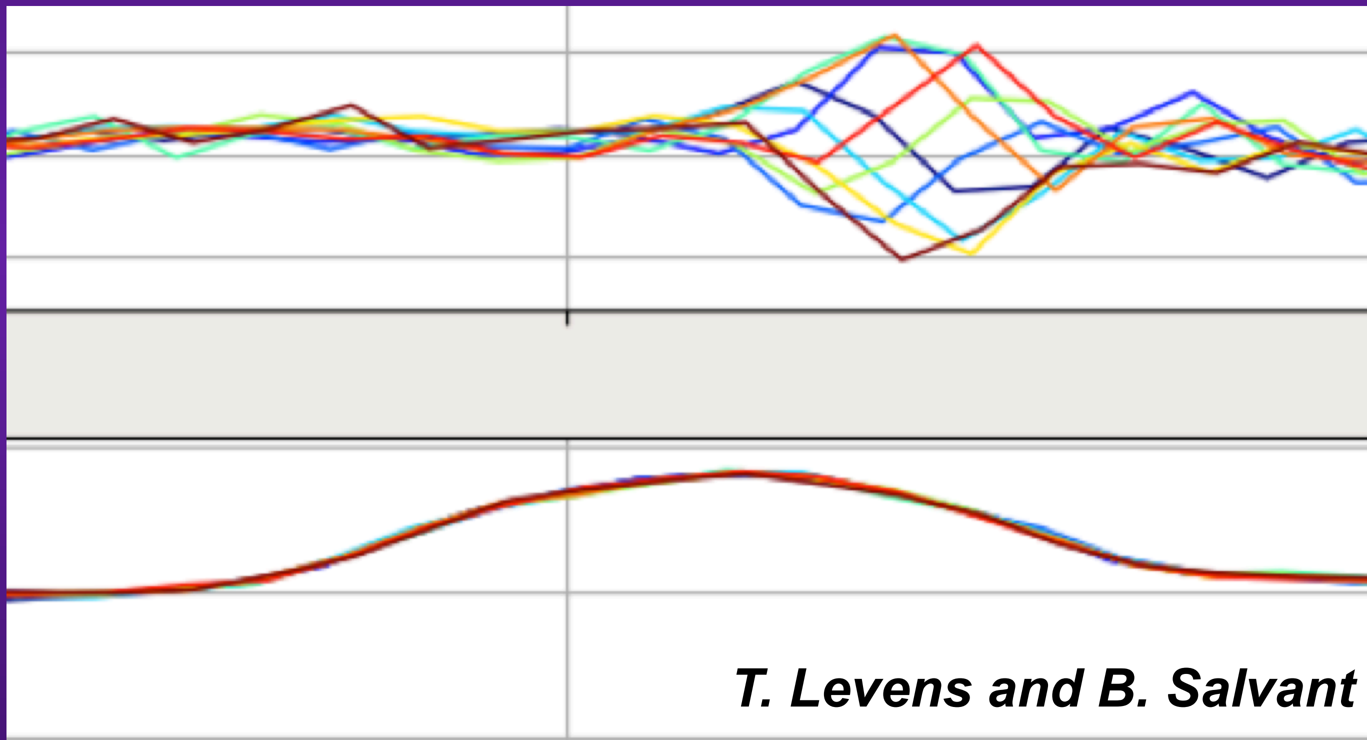
Some observations

- Instability rise-times of ~ 10 turns or few tens of turns

- Intra-bunch motion (from HEADTAIL monitor) => TMCI / BBU like instability

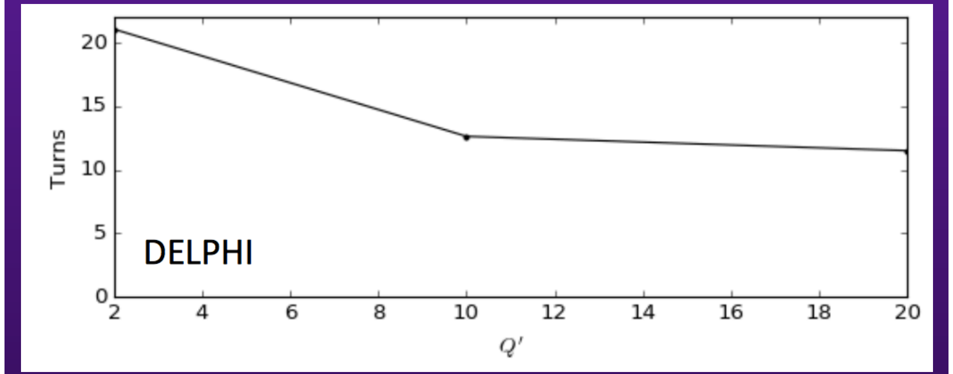


=> These high-frequency oscillations should come from e- (and not ions)

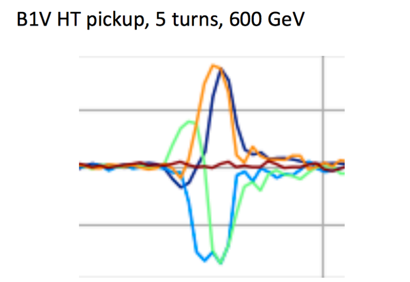
1) Simple e-cloud model (N. Biancacci et al.)

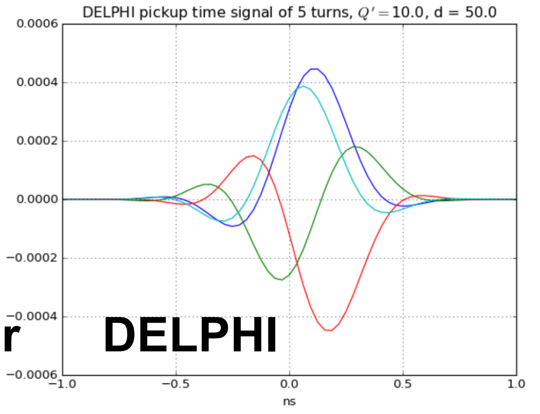
- **Equivalent resonator impedance model from an e-cloud (FrankZ et al.) => 3 parameters: R_s , f_r , Q**
