CONFERENCE PAPER

THE GENEVA ASSOCIATION

Neural Implants in Translational Research and Clinical Applications

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11th Annual Liability Regimes Conference
Keeping the Floodgates Shut? Mastering Accumulation and Bodily Injury Exposures in a Rapidly Changing Environment
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Neural Implants
in
Translational Research and Clinical Applications

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Neural implants…

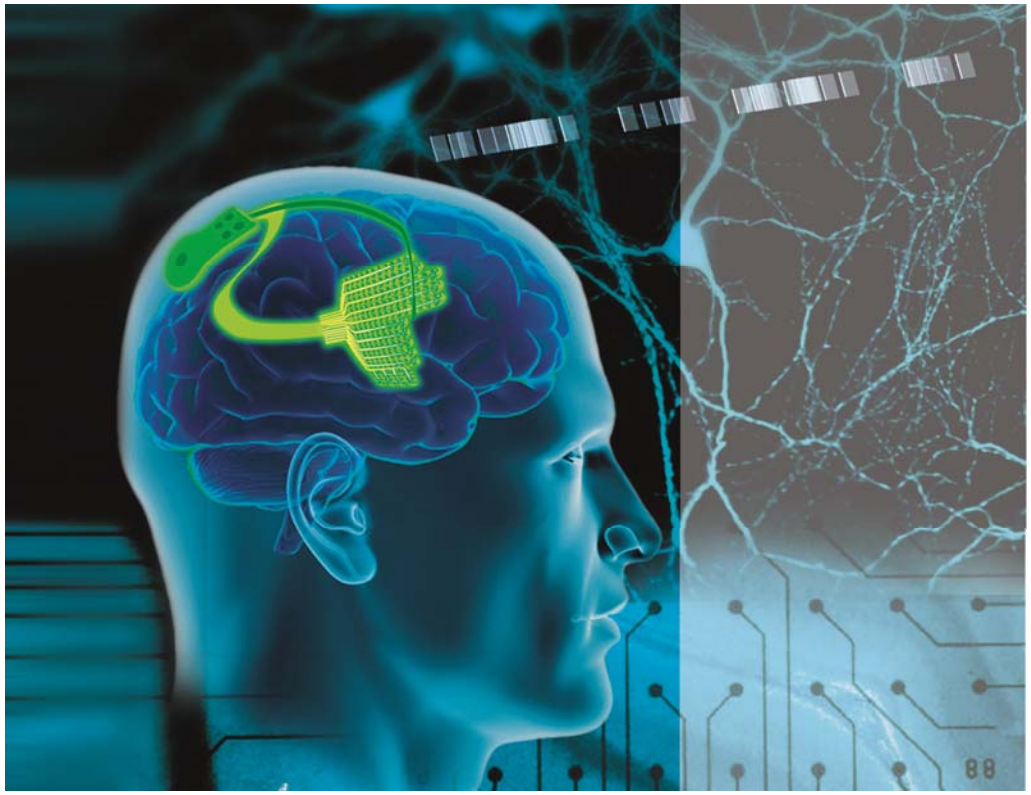
UNI FREIBURG

…from a clinical point of view

Stieglitz, T.: „Neuro-technical Interfaces to the Central Nervous System“, Poiesis and Practice 4 (2), pp. 95-109 (2006).

Active implantable medical devices

- Substitution
  of parts of the body
- Restoration
  of functions
- Alleviation
  of symptoms of diseases



