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A 2.45 GHz Surface Wave Plasma Source for Plasma Flood Gun

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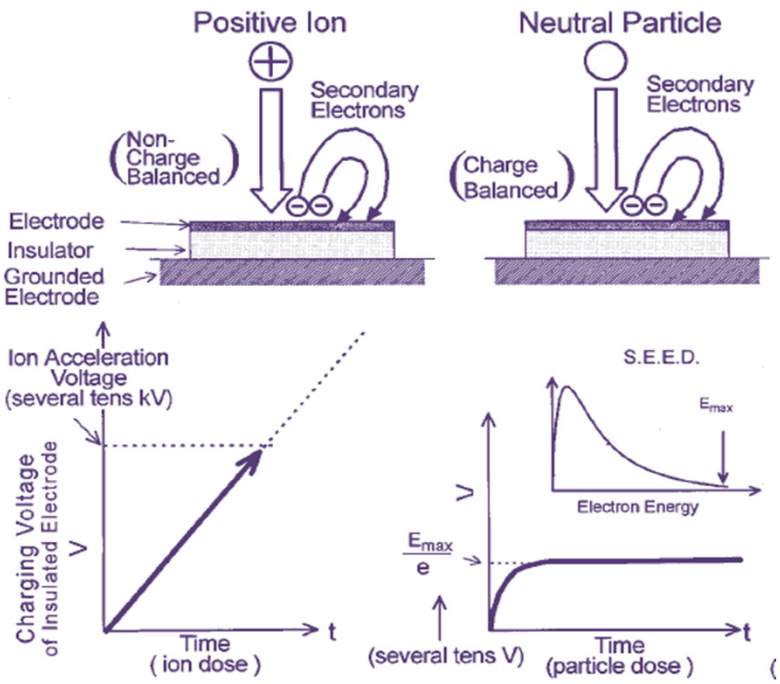
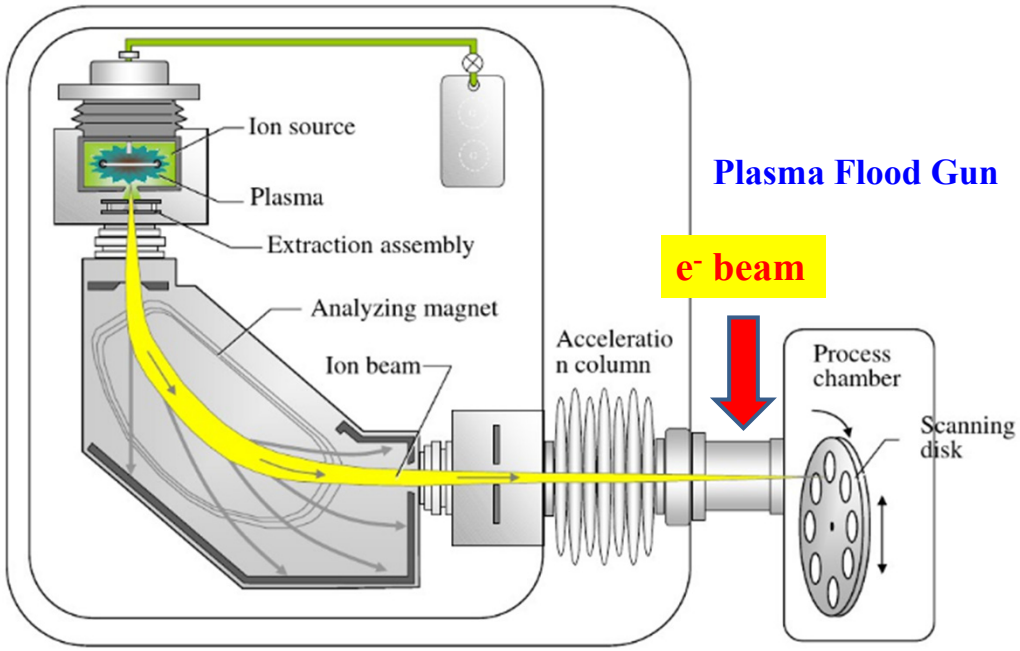
Outline

1. Introduction
2. 2.45 GHz Surface Wave Plasma Source
   - ☐ Source design and physical analysis
   - ☐ Experimental setup and results
   - ☐ Discussion
3. Summary and outlook

