Computer Lab: More madx with doglegs and achromats

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1. Dogleg

   (a) A dogleg (as illustrated in slide 5 of the afternoon lecture) is a pair of opposite-bend dipoles separated by a drift section. Last week you learned all the tools to build such a dogleg (with only three elements) in madx.

   (b) Construct a weak dogleg with 3° SBEND (sector bend) elements of length 2.0 m, with a drift length of 6.0 m between them. Track $\eta_x = 0, \eta'_x = 0$ through the dogleg and compare the results to the class notes.

   (c) Construct a strong dogleg with 30° SBEND (sector bend) elements of length 2.0 m, with a drift length of 6.0 m between them. Track $\eta_x = 0, \eta'_x = 0$ through the dogleg and compare the results to the class notes. What is the requirement for the weak dogleg approximation to apply?

   (d) Build an achromatic dogleg with four $\pi/2$ insertions instead of the drift to see that the dogleg indeed moves the beam without dispersion. Plot the dispersion for this achromatic dogleg in madx to see that it closes, similar to the plot on slide 8 of the class notes.

2. DBA

   (a) Construct a double bend achromat with the parameters given in class (slide 13) in madx.

   (b) Track $\eta_x = 0, \eta'_x = 0$ through the achromat and demonstrate that it is an achromat by reproducing the figure on slide 13.

   (c) Can a system like this be periodic in both β_x and β_y? That is, can you construct an achromatic bending "cell" out of a DBA?

   (d) Add an extra defocusing quadrupole on each end of the lattice, then a drift and a half a focusing quadrupole to each end. This cell looks like the DBA on slide 30 of the class notes.

   (e) Plot the periodic lattice functions $(\beta_x, \beta_y, \eta_x)$ for your DBA lattice and compare them to the picture on slide 30 of the class notes.