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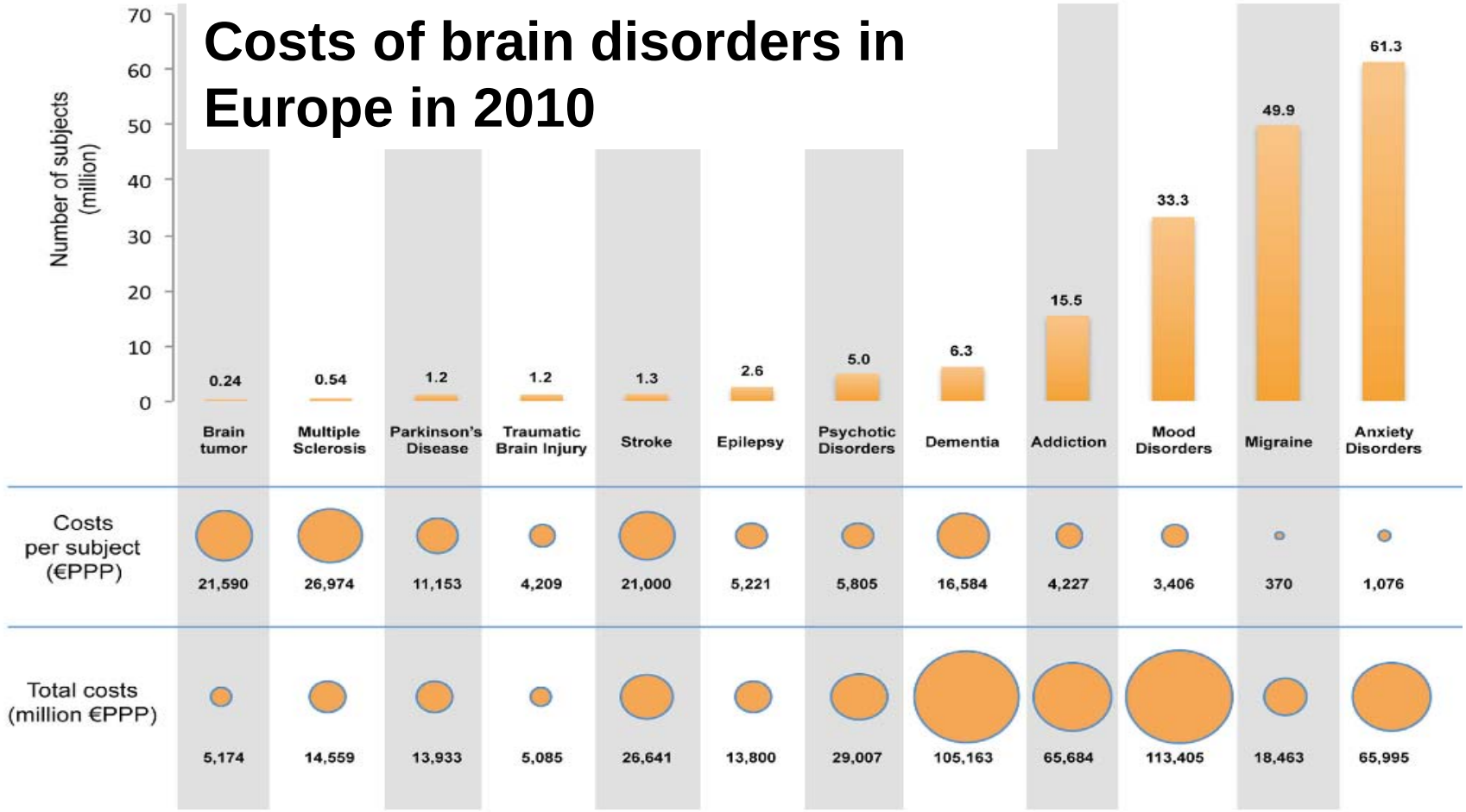
Is it worth ?



