

Runaway Experiments in GOLEM Tokamak

Experiments were performed to achieve repeatable, longer and stable discharges

- to understand the conditions of runaway generation and the effect of magneto-hydrodynamic (MHD) fluctuations on runaways.

For this, experiments were performed with

- various values of loop voltage and toroidal magnetic field
- various combinations of toroidal magnetic field (B_ϕ) direction (clockwise (CW)/ anticlockwise (ACW)) and electric field (E_ϕ) direction (CW/ ACW)
- different separation between vessel and Ohmic transformer coil

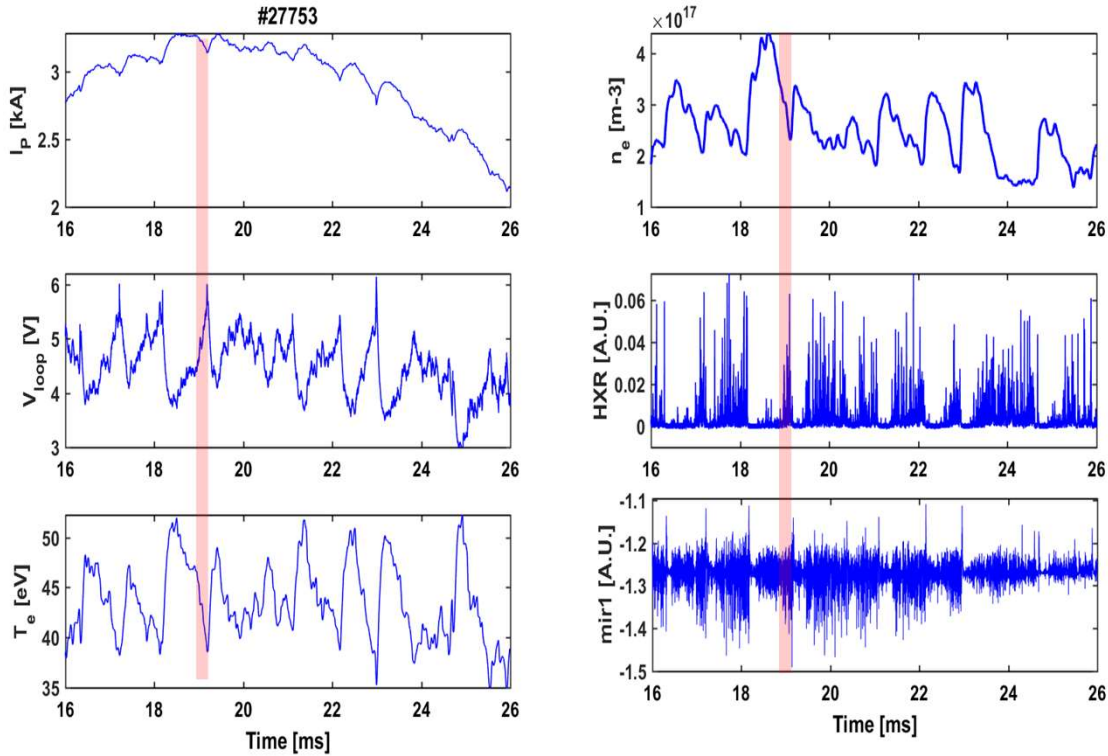
During the experiments HXRs were measured

- using NaI(Tl) and YAP scintillator probe;
- strip and pixel silicon radiation detectors

To measure MHD fluctuations

- a Mirnov ring was repaired and second ring was fabricated, calibrated and installed on GOLEM

Interplay Between MHD Fluctuations and Runaways: Role of Electric Field

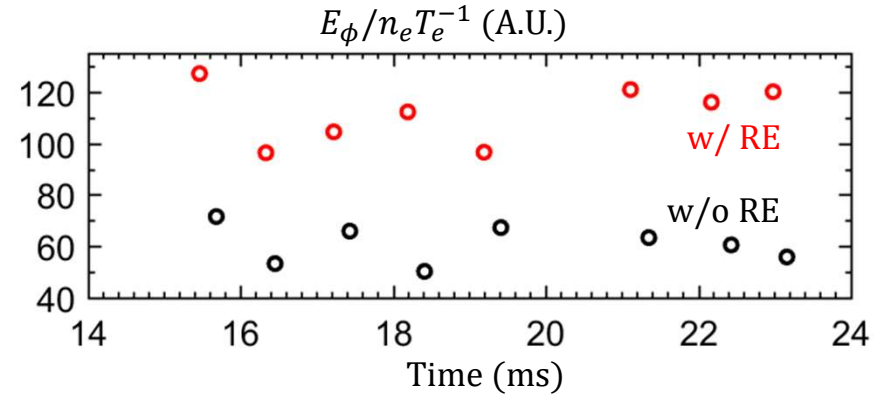


Observation:

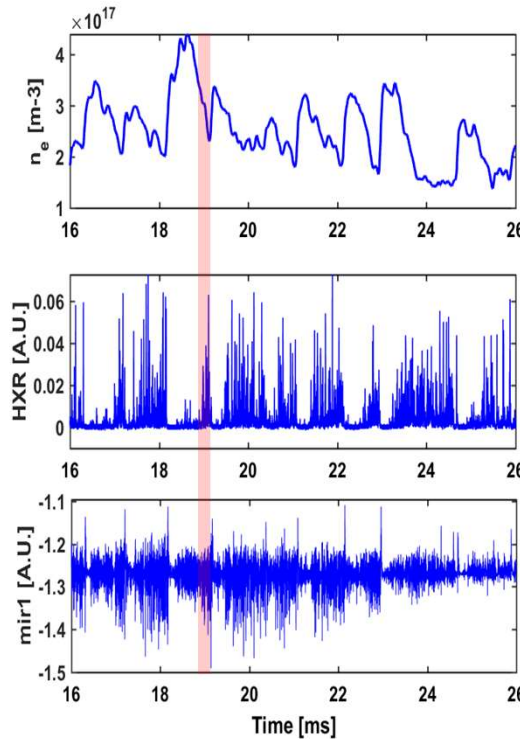
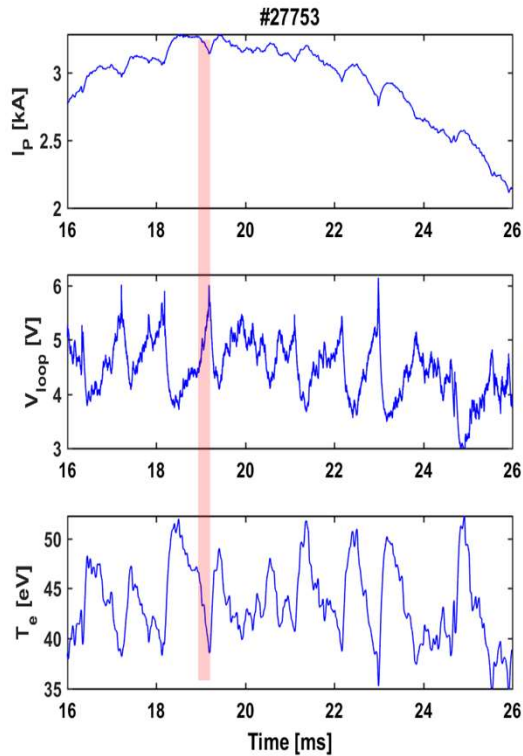
Higher U_{loop} (or E_ϕ)
 Lower density (weaker F_{drag})
 Larger \dot{B}_θ amplitude

→ Higher HXR amplitude

Toroidal electric field ($E_\phi = V_{loop}/2\pi R$) normalized by Dreicer electric field, $E_{Dreicer} = 0.43 n_e Z e^3 \ln \Lambda / 8\pi \epsilon_0^2 \kappa T_e$



Interplay Between MHD Fluctuations and Runaways: Role of Magnetic Fluctuations



Observation:

Higher U_{loop} (or E_ϕ)
 Lower density (weaker F_{drag})
 Larger \dot{B}_θ amplitude

→ Higher HXR amplitude

Possibilities

- (1) Larger \dot{B}_θ → wider islands → Stronger $E_{||} (\propto w)$
- (2) Larger \dot{B}_θ → Stochastic field lines → Expulsion of charged particles
- $$D_r \sim \pi R q v_{||} \left(\frac{\tilde{B}_r}{B} \right)^2$$

Cause of magnetic fluctuations?

Growth rate of tearing mode
 $\gamma \propto (q')^{2/5}$

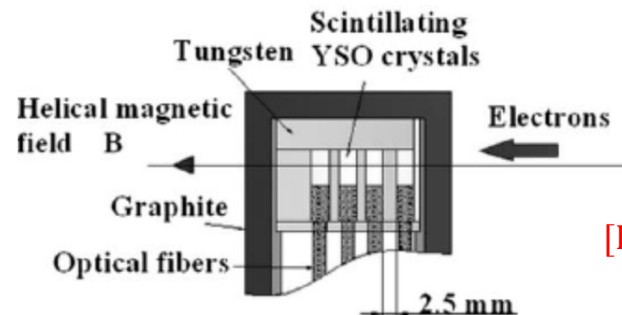
- Change in current density (j_ϕ) profile!!
- Why tearing modes suppress suddenly??



Future Plans for the Runaway Experiments at GOLEM

Experiments are planned

- with H₂, He Gas Puff- Gas puffing system is under development
 - Gas puffing might destabilize tearing modes, induce disruptions and produce runaways
- by changing the resistance and inductance in the current drive power supply circuit
 - To change rise time of loop voltage and see effect on runaway generation
- with runaway measurements using plastic scintillator
 - To compare signal with those of other scintillation probes
- Design of the customized scintillation probe- Currently in progress
 - Spectral measurement of runaways inside the plasma edge
 - Array of 4-5 scintillation crystals; YSO and LaBr₃ are possible candidate



[Kudyakov, RSI-2008]