

Update on Cu coating thickness and HL-LHC octupole thresholds

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At least 5 μm for Mo, 2(?) - 3 μm for Cu

Conclusion

The choice of bulk collimator material has little effect on the machine impedance and hence beam stability if the coating is sufficiently thick

5 μm coating provides a significant safety margin in terms of the octupole threshold

The increase of octupole current for thinner coatings is relatively small for most positive Q' , even when its thickness is reduced to 1 μm

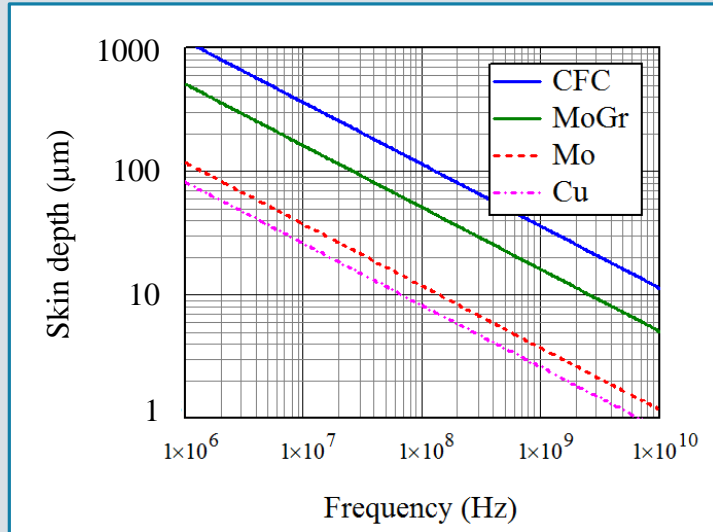
- Up to 20 A (~10% of the total) for Mo coating on MoGr and $Q' \sim 10$
- Nearly no effect for better coatings with lower resistivity, such as Cu
- The octupole threshold may double for certain values of Q'
 - Still, it shall **not exceed 300 A** at any chromaticity in the range $Q' = 5-20$

