Volume 12

Washington University
Undergraduate Research Digest

Spring 2017

Design and Activation of Frequency Tunable 200GHz Gyrotron

Natalie Golota
Washington University in St. Louis

Design and Activation of Frequency Tunable 200GHz Gyrotron

Natalie Golota

Mentor: Alexander Barnes

Dynamic Nuclear Polarization (DNP) when combined with Nuclear Magnetic Resonance (NMR) yields high sensitivity spectra while decreasing sample acquisition time. DNP transfers polarization from electron to nuclear spins, giving a strong enhancement of NMR signal. DNP is rapidly developing area of research due in part to application of cyclotron resonance masers (gyrotron) as high power microwave sources. Gyrotrons provide a high-power, high-frequency microwave source that can be used in close proximity to high field NMR magnets. Gyrotrons are operated under strong vacuum and within a cryogenic superconducting magnetic. Gyrotron microwave power is generated by a magnetron injection gun (MIG) composed of a molybdenum emitter coating a barium impregnated tungsten matrix cathode. In this 200 GHz gyrotron, a low capacitance between cathode and anode on the MIG and a variable potential field allow electrons to be accelerated into the magnetic field at variable frequencies. In previous DNP experiments, strong nuclear-electron spin couplings lead to short spin relaxation times and broad NMR line shapes. Voltage tunable gyrotrons are required for fast frequency sweeps of the irradiation bandwidth used for electron decoupling experiments. Using this tunable, fast frequency sweeping gyrotron, electron decoupling experiments will be possible, leading to higher resolution NMR spectra than previously possible. In this project, the assembly and use of a 200GHz gyrotron for DNP NMR is discussed.