Light Ion Helicon Studies on Mini-RFTF

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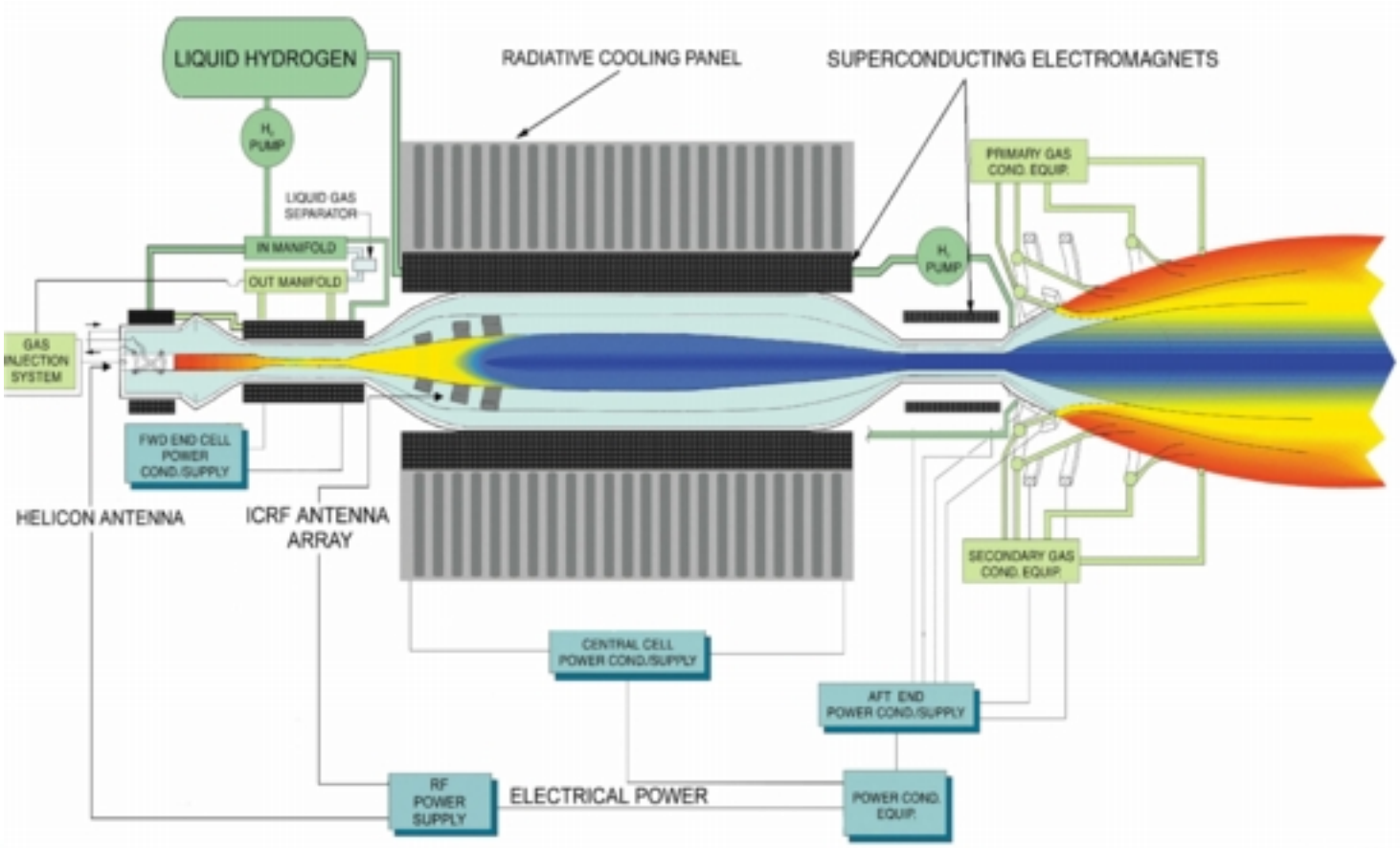
Outline

- Introduction
- Description of Mini-RFTF
- Recent results
- Summary and future plans

Recent results

- **Two antennas have been used: a single twisted-helical antenna and a double twisted-helical array.**
- **Observations:**
  - **High density hydrogen and deuterium operation with $\omega \leq \omega_{LH}$.**
  - **A high downstream mirror field is necessary to reach 10^{13} cm^{-3} in H_2.**
  - **The higher the mirror ratio the higher the maximum density.**
  - **No change in fluctuation level is observed as the mirror field is varied.**

