MONALISA:
Non-destructive technologies in post-harvest quality analysis

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Centro di Sperimentazione Agraria e Forestale
Research Centre for Agriculture and Forestry

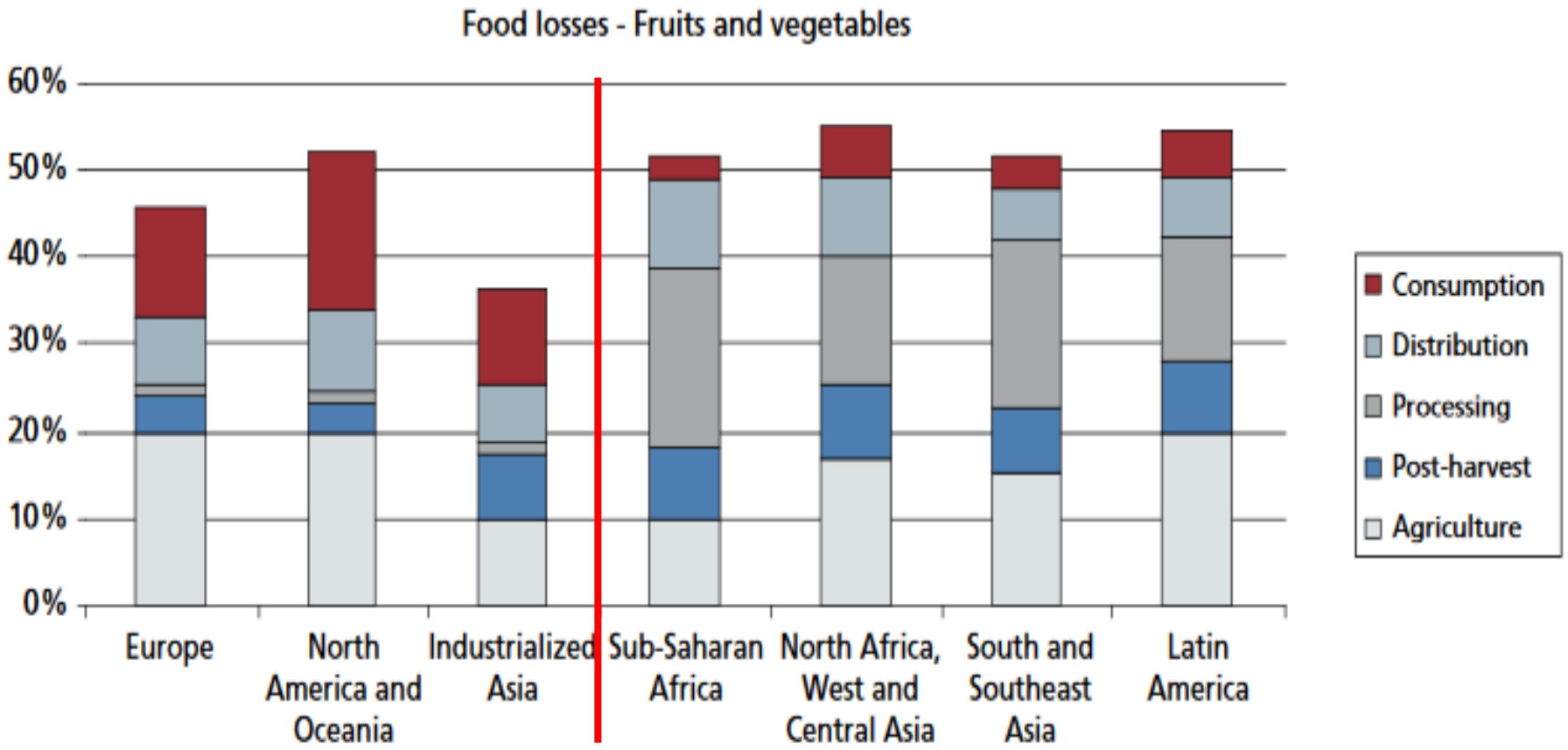
Environmental Sensing, 25th November 2016

MONALISA

Background – Apple market

- **Global** apple production ca. 81 Mio tonnes (FAOSTAT 2013)
  - South Tyrol:
    - 1.2 % of global apple harvest
    - 15 % of European
    - 50% of Italy‘s
- Competitive market conditions/ market saturation
- Ever-increasing consumers expectations on quality (Abbot 1999)

Background: Post-harvest losses



FAO. 2011. Global food losses and food waste – Extent, causes and prevention. Rome

QUALITY losses post-harvest

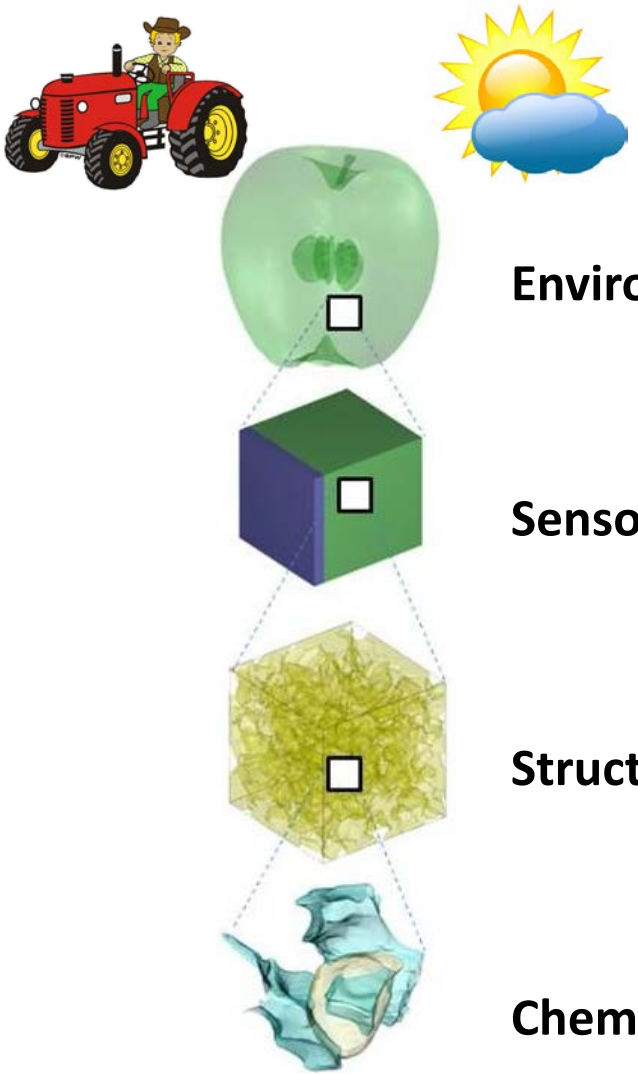
- The advanced fruit industry

  experiences significant post-harvest losses:

  → due to inferior quality of

  just a small harvest fraction !

