

Curing Epilepsy 2007: Translating Discoveries into Therapies

Neural Interfaces for Repair and Therapy: Potential for Epilepsy

An alternative and accessible version of this presentation is available at 2:15 pm in the [Videocast of Day Two](#)

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- **Conflict of Interest:** JPD is a shareholder, director and paid consultant for Cyberkinetics makers of BrainGate and Neuroport technology discussed in this presentation. (Managed by Brown University oversight committee and COI policy).
- LRH receives clinical trial support from Cyberkinetics.
- CS and RJE receive research support from Cyberkinetics.
- JPD is an NIH NINDS Javits Investigator
- Support also from VA, NICHD, ONR



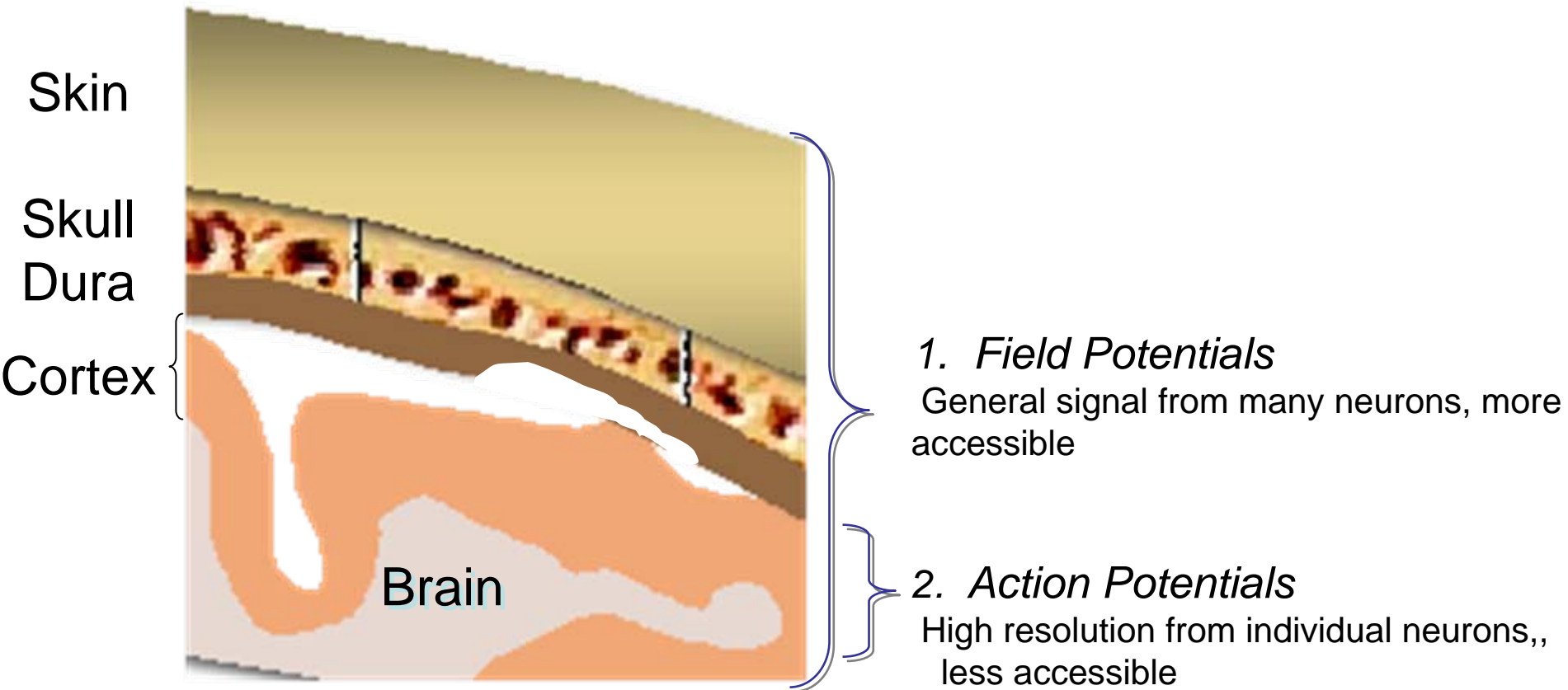
QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

Neural Interface for Epilepsy Concept

Neural Interface Concept: Sz Warning Device

QuickTime™ and a
decompressor
are needed to see this picture.

