TC Project RLA5066

Toluca, México – October 12, 2015

MACHINE SOURCES VS. ISOTOPES FOR PHYTOSANITARY APPLICATIONS OF IRRADIATION

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Joint FAO/IAEA Division
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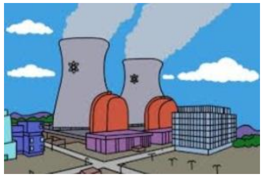
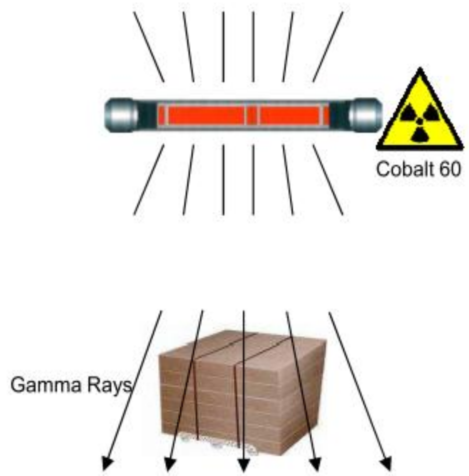
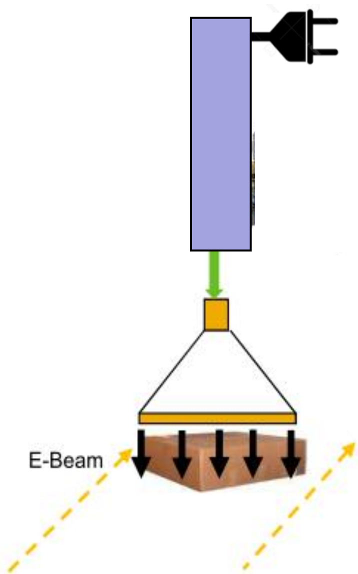
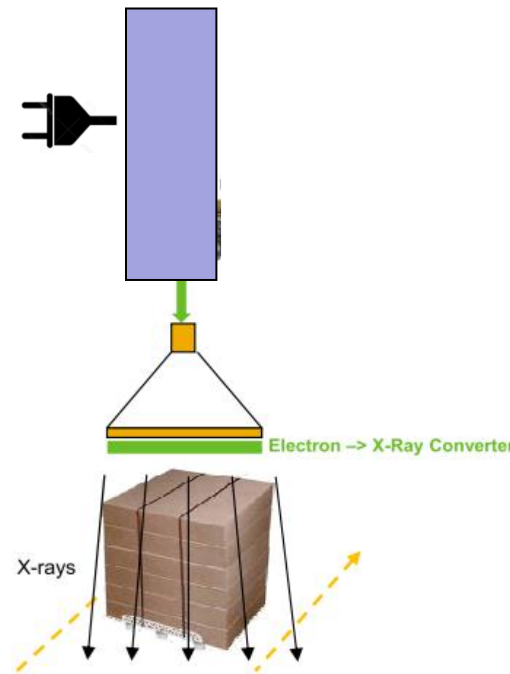
Three options for food irradiation









Gamma irradiation

Electron accelerators

X-Ray machines

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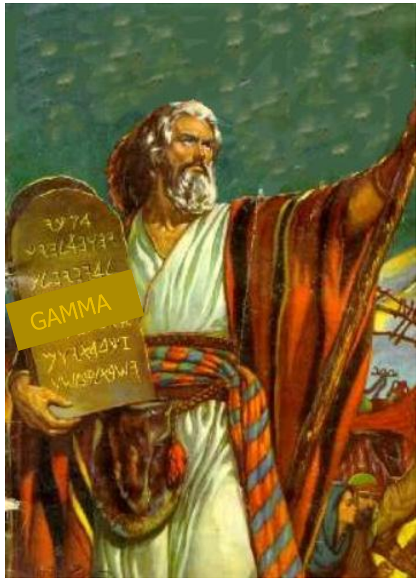
Which one is the best ?



No best technology

IAEA projects

- Promote safe and beneficial use of irradiation
- Do not favour a particular technology
- Create conditions that enable a broader choice
- Create conditions that enable an informed choice

Recent IAEA Coordinated Research Projects (CRPs)

- Development of Generic Irradiation Doses for Quarantine Treatments.

