Nested Head-Tail Computations for LHC

The computations are done by A. Burov (LARP-LTV) at November 2012 with his program NHT [1] (Acknowledgements to SlavaD, EliasM, NicolasM, SimonW, XavierB, TatianaP).

Generally, NHT is a Vlasov solver for transverse beam instabilities. It assumes arbitrary multi-bunch beam with arbitrary train structure, arbitrary impedance, arbitrary frequency profile of the damper gain, arbitrary transverse and longitudinal nonlinearities and beam-beam collision scheme. The corresponding functions are supposed to be provided in any form.

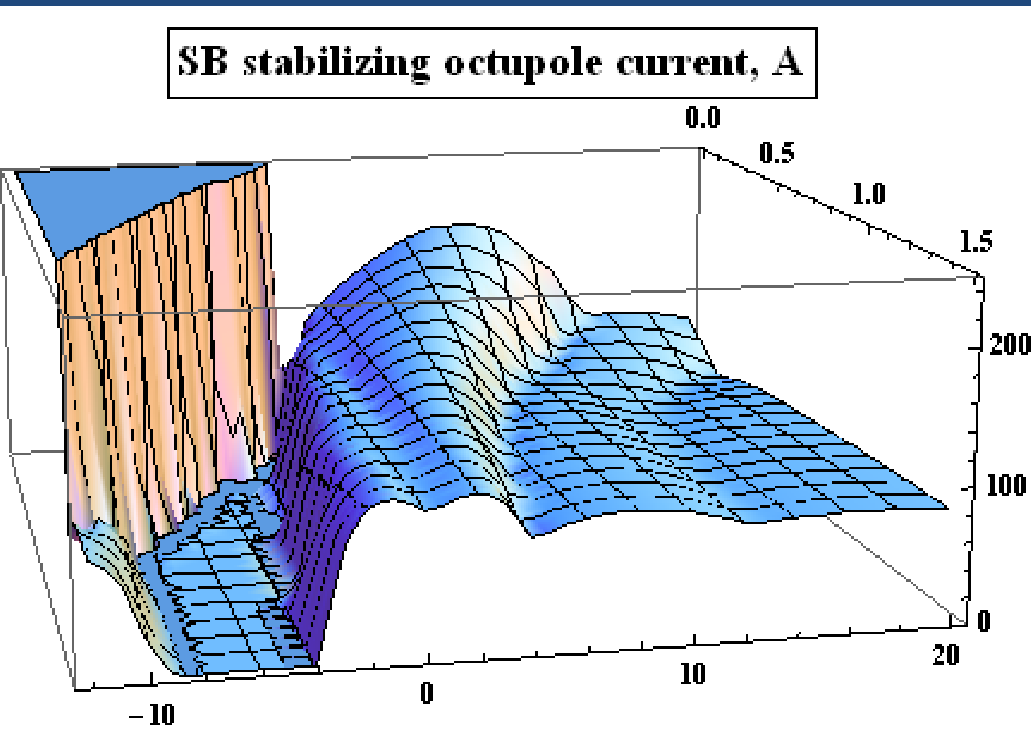
The program computes all the relevant coherent modes with their head-tail, radial and couple-bunch structure for a given gain amplitude and beam chromaticity.

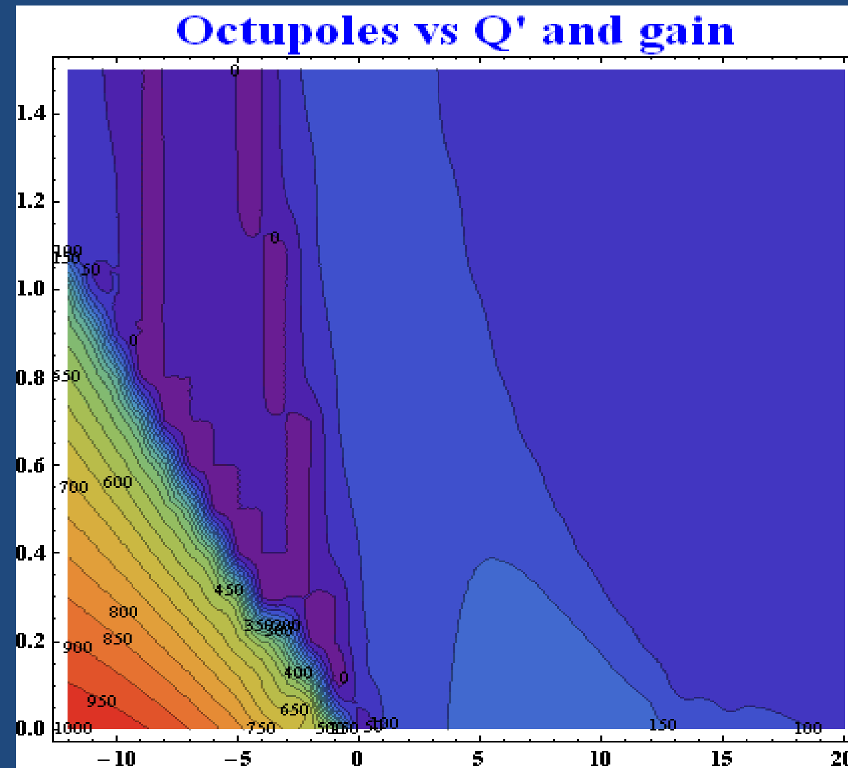
After that, the threshold strength of the Landau elements (MO currents for LHC) is computed by means of pre-calculated stability diagrams.

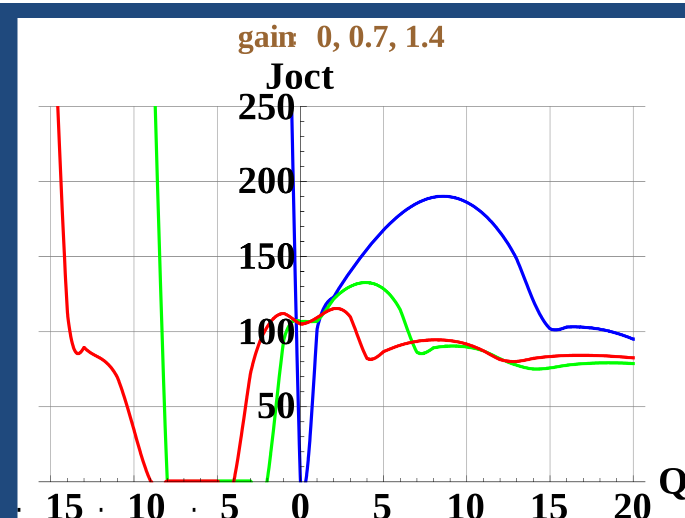
The NHT is under construction, being extended, upgraded and anti-bug checked day after day.

[1] A. Burov, "Nested Head-Tail Vlasov Solver", *to be published*.

