The Xnext team explain how XSpectra® stands to impact the food industry and, indeed, other sectors

XSpectra®, a better detector

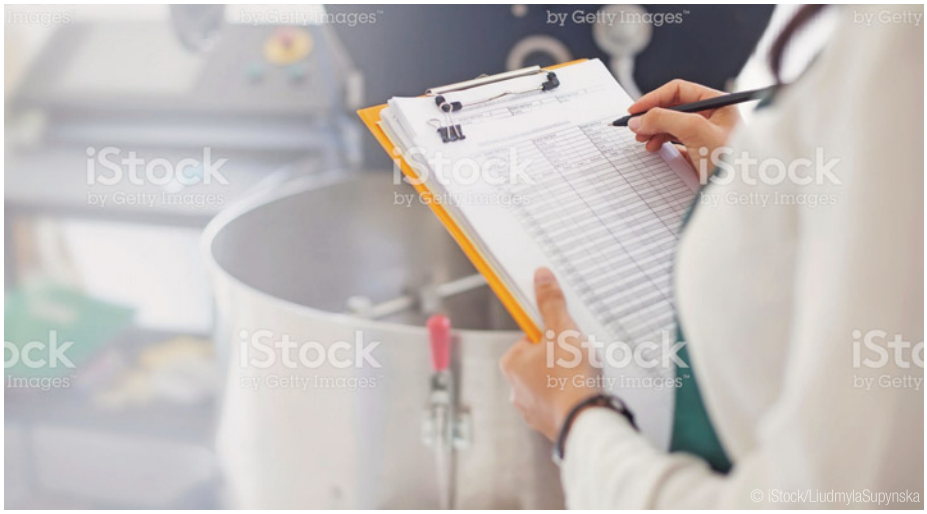
X-ray machines in the food industry today can easily detect high density foreign bodies, such as metal, lead, stones, bones and glass, hidden inside non-transparent foodstuff and non-transparent containers. There are, however, some challenging materials that go undetectable, such as low density foreign materials like wood, low density polymers, cigarette butt, dry fruit shells and insects, to name a few.

Xnext, an Italian SME, has developed XSpectra®, a new generation of X-ray inspection systems that can detect both low and high density, overcoming the difficulties of conventional X-ray machines. The multispectral detector works by making several scans of the material in different energies. Once the researchers put all the scans together, these can reveal the absorption of low energy photons in the material, which translate into low density objects.

In an interview with *SciTech Europa Quarterly*, the Xnext team explain the how the new technology stands to impact the food industry and, indeed, other sectors.

How does XSpectra improve on current X-ray systems when it comes to the detection of foreign bodies in the food sector?

In the Industry 4.0 era, the innovative concept of the total automation of processing lines reduces the possibility of human errors and increases productivity. However, this requires further and deeper controls on every single piece produced. The presence of foreign bodies inside processed foodstuff is harmful for the health of each customer and represents a huge issue for all the food companies due to market recalls.



Currently, the quality control department of each food company knows that it is a straightforward task to detect high density foreign bodies hidden inside non-transparent foodstuff and non-transparent containers. But there is a huge set of foreign bodies that can be found in a real processing lines which are completely undetectable by both kinds of conventional X-ray detectors

Currently, the quality control department of each food company knows that it is a straightforward task to detect high density foreign bodies hidden inside non-transparent foodstuff and non-transparent containers. Pieces of metal, lead, stones, bones and glass are visible with most X-ray machines equipped with conventional X-ray detectors, which are based on scintillator technology.

The challenges are confined to the foreign body dimension, mostly associated with the detector pixel pitch and the scan speed, which in turn are related to the electronic signal processing and the CPU algorithm analysis. Even the foodstuff homogeneity is crucial to determining the success of foreign body detection.

Conventional X-ray detectors rely on the ability to find a dark spot inside a brighter medium, but a non-homogeneous medium can have natural dark spot, due to different densities. Dual-energy detectors can overcome, in some situations, this last issue, thanks to the ability to compare low energy and high energy X-ray images. These detectors represent a real step forwards, even though they are based on the technology of two scintillators overlapped and separated by a filter.

Yet, there is a huge set of foreign bodies that can be found in a real processing lines which are completely undetectable by both kinds of conventional X-ray detectors. Low density foreign bodies such as wood, different kinds of low density polymers, cigarette butts, dry fruit shells and insects lie outside of the conventional capabilities of these detectors. Indeed, there is no way to distinguish them from air bubbles or low density regions of the product itself and, in the worst case, these bodies are completely invisible.

In this scenario, our innovative detector XSpectra emerges and makes it possible to go a step further. Its increased sensitivity gives us the possibility to detect low density foreign bodies, which until now have been impossible to find. Its

ability to collect the spectrum of each material inspected allows us to identify the unique atomic number, in other worlds the intrinsic nature, of the objects scanned. It is like taking their fingerprint and using it to distinguish the foreign bodies hidden inside the foodstuff.

What do you feel will be the biggest benefits to the food sector from this new technology?

