

Electromechanics & Power Electronics (EPE)

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TU / **e**
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Eindhoven
University of Technology

Where innovation starts

Electromechanics and Power electronics

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- **High-tech systems**
 - Linear and planar motors, magnetic levitation
 - Ultra-high precision power amplifiers
 - Field modeling, materials, parasitic effects
- **Health**
 - High-speed motors
 - Medical robotics
 - Power amplifiers and supplies for MRI and X-ray
- **Smart mobility and smart grids**
 - Distributed generation and net coupling
 - Storage and energy management
 - Active suspension
 - Drive trains for electric vehicles



Electromechanics and Power Electronics

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- **Big group with friendly atmosphere**
- **Fundamental and design oriented research**
- **Strong cooperation with industry**



Facts and figures EPE	
Total personnel	53
Professors	2
Associate professors	2
Assistant professors	9
Fellows from industry	9
PostDoc	1
PhD students	17
PDEng students	5



Actuators for high-tech mechatronics

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- **Linear and planar actuators**
- **Improved models**
 - Force and torque distribution
 - Deformations
 - Transient phenomena (eddy currents, thermal)
- **Integration of degrees-of-freedom**



Magnetically levitated planar motor



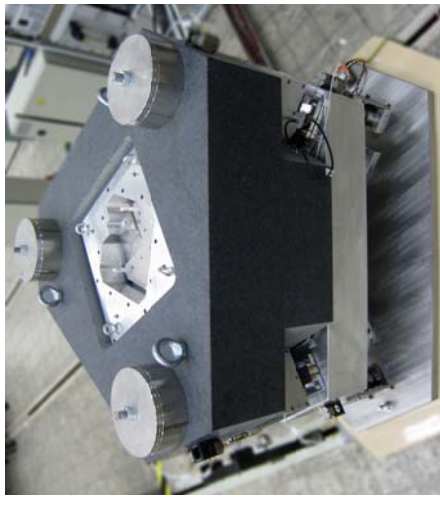
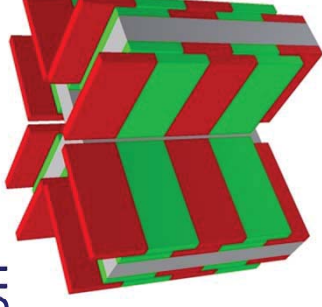
Integrated linear and rotary actuator
for pick-and-place (150 m/s^2)

High precision: elimination of disturbances

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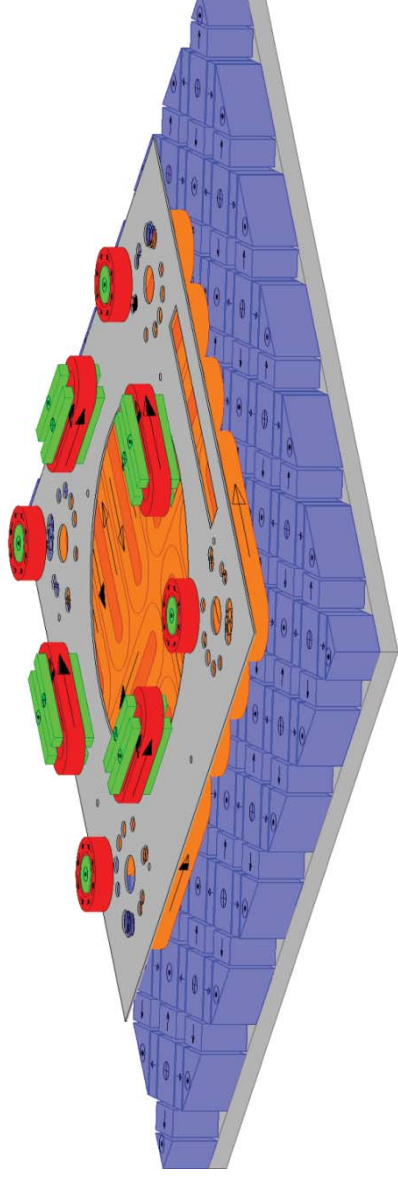
- **Mechanical: vibration isolation**

