TRANSVERSE RESISTIVE-WALL IMPEDANCE DERIVED FROM ZOTTER'S FORMALISM WITH AC CONDUCTIVITY

E. Métral

$c/\omega >> b/\gamma$

- **This is a high-frequency phenomenon $\Longrightarrow$ The "approximate" formula given by Zotter in his new paper to be published is not sufficient $\Longrightarrow$ Use the "general" formula (see RLC 04/02/05)**
- **Comparison between the cases without and with AC conductivity**
- **Comparison with the results presented by A. Grudiev at the RLC meeting on 18/03/05 using Bane's formula (SLAC/AP-87 (1991))**

AC CONDUCTIVITY

- **Equation of motion for 1 e-**

$$m\frac{d\vec{v}}{dt} = -e\,\vec{E} - \alpha\,\vec{v}$$

$$\alpha = \frac{m}{\tau}$$

e- mass

Relaxation time

- **Permanent regime (DC)**

$$\frac{d\vec{v}}{dt} = 0 \qquad \vec{J} = \rho\,\vec{v} = \sigma_{DC}\,\vec{E} \quad \Rightarrow \quad \sigma_{DC} = \frac{N\,e^2}{\alpha}$$

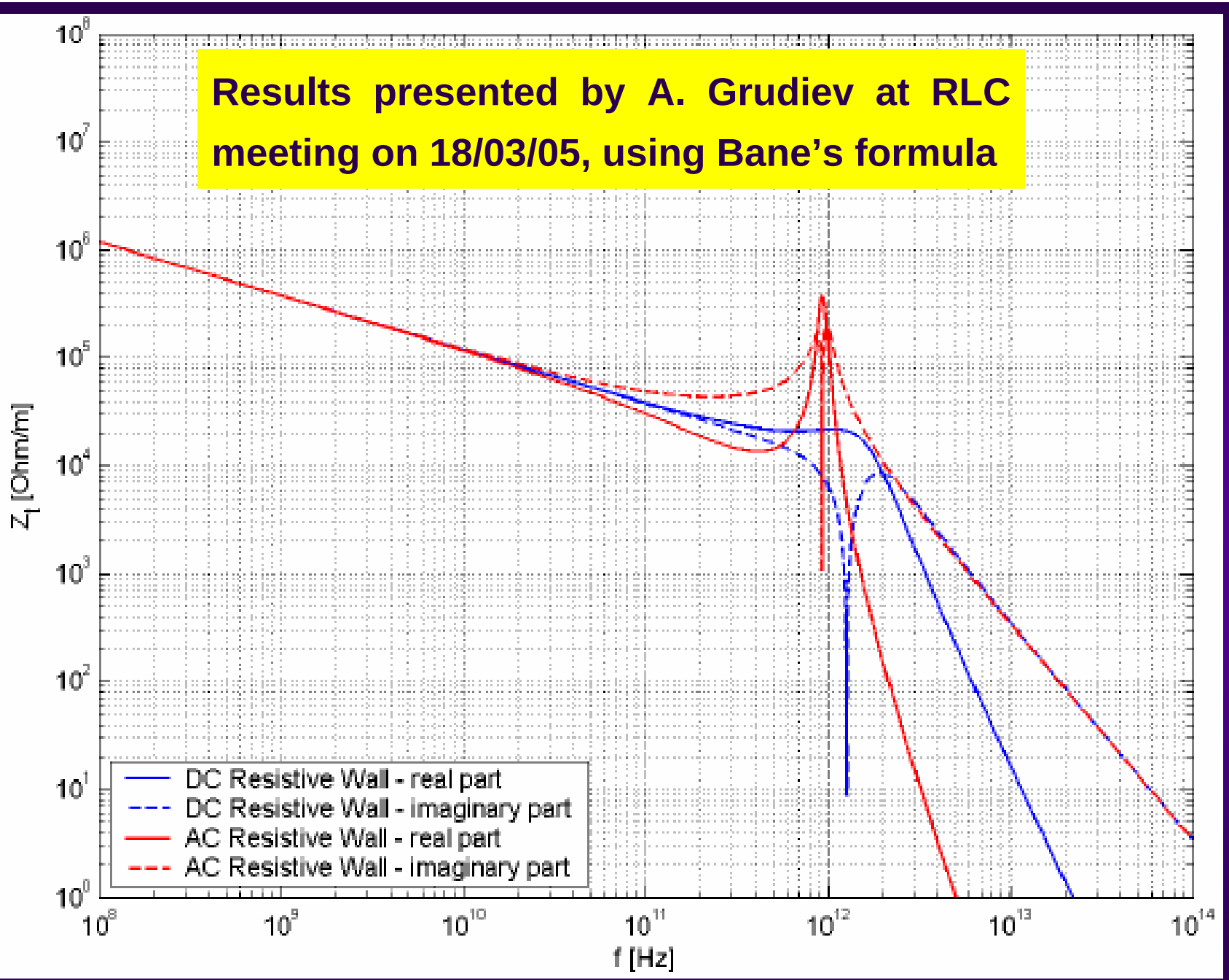
- **Sinusoidal regime (AC)** $\vec{E} = \vec{E}_0\,e^{j\omega t}$ $\vec{v} = \vec{v}_0\,e^{j(\omega t+\varphi)}$

$$\Rightarrow \quad \vec{J} = \sigma_{AC}\,\vec{E} \quad \text{with} \quad \sigma_{AC} = \sigma_{DC} / (1 + j\,\omega\,\tau)$$

