Simulations for FCC-ee beam self-polarization - cont.

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P vs. Q_{syn}

Yokoya (1983) and Mane (1990) predict, under the assumption resonances are well separated, energy spread would enhance the strength of synchrotron side bands by the *"enhancement factor"*

$$\xi = \left(\frac{a\gamma}{Q_{syn}}\frac{\sigma_E}{E}\right)^2$$

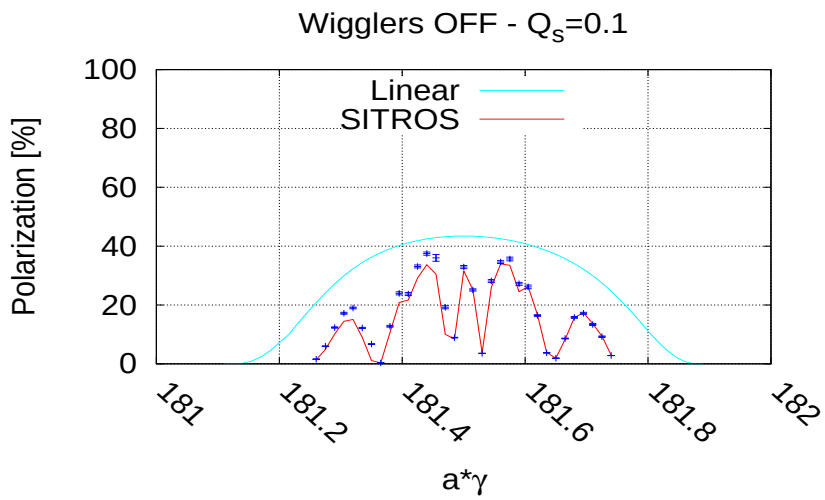
At very high energy and in presence of unavoidable alignment and/or field errors the Sokolov-Ternov effect is overwhelmed by the spin diffusion. Derbenev et al. (1979) predict a polarization resurrection if the condition

$$F_{\mathrm{D}} \equiv \frac{(a\gamma)^2\, T_{rev}}{\tau_p Q_{syn}^3} \ll 1$$

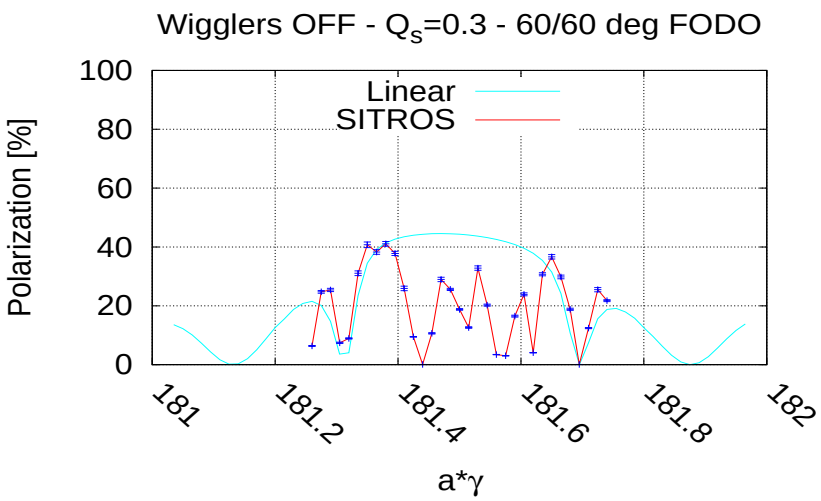
is satisfied.

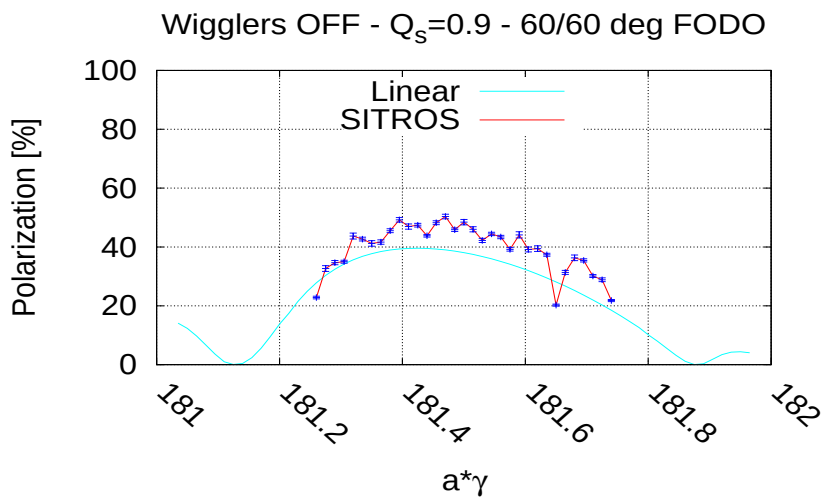
$\rightsquigarrow$ large Q_{syn} may be desirable at high energy and/or large σ_E. Obtaining larger synchrotron tunes while keeping the RF voltage to reasonable values requires increasing the momentum compaction factor.

