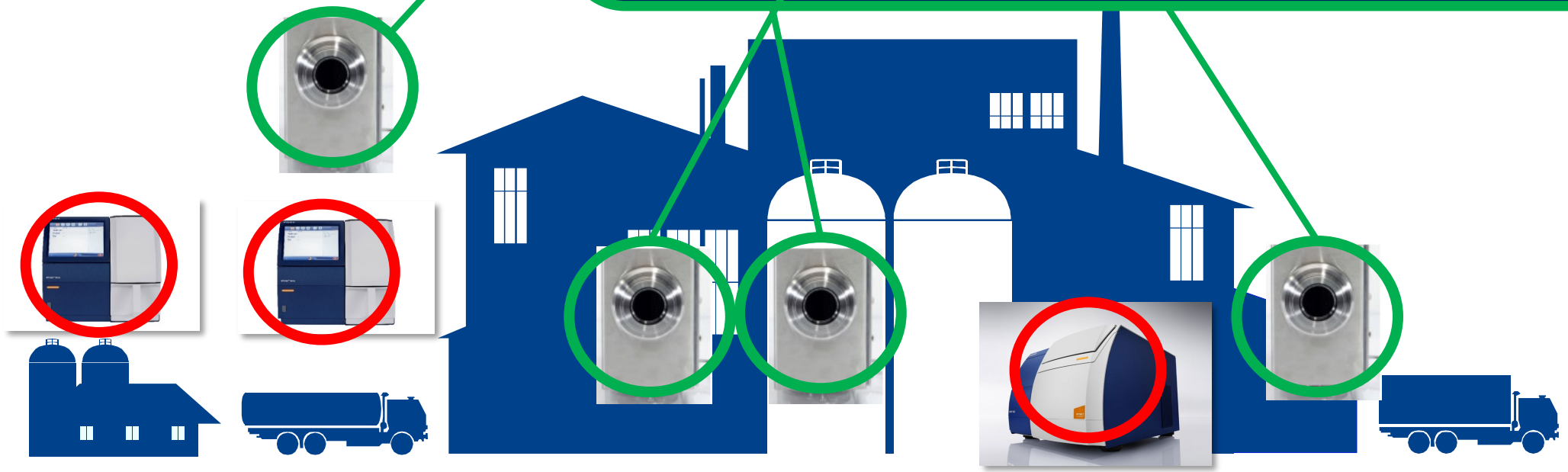
HOW NIR HELPS CUST

RAW MATERIAL

Ensure incoming production product meets specifications

Examples of Inline Applications, Ethanol Production

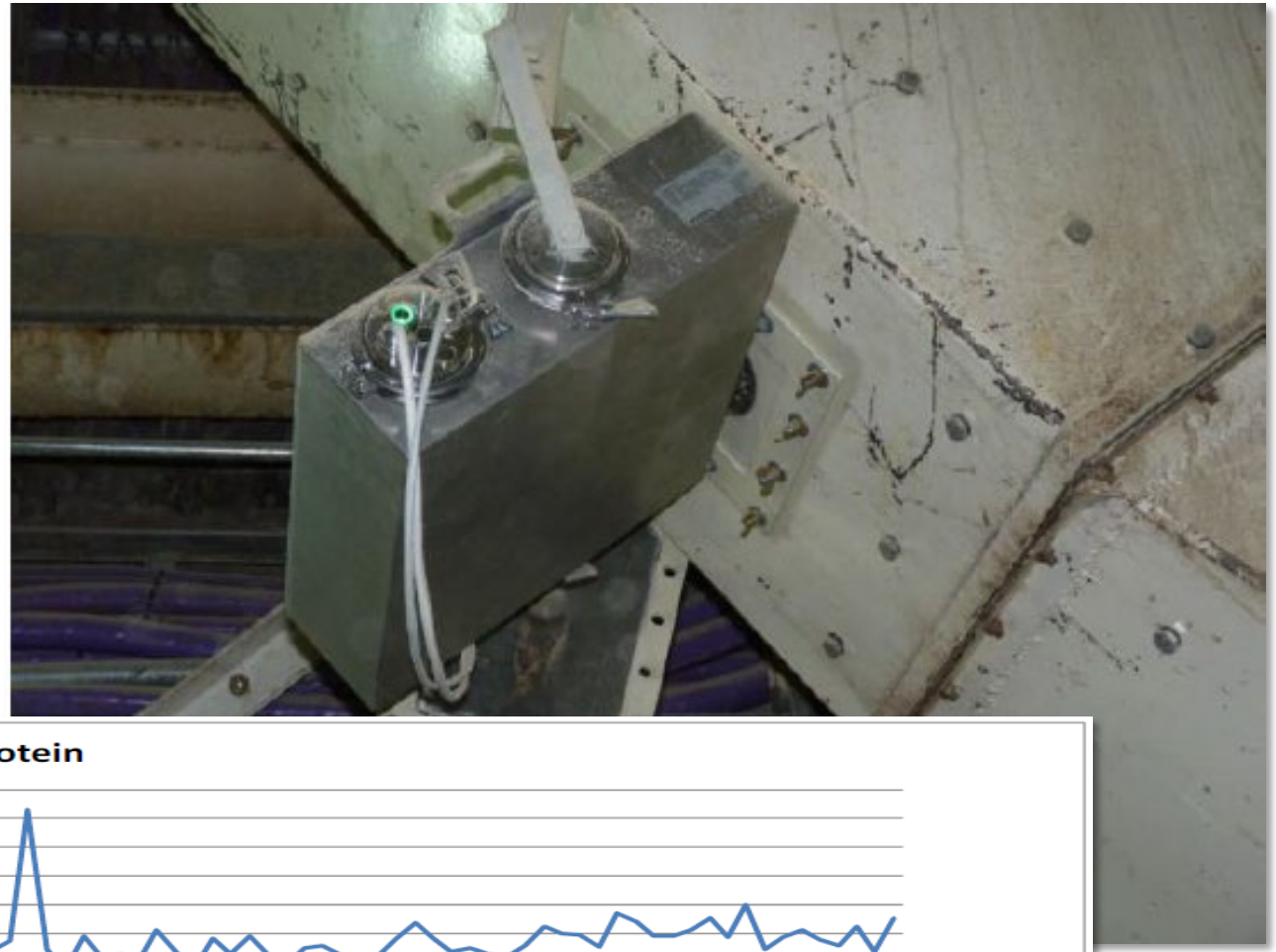
- Inbound Material at Hammermill (Starch &…)
- Fermentation Monitoring (*Development Required)
