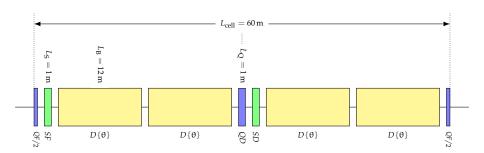
JUAS22: Accelerator Design Workshop - Lattice Design Group 10

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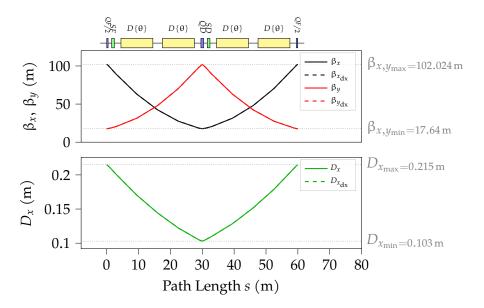
February 7, 2022

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;</pre>
```

ENDOLQUENCE,

• 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 :

$$\epsilon_x = \frac{C_q}{J_x} \gamma^2 \, \theta^3 F$$
, 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 :

$$\sin \frac{\mu}{2} = \frac{L_Q}{4f}$$
, and $\frac{1}{f} = k_1 L_Q \quad \Leftrightarrow k_1 = 0.057 \, 14 \, \text{m}^{-2}$

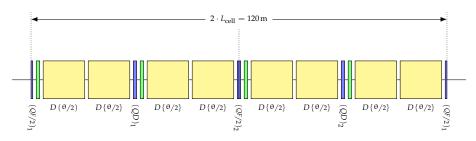
• Energy loss:

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

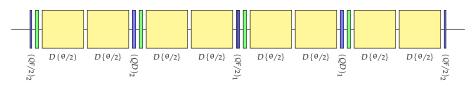
• Emittance:

$$\epsilon_x = \frac{C_q \gamma^2 I_5}{I_x I_2} = 2.58 \,\mathrm{nm}\,\mathrm{rad}$$

Dispersion Suppressor (1): Layout



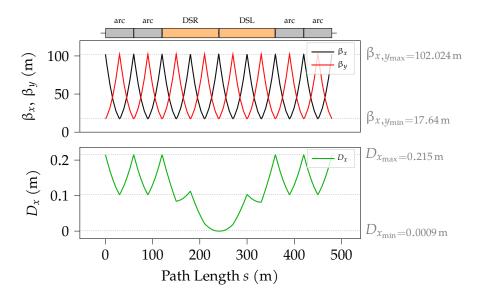
(a) DSL (Dispersion Suppressor Left)



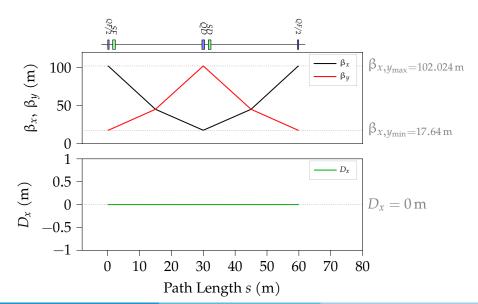
(b) DSR (Dispersion Suppressor Right)

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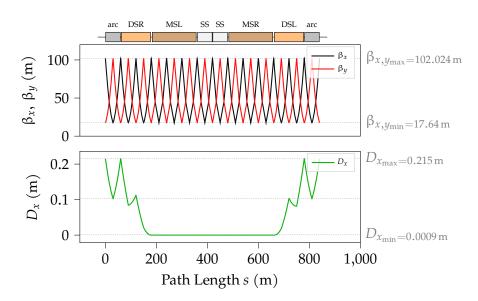
Dispersion Suppressor (2): β-Functions, Dispersion



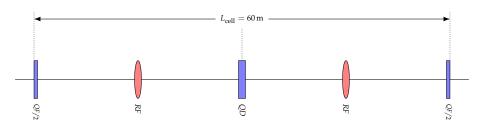
Straight Sections: β-Functions and Dispersion



Matching Sections



RF Sections (1): Layout

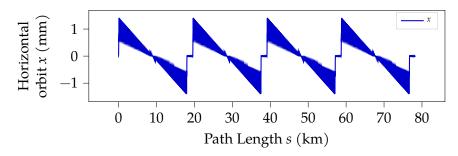


- From topic II groups: $V_{RF} = 10.64 \,\text{GV}$
- Synchronous phase:

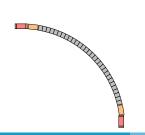
$$U_{\mathrm{turn}} = U(t = t_0) = e \, V_{\mathrm{RF}} \sin{(2\pi(\phi - h))}$$

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

RF Sections (2): Transverse orbit



Quarter Ring:



- FODO Arc Sections (297 times)
- Dispersion Supressors
- 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:

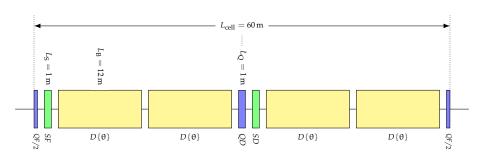
$$U_{\text{turn}} = 4.62 \,\text{GeV}$$

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

- $n_{\rm particles} \approx 2 \times 10^{11}$
- $P_{\text{max}} = 50 \,\text{MW}$
- 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?