Power dissipated by Joule effect

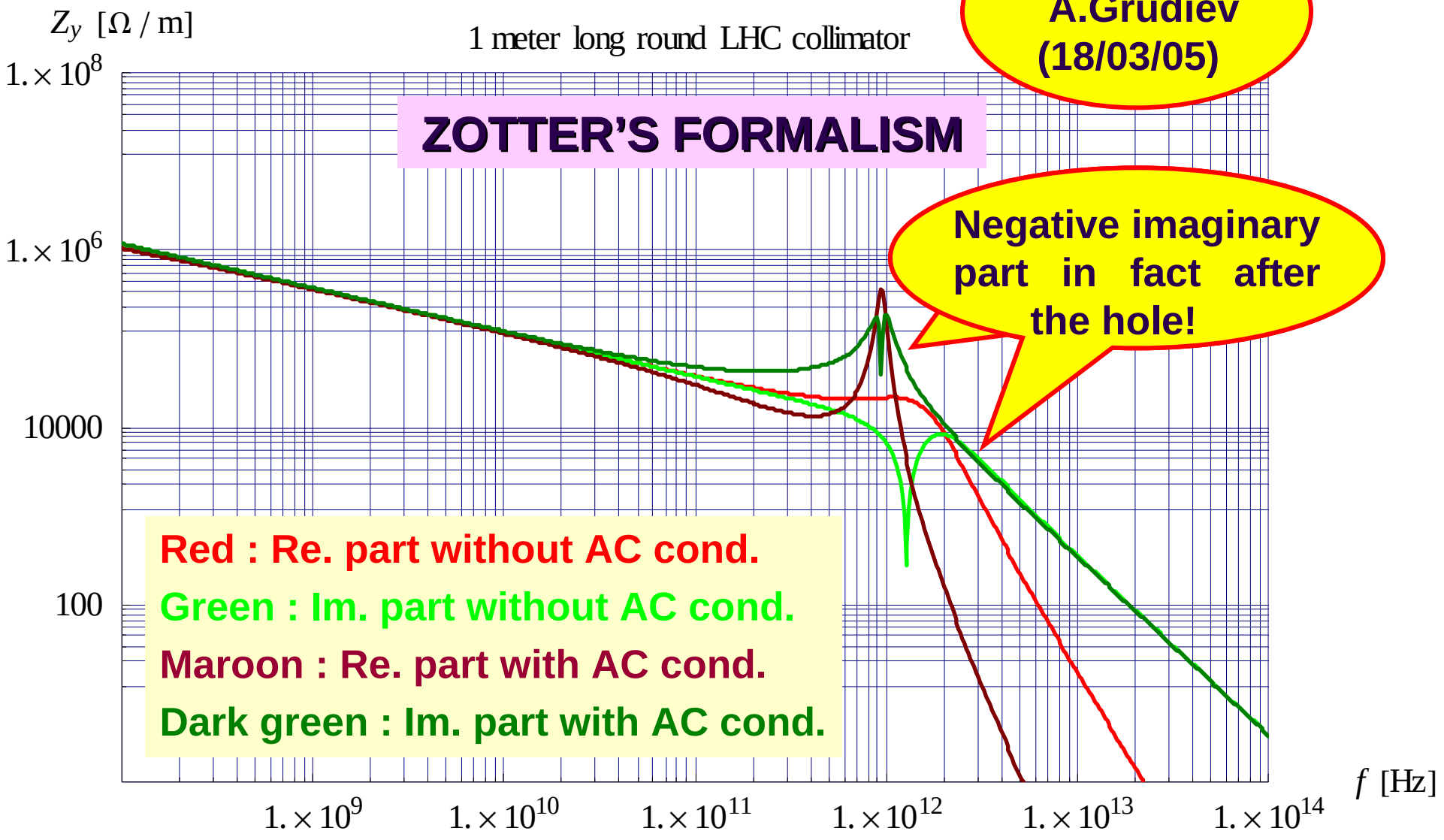
  - If $\omega\,\tau << 1 \Rightarrow \sigma_{AC} \approx \sigma_{DC} \Rightarrow P = \vec{J}.\vec{E}$
  - If $\omega\,\tau >> 1 \Rightarrow \sigma_{AC} \approx -\,j\,\sigma_{DC} / (\omega\,\tau) \Rightarrow P = 0$

Results presented by A. Grudiev at RLC meeting on 18/03/05, using Bane's formula



$\sigma_{DC} = 10^5\ \Omega^{-1}\mathrm{m}^{-1}$ $b = 2$ mm $\tau \approx 0.8$ ps

Data from A.Grudiev (18/03/05)



ZOTTER'S FORMALISM

Negative imaginary part in fact after the hole!

