Rask og ikke-destruktiv sortering av krabber

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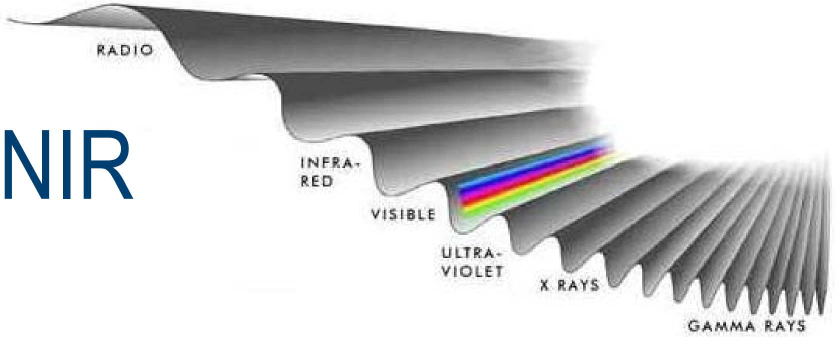
Oversikt

- Mål: Utvikle metode for rask og ikke-destrktiv måling av matfylde i krabber
  - Industriell sortering
  - System for sortering ombord
- Aktive partnere: Møreforskning, TI, QVision, Hitramat and NofimaMat

- Utgangspunkt: Instrument basert på nærinfrarød (NIR) spektroskopi spectroscopy
- Instrument installert hos Hitramat i 2007, koblet til automatisk grader
- Mange målinger er gjort for å kalibrere systemet

ADVARSEL - KLEMFARE
HOLD AVSTAND

Near-infrared spectroscopy - NIR



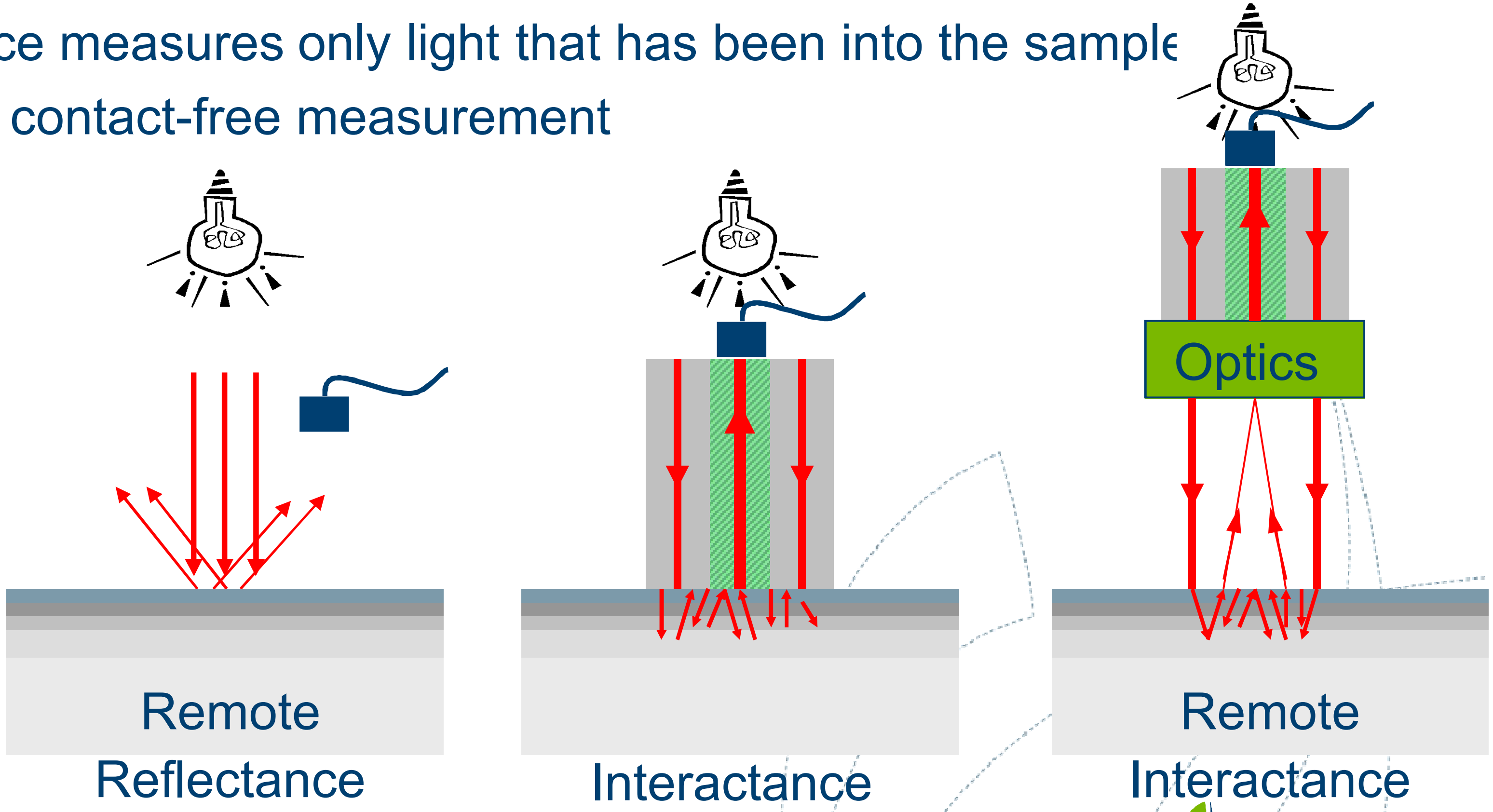
- Spectral range 800-2500 nm
  - near-NIR: 800-1100 nm, high penetration depth

- Enables measurement of the main components in foods:
  - fat, water, protein, sugars, salt, etc…..

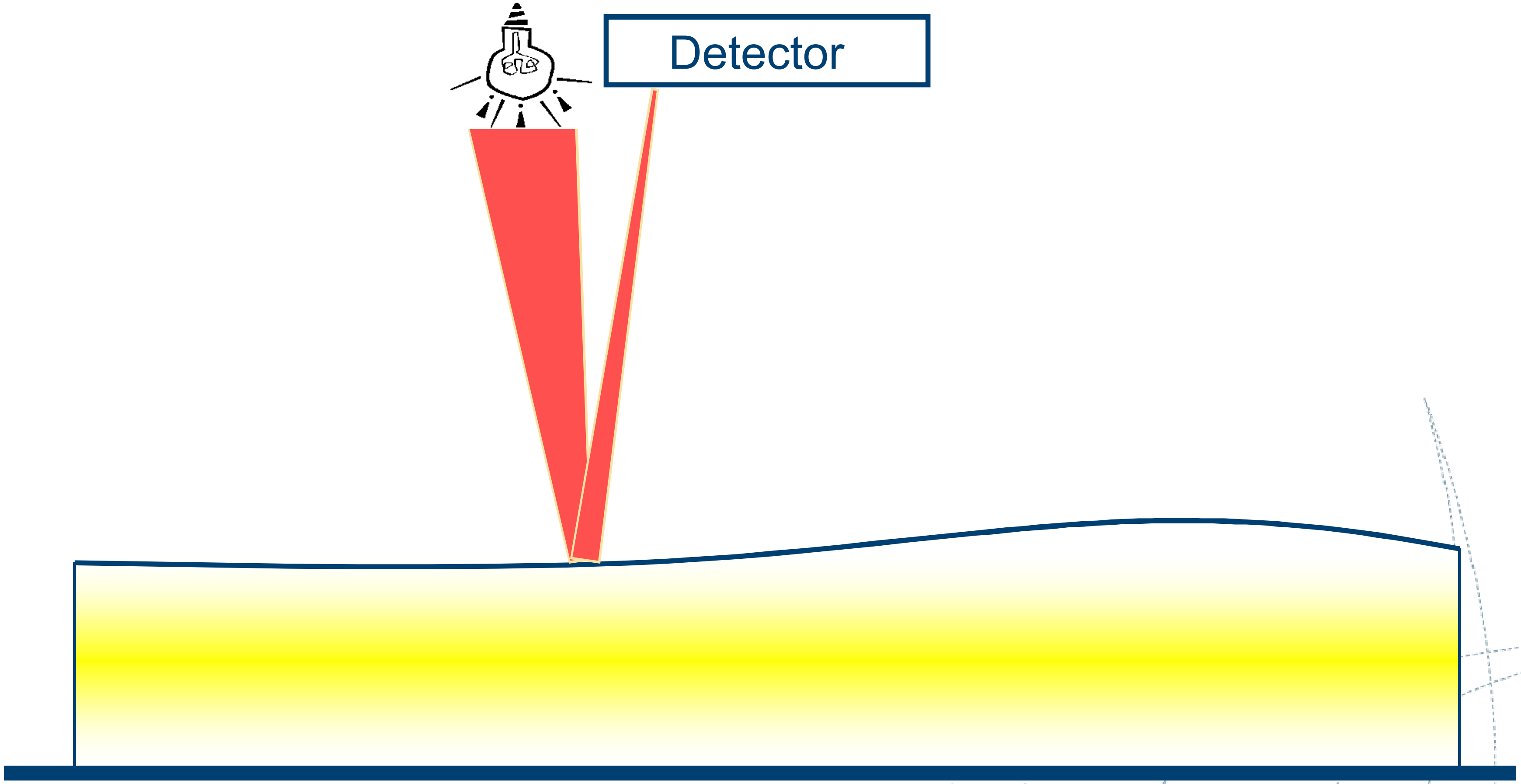
- Many different on/at-line systems for foods exist
  - Protein i grains
  - Sugar in fruits (apples, oranges, etc.), where measurements are done through the skin/peel.
  - On-line determination of fat, water, protein in ground meat
  - On-line determination of water in potatoe chips
  - On-line determination of fat in salmon fillets
  - Fat, water and protein in animal feed

NIR optical sampling

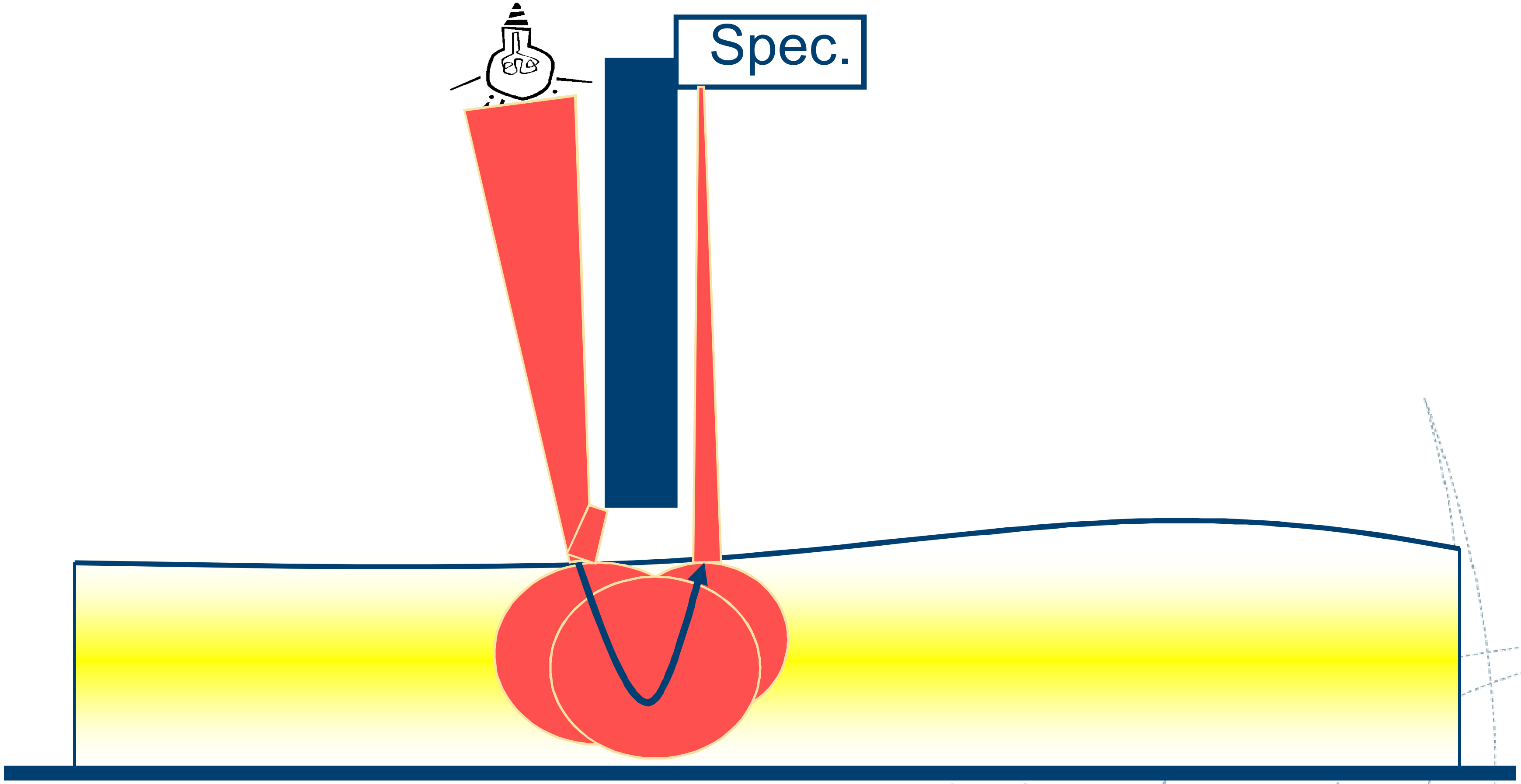
- Transmission is difficult in on-line setting
- Reflection does not reflect the interior of the sample
- Interactance measures only light that has been into the sample
- Preferably contact-free measurement


