MRI is increasingly being used to provide imaging-guidance of high-temperature thermal therapies primarily due to its inherent sensitivity to temperature changes which make it attractive for monitoring and control, as well as multiple contrast mechanisms useful for planning, targeting and verifying therapy delivery in a single setting. These advantages have opened the door for a new generation of FDA cleared laser ablation systems which can use MRI guidance. Using compact, solid state lasers operating in the near infrared (NIR) regime along with actively cooled catheters which facilitate use of higher powers and larger lesions, interstitial laser ablation of deep seated lesions in areas such as brain, prostate, liver, kidney and bone are being investigated clinically.

Gold nanoparticles (AuNP) can be designed to strongly absorb in the NIR portion of the spectrum. Even in the presence of relatively low applied power, which does not raise tissue temperatures to ablative levels, biologically relevant concentrations of AuNP aptly absorb the NIR energy generating ablative temperatures making them potent mediators of targeted laser induced thermal therapy. Because of their small size and ability to have their surface chemistry modulated for functionality, AuNP's may be designed to preferentially accumulate in a variety of diseased tissue. Additionally, unlike previous investigations using molecular dyes, these particles tend to maintain their effectiveness even at higher temperatures or laser power.

Here we provide an overview of our experience using MR-guidance and temperature imaging to investigate the potential for using AuNP as mediators for delivering highly conformal laser induced thermal therapy of soft-tissue tumors using phantoms as well as in vivo small and large animal models. MR temperature imaging provides a means to demonstrate feasibility of these therapies in a variety of scenarios as well as monitor and control therapy delivery. In addition, temperature feedback can be used to validate computational models of AuNP mediated therapy as well. In this manner, MRI is used to both verify and shape the approach to these therapies.

Educational Objectives:

(1) Gain perspective on the potential role of gold nanoparticles in laser induced thermal therapies.
(2) Understand the growing role of MR temperature imaging in clinical laser induced thermal therapy.
(3) Understand the role of MR temperature imaging in the development and validation of gold nanoparticle mediated laser induced thermal therapies.