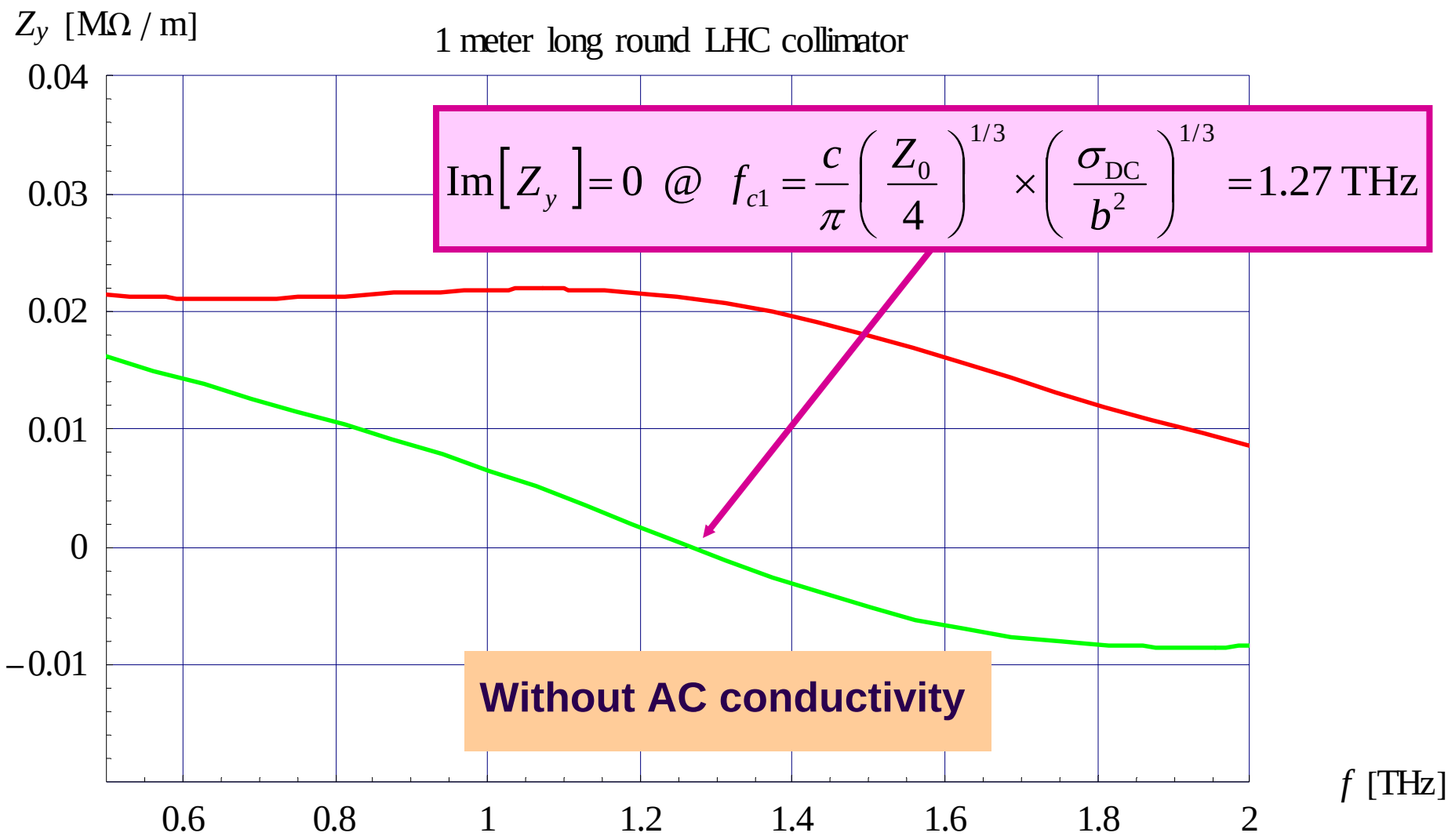
Red : Re. part without AC cond.

Green : Im. part without AC cond.