Cardio-vascular disorders 200 Billion €/year

Cancer: 150-250 Billion €/year

DiLuca & Olesen, Neuron, 2014

Applications of neural implants

REHABILITATION

bladder management

hearing

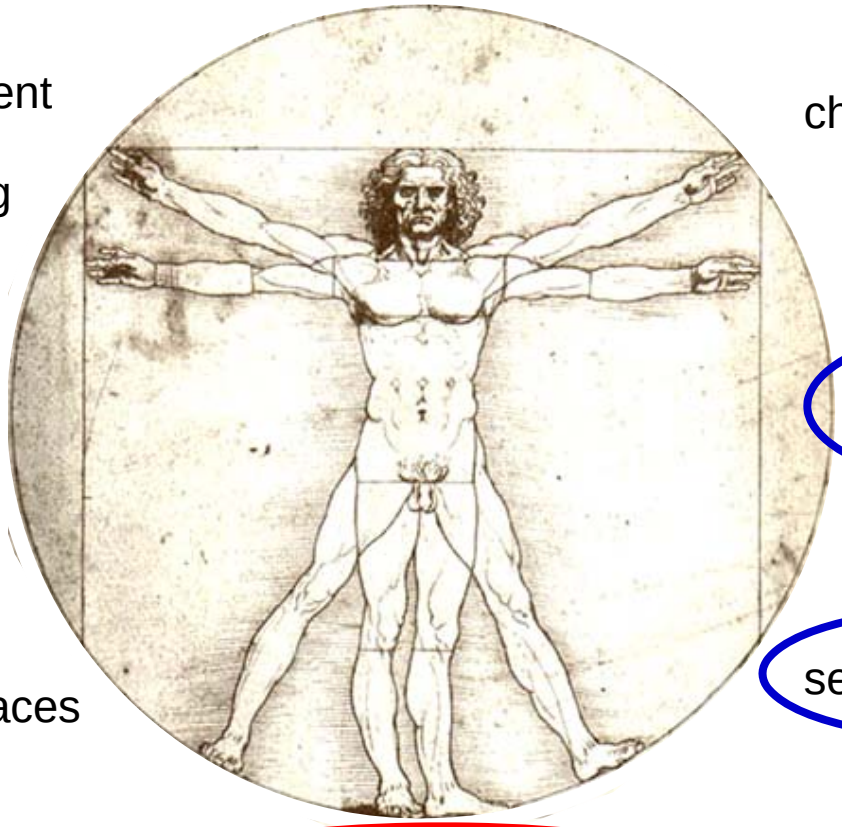
sight

grasp

stance and gait

drop foot (stroke)

brain computer interfaces



THERAPY

chronic pain

urge incontinence

Parkinson's disease (tremor, dyskinesis)

epilepsy

severe depression

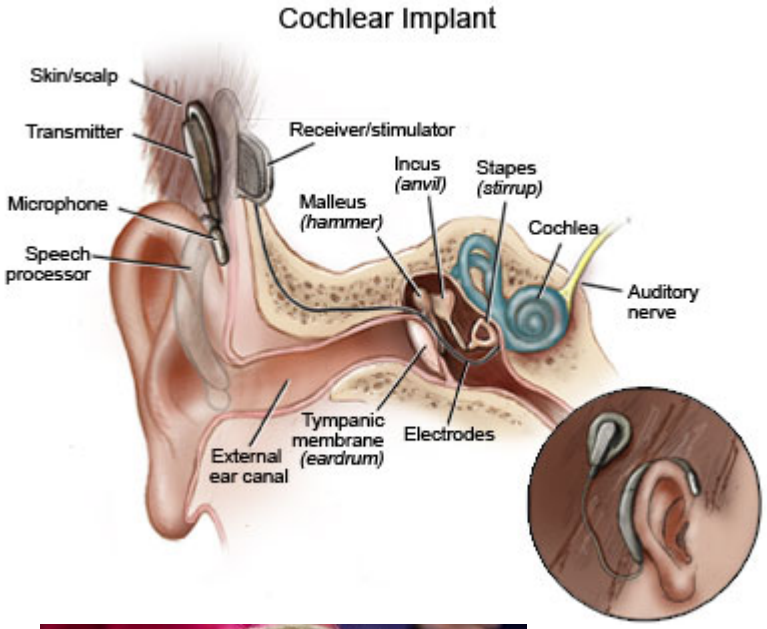
CNS

PNS

sensory feedback

Patient numbers

- Cardiac pacemaker
  - new: ~ 350,000 p.a.
- Cochlea implants
  - >300,000 worldwide
- Spinal cord stimulators
  - >130,000 worldwide
- Deep brain stimulators
  - >70,000 worldwide
- Vagal nerve stimulators
  - >70,000 worldwide



