

GSI-NIRS International Open Laboratory: filling the gap of oxygen effect measurements*

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The main goal of the GSI-NIRS International Open Laboratory (IOL) "Radiation Quality Research Unit" is the verification, with a set of experimental OER (Oxygen Enhancement Ratio) data points of a semi-empirical model developed at GSI that is being used for the implementation of adaptive treatment planning in TRiP98 [1,2], for specifically targeting hypoxic tumors. The longstanding lack of experimental measurements exactly in those conditions of oxygen concentration (pO_2) and linear energy transfer (LET) most relevant for a clinical application of the method, guided the need of this project, joining the two most experienced groups worldwide (GSI and NIRS) on hypoxic irradiation with ion beams. The IOL kick-off meeting was held in Darmstadt on 05.09.2011. The last progress report meeting was held in Chiba, Japan on 22.01.2013, where actual results were presented and further projects and collaborations between units were discussed.

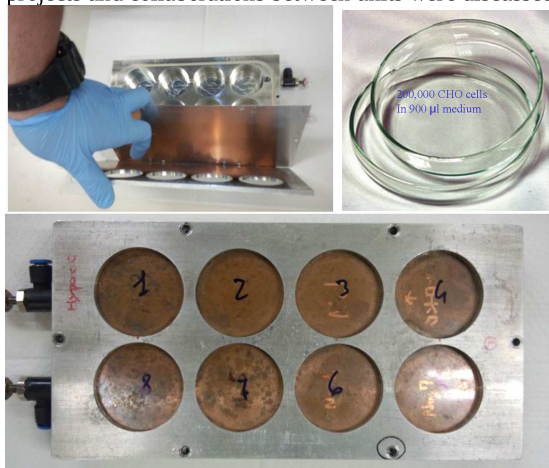


Figure 1: Experimental setup for hypoxic irradiation at several tunable oxygen concentrations adopted at NIRS for the present project, with ion beams and X-rays.

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Experimental points about the complete anoxic condition (0%) and a partially hypoxic (0.5%) one have been measured at NIRS with CHO cells and a dedicated experimental setup (Figure 1) to verify our model. The results (Figure 2) shown a reasonable agreement with the prediction model, especially in the slope region, suggesting

a slight adjustment of the low LET asymptote for the specific cell line. The higher OER value found for the very high LET, is due to the large ions fragmentation, since we used the HIMAC-NIRS passive beam experimental room.

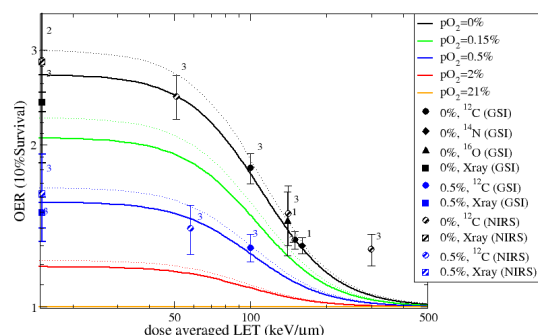


Figure 2: Model of the dependence of OER from LET for different oxygen partial pressures under implementation in TRiP98 and independent experiments performed at GSI-IOL/NIRS (points).

Collaborations

In the same time, our unit started the planned collaborations with the Particle Therapy Molecular Target Unit (Profs. Nickoloff, Colorado State University and Jeggo, University of Sussex). Several other projects related to the hypoxic irradiation with ion beams were initiated, namely related to the *Phoenix rising* effect [3], and suppression of the tumor immunogenicity capacity [4]. A link with the Radiation Response Model Unit for alternative OER modeling is also planned.

OUTLOOK

Further OER experiments are planned at 2% and 0.15% oxygen concentrations. Selected other experiments at LET 75-30 keV/ μ m at anoxia and 0.5% oxygen will be also performed. About the *Phoenix rising* effect we planned to verify with a specific experiment the molecular pathway. In February 2013 we will start the immune system-mediated radiation effect experiments.

References

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