COMPARISON BETWEEN THE HEADTAIL CODE AND THE "SIMPLE" TMC FORMULA

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⇒ **To try to understand better the fast instability at the SPS injection with dense single bunches and low longitudinal emittance…**

OBSERVATIONS IN THE SPS

⇒ cf. AB-Note-2003-093 (MD) by G. Arduini et al.

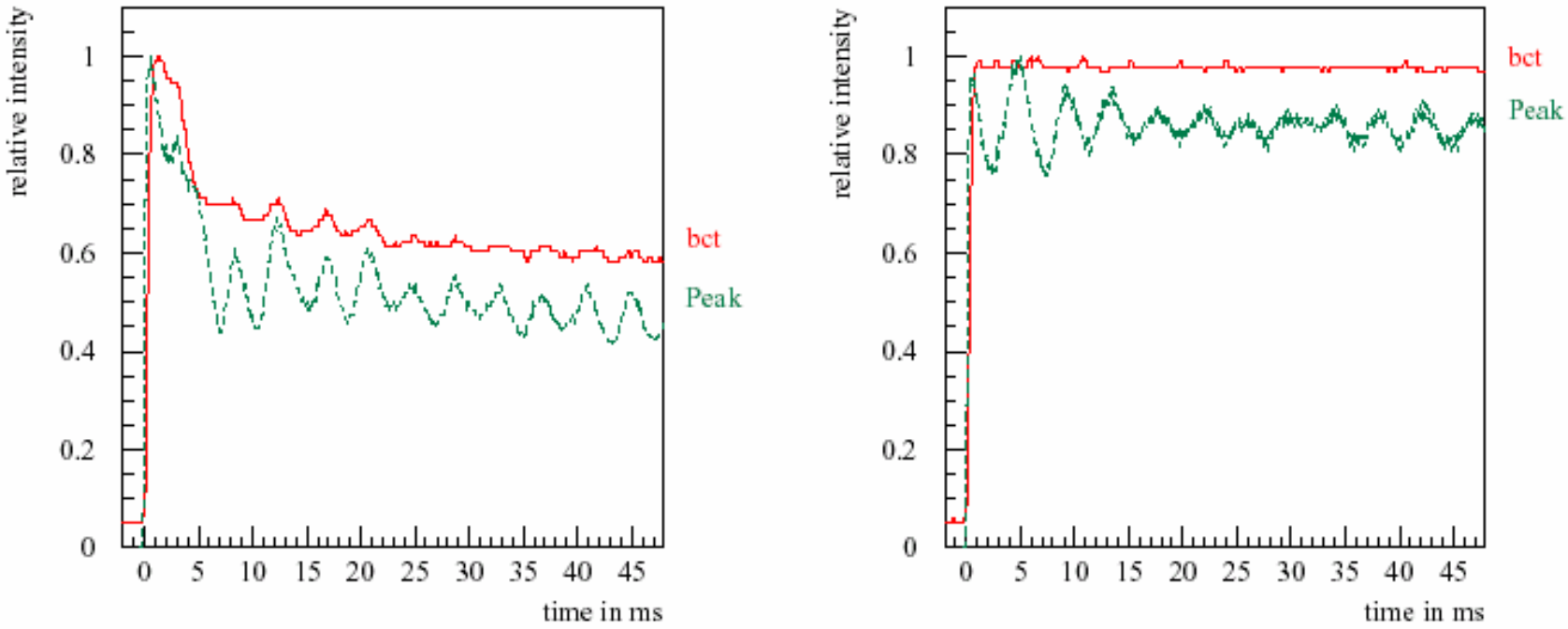


Figure 3: Injection at 0.6 MV. Low chromaticity $\xi_y \approx 0$ (left) and high chromaticity $\xi_y = 0.8$ (right). $\epsilon_l = 0.2\,\mathrm{eV\,s}$, $4\sigma_t = 2.7\,\mathrm{ns}$.

PARAMETERS USED

$p = 26\ \mathrm{GeV/c}$ $f_{rev} = 43.4\ \mathrm{kHz}$ $\gamma_t = 22.83$ $Q_y = 26.13$

