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A Computational Model for Radiotherapy Studies with Proton and Carbon ion Mini-Beams

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IST

OBJECTIVES

Study of TOPAS and TOPAS-nBIO

Study of the effects of the radiation in the cells

Study of the radiolysis products

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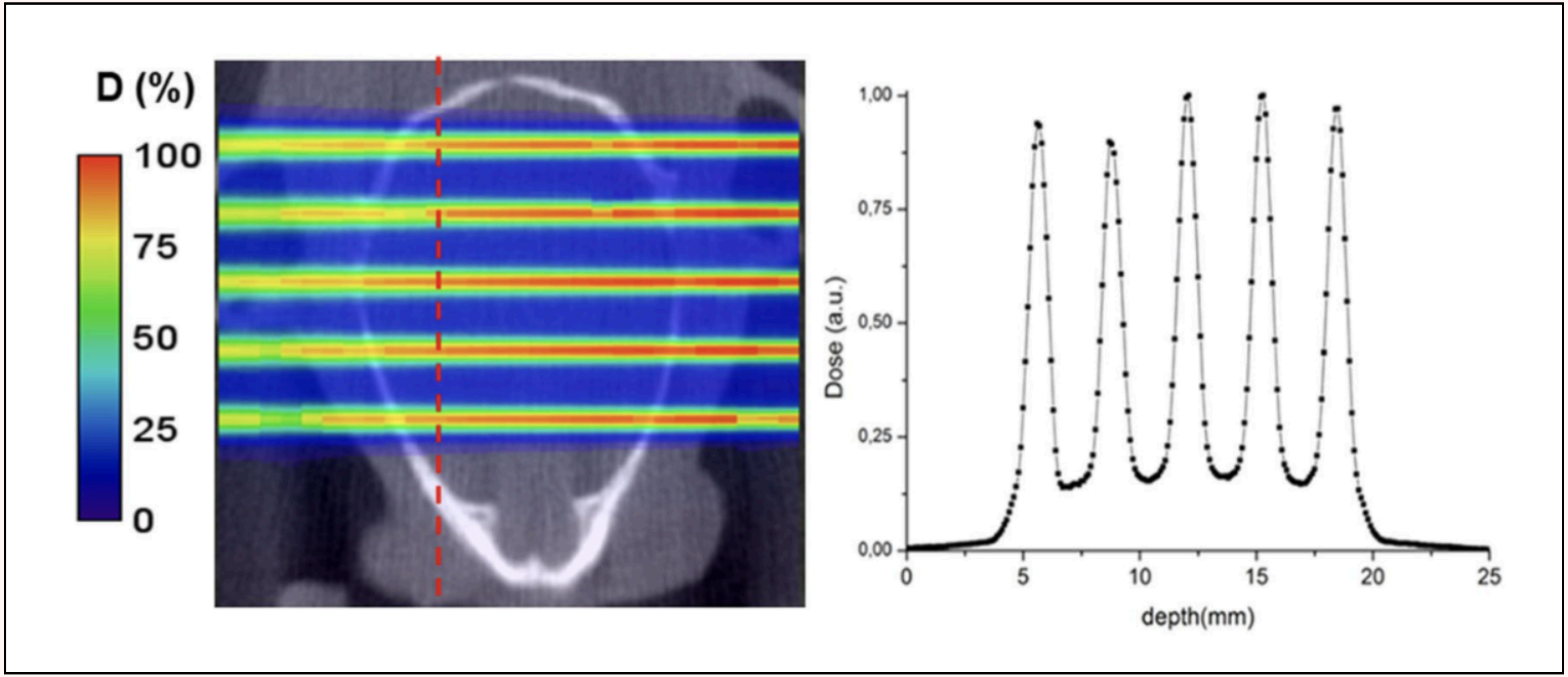
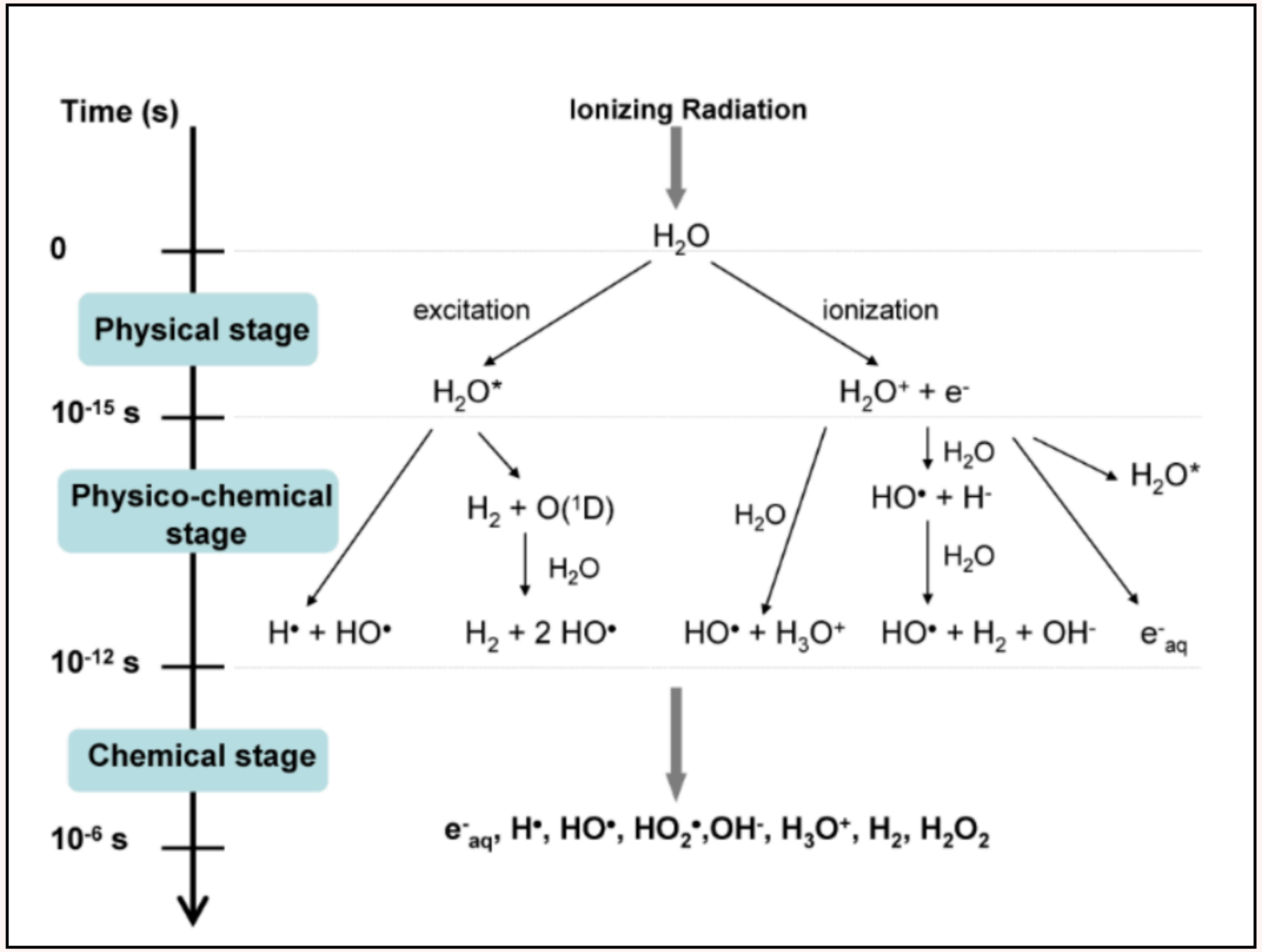
MINI-BEAMS



