Experiment proposal for AREAL

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CANDLE

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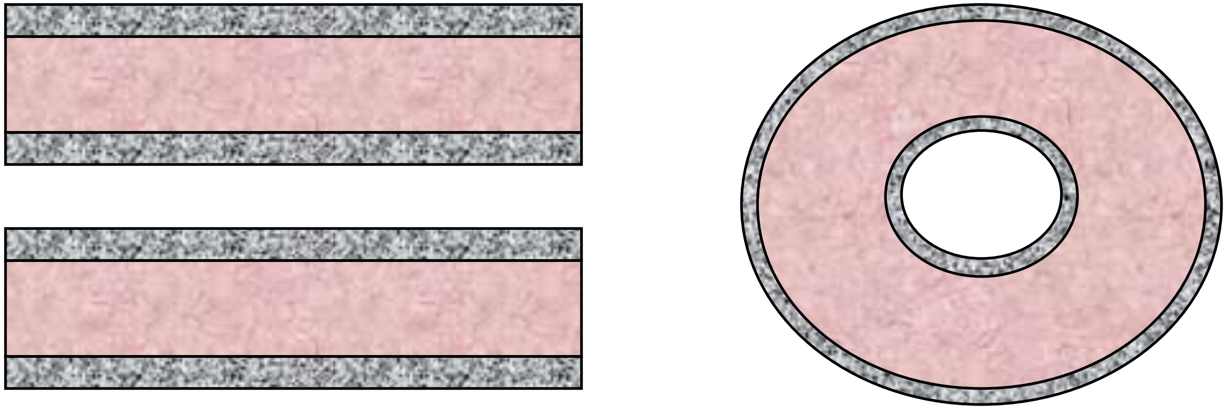
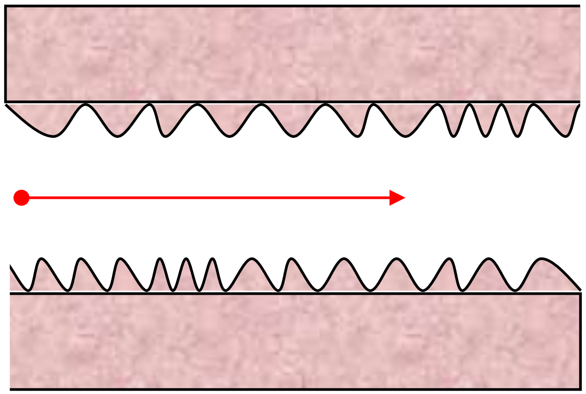
Introduction

