

High Energy Radiography Lecture

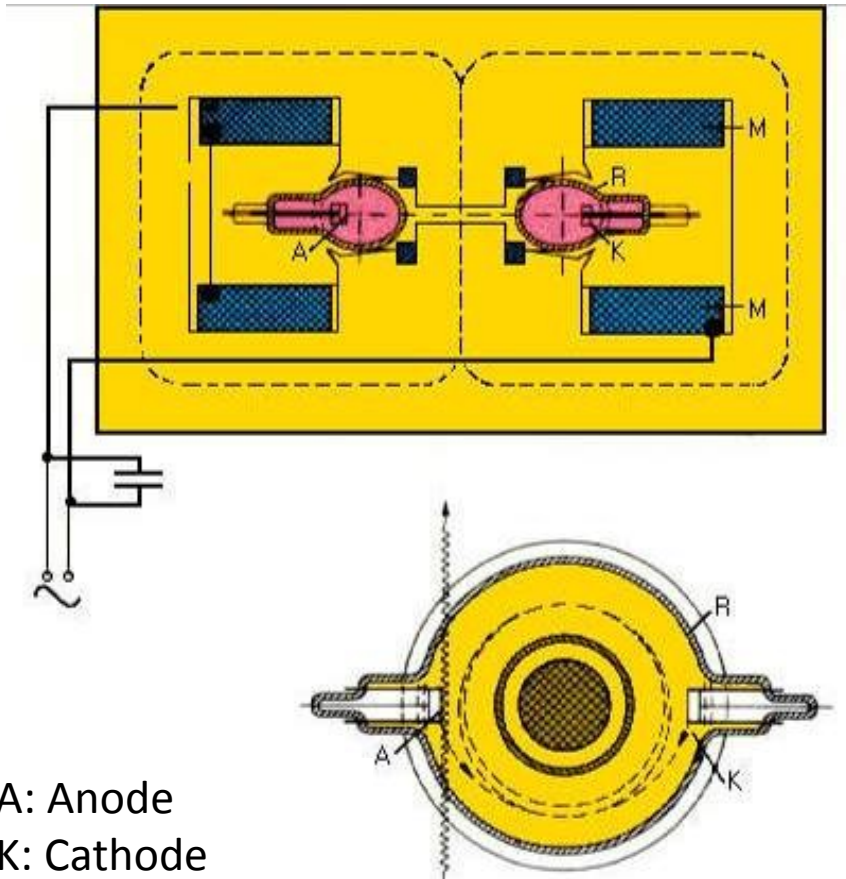


Betatrons & Applications

Michael Kröning

**ACCELERATOR PRINCIPLE
INSTRUMENTS
RADIOGRAPHIC PARAMETERS
APPLICATIONS
EXAMPLES**

High Energy Radiography Lecture



A: Anode
K: Cathode
M: Magnetic Field
R: Vacuum Torus

Radial Stability Criterion:

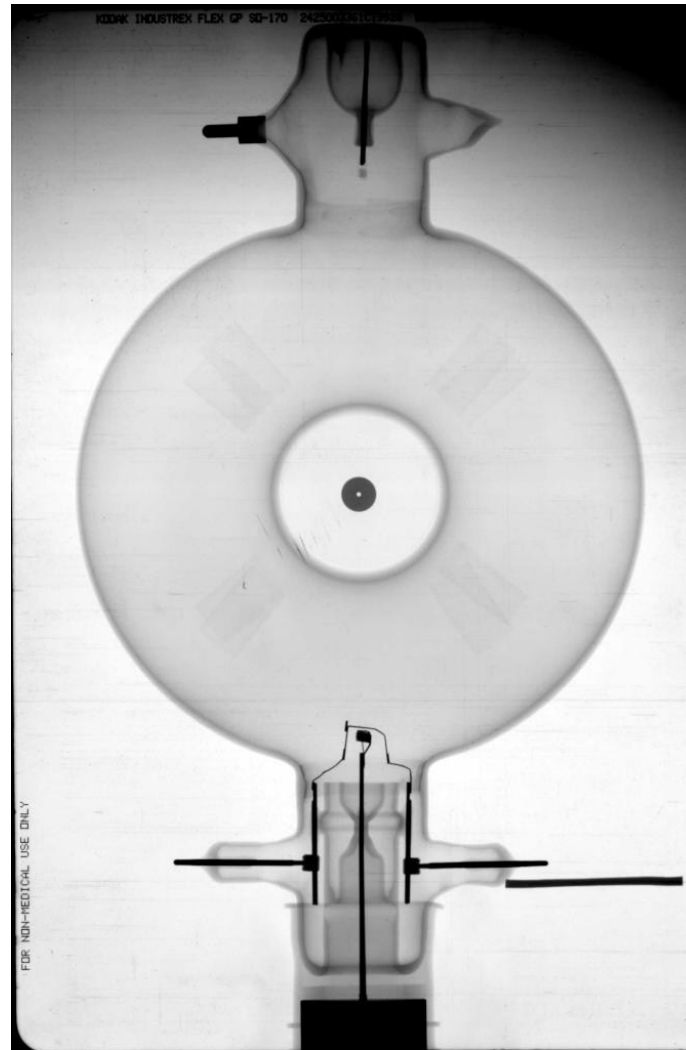
$$F_c = F_L$$

Centrifugal Force: $F_c = m_e v^2 / r$
 Lorentz Force: $F_L = evB(r)$
 as reactive centrifugal force

