# Vision Day 28th May 2008

## Revelations by Low-Energy X-rays

*Jørgen Rheinlænder*

***InnospeXion***

Innovative X-ray Solutions

www.innospexion.dk

# Topics

InnospeXion – expertise areas

X-ray physics

What is low energy X-rays ?

What facilitates low-energy usage industrially ?

What does low-energy X-ray offer ?

Application examples:

-**Natural materials, sealings, food products, packaged assemblies, packaging materials, low-density materials**

Image processing of X-ray images – critical issues

Demands for X-ray systems

Achievements since FoodPharmaTech Innovation Award

New developments

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# Innovative X-ray Solutions

## INNOSPEXION


**X-RAYS: How we use them**

InnospeXion uses the knowledge on X-ray interaction with matter to develop innovative techniques for inspection and characterisation, by imaging or by measurement of the spectrum of transmitted or scattered radiation. We apply these principles for non-destructive testing services, prototype characterisation, manufacturing prototyping and for the continuous development of state-of-the-art industrial solutions

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# X-ray inspection technologies

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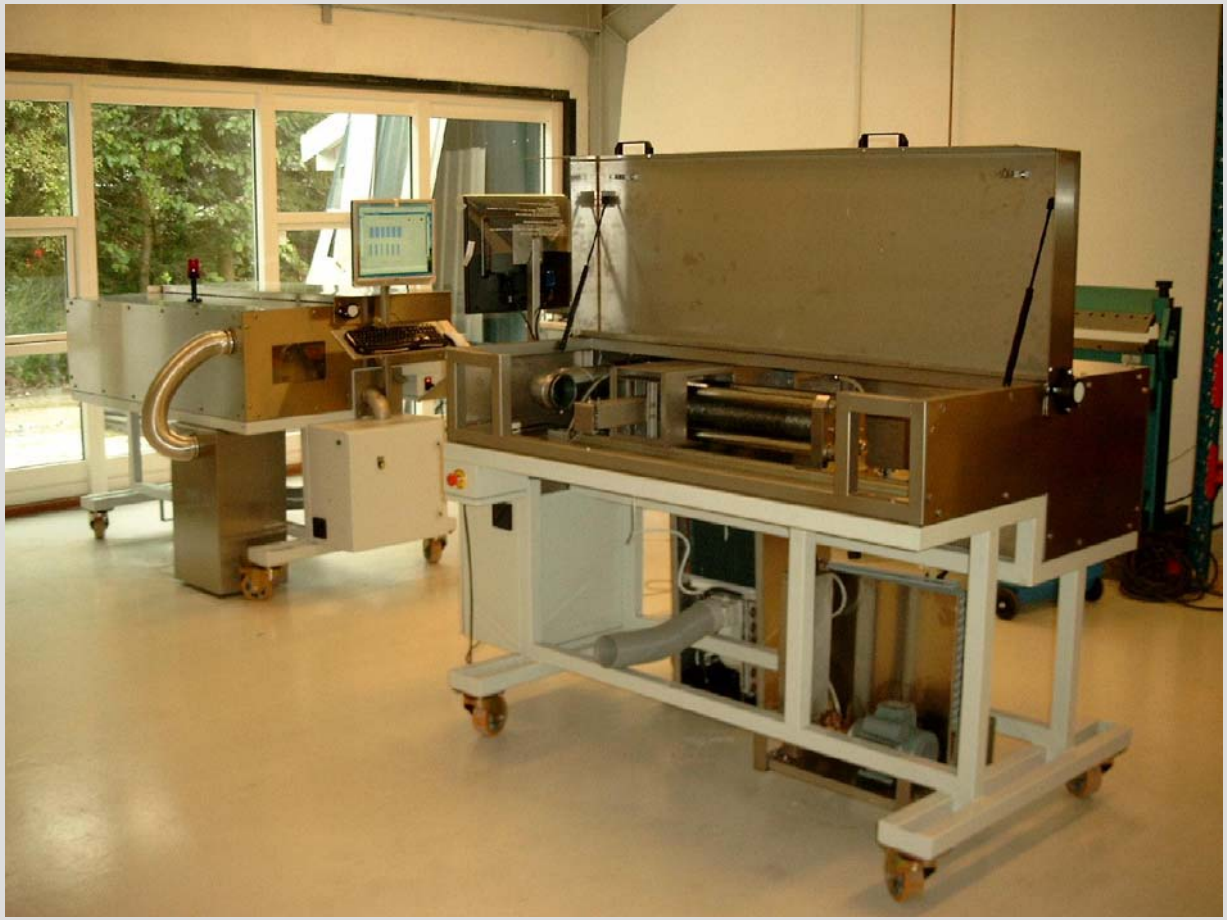
# X-ray inspection technologies

## INNOSPEXION



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# INDUSTRIAL X-RAY TECHNOLOGIES

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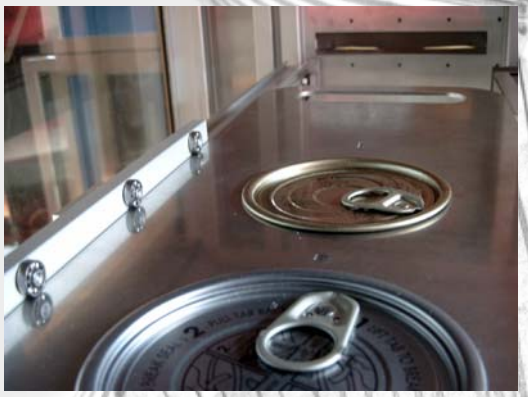

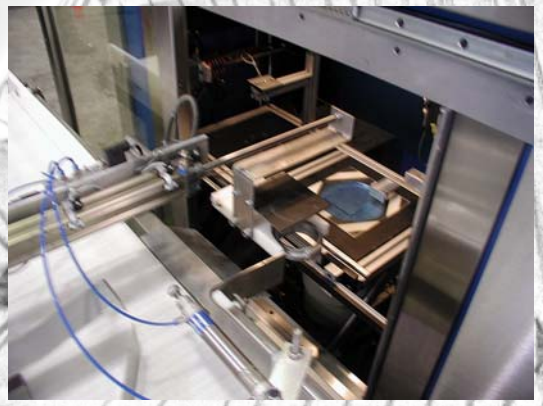

**DEMANDS**

-Best possible contrast
-Best possible resolution
-Safe
-Reliable
-Robust
-Inexpensive
-No maintenance

**INTERESTING SOLUTIONS**

-Sensitive detectors
-Robust X-ray technology
-Modular design
-Remote monitoring
-Radiation measurement vs. imaging

# APPLICATION AREAS

**Advanced materials and – components:**

oNew Alloys

oNew composites: Plant Fibre Composites, Carbon Fibre Composites

oAdvanced Ceramics

**Prototype development / rapid prototyping;**

oNew forming technologies

oNew processing technologies

**Process optimisation and –development;**

oHigh Strength Glass Fibre Reinforced Polyester

oFibre reinforced Composites in general

oAdvanced Ceramics

oSuper conductors

oOptical Fibres

oRubber materials

**Condition monitoring & Inspection;**

oPipe wall thickness determination

oArmouring of concrete

oSorting of garbage

oDetection of foreign materials and impurities

**Quality control:**

oMedical products

oFood & Beverages

oFood & Drug containers

o**Advanced technical products**

# Low energy X-ray inspection

## The new MCIS from InnospeXion


Innovation Award

MCIS is based on low energy X-rays:

**Improved contrast;**
**Less radiation dose;**
**Reduced weight;**
**Simple design**

FOODPHARMATECH 07

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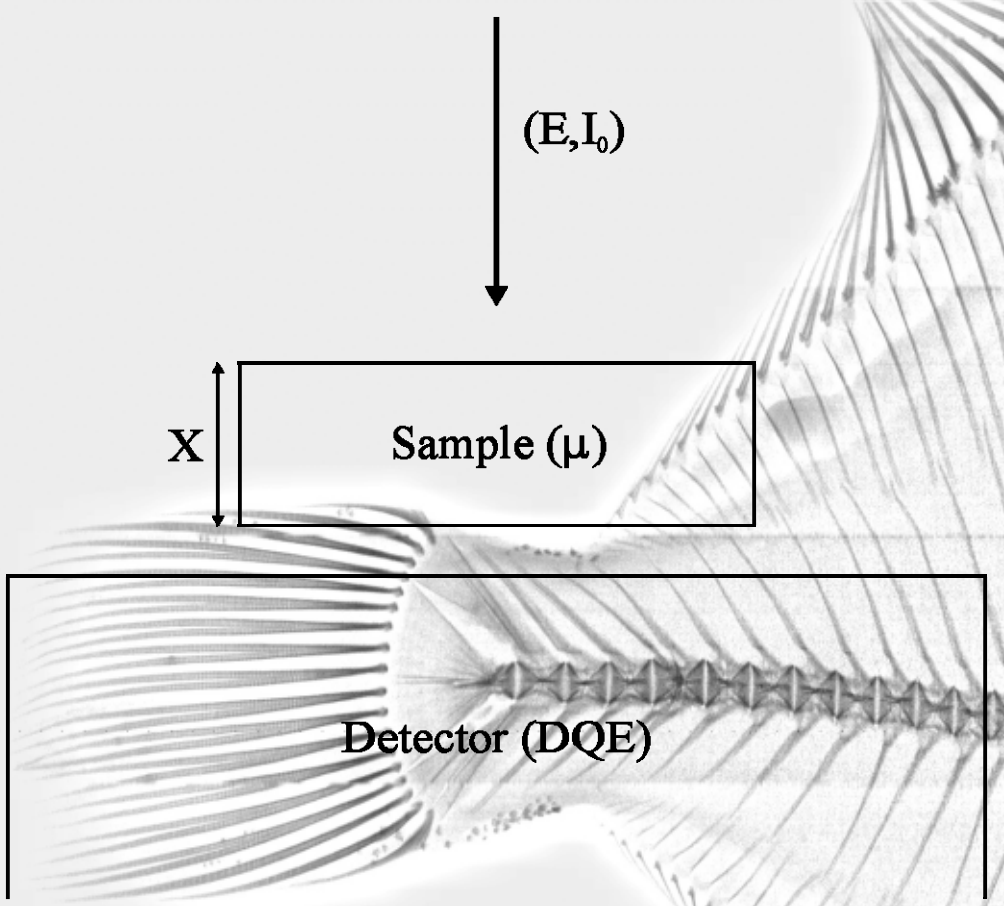
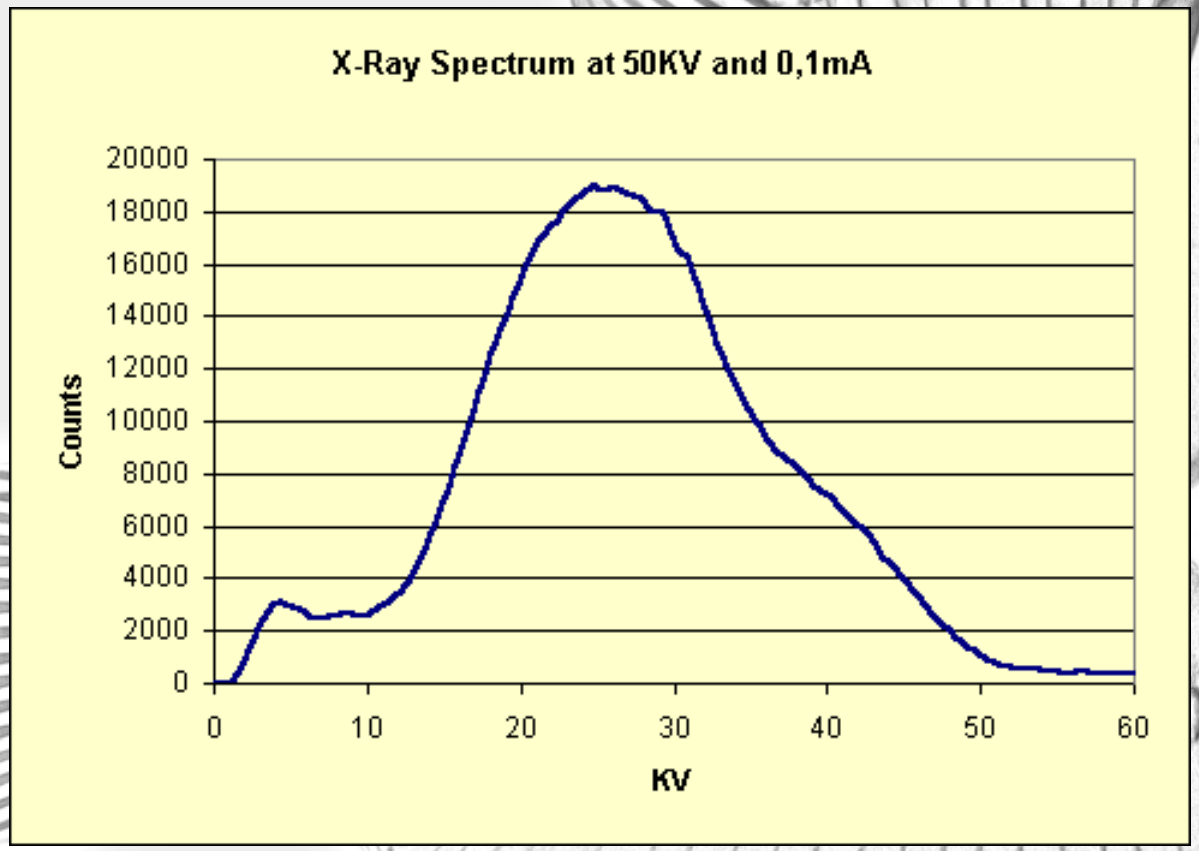
# X-RAY PHYSICS




- All materials attenuates X-rays. The attenuation is described by the linear absorption coefficient μ [$cm^{-1}$]
- $I=I_0*Exp[-\mu*X]$

# X-RAY PHYSICS



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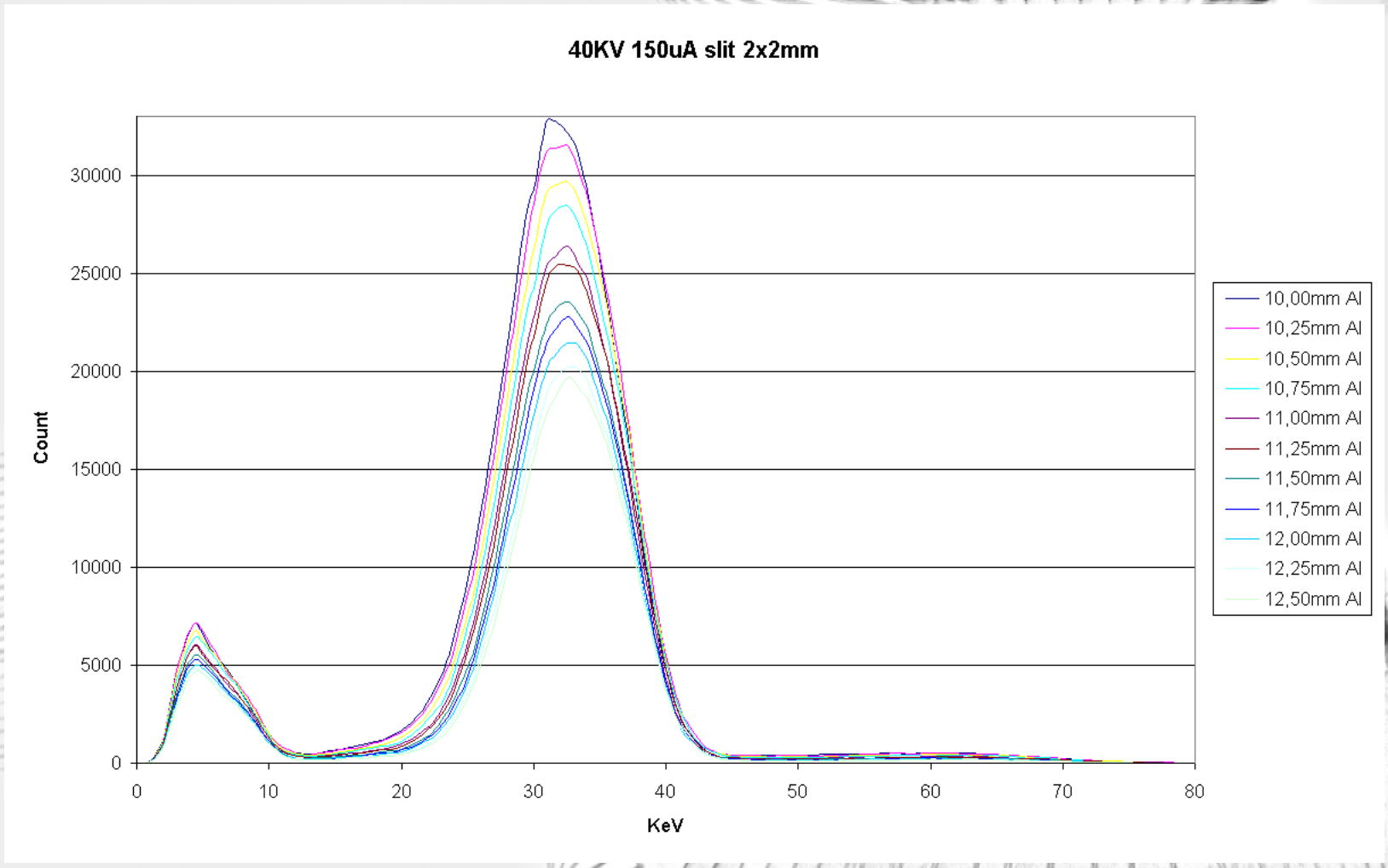

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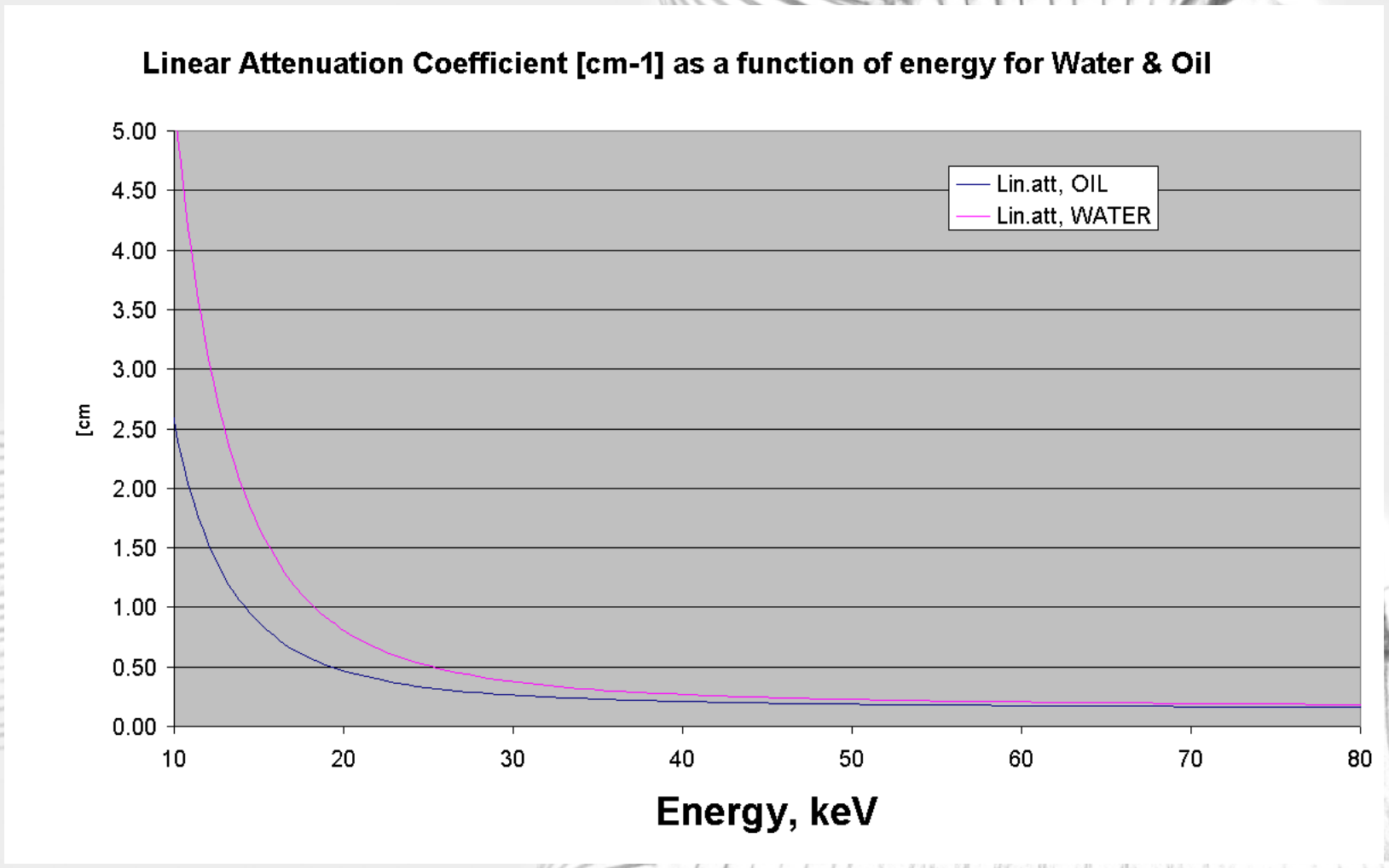

