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RADIOLYTIC ROS PRODUCTION MECHANISM UNDER PROTON FLASH CONDITIONS : COMBINATION OF EXPERIMENTAL AND SIMULATION INVESTIGATION

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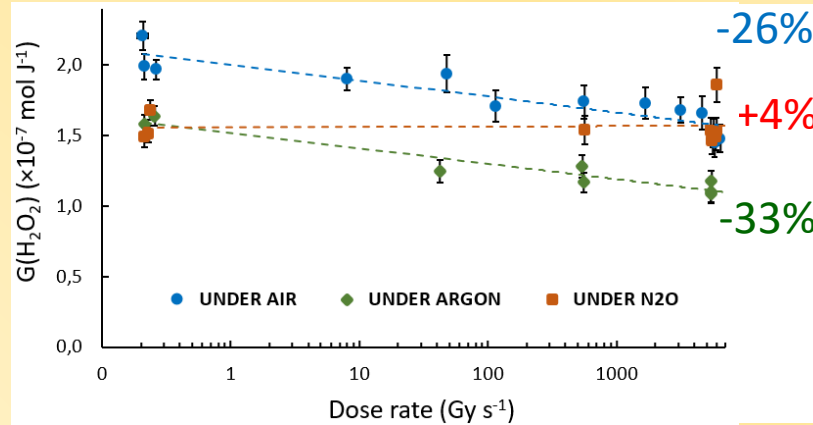
Previous results

Using **pulsed 68MeV H⁺ beam** of the radiobiological platform at **ARRONAX**, a **strong decrease of G(H₂O₂)** with increasing UHDR in the plateau region was shown [1]. By now, a new irradiation cell was designed to control the atmosphere. **Elucidate oxygen and radical recombination roles during the radiochemistry step of pure water UHDR irradiations is now possible.**

Materials and Methods

- 68MeV H⁺ plateau
- Doses : 10 to 80Gy, 3x replicates
- Conv 0,25Gy/s
- Single pulse UHDR 40 to 7kGy/s
- Ghormley's UV-vis H₂O₂ titration protocol
- Pure milliQ Water 18,2MΩ.cm
- Synthetic air (80%N₂ / 20% O₂)
- Saturated with pure argon (No O₂)
- Saturated with pure N₂O (No O₂, e⁻_{hyd} scavenger)

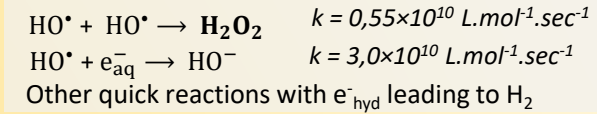
G(H₂O₂) production Yield vs dose rate under 3 atmospheres : O₂, No O₂, e-hyd scavenger



Mechanism proposal

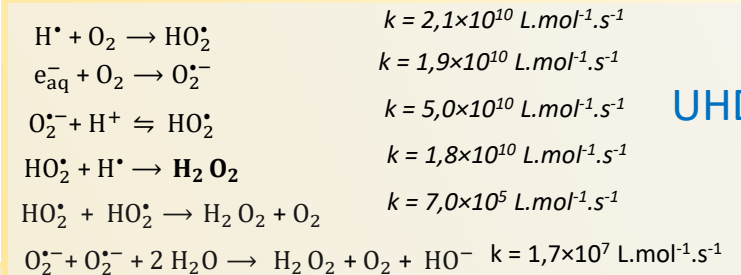
- UHDR boosts HO[•] + e⁻_{aq} → HO⁻ due to better k and diffusion
- e⁻_{hyd} acts like as HO[•] scavenger, leading to less H₂O₂
- In line with reduced G(HO[•]) under UHDR observed in Litt. [2]
- O₂ doesn't affect ROS reduction under UHDR

Under Argon condition, no O₂ : competition



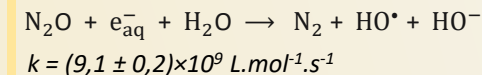
UHDR effect

Under Air condition, O₂ adds this :



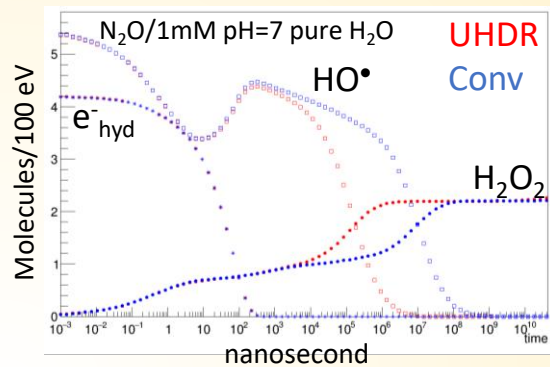
UHDR effect

Under N₂O condition, no O₂, e⁻_{hyd} is scavenged



NO UHDR effect

G4-DNA simulation of UHDR radiolysis with N₂O scavenger



- As a first trial, H₂O₂, HO[•] and hydrated electron G-values along time are obtained until 1 minute
- **Experimental H₂O₂ trend is described by the model, with the same production yield for both UHDR and CONV.**
- The good order of magnitude is calculated.
- Kinetic evolution of radicals for all conditions need to be investigated

Conclusions / Outlook

- ✓ **Key-role of hydrated electron** in the decrease of G(H₂O₂) production yield observed under UHDR condition up to 7kGy/s
- ✓ **No influence of dissolved O₂ on the specific radical recombination process under UHDR**
 - ROS production mechanism under UHDR seems to be driven by radicals diffusion and recombination
- ❑ **Direct hydrated electron detection using time resolved UV-Vis absorption** is in progress, allowing access to kinetic information to be used as input for modeling and mechanism studies
- ❑ G4-DNA modeling improvement started to reach a better experiment-model fit

[1] Blain et al, Radiation Research 198 (3), 318-324

[2] Kusumoto et al, RSC Advances 10:38709-14, 2020