Nominal Impedance, Single Bunch, MO+

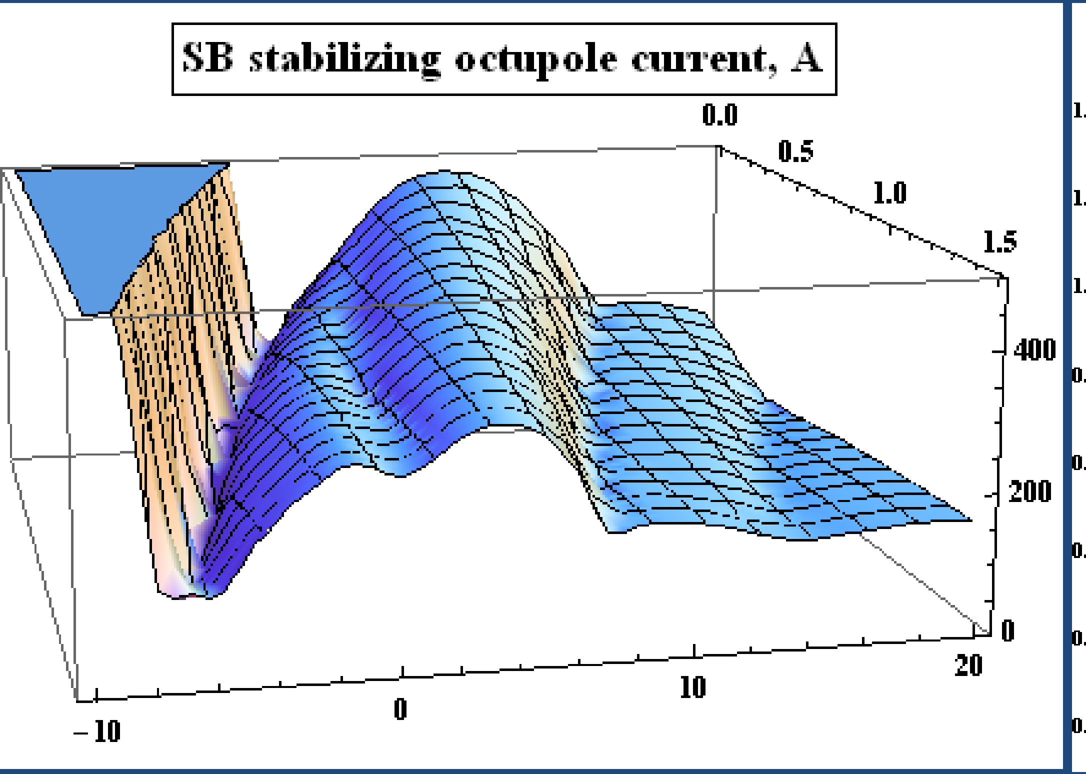


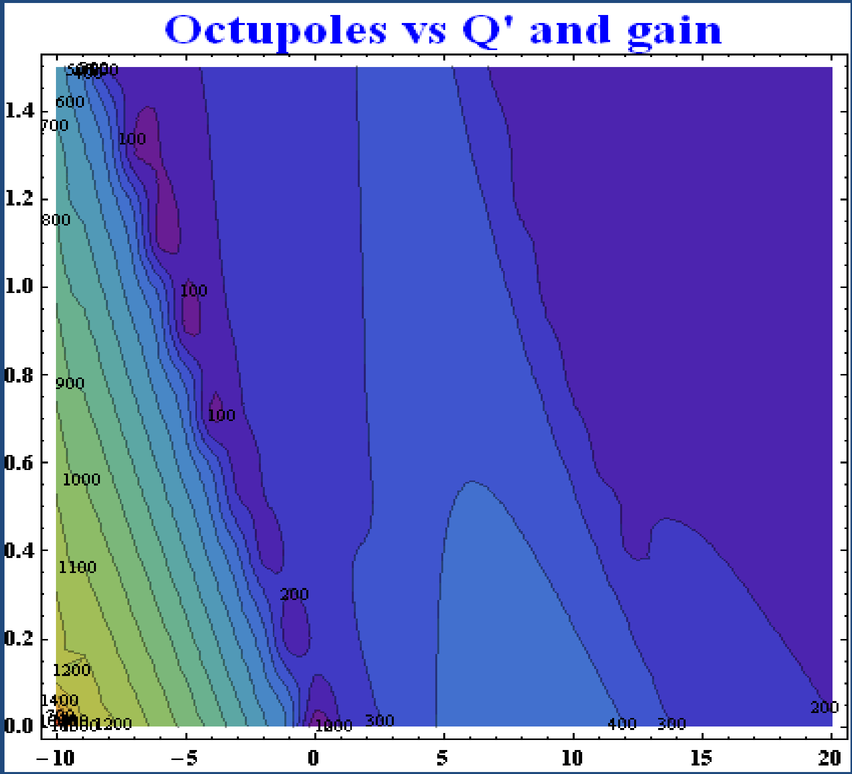




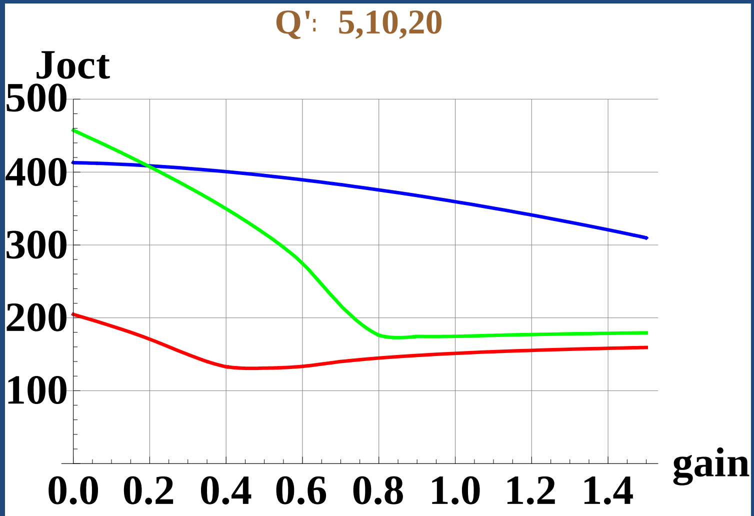
AB

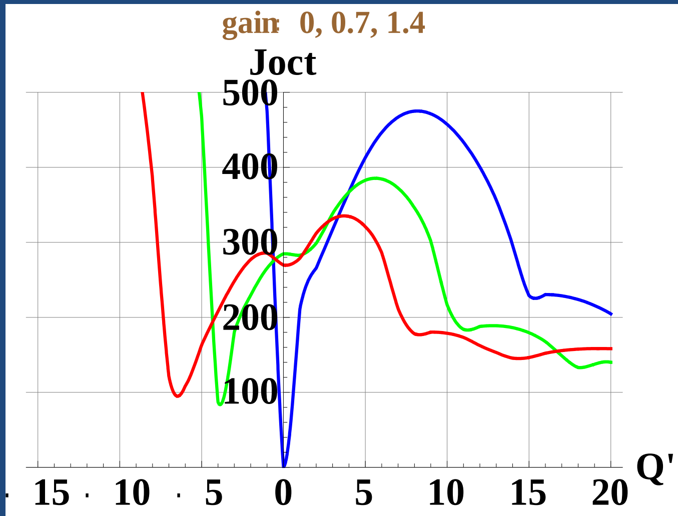
2⊗Impedance, Single Bunch, MO+





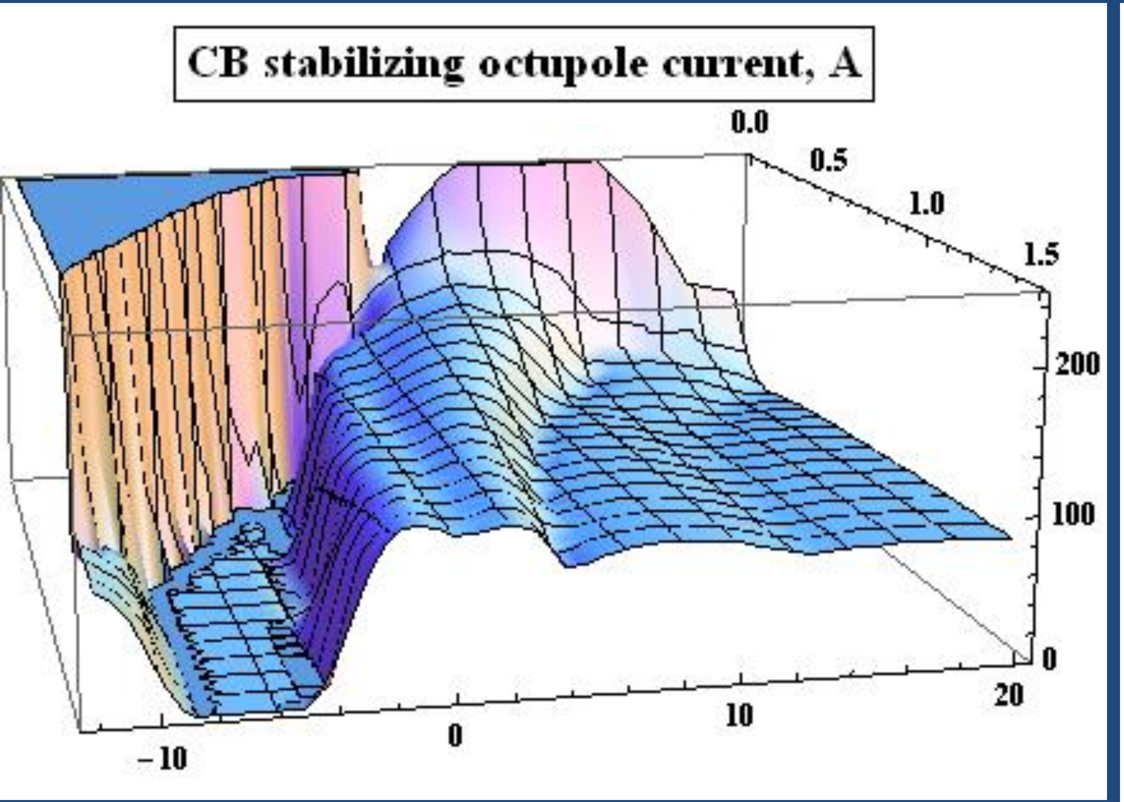
The Valley is lost…

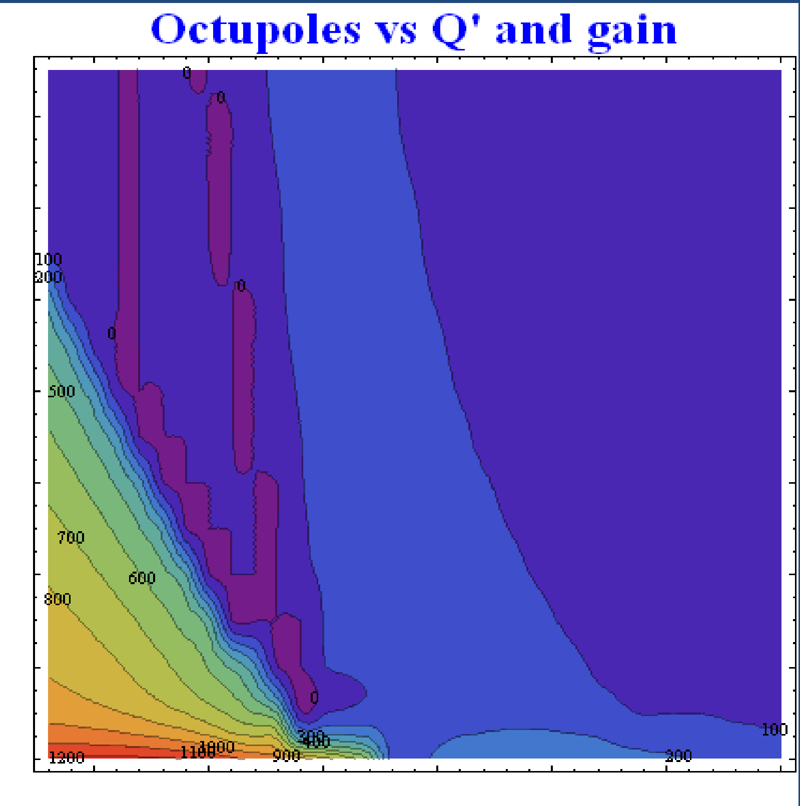




