The design of a 2.45 GHz microwave ion source for a high-efficiency, high-resolution isotope separator

Wu Qi[1,2], Liu Yuguo[1,2], Liu Jianli[1], Sun Liangting[1,2] and Zhao Hongwei[1,2]

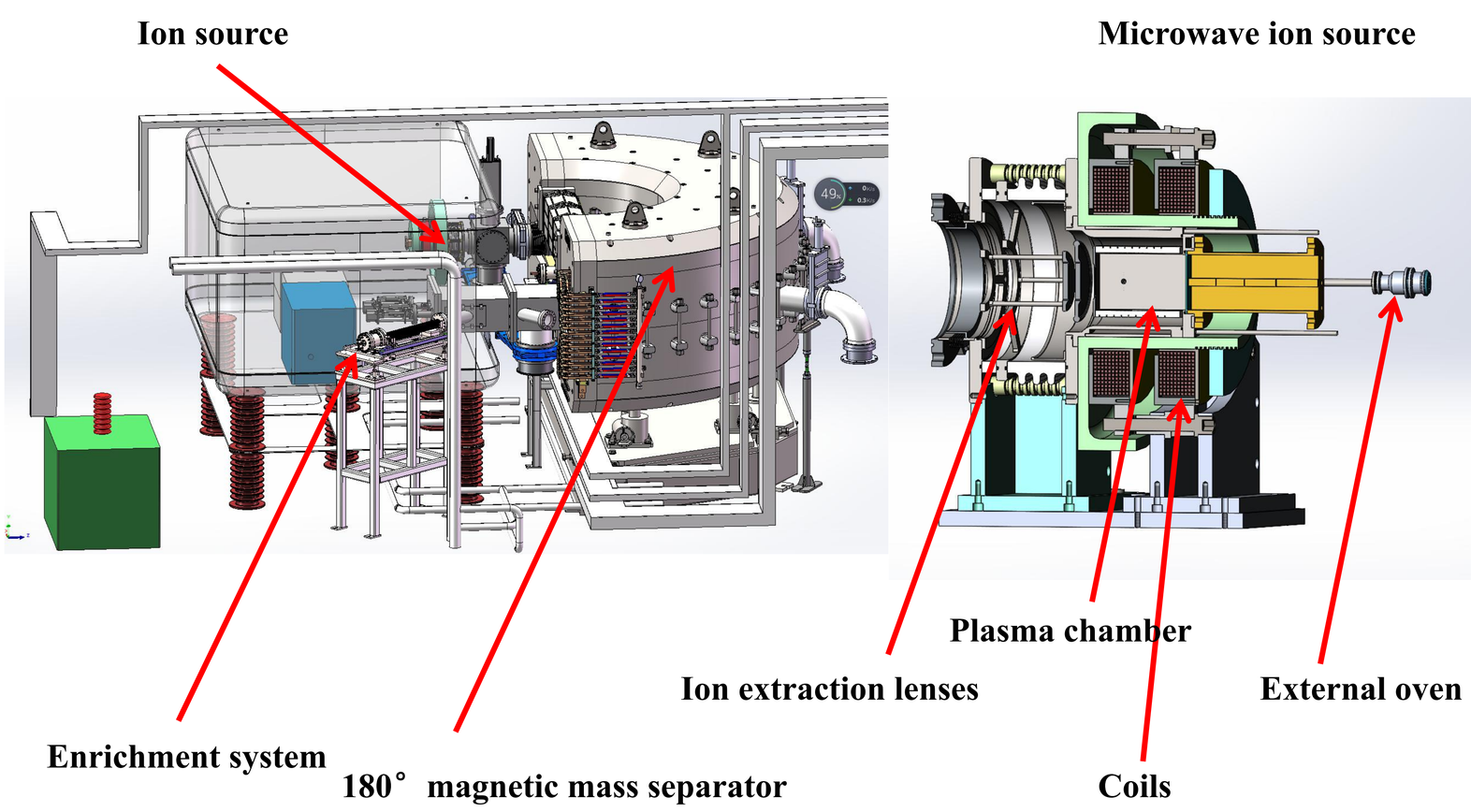
1. Institute of Modern Physics, Chinese Academy of Sciences, Lanzhou 730000, China

