

KRAK

OP ZOEK NAAR DE PERFECTE
CRUNCH

JAN 2025–
DEC 2026

TETRA PROJECT

BEPALING VAN DE PRODUCTKWALITEIT VAN VOEDING
AAN DE HAND VAN GEAVANCEERDE GELUIDSANALYSE



MET DE STEUN VAN

AGENTSCHAP
INNOVEREN &
ONDERNEMEN



Vlaanderen
is ondernemen



FLANDERS'
FOOD

KU LEUVEN

EEN SAMENWERKING TUSSEN

hogeschool
VIVES



www.project-krak.be

HBC.2024.0136

KRAK – Kick Off – 17 januari 2025

WIFI: POMWVL-BEZOEKERS
Pass: westvlaanderen

LUNCH

12:00 - 13:00

INTRO

13:00 – 13:10 Welcome by Yves De Bleecker (Plant Manager Food Innovation)

13:10 – 13:30 KRAK - Background and problem statement

WHO is WHO?

13:30 – 14:10 Presentation of the Partners (Flanders' FOOD, MeBioS, RG Food Processing, RG Mechatronics)

14:10 – 14:30 Tour de table of the companies

KRAK, What will we do?

14:30 – 14:45 Workpackages, flow of a product, product categories

14:45 – 15:00 Feedback and open discussion, content of the Form

Tour and demo

15:00 – 16:00 1 Tour Food Innovation Park - 2 Demo Audiosetup

16u Ending

WELCOME @ the





Food
Innovation
Park



Pilot Infrastructure



Body mass composition / Fitness



Labs



Meeting rooms





Food Innovation @ VIVES

Research topics:

- Cultivation and use of new crops / use of alternative resources
- Food Processing
- Food & Health

Team: 20 researchers - 14 FTE

Food Innovation @ VIVES

Collaboration with companies:

- Collective projects: PWO, TETRA, COOCK, Horizon, I3, ...
- As contractor / subcontractor: feasibility study, O & O, ...

Hoe deelnemen?



1

Ga naar wooclap.com

2

Voer de code van het evenement in de bovenste banner in

Evenementcode
UALJBL



Antwoorden per sms inschakelen

 [Deelnamelink kopiëren](#)

[Wooclap](https://wooclap.com)

what is flavour?



Alle Afbeeldingen Video's Web Nieuws Boeken Financieel

Definities van [Oxford Languages](#) · [Meer informatie](#)



flavour

/ˈfleɪvəl/

noun

1. the distinctive taste of a food or drink.
"the yoghurt comes in eight fruit flavours"

Vergelijkbaar:

taste

savour

tang

relish

palate

sapor

flavouring



2. an indication of the essential character of something.
"the extracts give a **flavour of** the content and tone of the conversation"

Vergelijkbaar:

impression

indication

suggestion

hint

taste

nuance

verb

What is flavour?



Flavour is the complex sensory experience perceived when consuming food or beverages. It results from the combined stimulation of multiple senses, including taste, smell, and touch, along with visual and auditory cues in some cases. Here's a breakdown of its components:

1. Taste

- **Detected by the tongue's taste buds**, taste is limited to five primary categories:
 - Sweet
 - Sour
 - Salty
 - Bitter
 - Umami (savory)
- These tastes provide the basic chemical signals about food.

2. Smell (Aroma)

- Mediated by the olfactory receptors in the nose, smell is responsible for the vast diversity of flavors perceived.
- Volatile compounds released from food contribute significantly to flavor, as most "taste" is actually aroma.

3. Texture and Mouthfeel

- Physical sensations in the mouth contribute to the perception of flavor. For example:
 - Creaminess
 - Crispness
 - Fizz
 - Astringency
- These are sensed by mechanoreceptors and thermoreceptors.

4. Temperature



Hot or cold sensations influence how flavors are perceived. For example, warm food often

4. Temperature

- Hot or cold sensations influence how flavors are perceived. For example, warm food often intensifies aromatic release, enhancing flavor.

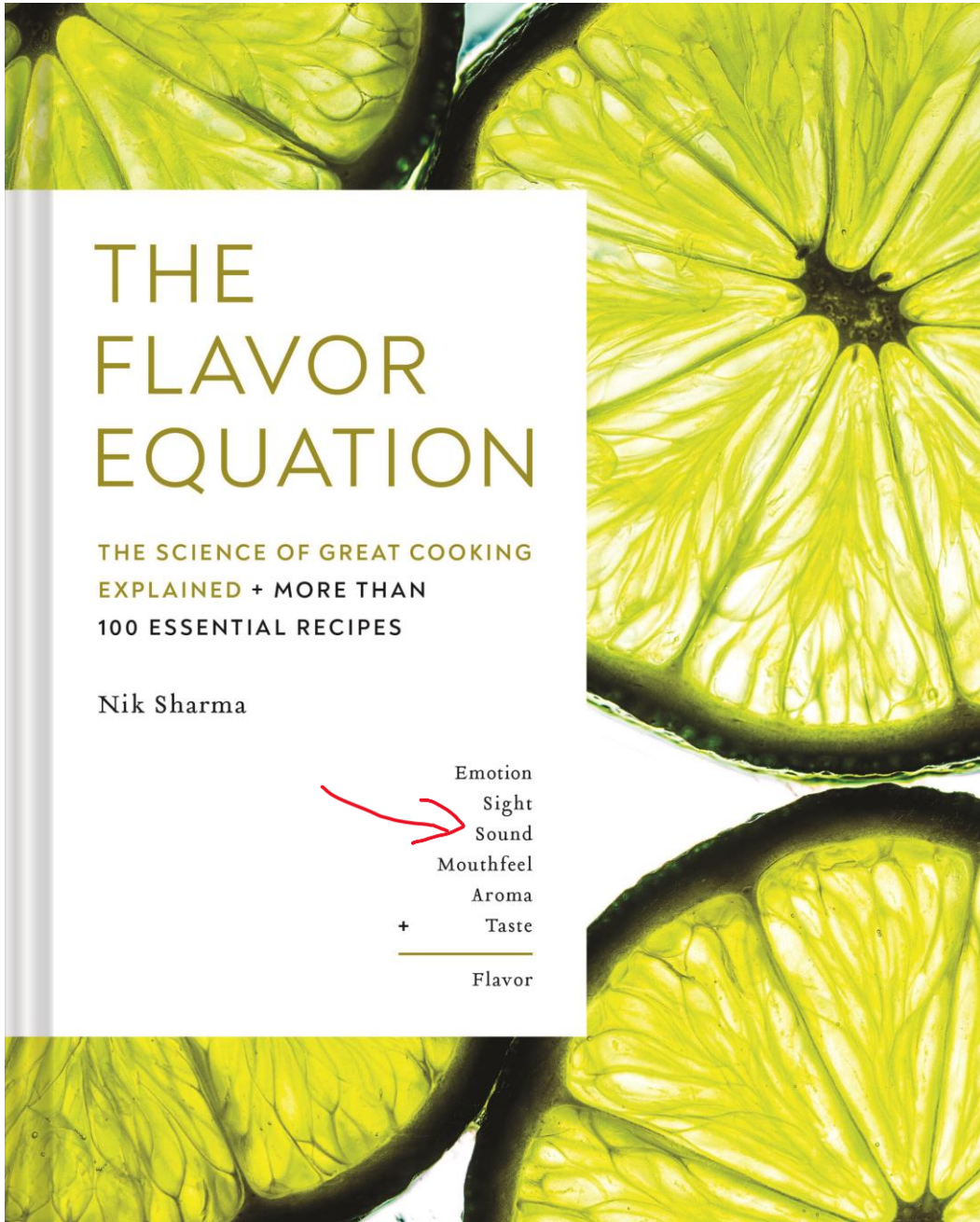
5. Trigeminal Sensations

- These are chemical sensations perceived through nerve endings in the face, such as:
 - Spiciness from chili (capsaicin)
 - Cooling from mint (menthol)
 - Pungency from mustard or horseradish.

6. Visual and Auditory Cues

- The appearance of food (color, shape, presentation) can affect flavor perception.
- Sounds, such as the crunch of a crisp snack, can influence how flavor is experienced.





1

Background & Problem statement



NuHCaS

Nutrition Health Care System

[OVER NUHCAS](#)[BERICHTEN](#)[EVENEMENTEN](#)[PROJECTEN](#)[ROADMAPS](#)[COMMUNITY](#)[CONTACT](#)[MEER](#)

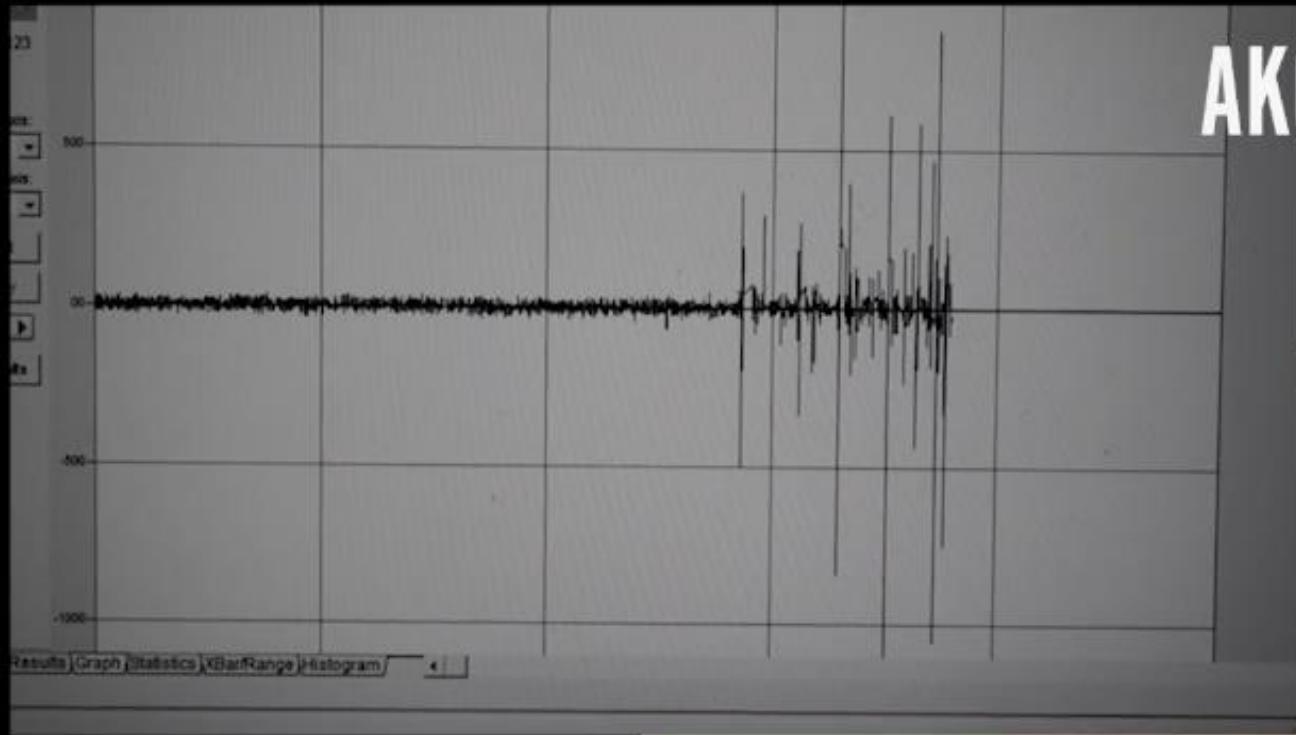
FoodCare project

In FoodCare werden methodieken ontwikkeld voor het optimaliseren van maaltijden en maaltijdcomponenten op basis van de specifieke voedingsbehoeften van de consument. Daarbij werden alle actoren in de volledige keten, van grondstof tot geserveerde warme maaltijd, in rekening gebracht.

