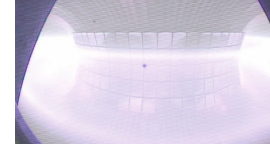# F18
Runaway electrons

FTU Experimental Campaign 2019-C1-A

Tuesday 25/03/2019 (Early & Late)
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Background (1/2)

Dedicated Runaway control has been designed and tested since 2013. A number of tools have been continuously modified and improved since then.

- Current Allocator (V, F)
- Hybrid PID (H, F)
- Switching-F (F)
- Ip double integrator (T)
- Ramp-controller (H, F)
- Vloop controller (T)
- PWM on Ip ref (Vloop oscillations, T)
- Ip ref generator for REs
- Final External Kick
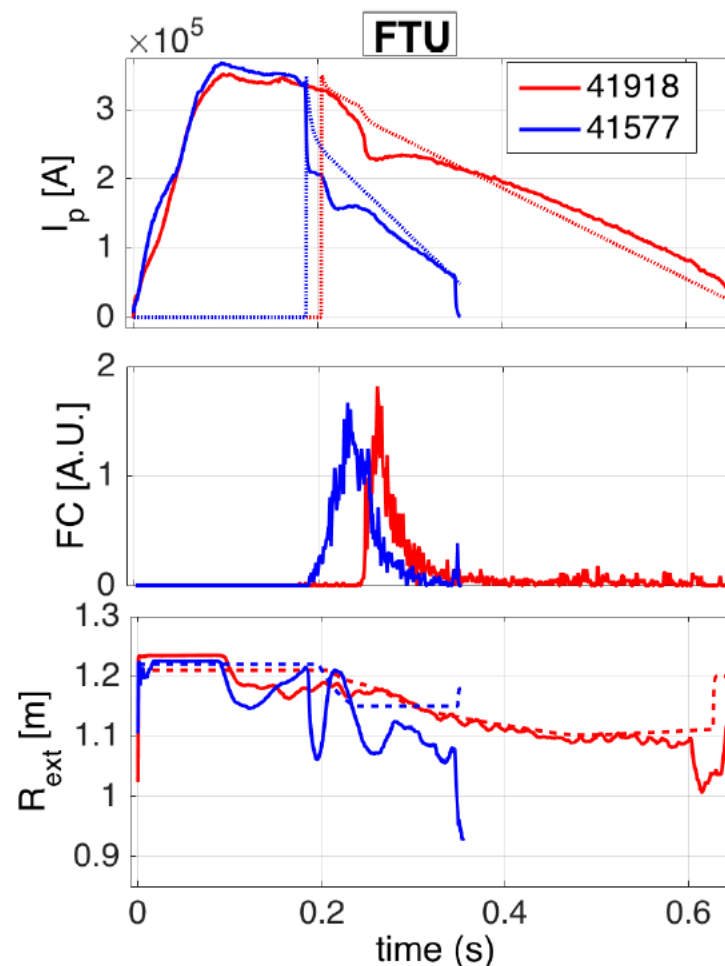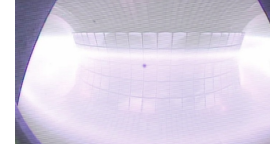
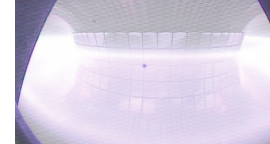Two (very) interesting results have been obtained by applying controllers developed at FTU for MST1 runaway experiments on TCV: vertical RE beam sweep and complete runaway to ohmic current conversion using Vloop oscillations.
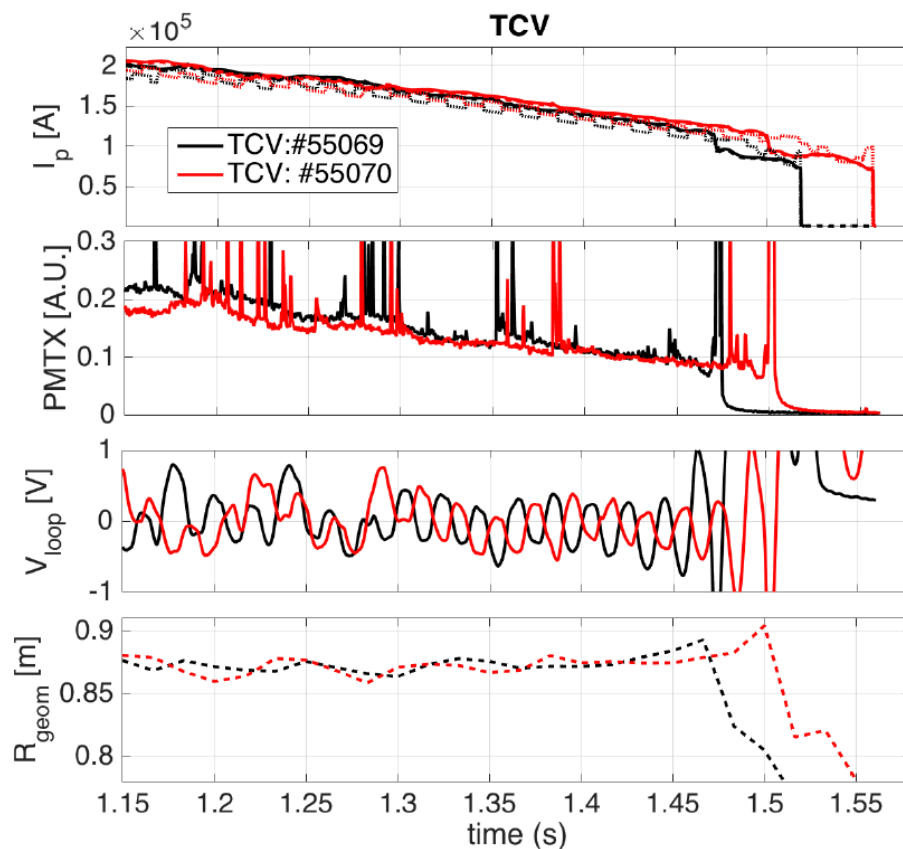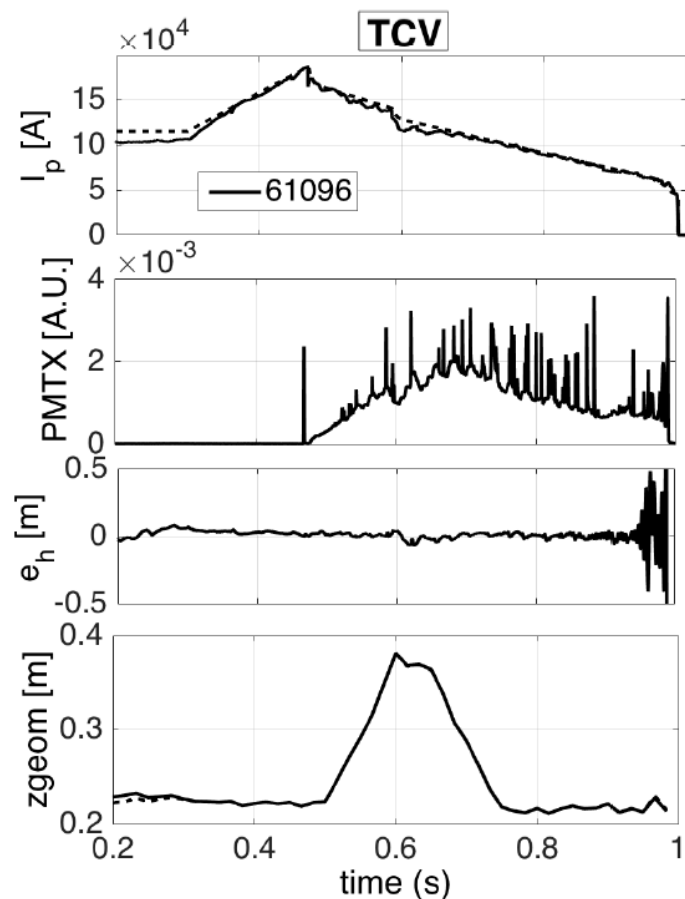
Goals & Strategy

