

# EISLAB

World leading research and teaching facility within  
Embedded Internet Systems

17 faculty and 28 PhD students working hard to develop new, extremely small and energy efficient units for sensor systems, data processing and wireless communication

Supporting industrial development within robotics, health care technology, energy efficiency systems and industrial measurement and control.

Extensive, worldwide collaboration and partnership programs with private enterprises and other academic entities.

EIS Architecture

Embedded EMC

Electronic design

Sensor Systems

Electronic  
Production

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**Wireless sensor networks**

**Biological inspired computing**

**Novel simulations of embedded electromagnetics**

**New paradigms in reactive programming**

**Next generation of PCB technology**

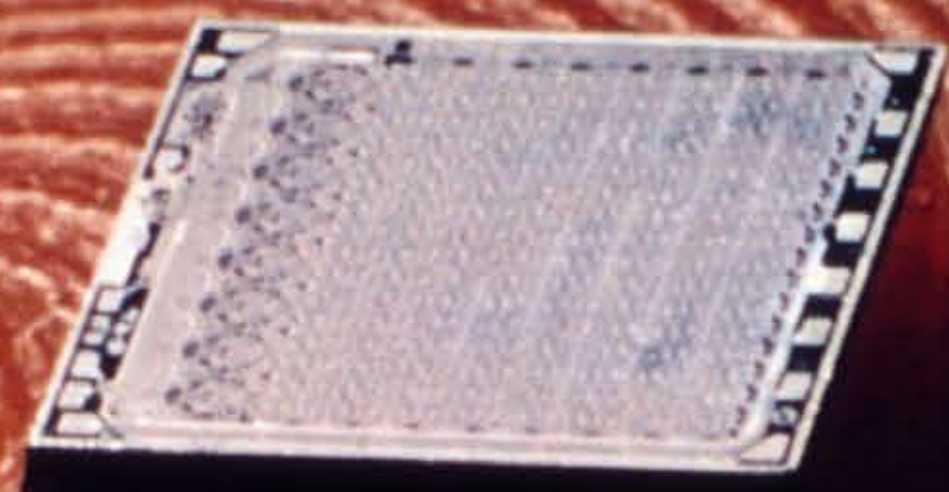
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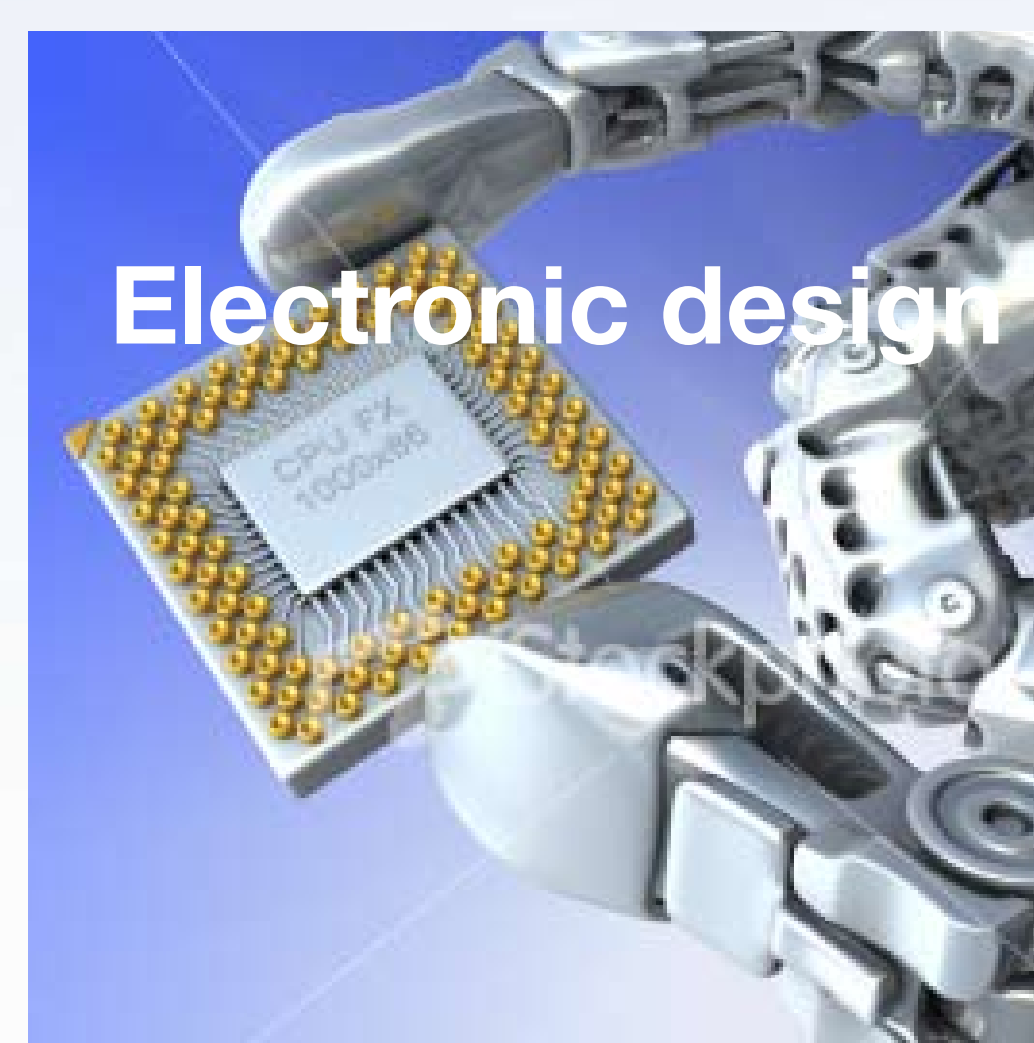
## EIS Architecture

**EIS Architecture**  
Performs research on design methodologies, tools and realizations of Embedded Internet Systems. Research aiming towards low-power, robust and scalable distributed systems with formally established real-time properties.



