Recap 4\textsuperscript{th} Lecture

**Periodic structures / circular accelerators:** periodic boundary conditions $\alpha = \alpha_0$, $\beta = \beta_0$, $\gamma = \gamma_0$

**Periodic FODO structure:** stable necktie, if $f_+ = -f_- = f \rightarrow 4f > L_{\text{FODO}} \cdot \langle \beta \rangle = \min \leftrightarrow \mu = 90^\circ$

**Optical functions are determined by the lattice only (periodicity)!**

$\beta(s)$ is always maximal in focusing quads and minimal in defocusing quads of plane considered!

**Betatron Tune:** indicates the number of transverse oscillations per turn $Q = \frac{1}{2\pi} \int \frac{ds}{\beta(s)}$

**Filamentation:** beam ellipse will rotate (and enlarge) in case of a non-matched beam

**Closed Orbit:** Equilibrium path influenced by field errors, is closed!

**Real circular accelerators with field errors:**

**Dipole Errors:** closed orbit deviations $x_{co}(s) \sim \frac{\sqrt{\beta(s)\beta(s_0)}}{\sin(\pi Q)} \delta(Bl) \leftrightarrow Q \neq n$

**Quadrupole Errors:** effect on beta function (beam size) and tune $\Delta Q = \frac{1}{4\pi} \int |\beta(s)| \delta K(s) ds \leftrightarrow Q \neq n / 2$