VAriable Specific Impulse Magnetoplasma Rocket Schematic



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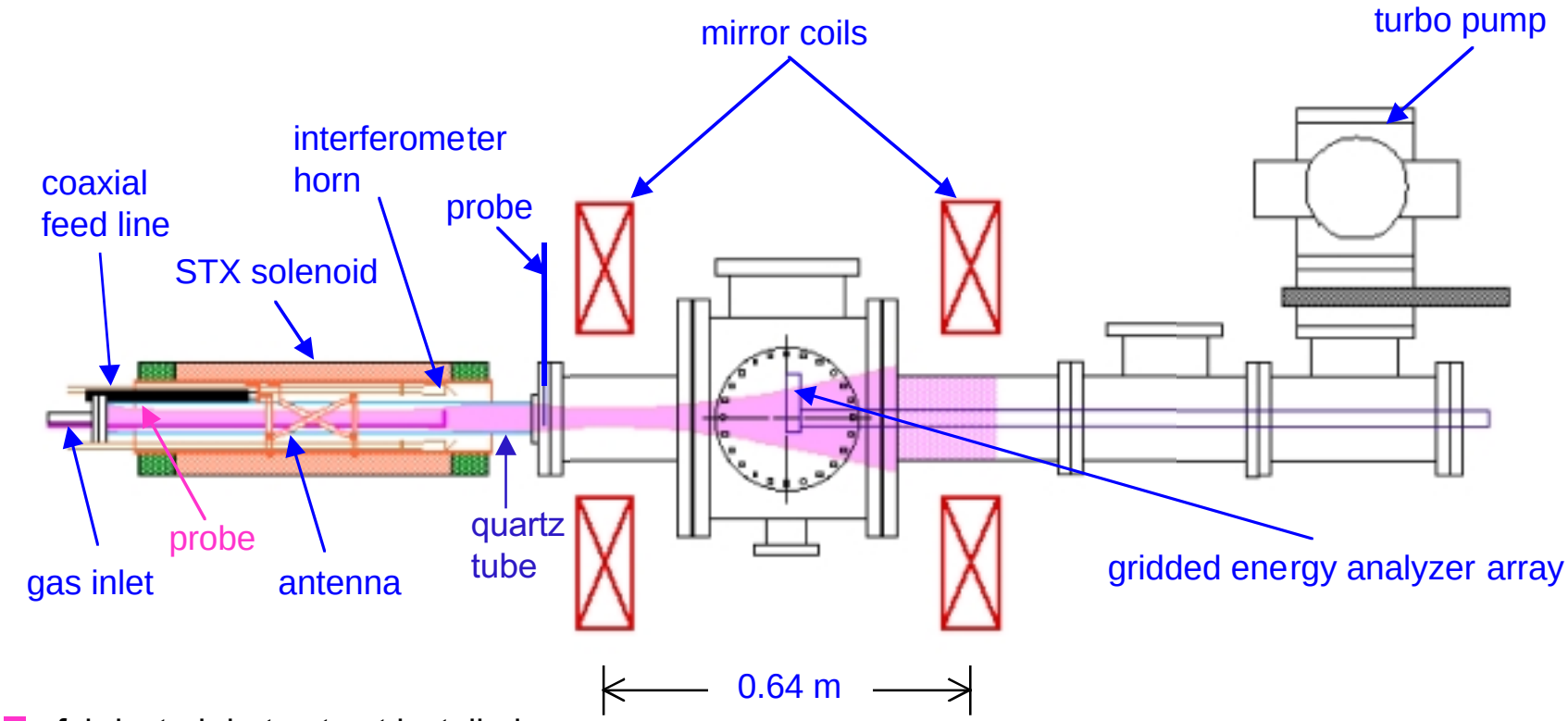
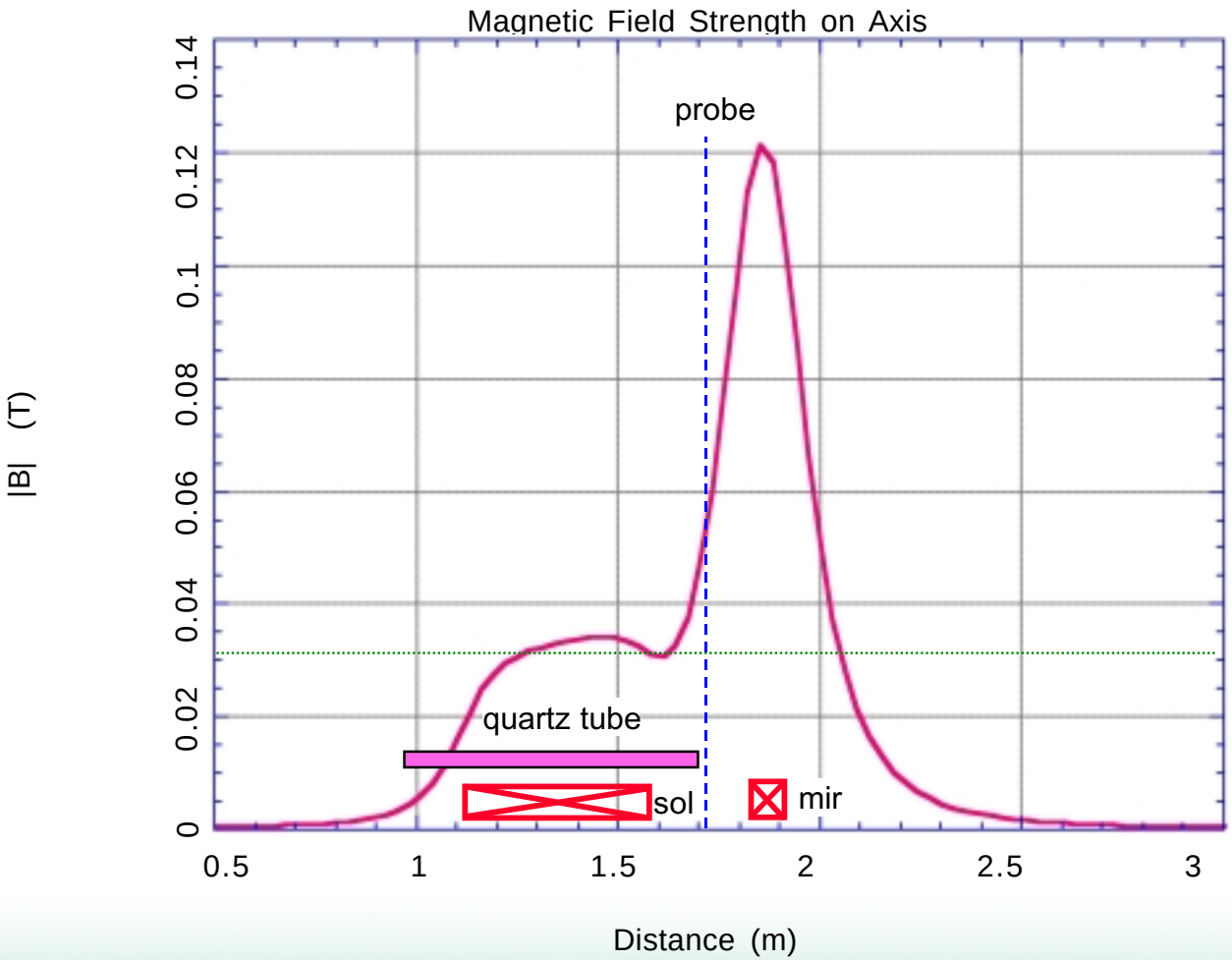
Mini-RFTF with STX solenoid



