

Saturation Dynamics, Output Power Optimisation, Fine Spectrum and Chirp Control in a CW FEL Oscillator

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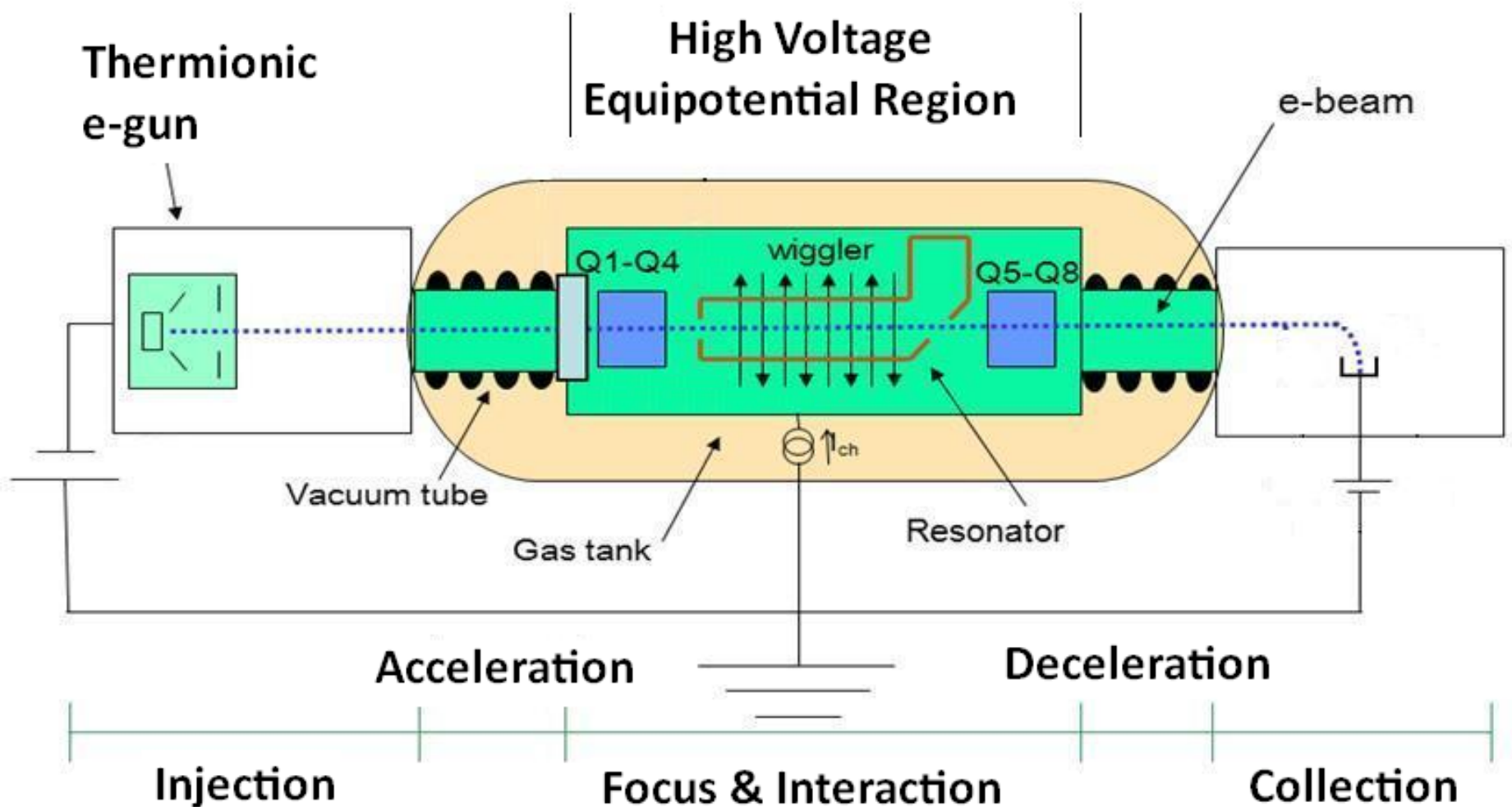


The Electrostatic Accelerator FEL

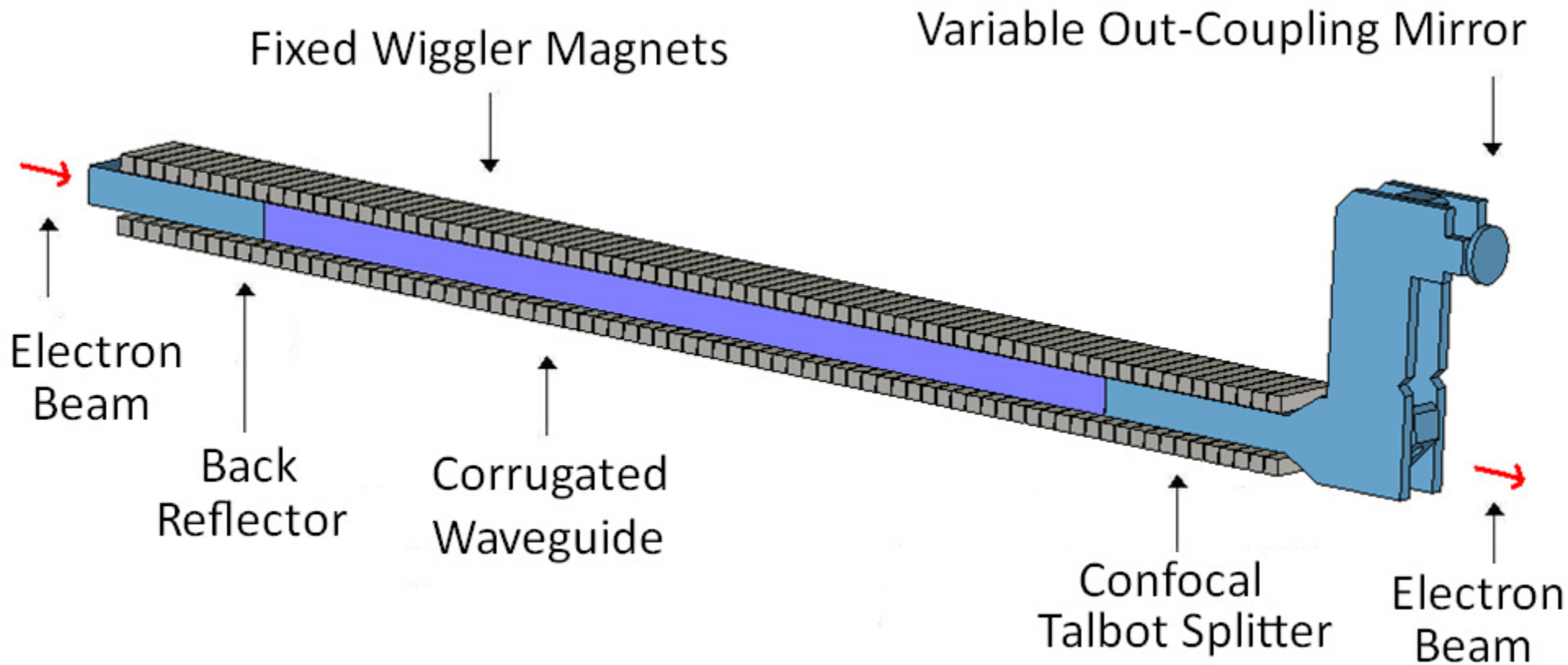


Schematic of the EA-FEL

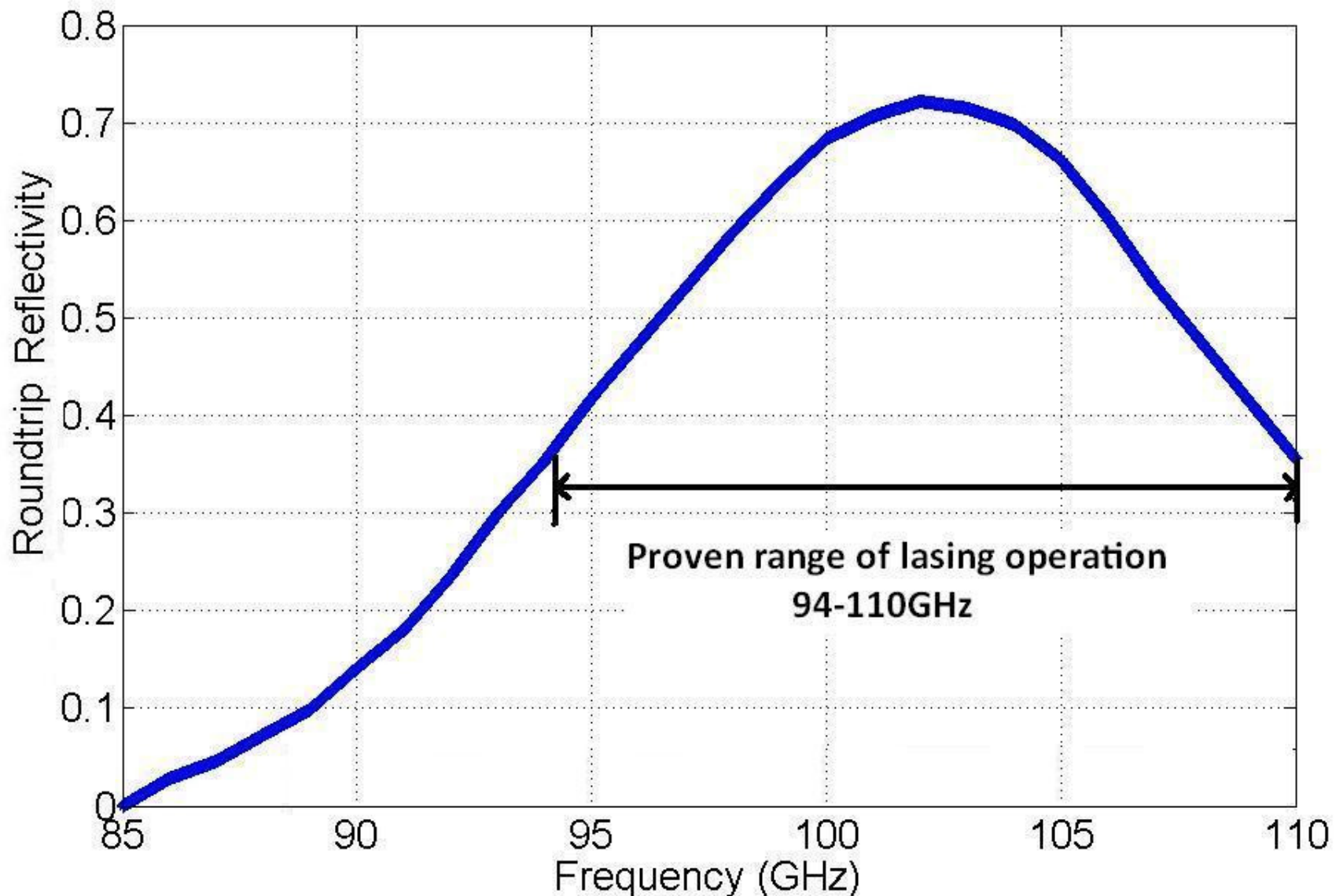
- Typical beam energies and currents 1.35-1.45 MeV, and 0.5-3 A depending upon frequency and power required.



