BAM
Bundesanstalt für Materialforschung und -prüfung

Sicherheit in Technik und Chemie

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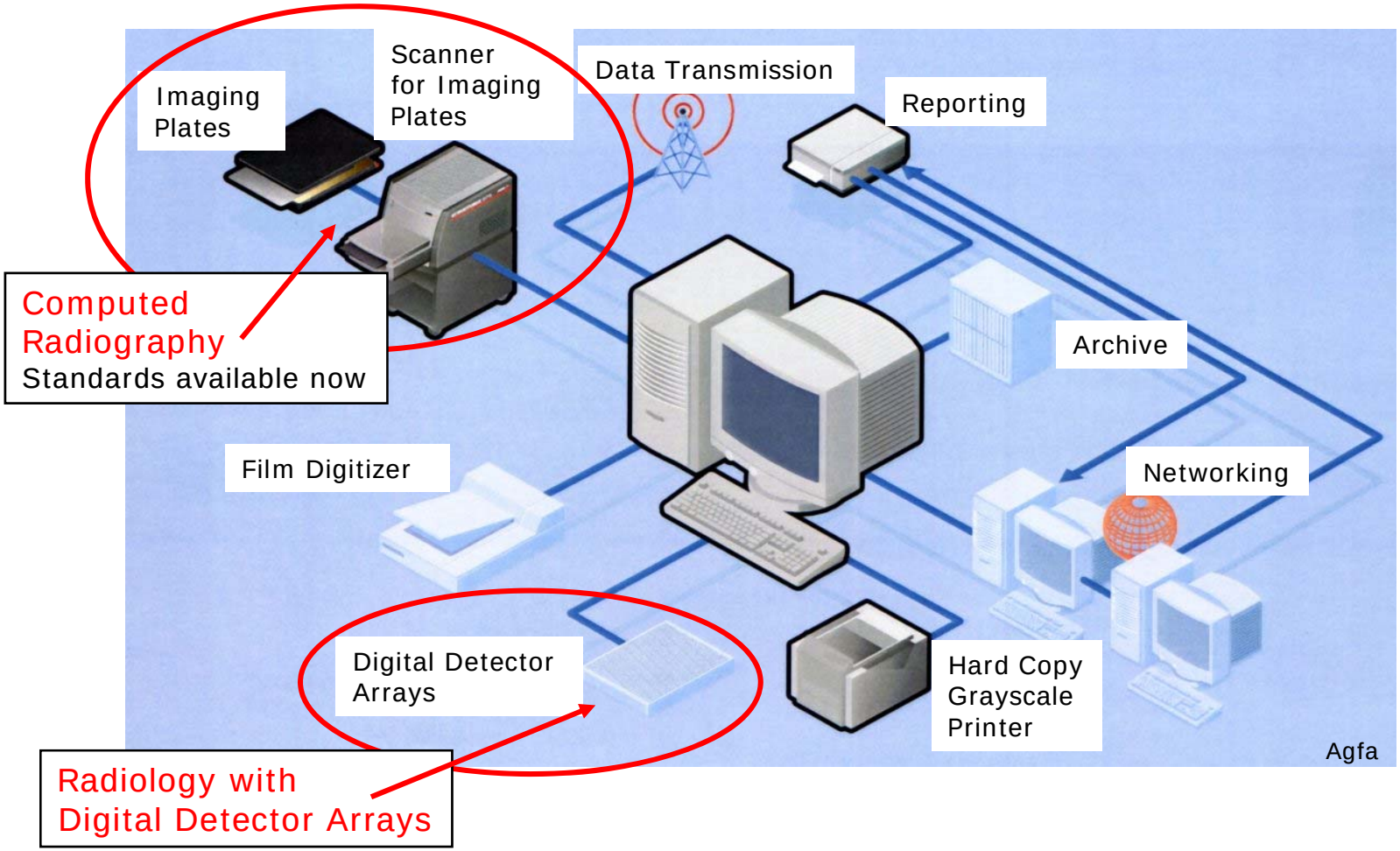
DOSE REDUCTION BY USE OF DIGITAL X-RAY DETECTORS

