

Foreign object detection using spectral imaging and machine learning

Mathé Zeegers

Computational Imaging

Scientific Meeting
Centrum Wiskunde & Informatica (CWI)
12 April 2019

Background - Foreign objects

Stukjes kunststof

HEMA roept alle hazelnoot-melkletters terug

30 november 2018 14:56
Aangepast: 30 november 2018 15:16



De letters van de HEMA.

HEMA roept uit voorzorg alle chocoladeletters van de variant melkchocola/hazelnoot terug. Er kunnen stukjes kunststof in zitten. Eerder werden al de letters B, M, N, R en S teruggeroepen. Nu gaat het dus om alle letters.

Lidl haalt hummus uit de schappen om stukjes plastic

23 NOV 2018, 12:41



Lidl haalt het product Houmous Pikant van het merk Baresa uit de handel omdat er mogelijk stukjes rood plastic in zijn terechtgekomen. Mensen die het product hebben gekocht wordt dringend verzocht het terug te brengen naar de winkel. Zij krijgen dan hun geld terug.

Mogelijk tijdelijk geen kipnuggets verkrijgbaar bij McDonalds

Nieuws 03-02-2019 Print dit artikel



Kipnuggets dreigen de komende dagen van het menu van de McDonald's te verdwijnen. Het bedrijf heeft een partij van de Chicken McNuggets afgekeurd nadat bij een controle bleek dat er mogelijk 'productvreemde stukjes' in de snack zitten.



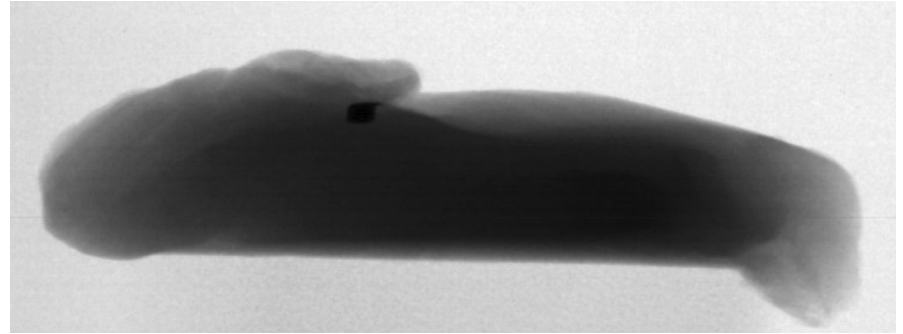
▲ De geraspte kaas die teruggeroepen wordt. © Jan Linders Supermarkten

Jan Linders roept de geraspte kaas terug vanwege plastic deeltjes

Supermarktketen Jan Linders heeft een veiligheidswaarschuwing uitgegeven voor de geraspte kaas, jong belegen 48+. Deze kunnen stukjes blauw plastic bevatten. De winkel roept de zakjes kaas terug.

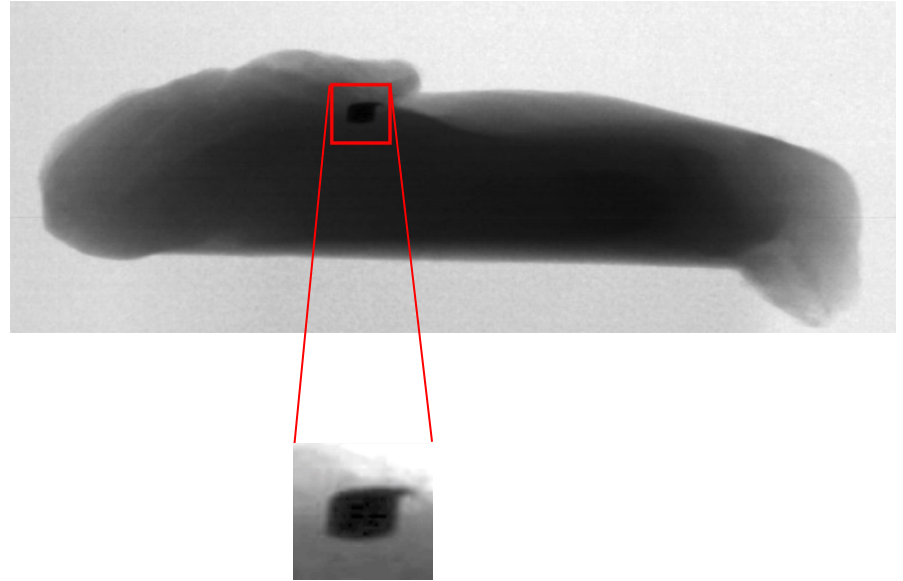
Background - Factory setting

Foreign objects can appear due to accidents at the factory production line.



