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The progress of Vlasov microwave launcher for high power operation

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Abstract

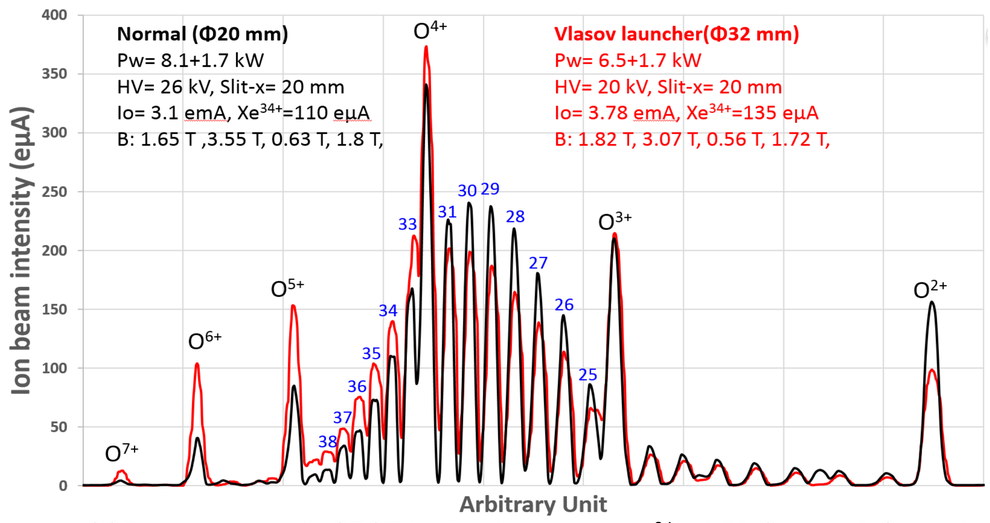
The efficiency of the microwave-plasma coupling is a key issue to enhance the performance of electron cyclotron resonance ion sources (ECRISs) in terms of charge states and extracted currents. The coupling properties are directly affected by the microwave injection scheme, especially for the high frequency(f ＞20 GHz) and high power（P＞5 kW) ECR ion sources. Based on the Vlasov launcher concept, we proposed a microwave injection scheme for ECRIS that can move the launcher on line. The power distribution inside the plasma cavity is optimized by online adjusting the position of the Vlasov launcher, so as to improve the performance of the ion source at high power. The preliminary test results and typical problems are presented in this article.

Previous results of fixed Vlasov microwave launcher

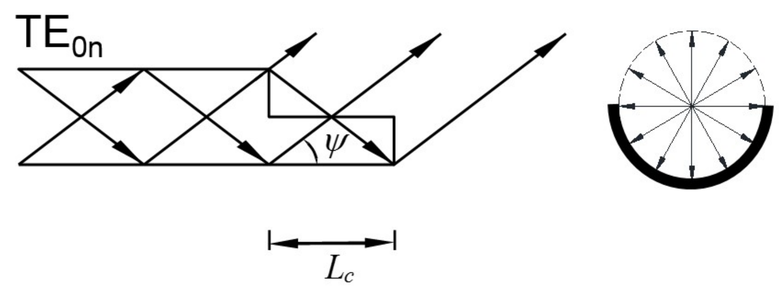
Features:

- **Change the direction of radiation**
- **Optimized power distribution**
- **Low reflection**
- **Simple structure**

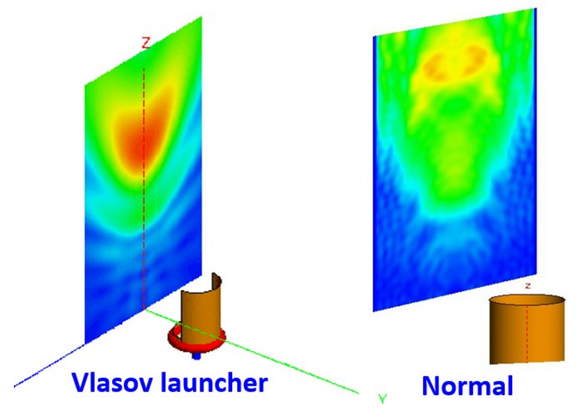
	Normal (Φ20 mm)	Vlasov launcher (Φ32 mm)	Improvement
$^{129}Xe^{30+}$	322 eμA @(8+1.1 kW)	365 eμA @(7.5+1.7 kW)	**13.3 %**
$^{129}Xe^{34+}$	110 eμA @(8+1.7 kW)	135 eμA @(6.5+1.7 kW)	**22.7 %**



