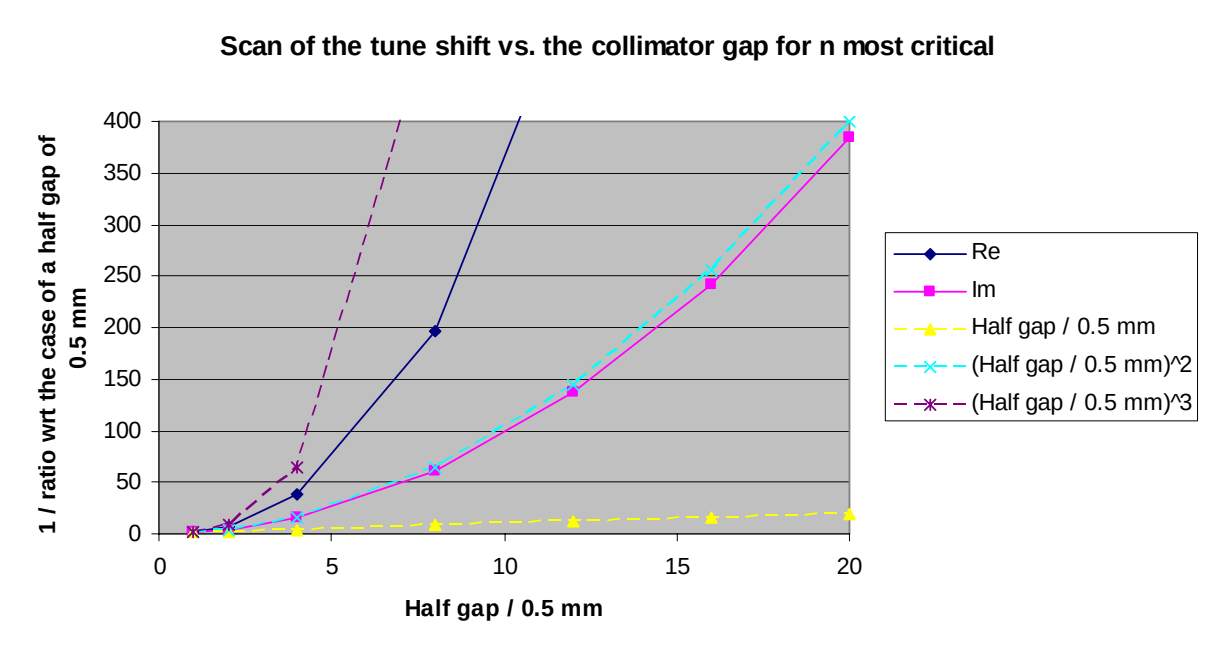
LHC COLLIMATORS TRANSVERSE IMPEDANCE: STATUS REPORT