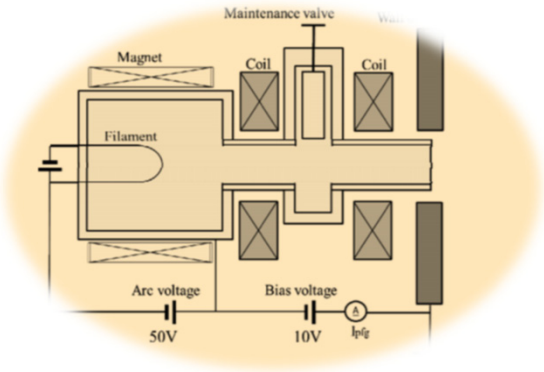
Wafer Charge Neutralization

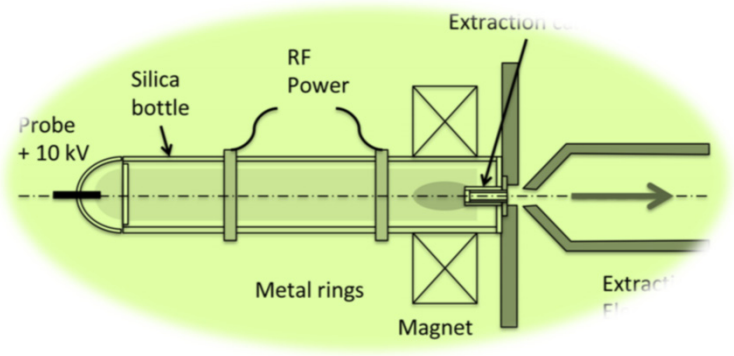


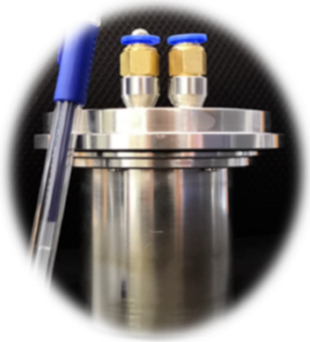
Ion Implantation Facility



Plasma Flood Gun, PFG



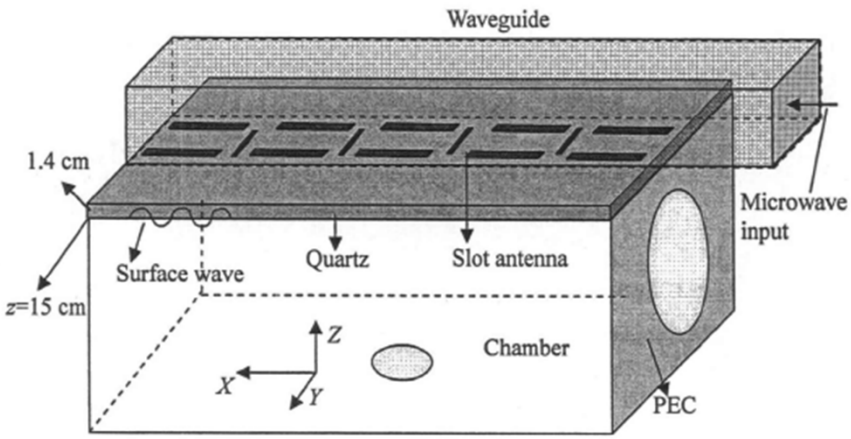




	Hot filament source	RF source	ECR source[PKU]
No metallic contamination	☹	🙂	🙂
Long lifetime	☹	😐	🙂
Electron beam uniformity	🙂	😐	☹
Low cost	🙂	😐	☹

Nagao, Tomokazu, et al. "Neutralization of Electrical Static Charge under High Vacuum by Plasma Flood Gun." 2018 22nd IIT. IEEE, 2018.
https://iopscience.iop.org/book/978-1-64327-356-3/chapter/bk978-1-64327-356-3ch12
Yaoxiang Jiang, et al., **A miniaturized ECR plasma flood gun for wafer charge neutralization.** *Review Scientific Instrument* (*Rev. Sci. Instrum.*) **91** (2020). DOI:10.1063/1.5128

Surface Wave Plasma Source



No magnet

- **Overdense plasma**
- **Simple structure**
- **Uniform beam**

Is there any possibility to make a SWP source from an ECR one?

Could SWP source be a potential choice for PFG?

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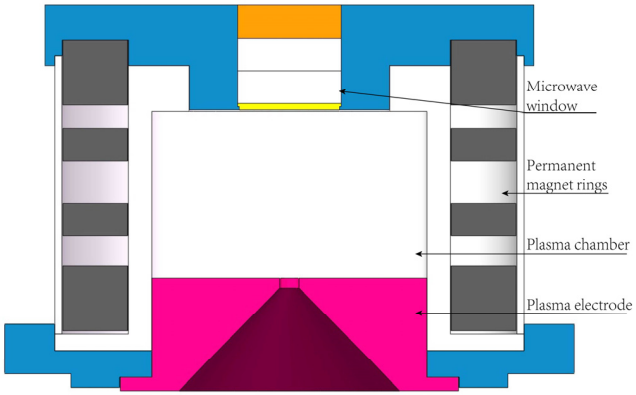
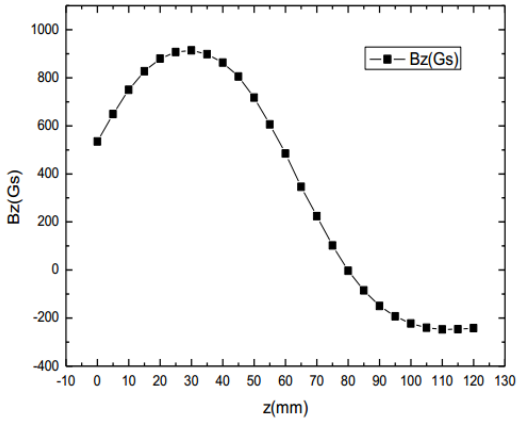
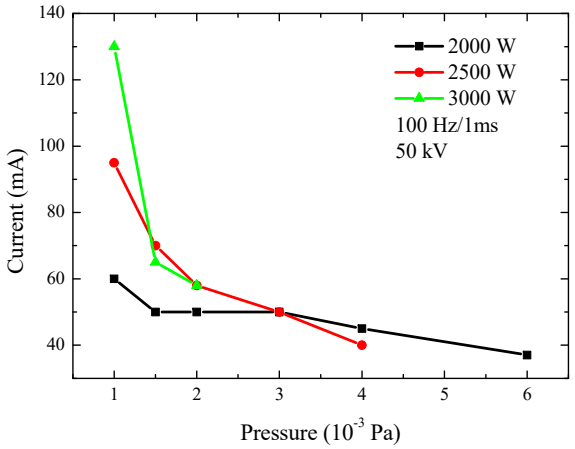
A 2.45 GHz ECRIS at Peking University