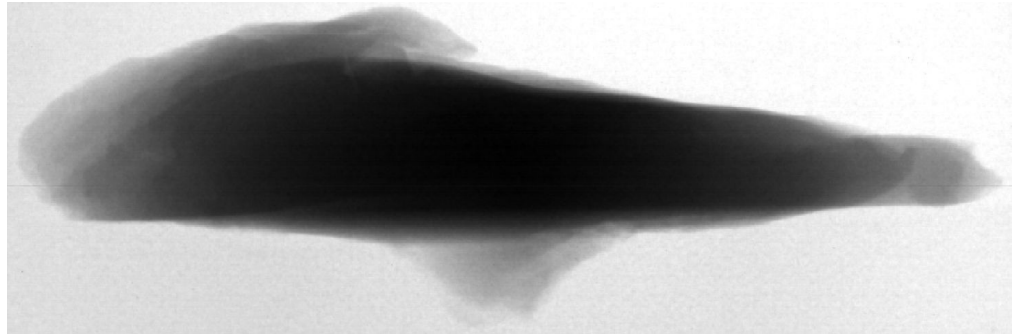
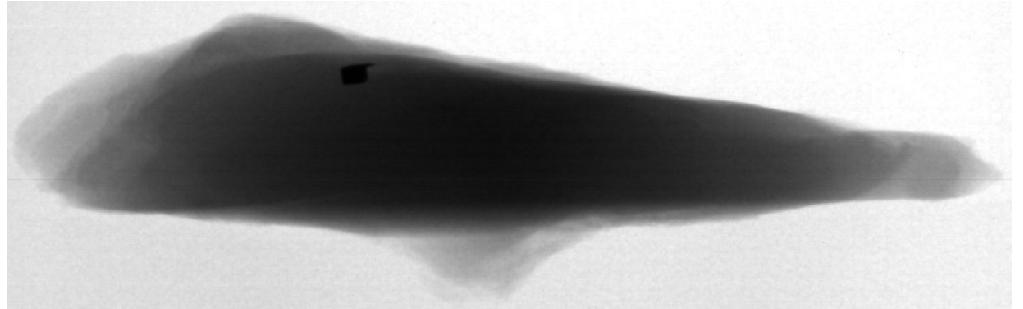
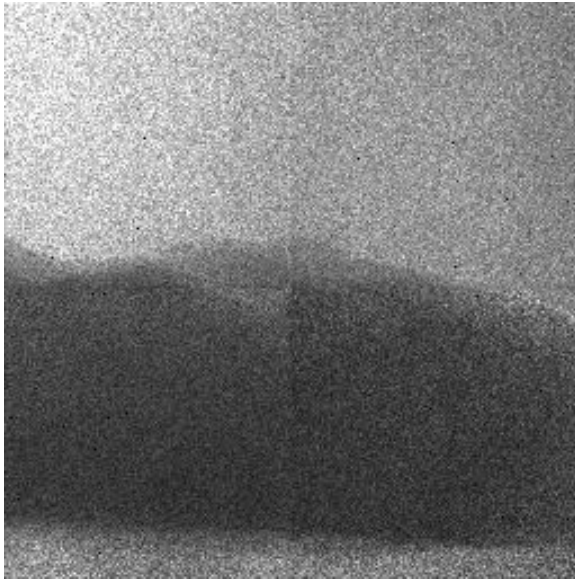
Background - Factory setting

Foreign objects can appear due to accidents at the factory production line.

