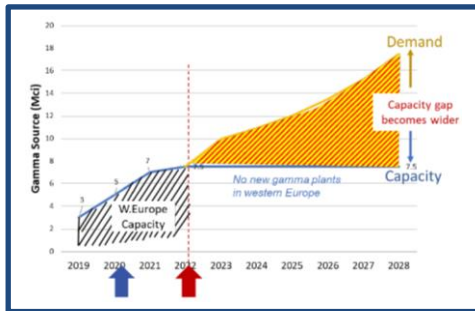


De-risk Single-Use Supplies with X-ray Sterilization Method in Addition to Gamma

Dr. Mathias Siebner, Product Specialist Separation Technology



Sterilization of single-use products?



Clear supply tensions by 2022

Picture: BPSA webinar 2nd September, 2020 & BPSA white paper



Sterilization market size:
\$6.9B by 2021,
at a CAGR of 8.8%

- 60Co complex, regulated supply chain
- 3+ yrs production in nuclear reactors
- T1/2 = 5.3 yrs → Replace 12%/yr
- Increasing demand – highly concentrated
- Regulators pushing for alternatives
- Costly, 24/7 utilization → demand inflexibility



Gamma-irradiation market strained and susceptible to risk



Bottle neck identified – imperious need to look for alternative such as X-ray

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Alternative sterilization modality Gamma and X-ray Irradiation



Sterilization modalities by ionization:
gamma & X-rays, and electron beam

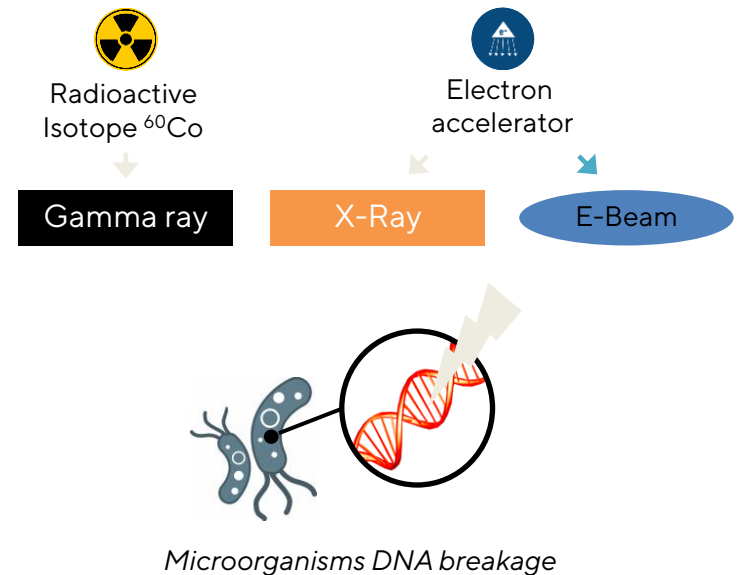


All irradiation modalities have the same goal:
obtaining sterility by disrupting the biologic
processes of micro-organisms^{a,b}



Dose is dose. 25 kGy is achieved in gamma,
X-rays & E-beam

- ^a Study from Steris: D10 values on bacteria, yeast, fungi. Vegetative forms and spores. Up to 6kGy.
- ^bTallentire, A. and Miller, A. (2015) 'Microbicidal effectiveness of X-rays used for sterilization purposes', *Radiation Physics and Chemistry*, 107, pp. 128–130.