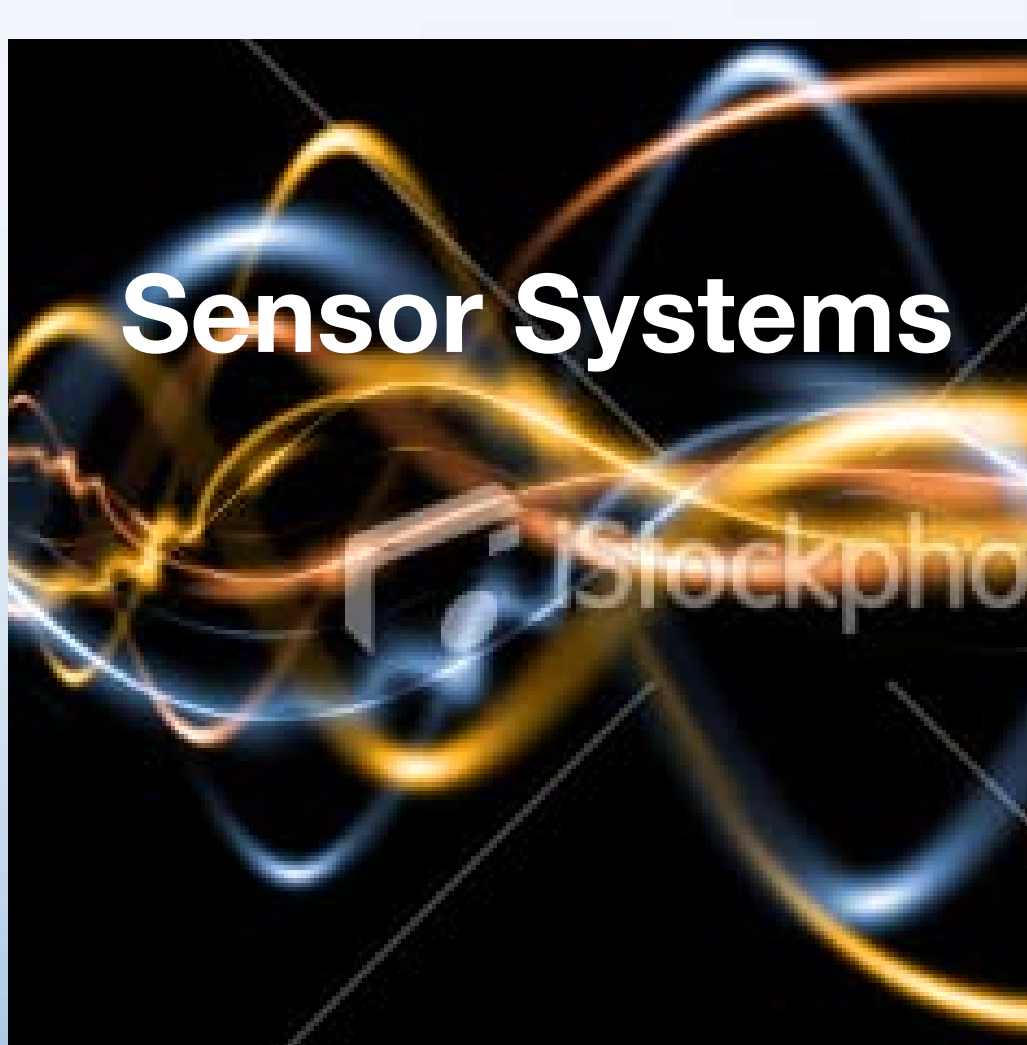
## Embedded EMC

**Embedded EMC**  
The EMC Center at EISLAB has two main purposes. Primarily it serve as a research and teaching facility. It also serves as a resource for the electronic industry in the region with a well equipped EMC lab. Research is performed within computational electromagnetics.



