Emerging technologies for detection of foreign bodies
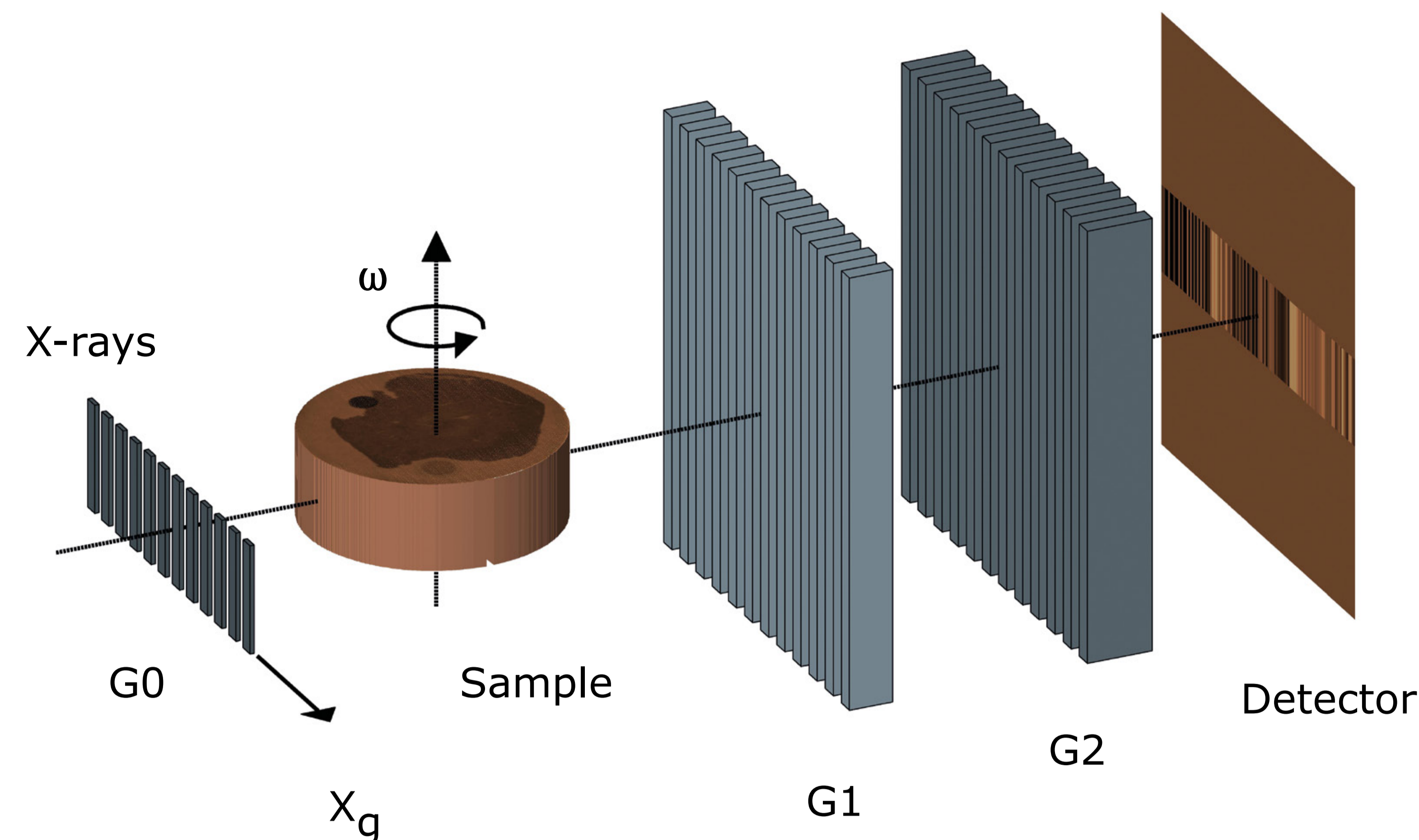