Detection of Contaminants in Raw Materials Using Spectral Imaging

Videometer A/S

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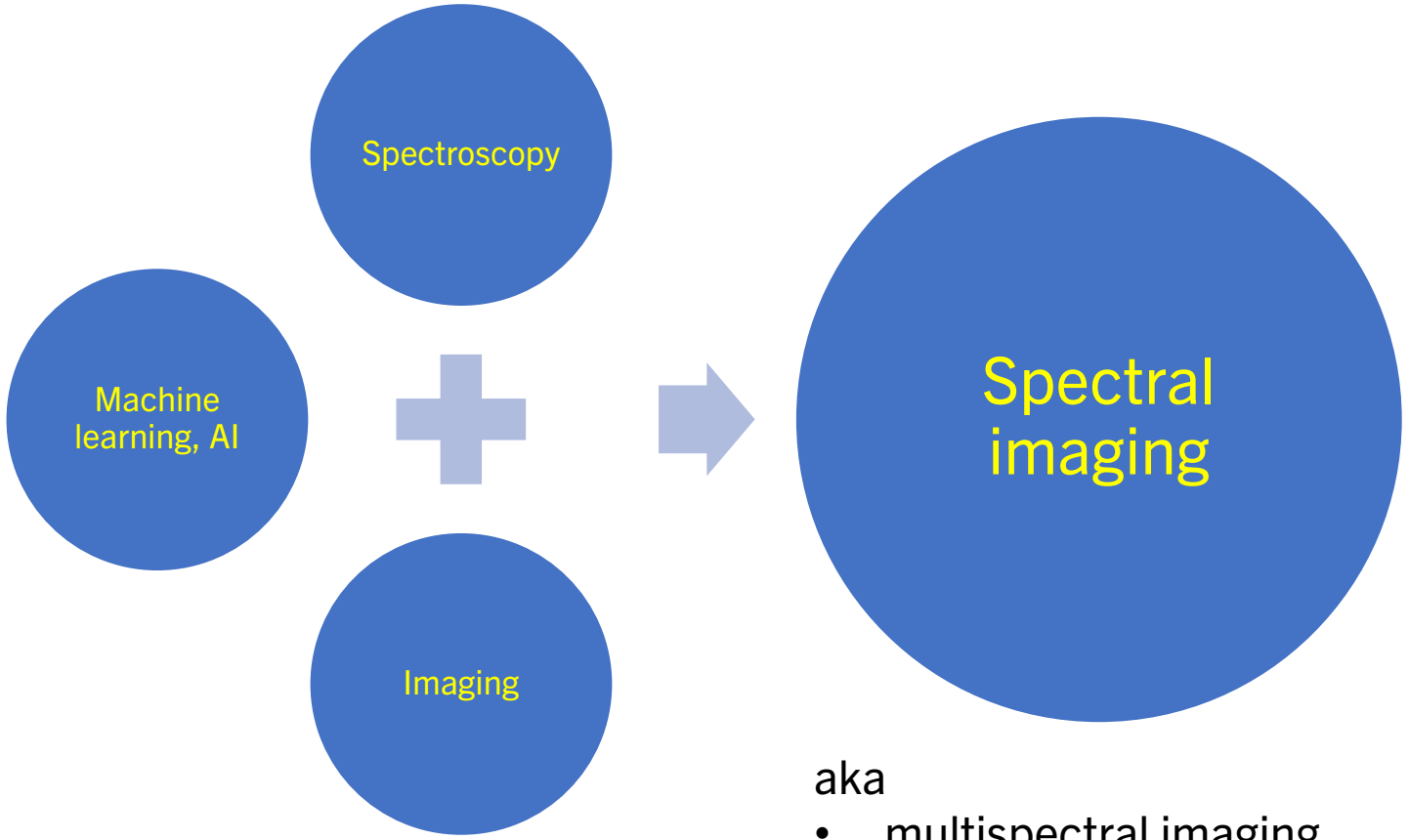
Videometer A/S

- Spectral imaging company
- Founded 1999
- Products
  - Lab instruments,
  - Turn-key in-line systems, and
  - R&D projects
- 750+ imaging R&D projects since 2000
- In-line 24/7 spectral imaging since 2002
- Based in Copenhagen, Denmark
- Partnerships worldwide

