



X-ray: The emerging alternative to gamma irradiation

October 13th 2015

Regional Meeting on use of E-beam or X-Ray for Phytosanitary Applications



Rick Galloway – IBA



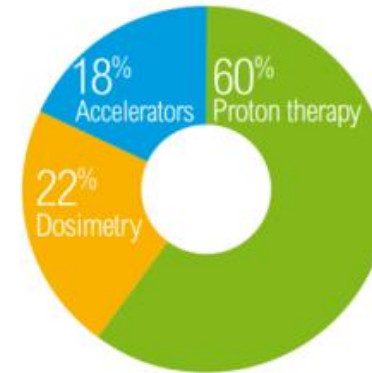
Presentation outline

- Brief introduction of IBA
- Industrial Accelerator applications
- X-ray irradiation, a comparison with Gamma
- Configurations for optimizing X-Ray DUR and throughput
- Reducing OPEX by improving accelerator efficiency
- X-ray systems installed today
- Conclusion

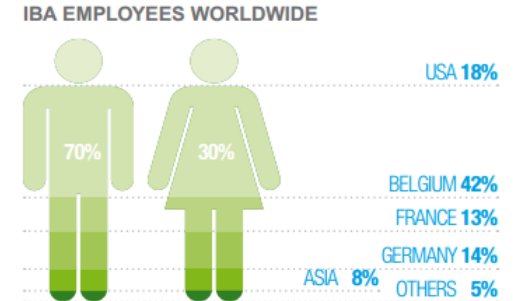
IBA in a nutshell

- Based in Belgium, listed on Euronext Brussels
- Focused on **particle accelerators**
- **>400 accelerators** worldwide
- 2014 sales of €220 million
- **1,200 people** worldwide, 40 nationalities
- 15 offices on 3 continents

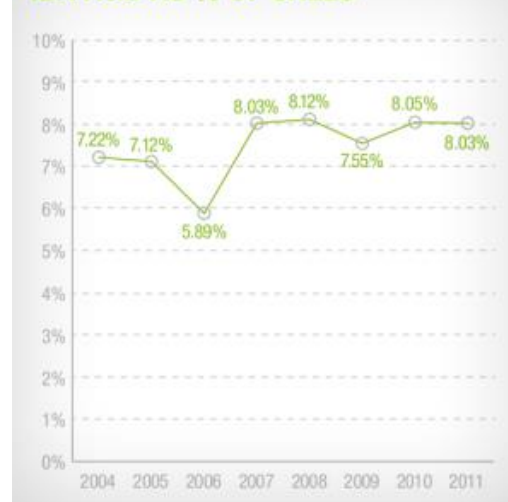
BREAKDOWN OF CONSOLIDATED
TURNOVER BY ACTIVITY



EMPLOYEE DISTRIBUTION
WORLDWIDE



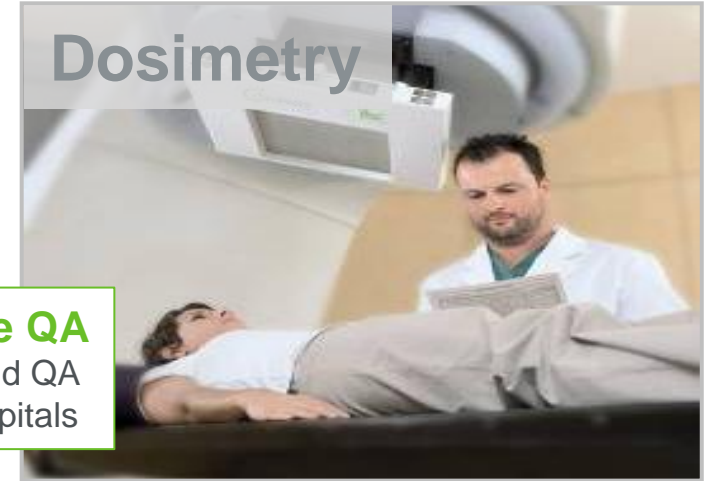
IBA R&D AS % OF SALES



IBA Main Activities



Cancer treatment
Accurate protons
Minimized side effects



Patient and machine QA
Calibration, validation and QA
Used in most hospitals



Cancer diagnostic
160+ Cyclotrons installed
Synthera multi-tracer system



Industrial applications
Medical Device Sterilization
Polymer crosslinking
Etc...

