Homework, due October 8, 2019

Tao practice problem set #1

Log on CLASSE Linux and run Tao inside the "optics_matching" directory.
The original directory is located at
/home/wl528/nfs/lib_SL7/tao/examples/optics_matching.

(1) In the Tao command mode, type "sho lat".   ("sho" is short for "show")
    (a) What's the index of element named "END"? This corresponds to how many
        (slave) elements the particle is tracked through in Tao for one pass through
        the lattice. Pay special attention to the symbol "#" and "\" in some of the
        element names. What do these symbols mean?
    (b) How many **lord elements** are there? Make sure you understand why they are
        lords, and their relationship with the **slave elements**.
    (c) What physical quantities are shown in the columns? (Hint: there are 8 of
        them) Explain what each one means.
    (d) Type "sho lat –at b_field –at angle". How many colums are shown now? In
        what UNITS are the new physical quantities in these columns shown?
    (e) How many magnets are in this lattice? What kind of magnets are they?

(2) Transfer matrix
    (a) Type "sho mat 1 2", which tells you the transfer matrix from the end of
        element #1 to the end of element #2. What value is the M12 element? What
        physical quantity (with unit) does this value correspond to?
    (b) Type "set ele 2 L = 0.25", then repeat part (a). Does the M12 value agree with
        your expectation?
    (c) Type "sho mat 0 1". What kind of matrix do you see? Why?
    (d) Type "sho lat quad::* -at k1". What are the quadrupole strengths?
    (e) Type "change ele Q1 k1 @20", then repeat part d.
    (f) Type "sho mat 4 5" to access the transfer matrix of Q1. What values are M11,
        M12, M21 and M22? Check these values by calculating by hand using the
        values of k and L of Q1.
    (g) According to Tao plot, what happens to the beta function in x and y as they
        go through Q1? What's the shape of beta_x in the pipe following Q1? Type
        "SLD" which is an alias for "set lattice model=design" to reset the lattice.
        Then plot, then repeat part (e) to check the difference. (Note that all aliases
        can be see with "show alias")

(3) Lattice Optimization   (First, type "SLD" to reset the lattice, or just restart Tao)

(a) Type "show var quad". How many variables are there under "quad"?

(b) Type "change var quad[1] @15", then type "show var quad" again. What physical quantity has changed? What value and unit has it changed to?

(c) Type "sho data". How many "d2 data" are shown? How many "d1 data" is under each "d2 data"?

(d) Type "sho dat twiss.end". Each "d1 data" shown corresponds to a physical quantity. What are these quantities, and where are they evaluated in the lattice?

(e) For each of the "d1 data" there is an associated **measured value**, **model value**, and **design value**. What do these three values mean? Why do the model values and design values disagree?

(f) Type "run". This should produce an error message. What is it?

(g) Type "use var quad[1:6]" so the optimizer in Tao uses all 6 quads. Then type "run" to run the optimizer. You should see that **merit** drop. How is merit defined in terms of **measured data values and model data values**? (Type "show merit" to see extra details)

(h) Type "run" for a few times until the merit no longer drops. What value has it dropped too?

(i) Type "sho dat twiss.end" again. Which column of data values has changed? Are the values similar to another column?

(j) Change the quad strengths k1 according to the table below using "change var" command like in part b.

	Q1	Q2	Q3	Q4	Q5	Q6
K1	5.9	-18.9	16.2	-16.7	-1.4	2.3

Note k1 has a default unit of 1/m^2.

(k) Type "show merit". What value is the merit now? Is it smaller than before?

(l) Type "run". Did the merit drop? What does this tell you about the variable values in part (j) as an initial guess for optimization?

(m) Type "sho dat twiss.end" again. Have you noticed something special between the column values?

(n) Type "sho dat twiss.max" and record the model value of the two "d1 data" What do these two values mean? Do they agree with the plot?