



# Tuning of thin film thickness in SRF cavities

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# OUTLINE

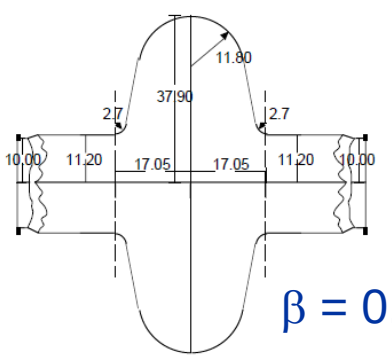
1. Context
2. Experimental Setup
3. Proposal / Simulation
4. Results
5. Outlook

# CONTEXT

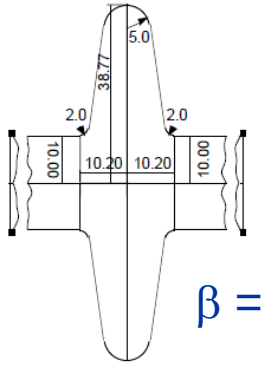
# Low Beta Cavities coating

## 1st Problematic

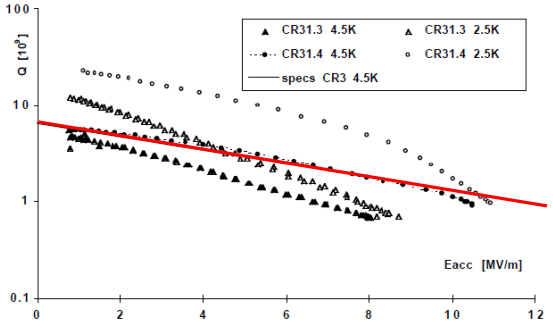
**Q-slope increases with beta factor decrease**

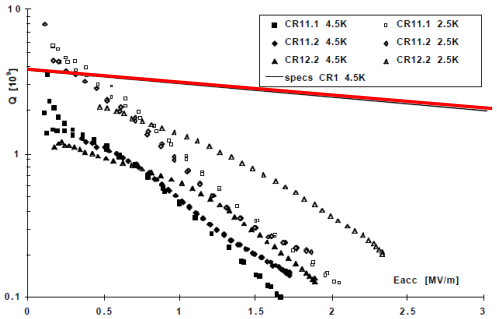



β = 0.8




β = 0.48



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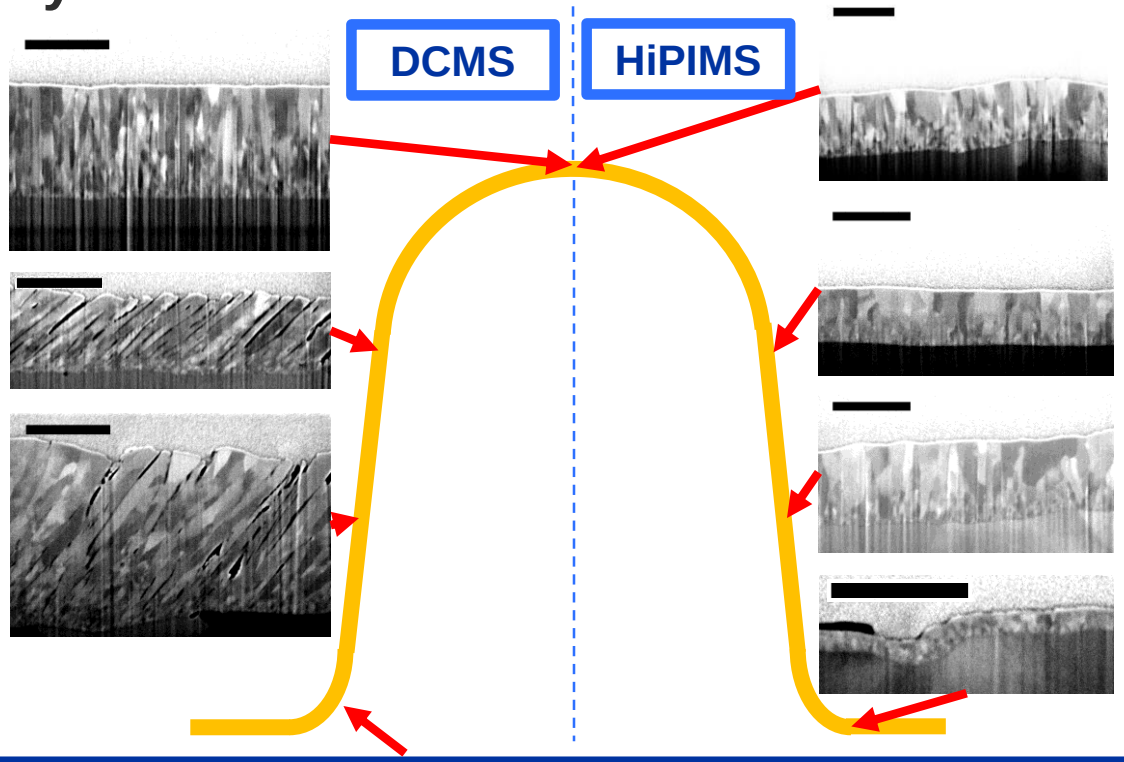
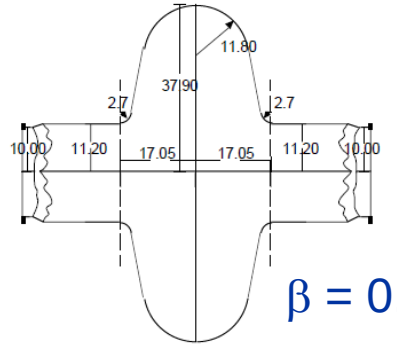
**→ Biased HiPIMS / Bipolar HiPIMS as solution = layer densification**

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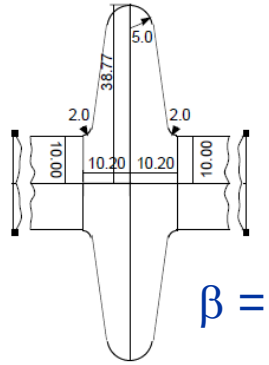


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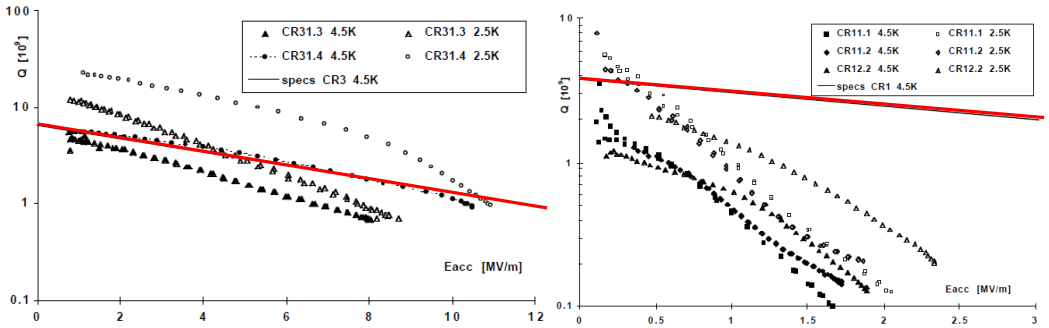
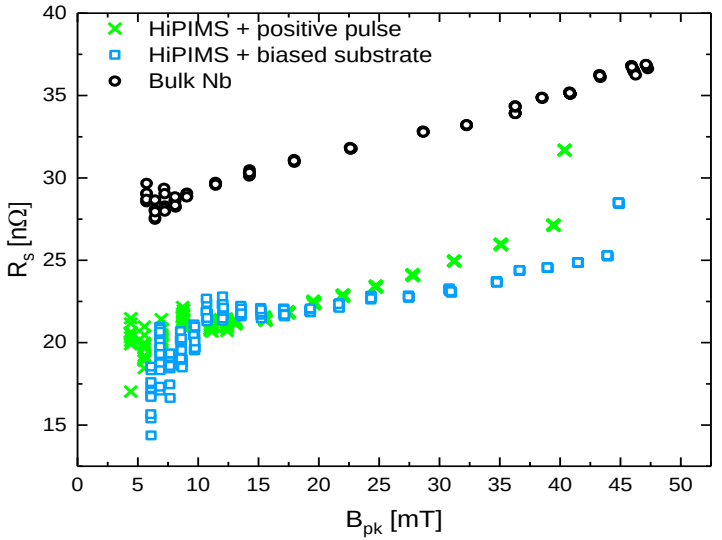



T = 1.85K , 400MHz



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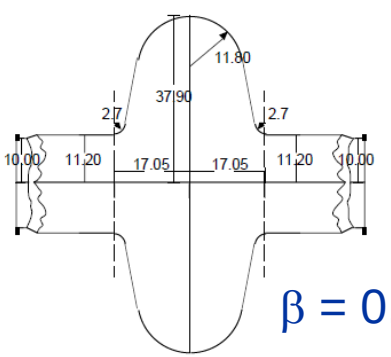
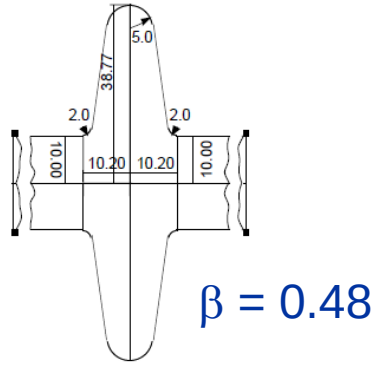
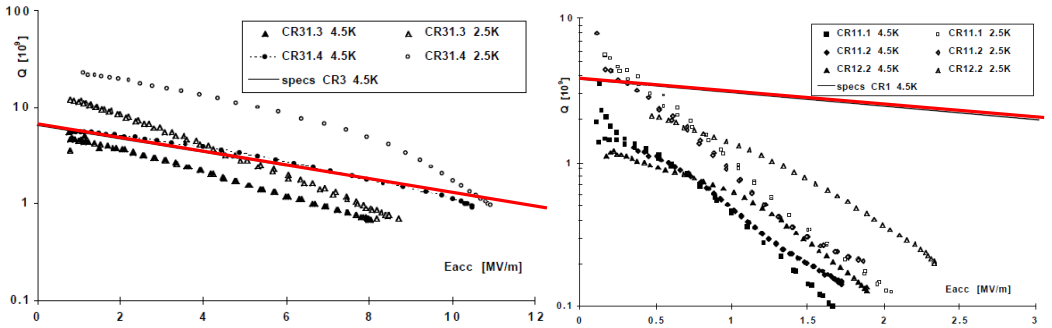


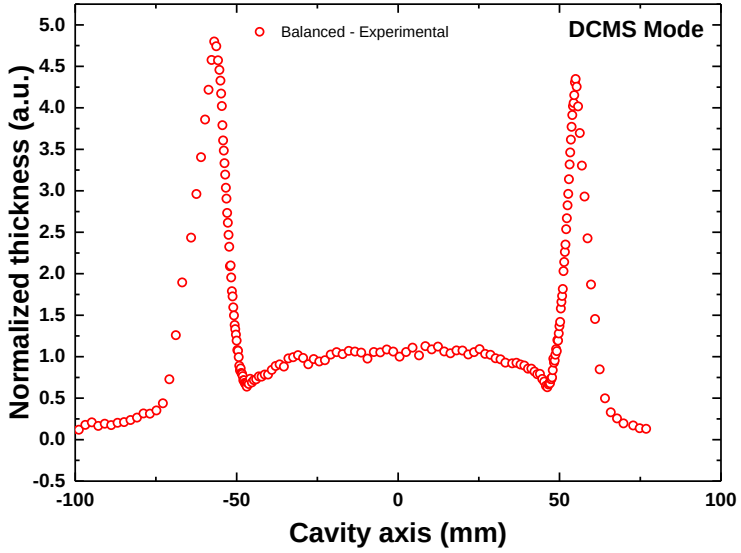




## 2nd Problematic

**Thickness ratio between iris and equator regions**

**→ Peel-off may occur at the iris**

**→ Long process duration to achieve required thickness at equator**



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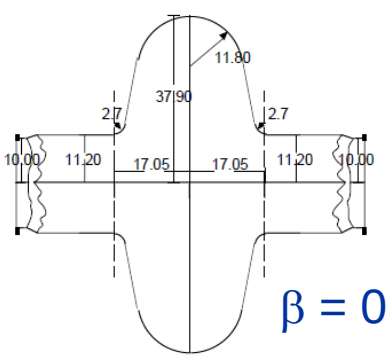