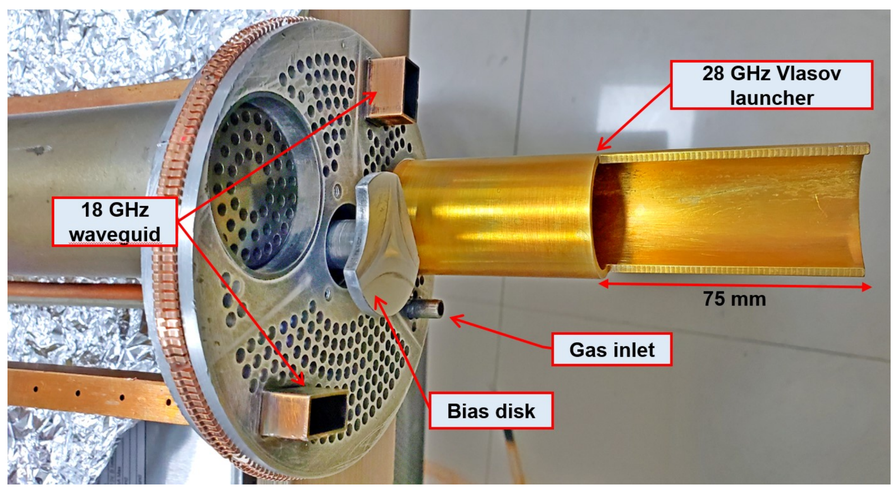
Xenon CSDs produced with SECRAL-II optimized on Xe^{34+} at 28 GHz + 18 GHz with normal circular waveguide or the Vlasov launcher. The black curve indicates the performance with normal circular waveguide, while red curve shows the first optimized with Vlasov launcher.



The propagation of TE_{on} microwave mode in the Vlasov launcher. The left is the side view and the right is the end view.

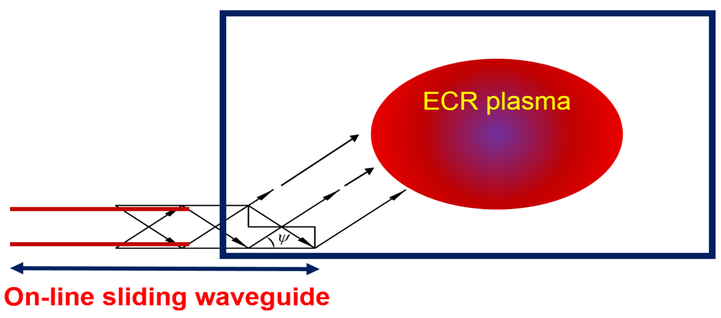


The axial radiation power distribution of the Vlasov launcher and normal waveguide.



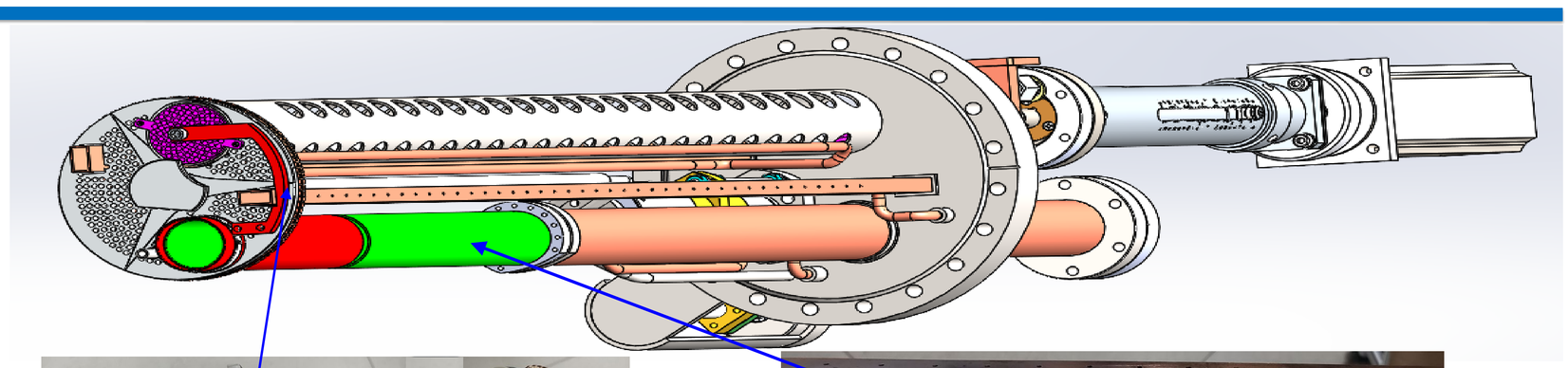
Plasma chamber injection system integrate the 28 GHz Vlasov launcher of SECRAL-II ion source.