- DDG Output Lines (Protein, Moisture, …)

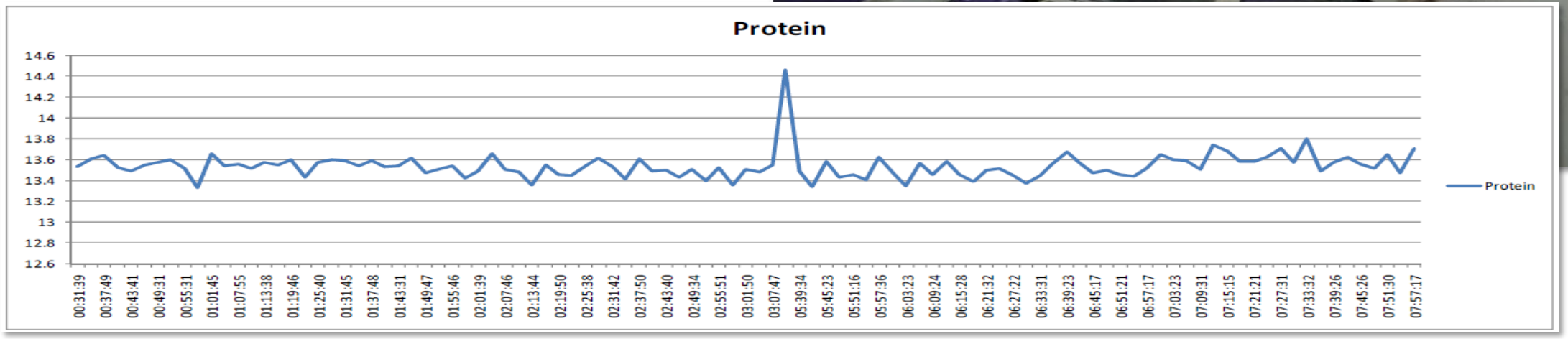


On-farm | Receiving points | At-line/In-line production | Quality Control Laboratories | Finished products

ANALYTICS BEYOND MEASURE

PROFOSS IN-LINE NIR





ANALYTICS BEYOND MEASURE

HOW IS OVERALL PROCESS ACCURACY IMPROVED?

