

LHC head-tail growth rates at injection

impedances:

- resistive wall in cold & warm sections
- collimator impedance
- broadband resonator

growth rates:

- single bunch vs. Q' for $m=0,3$
- CB vs CB mode # for $Q'=0,10$ & $m=0$

RW impedance for cold sections: use Burov-Lebedev formula with 50 μm Cu layer and $\text{RRR}=100$, surrounded by infinite stainless steel pipe; take $\langle\beta\rangle=70$ m and $L=23600$ m

vertical	8 kHz result	20 MHz result	8 kHz design r.	20 MHz design r.
cold chamber	23.2 – 8.8 i M Ω /m	0.0-2.4 i M Ω /m	-29.5 – 8.6 i M Ω /m	-1.5 -0.5 i M Ω /m
collimator	0 – 97 i M Ω /m	0-42 i M Ω /m	-7.6 -74 i M Ω /m	0 -33 i M Ω /m

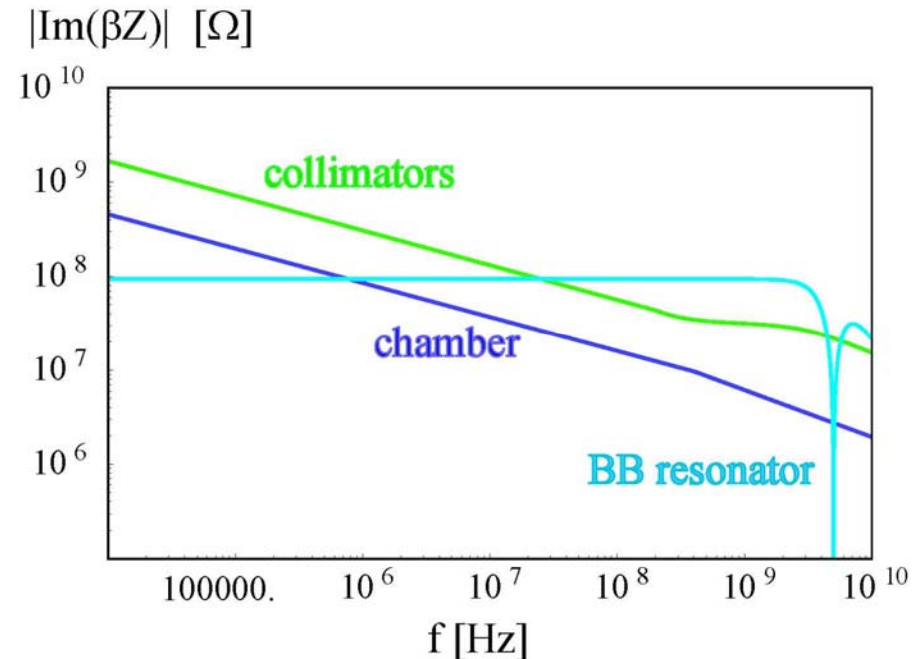
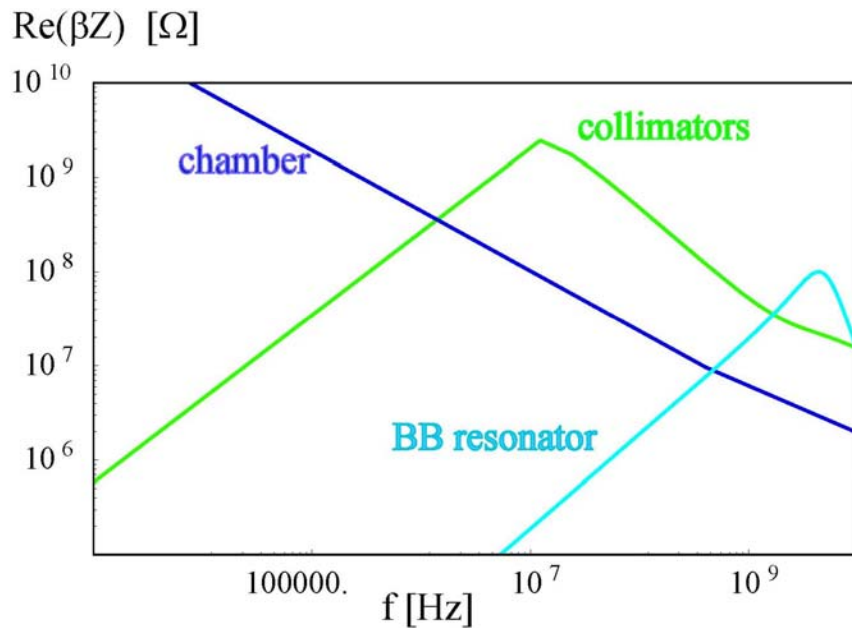
My impedance values are 2-6 time smaller than those in the LHC design report!?

