
XNEXT
ADVANCED INSPECTION TECHNOLOGY
XSpectra®
for pickles
and legumes

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Introduction

The purpose of the Paper is to provide an overview of the application of XSpectra®, our proprietary inspection technology, in the food segment of pickles and legumes (the "**Product(s)**") to show on a preliminary basis the capacity of XSpectra® Detector to identify the presence of foreign bodies (also "**FBs**").

Tests were executed using both low- and high-density FBs and specifically foreign bodies that are hard if not impossible to be detected by conventional inspection systems (like X-ray, metal detector, etc) generally used on processing lines for this type of product.

The Products were inspected using a geometric configuration of the inspection system in which the X-ray generator and the detector are placed in a lateral position with respect to the direction of movement of the Product

The Equipment

Tests were carried out at the XNEXT Demo Center using a demo machine, equipped with XSpectra®, placed on a 6-metre conveyor loop. The aim was to recreate the typical operating conditions of a processing line for this type of product in order to carry out realistic tests.

The demo-machine used for testing has fixed distances in terms of source-product and product-detector.

Therefore, when a dedicated machine is built, the geometric configuration can be further optimised, facilitating the operation of the foreign body detection software. We also do not rule out the use of an X-ray source more suitable for the type of product being inspected.

Tested Products

Shown here on the side are the Product samples that were used for the tests.

Products were inspected both in glass jar (samples #1-5) and tin can (sample #6) to show that the detection technology is not affected by the type of packaging.

The tests were executed by applying a belt speed of **35 cm/sec**. The following graphic representation provides evidence of the movement of the product on the belt.

The geometric configuration of the system also allows the inspection of the bottom of the packaging.

Sample #1
Giardiniera 580 gr

Sample #2
Capers 60 gr

Sample #3
Green olives 580 gr

Sample #4
Mixed peas and carrots 710 gr

Sample #5
Peas 370 gr

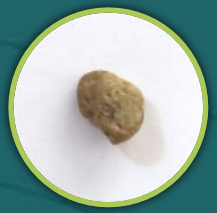
Sample #6
Peas 220 gr

FBs used for testing

We used **10 different types of FBs**, to our knowledge, quite common for this type of production.

Also, we focused more on **low-density FBs**, **which are difficult if not impossible to be detected with conventional inspection technologies**.

FB1
Pallet wood splinter



FB2
Stone

FB3
Rubber sheath

FB4
POM conveyor belt fragment

FB5
Glass fragment

FB6
Fruit pit

FB7
EPDM gasket fragment

FB8
Polypropylene white fragment

FB9
PVC white fragment

FB10
Metal wire

Background of the testing process

The purpose of these tests was to show the capability of XSpectra® to identify the selected FBs before the support of a dedicated detection software

The XNEXT proprietary inspection system, under normal operating conditions, performs the inspection analysis with the support of the XInspector, a self-learning detection software, which allows the automatic detection of foreign bodies and non-conformities.

Starting from a consolidated background, XInspector is a software that from time to time is further developed and adapted for the specific application needs through a dedicated training. Since these are preliminary tests, XInspector was not used but instead the image analysis tool XSpectrum Analyzer was applied to process the data obtained from the inspection.

The results of the test and the relative images shown in this Report are therefore the result of simply exploiting the precision of the XSpectra® Detector.

Compared to conventional X-ray inspection systems available on the market, which operate at energy levels above 25 keV, XSpectra® is able to operate even at low energies (up to 5 keV). This represents a significant competitive advantage since product non-conformities can become more visible at low energies.

Background of the testing process

XSpectra® detects foreign bodies not by analysing a picture but by processing a “cube” set of data generated by the detector

In practice, the system analyses the number of photons for each energy band of the X-ray spectrum and within a specific space. The same set of data is then used to generate an integral image of the product with the contaminant, which is what is shown in the following slides.

Besides the above, as mentioned before, the **tests** were **executed using a standard demo machine available at XNEXT Lab**. Since the standard machine has fixed settings, in terms of geometric configuration (the distance between the X-ray generator and the detector, in relation to the size of the product packaging) the inspection system used is **obviously not optimized to inspect the Products**.

Furthermore, please keep in mind that the quality of the images that follows is affected by the PDF conversion and the image compression, necessary to reduce the file size. A better image resolution would also be achieved by processing the data generated by XSpectra® with dedicated algorithms.