Laimburg in MONALISA: Apple fruit quality



Environmental and pre-harvest factors

Sensorial quality attributes

Structural quality level

Chemical quality level

E. Herremanns, 2013

Fruit Quality: One pillar of MONALISA

- time span: 3 years (2013 - 2016)
- funded by the Autonomous Province of Bolzano
- Collaborating partners:
  the main South Tyrolean research organizations

EURAC research

IDM SÜDTIROL ALTO ADIGE

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Scope

Top technology scouting for:

- the non/destructive **assessment**
- the **prediction**

…of:

maturity, **quality** and **storage potential**

1/5) Handling Quality Variability

- Environmental factors
- Production methods
- Novel measuring methods
- **Database:** EURAC Bolzano, *Roberto Monsorno*
- **Prediction – Modelling for DSS**

  Cooperation with:

  Wageningen University, Netherlands

  Rob Schouten et Pol Tijskens

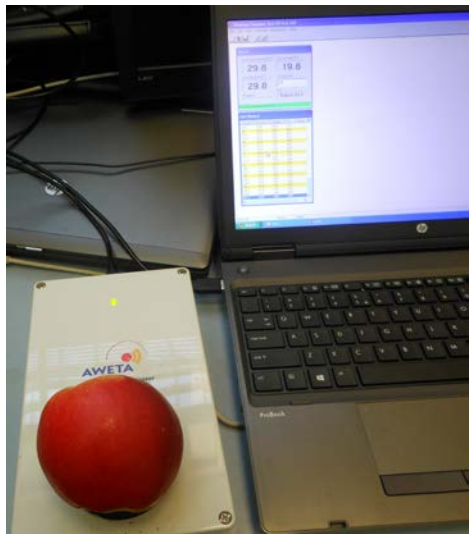
Pimprenelle (SSC, TA, FFF) at harvest

DA meter (IAD)

Amilon (Starch) at harvest

Dynamometer (FFF)

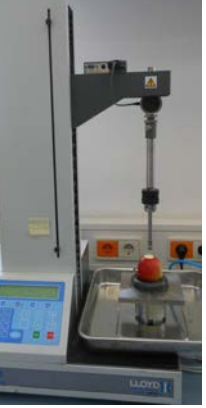
Multiplex (SFR_R; Cooperation G. Agati)



Acoustic Impact (AFS)

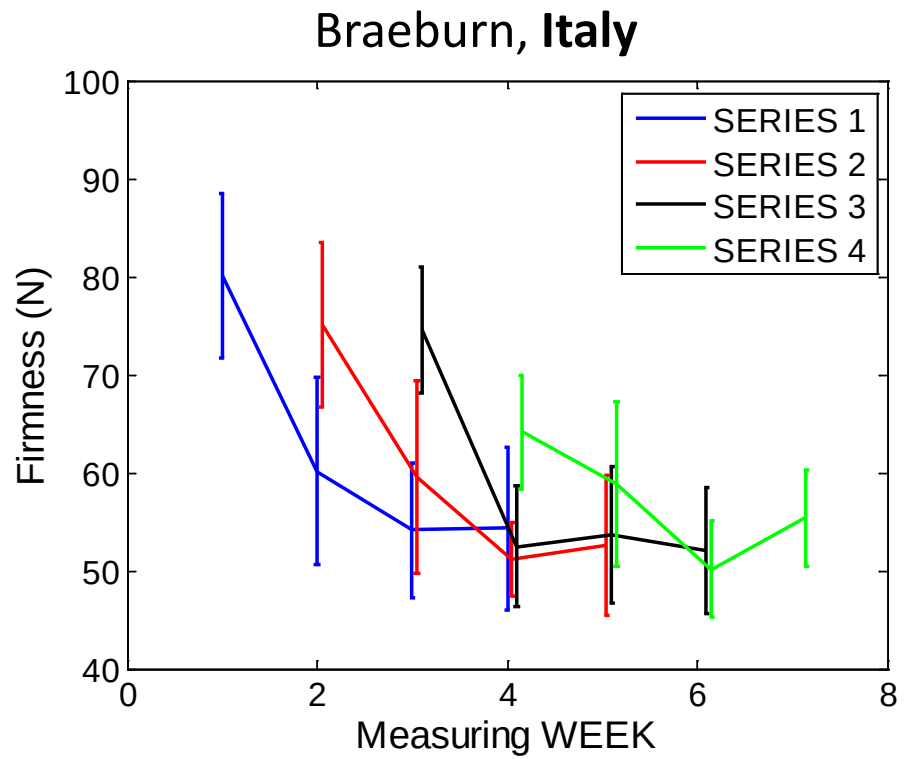
Modelling Texture changes in fruit flesh

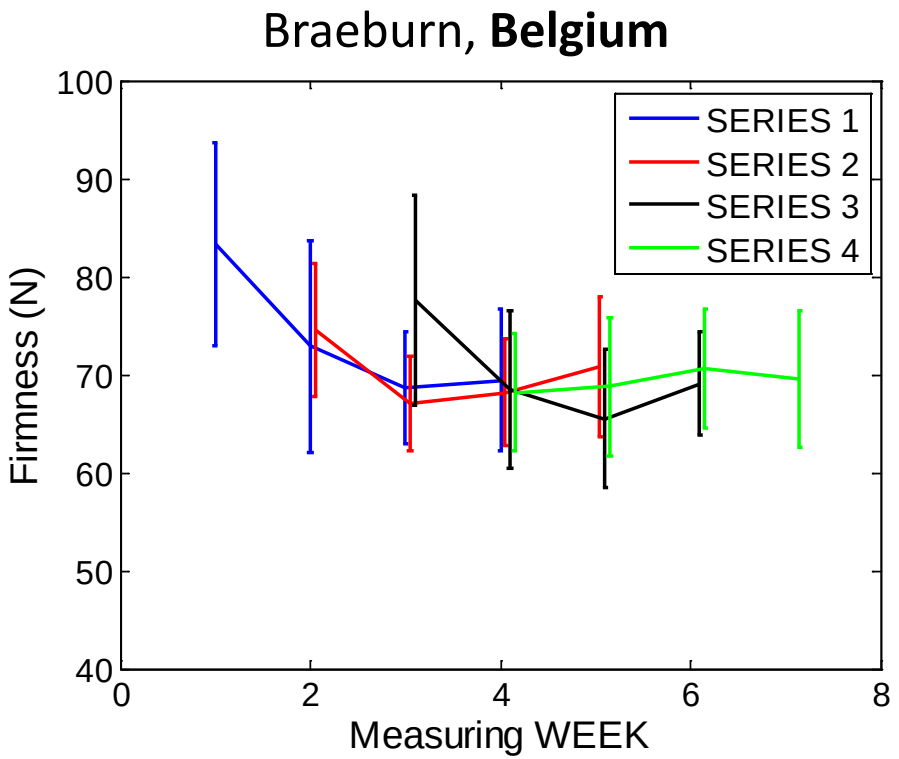
MT firmness – maximum force
Penetrometric value