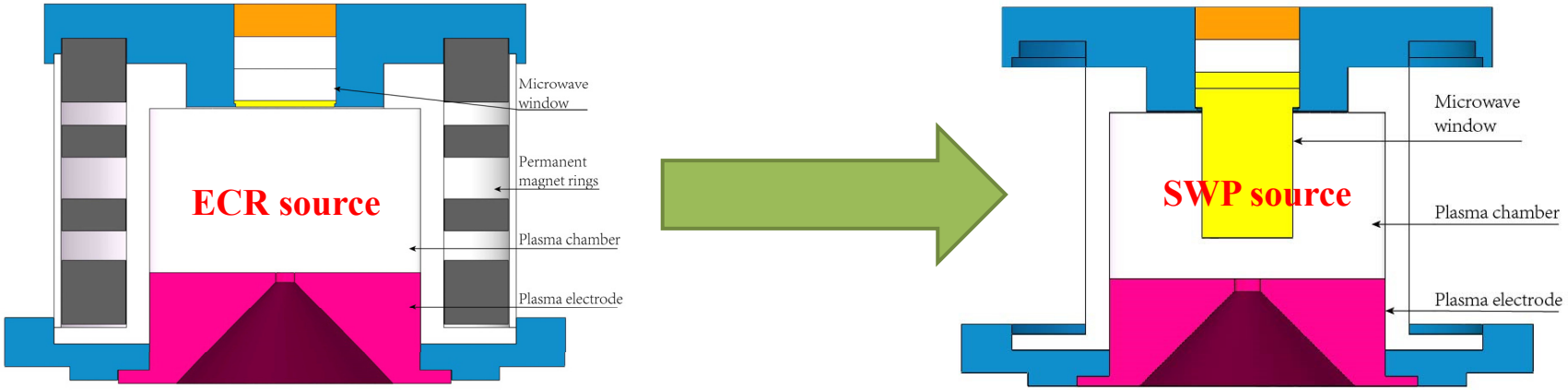






No.	Pressure/ 10^{-3} Pa	Power/ W	Total current/mA	H^+ /%	H_2^+ /%	H_3^+ /%	H_2^+ current /mA
1	1.0	2500	95	53.7	39.3	7.0	37
2	1.0	3000	130	63.7	29.0	6.3	37