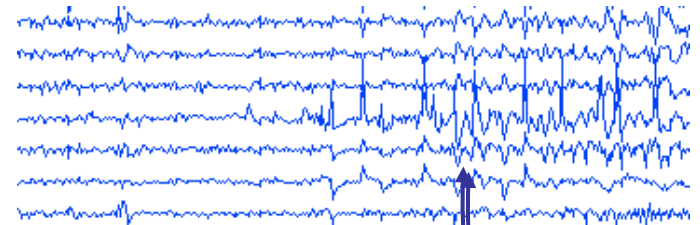
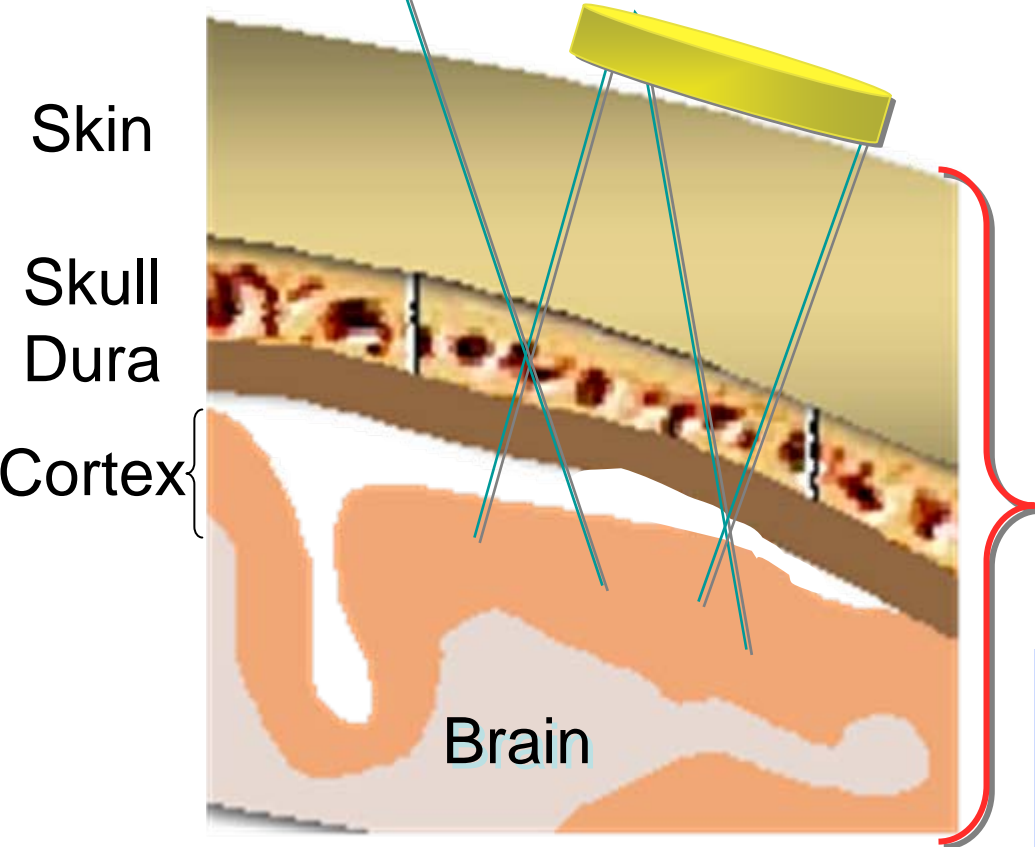
Two Types of Brain Electrical Potentials



Field Potentials

Electrode (4mm)

