



Custom design of multi-electrode arrays for stimulation and recording application



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Screen printed multi-electrode arrays

Design

- More than 100 different electrodes and sensor prototypes designed and manufactured
- Multilayer design – produced electrodes consisting of more than 10 layers

Pastes/Inks

- Experience with conductive and dielectric pastes for biomedical applications
- Pilot tests with newly developed inks (e.g. cellulose based ink by Tecnalía Biomat)

Substrates

- Polymer (PET, PS, PC), cellulose, Tyvek and textile based substrates

Printing/Production

- High resolution fast prototyping of small series

Electrodes

- Recording
- Stimulation
- Iontophoresis

Sensors

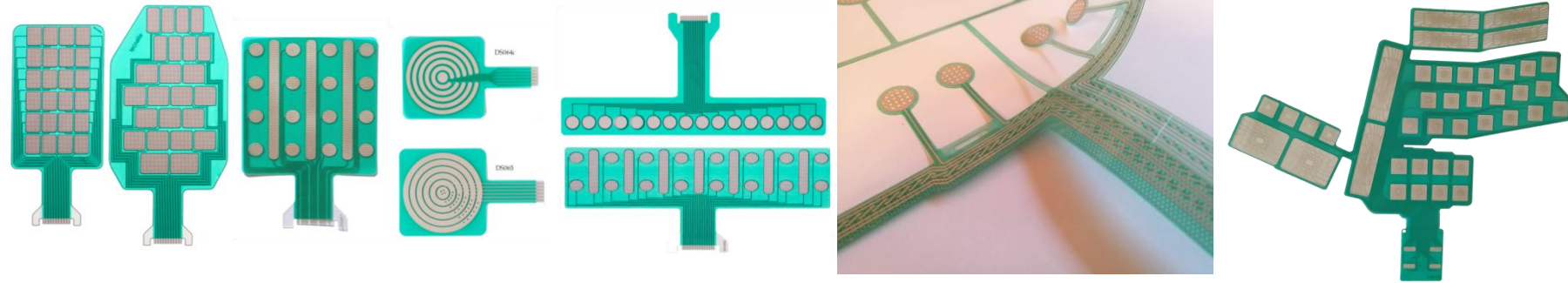
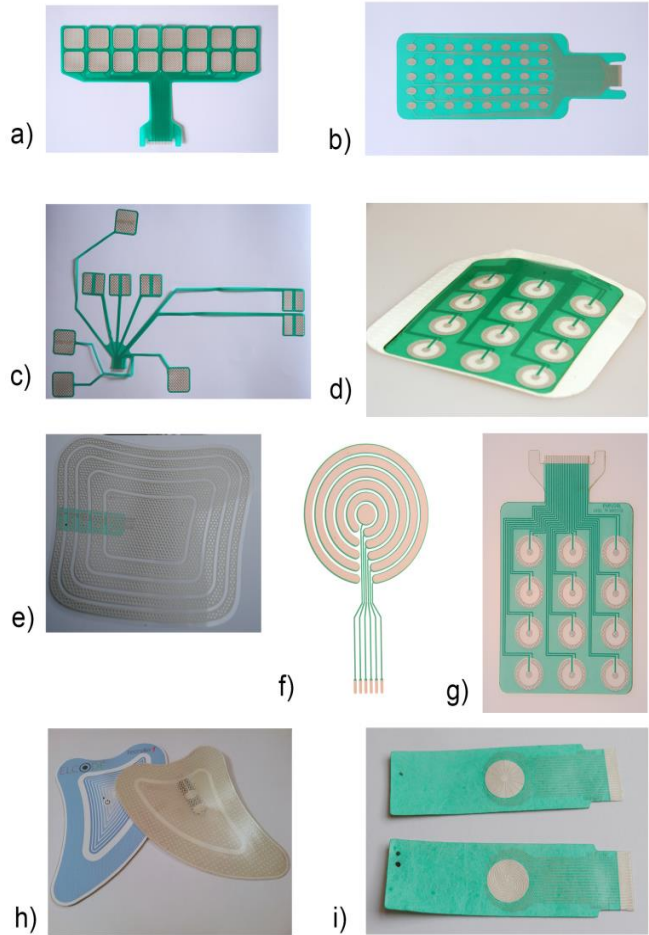
- Electrochemical/Microfluidic
- Pressure/Capacitive

