

# **Low Frequency Collimator Measurements Preliminary Results - 14 Nov 2007**

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# Theory

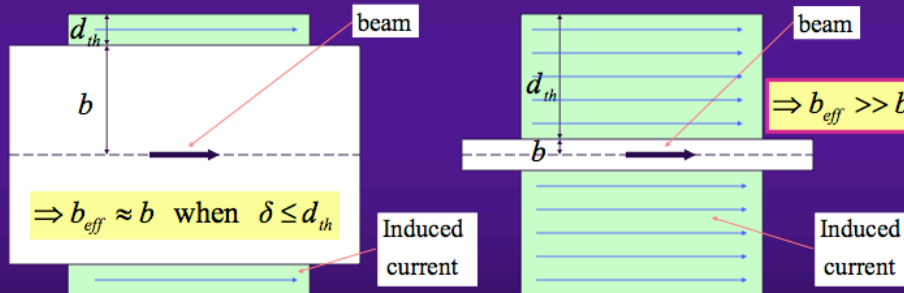
We want to bench mark theory:

◆ **In fact it is not** ⇒ The resistive impedance is ~ 2 orders of magnitude lower at ~ 8 kHz !

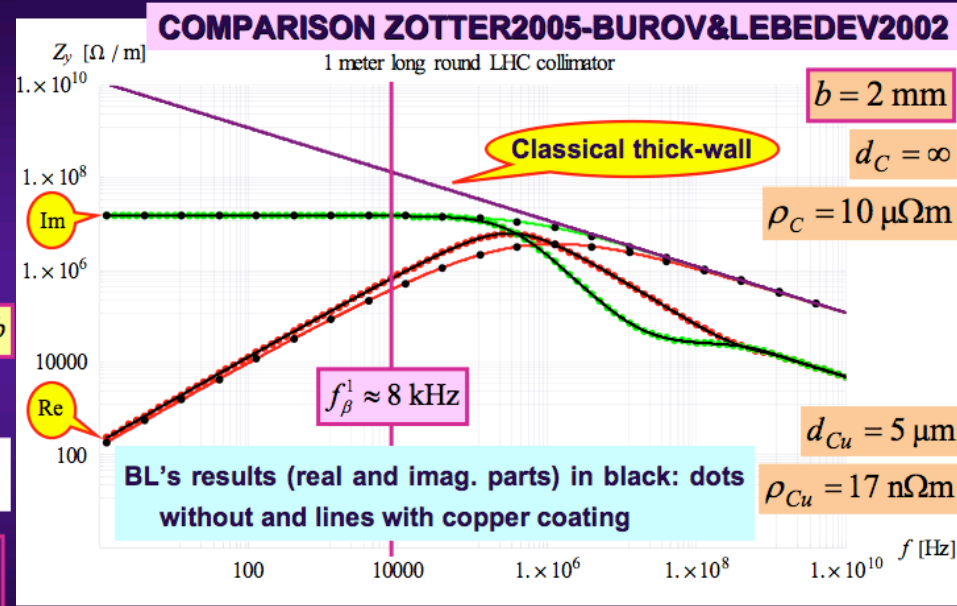
⇒ **A new physical regime was revealed by the LHC collimators**

Usual regime :  $d_{th}, \delta < b$

New regime :  $d_{th} \gg b, \delta \leq d_{th}$



⇒ **This inductive by-pass effect is therefore observed even with a single layer extending up to infinity**



# Measurement Method

Coaxial wire method to estimate transverse impedance

- single wire displaced
- two wires

has **low sensitivity at low frequencies**

Extension of two wires method:

**Evaluation of the transverse impedance of a DUT by measuring the inductance variation of a probe coil**

F.Caspers, A.Mostacci, L.Vos [http://lhcp.web.cern.ch/lhcp/LCC/LCC\\_2002-01.htm#main3a](http://lhcp.web.cern.ch/lhcp/LCC/LCC_2002-01.htm#main3a)

F.Caspers, A.Mostacci, U.Iriso

**Bench Measurements of Low Frequency Transverse Impedance,**  
CERN-AB-2003-051-RF

# Measurements

Measured quantity: the complex impedance of the coil from the S11 (reflection) signal

- Z reference --> high conductivity material (copper)
- Z DUT --> low conductivity material (graphite)

