NUCSAFE

ISIW Presentation

July 15, 2014

Then and Now Status of X-ray Backscatter at Nucsafe

World Class Protection

Nucsafe Inc. Founded in 1999

American owned and operated

Oak Ridge, TN
50 employees
30,000 ft^2
ISO9001:2000
ITRAP Certified

Proudly made in the USA

Corbin, KY
13 employees
17,000 ft^2
ISO14000
OHSAS 18001

International Organization for Standardization

NUCSAFE®

certificate of registration

This is to certify that the management systems of

Nucsafe, Inc.
Nucsafe Instruments, Inc.

have been formally assessed by International Certifications and found to comply with the requirements of

ISO 9001:2008
Quality Management Systems - Requirements

24 Jan 2012
Issue Date

16 Jun 2014
Expiry Date

D. L. Evans
Managing Director
International Certifications Ltd

INTERNATIONAL CERTIFICATIONS
C27501
REGISTRATION NUMBER

Scope of Registration:

Manufacture, assembly, and service of nuclear systems for radiation detection systems (KY)/Administration, design, and service monitoring (TN)

Registered Site(s):

103 23rd Street, Corbin, KY, 40701, United States
601 Oak Ridge Turnpike, Oak Ridge, TN, 37830, United States

JAS-ANZ

IAF MEMBER OF MULTILATERAL RECOGNITION ARRANGEMENT

ISO 9001 www.intlcert.com

This certificate is issued by International Certifications Limited, 138 Harris Road, East Tamaki, Auckland, New Zealand, 2141 (www.intlcert.com). Accreditation by the Joint Accreditation System of Australia and New Zealand (www.jas-anz.org/register). This certificate [illegible] Certifications Limited and must be returned upon request. [illegible] deliberate misuse of the certificate will result in cancellation without notification.

ISO International Organization for Standardization

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Operating Groups

Products

- Radiation Detection
  - System integration with full range of products for security field and industry
- Backscatter X-ray
  - High fidelity imaging for non destructive testing and security applications
- Radiation Detection Materials
  - Lithium 6 glass products – Fiber and solid glass & microparticles

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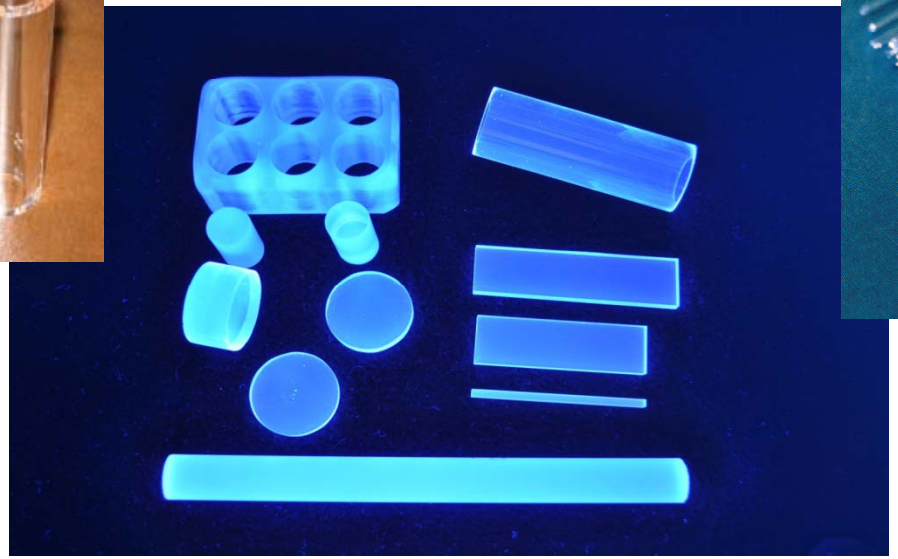
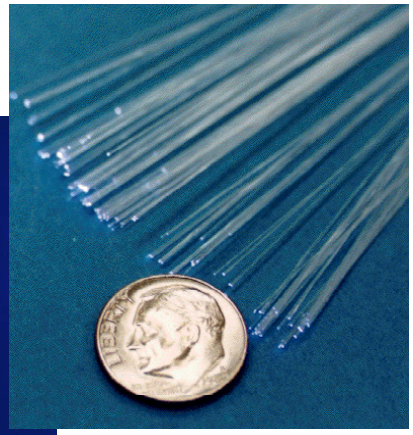
Detector Material Manufacturing

