Eigenmode Calculation for the BC0 Vacuum Chamber

W. Ackermann, W.F.O. Müller, T. Weiland
Institut für Theorie Elektromagnetischer Felder, Technische Universität Darmstadt

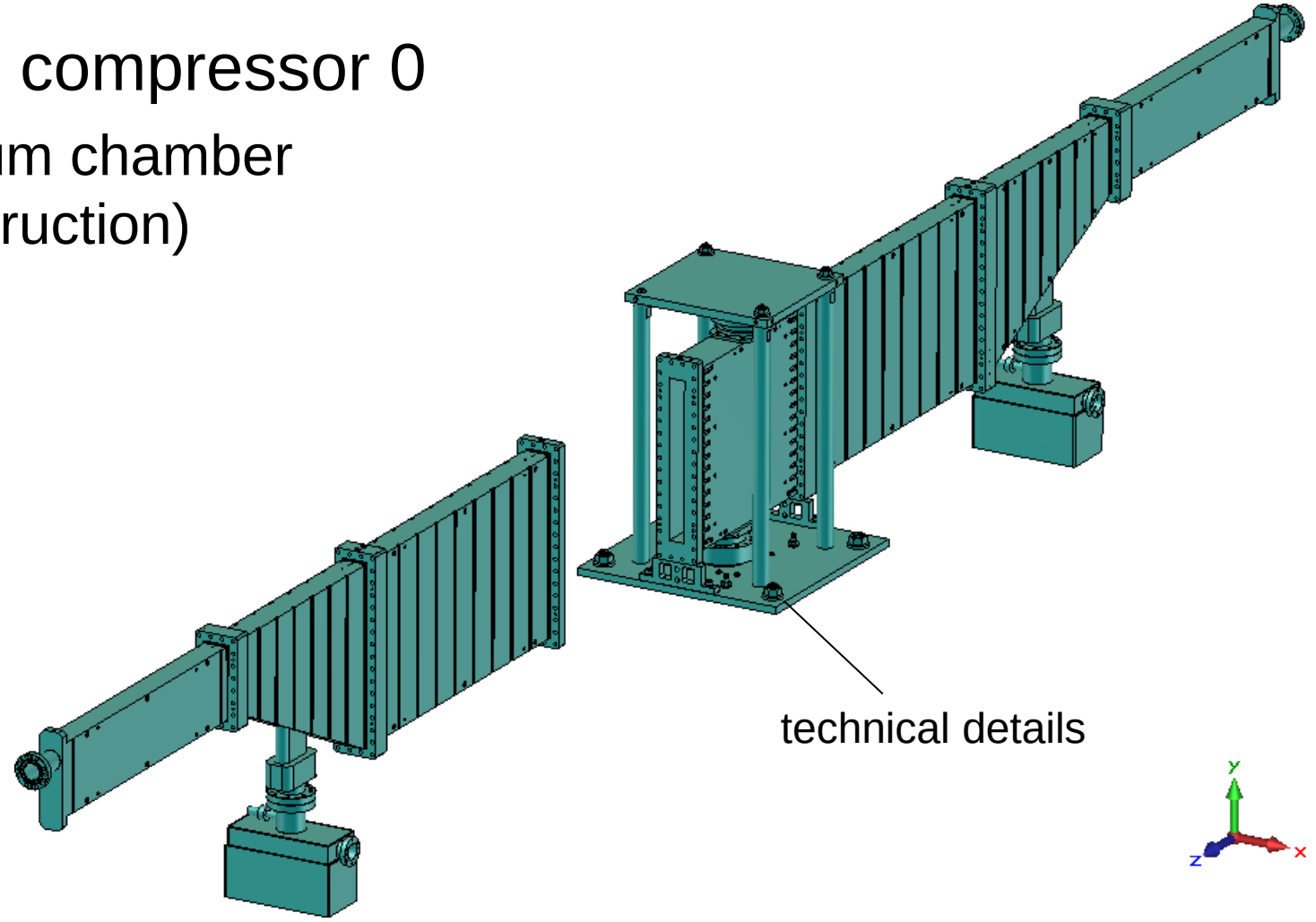
TECHNISCHE UNIVERSITÄT DARMSTADT

Status Meeting
December 19, 2013
TEMF, TU Darmstadt

