



# Role of radiation processing in technological development of the world

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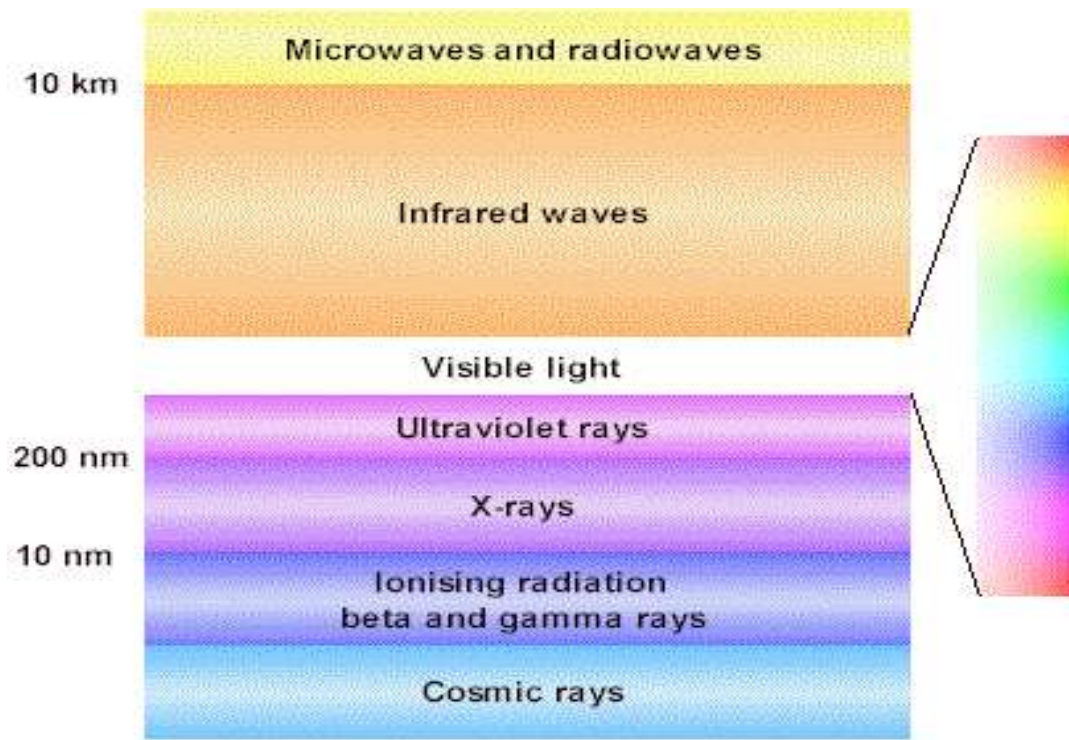


PERSPECTIVES OF PEACEFUL USE OF NUCLEAR ENERGY  
5th INTERNATIONAL CONFERENCE  
21-23 November 2012  
Baku, Azerbaijan



