Demonstration of the Sensitive Schottky-System for CR *

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Introduction

This report summarizes the development of a sensitive longitudinal and transversal Schottky-Sensor for the Collector Ring CR at FAIR. Based on the equivalent circuit model, numerical simulations with CST Microwave Studio, controlled by MATLAB were accomplished to optimize the performance of the sensor structure to the needs of the CR. To demonstrate the performance, a scaled non-hermetic demonstrator was optimized, fabricated and characterized.

Schottky-System Design

Resonant cavities exhibit excellent performances with moderate size for schottky measurements at the ESR [1]. The evaluation of the monopole mode TM_{010} and the dipole mode TM_{110} allows longitudinal as well as transversal schottky measurements. Due to the weak excitation of the dipole mode, both modes need to be coupled out independently and, to suppress the monopole mode for the extraction of the transversal signal, rectangular waveguide resonators are foreseen for the CR [2, 3].

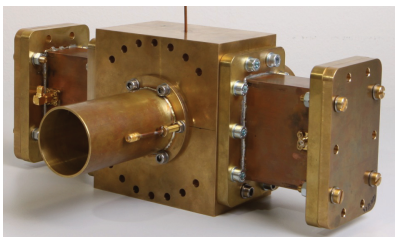

Figure 1: Non-hermetic demonstrator with a beampipe dimension of 46.5 mm.

Structure Optimization

Due to the strong inter-dependence of the relevant parameters and the complex structure, the sensor system cannot be separated into subsystems. To optimize the coupling geometry, the simulations with CST Microwave studio are iteratively controlled by MATLAB. The algorithm optimizes the length of the waveguide for maximum coupling between the pillbox and the waveguide resonators under condition that the monopole mode is kept constant at 200 MHz, which can be adjusted by the radius of the pillbox. The algorithm closes with the adaption of the coupling geometry, until the goal, the maximum gradient of the $\frac{R}{Q}$-value of the dipole mode is achieved.

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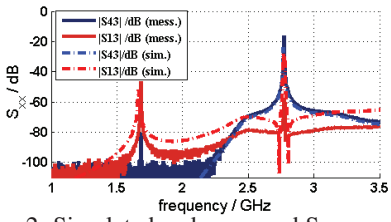

Figure 2: Simulated and measured S-parameters.

Non-hermetic demonstrator

To prove the simulation results, a non hermetic demonstrator scaled down by a factor of 8.6 was realized at TU Darmstadt (see fig.1). S-parameter results exhibit very good agreement between simulation and measurement (fig. 2). Preliminary perturbation measurements of the system exhibits good agreement with the expected behavior for both, the longitudinal and transversal detection (fig. 3).

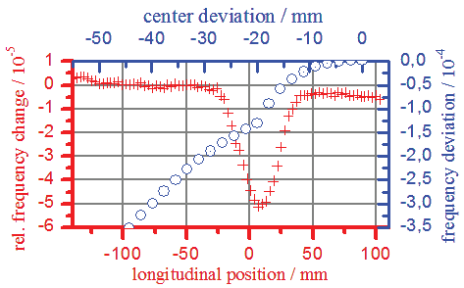

Figure 3: Preliminary results of the perturbation measurements.

Summary and Outlook

An iterative optimization algorithm based on Matlab controlled CST Microwave Studio simulations have been verified by a realized non-hermetic demonstrator. The optimization of the sensor geometry for the CR is ongoing.

References

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