To take into account warm sections, I will multiply the cold impedance by factor of two. Use Yokoya factors 0.63, 0.87.

collimator impedance at injection: received half gaps,
 beta_x,y's and collimation angle from Elias for 41 phase-1
 collimators ;
 use tensor approach to get impedance for 'odd' angles

broadband impedance:

take $Q=1$, $f_{res}=5$ GHz, $Z_{x,y}=-i$ 1.34 M Ω /m, $\langle\beta\rangle=70$ m



vertical impedance

total impedance

βZ [Ω]

10^{10}

10^9

10^8

10^7

10^6

$\text{Re}(\beta Z)$

$|\text{Im}(\beta Z)|$

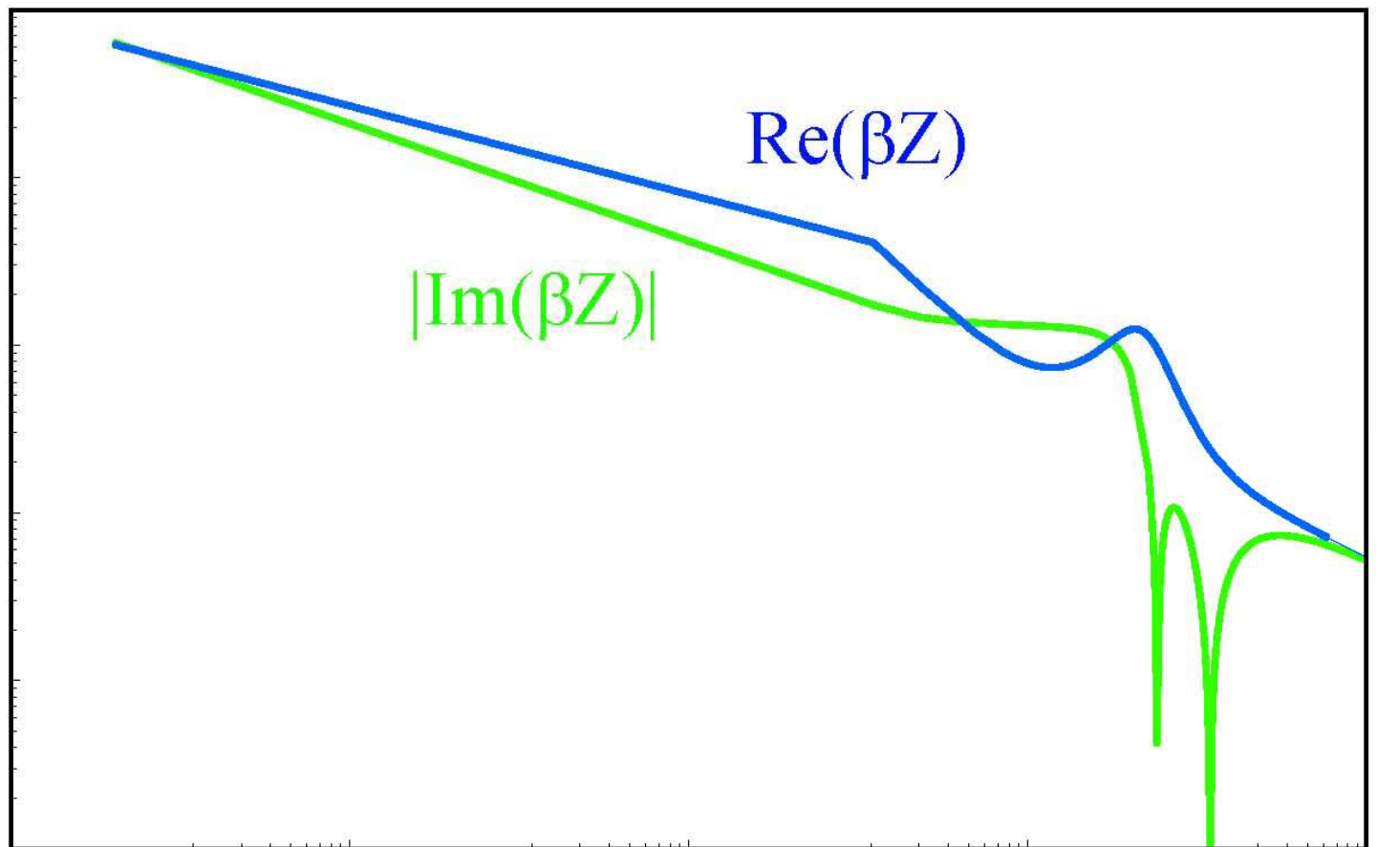
100000.