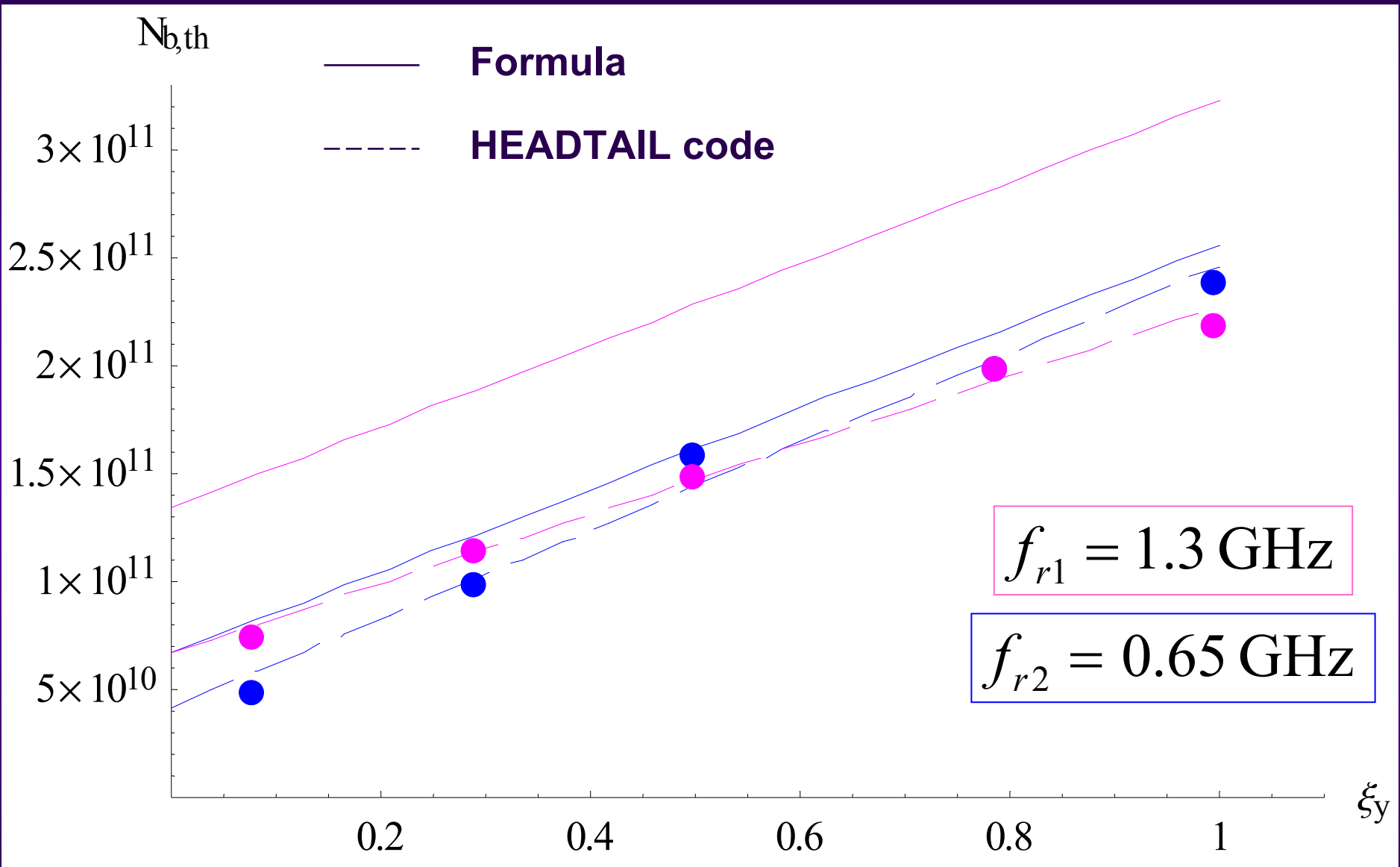
$$\left|Z_y\right|_c = 20\ \mathrm{M\Omega/m} \quad \Rightarrow \quad \left|Z_y\right| = \frac{\pi^2}{12}\left|Z_y\right|_c$$

$f_{r1} = 1.3\ \mathrm{GHz}$ $f_{r2} = 0.65\ \mathrm{GHz}$ $Q = 1$ $\varepsilon_l = 0.2\ \mathrm{eVs}$

"Simple" TMC formula

$$N_{b,th} = \frac{8\pi Q_{y0}\left|\eta\right|\varepsilon_l}{e\beta^2 c} \times \frac{f_r}{\left|Z_y\right|} \times \left(1 + \frac{f_{\xi_y}}{f_r}\right)$$

RESULTS


$N_{b,th}$
Formula
HEADTAIL code
3×10^{11}
2.5×10^{11}
2×10^{11}
1.5×10^{11}
1×10^{11}
5×10^{10}
0.2
0.4
0.6
0.8
1
ξ_y
$f_{r1} = 1.3$ GHz
$f_{r2} = 0.65$ GHz

PRELIMINARY CONCLUSIONS ON THE COMPARISON

- Both predict that the fast instability can be damped by increasing the chromaticity. This is also what E. Shaposhnikova said at Chamonix 2004 with MOSES results
- Note also that both predict that a slow head-tail instability can then develop later (depending on the non-linearities…). This is also what E. Shaposhnikova said at Chamonix 2004 with MOSES results. But here one looks only at the fast instability
- Both predict a linear dependence with chromaticity
- Both predict that for zero chromaticity, the threshold is higher for higher resonance frequency
- Both agree within a factor ~2

FUTURE WORK

⇒ Try to obtain this curve experimentally…

THANKS VERY MUCH TO ELENA FOR ALL THE SIMULATIONS AND THEIR ANALYSIS !!!