First results using sliding waveguide



Results

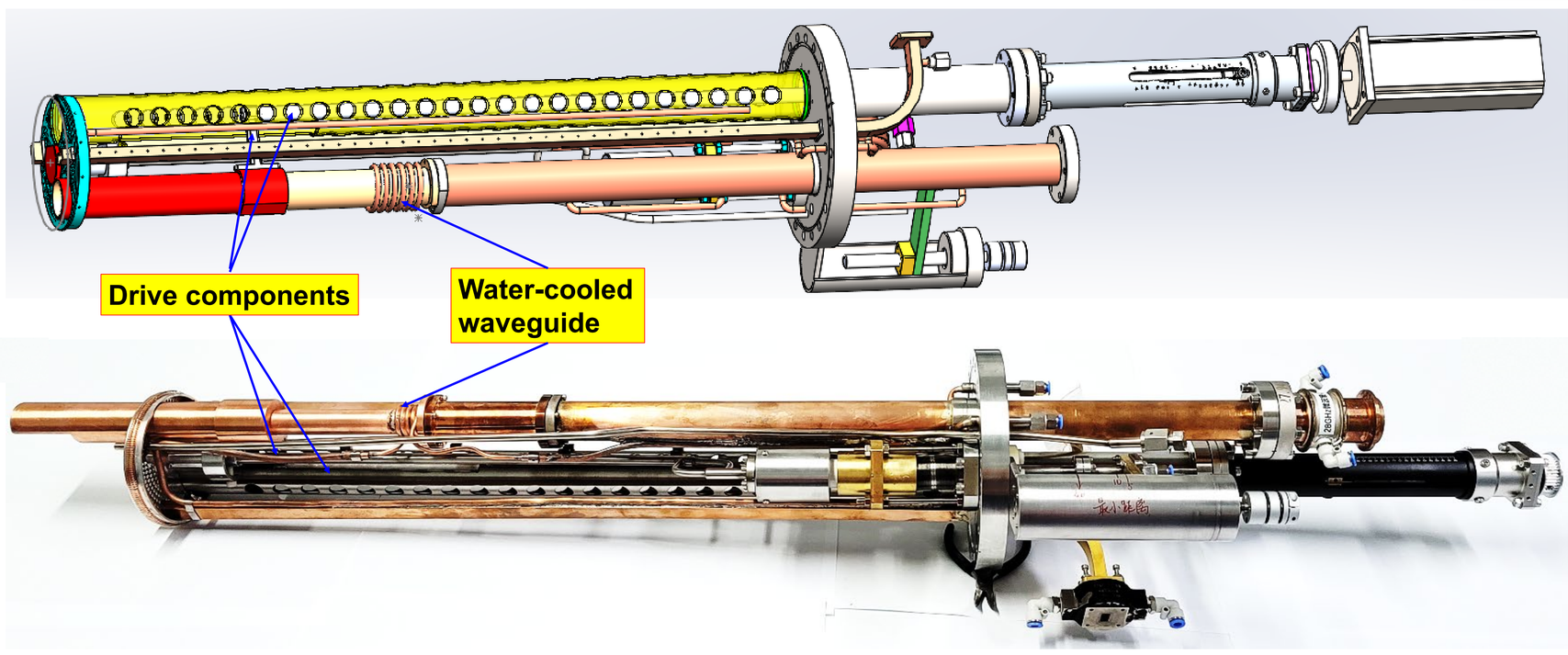
1. **The aluminum waveguide was burned by plasma at high power operation.**
2. **The sliding waveguide and drive parts are deformed by plasma heat and cannot move.**



Improved design

Features:

1. **Copper waveguide with water cooling**
2. **The drive components is located behind the injection baffle to avoid overheating at high power.**



Off-line test Results

1. **The sliding waveguide moves smoothly and the position accuracy is 0.2 mm.**
2. **The flow rate of waveguide cooling water is more than 2 L/m.**

Summary and outlook

- **Vlasov-type microwave launcher has shown very promising results and it's a possible solution for the 4th generation ECRISs.**
- **On-line moving waveguide operating at high power should have good cooling and structural design.**
- **The improved movable Vlasov microwave launcher tests will be started during the coming weeks.**