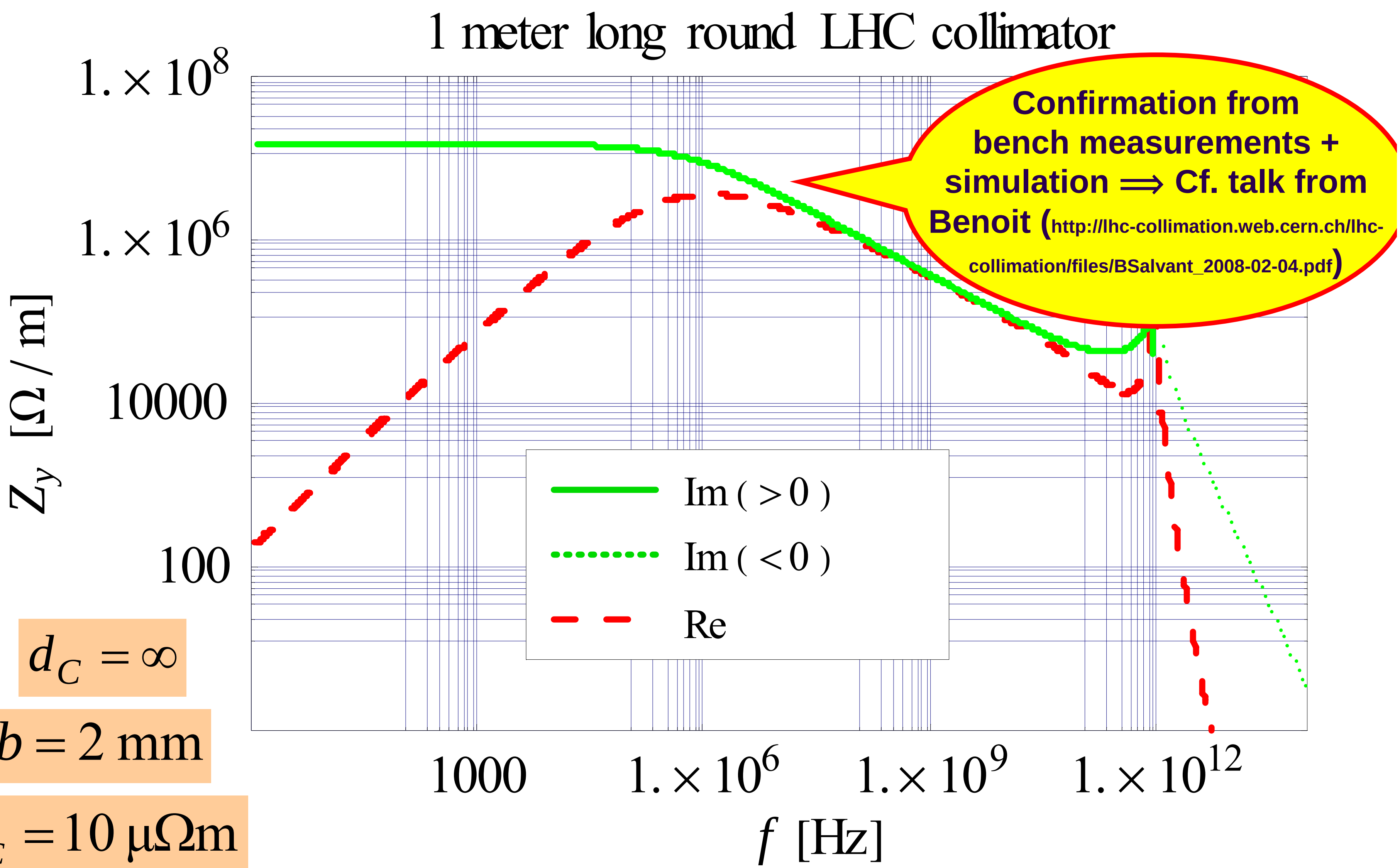
REVIEW OF IMPEDANCE ISSUES AND FIRST IDEAS FOR PHASE 2