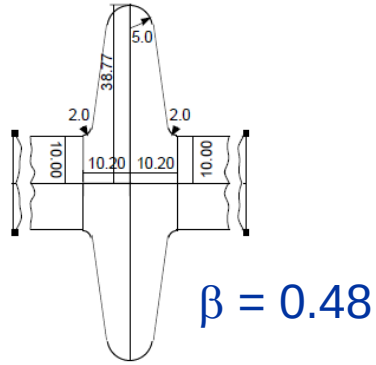


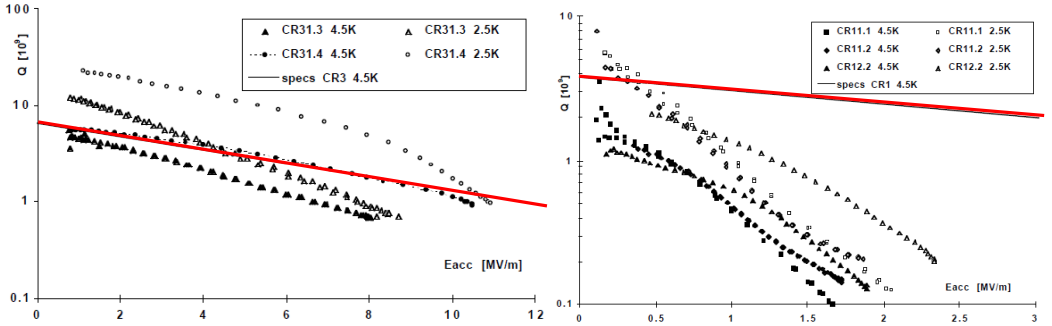


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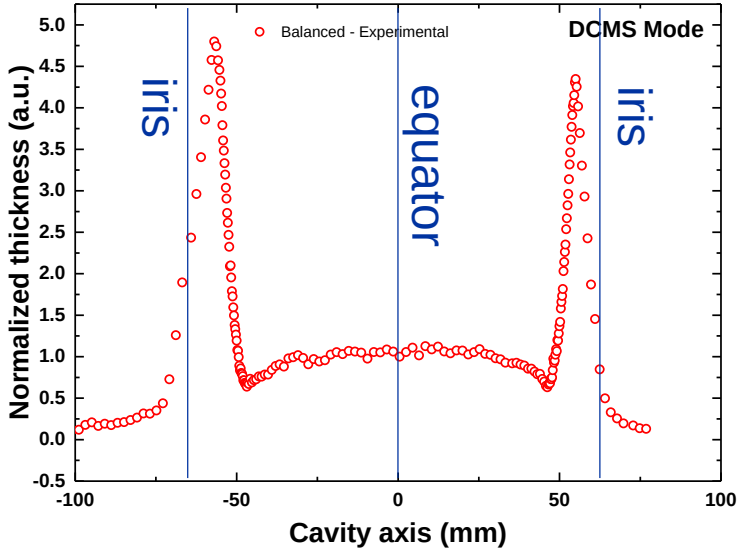
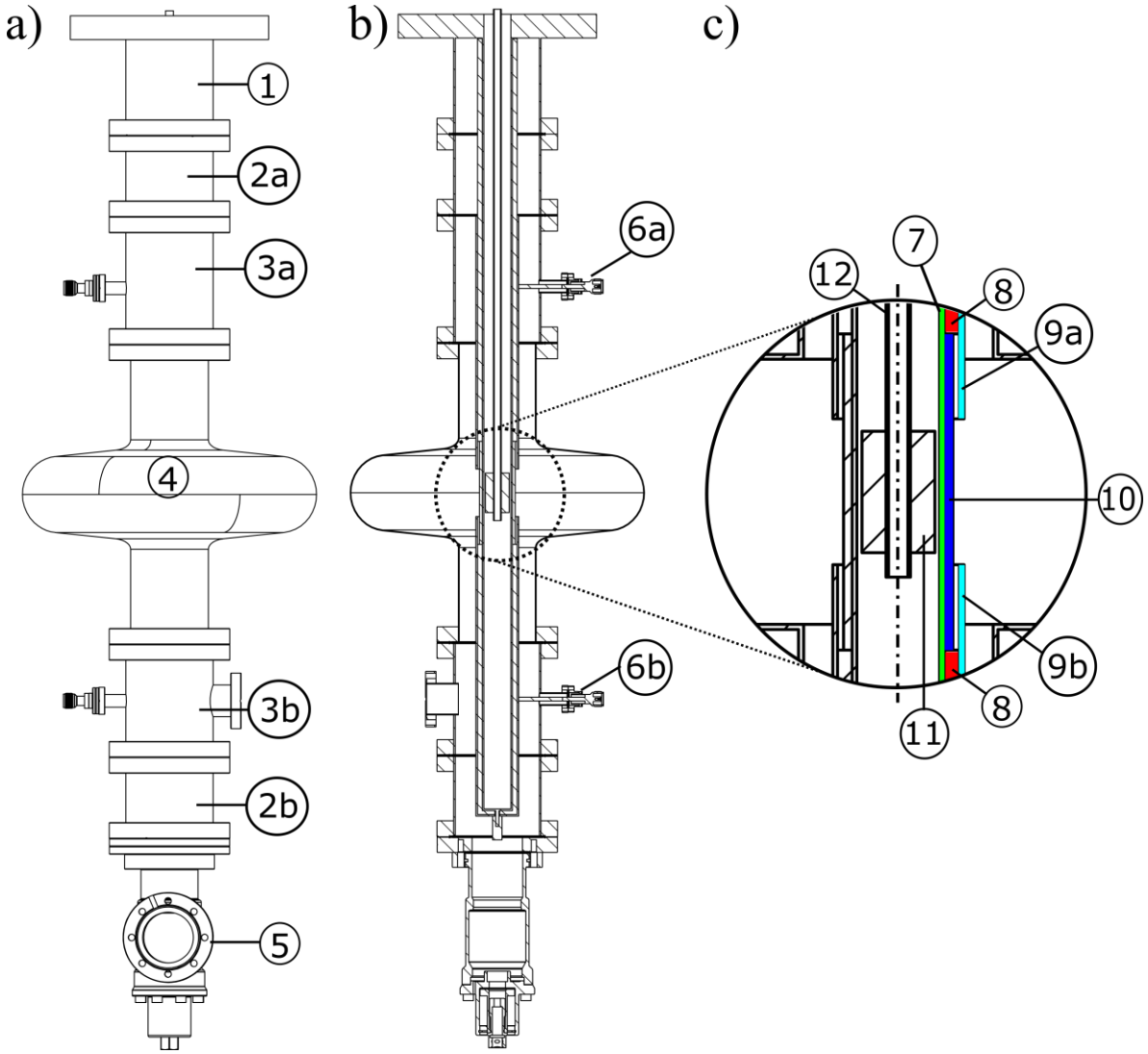


# EXPERIMENTAL SETUP

# Coating setup and samples



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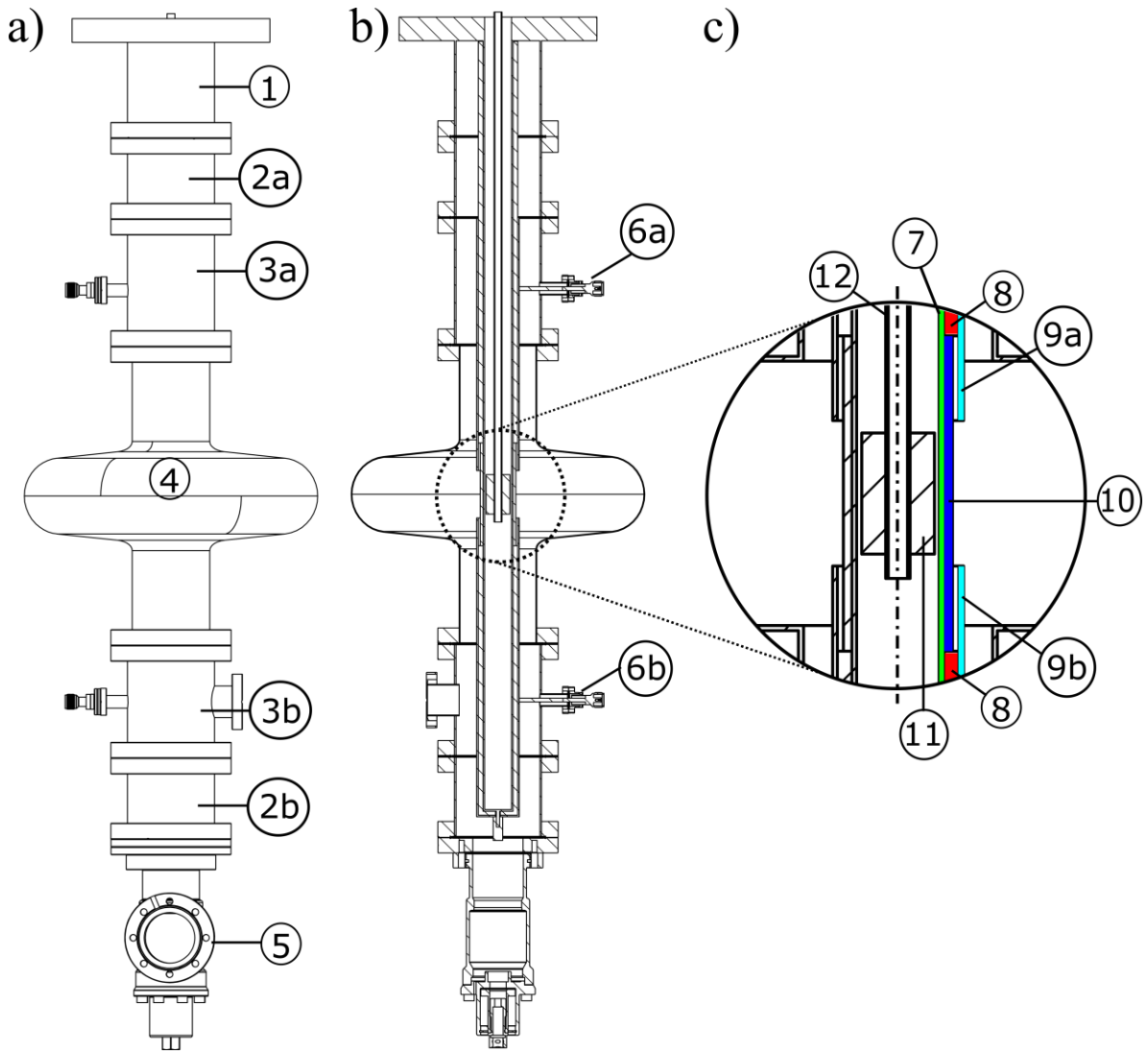


