Resistive wall impedance and wake

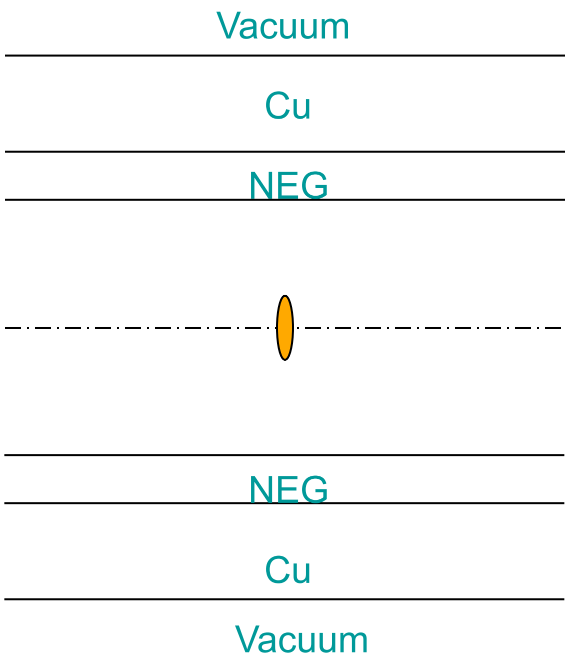
2016-5-13

WANG Na

Contents

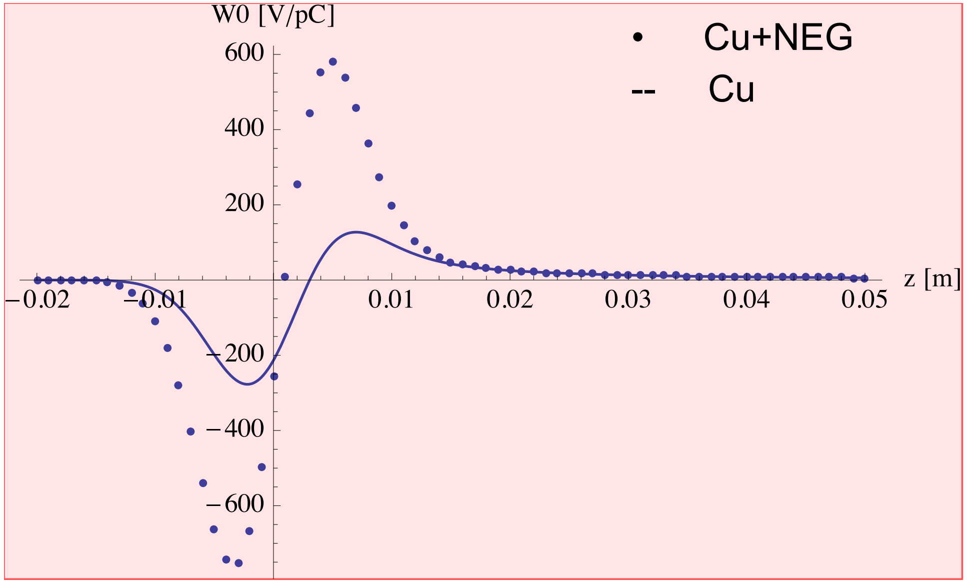
- Longitudinal impedance and wake contribution from NEG coating.
- Transverse wake potential of a Gaussian bunch.
- Transverse impedance and wake contribution from NEG coating.

Layers	Thickness, mm	Conductivity, S/m	ε_r	μ_r
Cu	1	5.9×10^7	1	1
NEG	0.001	1.0×10^6	1	1
Vacuum	∞	0	1	1



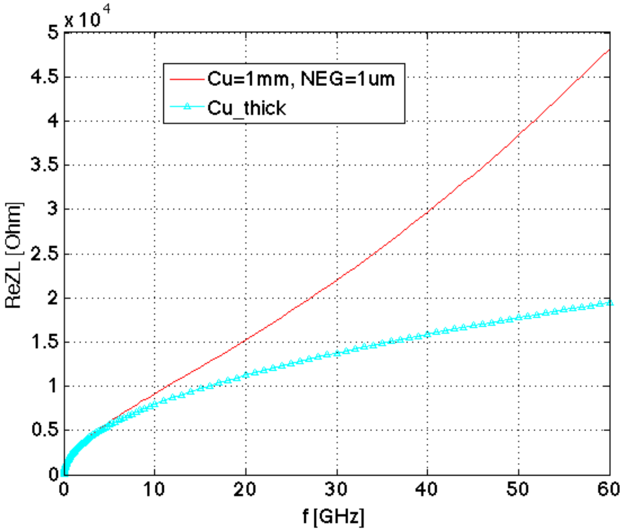
Longitudinal impedance and wake contribution from NEG coating

