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Finite element simulation of fast corrector magnets for Petra IV

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The new fourth-generation synchrotron radiation source PETRA IV at DESY (Hamburg) will use a fast orbit feedback system to meet stringent orbit stability requirements. To this end, hundreds of fast orbit corrector magnets will be installed to minimize orbit distortions from external sources. These magnets are operated at high frequencies, creating strong eddy currents that result in Joule losses and a time delay between the applied voltage and the aperture field. User experiments impose stringent requirements on beam operation to preserve the point of the radiation source. To meet the demanding feedback requirements, finite element simulations are needed to understand the characteristics of the fast corrector magnet and its environment.

However, due to the low skin depths at high frequencies and the laminated structure of the magnets' yoke, conducting finite element simulations of the fast correctors is computationally very demanding. Therefore, we homogenize the laminated yoke which drastically reduces the computational effort but still captures the eddy current effects accurately.

The homogenization technique reduces simulation times from several hours to just a few minutes, allowing us to conduct extensive studies of the power losses, the field quality, and the integrated transfer functions of the magnets.

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Footnotes

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