

FOREIGN MATTER TESTING

Mettler-Toledo Safeline

SAFELINE

Metal Detector & X-ray Inspection

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METTLER TOLEDO

Agenda

Introduction

- X-Ray Principles
- Application Notes X-Ray
- Inspections Metal detection
- Metal detection Principles
- Q & A

Why Have Foreign Matter Inspection

- To reduce foreign objects within your product
- To protect your customers
- To protect your brand name
- To protect inline equipment

Choosing the right technology

Factors that influence inspection systems performance

X-ray	Metal Detector
Type and size contaminant	Moisture Content
Product Homogeneity	Salt Content
Size (thickness) of product	Temperature of product
Overlapping / Stacked product	Packaging
Complexity of image vs. complexity of inspection	Contaminant orientation
Processing speed (multiple inspections)	Fe, non Fe, SS
Product Speed	Contaminant location in aperture
Aluminum	Vibration
	Electrical Noise

Agenda

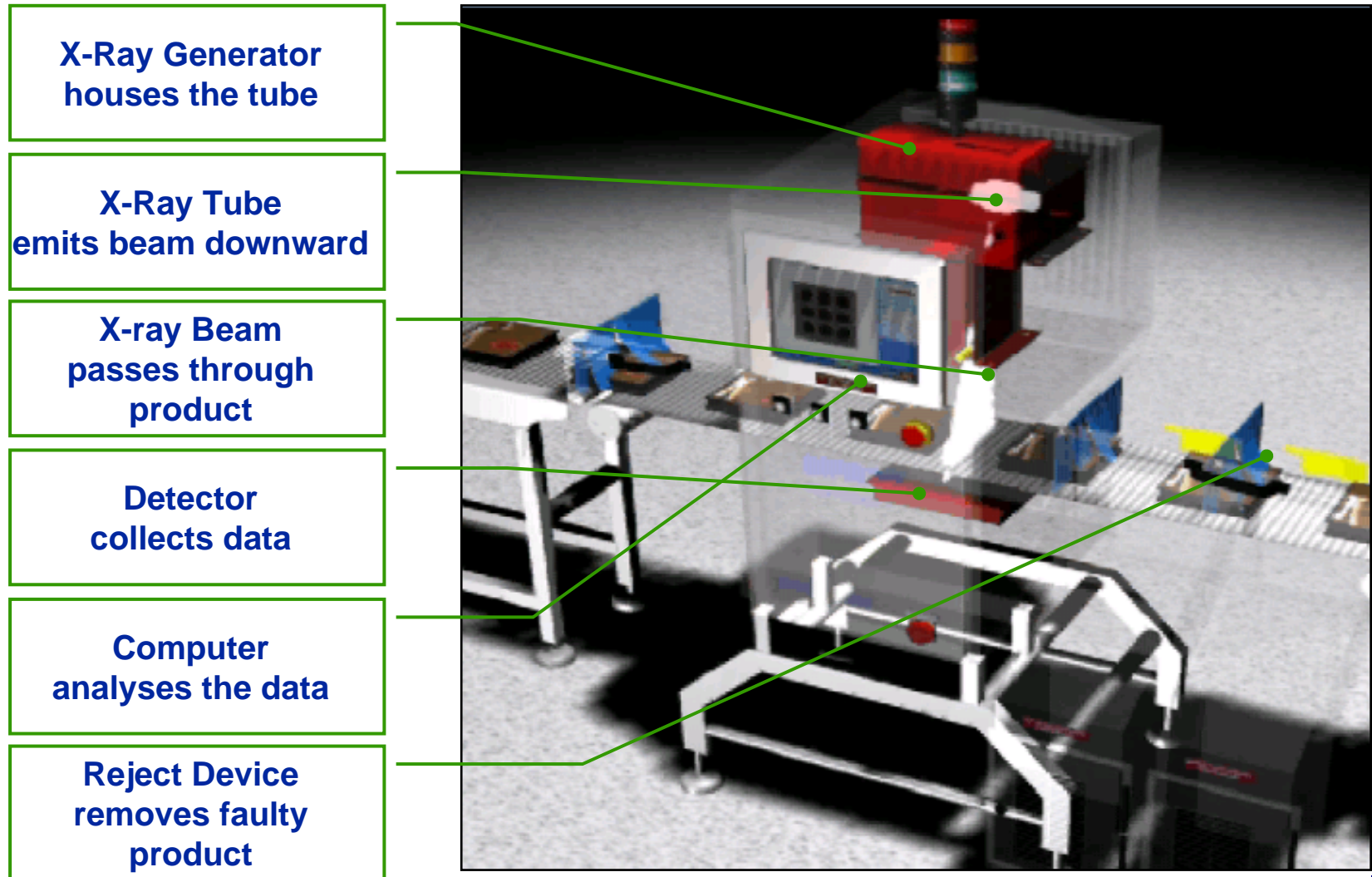
- Introduction

X-Ray Principles

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Understanding X-ray Technology

Major components that make up an x-ray system



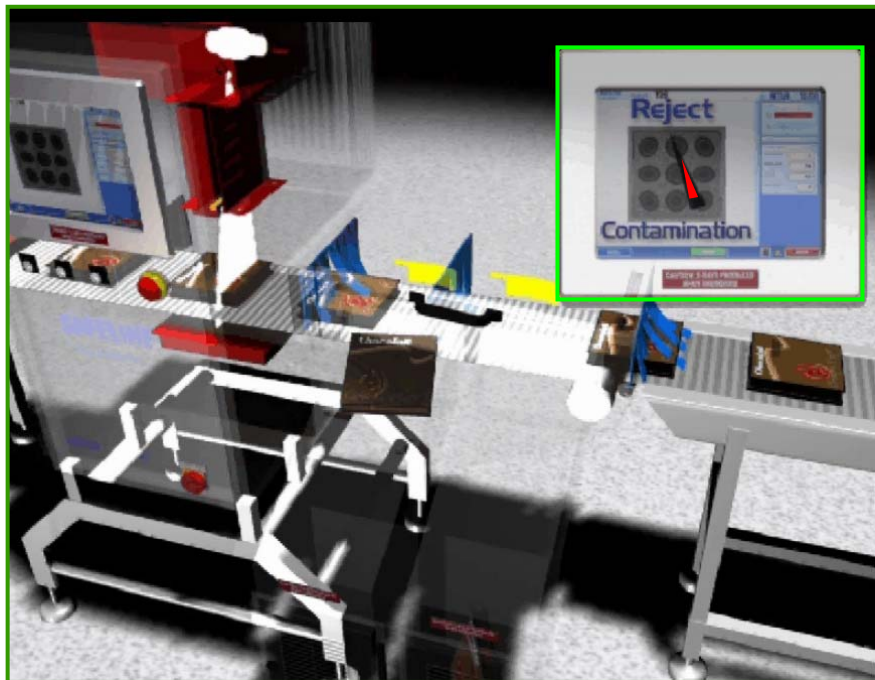
X-ray principles – **what can be achieved?**

Contaminated product can be rejected into bin 1.

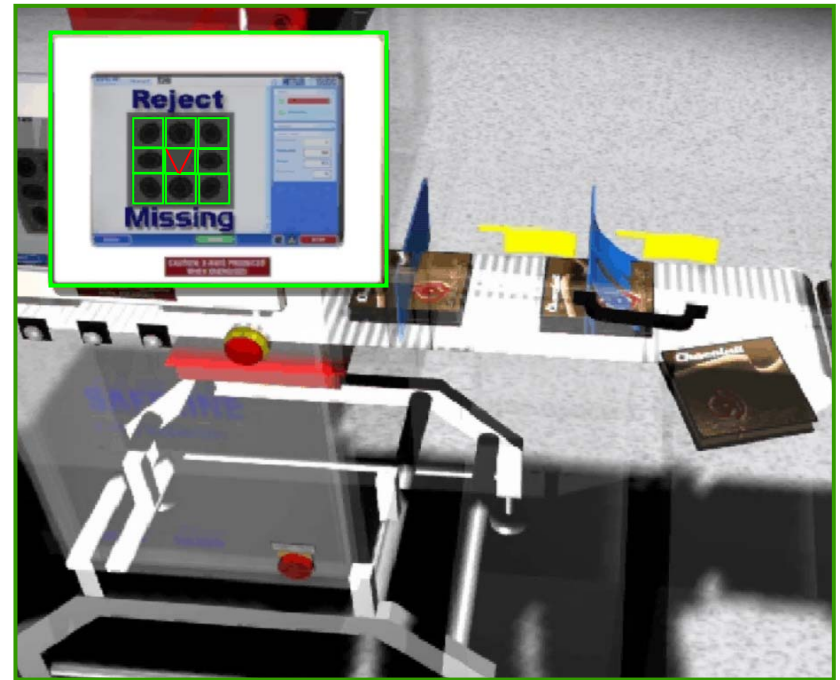
Product integrity faults can be rejected into bin 2.

