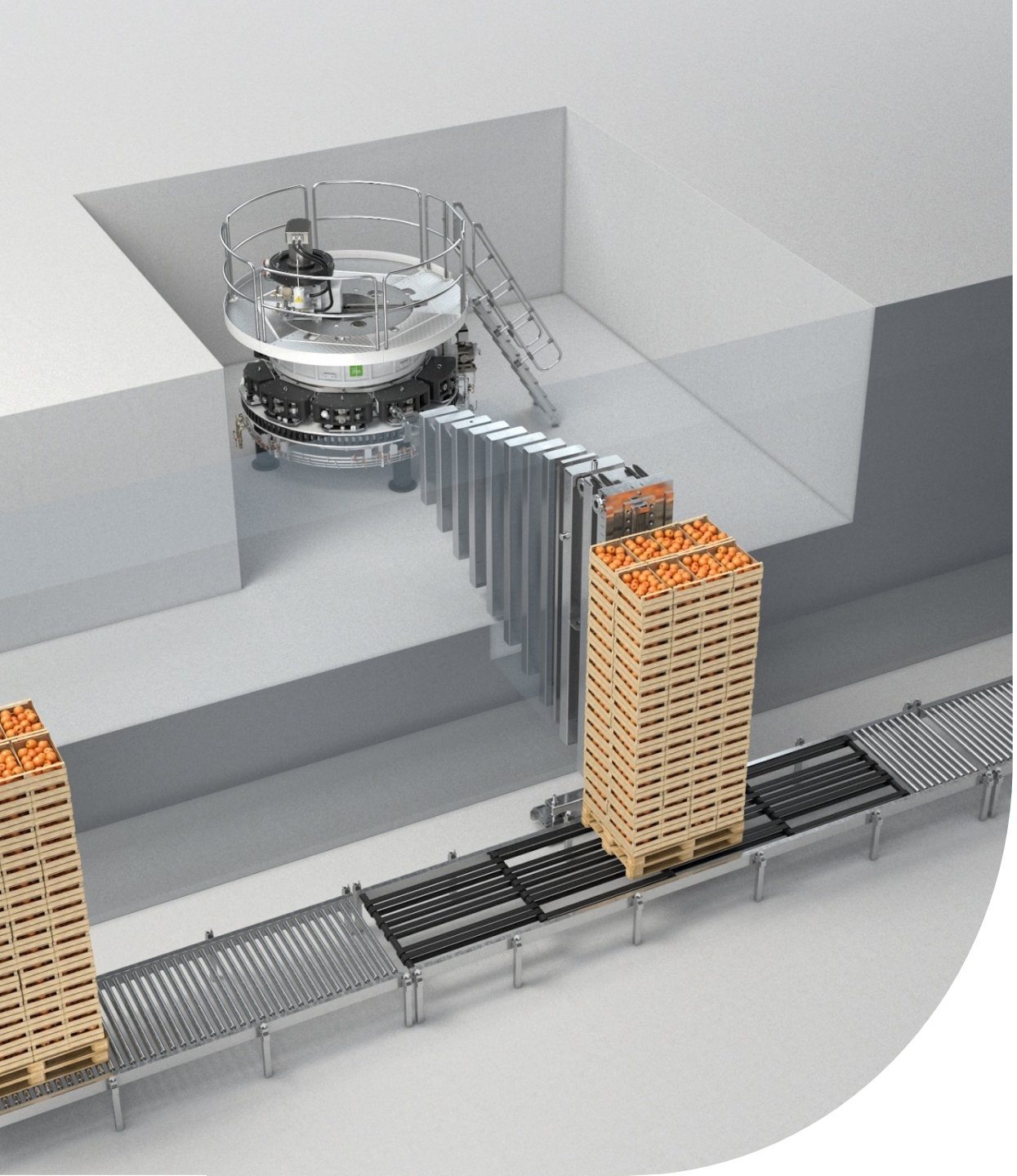
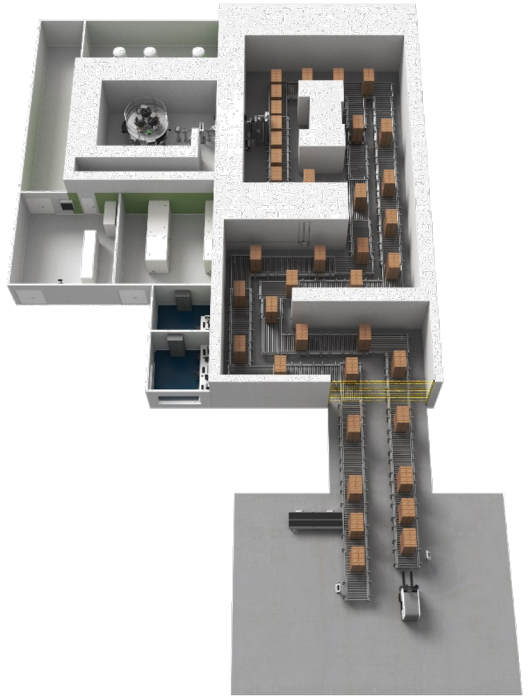


High energy E-beam and X-ray:
An overview of the technical solutions and typical cases of food irradiation

Jeremy Brison
Director of Product Management & Innovation at IBA

Context & Agenda

- The high energy food irradiator layout: **fundamentals**
- **End-to-end solutions for 3 customers:**
  - E-beam – *The highly efficient*
  - X-ray – *The simple*
  - Duo box/pallet – *The best of all worlds*
- Technology roadmap: **what is next ?**
- Market trends & manufacturers' **perspectives**



High Energy Food Irradiator

Fundamentals

The conveyor: Box, tray, totes, pallet
Compatible with all technologies & providers
Local or in-house – *bring your own !*

Shielding or Bunker
Energy & process dependent

Building safety
Keep your people safe

Accelerator: circulating, DC, linear
The electric engine for all drivers

Automatized warehouse
Robots, AGV

Technical rooms
Dosimetry, control, electrical
Ozone, maintenance

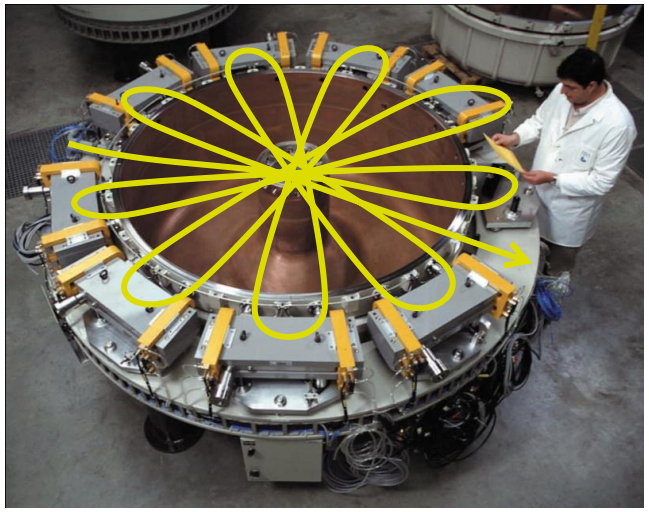
Process Control System - PCS
Recipes, control, monitoring, reporting
Interface with ERP

