2nd PhD Event in Fusion Science and Engineering, October, 22-25, 2012, Abbaye des Prémontrés, Pont-a-Mousson, (France)

First results on the plasma fluctuations of the TORPEX device in the new magnetic field configurations

F. Avino, A. Bovet, A. Fasoli, I. Furno, J. Loizu, A. Mosetto, P. Ricci

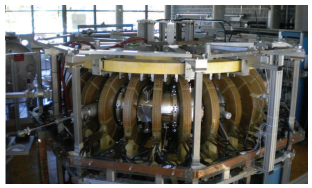
Ecole Polytechnique Fédérale de Lausanne (EPFL), Centre de Recherches en Physique des Plasmas (CRPP)
Association Euratom Confédération Suisse, Station 13, CH-1015 Lausanne, Switzerland

1. Introduction

The TORoidal Plasma EXperiment features a Simple Magnetized Torus configuration (SMT) using a small vertical magnetic field superimposed to the main toroidal field, resulting in helical open magnetic field lines[1],[2].
A new experimental set-up based on an in-vessel toroidal copper wire has recently been implemented into TORPEX to produce a poloidal magnetic field, driving a current with a dedicated external power supply. This leads to a rotational transform and to a magnetic configuration similar to the tokamak one:

- Scrape-Off Layer region.
- Core region.
- Closed-to-open magnetic field lines transition.

2. TORoidal Plasma EXperiment



Main parameters:

- $R = 1.0m$
- $a = 0.2m$
- $B_T \approx 76mT$
- $B_V \approx 1mT$ ($I_{BV} \approx 30A$)
- $n_e \approx 10^{16}m^{-3}$
- $T_e \approx 5eV$
- $f_{microwave} \simeq 2.45GHz$

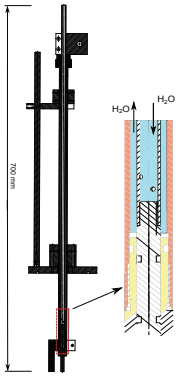
Main features:

- Gases: H_2, He, Ne, Ar.
- Density gradients.
- Magnetic field gradients and curvature.
- Direct measurements on the whole plasma volume.
- High plasma reproducibility.
- High flexibility of the control parameters.

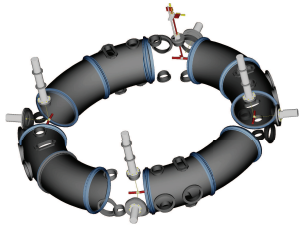
3. In-vessel toroidal wire system

Experimental set-up:

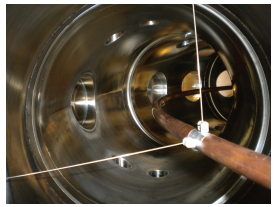
- Toroidal copper wire with 1 cm radius.
- 1 vertical feedthrough actively cooled.
- 3 vertical supports.
- 4 horizontal supports.
- Current up to 1kA.



Detail of the cooling system.

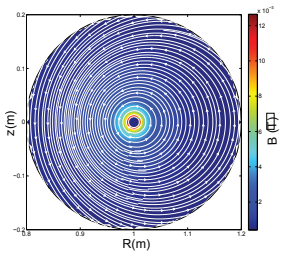


3D view of the in-vessel toroidal wire system installed on TORPEX.

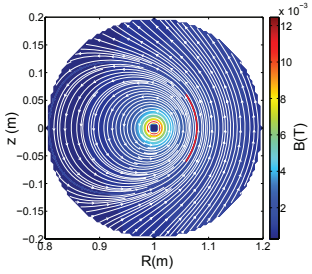


View of the copper wire inside the vacuum vessel of TORPEX.

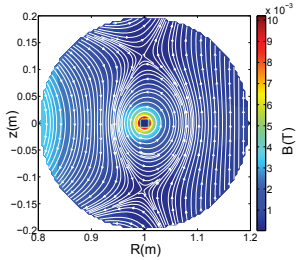
4. Simulated magnetic field



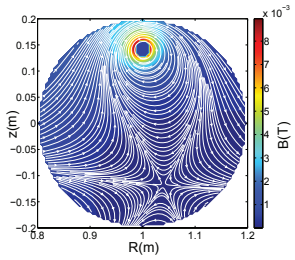
Magnetic field on the poloidal cross section with 630A in the toroidal wire.



Magnetic field on the poloidal cross section with 630A in the toroidal wire and 30A in the vertical field coils.



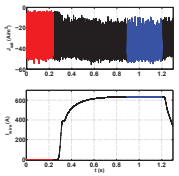
Vertical Double-Null X-points magnetic configuration.



