

# Problems of Tau-Charm factory lattice

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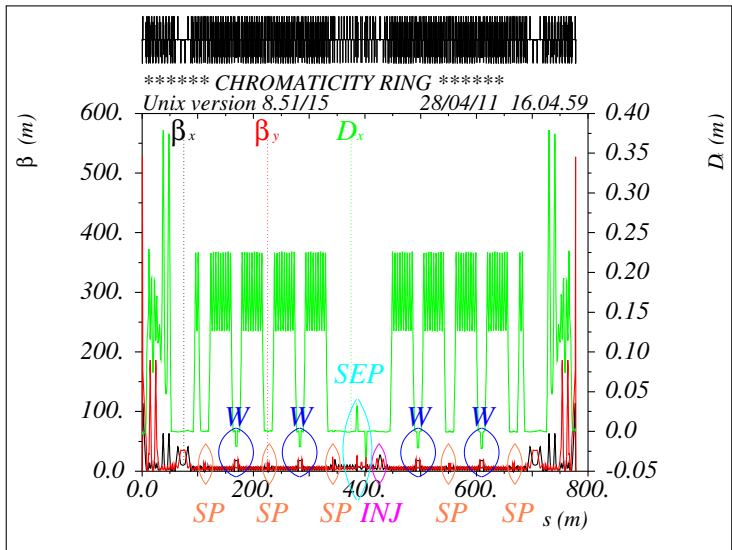
- Tau-charm ring is not symmetrical, possesses a number of insertions.
- We observed low energy acceptance and low dynamic aperture in the full ring.
- What are the reasons of limitations?
- What needs to be changed?

*Some issues have been solved and  
I am not going to talk about them, only those that are not solved yet.*

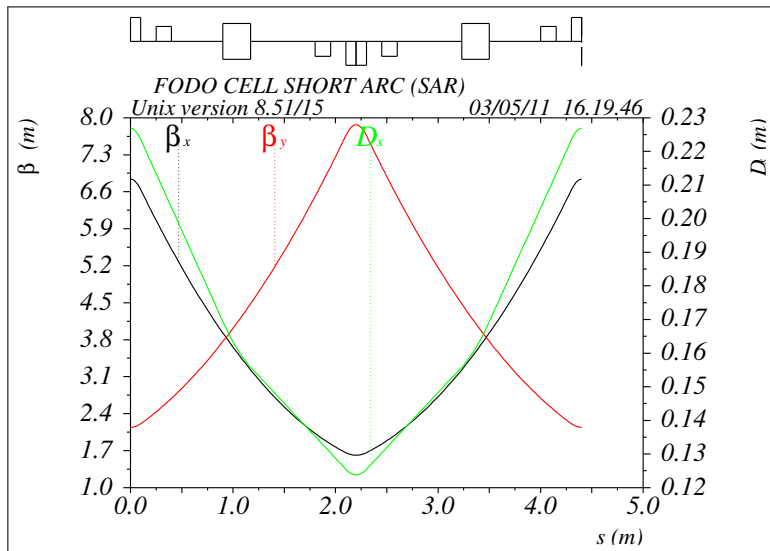
# Parameters of Tau-Charm.

Energy, GeV	1.0	1.5	2.0	2.5
Circumference, m	770			
Beta functions (IP $\beta_x/\beta_y$ ), cm	4/0.08			
Beam sizes (IP $\sigma_x/\sigma_y$ ), $\mu\text{m}$	17.9/0.18			
Luminosity, $\times 10^{35} \text{ cm}^{-2} \text{ sec}^{-1}$	0.63	0.95	1.0	1.0
Horizontal Emittance, nm rad	8			
Vertical Emittance, pm rad	40			
Damping times, msec	30/30/15			
Wiggler field, kGs	49.23	36.80	25.07	0

