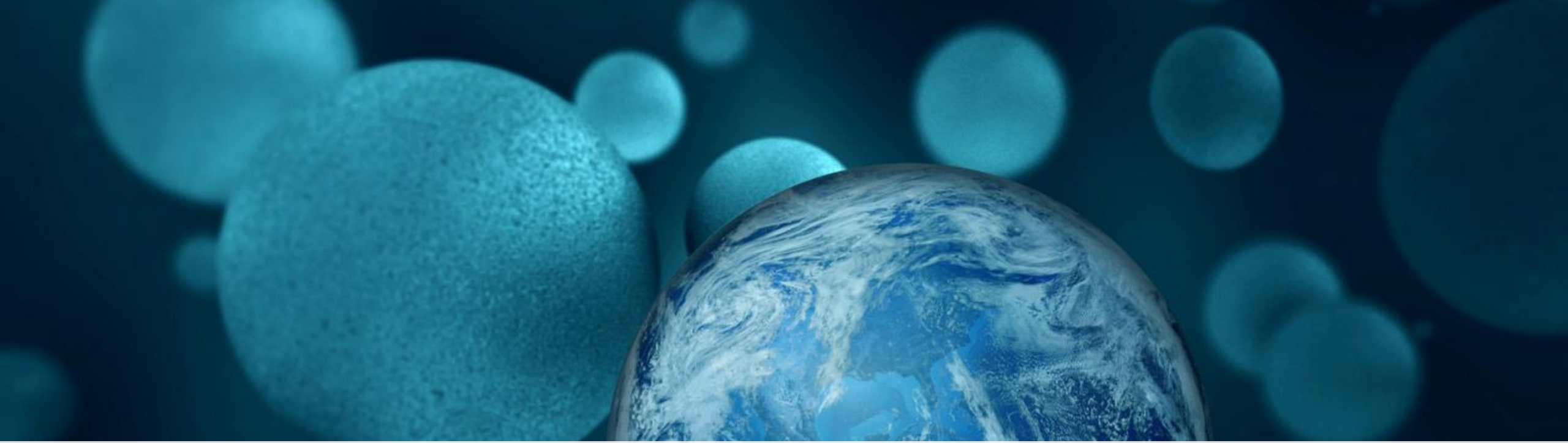

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Why Multiscan Improves Sensitivity AND Probability of Detection

Bob Ries

Lead Product Manager

Metal Detection and X-Ray Inspection

PACK EXPO® INTERNATIONAL

October 14-17, 2018

Chicago, Illinois USA

The Thermo Fisher Scientific Mission

Enabling our customers to make the world…

Healthier **Cleaner** **Safer**

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Our History in Metal Detection

Analog detectors invented 65+ years ago by Goring Kerr (UK)

DSP1

Digital detectors entered in the 1990s

ADCs and digital signal processors

APEX

2006: Our fifth generation digital metal detector

20% sensitivity improvements

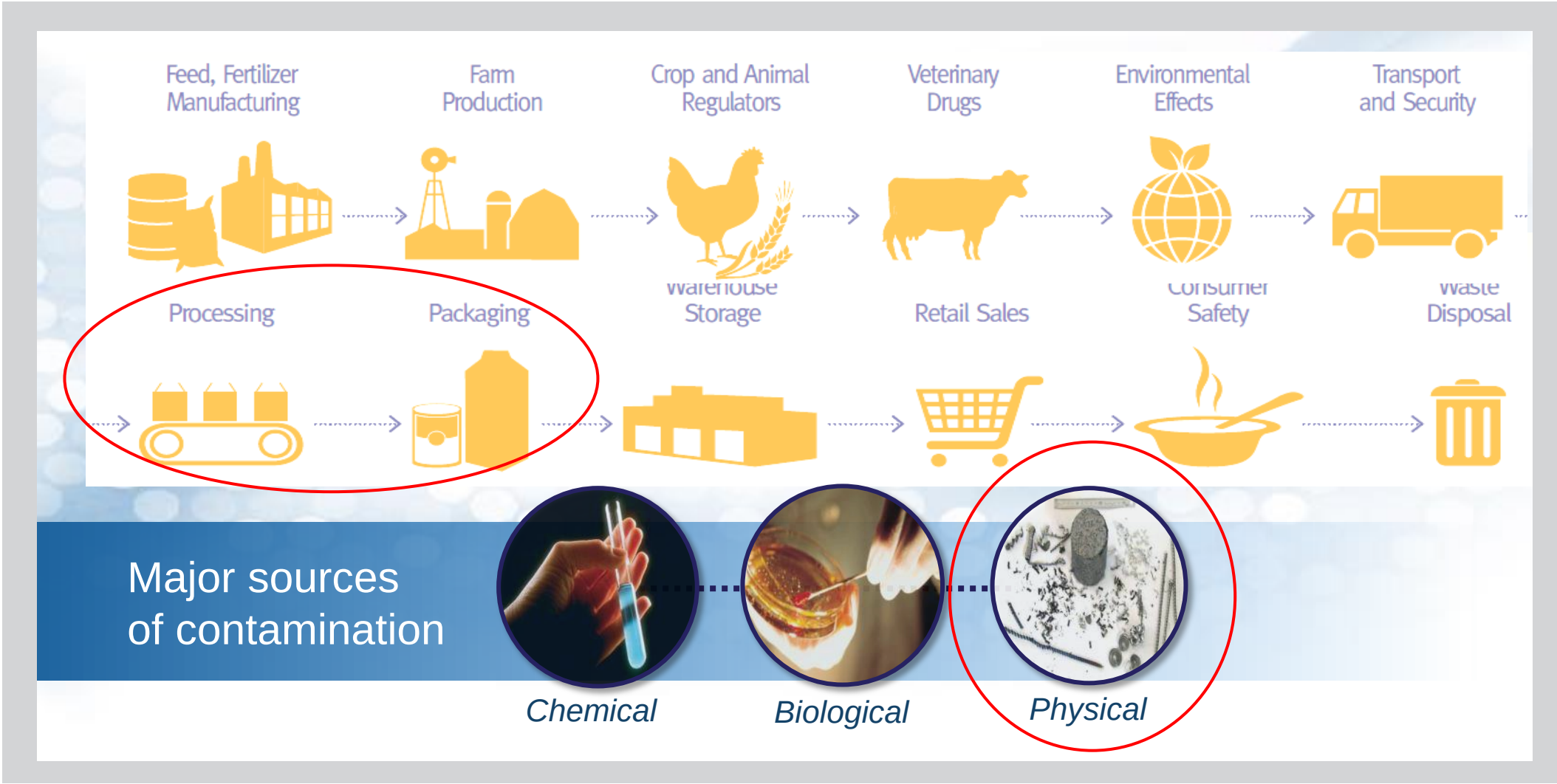
Intellitrack XR

Technology and customer-driven improvements

- Multiple transmit “coils”
- Multiple frequencies
- New product compensation techniques
- IP69K + ratings for thermal shock
- 300+ head sizes and styles for conveyors, gravity and pipe apps

>30,000 Thermo Scientific MDs in service today!