See the diagram below:

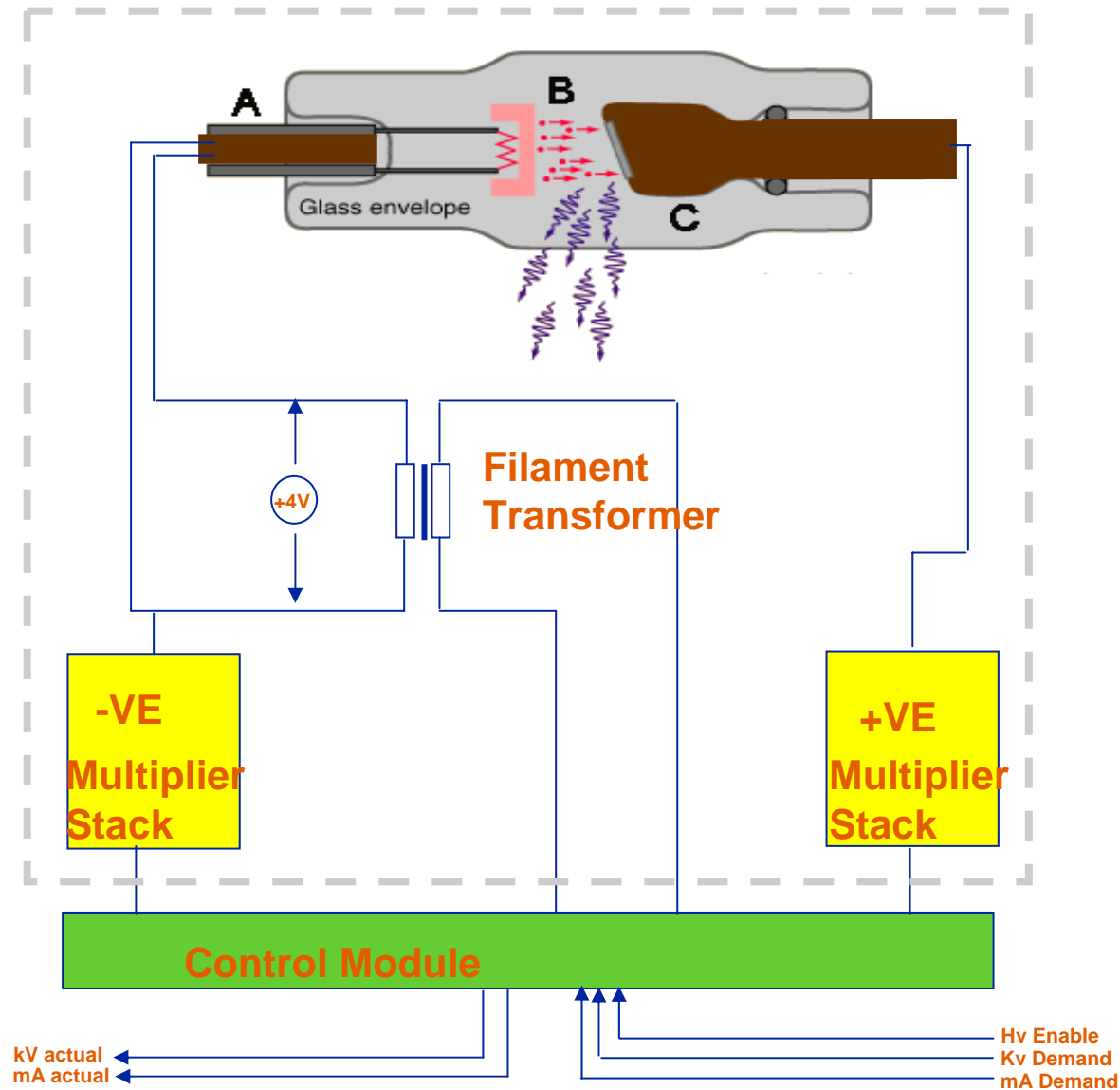
Contaminated pack in bin 1



Non conformity pack in bin 2



X-ray Generator - Circuit Design



Foreign Material Detection

Materials - Relative Detection

Density Chart

(kg/m³)

Water

1.0

Hair

0.32

Cherry Pit

0.56

Insects

0.59

Wood (Oak)

0.65

PP

0.9

Ice

0.92

UHMW

0.94

Nylon

1.15

PVC

1.7

Teflon

2.19

Bone

2.2

Stone

2.52

Glass

2.6

Aluminum

2.71

Iron

7.15

Steel

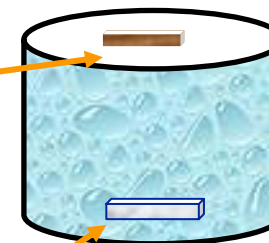
7.86

SS

7.93

Most food product,
slightly more than
1.0

Not Detectable



Detectable dependent on products
thickness/homogeneity/density and
size of contaminant

Rule of Thumb:
Typically, if a contaminant floats
in water, it is not detectable

X-ray Detection – Contamination detection



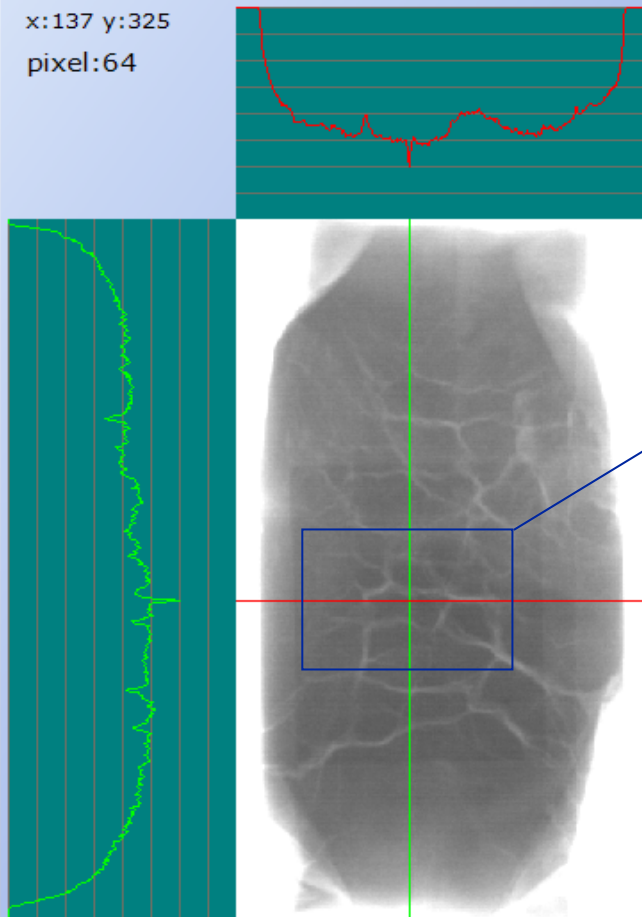
Analyse

Back

Image

x:137 y:325

pixel:64



Pixels

119	119	115	115	109	109	106	105	104	101	102	101	104	100	99	101	106	98	96	96	96	93	96
114	115	114	113	113	111	112	106	105	106	104	102	99	101	103	109	105	102	101	98	99	97	97
112	113	113	115	113	113	109	109	109	109	107	108	106	104	110	113	108	105	105	103	100	98	97
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103	104	105	105	101	98	101	102	103	99	97	94	97	97	97	97	97	94	96	96	94	94	94

The computer sees the product, as a grid of grey values ranging from 0 (black) to 255 (white). Notice the contaminant is the lowest value at 64 in the centre due to the contaminant absorbing more of the x-ray energy.