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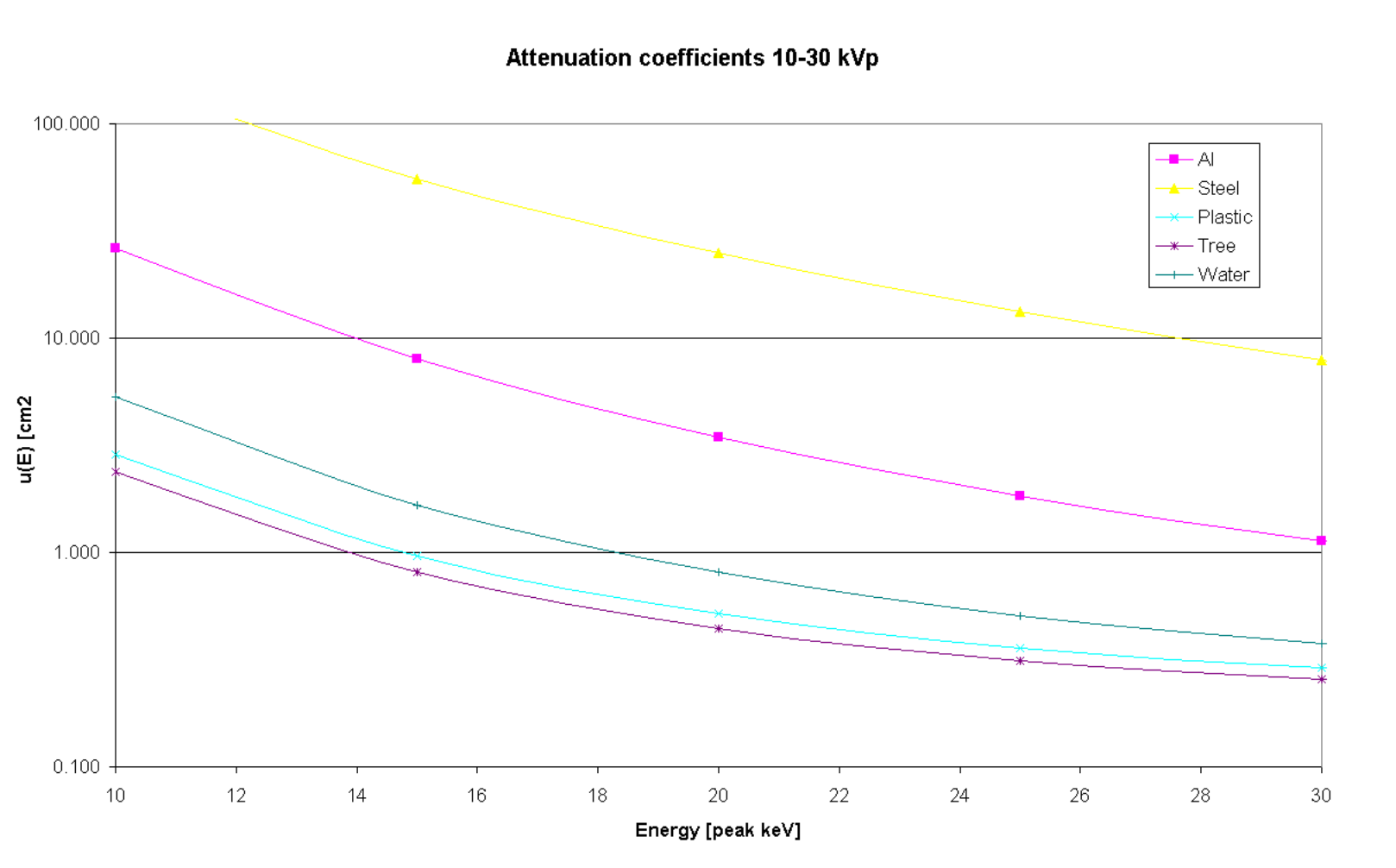
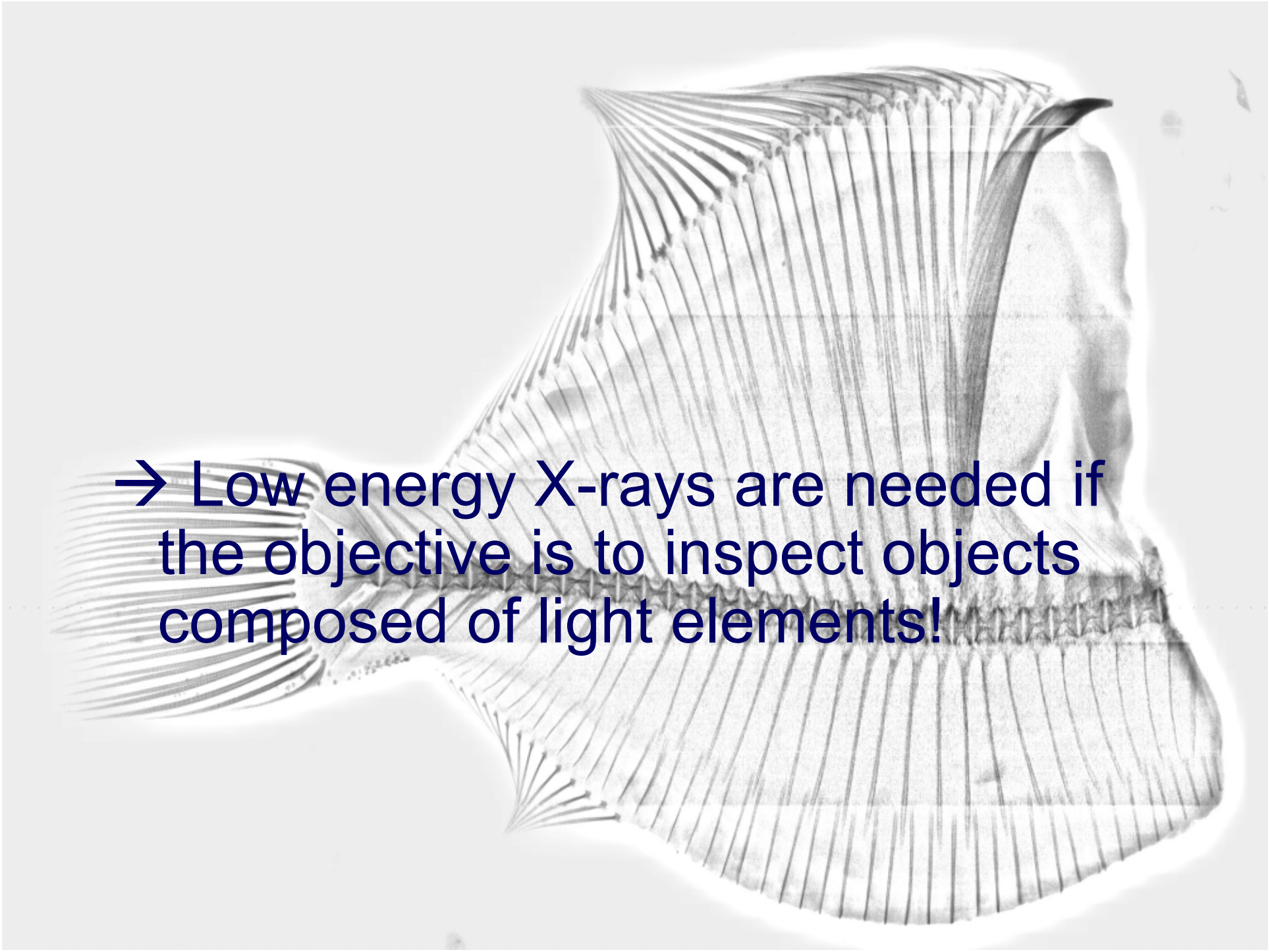
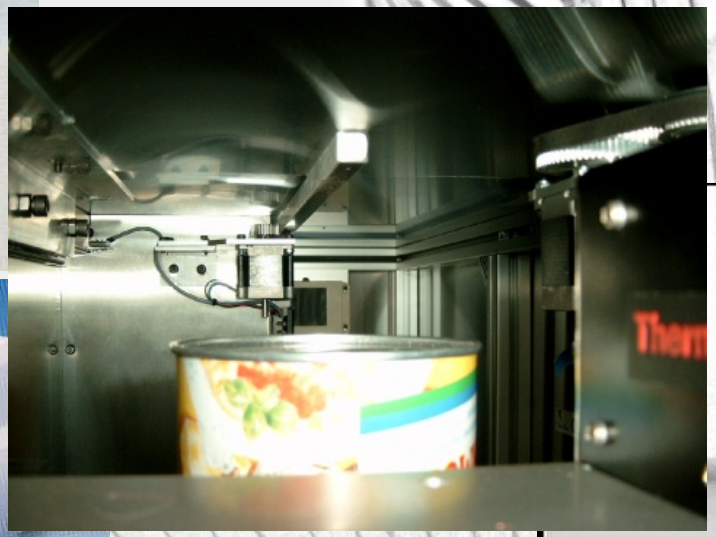
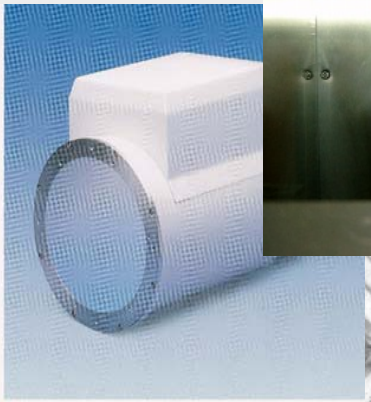




