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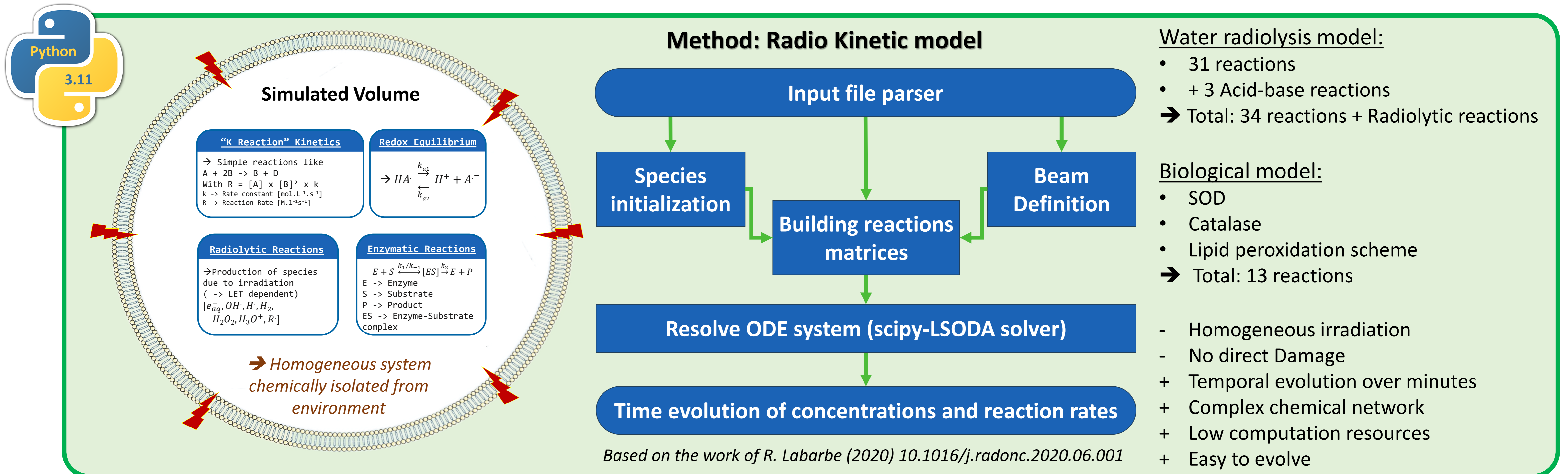
# Do Pure Water-Radiolysis Experiments Truly Unlock the Secrets of the FLASH Effect? A Numerical Revelation

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## Background and Aims

Reduced production of Reactive Oxygen Species (ROS) offers a potential explanation for the FLASH effect observed at ultra-high dose rates (UHDR). Recent studies consistently demonstrate decreased hydrogen peroxide ( $H_2O_2$ ) generation in pure water under UHDR conditions. Additionally, the nature of irradiating particles significantly influences this phenomenon. This research aims to investigate ROS formation and decay kinetics in both FLASH and conventional conditions, spanning various Linear Energy Transfer levels and particle types.



Comparison with Pure Water Radiolysis experiments: 4%  $O_2$  (Biology not activated)