Contamination Threats to the Food Supply Chain



Contamination threats exist in each step of the food chain

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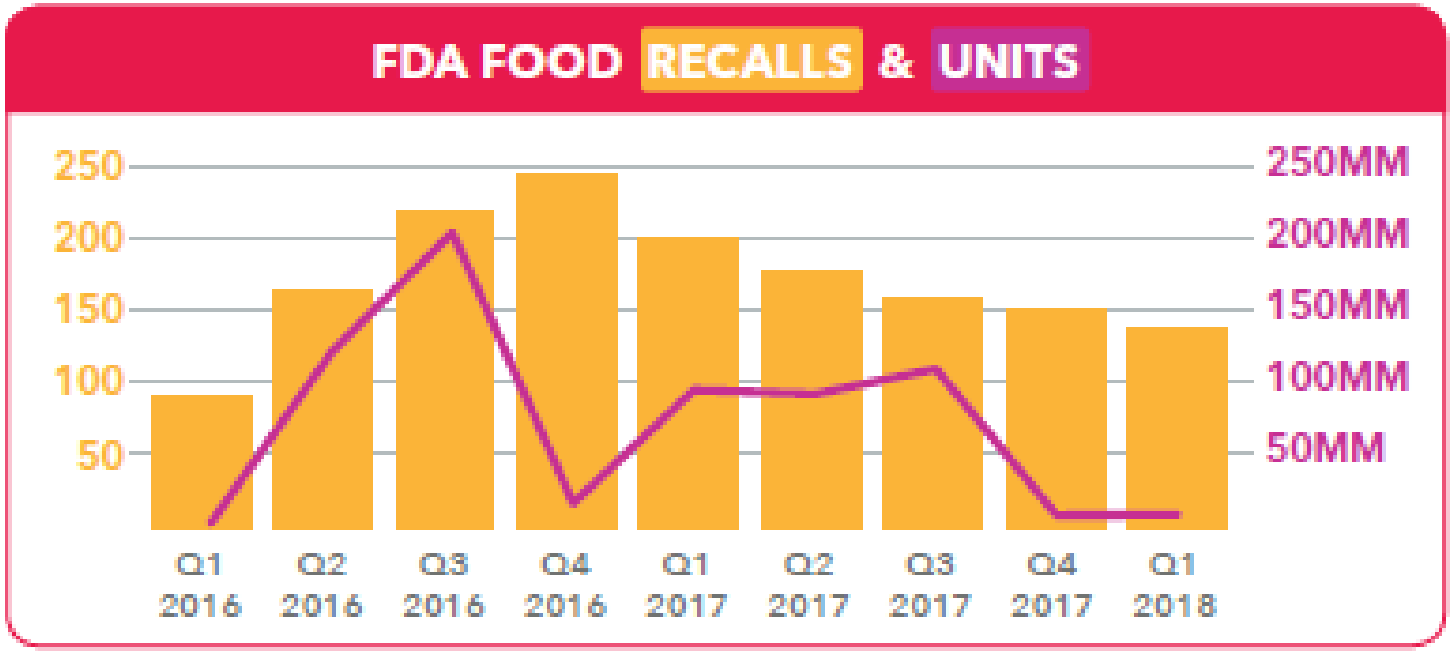
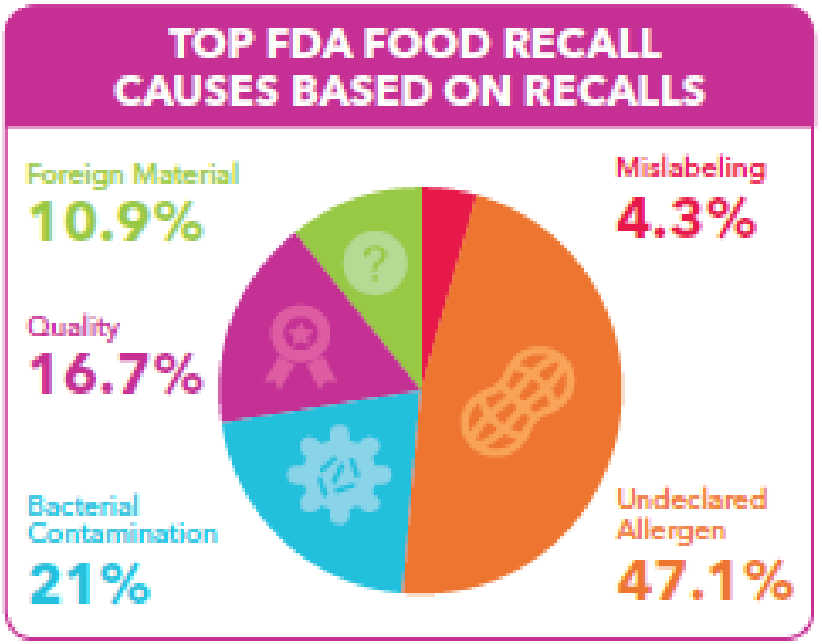
Recalls and Causes





- Recalls trending downward but still prevalent
- Foreign objects are 10% of recalls, even with metal detectors (and X-ray) in use
  - 15 recalls of 1 million units each per quarter!
- Data does not include scrap, rework or company-managed recalls

Stericycle Expert Solutions

Source

How do we keep making improvements?