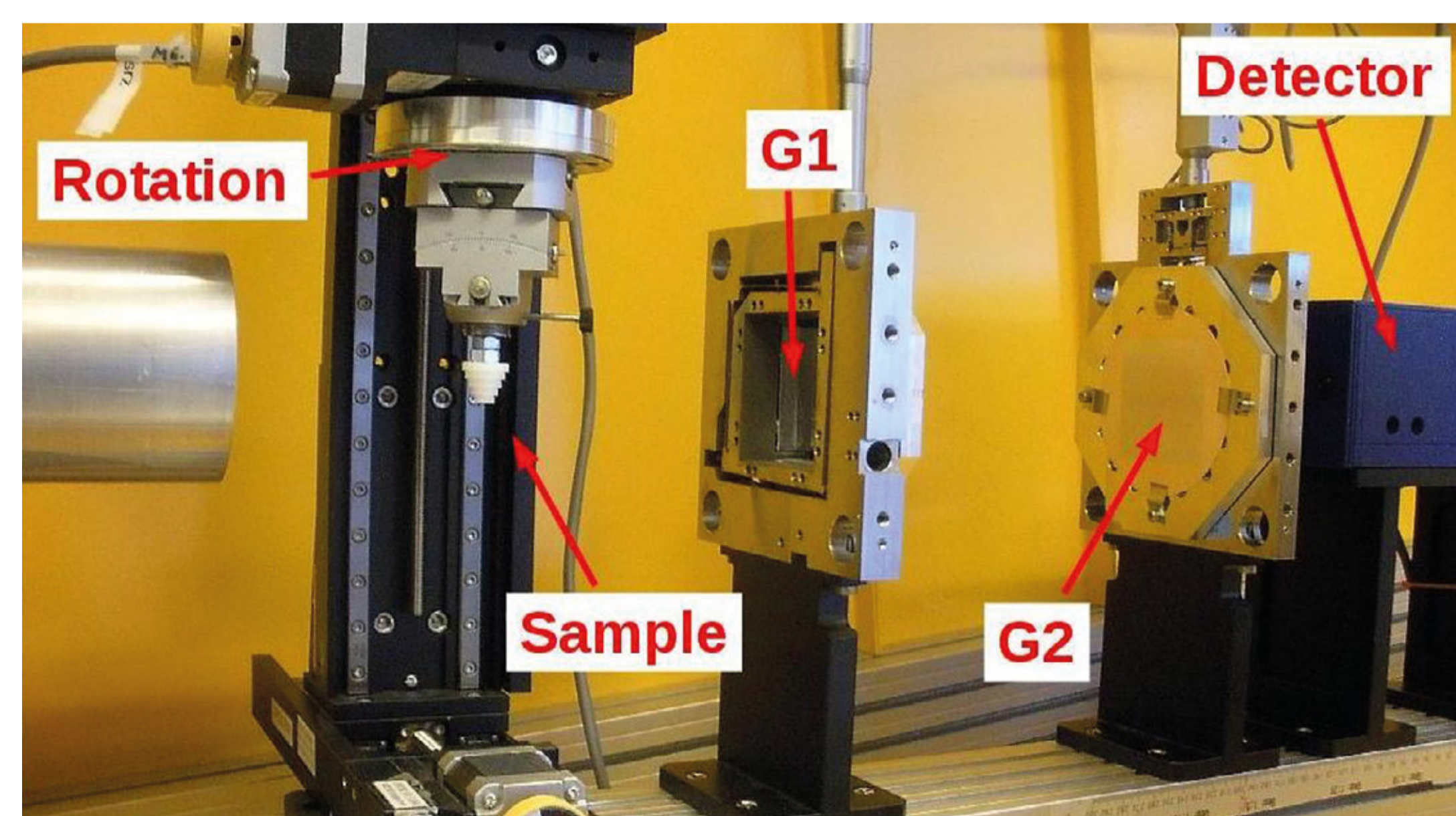
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X-rays

