# Gauss' law

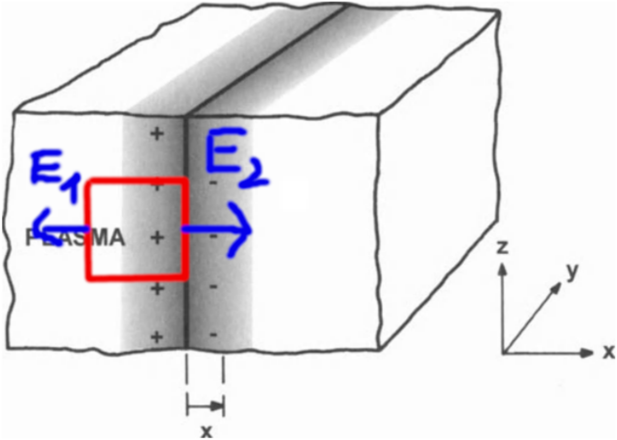
$$\nabla \cdot \vec{E} = \frac{\rho}{\varepsilon_0} \tag{1}$$

$$\mathrm{LHS}: \quad \int \nabla \cdot \vec{E} \, \mathrm{d}V = \oint_{\partial V} \vec{E} \cdot \mathrm{d}\vec{S} \tag{2}$$

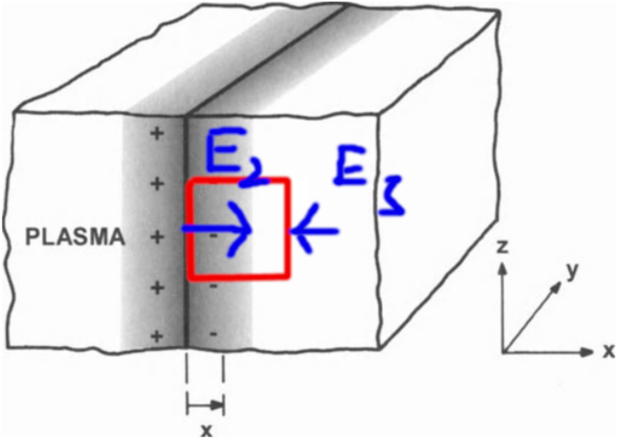
$$\mathrm{RHS}: \quad \int \frac{\rho}{\varepsilon_0} \, \mathrm{d}V = \frac{Q}{\varepsilon_0} \tag{3}$$

Parallel and constant vectors $\vec{E}$ and $\vec{S}$

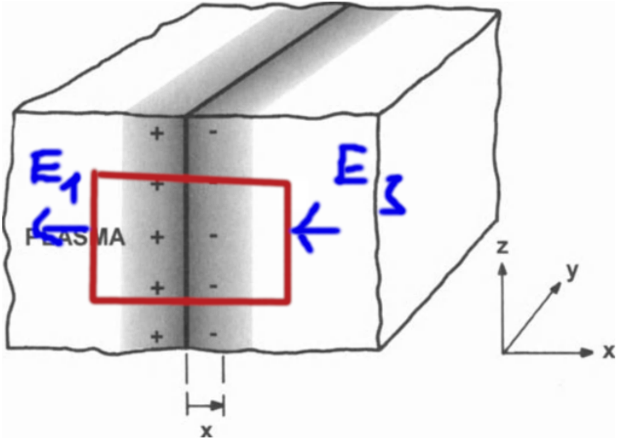
$$\sum_{i \in \partial V} E_i S_i = \frac{Q}{\varepsilon_0} \tag{4}$$



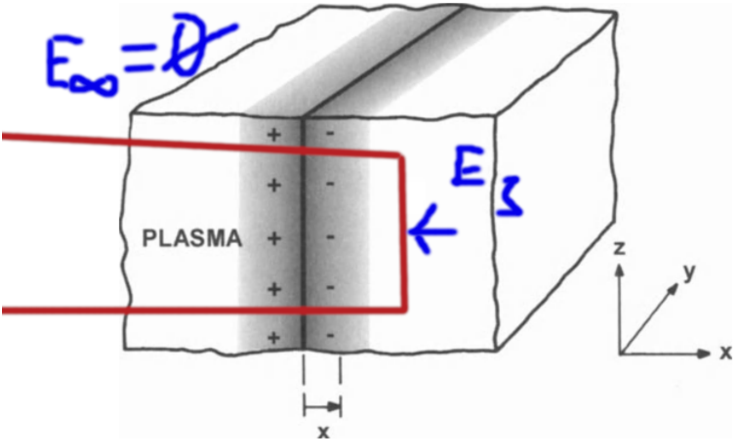

$$E_1 + E_2 = \frac{enSx}{S\varepsilon_0} \tag{5}$$



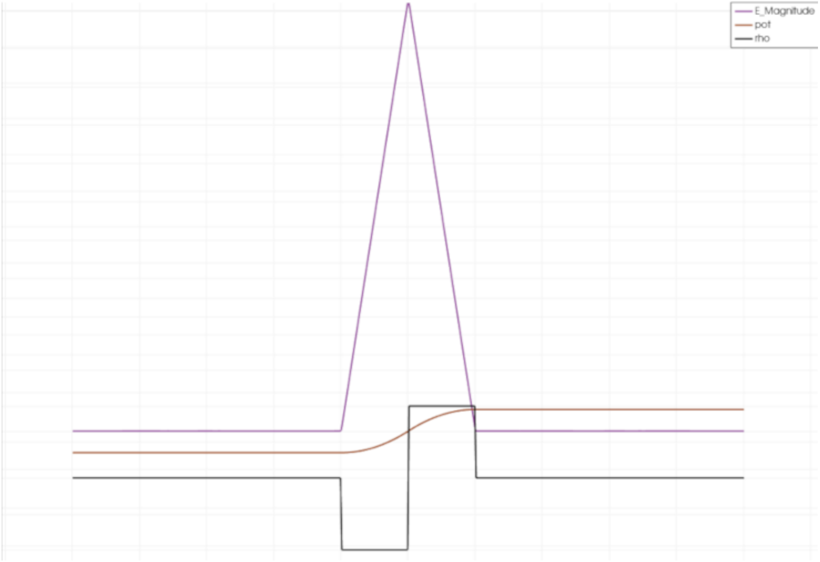

$$-E_2 - E_3 = -\frac{enSx}{S\varepsilon_0} \tag{6}$$




$$E_1 - E_3 = 0 \quad (7)$$


PLASMA
z
y
x
x

$$E_{\text{interface}} = \frac{nex}{\varepsilon_0} \tag{8}$$


E_Magnitude
pot
rho

# Equation of motion

Lorentz force on electron;

$$m\ddot{x} = -eE \tag{9}$$

$$\ddot{x} = -\frac{ne^2 x}{m\varepsilon_0} \tag{10}$$

# Solution

Characteristic polynomial:

$$\lambda^2 = -\frac{ne^2}{m\varepsilon_0} \tag{11}$$

$$\lambda = \mathrm{i}\sqrt{\frac{ne^2}{m\varepsilon_0}} \tag{12}$$

General solution:

$$x(t) = A\mathrm{e}^{\mathrm{i}\lambda t} + B\mathrm{e}^{-\mathrm{i}\lambda t} \simeq \sin\left(\sqrt{\frac{ne^2}{m\varepsilon_0}}\right) \tag{13}$$