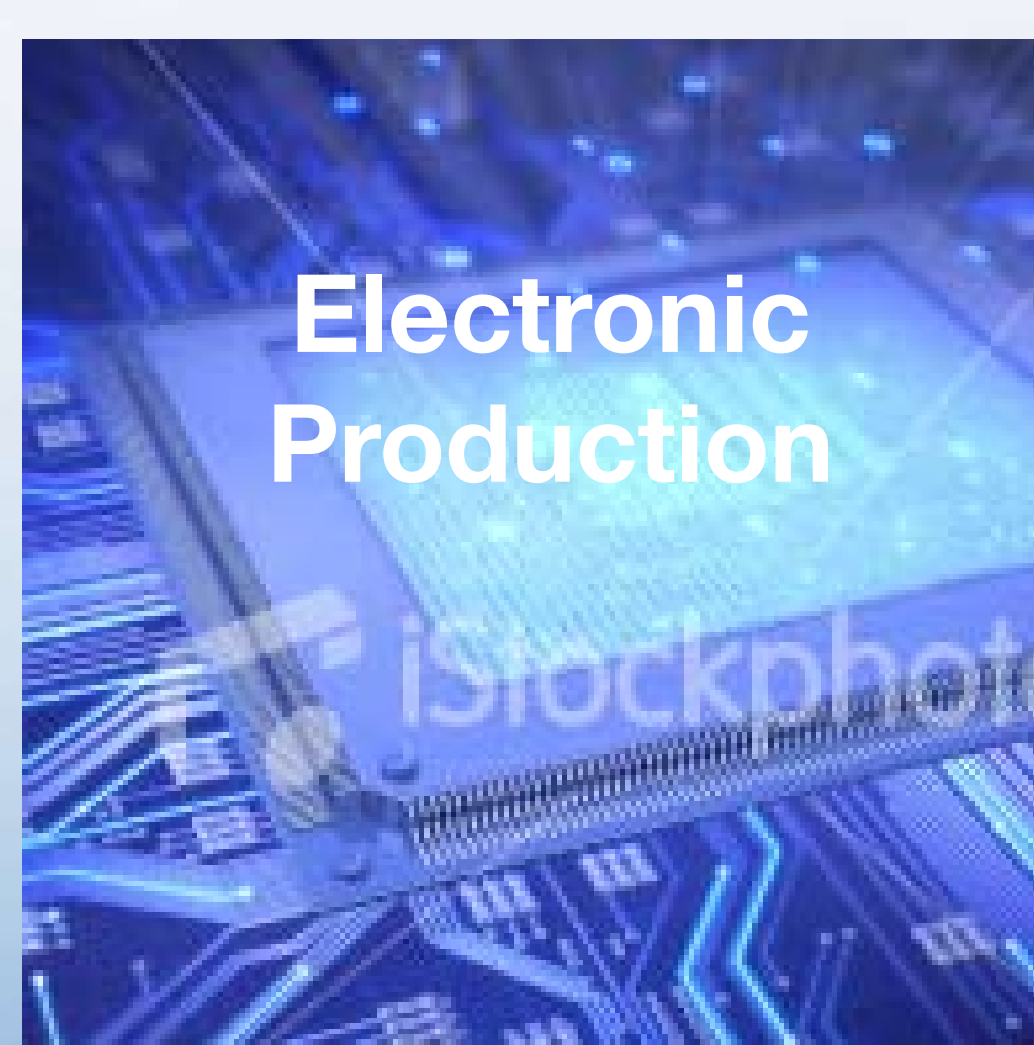
## Electronic design

**Electronic design**  
Performs research on analog and mixedsignal design for sensor systems. The group covers a wide range of projects, ranging from wireless platforms for sensor networking, down to low-noise transistor design on silicon. Low power consumption is the trademark.



## Sensor Systems

**Sensor Systems**  
Develops both ultrasonic and optical sources and receivers for measuring surface geometry, position and velocity of solid objects, fluids, gases and suspensions. A particular focus is development simulation models for sensors.



## Electronic Production

**Electronic Production**  
Conducting research on how to improve the quality, results, and predictability of soldering processes and development of automated test systems to increase the quality of small circuit boards.