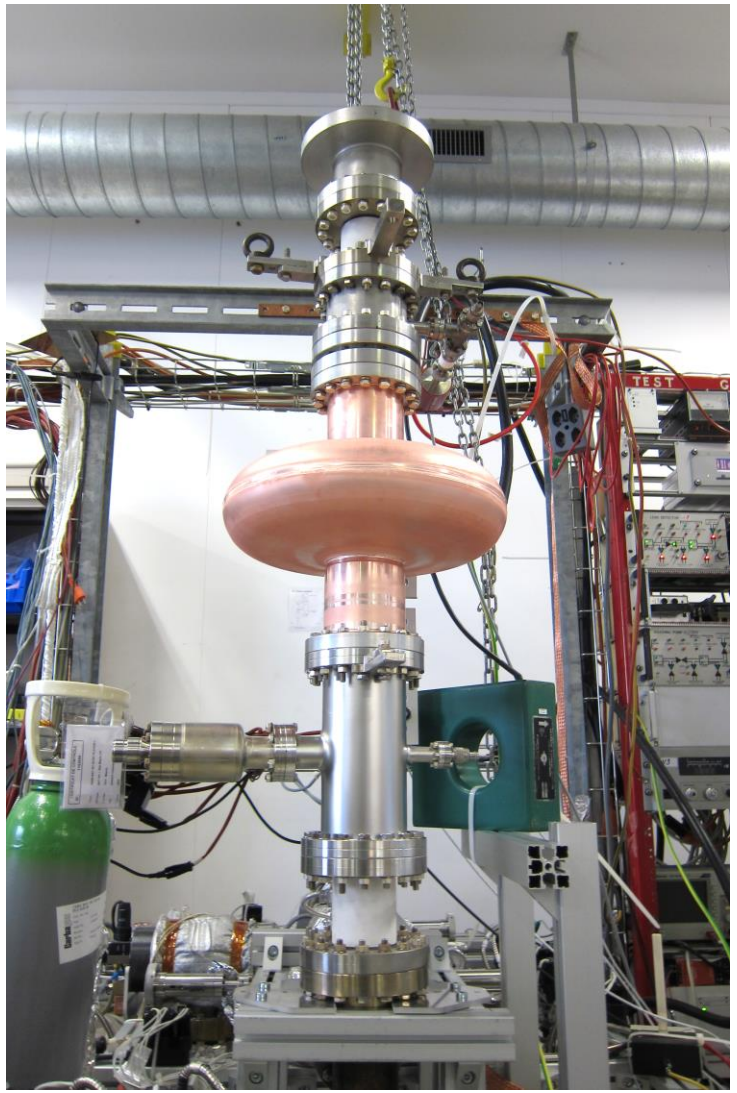

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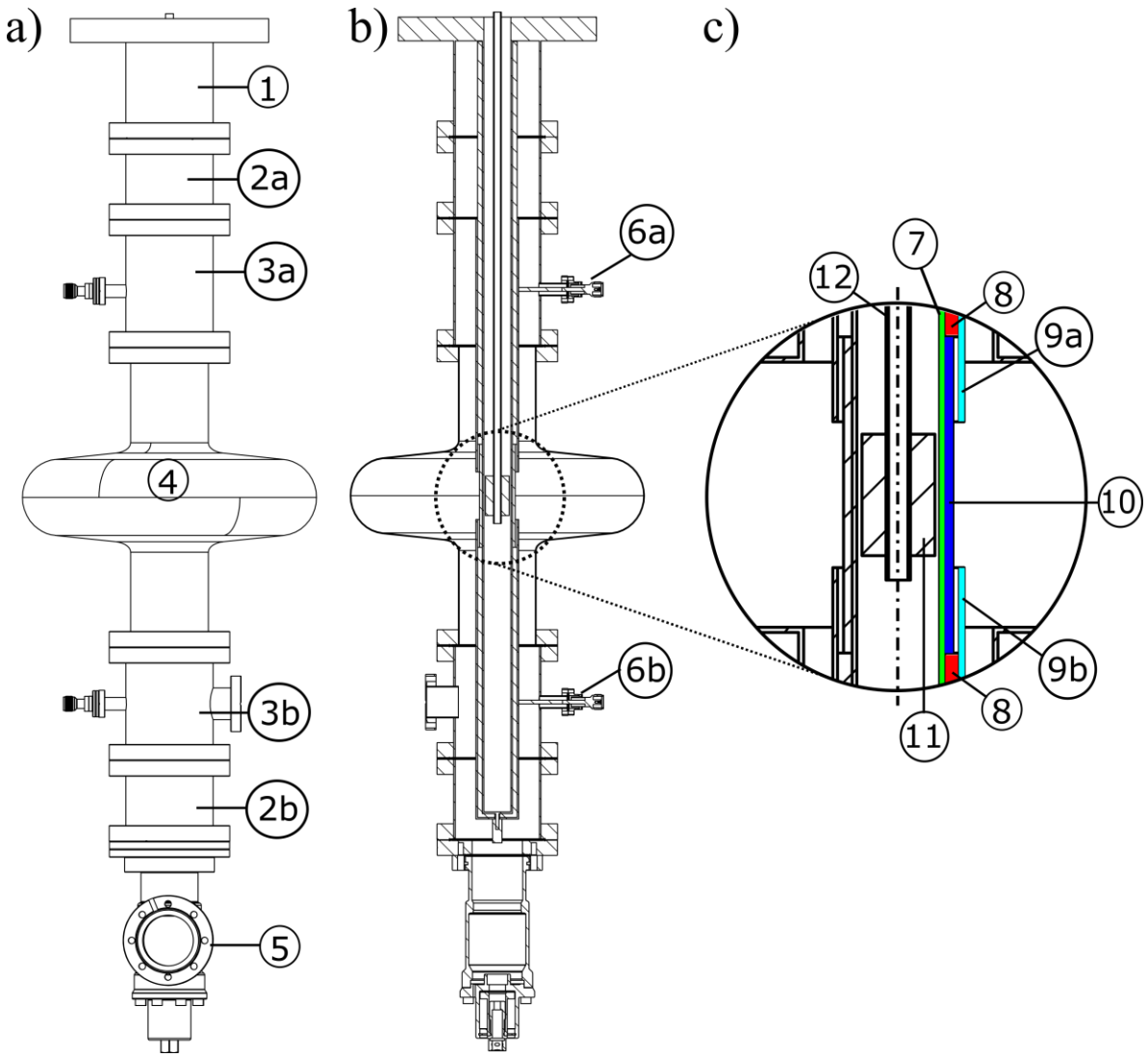


| | |
|---|---|
| DCMS Power supply | Huttinger 3010 |
| HiPIMS Power supply | HighPulse 4006 |
| Bias Power supply | TruPlasma 3018 |
| Average Power | 1.3 kW |
| Bakeout | 200C / 48h |
| Base Pressure | $6.10^{-10}$ mbar |
| Working gas | Kr |
| Pressure | $2.3.10^{-3}$mbar |
| Coating duration | 2h |

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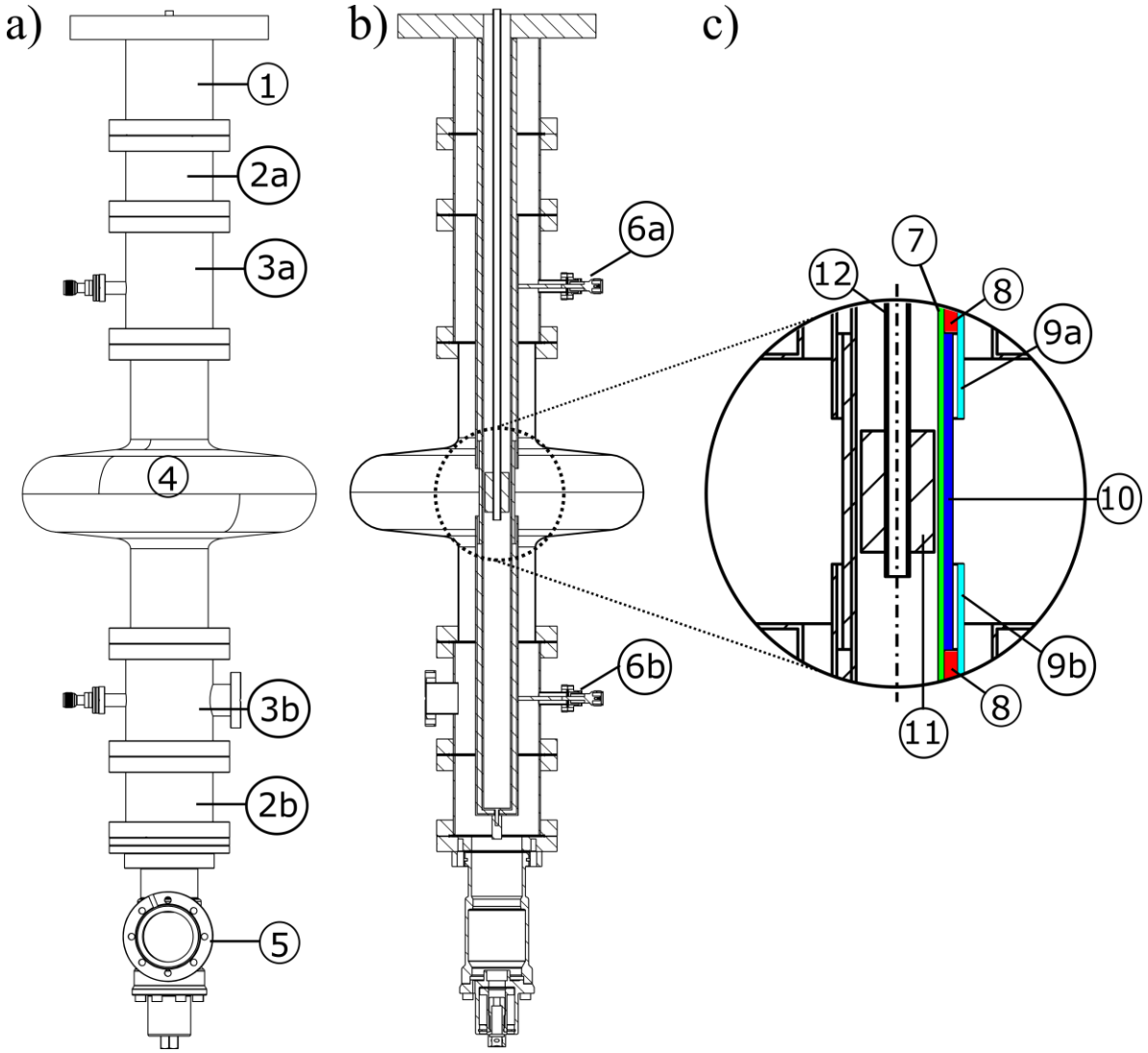
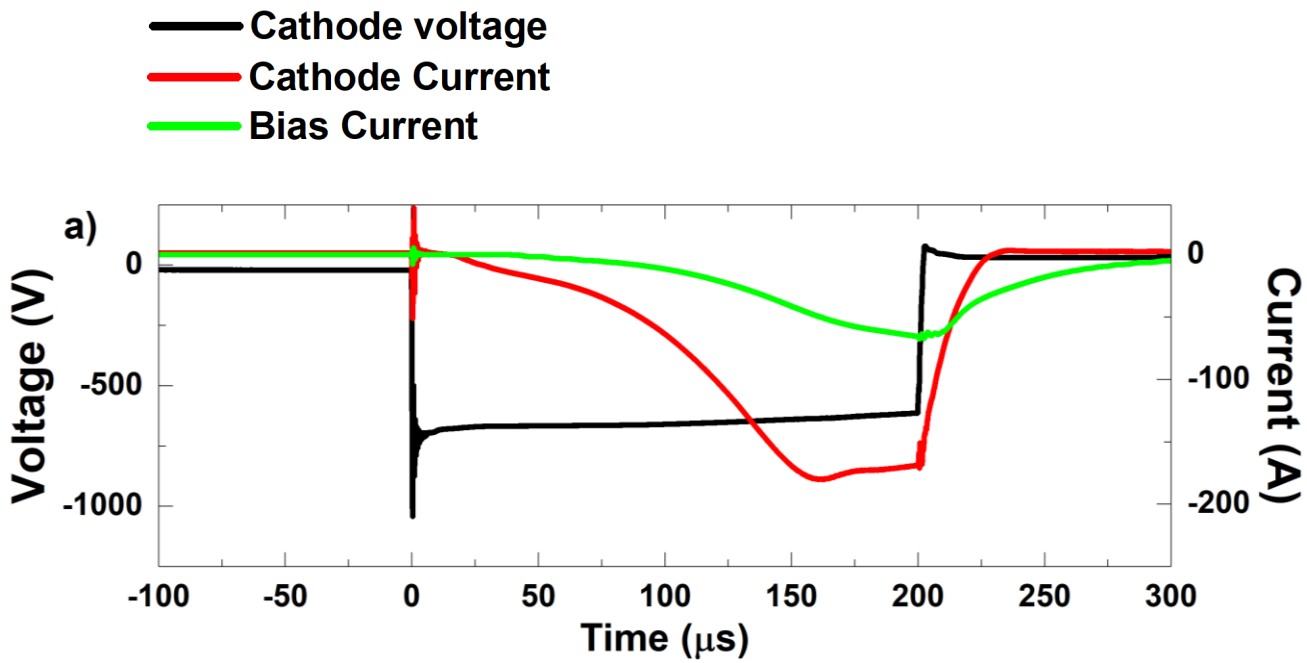



