

Aplikasi Iradiator

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Pelatihan Petugas Iradiator

Direktorat Pengembangan Kompetensi BRIN - 2025

Profile



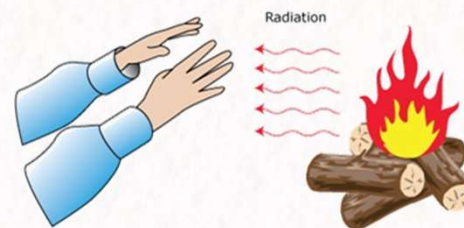
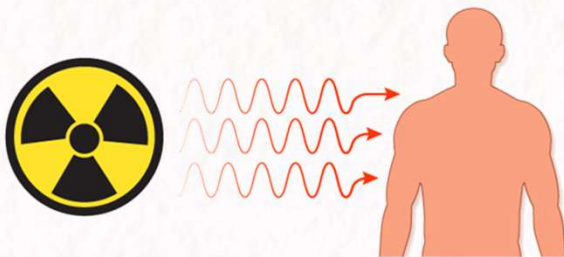
- Adam Tirta Kusuma
- Sarjana – Teknik Elektro
- BATAN 2018-2021
- BRIN 2021-Sekarang
- Penyelia, Mutu Laboratorium Iradiasi - 2022 s.d sekarang
- Workshop on Security Gamma Irradiation Facilities - 2022 (Thailand)
- Fellowship - Improving Technical Skill E-beam Tech - 2023 (Korea Selatan)
- Tim Komisioning Akselerator Elektron Energi Tinggi - 2024
- Regional Training QA/QC E-Beam Dosimetry - 2024 (Vietnam)