http://kidshealth.org/parent/general/eyes/images_94067/P_cochlear-noConsole.jpg

http://ais.southampton.ac.uk/files/2013/08/Chinese-NY-91.jpg

Stieglitz, T. Bundesgesundheitsblatt-Gesundheitsforschung-Gesundheitsschutz, 2010

Neural implants…

…from an engineering point of view

Stieglitz, T., Poiesis and Practice 4 (2), pp. 95-109 (2006).

Understanding the risk factor…

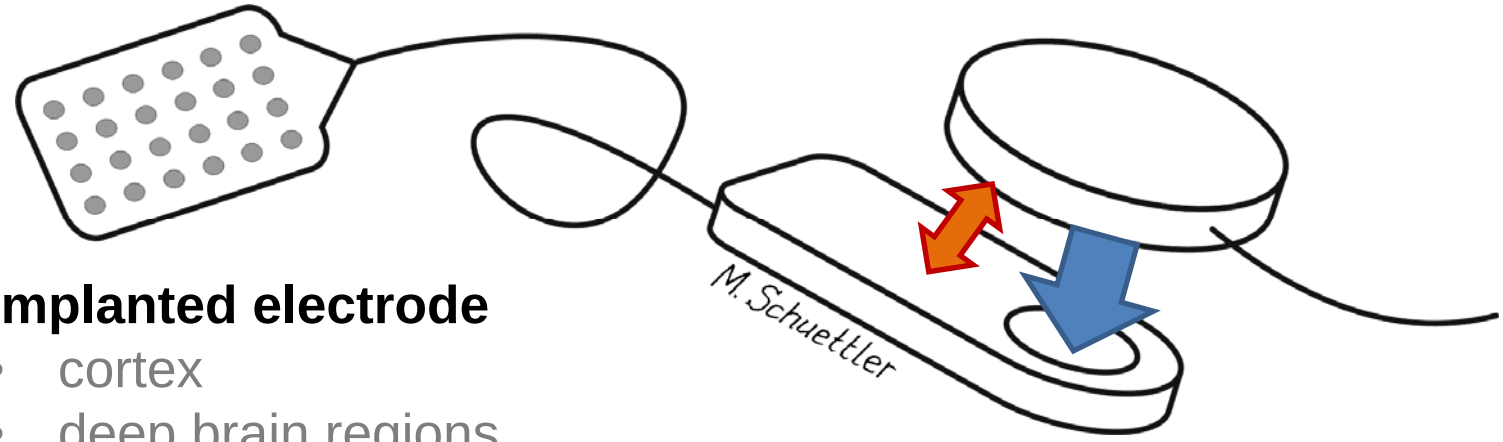
- Arne Larsson (1915-2001)
  - Received the 1st implantable cardiac pacemaker on 8 October, 1958
  - Received the 2nd implantable cardiac pacemaker on 9 October, 1958 (the first one failed in 3 hours, the second did not work at all).
  - By the time of his death at the age of 86, he had received 27 cardiac pacemakers