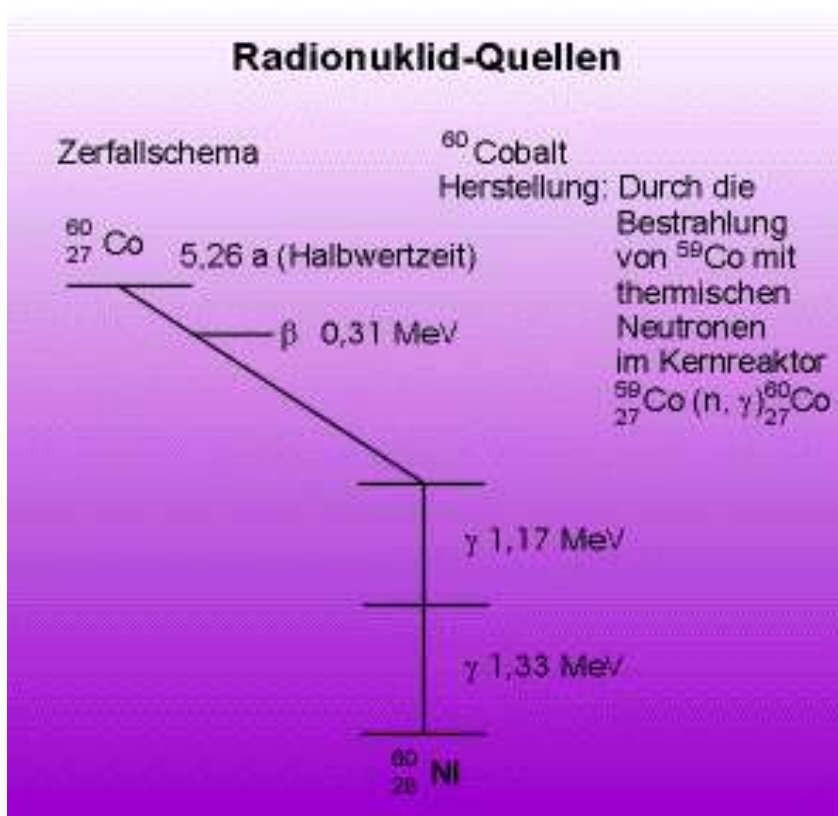


# Electromagnetic radiation





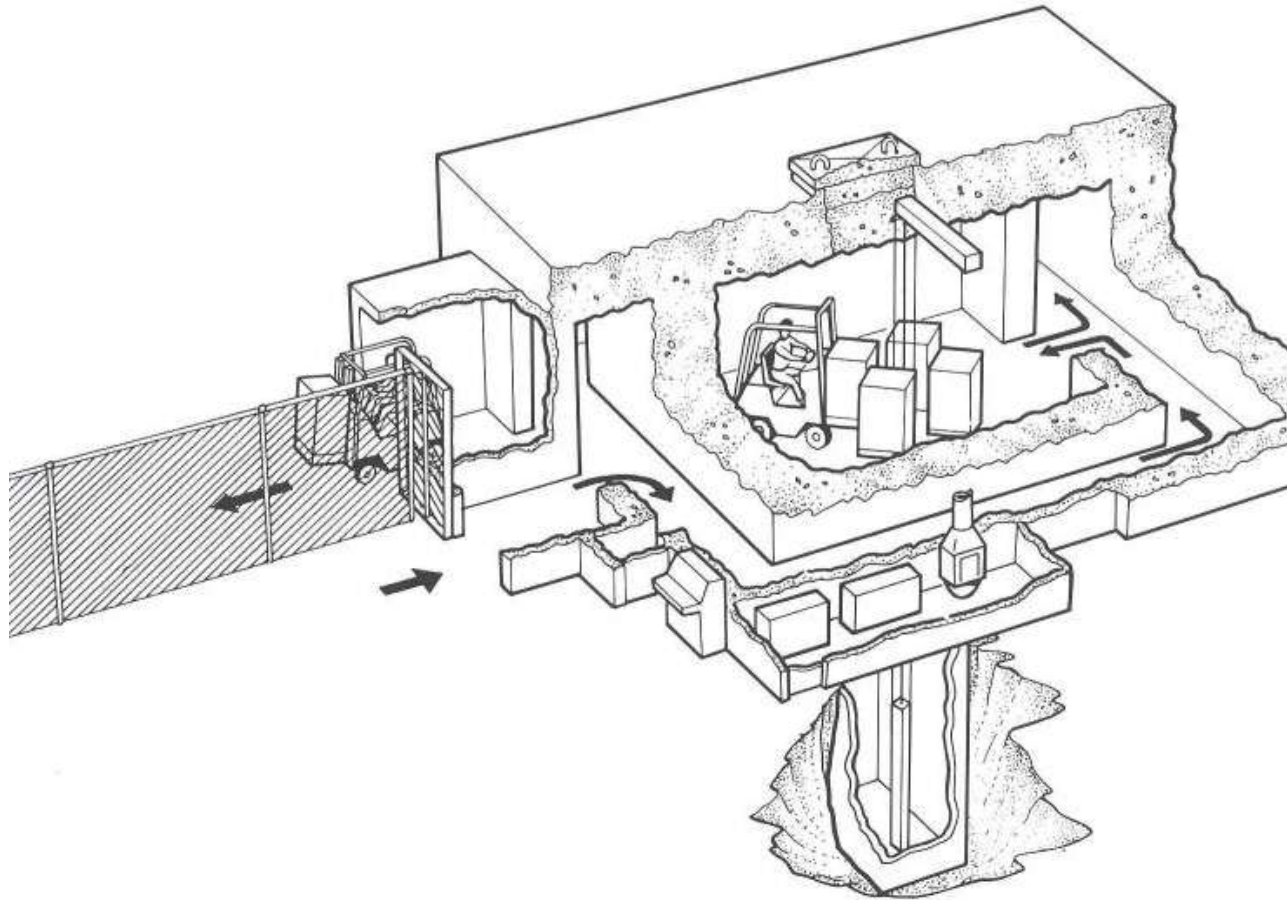
# Gamma Radiation from Co - 60



# Gammacell

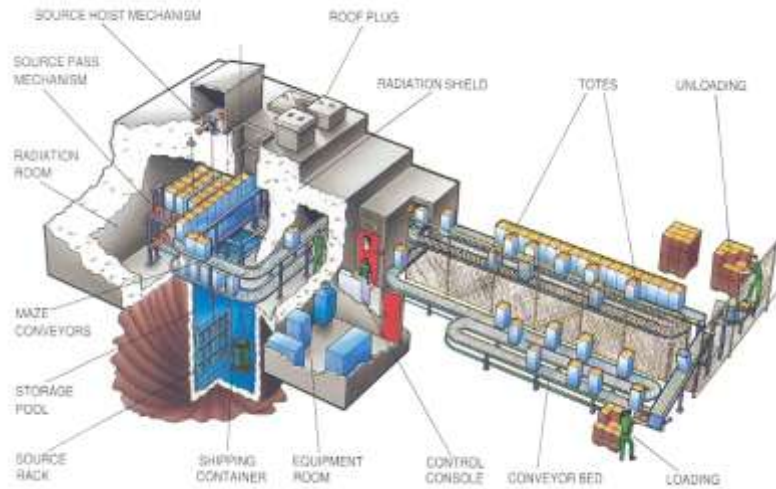


# Panoramic irradiator



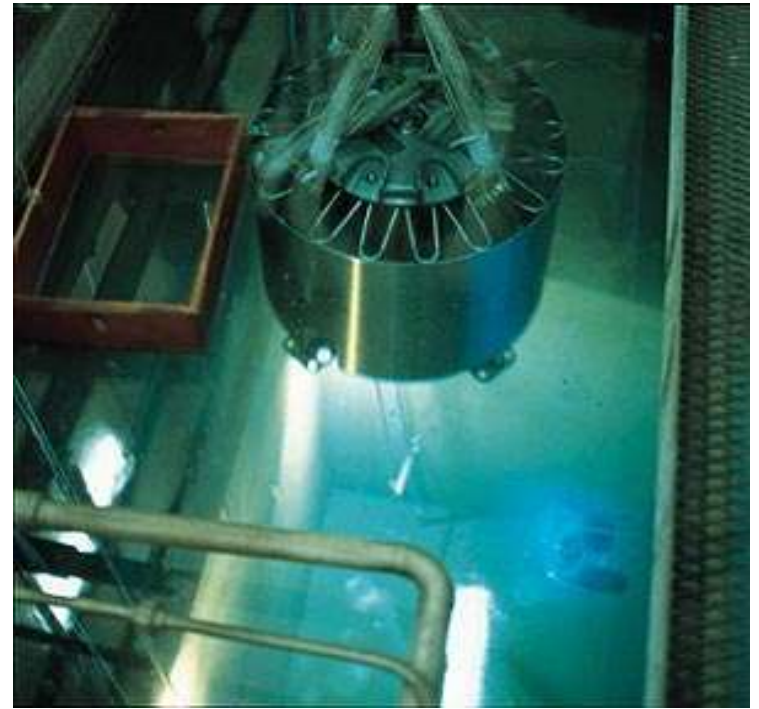


# Modern gamma plant Co-60



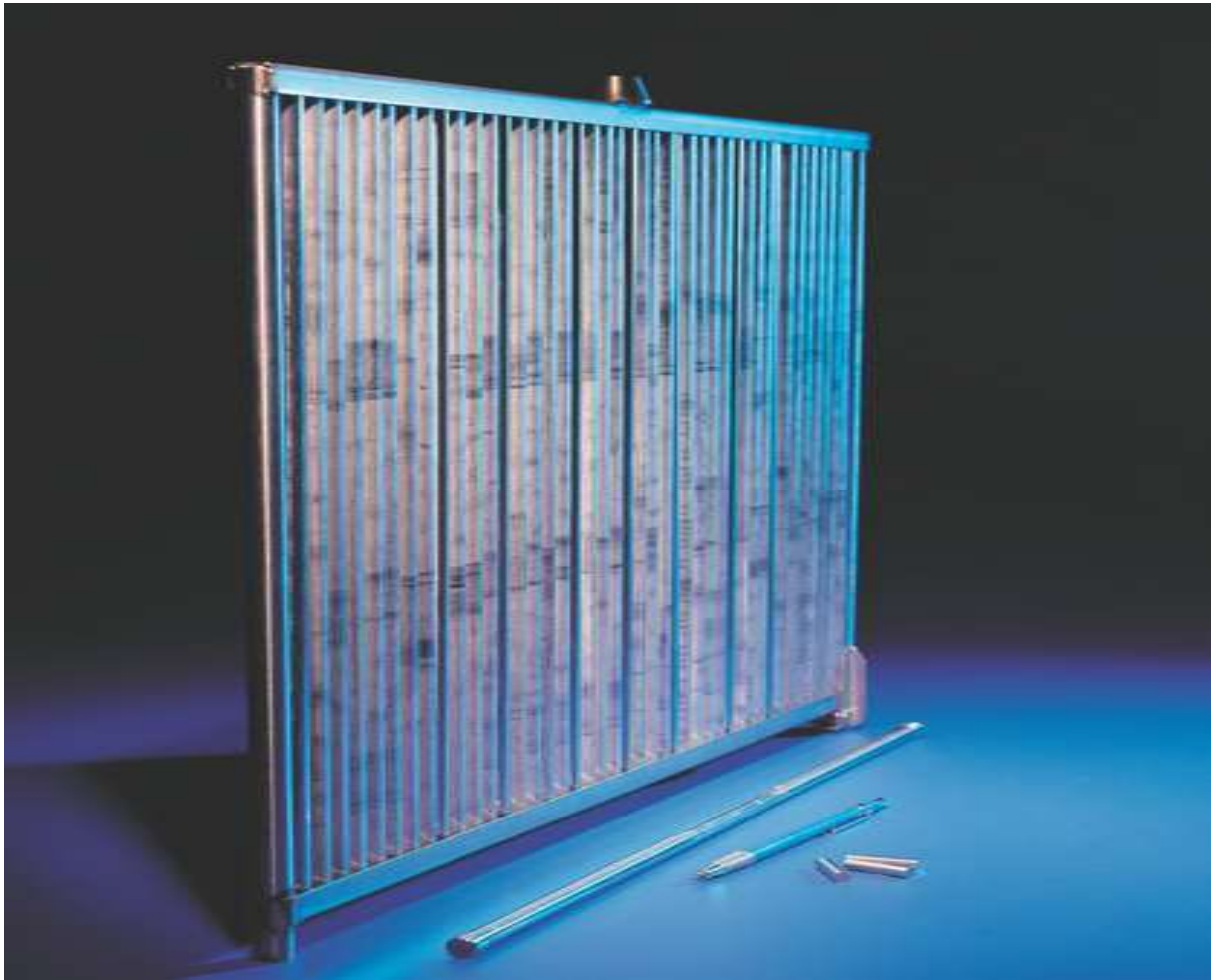


# Transport container





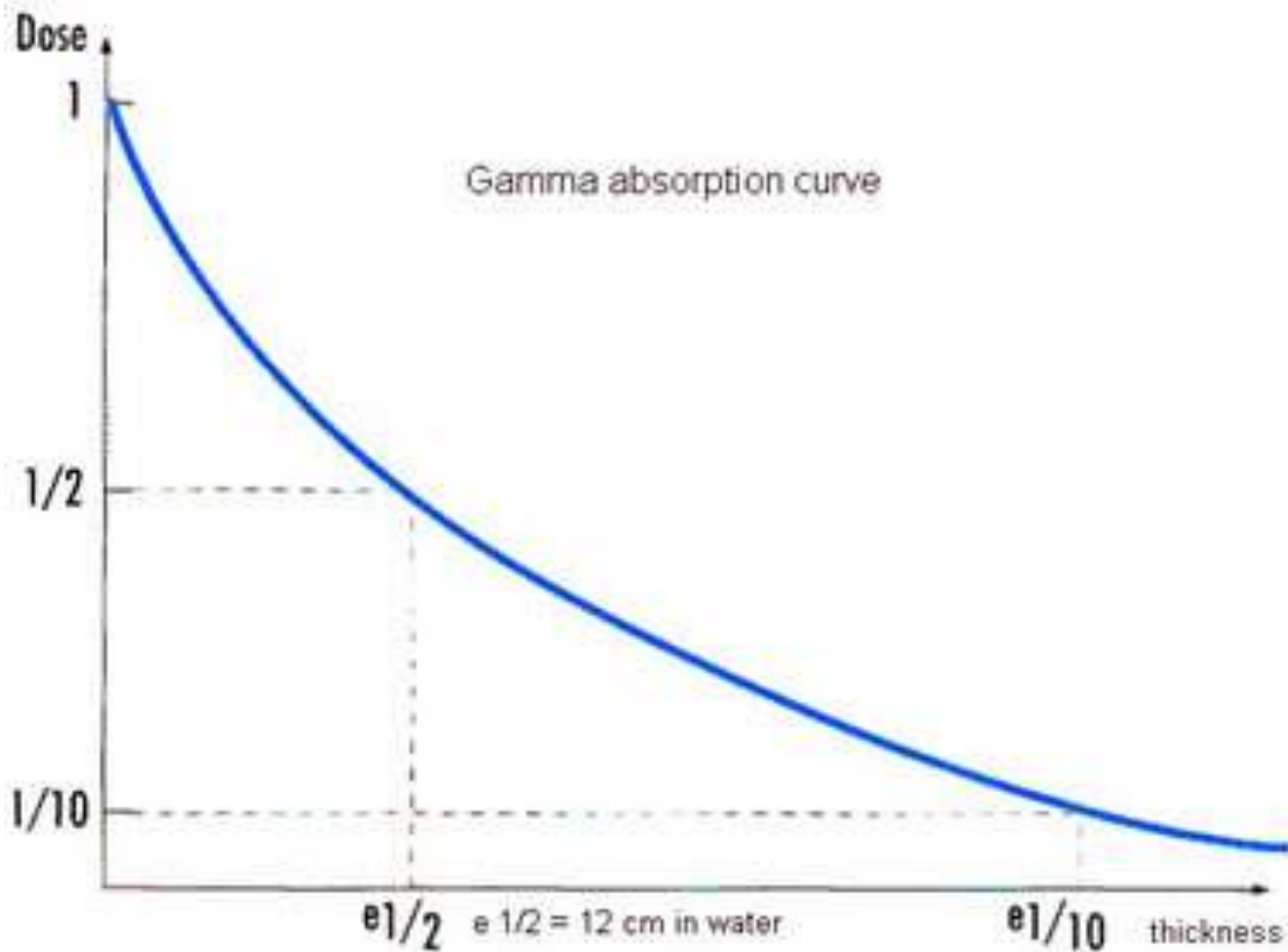
# Source rack module



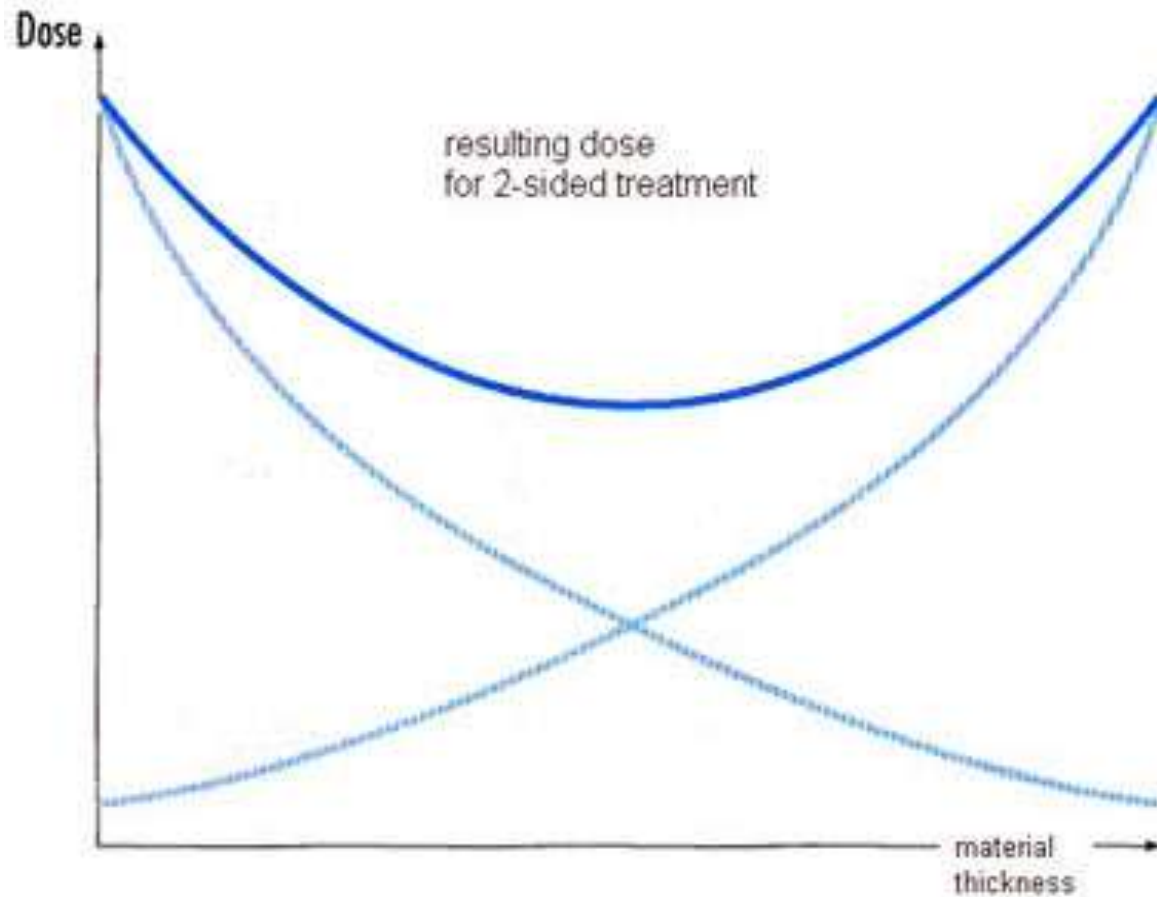
# Source reloading



# Gamma Rays Absorption Curve



# Double-sided-treatment



# Gamma tote irradiators

- JS-10000 hanging-tote irradiator  
The JS-10000 hanging-tote irradiator provides large-scale manufacturers and gamma-processing service providers with the capacity to process high volumes of product-efficiently, effectively and reliably.
- JS-9500 and JS-9600 tote irradiators  
Designed for small- to medium-sized manufacturers of products such as medical supplies, the JS-9500-and its larger-capacity alternative, the JS-9600-is a proven tote irradiator that treats diverse products in varied lots, regardless of packaging.



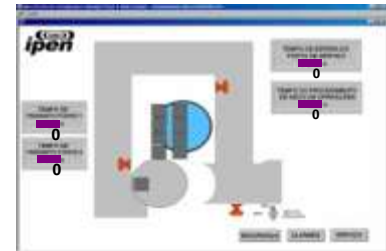
# Gamma pallet irradiators

- **Quadura™**  
Quadura marks an exceptional advancement in food irradiation technology from MDN Nordion to help you grow your business and expand your markets. It delivers full-pallet processing, precise dose uniformity, maximum operational flexibility and efficiency and safe and effective product treatment.
- **Centurion food irradiator**  
A high-throughput food-irradiation system for temperature-sensitive products, Centurion achieves exceptional dose uniformity-protecting consumers from harmful microorganisms in food products