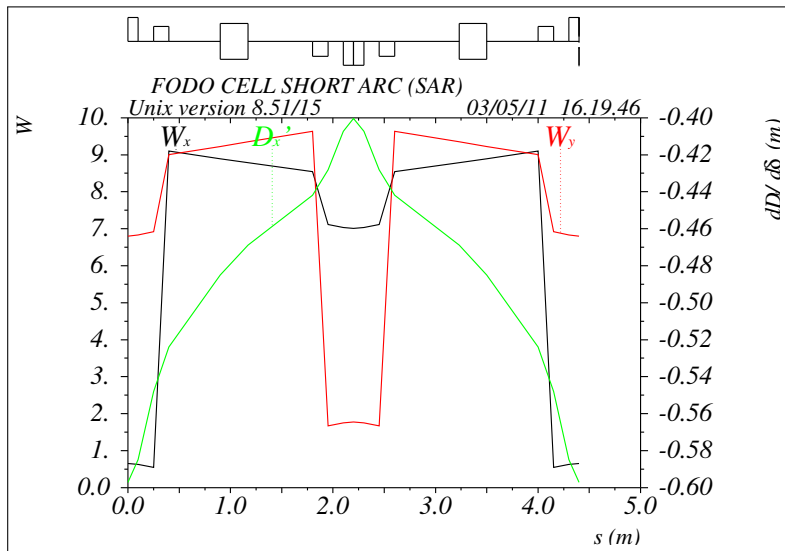
# Tau-Charm Lattice (Symmetrical FF).



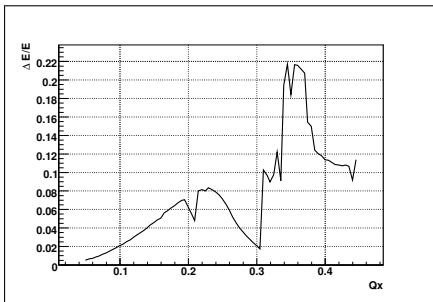
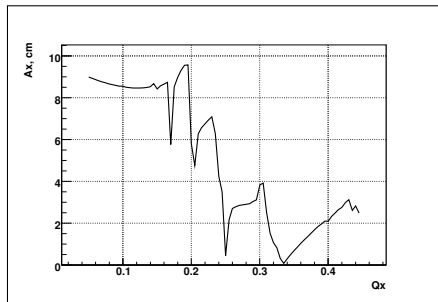
# FODO CELL, E=1 GeV



