HL LHC collimator scenarios: some impedance considerations

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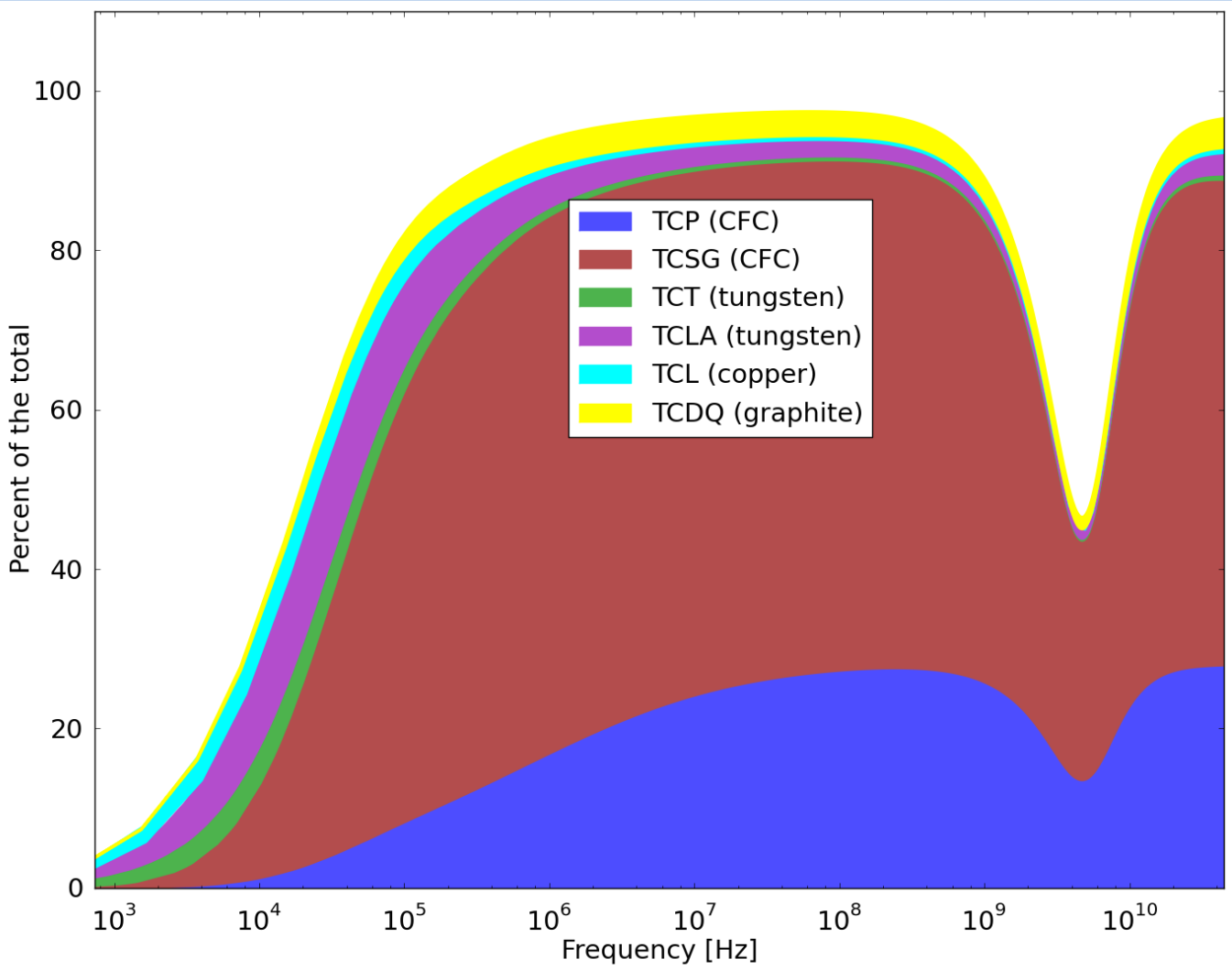
HL-LHC collimator scenarios: impedance considerations

- Introduction: some facts about the collimators impedance at 4 TeV in 2012
- HL-LHC preliminary impedance calculations for several collimator scenarios
- Conclusion and work to be done

Introduction: contribution of various collimator families to total ”2012 - 4TeV” impedance (1/2)

- Real part of the impedance: relative contribution of collimator families to total impedance model (vertical dipolar, 4 TeV, 2012 settings):

