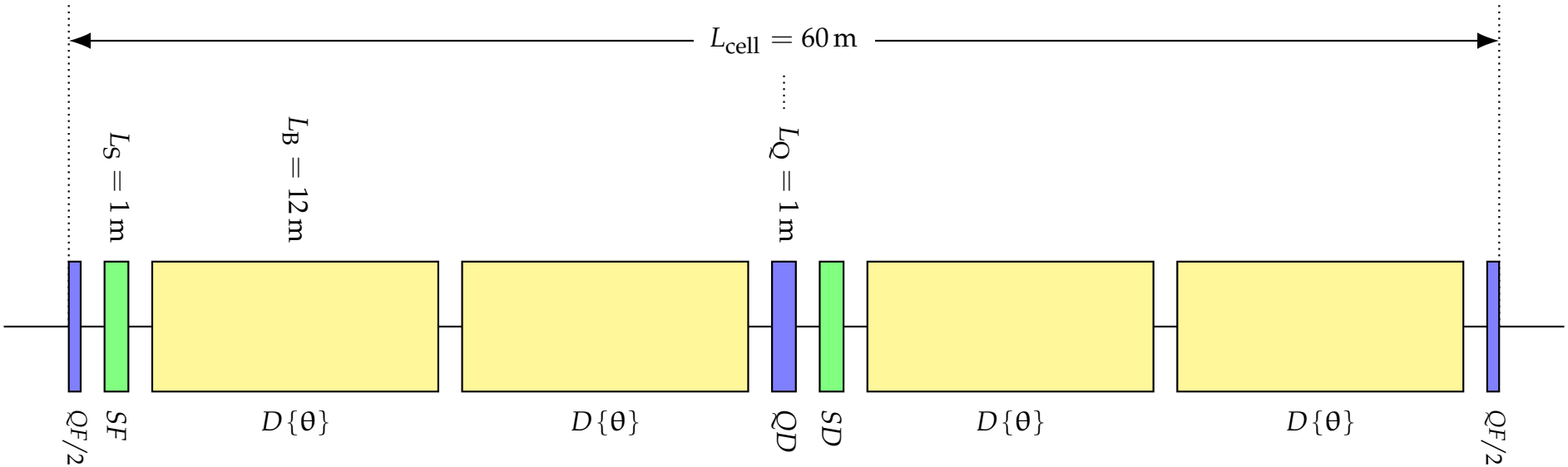
JUAS22: Accelerator Design Workshop - Lattice Design