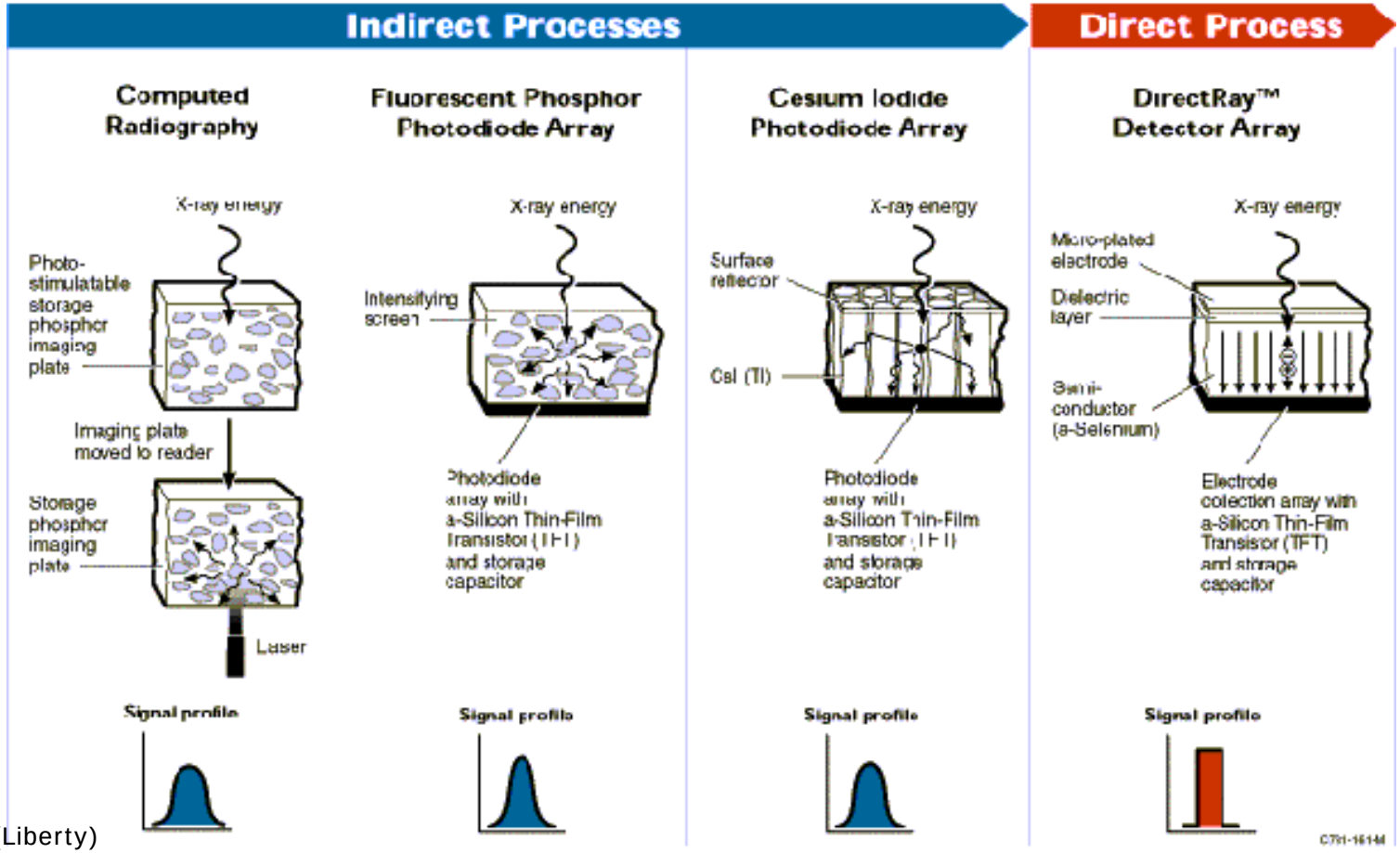
Bernhard REDMER

Digital Technology and Networking



Present Trends in Digital Industrial Radiography

NDT Image Capture Technologies



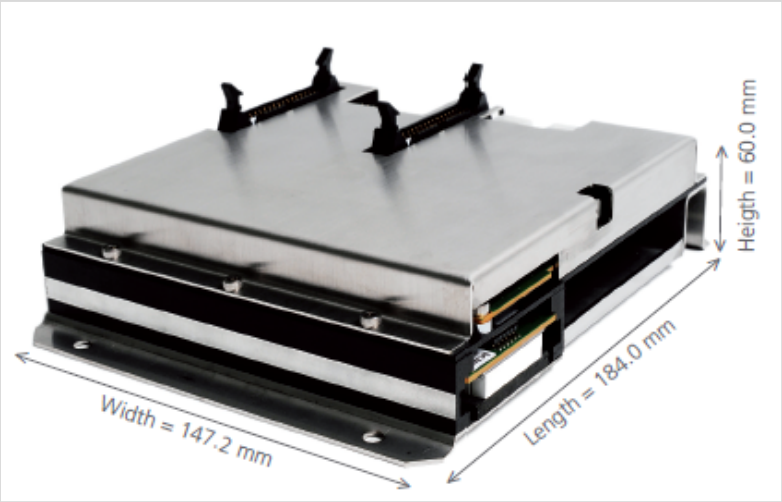
Ref.: Soltani (Liberty)

Filmless Radiography: Digital Detectors Array

Matrix detector PE1620

(www.PerkinElmer.com)

Energy range	20 kV – 15 MV
Szintillator	$Gd_2O_2S:Tb$
Pixel number	2048 x 2048
Pixel size	0,2 mm
A/D-resolution	16 Bits
Interface	Ethernet
Frame rate	3,75 fps



Line detector-Modul X-LSC 2.3

(www.DeeTee.com)

Energy range	450 kVp – 9 MeV
Szintilator	$CdWO_4$
Channels/Modul	64
Pixel size	2,3 mm x 7 mm
Absorption length	30 mm
A/D-resolution	18 Bits
Interface	Ethernet
Frame time (continous)	1,0 ms – 128 ms

BAM

Fast Test of Heat Exchangers
with Tiled DDA

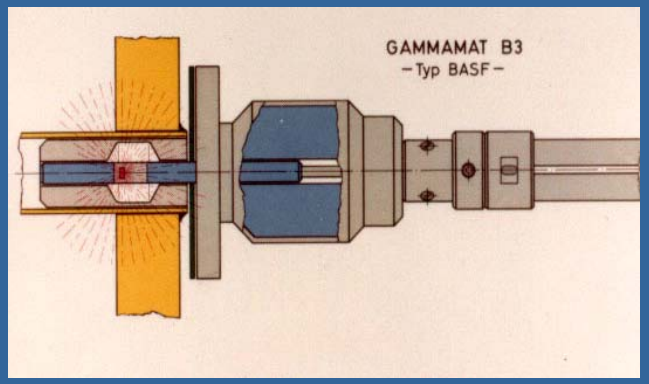
Testing of Heat Exchanger Welds

RT-testing of tube-to-tube-sheet joints Gammat B3

BASF The Chemical Company

Possible tube dimensions: 12*1.5 up to 76.1*4 (diameter*thickness)
Materials: carbon and stainless steel, Ni-alloys, Zr, (Ti, Ta)
Joint design shall be considered

