Identifying of anomalous Doppler resonance during current ramp down in HT-7 tokamak

Presented by
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Outline

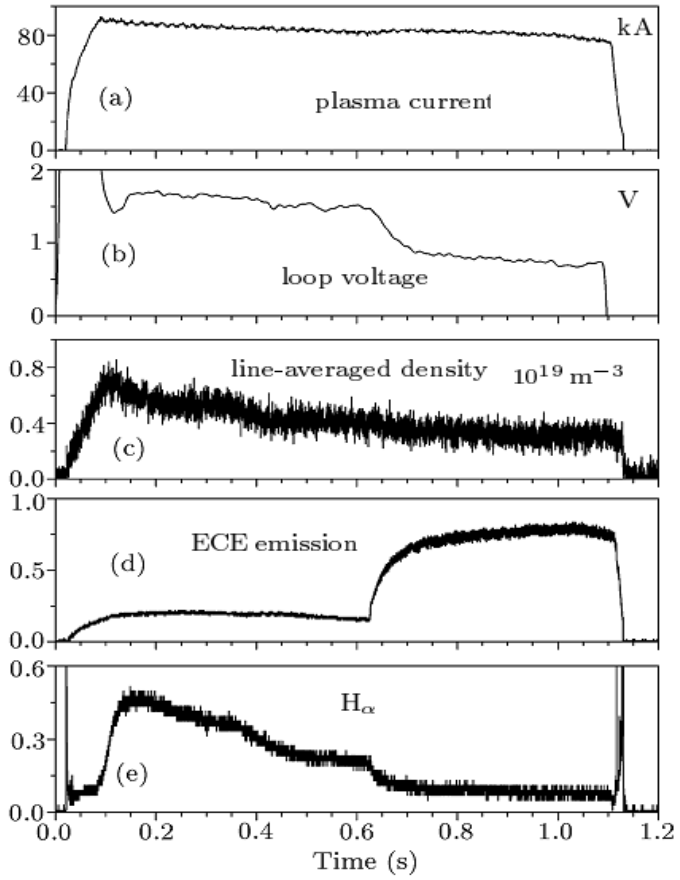
- Background and motivation

  ——anomalous Doppler resonance (ADR) investigation in HT-7
- Experimental setup and observation
- Method and discussions
- Conclusions

