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Modification of KOMAC Microwave Ion Source

Gyu-Sub Eom [*], Dae-il Kim, Hyeok-Jung Kwon, Han-Sung Kim, Yong-Sub Cho
korea multi-purpose accelerator complex, korea atomic energy research institute, 181 mirae-ro Geoncheon-eup, Gyeongju-si, Gyeonguk 780-904, korea
[*]Corresponding author: gseom@kaeri.re.kr

1. Introduction

A compact 2.45 GHz microwave ion source has been utilized for KOMAC 100 MeV proton linear accelerator. [1] For stable and safe operation, KOMAC 100 MeV proton linear accelerator requires highly reliable microwave ion source. Since magnet and plasma chamber are not insulated, solenoid magnet of the microwave ion source currently being used for KOMAC is induced by high DC voltage. Therefore, there is not only a risk of electric shock during operation and maintenance, but also it results in the system fault and unwanted maintenances sometimes. Besides, to extract higher ion beam current, operating parameter of microwave plasma was checked and additional modification plans are preparing. In this paper, we will present the modification process of KOMAC microwave ion source.

2. Microwave Ion Source

The microwave ion source is shown in Fig. 1. The microwave ion source consists of plasma chamber, solenoid coil, magnetron, beam extractor, and so on.

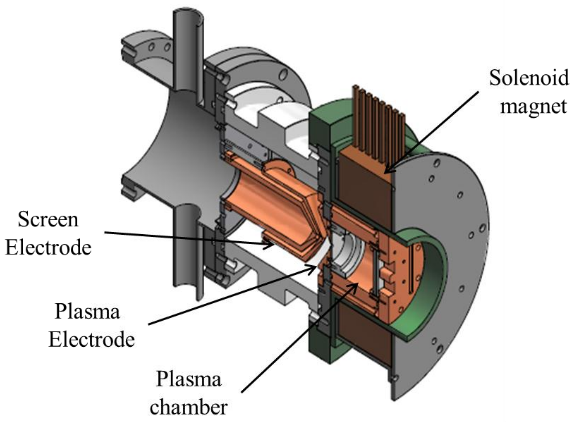

Fig. 1. Drawing of modified microwave ion source.

2.1 Solenoid Magnet Insulation

Solenoid magnet was designed and insulated from high voltage induced plasma chamber. Inner diameter of magnet should be enlarged for inserting the dielectric material between magnet and plasma chamber. Since the altered dimension of solenoid influences on plasma properties, the design of solenoid magnet was carefully modified in order to minimize the change of magnetic field strength and profile. G-10 was used as Insulation material; it was designed to endure over than 110 kV within 7% decrease of magnetic field strength compared to solenoid currently being operated. The measured magnetic field profile and strength of the new designed solenoid are shown in Fig. 2 and Fig. 3, respectively.

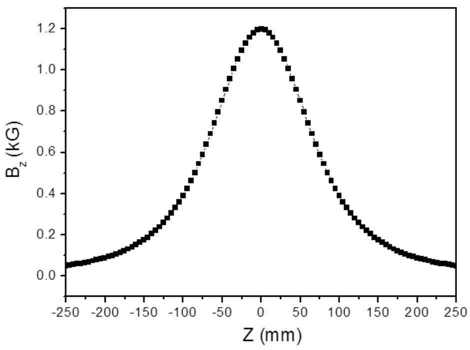

Fig. 2. Measured magnetic field profile of the new designed solenoid. Z = 0 is axial center of plasma chamber.

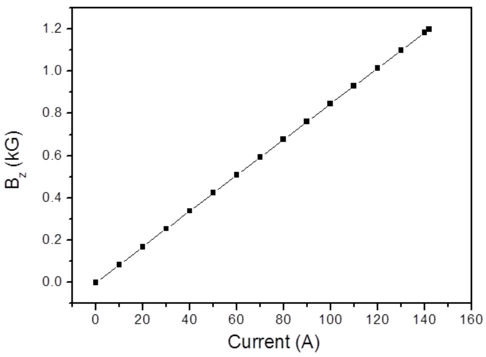

Fig. 3. Measured magnetic field strength of the new designed solenoid according to input current. It was measured at Z = 0, R=0.