**100Hz, 200μs, -75V bias**

# PROPOSAL / SIMULATIONS

# Redistribution of the species

**HiPIMS = highly ionized metallic plasma**

**How to bring these ions “where we want”?**

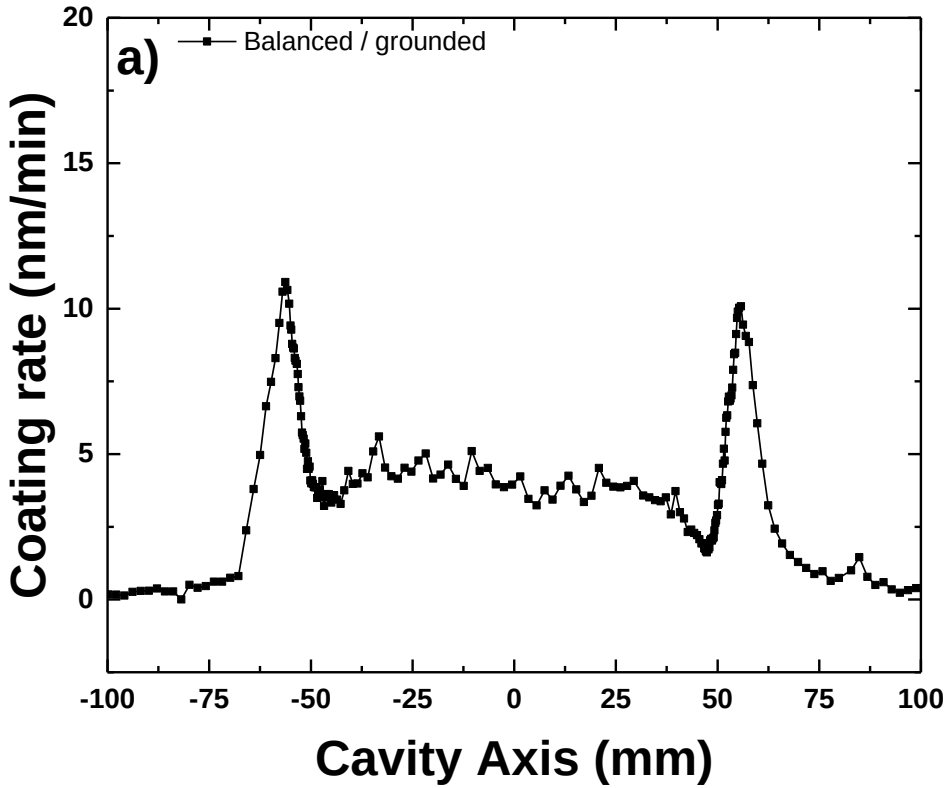
# Redistribution of the species

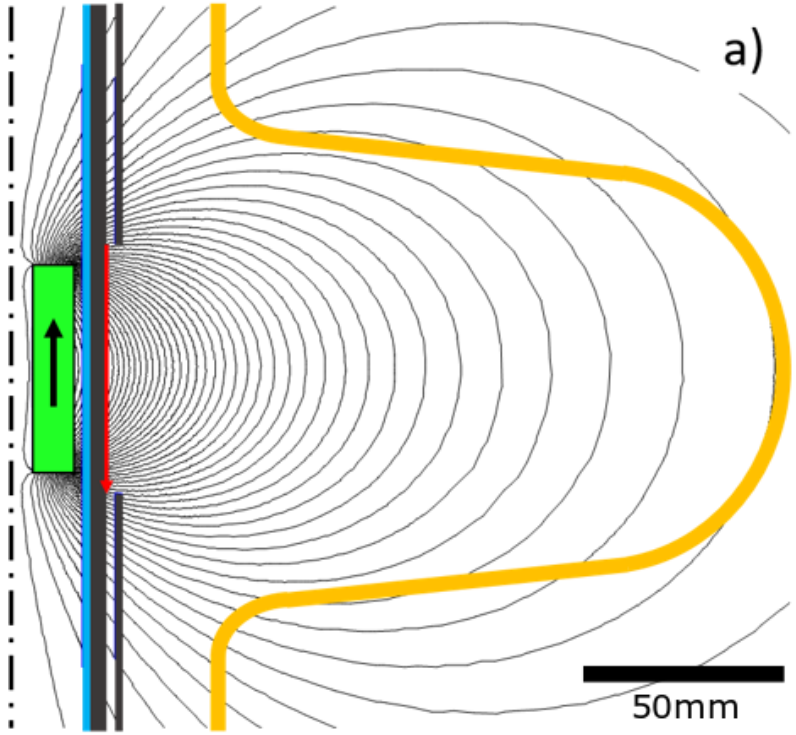
**1st: Can a negative bias contribute to redistribute the ionized species?**

**- HiPIMS grounded vs Biased HiPIMS trial**

# Biasing effect

- HiPIMS grounded
- Standard magnet



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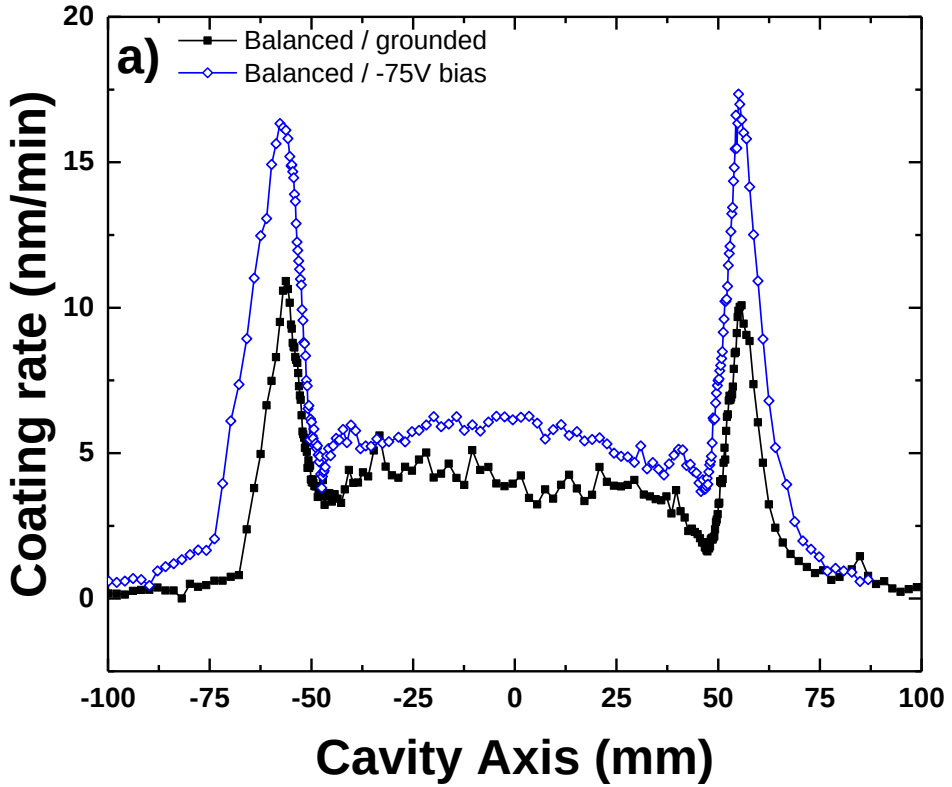


