

# Computed Tomography for Industry – Needs and Status

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International Atomic Energy Agency Scientific Forum

**ATOMS IN INDUSTRY**

Radiation Technology for Development

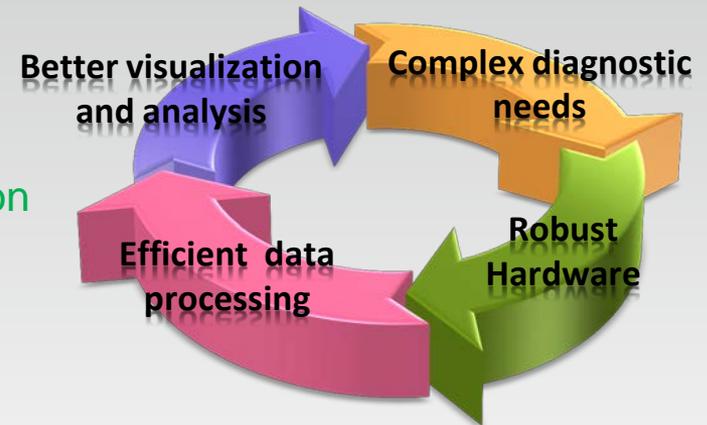
15–16 September 2015, Vienna, Austria

# Industrial Computed Tomography (ICT)– Needs

**Why industrial tomography is required when many conventional NDT techniques are available??**

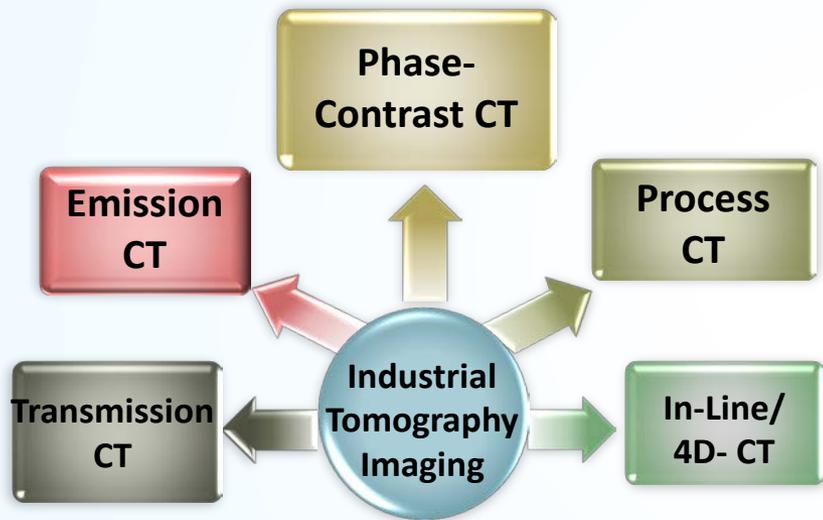
- Qualitative & Quantitative radiological imaging capability
- Exterior and interior visualization
- Dimensional measurements (CT metrology)
- A versatile computational imaging technology
- Minimal superimposition
- Enhanced image contrast and defect characterization
- Process tomography – tool for chemical and process engineering
- Emission Tomography – possibility of improved visualization of radioactive containments
- Possibility of various configurations and modalities to suit varied industrial NDT requirement