AB

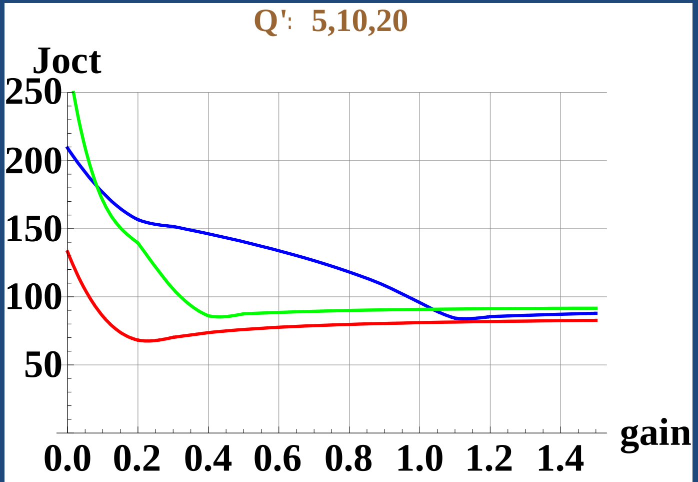
1⊗Impedance, CB, MO+, old ADT

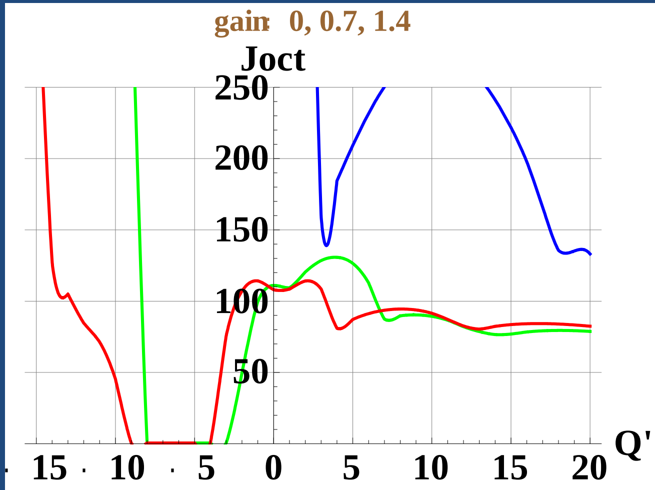




At high enough gain, CB and SB thresholds are the same.

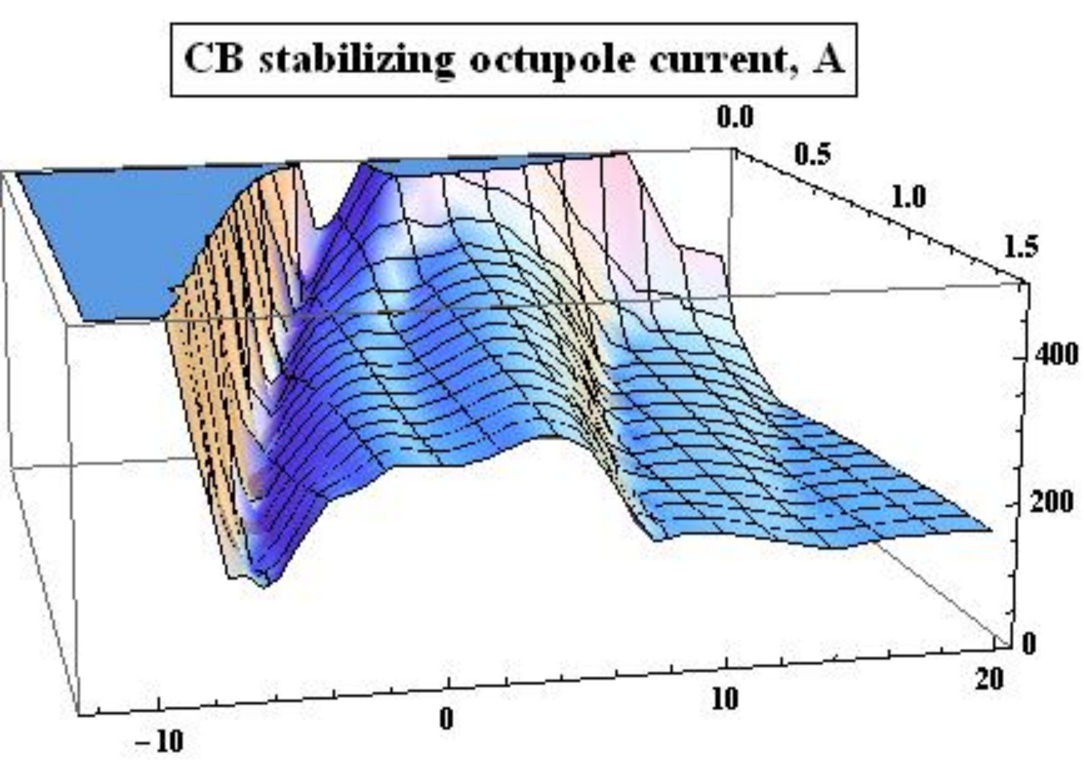
Bunch centers do not move, so bunches do not cross-talk. CB instabilities are essentially SB.

