AOTECH

ADVANCED OPTICAL TECHNOLOGIES S.L.

Experts on optical sensors technology

AONIR PLATFORM

IN-LINE & REAL-TIME MILK CHARACTERISATION

INTRODUCTION

AOTECH
ADVANCED OPTICAL TECHNOLOGIES S.L.

Presentation

Origin:

- Spin-off from the research group Applied Photonics Group (University of the Basque Country).

Company mission:

- To apply photonic solutions to all kinds of industries.

Own technology:

- Bladed-rotor monitoring system → Turbines, compressors, fans,…
- Integration of spectroscopy-based sensors in food and pharma processes.
- Biosensors development for food, water and healthcare sector.

PROBLEM

AOTECH
ADVANCED OPTICAL TECHNOLOGIES S.L.

SUSTAINABLE DEVELOPMENT GOALS 2:

ZERO HUNGER

2.4 By 2030, ensure **sustainable food production systems** and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality.

FOOD WASTE IN SPAIN:

- 7.7 Mt/year
- 39 % Manufacturing process → **3 Mt/year of food waste**

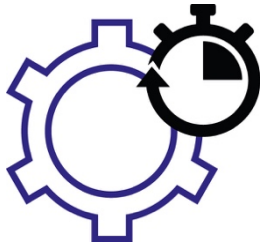
PROBLEM

AOTECH
ADVANCED OPTICAL TECHNOLOGIES S.L.

FOOD INDUSTRY DIGITALISATION

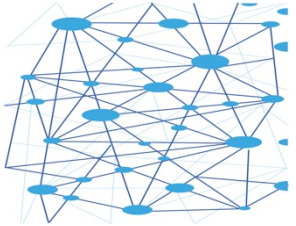
- ✓ Data through advanced instrumentation.
- ✓ Useful information.
- ✓ Real-time production adjustment and improved management.

OBJECTIVES:



✓ **Efficiency**
Lower production costs, waste and reprocessing; resources optimisation.

✓ **Quality**
Quality assurance, consistency, customer satisfaction and loyalty.



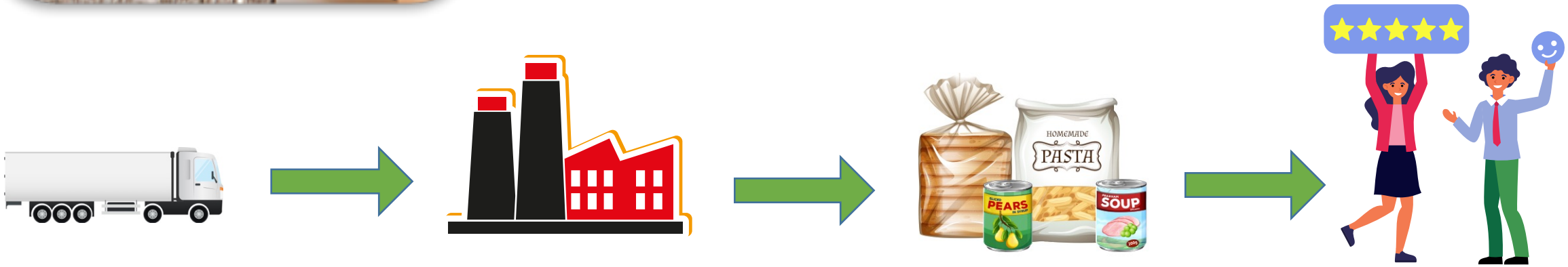
✓ **Traceability**
Origin and characteristics of the raw material assurance and detection of counterfeit products. Security.

SOLUTION

AOTECH
ADVANCED OPTICAL TECHNOLOGIES S.L.

