MD2490
Measurement of the TMCI threshold at flat-top

D.Amorim, S.Antipov, N.Biancacci, X.Buffat, L.Carver, E.Métral, B.Salvant

MD purpose

- Goal of the MD is to estimate the TMCI intensity threshold
- In principle, this measurement should be done at Q'=0 and without damper
- However, to prevent instabilities, we propose to measure the tune shift versus intensity for different collimators gap at Q'=5 and with damper
- Measurement in two ramps with different bunch intensities:
  - 1st ramp with Pilot, $0.7 \cdot 10^{11}$, $0.9 \cdot 10^{11}$ and $1.2 \cdot 10^{11}$
  - 2nd ramp with Pilot, $0.5 \cdot 10^{11}$ and $1.8 \cdot 10^{11}$

Proposed procedure

- **Tune shift versus intensity:**
  - Inject 2/3 bunches of different intensities per beam
  - Ramp with nominal collimators, maximum octupoles current and damper gain
  - Measure chromaticity, then reduce to chromaticity ~5
  - Excite the bunches with the ADT to get their tunes
  - Close TCSG7 to 6.0σ (to have a 1.0σ separation between TCP7 and TCSG7)
  - Excite the bunches with the ADT to get their tunes
  - Close TCP and TCSG collimator by 0.5σ
  - Excite the bunches with the ADT to get their tunes
  - Repeat steps 6 and 7 until the TCP7 are at 4σ
  - During the procedure, check: intensity losses to avoid tails scrapping, coupling, emittance and head-tail monitor
  - At the end of the measurement: get the collimators back to nominal position then reduce chromaticity to 0.

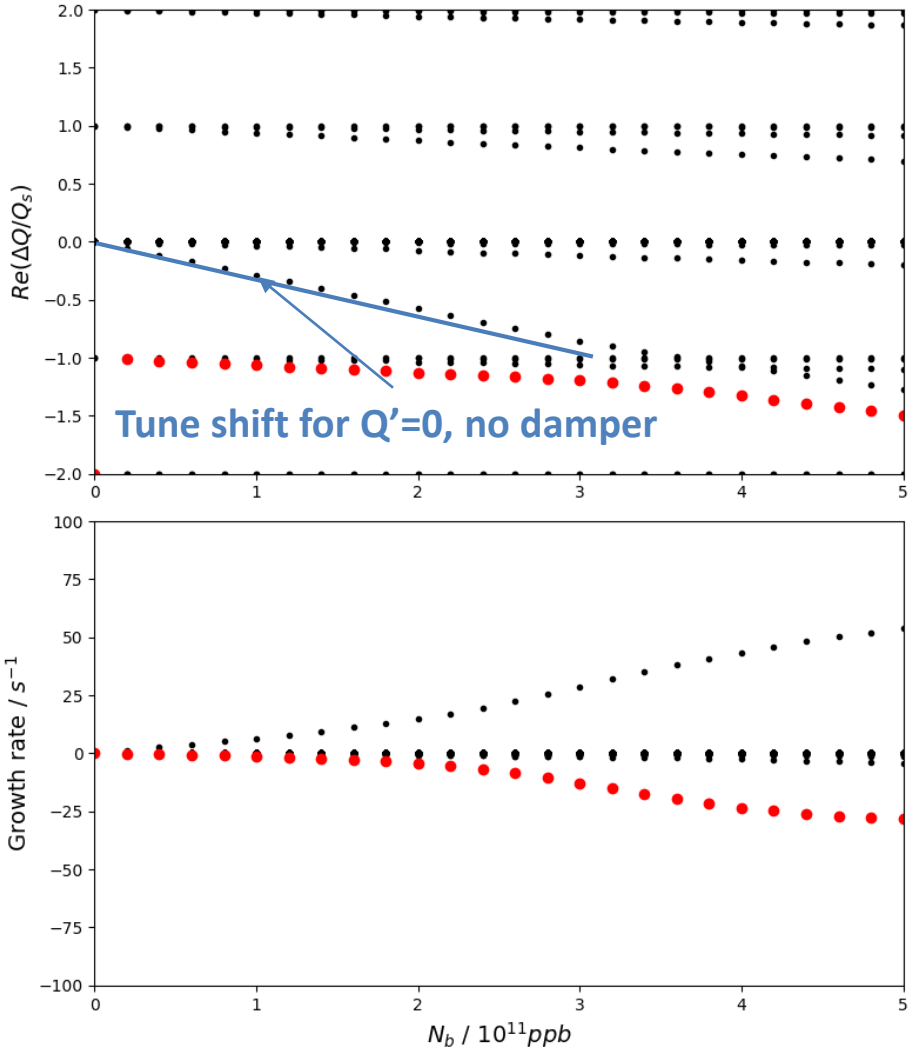
Simulations

- DELPHI simulations for different impedance scenarios
  - 2017 nominal collimators settings
  - Tighter gaps in TCP7 and TCSG7 (down to $4\sigma_{coll}/5\sigma_{coll}$ for TCP7/TCSG7)
  - Chromaticity between -5 and +5
  - No damper, 500, 100 or 50 turns damper
- Predicted octupole current for the different scenarios
  - Assuming $\varepsilon = 2.0\mu m$, Nb=2.0·10^{11} ppb

