

## PHY 554. Homework 2.

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HW 1 (4 pts). Magnet kicker (dipole)

Using the transfer matrix  $M$  to show that, when a particle is kicked at  $s_1$  by angle  $\theta$ , the displacement at a downstream location  $s_2$  is

$$\Delta x_2 = \theta \sqrt{\beta_1 \beta_2} \sin \mu,$$

Where  $\beta_1$  and  $\beta_2$  are values of betatron functions at  $s_1$  and  $s_2$  respectively, and  $\mu$  is the betatron phase advance between  $s_1$  and  $s_2$ . The quantity  $\sqrt{\beta_1 \beta_2} \sin \mu$  is usually called the kicking arm. In the scenario of designing a magnet kicker (which kicks the beam for injection/extraction or other orbit change), to obtain the maximum kick (or minimum kicker strength), what are the requirements for choosing the kicker location?

HW 2 (6 pts). FODO cells

An accelerator is made of 12 FODO cells with circumference of 180 m. The betatron tunes (phase advance per revolution divided by  $2\pi$ )  $Q_x/Q_y$  are 3.5/3.4 respectively. What are the maximum/minimum betatron functions ( $x$  and  $y$ ) and where are they located at?

Given the **RMS** beam emittance  $\varepsilon$  is 1 mm-mrad, what is the minimum vacuum chamber size to house such beam without losing particles and give your reasoning. (**This part needs knowledge from next class, bonus question 5 pts**).