BY REDUCING ANALYZER, SAMPLING AND PROCESS VARIATION ERROR

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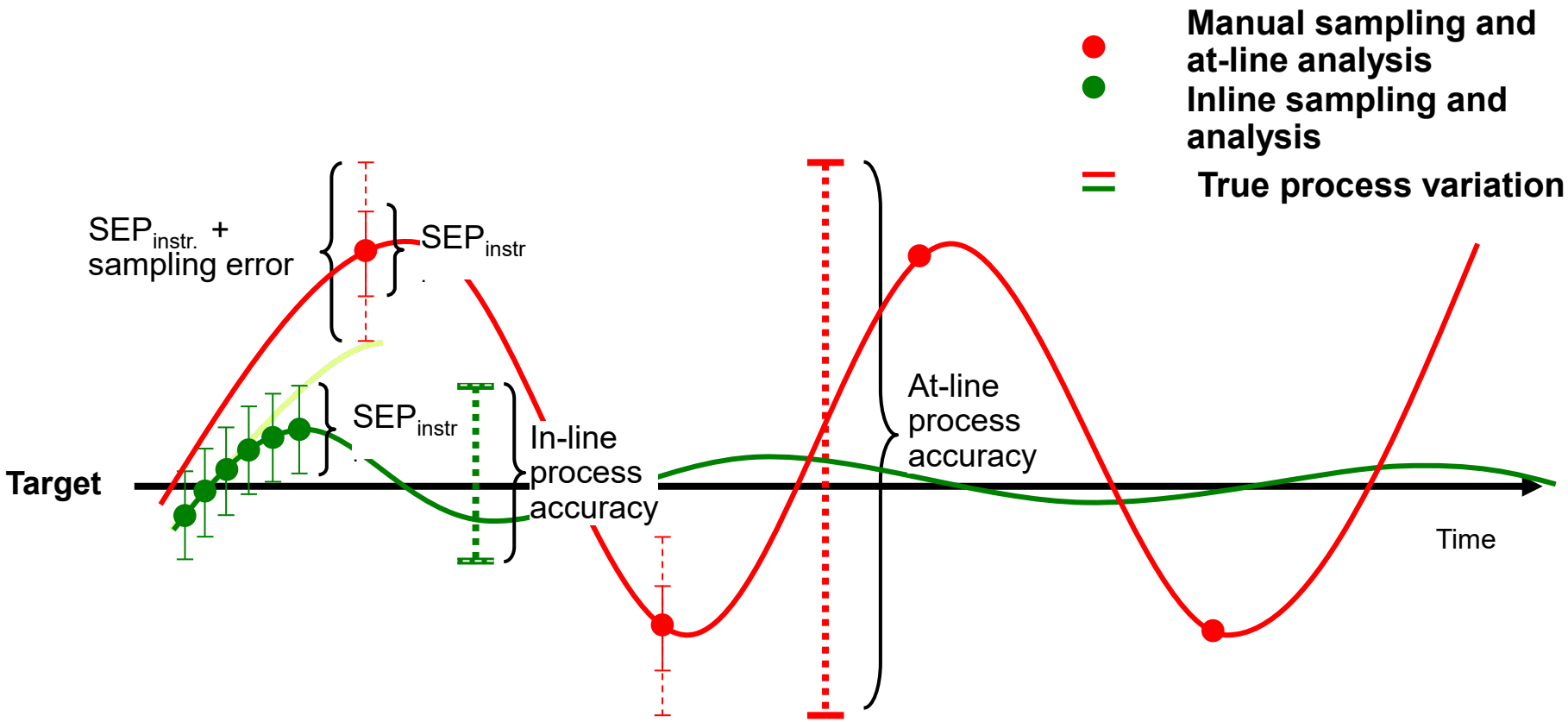
ANALYTICS BEYOND MEASURE

Process accuracy	=	Std. error of prediction (SEP_{instr})	+	Sampling error	+	Process variation error