- fabricated, but not yet installed

Magnetic field configuration for hydrogen operation with downstream peak

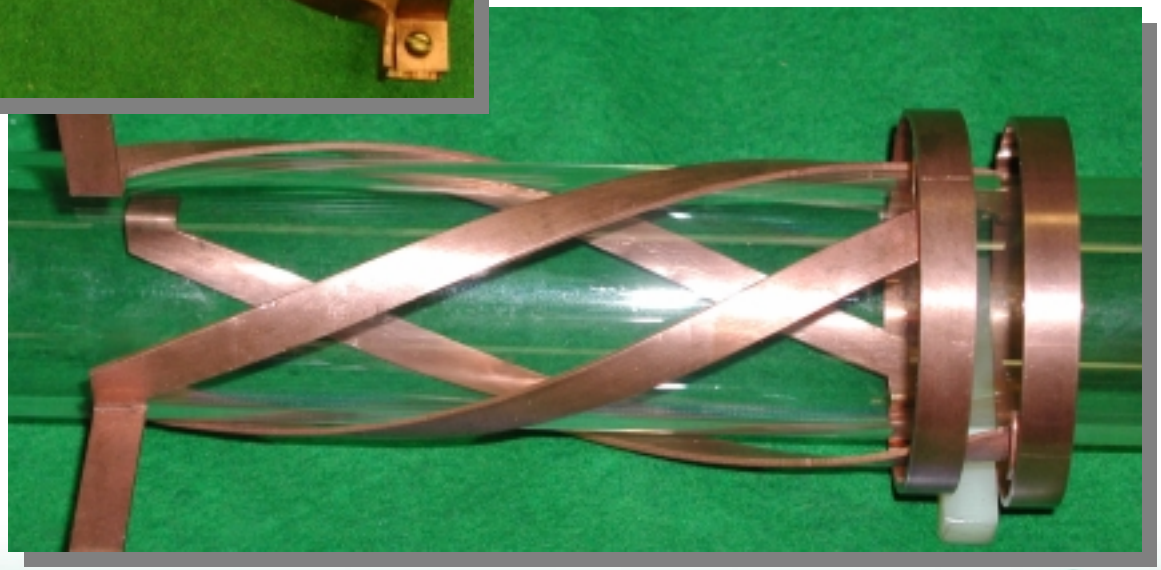


Field profile for a mirror ratio of 4

$\omega = \omega_{LH}$

Solenoid Current = 75 A
Mirror Coil Current = 750 A

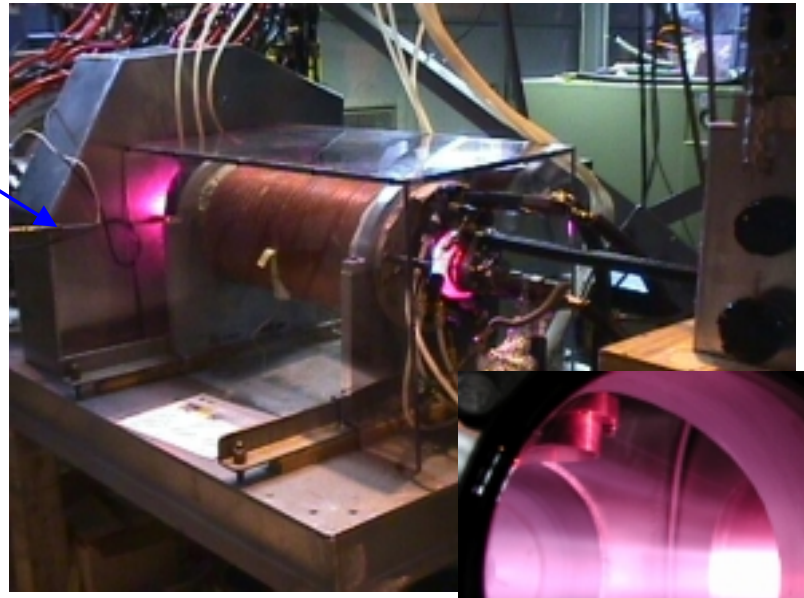
Single antenna and phased antennas have been used