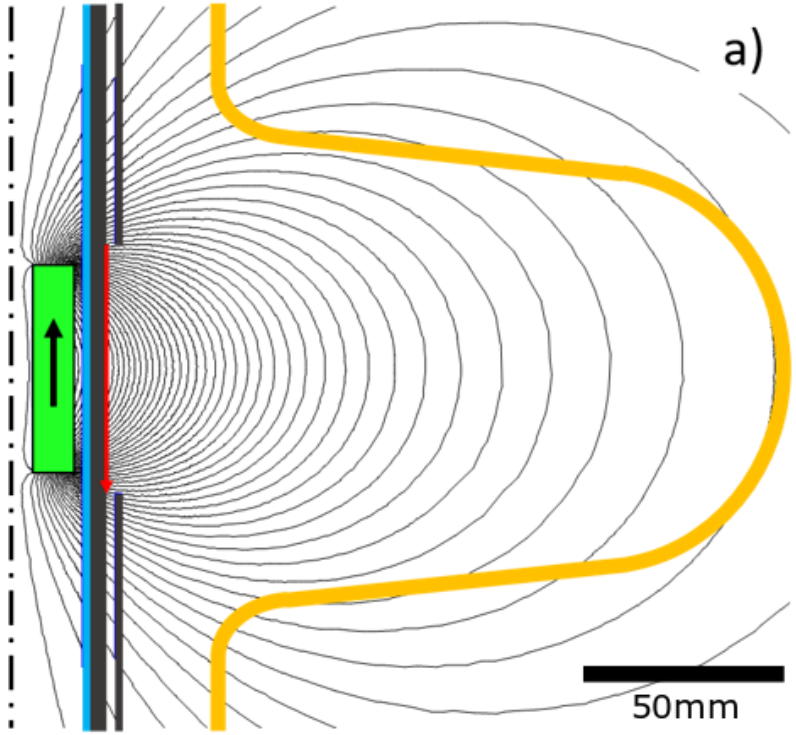

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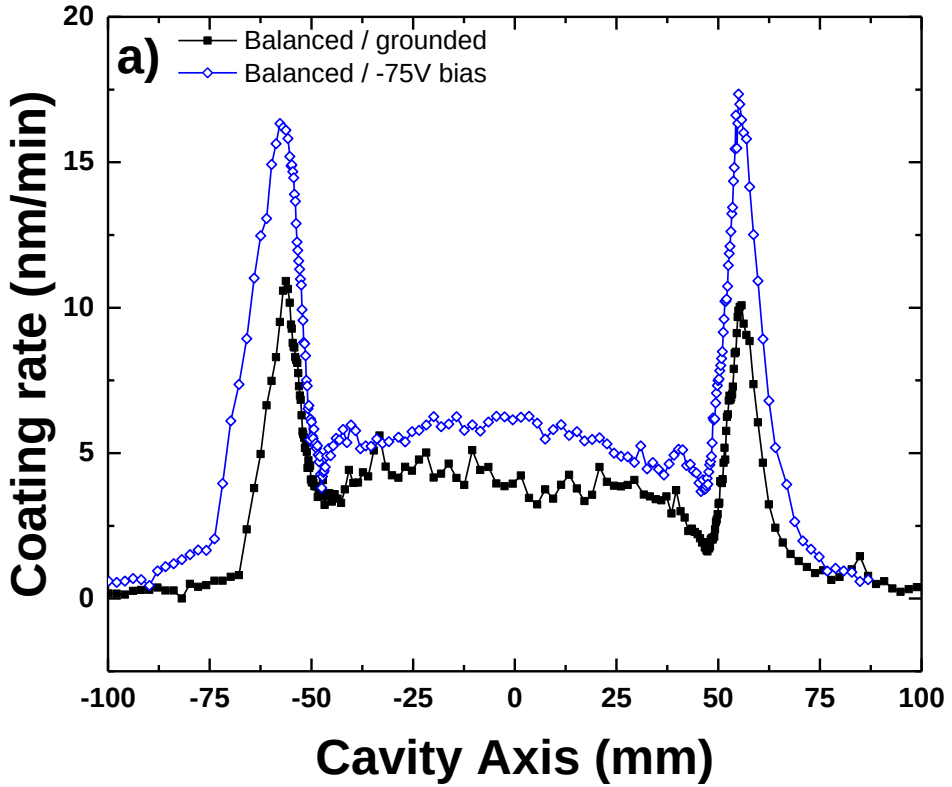


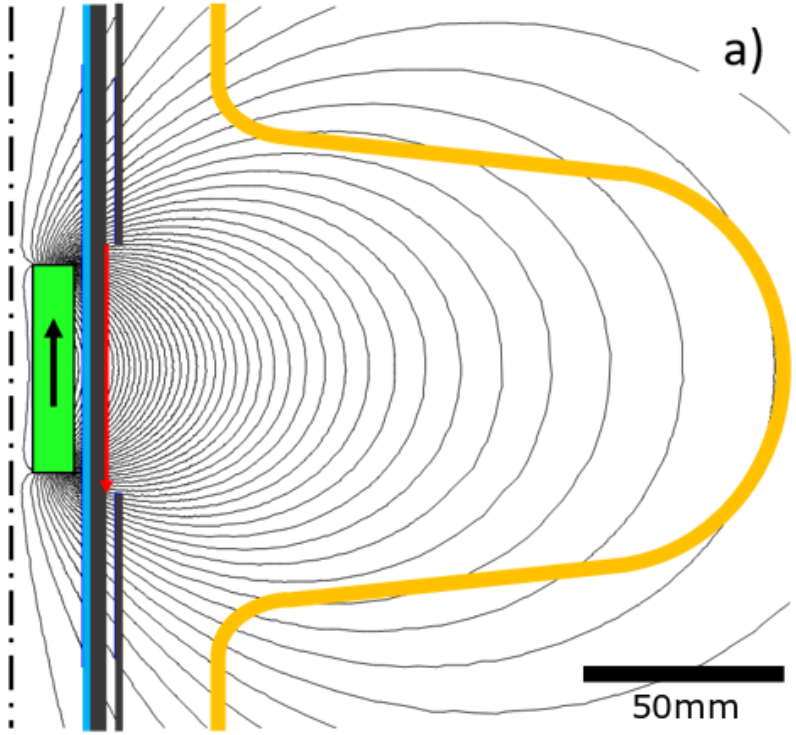


**No redistribution**

**Higher coating rate in biased configuration**

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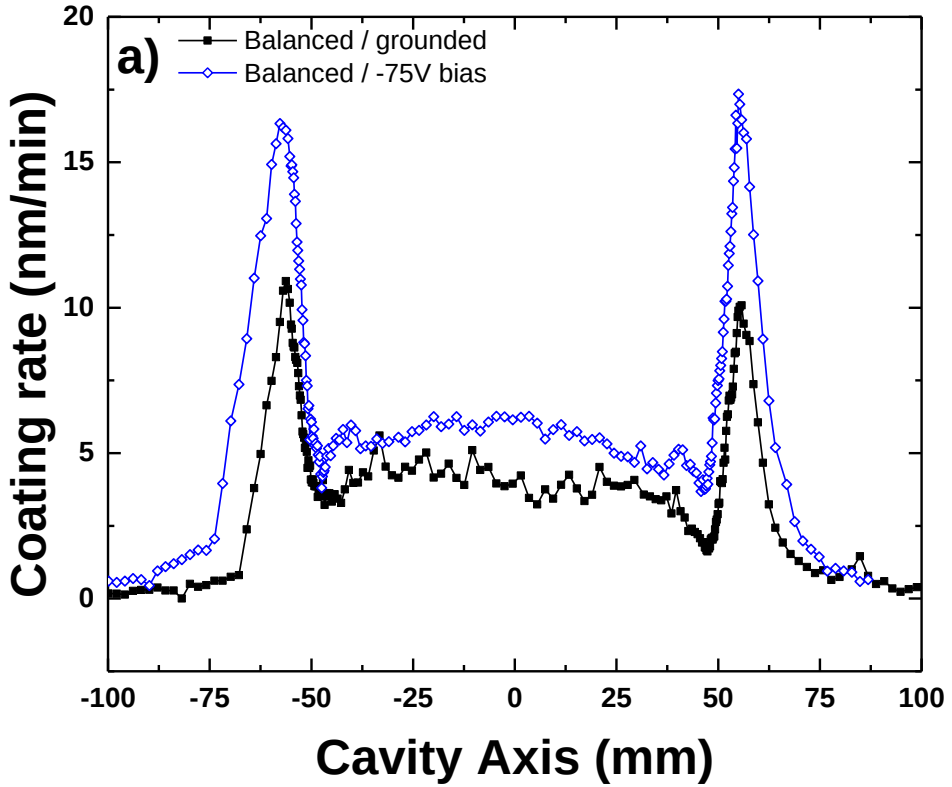


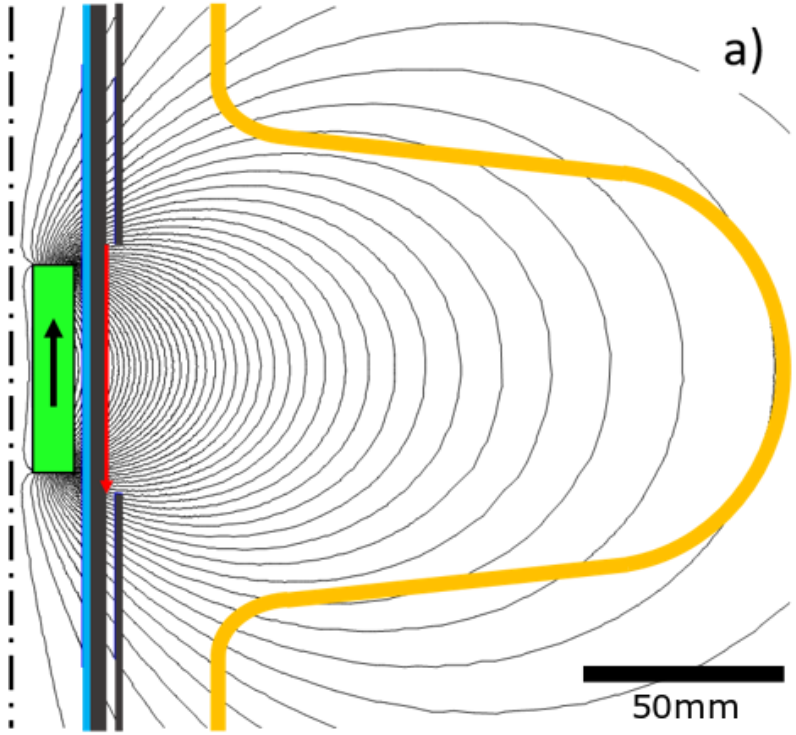


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**Higher coating rate in biased configuration**

**NEED TO ACT ON THE IONIZATION REGION**

**→ Increase ion flux at the sheath edge**

# Redistribution of the species

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**- HiPIMS grounded vs Biased HiPIMS trial**

**2nd: Can we tune the plasma plume profile in order to redistribute the ionized species?**

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**- Ions trajectories cannot be modified on large scale (too large Larmor radius). only electric field can act on them (only in the sheath ~mm)**

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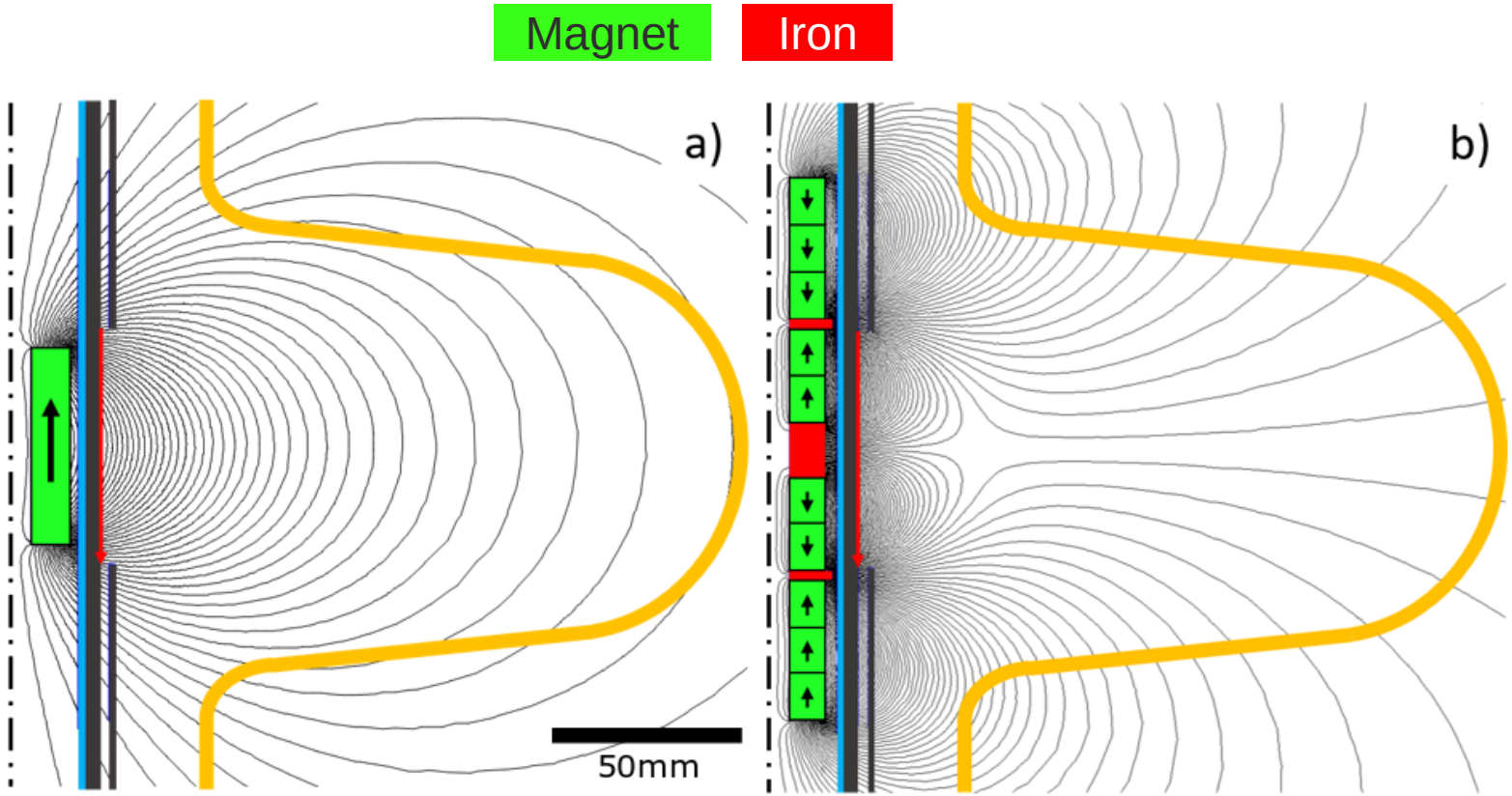
**- Try to redirect electrons → extend and shape the ionization region**

