International edge turbulence data base

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Introduction

One of the main challenges in fusion research is a better understanding of energy and particle transport. The international edge turbulence data base was initiated to enable direct comparison of plasma edge and SOL turbulence in different experiments and regimes. It is foreseen to combine data of electro-static fluctuations measured with Langmuir probes in various devices. Probes allow local measurements of I_{sat} and U_{float} with high temporal resolution and are available from many machines. Fast measurements of the electron temperature are necessary to derive plasma density and potential fluctuations from probes. Nevertheless, robust measurements of electron temperature fluctuations are currently not available. The technique of fast sweeping Langmuir probes shall therefore be improved to define a standard for future inter-machine comparisons. This development is motivated by results from W7-AS [1] and will start with an adaptation of the existing system for WEGA.

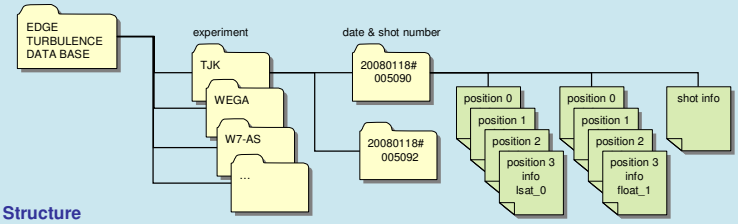
Topics to be addressed with the data base containing the currently available probe data are the experimental conditions for blob and hole generation, different regimes of blob propagation, scaling of turbulence with dimensionless parameters, extension of the available parameter range for comparison with simulations, blob transport to the wall and the general description of intermittency.

We, the autors, want to invite you to join this project and to supply probe data from your experiment, work on inter-machine data analysis and/or support the development of the future standard for probe measurements.

Current state

Requested data

- Langmuir probes (long time traces if available)
- Radial profiles from the SOL and across the separatrix
- 2 floating potential measurements (poloidally separated)
- 2 ion-saturation current measurements (poloidally separated)



Structure

- Directories ordered by date, shot and experiment
- Files contain meta information and fluctuation signal
- Data stored in ASCII files (good accessibility)
- Simple IDL routines available to write/read data
- MatLab write/read routines coming soon
- Addional meta information to be included:
  background profiles, LCFS geometry

```
!---U-FILE-0D----------------------------Fri Sep 25 11:30:11 2009
tjk                 ;-DEVICE
20080118            ;-DATE OF SHOT
  5090              ;-SHOT NUMBER
I_sat (mA)          ;-SIGNAL NAME
  1                 ;-PROBE TIP NUMBER
  0                 ;-POSITION NUMBER
 -48.0              ;-PROBE TIP DISTANCE TO SEPARATRIX r-a (mm)
                    ; (>0 IS SOL)
  1.0               ;-UNCERTAINTY OF DISTANCE TO SEPARATRIX (mm)
 12.5               ;-VERTICAL DISTANCE TO MAGNETIC MID-PLANE (mm)
  0.5               ;-UNCERTAINTY OF VERTICAL DISTANCE (mm)
638.0               ;-MAJOR RADIUS OF PROBE TIP (mm)
  1.0               ;-UNCERTAINTY OF MAJOR RADIUS (mm)
 1001               ;-NUMBER OF DATA POINTS
  1.00E-06          ;-TIME DELAY (s) BETWEEN DATA POINTS
 0.0000000          ;-TIME (s) AT CENTRAL DATA POINT
                    ; OR DATA POINT AFTER CENTER (for even numbers)
                    ; (for reciprocating probes)
;----START-OF-DATA----------------------
  4.7163E-01  4.7697E-01  4.8097E-01  4.8430E-01  4.8430E-01  4.8530E-01
  4.8663E-01  4.8630E-01  4.8347E-01  4.8363E-01  4.8263E-01  4.7947E-01
                          ...
  3.5980E-01  3.6197E-01  3.6013E-01  3.6047E-01  3.6180E-01  3.6097E-01
  3.6013E-01  3.5747E-01  3.5463E-01  3.5597E-01  3.5597E-01
;----END-OF-DATA-----------COMMENTS:------
Bias voltage of isat probes -90V applied to Isat probes
in H plasma with electron temperature below 20eV in TJ-K
with two toroidal limiter plates. Heating with 1.8kW ECRH at 2.45GHz, Bt=72mT,
nominal gas pressure p=12.4 mPa
```

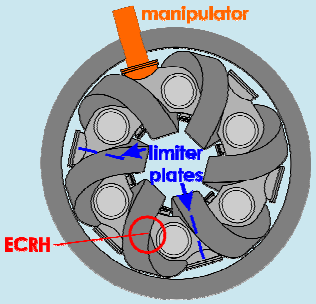
Next steps

- Contribution from your machine
- Joint papers

First data available

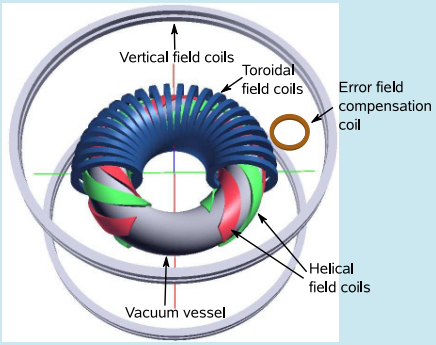
The torsatron TJ-K

- Magnetic configuration: l = 1, m = 6
- Major radius: R = 0.6 m
- Minor radius: a = 0.1 m (here: 0.05 m)
- Magnetic field: B = 0.3 T (here: 72 mT)
- Micro wave heating: 8.25 GHz or here 2.45 GHz
- Working gases: He, Ne, Ar and here H_2
- Probes scan discrete positions