Benieuwd naar wat het FoodCare project inhoudt? Bekijk de filmpjes en klik op onderstaande afbeeldingen voor gedetailleerde resultaten van de verschillende modeltrajecten.



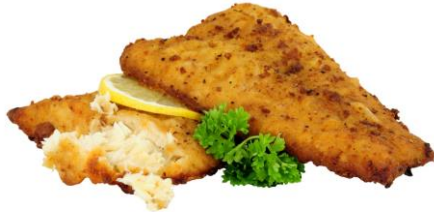
AKOESTISCHE KROKANTHEIDSMETING OP GEPANEERDE VIS NA HET REGENEREREN



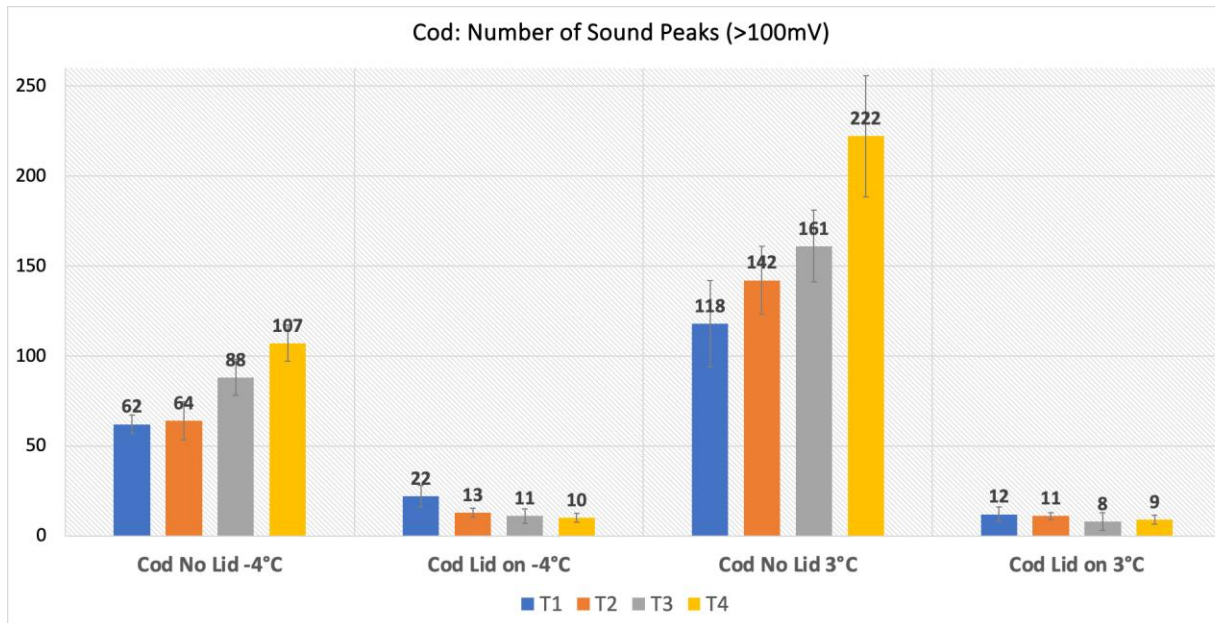
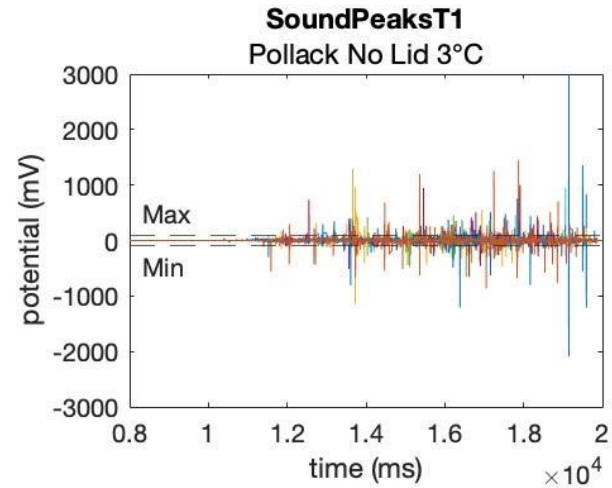
KRAK – Kick Off – 17 januari 2025

regeneratie
VIVES

Foodcare is een VLAIO Cook project van Flanders' FOOD, ILVO en Vives Hogeschool, begeleid door voedings- en zorgbedrijven. Dit project focust op de kwaliteit van maaltijden binnen de zorg. In het kader hiervan werden akoestische textuurmetingen ingezet om op een objectieve manier de krokantheid van gepaneerde vis te bepalen.



Het aantal geluidspieken is een objectieve parameter om de krokantheid te evalueren en te vergelijken.



Blijft de korst van de gepaneerde vis krokant tijdens het warmhouden? Wat zijn de verschillen als we opwarmen met of zonder deksel?

AKOESTISCHE TECHNIEKEN OFFLINE

'CRISPY' & 'CRUNCHY' FOOD



DOEL

- Offline kwaliteitscontrole
- Productkarakterisatie
- Productinnovatie, R&D
- Steekproeftesten

WAAROM AKOESTISCHE METINGEN?

Deze techniek laat toe om een objectieve en nauwkeurige bepaling te doen van de **krokantheid**

HOE?

Door het product gecontroleerd te breken ontstaat geluid. Deze geluidsgolven worden verder geanalyseerd.

WELKE PRODUCTEN?

- ✓ Brood & Gebak
- ✓ Koekjes & Crackers
- ✓ Groenten & Fruit
 - ✓ Snacks
- ✓ Gepaneerde producten
 - ✓ Frieten
 - ✓ Cornflakes
 - ✓ Chocolade

WAT KAN ONDERZOCHT WORDEN?

Wat is het effect van **verpakking**
bewaring
formulering
(bak)proces
(her)opwarmen
op de **krokantheid?**

Food sector challenges

Key developments in the sector

- Developing healthier products
- Optimizing formulations for air fryer and oven products
- Preserving quality with sustainable packaging
- ...

→ Importance of maintaining/getting the right **texture**

Crispiness - Crunchiness – Snap – Crack

→ Objective measurement of these parameters is critical

Texture via Sound Analysis

Analyzing sound during controlled product breaking

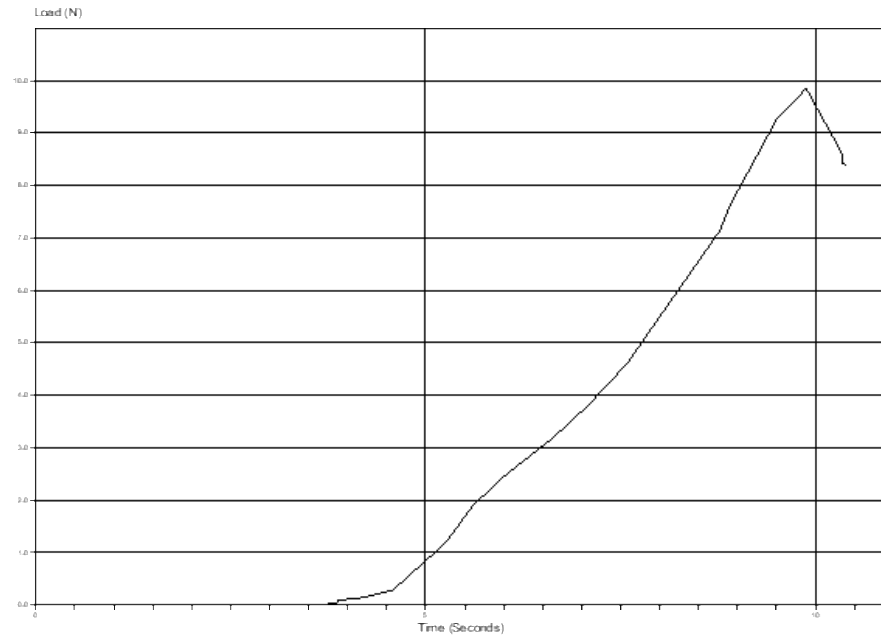
=

The only objective way to define crispiness related parameters

Current gaps in food companies

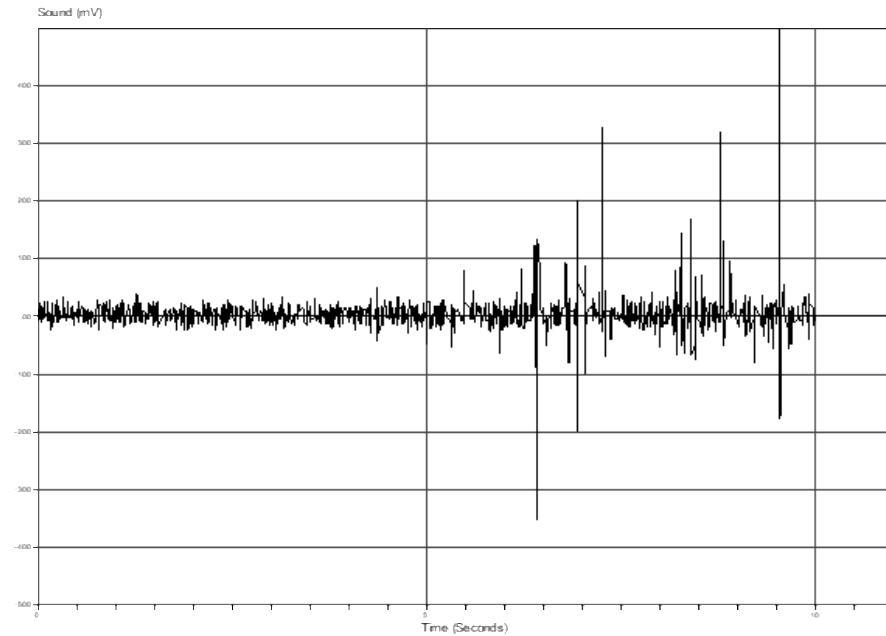
- Lack of knowledge about required **hardware**
- Limited understanding of **instrumental settings**
- Challenges in **interpreting** captured **sound waves**
- Sensory analyses: often time-consuming and subjective