IBA Industrial's Product Portfolio

Dynamitron

0.5 -> 5 MeV

Up to 160 mA

Electron beam

X-ray



Main application

Material Modification / Crosslinking

Rhodotron

3 -> 10 MeV

0 -> 560 kW

Electron beam

X-ray



Main application

Medical device sterilization

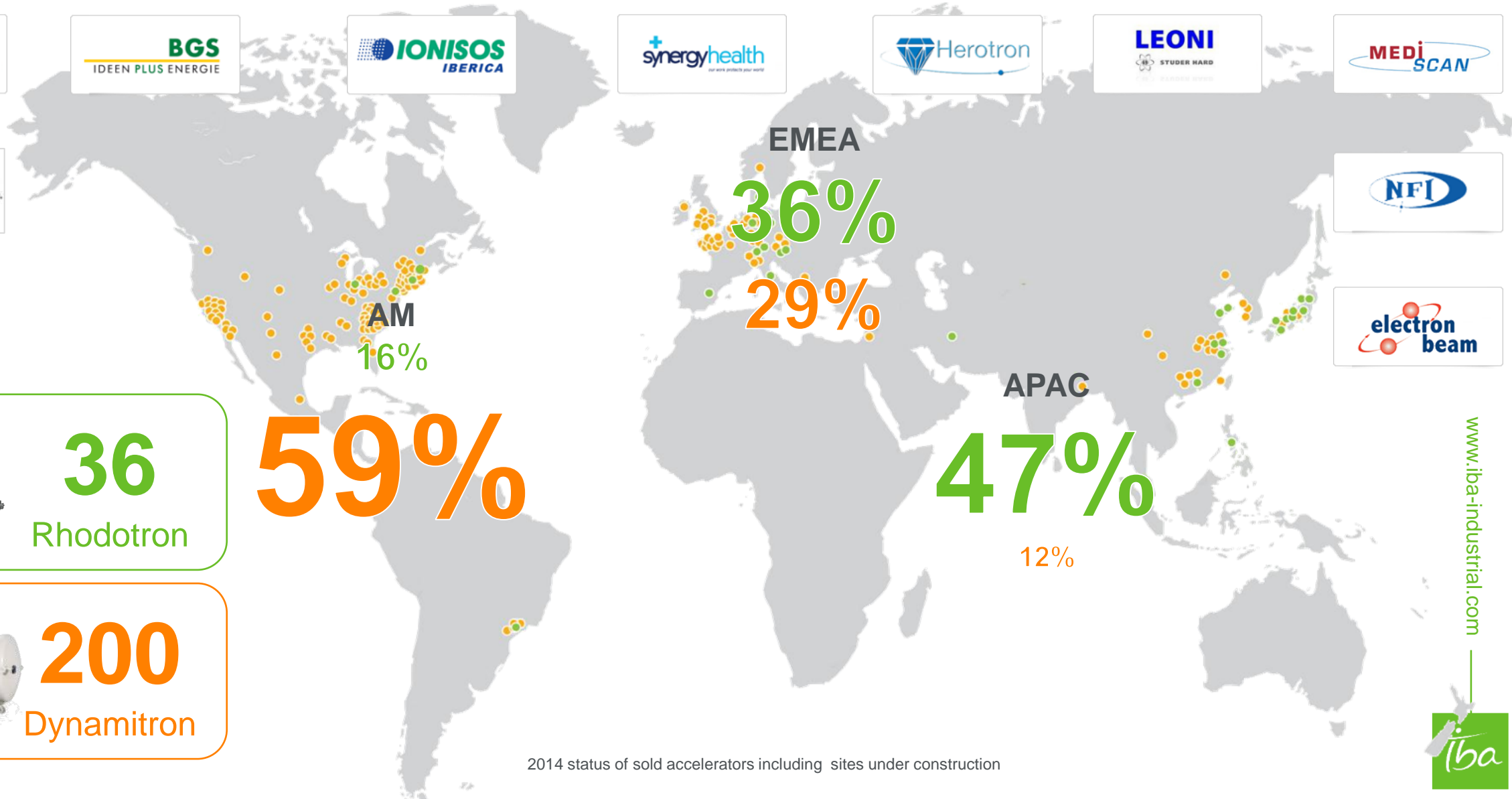
IBA Industrial - Installed Base



36
Rhodotron



200
Dynamitron



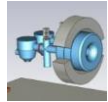
2014 status of sold accelerators including sites under construction

www.iba-industrial.com



Rhodotron and Dynamitron product ranges

Rhodotron product range



Coming soon : very compact TT50



10 kW, 1 mA



TT100 Compact 10 MeV



40kW, 4mA



TT200 Standard 10 MeV



100kW, 10mA

Models available from 35 kW to 100 kW



TT300 High power 10 MeV



245kW, 35mA

Models available from 50 kW to 245 kW



TT1000 High power 7 MeV



560kW, 80mA

Models available from 100 kW to 560 kW

Dynamitron product range *



Dynamitron® 500 KeV



550 KeV, up to 160 mA (Optional Self-shielding)



Dynamitron® 800 KeV



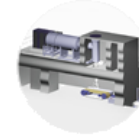
800 KeV, up to 160 mA (Optional Self-shielding)