Texture evolution in Europe

cv. Braeburn

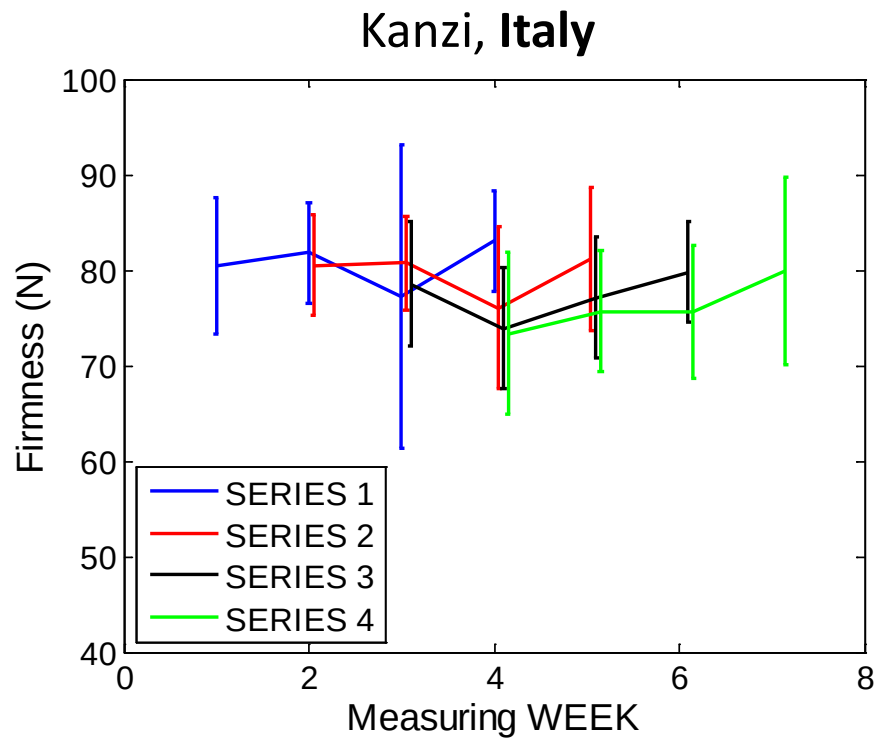


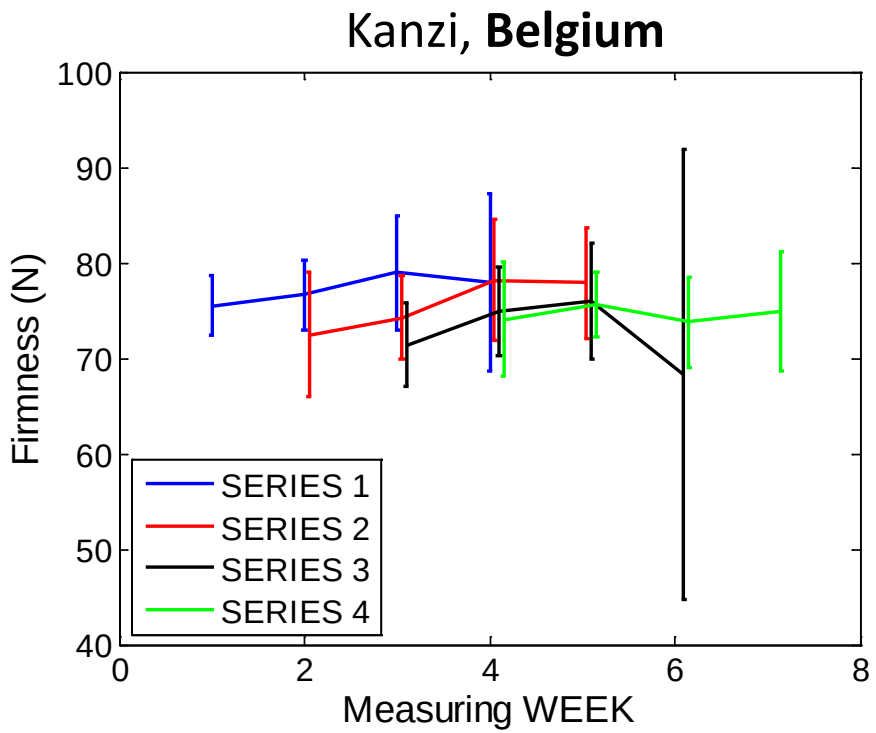


„Saeys et al.“

Texture evolution in Europe

cv. Nicoter/Kanzi(R)





„Saeys et al.“

HOW to mathematically model all this to get a PREDICTION system?

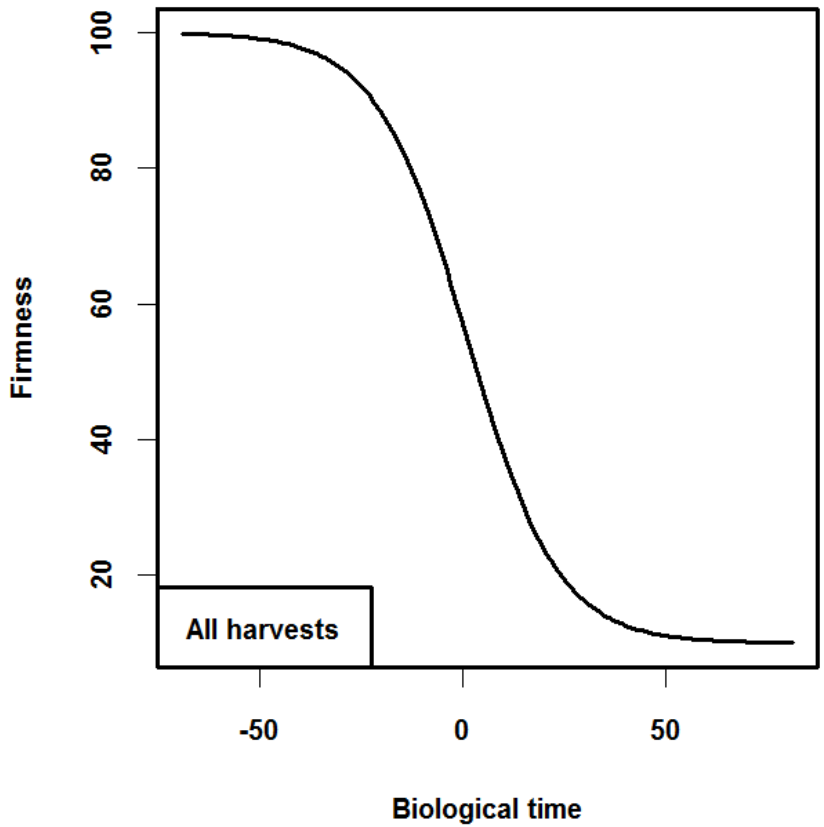
Sigmoidal model of „Quality“ after harvest