HARDHEIDSMETING

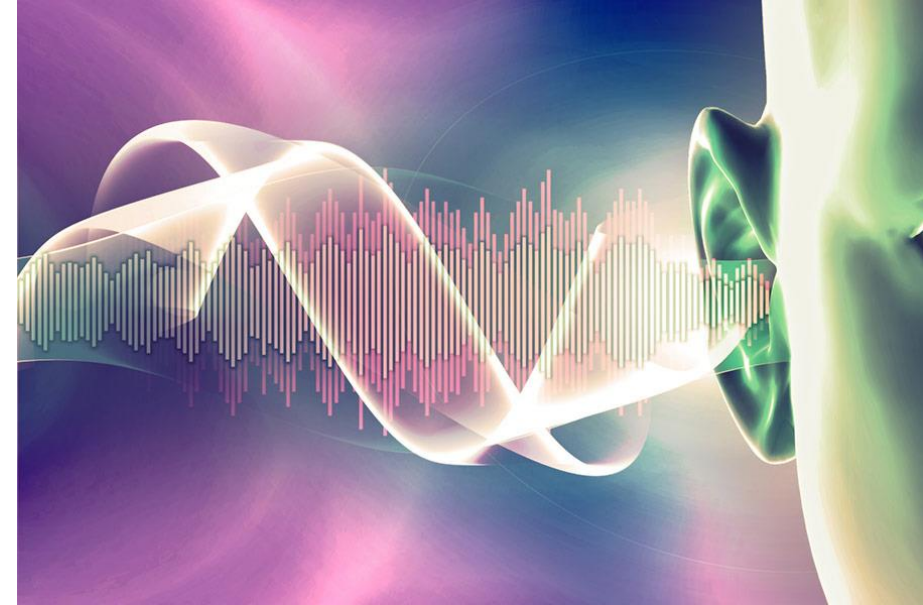
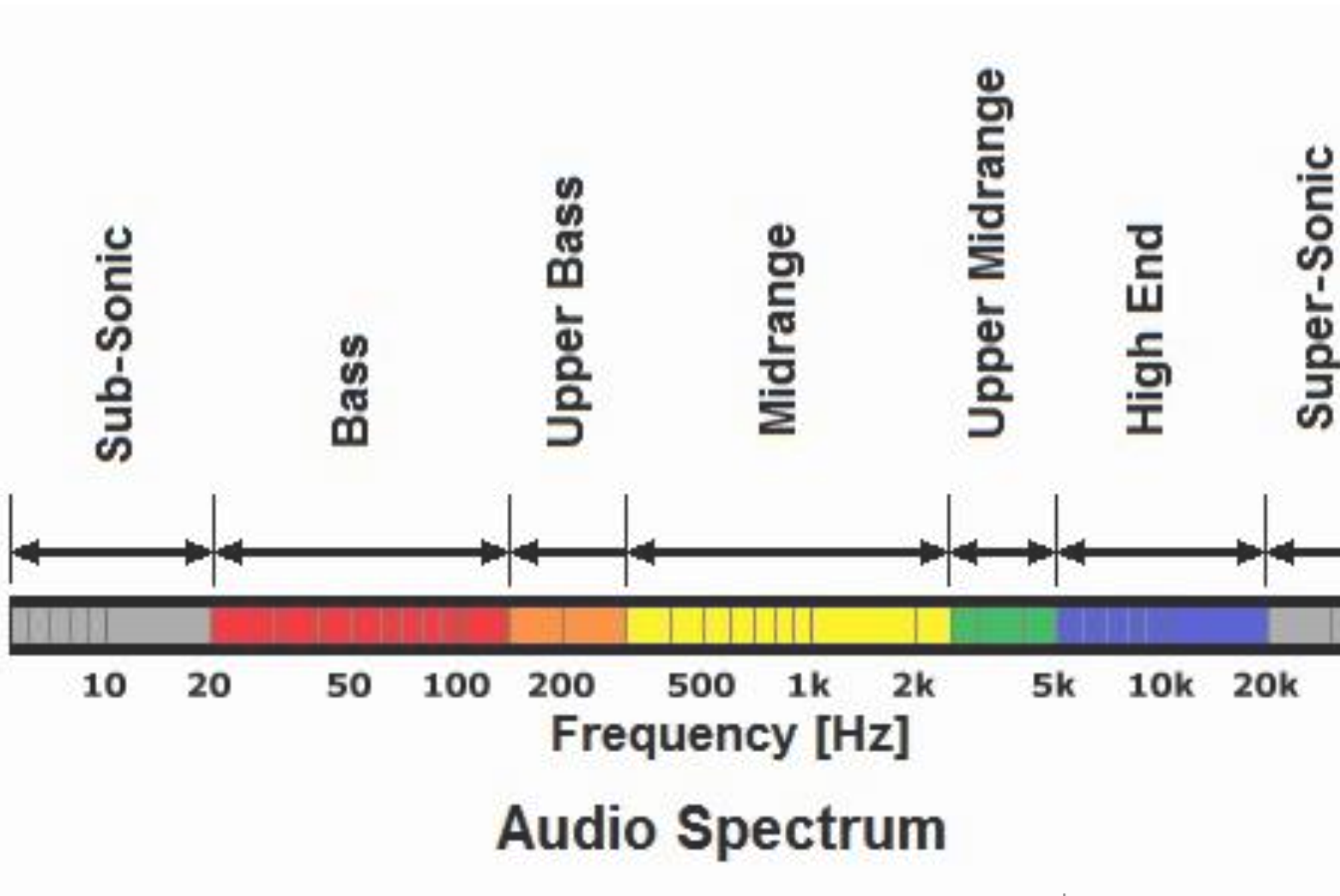


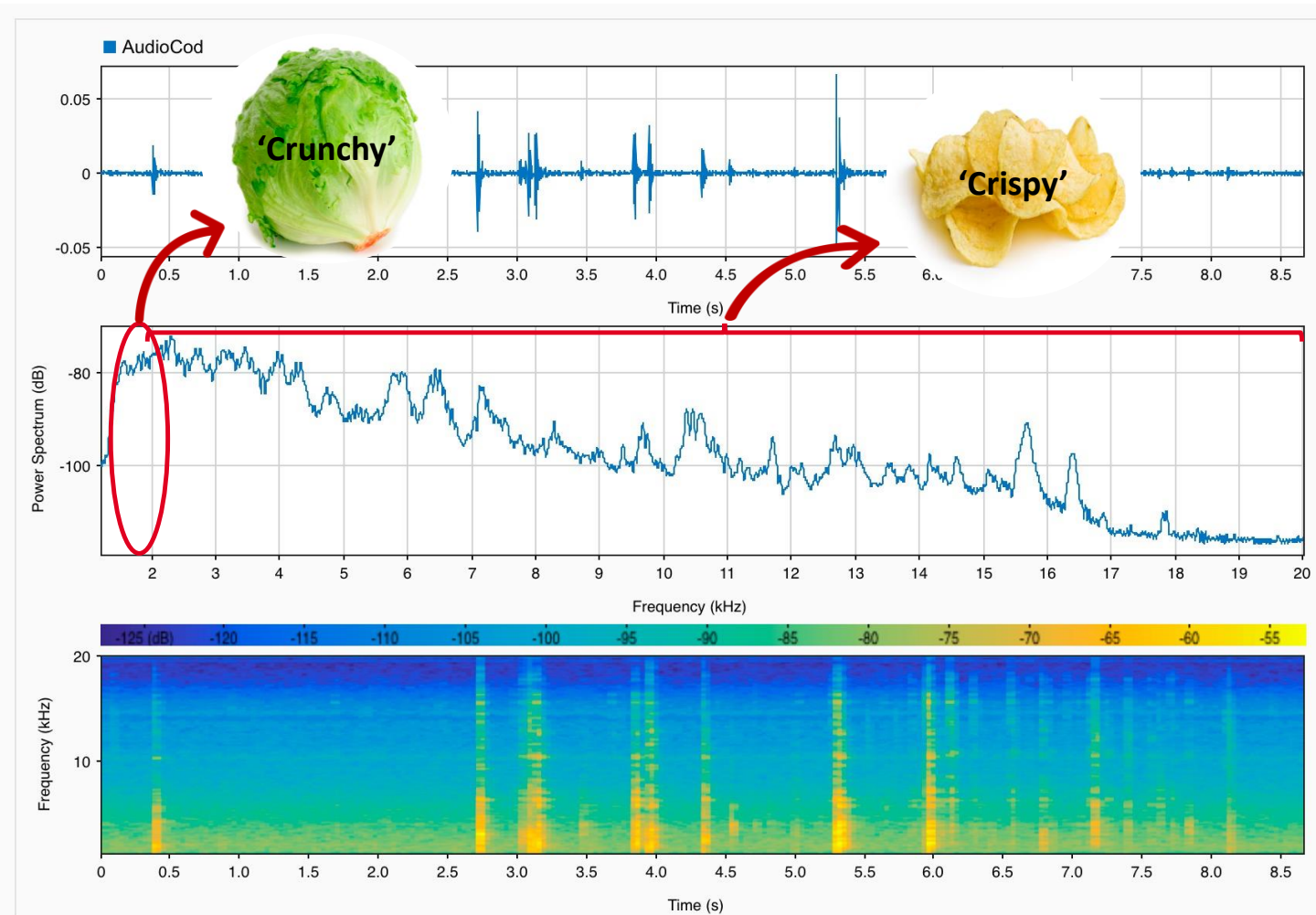
vs.

AKOESTISCHE METING



Bij textuurmetingen meet men de **hardheid ('load')** die nodig is om een product te breken of in te duwen. Dit geeft onder meer informatie over de hardheid, taaiheid en elasticiteit van een voedingsmiddel. Door de integratie van een **akoestische meting** kan men op het product de **krokantheid** objectief evalueren. Deze wordt geobjectiveerd door parameters zoals het aantal waargenomen geluidspieken en de maximale piekintensiteit.





Deze instrumentele techniek kan de waarneming van krokantheid van voedingsproducten voorspellen en vergelijken. Sensorische analyses (smaaktesten) kunnen gecorreleerd worden met instrumentele parameters. De akoestische input kan verder geanalyseerd worden binnen **specifieke frequentiedomeinen** waardoor verschillende soorten krokantheid kunnen bepaald worden. Zo kan men bijvoorbeeld **'crunchiness'** ($f = 1,2\text{-}2\text{kHz}$) (bvb. ijsbergsalade, appel) onderscheiden van **'crispiness'** ($f > 1,9\text{kHz}$) (bvb. chips, tempura).

Main Objectives - KRAK

- Facilitate the integration audio analysis to QC & R&D labs in the food industry
- Integration of AI into texture analysis
- To link sensory & instrumental analysis in sound related properties
- Disseminate the latest technology and knowledge about determining texture by sound analysis

2

WHO
is
WHO?