Q'=5, no damper

TCP7/TCSG7: 5.0/6.5σ_{coll}

LHC flat top 6.5 TeV B1H, TCP7 5.0σ, TCSG7 6.5σ
Q'=5, d=0.0, τ_b=1.08ns



TCP7/TCSG7: 4.0/5.0σ_{coll}

LHC flat top 6.5 TeV B1H, TCP7 4.0σ, TCSG7 5.0σ
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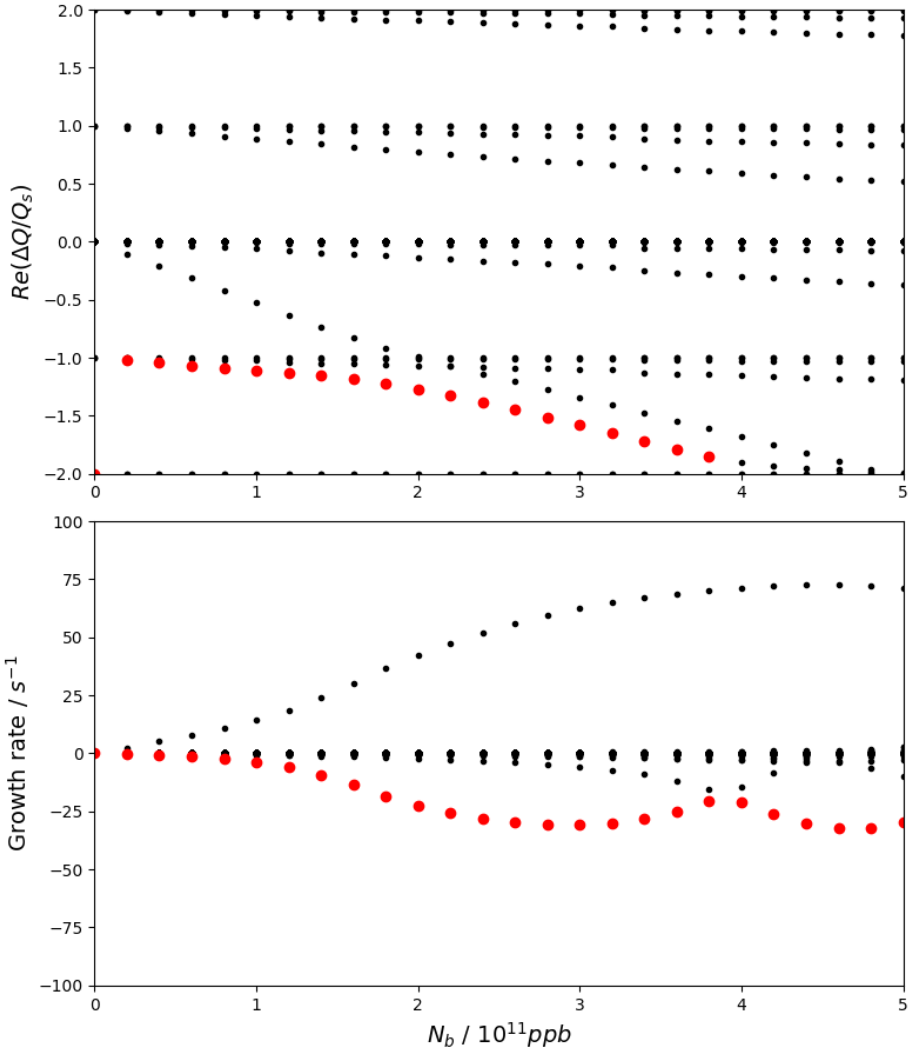
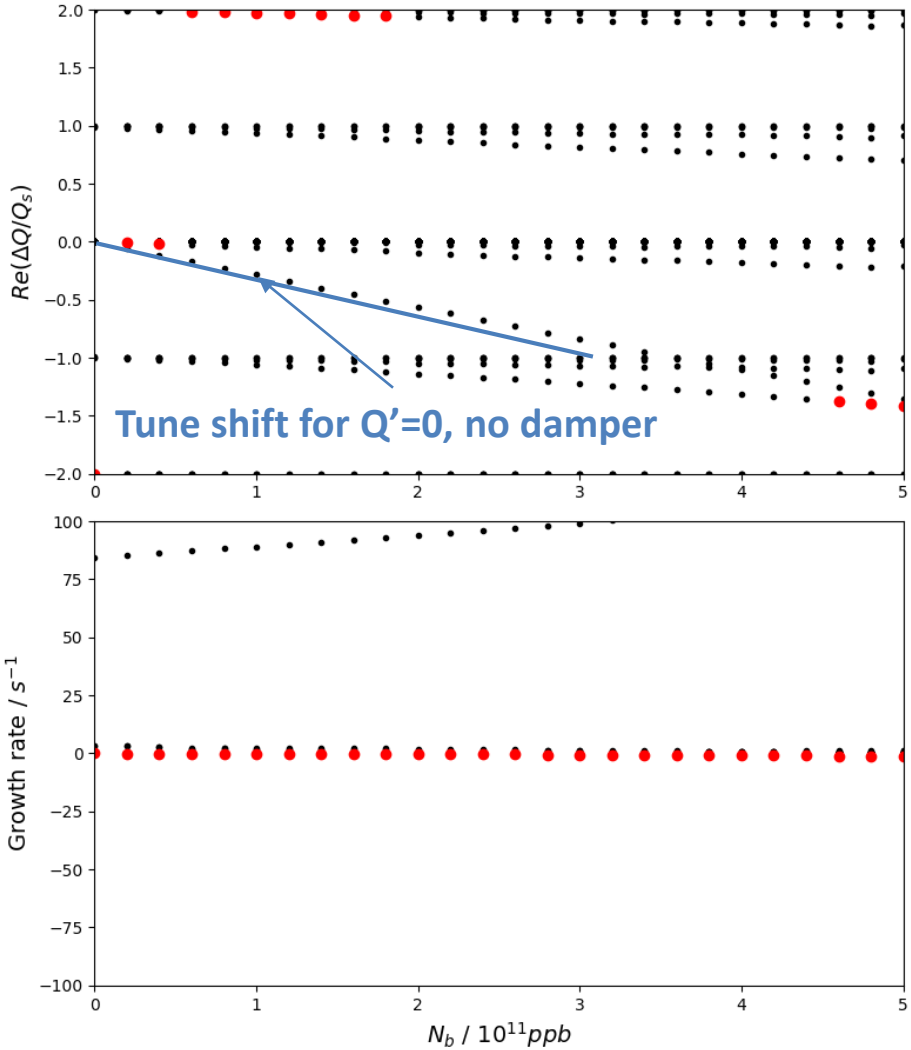