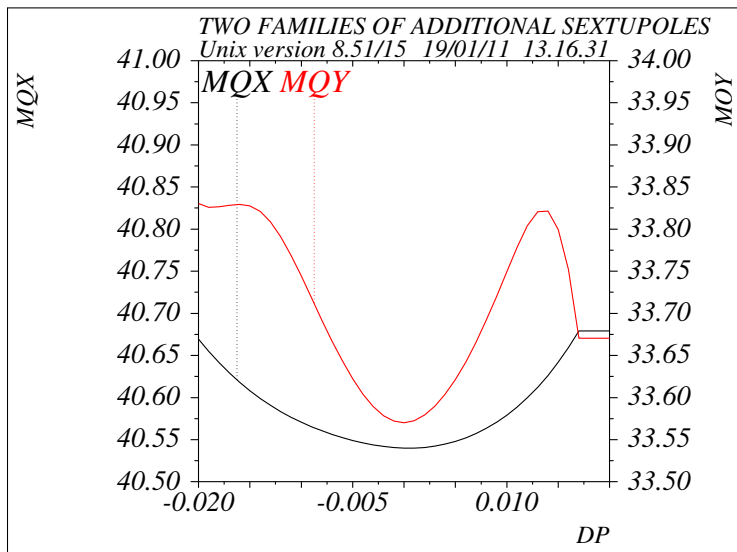
# FODO CELL, E=1 GeV



# FODO CELL

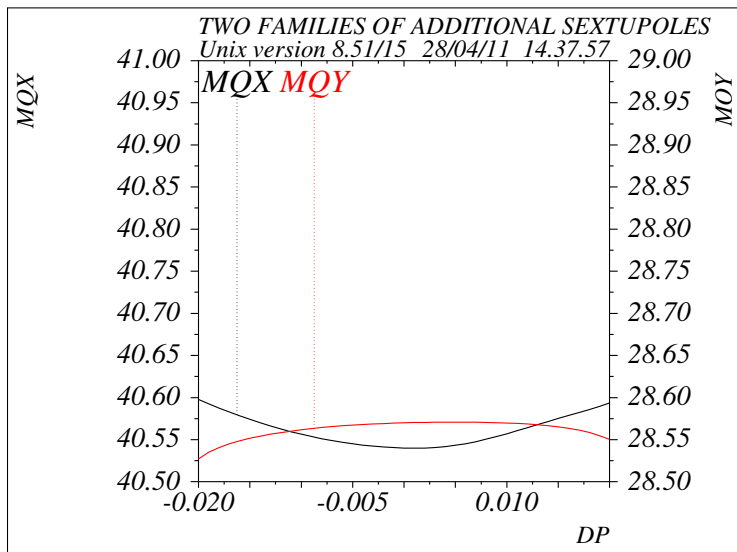


# Symmetrical FF-148, no injection, no separation.

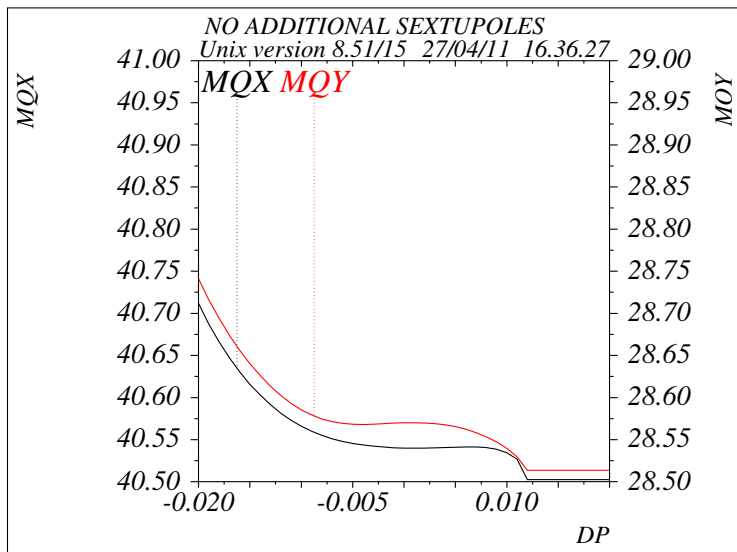




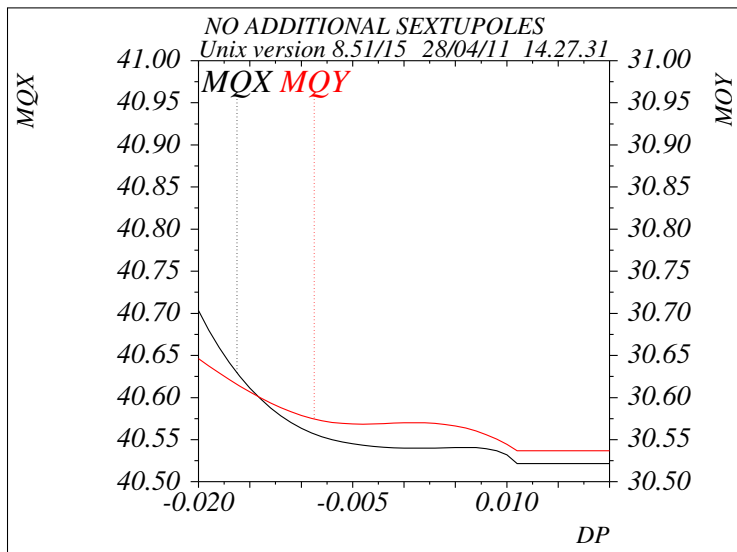
# Symmetrical FF-150, no injection, no separation.



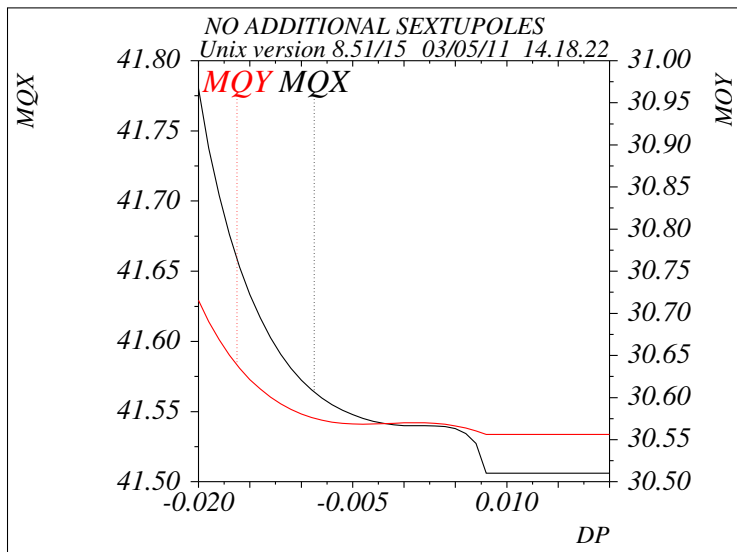
# Symmetrical FF-150, no injection, no separation.