Dynamitron® 1 MeV



1000 KeV, up to 100 mA (Optional Self-shielding)



Dynamitron® 1.5 MeV



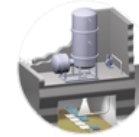
1.5 MeV, up to 65 mA



Dynamitron® 3 MeV



3 MeV, up to 50 mA



Dynamitron® 5 MeV

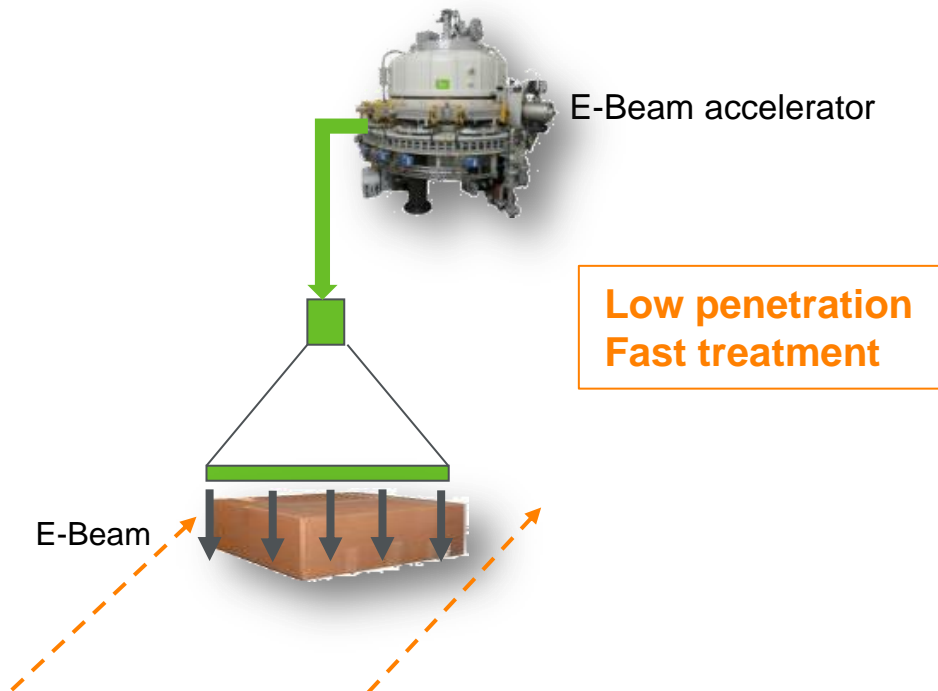


5 MeV, up to 30 mA

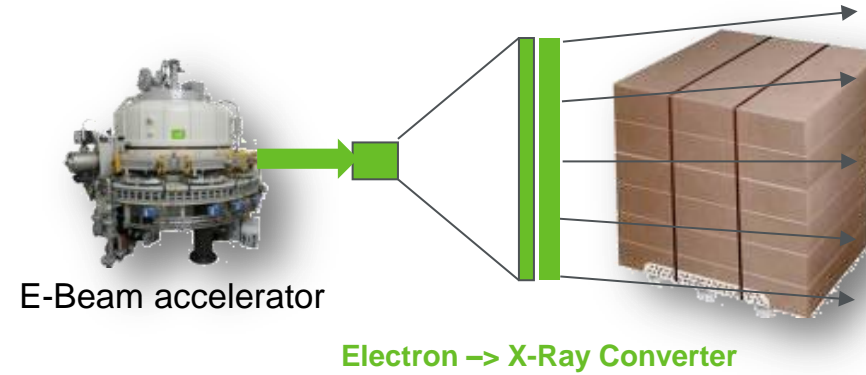
*Other models can be available on request

