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Nanoparticles Combined with Particle Therapy for the Treatment of Tumors

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The challenge of radiotherapy is to increase radiation damage on tumor whilst preserving healthy tissue. Particle therapy is superior to conventional x-ray modality thanks to ballistic properties, which improve tumor targeting. Also, carbon ion irradiation is more efficient than other modalities to treat radioresistant cases. This work aims to improve particle therapy's performance at tumors by adding Platinum Nanoparticles (PtNPs) that amplify ionizing radiation effects.[1]

To evaluate the effectiveness of combining PtNPs with carbon beams, experiments are conducted on 3D cell models for the first time. This tumor-like model, called "spheroid," mimics the geometric (3D) and environmental (nutrient and oxygen gradients) conditions of a tumor.

Spheroids obtained using human cell lines from different cancers: Hela (cervical), BxPC3 (pancreatic), and U-87 (glioma), were used in this study. The internalization and localization of metallic PtNPs in the cytoplasm of the spheroid cells were observed using confocal and light sheet microscopies (figure below). Irradiations were conducted using a Carbon ion beam (290 MeV/uma) at the Heavy Ion Medical Accelerator (HIMAC) in Chiba, Japan, a world leader in particle therapy and a long-term collaborator. A radio-enhancement effect of PtNPs was observed when irradiating the spheroids with this carbon beam, showing a 23% increase of efficiency at 2 Gy dose irradiation. A similar effect was observed with 6 MV photon irradiation (reference beam in radiotherapy).

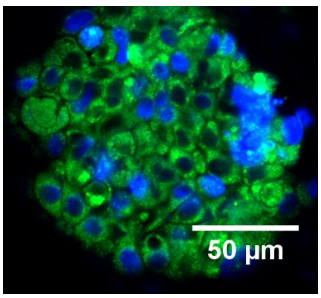

Figure: PtNPs (in green) localized in the cytoplasm of BxPC3 spheroid cells (cell nuclei in blue)

[1] *S. Lacombe, E. Porcel, E. Scifoni, Cancer Nanotechnology. 2017, volume 8, page 2.*