- PM based force vibration isolation for heavy loads (10 kN)
- 700 kg gravity compensator
- $P = 0.3 - 6 \text{ W}$



- **Electromagnetic:**

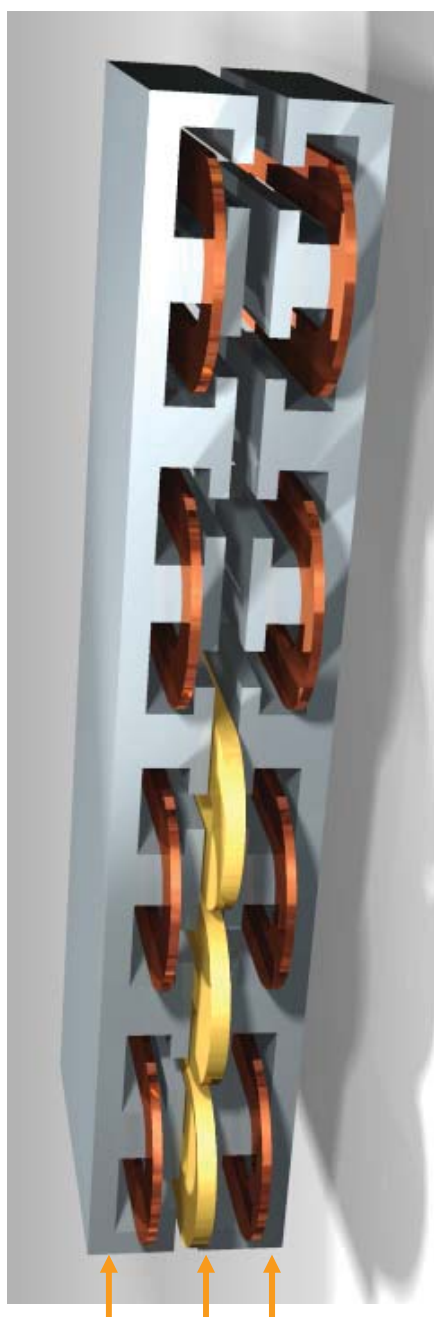
- Cross-talk between long stroke and short stroke stages
- Calculate cross-talk with magnetic shielding



Superconducting linear motor

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- **High-force density linear motor**



Ferromagnetic iron core

Copper coils

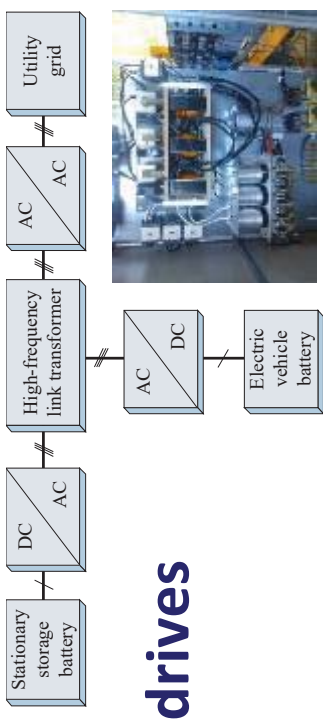
Superconducting coils

- **Superconducting coils achieve 4-5x current density of regular copper coils**
- **AC losses limit performance**
 - Result of highly non-linear behaviour of superconductor

Automotive systems

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- Drive-train systems
- Wide speed/torque range electrical drives
- Auxiliary automotive systems
- Power and battery management



