PERFORMANCE OF A LOW FREQUENCY QWR-BASED SRF GUN

Wisconsin Free Electron Laser (WiFEL) Electron Gun Cavity

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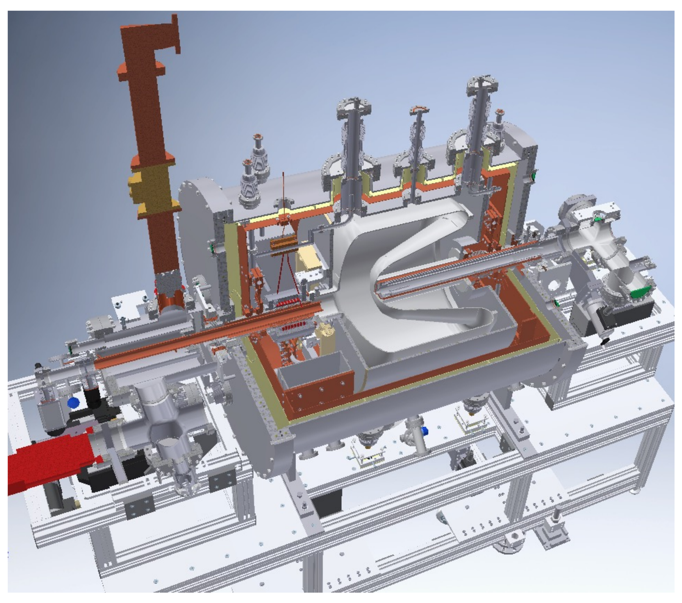
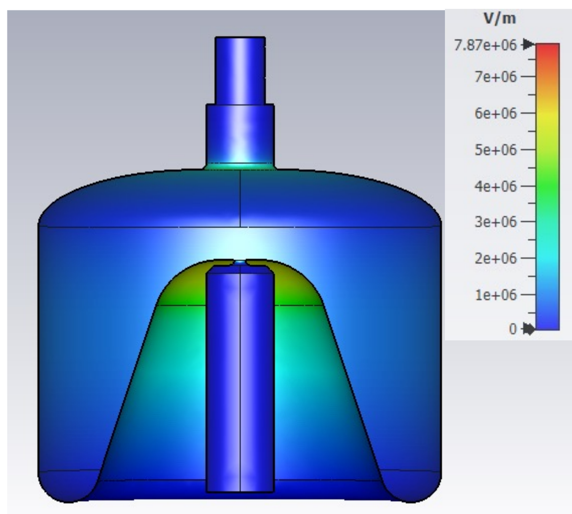
ABSTRACT

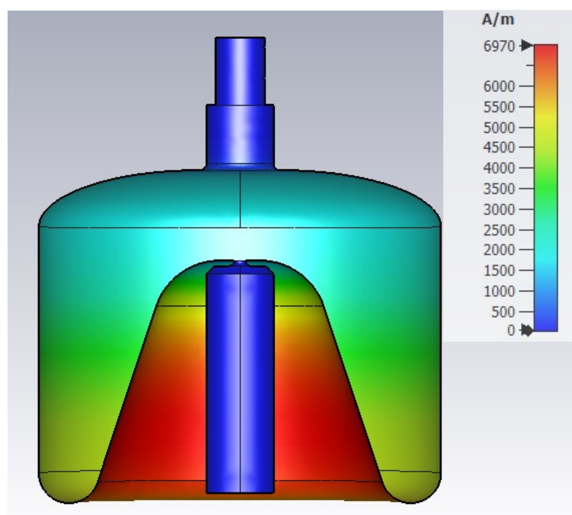
Superconducting radio-frequency (SRF) electron guns are generally considered to be an effective way of producing beams with high brightness and high repetition rates (or continuous wave). In this work, the 199.6 MHz quarter wave resonator (QWR)-based Wisconsin Free Electron Laser (WiFEL) superconducting electron gun was recently refurbished and tested at Argonne (ANL). The field performance of the e-gun was fully characterized. During this time, multipacting (MP) conditioning was performed for over 20 hours to overcome the hard MP barrier observed in the accelerating voltage range of 8 to 40 kV; the presence of multipacting is expected to operationally important for future e-guns. Here we simulated and studied the effect using CST [1] Microwave Studio and Particle Studio and compare with the measured data.