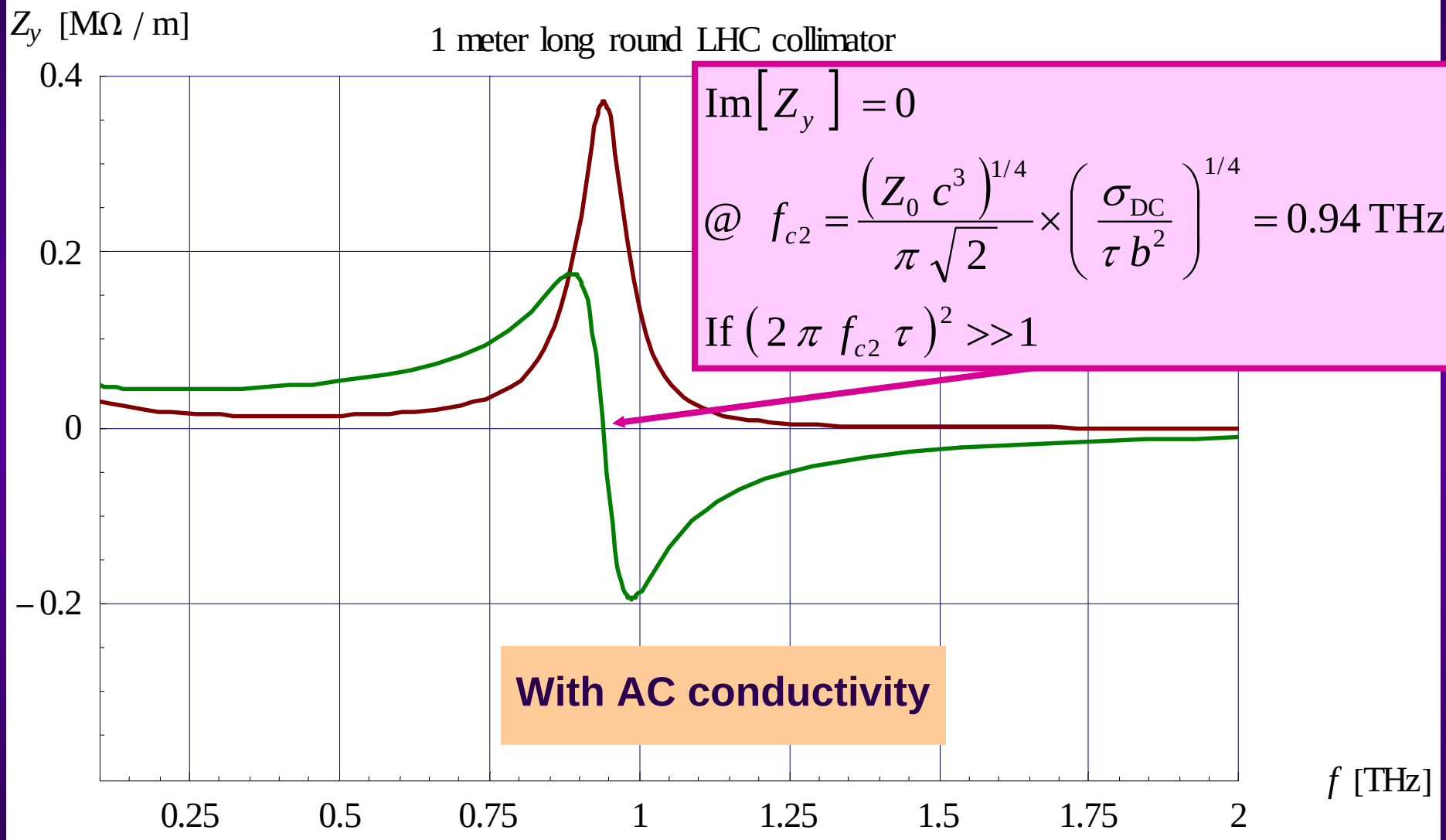
Maroon : Re. part with AC cond.

Dark green : Im. part with AC cond.

