

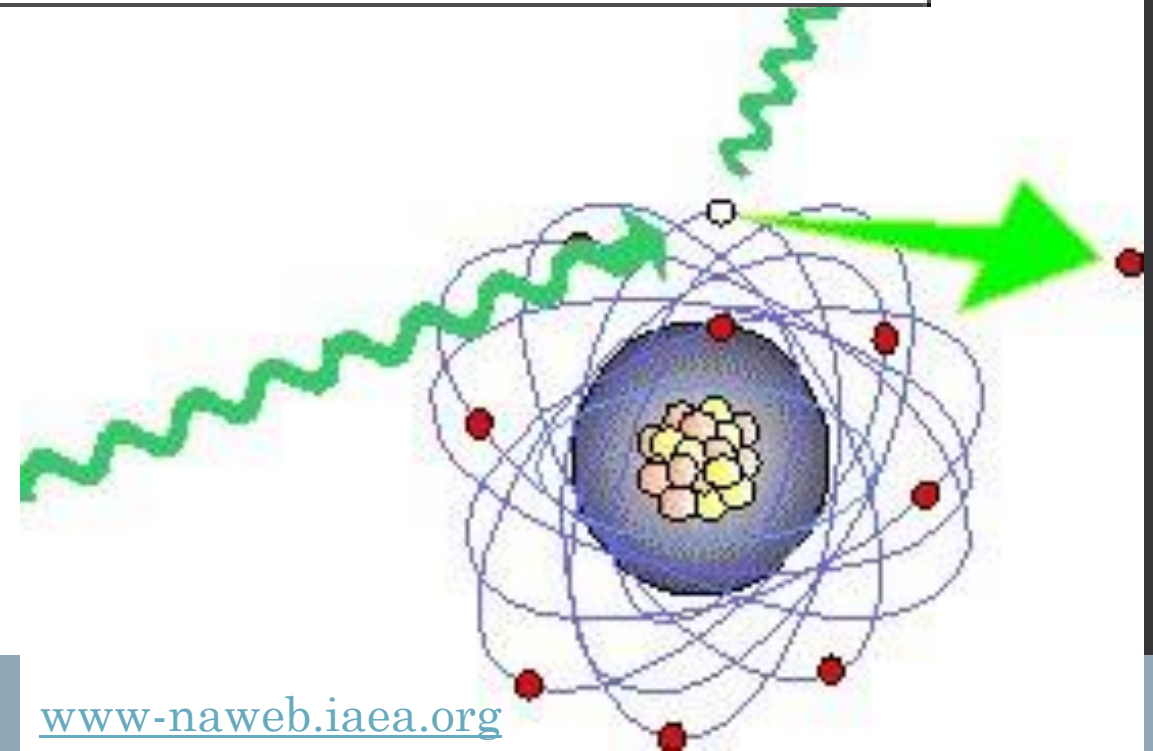
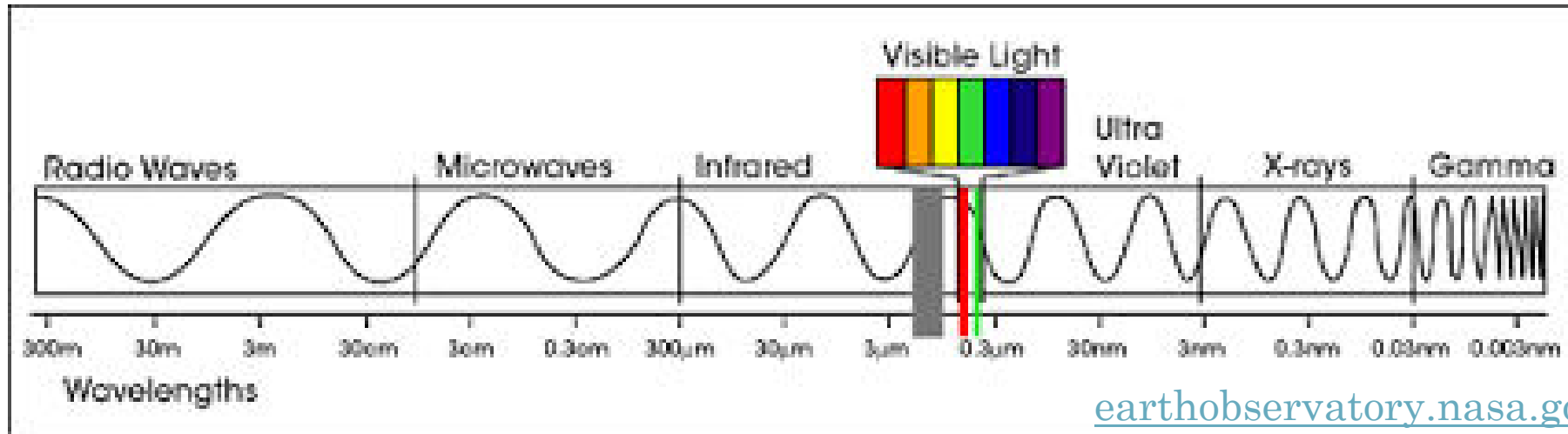
Effect of Irradiation on Food

