Emission and microparticle arrangement in a capacitevly-coupled rf discharge

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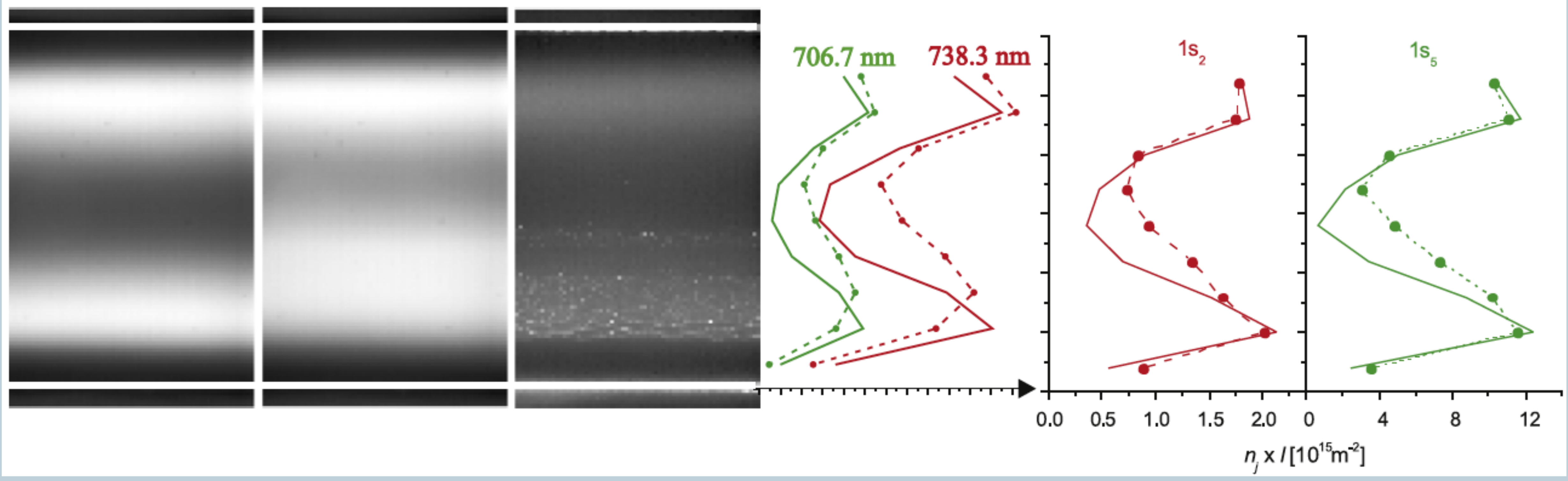
Introduction

Microparticles immersed in a plasma affect its properties. The main physical processes involved are:

- Absorption of electrons and ions on the microparticle surfaces;
- Conribution of microparticles to the local electric fields;
- Ion drag force.