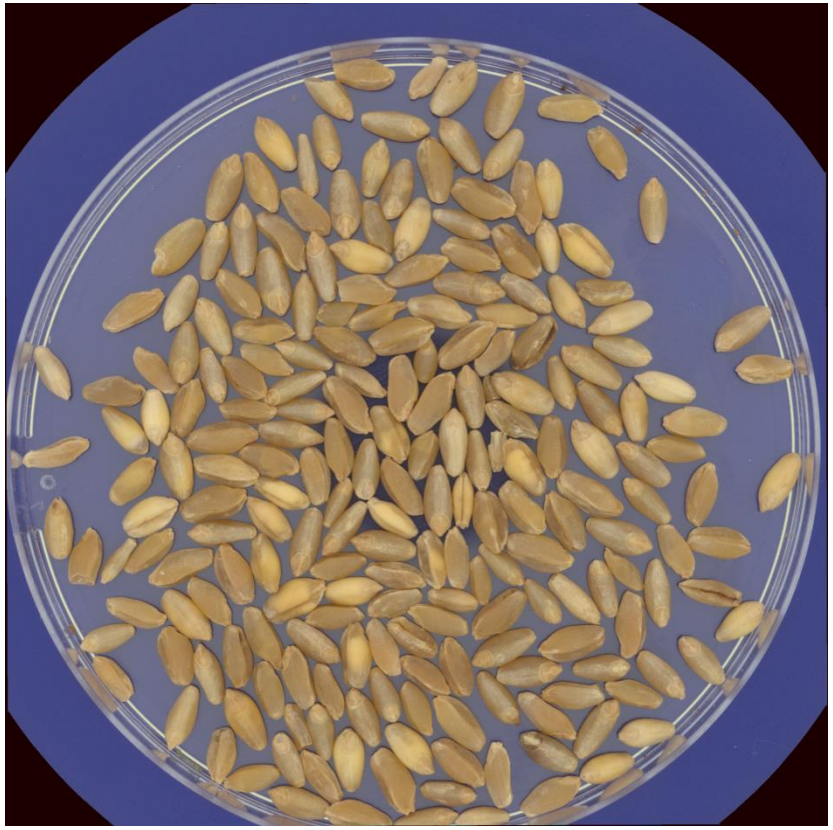
Spectral imaging



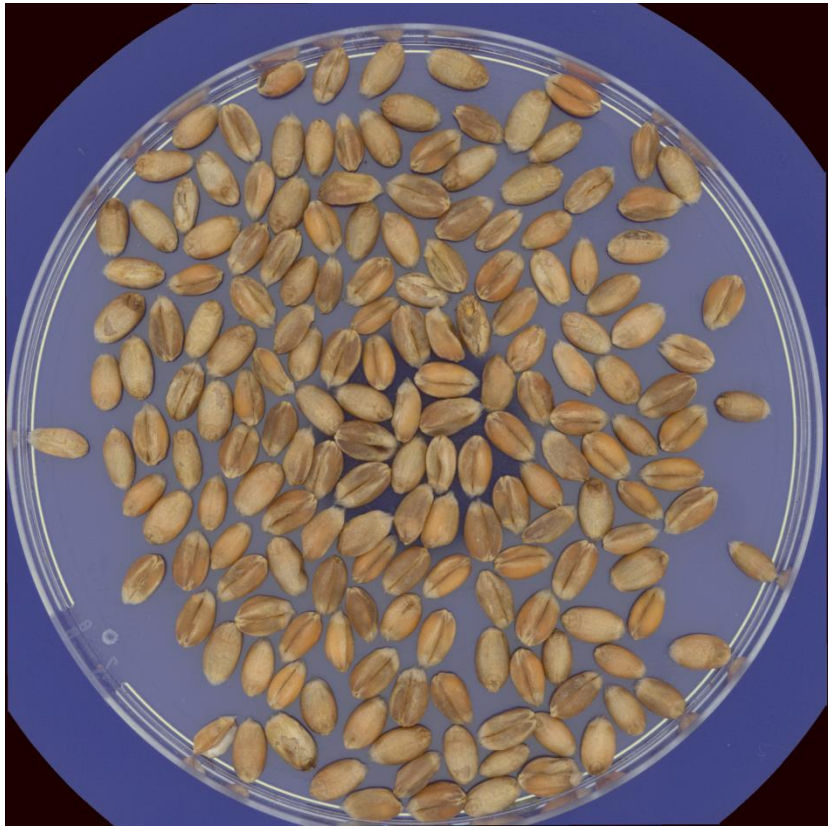
aka

- multispectral imaging
- hyperspectral imaging

Pure samples 1 and 2 in sRGB

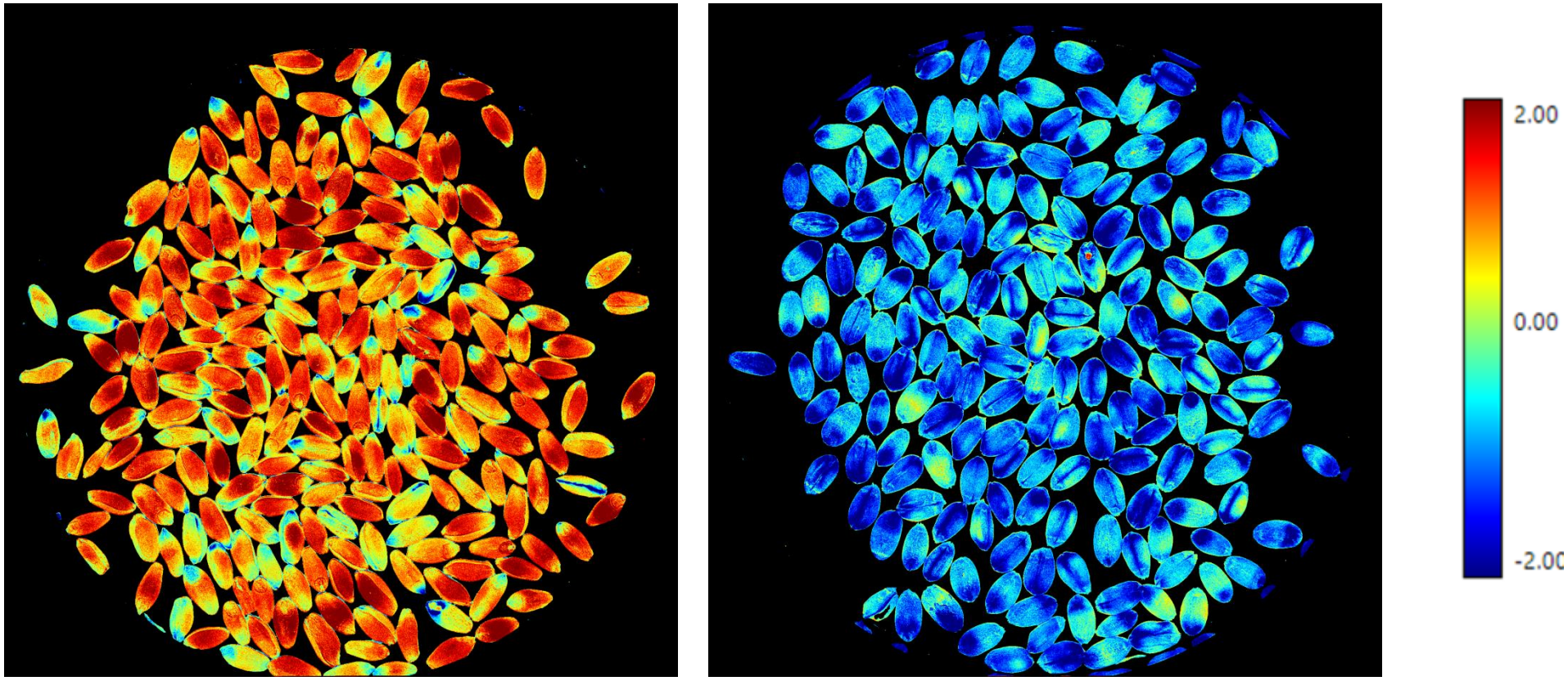


Durum



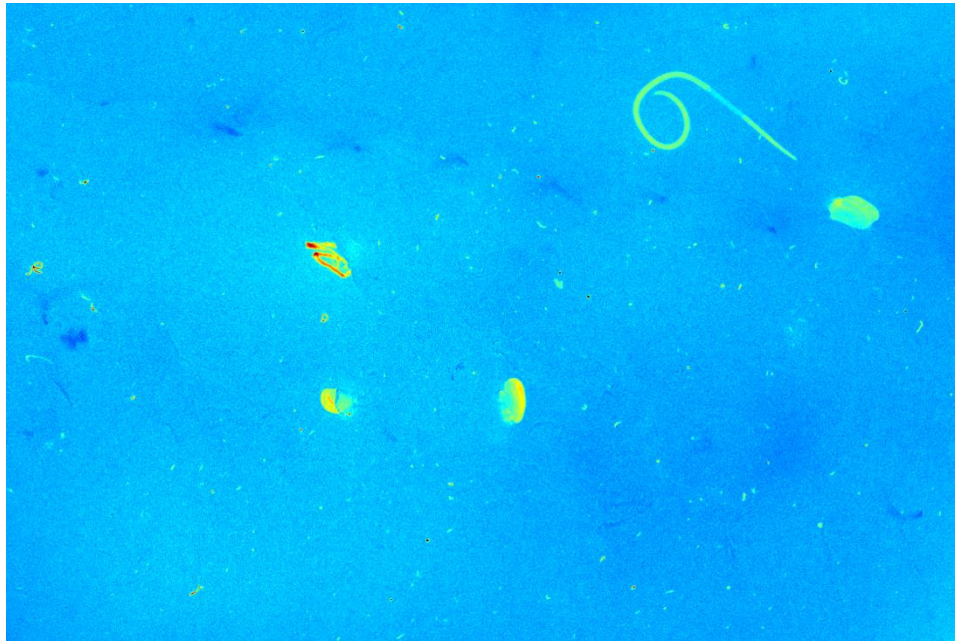
Common wheat

Pure samples 1 and 2 after nCDA



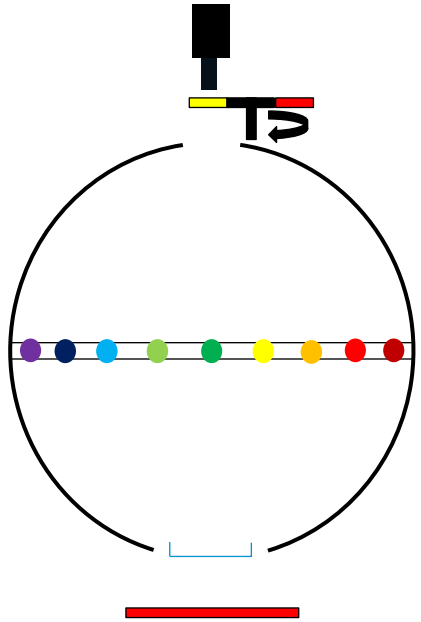
Anisakis in atlantic cod

sRGB image



Spectrally detected parasites

LED band-sequential spectral imaging



Camera and lens

Emission filter changer

Integrating sphere

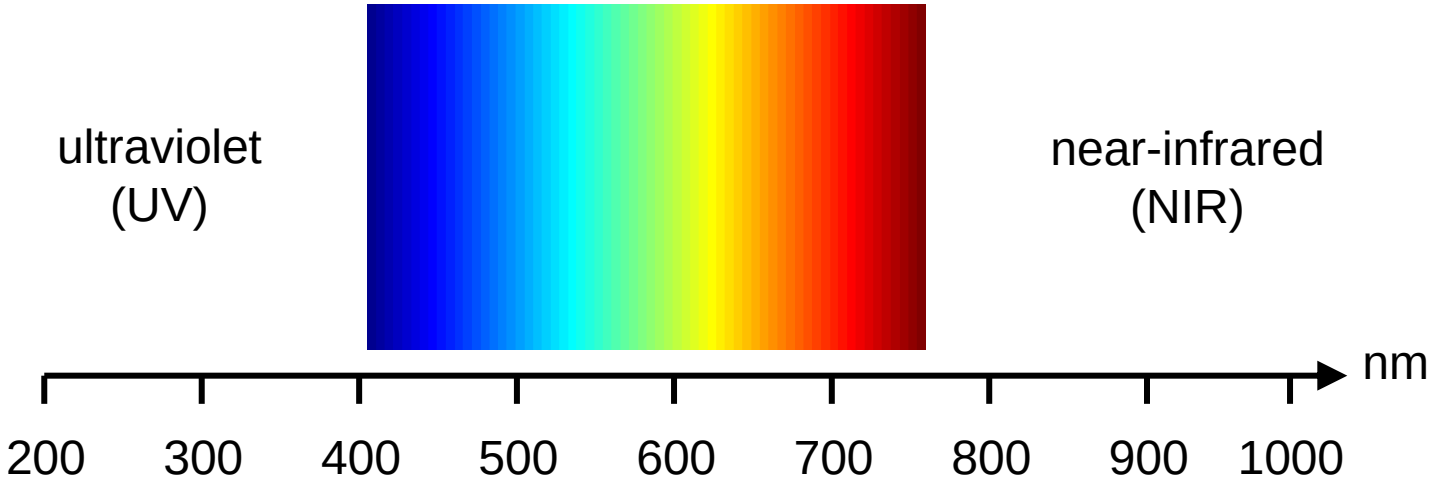
LEDs of multiple wavelengths

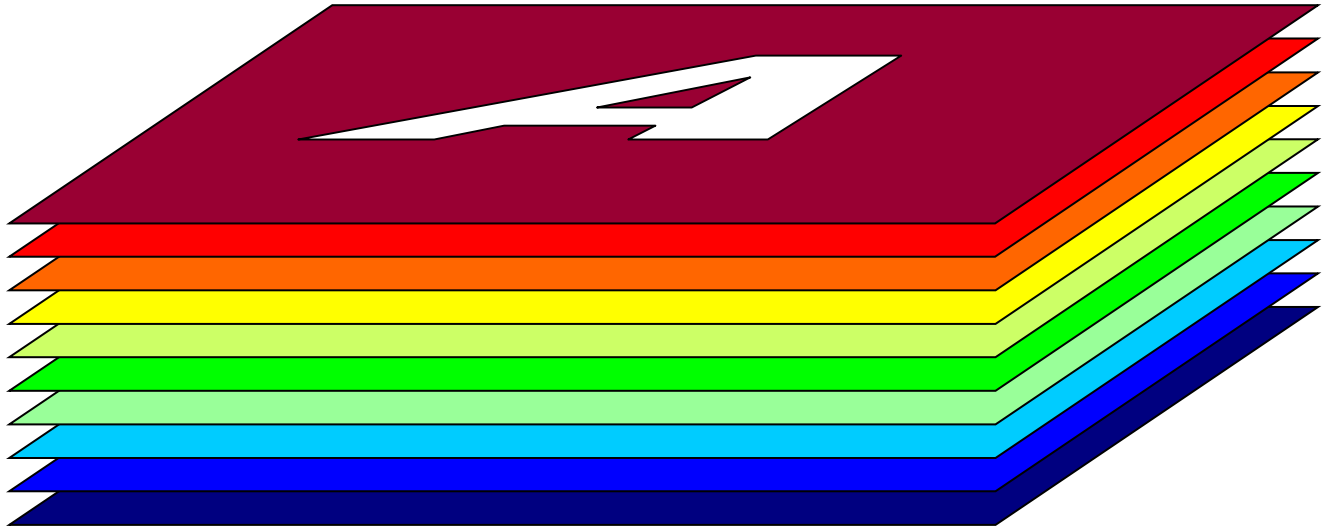
Sample is placed in target opening

Backlight or background

- LEDs: Stable, durable, large selection, rapidly developing technology
- Up to 20 different high-resolution bands acquired sequentially in 0.5-1.0 seconds
- May be combined with emission filters, backlight, and darkfield illuminant
- Combined **reflectance spectral imaging** and **fluorescence spectral imaging** possible!

