Medical and biopharma applications

Dagmara Chmielewska-Śmietanko

iiA's Leadership Program, Reims, 25-28 April 2023

MICROBIOLOGICAL CONTAMINANTS

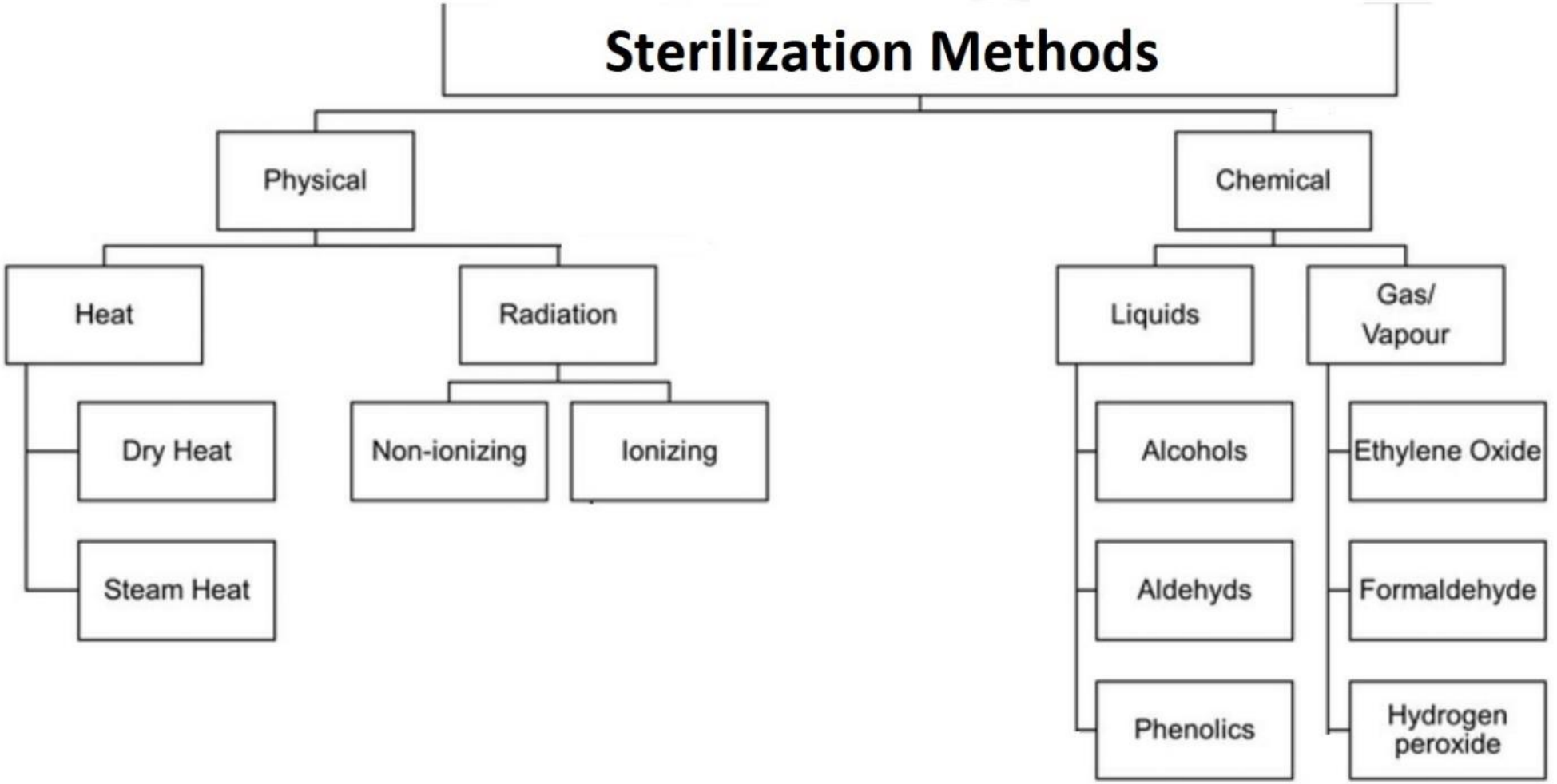
- INTRINSIC
- EXTRINSIC

Sterilization - any process that effectively kills or inactivates microorganisms like fungi, bacteria, viruses, and spore forms.

Disinfection - a process that eliminates many or all pathogenic microorganisms with the exception of bacterial spores.

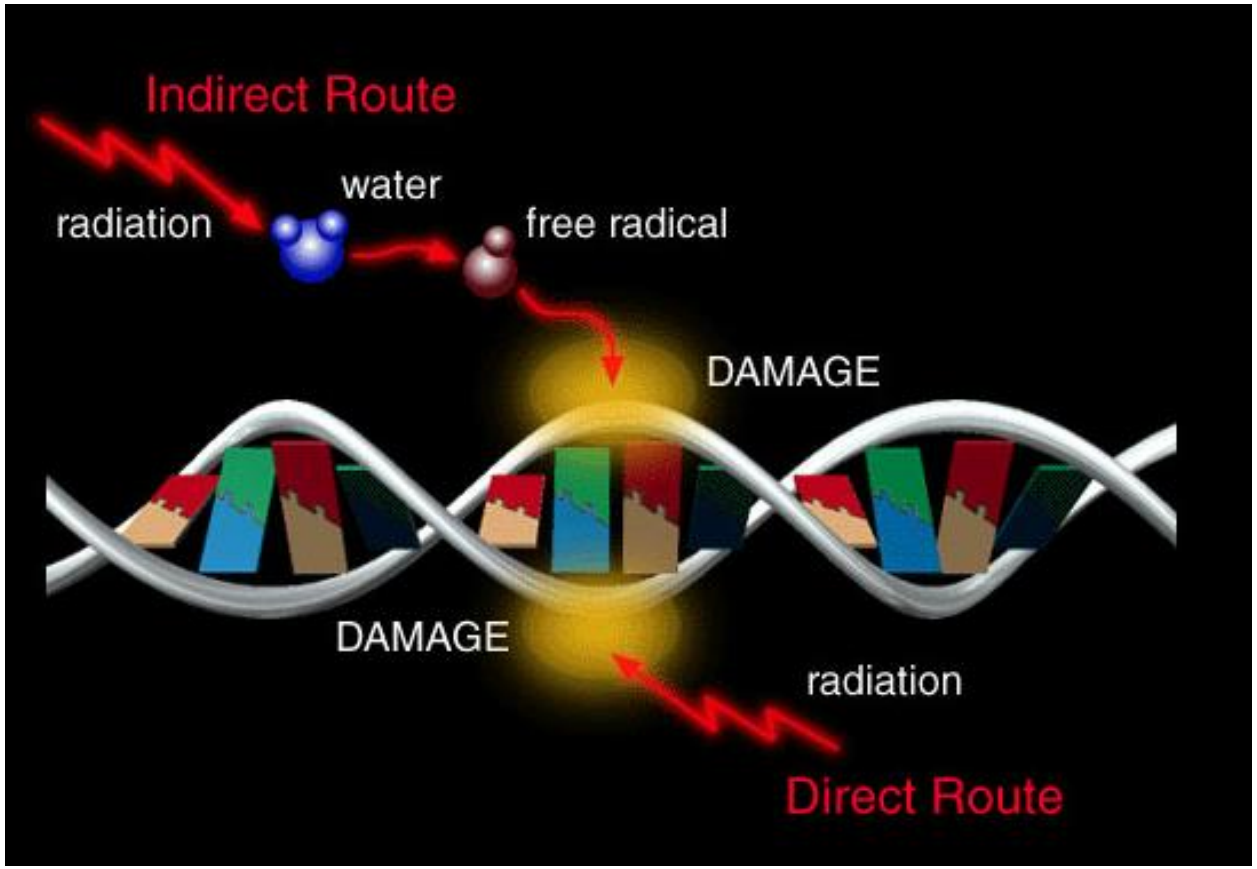
The choice of the sterilization method depends on the purpose of the sterilization and the material that will be sterilized.

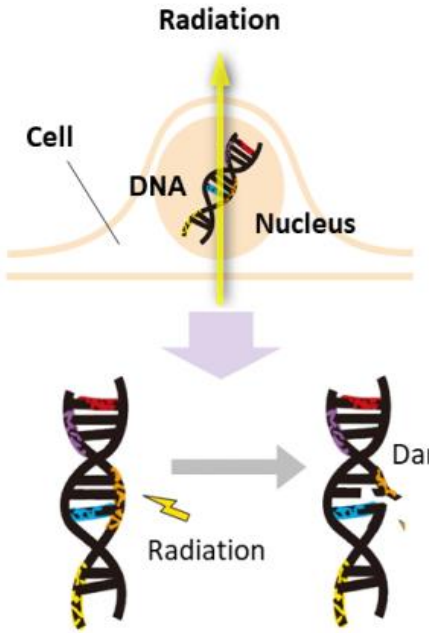
There is no single sterilization process for all the pharmaceuticals and medical devices.


Sterilization Methods
Physical
Chemical
Heat
Radiation
Liquids
Gas/
Vapour
Dry Heat
Steam Heat
Non-ionizing
Ionizing
Alcohols
Aldehyds
Phenolics
Ethylene Oxide
Formaldehyde
Hydrogen
peroxide

Method	Advantages	Drawbacks	Materials that can be sterilized
Moist heat	Simple, low cost, safety, and efficacy	Temperatures > 100°C and pressure Many metals have the potential to corrode or rust after repeated exposure to steam. Some plastics may lose their structural integrity, be sensitive to elevated levels of heat, be susceptible to migration of plasticizers to the substrate surface, or negatively react or break down when exposed to water.	Surgical dressings, sheets, surgical and diagnostic equipment, containers, closures, aqueous injections, ophthalmic preparations and irrigation fluids.
Dry heat	A simple method that can be used for sterilizing products that steam cannot penetrate	heat-resistant materials higher temperatures and larger processing times required can lead to melting, distortion, and degradation	Dry powdered drugs, suspensions of drugs in non-aqueous solvents, fats waxes, oils, soft hard paraffin silicone, oily injections, implants, ophthalmic ointments and ointment bases
Gas	High efficiency, low temperatures and compatibility with most materials For heat- and radiosensitive materials	The necessity of the elimination of residual sterilizing agents and other possible volatile residues. safety concerns regarding the flammable, toxic and carcinogenic nature of EtO long processing time	Hormones, proteins, and various heat-sensitive drugs
UV	UV irradiation is non-ionizing, products of unstable composition can be sterilized by this method.	Non-effective due to poor penetration power.	Sanitation of garments or utensils
Ionizing radiation	good assurance of product sterility, no chemical residue, the ability to operate at low temperature, and the immediate availability of the product after sterilization. Gamma-higher penetration.	possible undesirable changes in irradiated products, requires well-trained staff and specially designed and built installations.	Antibiotics, hormones, sutures, plastics and catheters, Implants, artificial joints, syringes, blood bags, gowns, bottle teats for premature baby units and dressings, surgical gloves
Liquids	Low-temperature process.	Phenols are ineffective against spores and most viruses. Phenols and aldehydes are toxic, corrosive, and/or irritating. Thus, there is a need for the rinsing step to remove chemical residues. FDA recommends that the use of liquid chemicals be limited to critical devices proven to be incompatible with other conventional methods.	pharmaceutical products, ophthalmic solutions, culture media, oils, antibiotics, and other heat-sensitive solutions

Influence of ionizing radiation on living organisms





Damage per 1 mGy of X-rays (per cell)	
Base damage	2.5 locations
Single-strand break	1 location
Double-strand breaks	0.04 locations

