HL-LHC with HOM

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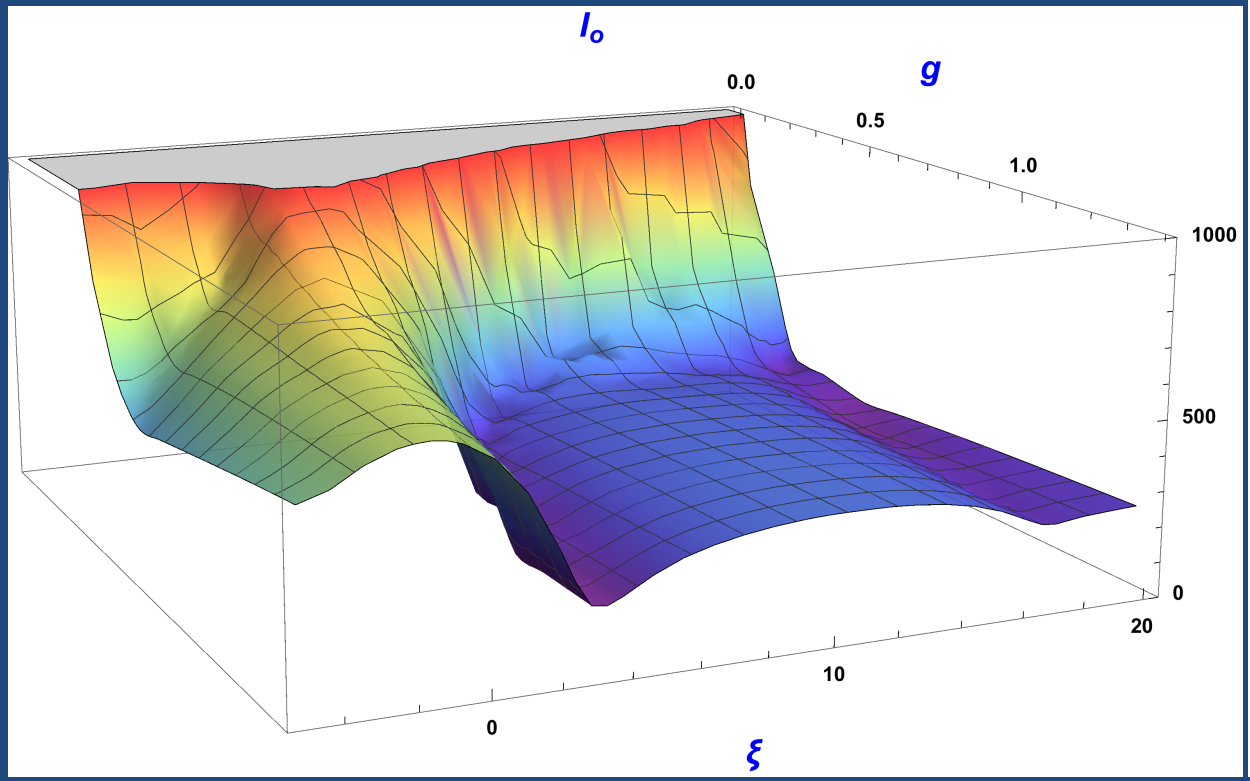
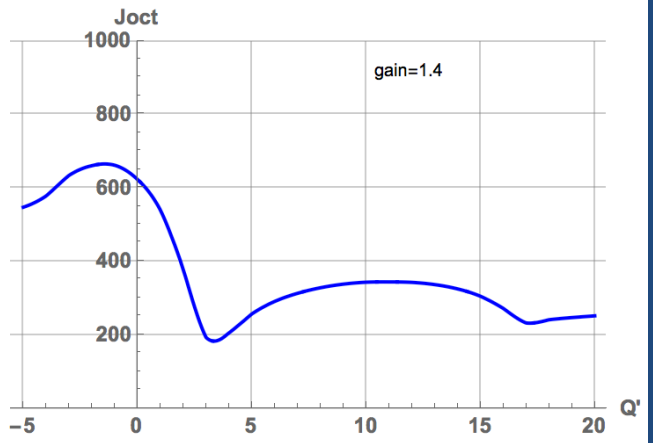
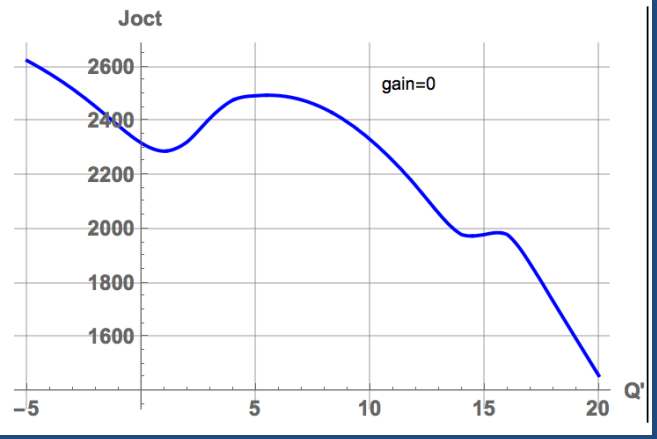
Impedance: Nicolas' X, doubled