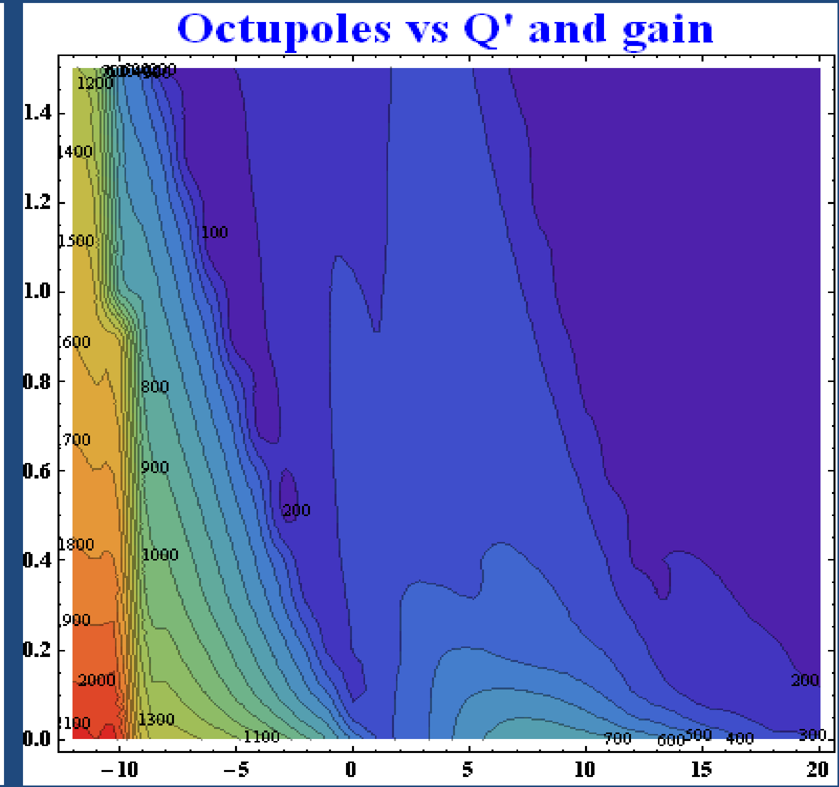


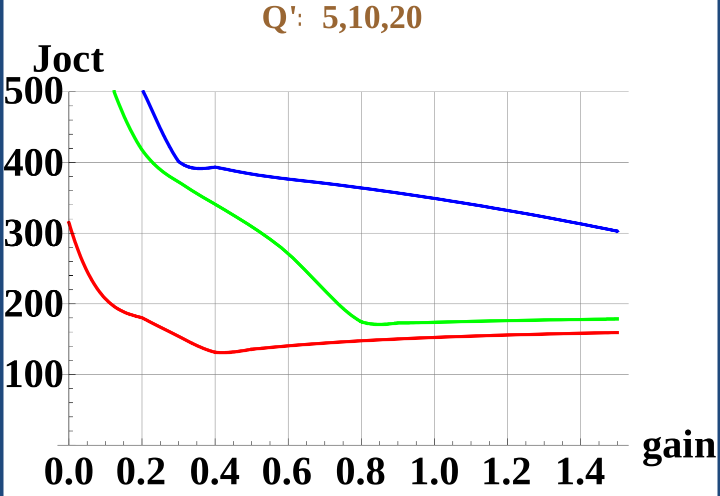


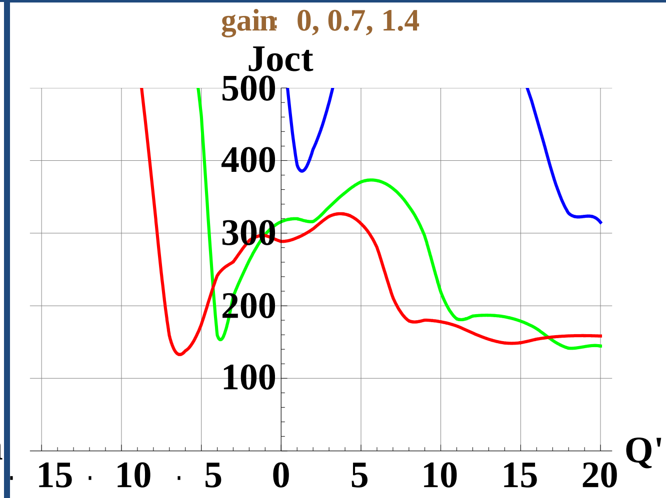
AB

2⊗Impedance, CB, MO+, old ADT



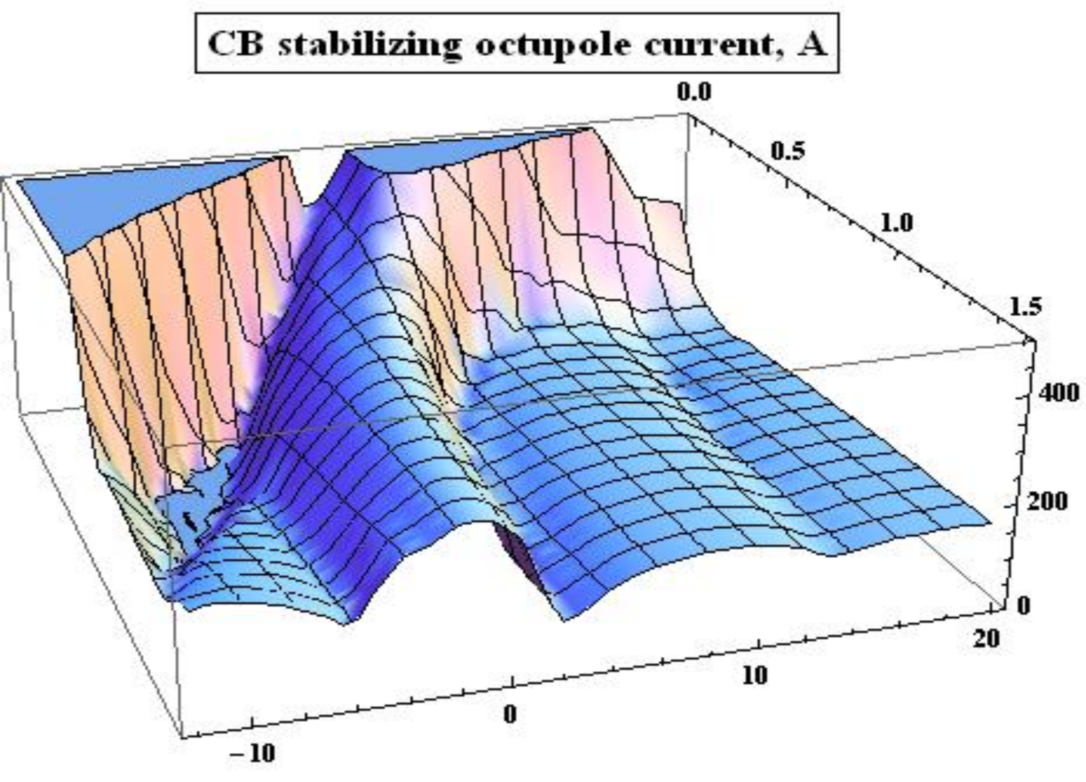


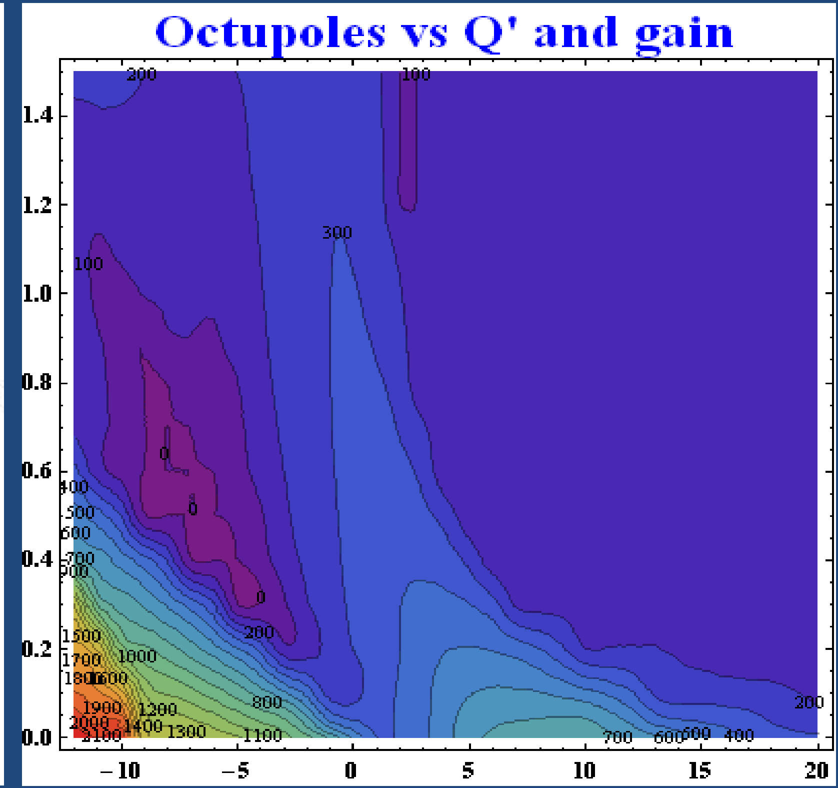