WiFEL CAVITY GEOMETRY AND THE FIELD DISTRIBUTION



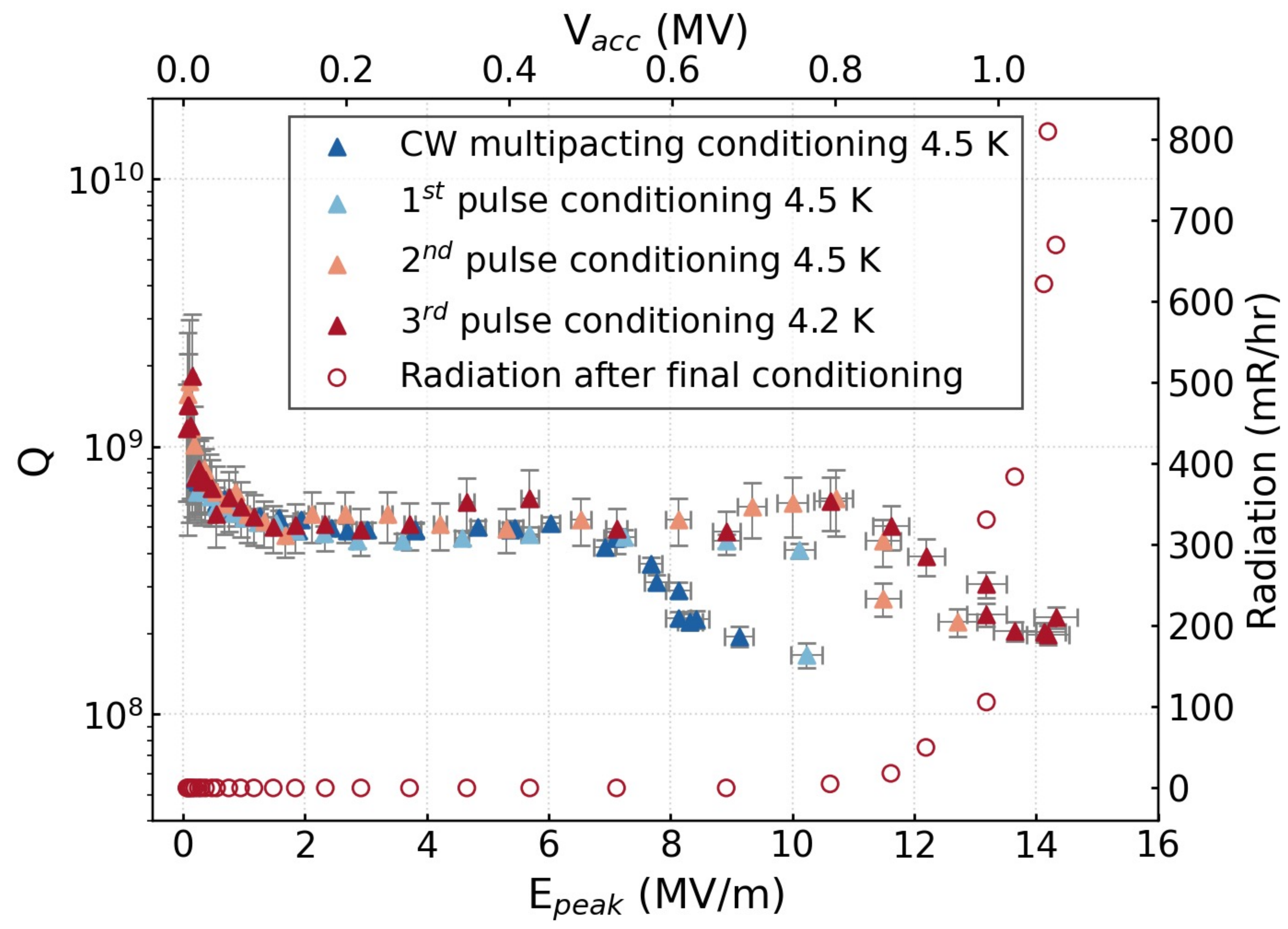


Electric field



Magnetic field

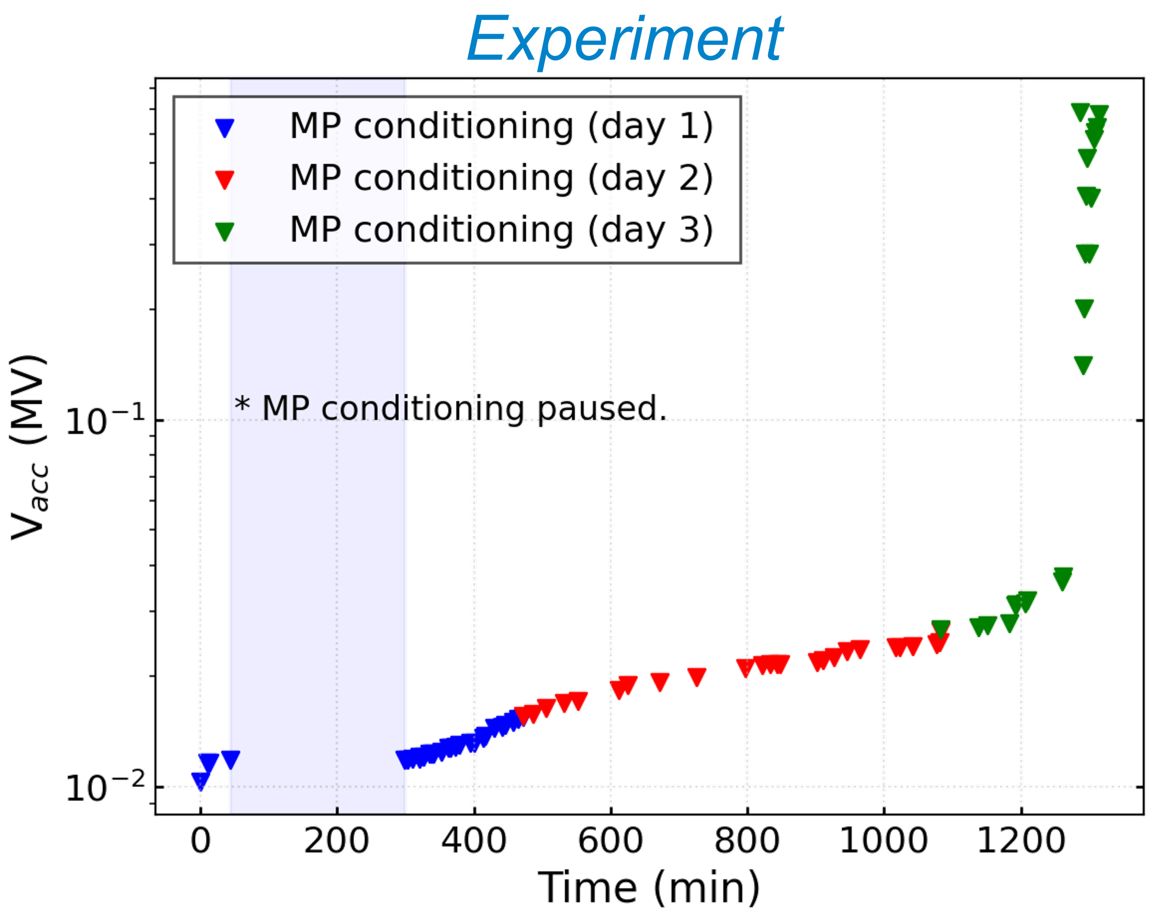
Q-CURVE



- $Q_0 = 2.3\times10^8$ @ highest stable CW E_{peak} of 15 MV/m.
- Low field Q-drop was found NOT caused by Q-disease, more likely related to physical imperfection.