The entire food processing industry will benefit from this great enhancement due to the high detection capabilities of XSpectra. The possibility of offering safer products to customers will raise the quality of production and at the same time reduce or even eliminate the risk of recalls. In the global and extremely competitive world of the food sector, customer complains can cause huge issues to company revenues. But most importantly, quality food regulations are becoming more stringent in order to protect people's well-being, thus forcing industry to find and implement new technological solutions.

Alongside food, what other applications does XSpectra have?

XSpectra is an extremely versatile X-ray inspection system and, alongside the food safety issues, there are several other applications where it can be employed. Pharma safety is similar to food safety but pushes the performance to a higher level, requiring the detection of smaller foreign bodies. All the Non Destructive Testing (NDT) controls needed here can benefit from XSpectra's superior performances. All kind of products, even low density materials inspection for non-conformities detection can be scanned with proficiency using XSpectra.

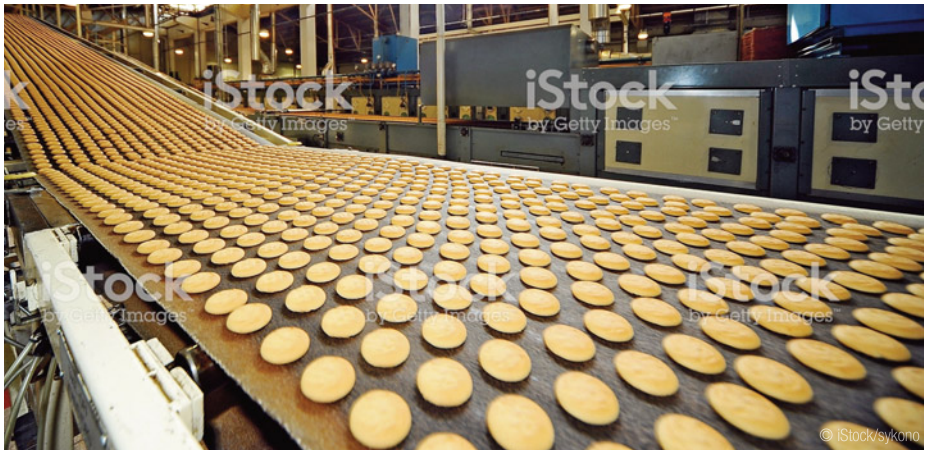
Thanks to its real time chemical physical characterisation capability, XSpectra can be employed for food quality issues, to reduce food waste, or material recycling, to avoid contamination in material sorting, or even security controls in order to raise the level of accuracy in the detection of hazardous materials.

What were the biggest (technical and otherwise) challenges involved in developing the new generation of X-ray inspection systems?

The many excellent results we have achieved certainly didn't come effortlessly. Xnext® is a high-tech enterprise that has developed a package of innovations on three levels:

- Photonics;
- Microelectronics; and
- Algorithms.

The combination of these three innovations constitute the strength of Xnext and the uniqueness



The possibility of offering safer products to customers will raise the quality of production and at the same time reduce or even eliminate the risk of recalls

of XSpectra. The challenges for success are both technical and financial/operational.

The first challenge we have overcome is a technical one, and we have done this by working intensively with an expanded group of engineers (nuclear, physical, mathematical, electronic and computer), who constitute the Xnext team, together with the best minds of major research centres and Italian universities including the Politecnico di Milano.

The second challenge, and perhaps the most important one (once the technology has been realised at the prototype level), is to find the financial resources and the commercial interests to realise and affirm XSpectra. Xnext has attracted the attention of investors and has the ability to integrate suppliers and industrial partners to develop core production processes.

What were the biggest benefits of working with/at the ESRF? How difficult was it to become familiar with the technology and processes?

In the last stage of XSpectra development, the tests carried out at the ESRF were fundamental. These experiments provided us with the necessary information to deeply take control of the potentiality of the inspection system. The monochromaticity of the X-ray beam generated by the synchrotron was extremely useful to characterize the CdTe crystal behaviour in different configurations. For the whole time spent at the European facility, the Xnext team was helped by ESRF staff to use the instruments to their full potential so as to not waste expensive and precious beam time.

Do you feel enough is done at the European level to aid innovative SMEs to commercialise their research? How would you like to see this support landscape evolve?

Xnext regularly applies for European project funding to continue to enhance the product and develop new features and, indeed, to participate in international collaborations. In particular, we apply to the SME Instrument within Horizon 2020, a tool specifically designed to help SMEs to scale up their innovations.

In our opinion, the support of the European Union in helping European SME companies to grow and develop innovative products could become even bigger. The global geopolitical framework shows how the world is substantially divided into three main area:

- North America (USA, Canada);
- Asia (mainly China, Japan, India and South Korea); and
- The European Union.

The first two areas account respectively for 28% and 42% of the total R&D spending, while the EU accounts for only some 21% (source: 2017 Global R&D Funding Forecast, *Research & Development magazine*). In the future, the prosperity of a country or a region will be proportional to the R&D developments of its industries even more than it is now, and so the EU should therefore invest much more in order to face the other two world players.

Moving forwards, what are your hopes for the future?

Xnext's main hope is to have a significant impact in the NDT real time quality control market worldwide. Its innovative inspection system XSpectra will enhance the performance of X-ray scanner machines, while the spirit of continuous innovation that characterises the company will guarantee its constant growth with new products and services constantly emerging.

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