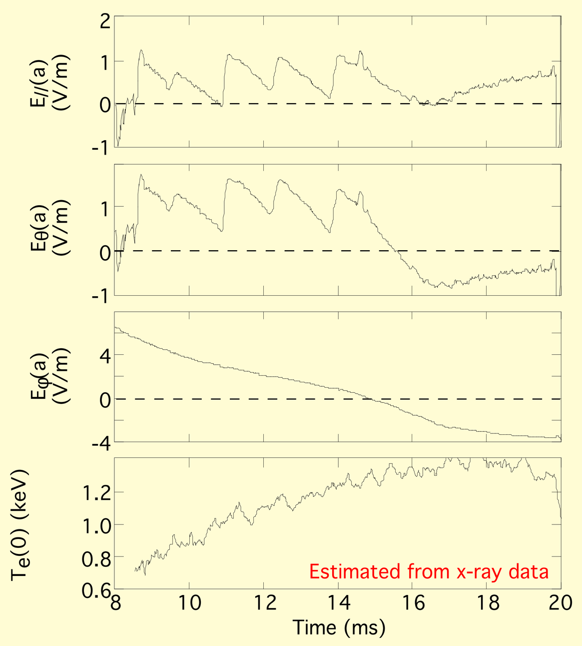
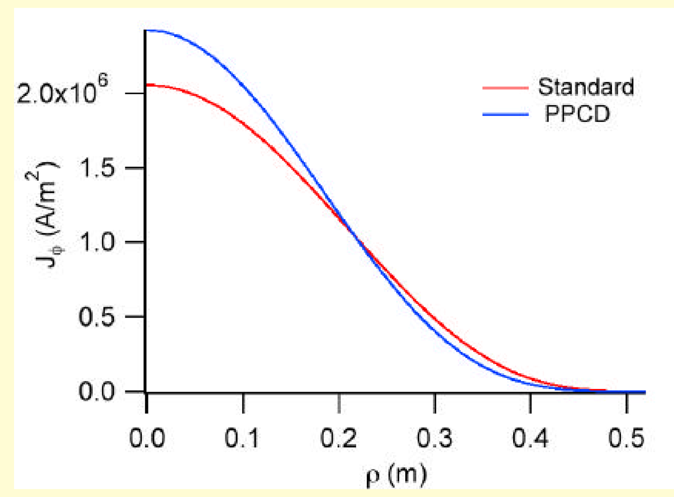
Confinement Improvement

Electric field programming

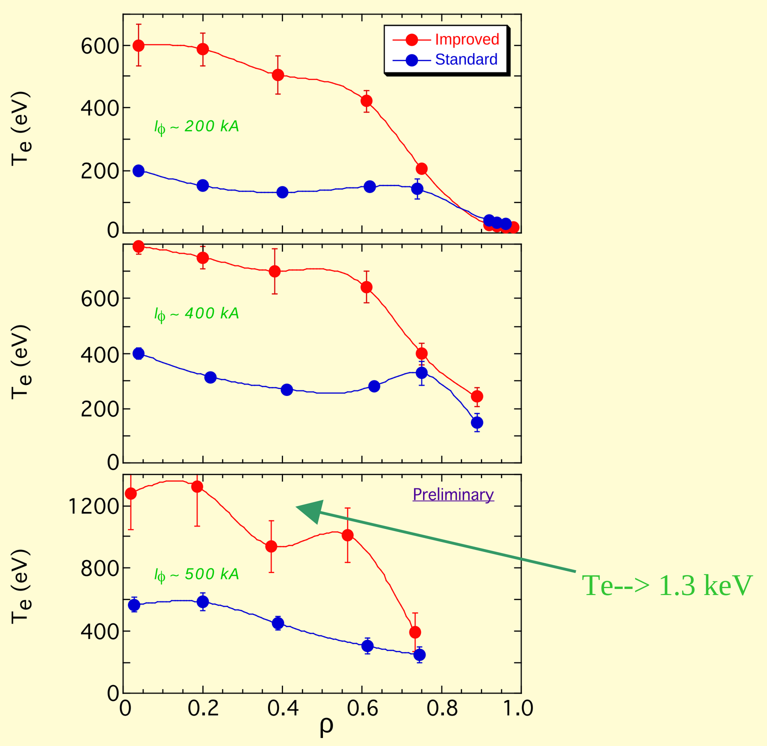


Current density profile
from FIR polarimetry (UCLA)