Irradiation Treatment Techniques overview

E-beam



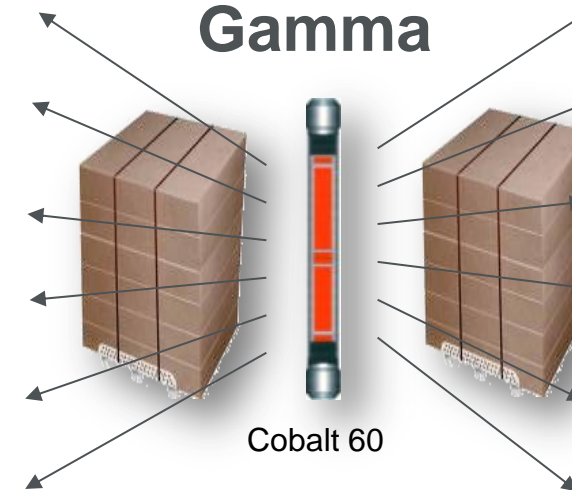
X-ray



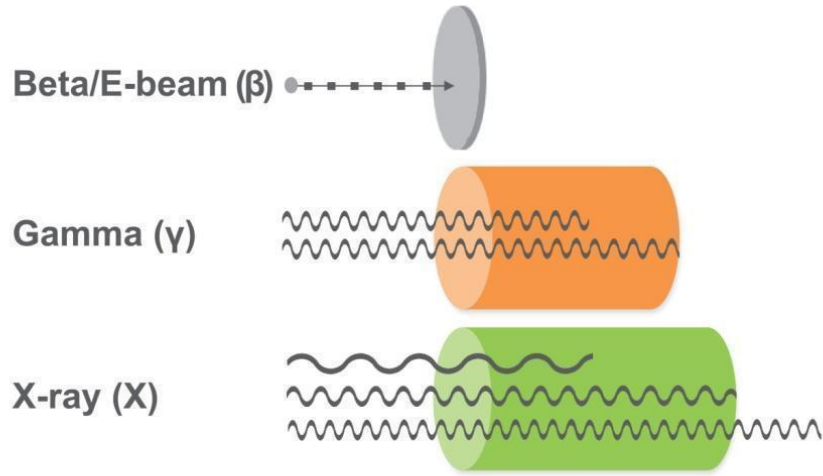
High penetration

10kCi takes
150 yrs to
decay to 2.7
 μ Ci (inactive).
Half life of 5.3
years

Gamma



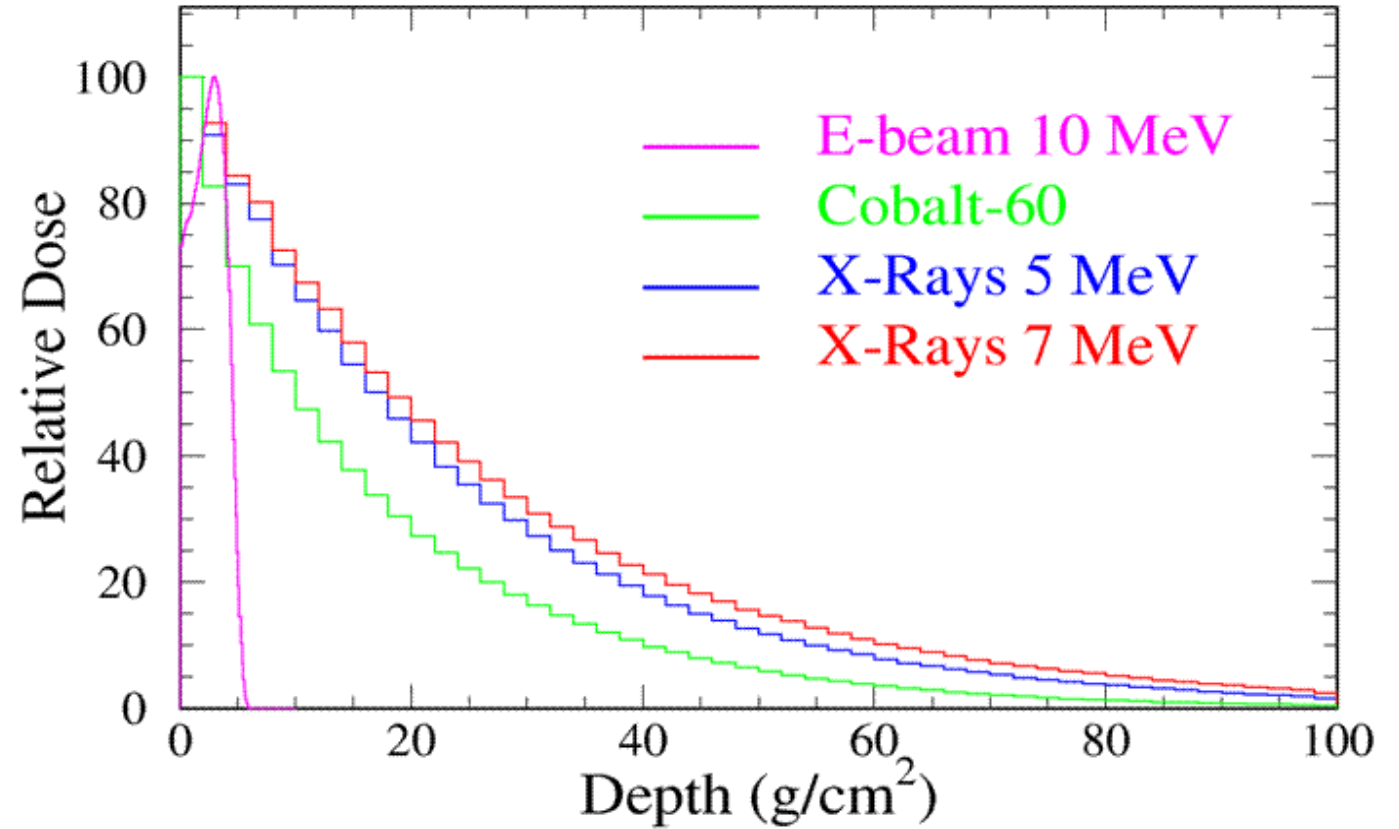
Monte Carlo results for different treatments



X-Ray

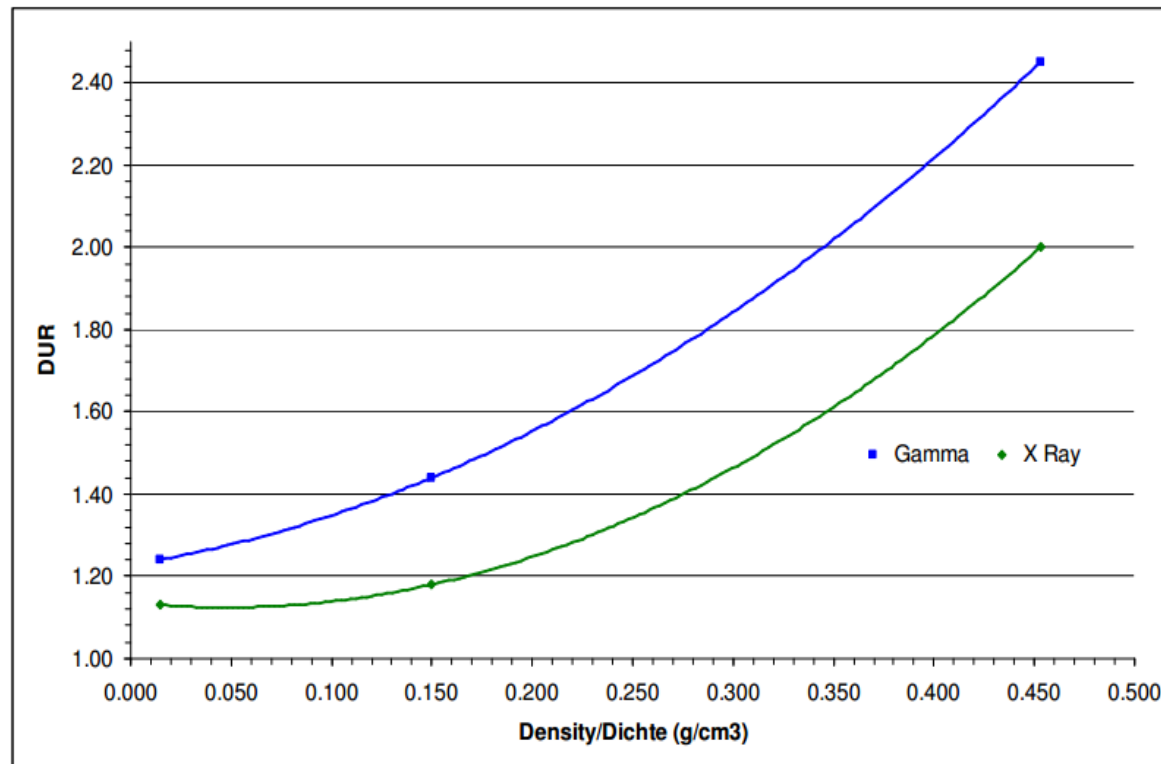
- Provides deeper **Penetration**
- Allows for bigger **Packaging**
- Better DUR = Better **Quality**

Dose vs. Depth Profiles



Dose Uniformity Ratio (DUR)

Homogeneity comparison Gamma irradiator vs. X-Ray unit



- Actual data from operational X-ray facility
- Lower DUR means better treatment quality

Data source:

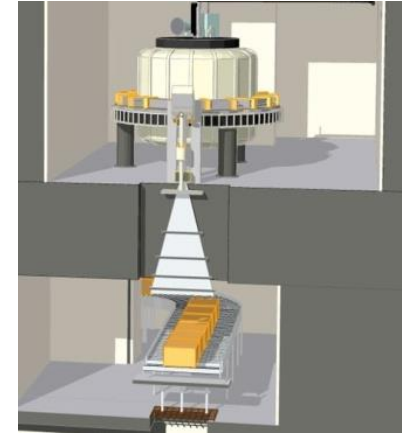
Synergy Däniken (Switzerland)
X-ray processing facility


our work protects your world

Which configuration for me?