Optics
Remote
Reflectance
Interactance
Remote
Interactance

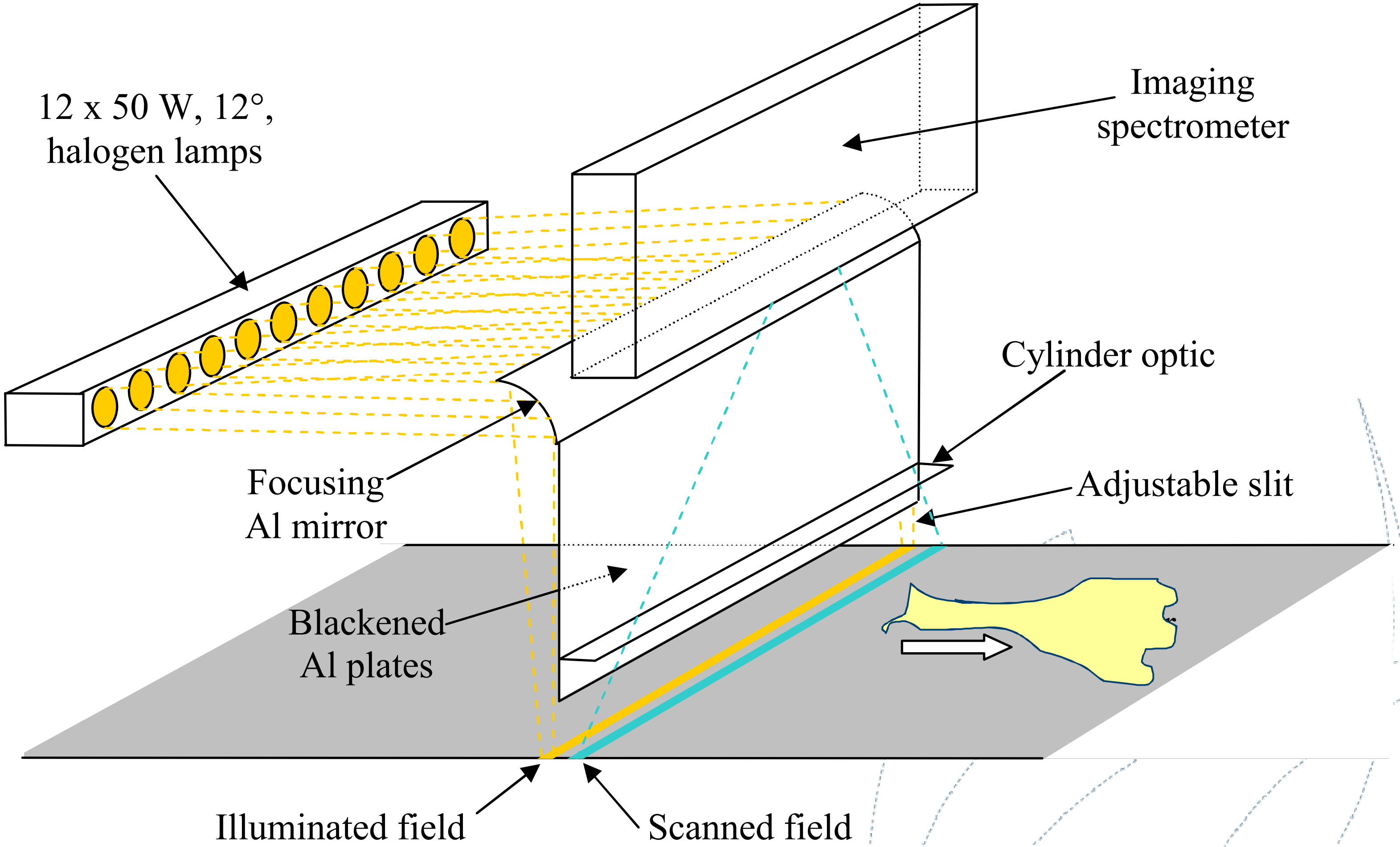
Reflection: Measures the surface



Interactance: Forces light into the product



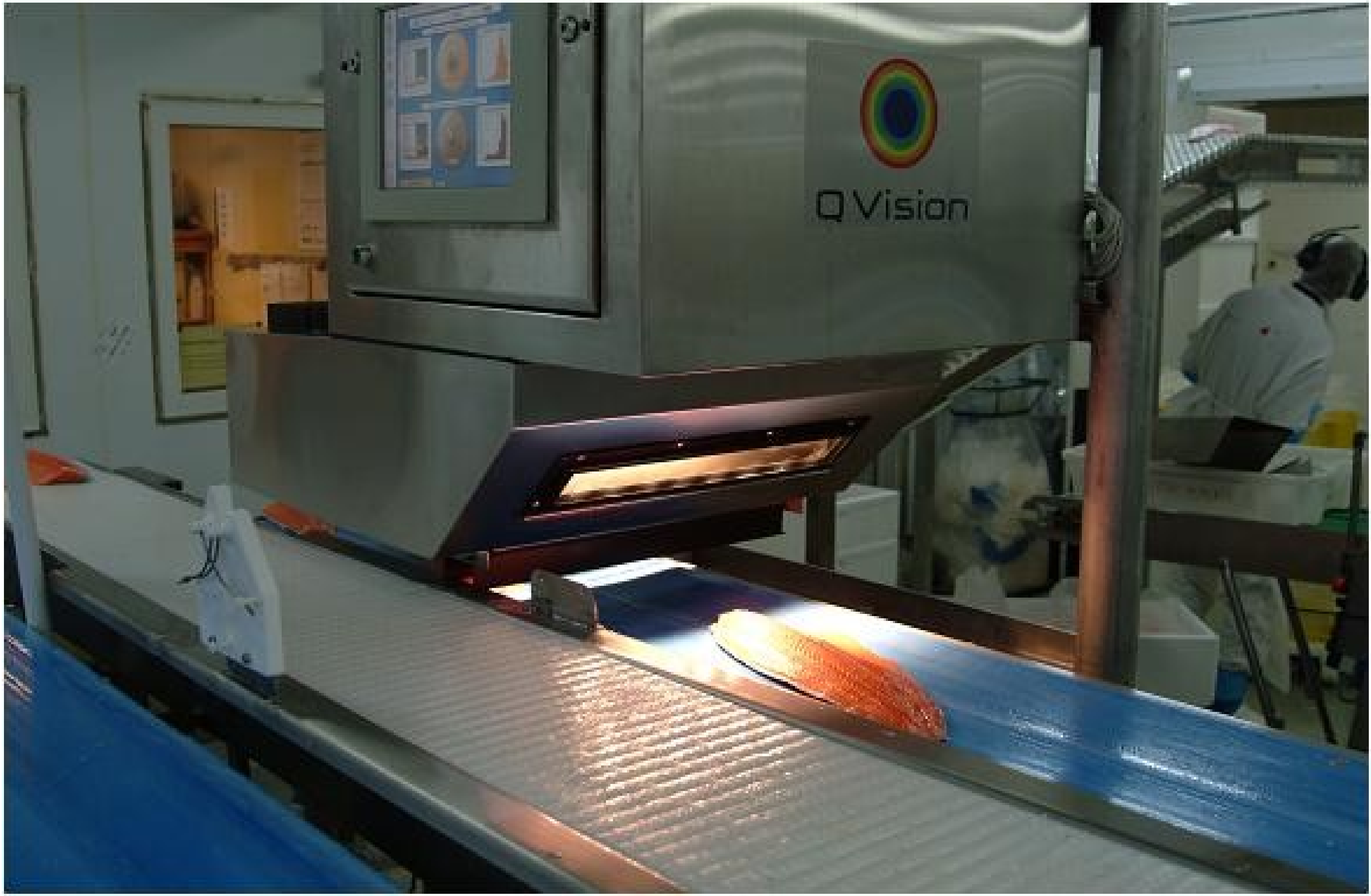
Instrumental solution (patented):
Scanning interactance measurement


12 x 50 W, 12°,
halogen lamps
Imaging
spectrometer
Cylinder optic
Adjustable slit
Focusing
Al mirror
Blackened
Al plates
Illuminated field
Scanned field