1. Ceramic

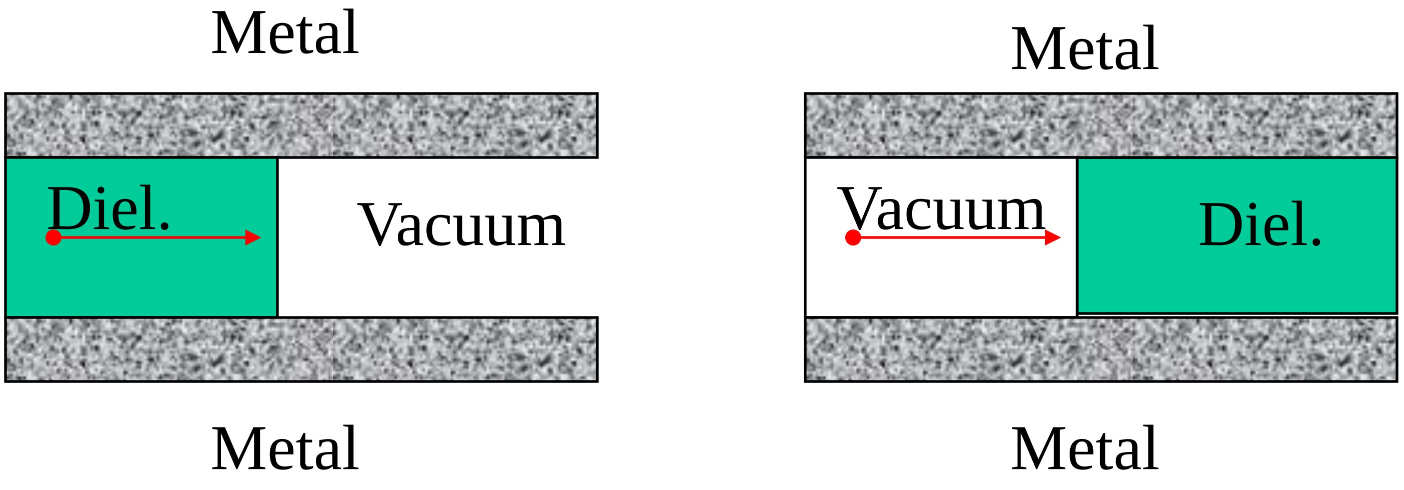
2. Metal+Ceramic+Metal



3. Corrugated inner surface

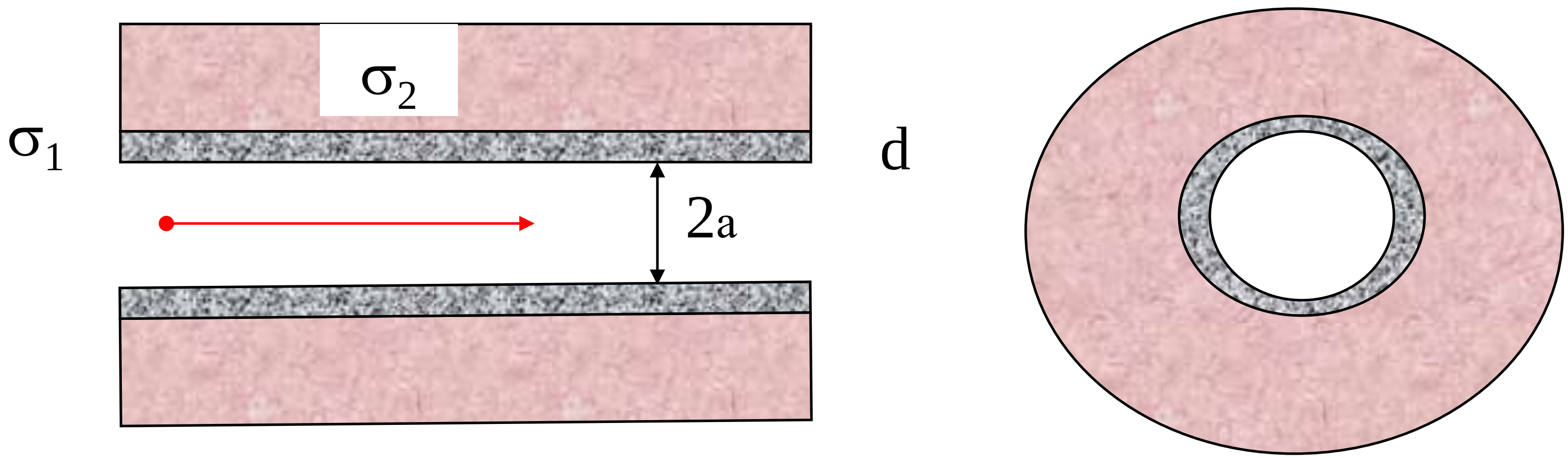


4. Transition radiation



Our suggestion:

Circular waveguide with bimetallic wall



Under conditions:

$\sigma_1 << \sigma_2$

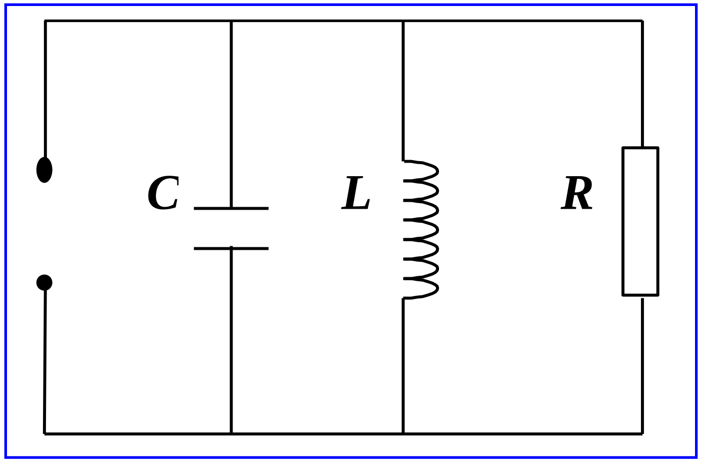
$d << a$

$$d << \frac{1}{\sqrt{k\sigma_1\mu_0}}$$

Ultrarelativistic limit

$$V \to c \qquad \sigma_2 \to \infty$$

Impedance of parallel resonant circuit with single mode resonance



$$Z_{\parallel}(\omega) = \frac{R}{1 + jQ\left(\omega_0/\omega - \omega/\omega_0\right)}$$

$$\omega_0 = 1/\sqrt{LC} = ck_0 = c\sqrt{2/ad}$$

$$Q = \omega_0/\alpha$$

$$\alpha = \frac{2c}{\sqrt{3}a}\left(\xi + \xi^{-1}\right) \qquad \xi = d_1\sigma_1 Z_0/\sqrt{3}$$

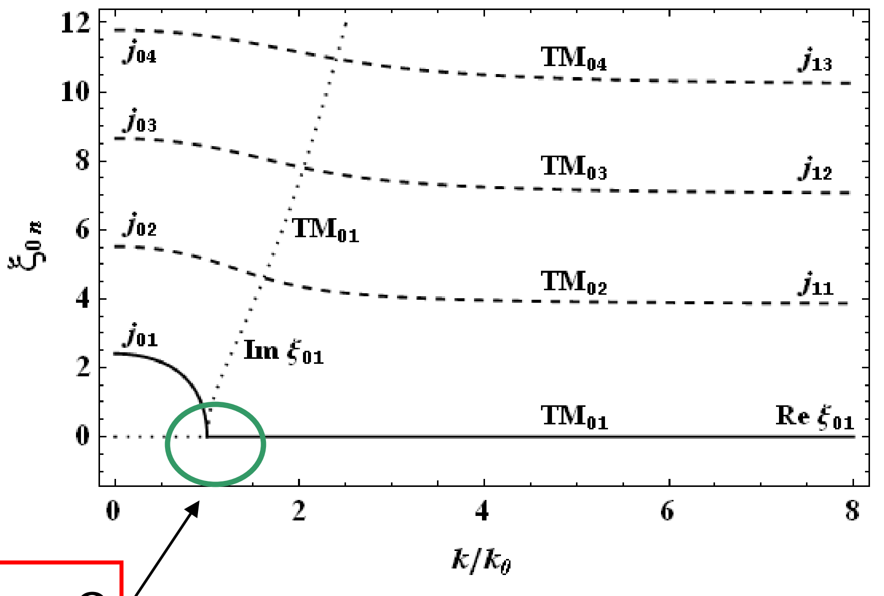
$$L = Z_0 d_1/2\pi a_1 c \qquad C = \pi a^2/Z_0 c \qquad R = Z_0 c/\pi a_1^2 \alpha$$

