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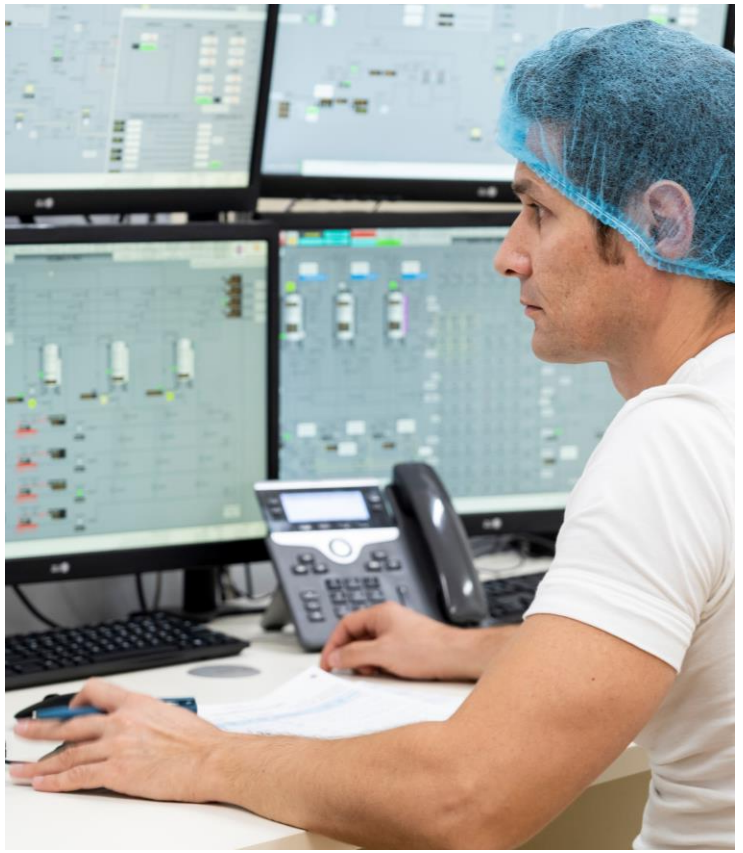
PHOTONICS FOR THE FOOD AND AGRICULTURAL INDUSTRY

STATE OF THE ART AND OPPORTUNITIES FOR THE FUTURE

Jacob Riis Folkenberg, VP Technology, FOSS R&D



ANALYTICS BEYOND MEASURE

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OUR MISSION

We contribute to the sustainable use of our planet's agricultural resources and thus to the nutrition and health of the people of the world.

We innovate analytics beyond measure to empower our customers by improving quality and optimizing food and agricultural production.