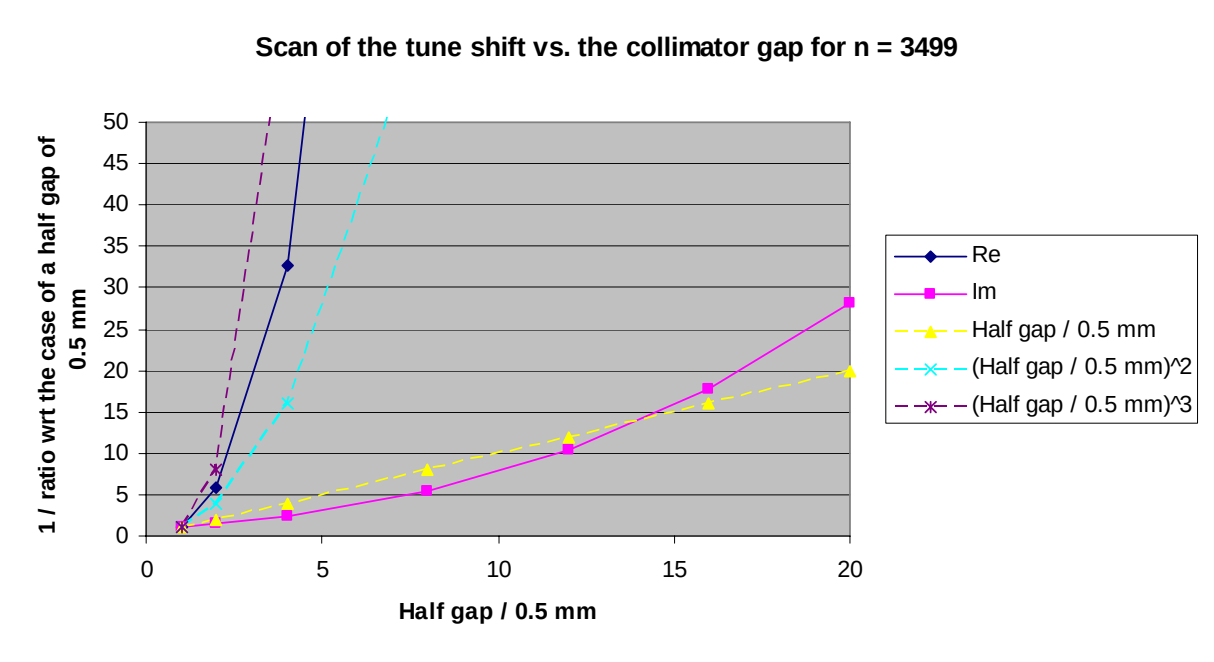
E. Métral

- **Scan of the tune shift from a single collimator at average beta vs.**
  - **Gap**
  - **Bunch spacing (keeping the same bunch intensity)**
  - **Bunch length**

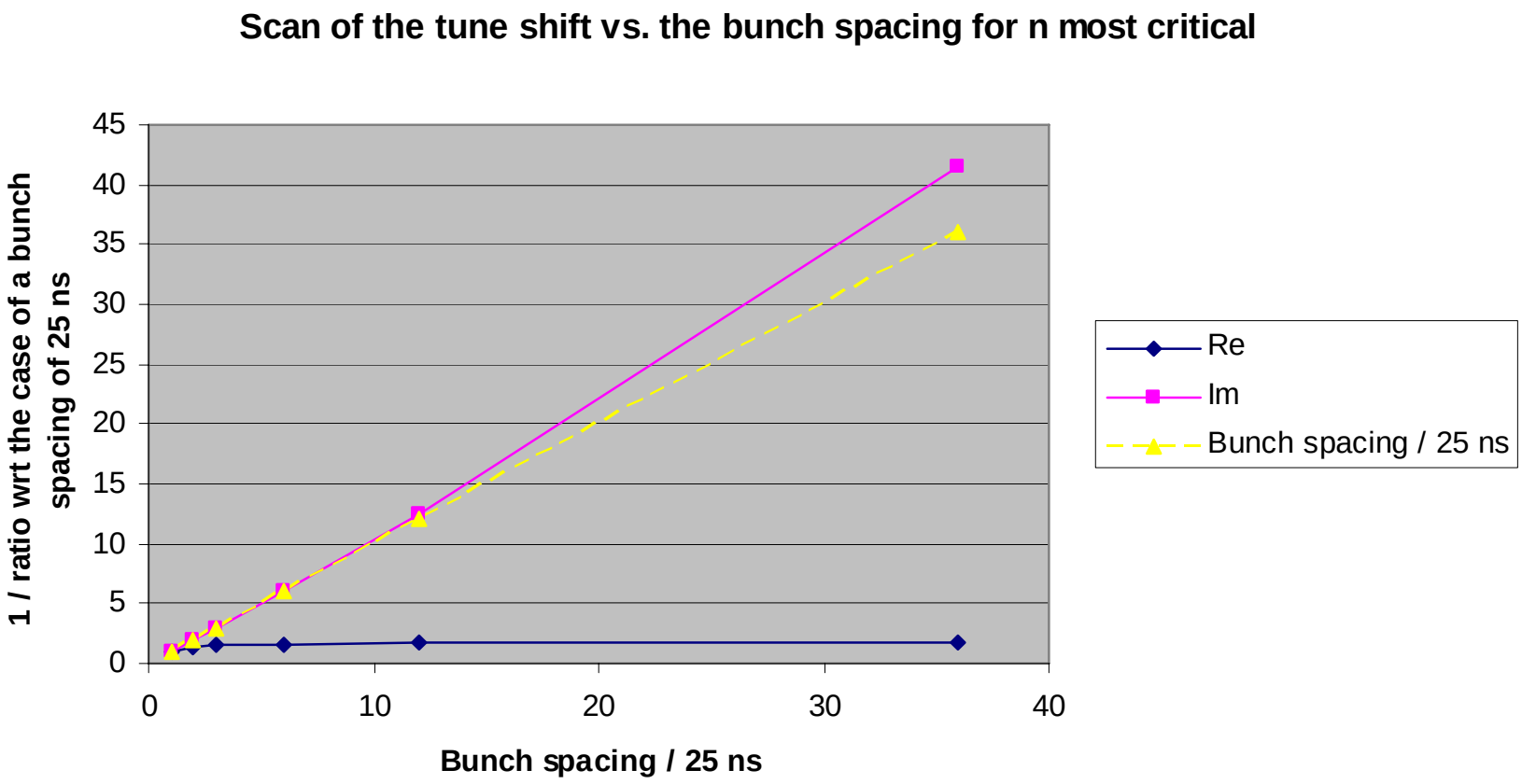
- **Other results which could be presented also at the next LTC meeting (i.e. new things from the last LTC I made on 08/12/04)**