Dispersion Relations and Slow TM Mode

$$K = \sqrt{k^2 - \nu_{0l}^2}$$

$$\frac{1}{\nu_{0,i} a_1} \frac{J_1(\nu_{0,i} a_1)}{J_0(\nu_{0,i} a_1)} = \frac{1}{k^2 a_1 d_1}$$

Real (red) and imaginary (blue) parts of TM_{01} transverse eigenvalues versus frequency.



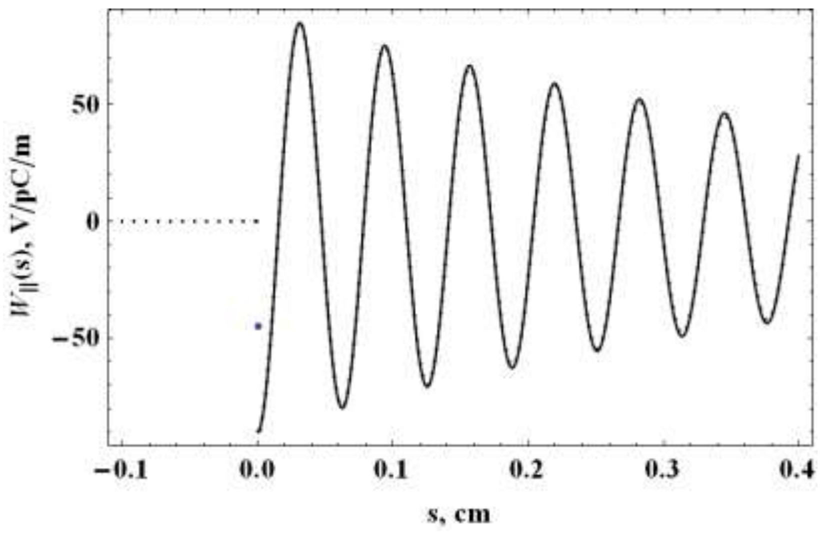
$$\nu_{01} = 0$$

Wake function

$$W_{\parallel}^{0}(s) = -Z_0 c/\pi a^2 \, e^{-\frac{\alpha}{2c}s}\left(\cos(k_\alpha s) - \frac{\alpha}{2ck_\alpha}\sin(k_\alpha s)\right)$$

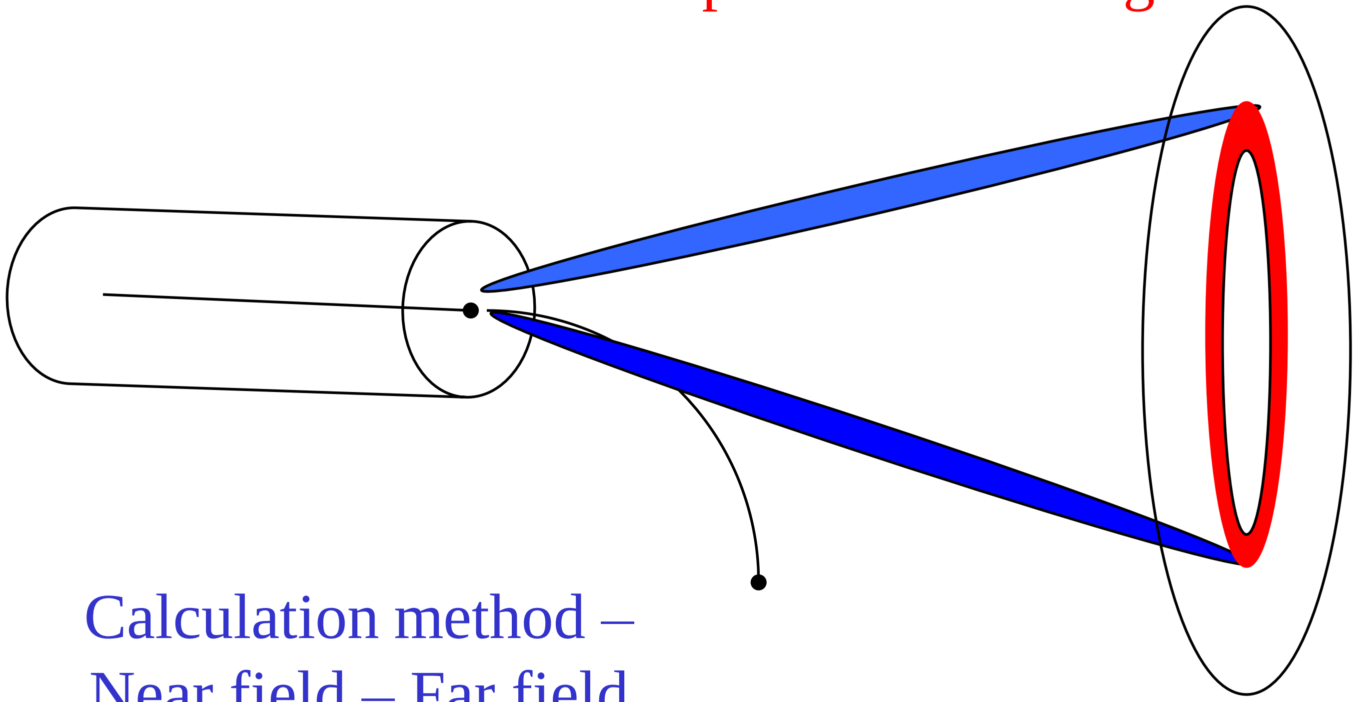
$$k_\alpha = \sqrt{k_0^2 - \left(\frac{\alpha}{2c}\right)^2}$$