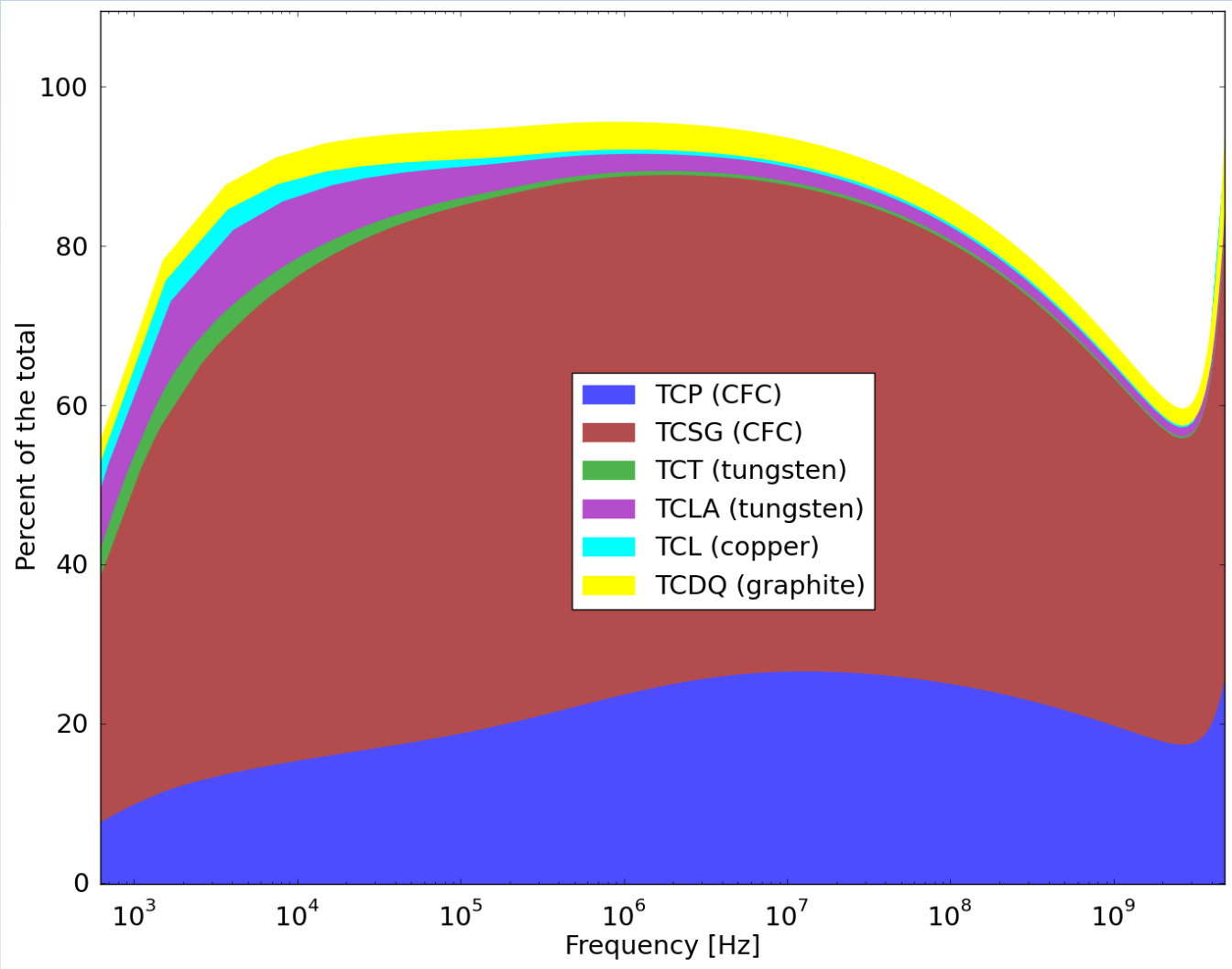


⇒ TCSG and TCP are largely dominant.

Note: this is similar in horizontal.

Introduction: contribution of various collimator families to total ”2012 - 4TeV” impedance (2/2)

- Imag. part of the impedance: relative contribution of collimator families to total impedance model (vertical dipolar, 4 TeV, 2012 settings):