Scan vs. gap

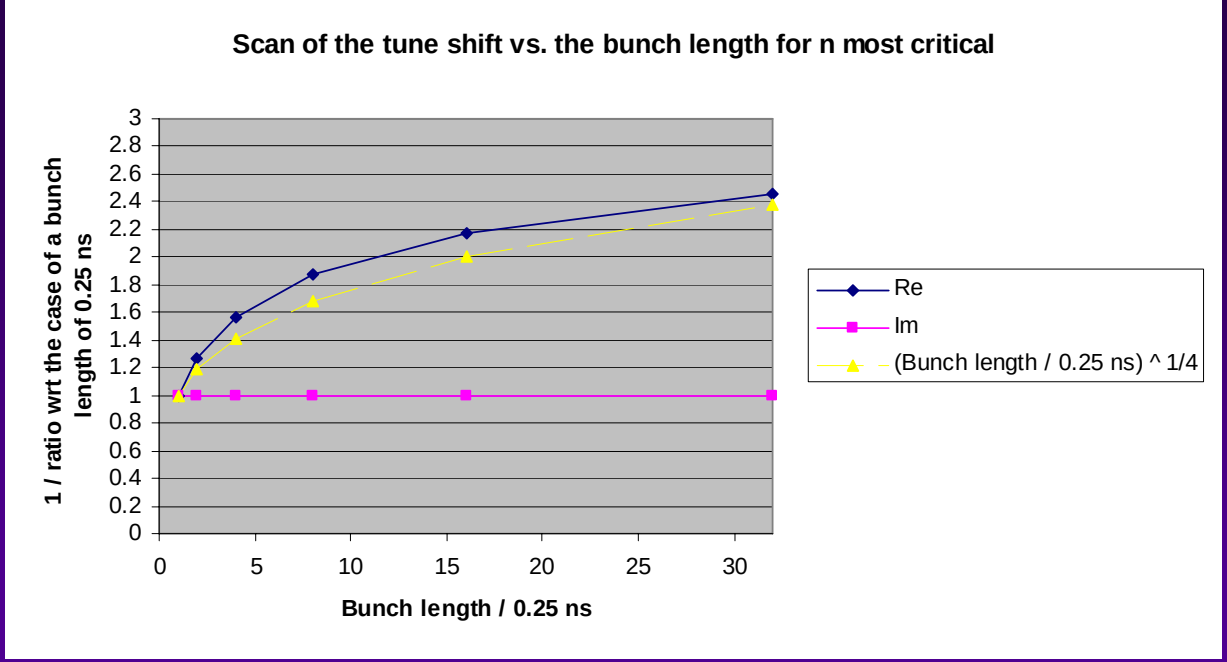

Scan of the tune shift vs. the collimator gap for n most critical
1 / ratio wrt the case of a half gap of 0.5 mm
Half gap / 0.5 mm
0
50
100
150
200
250
300
350
400
0
5
10
15
20
Re
Im
Half gap / 0.5 mm
(Half gap / 0.5 mm)^2
(Half gap / 0.5 mm)^3

