Control of the Oscillatory Regime by Local Current Perturbation in ECCD Plasmas on TCV

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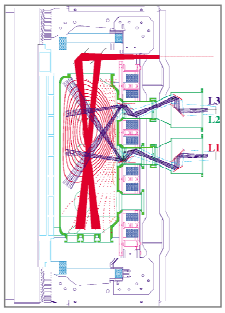
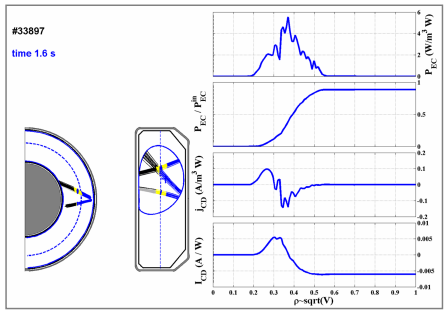
Introduction

- Global plasma oscillations (10 – 15 Hz; the **O-regime**) in fully non-inductive eITB discharges[1]
- **Reversed magnetic shear** and **MHD modes** are key requirements for the O-regime to occur in TCV
- The O-regime can be **suppressed** by adding ECCD-driven **localized current perturbation**
- **Transition** from the **ideal** (infernal[2]) to the **resistive** (NTM-like) MHD can be demonstrated during the oscillation cycle

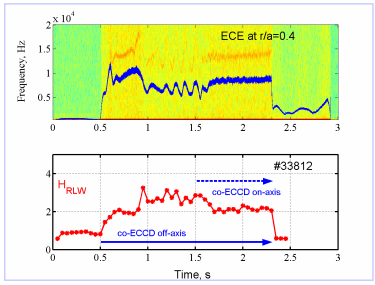
- **Co-ECCD** (1 MW) **off-axis** (w.r.t. **total I_p** direction which has **negative** sign for plasmas discussed here), $V_{loop} \sim 0$
- Confinement improvement: **H_{RLW}** up to **4**
- Oscillations: **m/n = 0/0**; MHD: **m/n = 2/1** or **3/1**[1]





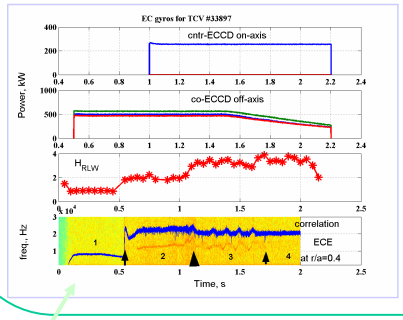
Suppression of the O-regime by central ECRH/ECCD

✓ Co-ECCD/ECH on-axis: 0.25 MW constant; co-ECCD off-axis constant



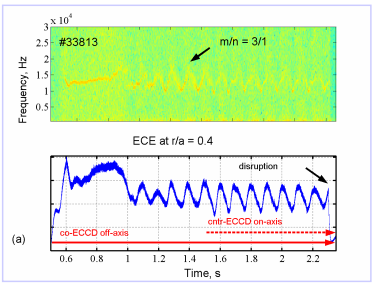
j(r) **less hollow** → **weaker** barrier → MHD **remains** but the O-regime **suppresses**

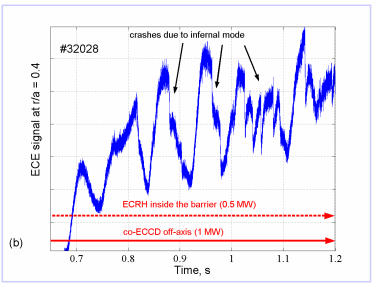
✓ Cntr-ECCD/ECH on-axis: 0.25 MW constant; co-ECCD off-axis power ramp down (1 MW → 0.75 MW)



Barrier strength **preserves** → q(r) **rises** → MHD mode **stabilizes together** with the O-regime at **1.7 s** (marked as **4** on the plot)

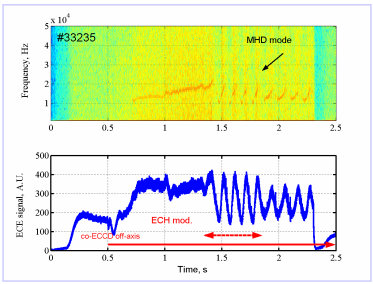
Transition to the infernal mode





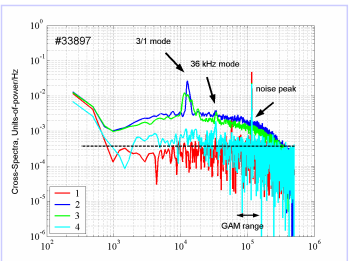
More ECH/cntr-ECCD inside eITB → H_{RLW} rises → steeper pressure gradients → transition to the ideal (infernal) mode with q=3 crashes instead of oscillations (caused by NTM-like MHD)

Excitation of the O-regime by modulated ECRH



- Modulated ECH (10 Hz) 1.4 – 1.8 s); MHD mode **follows** modulation
- After modulation stops, "**natural**" oscillations continue with the same frequency

High-frequency modes in the O-regime



- **Broadband fluctuations** (correlation ECE): 30 – 200 kHz during full-power ECCD/ECH phases (see numbers in the figure above)
- **35-37 kHz mode**: possibly e-fishbone[3]?

E-fishbone: requires **reversed q(r)** and barely trapped fast electrons with **13 keV** -> feasible for these plasmas[1]!

Conclusions

✓ Effective suppression of the O-regime and recovering the barrier by local ECCD (with and without MHD stabilization)

✓ Transition from resistive to ideal MHD by influencing the strength of a barrier and, thus, the pressure profile

✓ Observation of high-frequency modes (more analysis ahead)

References: [1]V.S.Udintsev et al., FS&T **8**, at press (2007); [2]G. Zhuang, EPS, **P2-143** (2004); [3]P. Maget, Nucl. Fusion **46**, 797 (2006)