Wireless implant concepts in general

- chronically implantable
- interfaces target tissue for (closed-loop) stimulation and recording

body-external transmitter

- connected to contol device;
- powers the implant
- communicates



implanted electrode

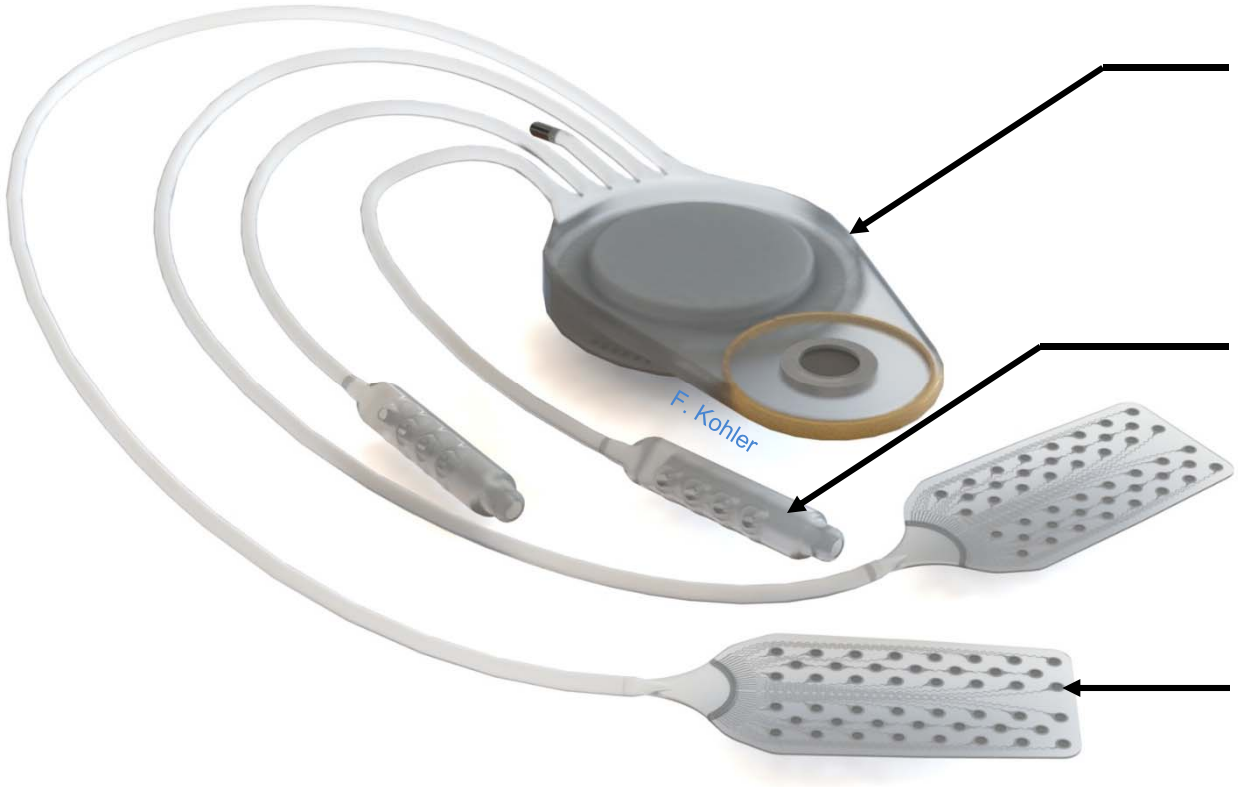
- cortex
- deep brain regions
- peripheral nerve

implanted electronics

- recording amplifiers
- stimulation pulse generator

Example: „Brain Interchange Platform Concepts“

Taken from: CorTec GmbH, Freiburg, Germany

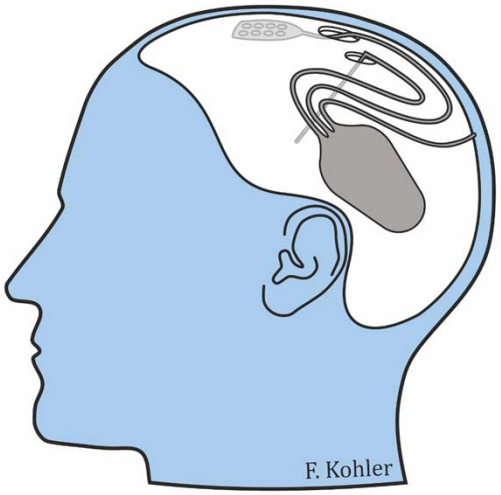


- Packaged electronics
- Telemetry
- Connector for DBS electrodes
- ECoG electrodes

