Eigenmode computation for the GSI SIS 18 ferrite cavity*

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Introduction

In the heavy-ion synchrotron SIS 18 two identical cavities are operated, which are loaded with the Ferroxcube 8C12m ferrite material. The permeability of the ferrites exhibits a characteristic dependence both on frequency and bias magnetic field strength. The latter is of particular importance for the tuning of the resonance frequency of the resonator system. Due to the extension of the existing facility to the FAIR, new interest in a better understanding of ferrite cavities of the SIS 18 type has aroused. As the aim of the presented study, a tool for the numerical simulation of the lowest eigenmodes of such resonators was developed. Clearly, its application to the SIS 18 cavity requires accurate material data. Hence, designated measurements were carried out at GSI.

Permeability measurement

The dependence of the permeability of the Ferroxcube 8C12m material on frequency and bias magnetic was determined using a reflection as well as a transmission measurement approach. The obtained values for low RF levels are fully compatible with each other within their estimated error margins up to moderate frequencies. A detailed discussion of the measurement results can be found in [1].

Computational approach

A dedicated solver was developed, implemented and successfully verified. It is able to efficiently handle nonlinear complex eigenvalue problems even on distributed memory machines, which arise in the context of the tensor material modeling. Furthermore, the distribution of the magnetic field excited by the bias current is precisely taken into account. For more details on the employed numerical methods we refer to [2, 3].

Analysis of the fundamental mode

The computational model used in the numerical simulation of the GSI SIS 18 cavity is depicted in Fig. 1. The simulation results for the resonance frequency of the fundamental mode are shown in Fig. 2. Also, additional results obtained with an alternative equivalent circuit model taking into account the radial dependence of the bias field are included. The simulation results are discussed in more detail in [3].

* Work supported by GSI.

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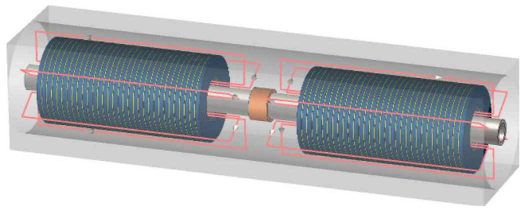

Figure 1: CAD model used for the numerical simulation of the GSI SIS 18 cavity. It consists of ferrite ring cores as well as copper discs. The coupling windings are represented by thin wires.

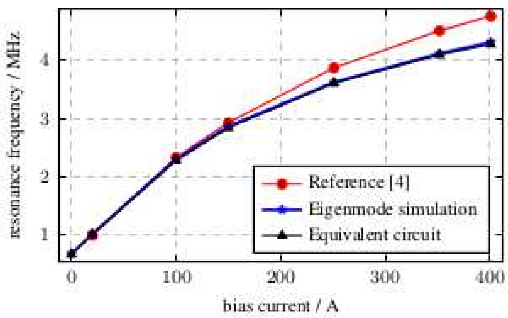

Figure 2: Resonance frequency as a function of the bias current for the prototype cavity with 29 cores on each side of the gap for small RF levels.

Summary

The computation of the fundamental mode of the GSI SIS 18 ferrite cavity has successfully been demonstrated.

References

[1] Klaus Klopfer, Uwe Niedermayer, Harald Klingbeil, Wolfgang Ackermann, Hans Günther König, and Thomas Weiland, "Measurement of the magnetic material properties and simulation and modeling of ferrite-loaded cavities", Phys. Rev. ST Accel. Beams, vol. 18, issue 1, 2015.

[2] Klaus Klopfer, Wolfgang Ackermann, and Thomas Weiland, "Computation of Complex Eigenmodes for Resonators Filled With Gyrotropic Materials", IEEE Trans. Magn., vol. 51, no. 1, 2015.

[3] Klaus Klopfer, "Computation of Complex Eigenmodes for Resonators Filled With Gyrotropic Materials", PhD thesis, TU Darmstadt, tuprints: 4210, 2014.

[4] Uta Hartel, "Modellierung des Regelungs- und Steuerungssystems einer Beschleunigungseinheit für Synchrotrons", Diploma thesis, TU Darmstadt, 2011.

DOI:10.15120/GR-2015-1-FG-SIS18-04