Spectral Imaging

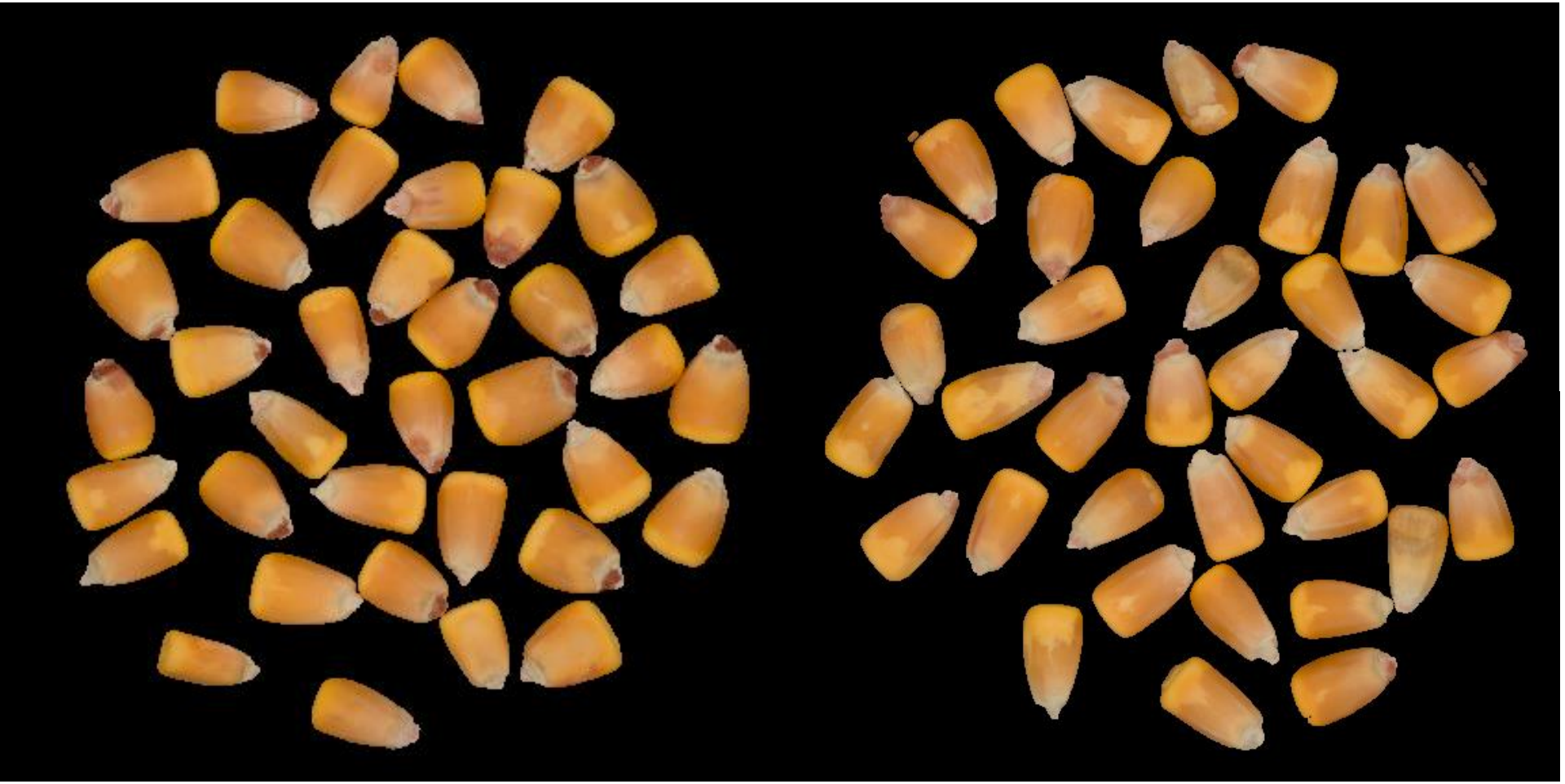


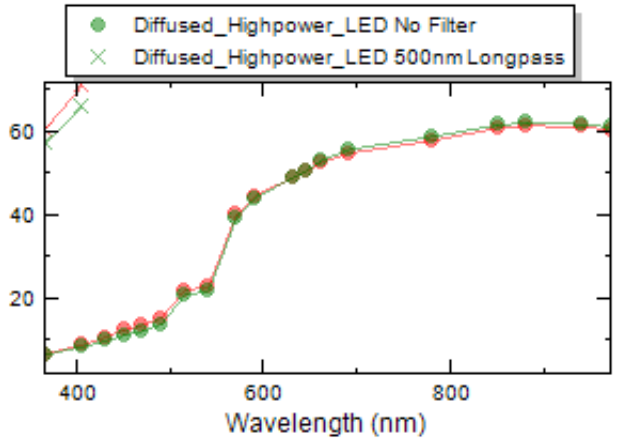


N images obtained at N specific wavelengths

Corn infection

Bartolić *et al.*: Fluorescence spectroscopy and multispectral imaging for fingerprinting of aflatoxin-B 1 contaminated (Zea mays L.) seeds: a preliminary study, March 2022, Scientific Reports 12(1), DOI: 10.1038/s41598-022-08352-4

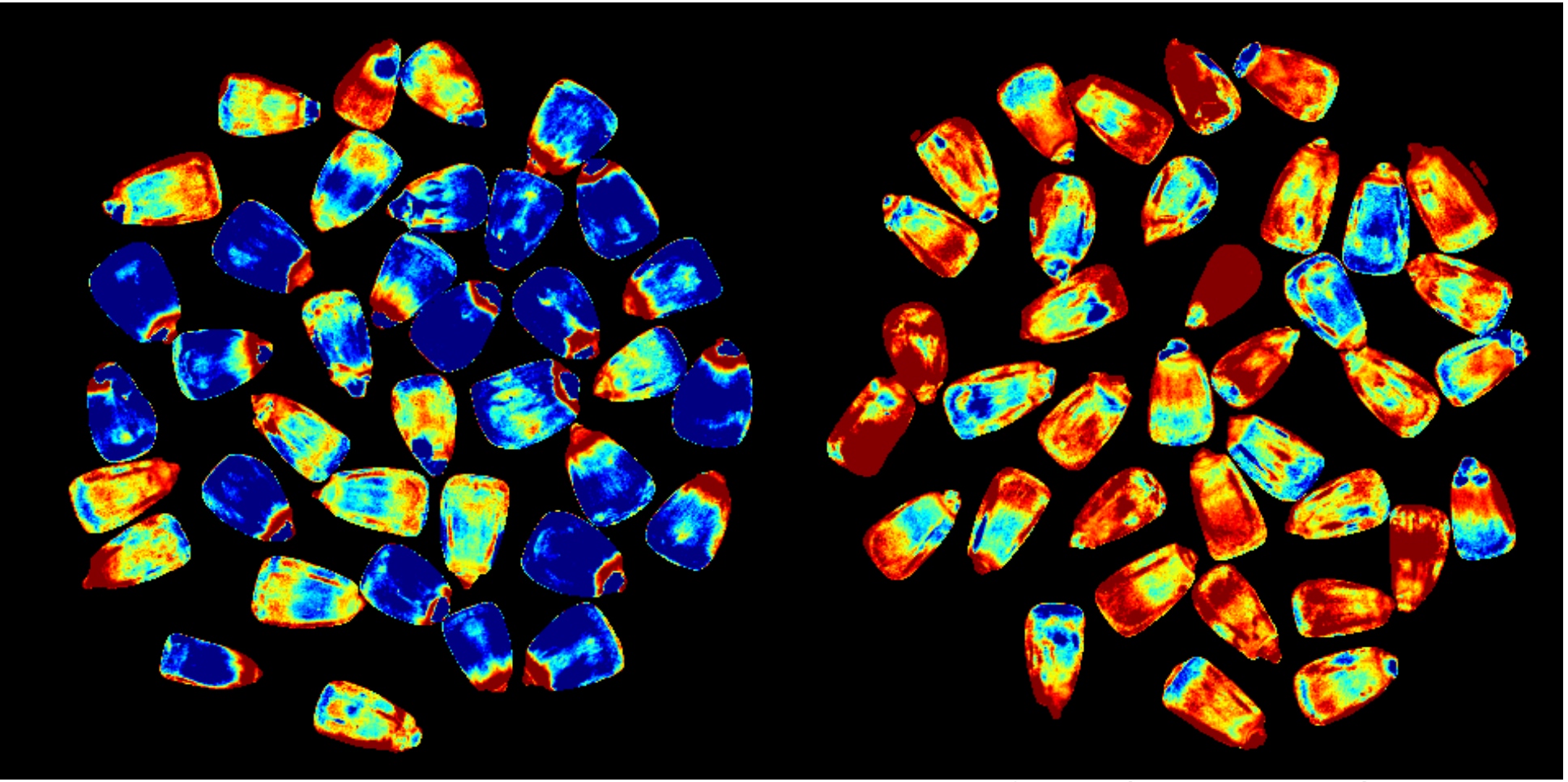




Control (embryo down)

Infected (embryo down)