Computational Model

TECHNISCHE UNIVERSITÄT DARMSTADT

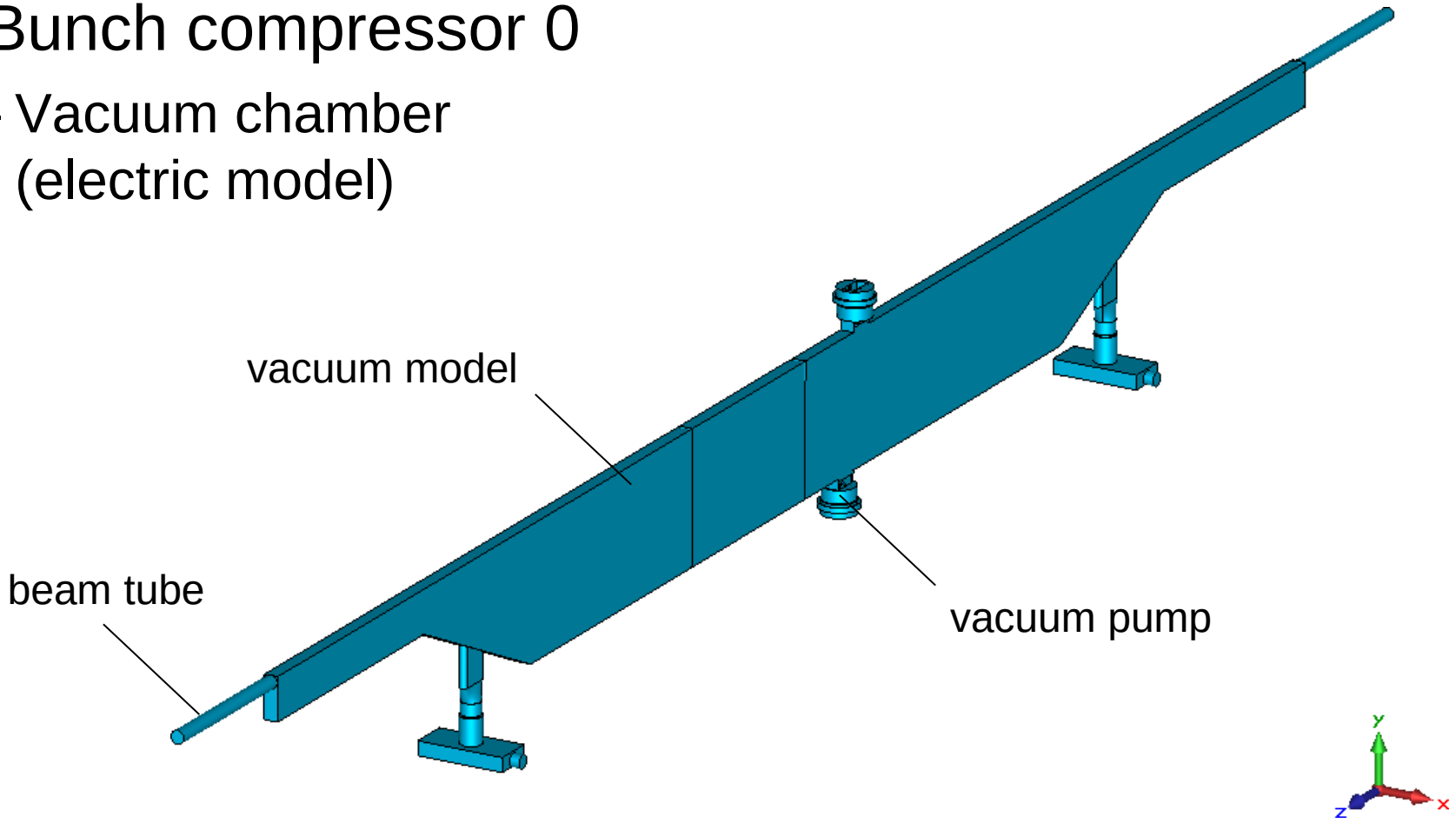
- Bunch compressor 0
  - Vacuum chamber (construction)



Computational Model

TECHNISCHE UNIVERSITÄT DARMSTADT

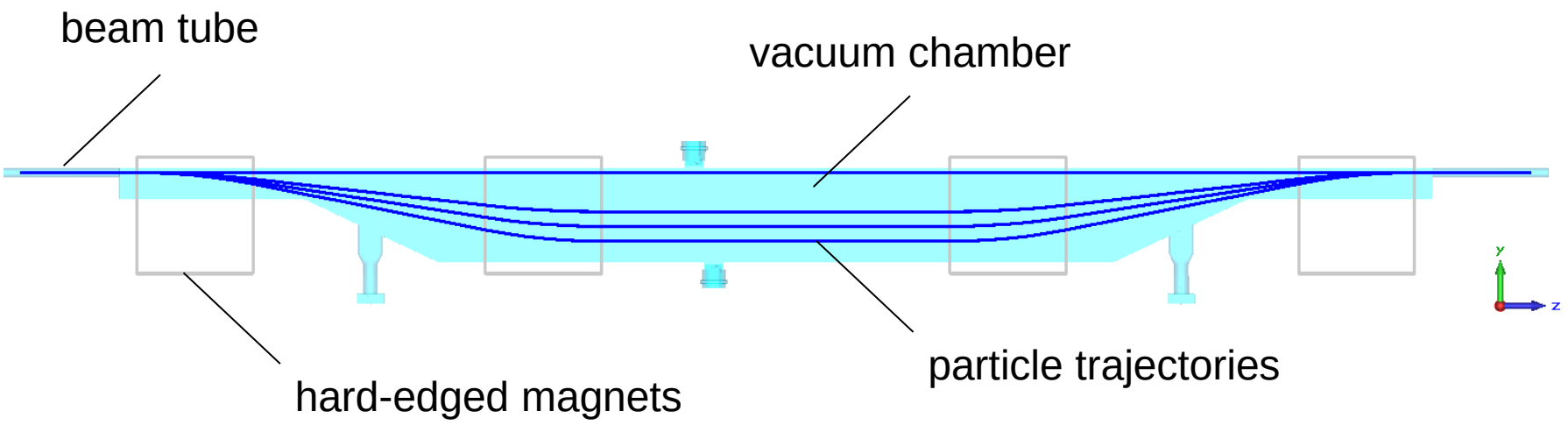
- Bunch compressor 0
  - Vacuum chamber (electric model)