Actuators

- Heaters
- Incorporation of active component



TecNALIA Serbia expertise in MEA design



Muscle activation

- Forearm and upper arm
- Lower and upper back
 - Peroneal nerve
- Quadriceps and soleus
- Abdominal muscles

Afferent stimulation

- Sensory substitution
- Tactile feedback on fingertips

Recording electrodes

- Various designs of EMG electrodes
- Various designs of EEG electrodes



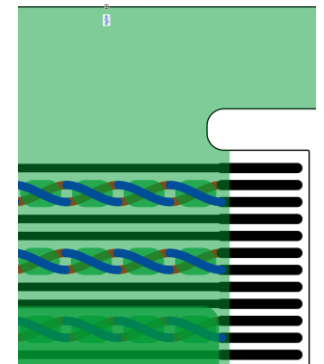
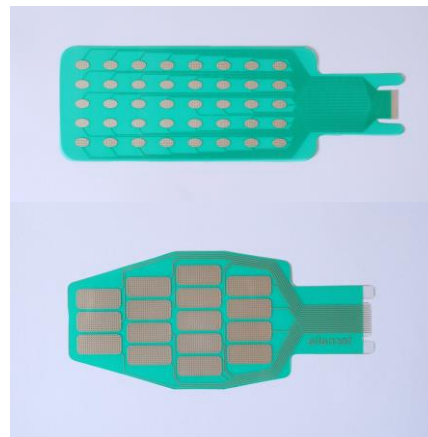
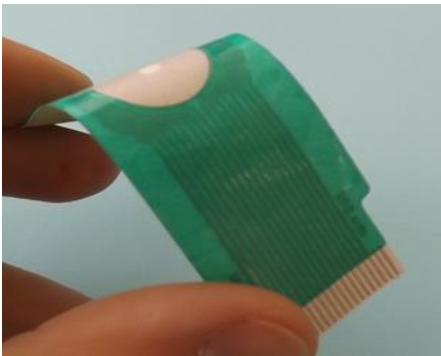
MEA design and optimization

MEA design considerations

- MEA surface and size
- Placement
- Number of electrodes
- Configuration of electrodes
- Arrangement of electrodes
- Size and shape of pads

Optimization of the design

- Anatomy
 - Simulations
 - Animal model
- Electrical characteristics
- In vivo experiments





Example: Design for FES hand rehabilitation

Extension

Superficial



- **Brachioradialis**
Flexes at the elbow
- * ■ **Extensor Carpi Radialis Longus and Brevis**
Extends and abducts the wrist
- * ■ **Extensor Digitorum**
Extends medial four fingers
- * ■ **Extensor Digiti Minimi**
Extends the little finger, and contributes to extension at the wrist
- * ■ **Extensor Carpi Ulnaris**
Extension and adduction of wrist
- **Anconeus**
Extends and stabilises the elbow joint

Deep



- **Supinator**
Supinates the forearm
- * ■ **Abductor Pollicis Longus**
Abducts the thumb
- * ■ **Extensor Pollicis Brevis**
Extends at the metacarpophalangeal and carpometacarpal joints of the thumb.
- * ■ **Extensor Pollicis Longus**
Extends all joints of the thumb