It may be technologically challenging to produce Cu coating thicker than 2 μm

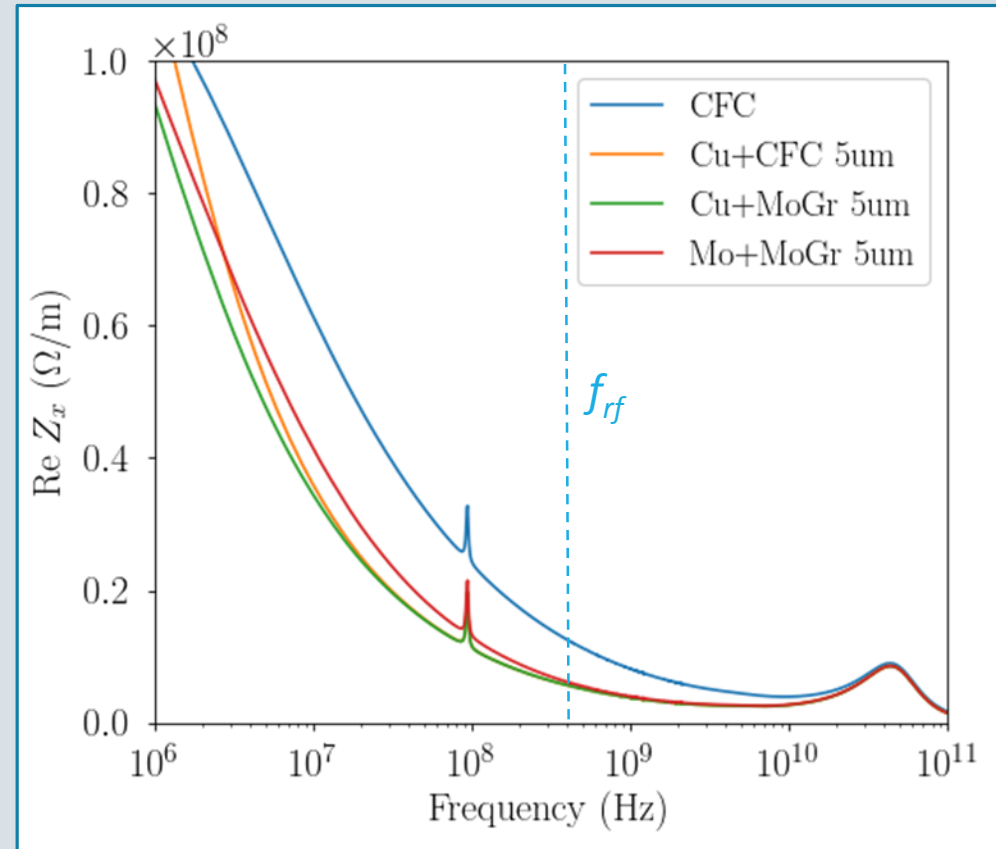
- Need to check also the 2 μm option

S. Antipov *et al.*, '[Effect of collimator coating thickness on HL-LHC octupole thresholds](#)', WP2 Meeting, 13.03.18

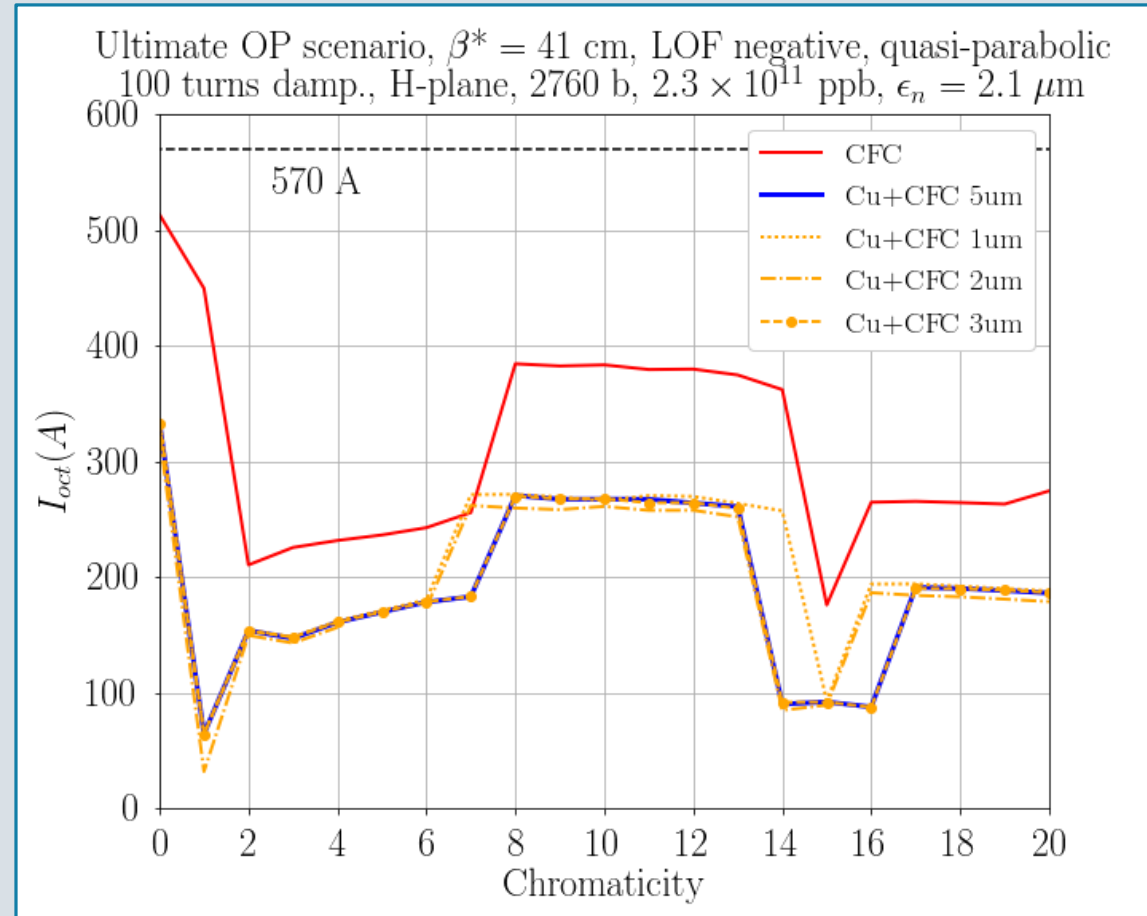
The bulk has little effect on impedance for a sufficiently thick coating



