An Overview of Nanodosimetric Ionization Detail (ID) Terminology and Quantities

Bruce Faddegon, Eleanor A. Blakely, Lucas Burigo, Yair Censor, Ivana Dokic, Naoki Domínguez Kondo, Ramon Ortiz, Jose Ramos Mendez, Antoni Rucinski, Keith Schubert, Niklas Wahl and Reinhard Schulte, “Ionization detail parameters and cluster dose: A mathematical model for selection of nanodosimetric quantities for use in treatment planning in charged particle radiotherapy,” 2023 Phys. Med. Biol. https://doi.org/10.1088/1361-6560/acea16

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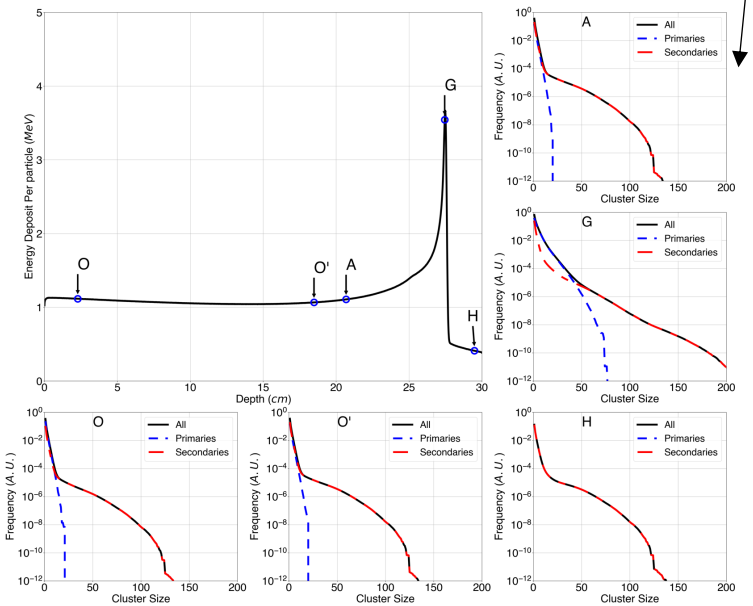