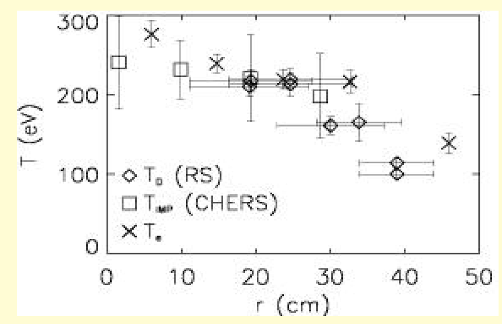
E programming flattens current, but fluctuation reduction peaks current

Core electron temperature increases

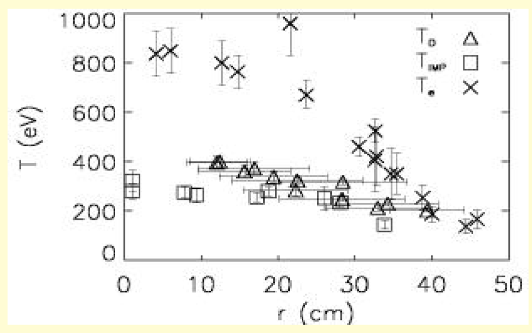


Ion temperature unchanged
(from Rutherford Scattering and CHERS)

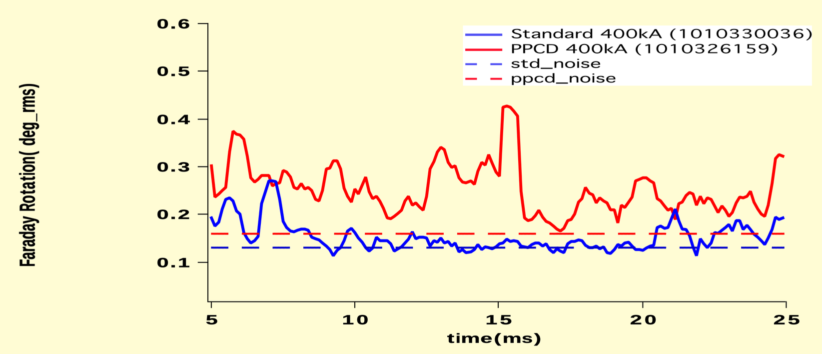
Standard

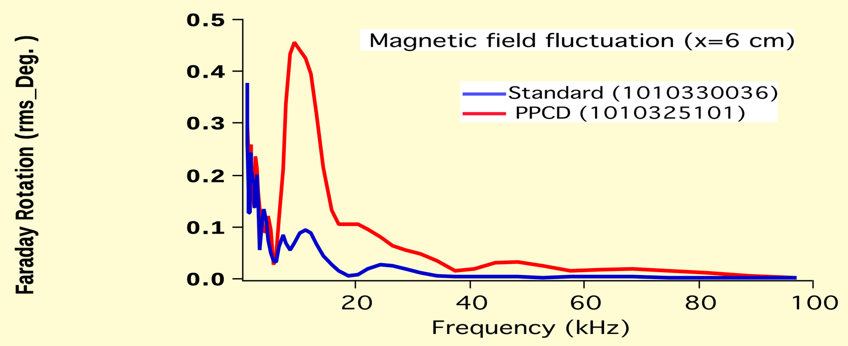


PPCD

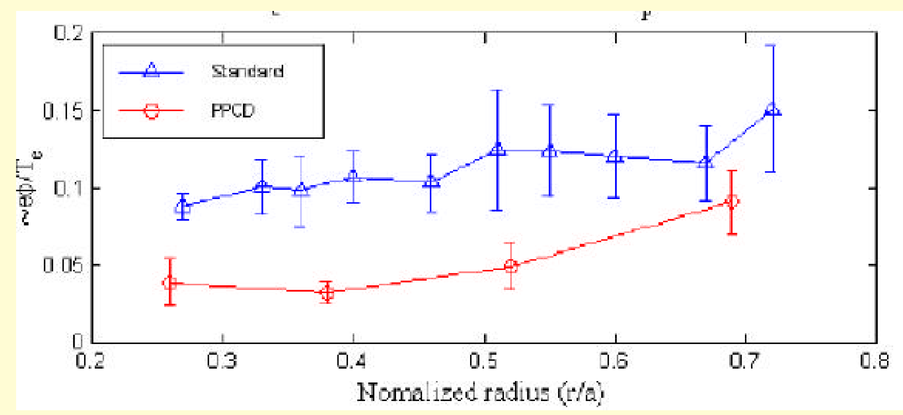


Core magnetic fluctuations decrease
from FIR polarimetry (UCLA)