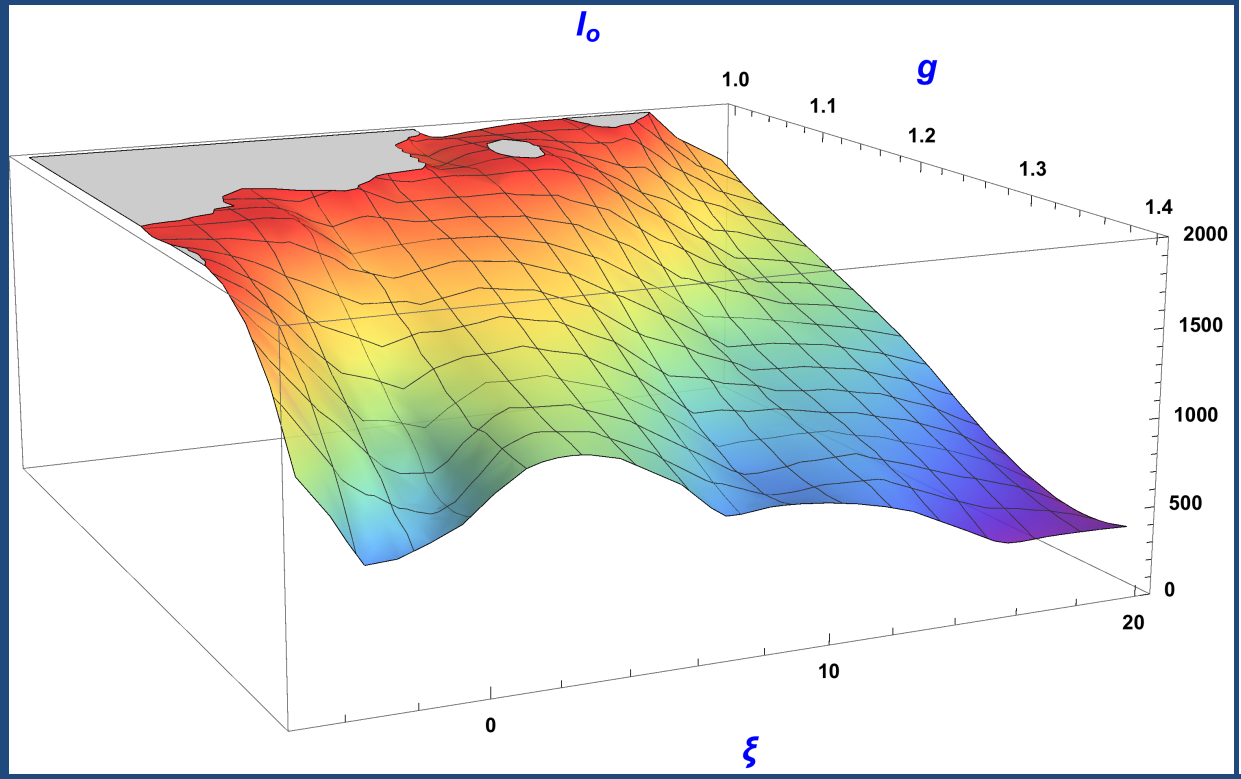


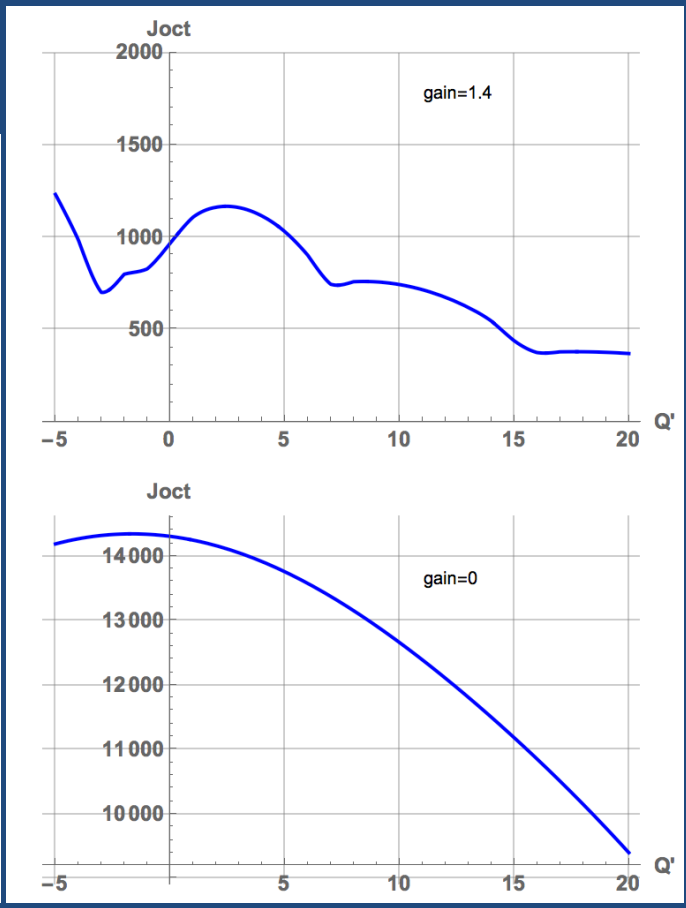


Stabilizing octupole current versus gain and chromaticity for HL LHC

$$E = 7\text{TeV}, \quad N = 2.2 \cdot 10^{11}\text{p/b}, \quad \tau_{\text{sep}} = 25\text{ns}, \quad \varepsilon_{\text{n}} = 2.5\,\mu\text{m}, \quad \sigma_{\|} = 7.5\text{cm}.$$

Same + HOM





Same, plus high order mode with

$$R_s = 1.4\,\mathrm{G\Omega/m}, \quad f_r = 800\,\mathrm{MHz}, \quad Q_r = 1000.$$

Conclusions (1)

- According to these computations, at highest gain and chromaticity, HOM increases the octupole threshold from 250A to 400A, which is not far from the maximal octupole current 550A. That octupole current results from subtraction of two big numbers: the HOM kick to growth and the damper kick to decay, both taken as “flat” in the current NHT approximation.

- However, the HOM kick is not flat at all, its phase advance over the bunch sigma is about 1 radian. It means, that the subtraction of the two big kicks should not be expected for this high frequency HOM.

- Hence, at the moment, it would not be reasonable to expect high efficiency of 40MHz (?) damper to suppress 800 MHz HOM. Before the correct calculations are done, It seems reasonable to estimate the damper reduction by a factor of 2 or so.

Conclusions (2)

- Without damper, HOM adds 9000A at Q'=15. With already 250A required by the standard impedance, and 550A available, the HOM must be limited by 300A for its contribution. Assuming that the damper reduces the HOM impact by a factor of 2, it means that at zero gain HOM impact must be limited by 600A. Thus, its shunt impedance must be reduced15 times, if without any safety factor.

- To have a reasonable safety, the shunt impedance must be reduced at least 30 times.

- The alternative solution is a narrow-band damper at this mode location (and of course at the locations of any other HOM like that).

Many Thanks!