  - **Measured tune shift (~ + 0.01-0.02) => Deduce e- density => Deduce shunt impedance R_s ~ 150 – 500 MΩ/m**
  - **Compute e- frequency (e- trapped by p+ beam) => f_r ~ 2.6 GHz**
  - **Q ~ 1 => Broad-band impedance**
- **Using this simplified model (with 150 MΩ/m) with DELPHI Vlasov solver, 2 observables could be reproduced**

Instability rise-time



Superimposed signals at the pick-up



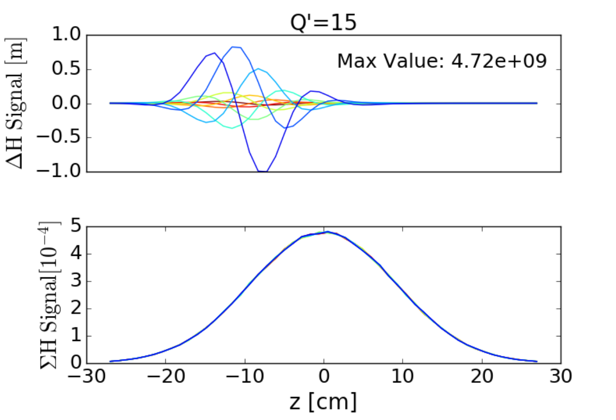


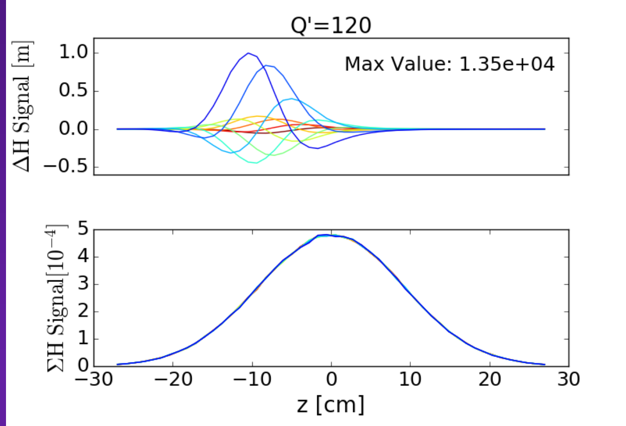
1) Simple e-cloud model (N. Biancacci et al.)