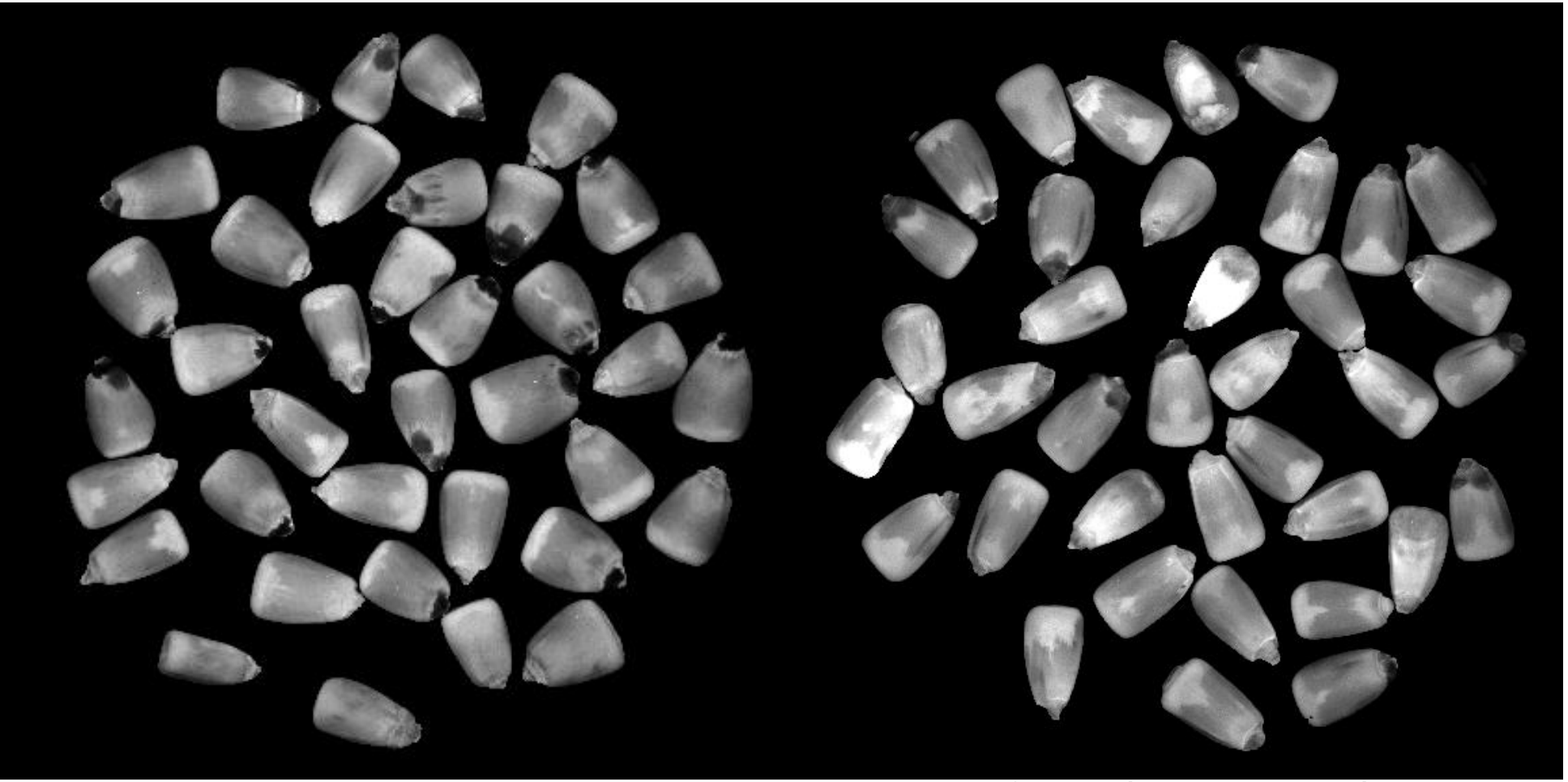
Corn infection fingerprint



Control (embryo down)

Infected (embryo down)

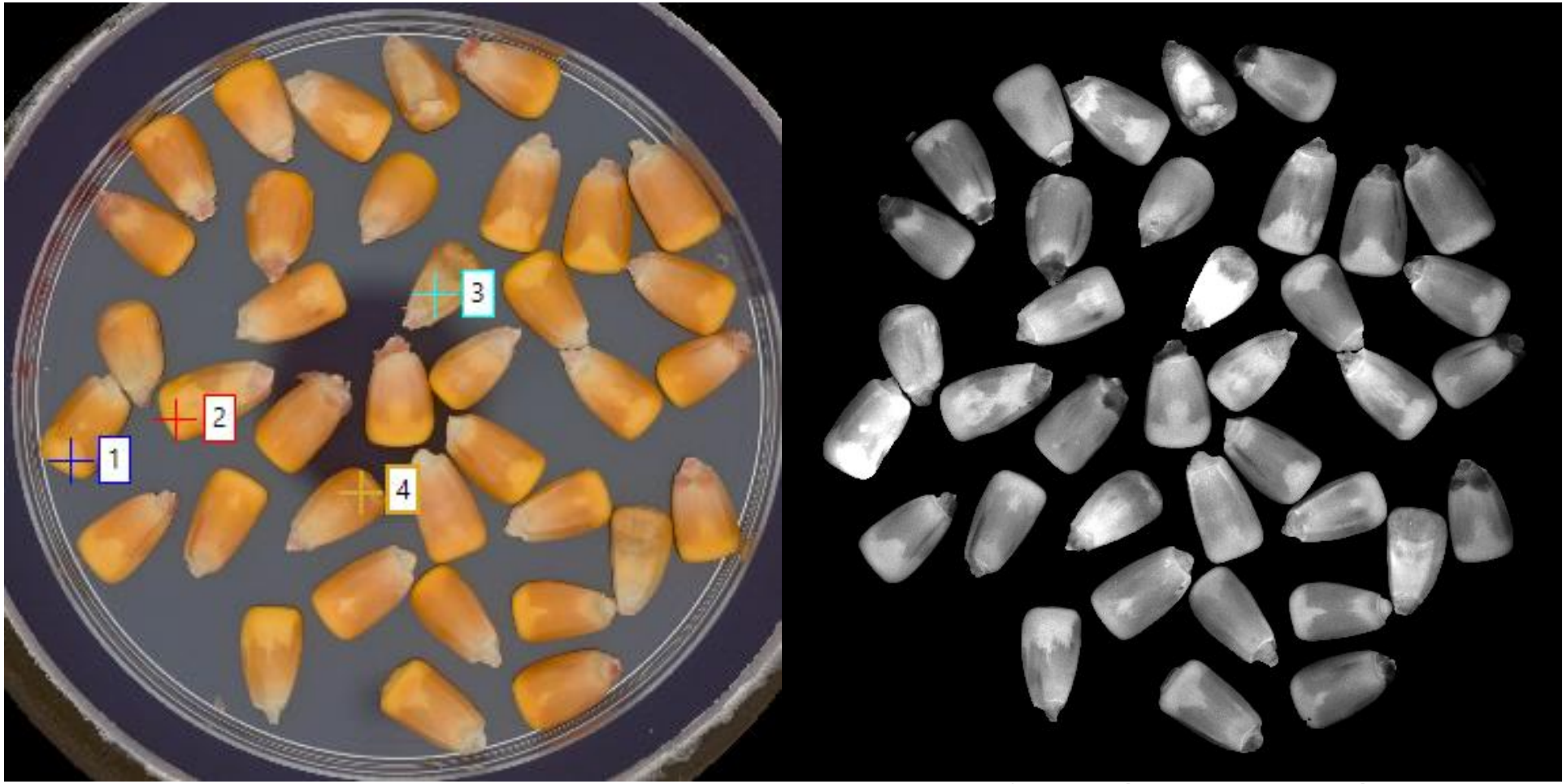
Corn infection fluorescence



Control (embryo down)

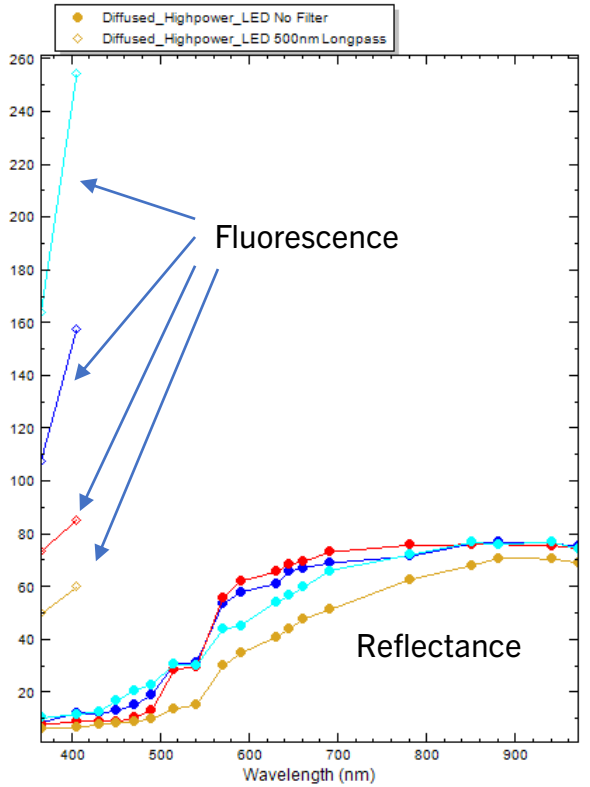
Infected (embryo down)

Corn infection fluorescence spectra



Infected (embryo down)

Infected (embryo down)