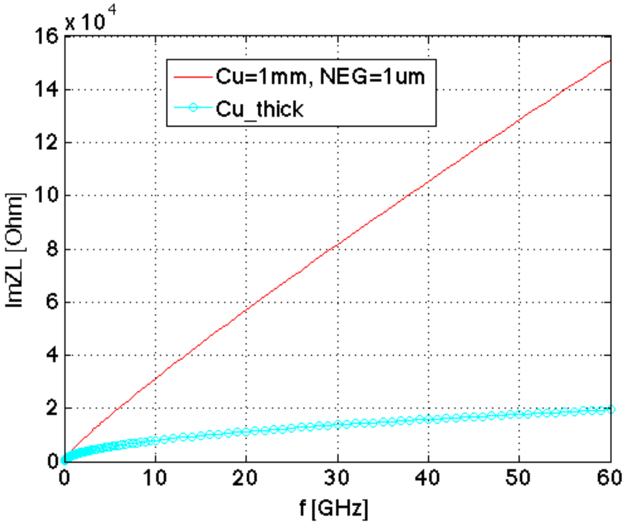
- Longitudinal wake



σ_z=4mm

- Longitudinal impedance





Compute transverse bunch wake from impedance

$$W_{\perp} = \frac{-i}{2\pi}\int_{-\infty}^{\infty} d\omega e^{i\omega z/c} Z_{\perp}(\omega)$$

$$W_{\perp\lambda}(\tau) = \int_{-\infty}^{\infty} dt \lambda(\tau - t) W_{\perp}(t)$$

$$\Downarrow$$

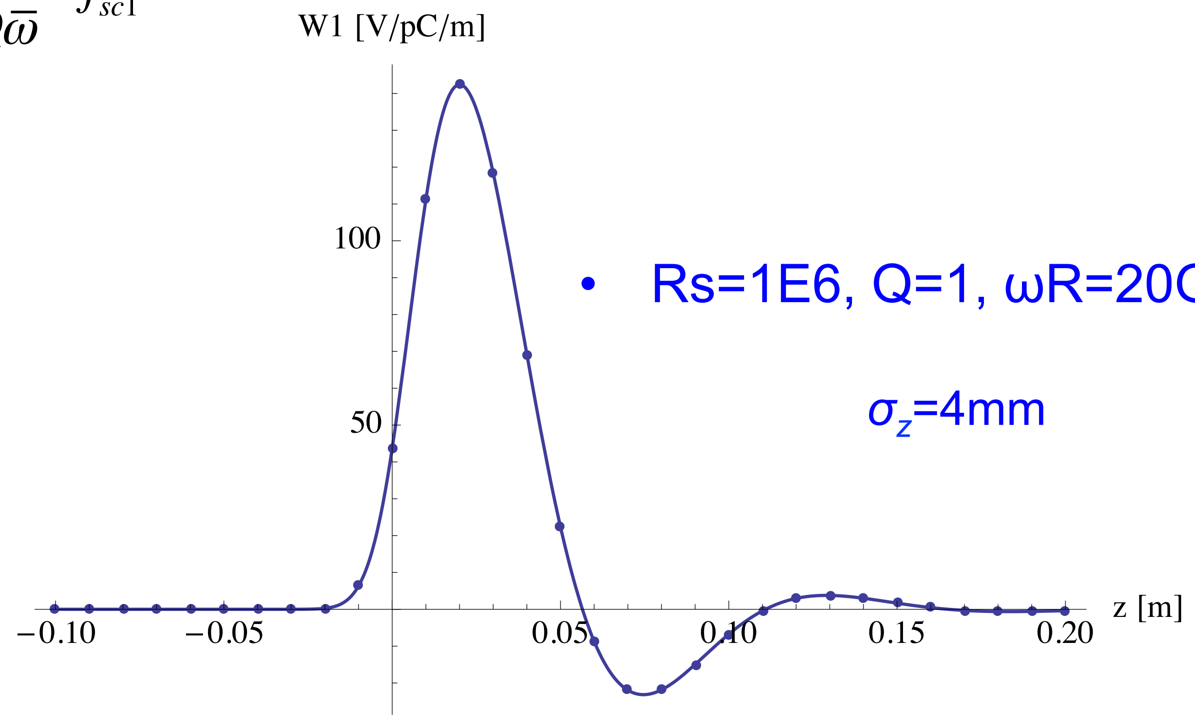
$$W_{\perp\lambda}(\tau) = \int_{-\infty}^{\infty} dt \lambda(\tau - t) \frac{-i}{2\pi}\int_{-\infty}^{\infty} d\omega e^{i\omega t} Z_{\perp}(\omega)$$