Anuradha Prakash



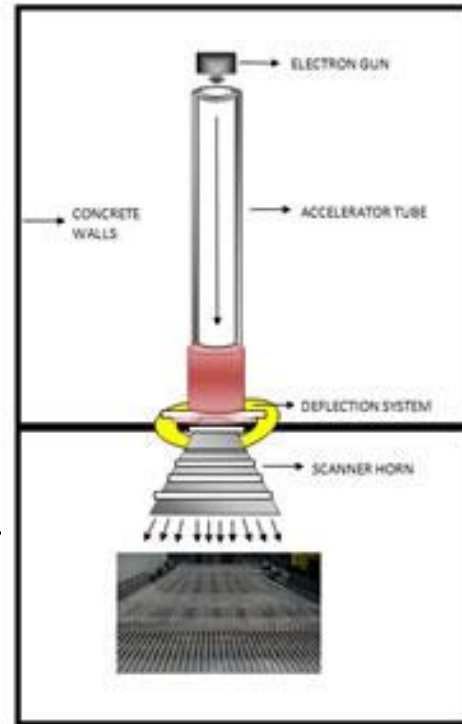
CHAPMAN UNIVERSITY

Ionizing energy



Three modalities

Electron Beam



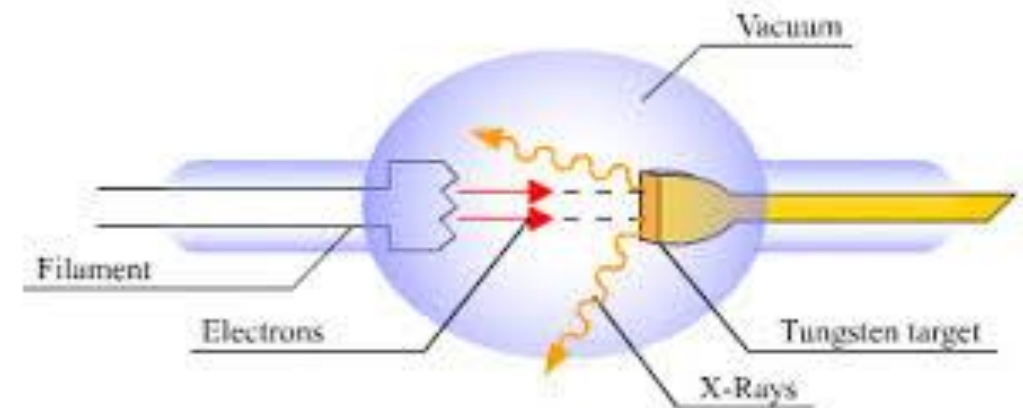
www.saicabtech.com

Gamma



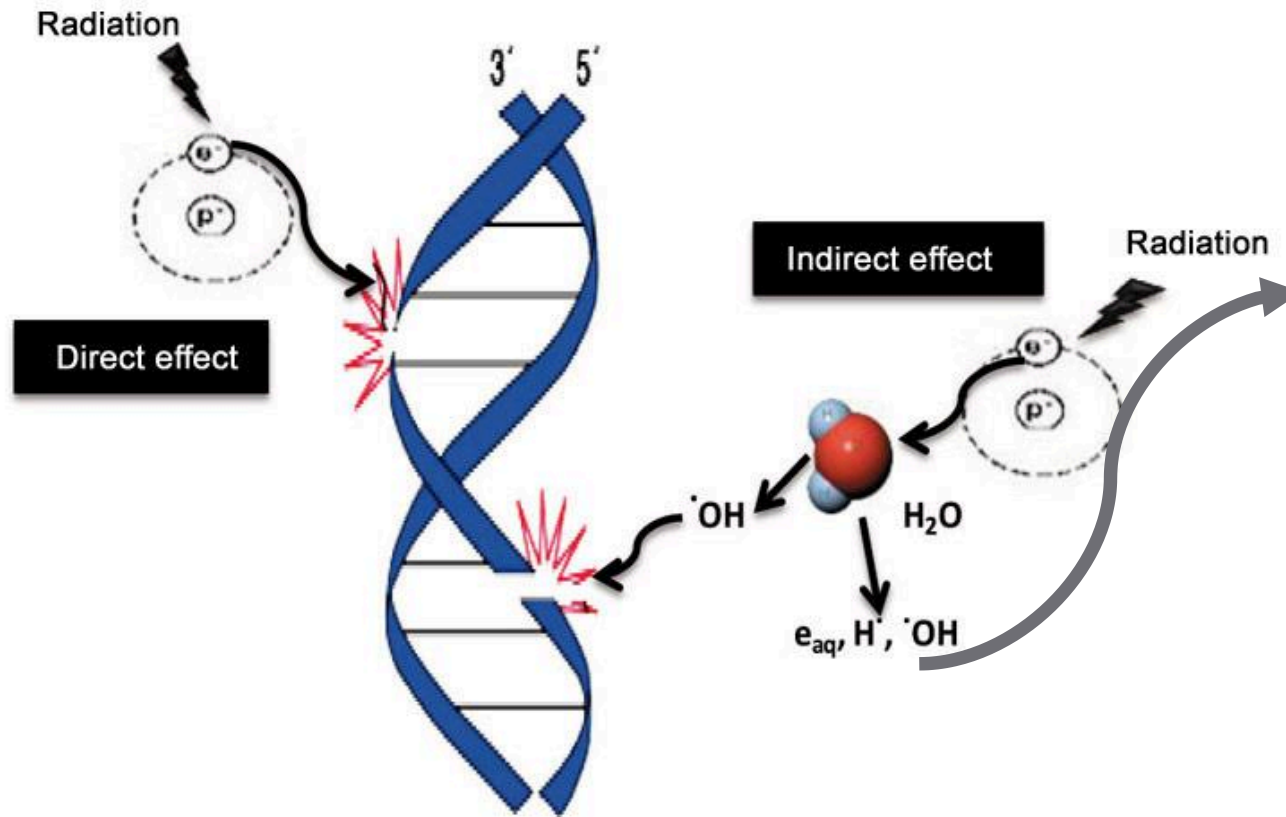
www.steritech.com.au

X-ray



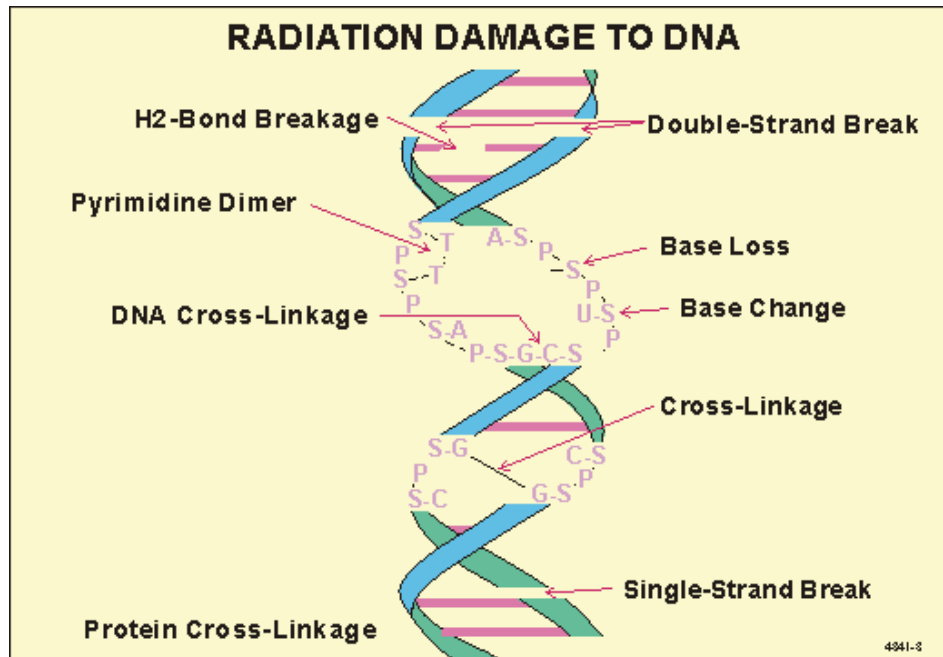
www.nde-ed.org

How it works?



- Proteins: peptide radicals leading to fragmentation and re-aggregation, limited denaturation
