

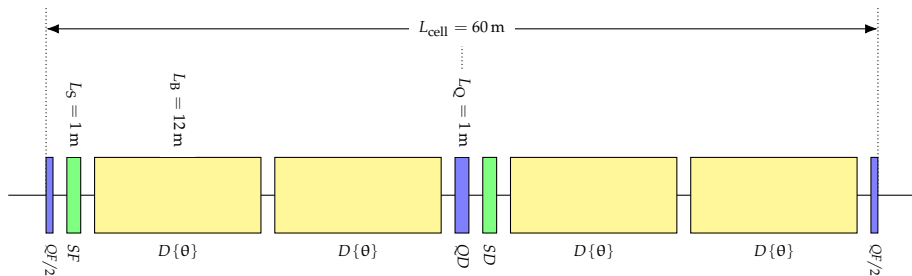
JUAS22: Accelerator Design Workshop - Lattice Design

Group 10

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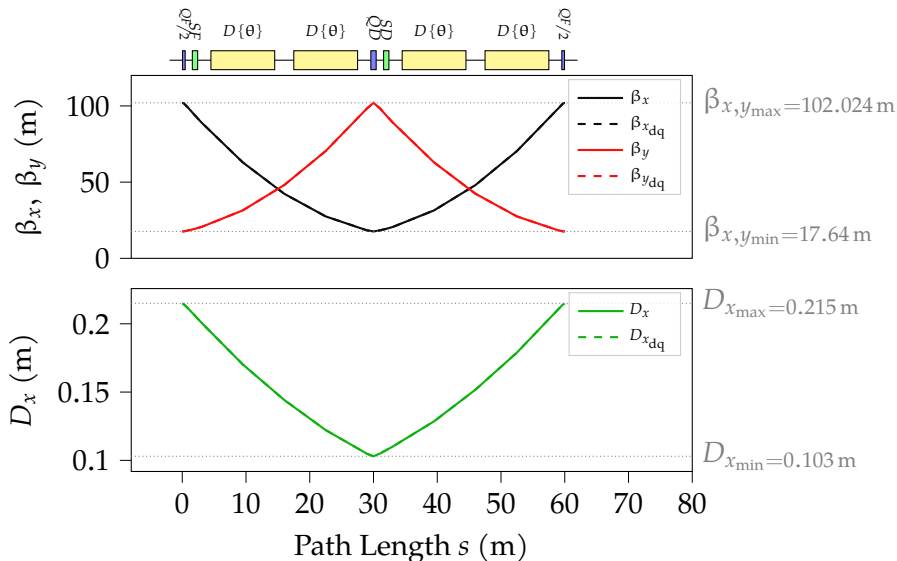
February 7, 2022

Arc Cell (1): Cell layout



- Cell type: FODO
- Phase advance: $\mu = 90^\circ$

Arc Cell (2): β -Functions and Dispersion



Arc Cell (3): Closing the Ring

- Building the ring with a loop:

```
i = 0;  
JC_ring : SEQUENCE, refer=centre , L=L_JC_ring;  
    while (i < numberOfCells) {  
        JC_fodo_arc , at=(i + 0.5) * Lcell;  
        i = i + 1;  
    }  
ENDSEQUENCE;
```

- Check if ring is closed with survey:

$$\frac{\oint_C d\theta - 2\pi}{2\pi} = \frac{6.2854196 - 2\pi}{2\pi} = 0.035\%$$

Arc Cell (4): Numerical Calculations

- Bending angle θ :

$$\epsilon_x = \frac{C_q}{J_x} \gamma^2 \theta^3 F, \quad \text{with: } F = F_{\text{FODO}} = \frac{1}{2 \sin \mu} \frac{5 + 3 \cos \mu}{1 - \cos \mu} \frac{L_{\text{cell}}}{L_B}$$
$$\Leftrightarrow \theta = 1.323 \text{ mrad}$$

- Quadrupole strength k_1 :

$$\sin \frac{\mu}{2} = \frac{L_Q}{4f}, \quad \text{and } \frac{1}{f} = k_1 L_Q \quad \Leftrightarrow k_1 = 0.05714 \text{ m}^{-2}$$

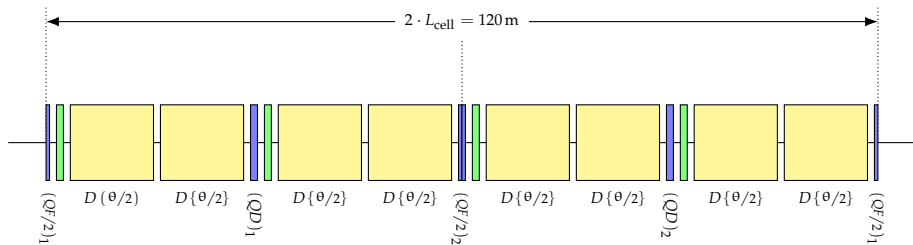
- Energy loss:

$$U_{\text{turn}} = \frac{C_q E^4 I_2}{2\pi} = 39.6 \text{ nJ}$$

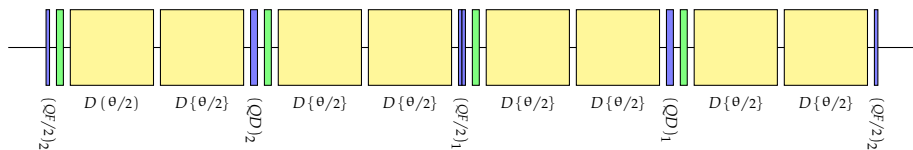
- Emittance:

$$\epsilon_x = \frac{C_q \gamma^2 I_5}{J_x I_2} = 2.58 \text{ nm rad}$$

Dispersion Suppressor (1): Layout

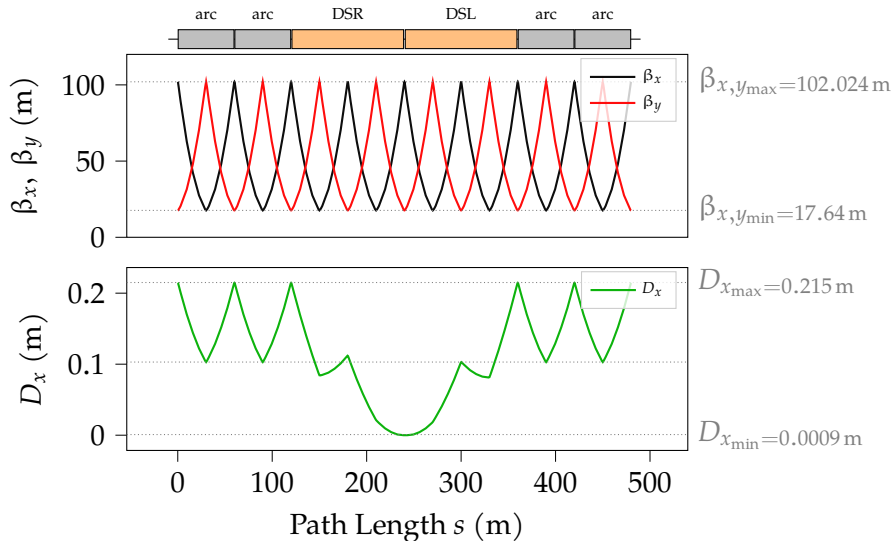


(a) DSL (Dispersion Suppressor Left)

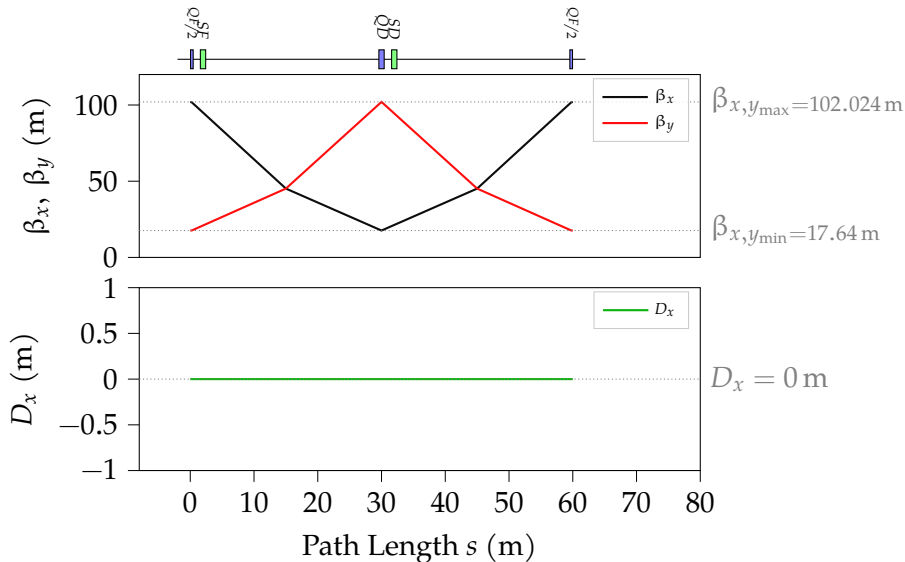


(b) DSR (Dispersion Suppressor Right)