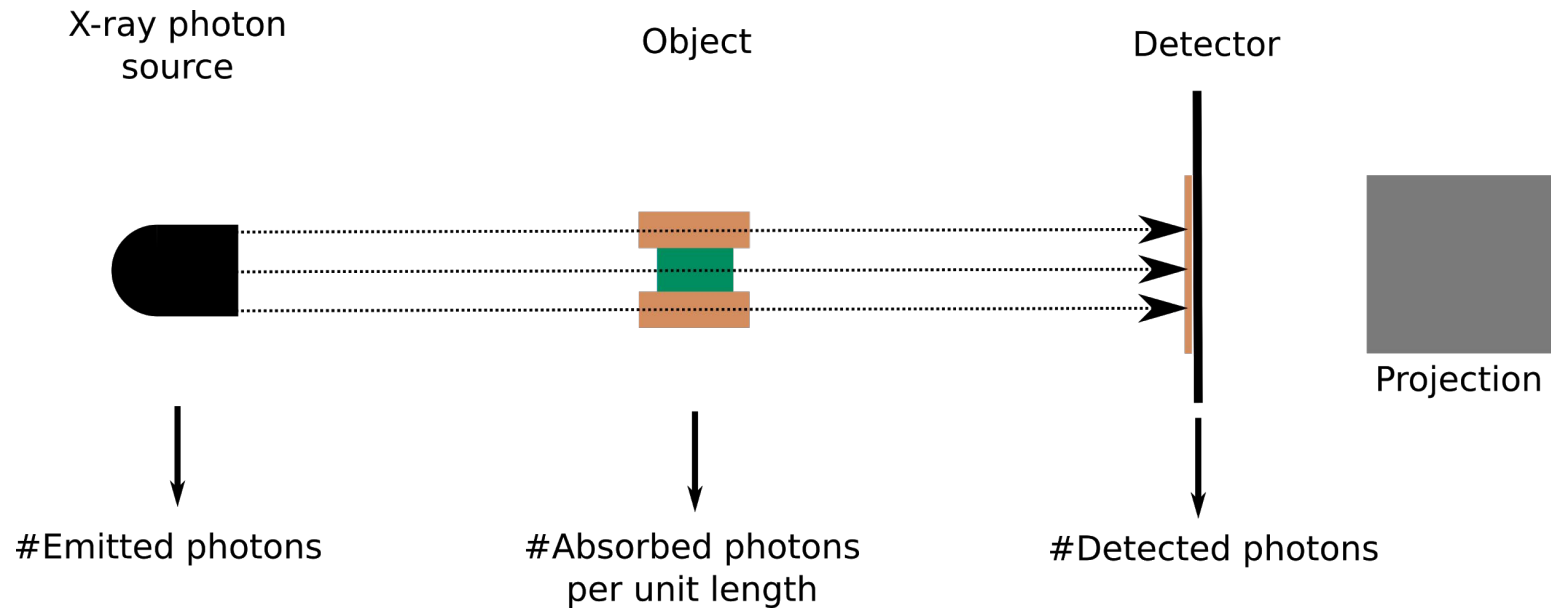


X-ray imaging - Practical problems

1. Low contrast between materials
2. High-throughput: noisy images



Attenuation spectra - Single-energy

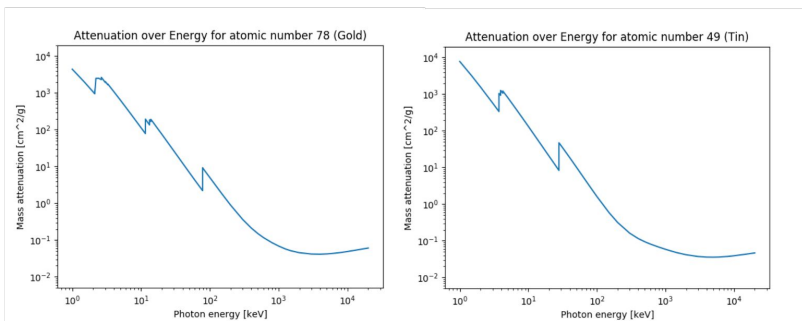
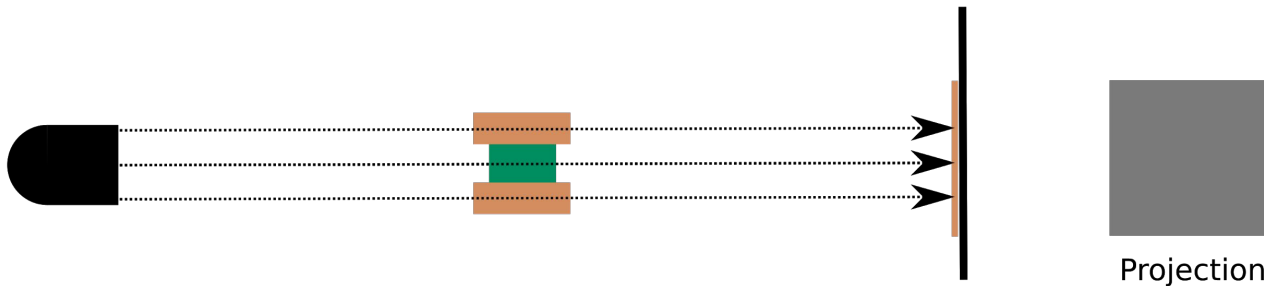


Attenuation spectra - Multi-energy (spectral)

X-ray photon source

Object

Detector

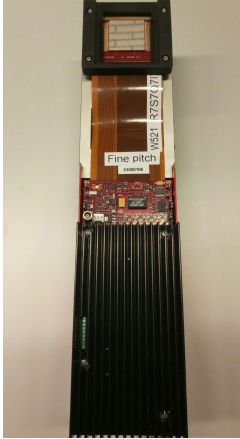
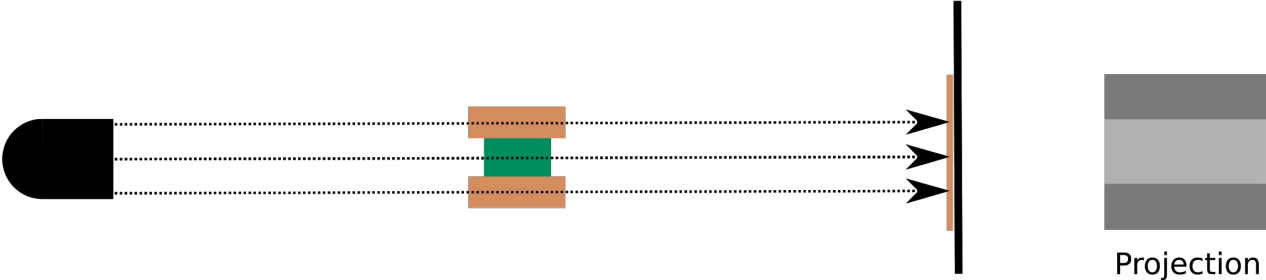


Attenuation spectra - Multi-energy (spectral)

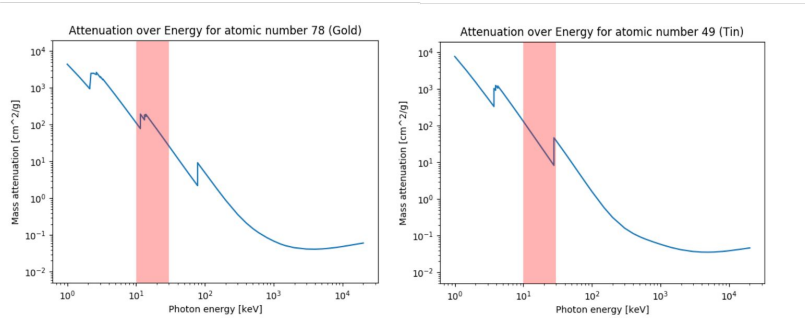
X-ray photon source

Object

Detector



Spectral detector

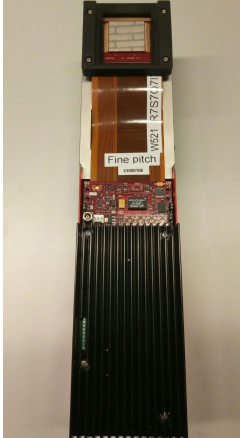


Attenuation spectra - Multi-energy (spectral)