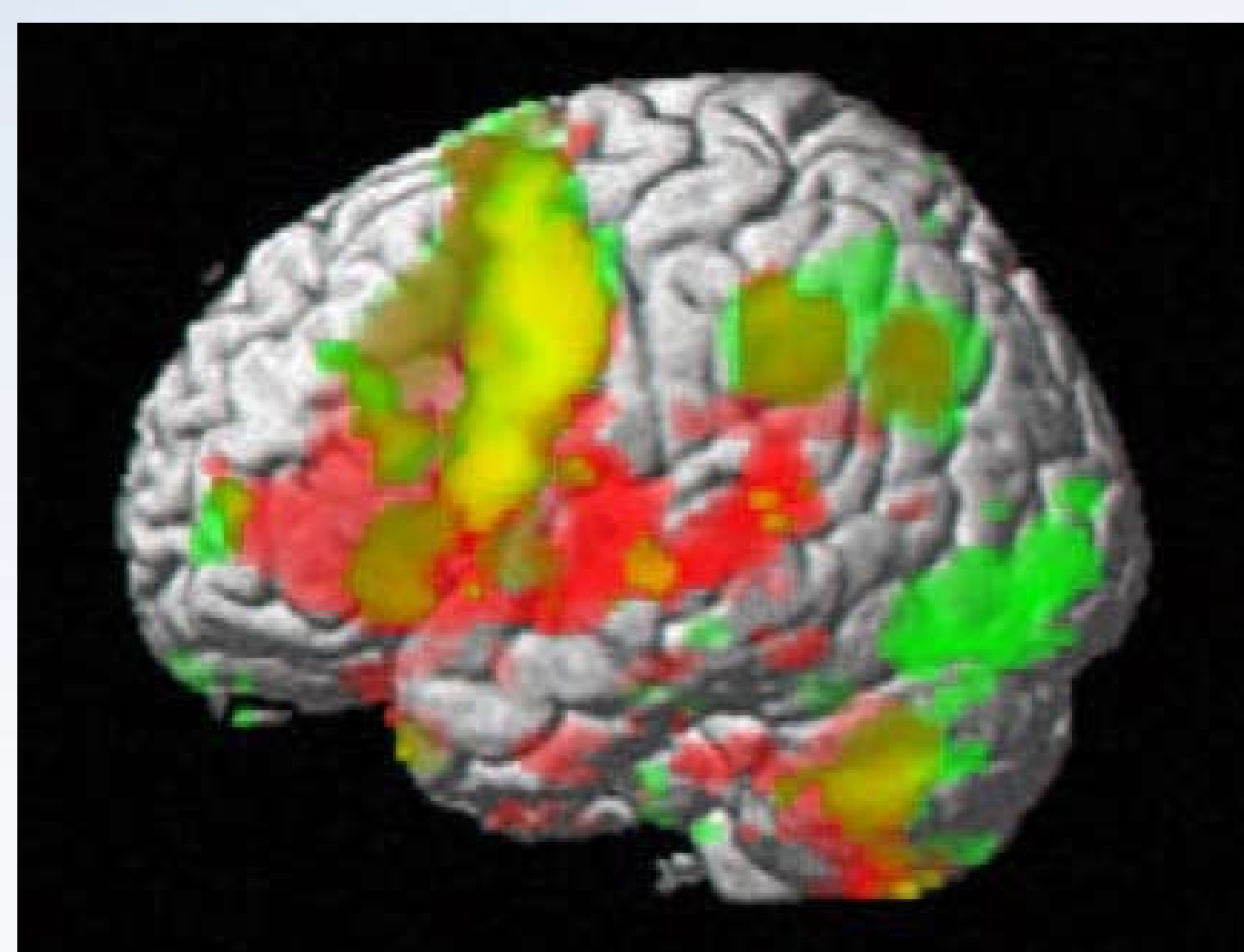
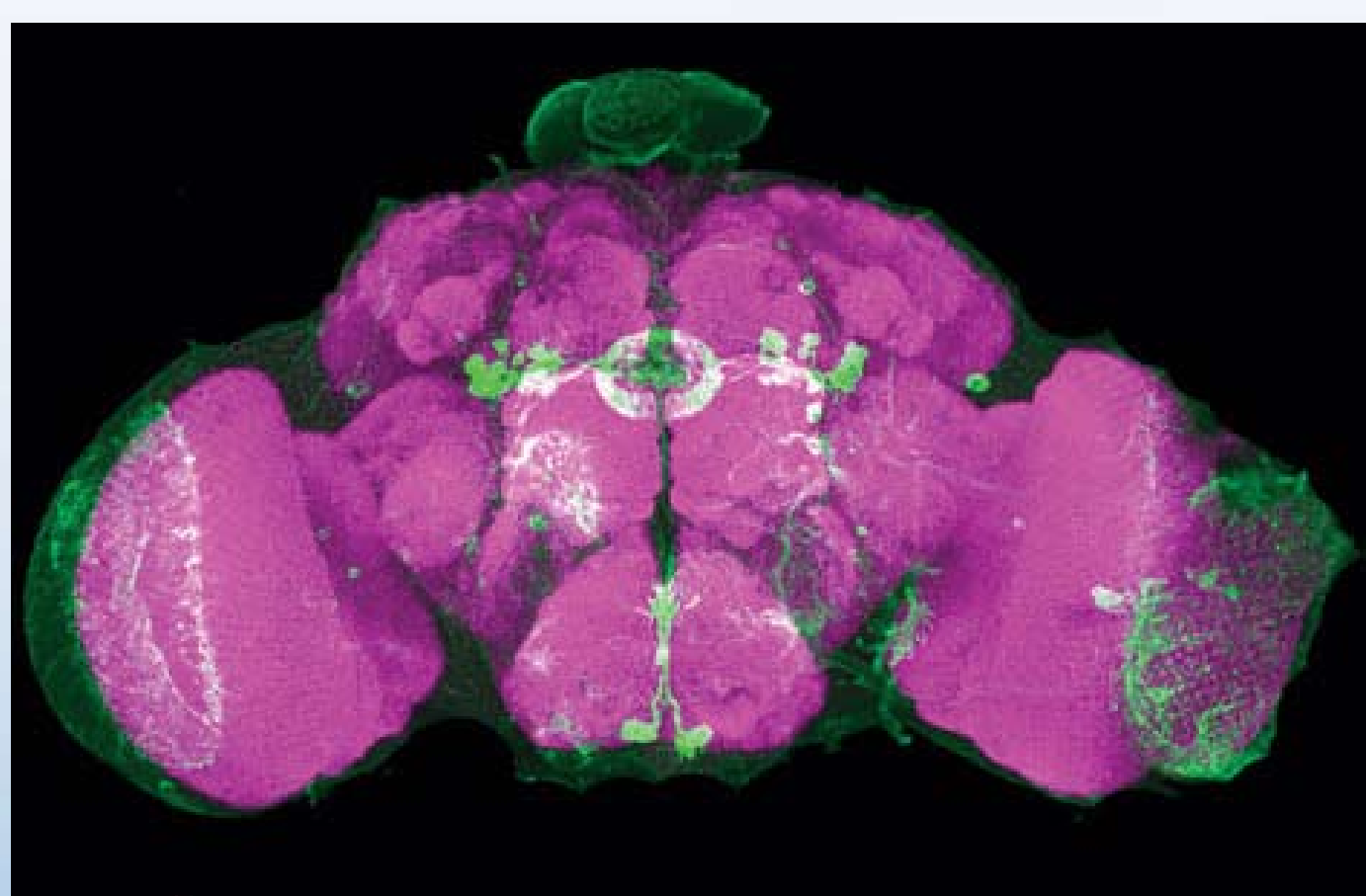
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## Brain-like Computing

### Wireless sensor networks

Networks of wireless sensor devices can monitor complex large-scale processes. We develop distributed cognitive models that makes such networks self-learning and able to recognize complex phenomena. Models used are inspired mainly by human cortex, but we are interested also in insect brains and societies. Fruit flies consume about 10-20 microwatts in total. Their brain is far superior to a CPU and contains some 200 000 neurons.



