INVESTIGATING WATER RADIOLYSIS WITH MONTE CARLO ALGORITHMS FOR FLASH DELIVERY OF PROTON MINI- AND MICRO-BEAMS

Miguel Molina-Hernández (LIP, DKFZ)

Supervisors:
– Patricia Gonçalves (LIP)
– João Seco (DKFZ)
– Yuyie Chi (UTA)

LABORATÓRIO DE INSTRUMENTAÇÃO
E FÍSICA EXPERIMENTAL DE PARTÍCULAS

DEUTSCHES
KREBSFORSCHUNGSZENTRUM
IN DER HELMHOLTZ-GEMEINSCHAFT

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Layout

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- State of the art: Mini–Beam and Micro–Beam

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- Future Work and Outlook

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Mini–Beam and Micro–Beam

- Reported tumor control and reduction of side effects
- Alternation of high and low dose peaks valleys

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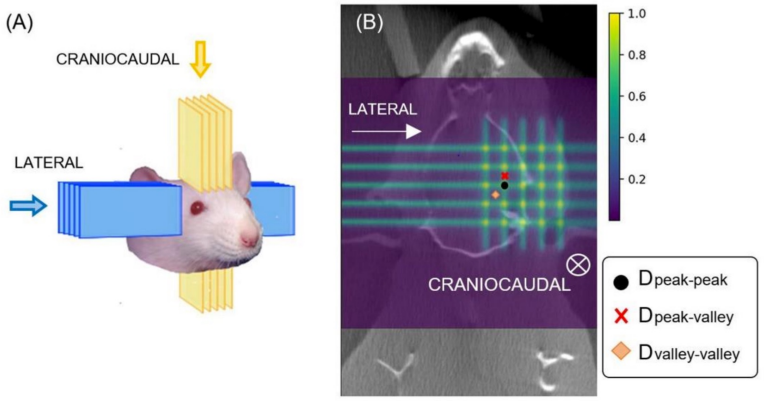

Source: Bertho et al. 2021

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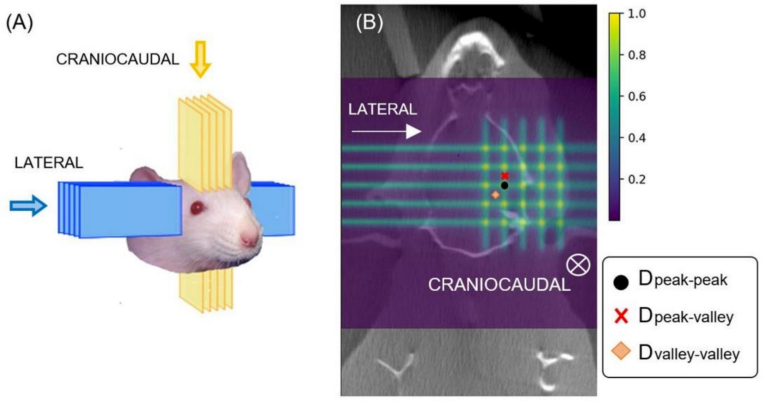

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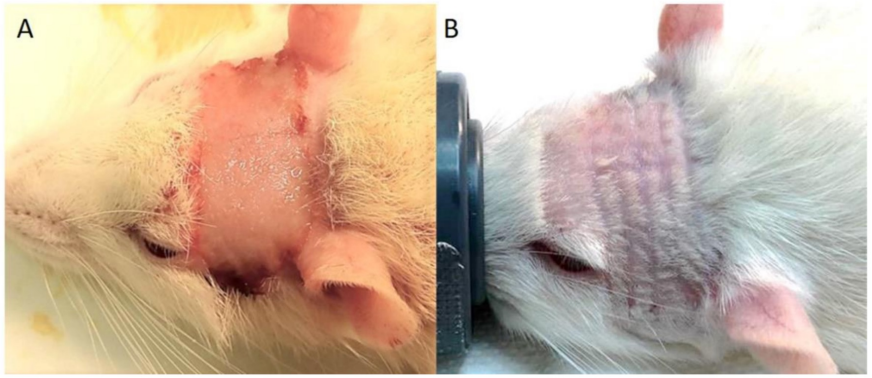

