FRC Experiments on FIX Apparatus

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- Translation
- Neutral Beam Injection
- Axial Compression
- Heating by Low Frequency Wave
- (RMF Experiment)

"Translation" for NBI Experiment

- to improve accessibility
  metal chamber with quasi-DC field
- to introduce NB deep into the plasma
  decompress from $n = 5 \times 10^{21}/m^3$ to $n = 5 \times 10^{19}/m^3$
- to improve confinement
  scrape off external flux (decompress and increase x_s)
  to increase P_{NB}/P_{loss} (P_{loss} ; 3MW, P_{NB} : 0.5MW)

Translation Experiments (result)

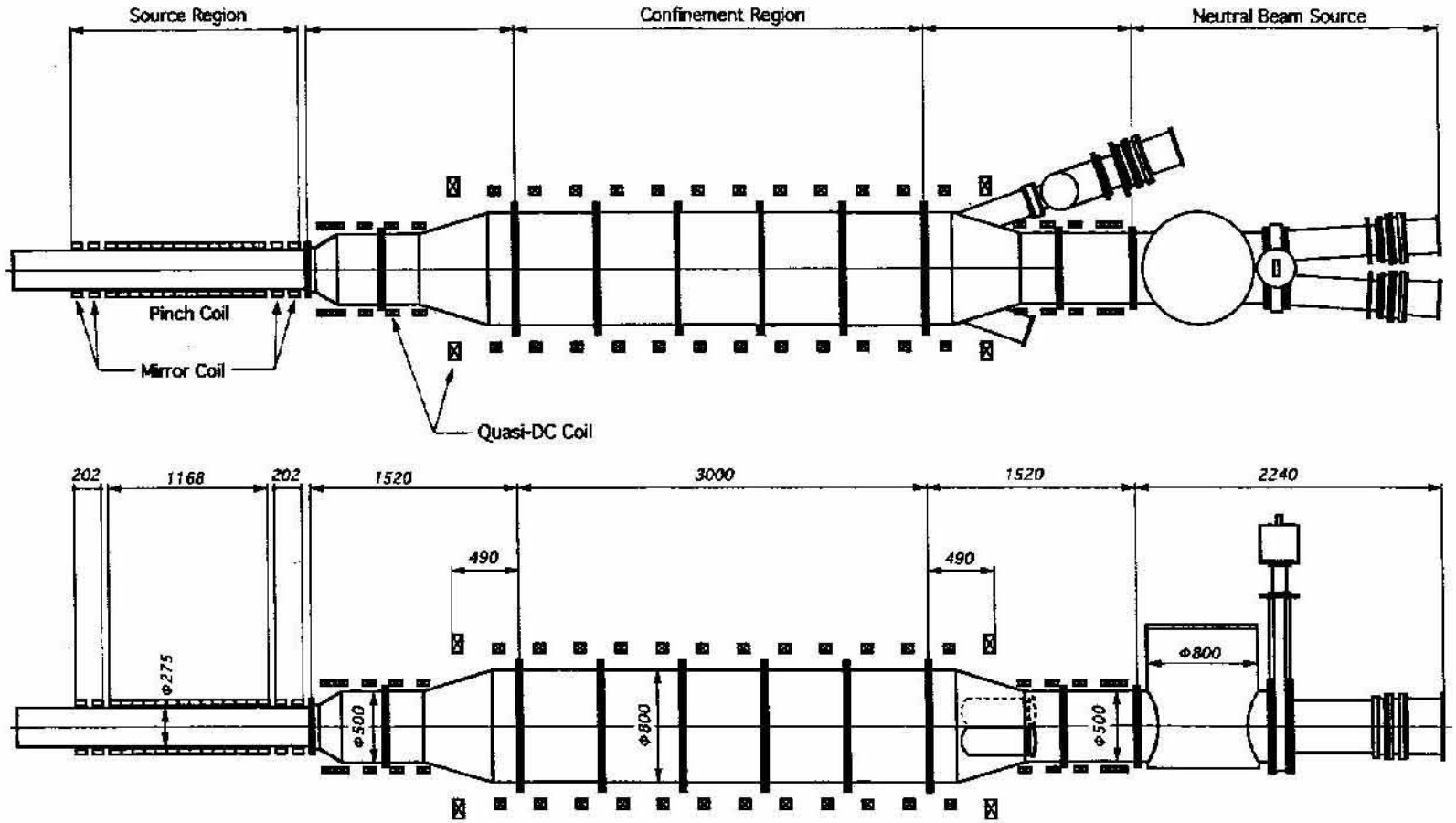
- realized $n = 5x10^{19}/m^3$
- realized $x_s = 0.6$
- x5 improvement in τ_N scaling

- rethermalization
- $B_{toroidal}$ generation and its gradual decay

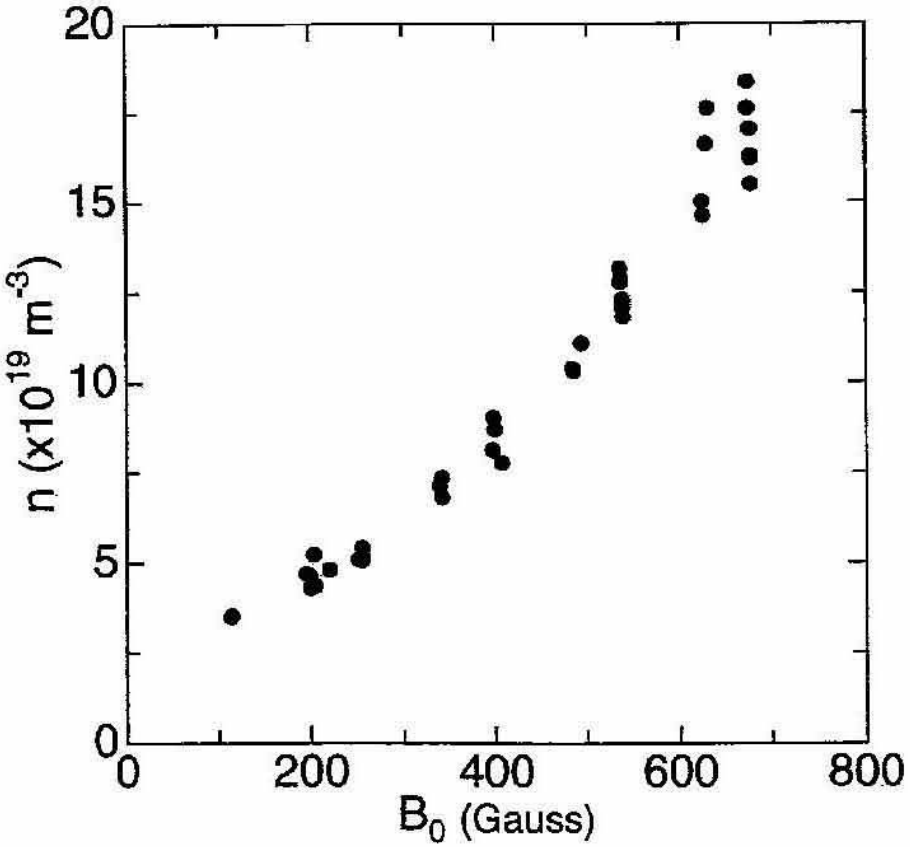
FRC Injection Experiment (FIX) Apparatus