AONIR platform

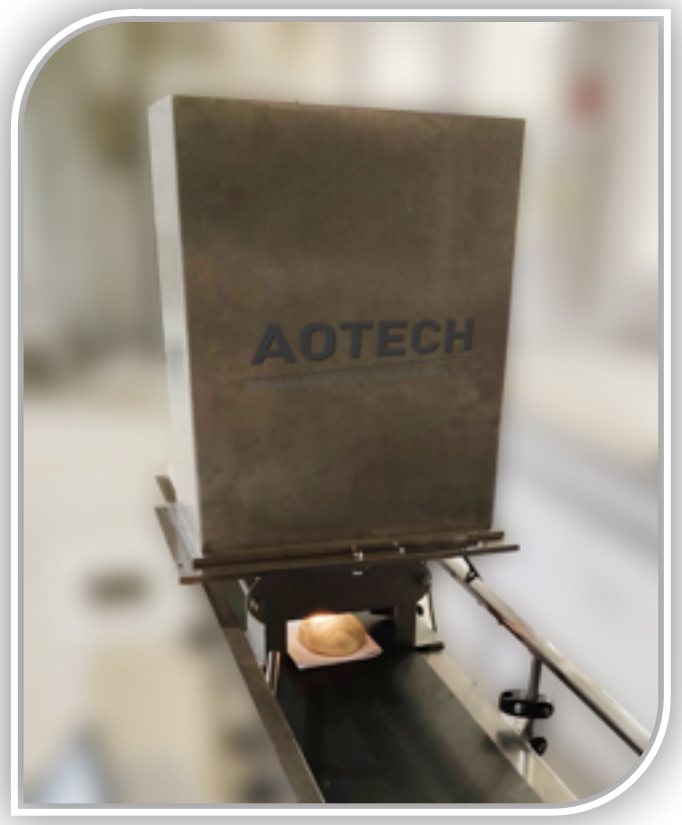
- ✓ Real-time measurements (seconds).
- ✓ Minimal or no sample preparation.
- ✓ Optimal results for different kinds of products: liquids, powder, grains, slurries, …
- ✓ Multiple parameters determined at the same time.
- ✓ Non-destructive measurements.



AOTECH
ADVANCED OPTICAL TECHNOLOGIES S.L.

AONIR platform

- 1 Single device → 2 versions (C/NC)
- Sending final data to PLC/SCADA/ IoT.
- Calibration development and maintenance service.



APPLICATION

AOTECH
ADVANCED OPTICAL TECHNOLOGIES S.L.

Main food applications








- Dairy
- Oil
- Milk/whey powder
- Grain & flour
- Meat & Fish
- Wine
- Chocolate
- Sauces & condiments

Total quality management from raw materials to finished product
→ increase product **quality and consistency** with tighter control.

Optimisation of mixing times.

Monitoring of fermentation.

Energy savings in drying process → **real-time** determination of moisture.

CASE STUDY

AOTECH
ADVANCED OPTICAL TECHNOLOGIES S.L.

Smart Sensor Systems for Food (S3FOOD)

Funded from the EU's Horizon 2020 Cascade Programme under Grant Agreement 824769.

Exploration Voucher for Project **NIR SYSTEM FOR IN-LINE MILK CHARACTERISATION** (NIRMILK).

1ST Pilot project to validate AONIR platform in real working conditions with the collaboration of Dulcegrado S.L.

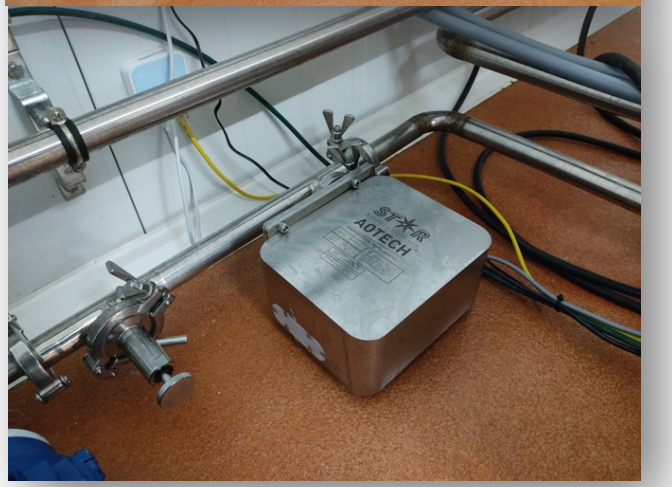
Objectives:

- Prediction of the percentages of fat, protein, lean dry matter and lactose of the milk used in the production of Dulcegrado desserts.
- Development of a simple IoT platform for data visualisation and storage.