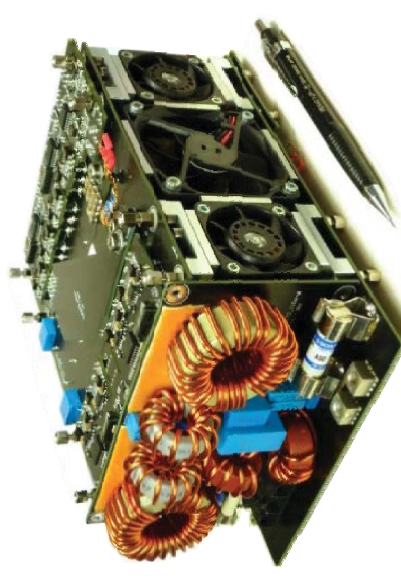
Fast charging converter
(50kW demonstrator)



Active car suspension
(tested on road)



In-wheel drive-train system



1-Phase bidirectional onboard
charger with power density

TU/e

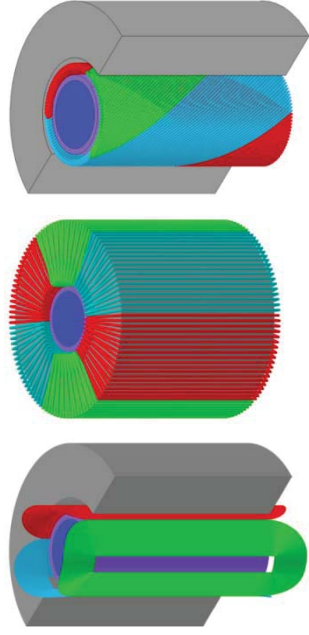
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Electromechanics & Power Electronics

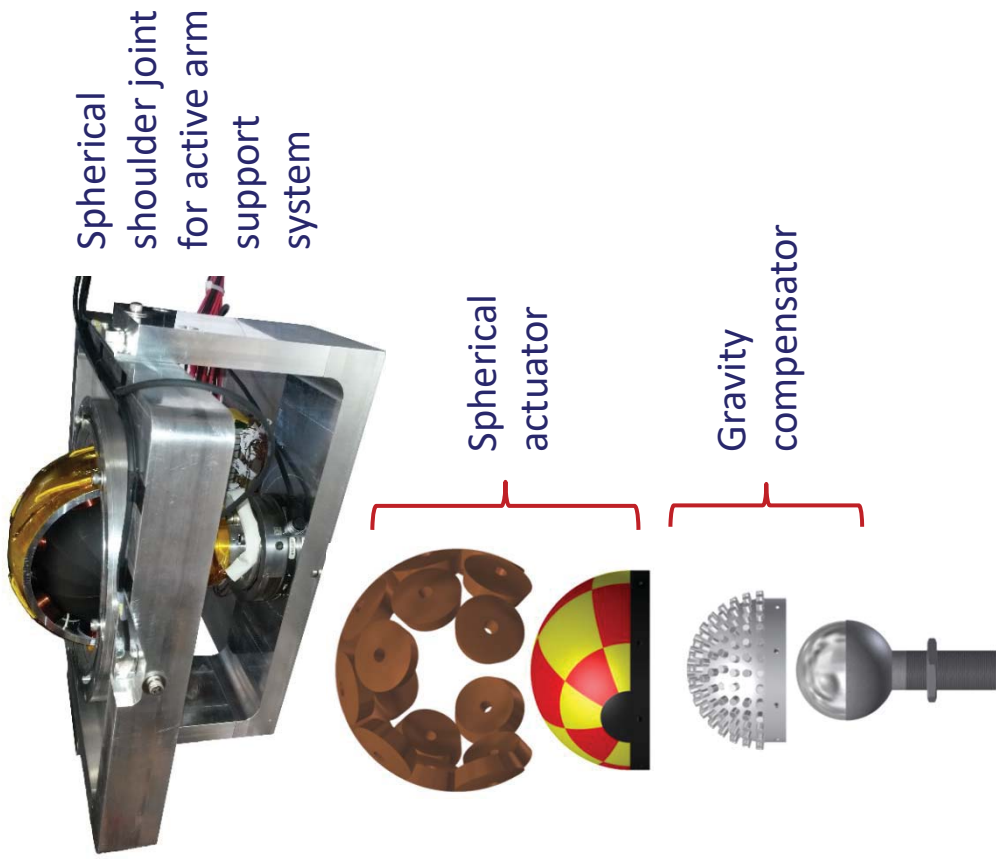
Actuators for medical application

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- Medical robotics
- Limb rehabilitation
- Highly-dynamic drives



