JUAS22: Accelerator Design Workshop - Lattice Design

Group 10

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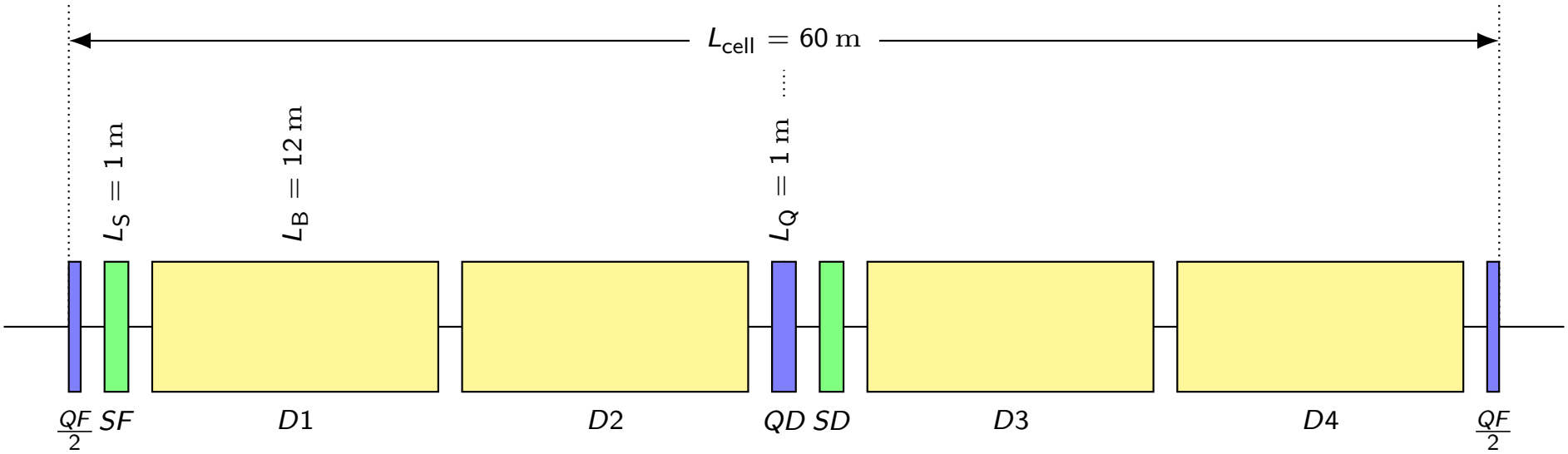
Design of Arc Cell (1): Cell type and phase advance

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

Design of Arc Cell (1): Cell layout



Design of Arc Cell (1): θ and k_1

- 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:

$$\sin\frac{\mu}{2} = \frac{L_Q}{4\,f}, \quad \text{and } \frac{1}{f} = k_1\,L_Q$$

$$\Leftrightarrow k_1 = 0.057\,14\,\text{m}^{-2}$$

Design of Arc Cell (1): Tune Matching

```
match, sequence = JC_fodo_arc;
     GLOBAL, Q1=0.25+0.00001;
     GLOBAL, Q2=0.25+0.00001;
     VARY, NAME= K1QF, STEP=0.000001;
     VARY, NAME= K1QD, STEP=0.000001;
     LMDIF, CALLS=50, TOLERANCE=1e-8;//method adopted
endmatch;
```

	Target Value	Final Value
q1	2.5001×10^{-1}	$2.500\,100\,3 \times 10^{-1}$
q2	2.5001×10^{-1}	$2.500\,100\,3 \times 10^{-1}$

	Before matching	After matching
k1qf	5.714×10^{-2}	4.767×10^{-2}
k1qd	-5.714×10^{-2}	-4.767×10^{-2}

Design of Arc Cell (1): Chromaticity Matching

```
match, sequence = JC_fodo_arc;
      GLOBAL, dq1=0;
      GLOBAL, dq2=0;
      VARY, NAME= K2SF, STEP=0.0000001;
      VARY, NAME= K2SD, STEP=0.0000001;
      LMDIF, CALLS=200, TOLERANCE=1e-6;
endmatch;
```

	Target Value	Final Value
dq1	0	7.035×10^{-14}
dq2	0	2.599×10^{-13}

	Before matching	After matching
k2sf	0	2.61×10^{-1}
k2sd	0	-5.003×10^{-1}

Design of Arc Cell (1): 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`:

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

Design of Arc Cell (1): Synchrotron Radiation and Emittance

- Energy loss:

$$U_0 = \frac{C_q \, E^4 \, I_2}{2 \, \pi} = 3.96 \times 10^{-8} \, \mathrm{J} \tag{1}$$

- Emittance:

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