

Mobile Computed Tomography

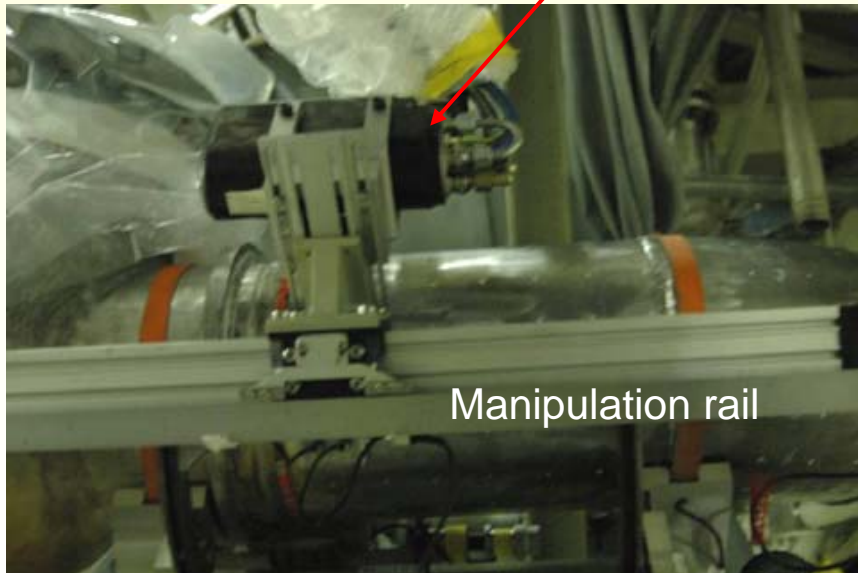
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Radiography in Nuclear Power Stations