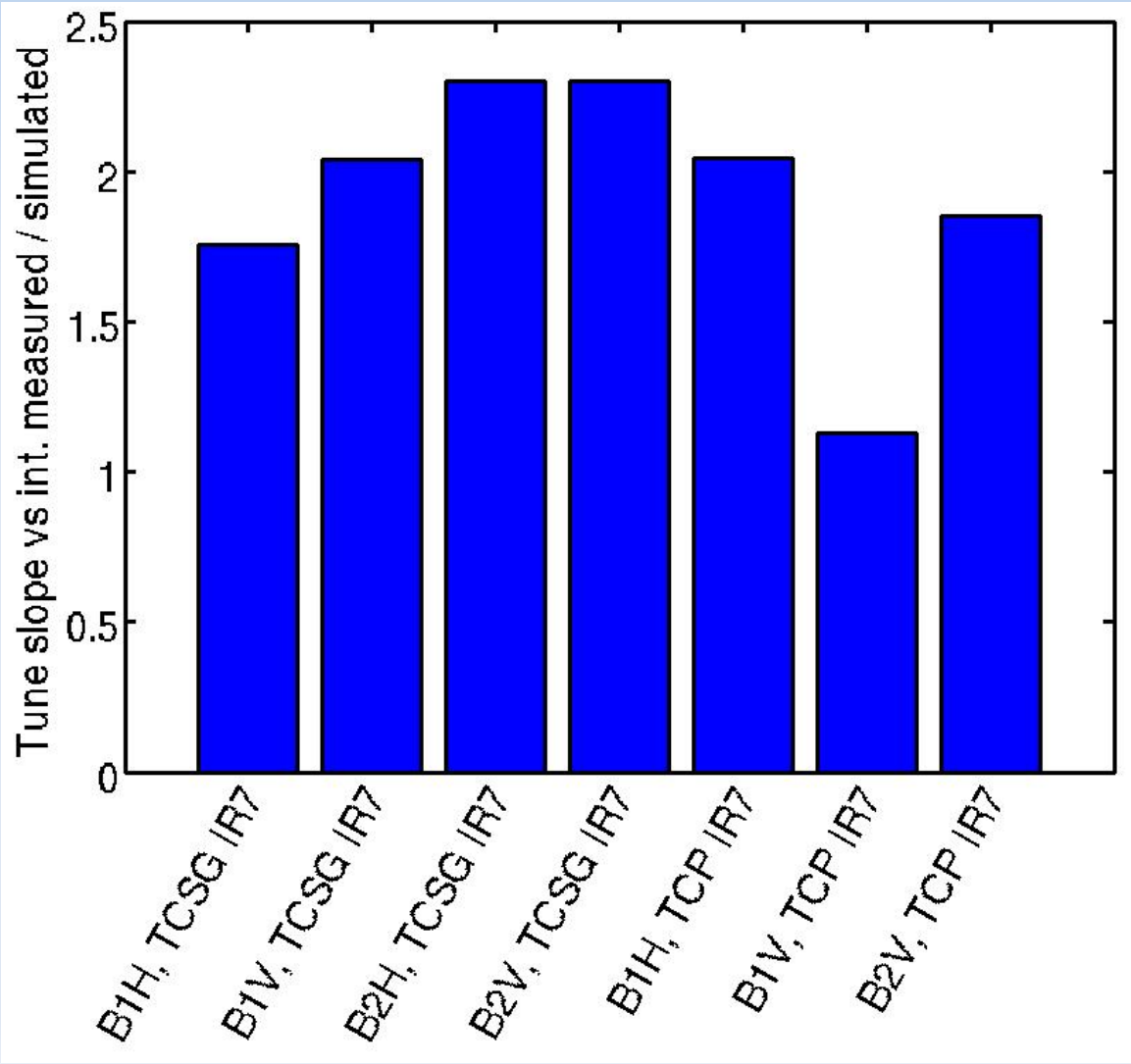


⇒ TCSG and TCP are largely dominant.

Note: this is similar in horizontal.

Evaluation of the LHC impedance model w.r.t beam-based measurements

- Tune shifts measurements when moving collimator families at 4TeV (*Q' ~ 0-2*)
  → compare tune slope w.r.t. intensity between simulations & measurements
  (thanks to R. Bruce, E. Quaranta, B. Salvachua, G. Valentino et al):



→ Discrepancy factor around 2
(under investigation)

