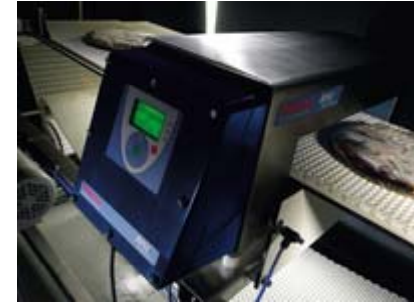


ThermoFisher
S C I E N T I F I C

The world leader in serving science



2011 UK Summer Symposium Metal Detection and X-Ray Food Safety Capabilities

Gianluigi Riva
Leader, Product Inspection Europe
June 2011

Thermo Scientific Lab/Line Food Safety Solutions



Inspection Solutions for Any Application



Our Contract with Customers

Confidence

- Brand protection
- Production efficiency
- Compliance to policies
- Robust, easy-to-use solutions
- High performance technology
- World class service and support

Commitment

- Solutions that exceed requirements
- High quality and durability
- Outstanding results every day
- Honest and professional people
- Competitive value
- Peace of mind

Your Confidence is Our Commitment



Confidence In Action

■ Finding contaminants in blueberries

- Problem: Find < 2 mm metal in cases prior to shipment to fruit processor
- Solution: High performance POWERx x-ray inspection



■ Weighing pizzas at high speed

- Problem: Verify product weight/ingredients are correct
- Solution: High speed, easy to use VersaWeigh checkweigher



■ Detecting metal fragments in mixed spices

- Problem: Assure no metal fragments in spices mixed for snack foods
- Solution: Easy to clean, zero false reject drop through APEX 300 metal detector



■ Controlling moisture in corn chips

- Problem: Broken or tough chips due to incorrect water content
- Solution: Guided Microwave System (GMS) moisture control prior to frying



A Key Driver for Contaminant Detection Systems

- FDA HACCP

- Hazard Analysis and Critical Control Point
- <http://www.cfsan.fda.gov/~lrd/haccp.html>
- Started in 1995 for Seafood, extended to Juice, Dairy and Retail/Food Service
- A guideline for best practices

- The seven key principles

- 1. Analyze hazards
- 2. Identify critical control points
- 3. Establish preventive measures with critical limits for each control point
- 4. Establish procedures to monitor the critical control points
- 5. Establish corrective actions to be taken when monitoring shows that a critical limit has not been met
- 6. Establish procedures to verify that the system is working properly
- 7. Establish effective recordkeeping to document the HACCP system



CURRENT & USEFUL INFORMATION FROM THE FOOD & DRUG ADMINISTRATION

HACCP: A State-of-the-Art Approach to Food Safety

Other Drivers Influencing Deployment of MD/XR

- Brand protection
 - Negative PR, legal issues, ...
- End customer requirements
 - Codes of practice, mandates
- Protect delicate equipment downstream from equipment malfunctions and/or foreign objects
 - Find metal, rocks, hard plastic ... prior to entering processing equipment that could be damaged
- Reduce scrap and save \$\$\$
 - Detect random occurrences so you don't have to quarantine entire lots for further screening and possible disposal/return
- Address concerns over importation to high quality/price countries (US, Japan, Germany...) from low cost production regions



Many Possible Sources of Contamination

1. Raw material

- Particulates including bones, shells, seeds, rocks
- Bacteria and germs



2. Machinery

- Parts and pieces (metal)
- Lubricants, fluids, or gases



3. People

- Accidental or intentional actions
- Insufficient training

4. Process

- By-product of ingredient production
- Cross contamination from changeover
- Poor sanitation processes
- Time (cooking, freezing, holding)



5. Environmental

- Construction in the plant, building failure
- Rodents, insects

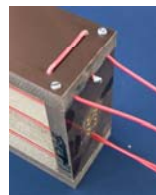
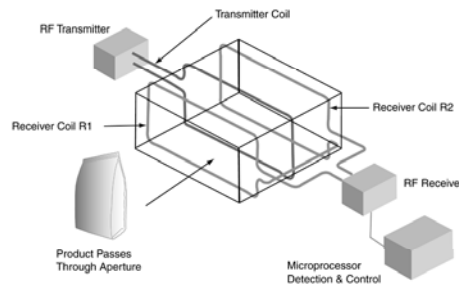


Technology and Basic Theory of Operation

The key to a successful application is understanding the strengths and limitations of the technology

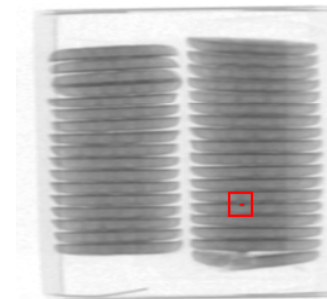
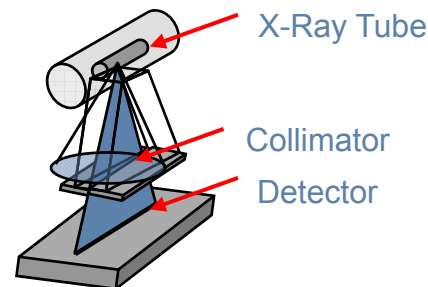
Metal Detectors

- Utilize an RF transmitter, antennas and digital signal processor (DSP)
- Only sensitive to metals, not all metals are the same
- Some products can act like metal and/or can change a lot over time



X-Ray Systems

- Utilize ionizing radiation combined with computer analysis
- Can find dense, sharp objects and also provide for various inspections
- Some products “look” like the contaminants





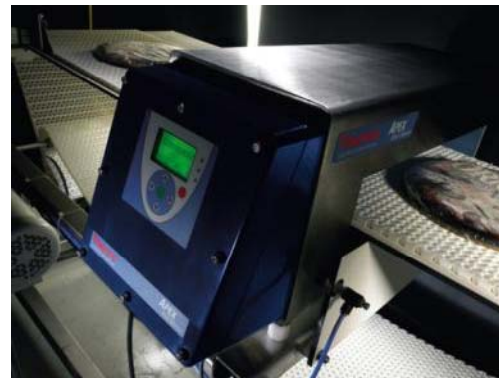
Overall Detection Capability Comparison

Contaminant	Metal Detectors	X-Ray Systems	Comments
Ferrous, non-Ferrous and Stainless Steel	0.3 - 5mm	0.5 – 2.5mm	Easy to set-up and use
Aluminum	Yes	Depends on size	X-ray can penetrate low density aluminum
Wires and needles	Yes	Depends on size	Diameter, composition, orientation and hollow/solid...
Glass	No	>=2mm soda lime composition	Depends on density, position and product type (glass jar)
Stones/Rocks	No	>=3mm for dense materials	Many types possible, must test to determine performance
Plastics	No	Sometimes	PVC easiest, must test to determine performance
Bones	No	Sometimes	Must be calcified
Pits and shells	No	Sometimes	Usually very difficult
Insects	No	No	Not dense enough
Wood	No	No	Not dense enough

