SET @ Electromechanics & Power Electronics (EPE)

A master at the Electromechanics and Power Electronics group

Prof. dr. ir. George Papafotiou, September 2022

Department of Electrical Engineering

Welcome to the EPE group

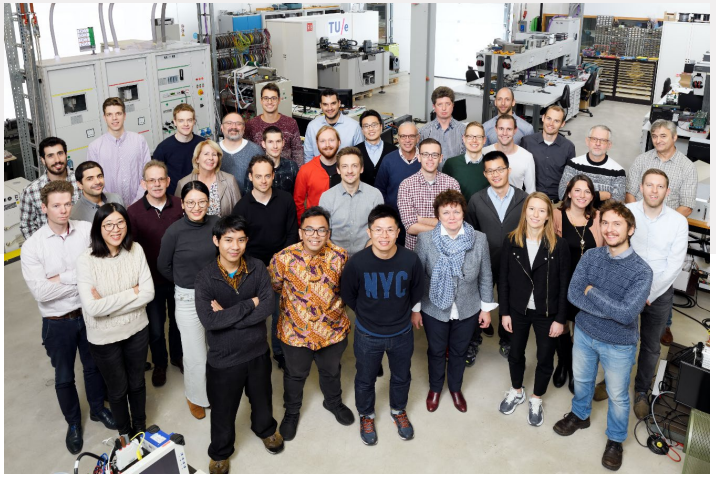
Enthusiastic team of ~55 people with a relaxed and informal atmosphere

Many (inter)national industrial partners

12 part-time fellows from industry

State-of-the-art laboratory

Very good job opportunities



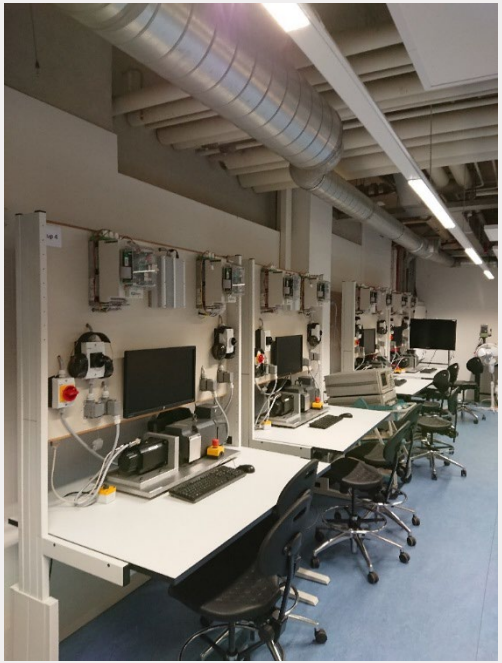
ASML PHILIPS PRODRIVE TECHNOLOGIES AME

Strukton Rail heliox TECNOTION THE LINEAR MOTOR COMPANY protonic holland TNO

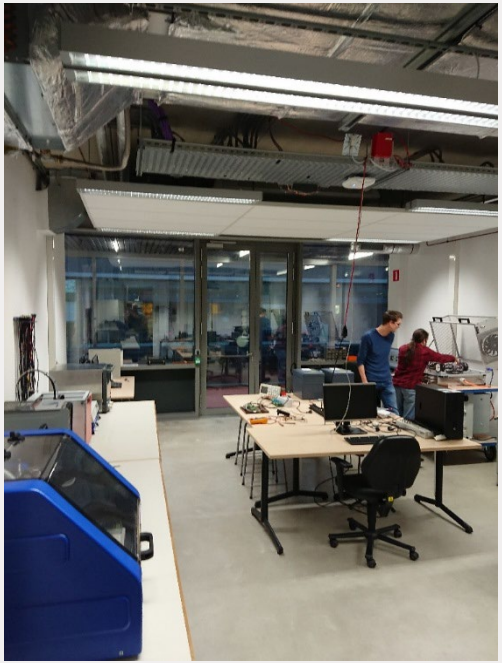
epe TU/e

680 m² state of the art research and education laboratories + new MV laboratory – 120 m² since June 2022

Research laboratory



Educational laboratory



Low power laboratory

Electromechanics & Power Electronics group

EPE = "systems** and **technology** for **processing electric energy"

Interaction between electrical and mechanical energy (electromechanics)

Dynamic control of flow and shape of electric energy (power electronics)