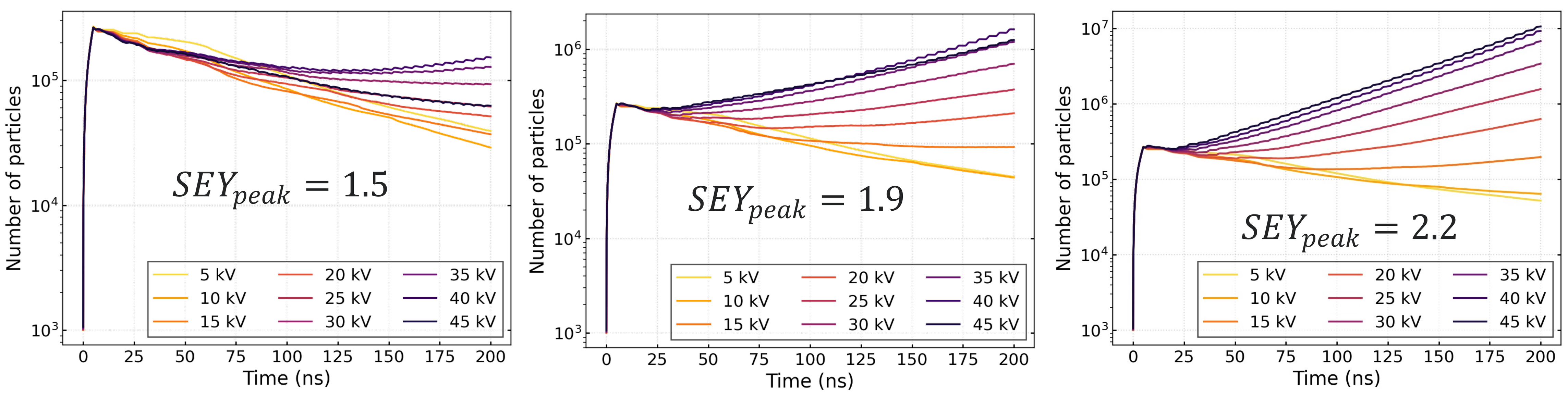
MULTIPACTING (MP) CONDITIONING

Experiment



- Measured MP turn-on @ ~8 kV.
- Strong MP observed in between 8 kV and 40 kV.
- Total conditioning time: >20 hours.

CST Simulation

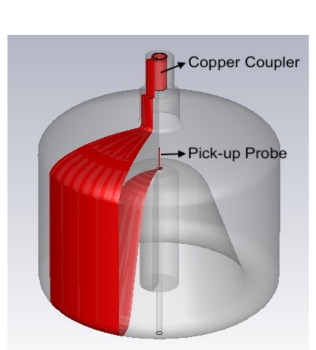


Fit to the exponential function:

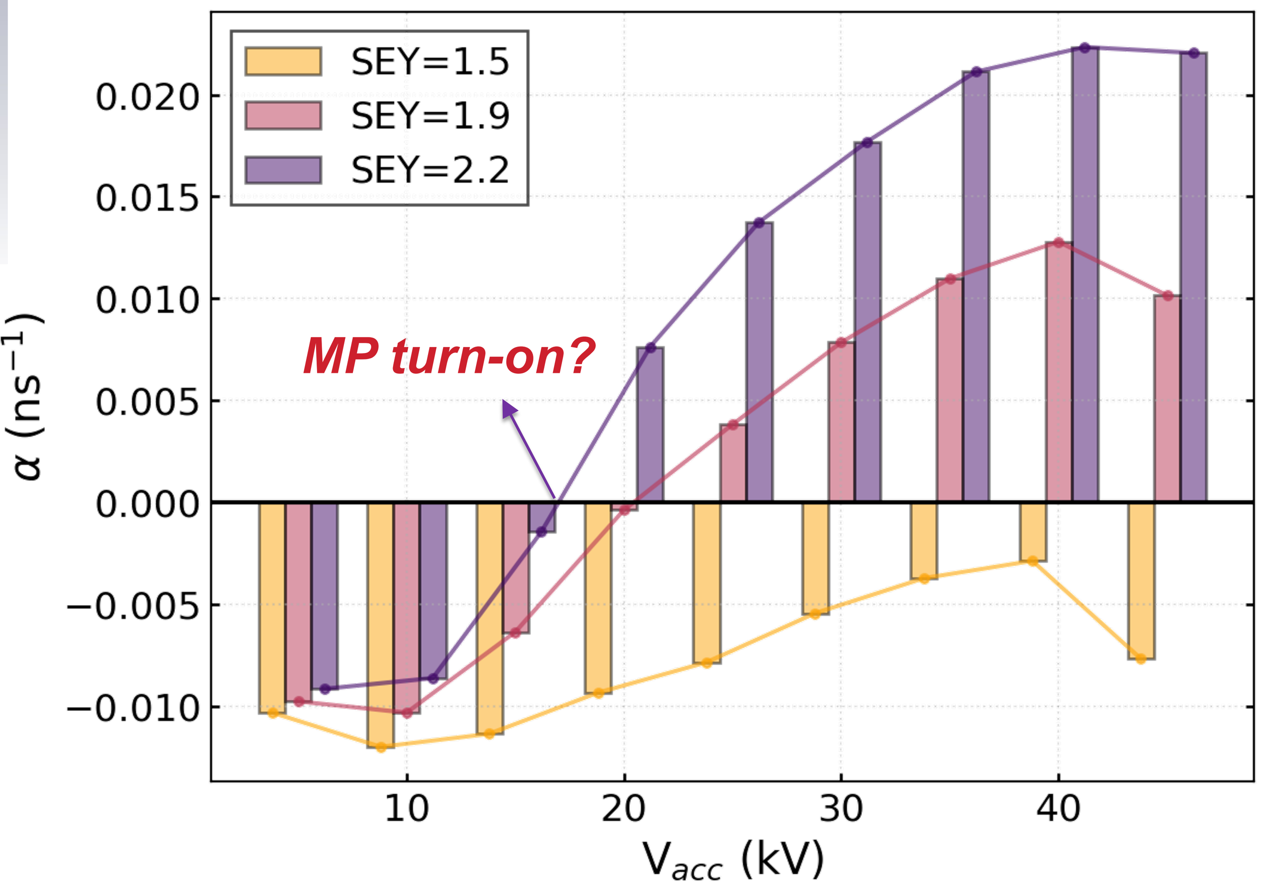
$$N_e(t) = N_0 e^{\alpha t}$$

where,

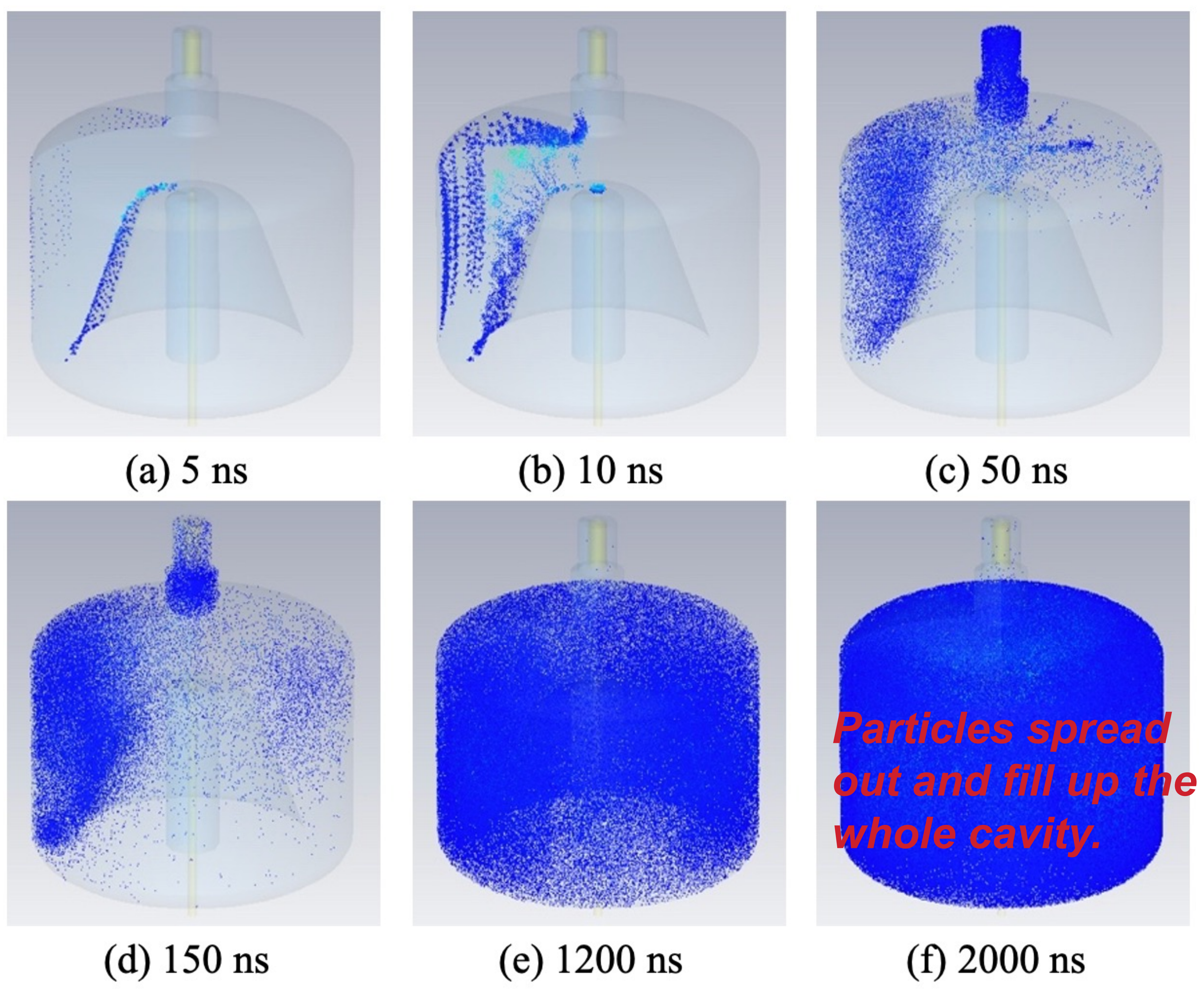
N_e - total number of particles
N_0 - primary number of particles
α - growth rate