MINI-BEAMS



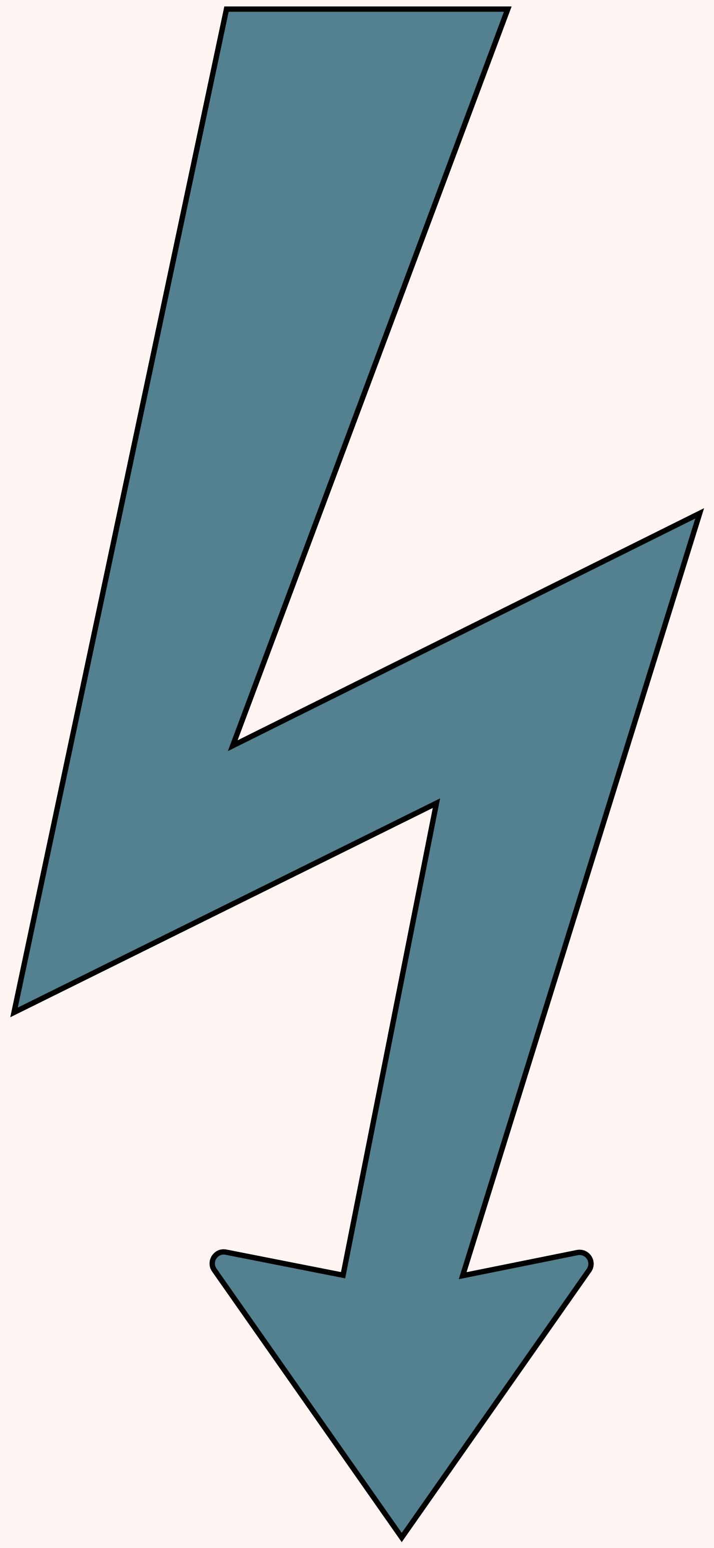
- **Ricardo Dal Bello et al:**
  - **The tumor control is not done directly by radiation;**
  - **Tumor control due to the diffusion of the radiolysis products;**
  - H_2O_2 **responsible for tumor control**