## Industrial CT – Key drivers for innovation

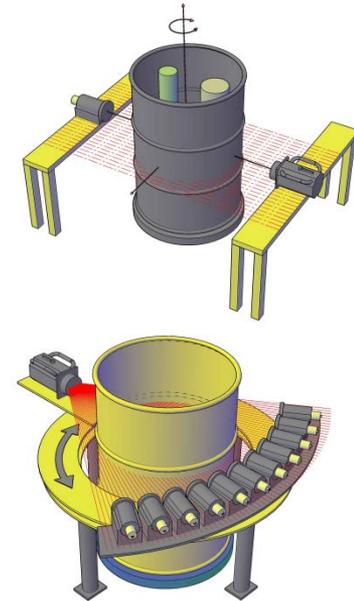
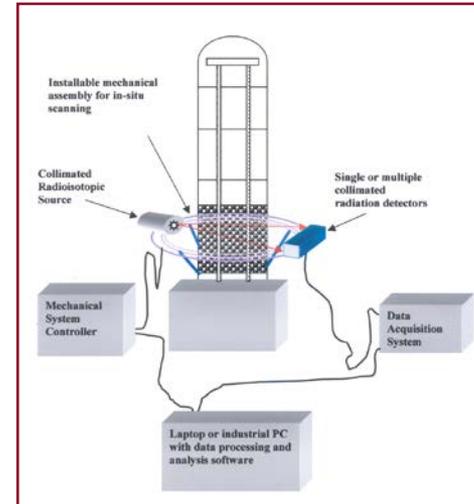
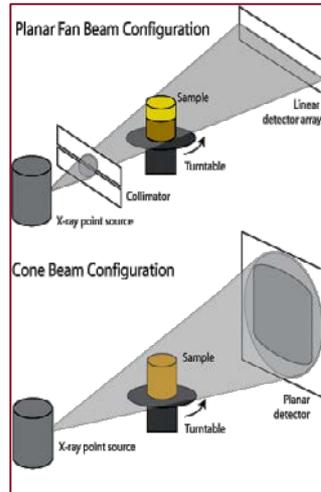
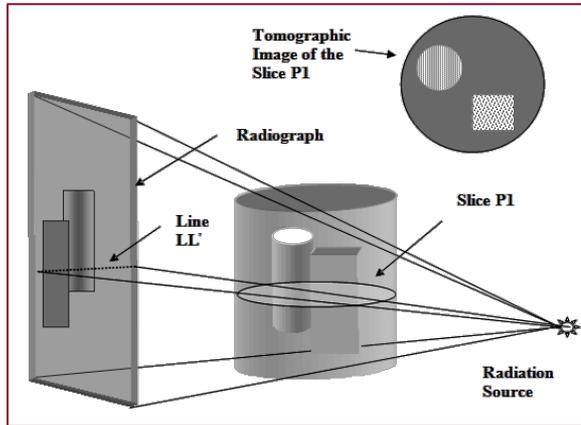


*ICT has its genesis in rapid evolution of tomographic imaging in medical field over the last three decades.*

# Modalities of Industrial Computed Tomography (ICT) & Development Cycle

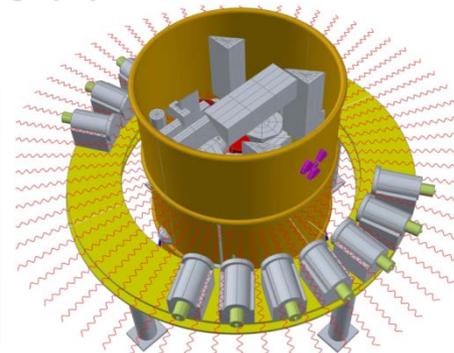


# Industrial Tomography – an advanced radiation based industrial diagnostic technology



*A typical medical CT scanner for reference*

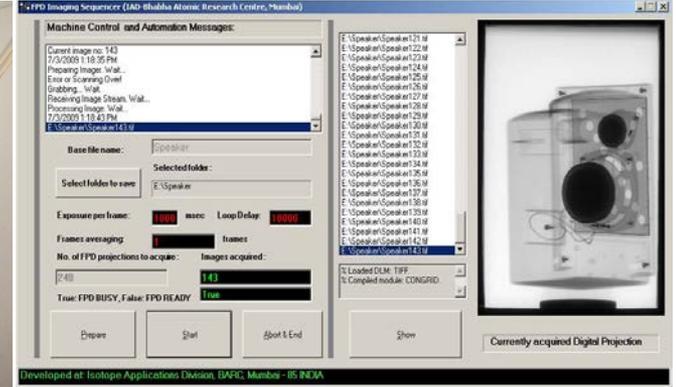
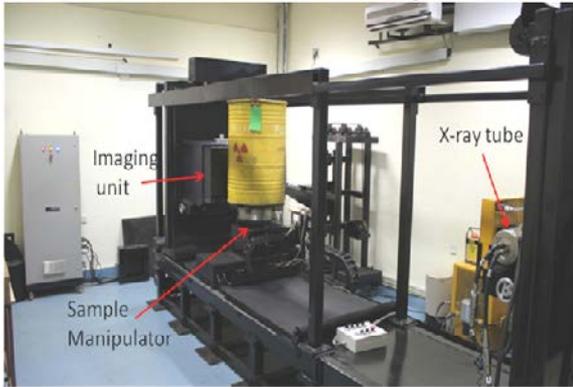
## Conventional Industrial Radiography and Tomography