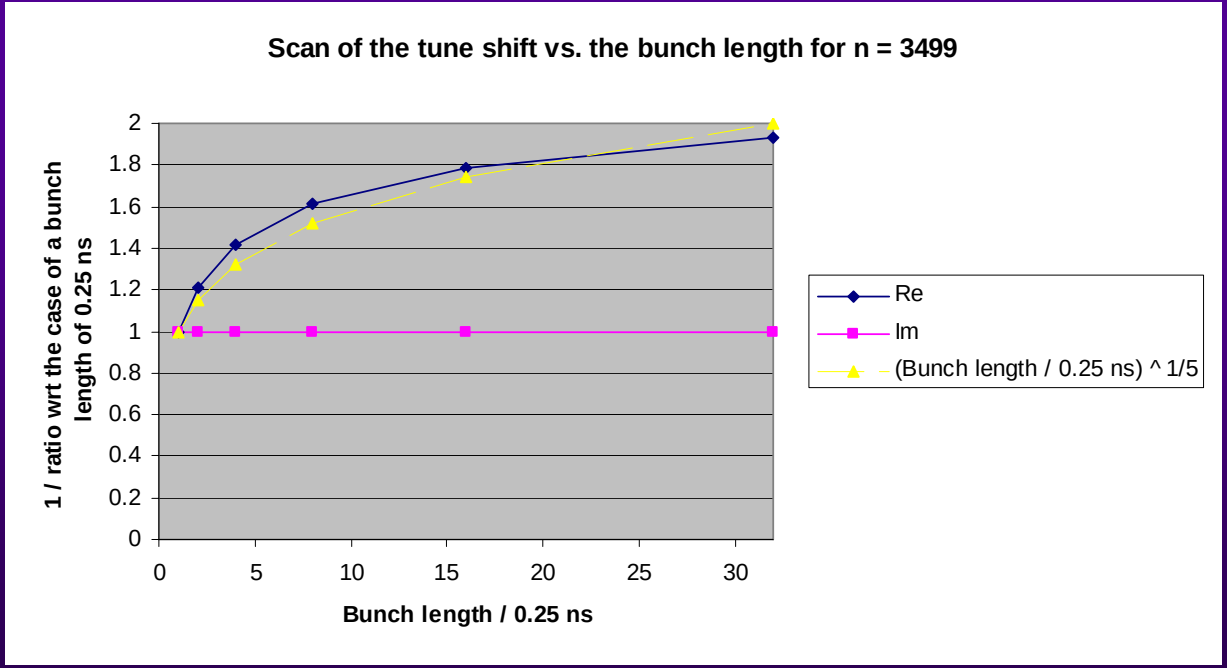

Scan of the tune shift vs. the collimator gap for n = 3499
1 / ratio wrt the case of a half gap of 0.5 mm
Half gap / 0.5 mm
0
5
10
15
20
25
30
35
40
45
50
0
5
10
15
20
Re
Im
Half gap / 0.5 mm
(Half gap / 0.5 mm)^2
(Half gap / 0.5 mm)^3

Scan vs. bunch spacing



Scan vs. bunch length





CONCLUSION (1/2)

- **Reminder: What is called the most critical (coupled-bunch) mode n is the (usual) one giving the largest imaginary part of the tune shift, but as I presented at the RLC meeting of 21/04/06 n = 3499 (= M - [Qx] - 1) gives the largest real part, and if we take the modulus it is the latter one which is the most critical. This is why I use this mode when I make the computation with all the collimators etc...**

- **1) SCAN VS. GAP**
  - **1.1) For n most critical**
    - The real part of the tune shift scales between 1/b^2 and 1/b^3 (it is about 1/b^2.5)
    - The imaginary part of the tune shift scales as 1/b^2
  - **1.2) For n = 3499**
    - The real part of the tune shift scales between 1/b^2 and 1/b^3 (it is about 1/b^2.5)
    - The imaginary part of the tune shift scales (roughly) as 1/b

CONCLUSION (2/2)

- **2) SCAN VS. BUNCH SPACING (assuming a constant bunch intensity)**
  - The real part of the tune shift is almost constant (it is the "famous" almost single-bunch effect due to the inductive bypass)
  - The imaginary part of the tune shift scales as ~ 1/bunch spacing