top view

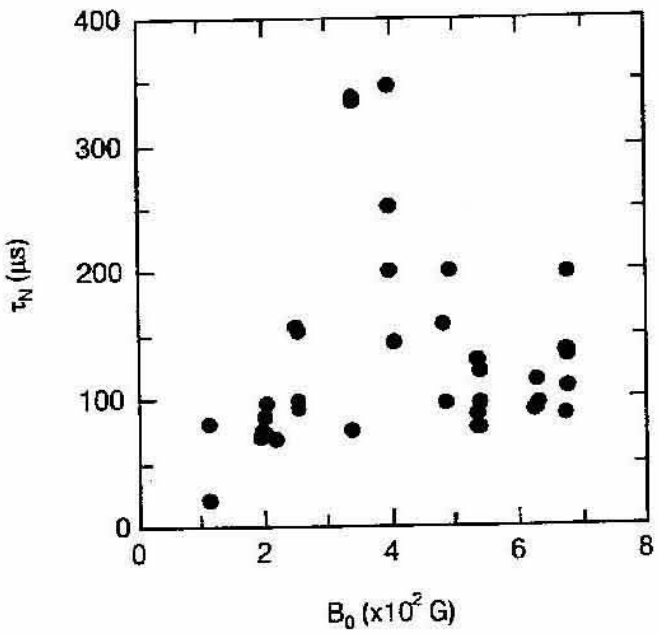
side view

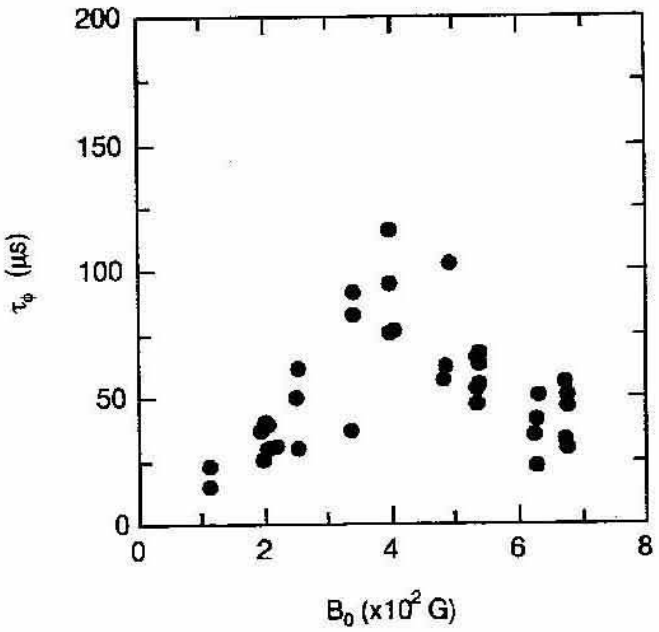


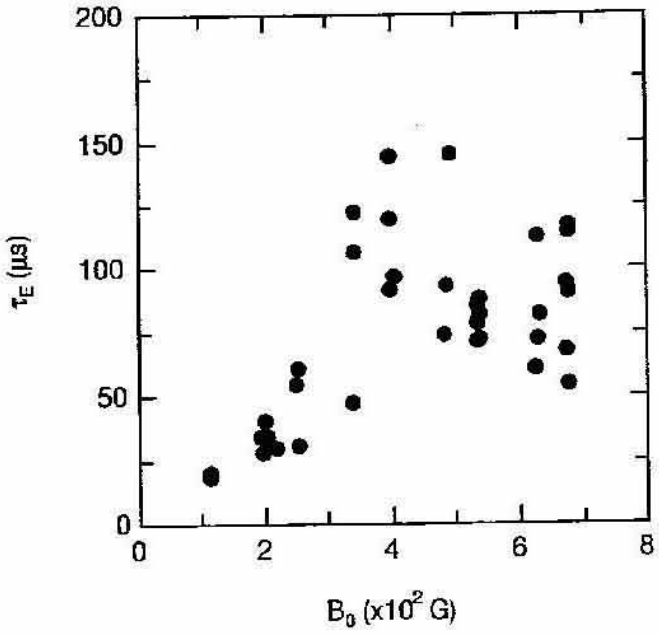
Attained Density by Translation (dependence on bias field)