Hydrogen plasma operation

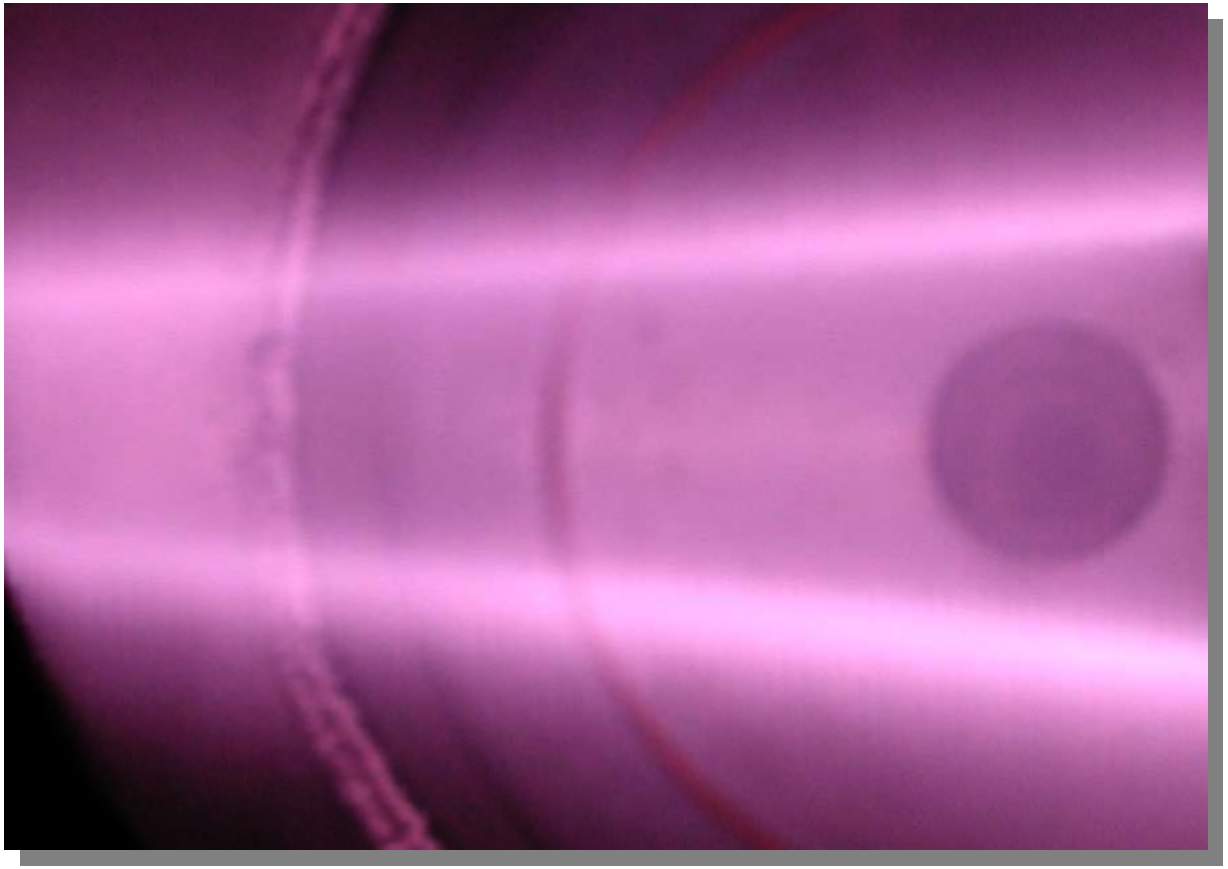
EXHAUST END VIEW

Langmuir probe



SIDE VIEW

A hollow discharge is sometimes observed



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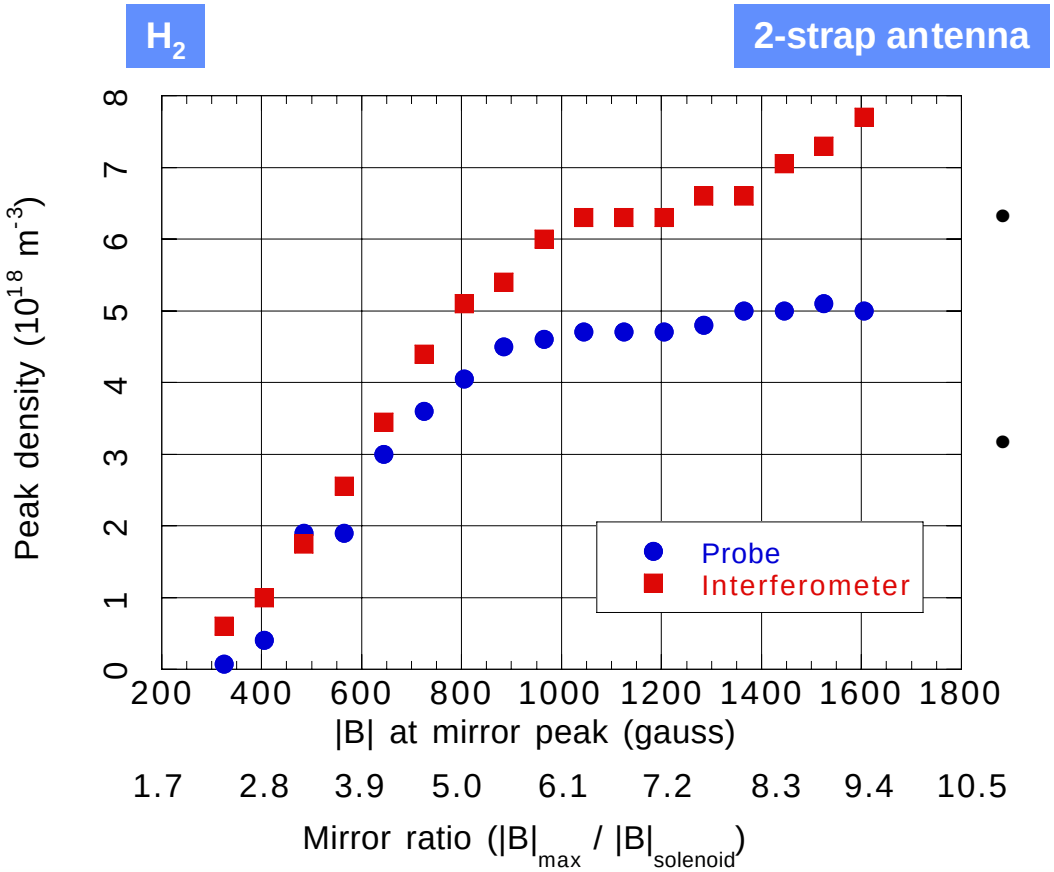
Source operation with hydrogen requires downstream mirror peak to attain high plasma density

