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GRAphene-based **F**lexible neural **I**nterfaces
for the control of **N**europrosthetic devices

Universitat Autònoma de Barcelona

ICN2 Institut Català de Nanociència i Nanotecnologia — EXCELENCIA SEVERO OCHOA

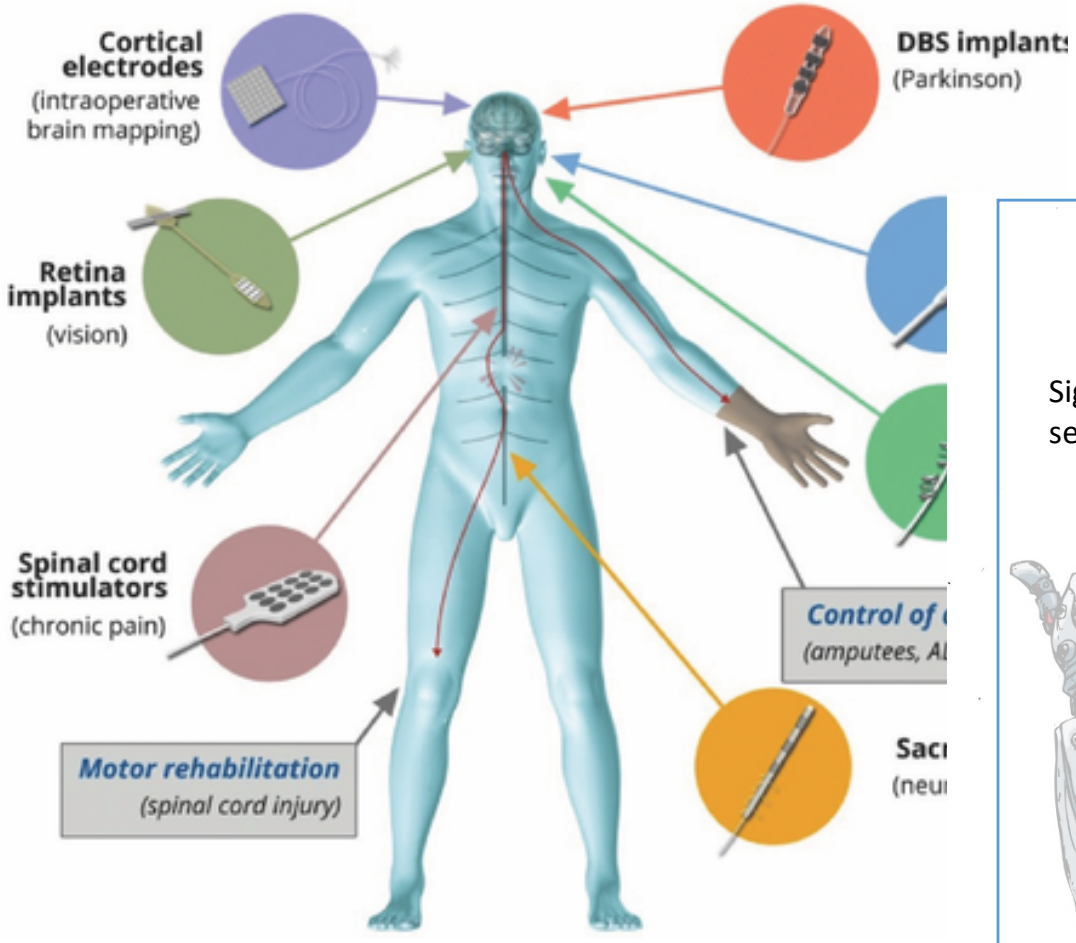
BOĞAZİÇİ ÜNİVERSİTESİ 1863

CHALMERS AVANCEZ 1829