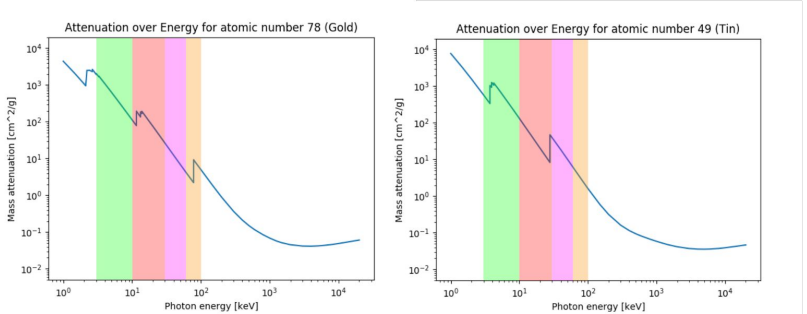
X-ray photon source

Object

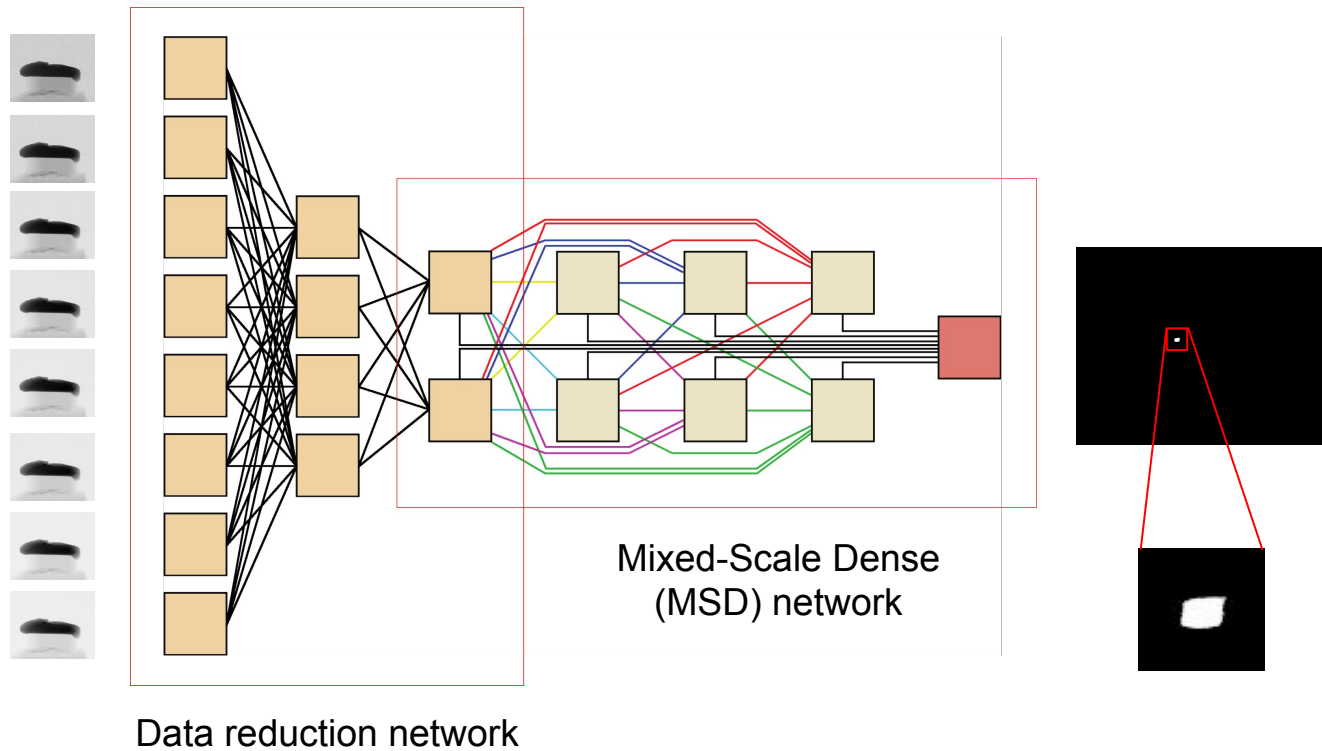
Detector



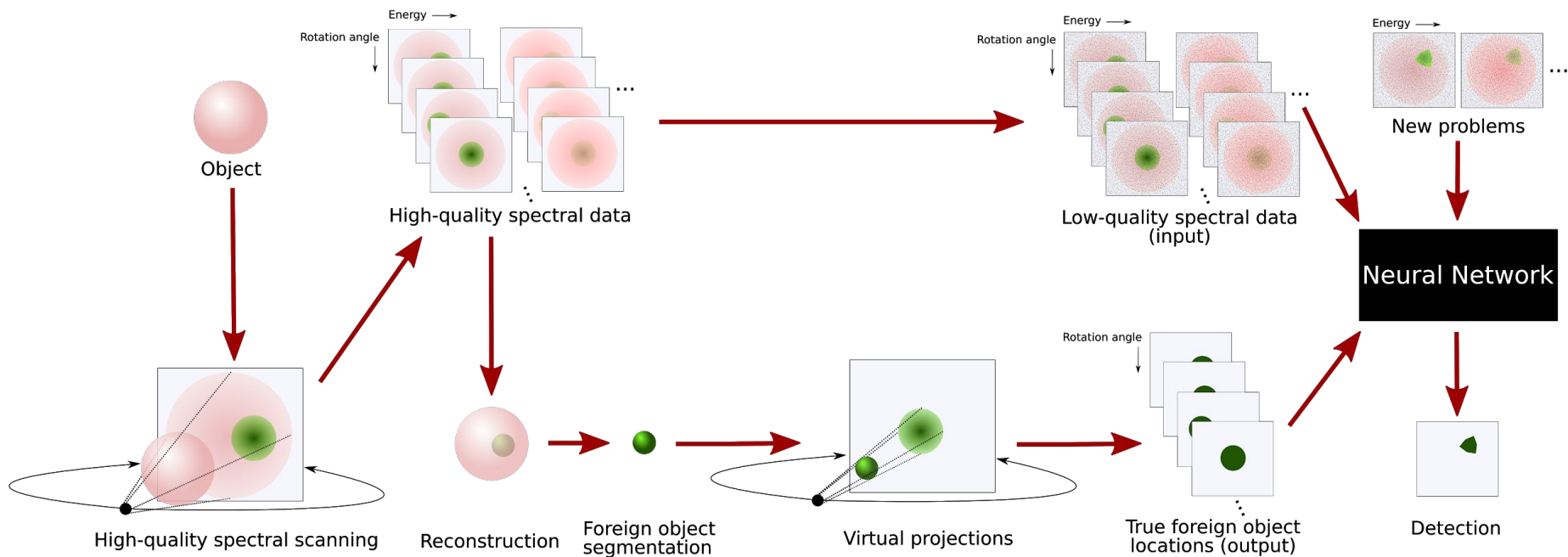
Spectral detector



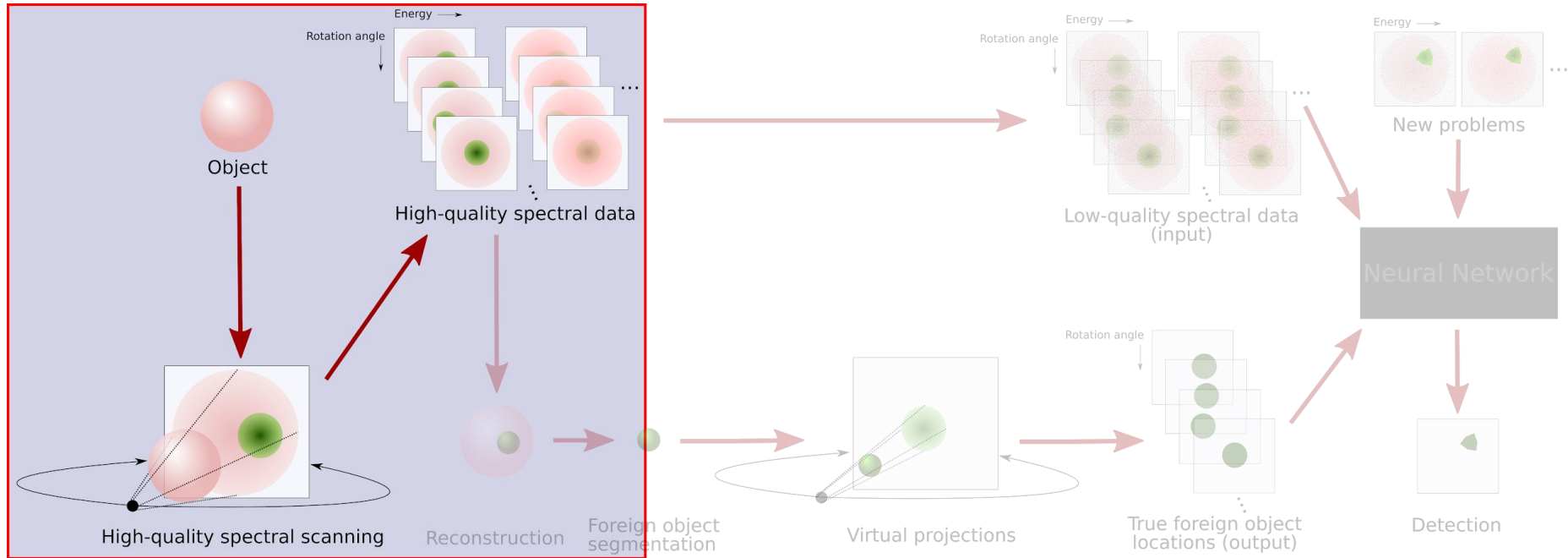