4

Assessment of the impact of X-rays vs gamma rays

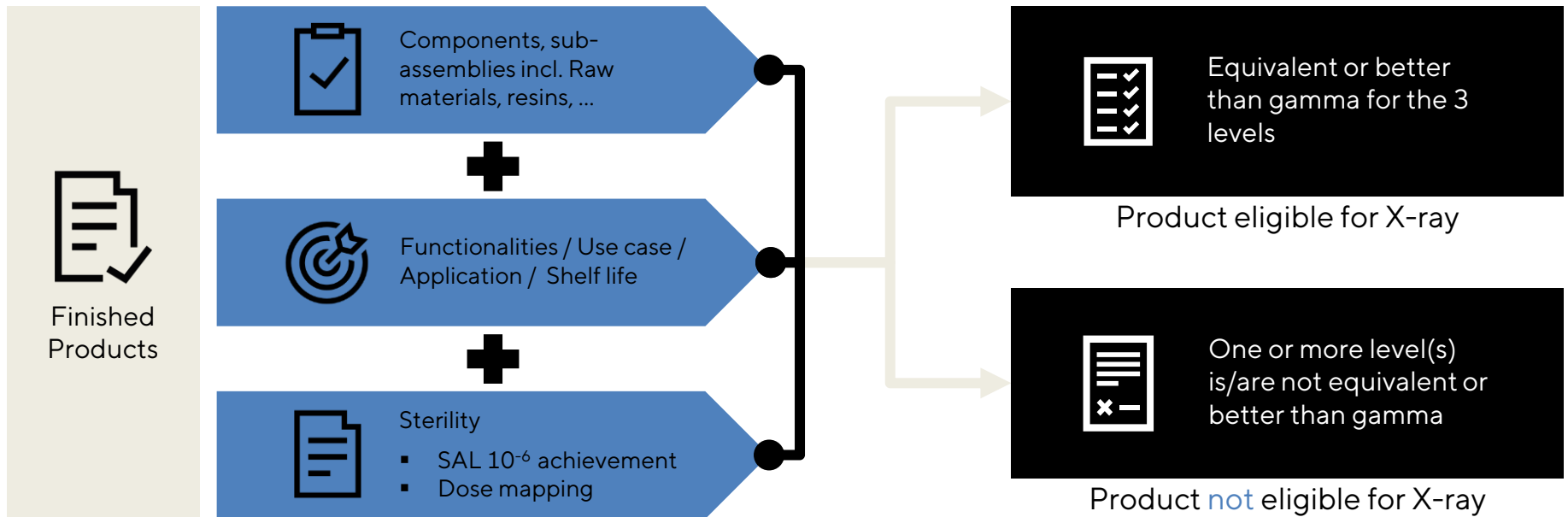


GOAL

Provide **evidence** that X-ray irradiation at the maximum dose impacts single-use materials/products in a way that is **equivalent** than gamma, through a science-based rationale

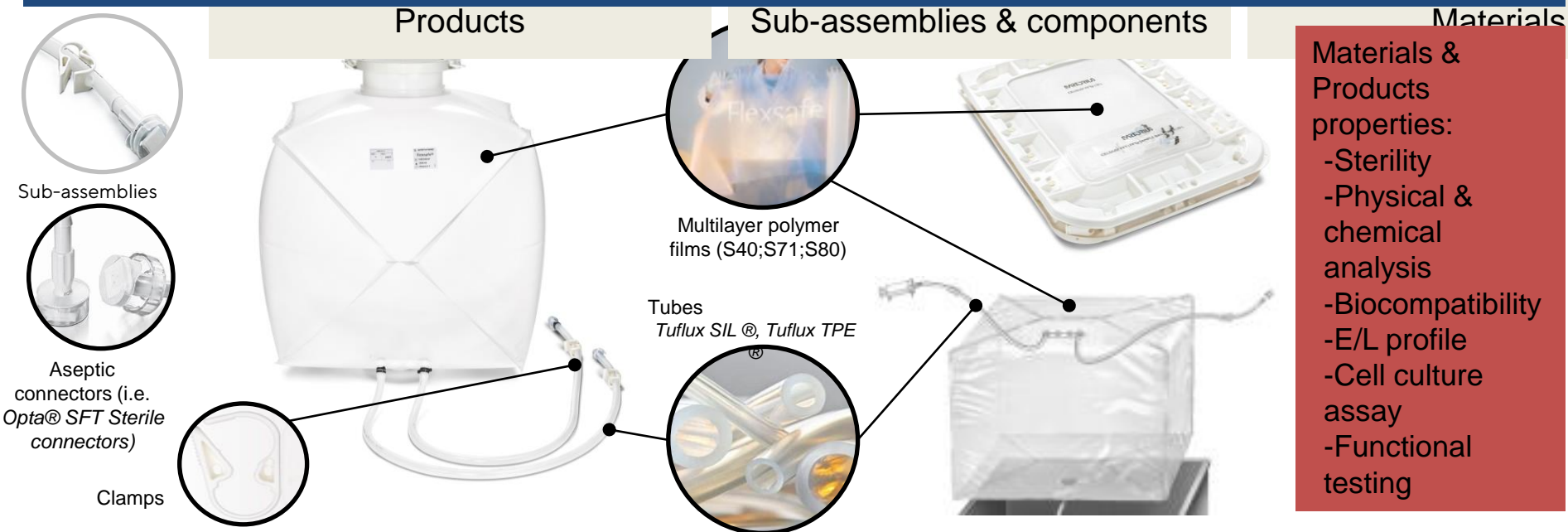
- Keep current Validation & Extractable guides concerning specifications and properties
- Keep current shelf life and sterility (e.g. SAL)
- Keep product compliance with standards & regulations

