

# Cold Plasma Treatment in Prostate Cancer

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**Abstract** — Cold Atmospheric Plasma (CAP) is an ionized gas generated at atmospheric pressure with the temperature of heavy particles (molecules, ions, atoms) close to the room temperature. For almost 10 years, it is increasingly used in medicine especially oncology [1]. Studies have shown that both *in-vitro* and *in-vivo* plasma expositions to many cancer cell lines are efficient to induce the apoptotic way of cell death. In some other works, normal cell lines seem to be less impacted by plasma than cancer cell lines [2-3]; this is called selectivity of plasma. It is highly likely that the generated RNOS (Reactive Nitrogen Oxygen Species) in the plasma jet play a key-role in this selectivity. For now, the selective aspect of plasma treatment on prostate cell lines has already been demonstrated in our previous work [4]. For the launch of the **Pepith** project, recently funded by INCa (INCa\_16714), first *in-vivo* treatments on prostate tumors of PTEN mice delivered encouraging results; histological scoring is still ongoing. Further experiments will be made to analyze the treated anterior prostate lobes. Pathological investigations and analysis of the apoptotic pathways and of the cell proliferation will be performed. The overall aim is to develop a CAP device to treat the surgical margins after tumor ablation. Cold plasma will be blown through a catheter in order to be used *in-situ* with an endoscope. Finally, anatomical images of treated mice will be acquired by microscopic imaging (magnetic resonance imaging and synchrotron X-ray phase contrast imaging modalities) in order to model the evolution of cancer tissues after a plasma treatment.

**Keywords** — Cold atmospheric plasma, prostate cancer, selectivity, molecular analysis, endoscopic treatment, cancer tissues model.

## References:

- [1] E. Alizadeh and S. Ptasińska, Recent Advances in Plasma-Based Cancer Treatments: Approaching Clinical Translation through an Intracellular View. *biophysica*, 2021.
- [2] I. Hamouda, C. Labay, U. Cvelbar, M.-P. Ginebra and Cristina Canal, Selectivity of direct plasma treatment and plasma-conditioned media in bone cancer cell lines. *Scientific Reports*, 2021.
- [3] X. Dai, K. Bazaka, E. W. Thompson and K. K. Ostrikov, Cold Atmospheric Plasma: A Promising Controller of Cancer Cell States. *Cancers*, 2020.
- [4] M. Fofana, J. Buñay, F. Judée, S. Baron, S. Menecier, M. Nivoix, F. Perisse, A. Vacavant and X. Balandraud, Selective treatments of prostate tumor cells with a cold atmospheric plasma jet. *Clinical Plasma Medicine*, 2020.