# Pallet irradiator



# Mini irradiator



# Control Room & Product Loading

## Cairo, Egypt



# TAEA – Gamma irradiation facility

- TAEA facility is in Saraykoy Nuclear Research and Training Center in Ankara



- Hungarian made SVST-1 Category IV tote type irradiator
- The source is Co-60 and the current activity is 250.000 Ci (max. 1 MCi)
- It has licences from TAEA and from Ministry of Health for irradiation of single-use medical products for sterilization.
- Quality Manual and the related documentations are being prepared to put the quality management system in the facility
- Harwell perspex dosimeters are being used as routine in the facility
- Calibration of the routine dosimeters is done in a gamma-cell in the center.
- The dose rate of the gamma-cell was measured by NPL with dichromate dosimeters
- Also the dose rate of the gamma-cell is measured with Fricke dosimeters in every year



# Gamma-Pak irradiation facility

- Gamma-Pak Irradiation Facility is in Cerkezkoý, Tekirdag



- The irradiator is Category IV tote type MDS Nordion JS9600
- The current activity is 914.000 Ci. (max. 3MCi)
- Gamma-Pak has licences from Turkish Atomic Energy Authority, from Ministry of Health for irradiation of single-use medical products for sterilization. Gamma-Pak has ISO9001-2000, ISO/EN 13485 EN552 and HACCP certificates
- In Gamma-Pak, Harwell perspex dosimeters are being used as routine and ceric-cerous is being used as reference-standard dosimetry system

# ISOMED, Austria



# Gamma irradiator Peru



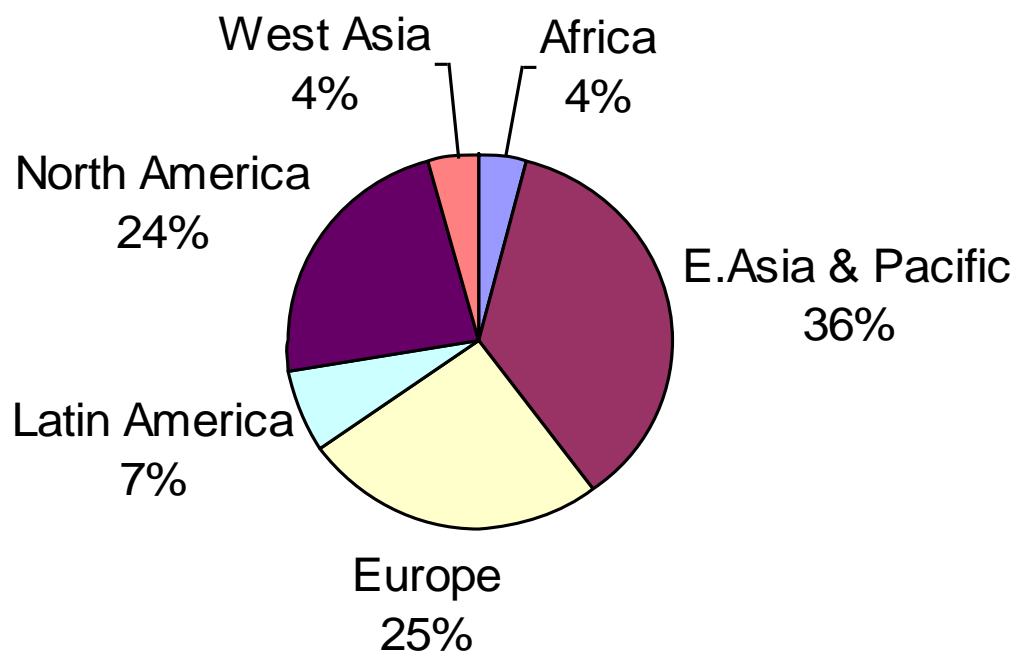
**Source of radiation Cobalt- 60**

**Irradiator storage Water**

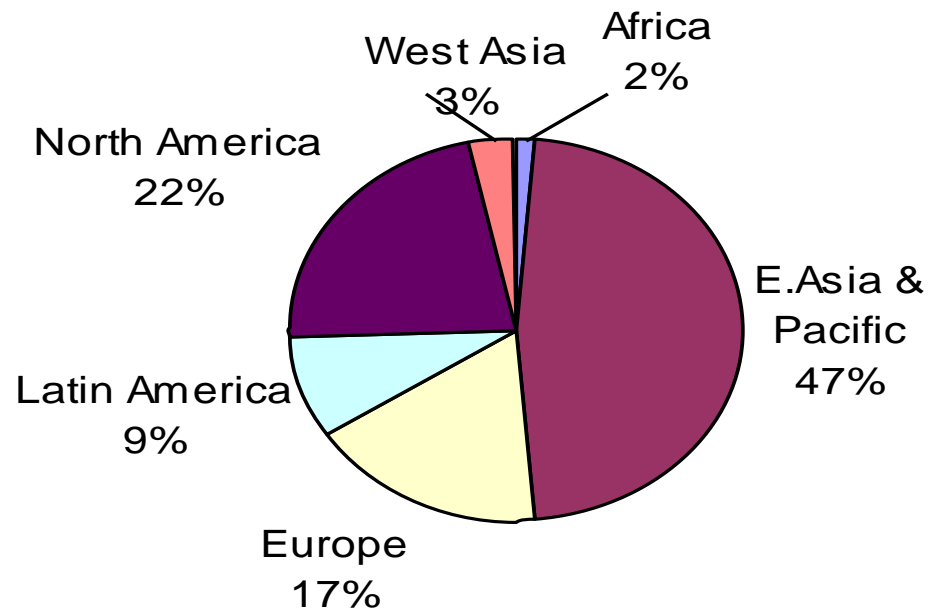
**The maximal activity of an irradiator, Bq  $3,7 \times 10^{15}$**