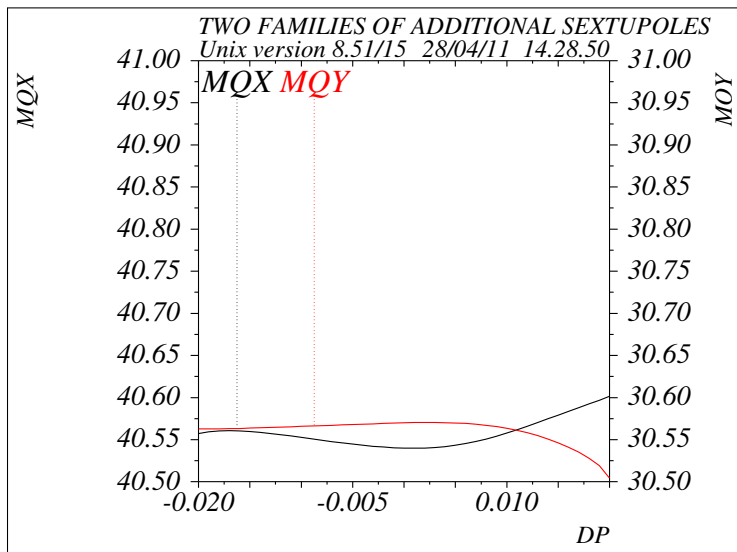
# Symmetrical FF-150, injection, no separation.



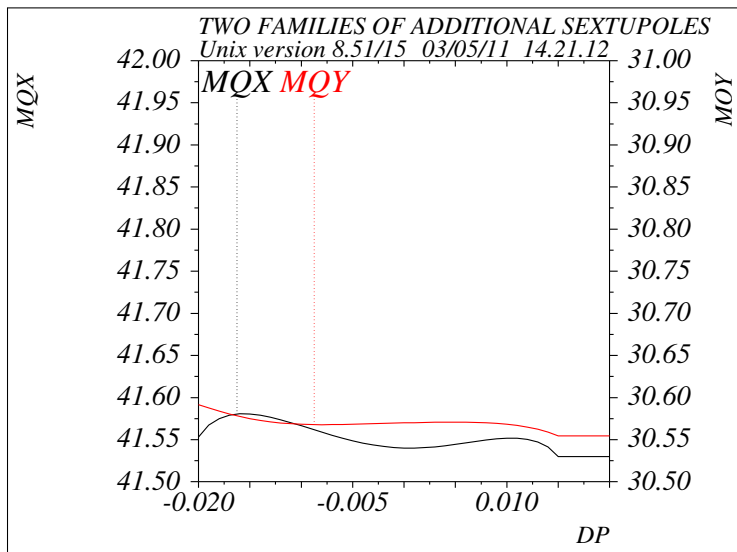
# Symmetrical FF-150, injection, separation.



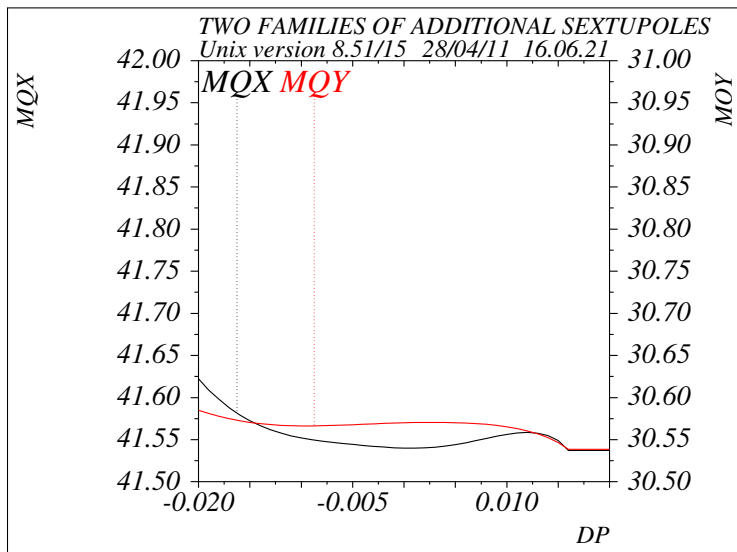
# Symmetrical FF-150, injection, no separation.