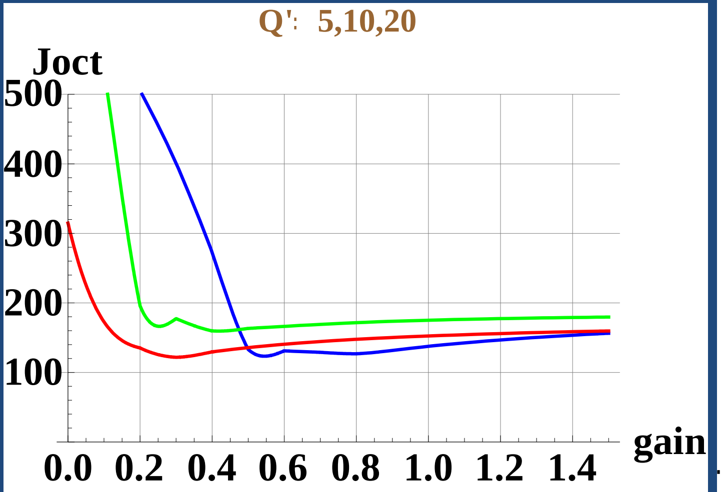
AB

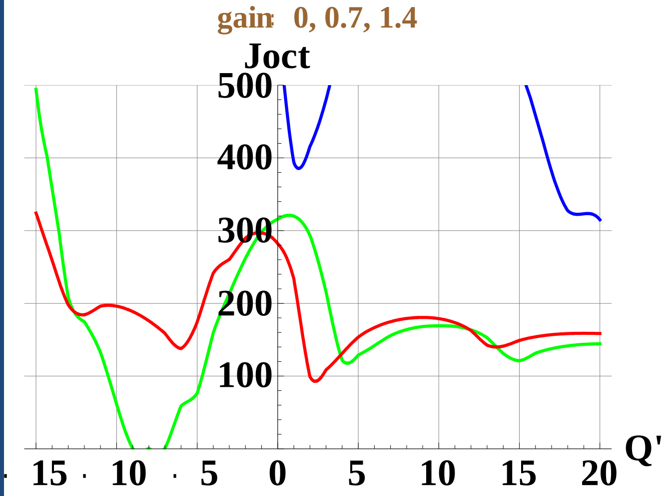
2⊗Impedance, CB, MO+, new bbb ADT





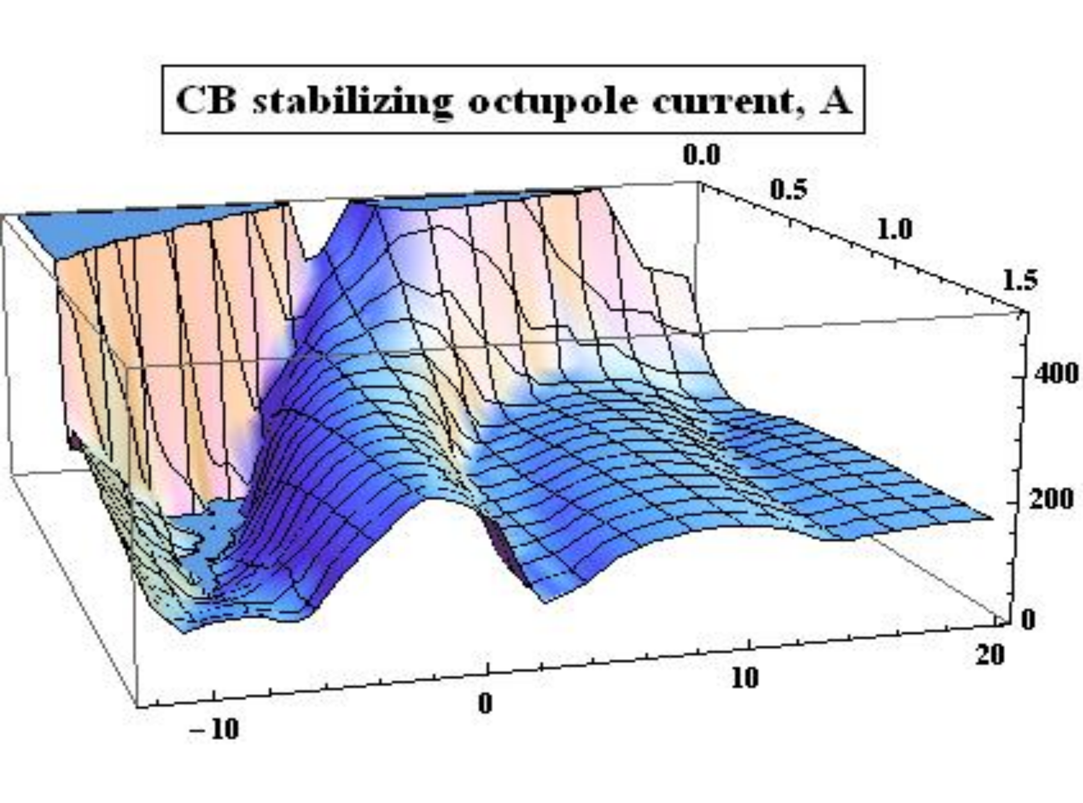
The Valley is back

