Artificial intelligence in Cancer imaging:
Unraveling the antitumor effects of cold plasma therapy on solid tumors

[**Scientific context**] Despite scientific and technological progress in cancerology, the therapies available today are still not completely effective and some of them associate high economic and/or societal costs. In this sense, "cold plasmas" have emerged as a powerful technique to generate active species (molecules, atoms, ions, electrons, photons, UV & visible radiation) which affect cells through complex biochemical procedures, opening a great window of opportunity in the novel area known as **Plasma Medicine**.

[**SU context**] Research in cold plasma applied to cancerology is leaded by a Consortium of four laboratories:

Lab.	UFR	Team leader	Expertise
LPP	925-919	Dr. Thierry DUFOUR	Science & Technology of cold plasmas
ISIR	919	Dr. Olivier SCHWANDER	Deep learning
CRSA	927	Dr. Laura FOUASSIER	Biology & endoscopy of cholangiocarcinoma
CRC	927	Dr. Isabelle CREMER	Biology & immunology of lung cancer

[**Previous results**] In the case of mice bearing non-small cell lung cancer (NSCLC), Fig. 1a shows the variation of tumor volume vs time. The antitumor effects resulting from cold plasma therapy are clearly visible for the “plasma jet” group (red curve) compared with control (black curve). Similar results have also been obtained on cholangiocarcinoma (CCA): cancer of the biliary ducts. The Fig. 1b compares photographs of CCA tumors either not-treated (control) or exposed 2 times to cold plasma. The plasma-treated tumors are smaller, do not show reddish appearance and seem poorly vascularized. Then, the tumors can be sliced to highlight effects at cell level. As shown in Fig. 2a, 8-oxoguanine reveals oxidative-stressed regions while cleaved caspase-3 indicates apoptosis. More recently, X-ray microtomography has been achieved on whole tumor volumes to decipher their inner architecture (Fig. 2b).

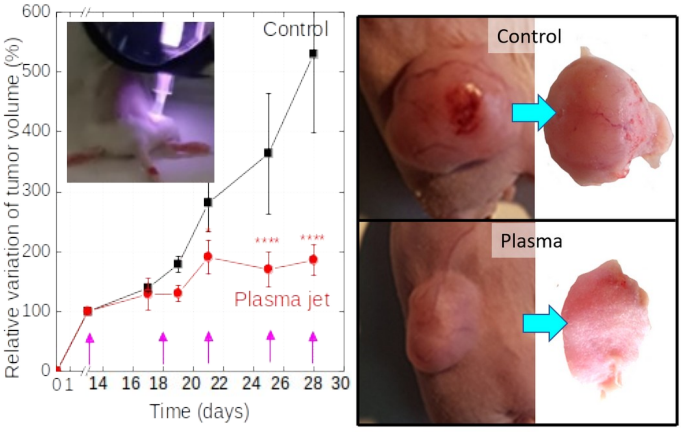

Figure 1. (a) Cold plasma therapy delivered to mice with NSCLC cancer. Monitoring volumes vs time (b) Subcutaneous tumors of CCA on mice at day 50.

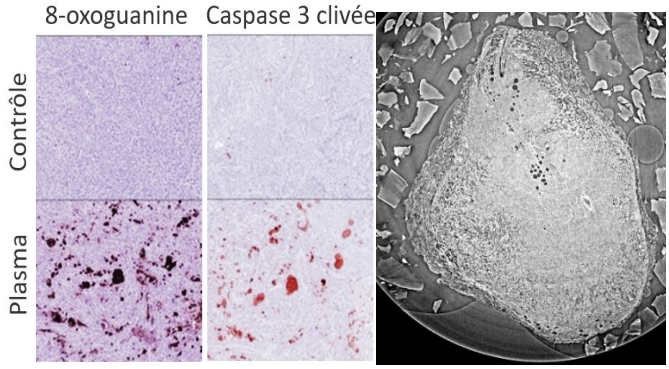

Fig. 2 (a) IHC slices of CCA tumors, (b) Computed section of NSCLC tumor obtained by X-ray microtomography.

[**Objective & missions**] The trainee will analyze the big data collected by the Consortium during several experimental campaigns, i.e. (i) images of tumor slices obtained by high resolution microscopy and stained by H&E and IHC, (ii) 3D-images obtained by synchrotron X-ray microtomography (SOLEIL).

These analyses should allow to reconstruct the internal three-dimensional architecture of solid NSCLC and CCA tumors in mouse models, and more precisely to map regions of biological interest to isolate complex and interdependent patterns (vascular network, apoptotic zones, vesicles, collagen, …). The comparison of these characteristics (morphological and physiological changes) will highlight the action mechanisms of cold plasma therapy but also characterize its performances and limitations (e.g. penetration depth).

The intern will process these images using the DragonFly software. First, she/he will apply Dragonfly's powerful segmentation features to selected reference slices, and then use these results to train existing neural networks (then to segment the rest of the same and subsequent stacks of experimental images). Second, she/he will be able to take advantage of the built-in tools to build new networks or modify activation functions and other node behaviors in existing models. If necessary, she/he will code directly in Python using the Keras API or import pre-existing Keras models and integrate them directly into Dragonfly.

[**Application**]

- The Consortium welcomes curious and proactive students who enjoy taking initiatives, proposing new lines of thoughts and are open to multidisciplinary research.
- Internship duration: 6 months
- To apply, send resume (in French or English) to Dr. O Schwander (olivier.schwander@lip6.fr) and T. Dufour (thierry.dufour@sorbonne-universite.fr).