The stellarator WEGA

- Magnetic configuration: l = 2, m = 5
- Major radius: R = 0.72 m
- Minor radius: a = 0.11 m
- Magnetic field: B = 0.5 T (here: 57 mT)
- ECRH heating: 28 GHz or here 2.45 GHz
- Working gases: H_2, Ne, Ar and here He
- Probes on fast reciprocating manipulator

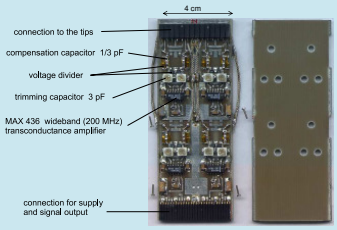


Standard for probe measurements

Electron temperature fluctuations

- Usually neglected in Langmuir probe measurements
  $\tilde{I}_{sat} \propto \tilde{n}$ $\quad$ $\tilde{\Phi}_{fl} \propto \tilde{\Phi}_{pl}$
- Strong influence on cross-phases between fluctuating parameters
- Important for cross field transport, e.g. radial ExB flux

$$\Gamma \propto \int d\omega |\hat{E}^*_\theta(\omega)||\hat{n}|(\omega)\cos(\varphi_{n,E}(\omega))$$



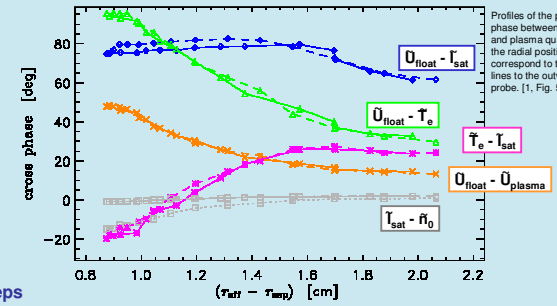
Amplifier board containing 4 miniaturized circuits for independent current measurements. The board has dimensions of 100 x 40 x 4 mm and was mounted behind the probe head in W7-AS to measure fast temperature fluctuations. [1, Fig. 3.5]

Fast sweeping probes in W7-AS

- Sweeping frequency up to 2 MHz
- Preamplification and compensation integrated in the probe head

Results from W7-AS

- Constant phase shift between U_{float} and I_{sat} through out the SOL
- Significant influcence of temperature fluctuations
- Phase between U_{plasma} and n_0 changes from $\Pi/4$ to 0



Profiles of the power weighted cross phase between primary fit parameters and plasma quantities as a function of the radial position in W7-AS. Solid lines correspond to the inward and dashed lines to the outward movement of the probe. [1, Fig. 5.25]

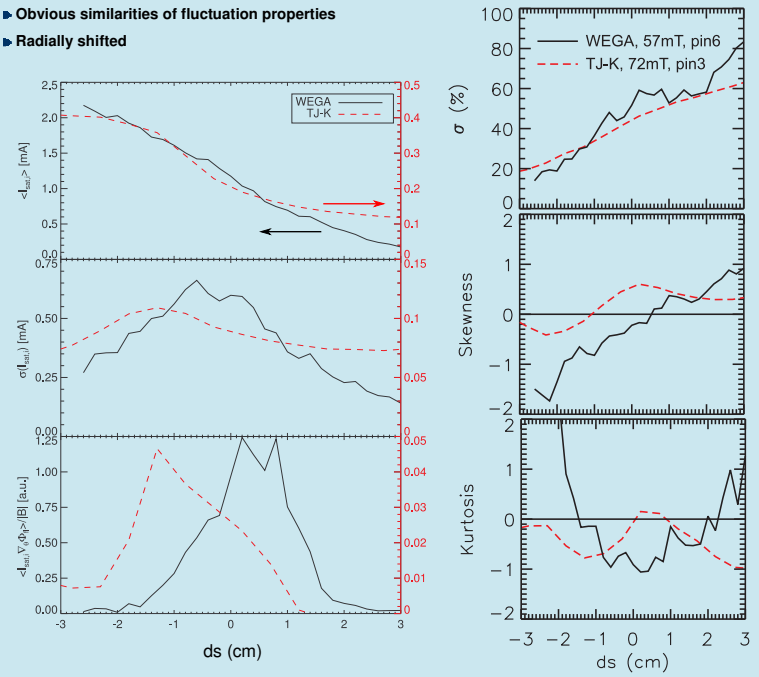
Next steps

- Adaptation for WEGA
- Improvement of model, techniques and analysis
- Transfer to other experiments
- Establishment of standard for probe measurements

First results

Radial profiles from TJ-K and WEGA

- Joint data analysis by S. Marsen from the WEGA Team (left side) and M. Ramisch from the TJ-K team (right side)
- Obvious similarities of fluctuation properties
- Radially shifted



Reference

[1]: M. Schubert, PhD Thesis, Greifswald 2005,
http://edoc.mpg.de/get.epl?fid=17419&did=246340&ver=0