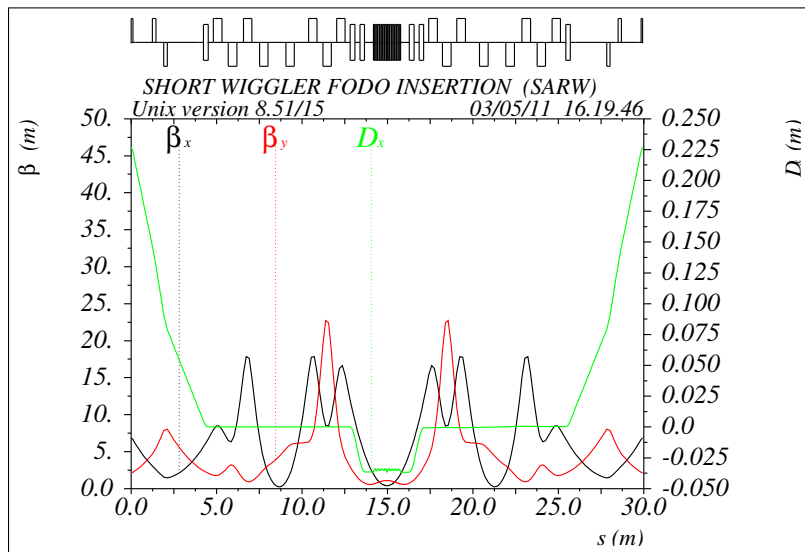
# Symmetrical FF-150, injection, separation.



Same, CELL  $\Delta\mu_x = -0.001$ .