90000 rpm turbo compressor for medical ventilator



Spherical shoulder joint for active arm support system

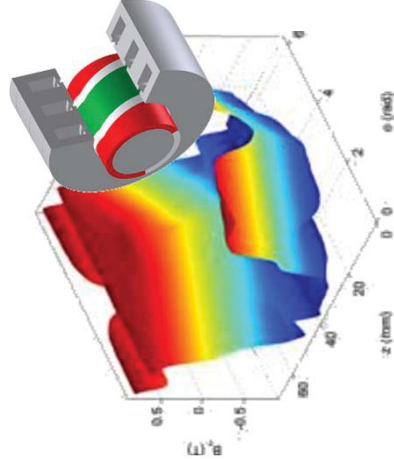
Spherical actuator

Gravity compensator

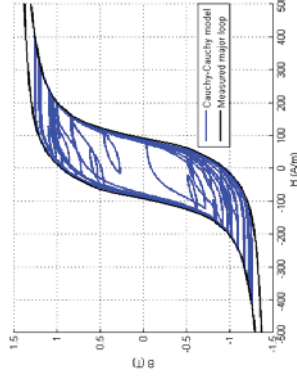
Electromagnetic analysis and design

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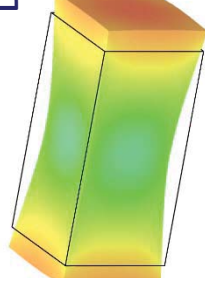
- Ultrafast simulation and design tools
- Coupled models: magnetic, mechanical, thermal and electric
- Modeling of magnetic materials: hysteresis and magnetostriction



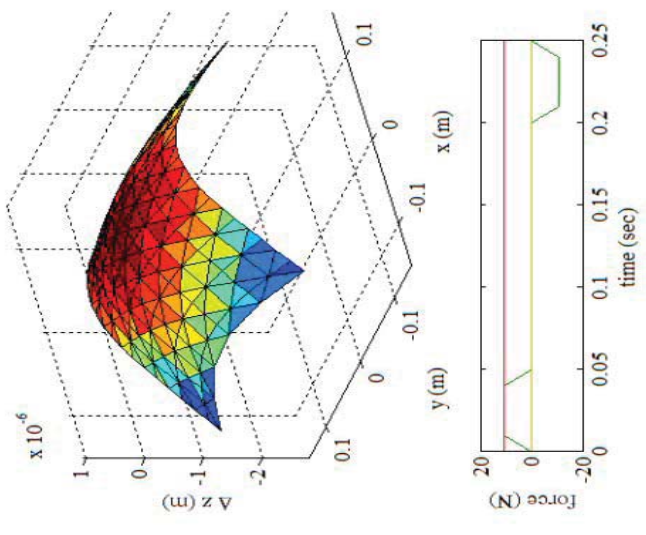
Magnetic fields in 3D slotted structures



Material modeling and characterization



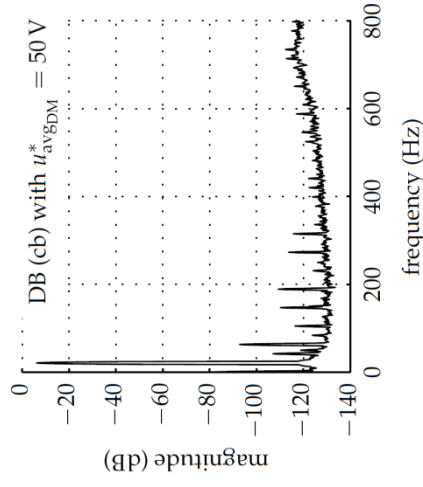
Deformation of planar motor during motion