Cross check with High Order modes

$$Z_{\perp} = \frac{c}{\omega} \frac{R_s}{1 + iQ\left(\frac{\omega_R}{\omega} - \frac{\omega}{\omega_R}\right)}$$

$$f_{sc1} = \frac{1}{2} e^{-\frac{\sigma_z^2}{2}(k_r^2 - \alpha_r^2) - \alpha_r \sigma_z x} \operatorname{Im}(e^{ik_r \sigma_z (x - \alpha_r \sigma_z)}(1 + Erf(\frac{(ik_r - \alpha_r)\sigma_z + x}{\sqrt{2}}))) |_{x = s/\sigma_z}$$

$$W_{\perp}(z) = \frac{cR_s \omega_R}{Q\overline{\omega}} f_{sc1}$$

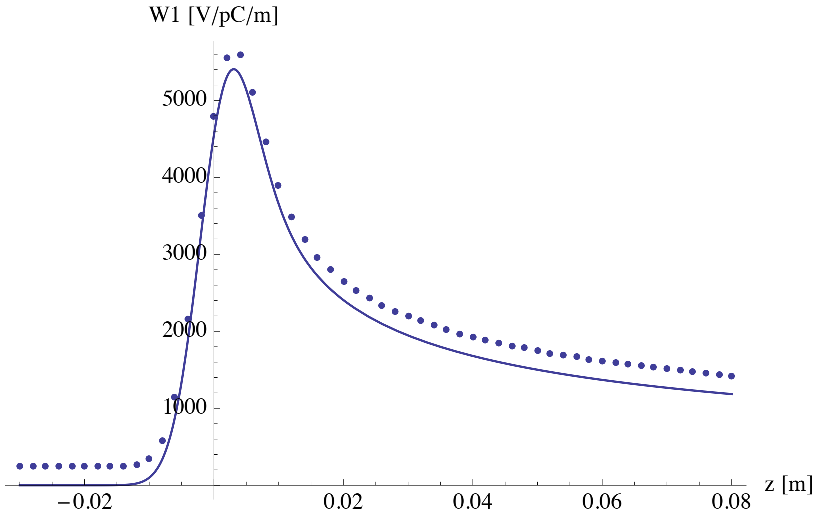


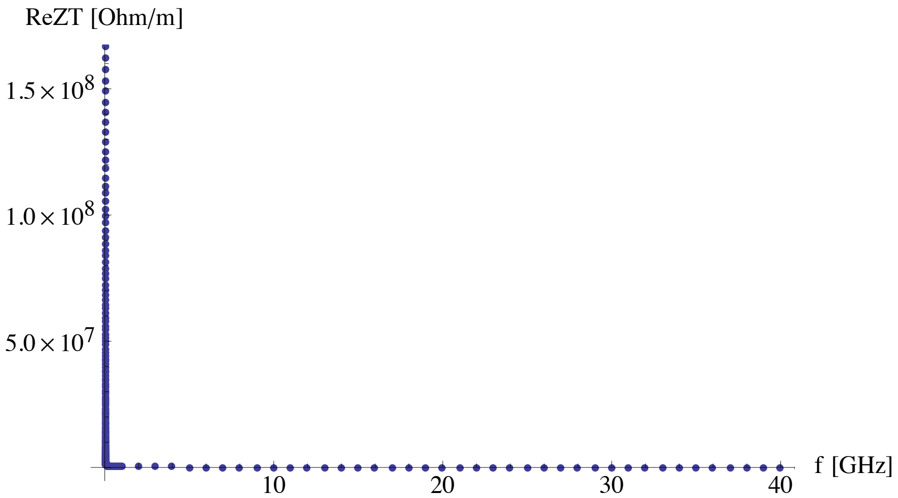
Cross check with Single layer thick wall

$$Z_{\perp} = \frac{c_0}{\omega}\frac{L}{\pi b_0^3}\sqrt{\frac{Z_0}{2\sigma_c c_0}}(1+sign(\omega)i)\sqrt{|\omega|}$$

$$W_{\perp} = \frac{c_0 L}{2\sqrt{2}\pi b_0^3}\frac{1}{\sigma_z^{0.5}}\sqrt{\frac{Z_0}{\sigma_c}}f_{sc}$$

$$f_{sc} = \sqrt{|x|}e^{-y}(I_{-1/4}(y) \pm I_{1/4}(y))|_{y=(s/\sigma_z)^2/4, x=s/\sigma_z}$$





