CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)
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Project Number
S1712

Project Title
Behavior of Toroidally Confined Plasmas in Sub-Fusion Conditions

Abstract

Objectives/Goals
The objective of this study is to determine if a tokamak scaling law will still apply (in L-Mode) if reactor size is scaled down. Some goals include building an ultra-high vacuum capable chamber and producing a ICP within it.

Methods/Materials
Setup a Vacuum Chamber and pumped down to 10^-7 Torr. Using a RF generator (bought online) and a ion source (built by me using a car ignition coil, car battery and 555 timer circuit) a plasma was generated within the chamber. A Poloidal magnetic field was created with a coil which wound around the center solenoid. Used an langmuir probe (built by me with alumina tube, copper wire and tungsten lightbulb filament) oscilloscope and multimeter to measure plasma characteristics like electron and plasma current, number density, and other plasma parameters. Applied the tau e scaling law to my reactor to see if a correlation exists.

Results
The tau e scaling law does not stay true for extremely small reactors. The confinement time for my reactor was 8.2x10^-17.

Conclusions/Discussion
Small fusion reactors face many engineering issues that larger reactors do not necessarily have to encounter. In small reactors, magnetic confinement cannot be achieved to the same levels ass that of larger reactors due to the fact that there is superconducting material on earth that can handle the extreme heat fluxes of being very close to the plasma. Additionally, small reacotr sizes may introduce new forms of turbulence to plasmas, increasing instability and the amount of energy required to contain the plasma.

Summary Statement
I built a small scale tokamak to see if tokamak scaling laws will still apply when scaling reactor size down.

Help Received