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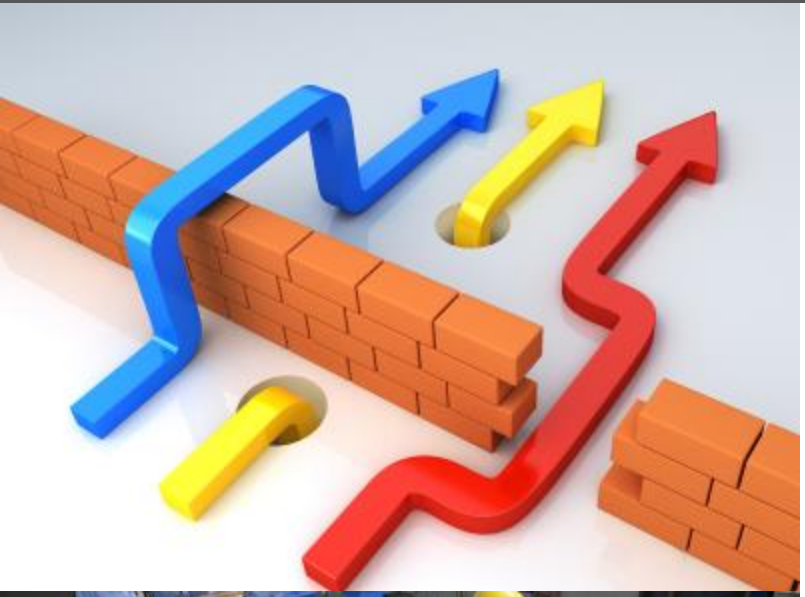
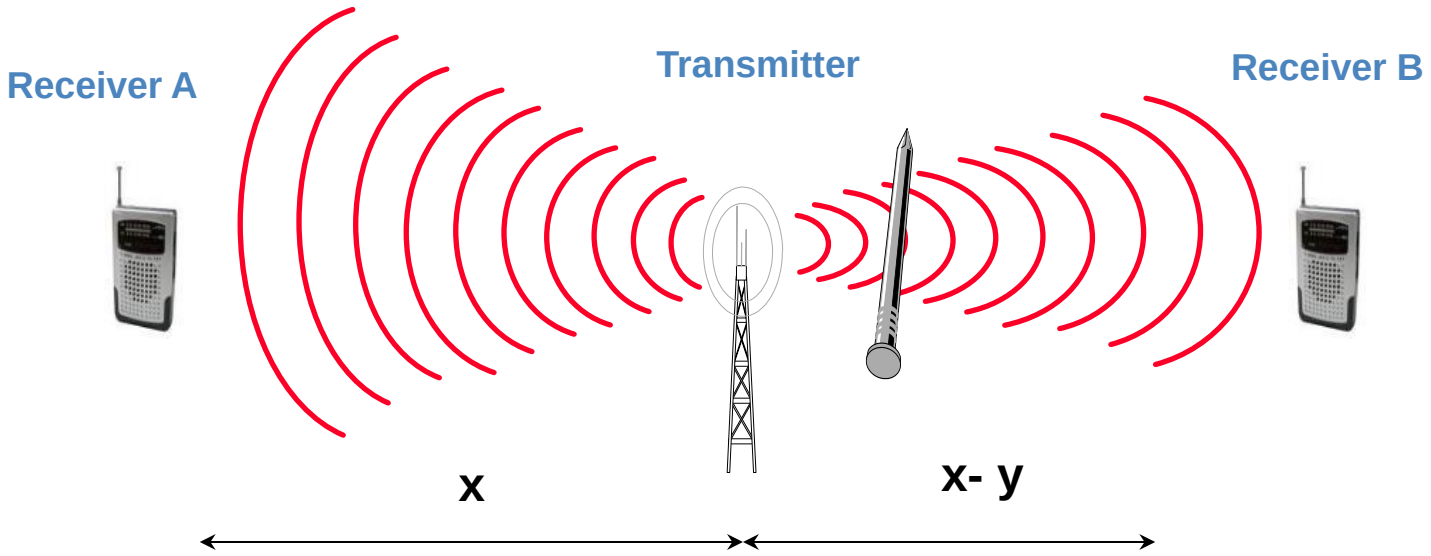
Three Things Make Metal Detection Challenging in the Real World

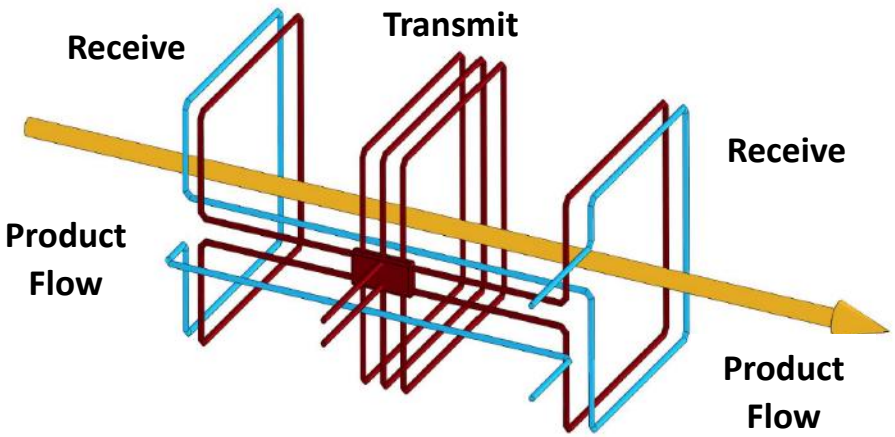


1. **Anything, anywhere in any product all the time**
   - Metal size, type, shape, position… Not spheres.
   - Dry, wet, mineral content, salt, layers, temp changes …
2. **Product effects that look like metal in electromagnetic fields**
   - Finding contaminants in air is easy
   - Product compensation can mask contaminants
3. **Small detection signals that are subject to many types of noise**
   - Motors/drives, dirty power, vibration, temperature changes, variation/drift…
   - Effects can come and go, making problem determination more difficult

How Signals Are Generated in a Metal Detector

- **Balanced RF system used to detect small field differences**
- **Not actually antenna as drawn but loop coils around the aperture**
- **Thermo Fisher detectors use a proprietary multicoil design to make signals more uniform**





