Introduction

- The Columbia Non-Neutral Torus (CNT)
- Stellarator with world’s lowest aspect ratio (≥ 1.99) [1]
- Established for study of pure-electron and arbitrarily neutral plasmas [2,3]
- Now repurposed for studying quasi-neutral, electron cyclotron heated plasmas
- Prospects for high β with increased heating power due to low magnetic fields.

Radial profiles

- Profile structure is partly determined by the current ratio in the interlocked vs. poloidal field coils
- Relatively flat temperature profiles suggest broad power deposition
- Density fluctuations observed in edge islands

ECRH/e-beam synergy

- Electron beams are emitted from a heated, biased filament at background pressures of ~ 10⁻³ Torr
- Plasma density in presence of ECRH and e-beam exceeds sum of densities of plasmas created by either source individually

10 kW ECRH heating system design

- Waveguide system designed to maximize first-pass absorption
- Vacuum break placed near plasma edge to avoid 2nd harmonic excitation
- Launcher enters vessel at oblique angle to aim at resonance near plasma core
- External twist-flex waveguide with rotatable taper will enable continuous transition from O to X polarization

Numerical and experimental diagnosis of error fields

- Observed flux surfaces differ from ideal Poincaré traces
- Rotational transform has systematic offset
- Symmetry-breaking 3/1 island chain observed
- Improved agreement:
  - Internal coils tilted by 0.75° to shift rotational transform
  - PF coils displaced according to photogammetry data:
    - Measurements taken by S. Balthasar et al. [PPPL] and P. Traverso (Albany U.) [5]

Equilibrium calculations

  - Low aspect ratio makes CNT simulations computationally demanding
  - Fixed-boundary simulations are acceptable for the low-beta plasmas currently produced
  - Simulating high β will require a free boundary; lower spatial resolution

Boundaries with highest attainable resolution

References

1. T. S. Pederson et al., Physics of Plasmas 13, 2006
4. Strzhel et al., Nuclear Fusion 36, 1996