Goals

- Investigate the RE into Ohmic current conversion using Vloop oscillations.
- Asses the runaway vertical controllability of the beam (2-3cm sweep).
- Confirm the effectiveness of the ramp-controller

Strategy

- Obtain post-disruption RE beams with very low D pre-fill, manual puffing (Bin recipe), injection of Ne and Pellet to maximize RE seeding to induce disruptions leading to RE beams.
- Activate the PWM generator on Ip ramp-down reference (post-disruption RE beams).
- Select the "best" ramp-down rate and Vloop threshold (adding D puffs).
- Activate the current allocator, ramp-controller on H and F.
- Design new vertical references with ramps and plateaus.
- Inject the LBO (Fe) during the early flat-top phase (F09 collaboration)
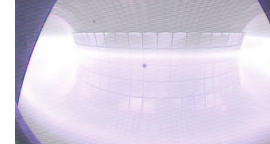
Requirements

Machine

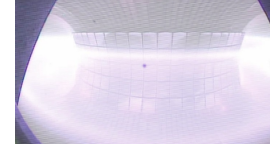|	
Toroidal magnetic field BT (T):	4.6 - 5.6
Plasma current Ip (MA):	0.36 0.50
Electron density ne (10^{20} m^{-3})	0.05 – 0.4

Diagnostics

HXR, FC, Interferometer, ECE, Soft-X (and temperature profiles), D-alpha, Mirnov coils, Cherenkov, (Schowb if available)

Special requirements: Ne, Poloidal Limiter 1 cm inside for all shots, allocator active in IFREF mode, Pellet injection

Modeling

Standard

Pulse Plan

Shot type 0: #41903, 5.3T, shortened, same manual gas puffing, extremely low prefill (0.3 E-5--0.5E-5).

Shot types 1[TO DO]: shot type 0 with modified (vertical) position references.

1. Zero at 5.6T
2. Shot type 0: Ne at 0.12s (no It cross) 6 mbar, 98V. Small Pellet at 0.15s. Vloop oscillations (SCAN period 150ms,+-2V) active on current ramp-down (1000ms duration) [**3 shots**, RE plateaus]
5. Recover: standard 500kA, ne 0.4E20. [**1 shot**]
6. Shot type 0: Ne at 0.12s (no It cross) 6 mbar, 98V. Small Pellet at 0.15s. Vloop oscillations (SCAN period 150ms,+-2V) active on current ramp-down (1000ms duration). Inject Deuterium GAS at ramp-down [**3 shots**, RE plateaus]
9. Recover: standard 500kA, ne 0.4E20. [1 shot]
10. Shot type 1: Ne at 0.5s (no It cross) 6 mbar, 98V. Scan on position reference changes. [5 shots, RE plateau].

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