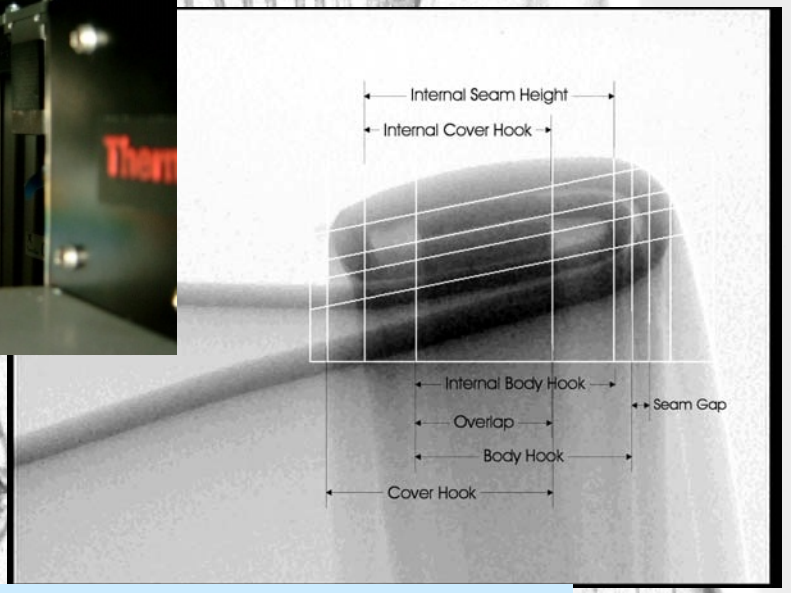
→ Low energy X-rays are needed if the objective is to inspect objects composed of light elements!

# X-RAY IMAGING





- X-Ray image intensifier coupled with CCD camera
- Preset for final operating conditions
- Motorized image rotation
- Electronic zoom® (TH 59464 dual-field)




## X-RAY IMAGING:

**The radiation absorbed and scattered through the object is measured with a real-time imaging sensor**

→Grey scale picture with a spatial resolution down to a few microns.

→Images with very good contrast between e.g. plastics and metals, plastics and glass fibres, etc.

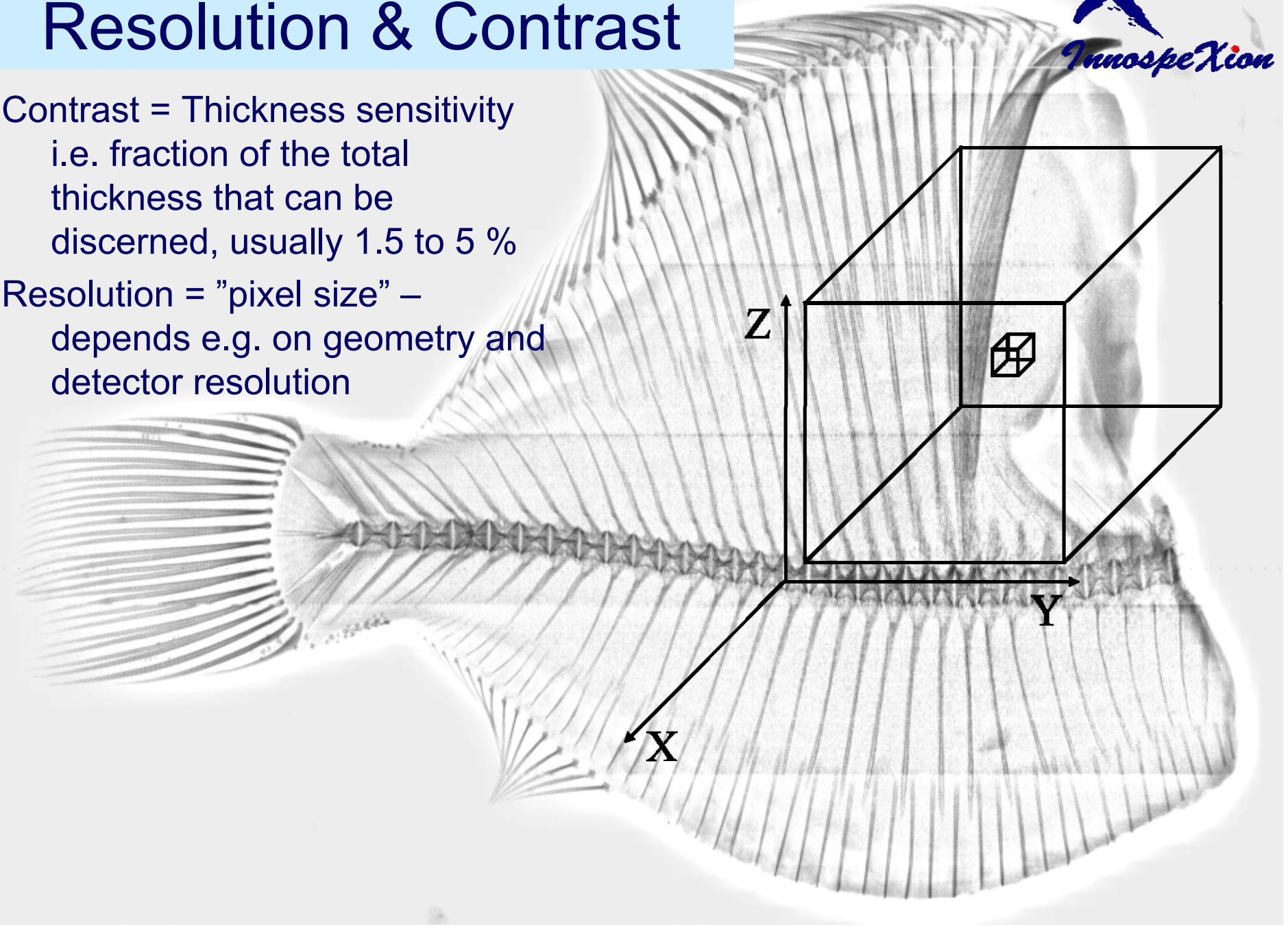
→Real-time images up to 60 fps enables a proces to be monitored

→Quantitative data on position, dimensions, impurities etc can be derived instantaneously.

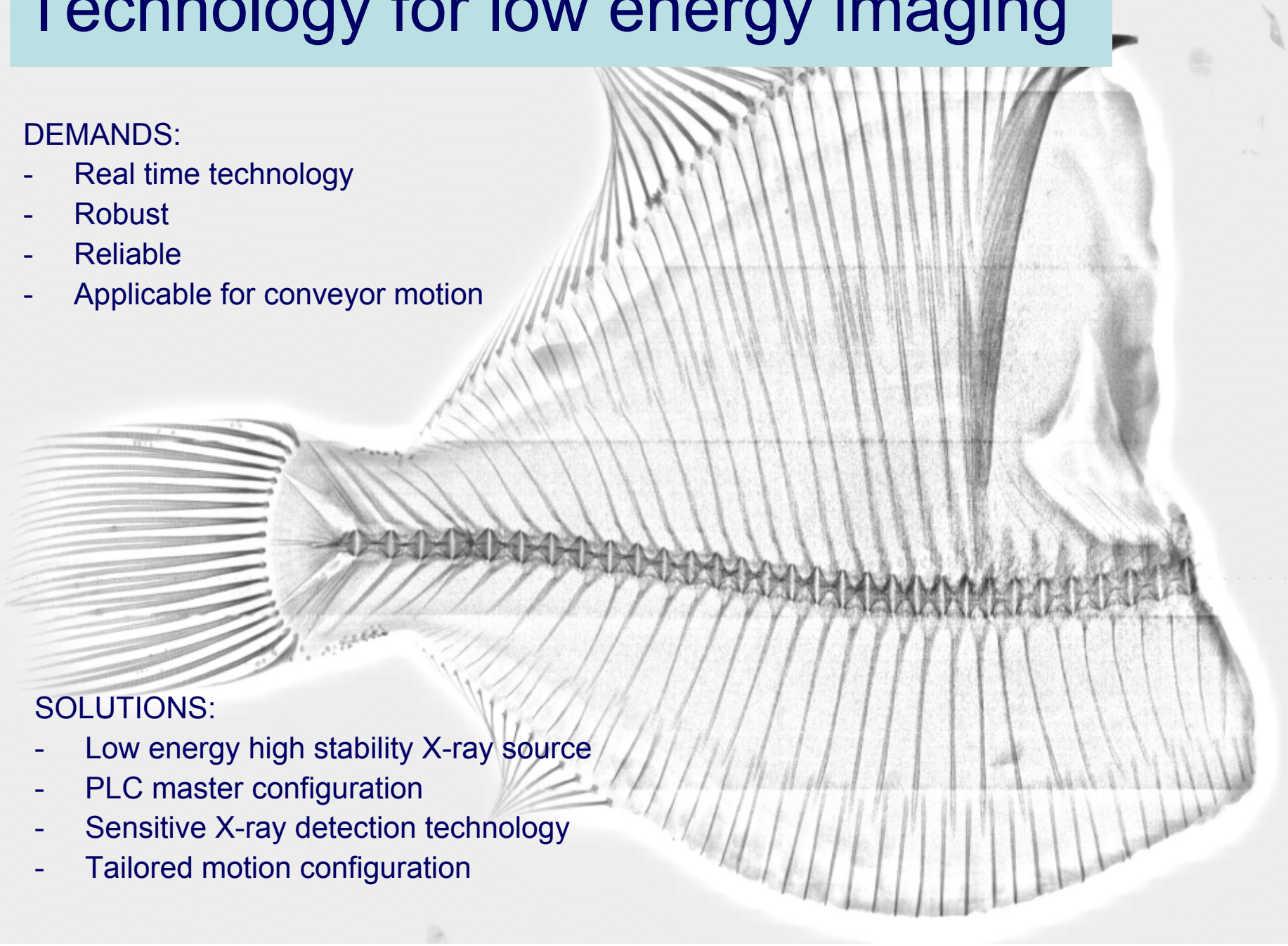
# Resolution & Contrast

Contrast = Thickness sensitivity
i.e. fraction of the total thickness that can be discerned, usually 1.5 to 5 %