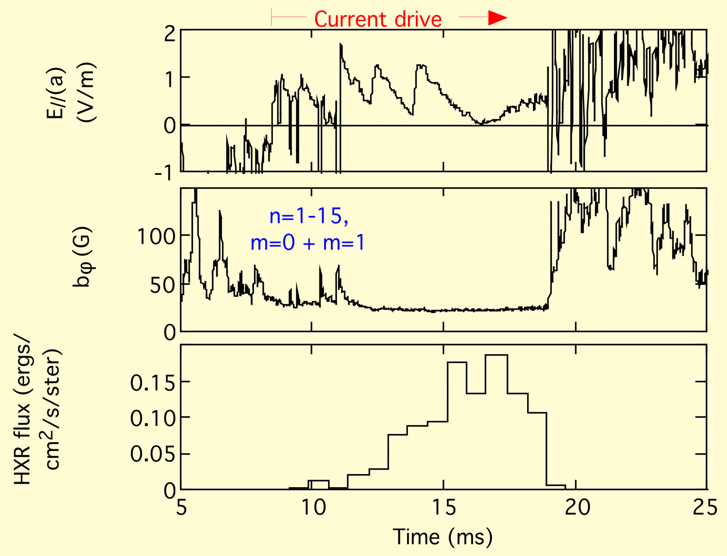


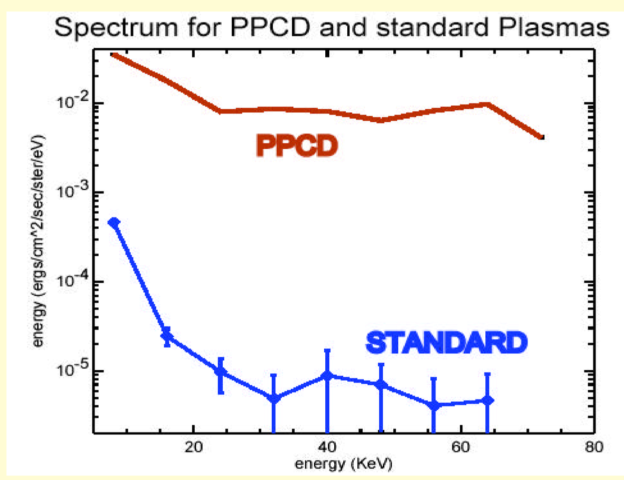


Electric potential fluctuations decrease
from heavy ion beam probe (RPI)



Energetic electrons confined





Fokker-Planck modeling (CQL3D) ->

- Runaway electron density ~ 2%
- Connection lengths ~ 100 km
- Diffusion coefficient < 5 m^2/s
- Magnetic surfaces maybe becoming well-formed

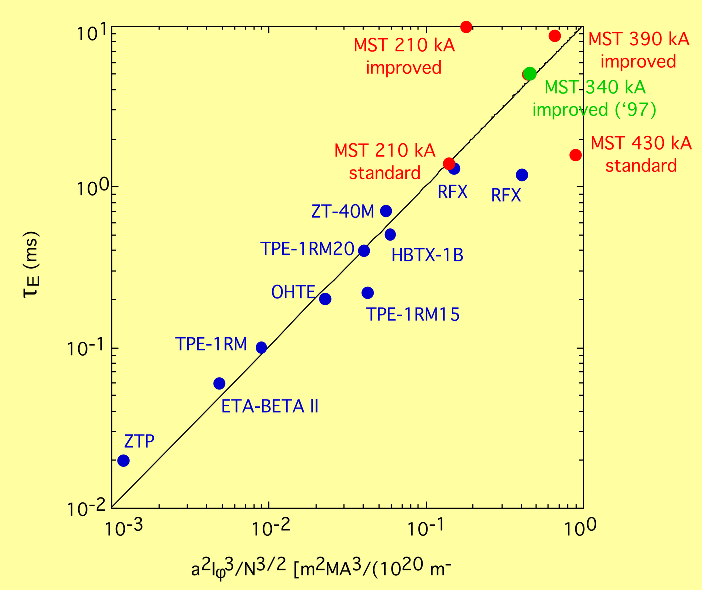
Confinement summary

	Standard	Imp.	Standard	Imp.
I_ϕ (kA)	210	210	430	390
$\langle n_e \rangle$ (10^{19} m^{-3})	0.8	0.7	1.0	1.0
$T_e(0)$ (eV)	200	600	400	792
dW_{th}/dt (MW)	0	0.47	0	0.55
P_{oh} (MW)	2.0	1.0	4.0	2.0
τ_E (ms)	1.4/1.0	10.1	1.6/1.0	8.8
β_{tot} (%)	9.0	15.4	4.8	10.7
β_θ (%)	9.0	18.1	4.8	11.8

