Optimum magnetising apparatus for standardised measurements of rotational power loss

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Several international research laboratories attempted the round robin measurements of rotational power loss P_{rot}, with the aim of possible standardisation of the measurement method [1,2]. Majority of the laboratories employed the fieldmetric method, some used the thermometric technique. The comparison showed discrepancies at the level of tens of percents and thus at the time the results were deemed to be too unreliable for a standardisation procedure.

High levels of magnetisation could not be achieved with the magnetising yokes used for those measurements and the scattering of the measurements was not very well understood at the time.

Over the past two decades the computer technology progressed significantly. The data acquisition devices became less expensive, but also much more sophisticated offering simultaneous sampling, faster sampling rates and higher resolution. Hence, any inaccuracies resulting from the data acquisition (and generation) were appreciably reduced [3].

Digital technology also facilitated improvements in digital feedback algorithms, which can attain better stability and accuracy, as well as speed of control. However, excessive acceleration should be avoided [4]

The clockwise-anticlockwise (CW-ACW) differences in measured Prot are now much better understood. Obviously, the results should be averaged from the two directions of rotations [1, 2]. The large CW-ACW differences at high amplitudes of magnetisation were shown to be attributed to the small angular misalignment between the sensors of flux density B and magnetic field strength H [5].

Recently, also an explanation for the CW-ACW differences persisting at lower excitation was also proposed [6]. Such differences can arise because of the non-ideal immunity of H-coils to the off-axis vector components of H [7]. Some improvements to magnetic shielding offering possibility of more efficient and more uniform magnetisation were proposed as well [8].

Analysis of all these improvements allows performing an analysis of the likely "optimum" design for the rotational magnetisation apparatus [4]. A synthesis of such a hypothetical optimum apparatus is presented in this paper.

It should be noted that most of the concepts referred to in this paper are supported by results already reported in the literature, with larger samples used in some systems, by using two-phase round yokes, larger B-coils and larger H-coils [4]. Just five ideas would require further experimental validation: maximum practical sample size, type of yoke winding (simple or "sinusoidal"), circular sample positioning (notches/edges), vertical shielding and rigorous testing of PCB-based H-coils.

The sample has 20 cm diameter and has trimmed straight edges for precise linear and angular positioning. The yoke is made similar to a stator of an induction rotor, with two-phase windings, with quasi-sinusoidal turn distribution. The B-coils can be as large as 150 mm, and their wires can be accommodated in a groove underneath the PCB-based equally large H-coils. The "vertical" shielding can be added around the sample if it was found to be beneficial through experiments (Fig. 3b).

Hence the hypothetical "optimum" magnetising setup could look as shown in Fig. 1.

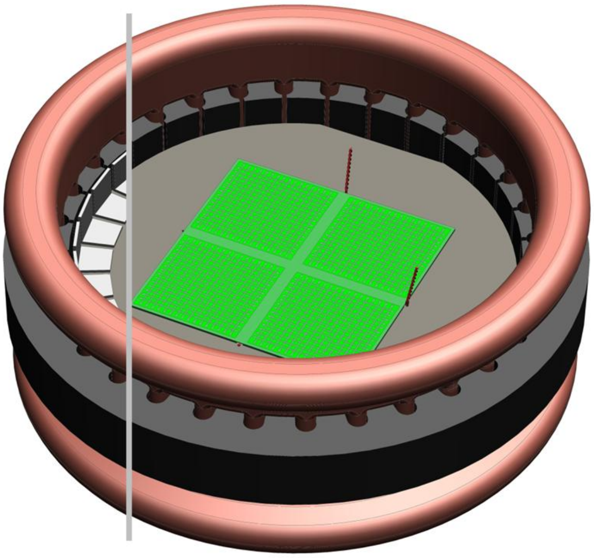

Figure 1: Overview of a magnetising apparatus without shielding and with visible straight edges of the sample (and an optional "vertical" shield).

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