

# SINGLE-BUNCH AND COUPLED-BUNCH INSTABILITY AT LHC TOP ENERGY VS. CHROMATICITY

E. Métral

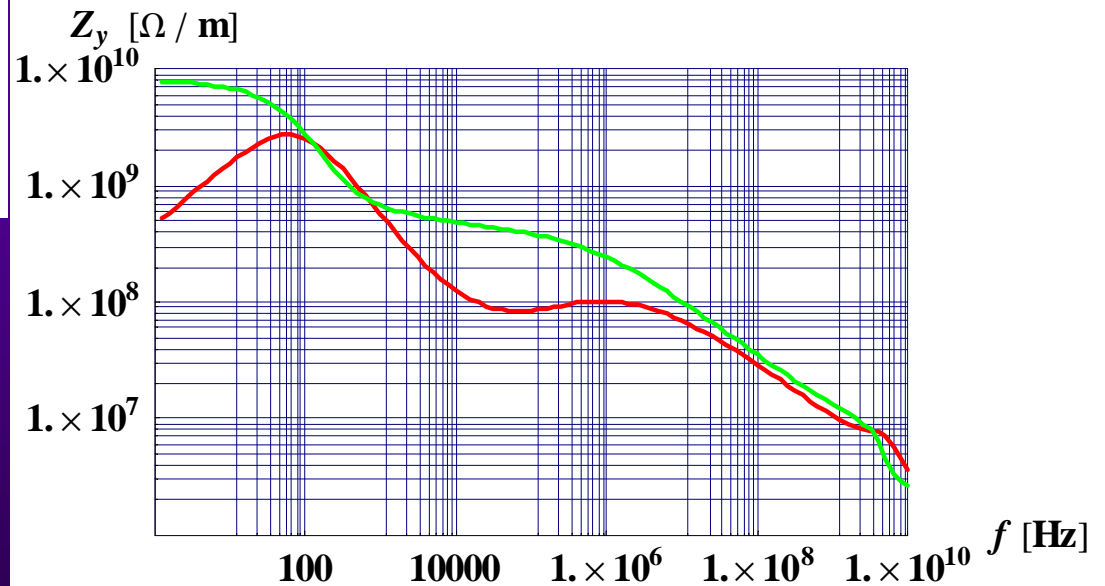
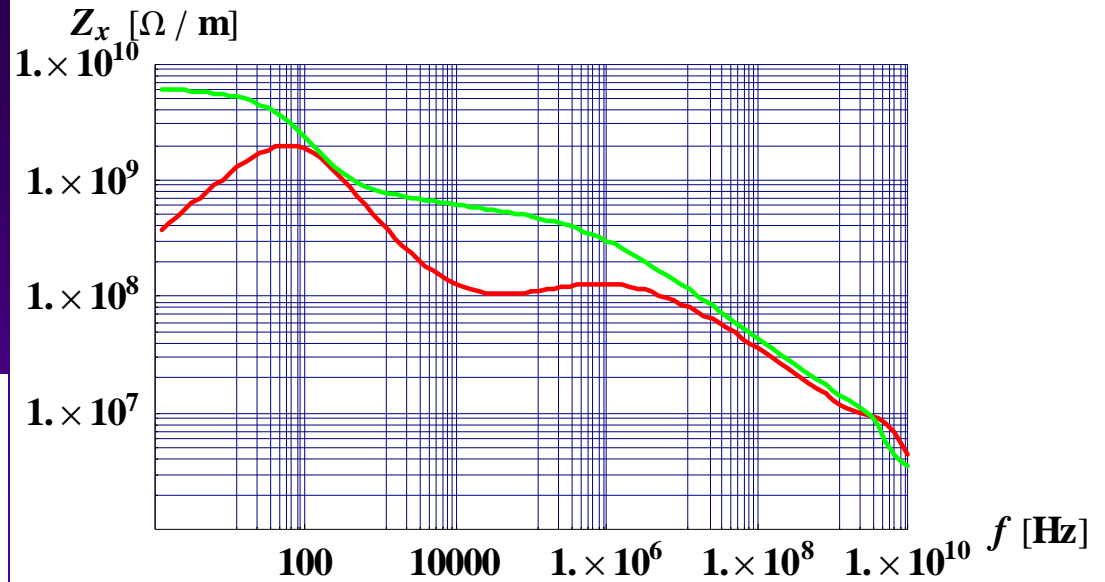
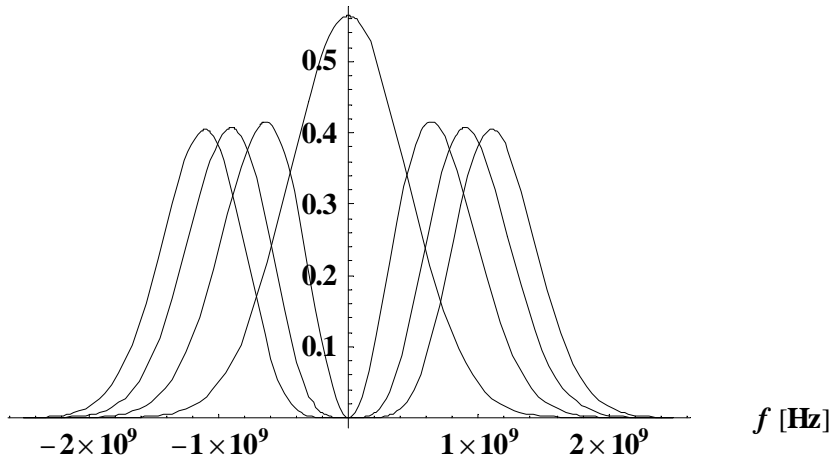
- ◆ **All the collimators of PHASE 1, with the TDI and TCDQ treated separately, beam screen, warm pipe, MQW (2 mm Cu), MBW (2 mm Cu)**
- ◆ **Computations for**
  - **Horizontal plane**
  - **Vertical plane**
- ◆ **Same computations for the secondaries (TCSG) in Copper**

Latest  
collimator list  
(except TDI  
and TCDQ  
treated  
separately)  
sent by G.  
Robert-  
Demolaize on  
11/10/05

#name	angle[rad]	betax[m]	betay[m]	halfgap[m]	Resistivity [Ohm m]	Length[m]
TCL.5R1.B1	0	131.930046	925.939244	0.002575162	0.000000017	1
TCTH.L2.B1	0	50.8905324	49.7634705	0.001327484	0.00000005	1
TCTV.4L2.B1	1.571	132.878596	57.7485257	0.001414104	0.00000005	1
TCLIA.4R2.B1	1.571	54.9399025	126.695909	0.227120612	0.00001	1
TCLIB.6R2	1.571	271.5918	30.8891662	0.112144615	0.00001	1
TCP.6L3.B1	0	133.173819	142.421503	0.003880909	0.00001	0.6
TCSG.5L3.B1	0	55.2316125	295.084643	0.002999156	0.00001	1
TCSG.4R3.B1	0	26.2566047	402.556797	0.002067876	0.00001	1
TCSG.A5R3.B1	2.981	36.2555658	350.426671	0.002685595	0.00001	1
TCSG.B5R3.B1	0.1885	46.1122737	318.428996	0.003011138	0.00001	1
TCLA.A5R3.B1	1.571	144.265025	179.180893	0.006002174	0.00000005	1
TCLA.B5R3.B1	0	153.437469	171.707025	0.005554289	0.00000005	1
TCLA.6R3.B1	0	130.137774	167.358555	0.005115221	0.00000005	1
TCLA.7R3.B1	0	66.0337326	93.1616861	0.003643726	0.00000005	1
TCTH.L5.B1	0	1646.47497	623.773574	0.007550721	0.00000005	1
TCTV.L5.B1	1.571	1651.5656	657.575043	0.004771814	0.00000005	1
TCL.5R5.B1	0	128.604788	907.761503	0.002542502	0.000000017	1
TCS.TCDQ.B1	0	501.167596	165.505192	0.003764311	0.00001	1
TCP.D6L7.B1	1.571	168.879644	73.4174845	0.001152614	0.00001	0.6
TCP.C6L7.B1	0	160.233365	77.6735947	0.001702788	0.00001	0.6
TCP.B6L7.B1	2.215	151.86291	82.1555769	0.001393408	0.00001	0.6
TCSG.A6L7.B1	2.463	43.0720503	216.932384	0.001657723	0.00001	1
TCSG.B5L7.B1	2.504	147.345413	163.177444	0.001940944	0.00001	1
TCSG.A5L7.B1	0.71	171.206577	143.46244	0.001981527	0.00001	1
TCSG.D4L7.B1	1.571	306.612559	69.6322005	0.001309592	0.00001	1
TCSG.B4L7.B1	0	131.22721	138.531839	0.001797806	0.00001	1
TCSG.A4L7.B1	2.349	121.231917	149.143312	0.001826087	0.00001	1
TCSG.A4R7.B1	0.808	111.88628	160.369012	0.001838418	0.00001	1
TCSG.B5R7.B1	2.47	131.104839	272.505246	0.002139507	0.00001	1
TCSG.D5R7.B1	0.897	228.139661	159.916518	0.002143107	0.00001	1
TCSG.E5R7.B1	2.277	257.03478	136.813892	0.00214865	0.00001	1
TCSG.6R7.B1	0.009	353.17157	44.9237507	0.002949228	0.00001	1
TCLA.A6R7.B1	1.571	311.567299	45.2928573	0.001508856	0.00000005	1
TCLA.C6R7.B1	0	163.888957	73.0525544	0.00287017	0.00000005	1
TCLA.E6R7.B1	1.571	66.3427234	151.468451	0.002759268	0.00000005	1
TCLA.F6R7.B1	0	62.6000088	157.726835	0.001773862	0.00000005	1
TCLA.A7R7.B1	0	59.8259125	148.758902	0.001734113	0.00000005	1
TCTH.L8.B1	0	47.1043837	47.8950155	0.001277149	0.00000005	1
TCTV.4L8.B1	1.571	128.802029	52.8559028	0.001352875	0.00000005	1
TCTH.L1.B1	0	1648.69683	624.83177	0.007555814	0.00000005	1
TCTV.L1.B1	1.571	1653.81877	658.708163	0.004775924	0.00000005	1

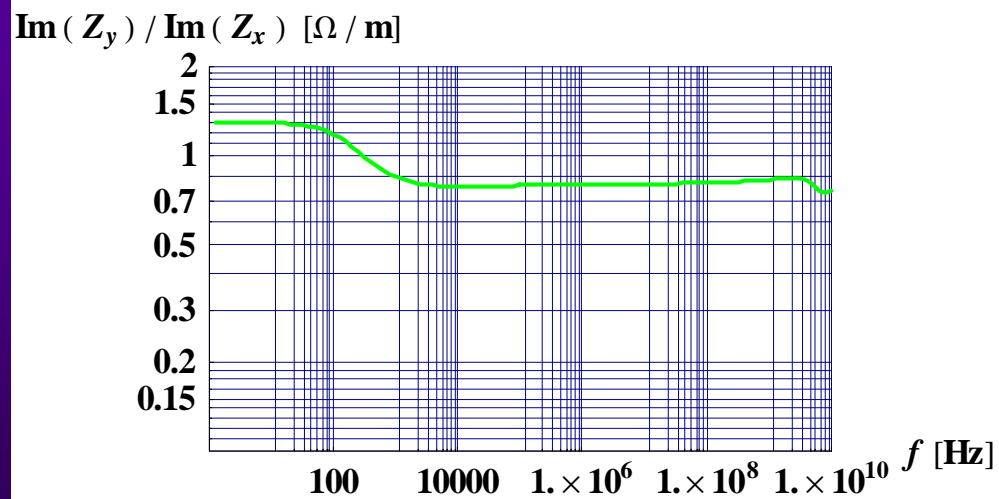
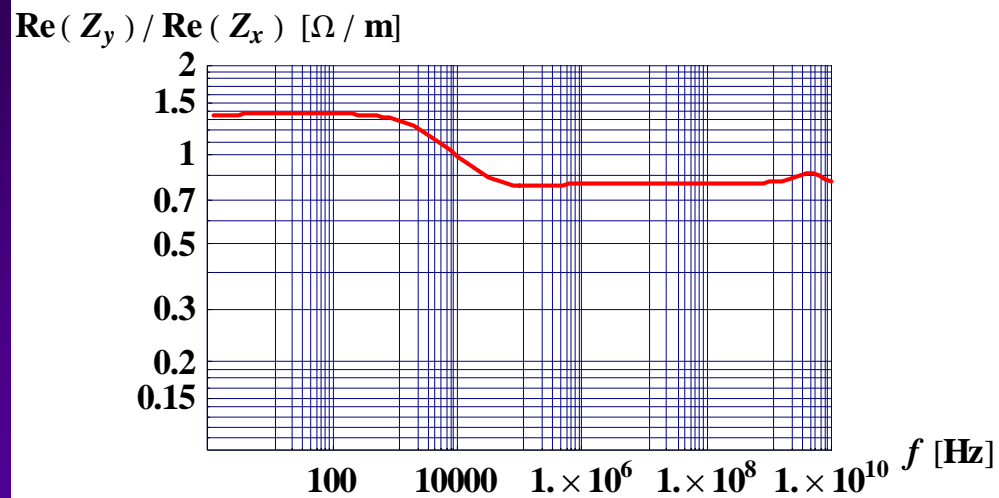
# Bunch spectrum and total impedances