Flexion



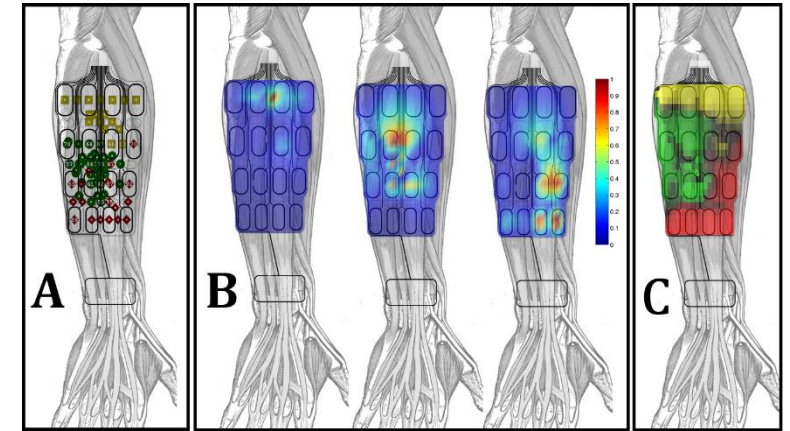
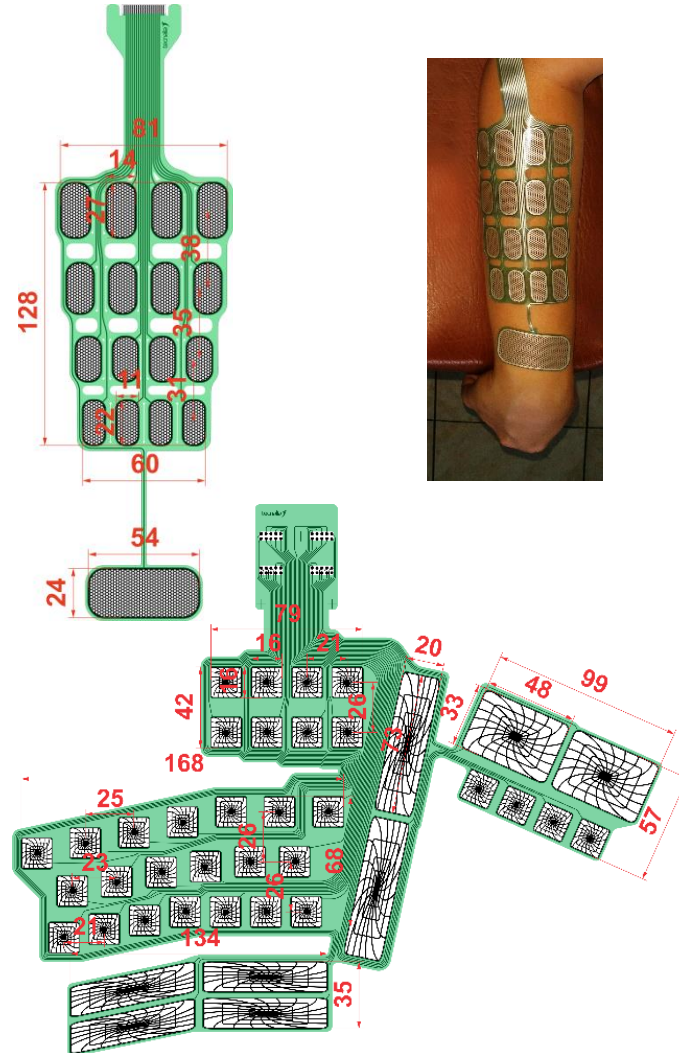
- **Pronator Teres**
Pronation of the forearm
- **Flexor Carpi Radialis**
Flexion and abduction at the wrist
- **Palmaris Longus**
Flexion at the wrist
- * ■ **Flexor Carpi Ulnaris**
Flexion and adduction at the wrist