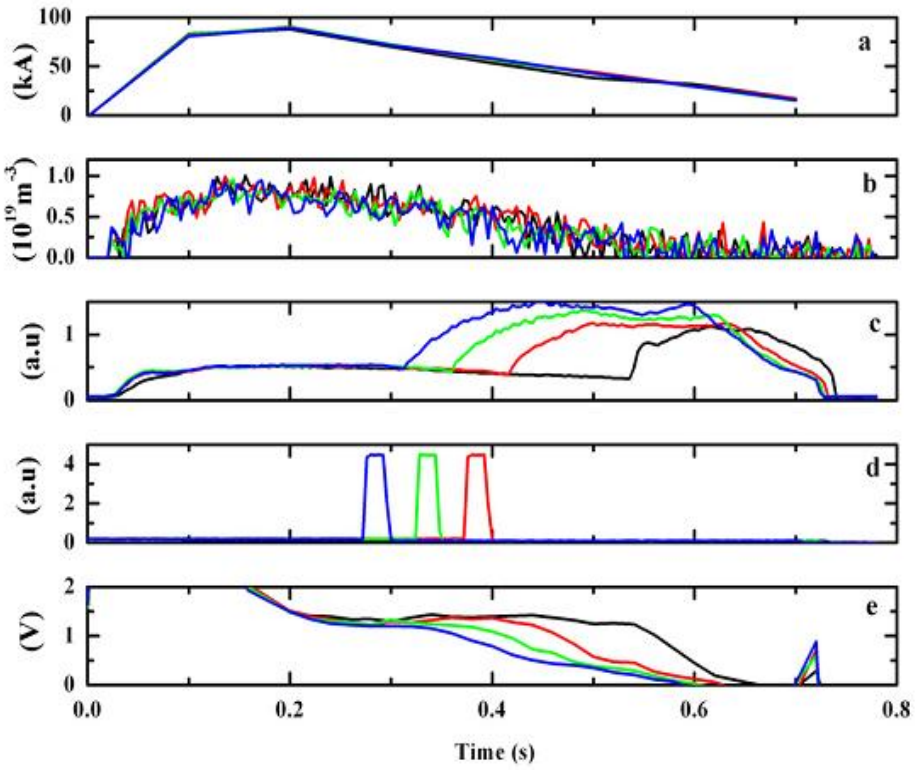
Background and motivation

HT7

ASIPP



Chen et al Chin.Phys.Lett.24 3195 (2007)



S.Sajjad et al Phys. Lett. A 373 1133 (2009)

- ADR usually happened in slide-away discharge through decreasing density or ramping down current
- ECE signals jumping up interpreted by the conversion from parallel to transverse energy through ADR

Motivation:

Try to explain the ECE signals

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Experimental setup and observation

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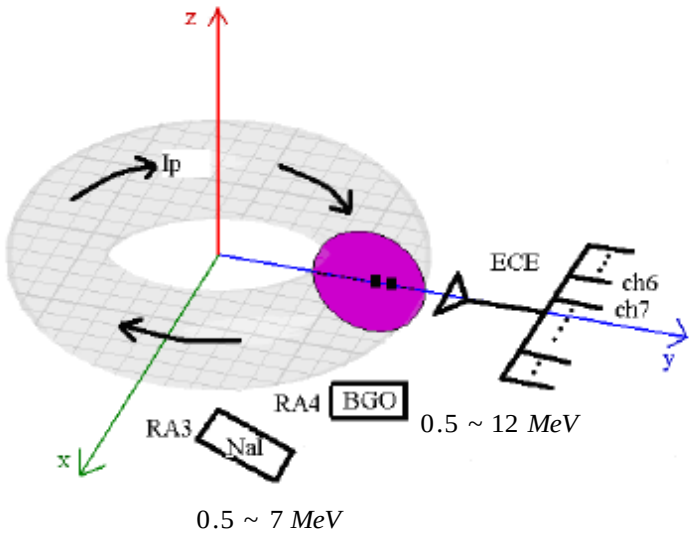
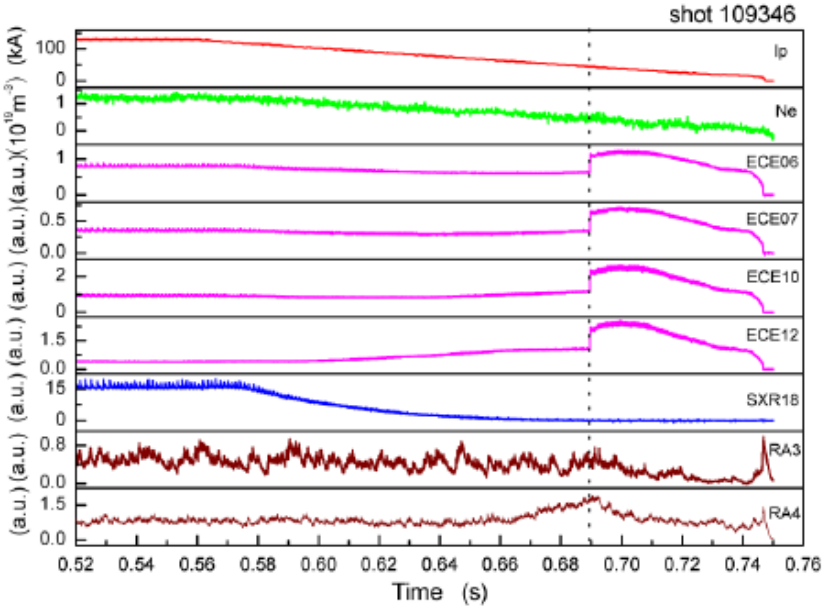


