
Infrared analysis
of beer
MASTER BREWERS
ESTD 1887
ASSOCIATION OF THE AMERICAS
UNITED WE BREW™

Content

- What is infrared spectroscopy
- Where can we use infrared technology
- Applications

applied sciences

MDPI

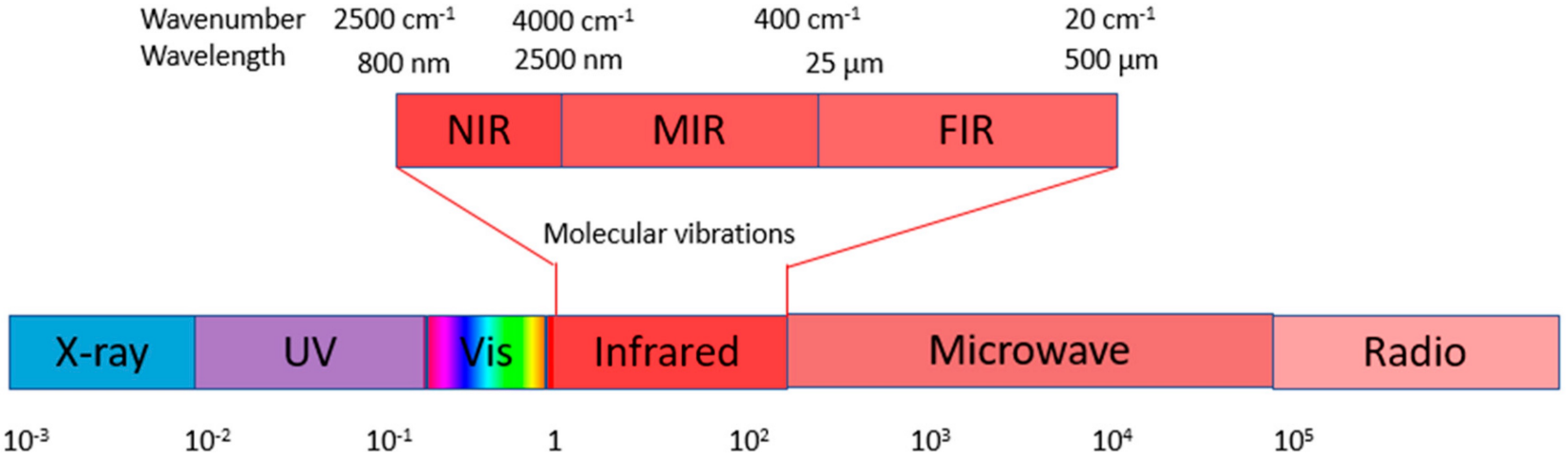
Review

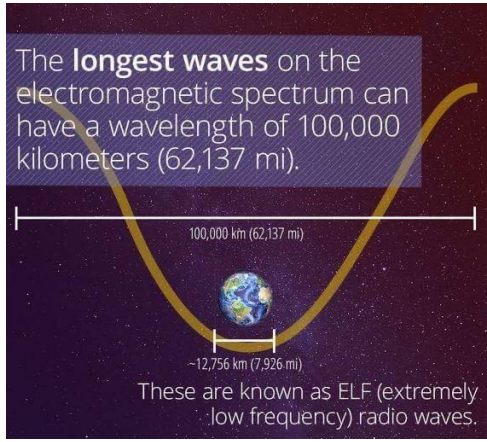
The Brewing Industry and the Opportunities for Real-Time Quality Analysis Using Infrared Spectroscopy

Glen Fox [1,2]