F. Caspers and E. Métral

ZOTTER2005'S THEORY FOR 1 GRAPHITE COLLIMATOR



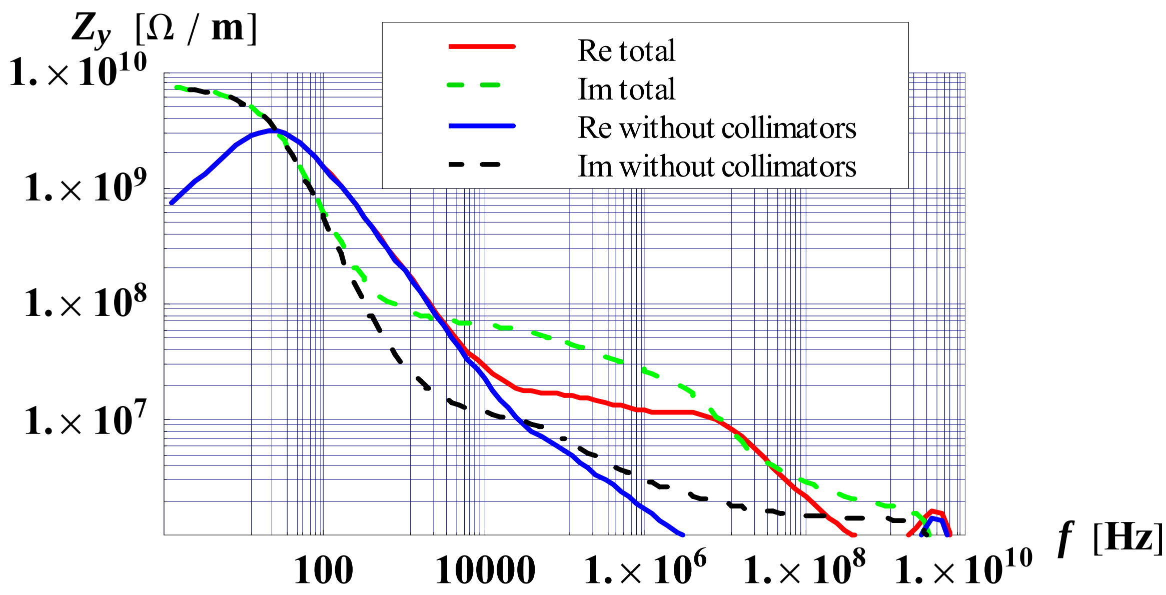
$d_C = \infty$

$b = 2$ mm

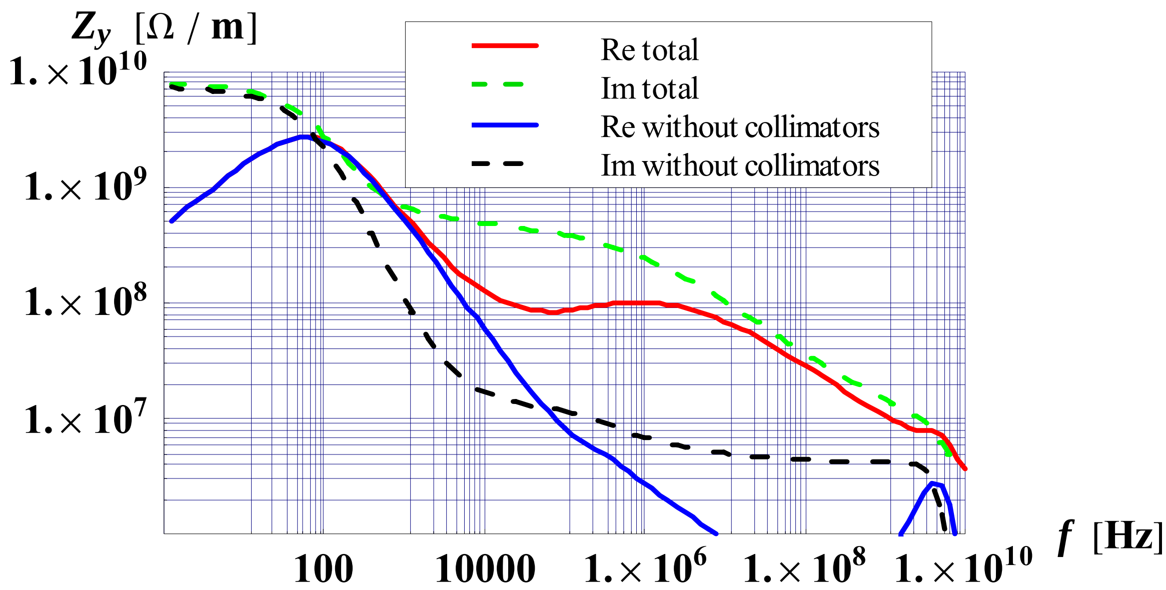
$\rho_C = 10\ \mu\Omega\mathrm{m}$

LHC TRANSVERSE IMPEDANCE

INJECTION



TOP ENERGY (after squeeze)



STABILITY DIAGRAM (1/3)