ThermoFisher
SCIENTIFIC

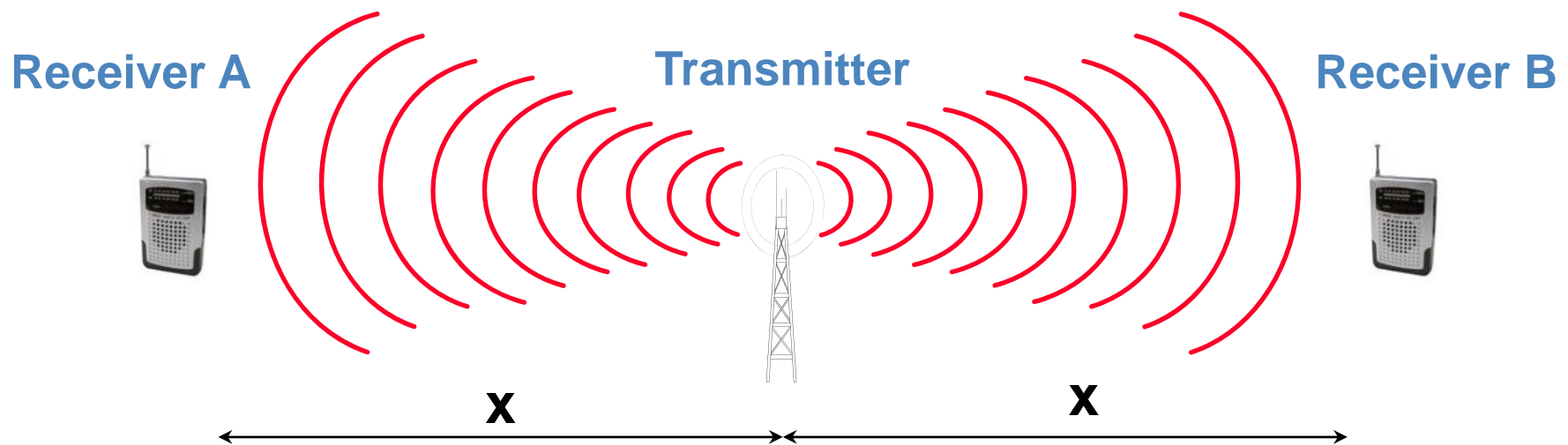
The world leader in serving science

Basic Metal Detection Theory of Operation



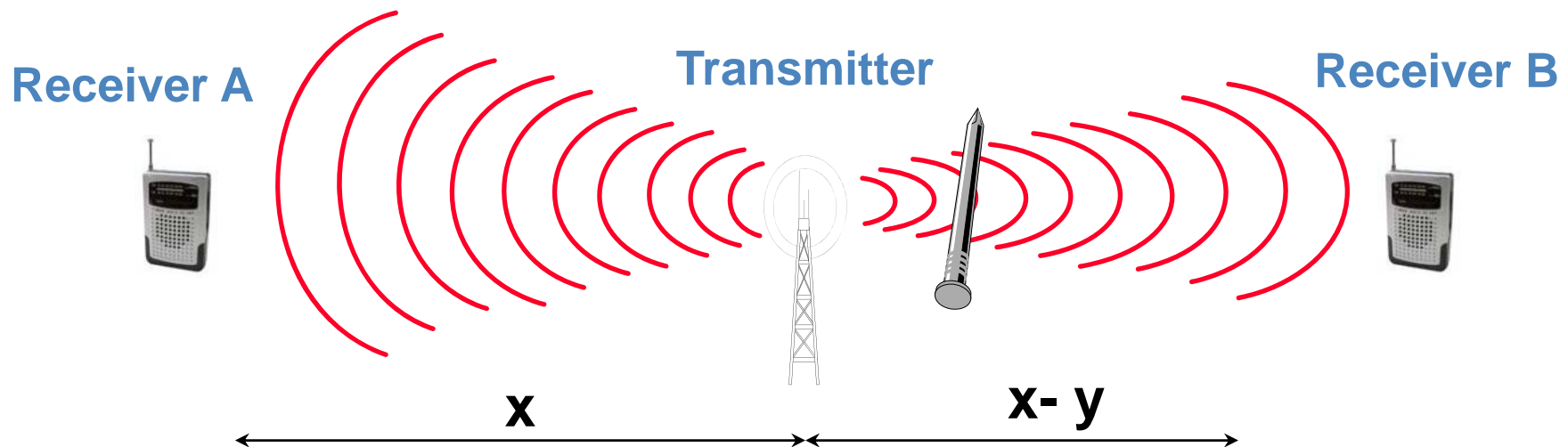
The Basic Principle of Metal Detection

- A transmitter sends a signal out
- Two receivers equal distance from the transmitter receive them
- The signals from the receivers are subtracted and the result is zero - a balanced condition



What Happens When Metal is Present

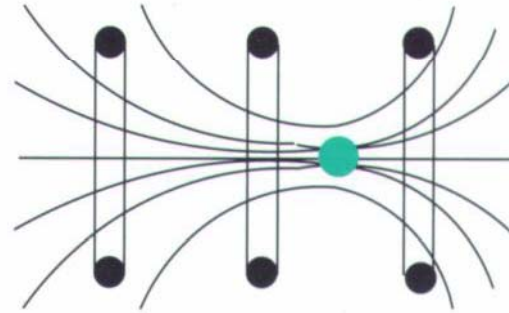
- Metal objects between the coils “unbalance” the system and thus metal may be detected
- A digital signal processor analyzes the signals to find the metal and ignore the product