Tubes





Fiber

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SXI™
Scatter X-ray Imaging

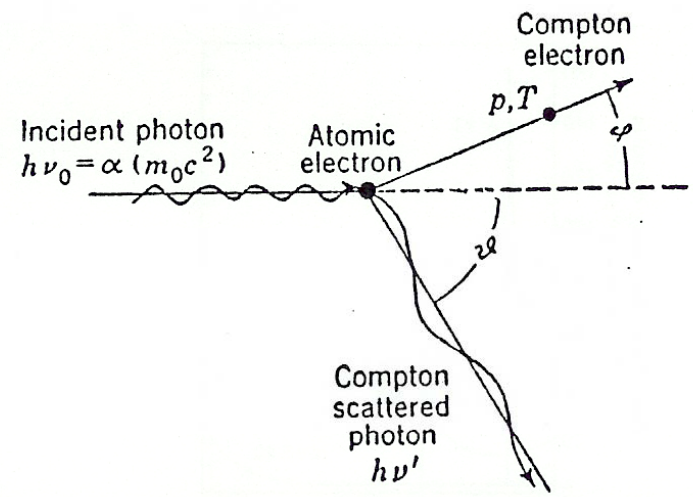
X-Ray Backscatter Systems

Non-destructive Testing for a Variety of Industrial and Military Applications

NUCSAFE®

Compton Scattering Characteristics

- **Compton scattering characteristics**
  - Compton scattering produces a recoil electron and a new photon from a collision between an atomic electron and incident photon (x-ray).
  - The recoil electron is often absorbed in material; the scattered photon may escape the material and can be detected.
  - Conservation of momentum of the x-ray photons and the atomic electron determines the momentum and directions of the scattered particles.
  - The energy of the scattered x-ray can be calculated:



$$E_{scattered} = \frac{E_{incident}}{1 + \left(\frac{E_{incident}}{0.511\ MeV}\right)(1 - \cos\theta)}$$

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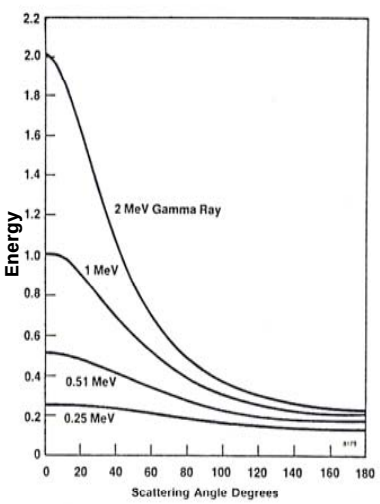
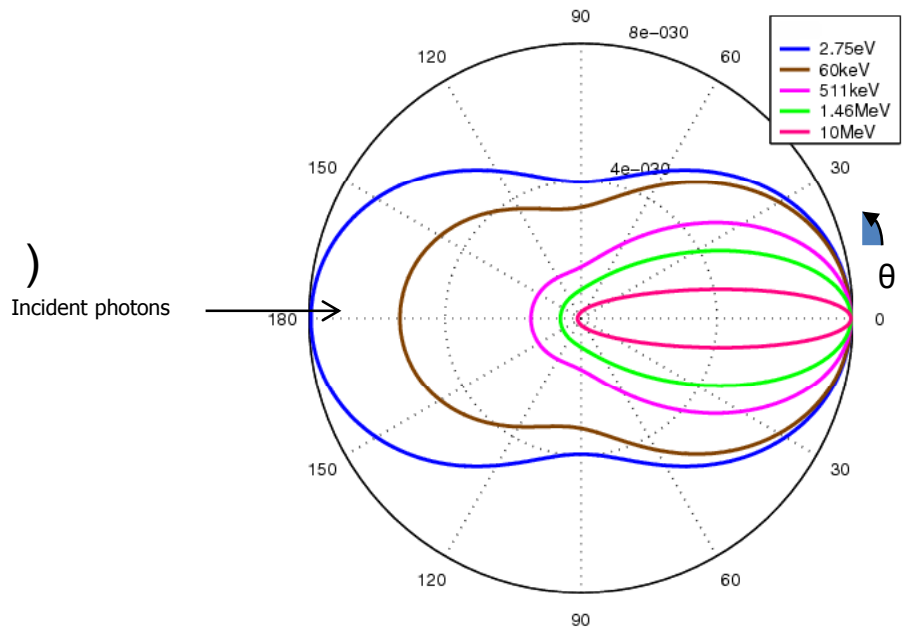
Klein Nishina Formula

- The scattered photon has lower energy than the original incident x-ray.
  - Forward scattering: Cos θ = 1 (0)
  - Fully backscattered: Cos θ = -1 (180)
  - Maximum possible energy of a 180 backscattered x-ray: 0.25 MeV





A polar plot of the number of photons (incident from the left) Compton scattered into a unit solid angle at the scattering angle θ. The curves are shown for the indicated initial energies.

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NASA Orion Shield X-ray Backscatter System

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URL For NASA Orion X-ray Backscatter Video

- http://spaceref.com/missions-and-programs/nasa/space-launch-system/nasas-orion-spacecraft-heat-shield-takes-shape.html