10^7

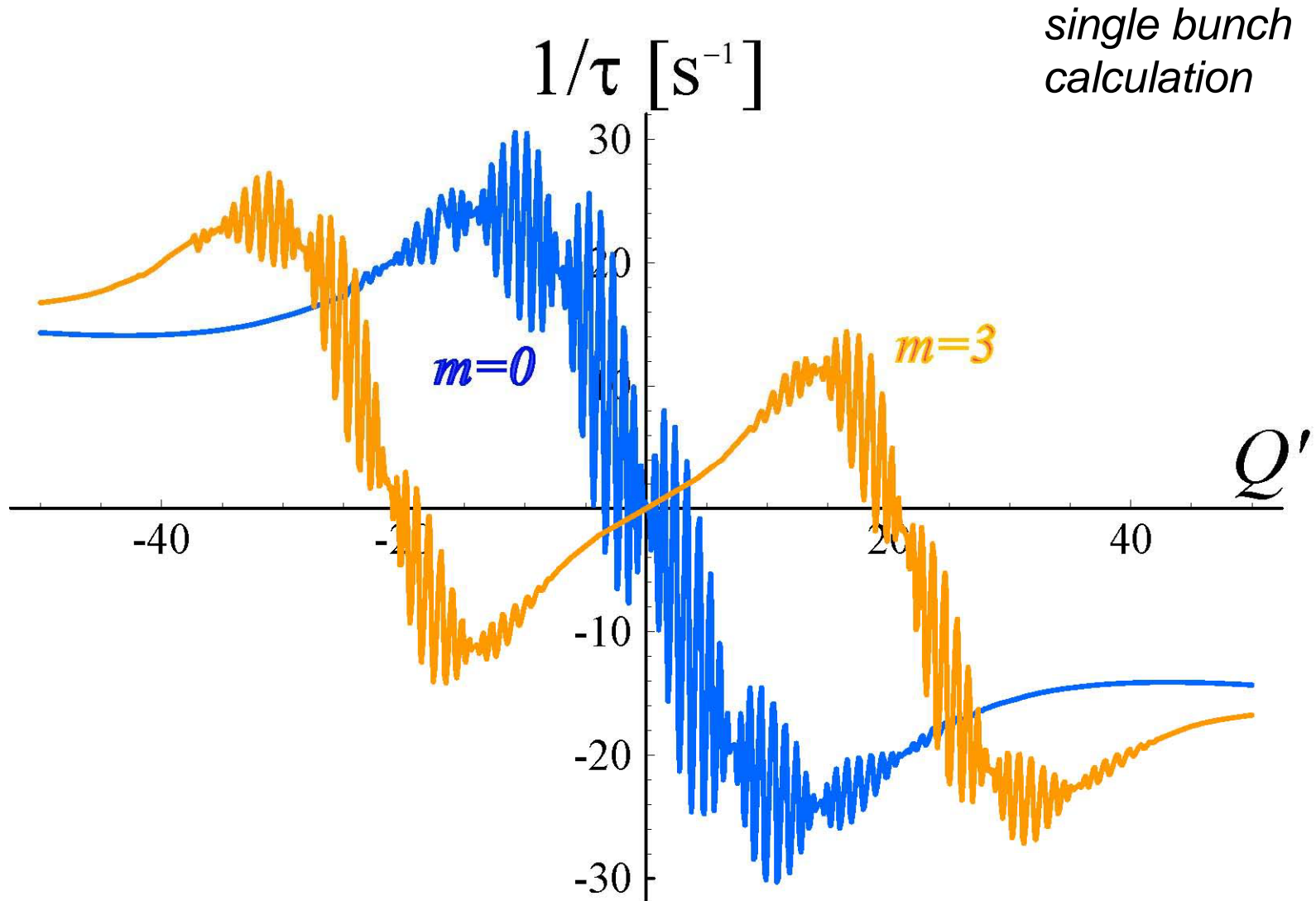
10^9