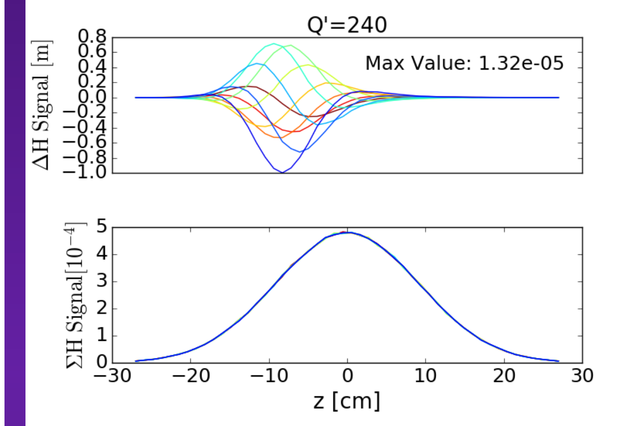
- **Corresponding atom density in 16L2**
  - Measured tune shift => Average (over LHC) e^- density ~ 1E13 e^-/m^3
  - Over 1 m it corresponds to few 1E17 e^-/m^3 (and few 1E18 e^-/m^3 over 10 cm)
  - Assuming ionization, this gives a density of atoms of few 1E20 atoms/m^3 => See computation/assumption by XavierB
  - Seems consistent with AntonL who estimated a density between ~ 1E20 and ~ 1E22 atoms/m^3

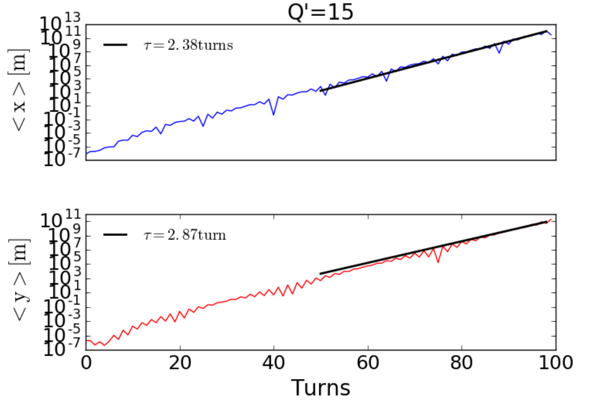
2) Simple e-cloud model (L. Carver et al.)

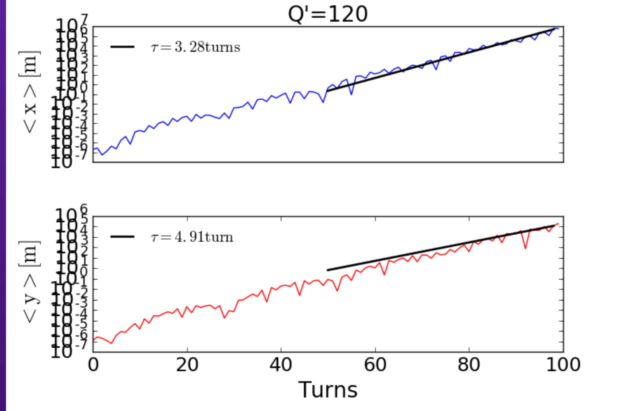
- **Same "equivalent" impedance model as before (using 500 MΩ/m) but DELPHI Vlasov solver replaced by pyHEADTAIL tracking code**