$$\alpha = \frac{2c}{\sqrt{3}a}\left(\xi + \xi^{-1}\right)$$

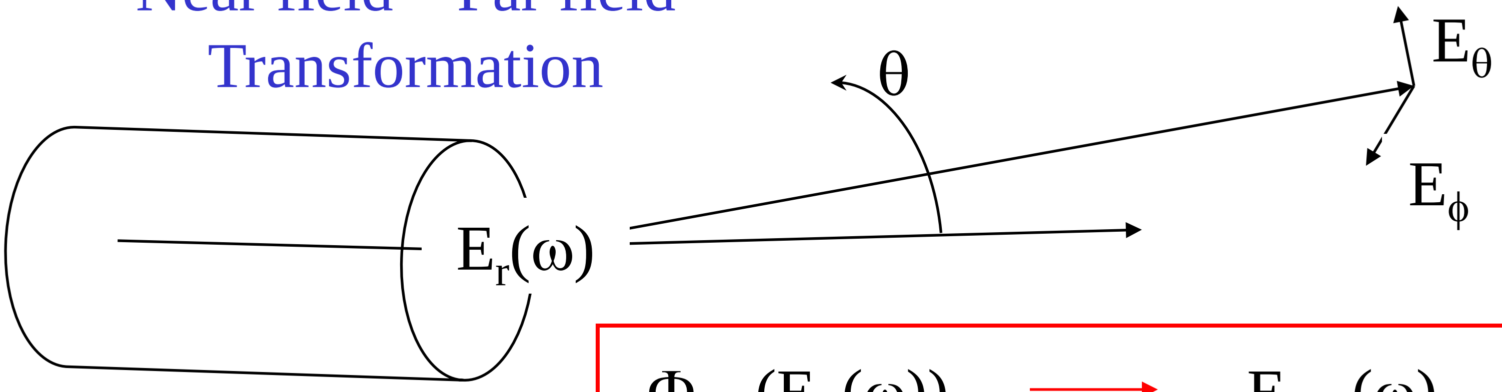


Point wake function for perfectly conducting pipe with NEG thin film coating.

Radiation from the open end of waveguide



Calculation method – Near field – Far field Transformation



$$\Phi_{\theta,\phi}(E_r(\omega)) \longrightarrow E_{\theta,\phi}(\omega)$$

Transformation stages:

1. Frequency-domain undisturbed field calculation in the cross-section of open end

2. Near Field – Far Field Transformation (in frequency domain)

$$\Phi_{\theta,\phi}(E_r(\omega)) \longrightarrow E_{\theta,\phi}(\omega)$$

3. Time-domain field calculation

$$E_{\theta,\varphi}(\theta,\varphi,R,t) = \int_{-\infty}^{\infty} E_{\theta,\varphi}(\omega)d\omega$$

4. Energy, accumulated in observation point

$$P(\theta,\varphi,R) = \frac{1}{Z_0}\int_{-\infty}^{\infty}\left(\left|E_\theta(\theta,\varphi,R,t)\right|^2 + \left|E_\varphi(\theta,\varphi,R,t)\right|^2\right)dt$$

Ultrarelativistic limit

$$\int_{-\infty}^{\infty} E_{\theta,\varphi}(\omega)d\omega = 2\pi Z_0 \left(\frac{\omega_1^2}{\omega_1-\omega_2} \frac{J_2(a\omega_1 \sin\theta/c)}{\sin\theta} \frac{e^{-j\frac{\omega_1}{c}s_t}}{R} - \frac{\omega_2^2}{\omega_1-\omega_2} \frac{J_2(a\omega_2 \sin\theta/c)}{\sin\theta} \frac{e^{-j\frac{\omega_2}{c}s_t}}{R} \right)$$