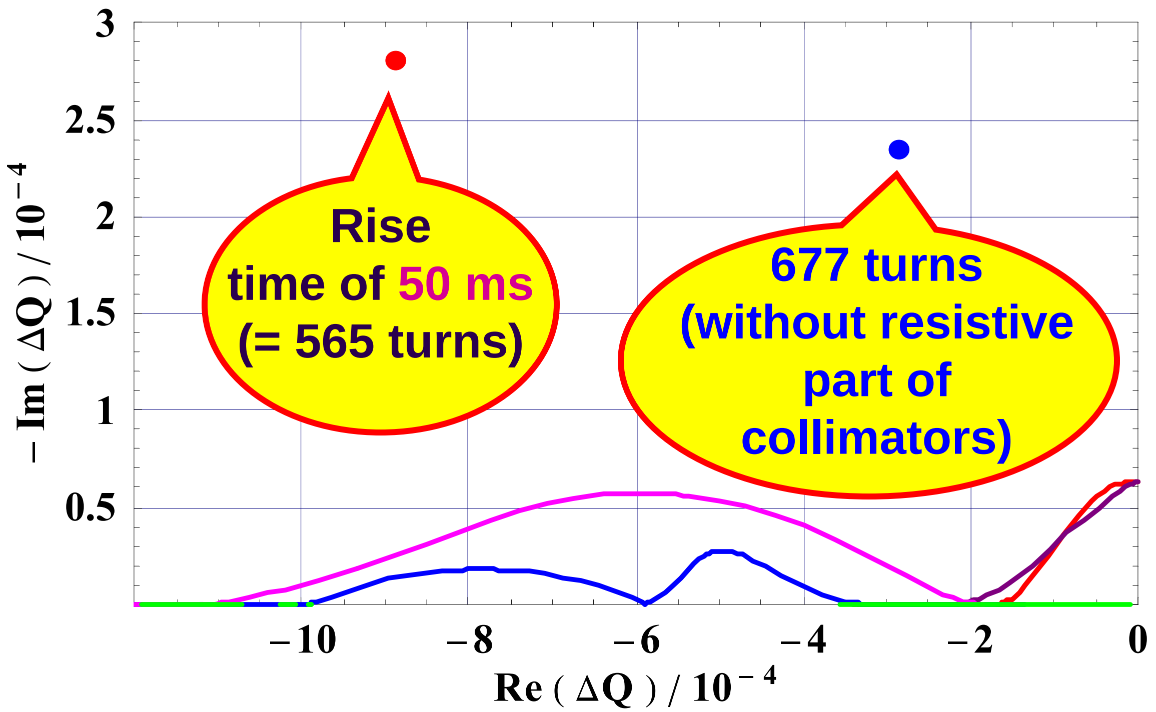
INJECTION

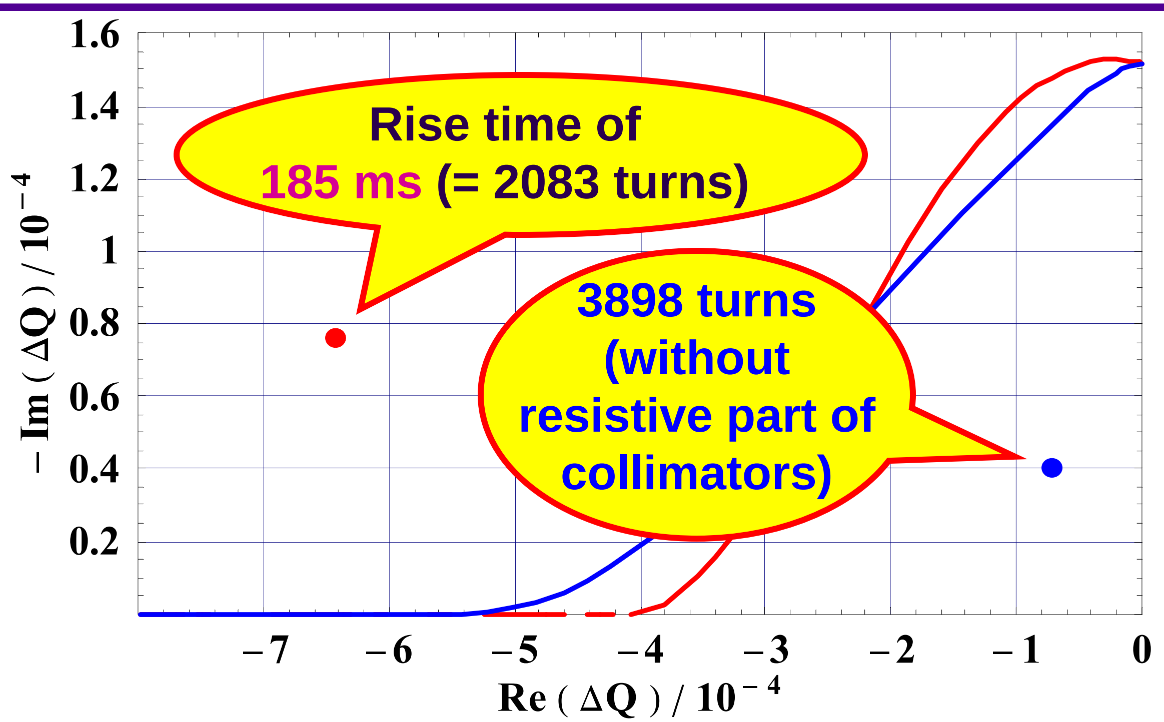
- Nominal case (25 ns bunch spacing and nominal intensity)

$T_{rev}^{LHC} \approx 89\ \mu s$

TOP ENERGY (after squeeze)

Reminder: $- \text{Im}\ (\Delta Q) / 10^{-4} = 1 \Longrightarrow$ Rise time ≈ 1600 turns ≈ 140 ms