ANALYTICS BEYOND MEASURE

EXAMPLE - HOW TO MAKE MILK POWDER

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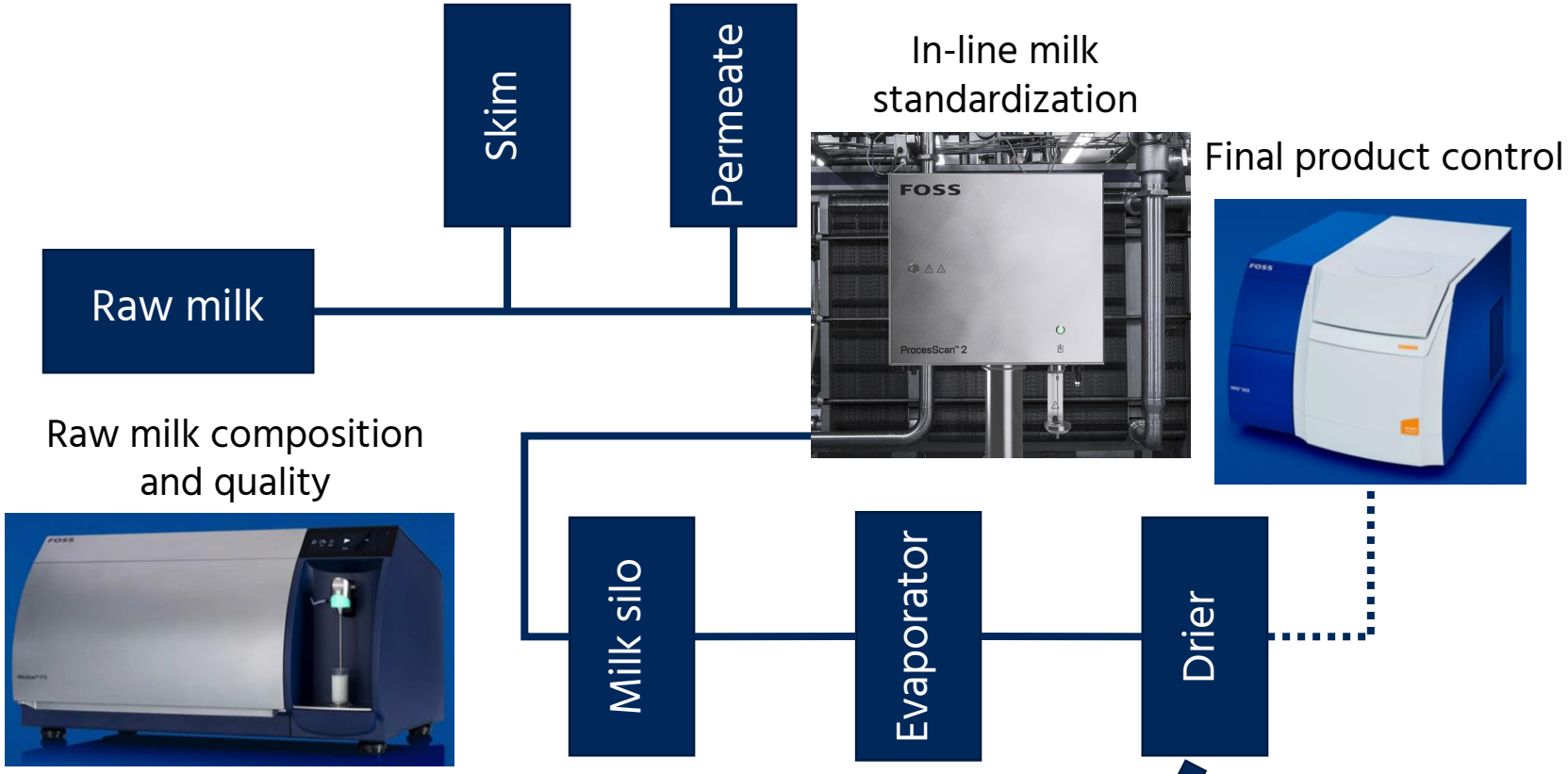

0,1% error on protein corresponds to 25 kg protein per hour!

ANALYTICS BEYOND MEASURE

INDUSTRY LEADING SOLUTIONS
FOR INDUSTRY LEADING CUSTOMERS

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ANALYTICS BEYOND MEASURE

RAW MILK TESTING

mpr
valacta
NML national milk laboratories
eurofins
Qlip

DAIRY

Fonterra
Groupe Lactalis
Nestlé
Danone
glanbia
Kraft
FrieslandCampina
Arla

GRAIN & OILSEED

Barilla
CBH Group
ADM
DCOOP
SGS
LDC Louis Dreyfus Company

WINE & BEER

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

MEAT

Tyson
VION Food Group
OSI
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
SGS
Merieux NutriSciences
Agrolab Group

OPTICAL TECHNOLOGIES AND APPLICATIONS

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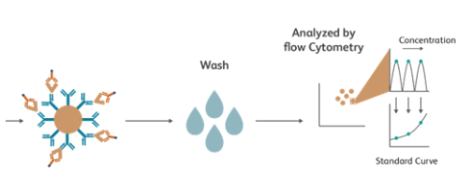
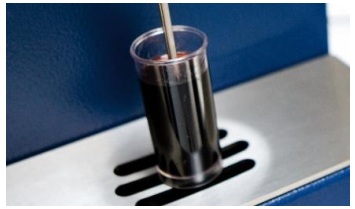
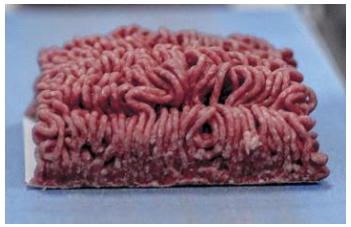


- Bacteria and cells in milk
- Mycotoxins (bead based)



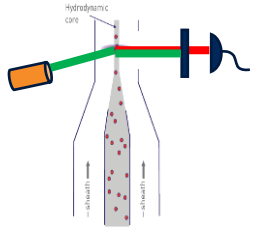
- Composition of liquids:
- Milk, wine and beer

- Composition of solids:
- Grain, feed, cheese, milk powders, plant-based meat ...

