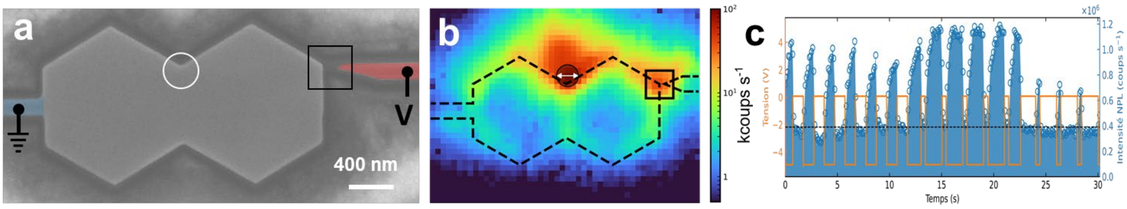
Master 2 internship (*)

ICB, *Univ. Bourgogne Europe, CNRS (Dijon)*

2025-2026

TITLE	**Electro-plasmonic reconfiguration of all-optical calculators in single 2D gold cavity.**
CONTEXT	While optical information transfer in fibers is a mature and relatively energy-efficient technology, the processing of this information remains essentially electronic, which has become significantly energy-intensive and requires inefficient opto-electronic conversion.[1] The miniaturization of optical components is a challenge that surface plasmon engineering proposes to address with sub-wavelength guides and, more recently at ICB, micrometric all-optical calculators.[2] These calculators are produced from ultra-thin gold single crystals (20-80 nm) with micrometric lateral dimensions by ion or electron beam lithography. Upon adding a nanogap electrode near the device output, the non-linear optical response, used to carry the calculation result, can be enhanced or attenuated by applying a bias voltage that modulates the hot electron population responsible for the non-linear photoluminescence (NPL) or the NPL emission cross-section.[3] It therefore appears appealing to electrically reconfigure the type of calculation performed by the plasmonic cavity. **(*)** *A 2026-29 PhD grant funded by an ANR project will be open for applications in early 2026.*
OBJECTIVES	**Nanofabricate** modal plasmonic cavities similar to Figure A by electron beam lithography and metal deposition or etching. Perform **non-linear optical and electrical characterization** of the devices and explore some key experimental parameters such as the nanogap geometry. **Establish a simple model** to account for the electro-plasmonic modulation of the NPL output signal.
DESCRIPTION	The prototypical plasmonic cavity used to perform Boolean computation is shaped as a double hexagon (DH). [2] When ground and drive electrodes are added as in Fig. 1a, the NPL response il globally unperturbated (Fig. 1b), unless a bias is applied. Figure 1c shows the modulation of the NPL in the output region (black square in Fig. 1b) when the cavity is remotely excited by a fs pulsed laser (focused on the white circle in Fig. 1a) and the drive electrode is biased to -5 V DC. The internship will consist in fabricating similar devices with a range of gap sizes and geometry, recording the NPL response maps upon remote pulsed excitation and explore the modulation mechanisms. In particular, we will be looking for memristive regimes as recently evidenced in similar gap systems.[4] The nanofabrication will be carried out in ICB ARCEN facility that includes a cleanroom fitted with electron beam lithography as associated techniques and several deposition/etching instruments. The characterization will be performed on dedicated non-linear optical set-ups in collaboration with other post-docs and students working on related projects. Finally, we expect the candidate to dedicate a significant effort to in-depth data analysis and to contribute to elementary modelling of the electro-plasmonic observations on these 2D cavities. **[1]** "L'ordinateur optique", podcast. **[2]** F. Dell'Ova et al, *ACS Photon.*, **2024**, 11, 752. Video **[3]** F. Dell'Ova, A. Bouhelier, G. Colas des Francs, E. Dujardin, et al., **2025**, unpublished. **[4]** D. K Sharma, et al., *ACS Nano*, **2024**, 18, 15905.  **Figure 1: (a)** SEM image and **(b)** wide-field NPL map of a DH with ground and gap electrodes. The 810-nm excitation is focused in the circle. **(c)** Remote NPL intensity modulation (x 300%) upon biasing the gap with 5 V (*ICB, unpublished*).
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FACILITY ACCESS	**Office** with dedicated PC. **Lab space** with dedicated non-linear optical bench. **Access and training** to nanofabrication and characterization tools in the **ICB-ARCEN** platform.
PRE-REQUISITE	**Academic profile in optical physics**. Taste for experimental work. Knowledge of electronics measurements or nanofabrication techniques will be appreciated. Knowledge in data analysis softwares or in Python coding would be an asset. Good level of English