Metal Can Have Two Effects

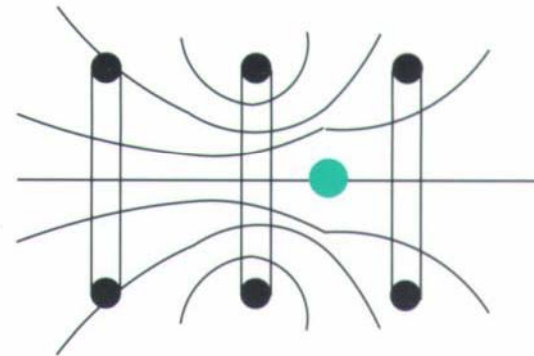
Magnetic Effect

MAGNETIC ● METAL PRESENT
FIELD DISTORTED INDUCED
VOLTAGE INCREASED



Conductive Effect

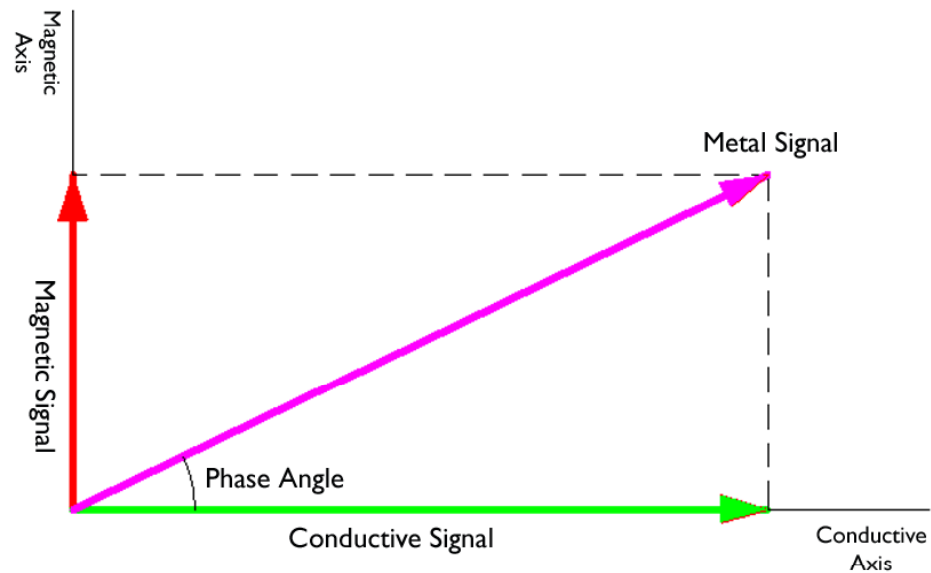
NON MAGNETIC ● METAL PRESENT
FIELD DISTORTED INDUCED
VOLTAGE DECREASED



In the APEX Magnetic = X and Conductive = R

What is Phase Angle?

- All real contaminants have a combination of both magnetic and conductive effects
- The ratio of the two effects can be measured by the phase angle of the out of balance voltage
- All products and metals have phase angles. The product must be ignored, the metal must be detected.



Factors That Affect Metal Detector Sensitivity

Sensitivity is typically expressed as the minimum sphere diameter that can be detected 100% of the time

1. Operating Frequency (50-500 khz)
 - Higher freq detects SS better, but Fe worse. Higher freq also can make conductive (wet) product effects worse.
2. Aperture Size
 - The closer the aperture is to the product the better the sensitivity
3. Product Effect
 - Most difficult when the product (X and R) look like the metal you want to find
4. Orientation Effect
 - Important when metal wire is an important hazard

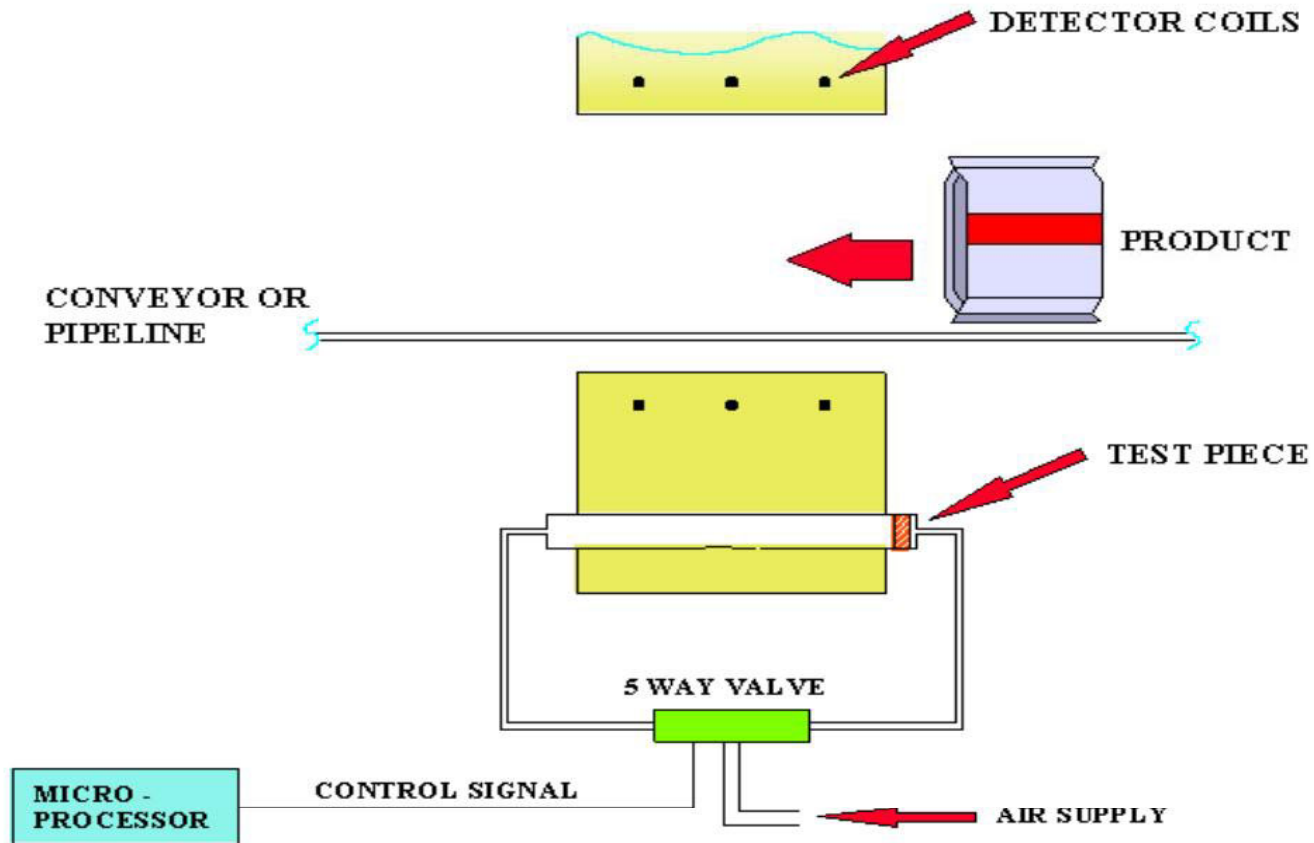


Key Applications for Metal Detectors

- Package products – conveyor
 - Any product you see in the grocery store
- Bulk products – gravity or conveyor
 - Unpackaged discrete or bulk flow products
 - Detect prior to packaging
- Pipelines
 - Sauces, slurries, soups, meat...
- Pharmaceutical
 - Post tablet press or capsule production
- Unique applications
 - Recycled plastic pellets
 - Automotive web needle detection

