JUAS22: Accelerator Design Workshop - Lattice Design

Group 10

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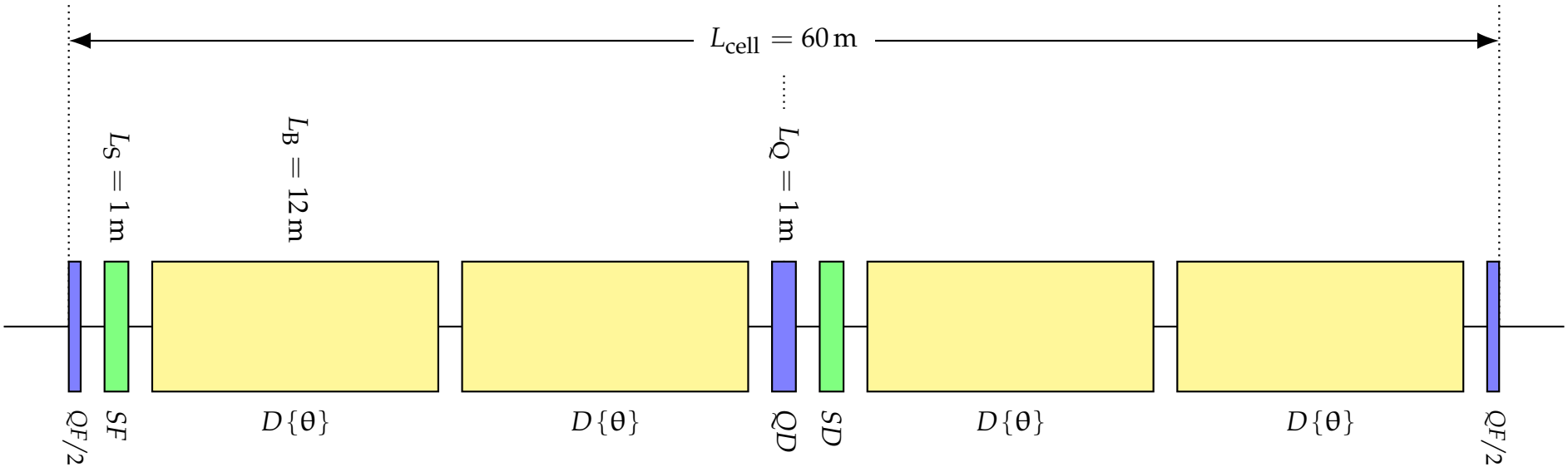
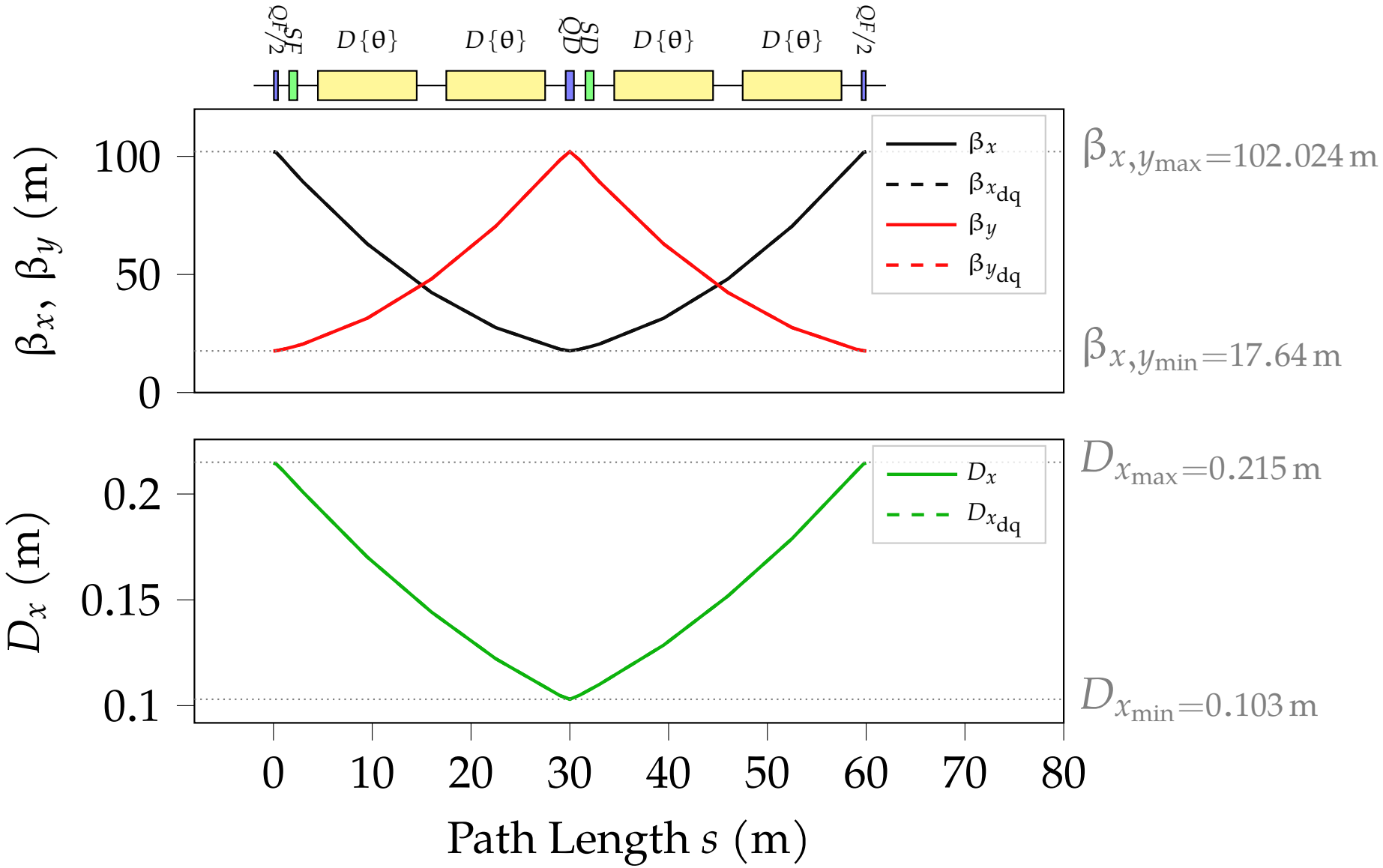
Arc Cell (1): Cell layout