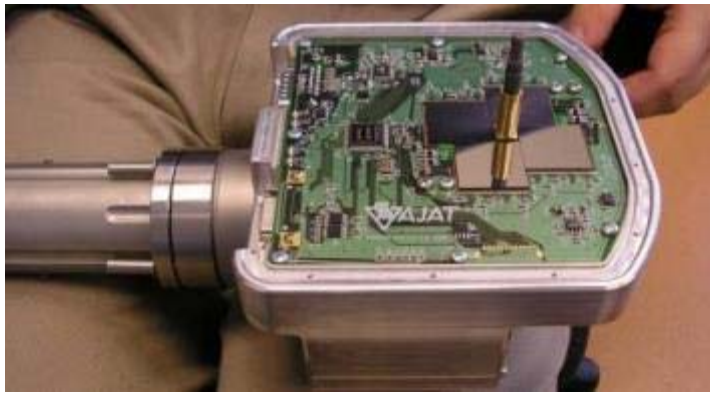
Ir 192, Radiator: 1 x 0.5 mm²



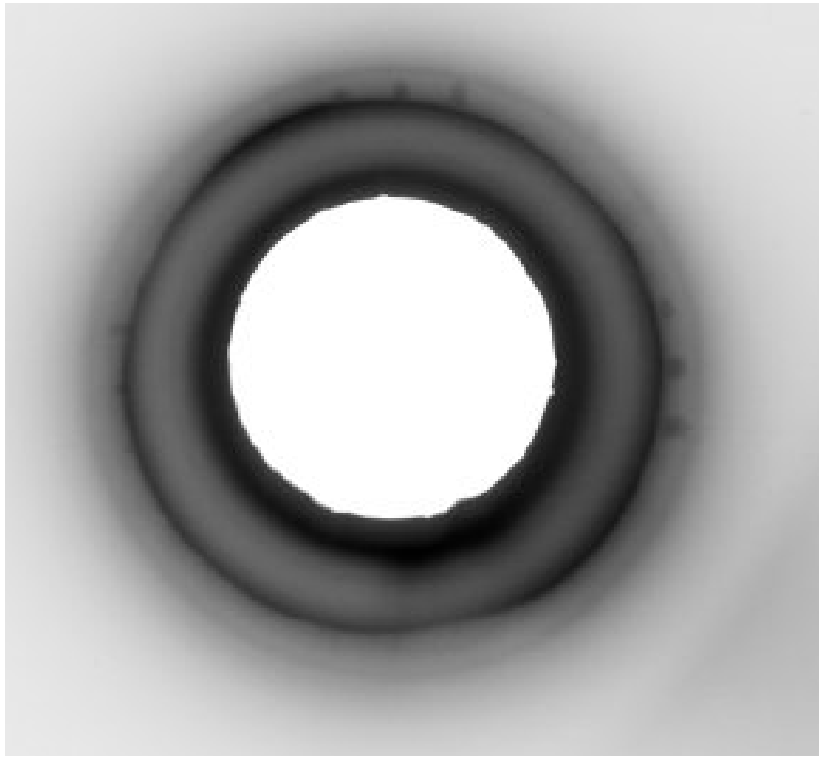
Testing of Heat Exchanger Welds with a specialised Digital Detector Array Through the Detector