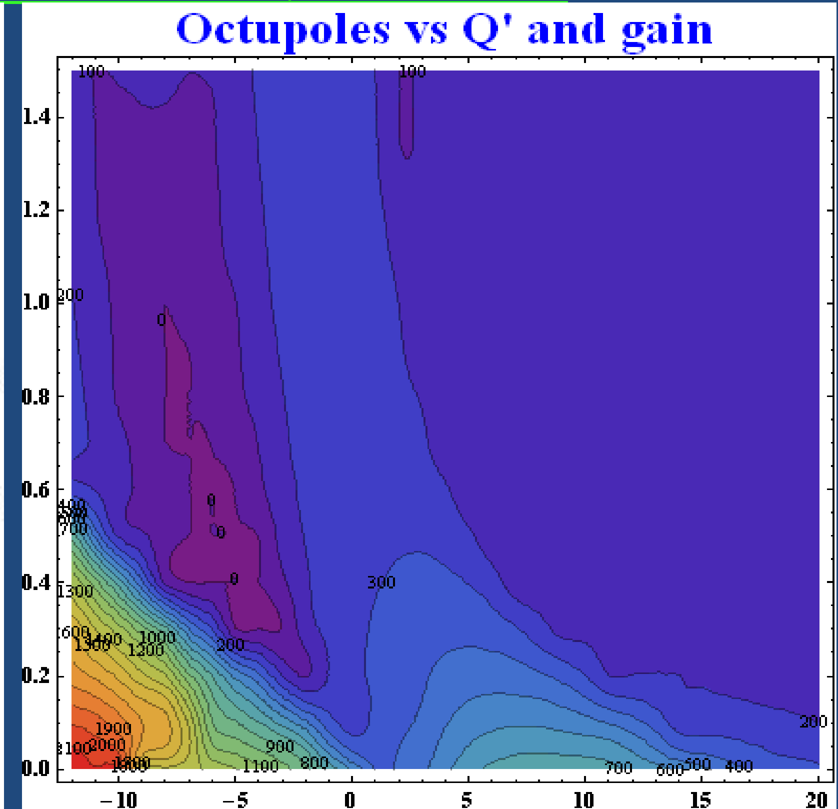




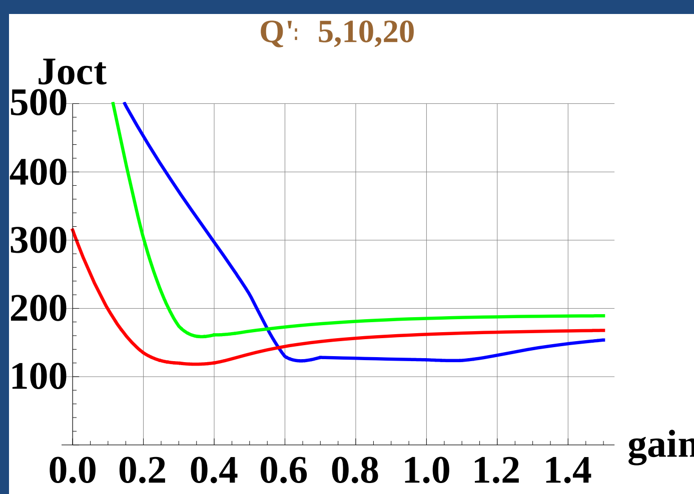
AB

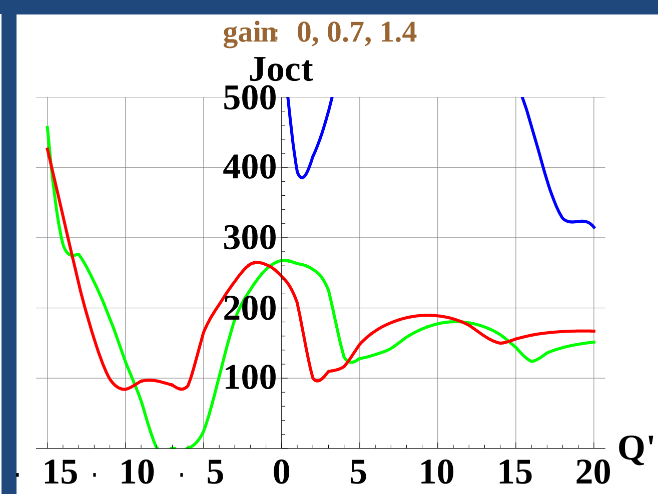
2⊗Impedance, CB, MO+, new bbb ADT, 90°+30°



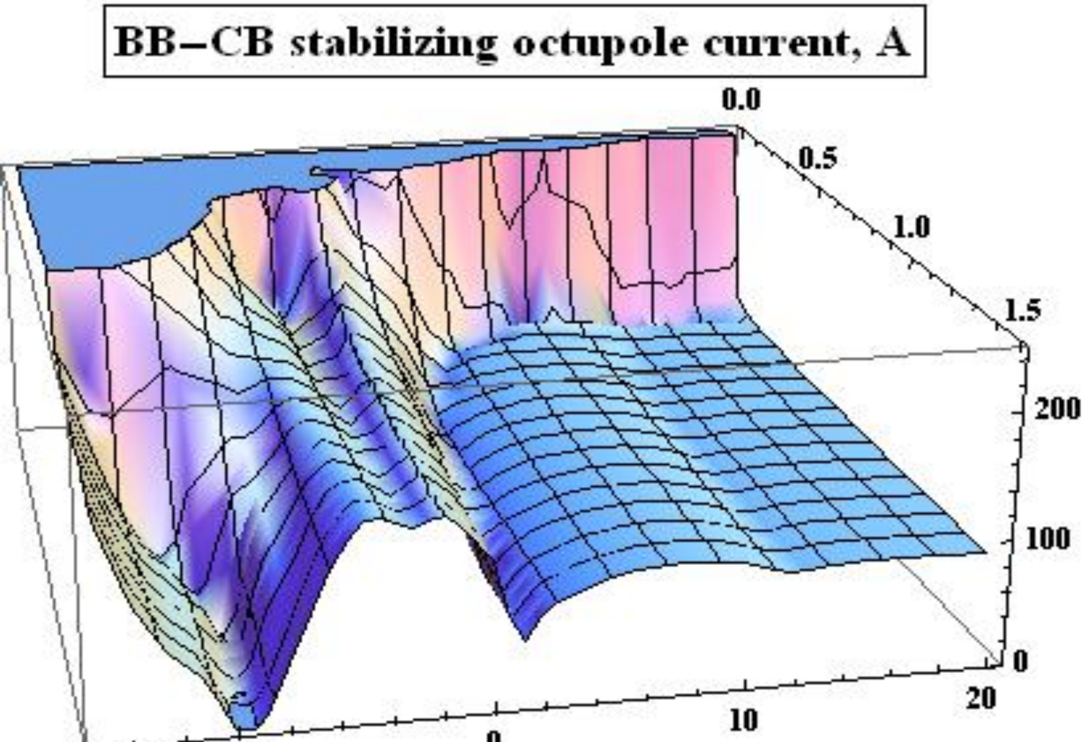


No big difference with 90°.