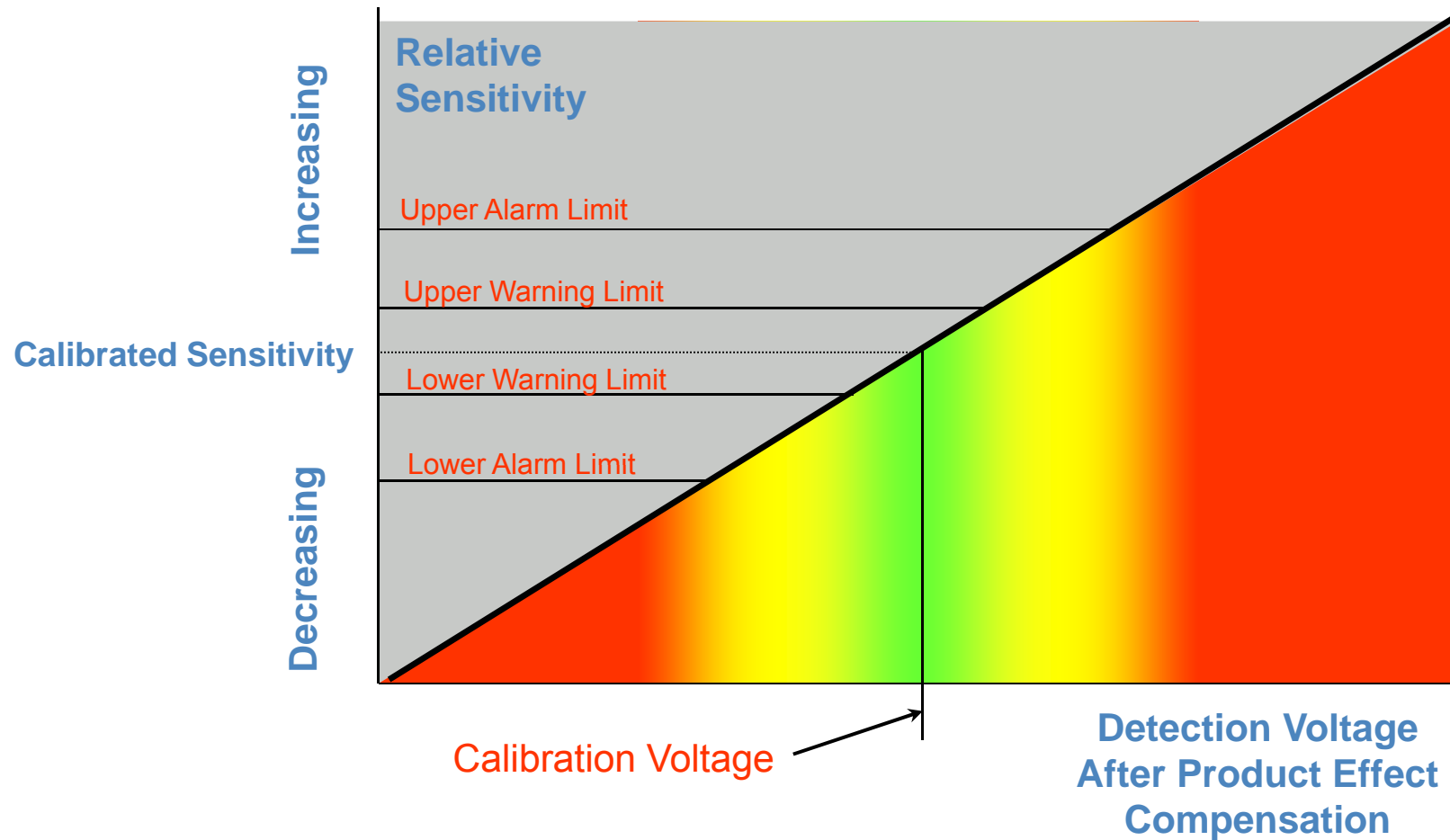


AuditCheck Principle of Operation



A Calibrated Test Process

- Independent measurements on X and R signals (non Ferrous metal used typically)



Test Pieces for Performance Testing/Auditing

- Metal detector customers request sensitivity in diameter (mm) for:
 - Ferrous
 - Non-Ferrous
 - 316 Stainless Steel (non-magnetic alloy)
- Thermo Scientific test piece styles
 - Cards (conveyors)
 - Sticks (conveyors too)
 - Disks (drop through, pipeline)
 - Disks (pharma)
- All test pieces have Certificate of Conformance (C of C)
- 100s of sizes, must specify at order time



ThermoFisher
SCIENTIFIC

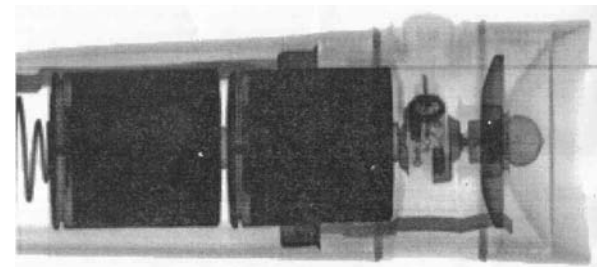
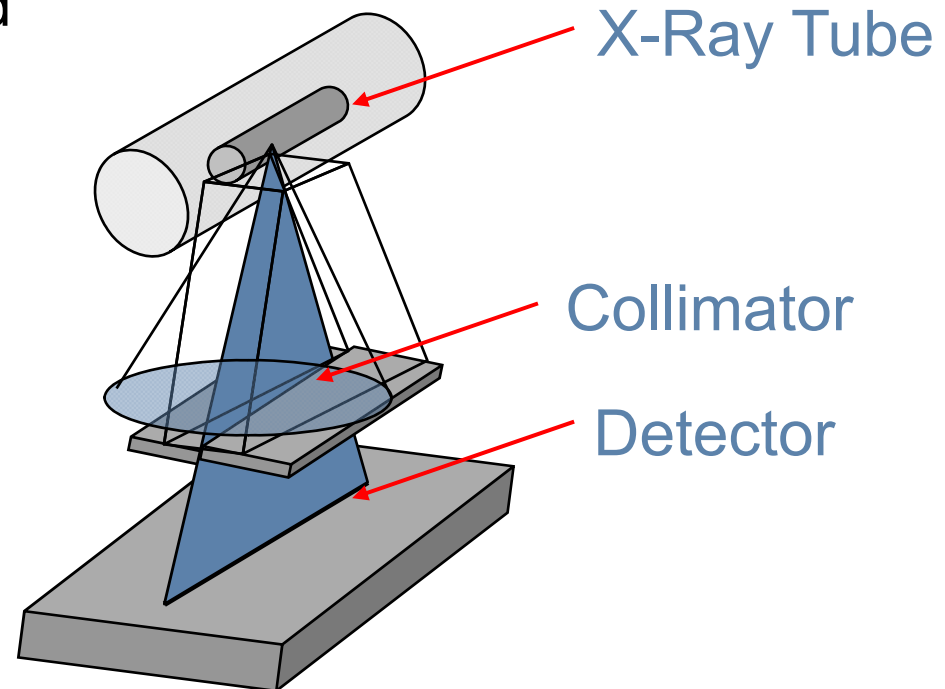
The world leader in serving science

Basic X-Ray Training



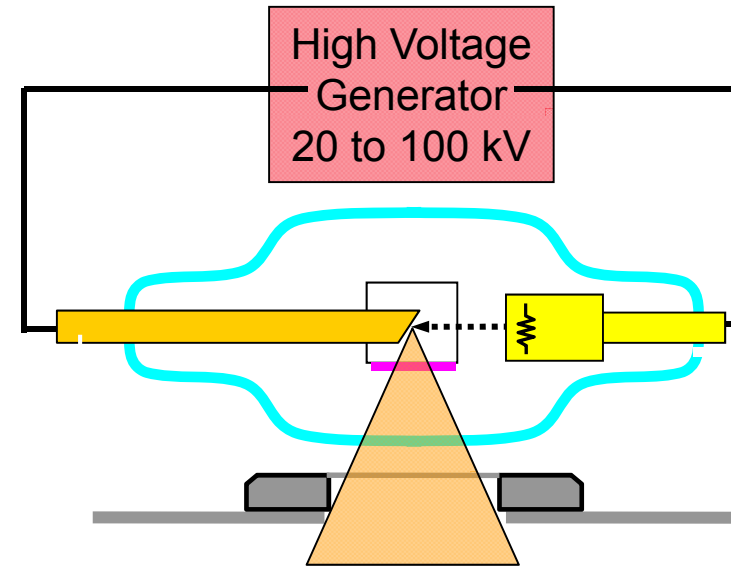
X-Ray Inspection Basic Principle of Operation