# How to shape the ionization region?

**Expel the electrons away toward cavity's surface**

**→ Magnetic profile modification**

**→ Electrons can escape**



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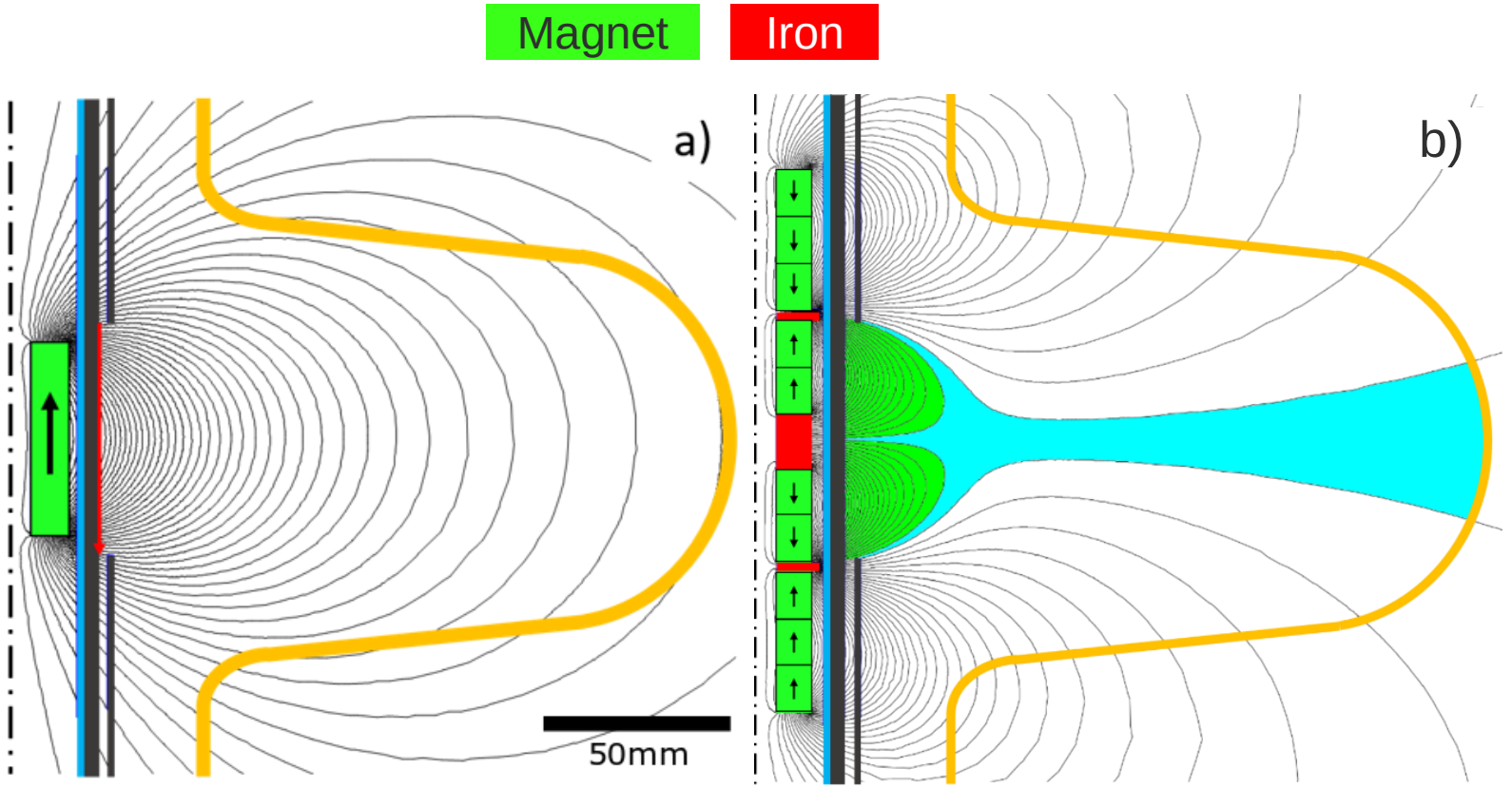

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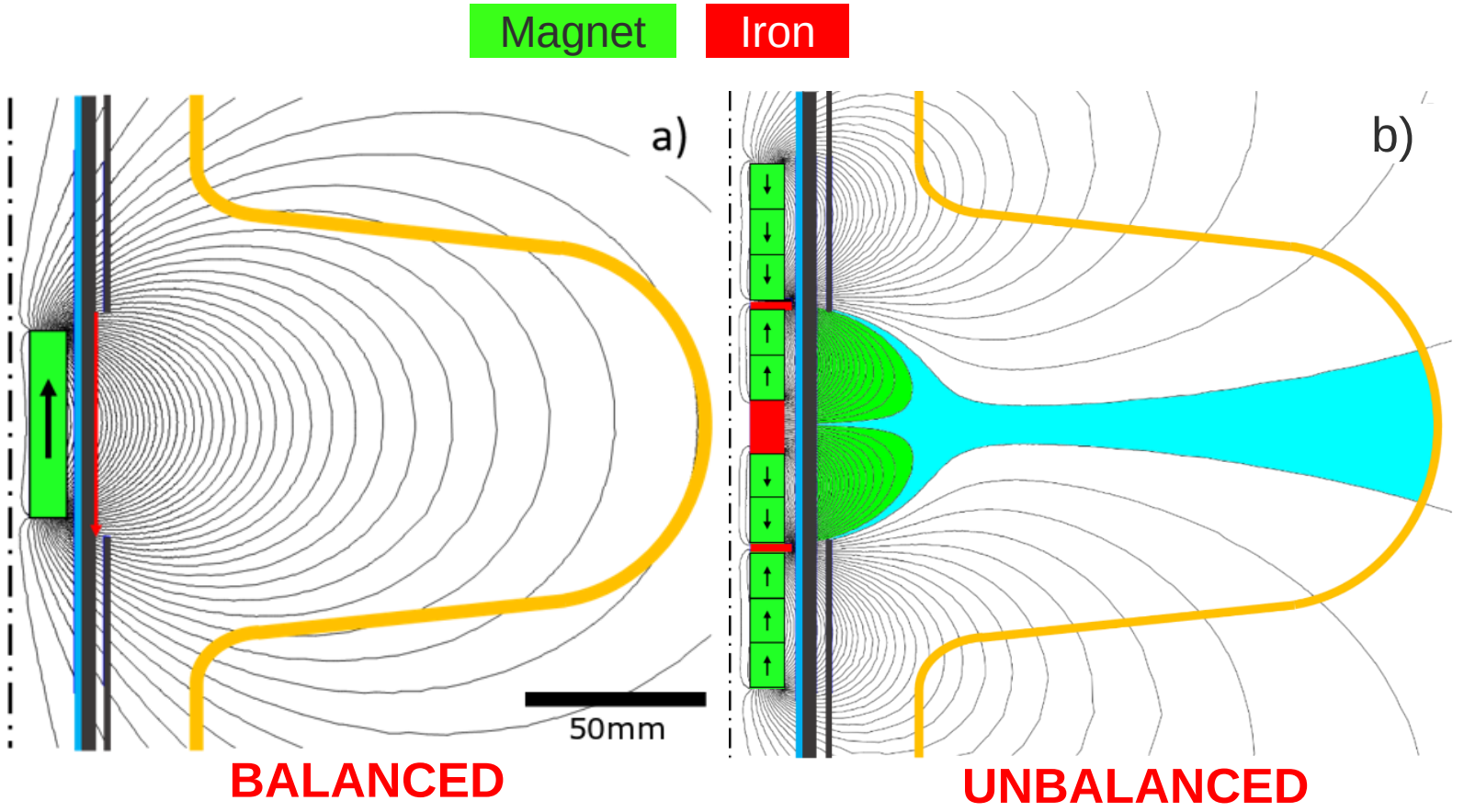

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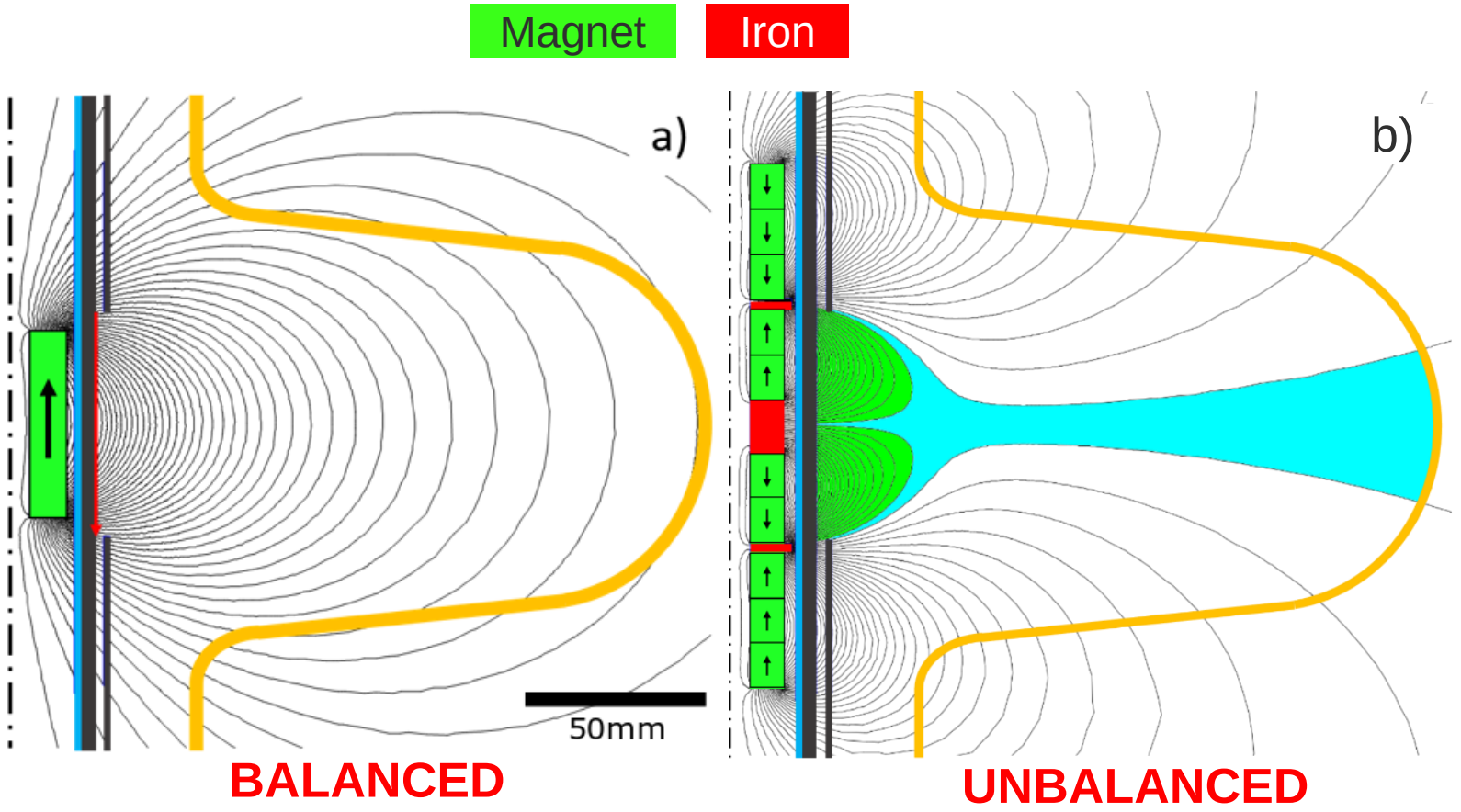