High-tech systems

Robotics

Renewables & smart grids

Automotive & smart mobility

Healthcare

A relevant and challenging discipline

- Electric energy is omnipresent
  - Truly multi-disciplinary
- No two projects are the same
  - Determine your own focus:
    - Modeling
    - Design
    - Experimental
- Your choice
  - Become a specialist… (components)
  - … or a generalist (systems)

Electromechanics & Power Electronics - group

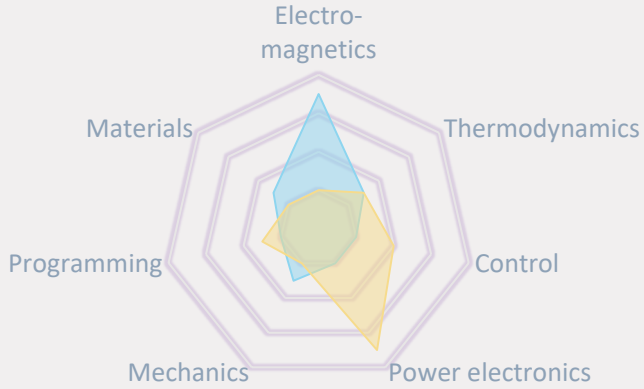
Our *scientific* mission:

Performing top-class scientific *research* with societal and industrial **relevance** in electromechanical and power electronic systems

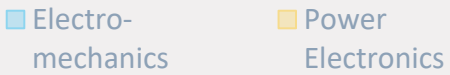
Our *educational* mission:

Educating **top-class** engineers in our discipline by providing them with a well-balanced skill-set to start or further their industrial or academic career

We strive for a system-level approach…



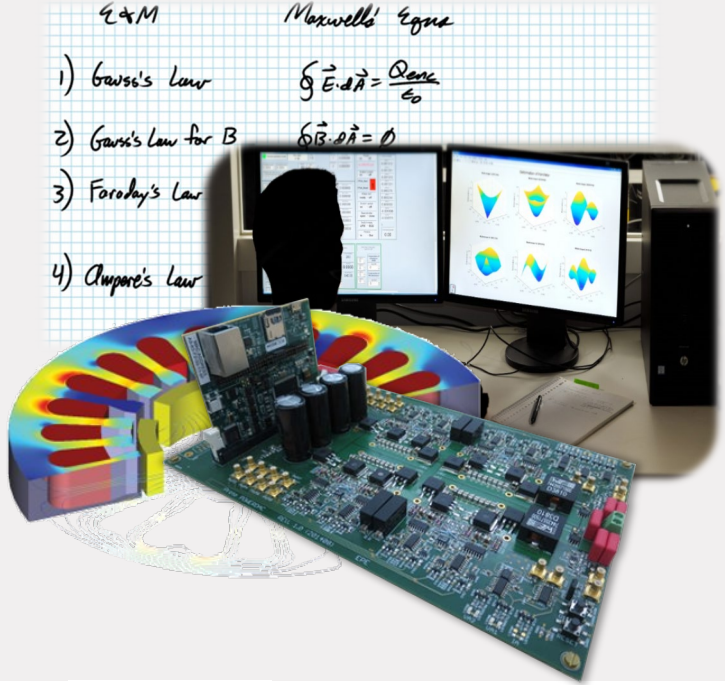
…where you can determine *your focus*!



Our mission is reflected in the *master courses*

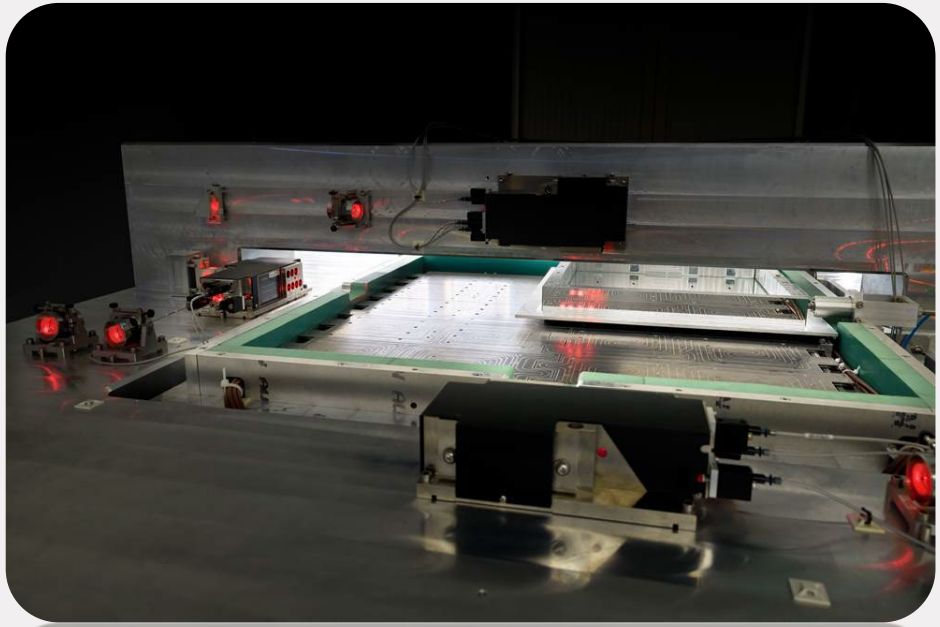
Design oriented teaching in the advanced courses, through which you will:

1. ***learn*** the fundamental basics during the lectures
2. ***gain insight*** into fundamentals through interactive, simulation-based instructions
3. ***apply*** the newly gained knowledge with design-oriented homework assignments
4. ***be tested*** through design assignments representative of a practical problem



Our mission is reflected in the *graduation projects*

- Gain broader and **deeper knowledge** and experience
- You are the **problem owner**:
  - Tailored assignment
  - Individual freedom
  - Take your responsibility, well-supported by coaches
- Both industry and academic oriented projects possible
- Informal atmosphere



PEL/e Research portfolio

Research areas:

High Performance Power Electronics

- **GaN**

Computational intelligence for Resilience

- **MPC**

Control of Power Electronics

Grid-connected & MV Power Electronics

- **SST and SiC in MV**

Modular topologies & systems

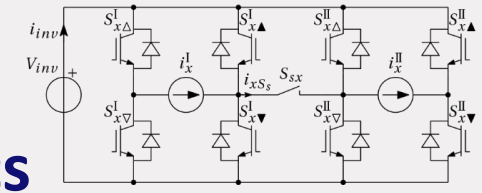
WBG

Distributed control

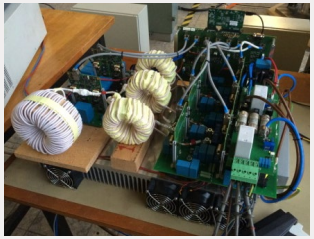
Magnetics for PE

PEL/e Research portfolio – Grid connected and MV Power Electronics

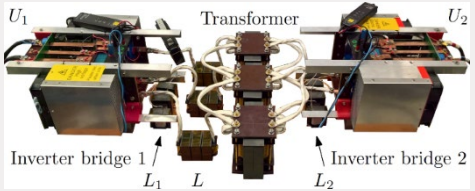
- Scalable architectures
  - Multi-level and interleaved topologies
  - Multi-port converters
  - Passive component reduction
- High power density
  - Optimal SS modulation and control
  - Wide band gap optimized circuits
  - RF power conversion
- Converter reliability and lifetime
  - Physics of reliability
  - Thermal cycling reduction
  - Redundant power conversion



Dynamic drive reconfiguration

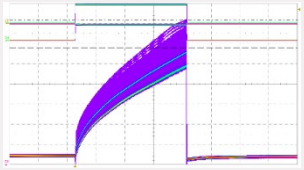


Multiport SS AC/DC converter



100 kW 3-level, 3phase SiC DAB

Redundant battery system



SiC mosfet lifetime determination

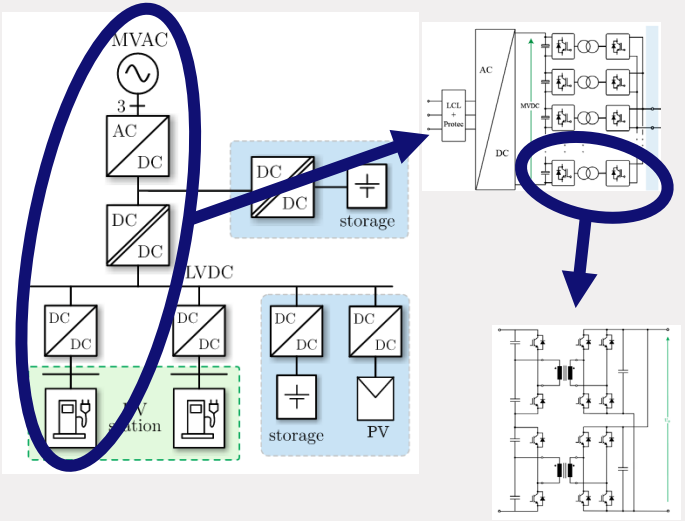
The Solid-State Transformer (SST) – Grid connected and MV Power Electronics