Bunch spectrum



$$Q'_{x,y} = 1 \Rightarrow f_{\xi_{x,y}} \sim 40 \text{ MHz}$$

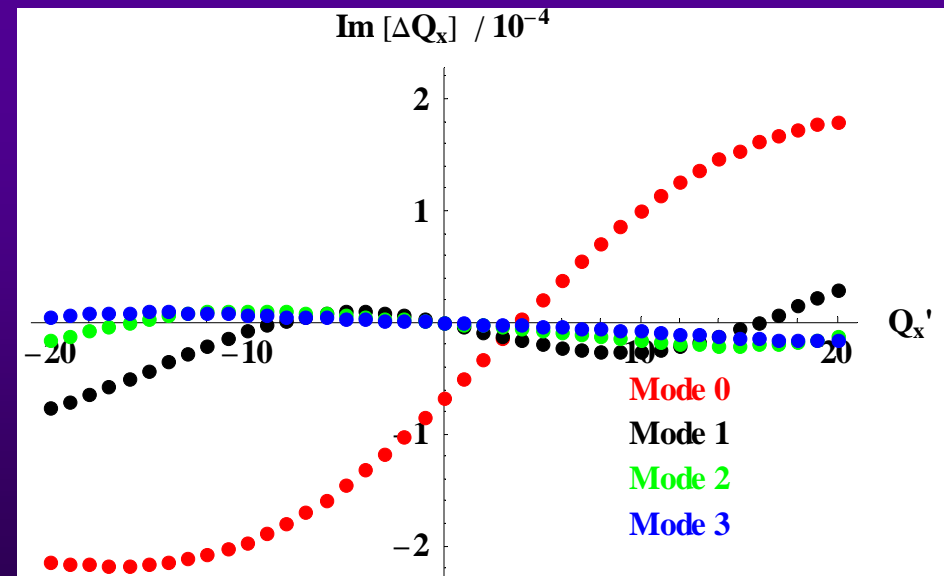
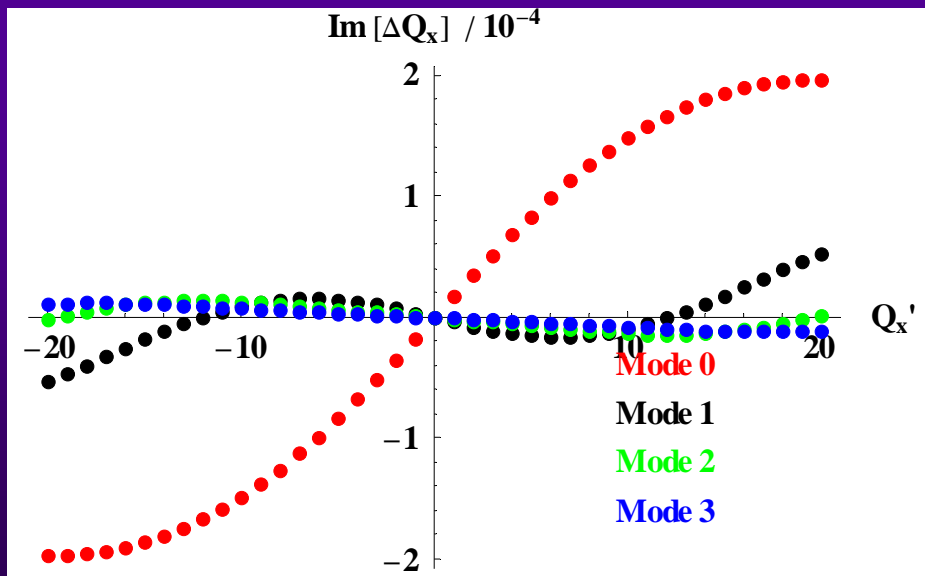
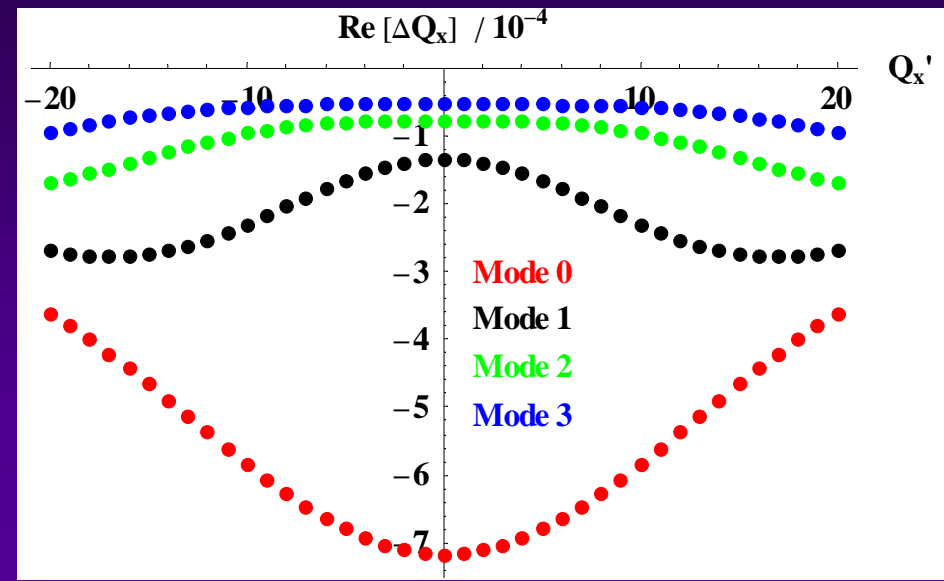
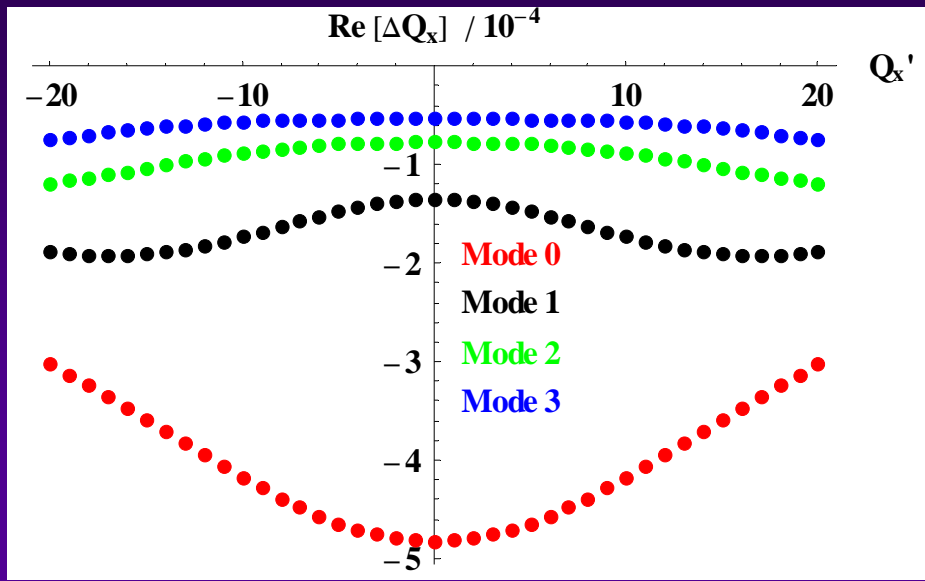
## Comparison between the two transverse impedances



# Single-bunch

# X-plane

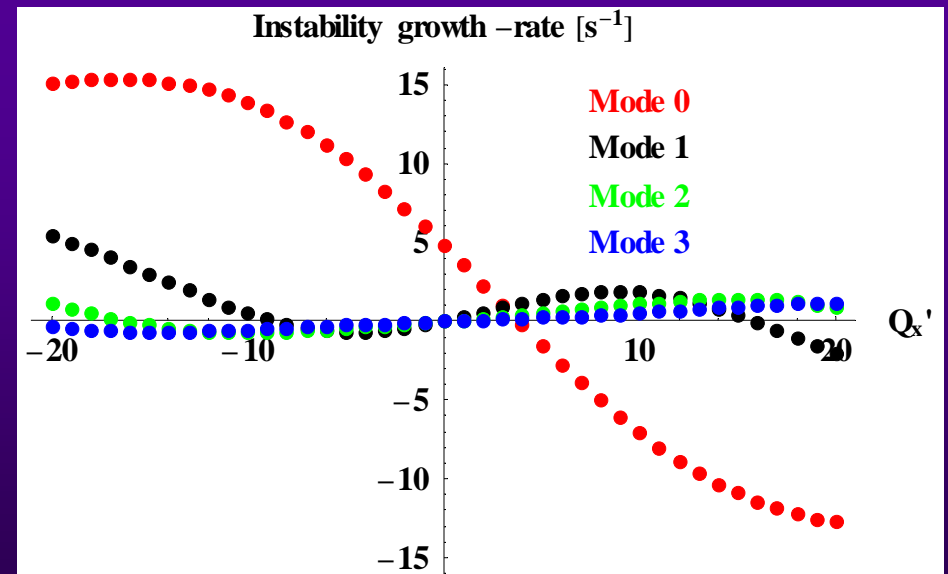
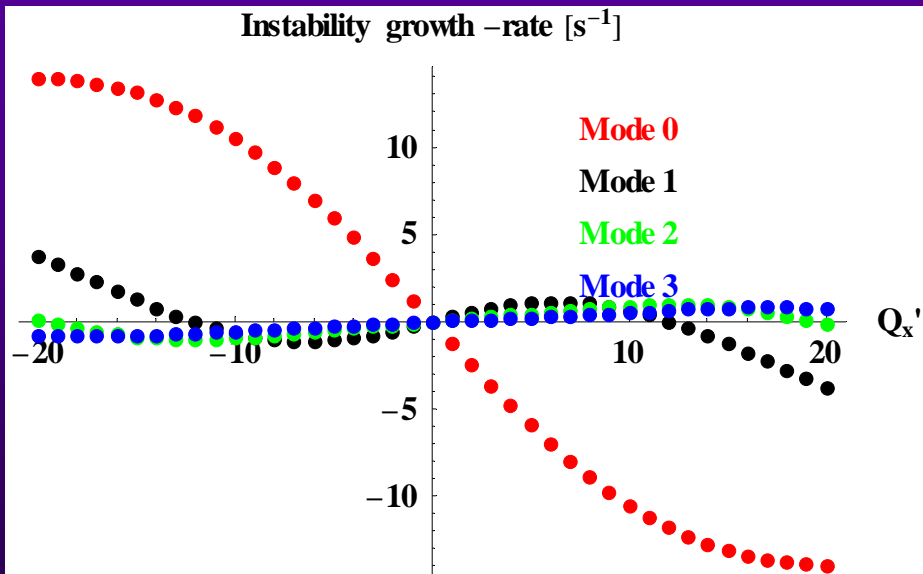
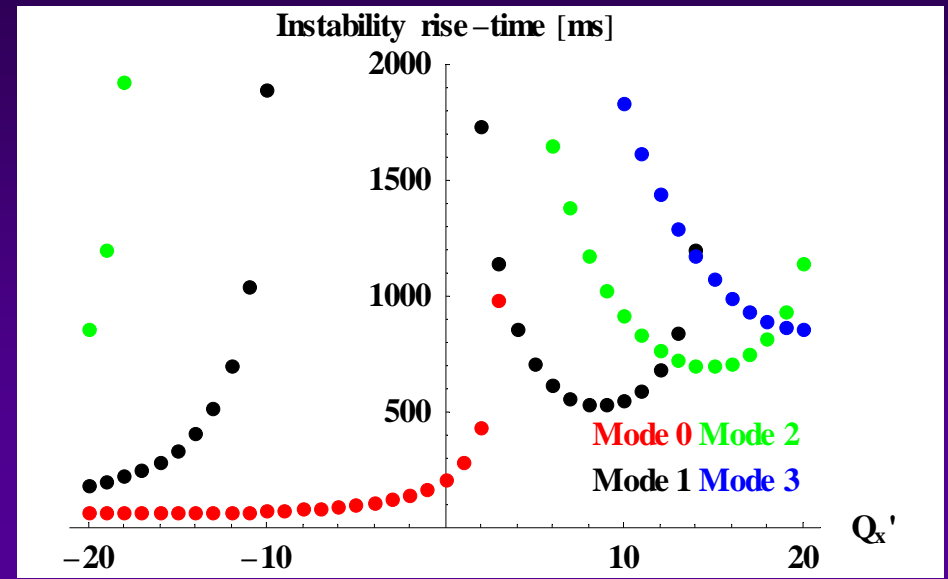
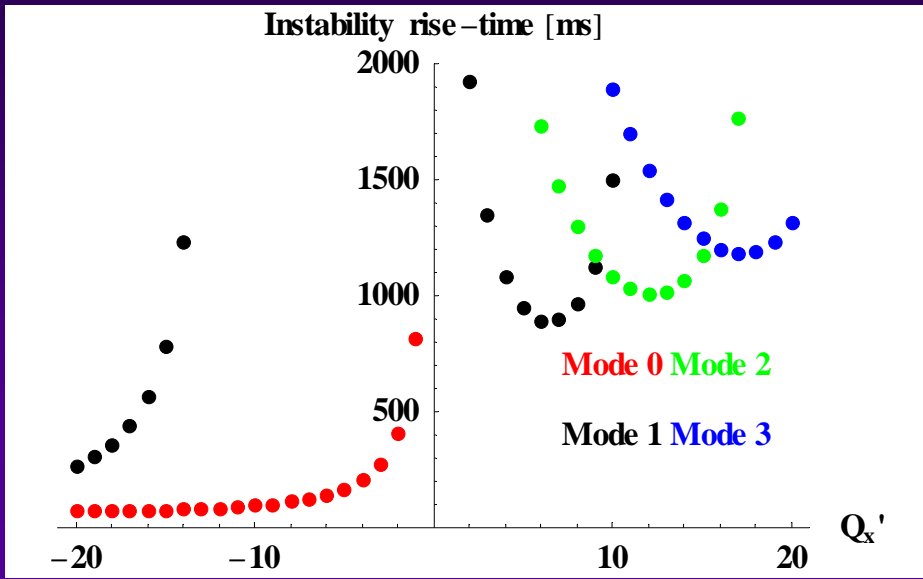
# Coupled-bunch