Thermal diffusivity ~ 5 m^2/sec

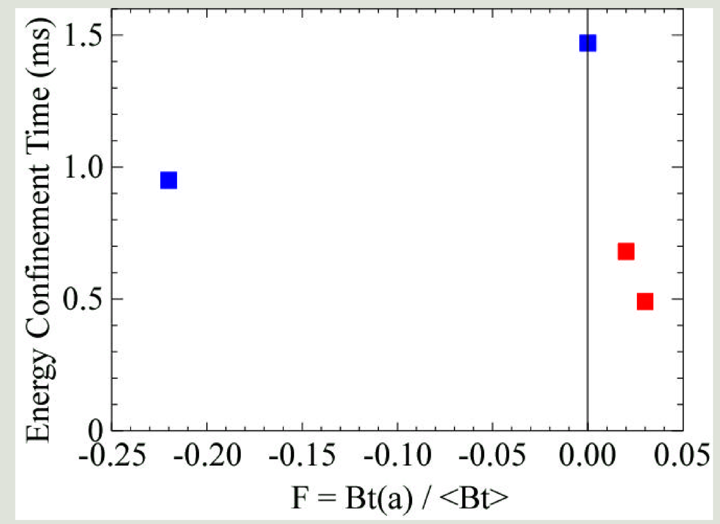
(getting close to electrostatic transport?)

Improved energy confinement times exceed RFP "constant β" scaling



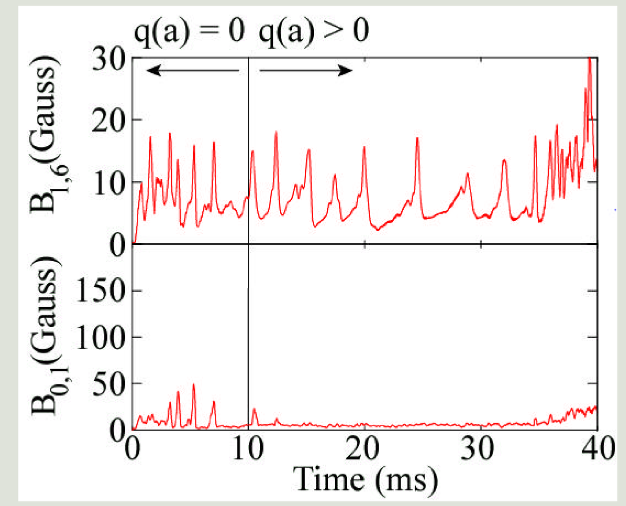
Plasma behavior without reversal

confinement



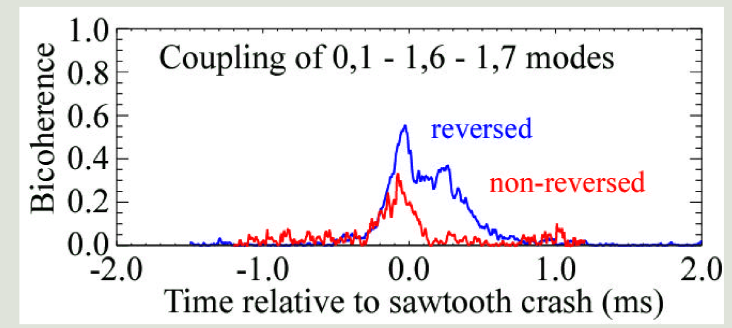
Reversal not required for confinement

m = 0 behavior



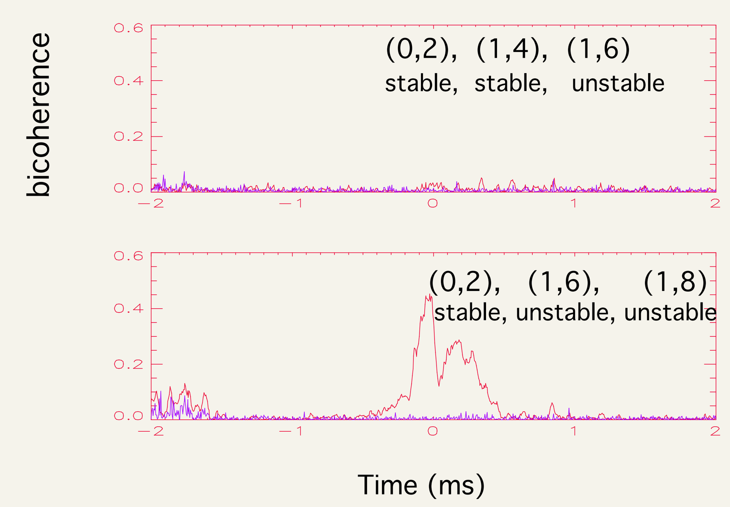
m = 0 mode small in nonreversed plasmas

Nonlinear coupling



Nonlinear coupling through the m = 0 is active, even if m = 0 is nonresonant and stable

