Nested HT Method: Impedance & Damper

A. Burov, N. Mounet

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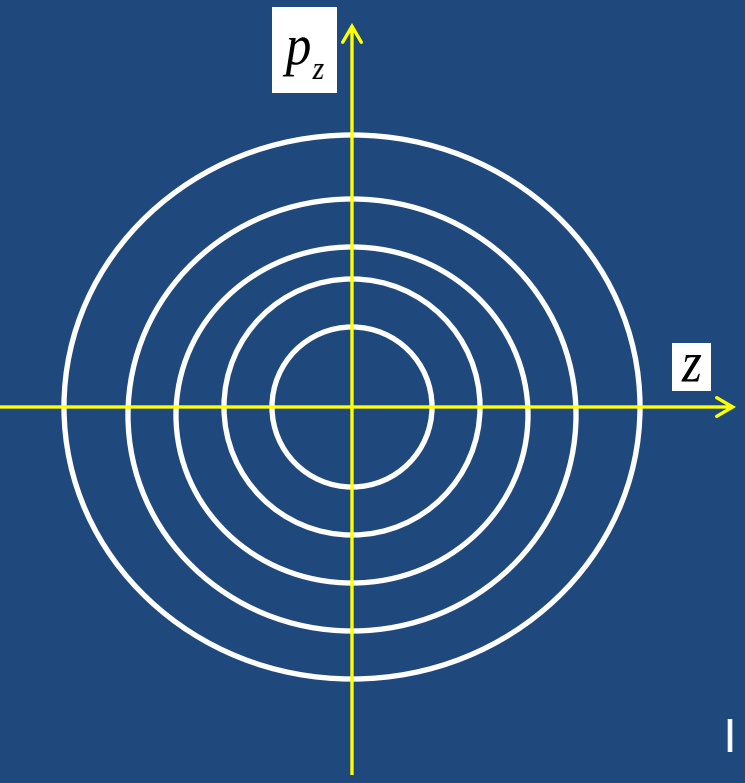
Nested Head-Tail Basis



$$\psi_{lm} \propto \exp(il\phi + i\chi_\alpha \cos\phi - i\Omega_{l\alpha} t)\,;$$

$$\chi_\alpha = \frac{Q'\omega_0 r_\alpha}{c\eta}\;;$$

$$\Omega_{l\alpha} = \omega_b + l\omega_s + \Delta\Omega_{l\alpha}\;.$$

I am using n_r equally populated rings which radii r_α are chosen to reflect the phase space density.

Main Equation

- In the water-bag single bunch approximation, beam equations of motion can be presented as in Ref [A. Chao, Eq. 6.183]:

$$\dot{X} = \hat{W} \cdot X - \hat{D} \cdot X$$

where X is a vector of the HT mode amplitudes,

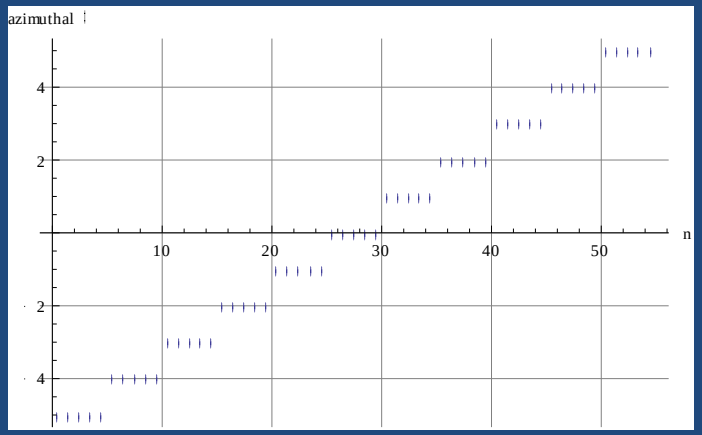
$$\hat{W}_{lm\alpha\beta} = -il\omega_s \delta_{lm}\delta_{\alpha\beta} - i^{l-m}\frac{\kappa}{n_r}\int_{-\infty}^{\infty} d\omega Z(\omega) J_l(\omega\tau_\alpha - \chi_\alpha) J_m(\omega\tau_\beta - \chi_\beta)$$

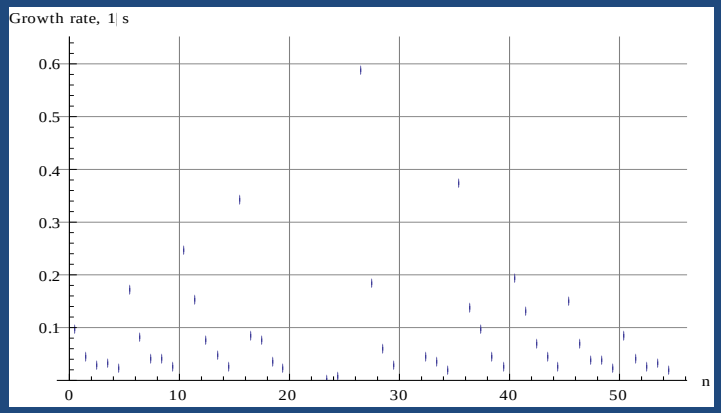
$$\hat{D}_{lm\alpha\beta} = i^{m-l}\frac{d}{n_r} J_l(\chi_\alpha) J_m(\chi_\beta)$$

