Reduced Order Modelling for Lorentz Detuning of Superconducting Accelerator Cavities

J. Corno*, **C. de Falco**† **and S. Schöps***

* Computational Engineering, Technische Universitt Darmstadt, Germany; {corno,schoeps}@gsc.tu-darmstadt.de

†MOX Modeling and Scientific Computing, Politecnico di Milano, Italy; carlo.defalco@polimi.it

ABSTRACT

Controlling resonant frequencies of superconducting cavities in particle accelerators is crucial for synchronization. The electromagnetic fields cause pressure on the cavity walls, which gives raise to a mechanical deformation of the geometry. This leads to a frequency shift of the resonant frequency (Lorentz detuning). The use of Isogeometric Analysis (IGA) for this task has been proven to be beneficial both in terms of accuracy and of overall reduction of the computational cost [1]-[2]. However, the simulation of large and complex structures remains an overwhelming task.

In order to overcome computational difficulties we consider the State Space Concatenation (SSC) method introduced by Flisgen et al. [3]-[4]. In the SSC approach, the computational domain geometry is substructured into smaller sub-domains in which the fields are given by means of low dimensional modal bases. By placing the interfaces between neighbouring sub-domains at suitable locations, where the domain geometry approaches that of a waveguide, physical knowledge about the waveguide dispersion relation may be exploited to a priori select the most relevant elements of the local modal bases. The model for the complete system is then recovered by treating each sub-domain as a dynamical system with given Input/Output characteristics and by coupling the I/O 'ports' of neighbouring cells.

Acknowledgements: This work is supported by the 'Excellence Initiative' of the German Federal and State Governments and the Graduate School of Computational Engineering at Technische Universität Darmstadt.

REFERENCES

[1] J. Corno, C. de Falco, H. De Gersem, S. Schöps, "Isogeometric Simulation of Lorentz Detuning in Superconducting Accelerator Cavities", Computational Physiscs Communication, In Press.

[2] J. Corno, C. de Falco, H. De Gersem, S. Schöps, "Isogeometric Analysis Simulation of TESLA Cavities under Uncertainty", Electromagnetics in Advanced Applications (ICEAA), 2015 International Conference on, pp.1508-1511, 2015.

[3] T. Flisgen, H. Glock, U. van Rienen, "Compact Time-Domain Models of Complex RF Structures Based on the Real Eigenmodes of Segments", IEEE Transactions on Microwave Theory and Techniques, 61(6), pp. 2282-2294, 2013.

[4] T. Flisgen, J. Heller, U. van Rienen, "Computation of Eigenmodes in Long and Complex Accelerating Structures by Means of Concatenation Strategies", Proceedings of IPAC2014, Dresden, Germany, 2014.