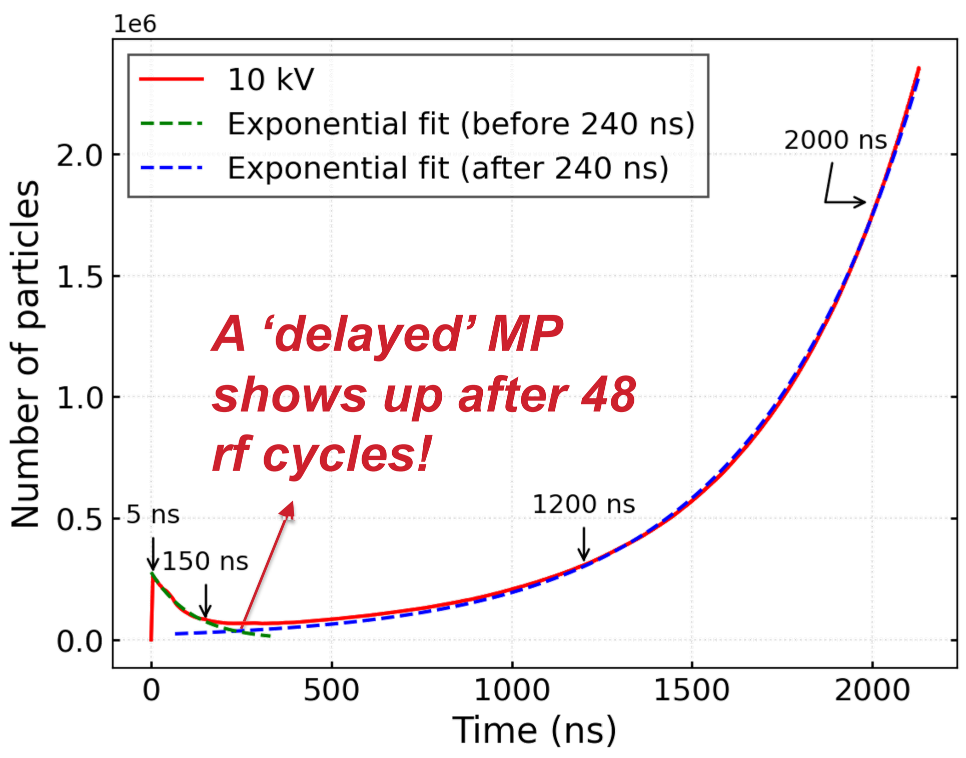
- Cavity may have a high SEY.



PARTICLE EVOLUTION



(a) 5 ns (b) 10 ns (c) 50 ns (d) 150 ns (e) 1200 ns (f) 2000 ns



- A 'delayed' MP behavior shows up after extending the running time.
- Lower MP turn-on voltage is found (<10 kV). In good agreement with the experimental results!

ACKNOWLEDGEMENT

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REFERENCES

[1] CST Studio Suite, version 2020, https://www.cst.com.