High Energy Food Irradiator

Fundamentals

VINCENT Dominique

Product Manager Industrial

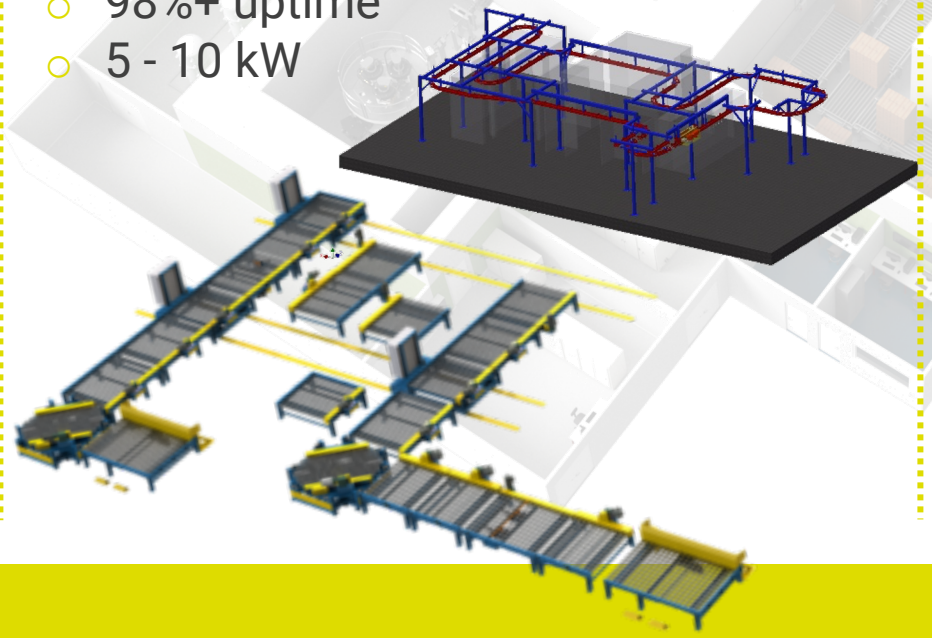


Accelerator – e.g. *Rhodotron®*

- 1 to 10 MeV
- Multi-Energies: 5, 7, 10MeV
- 10 to 560 kW
- ***"Pay per kW, as you grow"***
- 97%+ uptime
- 20 to 55% efficiency

Product handling or Conveyor

- Rollers, trays, overhead, totes
- 0.1 to 10 $m.s^{-1}$
- **Modular** - Underbeam specific to irradiation: speed control & **radiation hardness**
- Product tracking, Rotation, flipping, etc.
- 98%+ uptime
- 5 - 10 kW



Process Control System – *e.g. Beagle®*

- Software suite to drive equipment & validate treatment
- Connected to ERP
- Data logging and tracing
- Fully flexible & "tailormade"
- FDA compliant

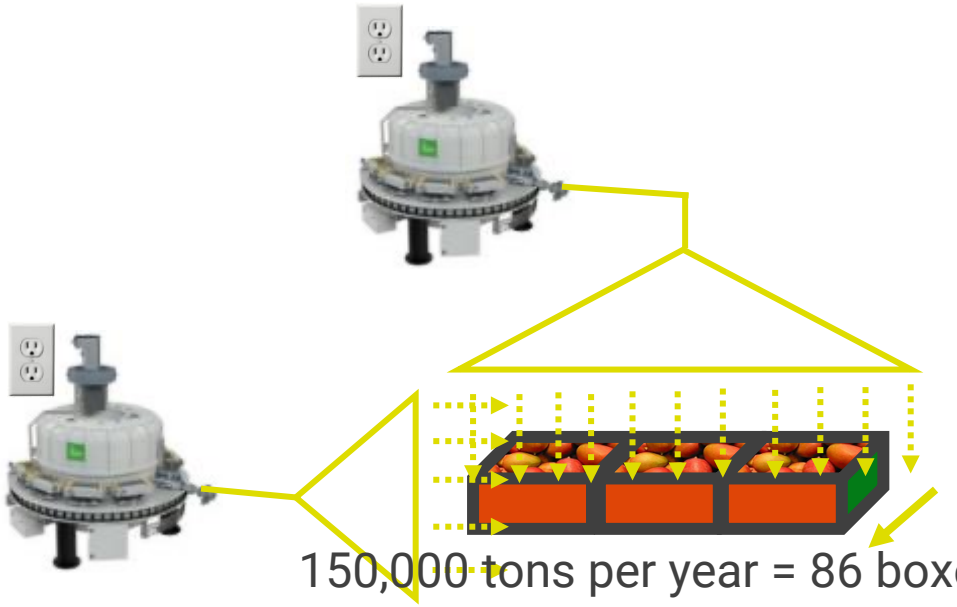
E-beam, X-ray or both ?

Food irradiation specificities

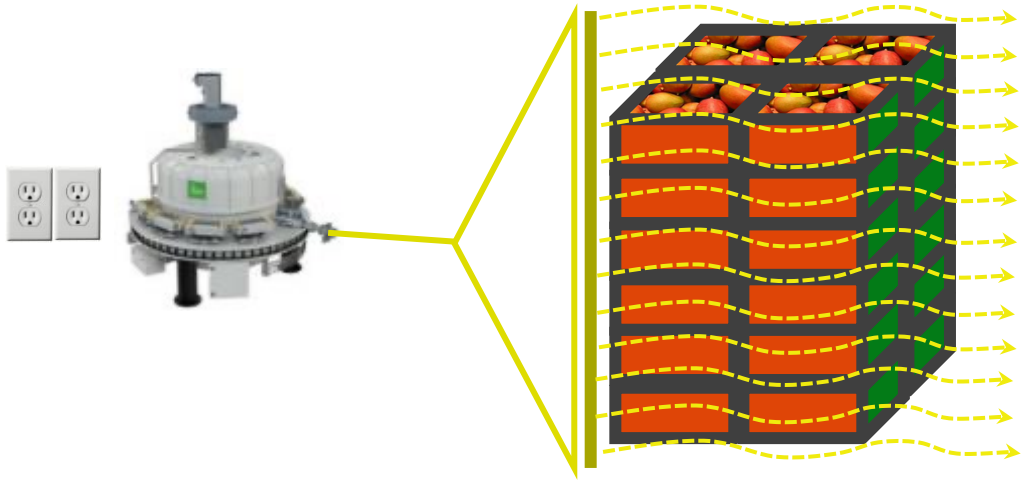
Design is optimized around the products and business plan:

- Higher product densities → Low penetration in EB & higher DURs in X-Ray
- 5-10 times lower dose → Higher volumes & throughput → product handling ?
- Delicate products → minimum manipulations & cold chain compatility

0.5 gr/cm³ =
10 cm penetration in EB



150,000 tons per year = 86 boxes per minute…



0,6 pallets per minute !

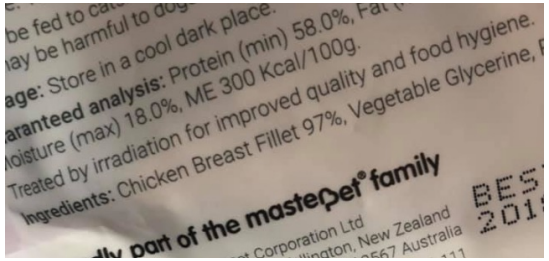
An E-beam case in Asia: the high efficiency solution

E-beam case – Frozen food in boxes

The high efficiency solution

The customer needs:

- Service center
- Mix of products in boxes:
  - 60% seafood – 0.40 gr.cm^{-3}
  - 20% frozen fish – 0.50 gr.cm^{-3}
  - 20% pet food – 0.20 gr.cm^{-3}
  - *And some frozen fruits*
- Dose: 5 kGy – DUR: < 2.6
- Currently treated in Gamma
- Seafood is 2% of country's export
- Annual volume of ~50 kT – 120,000 m³

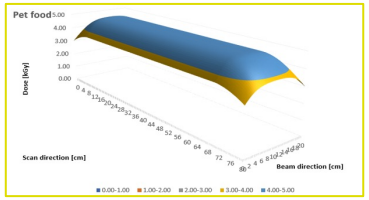


https://www.iaea.org/newscenter/news/viet-nam-enhances-food-quality-using-irradiation