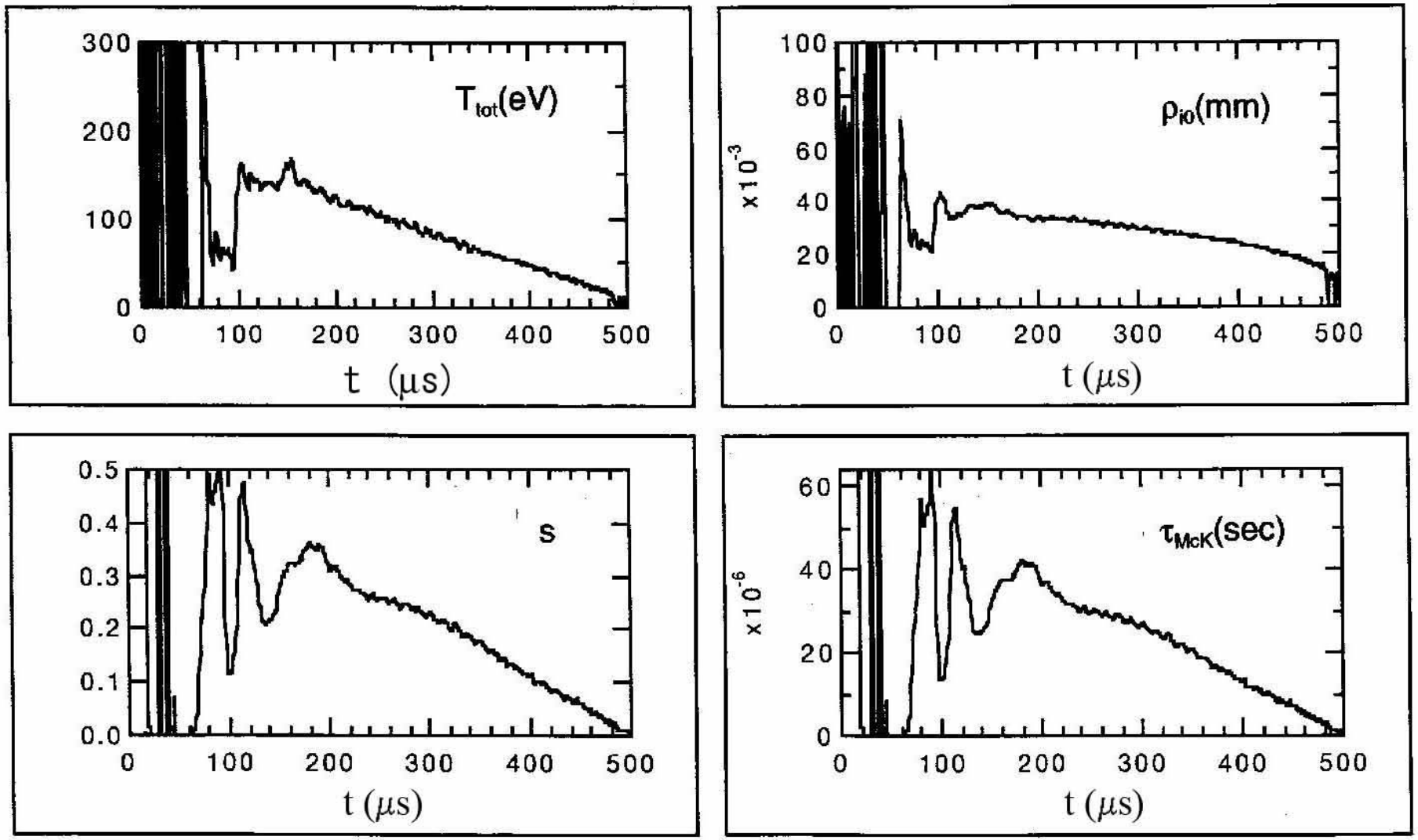
Attained Confinement Times by Translation





