



Water Irradiation Solution using an Industrial Electron Beam Accelerator



HEPTech Environmental Applications of Accelerators

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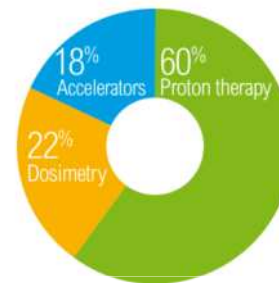
Agenda

- About IBA
- IBA's E-beam accelerators
- Main E-beam applications
- Waste water treatment solutions

IBA in a nutshell

- Based in Belgium, listed on Euronext Brussels
- Focused on **particle accelerators**
- **>400 accelerators** worldwide
- 2012 FY sales of €221 million
- **1,200 people** worldwide, 40 nationalities
- 15 offices on 3 continents

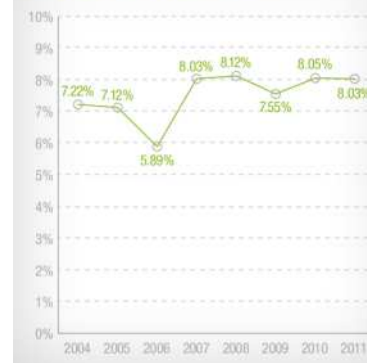
BREAKDOWN OF CONSOLIDATED
TURNOVER BY ACTIVITY



EMPLOYEE DISTRIBUTION
WORLDWIDE



IBA R&D AS % OF SALES



IBA Main Activities

Proton Therapy



Cancer treatment

Accurate protons
Minimized side effects
55% market share
22 IBA supplied centers

Dosimetry



Patient and machine QA

Calibration, validation and QA
Used in most hospitals

Cancer diagnostic

160+ Cyclotrons installed
Synthera multi-tracer system
From Cyclotron to turnkey

RadioPharma



Industrial



Industrial applications

Medical Device Sterilization
Polymer crosslinking
Food pasteurization

IBA Electron-beam Product Portfolio

Dynamitron

0.5 -> 5 MeV | 160 mA
Electron beam



Main application
E-beam Crosslinking

Rhodotron

3 -> 10 MeV | 700 kW
Electron beam and X-rays



Main application
E-beam and X-ray sterilization

IBA E-beam Equipment Evolution

| | | |
|--------|----------|--------|
| 1970's | • 3 MeV | 150 kW |
| 1980's | • 5 MeV | 150 kW |
| 1990's | • 10 MeV | 150 kW |
| 2000's | • 10 MeV | 190 kW |
| 2010's | • 7 MeV | 700 kW |