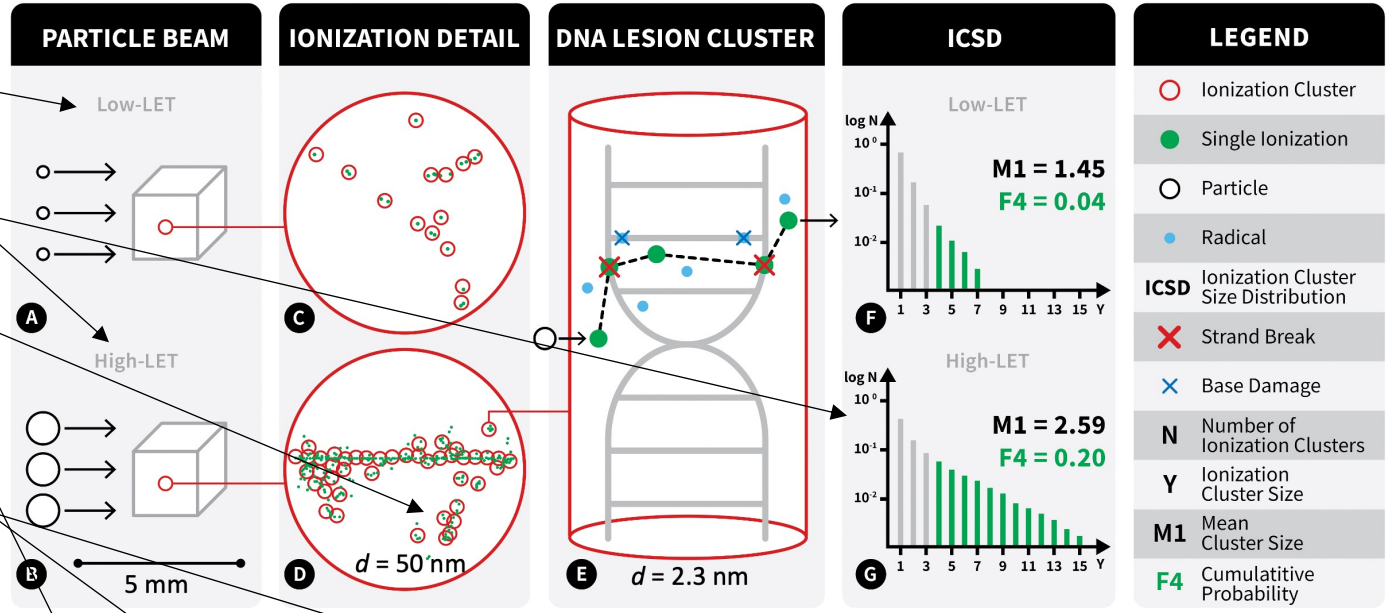
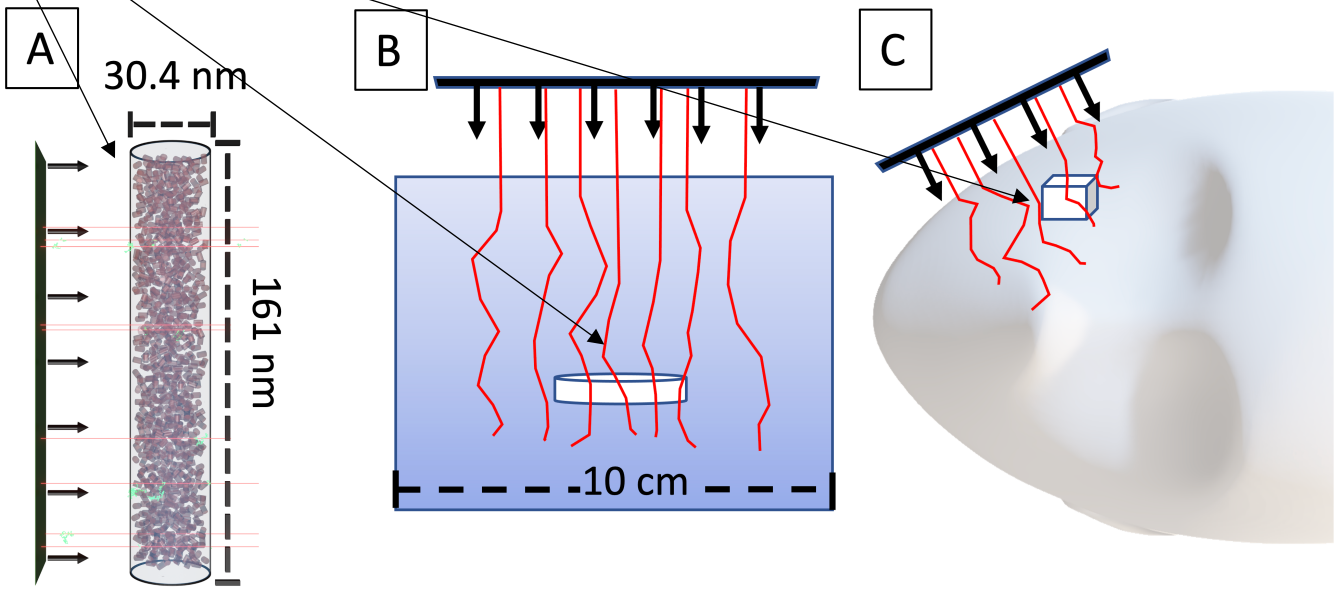
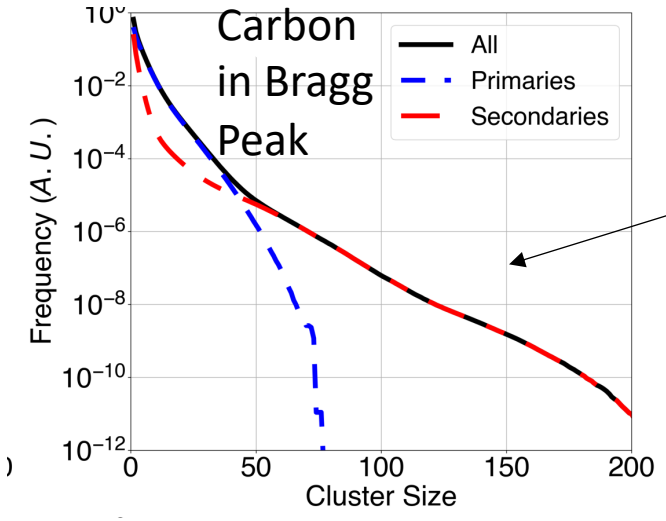
c	Particle class (particle type and energy)
$\mathscr{C}$	A set of particle classes
ν	Ionization cluster size
$f_c(\nu)$	Frequency distribution of ν for particle class c
I_p	ID parameter calculated from $f_c(\nu)$
I_p^c	ID parameter for particle class c
G_p	General operator to convert $f_c(\nu)$ to I_p
g	Cluster dose
$g_j^{(I_p)}$	Cluster dose for I_p in region j
ϕ_j	Fluence in region j
ϕ_j^c	Fluence of particles of class c in region j
$\mathscr{F}_j(\nu)$	Track-length weighted frequency distribution in voxel j