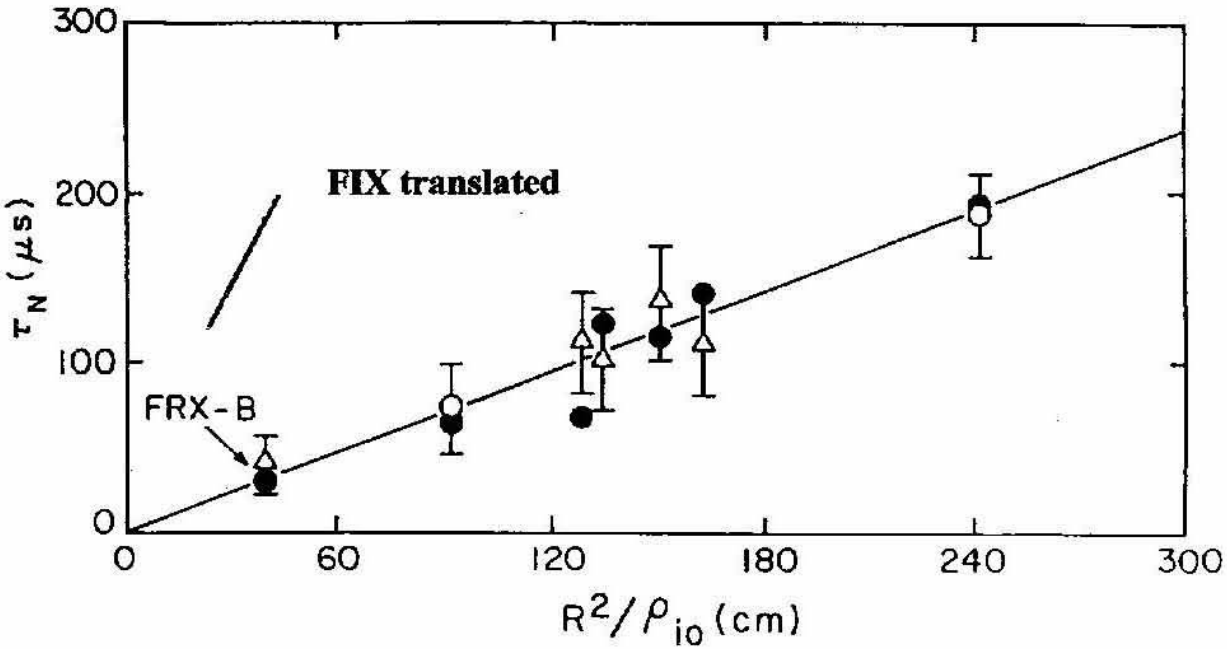


Parameters of Translated FRC

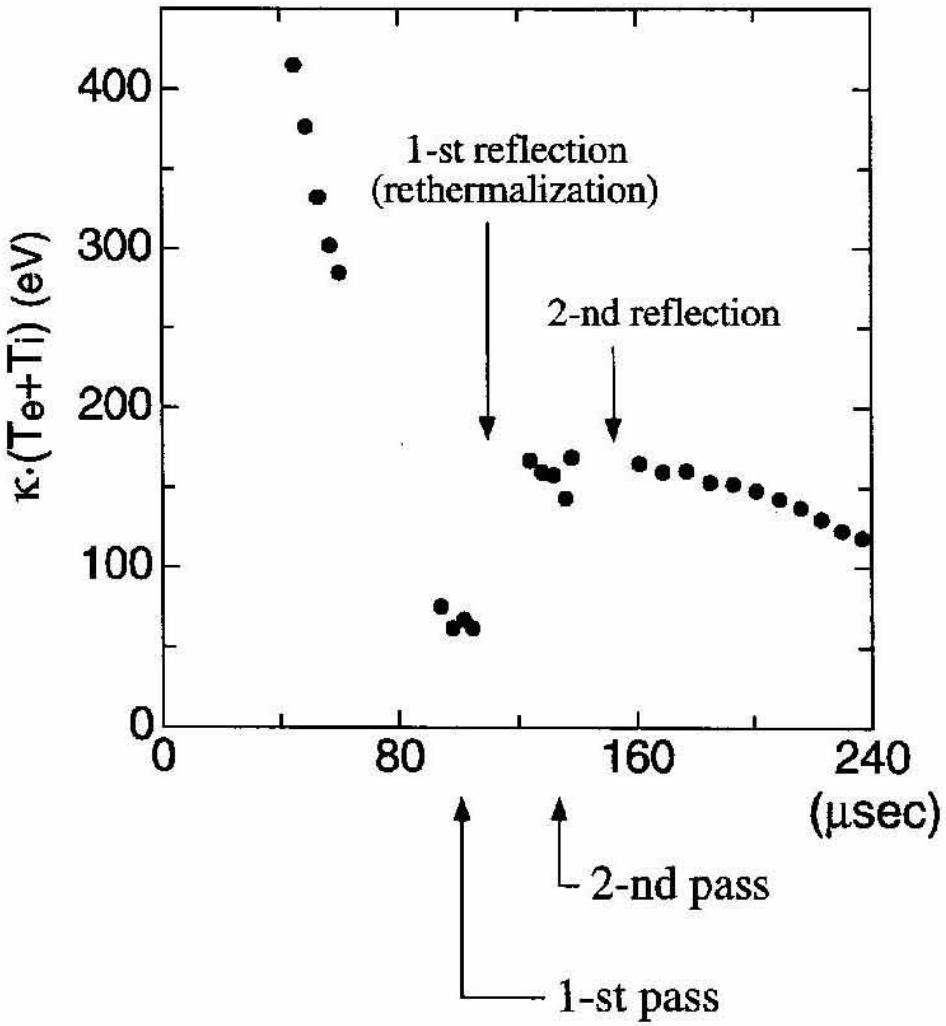


Empirical Scaling Law of τ_N

$$\tau_N(\text{sec}) = 6.4\times10^{-5} R^2/\rho_i(\text{m})$$



Rethermalization



Axial compression to Reduce P_{loss}

- improve confinement
  attain larger x_s than by the translation

- decrease P_{loss}