HL-LHC impedance calculations

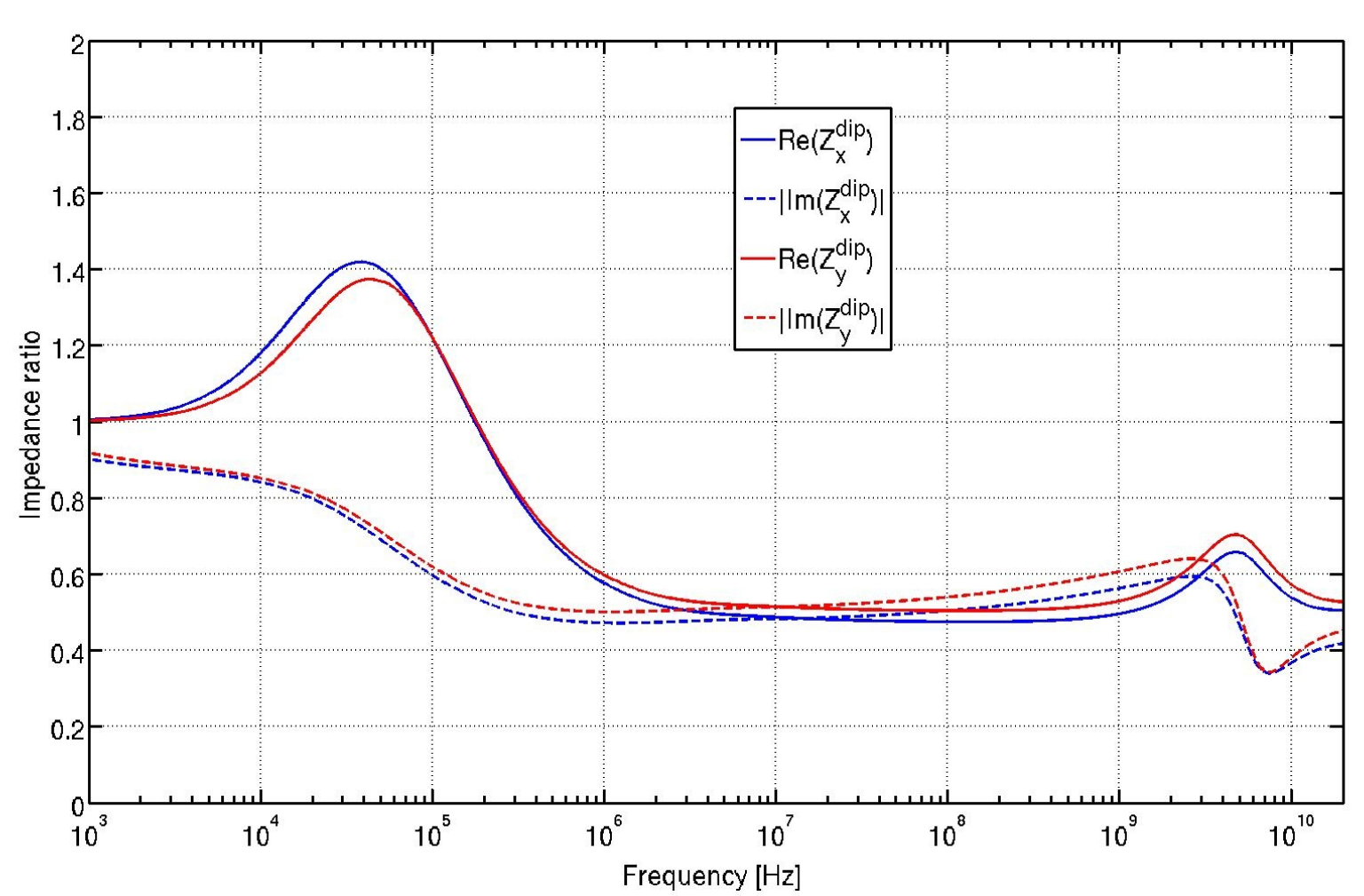
- Impedance model = cold beam screen (~86% of the LHC circumference)
  + warm vacuum pipe (~ the rest)
  + broad band model (taperings, etc.)

  } as in the current LHC model

  + collimators in two ”extreme” scenarios:
    - nominal settings (6σ TCP, 7σ TCS IR7), same materials as now (carbon-reinforced carbon or CFC – ρ_{CFC} = 5 μΩ.m)
    - relaxed settings (6σ TCP, 8.3σ TCS IR7), TCS in IR7 in molybdenum-coated graphite ($\rho_{graphite}$ = 15 μΩ.m, ρ_{Mo} = 5.35 μΩ.cm – cf. A. Bertarelli et al).

Comparison between two extreme cases

- Ratio between ”relaxed-metallic” and ”nominal-CFC” scenarios (horizontal and vertical dipolar terms, flat top):