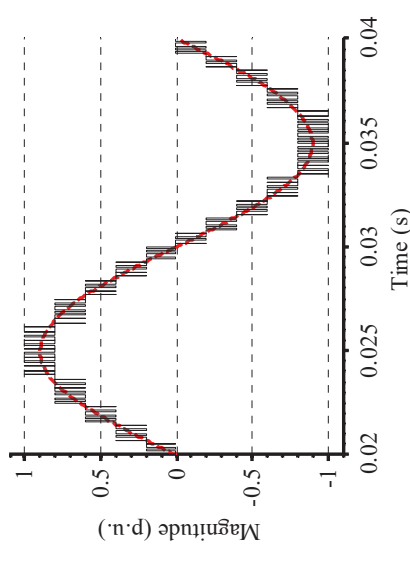
High precision & multilevel converters

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- **Topologies for high-precision power amplifiers**
 - Elimination of zero-crossing distortion
 - Ultra-level converters:
 - Increased bandwidth and accuracy
 - Reduced size of passive components



High precision switching amplifier with
<-90dB zero crossing distortion

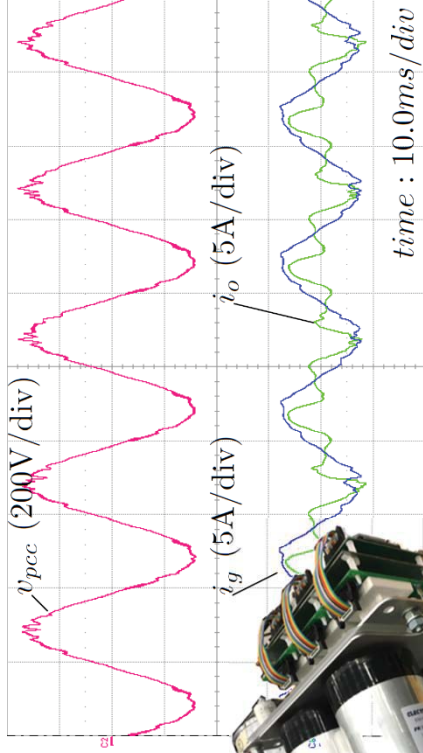


Power DAC for filterless high
precision power conversion

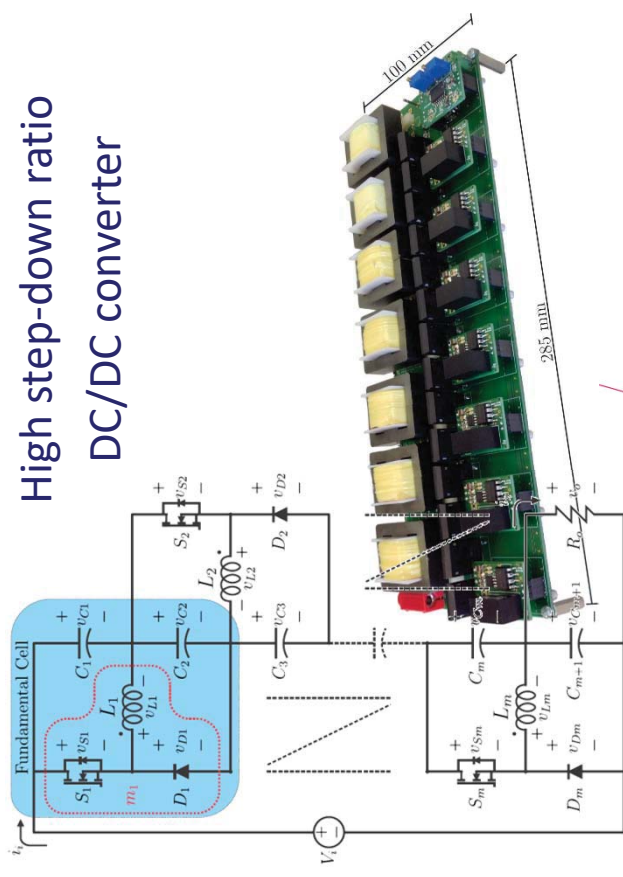
Grid applications

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- **Local power quality enhancement**
 - Compensate for disturbance due to loads
 - Control of injected power and voltage harmonics
- **Auxiliary supply for high voltage applications with high step-down ratio (3kV to 24V)**