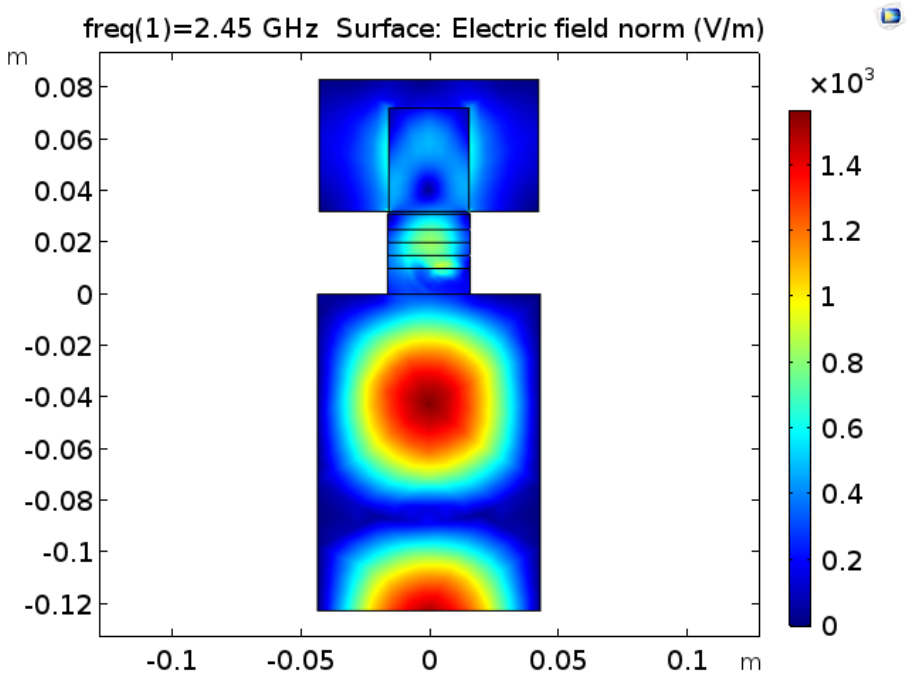
The 2.45 GHz SWP source

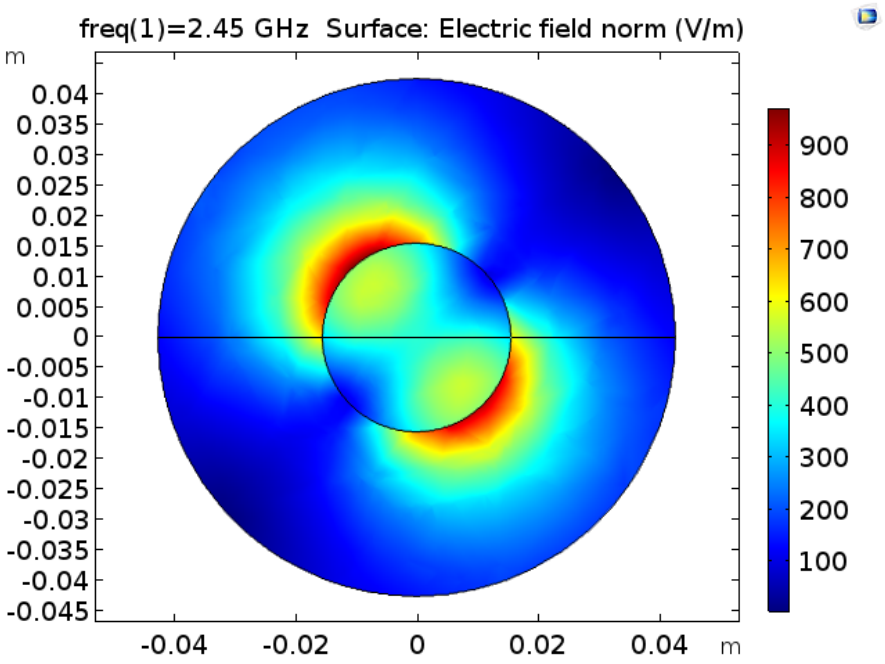


1. The boron nitride disk is replaced by a ceramic cylinder with a length of 40 mm.

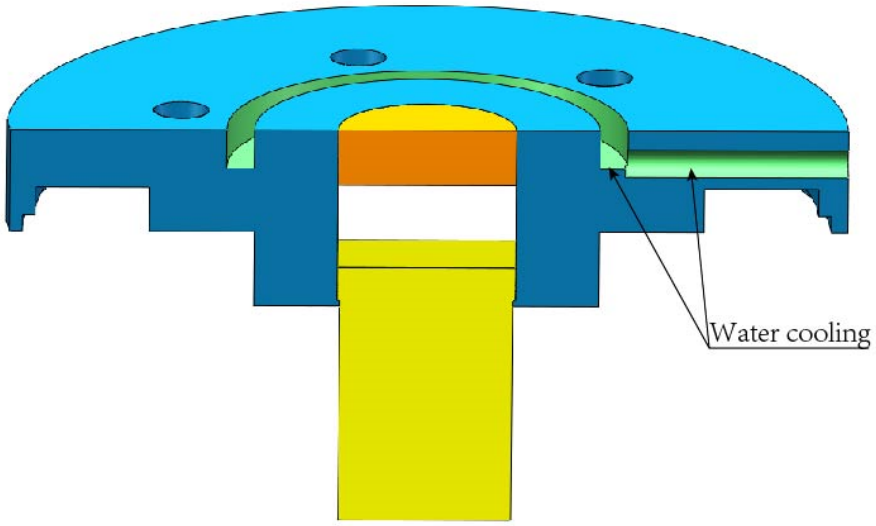
2. The NdFeB permanent magnet rings are removed.