- Carbohydrates: depolymerization
- Lipids: autoxidation
- Vitamins: Thiamin, vitamin C, folic acid, carotenoids, vitamin E are sensitive

Effect on microorganisms



www.radiation-scott.org/radsourc/4341-3.gif

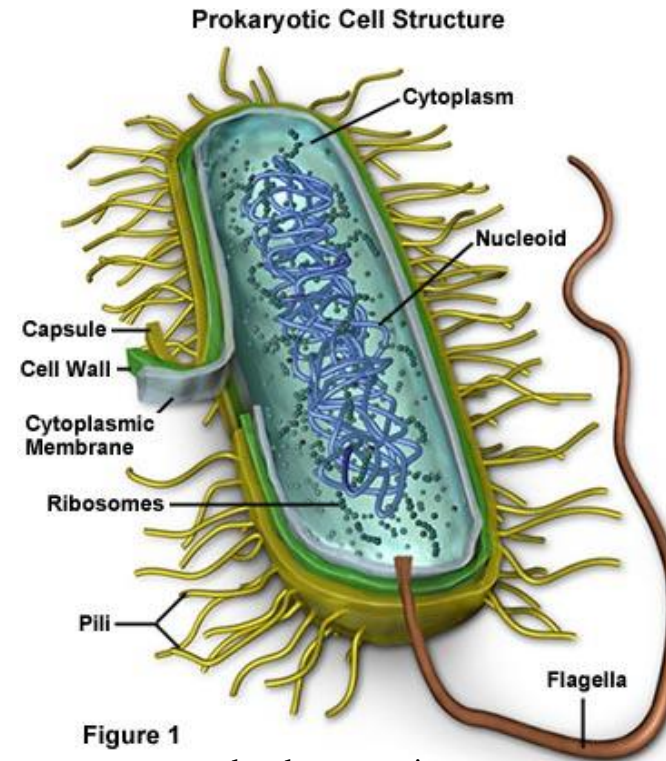


Figure 1

www.molecularexpressions.com

Commercial Food Uses



Dose	Purpose	Examples
0.05-0.15 kGy	Inhibit sprouting	Garlic, onions, potatoes
0.15-0.40 kGy	Insect disinfestation	Mangoes, dragon fruit, rambutan, capsicum, etc
1.0- 7.0 kGy	Pathogen reduction	Ground beef, frozen frog legs, shellfish
7.0-25.0 kGy	Pathogen reduction	Spices
44 kGy	Sterilization	NASA meals



Food Safety

- Spices
- Ground beef
- Chinese products
- Frog legs
- Pet treats
- NASA irradiated meals
- Meals for immunocompromised patients