Test findings glass jar

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Sample #1

FB1 – Pallet wood splinter
10 x 4 mm

FB2 – Stone
4 x 6 mm

FB3 – Rubber sheath
2 mm thick

Giardiniera
580 gr

Sample #2

FB3 – Rubber sheath
2 mm thick

FB4 – POM conveyor belt fragment
4 x 7 x 16 mm

Capers
60 gr

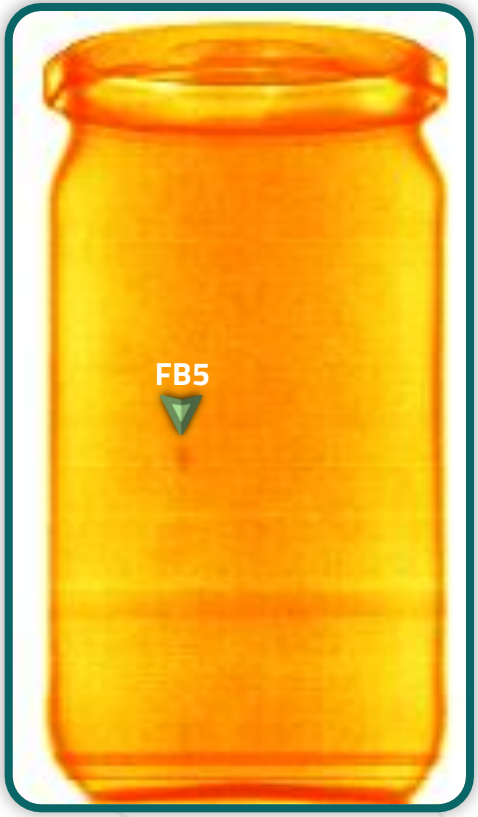
Sample #3

FB1 – Pallet wood splinter
14 x 4 mm

FB5 – Glass fragment
3 x 4 mm

Green olives
580 gr

Glass fragments used for testing were taken from the same jar



Sample #4

FB1 – Pallet wood splinter
12 x 3 mm

FB5 – Glass fragment
1.7 x 4 mm

Air bubbles

Mixed peas and carrots
710 gr

Glass fragments used for testing were taken from the same jar

Sample #5

FB5 – Glass fragment
5 x 5 mm

FB5 – Glass fragment
2 x 2 mm

Peas
370 gr

Glass fragments used for testing were taken from the same jar

Test findings tin can

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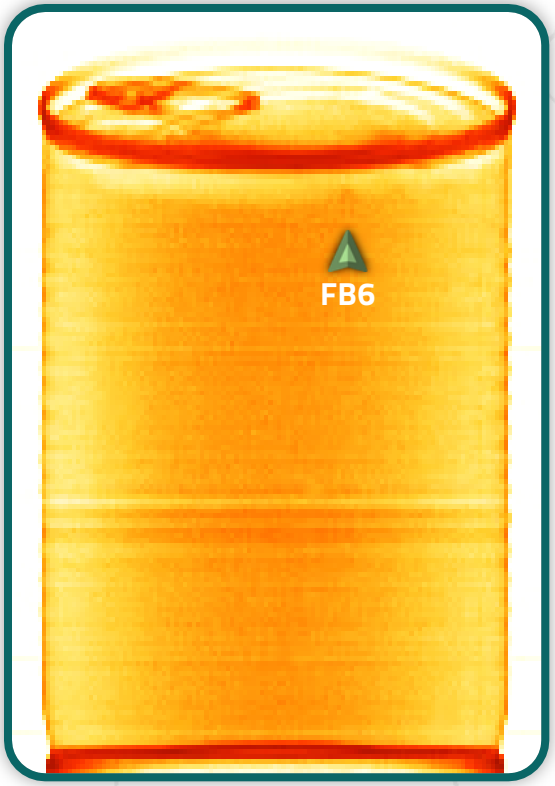
Sample #6 (1/3)

FB2 – Stone
5 x 8 mm

FB6 – Fruit pit
4 x 7 x 9 mm

Peas
220 gr

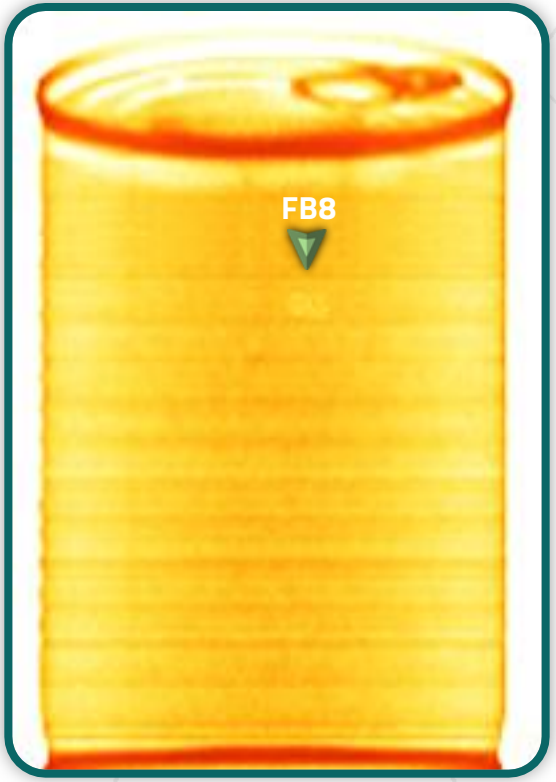


Sample #6 (2/3)