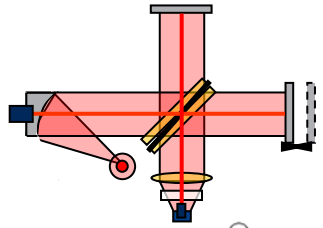


- Meat processing:
- “Full volume” composition and foreign object detection

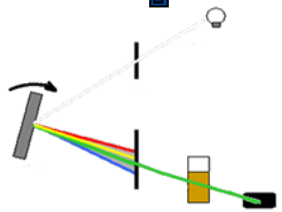
- Minerals in plant materials



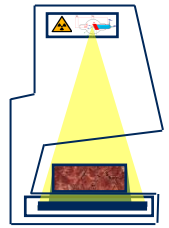
Flow cytometry (VIS-range)



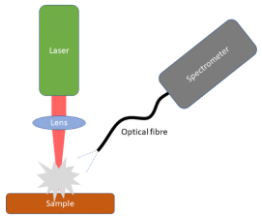
FT-IR spectroscopy (3 – 10µm)



NIR spectroscopy (850 – 2500 nm)



Dual energy X-ray absorption (140 keV)



Laser induced break-down spectroscopy (LIBS) (175 – 400 nm)

ANALYTICS BEYOND MEASURE

COMPOSITIONAL ANALYSIS WITH FTIR FOR LIQUID MILK PRODUCTS AND PLANT DRINKS

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ANALYTICS BEYOND MEASURE

- **Where:** on-line process, QC lab, in-take control lab, raw milk testing labs and more
- **Sample types:** raw milk, cream, yoghurts, consumer milk, standardized process milk and more
- **Parameters:** Fat, Protein, Lactose, Total Solids, Solids-non-Fat, Casein, Urea, Density, Freezing Point Depression, Sucrose, Fructose, Glucose, Galactose, Total Sugar, Lactic Acid, Citric Acids, Free Fatty Acids, Saturated and Unsaturated Fatty Acids, Moisture and Screening for Abnormal Milk (Untargeted and Targeted adulterants)

A HISTORY OF PIONEERING INVENTIONS

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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
Foss Electric was founded by Nils Foss

1963
ProMilk™

1980
Bactoscan™

1999
WineScan™

2003
MeatMaster™

2014
MilkoScreen™

2021
MycoFoss™

ANALYTICS BEYOND MEASURE

WE RECOGNIZE THAT INNOVATION CAN FAIL!

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The "Chamber of Horrors" in the basement of FOSS HQ

ANALYTICS BEYOND MEASURE

INNOVATION DRIVES OUR GROWTH

FOSS

- Strive to bring the advantages of new technology to our customers first
- More than 10 % of FOSS turnover invested in R&D
- More than 350 highly skilled engineers and scientists in R&D (≈ 50 with a Ph.D. degree)
- Partnership with leading international universities
- Tightly woven network of technology partners
- Customer driven innovation
  - Co-development projects with key accounts
  - Customer field trials part of all new development

FOSS INNOVATION FACTS

- More than 100 patents
- More than 25 world first introductions
- First to integrate analysis directly in line

ANALYTICS BEYOND MEASURE

KEY FIGURES – THE HARD FACTS

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ANALYTICS BEYOND MEASURE

FOSS business

100%
A 100% family-owned company – HQ in Hillerød, Denmark

AAA
AAA-rated by D&B

99%
99% of turnover outside Denmark

>21%
EBITA of > 21% of turnover

328 mill.
A turnover of 328 million EUR in 2022

FOSS photonics business

70
Total number of optical suppliers

400
Different optical components

10 MEUR/year
Purchase of optical components

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FOOD AND AGRICULTURAL INDUSTRY – FUTURE TRENDS

OPPORTUNITIES AND CHALLENGES FOR THE PHOTONICS INDUSTRY

ANALYTICS BEYOND MEASURE

GLOBAL DRIVERS IN THE FOOD AND AGRICULTURAL INDUSTRY

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ANALYTICS BEYOND MEASURE

9.3 billion

people

By 2050 we will need to produce 60% more food to feed the people of the world.

420.000

lives

An estimated 600 million – almost 1 in 10 people – fall ill after eating contaminated food each year, resulting in 420.000 deaths and the loss of 33 million healthy life years.