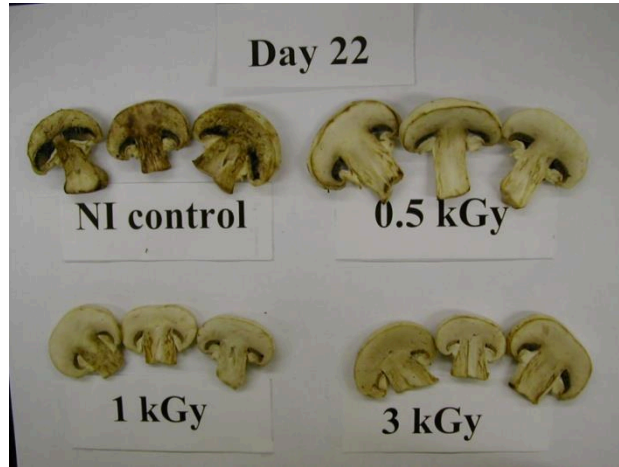


Microbial efficacy and food quality

- Greater microbial reduction at higher temperatures
 - but lower temperatures maintain better quality
- Greater microbial reduction at higher moisture contents
 - thus, dry products need higher dose treatment
- *E. coli*, *Listeria*, *Salmonella* spp, and parasites - easily destroyed
- Spores and viruses – more resistant

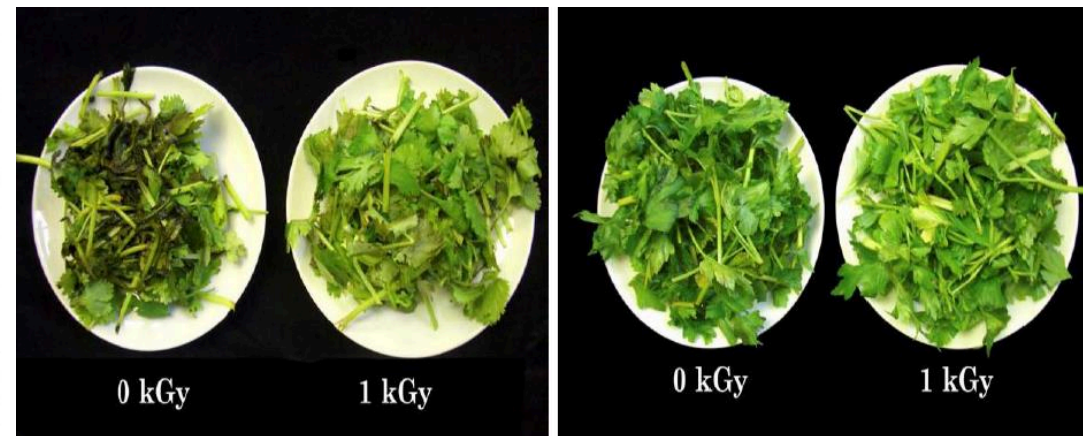


Shelf-life extension



Control

0.50kGy



Parsley and cilantro 14 days

Inhibition of sprouting

- Onions
- Potatoes in Japan



Krushak, Nasik, India



http://www.laradioactivite.com/en/site/pages/Food_Processing.htm

Elimination of Plant Pests



International Plant Protection Convention
Protecting the world's plant resources from pests

International Standards for Phytosanitary Measures

- ISPM 18 (2003): ***GUIDELINES FOR THE USE OF IRRADIATION AS A PHYTOSANITARY MEASURE***
- ISPM 28 (2007): ***PHYTOSANITARY TREATMENTS FOR REGULATED PESTS***



... reducing trade barriers.