CRP 62008

- Irradiated Food for Immuno-compromised Patients and other Target Groups.

CRP 62009

- Development of Electron Beam and X Ray Applications for Food Irradiation.

CRP 61024

- Use of irradiation to prevent foodborne parasitic infections associated with fresh fruits and vegetables.

Proposed CRP

Irradiation facilities used for phytosanitary irradiation

	Multipurpose service centres	Service centres dedicated to food
Gamma	Steritech, Australia Hepro, South Africa Synergy Health, Thailand Thai Irradiation Centre, Thailand Sterigenics, FL, USA AnPhu, Viet Nam	Krushak, India Benebion, Mexico Pa'ina, HI, USA Gateway America, MS, USA
Electron beam	Sadex, IA, USA NECBR, TX, USA Son Son, Viet Nam	
X ray		Hawaii Pride, HI, USA

Quantities (tons) of produce irradiated for phytosanitary purpose in 2014

Confirmed *Estimates*	Gamma	Electron beam	X ray
Australia	2,002		
India	265		
Mexico	10,120		
South Africa	32		
Thailand	543		
Hawaii, USA	*2,000*	← *6,500* →	*4,500*
USA excl. Hawaii	*500*	*200*	
Viet Nam	*793*	←2,293→ *1,500*	
22,500	***~16,300***	***~1,700***	***4,500***
	72%	***8%***	***20%***

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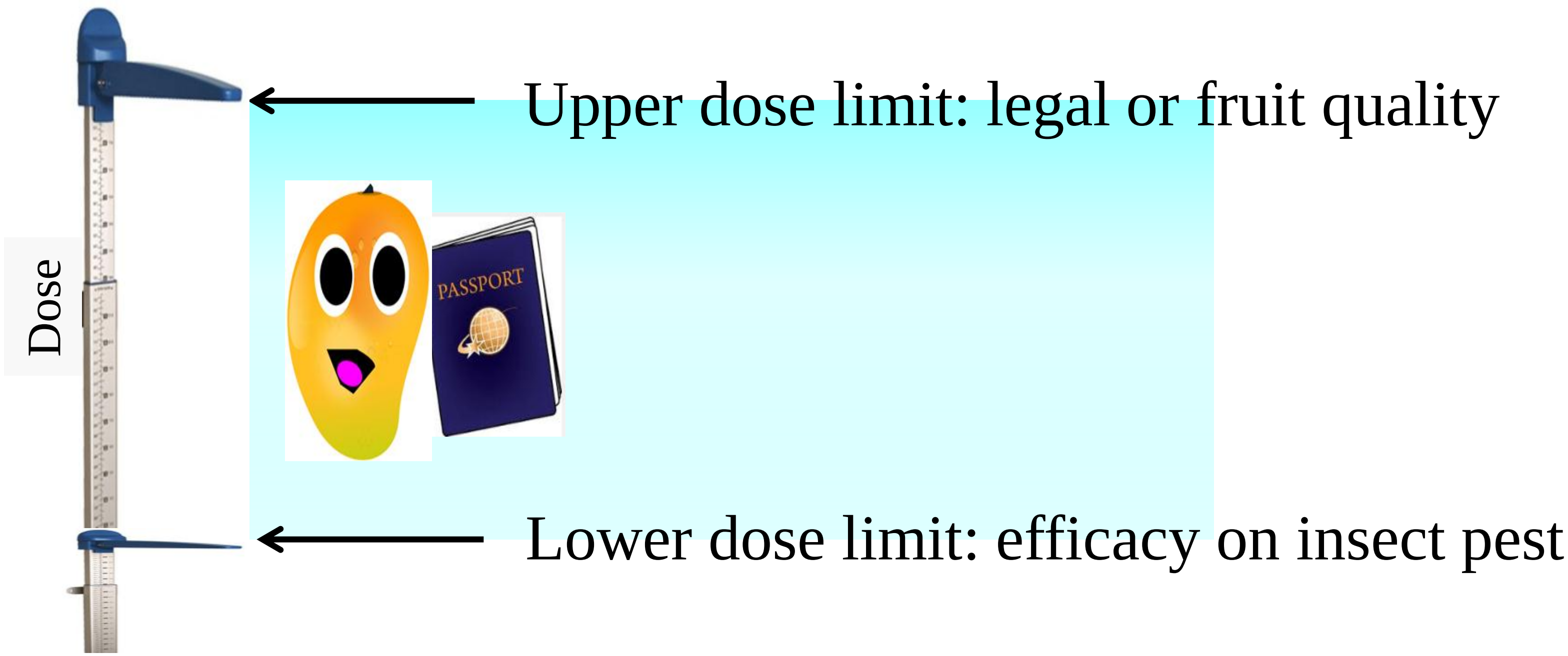
Phytosanitary irradiation