Resolution = ”pixel size” – depends e.g. on geometry and detector resolution



# Technology for low energy imaging



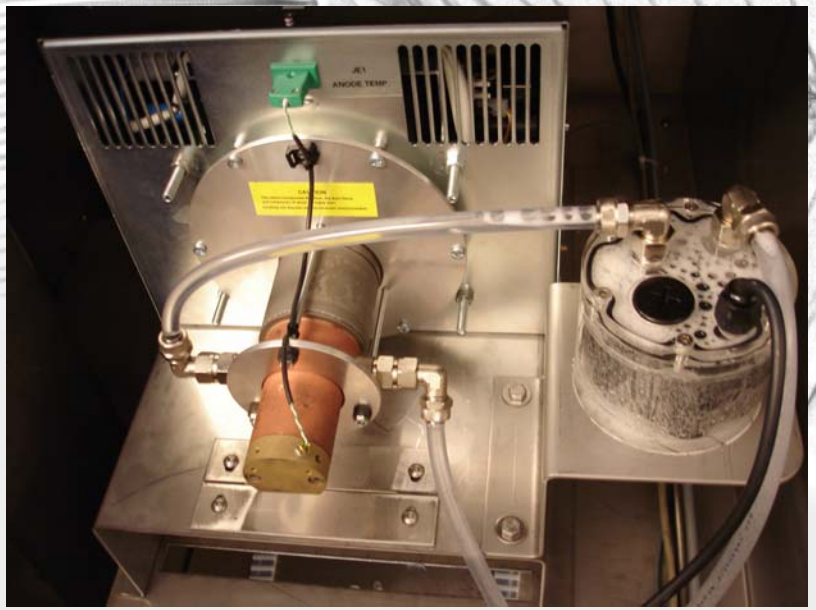
DEMANDS:

- Real time technology
- Robust
- Reliable
- Applicable for conveyor motion

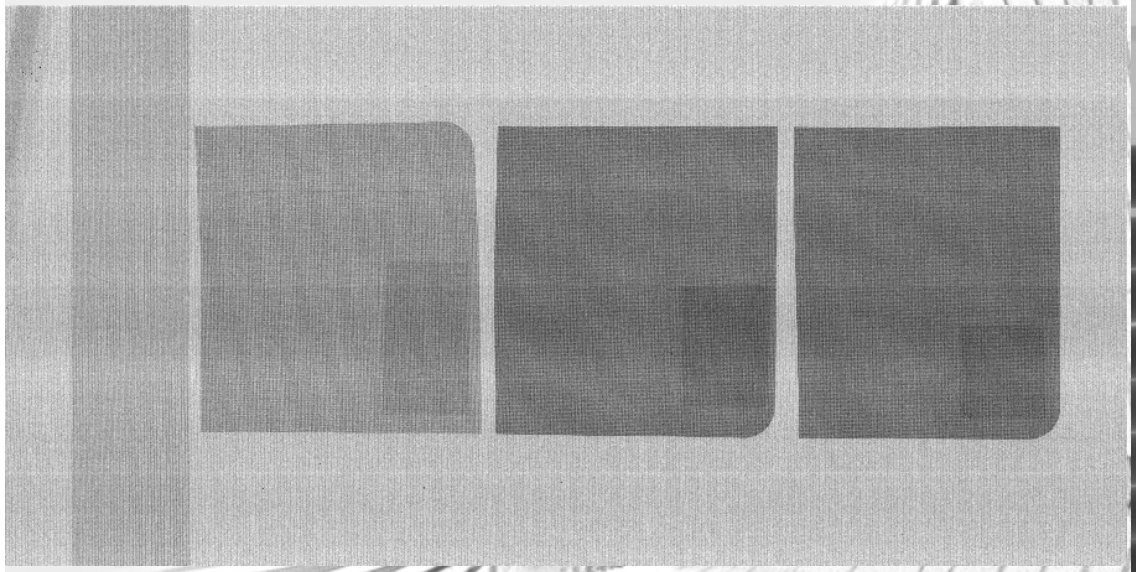
SOLUTIONS:

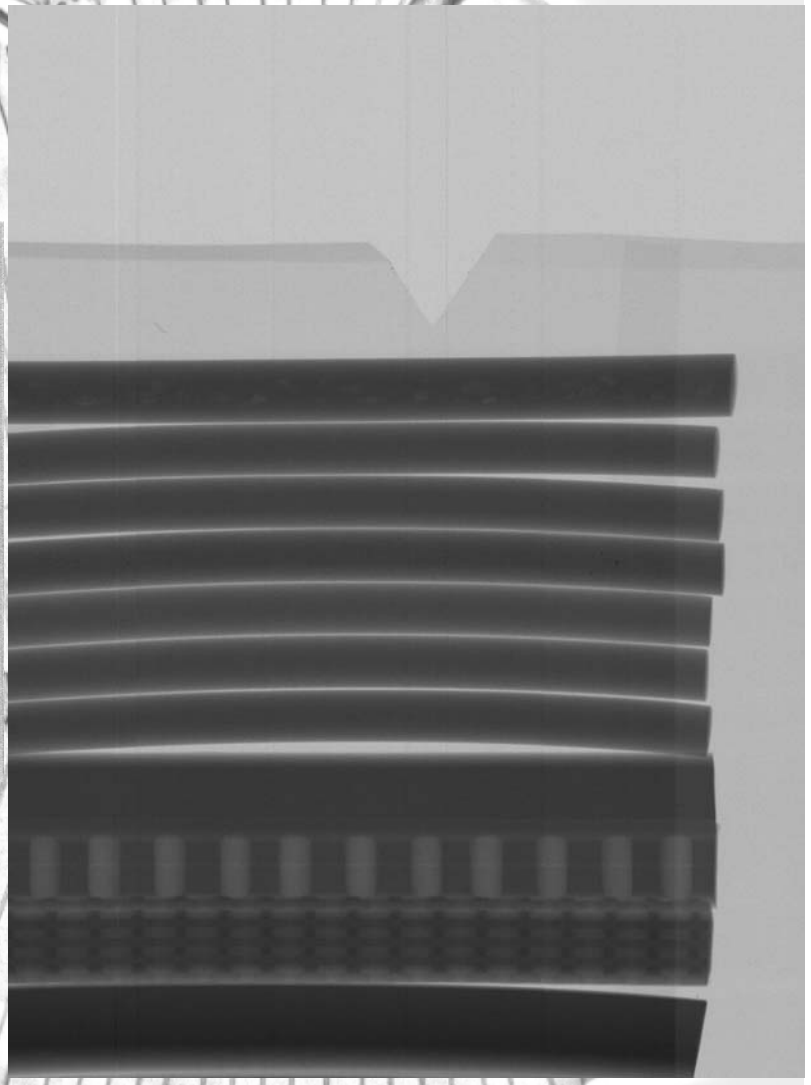
- Low energy high stability X-ray source
- PLC master configuration
- Sensitive X-ray detection technology
- Tailored motion configuration

# Technology for low energy imaging



# Technology for low energy imaging

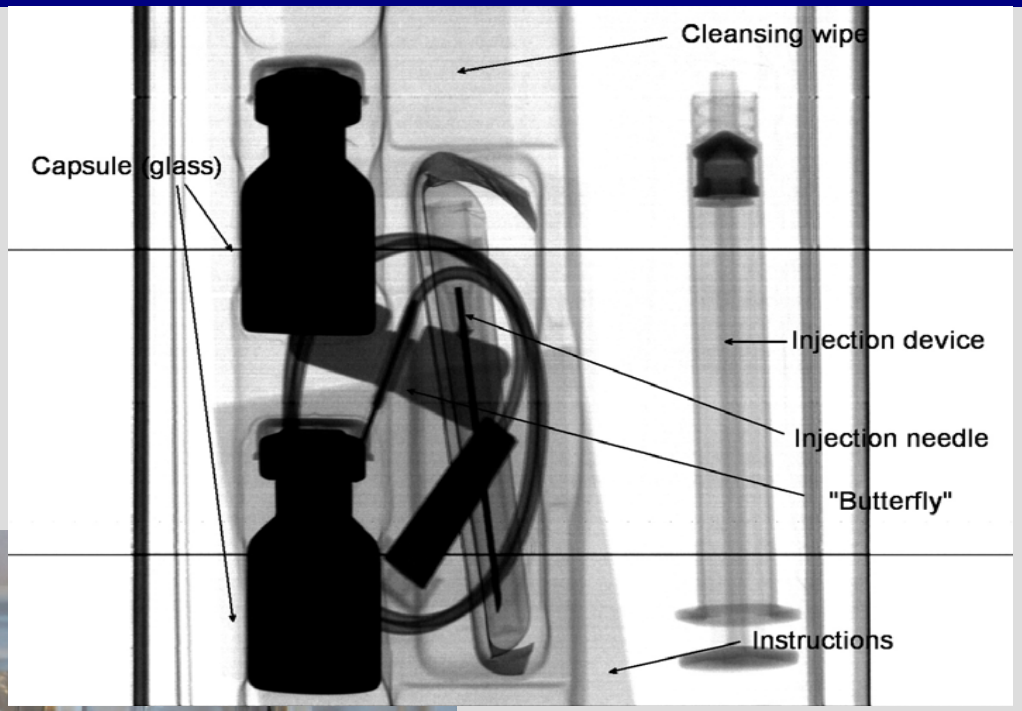


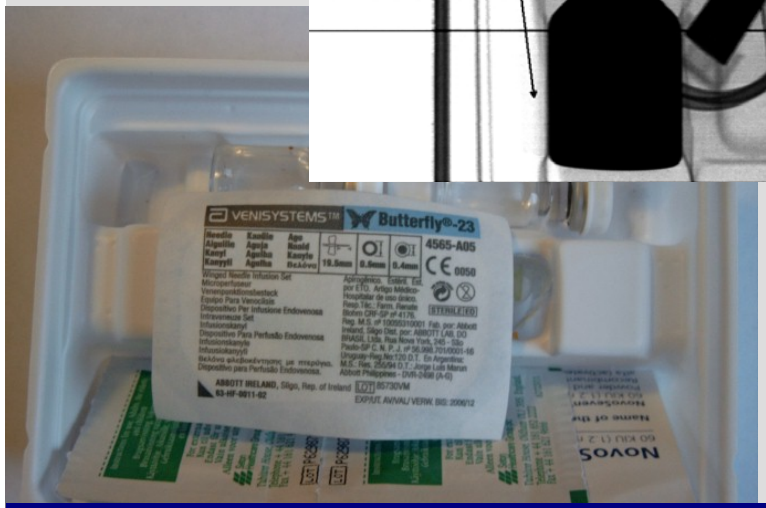


# Technology for low energy imaging

# LOW-ENERGY X-RAYS

## APPLICATION EXAMPLES




Packaged items: Ability to detect also the low density and thin parts – cleansing wipe and instructions leaflet