Toy ring 60/60 degrees FODO



V_{RF}=91 GV

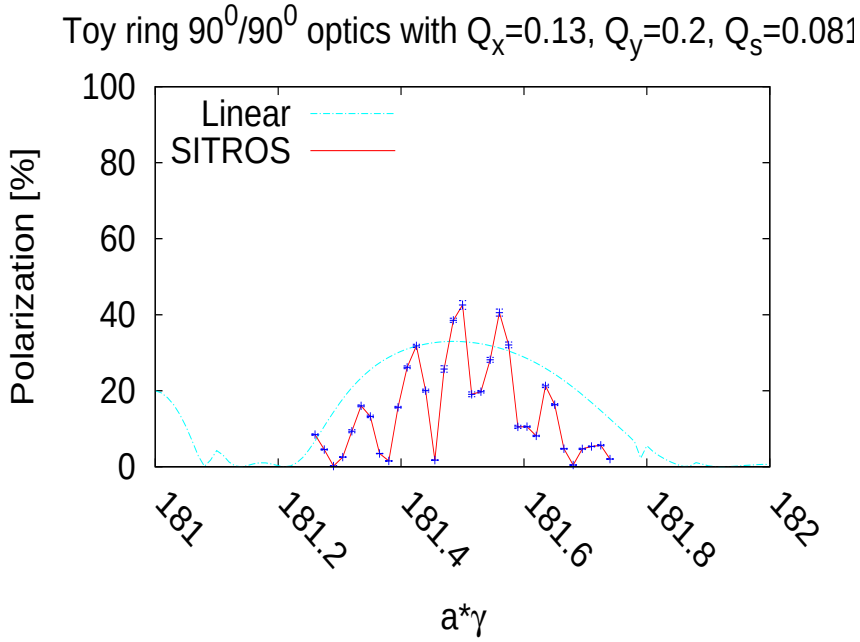


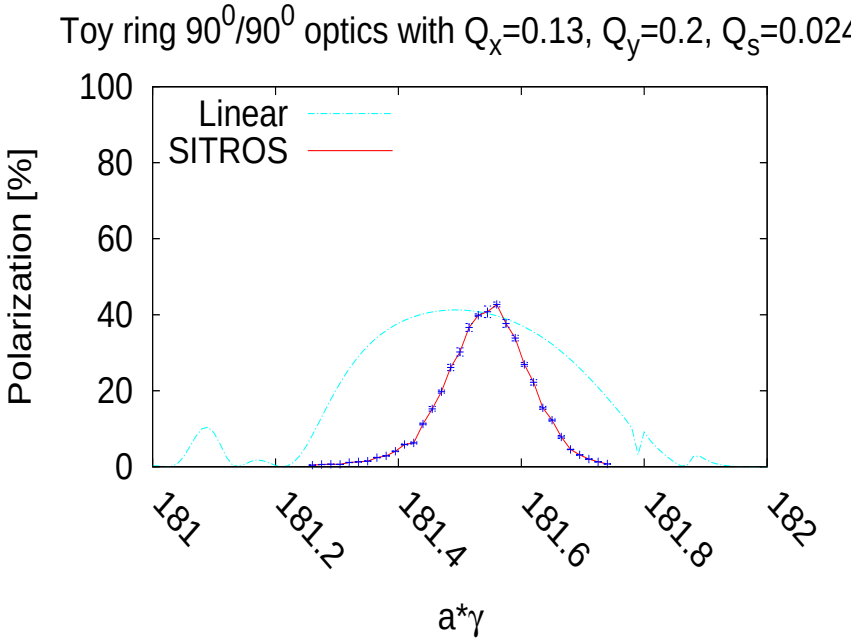


ξ: 1.5 $\rightarrow$ 0.17 $\rightarrow$ 0.018

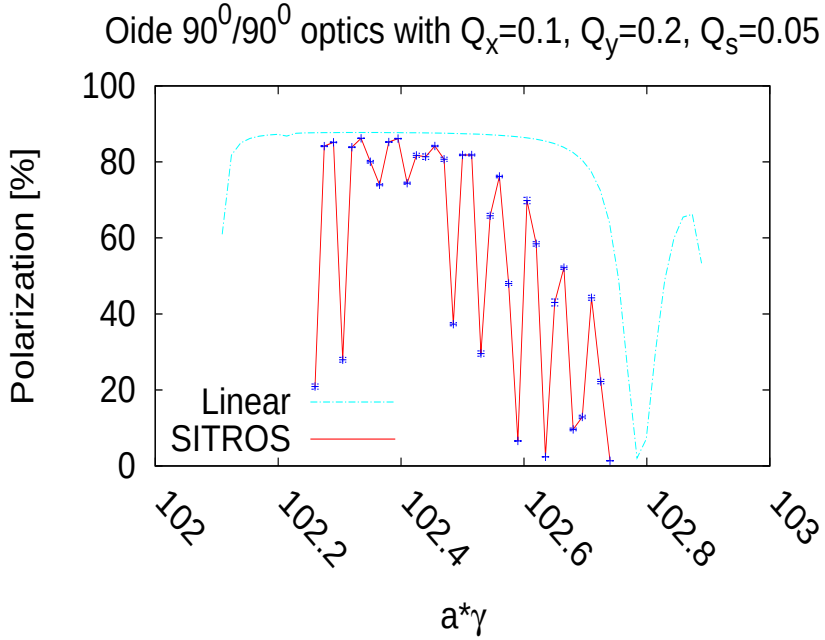
F_D: 0.2 $\rightarrow$ 8×10^{-3} $\rightarrow$ 2.7×10^{-4}