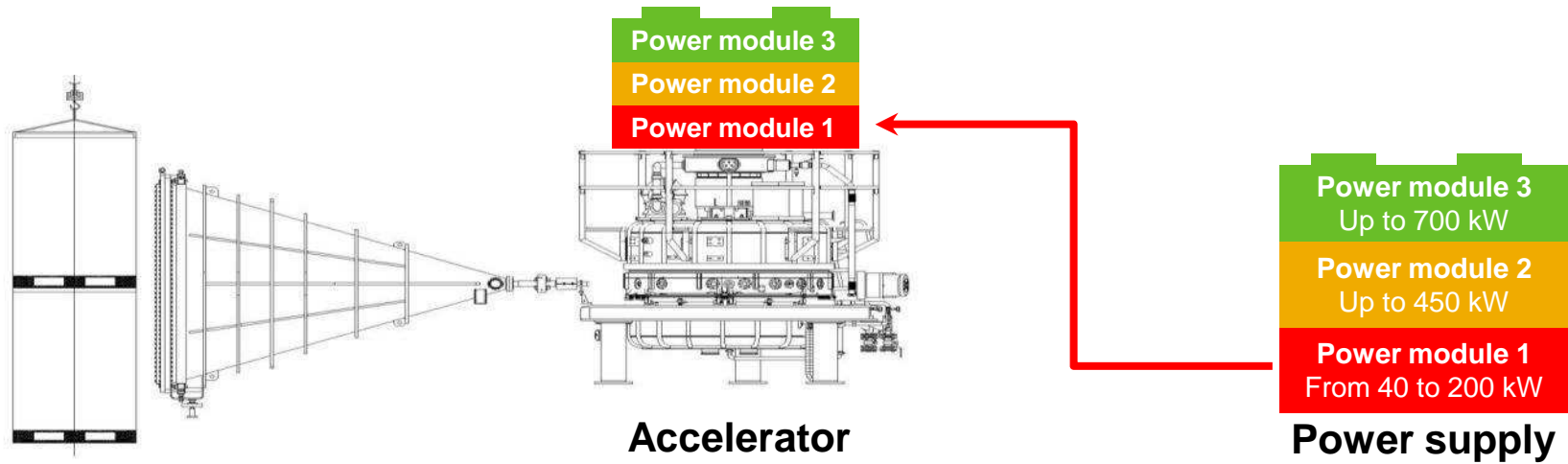


Dynamitron



Rhodotron

Modular E-beam Rhodotron



IBA Industrial Installed Base



200+ Dynamitron

- United States
- Europe

30+ Rhodotron

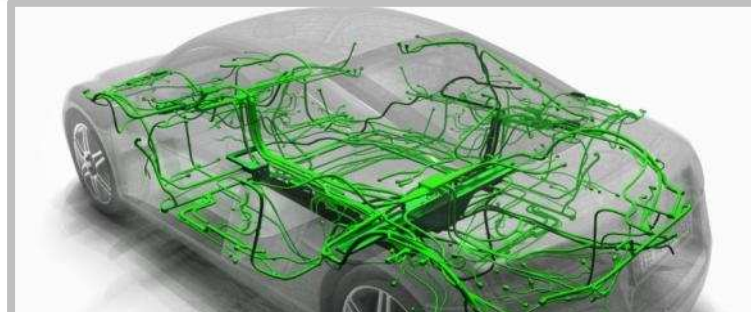
- Europe
- Asia

Dynamitrons ●
Rhodotrons ●

Key Industrial Applications for IBA



Medical Device Sterilization



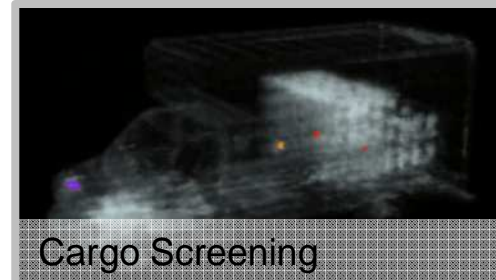
Polymer Cross-linking



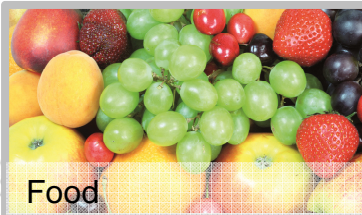
Mail Sanitization



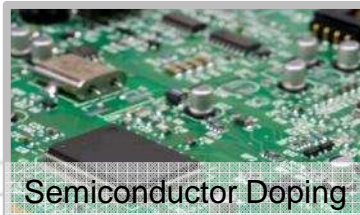
Gemstones



Cargo Screening



Food



Semiconductor Doping



Sterile Insect Technique

Protect, Enhance, and Save

The logo for IBA, consisting of the lowercase letters 'iba' in a stylized, green, cursive font.

Why Electron Beam for Water Radiation?

| | E-beam | X-ray | Gamma |
|-----------------|-----------|-----------|-----------|
| Cost of power | Low | High | Very high |
| Dose rate | Very high | Low | Very low |
| Dose uniformity | Low | Very good | Good |
| Penetration | Low | Very high | High |

Important for water treatment

It takes two to Tango

Roles & Responsibilities

IBA -> Radiation equipment provider

- Provides **solutions delivering desired dose** to products
- Support in **design the water handling solution** and the facility
- Provide a **test facility** (NY, US) for (water) radiation