E-beam case – Frozen food in boxes

The high efficiency solution

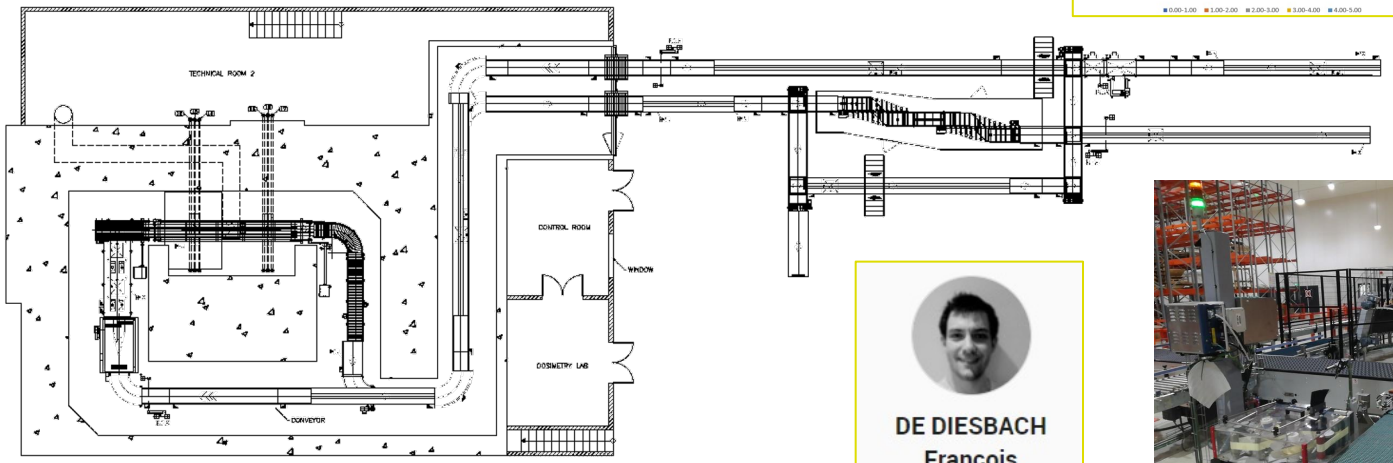
40 kW	M³/h	kTons/yr	DUR
Seafood	25	31	2,6
Frozen fish	20	10	2,5
Pet food	103	6	2,0



10 MeV
6000 hours

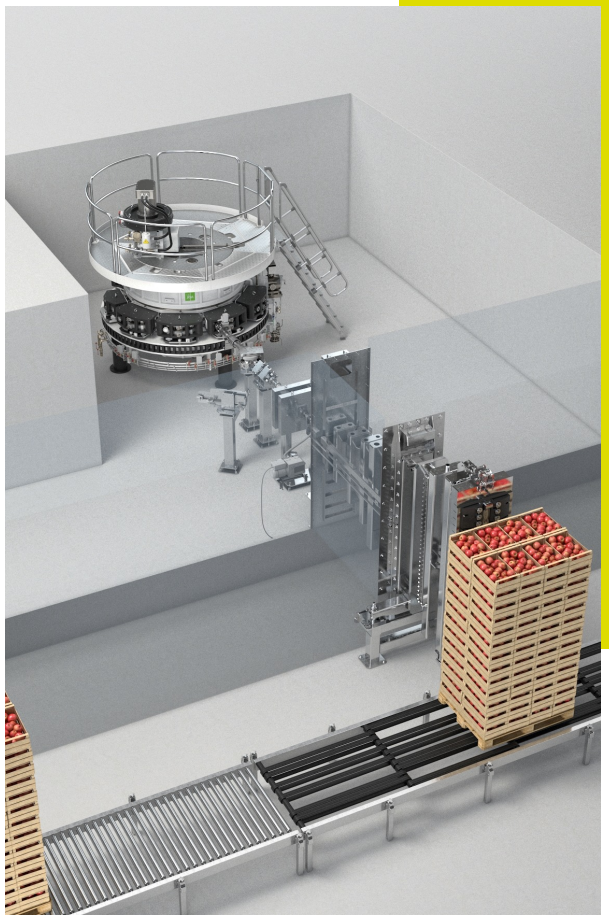
28 m

19 m



DE DIESBACH François
Facility Engineer

PIERARD Arnaud
Product Manager Industrial



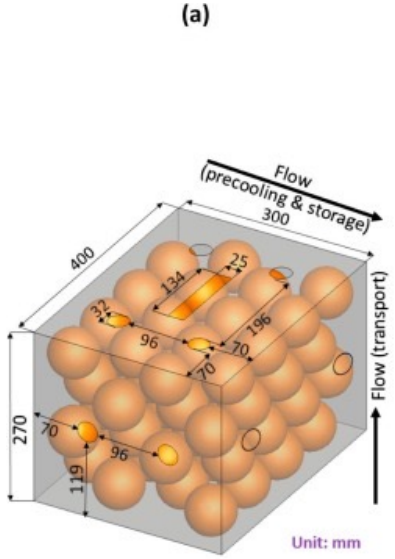
An X-Ray case in South-America: the simple solution

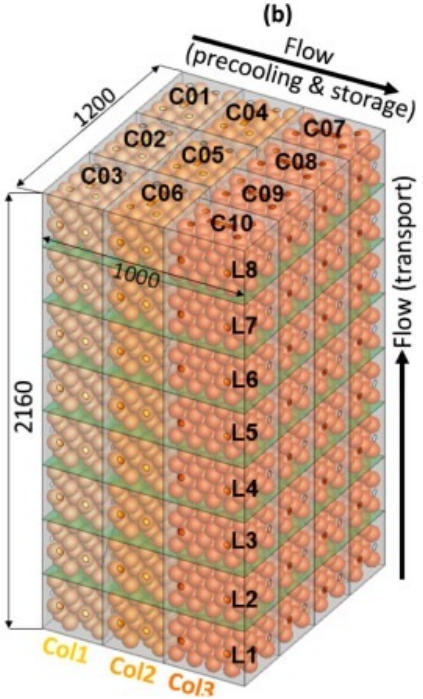
X-Ray case – Fresh products in pallets

The simple solution

The customer needs:

- Mix of fresh fruits on 2,4m high pallets:
  - 25% Grapes – 0.30 gr.cm^{-3}
  - 25% Citrus – 0.40 gr.cm^{-3}
  - 25% Oranges – 0.50 gr.cm^{-3}
  - 25% Pineapples – 0.60 gr.cm^{-3}
- Dose: 400 Gy – DUR: < 3
- 2.7m high US pallets
- Currently treated in Gamma
- Annual volume of ~50 to 100 kT

