Simulation Code for Multi-layer Tube Impedance Calculation

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PROBLEM DESCRIPTION

Circular-cylindrical many-layer tube

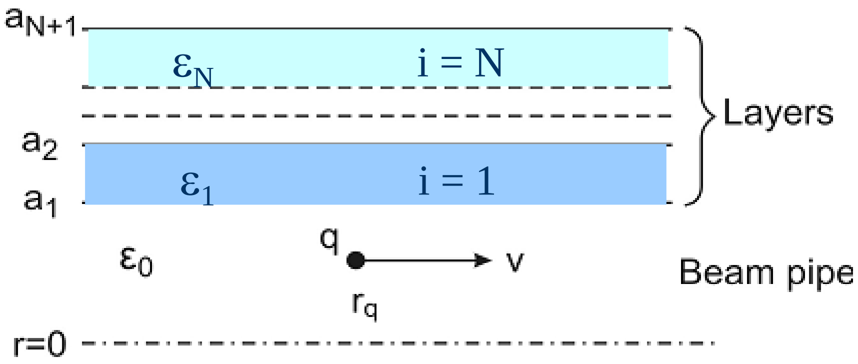


Fig.1. ***Geometry of the laminated vacuum chamber.***

$a_{1,}$ - inner radius

a_{N+1} - outer radius

ε_i - permittivity

μ_i –magnetic permeability

(i=1,2,3,…N)

q - point-like charge

r_q - offset

v - constant velocity

FIELD MATCHING TECHNIQUE

The problem is solved by the field matching technique that implies the continuity of the tangential components of electric and magnetic fields at the borders of the layers.

$$\text{N layer tube} \Rightarrow \left\{ \begin{array}{l} \text{N+2 regions} \\ \text{N+1 borders} \end{array} \right.$$

4 boundary equations for each border that matches E_θ, E_z, B_θ, B_z, components of E&M field

$$\Downarrow$$

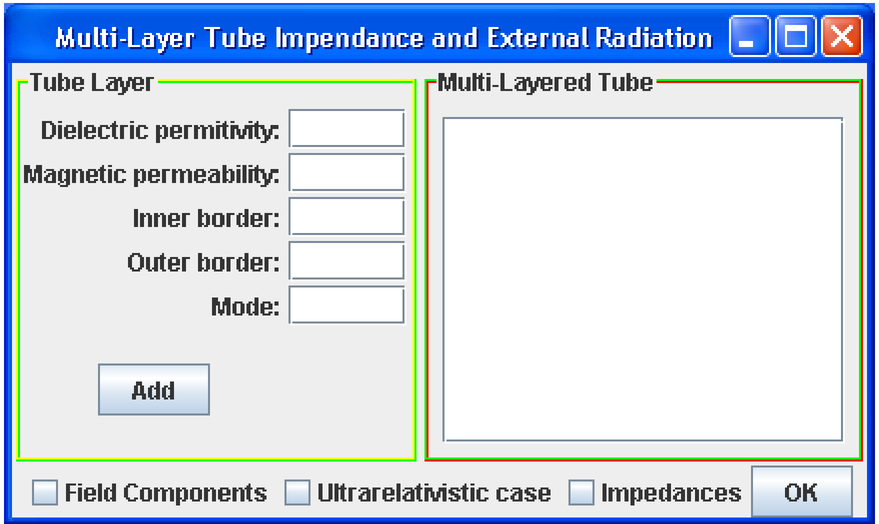
4(N+1) equations, 4(N+1) unknowns

SOLUTION METHOD

coupling of the tangential components of electromagnetic fields inside and outside the pipe.

$$\boxed{\hat{T}_m^{in}(r=a_1)=\hat{Q}\,\hat{T}_m^{out}(r=a_{N+1})}$$

$$\hat{Q}=\overset{\frown}{Q}{}^{(1)}\overset{\frown}{Q}{}^{(2)}\ldots\overset{\frown}{Q}{}^{(N)}$$



Multi-Layer Tube Impendance and External Radiation

Tube Layer

Dielectric permitivity:

Magnetic permeability:

Inner border:

Outer border:

Mode:

Fig. 2. *Snapshot of a Simulation Code*

LONGITUDINAL AND TRANSVERSE IMPEDANCES OF XFEL KICKER VACUUM CHAMBER

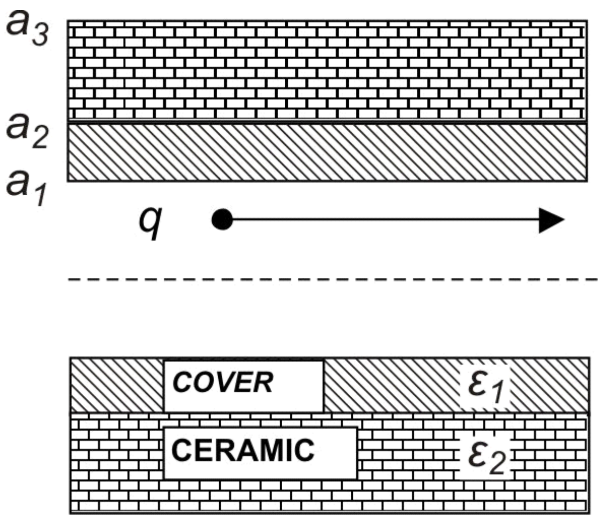


Fig. 3 *Ceramic tube with inner cover of special thin metallic film of Titanium-Stabilized High Gradient Steel.*

$$T_{in} = Q\,T_{out}$$

$$Q = Q_1 \cdot Q_2$$

T_{in} –vector of tangential E&M fields in inner surface .

T_{out}- vector of tangential E&M fields in outer surface

Q (4x4)– Field Transformation Matrix of Laminated Tube

TRANSVERSE IMPEDANCE (EPAC’08)