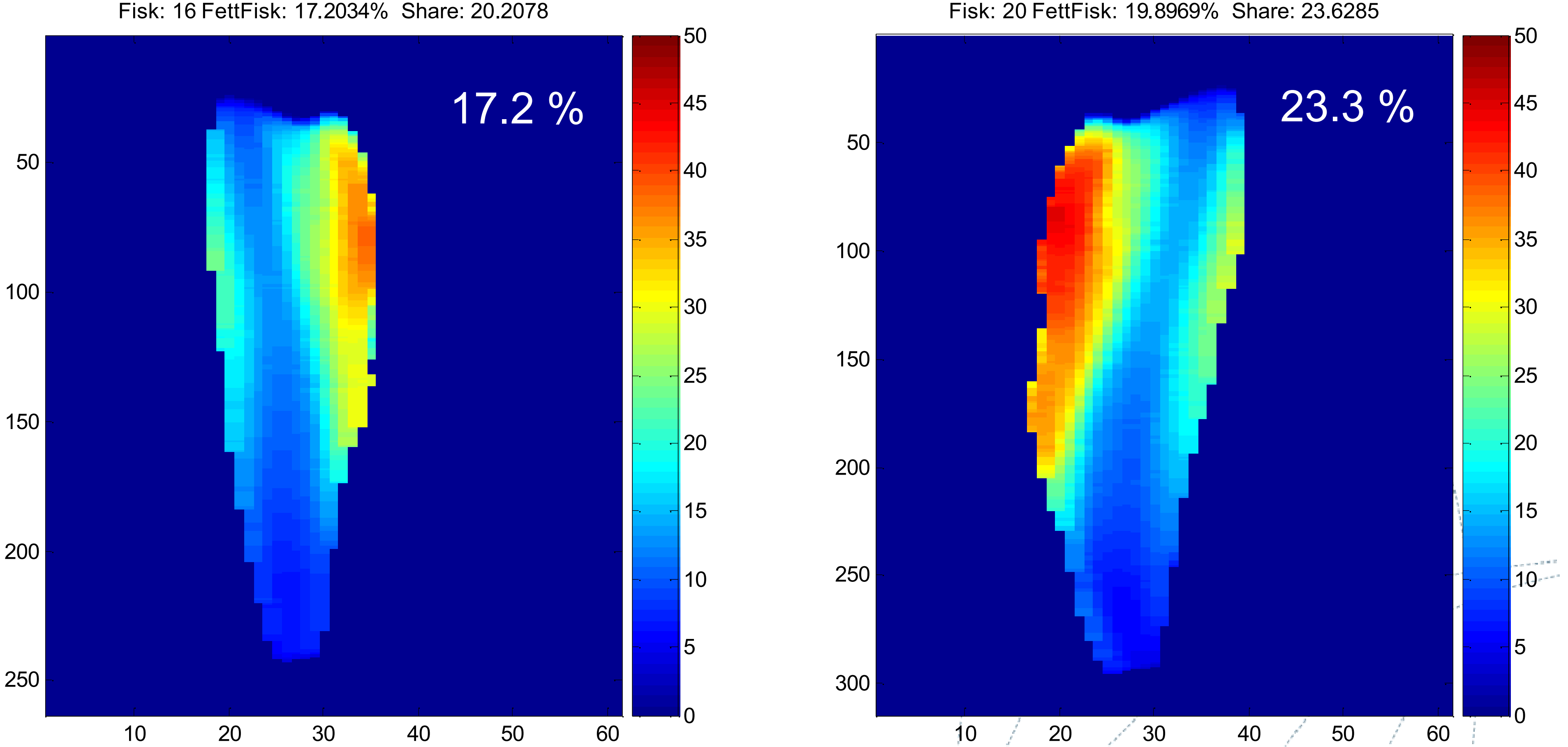
Installasjon i praksis

- Sorterer på vanninnhold
- Produsenten får riktig pris
- Unngår reklamasjoner

Commercial implementation: fat in salmon fillets

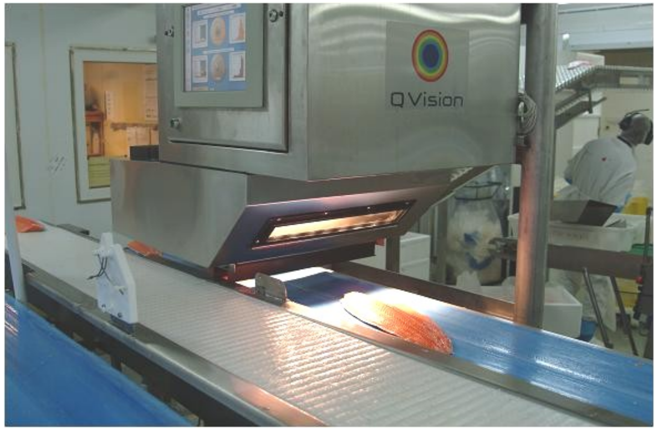


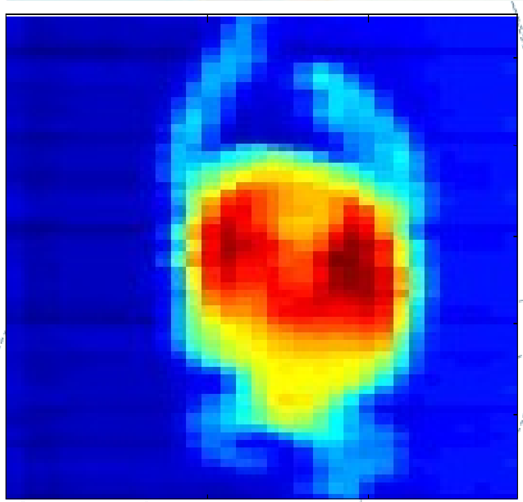
Chemical images: Fat content in each pixel

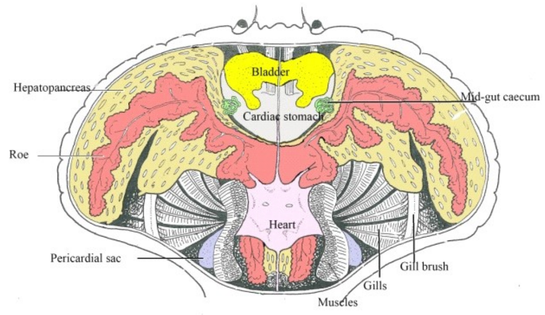


How and what do we measure?

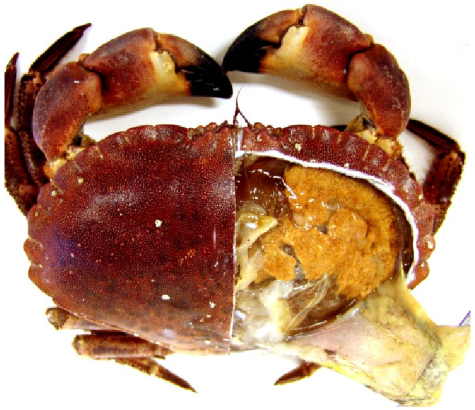
- Crabs are scanned on-line on a conveyor with the shell up and exposed to the scanner
- The crab is measured from above
- Mainly the upper 15 mm is probed
- Multispectral NIR images are captured
- 15 NIR channels in each image





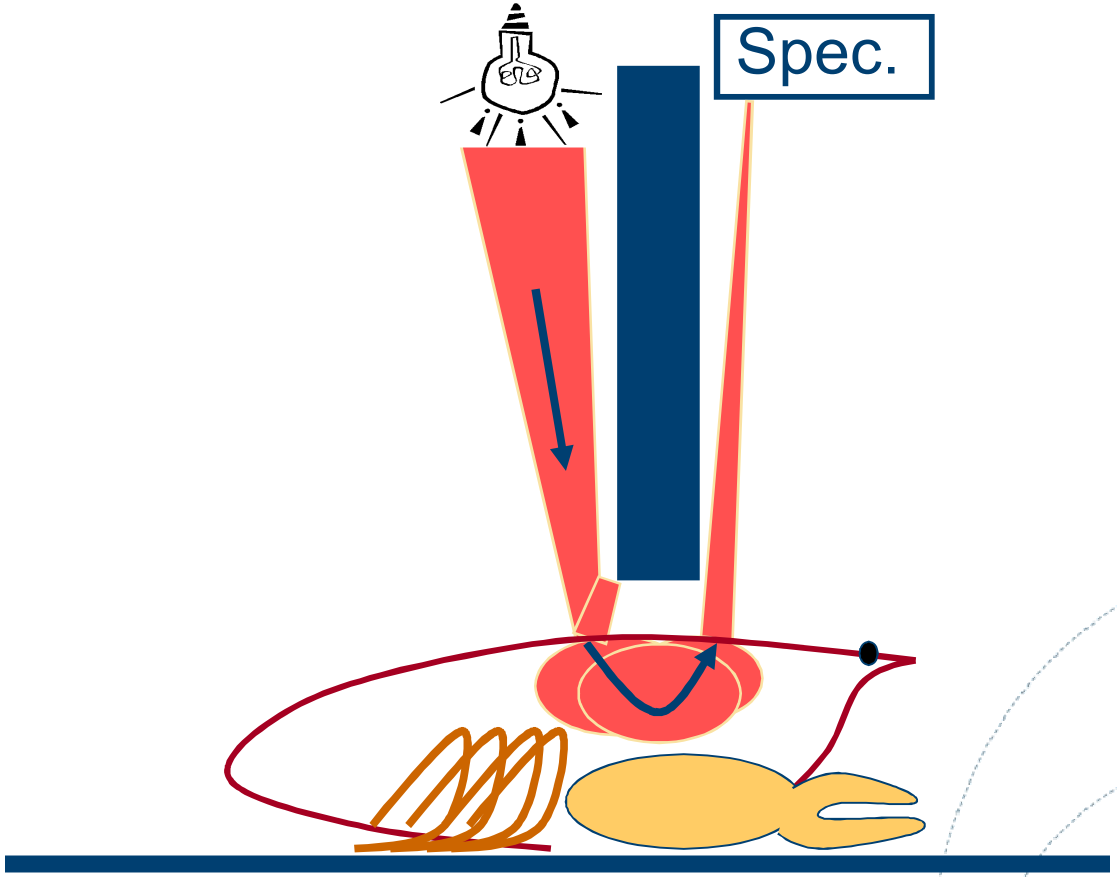

Hepatopancreas
Bladder
Mid-gut caecum
Cardiac stomach
Roe
Heart
Pericardial sac
Gill brush
Gills
Muscles

