

Homework #2 for Beam-based Diagnostics USPAS Knoxville, TN, January 2019

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Homework #2: Part 1: Tune Correction

Continue to use ALS as example (i.e. setpathals like in homework #1)

Given the following middle layer commands (and similar ones for QD):

```
Tune = gettune;           % Tune [NuX; NuY]
qf = getsp('QF', 'Physics'); % Get all the QF setpoints in
                             % physics units – i.e. k-value
setsp('QF', 'Physics', qf+0.001); % Change k(QF) by 0.001 m^-2
```

As well as the Matlab commands `inv()` or `^-1` or `\` to invert a matrix (matrix indexing works like `R(1,1)`, `R(1,2)`, `R(2,1)`, `R(2,2)`) and the nominal operation fractional tunes of the ALS of 0.165 (16.165) and 0.25 (9.25) (the starting tunes in the lattice file on the computers are slightly different) with the following definition of a tune response matrix

Tune Response Matrix Equations

$$R = \begin{pmatrix} \Delta \nu_x / \Delta QF & \Delta \nu_x / \Delta QD \\ \Delta \nu_y / \Delta QF & \Delta \nu_y / \Delta QD \end{pmatrix}$$

$$\begin{bmatrix} \Delta \nu_x \\ \Delta \nu_y \end{bmatrix} = R * \begin{bmatrix} \Delta QF \\ \Delta QD \end{bmatrix}$$



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Tuesday Homework #2: Tune Correction

Write a Matlab script to:

1. Record the starting tunes
2. Measure the [2x2] tune response matrix. I.e., the response of horizontal and vertical tune to changes of QF and QD. There are 24 magnets in each of the families, however, treat each of the entire quadrupole families as a single tune corrector (which happens if you do not give setsp any specific magnet index, but just a family).

Use a .001 m⁻² k-value change in the quadrupole families to compute the response matrix.

3. Change the tunes to the nominal values for the ALS of [0.165;0.25] using the QF & QD families. (Tip: You need to multiply the second equation on the right with inv(R) from the left to get deltaQF,QD for a given deltaNu).

How much change in the QF & QD families did it take?

$$R = \begin{pmatrix} \Delta \nu_x / \Delta QF & \Delta \nu_x / \Delta QD \\ \Delta \nu_y / \Delta QF & \Delta \nu_y / \Delta QD \end{pmatrix}$$

$$\begin{bmatrix} \Delta \nu_x \\ \Delta \nu_y \end{bmatrix} = R * \begin{bmatrix} \Delta QF \\ \Delta QD \end{bmatrix}$$

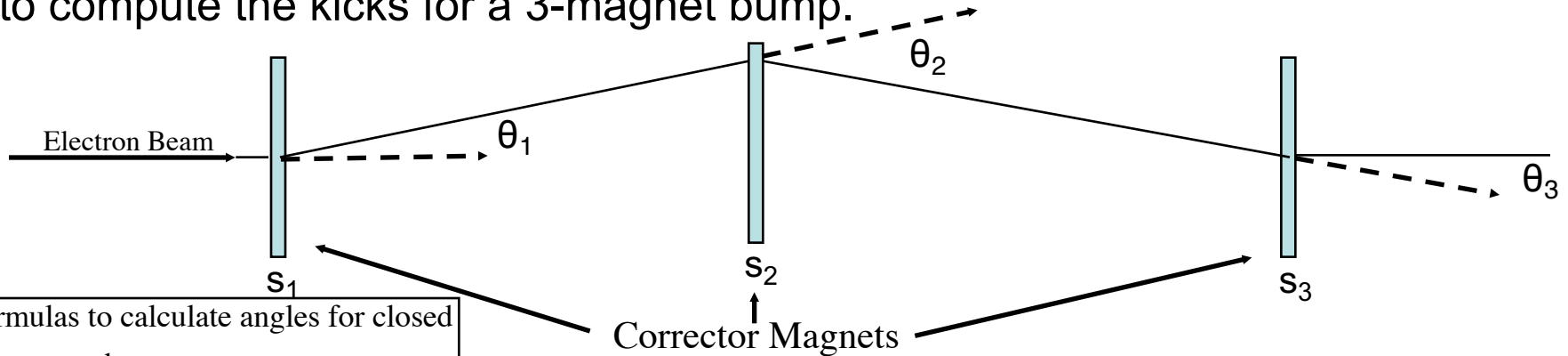


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Part 2: Local Bumps

Use the equations below and the optics data below (compute missing numbers from model after resetting lattice to default by running setpathals) to compute the kicks for a 3-magnet bump.



Formulas to calculate angles for closed 3 corrector bump

$$\Theta_2 = -\Theta_1 \sqrt{\frac{\beta_1 \sin(\varphi_{13})}{\beta_2 \sin(\varphi_{23})}}$$

$$\Theta_3 = \Theta_1 \sqrt{\frac{\beta_1 \sin(\varphi_{12})}{\beta_3 \sin(\varphi_{23})}}$$

Reset lattice to default first by running setpathals!

4. For a 3-magnet bump in the ALS (in sector 7) assume a 0.1 mrad change in the first corrector. Fill in the missing data below and compute Θ_2 and Θ_3 .

HCM[7 1]: $\beta_1 = 21.0814$ $\varphi_{12} = \varphi_2 - \varphi_1 = 53.6541 - 50.8150 = 2.8391$ rad

HCM[7 4]: $\beta_2 = \underline{\hspace{2cm}}$ $\varphi_{13} = \varphi_3 - \varphi_1 = \underline{\hspace{2cm}} - 50.8150 = \underline{\hspace{2cm}}$ rad

HCM[7 8]: $\beta_3 = 21.0797$ $\varphi_{23} = \varphi_3 - \varphi_2 = \underline{\hspace{2cm}} - 53.6541 = \underline{\hspace{2cm}}$ rad



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Part 2 continued: Local Bumps

Commands you might need for local bump exercise:

```
% Get the horizontal orbit
x = getam('BPMx');

% Change HCM[7 1] by +.1 mrad ( 'Physics' units are radians for a corrector magnet)
hcm = getsp('HCM', [7 1], 'Physics');
setsp('HCM', hcm+.0001, [7 1], 'Physics');

% Get the beta function [m] & phase advance [radian] from the model
beta1 = modeltwiss('Beta', 'HCM', [7 1])
phase1 = modeltwiss('Phase', 'HCM', [7 1])    % do not call without output argument!

% Get & Set the RF frequency
RF = getrf;
setrf(RF);
```

5. Put the 3 correction magnet changes in the model and plot the horizontal orbit. The bump should look basically closed at this point.
6. Since the dispersion function is not zero at the corrector magnets, the correctors changed the energy of the beam. Can you change the RF frequency by the classic “knob turning” method (i.e. trial-and-error) to make the bump more “local”? How much RF change did it take?
7. [Energy, HCMEnergy] = getenergy will return the energy change due to the HCMs. Compute the required RF change to counter the energy change due to the corrector magnet change.



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