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 2.1 Beam parameters	3 3 3
3	Project concept and implementation	5
4	Software manual	6
R	eferences	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

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

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

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

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

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

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

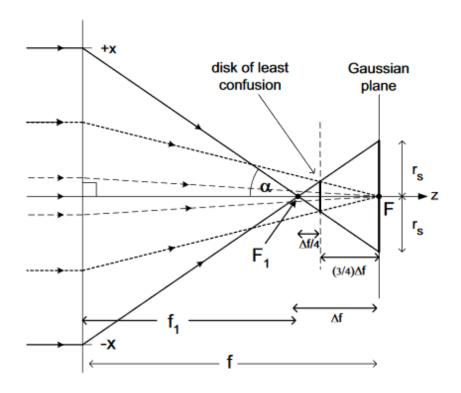


Figure 1: Focus shift due to spherical aberrations

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

If $f \approx f_1$ then replace f in (1) with $f - \max\{x\}^2 \cdot \frac{C_s}{f^2}$

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.