Quality factors in fresh produce that may be affected by irradiation

- Spoilage organisms
- Appearance
 - Peel damage
 - Interior
- Electrolyte leakage
- Texture
 - Pectic substances
- Color
 - Chlorophyll
 - Anthocyanins
 - Carotenoids
- Flavor and aroma
 - Organic acids
- Wound response
 - Respiration rate
 - Ethylene
 - Phenol biosynthesis
- Scald (apples and pears)
- Lipid oxidation
- Nutritional factors



Vegetables	Control	1 kGy
Broccoli	8.5a	8.5a
Red cabbage	8.4a	8.2a
Endive	5.8b	6.5a
Parsley	6.2b	7.6a
Green leaf lettuce	5.4a	7.1b
Cilantro	5.5a	6.2a
Iceberg lettuce	6.8a	6.2a
Spinach	5.0a	6.9b
Romaine lettuce	6.8a	6.0a
Alfalfa sprouts	7.8a	8.0a
Carrots	8.5a	8.5a
Red leaf lettuce	4.0a	4.3a
Green onion	3.7a	5.3b
Celery	3.9a	4.9b

Visual Quality of Non-irradiated (Control) and Irradiated (1 kGy) Fresh-cut Vegetables after 14 days storage at 4°C.
9 =excellent, 1=unusable.

Fan and Sokorai 2005.

Effect on nutritional value



- Folic acid
- Thiamin
- Vitamin C
- Vitamin A (carotenoids)
- Vitamin E
- Phenolics

	<i>Day 1</i>		<i>Day 14</i>	
	0 kGy	1 kGy	0 kGy	1 kGy
<i>Broccoli</i>	926	902	855	855
<i>Cilantro</i>	528	538	115	157
<i>Red leaf lettuce</i>	74	39	34	15.7
<i>Spinach</i>	265	199	198	69

Vitamin C content ($\mu\text{g/g}$ fresh weight)

Fan and Sokorai. J. Food Science. 2008.

Process Optimization

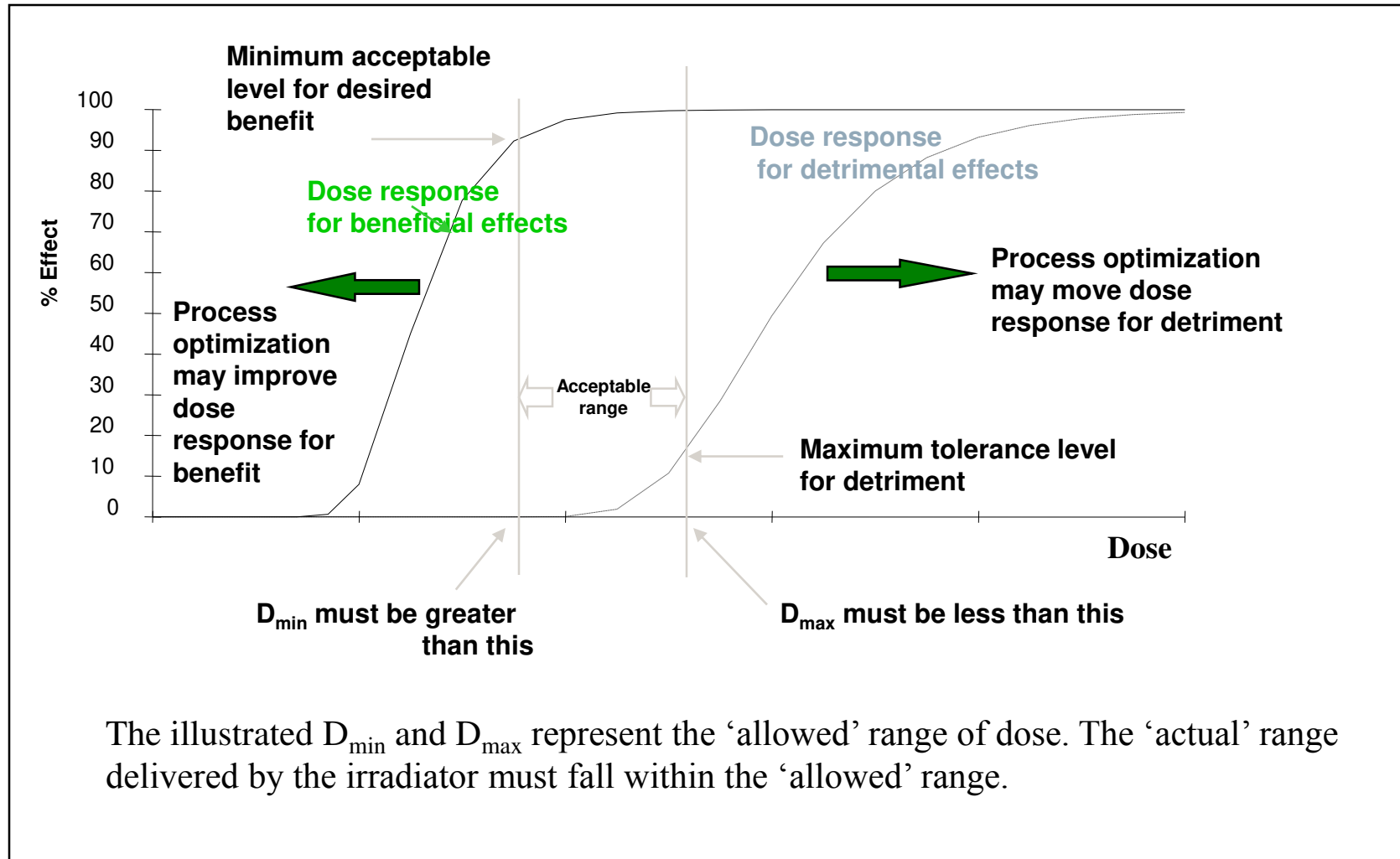
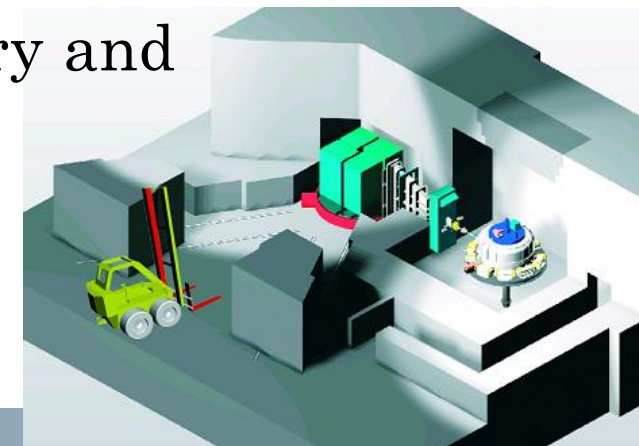