CONSORTIUM OVERVIEW

STEERING COMMITTEE



PARTNERS



FEDERATIONS & RESEARCH



Flanders' Food

Inge Dirinck

Flanders' FOOD



VLAIO



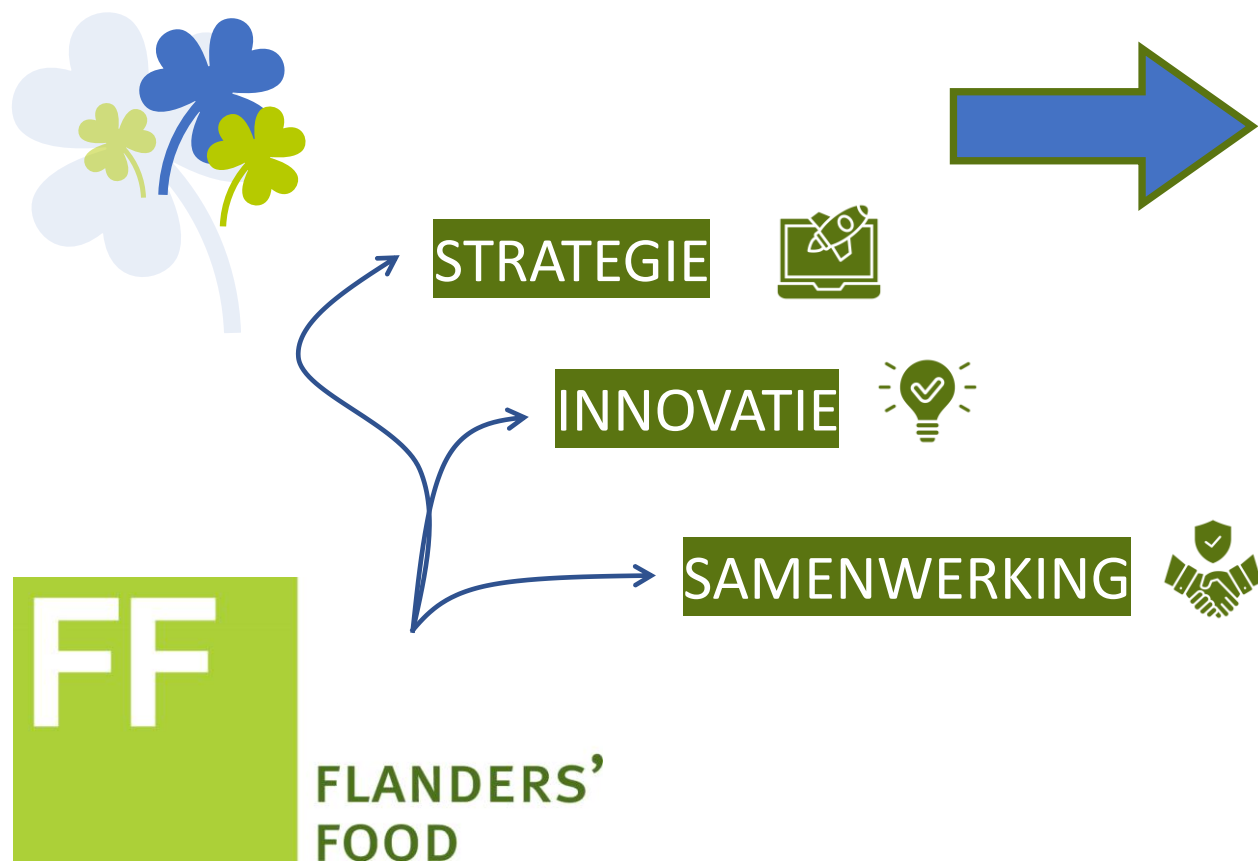
**FLANDERS'
FOOD**

samen voor
#sterkgroeien

Wie zijn we en wat doen we



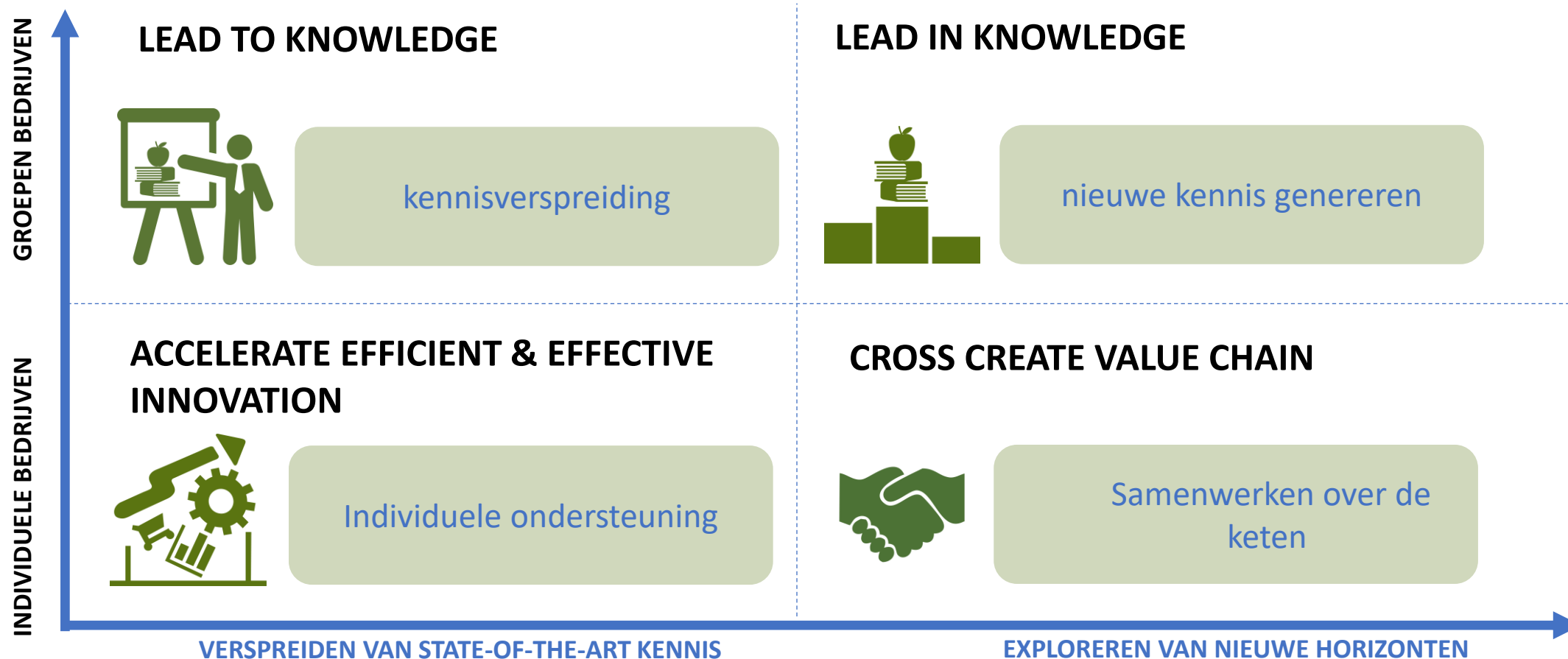
Wie zijn we en wat doen we



Speerpuntcluster Agrofood

- 300 industrie leden
- 10 kennisinstellingen
- 800 bedrijven actief in het netwerk
- 70 lopende projecten

De vier strategische pijlers



De vier programma's

Resilient and sustainable agrifood systems

- Aardappel tot Friet
- Graan tot Bakkerijproduct
- Groente tot Veggies
- Varken tot Charcuterie

World class food production

- Food Processing
- Voedselverpakking van de toekomst
- Voedselveiligheid
- Ecoproductie

Personalised food and healthy diets

- Nutritie
- Zorg

New and shifting resources

- Eiwittransitie
- Nevenstromen

De radar



FLANDERS'
FOOD
RADAR



Vragen en/of ideeën
Er staat een gans team voor jou klaar!

vraag@flandersfood.com tot uw dienst.

Meer info op onze website
www.flandersfood.com



VLAIO



FLANDERS'
FOOD

samen voor
#sterkgroeien

MeBioS

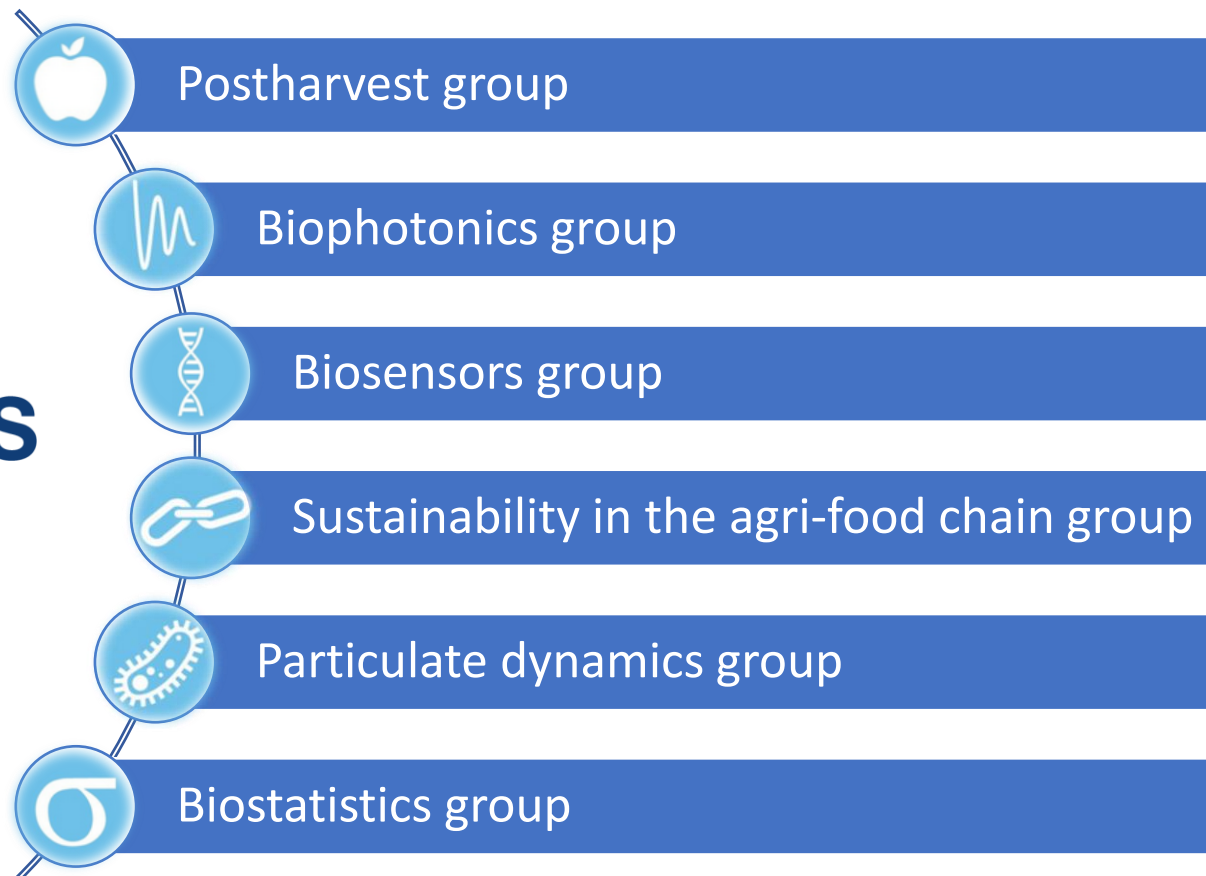
Mechatronics, Biostatistics and sensors

Bart De Ketelaere
Mohammed Saif Ismael Hameed

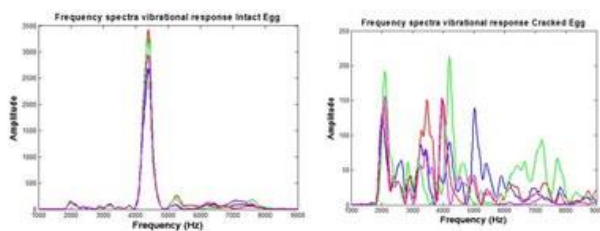
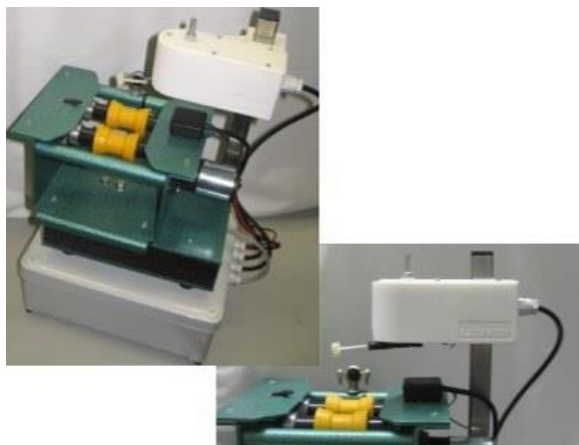
KU LEUVEN