Axonic NEUROSTIMULATION SYSTEMS

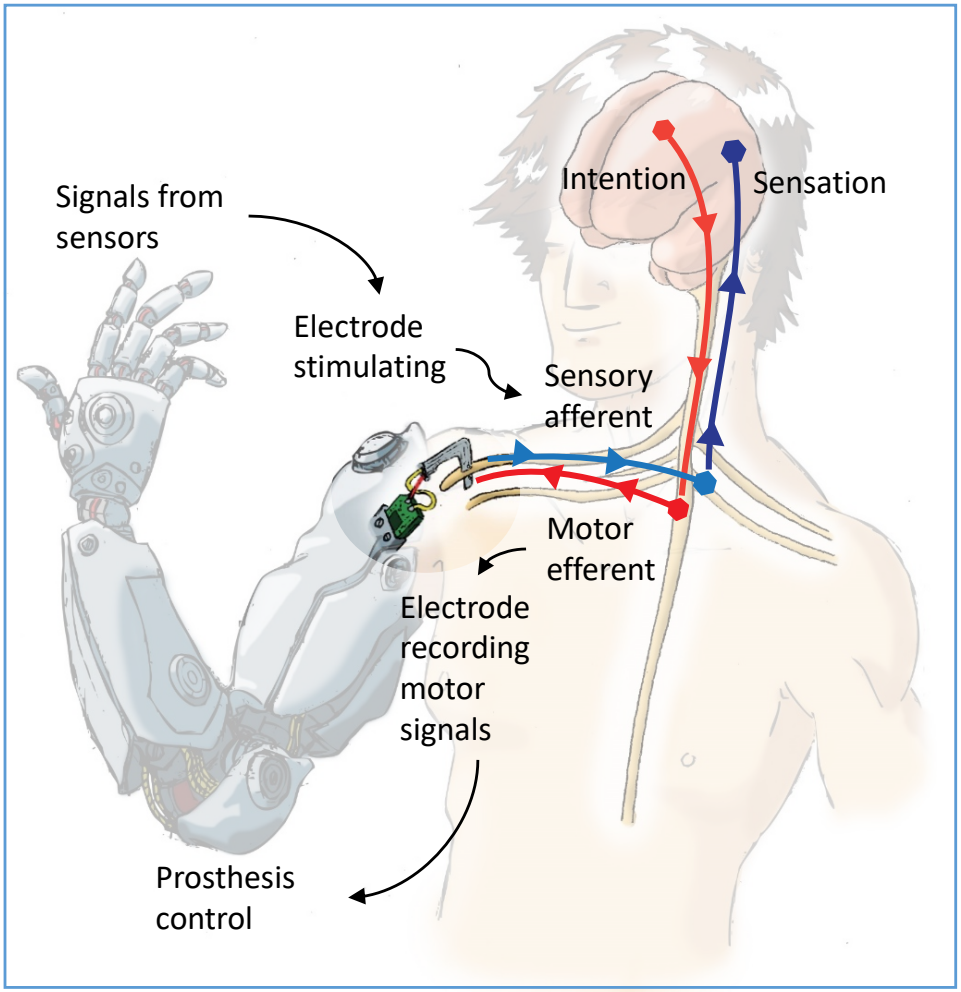
Introduction

Neural interfaces for neuroprostheses

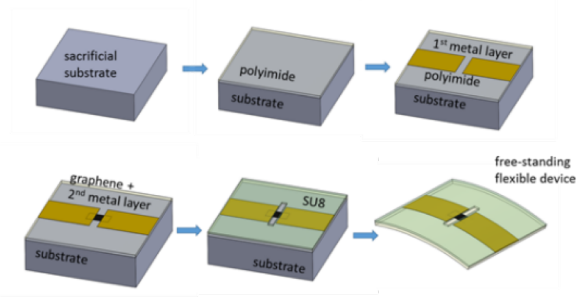


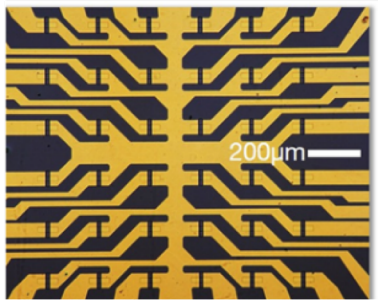
Kostarelos et al. Adv Mater 2017

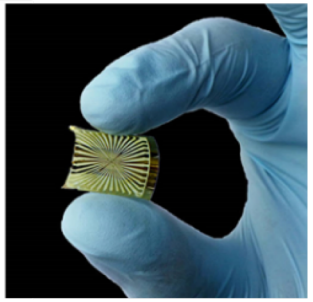
Neural interfaces for motor control and sensory feedback of advanced hand prosthesis