Local voltage quality enhancement

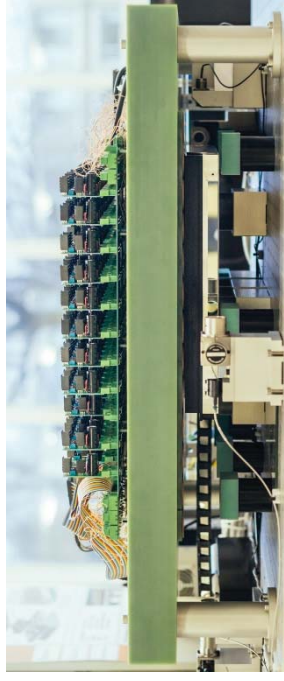


Wireless energy transfer

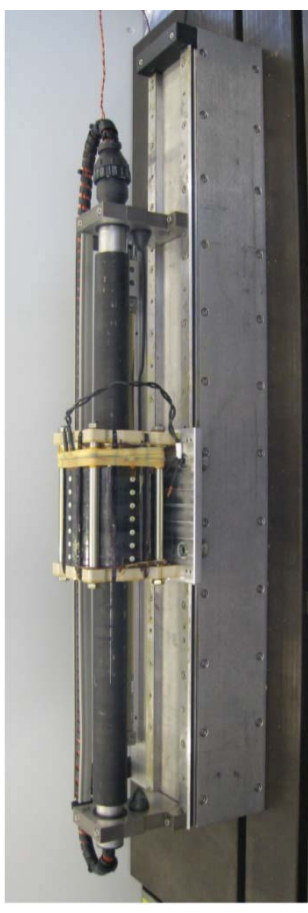
- Inductive charging
- Acoustic energy transfer
- Energy to moving objects
- Integrated energy transfer



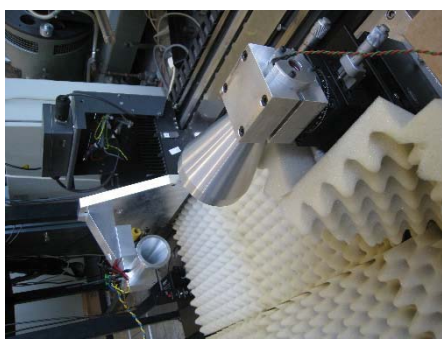
Low-power domestic applications



Ceiling robot with integrated wireless energy transfer



Wireless energy transfer integrated in tubular linear motor



Acoustic energy transfer

Supported student projects

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World Solar challenge (STE),
1st place 2013 & 2015 in cruiser class



Robocup (TechUnited),
World champion 2012, 2014, 2016
EU 2016, Portuguese open 2017



Formula student (URE)