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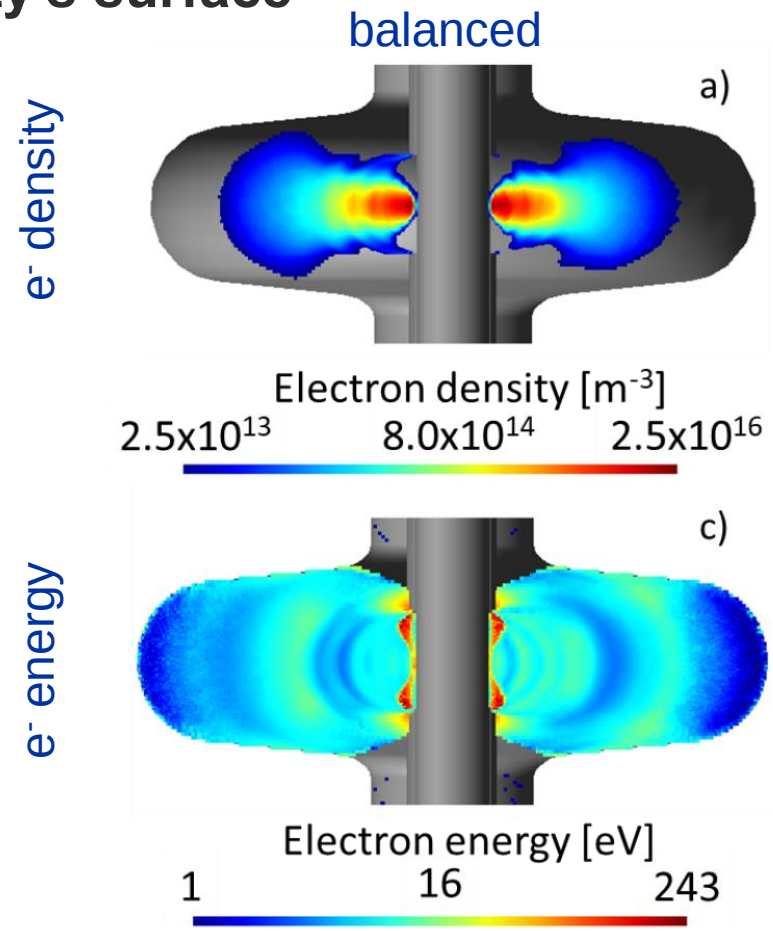
PIC-MC Plasma simulations (10W)

balanced



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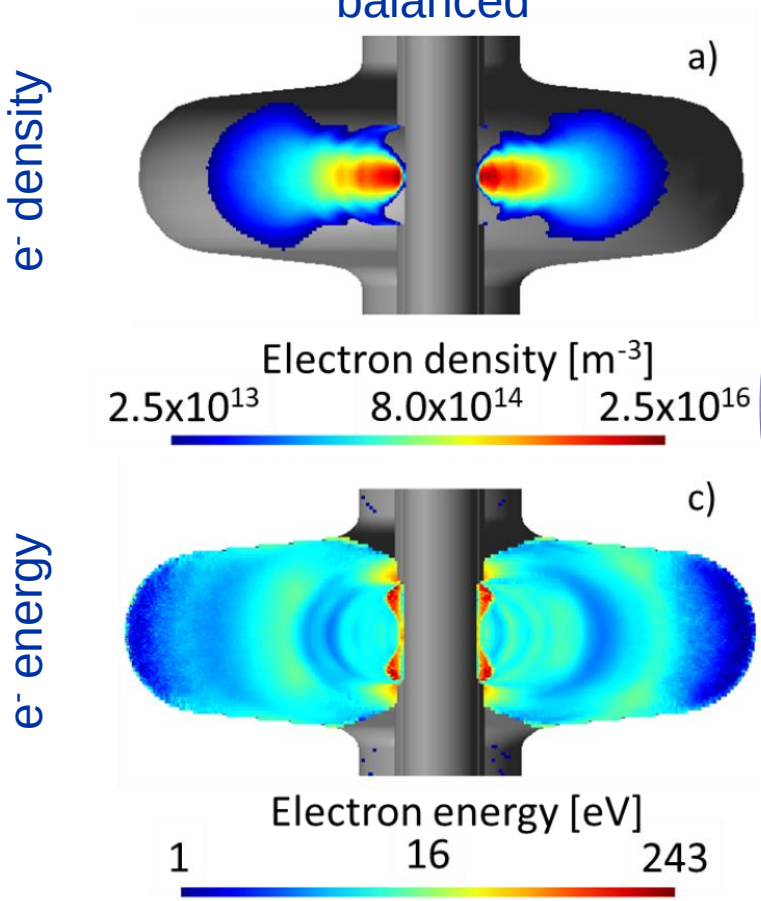


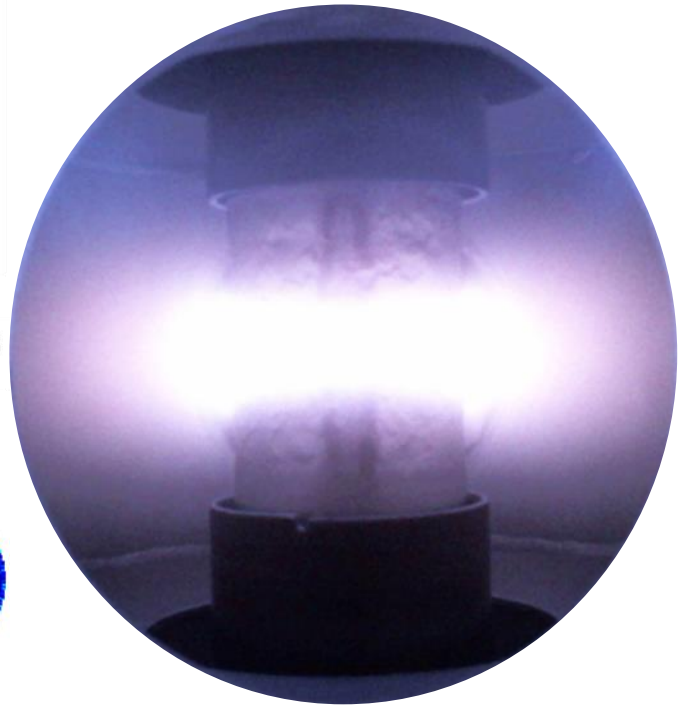

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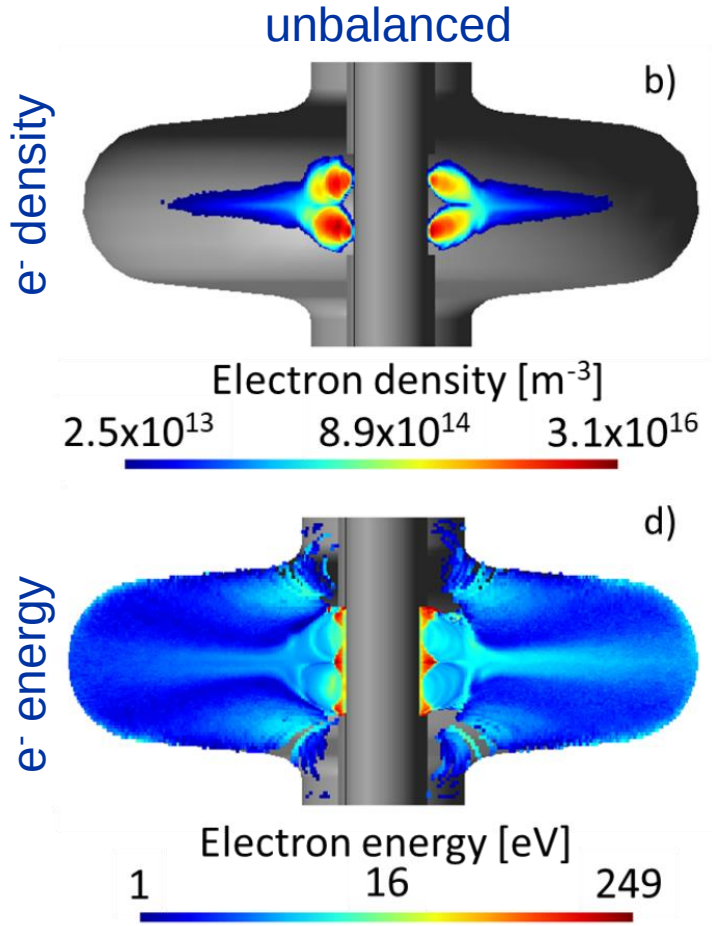

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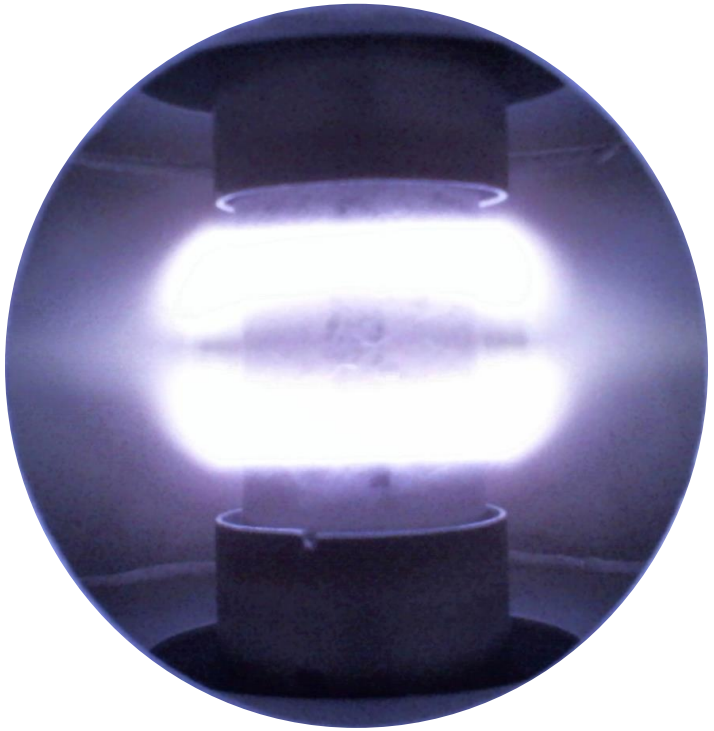

