## Chapter 2: Texas Helimak

### 2.1 Motivation

The Texas Helimak[3] has an axisymmetric, helical magnetic field. The Helimak was built to study turbulent transport in curved magnetic field geometry such as those found in the edge of a Tokamak plasma. It features potentially very long magnetic connection lengths due to the helical field wrapping from top to bottom. In addition to the curved magnetic field, it also possess velocity flow shear in the vertical direction, which has been suspected for mitigating plasma turbulence [17].

The plasma terminates on end plates at the top and bottom which allow probes to measure the plasma properties directly, which should be fairly uniform in the vertical direction. The plates can also be biased with different voltages, which can alter the plasma potentials, and thus the flows within the plasma. The vacuum chamber also has several viewports which allow spectroscopic measurements to be taken in chord integrals through the plasma. Spectroscopic measurements of plasma flow, and calculated flow shear, have been accomplished [16][18].

### 2.2 Structure

The Helimak vacuum chamber is a toroid with a rectangular cross section depicted in figure 2.1. The inner radius of the vacuum chamber is 0.6m and the outer radius is 1.6m. The height of the chamber is 2m. The chamber is surrounded by a series of electromagnetic coils to produce a helical magnetic field. The toroidal component of the field is generated from 16 equally spaced coils encircling the chamber. This field will inherently drop off as 1/r due to the curvature of the field. The vertical component of the field is generated by three axially aligned coils. The relative strength of the vertical and toroidal fields can be varied independently to make many different helical field pitches, and the resulting connection lengths from the top of the chamber to the bottom. The magnetic field strength generated is in the range of 500-1300 gauss [3][23].

The shot frequency of the Helimak is limited only by the heating of the magnetic field coils, which are only cooled by air flow. A typical number is about 100 shots per day with casual running with breaks given for cool-down. A peak frequency is about one shot every 1-2 minutes, each lasting about 30 seconds.

The plasma is produced by microwave RF input power up to 6kW at a frequency of f= 2.45 GHz. The generator is a single magnetron located below the chamber, and the power is fed in through a wave-guide window on the inner radius near the bottom of the chamber. The RF is polarized with the electric field perpendicular to the magnetic field on the high-field side until it reaches the electron-cyclotron resonant heating (ECRH) point at where much of it would be absorbed. Some RF power that is not absorbed at the ECRH location also heats the plasma at the upper-hybrid resonance at other locations in the plasma.

|  |  |
| --- | --- |
|  |  |

Figure 2.1: External and internal view of Helimak

The vacuum chamber has many access ports, not all of them are used. One on the side, bottom half, is used for pumping, gas feed, and pressure gauge readings. The ionization gauge used for pressure readings in this thesis is connected through this port. The gas feed is accomplished with a variable leak valve feeding into the same port, but vents directly into the chamber and not through the pumping tube.

A port located on the bottom of chamber has a viewport which extends for about 40cm near the R=1m location. This is the expected location of the profile peaks of the plasma, and is used for all spectroscopic measurements in this thesis. The top of the chamber above the viewport does not have a specific viewing dump, which could affect measurements by scattered light into the optics. This would cause an over-estimate of the absolute radiance of the plasma. However, resulting measurements are near their expected values.

Plasma termination plates are located on the top and bottom of the chamber in two locations, separated by . The plates extend 28cm from the top and bottom, and serve as probe mounts to measure plasma parameters. They can also serve as bias plates, which allow the potential within the plasma to be altered by changing the voltages on the plates.

### 2.3 Plasma Parameters

A typical plasma in the Helimak has a peak on the order of 10eV, a peak of order , and neutral back-fill pressure of order . The particle confinement time is estimated to be on the order of [3]. Plasma profiles from a 6kW Argon discharge are shown in figure 2.1.

|  |  |
| --- | --- |
|  |  |

Figure 2.1: and profiles for Argon shot from probe measurements.