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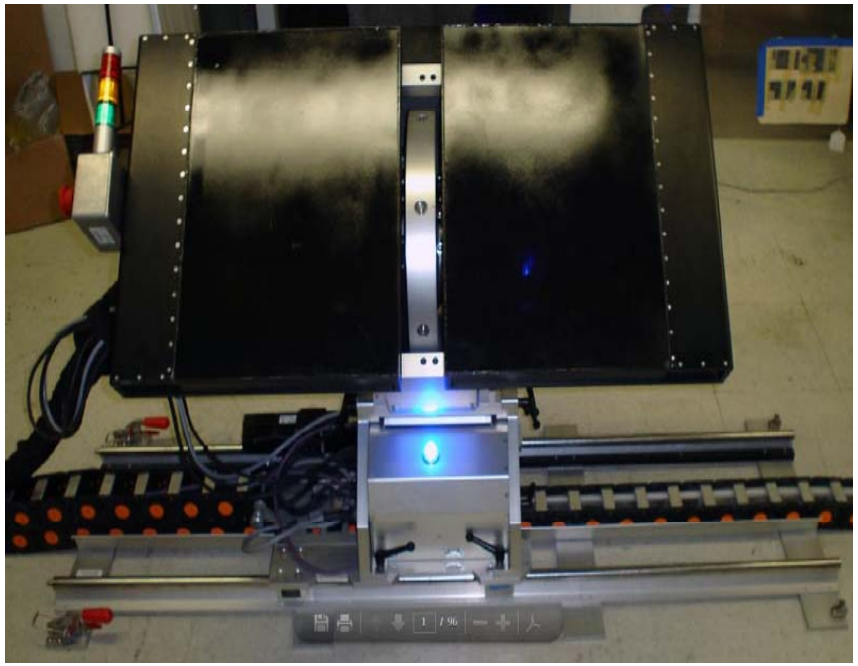
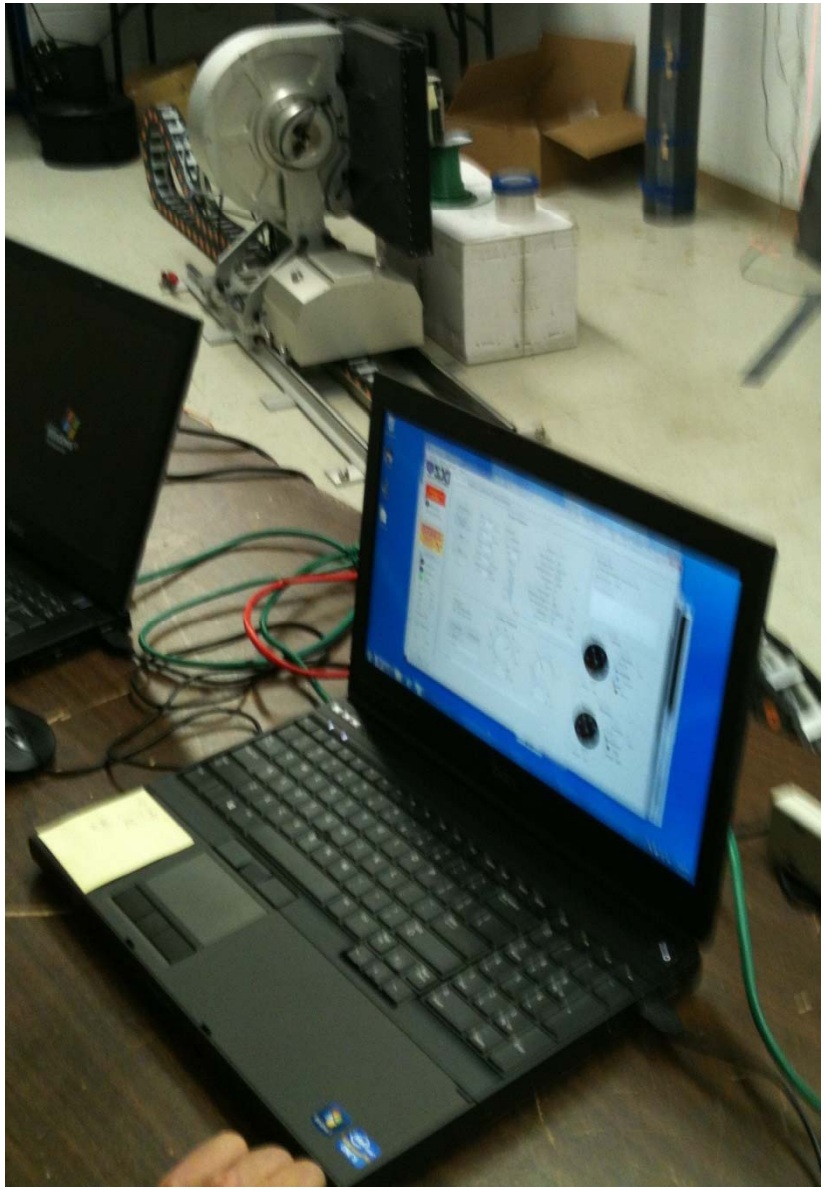
SXI 225 kV Linear Rail System





SXI 225 kV X-Ray Backscatter System

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FOD Plate Setup

- 1- Safety Glasses
- 2- Latex Glove
- 3- Adhesive Container
- 4- Tape
- 5- Marker
- 6- Rocks
- 7- Plastic Cap
- 8- Plastic Nut
- 9- Zip Tie
- 10- Bag of Dirt
- 11- Leaf
- 12- Hose Clamp
- 13- Foam Ear Plugs
- 14- Plastic Spatula
- 15- Cardboard
- 16- Steel Nut and Bolt
- 17- Pencil
- 18- Granola Bar
- 19- Drill Shavings
- 20- Drill Bit
- 21- Small Wrench
- 22- Small Screwdriver
- 23- Wood Pieces
- 24- Folded Paper
- 25- Wiping Cloth
- 26- Lead Piece
- 27- Small Socket
- 28- Small Driver Bit
- 29- Penny
- 30- Cotton Rag
- 31- Cotton Glove
- 32- Nacho Chips
- ** Not pictured
- - Wooden Swab
- - Plastic Swab