Task: Non destructive measurement of flaws in cross sections of austenitic welds

X-ray tube

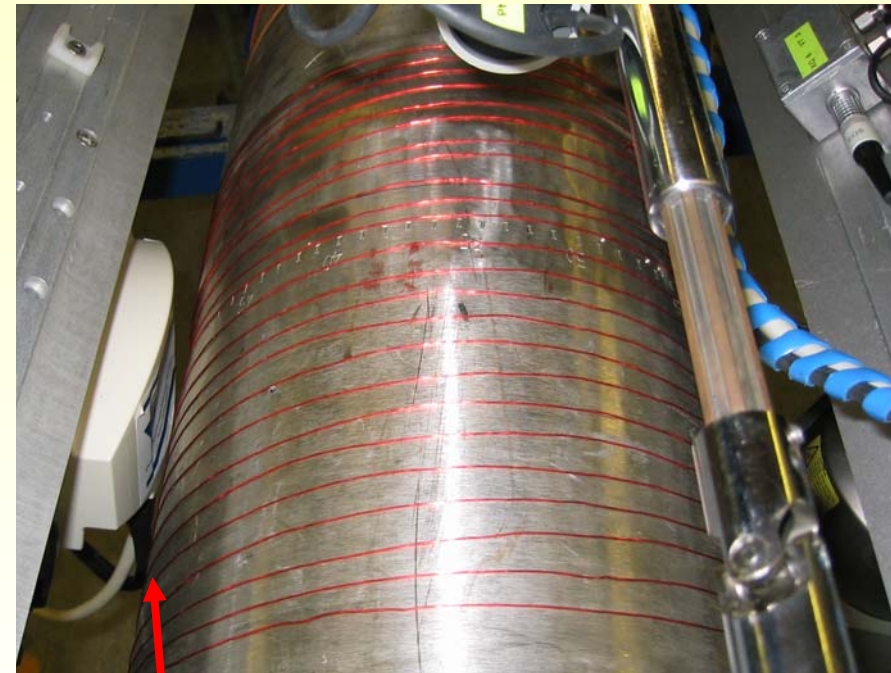
Control and Power supply



Development of a Mechanised X-Ray Inspection System



X-ray tube

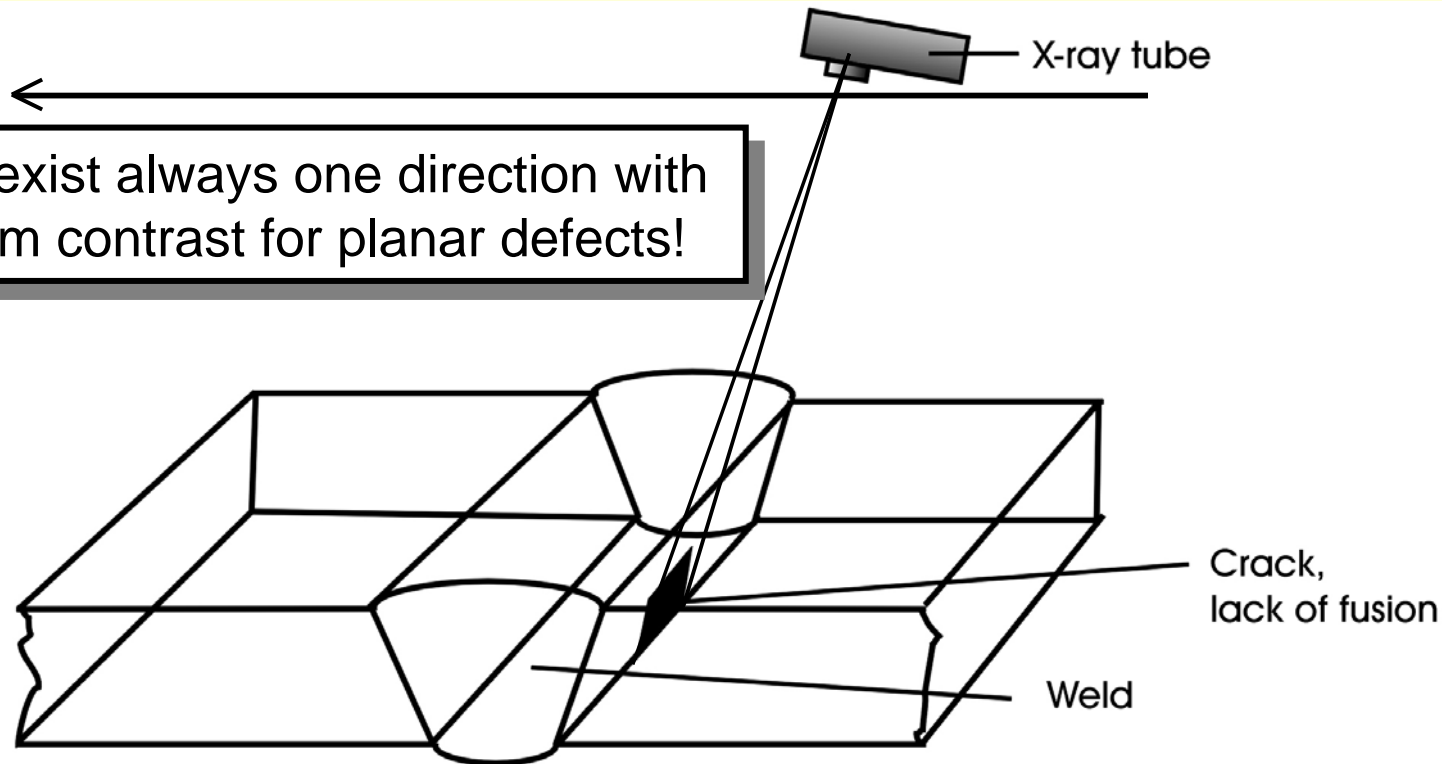


Camera

New Tasks for Radiography

Task: - Reliable detection of planar defects

There exist always one direction with optimum contrast for planar defects!



New Tasks for Radiography

Task: - Reliable detection of planar defects

Linear scan of X-ray tube for sizing of cracks or lack of fusion

X-ray tube

There exist always one direction with optimum contrast for planar defects!



Mechanized Tomographic X-Ray System in a Power Station

In-field test:

Setup of the scanning unit and adjustment of the digital array detector



Mechanized Tomographic X-Ray System

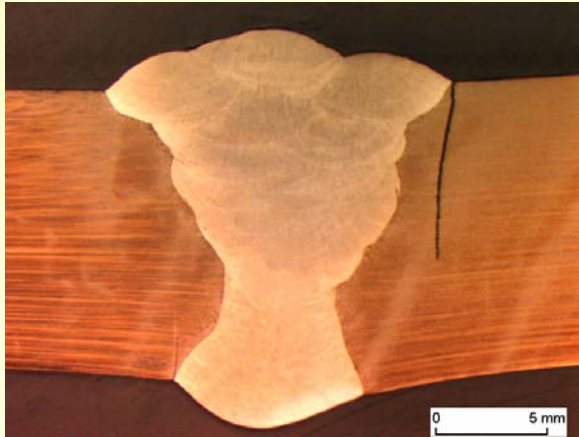
In-field test:

Control unit for measurements in a power station



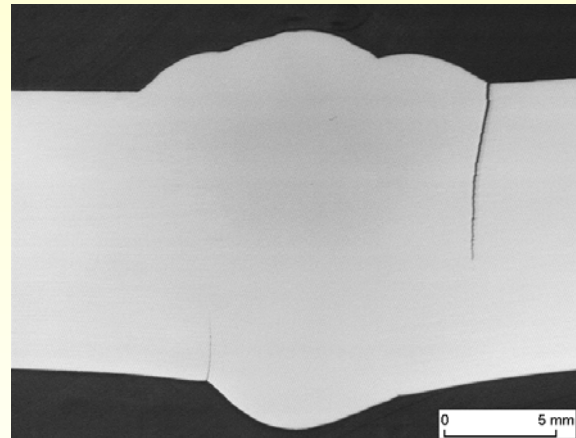
Environment for the measurements in a power station

**Metallographic transversal section,
etched**

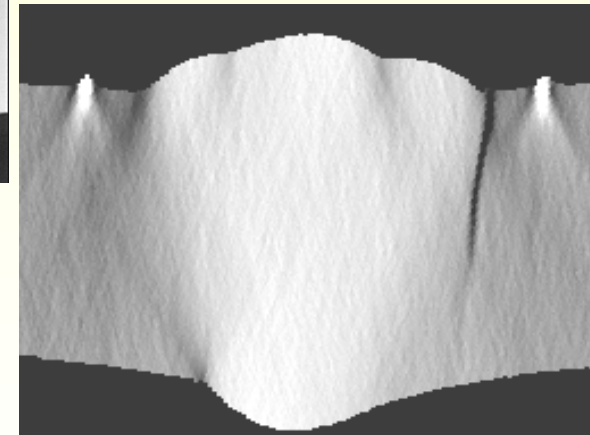


Austenitic weld sample

**Untreated metallic surface
after mechanical cut**



**Non-destructive
tomographic section**



Results

destructive

non-destructive

Metallography – 8.1mm

Tomography – 7.7mm

Innovations included:

- New flat X-ray tube
- New digital array detector on basis of CdTe
- C-MOS line Camera
- New tomographic reconstruction algorithms
- Special manipulator

Innovations included:

- New flat X-ray tube

Bipolar Extra Flat X-ray Tube MCT240

Window for fan beam
geometry ($\pm 45^\circ$)



Technical Data

Energy	240 keV
Current/Power	2,5 mA / 600W
Focal spot	0,5 x 0,5 mm
Weight	ca. 7 kg

Manufactured by
Röntgen-Technik Warrikow (rtw)

Innovations included:

- ...
- New digital array detector on basis of CdTe

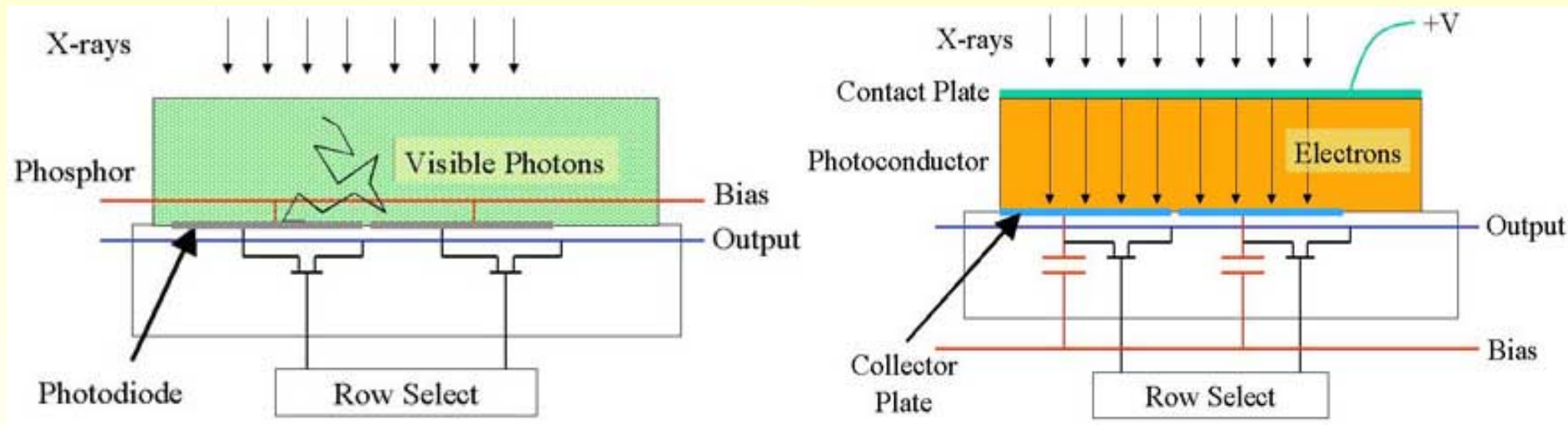
Direct Converting Detector Array

Dynamic Imaging Camera (DIC 100):