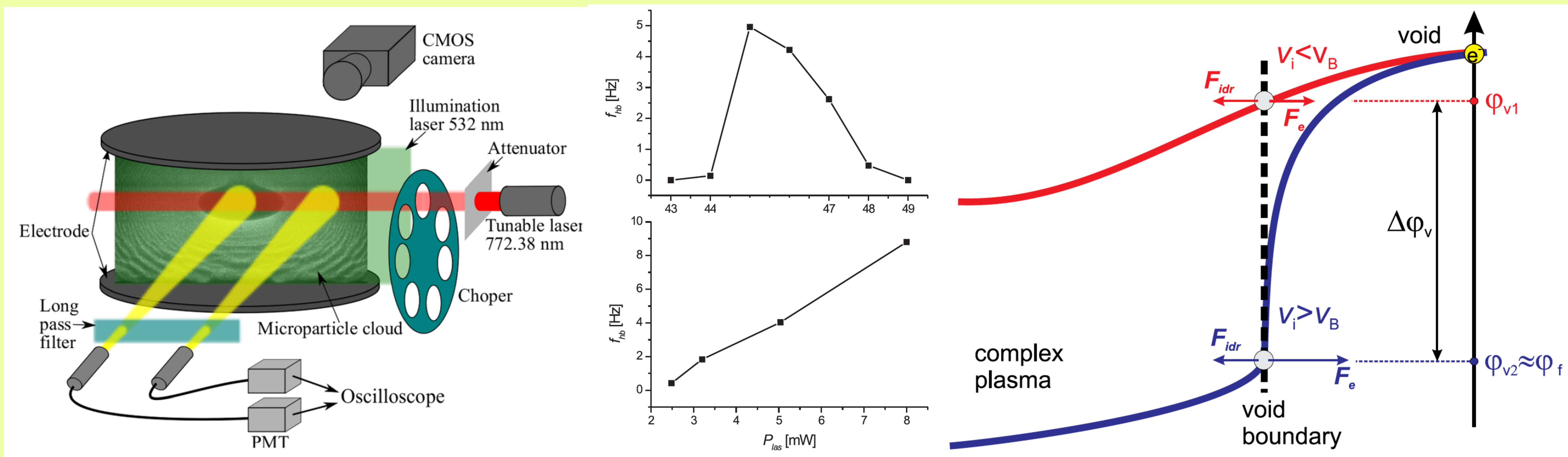
Under microgravity conditions, the effect of the microparticles on the background plasma often cannot be neglected since microparticles occupy *significant fraction of plasma volume.*



Pustylnik et.al., Nucl. Instr. and Meth. A **623**, 754 (2010)

The heartbeat instability

Could be parametrically excited by a modulated laser tuned to an argon atomic transition. Influence of the laser on the plasma is very weak. Therefore, it was supposed that the instability occurs due to the **critcal phenomenon on the void boundary**.



Pustylnik et.al., Phys. Plasmas, **19**, 103701 (2012)

Is there really a critical phenomenon on the void boundary?

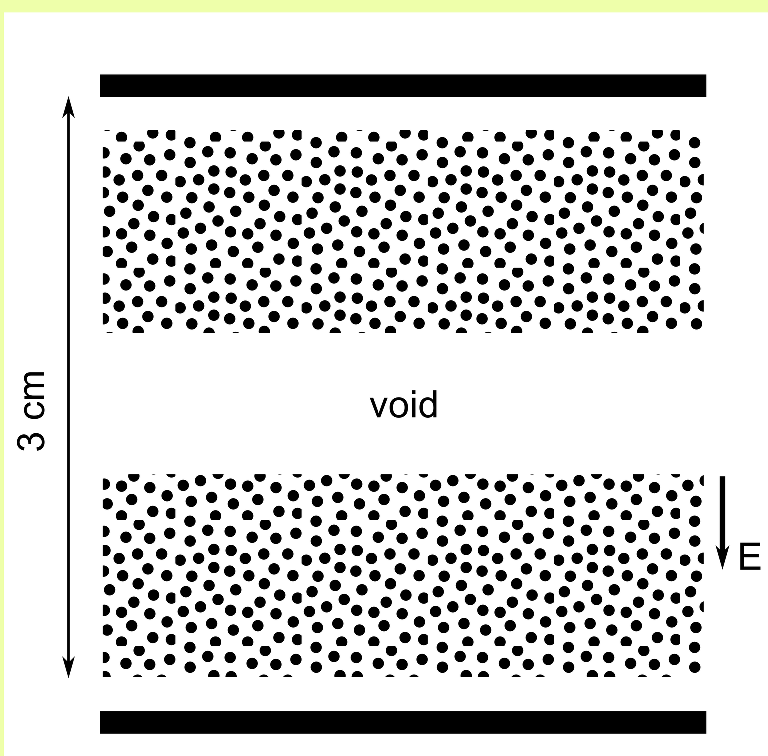
Plasma was simulated by a hybrid 1D (PIC-fluid) model with a fixed dust configuration with a slab void. Parameters were close to the experiment:

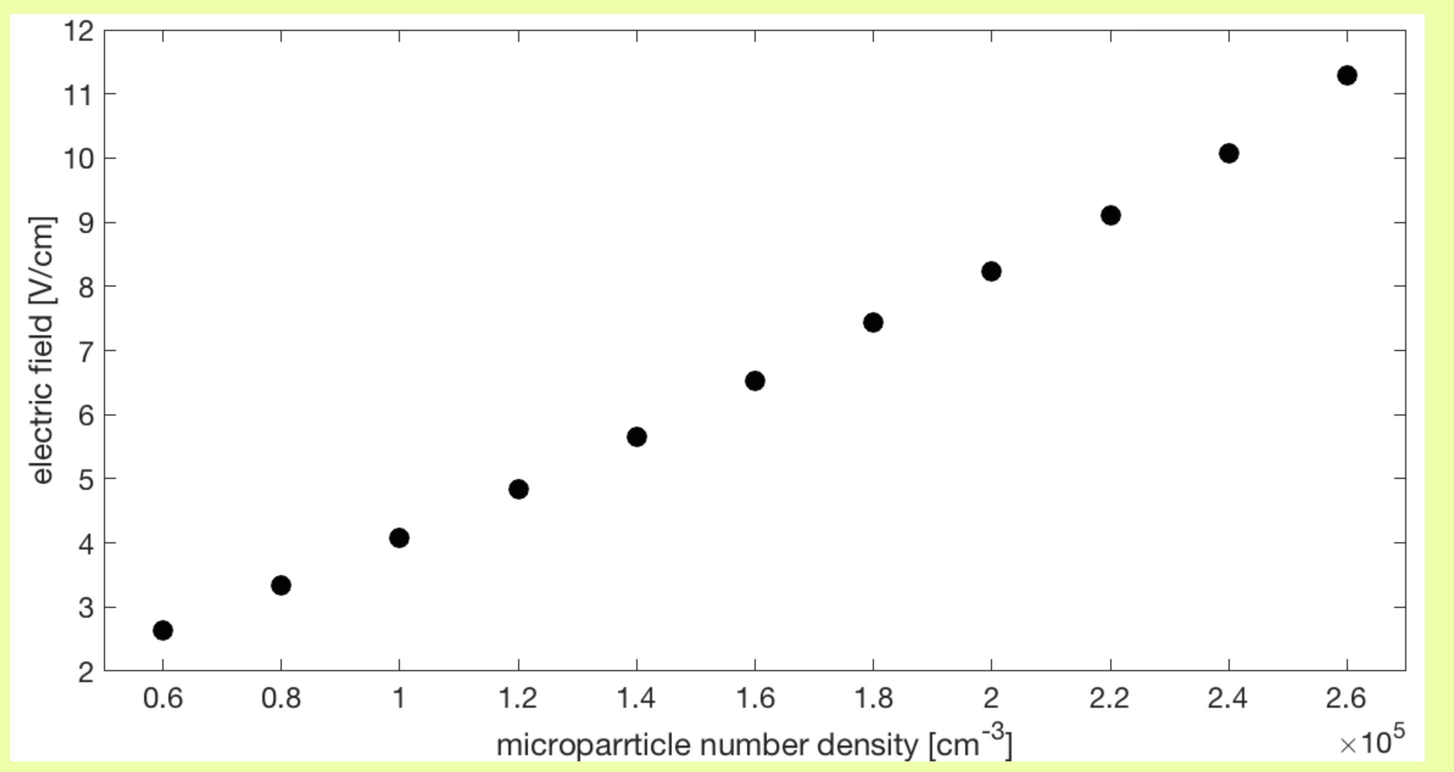
peak-to-peak rf voltage 110 V

pressure 30 Pa

particle diameter 2 μm

model from
Semenov, Phys. Rev. E **95**, 043208 (2017)
Pustylnik et.al., Phys. Rev. E **96**, 033203 (2017)