Neural network



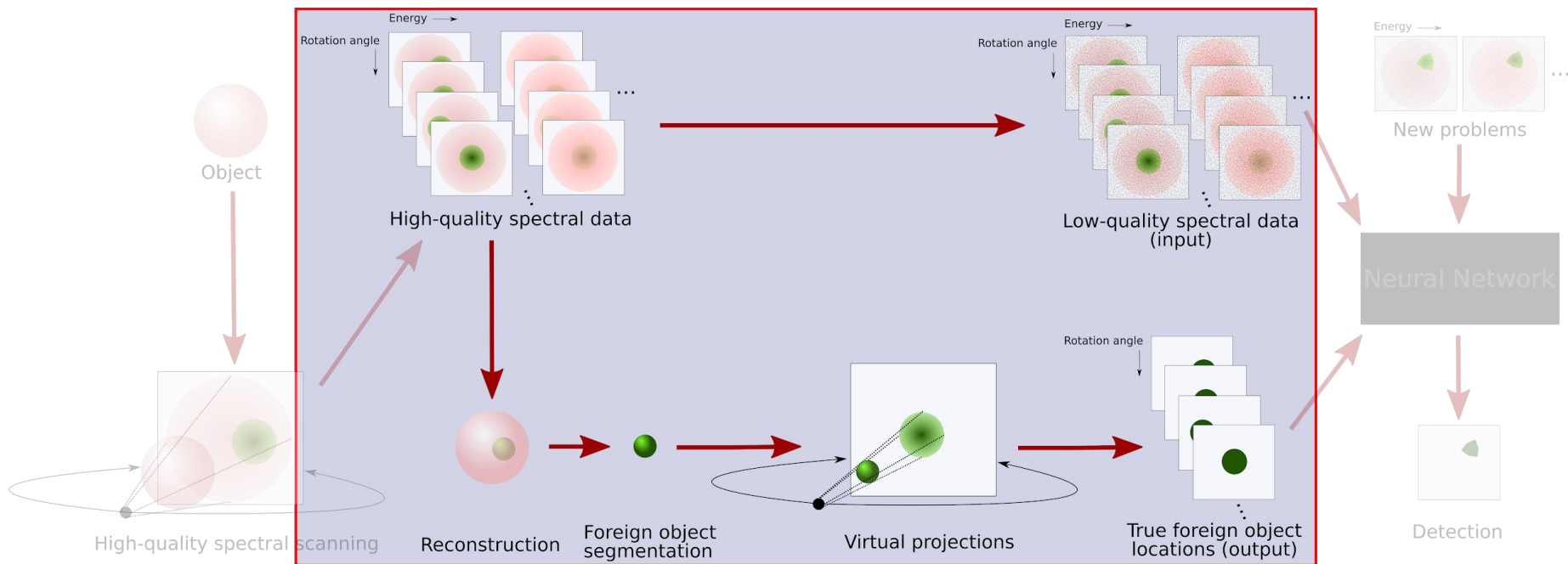
Research workflow



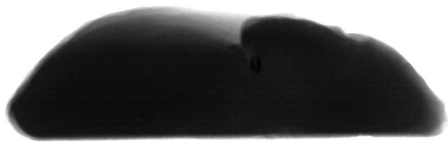
Research workflow - Data acquisition



Research workflow - Data processing

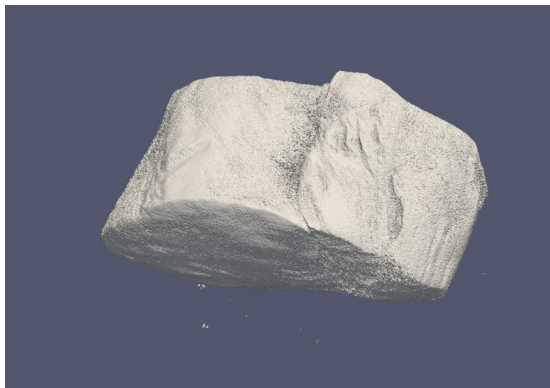
