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Supervisor Expression of Interest
MSCA - Marie Sklodowska Curie Action - (PF) Postdoctoral Fellowship 2021

Supervisor name:	Prof. Dario Polli
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Link pagina docente:	http://polli.faculty.polimi.it/
Department Name:	Physics
Research topic: (https://www.polimi.it/en/scientific-research/research-at-the-politecnico/departments/)	Research Line number 1 – "Ultrashort light pulse generation and applications to the study of ultrafast phenomena in the matter"
MSCA-PF Research Area Panels:	☐ CHE_Chemistry ☐ ECO_Economic Sciences ☐ ENG_Information Science and Engineering ☐ ENV_Environmental and Geosciences ☐ LIF_Life Sciences ☐ MAT_Mathematics **X** PHY_Physics ☐ SOC_Social Sciences and Humanities
Politecnico di Milano Areas:	☐ Cultural Heritage ☐ Smart Cities **X** Horizon Europe Missions **X** Health ☐ Industry 4.0
Title and brief description of the Department and Research Group (including URL if applicable):	The "VIBRA" Research Group (see http://www.vibra.polimi.it/) is made of three associate/full professors plus several post-doc, PhD and diploma students, for a total of approx. 10 people with multi-disciplinary expertise in non-linear optics, lasers, photonics, microscopy, optoelectronics, ultrafast processes, radiation-matter interaction, biomedical applications (cells, tissue imaging) and artificial-intelligence data analysis. The group can count on state-of-the-art facilities for coherent Raman scattering spectroscopy and microscopy. It works in a fully dedicated lab space, with three laser sources and three home-built multimodal microscopes for stimulated Raman scattering, CARS, second-harmonic generation microscopy and two-photon excited fluorescence.

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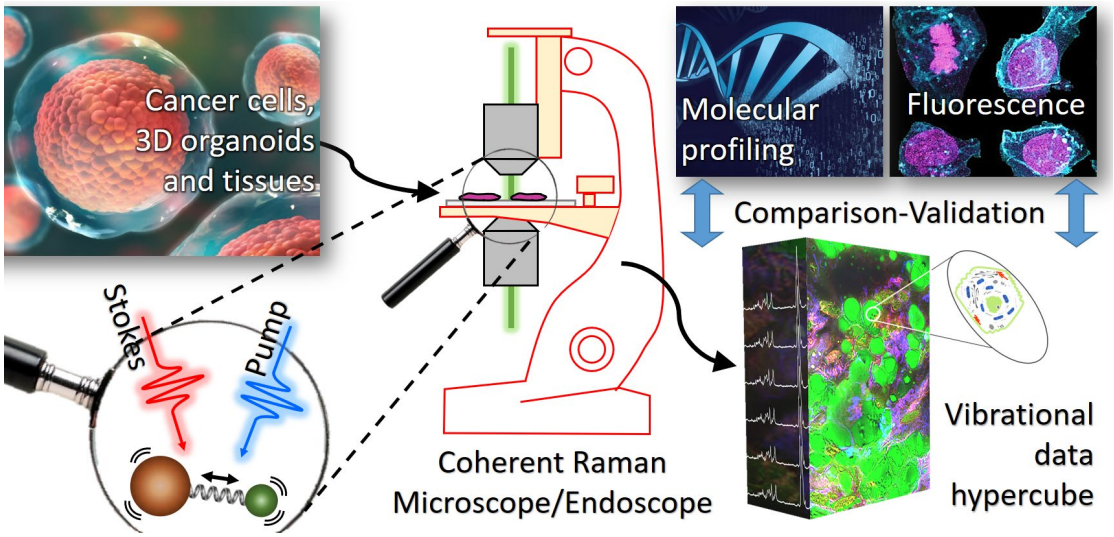
Brief project description: (max 1 page)	**Optical microscopy** represents an extremely powerful investigation tool for life sciences, allowing for a detailed optical study of biological samples in their native state approaching single-molecule resolution. **Fluorescence** microscopy offers superb sensitivity, but it often requires the addition of dyes that can interfere with biological functions, thus calling for **non-invasive, label-free, 3D sectioning methods**. A solution comes from **vibrational imaging**, which measures the chemical response of molecules via their intrinsic vibrational response that can be used as a fingerprint for their unique characterization. In particular, **coherent Raman scattering** (CRS) based on ultrashort laser pulses enhances the signal by many orders of magnitude, thus offering high-speed imaging capability. This project aims to provide a **next-generation bio-photonics imaging device** based on vibrational spectroscopy, with the potential to **revolutionize the study of the cellular origin of diseases**. The candidate will employ label-free broadband coherent Raman scattering (CRS) extended to the fingerprint region, in combination with **artificial-intelligence** spectroscopic data analysis, for fast cell/tissue classification with unprecedented biochemical sensitivity. He will develop a hyperspectral CRS microscope for **3D quantitative imaging** of sub-cellular compartments in living cells and organoids. High acquisition speed will enable the observation of intra- and inter-cellular dynamic changes by time-lapse imaging. This broadband CRS microscope will extract the maximum amount of information about the bio-molecular composition of the cell, coupling it with morphological information, without altering the natural state of the cell with exogenous molecules or invasive interventions.  In this infographics, we summarize the objectives of this research. We will develop an innovative detection scheme for CRS, based on a wide-field coherent anti-Stokes Raman scattering (CARS) setup coupled to an innovative birefringent interferometer for hyperspectral imaging. Cancer cells in 2D cultures, 3D spheroids/organoids, histological samples and *ex-vivo* tissues will be imaged using an innovative coherent Raman microscope to perform vibrational imaging. It will outperform standard staining, fluorescence microscopy and molecular profiling procedures in studying cellular mechanisms.