solensim project documentation

Anton Douginets (anton.douginets@physik.hu-berlin.de)
Andrii Yanovets (yanoveta@hu-berlin.de)

June 29, 2020

Summary

TODO

Contents

1 Introduction **2**

2 Physical model **3**
2.1 Beam parameters 3
2.2 Field calculation 3
2.3 Deriving characteristic values 3
2.4 Aberrations 3
2.4.1 Chromatic aberrations 4

3 Project concept and implementation **5**

4 Software manual **6**

References **7**

1 Introduction

TODO

2 Physical model

TODO Few general words

Solenoid geometry ***TODO***

2.1 Beam parameters

A symmetrical, axial beam of known radius and energy distribution is assumed; the interactions of electrons within the beam are neglected.

Electron energy distribution ***TODO*** [2]

Beam radius ***TODO*** [1]

Electron momentum The formulas involving $p_{z,0}$ call for relativistic momentum [1, p. 27]. The energy-momentum relation is:

$$E^2 = p^2 + m_0^2;$$

With SI factors, this yields

$$p = \frac{1}{c}\sqrt{E^2 - m_0^2 c^4}. \tag{1}$$

2.2 Field calculation

For on-axis electrons, only the on-axis $B_z(x)$ field component is relevant [1]. The models used to describe this field are listed below.

Two-loop approximation ***TODO***

2.3 Deriving characteristic values

TODO

2.4 Aberrations

TODO

Spherical aberrations ***TODO***

$$1/f = const. \cdot F2$$

$$\triangle f \simeq c \cdot x^2$$

$$x = f_1 tan\left(\alpha\right) \simeq f \cdot tan\left(\alpha\right)$$

$$r_s = \triangle f \cdot tan\left(\alpha\right) \simeq \triangle f \cdot \alpha \approx \left(c\left(f \cdot tan\left(\alpha\right)\right)^2\right) \cdot tan\left(\alpha\right) = C_s tan\left(\alpha\right)^3 = C_s \cdot \left(\frac{max\left\{x\right\}}{f - \triangle f}\right)^3$$

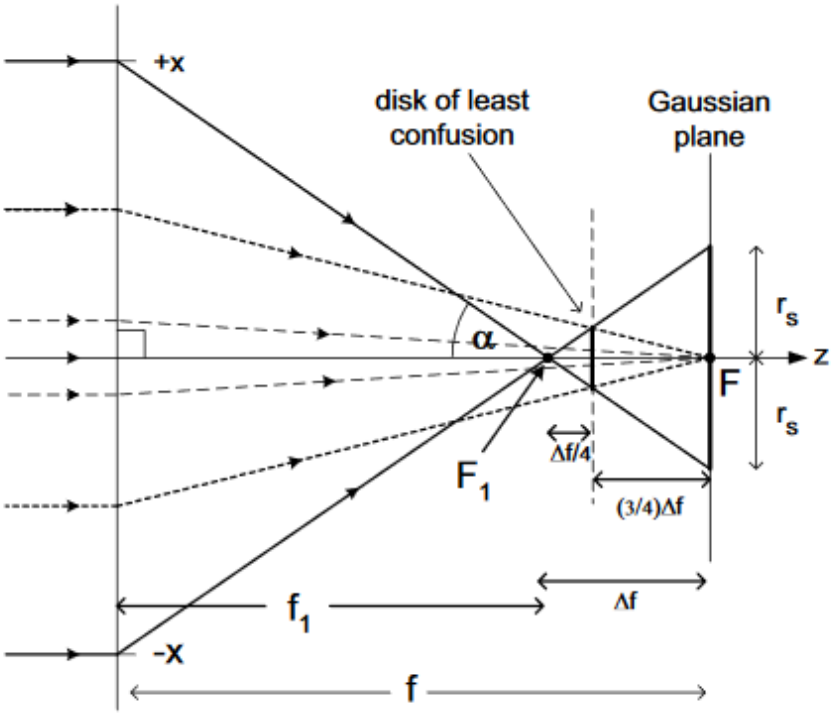

Figure 1: Focus shift due to spherical aberrations

$$\underset{f \approx f_1}{=} C_s \cdot \left(\frac{max\left\{x\right\}}{f} \right)^3 \quad (1)$$

If $f \not\approx f_1$ then replace f in (1) with $f - max\left\{x\right\}^2 \cdot \frac{C_s}{f^2}$

2.4.1 Chromatic aberrations

TODO

3 Project concept and implementation

TODO

4 Software manual

TODO

References

[1] T. Gehrke. "Design of Permanent Magnetic Solenoids for REGAE". MA thesis. Hamburg: Universität Hamburg, 2013.

[2] B. Grigoryan et al. "Status of AREAL RF Photogun Test Facility". In: *Proceedings of IPAC2014, Dresden, Germany* (Dresden, Germany). International Particle Accelerator Conference 5. https://doi.org/10.18429/JACoW-IPAC2014-MOPRI017. Geneva, Switzerland: JACoW, July 2014, pp. 620–623. ISBN: 978-3-95450-132-8. DOI: https://doi.org/10.18429/JACoW-IPAC2014-MOPRI017. URL: http://jacow.org/ipac2014/papers/mopri017.pdf.