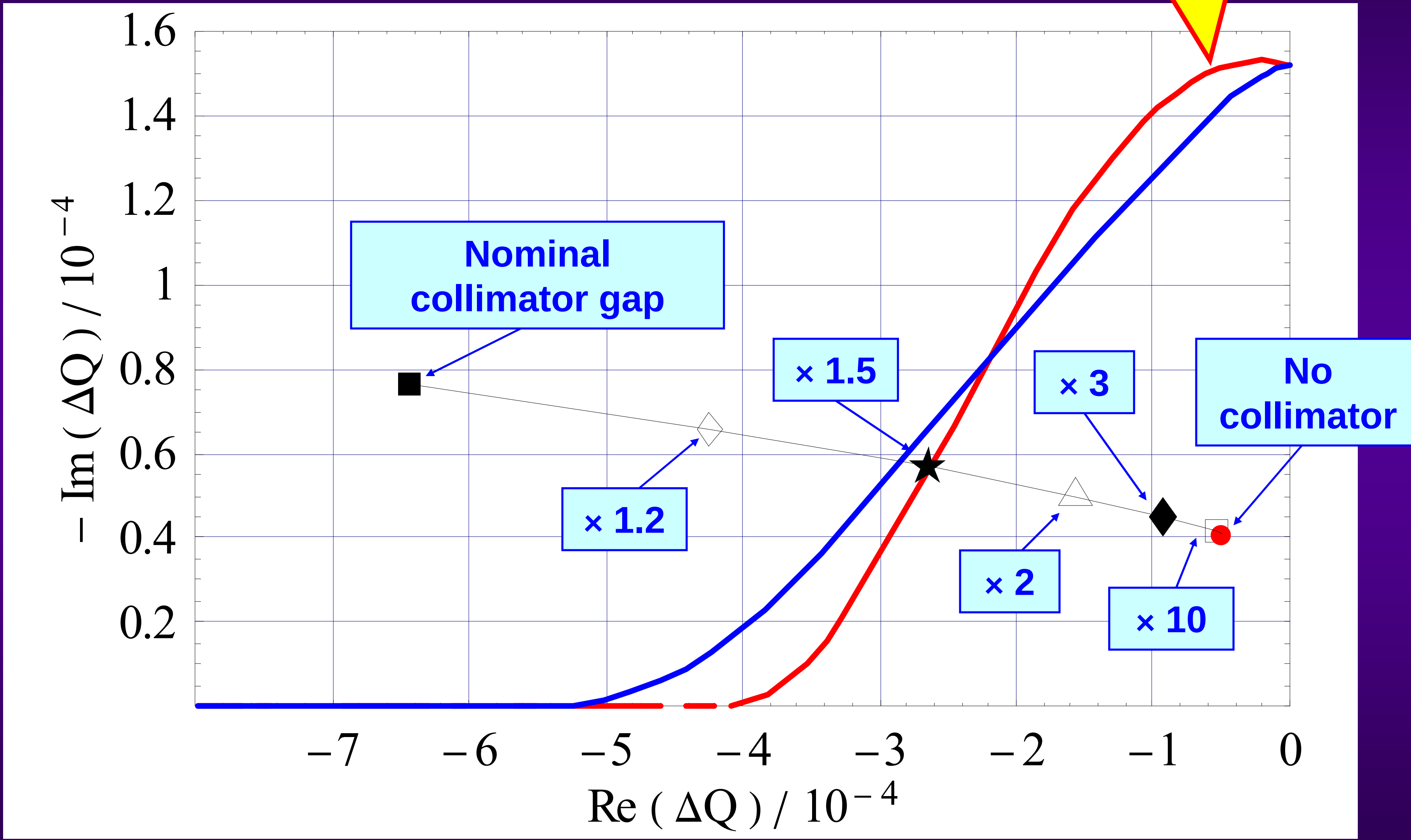




STABILITY DIAGRAM (2/3)