A

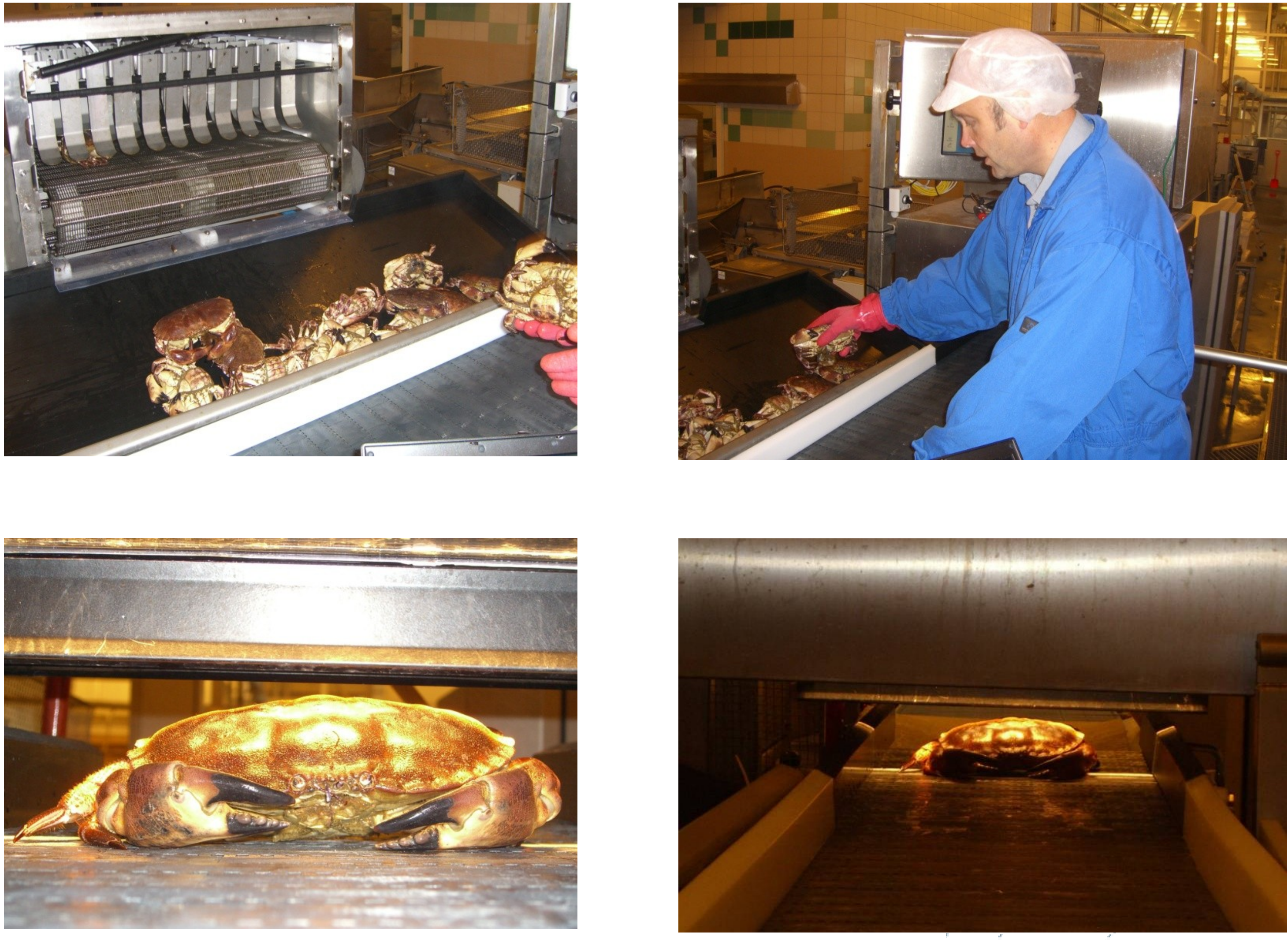


B

Interactance: Forces light into the crab



Qmonitor scanner at HitraMat

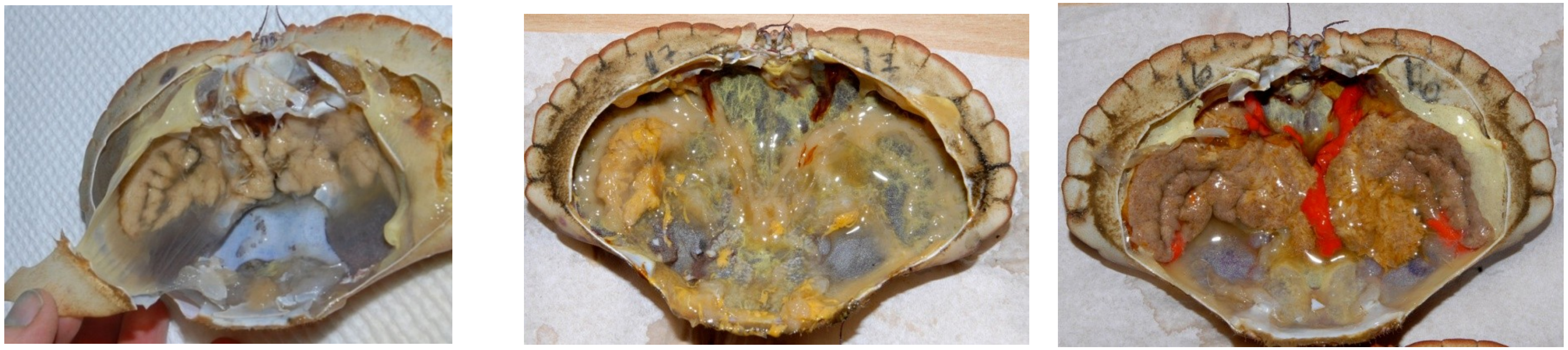


Fire krabbesorteringer:

1. Topp kvalitet
    - Mye rogn og lever
    - Kokes hel, til Frankrike
2. Bra konsum kvalitet,
    - bra matfylde
    - Kokes hel, til Norge
3. Lite matfylde
    - Skall åpnes, innmat tas ut og kokes for seg
    - Setter sammen skjell, klør til eget produkt
4. Tom krabbe
    - Klørne tas, resten kastes

- Problem: Vanskelig å se forskjell!

Measurement of food content



- As a measure for the amount of food, we have calculated a Measured Quality Index (MQI)
- Important: Before weighing, the carapace was drained for water for 30 min.
- The instrument is then calibrated against MQI
- If no meat, then the crab is full of water

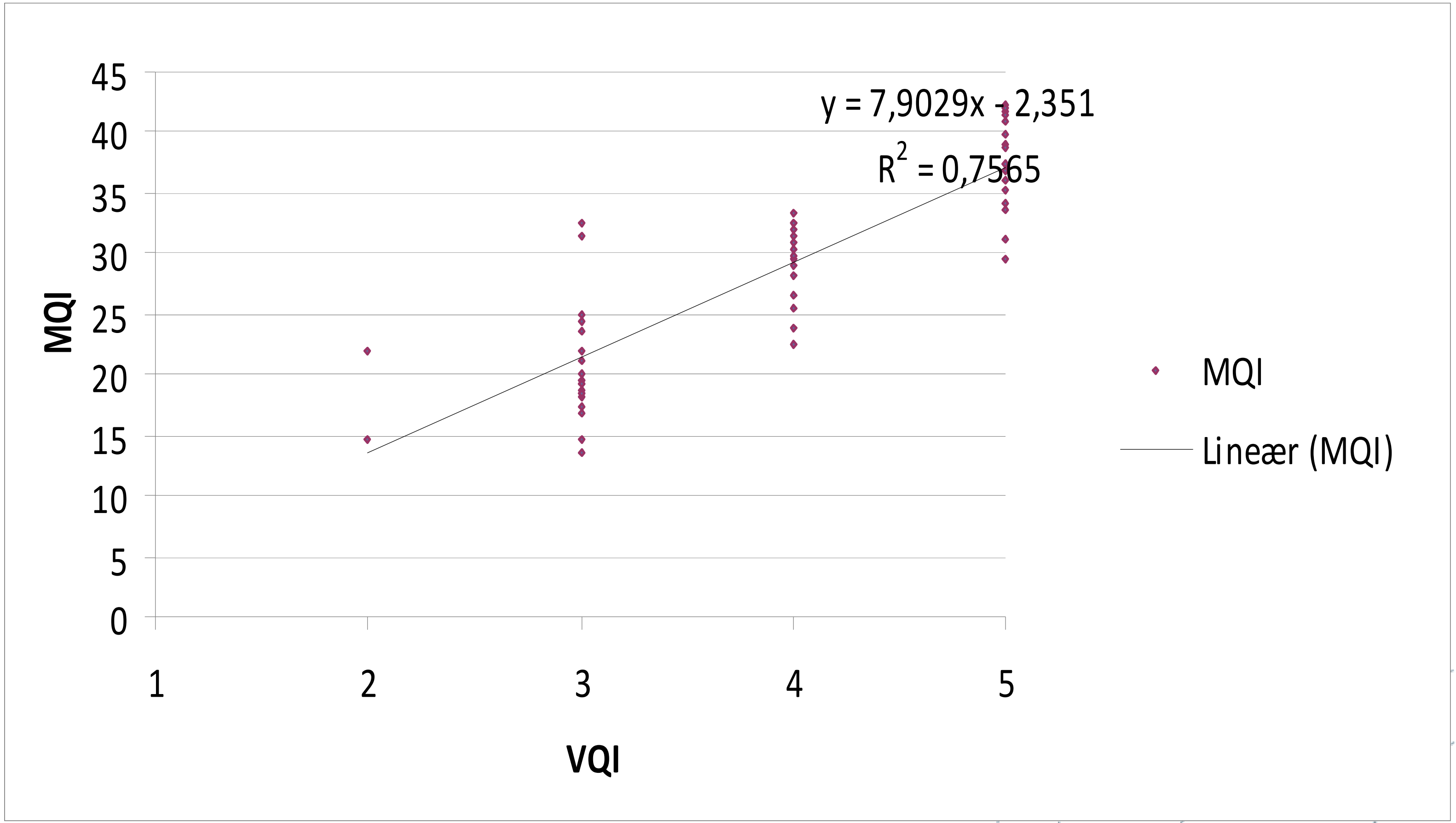
Determination of food content in crabs:
The meat index

Meat Index, MQI:

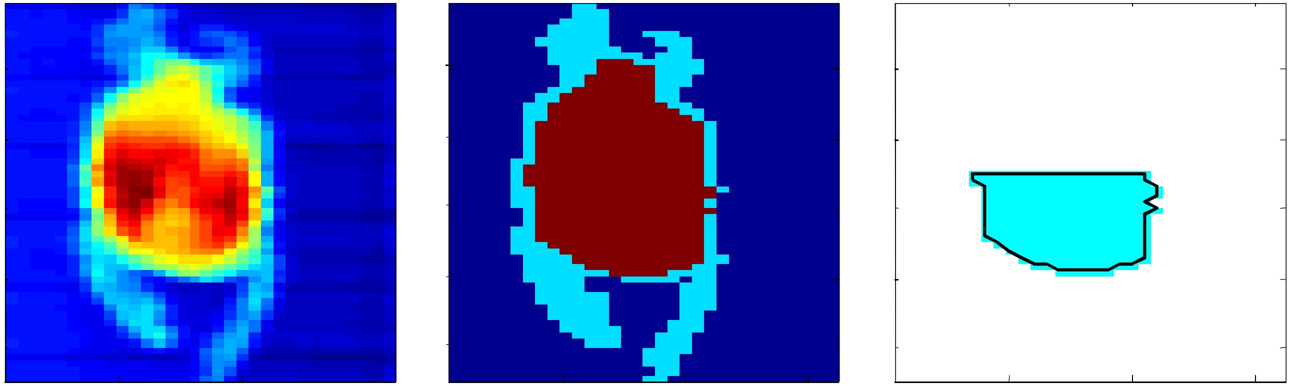
$$MQI = \frac{(L+R)*100}{(W/10)^2}$$

- L = liver content
- R = Roe content
- W = Width of the crab shell

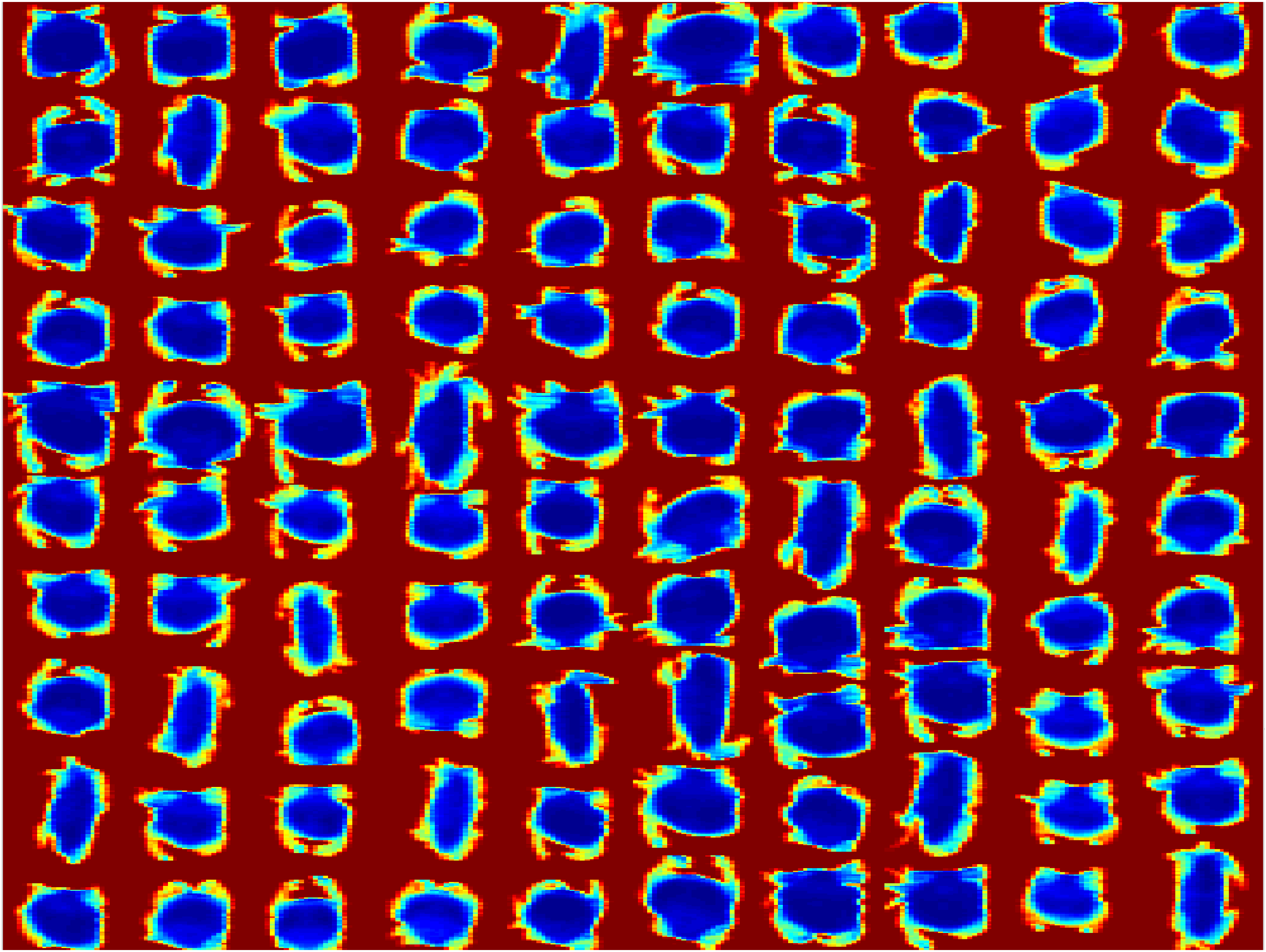
Relation between MQI and VQI for 50 crabs (Visually assessed Quality Index : 1-5)