**The sizes of an irradiator, mm  $1000 \times 2000$**

## Regional distribution of irradiation units



## Growth of Industry since 1990

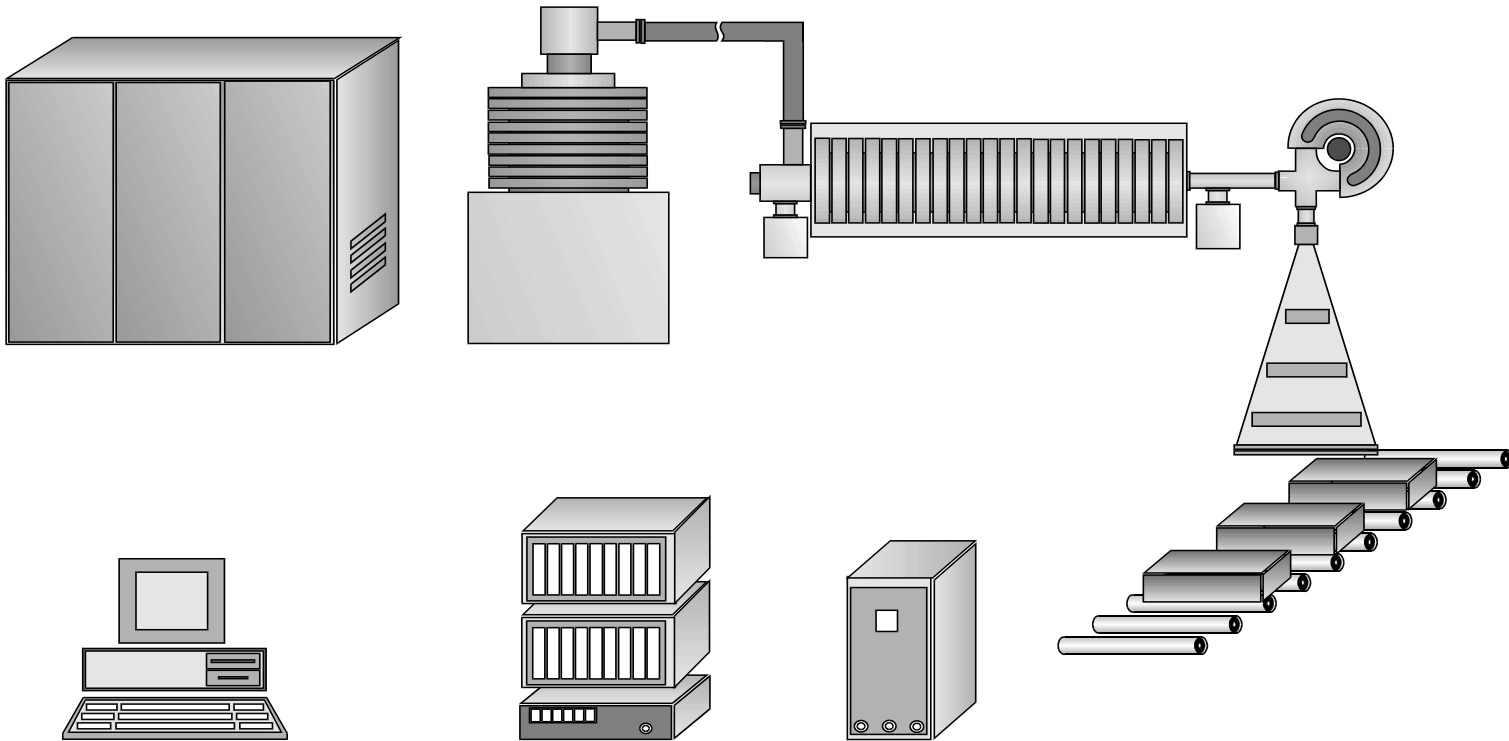




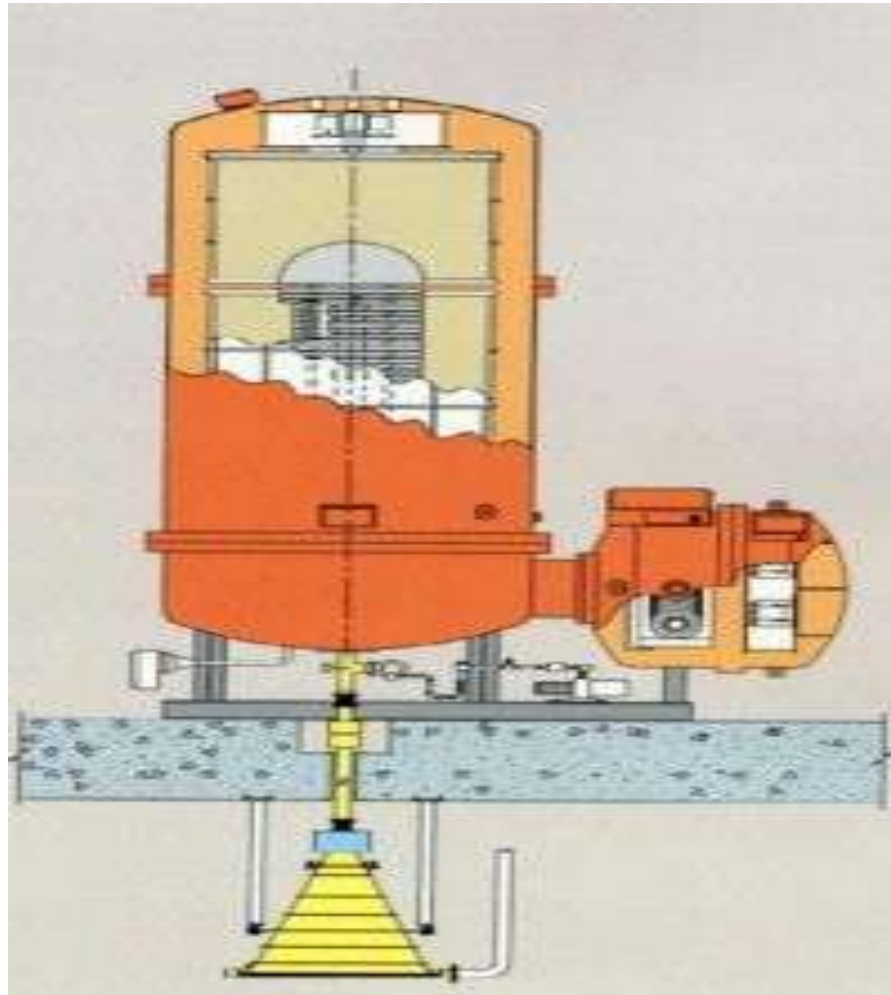
# Type of source

Source storage	dry (10%)	wet (90%)
Source rack	rectan. (86%)	cylind. (10%)
S.hoisting	electr. (29%)	pneum. (54%) hydraulic (15%)
Product transp.	pallets (11%)	totes (35%) carriers (50%)
Oper.mode	continuous (72%)	batch (28%)

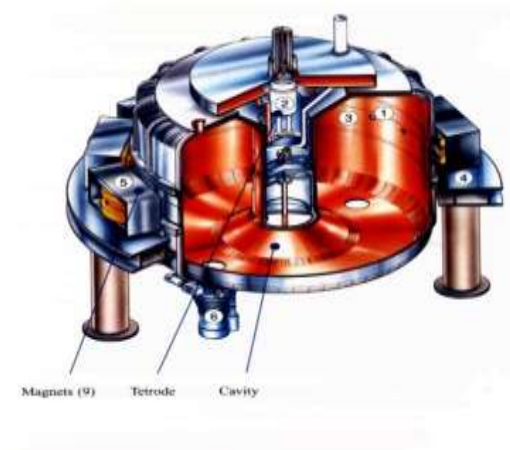
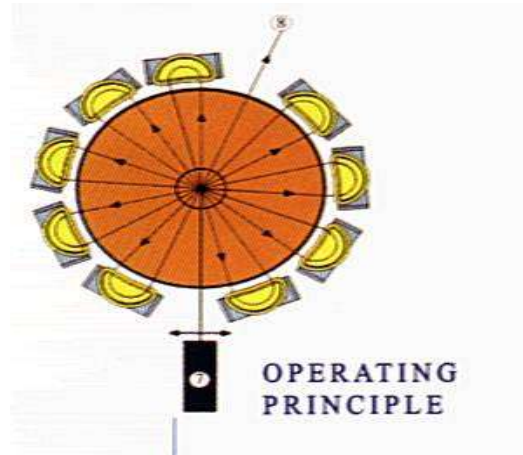
# Linear accelerator



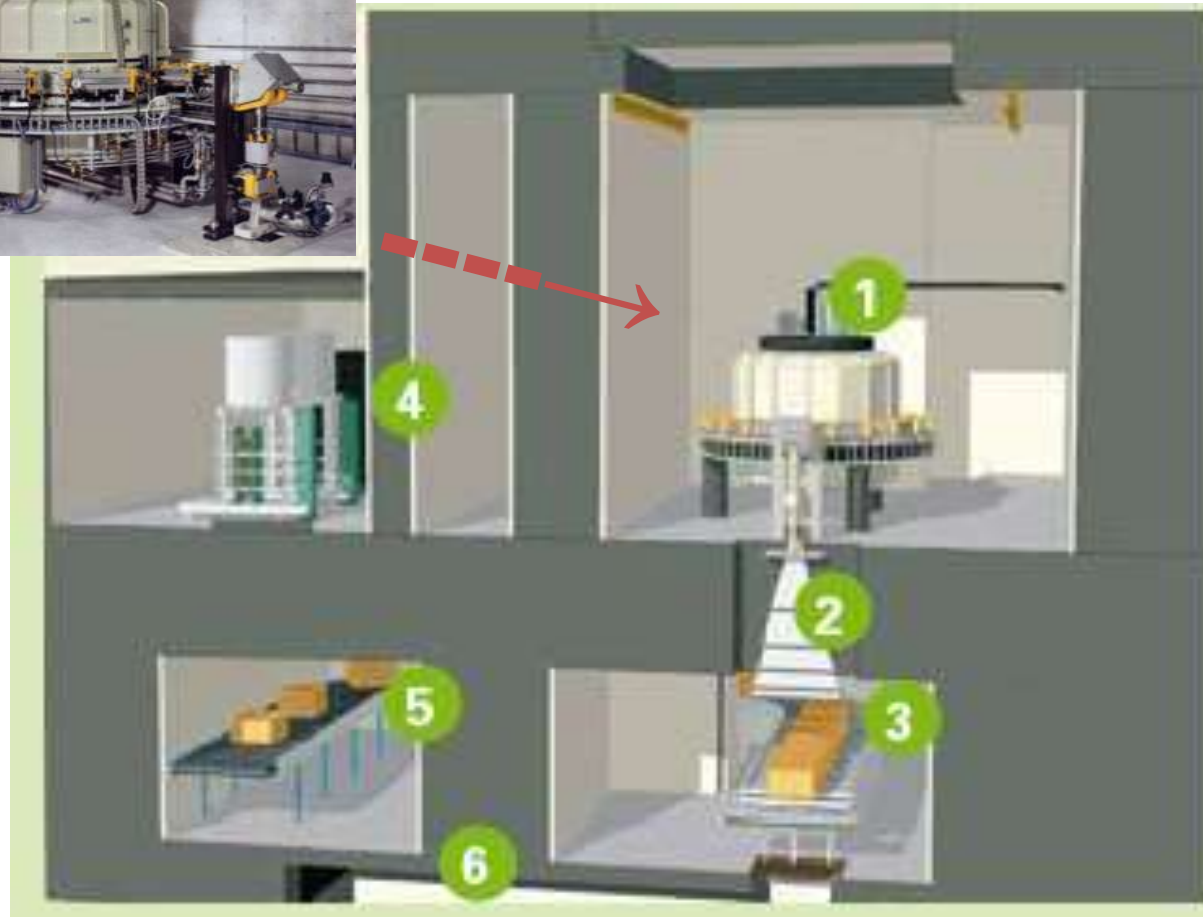
# Accelerator



# RHODOTHON



# Accelerator plant



# ELECTRON BEAM PENETRATION

MARKET	ENERGY	PENETRATION
Sterilization	10 MeV	38 mm
Wire @ Cable	1.5 MeV	5 mm
Shrink Film	300 – 800 keV	2 mm
Surface Curing	80 – 300 keV	0.4 mm