2.2 Material for Extractor Body

Since plasma electrode is induced by DC 50 kV, the extractor body should be insulated and be free from the contamination originated from plasma faced material. Considering the sputtering yield to ion bombardment, dielectric strength, and vacuum tightness, alumina was selected as the material of extractor body, and alumina body was brazed with flanges. The assembled extractor body is shown in Fig. 4.

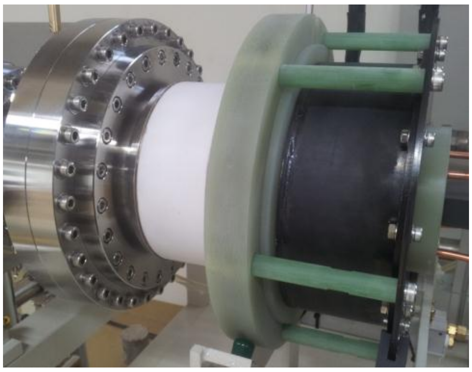

Fig. 4. Picture of modified microwave ion source.

2.3 High density plasma generation

To extract high current ion beam, it is essential to generate high density plasma. Plasma heating in the condition of electron cyclotron resonance (ECR) is considered and the additional modifications are in progress. For higher density plasma generation and higher beam current, compact mirror magnetic field and cusp field are evaluating to enhance the plasma confinement. In addition, since the wave heating is more effective when microwave is injected from high field region, magnetic field profile was asymmetrically designed. The proposed axial field profile is shown in Fig. 5.

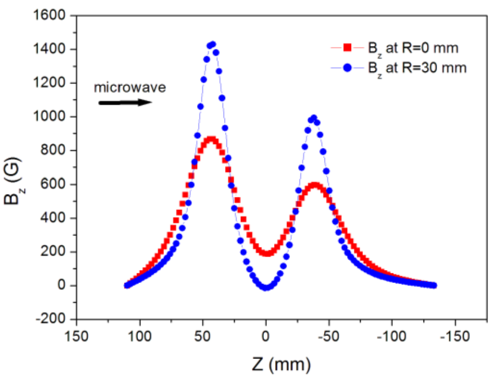

Fig. 5. Designed magnetic field strength of asymmetrical mirror magnet. It was calculated by using Poisson Superfish.

2.4 Ion Beam Extraction

The geometry of electrodes for ion beam extraction should be matched to the subsequent accelerator system. [2] Therefore, the detailed design alternation of electrodes is remained in future work and is not included current process. As seen in Fig. 6, the simulated ion beam profile is moderate. However, the geometry of electrodes may be optimized to upgrade the ion beam quality in future works.

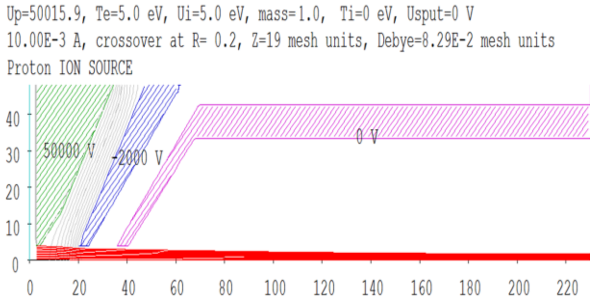

Fig. 6. Ion beam profile simulated by using IGUN code.

3. Conclusion

The modification of KOMAC microwave ion source was described. To operate accelerator more stable and safe, electrical insulation of solenoid magnet and extractor body was improved. Additional modifications for higher ion beam current extraction are in progress.

ACKNOWLEDGEMENT

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REFERENCES

[1] I. S. Hong, B. S. Park, and Y. S. Cho, Journal of the Korean Physical Society, Vol.56, p. 2013, 2010.
[2] H. -J. Kwon, H. -S, Kim, D. –I. Kim, J. –H. Jang, and Y. S. Cho, Journal of the Korean Physical Society, Vol.54, p. 2015, 2009.