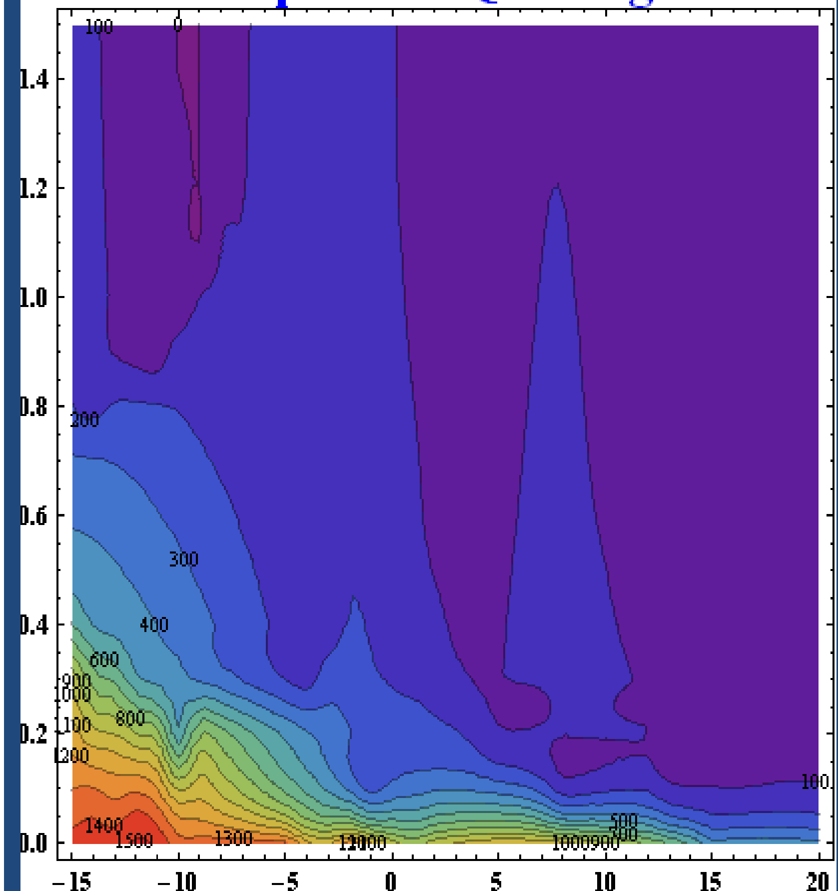


1⊗Imp, CB, CBB dϕ15=π/2, MO+, bbb ADT

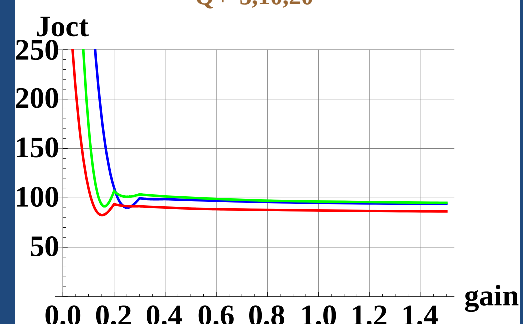


incoherent $dQ_{bb}/Q_s\big|_{IR1,5} = \pm 1.1;\quad d\phi_{15} = \pi/2$

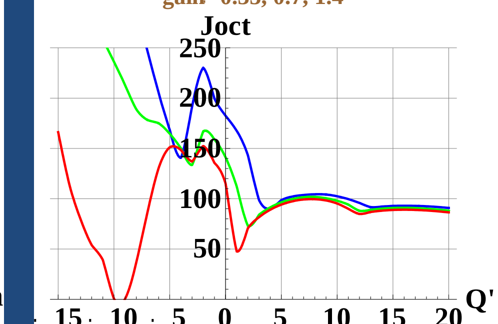
Octupoles vs Q' and gain



Q': 5,10,20



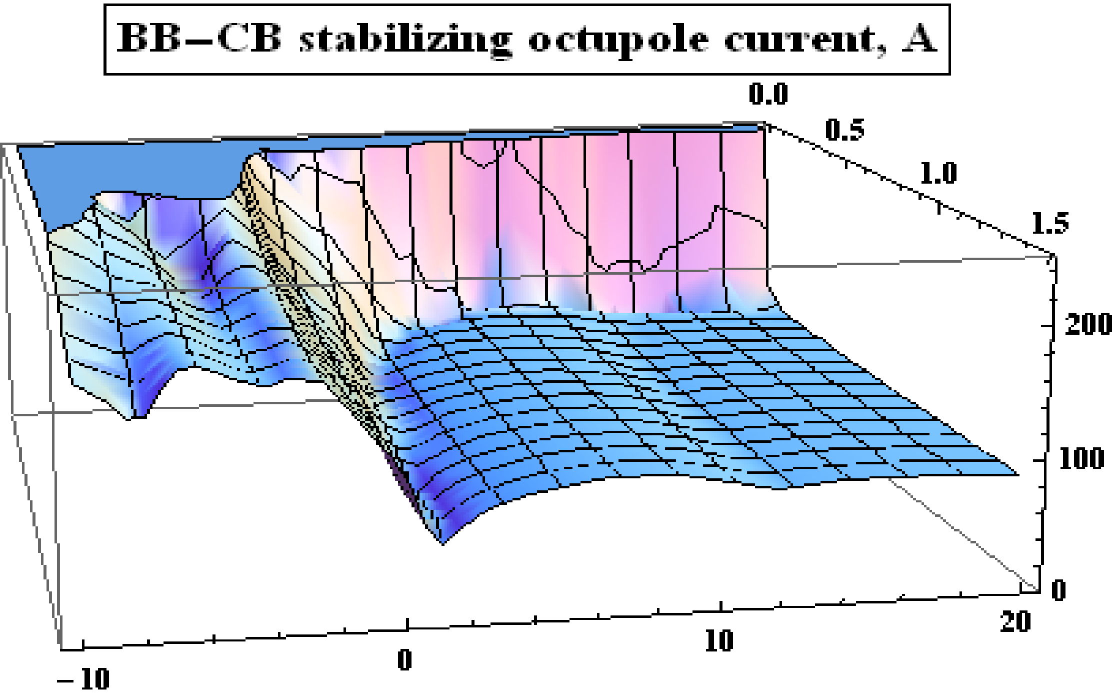
gain 0.35, 0.7, 1.4



Valley is at its threshold with that beam-beam.

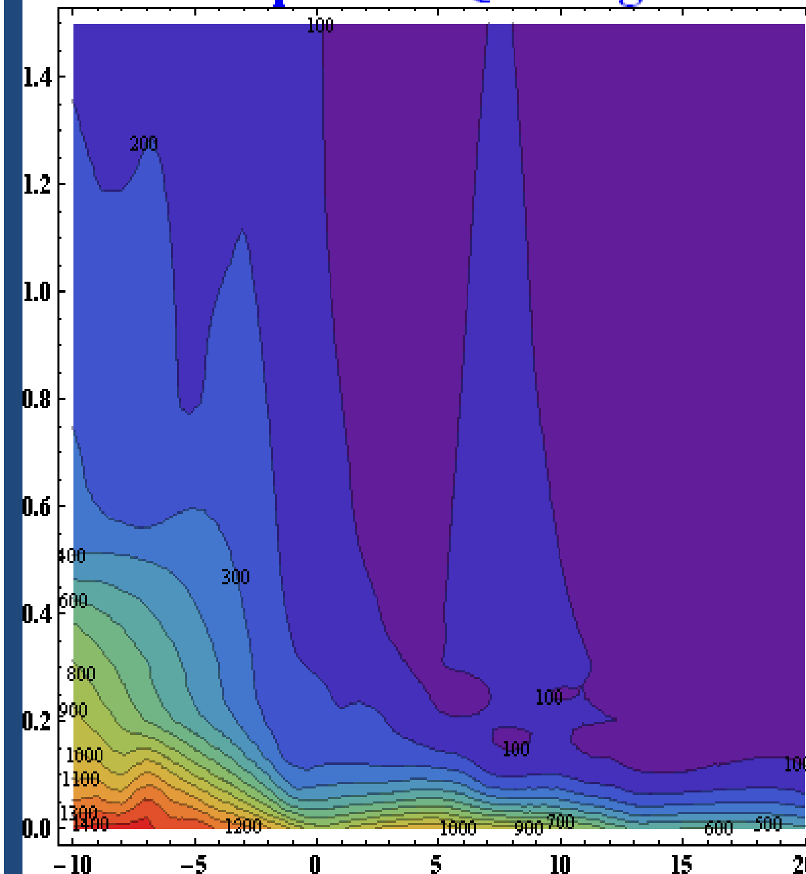
AB

1⊗Imp, CB, CBB dϕ15=π, MO+, bbb ADT

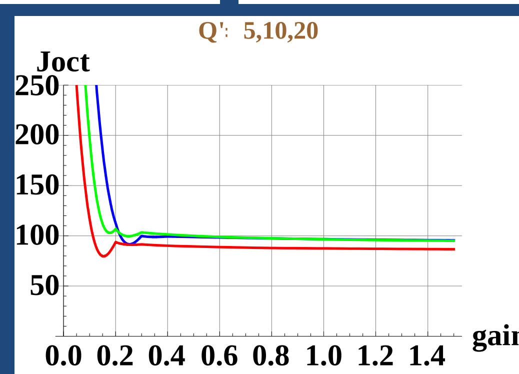


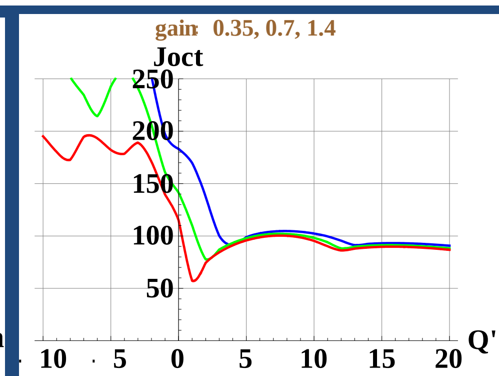
$$\text{incoherent} \quad dQ_{bb} / Q_s \big|_{IR1,5} = \pm 1.1; \quad d\phi_{15} = \pi$$

Octupoles vs Q' and gain



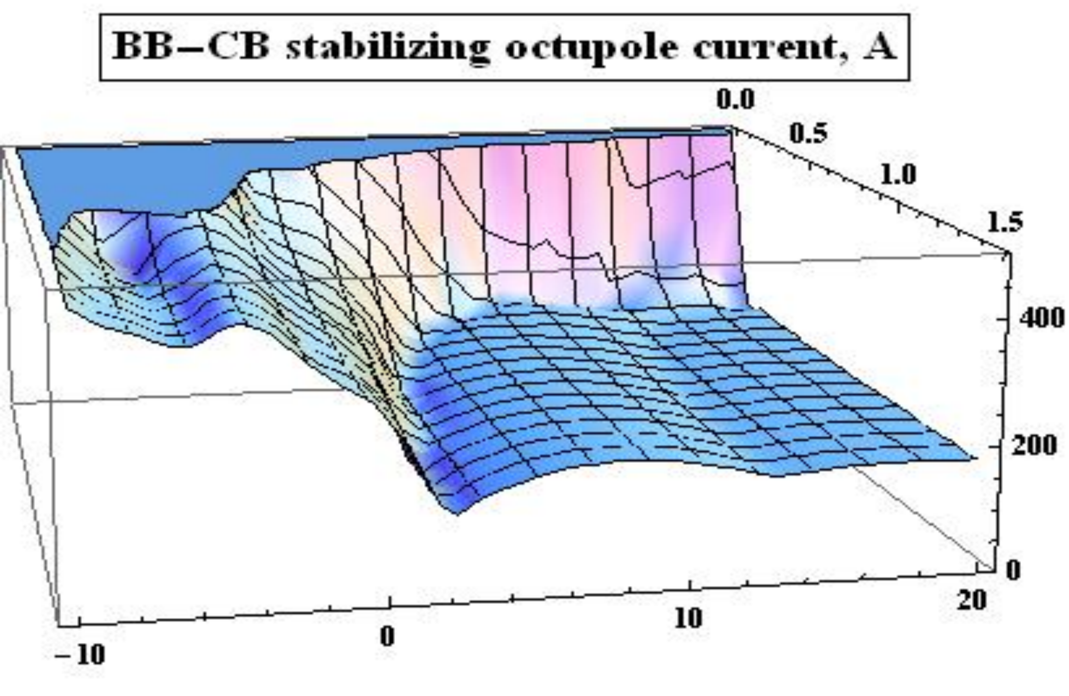
No valley with that beam-beam.