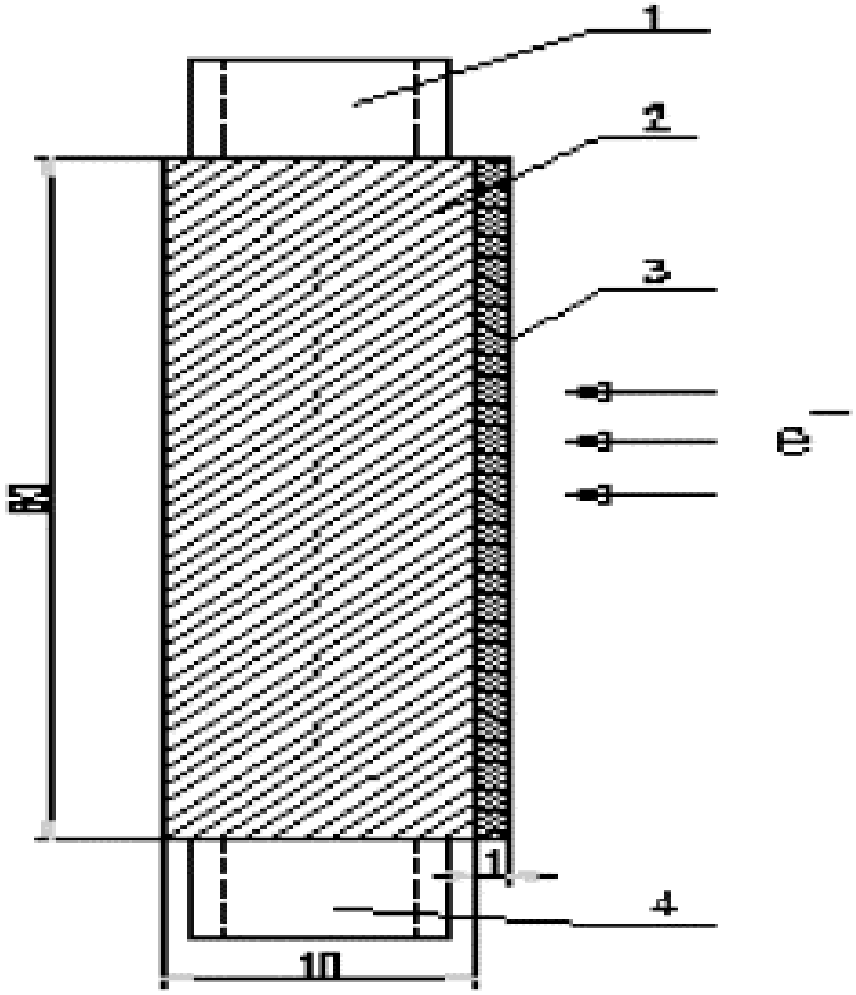


# ELECTRONS

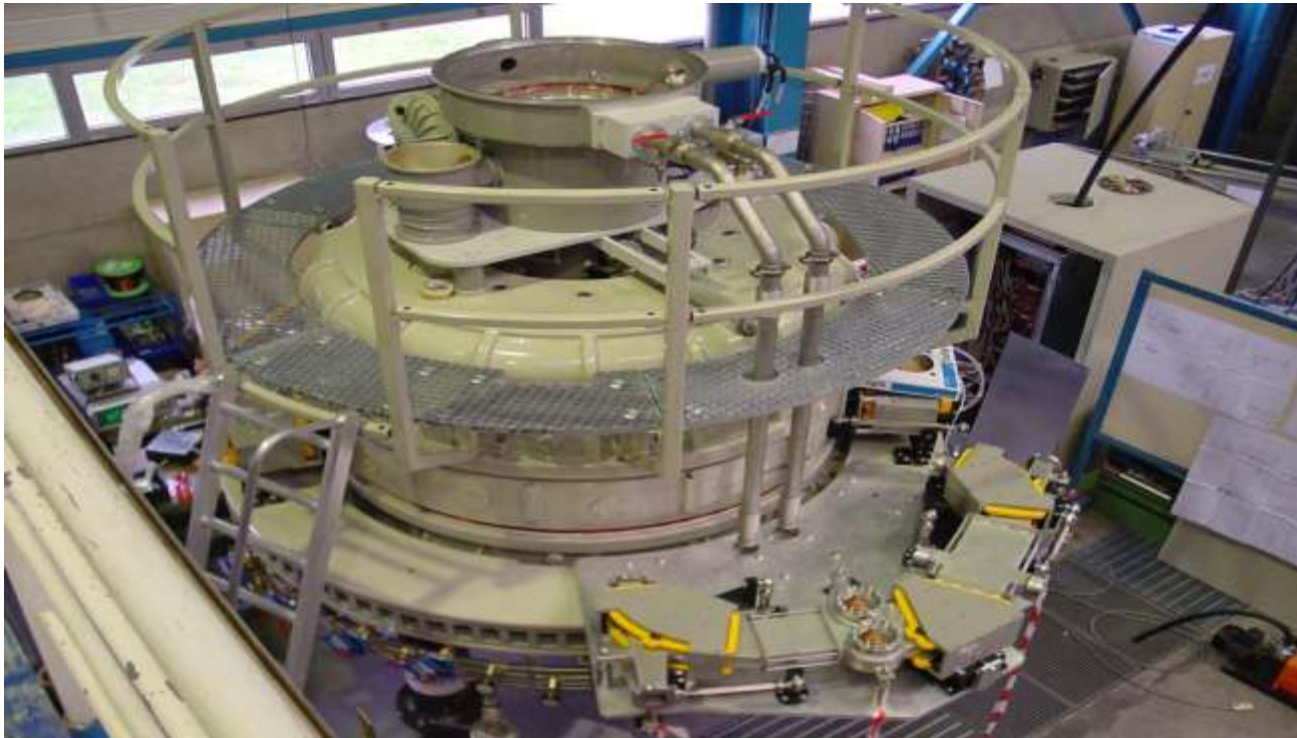
Energy	Relative velocity ( $v/c$ )	Mass ratio ( $m/m_0$ )
10 keV	0.195	1.020
100 keV	0.548	1.196
500 keV	0.863	1.979
1 MeV	0.941	2.957
5 MeV	0.996	10.79
10 MeV	0.999	20.58

# TARGET, e/X

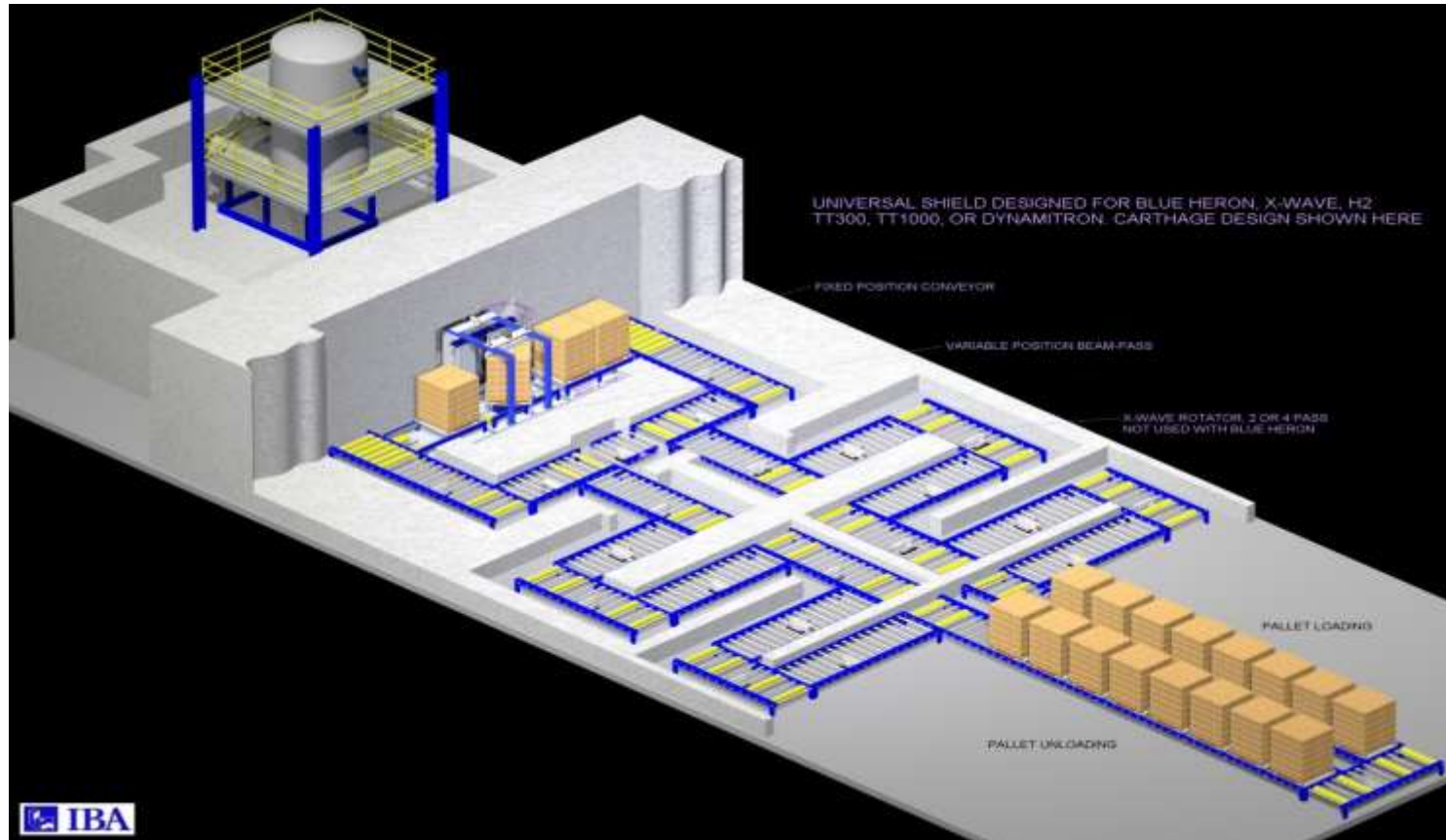
- 1. Input cooling water.
- 2. Aluminum collector.
- 3. Tantalum plate.
- 4. Output cooling water.