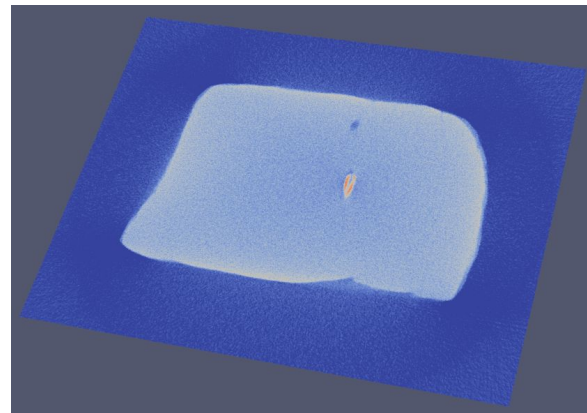


Reconstructions and segmentations



Energy range
with highest
contrast

Slice with
absorption
intensities

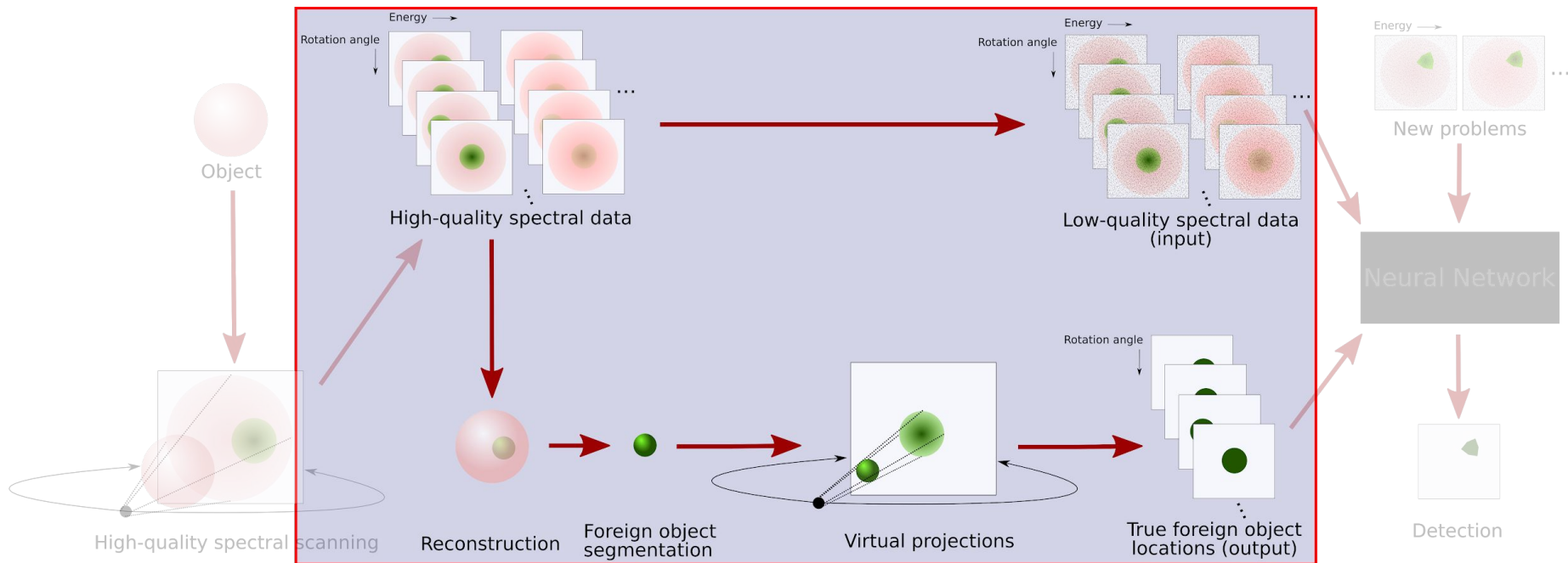


Reconstruction
(ASTRA Toolbox)

