

# **HYPERSPECTRAL IMAGING IN FOOD INDUSTRY**



# COMPAN

World leading manufacturer and supplier for hyperspectral imaging technology and solutions.

- Business worldwide
- Headquarters in Oulu, Finland
- 25+ years of experience



# EXPERTI

Spectrographs and spectral cameras

- Lab systems
- Field measurements
- Airborne measurements



# Remote Sensing

*Airborne hyperspectral imaging  
detects and classifies targets*



Geological  
exploration



**Environmenta  
l health**



Inspection of  
manmade  
infrastructure



**Precision  
Agriculture**




Law  
enforcement  
& military




# Detection & Identification


*Hyperspectral imaging  
sees much more than the human eye*



**Plant  
disease and  
stress  
detection,  
phenotyping**



**Food, fruit,  
vegetable,  
grain, seed  
quality  
sorting**



Forensics  
sample and  
crime scene  
inspection



Skin  
anomalies  
detection




Life sciences

# Colour

*Hyperspectral imaging accurately measures colours*



Printing  
process  
monitoring



Display  
quality &  
colour  
accuracy



**Colour  
conformity  
check of  
manufacture  
d products**




Art analysis &  
restoration

# Chemical imaging


*Hyperspectral mapping of chemical compositions*



**Waste material sorting & recycling**




**Bulk material monitoring, moisture content, foreign material detection**



Composition of pharmaceutical products



**Quality of food raw materials & products**



Mineral mapping of geological samples

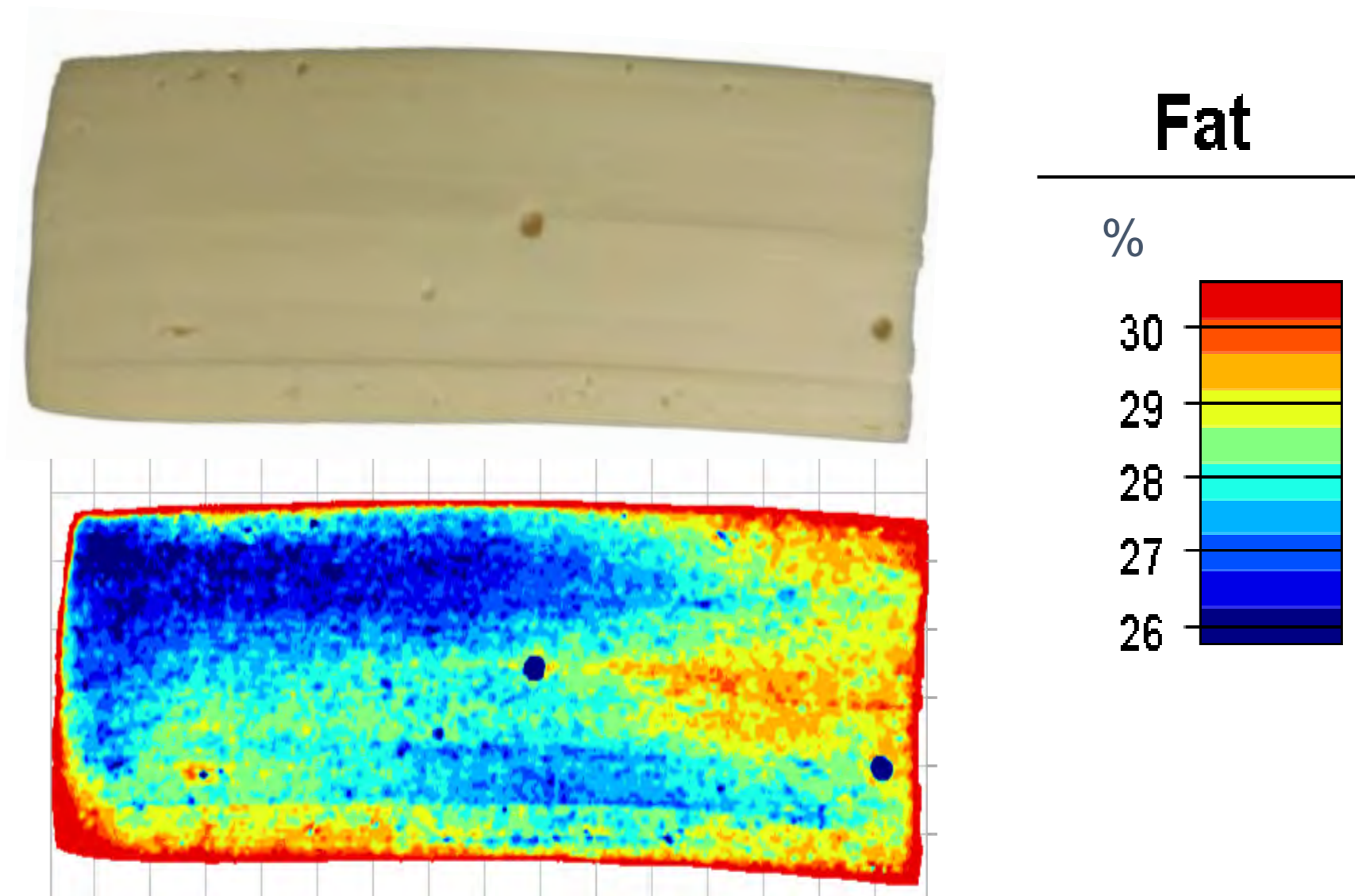
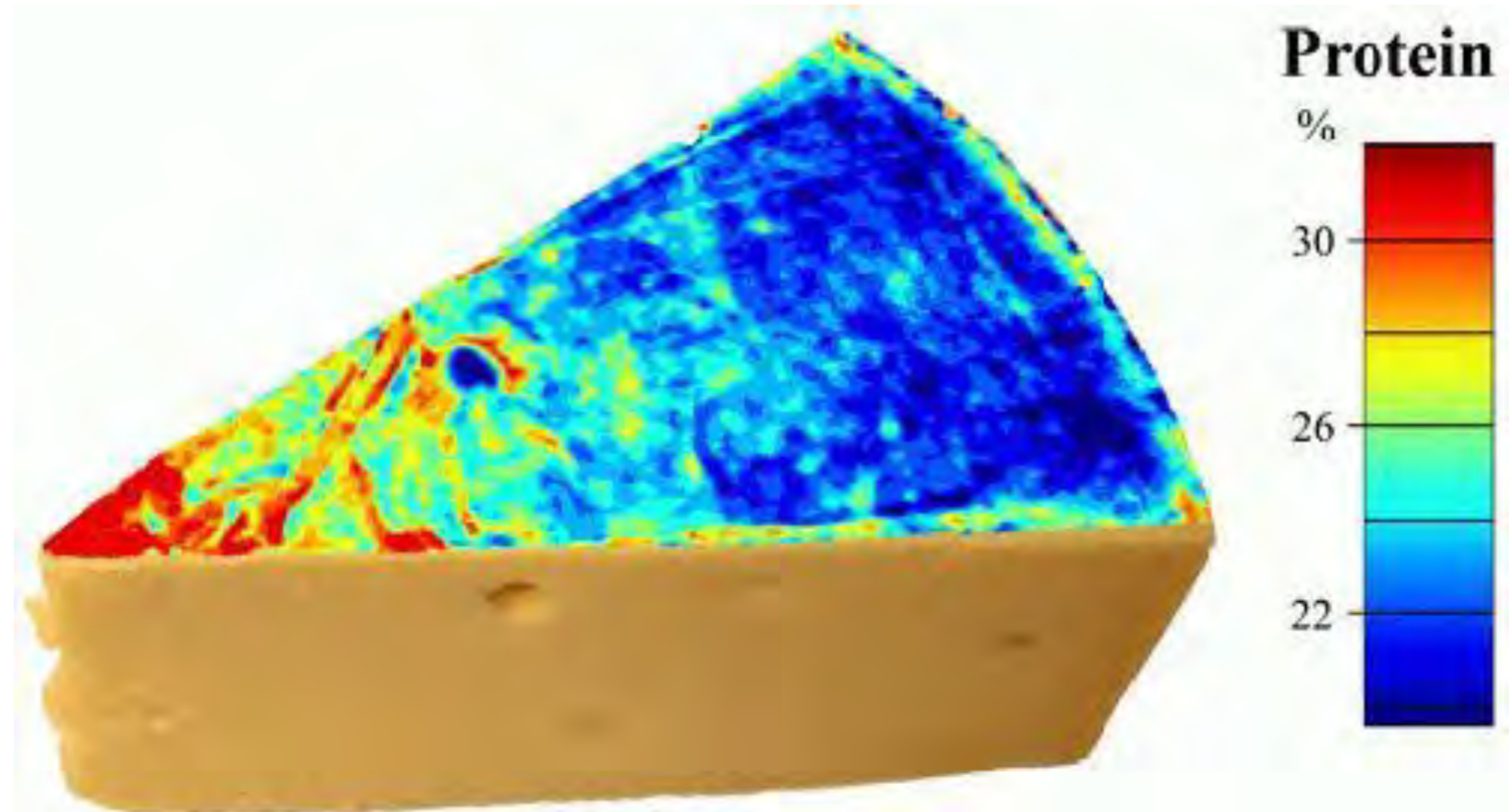