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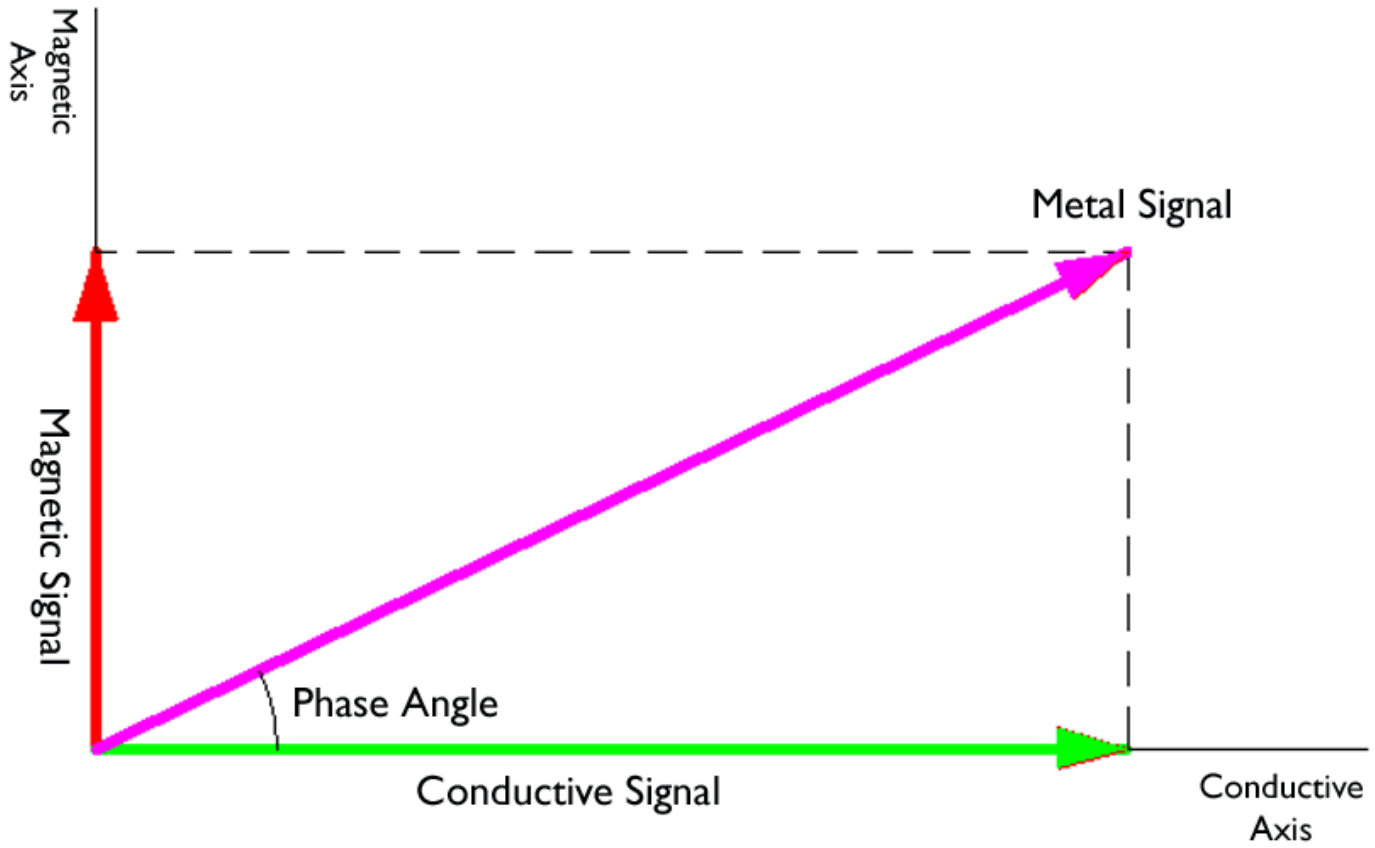
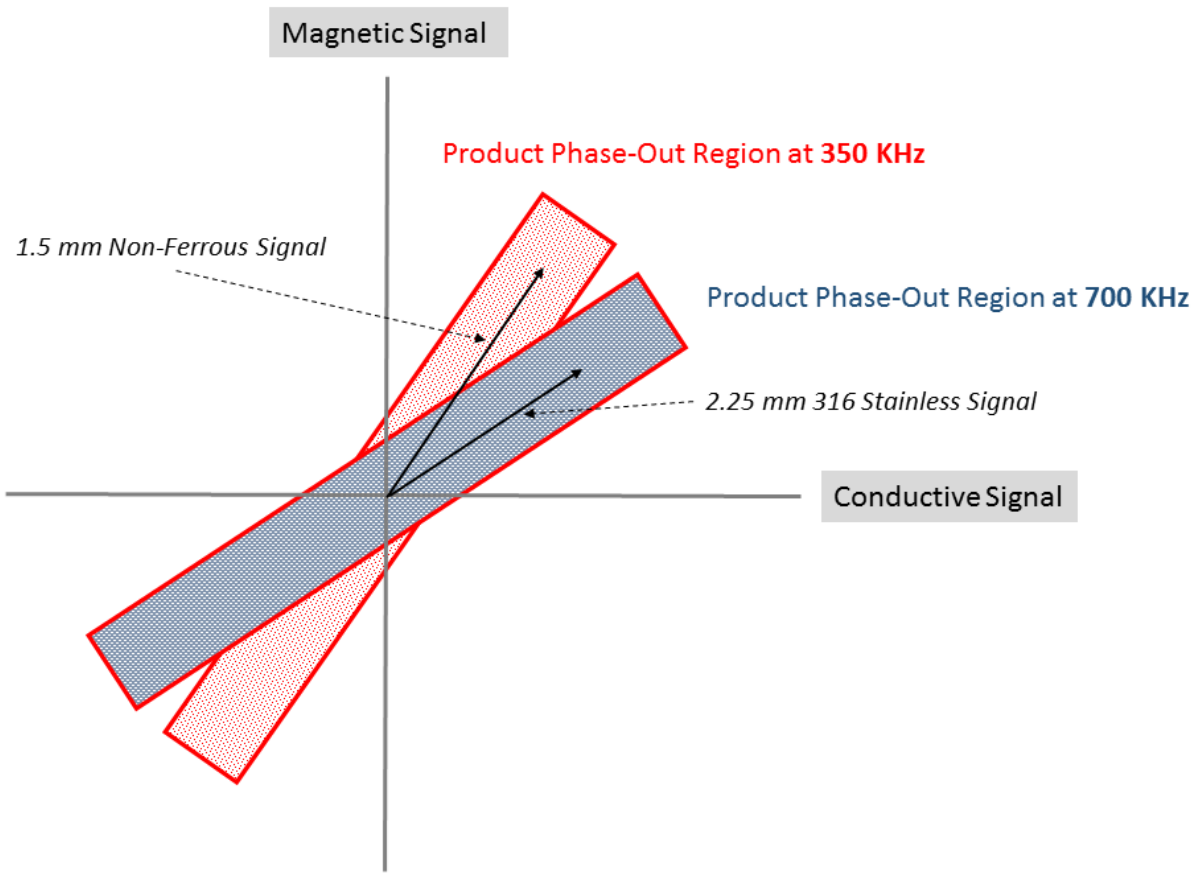
What is a Phase Angle?

