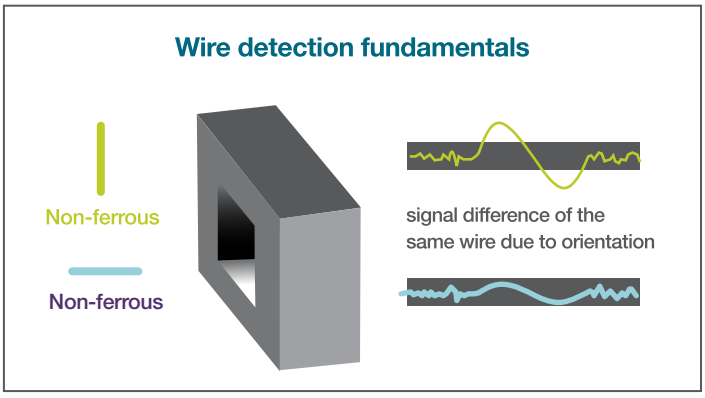
Orientation effect: addressing a food metal detection challenge

Among the limitations of metal detection technology is finding foreign objects such as small, oblong metal pieces like wires and pins. These types of contaminants exhibit "orientation effect," a phenomenon in which the signal the metal detector sees is largely dependent on the contaminant's alignment in relation to the detector's aperture. Orientation effect creates a challenge for inspection systems – a challenge that may not be obvious at first glance, but with consequences that could compromise consumer safety and brand reputation.

Metal detection technology that could be agnostic to orientation effect, that is able to detect metal contaminants in any orientation, would be optimal. After all, it is impossible to say just how a real contaminant will embed inside a product.

Orientation effect – the cause of an age-old challenge

The challenge of detecting wires, needles, pins and shavings exists because of the geometry of the metal detector coils and the orientation of the contaminant. Consider a metal wire traversing the aperture perpendicularly as shown in the following illustration. It can be observed that the cross-section of the wire is maximized, resulting in a large signal and an easy detection. On the other hand, if the wire goes straight through the aperture the cross section, and therefore the evoked signal level, will be minimized, making it much more challenging to detect.



During production, contaminants can come in many shapes and sizes and composed of different metal materials. There are endless possibilities of foreign objects, making it impossible to predict how metal contamination will manifest. Thus, production facilities must respect the unpredictable nature of orientation effect and consider their inspection system's ability to address this concern.

Verification testing pitfall

The conventional method for assessing metal detector performance is to audit using three metal types in a spherical shape: ferrous, nonferrous, and stainless steel. Safety plans call for regular audits by adding each spherical metal test piece to the food product and verifying detection. The reason for using spheres is specifically to circumvent orientation effect. (After all, a sphere is "seen" the same to a metal detector regardless of alignment, thus creating a perceived fair test.) While this may seemingly create a fair test, it is illogical for understanding the detectability of the broad range of possible foreign object shapes. For this reason, food processors must think beyond metal spheres; when a source of metal contaminant is found, samples should be collected and tested in their inspection equipment. Otherwise, production facilities remain vulnerable to the dangers of real-world contamination.

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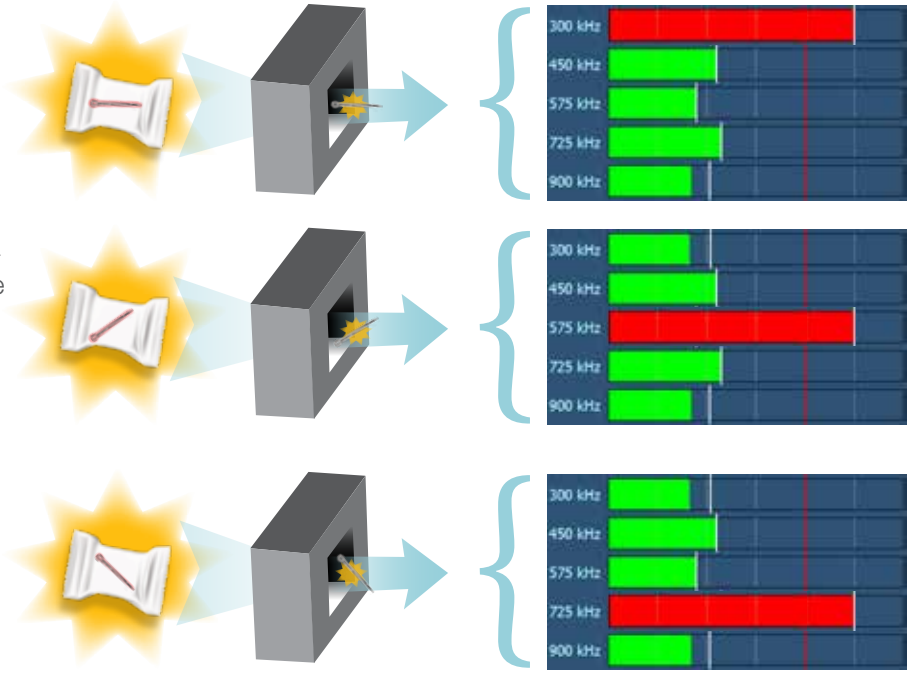
Multiscan technology – a modern solution

To achieve a higher level of food safety, Multiscan technology was developed for the Thermo Scientific™ Sentinel™ Multiscan metal detector. Multiscan technology employs five frequencies at once; each frequency induces a unique response in the metal contaminant. The effect is like having five metal detectors in one, each scanning at a different frequency. When an oblong contaminant is oriented such that it evokes a weak response at one frequency, there will be a much stronger response on another frequency and the probability of contaminant detection will be increased. The benefit is especially pronounced for high product effect foods, which typically make the most challenging applications.



To put Multiscan technology to the test, a controlled experiment was performed using a 24 oz bag of fresh garden salad. The bag was sealed shut, retaining moisture and nutrients, and as such exhibited high product effect. A 10mm long piece of 22-gauge wire was embedded within the salad. The wire was tried with four orientations with respect to the aperture: 0 degrees (parallel to flow), 30, 60 and 90 degrees (perpendicular to flow). For comparison, an older, single fixed-frequency metal detector was tested in the same manner.

Wire orientation (degrees)	Single-frequency detection (%)	Multiscan detection (%)
0 (parallel to flow)	10	100
30	30	100
60	100	100
90 (perpendicular to flow)	100	100
TOTAL	**53%**	**100%**

It can be seen that the single frequency metal detector was unable to detect the wire reliably in some orientations. On the other hand, the Sentinel Multiscan metal detector detected the wire reliably in all orientations. For this application, the benefit of Multiscan technology is clear.

But still it is important to consider the unknown – there will always be new shapes and orientations of real-world contaminants presented to the metal detector. With Multiscan technology, users know they are best protected against the contaminants they don't see coming.

Take the next step

Thermo Fisher is dedicated to providing the highest-performing inspection technology – and we want to prove it to you. Product tests are a complimentary service offered to prospective customers – you provide or specify your product and we will run a comprehensive sensitivity study. It is recommended that real contaminants are provided, but if this is not possible, wires or other custom test pieces will be used. For more information or to request a product test visit thermofisher.com/productinspection.

Find out more at **thermofisher.com/sentinel5000**

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