- **3) SCAN VS. BUNCH LENGTH**
  - **3.1) For n most critical**
    - The real part of the tune shift scales as ~ 1/(bunch length)^(1/4)
    - The imaginary part of the tune shift is constant
  - **3.2) For n = 3499**
    - The real part of the tune shift scales as ~ 1/(bunch length)^(1/5)
    - The imaginary part of the tune shift is constant

APPENDIX: What I think could be presented also at the next LTC meeting (i.e. new things from the last LTC I made on 08/12/04) (1/4)

- **From the minutes of the last LTC meeting: "Steve Myers asks what is the confidence level of the new LHC impedance estimates? Elias Metral replies more laboratory measurements are planned for the future and that these results will help in answering the question. Ralph Assmann adds that the collimator impedance measurements in the SPS indicated the same order of magnitude for the impedance as has been predicted by the analytical estimates"**

  ⇒ After careful analysis, I found a good agreement (until a factor 2 for the lower gaps). Very good agreement now with FZ's nonlinear theory (see EPAC06 paper)

- **Furthermore, Steve Myers also said (if I remember well…) that B. Zotter (who is one of the best experts on impedances) finds a value which is about 2 orders of magnitude higher, and that this should be understood**

  ⇒ This has been solved: B. Zotter now finds the same (numerical) result as Burov-Lebedev for a LHC collimator

APPENDIX: What I think could be presented also at the next LTC meeting (i.e. new things from the last LTC I made on 08/12/04) (2/4)

- **B. Zotter formula for the transverse RW impedance (see his paper CERN-AB-2005-043) is more precise than the one of BL in 1 aspect**
  - ⇒ He considers both TE and TM modes, whereas BL considers only TM mode

- **Using B. Zotter formalism I extended his formula (in the paper CERN-AB-2005-084) in 2 aspects. The new formula is now valid**
  - Without making the "low-frequency" approximation
  - Without assuming (necessarily) a good conductor for the first layer

⇒ **This new Zotter formula is therefore more "precise" than the one from BL in 3 aspects**

APPENDIX: What I think could be presented also at the next LTC meeting (i.e. new things from the last LTC I made on 08/12/04) (3/4)

- Those interested can use the Mathematica Notebook I made available (see RLC meeting of 17/06/05) where the new Zotter formula is given for 1 and 2 layers, as well as the multi-layer formula of Burov-Lebedev implemented by Alex Koschik

- I tried to explain in some detail Zotter's theory at the GSI workshop in March 2006 (http://care-hhh.web.cern.ch/care-hhh/Collective%20Effects-GSI-March-2006/Talks/TransverseResistiveWallImpedanceFromZotter2005Theory_GSI_30&31-03-06.ppt)

APPENDIX: What I think could be presented also at the next LTC meeting (i.e. new things from the last LTC I made on 08/12/04) (4/4)

- **RLC meeting of 21/04/06 where I** compare Cu, C and CuC results and explain the different modes (http://ab-abp-rlc.web.cern.ch/ab-abp-rlc/Meetings/2006/2006.04.21/Circular1mLongCollimatorWithHalfGap2mmAtAverageBeta_ImpedanceAndTuneShift_RLC_21-04-06.pdf)
- **RLC meeting of 21/04/06 on the** effect of chromaticity for both single-bunch and coupled-bunch instability, H and V planes, and at both injection and top energy (http://ab-abp-rlc.web.cern.ch/ab-abp-rlc/Meetings/2006/2006.04.21/CBI&SBIAtLHCInjection&TopEnergy_RLC_21-04-06.pdf)
- **RLC meeting of 08/07/06 on the** new results of the GSI experts (http://ab-abp-rlc.web.cern.ch/ab-abp-rlc/Meetings/2006/2006.07.07/FollowUp_LHCCollimatorImpedanceFromEPAC06_RLC_07-07-06.pdf)
- **RLC meeting of 07/04/06 which explains** our strategy for the TCT and TCLI (http://ab-abp-rlc.web.cern.ch/ab-abp-rlc/Meetings/2006/2006.04.07/EM-StrategyForTheTCTAndTCLIInTheLHC_RLC_07-04-06.pdf) $\Rightarrow$ Based on AG simulation, who gives the plot of the variation of the BB impedance vs. gap