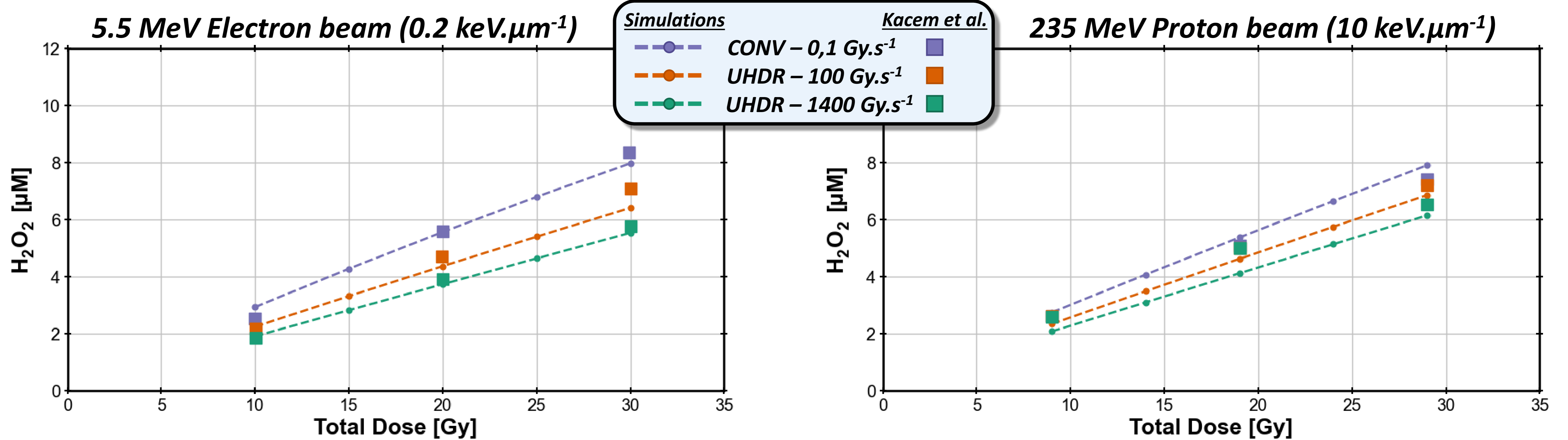


Fig.1: Concentrations of  $H_2O_2$  after irradiation, measured (squares from H. Kacem, 2022, doi:10.1016/j.radonc.2022.07.011) and simulated (dotted lines)

Biology Activated (Focus on the 20 Gy case)