Phytosanitary irradiation

Dose

Upper dose limit: legal or fruit quality

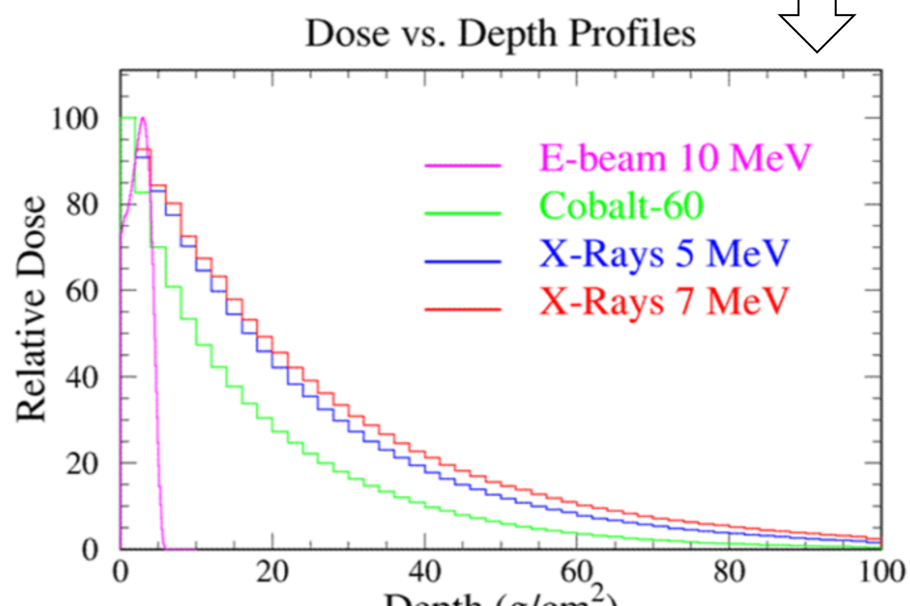
Actual maximum dose

x ~1.5 to ~3

package size, configuration, density, type of radiation

Actual minimum dose

Lower dose limit: efficacy on insect pest



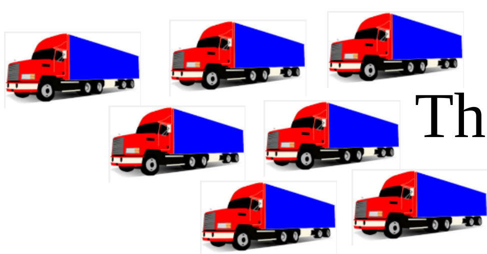
Phytosanitary irradiation vs. other applications of irradiation