Computational Model

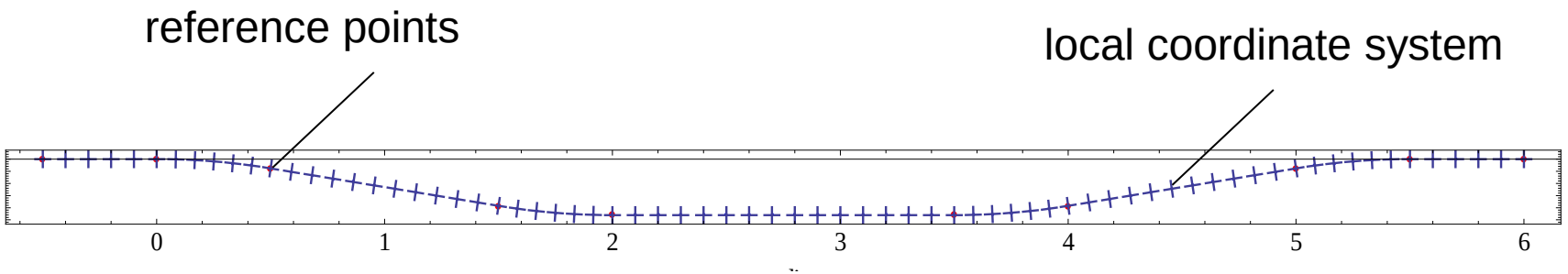
TECHNISCHE UNIVERSITÄT DARMSTADT

- Bunch compressor 0
  - Particle trajectories
    - Hard-edged magnets: analytical calculation of particle trajectories
    - Determination of local coordinates aligned to tangential direction
    - Specification of sample points to evaluate eigenmode fields



Implementation

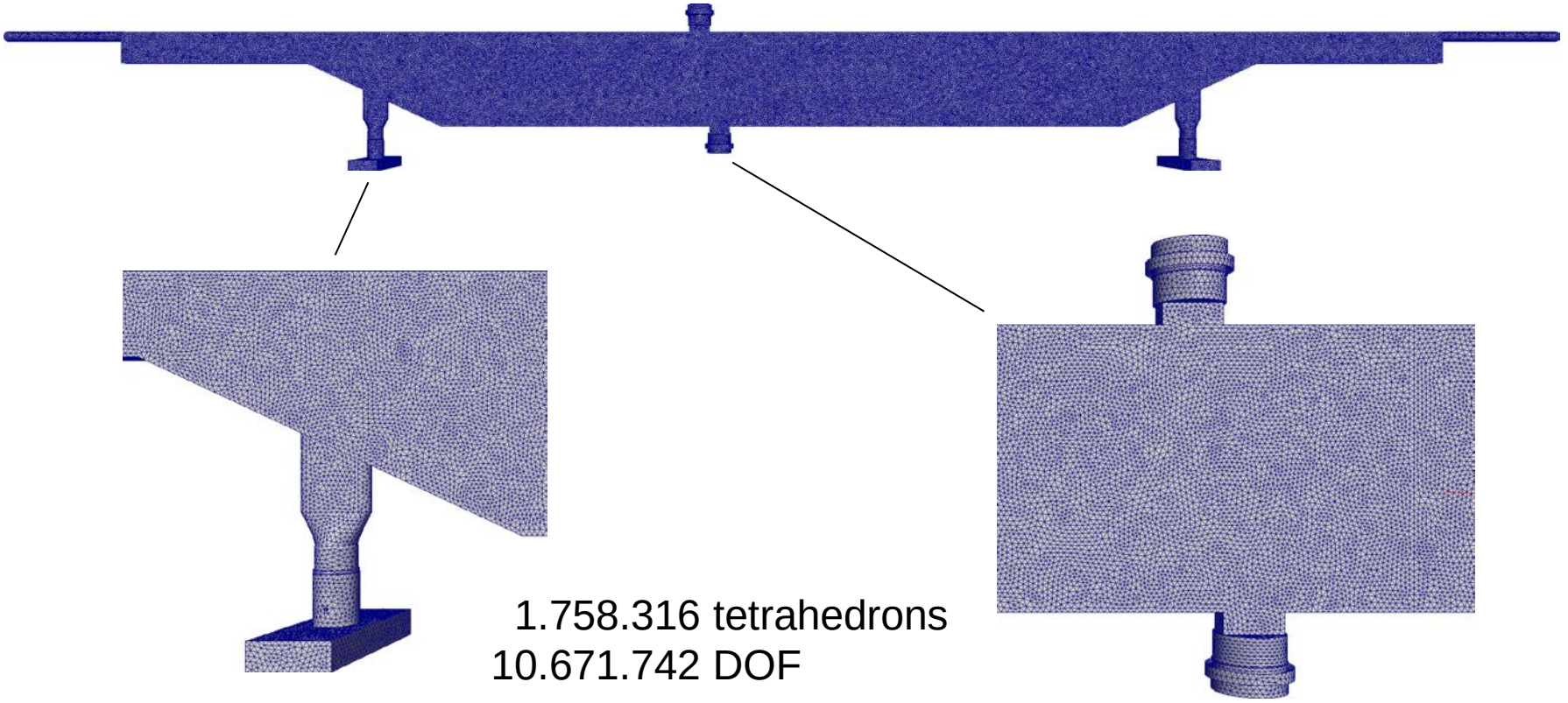
- Eigenvalue solver and auxiliary programs
  - Postprocessing
    - Change point evaluation from existing ‘line’ to new ‘arbitrary list’
    - Specify list of points along selected trajectory
    - Evaluate field components for all determined modes and all points
    - Transform field components to the particles coordinate system
    - Perform path integration to determine shunt impedance