Research groups

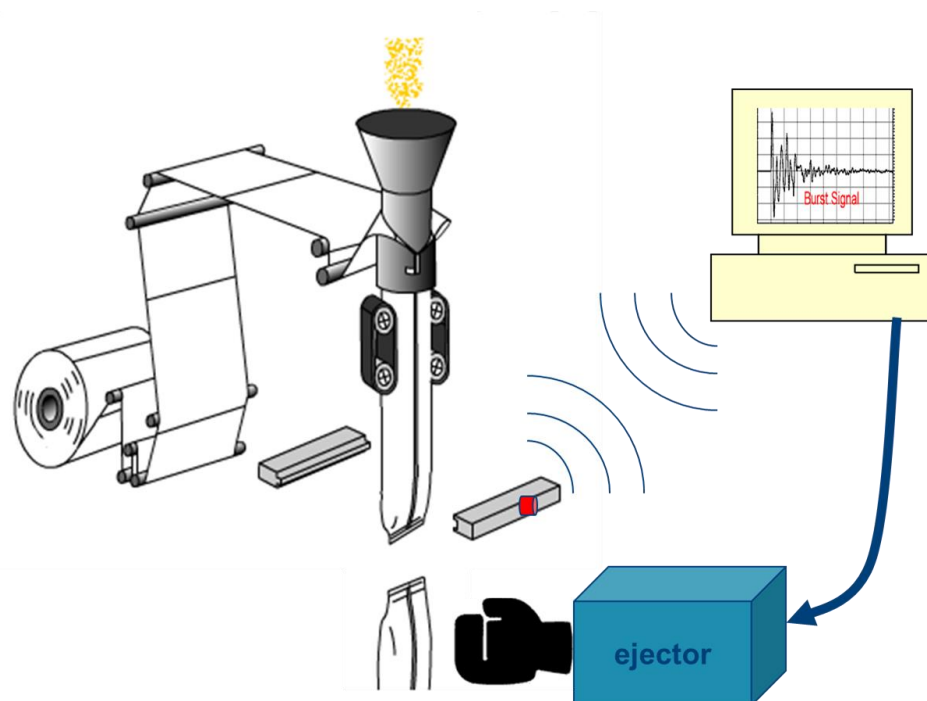
MeBiOS



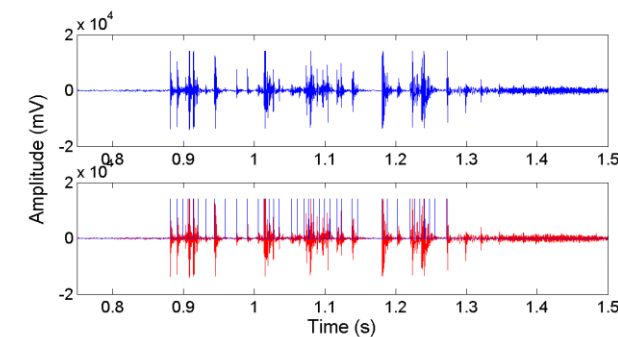
Related to acoustics



<http://octinion.com/column-bus-egg-tester>



<https://www.engilico.com/seal-inspection-sealscope/>



Mission Biostatistics group

Our mission is to develop statistical methodology to reduce products' time to market, to improve quality and productivity in agriculture and industry and to monitor production processes efficiently and effectively.

A key aspect in the whole process is to acquire the right kind of data, using suitable sensor technologies. We also aim at utilizing novel optimization techniques in bioscience engineering.

Research topics:

Main research topics

1. Design of experiments (DOE) & statistical modeling

2. Multivariate statistics & chemometrics

3. (Multivariate) Statistical process control

4. Artificial Intelligence & Deep Learning for quality control

Design of experiments (DOE)

Trial and error

Based on experience

"This should work better"

"Cook and look"

One factor at a time

Simple approach

Requires many experiments

Seldomly yields real optimum

Design of experiments

Highly efficient

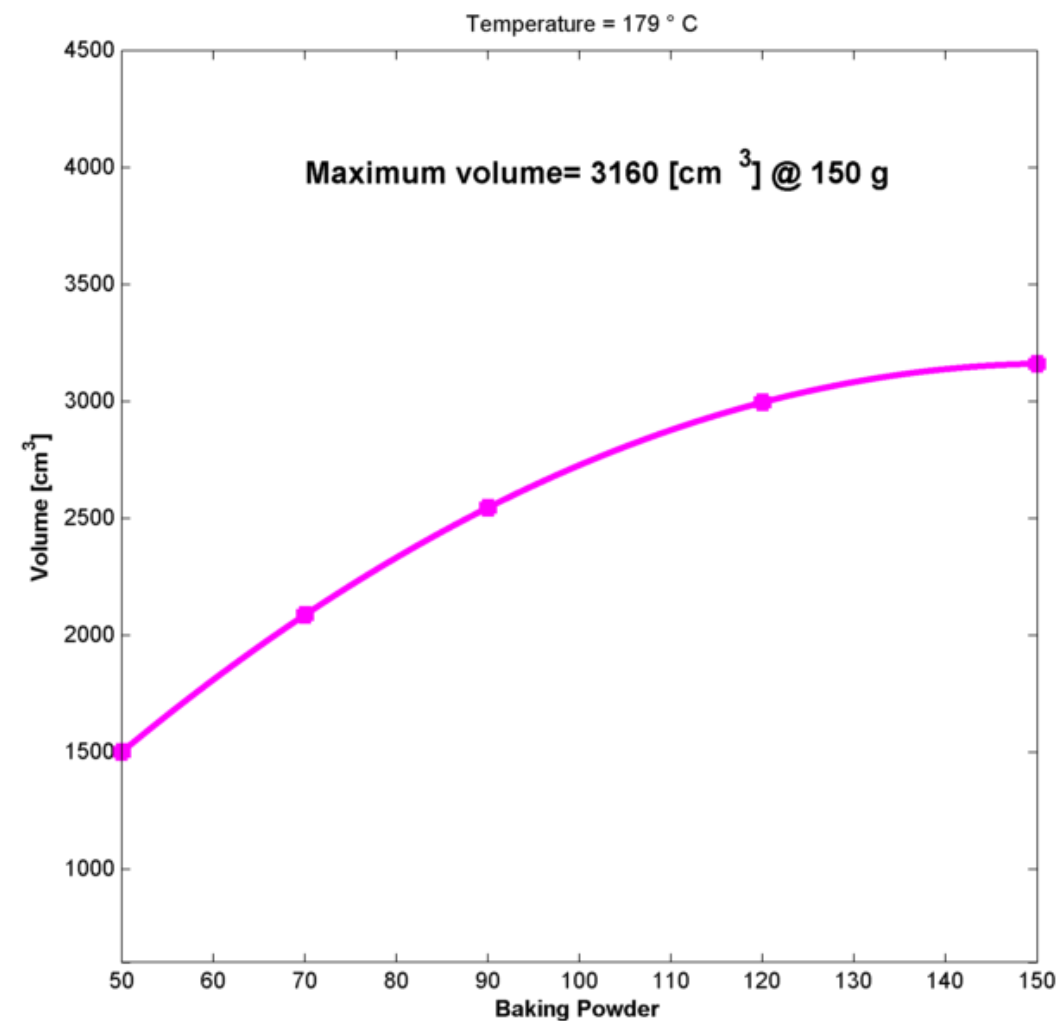
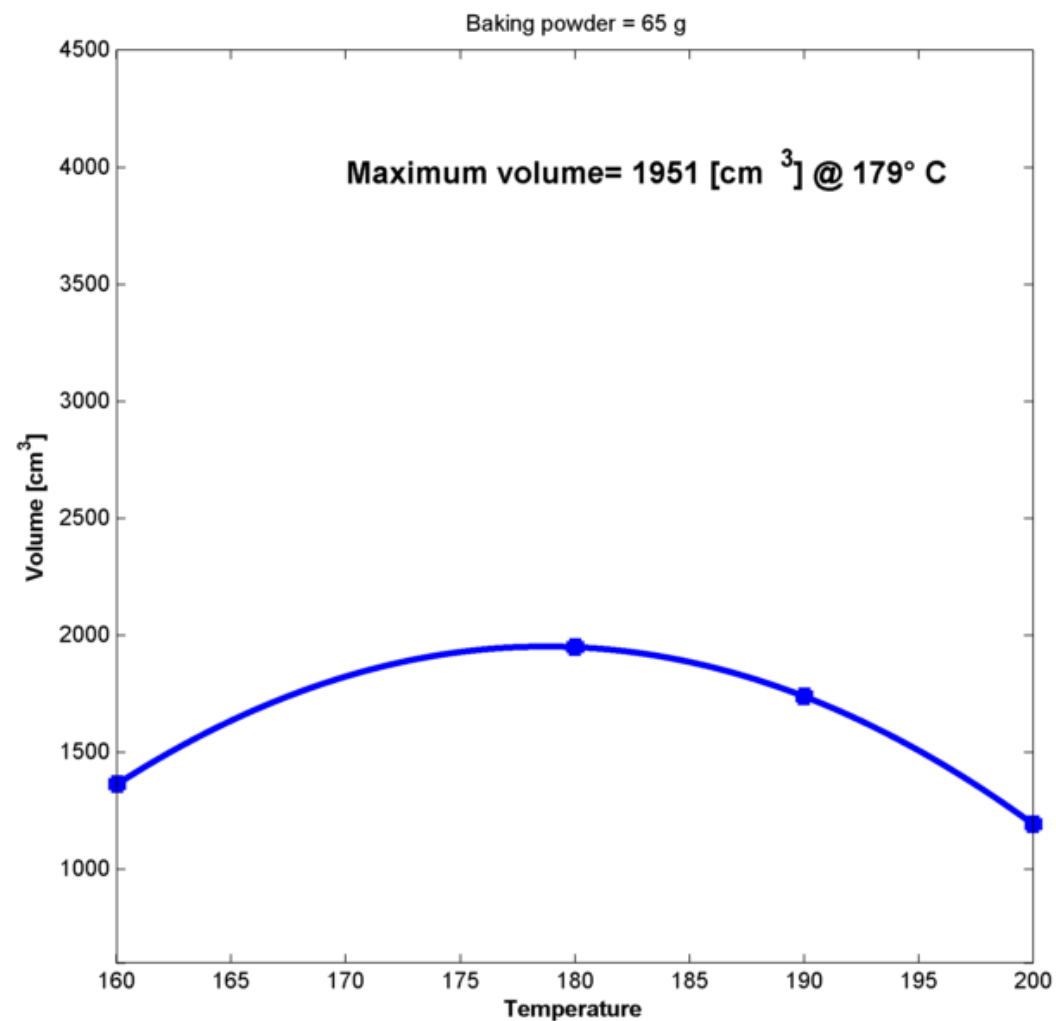
New developments allow tailored solutions