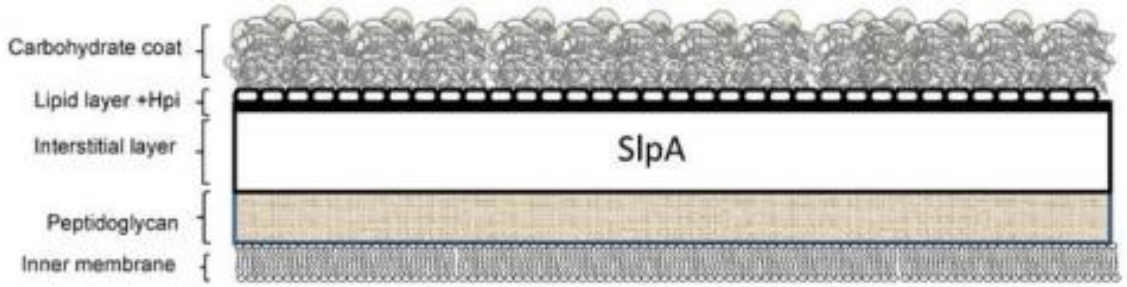
Radioresistance

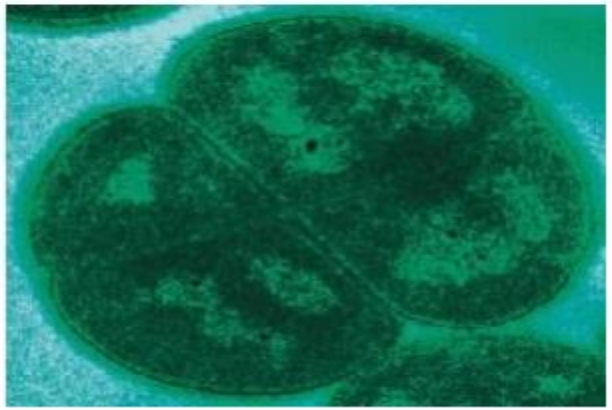
	D_{10} (kGy)
Humans	0.007– 0.01
Bats	0.15
Molds	0.03 – 0.5
Escherichia coli	0.25
Vegetative form of bacteria	1-2
Bacterial spores	3-7
Viruses	5-9
Deinococcus radiodurans	10-12

D_{10} – dose killing 90 % of individuals;

Deinococcus radiodurans

- *D. radiodurans* is the most extreme in terms of radiation resistance;
- *D. radiodurans i*s the flagship organism to investigate radioresistance, there is around 870 publications about it in Pubmed.



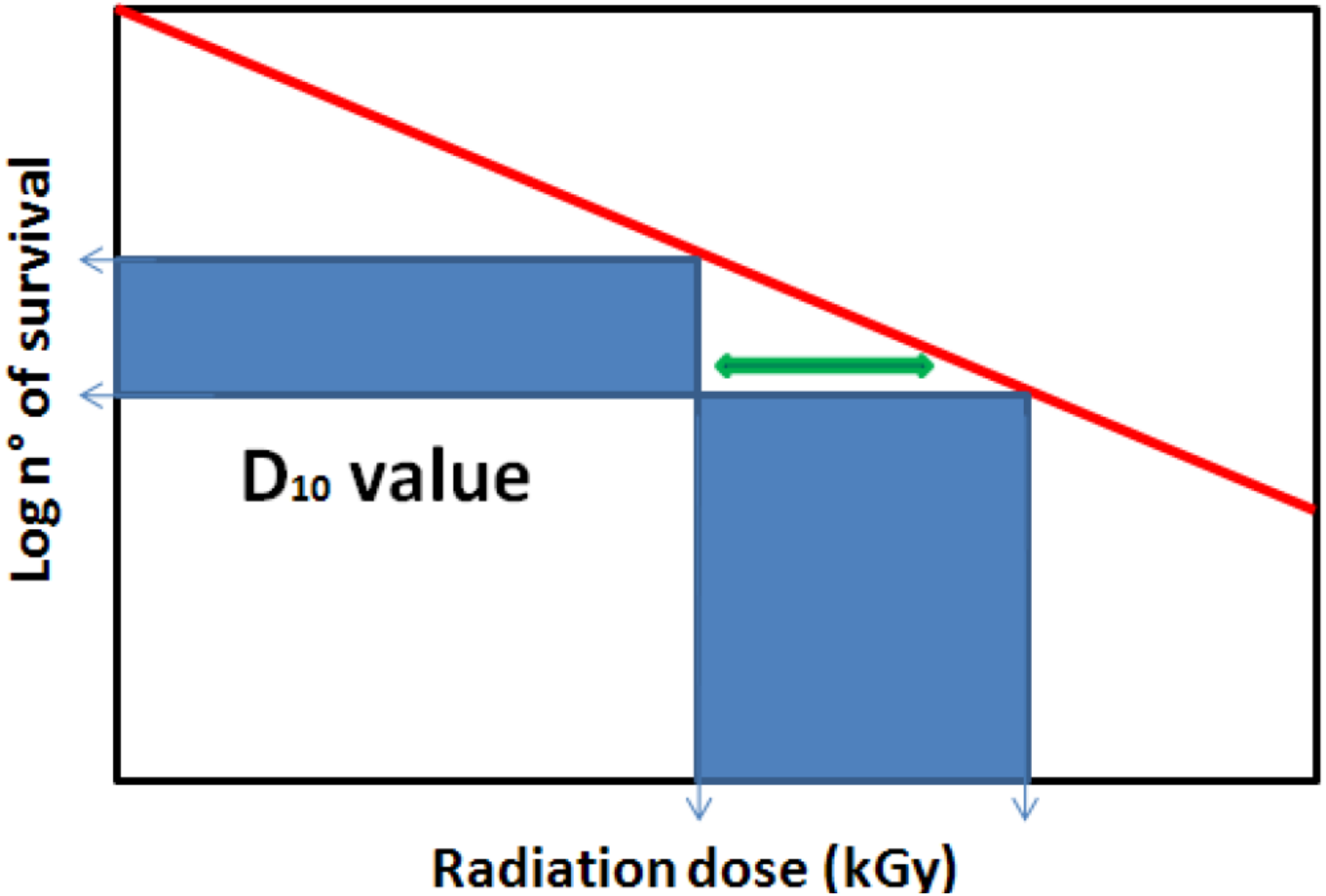


D. radiodurans acquired in the laboratory of Michael Daly, Uniformed Services University, Bethesda, MD, USA. Wiki

"Protective layers" - the most radiation-resistant bacteria Deinococcus radiodurans - apart from the cell wall and plasma membrane, has five other layers outside the cell membrane (Apte 2015);

D_{10} value

radiation dose (kGy) required to reduce the number of microorganisms by 10-fold (one log cycle) or required to kill 90% of the total number



Influence of irradiation and post-irradiation conditions

Oxygen: increases the lethal effect on microorganisms.

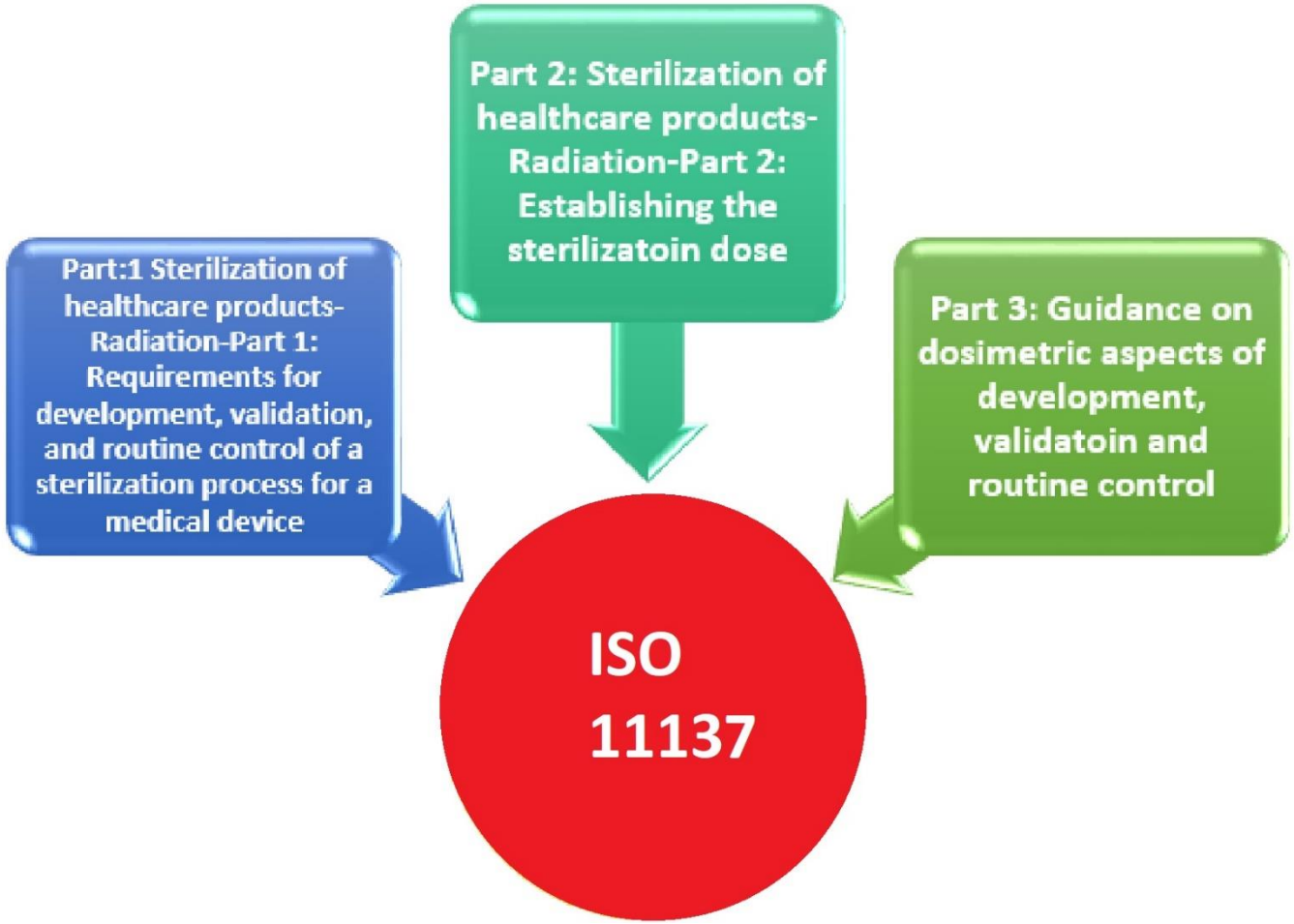
Water content: Microorganisms are most resistant when irradiated in dry conditions.

Temperature: Treatment at elevated temperature, generally in the sub-lethal range above 45°C, synergistically enhances the bactericidal effects of ionizing radiation on vegetative cells. Vegetative microorganisms are considerably more resistant to radiation at subfreezing temperatures than at ambient temperatures.