2. School of Nuclear Science and Technology, University of Chinese Academy of Sciences, Beijing 100049, China

✉ **wuq@impcas.ac.cn**

I. Introduction: Due to the rapid development of applications of nuclear science and technology in China, the production capacity of isotopes cannot meet the growing demands. Therefore, the development of electromagnetic isotope separators with high yields and high isotopic purity is needed. An electromagnetic isotope separator based on a 2.45 GHz microwave ion source and high-resolution magnet has been developed to study a number of important heavy isotopes, such as Xenon and molybdenum isotopes. The ion source is expected to produce 20 emA Xe+ and 10 emA Mo+ respectively. To achieve this goal, series of technical difficulties need resolving, such as metal vapor damage of the microwave window, design of the special-shaped discharge chamber and precise control of the oven temperature.

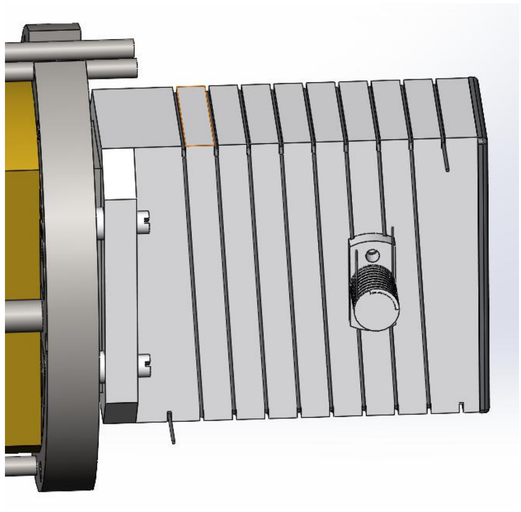
II. Electromagnetic Isotope Separator



Parameters of the ion source

Extraction voltage	30~40 kV
Ion exit slit	60×2 mm²
Maximum beam current	5 mA Mo+, 20mA Xe+
Isotope ion species	^{129}Xe、^{131}Xe、^{100}Mo、^{99}Mo、^{88}Sr
Dimension of the Plasma chamber	L×W×H (100×34×70)
Microwave power	2 kW
Oven temperature	500~1000 ℃

III. Design of the ion source and extracted system



Layout of the internal oven. the diameter of the internal oven is 10 mm, and the sample capacity is designed as 20 g.