Frequently used for

- Firmness
- Colour
- Other variables

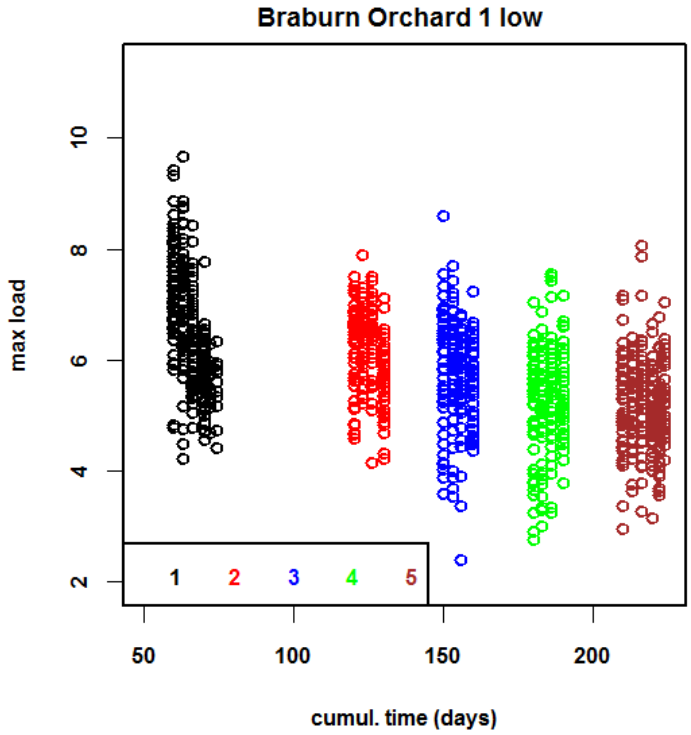
Logistic Model firmness

$$F = \frac{F_{max} - F_{min}}{1 + e^{-k \cdot (F_{max} - F_{min}) \cdot (t + \Delta t)}} + F_{min}$$



Texture after different storage durations

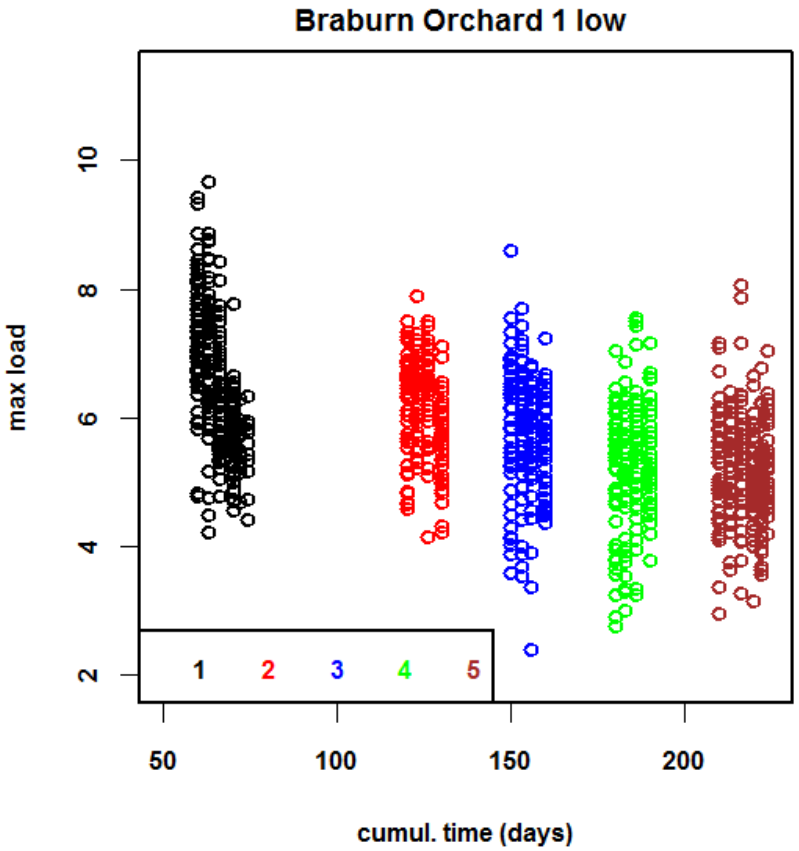
Biological variability is higher than the differences between different storage durations (age)