- Same familiar approach used in medical/baggage x-ray systems
 - Density image generation created by ionizing radiation
- Manual x-ray systems “read” by humans
 - Sometimes with image enhancement or multiple views
- Industrial x-rays “read” by image analysis software
 - Image processing and analysis algorithms
 - Can use enhancement and/or multiple views too



X-Ray Beam Generation Method

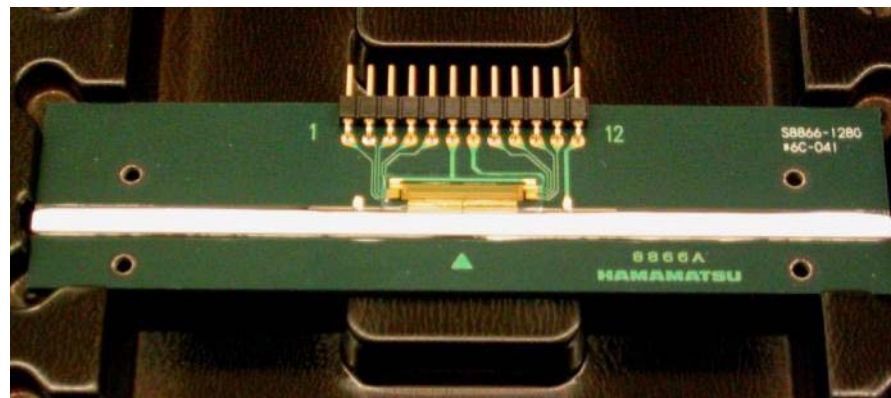
- Current flows through a filament in a tube (mA)
- Electrons leave the filament and are accelerated by a high voltage (kV) from a cathode (-) to a tungsten covered anode (+)
- When the electrons impact the anode x-rays are emitted
- A collimator/slit is used to focus or shield the x-ray beam



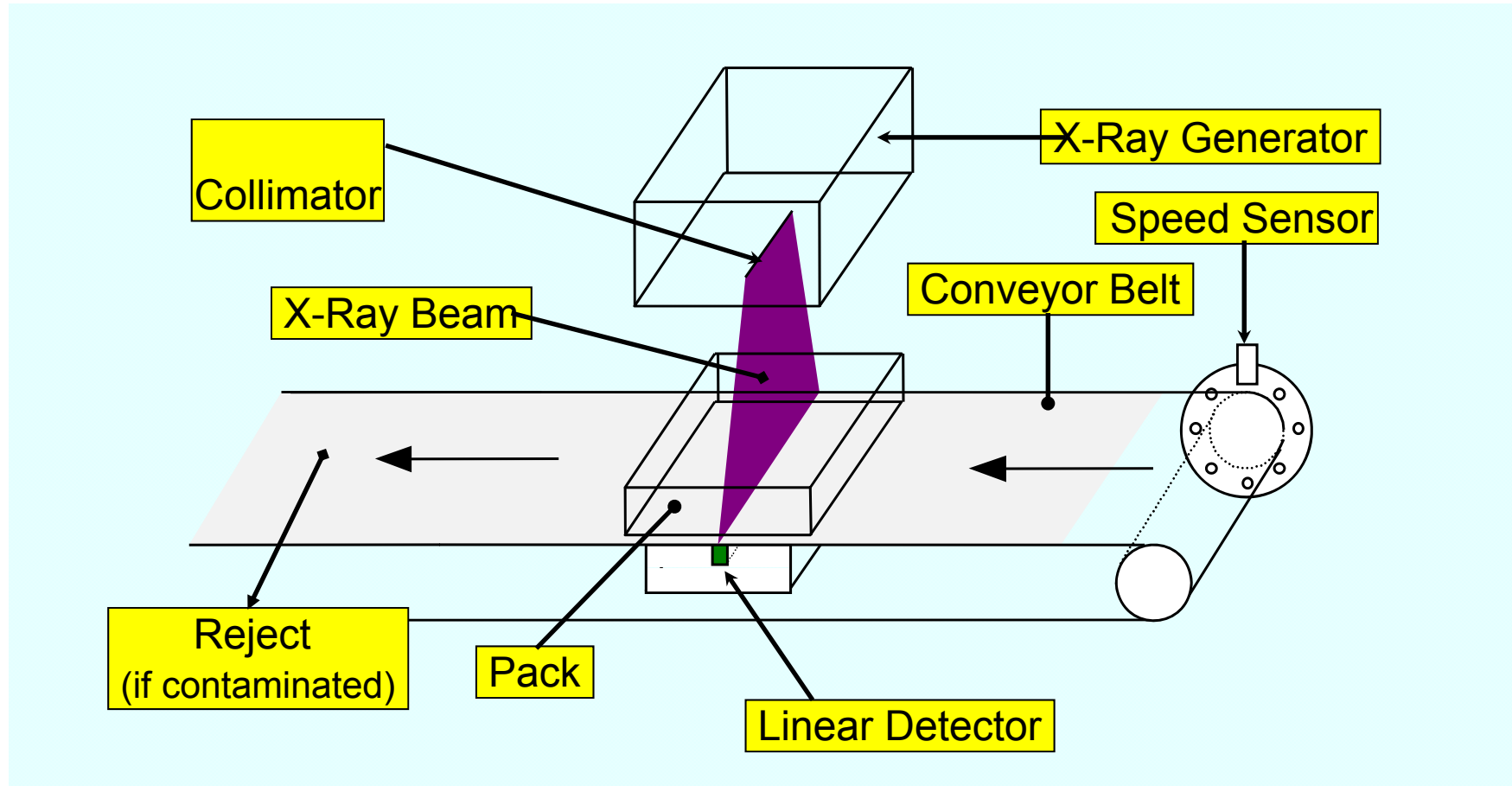
Voltage \approx penetration/punch through
Current \approx brightness/intensity

X-Ray Detection Method

- X-rays penetrate the object being bombarded and those that pass through strike a detector assembly
- The detector has a scintillator crystal that converts x-rays into photons that are “counted” by a photo diode
- The spacing between these diodes defines the image pixel size (1.5mm to 0.2mm, 0.8mm typical)
- Usually x-ray systems can detect contaminants slightly larger than the diode size