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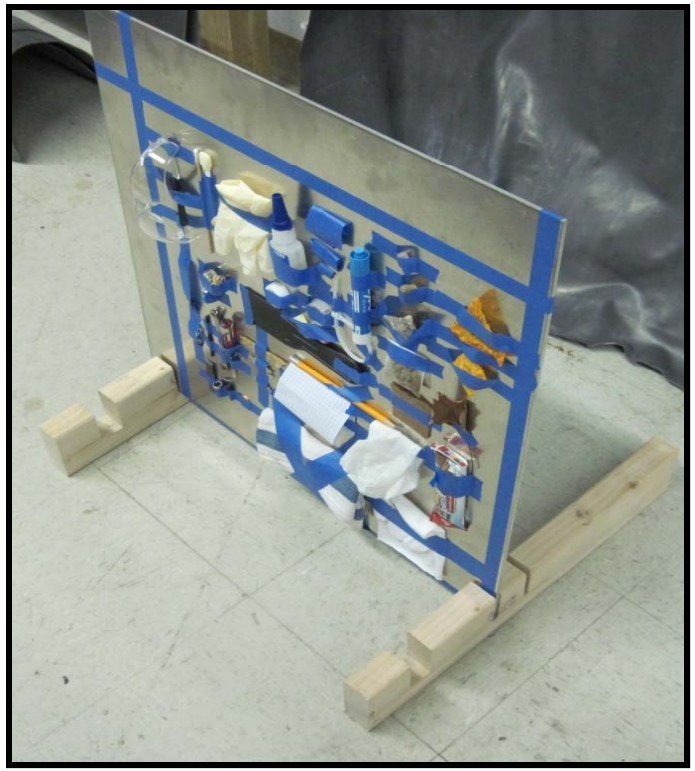
FOD Plate and Shield Setup



- FOD plate setup for scanning with 225kV X-ray Linear Rail System.

- Shield plate setup in front of FOD plate for scanning with 225kV X-ray Linear Rail System

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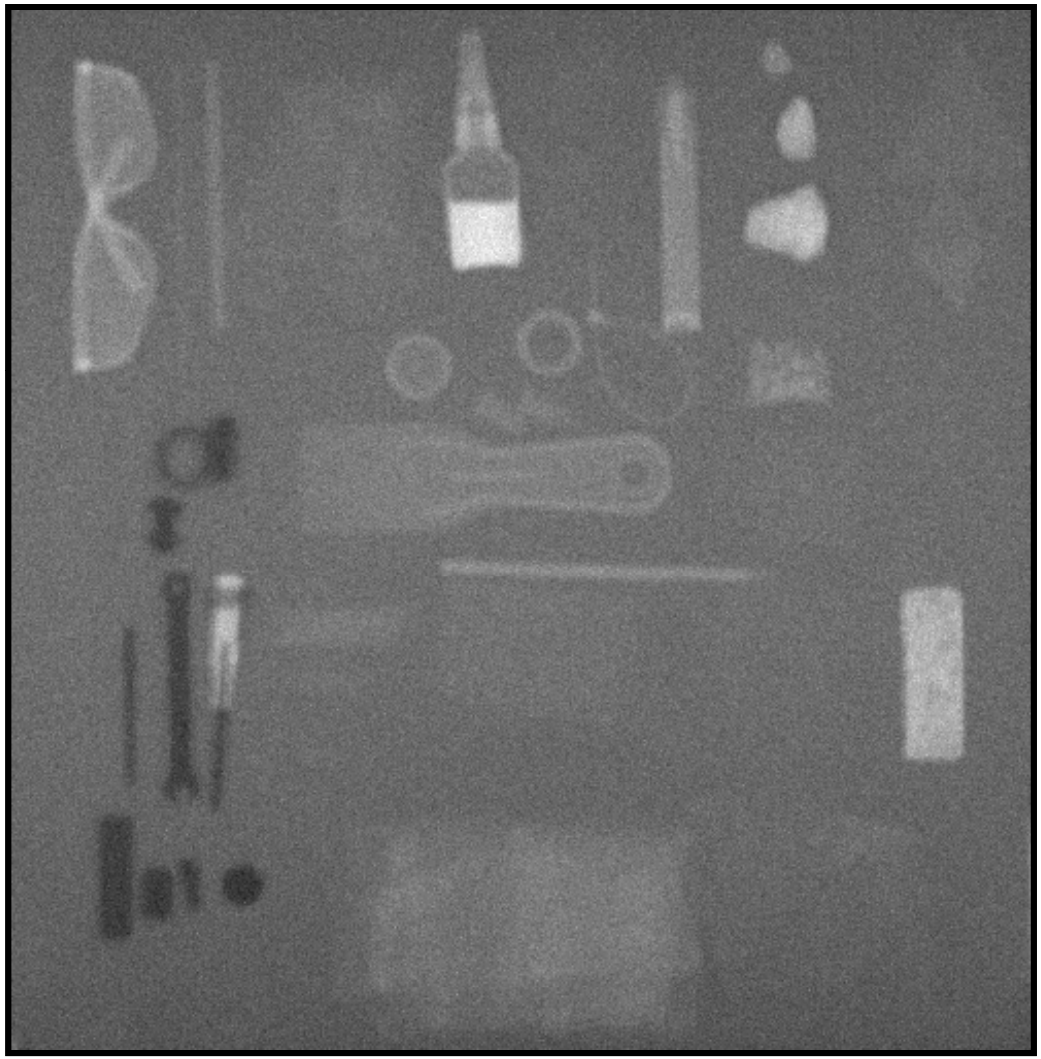
FOD Scan .125” Shielding- 1min/sqft