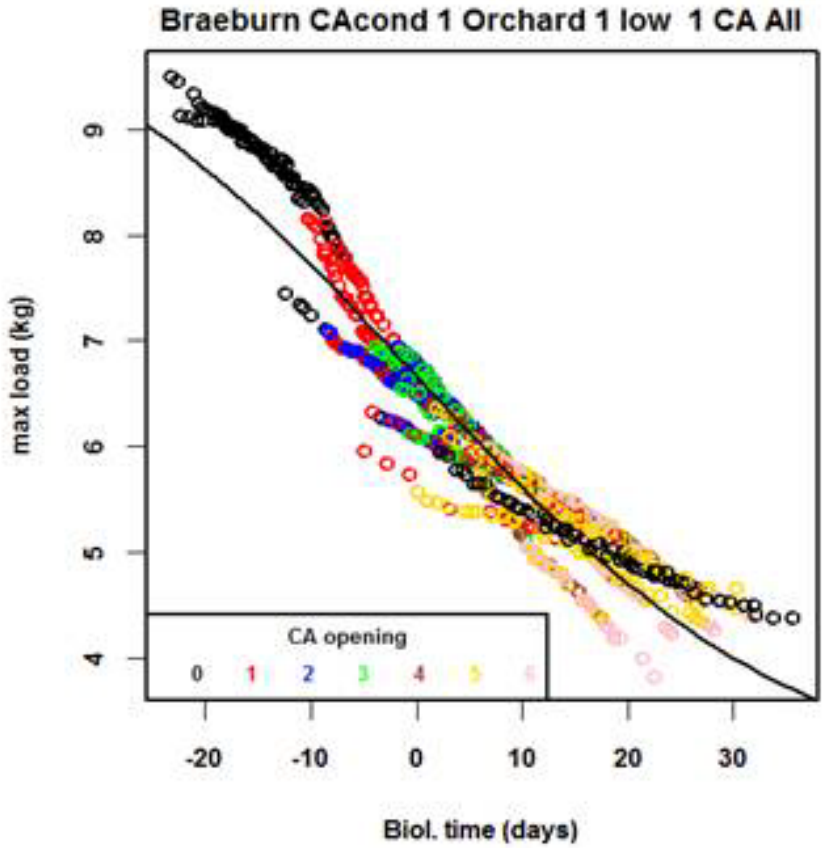
Probelation & Quantile regression

Biological variability and biological time

VARIABILITY



PROBELATION



„Schouten et Tijskens“

2/5) Non-destructive Texture Assessment of each fruit

What potential

lays in the *top-technologies*

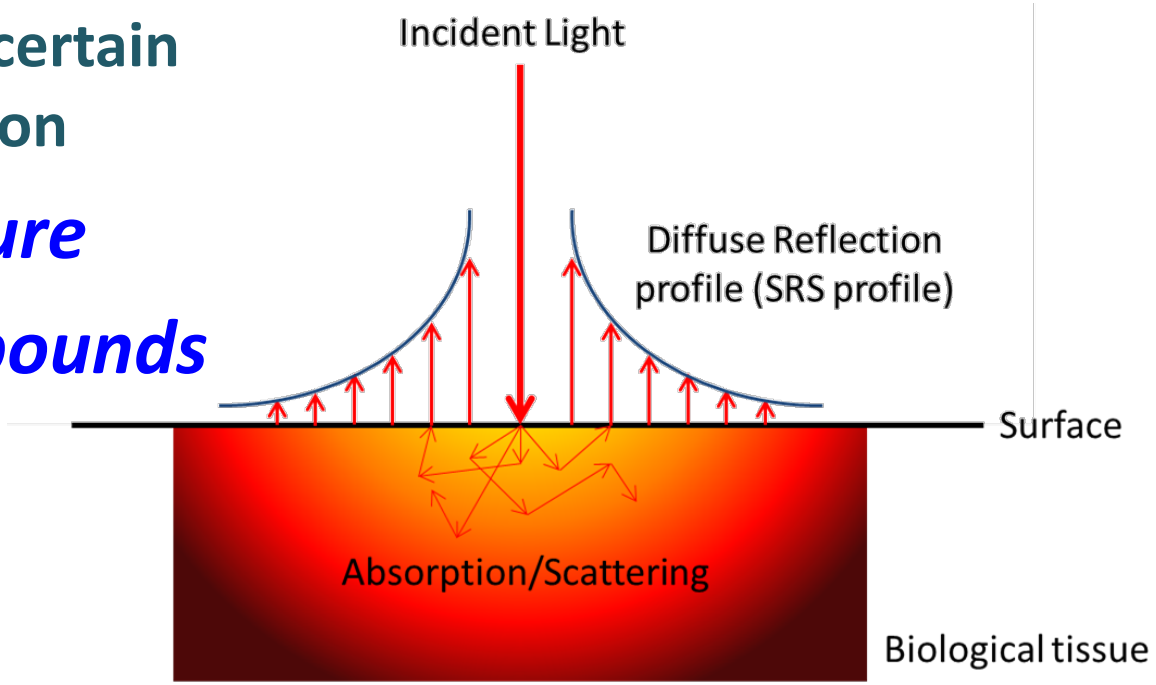
Cooperation with:

- **CNR Fotonica (Milano, I), *Spinelli & Vanoli et al.***
- **University of Leuven (Leuven, B), *Saeys et al.***

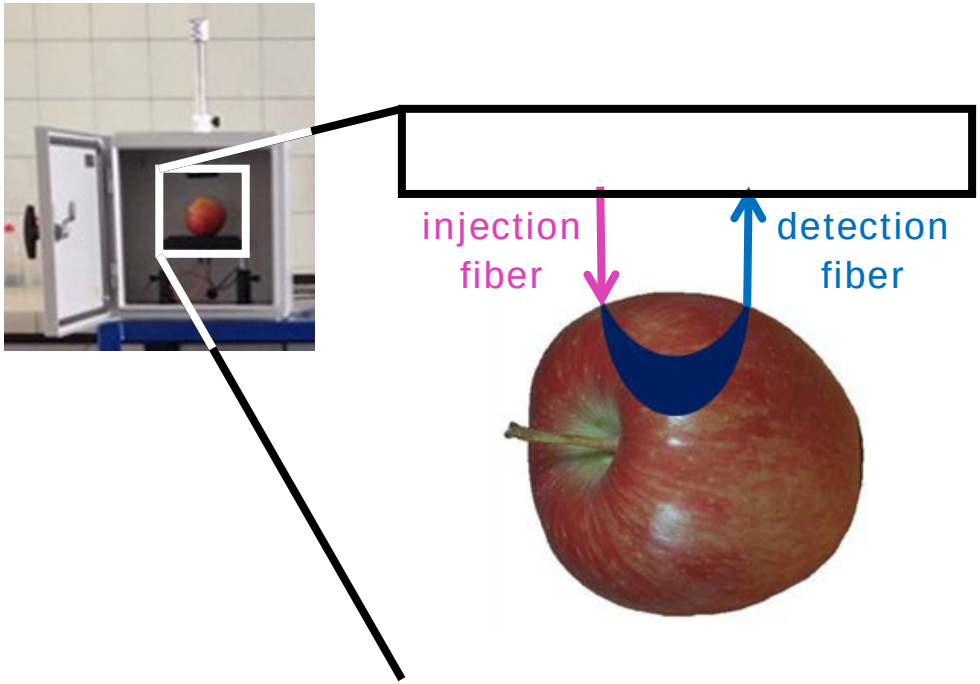
SRS - Space Resolved Spectroscopy (Leuven, B)

- Light entering the (biological) sample
  - spot/fiber illumination:
  - Interactance with tissue

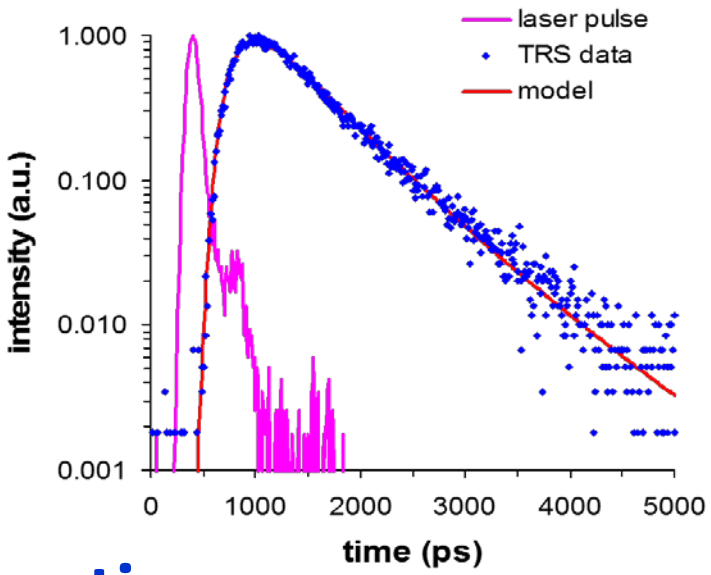
- **Collecting photons at a certain distance from illumination**
- **Scattering by *structure***
- **Absorption by *compounds***



TRS – Time Resolved Spectroscopy (Milano)