Kohler ete al. Proc IMAPS 2014

The Package Challenge

- Implantation in the skull
  - Above the ear
  - Similar location as some cochlear implants (CI)
    - Hazards are comparable
    - Normative-technical elements are applicable (EN 45502-2-3 & ISO 14708-7)



Kohler et al. Proc IMAPS 2014

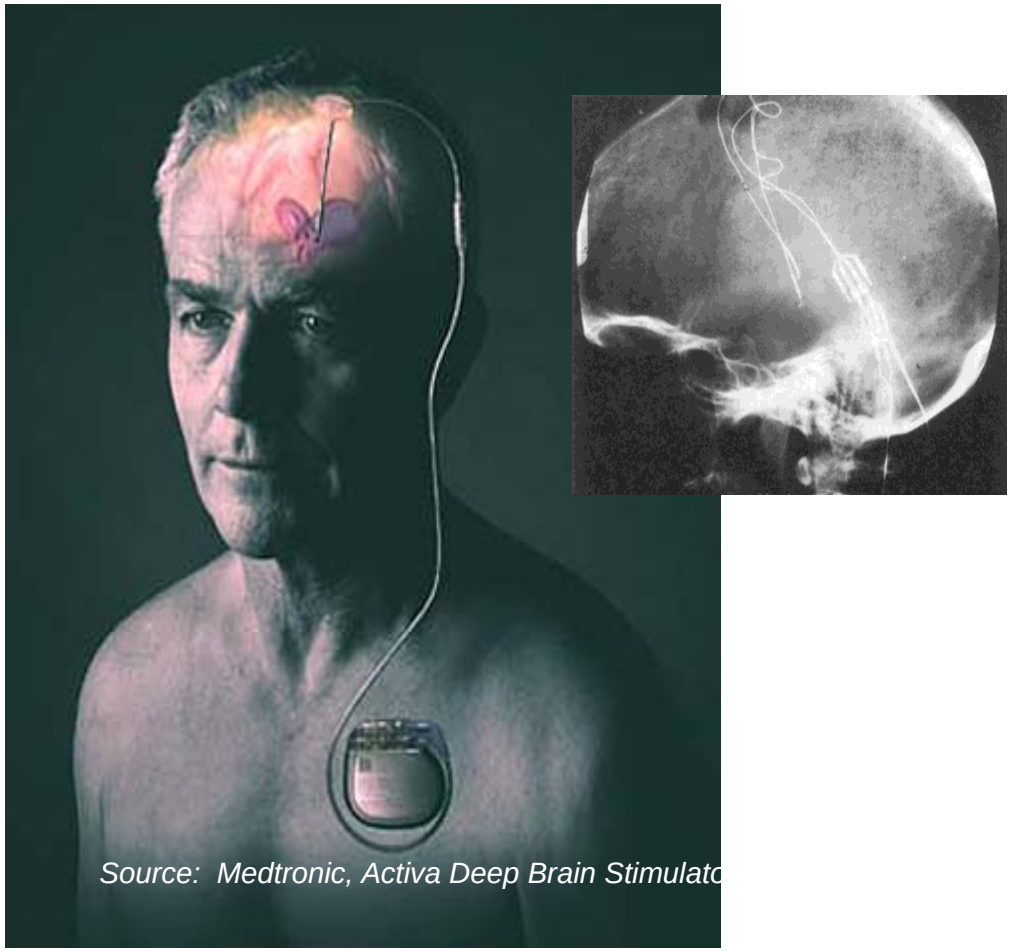
image: http://www.history.com/news/ask-history/who-invented-baseball