FB7 – EPDM gasket fragment
5 x 4 x 18 mm

FB8 – Polypropylene white fragment
6 x 5 x 11 mm

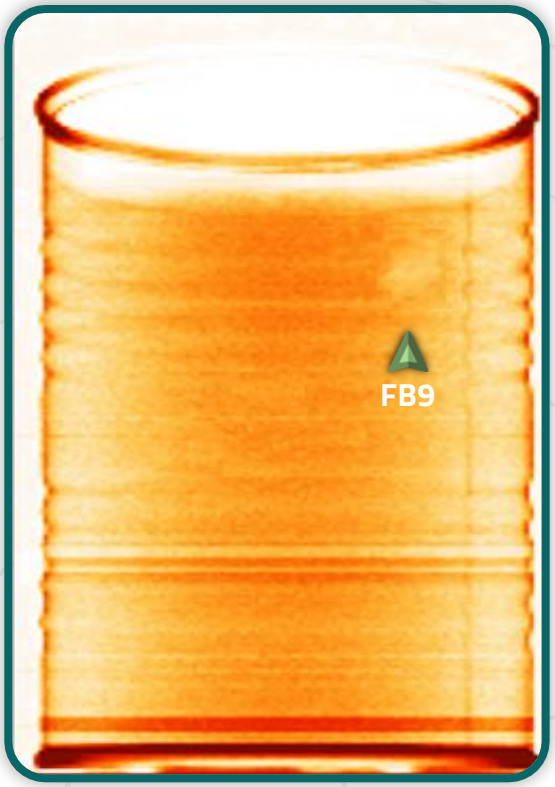
Peas
220 gr



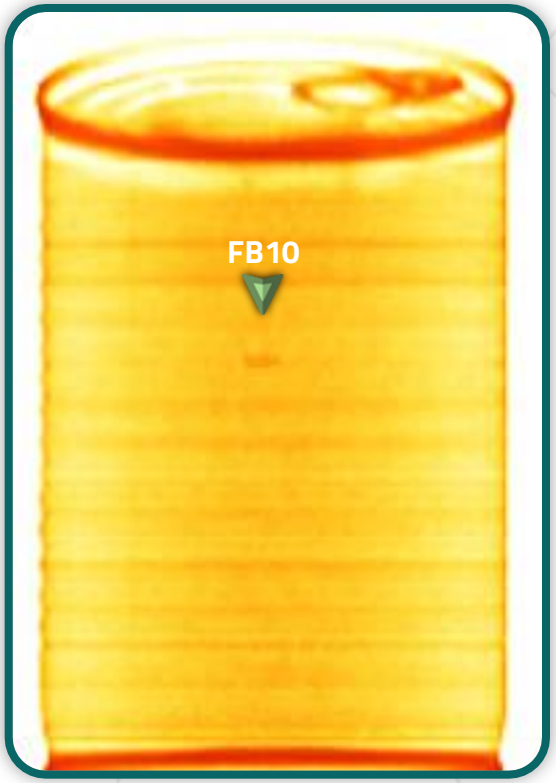
Sample #6 (3/3)

FB9 – PVC white fragment
6 x 8 x 13 mm

FB10 – Metal wire
1 mm thick



Peas
220 gr



Final remarks

Although the results achieved are already remarkable, when compared to the performance of a conventional X-ray inspection system, there is room for further improvement that could be achieved through:

- the use of XInspector automatic detection software, developed for this specific application;
- a geometric configuration of the system optimized for the product features

XInspector is a self-learning software, which means that the performance and efficiency increase as the statistical data acquired during the inspection of contaminated/non-conforming products increase. Like any AI software, the more it learns to recognise product non-conformities, the more efficient it becomes.

In relation to the above, once installed on the processing line, XInspector can achieve a continuous improvement of its accuracy.

In conclusion, we would like to emphasise the fact that the inspection system, both in its software and hardware parts, is continuously evolving. In particular, we periodically introduce technological upgrades as XNEXT is primarily a technology innovator. This innovation will be made available to our customers.

About Xnext

who we are

Xnext is high-tech SME, a technology innovator with the ambition to revolutionize the quality inspection sector, overcoming the weaknesses of conventional solutions. A team of professionals made of data scientists, electronic and nuclear engineers, mathematicians and physicists, AI and software developers

what we do
(why we are so unique)

We perform a real-time (few milliseconds) chemical-physical analysis of the product to identify foreign bodies and defects or non-conformities not detectable by existing inspection technologies

how we do it

Thanks to XSpectra®, our patented technology. It is not simply innovative but rather disruptive as it performs a multi-energy analysis of the x-ray spectrum (up to 1.024 energy bands) and detects also low-density contaminants. Like no other, it is the result of a unique synergy between photonics, nuclear micro-electronics and Machine Learning software

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