10^{11}

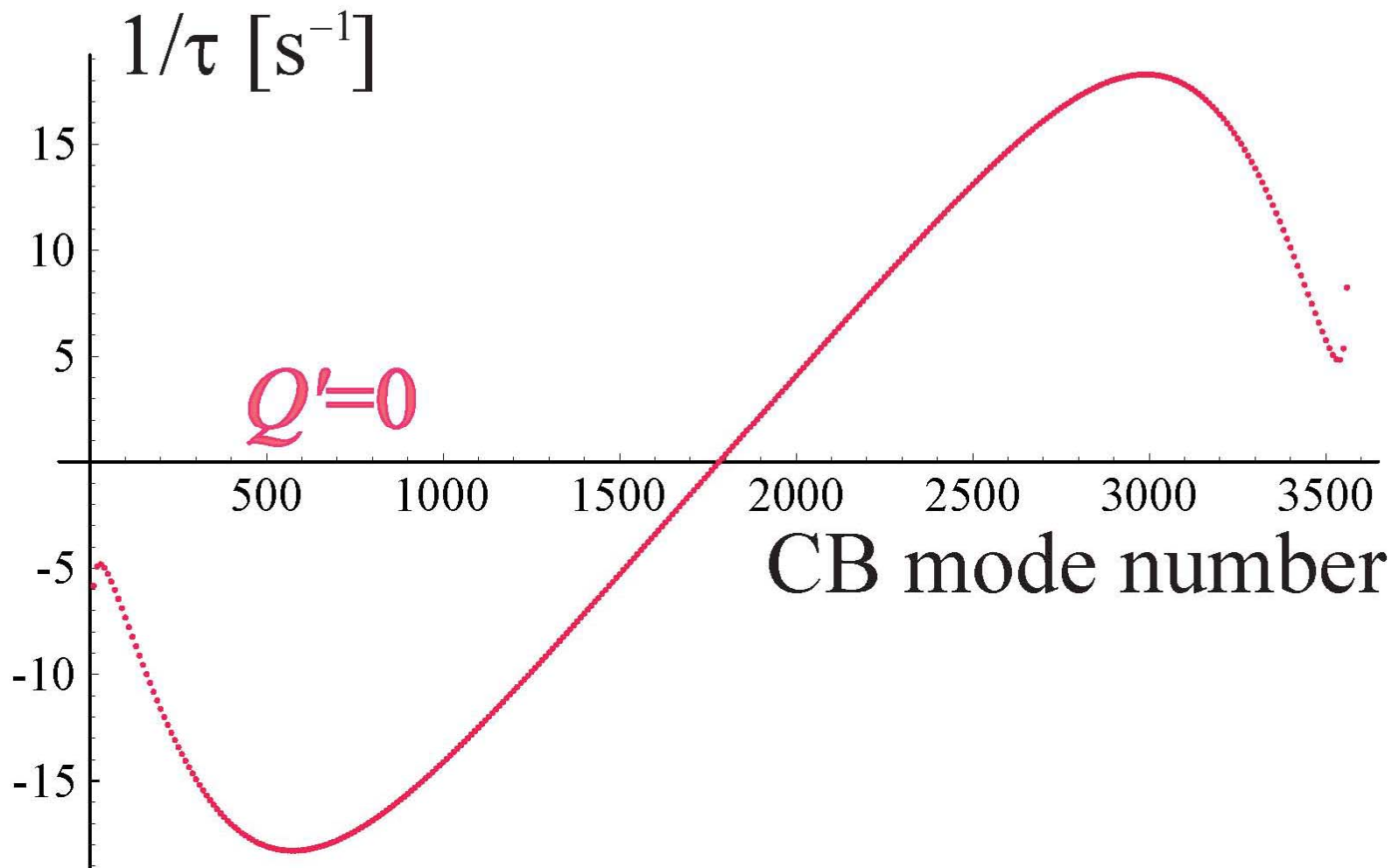
f [Hz]