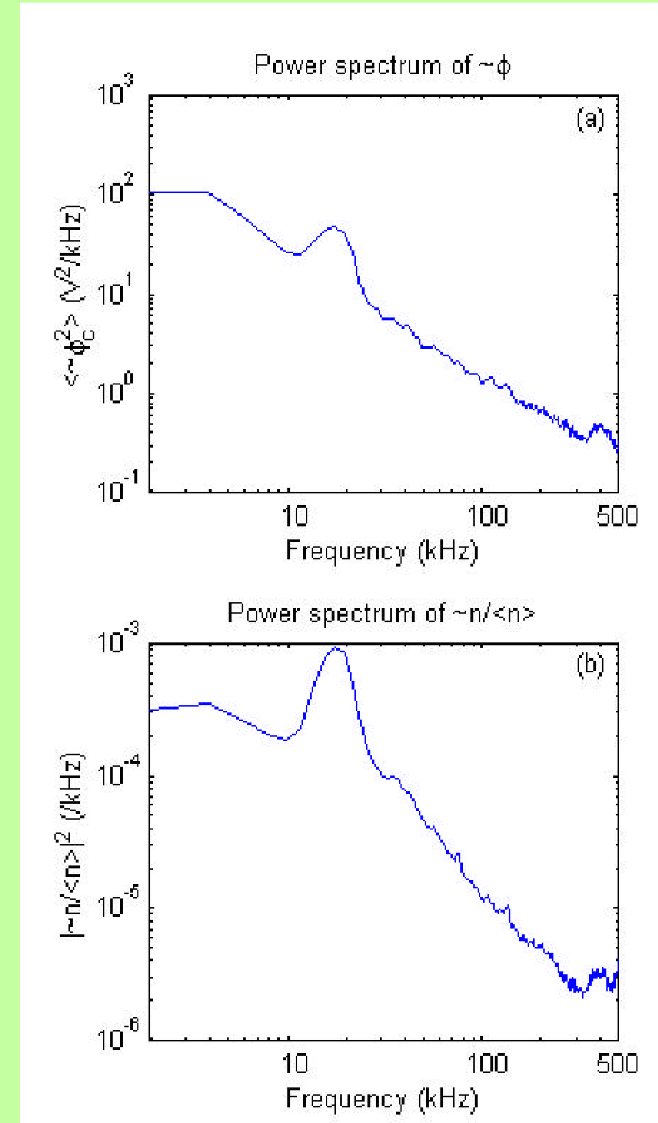
In RFP,



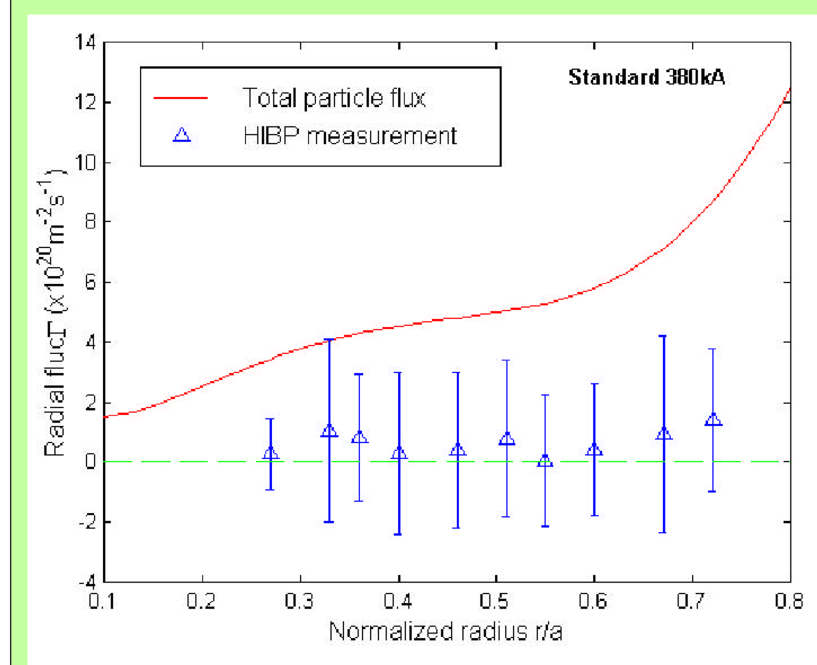
2 unstable, 1 stable --> strong coupling
1 unstable, 2 stable --> weak coupling