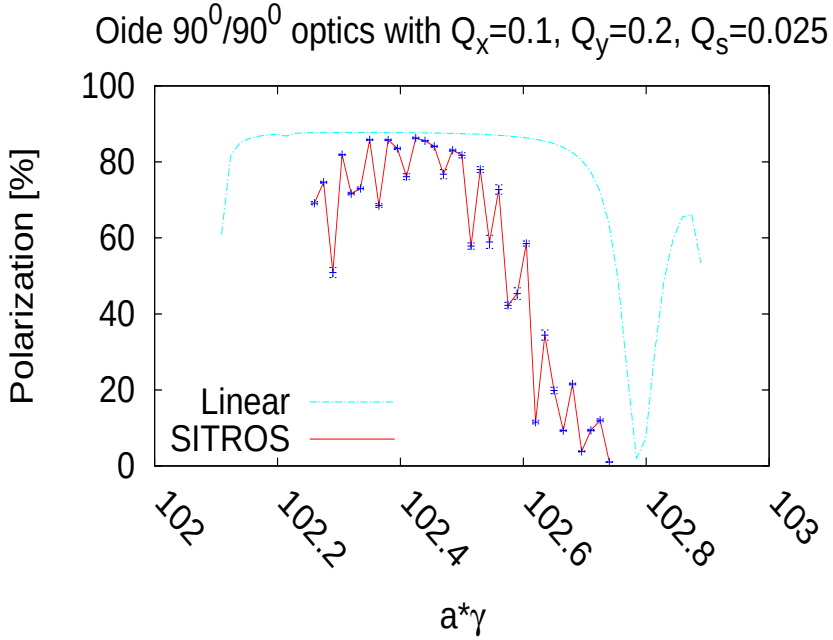
Toy ring 90/90 degrees FODO





Olde-san ring β_y^*=1mm, 90/90 degrees FODO



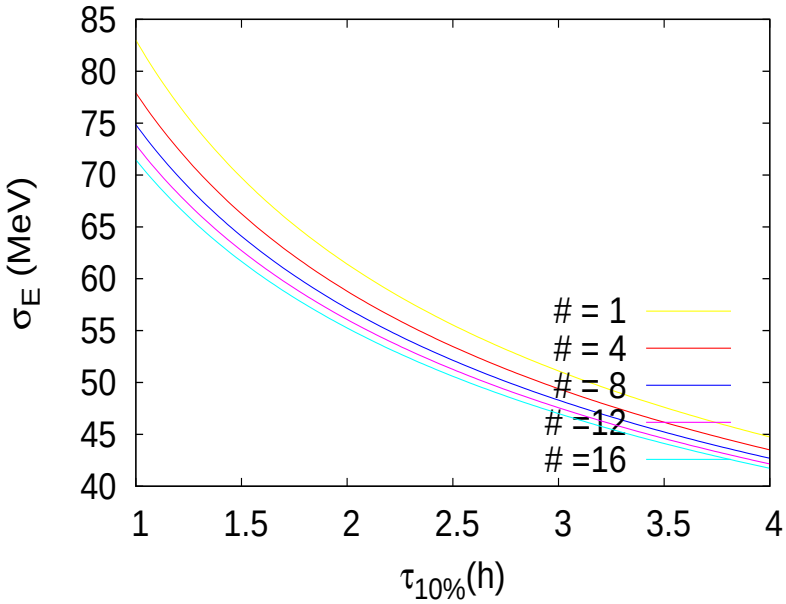


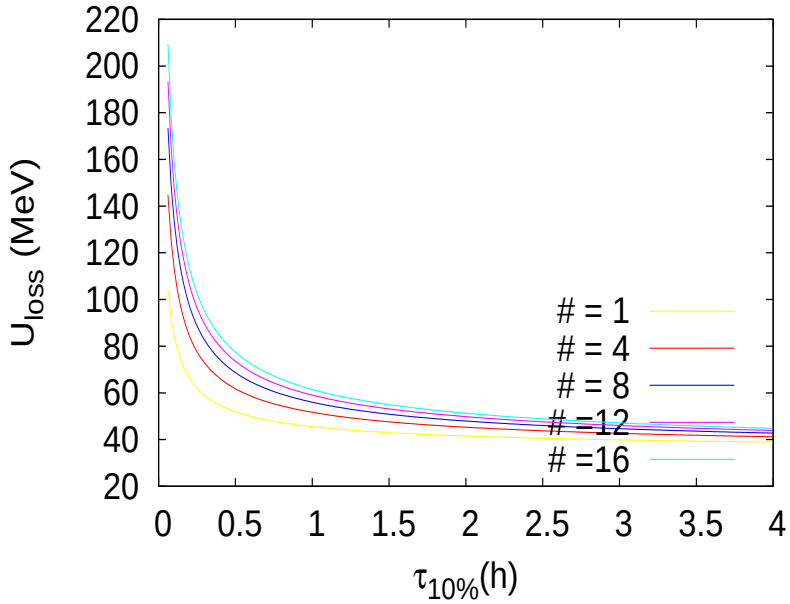
Reducing $\tau_{10\%}$

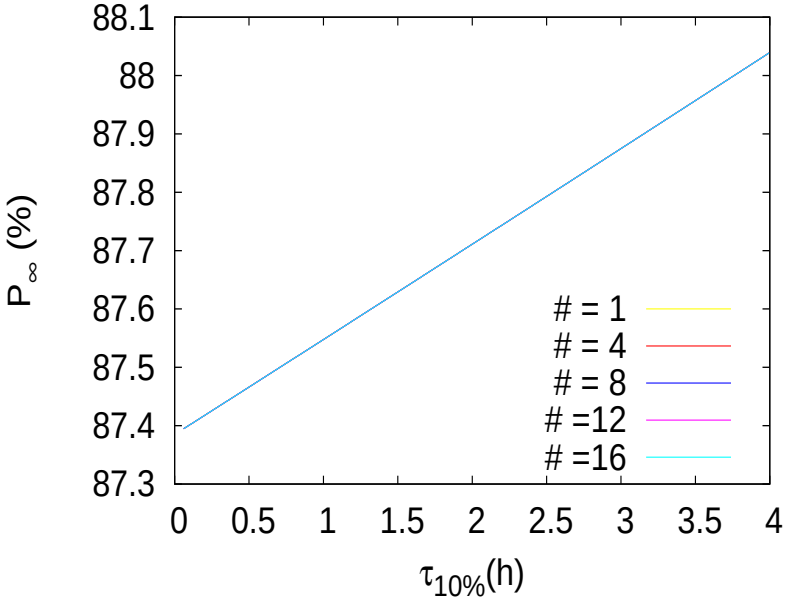
In general