Tools

Anchor

Zoom

Histogram

X-ray Detector – Image scanning

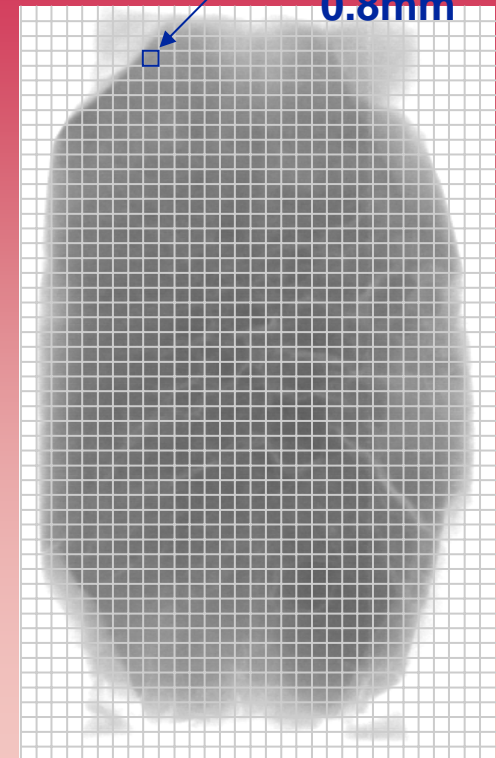
As the product passes over the detector each line of grey level data is rebuilt back into a complete pack image:

- Each image is made up of 'pixels'.
- Each pixel can have a value which goes from black to white (0 to 255)



Product flow →

Detector



X-ray image

X-ray Principles – Typical Contaminants sizes

Typical contaminants which can be identified by x-ray inspection are:-

Contaminant type	Typical Detection sizes in various Packaging Types (sphere diameters)			
	Plastic or paper	Metalized film or foil	Metal Can	Glass Jar
Metal *	0.8mm	0.8mm	1.2mm	1.2mm
Aluminum	2.0mm	2.0mm	2.5mm	2.5mm
Glass	2.0mm	2.0mm	3.0mm	3.0mm
Stone	2.0mm	2.0mm	3.0mm	3.0mm
Bone	3.5mm	3.5mm	5.0mm	5.0mm
Dense plastic	3.5mm	3.5mm	5.0mm	5.0mm

* Excluding aluminium

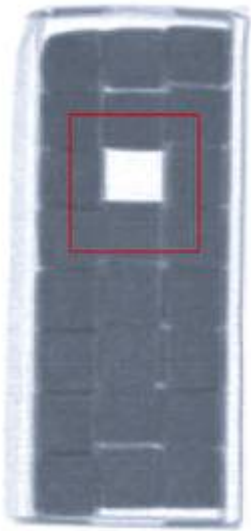
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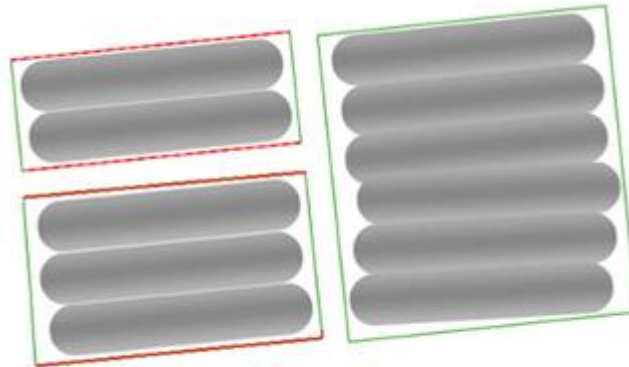
Missing Component

Detection of Missing Products – Object Tool

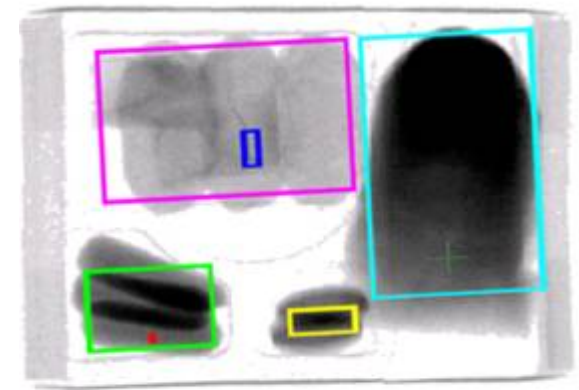
X-ray systems can use an object finder tool to count individual parts / components in a sealed package to ensure it meets specifications



Missing cheese cube
in a small retail pack



Detected missing
sausage

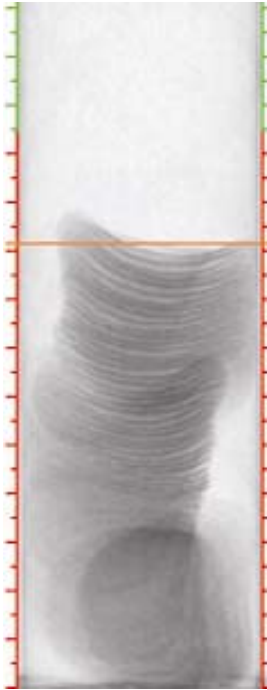


Component count in a
lunch box

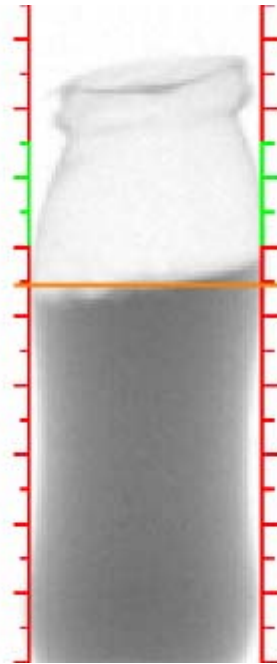
Fill Level

Fill Level Control

X-ray inspection systems can detect over fill and under fill in different types of packaging with (a filler) feedback to the filling machine saving costs and minimizing product waste



Under-Fill in a
canister of potato
chips



Fill level control in a drinking
yogurt pet bottle



Fill level control in
a yogurt cup

Application Note - Baby Food

Powdered Baby Formula, Composite Canisters

Customer Requirements:

Packaging: Composite containers

Sizes: 8-oz to 38-oz

Throughput:: 700-ppm

Detect 1.0mm SS and 3.0mm Glass or better



Application Note - Baby Food

Baby Food, Glass Jar

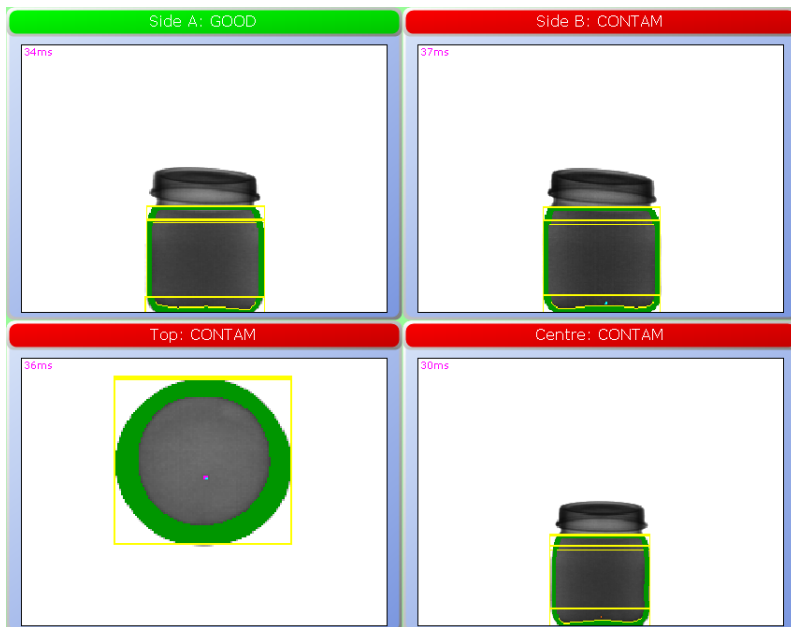
Customer Requirements:

Packaging: Glass Jar

Sizes: 213-ml

Throughput:: 850-ppm at 250-fpm

Detect 1.2mm SS and 3.5mm Glass or better



Same jar 4 views

Application Note - Bakery

Pies, Foil Tray

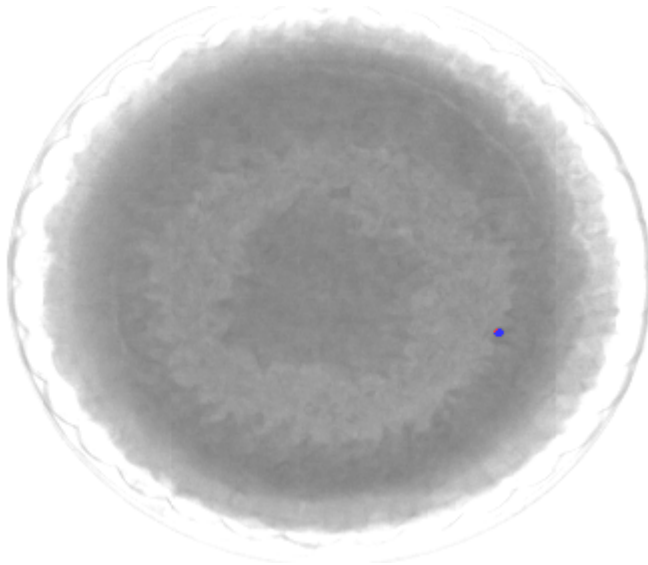
Customer Requirements:

Packaging: Foil tray with Plastic overwrap

Sizes: 4-oz to 16-oz

Throughput:: 55-ppm

Detect 1.0mm SS and 3.0mm Glass or better



Application Note - Beverages

Powdered Beverages, Stick Pack in a Carton

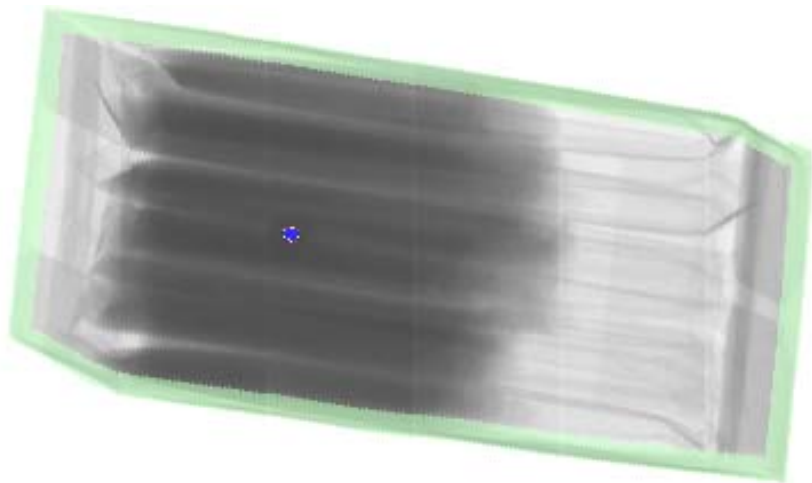
Customer Requirements:

Packaging: 16-ct Stick Pack in Carton

Sizes: 1136-g

Throughput:: 10-cpm

Detect 1.2mm SS or better and 3.0mm
Glass or better



Application Note – Dairy

Cheese, Plastic Wrapped

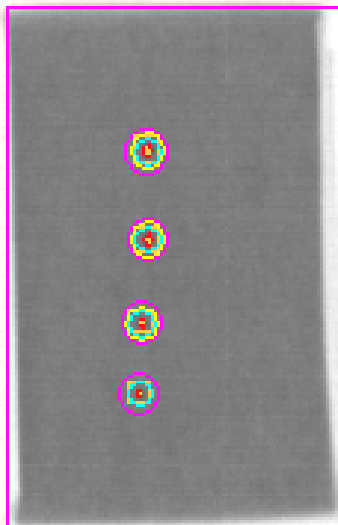
Customer Requirements:

Packaging: Plastic pouch

Sizes: 1-oz

Throughput:: 375-ppm per lane, 2 lanes

Detect: 0.8mm SS, product in seal and packaging flaws



Application Note – Dairy

Yogurt, Poly Cup

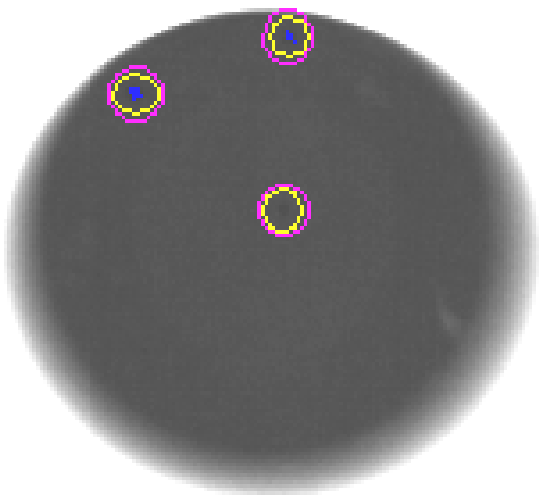
Customer Requirements:

Packaging: Poly Cup

Sizes: 4 to 16-oz

Throughput:: 120-ppm per lane, 2 lanes

Detect: 1 to 1.5mm SS or better, 3 to 4.5mm Glass or better, Weight accuracy +/- 1% at 2 STD dev



Application Note – Dairy

Yogurt, Case

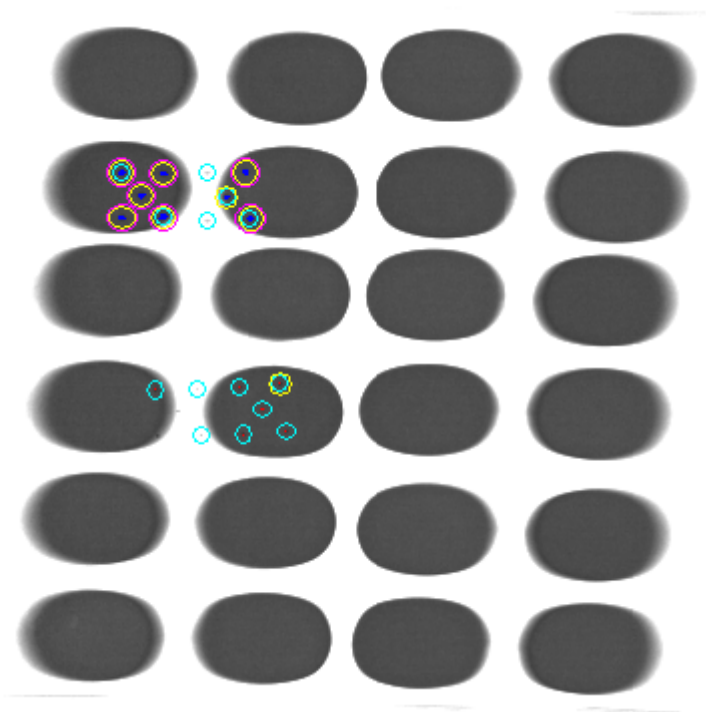
Customer Requirements:

Packaging: Poly Cups in Case

Sizes: 12-lbs

Throughput:: 32-cpm

Detect: 1.5mm SS or better



Application Note – Red Meat

Pork Butt, Individual Vacuum Bag

Customer Requirements:

Packaging: Vacuum Bag

Sizes: 8-lb

Throughput::30 to 50-ppm

Detect 3.0mm SS, 16-18 gauge
inoculation needs or better



Application Note – Poultry

Chicken Pieces, Cryovac Bag Frozen



Customer Requirements:

Packaging: Cryovac bag

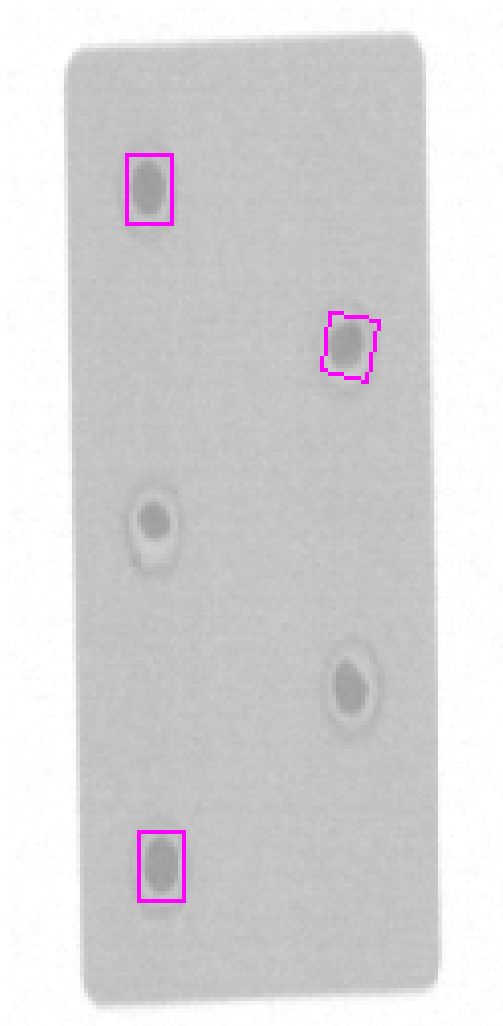
Size: 12-oz

Throughput:: 80-ppm

Detect: 1.0mm SS and 3mm Glass or better

Application Note – Pharmaceutical

Tablets, Blister Card



Customer Requirements:

Packaging: Blister card

Size: 3 to 6-ct

Throughput:: 100-ppm at 60-fpm

Detect: 0.6mm SS or better, missing,
15% additional, more than one,
chipped, capped, broken or crushed
tablets

Agenda

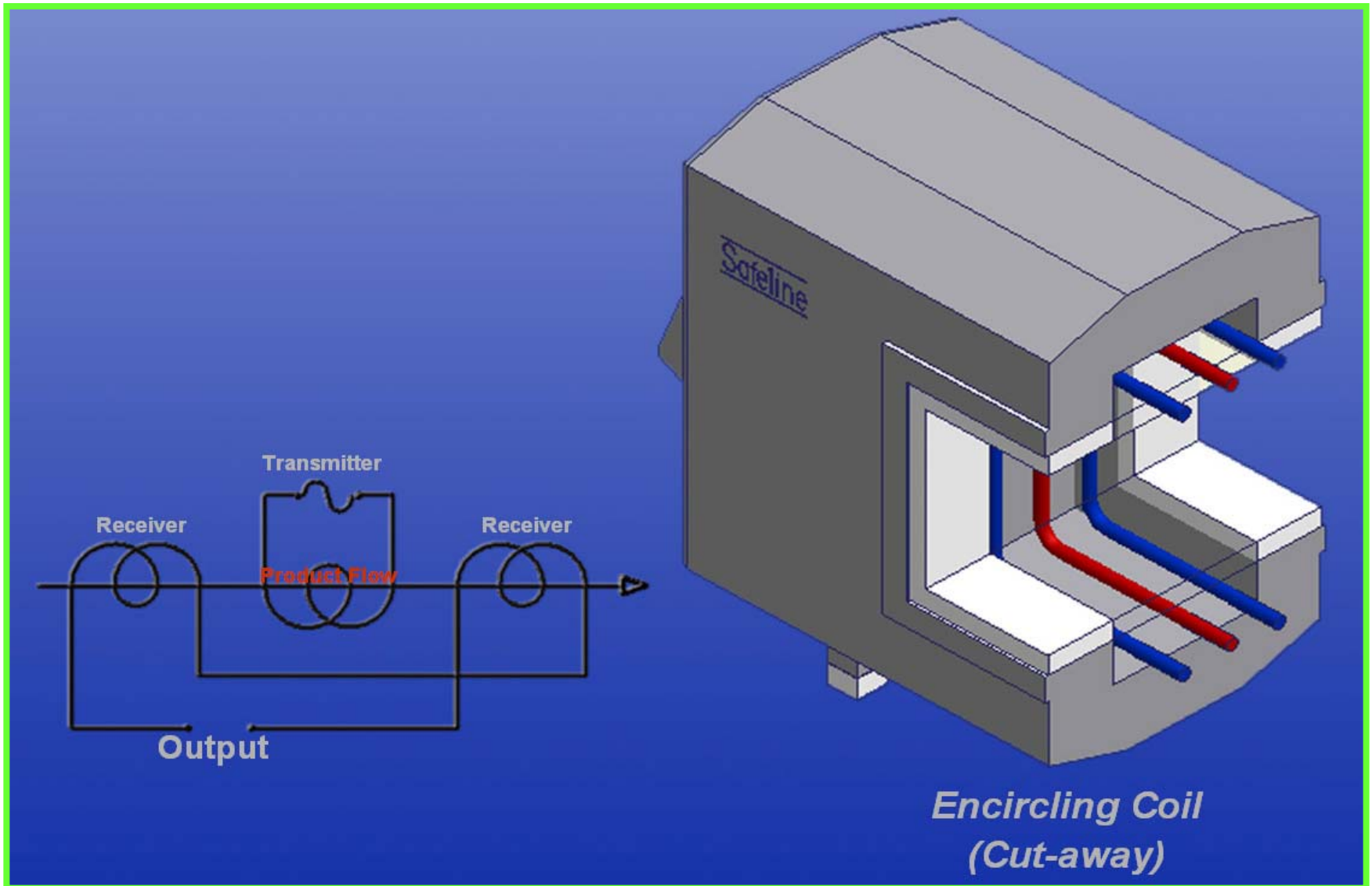
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What is a Metal Detector?

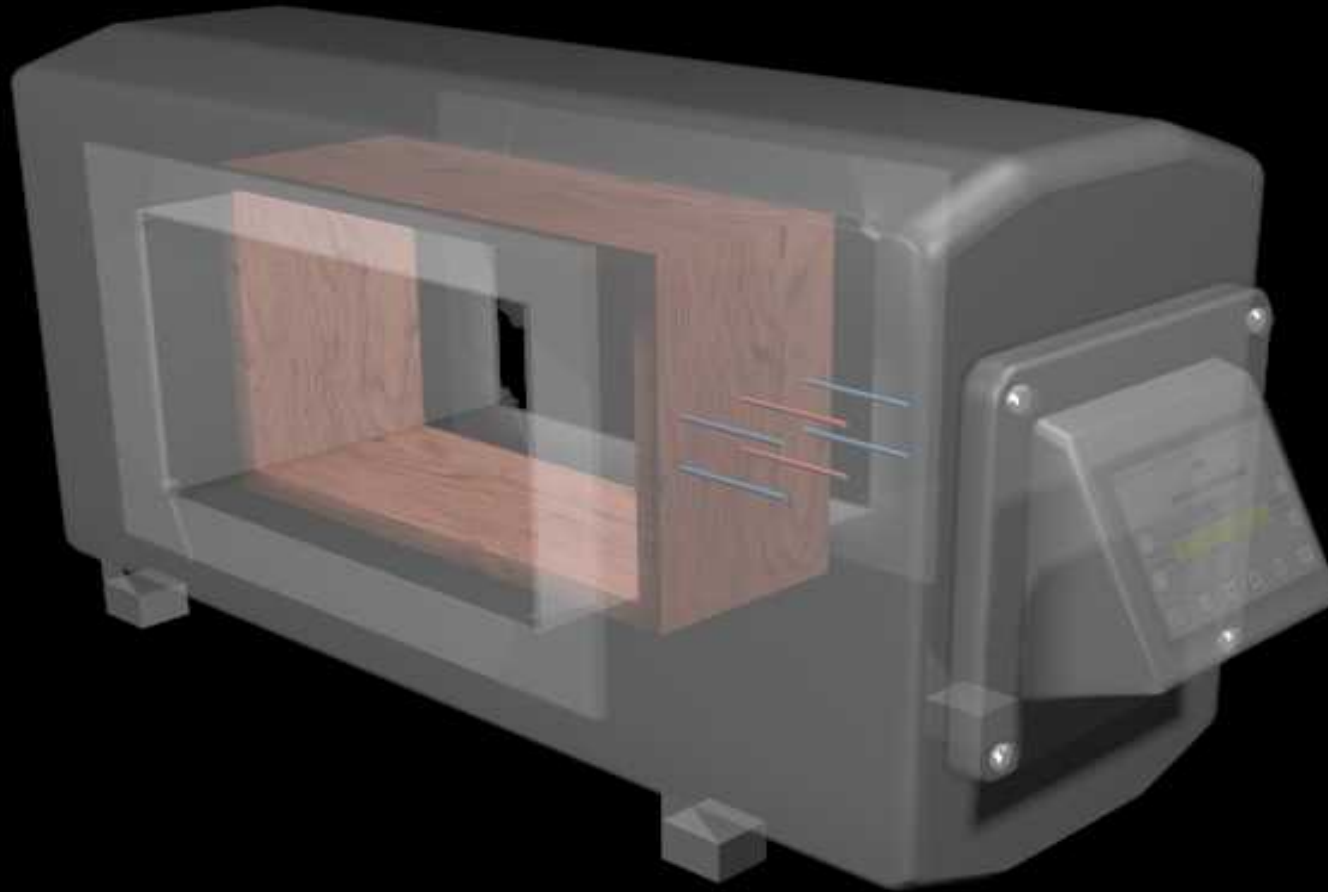
- A metal detector is a sophisticated instrument used to detect metal contaminants that have been inadvertently introduced to products through processing equipment failure and/or human error.