# Single-bunch

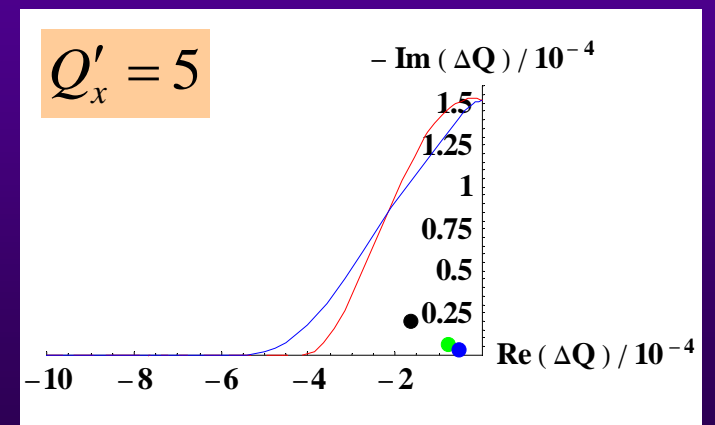
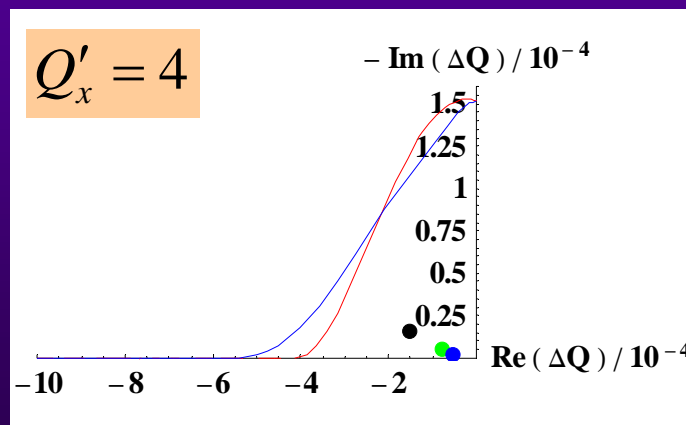
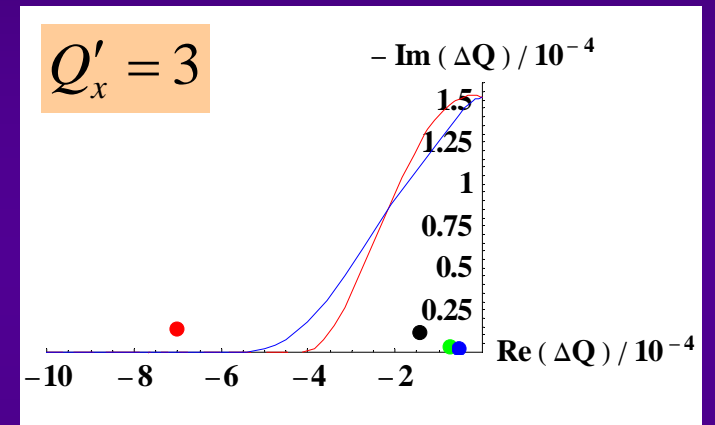
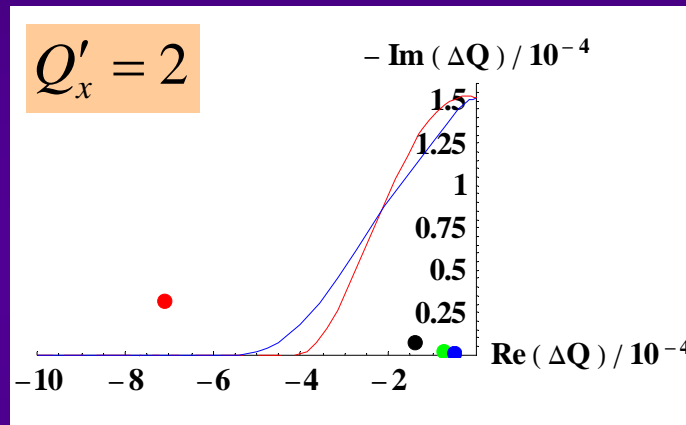
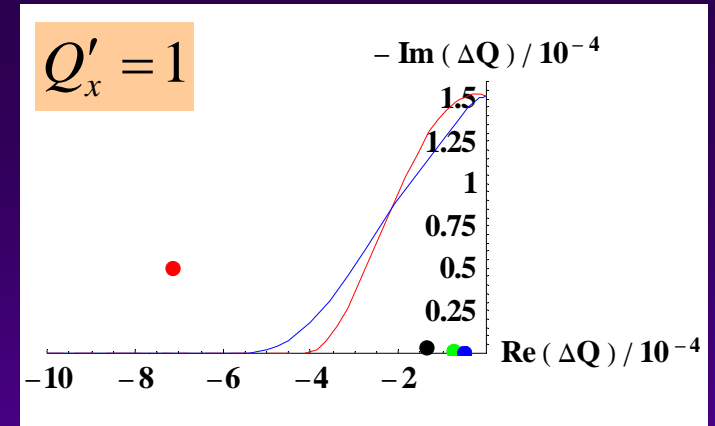
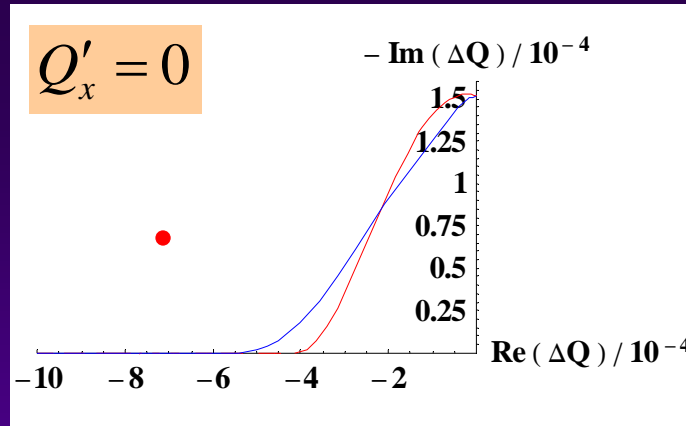
# X-plane

# Coupled-bunch



# Stability diagrams (X-plane)

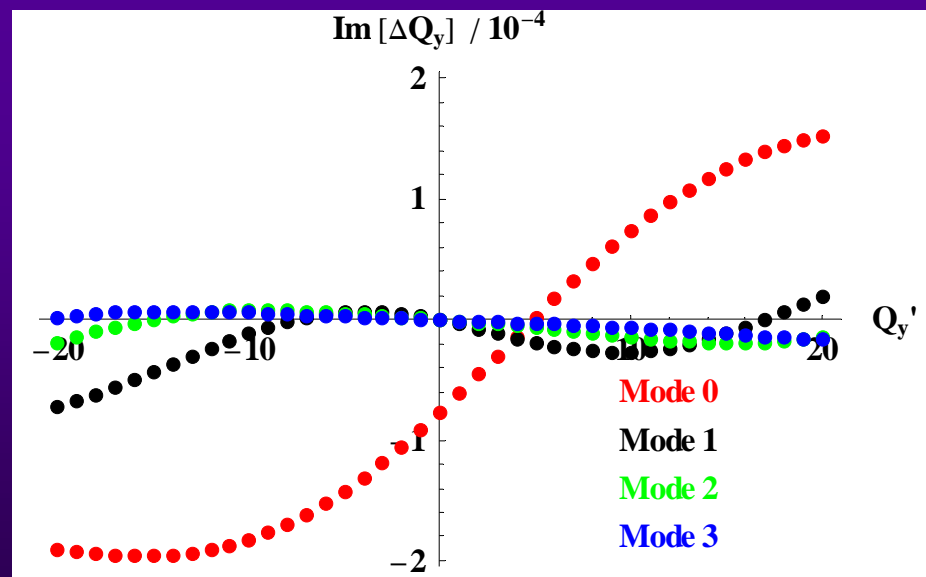
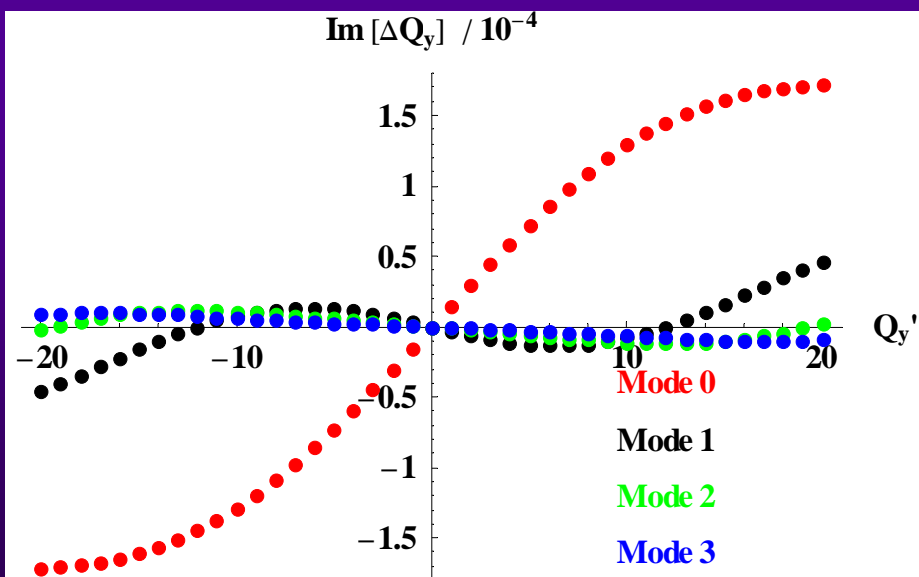
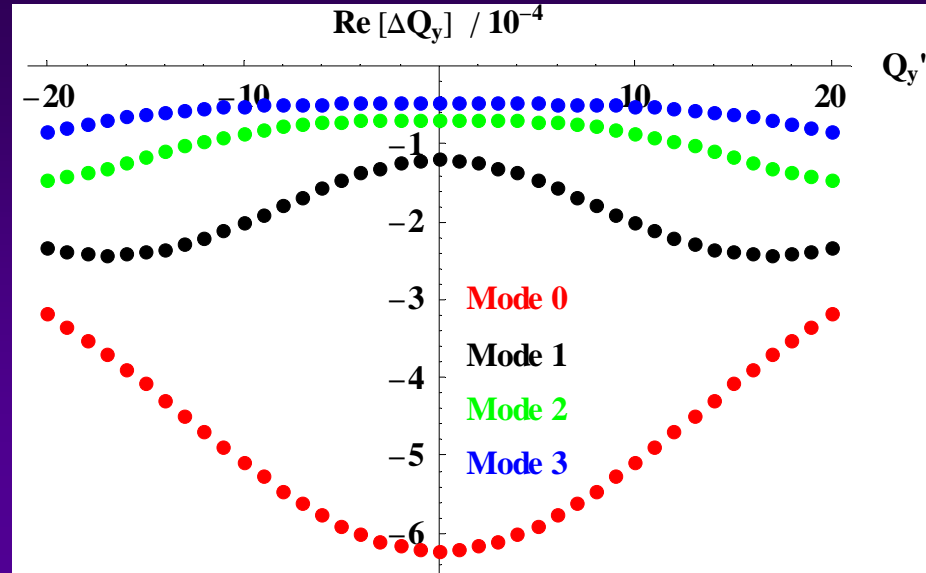
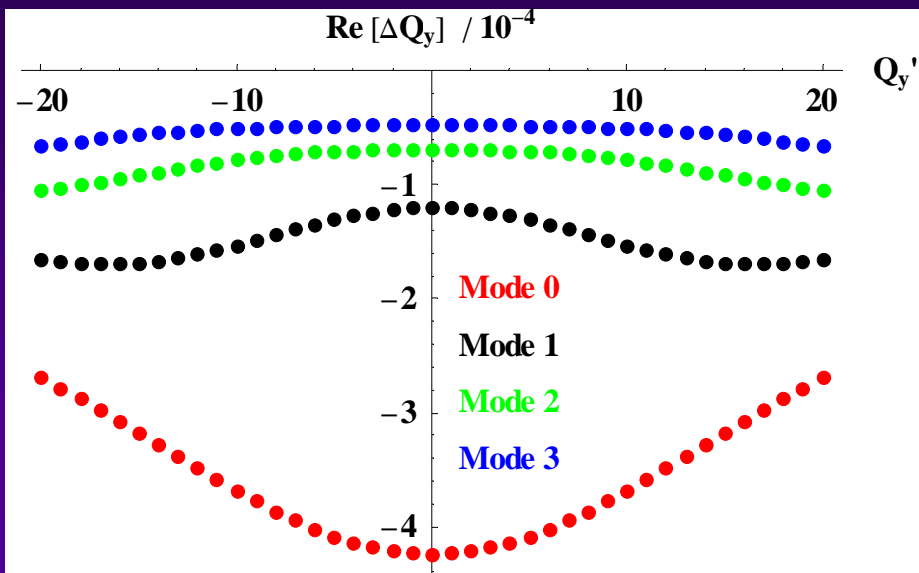
- Mode 0
- Mode 1
- Mode 2
- Mode 3