Group 10

Marvin Noll Javier Olivares Adrien Plaçais

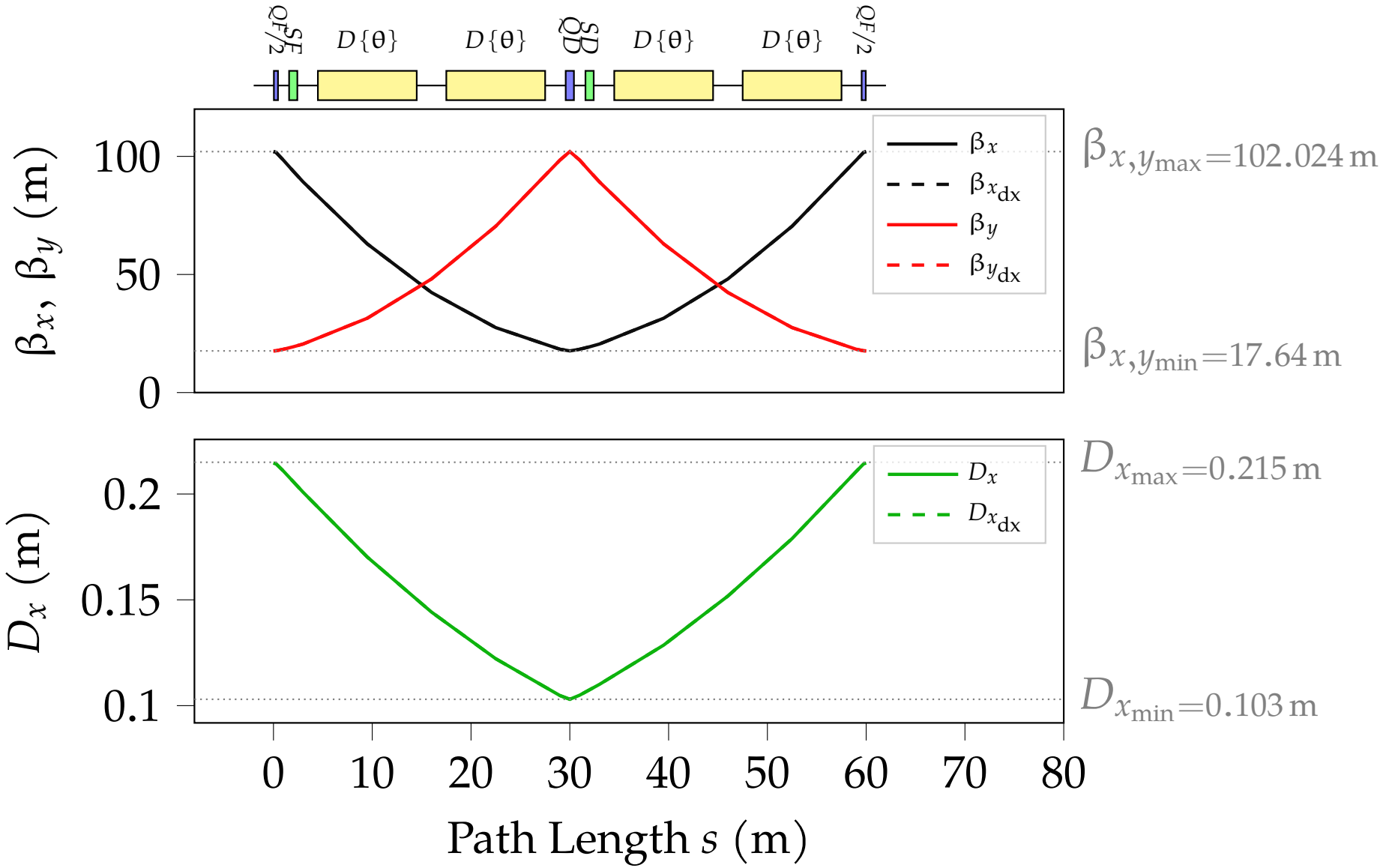
February 6, 2022

Design of Arc Cell (1): Cell layout



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

Design of Arc Cell (2): β-Functions and Dispersion



Closing the Ring

- Close 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`:

$$\frac{\int \rho \, d\theta - 2\pi}{2\pi} = \frac{6.2854196 - 2\pi}{2\pi} = 0.035\,\%$$

Synchrotron Radiation and Emittance

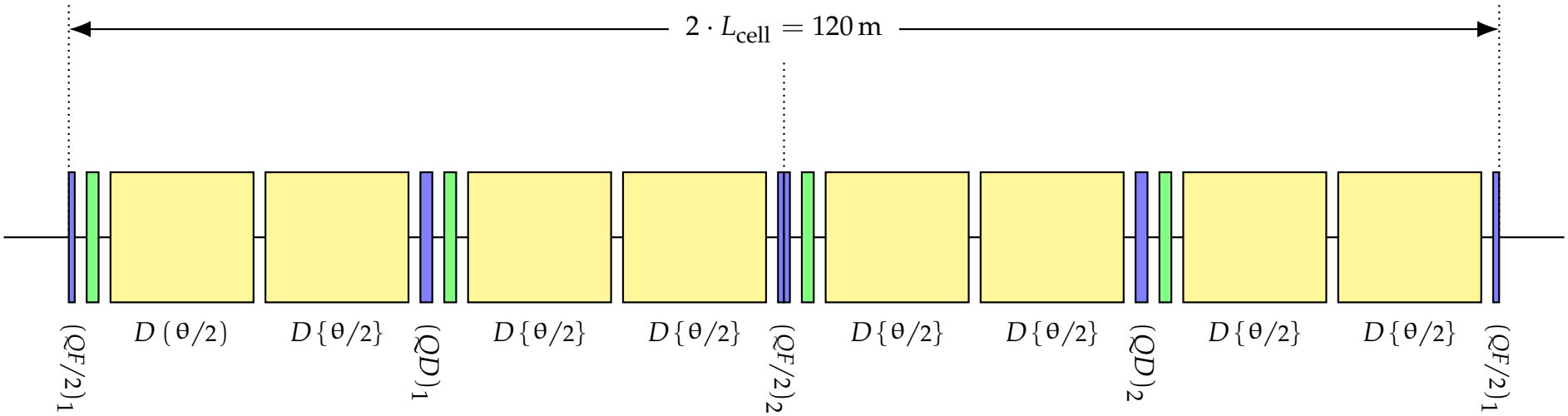
- Energy loss:

$$U_0 = \frac{C_q \, E^4 \, I_2}{2\,\pi} = 3.96 \times 10^{-8}\,\mathrm{J}$$

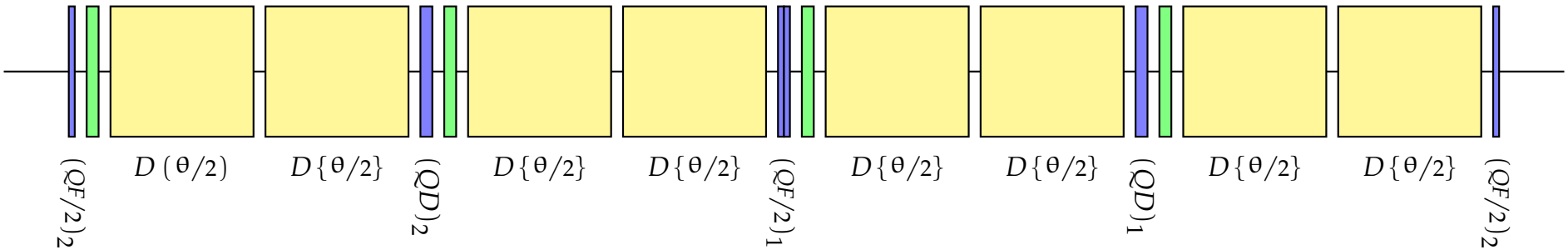
- Emittance:

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

Dispersion Suppressor (1): Layout

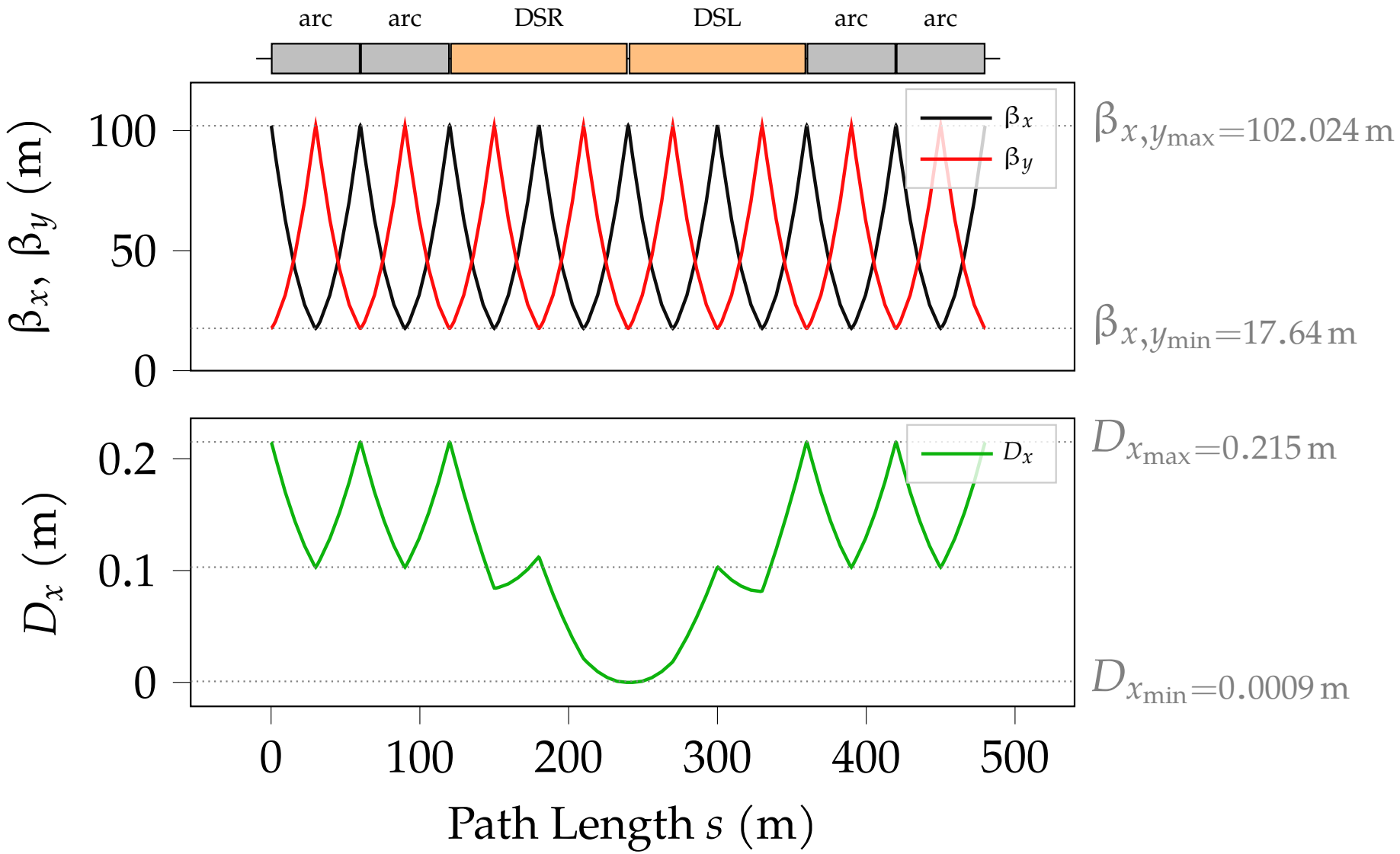


(a) DSL (Dispersion Suppressor Left)