X-ray tube Warrikhoff MCTS 130A-0,6 and
CdTe-Detector Ajat DIC100TH

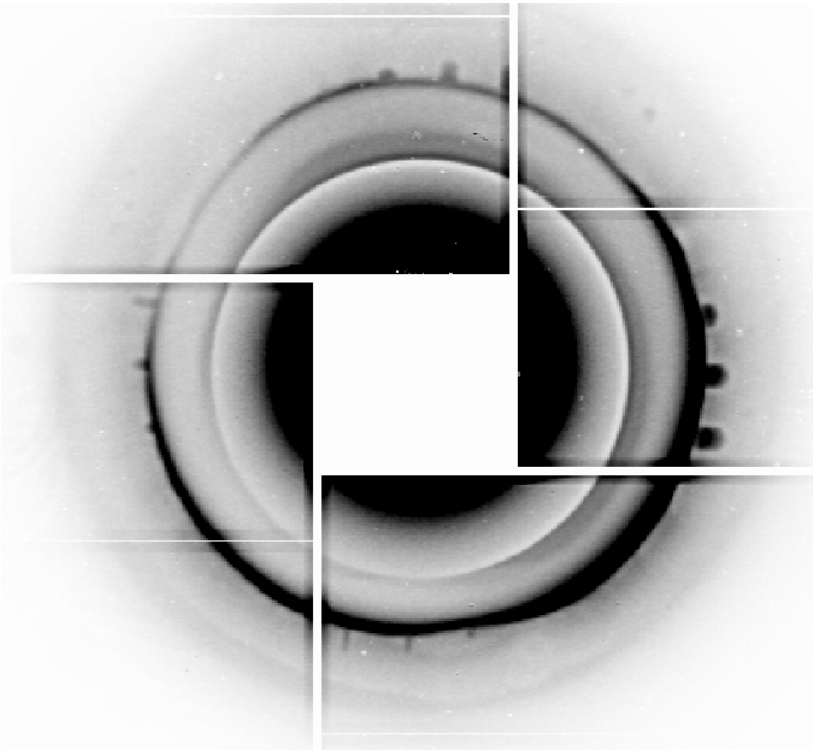
Quelle: Alekseychuk, Zscherpel, Rost



Research-Project BASF / Ajat / BAM since 2006, First Results on Test Weld



D4 film with 130 kV:
1 min (1mm Sn filter)