Medium: The composition of the medium surrounding the microorganism plays an important role in the microbiological effects. D10 values for certain microorganisms can differ considerably in different media;

Post-irradiation conditions: Microorganisms that survive irradiation treatment will probably be more sensitive to environmental conditions (temperature, pH, nutrients, inhibitors, etc.) than the untreated cells

Standards in radiation sterilization of medical equipment



Radiation Sterilization Plant (SSR)

CERTIFICATE

No. M - 7/9/2022

This is to certify that:

Instytut Chemii i Techniki Jądrowej (IChTJ)
Zakład Naukowy - Centrum Badań
i Technologii Radiacyjnych
Stacja Sterylizacji Radiacyjnej
Wyrobów Medycznych i Przeszczepów
ul. Dorodna 16, 03-195 Warszawa

is in conformance with

PN-EN ISO 13485:2016-04

in the following scope of activities:

designing and performing of sterilization process
for medical devices

The audit carried out by the Polish Centre for Testing and Certification has afforded evidence of the above.
This Certificate shall remain valid provided that above standard are respected by the Organization.
This certificate is valid:
from 10.01.2022 to 12.06.2022

Issued under the Contract No. 2712/M/4/2019
Date of certification decision: 10.01.2022
Certificate bears a qualified signature.
Warsaw, 10.01.2022

PARTNER OF IQNet

AC 019

Digitally signed by Aleksandra Kostrzewa

Polish Centre for Testing and Certification 469 Puławska Street, 02-844 Warsaw, Poland, phone +48 22 46 45 200, e-mail: pcbc@pcbc.gov.pl

IQNet

THE INTERNATIONAL CERTIFICATION NETWORK

CERTIFICATE

PCBC has issued an IQNet recognized certificate that the organization:

Instytut Chemii i Techniki Jądrowej (IChTJ)
Zakład Naukowy - Centrum Badań
i Technologii Radiacyjnych
Stacja Sterylizacji Radiacyjnej
Wyrobów Medycznych i Przeszczepów
ul. Dorodna 16, 03-195 Warszawa

has implemented and maintains a

Medical Devices Management System

for the following scope:

designing and performing of sterilization process
for medical devices

which fulfils the requirements of the following standard:

PN-EN ISO 13485:2016-04

Issued on: 10.01.2022
Expires on: 12.06.2022

This attestation is directly linked to the IQNet Partner's original certificate and shall not be used as a stand-alone document

Registration Number: PL - M - 7/9/2022

Alex Stoichitoiu
President of IQNet

Digitally signed by Aleksandra Kostrzewa

IQNet Partners*:
AENOR Spain AFNOR Certification France APCER Portugal CCC Cyprus CISQ Italy
CQC China CQM China CQS Czech Republic Cro Cert Croatia DQS Holding GmbH Germany EAGLE Certification Group USA
FCAV Brasil FONDONORMA Venezuela ICONTEC Colombia Inspecta Sertifiointi Oy Finland INTECO Costa Rica
IRAM Argentina JQA Japan KFQ Korea MIRTEC Greece MSZT Hungary Nemko AS Norway NSAI Ireland
NYCE-SIGE México PCBC Poland Quality Austria Austria RR Russia SII Israel SIQ Slovenia
SIRIM QAS International Malaysia SQS Switzerland SRAC Romania TEST St Petersburg Russia TSE Turkey YUQS Serbia

* The list of IQNet partners is valid at the time of issue of this certificate. Updated information is available under www.iqnet-certification.com

GŁÓWNY INSPEKTORAT FARMACEUTYCZNY

1/2

Chief Pharmaceutical Inspector

IWPS.405.7.2020.WK.1
WTC/0012_01_01/135

CERTIFICATE OF GMP COMPLIANCE OF A MANUFACTURER

Part 1

Issued following an inspection in accordance with Art. 111(5) of Directive 2001/83/EC as amended

Chief Pharmaceutical Inspector
/the Competent Authority of Poland/

confirms the following:

the manufacturer

Instytut Chemii i Techniki Jądrowej
ul. Dorodna 16, 03-195 Warszawa, POLAND

site address

Instytut Chemii i Techniki Jądrowej
ul. Dorodna 16, 03-195 Warszawa, POLAND

has been inspected under the national inspection programme in connection with manufacturing authorisation No. 014/0012/15 in accordance with Art. 40 of Directive 2001/83/EC transposed in Pharmaceutical Law of 6th of September 2001 (Journal of Laws from 2020, item 944 as amended).

From the knowledge gained during inspection of this manufacturer, the latest of which was conducted on 24-26/08/2020, it is considered that it complies with the Good Manufacturing Practice requirements laid down in Directive 2003/94/EC.

This certificate reflects the status of the manufacturing site at the time of the inspection noted above and should not be relied upon to reflect the compliance status if more than three years have elapsed since the date of that inspection. However, this period of validity may be reduced or extended using regulatory risk management principles by an entry in the Restrictions or Clarifying remarks field.

This certificate is valid only when presented with all pages and both Parts 1 and 2.

The authenticity of this certificate may be verified in EudraGMP. If it does not appear, please contact the issuing authority.

date: 2020 -11- 12

Chief Pharmaceutical Inspectorate
ul. Senatorska 12, 00-082 Warszawa, Poland
Tel. +48 22 635 99 51, fax. +48 22 635 99 57

Paweł Piotrowski
Chief Pharmaceutical Inspector

The sterilization process was validated in accordance with the requirements of PN-EN ISO 11137-1: 2015-07 Sterilization of products used in health care - Radiation - Part 1: Requirements for the development, validation and routine control of a sterilization process for medical devices. Since 2007, the SSR has a certified Quality Management System based on the PN-EN ISO 13485: 2016-04 standard for the design and performing of sterilization process for medical devices. The SSR has also a manufacturing authorization for human medicinal products in the field of sterilization of active substances, excipients and final product with the use of an electron beam. The process is carried out taking into account the principles of the GMP, which has been confirmed by the certificate of GMP compliance of a manufacturer.

ISO 11137-1:2015
Sterilization of health care products - Radiation - Part 1: Requirements for development, validation and routine control of a sterilization process for medical devices

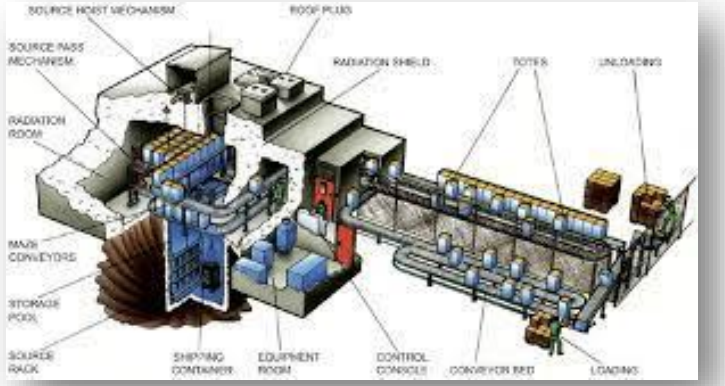
STERILIZING AGENT CHARACTERIZATION

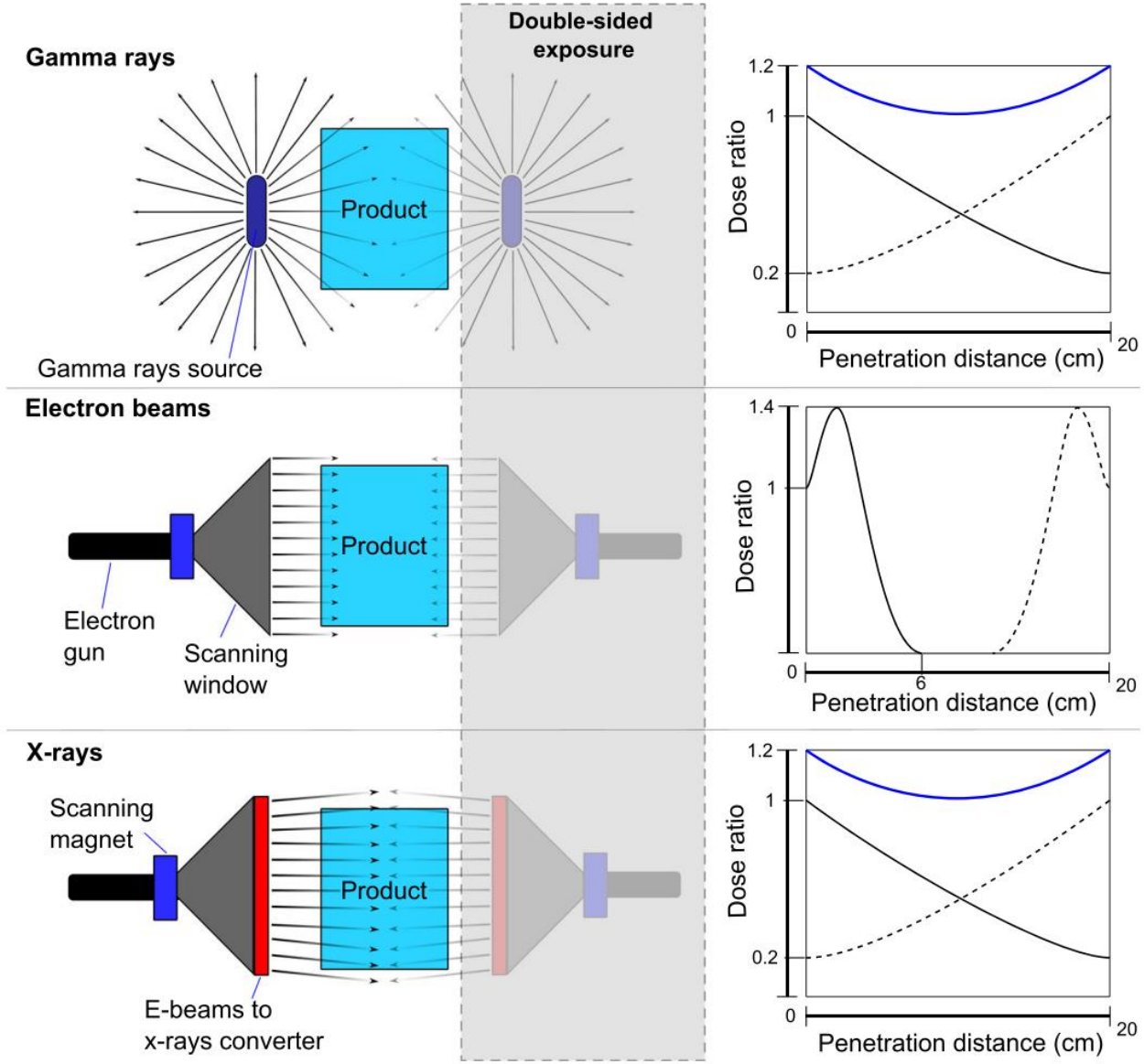
- Irradiation type (EB and X-rays energy defined, above 10 MeV (EB) and 5 MeV(X-rays) radioactivity assesment)

Sources of ionizing radiation used in sterilization

Medical devices may be sterilized by the following sources of ionizing radiation:

- gamma rays from radionuclides ^{60}Co or ^{137}Cs;
- X-ray generated from machine sources operated at a nominal energy level of 5 MeV;
- electrons generated from machine sources operated at or below a nominal energy level of 10 MeV.




