ABSTRACT - A 10 kW, CW, 28 GHz gyrotron is being implemented on LDX to increase the plasma density and to more fully explore the potential of high beta plasma stability in a dipole magnetic configuration. Higher density increases the heating of ions by thermal equilibration and allows for improved wave propagation in planned ICRH experiments. This represents over a 50% increase over the present 17 kW ECRH from sources at 2.45, 6.4, and 10.5 GHz. The higher frequency will also make possible access to plasma densities of up to 10^11 cm^-3. The 1 Tesla resonances are located above and below the floating coil near the dipole axial region. The gyrotron beam will be transmitted in TE01 mode in 32.5 mm diameter guide using one 90° bend and a short < 5 m straight waveguide run. A Vlasov launch antenna in LDX will direct the beam to the upper 1 Tesla resonance region. A layout of the planned system is presented.

28 GHz Gyrotron Installation at LDX

**Motivation**

- Advance to more fusion relevant plasmas
  - 10 kW ECRH power increase
    - > 50% increase over present ECRH (17 kW)
  - Increase plasma density
    - 10^11 cm^-3 density cut off limit (tokamak regime)
  - Enable new physics investigations
    - Higher density will increase j and improve thermal equilibration with ions
    - Higher density will improve wave propagation for planned ICRH experiments

**Current ECRH heating capability is a maximum of 17 kW**

- 2.45 GHz magnetrons, 2.5 & 1.9 kW
- 6.4 GHz klystron, 2.5 kW
- 10.5 GHz klystron, 10 kW

**Density Increases with ECRH Power**

- Data to date shows electron density increasing linearly with ECRH power

**28 GHz EC Resonances in LDX**

- A diverging 28 GHz beam will be launched by a Vlasov antenna
  - The beam will be incident on the upper dipole plasma region
  - The incident beam will be linearly polarized and mostly at oblique angles to the magnetic field direction
  - Reflections and propagation down the donut hole should distribute the 28 GHz absorption around and above/below the dipole

**Circular TE0, Transmission Line**

- The gyrotron cabinet location and LDX vacuum port entry have been chosen to simplify the transmission line as much as possible
  - Main transmission losses due to:
    - Tilts and offsets
      - Waveguide bend
      - Window
  - Water cooling will be implemented to allow continuous plasma operation > 1 min.

**New Vacuum Port Installation**

- 28 GHz ECRH system is being rapidly implemented on LDX
  - Will be available for next plasma campaign

**Tilt and Offset Losses**

- Waveguide overmoding is small, D/λ = 3.2, with good tolerance for imperfections
  - Tilt mode conversion to TE0, TM0
    - Offset mode conversion to TE0
  - Commercial (GPO) corrugated TE0 waveguide is a perfect null bend with low losses corresponding straight TE0 waveguide

**Beam Dump Water Load**

- A beam dump will be implemented for testing and calibration between LDX plasma campaigns

**Beam trapping cavity with PTFE water line**

- For water flow of ~ 0.5 liter/sec, temperature rise will be ~ 20°C for 10 kW cw operation