

## **Worksheet 10.1    Collector design**

© 2018 Richard G Carter

This Mathcad 14 worksheet is designed to accompany the author's book "Microwave and RF Vacuum Electronic Power Sources", Cambridge University Press (2018). The section, equation, and figure numbers refer to the corresponding sections, equations, and figures in the book. Data input fields are highlighted in yellow and output fields are highlighted in green.

This resource is provided free of charge by Cambridge University Press with permission of the author, but is subject to copyright. You are permitted to view, print and download this resource for your own personal use only, provided any copyright lines are not removed or altered in any way. Any other use, including but not limited to, distribution of the resource in modified form, or via electronic or other media, is strictly prohibited unless you have permission from the author and provided you give appropriate acknowledgement of the source.

The contents of this sheet are provided for educational purposes only and no warranty is expressed or implied that they are suitable for use as professional design tools.

This sheet includes the basic equations that are needed for collector design.

The beam spreading curve for a rotating beam is obtained from

$$\beta_{pz}(R, m) := \int_0^{\sqrt{\ln(R)}} \frac{2 \cdot x \cdot \exp(x^2)}{\sqrt{x^2 + 0.25 \cdot (m^2 - 1) \cdot (1 - \exp(-2 \cdot x^2))}} dx$$

Equation 7.82

$$R := 1, 1.01 \dots 4$$

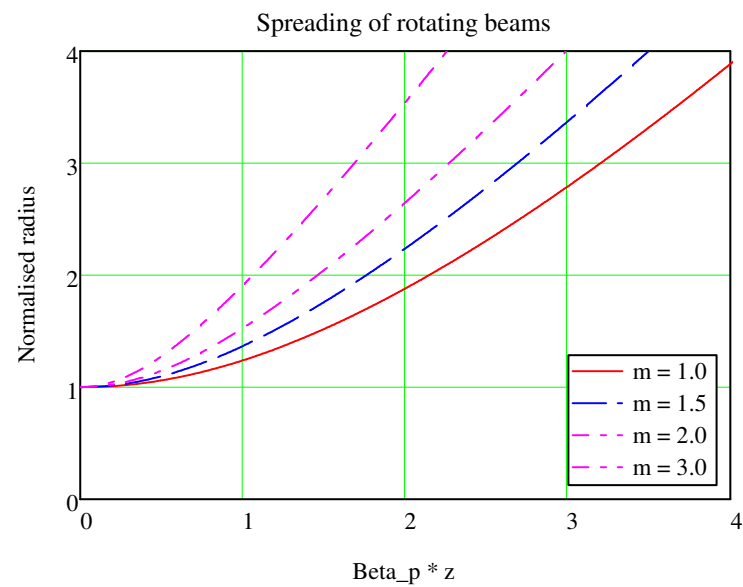
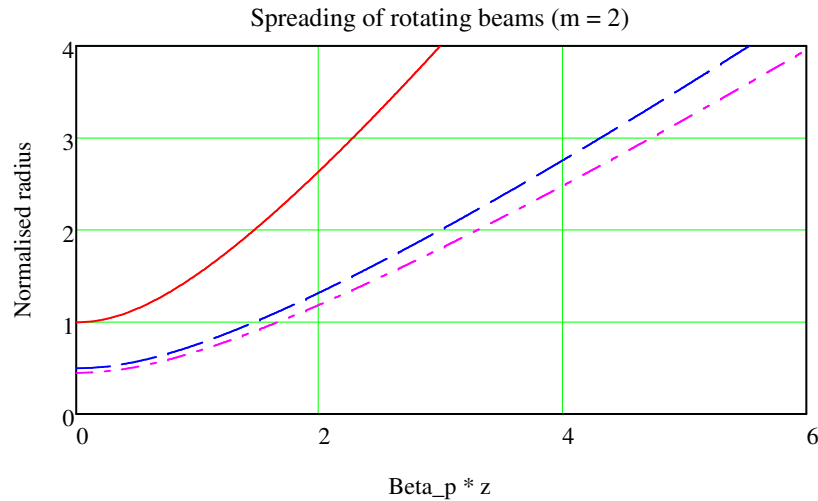