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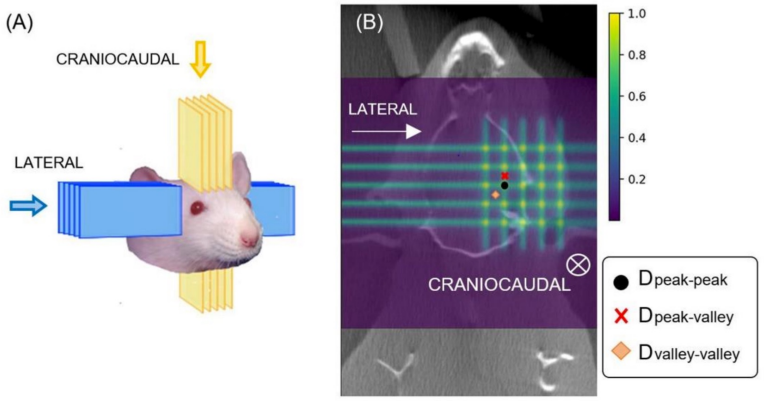
- Alternation of high and low dose peaks valleys
- Chemical and biochemical trigger under research: Dal Bello et al. 2020 proposal



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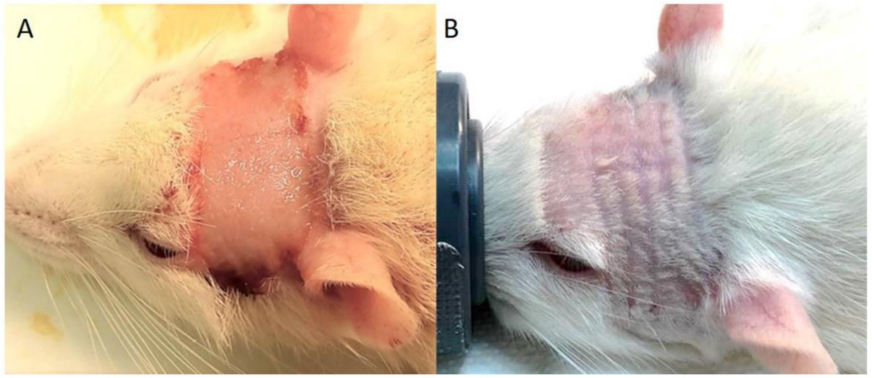

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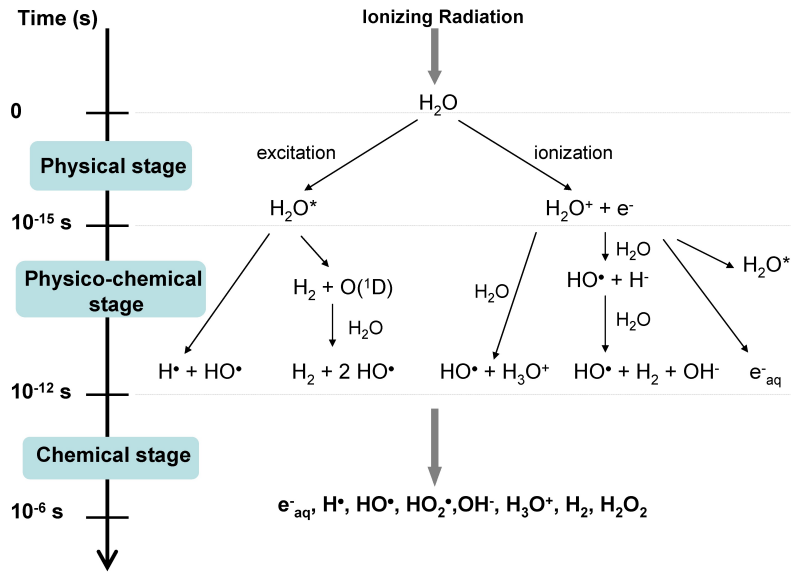

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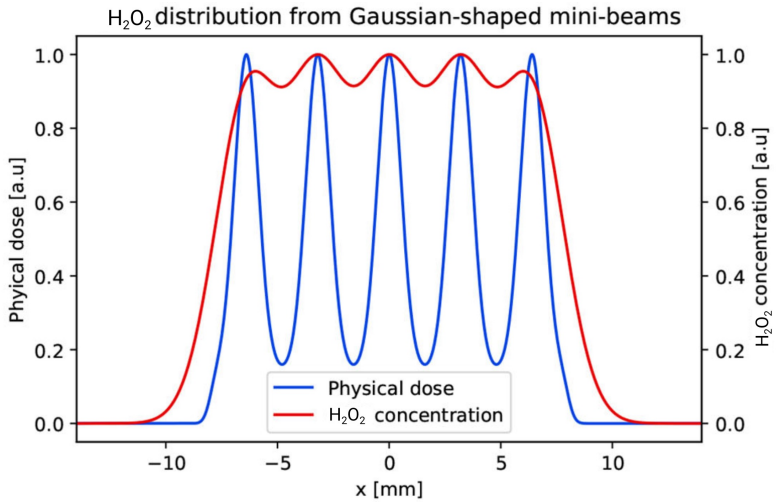