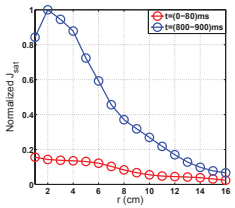
Snowflake magnetic configuration.

5. 1-D plasma profiles

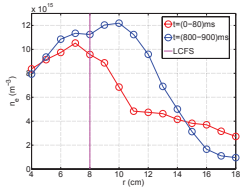
Measurements on the LFS, at $z = 0$, using H_2 gas and a constant magnetron power $P_{mag} \approx 150W$.
A current of $630A$ in the toroidal wire and $30A$ in the vertical field coils has been used.



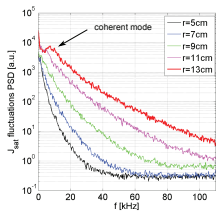
Probe J_{sat} signal and toroidal wire time profile.

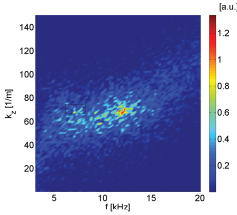


Radial profiles of the time-averaged J_{sat} normalized to the maximum value, with $R_{EC} = 0.9m$.

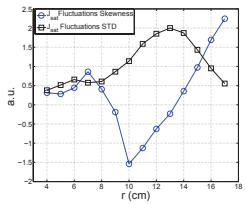


Radial profile of the time-averaged density (n_e), with $R_{EC} = 1.0m$.





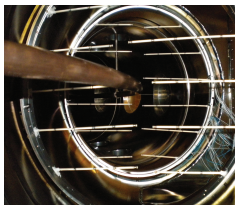
J_{sat} fluctuations PSD and statistical dispersion relation at $r = 13cm$ and $R_{EC} = 1.0m$.

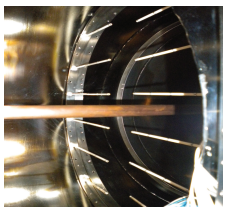


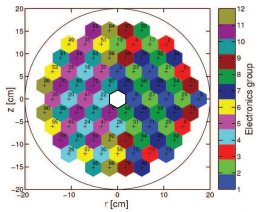
Standard deviation and Skewness of J_{sat} fluctuations.

The statistical dispersion relation shows a coherent mode at $f \simeq 12kHz$ and $k_z \simeq 70m^{-1}$.

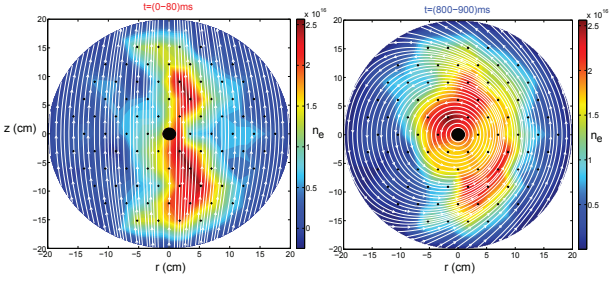
6. 2-D plasma profiles



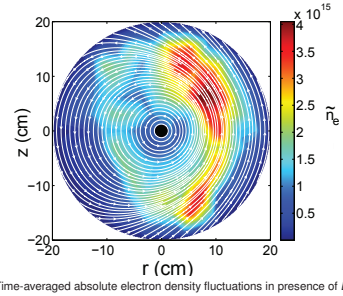




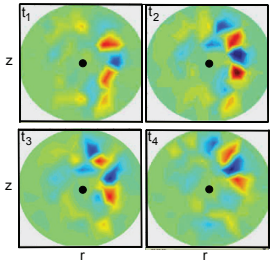
Picture of HEXTIP inside the vacuum vessel and corresponding mapping of the probes.



Time-averaged electron density with and without the poloidal magnetic field. In white the simulated magnetic field lines.



Time-averaged absolute electron density fluctuations in presence of B_p.



Snapshot of the conditional sampling on the density fluctuations signal of a probe of HEXTIP.

7. Conclusions and outlook

First measurements of plasma fluctuations and background parameters have been performed on the TORPEX device with new magnetic field configurations, both in 1-D and 2-D.

Outlook:

- Plasma turbulence characterization;
- Comparison of the experimental results with linear/non-linear fluid simulations[3];
- Exploration of more complicated magnetic field configurations.

Acknowledgment

This work was supported in part by the *Swiss National Science Foundation*.

References

[1] Podestá *et al.* Europhys. Conf. Abstr. vol. 27A, 2003.
[2] A.Fasoli *et al. Plasma Phys. Controlled Fusion*, vol. 52, p. 124020, 2010.
[3] A.Mosetto *et al.* European Fusion Theory Conference, Frascati, Italy, 26-29 September 2011.

http://crpp.epfl.ch fabio.avino@epfl.ch