Accelerator Lattice Design – Part II Insertions

– Laboratory Exercise –

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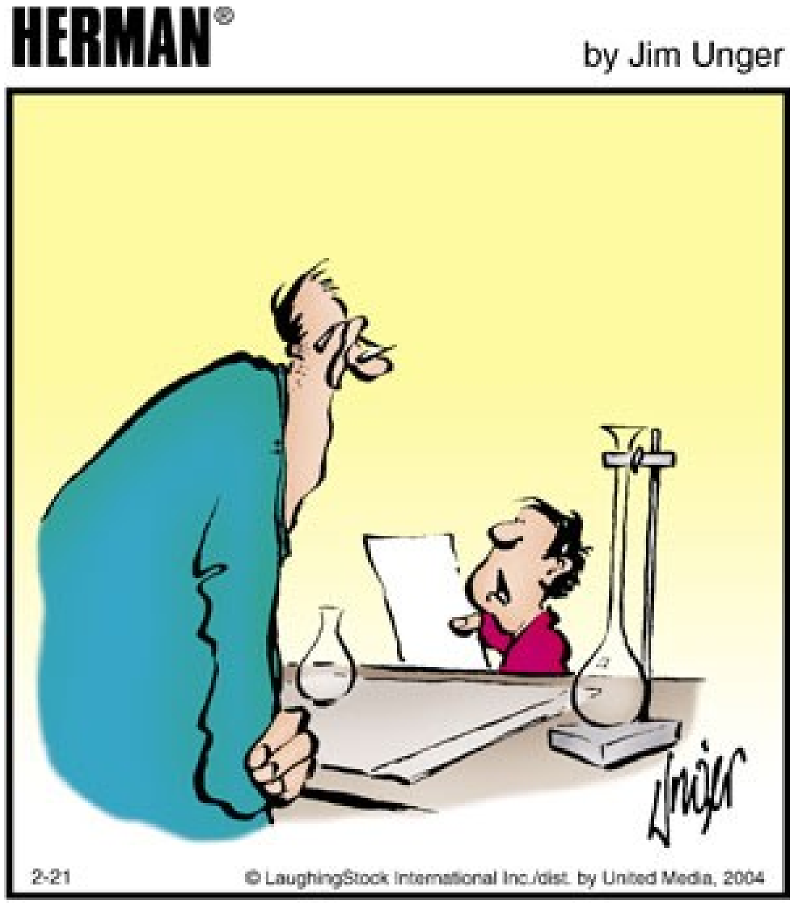
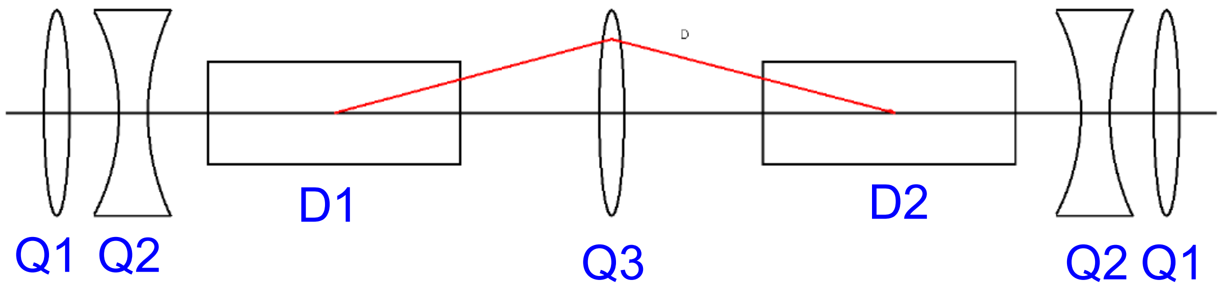


"I think my test results are a pretty good indication of your abilities as a teacher."

- Acknowledgements and credits to: W. Herr, B. Holzer, A. Streun, A. Wolski

Exercise I – 1/2

- Design a Chasman-Green Double-Bend-Achromat



  – Start with the doublet Q1+Q2, use the same constraints as during the day before.
    - Assume a fixed cell length of ~10-30m
      → get a reasonable optics with 100 m > β_x > β_y a the beginning and end of the cell
    - Once you are happy insert the Q3 and D2 at the centre of the doublets
  – The dipole D1 generates dispersion wave which is closed by dipole D2, which is 180° apart → phase advance condition is steered with Q3 and distance between D1 & D2 (hint: $M_{180°\text{-cell}} = M_{Drift} \cdot M_{Q3} \cdot M_{Drift}$).
    - Q1,Q2 are used to make β_x in D1 & D2 small
  – Leave some space (~5 m) left and right of the Q1s to allow some space for undulators, RF cavities, or instrumentation.

Exercise I – 2/2

- Design tips:
  - there is only a narrow range of kQ1, kQ2, and Q3 for which the DBA converges ↔ many local optima → need to guide MAD-X before you can do the regular cell matching (i.e. start with the linear approximations)
  - The first step is thus very much iterative and it's (strongly) recommended that you first match the cell as a transmission line with fixed initial conditions
    - i.e. $\beta_{x,}$ β_y being constant & $\alpha_{x/y}$,$\mu_{x/y}$, $D_{x/y}$, and $D'_{x/y}$ being zero. Use the following line to compute the 'Twiss' call : twiss, file=test_output.twiss, betx=<your value>, alfx=0, mux=0, bety=<your value>, alfy=0, muy=0, DX=0, DY=0, DPX=0, DPY=0, deltap=0.0, X=0, Y=0, PX=0, PY=0;
    - Vary Q3, check that you reached the dispersion cancelling condition via:
      - value, table(twiss,MB2,mux)-table(twiss,MB1,mux);
      - Should be equal/very close to '0.5' (ie. phase advances given in units of 2π)
  - Once you are happy with the symmetry of the initial conditions try to match the dispersion suppression and exact beta-function with the cell-matching, I.e use
    - match,sequence=DBACell, betx=<your value>, alfx=0, mux=0, bety=<your value>, alfy=0, muy=0; // [..]
    - and then simply: Twiss; match, sequence=DBACell;
  - Check how your Q3 value compare with the theoretic linear approximation
  - **Enjoy!**

Exercise II – Dispersion Suppressor (DS)

- Aim: we need (at least) two regions with low dispersion in our existing FoDo lattice to accommodate our RF system and an experiment (e.g. undulator or high-energy physics interation point).

- Insert two straight sections each consisting of at least cells (e.g. FoDo cells without bending magnets). Keep the same quadrupole focusing:
  – Insert the two straight sections opposite in azimuth in the ring. Plot the results.

- The dispersion shall be well below (< 1 m) along this straight section. Chose and implement one of the following options:
  a) missing-dipole scheme (tip: for the simplest case you need to change $\Delta\mu_{cell}$:= 60°), or
  b) changing the bending radius of some or all the bending magnets, or
  c) Full Monty – independent quadrupole-based DS
  – At this stage do not change the focusing properties of the arc cells.

Exercise III

- Start from the previous lattice and design a symmetric insertion with a low-β section in a dispersion free region. The β should be small at least in one plane and should have a waist at an "interaction point".

- Two options:
  - Try to design the insertion yourself
  - Use an already prepared example sequence and try to match