Considered to be complex

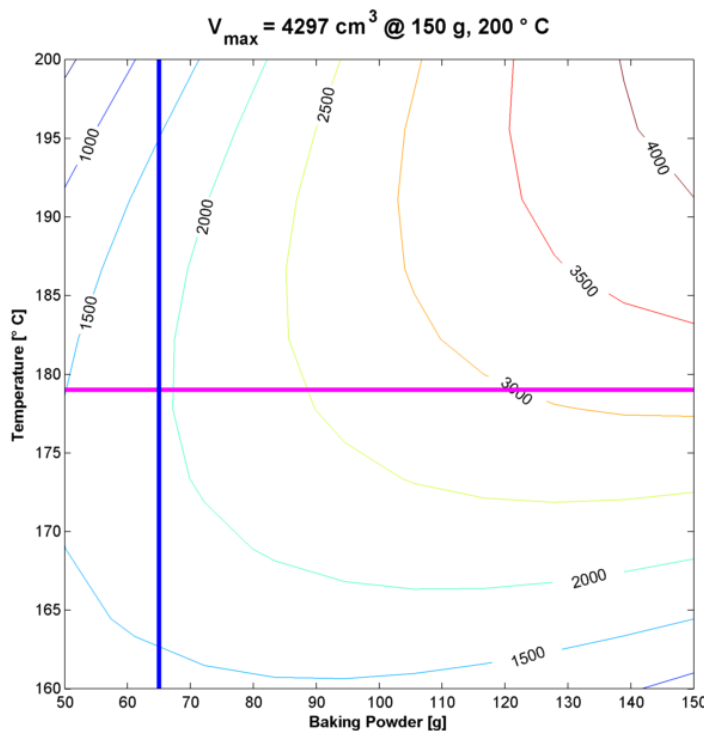
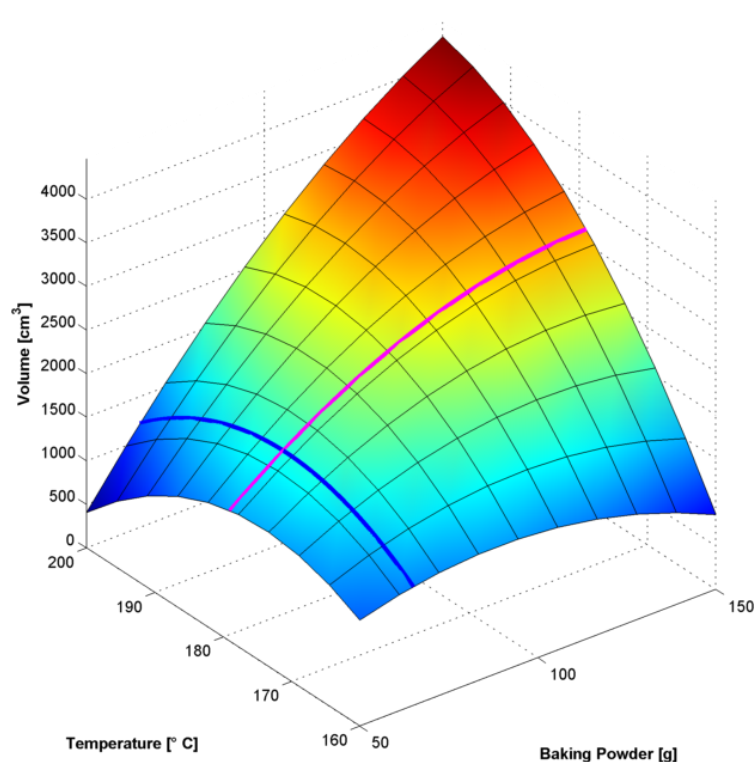
One Factor At a Time (OFAT)

- Illustrative example: volume of bread is influenced by
 - Amount of baking powder [*g*]: 50 g – 150 g
 - Oven temperature [$^{\circ}$ C]: 160 $^{\circ}$ C – 200 $^{\circ}$ C
- Fix baking powder at 65 g, vary temperature
 - Find best temperature, vary baking powder
- Find best baking powder

One Factor At a Time (OFAT)



OFAT – Limitations



- The true optimum is much higher!
- Vary two variables simultaneously
- How to optimally change variables together to learn most and/or optimize processes = topic of design of experiments (DOE)

Design of experiments (DOE)

- Main challenge: how to learn as much as possible about a product or process using a minimal number of tests?
- How to tackle industrial applications that have many complicating factors?



An example: optimizing field test campaigns

Limited time
for testing

Many inputs

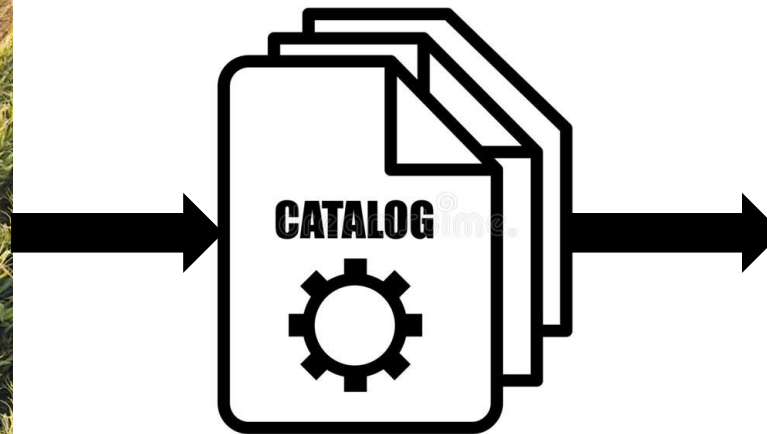
Some inputs
hard to change



Uncontrollable
factors (weather,
crop properties, ...)

Limited number of
tests

Design of experiments: the old fashioned way



- Search small, rigid catalog of experimental plans that comes closest to the practical case
- Adapt (simplify) the case so that it fits an experimental plan

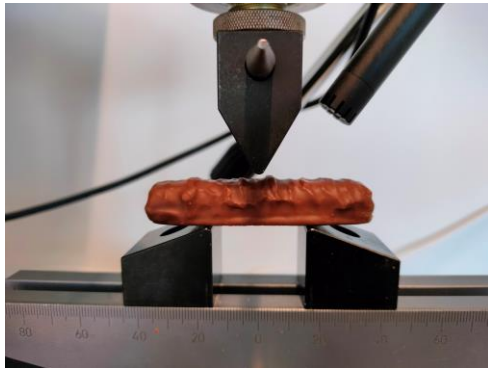
Design of experiments: the innovative way



- Tailor a plan to the unique practical case

Workflow of DOE

1.



Variables of interest with their limits:

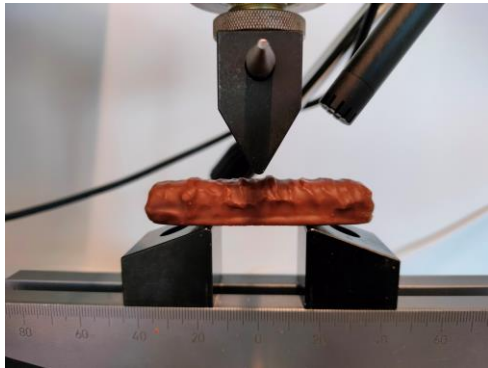
- Test speed: min – max
- Type of support: A – B – C
- Support distance: min – max
- Type of probe: A – B – C
- Microphone angle – distance – type

Experimental constraints

- Maximum number of tests = 36
- Some variables easier to change than others

Workflow of DOE

2.



Translate the requirements into a **tailor-made experimental plan**:

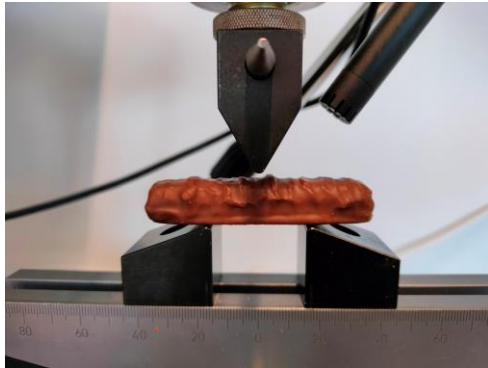
Test	Speed	Type	...	Angle
1	75	A	...	90
2	100	C	...	75
3	125	B	...	45
...
36	75	A	...	90

The experimental plan tells which tests to perform in which order to **gain maximal insight at the lowest cost**

Workflow of DOE

3.

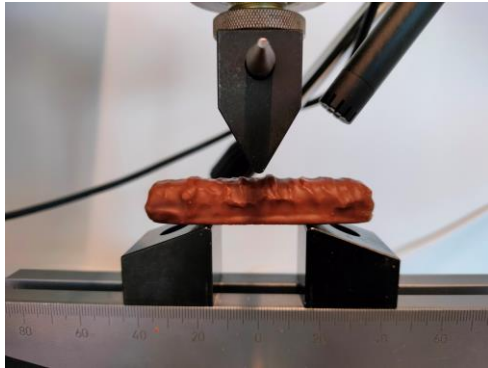
Perform the tests and adds the results (**quality**) to the experimental plan table:



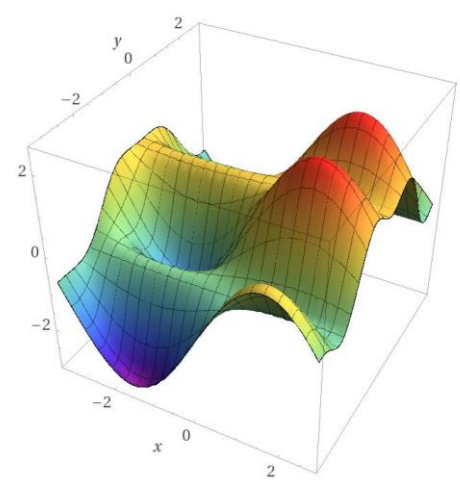
Test	Speed	Type	...	Angle	Quality
1	75	A	...	90	9
2	100	C	...	75	5
3	125	B	...	45	2
...
36	75	A	...	90	10

Workflow of DOE

4.



Analyze the data to find the **optimal measurement conditions:**



Speed	Type	...	Angle	Predicted Quality
<u>95</u>	<u>B</u>	<u>...</u>	<u>87.5</u>	<u>10</u>



RESEARCH GROUP
FOOD PROCESSING

Michaël Verlinden

Theme 1: Optimization of Meal components and Food product quality

- Quality of meals and their components in large kitchens
- Innovative product development
- Innovative processing techniques



Theme 2 - Sustainable and Alternative ingredients and sources

- Valorization of nutritionally interesting by-products (BSG, oyster mushroom stems)
- Alternative protein sources (seaweed, insects)
- Innovative crops (yacon, duckweed)



Theme 3 - Data-Based Quality Monitoring and Process monitoring

- **Quality control:** AI, intelligent audio analysis
- **Process monitoring:** Focus on energy consumption, process and preparation parameters and food waste.