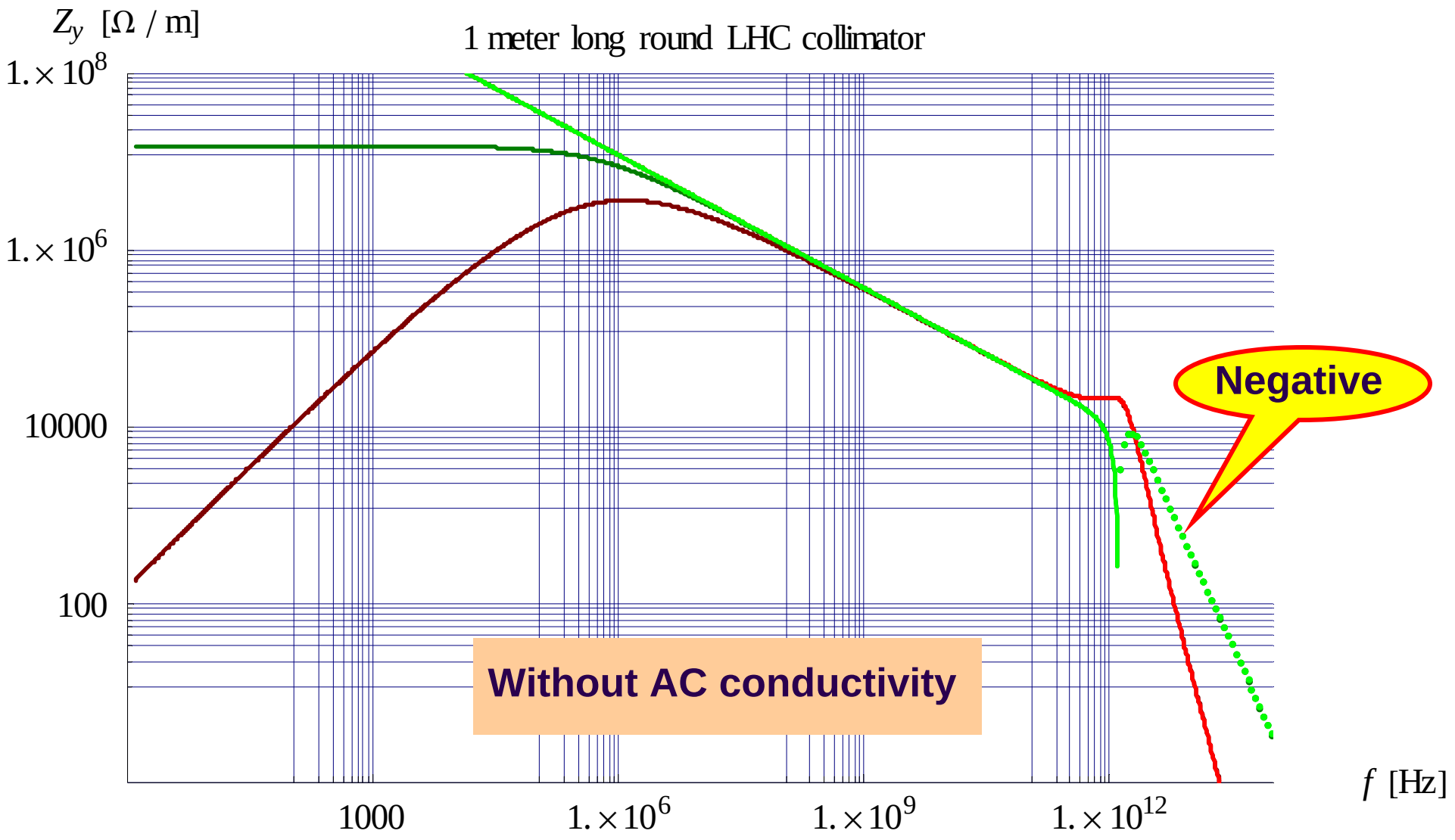
ZOOM NEAR 1 THZ



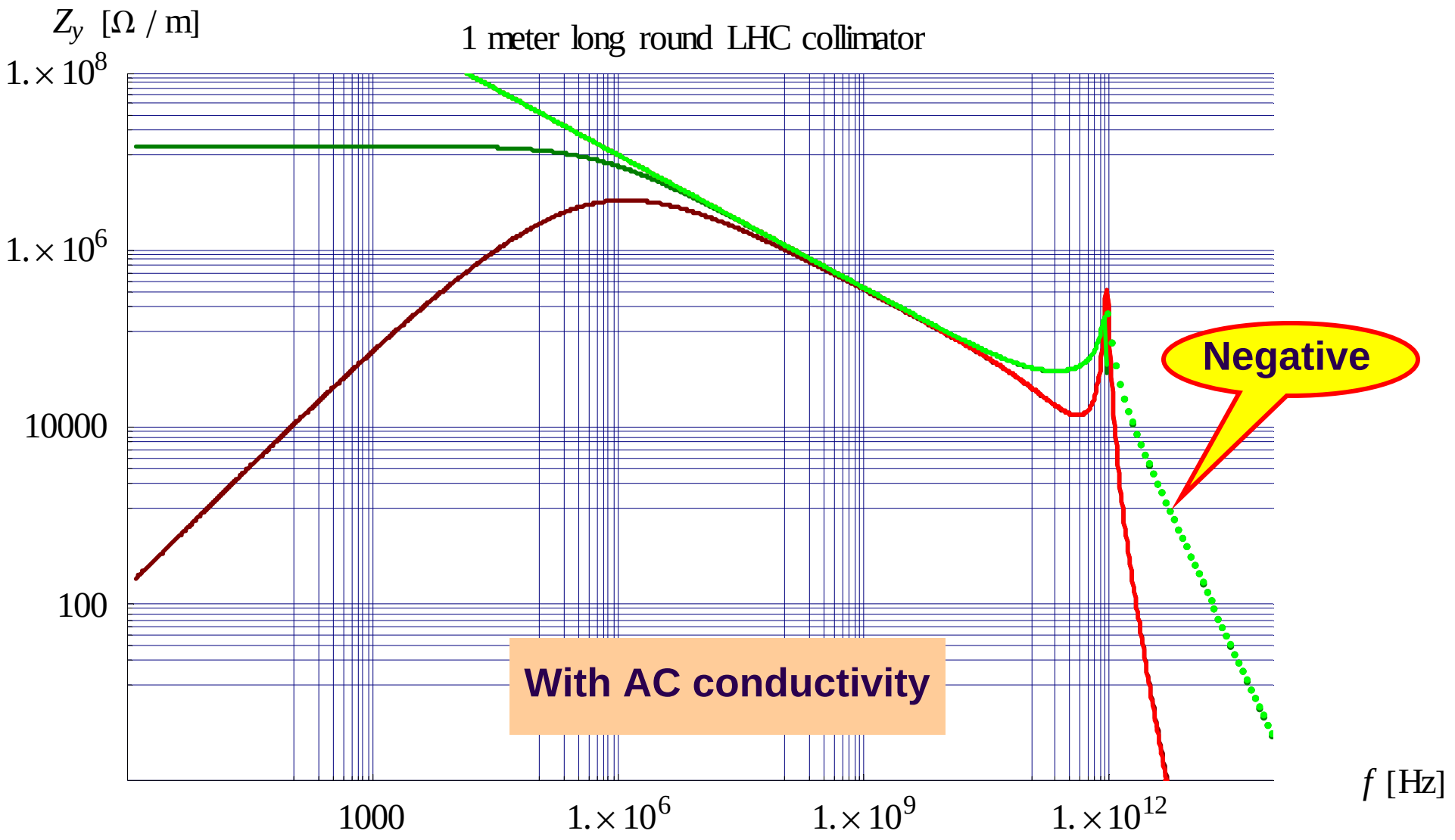