- Time: 2014-05-28 17:02:05
- System Name: 225kv Linear Rail
- XrayParams: kV=120, mA=6, filament=Large
- Motion Profile: SpinningCollTrackDrive
- Aperture: 2.00 mm
- Scan Length: 500 mm @ 1 mm @ 2 mm/s
- Sweep Angle: 40 deg @ 0.06060606 deg @ 15 rpm
- Distance to Target: 711 mm
- Pixels per Line: 660
- Roll position: -90 deg
- Aspect Ratio (scan/sweep) pixel: 0.9908935, image: 500 x 667
- Pixels/segment: 330, Segs/line: 2
- Pixel Dwell Time: 0.6734007 ms
- Total Scan Time: 00:04:10
- Detector Mode: Using Event Rate, Charge Mode Off, Deadtime Correction Off, Pileup Rejection Off
- Detector1: sn=37, ip=192.168.5.61
- Detector2: sn=38, ip=192.168.5.62
- Description: .125 shield

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Detectability Assessment- .125 Shield

FOD Group- Detectability Assessment		.125" Shield					
						Total #	%
Metallic	**Plastic**	**Fibrous**	**Miscellaneous**		Clearly Shown	23	67.6
Hose Clamp	Safety Glasses	Cardboard	Tape (3 sizes)		Shown	1	2.9
Steel Nut and Bolt	Latex Glove	Pencil	Rocks (3 sizes)		Barely Shown	7	20.6
Drill Shavings	Adhesive Container	Wood Chips (3 sizes)	Bag of Dirt		Unable to Detect	3	8.8
Drill Bit	Marker	Folded Paper	Leaf			34	100.0
Small Wrench	Plastic Cap	Wiping Cloth	Nacho Chips				
Small Screwdriver	Plastic Nut	Cotton Rag	Foam Ear Plugs				
Lead Piece	Zip Tie	Cotton Glove	Granola Bar				
Small Socket	Plastic Spatula	Wooden Swab					
Small Driver Bit	Plastic Swab						
Penny							

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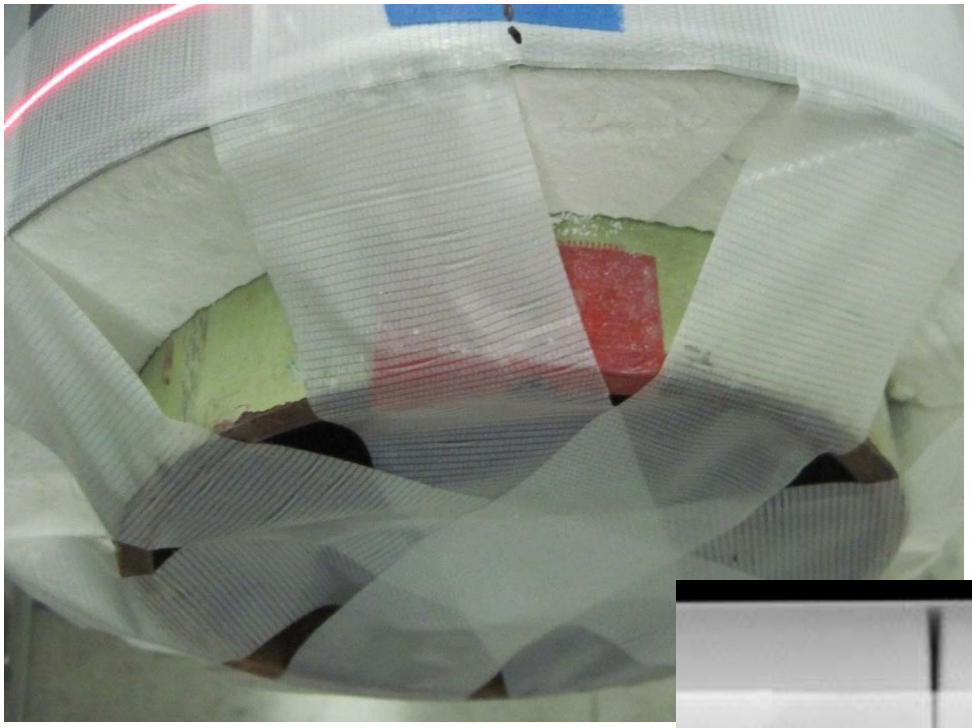
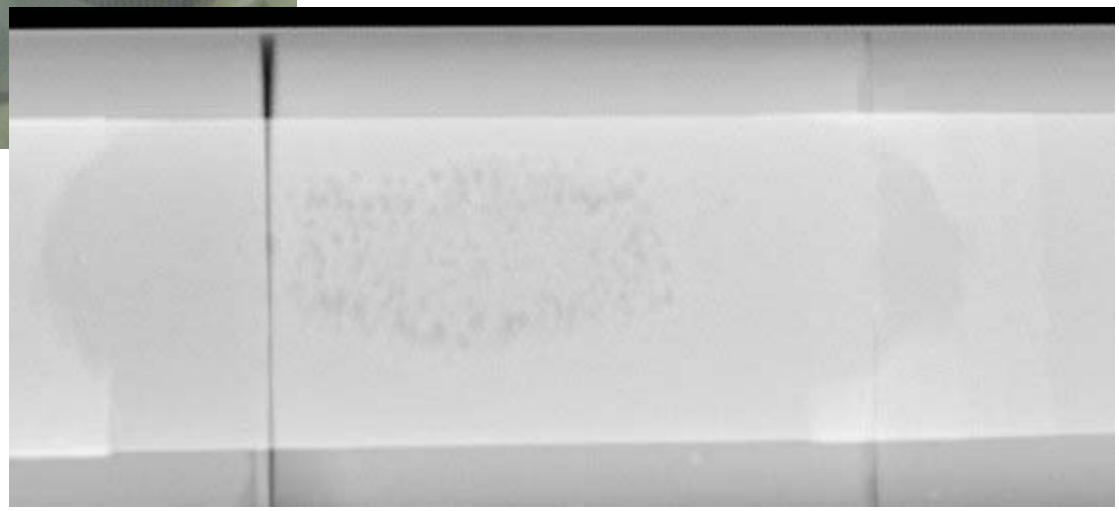
Corrision on a steel pipe under 1 inch of CalSil insulation