Palper
TOCINILLO DE CIELO

AOTECH
ADVANCED OPTICAL TECHNOLOGIES S.L.

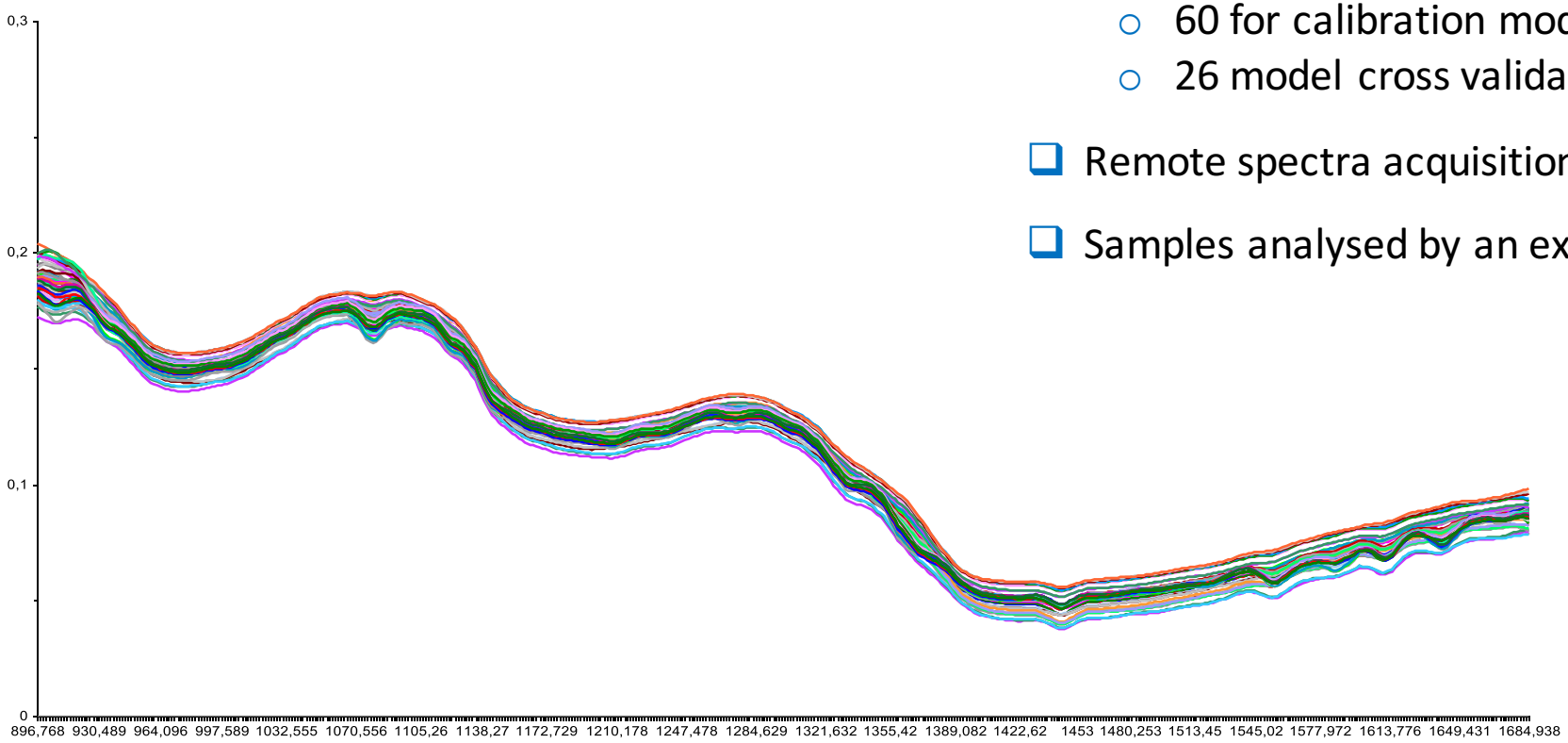
AONIR system installation



NIRMILK PROJECT

AOTECH
ADVANCED OPTICAL TECHNOLOGIES S.L.