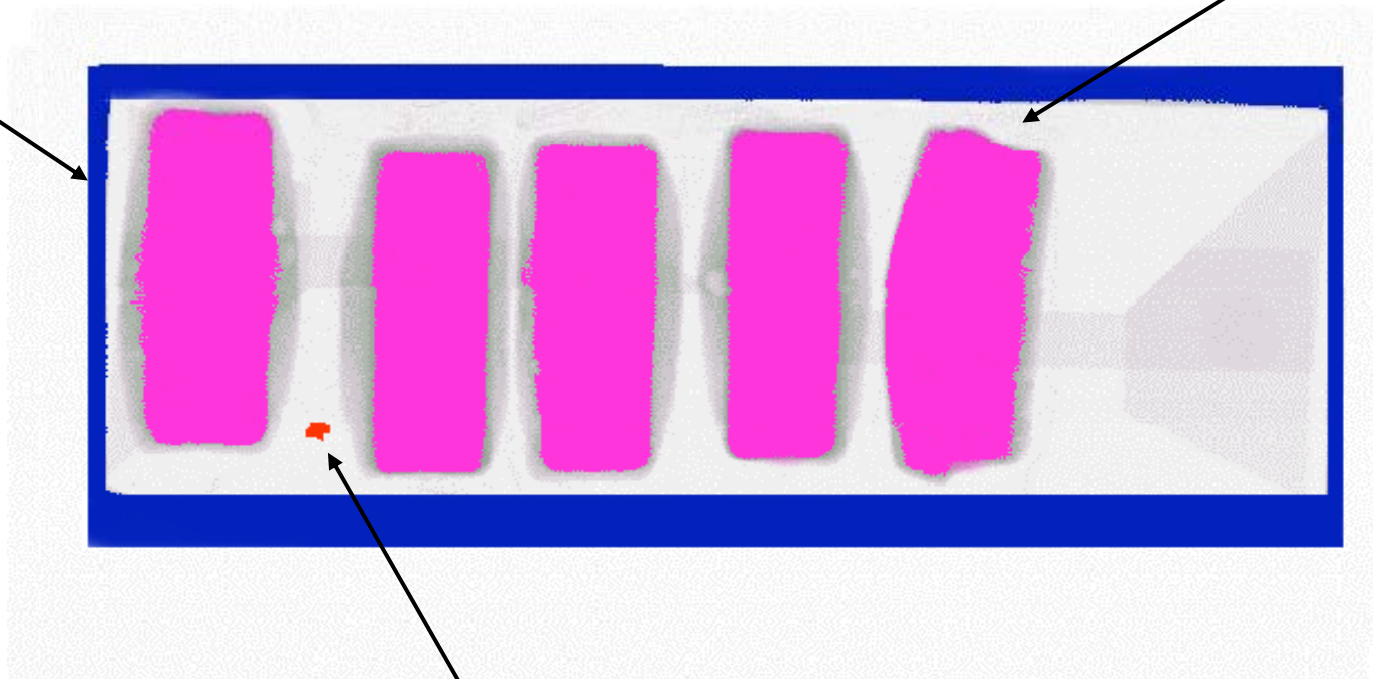
Block Diagram of A Complete X-Ray System



Designed to meet FDA CFR 21 part 1020.40/IRR 199 and many other worldwide standards for safety

Some Typical Image Analysis Tools (Filters)