Main diagnoses:

(1) ECE diagnosis: viewing plasmas horizontally on the low field side (LFS) monitoring the transverse emission——the second harmonic of X-mode

(2) Runaway electrons diagnosis (RA): tangential view field monitoring the runaway loss



Observation at the dash line:

- ECE signals jumping up
- RA decreasing

Observation on the spectrum

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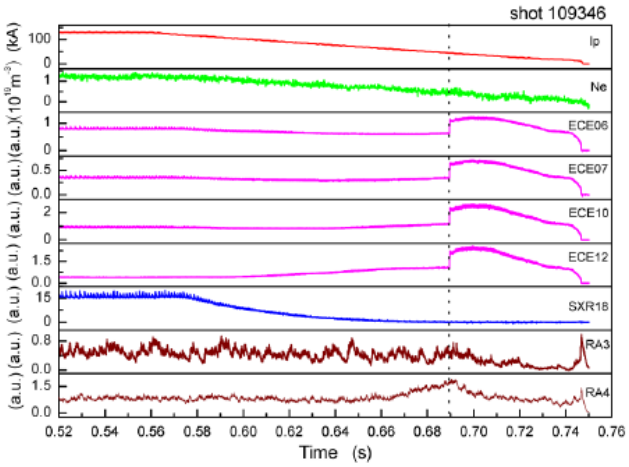
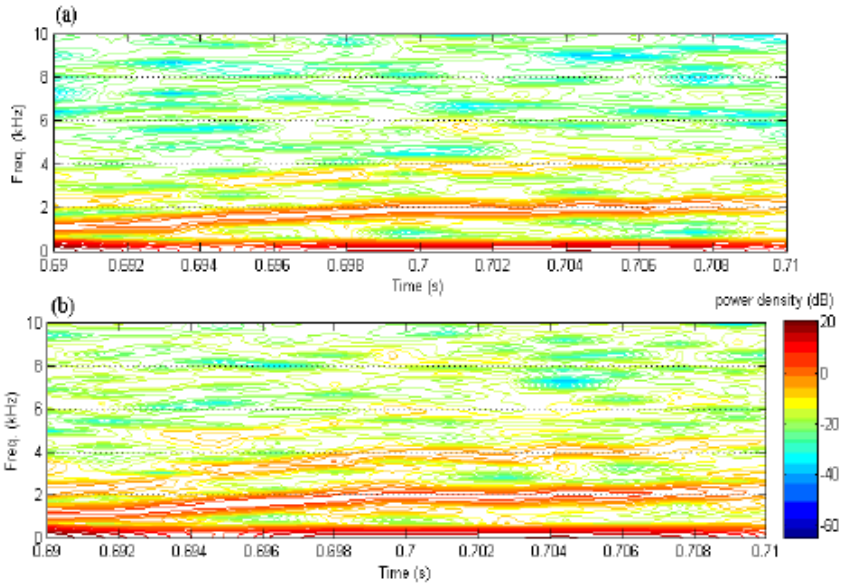
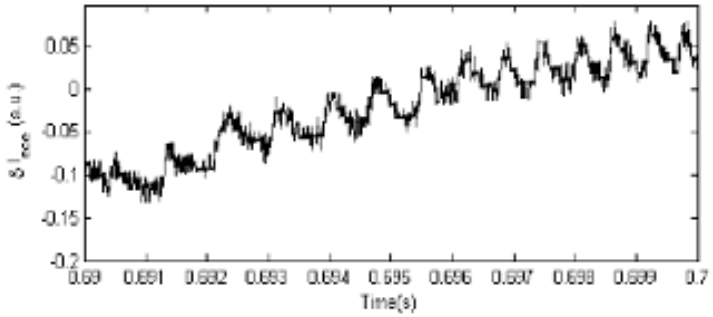


Spectrum at adjacent channels:



Just after the jumping up on ECE signals



- Step-like ECE signals after jumping up
- The fundamental frequency at the beginning ~1kHz and growing to about 2kHz at last

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Analysis and discussion

Two questions:

Why ECE signals jump?