Suitable model describes photon propagation in diffuse media



Non-destructive assessment of **light-absorption** and **light-scattering** in the fruit flesh-structure by TRS for each fruit

- Scattering coefficient independent from wavelength (assumption)
- Chlorophyll and water koncentration calculated from the absorption spectra

3/5) „Scanning“ Internal Defects inside each fruit (Leuven, B)

What potential

lays in the *top-technologies*

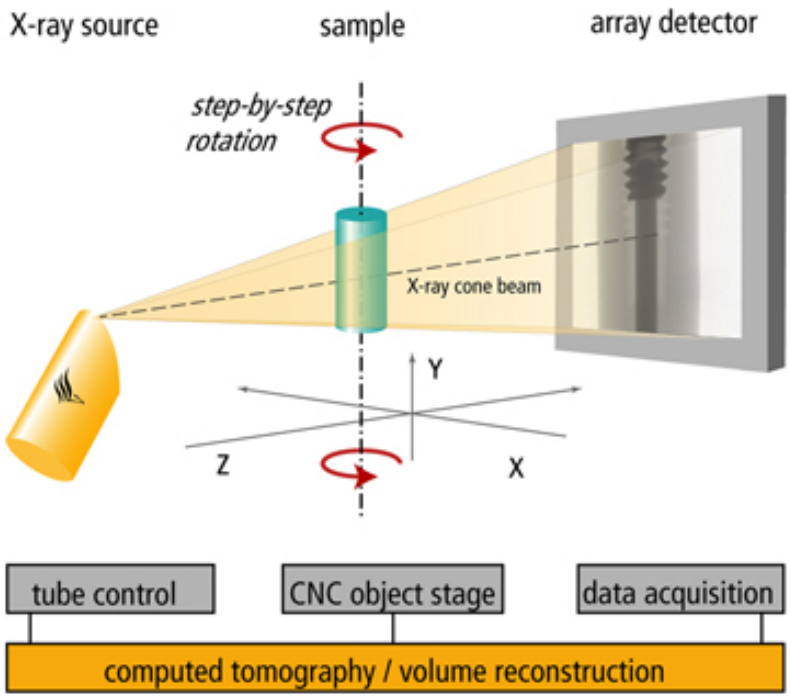
Cooperation with:

University of Leuven (Belgium)

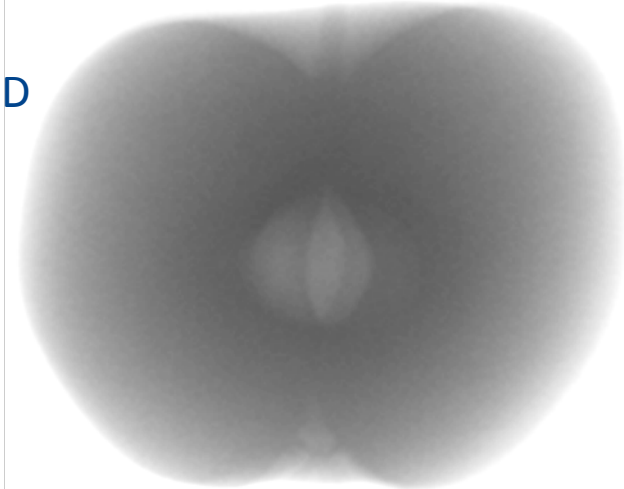
Verboven et al.

Top solution? Computer tomography (CT)

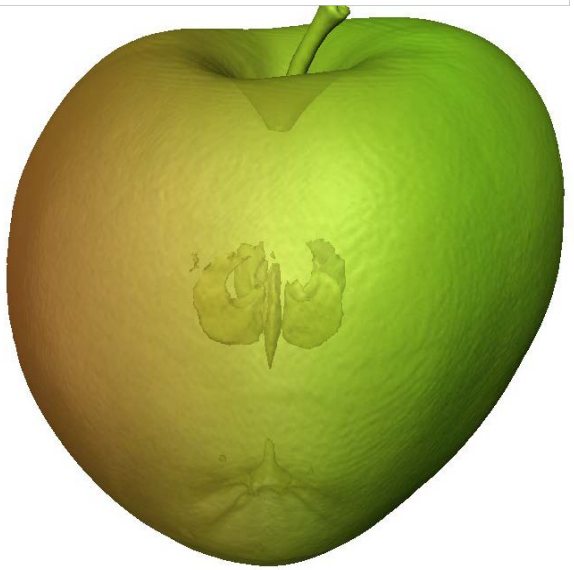
- Radiography (2D)
- Tomography (3D)