1

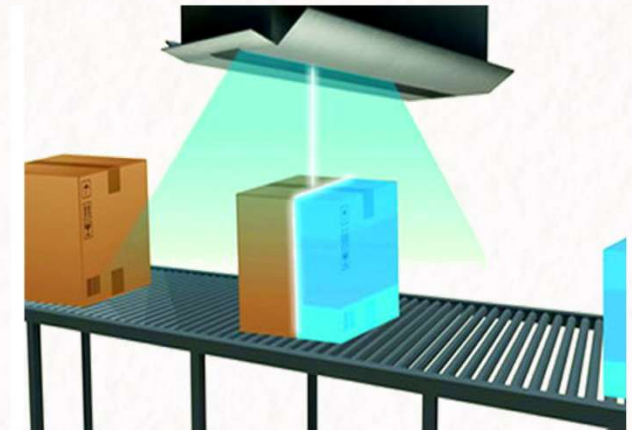
Pendahuluan

Pendahuluan

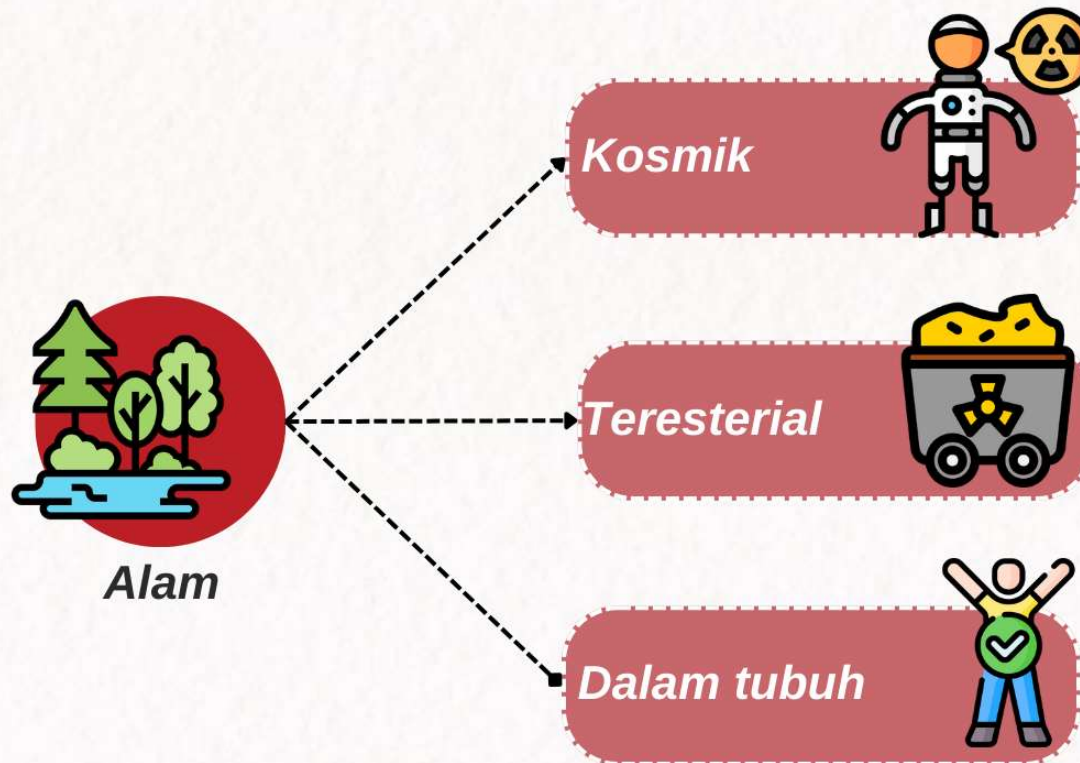
Radiasi



Iradiasi



Pendahuluan

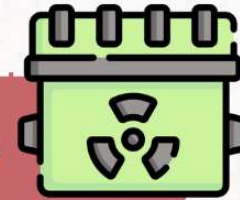


Pendahuluan



Buatan

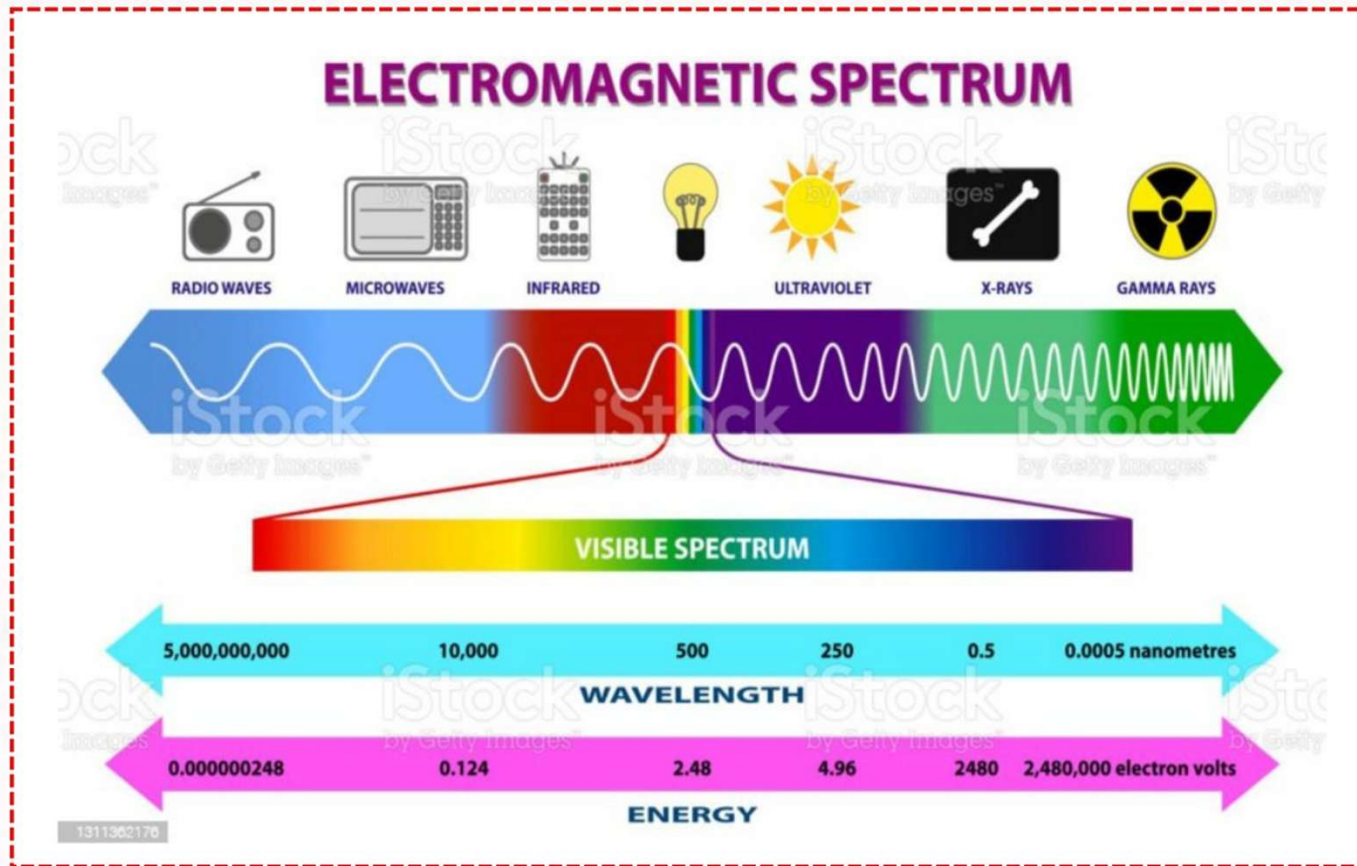
Zat radioaktif buatan



Pembangkit radiasi pengion



Pendahuluan



1311362176

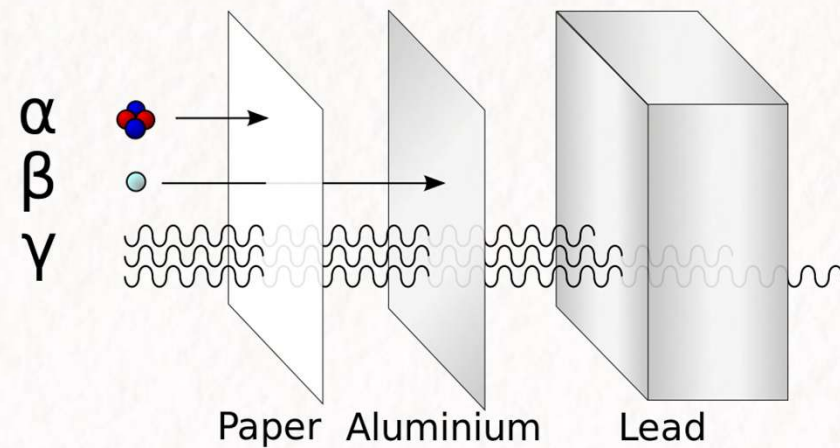
Pendahuluan

| Type | Substance | Permeability | Ionizing Action |
|-------------|---------------------------|-----------------------|-----------------|
| alpha | flow fo alpha particle | low | high |