# IBA Rhodotron TT1000



# Pallet concept

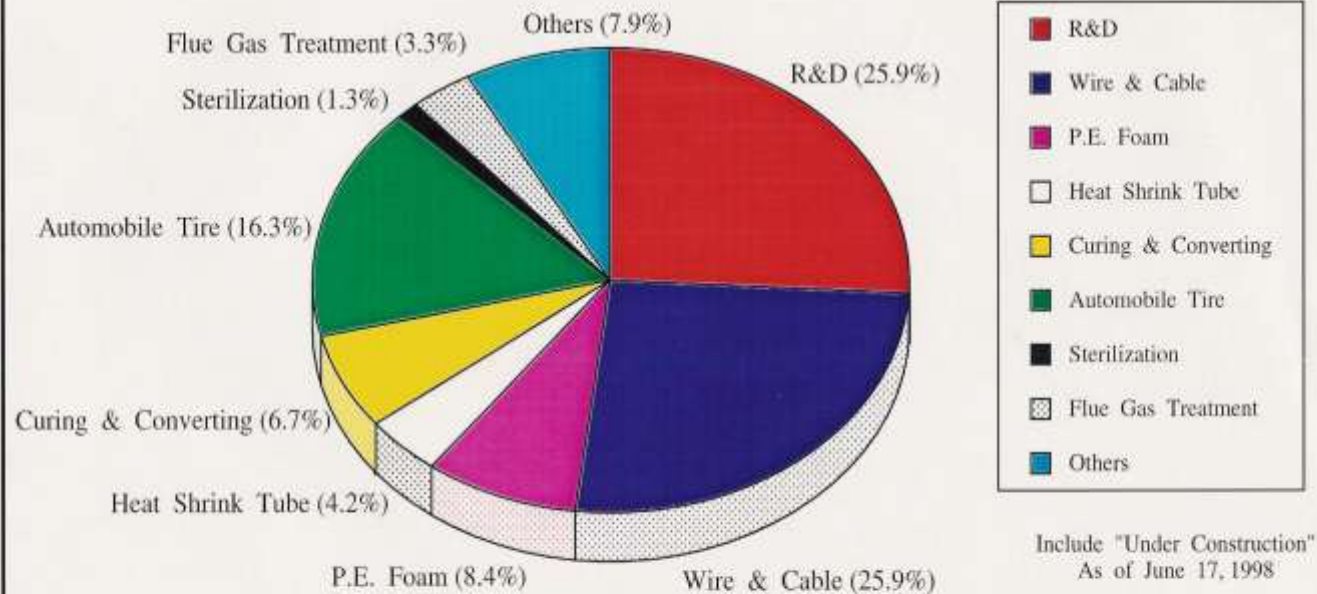




# Doses applied

<b>Application</b>	<b>Dose range</b>
<b>Medical – diagnostic</b>	<b>10 – 100 mGy</b>
<b>Medical – therapy</b>	<b>1 – 10 Gy</b>
<b>Industrial – food and agriculture</b>	<b>0.1 – 10 kGy, or more</b>
<b>Industrial - sterilization</b>	<b>10 – 30 kGy</b>
<b>Industrial – materials modification</b>	<b>50 – 100 kGy, or more</b>

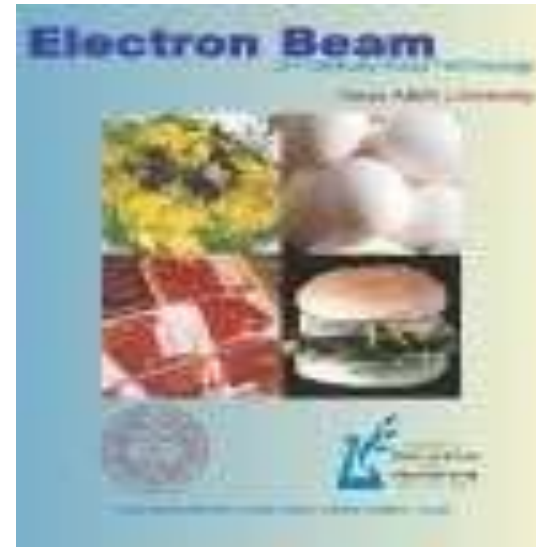
## Total Number of EB System





# Food irradiation

- Inactivation of harmful organisms in food ingredients
- Inactivation of salmonella food poisoning micro organism
- Extension of refrigerated shelf life
- Control of parasites and insects
- Inhibition of sprouting



# Irradiated meat in the USA.

- Irradiated meat is being marketed in the USA since 2000
- In 2003 approx. 22,700 metric tons were irradiated and sold in some 8,000 supermarkets !



# FOOD IRRADIATION PLANT POLAND





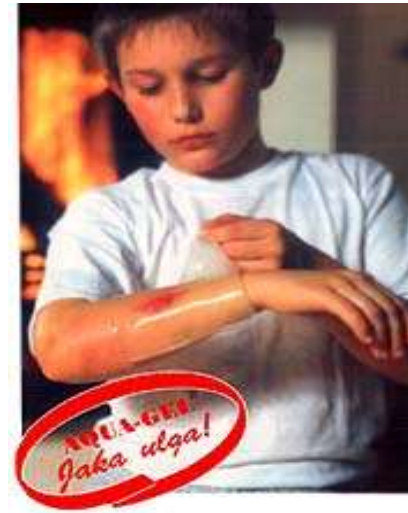
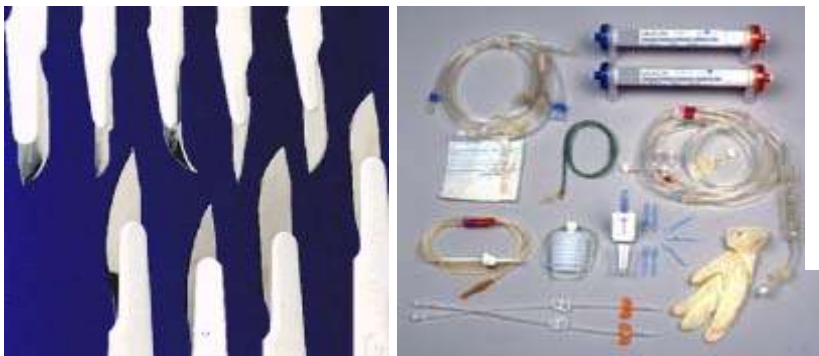
# Medical products sterilization

## Tissue grafts



- Clean, chemical free process
- Require time only to sterilize
- No need for sterility testing