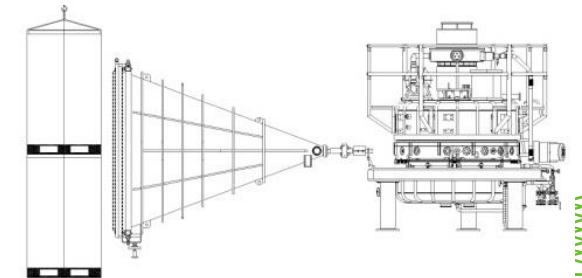
Dedicated **E-beam** facility

- I want solely to focus on highly efficient E-beam
- I can change the packing of my products for E-beam
- I can't handle a small part of my products but that's OK



Dedicated **X-ray** facility

- I want to minimize the product handling and reduce damage
- I want to maintain the pallet and pest protection integrity
- I need high quality treatment with low impact on products



E-beam and X-ray on one single accelerator

- I want to focus on high efficiency E-beam processing
- But I need X-ray for some high density products

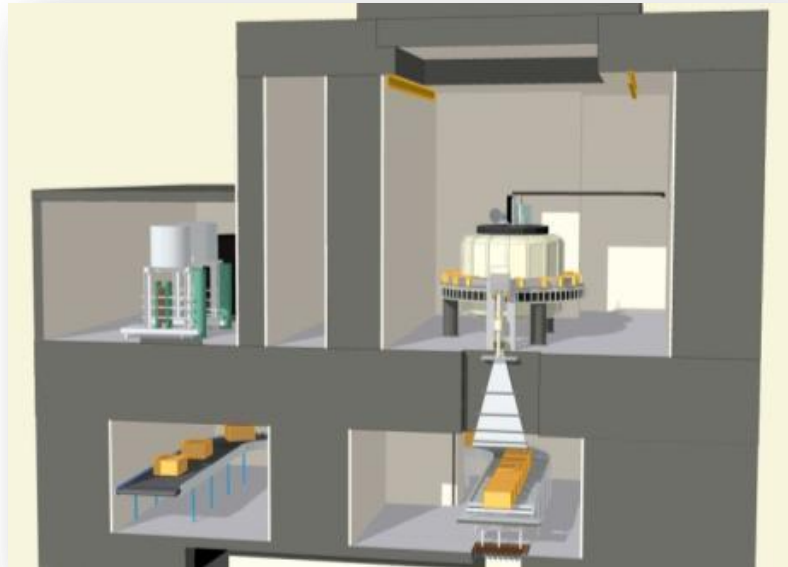


Typical E-beam and X-ray configurations

Rhodotron E-beam

10 MeV E-beam

Boxes



E-beam top irradiation

eXelis X-ray

5 or 7 MeV X-ray

Pallets



X-ray lateral irradiation

Rhodotron Duo

10 MeV E-beam

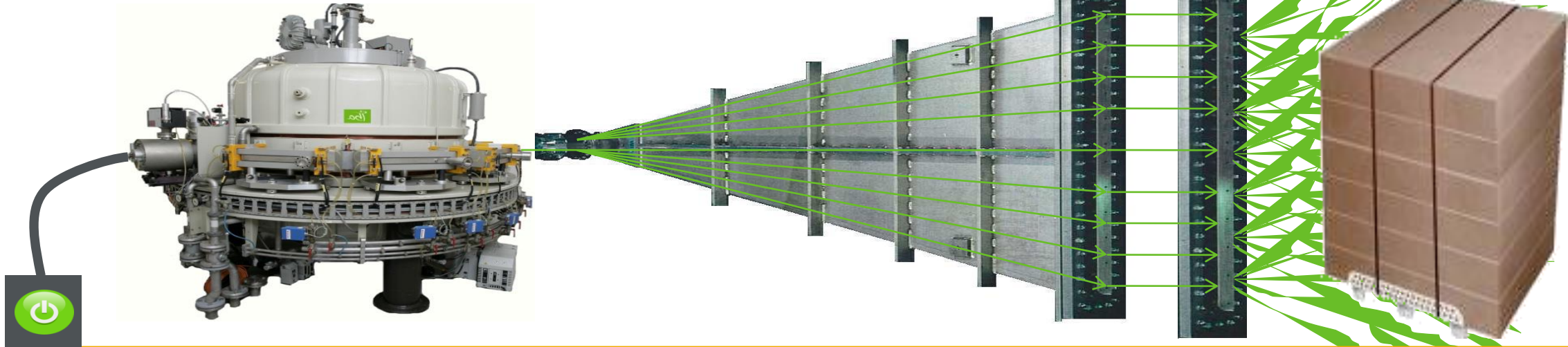
+ 5 or 7 MeV X-ray

Boxes



E-beam and X-ray top irradiation

X-ray advantages



- **Electrically powered Flexibility**

- ON / OFF when needed
- Power / Capacity « on Demand »

- **Pallet treatment**

- no radioactive source, simple regulatory compliance and licensing
- seasonal products, power demand license

- **Excellent Dose Uniformity**

- Ability to treat low and high density products, limit material handling and maintain insect control