Application 1

Deep Brain Stimulation

Background: Deep Brain Stiumlation

- Anatomical targets
  - thalamiic nuclei
  - subthalamic nuclei
  - limbic system
- Applications:
  - Parkinson‘s disease
    - Tremor
    - Akinesis
    - Dyskinesis
  - psychiatric diseases
    - Depression
    - Obsession-compulsion disease



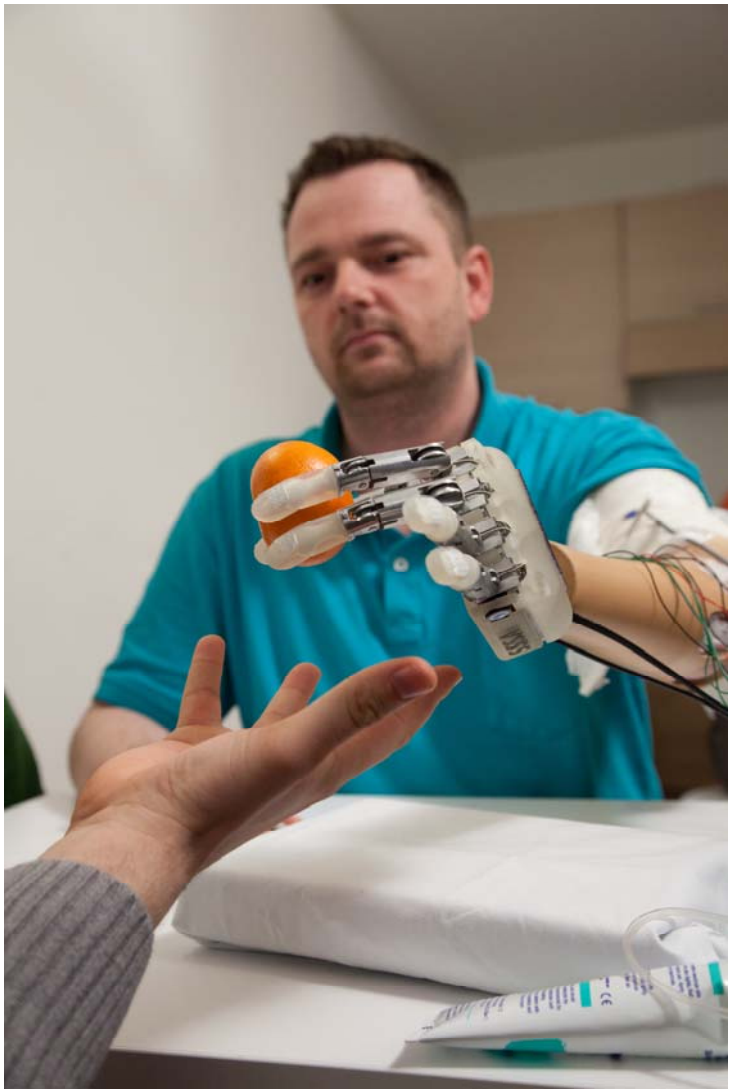
Effect of Deep Brain Stimulation

Video clip

Application 2

Sensorized Prostheses

Pilot study: sensory feedback in hand prosthesis



- 1 male subject
- 36 years old
- Amputation
  9 years ago due to fireworks accident
- Phantom limb pain
- 4 TIME implants
- 56 electrode sites
- Implantation period:
  30 days