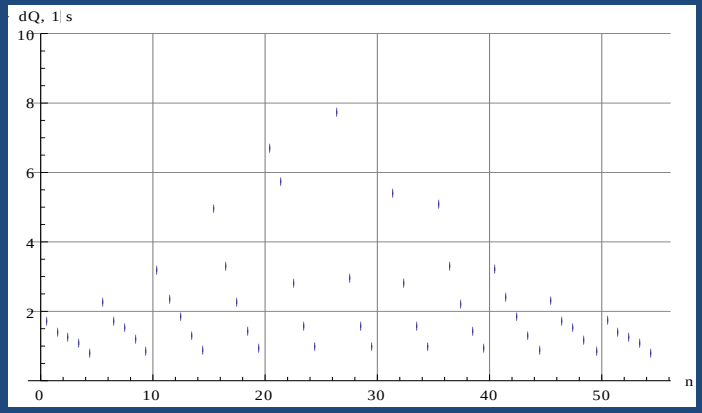
d is the damper gain in units of the damping rate,

$$\kappa = \frac{N_b r_0 c}{8\pi^2 \gamma Q_b}$$

Example of the Results





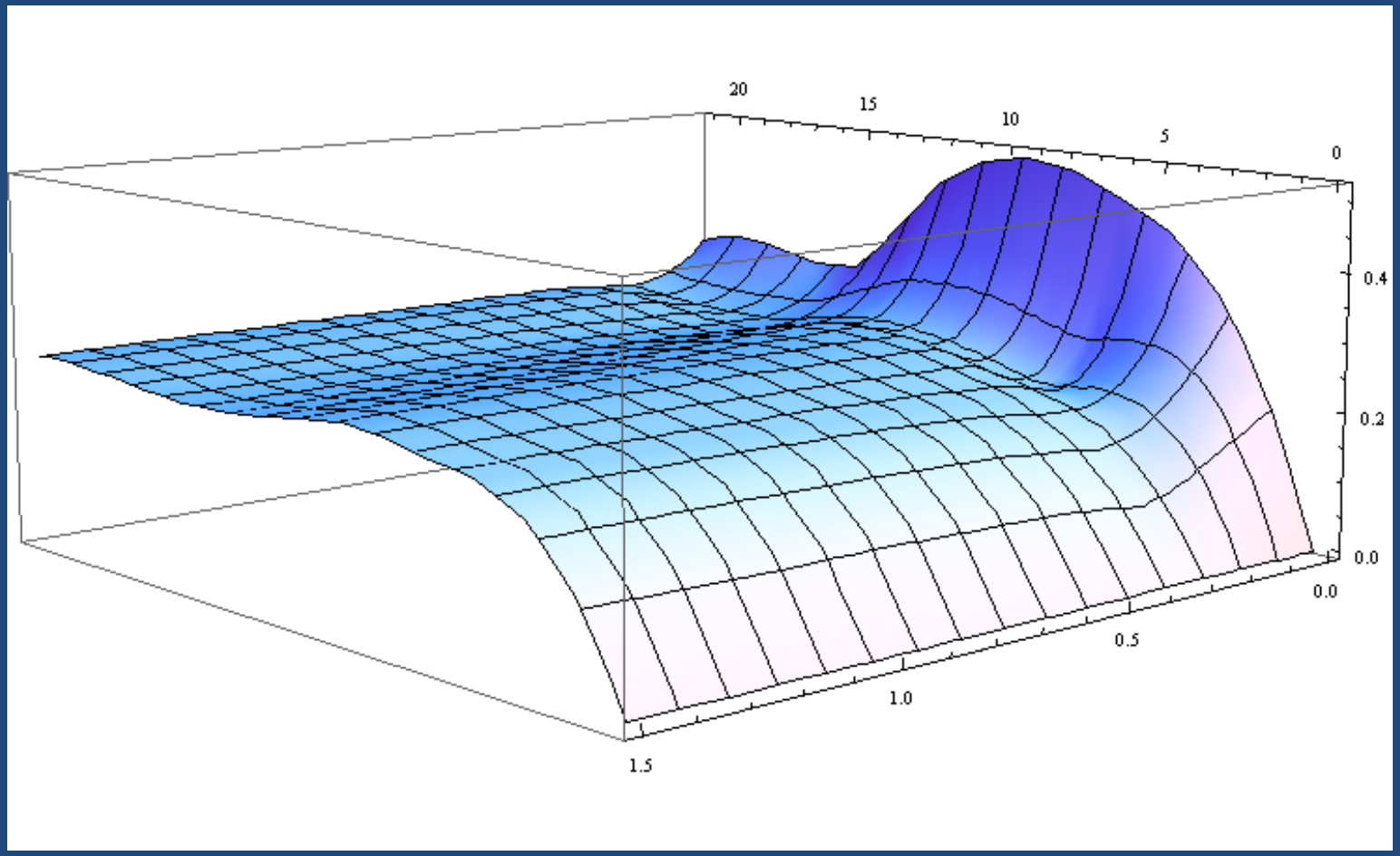


Growth rates and tune shifts

Cromaticity =6,

Gain = 1 omega_s

Example of the Results



Threshold octupole current vs gain and chromaticity

Next steps

- To include couple-bunch
- To include beam-beam
- To compare with Nicolas' Laclar results and Simon's tracking

Many thanks for everyone of you!