Why RA flux decreases just after ECE signals jumping up?

One Implication:

the interaction of wave and particles

near electron cyclotron frequency

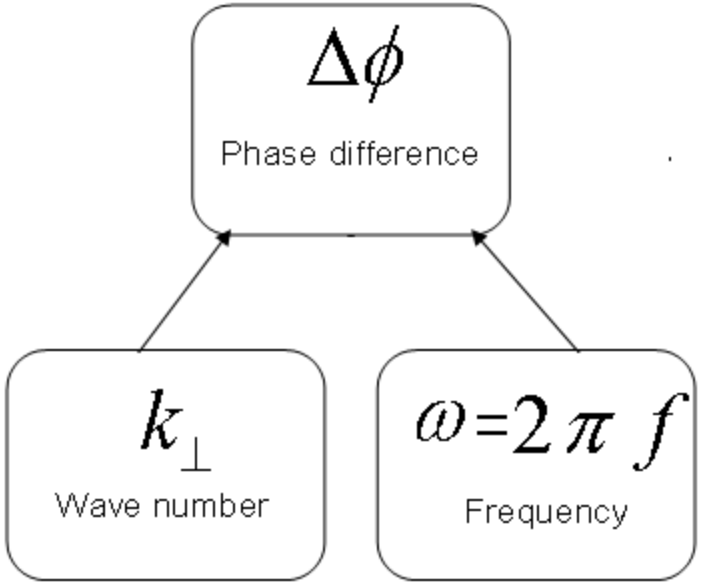
Martin-Solis J R et al

Phys. Plasmas 9 1667 (2002)

Phys. Plasmas 15 112505 (2008)

We easily obtain: $\frac{dp_{//}/dt}{dp_{\perp}/dt} \sim -k_{\perp}$

the transverse wave number



We need to check the phase difference at 2 kHz!

Method and result

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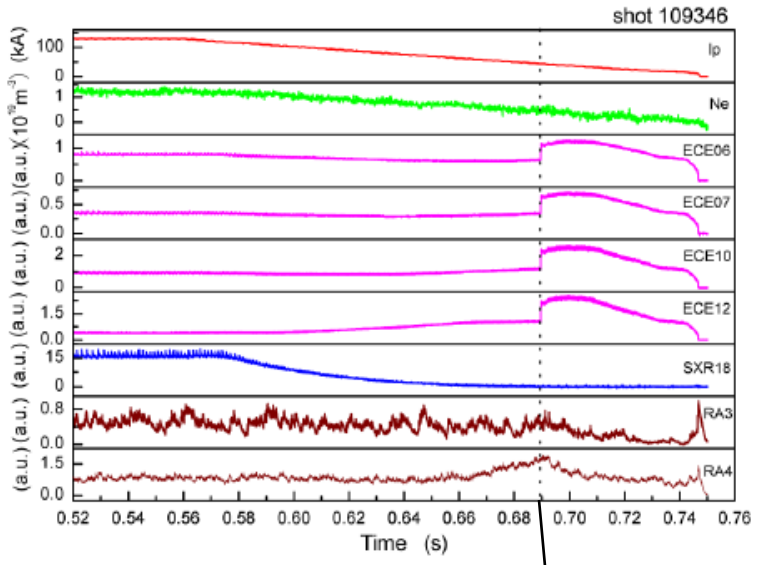
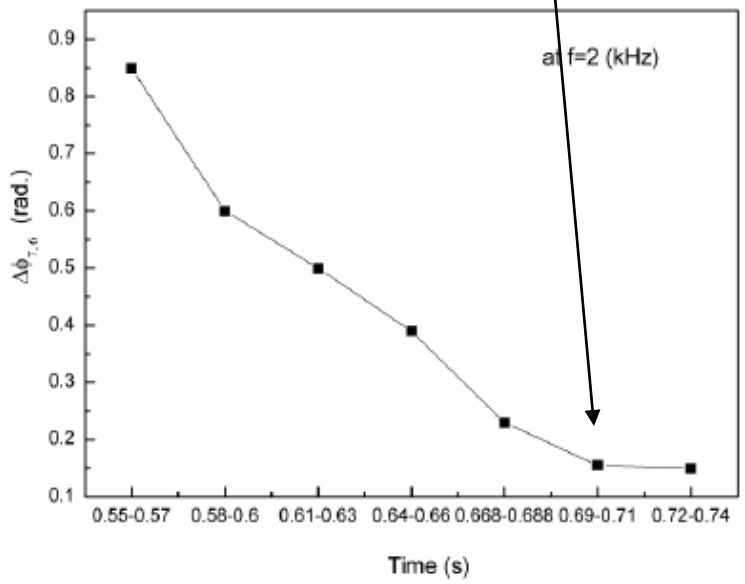