ZOOM NEAR 1 THZ



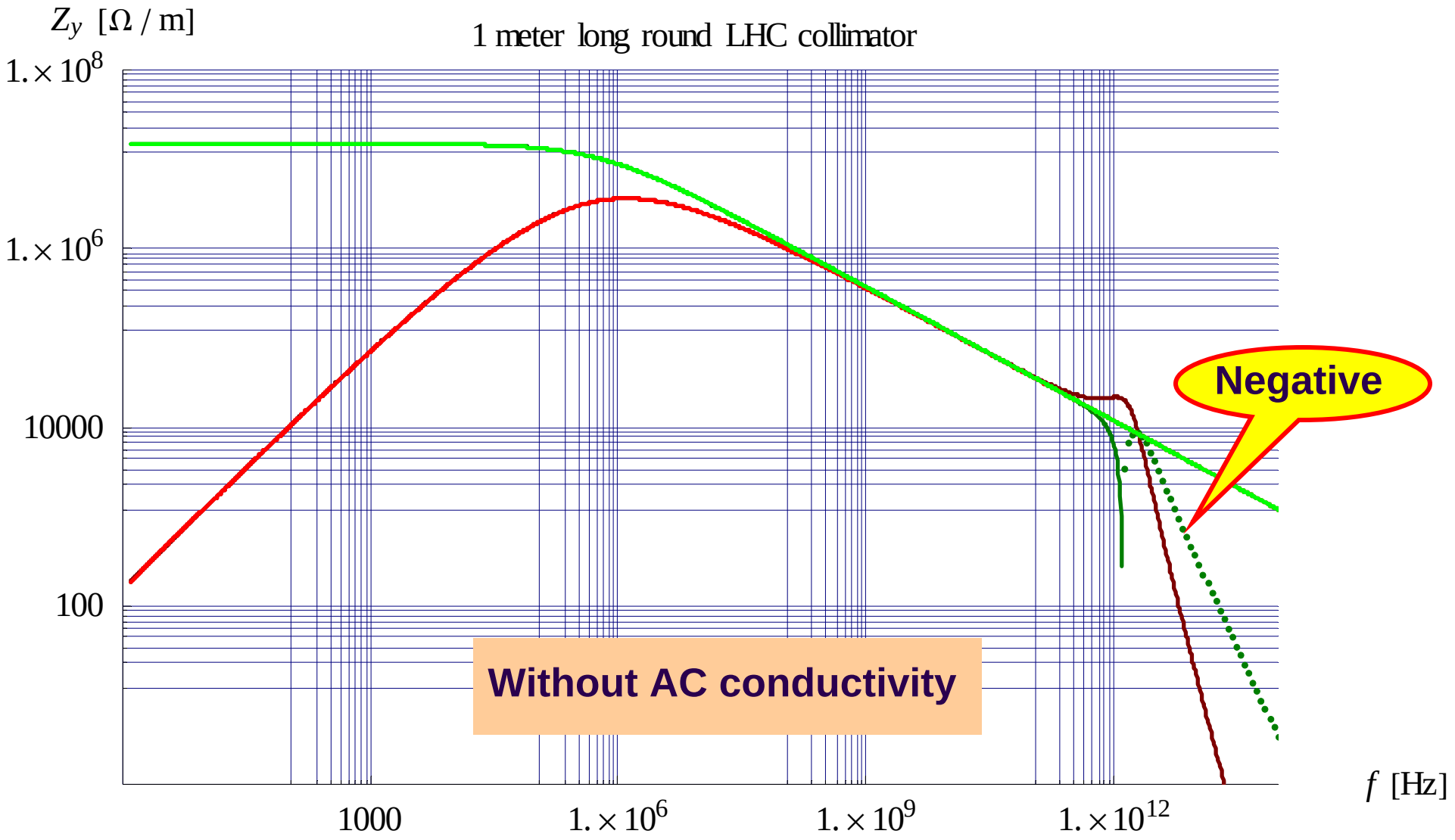
COMPARISON ZOTTER-BANE (1/2)