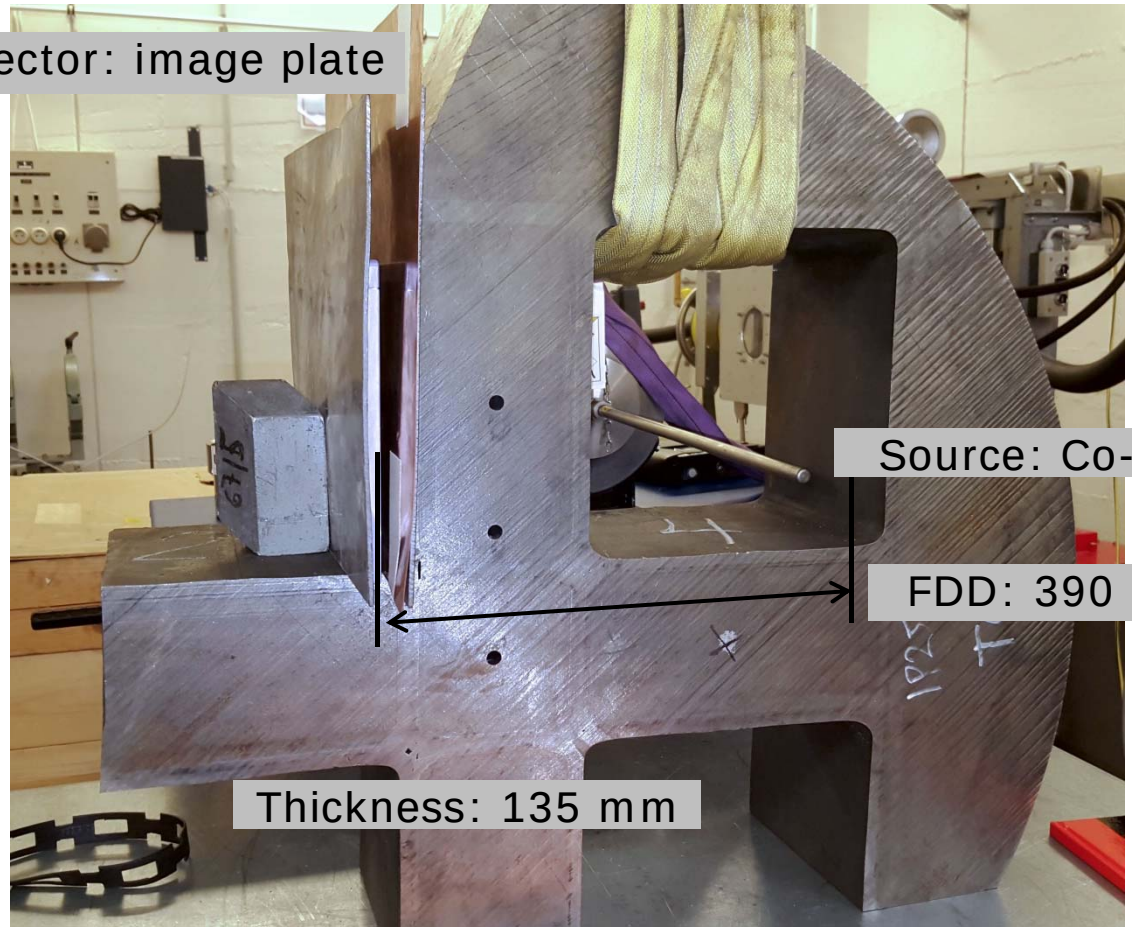


X-Ray tube with DIC100TH detector
75 kV, 0,5 mA, 10s

- greater sensitivity → smaller energy → smaller exposure dose

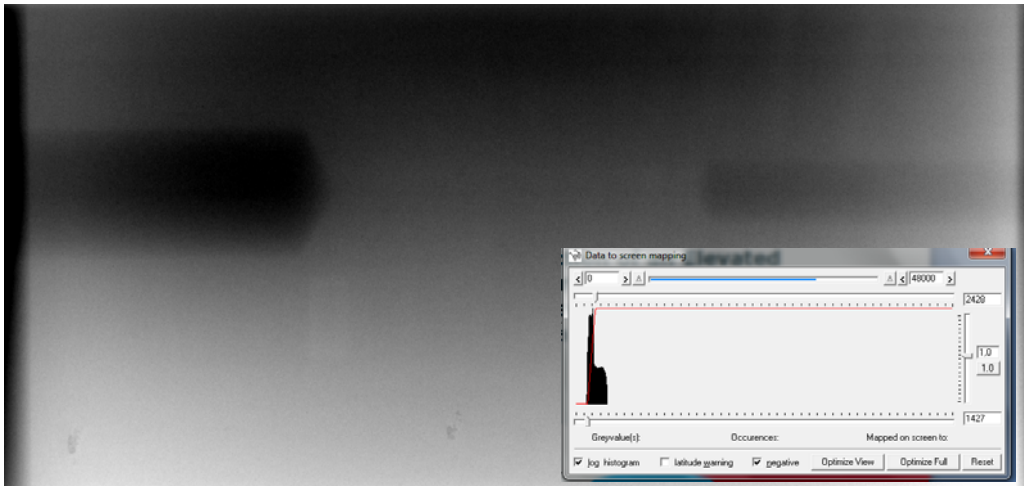
Radiography on thick-walled components

Radiography of thick-walled components with Co-60