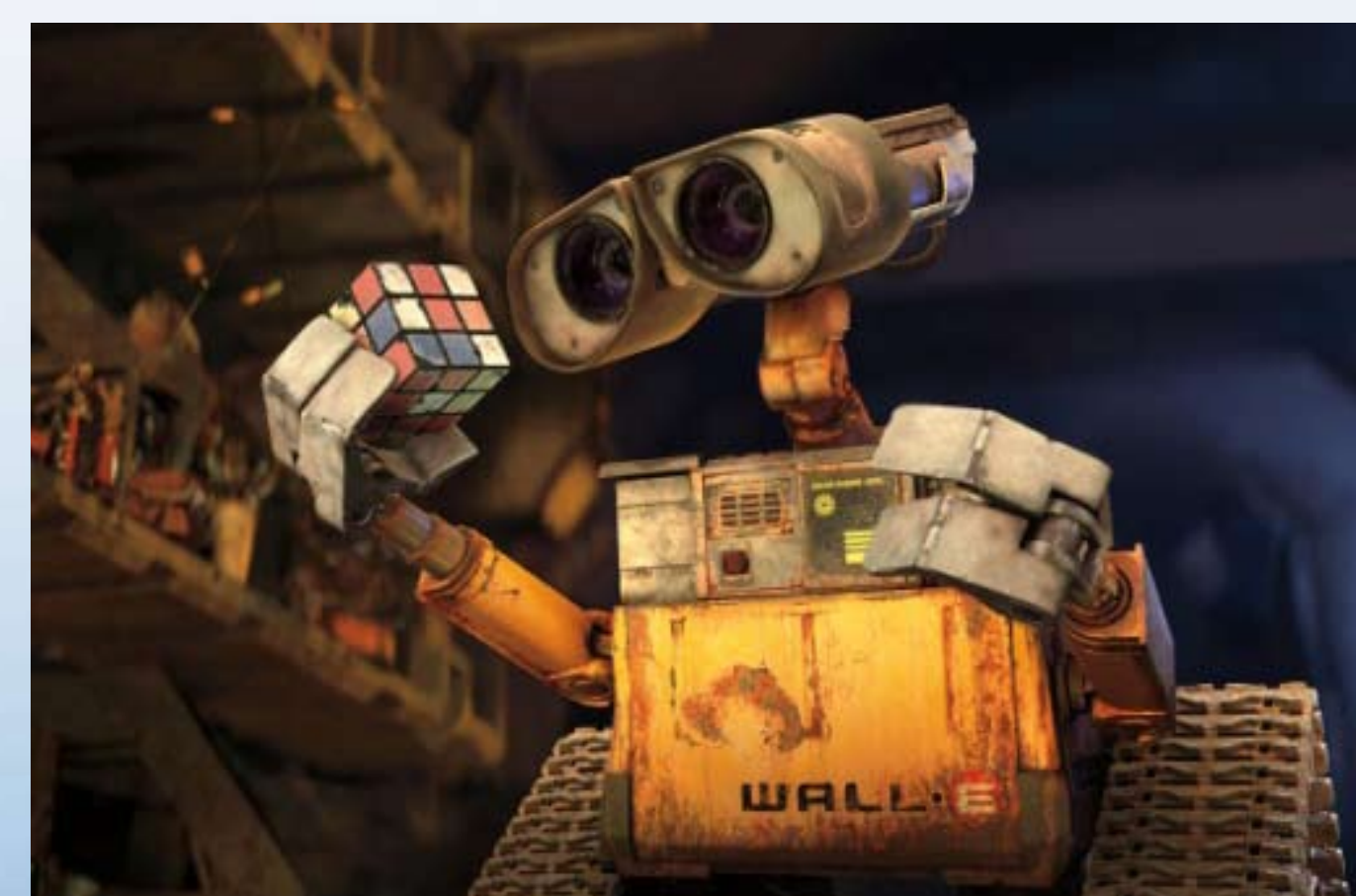
### Models of human cortex and perception

The folded surface of the brain is the cerebral cortex. It is the major logical processing unit of the brain. Our phenomenal ability to recognize and make sense of complex events depends on cortex ability to interpret and combine information from different senses to a unified perception. We have developed a neural network architecture that mimics cortex computing principles. It is used to model human perception and to process complex sensor information.

### Consciousness

Consciousness presumably is the highest level of cognition. It gives the ability to distinguish what is important in vast amounts of sensor information.

We are interested in two aspects of consciousness, how experience and the content of experience are generated. In this context we model synchronization in neural networks, based on results from neuroscience, brain imaging and studies of human disorders with altered levels of consciousness.



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## Sensing for medicine

### Ultrasound measurement

Using ultrasound for continuous measurement of  
bone cement curing

### Opto acoustic

Investigating new approaches to cancer detection

/Bilder?/

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## Ultrasonic and opto acoustic sensing for industrial environment

### Opto acoustics

Applied to paper and pulp industry. Targeting the measurement of pulp consistency and fiber properties like E-modulus. Supporting efficiency and quality in the paper industry.