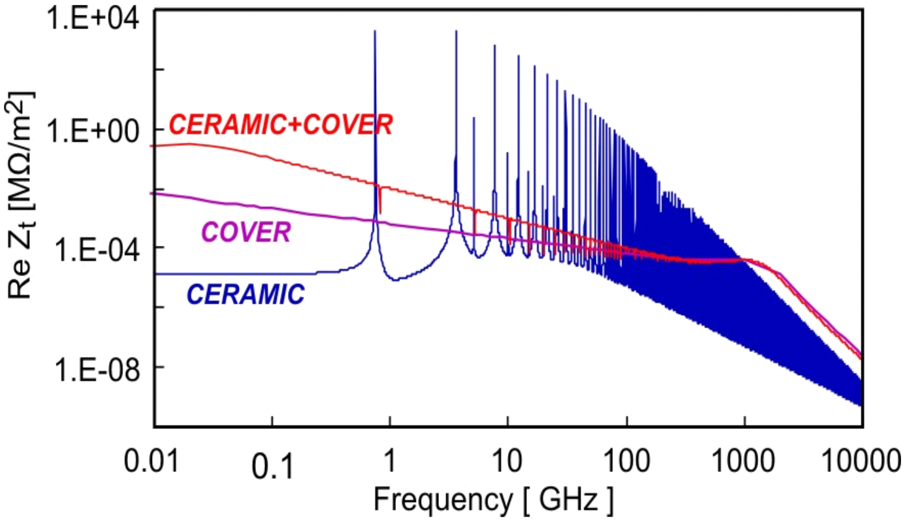


Fig. 4. ***Real parts of transverse dipole impedance***

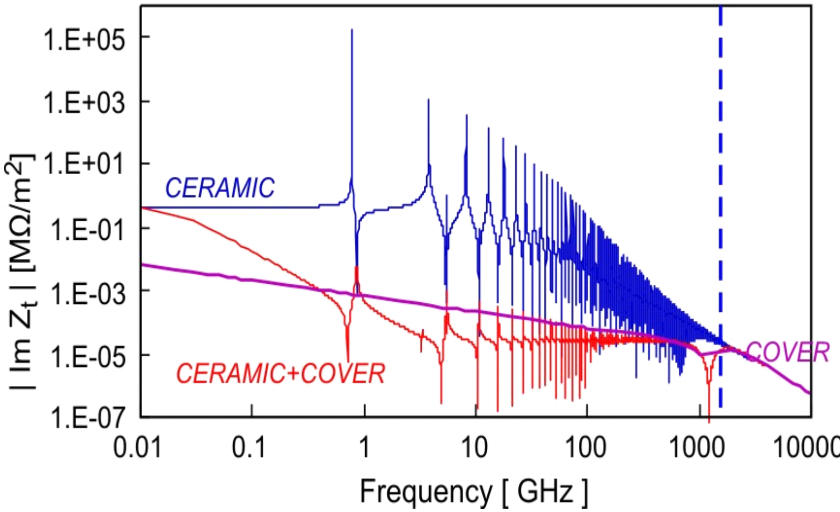
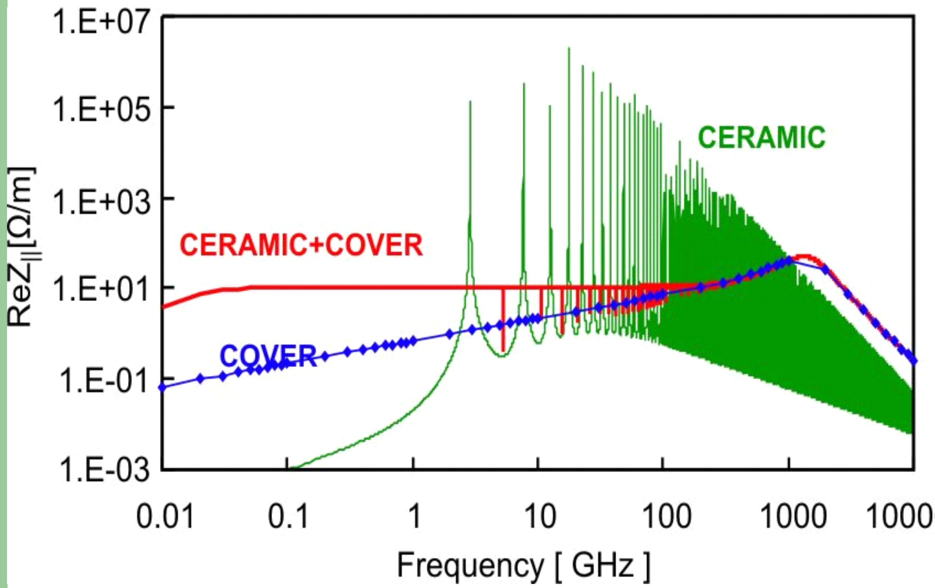


Fig.5. ***Imaginary parts of transverse dipole impedance***

LONGITUDINAL IMPEDANCE (EPAC'08)



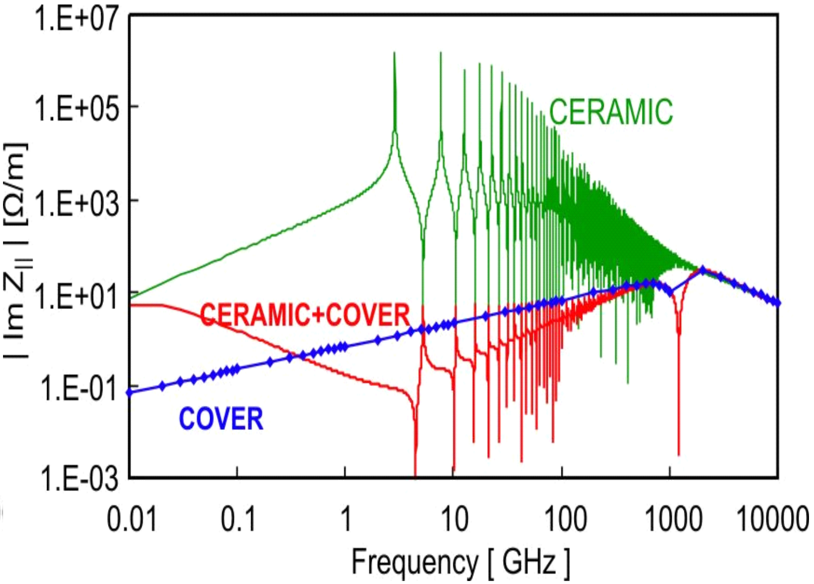


Fig. 6. ***Real part of the longitudinal impedance***

Fig. 7. ***Imaginary part of the longitudinal impedance***