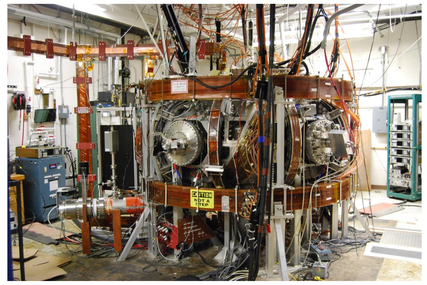


CTH parameters

5 field periods — **discharge duration ~0.1s**

R_o = 0.75 m — **n_e ≤ 5 x 10^{19} m^{-3}**

a_{vessel} = 0.29 m — **T_e ≤ 200 eV**

a_{plasma} ≤ 0.2m

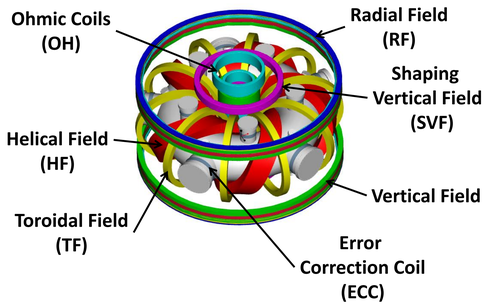
B_o ≤ 0.7 T

P_{input} ≤ 15 kW ECRH ~ 200kW OH **I_p ≤ 80 kA**

~ 150 kW 2nd Harmonic x-mode (under construction)

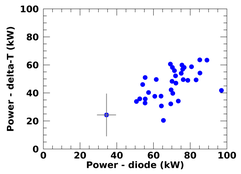
Vacuum transform 0.02 – 0.35 **<β> ≤ 0.2%**

CTH has a flexible coil set that allows for exploration of multiple magnetic field configurations



VGA-8050M pulsed gyrotron oscillator

Gyrotron, magnet control, and 75kV PS



Output power to date
Into dummy load

Gyrotron and components
up to the polarizer

Overview

- ❑ The CTH laboratory is installing a 200 kW, 28 GHz gyrotron for plasma heating at 2nd harmonic.
- ❑ Target plasma generation will be achieved with 6kW, 17.65 GHz and 18 GHz klystrons operating at the fundamental.
- ❑ ECRH power absorption for two launch positions is modeled using the TRAVIS[1] code. It is shown that launching from the top-port location gives better absorption of the microwave power than launching from a side-port location.
- ❑ The waveguide path from the gyrotron to the CTH device is shown as well as the design for the final beam launcher.
- ❑ The TE02 mode produced by the gyrotron is converted to TE01. This is then converted to TE11 with a polarizing element. The TE11 mode is converted to HE11.
- ❑ Low loss, corrugated waveguide is used to transmit the power to the CTH system.
- ❑ A 2λ thick, fused quartz window separated the CTH vacuum from the atmospheric pressure in the waveguide.

Motivation

- ❑ Generate hotter plasmas that are relevant to studying stellarator physics, including the possibility of performing divertor studies.
- ❑ Hotter plasmas also allow access to higher ionization states for spectroscopic calibrations and studies.

References and acknowledgements

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[1] Marushchenko et al., *Comput. Phys. Commun.* **185**, 165 (2014)

The CTH laboratory is grateful to Max Planck IPP-Greifswald for permission to use the TRAVIS code, to ORNL for the loan of the 28 GHz gyrotron, and to the HSX laboratory of the University of Wisconsin for the loan of RF transmission line components.

TRAVIS modeling used to determine launch position

- ❑ TRAVIS is an electron cyclotron wave ray tracing codes for non-axisymmetric toroidal equilibria
- ❑ 3D stellarator equilibrium modeled with VMEC
- ❑ Necessary because 3D geometry of stellarator equilibrium has strong impact on ray trajectories and absorption; magnetic field geometries vary with toroidal angle
- ❑ X-mode, 2nd harmonic assumed for all modeling

I. Launch through side-port into radial B-gradient

n_{eo} = 3.0 x 10^{18} m^{-3}, T_{eo} = 200 eV

n_{eo} = 4.0 x 10^{18} m^{-3}, T_{eo} = 400 eV

II. Launch through vertical port into saddle structure

1. Breadth of resonance makes its location sensitive to magnetic field strength

n_{eo}= 3 x 10^{18} m^{-3}
T_{eo} = 200 eV

2: Refraction is significant; launch position has effect

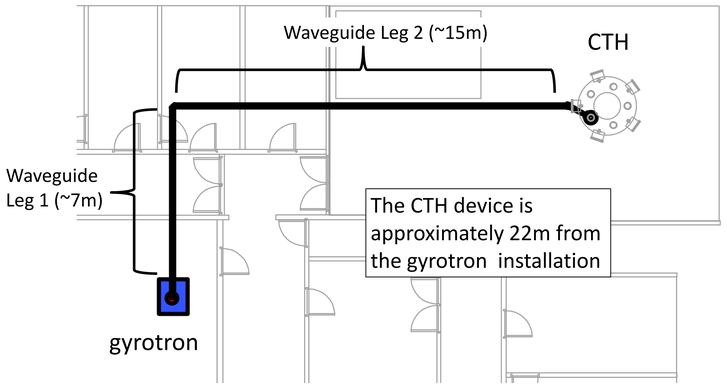
3: Top-launched beams will undergo greater refraction due to the non-normal incident angle, and may limit effective heating to density n_{eo}≤ 0.3 x10^{19} m^{-3}.

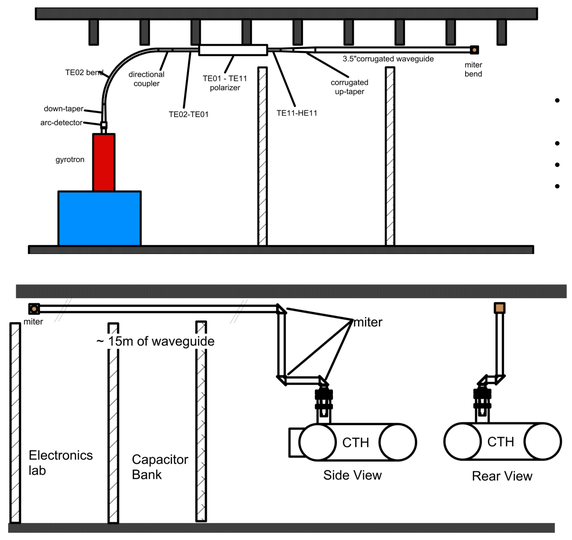
n_{eo} = 2 x 10^{18} m^{-3} n_{eo} = 3 x 10^{18} m^{-3} n_{eo} = 4 x 10^{18} m^{-3}

- **Predicted deposition within inner half**
- **Most power absorbed on passing particles**

Power Deposition Profiles

Waveguide path and components





Waveguide Leg 1

- Measure forward and reflected power with directional coupler
- Convert TE02 – TE01 – TE11 – HE11
- Polarization is continuously variable
- Transition to corrugated waveguide

Waveguide Leg 2

- Main transmission leg - 15m
- waveguide is corrugated for low loss transmission of the linearly polarized HE11 mode with a Gaussian-like antenna pattern
- Miter bends used to route power to CTH plasma

Top port launch hardware