- Two different signals are generated internally in a metal detector:
  - Magnetic
  - Conductive
- Various metals have different amounts of each signal
- The ratio of the two effects is referred to as the *phase angle*
- Most products with water, salt, minerals … also have phase angles
  - The product must be ignored (phased out) while the metal must be detected



Phase Out the Product AND the Metal; A Common Problem

- **Metal can line up with the product phase and be missed**
- **Changing the frequency just moves this condition to another metal type**



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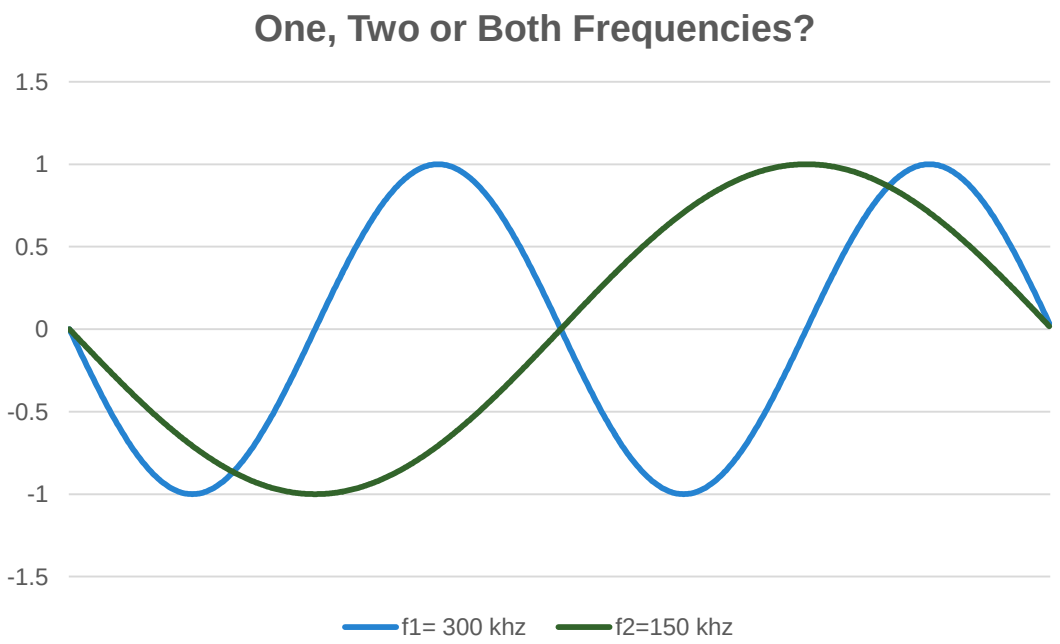
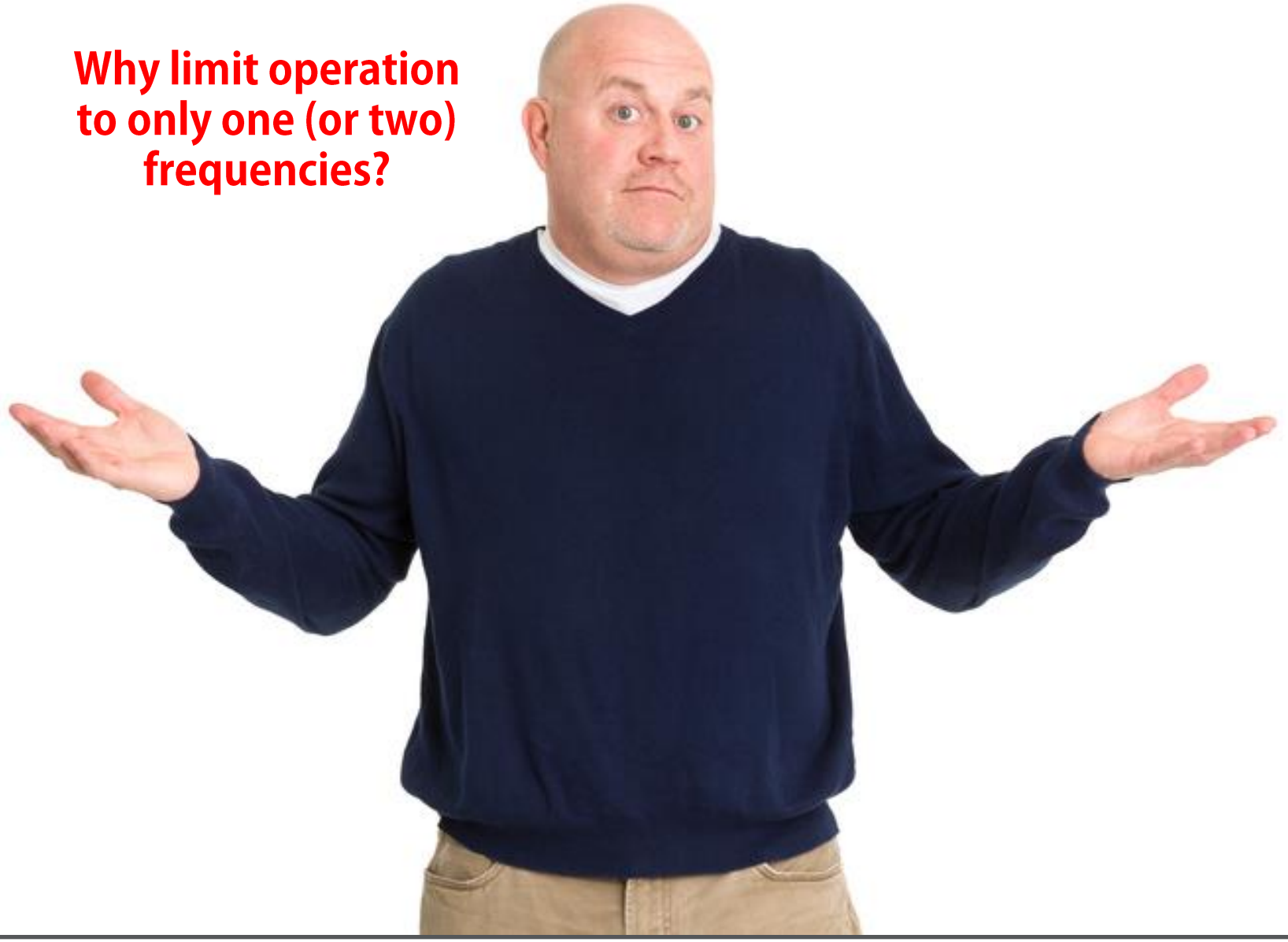
The Evolution of Frequency of Operation

