SIMPLE FORMULAE FOR THE "INDUCTIVE-BYPASS REGIME"

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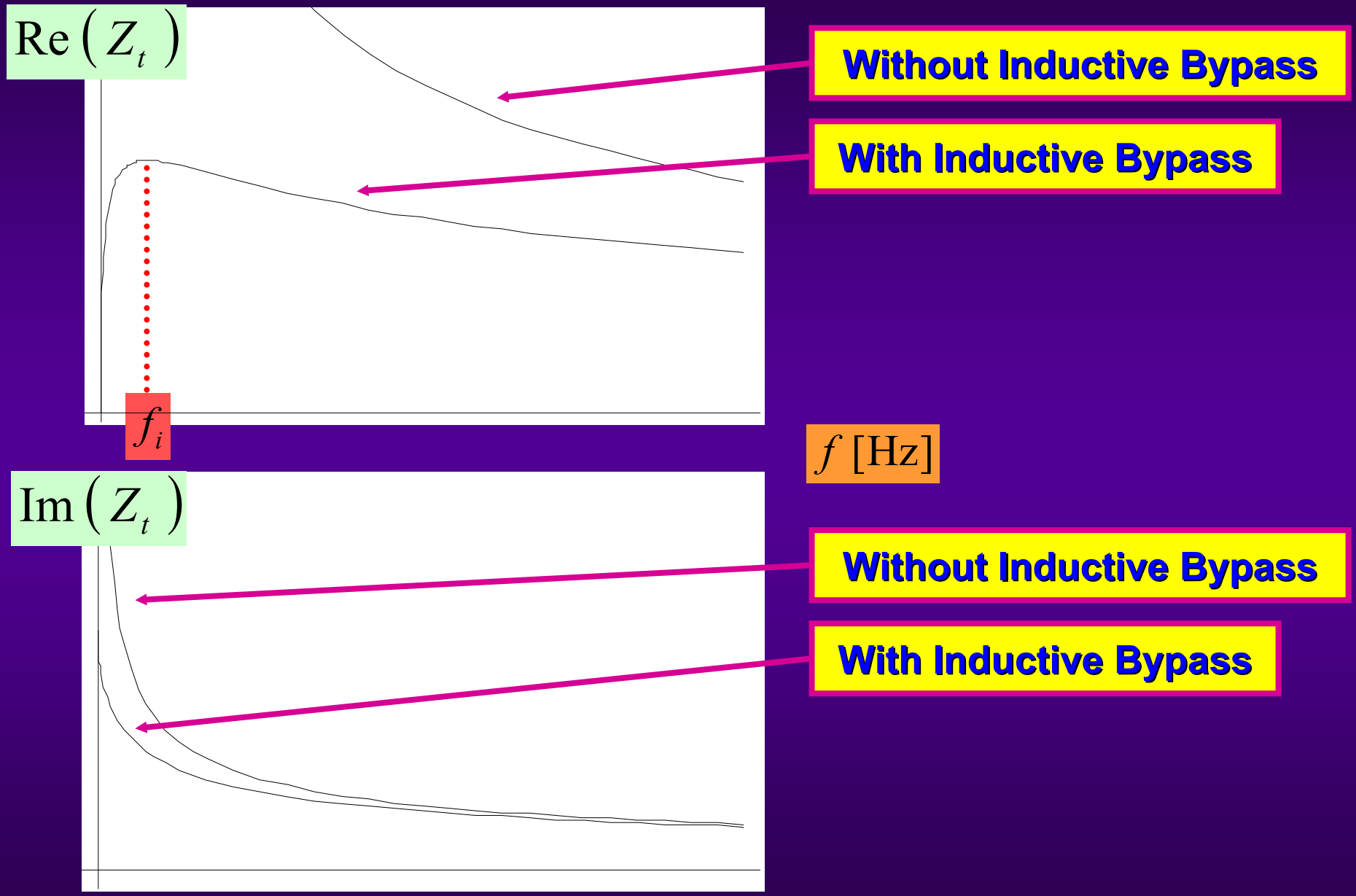
TYPICAL PICTURE



INDUCTIVE BYPASS REGIME (1/2)

- **Non inductive-bypass regime**

$$f >> f_i = \frac{2\rho Z_0}{\pi c \mu^2 b^2} \approx 5\times 10^5 \frac{\rho}{b^2}$$

$$\Rightarrow \quad Z_t \approx (1+j)\frac{l\sqrt{\rho Z_0 c}}{2\pi^{3/2} b^3 \sqrt{f}} \approx (1+j)\frac{30200\, l\sqrt{\rho}}{b^3\sqrt{f}}$$

- **Inductive-bypass regime** $f >> f_i$

- **If** $f = f_i$ $\Rightarrow$

$$\mathrm{Re}\left[Z_t^{WithIB}(f_i)\right] = \frac{cLl}{2\left(1+\sqrt{2}\right)\pi b^2} \approx 12.4\frac{l}{b^2}$$

- **If** $f << f_i$

$$\Rightarrow \quad \mathrm{Re}[Z_t] \approx \frac{c^{3/2} L^2 l\sqrt{f}}{b\sqrt{\pi\rho Z_0}} \approx 0.06\frac{l\sqrt{f}}{b\sqrt{\rho}}$$

$$\mathrm{Im}[Z_t] \approx \frac{cLl}{\pi b^2} \approx 60\frac{l}{b^2}$$

INDUCTIVE BYPASS REGIME (2/2)

$c = \text{speed of light}$

$\mu = 4\pi \times 10^{-7} \left[\text{N} / \text{A}^2 \right] = \text{permeability of vacuum}$

$L = \mu / 2$

$Z_0 = 120\pi \left[\Omega \right] = \text{vacuum impedance}$

$l = \text{collimator length}$

$b = \text{collimator aperture}$

$\rho = \text{collimator resistivity}$

NUMERICAL APPLICATION : LHC graphite collimator

$b = 2\,\text{mm}$ $l = 20\,\text{m}$ $\rho = 18.1818\times10^{-6}\ \Omega\,\text{m}$

- **Non inductive-bypass regime** $f >> f_i = 2.3\,\text{MHz}$

$$\Rightarrow \quad Z_t \approx (1+j)\frac{3.2\times10^{11}}{\sqrt{f}}$$

- $f = f_i \quad \Rightarrow \quad \text{Re}\left[Z_t^{WithIB}(f_i)\right] = 62\,\text{M}\Omega/\text{m}$

- **For** $f << f_i = 2.3\,\text{MHz}$

$$\Rightarrow \quad \text{Re}[Z_t] \approx 1.4\times10^5\sqrt{f} \qquad \text{Im}[Z_t] \approx 300\,\text{M}\Omega/\text{m}$$