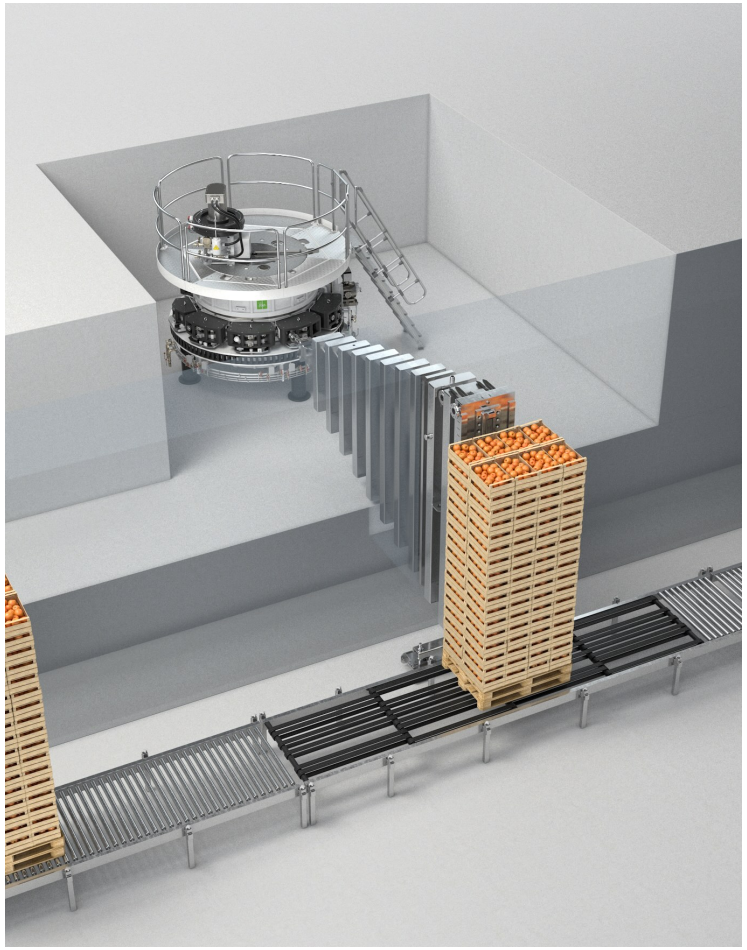


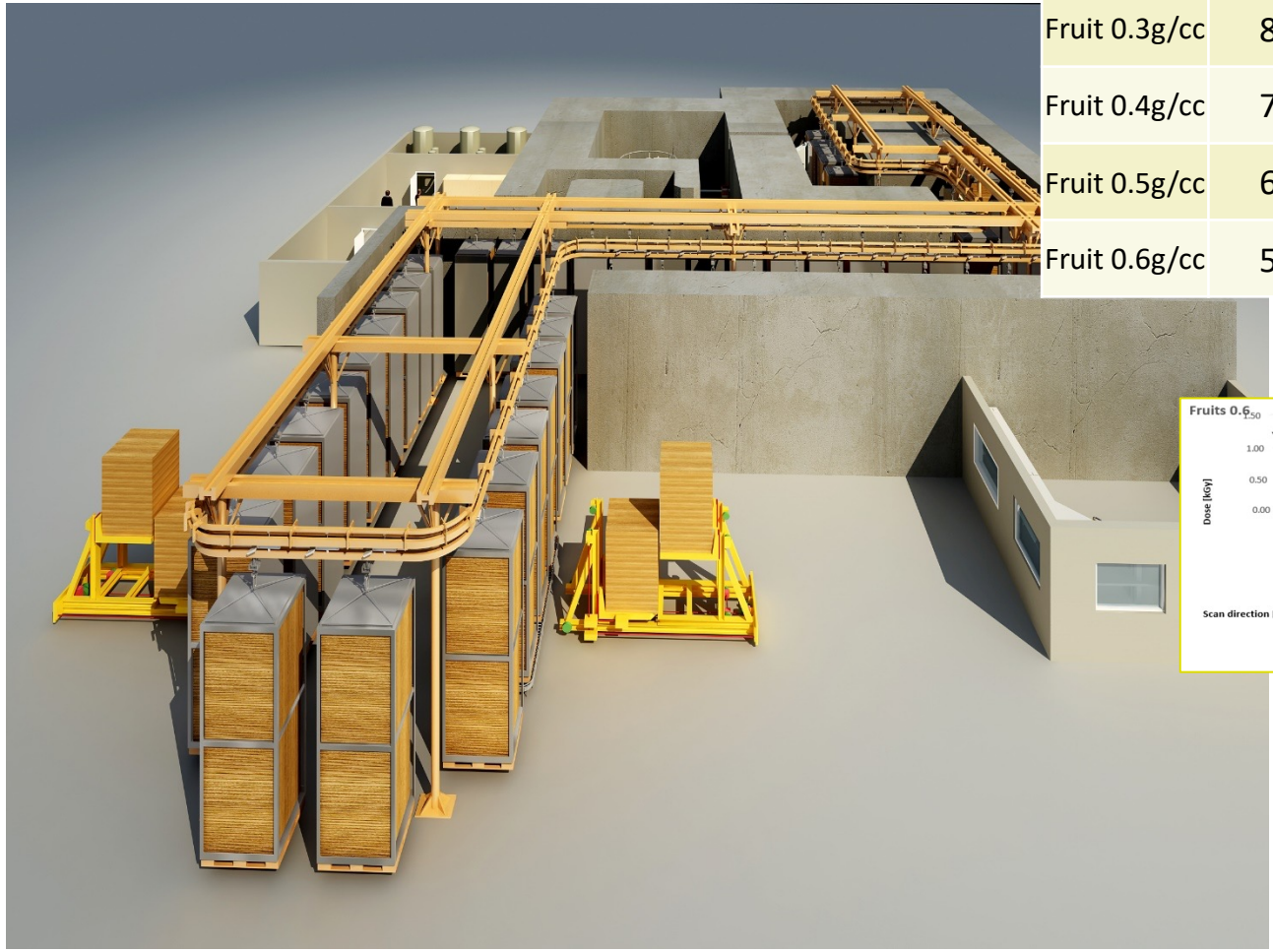


X-Ray case – Fresh products in pallets

Double side: the super simple solution

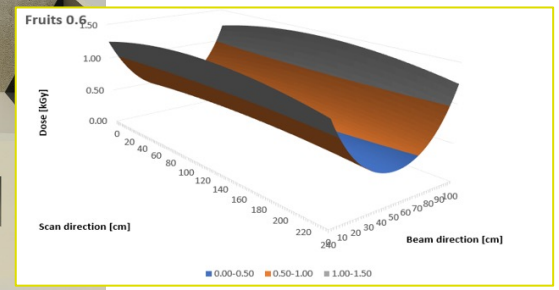
DESSY Frederic
Product Manager Industrial





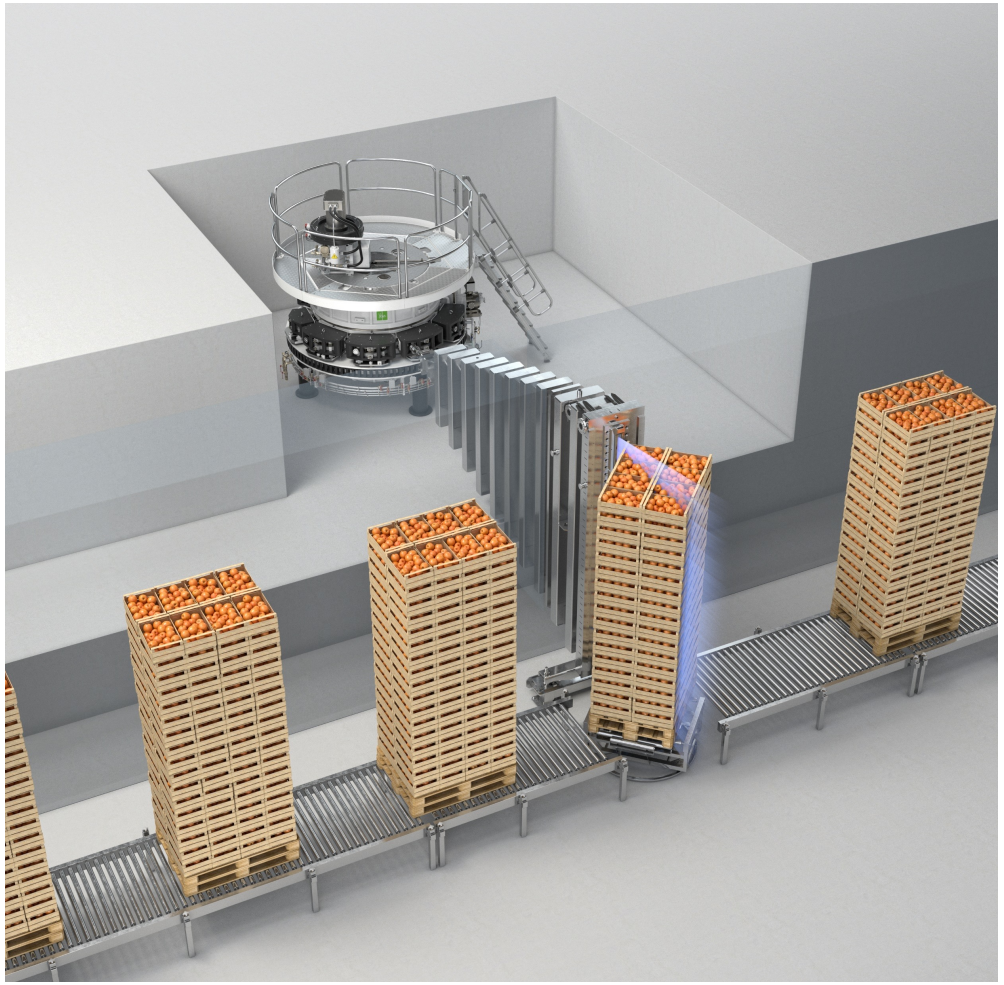
190 kW	M³/h	kTons/yr	DUR
Fruit 0.3g/cc	87	45	2,26
Fruit 0.4g/cc	75	51	2,59
Fruit 0.5g/cc	65	56	2,93
Fruit 0.6g/cc	58	59	3,28

