"MICROBE": Microwave Ionization in a Crossed Beam Experiment

G. Cattanei, and J.-G. Wegrowe, Institut für Plasmaphysik GmbH, 8046 Garching near Munich, Federal Republic of Germany

Abstract: A new plasma source using microwave power focused on a neutral beam has been developed. Some results are presented.

Introduction: An adequate plasma source for various confinement and heating experiments in stellarators should possess the following characters:

- Small spatial extension compared to the dimensions of the vacuum vessel.
- Absence of electrodes, antennas, limiters etc. in the source region.
- Measurable intensity.
- Ability to produce continuously a quiescent plasma of high density with respect to the background gas density.

For this purpose a source was deviced using microwave power at the electron gyrofrequency focused on a collimated neutral-gas beam. The neutral and the microwave beams are perpendicular to each other and to the static magnetic field B_o.

The minimum neutral flux necessary for breakdown is inversely proportional to the lifetime of the plasma particles and to the ionization cross section. Even with the poor confinement of a straight device this flux is realizable by using alkali metals.

We present preliminary results obtained in such an experimental set-up.

Experimental set-up: Figure 1 shows a blockdiagram of the machine. The stainless steel vacuum vessel has a diameter of 17 cm and a length of about 1 m.

The magnetic field may be varied up to 6 kG and is homogeneous to within $5\cdot10^{-3}$ in the interaction region. The microwave power (up to 20 watts at 13.3 GHz) is fed through horns and ceramic lenses (12 cm in diameter) which are also used as parts of an 8 mm interferometer.

Further diagnostic tools are: a Langmuir probe, a diamagnetic coil and a contact ionization probe for neutral flux measurements.

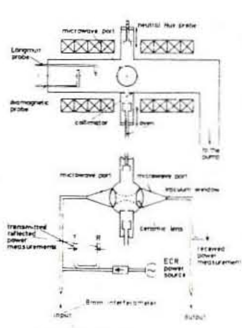

Fig.1 MICROBE Experimental set-up

Results: The plasma was produced using a collimated beam of Cs. The oven could be moved to vary the width of the beam on the axis of the device between 1 and 2 cm.

Fig. 2 shows the dependence of the ion saturation current of the Langmuir probe on the magnetic field for three different radial positions: on axis and 3 cm apart on each side.

For comparison, Fig. 3 shows the corresponding results obtained without Cs beam and filling the machine with Argon.

As may be seen a good spatial limitation of the plasma is obtained with the Cs beam. (a radial profile is shown in Fig.4). Half-width down to about 2 cm could be measured. This corresponds, as expected, to the dimensions of the interaction region between the microwave and neutral beams.

The density was evaluated from Langmuir probes and checked by the microwave interferometer. Peak densities up to some times $10^{12}cm^{-3}$ have been obtained.

The results obtained up to now indicate the feasibility of a source possessing the required properties. More quantitative measurements e.g. particles and power balance, are in progress.

This work was performed as part of the agreement between the Institut für Plasmaphysik GmbH, Munich-Garching, and Euratom.

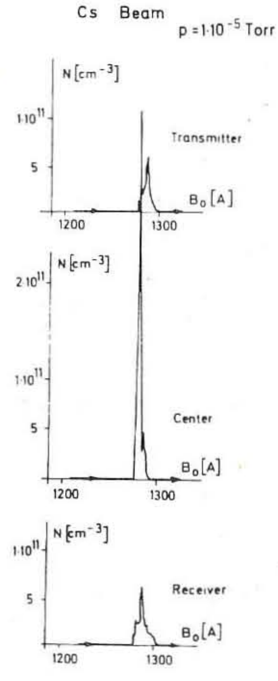

Fig. 2

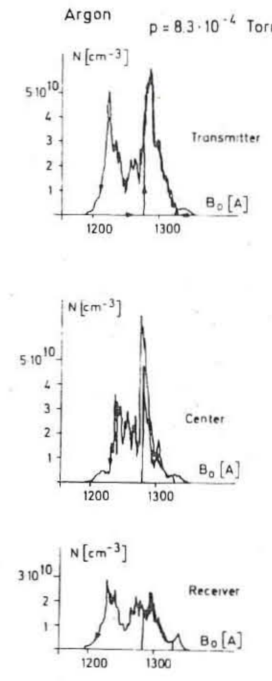

Fig. 3

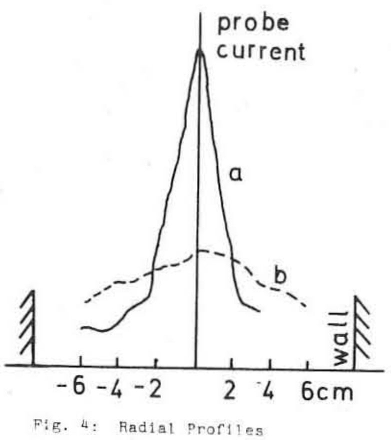

Fig. 4: Radial Profiles
a) Cs Beam
b) N_2 (P = 4.5×10^{-5} Torr)