AONIR system calibration



- 86 milk samples:
  - 60 for calibration model development
  - 26 model cross validation
- Remote spectra acquisition (900-1600 nm)
- Samples analysed by an external laboratory

AOTECH
ADVANCED OPTICAL TECHNOLOGIES S.L.

AONIR system calibration

Fat			Protein			Lactose			Lean Dry Matter		
RMSE	m (≈R^2)	EV (factors)	RMSE	m (≈R^2)	EV (factors)	RMSE	m (≈R^2)	EV (factors)	RMSE	m (≈R^2)	EV (factors)
0,03	0,88	89 % (6)	0,02	0,88	93 % (6)	0,02	0,72	66 % (6)	0,02	0,84	85 % (6)
0,02	0,94	92 % (5)	0,01	0,94	94 % (5)	0,01	0,89	85 % (6)	0,01	0,95	95 % (5)
0,04	0,78	79 % (6)	0,02	0,79	88 % (6)	0,02	0,62	65 % (4)	0,03	0,74	81 % (6)
0,04	0,73	65 % (6)	0,02	0,83	78 % (6)	0,02	0,79	72 % (6)	0,02	0,87	84 % (6)

Raw spectra, smoothing, 1st derivative and SNV.

Theoretical prediction error < 1%

AOTECH
ADVANCED OPTICAL TECHNOLOGIES S.L.

Validation tests

- 4 batches of milk sent to production in 3 different days.
- 3 control samples per batch.

Date	Sample	Lab. value (%)	AONIR Value (%)	Relative error (%)
15/03/21	1	3.58	3.72	3.91
15/03/21	2	3.58	3.71	3.63
15/03/21	3	3.58	3.70	3.35
16/03/21	1	3.60	3.66	1.67
16/03/21	2	3.60	3.69	2.50
16/03/21	3	3.60	3.67	1.94
22/03/21	1.1	3.57	3.54	0.84
22/03/21	1.2	3.57	3.57	0.00
22/03/21	1.3	3.57	3.55	0.56
22/03/21	2.1	3.58	3.60	0.56
22/03/21	2.2	3.58	3.62	1.12
22/03/21	2.3	3.58	3.62	1.12
AVERAGE ERROR OF MEASUREMENTS (%)				1.53

Table 1: Results obtained in the measurement of fat.

Validation tests

Date	Sample	Lab. value (%)	AONIR Value (%)	Relative error (%)
15/03/21	1	3.44	3.42	0.58
15/03/21	2	3.44	3.42	0.58
15/03/21	3	3.44	3.42	0.58
16/03/21	1	3.47	3.43	1.15
16/03/21	2	3.47	3.44	0.86
16/03/21	3	3.47	3.42	1.44
22/03/21	1.1	3.28	3.36	-2.44
22/03/21	1.2	3.28	3.37	-2.74
22/03/21	1.3	3.28	3.37	-2.74
22/03/21	2.1	3.29	3.41	-3.65
22/03/21	2.2	3.29	3.39	-3.04
22/03/21	2.3	3.29	3.39	-3.04
AVERAGE ERROR OF MEASUREMENTS (%)				1.90

Table 2. Results obtained in the measurement of protein.

Validation tests

Date	Sample	Lab. value (%)	AONIR Value (%)	Relative error (%)
15/03/21	1	4.7	4.77	-1.49
15/03/21	2	4.7	4.78	-1.70
15/03/21	3	4.7	4.78	-1.70
16/03/21	1	4.66	4.81	-3.22
16/03/21	2	4.66	4.81	-3.22
16/03/21	3	4.66	4.80	-3.00
22/03/21	1.1	4.87	4.69	3.70
22/03/21	1.2	4.87	4.68	3.90
22/03/21	1.3	4.87	4.69	3.70
22/03/21	2.1	4.87	4.75	2.46
22/03/21	2.2	4.87	4.75	2.46
22/03/21	2.3	4.87	4.77	2.05
AVERAGE ERROR OF MEASUREMENTS (%)				2.71