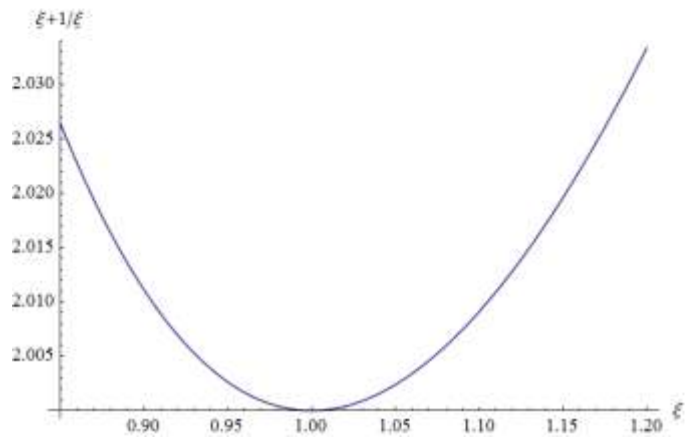
Cosθ Sinϕ

Cosϕ

$$\omega_{1,2} = \left(-jA \mp \sqrt{4\omega_0^2 - A^2}\right)/2$$

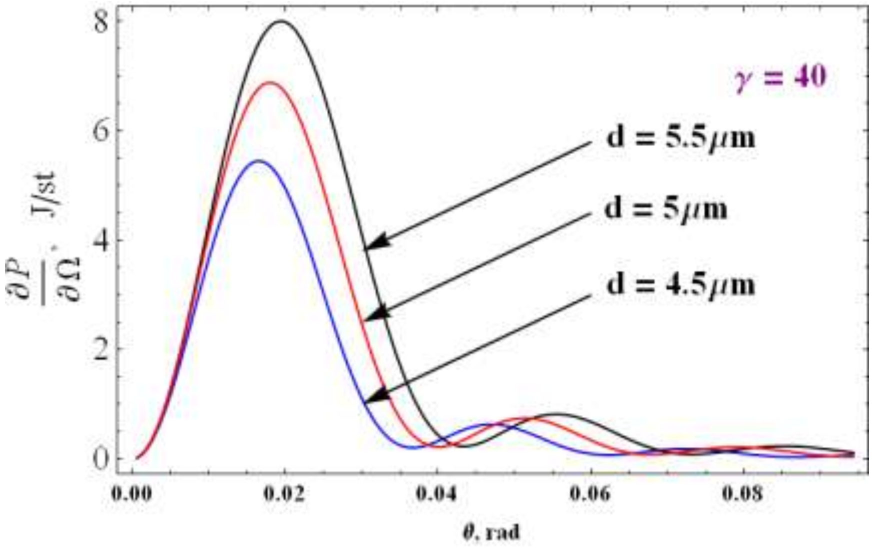
$$A = \frac{2c}{\sqrt{3}a}\left(\varsigma + \varsigma^{-1}\right)$$

$$\varsigma = d\sigma_1 Z_0 / \sqrt{3}$$

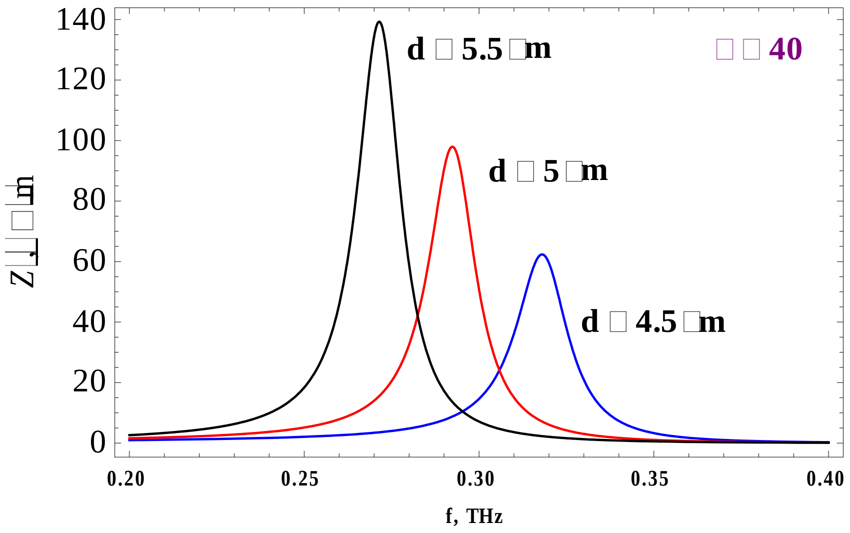


$$P(\theta,\varphi,R) = \frac{1}{Z_0}\int_{-\infty}^{\infty}\left(\left|E_\theta(\theta,\varphi,R,t)\right|^2 + \left|E_\varphi(\theta,\varphi,R,t)\right|^2\right)dt \to \infty$$