| beta | flow of electron | middle | middle |
| gamma, xray | electromagnetic | high | low |
| electron | flow of electron particle | depend on beam energy | middle, high |



Pendahuluan

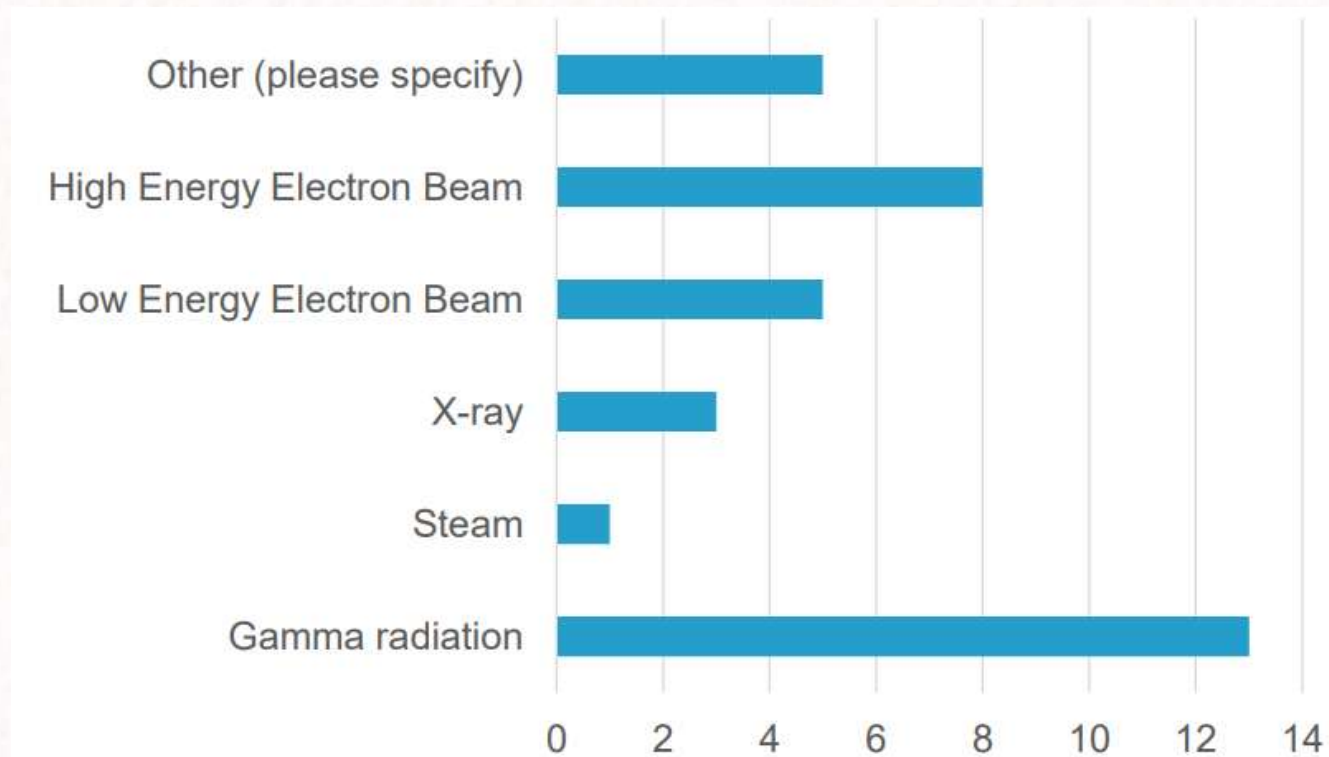
| Beam Energi (MeV) | Air (mm) | Alumunium (mm) | Timbal (mm) |
|-------------------|----------|----------------|-------------|
| 30 | 132 | 53.8 | 10.2 |
| 10 | 49.8 | 21.7 | 5.42 |
| 1 | 4.37 | 2.05 | 0.69 |
| 0.1 | 0.14 | 0.069 | 0.027 |
| 1.25 (Co-60) | 110 | 46.7 | 10.4 |
| 0.6 (Cs-137) | 80.0 | 34.4 | 5.56 |