**Fake/Threat detection**

# Drivers to food industry

- Combines chemical composition and image
- Non-contact, non-destructive optical method
- Safe, fast, reliable, on-line
- Real time results and sorting of rejected items
- Laboratory, on-line and portable solutions

# EXAMPLE: CHEESE





# Articles

Hyperspectral imaging applications for food and agricultural products.

Class	Product	Application	Image acquisition method	Wavelength (nm)	Reference
Fruits and Nuts	Apple	Bruise detection	Line-scan reflectance	900–1700	Lu (2003)
	Apple	Bitter pit detection	Line-scan reflectance	954–1350	Nicolaï et al. (2006)
	Apple	Firmness evaluation	Area-scan scattering	650–1000	Peng and Lu (2006)
	Apple	Defect and feces detection	Line-scan reflectance/fluorescence	400–1000	Kim et al. (2007)
	Banana	Quality and maturity evaluation	Line-scan reflectance	400–1000	Rajkumar et al. (2012)
	Cantaloupe	Feces detection	Line-scan fluorescence	425–774	Vargas et al. (2005)
	Cherry	Pit detection	Line-scan transmittance	450–1000	Qin and Lu (2005)
	Citrus	Rottenness detection	Area-scan reflectance	460–1020	Gómez-Sanchis et al. (2008)
	Citrus	Canker detection	Line-scan reflectance	450–930	Qin et al. (2009)
	Grape	Quality evaluation	Line-scan reflectance	400–1000	Baiano et al. (2012)
	Peach	Firmness evaluation	Line-scan scattering	500–1000	Lu and Peng (2006)
	Strawberry	Quality evaluation	Line-scan reflectance	400–1000	ElMasry et al. (2007)
	Walnut	Shell and meat differentiation	Line-scan fluorescence	425–775	Zhu et al. (2007)
	Vegetables	Cucumber	Chilling injury detection	Line-scan reflectance	447–951
Cucumber		Quality evaluation	Line-scan reflectance/transmittance	400–1000	Ariana and Lu (2008)
Mushroom		Bruise detection	Line-scan reflectance	400–1000	Gowen et al. (2008)
Onion		Sour skin disease detection	Area-scan reflectance	950–1650	Wang et al. (2012)
Potato		Cooking time prediction	Line-scan reflectance	400–1000	Nguyen Do Trong et al. (2011)
Tomato		Ripeness evaluation	Line-scan reflectance	396–736	Polder et al. (2002)
Meat		Beef	Tenderness evaluation	Line-scan reflectance	400–1000
	Beef	Microbial spoilage detection	Line-scan scattering	400–1100	Peng et al. (2011)
	Chicken	Skin tumor detection	Line-scan reflectance	420–850	Chao et al. (2002)
	Chicken	Feces and ingesta detection	Line-scan reflectance	400–900	Park et al. (2002)
	Chicken	Bone fragment detection	Line-scan reflectance/transmittance	364–1024	Yoon et al. (2008)
	Fish	Moisture and fat evaluation	Line-scan reflectance	460–1040	ElMasry and Wold (2008)
	Fish	Ridge detection	Line-scan reflectance	400–1000	Sivertsen et al. (2009)
	Lamb	Lamb type discrimination	Line-scan reflectance	900–1700	Kamruzzaman et al. (2011)
	Pork	Quality evaluation	Line-scan reflectance	430–1000	Qiao et al. (2007)
Grains	Corn kernel	Constituent evaluation	Area-scan transmittance	750–1090	Cogdill et al. (2004)
	Corn kernel	Oil and oleic acid evaluation	Area-scan reflectance	950–1700	Weinstock et al. (2006)
	Corn kernel	Aflatoxin detection	Line-scan fluorescence	400–600	Yao et al. (2010)
	Wheat kernel	Fungus detection	Area-scan reflectance	1000–1600	Zhang et al. (2007)
	Wheat kernel	Sprout damage detection	Line-scan reflectance	1000–2500	Xing et al. (2009)
	Wheat kernel	Fusarium damage detection	Line-scan reflectance	400–1700	Delwiche et al. (2011)
Beverages	Milk	Fat content evaluation	Line-scan scattering	530–900	Qin and Lu (2007)
	Milk	Melamine detection	Point-scan Raman	102–2538 cm <sup>-1</sup>	Qin et al. (2010)
	Tea	Quality classification	Line-scan reflectance	408–1117	Zhao et al. (2009)