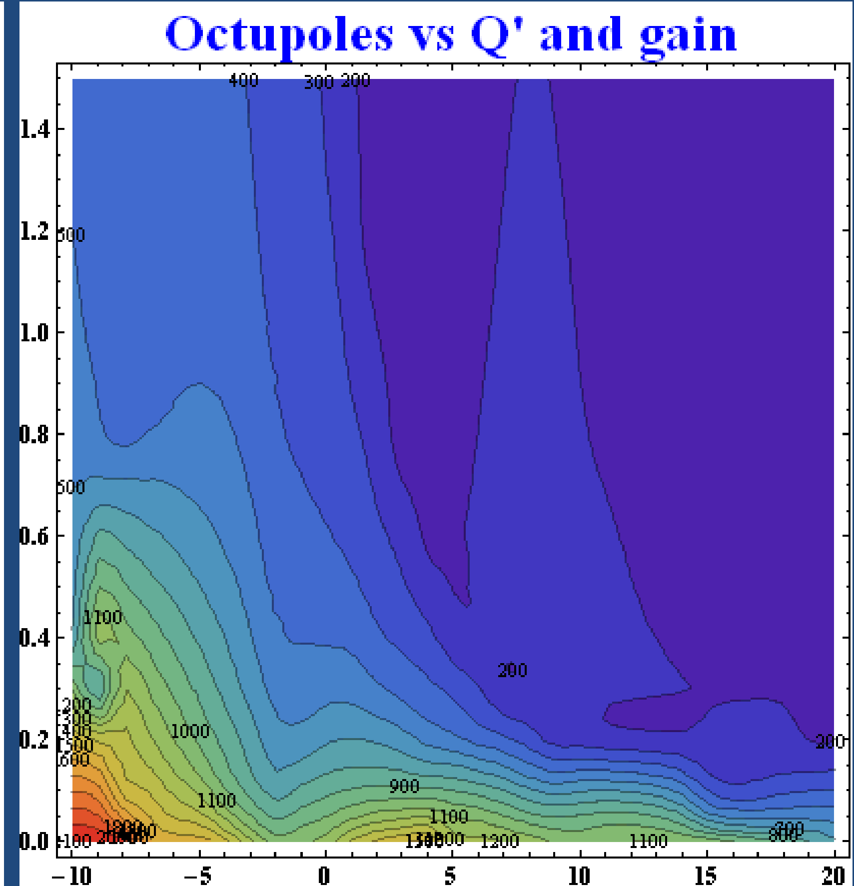


AB

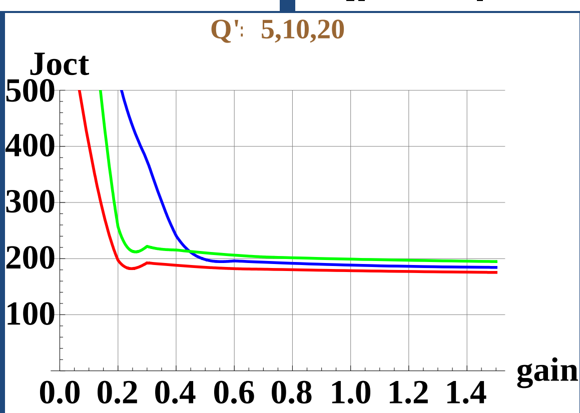
2⊗Impedance, CB, CBB, MO+, new bbb ADT, 90°

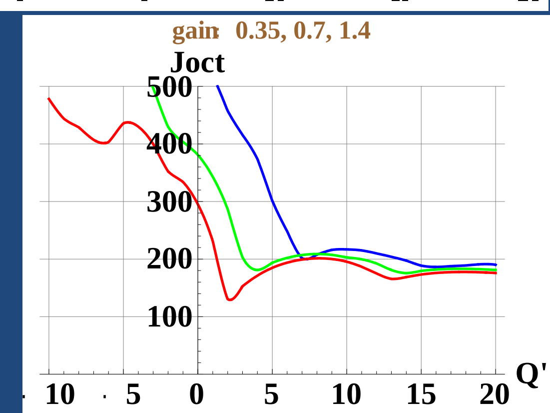


incoherent $dQ_{bb} / Q_s \big|_{IR1,5} = \pm 1.1; \quad d\phi_{15} = \pi$



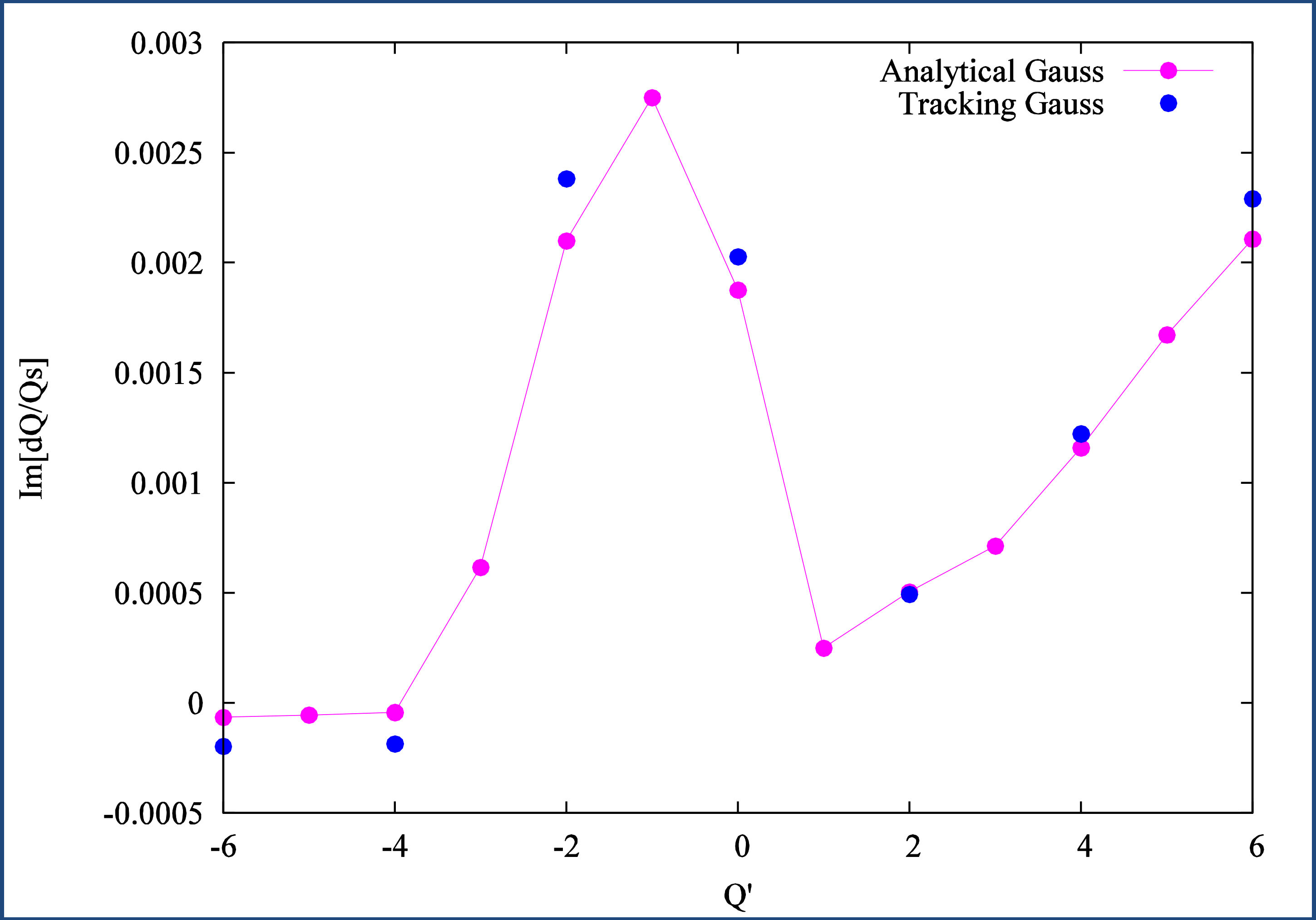
Essentially, it scales linearly with impedance





AB

Comparison of NHT with tracking of Simon White



Highest growth rates for single bunch, gain=1.4 and nominal impedance