Gamma rays
Double-sided exposure
Product
Gamma rays source
Dose ratio
1.2
1
0.2
0
20
Penetration distance (cm)
Electron beams
Product
Electron gun
Scanning window
Dose ratio
1.4
1
0
6
20
Penetration distance (cm)
X-rays
Scanning magnet
Product
E-beams to x-rays converter
Dose ratio
1.2
1
0.2
0
20
Penetration distance (cm)

ISO 11137-1:2015
Sterilization of health care products - Radiation - Part 1: Requirements for development, validation and routine control of a sterilization process for medical devices

PROCESS AND EQUIPMENT CHARACTERIZATION

- Equipment specification

Gamma	EB	X-rays
Radionuclide type	Electron energy	Electron or X-ray energy
Radionuclide activity	Average beam current	Average beam current
Gamma chamber geometry	Scan width and unirormity	Scan width and unirormity
The means of indicating the position of the gamma source;	The means of indicating that the beam and the conveyor are operating;	The dimension, materials and nature of construction of the X-ray converter
		The means of indicating that the beam and the conveyor are operating
The means of automatically returning the gamma source to the storage position and automatically ceasing conveyor movement if the process control timer or the conveyor system fails;	The means of ceasing irradiation if any failure of the conveyor occurs which affects the dose	The means of ceasing irradiation if any failure of the conveyor occurs which affects the dose
The means of returning the gamma source to the storage position and automatically ceasing conveyor movement or identifying affected product if the gamma source is not at its intended position	The means of ceasing conveyor movement or identifying affected product if any fault in the beam occurs	The means of ceasing conveyor movement or identifying affected product if any fault in the beam occurs
		The means of ceasing irradiation if failure of the target cooling system occurs

ISO 11137-1:2015
Sterilization of health care products - Radiation - Part 1: Requirements for development, validation and routine control of a sterilization process for medical devices

PROCESS AND EQUIPMENT CHARACTERIZATION

All types of irradiation

- the premises including the location of the irradiator
- product segregation
- conveyor system + path
- irradiation container(s)
- means of process monitoring and control

STERILIZATION FACILITY AT INCT, WARSAW, POLAND

IAEA Institute of Nuclear Chemistry and Technology
IAEA Collaborating Centre for Radiation Processing and Industrial Dosimetry
2010 - 2014

ichtj

ACCELERATOR	Elektronika 10/10
• electron energy	10 MeV
• beam power	15 kW
• scan width	65 cm
• AC power consumption	120 kVA
BUILDING	
• total surface	1814 m^2
• total capacity	9230 m^3
• storage surface	2x288 m^2
PROCESS PARAMETERS	
• conveyor speed	0.3 - 7 m/min.
• productivity	10 000 kg kGy/h
• unit size	58x46x(10-20) cm; 0.05 m^3

Elektronika 10/10

ISO 11137-2:2013
Sterilization of health care products - Radiation –
Part 2: Establishing the sterilization dose

PRODUCT DEFINITION

- Together with packaging material, updated if changes implemented

- Product families (bioburden+ factors influencing:
- type and origin of raw materials
- components
- production process
- equipment used in the production process
- production place
- production environment.

Representative product - The number and types of microorganisms on or in a product shall be used as the basis for selecting a product to represent a product family,

Sterilization dose

Should be chosen according to the initial bioburden, sterility assurance level (SAL) and the radiosensitivity of microorganisms.

A sterility assurance level (SAL) - the probability of a viable microorganism being present on an individual product unit after sterilization.

Sterilization of medical devices – **SAL of 10^{-6}** indicates a probability of one item being contaminated in one million

ISO 11137-2:2013
Sterilization of health care products - Radiation –
Part 2: Establishing the sterilization dose

DETERMINATION OF STERILIZATION DOSE

- **Method 1 Using Bioburden Information**

The information on the number of microorganisms on or in a product compared to a standard distribution of resistances (SDR) to determine the minimum sterilization dose.

- **Method 2 Fraction positive information from incremental dosing**

Information about the resistance to radiation of microorganisms as they occur on the product. This specific resistance is being used for dose setting.
Method 2A for products with bioburden as would be expected from a normal manufacturing process
Method 2B for products with consistent and very low bioburden.

- **Substantiation of 25 or 15 kGy**

Selection of the minimum sterilization dose of 15/25 kGy and further laboratory testing to demonstrate that a SAL 10^{-6} has been achieved with the selected minimum sterilization dose.
If bioburden:

- 1 000 cfu per product unit →VDmax25
- 1.5 cfu per product → VDmax15.

	Method 1	Method 2 A i B	VD_{max}^{25}	VD_{max}^{15}
Batch size	All	Medium-Large	All	All
Max.level of bioburden (CFU)	1000000	-	≤1000	1.5
Number of pcs. for testing	130	2A – 840 2B - 780	40	40

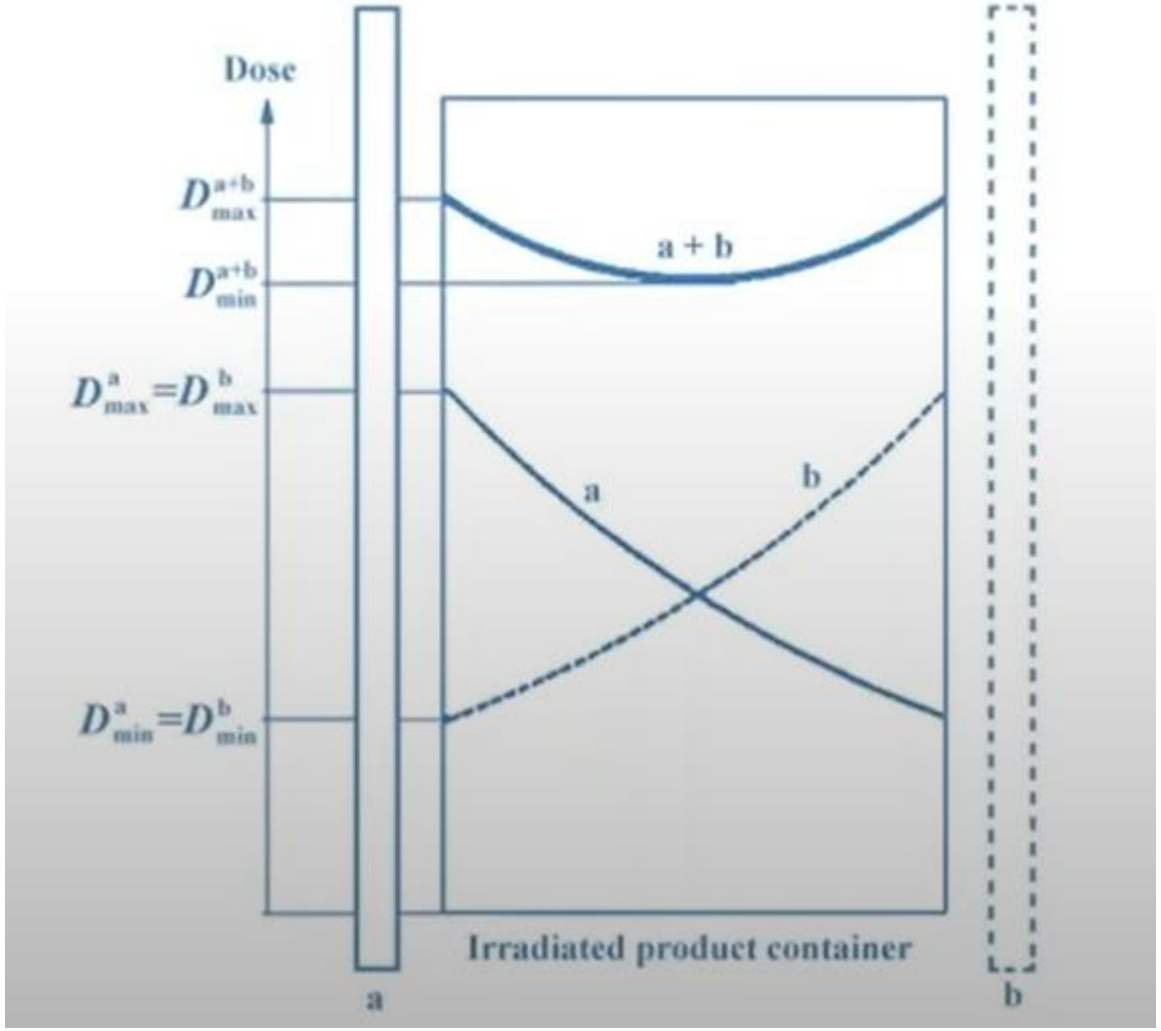
Dose range

Minimum dose – dose necessary to achieve the required or desired SAL

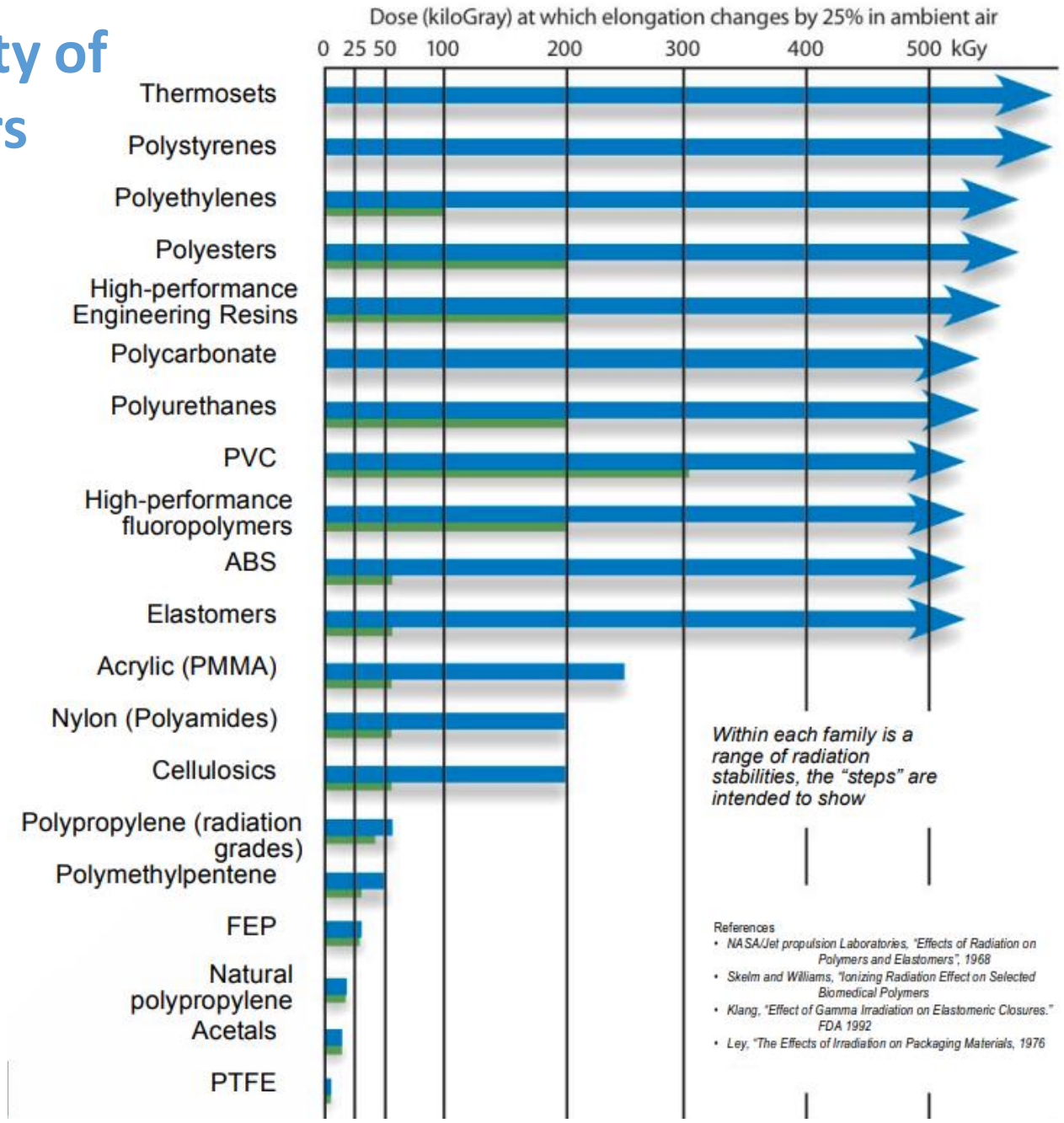
1. Dosimetry
2. Bioburden
3. Verification dose and sterility testing