7MeV
8000 hours



X-Ray case – Fresh products in pallets

Adding rotation for better DUR

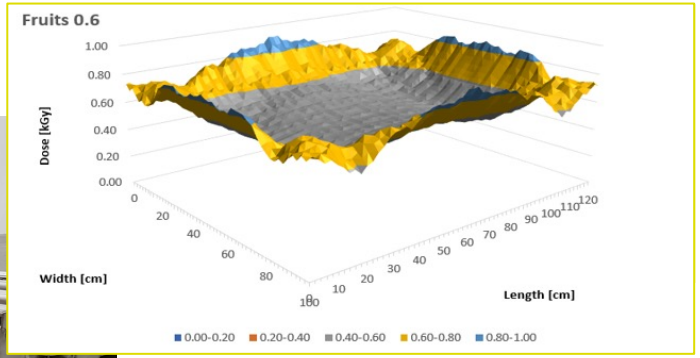


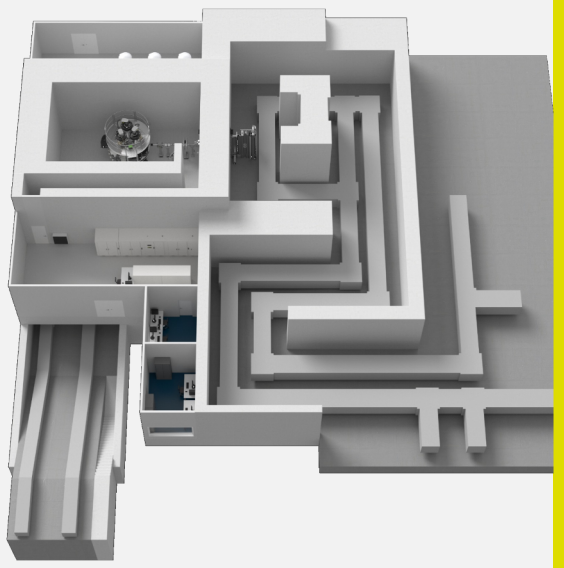
DESSY Frederic

Product Manager Industrial

190 kW	M³/h	kTons/yr	DUR
Fruit 0.3g/cc	57	34	1,83
Fruit 0.4g/cc	52	42	1,99
Fruit 0.5g/cc	49	49	2,15
Fruit 0.6g/cc	46	55	2,29

7MeV
8000 hours





A Duo Case in Asia: the best of all worlds

Duo case – fruits in pallets, MD in boxes

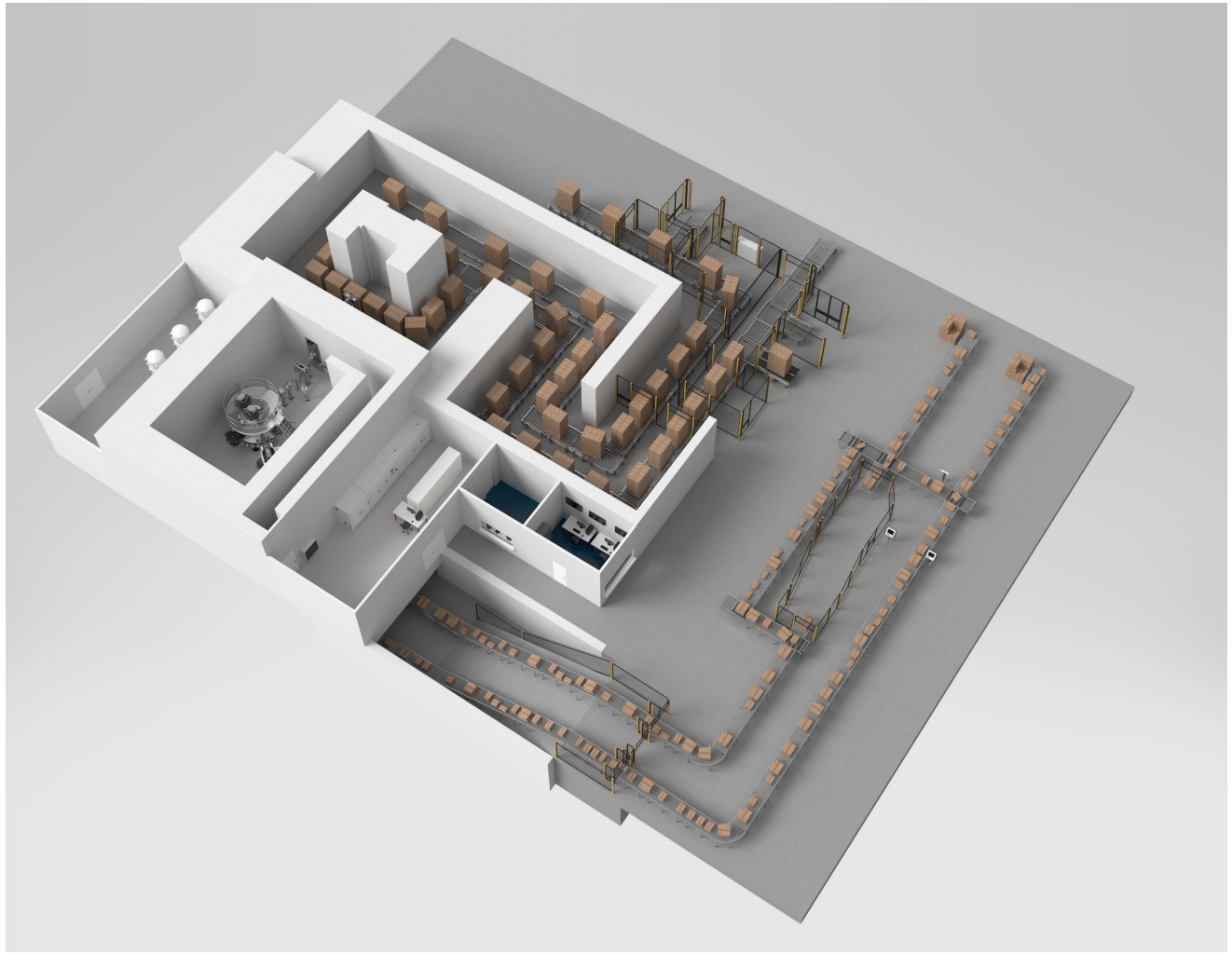
The best of all worlds

The customer needs:

- Mix of food, fruits and medical devices:
  - 50% fruits pallets – 0.30 gr.cm^{-3}
  - 25% medical devices boxes – 0.10 gr.cm^{-3}
  - 25% frozen food – 0.50 gr.cm^{-3}
- Dose: 400 Gy to 25 kGy – DUR: < 2.5
- 1.8 m high EU pallets
- Currently treated in Gamma & EtO
- Annual volume of:
  - ~ 40,000 M³ medical
  - ~ 50,000 tons food

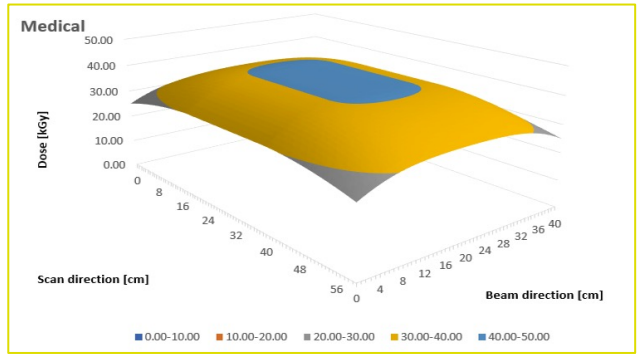
Duo case – fruits in pallets, MD in boxes