STUDIES OF WATER RADIOLYSIS

- **Dose Calibration: using TOPAS**

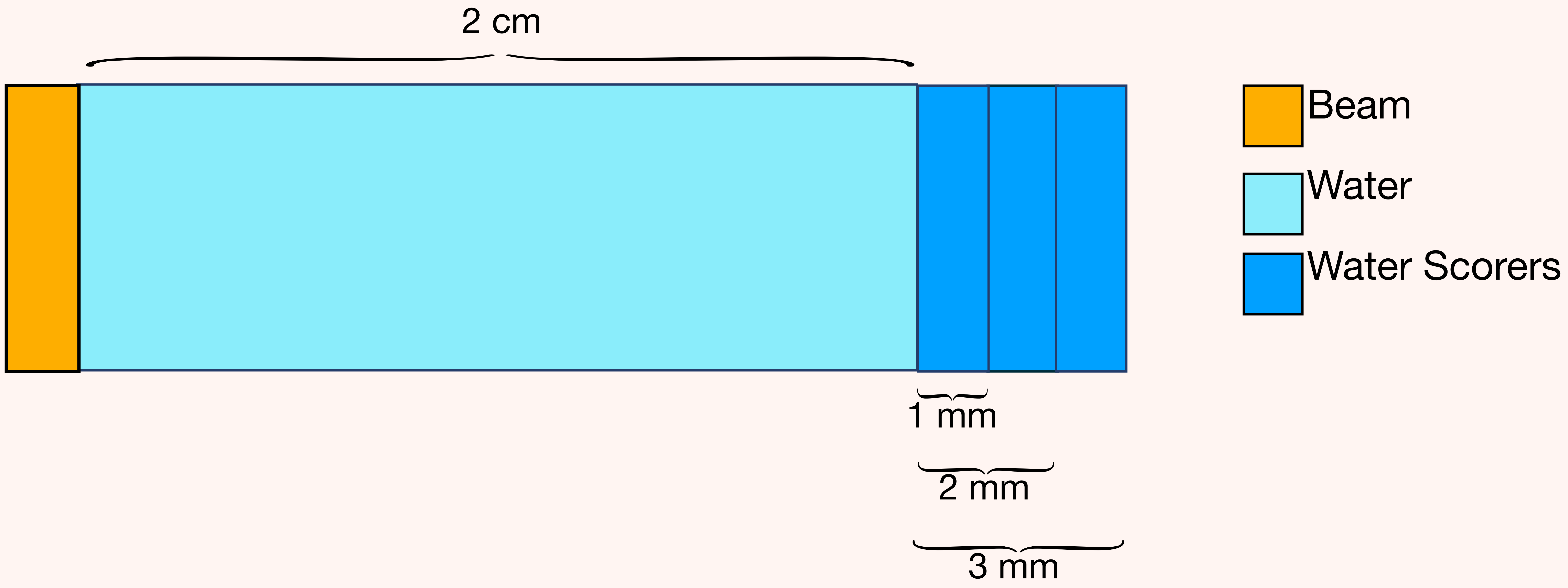
- **Water Radiolysis products behavior analysis: using TOPAS-nBio**