## Disposable medical products



Inventor Prof. J. Rosiak



# Sterilization plant, POLAND



# Aseptic packing





# Tissue sterilization



# Art objects preservation



**iRASM**  
Radiation Processing Center

**Conservation  
by Irradiation**

Items from Moldova Museum and National Film Archive

**IFIN-HH, Bucharest, ROMANIA**



# POLYMERS PROCESSING

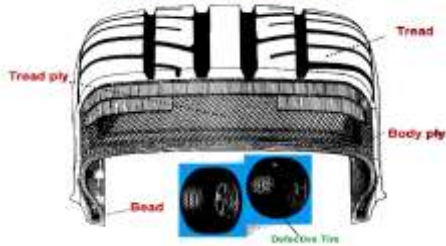
- Crosslinking
- Degradation
- Grafting

# Flame retardant





**TIRE COMPONENTS**

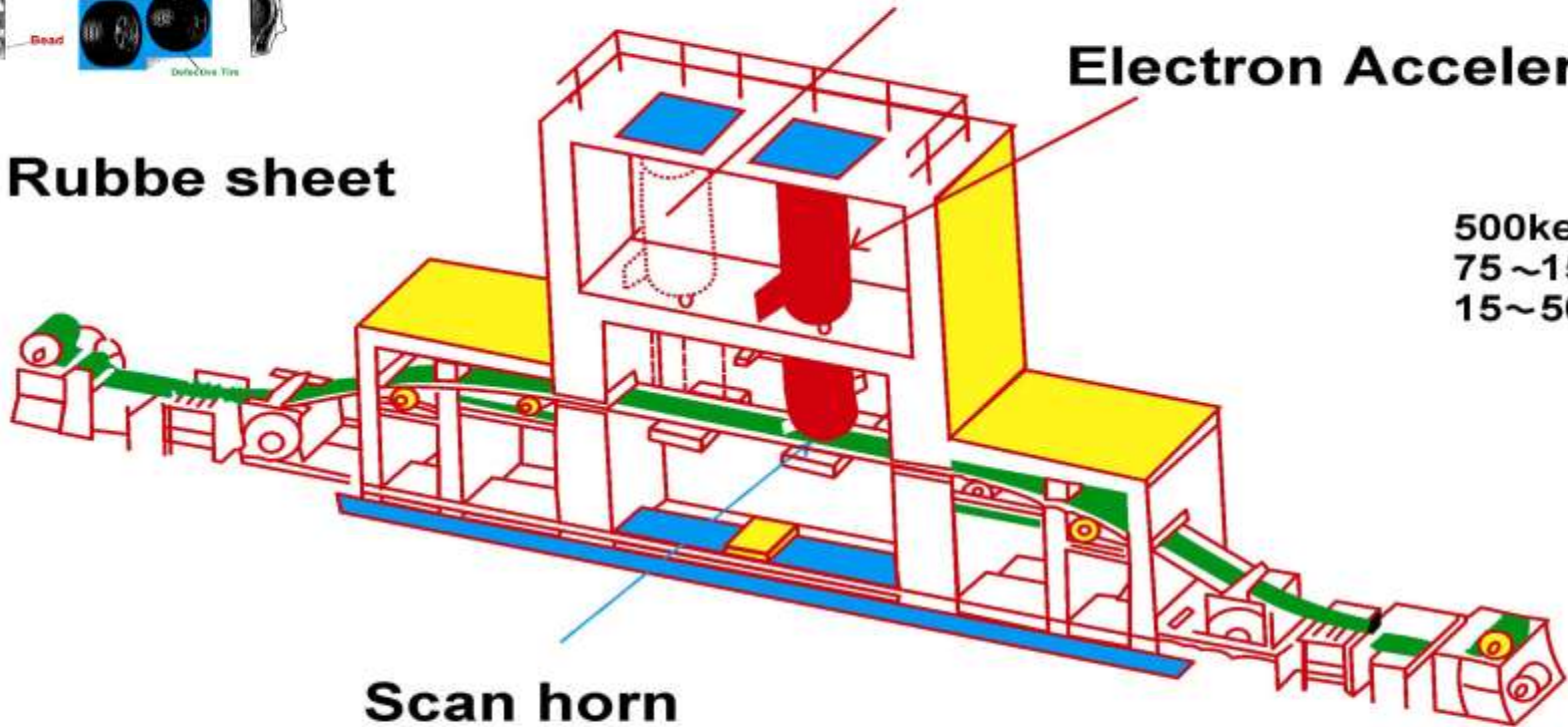


**Space for spare  
Electron Accelerator**

**Electron Accelerator**

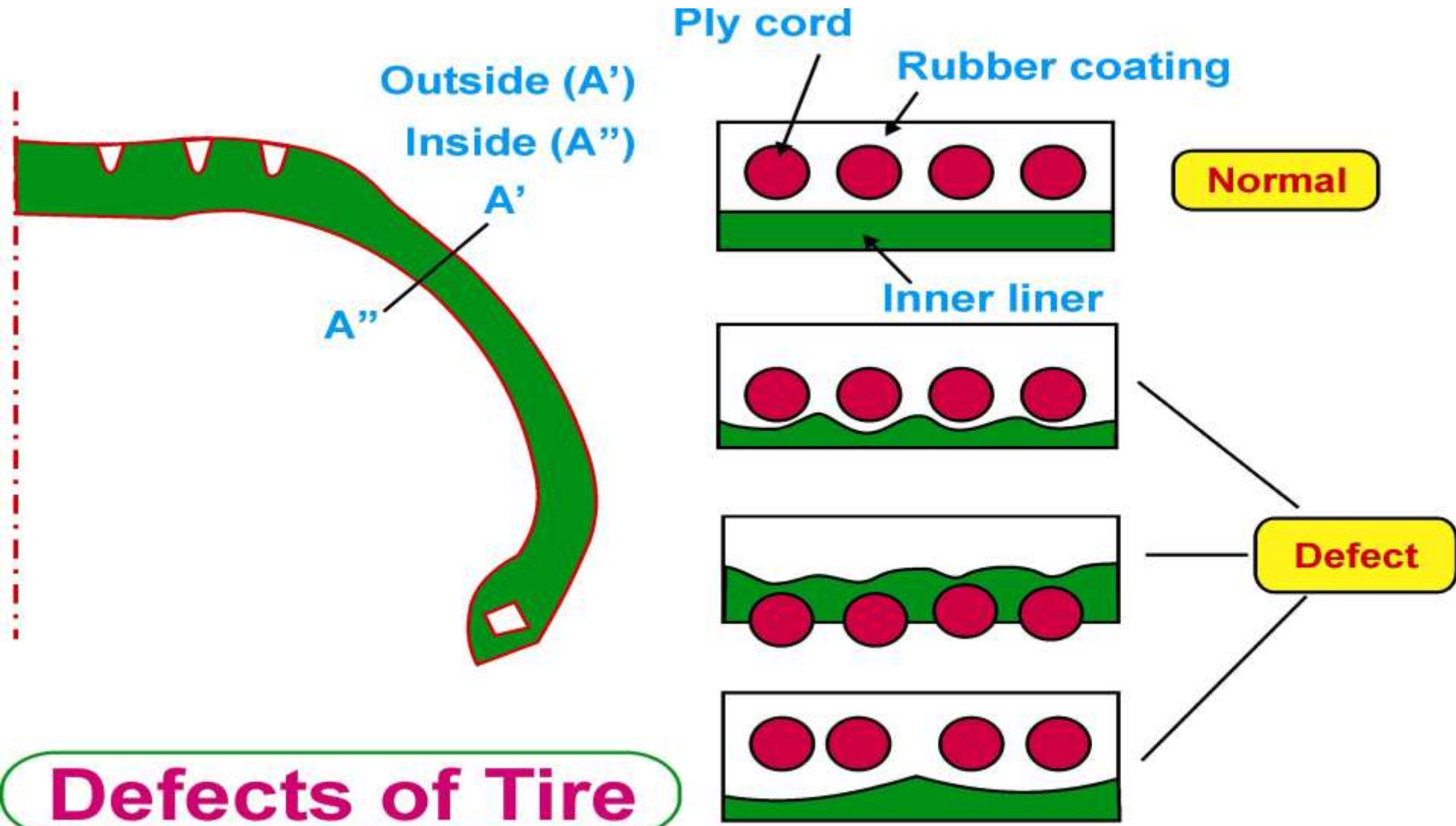
500keV  
75~150 mA  
15~50 kGy

**Rubber sheet**



**Scan horn**

# EB Processing of Rubber Sheet

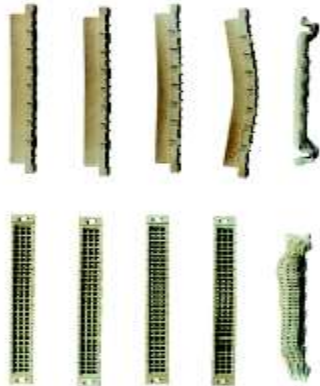


## Defects of Tire

Radiation Processing Avoids These



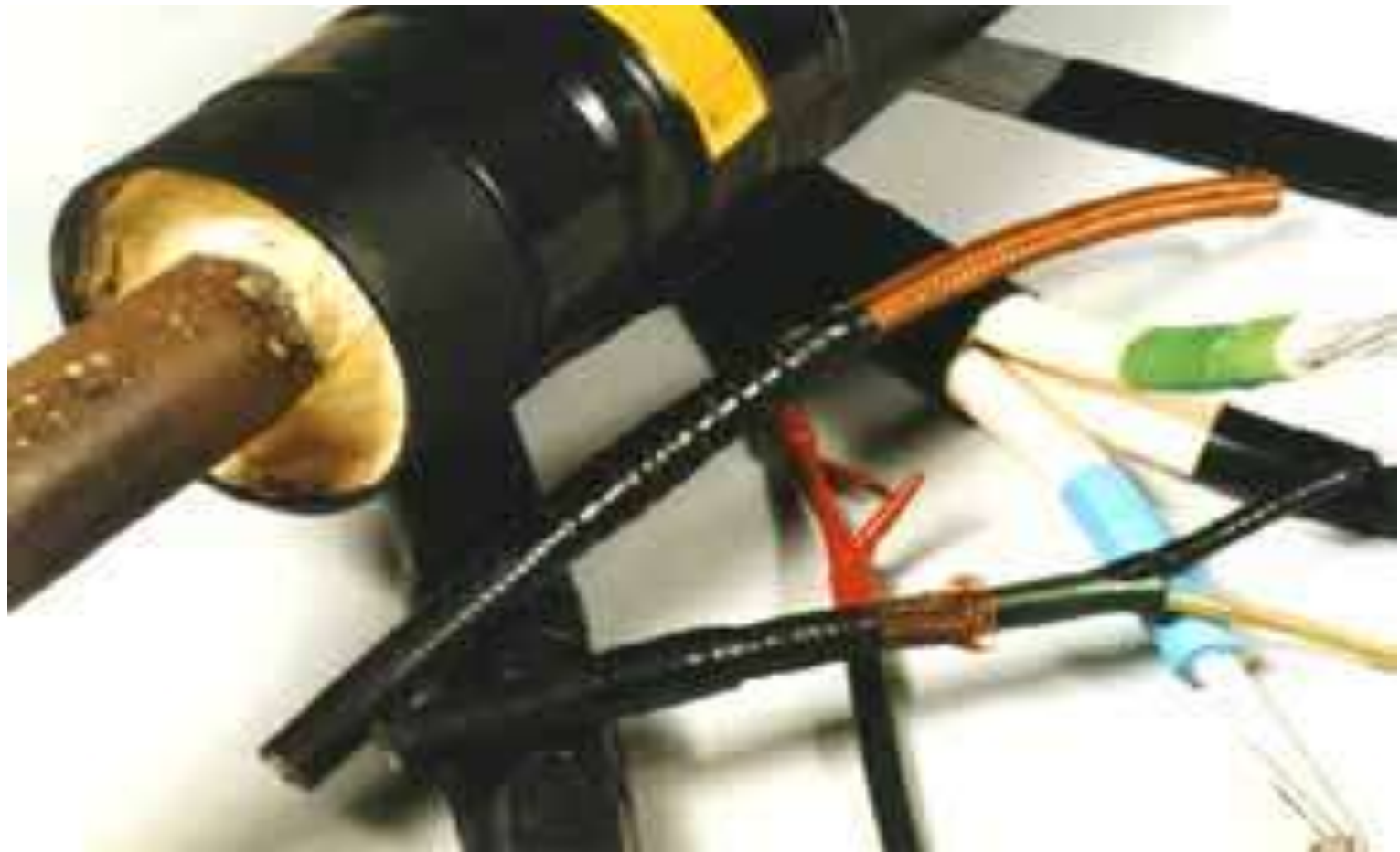
# Wires and cables, car parts, pipes, electronics



360 kGy 320 kGy 250 kGy 150 kGy 0 kGy







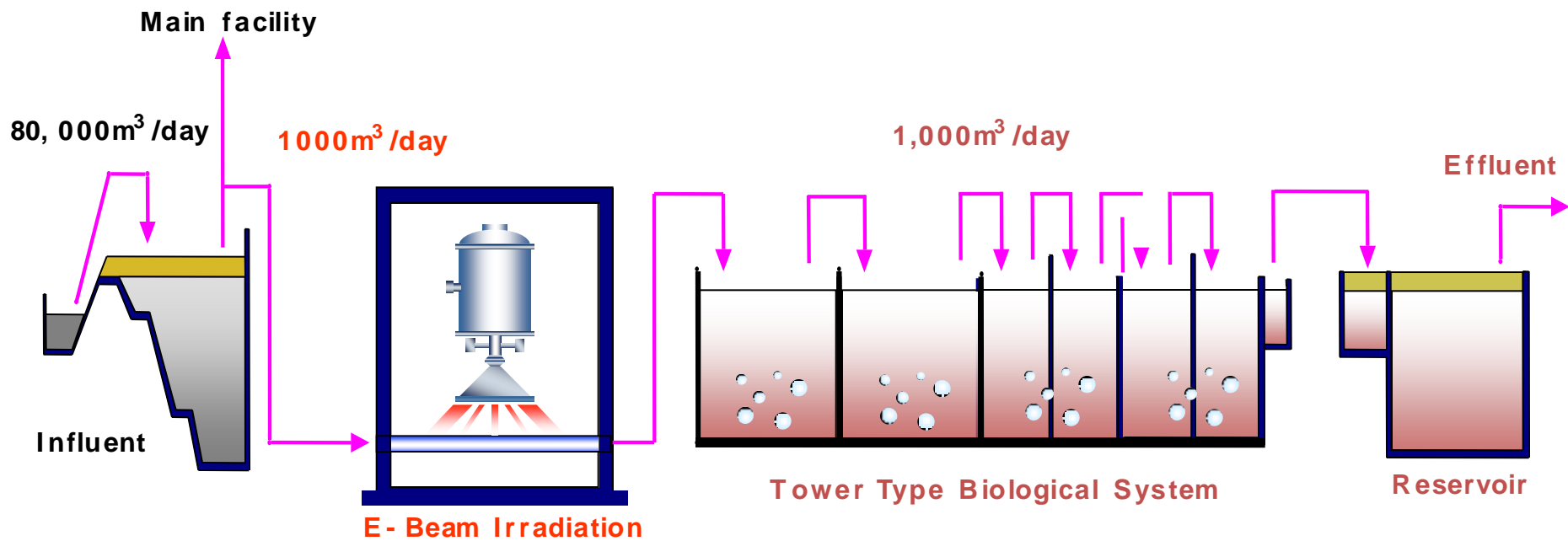
# ***Value addition to even valuable materials!!***