2D



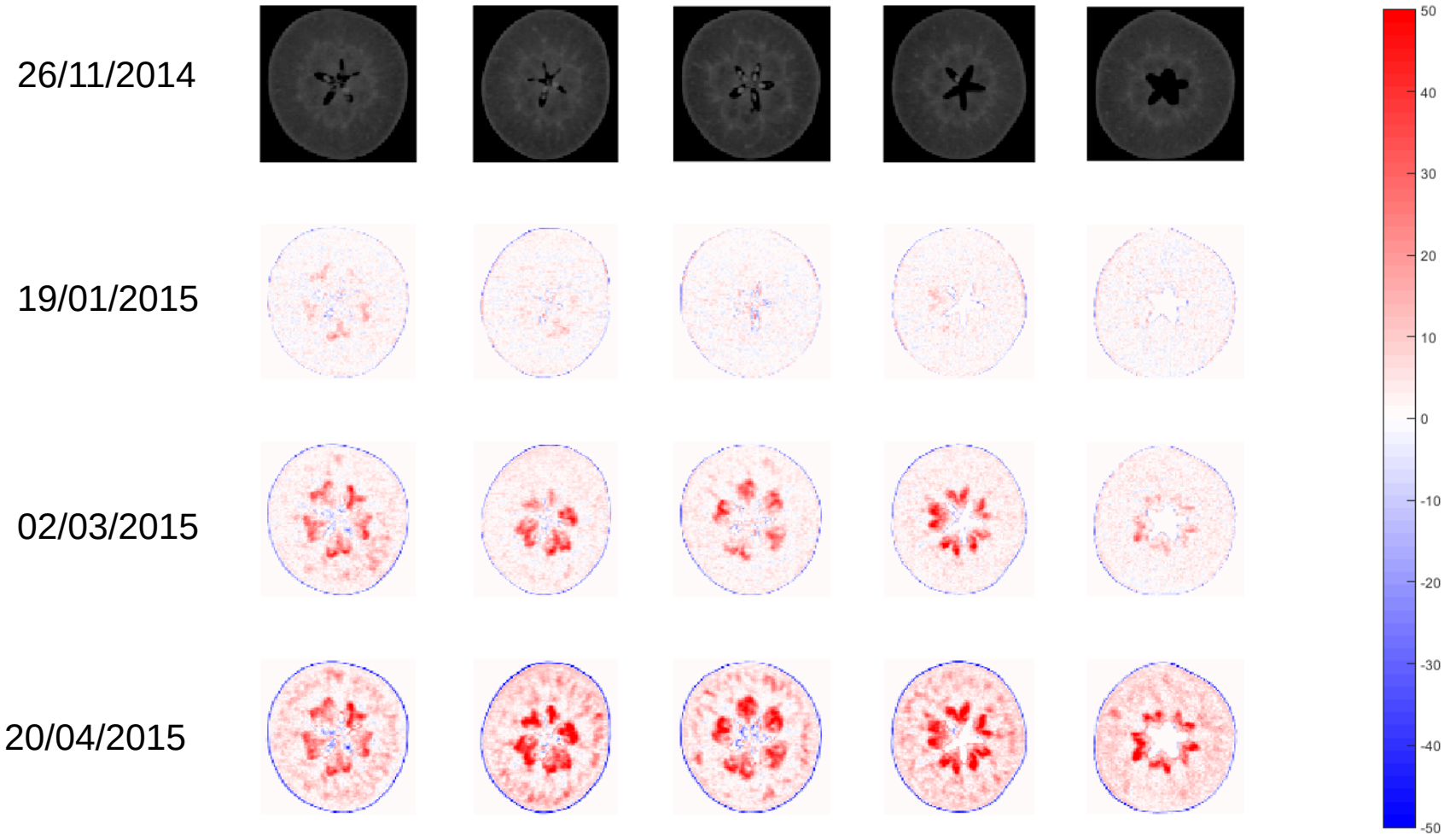
3D



Example: 3D image of internal structure of an apple

“Verboven et al.”

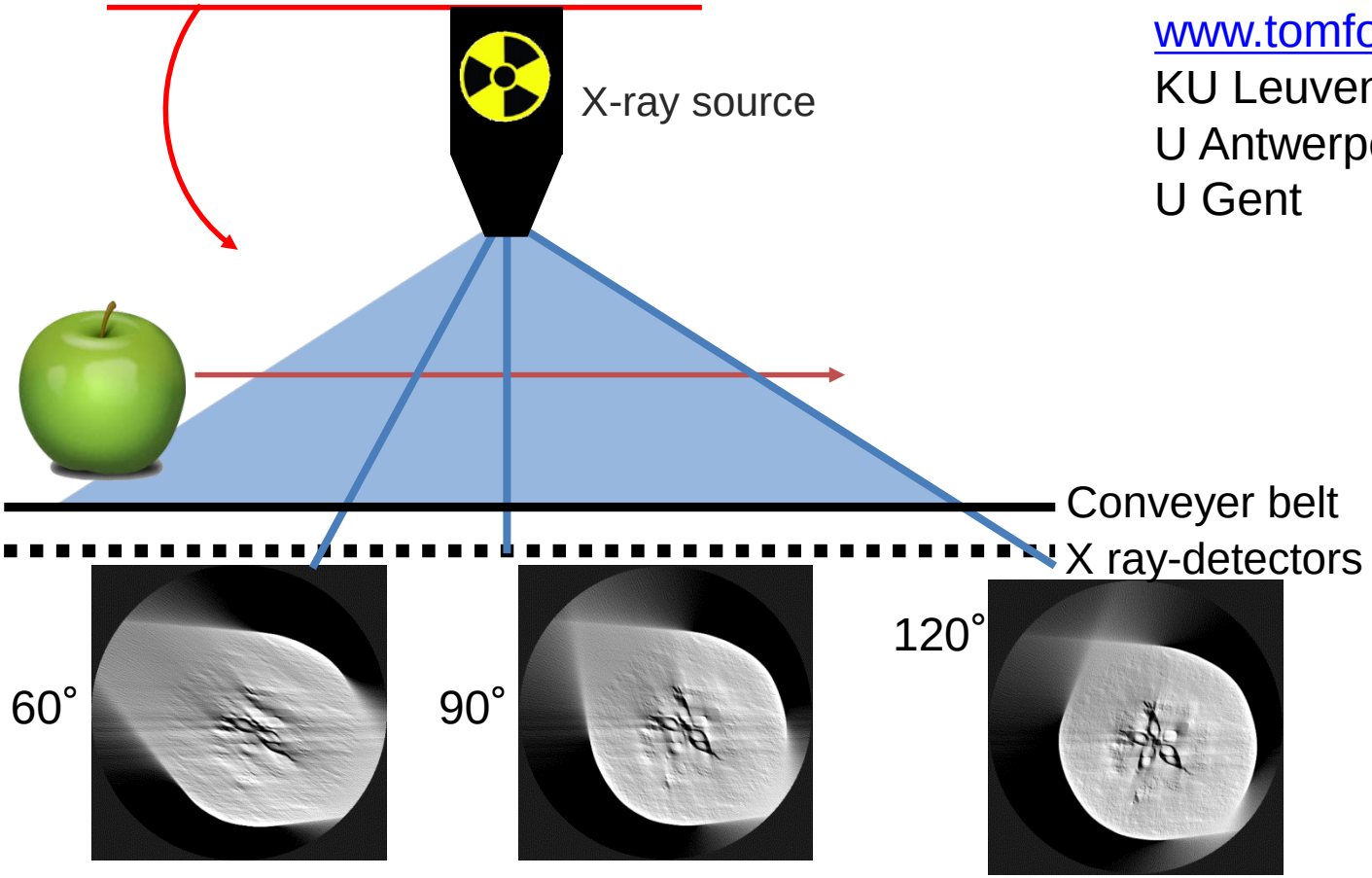
CT Scans: Braeburn Italy, defect-inducing



"Verboven et al."