**From measurements:**

$$\vec{Z}_T(\omega) = \frac{c}{\omega} \frac{\vec{Z}^{DUT}(\omega) - \vec{Z}^{REF}(\omega)}{N^2 \Delta^2}$$

# of turns

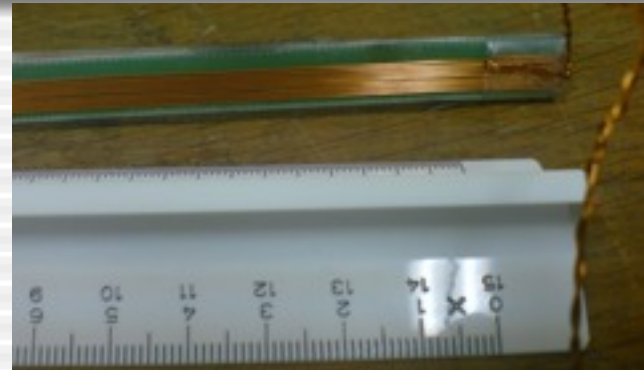
Coil width

$$Z_{meas} = Z_{rw}^{graph} - Z_{rw}^{Cu} \Rightarrow \text{simple processing to plot } Z_{rw}^{graph} \text{ (next slide)}$$

# Measurement set up

Best coil prototype used until now:

$$L = 30 \text{ cm}$$
$$\Delta = 2.5 \text{ mm}$$
$$N_{\text{turns}} = 9$$

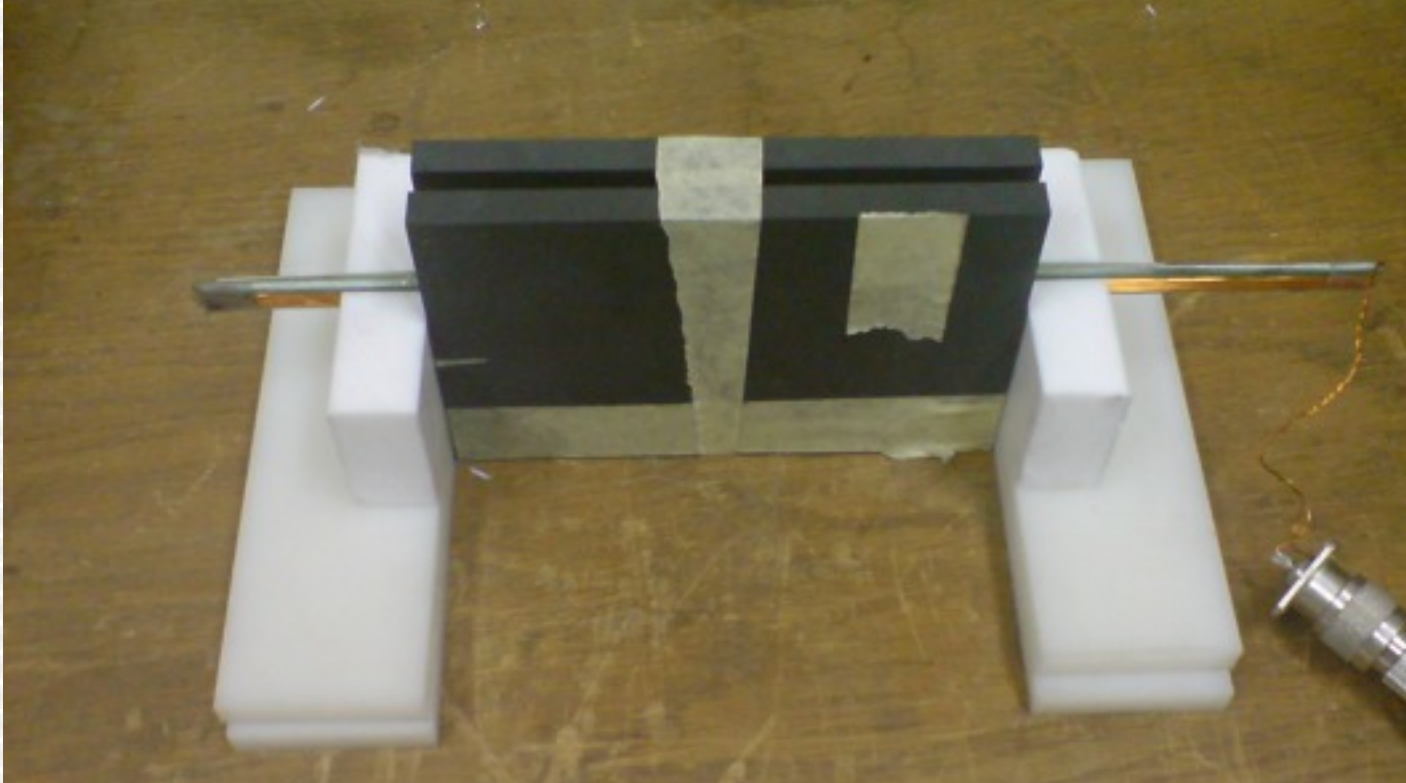


Used with Copper and Graphite blocks:

$$10 \text{ cm} \times 15 \text{ cm}$$
$$1 \text{ cm thick}$$

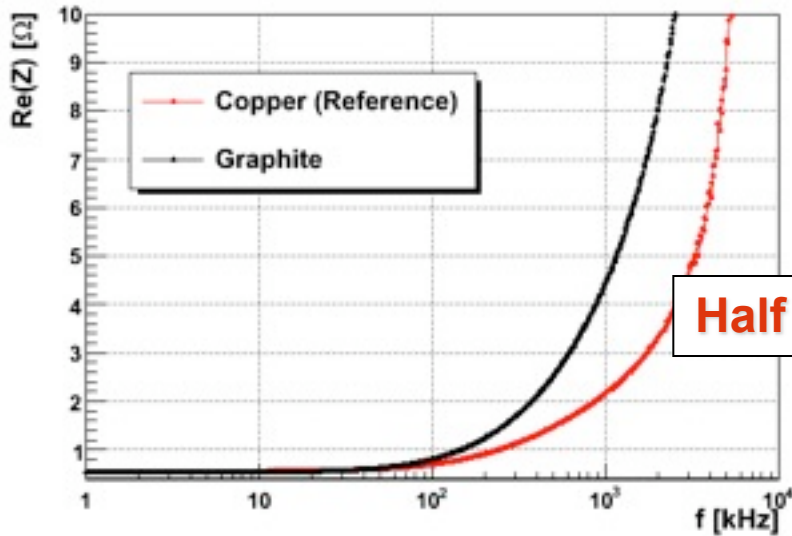


# Measurement Setup

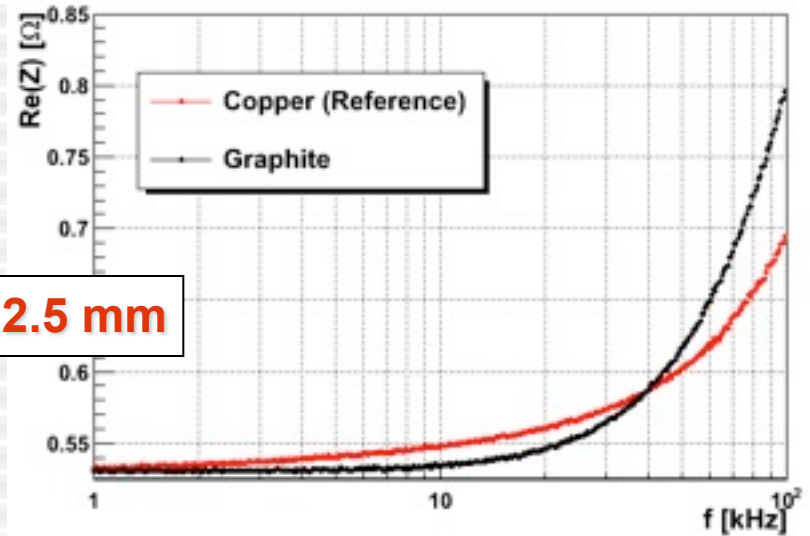


# Raw data, as measured with VNA

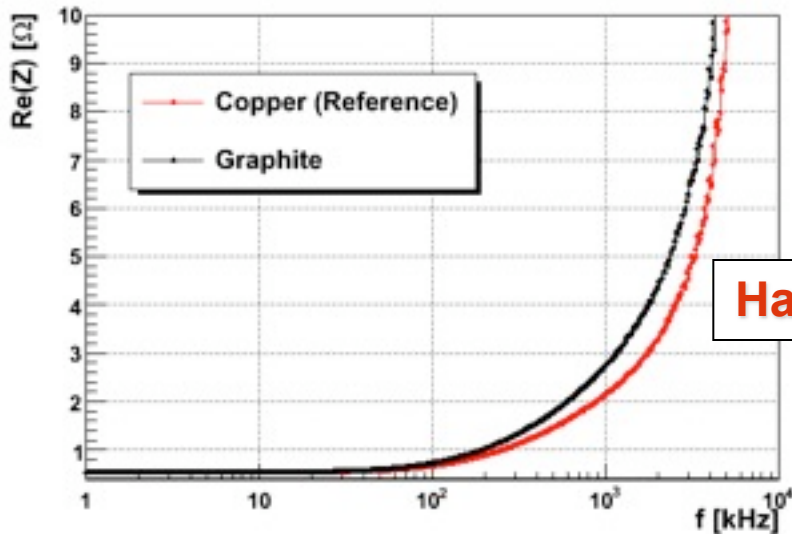
Raw Data: Re(Z) from reflection



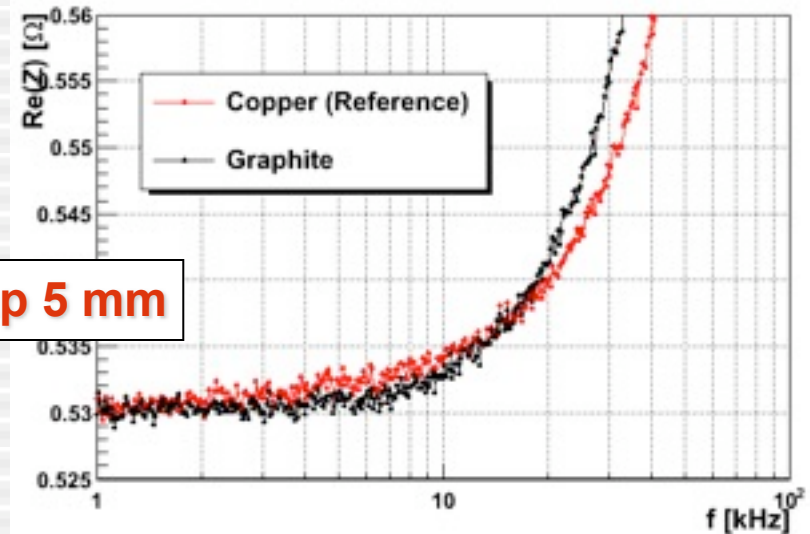
Raw Data: Re(Z) from reflection (detail at low freq)