The best of all worlds



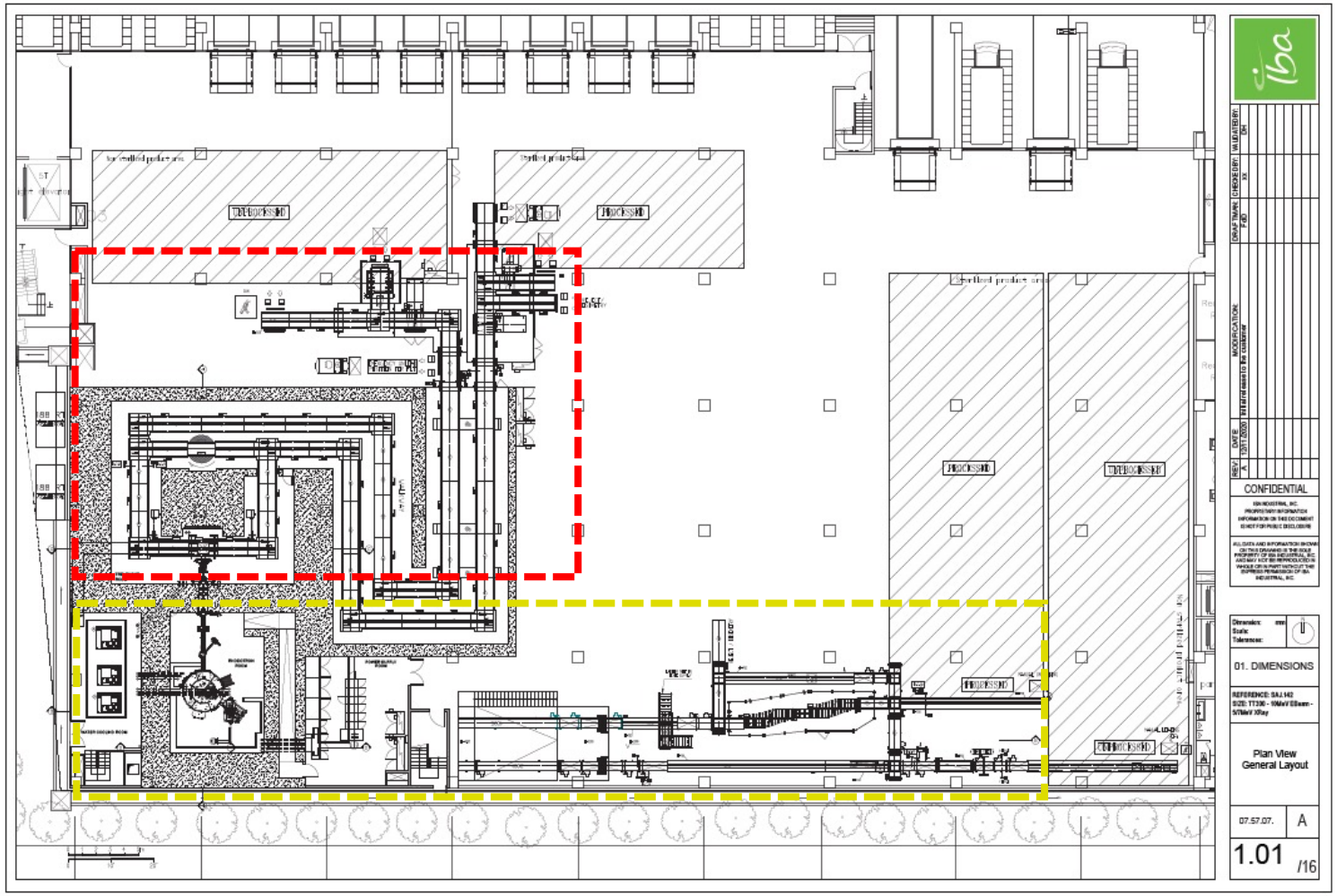
50 kW	M³/h	kTons	DUR
Pallet of fruits	40	42	2,06
Box of medical devices	30	38,000 m³	1,62
Box of food	33	20	2,12