Challenge: cost-effective inline CT

Limited amount of data in a limited amount of time



www.tomfood.be:
KU Leuven
U Antwerpen
U Gent

X-ray microcomputed tomography

Braeburn green cortex during Self-Life

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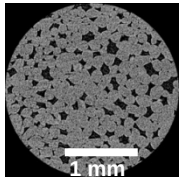
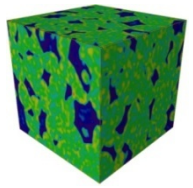
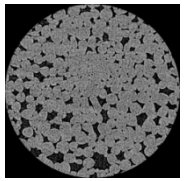
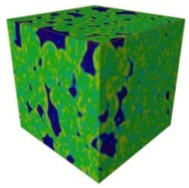
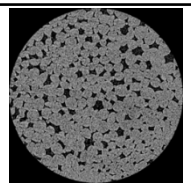
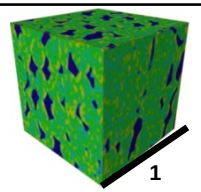
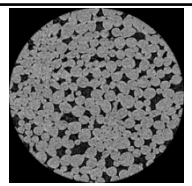
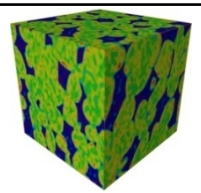
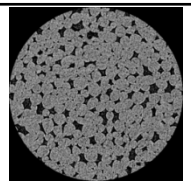
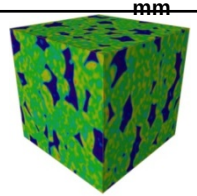
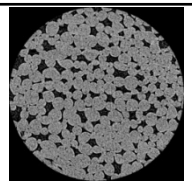
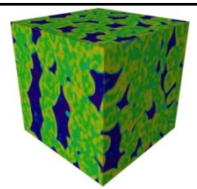
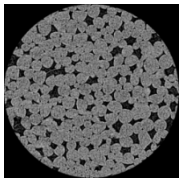
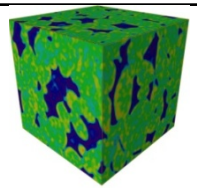
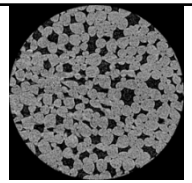
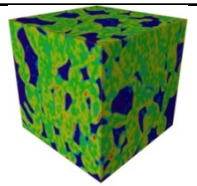
	Section	Volume	Section	Volume
1				
2				
3				
4				

"Verboven et al."

4/5) Measuring bio-active compounds non-destructively of each fruit

Which bio-active compounds are measurable with NIRS technologies

Cooperation with:

Res. Centre Laimburg (Italy)

Robatscher et al.

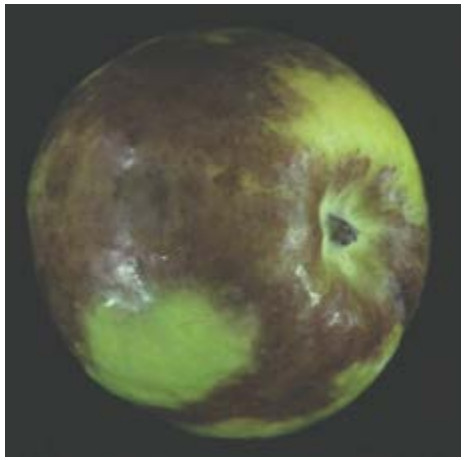
NIRS determination of nutraceuticals in the apple peel

- Vitamin C
- Antioxidant capacity (2 methods: FRAP, ABTS)
- Total polyphenol content
- Total anthocyanin content

On both shaded and sun-exposed side of 27 apple cultivars

Non-destructive measurements for apple superficial scald biomarkers

Monitoring of the relevant biomarkers and their correlations with superficial scald in apples during storage:



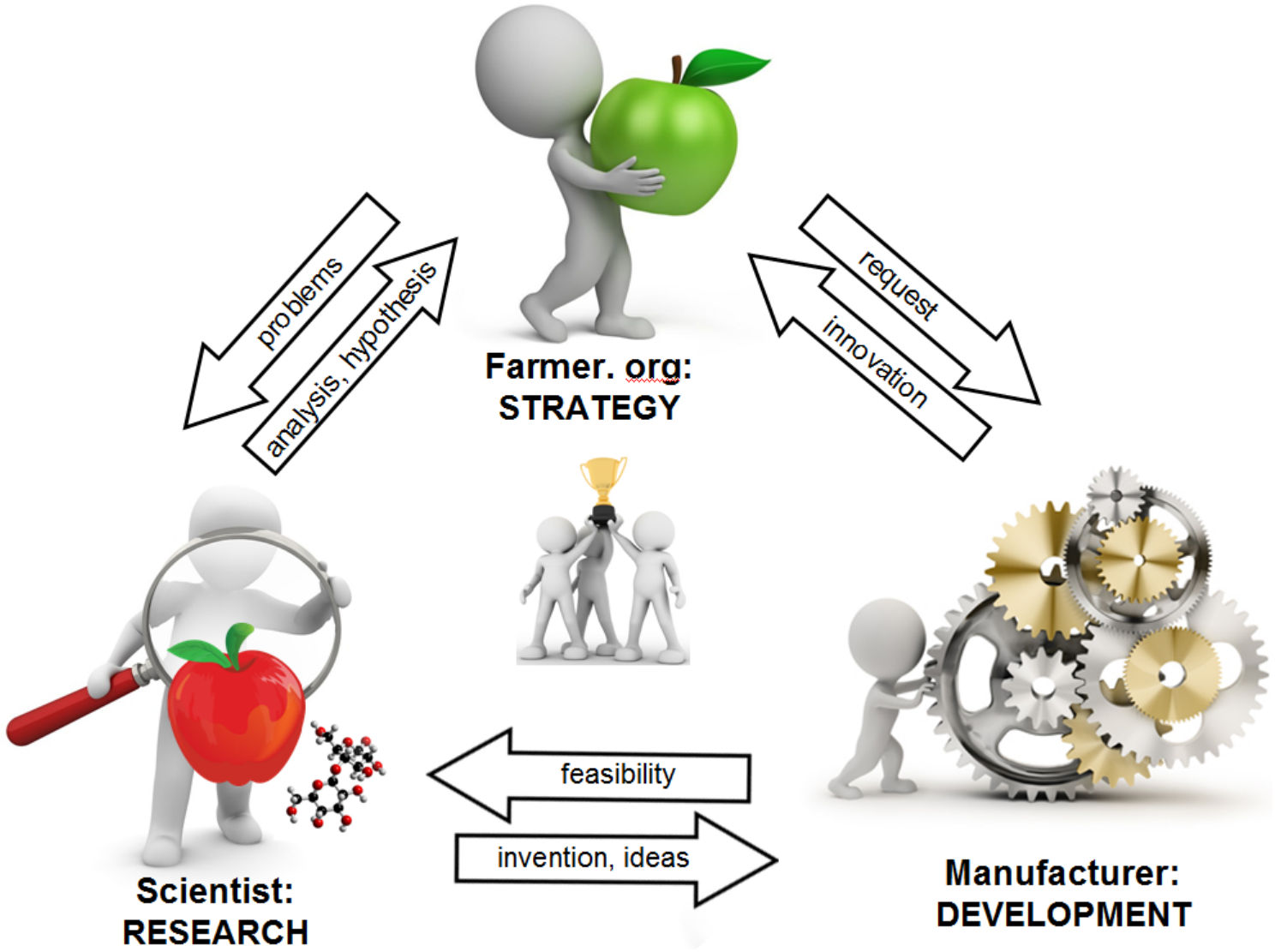
- α-farnesene
- conjugated trienols (CTols)

5/5) Last but not least….
Research interacts with „Users“

- USER: device-manufacturers, producer organizations

- To collect ideas, wishes, opinions and suggestions from USER on:
  - -Current objectives
  - -Challenges, gaps
  - -Feed-back and Future collaboration

The User Interaction



Thank you for your kind attention!

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