**Harnessing quantum optical states for sensing and imaging applications**

**Description and work plan**

Quantum sensing is a recent topic of research that explores the development of solutions based on quantum phenomena to deploy solutions with specific advantages against their classical counterpart. In this context, and leveraging on the emergent quantum technologies laboratory at INESC TEC, this work will consist of a full-stack approach –from theory to experiments – to quantum sensing and imaging with single photon sources.

Non-classical Optical Sources: Why we need it? What types? How these work?

* Single Photon Sources
* Correlated Photon Pair Sources
* Entangled (Polarization) Photon Pair Sources
* Hypertentangled (Polarization + frequency) Photon Pair Sources

Photon Detectors: how states can be measured? What types of measurements?

* Single pixel detectors: Single Photon Avalanche Diode;
* Cameras: EMCCD and ICCD; SPAD Camera;
* Time taggers and counters;

To explore:

Hong-Ou-Mandel Sensor

Hong-Ou-Mandel Microscopy

Hong-Ou-Mandel Polarization Microscopy

**Workplan:**

(Novembro)

1. Overview of quantum technologies with non-classical states of light
   1. Quantum advantages and how they are explored in quantum sensing and its subdomain quantum imaging;
   2. Overview of sources (SPDC) and photon detection;
   3. Overview of HOM and Nonlinear interferometry;

(Dezembro – Janeiro)

1. Probing Non-classical states of light and quantum effects
   1. Turnkey source (SPDC type I)
      1. Grangier-Rose (to probe non-classical nature of states)
      2. HOM
   2. Undetected photons (SPDC type X)
      1. Photon pair generation
      2. Imaging with undetected photons

(Fevereiro – Fim)

1. Case study: Imaging in IR with undetected photons
   1. Gas plume imaging; (Quantum ghost imaging)

(Janeiro – Fim)

1. Case study: HOM sensing
   1. **Sagnac interferometer (OFS, 20 Janeiro 2025)**
   2. Birefringence