FIRST EXPERIMENTS ON CHEMICAL EFFECTS OF ELECTRON BEAM AT FLASH*lab*@PITZ

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FLASH*lab*@PITZ is a multidisciplinary R&D platform, established at the Photo Injector Test facility at DESY in Zeuthen (PITZ) allowing ultra-high dose rates (UHDR) radiation research in a unique parameter range.

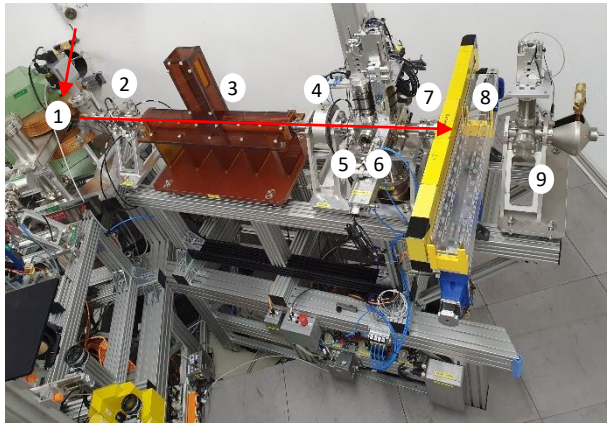

*Fig. 1. Start-up setup for FLASH*lab*@PITZ radiation beamline: 1 - Dipole deflects the beam by 60° to the left, 2 - BPM, 3 - Vertical kicker, 4 - ICT, 5 - BPM, 6 - Screen and Faraday cup, 7 - Ti window, 8 - Sample in holder on motorized transverse stage, 9 - Screen and Faraday cup.*

Our 22 MeV electron beam is capable to deliver radiation at UHDR that is higher by several orders of magnitude than conventional dose rates used during common cancer radiotherapy. FLASH*lab*@PITZ works together with the Technical University of Applied Sciences Wildau as partner in close vicinity for the biological resources.

The mechanisms behind radiotherapy are water radiolysis, reactive oxygen species (ROS) formation and DNA damage. H_2O absorbs the ionizing energy and dissociates into e_{aq}^-, HO•, H•, HO_2•, H_3O^+, OH^-, H_2O_2 and H_2.

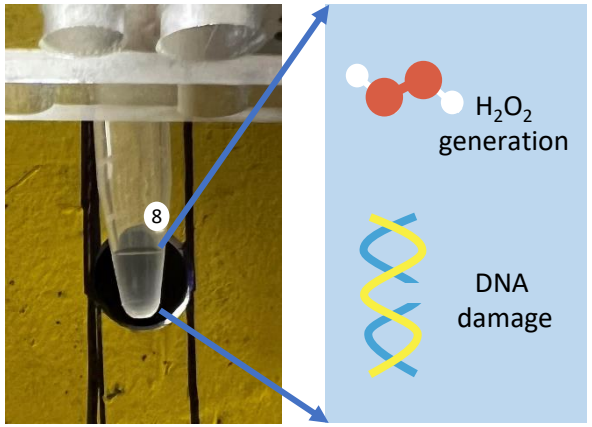

Fig. 2. Sample in a tube, placed to be irradiated and analyzed for H_2O_2 generation and DNA damage.

Those species diffuse, react and build a further physicochemical cascade of radical species. These reactive species - mainly ROS and reactive nitrogen - affect biomolecules. The indirect and direct interaction of ionizing energy with DNA molecules leads to its damage, i.e. single- and double-strand breaks (SSB and DSB).

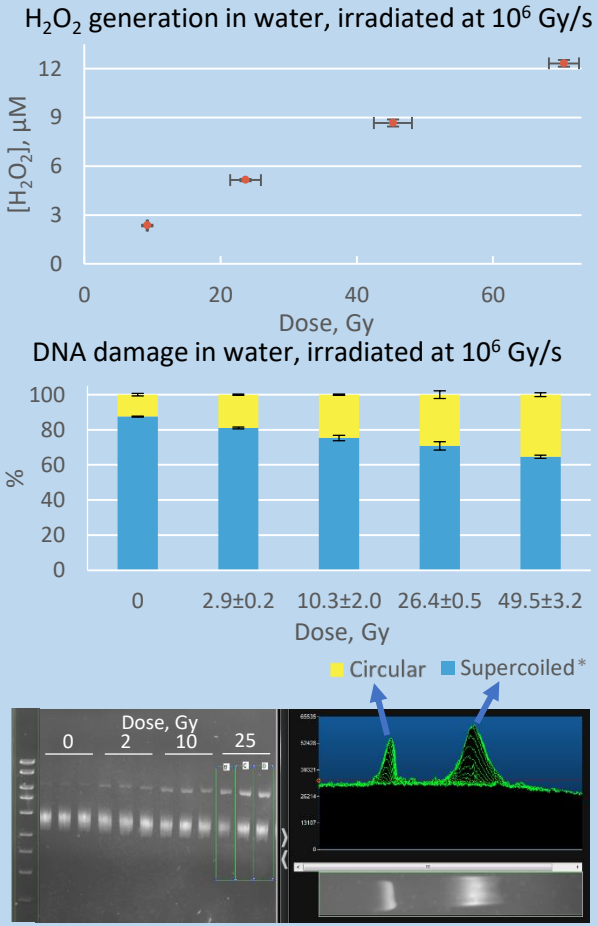

*Fig. 3. pBR322 plasmid irradiated at 10^6 Gy/s with 0-25 Gy and analyzed with 1% agarose gel electrophoresis, stained with ethidium bromide. Fluorescence images were taken and analyzed with FUSION FX Software (Blackmagic Design). * no linear conformation of DNA plasmid was detected.*

Methods

H_2O_2 generation was evaluated with Amplex Red staining (Invitrogen™). Forms of pBR322 plasmid (4361 bp, Thermo Scientific™) were quantified with agarose gel electrophoresis.

Results

The experiments are evaluating H_2O_2 production and DNA plasmid damage with increasing doses and varying beam structure. Irradiation was performed with 22 MeV PITZ electron beam with increasing doses in the ≤75 Gy range and dose per pulse in 5 x 10^{-2} Gy/s for conventional, 10^6 and 10^{11} Gy/s for UHDR. Two exemplary experiments are shown in this contribution for 10^6 Gy/s irradiation at PITZ. Further data processing is ongoing for 5 x 10^{-2} Gy/s and 10^{11} Gy/s radiation biochemical effects.

Conclusions

The first *in vitro* study at FLASH*lab*@PITZ focuses on the early chemical and biochemical effects of the UHDR radiation.

The dose-dependent H_2O_2 generation and DNA plasmid SSB induction after irradiation at conventional and UHDR dose rate present **a proof-of-concept and high perspective of chemical and biological research at PITZ.**

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DON'T MISS OUT

FRPT Lecture by Dr. Frank Stephan: Progress on the R&D Platform FLASH*lab*@PITZ

When? 30.11.2022 at 9:25 AM, **Where?** in Hall 113-114