## Emission Tomography modality



# Industrial Tomography – Typical system views

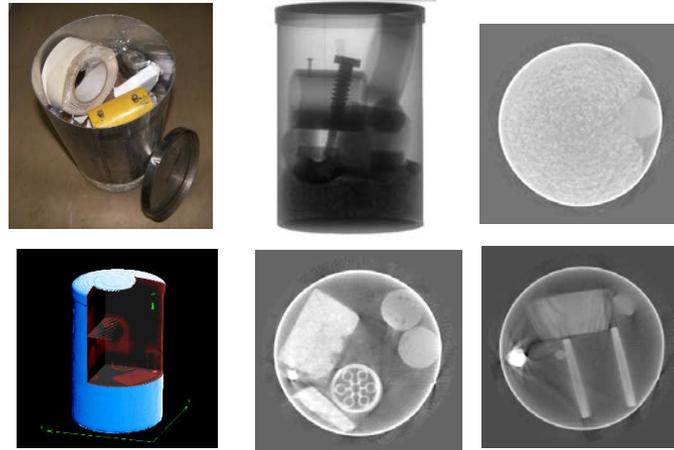


The picture shows a typical 3D industrial tomography imaging system which can handle large objects

Another DR&VCT laboratory at BARC. The picture shows a six-axis manipulator, X-ray tube head and an a-Si 2D detector assembly.

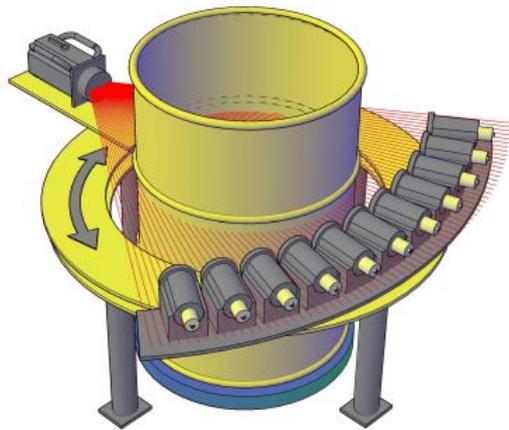
Common Graphical Use Interface of VCT Control Software

A typical simulated waste container containing metal/ non-metal parts, X-ray digital radiograph, some representative cross-sectional X-ray tomographs and 3D volume tomograph (images from top-left and going in clock-wise direction)



A typical cold-bed test reactor, full digital radiograph, 3D surface rendering from CT data

# Industrial Process Tomography



Radiation Source - Cs-137  
Detector: NaI(Tl) - 2" x 2"  
Detector Collimator - 2 mm  
Programming - Expectation-Maximisation (EM) and Alternating-Maximisation (AM) algorithms written in Visual-Fortran programming language

Experimental Gamma ray based process Tomography setup for Research and Development Studies

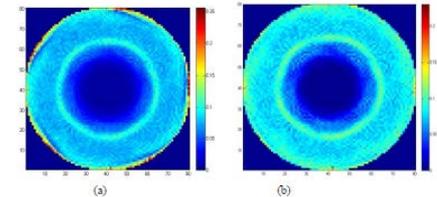
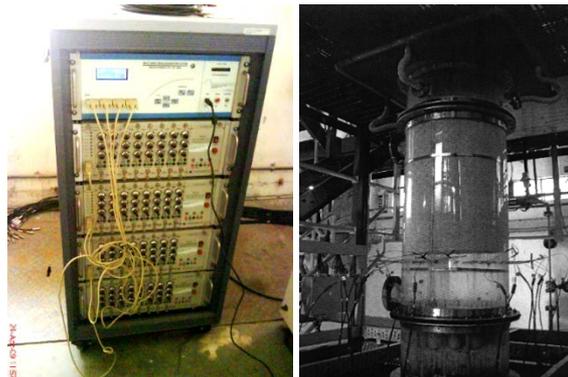