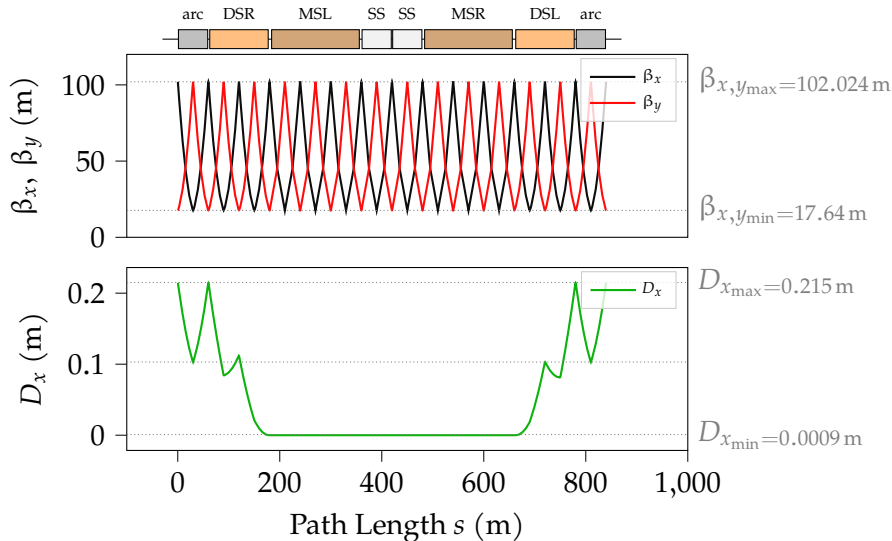
Dispersion Suppressor (2): β -Functions, Dispersion



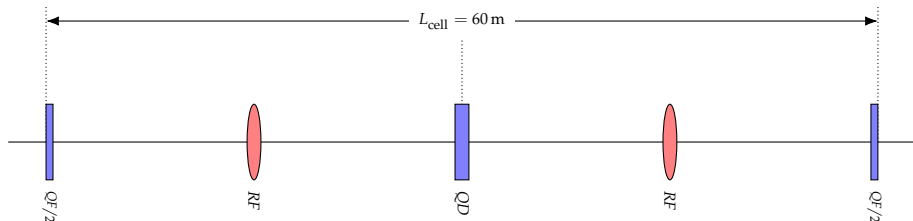
Straight Sections: β -Functions and Dispersion



Matching Sections



RF Sections (1): Layout

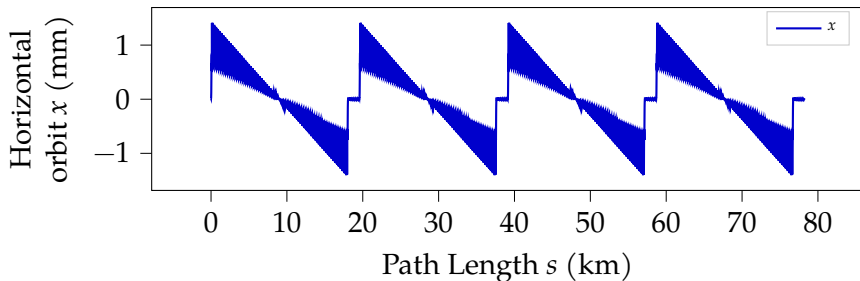


- From topic II groups: $V_{\text{RF}} = 10.64 \text{ GV}$
- Synchronous phase:

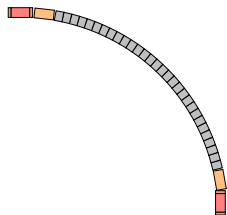
$$U_{\text{turn}} = U(t = t_0) = e V_{\text{RF}} \sin(2\pi(\phi - h))$$

$$\Rightarrow \phi_{\text{above transition}} = 0.5 - \frac{\arcsin\left(\frac{U_{\text{turn}}}{e V_{\text{RF}}}\right)}{2\pi} = 0.33 \text{ rad}$$

RF Sections (2): Transverse orbit



Quarter Ring:



- FODO Arc Sections (297 times)
- Dispersion Suppressors
- Straight Sections with RF (19 times)
- Matching Sections

Number of Bunches in the Ring

- Energy lost per particle and per turn, calculated with MAD-X:

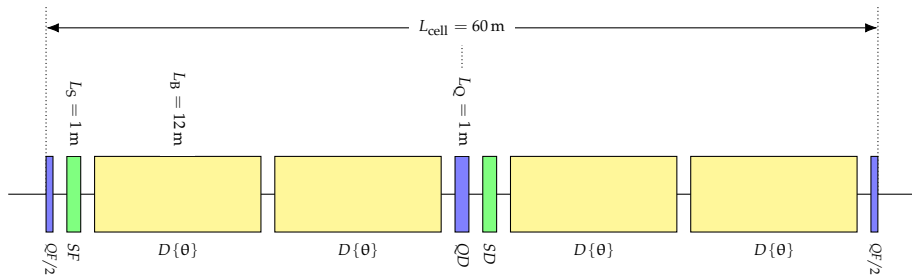
$$U_{\text{turn}} = 4.62 \text{ GeV}$$

$$P = \frac{\beta c}{L_{\text{ring}}} U_0$$

- $n_{\text{particles}} \approx 2 \times 10^{11}$
- $P_{\text{max}} = 50 \text{ MW}$
- Number of bunches limited by synchrotron radiation:

$$n_{\text{bunches}} = \frac{P_{\text{max}}}{P \cdot n_{\text{particles}}} = 122$$

Thanks for Listening!



- Questions?
- Discussion?