Q'=5, 100 turns damper

TCP7/TCSG7: 5.0/6.5σ_{coll}

LHC flat top 6.5 TeV B1H, TCP7 5.0σ, TCSG7 6.5σ
Q'=5, d=0.01, τ_b=1.08ns



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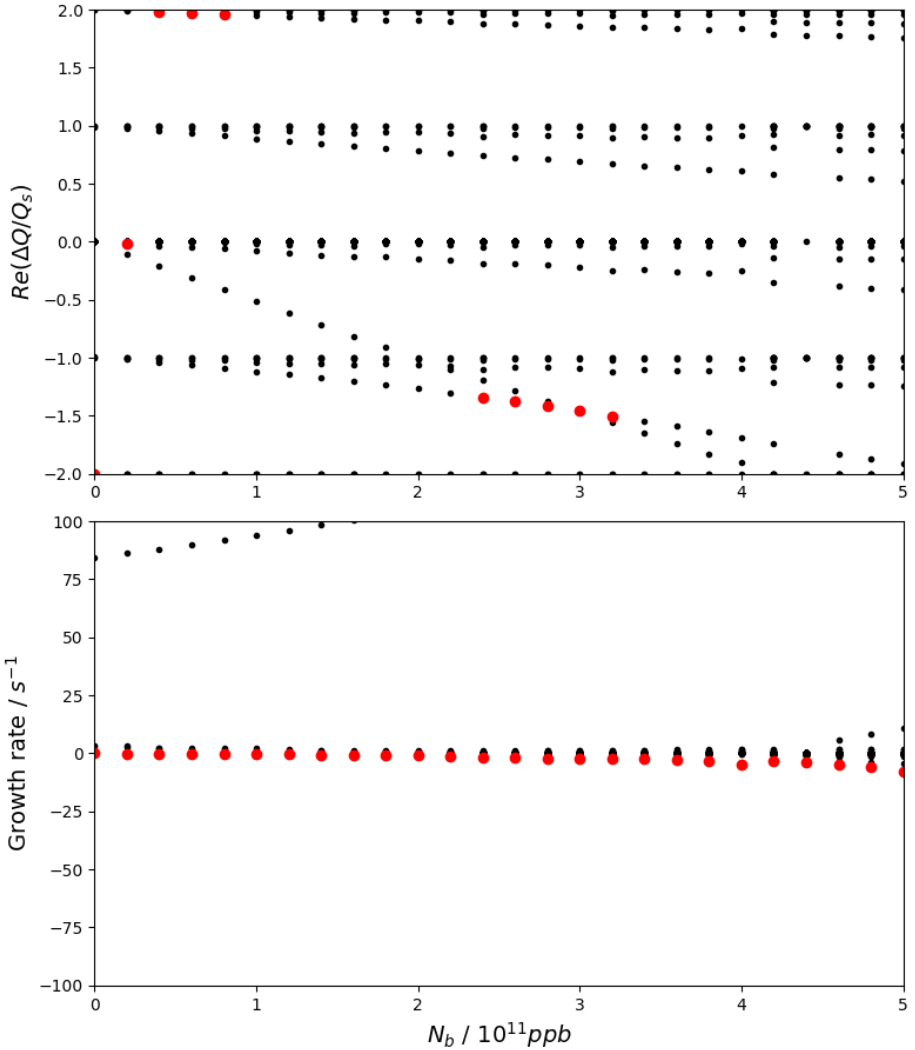
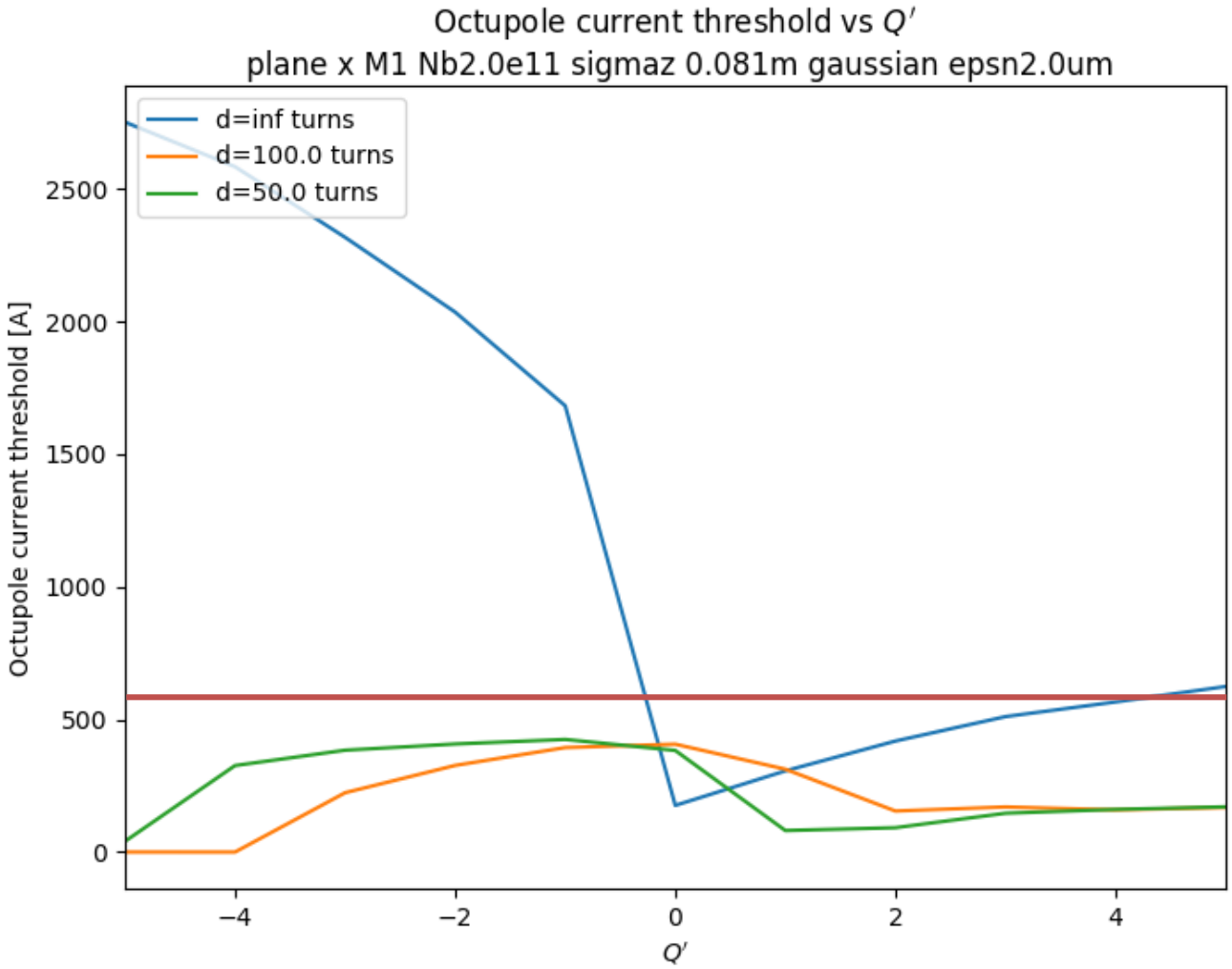