Visible and Infrared

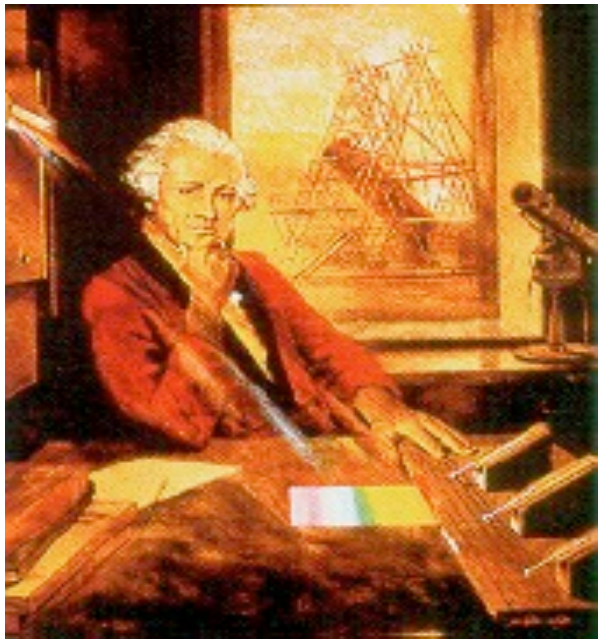
- Visible
- Near infrared
- Mid infrared





"Perhaps the sun, shining above from rosy lamp, is surrounded by much fire and invisible heat. Thus the fire may be accompanied by radiance, which increases the power of the rays" (Lucretious *ca* 60 BC)

Discovery of Near InfraRed Radiation



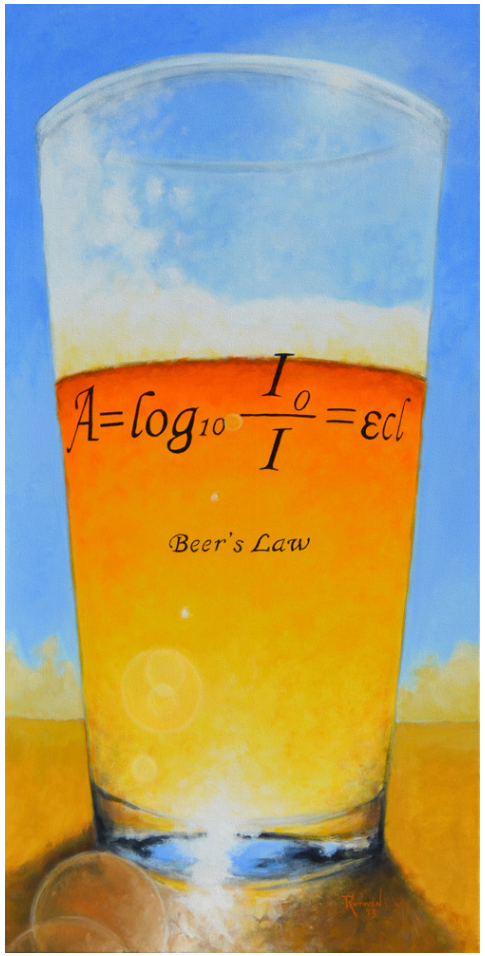
- **17 March 1800**
- **William Herschel, Astronomer Royal attempts to find out the spectral region responsible for heat formation in his telescope.**
- **The NIR is discovered.**
- *Philosophical Transactions of the Royal Society* **90:**255-83