PROFOSS IN-LINE NIR

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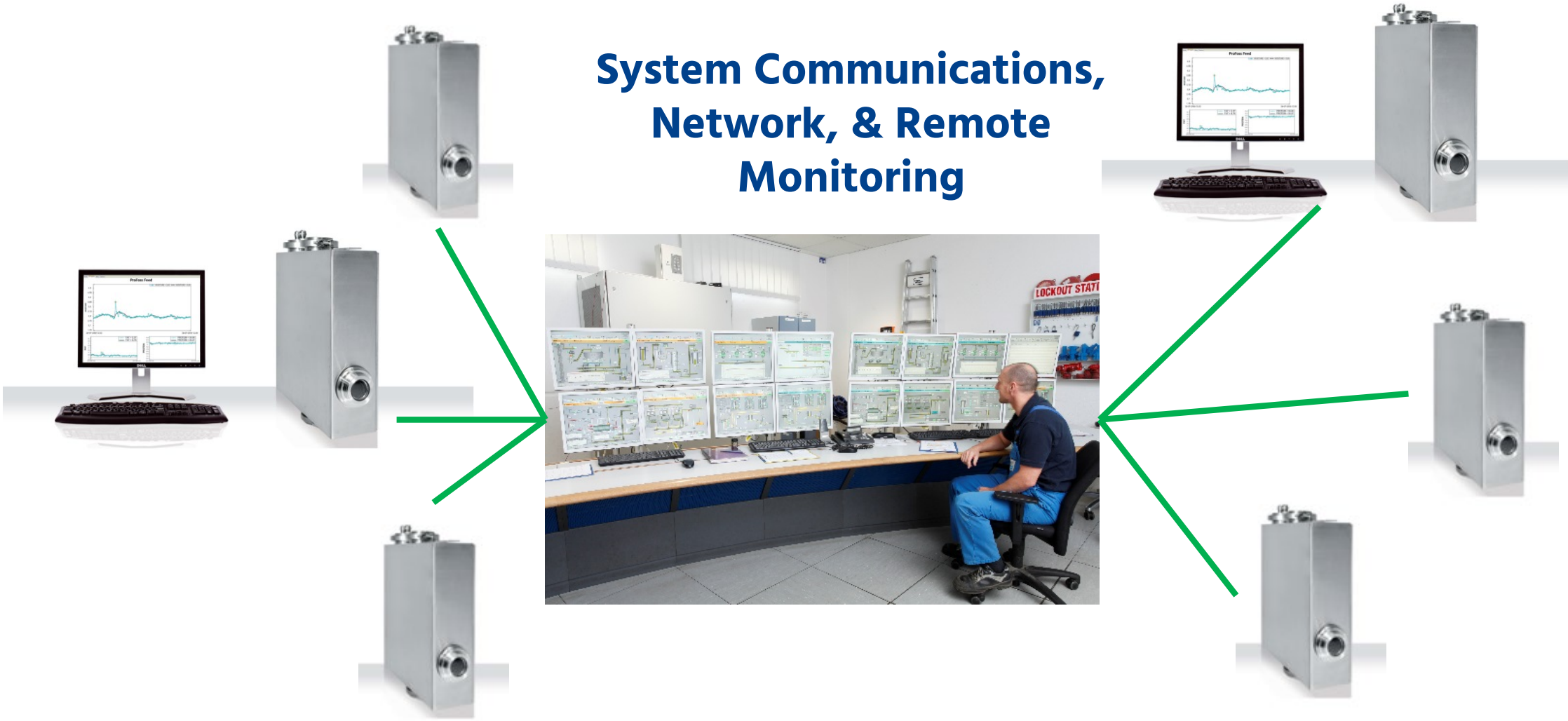
ANALYTICS BEYOND MEASURE

System Communications, Network, & Remote Monitoring



ProFoss Complete Solutions

COMPARING (BENCHTOP TO PROFOSS)