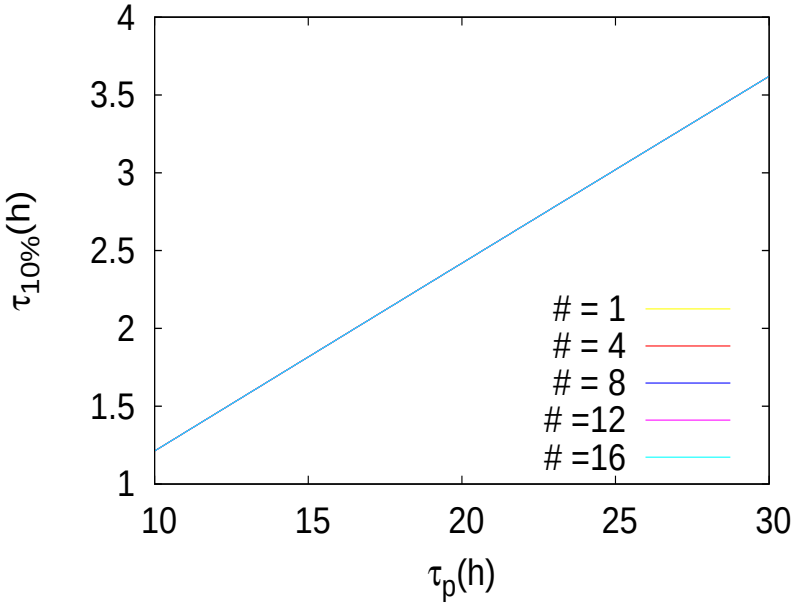
$$(\sigma_E/E)^2 = \frac{C_q C_\gamma E^4}{2\pi J_\epsilon F \gamma^3} \frac{1}{\tau_p U_{loss}} \qquad F \equiv \frac{5\sqrt{3}}{8} \frac{r_e \hbar}{m_0 C}$$

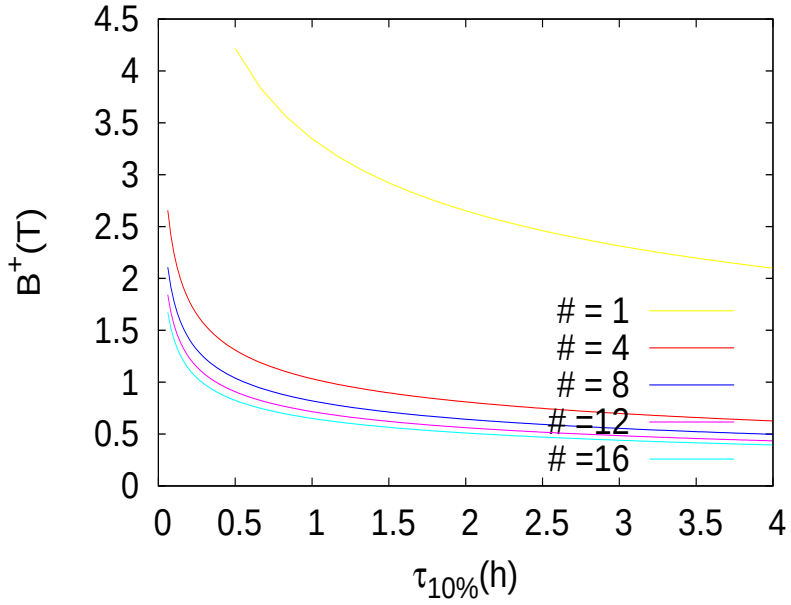
$\rightsquigarrow$ small τ_p is at price of a higher U_{loss} and/or σ_E.