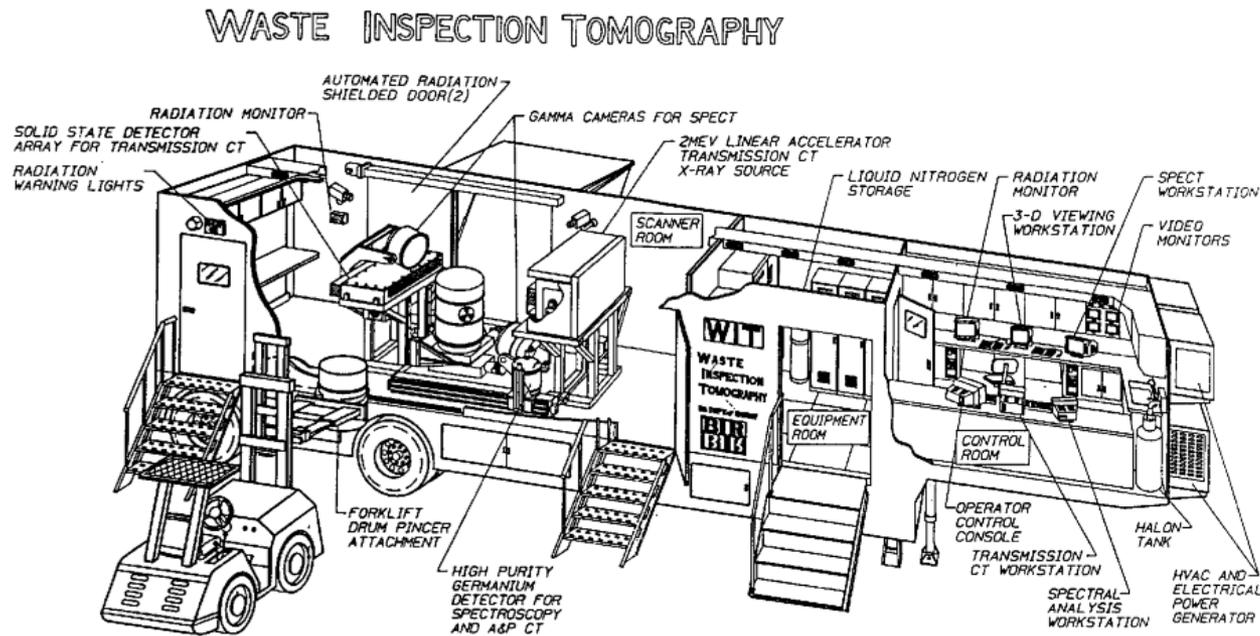
Figure 3. Tomographic images of the phantom reconstructed by using (a) E-M algorithm, and (b) A-M algorithm.

*Ref: Development of a Gamma-Ray Process Tomography System for Hydrodynamic Characterization of Multiphase Reactors*  
Jaafar Abdullah1 et. Al  
Applied Mechanics and Materials, Vol. 83, pp. 41-47, Jul. 2011

# Emission Tomography in Industry and other combined imaging modalities

Representative collaborative work in Industrial Tomography  
(Government ↔ Academia ↔ Industrial Partner)

Active and passive tomography for waste drum inspection: for characterization and studies on activity distribution of radioisotopes