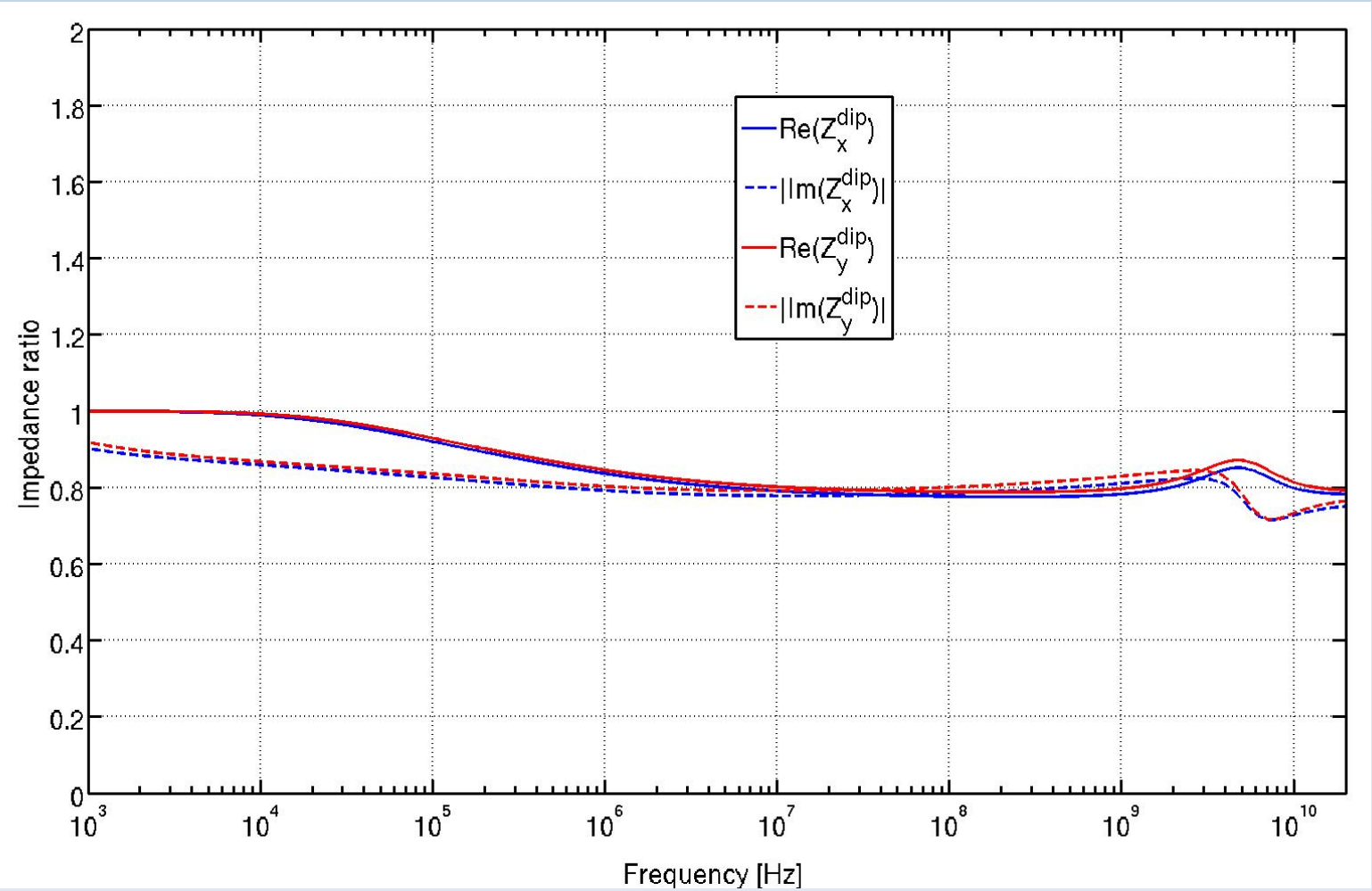


⇒ Only real part of imp. at very low frequency is higher with the ”relaxed-metallic” option.

At intermediate frequencies, factor 2 gain in imp.