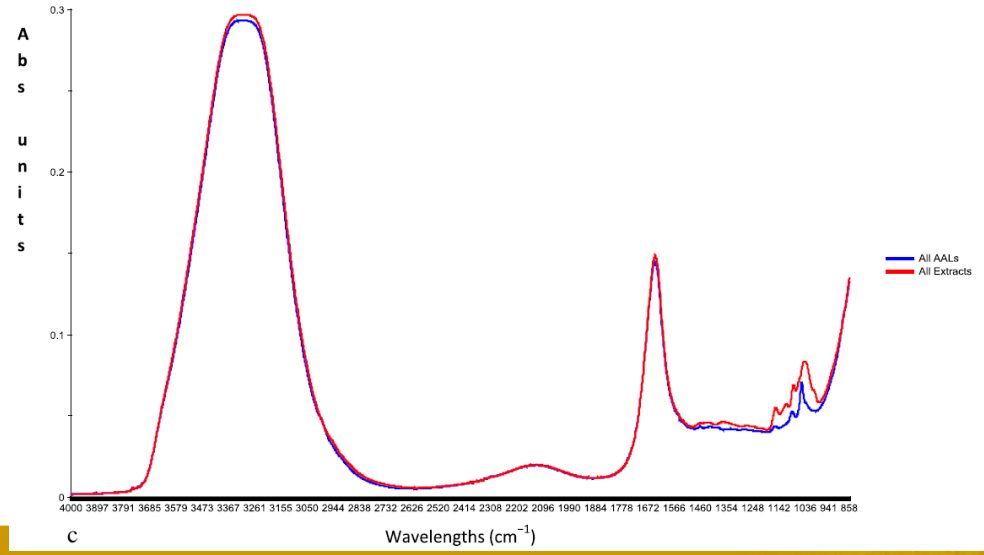
Beer’s law

Equation (2)

$$A_\lambda = \log (1/R_\lambda) = c \bullet \varepsilon_\lambda \bullet l$$

A_λ	Absorption
R_λ	Reflexion
c	Concentration of the ingredient
ε_λ	extinction coefficient of the ingredient for wavelength λ
l	Pathlength of the light through the sample

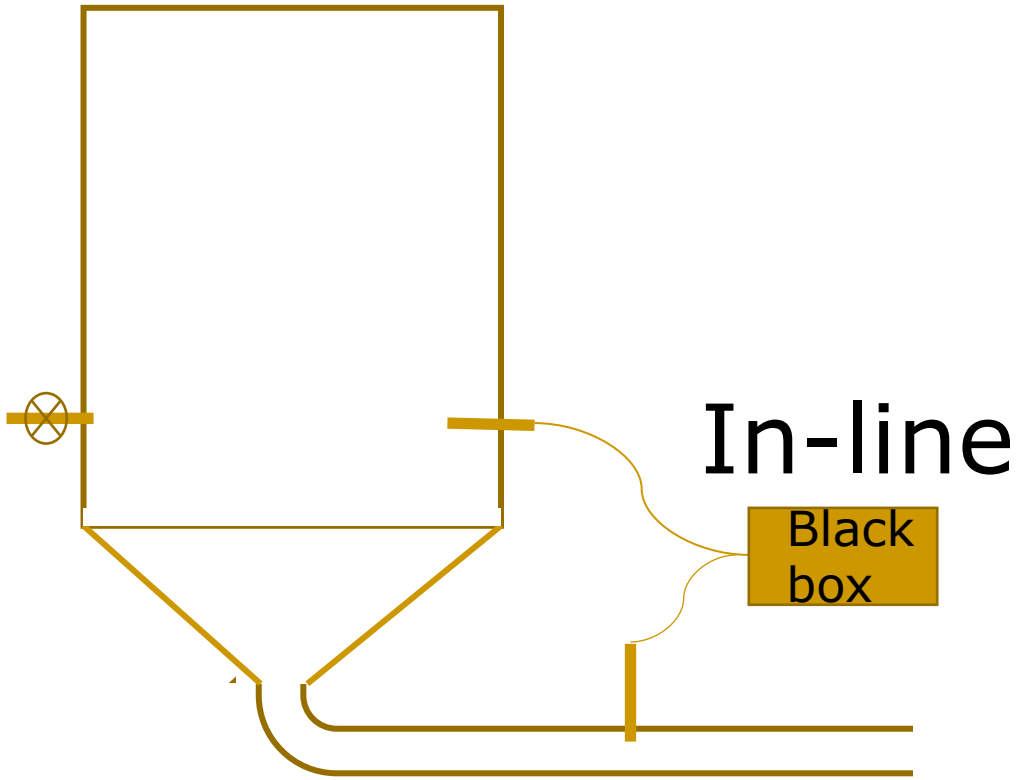




Real-time measurements

At-line

Black box



In-line

Black box

In-line

- Dedicated probes
- Measurement real-time
- Temperature, DO, pH, color……..
- Real-time data assists brewers deal with out of spec brews