Transverse wake (σ_z=4mm)

Solid line: wake potential formula

Dots: transformation from impedance spectrum (df=0.5MHz)

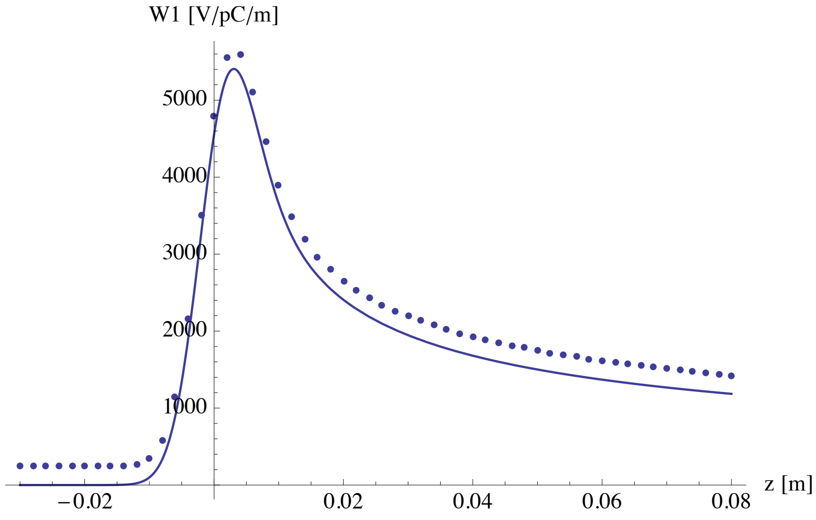
Beam spectrum goes to 40GHz

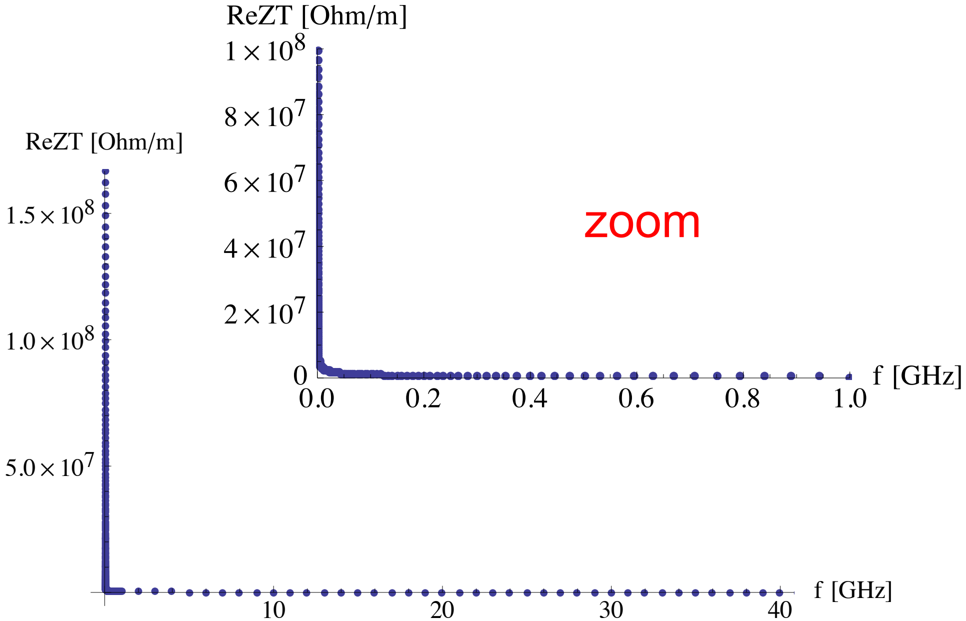
Cross check with Single layer thick wall

$$Z_\perp = \frac{c_0}{\omega}\frac{L}{\pi b_0^3}\sqrt{\frac{Z_0}{2\sigma_c c_0}}(1+sign(\omega)i)\sqrt{|\omega|}$$

$$W_\perp = \frac{c_0 L}{2\sqrt{2}\pi b_0^3}\frac{1}{\sigma_z^{0.5}}\sqrt{\frac{Z_0}{\sigma_c}}f_{sc}$$

$$f_{sc} = \sqrt{|x|}e^{-y}(I_{-1/4}(y) \pm I_{1/4}(y))|_{y=(s/\sigma_z)^2/4, x=s/\sigma_z}$$





Transverse wake (σ_z=4mm)