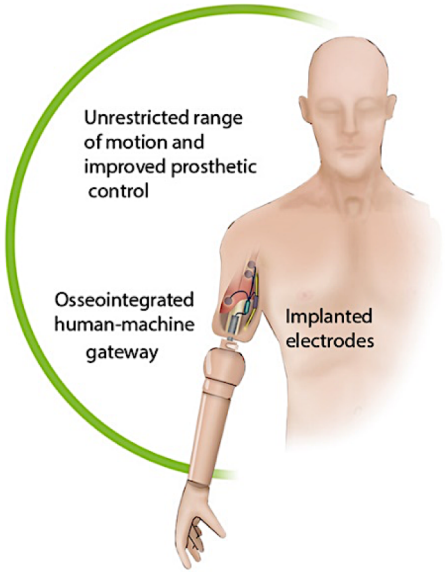


Objectives



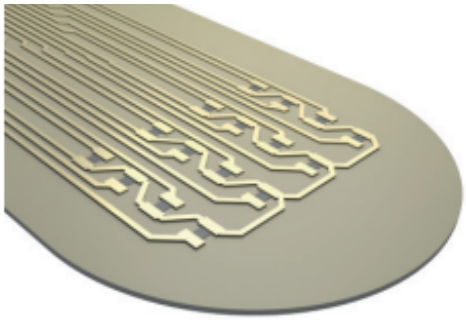


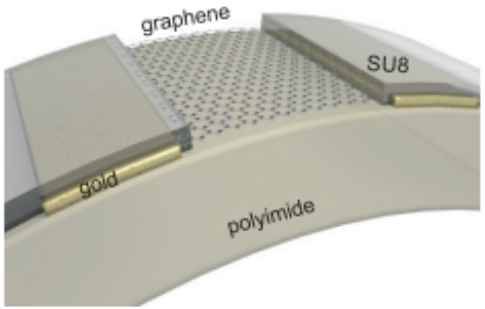


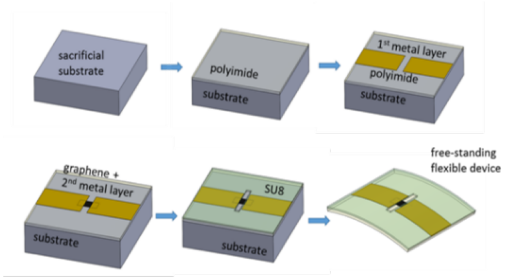


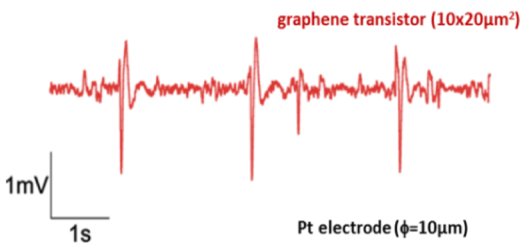
- Fabrication of **graphene-based sensors and stimulating devices** on ultra-flexible substrates (ICN2)
- Biocompatibility and efficacy of the **bidirectional electrical communication** of graphene based flexible devices **in the PNS** (UAB).
- Test of the developed **graphene interfaces** to record and to activate the **brain cortex** (BOUN).
- Set up of a **multichannel stimulator** to provide microstimulation to the PNS and CNS (AXO).
- Advancement towards a **close loop system for prosthetic control** and treatment of phantom limb pain in amputee subjects (CUT).

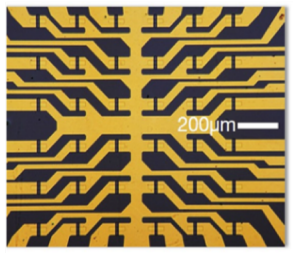
WP1: Flexible graphene-based neural and surface devices

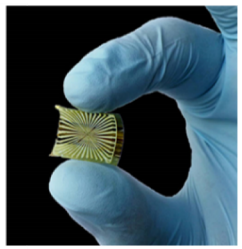


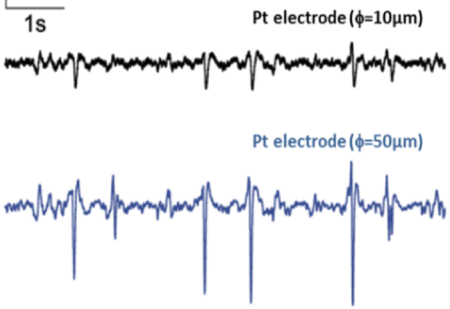












Arrays of **electrodes for nerve stimulation** using thin films of reduced graphene oxide.