### Ultrasound measurement

- Gas flow metering in extreme environment up to 1200 °C
- Analysis of biogas mixtures and energy metering
- Material characterisation

/Bilder?/

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## Positioning

### GPS receiver technology

- Antenna technology
- Integration with inertial sensors
- Software radio GPS
- Low power GPS receiver technology

/Bilder?/

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## Robot Technology

### **Sensing and actuation for welfare robots**

- Distant palpation robot
- Intelligent wheelchair

### **Sensing and actuation for industrial robots**

- Optimization of robot truck drive paths
- Remote control of robots

/Bilder?/

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## **Electronics production - a research area for EISLAB since fall 2009**

### **Solderability**

Research in solderability - enhancing production yield  
Advanced thermal simulations - to ensure production  
reliability.

### **Testability**

Methods, tools and equipment for PCB testing, Automatic  
Test Equipment (ATE), Design for Testability (DFT), Built-  
in-self-test (BIST) etc.

### **Cuptronic circuit board technology**

World leading circuit boards in high frequency perform-  
ance, feature sizes and PCB interconnection techniques.

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## Embedded EMC

### EMC Lab

The EMC Lab has a large, fully attenuated electromagnetically shielded chamber. It provides a platform for teaching and research, and it serves as an industrial test ground to solve electromagnetic problems.

The EMC Lab has a shielded chamber sized 8 x 5 x 4 m, where all the inside surfaces are covered by nonreflecting material, making the measuring site similar to free space in the frequency range 30 MHz – 18 GHz.

Radiated electromagnetic fields from electronic equipment can be measured in the range 30 MHz – 6 GHz.

Immunity against radiated electric fields can be tested in the range 80 MHz – 6 GHz with magnitudes up to 18V/m.

#### Outside the chamber there are facilities for the following:

- Measuring conducted emissions on the mains (Artificial Mains Network).

#### And the following immunity tests:

- Electrostatic discharges
- Electric Fast Transient pulses (breaking inductive loads) on the mains
- Surge (lightning) pulses on the mains
- Surge pulses, injected by means of CDN (Coupling Decoupling Network)
- Conducted harmonics 0.15 – 1000 MHz, injected by means of injection clamp
- Conducted harmonics 0.15230 MHz, injected by means of CDN

#### Extra facilities available at the EMC Lab

Network analyzer 10 MHz – 26.5 GHz,  
Digital oscilloscope 2.5 GHz , 4 channels  
Spectrum analyzer 26.5 GHz  
Signal generator 26.5 GHz