Solid line: wake potential formula

Dots: transformation from impedance spectrum (df=0.5MHz)

Beam spectrum goes to 40GHz

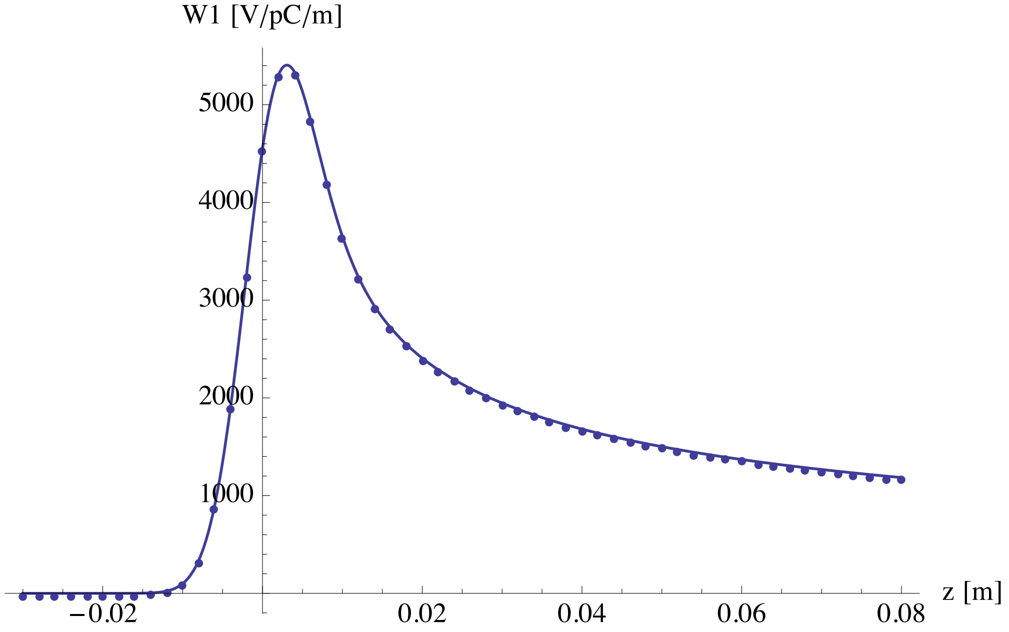
Redefinition of df

100Hz~10MHz: log increase

100 points per magnitude

10MHz~40GHz: linear increase

(df=10MHz)



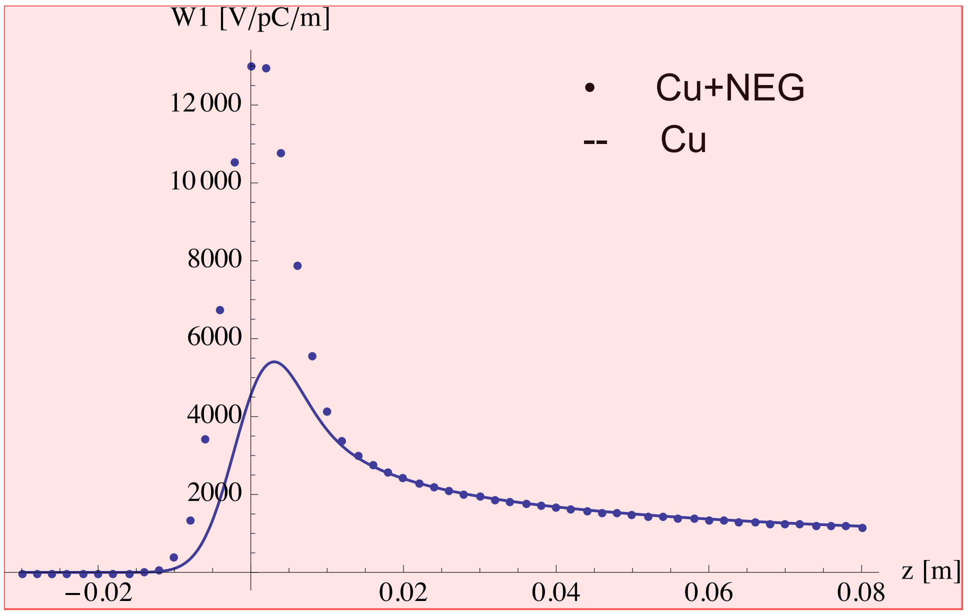
Transverse wake (σ_z=4mm)

Solid line: wake potential formula

Dots: transformation from impedance spectrum

Transverse impedance and wake contribution from NEG coating

- Transverse wake



σ_z=4mm

- Transverse impedance