Arrays of **recording devices** based on low impedance electrodes as well as on graphene field effect transistors.

Designs for implants in brain cortex and in peripheral nerve, and for surface devices.

In vitro characterization of the devices

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WP2: Graphene based electrodes in the PNS

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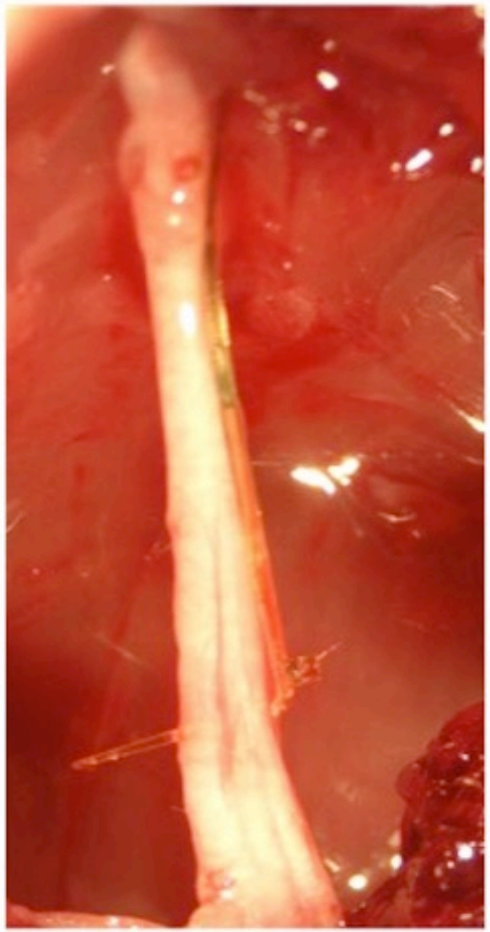
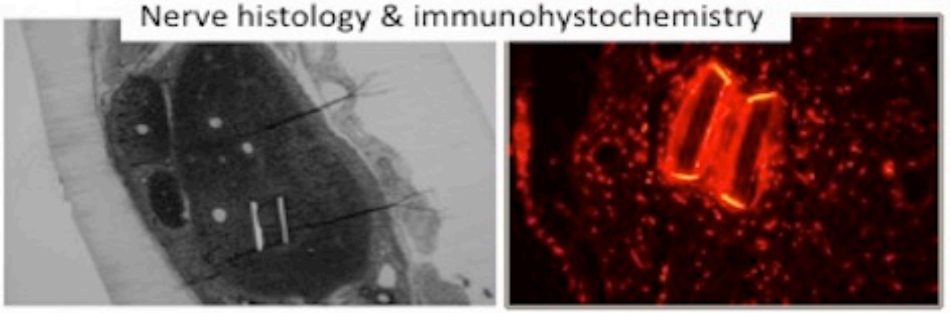
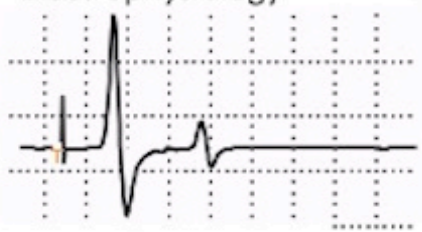
PNS intraneural interface