Potential and density fluctuations

(Heavy ion beam probe, RPI)



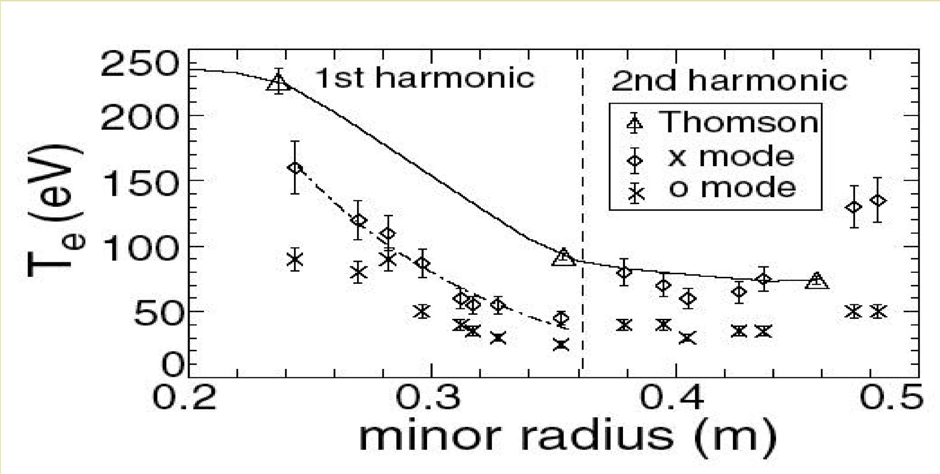
Electrostatic particle flux



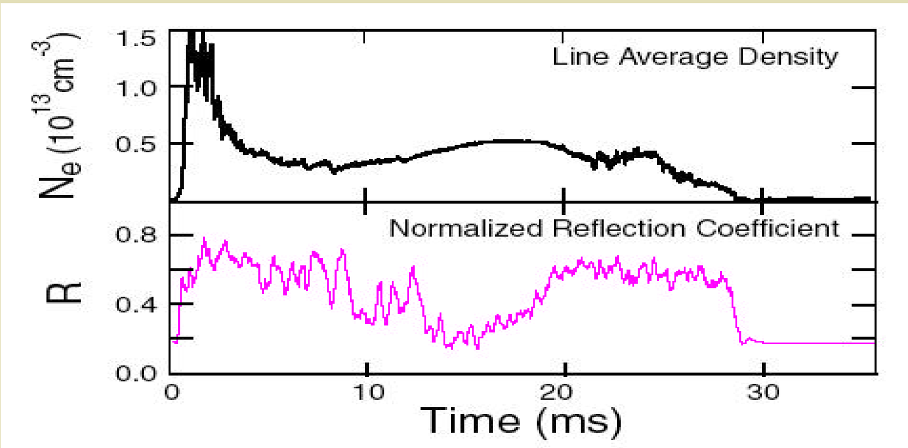
Does not account for transport in standard plasmas

