Survey of Density Modulaton Experiments on the HT-7 Tokamak

EX/P3-25

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Introduction

The study of particle confinement and transport is a very important issue for magnetically confined plasmas. However only a few studies have been reported, far fewer than the energy transport studies. This is due to the technical difficulty of the estimation of the particle source and the existence of the convection term. Density modulation is a powerful approach to solve these experimental difficulties. From the radial propagation data of the modulation, it is possible to estimate diffusion coefficient D and convection velocity V separately. The particle diffusion coefficient and the convection velocity have been studied by means of the density modulation using pulsed deuterium gas puffing on the HT-7 tokamak recently.

Experiment al set-up

HT-7 superconducting tokamak

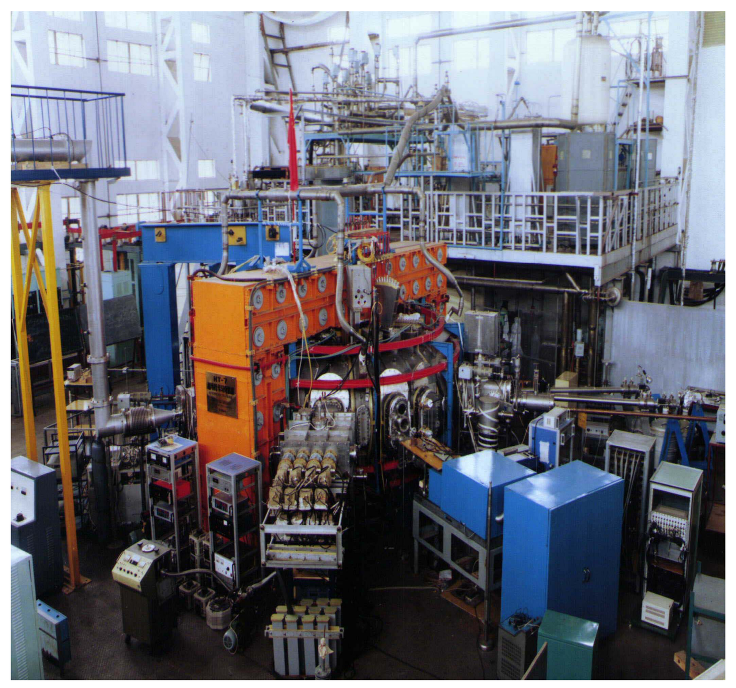

Figure 1: *HT-7 tokamak*

R = 1.22m (achieved)
a = 0.285m (C Limiter)
I_p = 100~250 kA (250)

n_e = 1~6x10^{19}m^{-3} (6.5)
B_T = 1~2.5T(2.5)
T_e = 0.5~3 KeV (4.6)
T_i = 0.2~1.5 K eV (1.8)
t = 1~ 5s (5min.)
ICRF: f = 15~45MHz, CW(0.5MW, 10s)
LHCD: f = 2.45GHz, 10s (0.65MW)
Pellet injector: up to 8 pellets /per shot,
Supersonic beam injection: <1.0 km/s
Main Goal: Steady-state advanced operation and related physics (Ip > 100kA, Ne>1.0x13cm-3, Te>1keV, t=30-60s)

The particle diffusion coefficient and the convection velocity have been studied by means of the density modulation using pulsed deuterium gas puffing on the HT-7 tokamak since 2004.

Experimental results (1)

Case	Shot	n_e (10^{19} m^{-3})	D (m^2/s)	V_0 (m/s)	τ_p (ms)
Case 'a'	91022	~1.0	0.30	−0.95	17.6
	91025	~2.0	0.17	−3.47	27.4
Case 'b'	93367	~1.0	0.37	−3.4	29.7
	93370	~2.0	0.15	−3.38	52.2
Case 'c'	92953	~1.0	0.34	−0.69	28.6
	92957	~2.0	0.19	−2.30	48.1

