

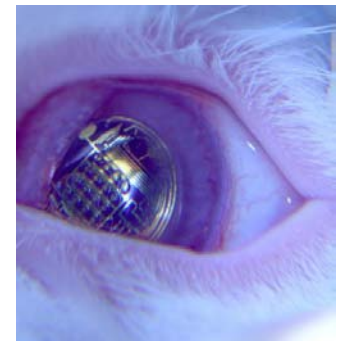
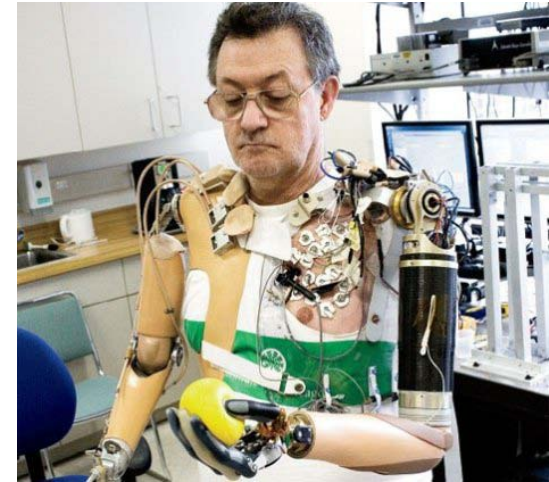
# Brain Machine Interface

Awais M. Kamboh

Nov 10, 2010

# Brain Machine Interface

- One of the greatest mysteries is the human brain
- This is about understanding how neural systems work and how to fix them.
  - Why scratching relieves itching
  - How memory works??
  - Restoration
  - Enhancement

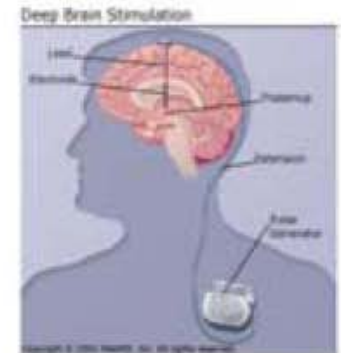


# Applications

- Artificial Limbs
- Cochlear Implants
- Deep Brain Stimulation
- Retinal Implants



Cochlear Implant  
Source: wikipedia



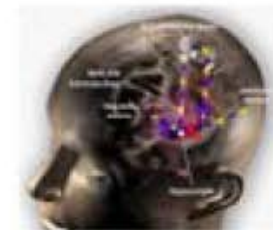
Deep Brain Stimulation  
Source: WebMD



Artificial Limb  
Source: Univ. of Pittsburgh



Retinal Implant  
Source: Boston VA center



Memory Implant  
(source USC)

# Neural Recording Systems

- Electro-encephalogram (EEG), Magneto-encephalogram (MEG)
  - Aggregate response of a number of neurons over the scalp
  - Poor spatial resolution, good time resolution
- fMRI & PET
  - Good spatial resolution, poor time resolution
  - 3D spatial information
- Electro-corticogram (ECoG)
  - Flexible sheet of electrodes over the cortex, requires surgery
  - Better spatial and time resolution than EEG
- Intra-Cortical – EEG
  - Signal from individual neurons
  - Microelectrode array implantation into the cortex through surgery
  - High spatial and time resolution >> large amount of data

## EEG based BMI

<http://www.youtube.com/watch?v=oJ-HD4uIKdc>

<http://www.youtube.com/watch?v=gJatpR15Ip8>



## Neural Implant – Restoration

<http://www.cbsnews.com/stories/2008/10/31/60minutes/main4560940.shtml?tag=currentVideoInfo;segmentTitle>

## Neural Implant – Enhancement

<http://www.youtube.com/watch?v=sm2d0w87wQE>

<http://www.youtube.com/watch?v=gnWSah4RD2E&feature=related>

## Robo Rat -

<http://www.youtube.com/watch?v=-EvOIJp5KIY>

ather

ay: Rain. High 73.  
63.  
ay: Mostly cloudy. High  
Low 64.  
ails, B10

# The Washington Post

THURSDAY, SEPTEMBER 14, 2006

TH YEAR NO. 283 S MD

M1

## For 1st Woman With Bionic Arm, a New Life Is Within Reach

By DAVID BROWN  
Washington Post Staff Writer

The first time Claudia Mitchell peeled a banana one-handed, she cried.