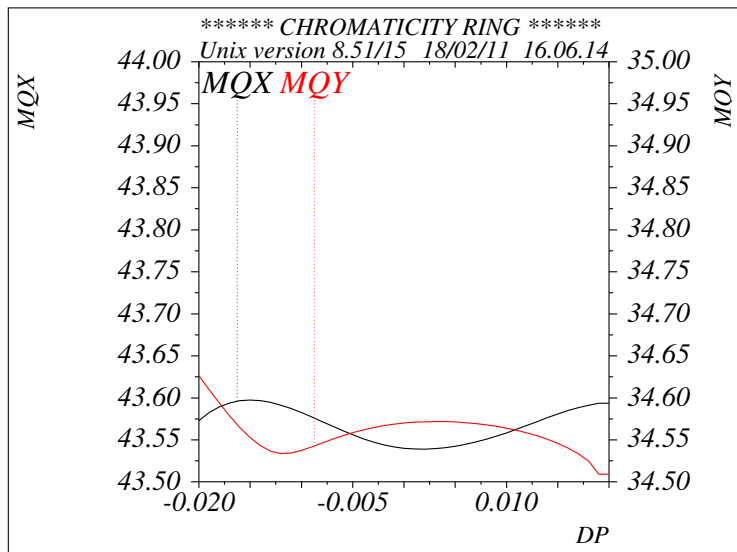


# New wiggler cell, E=1 GeV

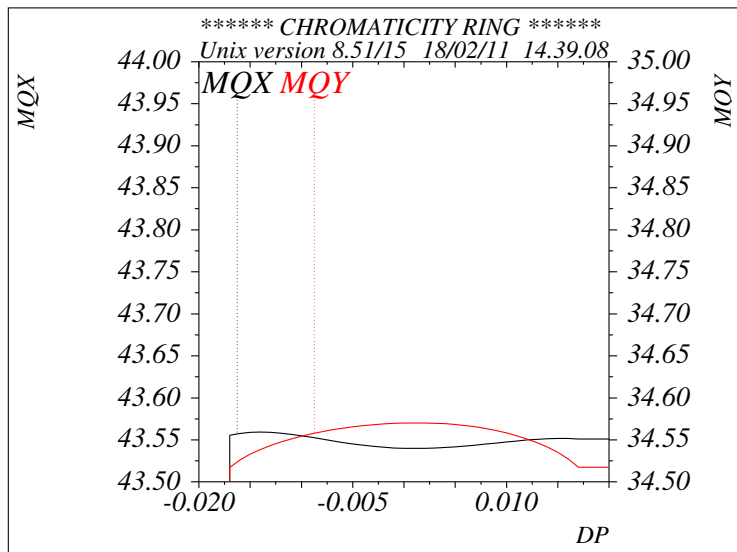




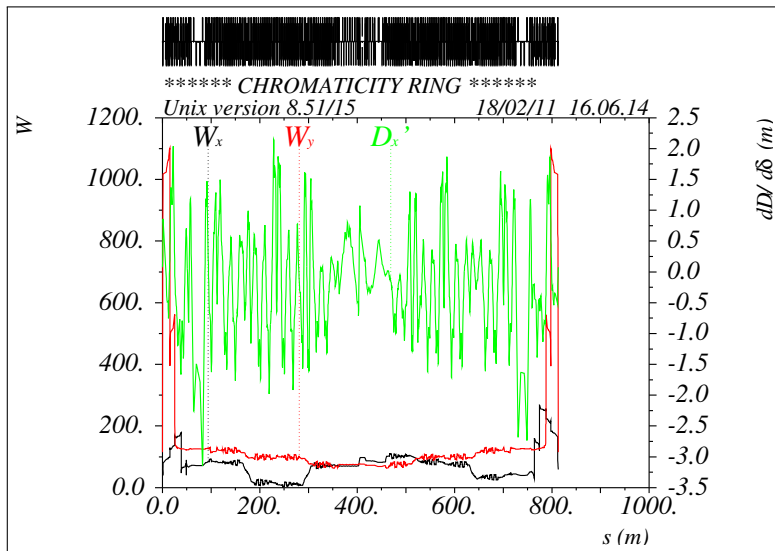
# Same and new wiggler cell. E=1 GeV



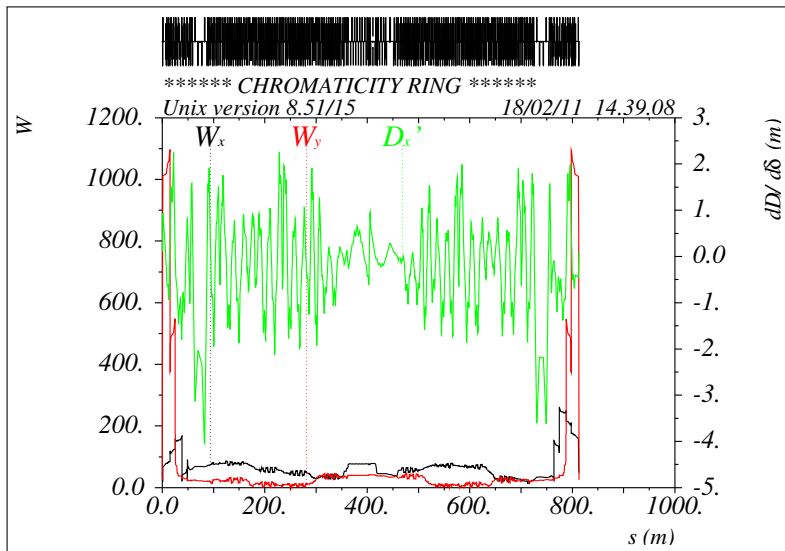
# Same and new wiggler cell. E=2.5 GeV



# Same and new wiggler cell. E=1 GeV



# Same and new wiggler cell. E=2.5 GeV



# Chromaticity of periodic structure

It is impossible to bring simultaneously all three chromaticities to zero.

$$\begin{aligned}\frac{d\beta}{d\delta} &= \frac{T_{126} + \beta^2 T_{216}}{2 \sin \mu} \\ \frac{d\alpha}{d\delta} &= \frac{T_{116}}{\sin \mu} + \frac{T_{126} - \beta^2 T_{216}}{2\beta \cos \mu} \\ \frac{d\mu}{d\delta} &= \frac{T_{126} - \beta^2 T_{216}}{2\beta \cos \mu}\end{aligned}$$

Canceling chromaticity of  $\beta$  and  $\alpha$  gives

$$\begin{aligned}T_{126} &= \mu' \beta \cos \mu \\ T_{116} &= -\mu' \sin \mu \\ T_{216} &= -\frac{\mu'}{\beta} \cos \mu\end{aligned}$$

# Chromaticity of periodic structure (useful formulas)

$$T_{116} = M_{12}A_1 - M_{11}A_2$$

$$T_{126} = M_{12}A_2 - M_{11}A_3$$

$$T_{216} = M_{22}A_1 - M_{21}A_2$$

$$T_{226} = M_{22}A_2 - M_{21}A_3$$

$$T_{116} = 0, T_{216} = 0 \Rightarrow M_{11}M_{22} - M_{21}M_{12} = 0$$

$$T_{116}M_{22} + T_{226}M_{11} = T_{126}M_{21} + T_{216}M_{12}$$

# Conclusion

- Breaking symmetry of the ring decreases energy acceptance.
- Introduction of insertions decreases energy acceptance.
- Manual tuning of phase advance per cell helps to increase energy acceptance.
- Manual tuning of additional sextupoles helps to increase energy acceptance.
- Chromatic functions matching is needed.
- New periodic cell is needed.