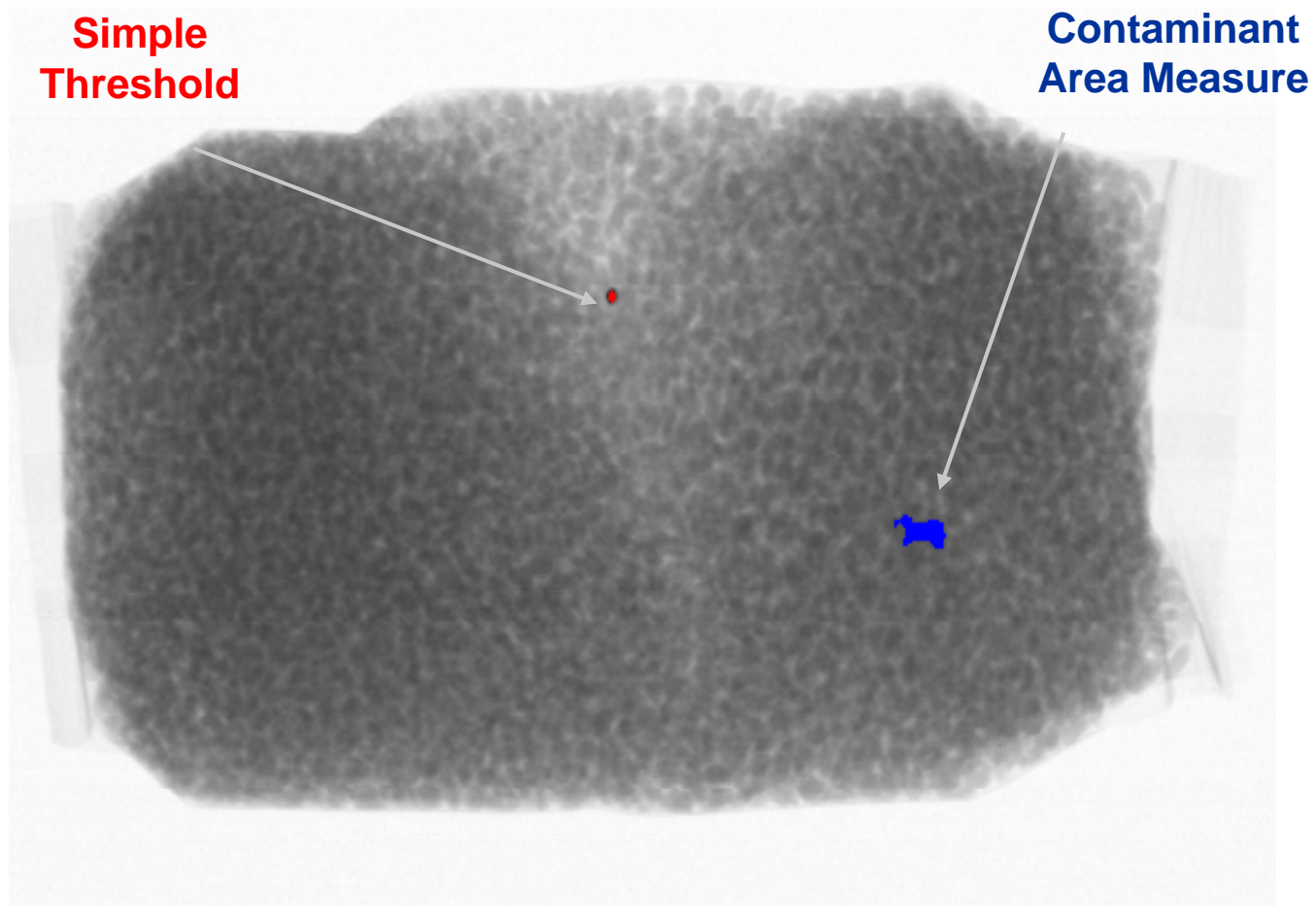
Filter No.1
Pack Edge
Masking



Filter No. 2
Product Area
Measure

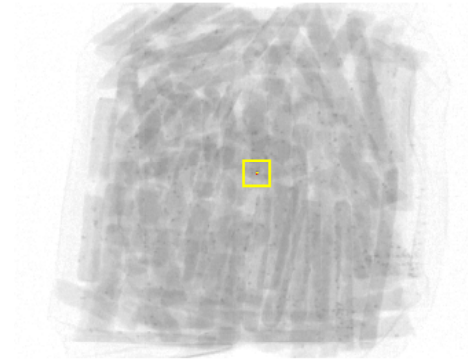
Filter No. 3
Gradient Image
Processing

More Filter Examples

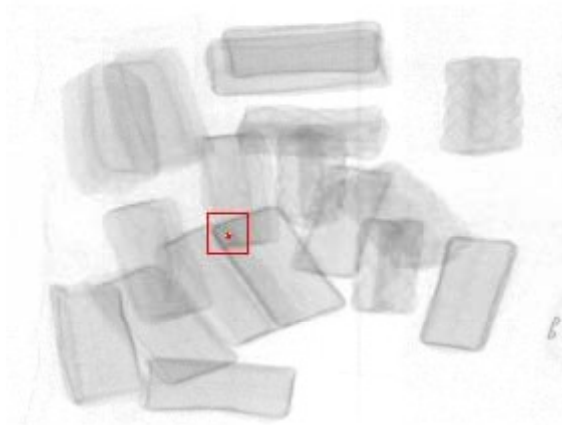


Some Sample X-Ray Images/Contaminants

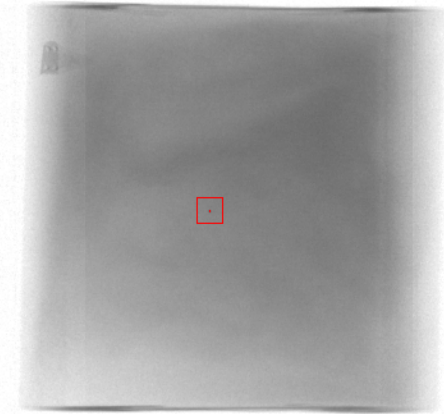
Bread sticks (1.5mm metal)



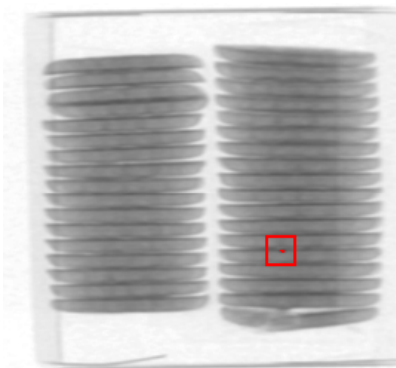
Candies (2mm glass)



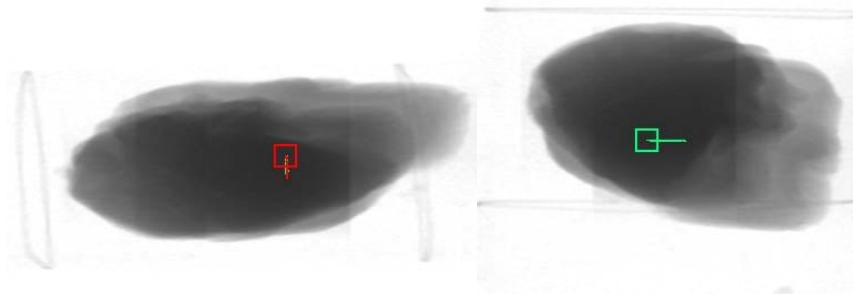
Milk Powder (1mm SS)



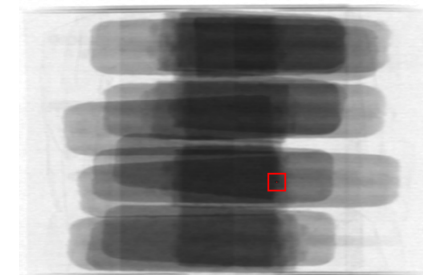
Cookies (1.5mm glass)



#18 SS Needle in 100mm of Pork

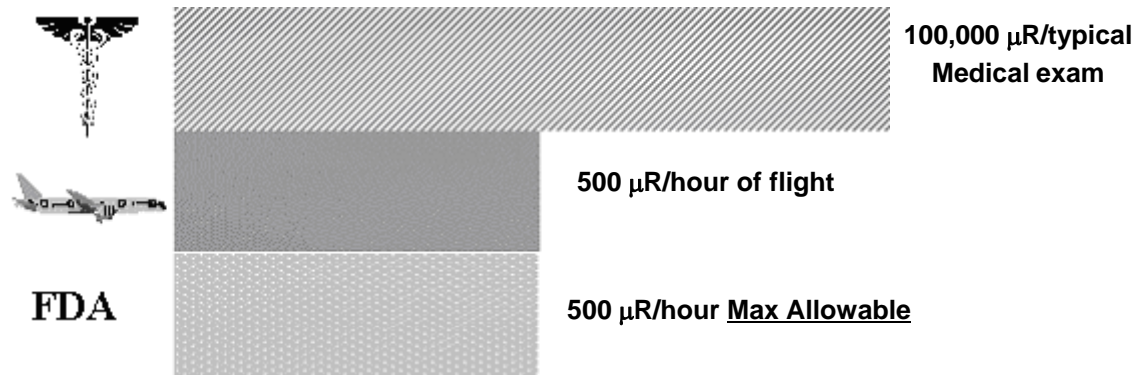


Ice Cream Bars (1.5mm metal)



X-Ray Systems are Certified/Tested to be Safe

- Meet or exceed FDA CFR 21 part 1020.40 (and the more stringent UK IRR 1999 limits)

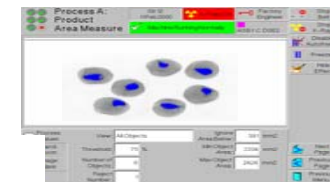
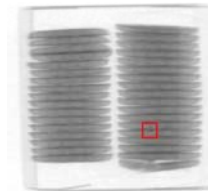


- Built-in safety features
 - Xray annunciation lamp, key switch, door safety interlocks, dual lead curtains, emergency stop, lockable power switch, on-screen x-ray off button
- Radiation surveys done by Thermo Fisher at the factory and after installation
- Thermo Fisher Scientific meters available too