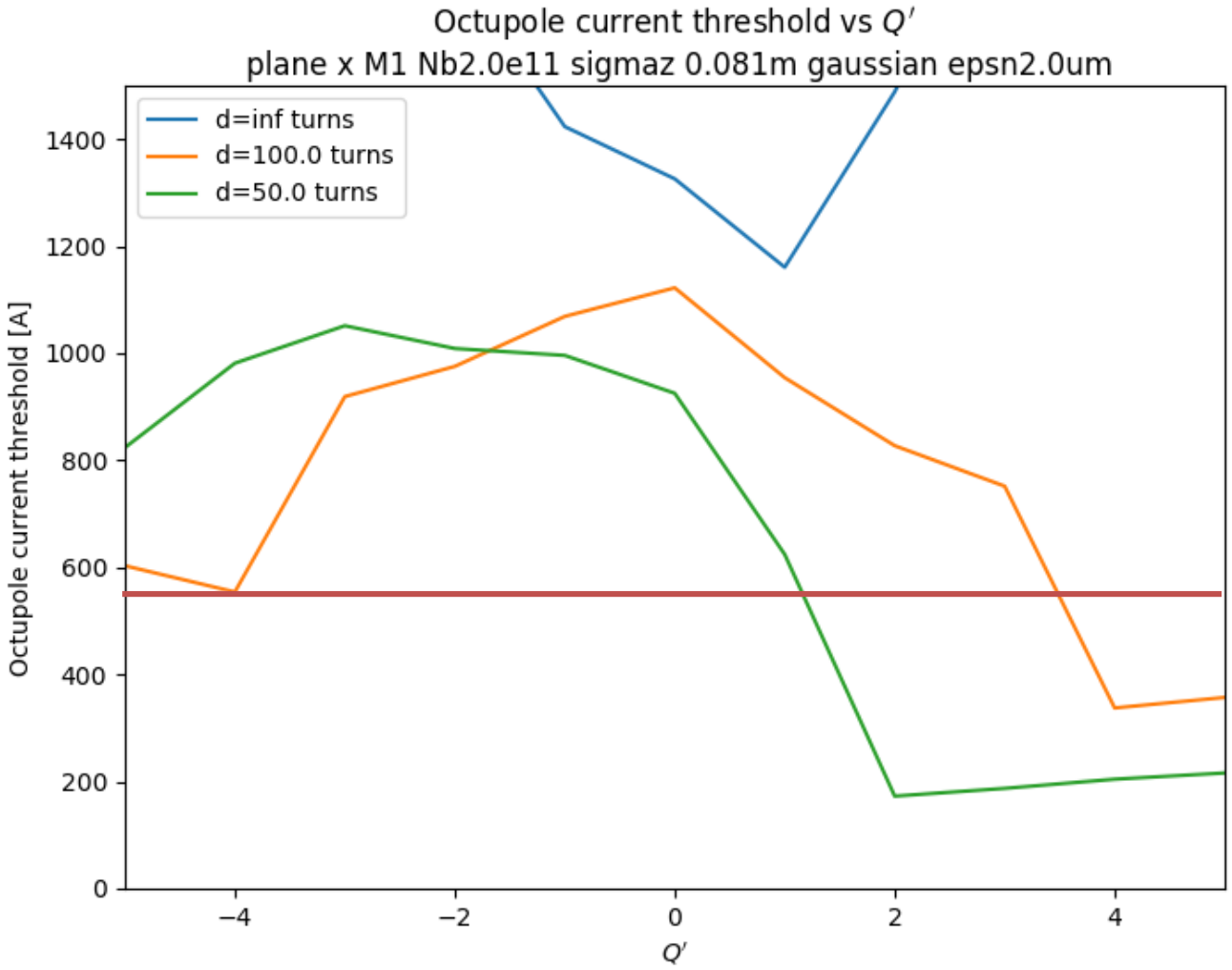
Octupole current

Nominal LHC collimators



Octupole current

TCP7/TCSG7: 4.0/5.0σ_{coll}



Conclusion

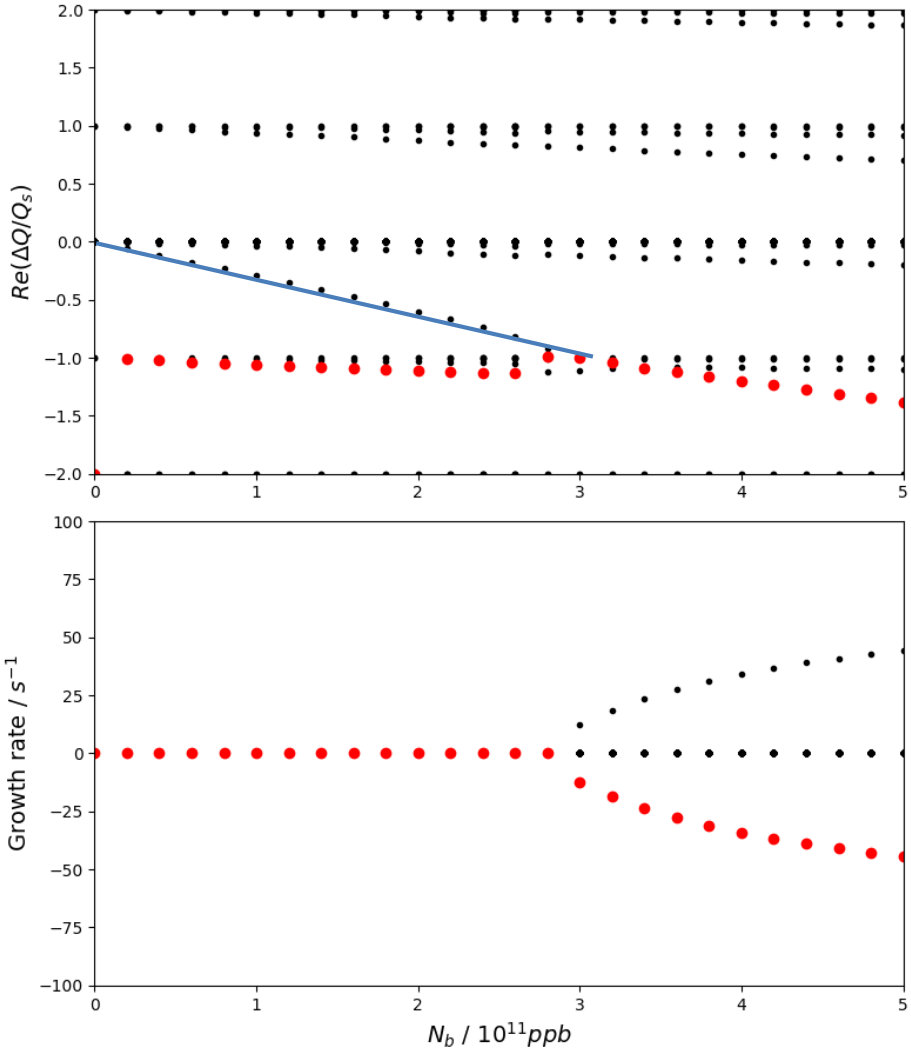
- The measurement of tune shift versus intensity at Q'=5 and with damper would allow to extrapolate the TMCI intensity threshold
- We would also assess the validity of the LHC impedance model
- At the end of each fill, measurements with chromaticity reduced to 0 and/or lower damper gain could be performed