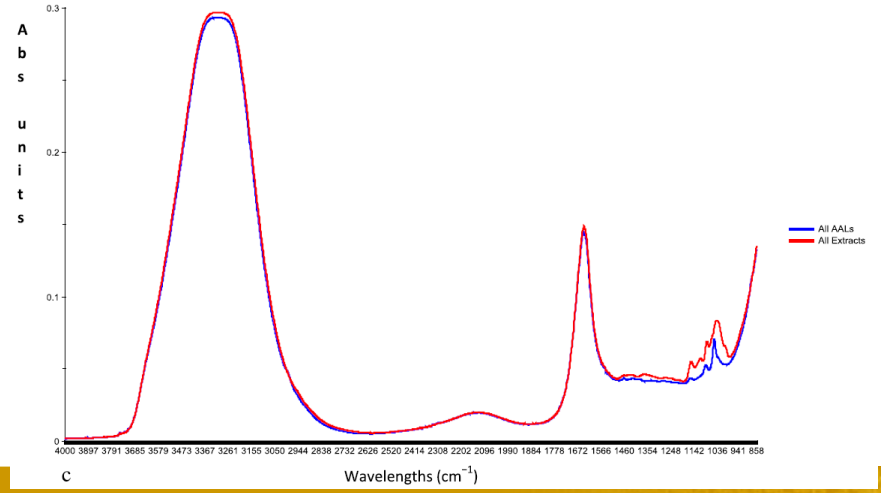
At line

- Sub-sample and test
- Testing within minutes
- Also provides options to deal with problems
- But possible deals
- Staff to do testing and act to trouble shoot
- Have data for current and retrospective analysis

Pros and cons of infrared

Pros

- Results within seconds
- Multiple traits simultaneously
- Solids and liquids
- Minimal maintenance
- User friendly