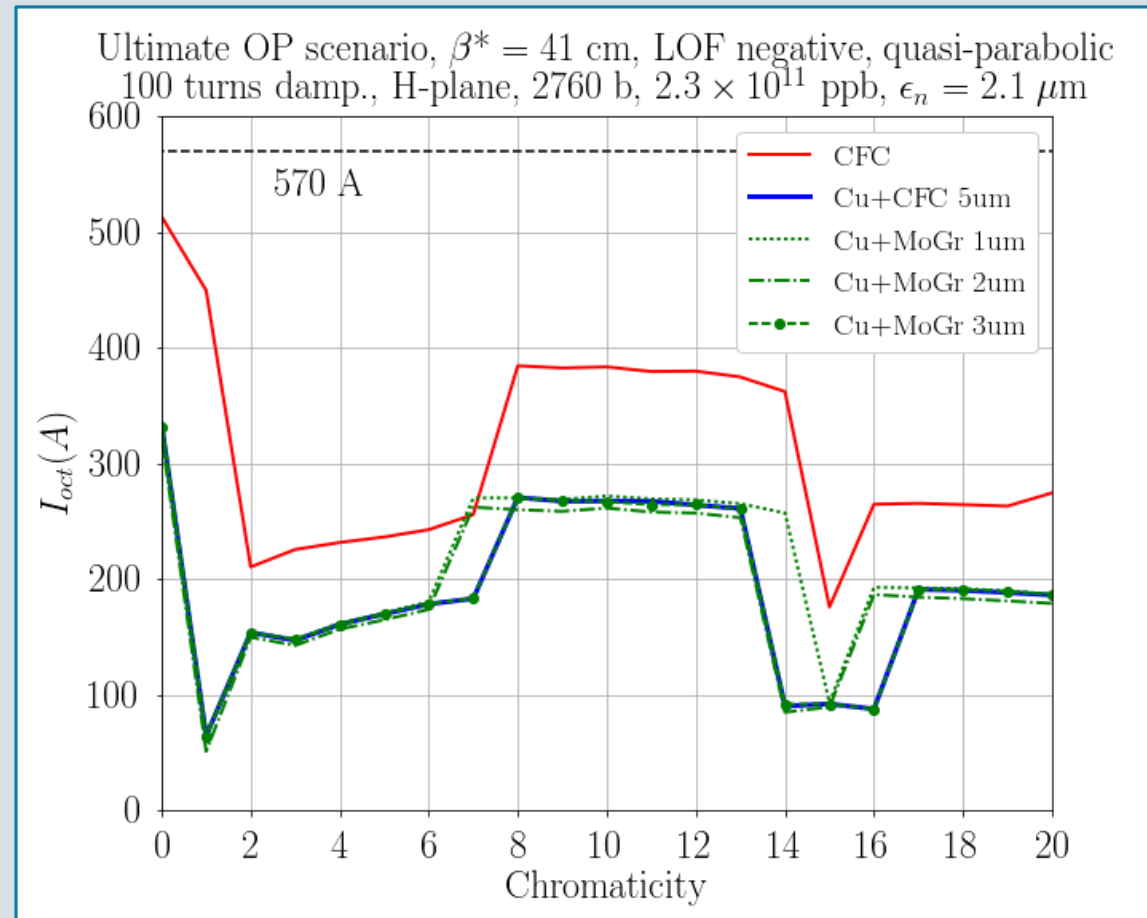
Material	Bulk resistivity (nΩ-m)
CFC	5000
MoGr	1000
Cu	26
Mo	53.5



Octupole threshold for thinner coatings, Cu on CFC: No significant increase for 2 μm , most Q'



Octupole threshold for thinner coatings, Cu on MoGr: No significant increase for 2 μm , most Q'



Conclusion

2 μm Cu coating seems acceptable, both on CFC and MoGr

- Effectively screens the bulk, since its thickness is larger than the skin depth at the relevant freqs.

There are certain chromaticities that require up to 100% more octupole current compared respect to a thicker coating

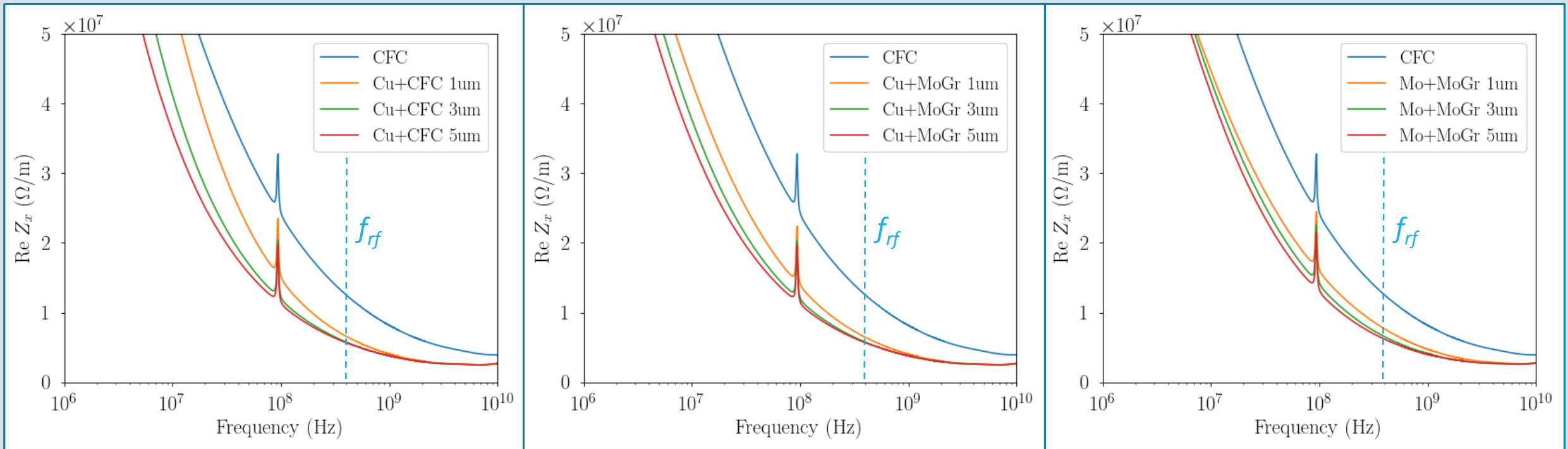
- Only in a small range of Q'
- The amount of Landau octupole is smaller than at $Q' \sim 10$

Benoit: We start seeing detrimental effects below 3 μm .