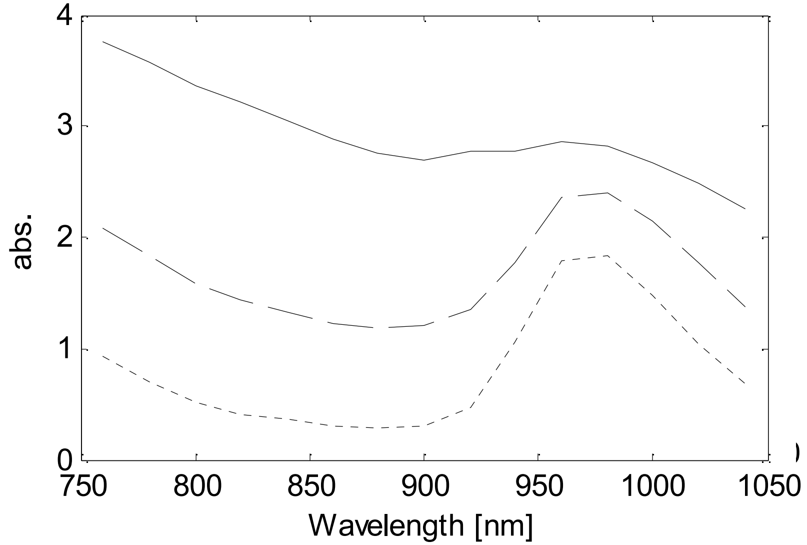


Where on the crab should we measure?


Raw image from scanner Detected shell and legs Selects region for measurement

- Pick out front part of shell
- But: difficult to determine certain area of the crab if it is randomly oriented
- Crabs have to be sent with back first



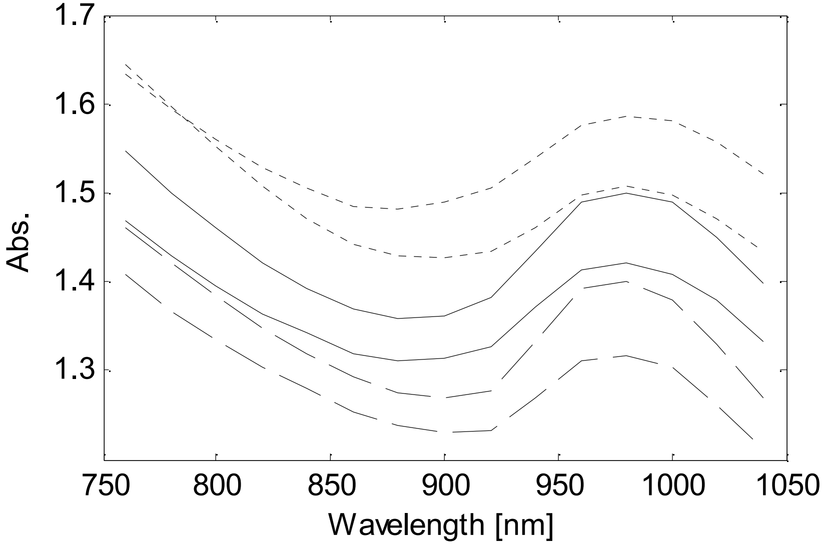


NIR spectra from

Liver

Roe

Water



NIR spectra from

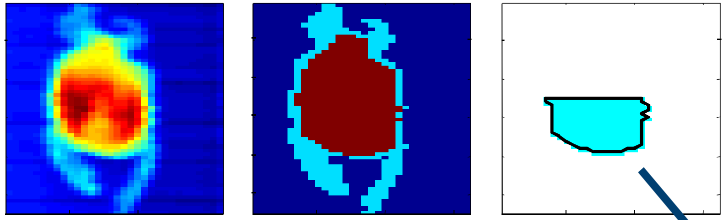
Full crabs

Medium crabs

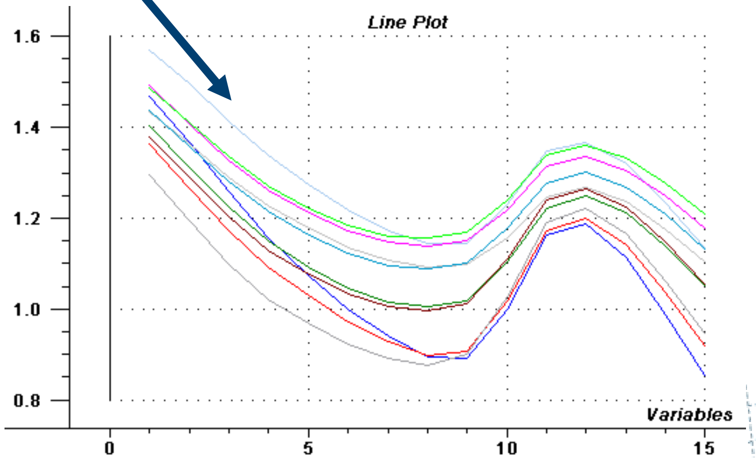
Empty crabs

Development of calibration

- Extract average spectrum from crab.

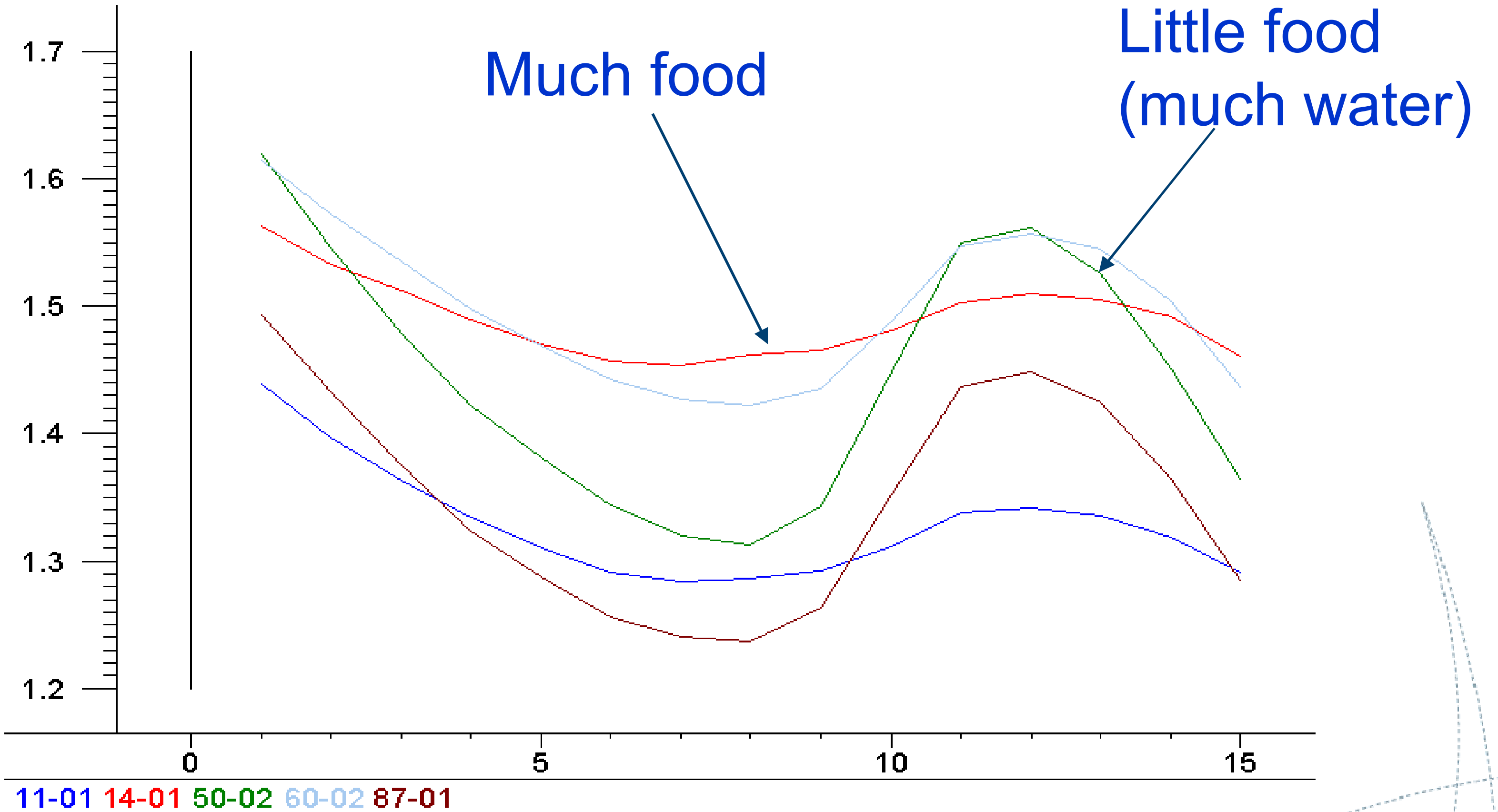


- Make model based on these spectra



- Model is used to estimate MQI in new crabs

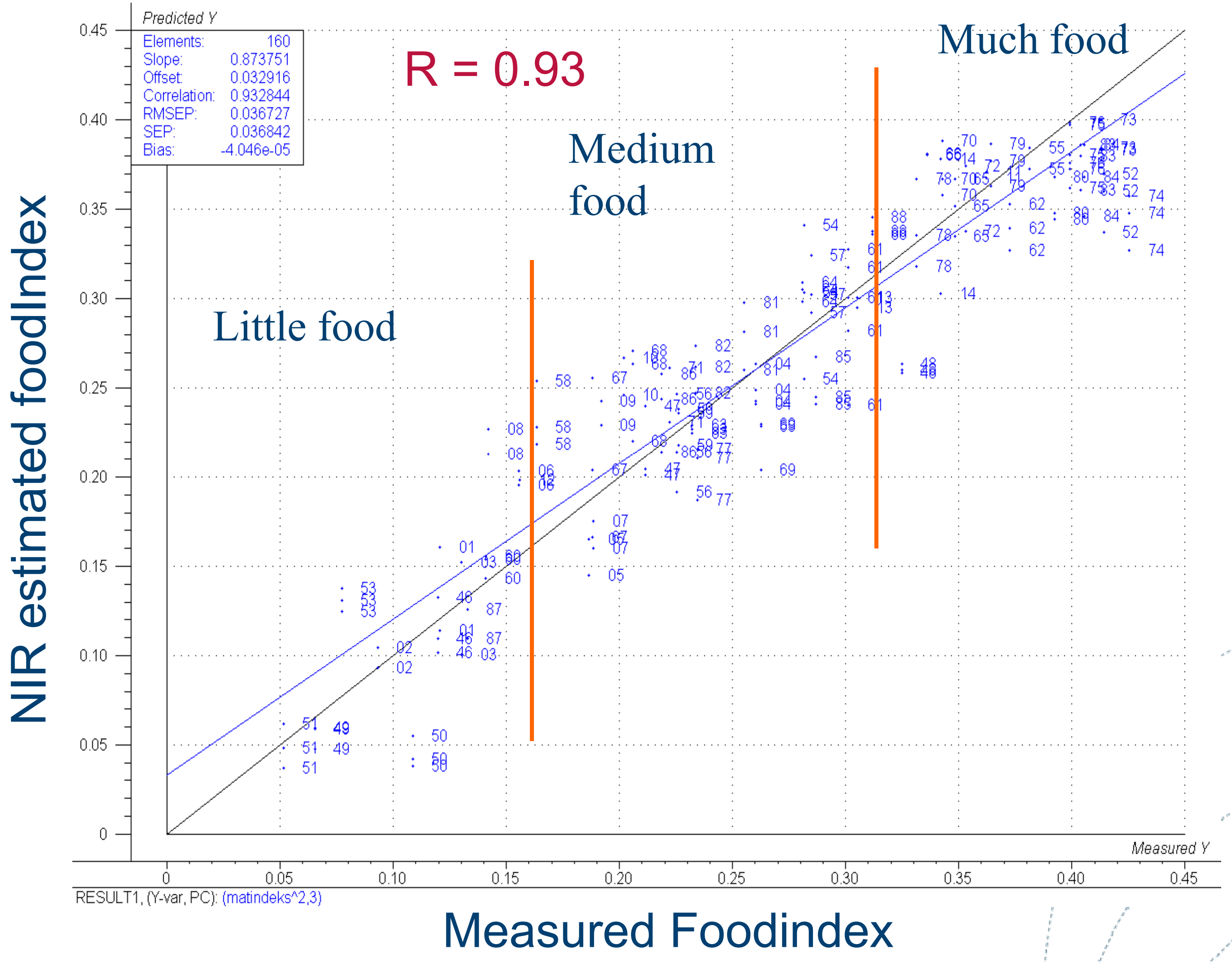
2. Extraction of NIR spectra:



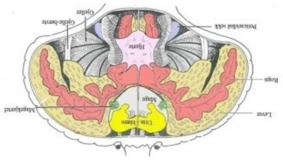
One spectrum per crab is input to the model, which then estimates the food index

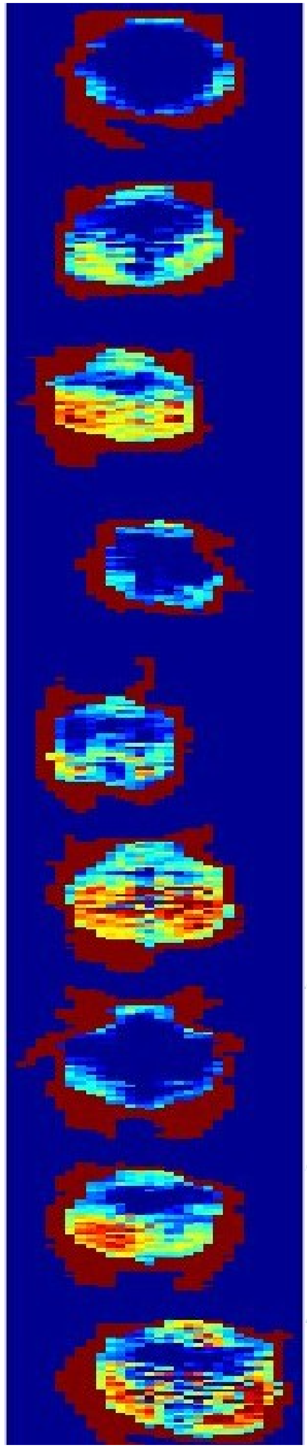
Model for food index

RMSEP=3.2

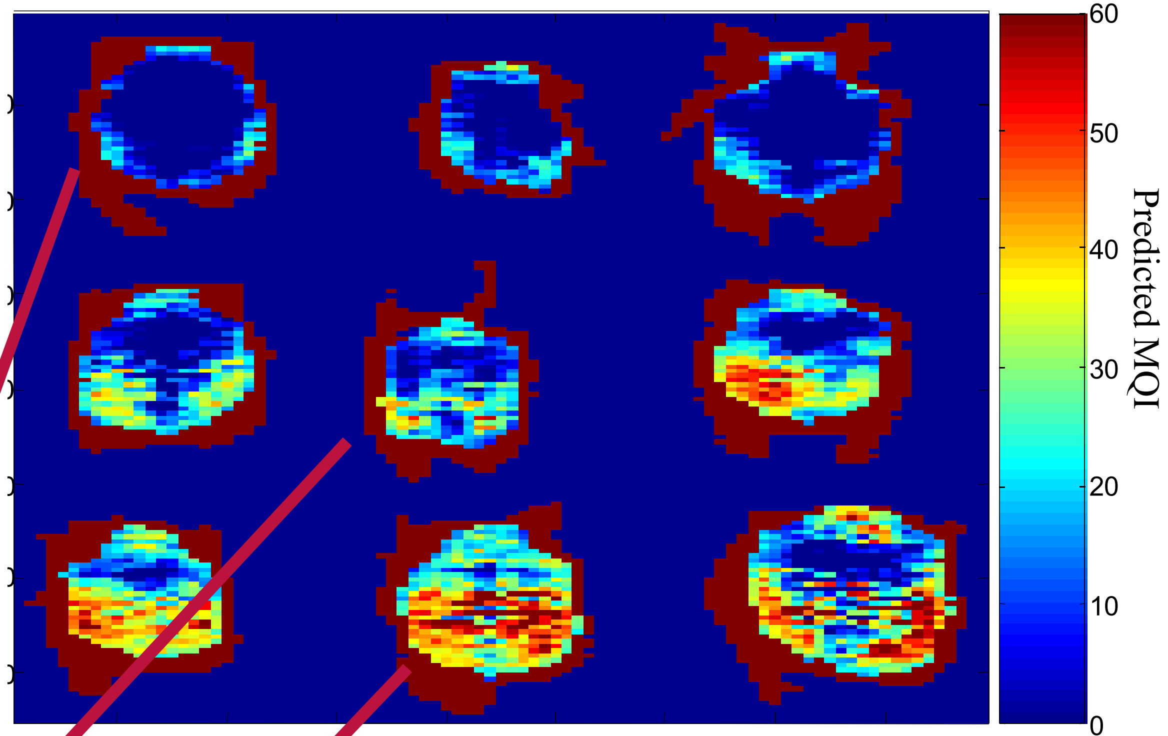


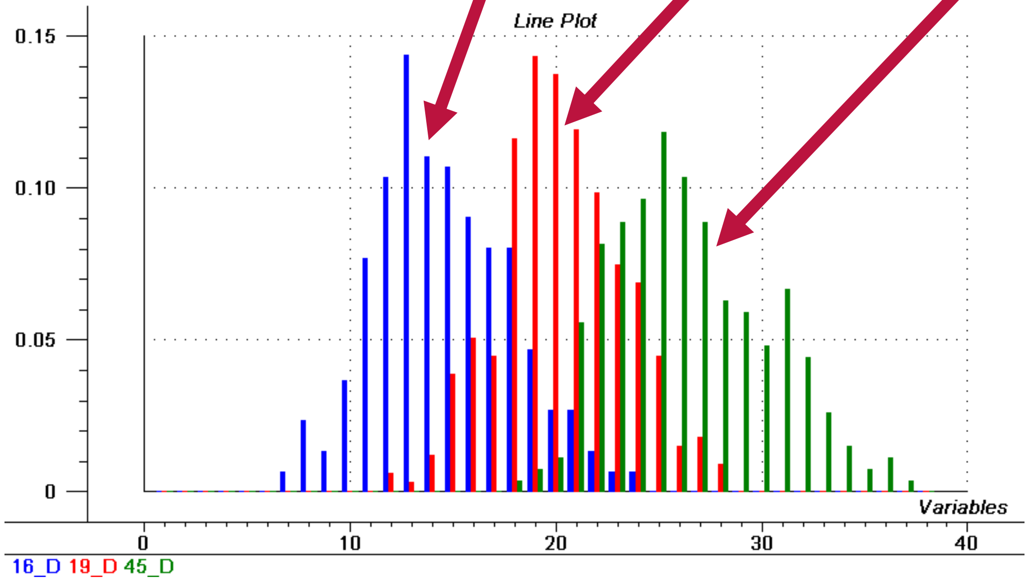
Vi ser inn i krabbene:


Gjeller
Gjelle-børste
Pericardial sekk
Hjerte
Rogn
Mage
Magekjertel
Lever
Urin - blære



Model applied at pixel level:





Histograms of predicted pixel values from

Empty (blue)

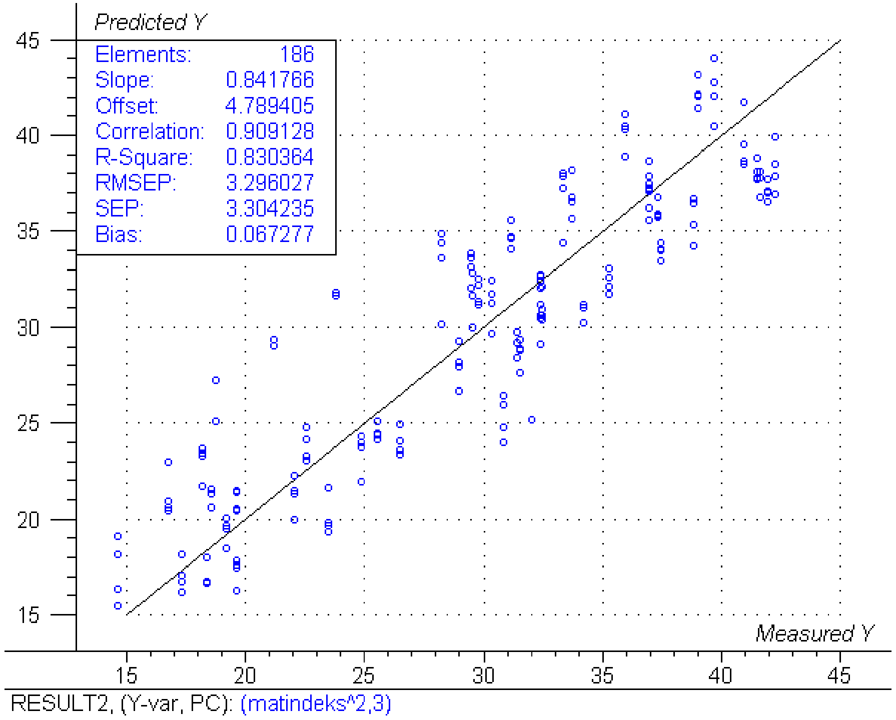
Medium (red)

Full crab (green)