- Typical range: 50 khz to 1000 khz
- High frequencies best for stainless steel (SS) detection
  - Reduce the frequency for “wet” products
- Low frequencies best for iron (Fe) detection
  - Increase the frequency for SS detection
- **First gen** was to offer one or two frequencies, generally fixed in hardware
- **Second gen** was software adjustable single frequency
  - More control and flexibility but still only one frequency
- **Third gen** was dual simultaneous frequency
  - Pick from a fixed list of possible frequencies to use at the same time



A compromise with limited flexibility

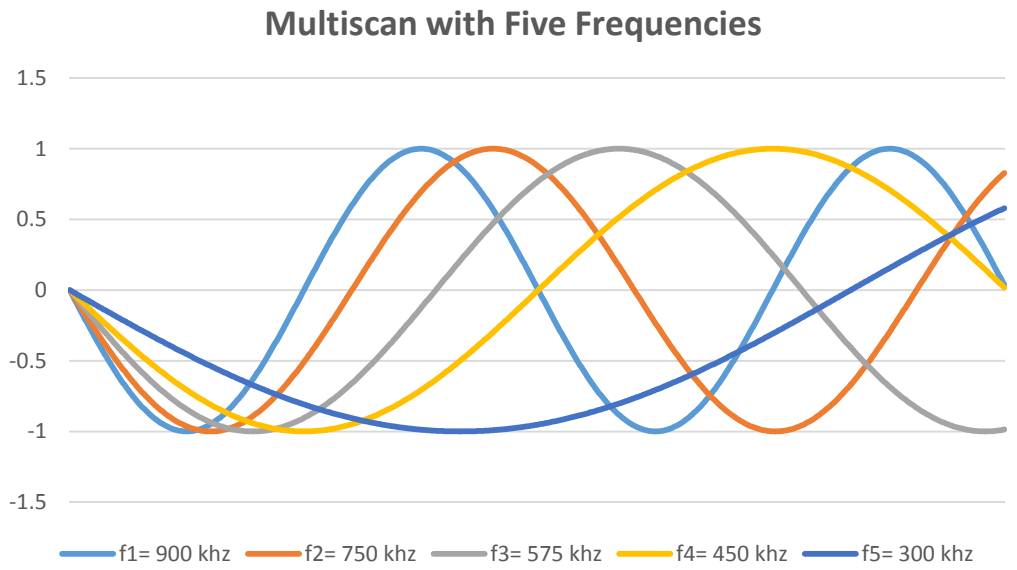
There Is No Best Frequency for Detection



- Varying reactions to magnetic and conductive properties
- False sense of security
- Impacts of size, shape, position, orientation

The Next Gen - Multiscan

- **Scan a range of five user-selectable frequencies**
  - 50 to 100 khz range
  - Each frequency set-up as a separate “virtual” metal detector
  - Complete control for any application!



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Real World Example Showing the Value of Five Frequencies

- 2.25 mm 316 Stainless Steel

- 1.4 mm Ferrous (Iron)