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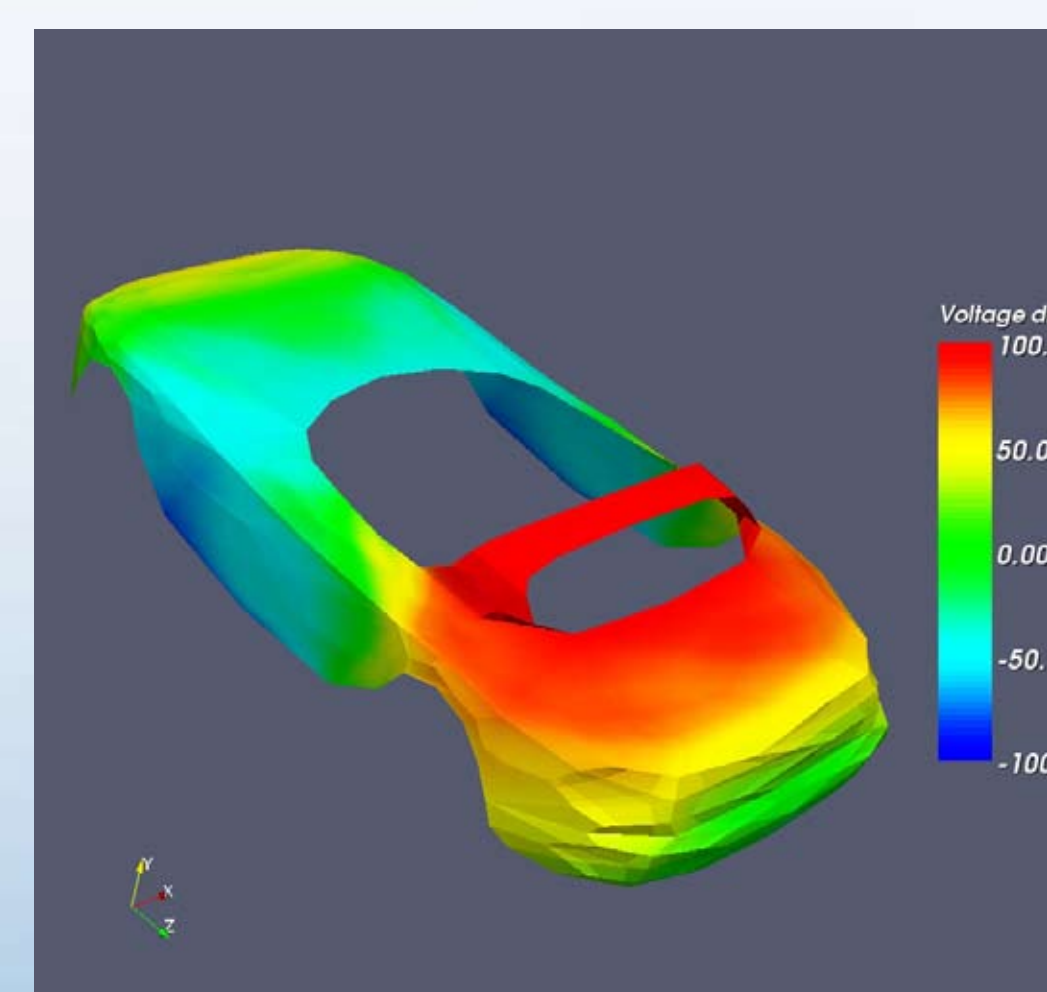
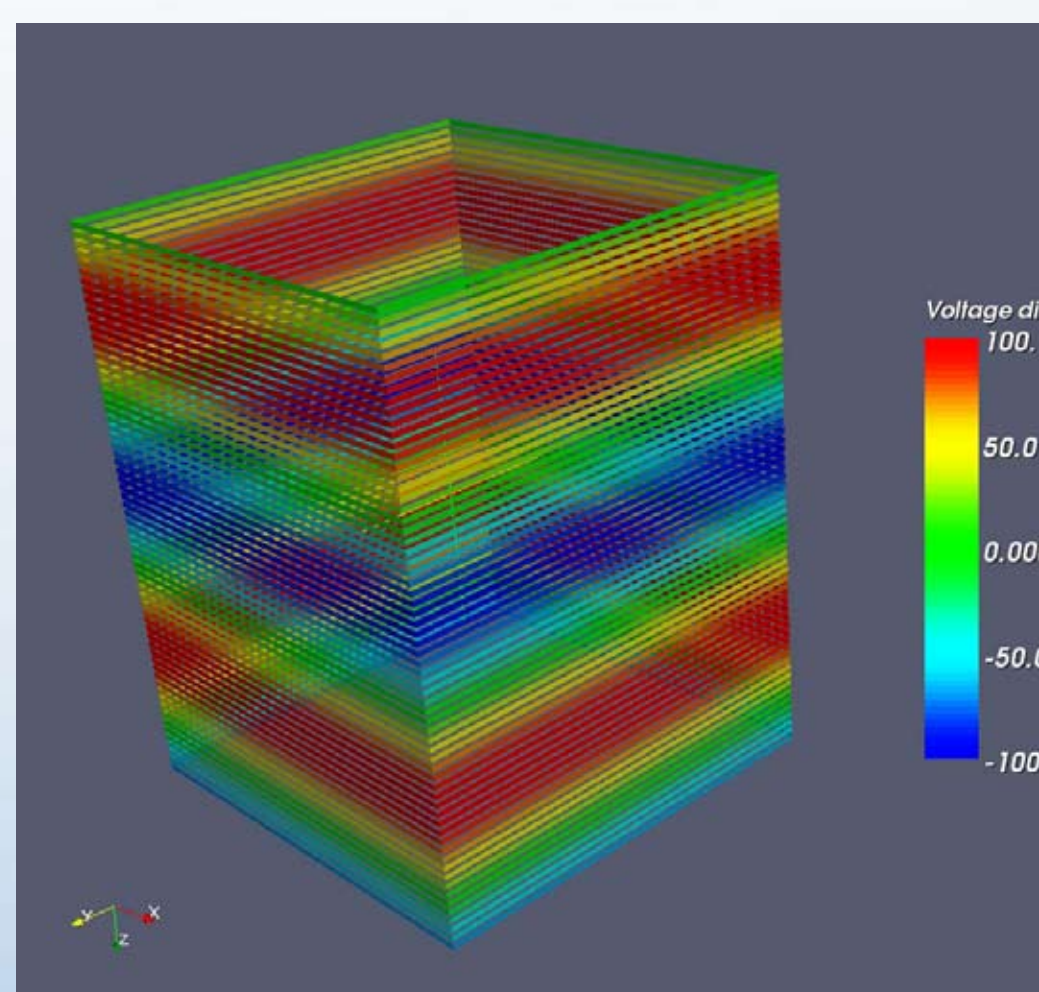
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## Embedded EMC

### PEEC

The group is working with the development of a Partial Element Equivalent Circuit (PEEC) based software for electromagnetic analysis, entitled MultiPEEC. The MultiPEEC software transforms an electromagnetic problem to a circuit formulation and solve the corresponding circuit equations. In this way, combined electromagnetic and circuit problems are easily solved in both the time- and frequency domain.