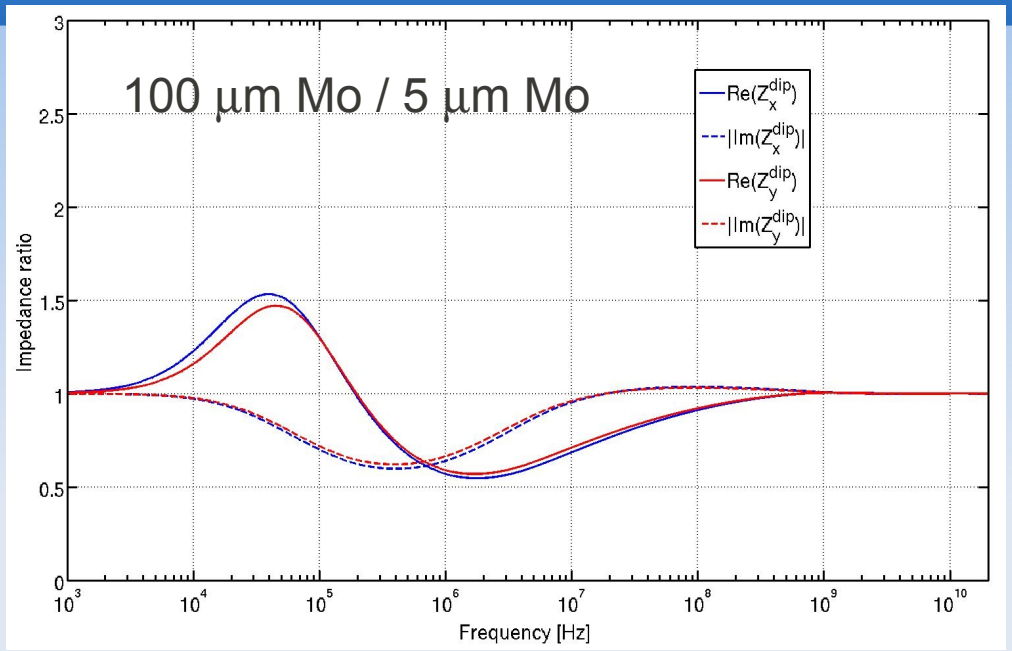
Effect of the settings alone

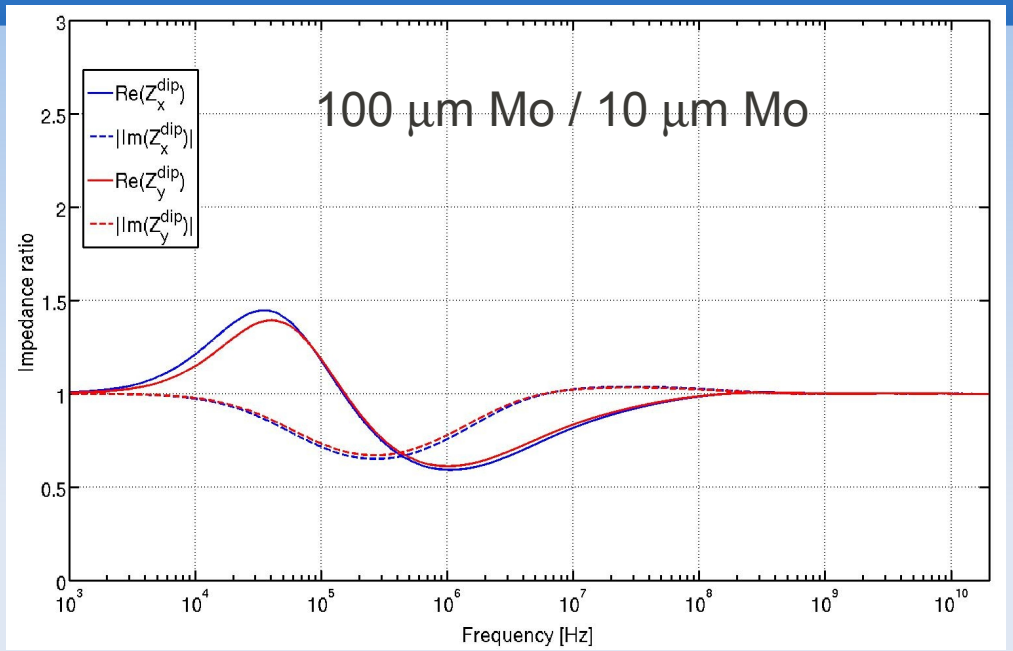
- Ratio between ”relaxed-CFC” and ”nominal-CFC” scenarios (horizontal and vertical dipolar terms, flat top):

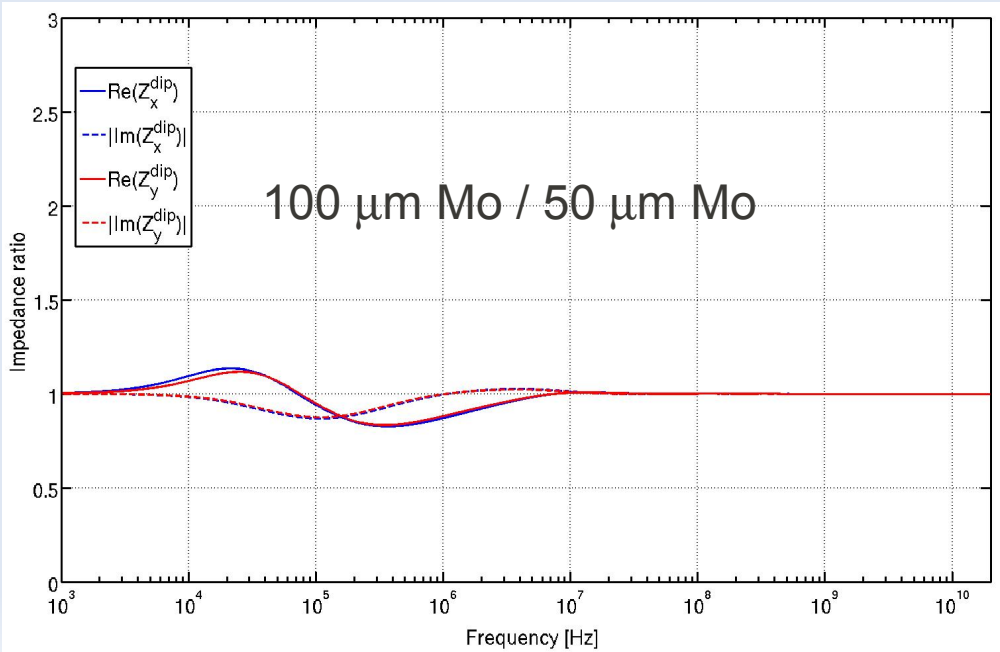


⇒ At intermediate frequencies, gain of only ~20% in impedance.