Electron Bernstein waves

emission



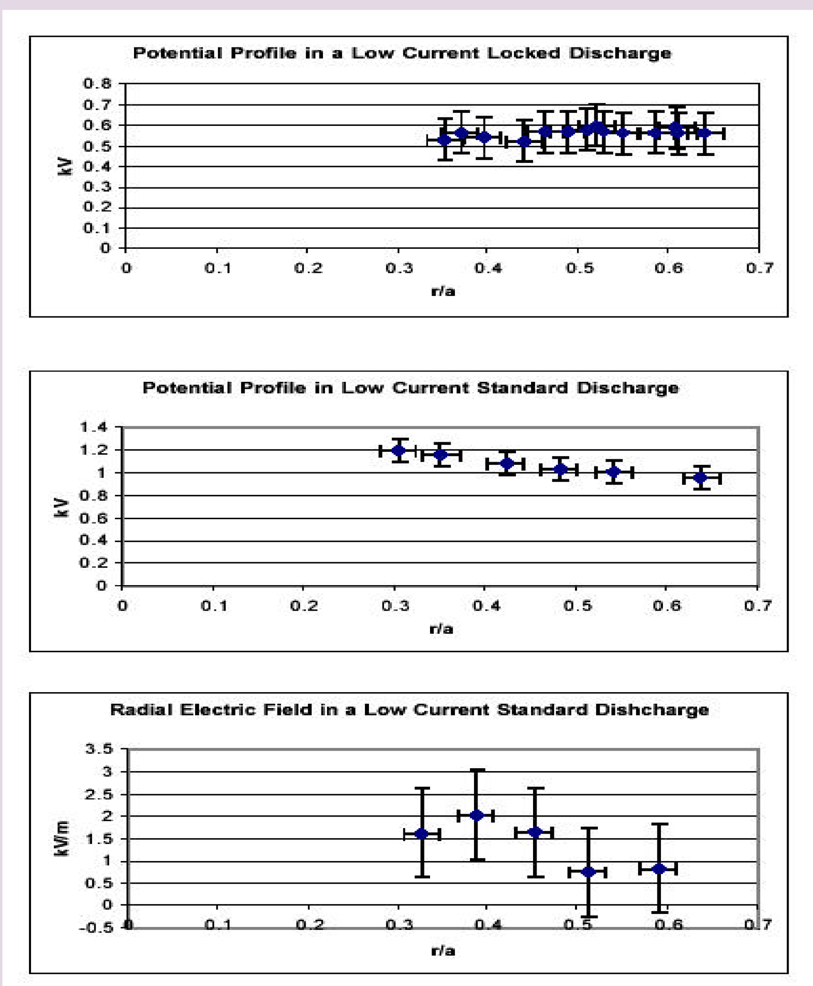
Coupling of injected power



Coupling observed

Radial electric field measurements

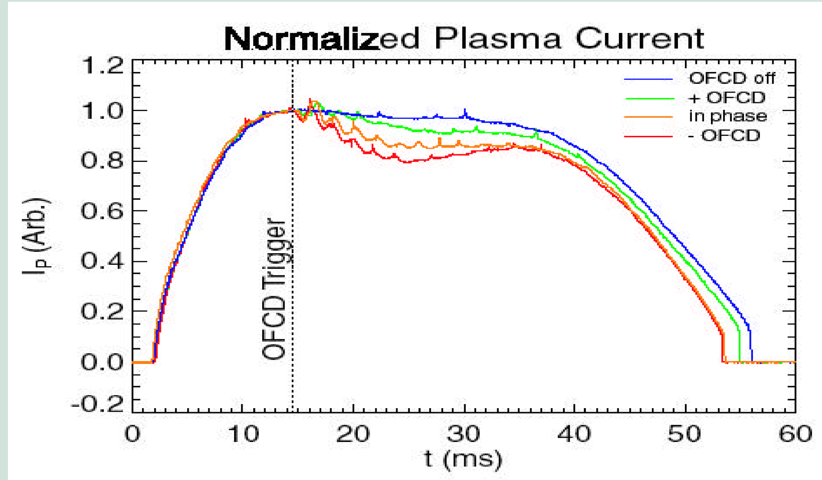
(HIBP)



E_r consistent with radial force balance

Oscillating field current drive

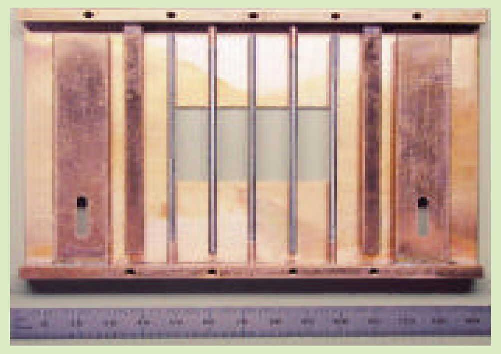
Initial result at low current,
with high impurity contamination