Simulation Results

TECHNISCHE UNIVERSITÄT DARMSTADT

- Eigenvalue solver
  - Computational mesh

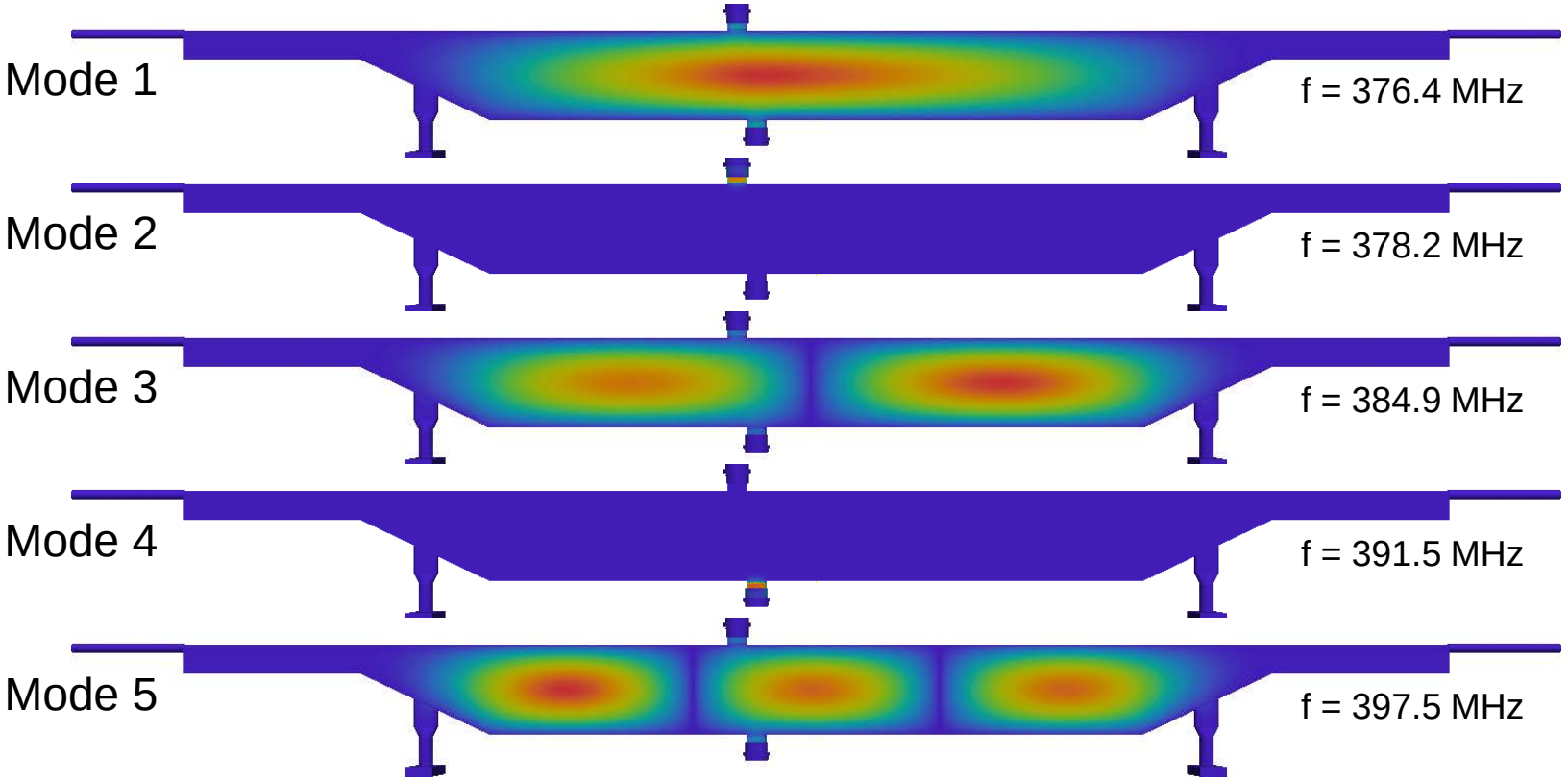


1.758.316 tetrahedrons
10.671.742 DOF

Simulation Results

TECHNISCHE UNIVERSITÄT DARMSTADT

- Eigenvalue solver
  - Field pattern of the electric field strength

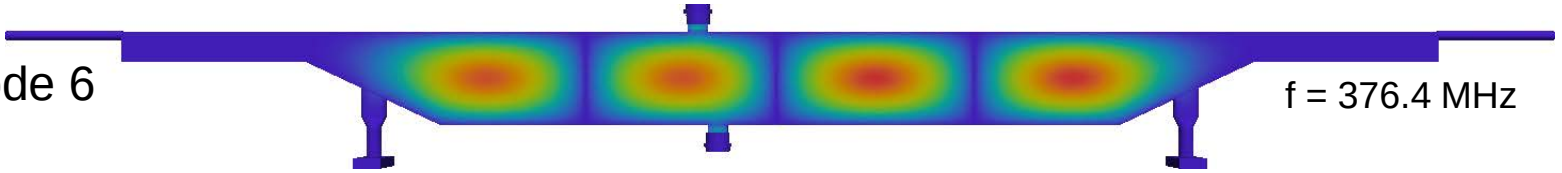


Simulation Results

TECHNISCHE UNIVERSITÄT DARMSTADT

- Eigenvalue solver
  - Field pattern of the electric field strength

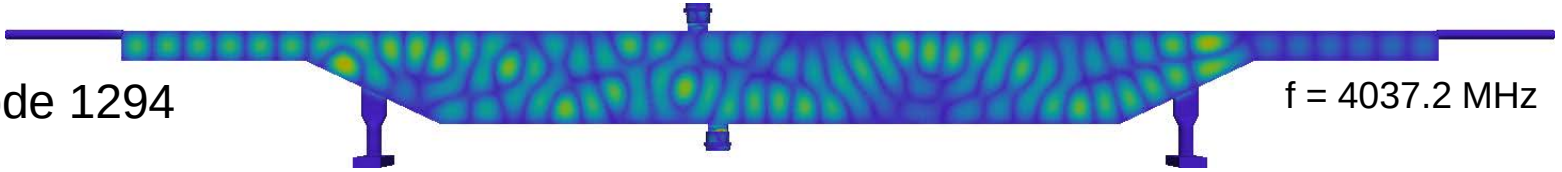