2

Machine Based (EB/ Xrays) Radiation Application

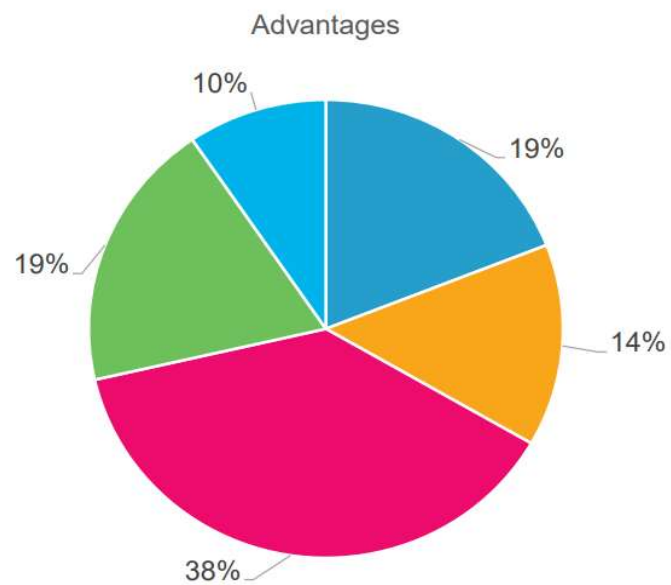
Food Irradiation Treatment



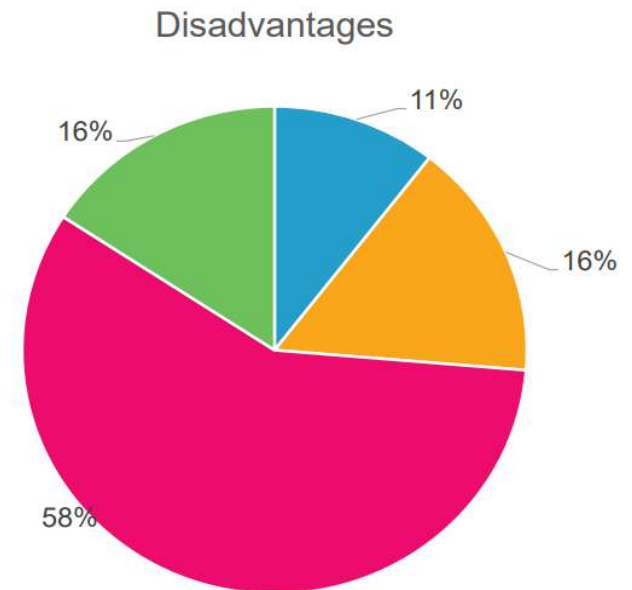
Note: "other" included EtO and low energy x-ray

Sources: Hannah Gagarin and Drew Wilcox (US DoE, NNSA, Sandia Labs)

Food Irradiation: Perceptions of Machine Based (EB/Xrays)



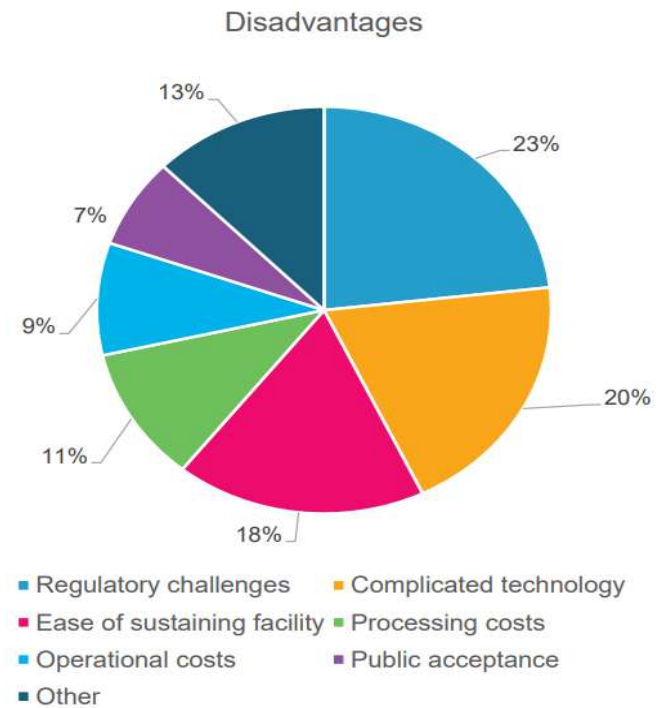
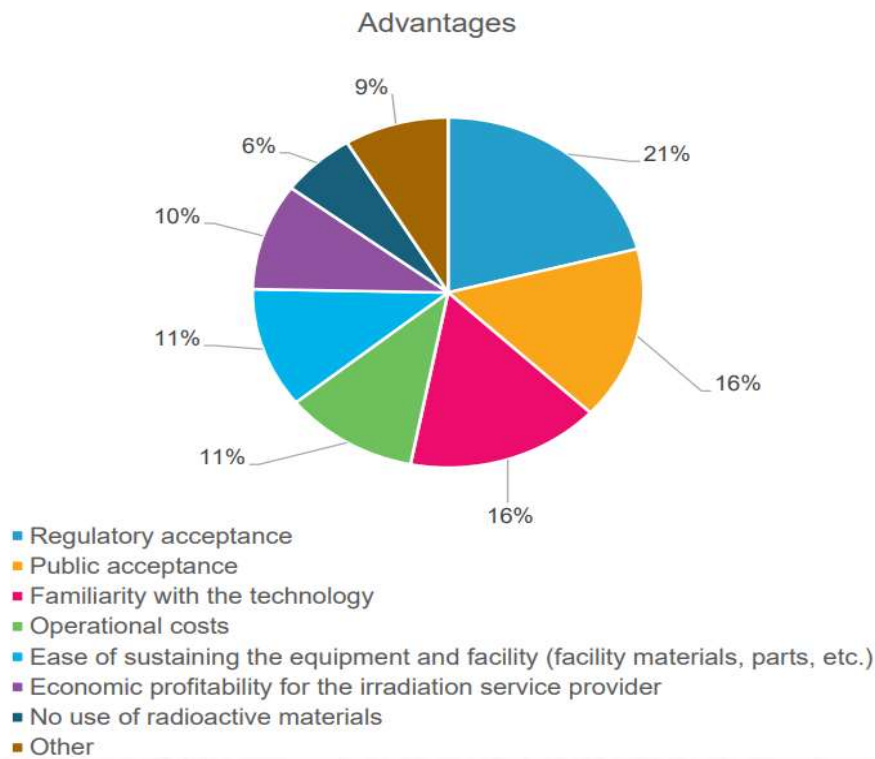
- Economic profitability
- Public acceptance
- Supply chain resilience
- Regulatory acceptance
- On-site solution



