Processes study in the amplification effect by nanoparticles in hadrontherapy

Treatment of cancer remains a major challenge. 50% of patients undergo radiotherapy, a non-invasive technique but whose use is limited by damage to healthy tissues and related side effects. In order to improve the irradiation effect, our group is leading research in combining hadrontherapy (protons, carbon or helium ions…) with nanoparticles in tumor for better efficiency and selectivity of the treatment.

High energy ions have a biological efficiency three times higher than conventional X-rays. Besides, their specific properties of targeting prevent damage to the healthy tissues located behind the tumor. Although, it is unfortunate to note a limit: the dose deposition is still significant at the beam entrance, before the tumor.

The addition of electron emitters nanoparticles (radio-enhancers) able to target tumors would amplify the effects of radiation to the tumor specifically. Moreover, thanks to their density or magnetic properties, they could also improve medical imaging and allow theranostic.

Our group, in collaboration with NIRS (Chiba, Japan), has already demonstrated the efficiency of small metallic nanoparticles to amplify the effects of medical carbon ions. Nevertheless, these results were obtained *in vitro* using tumoral monolayers cells which are models far from *in vivo* tumor.

Indeed, they do not present the extracellular matrix nor cells/cells and cells/substrate interactions. Consequently, the aim of my thesis is to develop 3D models, more representative of reality, and to evaluate the combination NP/hadrontherapy at this level.

For prediction of the amplification effect by nanoparticles, it is necessary to make a model of physical, chemical and biological processes that occur under irradiation. In addition, Monte Carlo simulations are carried out in collaboration with the Gustave Roussy Institute (Villejuif, France).