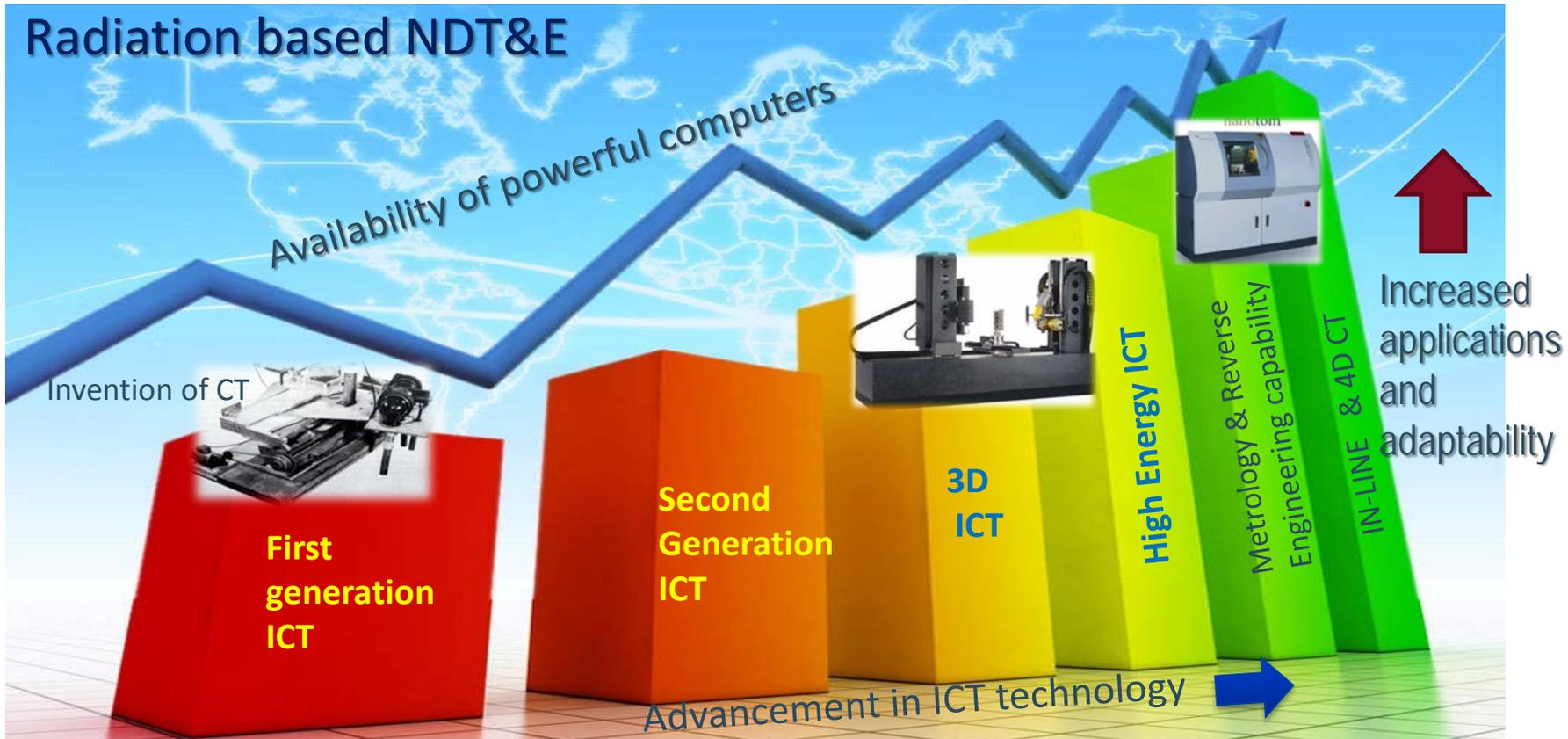


BIR Mobile Inspection Trailer and the equipment layout

Ref: Innovative Technology Summary report – DOE-EM/0740 SEP 1999



# Growth of Industrial CT Technology



Other application areas of computational tomographic imaging:

Emission based ICT

Process CT

# Advanced Radiation Technologies (RT) in Industry: Socio-economic benefits

**1. Advances in RT/ICT mean better compliance to near-zero defect philosophy**

**3. Green technologies in industrial environment, mitigation in large-scale industrial system and process failures**

**5. RT in Industry - an important attribute to improved Socio-economic indicators over the last few decades**

**2. Driving force for competitive manufacturing processes: win-win situation for manufacturers and consumers**

**4. Newer avenues for skilled / trained manpower generation and better employability of Human Resources**



## **Conclusion:**

**With ever-increasing applications of industrial computed tomography especially in flaw detection, failure analysis, metrology, assembly analysis, reverse engineering, process visualisation, conservation of museum artifacts and many others,**

**one can have a very prospective outlook on the cost-effectiveness and socio-economic benefits of this innovative technology.**

# **Thank you!**