Superficial



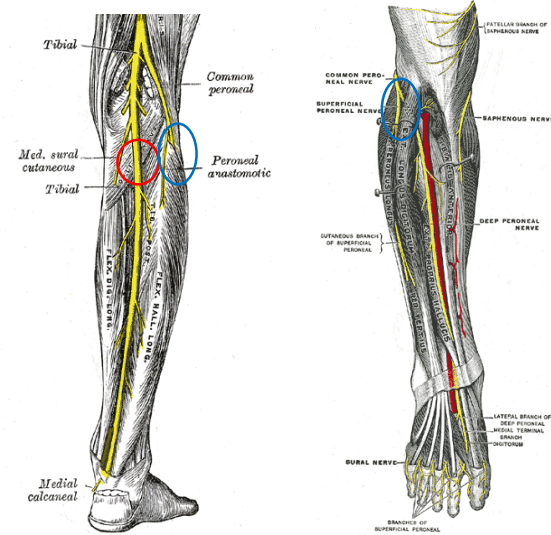
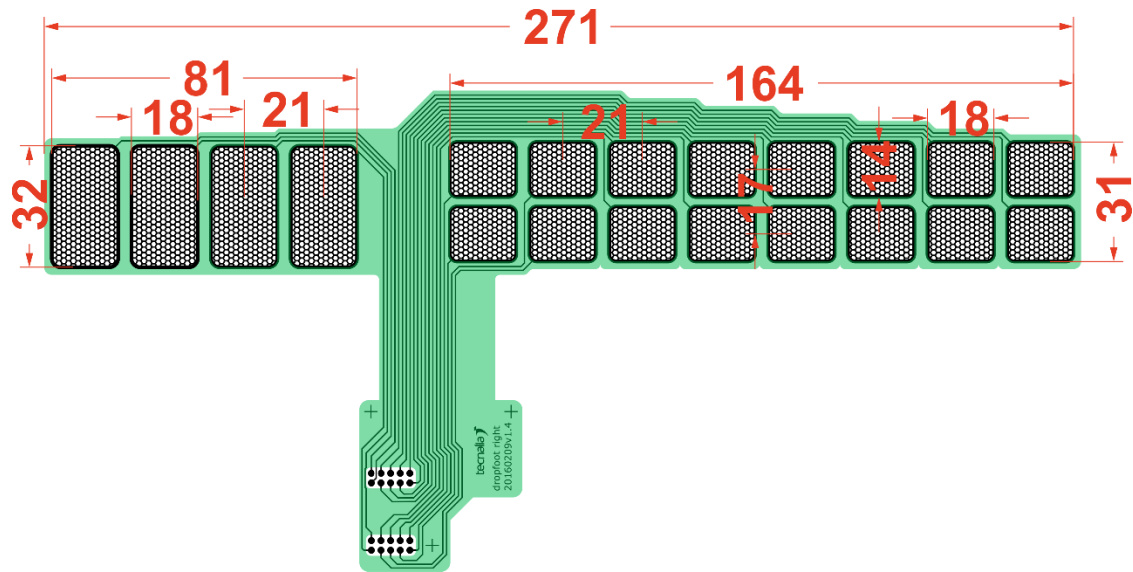
- **Flexor Digitorum Profundus**
Flex the distal interphalangeal joints of the fingers
- * ■ **Flexor Pollicis Longus**
Flex joints of the thumb
- * ■ **Pronator Quadratus**
Pronates the forearm

Deep



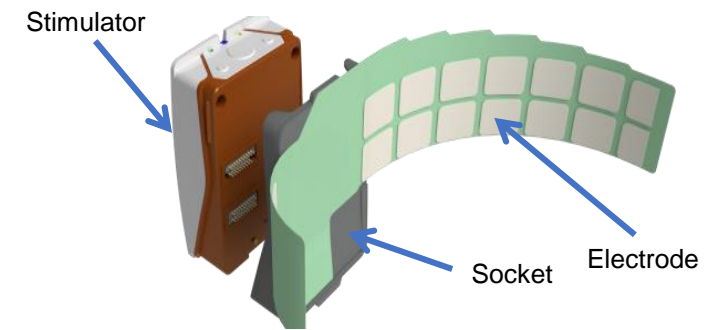
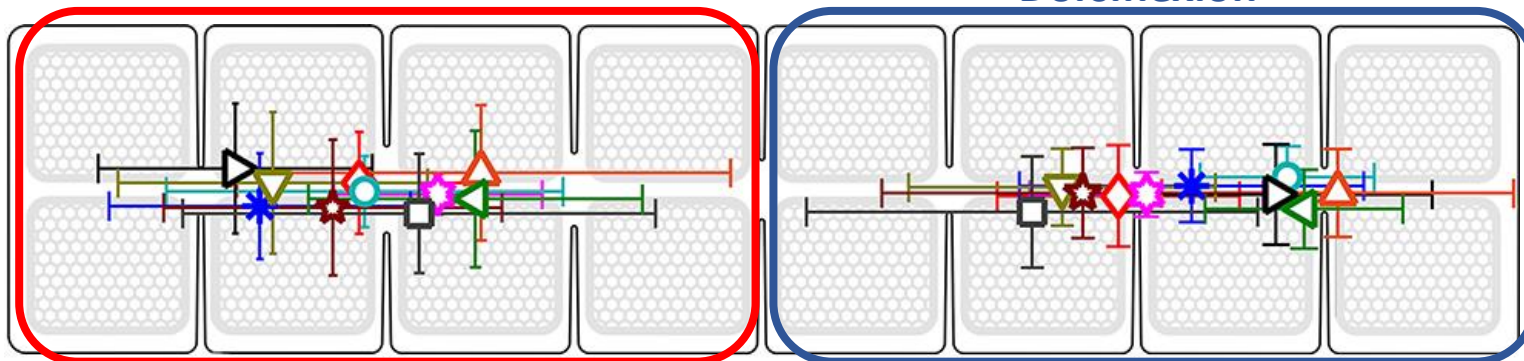