# Single-bunch

# Y-plane

# Coupled-bunch

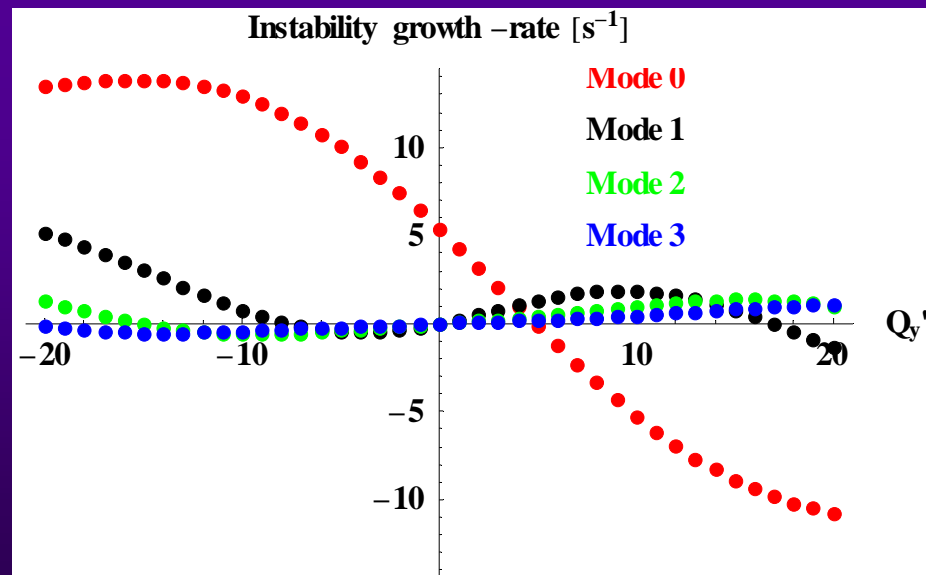
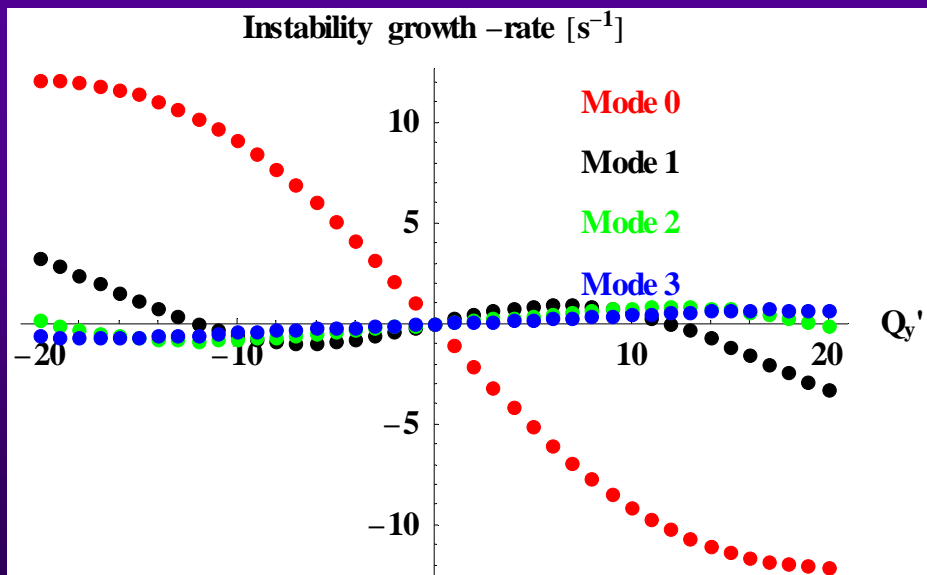
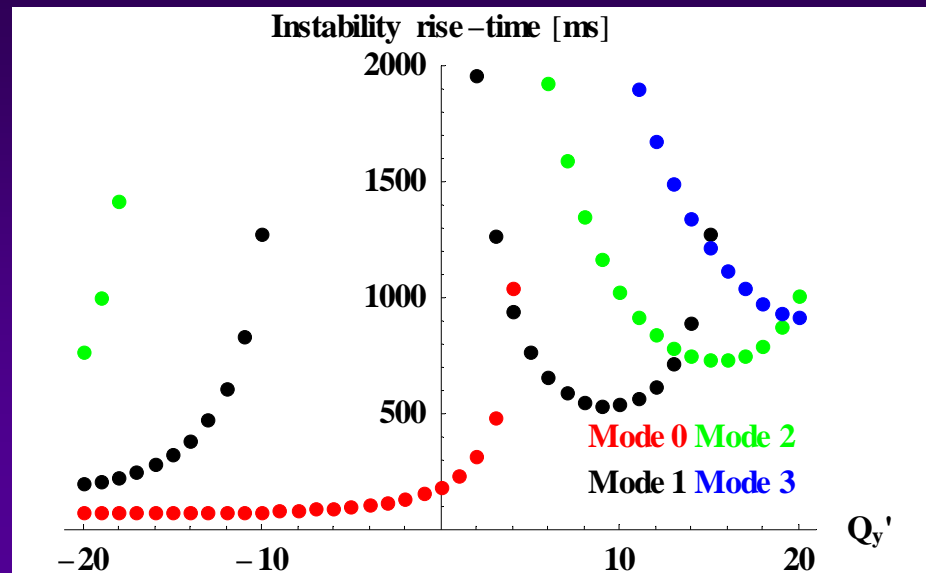
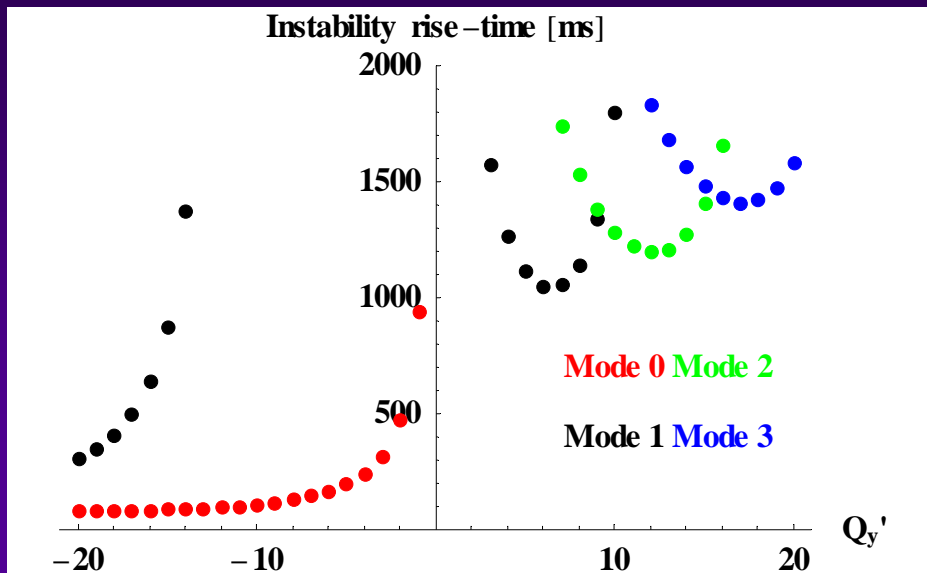




# Single-bunch

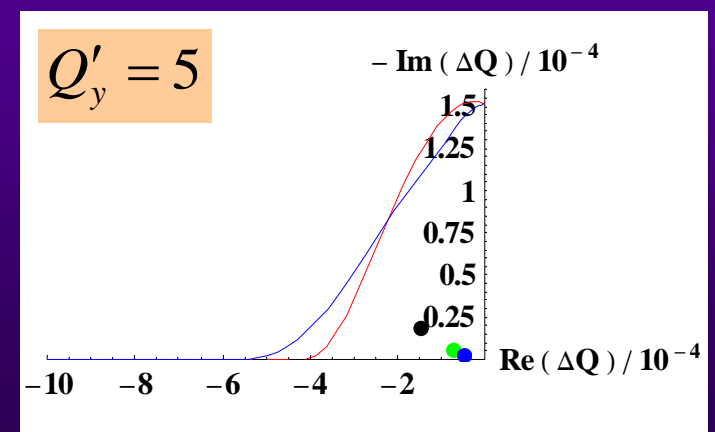
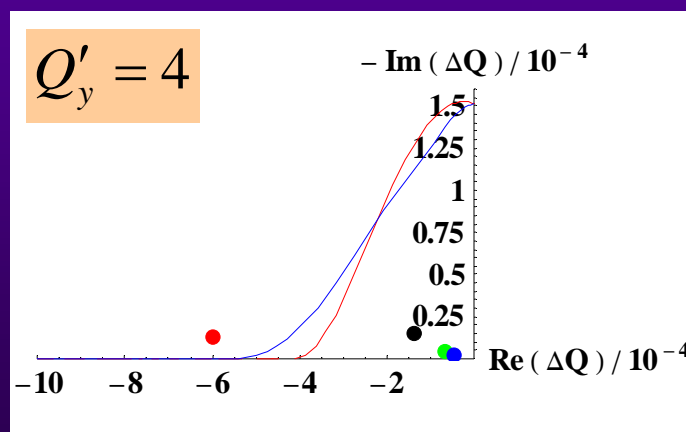
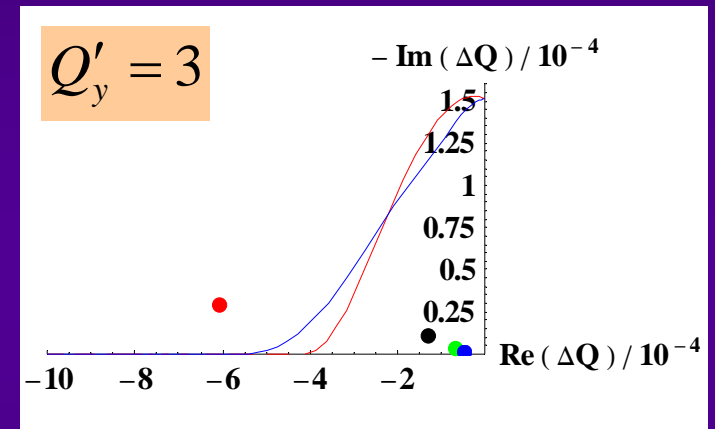
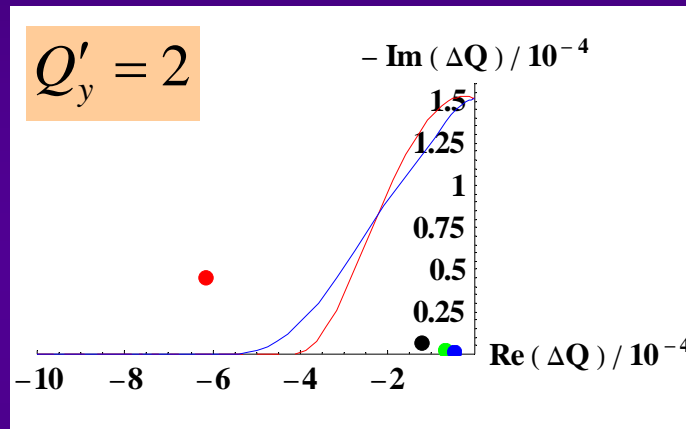
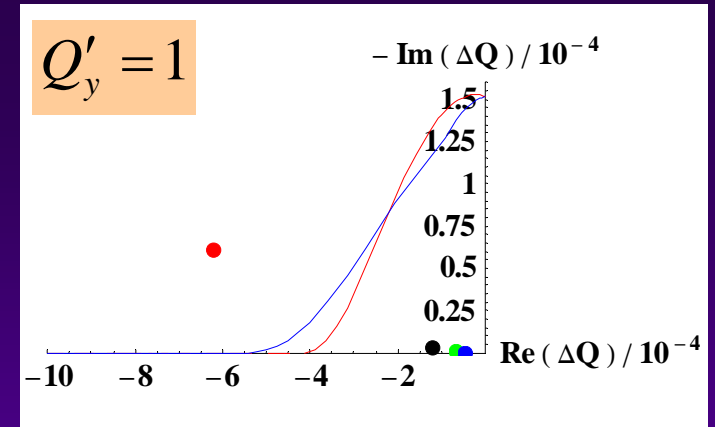
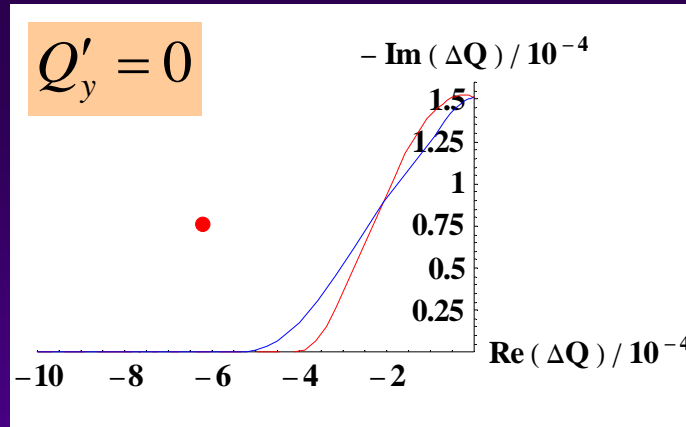
# Y-plane