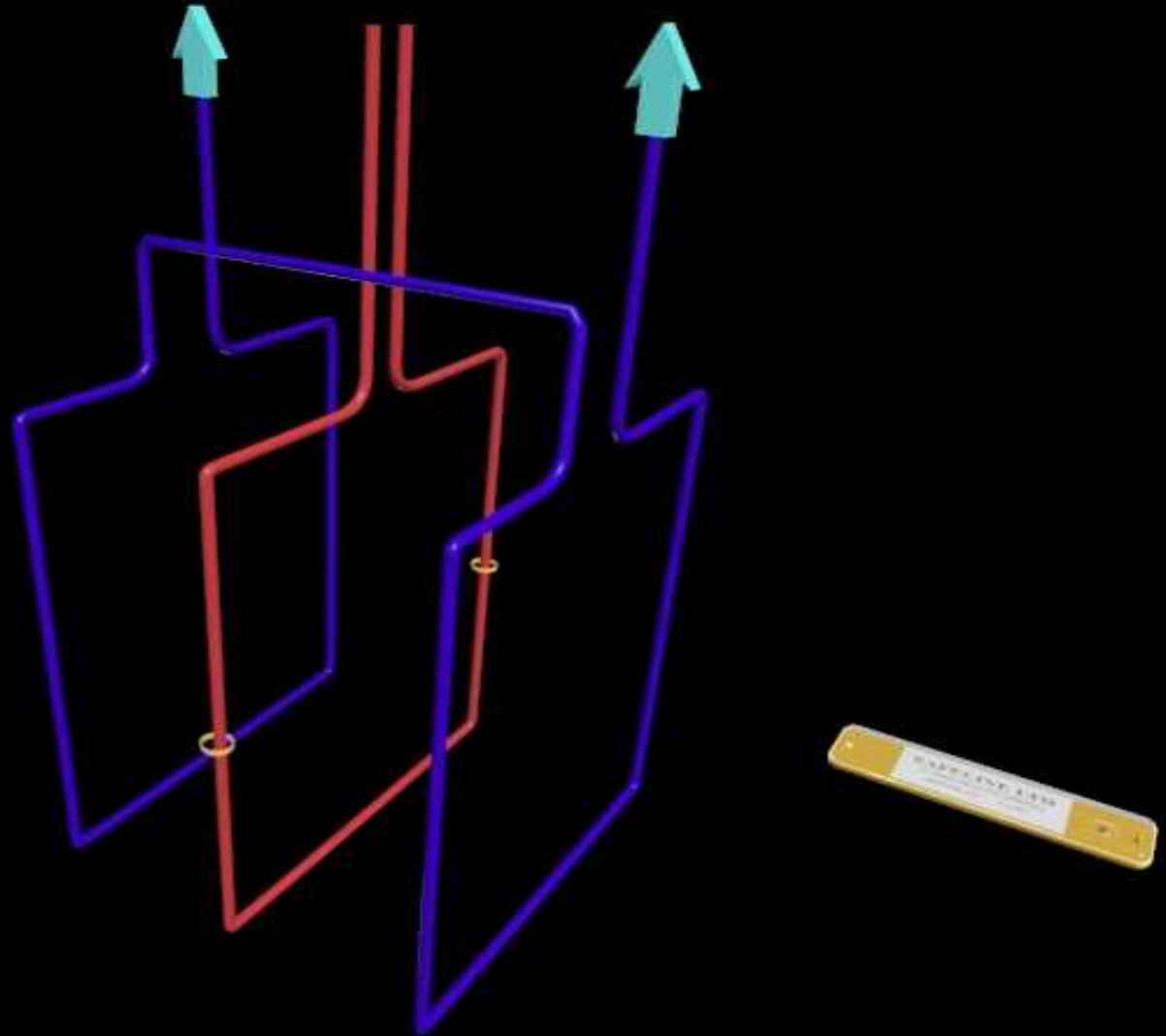
How Does a Metal Detector Work ?



