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Microwave Diagnostics tools for compact plasma traps and beyond

Giuseppe Torrisi[1]. Eugenia Naselli[1], Loreto Di Donato[2], Giorgio S. Mauro[1], Maria Mazzaglia[1], Bharat Mishra[1], Angelo Pidatella[1], G. Sorbello[1,2] and D. Mascali[1]

1) *Istituto Nazionale di Fisica Nucleare - Laboratori Nazionali del Sud (INFN-LNS), Via S. Sofia 62, 95123 Catania*
2) *Dipartimento di Ingegneria Elettrica, Elettronica e Informatica, Università degli Studi di Catania, Viale Andrea Doria 6, 95125, Catania*

Plasma diagnostics is a topic having a great impact in addressing the R&D in compact ion sources as well as in large fusion reactors. Towards this aim, non-invasive microwave diagnostics approaches, such as interferometric, polarimetric and microwave imaging profilometry techniques allow obtaining volumetric, line-integrated or even space-resolved information about plasma electron density. Special probes can be also designed and implemented in order to characterize external and/or self-generated radio-waves in the plasmas. In particular, the design, construction and operations at INFN-LNS of a K-band microwave interferometry/polarimetry setup based on the Frequency-Modulated Continuous-Wave (FMCW) method will be shown: this tool provides reliable measurements of the plasma density even in the extreme unfavorable wavelength-to-plasma scale ratio in plasma-based ion sources. A “frequency sweep” and a post-processing filtering method (for interferometry and polarimetry, respectively) have been used to filter out the multipath contributions or cavity induced depolarizations in the detected signals. Besides, the aforementioned RF plasma-immersed probes allow the measurement of local E-fields and fast temporal response in order to characterize turbulent (by kinetic instabilities, cyclotron maser emission, etc.) vs stable plasma regimes. An analysis based on wavelet transform applied to measurements of plasma radio self-emission in B-minimum and simple mirror traps will be presented. These tools and methods have the potentialities to be applied to plasma machines both in compact traps and large-size reactors with a proper scaling.

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