# Meat, fish



- **Tenderness**

Cluff *et al.*, 2008  
Naganathan *et al.*, 2008a,b  
Peng and Wu, 2008

- **Microbial load**

Peng *et al.*, 2009



- **Quality prediction**

Qiao *et al.*, 2007a  
Qiao *et al.*, 2007b  
Qiao *et al.*, 2007c

- **Microbial load**

Peng and Wang, 2008



- **Tumour detection**

Kong, 2003,  
Kong *et al.*, 2004  
Nakariyakul and  
Casasent, 2004, 2007

- **Fecal contamination**

Heitschmidt *et al.*, 2007  
Lawrence *et al.*, 2004  
Park *et al.*, 2002  
Park *et al.*, 2006a



- **Predicting fat, water & salt**

ElMasry and Wold, 2008  
Segtnan *et al.*, 2009b

- **Detection of parasites**

Wold *et al.*, 2001  
Heia *et al.*, 2007

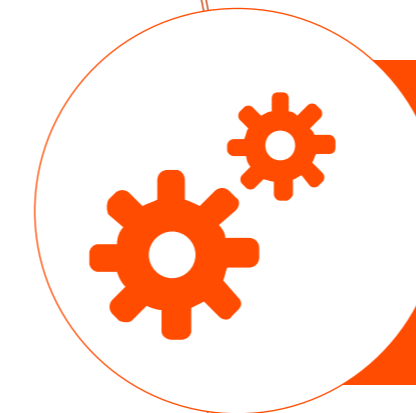
# Hyperspectral Imaging

Imaging Spectrographs  
Hyperspectral Cameras & Accessories  
Hyperspectral Imaging Solutions



## Turnkey solutions

- Airborne
- Geological Core Logging
- Chemical Imaging



## Cores for OEM's & System Integrators

- Process Control QA
- Life Sciences
- Machine Vision



## Research

- System chain from lab to field

**SPECIM**



**SPECTRAL IMAGING**