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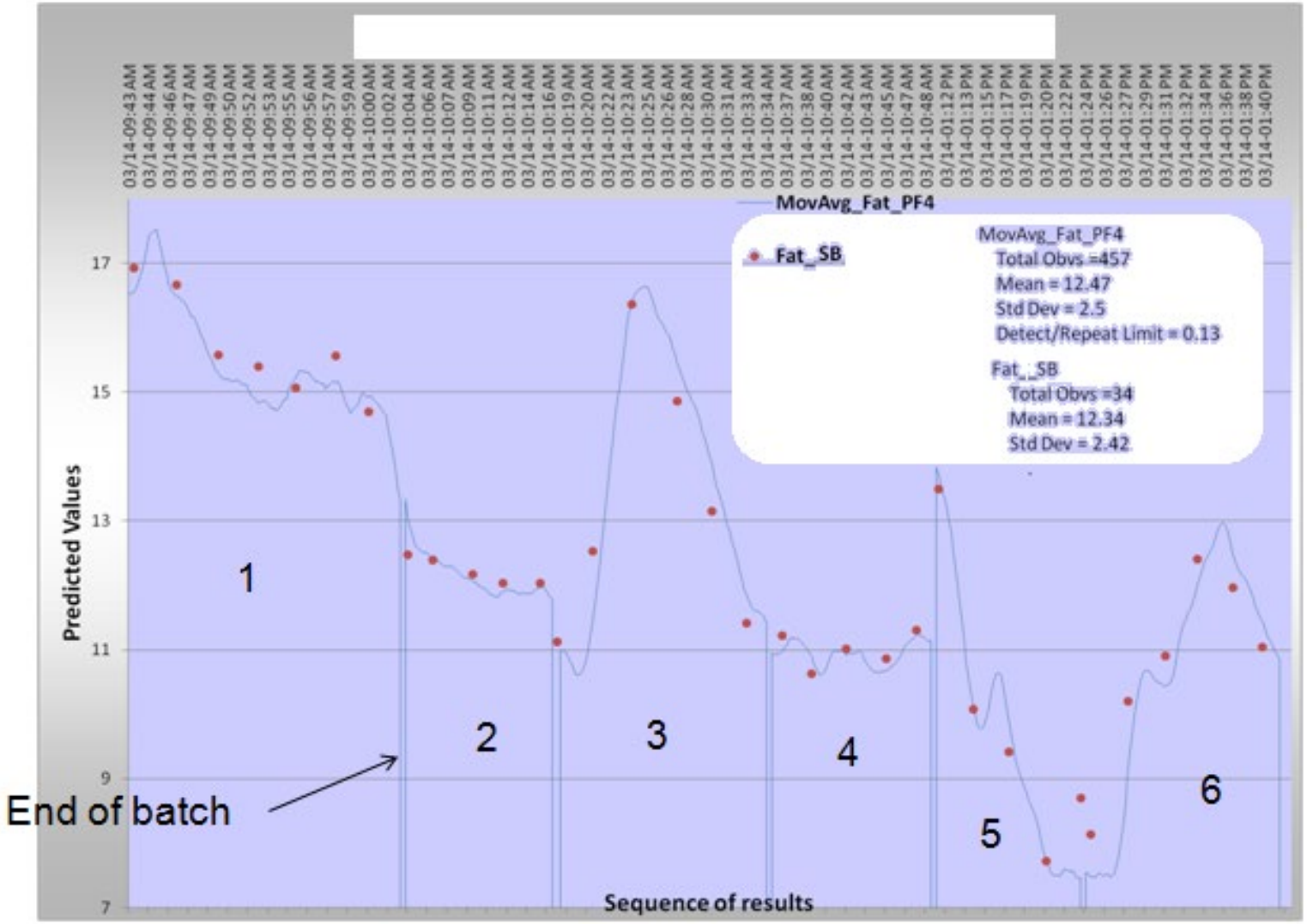

ANALYTICS BEYOND MEASURE

ANALYTICAL METHOD “WHATS”

