Extra assignments

1. Quadrupole scan

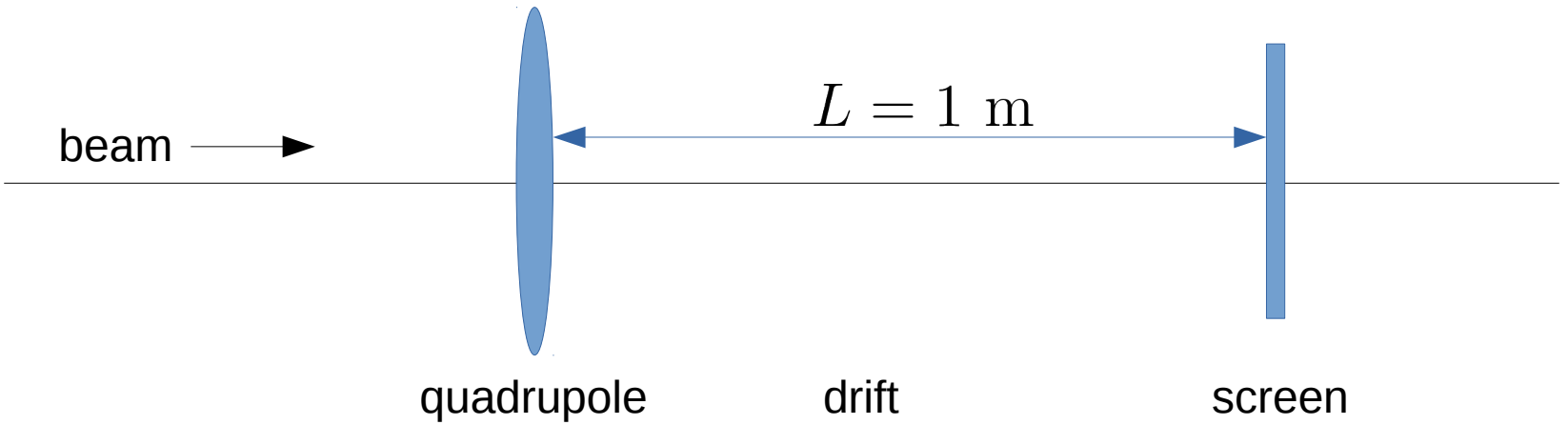
2. A spectrometer

1. Quadrupole scan

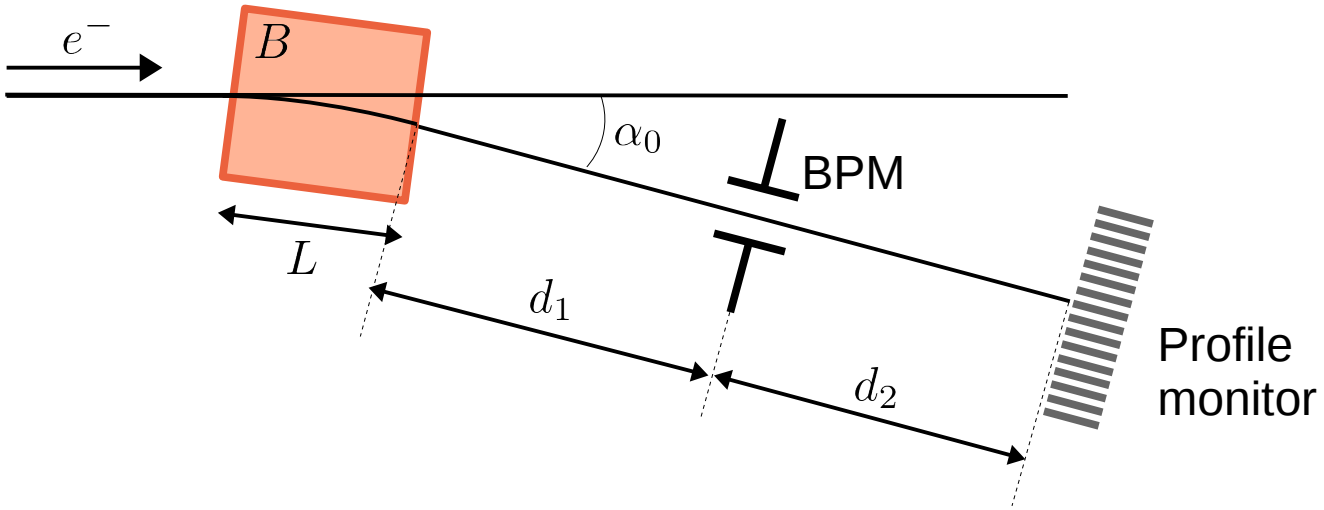
- You are commissioning a beam line and must measure the emittance and Twiss parameters through a quadrupole scan.
- You change the current setting I of one focusing quadrupole and measure the beam size w on a screen downstream from the quadrupole. The quadrupole current and the measured beam size for eight settings are given in the table to the right.
- Compute the Twiss parameters at the entrance of the quadrupole using the data in the table and the numbers in the figure below.

I (A)	w (mm)
0.7	10.6
0.8	7.2
0.9	4.6
1.0	3.0
1.1	2.5
1.2	3.0
1.3	3.9
1.4	4.8

Quadruple focal length $f = \kappa I$, with $\kappa = 1\ m/A$



2. Spectrometer



$$L = 0.5 \text{ m}$$
$$B = 0.2 \text{ T}$$
$$\alpha_0 = 10^\circ$$
$$d_1 = 1.0 \text{ m}$$
$$d_2 = 0.8 \text{ m}$$

- A new spectrometer has been installed in your electron beamline and you want to figure out how well it will performs in terms of momentum resolution and acceptance.
- The spectrometer, shown in the sketch to the right, has two instruments: a beam position monitor (BPM) and a profile monitor.
- The BPM has a position resolution of 0.2 mm. The profile monitor is a segmented Faraday cup, consisting of 21 segments. Each segment is 2 mm thick and there is a 1 mm gap between each segment.
- Calculate the relative momentum resolution of the BPM and the segmented Faraday cup. Which is more precise?
- Calculate the largest energy spread that you can measure with the spectrometer.
- Assume that the beam is centered in the spectrometer for a magnetic field of 0.2 T. What is the beam energy?

Extra assignments

1. Quadrupole scan:

$$\varepsilon = 50 \text{ mm mrad}$$
$$\alpha = 0.7$$
$$\beta = 8 \text{ m}$$

2. Spectrometer:

$$\frac{\Delta p}{p_0} = 1\,\%$$ (BPM: 1.1 %, FC: 0.96%)

$$\Delta p_{max} = \pm 10\,\%$$

$$p_0 = 172 \text{ MeV/c} \qquad E_0 = 172 \text{ MeV}$$