1.3 billion

tonnes

Roughly one third of all the food produced in the world for human consumption every year is lost or wasted.

TREND 1 - ANALYTICS MOVING CLOSER TO PRIMARY PRODUCTION

- Higher volumes of optical modules with low cost and high robustness
- Critical to develop ”good enough” components in collaboration with suppliers
- Scalability is mandatory → consistent quality in high volume to ensure standardized instruments

TREND 2 - INCREASED FOCUS ON SUSTAINABILITY IN PRODUCTION

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

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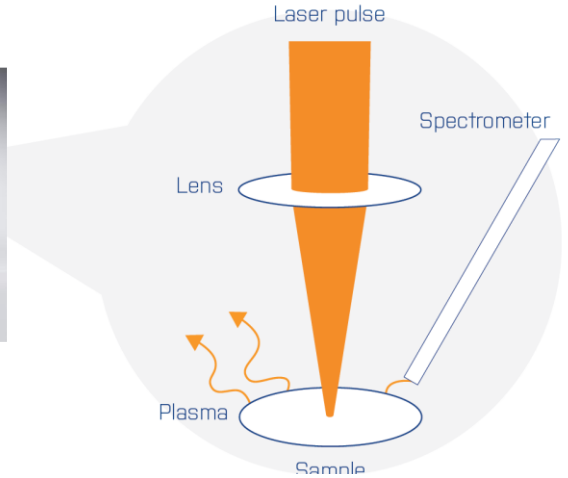
ANALYTICS BEYOND MEASURE

Current method for element analysis in food (ICP spectroscopy)

- Workflow involves the use and handling of chemicals like nitric acid and perchloric acid for digestion
- Time to result: 6-24 hours (depending on method)
- Cost per sample: EUR 3,5

Using laser induced breakdown spectroscopy



- Simple workflow – pressing pellet and searing the surface
- Time to result: 3 min
- Cost per sample: EUR 1,9

TREND 3 – MANY MORE TECHNOLOGIES AVAILABLE REQUIRING CLOSER SUPPLIER COLLABORATION

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What does it take to be a good supplier to FOSS?

- A leading edge/unique technology offering superior value to applications in the food and agricultural industry
- Willingness to listen and share knowledge
- A little patience .. FOSS follows a well-proven stage gate model for development of new products, typically spanning 2-4 years from proven concept to the commercial launch

What do you get as a strategic supplier to FOSS?

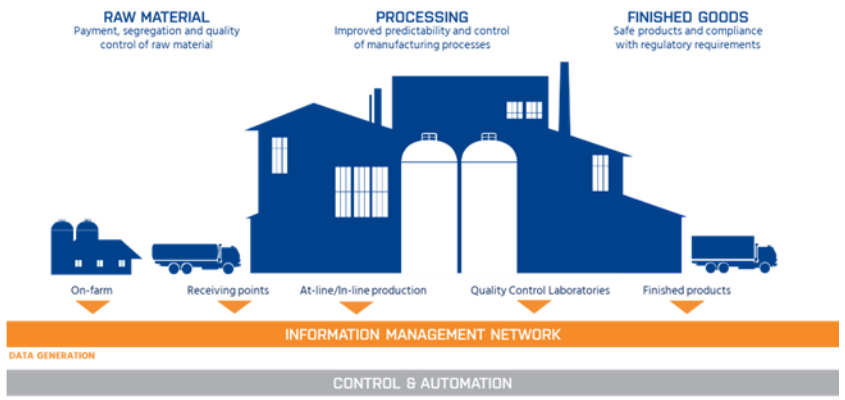
- ”Close collaboration and qualified feedback on your technology”
- ”A fair and long term business relation”
- ”An opportunity to attract investment to grow your business”

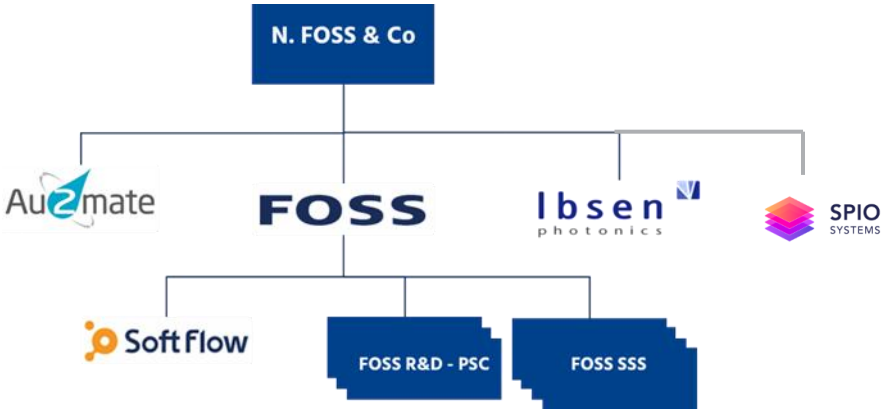
- Input from Ibsen photonics, supplier to FOSS of DDA spectrometers since 2007 for LIBS, bench and process solutions