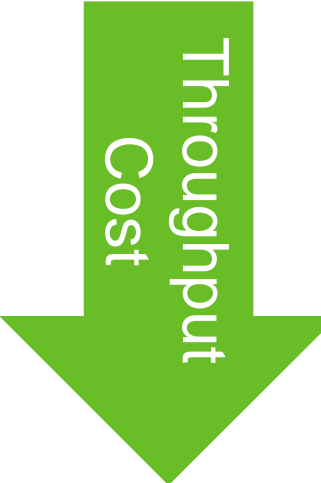
The IBA Long Island test facility

Partner/Customer -> Application expert

- Understands **impact of dose on water**
- Defines **required dose** for specific waste water treatment
- **Improving treatment efficiency** by combining irradiation with other techniques

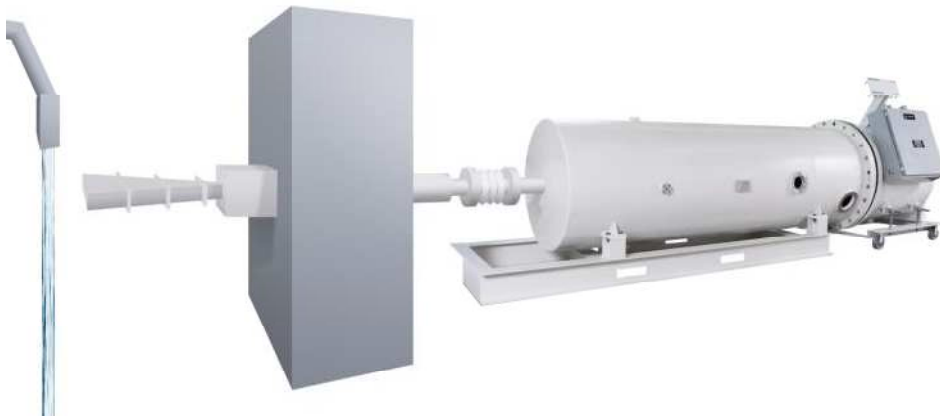
Energy -> Penetration -> Throughput

| <u>Energy</u> | <u>Penetration in water</u> |
|---------------|-----------------------------|
| 1.5 MeV | ~0.5 cm |
| 5 MeV | ~1.5 cm |
| 7 MeV | ~2.4 cm |
| 10 MeV | ~3.6 cm |



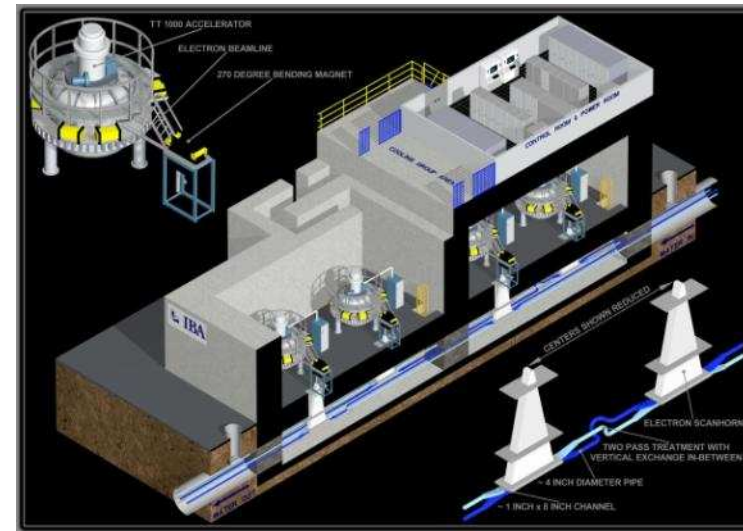
Dynamitron and Rhodotron based Water solutions

Low throughput solution



1 * 1.5 MeV 75kW Dynamitron
@ 500 Gy -> 380 m³/h
~0.4 € / m³

High throughput solution



4 * 5 MeV Rhodotrons - total 1.700 kW
@ 500 Gy -> 11.000 m³/h
~0.1 € / m³

Impact of dose requirements

- **Dose level is**

- inversely proportional to **speed**
- proportional to **cost**

- **Example:**

- 0.5 kGy 0,1 € / m³ Municipal waste water
- 4 kGy 0.8 € / m³ Liquid Sludge, some hazardous chemicals
- 10 kGy 2.0 € / m³ Industrial waste, pesticides
- 50 kGy 10 € / m³ PCB breakdown

Thank you

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IBA Industrial

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