RESEARCH GROUP
MECHATRONICS

Jonas Lannoo
Senior Researcher
Innovation Manager

Research Group Mechatronics

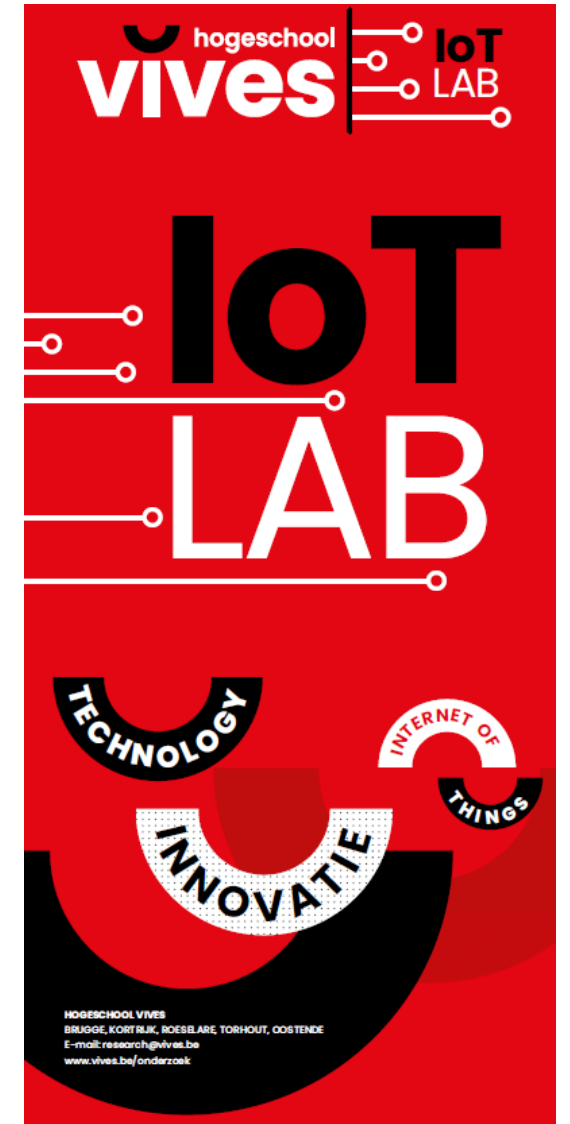
- Horizontal research group
- Two complementary research tracks
 - **Machinebuilding and Product**
 - Design and development of innovative machines
 - Focus on data insights for quality control and safety
 - New product manufacturing technologies
 - **Internet of Things and AI**
 - End-to-end prototyping of IoT and sensors
 - Focus on low power, connectivity and privacy
 - Application of AI on the extreme edge

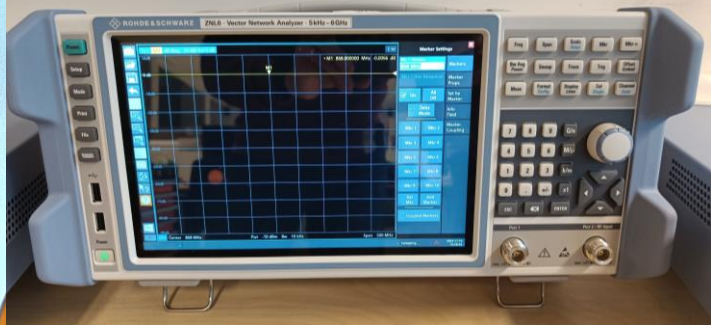
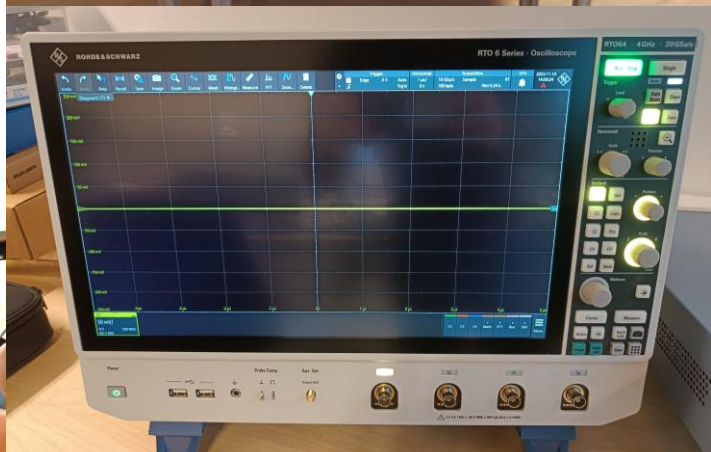
→ Increasing the operational efficiency of systems through digitalisation



IoT-lab @ VIVES Bruges

- Development of custom IoT systems and architectures
 - Hardware, firmware, software
 - Connectivity & low-power
 - Implementation of AI on IoT (edge/tinyML)
- Infrastructure
 - Creating prototypes
 - Test equipment
 - Calculation & hosting servers





Connections with KRAK

1. Complementary research on sound analysis

- Battered products vs ceramic products

2. TETRA project AI@EDGE

- Fundamentals for implementing AI on edge



3. TETRA project MLOps4ECM

- Management of AI on edge in production



VIVES Research Day 2024



Acoustic roof tile quality assessment

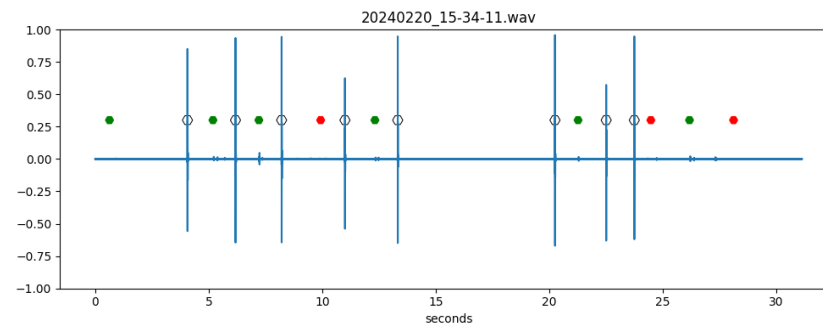


Path towards an intelligent system

“Smart” device
Measurement device



Data Analysis and transformation



AI development



Optimization and deployment

Tour the table

Who?

Company?

Why interested in the project?

Which products are interesting for KRAK?

3

K R A K

What will we do?

WP1. Identificatie



Kennis
Noden
Toepassingen
Modeltrajecten

WP2. Literatuur SOTA

- * Textuuranalyser
- * Audio apparatuur (HW)
- * Analysetechnieken (SW)
 - Klassiek
 - Datagedreven (AI)



WP3. Optimalisatie krokantheidsanalyse

- * Slimme akoestische module (HW & SW)
- * Representatieve datasets (3)
- * Design Of Experiments
- * Belangrijkste features bepalen



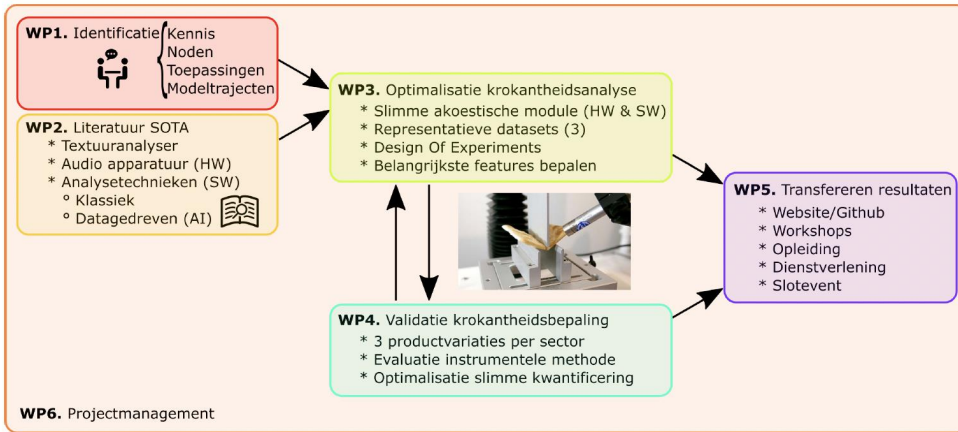
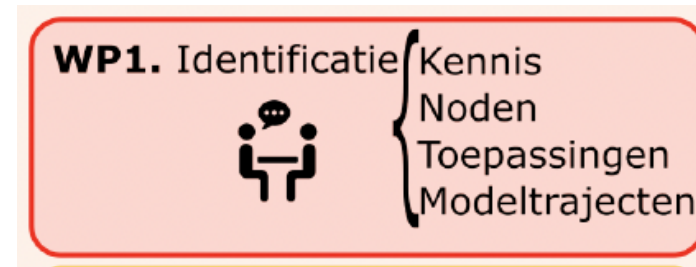
WP4. Validatie krokantheidsbepaling

- * 3 productvarianties per sector
- * Evaluatie instrumentele methode
- * Optimalisatie slimme kwantificering

WP5. Transfereren resultaten

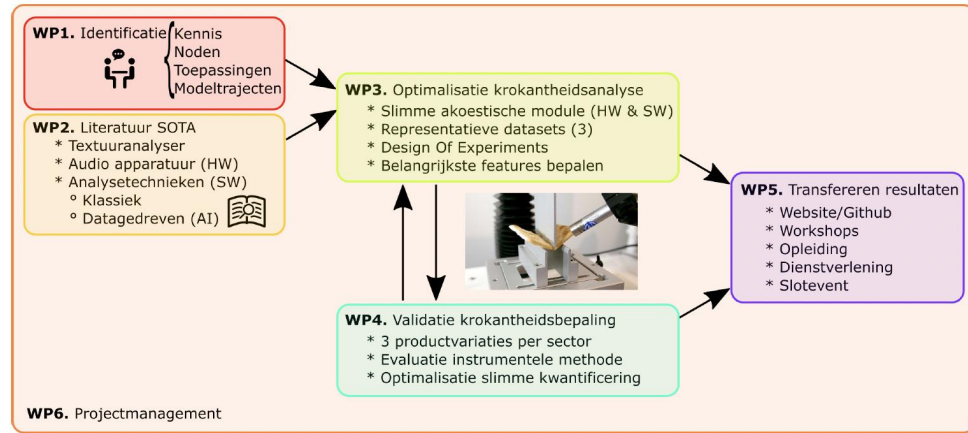
- * Website/Github
- * Workshops
- * Opleiding
- * Dienstverlening
- * Slotevent

WP6. Projectmanagement



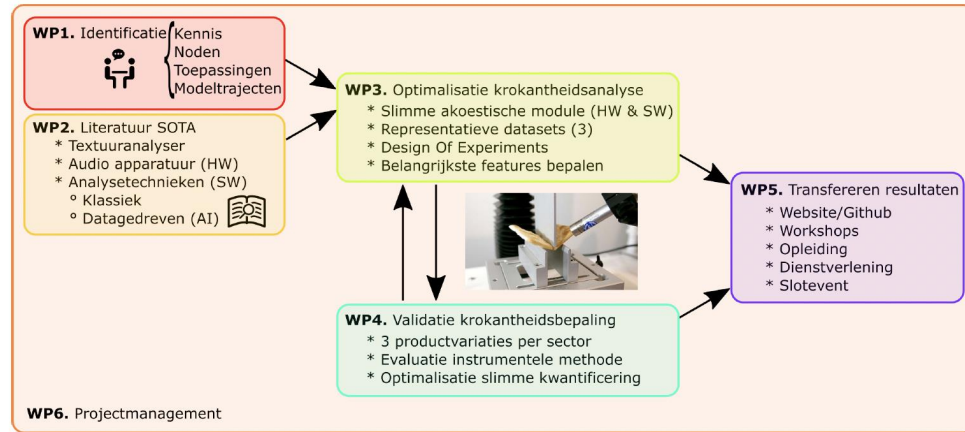
WP1: Identifying existing knowledge, needs, and applications within the different sectors.