  by avoiding thinning of r_s in decay process

  τ_E nearly equal to $\tau_N/2$ proportional to R^2/ρ_{i0}

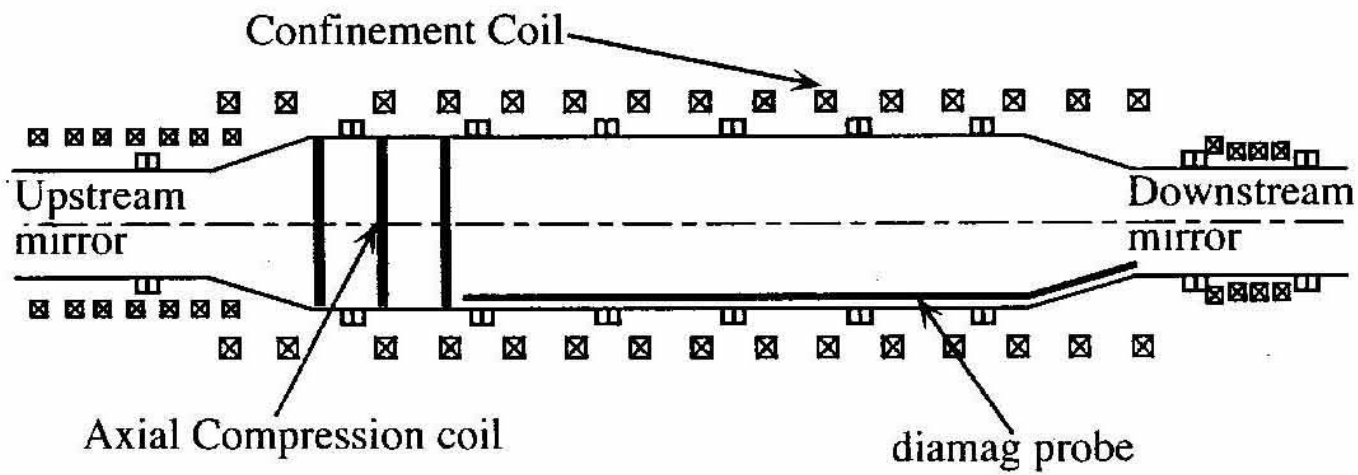
  $E = (5/2)\pi r_s^2 l\, n\kappa T$

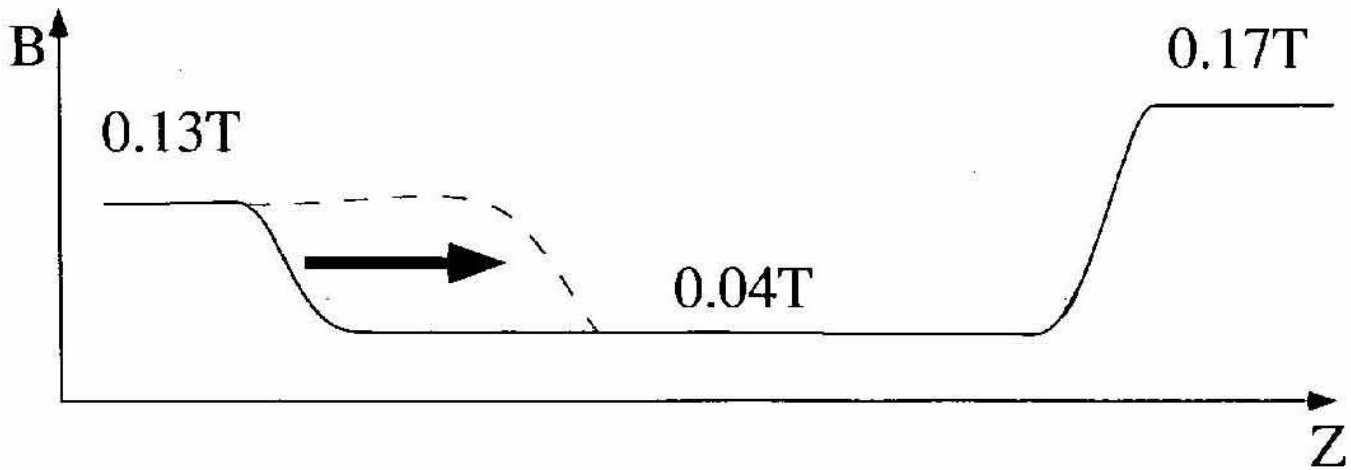
  $P_{loss} = dE/dt = E/\tau_E$

  ; P_{loss} decreases with l

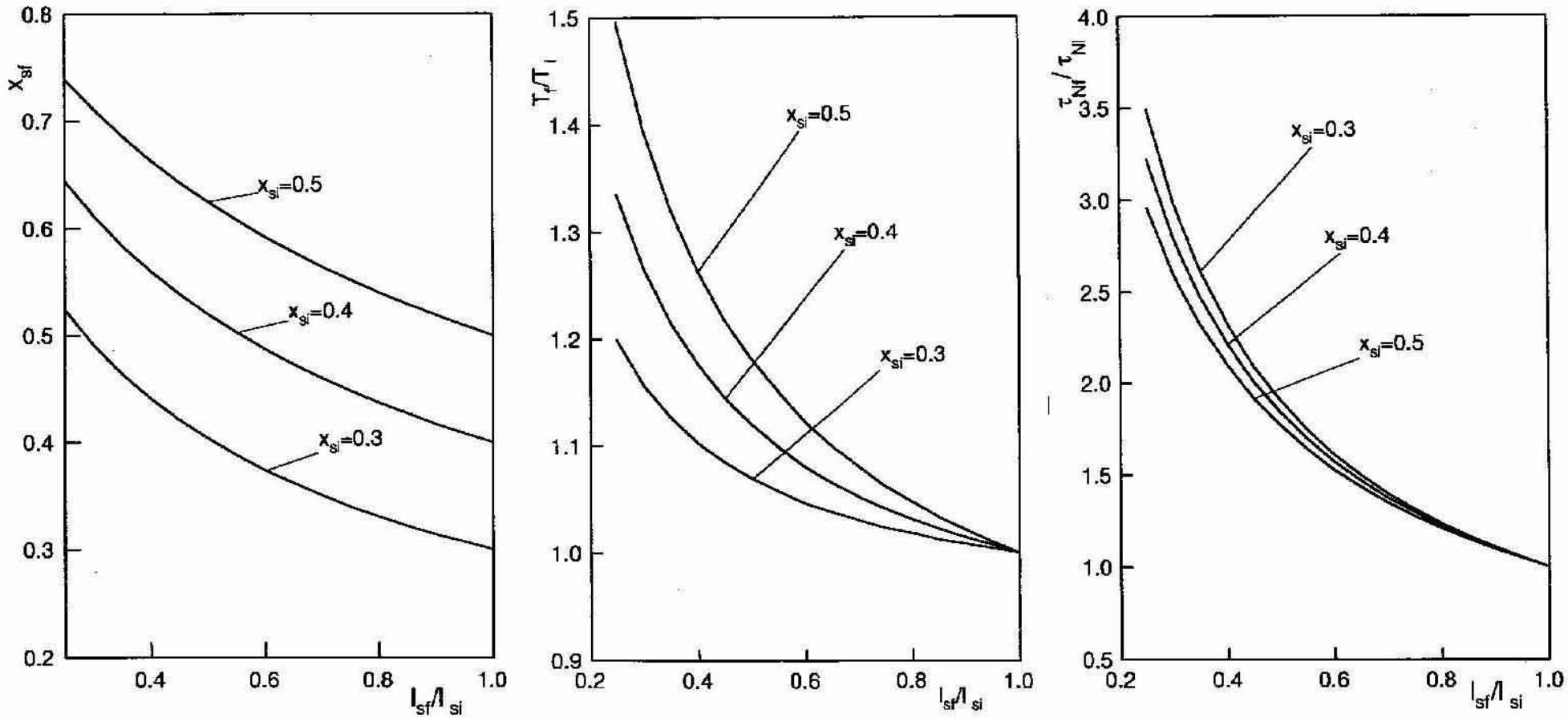
  if r_s and $n\kappa T$ are kept constant