2.5 MeV	$r \sim 25 \text{ mm}$
300 MeV	$r \sim 1 \text{ m}$

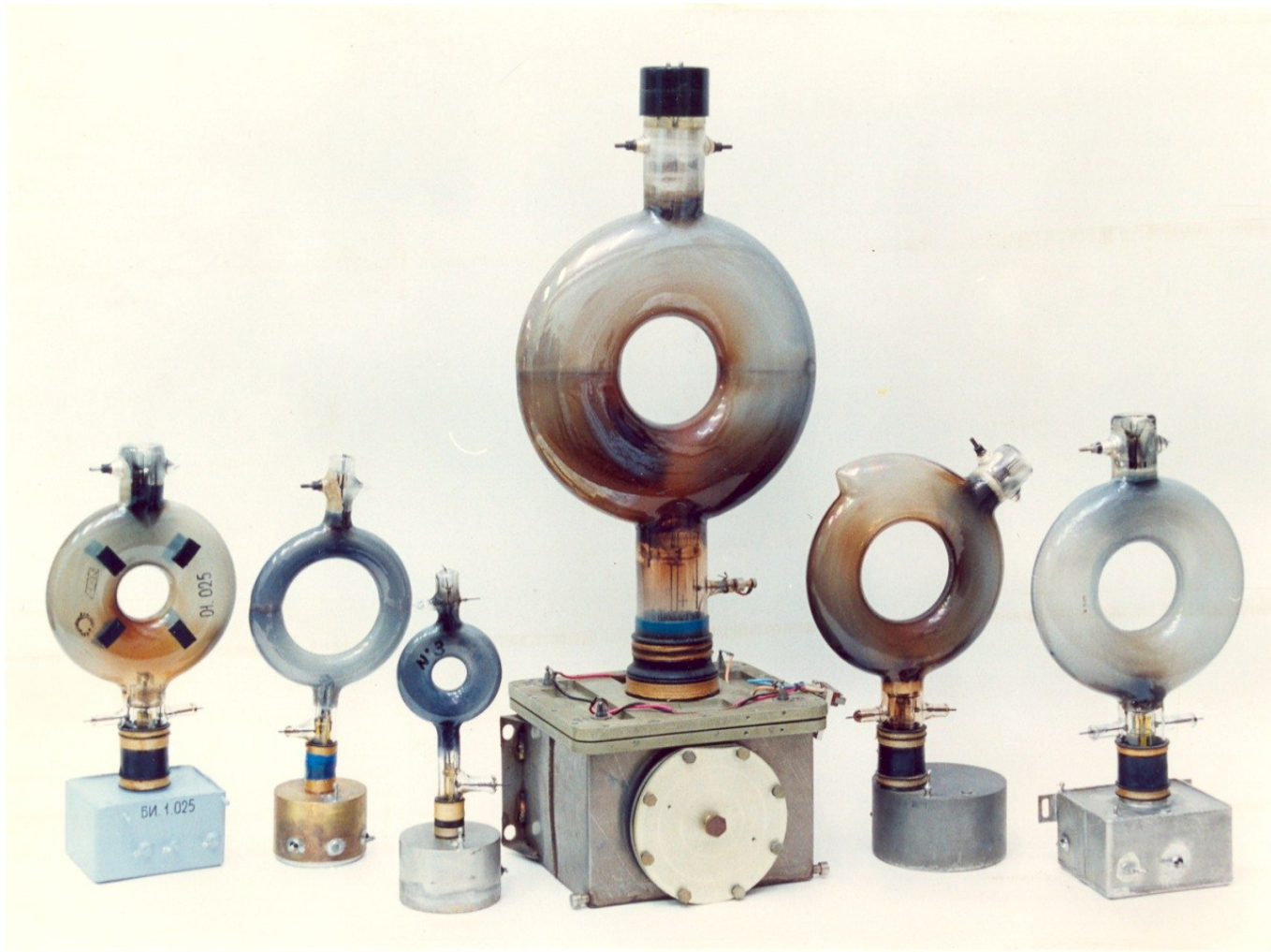
Betatron Electron Accelerator

High Energy Radiography Lecture



Betatron Torus

High Energy Radiography Lecture



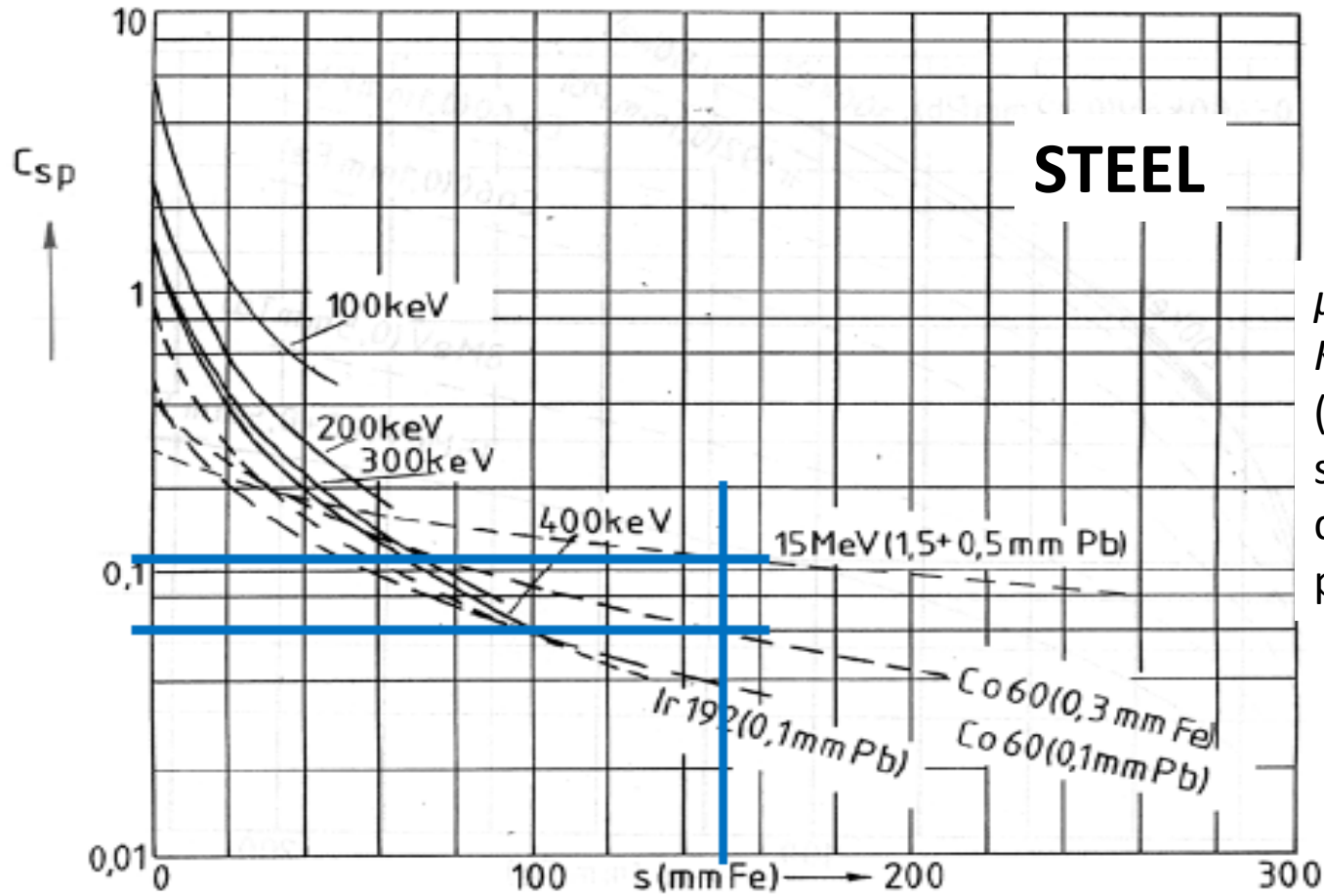
Accelerator Chambers

High Energy Radiography Lecture



RADIOGRAPHIC PARAMETERS

High Energy Radiography Lecture



$$C_{sp} = \frac{\mu}{1 + k}$$

μ : absorption coefficient
 K : scatter ratio
 (quotient of the intensities scattered radiation divided by primary radiation).