Backup

Q'=0, no damper

TCP7/TCSG7: 5.0/6.5σ_{coll}

LHC flat top 6.5 TeV B1H, TCP7 5.0σ, TCSG7 6.5σ
Q'=0, d=0.0, τ_b=1.08ns



TCP7/TCSG7: 4.0/5.0σ_{coll}

LHC flat top 6.5 TeV B1H, TCP7 4.0σ, TCSG7 5.0σ
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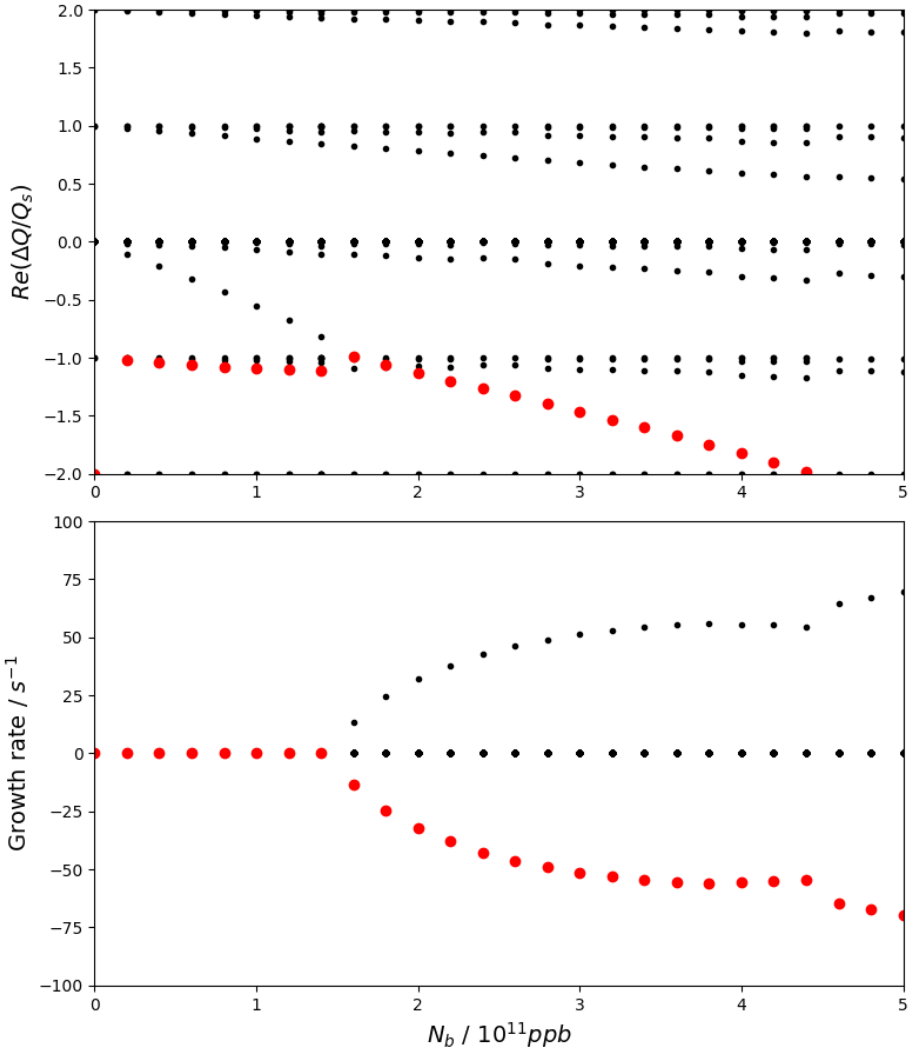

