# DESIGN AND DEVELOPMENT OF A LOW COST 2.45 GHZ ECR ION SOURCE FOR MATERIAL SCIENCES AND OTHER APPLICATIONS AT IUAC, NEW DELHI

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*Abstract*

A low cost 2.45 GHz ECR ion source for producing intense beams of singly charged ions has been designed and is under development at Inter University Accelerator Centre. This source will cater to various users for material sciences experiments with the aim to reduce the time of exposures/implantation compared to the time required when multiply charged ion beams are used. Various techniques and methods have been utilized to reduce the cost of development of this kind of source. This paper will discuss in detail the design and development aspects of this kind of ECR source.

## INTRODUCTION

Due to demands for high intensities of singly charged ions for various kind of experiments in Materials Sciences and related applications, a low cost 2.45 GHz Electron Cyclotron Resonance (ECR) source has been designed which uses commercially available 800 W microwave ovens and permanent magnets. The total time related to the experiment for singly charged, ion implantation/irradiation on to the target sample can be reduced which is a major advantage. The major components of the ECR source are microwave system, plasma chamber and permanent magnets. Most of the components for this kind of source are being developed indigenously at IUAC.

## DESCRIPTION

The microwave system for the ECR source consists of a microwave source, waveguide system for transferring microwave power from the microwave source to the plasma chamber and the microwave coupling device. The microwave system is sourced by a 800W magnetron. To reduce the cost of the ECR source we have used the magnetron of commercially available microwave ovens. The microwave oven normally works in pulse operation mode. We have modified its high voltage power supply to operate it in continuous mode. An additional heat sink has also been designed to provide additional cooling and to operate the magnetron in continuous mode. A high power isolator or circulator will be used to protect the magnetron from load mismatch by directing the reflected power to the dummy load. Direction coupler will be used along with the RF power meters to monitor the forward and reflected power. The RF waveguide window will be used to provide vacuum isolation to the plasma chamber. DC break will be used for the high voltage isolation to the microwave source side from the plasma chamber. The schematic diagram of the 2.45 GHz ECR source system coupled to RF and beam extraction system is shown in figure-1.

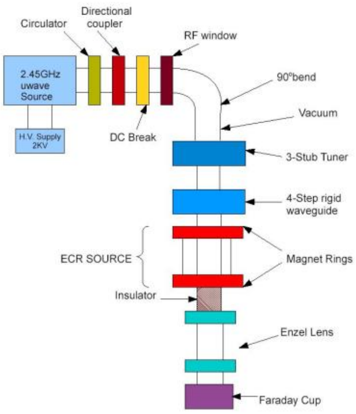


Figure-1: Schematic Diagram of the 2.45 GHz ECR source with beam extraction system

The designated waveguide for the operating frequency of 2.45GHz is WR340. Hence the microwave transmission line has been designed using WR340 waveguide sections. The inside dimension of the waveguide is 3.4inch x 1.7inch with the typical wall thickness 2mm. The major components of microwave line are magnetron mount, circulator/isolator, directional coupler, impedance matching device, RF window and a DC break.

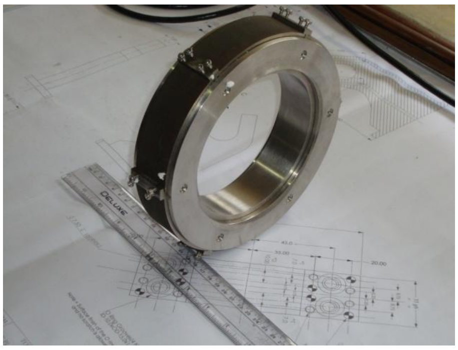

Figure-2: View of the assembled permanent magnets in a ring.

The other major components of the ECR source system are plasma chamber and magnet system. Most of the

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components has been designed and are being developed indigenously. A view of the assembled permanent magnets in a ring is shown in figure 2. The field mapping of both the rings is shown in figure 3. Two such rings will be used for sustaining 2.45 GHz plasma (injection and extraction sides).

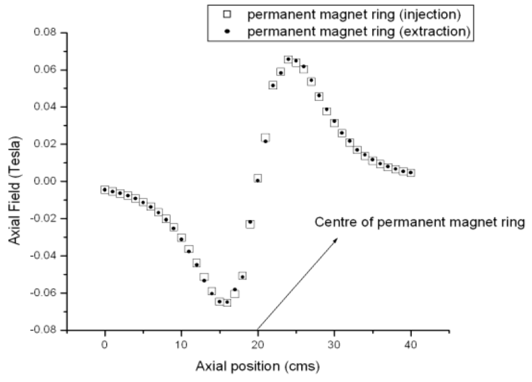


Figure-3: Field distribution of both the permanent magnet rings

Figure 4 shows the photos of some of these indigenously developed components and the magnetron source.

Figure-4: (Left) Plasma chamber with permanent magnets coupled to the extraction flange and waveguide; (Right) View of magnetron used for powering the ion source

Various methods are being used for launching the RF power with efficient coupling in the chamber viz. coaxial line, open ended waveguide, horn, slotted and helical antenna, ridged/ tapered waveguide to increase the plasma density. For example, the tapered waveguide or a ridged waveguide structure can be effectively used to increase the plasma density. Simulations using a 4 step ridged waveguide structure show improved electric fields in the plasma chamber as compared to normal waveguide structures for coupling the RF power to the plasma chamber as shown in figure 5.

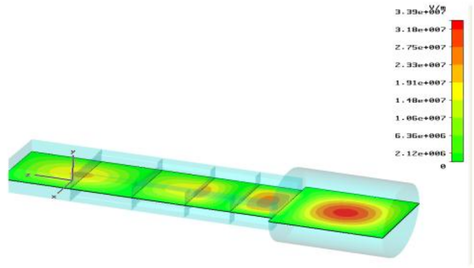

Figure-5.: Influence of a 4 step ridged waveguide on the electric field in the plasma chamber for $TE_{111}$ mode

Various other options are being looked into, for example by using a helical slotted antenna. This source will produce intense beams of singly charged ions using a simple multi-electrode extraction system as shown in figure 6. It will cater the need of various materials science users for implantation experiments etc.

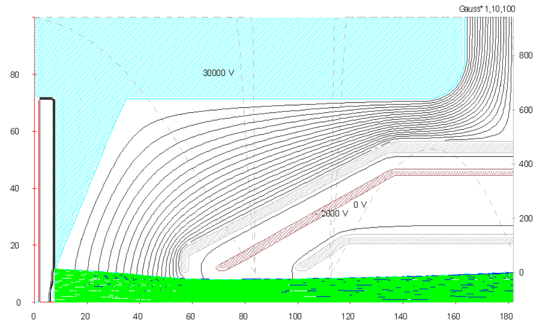


Figure-6: View of multi electrode extraction system designed for extracting intense beams of singly charged ions

## CONCLUSION

The 2.45GHz ECR source has been designed by minimising the cost to performance ratio. The development of the source is going on as per the design with many components being under fabrication at workshop at IUAC.

## ACKNOWLEDGEMENT

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