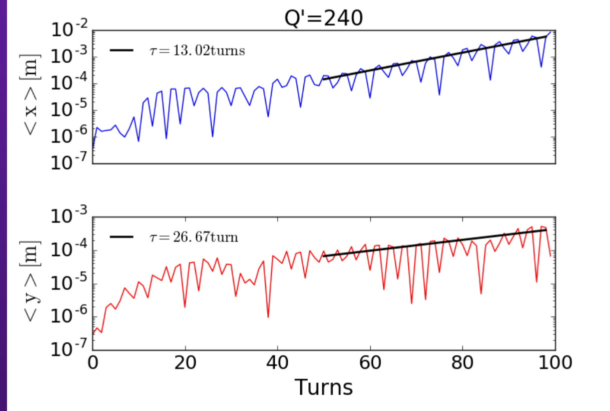












=> Consistent with DELPHI and Q' >(>) 100 would be needed for stability

2) Simple e-cloud model (L. Carver et al.)

- **Comparison to past e-cloud simulations from ElenaB (PHD thesis)**

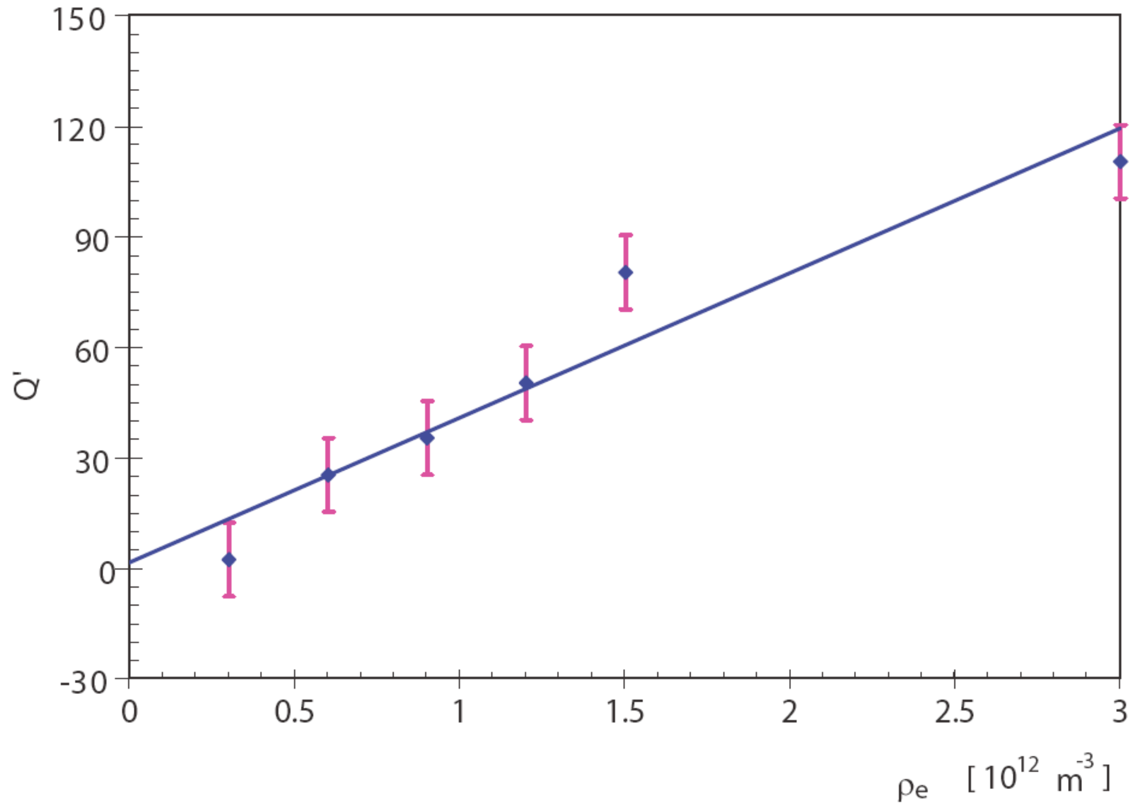
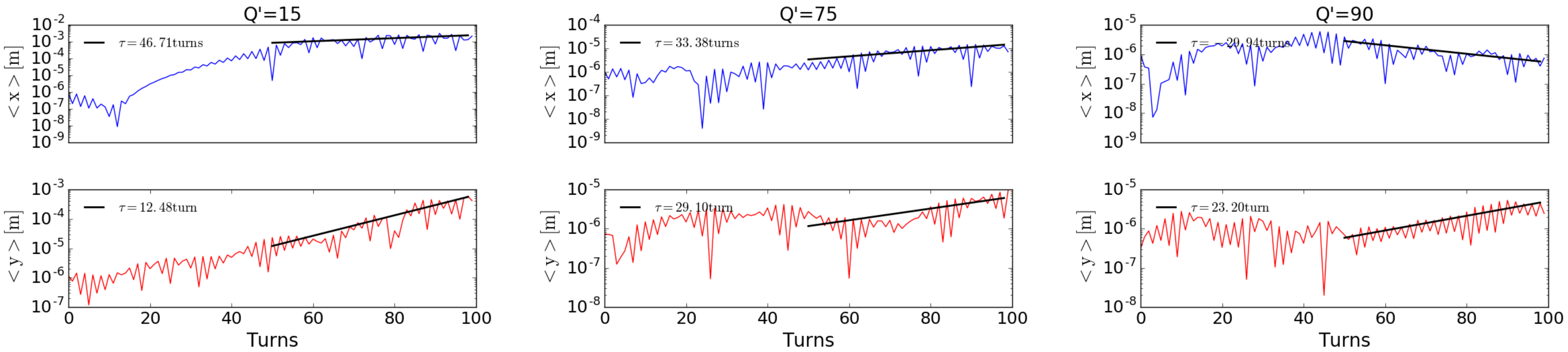