Eligibility of Products to X-ray sterilization



How to revalidate products/ sub-assemblies/ materials ?

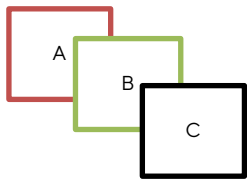
Selection of representatives acc. to stress, worse case applications, consumption, polymer resistance, etc.



Validation of sterility (ISO11137) to alternative irradiation modality

Gamma Rays

Product Family Definition



Initial Validation SAL 10^{-6}

Bioburden on 3 batches of 10 units

Define experiment dose SAL 10^{-1}

Sterility test on 10 units

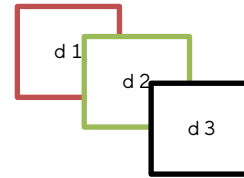
Verification (Dose audit)

Bioburden on 1 batch of 10 units

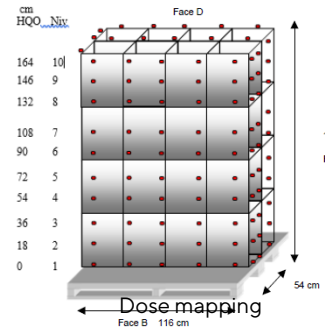
Submit to experiment dose SAL 10^{-1}

Sterility test on 10 units

Dose mapping Category Definition



Dose mapping



X Rays

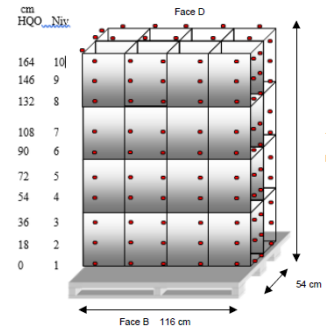
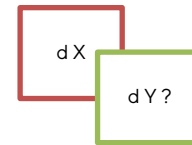
Transfer product family strategy & validation of min dose SAL 10^{-6}



Bioburden on 1 batch of 10 units

Submit to experiment dose SAL 10^{-1}

Sterility test on 10 units




Shelf life Verification



- Material level: When material testing results up to 3y are able to confirm the same evolution after gamma and X-ray, the material properties assessment can be used to extrapolate the shelf life at the component and product levels after respective functionality testing at t0 (freshly irradiated)
- The sterility check performed on representative products, together with the check of the packaging integrity after the end of the product shelf life (accelerated conditions)




Results Summary




SARTORIUS

Simplifying Progress



Executive summary report supporting the introduction of X-ray as an alternative sterilization method for Single-Use Systems.

Approach & comparison's results of the effects of gamma & X-ray irradiation.



2807981MS0400000 EUSUM / Approach Site: MUB/Effective Date: 2021-10-17

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