COMPARISON ZOTTER-BANE (2/2)



COMPARISON ZOTTER-BUROV&LEBEDEV



CONCLUSION (1/4)

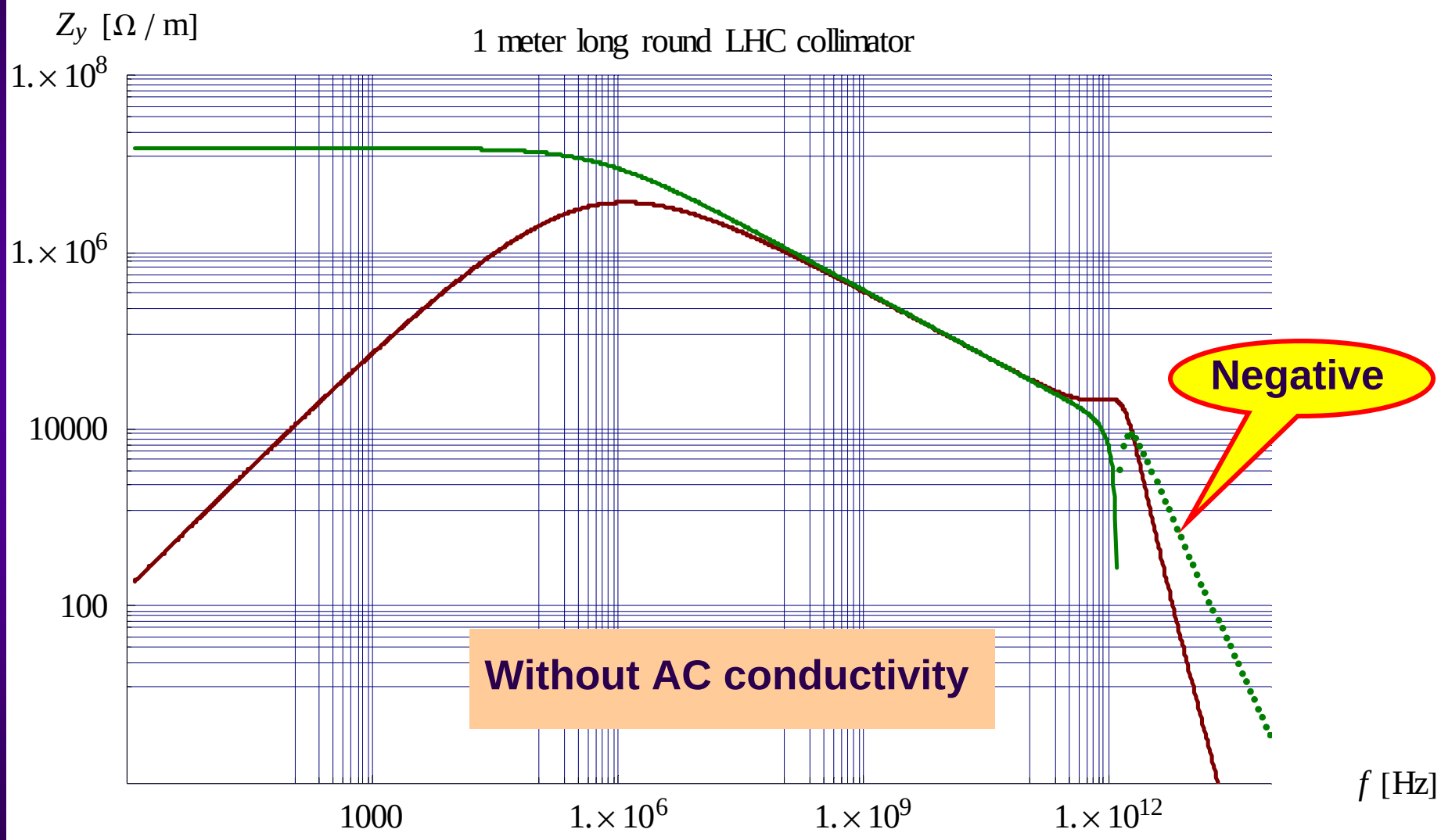
- Very good agreement between Zotter and Bane (SLAC/AP-87 (1991)) for high frequencies. Bane's impedance formula was used by A. Grudiev (18/03/05). It is also discussed in Chao's book (p. 44 for Long. and 54 for Trans. without AC conductivity) and Zotter's book p. 147

- Very good agreement between Zotter and Burov&Lebedev for "low frequencies" (Burov&Lebedev made the approximation $\omega << c/b$)

- Zotter's formalism unifies the 2 approaches (Bane for high frequencies and Burov&Lebedev for low frequencies) and it is also valid for any velocity !