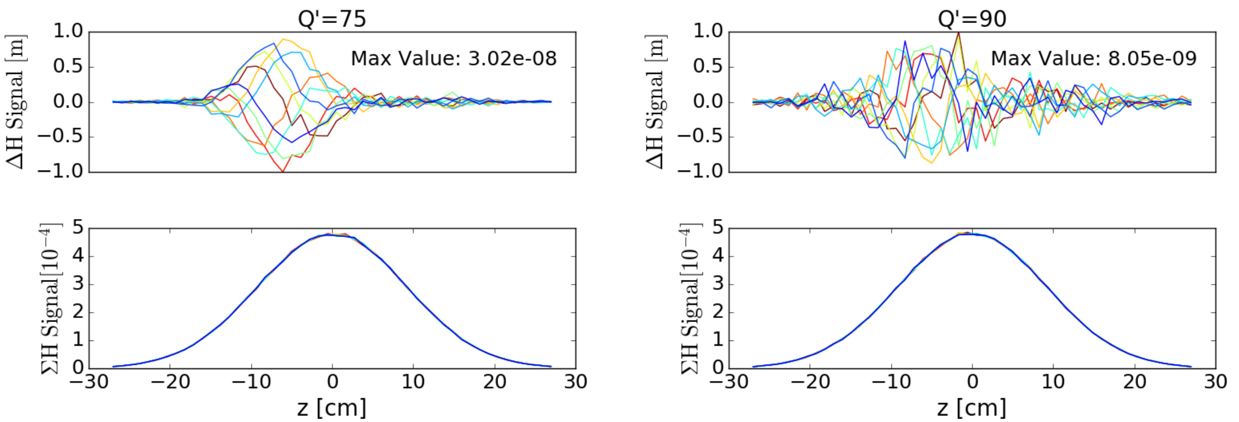
Figure 7.13. Chromaticity as a function of the electron-cloud density level at which the transition between the two regimes occurs in the simulation.

=> Would mean that a Q' of few 100s would be needed to stabilize the beam if the average density along the LHC is ~ 1E13 e^-/m^3

2) Simple e-cloud model (L. Carver et al.)