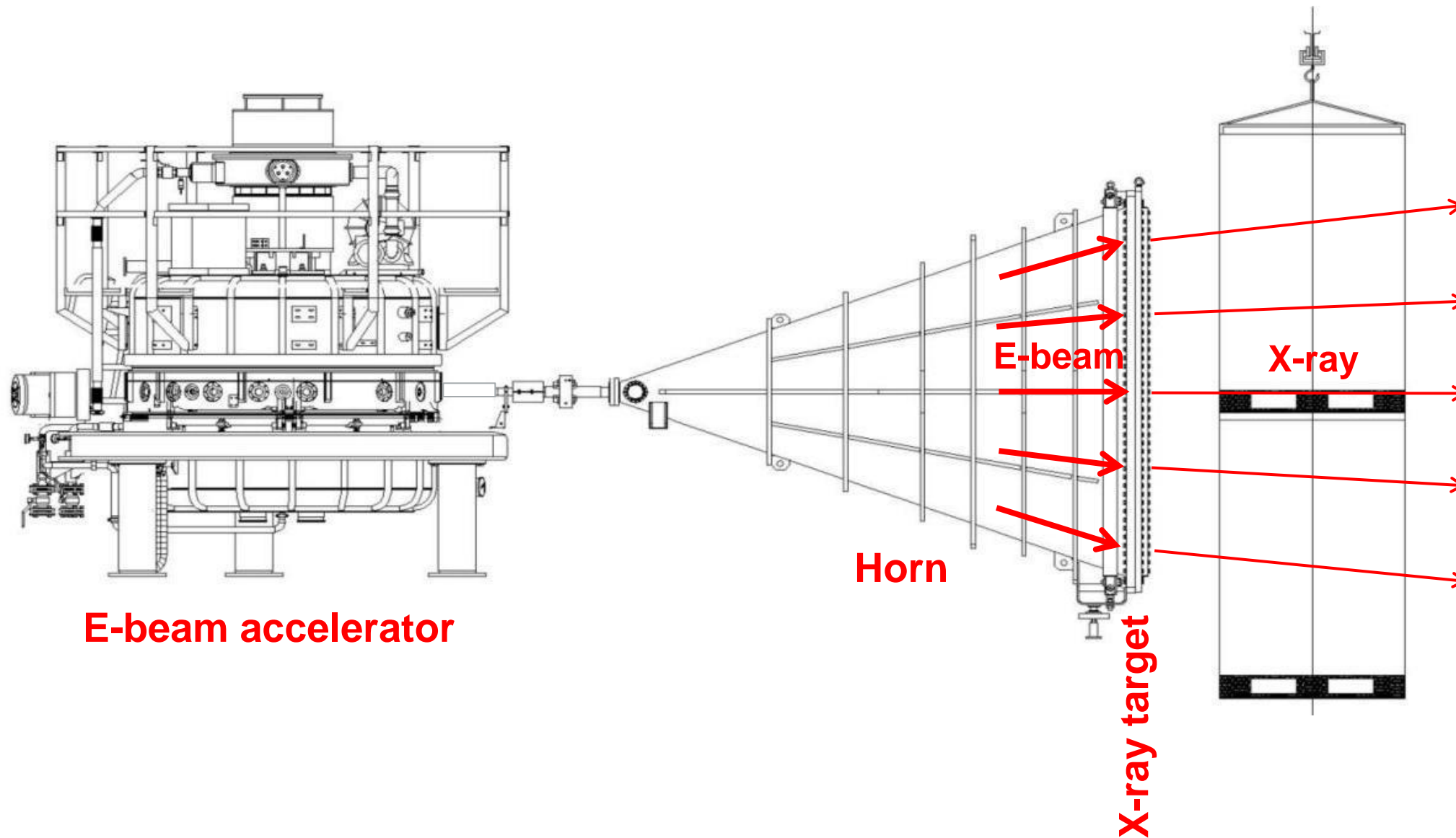
- **Short Treatment Time**

- limited overdosing because of better dose control (lower DUR)
- Refrigeration may not be required during treatment