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# LOW-ENERGY X-RAYS

## APPLICATION EXAMPLES

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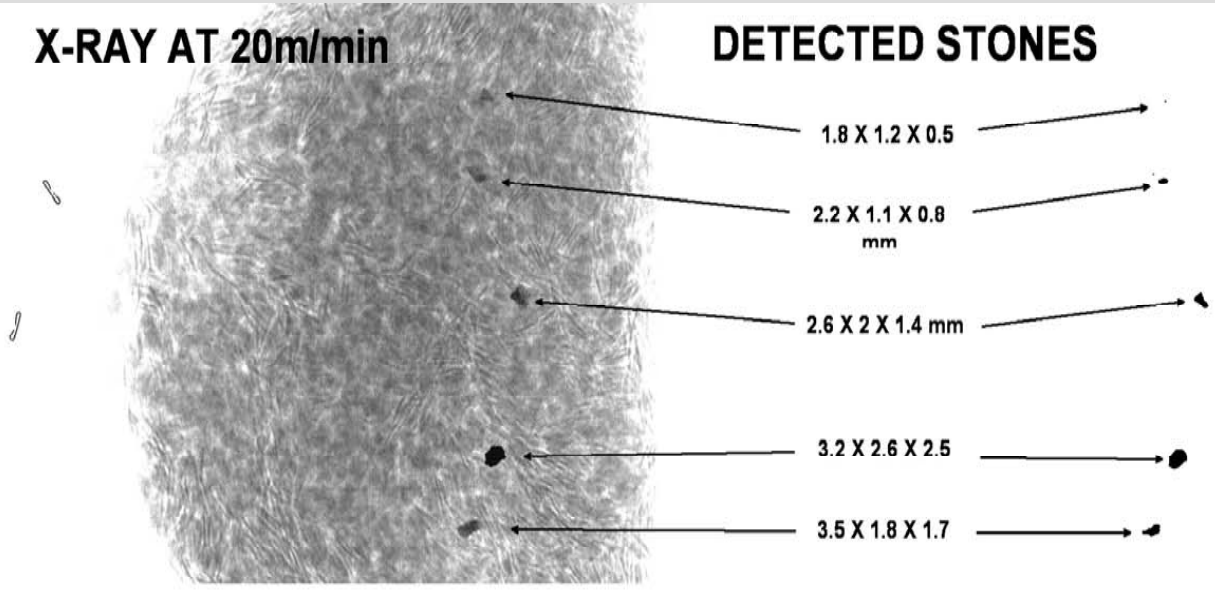
Foreign objects in grain and bakery products:
Ability to detect small stones to less than 0.5 mm -
high **contrast**, high **speed** and high **resolution**



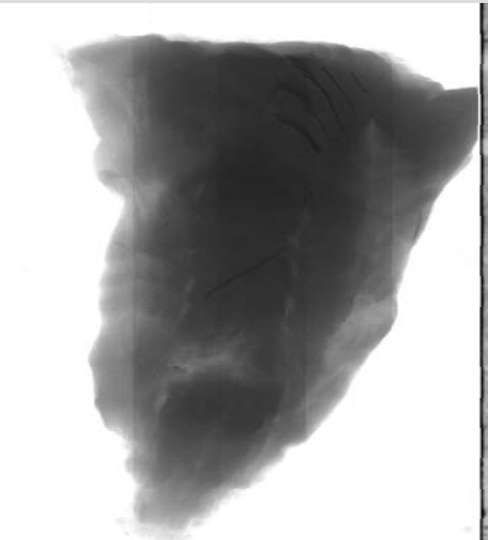

# LOW-ENERGY X-RAYS

## APPLICATION EXAMPLES

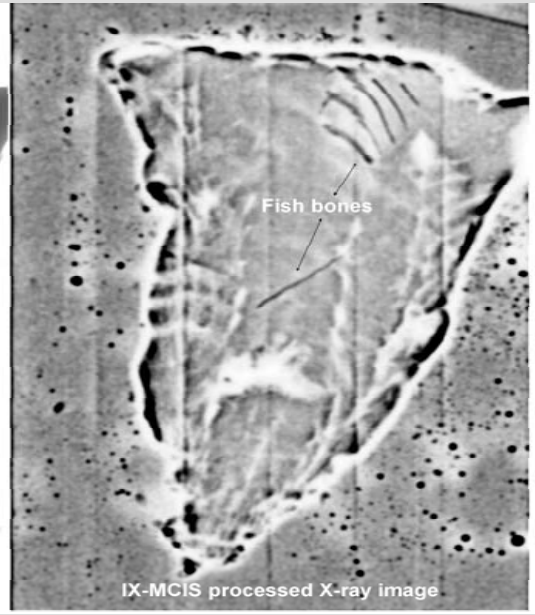
InnospeXion

Fish bone detection:
Ability to detect small bones to less than 0.25 mm -
high **contrast**, high **speed** and high **resolution**

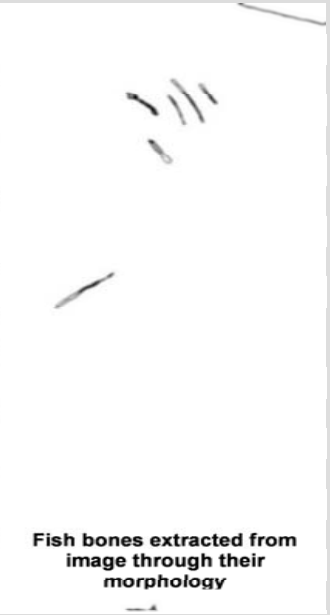
Fillet on conveyor



IX-MCIS X-ray raw image, 15 m/min




IX-MCIS processed X-ray image



Fish bones extracted from image through their morphology

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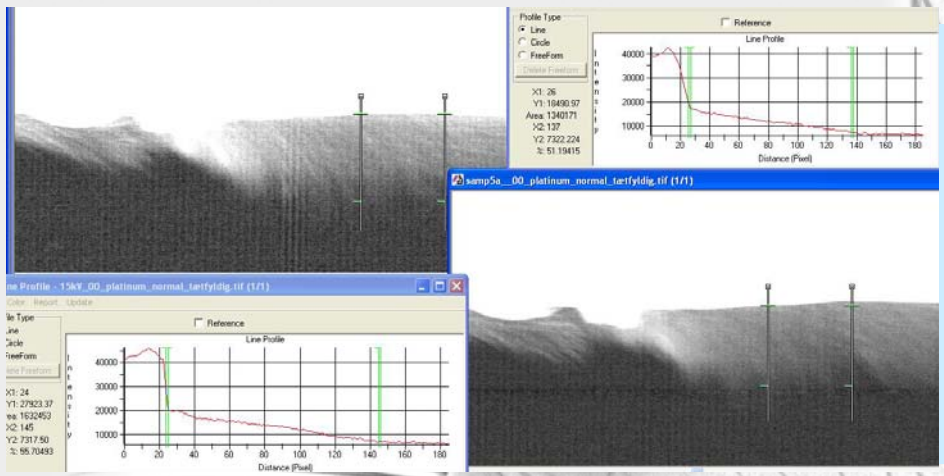
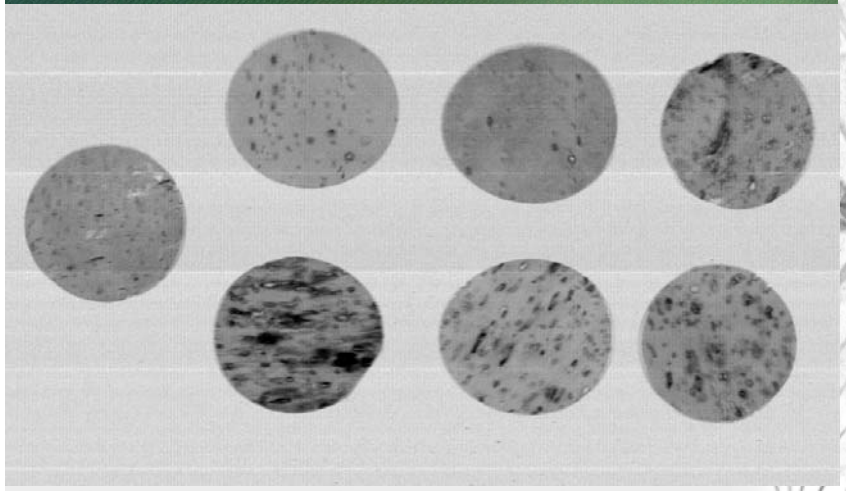
# X-RAY INSPECTION APPLICATION: FURS