Figure courtesy Joseph Borsa, MDS Nordion

Process Control

- Dose measured using dosimeters
- Dose uniformity ratio (DUR) = D_{max}/D_{min}
- D_{min} cannot fall below minimum level needed to achieve a particular goal
- D_{max} should not exceed a certain maximum due to effects on quality and to stay under maximum dose allowed by regulations
- Need to consider optimal dose delivery and processing efficiency



Safety of Irradiated Food

- Toxicological
- Radiolytic

- 2 alkylcyclobutanones
- Furans

Regulations



- Defined as food additive
- FDA has main regulatory responsibility, also USDA (FSIS and APHIS)
- Labeled with a radura (no size specification) and the words “Treated with irradiation” or “Treated by irradiation”
- Required for retail, finished products or foods destined for further processing, not required for minor ingredients

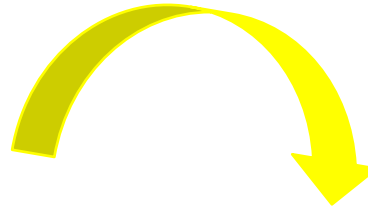
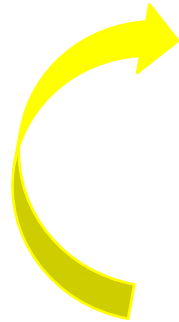
Consumer Acceptance

Distributors
Will retailers stock the product?

Retailers
Will consumers buy irradiated product?

Growers
Will retailers stock irradiated food?

Consumers
Does the product taste good?
Is it reasonably priced?



Product focus

- Consumers respond positively when informed
- People purchase irradiated food
- Insect quarantine applications with produce are expected to grow
- Focus on the product and its benefits, rather than the technology
- Most (but not all) will buy when given the opportunity



Courtesy Bill Gerlach, Melissas

