Low Frequency Collimator Measurements
Preliminary Results - 14 Nov 2007
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We want to benchmark theory:

**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: \( d_{th} \gg b, \delta \leq d_{th} \)

⇒ \( b_{eff} \approx b \) when \( \delta \leq d_{th} \)

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

COMPARISON ZOTTER2005-BUROV&LEBEDEV2002

\[ f_{\beta} \approx 8 \text{ kHz} \]

1 meter long round LHC collimator

- Classical thick-wall
- \( \rho_C = 10 \mu\Omega m \)
- \( d_{Cu} = 5 \mu m \)
- \( \rho_{Cu} = 17 \text{ n}\Omega m \)

BL's results (real and imag. parts) in black: dots without and lines with copper coating

Elias Mérat, LHC collimation working group meeting, 17/07/06
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
Measured quantity: the complex impedance of the coil from the S11 (reflection) signal

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

From measurements:

\[
\tilde{Z}_T(\omega) = \frac{c}{\omega} \frac{\tilde{Z}_{DUT}(\omega) - \tilde{Z}_{REF}(\omega)}{N^2\Delta^2}
\]

\( Z_{meas} = Z_{r_w}^{\text{graph}} - Z_{r_w}^{Cu} \Rightarrow \text{simple processing to plot } Z_{r_w}^{\text{graph}} \) (next slide)
Best coil prototype used until now:

\[ L = 30 \, cm \]
\[ \Delta = 2.5 \, mm \]
\[ N_{\text{turns}} = 9 \]

Used with Copper and Graphite blocks:

10cm × 15cm
1cm thick
Measurement Setup
Raw data, as measured with VNA

Half Gap 2.5 mm

Half Gap 5 mm
Preliminary results

Apply formula:

\[ Z_T(\omega) = \frac{c}{\omega} \frac{Z_{DUT}(\omega) - Z_{REF}(\omega)}{N^2 \Delta^2} \]

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
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