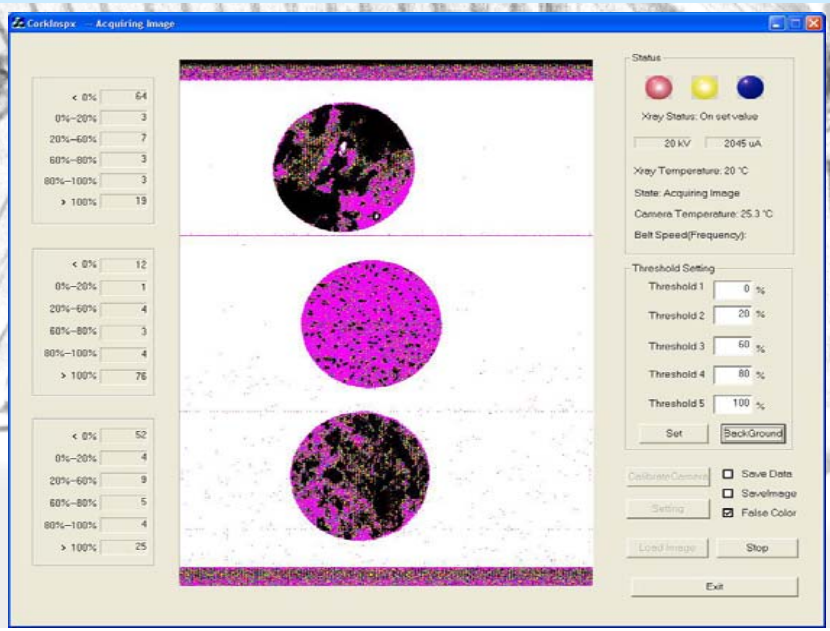

- Low energy
- High resolution, 0.1 mm
- High speed 15-20 m/min
- Quantification of image data

InnospeXion

# X-RAY INSPECTION APPLICATION: CORK



- Low energy
- High speed
- Segmentation to density levels
- Large savings
- 100% inspection
- No competing technology



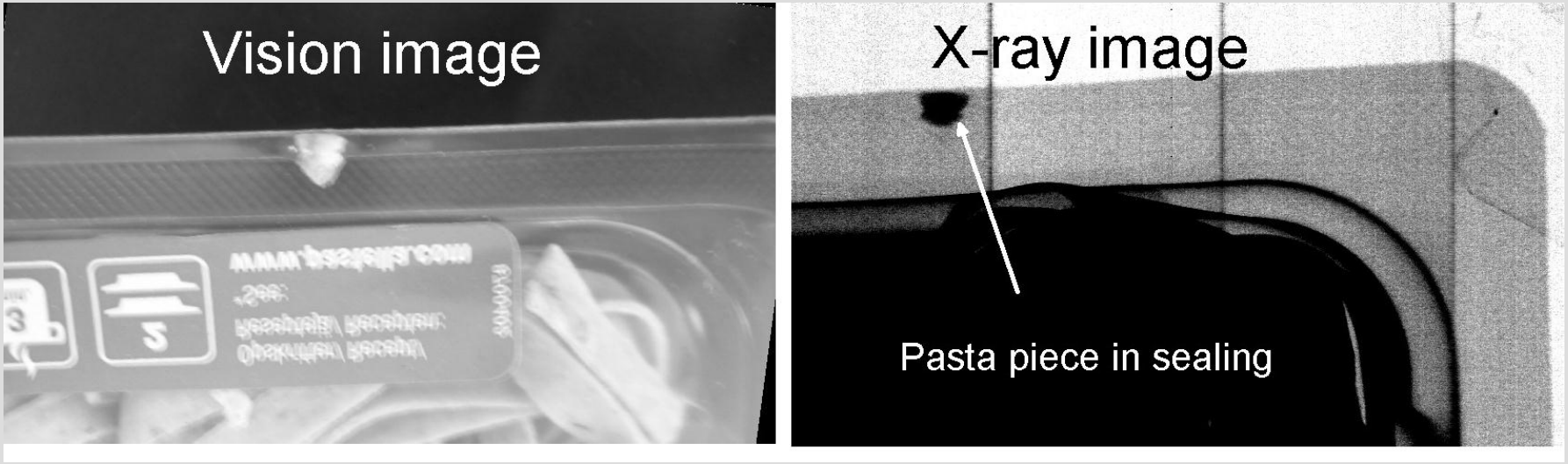

InnospeXion

# LOW-ENERGY X-RAYS

## Application Examples

InnospeXion

## Food inspection: Packaging integrity

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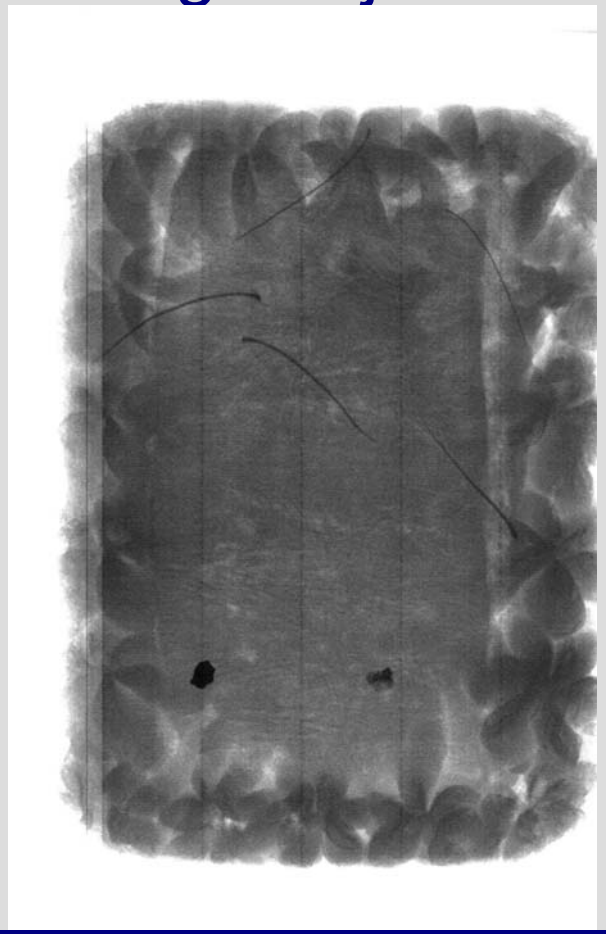
# LOW-ENERGY X-RAYS

## Application Examples

### Food inspection: Foreign objects

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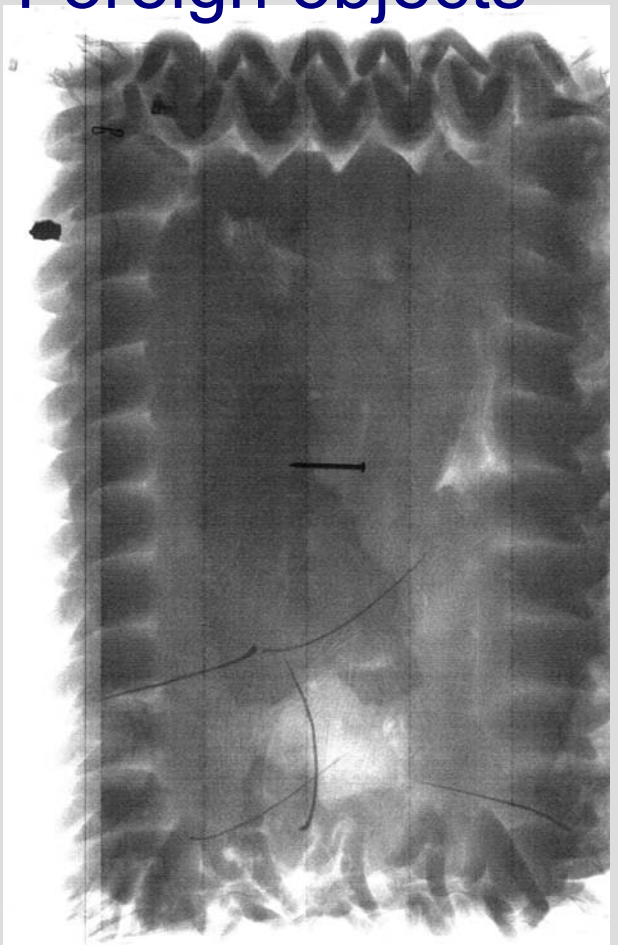
# LOW-ENERGY X-RAYS