Pallet Treatment configurations

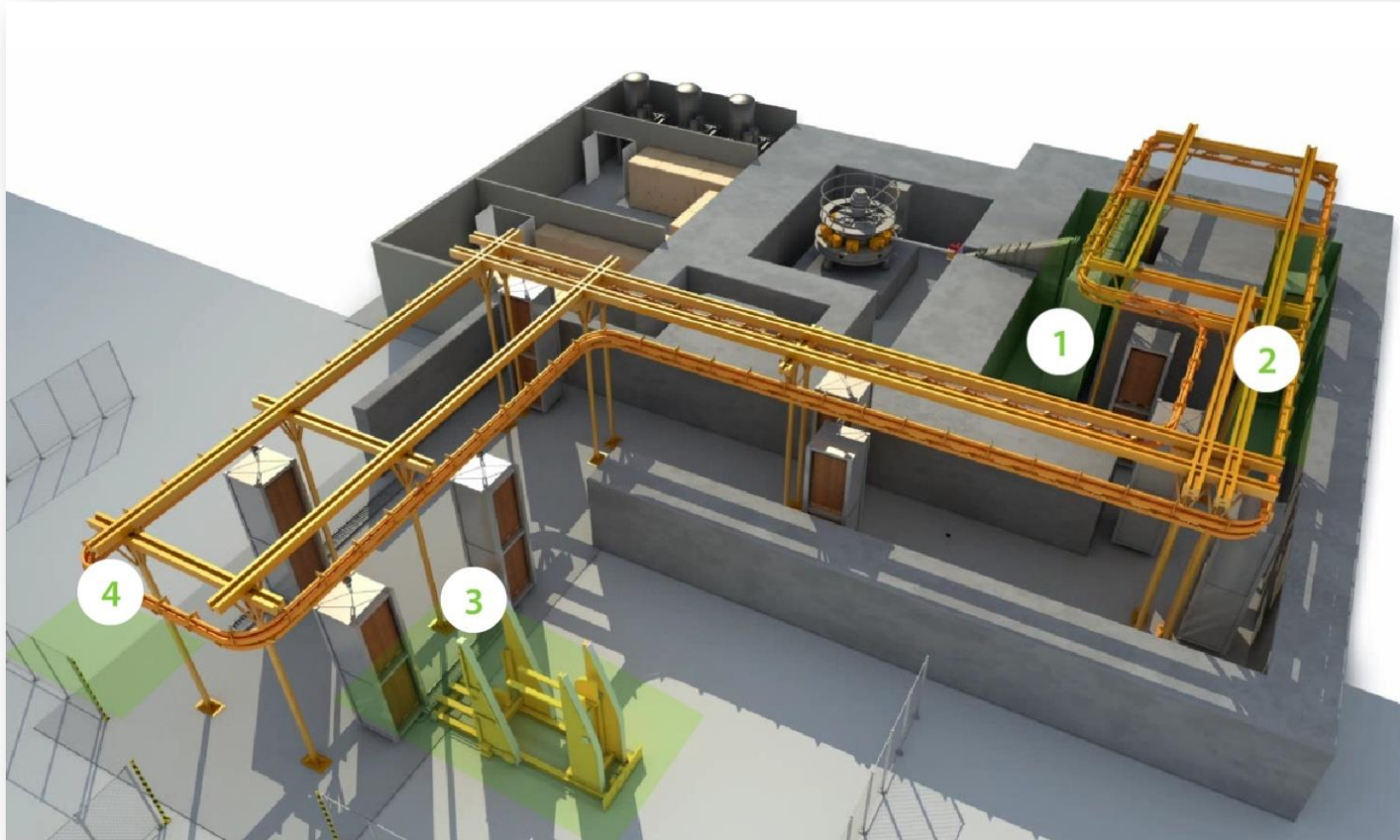
	ROTATING	2-SIDED
1 L E V E L		
2 L E V E L		

X-ray Product Overlap Configuration



A Typical dedicated X-ray Center

[Animation video](#)



Which Configuration ?

□ Here is a case study for estimated throughputs for 2 different density products

□ Phytosanitary application

➤ **Products :**

- $\rho = 0.3 \text{ gr/cc}$ → Mangoes
- $\rho = 0.5 \text{ gr/cc}$ → Dates
- Minimum 25 tons per hour

➤ **Doses :**

- $D = 400 \text{ Gy}$

➤ **Accelerator Power :**

- 100 kW (14.3mA @ 7 MeV)
(7.0MeV For products exported to the US)



Which Treatment Configuration ?

□ **Performance** : (MC Simulations benchmarked by measurements)

➤ **< 2 DUR**

	ROTATING		2-SIDED	
	1-level	2-level	1-level	2-level
Mangoes (0.3 g/cc)	1.54	1.57	2.16	1.58
Dates (0.5 g/cc)	1.58	1.51	2.91	2.24

➤ **> 25 Throughput** (Tons/h/100kW*)

	ROTATING		2-SIDED	
	1-level	2-level	1-level	2-level
Mangoes (0.3 g/cc)	17.27	22.83	29.37	39.59
Dates (0.5 g/cc)	23.68	33.78	33.09	42.58

* Throughput at 5.0MeV will be approximately 25% lower

Which Treatment Configuration ?

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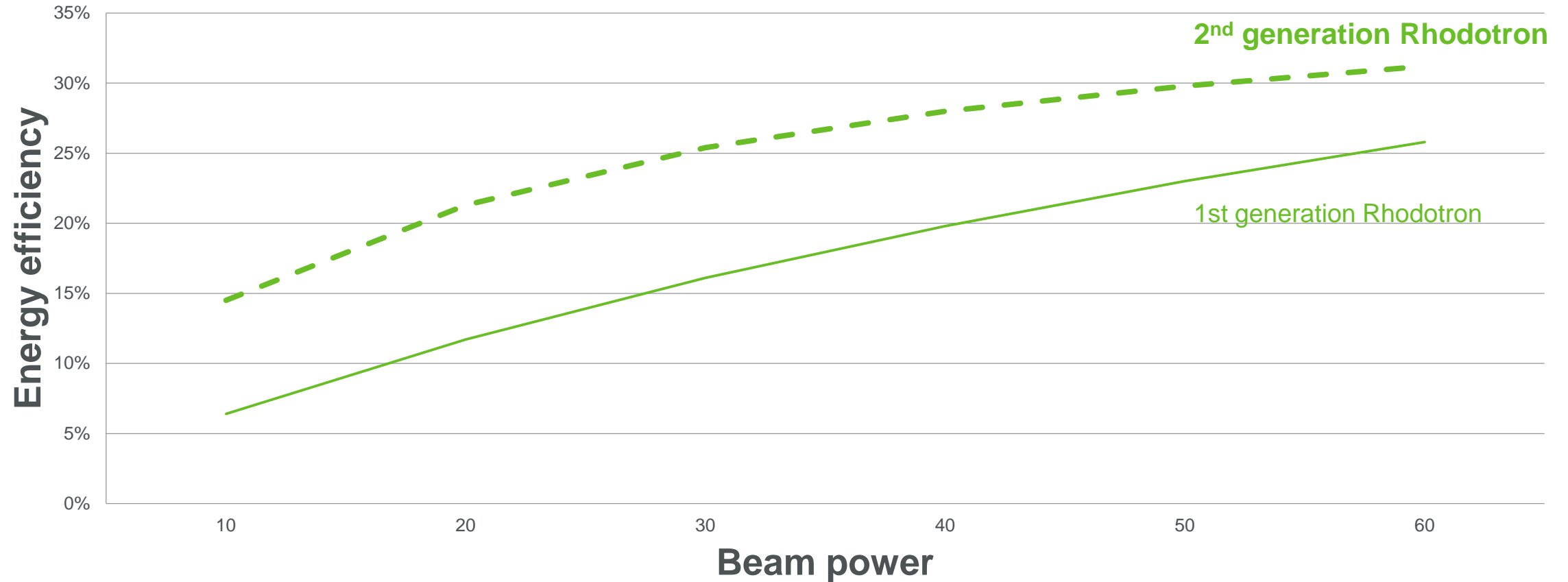
Every customer's situation is unique and requires a customized optimal configuration, depending on Product Density Range