Oy Ajat Ltd
Tietotie 3
02150 ESPOO
Finland
www.ajat.fi



Resolution Enhancement by Direct X-Ray Conversion



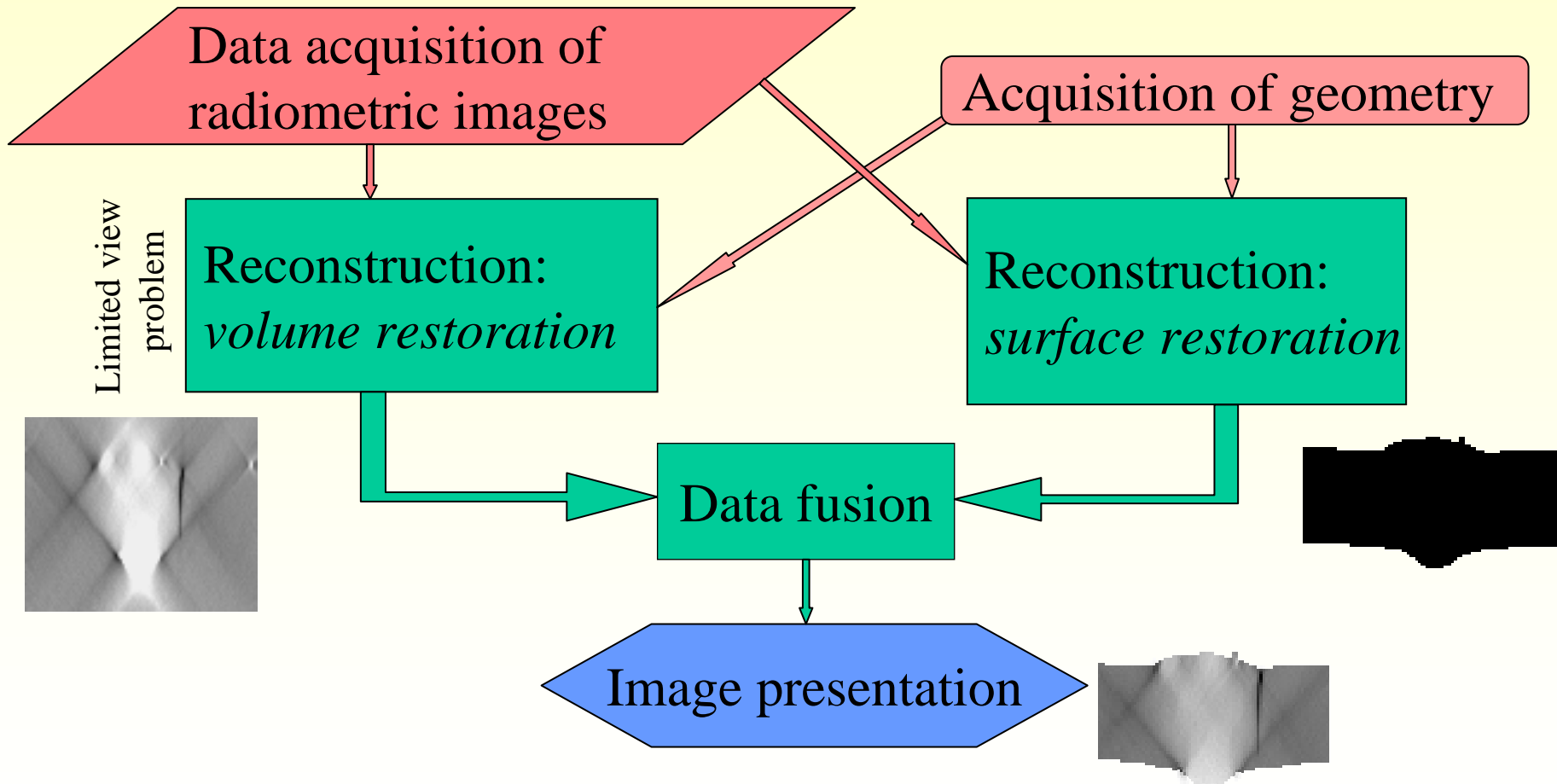
TFT-Structure on am-Si

CMOS ASIC

Innovations included:

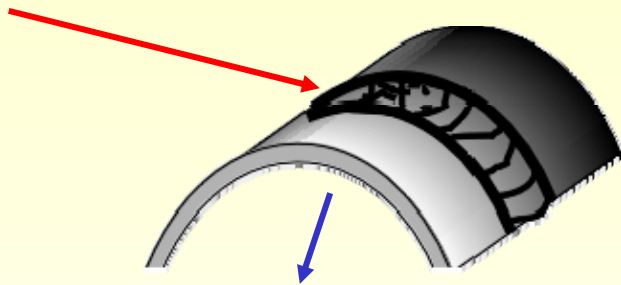
- ...
- ...
- ...
- New tomographic reconstruction algorithms

3D-Reconstruction – Limited view problem

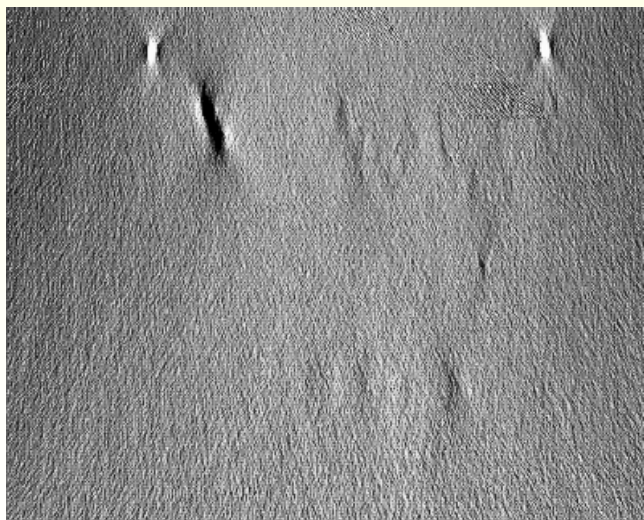


Results: Austenitic Pipe

3D-Planar Tomography

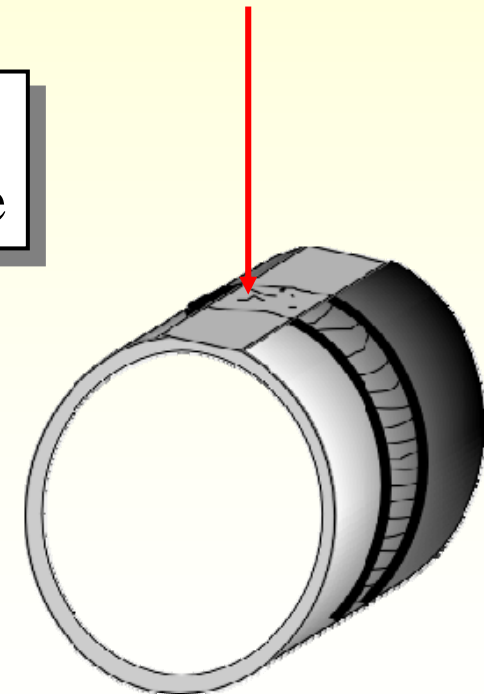


Transversal section scan:



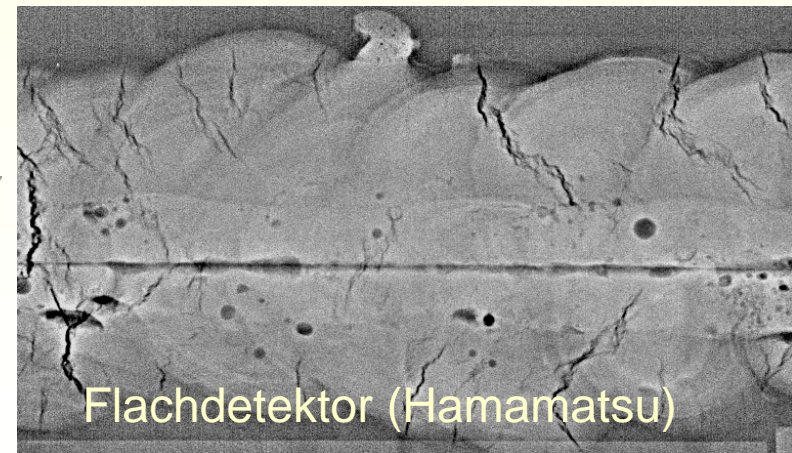
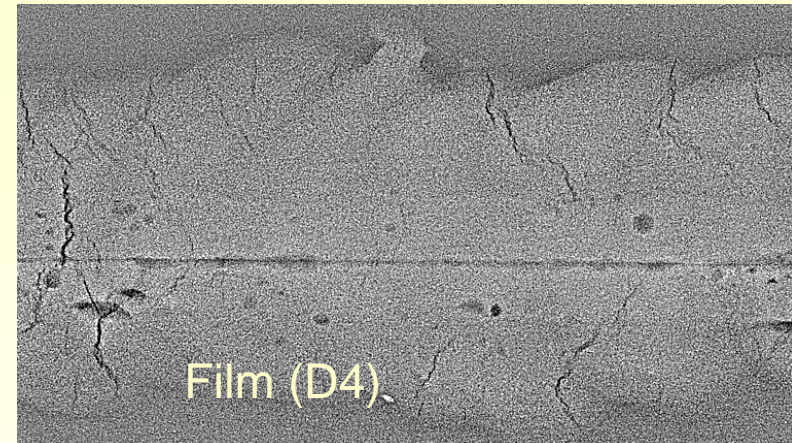
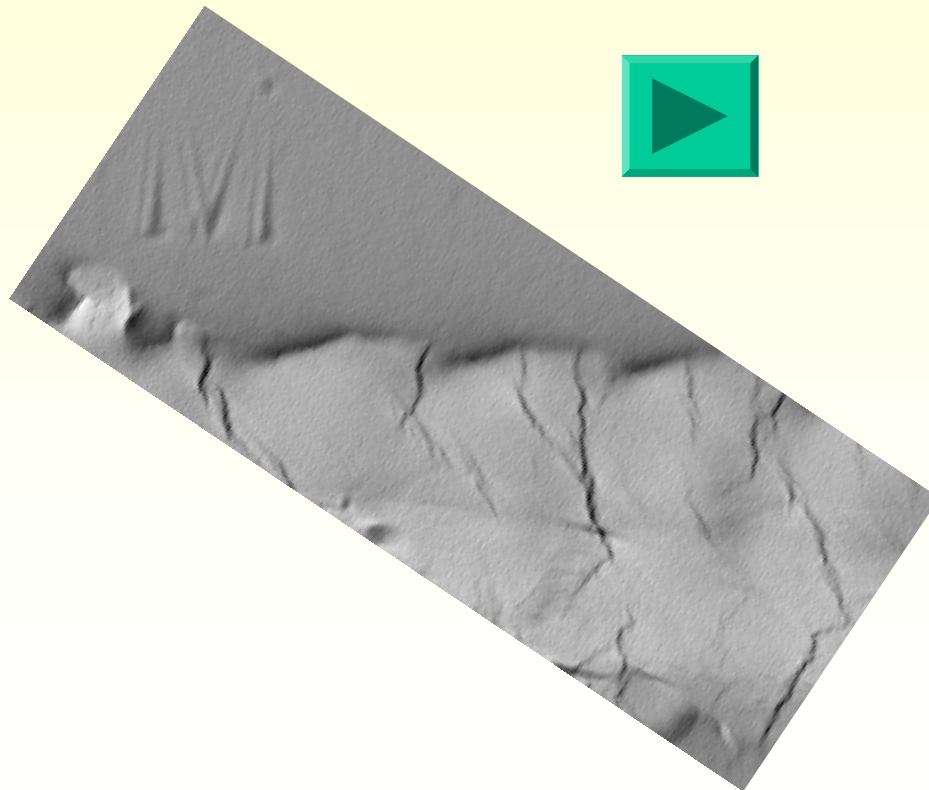
Camera trip
trough surface