It was several months after she lost her left arm at the shoulder in a motorcycle accident. She used her feet to hold the banana and peeled it with her right hand. She felt like a monkey.

"It was not a good day," Mitchell, 26, recalled this week. "Although I accomplished the mission, emotionally it was something to be reckoned with."

Now, Mitchell can peel a banana in a less simian posture. All she has to do is place her prosthetic left arm next to the banana and think about grabbing it. The mechanical hand closes around the fruit and she's ready to peel.

Mitchell, who lives in Ellicott City, is the fourth person — and first woman — to receive a "bionic" arm, which allows her to control parts of the device by her thoughts alone. The device, designed by physicians and engineers at the Rehabilitation Institute of Chicago, works by detecting the movements of a chest muscle that has been rewired to the stumps of nerves that once went to her now-missing limb.

Mitchell and the first person to get a bionic arm — a power-line technician who lost both arms to a severe electric shock — will demonstrate their prostheses today at a news event in Washington. The Rehabilitation Institute of Chicago is part of a multi-lab effort, funded with nearly \$50 million from the Defense Ad-

See BIONIC, A4, Col. 1

CAMPAIGN  
2006

**VOTING DELAYS:** Montgomery County tries to determine what went wrong after human error mars the count. **Stories: A23, C1**

**SCHAEFER'S FALL:** One of the dominant figures in Maryland political history, William Donald Schaefer, is out. **Stories: A23, C1**

**HELP FOR CH**  
money and ma  
Lincoln Chafee  
Rhode Island.

## New Day for Md. Democ



## Washington Assert Th In Party P

By ROBERT BARNES and  
Washington Post Staff Writer

Maryland voters on t  
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most competitive states  
and defining a new rol  
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wide office — State's A  
for attorney general an  
comptroller. No one fr  
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in Baltimore. Franchot  
rally with Baltimore M  
party's nominee for gov

THE WASHINGTON POST  
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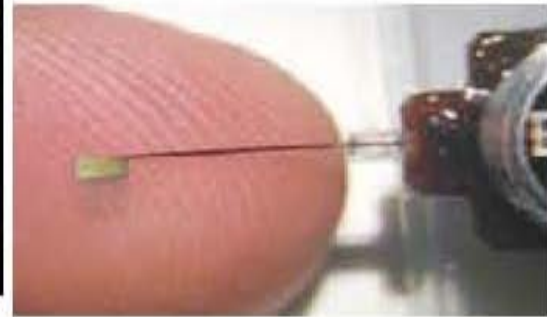
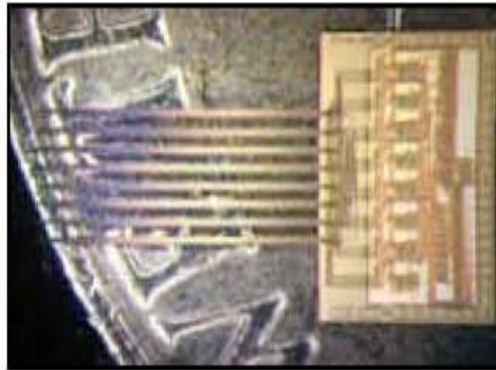
# The first human implant



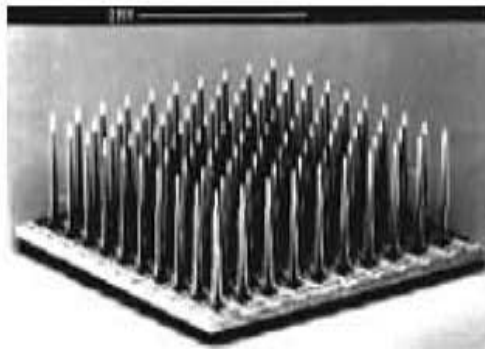
Hochberg et al., *Nature* **442**,  
164-171 (July 2006)