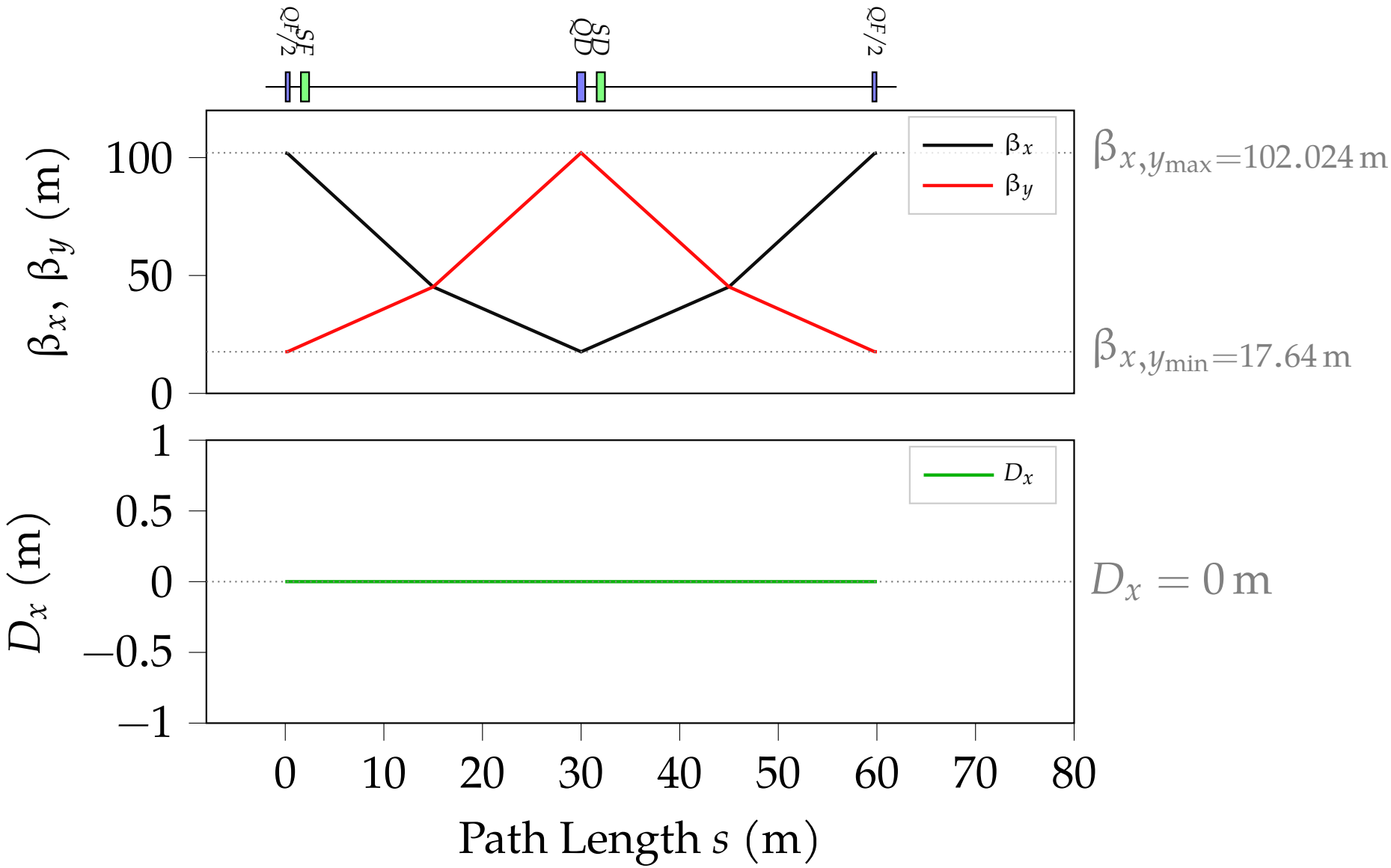


(b) DSR (Dispersion Suppressor Right)