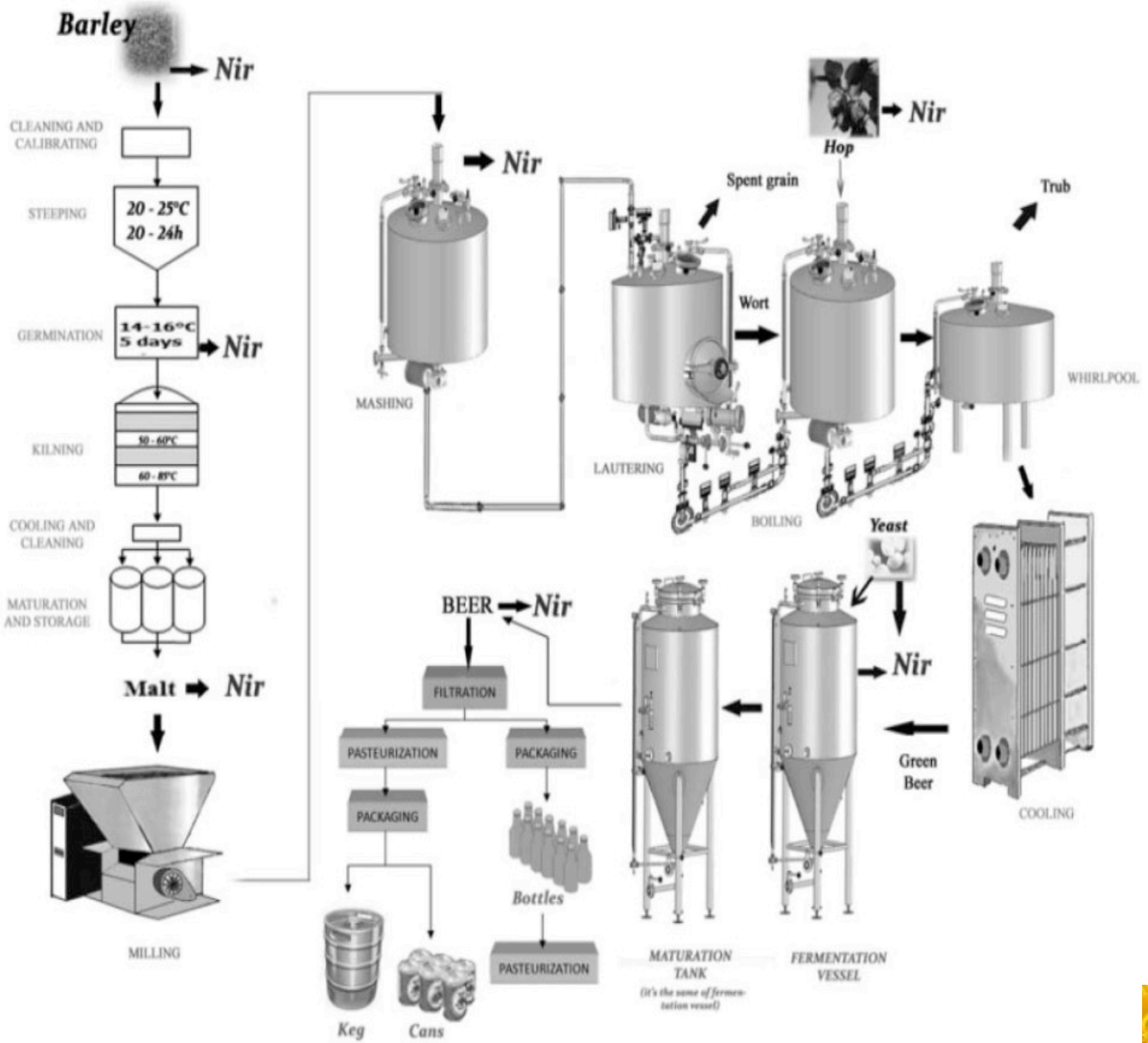


C

Cons

- Dedicated lab to do chemistry for calibrations or 3rd party
- Instruments are expensive
- Level of detection (0.1%)
- term investment

NIR probes in a brewery



Critical Reviews in Food Science and Nutrition

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Near-infrared Spectroscopy in the Brewing Industry