y head-tail growth rate for 0 and 3 mode

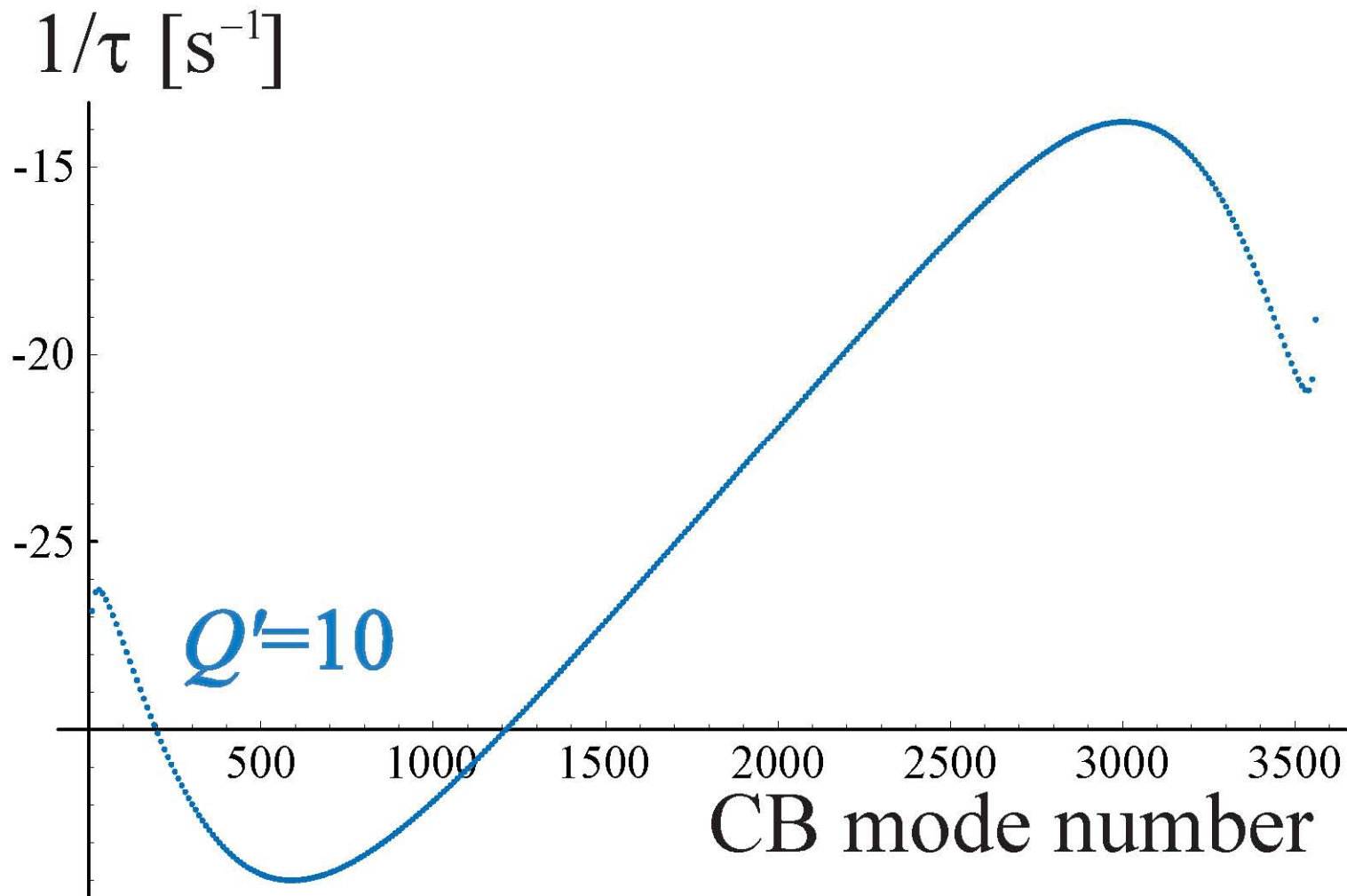


CB growth rates (head-tail mode = 0) vs. CB mode



for $Q'=0$, fastest rise time is 50 ms

CB growth rates (head-tail mode = 0) vs. CB mode



for $Q'=10$, all CB modes are damped