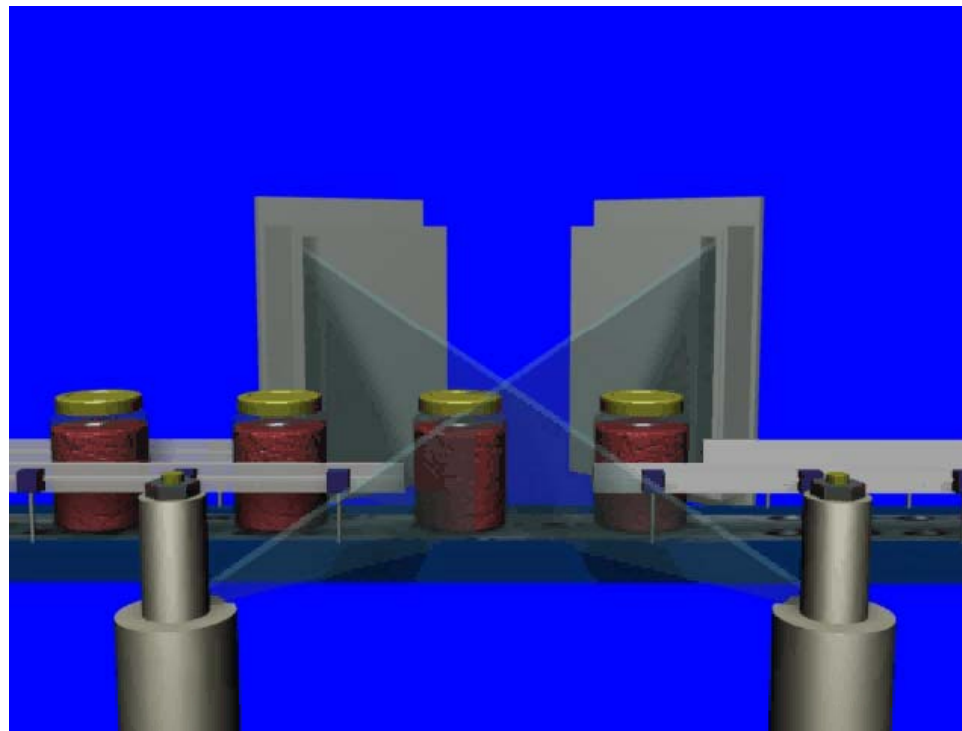
Key Applications

- Horizontal packaged products – conveyor
 - Contaminants and product inspection
 - Metallized film a popular application
- Bulk products – conveyor
 - Nuts, seeds, grains, fruit, beans, ...
 - Remove rocks, metal, glass, ... early in the process
- Pipelines
- Vertical packaged products - conveyor
 - Contaminants and fill level
 - Glass-in-glass

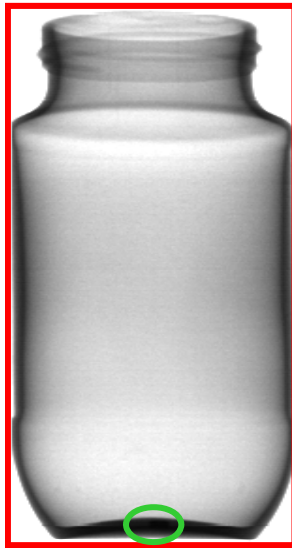


A Primer on Glass in Glass Detection

- The double side view is a unique technology that improves:
 - Detection performance on the **bottom area** of the container
 - Detection performance on the **sidewalls** of the container
 - Detection performance of **large but thin** contaminants

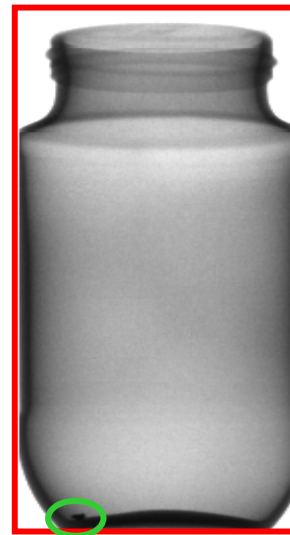


Bottom Area Inspection Basics



FIRST VIEW

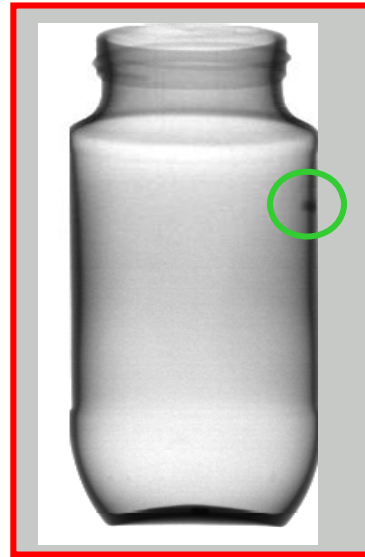
Due to jar/beam orientation the contaminant can be hidden behind the bottom glass contour



SECOND VIEW

The contaminant appears clearly in the image taken at 90 degrees from the first view

Sidewall Inspection Basics

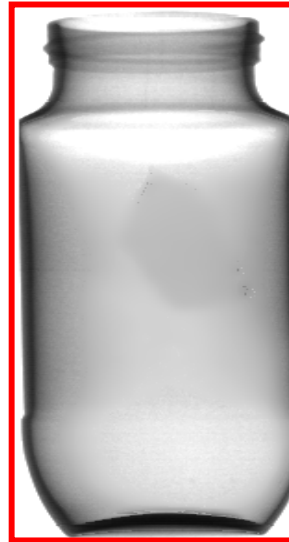


FIRST VIEW
Depending on jar orientation, the contaminant may be hidden by the shadows caused by the thickness of the sidewalls

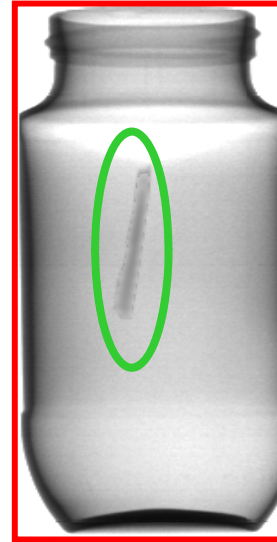


SECOND VIEW
The contaminant appears clearly in the middle of the image

Large But Thin Contaminant Basics



FIRST VIEW
The contaminant is large but thin, so it has a low contrast and weak edges and can't be detected



SECOND VIEW
The contaminant appears clearly because of its thickness in this direction

Key Detection and Application Differences

Metal Detection



- Detects metal including aluminum and wires
- Can be used almost anywhere in a process; conveyors, drop through and pipelines
- Operates at just about any speed
- **Conductive (wet/salty) products most difficult**
- Performance dependent on aperture size, coil configuration and software
- **Long life in harsh environments**
- Metal only usually > 1 mm in size
- Dry products, small products, piped or bulk products have best sensitivity
- Sensitive to metallic packaging

X-Ray Inspection



- Detects most metals and many other solid contaminants
- Conveyor, bulk and pipeline; not for gravity applications
- Speed must be constant and may be limited
- **Dense products with a lot of texture most difficult**
- Performance dependent on X-ray source, receiver, power and software
- **Controlled environments best, shorter life**
- Typically can find smaller contaminants than metal detectors and also nonmetallic contaminants
- Large packaged products and cases can be inspected; cans and bottles too
- Ideal for metalized film and foil packages

Why Customers Prefer Us?



ThermoFisher
S C I E N T I F I C

The world leader in serving science

Questions