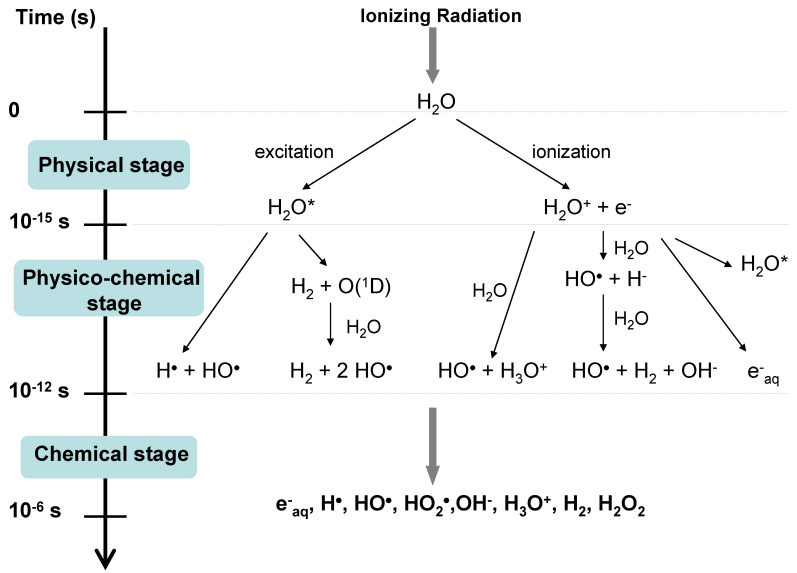

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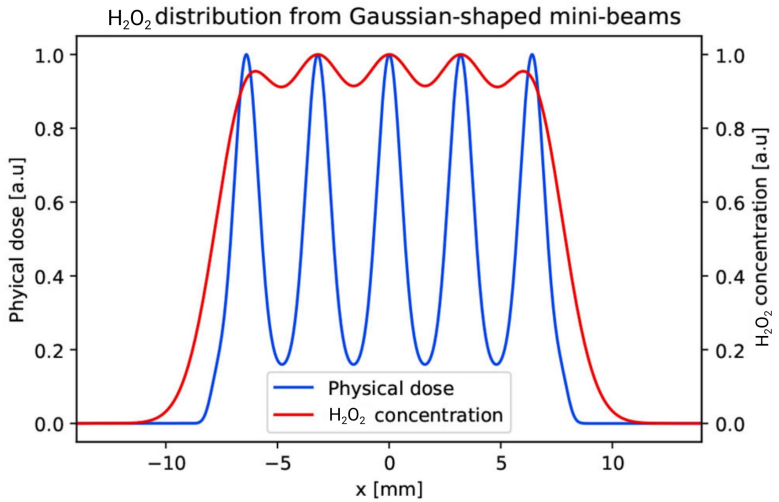