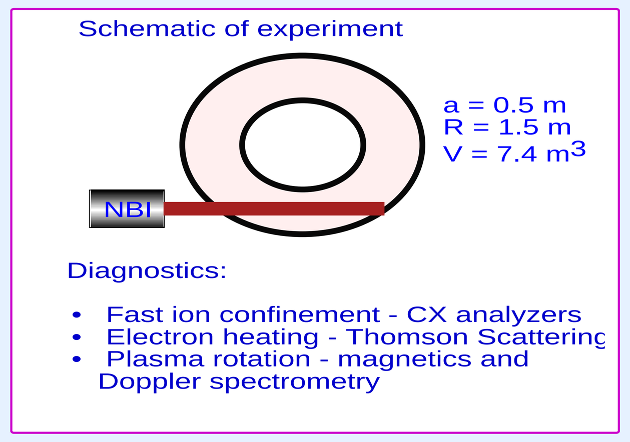


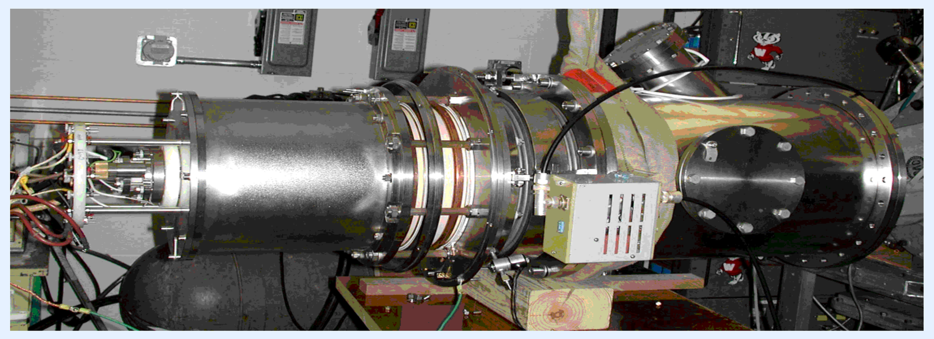
Shows phase dependence of helicity injection

Old LH antenna

new LH test antenna



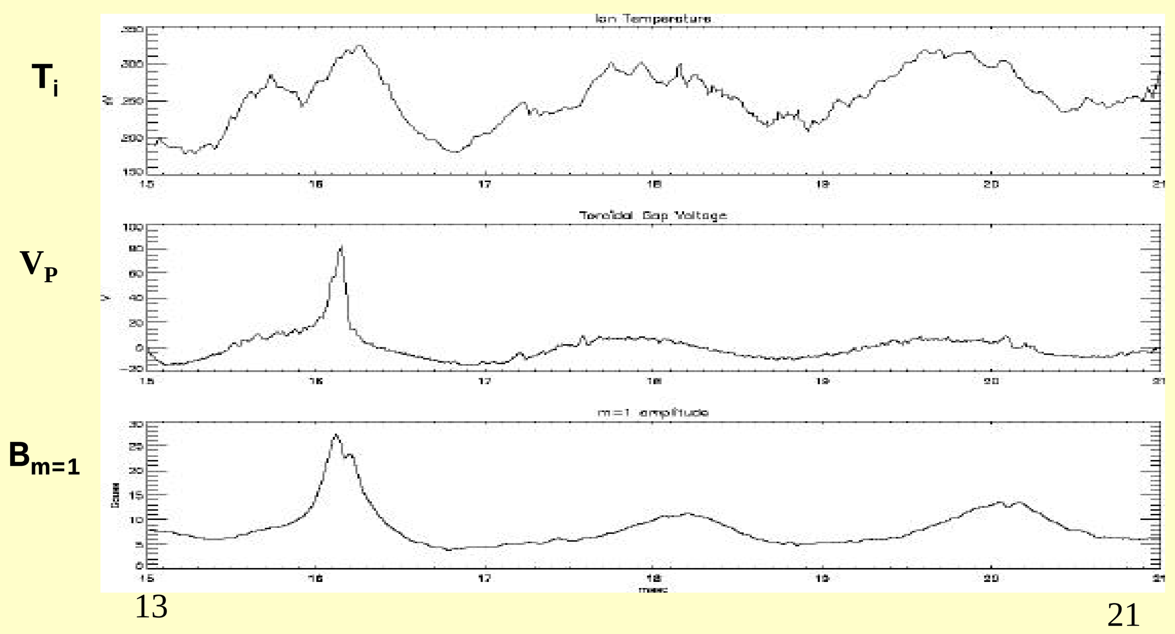




25 keV, 60 A, 1.5 MW, 1 ms

Anomalous ion heating

Apply oscillating poloidal voltage



Magnetic fluctuations correlates with ion heating

Plans

Plasma Control Systems

- Pulsed Parallel Current Drive
  (further optimize V_T, V_P)
- Oscillating field current drive
  (medium power underway, high power under construction)
- Lower hybrid current drive
  (antenna tests underway)
- Electron Bernstein wave injection
  (low power tests underway)
- Neutral beam injection (Novosibirsk)
  (feasibility tests beginning)
- Pellet injection (with ORNL)
  (initial tests beginning)

Evolving diagnostics

- FIR polarimetry (UCLA)
  (equilibrium and fluctuating B)
- Heavy ion beam probe (RPI)
  (equilibrium, fluctuating potential, density
- Motional Stark effect
  (equilibrium and fast B)
- Multi-point Thomson scattering
  (begin operation by summer, 02)