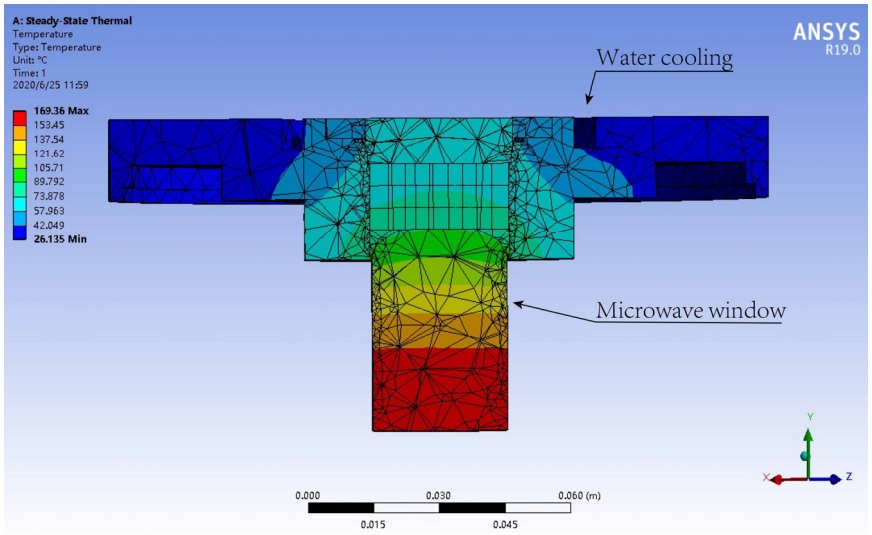
Microwave coupling analysis





Thermal analysis





- **100W: highest temperature is 169 ℃; lowest temperature is 50 ℃.**

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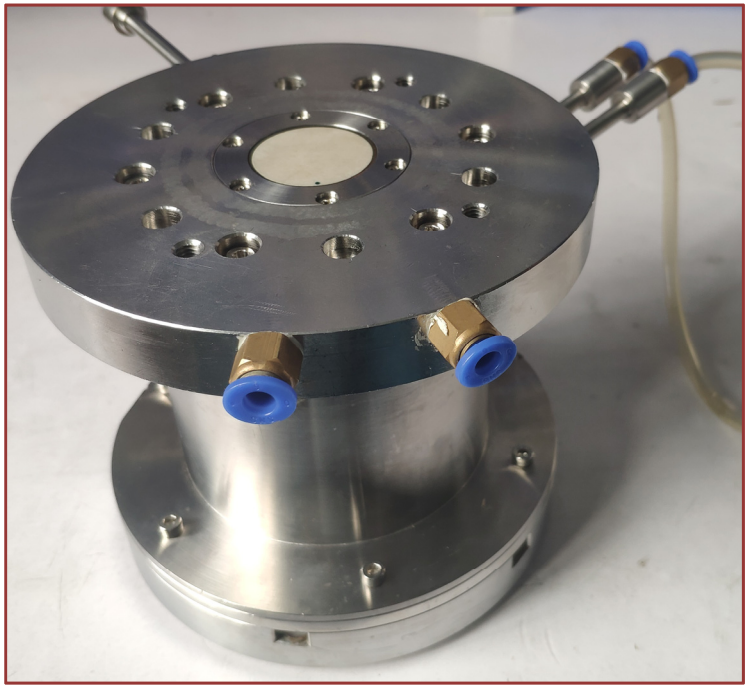
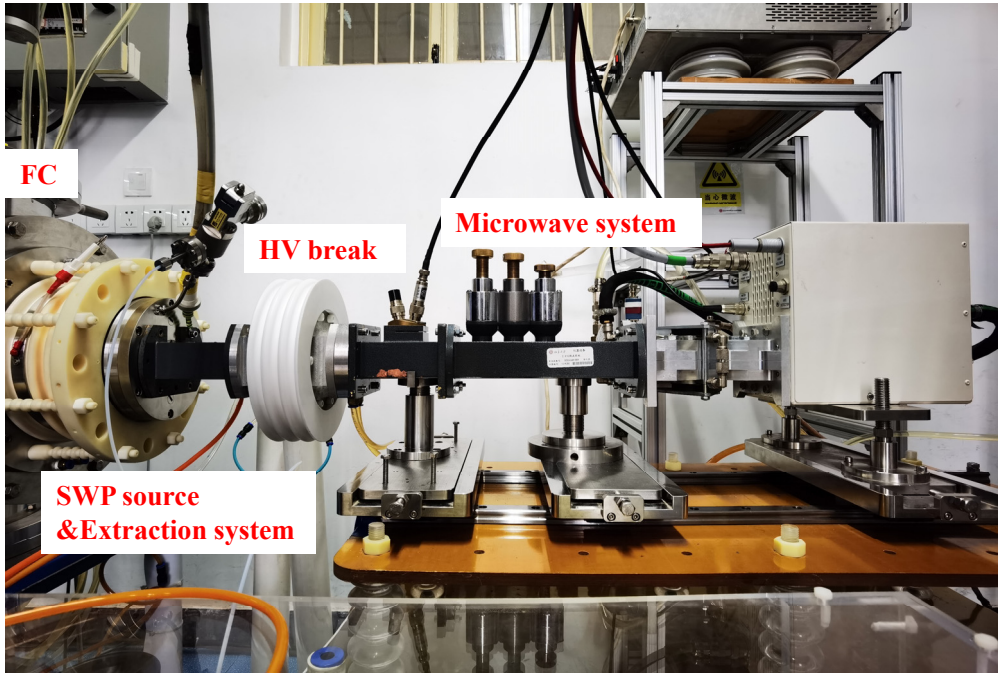
Experimental setup