Specific Contrast Diagram for Steel High Energy Radiography

High Energy Radiography Lecture



INSTRUMENTS

INSTRUMENTS

High Energy Radiography Lecture



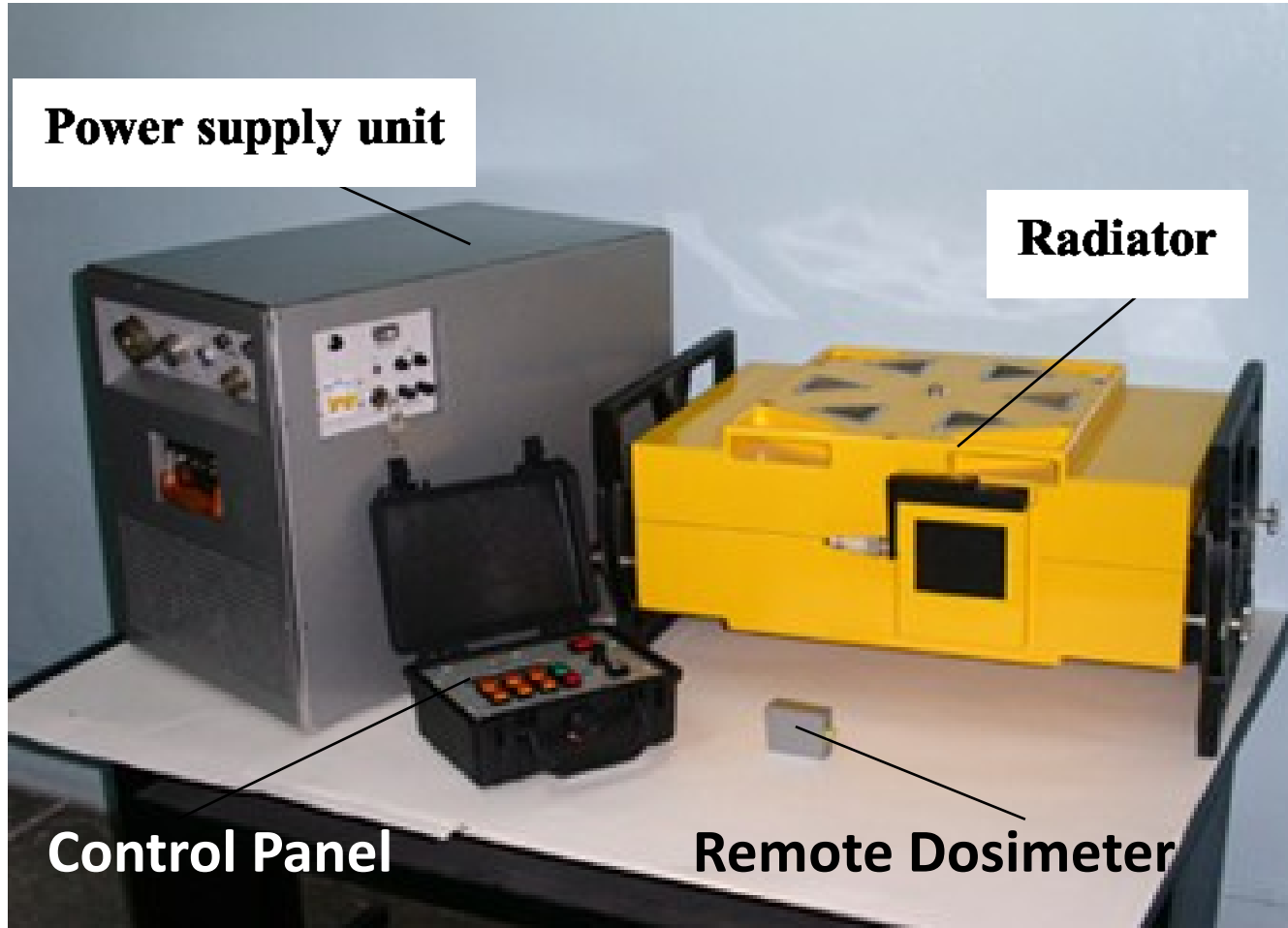
2.5 MeV Betatron Equipment

High Energy Radiography Lecture



7.5 MeV Betatron Equipment

High Energy Radiography Lecture



7.5 MeV Betatron Equipment

High Energy Radiography Lecture



Technische Parameter

	Betatron 2,5 MeV	Betatron 7,5 MeV
Energy	1,0 and 2,5 MeV	2,0 and 7,5 MeV
Exposure Dose Rate	0,7 R/min @ 1 m	5 R/min @ 1 m (measured: 6 R/min)
Focal Spot size	0,2 x 2 mm	0,3 x 3 mm
Duty cycle	45 min. operation 15 min. break	40 min. operation 20 min. break
Power consumption AC (1-phase)	1 kW	2 kW
Weight of the radiator	31 kg	105 kg

High Energy Radiography Lecture