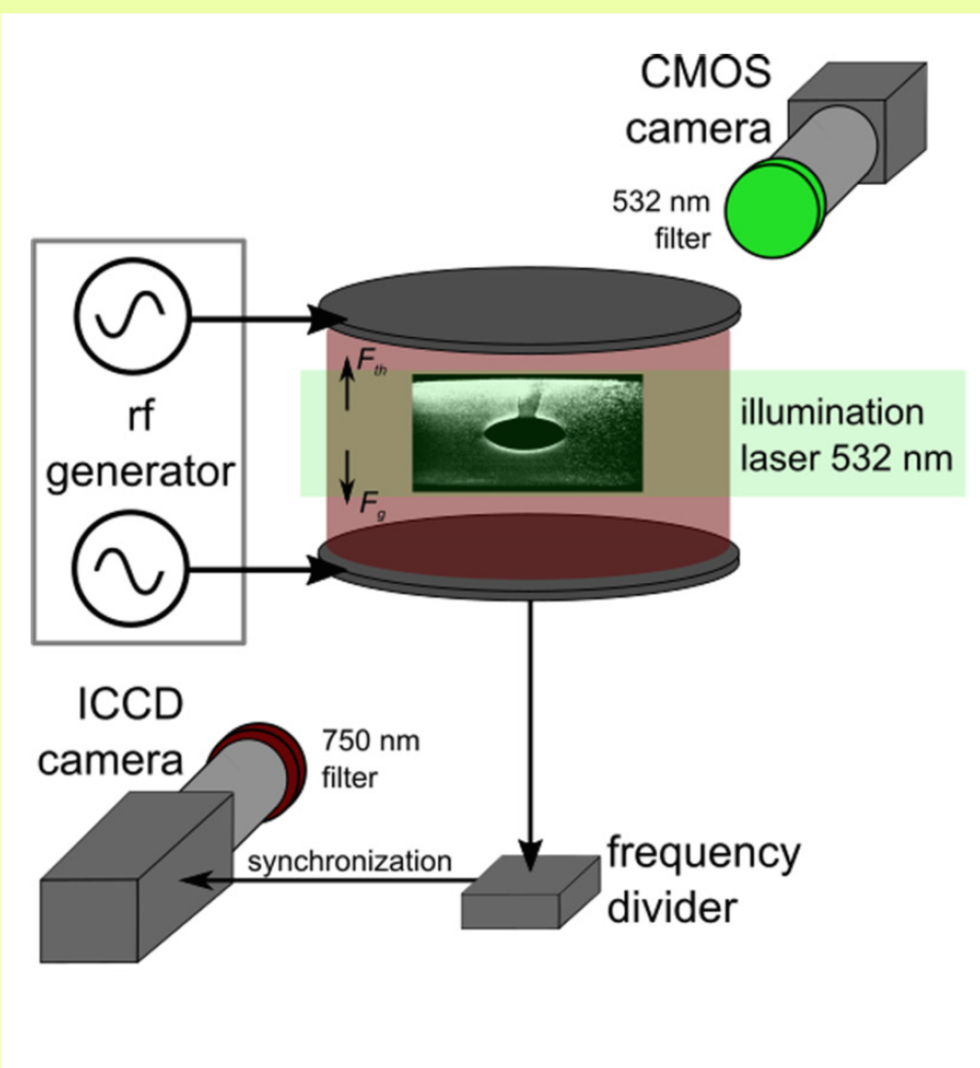


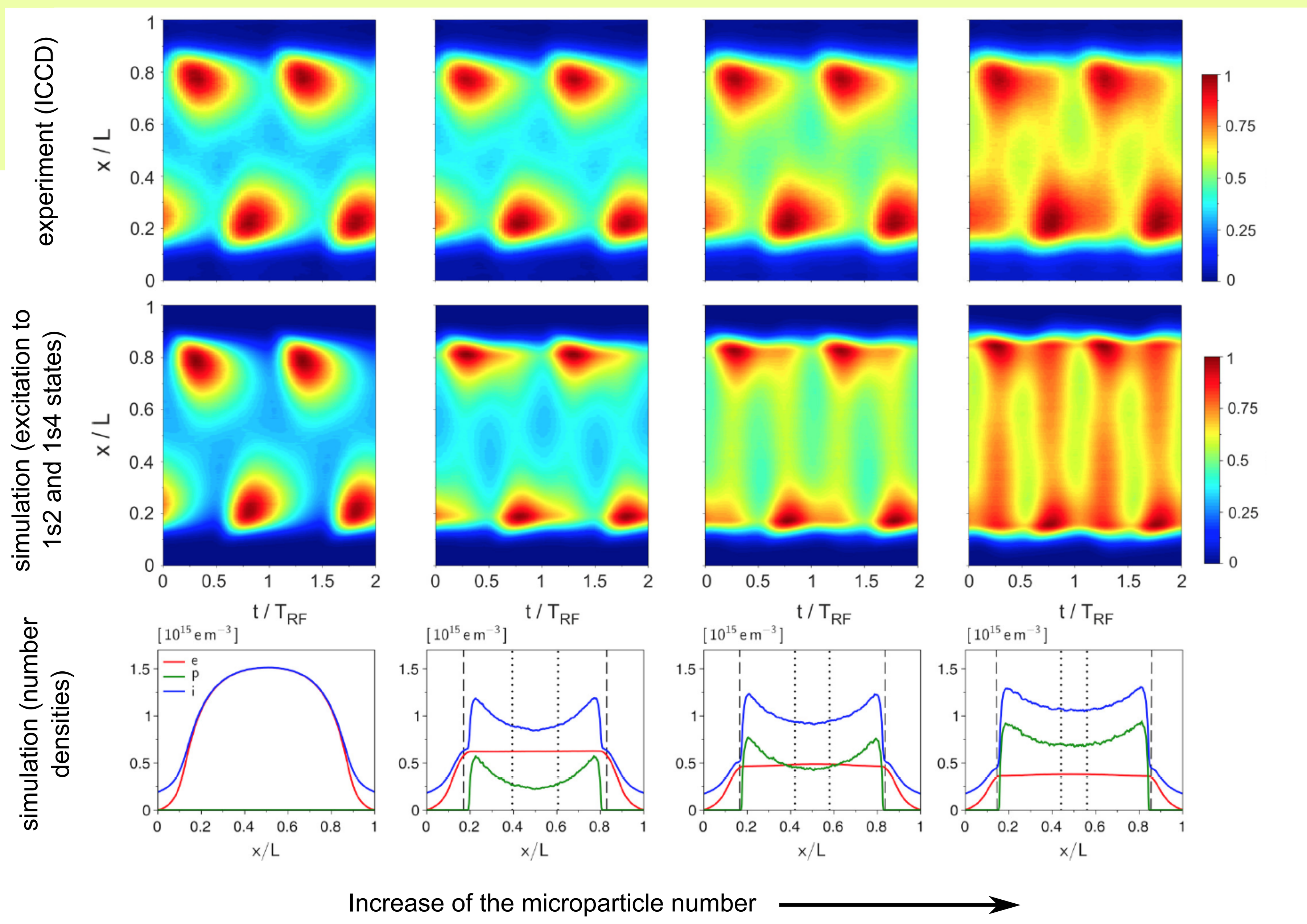


Spatiotemporal emission pattern

Spatiotemporal emission patterns and spatial arrangements of microparticles obtained in
(i) hybrid simulations *with self-consistent microparticle charging and steady-state spatial profile* and measured in the
(ii) **experiment** *using ICCD and CMOS cameras* were compared.

Results of the comparison are controversial:
Emission patterns exhibit similar tendency on the increase of microparticle number, but simulated microparticle number density profiles do not form void.