Movies at  
<http://www.nature.com/nature/focus/brain/experiments/index.html>

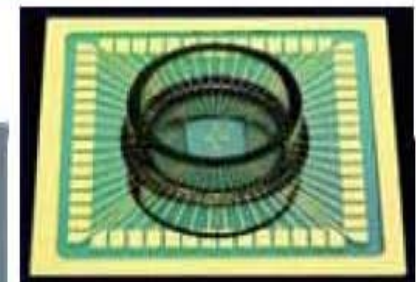
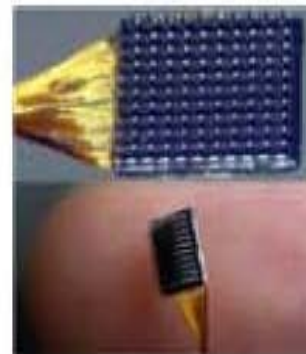
# The Technology



University of Michigan  
Center for Neural Communication Technology  
1994 – present  
Neuronexus Tech, Inc.

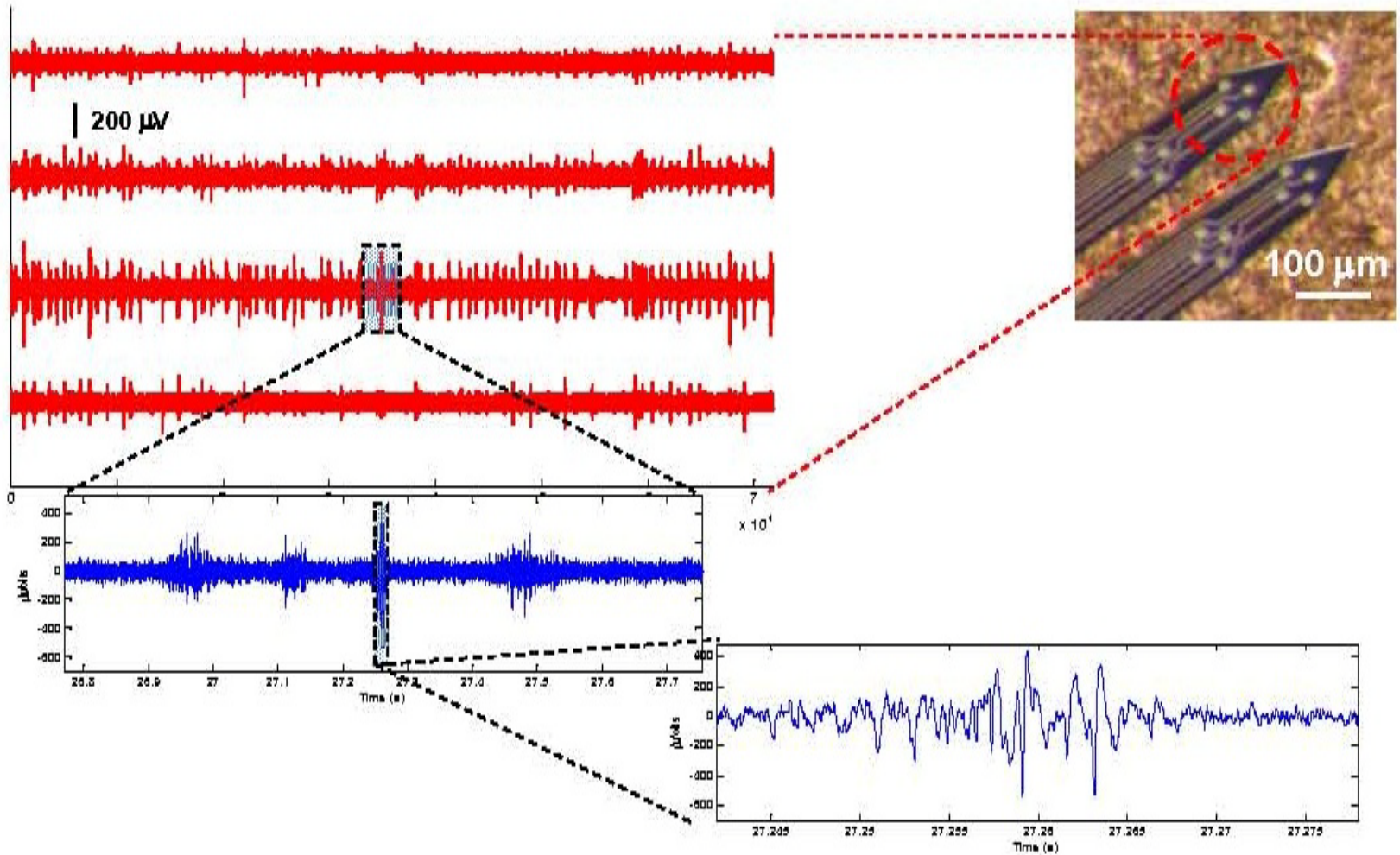


University of Utah  
1999 - present  
Cyberkinetics, Inc.