Q'=0, 100 turns damper

TCP7/TCSG7: 5.0/6.5σ_{coll}

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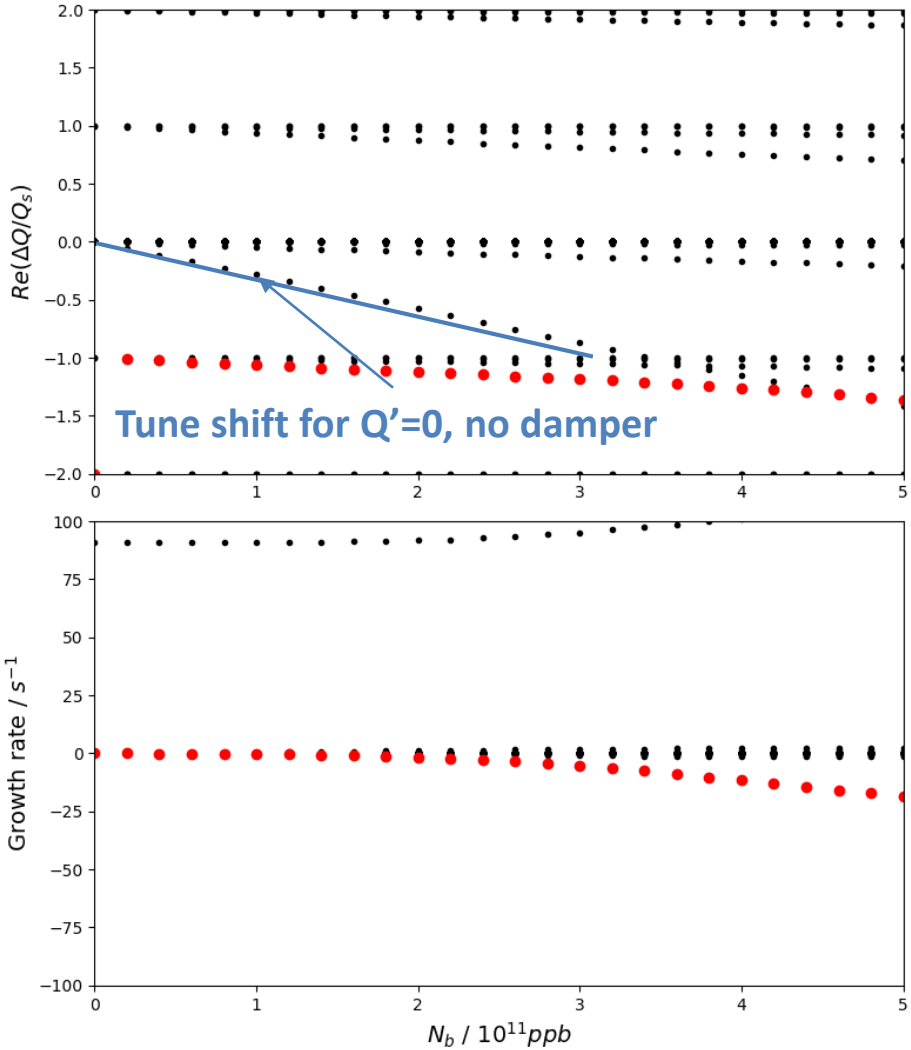