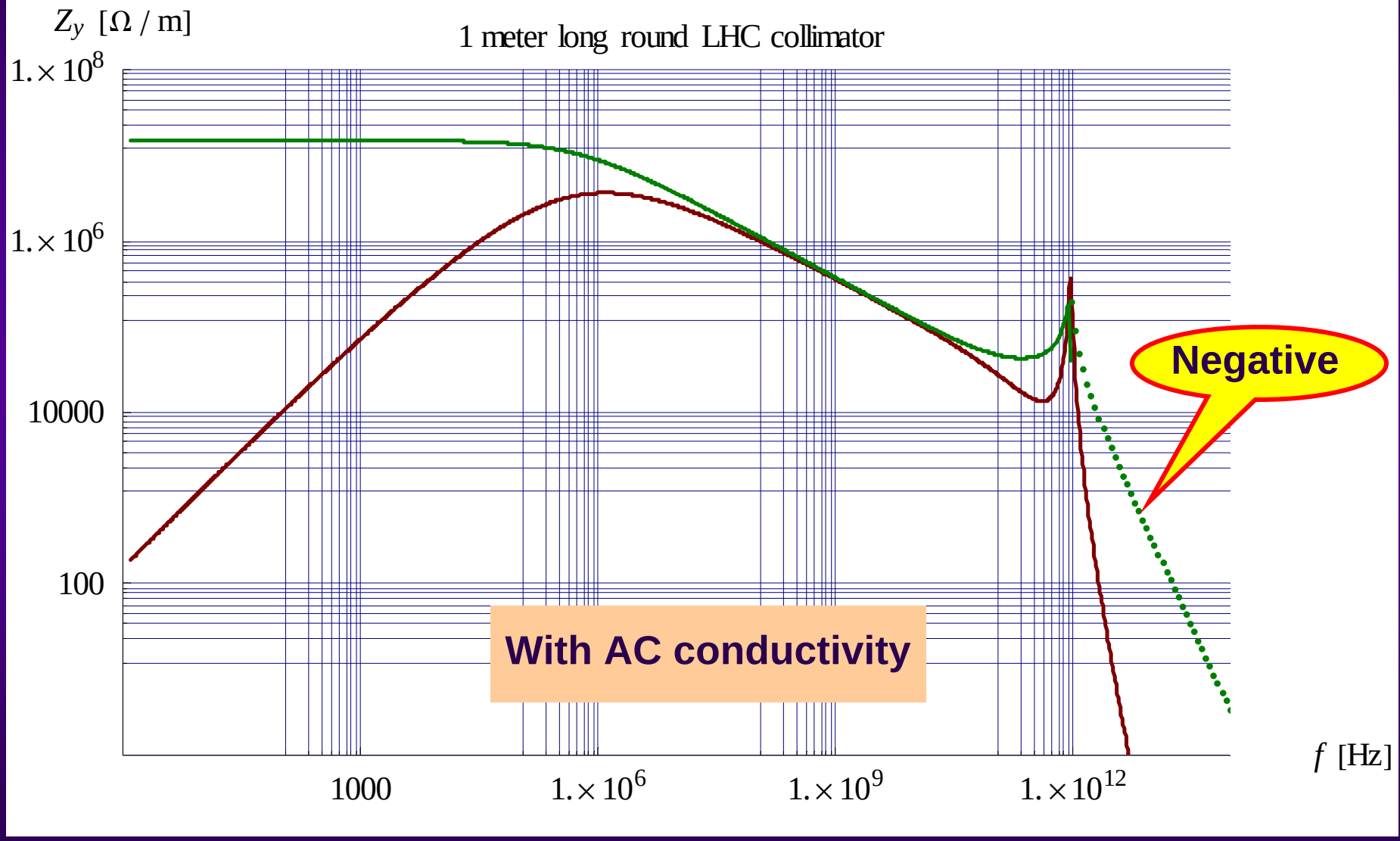
CONCLUSION (2/4)

$\Longrightarrow$ Global plot for a 1m long LHC graphite collimator with 2 mm half gap



CONCLUSION (3/4)

⟹ Global plot for a 1m long LHC graphite collimator with 2 mm half gap



CONCLUSION (4/4)

⟹ Global plot for a 1m long LHC graphite collimator with 2 mm half gap