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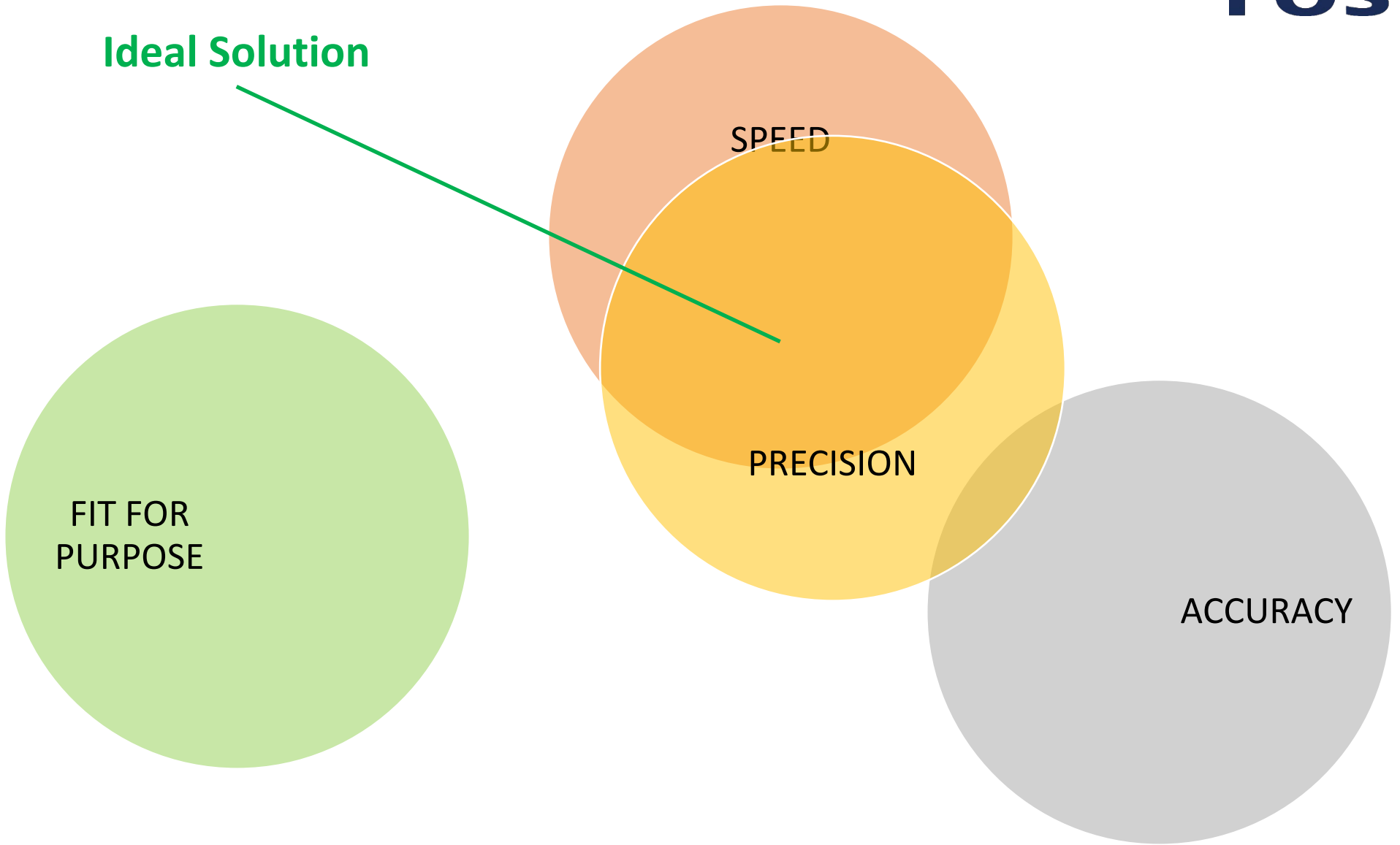