- Image shot at:
- 225 kV
- 3 mA
- 4 minutes10 s.



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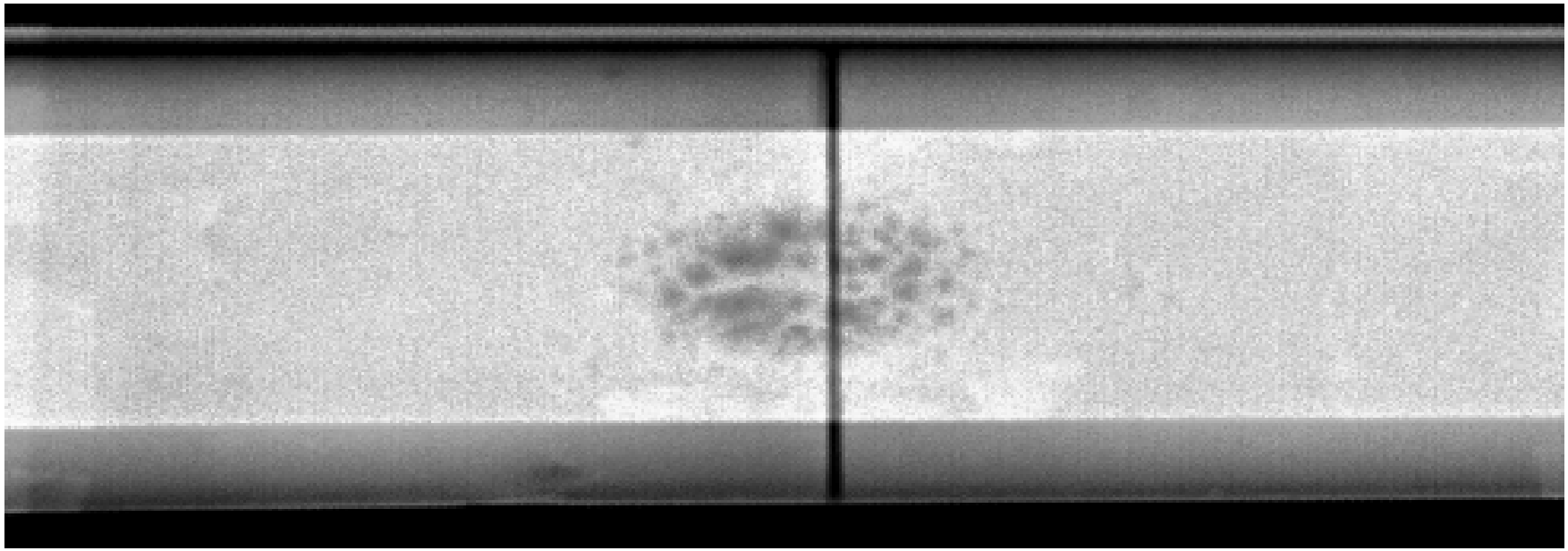
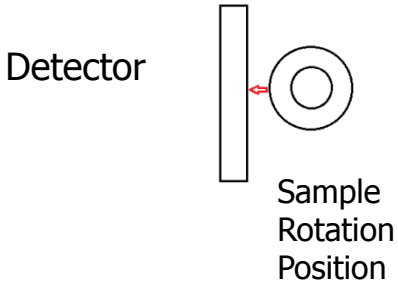
Pipe Sample with CLAHE Filter



