Institute for Accelerator Science and Electromagnetic Fields

Prof. Oliver Boine-Frankenheim, Prof. Herbert De Gersem, Prof. Harald Klingbeil, Prof. Stefan Kurz, Prof. Irina Munteanu, Prof. Sebastian Schöps, Prof. Thomas Weiland
Organisation

Institut for Accelerator Science and Electromagnetic Fields (TEMF)

Chairs
• Accelerator Physics (Boine-Frankenheim)
• Electromagnetic Field Theory (De Gersem, Munteanu, Weiland)
• Accelerator Technology (Klingbeil)
• Electromagnetism and Mathematical Modelling (Kurz)
• Computational Electromagnetics (Schöps)

Staff
• 7 professors + 6 associated investigators
• 3 postdocs + 26 PhD students + 10 external PhD students
• 3 administrative staff members
Equipment

- Hardware
  - desktop PCs
  - workstations
  - cluster
  - GPU computing
  - access zu HPC (inside/outside TU Darmstadt)

- 200 nodes
- 400 CPUs
- 2400 cores
- 90kW cooling power
- 80kW power
- 3200 GB memory
- ~7t weight
- ~1M€ investment cost
- 40 GBIT connection
Software

commercial software (academic use)
- CST Studio Suite
- Ansys
- COMSOL Multiphysics
- J MAG

freeware
- Gmsh
- GetDP
- FEniCS
- FEMM
- LTSpice

own software parts
- CEM
- PBCI
- FEMK
- Niobe
Know-how

- electromagnetic field simulation (meshing, formulations, discretisation in space and time)
- circuit simulation (including PEEC, hybrid systems, control, coupling)
- material models (ferromagnetic, superconducting, composites)
- algebraic techniques (solvers and preconditioners, eigenvalue solvers, model order reduction, optimisation, uncertainty quantification)
- particle tracking, beam dynamics, multipacting
- accelerator components (magnets, cavities, diagnostics)
- electrical power devices (machines, transformers, power electronics)
- electronics, sensors, crosstalk, signal integrity, EM compatibility
DFG-GRK-Accelence: $\beta$-reduced SC cavity (+ TUDa-IKP + UniMainz)

Dmitry Bazyl, Wolfgang F.O. Müller, Herbert De Gersem
DFG-GRK-Accelence: Beam-dynamic studies for electron guns

Steffen Schmid, Erion Gjonaj, Herbert De Gersem

BMBF-STEAM: Simulation of transient effects in accelerator magnets (+ CERN)

Interfilament Losses [W/m³]

Ohmic Losses [W/m³]

Interstrand Losses [W/m³]

Eddy-Current Losses [W/m³]

Temperature [K]

Voltage to Ground [V]

~1 mm

~100 µm


Idoia Cortes Garcia, Laura A.M. D’Angelo, Herbert De Gersem, Sebastian Schöps
**BMBF-CCC: Cryogenic current comparator (+ GSI, Universität Jena)**

- **Contour integral method**
- **Multi-level preconditioner**
- **Parallelisation**

**Graphical Illustration**
- Monopole modes vs Dipole modes
- Fundamental mode

**Authors**
- Vinh Pham-Xuan,
- Wolfgang Ackermann,
- Herbert De Gersem
CERN: Inductive adder with SiC-MOSFETS

David Woog (CERN), Herbert De Gersem
BMBF-CCC: Cryogenic current comparator (+ GSI, Universität Jena)

CCC with axial shielding

CCC with radial shielding

damping as a function of outer radius and axial length

rotational vibration mode of the helium vessel

Nicolas Marsic, Wolfgang F.O. Müller, Herbert De Gersem
ERC-PUMA (Alexandre Obertelli)
Design of a superconducting magnet

magnet design and optimisation

Alexandre Obertelli (TU Darmstadt, IKP)
Nicolas Marsic, W.F.O. Müller, H. De Gersem

collision with heavy ions
magnetic bottle for antiprotons
Chair Computational Electromagnetics

Prof. Dr. rer. nat. Sebastian Schöps

- field-circuit coupling
- co-simulation (waveform relaxation)
- isogeometric analysis (IGA)
- parareal and multirate time integration
- uncertainty quantification
Chair Electromagnetism and Mathematical Modelling

Prof. Dr.-Ing. Stefan Kurz

- differential forms
- boundary element methods
- matrix compression techniques

Buffa-Christiansen 1-form

Control polygon of Bézier segments

NURBS curve

support {b_i}

support {b_j}

isogeometrical analysis for boundary element methods
Chair Electromagnetic Field Theory: Uncertainty Quantification

Dr.-Ing. Ulrich Römer

uncertainties in bond-wire connections

error-controlled adaptive finite-element methods
Chair Electromagnetic Field Theory: Discretisation of HF Problems

- finite integration technique
- finite-element methods
- eigenvalue problems
- discretisation of Maxwell equations

fundamental mode in a TESLA cavity (W. Ackermann, TEMF)

electric scalar potential distribution for a dynamic eigenmode in a common-mode choke (S. Schuhmacher, Bosch)

inductive adder (David Woog, CERN)

Dr.-Ing. Wolfgang Ackermann
Chair Electromagnetic Field Theory: Cavities

Dr. phil. nat. Wolfgang F.O. Müller

- SC and NC cavities
- cooling
- deformation, tuning
- beam dynamics
Chair Electromagnetic Field Theory: Group Coupled Problems

PD Dr. rer. nat. Erion Gjonaj

droplets in electric fields

$\text{t} = 75\text{ms}$

high-voltage arresters

$\text{t} = 90\text{ms}$

detachment

experiment

simulation

Electric Field in kV/m

Temperature in K
Chair Accelerator Physics

Prof. Dr. rer. nat. Oliver Boine-Frankenheim

- development and testing of computer models for ion beams
- collective effects in ion beams (space charge, impedances, electron clouds)
- plasma acceleration
- dielectric wavefield acceleration
Chair Accelerator Technology

Prof. Dr.-Ing. Harald Klingbeil

• ferrite cavities
• electronics
• measurement technology
• beam experiments
• bunch merging
• control of accelerator facilities

bunch merging