Parameter	MIB-2.5	MIB-3	MIB-4	MIB-6	MIB-7.5	MIB-10
Peak energy of bremsstrahlung radiation, MeV	2.5	3	4	6	7.5	10
Peak dose rate at 1m from the target, cGy/min	0.1	2	1	3	5	16
Pulse repetition rate, Hz	50	400	200	200	200	100
Power consumption, kVA	0.7	2.5	2.0	3.0	3.0	3.6
Radiator weight, kg	27	50	56	100	110	275
Total weight of units, kg	45	120	120	180	220	405
Size of focal spot, mm	0.2x3	0.2x3	0.25x2	0.25x3	0.25x3	0.3x3
Maximal controlled thickness (of steel), mm	70	130	150	250	300	350

High Energy Radiography Lecture



APPLICATIONS

High Energy Radiography Lecture



High Energy Radiography Lecture



High Energy Radiography Lecture



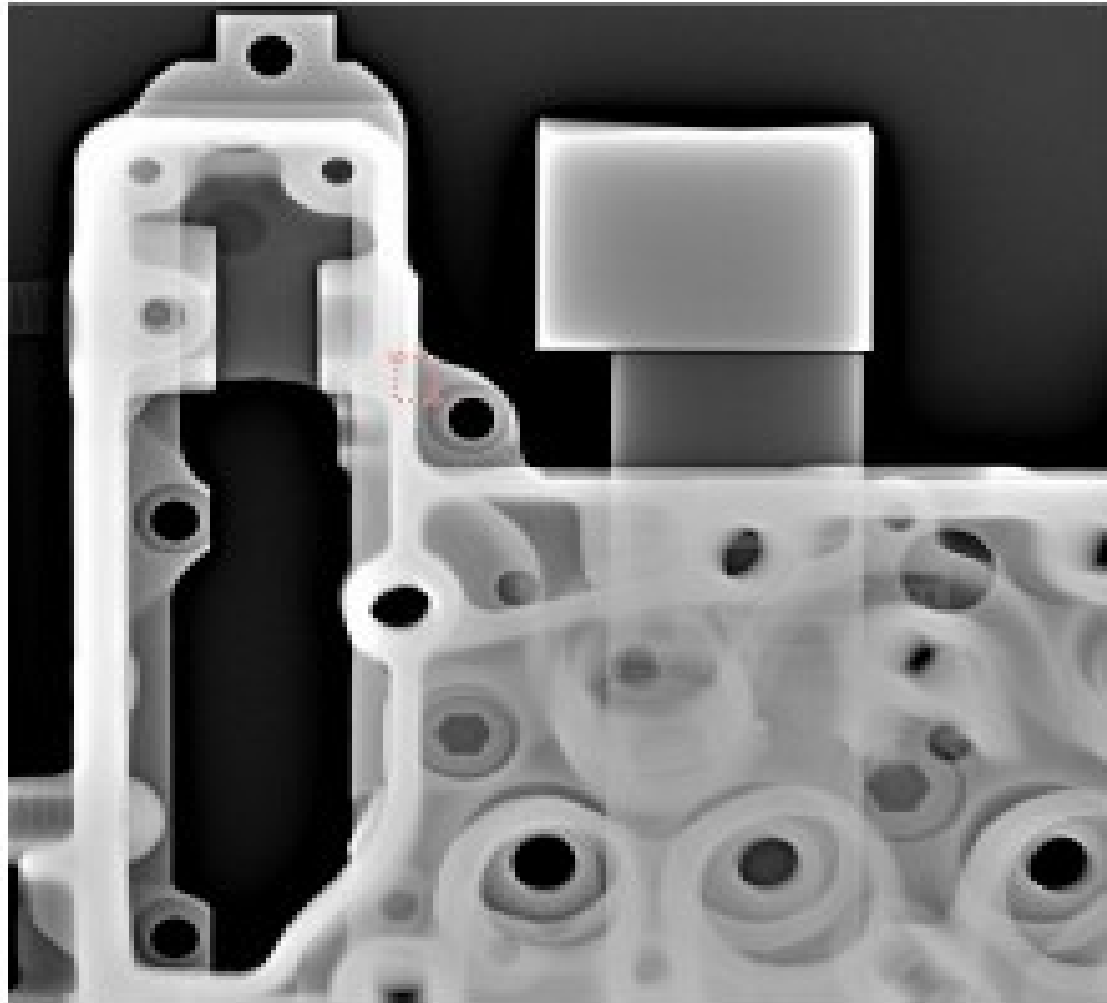
**7.5 MeV Betatron Inspection Station
in Volgogradneftemash production plant, Russia**