MEA for dissociated cell  
cultures,  
(Multichannel systems)  
Germany

# The Data

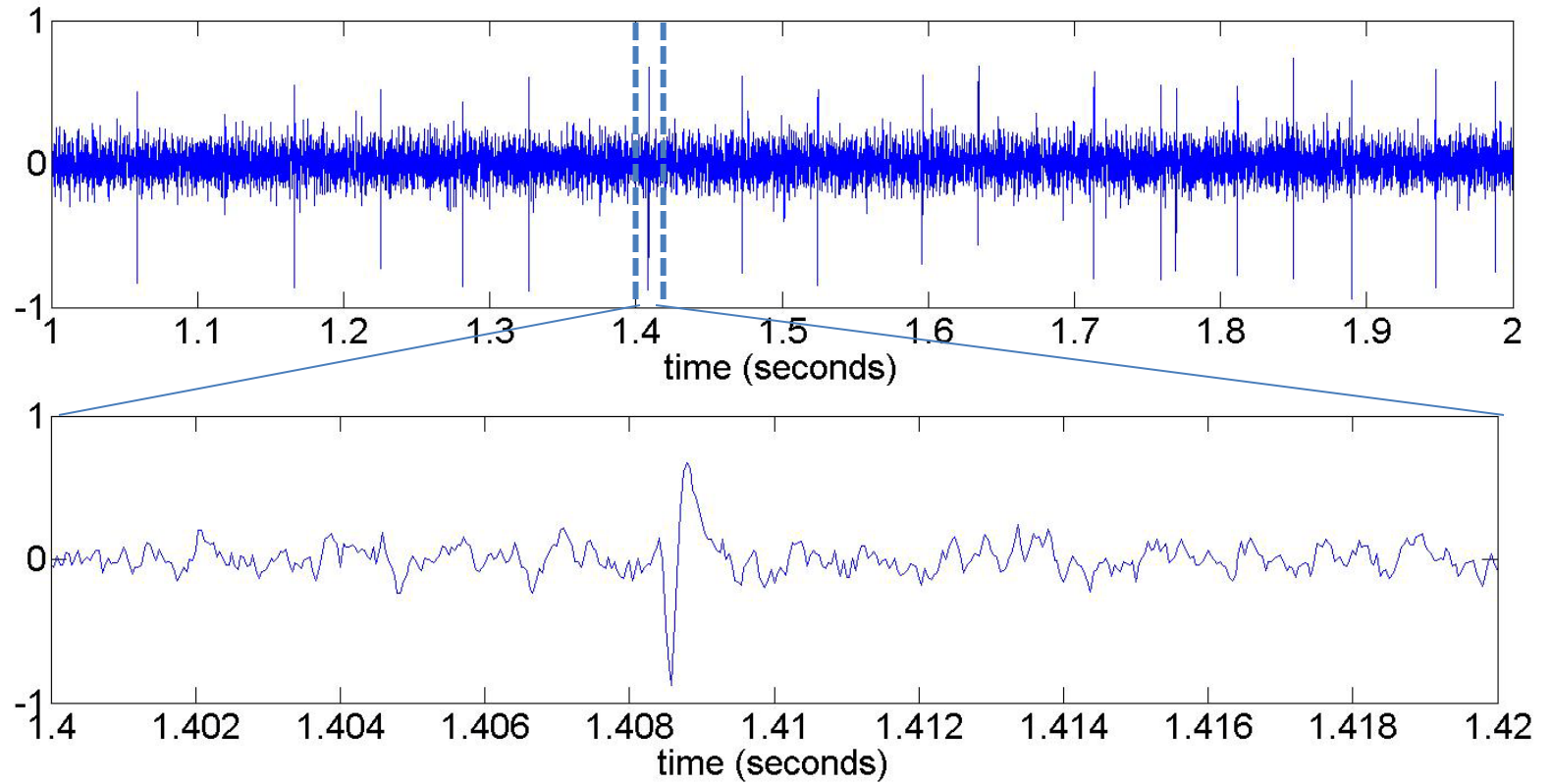


# Intra-Cortical Neural Signals

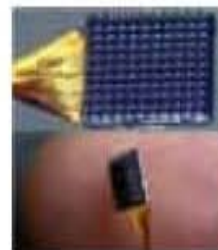
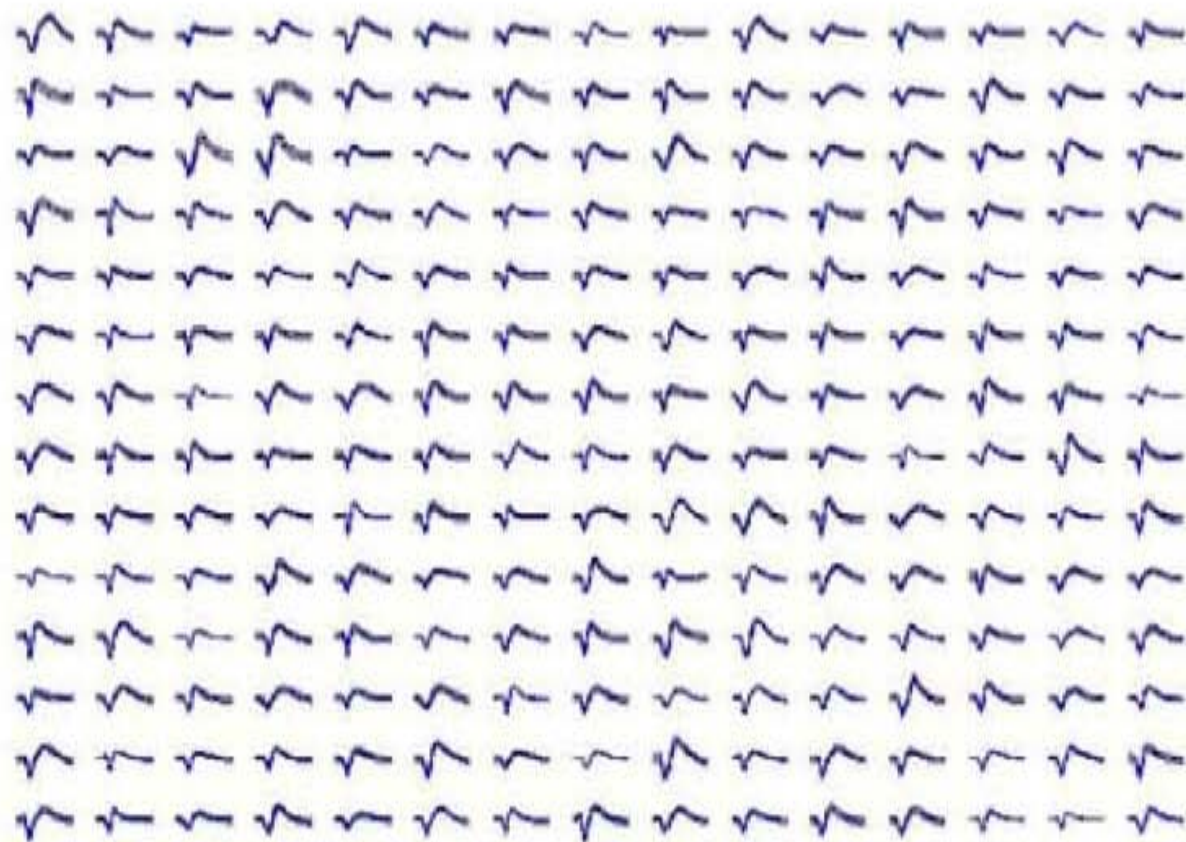
- Local Field Potentials
  - High amplitude, low frequency
- Action Potentials (Neural Spikes)
  - Produced when a neuron ‘fires’
  - Typical firing rate: 10 to 100 spikes per second
  - Typical spike: about 1.5ms long, 2ms refractory period