Upper dose limit 1.0 kGy

Which is at least 20 times less than

- sterilization of medical disposables
- polymer modification

Processing time at least 20 times shorter



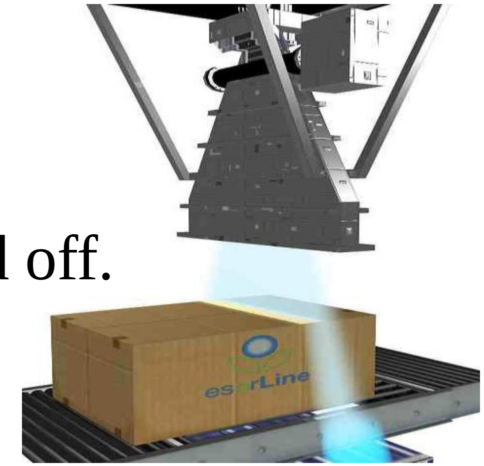
Throughput at least 20 times larger

Conventional multipurpose (gamma) irradiators not well suited

Global comparaison of the 3 technologies

Attribute	Gamma	EB	X
Equipment complexity	Low	Moderate	High
Generator complexity	None	High	High
Reliability	Excellent	< Gamma	< E-beam
Cost of maintenance / spare parts	Low	High	High
Penetration high density	Good	Poor	Excellent
Environmental impact	Source disposal	Energy consumption	Energy consumption
Current market share for food applications	High	Low	Minimal
Main issue	Transportation, cost, long term availability, disposal of cobalt-60	Poor penetration	Commercial experience still limited

Advantages of electron accelerators



- Use electricity (abundant) and can be switched off.
- No radionuclide involved. Licensing easy.

- Very short processing times. Very large throughput possible.
- Many potential suppliers.
- Less requalification work (OQ, PQ) compared to gamma (every time the source is modified)
- No dose attenuation effects between products in the irradiation chamber - Possibility to treat products with different characteristics and dose requirements in rapid succession
- Public perception probably better (relate to luggage inspection / X ray imaging)

Advantages of X ray generators

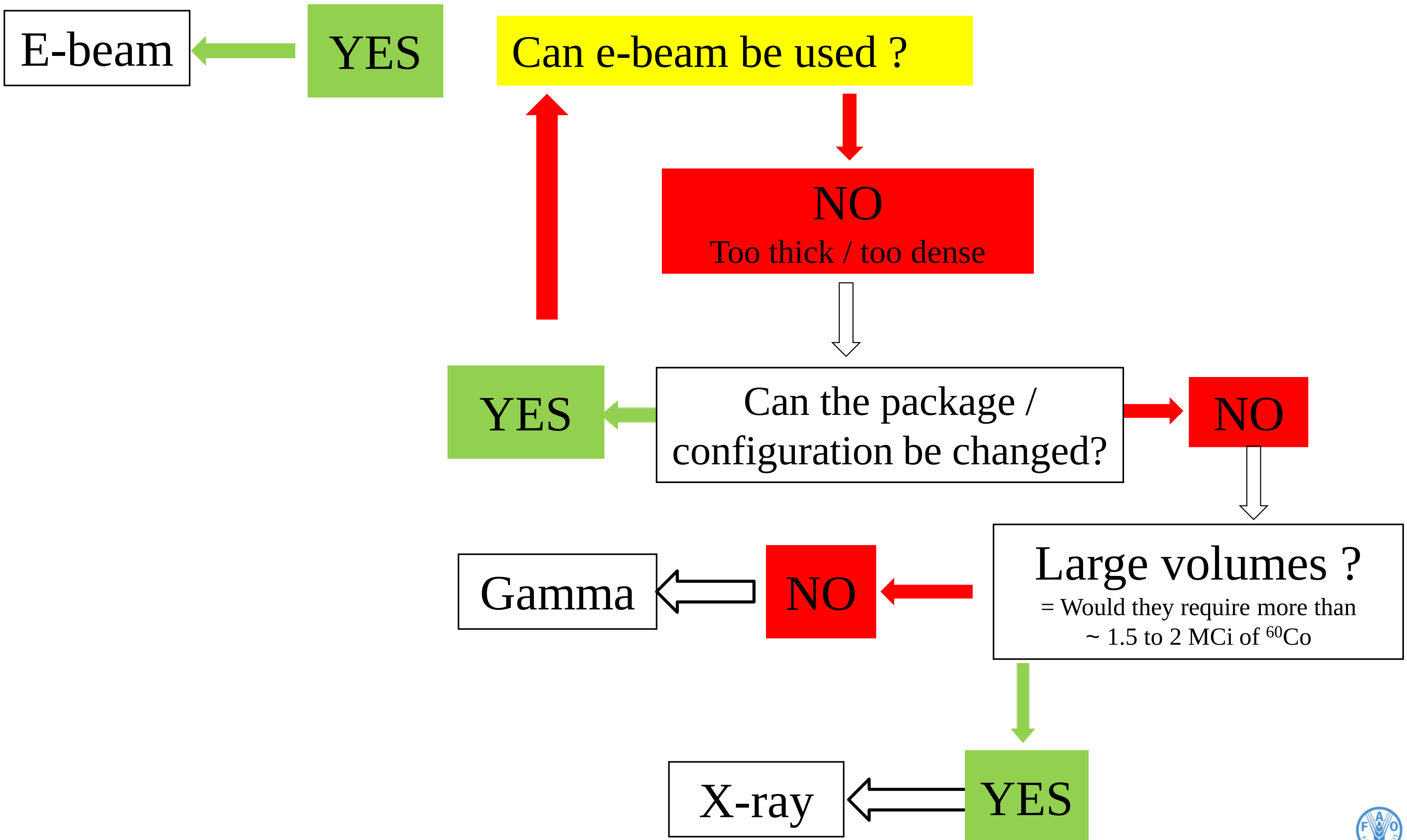
- Use electricity (abundant) and can be switched off.
- No radionuclide involved. Licensing easy.