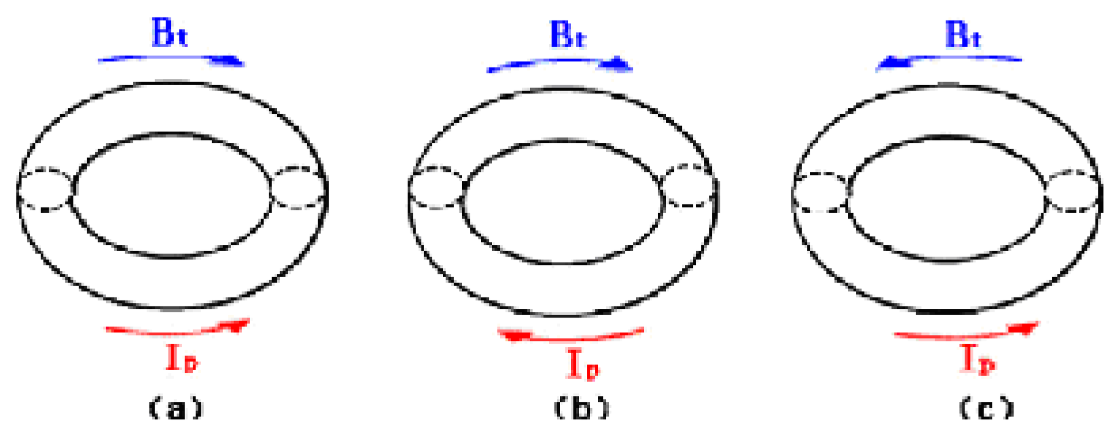

Figure 2: *(a) Sketch of the toroidal field is in the clockwise direction and the plasma current is in the anticlockwise direction; (b) Both of them is in the clockwise direction; (c)Both of them is in the anticlockwise direction on HT-7 tokamak*

The particle diffusion coefficient for the positive plasma current case is almost the same as for the negative one, but the absolute value of inward pinch velocity of the positive current plasma is much lower than that of the negative one.

By comparing with each other in figure 2, it is found that the particle confinement time becomes much higher when the directions of plasma current and toroidal field are uniform.

Experimental results (2)

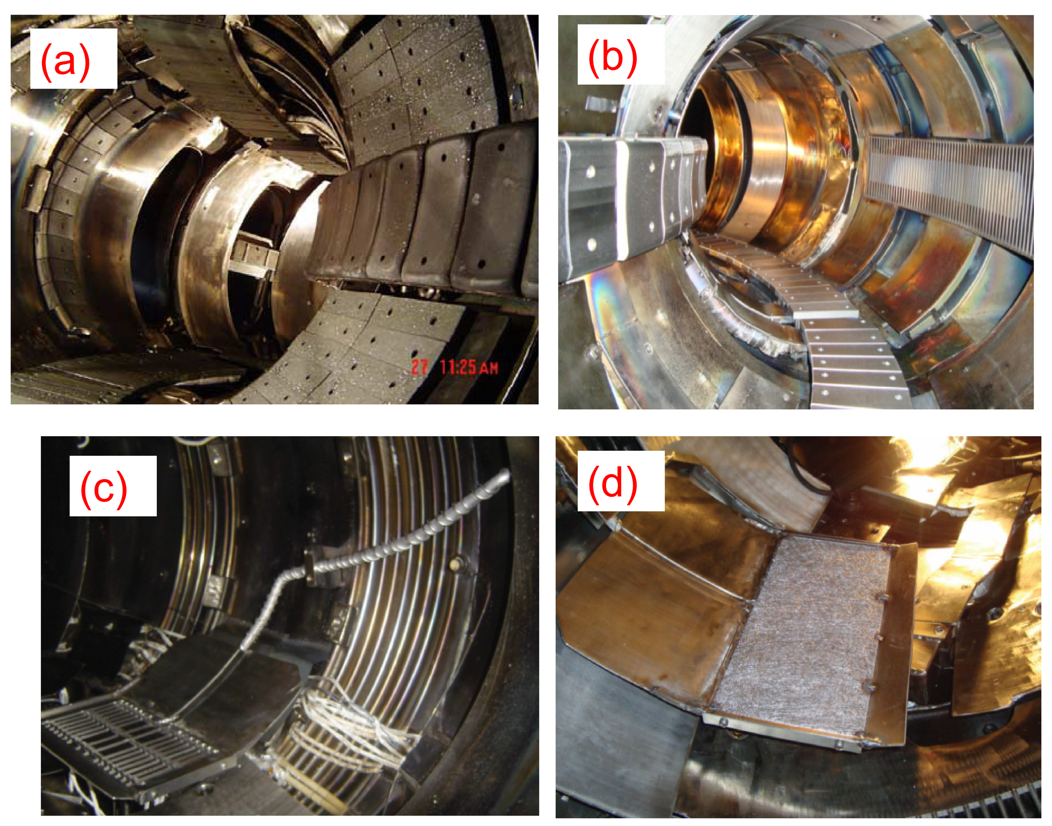

Figure 3: *limiter in EAST, (a) C limter in 2004; (b) Mo limter in 2011; (c) Moveable advanced liquid lithium limiter limiter in 2011; (d) The stainless steel net sticking to the CPS.*