BEAM USED



- **Proton Beam: 92 MeV**
- **Carbon Ion Beam: 278 MeV**

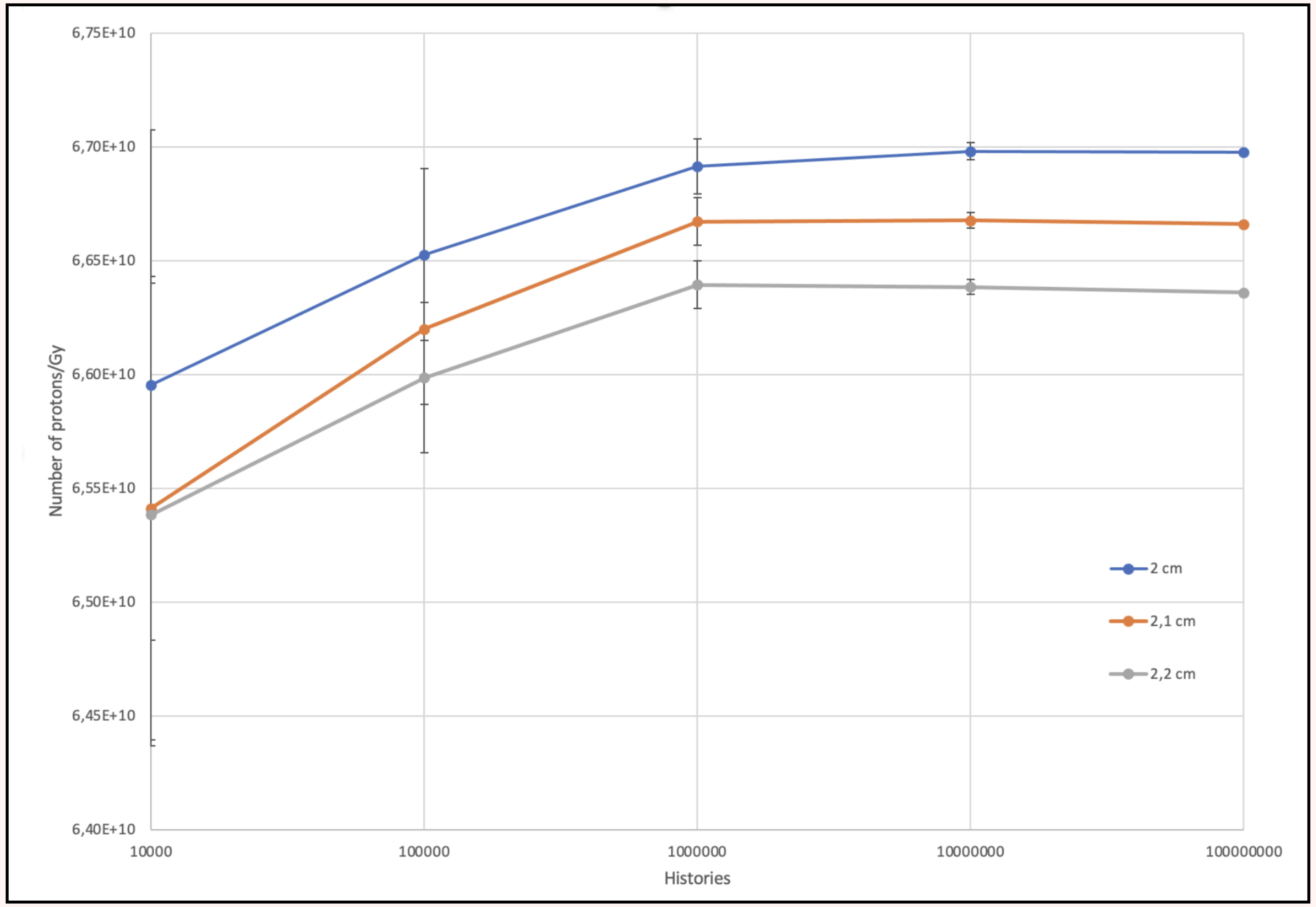
DOSE CALIBRATION



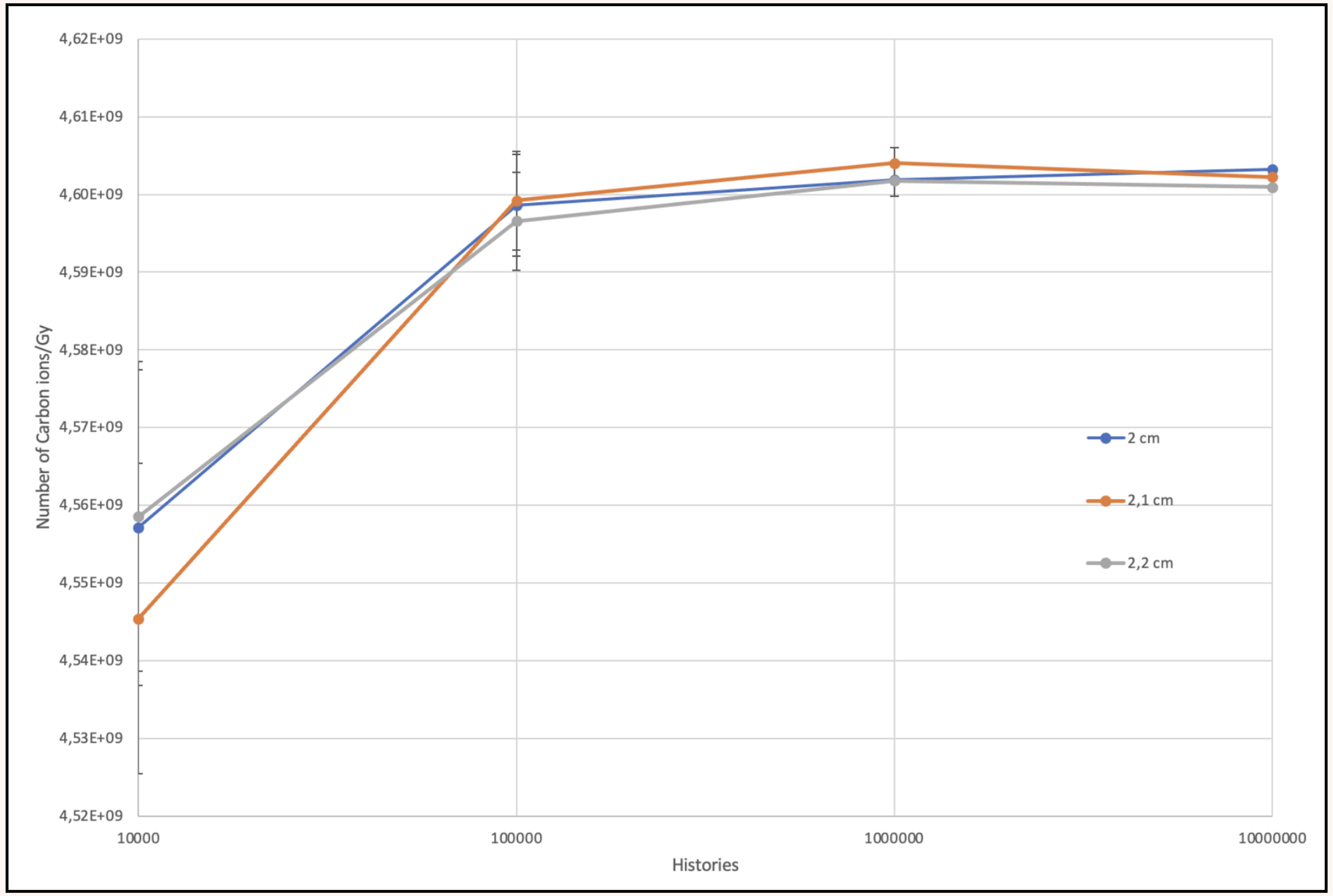
DOSE CALIBRATION

- The purpose is to obtain the number of particles of a certain energy necessary to delivery a certain dose in TOPAS.

DOSE CALIBRATION



Proton Beam



Carbon Ion Beam