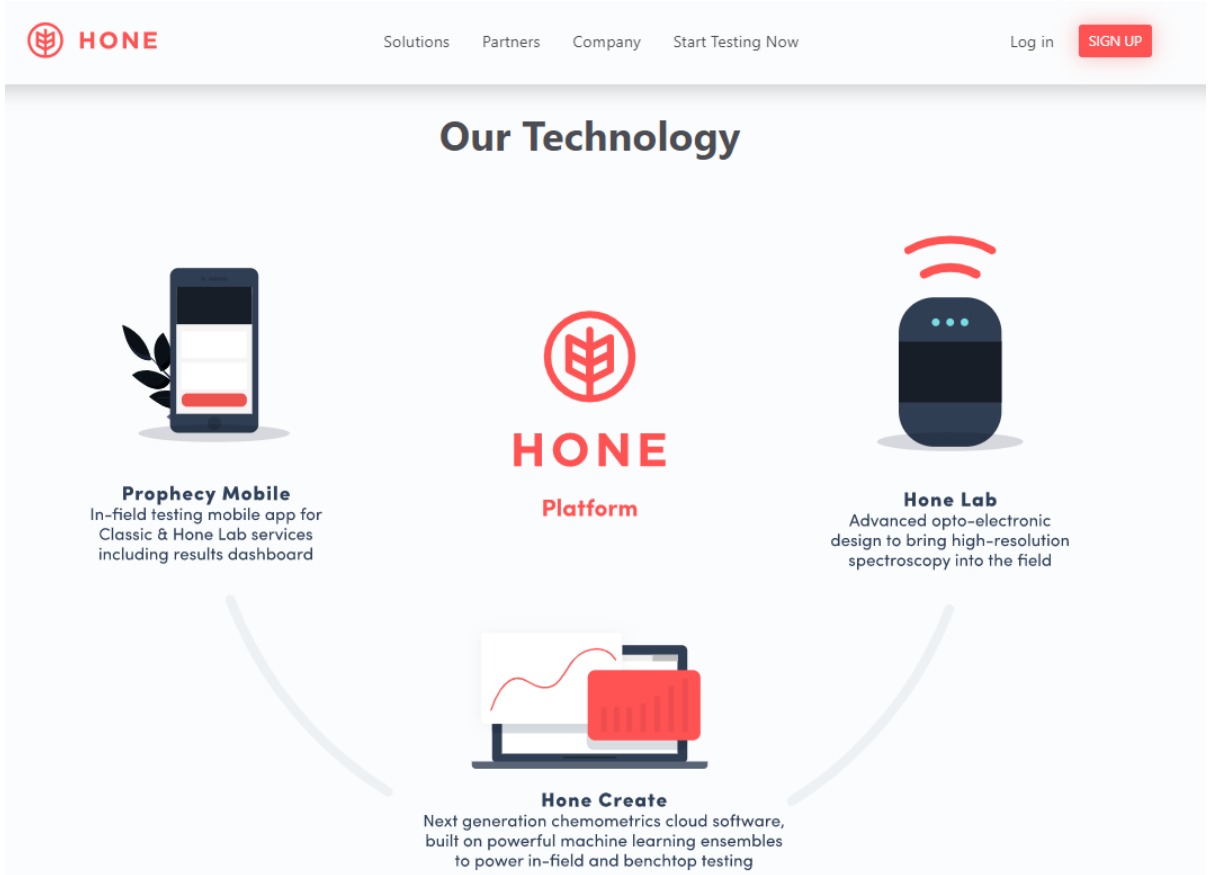
Valeria Sileoni, Ombretta Marconi & Giuseppe Perretti