Maximum dose – the highest dose which can be used in the sterilization process without altering material properties and quality of the product

1. Dosimetry
2. Evaluation criteria
3. Product testing



Radiation stability of medical polymers



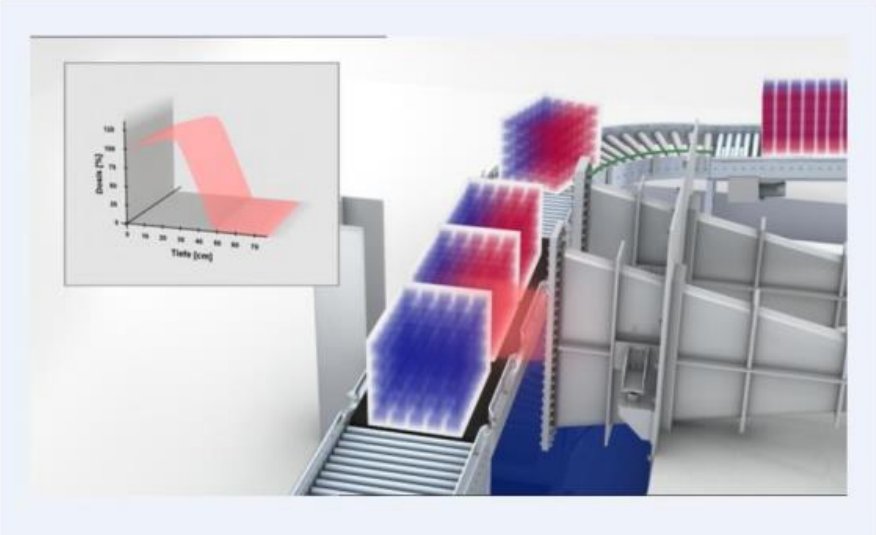
Source: E_BEAM Services, https://ebeamservices.com/wp-content/uploads/2015/05/Relative-Radiation-Stability.pdf

Dose Uniformity Ratio (DUR)

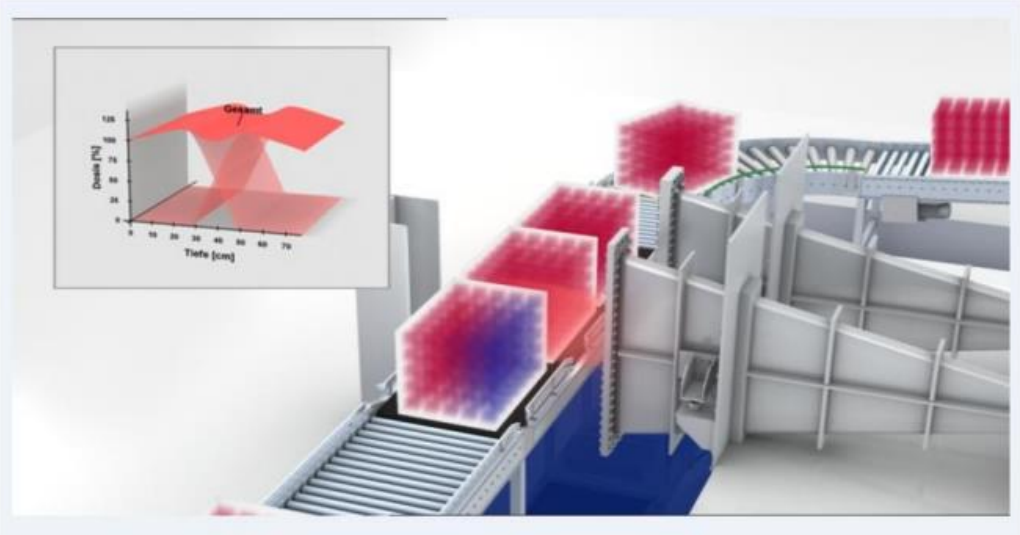
DUR = Dmax/Dmin

DUR<Dmax,acc / Dster

1st Pass



2nd Pass



Source: Mediscan

ISO 11137-1:2015
Sterilization of health care products - Radiation - Part 1: Requirements for development, validation and routine control of a sterilization process for medical devices

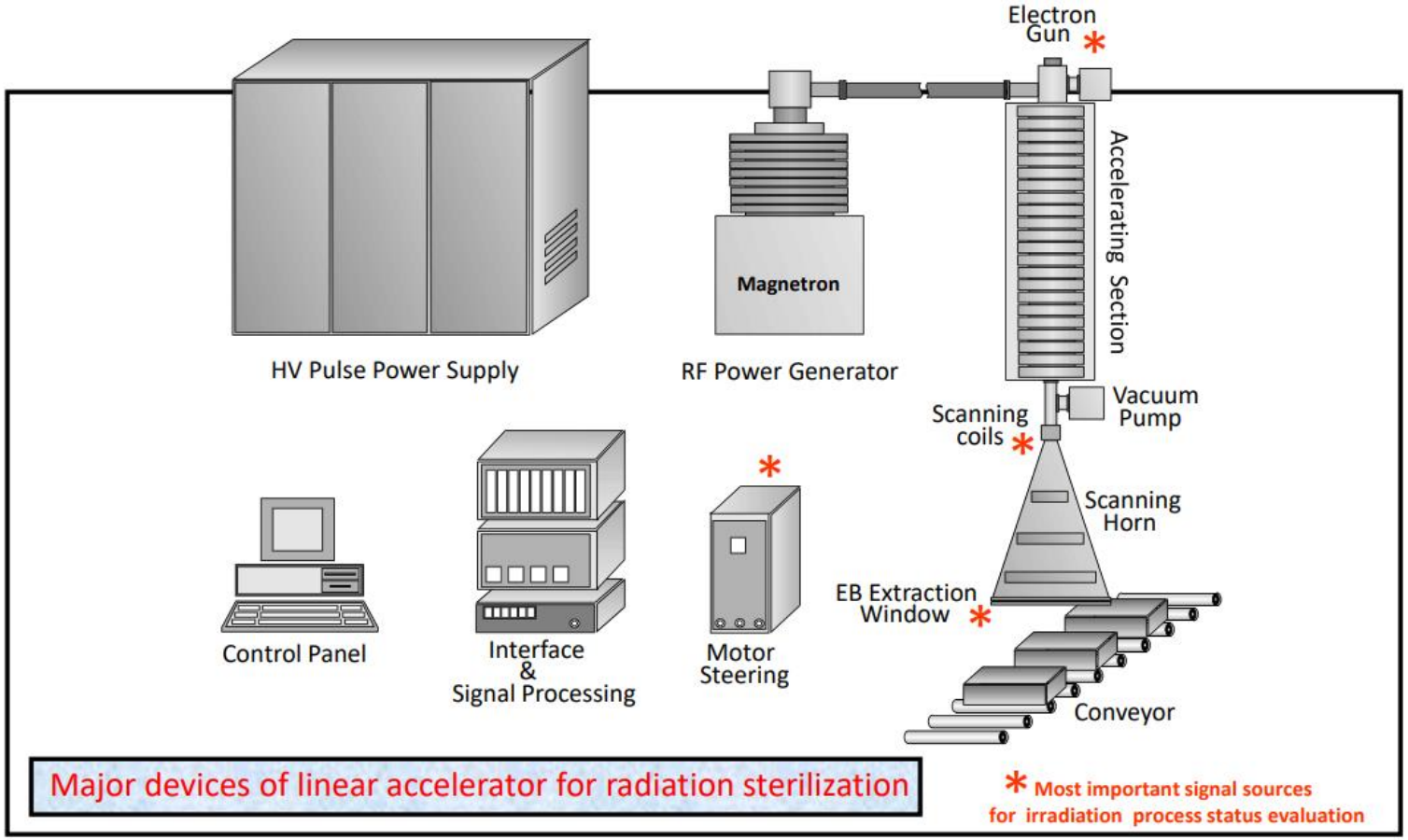
VALIDATION

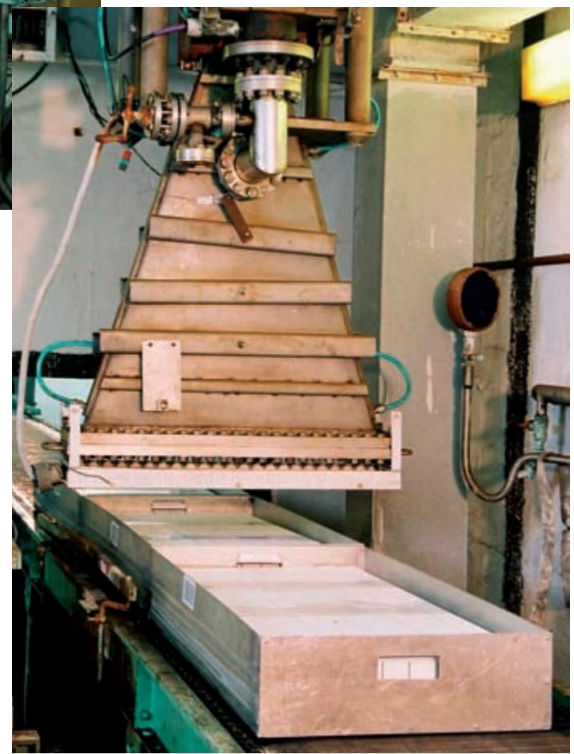
- **Instalation Qualification (IQ)**

process of obtaining and documenting evidence that equipment (together with ancillary items+software) has been provided and installed in accordance with its specification

.

Upgraded accelerator control system for delivering required dose and data acquisition in sterilization process





ISO 11137-1:2015
Sterilization of health care products - Radiation - Part 1: Requirements for development, validation and routine control of a sterilization process for medical devices

VALIDATION

- **Operational Qualification (OQ)**

To demonstrate that installed equipment operates within predetermined limits when used in accordance with its operational procedures

- the calibration of all instrumentation
- characterization the irradiator – dose mapping

Conveyor with aluminium box

ISO 11137-1:2015
Sterilization of health care products - Radiation - Part 1: Requirements for development, validation and routine control of a sterilization process for medical devices

VALIDATION

- **Performance Qualification (PQ)**

uses product to demonstrate that equipment consistently operates in accordance with predetermined criteria and the process yields product that is sterile and meets specified requirements.

- Determination of the product loading pattern and presentation of the product for sterilization (path, container)

- Product dose mapping for specified loading pattern (Dmin, Dmax)

LABORATORY FOR MEASUREMENTS OF TECHNOLOGICAL DOSES (LMTD)

- The Laboratory for Measurements of Technological Doses (LMTD) was created in 1998 to ensure reliable technological dose measurements and to enhance quality assurance of the INCT technological plants.
- LMTD was accredited as a testing laboratory in February 2004 (Polish Centre for Accreditation, accreditation number: AB 461).

The LMTD quality system is based on the PN-EN ISO/IEC 17025 standard „General requirements for the competence of testing and calibration laboratories”.

POLSKIE CENTRUM AKREDYTACJI
POLISH CENTRE FOR ACCREDITATION

Sygnatariusz EA MLA
EA MLA Signatory

CERTYFIKAT AKREDYTACJI
LABORATORIUM BADAWCZEGO
ACCREDITATION CERTIFICATE OF TESTING LABORATORY
Nr AB 461

Potwierdza się, że: / This is to confirm that:

INSTYTUT CHEMII I TECHNIKI JĄDROWEJ
LABORATORIUM POMIARÓW DAWEK TECHNOLOGICZNYCH
ul. Dorodna 16, 03-195 Warszawa

spełnia wymagania normy PN-EN ISO/IEC 17025:2018-02
meets requirements of the PN-EN ISO/IEC 17025:2018-02 standard

Akredytowana działalność jest określona w Zakresie Akredytacji Nr AB 461
Accredited activity is defined in the Scope of Accreditation No AB 461

Akredytacja pozostaje w mocy pod warunkiem przestrzegania wymagań jednostki akredytującej określonych w kontrakcie Nr AB 461
This accreditation remains in force provided the Laboratory observes the requirements of Accreditation Body defined in the Contract No AB 461

Akredytacji udzielono dnia 27.02.2004 r.
Accreditation was granted on 27.02.2004

DYREKTOR
POLSKIEGO CENTRUM AKREDYTACJI
LUCYNA OLBORSKA

Warszawa, 6 lutego 2020 r.