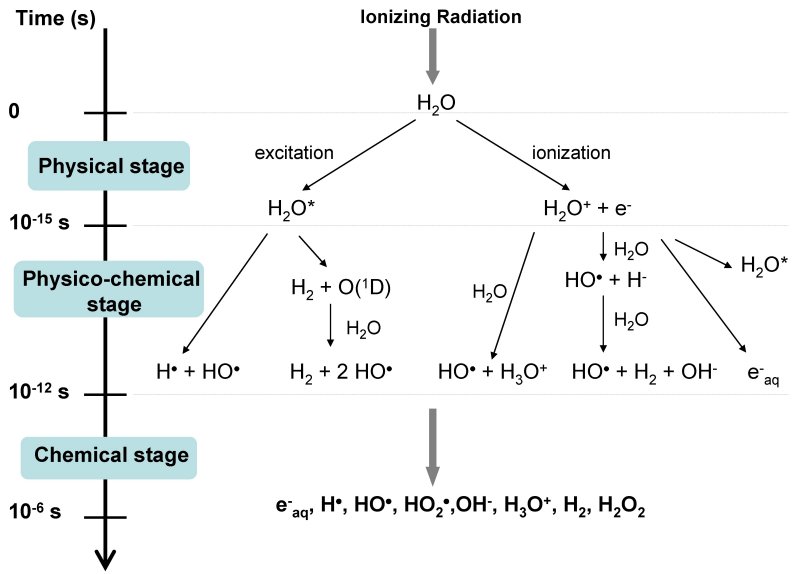

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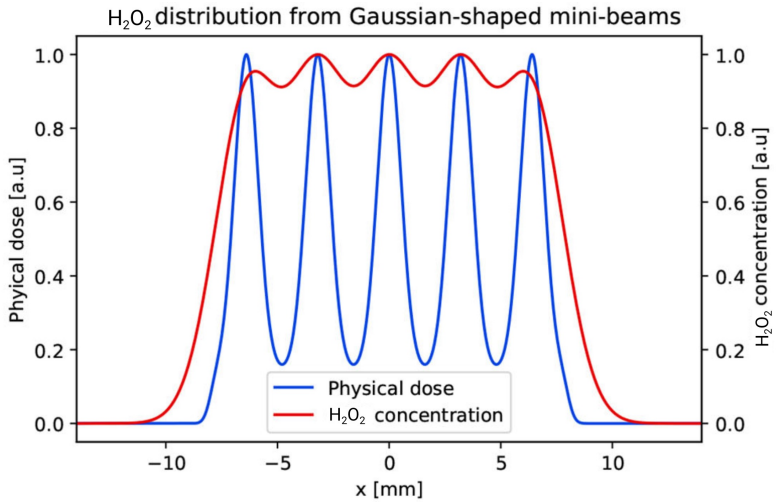
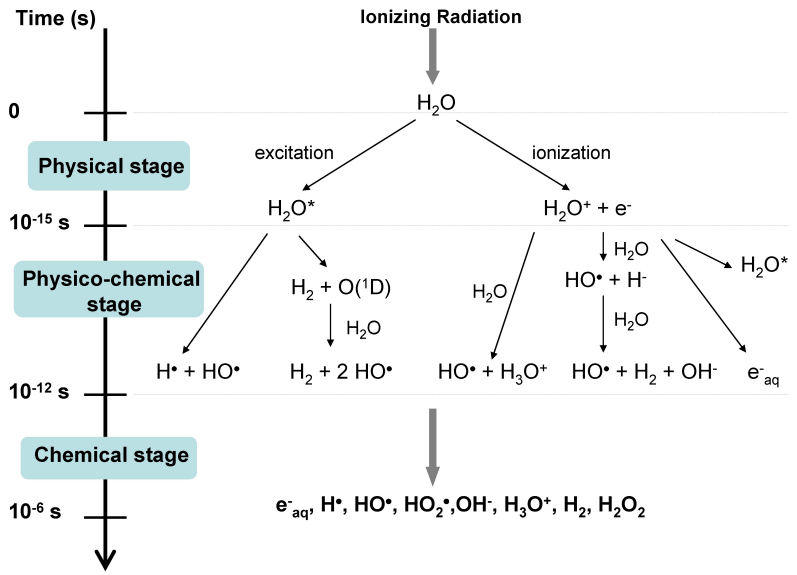
- Tumor coverage time comparison with animal experiments





$$\hat{t} = \begin{cases} 2120 \pm 240 \text{ s} & \text{for Prezado et al. [8]} \\ 13.9 \pm 1.5 \text{ s} & \text{for Dombrowsky et al. [6]} \\ 3.5 \pm 0.4 \text{ s} & \text{for 200* in Regnard et al. [9]} \\ 0.70 \pm 0.08 \text{ s} & \text{for 100LR in Regnard et al. [9]} \end{cases}$$

$$t_{exp} = \begin{cases} 2100 \text{ s} & \text{for Prezado et al. [8]} \\ 300 \text{ s} & \text{for Dombrowsky et al. [6]} \\ 1 \text{ s} & \text{for Regnard et al. [9]} \end{cases}$$