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

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`:

$$\frac{\oint_C \mathrm{d}\theta - 2\pi}{2\pi} = \frac{6.285\,419\,6 - 2\pi}{2\pi} = 0.035\,\%$$

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:

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

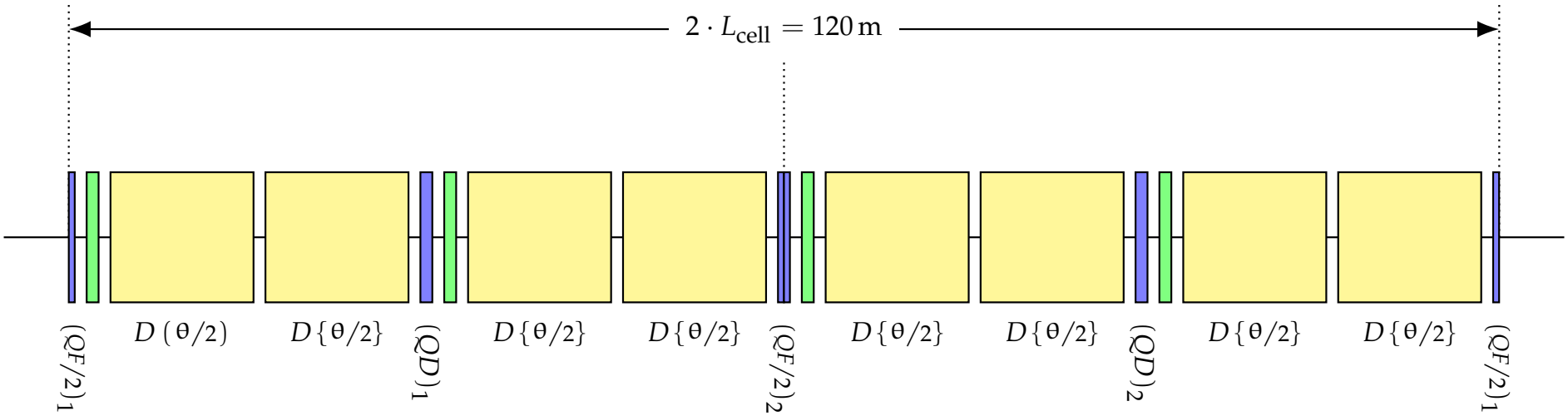
- Energy loss:

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

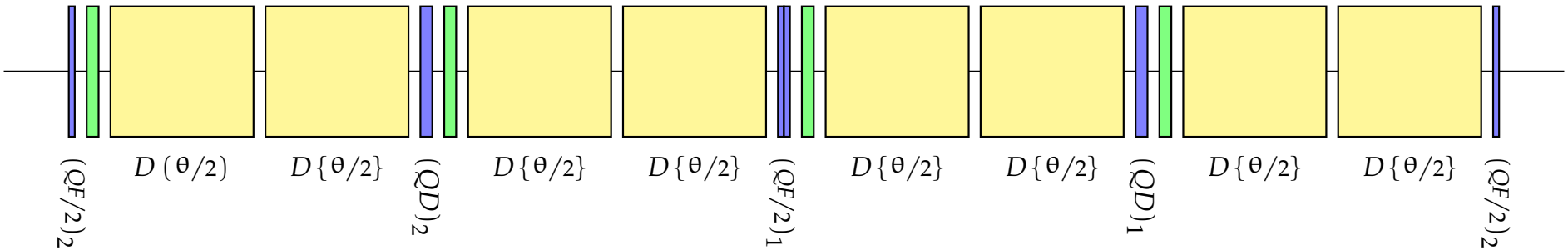
- Emittance:

$$\epsilon_x = \frac{C_q\,\gamma^2\,I_5}{J_x\,I_2} = 1.30\,\text{nm rad}$$

Dispersion Suppressor (1): Layout

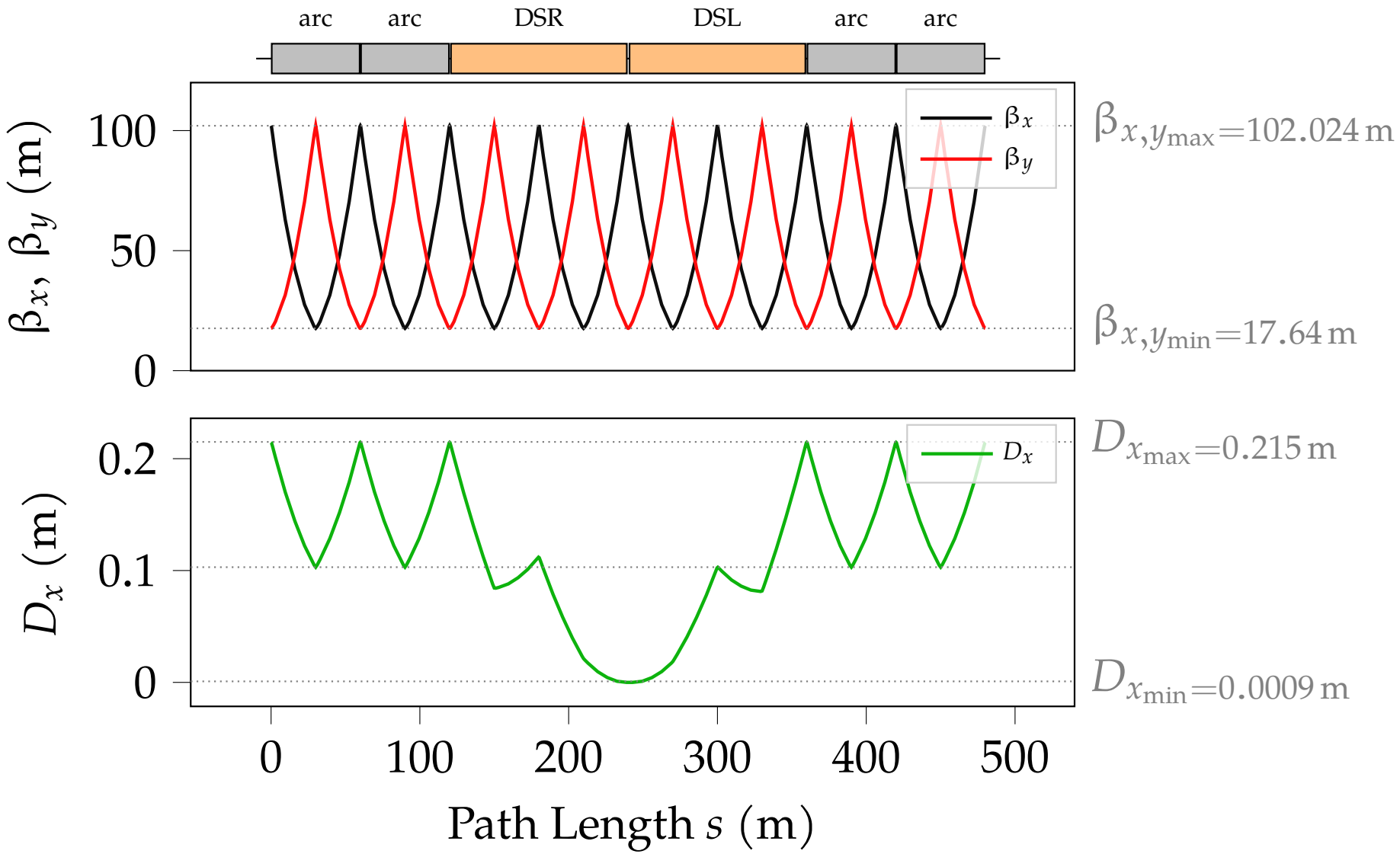


(a) DSL (Dispersion Suppressor Left)