WATER RADIOLYSIS PRODUCTS BEHAVIOR ANALYSES

- The main goal of this work was to study the effects of radiation in the cells in order to better understand the processes underlying mini-beams.
- Two different studies:
  - G-value temporal evolution
  - Diffusion of H_2O_2

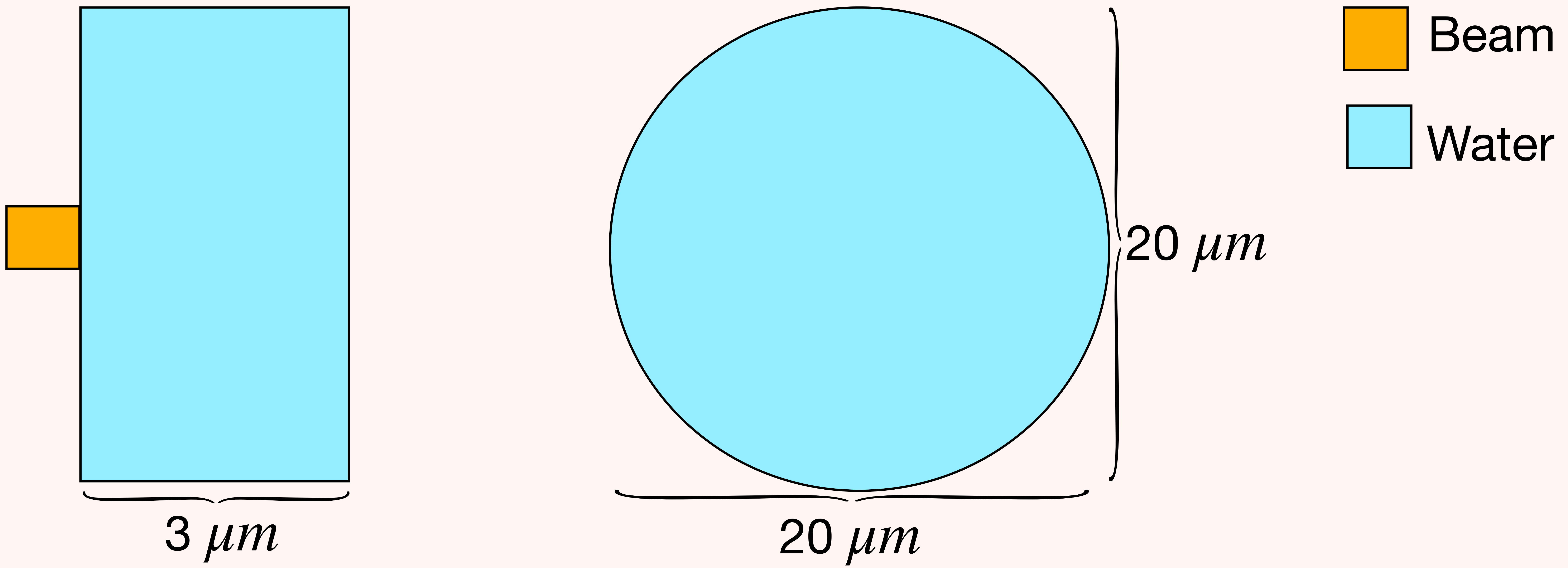
WATER RADIOLYSIS PRODUCTS BEHAVIOR ANALYSES