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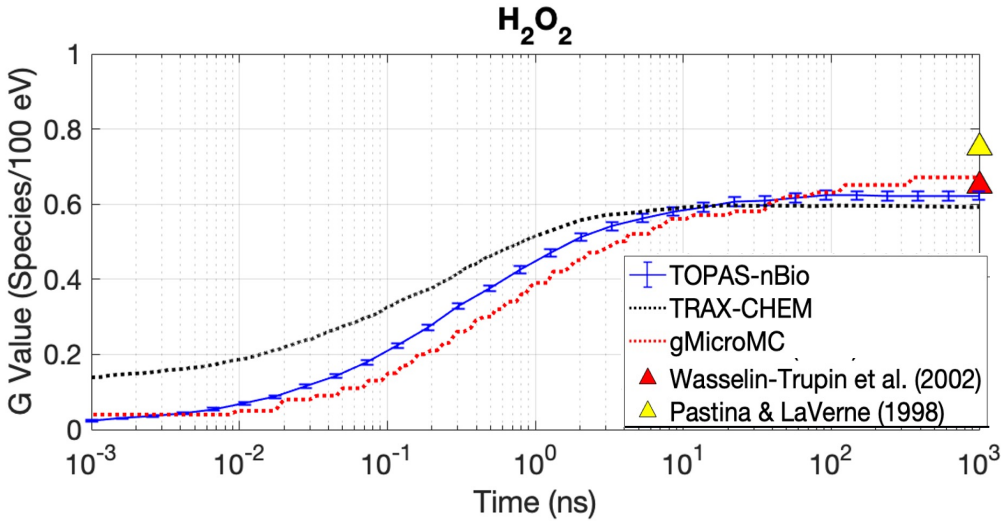
TOPAS-nBio

- G Value : Calibration



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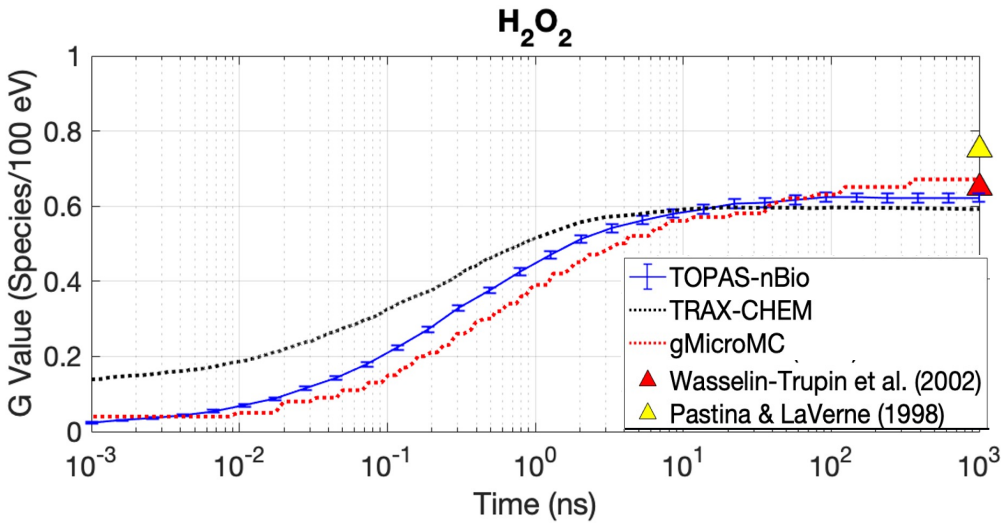
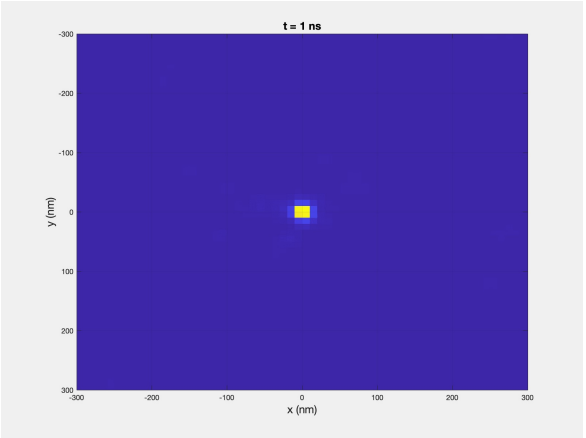
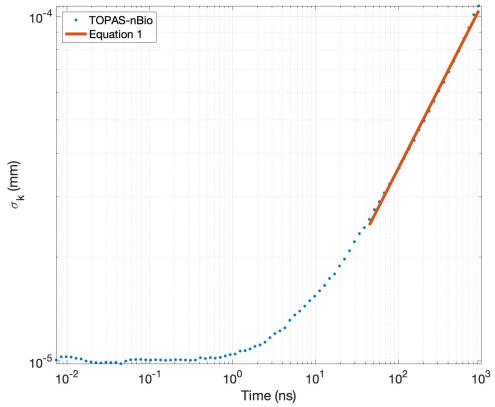