Example: Design for Dropfoot



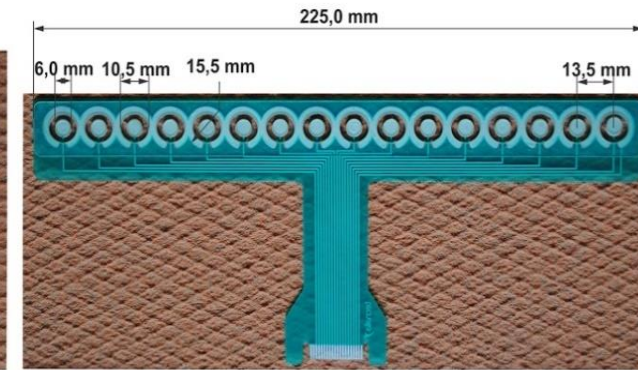
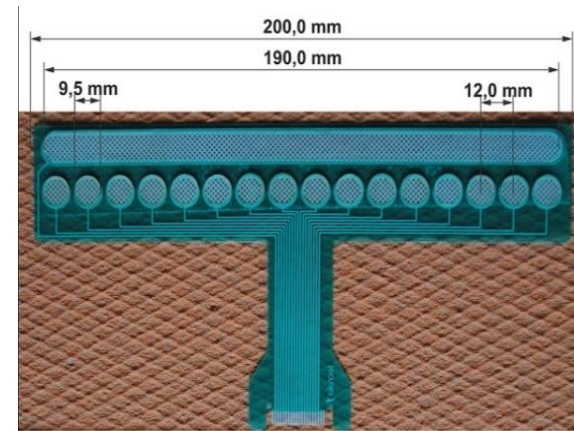
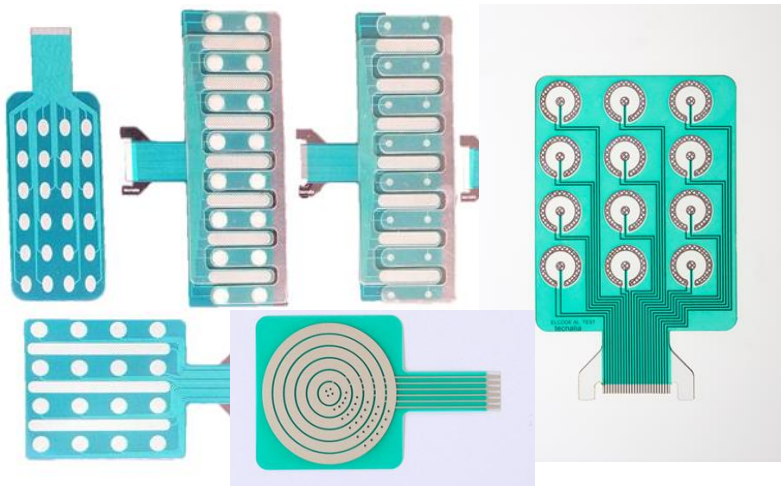
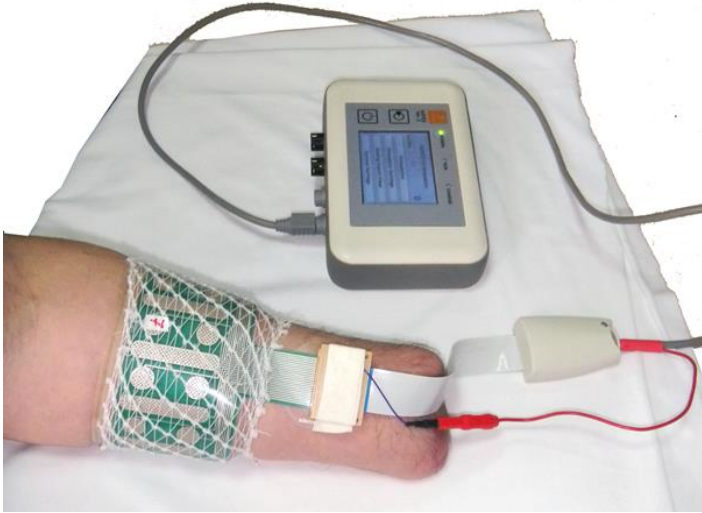
Plantar flexion