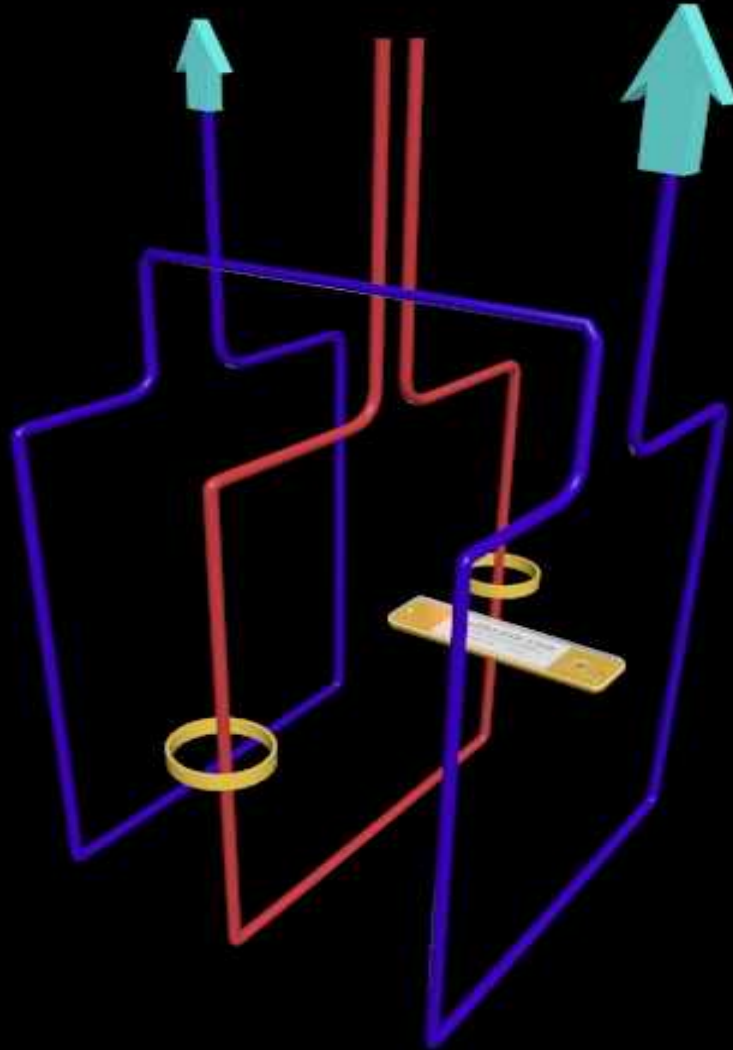
The Coil System



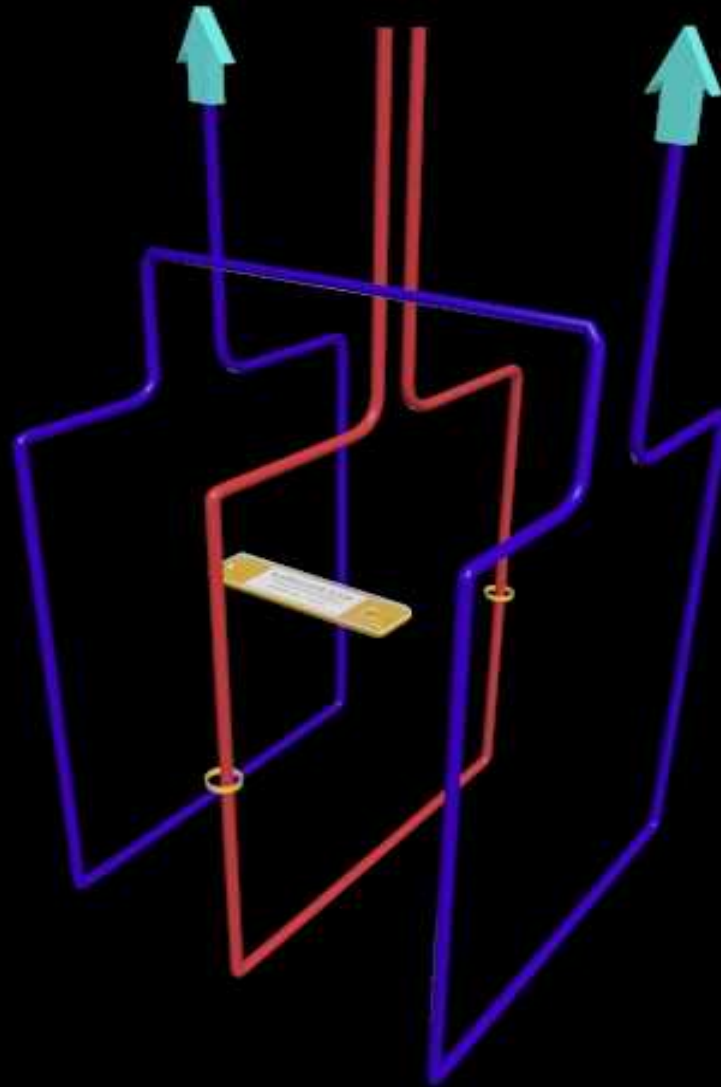
The Coil System



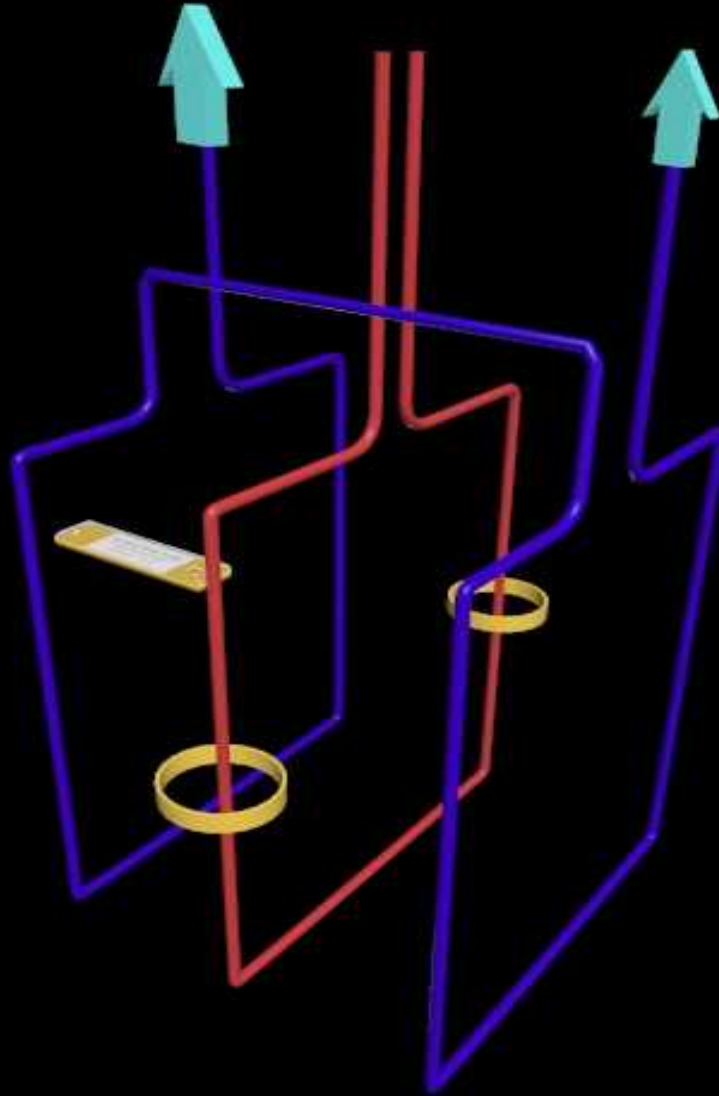
The Coil System



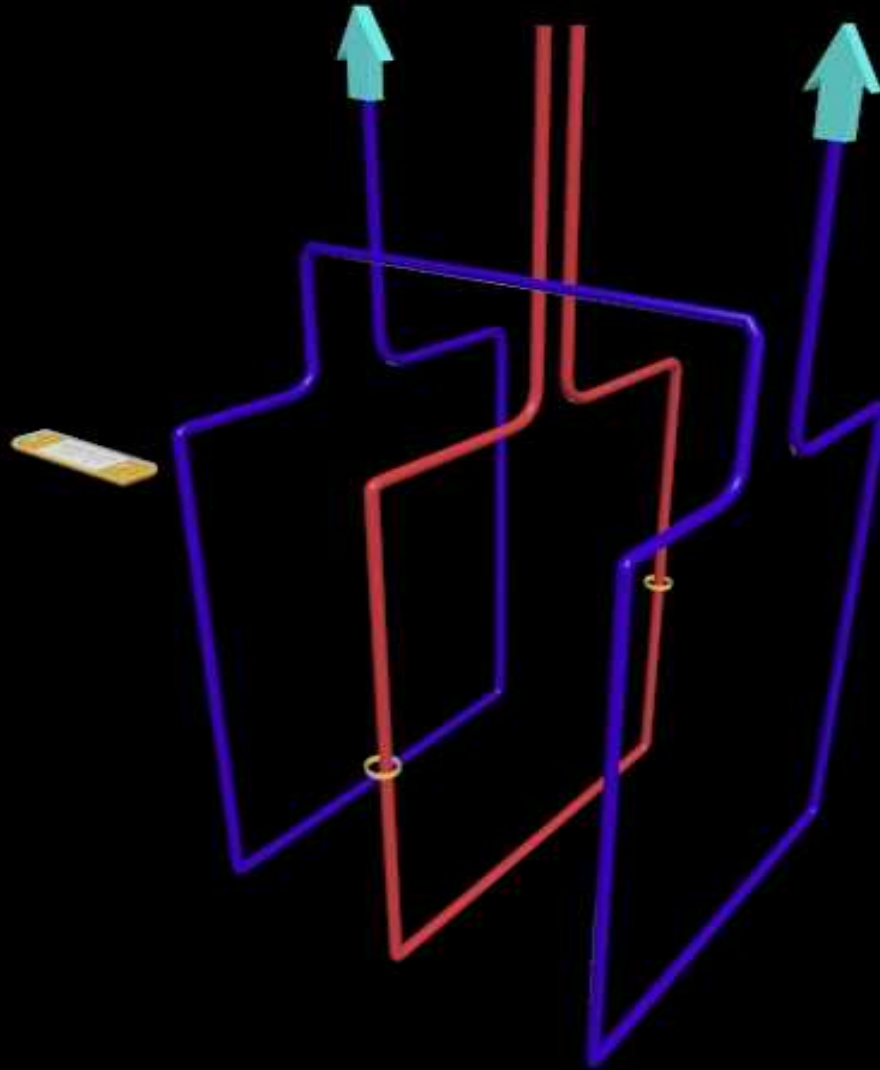
The Coil System



The Coil System



The Coil System



Factors Influencing MD Sensitivity

1. Type of metal
2. Orientation Effect
3. Product Effect
4. Metal Position in Product
5. Packaging Material
6. Environmental Interference

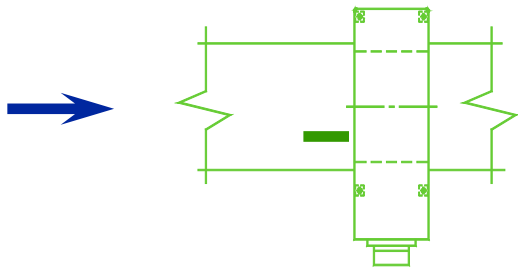
Factor #1 - Type of Metal

Metal Type	Magnetic Permeability	Electrical Conductivity	Ease of Detection
Ferrous (Iron)	Magnetic	Good Electrical Conductor	Easily Detected
Non-ferrous (Copper, Lead)	Non-magnetic	Generally Good or Excellent	Relatively Easily Detected
Stainless Steel various Grades	Usually Non-magnetic	Usually Poor Conductors	Relatively Difficult to Detect

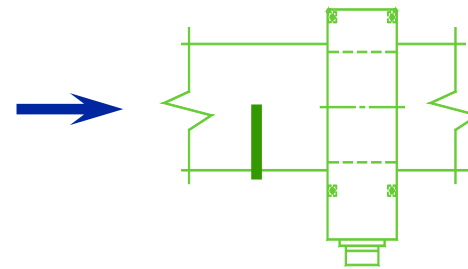
Factor #2 - Orientation Effect

The ease of detection depends on its shape and orientation

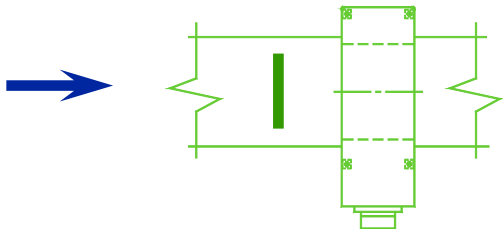
Ferrous-Easy



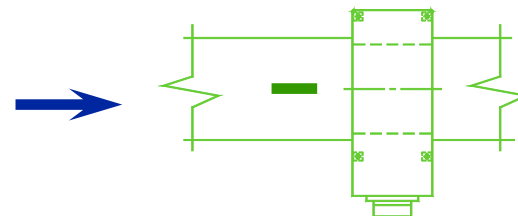
Ferrous-Difficult



Non Ferrous-Easy



Non-Ferrous Difficult



Factor #3 – Product Effect

Most food, particularly wet food, produces a signal of its own in the metal detector.