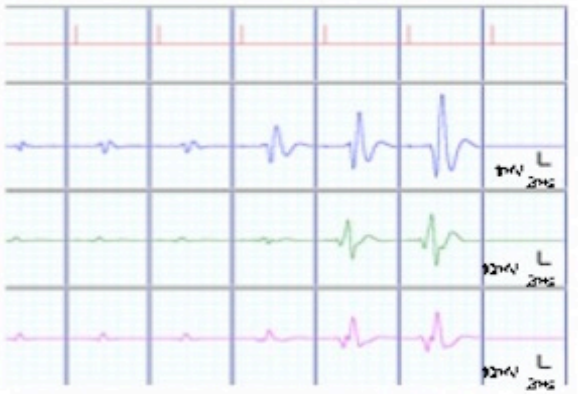
Nerve histology & immunohystochemistry



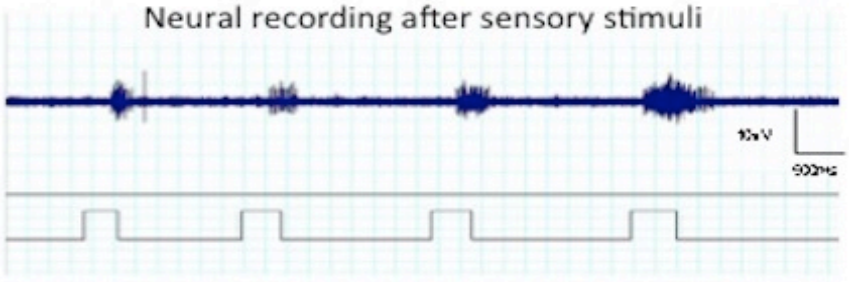
Electrophysiology



Muscle responses after stimulation



Neural recording after sensory stimuli



PI: X Navarro

Biocompatibility and safety of GRM devices implanted in the nervous system
Electrophysiological testing in vivo for **nerve stimulation selectivity** and **neural signal recording**.

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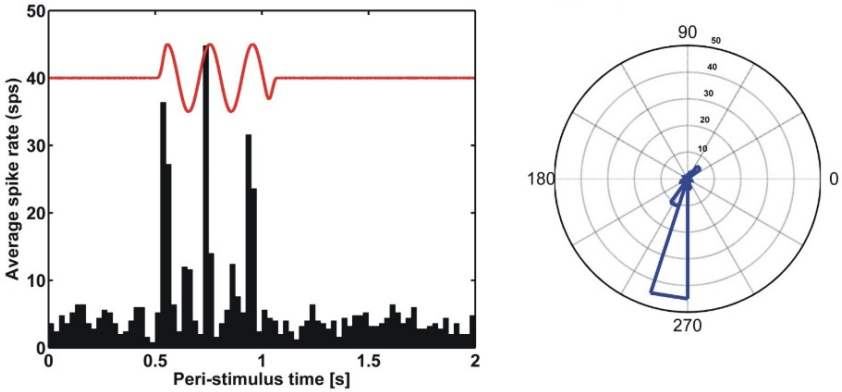
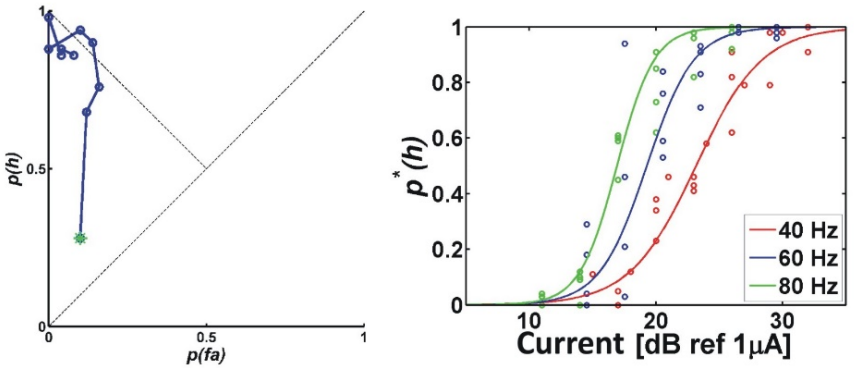
WP3: Graphene based electrodes in the CNS