Dorsiflexion



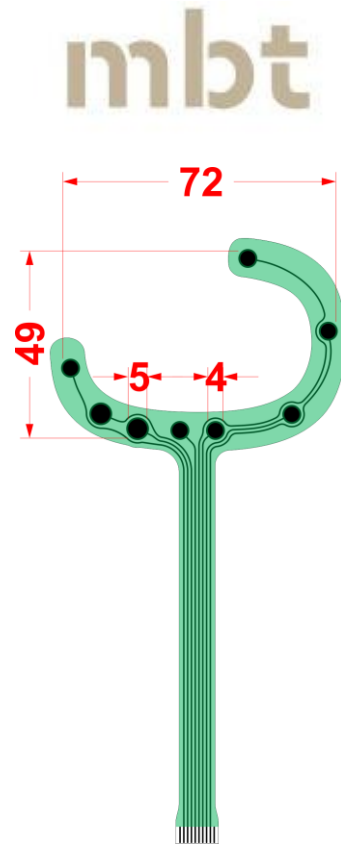
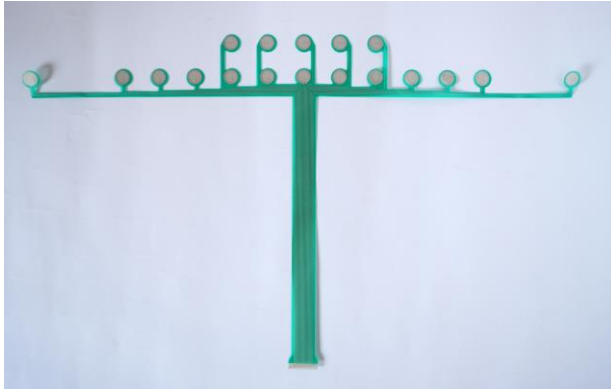