Pipe 156 x 20 mm,
Austenit 1.4550
Tube voltage 190 kV



Planar Computed Tomography vs. High Contrast Sensitivity RT

Planar Tomogram



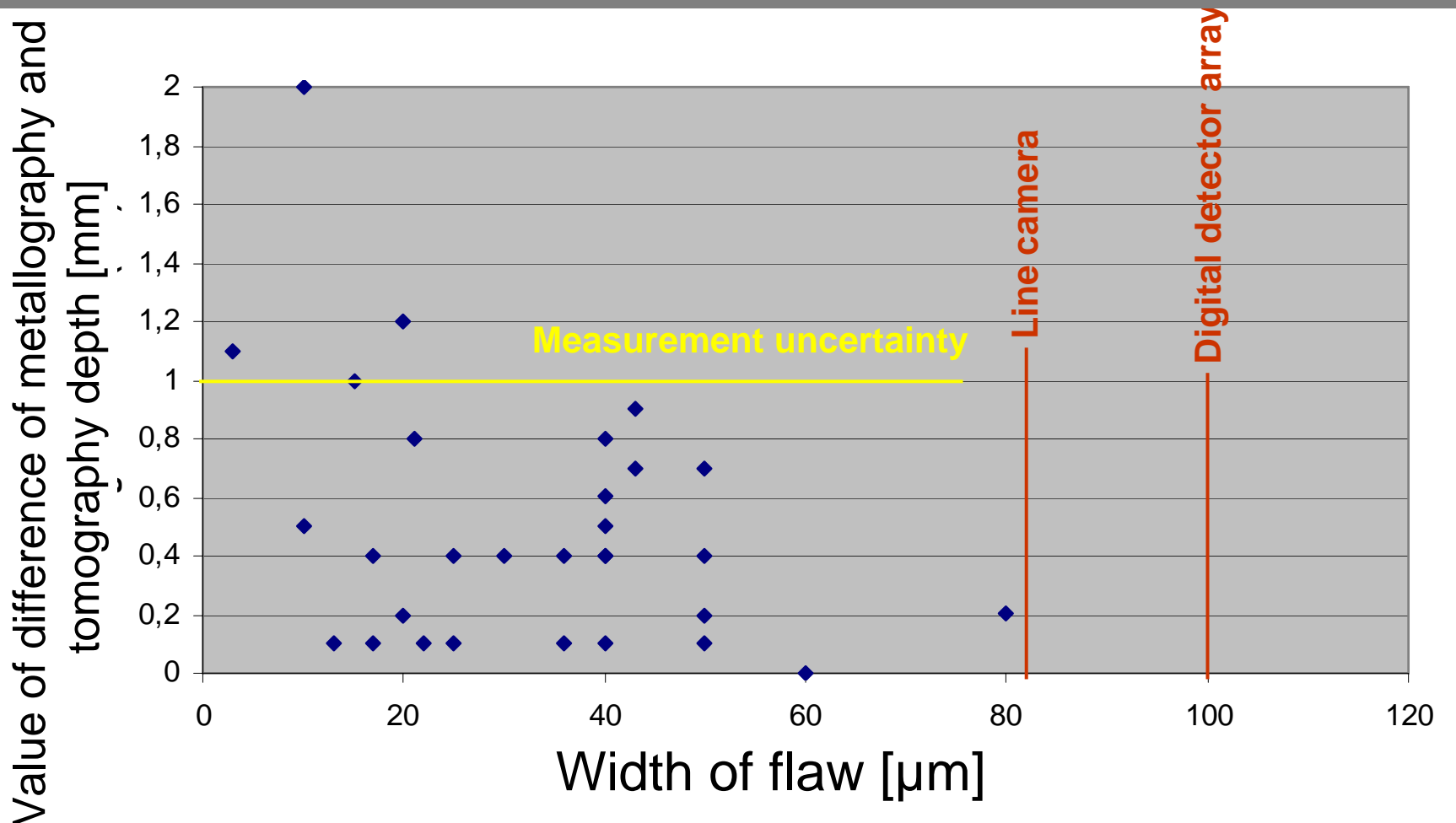
European Network of Inspection and Quality (ENIQ)

- Method has been selected for a German pilot qualification study
- Tests are successfully performed at test specimen of German nuclear power stations
- Certificates were issued

Quelle: Neundorf, 2001

Metallographie vs. Planartomographie

Value of difference of indication and measured dimension of the discontinuity as function of opening of flaw (with of discontinuity)