# Coupled-bunch



# Stability diagrams (Y-plane)

- Mode 0
- Mode 1
- Mode 2
- Mode 3

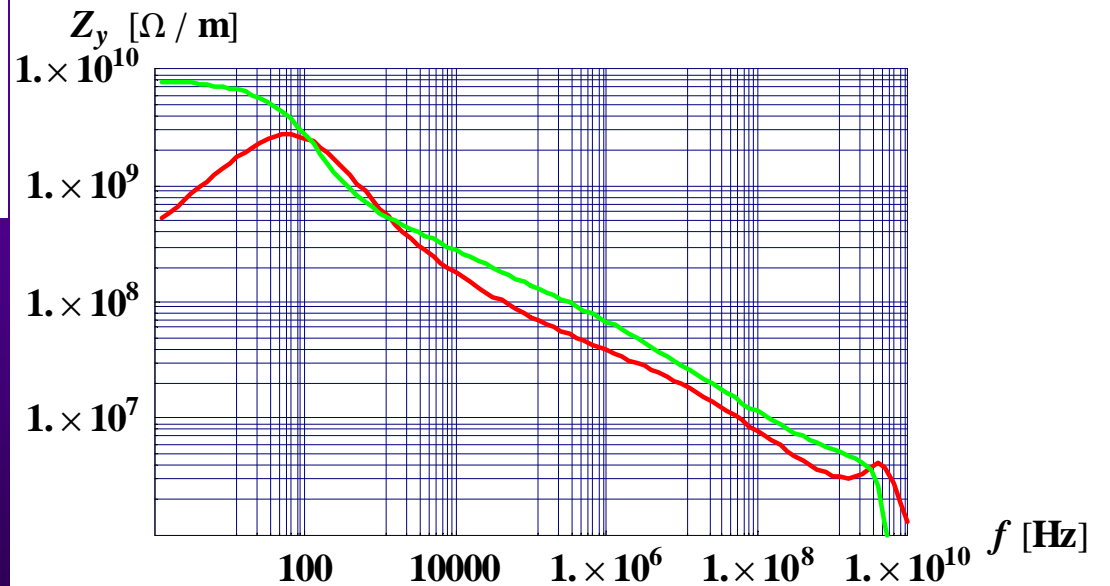
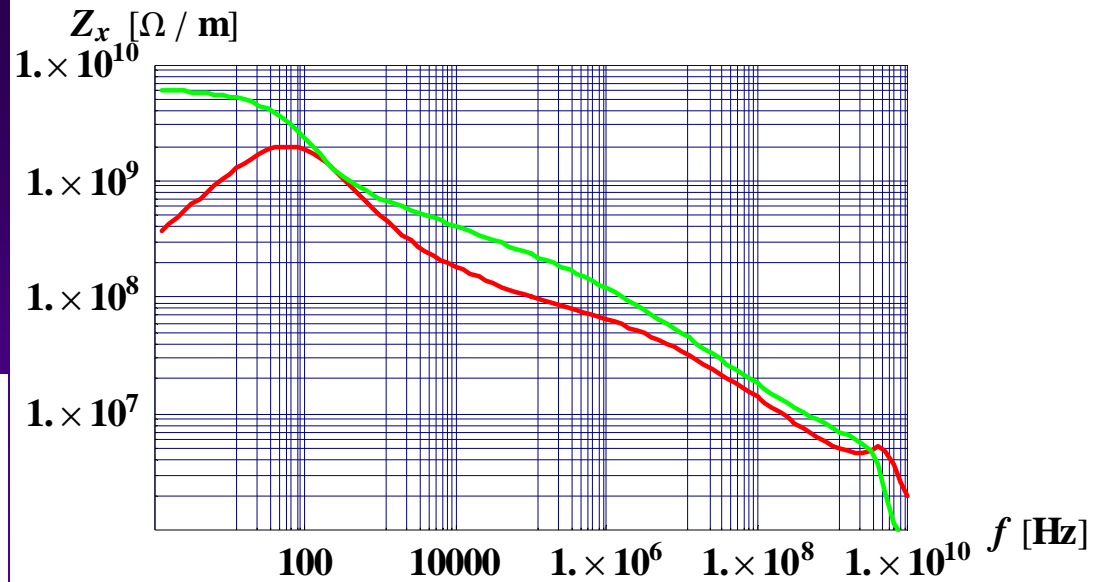
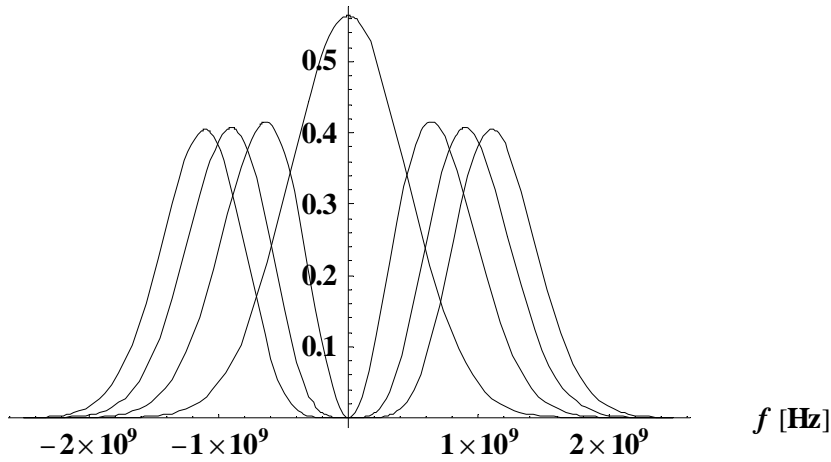


**Secondaries  
(TCSG) in  
copper instead  
of graphite**

#name	angle[rad]	betax[m]	betay[m]	halfgap[m]	Resistivity [Ohm m]	Length[m]
TCL.5R1.B1	0	131.930046	925.939244	0.002575162	0.000000017	1
TCTH.L2.B1	0	50.8905324	49.7634705	0.001327484	0.00000005	1
TCTV.4L2.B1	1.571	132.878596	57.7485257	0.001414104	0.00000005	1
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TCLA.6R3.B1	0	130.137774	167.358555	0.005115221	0.00000005	1
TCLA.7R3.B1	0	66.0337326	93.1616861	0.003643726	0.00000005	1
TCTH.L5.B1	0	1646.47497	623.773574	0.007550721	0.00000005	1
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TCSG.E5R7.B1	2.277	257.03478	136.813892	0.00214865	0.000000017	1
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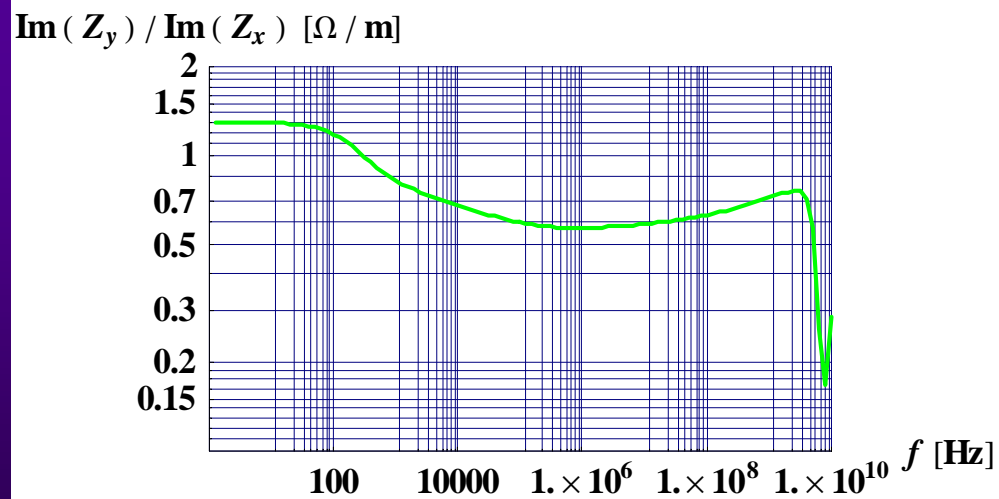
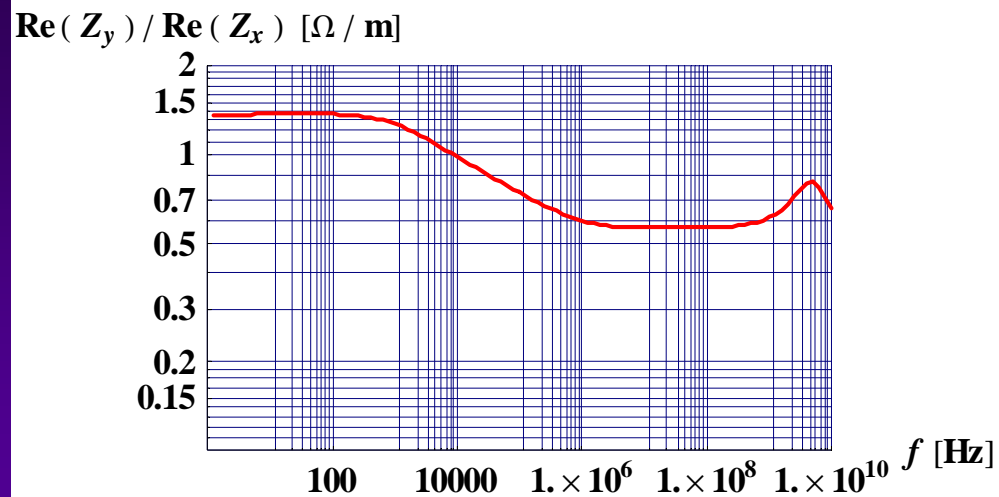
# Bunch spectrum and total impedances