High Energy Radiography Lecture



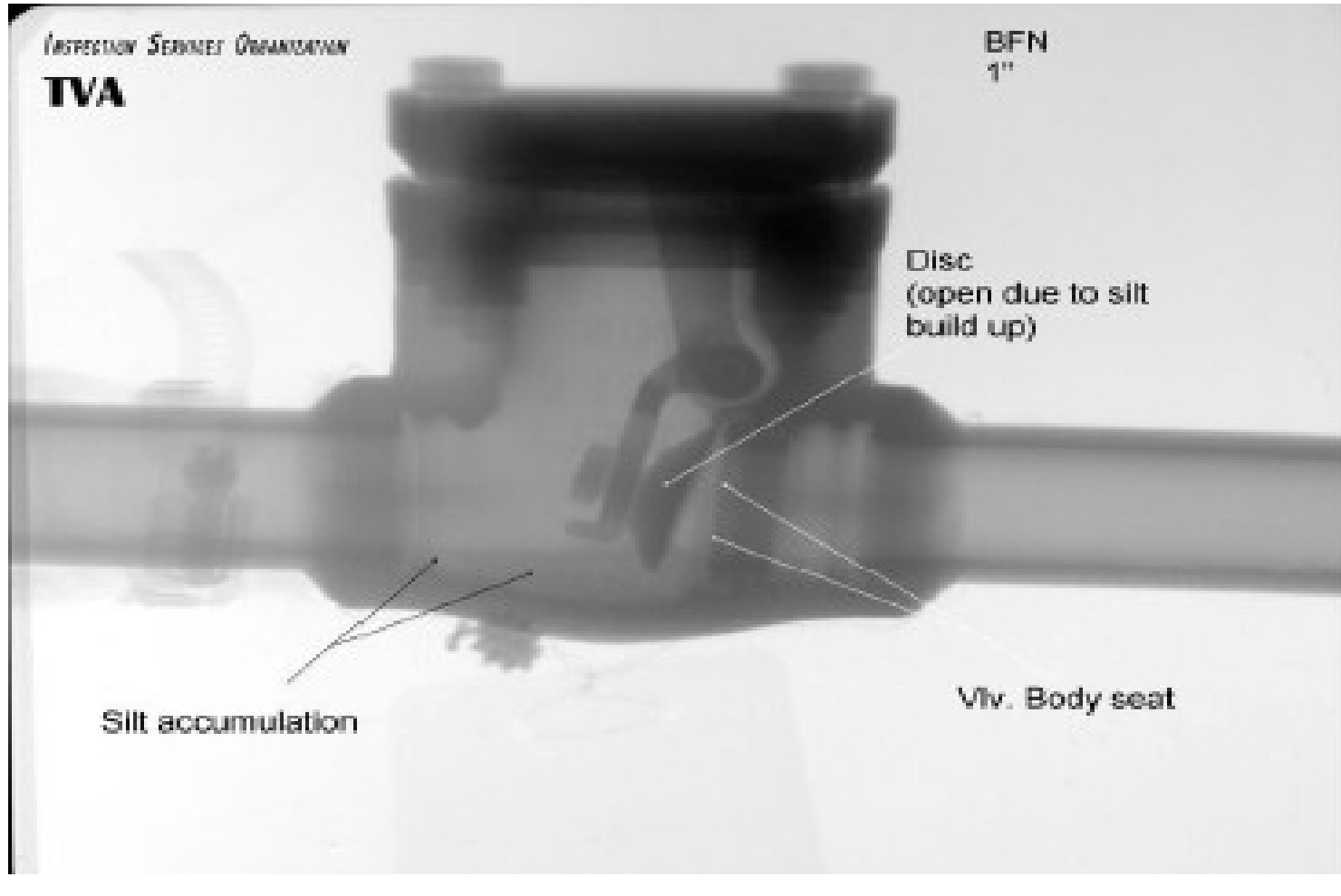
Inspection of Casting Process

High Energy Radiography Lecture



Engine Block (Defect Inspection)

High Energy Radiography Lecture



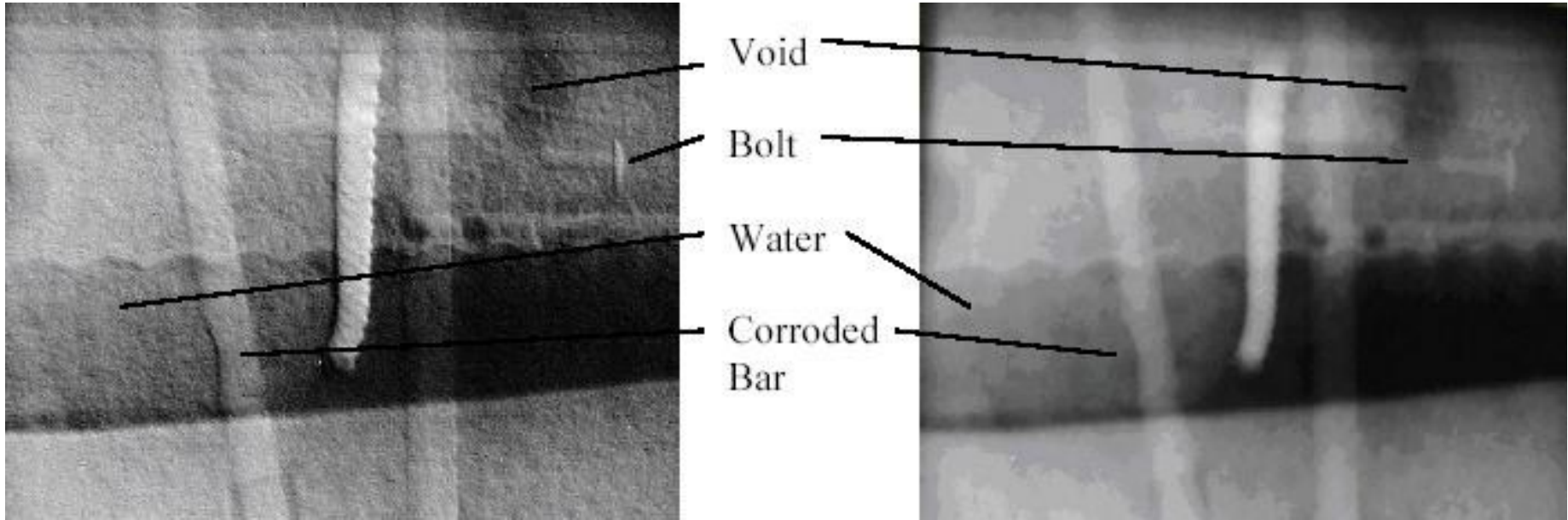
Valve Housing (Functional Control)