ω

G0

X_g

Sample

G1

G2

Detector

Introduction

Screening for foreign materials in food is a basic procedure in industrial production. Many dense materials can be detected using X-ray systems based on attenuation and transmission contrast. Still challenges persist from light materials like paper, insects and wrapping foil. We face this challenge by employing two technologies. X-ray based darkfield radiology and hyper spectral image analysis.

Rotation

G1

Detector

Sample

G2

Our work demonstrates preliminary results from a darkfield X-ray setup with penetrating power for detection of foreign bodies within bulk products. Furthermore we demonstrate calibration results and laboratory validation of a hyper spectral image analysis for detection of surface contaminants in fresh meat products.

Materials and methods

Left:
The minced beef, the glass piece, the paper and the Ladybug for Darkfield experiment.
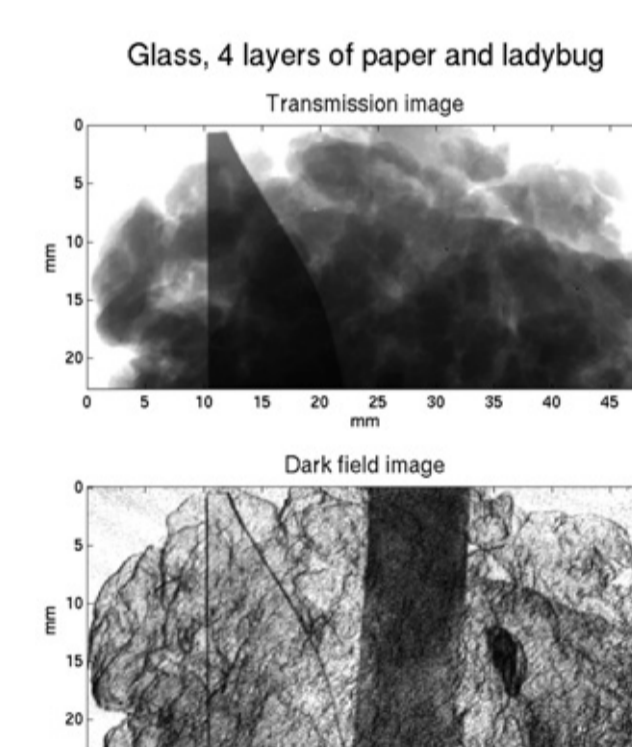
Right:
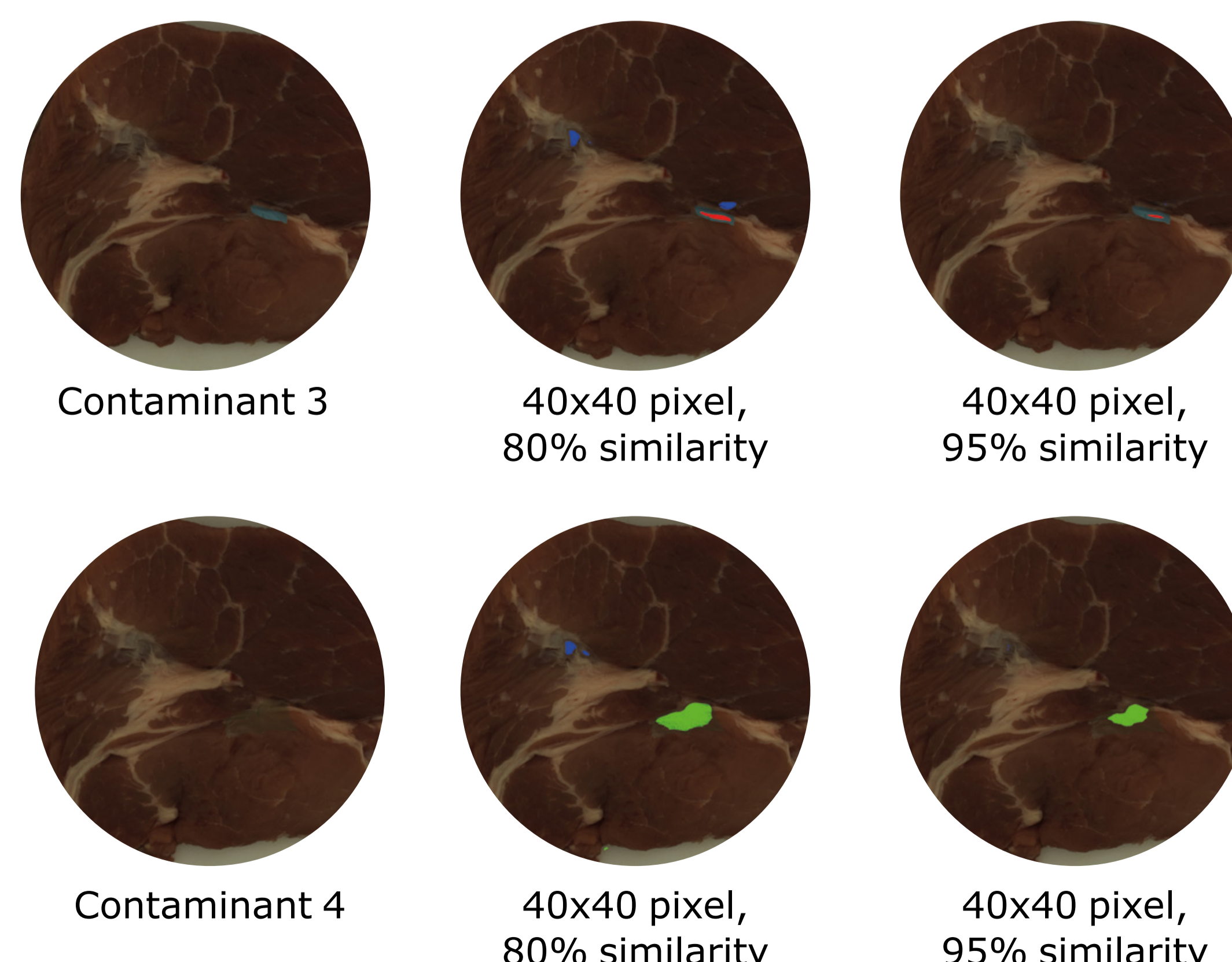The porcine neck sample used for model development and calibration of the hyperspectral vision system.

Results

Glass, 4 layers of paper and ladybug
Transmission image

Dark field image

Food product	Foreign body	Transmission contrast	Dark field contrast
Minced meat	Glass	0.13	0.05
	Paper	0.05	0.22
	Ladybug	0.01	0.28

Darkfield radiography: Conventional transmission (top) and darkfield X-ray radiograph. Tabel compares the contrast between the minced meat and three challenging materials, glass, paper and insect. The improvement of fibrous contaminants is clearly seen.

Contaminant Calibration (Extracts only)	No. 3	No. 4	False negative
No. 3	91.64%	0.00%	0.00%
No. 4	0.00%	77.82%	13.09%
False positive	0.00%	0.11%	NR

Calibration performance of the Can2 model on three meat products with selected contaminants.

Validation in the laboratory on two contaminant examples

Contaminant 3

40x40 pixel, 80% similarity

40x40 pixel, 95% similarity

Contaminant 4

40x40 pixel, 80% similarity

40x40 pixel, 95% similarity

Conclusion

Detection of light, fibrous contaminants as insects and paper is demonstrated with darkfield radiology. The six wavelength vision algorithm shows good potential for detection of wrapping plastic film.