Bunch spectrum



$$Q'_{x,y} = 1 \Rightarrow f_{\xi_{x,y}} \sim 40 \text{ MHz}$$

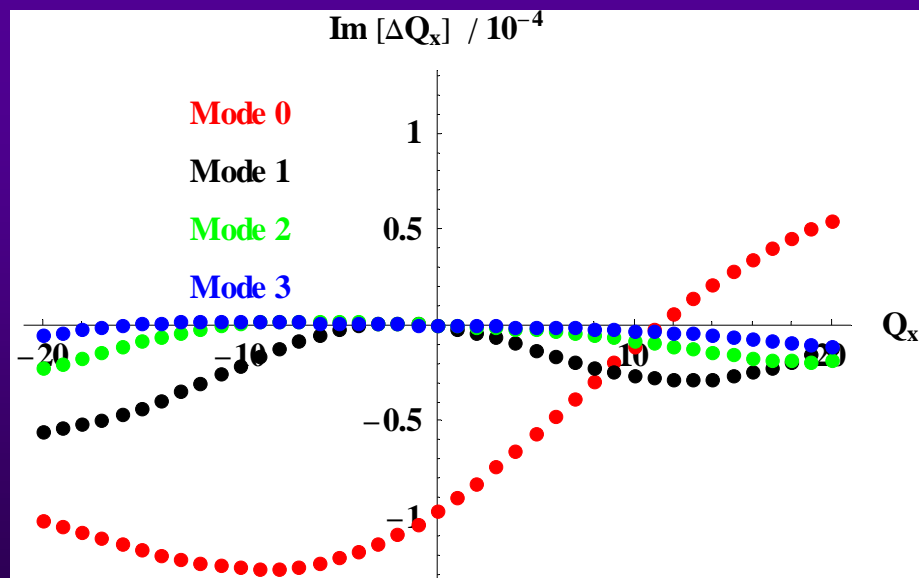
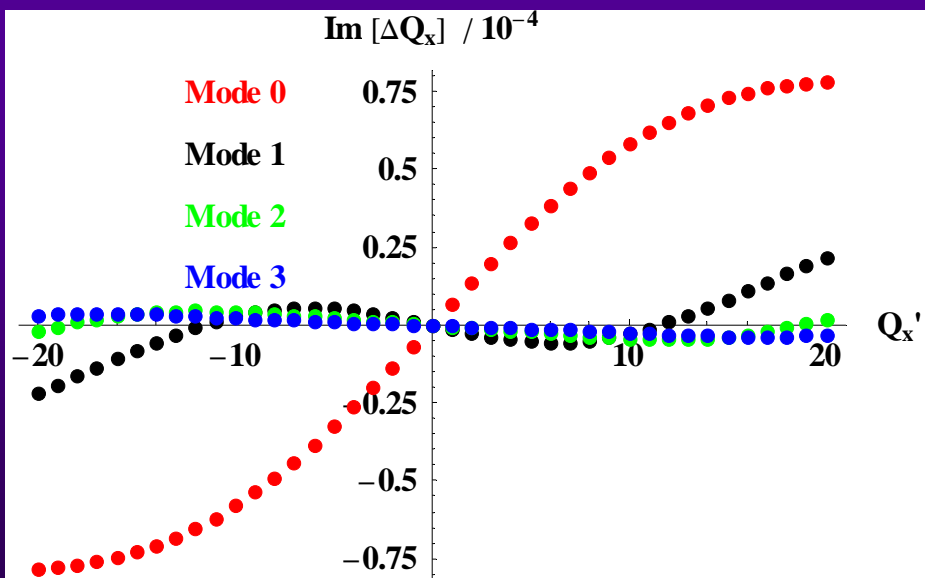
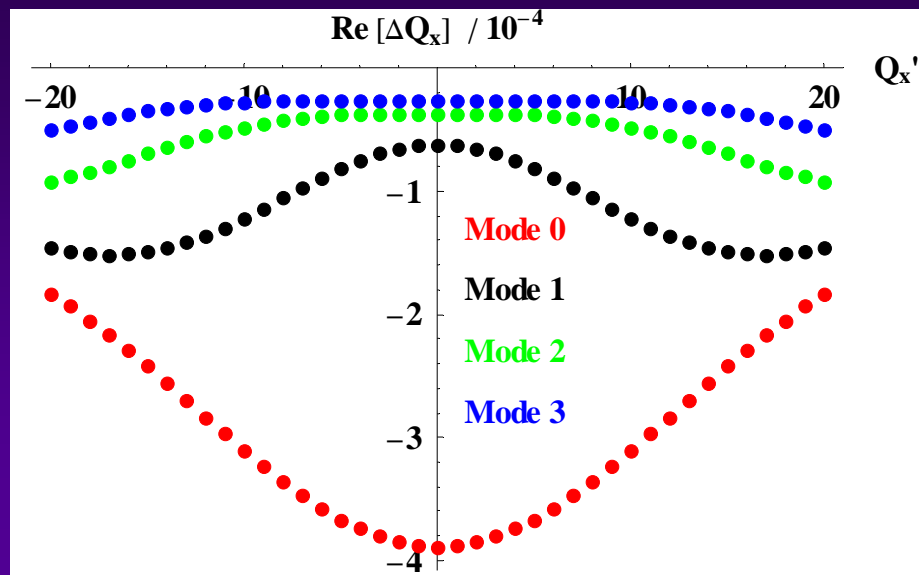
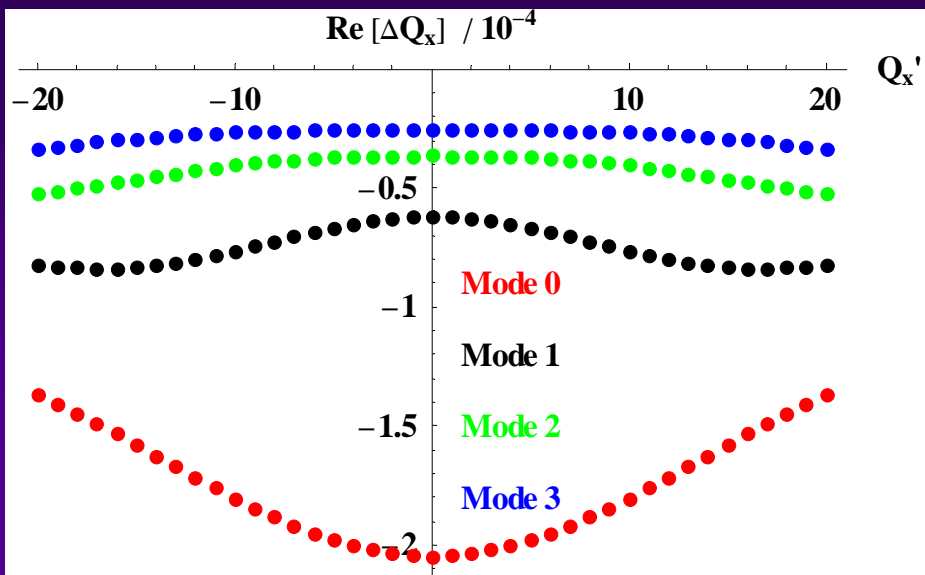
# Comparison between the two transverse impedances



# Single-bunch

# X-plane

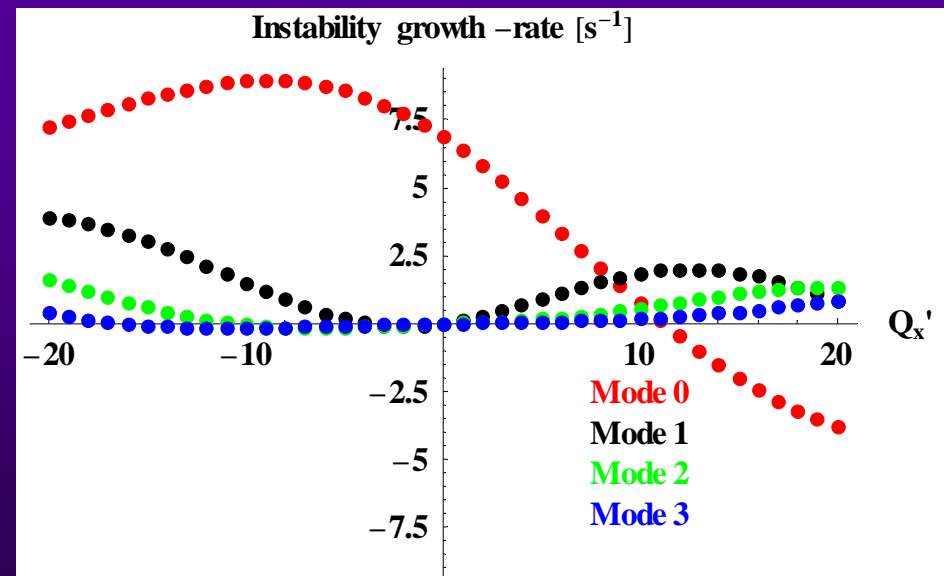
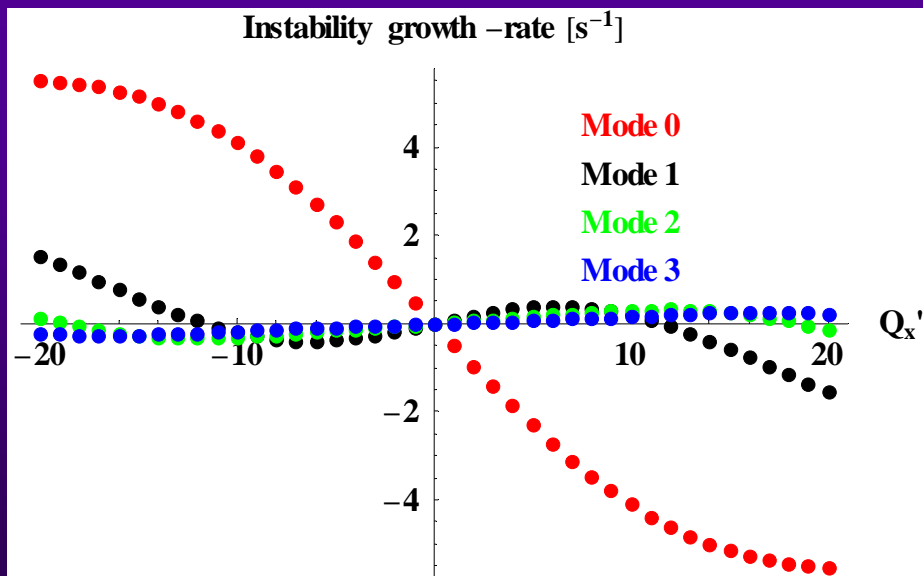
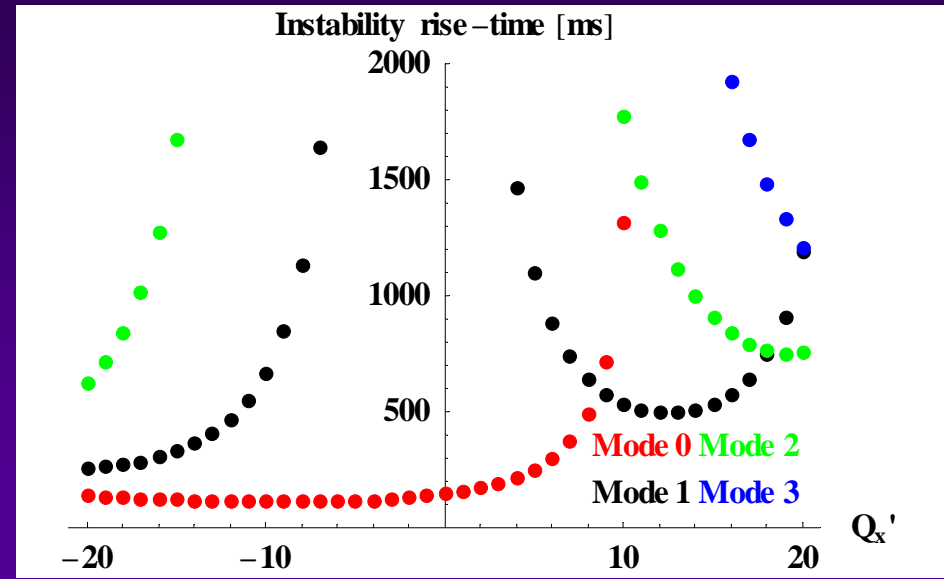
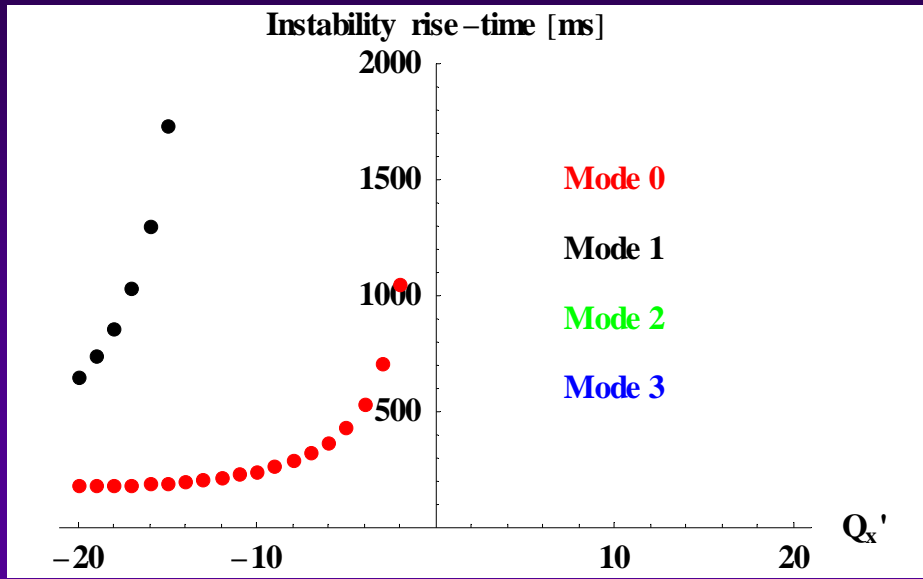
# Coupled-bunch