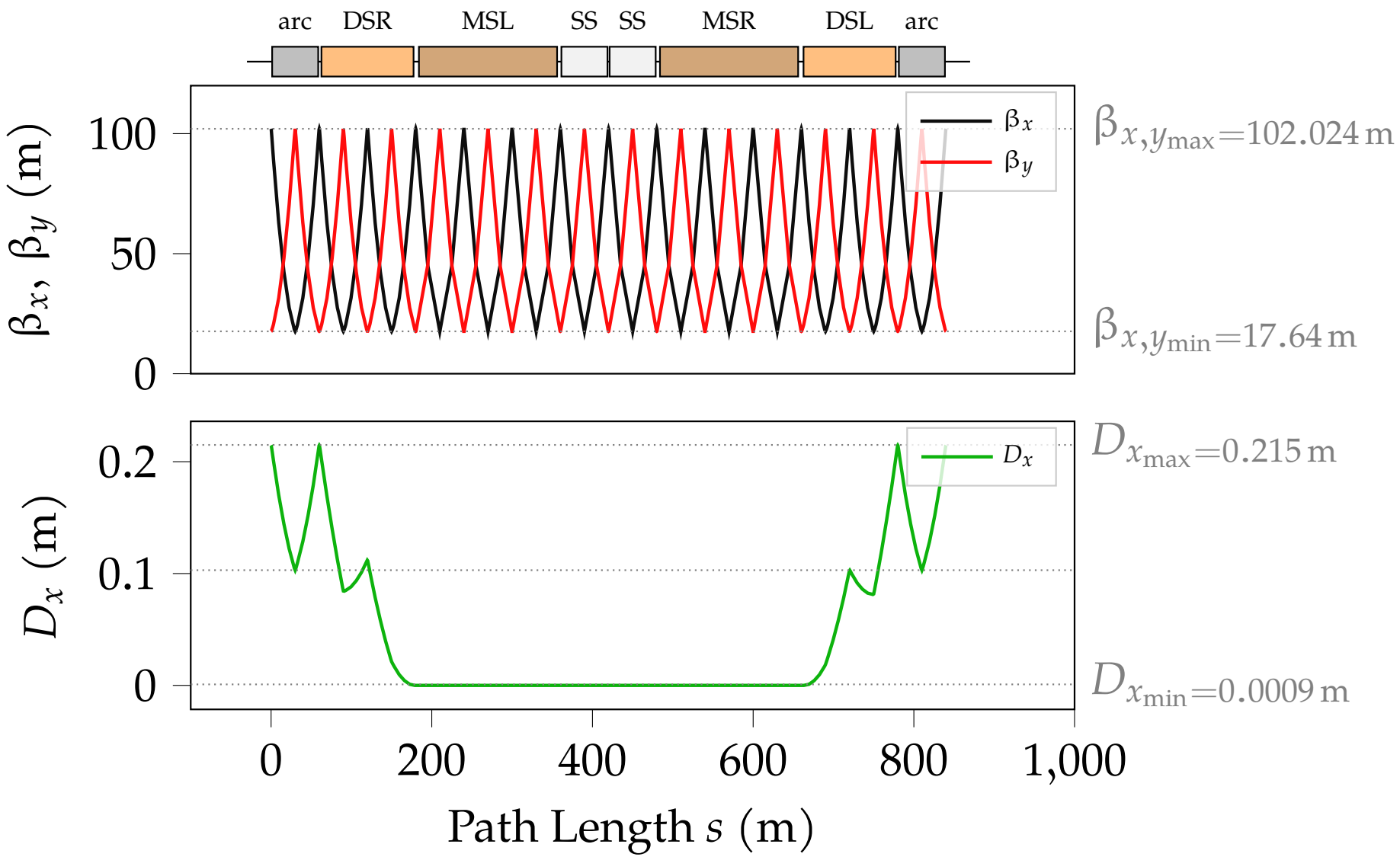
Dispersion Suppressor (2): β-Functions, Dispersion



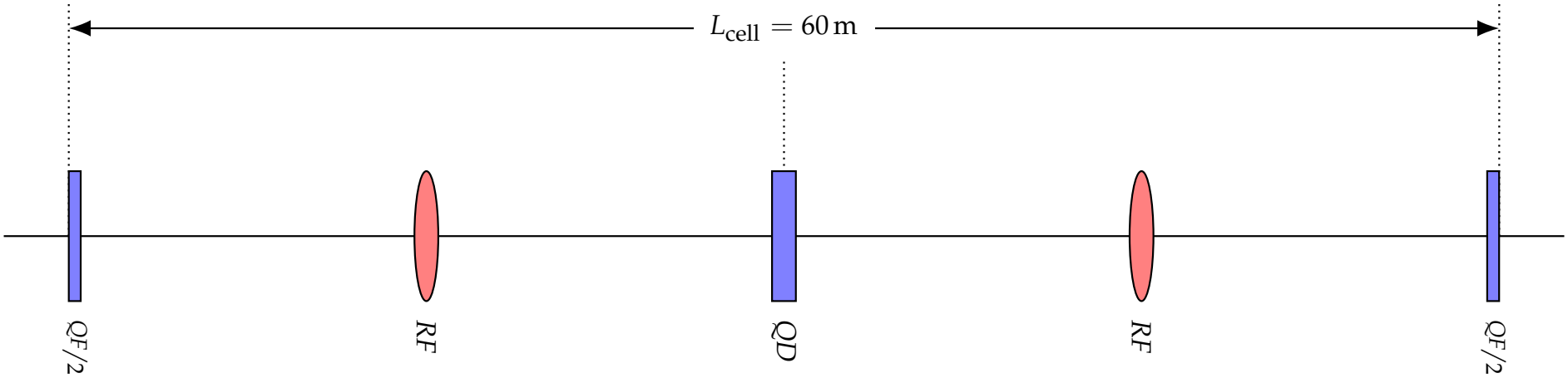
Straight Sections: β-Functions and Dispersion