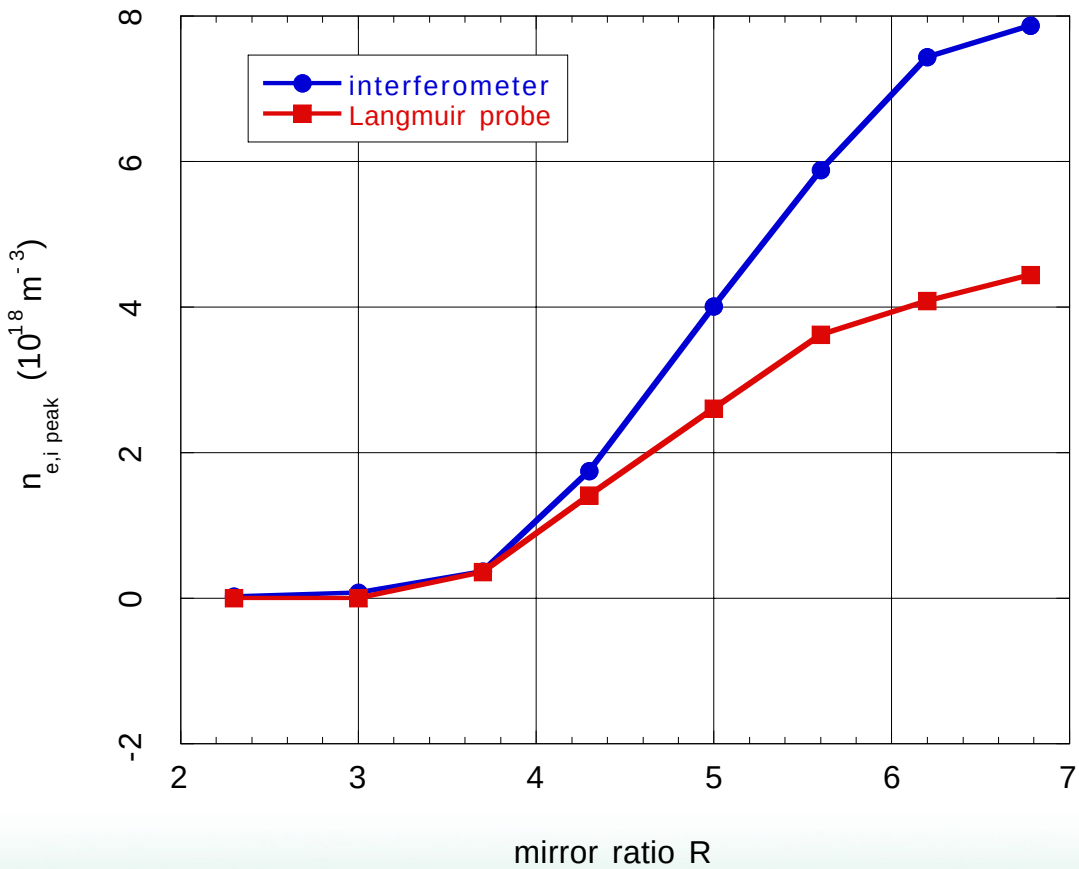


- **Plasma density increases linearly with |B| for mirror ratio R ≤ 5.5, then begins to saturate**
- **Interferometer again sees increase with R for R ≥ 8.3**

Deuterium Mirror Ratio Scan

D_2

4-strap antenna



- $|B_{helicon}| \sim 225$ G
- Maximum near R = 8? (Need larger power supply to check)

