# E207 - LAB

▷ types of particle accelerators and their working principle
- LINAC
- Cyclotron
- Microtron
- Betatron
- Synchrotron

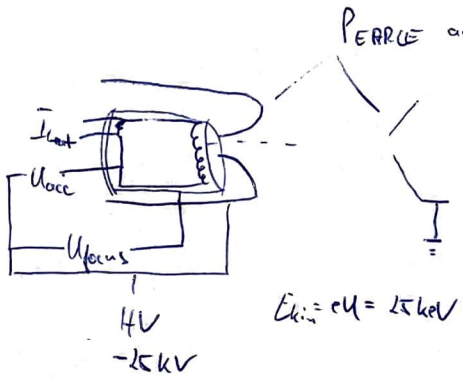
▷ typical components
- optical elements ; dipole, quad, sext., solenoids, Corrector magnets

$$\frac{1}{R} = \frac{e}{p} \cdot B_{ext} \quad k = \frac{e}{p} \frac{dB_z}{dx} \propto \frac{I}{} \; ; \; f = \frac{1}{kL} \qquad \alpha = \frac{e}{p} BL$$

$$x(s) + \left( \frac{1}{R^2} - k(s) \right) x''(s) = \frac{\Delta p}{p} \cdot \frac{1}{R}$$

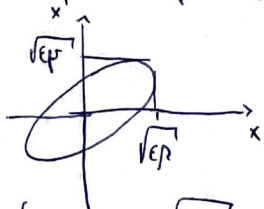
$$z(s) + k(s) z''(s) = 0$$

- acceleration mechanism




- monitoring : fluorescent screen in beampipe -> frame grabber camera

▷ characteristic variables
- beam emittance $\varepsilon$ is the area of the phase space ellipse -> conserved twiss parameters




$\alpha$ is a measure for correlation

envelope given by $E = \sqrt{\varepsilon\beta} \qquad \alpha = -\frac{\beta'(s)}{2} \qquad \gamma = \frac{1 + \alpha^2(s)}{\beta(s)}$

▷ matrix optics

▷ Measurement methods for determination of the beam emittance

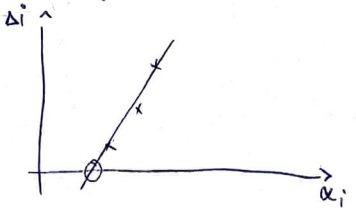
- basic principle: measure the beam width at position $\sigma_1 = \sigma_1(\alpha_0, \beta_0, \gamma_0)$
- quad. scan: determine $\sigma_1^2(k)$ obtain, $\varepsilon_x, \varepsilon_y, \varepsilon_z$ from quadratic fit
  - ↳ $\det(S) = \beta\gamma - \alpha^2 = 1$
  - ↳ determine beam waist and use transf. eq. of $\gamma$ function
- multi-screen-method: measure width at multiple screens and solve

$$\begin{pmatrix} \sigma^2(k) \\ \sigma^2(s_1) \\ \vdots \end{pmatrix} = M \cdot \begin{pmatrix} \varepsilon\beta_0 \\ \varepsilon\alpha_0 \\ \varepsilon\gamma_0 \end{pmatrix}$$

↳ use $\det(S) = 1$ to get $\varepsilon$

▷ beam based alignment:

- use corrector angle $\alpha_x$ and measure deviation $\Delta x$ after quad

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