- Time: 2014-07-07 10:45:42
- System Name: 225kv Linear Rail
- XrayParams: kV=225, mA=3, filament=Large
- Motion Profile: SpinningCollTrackDrive
- Aperture: 2.00 mm
- Scan Length: 500 mm @ 1 mm @ 2 mm/s
- Sweep Angle: 40 deg @ 0.155642 deg @ 15 rpm
- Distance to Target: 150 mm
- Pixels per Line: 257
- Roll position: -90 deg
- Aspect Ratio (scan/sweep) pixel: 0.9973188, image: 500 x 258
- Pixels/segment: 257, Segs/line: 1
- Pixel Dwell Time: 1.729356 ms
- Total Scan Time: 00:04:10
- Detector Mode: Using Event Rate, Charge Mode Off, Deadtime Correction Off, Pileup Rejection Off
- Detector1: sn=37, ip=192.168.5.61
- Detector2: sn=38, ip=192.168.5.62
- Description: 9 oclock position marker



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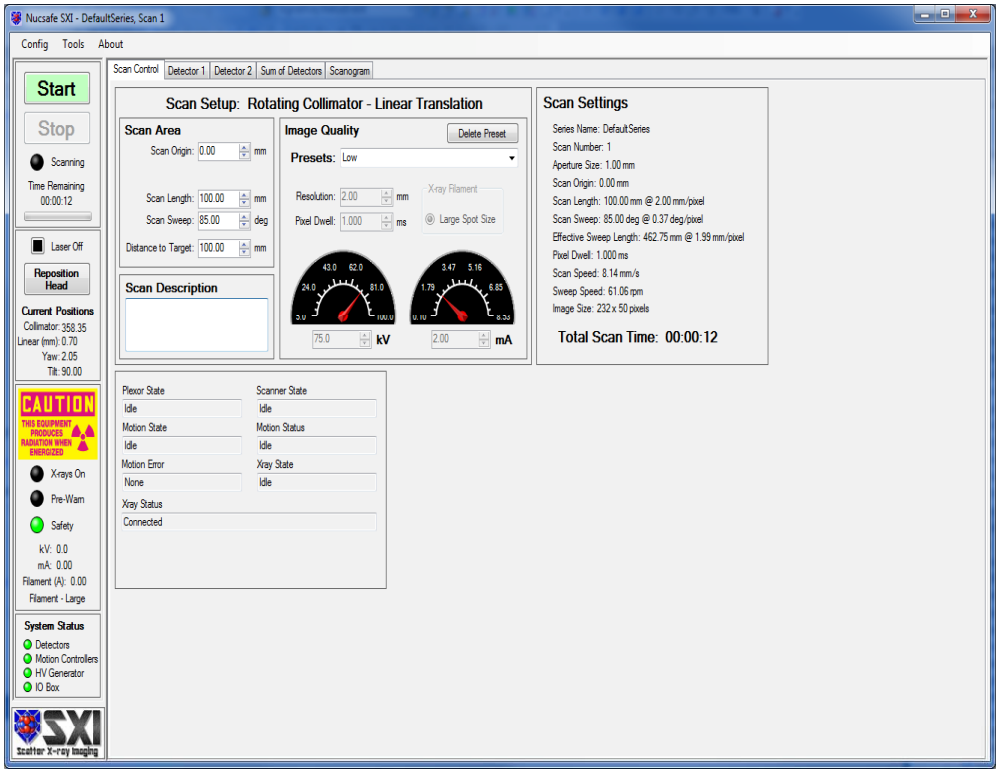
100 kV Portable X-Ray Backscatter System



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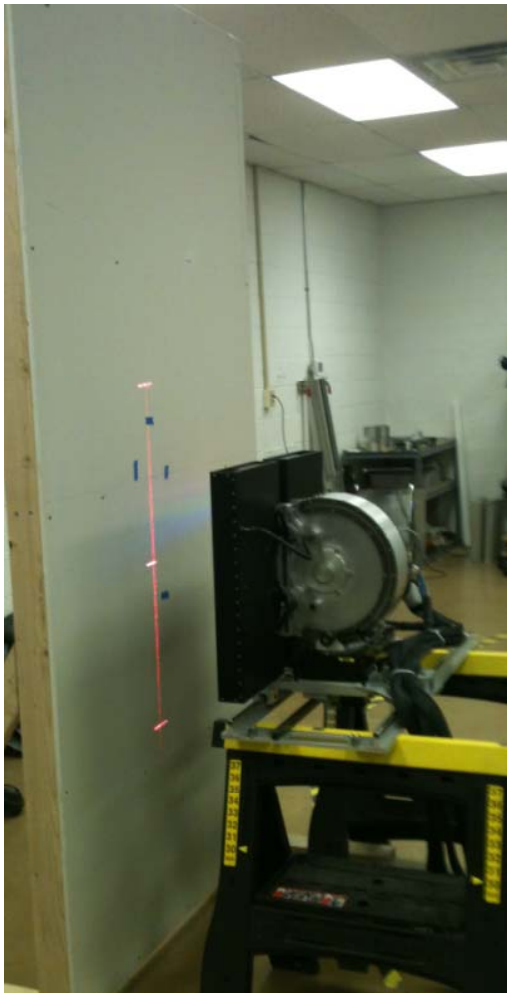
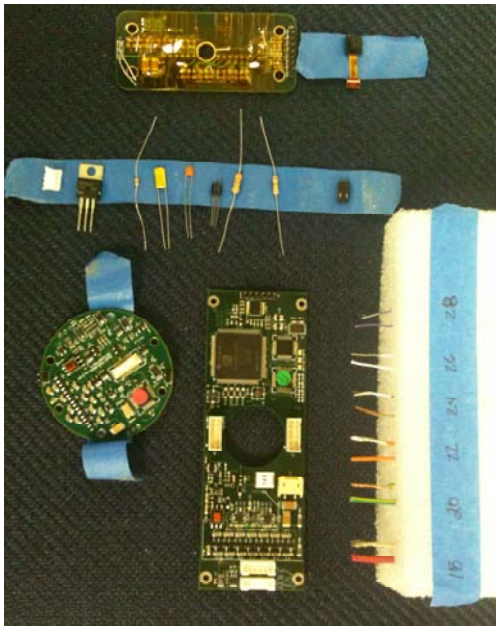
Test Items Photos