VIDEOMETER

Automated Corn Quality Inspection

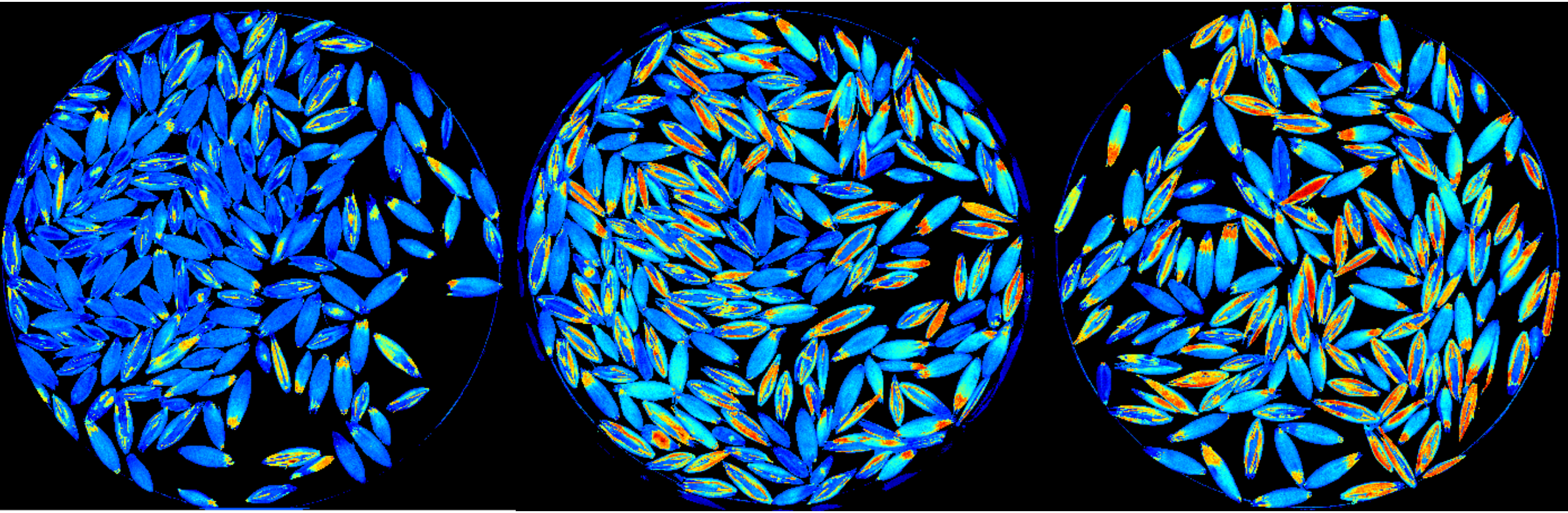
HT-2 in oats

Sample 21: 0.0 ppb

Sample 14: 136.1 ppb

Sample 9: 34.6 ppb

HT-2 in oats

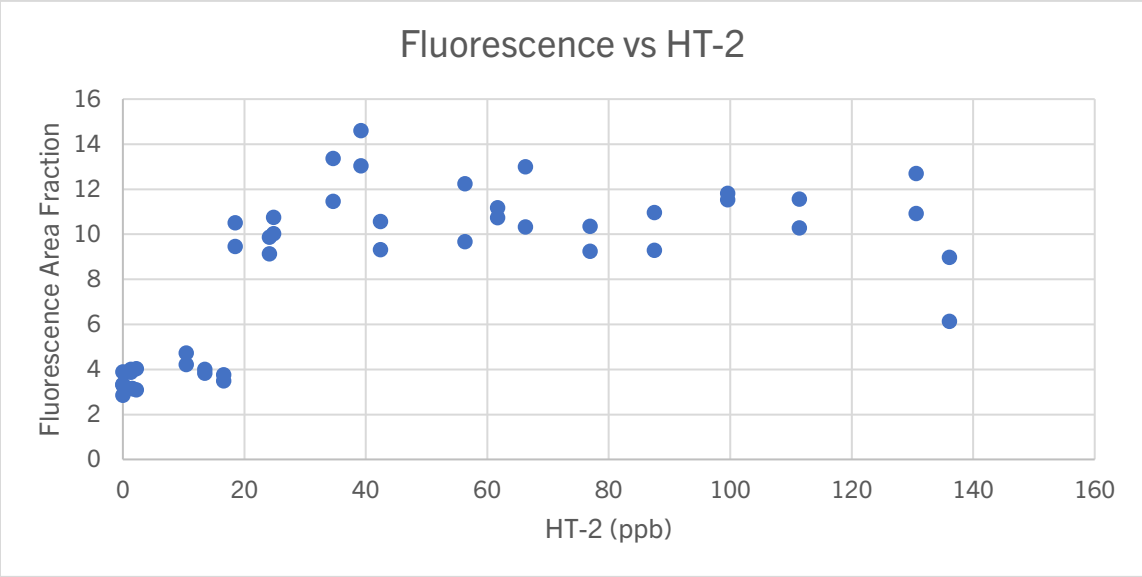


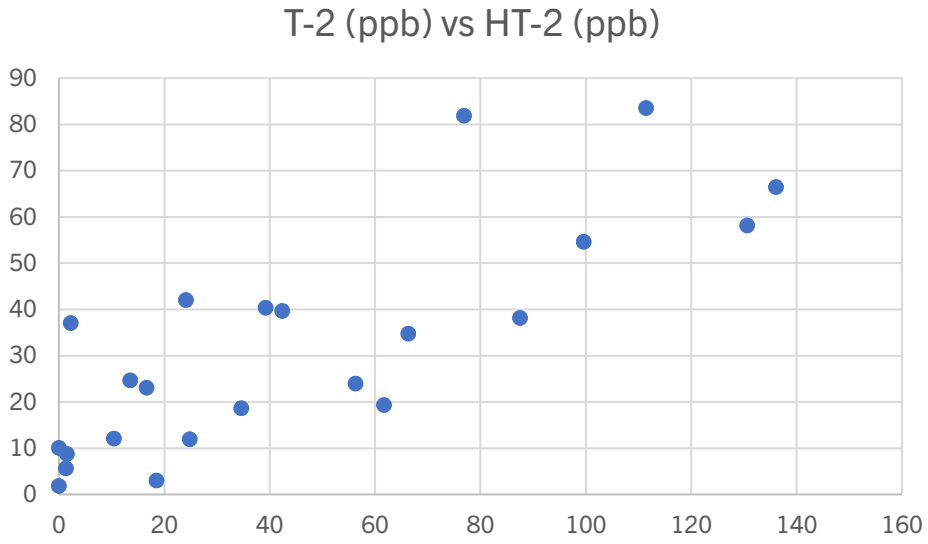
Sample 21: 0.0 ppb

Sample 14: 136.1 ppb

Sample 9: 34.6 ppb

T-2/HT-2 LCMS results from QUB



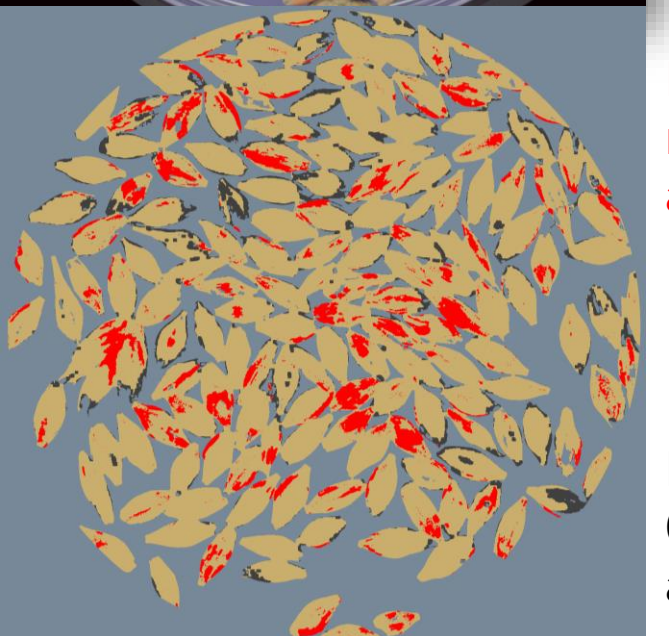


Indicative T-2/HT-2 levels on oats for direct human is 200 ppb (µg/kg)

EU COMMISSION RECOMMENDATION of 27 March 2013 on the presence of T-2 and HT-2 toxin in cereals and cereal products

Red Fusarium and gray mold model validation

Malting barley

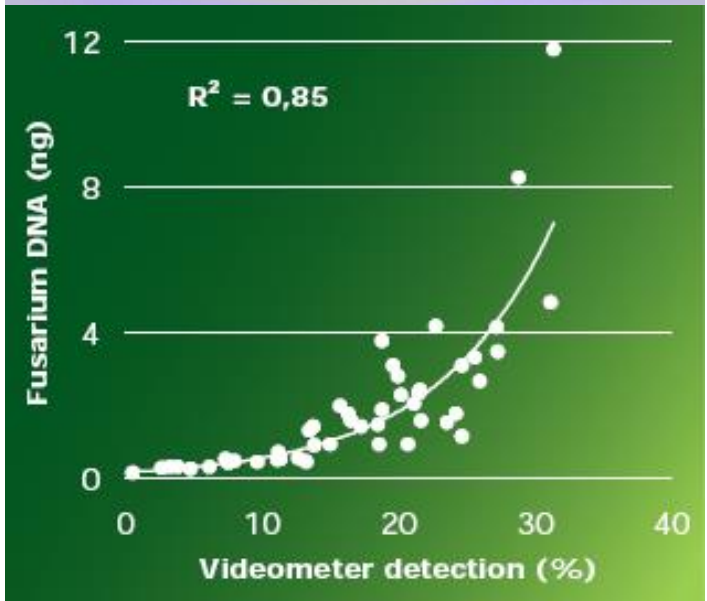


Red color:
red, orange or purple areas on kernels

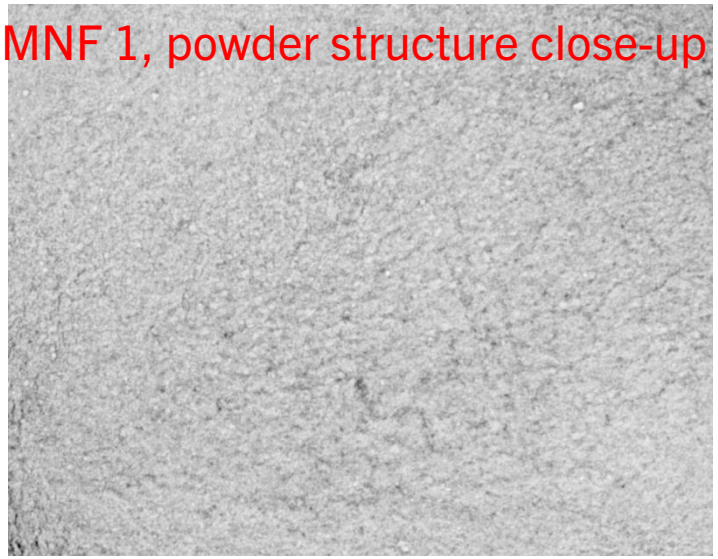
Black color:
Gray and black mold areas on kernels

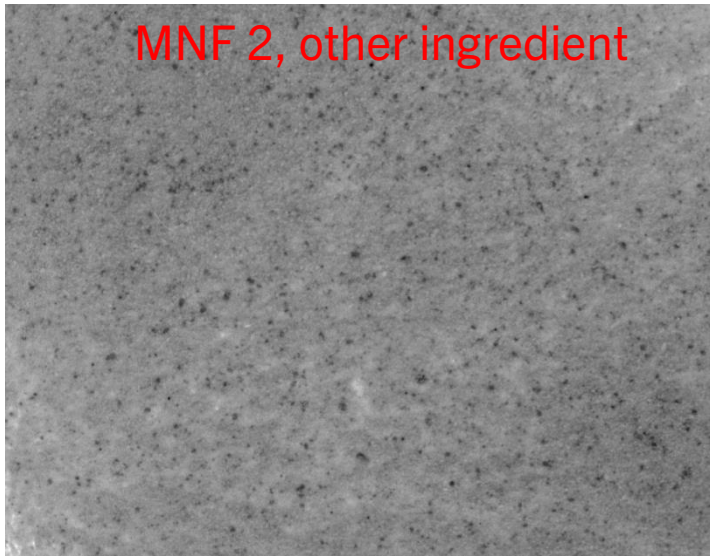
*The Fusarium calibration for barley is developed together with **Carlsberg Research Center** and **Viking Malt.***