Model invariant of orientation

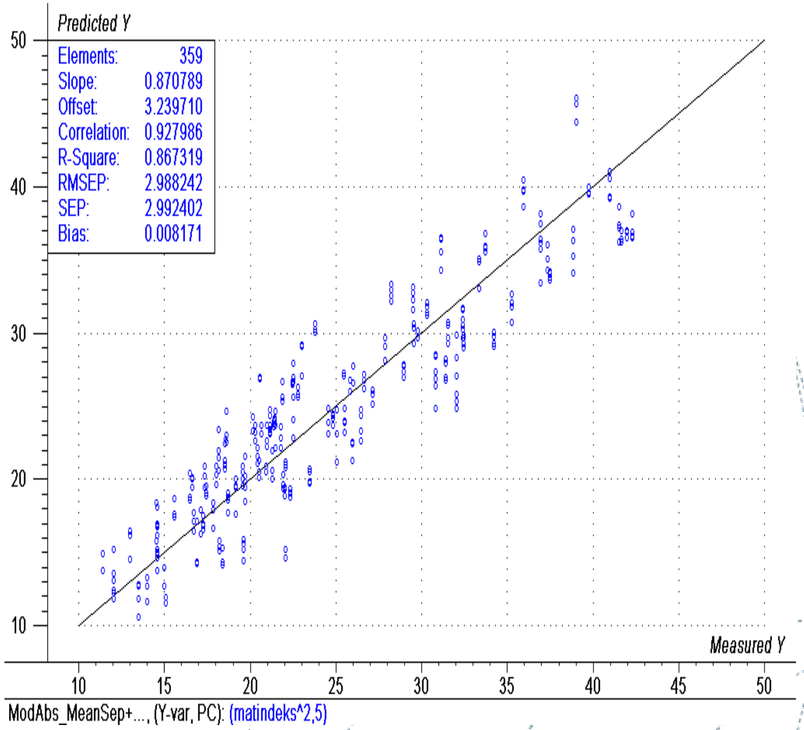
Histogram

RMSEP=3.3

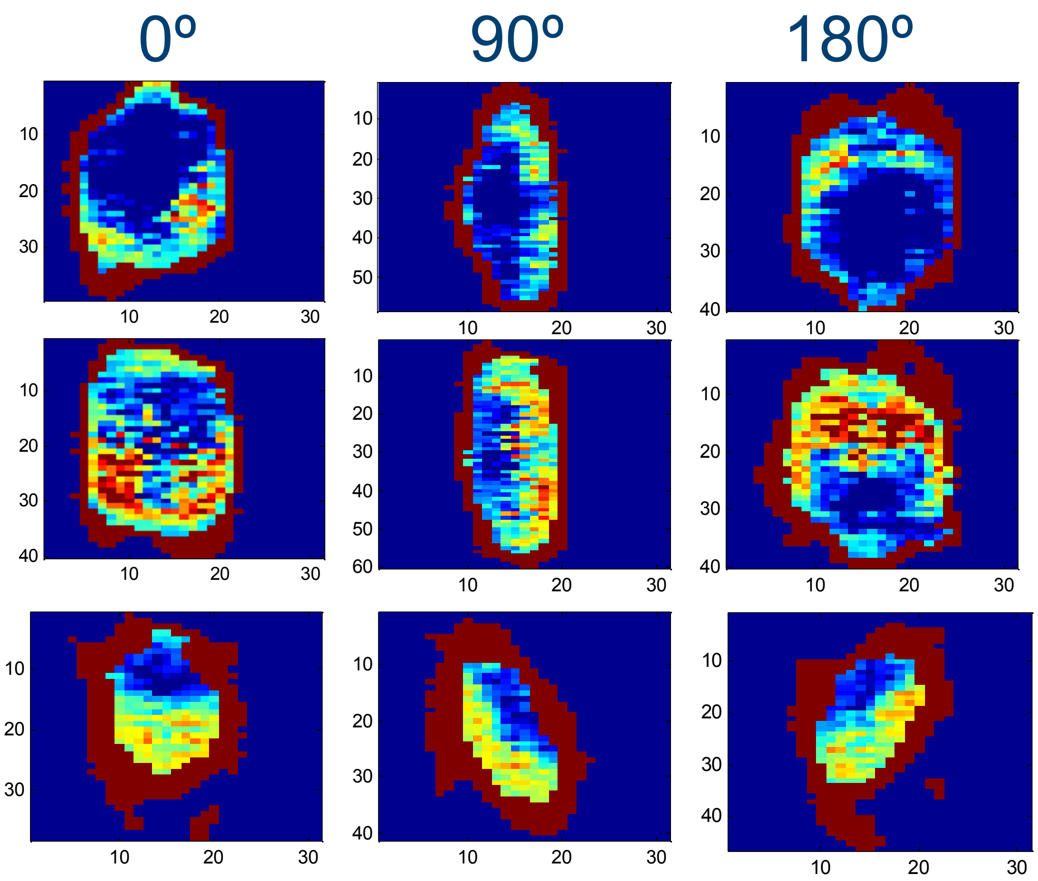


Average spectrum

RMSEP=3.0



Varying orientation

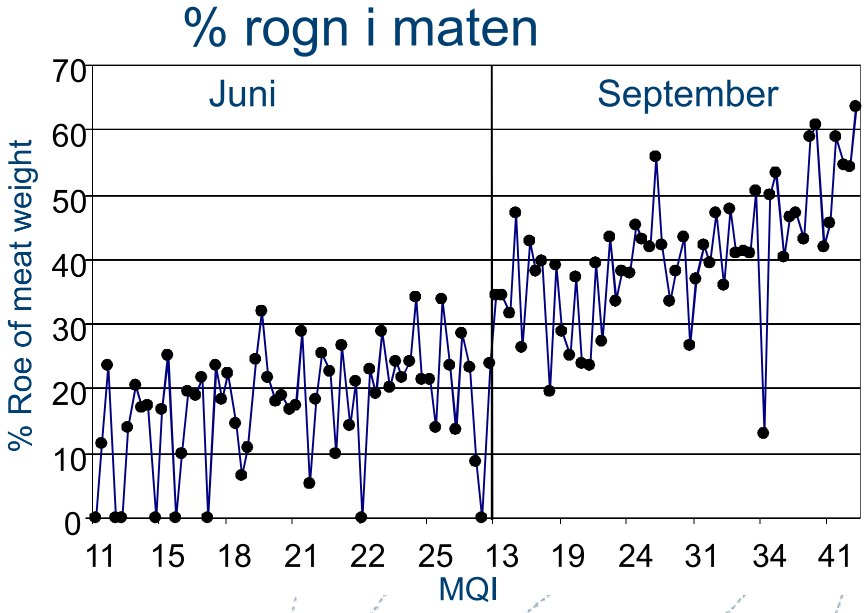


Mulig utfordring

- Sesongvariasjoner
  - Matsammensetning varierer

- Men: Det er mulig å estimere mengde rogn og lever hver for seg.

- Mye rogn: Ekstra god kvalitet



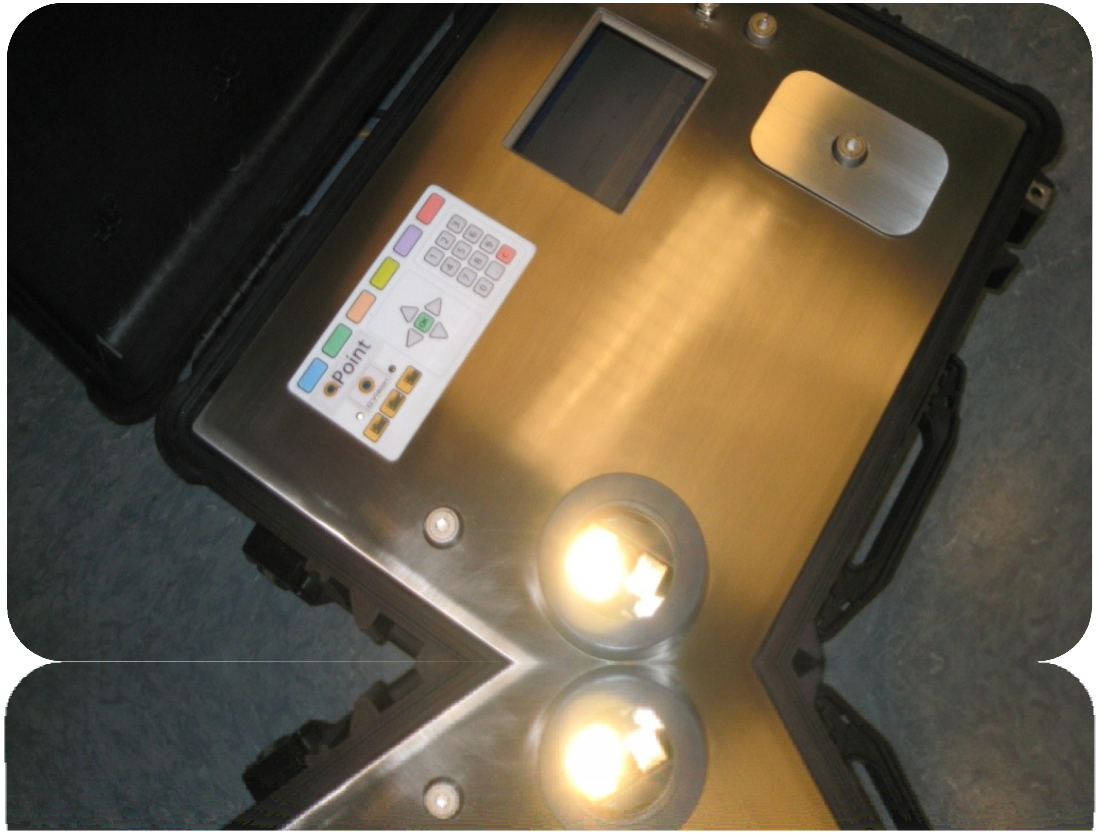
Practical challenges

- The crabs can walk on the belt or rise up. This can obscure the measurements and reduce accuracy.
- Preliminary solution: cool the crabs, or electrical stunning
- Up till now the crabs have been scanned with back first, so that we easily can extract the optimal region for spectral extraction.
- With the histogram method, the orientation is not critical
- We have had some technical challenges, but system seem to work well now.

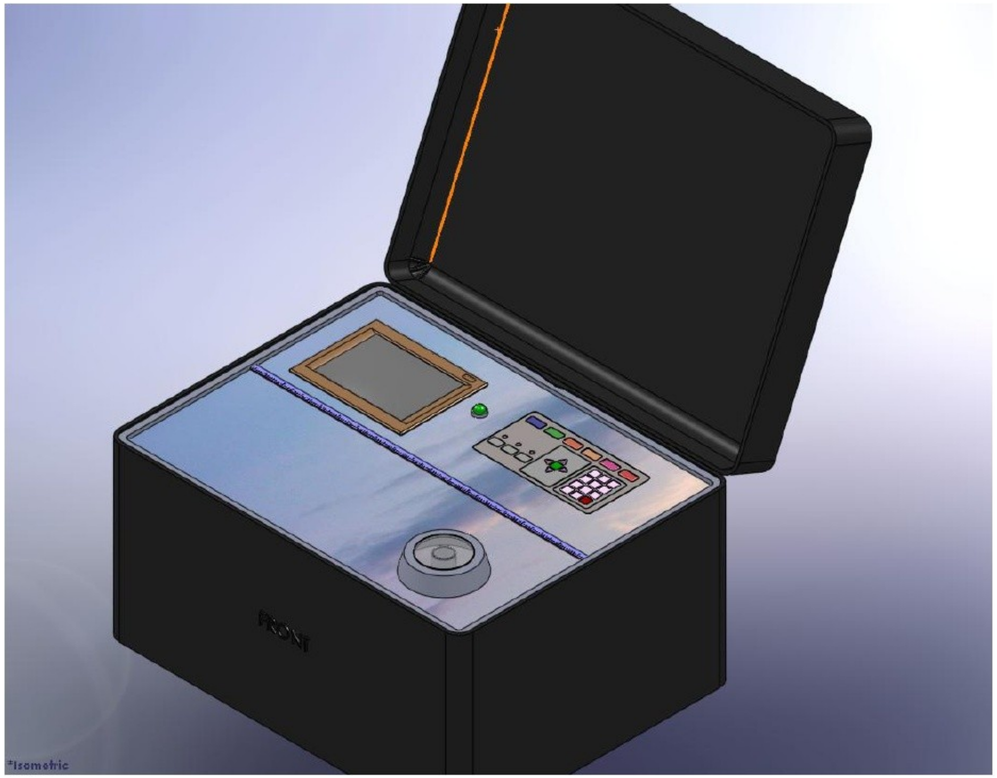
Praktiske resultater

- Krabbene sorteres I 3-4 klasser, 1-2 krabber / sek
- Raskere og mer pålitelig enn manuell gradering
- Utbytte I prosessen har økt, mindre svinn
- Kan garantere kvaliteten på superior krabber, noe som er meget viktig for å opprettholde markedet
- Systematiserte data gir oversikt over regionale og sesongbaserte kvalitetvariasjoner
- Vil kunne brukes som underlag for betaling til fiskerne