High Energy Radiography Lecture



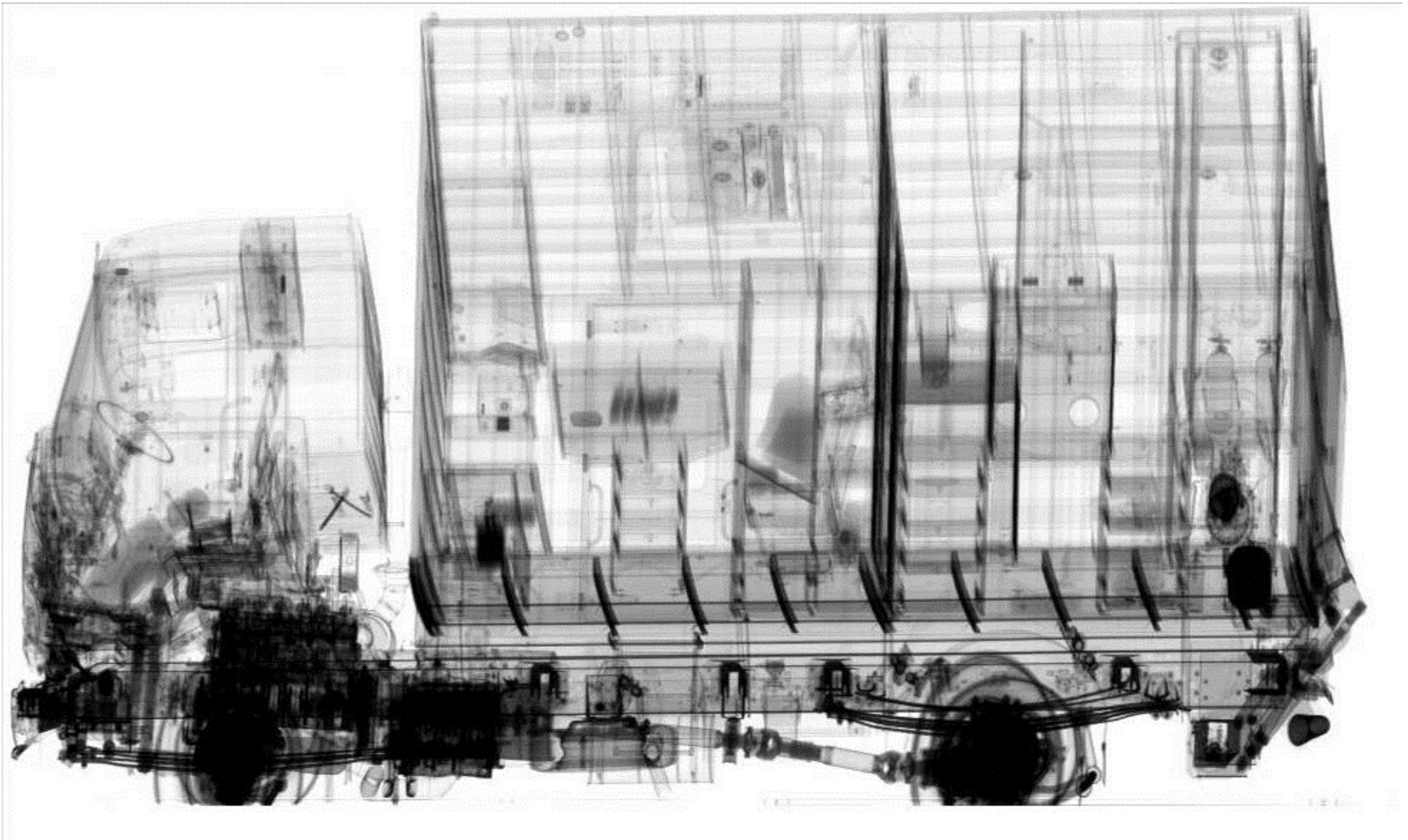
BRIDGE INSPECTION

High Energy Radiography Lecture



BRIDGE INSPECTION

High Energy Radiography Lecture



Lorry Control by Betatron Radiograph

X-ray betatron sources for cargo inspection systems



Dual energy Betatron

Different energies are selectable by changing the acceleration cycle time.

High Energy Radiography Lecture



High Energy Radiography Lecture



High Energy Radiography Lecture

THANK



YOU