ANALYTICS BEYOND MEASURE

NIR AT ITS BEST

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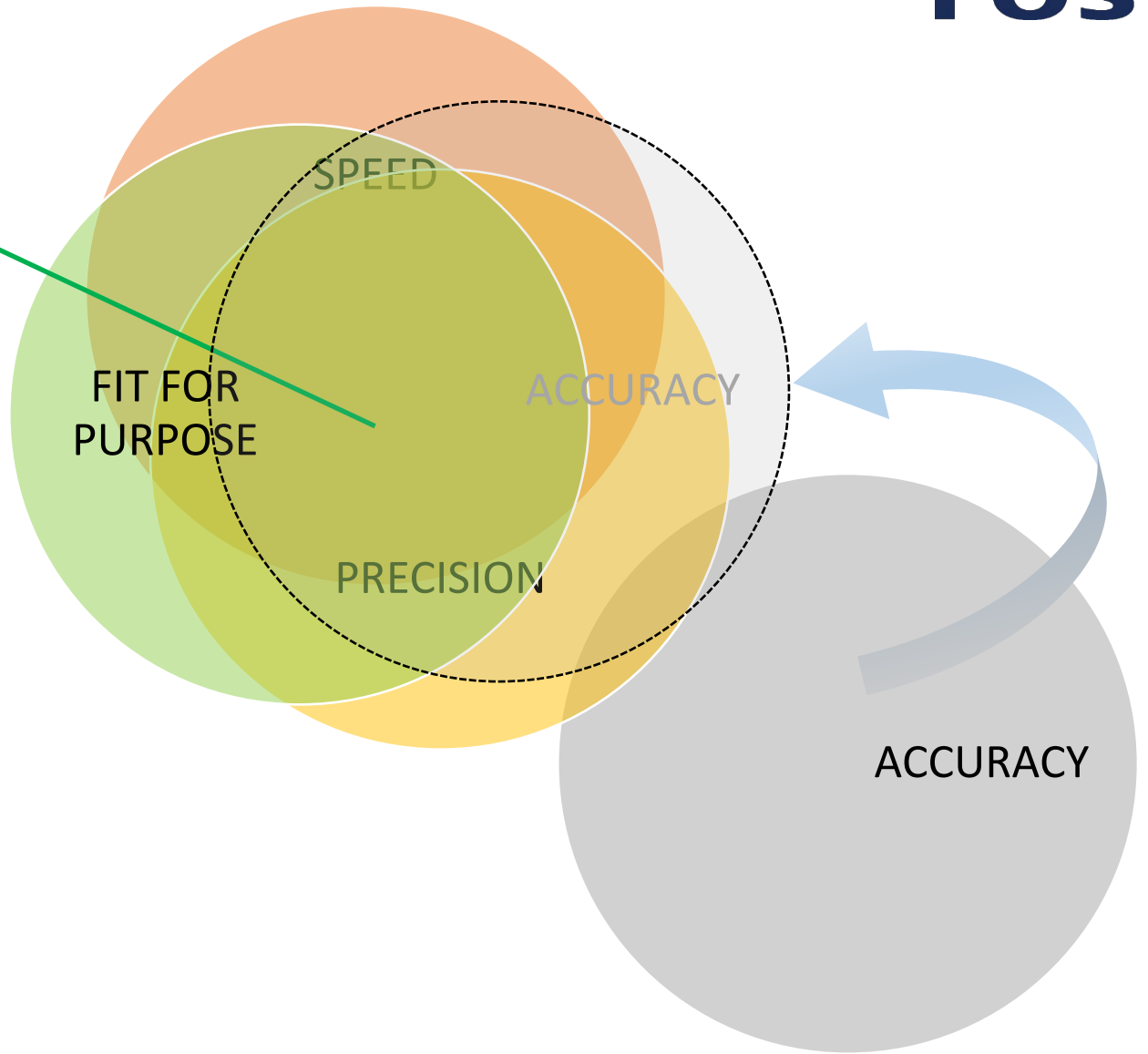
Ideal Solution



NIR Benefits

- Higher data rates = more control at less cost
  - Faster Results
  - Reduced Testing Costs
  - Higher Precision Potential
  - Easier Data Handling & Management
  - Active To-The-Minute Monitoring

ANALYTICS BEYOND MEASURE

MYCOFOSS – MYCOTOXIN TESTING

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ANALYTICS BEYOND MEASURE

MycoFoss™

MycoFoss™ is the first ever mycotoxin testing solution to combine automation and speed in one. Accurate results on up to 6 mycotoxins are achieved within a few minutes. The fully automated process requires no special skills, just place the grinded sample and push start.

SEE HOW IT WORKS

ProFoss Complete Solutions

MYCOFOSS

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Measuring ranges

Singleplex solutions	
Mycotoxin	Measuring range, ppb
Aflatoxins - AFLA (AFB1, AFB2, AFG1 and AFG2)	2 - 300 (automatic dilution above 100)
Deoxynivalenol - DON	200 - 30,000 (automatic dilution above 5,000)
Multiplex solutions	
Mycotoxin	Measuring range, ppb
Aflatoxins - AFLA (AFB1, AFB2, AFG1 and AFG2)	4 - 100
Deoxynivalenol - DON	200 - 5,000
Zearalenone - ZEA	30 - 500
Fumonisins - FUM (FB1, FB2 and FB3)	500 - 5,000
Ochratoxin A - OTA	5 - 100
Trichothecene 2 - T-2	50 - 500

ANALYTICS BEYOND MEASURE

Quality of materials, raw and finished, will continue to grow…

Variables be it weather driven, economics, or political, will drive trends of providing crop and finished goods quality checks…

Export and process efficiencies will continue to demand more quality and value…

When you need data on Protein, Moisture, Fat, Ash, Fiber, Starch, Color…

What is NIR doing for you right now?

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ANALYTICS BEYOND MEASURE

THANK YOU