System architecture with **Solid State Transformer (SST) concept** as building block

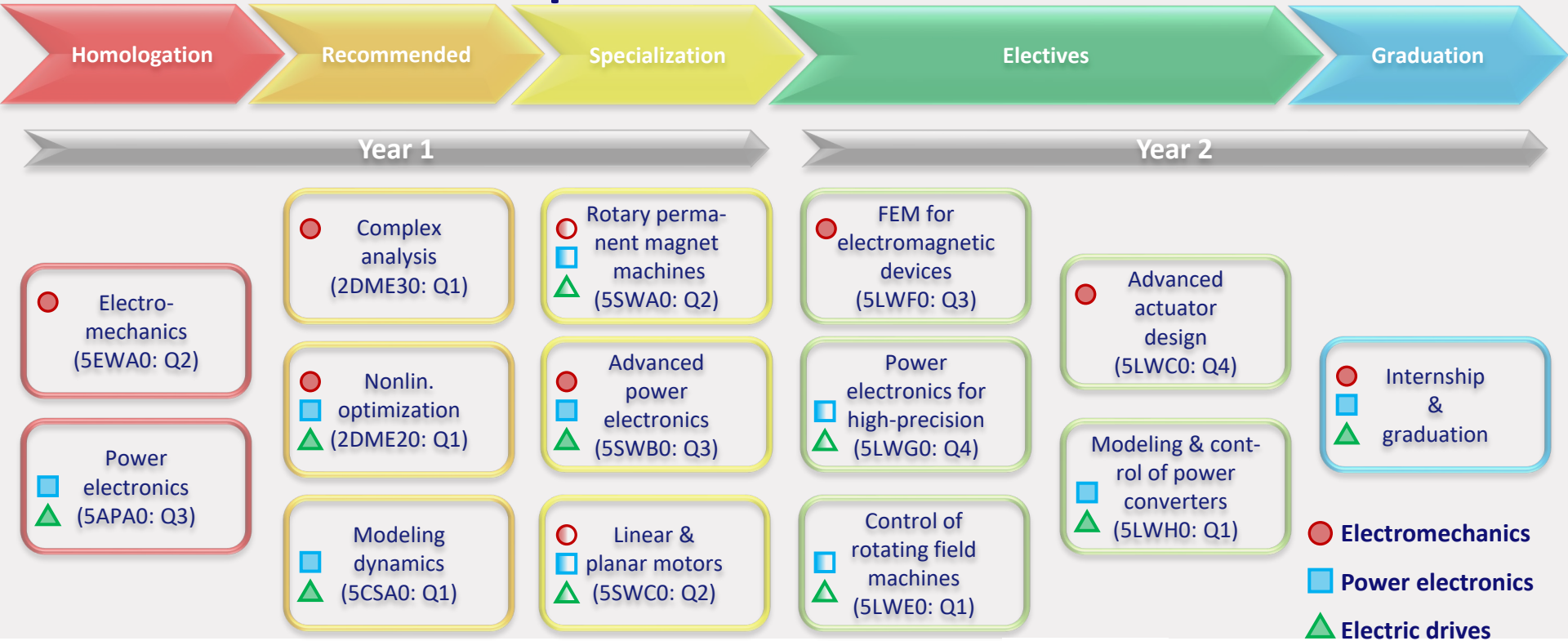
- Optimal **number, voltage levels and topologies** of conversion stages for **reduced cost, footprint**
- DC **protection concepts**
  - Identification of faults & **current limitation**
  - **Isolation** and current interruption

Critical Components

- **Medium frequency** transformers
  - **Isolation** properties under MF switching
  - Magnetics – **new materials** and design
  - Cooling
- Semiconductors: **Wide Band-Gap**
  - SiC technology in MV – **packaging and optimal topology design**
  - **Parasitic inductances** and their effects
  - EMI
  - design of **passives**
  - **reliability**



3 Tracks towards specialization: 7 courses



Next steps

- Plan your master, and if considering EPE – request a follow-up meeting @EPE by mailing Ms. Tanja Swanink - *secretariaat-epe@tue.nl*