Scheme for Axial Compression Experiment

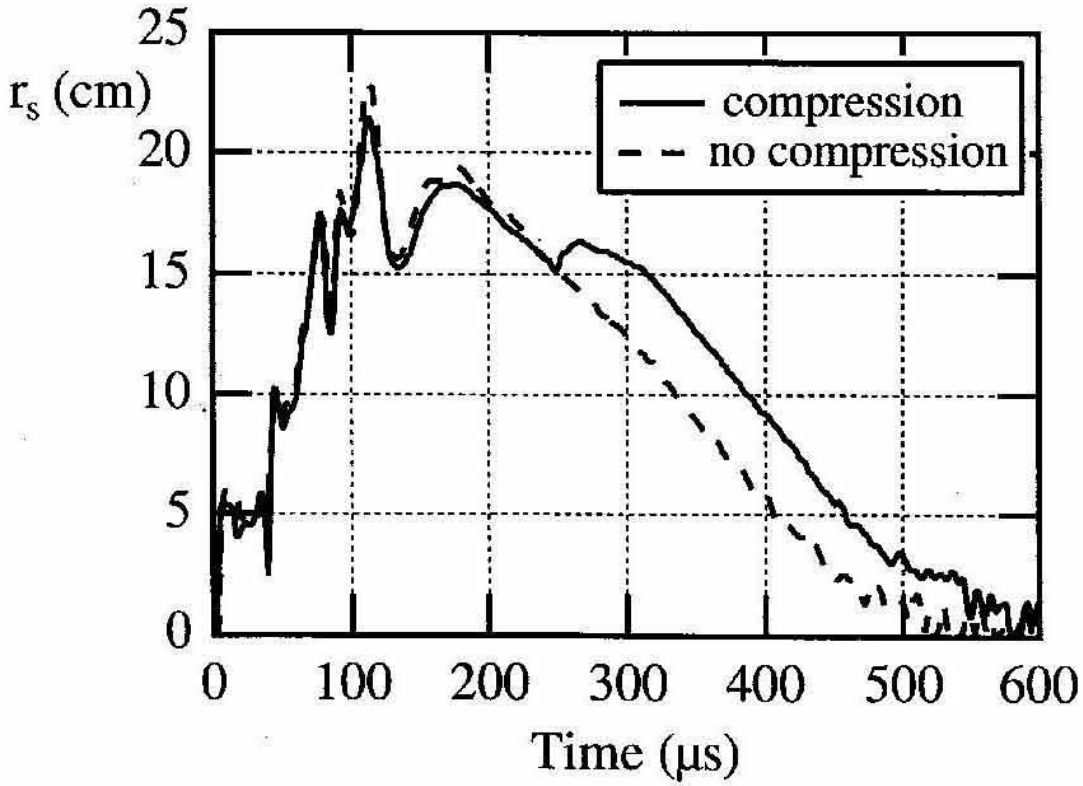




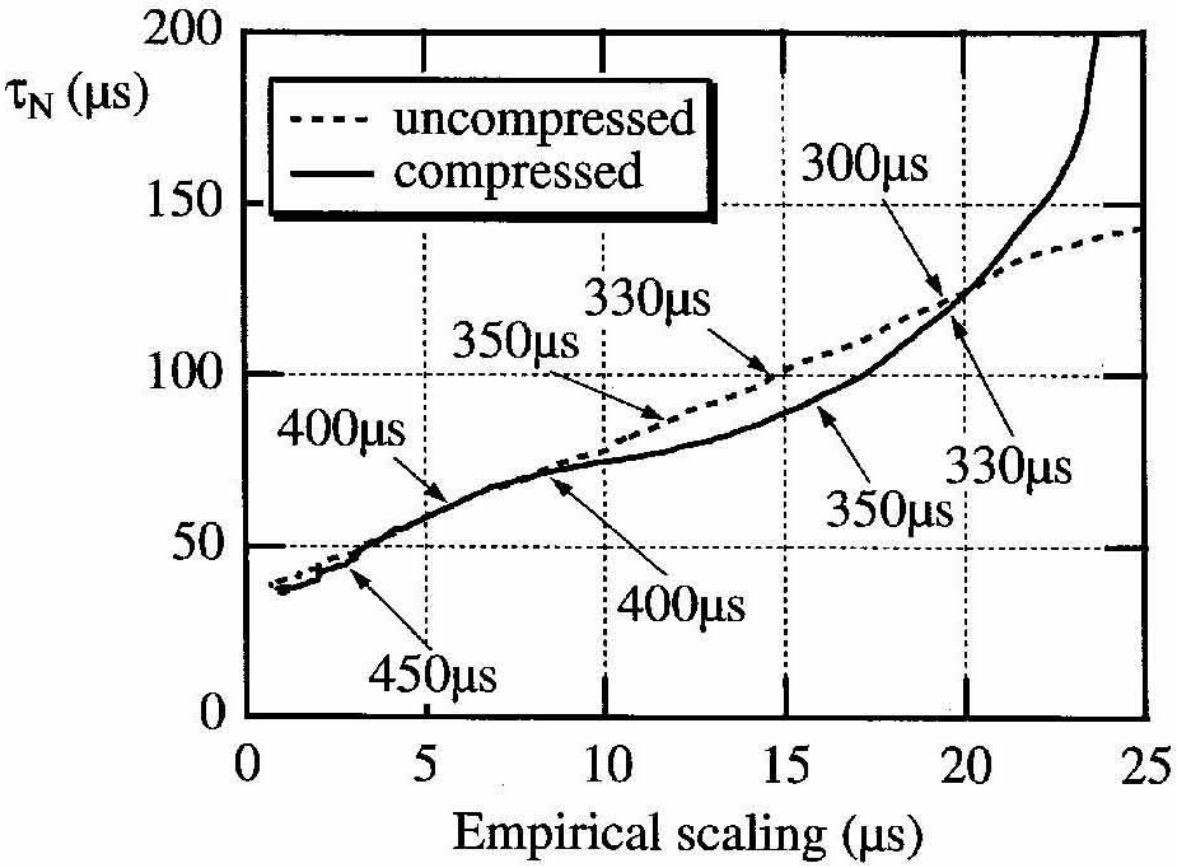
Change of Parameters with Axial Compression



Temporal Developement of Separatrix Radius with Axial Compression



Change of Confinement by Axial Compression

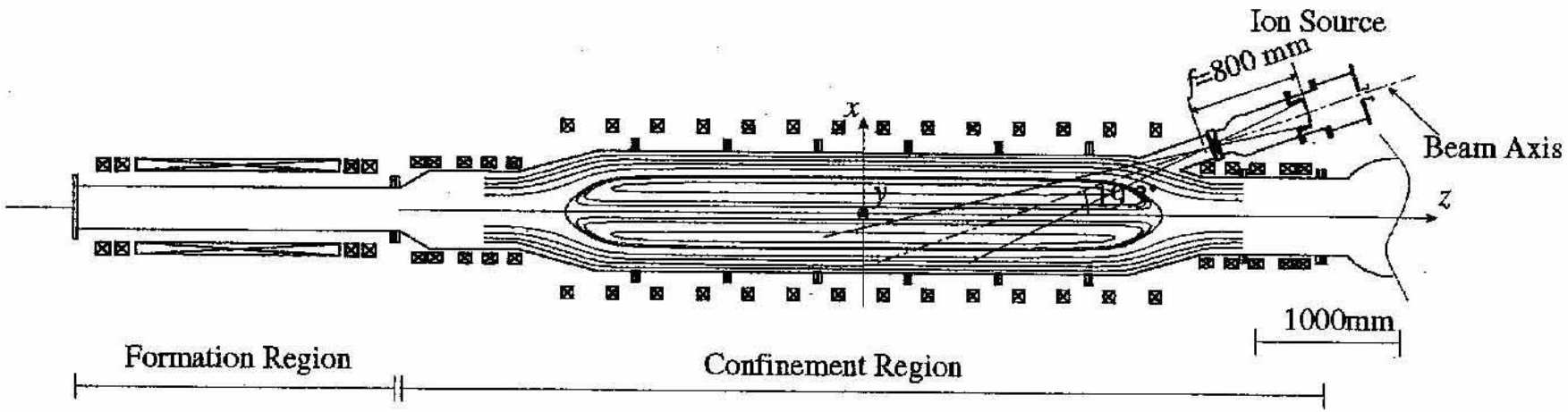


NBI Experiments

- to increase NB current I_{NB}
  Increase NB energy E_{NB}
- for better beam trapping
  proper choice of beam injection geometry
    clino-axial and off axis beam injection
    increase E_{NB} without increasing E_{NBperp}
  to trap beam ions with E_{NBpara}
    strong mirror field