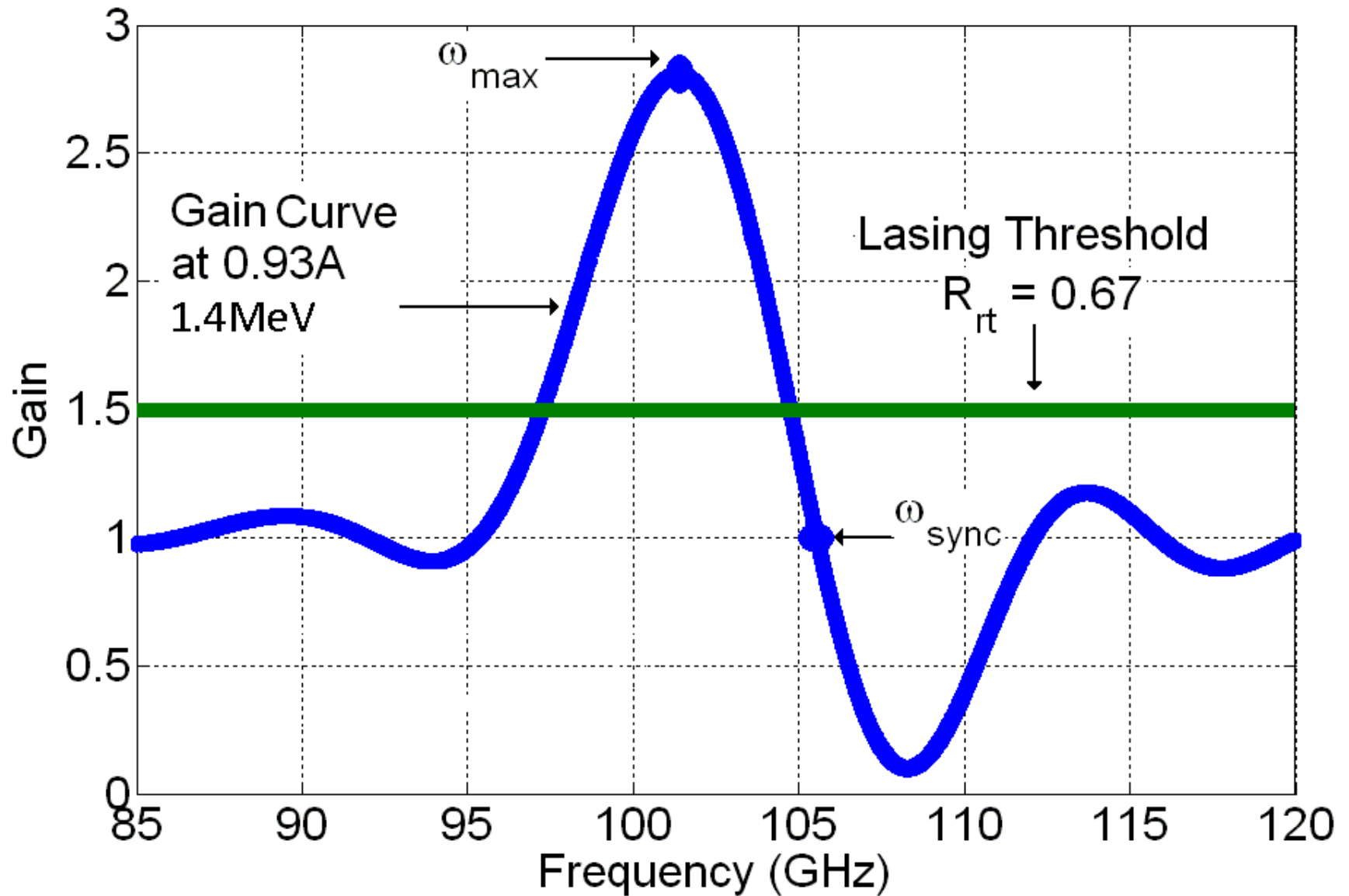
Corrugated Waveguide Confocal-Talbot Resonator



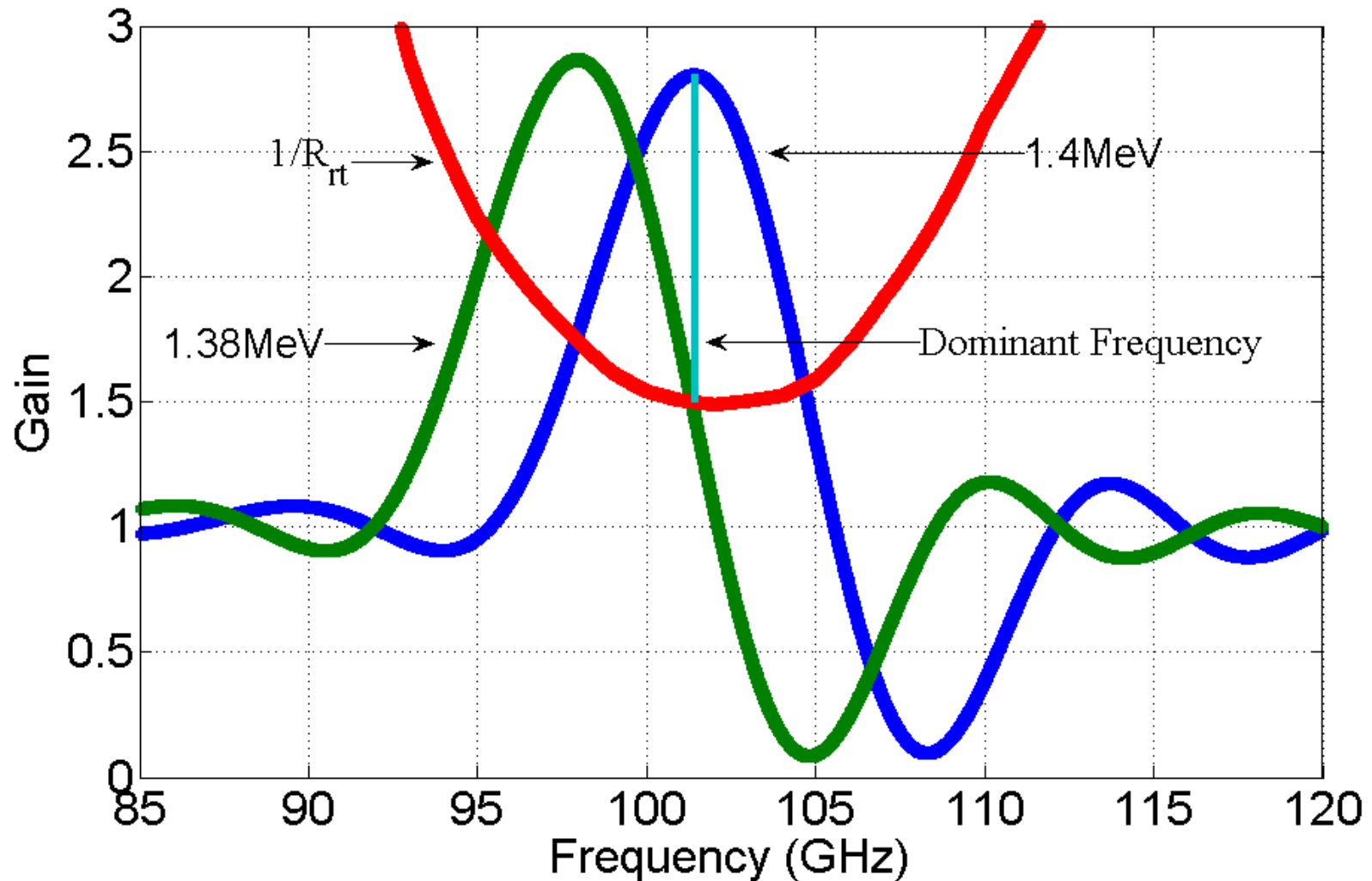
Round-trip reflectivity of the resonator as a function of the frequency:



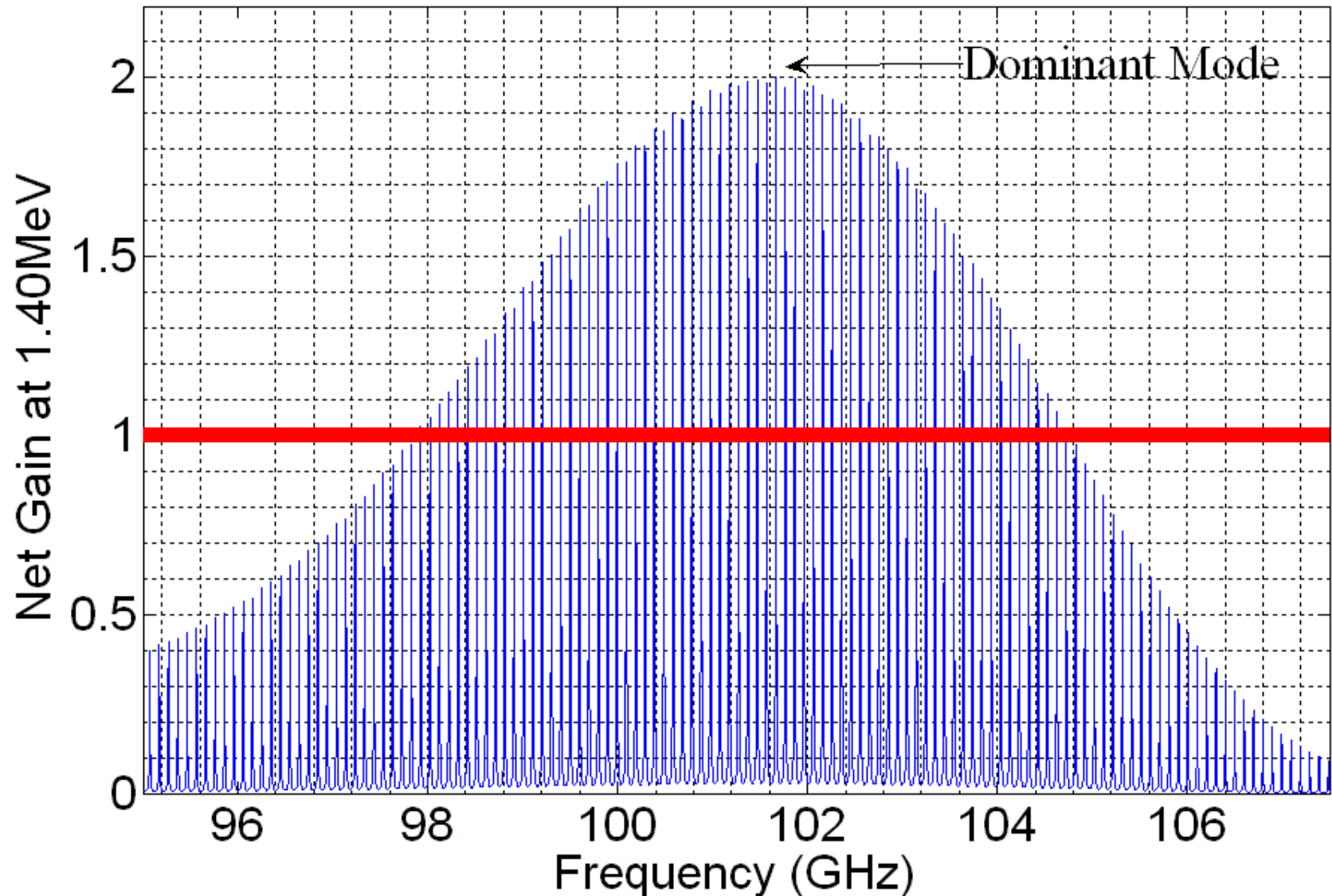
$$\text{Lasing when Gain} \geq \frac{1}{\text{Roundtrip Reflectivity}}$$



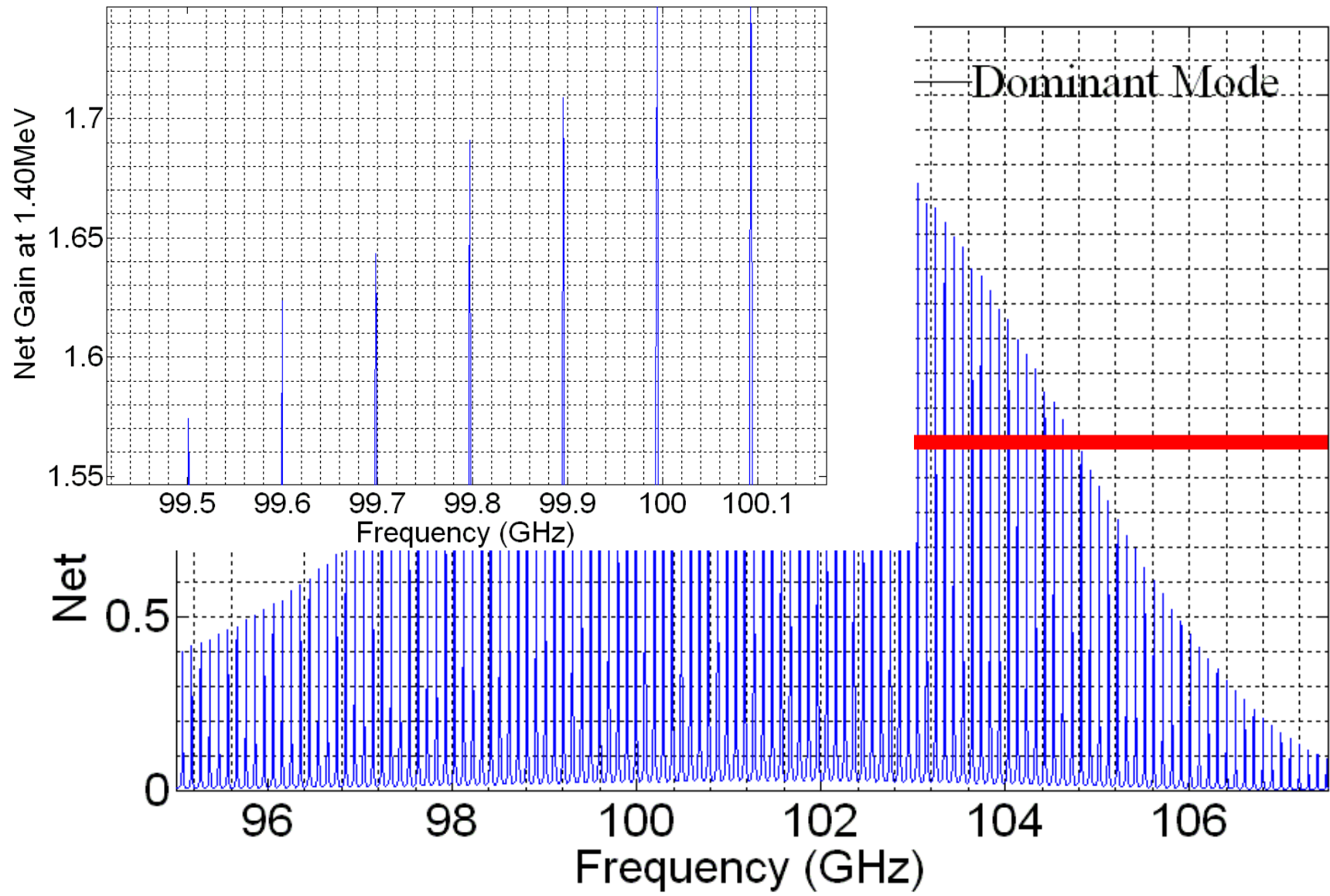
Small signal gain curves for single pass of a 0.93A beam through the waveguide.



Including roundtrip losses as a function of frequency the net small signal gain curve at 1.4MeV becomes:



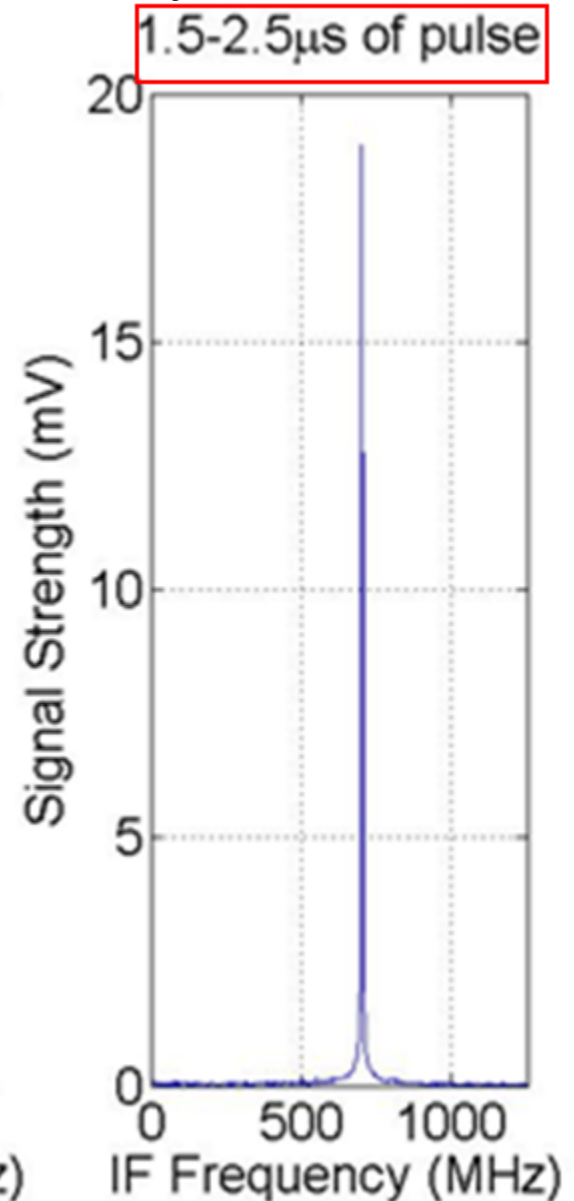
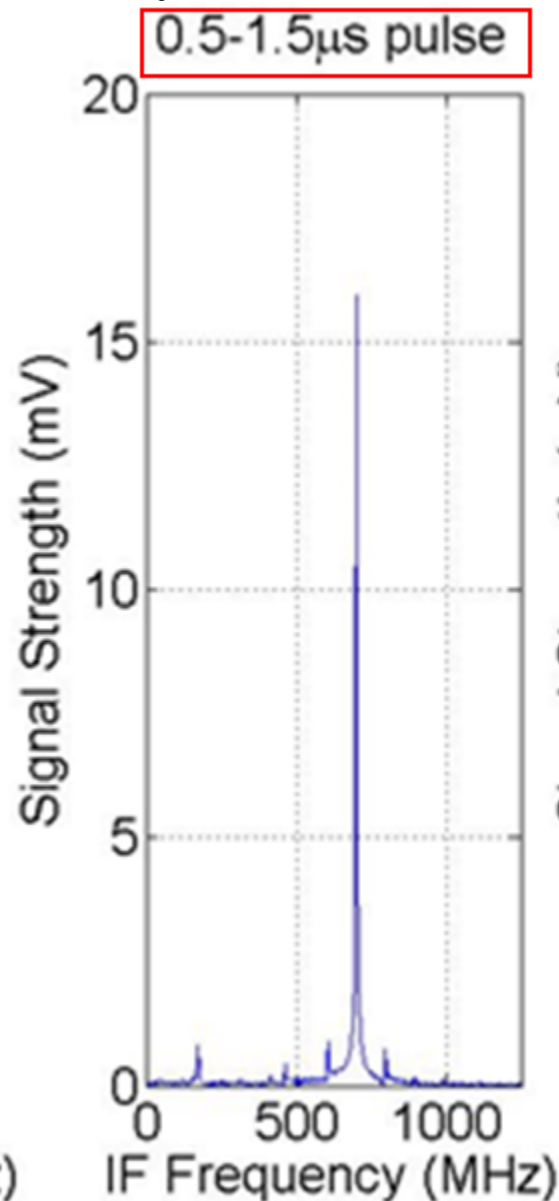
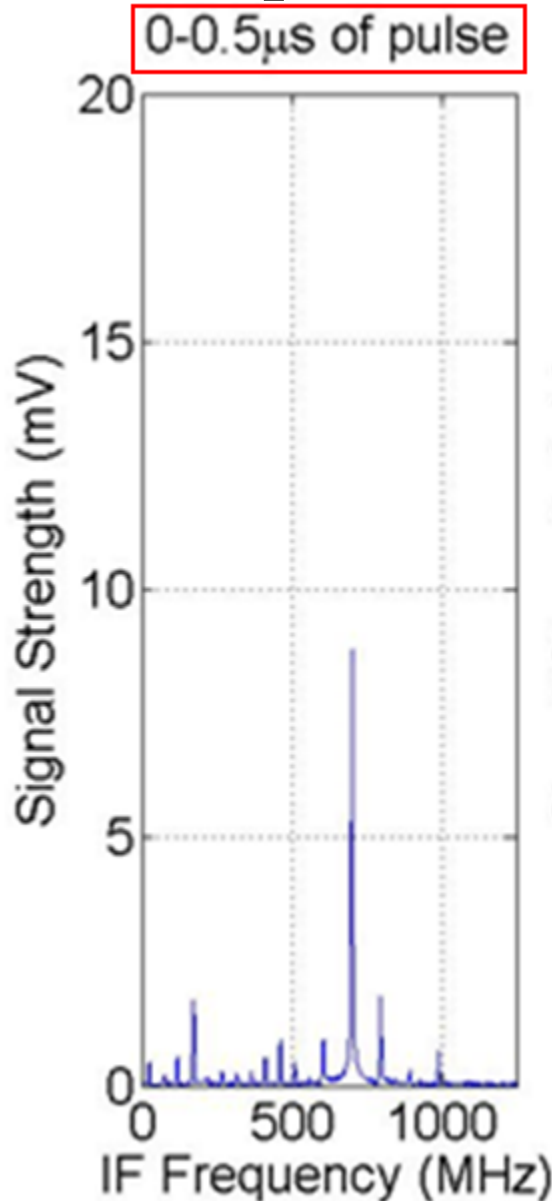
Including roundtrip losses as a function of frequency the net small signal gain curve at 1.4MeV becomes:



Mode Competition:

Roundtrip Reflectivity: 0.32%

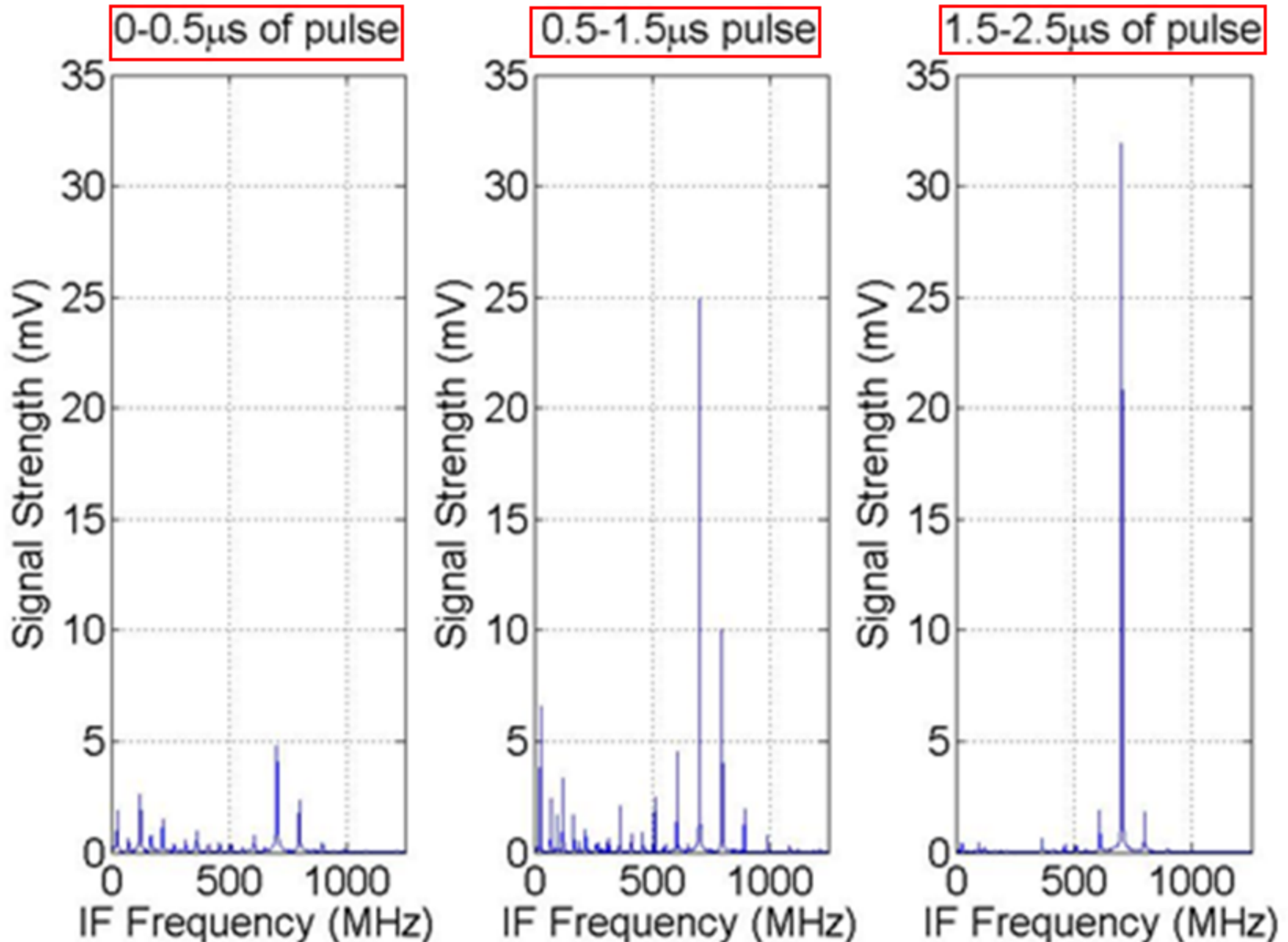
f_{LO} : 95.7GHz



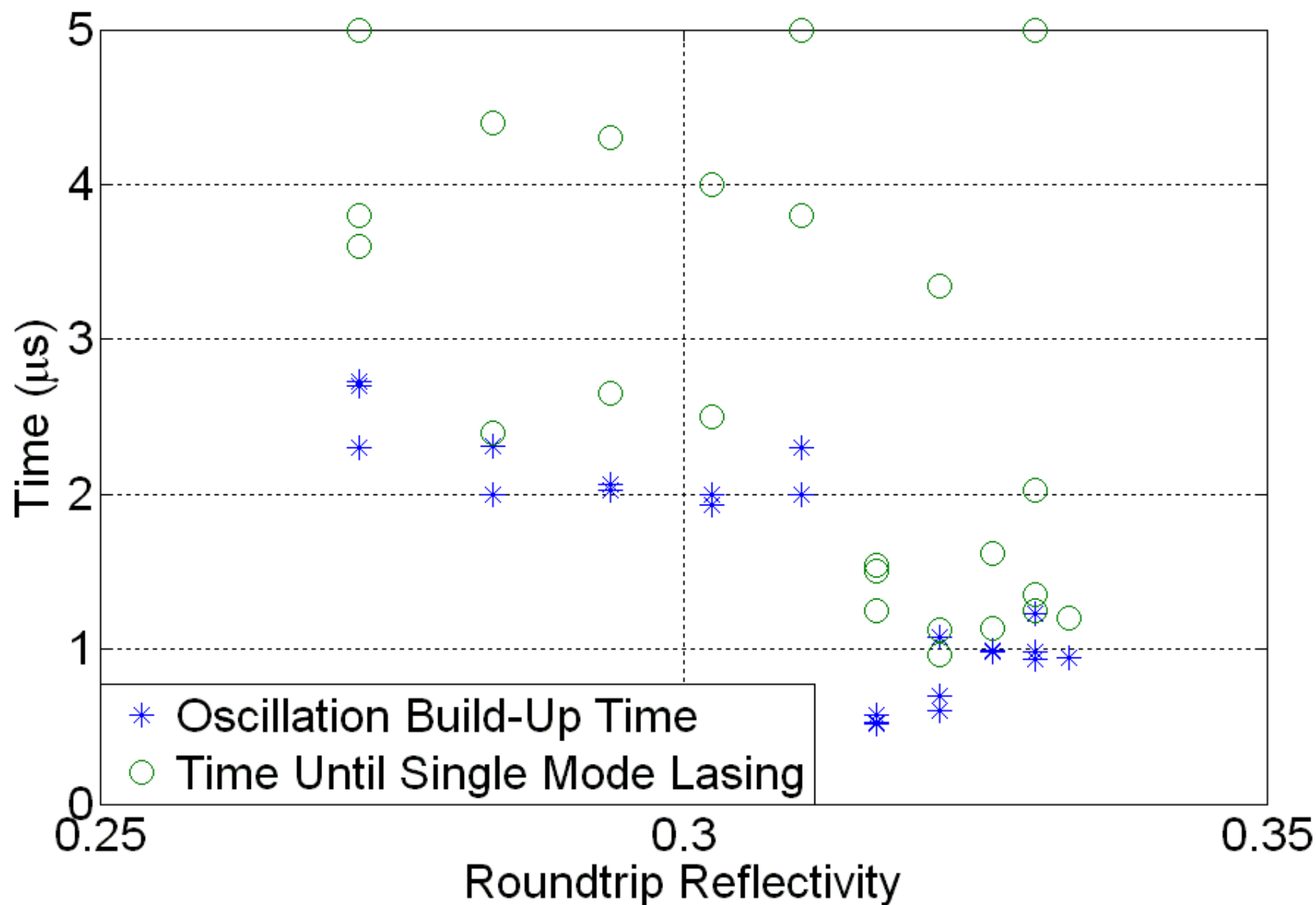
Mode Competition:

Roundtrip Reflectivity: 0.29%

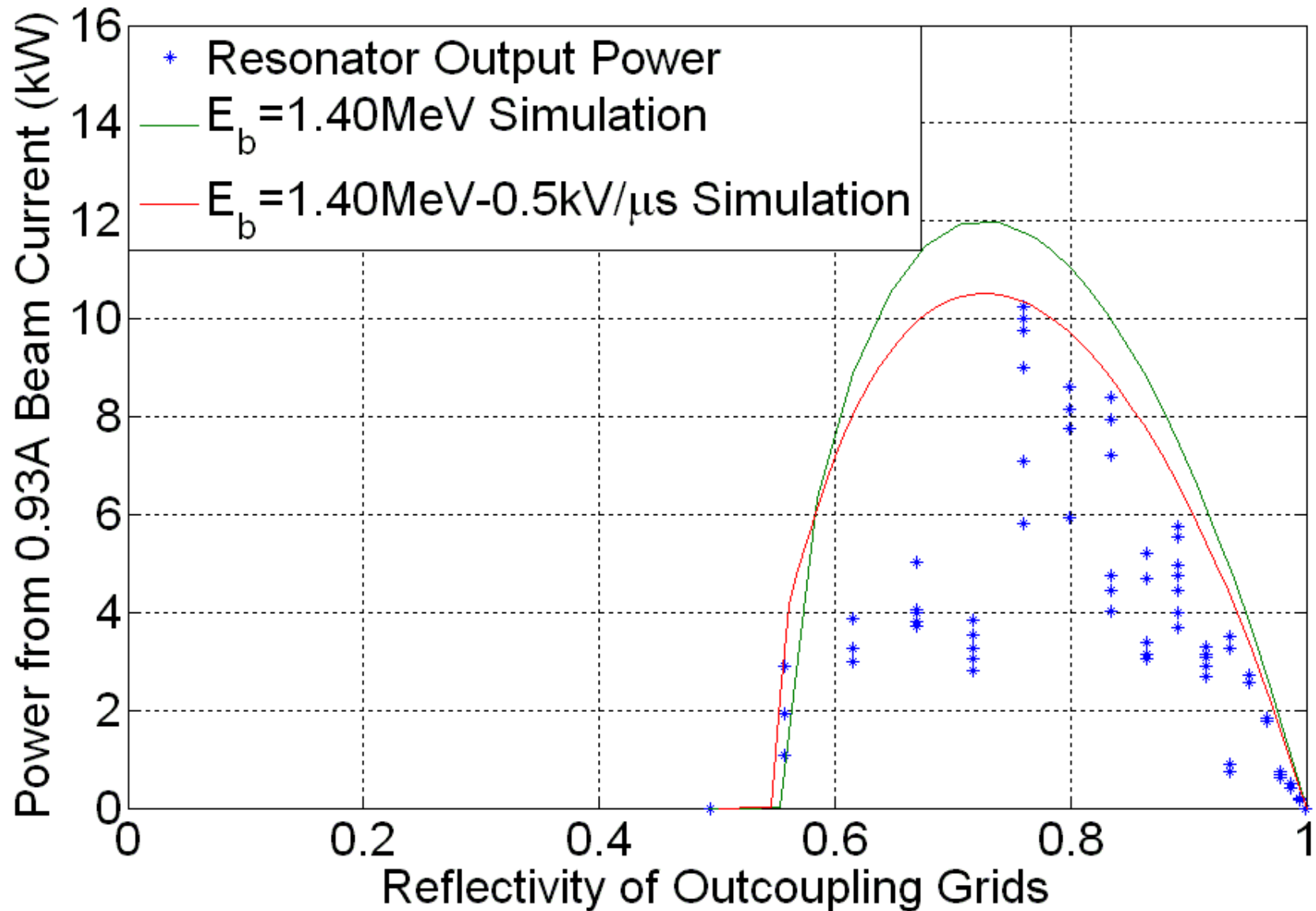
f_{Lo} : 95.7GHz



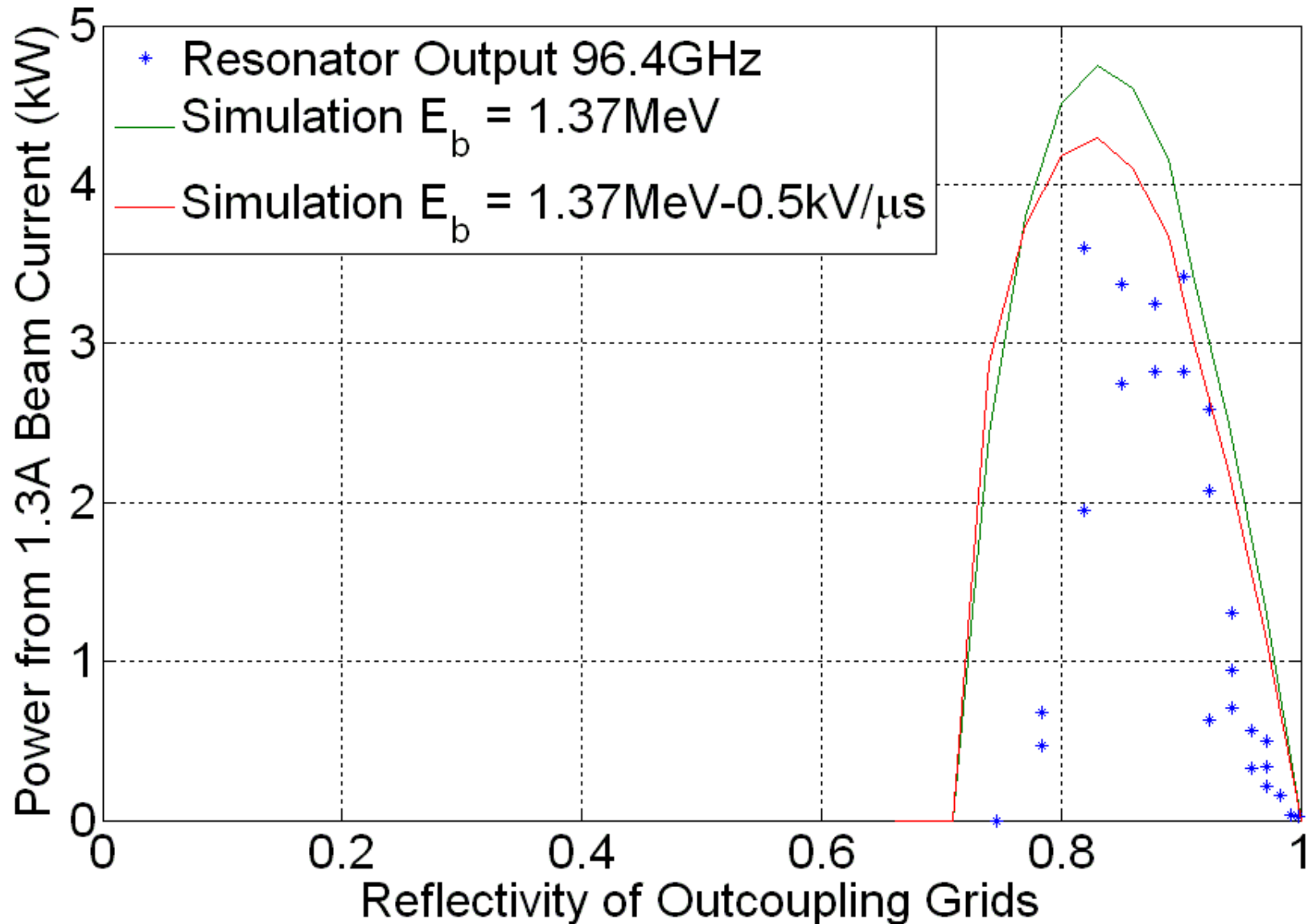
Laser Oscillation Build-Up Time



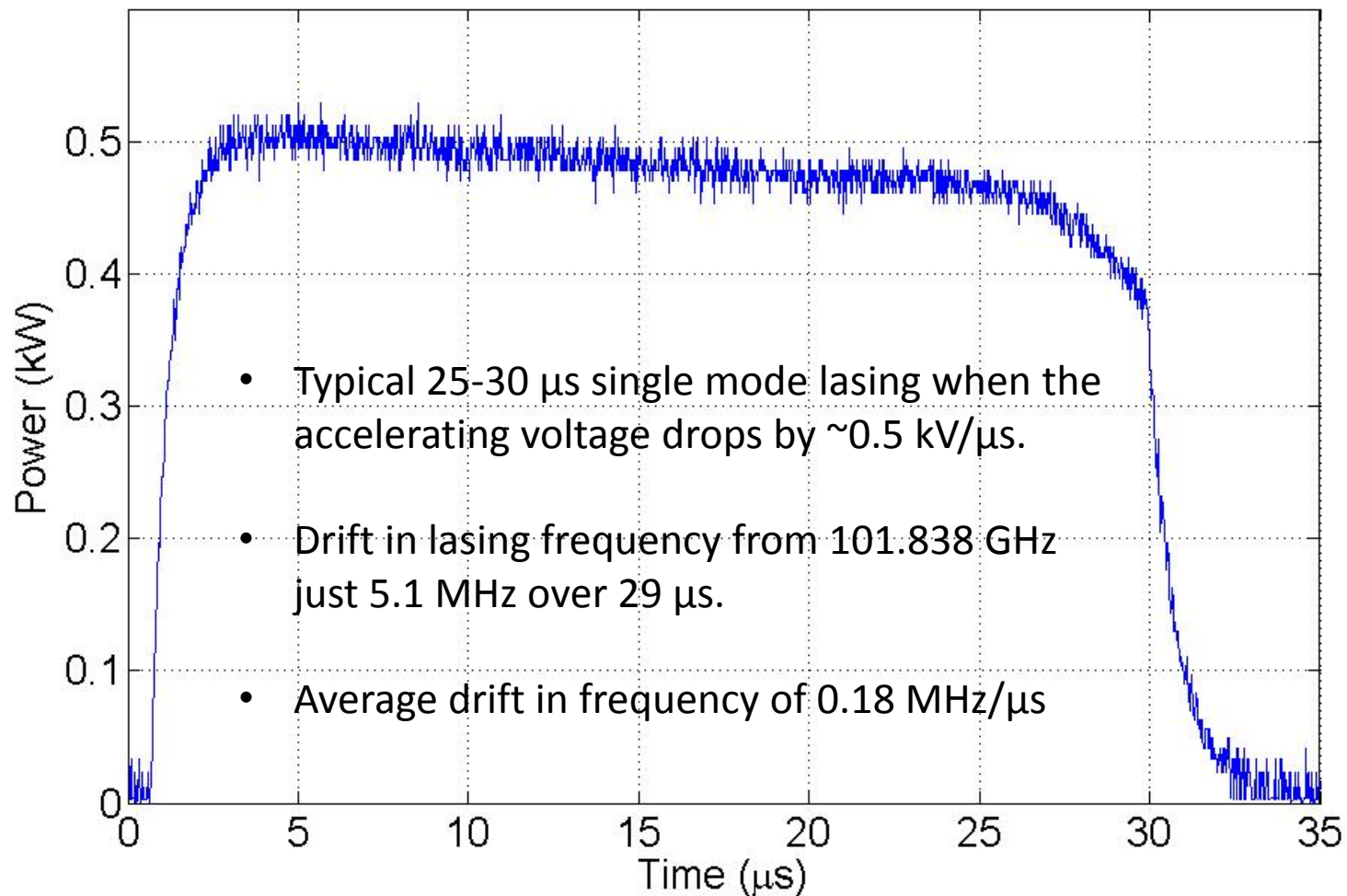