## Application Examples

### Food inspection: Foreign objects

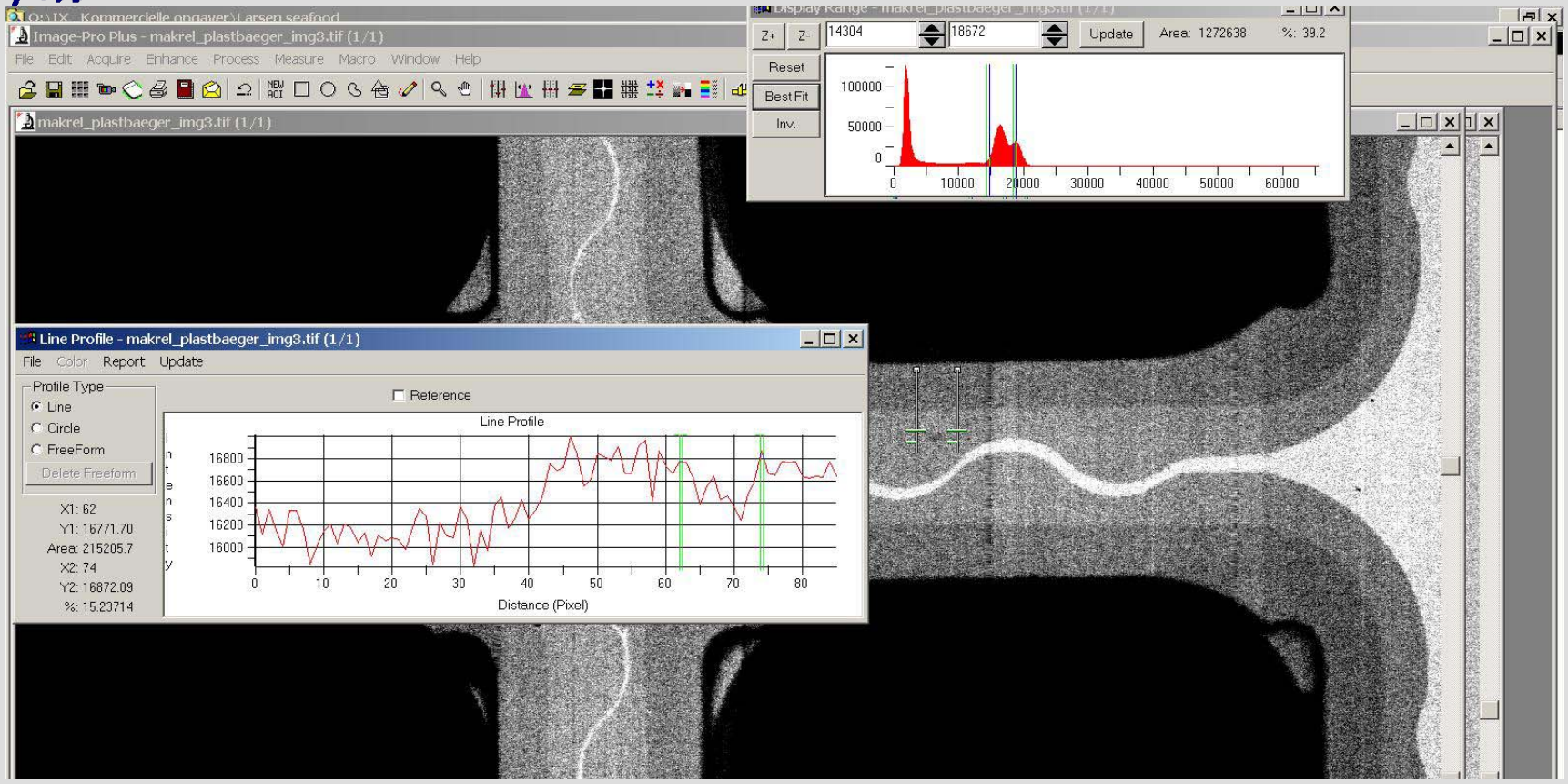



# LOW-ENERGY X-RAYS

## Image processing

InnospeXion

## Food inspection: Foreign objects

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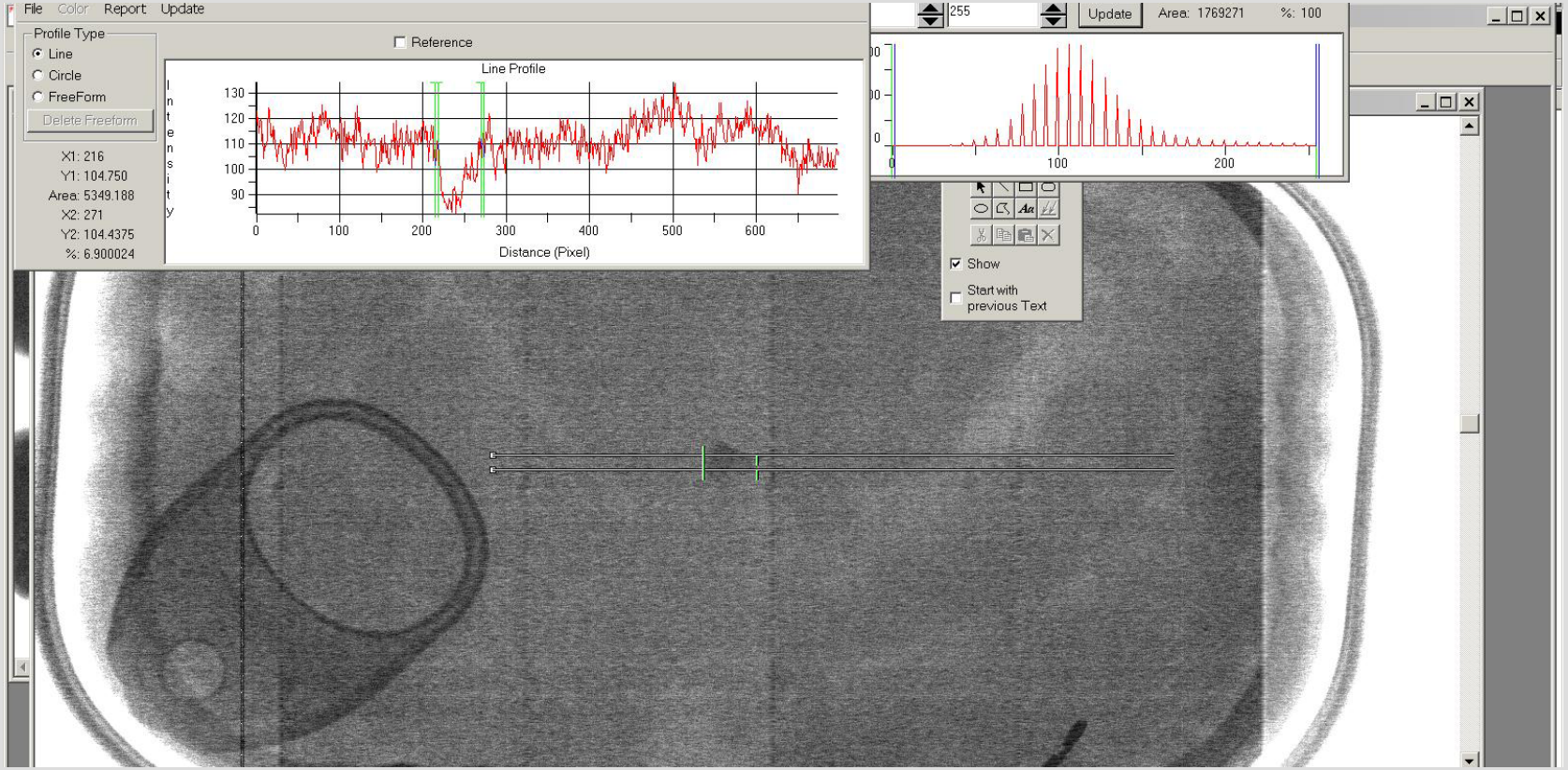
# LOW-ENERGY X-RAYS

## Image processing

## Food inspection: Foreign objects

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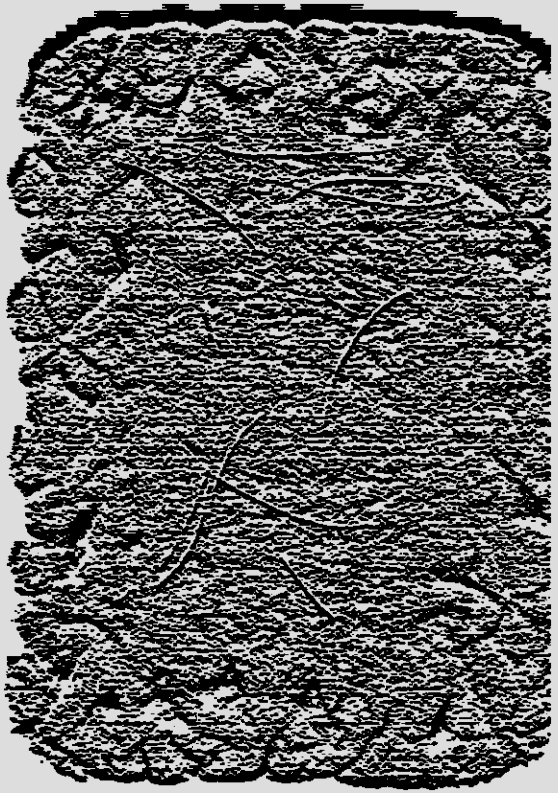
# LOW-ENERGY X-RAYS

## Image processing

InnospeXion

## Food inspection: Foreign objects – edge filter combination



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# LOW-ENERGY X-RAYS

## Image processing

InnospeXion

### Materials inspection – homogeneity & design conformity

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# LOW-ENERGY X-RAYS

## NEW DEVELOPMENTS

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Food inspection:
Hygienic design
as imposed by
EHEDG and FDA

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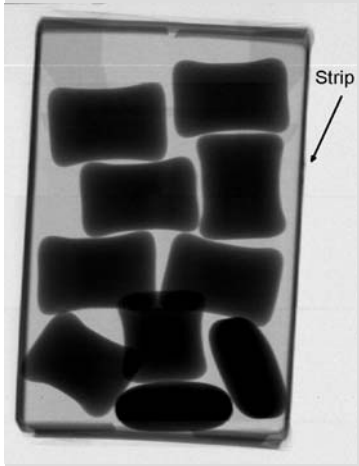
# LOW-ENERGY X-RAYS

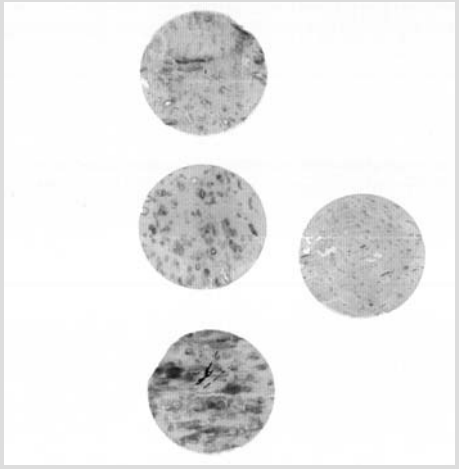
## Summary of Experiences

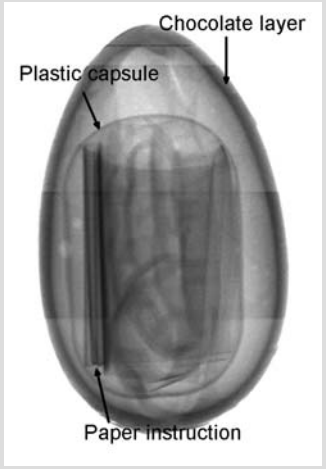
Low energy X-ray imaging is a key requirement for a large number of inspection tasks.

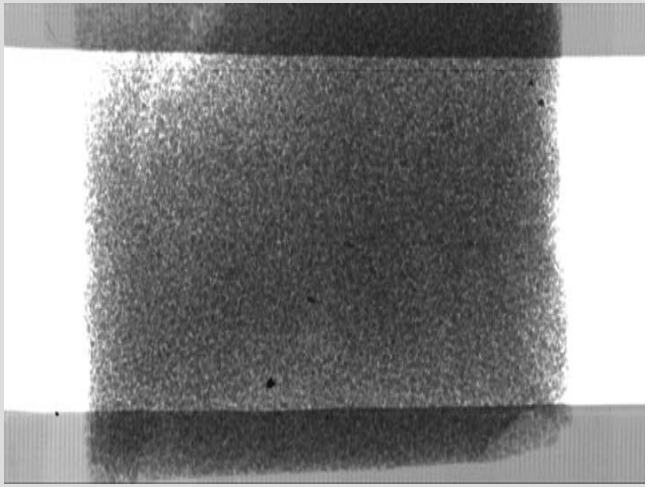
In food inspection, the ability to inspect BOTH packaging AND contents is a key novelty.

For a number of applications – low energy X-rays is the only technology applicable – but dissemination is needed!





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