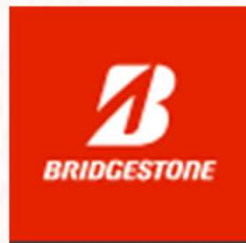
- Economic profitability
- Startup costs
- Regulatory acceptance
- Public acceptance

Sources: Hannah Gagarin and Drew Wilcox (US DoE, NNSA, Sandia Labs)

Medical Sterilization: Perceptions of Machine Based (EB/Xrays)



Sources: Hannah Gagarin and Drew Wilcox (US DoE, NNSA, Sandia Labs)



PT NIPRO INDONESIA JAYA



PT Sumi Rubber Indonesia (Dunlop)

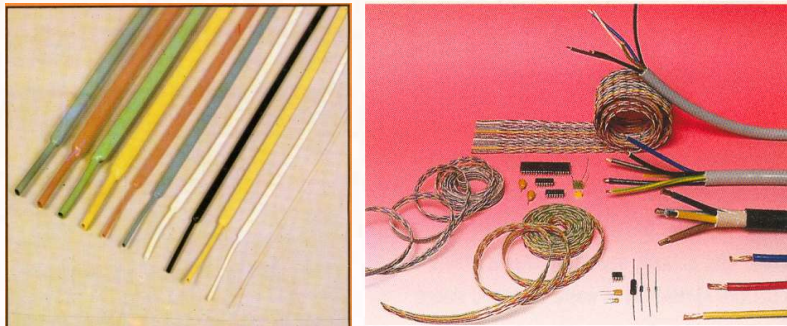


MULTISTRADA
ARAH SARANA Tbk

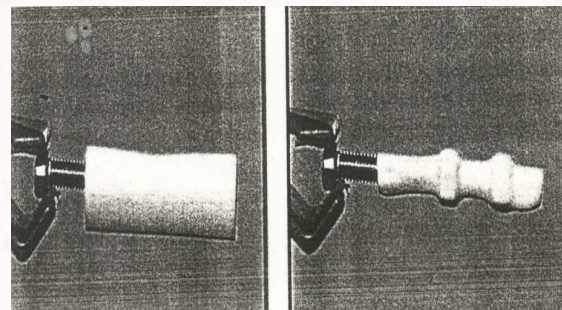
eBeam Application

Radiation Crosslinking for the Production of Polymer Products

Due to ionizing radiation a linear polymer molecule crosslinks to a three-dimensional macromolecule resulting in better mechanical, thermal and electrical properties.



Wire and cable insulations:



Heat shrinkable products:

eBeam Application

Radiation Crosslinking

Rubber vulcanization:

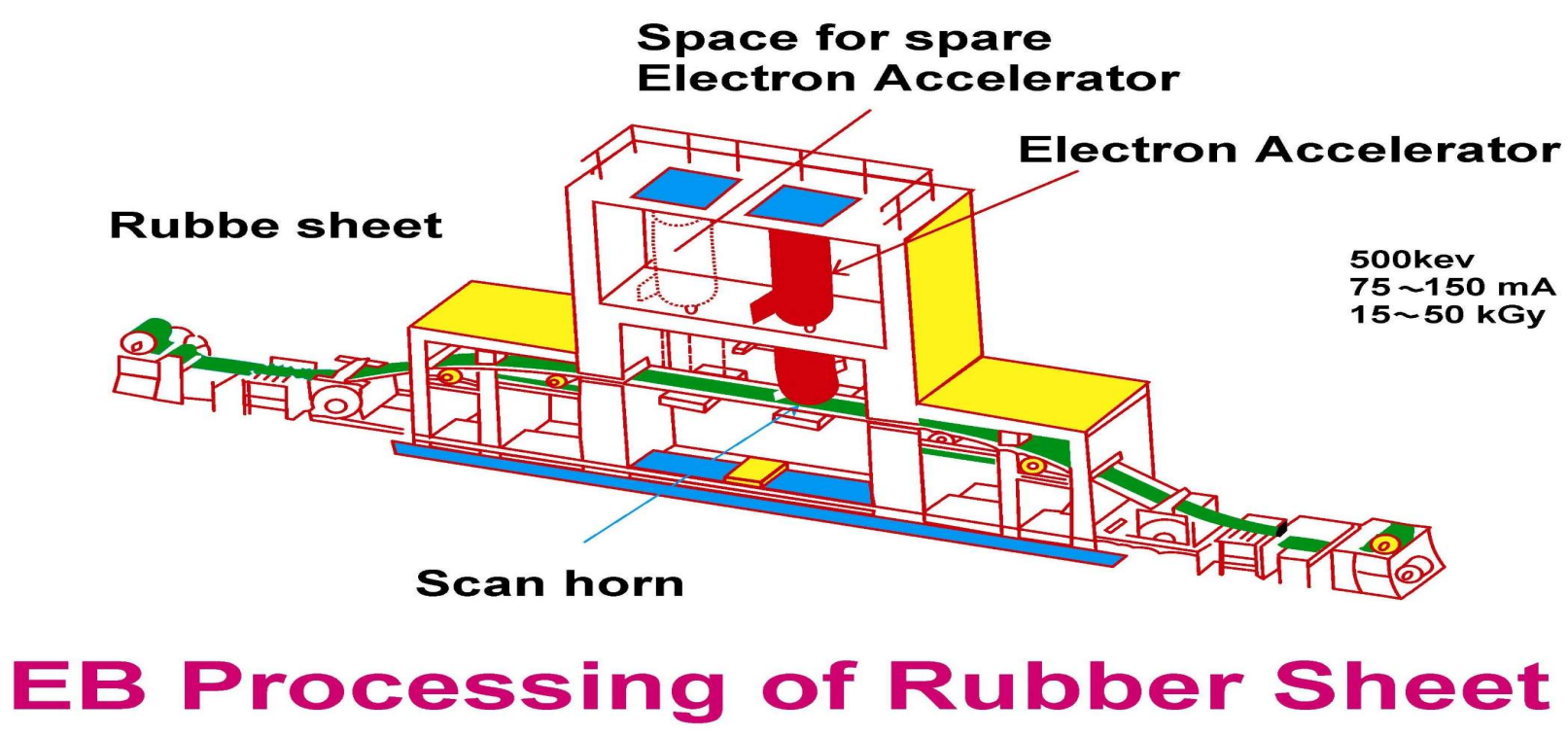


Foamed polymers:



Sources: Hannah Gagarin and Drew Wilcox (US DoE, NNSA, Sandia Labs)

eBeam Application



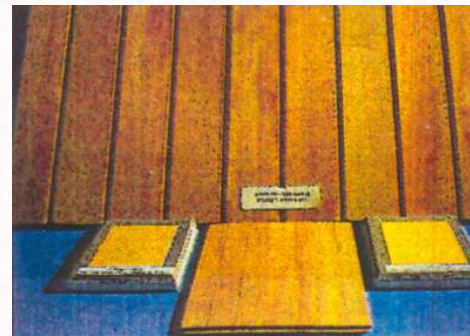
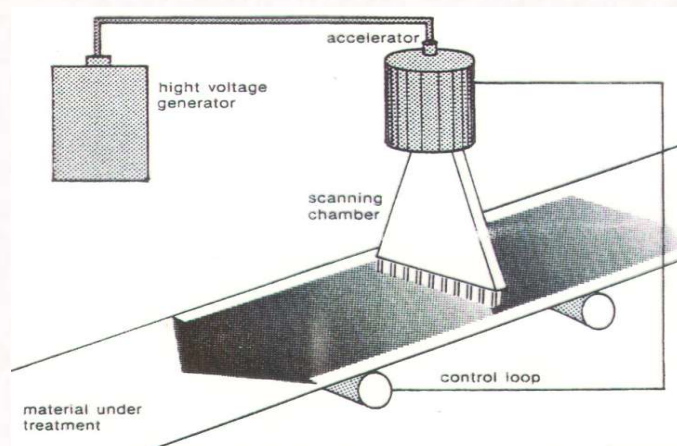
eBeam Application