Mode 6



f = 376.4 MHz

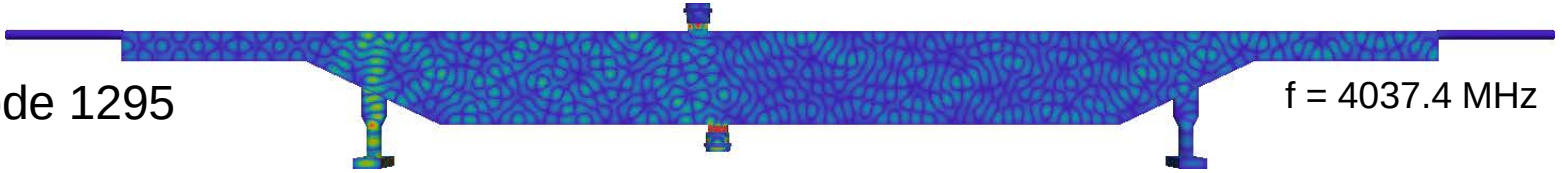
… more than 1000 modes have been examined (all modes up to 4 GHz).

Mode 1294



f = 4037.2 MHz

Mode 1295



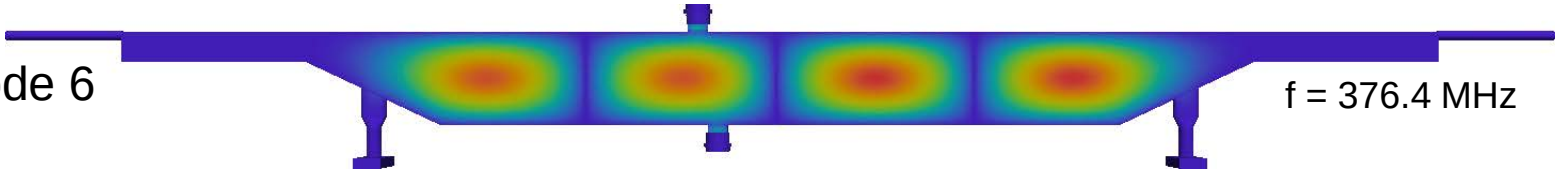
f = 4037.4 MHz

Simulation Results

TECHNISCHE UNIVERSITÄT DARMSTADT

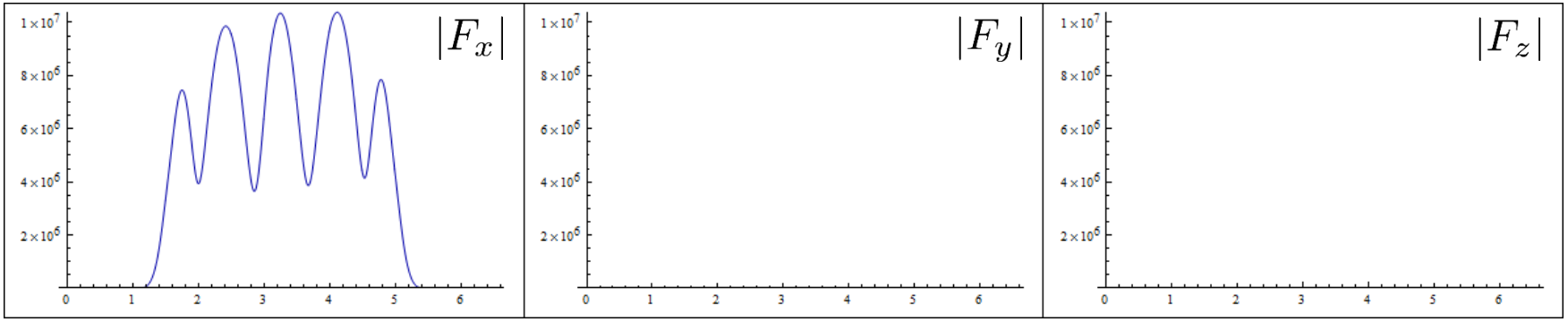
- Eigenvalue solver
  - Field pattern of the electric field strength

Mode 6



f = 376.4 MHz

  - Components of the electromagnetic ‘force’ $\vec{F} = \vec{E} + \vec{v} \times \vec{B}$