In-line infrared predictions

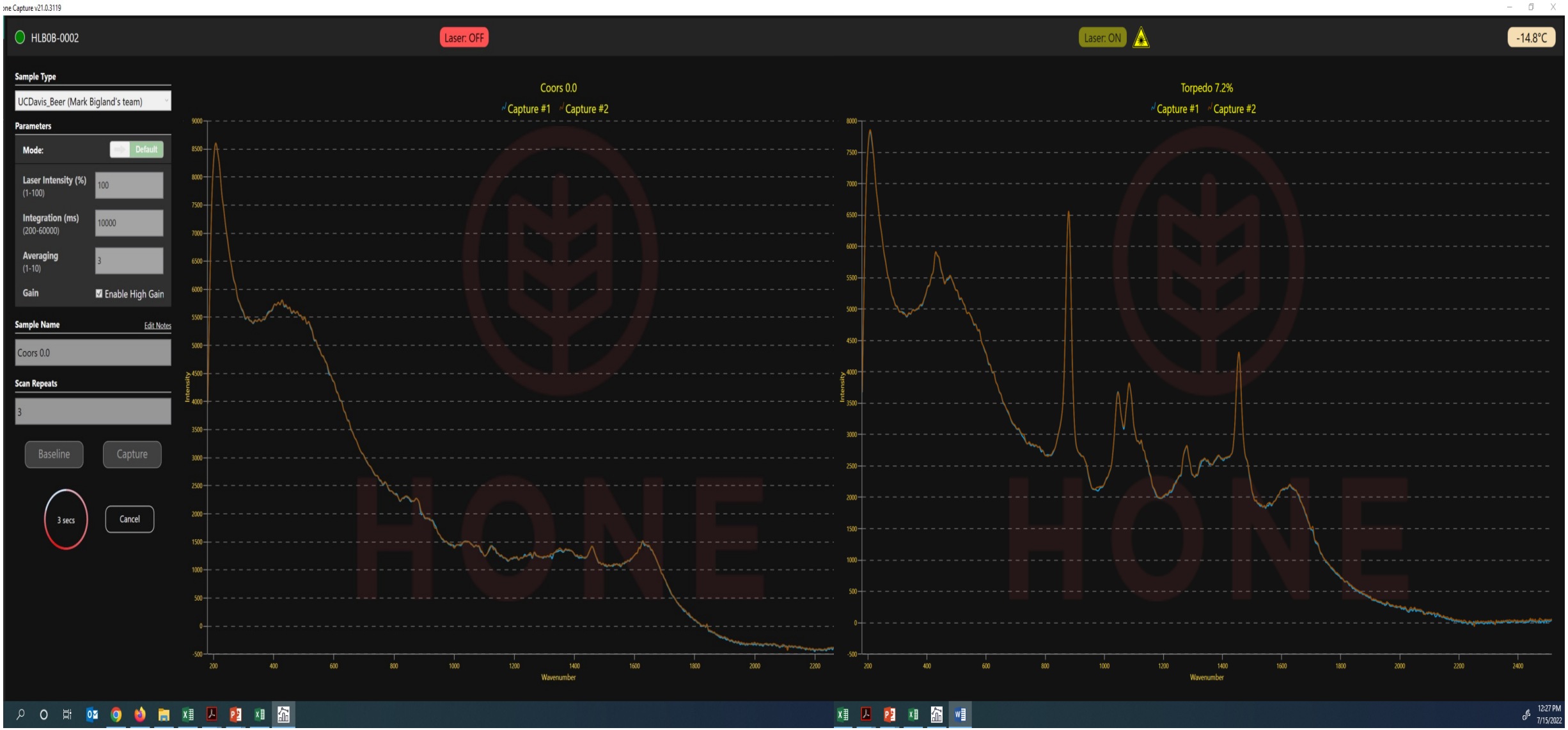
- Wort: gravity, sugars, color, FAN, total nitrogen,
- Hopped wort: bitterness, color,
- Fermented beer: ABV, color,