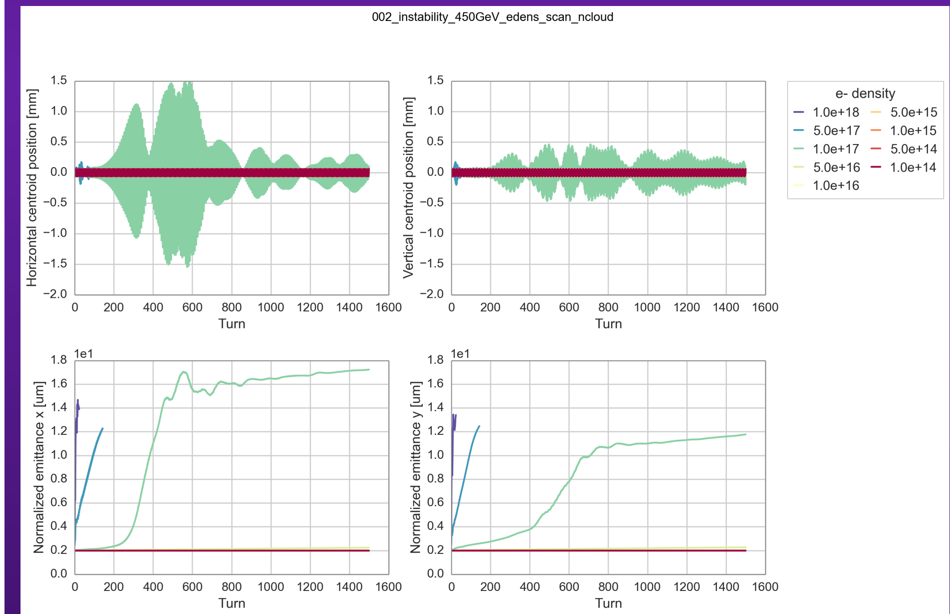
- **Using 150 MΩ/m and Ioct = 40 A**

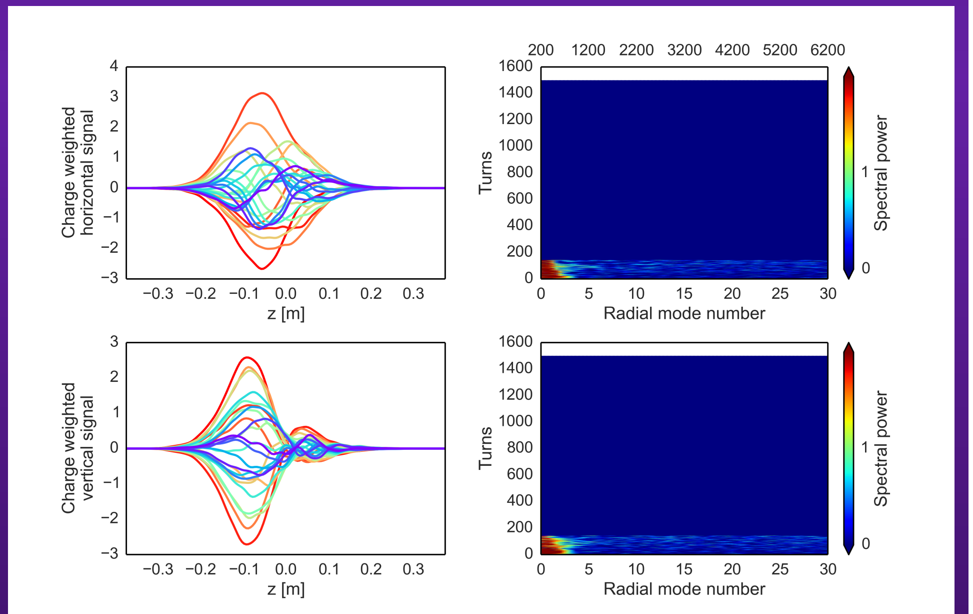




3) E-cloud model (L. Mether et al.)

- **E-cloud simulation**
  - Removing the space charge between e- (there are reasons for this but tbc in the future: e- should be created by ionization and there will be also positive ions…)
  - Assuming that the e- are already there when bunch arrives and do not build-up by ionization along the bunch





=> Seems consistent with the previous model... To be continued...