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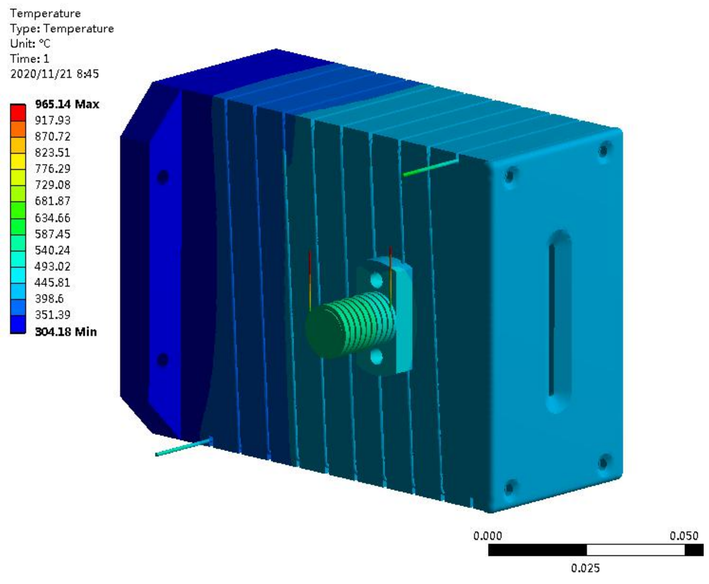
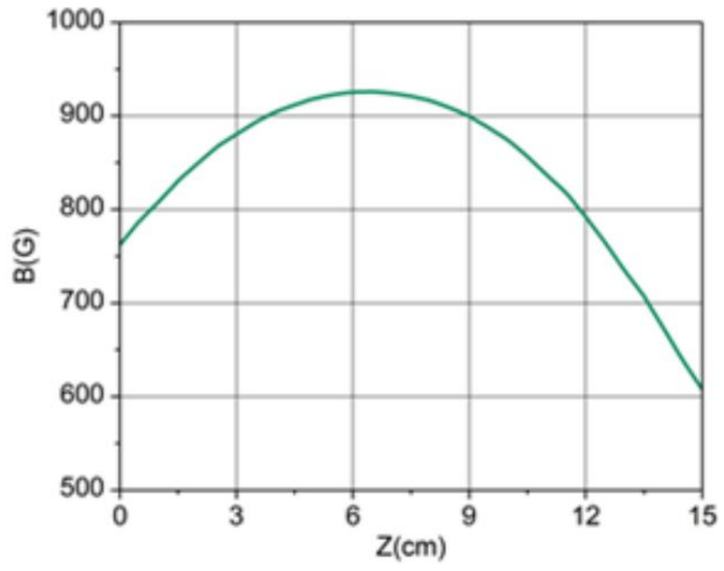
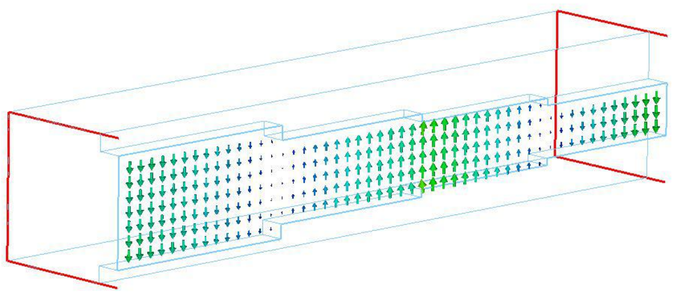
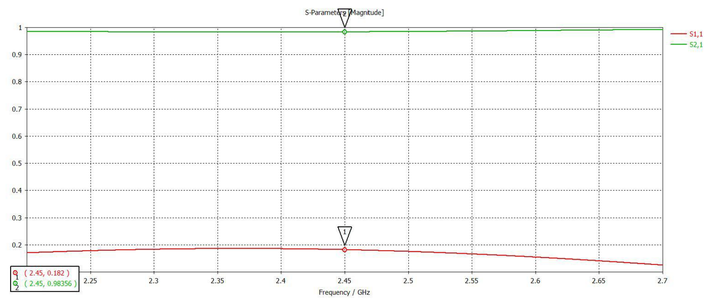


The temperature simulation of the oven.

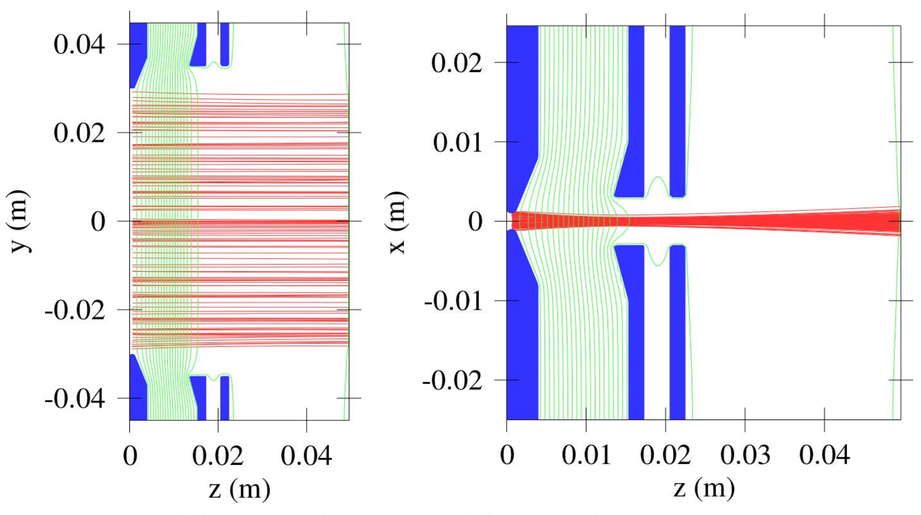


The axial magnetic field distribution along the plasma chamber.





The microwave transmission and S parameters of the matching waveguide is simulated by CST.



The simulation of Xe^+ ion beam extraction and transport at the energy of 40 kV and the beam current is 20 emA. The slit size is 60×2 mm².