



Contribution ID: 18

Type: not specified

Digital signal processing approaches for varying magnetic field measurements through rotating coils system

At CERN, varying magnetic field measurements involve massive use of rotating coils systems.

Standard procedure for estimating magnetic harmonic coefficients provides for the fast Fourier transform (FFT) of the magnetic flux, acquired over one complete coil turn and assumed to be stationary. The assumption certainly holds for magnets measured along the loadline, i.e. through a powering cycle characterized by several steps, during each of which a magnetic flux measurement is carried out. For magnets measured during a LHC cycle, in which the supply current ramps up at 10 A/s, only the mean value of harmonic coefficients over each coil turn is provided by the standard procedure. No possibility of tracking the instantaneous value of the coefficients is given.

In this talk, tests concerning the application of the standard procedure to simulated magnetic fluxes expected to be measured in the presence of different current laws and variation rates are presented. In each simulated condition, difference between estimated and nominal mean value, assumed as reference, of harmonic coefficients is given. The results clearly highlight the need for new measurement approaches.

Two new digital signal processing approaches are proposed. The first one applies, in a combined way, quadrature detection and short time Fourier transform (STFT) to the acquired magnetic flux samples. The second approach extrapolates magnetic flux samples outside those covering three complete coil turns, thus giving the possibility of reconstructing the magnetic flux over a complete coil turn at a given time instant. The performance of both approaches is assessed and compared.

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Track Classification: Measures