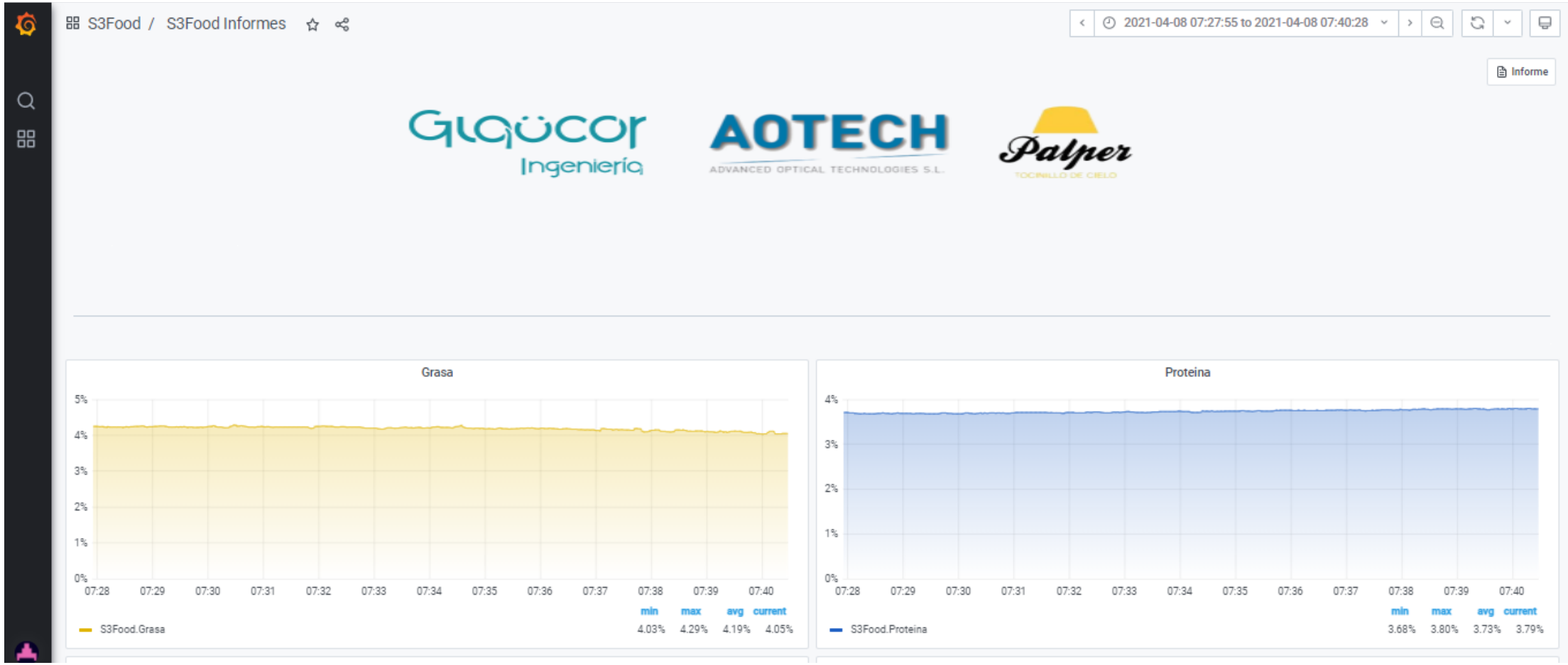
Table 3. Results obtained in the measurement of lactose.

Validation tests

Date	Sample	Lab. value (%)	AONIR Value (%)	Relative error (%)
15/03/21	1	8.87	8.94	-0.79
15/03/21	2	8.87	8.94	-0.79
15/03/21	3	8.87	8.94	-0.79
16/03/21	1	8.85	8.96	-1.24
16/03/21	2	8.85	8.98	-1.47
16/03/21	3	8.85	8.94	-1.02
22/03/21	1.1	8.88	8.81	0.79
22/03/21	1.2	8.88	8.80	0.90
22/03/21	1.3	8.88	8.80	0.90
22/03/21	2.1	8.89	8.89	0.00
22/03/21	2.2	8.89	8.88	0.11
22/03/21	2.3	8.89	8.88	0.11
AVERAGE ERROR OF MEASUREMENTS (%)				0.74

Table 4. Results obtained in the measurement of the lean dry matter.