Iron cast insert for the transport of fuel rods in Castors (skb.com)

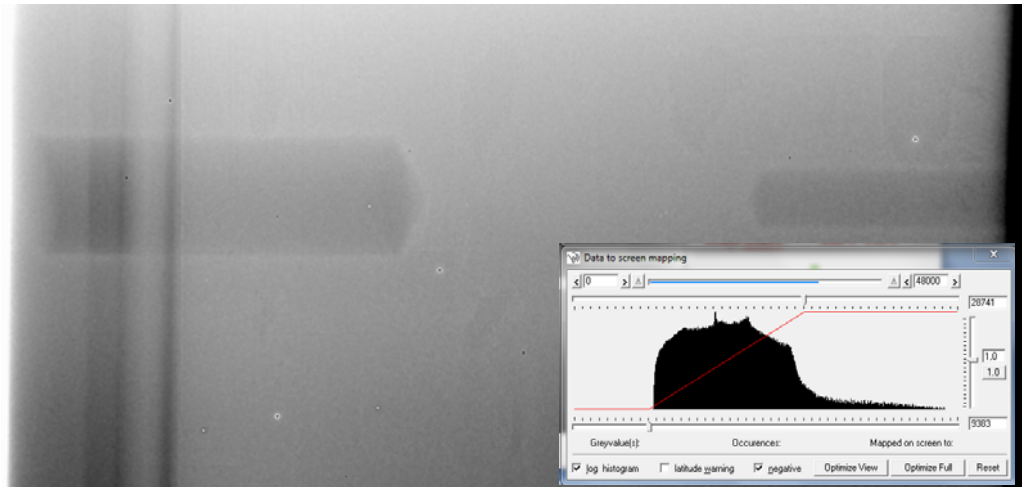
Radiography of thick-walled components with Co-60



Film Agfa D7, IF+BF: 0,6 mm

FDD	360 mm
Acitivity	3343,97 GBq
Exposure time	8 min.