- **Chemical list used: "TsEmDNAChemistryExtended"**

- **Simulation done using a system of Seeds:**

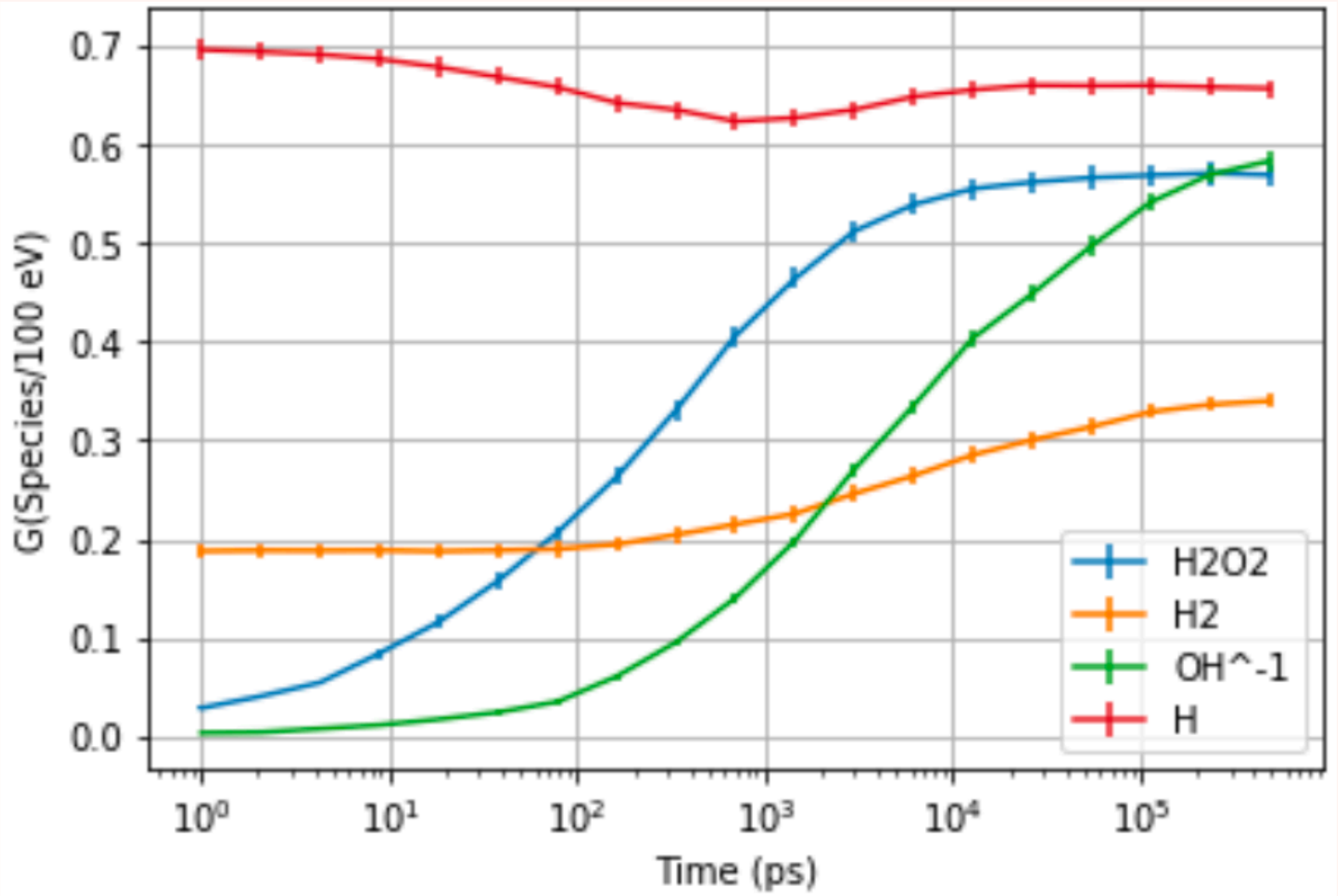
$$\overline{Y} = \frac{\sum_i^n \frac{Y_i}{(\Delta Y_i)^2}}{\sum_i^n \frac{1}{(\Delta Y_i)^2}} \pm \frac{1}{\sqrt{\sum_i^n \frac{1}{(\Delta Y_i)^2}}}$$