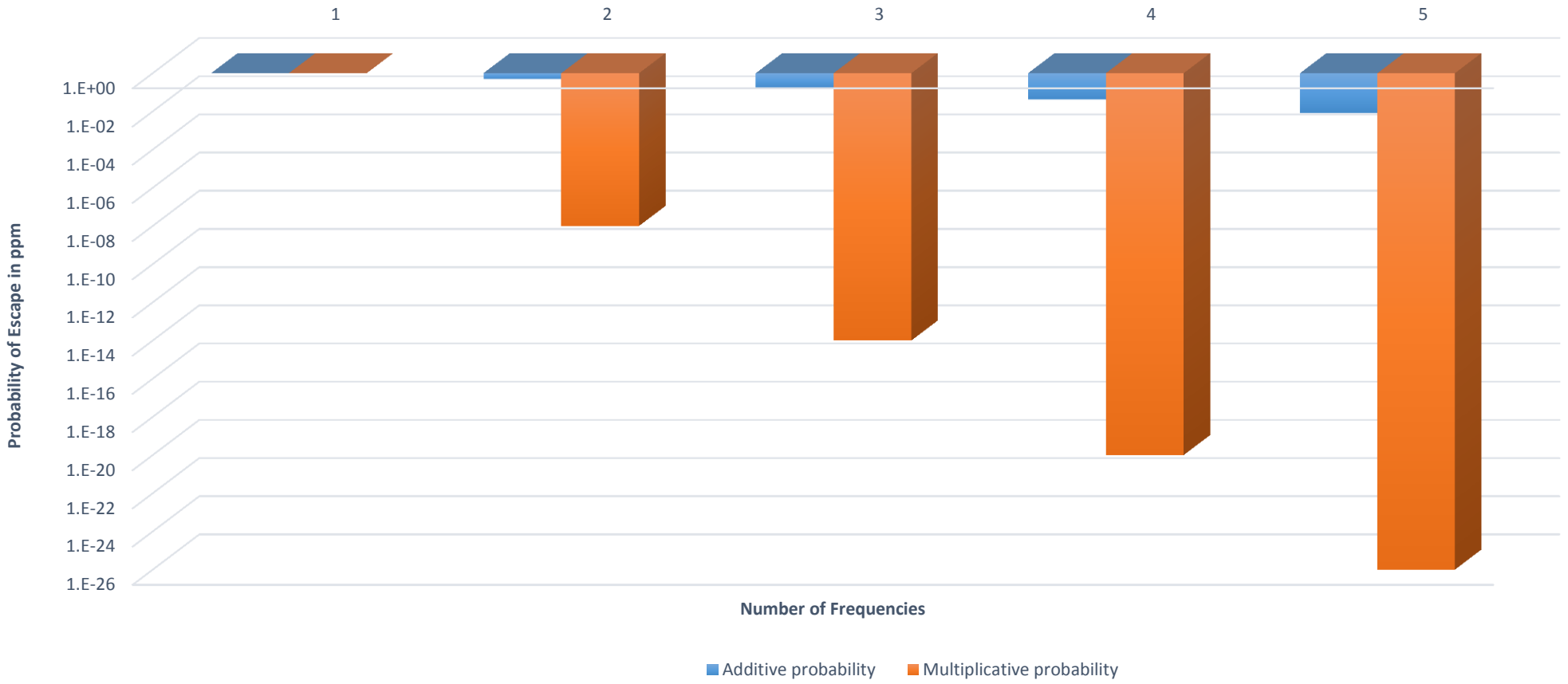
- 1.8 mm Non Ferrous (Brass)

- Test Conditions
  - 350 X 150 mm aperture
  - Moist apricots in a plastic pouch
  - Test cards placed in the center of the bag and the center of the aperture
  - Conveyor speed approximately 100 ft/min
  - Default sensitivity settings

Probability of Detection

- Every detection system has a probability of an escape
  - Assume 1 out of 1 million packs = 1 ppm
  - At a pack/second, 16 hours a day, 5 days a week that is an escape about every 3-4 weeks!
- That escape could cost thousands to millions of $
- Escape factors:
  - Type of metal, shape, position, product effect…
- So what happens if you have five metal detectors back to back running the same package at different frequencies?

With Multiscan, Probability of Escape Decreases Exponentially!



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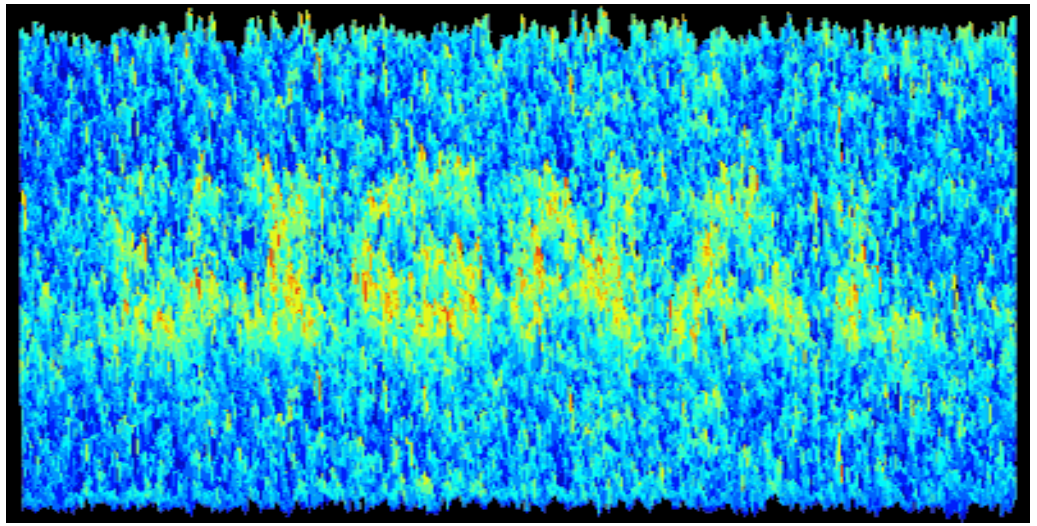
Multiscan Can Reduce False Rejections Too

- **What causes a false rejection?**
  - High product effect at a given frequency
  - Too high a sensitivity setting to find a target size metal
  - A system not designed to handle product signal variability
  - Sporadic noise sources
  - Thermal drift in the metal detector
  - Operator error
- **Multiscan reduces false rejections**
  - Change frequencies
  - Use many channels to find the metal
  - Track product phase & temperature including auto-relearn
  - Noise immune design
  - Easy to use graphical interface

Noise Is Everywhere So Immunity Is Key

- **Electrical** – immune power supply with filtering
- **Electromagnetic** – shielding and software filtering
- **Vibration** – solid fill to minimize movement of coils in relation to case
- **Balance** – every frequency being used is electrically balanced
- **Conveyor system ground loops** – Thermo Fisher Scientific designed/built conveyors

If there is still noise at some frequency just adjust it or disable it!