For H_2 peak density occurs very close to the lower hybrid resonance

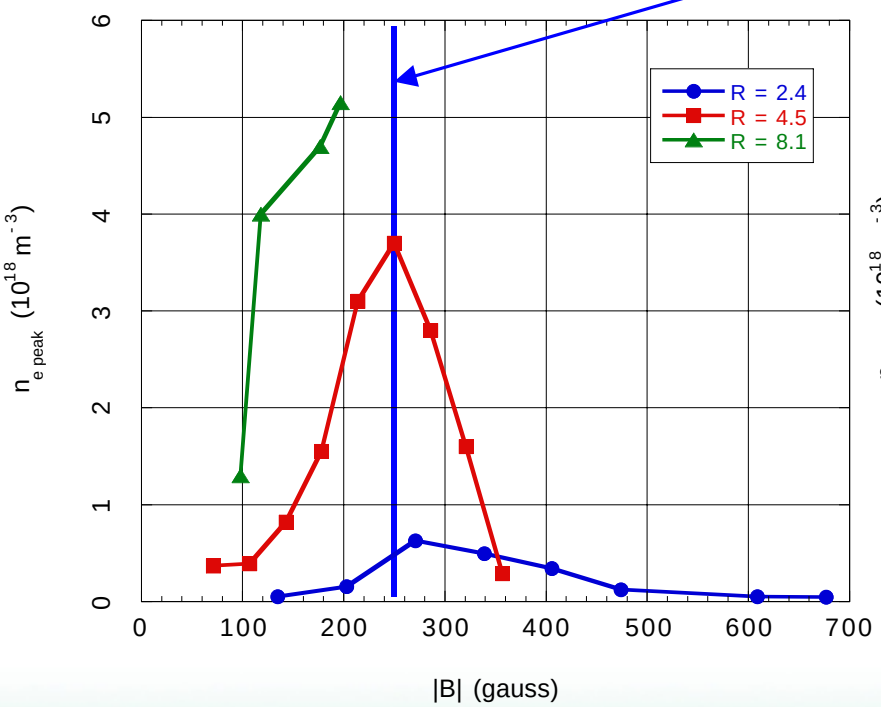
H_2

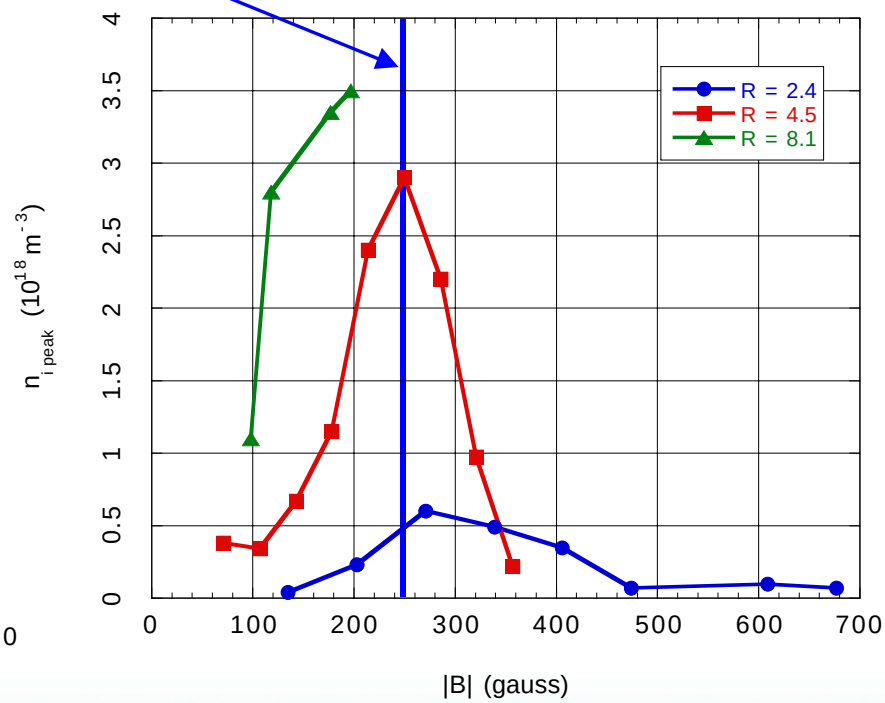
4-strap antenna

Interferometer

16 MHz = LH resonance

Langmuir probe





For D_2, the peak density occurs when f is below the lower hybrid resonance

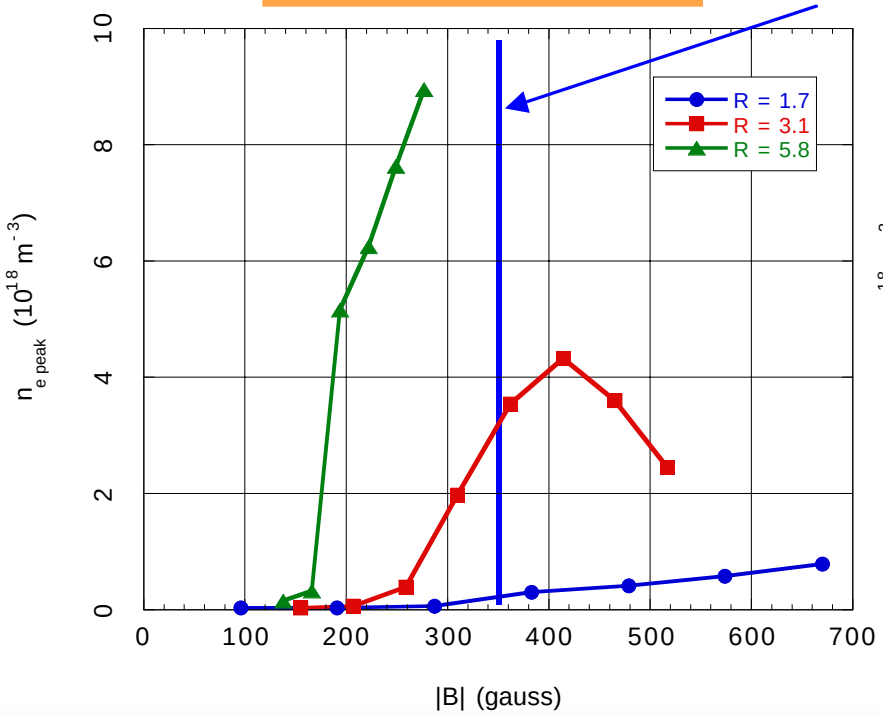
D_2

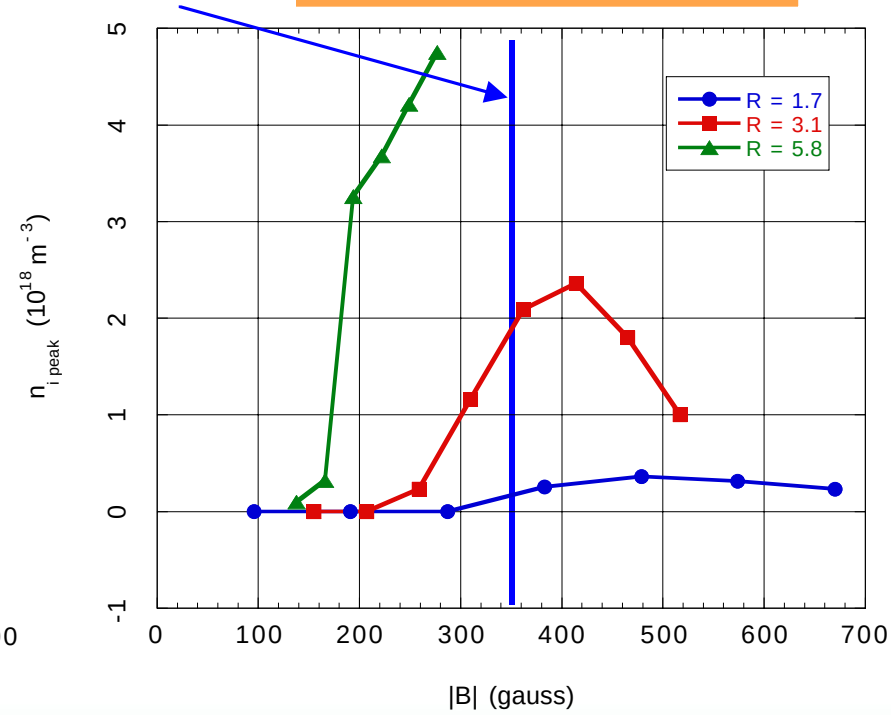
4-strap antenna

Interferometer

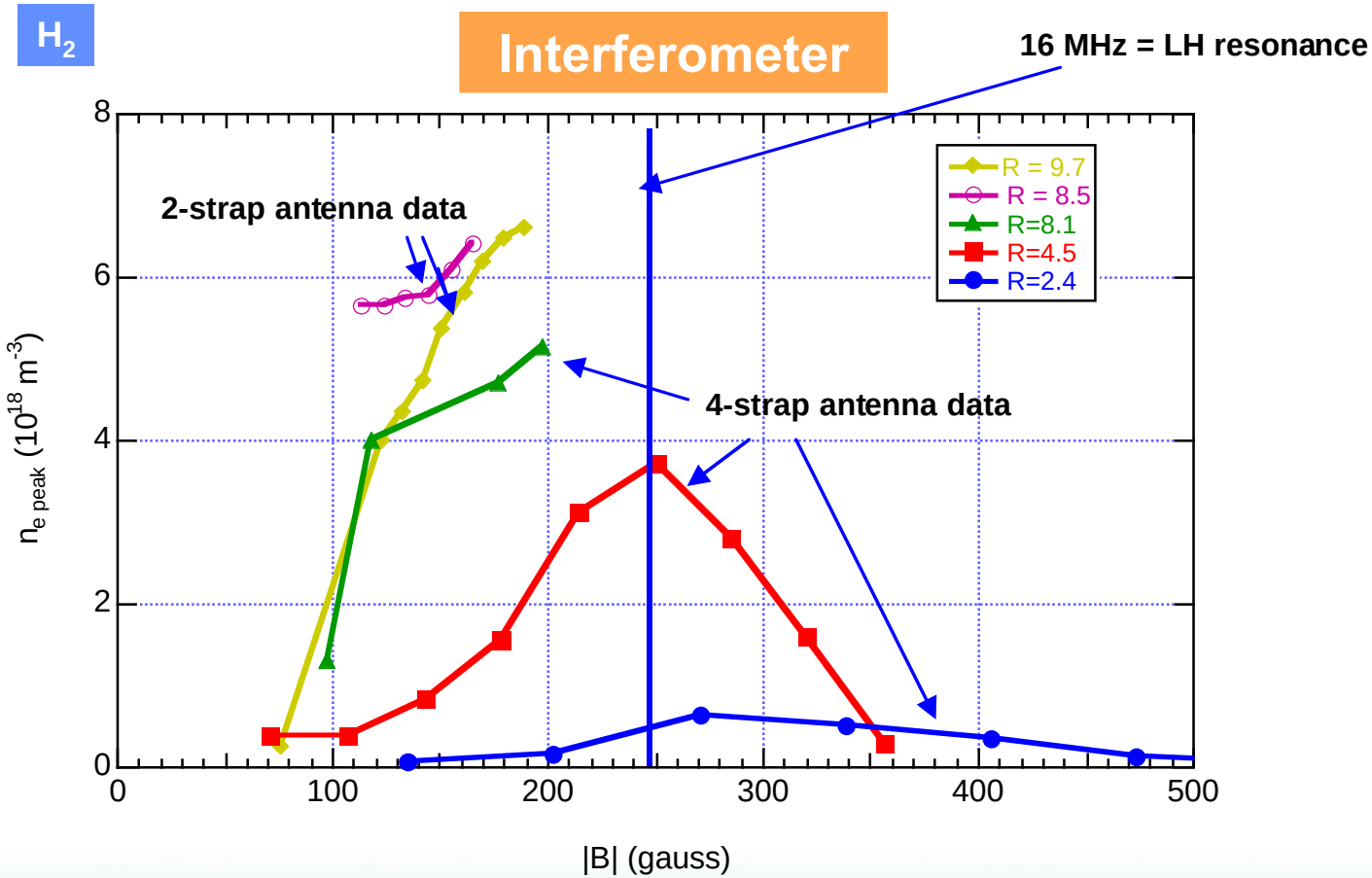
16 MHz = LH resonance

Langmuir probe





The 2-strap antenna density is larger, but the operating range is restricted



Summary

- A high downstream mirror field is necessary to reach 10^{13} cm^{-3} in H_2.
- The higher the mirror ratio the higher the maximum density (at least to the limit of the present power supply).
- No change in fluctuation level is observed as the mirror field is varied.
- The 2-strap antenna array produces higher density, but requires less RF power.
- The 4-strap antenna has a wider operating parameter space.

Future work

- Re-examine plasma production at higher frequency in $\omega < \omega_{LH}$ regime and with higher B field capability
- Optimize plasma production efficiency through
  - Antenna configuration
  - Gas feed configuration
  - Scan of frequency, magnetic field, mass flow rate, etc.
- Perform RF magnetic field measurements in source and expansion chamber
- Perform ion energy and plasma potential measurements using RPAs