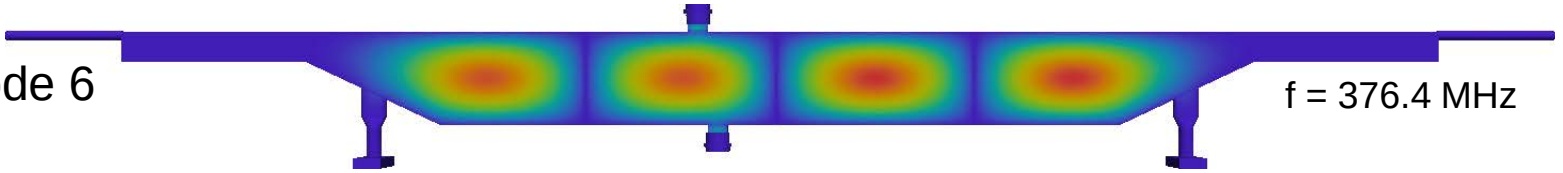


Simulation Results

TECHNISCHE UNIVERSITÄT DARMSTADT

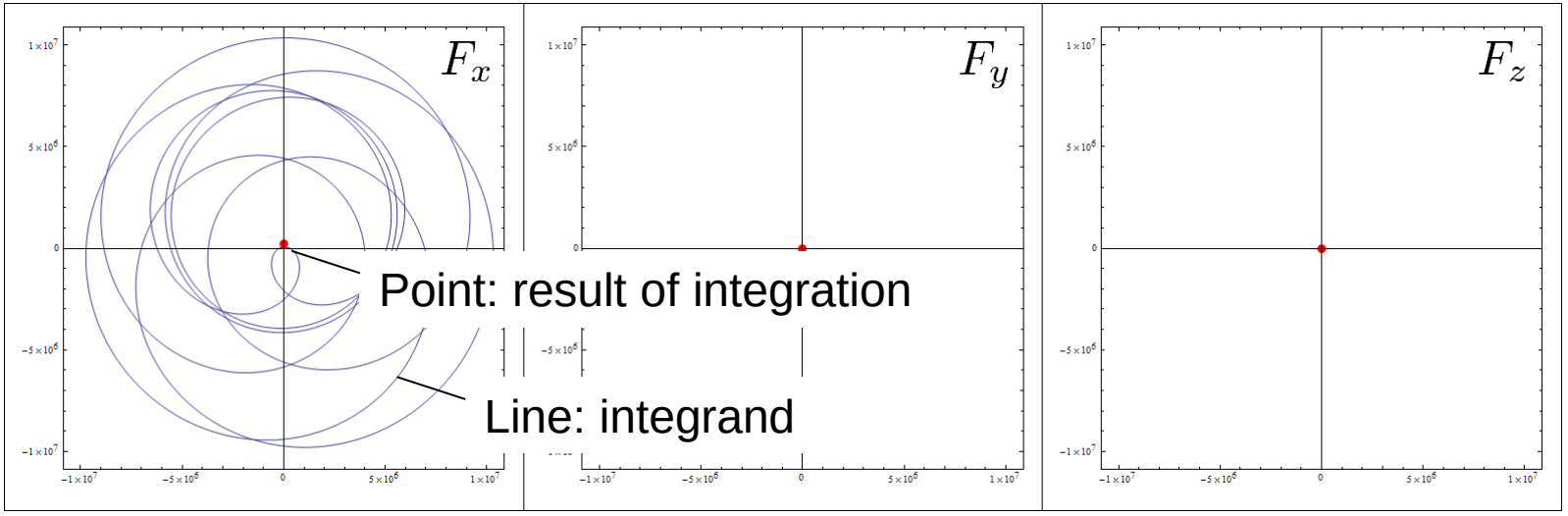
- Eigenvalue solver
  - Field pattern of the electric field strength

Mode 6



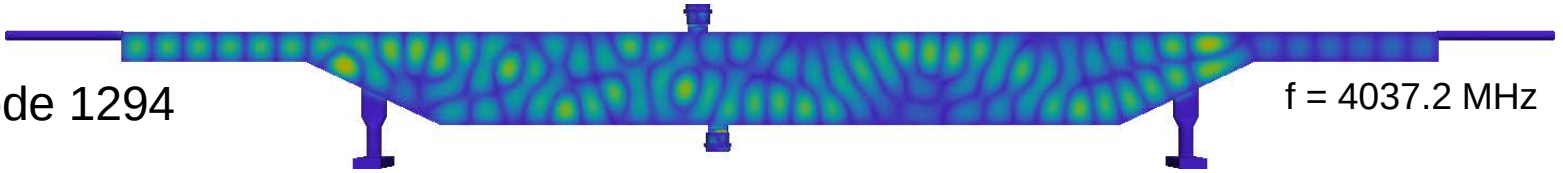
f = 376.4 MHz

- Components of the electromagnetic ‘force’ $\vec{F} = \vec{E} + \vec{v} \times \vec{B}$



Simulation Results

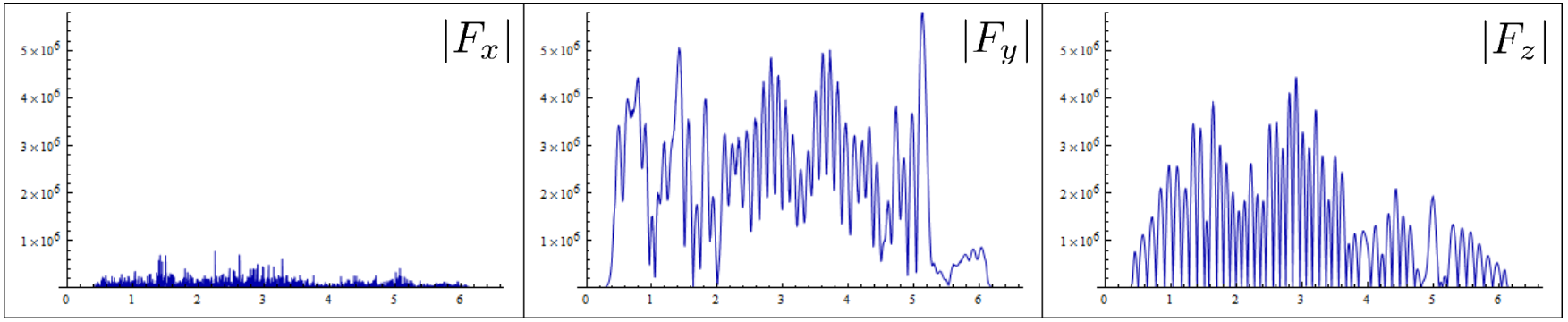
- Eigenvalue solver
  - Field pattern of the electric field strength



Mode 1294

f = 4037.2 MHz

  - Components of the electromagnetic ‘force’ $\vec{F} = \vec{E} + \vec{v} \times \vec{B}$