LABORATORY FOR MEASUREMENTS OF TECHNOLOGICAL DOSES (LMTD)

The LMTD maintains the following accredited dosimetry systems:

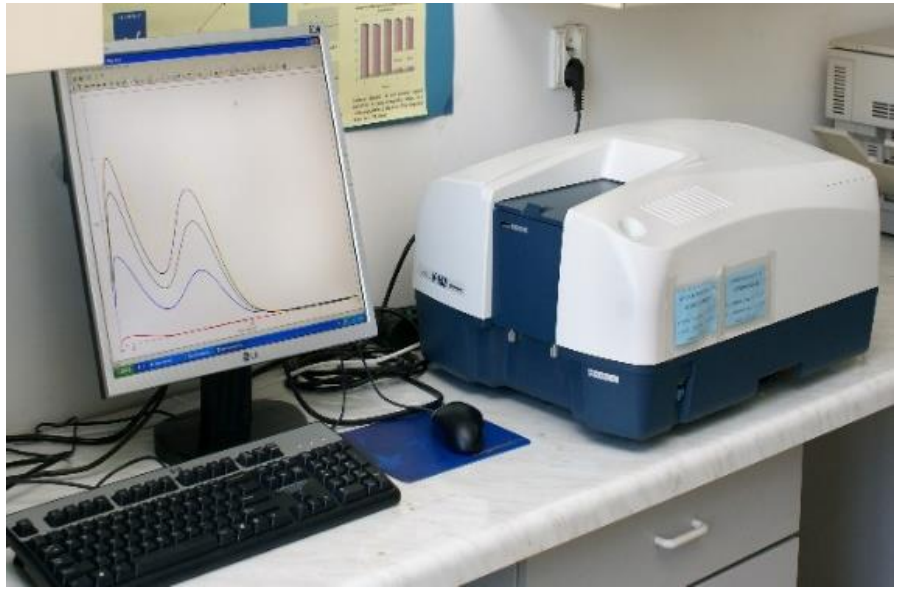
- Fricke,
- CTA,
- Alanine,
- Calorimetry.

The scope of the LMTD accreditation includes measurements of absorbed doses of gamma radiation from 20 Gy to 150 kGy and high energy electrons from 1.5 to 150 kGy.

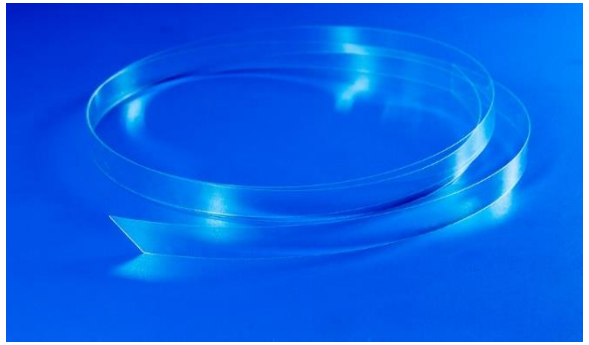
LABORATORY FOR MEASUREMENTS OF TECHNOLOGICAL DOSES (LMTD)

Dosimetry systems in LMTD

UV-VIS spectrophotometer Jasco V-650



FRICKE
20 - 400 Gy

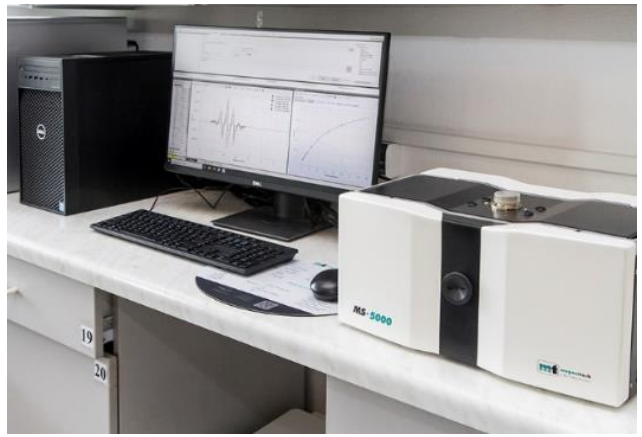


CELLULOSE TRIACETATE FOIL (CTA)
10 - 80 kGy

LABORATORY FOR MEASUREMENTS OF TECHNOLOGICAL DOSES (LMTD)

Dosimetry systems in LMTD

EPR spectrometer MiniScope MS 5000 (Magnettech)



HOLDERS FOR ALANINE IRRADIATIONS

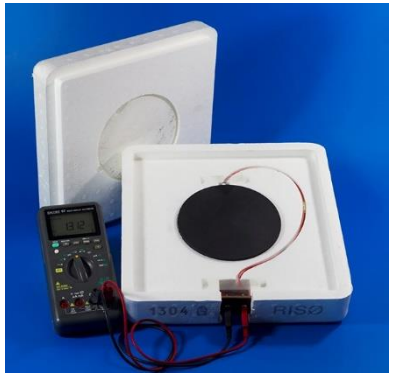
ALANINE PELLETS 50 Gy – 150 kGy

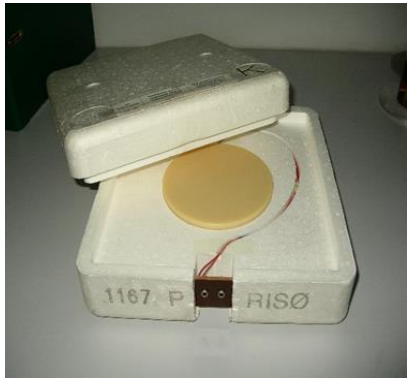
Alanpol® RODS (non-accredited)

EPR standards:

- Rubin (Al_2O_3: Cr^{3+})
- Cr^{3+} in MgO

Dosimetry systems in LMTD

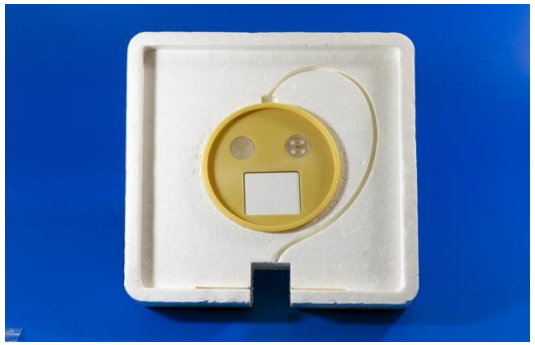




GRAPHITE CALORIMETER
1.5 – 15 kGy

POLYSTYRENE CALORIMETER
3 – 40 kGy

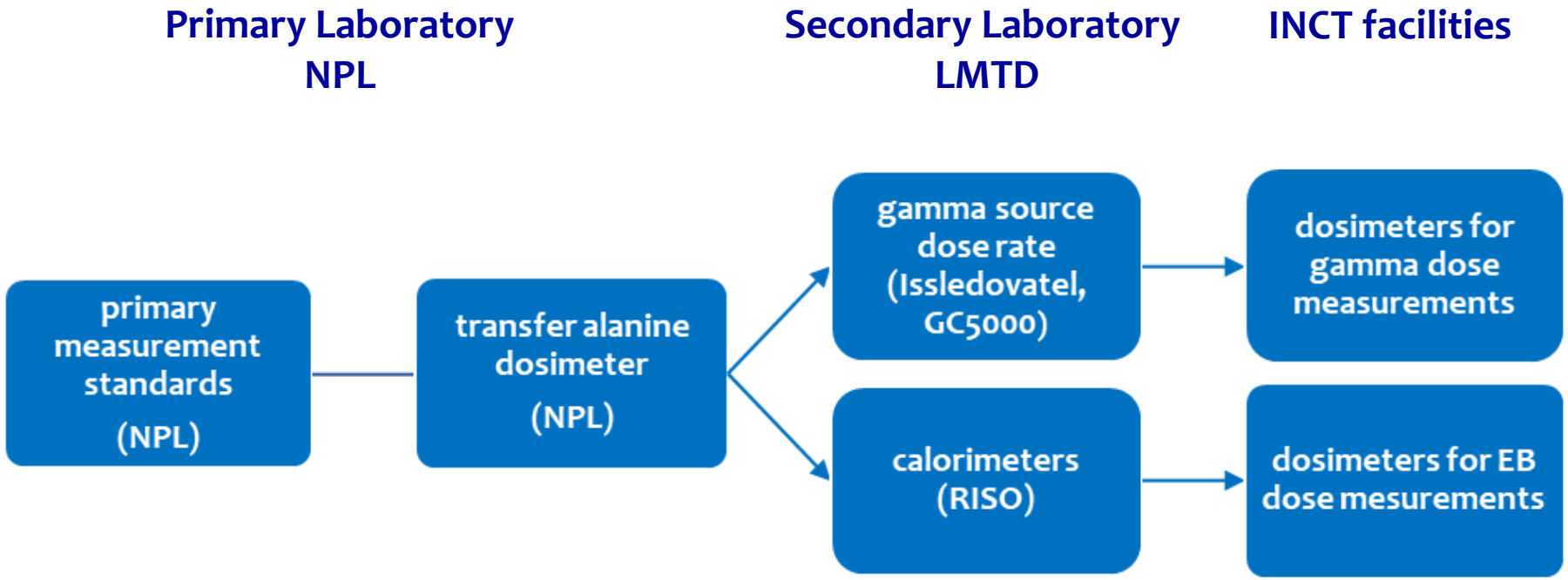
alanine



PHANTOM FOR EB IRRADIATION

LABORATORY FOR MEASUREMENTS OF TECHNOLOGICAL DOSES (LMTD)

METHOD FOR ESTABLISHING OF TRACEABILITY TO PRIMARY STANDARDS



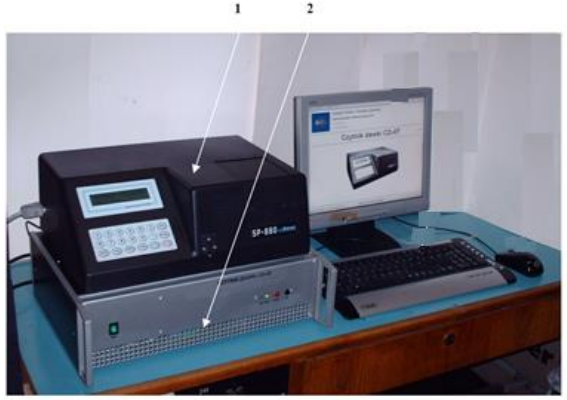
All results of the dose measurements are traceable to the National Physical Laboratory (NPL) primary standards.