Table 1: Key symbols used in the mathematical model.









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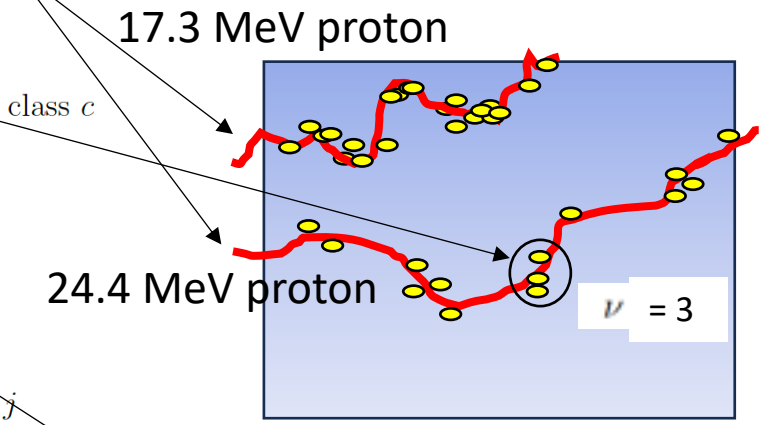
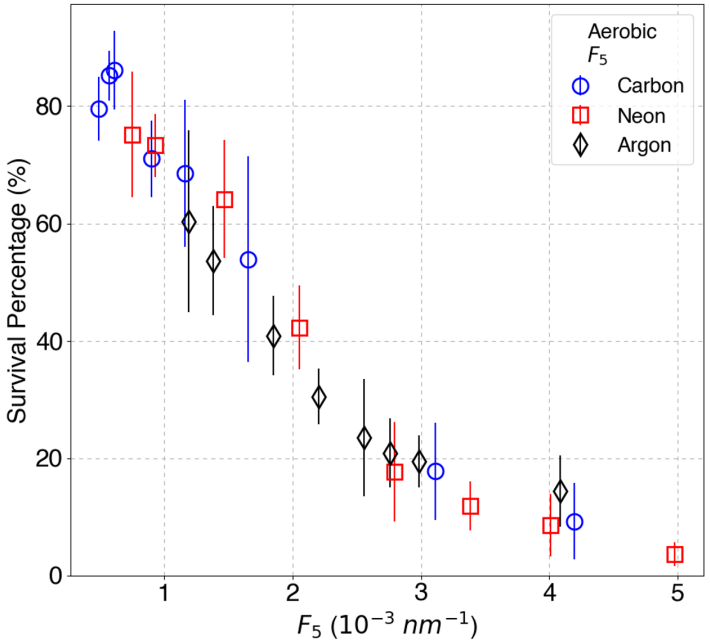


$$\{I_p^c \mid c \in \mathscr{C}\} = \{G_p[f^c] \mid c \in \mathscr{C}\}.$$



$$F_k^c := \sum_{\nu=k}^{\nu_{max}} f^c(\nu).$$

$$g_j^{(I_p)} := \frac{1}{m_j} \sum_{c \in \mathscr{C}_j} \frac{\rho_j}{\rho_0} t_j^c I_p^c = \frac{1}{\rho_0 V_j} \sum_{c \in \mathscr{C}_j} t_j^c I_p^c,$$

$$g_j^{(F_k)} = \frac{1}{\rho_0 V_j} \sum_{c \in \mathscr{C}_j} t_j^c F_k^c.$$