Matching Sections



RF Sections (1): Layout

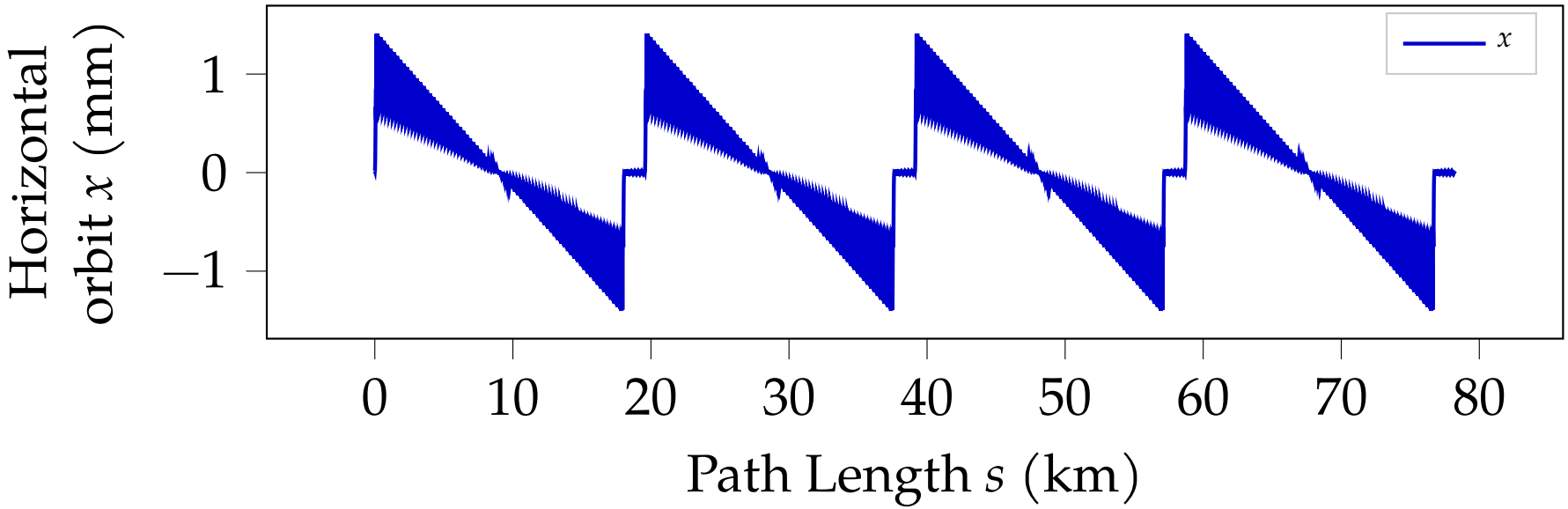


- From topic II groups: $V_{\text{RF}} = 10.64\,\text{GV}$
- Synchronous phase:

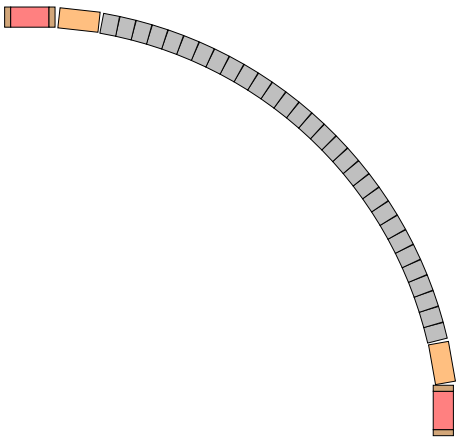
$$U_{\text{turn}} = U(t = t_0) = e\,V_{\text{RF}}\,\sin\left(2\pi(\phi - h)\right)$$

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

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:

$$U_0 = 4.62\,\mathrm{GeV}$$

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

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

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