Example: Design for sensory substitution





Example: Design for EEG recording



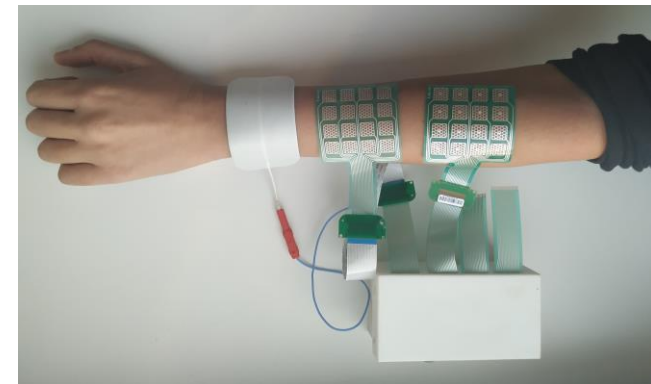
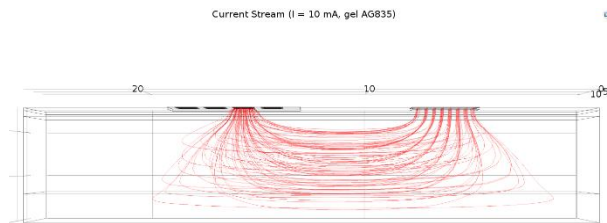
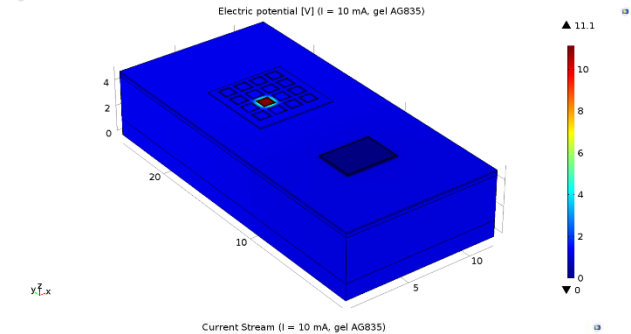
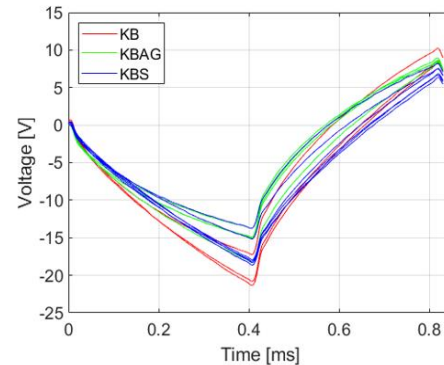
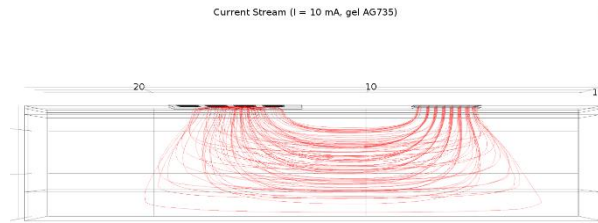
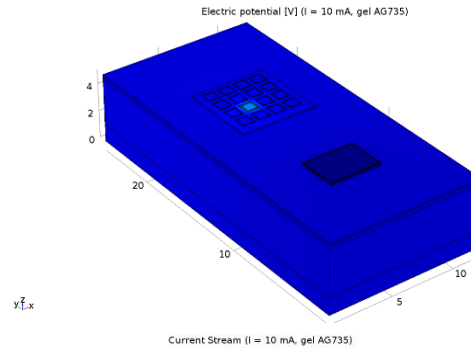
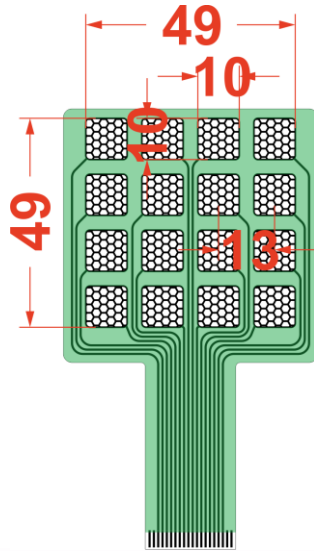
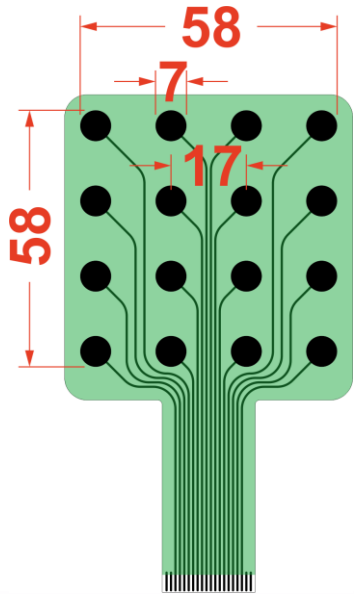
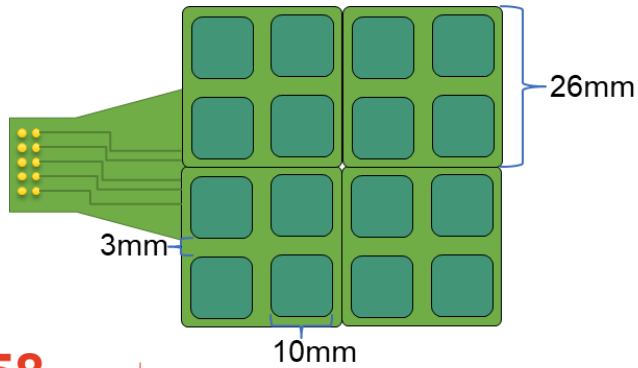
SMARTFONES





Example: Design for WEARPLEX

SPECS AND RECS





Conclusion

MEA design

- Of high relevance for the results in stimulation and recording
- Not always straight forward due to conflicting requirements
- Adaptation after in-vivo trials is usually recommended

Expertise

- Necessary for defining specs and recs for application of interest
- Important for doing tests, establishing flaws and shortcomings
- Critical for updating the design based on obtained results