γ=40, ~20MeV

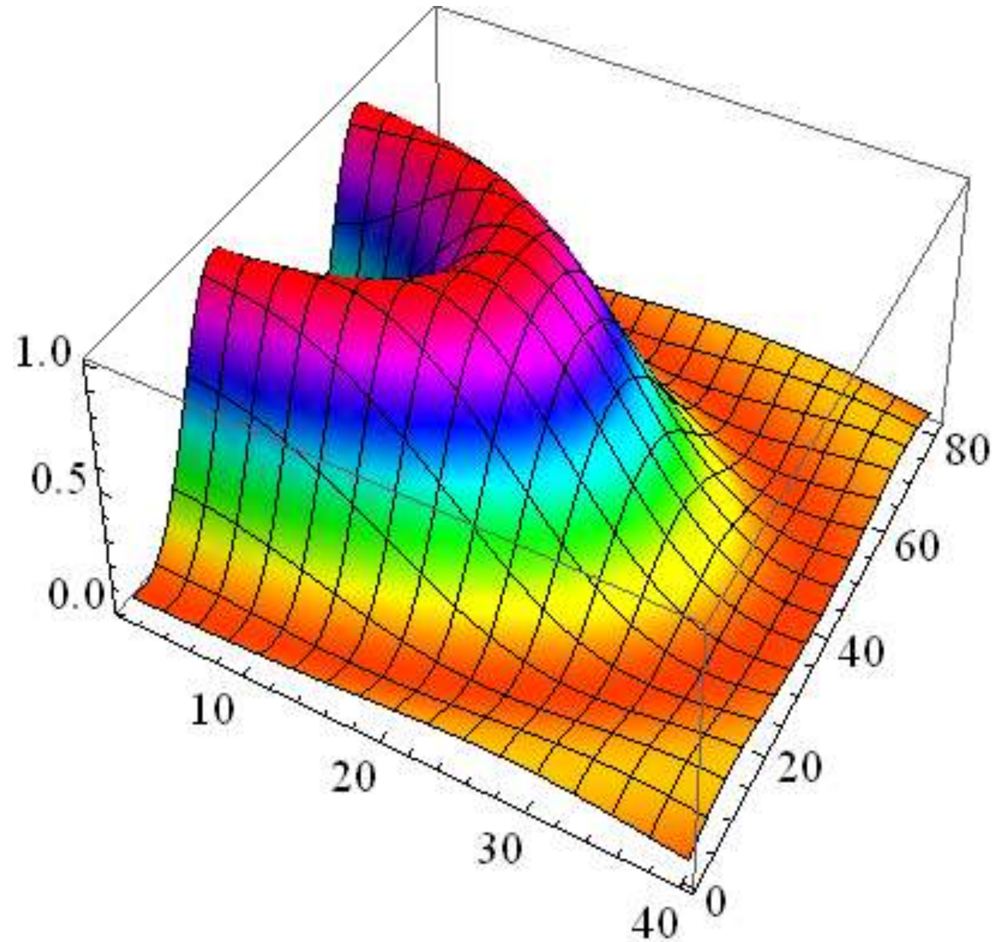


Total energy distribution on the screen

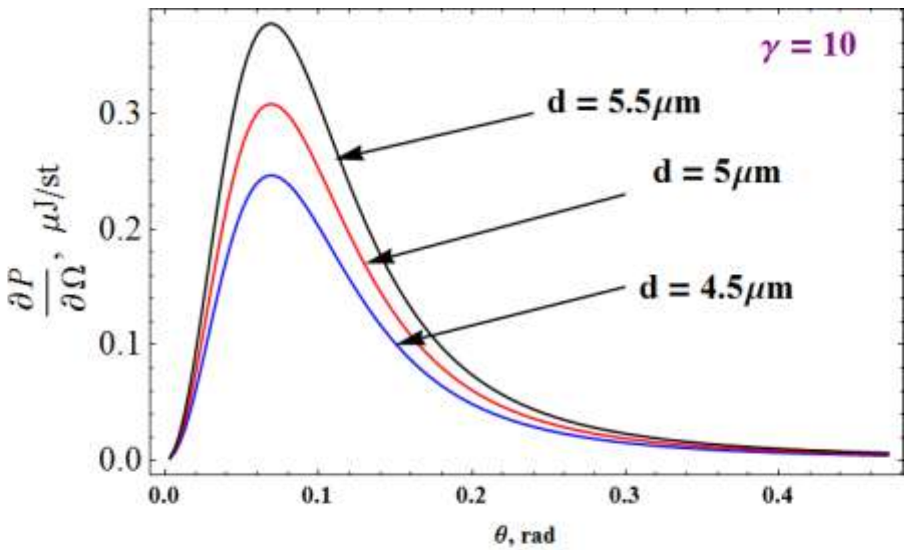


Impedances

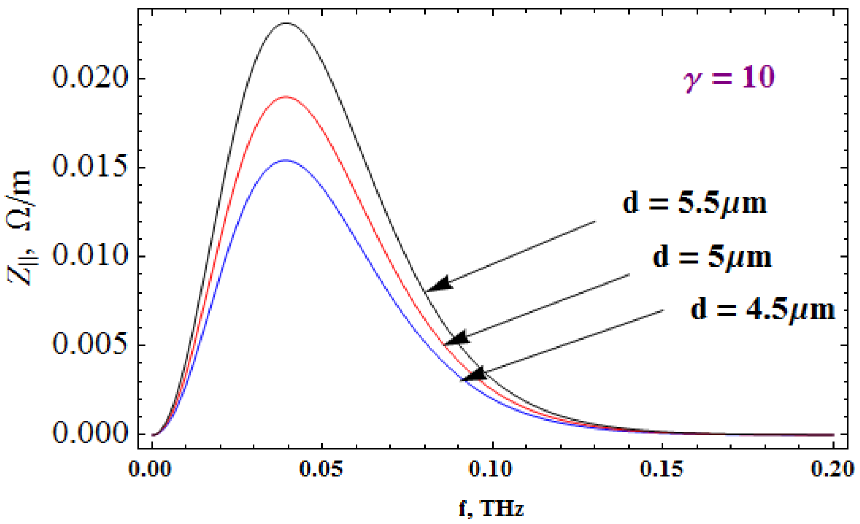
γ=40, ~20MeV