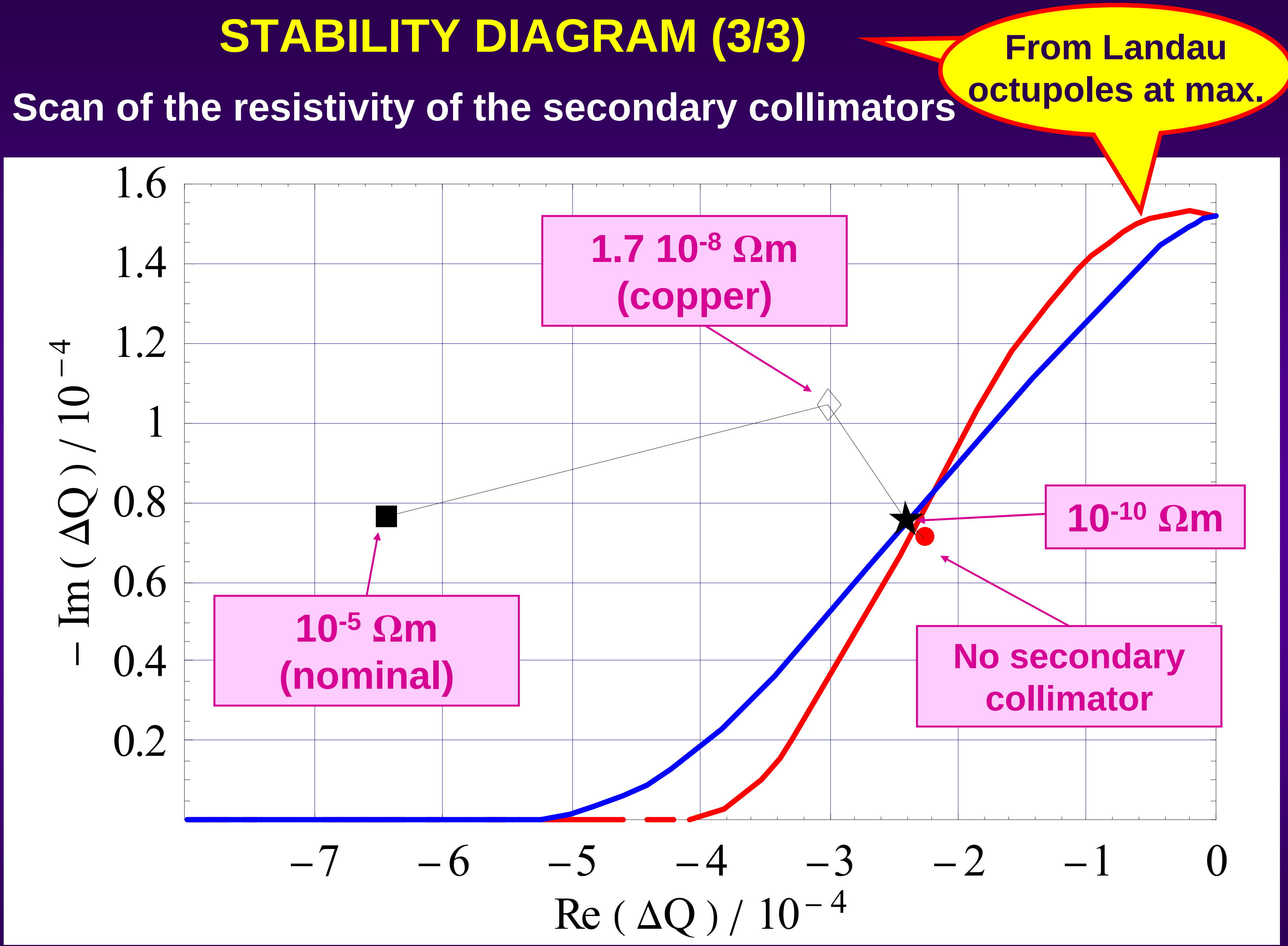
From Landau octupoles at max.

- **Scan of the gap of the collimators (top energy)**



STABILITY DIAGRAM (3/3)

- **Scan of the resistivity of the secondary collimators**



TRANSVERSE FEEDBACK (1/2)

- **The transverse feedback system should be able to damp instability rise-times of (I take a safety margin of a factor 2 compared to what was computed in the previous slides)**

  - **AT INJECTION ENERGY**

    - **~ 280 turns (i.e. ~ 25 ms) at injection for nominal intensity**
    - **~ 190 turns (i.e. ~ 17 ms) at injection for ultimate intensity**

  - **AT TOP ENERGY (AFTER THE SQUEEZE)**

    - **~ 1040 turns (i.e. ~ 93 ms) at injection for nominal intensity**
    - **~ 705 turns (i.e. ~ 63 ms) at injection for ultimate intensity**

TRANSVERSE FEEDBACK (2/2)