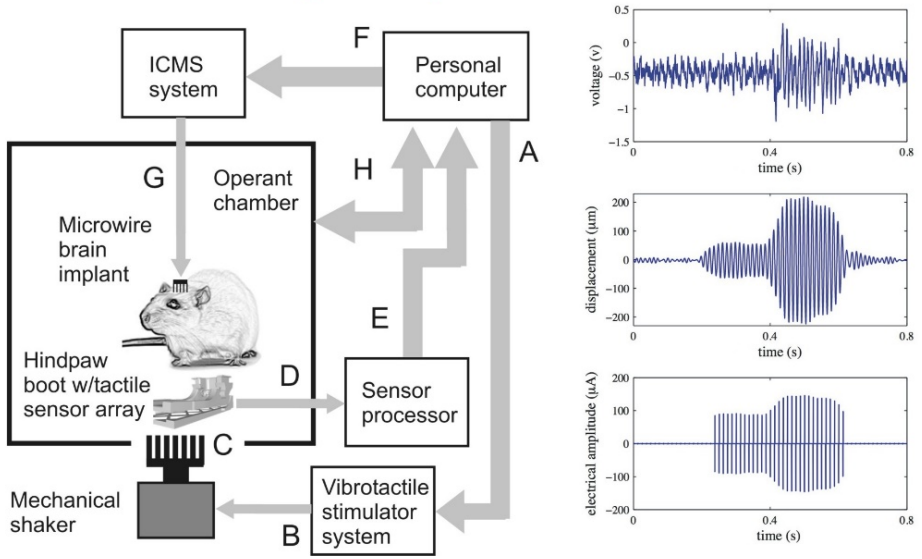
PST and SP histograms



ROC curve and psychometric functions



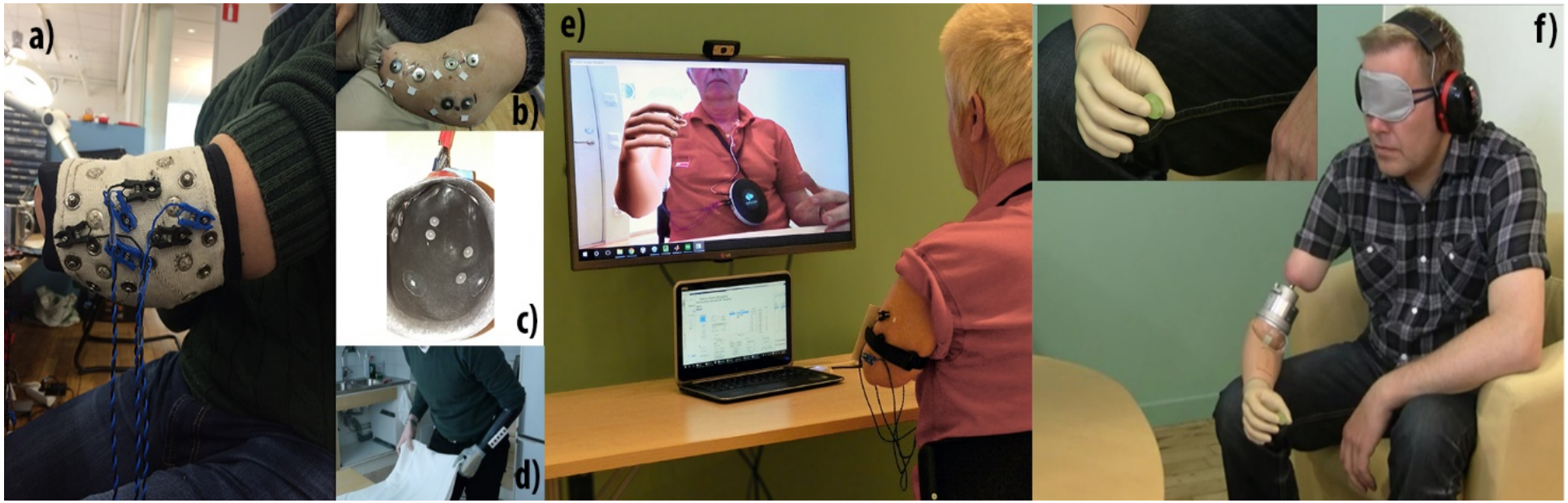
Sensory neuroprosthesis



PI: B Güçlü

Epidural electrodes and **intracortical** electrodes placed **in brain** cortex
Experiments will provide both **recording** and **stimulation** data from acute and chronic experiments. Closed-loop psychophysical experiments

WP4: Graphene based surface electrodes in humans



Graphene based surface electrodes will be compared with state-of-the-art wet, dry and textile electrodes in their suitability to

- record bioelectric signals for decoding motor volition, and
- deliver electric current for sensory feedback.