Over 100,000 Carats of diamonds processed last year

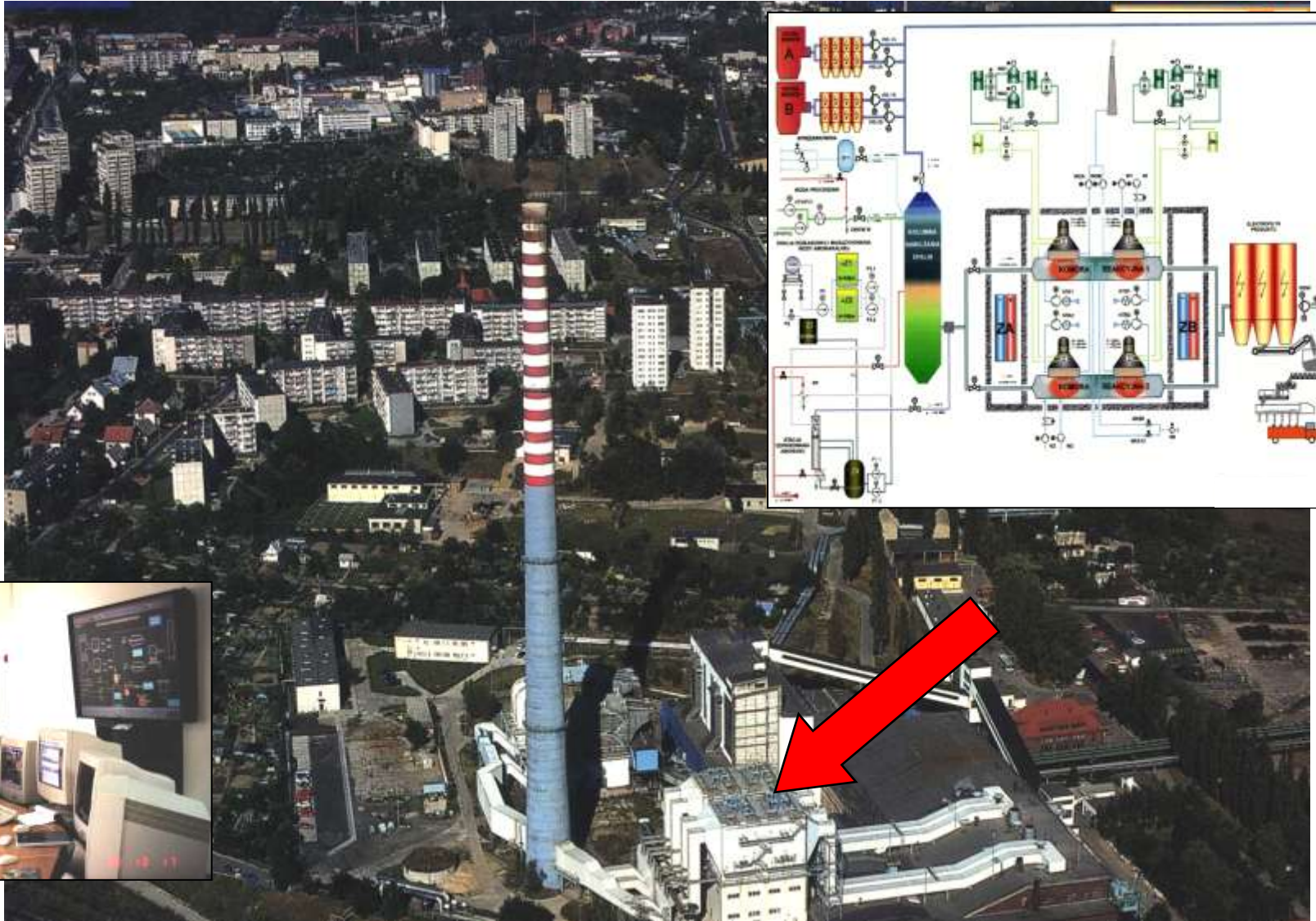




# 【 Schematic Diagram of Pilot Plant 】



# Flue gas treatment



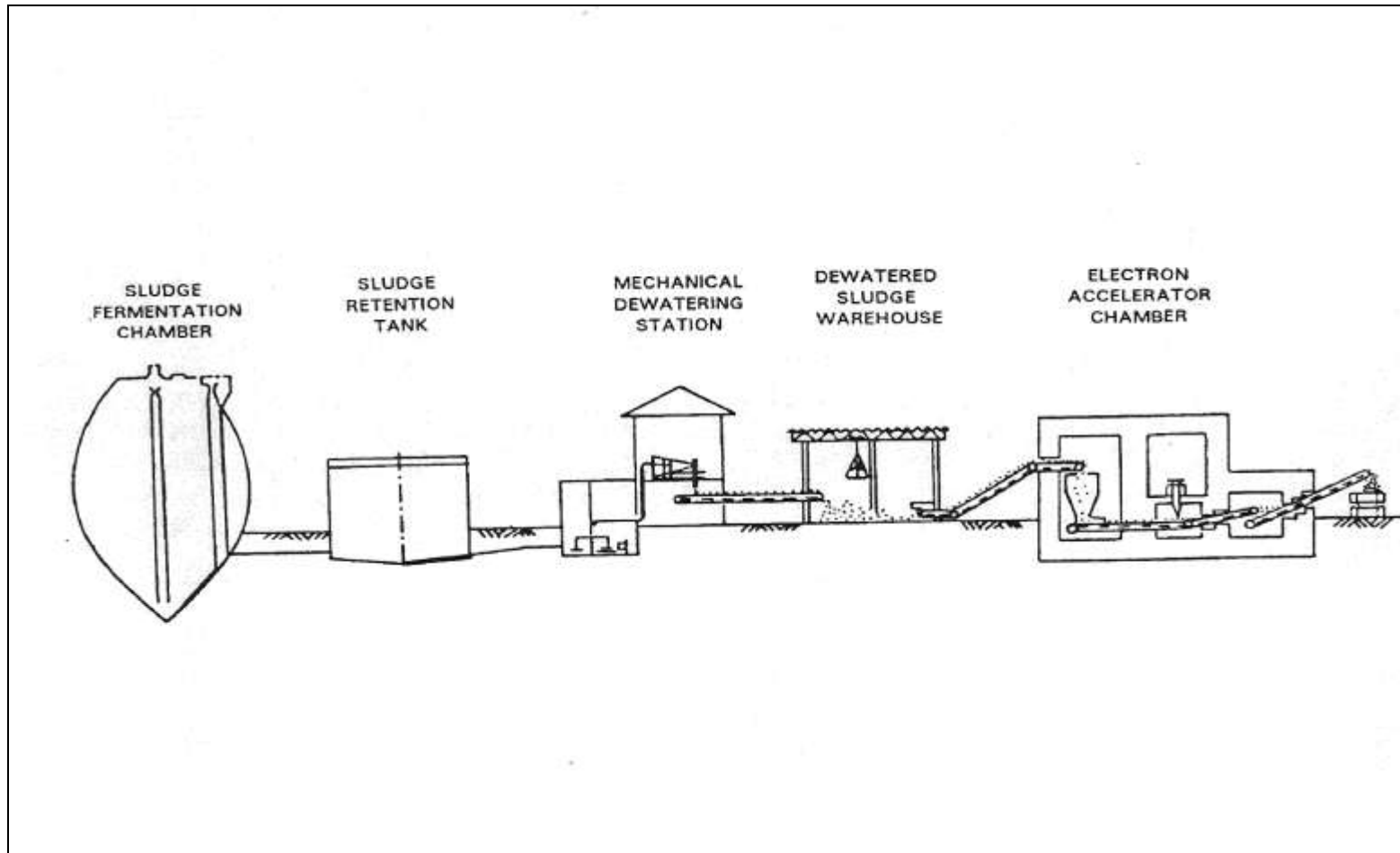




# ARAMCO OIL FIRED BOILER



# Municipal sludge hygenization

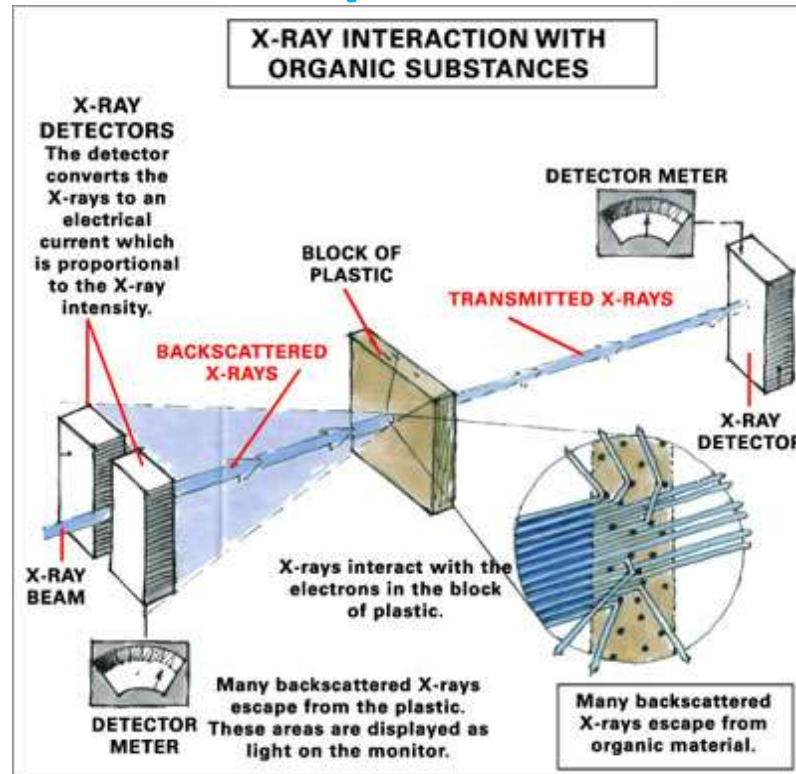




# Application of irradiated sludge

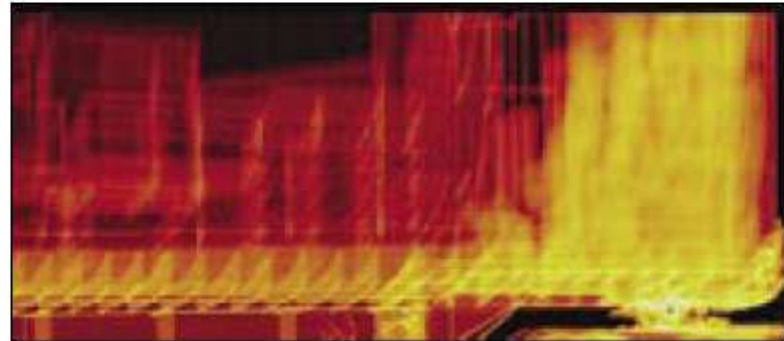


# AS&E cargo and vehicle X-ray inspection





# Rapiscan Eagle Gantry



# Conclusions

- Any modern economy needs irradiators for technological development
- About 200 industrial gamma irradiators are in service worldwide
- More than 1200 electron beam accelerators are applied for radiation processing worldwide

**THANK YOU !**