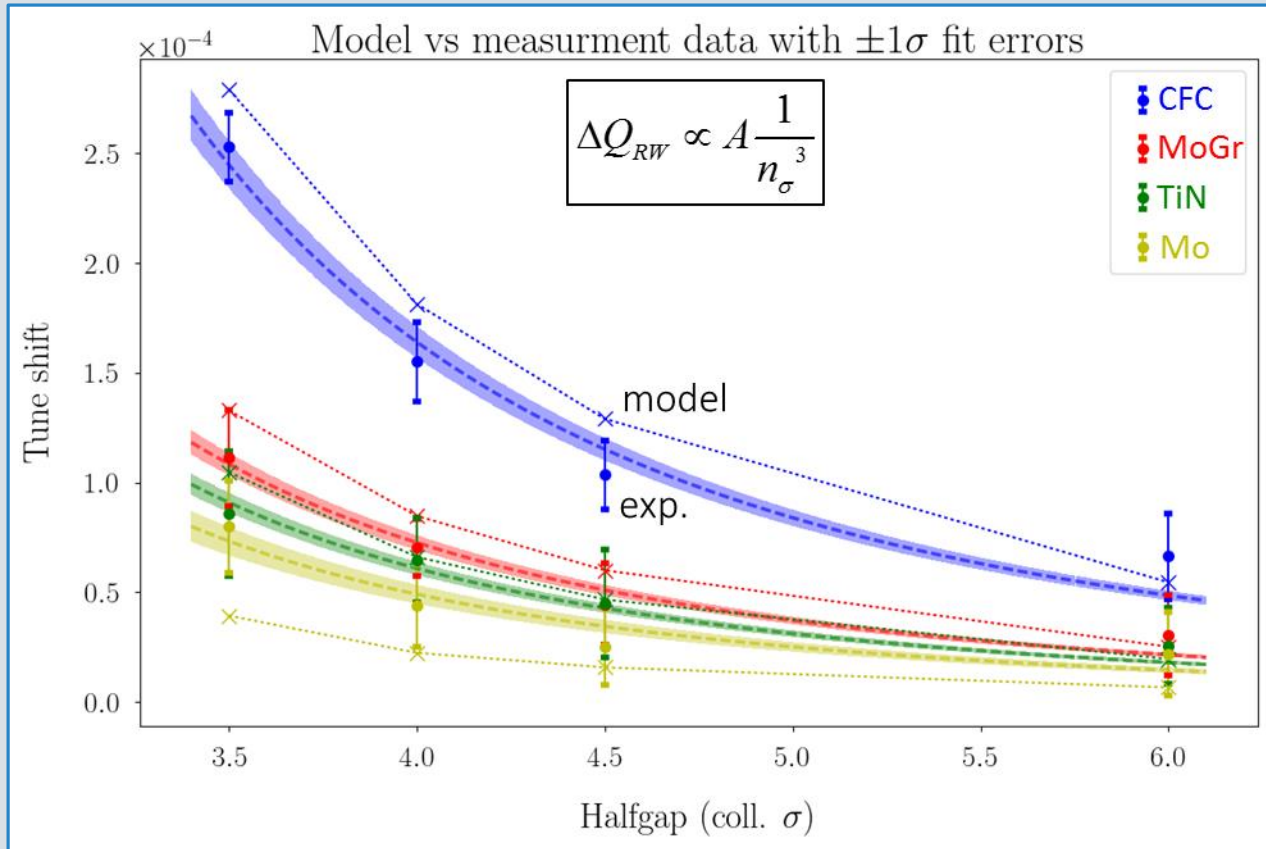
- A sound safety margin is required
- Need to understand the implications of thicker coatings. What is the extra cost?

Back-up slides

Impedance of different coating thickness options



Mo resistivity might be not as good as expected



Material resistivities (in nΩ-m): measured vs expected

Material	Beam Meas.	Lab Meas. (AC)	IW2D Model
CFC	4030 ± 380	–	5000
MoGr	760 ± 60	800 – 1200	1000
TiN	340 ± 40	Not measurable	400
Mo	250 ± 50	20 – 100	50