- $\tau_{NBrise} > \tau_{FRClife}$

Arrangement for Neutral Beam Injection Experiment

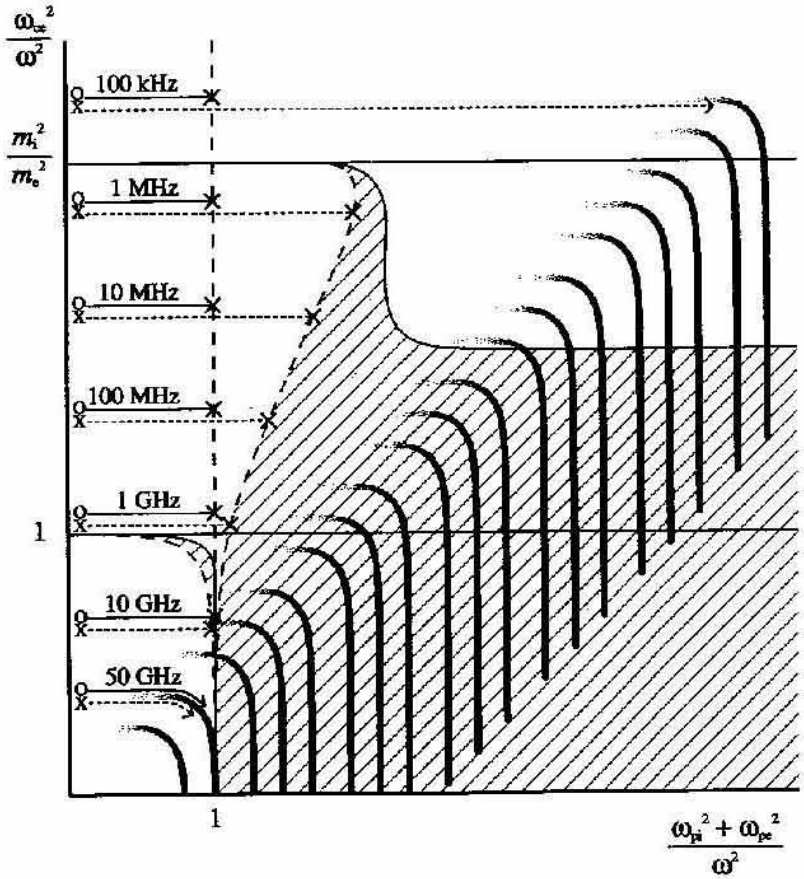


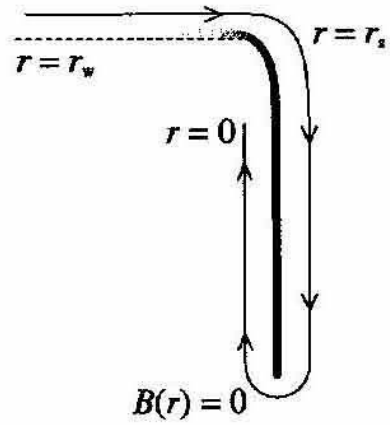
Heating by Low Frequency Wave

- by compressional perturbation
  torsional disturbance is induced
- propagates almost axially
- ion heating is observed
- $B_{toroidal}$ is generated