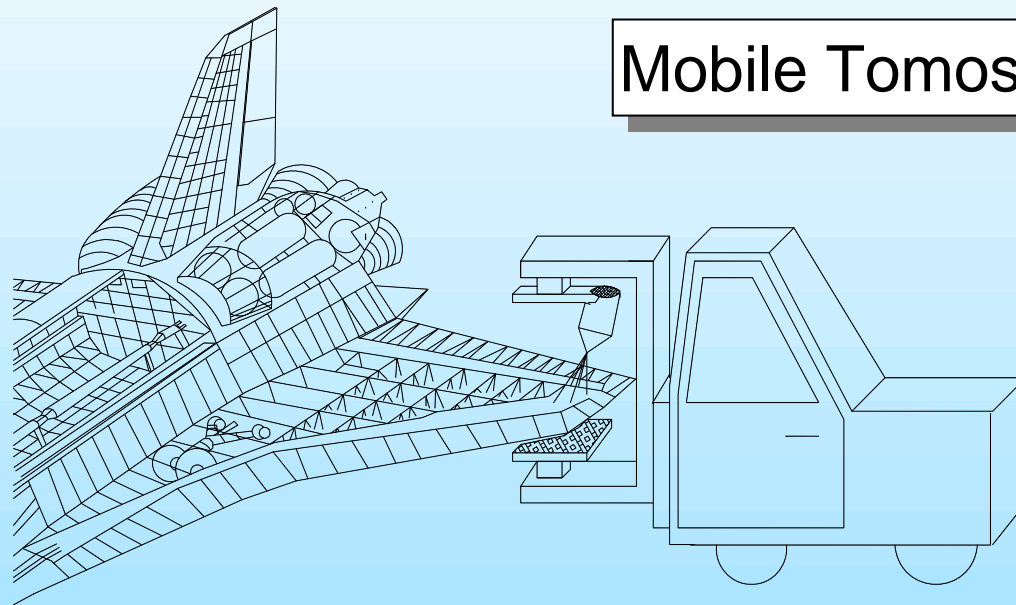


Inspection of Composites of Aircraft Components

CT of large components

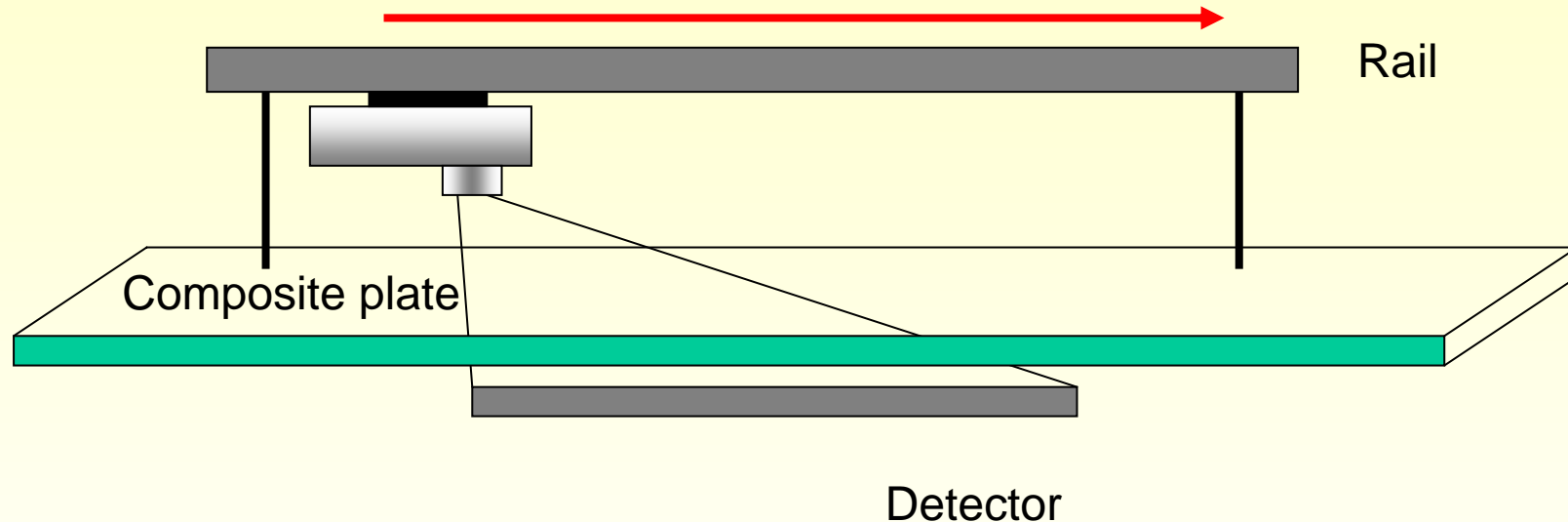
Mobile Airplane Inspection by Digital Laminography