100 kV Man-Portable

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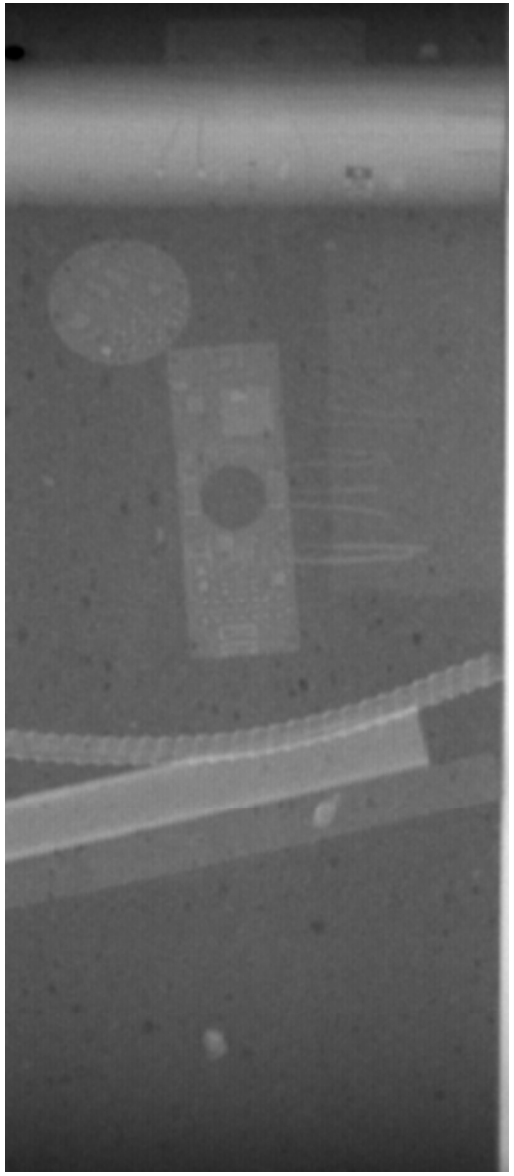
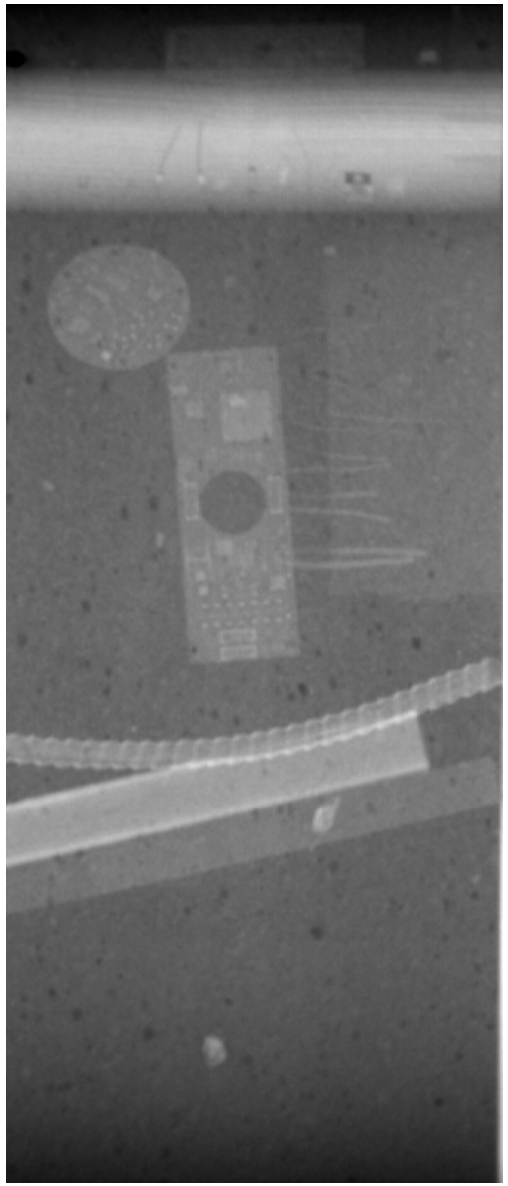
100mm DDT - .5 and .3mm Pixel Size



100mm DTT

Scan Length 200mm
Scan Time 3m15s
Area scanned 1.1 sq ft

100kV / 6mA
.5mm pixel size



100mm DTT

Scan Length 200mm
Scan Time 18m07s
Area scanned 1.1 sq ft

100kV / 6mA
.3mm pixel size

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