Visible spectrum tomography of rotating coherent modes in a linear magnetized plasma

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Introduction

Tomography plays an important role in plasma diagnostics when it comes to spatial resolution without intrusion. To date, several devices (tokamaks, stellarators, laboratory experiments...) routinely use tomography to reconstruct the local plasma emissivity from many synchronized line integrated measurements. Mathematically, tomography relies on the inversion of a linear system of equations, with one equation per line of sight (LoS) and one unknown per volume, or 'pixel', in which one wants to infer the local emissivity. One of the main difficulties of a tomographic inversion is that this system is ill defined and has to be regularized, most of the time using strong hypotheses.

Experimental setup

In this work, tomography in the visible range is used on the linear magnetized plasma device MISTRAL[1][2].

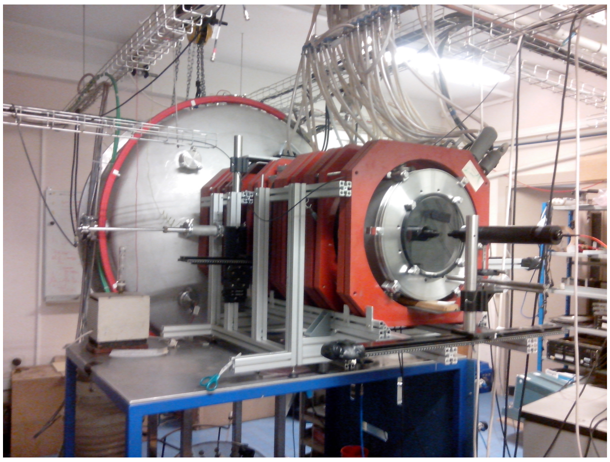

Fig. 1: *MISTRAL device: the source chamber (on the left) and the magnetized column (on the right)*

In this device, the plasma is created in a large source chamber (1.4m diameter, 1m length) where a thermoionic discharge is created using 32 tungsten filaments and then injected in a one meter long cylindrical magnetized (0.025T) interaction chamber. We study here low frequency instabilities regularly rotating around the central plasma column called 'flute modes'.

The plasma rotation being stable for several hours, a single fibre can be moved to different acquisition positions, and synchronized with the plasma rotation to simulate the simultaneous acquisition of 32 LoS. On one end this fibre collect light from a plasma volume of width between 8 and 13mm, and on the other it is connected to a photomultiplier with a gain of about 10^{6-7} and a multichannel scaler that counts the number of photons every 2.5µs for 500µs (about two full rotations of the plasma).

Results

Different sets of general hypothesis are tested for the numerical inversion, and give similar results even with more than seven times as many pixels (unknowns) as LoS (equations). Those results are compared to a lower resolution, intrusive, Langmuir probe spatial studies done on the same device and to theoretical predictions of rotating instabilities in linear plasma columns with the 2D PIC code developed at LAPLACE (Toulouse, France)[3].

References

[1] Th. Pierre, et al., Phys. Rev. Lett. **92**, 065004 (2004).
[2] A. Escarguel, Eur. Phys. J. D **56 (2)**, 209-214 (2010)
[3] J.P. Boeuf et al., Phys. Rev. Lett. **111**, 155005 (2013)