Exposure value	26751,76 GBq*min
Image quality:	SNR = 230:1



DDA PerkinElmer XRD1622, 200µm

FDD	390 mm
Acitivity	3340,97 GBq
Exposure time	4 min. (60frames, 4sec)

Exposure value	13363,88 GBq*min
Image quality:	SNR = 207 : 1

On-site Inspection of an Elevated Subway Construction with an Ir-192 Gamma Source

Subway construction - U2: Task

➢ Riveted steel truss girder viaduct of the elevated metro line **U2** in Berlin-Kreuzberg.

➢ Start of operation: 1902, forced break in operation between 1961 und 1995 caused by cold war separation of Berlin.

➢ Verification of the structures safety against fatigue failure for the coming 30 years.

Subway construction - U2: Task

Rivet 1:
Crack in the gusset plate connection at the vertical strut

Iridium 192 @ 2220 GBq
DDA: Vidisco (145 µm)
SDD=80 cm; 16f @ 20s/f: 320 sec
Exp.value = 11840 GBq*min
Image is highpass-filtered (EnhanceDetails).

Film: Agfa D7
Exp.value = 16576 GBq*min
@ 2405 GBq , 414 sec

New Detector in Radiology: DDA

Advantages

- direct process of radiation detection
- high sensitivity - shorter exposure time
- no dark room required
- digital images available
- evaluation through digital algorithm possible
- higher accuracy
- easy handling (size, weight)
- time integration on the detector

Disadvantages

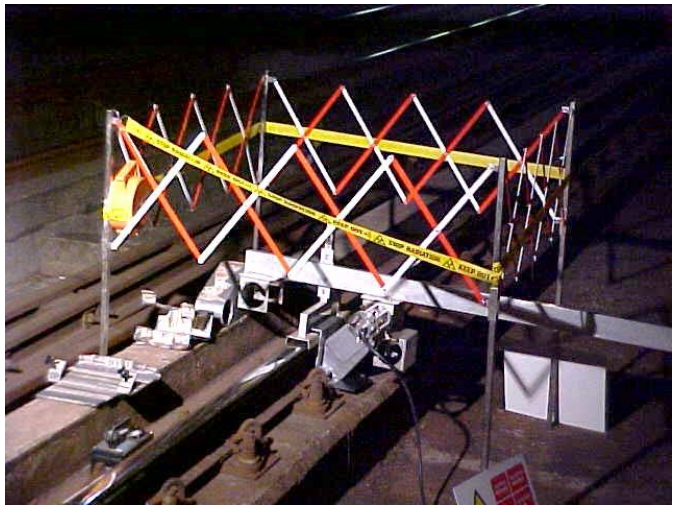
- limited spatial resolution
- different characteristic to the film

Ref.: Beckmann, Onel, Ewert (Juni 2000)

Inspection of rail system

- Southern Region of London
- Hong Kong MTR and KCR Corporations
- Eurotunnel

- Controlled area < 1m
- System Se-75 and CR (image plate) with collimation tube
- on-site inspection



Conclusion

Fan Beam Geometry
reduction of the radiation beam
smaller control zone
Application: line camera with slit collimator in front

Shorter Exposure Time
Minimisation of the exposure of persons
Application: Image Plates (up to 60%, limited resolution)
Flat Panel Detector

Mechanised Scanner-Principle
no film handling --> Minimisation of the exposure of persons (e.g. Nuclear Power Plant)
one-time setup of the manipulator on the test object for multiple repeated exposures