Method:

- From spectrum, the frequency of step-like ECE signals: 2kHz at last implying the interaction reaching steady-state
- Calculating the phase difference at 2 kHz between ch.7 and ch.6 using FFT every 20millisecond sampling data

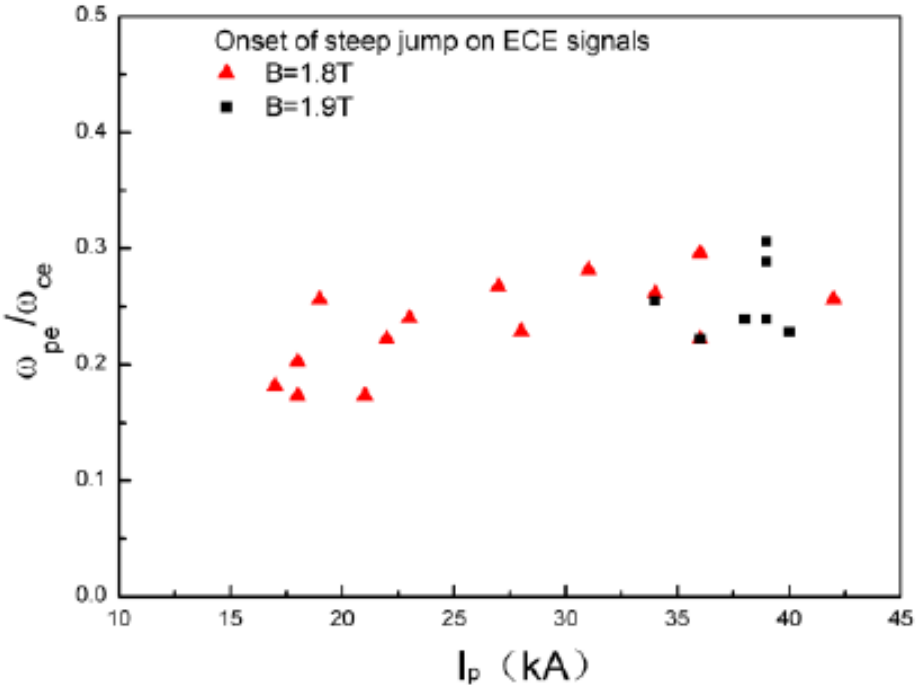
Result:

- The critical phase difference at 2 kHz:

$$\Delta\phi_{cri.} \approx 0.15$$

Different discharges

A series of discharges with different densities and different current ramp-down rates :



the ratio of electron plasma frequency to electron cyclotron frequency :

$$\frac{\omega_{pe}}{\omega_{ce}}: \quad 0.17 \sim 0.31$$

Satisfying the threshold condition for ADR occurring in slide-away discharge observed in several machines

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Conclusions

- ADR happened in slide-away discharge during current ramping down
- ECE signals jumping up and step-like oscillations generated by conversion from parallel to transverse energy due to ADR
- ADR process identified by phase difference decreasing to a critical value 0.15 rad.