

Initialization:

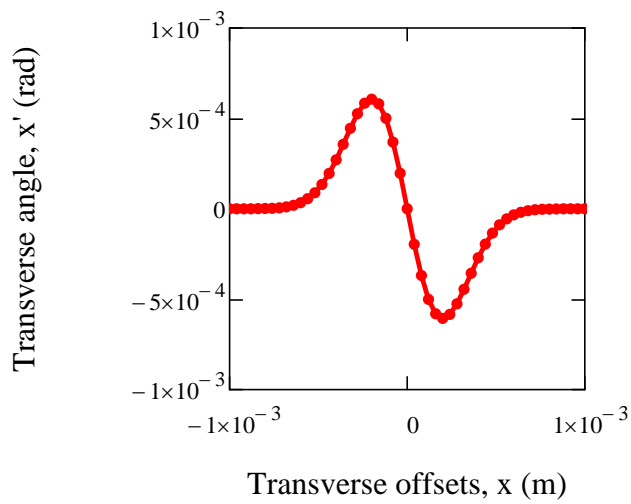
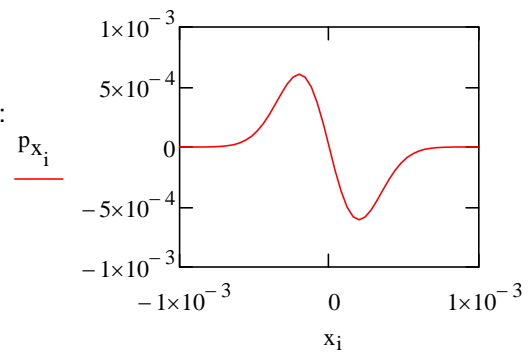
$$N_{\text{part}} := 50 \quad x_{\text{max}} := 10^{-3} \quad x_{\text{min}} := -10^{-3} \quad p_{\text{max}} := 10^{-3} \quad p_{\text{min}} := -1$$

$$i := 0..N_{\text{part}}$$

$$x_i := x_{\text{min}} + \frac{x_{\text{max}} - x_{\text{min}}}{N_{\text{part}}} \cdot i \quad \sigma_x := 0.2 \cdot 10^{-3} \quad x_{\text{sh}} := 0 \cdot \sigma_x$$

$$p_{x_i} := -p_{\text{max}} \cdot \frac{x_i - x_{\text{sh}}}{\sigma_x} \cdot \exp\left[\frac{-(x_i - x_{\text{sh}})^2}{2 \cdot \sigma_x^2}\right]$$

Initial horizontal phase space distribution:



Settings of quads:

$$k_{q1} := -2.102 \cdot \frac{1}{m^2} \quad l_{q1} := 0.157m$$

$$k_{q2} := 6.713 \cdot \frac{1}{m^2} \quad l_{q2} := 0.157m$$

$$k_{q3} := -7.661 \cdot \frac{1}{m^2} \quad l_{q3} := 0.157m$$

$$k_{q4} := 3.383 \cdot \frac{1}{m^2} \quad l_{q4} := 0.157m$$

Settings of drift sections between any two quads

$$l_{d1} := 5.4785m - 5.3215m \quad l_{d3} := 6.5785m - 6.0285m$$

$$l_{d2} := 6.0285m - 5.4785m \quad l_{d4} := 7.1285m - 6.5785m$$

$$l_{d5} := 8.55m - 7.1285m$$

Transfer matrices of thin quads:

In mad-x positive k1 means focusing and hence the minus sign in the m21 element of the quad matrices.

$$q1 := \begin{pmatrix} 1 & 0 \\ -k_{q1} \cdot l_{q1} \cdot m & 1 \end{pmatrix} \quad q3 := \begin{pmatrix} 1 & 0 \\ -k_{q3} \cdot l_{q3} \cdot m & 1 \end{pmatrix}$$

$$q2 := \begin{pmatrix} 1 & 0 \\ -k_{q2} \cdot l_{q2} \cdot m & 1 \end{pmatrix} \quad q4 := \begin{pmatrix} 1 & 0 \\ -k_{q4} \cdot l_{q4} \cdot m & 1 \end{pmatrix}$$

Transfer matrices of drift space among quads:

$$d1 := \begin{pmatrix} 1 & \frac{l_{d1}}{m} \\ 0 & 1 \end{pmatrix}$$

$$d3 := \begin{pmatrix} 1 & \frac{l_{d3}}{m} \\ 0 & 1 \end{pmatrix}$$

$$d2 := \begin{pmatrix} 1 & \frac{l_{d2}}{m} \\ 0 & 1 \end{pmatrix}$$

$$d4 := \begin{pmatrix} 1 & \frac{l_{d4}}{m} \\ 0 & 1 \end{pmatrix}$$

$$d5 := \begin{pmatrix} 1 & \frac{l_{d5}}{m} \\ 0 & 1 \end{pmatrix}$$

Initial phase space coordinates  $(x, x')$  of all particles

$$x_{2d_i} := \begin{pmatrix} x_i \\ p_{x_i} \end{pmatrix}$$

Phase space coordinates of all particles at the end of the modulator

$$x_{2df_i} := d5 \cdot q4 \cdot d4 \cdot q3 \cdot d3 \cdot q2 \cdot d2 \cdot q1 \cdot d1 \cdot x_{2d_i}$$

phase space distribution at the end of the modulator