Results with C limiter in 2004

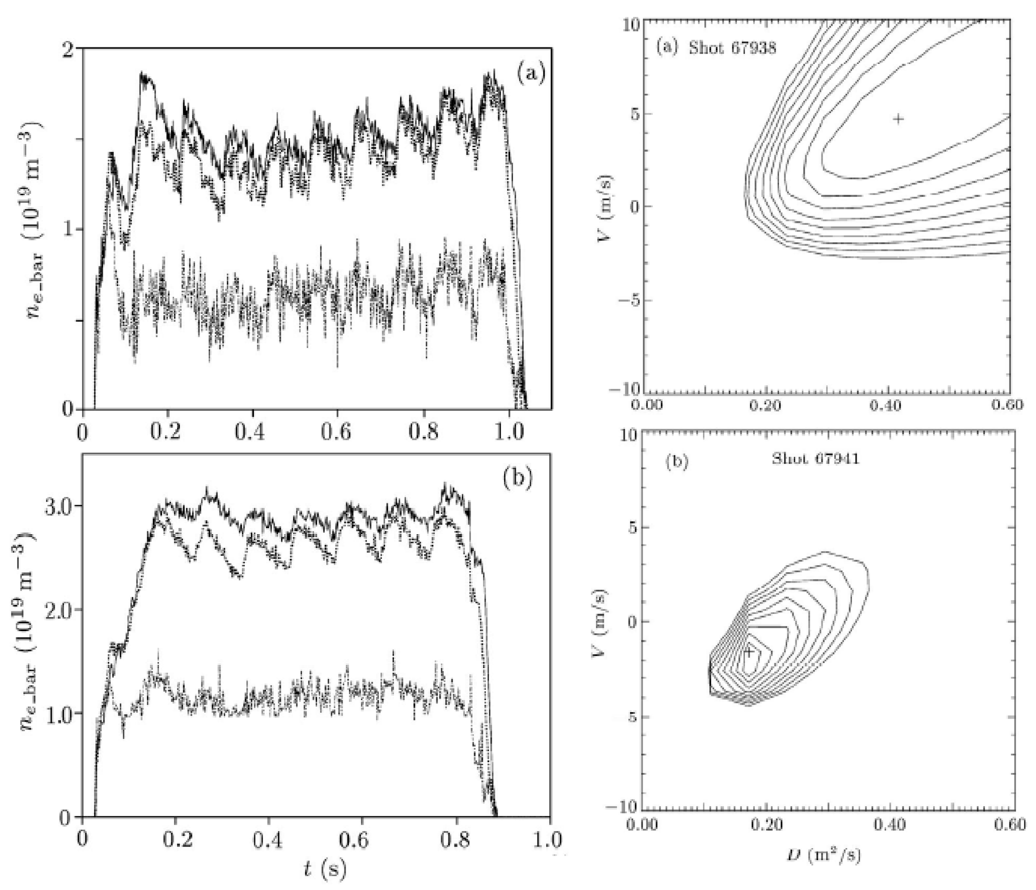

Figure 4: *Calculated particle diffusion coefficients D and convection velocity V with C limter.*

Mo limiter and a vertical moveable advanced liquid lithium limiter limiter in 2011