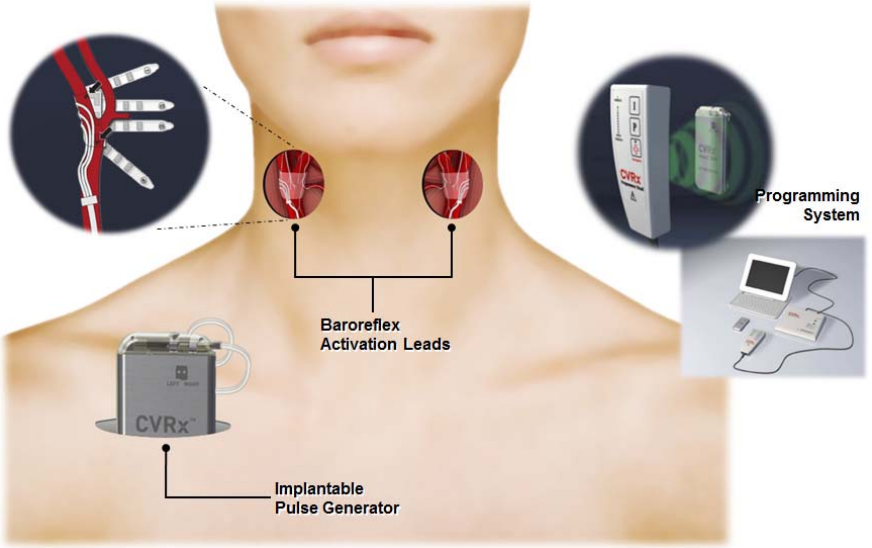
Raspopovic et al., Sci Tansl Med 6 (22), 222ra19 (2014)

Sensory feedback in grasp prostheses

Video clip

Other Applications

- Hypertension
  - Stimulation of arteries
- Hemiparesis after stroke
  - Drop foot
  - Peripheral nerve stimulation
- Retinal Vision prostheses
  - Retinitis pigmentosa
  - Stimulation of retina
- Many other applications in preclinical and clinical research



Rothstein et al. : Chronic Treatment of Resistant Hypertension with an Implantable Medical Device: Interim 3 Year Results of Two Studies of the Rheos® Hypertension System

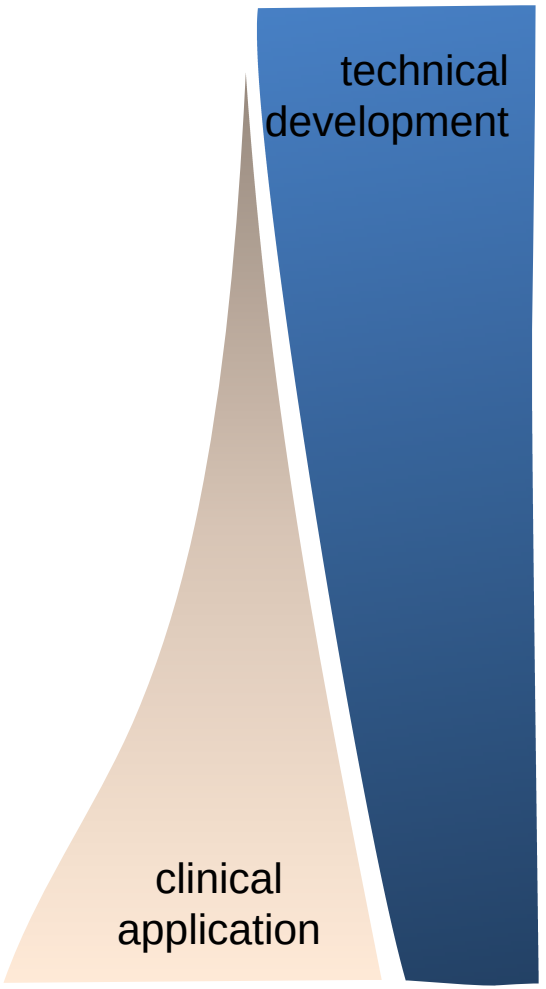
http://www.cvrx.com/usa/healthcare/hypertension/barostim-neo/barostim-neo-components/

And finally…

…some concluding remarks

Conclusions

- Applications of neural implants
  - Some in clinical applications
  - More to come
- Technology
  - Systems get complex
  - Implant and patient life time converge
- Society
  - Attitude towards „body electronics“ changes
  - Brain and personality
  - Resonsibility and liability



Thank you for your attention!

Campus Faculty of Engineering

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