- **According to W. Hofle (email of 18/10/2007):**
  - **In the SPS ~ 20 turns damping is achieved in the vertical plane on a regular basis**
  - **The normal operating mode of the feedback should be at gains corresponding to 20-40 turns damping**

    $\Longrightarrow$ It seems therefore feasible to damp the foreseen instability rise-times both at injection and top energy
  - **The issue of the noise at top energy: K. Ohmi et al. (PAC 2007, LHC Project Report 1048) has estimated from numerical calculations that we can run in the LHC at a gain of 0.1 (10 turns damping) with a monitor resolution of 0.6% of σ and still have a luminosity life-time of one day. The corresponding required resolution is 7.2 μm at 450 GeV (σ = 1.2 mm) and 1.8 mm at 7 TeV (σ proportional to $\gamma^{-1/2}$). If the gain can be reduced, then the requirement for the monitor resolution can be relaxed. The improvement in monitor resolution required for LHC when compared with the SPS can be achieved due to the increased number of bits used and the higher signal power available from the coupler type pick-up**

CONCLUSIONS AND OUTLOOK (1/2)

- **The transverse impedance (both RE and IM parts) of the LHC can be decreased by increasing the gap of the collimators**

- **The RE part of the transverse impedance of the LHC is increased by reducing the resistivity of the secondary collimators**

- **The beam will be stabilized at injection by a transverse feedback**

- **At top energy:**

    - **If one wants to stabilize the beam at top energy by Landau damping $\Longrightarrow$ One should try and reduce the IMAGINARY part of the collimator impedance (this has a huge effect compared to the rest of the machine!)**

    - **If one wants to (can) stabilize the beam at top energy by transverse feedback $\Longrightarrow$ It seems that it should be possible (Check however carefully the range between 10 and 20 MHz as the gain of power amplifier rolls off!). In this case one can help the feedback system even more by reducing the REAL part of the collimator impedance (in particular until ~ 20 MHz)**

CONCLUSIONS AND OUTLOOK (2/2)

- **First ideas from Fritz to try and reduce the transverse impedance of the collimators $\Longrightarrow$ Use (depending on what we want)**
  - **Ceramics**
  - **Litz-wires**
  - **…**

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Frequency-Dependent Resistance in Litz-Wire Planar Windings for Domestic Induction Heating Appliances

Jesús Acero, *Member, IEEE*, Rafael Alonso, José M. Burdío, *Member, IEEE*, Luis A. Barragán, and Diego Puyal

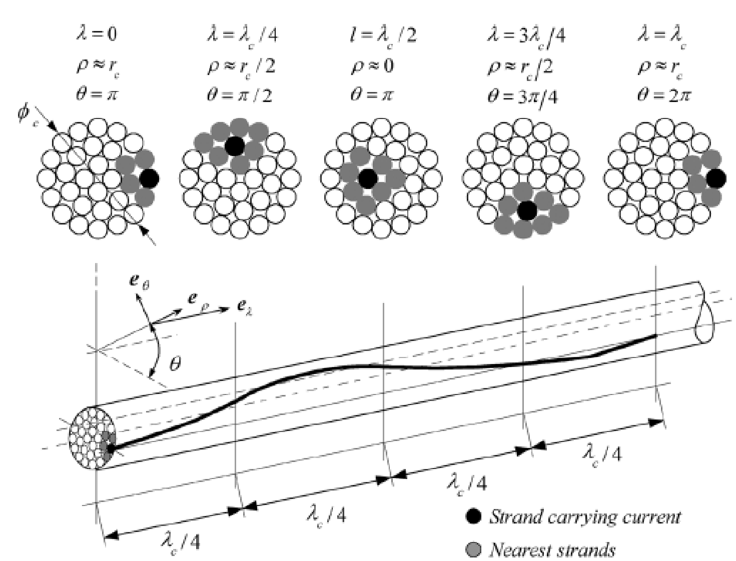

Fig. 2. Length λ_c of a Litz wire. A strand and its nearest strands are shown for the different λ coordinates. The coordinates of the strand inside the bundle are also shown for the different λ.