	<b>Bandwidth (Hz)</b>	<b>Amplitude (mV)</b>
Local Field Potential	0.1 – 100	0.5 – 5
Extracellular Action Potential	200-10K	0.05-0.2

# Neural Signals

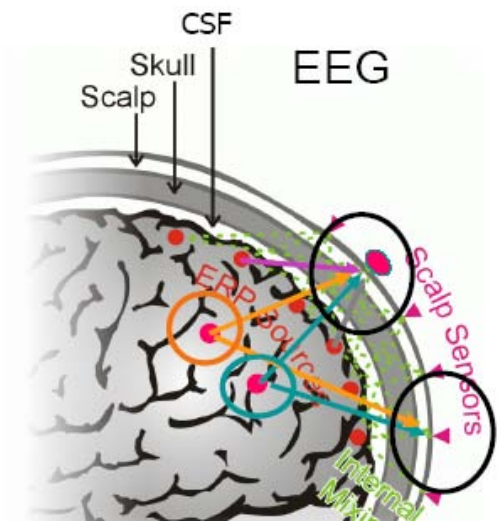
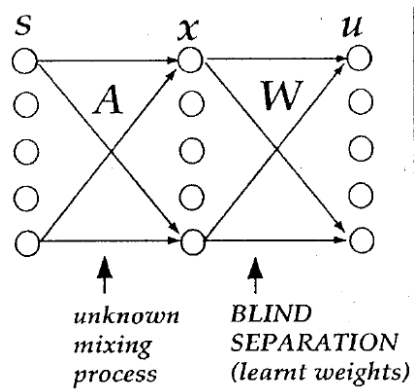