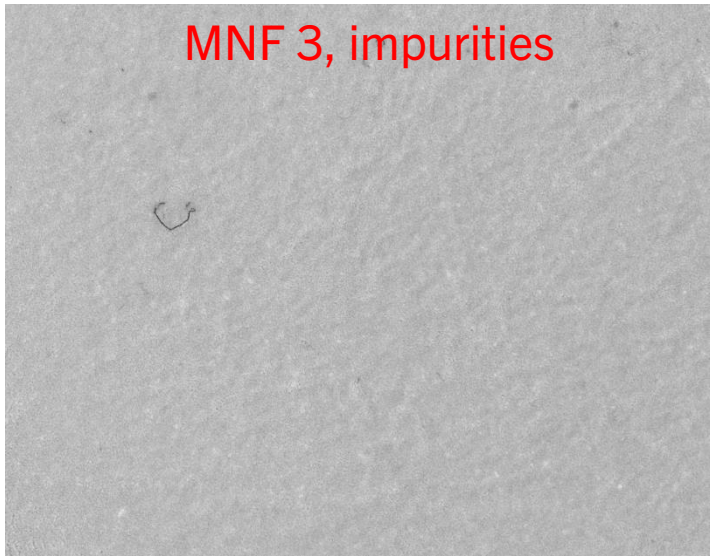
Comparison between VideometerLab® measurements and the level of Fusarium DNA quantified by qPCR