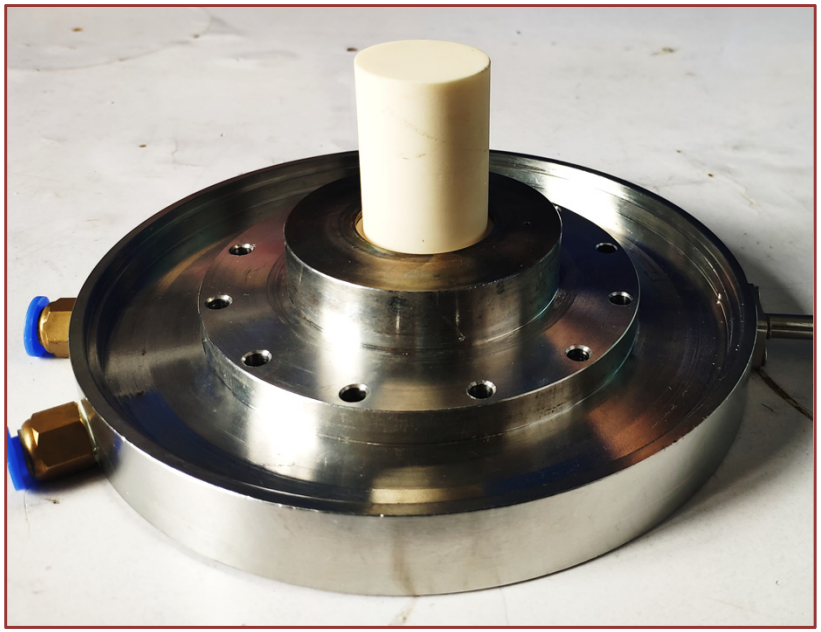
SWP source

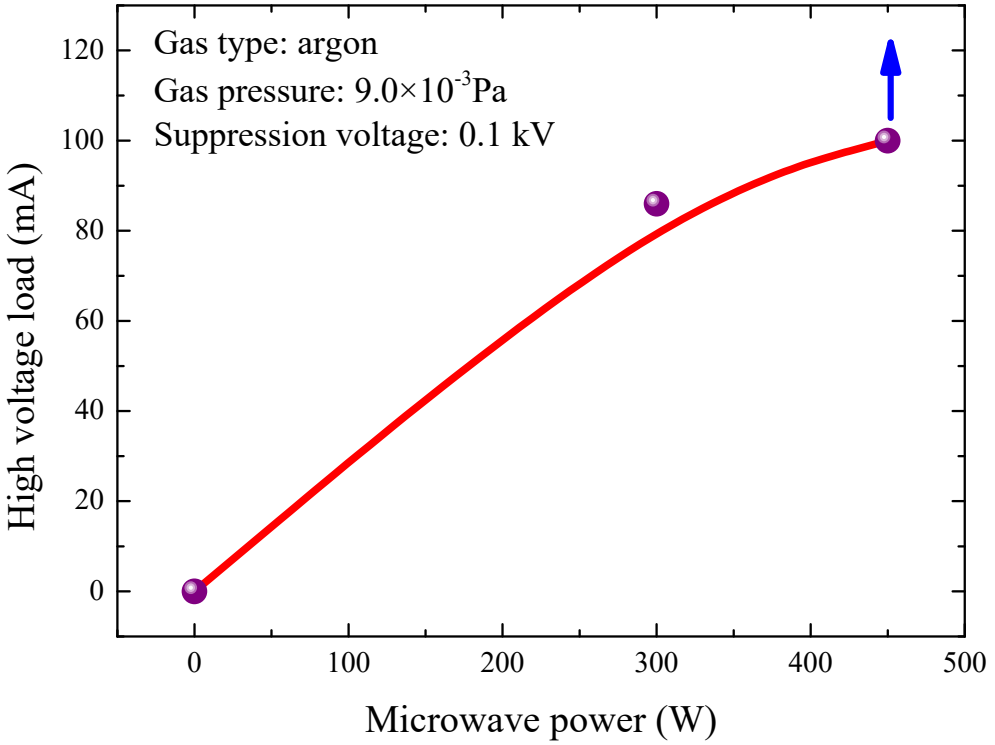


Ion source test bench at PKU

Experimental results

1. Ceramic antenna for electron beam

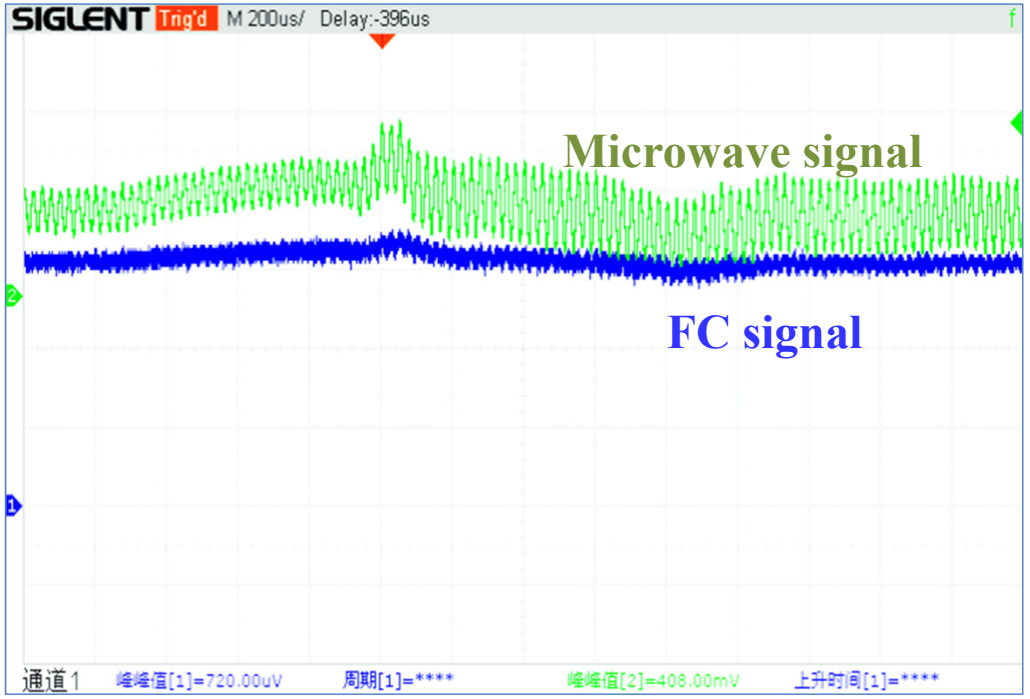




Experimental results

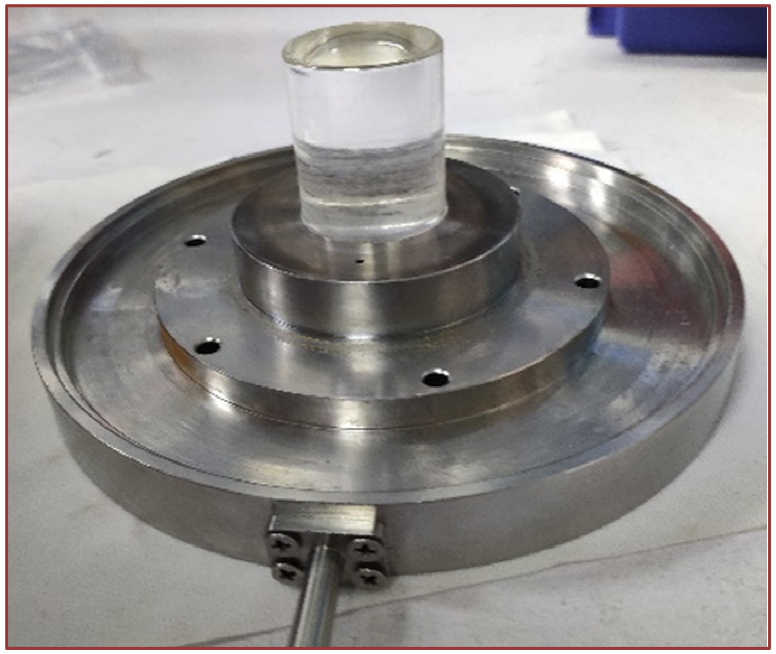
2. Ceramic antenna for Ar^+ beam

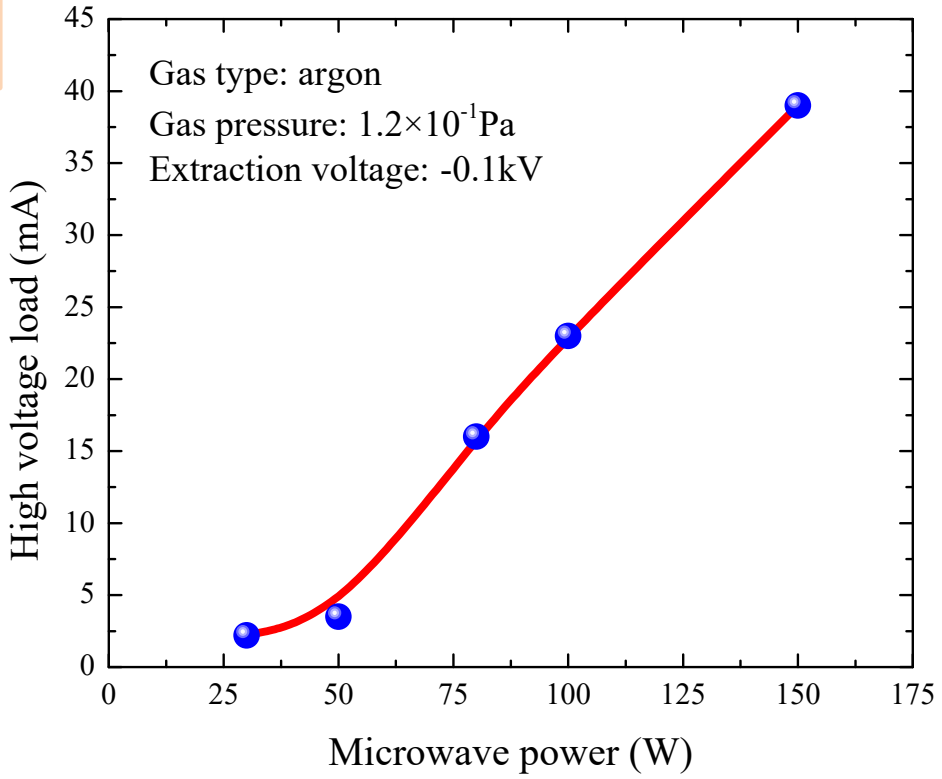
Microwave power (W)	600
Reflecting power (W)	200
Gas pressure (10^{-2} Pa)	1.9
Extraction voltage	40kV×6.3mA
Suppression voltage	-2.0kV×0.6mA
FC current (mA)	3.0