Ibsen photonics

ANALYTICS BEYOND MEASURE

FOSS AS A PARTNER MEANS





- **A LEADING PROVIDER OF ANALYTICS TO FOOD-AGRI**
  We help producers optimize the value of their production with best possible use of valuable natural resources
- **SOLUTIONS PROVIDE A WEALTH OF DATA**
  Which enables sophisticated digital solutions
- **A COMPREHENSIVE END TO END PLATFORM**
  For food safety and supplier management is a natural extension
- **OUR GLOBAL PRESENCE AND DIGITAL PRESENCE**
  can improve and preserve customers uptime

- **AN INNOVATIVE PARTNER**
  We constantly invest in being first
- **A SAFE BUSINESS PARTNER**
  We focus on profitability, sustainability, productivity, safety, environment and animal welfare
- **A RELIABLE BUSINESS PARTNER**
  We ensure excellent quality, reliability

ANALYTICS BEYOND MEASURE

GLOBAL FOOD AND AGRICULTURAL INDUSTRY BECOMES MORE INDUSTRIALIZED

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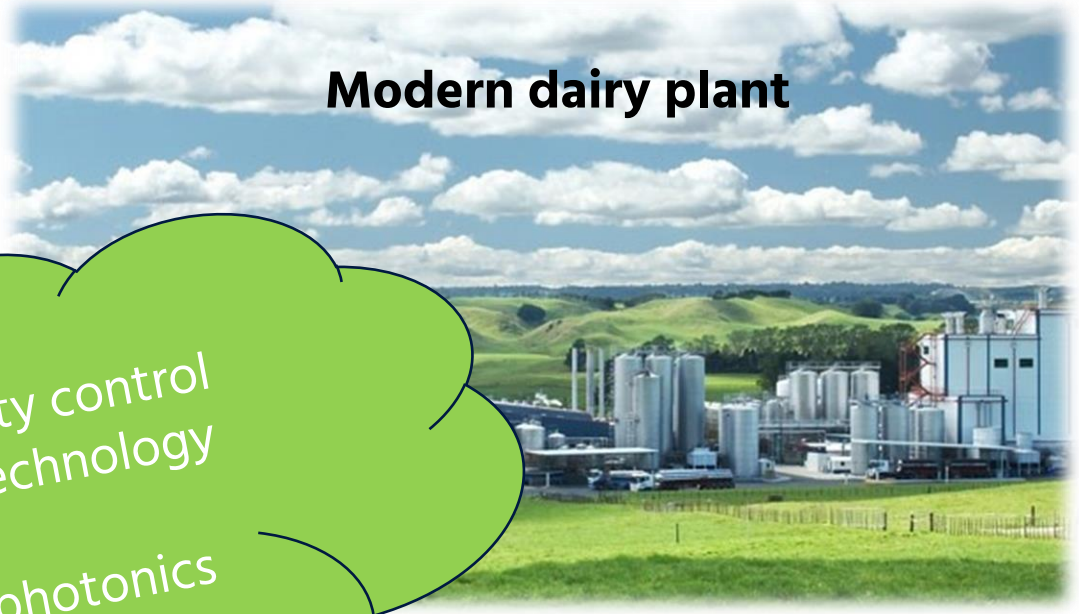

Many new needs for quality control using fast and accurate technology

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new opportunities for photonics based sensors

- Manual QC procedures fo
  and final products
- Limited economy for proce
- Simple logistics, few suppliers and customers
- Batch variations of products acceptable

- utomated QC procedures for raw materials
  nd final products
  Process efficiency, sustainability and reduction of waste is critical in the whole value chain
- Logistics complicated, many suppliers
- Customers expect consistent product quality

ANALYTICS BEYOND MEASURE

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ANALYTICS BEYOND MEASURE

THANK YOU