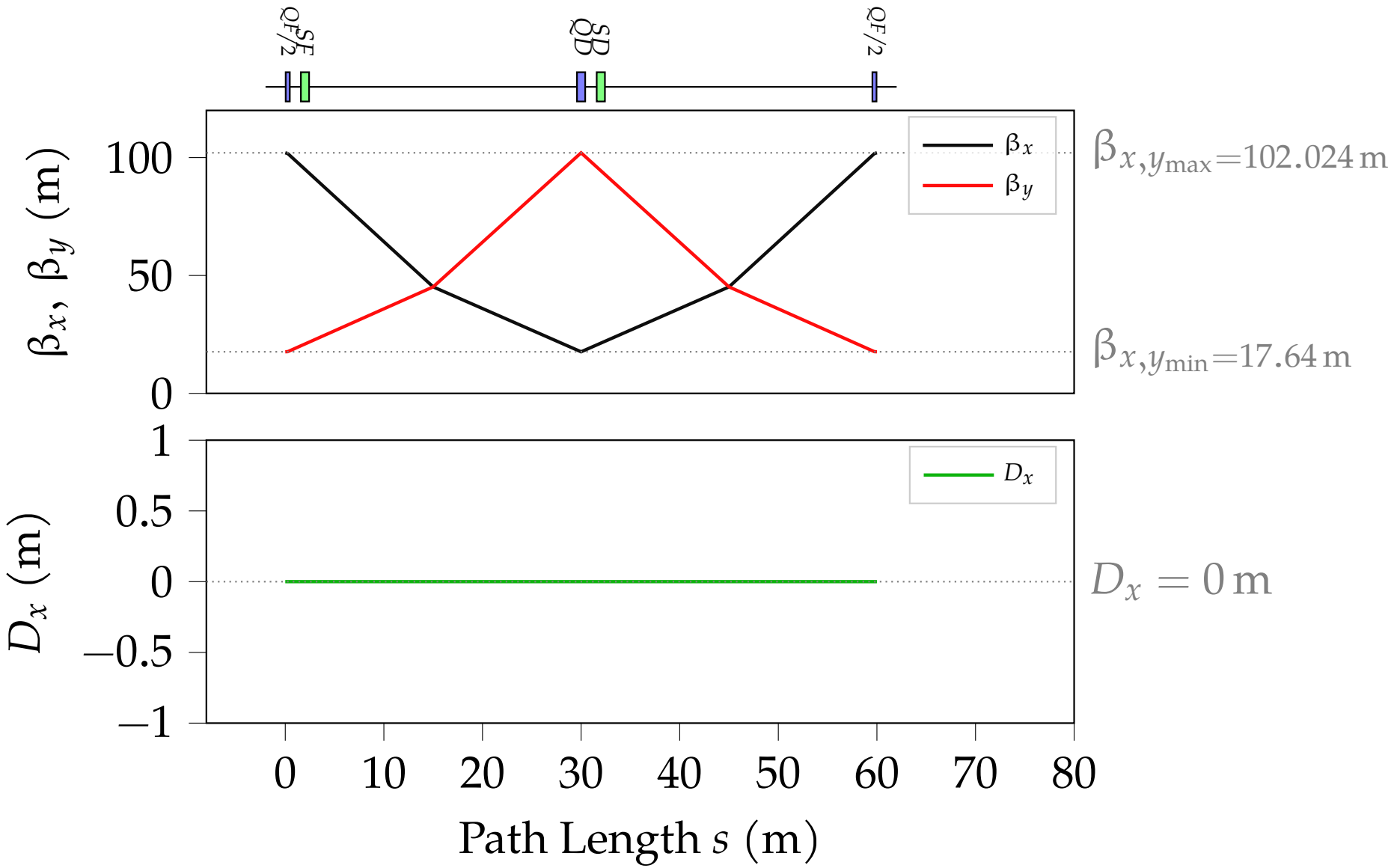


(b) DSR (Dispersion Suppressor Right)