# Single-bunch

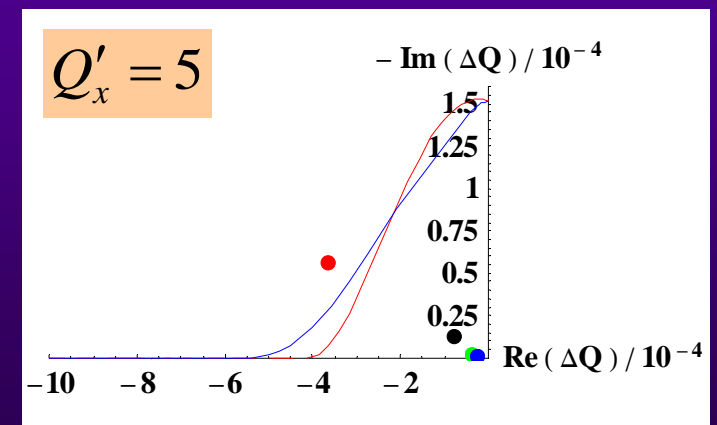
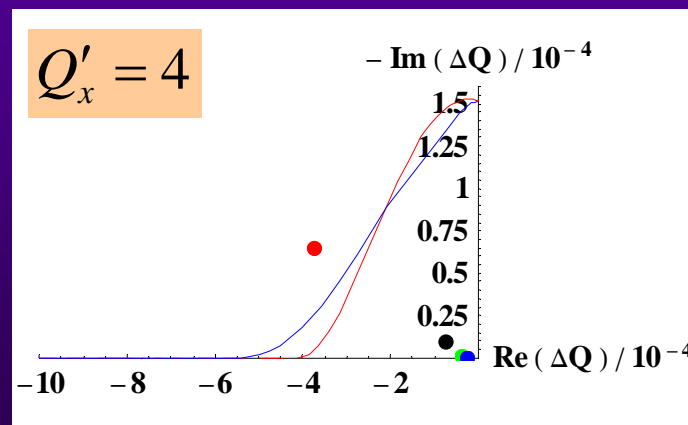
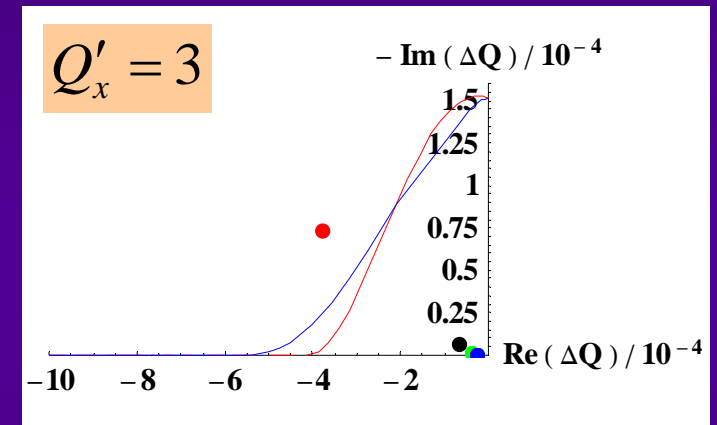
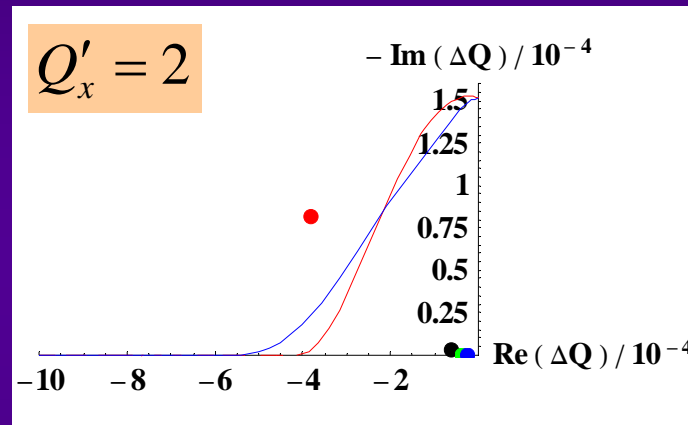
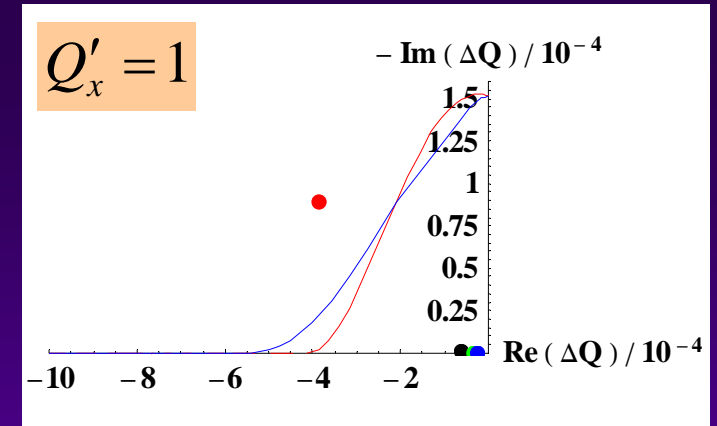
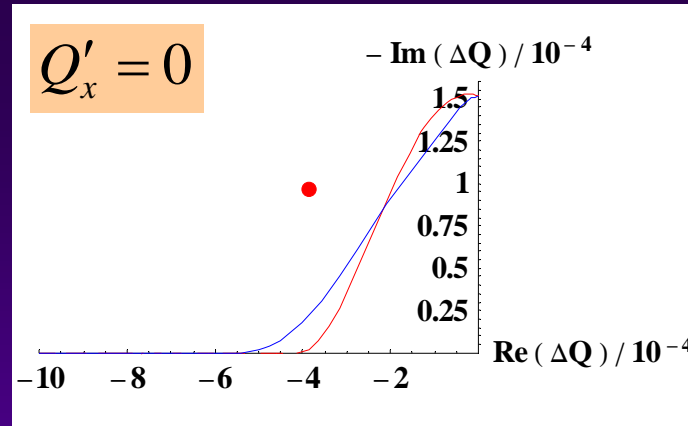
# X-plane

# Coupled-bunch



# Stability diagrams (X-plane)

- Mode 0
- Mode 1
- Mode 2
- Mode 3

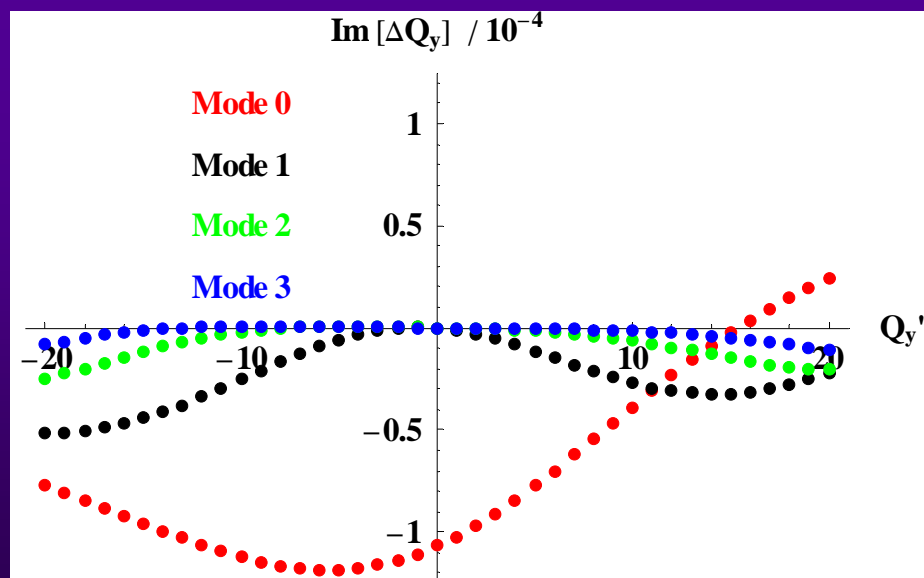
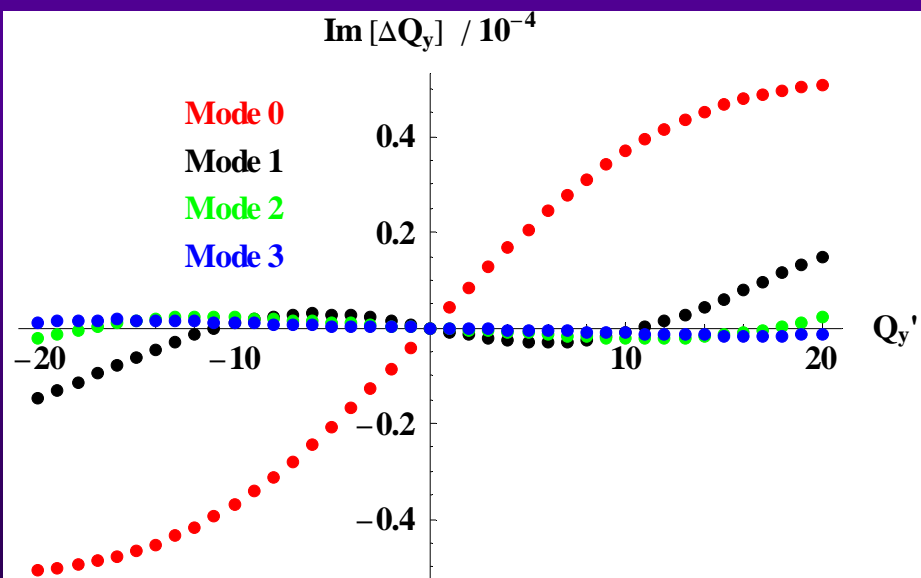
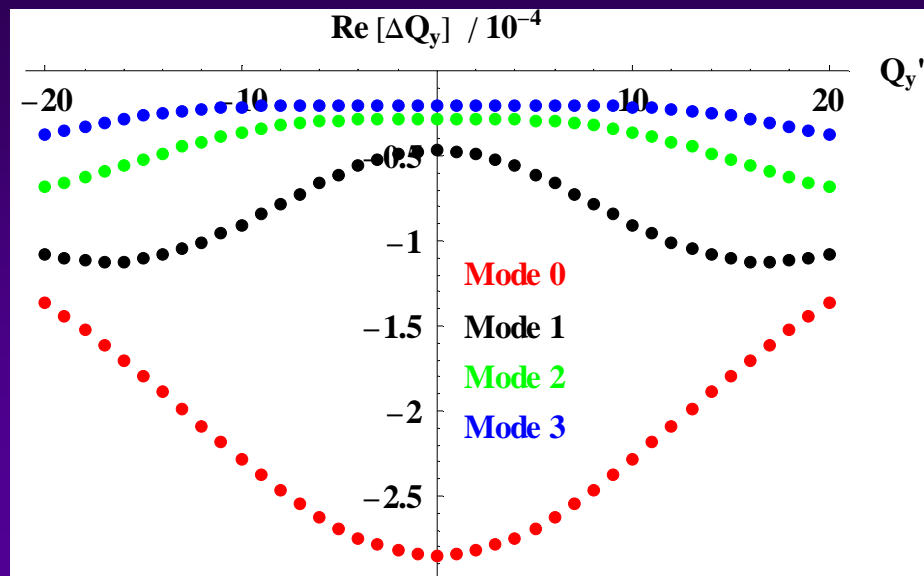
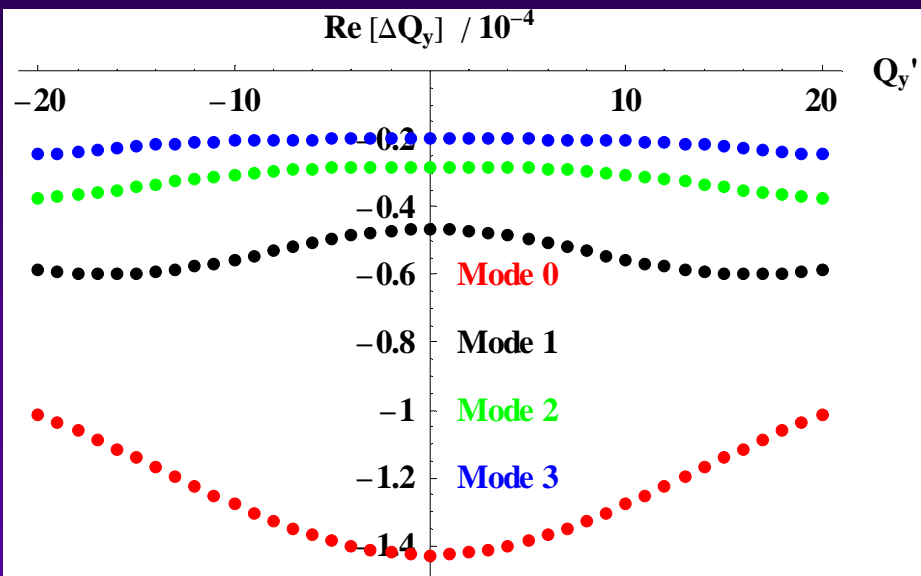