Figure 7.8

**Plot the spreading curves for electrons within the beam**

R := 1, 1.01.. 12



Compare Figure 10.3

Calculate the normalised axial distance at which a trajectory whose initial radius is  $r_0$  strikes the wall of a collector of radius  $c$  as a function of the magnetic field parameter  $m$

$$S_z(c, r_0, m) := \int_0^{\sqrt{\ln\left(\frac{c}{r_0}\right)}} \frac{2 \cdot x \cdot \exp(x^2)}{\sqrt{x^2 + 0.25 \cdot (m^2 - 1) \cdot (1 - \exp(-2 \cdot x^2))}} dx$$

**Calculate the power density at the wall of a collector** of radius  $c$ , normalised to the power density in the initial beam, as a function of normalised axial position and magnetic field parameter  $m$

$$P(c, r_0, m) := \begin{cases} -\left(\frac{r_0}{c}\right) \cdot \frac{1}{\left(\frac{d}{dr_0} Sz(c, r_0, m)\right)} & \text{if } r_0 \leq 1 \\ 0 & \text{otherwise} \end{cases}$$

Plot the normalised power density on the wall of a collector of radius  $c$  for a beam whose initial radius is 1 and magnetic field parameter is 2

$$r_0 := 0, 0.001..1.01$$

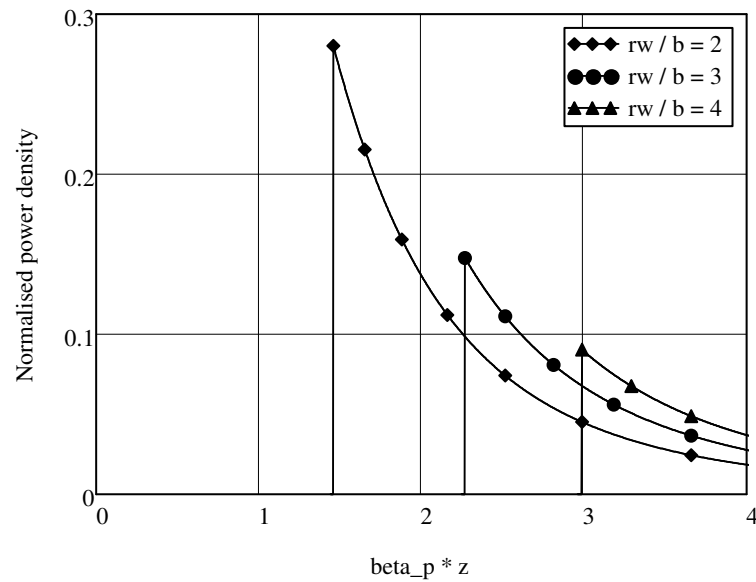


Figure 10.4

**Efficiency of a tube with a depressed collector** expressed in terms of the electronic efficiency  $\eta_e$  and the collector efficiency  $\eta_c$

$$\eta_{rf}(\eta_e, \eta_c) := \frac{\eta_e}{1 - \eta_c \cdot (1 - \eta_e)}$$

Equation 10.13

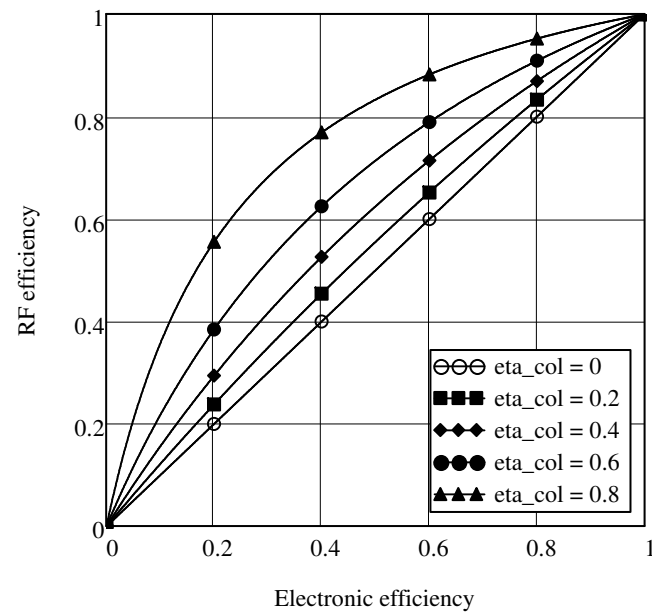


Figure 10.7

**Effect of number of stages on the collector efficiency**

$$\eta_c(\eta_e, n) := 1 - \frac{\eta_e}{n \cdot (1 - \eta_e)}$$

Equation 10.22

n := 1, 2.. 10