At line

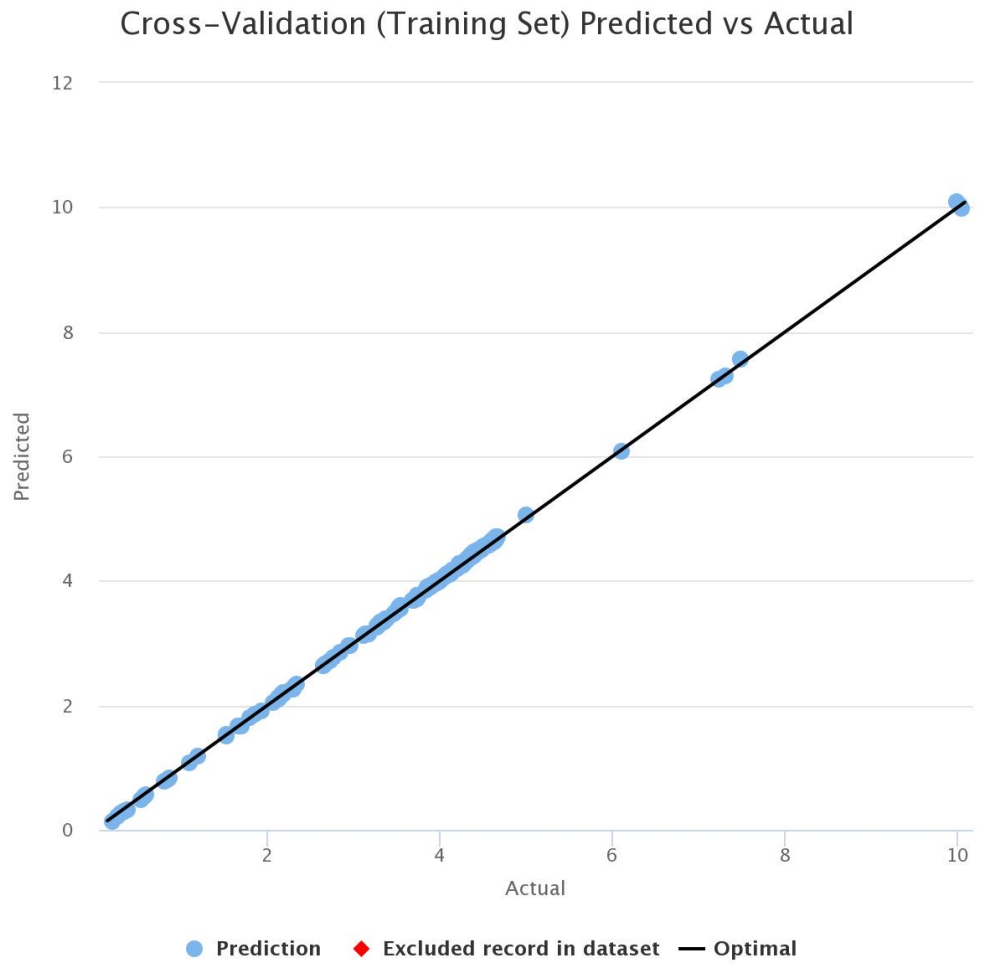
- Hand-held infrared
- Sub-sampling required
- No laboratory needed
- Scan time in seconds
- Spectra to cloud and data predicted in seconds
- Multiple parameters simultaneously
- In development: gravity, sugars, FAN



https://www.honeag.com/


HLB0B-0002
Laser: OFF
Laser: ON
-14.8°C
Sample Type
UCDavis_Beer (Mark Bigland's team)
Parameters
Mode:
Default
Laser Intensity (%)
(1-100)
100
Integration (ms)
(200-60000)
10000
Averaging
(1-10)
3
Gain
Enable High Gain
Sample Name
Edit Notes
Coors 0.0
Scan Repeats
3
Baseline
Capture
3 secs
Cancel
Coors 0.0
Capture #1
Capture #2
Intensity
Wavenumber
Torpedo 7.2%
Capture #1
Capture #2
Intensity
Wavenumber
12:27 PM
7/15/2022

Precision of calibration



Model	**23494**
RMSECV	0.02
RMSECV as % of range	0.23%
R2	0.999
Accuracy	98.87
Number of records	191
Min value	0.22
Max value	10.05
Mean value	3.73
Range	9.83
RMSEP	0.04
RMSEP as % of range	0.37%
R2	0.999

Traits under development

- Gravity
- ABV
- IBU
- Total Polyphenols
- Fermentable & non fermentable sugars

Pros and Cons of In-line and At-line

Pros

- Speed
- Data now
- Control
- Confidence
- Deeper understanding

Cons

- Costs
- Extra work
- Who has control
- So much data

Future

- Real time data during mash, post boil and post fermentation
- Not limited to current ‘standard’ parameters
- Flavor profiles from malt and hops
- Researchers: keep it real and keep it relevant

TWO THINGS

1. Useful technology for real time analysis
2. Multiple traits simultaneously

Resources

- Fox GP (2020) The brewing industry and opportunities for real time quality using infrared spectroscopy, Applied Sciences : Optics and Lasers. Special Edition: Non-destructive Sensors in Food Authentication. 10:616. HTTPS://doi:10.3390/app10020616

- https://cpe.ucdavis.edu/areas-study/brewing

@GlenFox9


Q&A