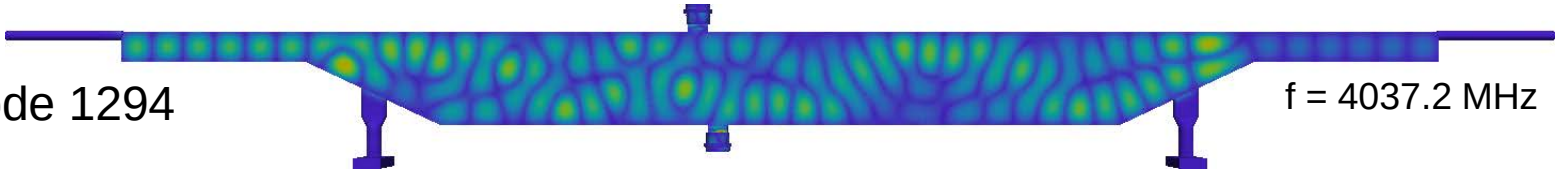


Simulation Results

TECHNISCHE UNIVERSITÄT DARMSTADT

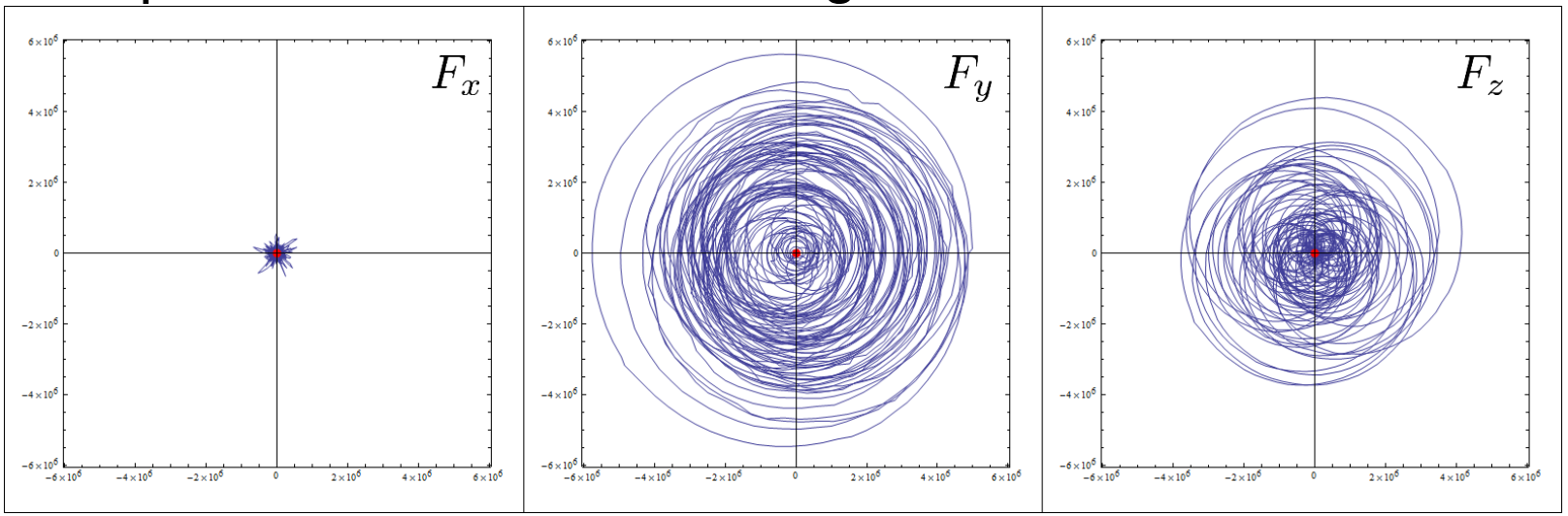
- Eigenvalue solver
  - Field pattern of the electric field strength

Mode 1294



f = 4037.2 MHz

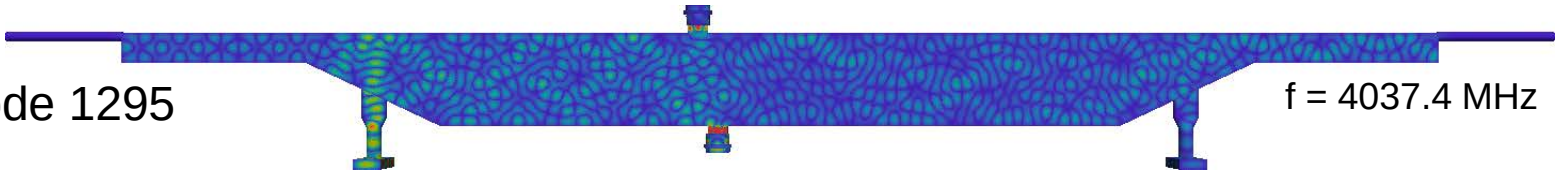
- Components of the electromagnetic ‘force’ $\vec{F} = \vec{E} + \vec{v} \times \vec{B}$