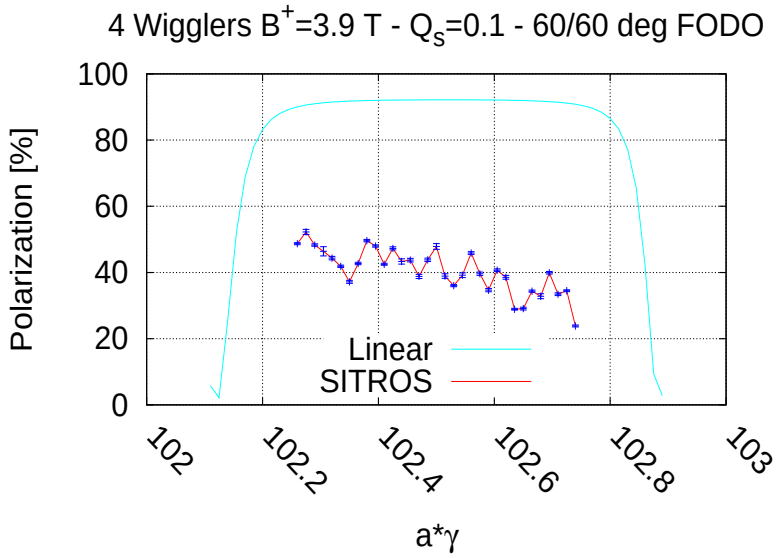





88.1
88
87.9
87.8
87.7
87.6
87.5
87.4
87.3
P∞ (%)
0
0.5
1
1.5
2
2.5
3
3.5
4
τ10%(h)
= 1
= 4
= 8
=12
=16


4
3.5
3
2.5
2
1.5
1
τ10%(h)
10
15
20
25
30
τp(h)
= 1
= 4
= 8
=12
=16





σ_E = 247 MeV

U_{loss}= 278 MeV/turn

$\tau_{10\%}$=1 minute