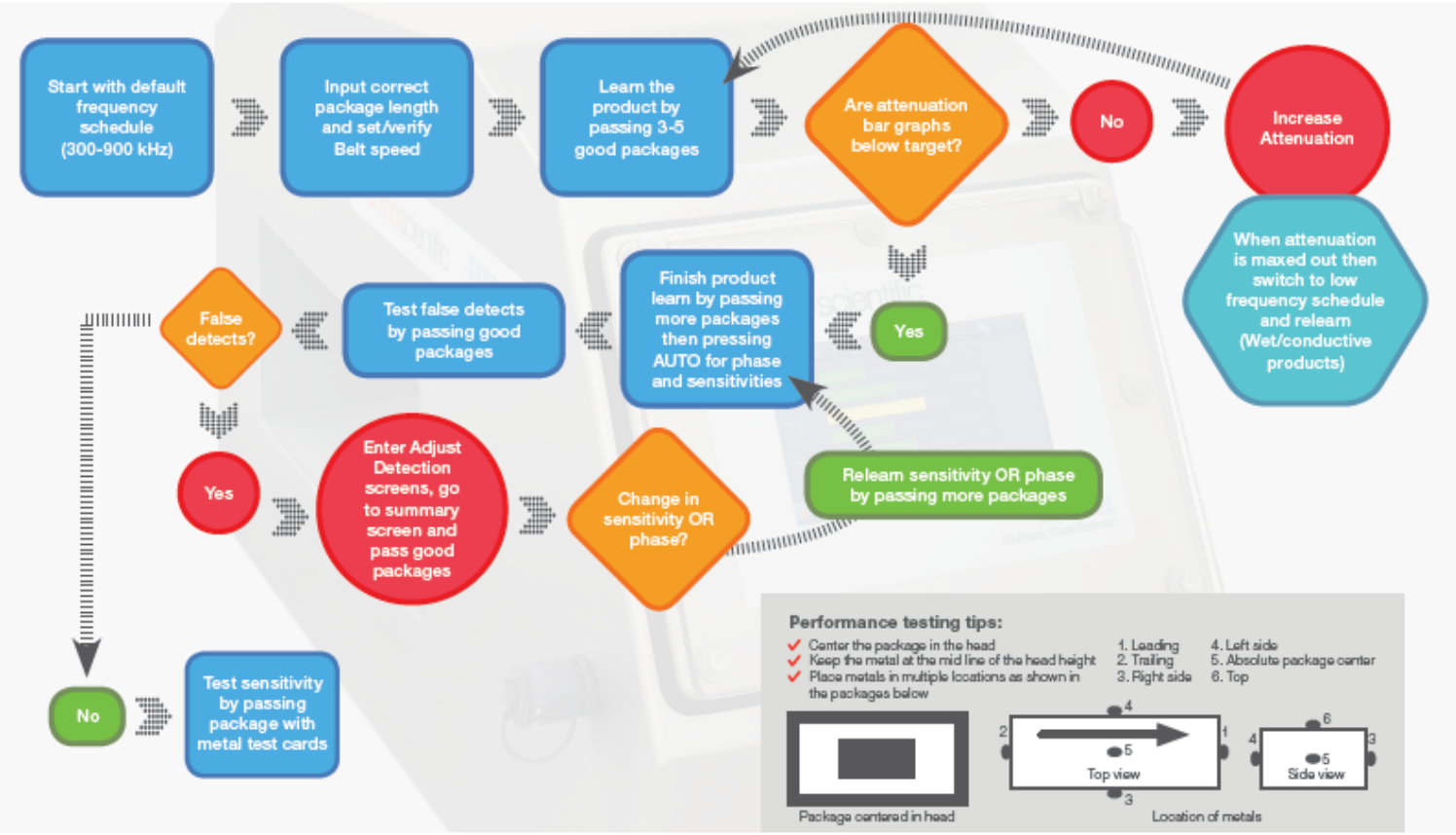
Multiscan Performance Improvements

	APEX 500			Sentinel 5000			Improvement	
	Fe	non-Fe	316 SS	Fe	non-Fe	316 SS	% Diameter	% Volume
On Air (No Product)	1.3	1.3	1.8	1	1.2	1.5	16%	41%
 Iron Fortified Cereal	1.3	1.3	1.7	1	1	1.3	23%	55%
 Shingled Sliced Cheese	1.4	1.9	3.6	1.1	1.6	2.4	26%	60%
 Wet Spinach	1.5	1.6	2.3	1.4	1.3	1.8	17%	42%
				Overall Average			20%	49%

NOTE: 500 X 200 mm (20 X 8 in) aperture size, Sphere diameter in mm

A Final Consideration, Testing Process and Considerations (Be Careful)

- **They way you test and certify metal detector performance makes a BIG difference!**
  - Product and metal position in aperture
  - Position of metal in relation to product
  - Product temperature, consistency, formula
  - Ambient temperature in the factory
  - Metal detector set-up; sensitivity versus false rejection
  - Number of passes



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So What About X-Ray?

Evaluate cost/benefit and then decide

- Price has decreased but is still 2-5x higher
- Machine complexity means more maintenance and shorter life
- Product effect is now density, finding small objects in big packs is difficult
- Speed and belt size limits
- Best for these applications
  - Metallized film or other metal in the package
  - Non-metallic contaminants
  - Desires for extremely small metal specs in products with high product effect that changes randomly

How to See Sentinel with Multiscan at Pack Expo Today

- Go to booth N-5706
- www.thermofisher.com/Sentinel5000
- Talk to us about an in-factory “test drive”

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WHITE PAPER Metal Detection

Why Multiscanning Technology Improves Metal Detection and Food Safety

Bob Ries, Lead Product Manager,
Metal Detection and X-ray Inspection
Thermo Fisher Scientific

Introduction

Metal detectors are ubiquitous in food processing facilities. They are most commonly used at the end of the line and as the last line of defense to support food quality and safety before a packaged product is on its way to the consumer. The core technology has always had its limitations and compromises such as noise that can interfere with signals and product effect that can confuse a wet product with metal.

While metal detection technology has slowly evolved over the years, the challenges facing food processing have changed considerably. There are increasingly demands such as new regulations, retailer detection mandates and greater productivity demands. The stakes are higher too: the potential for a costly recall and collateral damage via social media.

No company is immune. Just visit www.fda.gov, and click on “recalls” to get an idea of the plethora of food safety problems reported every day.

Bear in mind that while some companies are transitioning to X-ray inspection to find foreign objects, it is not necessary in many applications due to the low risk of non-metallic contaminants and a cost that can be prohibitive for smaller producers.

Why Metal Detection is Not Easy

Why is it so hard to detect metals in food? A simple analogy may help: why does a coin or piece of jewelry set off a metal detector on your outbound flight but not your inbound flight? Why the inconsistencies?

The same unpredictable performance can exist when trying to detect metal in food. Metal detection is easy – when it works – but it doesn’t always work. Audits can fail, detectable metal types and sizes may not be what the quality manager wanted and, worse yet, a piece of metal may have escaped inside a product and a customer finds it.

Clearly, an on-again, off-again contaminant detection approach is not acceptable.

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Thank you

Questions?

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