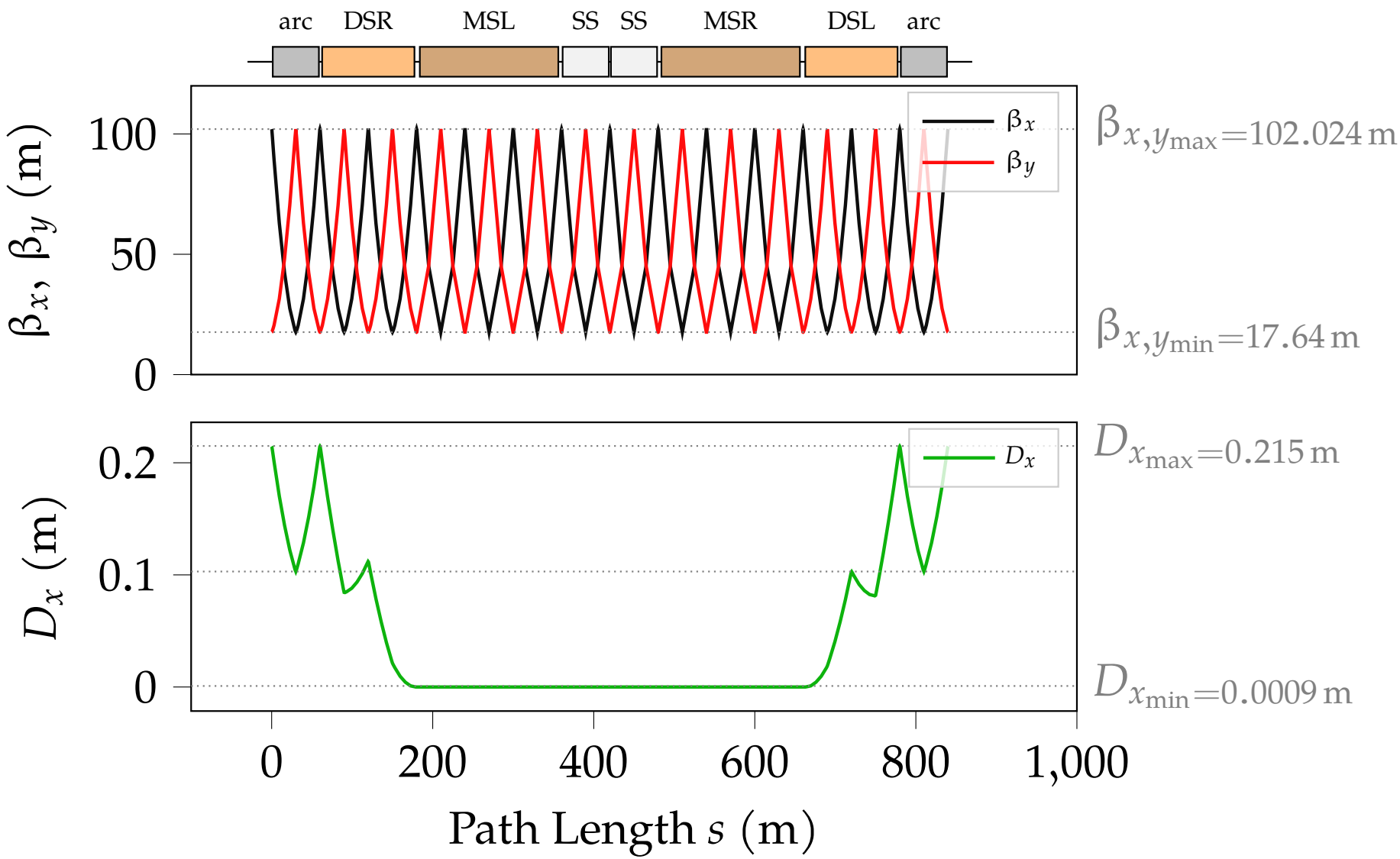
Dispersion Suppressor (2): β-Functions, Dispersion



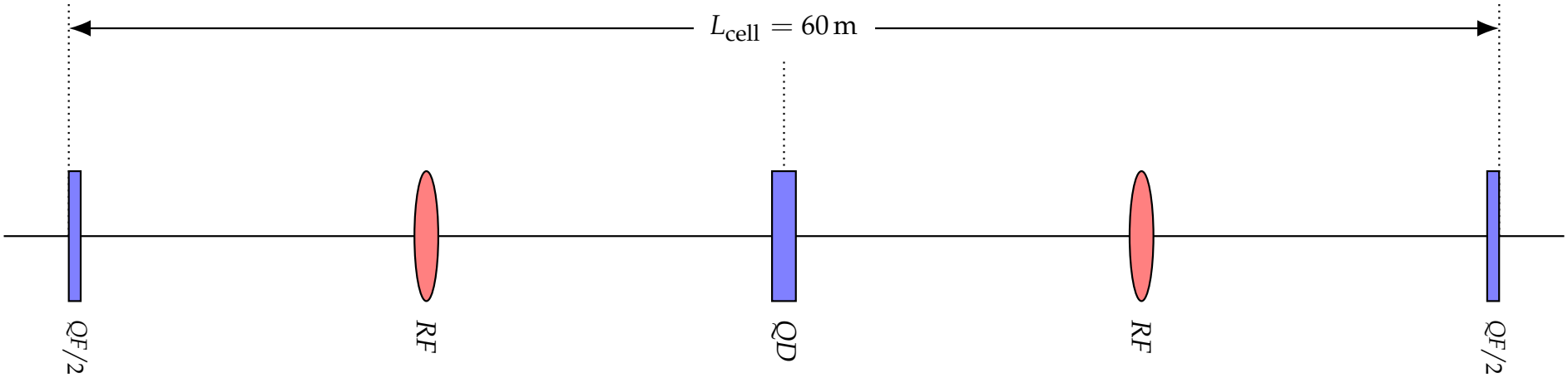
Straight Sections: β-Functions and Dispersion