γ=10, ~5MeV

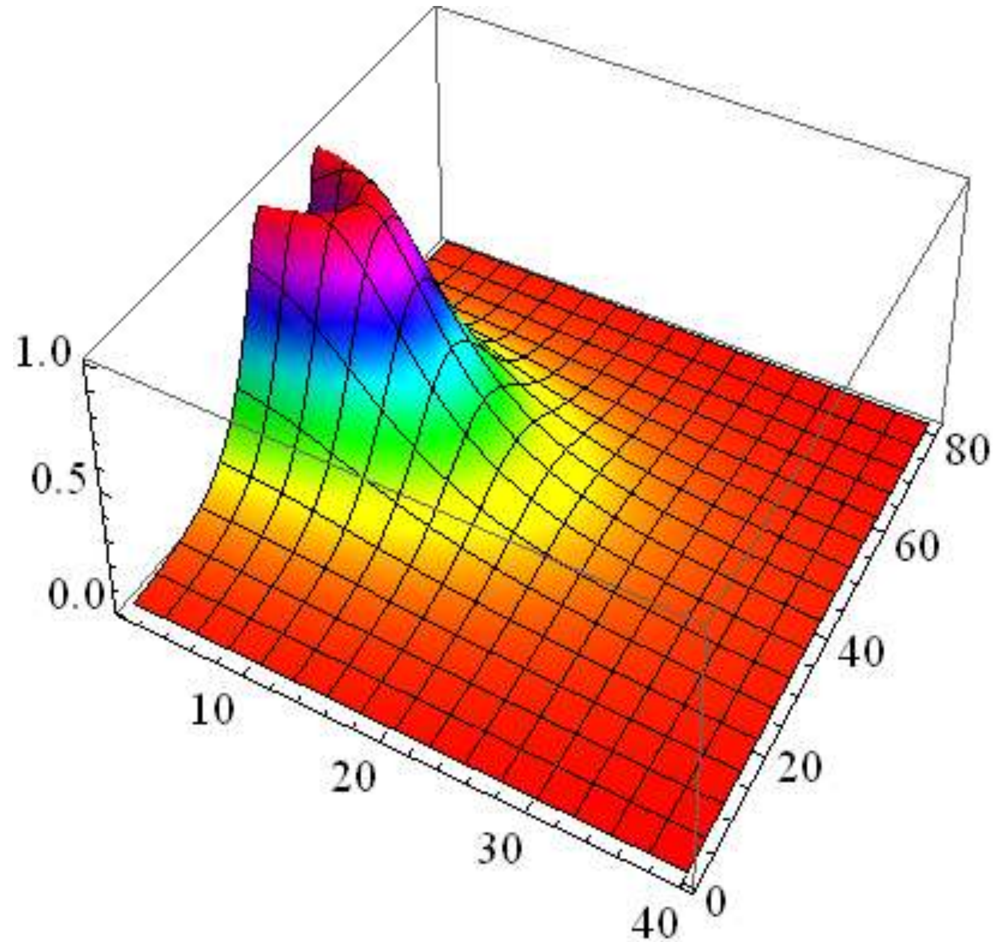


Total energy distribution
on the screen

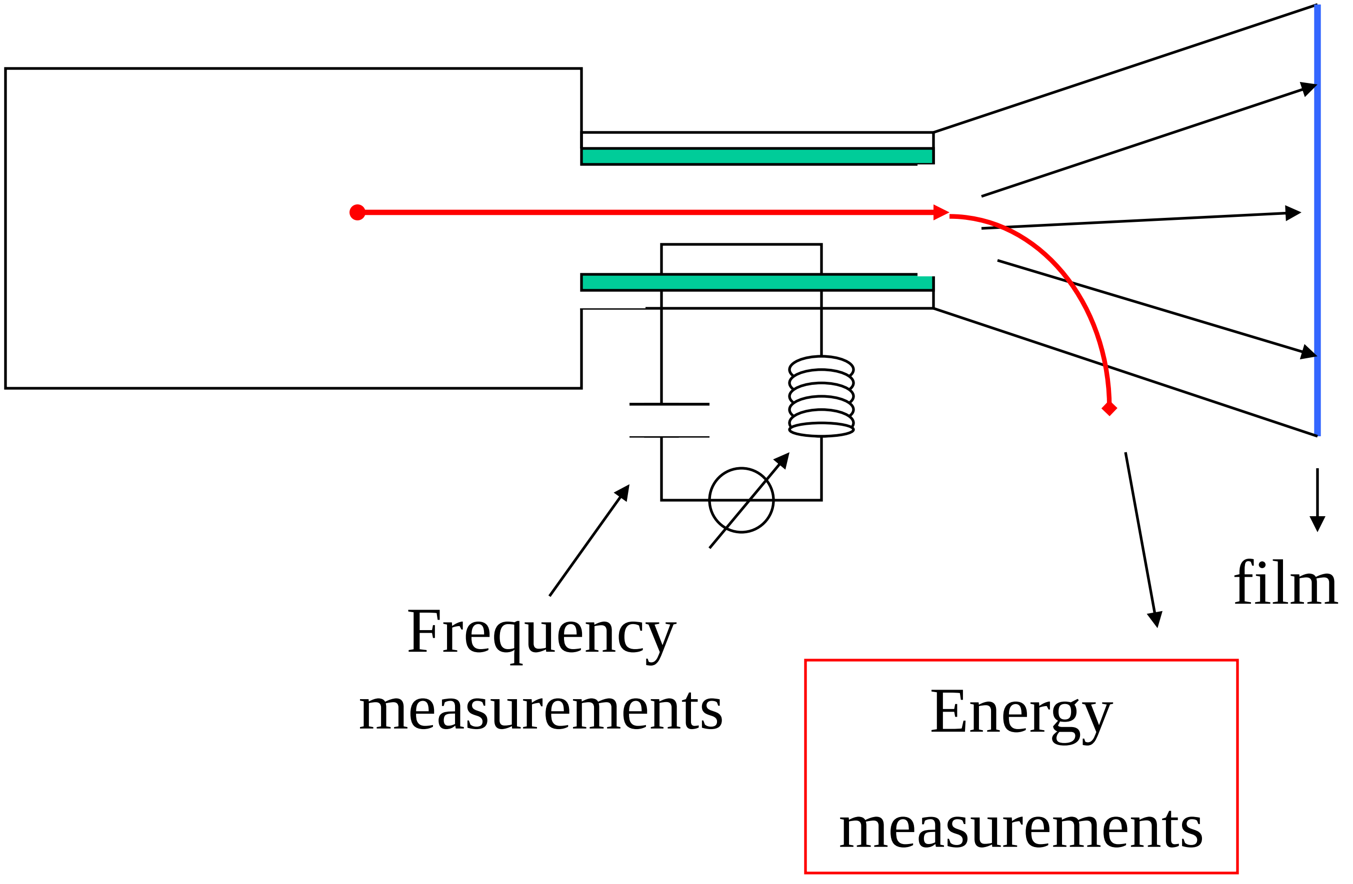


Impedances

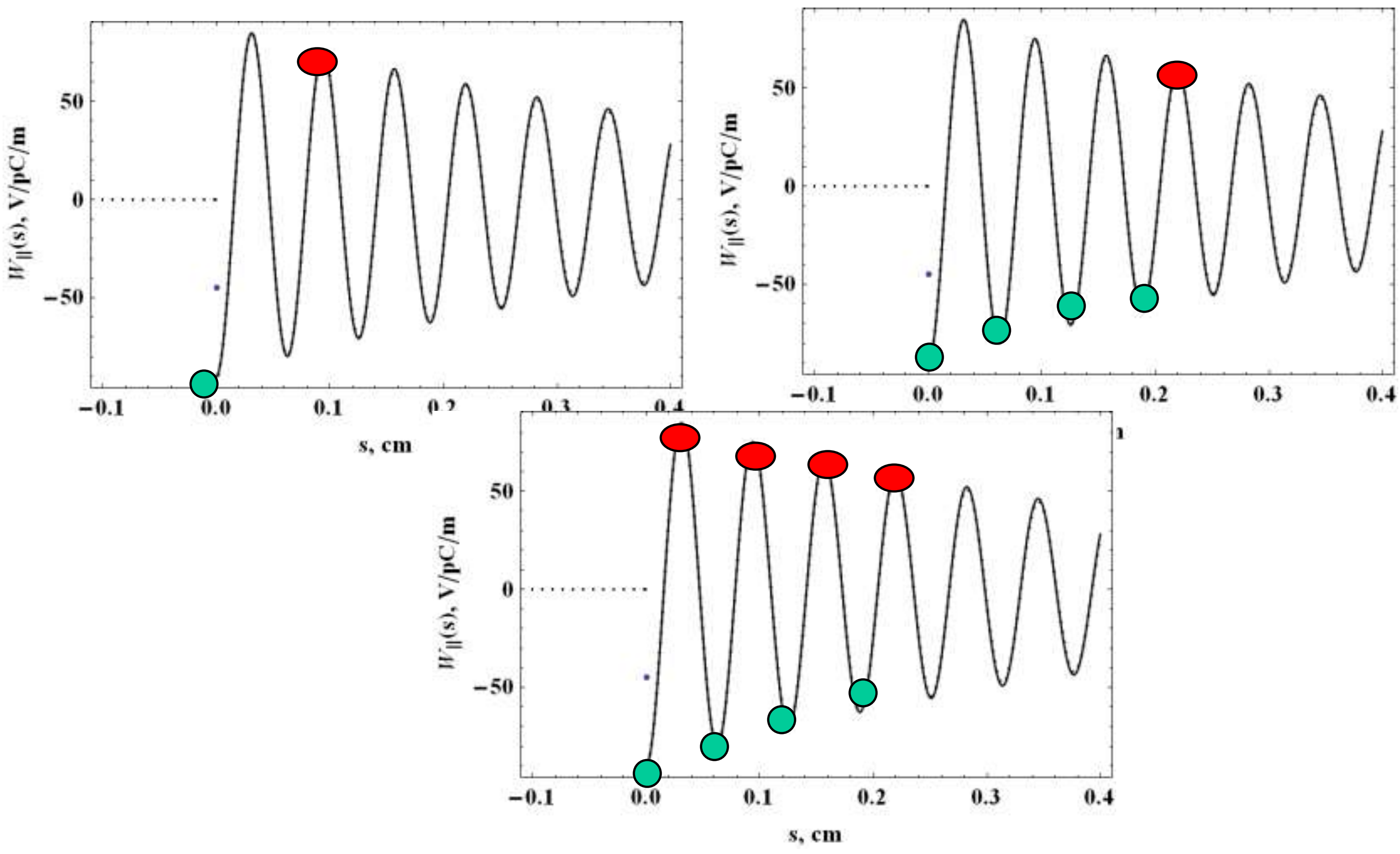
γ=10, ~5MeV



SCKETCH of MEASUREMENTS



Two-Beam Acceleration



To do:

1. Choosing the materials and dimensions for waveguide

2. Choosing the devices

3. Installation waveguide and devices in vacuum chamber

Thank you!