- Short processing times. Large throughput possible.
- Excellent penetration / dose distribution at high energies.
- Less requalification work (OQ, PQ) compared to gamma (every time the source is modified)
- No dose attenuation effects between products in the irradiation chamber - Possibility to treat products with different characteristics and dose requirements in rapid succession
- Public perception probably better (relate to luggage inspection / X ray imaging)

Phytosanitary irradiation project: factors

- Volumes to be treated and seasonality
- Suitability of product and packaging for the type of radiation
- Logistics and distance to production area vs market
- Local perception of radiation technologies
- Regulatory aspects
- Proximity of an irradiation service contractor
- Cost of service vs. capital expenditure and operational cost
- Familiarity with and understanding of the technology

Simple decision tree for a new project



Time for a new approach

Food irradiated mostly in centralized facilities operated by specialists.

The future points to in-line processing

Much more likely to happen with EB and X-ray.

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Advantages of in-house / in-line solutions

No added transportation cost

Minimum time between harvest - irradiation - shipment

Fully under the control of the packer

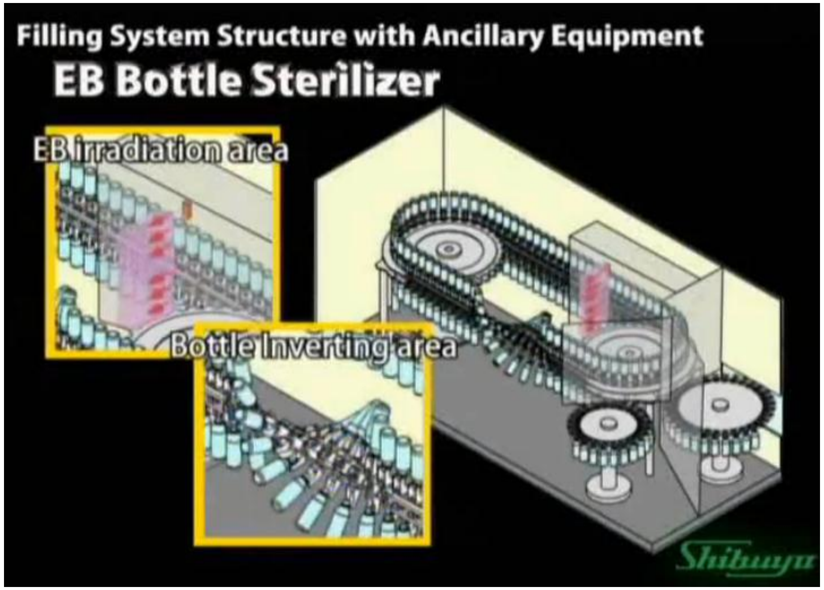
Possibility to irradiate inside a cold room

Capital expenditure lower than a stand alone facility

In-line pasteurization / sterilization now happening

Tetra Pak® E3 filling machine that uses EB to sterilize packaging material

Empty syringes treated by e-beam before filling
Gettinge



EB sterilization of PET bottles line
Shibuya Kyogo

RD irradiation units

Self-shielded
gamma irradiators

Increasingly:

Self-shielded EB /
X ray cabinets