Mobile Tomosynthesis



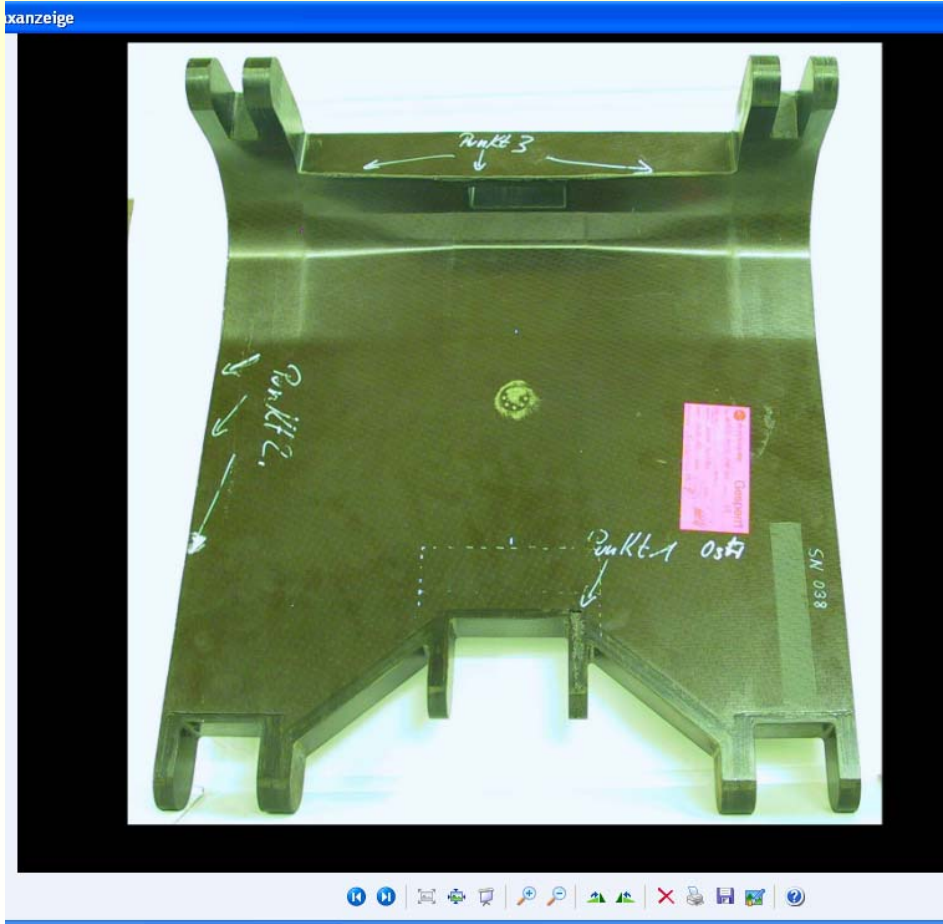
BAM, Lab. 6.21, Ewert

Planar Tomography with Simple Means

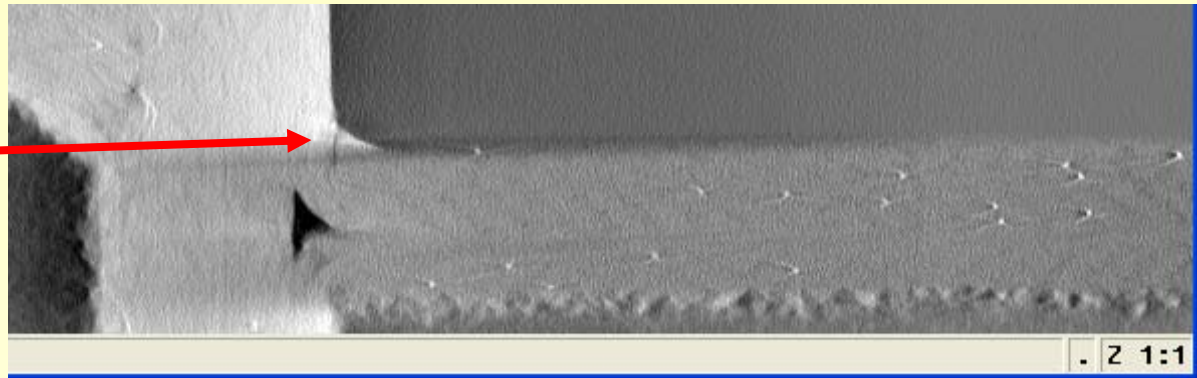


- X-ray tube is shifted parallel to the object to inspect
- Measurement of few hundred projections.
- Reconstruction of 3D-image.

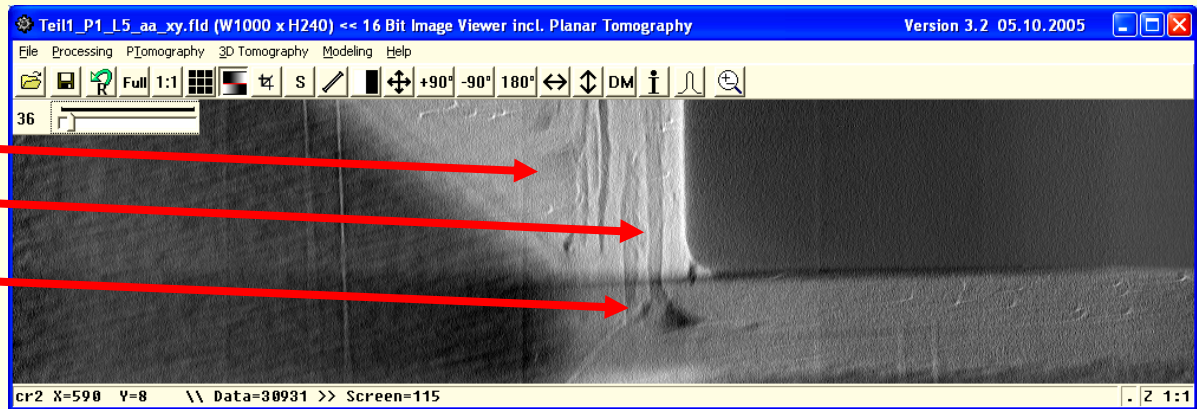
Mobile CT of Fibre Composites



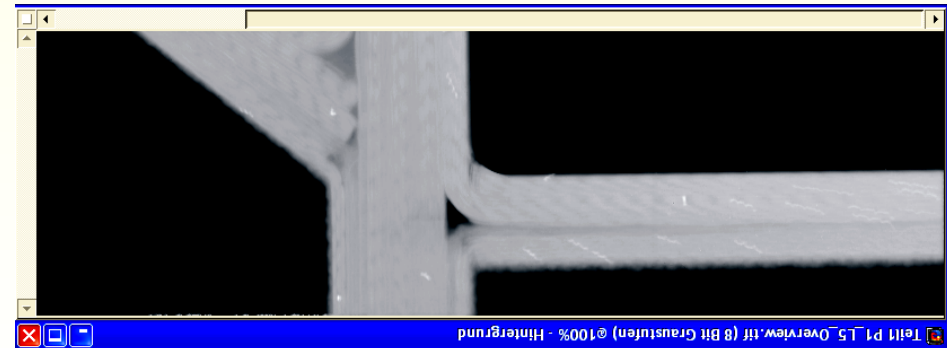
Crack indication



Resin nest
Planar imperfection
Incomplete filled



X-ray exposure



Conclusions:

- Planar tomography (also coplanar laminography) generates non destructive cross sectional images containing all planar and volumetric indications in the observation angle.
- The depth and length of planar discontinuities (crack, lack of fusion) with an opening width of $> 25 \mu\text{m}$ can be reconstructed with an uncertainty of $\pm 1 \text{ mm}$.
- The spatial resolution is sufficient to detect longitudinal discontinuities with an quarter of the pixel size.
- Welds of austenitic and ferritic materials were successfully examined in a European pilot study on the basis of the European Network for Inspection and Qualification (ENIQ). Certificates were issued.
- The system is furthermore suitable for the inspection of large fibre composite parts in the aircraft industry. Detector and X-ray tube at a control rail can be mounted independently from each other.
- The maximum penetrated thickness of steel amounts to 50 mm.

End