5, 7 & 10 MeV
8000 hours

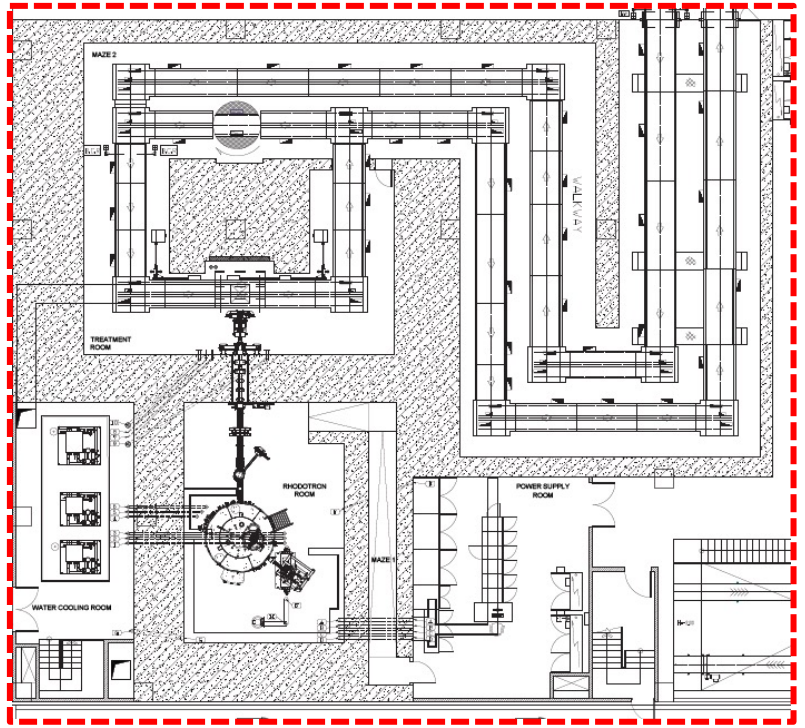


Duo case – Fresh products in pallets

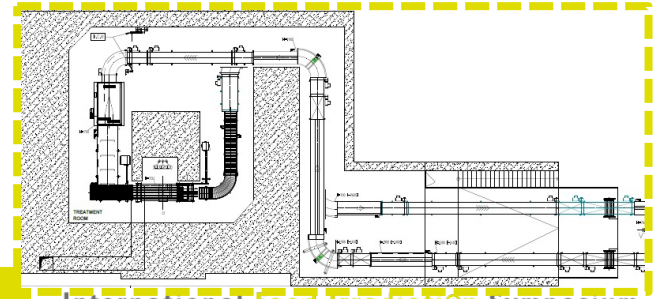
The best of all worlds



X-ray facility



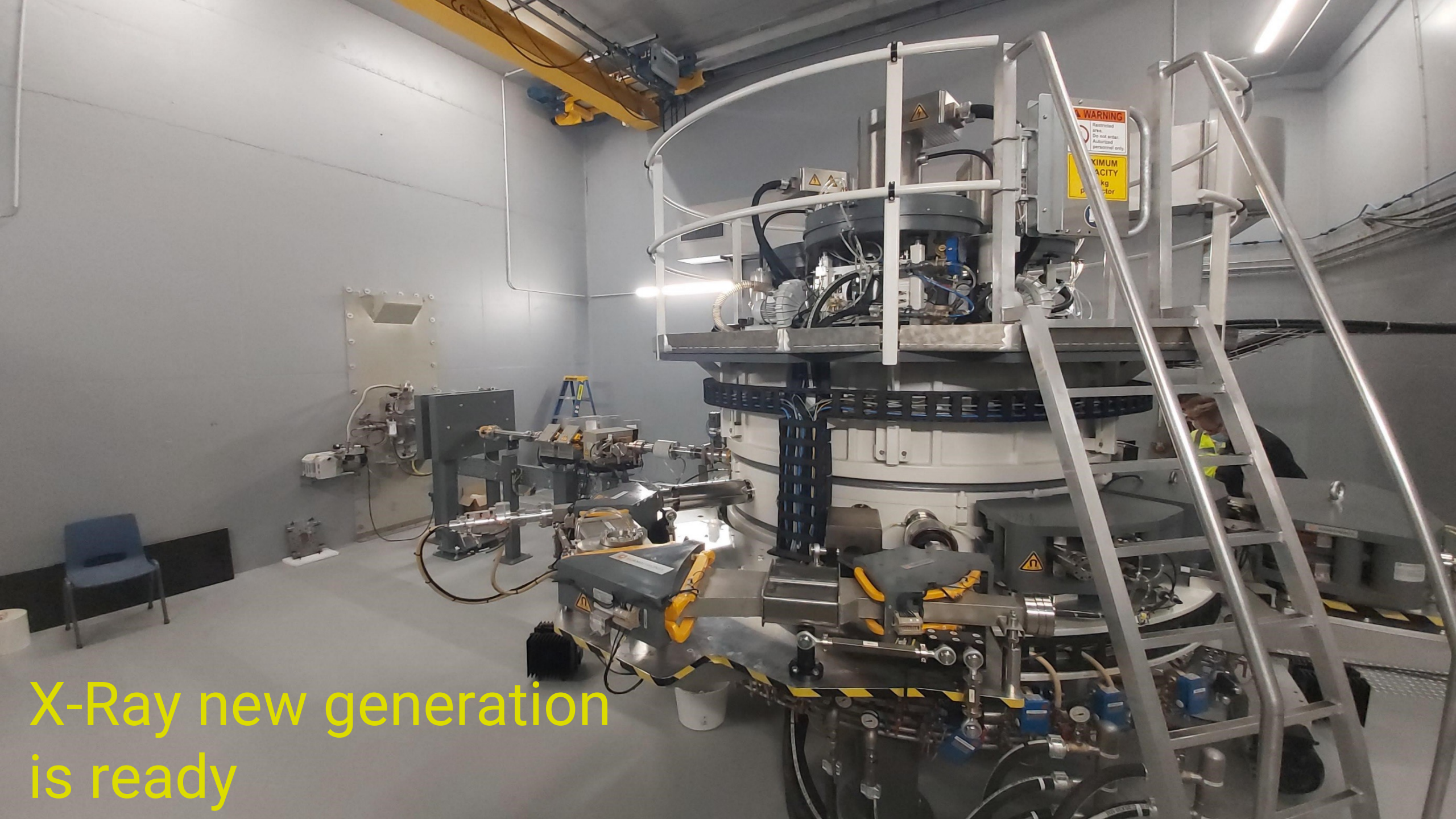
E-beam facility



What's next ?

Technology roadmap

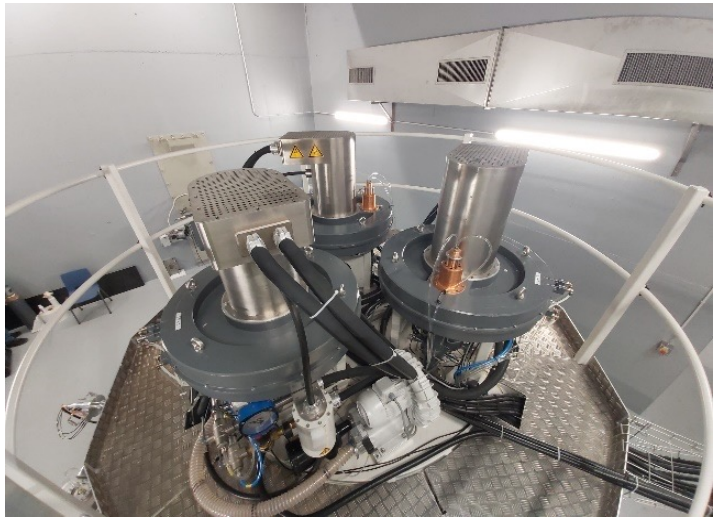
For technology lovers



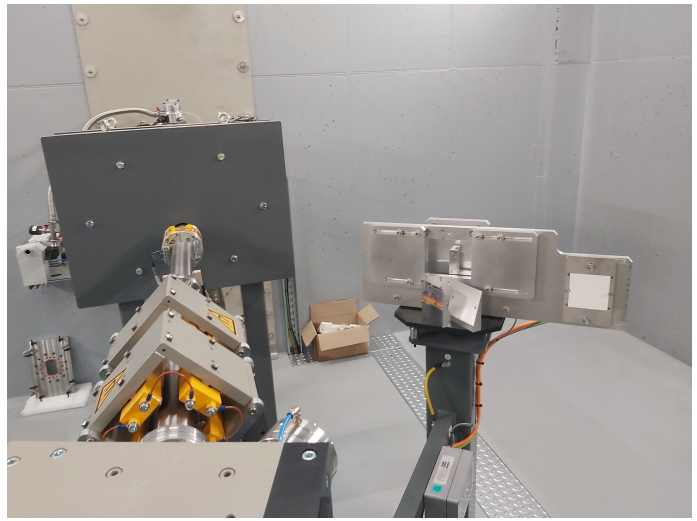
X-Ray new generation is ready

Technology roadmap

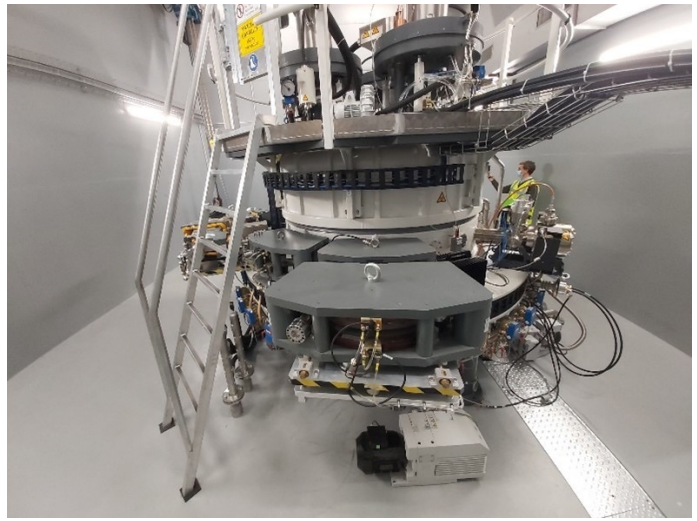
Solid State RF Drivers
Safer, Digital, plug & play