IoT platform

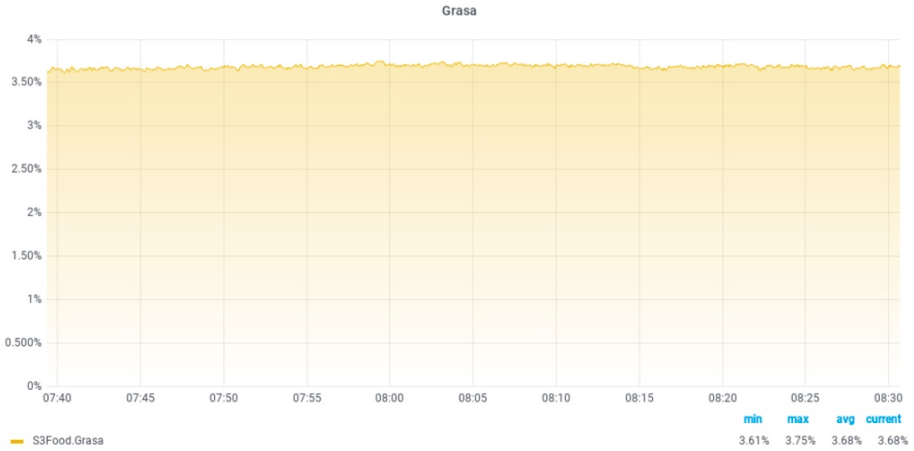


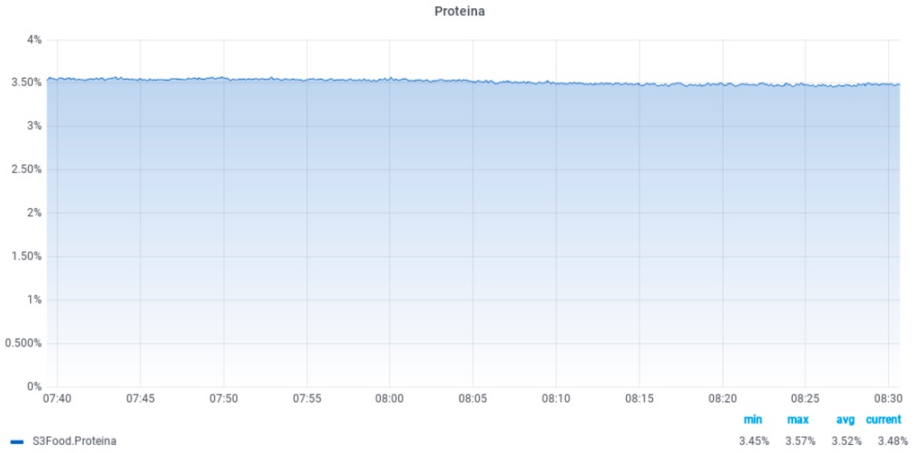
AOTECH
ADVANCED OPTICAL TECHNOLOGIES S.L.

IoT platform

S3Food Informes

Tue Apr 13 07:39:20 CEST 2021
to
Tue Apr 13 08:30:41 CEST 2021





AOTECH
ADVANCED OPTICAL TECHNOLOGIES S.L.

Project outcomes

I. Demonstration of the **NIR technology potential** for the in-line characterisation of certain milk parameters.

II. Easiness to integrate AONIR into an **IoT platform**.

III. Estimated average reduction of cream for Greek yogurt production: **14,3%.**

IV. Potential high impact in the product **quality homogenisation** → "CLOUD-ASSESSMENT OF DAIRY PRODUCTION PERFORMANCE (CAD2P)"

V. Elaboration of products according to the milk characteristics provided by an **AONIR system.**

Experts on optical sensors technology

AOTECH

ADVANCED OPTICAL TECHNOLOGIES S.L.

Iker García Esteban-Barcina
igarcia@aotech.es
+34 621.004.487