Raw Data: Re(Z) from reflection

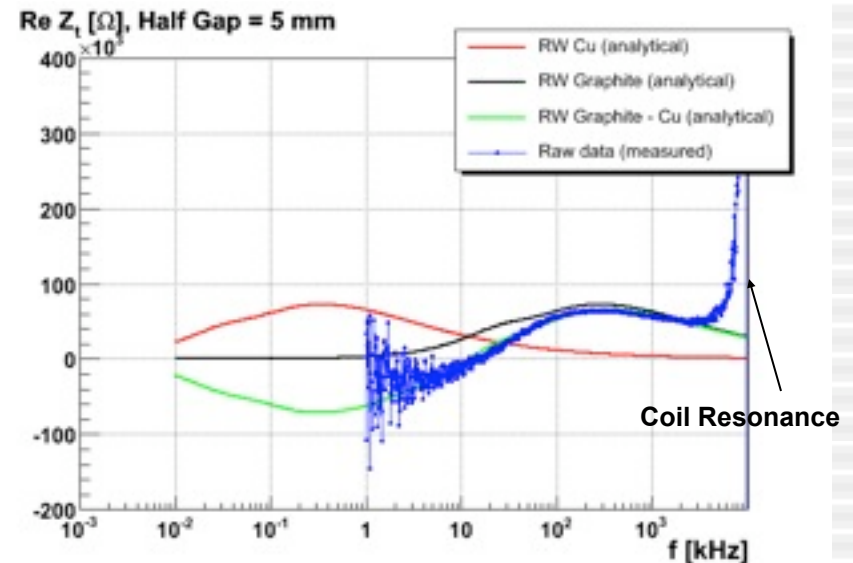
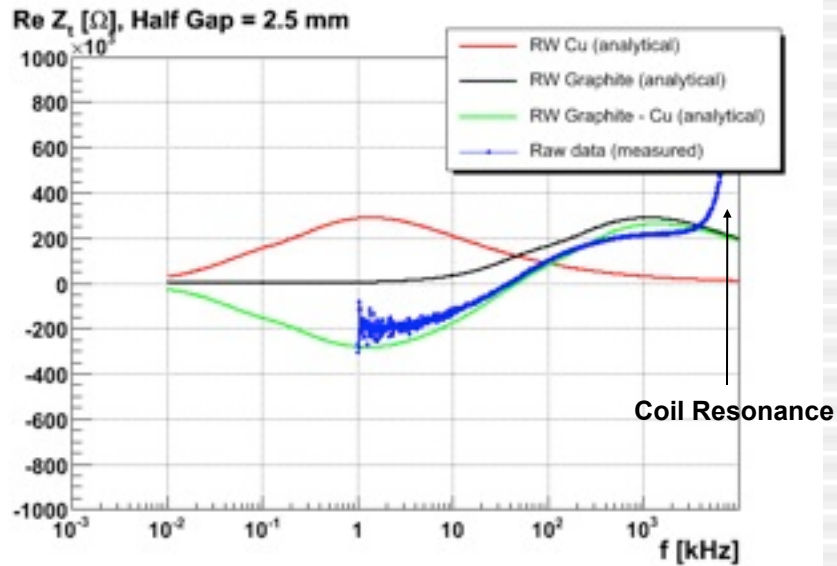


Raw Data: Re(Z) from reflection (detail at low freq)



# Preliminary results

Apply formula : 
$$\vec{Z}_T(\omega) = \frac{c}{\omega} \frac{\vec{Z}^{DUT}(\omega) - \vec{Z}^{REF}(\omega)}{N^2 \Delta^2}$$



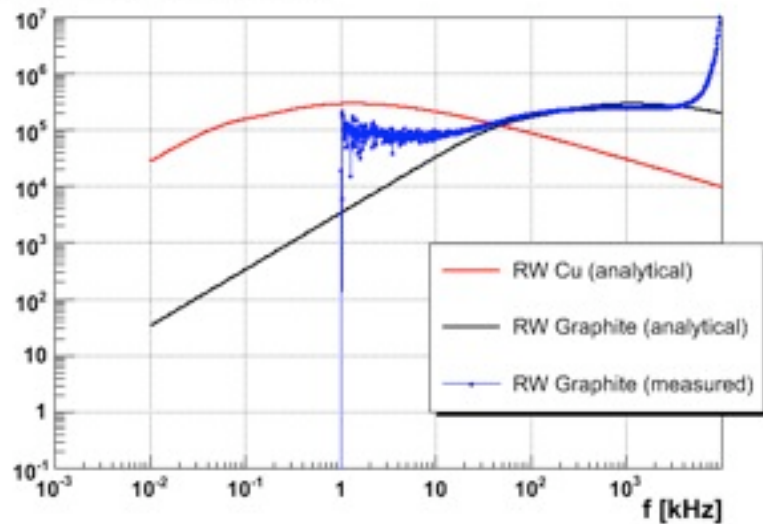
But:

$$Z_{meas} = Z_{rw}^{graph} - Z_{rw}^{Cu} \Rightarrow \text{simple processing to plot } Z_{rw}^{graph} \text{ (next slide)}$$

