TJ-K: Recent Results and Future Projects

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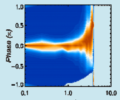
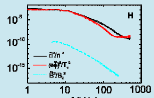
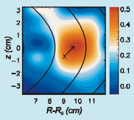
Plasma Turbulence Studies

Turbulence in TJ-K is drift-wave like

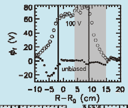
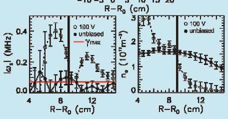
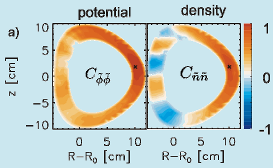
- Structures propagate into the electron diamagnetic direction
- Density and potential are in phase
- A finite parallel wave number is measured
- Due to low β, the electro-magnetic fluctuations are small
- Size of structures scales with ρ_s
- Excellent agreement with drift-Alfvén wave code DALF

U. Stroth, PoP **11**, 2558 (2004)
M. Ramisch, PoP **12**, 032504 (2005)
N. Mahdizadeh, PPCF **49**, 1005 (2007)
K. Rahbarnia, PPCF **50**, 085008 (2008)

Biasing induces transport barrier and zonal flows

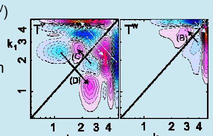
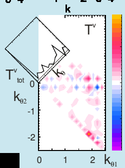
- Biasing leads to a shear-flow induced transport barrier
- Broad-band turbulence is reduced and coherent modes dominate spectrum
- Dominant m=3 mode causes inward transport
- Zonal flow (m = 0) and m = 3 mode dominate potential and density fluctuations, respectively

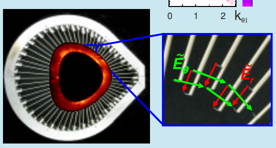
M. Ramisch, PPCF **49**, 777 (2007)
P. Manz, PoP **16**, 042309 (2009)

Dual turbulent cascade detected

- Turbulent fluctuation energy (T^V) follows an inverse cascade to larger scales
- Enstrophy (T^W) is transported in a direct cascade to smaller scales
- Non-local energy transfer is observed (A)
- Energy transfer to the zonal flow (k_θ= 0, $k_r \neq 0$) is predominantly from the smaller scales

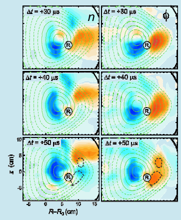
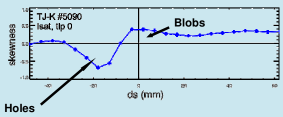



P. Manz, PPCF **50**, 035008 (2008)
P. Manz, PPCF **51**, 035008 (2009)
P. Manz, PRL (accepted)



Edge-SOL transition

- Blobs in the SOL are generated at the separatrix by drift-wave structures
- Blob dynamic differs from drift-wave dynamics.
- Radial skewness profile shows holes inside and blobs outside the separatrix

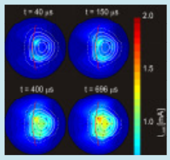
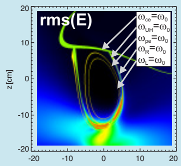



T. Happel, PRL **102**, 255001 (2009)
B. Nold, PPCF (to be submitted)

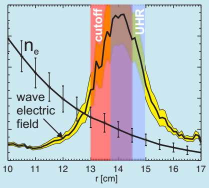
Wave Physics

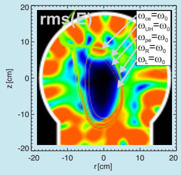
Plasma is heated at UH resonance

- Plasma start-up at ECR measured with multiple probe array
- Hollow T_e profile indicates power deposition at plasma boundary
- Full-wave simulations for incident X-mode yield single pass absorption of 12 %
- Including vacuum vessel walls strongly increases the absorption to 80 %
- Absorption takes place at upper hybrid resonance, where a strong enhancement in the wave electric field can be seen
- Heating at upper hybrid resonance confirmed by wave field measurements with monopole antenna and power-modulation studies