- Amplitude profile (eigen function) near $B = 0$

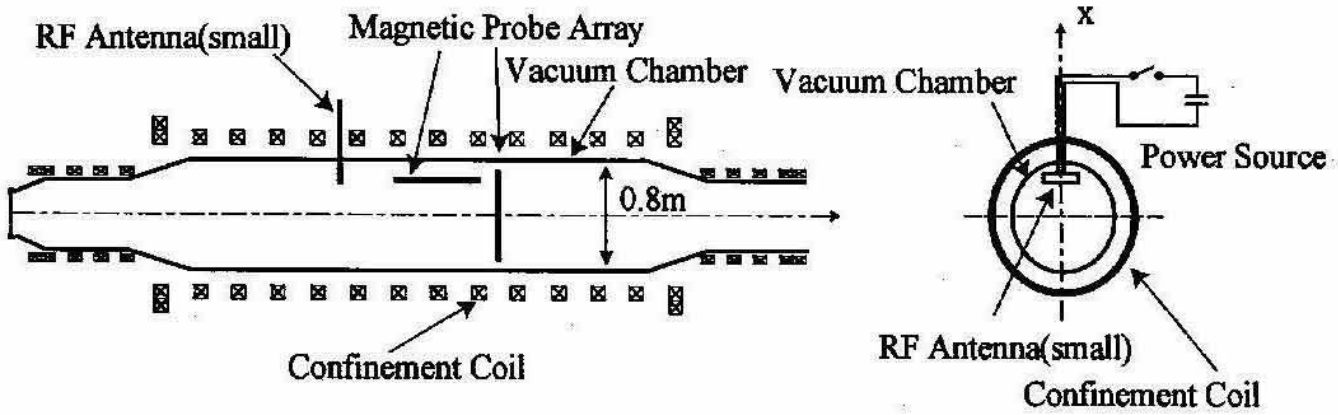
Accessibility of Waves to FRC Plasma



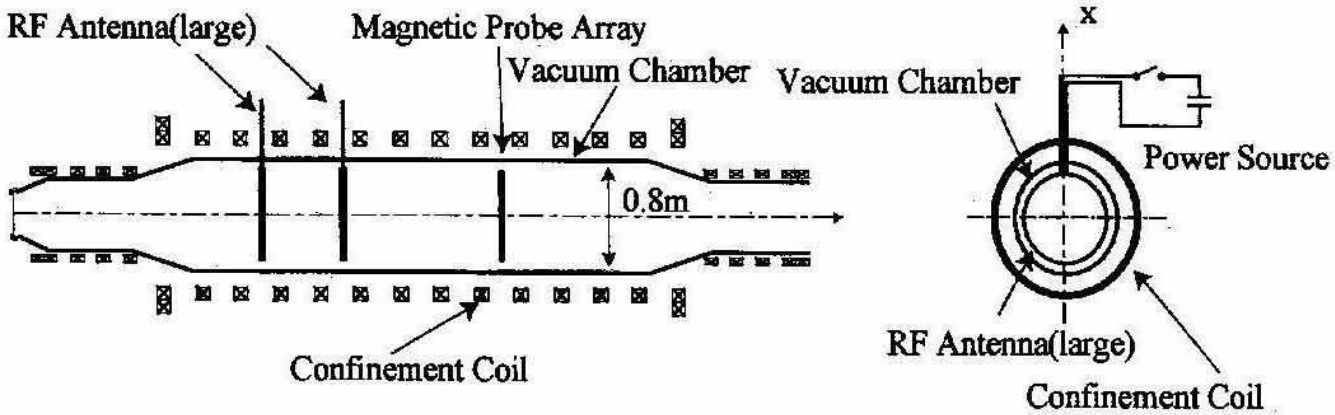


Arrangement for Low Frequency Wave Experiments

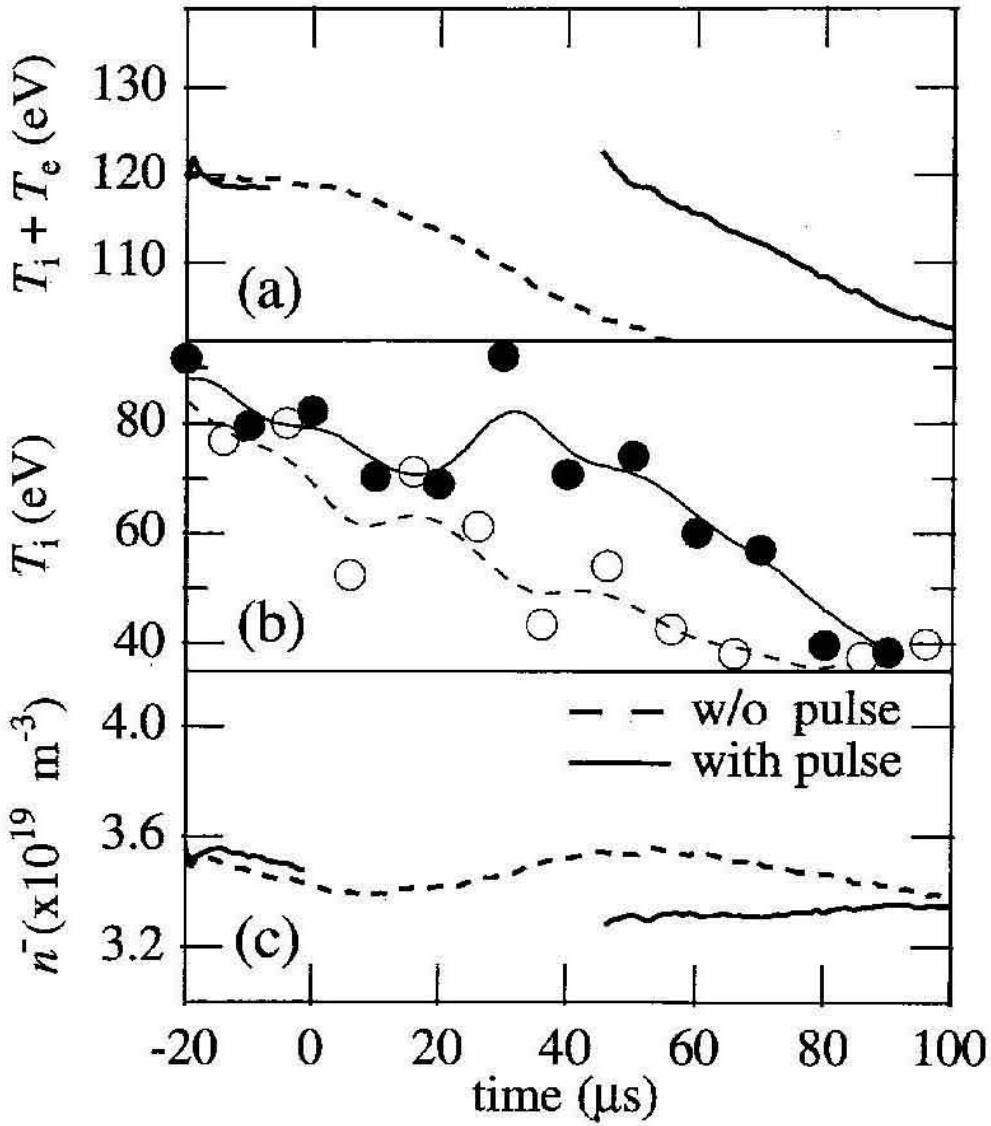
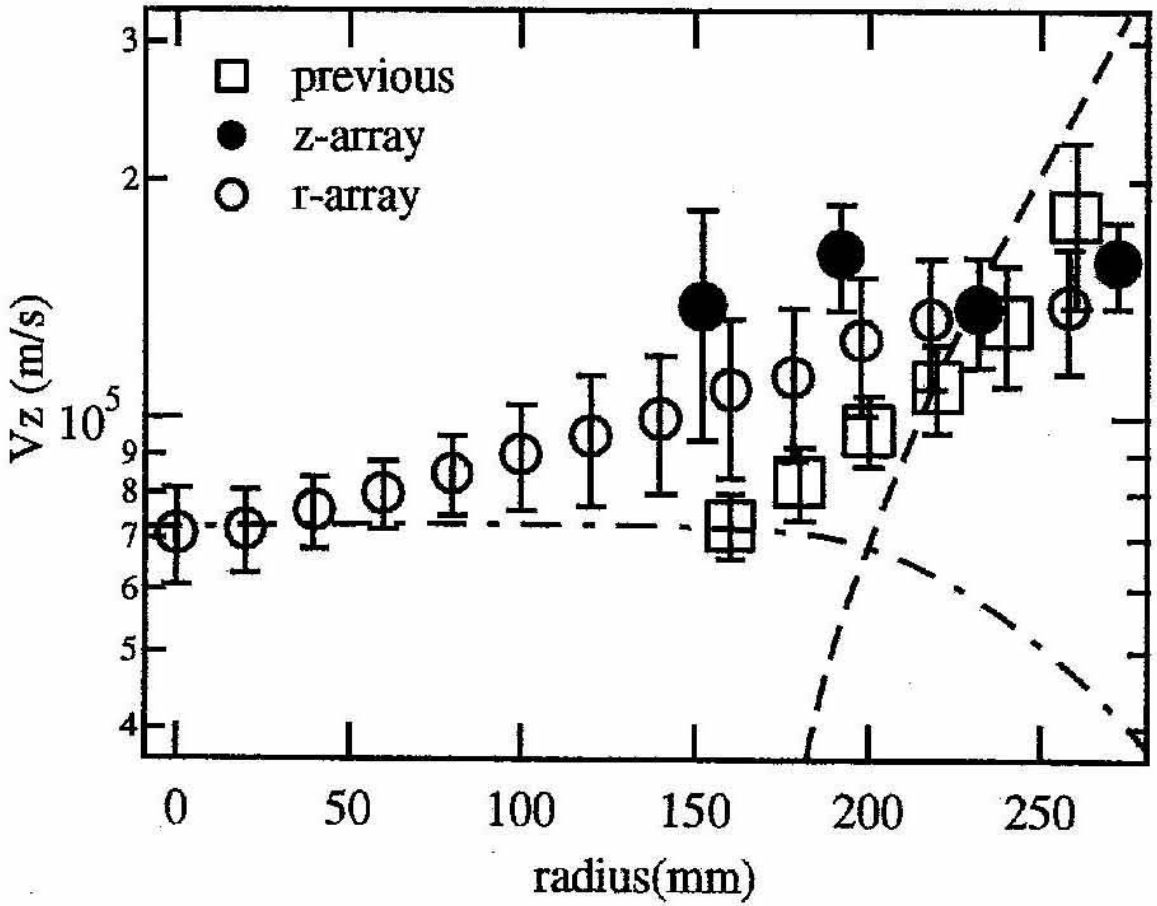
- Small Antenna



- Large Antenna



Ion Heating by Low Frequency Wave



Propagation of Induced B_θ Disturbance