Prototype of a Novel DCCT for FAIR

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Overview

The existing DCCT in the SIS18 is expected to not work correctly with the higher bunch current intensities in the prospective SIS100 [1]. This contribution gives a brief introduction to the prototype of the Novel DCCT for the SIS100, based on a GMR-sensor [2] and a split flux concentrator.

System Design

Figure 1 shows the preliminary system design. The magnetic field of the beam current I_S is concentrated with a slotted toroidal core. A sensor which detects the magnetic field in the air gap is read out by a differential preamplifier and filtered by a low pass. By a secondary winding, an AC transformer path is realized, and filtered by a high pass filter. Due to the concept of a flux compensated measurement system, the corrected and amplified signals compensate the magnetic field inside the toroid at a constant value, over an auxiliary winding. The voltage drop U_{out} across the resistor R_0 is proportional to the beam current I_S and the inverse number of the auxiliary winding.

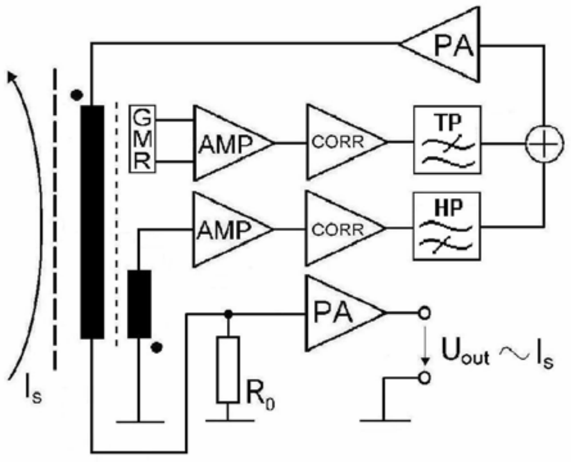

Fig. 1: block diagram of the NDCCT.

Mechanical Construction

The mechanical design of the flux concentrator assembly is described in [3]. The concentrator is split into two parts, so the whole construction can be dismounted from the beam pipe during the bake-out process. The halves are fixed in a Mu-metal mounting frame to reduce external fileds. This frame can be adjusted in 3 dimensions. The sensor is fixated in the air gap of the split toroidal core.

Frequency behaviour of the GMR bridge

A magnetic field from DC to ~1 MHz is measured with a sensor based on the Giant Magnetic Resistance (GMR), type AA-0002 (Nonvolatile Electronics Co.). The sensor's frequency response was investigated up to 5MHz, using an amorphous laminated, and a ferrite material, at different premagnetization values respectively.

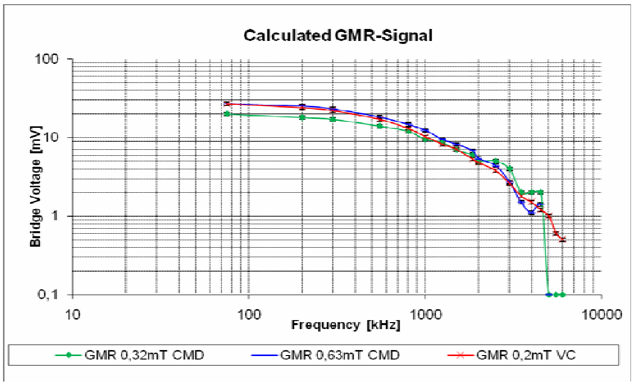

Fig. 2: GMR-Signal vs. frequency

It is evident that an inductive loop is spanned by the sensor IC's internal structures, whereby induced voltages falsify the GMR's frequency response.
Furthermore, the sensor bridge consists of 4 GMR elements, 2 of these buried under magnetic shields. The shielding efficiency decreases with rising frequency due to eddy currents in the NiFe-alloy. This in turn reduces the bridge's sensitivity. Fig. 2 shows the post processed GMR signal, exhibiting a -3 dB cut-off at 1 MHz.

Outlook

In a next step the measurement setup will be improved for operating frequencies above ~1 MHz. Applying a coaxial wave guide structure with a characteristic impedance of 50 Ohm and an outer diameter of 320 mm, a pulse excitation of the core/sensor device with fast rise-times will be possible, thus enabling the determination and optimization of the compensating loop parameters.

References

[1] H. Reeg „Performance Limitations of the DCCTs at GSI“, CARE, Lyon, France 2004

[2] M. Häpe “Magnetische Strahlstrom-Messung hoher Dynamik mittels optimierter magnetoresistiver (MR) Sensortechnik im GSI-FAIR-Projekt”, Final Report, University Kassel, 2007

[3] A. Schlörit „Entwurf, Auslegung und Aufbau von teilbaren, geschlitzten Flusskonzentratoren für Strahlstromsensorik“, Diploma thesis, FH Wiesbaden, 2006