Surface Coating

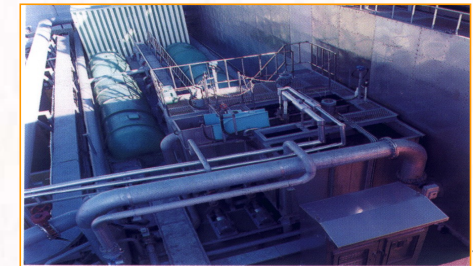
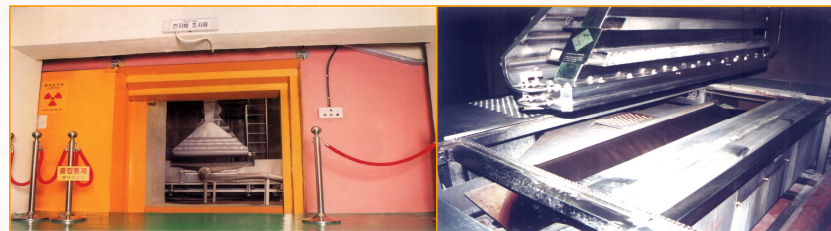
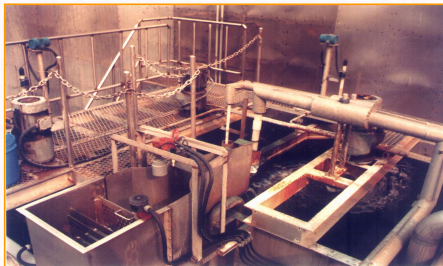
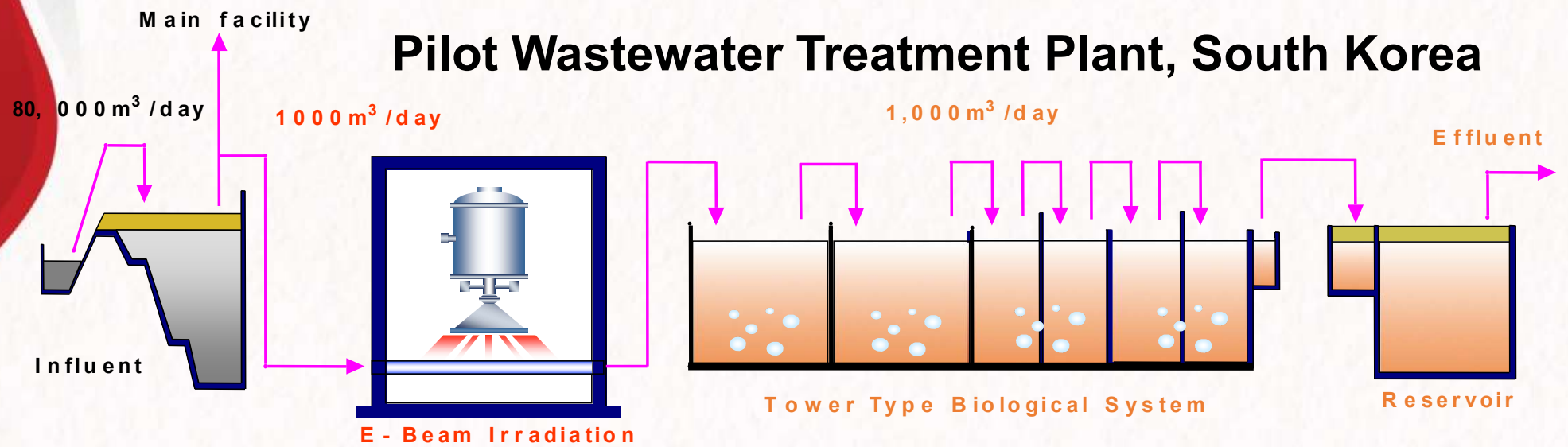
Simultaneous radiation polymerization and crosslinking of monomer and oligomer molecules on the surface of e.g. wood, metal, paper, ceramics, film resulting in a homogeneous layer in room temperature without using solvents

Industries: **printing, furniture, building, etc.**

Low energy curing of pigmented coatings on metal coil (energy saving)



eBeam Application



3

Application by Principles

Biological Effect

Sludge treatment:

Utilization of irradiated sludge (5 – 10 kGy) as fertilizer in agriculture, if its heavy metal content is negligible. On-line procedure.

Flue gas treatment:

Coal and oil based power stations emit sulphur and nitrogen containing gases, resulting in “acidic rain”. Responsible also for the formation of smog and green house effect.

- SO_2 (~ 95 %) and NO_x (~ 80 %) removal.
- NH_3 addition to produce fertilizers.
- Use of low energy accelerators.



Biological Effect

- Pembangkit Listrik Batubara 100 MW di Chengdu-CHINA
- Kapasitas pengolahan: 300.000m³/jam