- Input of the steering board (forms, one on one, meetings) --> starts today!
- Selection of the different products and sensory parameters for evaluation



WP 2: Consolidate the existing knowledge in texture measurements, audio recording and analysis

- Consolidating knowledge of texture measurements in food and materials science related to auditive parameters
- Assembling the necessary equipment for audio capture for texture measurements
- Gathering the necessary software tools and packages to perform data processing (Data & not data-driven)



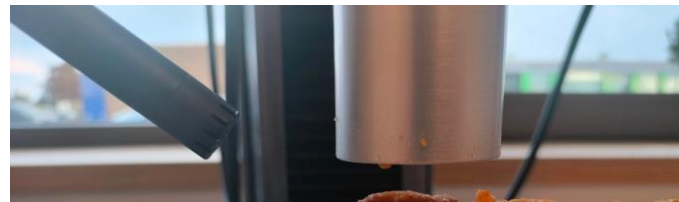
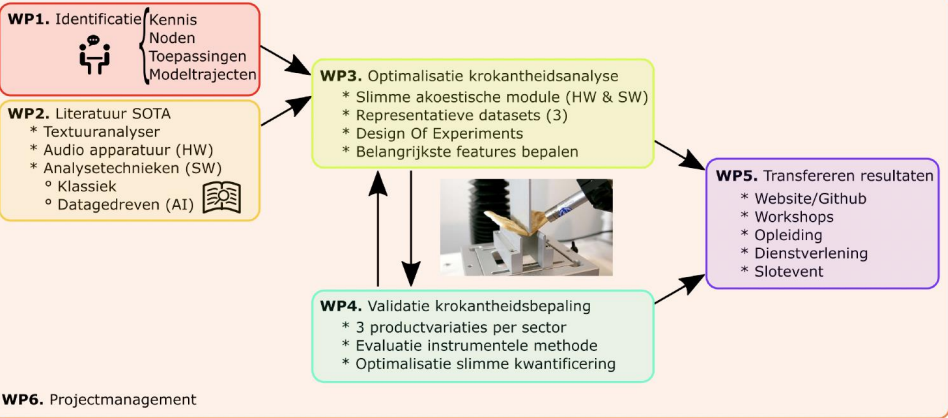
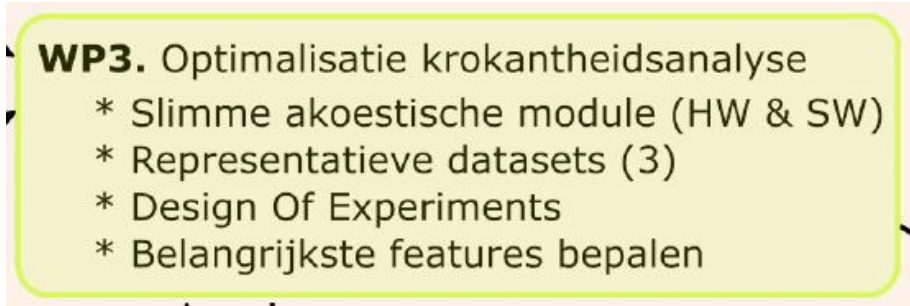
WP3: Determining optimal acoustic analysis/methods for at least three model products.

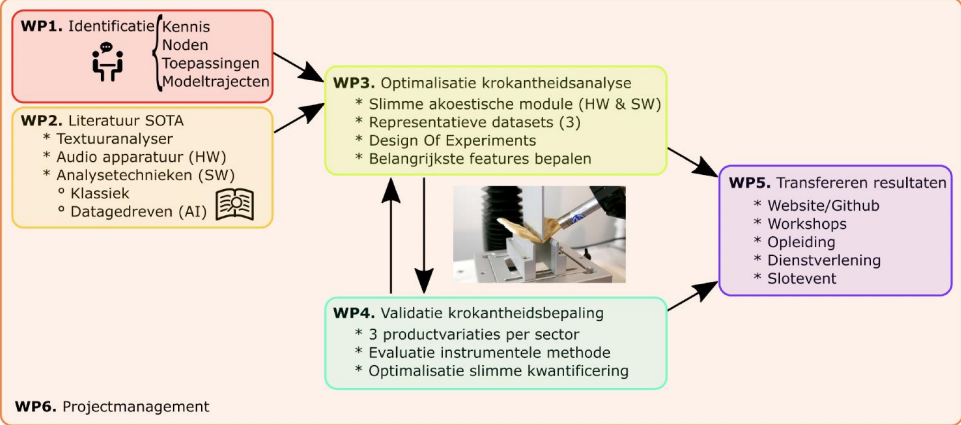
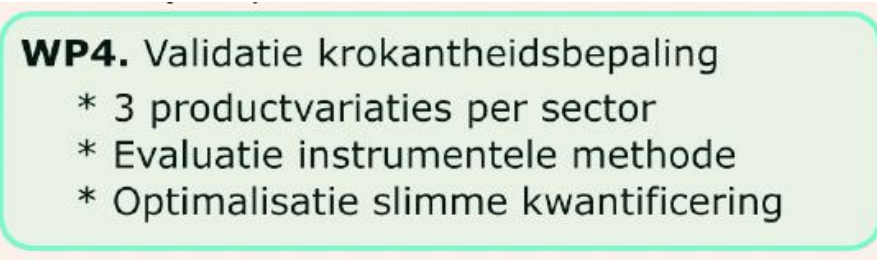
1- Development of a flexible audio module

2- Sample selection of the different model systems, and selection of variable (eg. storage time)

3- Statistical experimental design (DOE) & conducting experiments

4- Analyze experimental data: The previous activity generates audio signals for a rich set of experimental settings.





WP4: Validation of the method

Evaluation of the instrumental methods

1/ sensivity

2/ Repeatability

Correlation with sensory evaluation and finetuning of the method

(Optional) Adjusting the developed module from WP3:



MODEL PRODUCTS
(min 3)

PARAMETER 1

PARAMETER 2

PARAMETER 3

VARIATION 1

VARIATION 2

VARIATION 3

VARIATION 1

VARIATION 2

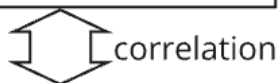
VARIATION 3

VARIATION 1

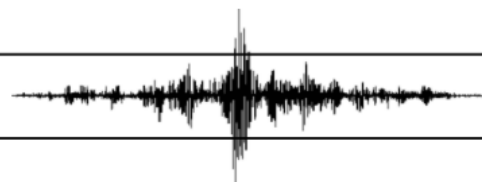
VARIATION 2

VARIATION 3

SENSORY ANALYSIS



ACOUSTIC ANALYSIS



MODEL PRODUCT X

3 PARAMETERS

e.g. : coating, new ingredient, warm holding, baking process

3 VARIATIONS

3 different coatings, warm holding times

ANALYSIS

WP5. Transfereren resultaten

- * Website/Github
- * Workshops
- * Opleiding
- * Dienstverlening
- * Slotevent

- * Website/Github
- * Workshops
- * Opleiding
- * Dienstverlening
- * Slotevent

- WP3. Optimalisatie krokantheidsanalyse**
- * Slimme akoestische module (HW & SW)
 - * Representatieve datasets (3)
 - * Design Of Experiments
 - * Belangrijkste features bepalen

- WP4. Validatie krokantheidsbepaling**
- * 3 productvarianties per sector
 - * Evaluatie instrumentele methode
 - * Optimalisatie slimme kwantificering

- WP1. Identificatie**
- o Kennis
 - o Noden
 - o Toepassingen
 - o Modeltrajecten

- WP2. Literatuur SOTA**
- * Textuuranalyser
 - * Audio apparatuur (HW)
 - * Analysetechnieken (SW)
 - o Klassiek
 - o Datagedreven (AI)

WP6. Projectmanagement

WP5: Knowledge Transfer

The 'KRAK' platform

www.project-krak.be

User: krak

Passw: food

TETRA KRAK Search

Startpagina Poster Use cases Evenementen

VLAIO TETRA KRAK

KRokantheid kwantificeren met AKoestische analyse

Binnen het kader van het **VLAIO TETRA** programma (Technologie TRAnsfer) starten **Hogeschool VIVES** en **KU Leuven** gezamenlijk onderzoek rond het bepalen van productkwaliteit van voedingsmiddelen aan de hand van geluidsanalyse.

VLAIO **hogeschool VIVES** **KU LEUVEN**

Projectsituering

De kwaliteitsvereisten voor de industrie worden steeds strenger en veeleisender waardoor kwaliteitscontrole accuraat dient te gebeuren. Binnen dit project wordt de toepasbaarheid van **akoestische methodes** binnen voedingssector verder onderzocht. Het analyseren van het geluid dat vrijkomt tijdens het gecontroleerd breken van een voedingsproduct is de

WP1. Identificatie



Kennis
Noden
Toepassingen
Modeltrajecten

WP2. Literatuur SOTA

- * Textuuranalyser
- * Audio apparatuur (HW)
- * Analysetechnieken (SW)
 - Klassiek
 - Datagedreven (AI)



WP3. Optimalisatie krokantheidsanalyse

- * Slimme akoestische module (HW & SW)
- * Representatieve datasets (3)
- * Design Of Experiments
- * Belangrijkste features bepalen



WP4. Validatie krokantheidsbepaling

- * 3 productvarianties per sector
- * Evaluatie instrumentele methode
- * Optimalisatie slimme kwantificering

WP5. Transfereren resultaten

- * Website/Github
- * Workshops
- * Opleiding
- * Dienstverlening
- * Slorevent

WP6. Projectmanagement

TETRA KRAK - Input modelproducten



<https://forms.office.com/e/MwwiqsAQ1Q>

KRAK

OP ZOEK NAAR DE PERFECTE
CRUNCH

JAN 2025–
DEC 2026

TETRA PROJECT

BEPALING VAN DE PRODUCTKwaliteit VAN VOEDING
AAN DE HAND VAN GEAVANCEERDE GELUIDSANALYSE



MET DE STEUN VAN

AGENTSCHAP
INNOVEREN &
ONDERNEMEN



Vlaanderen
is ondernemen



KU LEUVEN

EEN SAMENWERKING TUSSEN

hogeschool
vives

Feedback?

Michaël Verlinden

Michael.Verlinden@vives.be

hogeschool
VIVES

RESEARCH GROUP
FOOD PROCESSING

4

TOUR

1 Food Innovation Park



2 Audiolab

KRAK

OP ZOEK NAAR DE PERFECTE
CRUNCH

JAN 2025–
DEC 2026

TETRA PROJECT

BEPALING VAN DE PRODUCTKWALITEIT VAN VOEDING
AAN DE HAND VAN GEAVANCEERDE GELUIDSANALYSE



MET DE STEUN VAN

AGENTSCHAP
INNOVEREN &
ONDERNEMEN



Vlaanderen
is ondernemen



FLANDERS'
FOOD



EEN SAMENWERKING TUSSEN



HBC.2024.0136

www.project-krak.be

KRAK – Kick Off – 17 januari 2025