Physics & Astronomy Colloquium – Spring 2019

Tuesday, Feb 19th at 3:30 pm in SC 234

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A NOVEL ULTRA-LOW TEMPERATURE CRYOABLATION TECHNOLOGY TO TREAT CARDIAC ARRYTHMIAS

Atrial fibrillation (also called AFib or AF) is a quivering or irregular heartbeat (arrhythmia) that can lead to blood clots, stroke, heart failure and other heart-related complications. At least 2.7 million Americans are living with AFib. As the population ages globally, atrial fibrillation is predicted to affect 6–12 million people in the USA by 2050 and 17.9 million in Europe by 2060.

Ultra-low temperature cryoablation is a novel and very promising method of treating this medical condition by creating durable, non- arrhythmogenic, truly continuous, and transmural lesions inside the affected heart using very short ablation times. The new multi-shaped catheter that utilizes Near-Critical Nitrogen technology is a powerful and safe cryoablation tool that has the potential of significantly improve the treatment outcome for cardiac arrythmias patients.

Technology:

Cryoablation has evolved with the development of technologies that allowed for more efficient uses of the most performant cryogens. Although most of the "traditional" cryogenic solutions involve cryogens it their liquid form, some technical limitations specific to the field of cryoablation led to alternative technologies that we know today, like Joule-Thomson (JT) expansion of a high-pressure gas. The JT port generates a temperature drop and can be used as a cooling mechanism inside a catheter or a balloon. One practical example of this method is the JT based Nitrous Oxide systems capable of achieving freezing temperatures of approximately -80°C. Most of the commercial cryoablation catheters use N_2O gas in a multitude of JT ports (typically 4-8) to achieve the required cooling power and temperature distribution. Liquid Nitrogen (LN_2) can provide much greater cooling capacity due to its very low boiling temperature, high density, heat capacity, and small viscosity; all of that making it an ideal cryogenic liquid for the application. We describe the fundamentals and results of a novel ultra-low temperature cryoablation technology system that employs Near-Critical Nitrogen (NCN) to reach -190°C, anywhere along percutaneous catheters that can adopt any shape.

In its Near Critical state, a cryogen remains in the state where its liquid and gaseous phases are virtually identical therefore avoiding the common limitations of the liquid nitrogen based applications e.g. vapor lock. We developed a system that maintains an uninterrupted flow of NCN thought a small diameter cryoablation catheter. The system incorporates a specialized console that is capable of maintaining Nitrogen in its near-critical state, and a disposable catheter that can be cooled down to approximately -190C. The catheter has a 110 mm long ablation element, capable of forming true continuous and transmural lesions in both atria of a human heart. Its ablation element can form a multitude of specialized shapes, using pre-shaped stylets, aimed to provide the best possible match to targeted anatomical regions

The presentation will address and explain the underlying physics model of near-critical cooling, including its essential parameters (adequate cooling power of the catheter; flow rate of the cryogenic fluid; as the expected ablation duration) required to achieve complete transmural and durable lesions. I will also discuss the essentials of creating Ultra-Low Temperature (ULT) lesions (as compared to traditional cryoablation techniques) including the relation between the "lethal ice" isotherms and ablation times.

Refreshments at 3:00 pm in SC 103