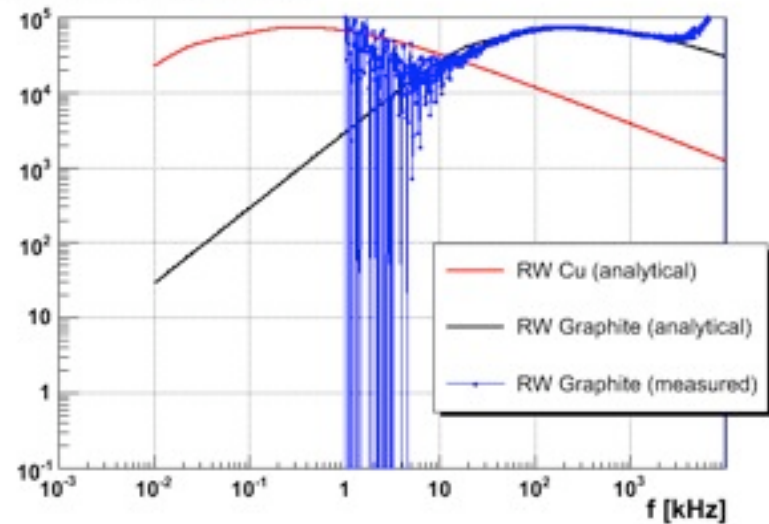


# Preliminary results - processed data

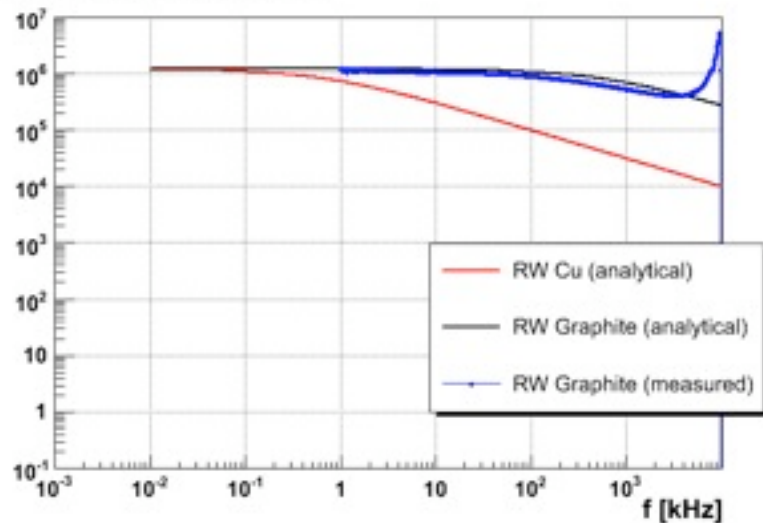
Re  $Z_i$  [ $\Omega$ ], Half Gap = 2.5 mm



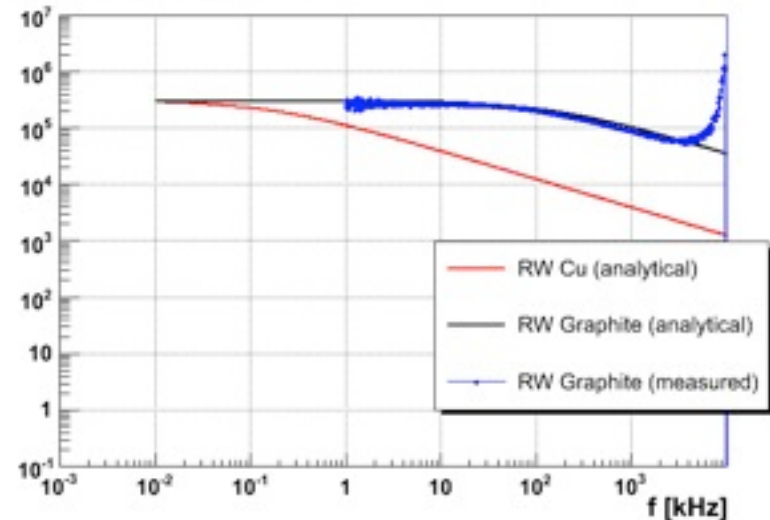
Re  $Z_i$  [ $\Omega$ ], Half Gap = 5 mm



Im  $Z_i$  [ $\Omega$ ], Half Gap = 2.5 mm



Im  $Z_i$  [ $\Omega$ ], Half Gap = 5 mm



# Next steps I

## Check/Improve:

- coil and plate positioning and alignment
- data processing/averaging
- other gap configurations

## Test

- more coil prototypes produced by us
  - with more turns
  - different lengths

- coils from AT department
  - much more turns but thinner wires

## Next steps II

Collimator Jaws

Collimator assembly