Wendelstein 7-X

IPP Max-Planck-Institut für Plasmaphysik

W7-X OP2 proposals on electrostatic turbulence (w/ lead proponent Stechow)

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EUROfusion

turbulence limits of NBI core density peaking

Main hypothesis tested

- OP1.2: NBI-only programs achieved significant core density peaking within half radius
- line-integrated turbulent density fluctuations as measured by phase contrast imaging (PCI) surprisingly showed largely unchanged amplitude and wavenumber spectra
- doppler systems have limited access to core at high densities, but suggest decrease of scattered power far in core
- hypothesis: there is a turbulence limit to achievable core density gradients (by grad-n TEMs?)
- Why is the NBI-induced gradient so localized in the core? Can we identify relevant instabilities at different radii?

Actuator to test that hypothesis

- NBI fueling (including new sources) for core density gradient control, without “losing“ discharge due to P/n limits

Estimated number of dedicated discharges

- 2x reproduce results from OP1.2 with single NBI source at 2 starting densities
- 2x attempt to extend
- possibly repeat in TEM-unfavorable magnetic configuration (e.g. low mirror)

ion-scale turbulence during sustained/repeated pellet fueling

Main hypothesis tested

- transiently decreased anomalous transport and ion-scale fluctuations observed after pellet injection in OP1.2
- associated with density peaking and reduced η_i drive of ITGs
- hypothesis 1: this effect is reproducible with the new steady-state pellet injector
- hypothesis 2: this effect can be sustained with continuous pellet injection, or with repeated injection after a pause
- (companion proposal to S. Bozhenkov‘s in TG profile)

Actuator to test that hypothesis

- (largely uncontrolled) core density gradient modification by cryogenic pellet injection

Estimated number of dedicated discharges

- none, since all measurements are done piggyback on the pellet injection scenario development
- interesting findings during campaign (mode activity, strongly reduced fluctuations) can feed back in to pellet injection parameter selection

Main hypothesis tested

- transiently increased confinement and T_i after pellet injections are postulated to be associated with reduced instability growth rates in the „stability valley“
- hypothesis: magnetic configurations without “stability valley“ are worse at providing improved confinement
  - performance indicators such as T_i and W_{dia} do not peak as strongly
  - fluctuation diagnostics see a limited reduction in ion-scale fluctuations

Actuator to test that hypothesis

- (largely uncontrolled) core density gradient modification by cryogenic pellet injection

Estimated number of dedicated discharges

- 8? Attempt to repeat “pellet recipe“ in low mirror configuration, vary ECH heating and timing, pellet timing etc. as required to reach highest W_{dia} and T_i
- If possible, profile matching to pellet experiments in standard or high mirror conf. should be attempted

turbulence "matching" between pure ECH and pure NBI heating

Main hypothesis tested

- OP1.2: on switchover from ECH-only to NBI-only, turbulence amplitude and spectra can be very similar before significant peaking begins
- Hypothesis: the ECH power can be tuned to create a near-perfect fluctuation power match between both phases
  - How do the equilibrium and E_r profiles, as well as the power balance change?
  - Does the resulting ECH power level provide matched ion heating power?
  - How do turbulent fluctuations (including T_e in the core) change, especially in light of the large change in T_e, grad(T_e) and T_e/T_i

Actuator to test that hypothesis

- ECH input power variation

Estimated number of dedicated discharges

- 3 to converge on optimal ECH power
- 1 repeat at ECH power optimum with multiple switchovers between NBI and ECH