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Append. A: MathCad program for preparing e-beam parameters (waist sizes and positions) needed to run QuadOpt

Description:

This program calculates, using analytical expressions, the beam parameters X_w, X_b, Y_b that assure optimal beam propagation through the wiggler (no betatron and no scalloping). These values can be used as a starting point for fine determination of the parameters by trial and error using ELOP.

Fixed Input Parameters

The parameters that are not changed often are:

General Data:

$c := 2.9979 \cdot 10^{8}$	[m/s]	- velocity of light
$qe := 1.6022 \cdot 10^{-19}$	[coul]	- electron charge
$me := 9.1095 \cdot 10^{-31}$	[Kg]	- electron mass

$i := \sqrt{-1}$

Electron Beam Parameters:

$V := 1.4 \cdot 10^{6}$	[V]	- beam energy
$\gamma := \frac{qe \cdot V}{me \cdot c^{2}} + 1 \qquad \gamma = 3.73978156187106$		- relativistic γ
$\beta := \sqrt{1 - \frac{1}{\gamma^{2}}} \qquad \beta = 0.964$		- relativistic b
$\varepsilon n := 80 \cdot \pi \cdot 10^{-6}$	[m*rad]	- normalized emittance
$\varepsilon := \frac{\varepsilon n}{\gamma \cdot \beta} \qquad \frac{\varepsilon}{\pi} = 2.22 \times 10^{-5}$	[π*m*rad]	- emittance

Wiggler Parameters:

$Bw := 1935 \cdot 10^{-4}$ [Tesla] - wiggler field

$\lambda w := 4.444 \cdot 10^{-2}$ [m] - wiggler period

$kw := \frac{2 \cdot \pi}{\lambda w}$ $kw = 141.386$ [m-1] -electron wiggler wavenumber

$aw := \frac{qe \cdot Bw}{kw \cdot me \cdot c}$ $aw = 0.803$

$$\gamma z := \frac{\gamma}{\sqrt{1 + \frac{aw^2}{2}}}$$

$$\beta z := \sqrt{1 - \frac{1}{\gamma z^2}}$$

$k\beta := aw \cdot \frac{kw}{\sqrt{2} \cdot \gamma \cdot \beta z}$ $k\beta = 22.558$ - betatron wavenumber

$\alpha rx := 2.93$ [Ts/m] - long magnets field x-gradient

$k\beta x := \sqrt{qe \cdot \frac{\alpha rx}{\gamma \cdot \beta z \cdot c \cdot me}}$ $\lambda\beta x := 2 \cdot \frac{\pi}{k\beta x}$ $\lambda\beta x = 0.286$ [m] -x-betatron wavelength (numbe

$k\beta x = 21.978$

$k\beta y := \sqrt{\frac{k\beta^2}{1 - \left(\frac{k\beta x}{kw}\right)^2} - k\beta x^2}$ $\lambda\beta y := 2 \cdot \frac{\pi}{k\beta y}$ $\lambda\beta y = 1.014$ [m] -y-betatron wavelength (numbe

$k\beta y = 6.196$

Output

$$Xw := \frac{\left(\frac{aw}{\beta z \cdot \gamma \cdot kw}\right)}{1 - \frac{k\beta x^2}{kw^2}}$$ $Xw = 1.635 \times 10^{-3}$ [m] -wiggling amplitude

$$Xb := \sqrt{\frac{\varepsilon}{\pi \cdot k\beta x}}$$ $Xb = 1.005 \times 10^{-3}$ [m] -optimal beam radius (x

$$Yb := \sqrt{\frac{\varepsilon}{\pi \cdot k\beta y}}$$ Yb = ~~1.005×10^{-3}~~ [m] -optimal beam radius (y