Effect of the molybedenum coating thickness



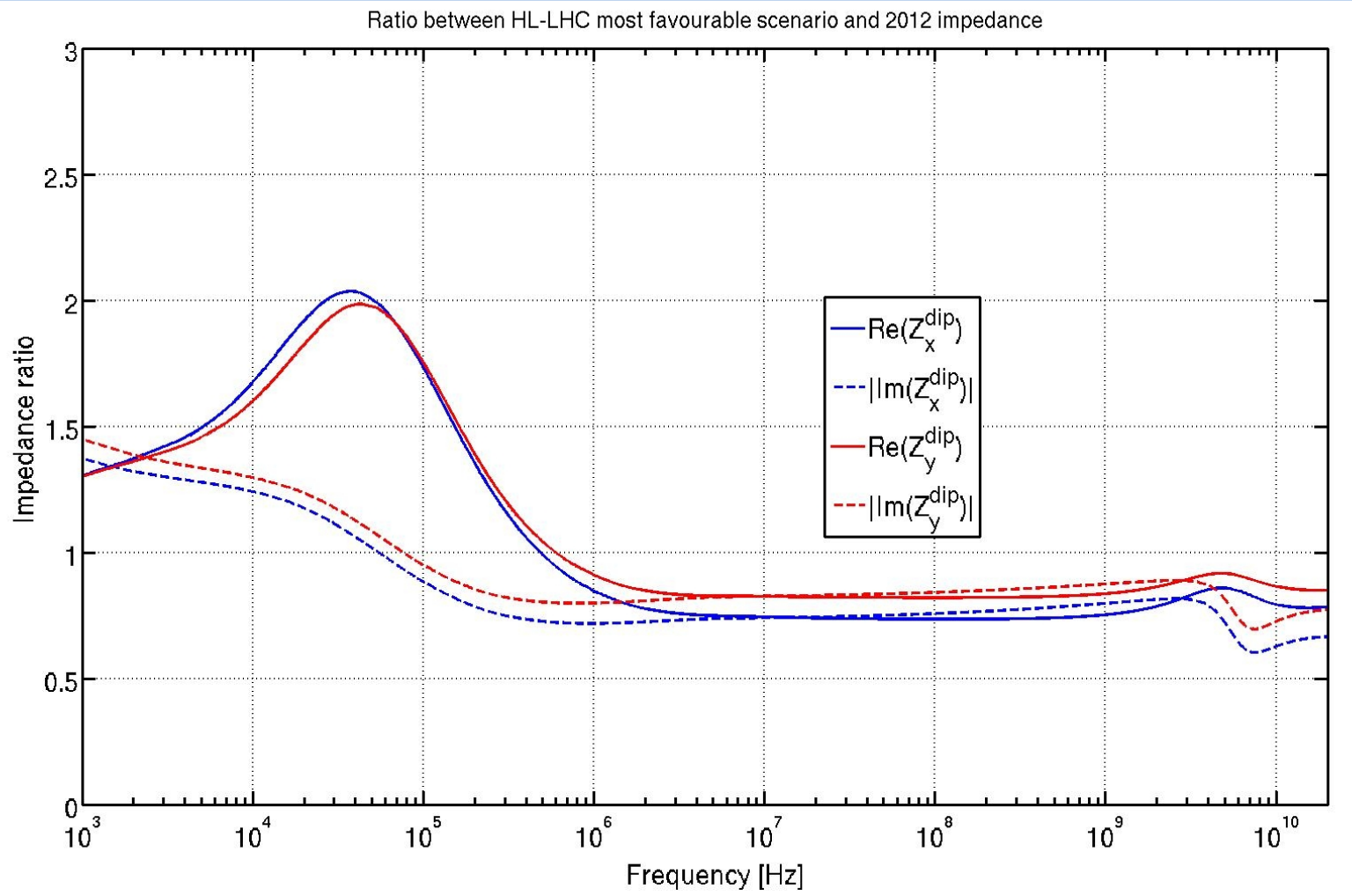




⇒ 50 μm of molybdenum are probably enough.
⇒ Need to check effect on beam stability to get an optimal (possibly lower) coating thickness.

Comparison between most favourable scenario and 2012 situation

- Comparing the impedances of the ”relaxed-metallic” scenario to the 2012 situation:



⇒ At intermediate frequencies, we gain ~20 % w.r.t. 2012.