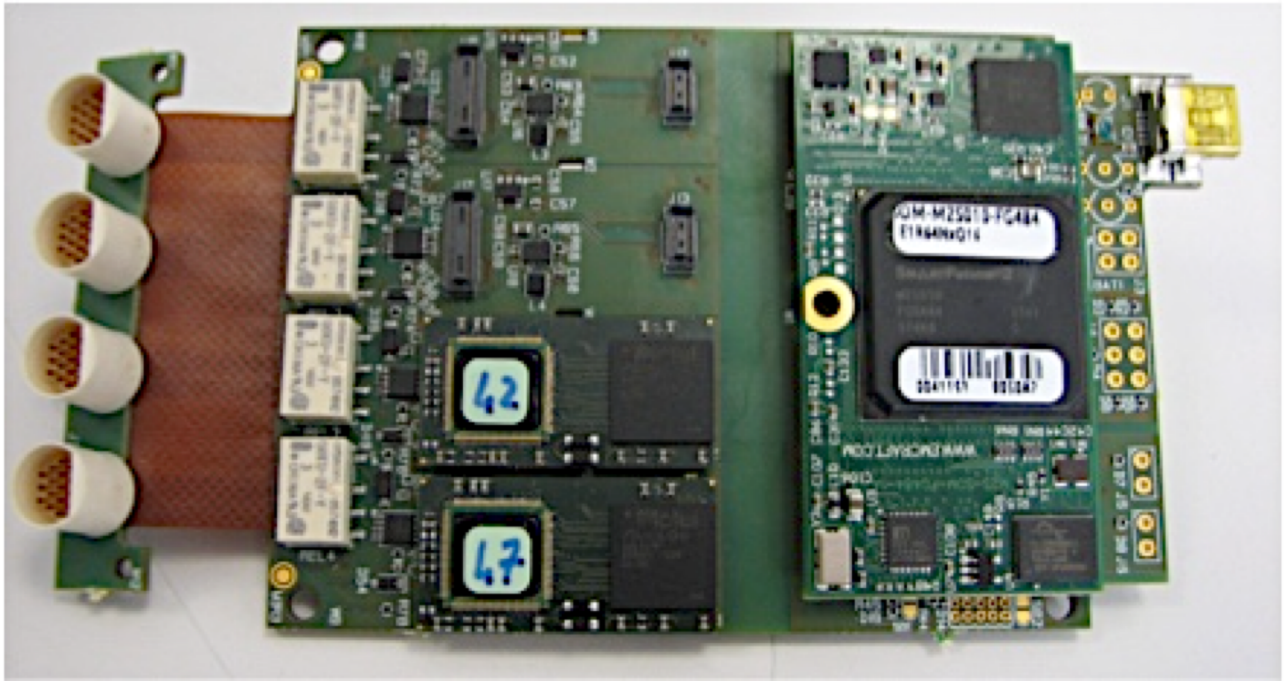
Close-loop control strategies will be investigated using graphene electrodes for both recording and stimulation as a final step

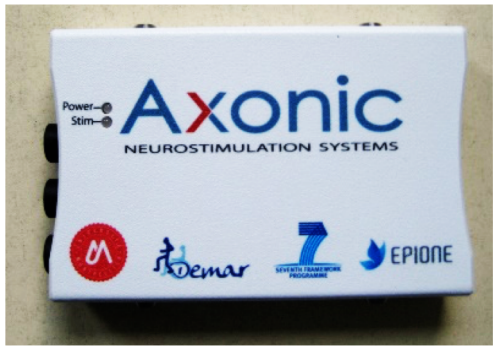
PI: M Ortiz-Catalan

CHALMERS

WP5: Electronics and Regulations

Specification, design and fabrication of desktop **stimulators to drive GRM electrodes** with high precision current steering
Dedicated software will be developed for in vivo experimentation





Recording systems from ICN2 will be integrated (hardware and software) with the stimulator to form a first close loop system evaluator.

Preparatory work for exploitation will focus on **regulatory requirements**

PI: JL Divoux

Axonic
NEUROSTIMULATION SYSTEMS