Secondary QVision product: The QPoint



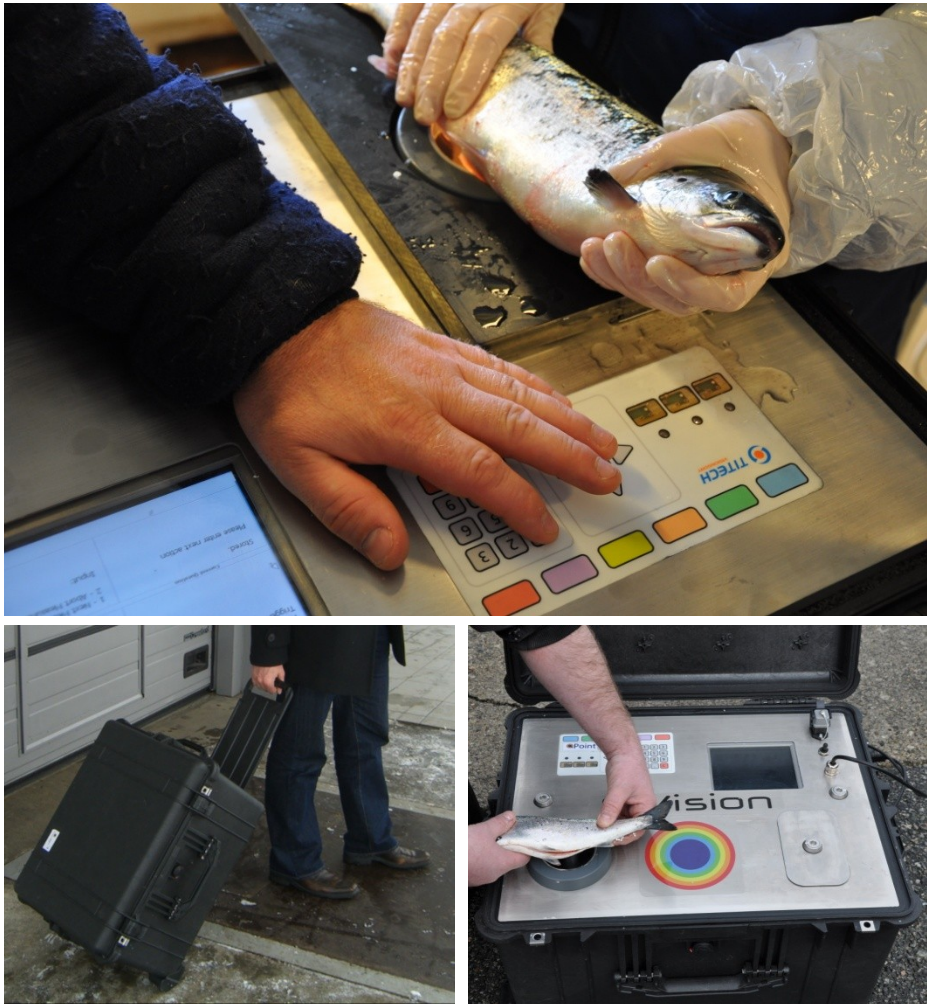
Qpoint is a transportable NIR instrument.



Key features:

- Transportable.
- Two spectroscopes
- Easy to operate.
- Easy to maintain and clean.
- Easy calibration.
- Water proof (IP 67).
- Configurable input fields.
- Easy to integrate with other systems.

Qpoint: Applications for complete and live fish



Applications for salmon

Measurement of fat and pigment in complete salmon. Typically used to sample alive fish.

Typical customers

- Salmon farming companies who want to optimize feeding and reduce the amount of expensive pigment feed given to the fish
- Feed producers who research effects of different feeds and feeding procedures
- Companies concerned with quality control

Qpoint: Application on live crabs

Applications for crabs

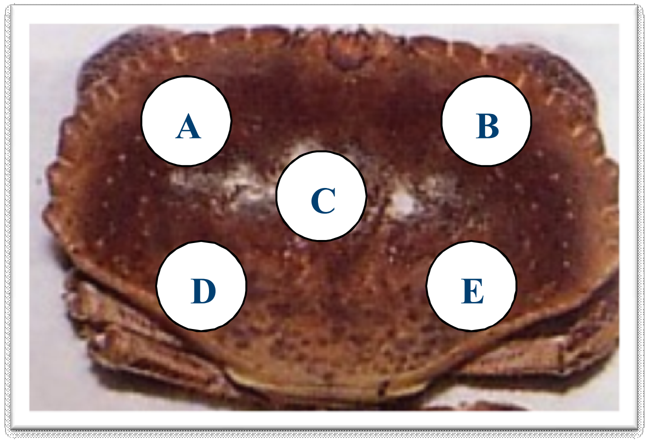
Measurement of food content

- The Qmonitor scanner is able to scan whole crabs and measure the food content.
- Analysis of scanner data shows that the front part of the crab is more important for food content determination.
- Is it possible to measure the food content of the whole crab using only a single point on the crab?

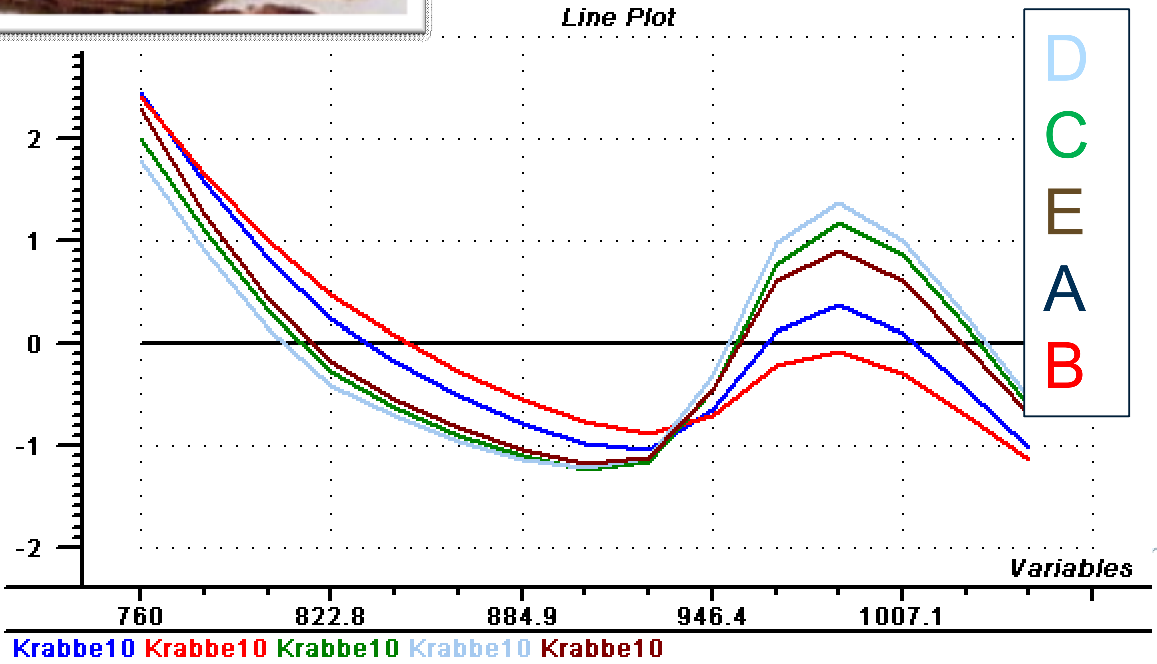
Qpoint: Application on live crabs

- 15 crabs of varying quality were selected for testing.
- Scanning of all crabs was performed on the Qmonitor skanner.
- Estimated meat index values were used as references.
- Posterior measurements were done on the point measurement system: QPoint.

Qpoint: Application on live crabs

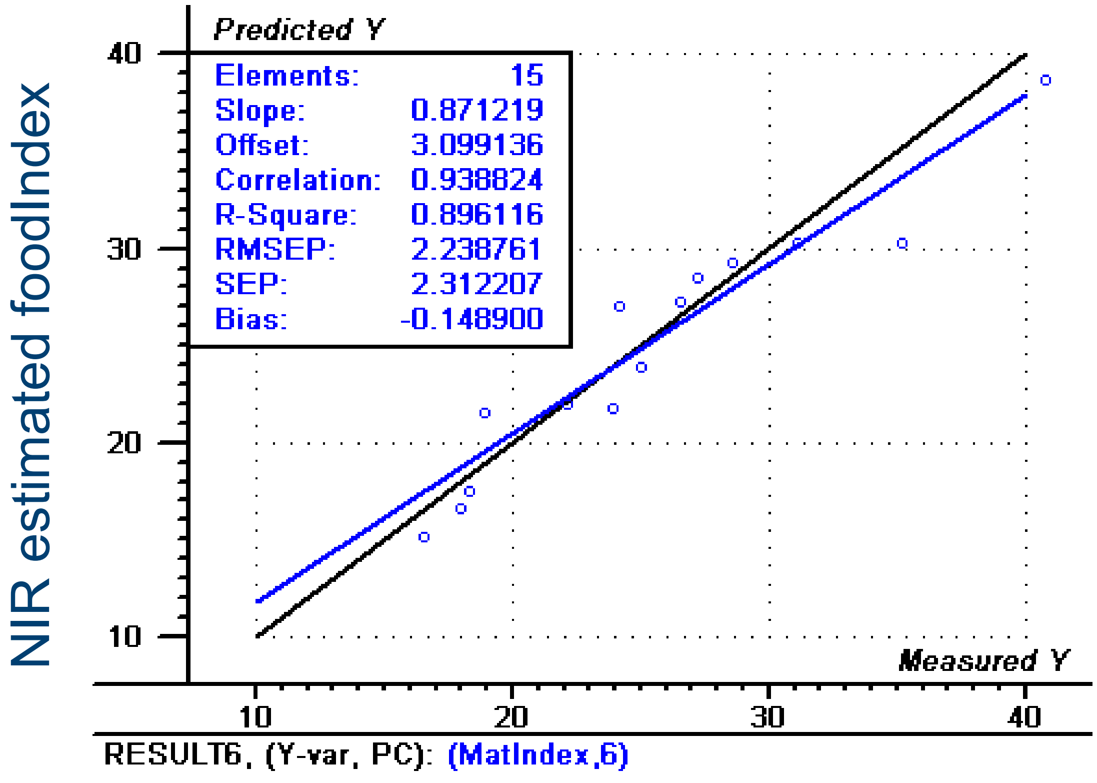


- 5 points were selected for point measurements.
- Point A was found to give best the result and used in further analysis.



Qpoint: Model for food index

RMSEP=2.23



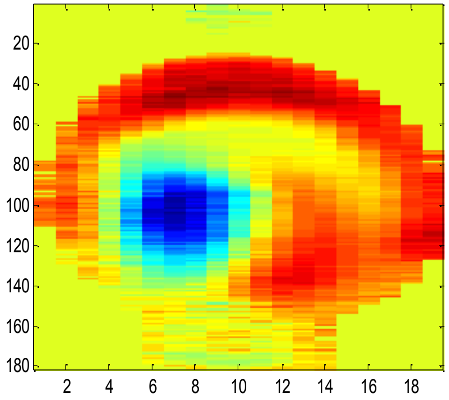
Measured Foodindex

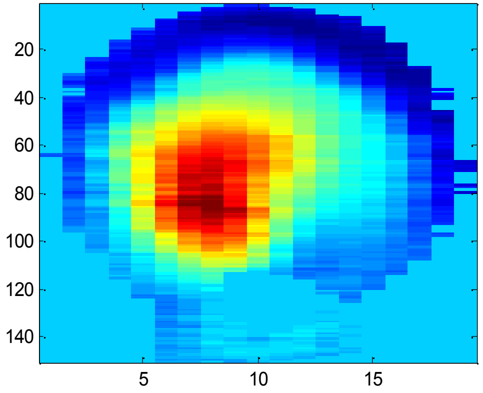
The model shows a performance comparable to the scanner.

Measurement of muscle size and dry matter in muscle of live scallops

- Interesting for selection during breeding

- Andre skalldyr?
- Kongekrabbe?





Sammendrag

- Vi har utviklet et system kan måle matinnhold I ktabber raskt og ikke-destruktivt
- Systemet er installert hos Hitramat og er i drift

- Samme type målinger kan gjøres på båt med enklere og billigere systemer. Plassert I en liten boks eller et håndholdt
- Tomme krabber kan da slippes ut, og god kvalitet kan garanteres på de som selges.