Power Out-Coupling Maximisation



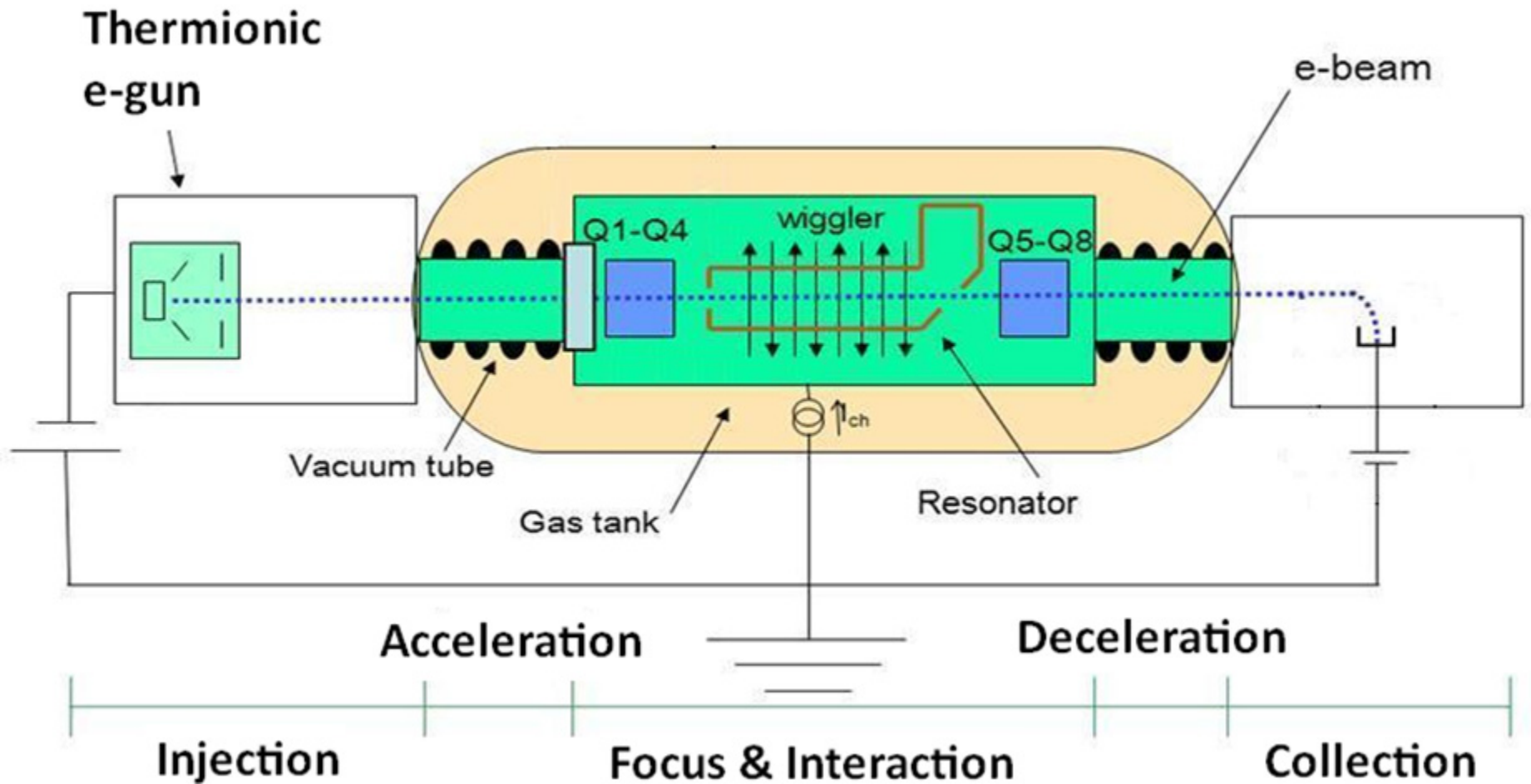
Power Out-Coupling Maximisation



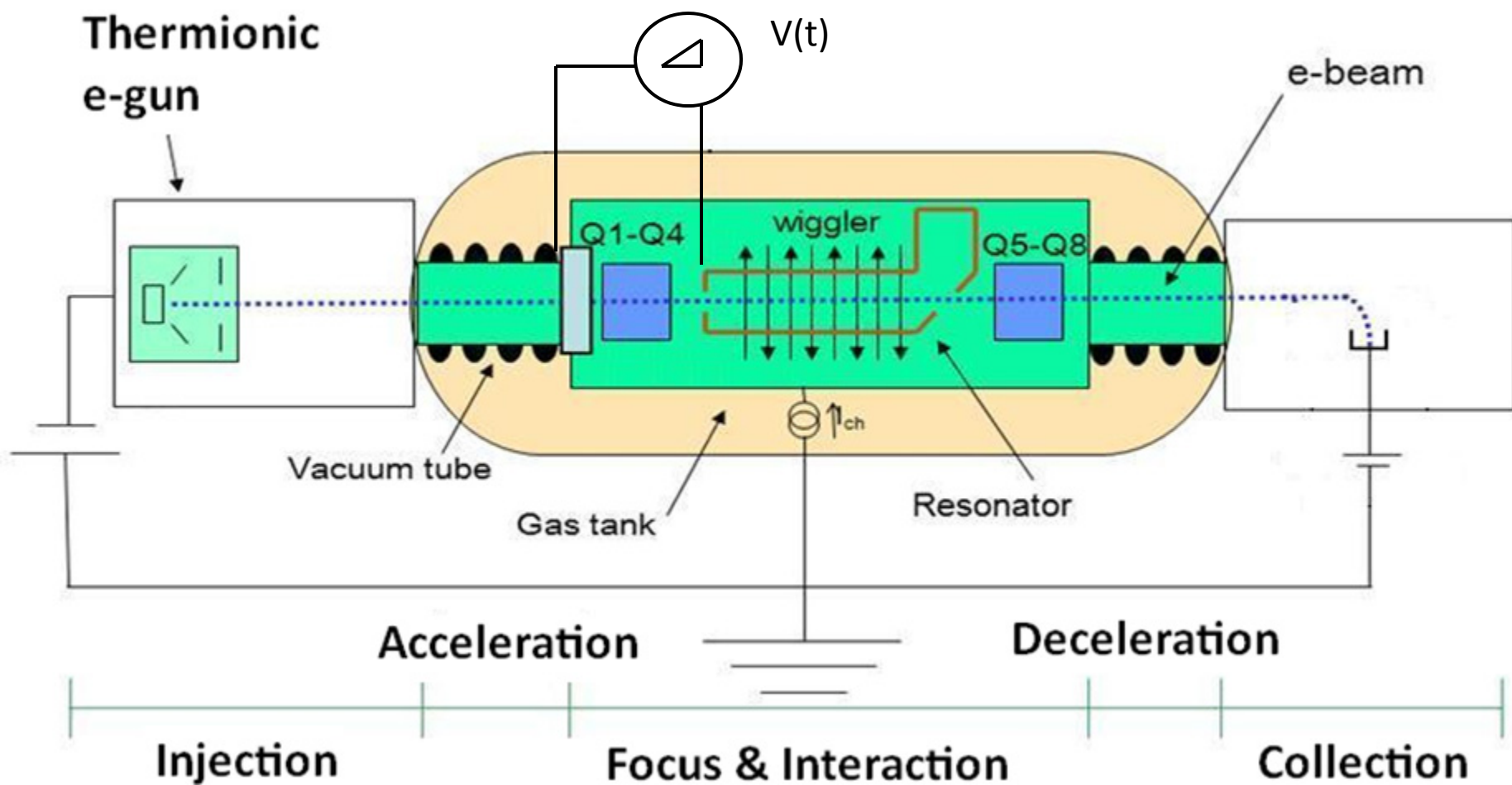
Sample long pulse measured in the user room:



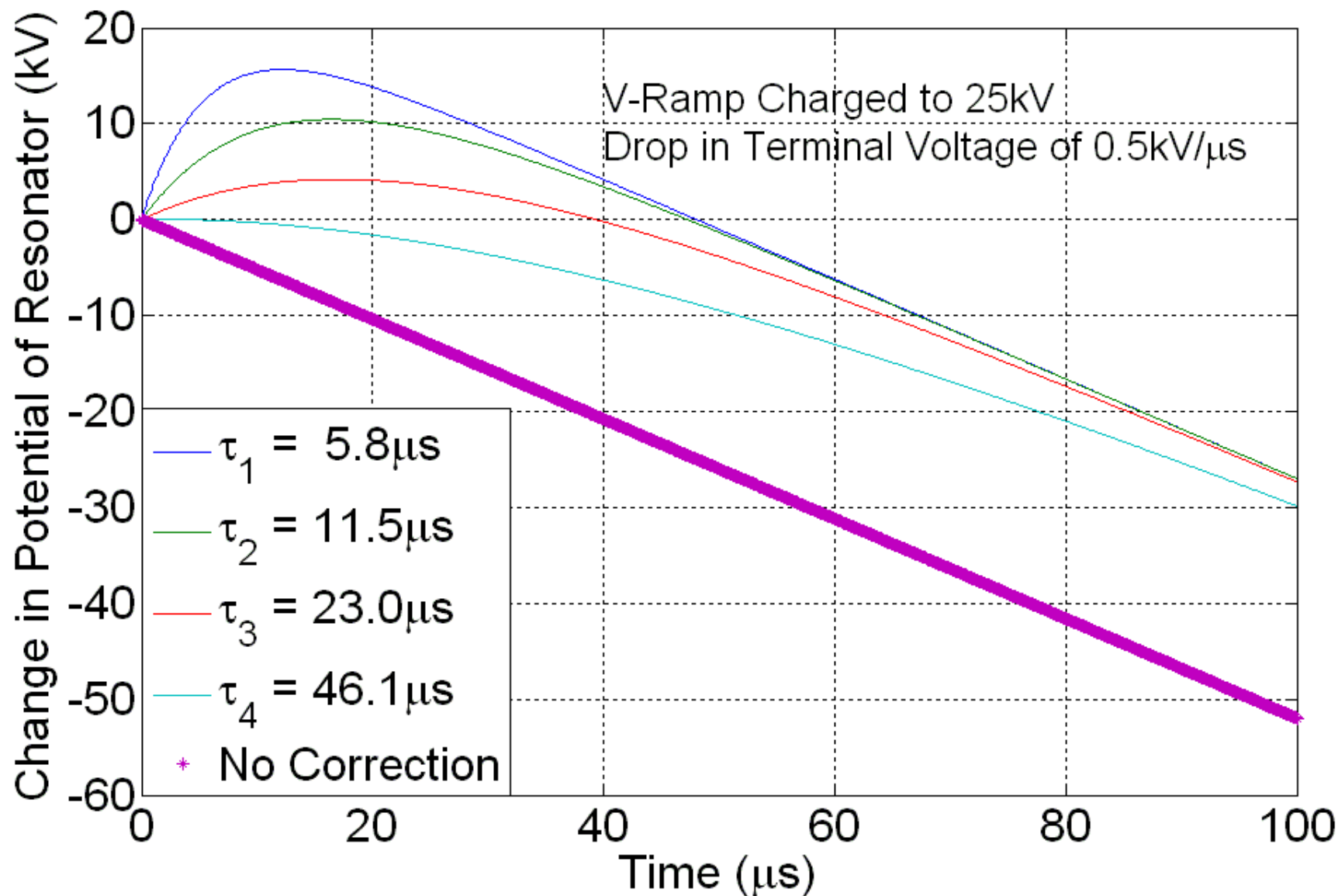
Voltage-Ramping



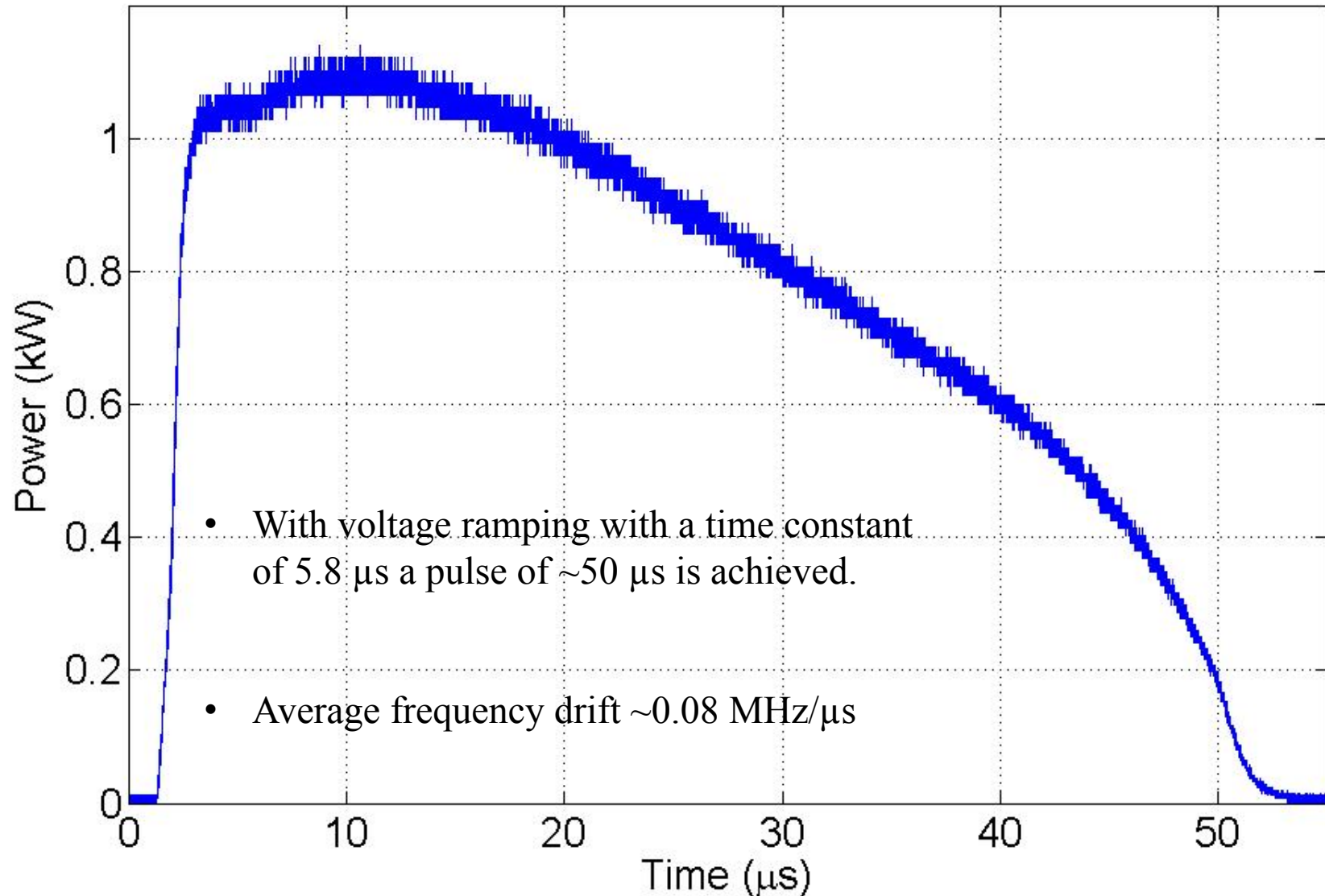
Voltage-Ramping



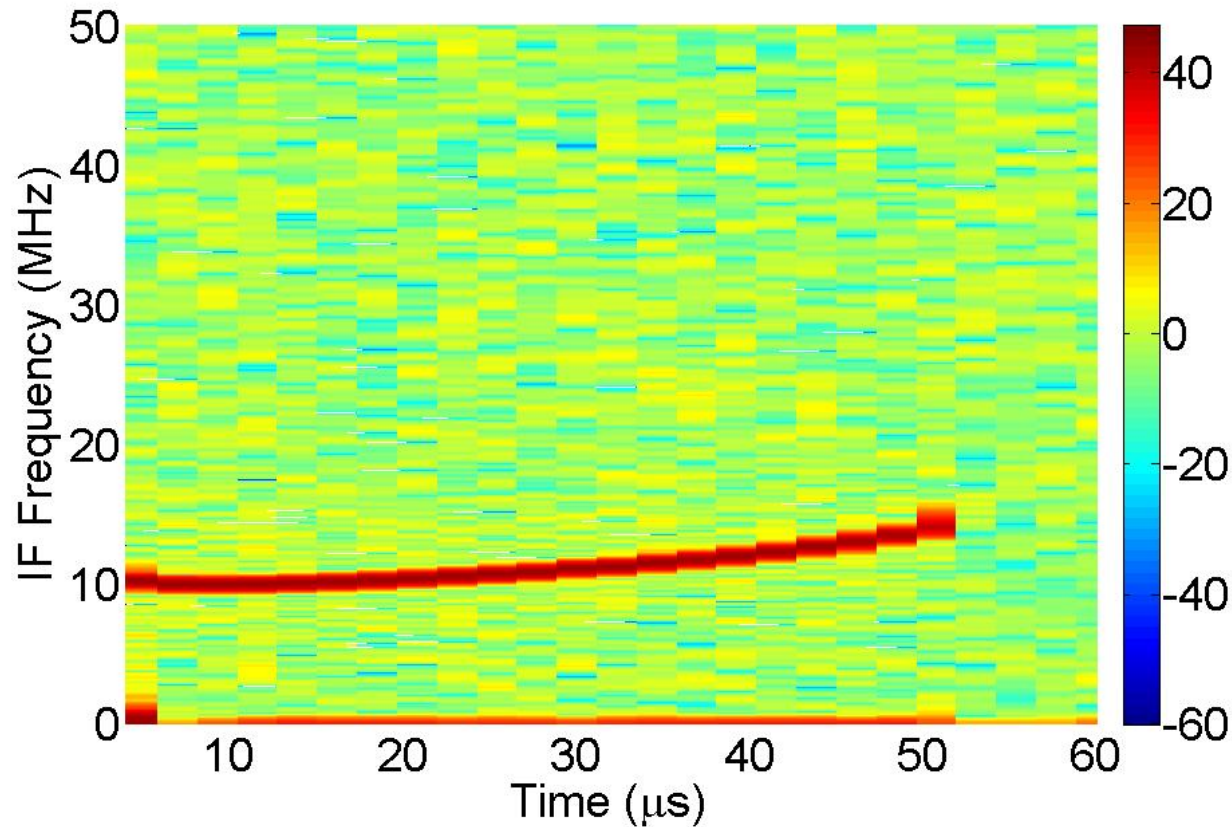
Voltage Correction and Control:



Power of long pulse with ramp compensation:

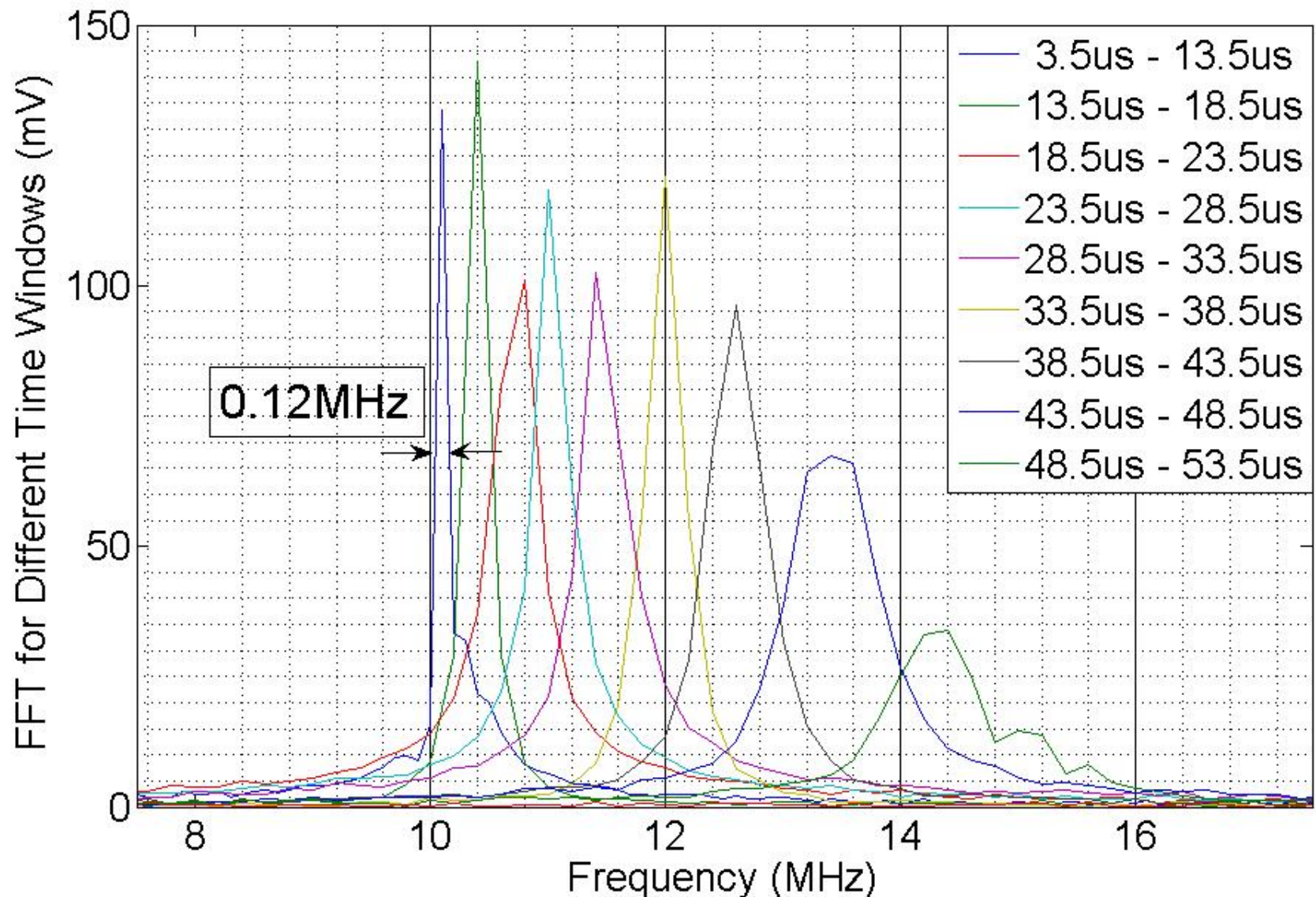


Frequency chirp during a long lasing pulse: (Frequency Pulling)

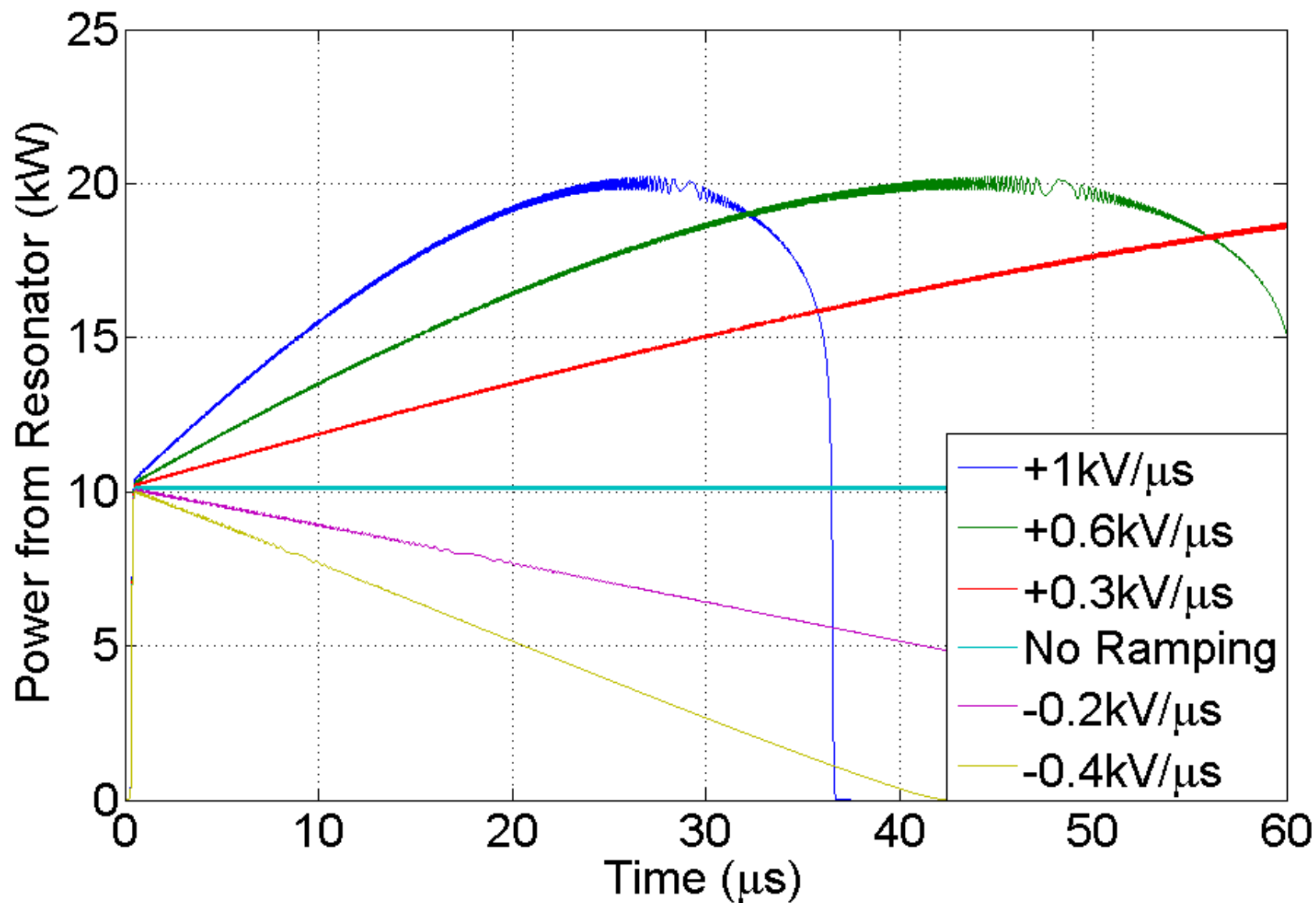


- The IF signal decreases due to the positive voltage ramping, showing a small increase in the lasing frequency before falling.
- From 3.5-13.5 μs the drift in frequency is just 12.4 KHz/ μs

Line width and frequency chirp during lasing with a changing beam energy:



Power output enhancement via voltage ramping: (simulation with the FEL3D code)



- Thank you for your attention!