Matching Sections



RF Sections (1): Layout

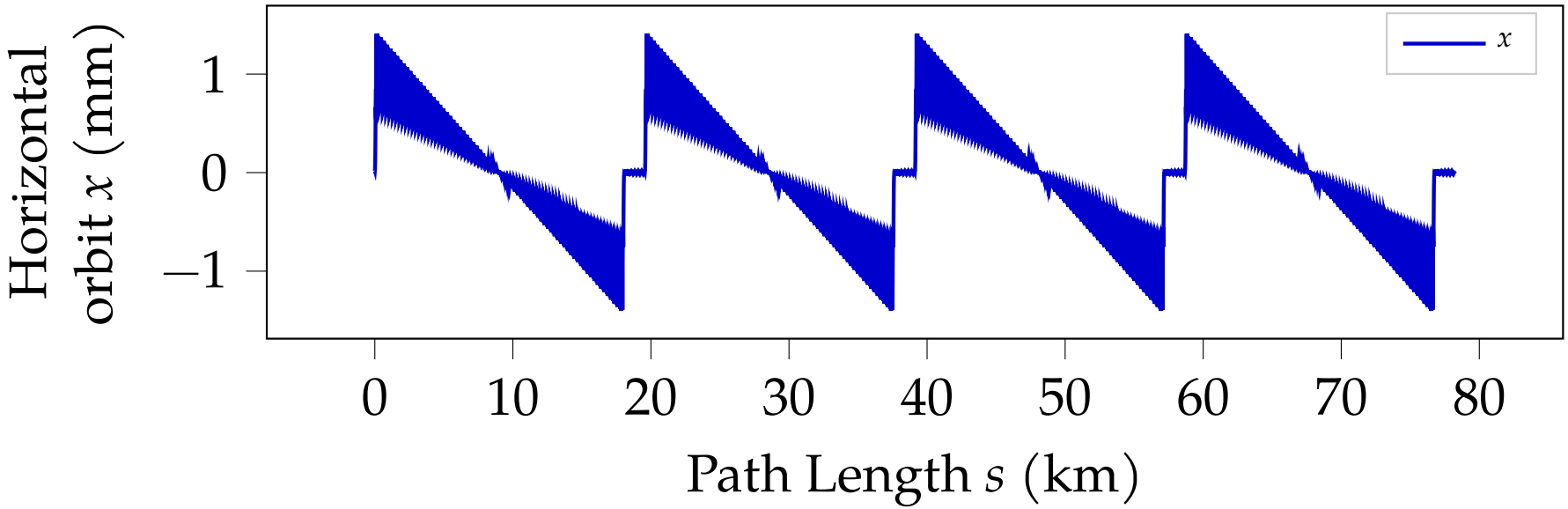


- From topic II groups: $V_{\text{RF}} = 10.64\,\text{GV}$
- Synchronous phase:

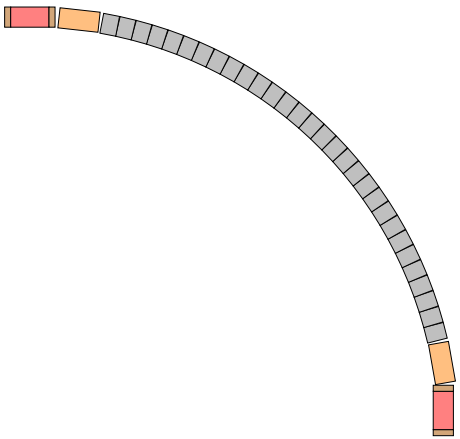
$$U_{\text{turn}} = U(t = t_0) = e\,V_{\text{RF}}\,\sin\left(2\pi(\phi - h)\right)$$

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

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:

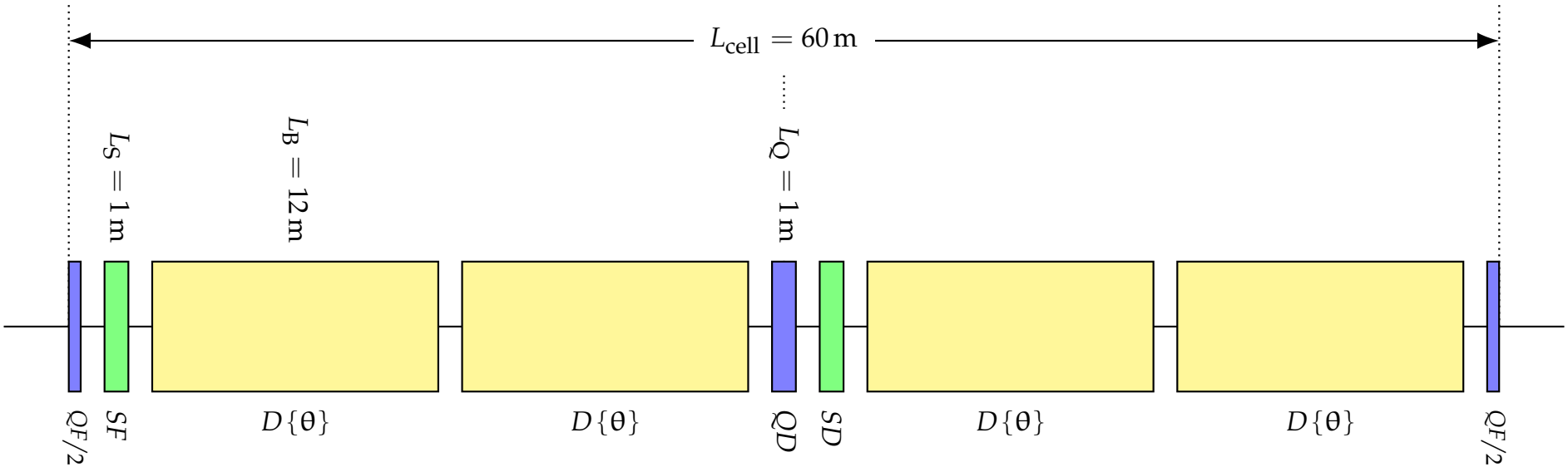
$$U_{\text{turn}} = 4.62\,\text{GeV}$$

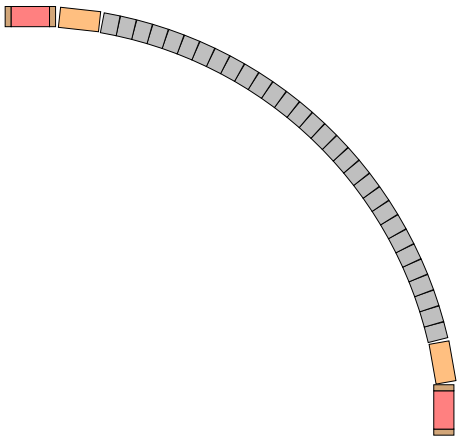
$$P = \frac{\beta c}{L_{\text{ring}}} U_{\text{turn}}$$

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