Product Density Range	ROTATING		2-SIDED	
	1-level	2-level	1-level	2-level
Mangoes (0.3 g/cc) DUR requirements (Dmin required, Dmax allowed)	17.27	22.83	29.37	39.59
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Rhodotron Reducing OPEX

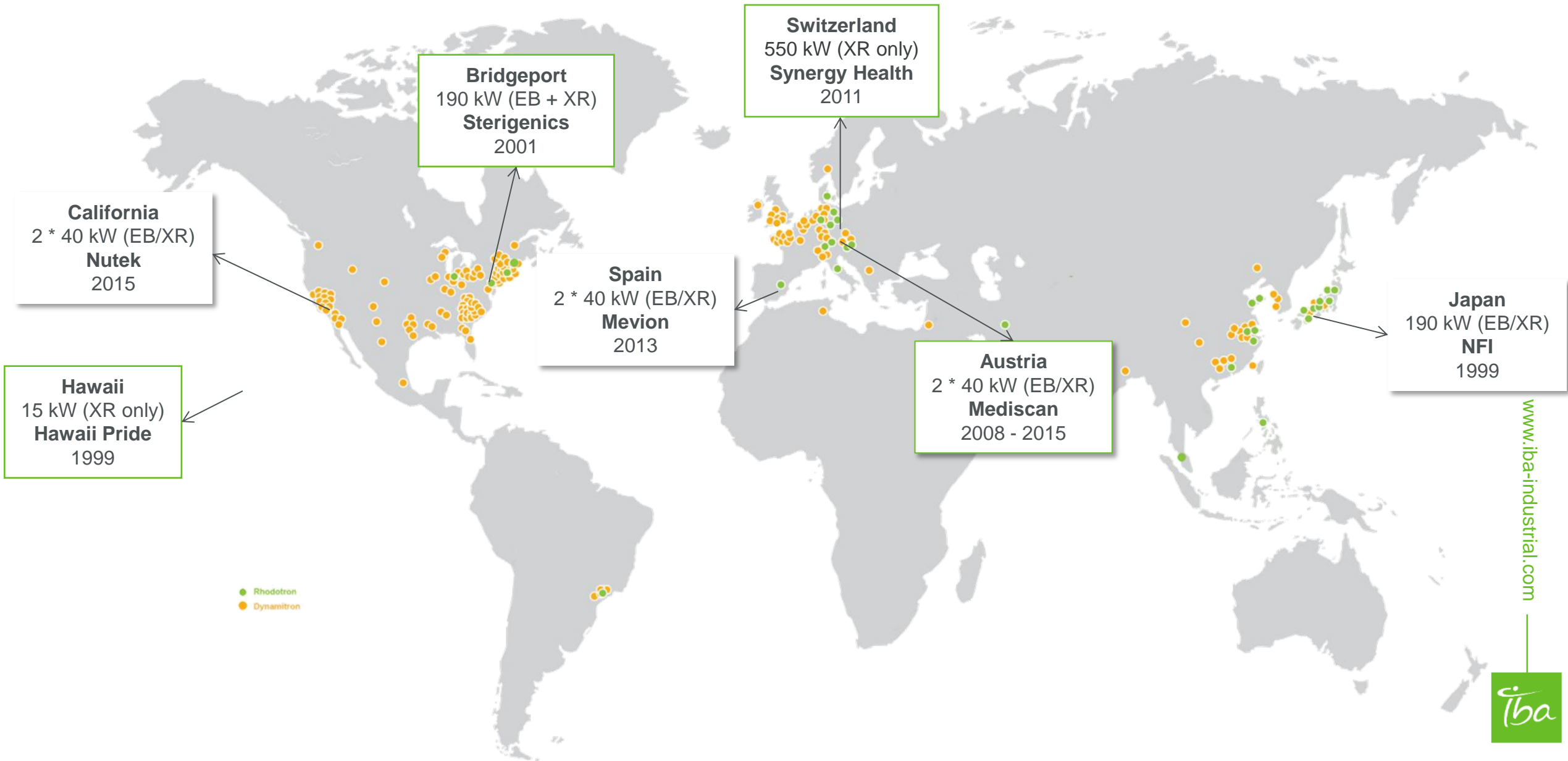
Energy efficiency
(beam power / total power consumption)



Assumptions:

- 10 MeV
- 10 MeV TT200

High power X-ray systems available



Our vision: X-ray and E-Beam are the alternative to Gamma

- We believe the **industry needs an alternative irradiation technology** to radioactive sources
- We believe that **X-ray Treatment (and electron beam) is the alternative** because:
 - Equivalent or **better Quality treatment**
 - Proven **Reliability** and performance of **E-Beam and X-Ray**
 - X-Ray **provides for maintaining pallet and pest netting**
 - X-Ray **reduces product handling, improving quality**
 - **Electrically powered**, electricity is the energy of the future increasingly produced through renewable energy sources, known operational costs
 - **No packaging or configuration changes** required when processing in X-Ray instead of gamma pallets



Gracias!



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