SO₂ removal: 80%

No_x removal 20%

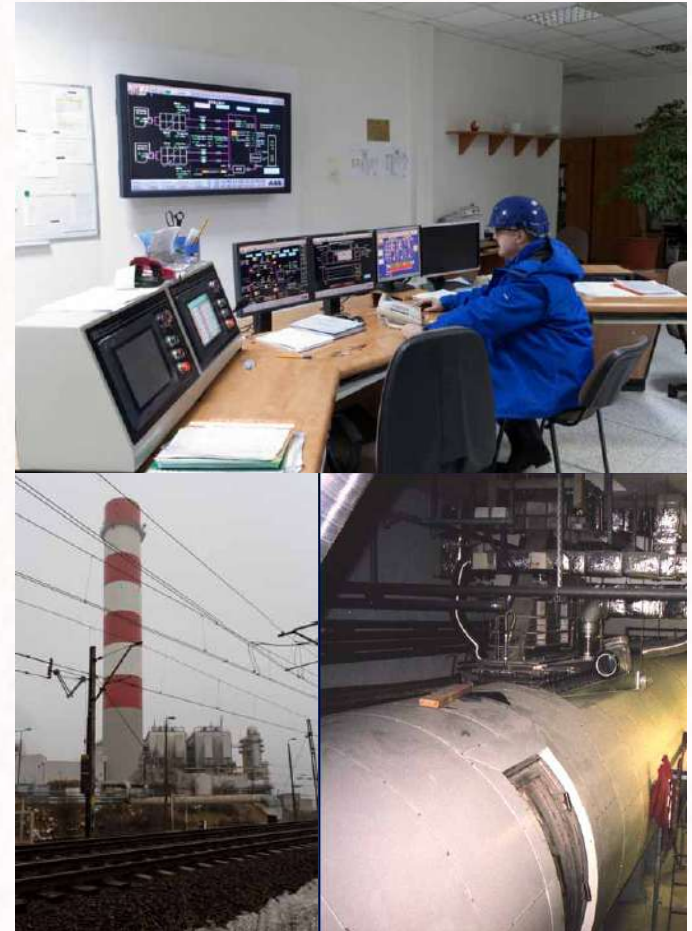


Flue gas cleaning plant in Chengdu, China.

Biological Effect

- Pembangkit Listrik Batubara 100 MW di POLANDIA
- EB Accelerator: 700 KeV x 375 mA, 4 unit

Kapasitas pengolahan: 270.000m³/jam



Biological Effect

1. Inhibition of sprouting (hot countries, expensive cooling); 50 – 150 Gy.
 - onion, garlic, potato (Japan, Hungary);
2. Insect disinfestation (import, transport); 50 – 500 Gy.
 - grains, cereals, flour; fruit flies; mango;
3. Delay of ripening (delay of the physiological process); 0.5 – 1.0 kGy.
 - papaya, mango, fresh vegetables;

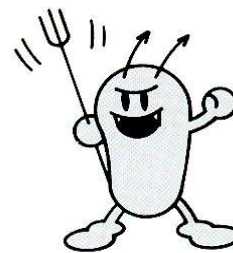


Biological Effect

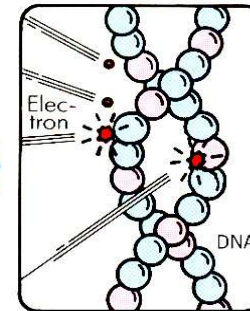
4. Extension of shelf-life (against spoilage microorganisms); 1 – 3 kGy.
- strawberry, fish, mushroom;
5. Decontamination of pathogenic microorganisms; 1 – 10 kGy.
- sea food, fast food, poultry, spices, herbs;
6. Food sterilization (hospital food, space missions); >25 kGy.



Micro Biological Effect



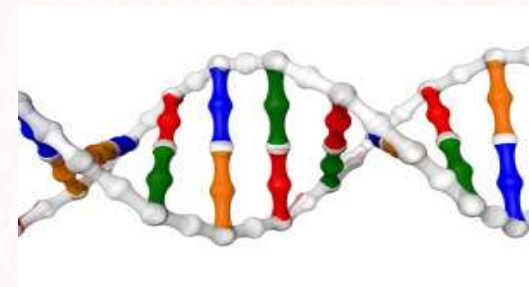
Effect on DNA



Chemical Effect

Polimerization, crosslinking

- Kawat, Kabel (Rubber Material)
- Pelapisan permukaan (Surface coating) untuk kayu, papan, kertas, metal, keramik, dll.
- Vulkanisasi karet alam (Natural rubber latex)
- Pembuatan hidrogel dan super water absorbent (wound dressing, popok, pembalut)



Chemical Effect

Grafting

- Textiles, biomaterials, Al-foils

Degradation

- Viscose, paper industry, teflon-ink
- Destruction of organic molecules in drinking/waste water



Chemical Effect

- Instalasi Industri Pengolahan Air Limbah dengan Elektron Beam - Korea
- Membersihkan air limbah dari pabrik pewarnaan kain di kota Daegu
- Kapasitas pengolahan: 10.000m³/hari
- EB Accelerator 1 Mev, 500 kW



Chemical Effect

| Application | Required Dose (kGy) |
|---|---------------------|
| Crosslinking of cable and wires | 30~200 |
| Heat Shrinkable materials | 50~100 |
| Degradation of PTFE | 50~1000 |
| Pre-vulcanization of tire | 15~50 |
| Crosslinking of polymer foams | 20~50 |
| Preparation of hydrogels | 50~100 |
| Curing of coating, composite, adhesives | 30~200 |
| Graft polymerization | 50~200 |

REFERENCES

BATAN.(2018). *Dasar Fisika Radiasi*, Pusdiklat BATAN

KAERI.(2023). *Introduction of Electron Accelerator and Its Application*

Saputro, Bimo.(2024). *Radiation Processing Application For Gamma and EB Machine*, Dirbangkom BRIN

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