**Lecture 1.**

**The new thermometry with light: fiber optic sensors and novel imaging technologies for monitoring thermal-based therapies for localized tumors.**

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Energy-based image-guided interventions provide a minimally-invasive treatment option for cancer patients who may not be surgical candidates, with limited systemic toxicity, and the potential to synergize with other therapeutic modalities. Achieving optimal therapeutic outcomes relies on precise and conformal energy delivery localized to targeted tissues.

Small-size and flexible fiber optic sensors (FOSs) are increasingly entering in the design of minimally invasive medical devices. Technologies based on high-density Fiber Bragg Gratings (FBGs) or distributed sensing, based on Brillouin and Rayleigh scattering, allow for accurate and spatially resolved information along the entire length of a surgical instrument (pressure, strain, temperature), without the use of additional devices. Thus, recently, FOSs have emerged as optimal tool to control energy-based therapies, thus providing temperature monitoring with millimetric spatial resolution for thermal-based therapies for localized tumors.

This lecture will present emerging applications of FOSs for thermometry and feedback-controlled delivery of thermal treatments. FBGs and distributed sensors will be described and discussed for their capability to perform the accurate analysis of the thermal effects of medical devices for thermal therapies and to tune and validate organ-specific numerical models for the prediction of temperature distribution in biological tissues. Emerging application of FBGs for the investigation of the thermal response of nanomaterials intended for photothermal therapies will also be presented.

While FOSs allow measuring and controlling the tissue temperature distribution evolving during laser treatment, novel solutions are needed to directly monitor the thermal state of biological tissues. Thus, this lecture will also present an innovative hyperspectral imaging approach for monitoring and predicting the thermal state of biological tissues, using its optical “fingerprint” as sensor.