# Large Scale Recording



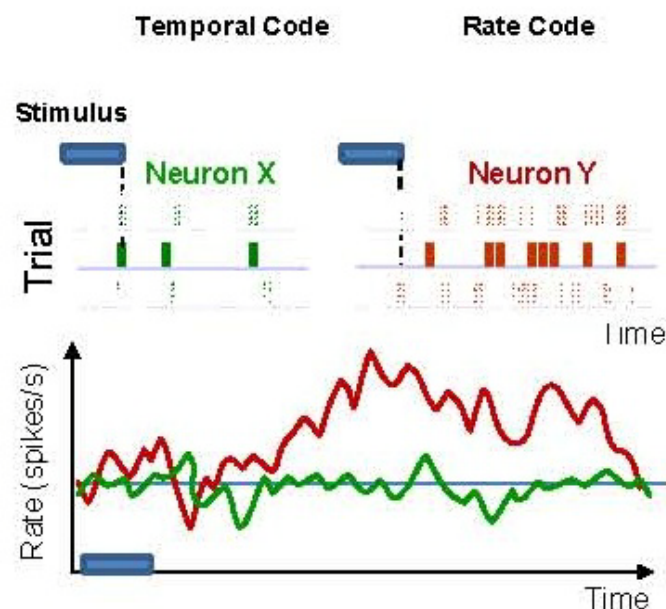
*N. Hatsopoulos et al., 2007*

- Blind Source Separation
- Source localization

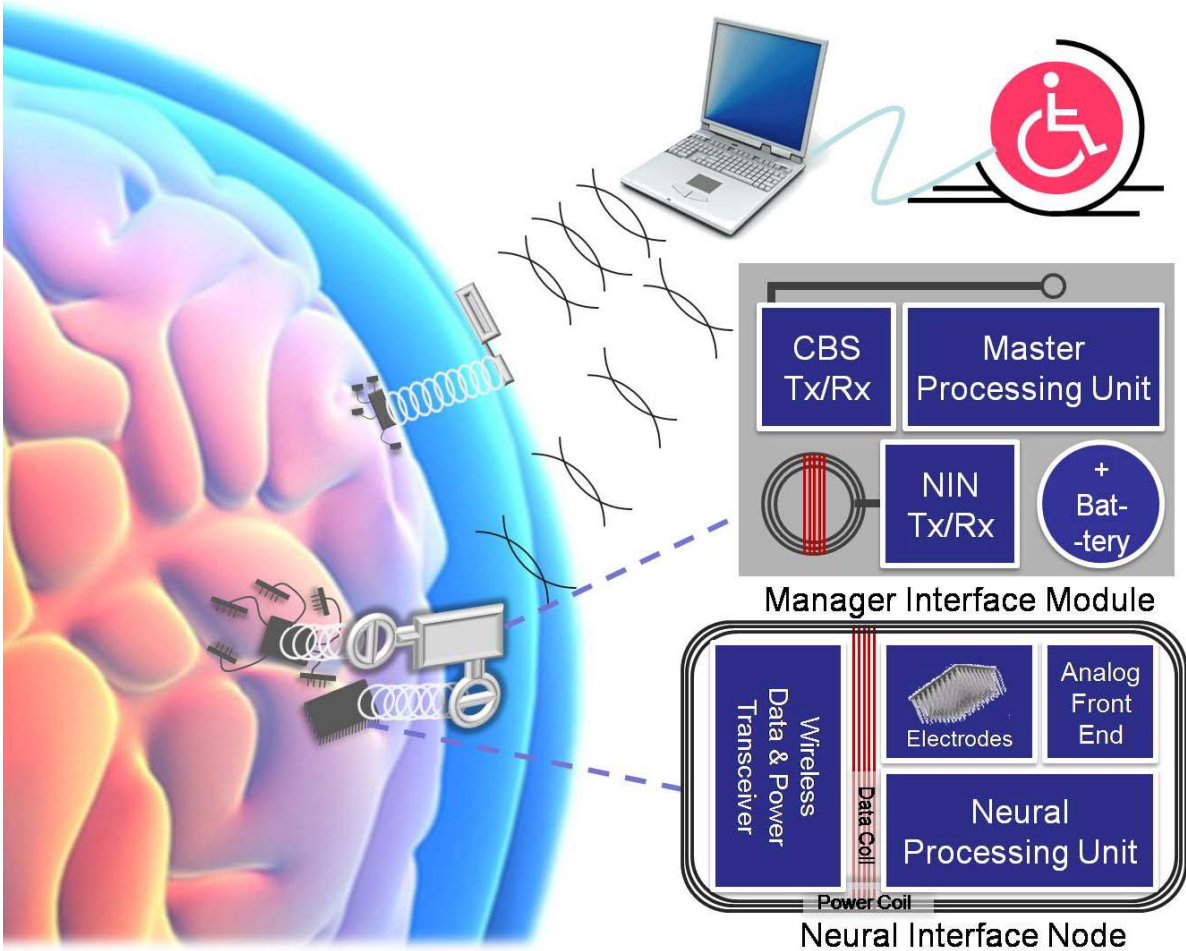


# What do neural signals tell us?

1. Precise spike time
2. Spike Rate
3. Response Time & Duration
4. Network Interaction



# Proposed System Architecture



# The Future



*Lebedev & Nicolelis, Trends in Neuroscience, July 2006*