**Scanning Laser Microscopy for Probing Dynamics in Superconductors and Micro-Devices**

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This talk presents advanced laser-based characterization techniques applied to superconducting resonators and micro-devices, focusing on both spatial and temporal resolution.

The first part discusses the use of spatially resolved photodoping in oxygen-deficient $YBa_2Cu_3O_{7-\delta}$ (YBCO) resonators. By exploiting the metastable, photo-induced increase in superconducting critical temperature, we locally and reversibly modify the microwave response of half-wavelength resonators. The distinct time scales of the bolometric effect and photodoping allow for precise control and investigation of persistent photodoping. Using a scanning laser spot, we demonstrate the position-dependent sensitivity of these devices, enabling the direct imaging of standing waves at fundamental and harmonic frequencies. The second part introduces a multiharmonic lock-in detection approach for time-resolved scanning laser microscopy. This method utilizes an inverse Fast Fourier Transform to reconstruct the local evolution of thermal susceptibility. Implemented on a custom-built, cryostat-compatible modular microscope, the technique facilitates thermal imaging at time scales significantly shorter than the scanning speed. Case studies demonstrate the efficacy of this approach for the dynamic thermal characterization of superconducting circuits and low-dimensional systems, highlighting its potential for probing the fast dynamics of emerging electronic devices.

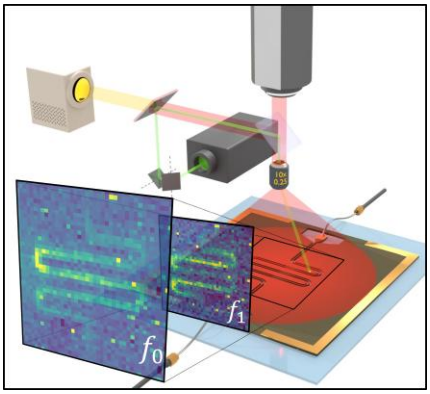


**Fig. 1:** ***Imaging Standing Waves via Photodoping****. A focused laser beam is used to induce local photodoping in oxygen-depleted $YBa_2Cu_3O_{7-\delta}$ resonators. This technique allows for the direct mapping of microwave current densities, clearly distinguishing the fundamental ($f_0$) and second harmonic ($f_1$) modes of the resonator, as shown in the inset data maps.*

## References

[1] N. Lejeune, L. Nulens, H. Li, *et al.* "*Spatially Resolved Photodoping of Oxygen-Deficient $YBa_2Cu_3O_{7-\delta}$ Resonators.*" Adv. Mater. Technol.: e01724. (2025)

[2] N. Lejeune, S. Van der Heyde and A. V. Silhanek. *"Time-Resolved Thermal Susceptibility Mapping via Low-Temperature Scanning Laser Microscopy."* In preparation