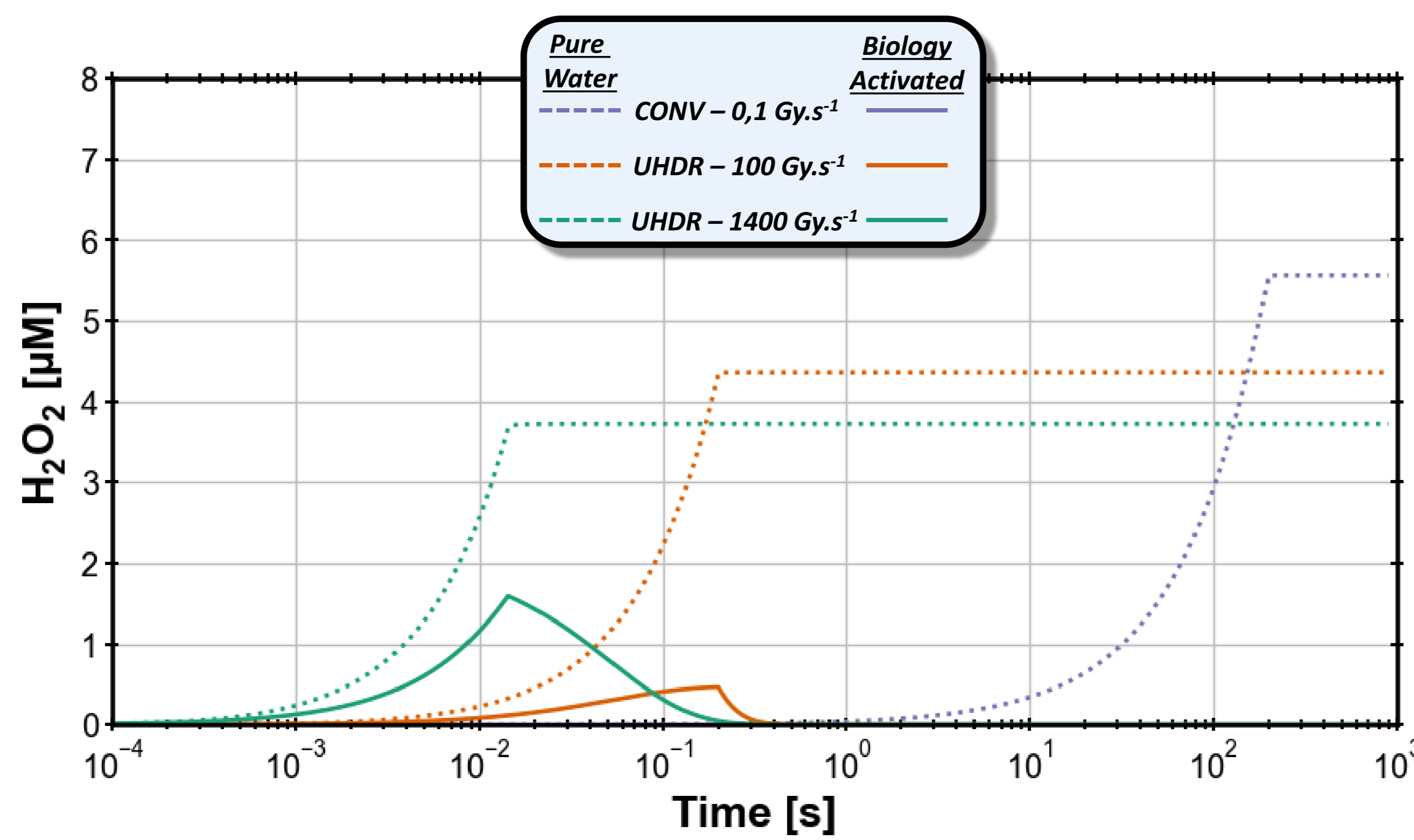


Fig.2: Time Evolution of the concentration of  $H_2O_2$

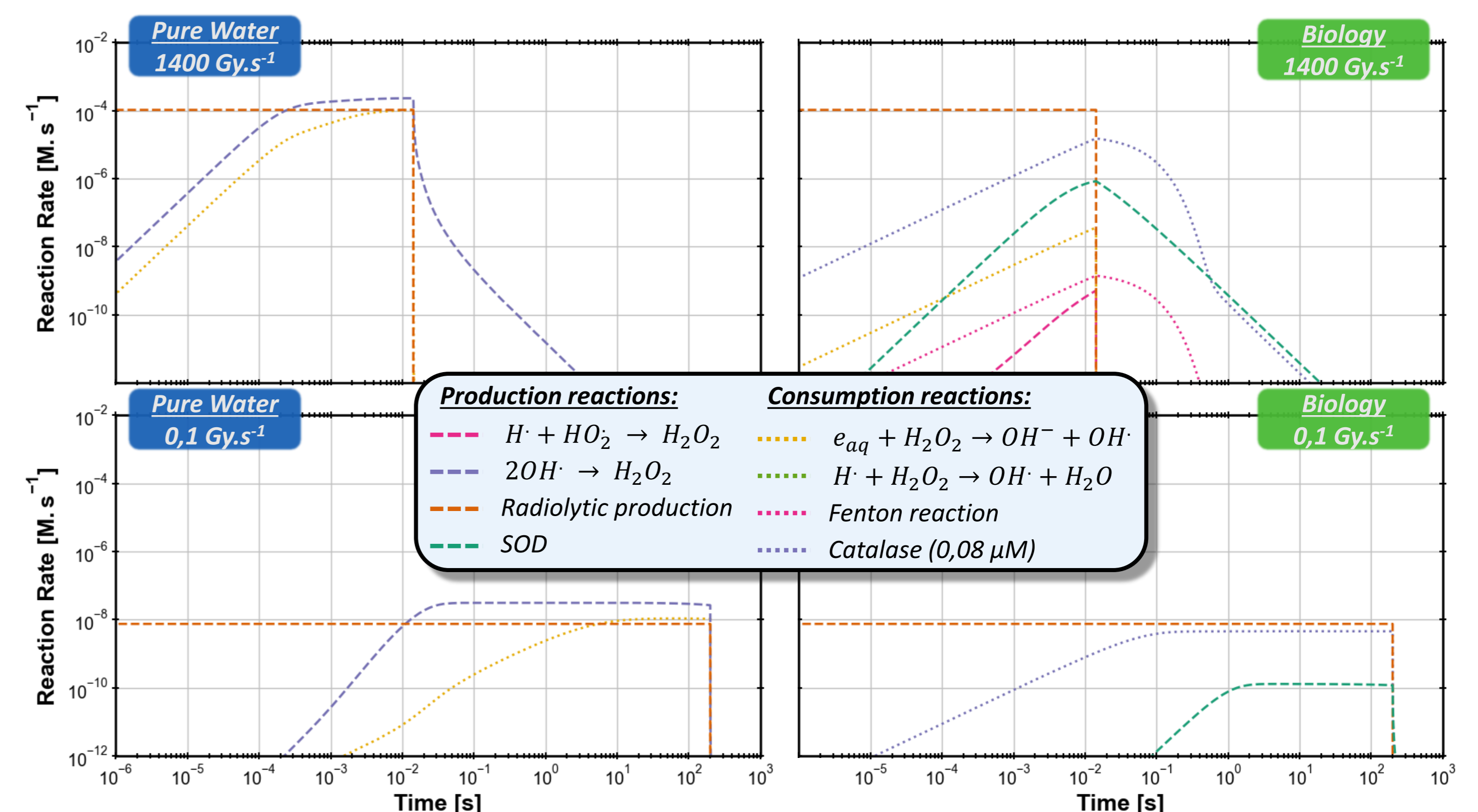


Fig.3: Time Evolution of the reaction rates of reactions involving  $H_2O_2$

## Conclusion

A distinct correlation emerges between UHDR and decreased  $H_2O_2$  levels in pure water, aligning with established experimental data. Nevertheless, the association wanes notably when enabling cellular systems, primarily due to the potent ROS scavenging abilities inherent to cells. The translational applicability of water radiolysis findings to biological contexts remains an open inquiry, carrying profound implications for our comprehension of the FLASH effect in radiotherapy.

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