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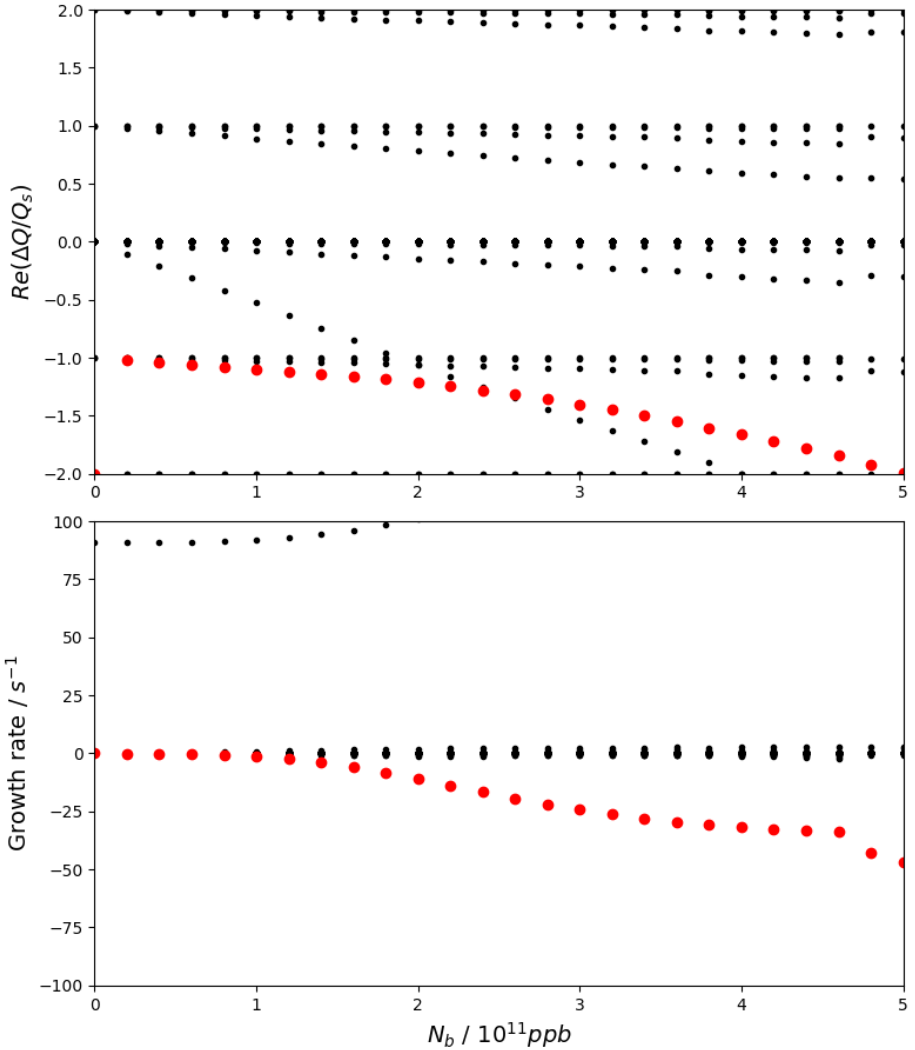
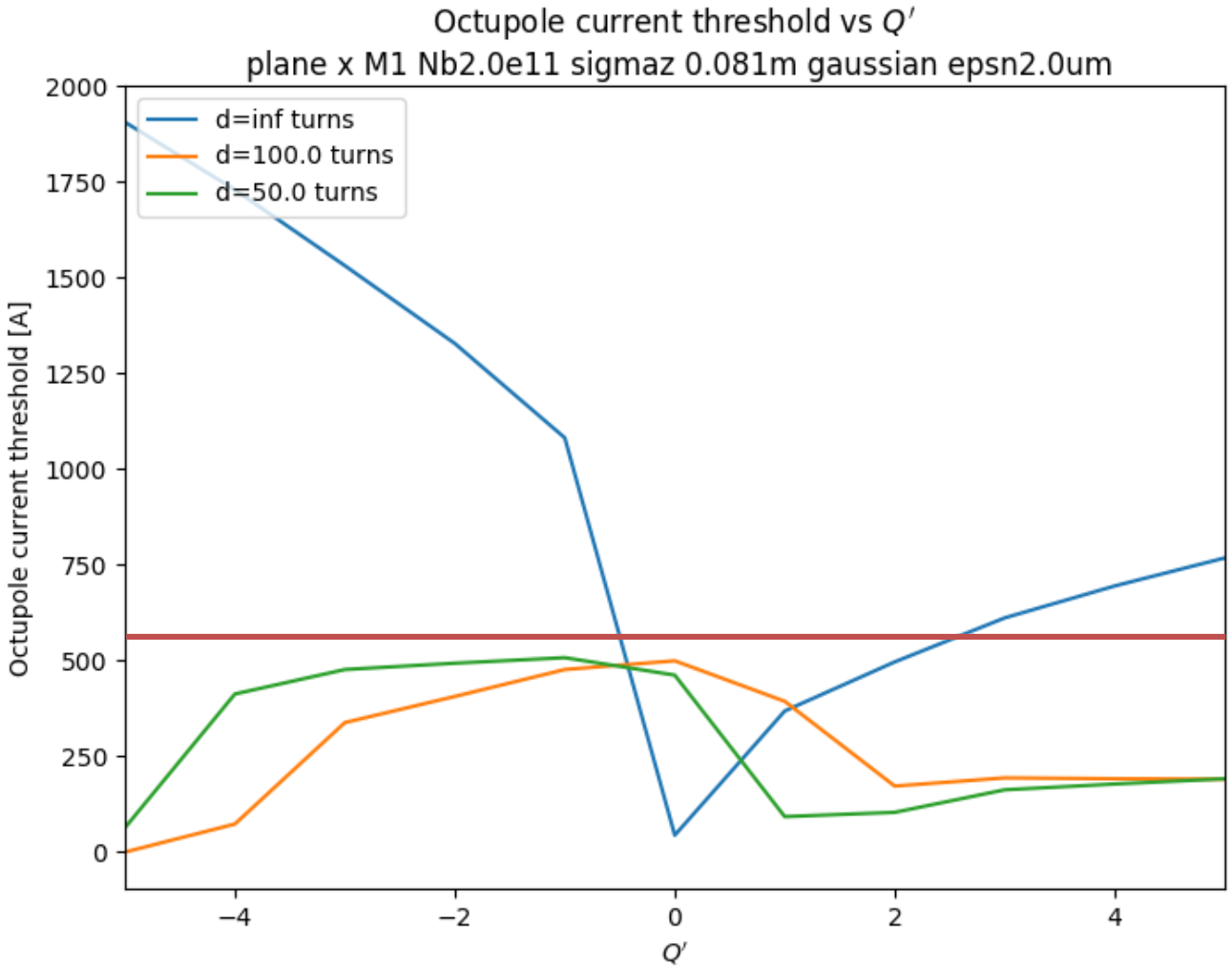


Octupole current

TCP7/TCSG7: 5.0/6.0σ_{coll}



Octupole current

TCP7/TCSG7: 4.5/5.5σ_{coll}