WATER RADIOLYSIS PRODUCTS BEHAVIOR ANALYSES

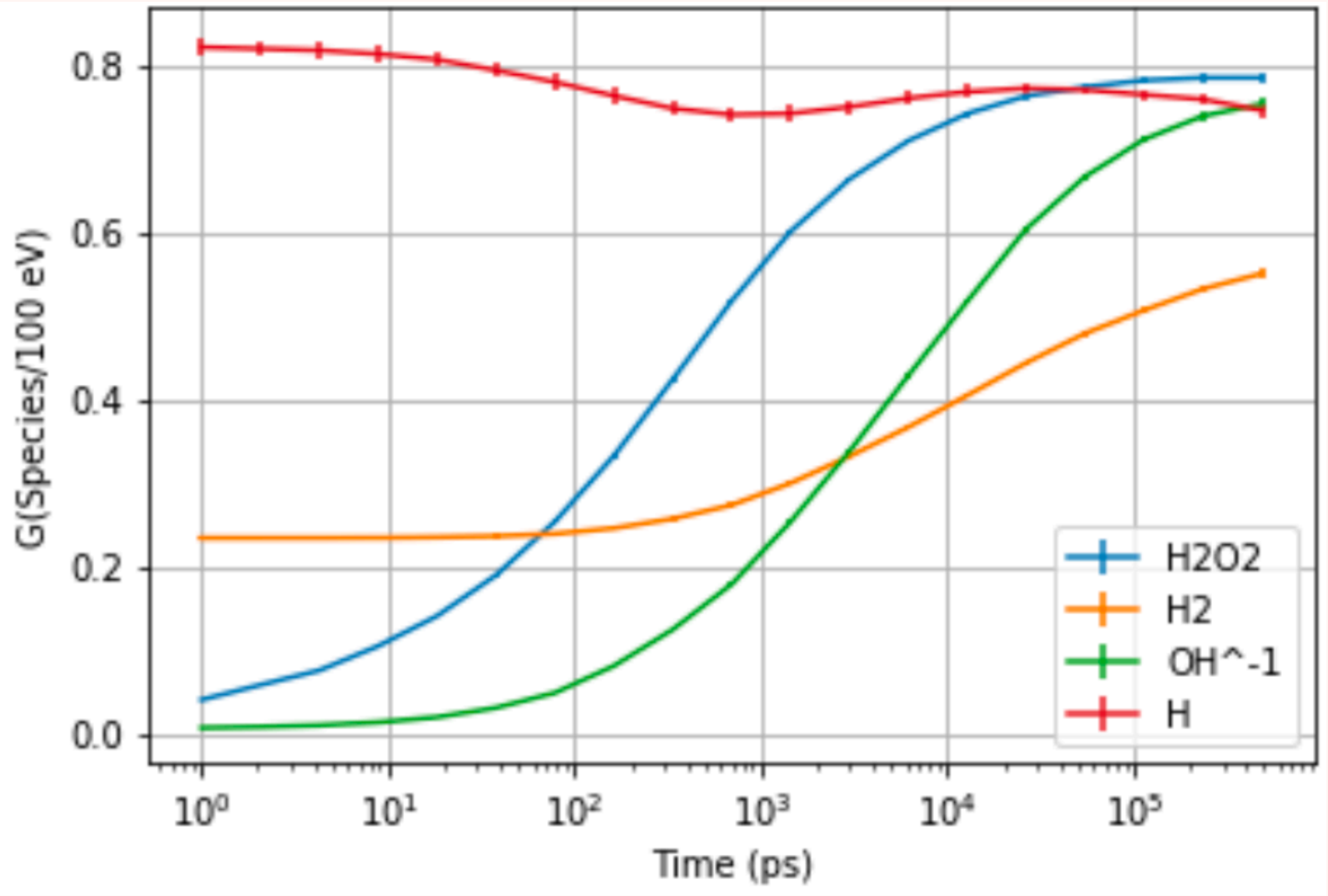


WATER RADIOLYSIS PRODUCTS BEHAVIOR ANALYSES

G-value Evolution:



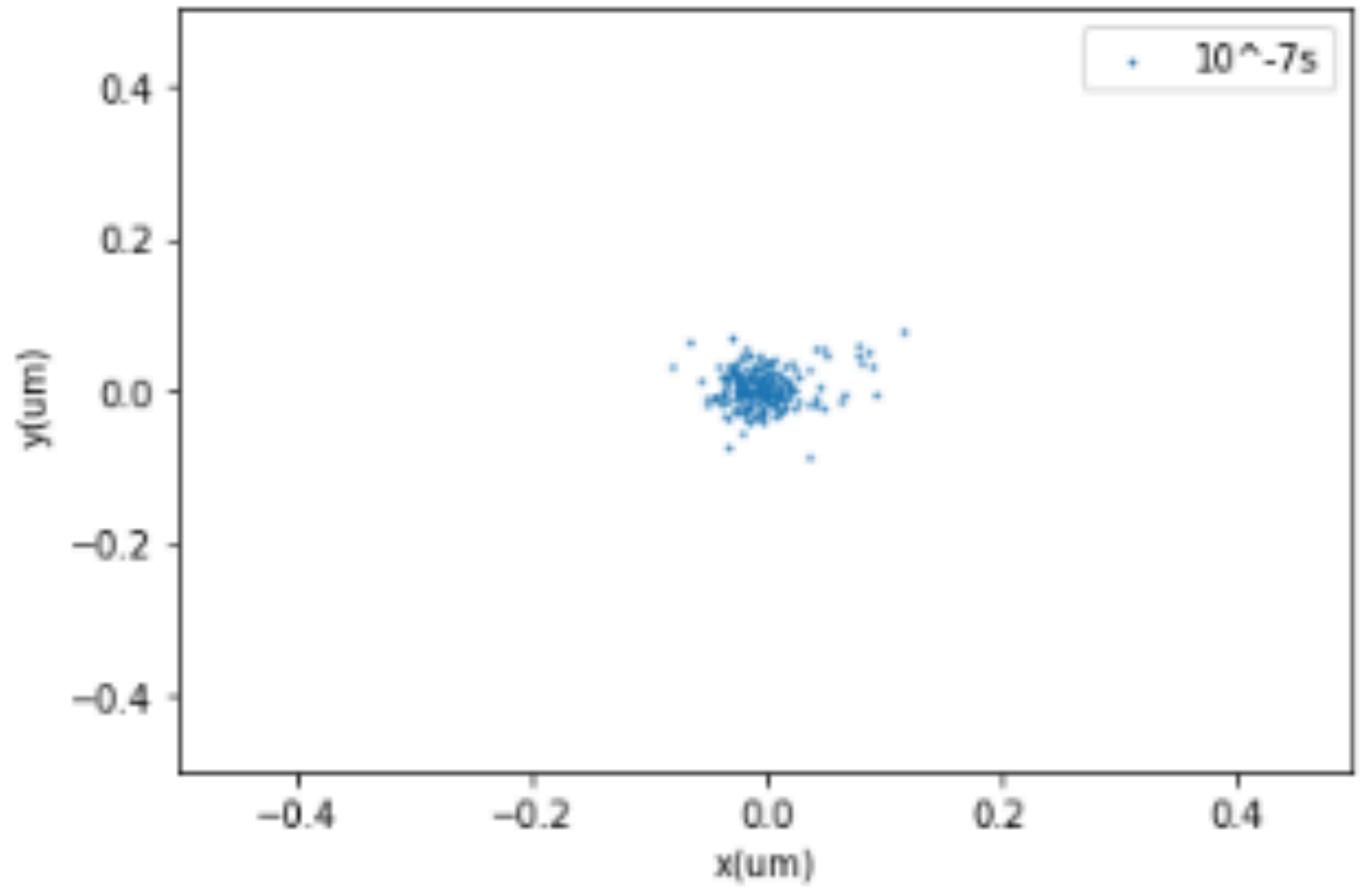
Proton Beam

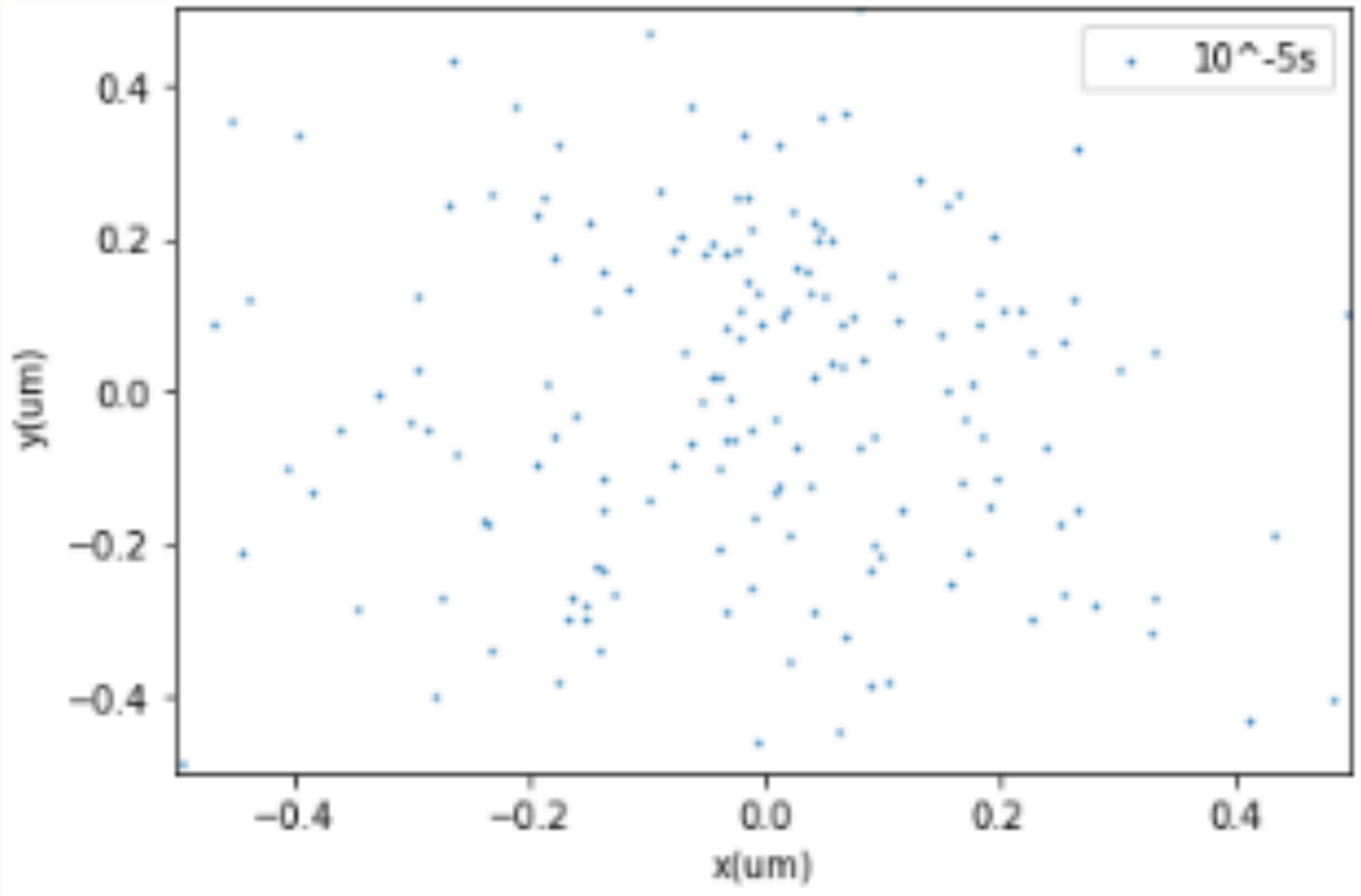


Carbon Ion Beam

WATER RADIOLYSIS PRODUCTS BEHAVIOR ANALYSES

Diffusion:





CONCLUSION

Dose Calibration	For a proton beam of 92 MeV the minimum number protons is 6.6×10^{10} to obtained a stable dose and for a carbon ion beam with an energy of 278 MeV is 4.6×10^{9}
G-Value study	Both H_2 and H_2O_2 reach a steady state. Only the second one can cause damage to the cell and be responsible for tumor control.
Diffusion study	At 10^{-5} s, for both proton and carbon ion beam, the H_2O_2 was widespread through all the area of the target.

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