Fully redundant RF power
840 kW, target: 100% reliability



Automatic energy measurement
Accurate X-ray beam energy

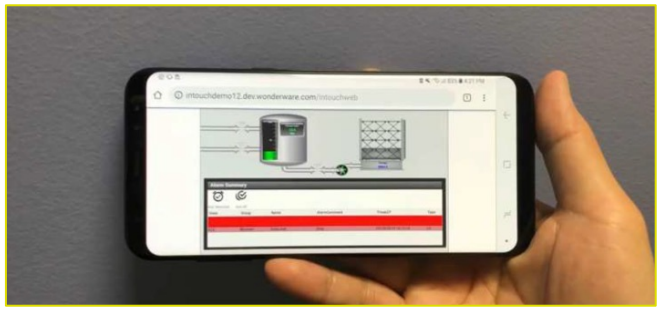


Full Power Multi-Energy
5 or 7 MeV,
by a single click

Technology roadmap

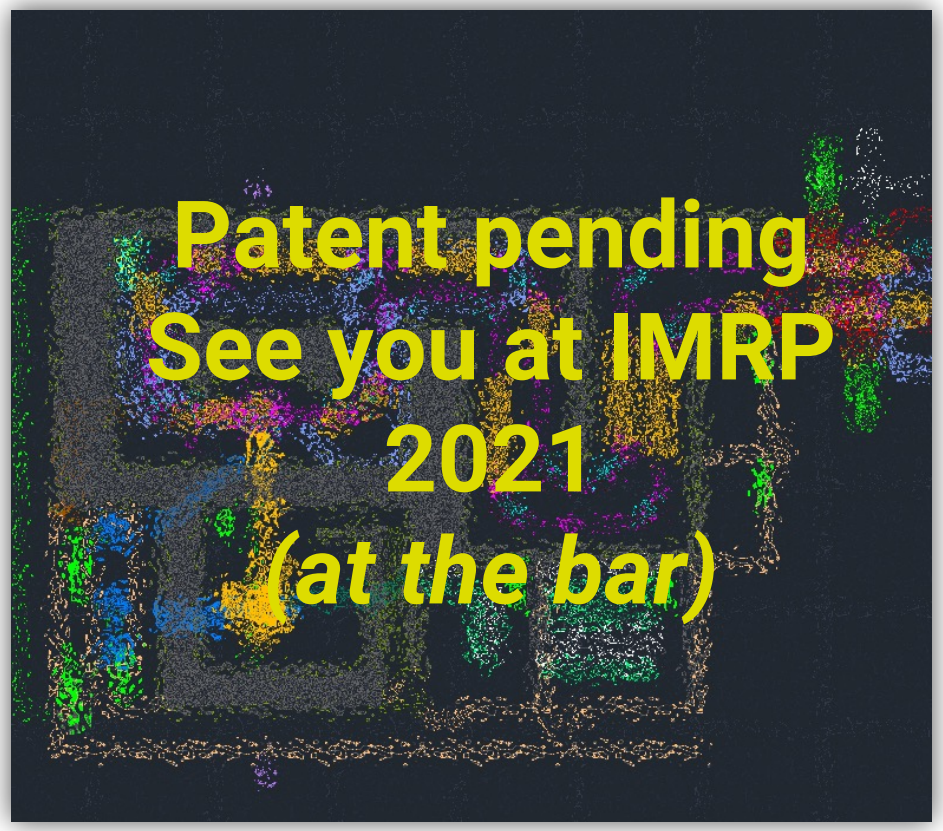
Digitalization of products & service

Body cameras, auto-monitoring & diagnostics



Process Innovations

New configurations for better DUR & efficiency

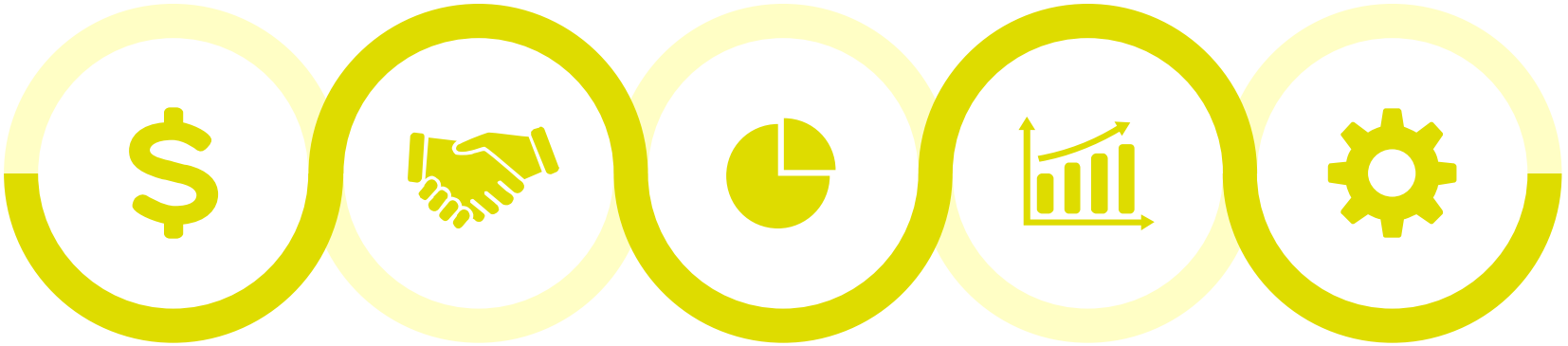


Conclusions: Market trends & manufacturers' **perspectives**

Cody Wilson
Product Manager Industrial

3 solutions for food irradiation
will be commissioned in 2021-2022
2/3 will have X-Ray – Asia is leading

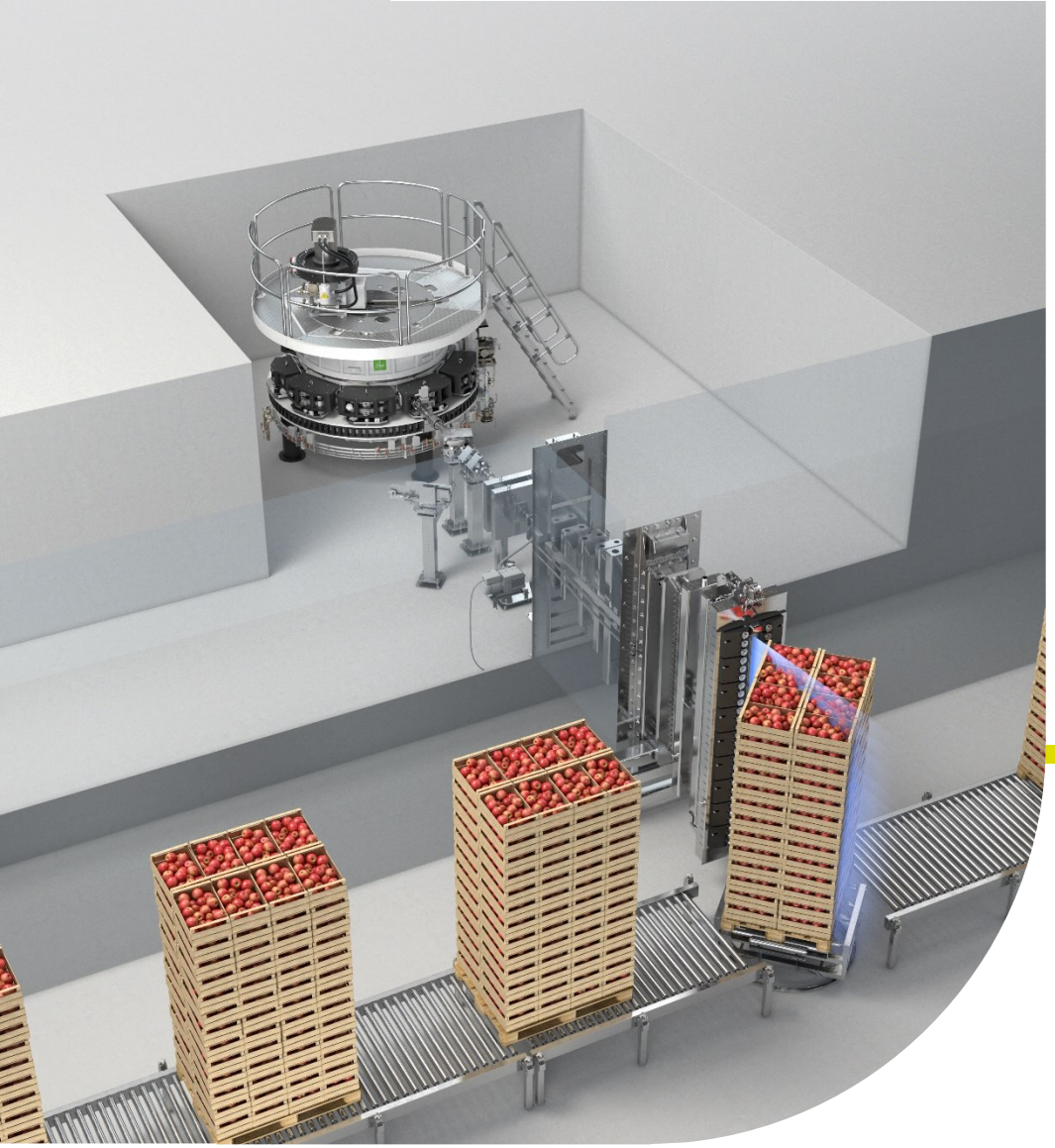
More than 10% of IBA solutions will process food daily: Frozen fish, meat, fresh food, pet food, spices, etc.



Medical sterilization growth has accelerated the maturity of products and services
Industrialization and regionalization are real

Aerial/FEERIX is a unique tool
to optimize process
and perform **world-class research & dosimetry**
> bring your ideas !

Huge opportunity for the food industry
to build on this momentum !



IFIS 2021

Thanks.

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