Experimental results

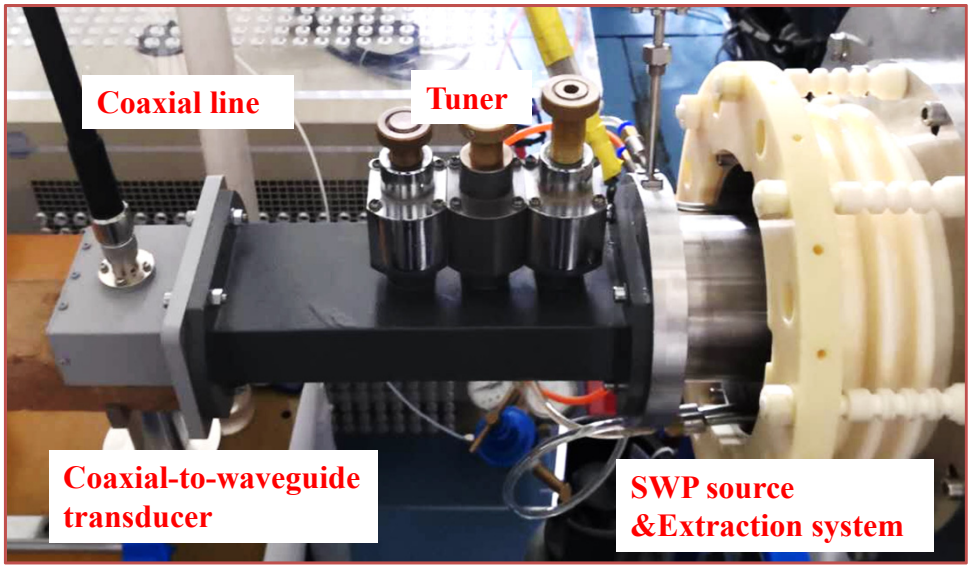
3. Quartz antenna for electron beam

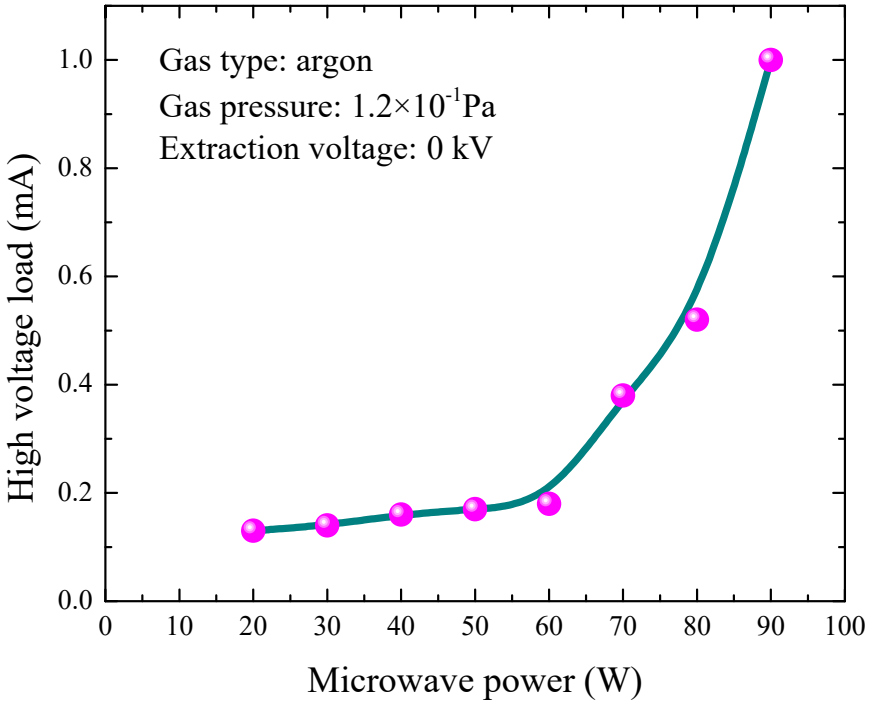




Experimental results

4. Results with a compact microwave system





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Similarity law

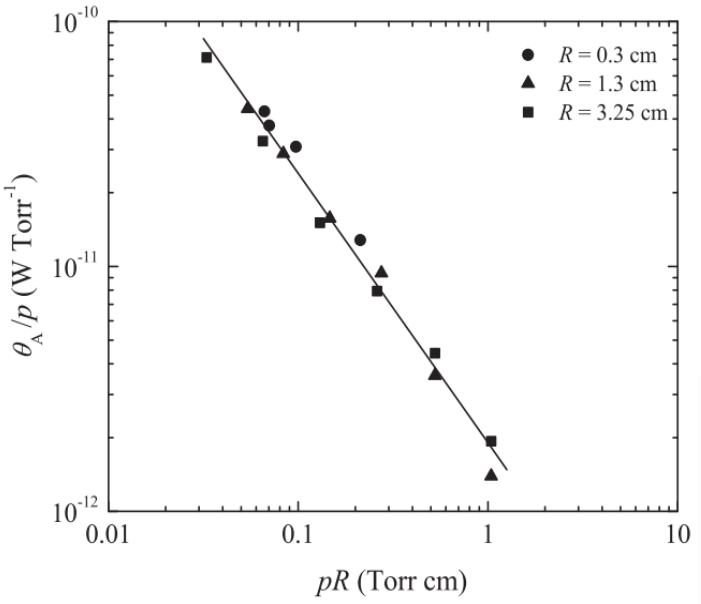
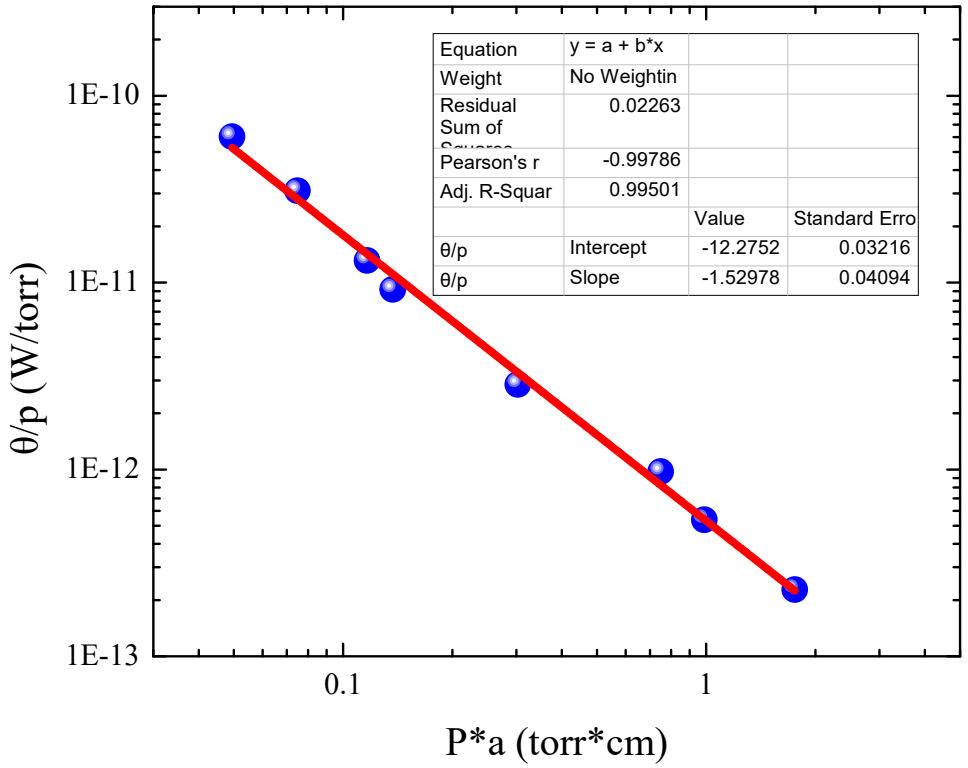
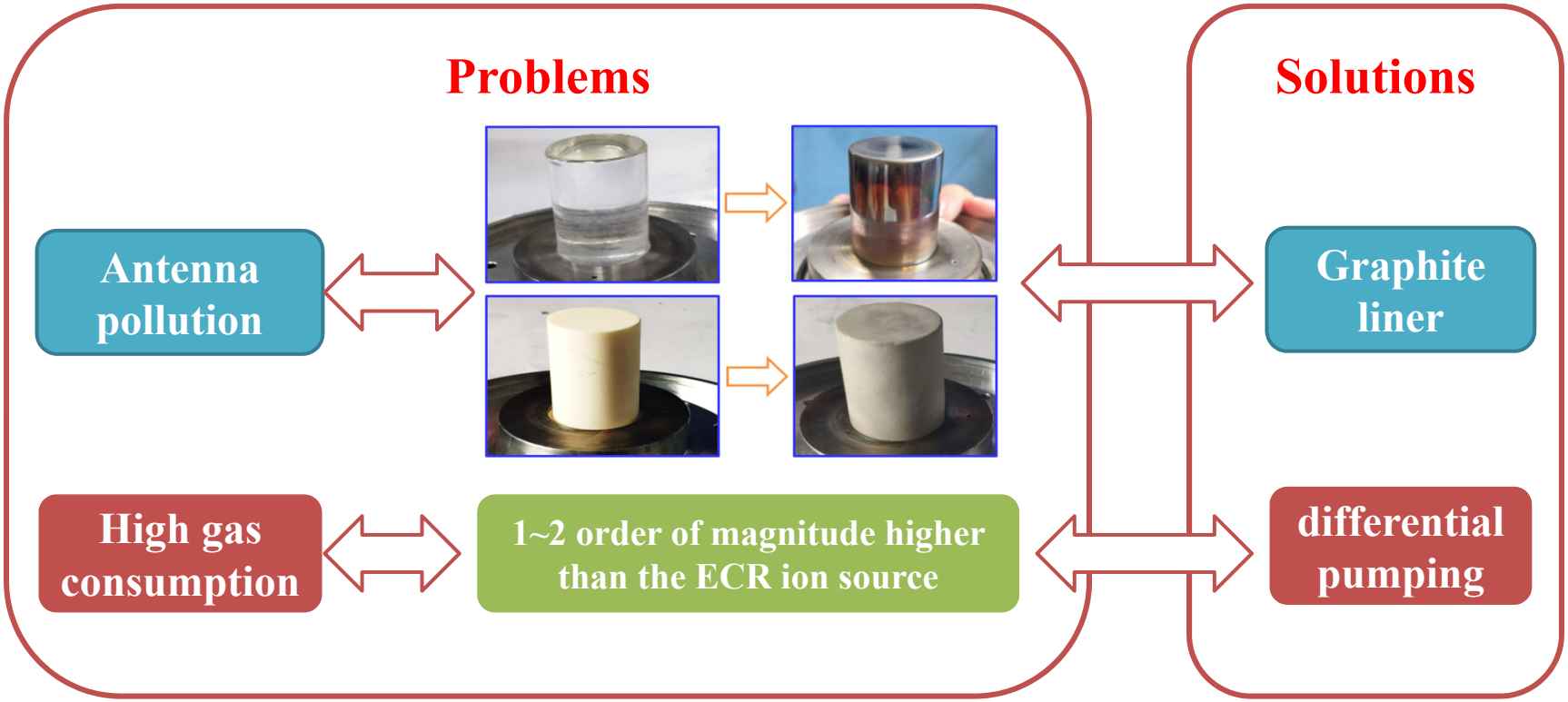


Figure 14. Measured θ_A/p values as functions of the pR product at 200 MHz, for three values of the discharge tube inner radius [67], establishing that θ_A/p versus pR constitutes a similarity law. Reproduced with permission from [67].



Some problems



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Summary and outlook

1. **A 2.45 GHz ECR source is improved to a SWP source. Experimental results show that both ceramic antenna and quartz antenna are available to produce several to tens milliampere of electron beams.**
2. **This work has indicated that the 2.45 GHz SWP source can be a potential choice as PFG for charge neutralization of wafers.**
3. **In the future, another SWP source with a rectangular chamber and microwave multi-slot antennas for the generation of ribbon electron beams will be tested.**




Thank you for your attention!