# Single-bunch

# Y-plane

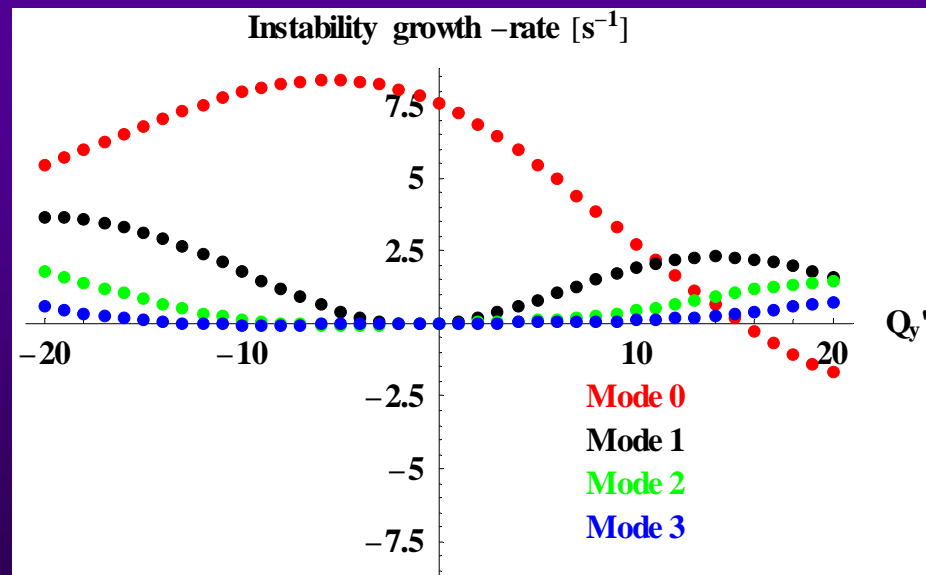
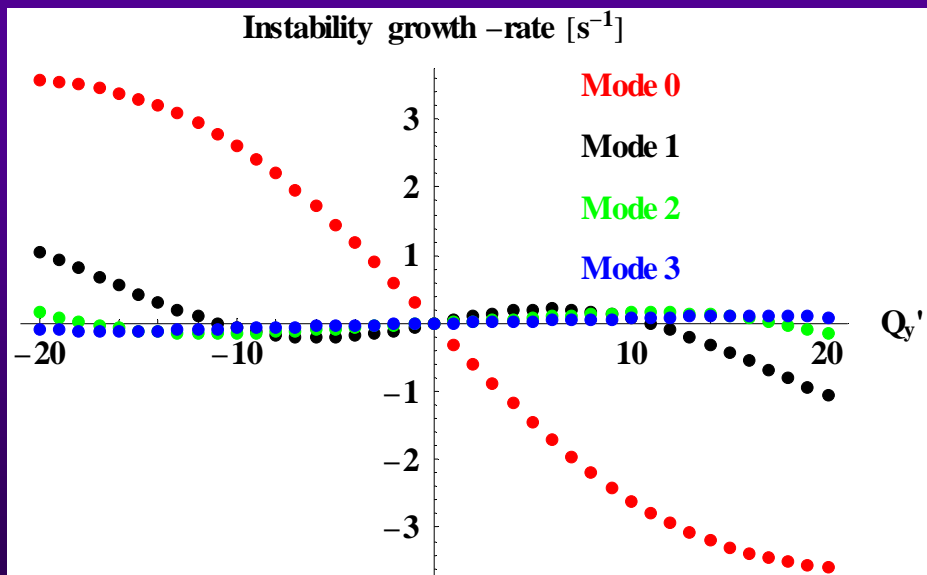
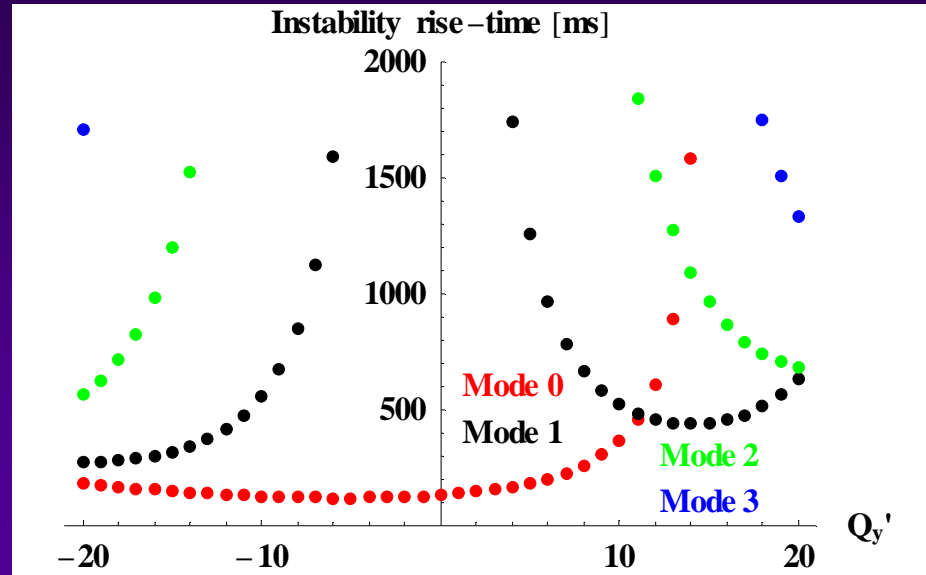
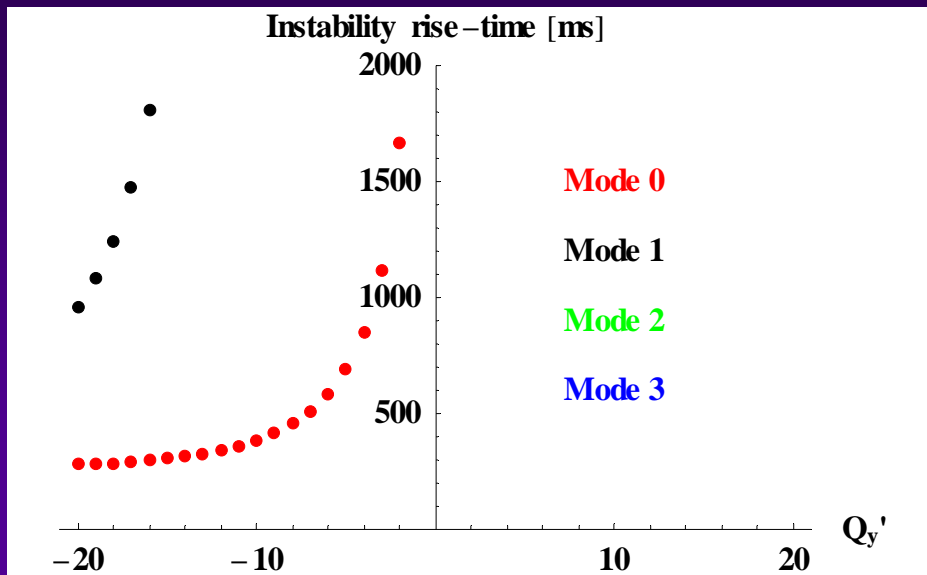
# Coupled-bunch



# Single-bunch

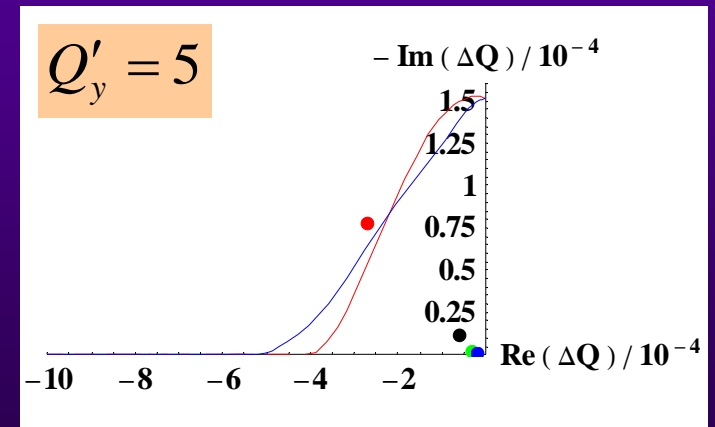
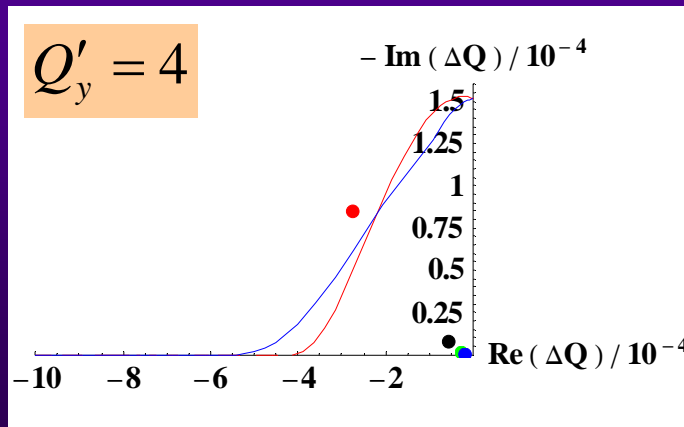
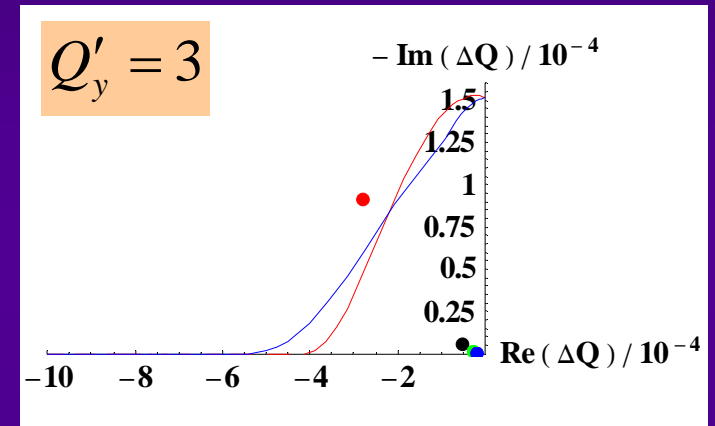
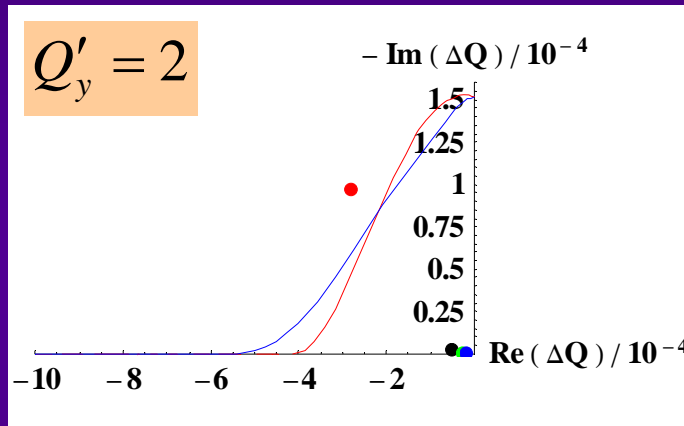
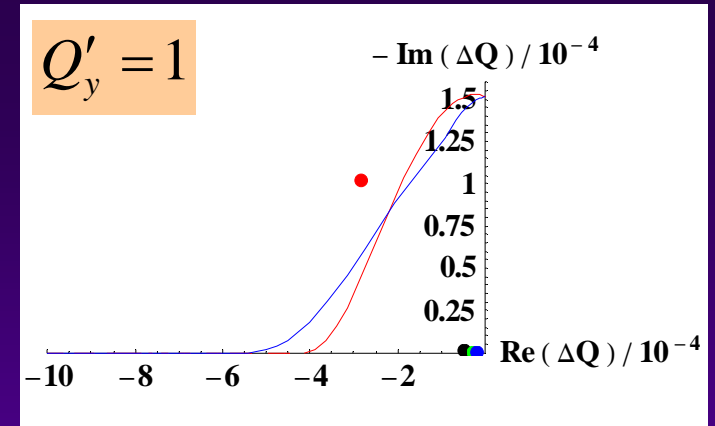
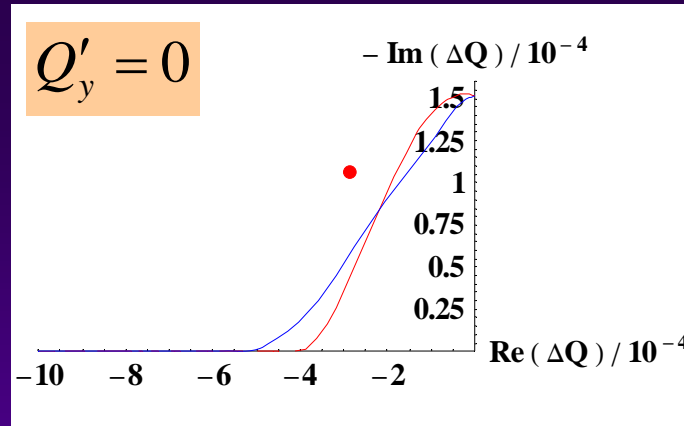
# Y-plane

# Coupled-bunch



# Stability diagrams (Y-plane)

- Mode 0
- Mode 1
- Mode 2
- Mode 3



## CONCLUSION

- ◆ **With the TCSG in graphite, ~50% of the nominal beam is stable**
- ◆ **With the TCSG in copper, ~70% of the nominal beam is stable**
- ◆ Increasing the chromaticities  $Q'_{x,y}$  by few units helps
- ◆ **I can refine these computations (and also for the injection) by adding the other sources of impedances (kickers, septa, BPMs...) if I have the data**