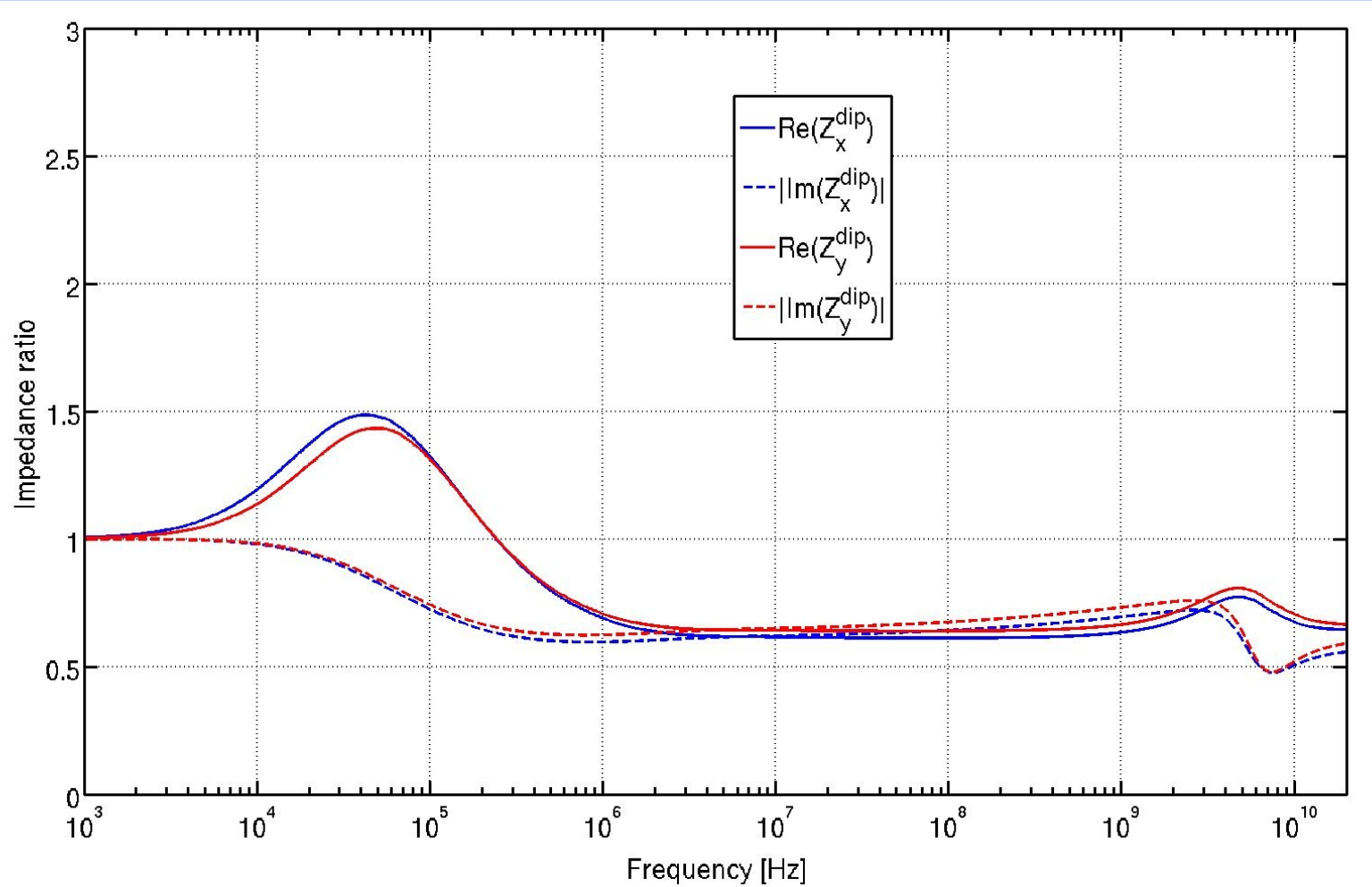
Preliminary conclusions and perspectives

- Beam stability with these collimator scenarios still to be studied, but most probably metallic secondary collimators in a relaxed configuration is what we would aim too (much better for the transverse impedance at intermediate frequencies).

- Future work:
  - Other possible settings scenarios.
  - Beam stability and heating studies.
  - Realistic geometric impedance evaluation of all present and future collimators (collaboration with M. Zobov, A. Mostacci et al at INFN).

Spare: comparison between CFC TCS and Mo-graphite TCS configurations

- Comparing the impedances of the ”relaxed-metallic” scenario to the ”relaxed-CFC” scenario:



⇒ At intermediate frequencies, we gain ~40 % with molybdenum.