Plasma physics is the study of ionized gases and had its beginnings in 1952 when it was first proposed that the reaction of a hydrogen fusion bomb could be controlled in such a way that it could sustain operation as an energy reactor. The reactions involve the fusing of isotopes of hydrogen, such as deuterium (^2H) and tritium (^3H). Some of the most common and efficient reactions in machines used to confine plasmas (called tokamaks) are the deuterium-deuterium (DD) and deuterium-tritium reactions. The purpose of the FIU plasma physics team's experiment involves designing a new instrument to study plasma instabilities through determining the emission profile of the charged fusion products of the DD reaction in the plasma. This emission profile describes the location and rate of protons and tritons in the plasma. The FIU plasma physics team collaborates with the Princeton Plasma Physics Laboratory and the Culham Centre for Fusion Energy (CCFE) for its research efforts of the instrument design, prototyping, testing, and validation of theoretical plasma instability models. Through our collaboration we will significantly contribute to the research through proposing the following three extended McNair projects:

1. Detector calibration is of pivotal importance as it lays the foundation for quantitative statements about the data. Fusion emission products are measured by placing four silicon surface barrier detectors (SSBDs) in the tokomak to detect particles at a range of angles inside the plasma. We must know their acceptance to confidently assess our collected data when recreating particle trajectories. In order to do this, an accurate measurement of the SSBDs' solid angle acceptance must be performed; this requires the design, simulation, and testing of said SSBDs in conjunction with a radiation source. After measuring the energy of the alpha decay products the researcher would statistically analyze the SSBDs' efficiency at different angles of incidence.
2. The nature of the plasma state is such that it forces charged particles, namely electrons and ions, into curved orbits determined by the electromagnetic fields within it. The ORBIT code is a mixture of the Fortran and Python programming languages used to model said particle orbits and simulated detector efficiencies at various orientations by means of numerical calculations. The researcher must run the code to predict the most efficient detector orientations for data acquisition and fit different parameter values for the function describing the emission profile. They must understand the electromagnetic fields and physical phenomena in the code that create the observed orbits as well as work on code development.
3. The final piece of the puzzle is the analysis of the collected data complementing the above experimental and computational portions of the project. This involves the use of signal processing techniques including subtracting background noise from the data, which requires a proper understanding of characteristic plasma parameters such as plasma current and bulk plasma temperature. Peak-height analysis will then be used to identify different particle species by their characteristic energies. The researcher will calculate the ratio of the total number of particles detected to the total number of particles created (using the neutron spectrum of the plasma) for comparison to ORBIT calculations describing the emission profile.

The final tenet of our McNair research will be a team visit during the summer of 2013 to the Mega Amp Spherical Tokamak (MAST) in the United Kingdom's CCFE. We will take shifts in collecting data, perform safety training, meet collaborators, and experience working with professionals on a large-scale international research collaboration; all of which is vital to our future careers as scientists and integral to the FIU plasma physics team's completion of on-site data collection.