A. Köhn, submitted to PPCF, June 2009
G. Birkenmeier, IEEE, 5, (2008)

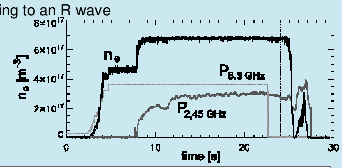




Nonresonant high-density regime at 0.3 T

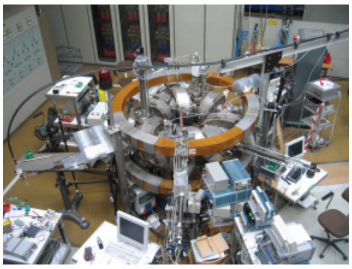
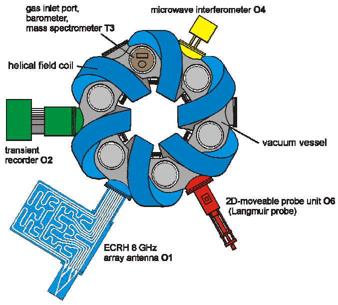
- 8 GHz microwave for plasma start-up at 0.3 T
- If density exceeds cutoff for 2.45 GHz, additional 2.45 GHz power increases plasma density without resonance inside plasma
- Plasma is sustained by 2.45 GHz alone (8 GHz switched off)
- Possible reason is coupling to an R wave

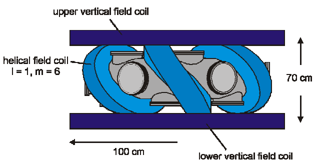
A. Köhn, EPS 2009

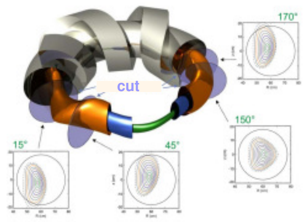
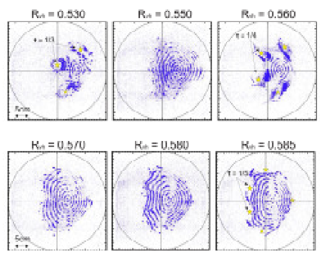
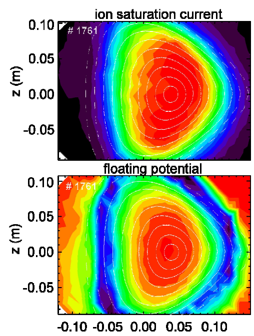


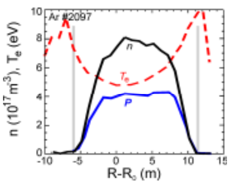
Torsatron TJ-K

Major plasma radius:	R = 0,6 m
Minor plasma radius:	a = 0,1 m
Magnetic field:	48 mT ≤ B ≤ 300 mT
Electron temperature:	$T_e \approx$ 10 eV
Ion temperature:	$T_i \approx$ 1 eV
Electron density:	$n_e \approx 5 \cdot 10^{17}$ m^{-3}
Working gases:	H, D, He, Ne, Ar
Iota:	0.13 – 0.4
Pulse Duration:	up to 45 min





Future Program

Hardware upgrades

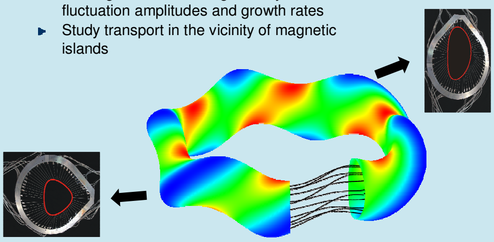
- Upgrade 8 GHz power from 1 – 3.5 kW for ECRH at 0.3 T
- Three 2.5 kW klystrons at 14 GHZ for ECRH at 0.5 T
- Intensified fast camera
- Upgrade TJ-K for short pulse operation

Neoclassical transport studies

- At higher power and magnetic field low collisionality plasmas are envisaged
- Study of ambipolar electric field and neoclassical transport.

Turbulence studies

- Investigate influence of geometry on turbulent fluctuation amplitudes and growth rates
- Study transport in the vicinity of magnetic islands



Equilibrium studies and current drive

- Magnetic diagnostics for studies of equilibrium currents
- Bolometry studies
- Simulation and Measurement of Pfirsch-Schlüter currents
- Investigate currents driven by ECRH