LABORATORY FOR MEASUREMENTS OF TECHNOLOGICAL DOSES (LMTD)

Routine dosimeters used in INCT e-beam irradiation facilities

a) Graphite and polystyrene calorimeters

Dose range: 5 – 40 kGy



General view of the dose reader CD-07.
1) Spectrophotometer SP-880,
2) electronics unit based on embedded microcomputer

b) PVC foil dosimeters

Dose range: 5 – 40 kGy

c) Gammachrome

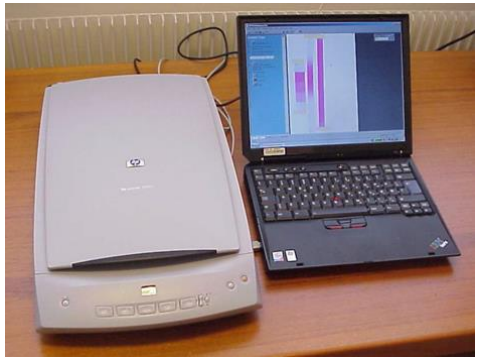
Dose range: 0.5 – 3 kGy

d) Amber

Dose range: 2 – 30 kGy

e) Radiochromic film – B3

Dose range: 10 - 40 kGy



RISOSCAN

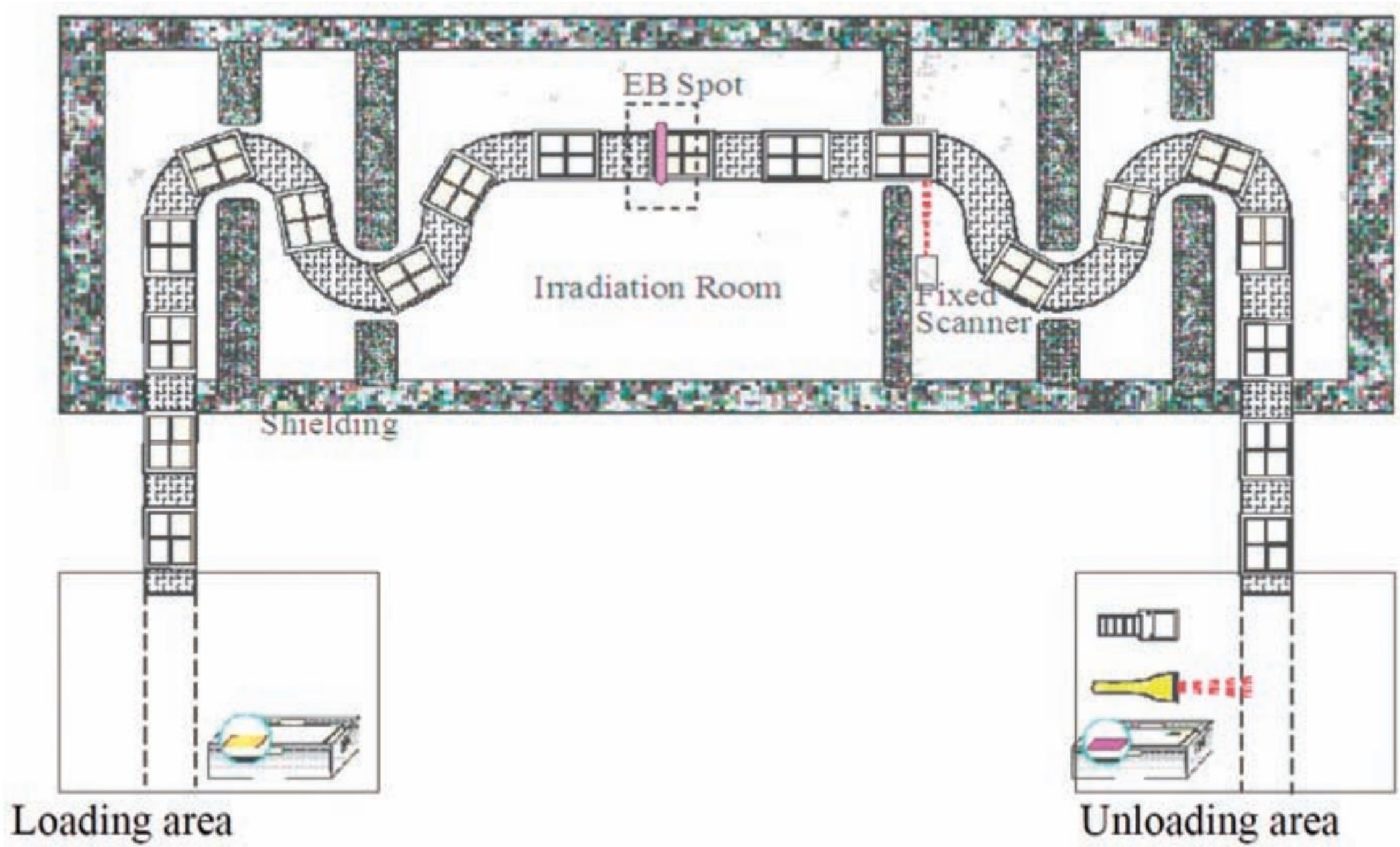
ISO 11137-1:2015
Sterilization of health care products - Radiation - Part 1: Requirements for development, validation and routine control of a sterilization process for medical devices

VALIDATION

- **Routine monitoring and control**

- Separation of non-irradiated and irradiated products
- Visual indicators
- Disimeters in predetermined routine monitoring position(s).
- EB and X-rays – beam parameters and conveyor speed monitored.
- Gamma – source geometry, irradiation time or/and conveyor speed should be monitored.

Storage room


EB Spot
Irradiation Room
Fixed
Scanner
Shielding
Loading area
Unloading area

ISO 11137-1:2015
Sterilization of health care products - Radiation - Part 1: Requirements for development, validation and routine control of a sterilization process for medical devices

VALIDATION

- **Maintaining process effectiveness**

- Bioburden specification (number and type)
- Frequency depends on bioburden level and method used for the determination of D_{ster}

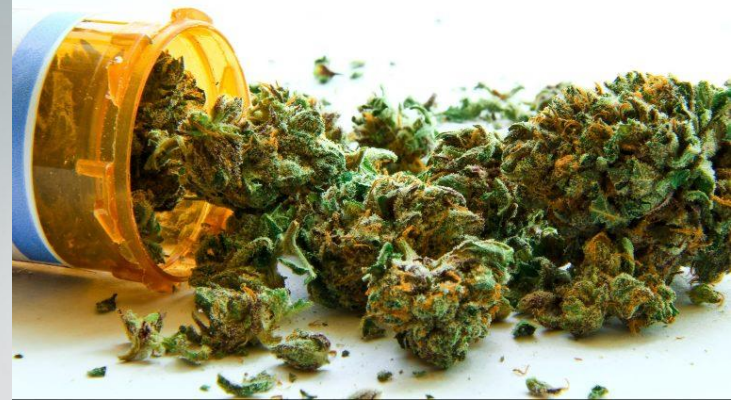
- Dose audits to demonstrate the continued effectiveness of the established sterilization dose.
-three months (with a possible reduction in frequency)

Irradiation Sterilized Medical Disposable Products:

- Syringes
- Catheters
- Drains
- Tubing
- Urine bags
- Drain pouches
- Bandages
- Hydrogels
- Absorbents
- Gloves
- Surgical gowns
- Hand towels
- Beakers and lab
- Petri dishes
- Culture tubes
- Personal protection equipment
- Bottles for eye drops

40 000 000 pcs. /year
(80 companies)

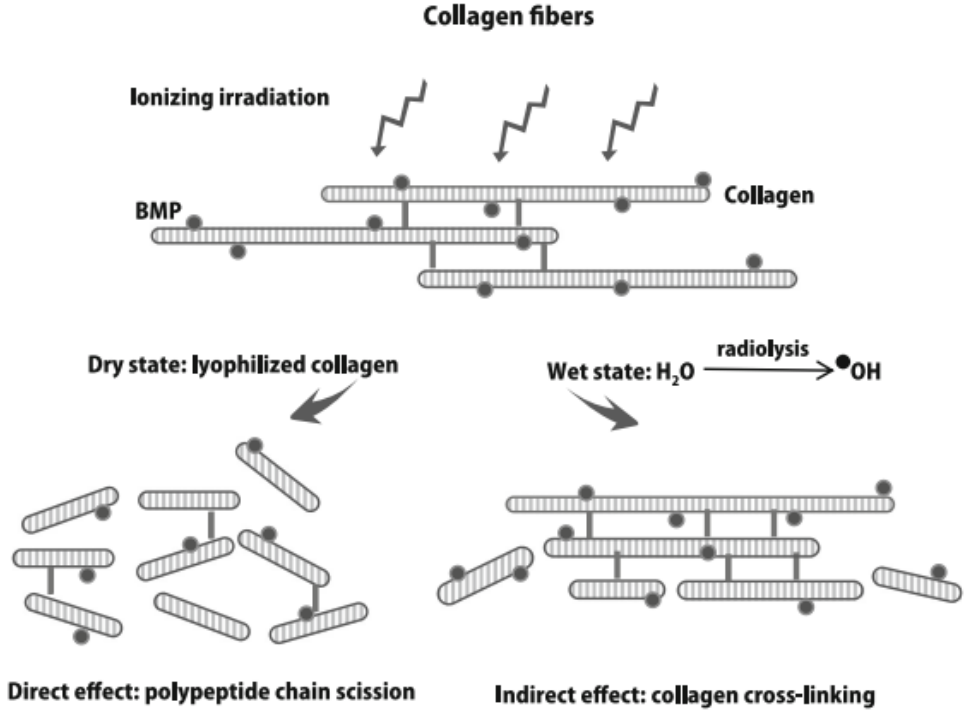
Pharmaceutical products



400 kg/year
(3 companies)

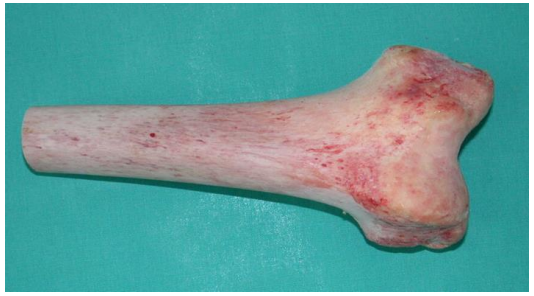
Transplants

Irradiation conditions



14 000 pcs. / year
(4 Tissue Banks)

Dose recommended by the IAEA 25 kGy, in Poland recommended by the Tissue Banks 35 kGy

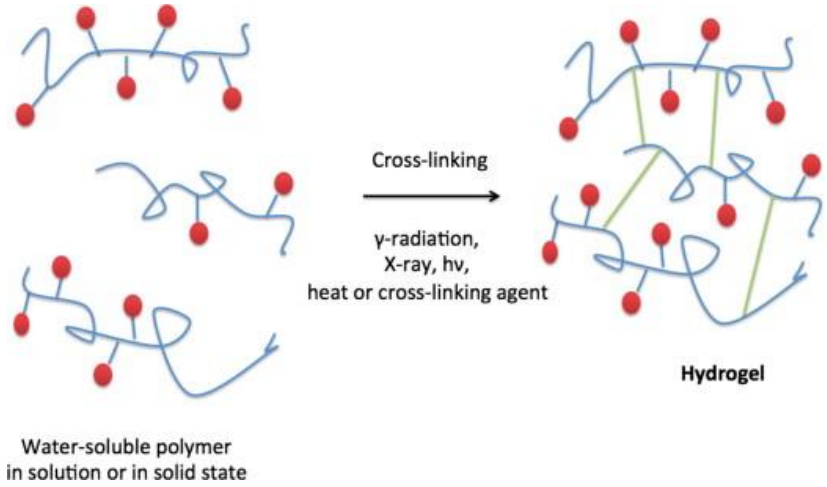


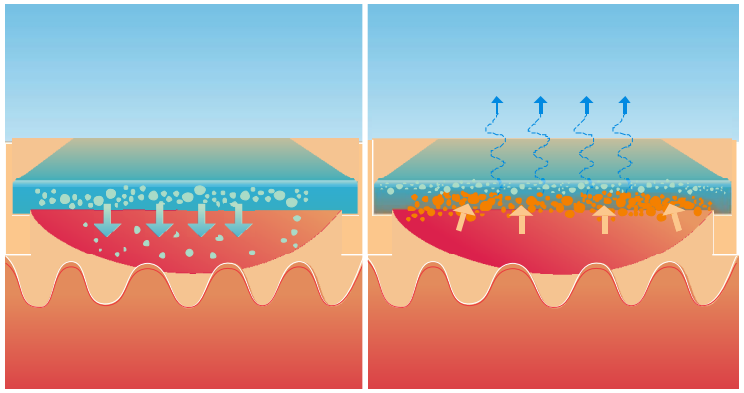
Advantages:

- High effectiveness
- Small temperature increase
- (possibility of the thermolabile material sterilization)
- Dose homogeneity
- Lack of residues
- Possibility of sterilization in barrier packaging

Hydrogel wound dressings

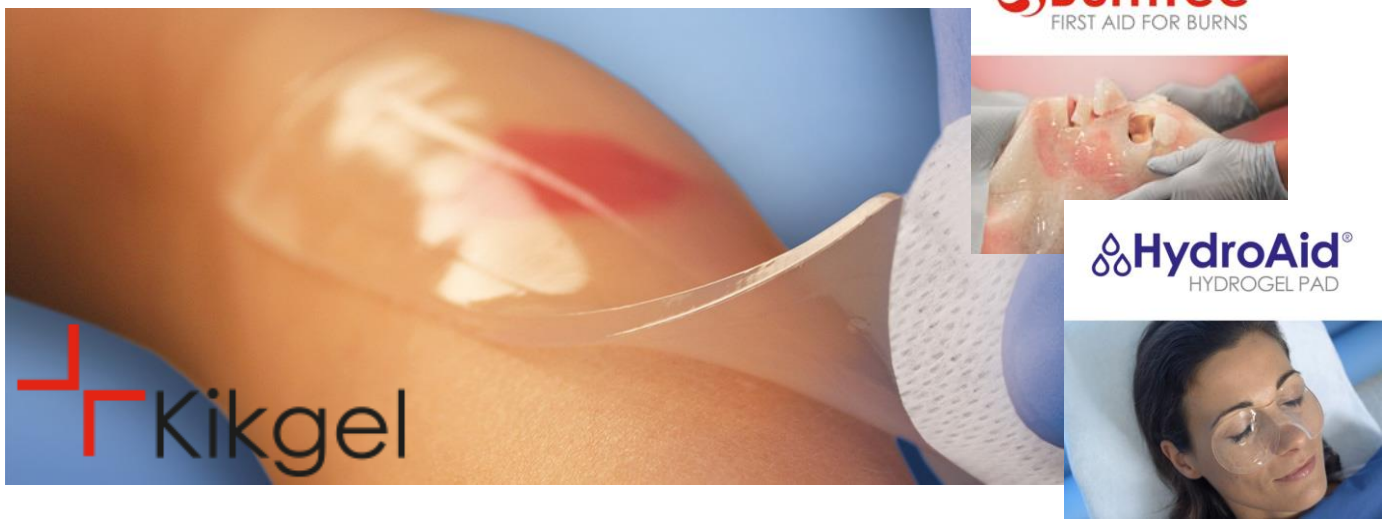
Cross-linking + sterilization





In case of dry wounds hydrogel gives the moisture into the wound.

When the wound exudates the hydrogel absorbs moisture into its structure.



PROPERTIES

- transparent piece of hydrogel in thickness of 3.5 mm and about 90% content of water
- it creates and keeps optimal moist wound environment what accelerates the processes of epithelialization
- it protects wound against external contamination
- it is oxygen permeable
- it absorbs exudate from the wound
- soothes local pain and discomfort

Journal of the Mechanical Behavior of Biomedical Materials
Volume 122, October 2021, 104652

Influence of radiation conditions on the wear behaviour of Vitamin E treated UHMWPE gliding components for total knee arthroplasty after extended artificial aging and simulated daily patient activities

Jens Schwiesau [a c], Bernhard Fritz [a], Georg Bergmann [b], Ana Laura Puente Reyna [a], Christoph Schilling [a], Thomas M. Grupp [a c]

Scientific approach: Vitamin E blended UHMWPE gliding components

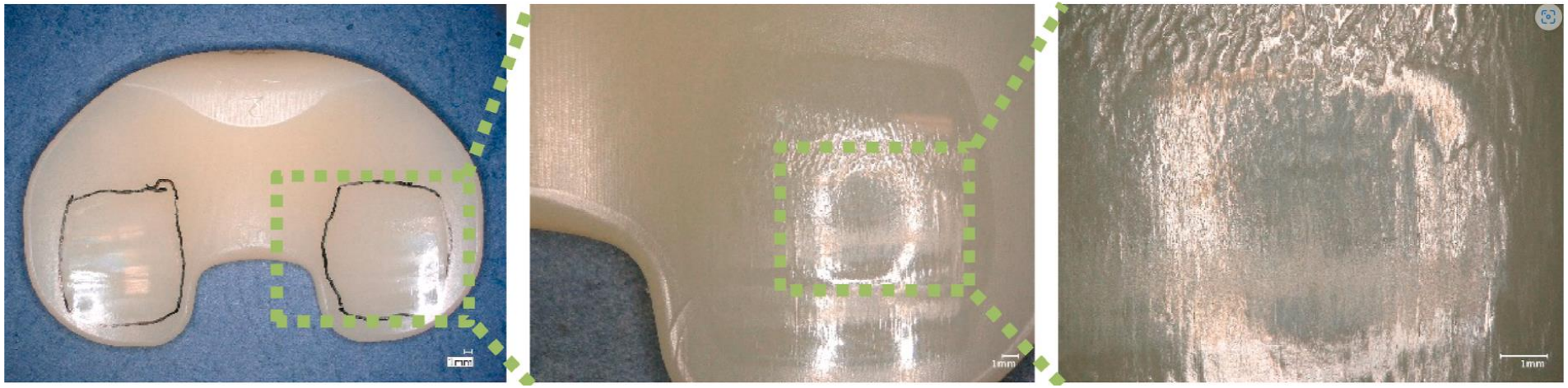
- EB (RT, 115 °C)
- Gamma (RT)
- 30 kGy
- Artificial aging (ASTM F2003-2)

Results:

- No change in the oxidation index (ISO 5834–4:2005)
- Weight reduction due to wear (ISO 14243–1:2009)

Significant differences were detected for the test group E-beam RT

- nearly three times reduced wear can be linked to an increased temperature during E-beam irradiation.
- no influence of the extended aging period can be observed for this Vitamin E blended material demonstrating its high oxidative stability.
- no indication of structural failure was observed on any of the tested specimens, even when the mechanical and chemical stress applied



Different products including components:
-low-density polyethylene (LDPE),
-chlorobutyl rubber (CIIR),
-polyethylene terephthalate (PET)
-polypropylene homopolymer (PPH),
-polyolefin elastomer (POE),
-polyvinyl chloride (PVC)

Doses: 15, 35, 50 and 80 kGy

Outcomes:

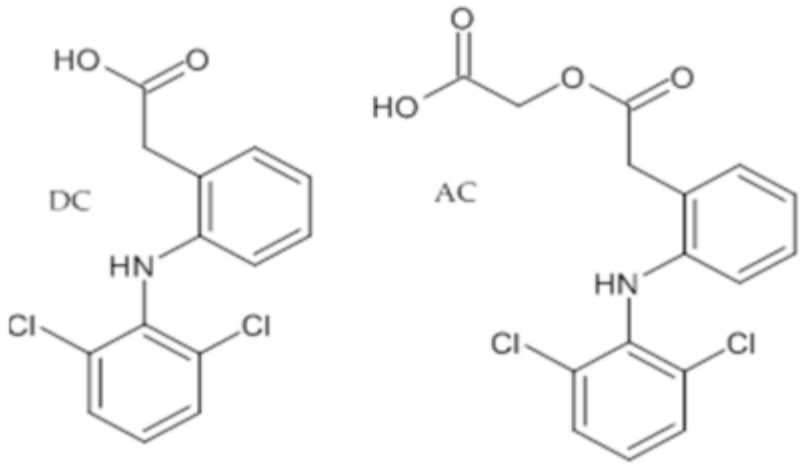
- No devices were found to fail the functional performance tests at any of the doses
- Small differences were observed in device discoloration from e-beam, X-ray and gamma radiation following processing

ELSEVIER

Radiation Physics and Chemistry
Volume 180, March 2021, 109282

Direct comparison of gamma, electron beam and X-ray irradiation effects on single-use blood collection devices with plastic components

Leonard S. Fifield [a], Matt Pharr [b], David Staack [b], Suresh D. Pillai [b c], Larry Nichols [d], James McCoy [e], Tony Faucette [e], Tucker T. Bisel [a], Min Huang [b], Md Kamrul Hasan [b], Lucas Perkins [b], Scott K. Cooley [a], Mark K. Murphy [a]



Structure of dicklofenac (DC) and aceclofenac (AC).

pharmaceutics

MDPI

Article

Electron Beam Radiation as a Safe Method for the Sterilization of Aceclofenac and Diclofenac—The Usefulness of EPR and ^{1}H-NMR Methods in Determination of Molecular Structure and Dynamics

Marcin Janiaczyk [1,2], Anna Jelińska [1], Aneta Woźniak-Braszak [3], Paweł Bilski [4], Maria Popielarz-Brzezińska [1], Magdalena Wachowiak [3], Mikołaj Baranowski [3], Szymon Tomczak [1] and Magdalena Ogrodowczyk [1,*]

Doses: 25-400 kGy EB
Dry

- No change in the physicochemical properties
- Slight color change
- No changes in composition
- Change in the structure above dose of 100 kGy

Products: three different FFRs

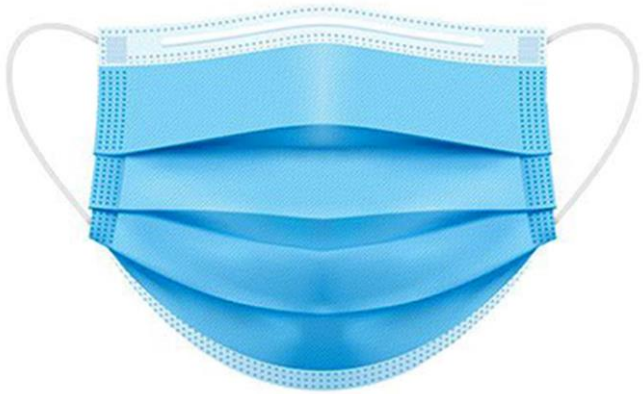
Doses: 12 and 25 kGy (EB)

Outcomes:
- Mechanical properties and wettability of the irradiated PP fabrics composed of all studied FFRs did not change
- a significant change in thermal stability of all FFRs is observed
- the decrease in filtration efficiency after irradiation of all respirators results from the elimination of the electric charge from the PP fibers in the irradiation process

NUKLEONIKA 2022;67(2):23–33
doi: 10.2478/nuka-2022-0002
ORIGINAL PAPER
sciendo

Effect of electron beam irradiation on filtering facepiece respirators integrity and filtering efficiency

Dagmara Chmielewska,
Łukasz Werner,
Urszula Gryczka,
Wojciech Migdał



- More than 40 percent of all single-use medical devices produced worldwide are sterilized with ionizing irradiation
- Well developed application -standards and guidances avaiable
- …but there are still challenging products


Thank you
for your attention