**Frequency
Required**

- **No product Effect:**

Highest

- **Significant product effect:**

Low



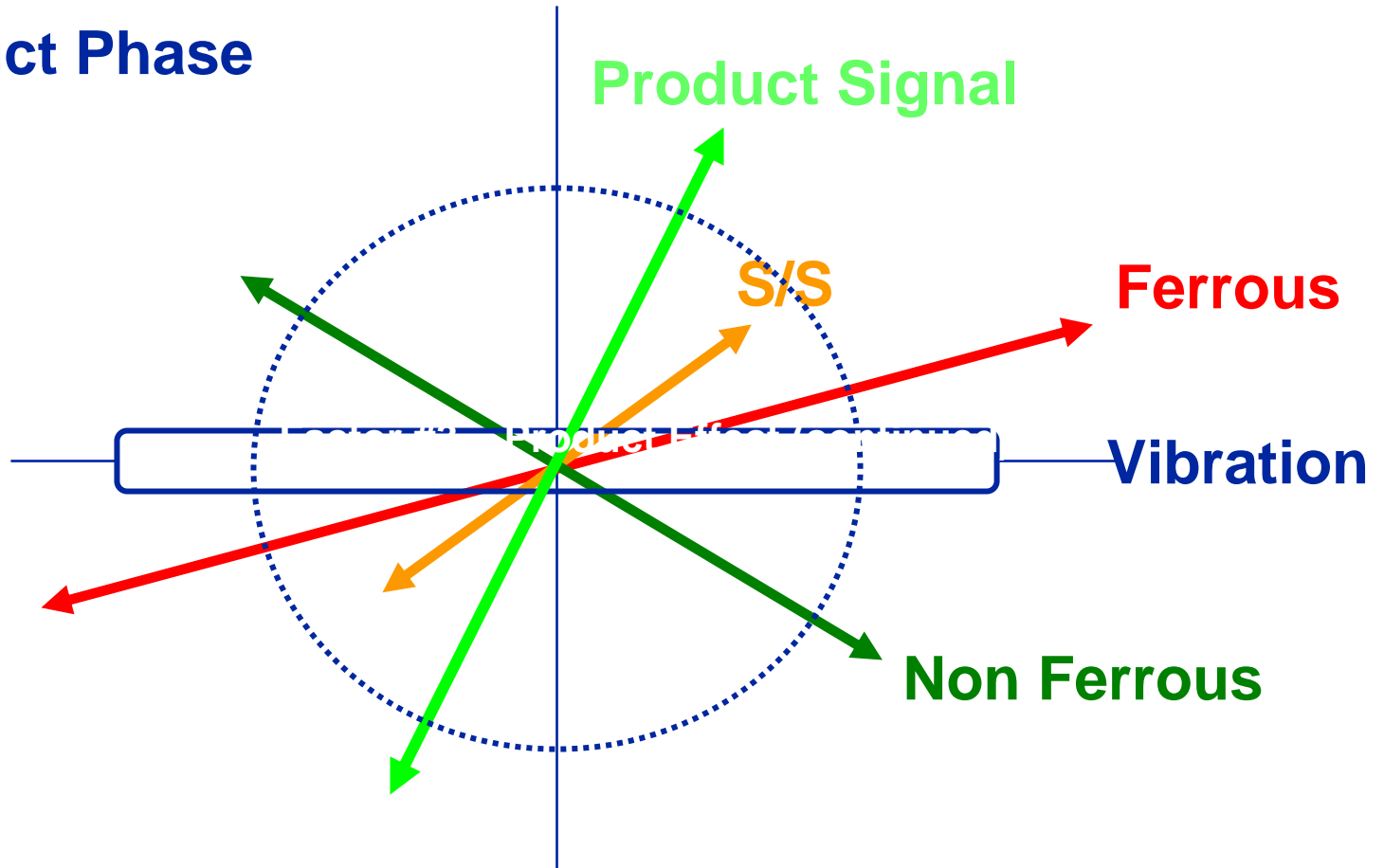
Fe

Higher



SS

Product Phase

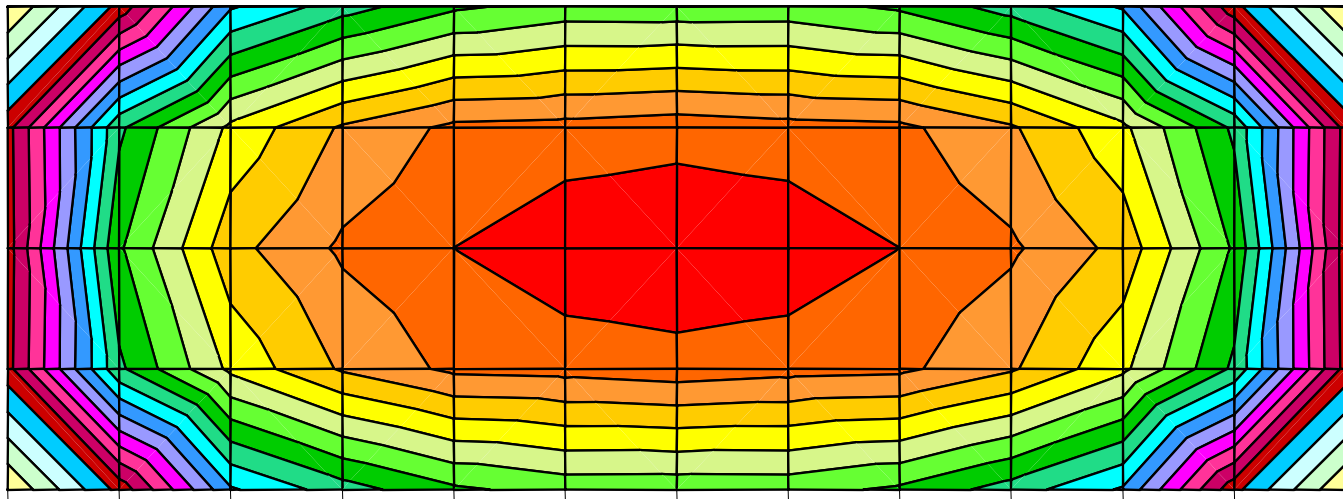


Wet or conductive products produce signals that can cause a detection.

Factor #4 - Position of metal in product

Signal Strength Across Aperture

■ 1.00-1.10 ■ 1.10-1.20 ■ 1.20-1.30 ■ 1.30-1.40 ■ 1.40-1.50 ■ 1.50-1.60 ■ 1.60-1.70
■ 1.70-1.80 ■ 1.80-1.90 ■ 1.90-2.00 ■ 2.00-2.10 ■ 2.10-2.20 ■ 2.20-2.30 ■ 2.30-2.40
■ 2.40-2.50 ■ 2.50-2.60 ■ 2.60-2.70 ■ 2.70-2.80 ■ 2.80-2.90 ■ 2.90-3.00



Factor #5 – Packaging Material

- Paper and Plastic materials: No effect
- Metallic Films: Testing required
- Aluminum Foil Packages: Use X-Ray system

Factor #6 – Environmental Interference

- Vibration
- Belt contamination
- Moving metal outside metal detector
- Conductive loops
- Radio frequency interference
- Drift

Thank You



Questions?

