### **Laser Diagnostics for Low-Temperature Plasma Characterization:**

### **E-FISH and Laser Induced Fluorescence**

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Low-Temperature Plasma (LTP) applications for medicine, sterilization and agriculture are rapidly increasing. A deep understanding of the physics and chemistry of LTPs is still missing because of the multitude of parameters involved, especially in air at atmospheric pressure. A comprehensive characterization, electrical and chemical, of LTPs is necessary to optimize the devices to better suit the application. Electric field characterization is often overlooked as trivial, despite being one of the possible key factors in direct plasma treatments. Optical Emission Spectroscopy (OES) is used to measure indirectly the electric field, however only in the plasma phase. Advanced laser diagnostic such as Electric-Field Induced Second Harmonic (E-FISH) generation can measure the electric field inside the plasma discharge locally, with better space and time resolution during the whole operation of the device. To better understand the dynamics of the ionization wave and the electric field evolution during and after the plasma discharge, E-FISH measurements are needed. Here, we perform direct E-FISH measurements in a Volume Dielectric Barrier Discharge (VDBD) nanosecond-pulsed plasma at atmospheric pressure, showing the electric field evolution, due to ion and electron dynamics, is quite different in humid air with respect to other gases. Concerning the chemical characterization of LTPs, Fourier Transform Infrared Spectroscopy (FTIR) is often used to measure different relevant molecules but it is limited in sensitivity, as well as in space and time resolution. Laser Induced Fluorescence (LIF), on the contrary, can measure the concentration of different key molecules like NO, O, OH and N, at the nanosecond timescale. The dynamic of these molecules in LTPs is of major importance in the understanding of interaction mechanisms with biological substrates. Absolute measurements of NO concentration by picosecond LIF are performed in a nanosecond-pulsed Surface Dielectric Barrier Discharge (SDBD) plasma at atmospheric pressure, resolving the time evolution and the 2D distribution of NO concentration. The results also call attention to relative humidity to be an important parameter, often underestimated, but critical in real life scenarios.