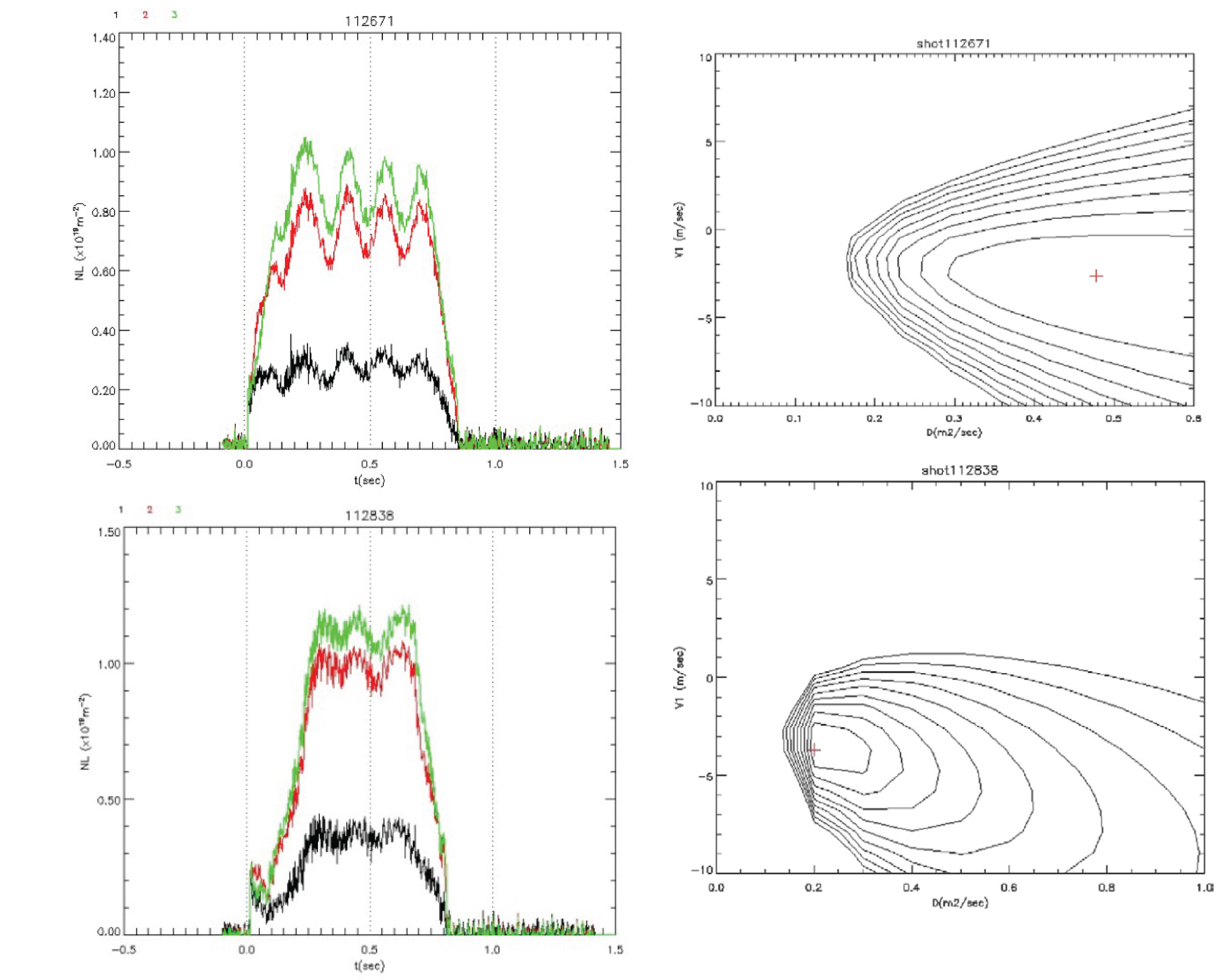

Figure 5: *Calculated D and V with Mo limter, Density modulation shot1 12671(up) and shot 112838(down).*

A comparison between with C and Li limiters

Shot No.	<ne> ($\times10^{19}$ m^{-3})	D (m^2 s^{-1})	V (m s^{-1})
Estimated D and V by density modulation experiments with C limiter			
67938	1.5	0.42	4.7
67941	2.2	0.28	−0.4
Estimated D and V by density modulation experiments with Li limiter			
112671	1.5	0.47	−2.5
112838	2.2	0.21	−3.6

When the background plasma density is 1.5×10^{19} m^{-3}, the V is positive under the graphite limiter, suggesting that the particles transport outside. However under the liquid lithium limiter, the V is negative, implying the desirable and expected the pinch effect.

Acknowledgement

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