Simulation Results

TECHNISCHE UNIVERSITÄT DARMSTADT

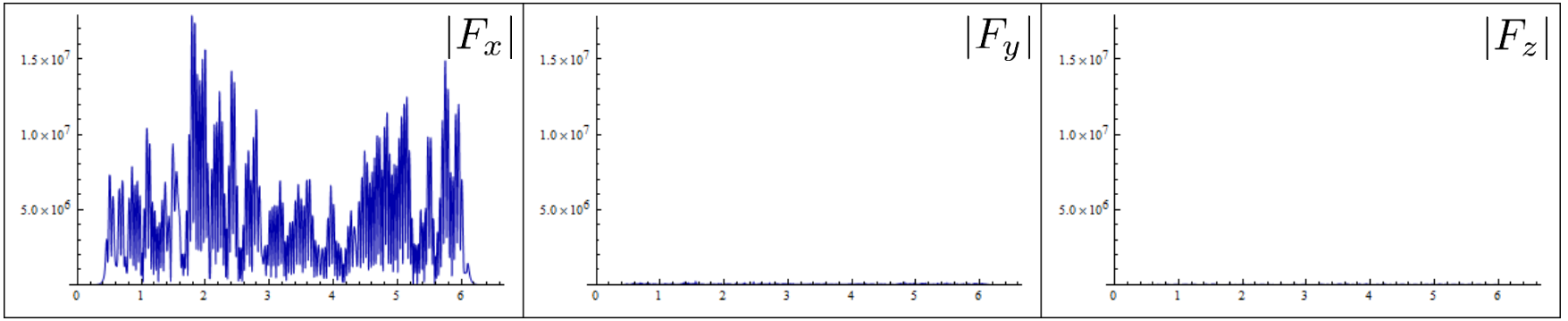
- Eigenvalue solver
  - Field pattern of the electric field strength



Mode 1295

f = 4037.4 MHz

  - Components of the electromagnetic ‘force’ $\vec{F} = \vec{E} + \vec{v} \times \vec{B}$

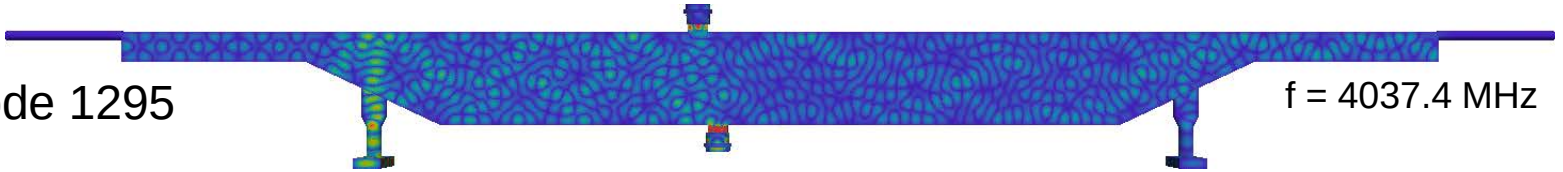


Simulation Results

TECHNISCHE UNIVERSITÄT DARMSTADT

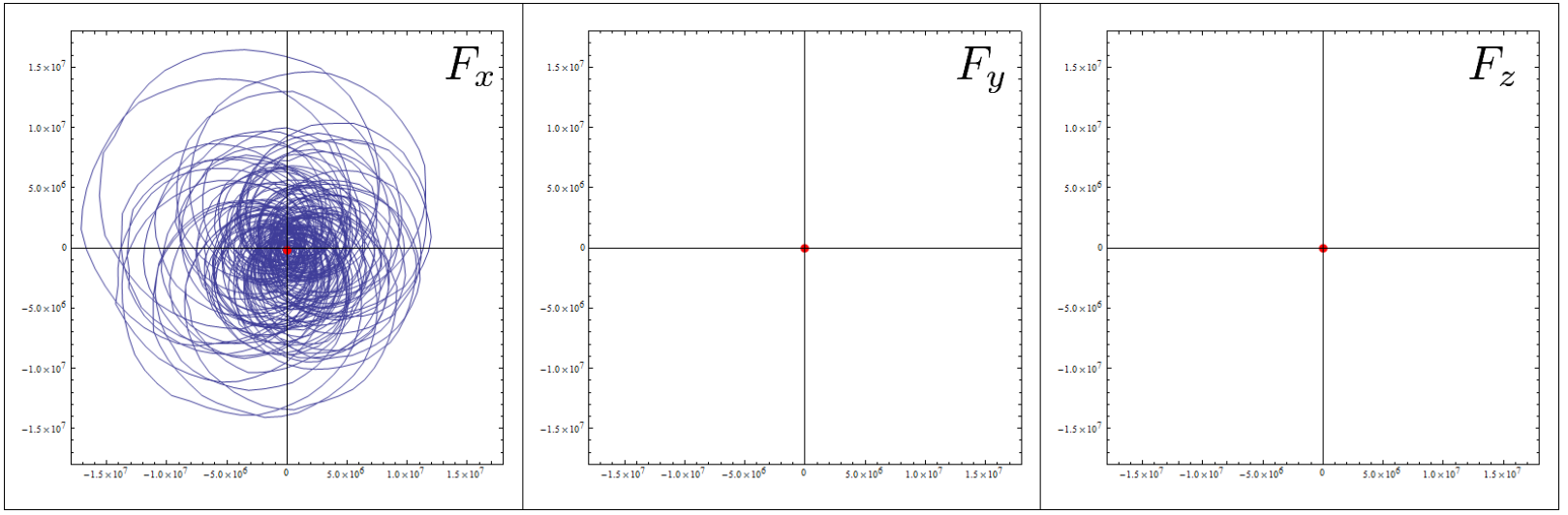
- Eigenvalue solver
  - Field pattern of the electric field strength

Mode 1295



f = 4037.4 MHz

- Components of the electromagnetic ‘force’ $\vec{F} = \vec{E} + \vec{v} \times \vec{B}$



Summary / Outlook

TECHNISCHE UNIVERSITÄT DARMSTADT

- Summary:
  - Computational model for BC0 available from DESY
  - Trajectories used for field evaluation can be determined analytically due to hard-edge magnet approximation (applicable to extract points and local coordinate systems)
  - Field pattern for various modes have been determined with the help of real-valued eigenanalysis
  - Postprocessing of all modes (>1000) up to 4 GHz did not identify any harmful modes for the selected trajectories