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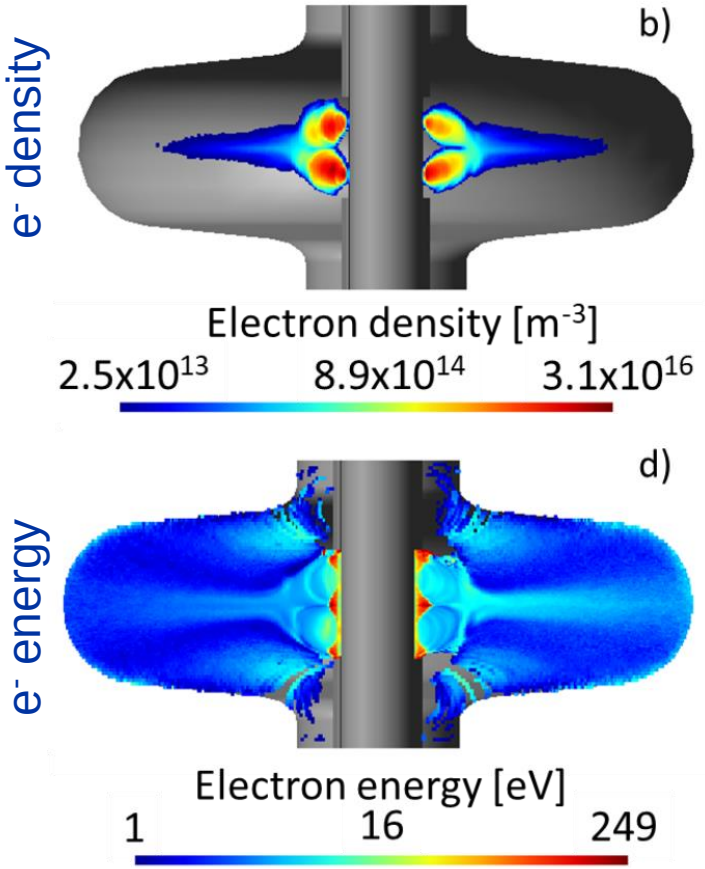
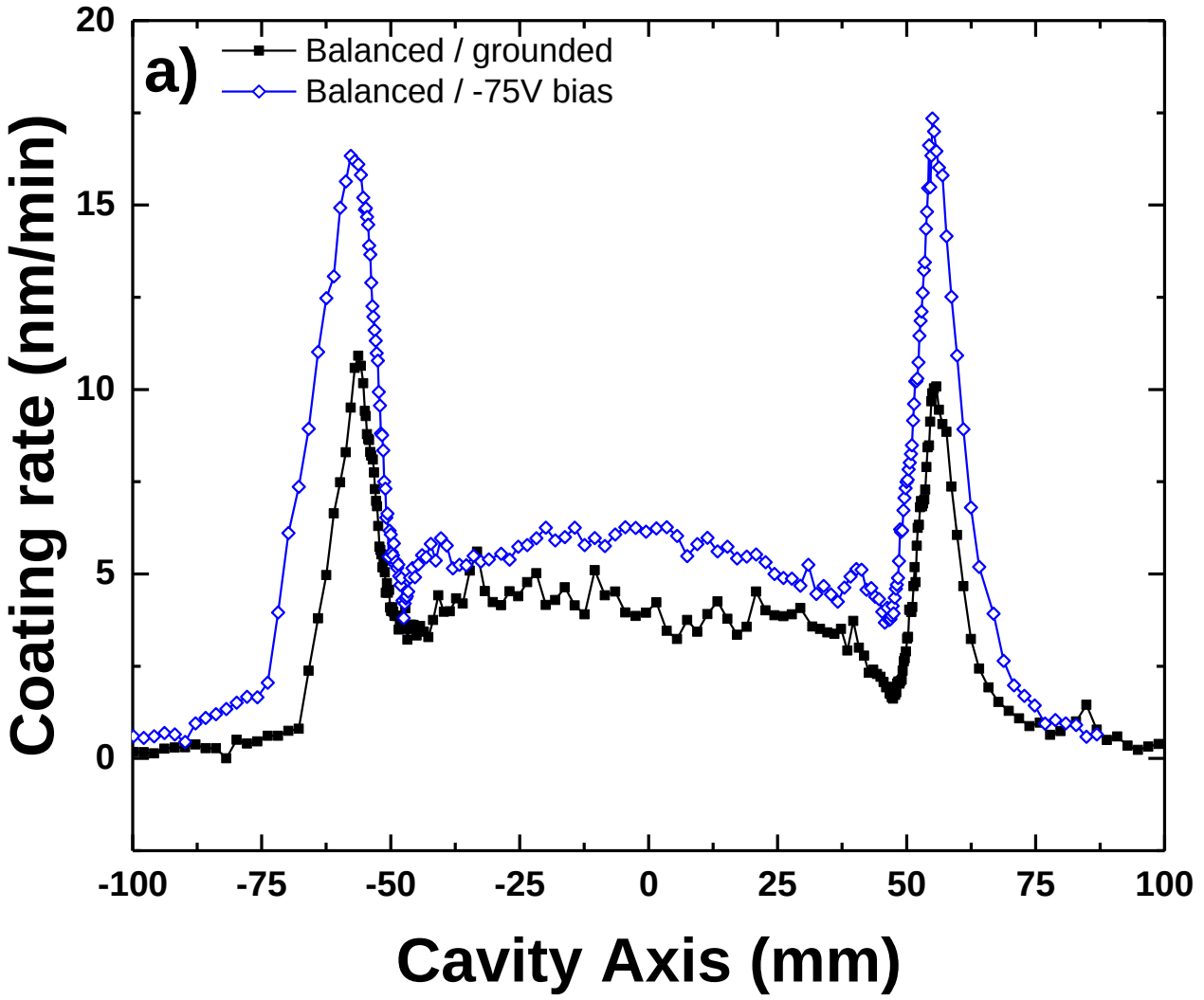


# RESULTS

# Does it work?

1. Use of unbalanced configuration

2. Biasing of the substrate (-75V)



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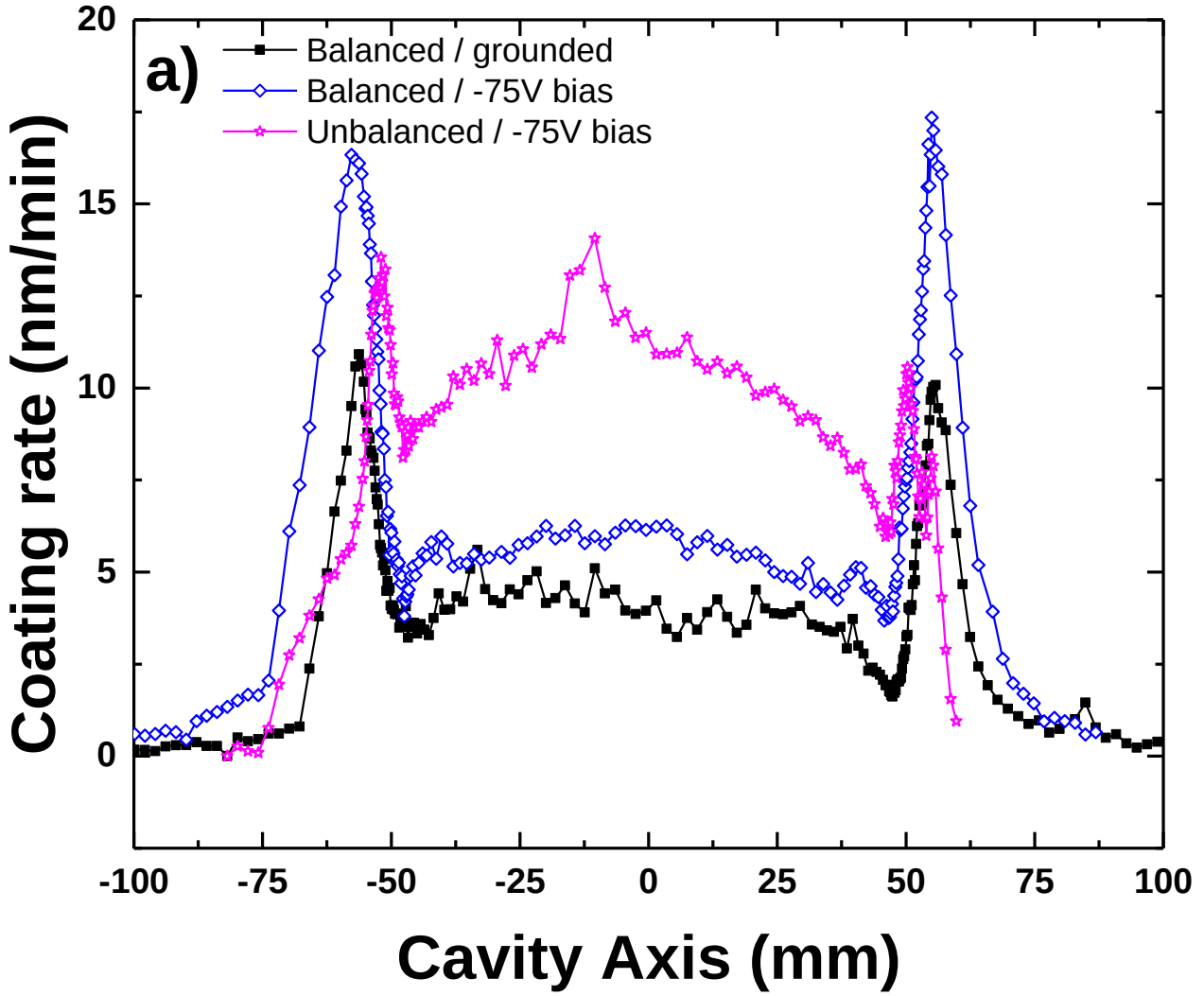
**Redistribution of the profile**

**Increase of the coating rate at the equator**



# Summary / Outlook

**Thin film thickness can be tuned using**

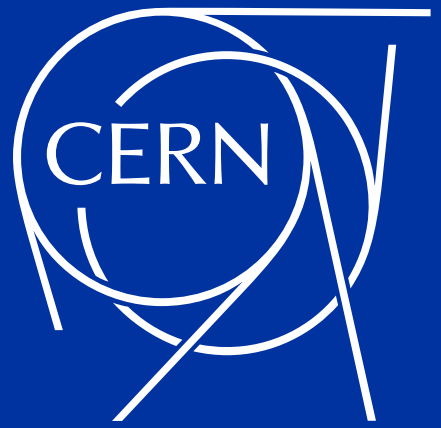
- Biased HiPIMS
- Appropriate magnetic configuration

**Enables complex shapes coating**

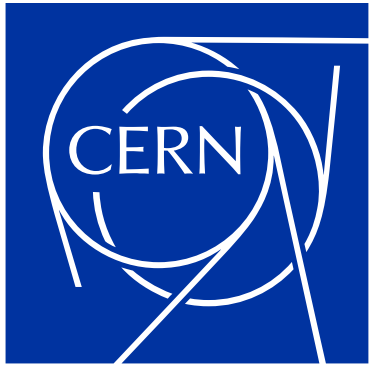
**Plasma simulations efficient into predicting the magnetic assembly effect**

**Magnetic strength and profile effect investigated (to be published)**

**RF performance to be assessed  (ion flux effect)**




# Thank you for your attention

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