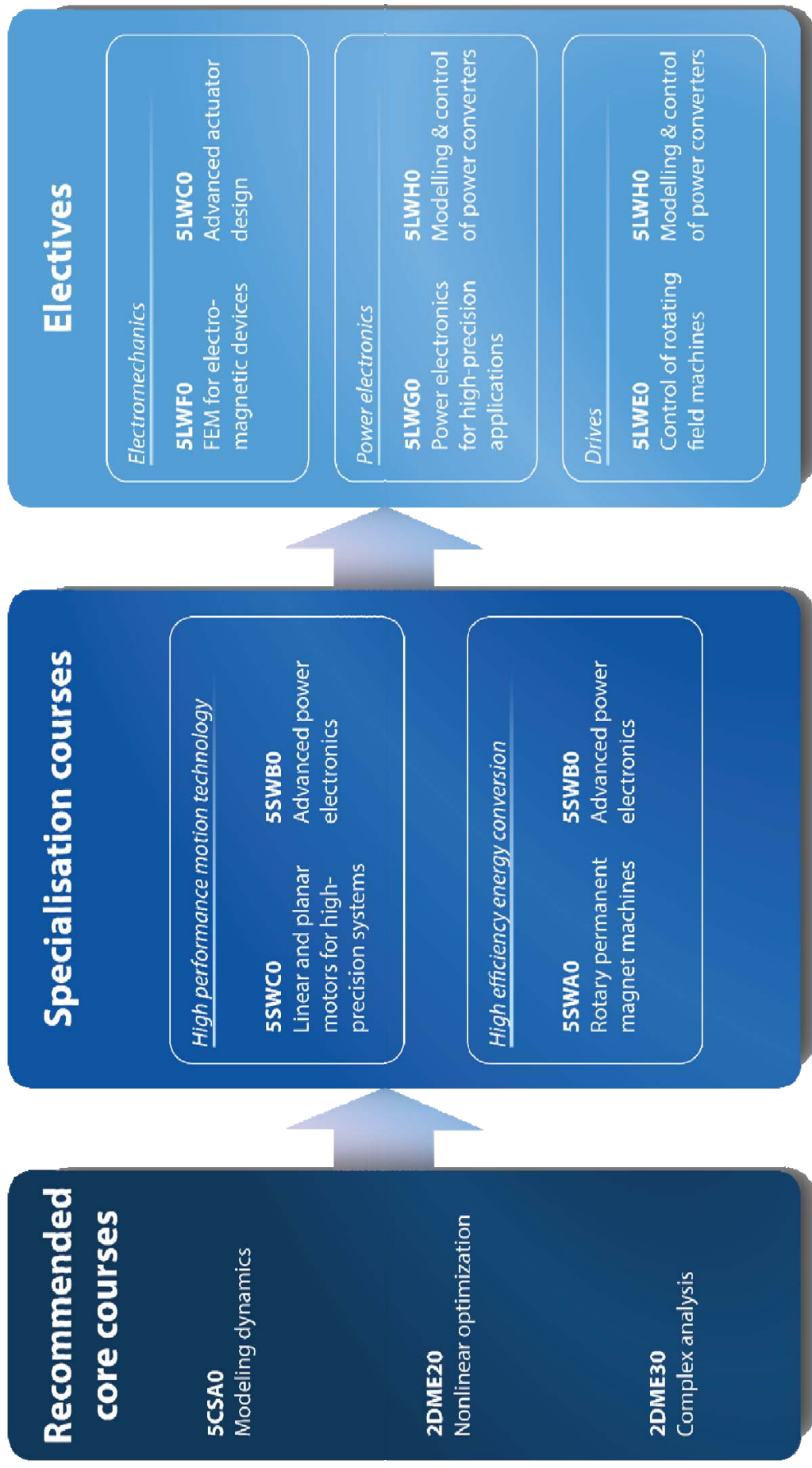
InMotion



STORM

EPE Courses

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Traineeships, graduation and job prospects

- **Many options:**
 - National / international
 - Industry / academia
- **Excellent job prospects**

AME  **ASML**

heliox

PHILIPS

protonic
holland
industrial electronics

PRODRIVE
TECHNOLOGIES

ROYAL SMIT
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of the SGB-SMIT Group

RR Mechatronics
Masters of Measurement

BRONSWERK
HEAT TRANSFER

FEI



punch
powertrain
Gear up for the future

NXP

ccm
centre for concepts in mechatronics

DEMCON

HEIDENHAIN

Rolls-Royce

Strukton
Rail

TENNECO

tripphase

ABB



BOSCH

DNV-GL


technology that matters



Vostermaans
Ventilation

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Electromechanics & Power Electronics

Thank you



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