- pTuple: H_2O_2 Diffussion





- $\sigma_k(t) = a \cdot (t/t_0)^b$

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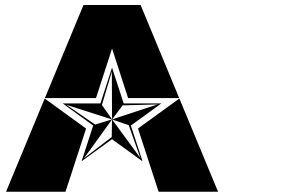
gMicroMC

- GPU-based



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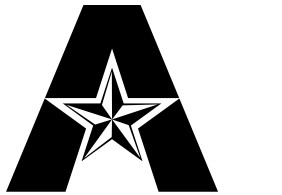
gMicroMC

- GPU-based
  - Speed up factor of 1228!!



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Source: Lai et al. 2021

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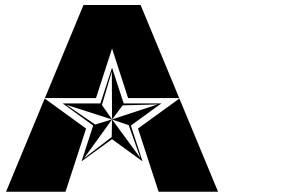
gMicroMC

- GPU-based
  - Speed up factor of 1228!!
  - High computational power
  - Dose rate
  - Oxygen concentration



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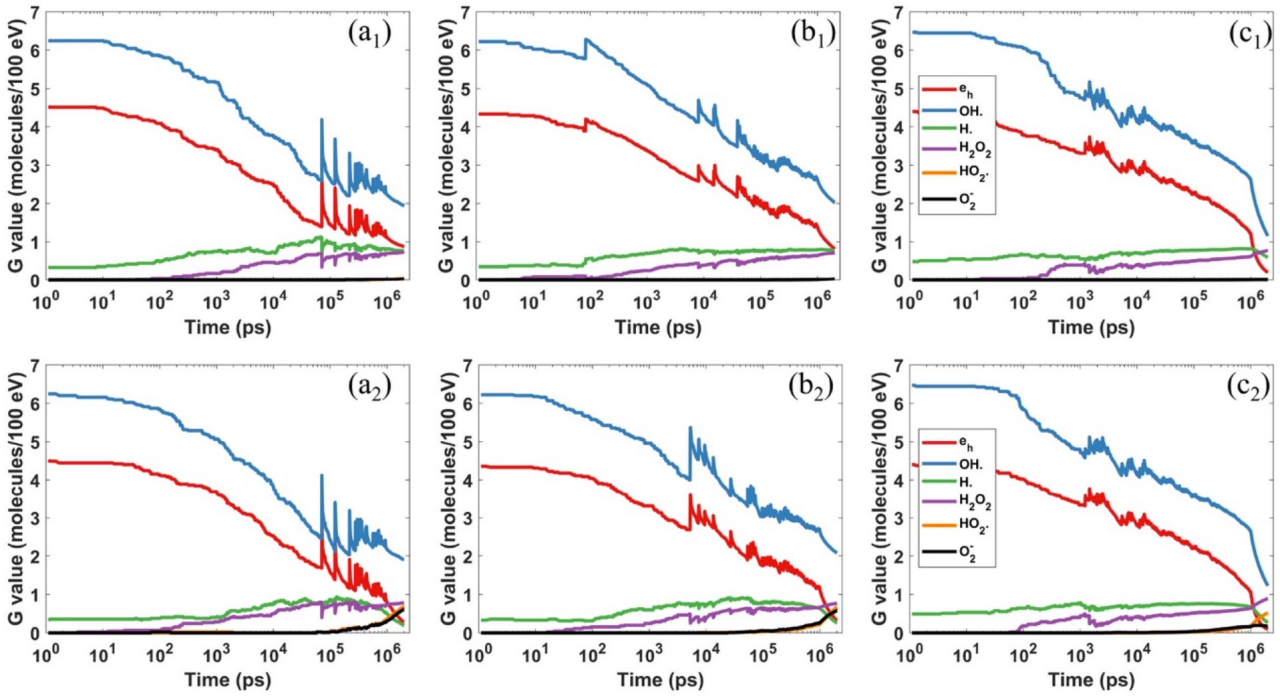

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Future Work and Oulook

- Train on gMicroMC, Geant4 & TOPAS-nBio
- Tracking of H_2O_2 under different conditions:
  - Dose rates
  - Oxygen conditions
  - Primaries
  - Beam energies

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