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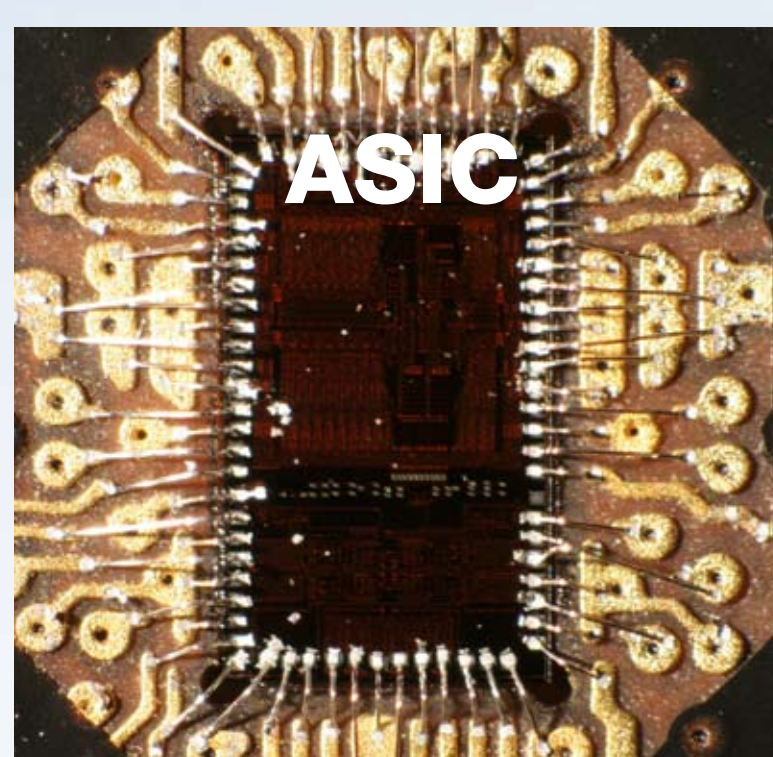
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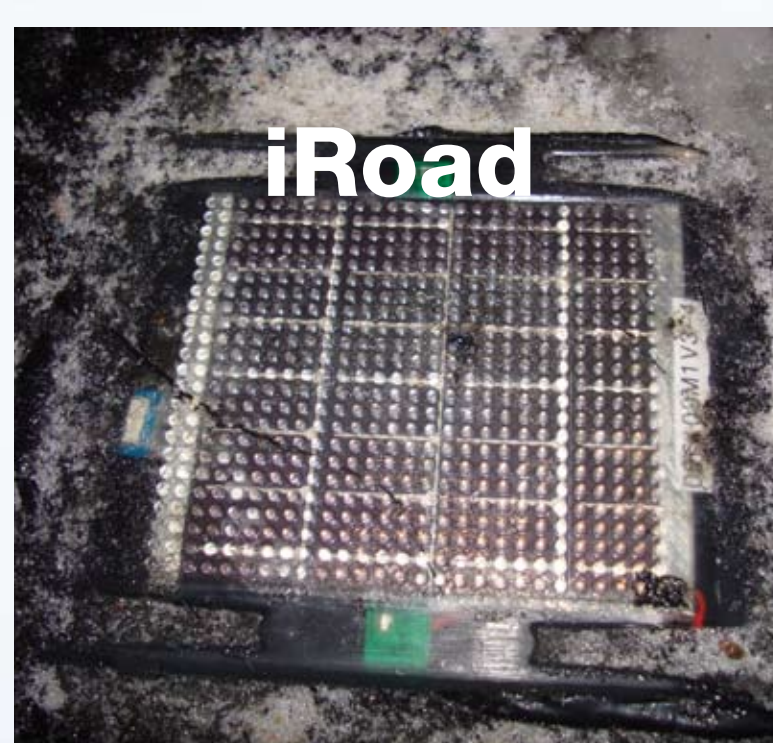
## Electronics Design

– research on analog and mixed signal design



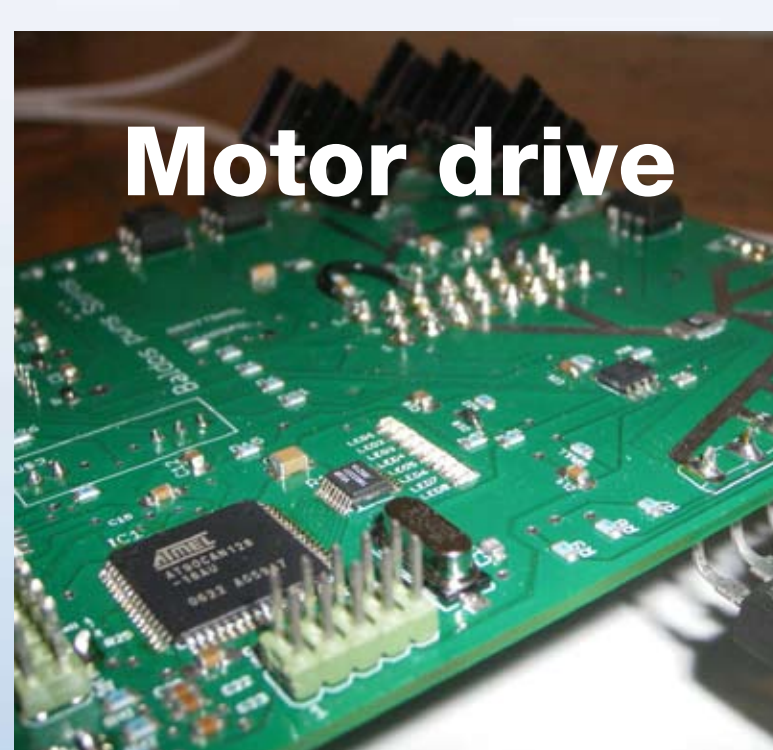
### ASIC design

– ultra low power, small size sensor front-end electronics



### Embedded systems

– low power, small size embedded system hardware design



### High efficiency motor drives

– transient minimization and EMC suppression in a hybrid driveline

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## EIS Architecture

EISLAB performs research on design methodologies, tools and realizations of Embedded Internet Systems. The concept of reactivity is key to the research performed at EISLAB; reactivity in the sense that a system reacts to events, either internal to the system or caused by its environment. This is manifested through the modeling paradigm of Timber. The ultimate goal is to find low-power, robust, scalable, distributed system solutions, with formally established real-time properties. The reactive approach is applied throughout the system design, all the way from protocols for service discovery, Internet Protocol based communication, down to analog and digital sensor interfaces.

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## Timber

Timber is a general programming language specifically aimed at the construction of complex event-driven systems. It allows programs to be conveniently structured in terms of objects and reactions, and the real-time behavior of reactions can furthermore be precisely controlled via platform-independent timing constraints. This property makes Timber particularly suited to both the specification and the implementation of real-time embedded systems. EISLAB is currently involved in development of Timber in collaboration with industry and other universities world wide.

[www.timber-lang.org](http://www.timber-lang.org)

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