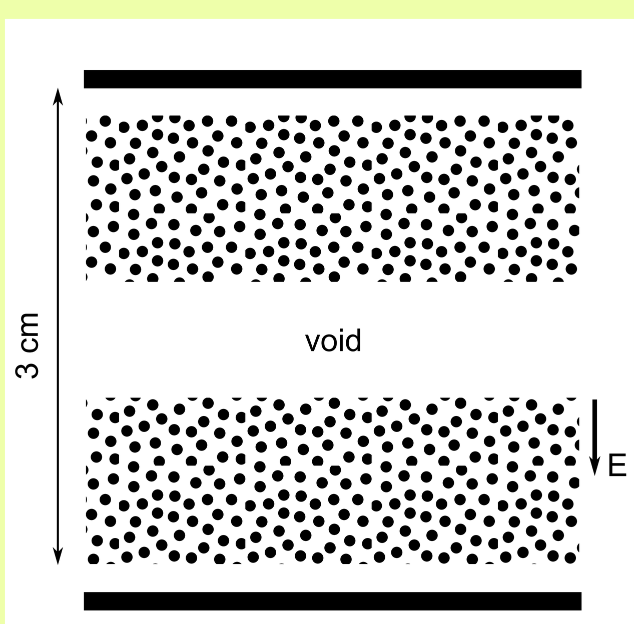


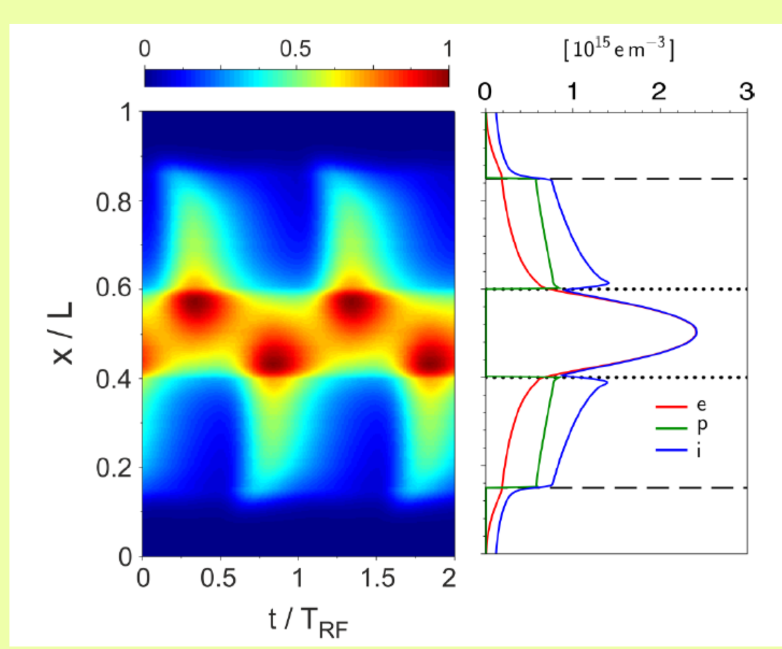


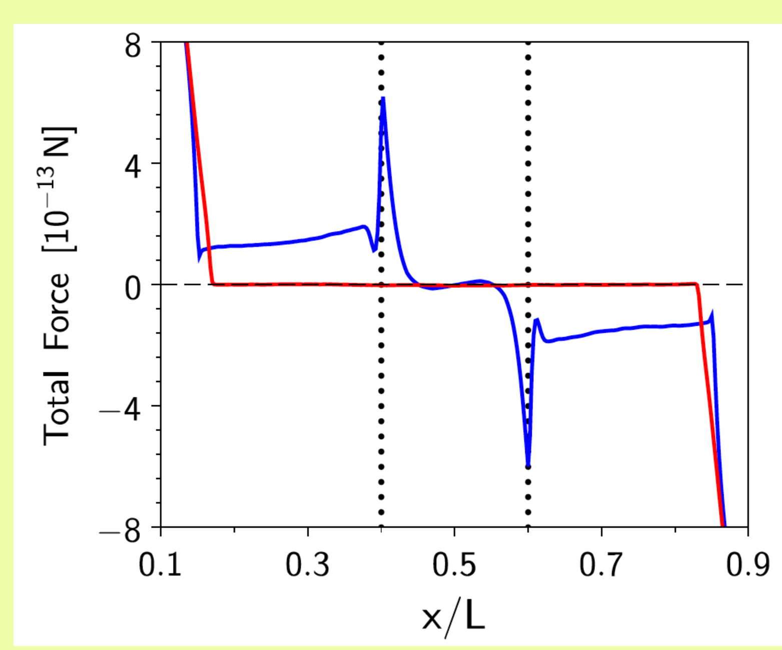
In case of a fixed void

(i) In contradiction to the experiment, **emission concentrates inside the void**.

(ii) Electrostatic force on the void boundary **pushes the microparticles inside the void** - this leads to void closure in self-consistent simulations.







Pustylnik et.al., Phys. Rev. E 96, 033203 (2017)