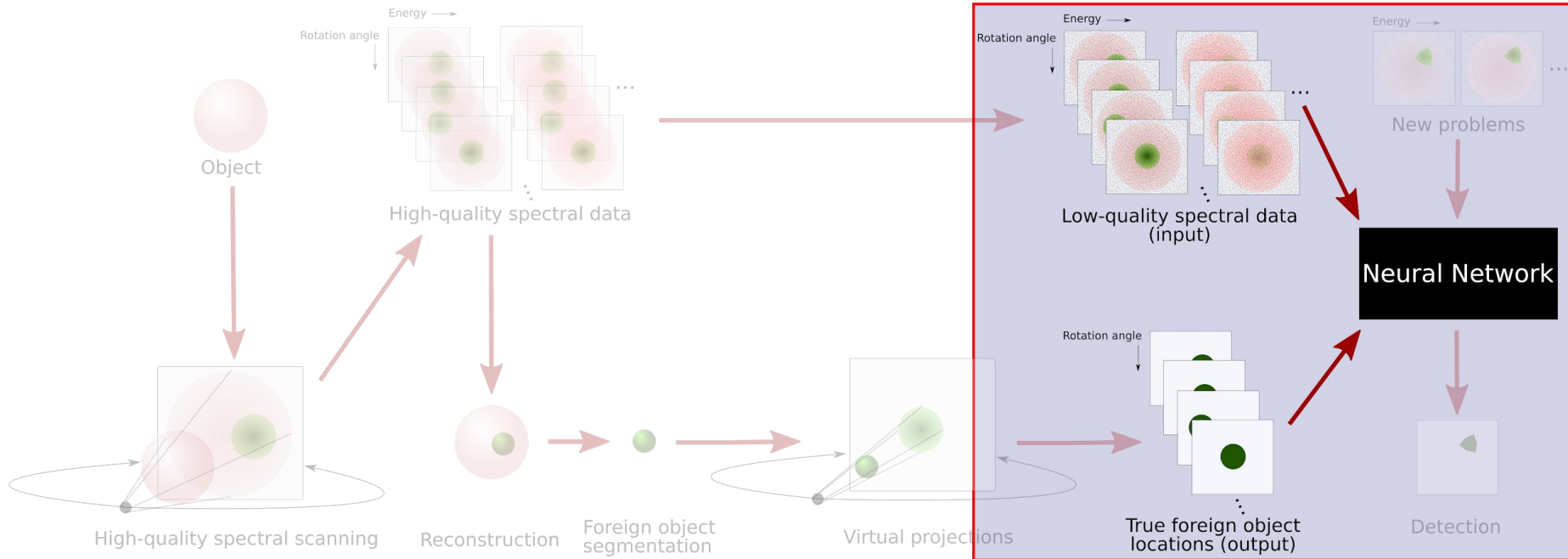
Segmentation



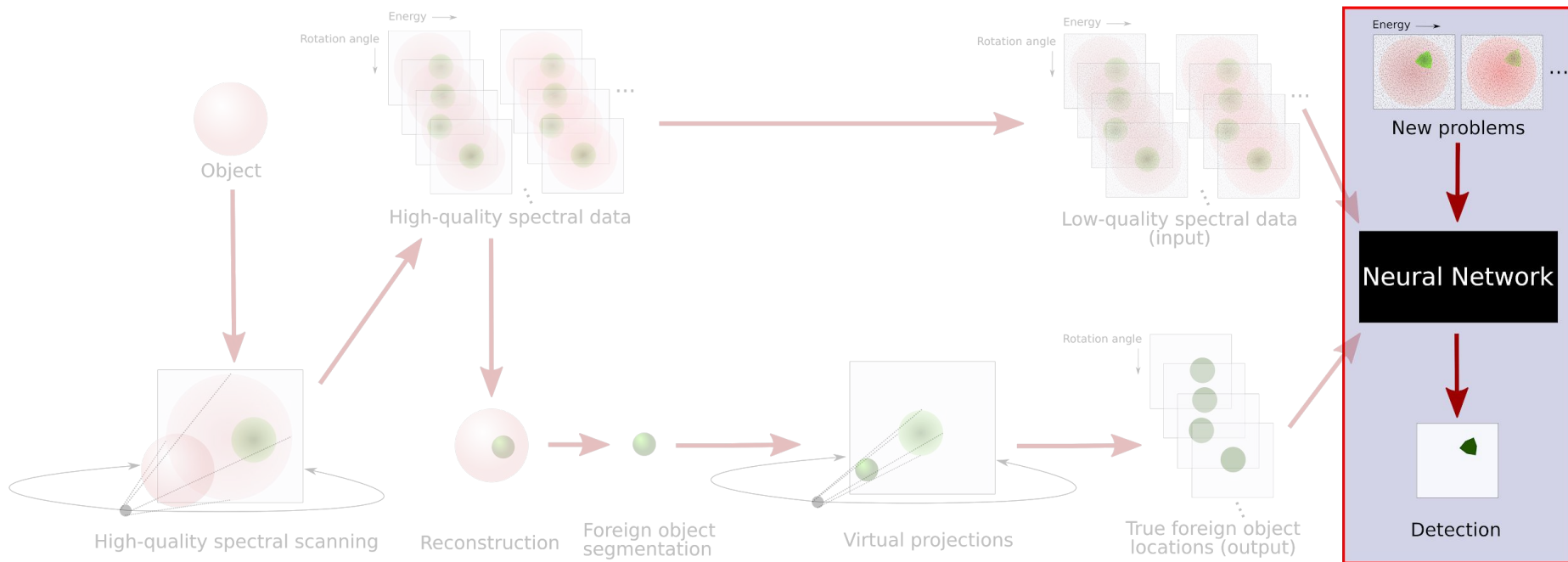
Research workflow - Data processing



Research workflow - Neural network training

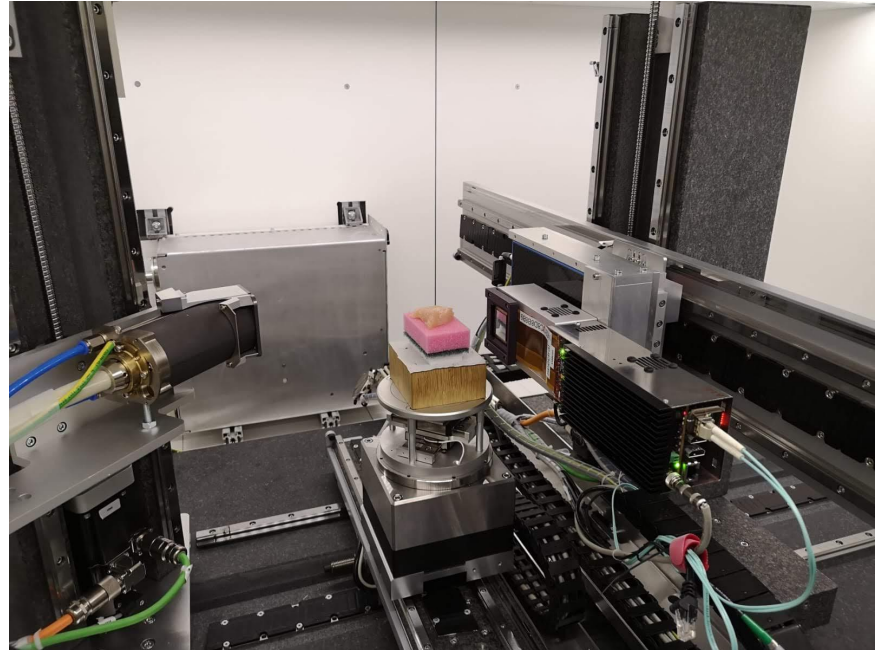
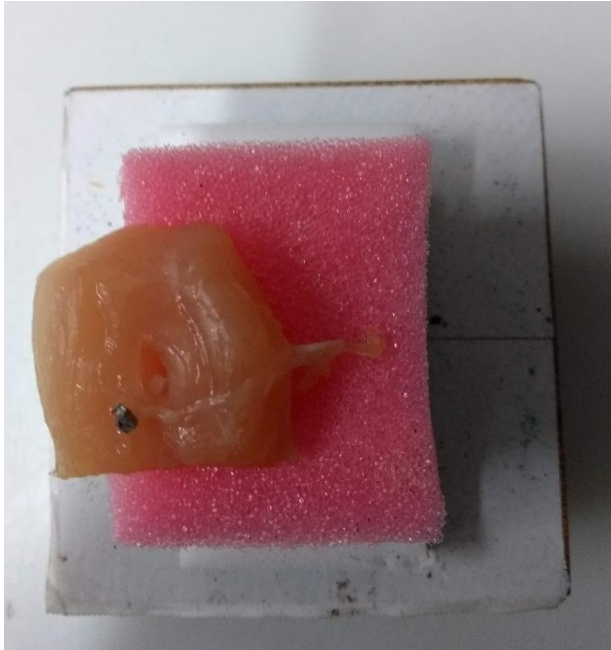


Research workflow - Application



Experiments - Setup

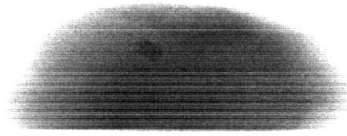
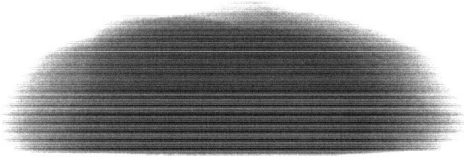
Hide foreign object in piece of the chicken and scan in the FleX-ray lab.



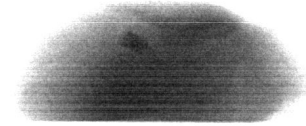
Experiments - Results with bone

415 projection angles and 31 energy settings

Low energy

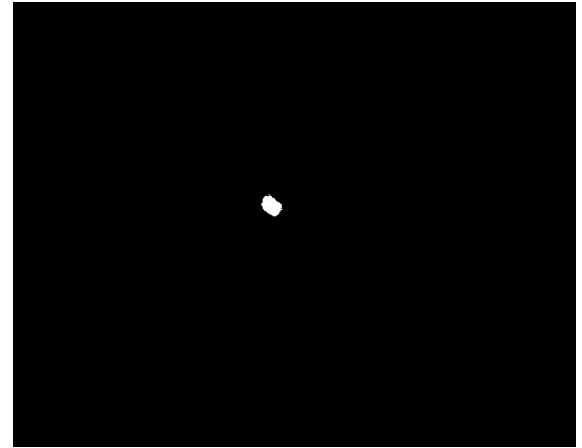
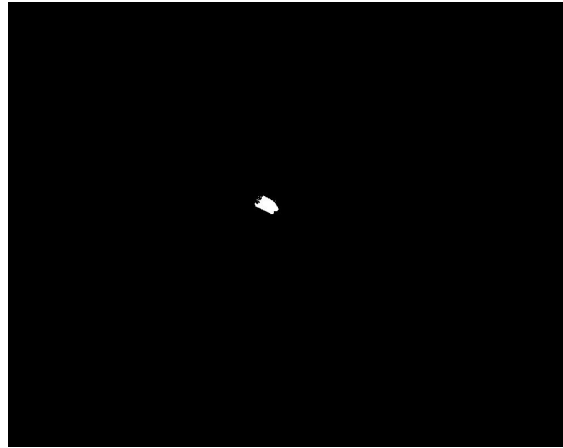


Ground truth



High energy

Network result



Conclusions and outlook

Preliminary result:
Successful detection of bone in chicken filets

Present:

- Harder problems (less contrast)
- Problems whose solution rely on spectrality
- More foreign objects at the same time
- Spectral reconstructions



Thank you for your attention!

Email: m.t.zeegers@cwi.nl

References:

MSD (neural network architecture):

D. M. Pelt and J. A. Sethian, *A mixed-scale dense convolutional neural network for image analysis*, Proceedings of the National Academy of Sciences 115.2 (2018): 254-259

ASTRA (reconstruction toolbox) :

W. van Aarle et al.: *Fast and flexible X-ray tomography using the ASTRA toolbox*, Optics Express 24 (22), 25129-25147 (2016)