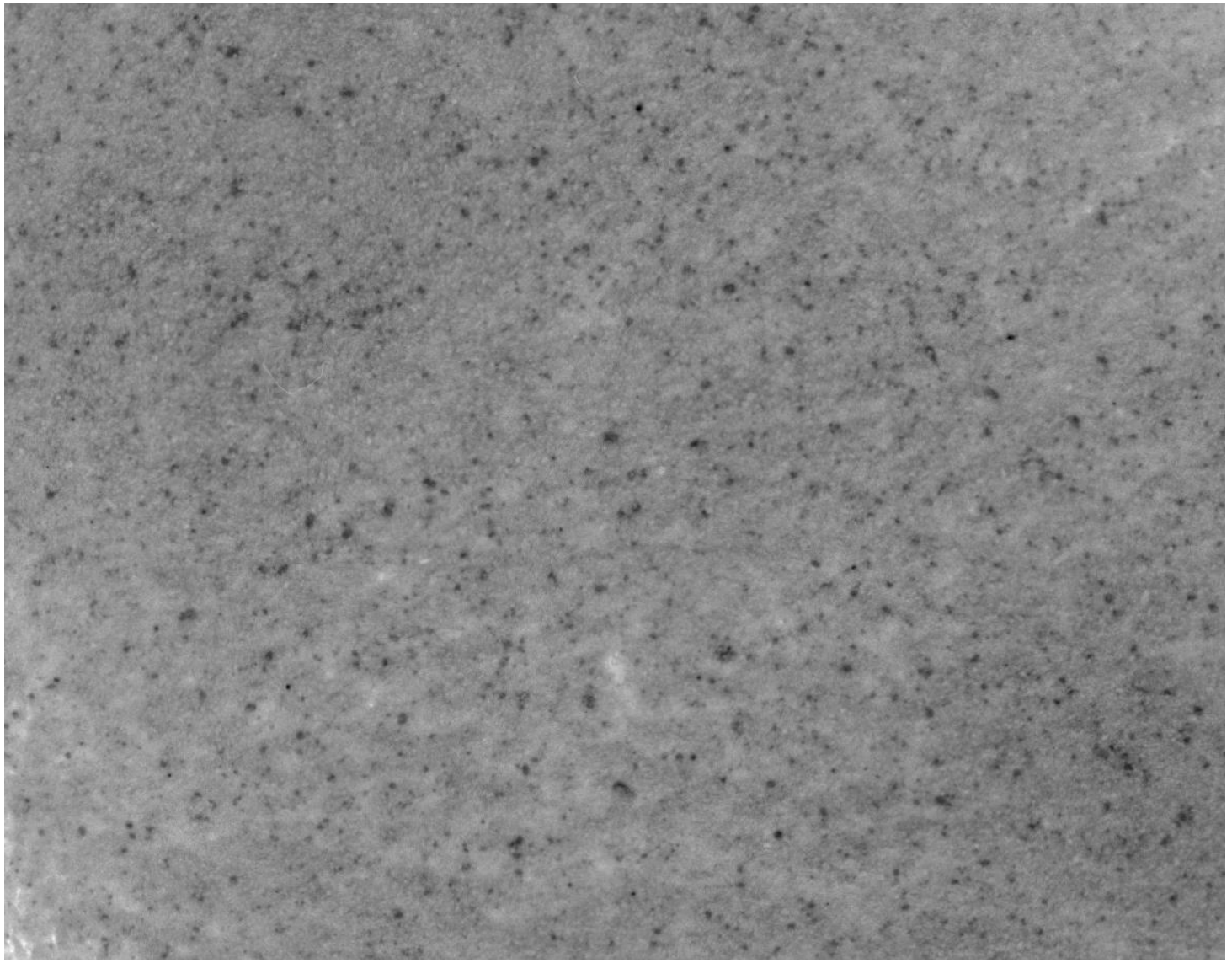
White powder problem



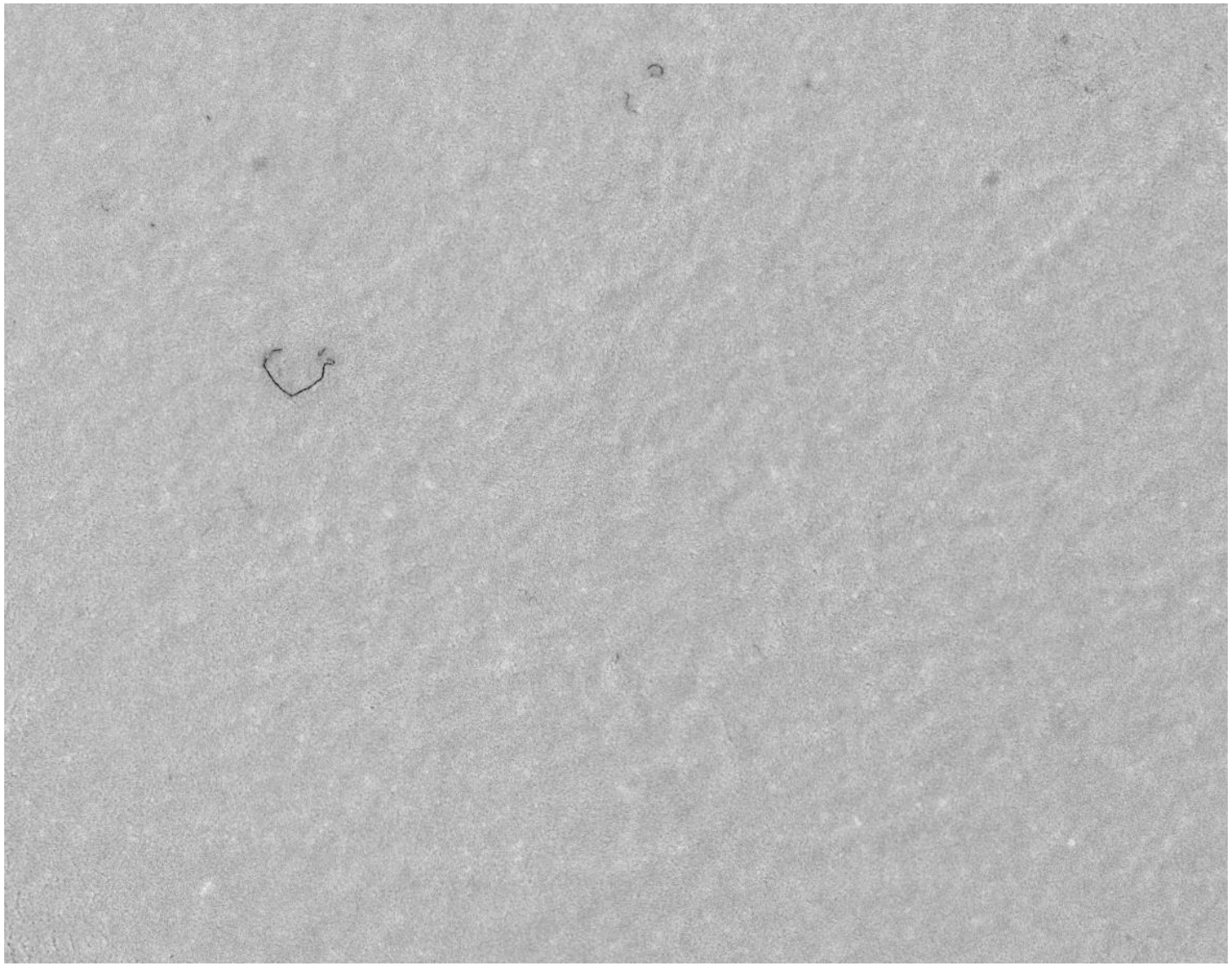




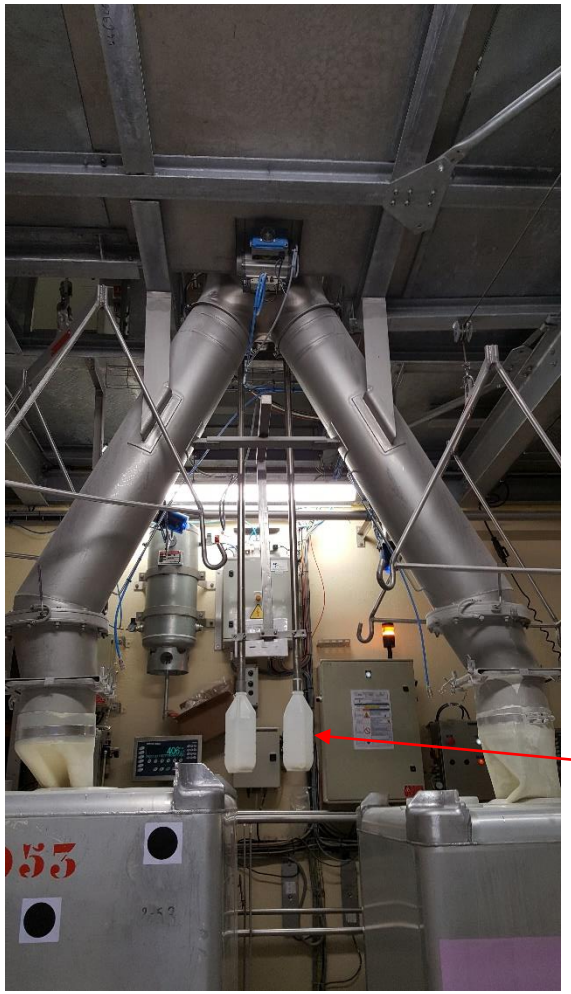
Other ingredient



Impurities

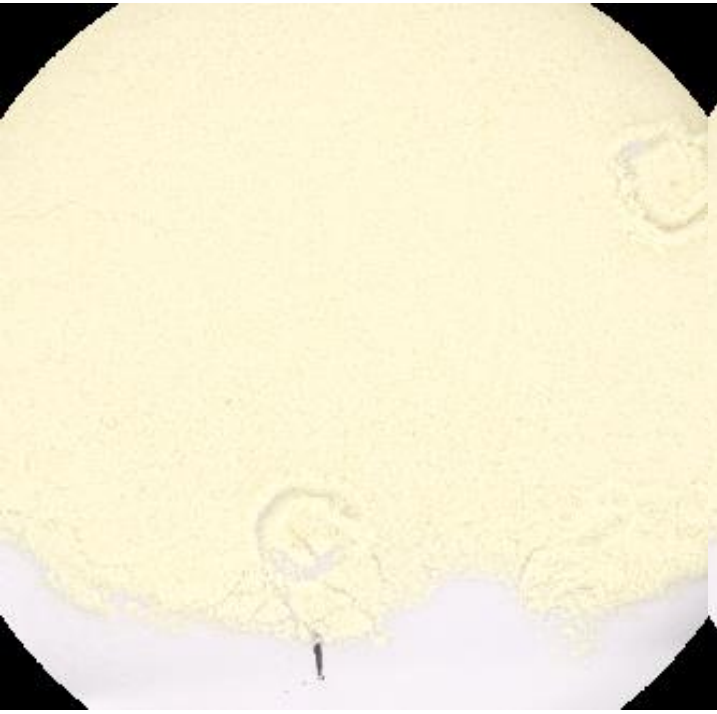


At-line or on-line milk powder analysis after drying

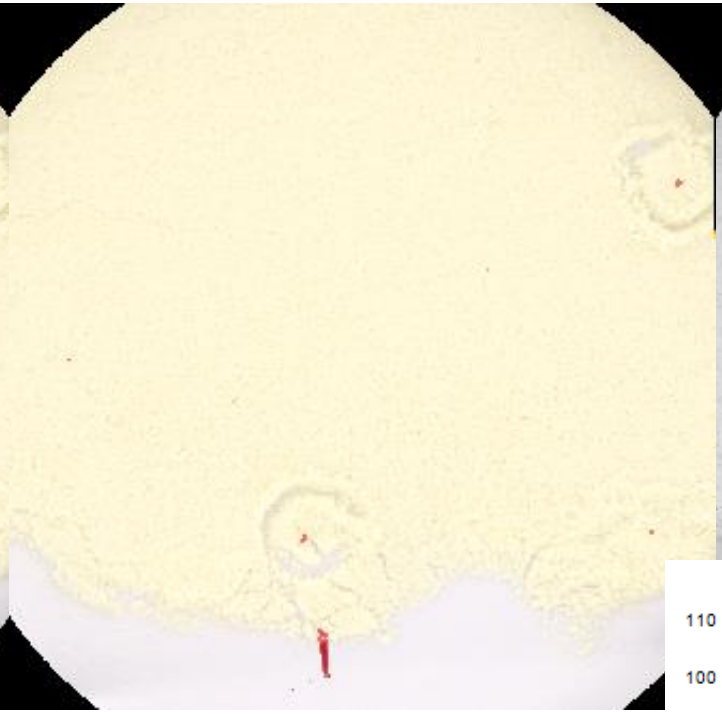


Manual or automatic sampling after spray-drying

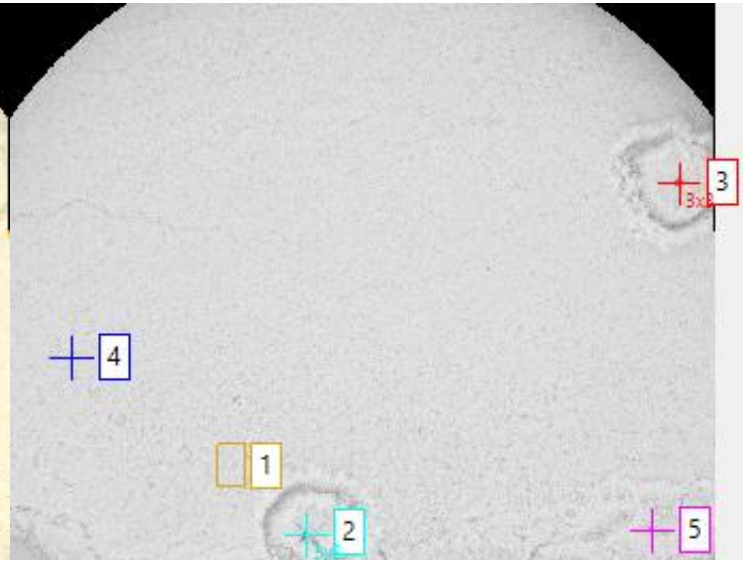
Scorched particle spectral signatures

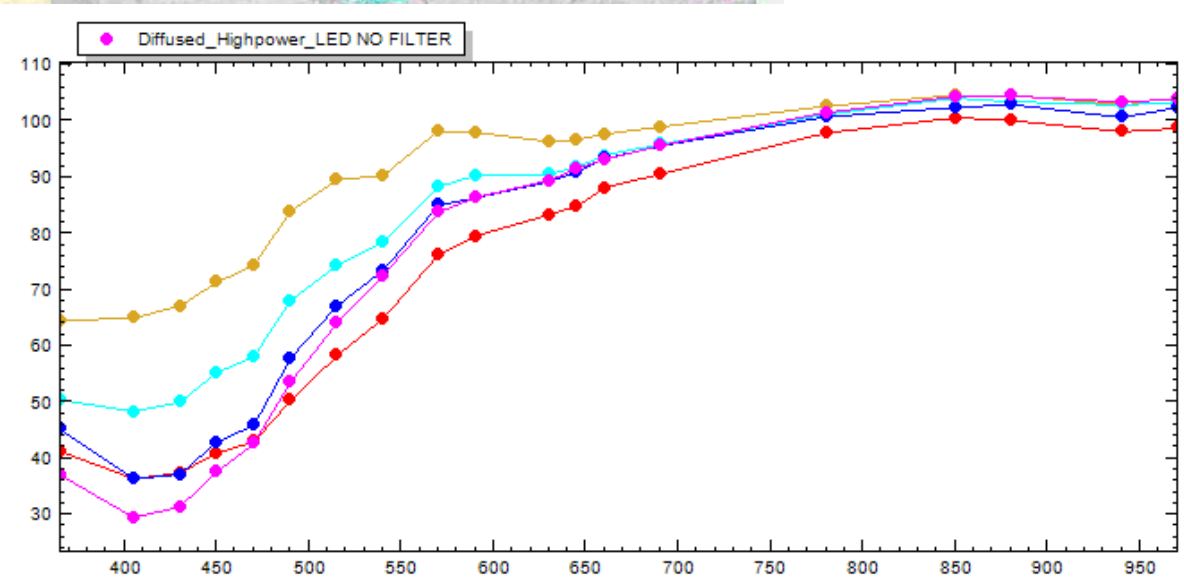


sRGB image

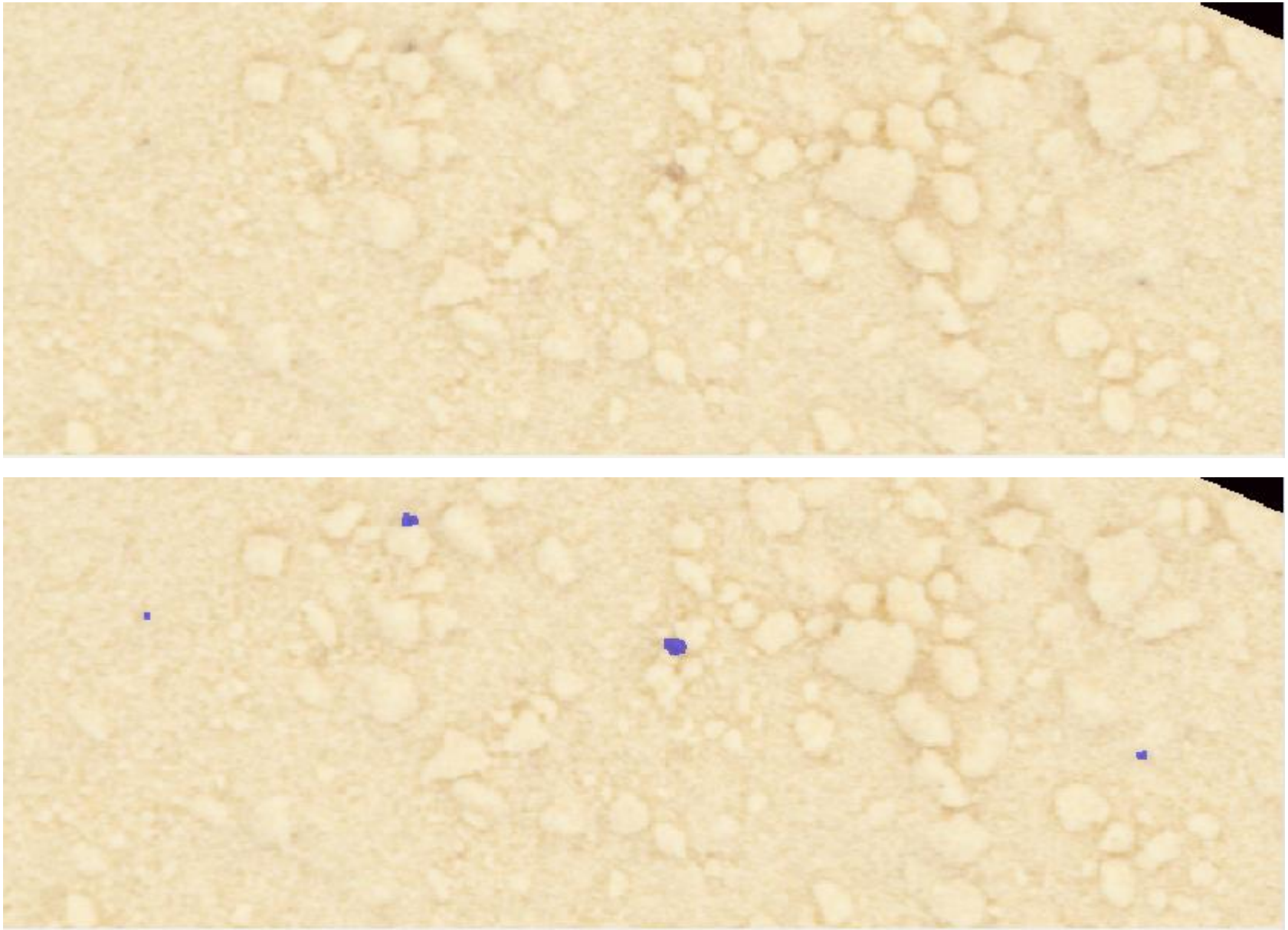


Segmented particles

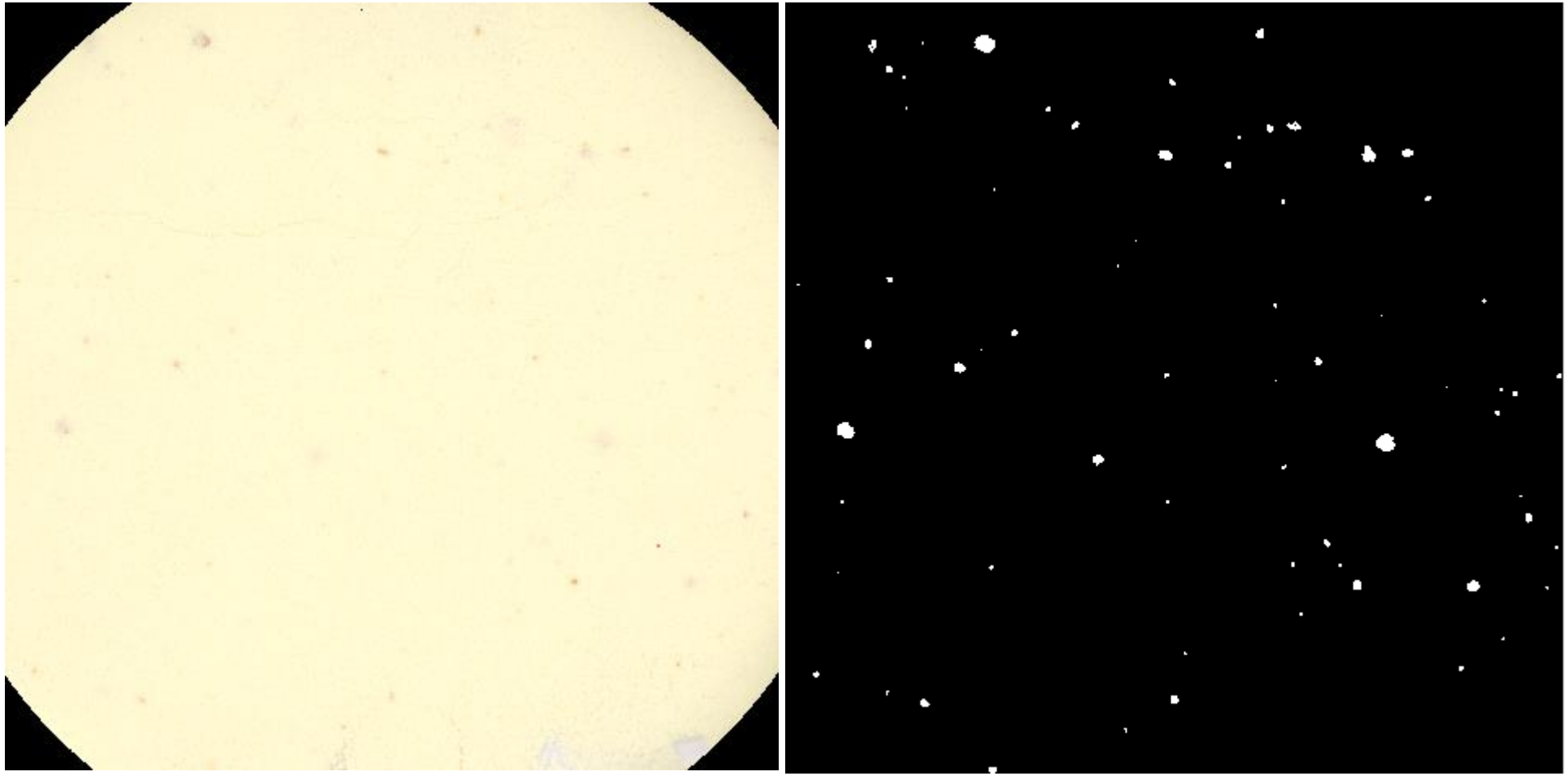




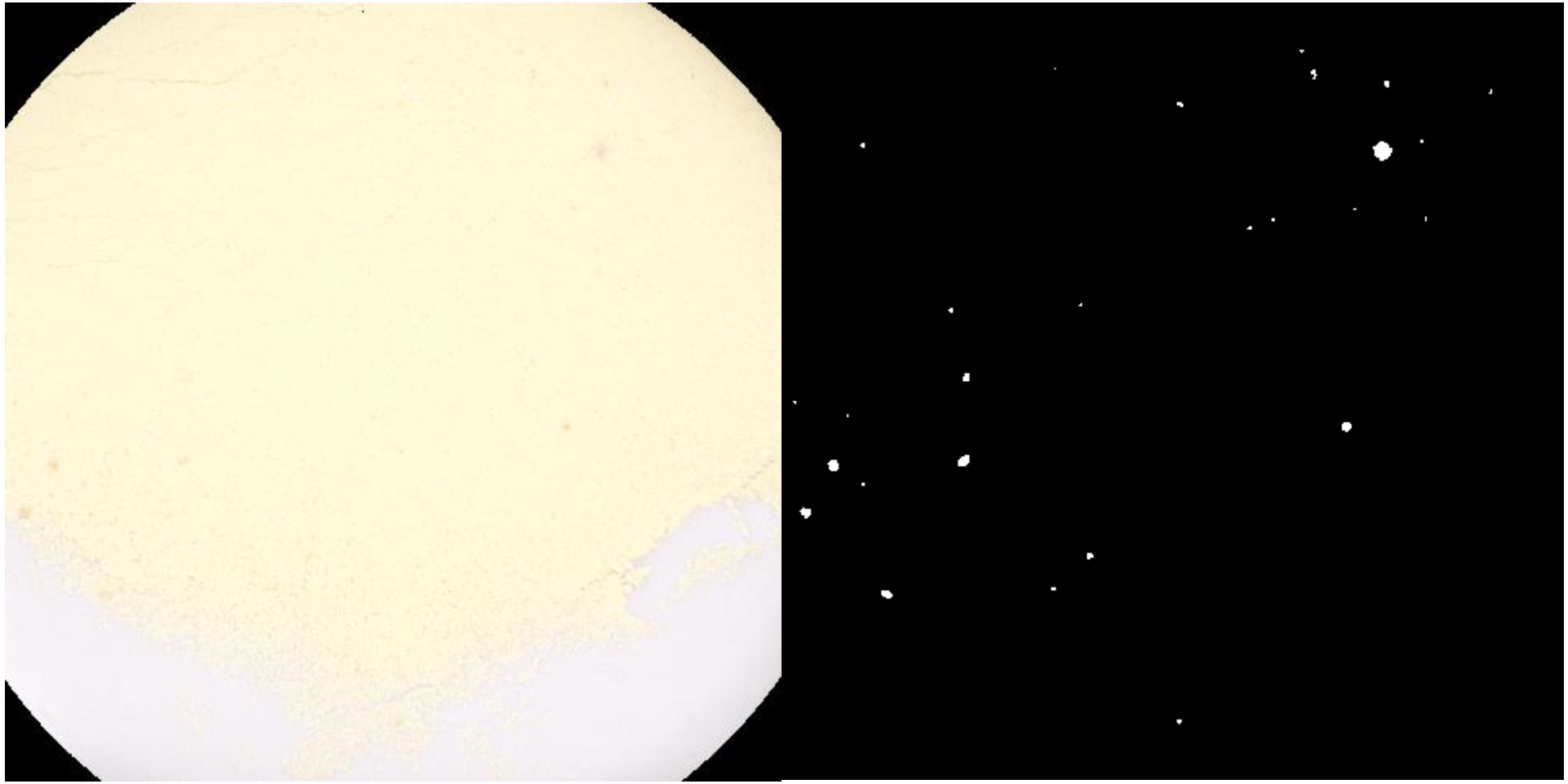
sRGB close-up with scorched particles marked



Bad sample



Slightly better sample



Conclusion

- Spectral imaging is a versatile, non-destructive and rapid screening tool for food safety assessment
- Examples included here:
  - Parasite detection in Atlantic cod (for illustration)
  - Aflatoxin detection in corn
  - General insect and mold damage detection in corn
  - DON potential, Fusarium and gray mold detection in malting barley
  - HT-2 detection in oats
  - General contaminant detection in powder, blending homogeneity
  - Powder allengen detection, peanut powder in almond powder
  - Process induced toxin potential in dairy powder, scorched particles

EU Horizon 2020 Research grant no. 861915, the DiTECT project supported this work.