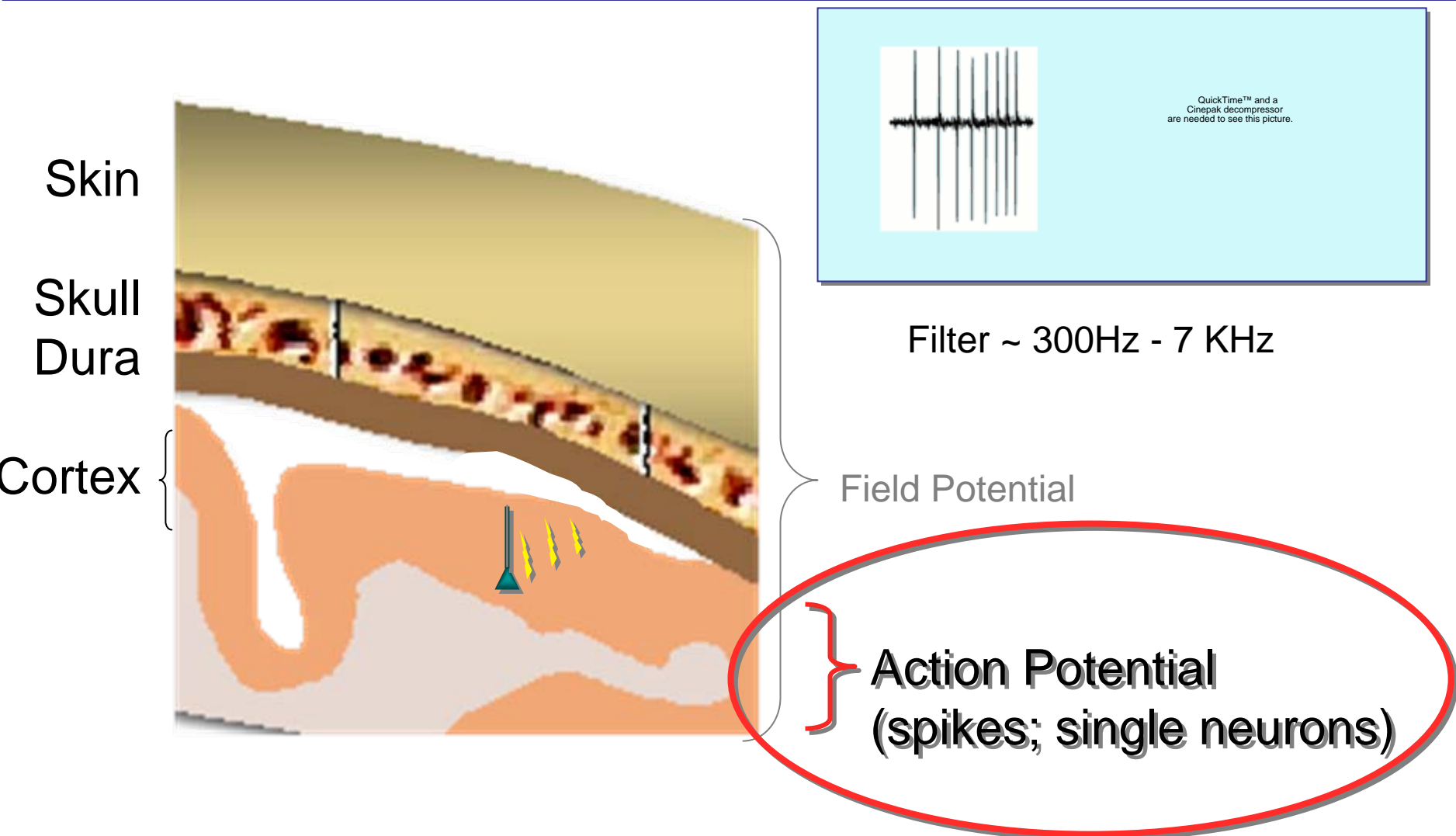
EEG (electroencephalogram)



Field Potentials
(~DC- 100Hz)

Summed synaptic currents
and synchronous action potentials
From groups of neurons
(= INPUT?)

Brain Signals: Action Potentials



Skin

Skull
Dura

Cortex

Field Potential

Action Potential
(spikes; single neurons)

Filter ~ 300Hz - 7 KHz

QuickTime™ and a
Cinepak decompressor
are needed to see this picture.

Brain Signal Sources: Action Potentials (= spikes)



Action Potential



Cinepak decompressor are needed to see this picture.



QuickTime™ and a Cinepak decompressor are needed to see this picture.

~ 1 sec

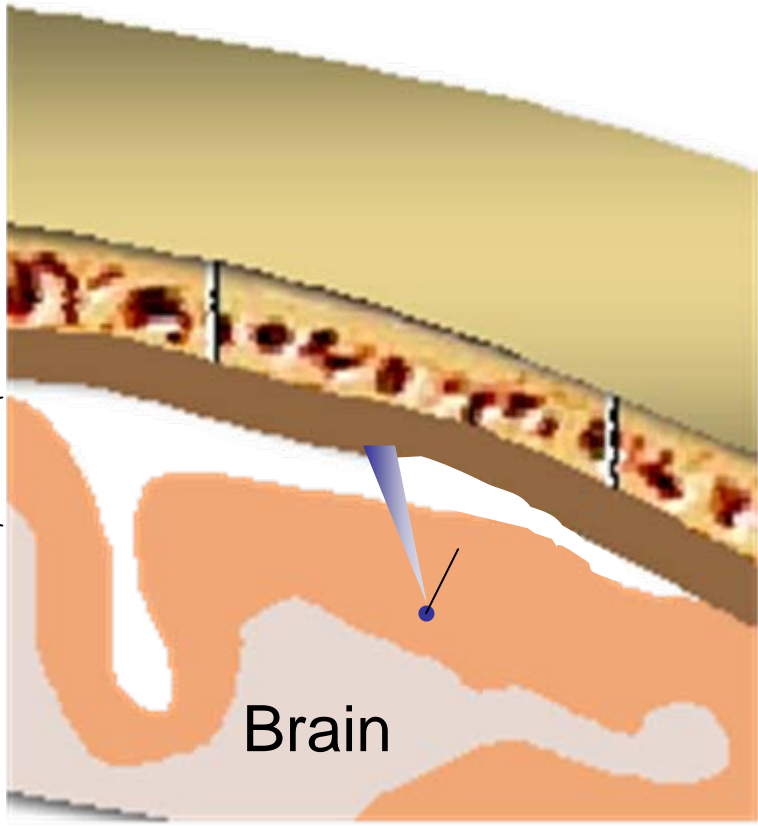
Spikes:

- Major form of brain information 'coding' (via rate)

Monkey, action potential 16252 in pub med

Action Potentials: Sensor

Skin
Skull
Dura
Cortex



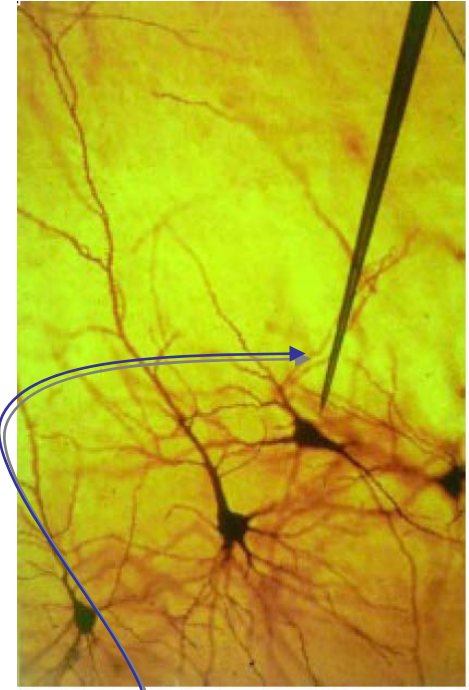
Must be in brain!



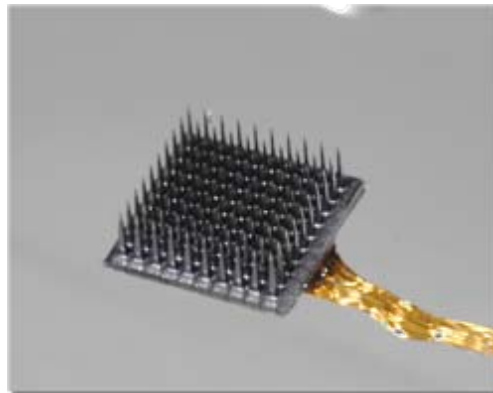
Action Potential & LFP



Microelectrode



Is a long term (i.e. *implanted*) action potential sensor feasible?

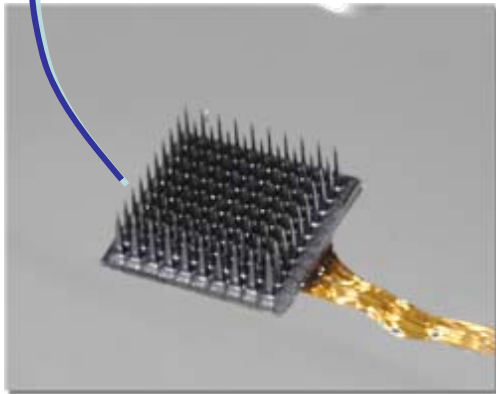
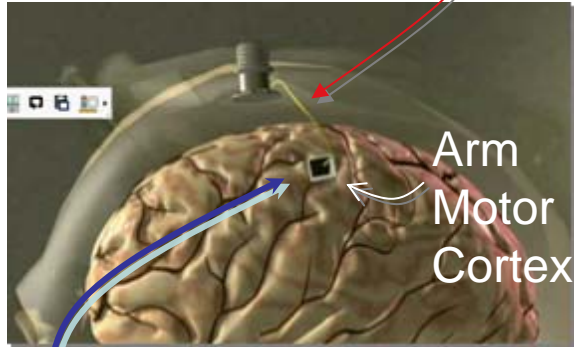


100 microelectrode
array (Human)



BrainGate Human Neural Interface System for Paralysis (pilot)

- *Sensor Implant*



100 microelectrode array
4 x 4 mm 1-1.5 mm long



Neural Interface System: Restoring Control in Paralysis

See: Hochberg et al., (2006)
Nature, 442, 164-171 (13 July 2006)

QuickTime™ and a
H.264 decompressor
are needed to see this picture.



Robotic Hand
(S1)

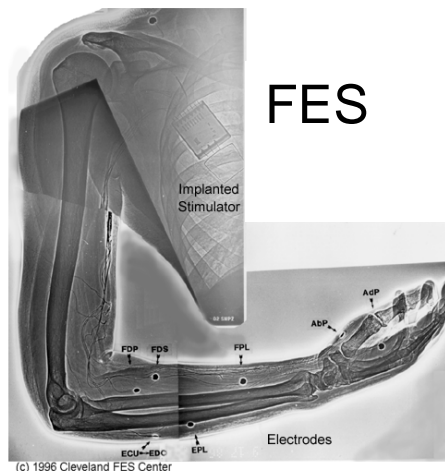
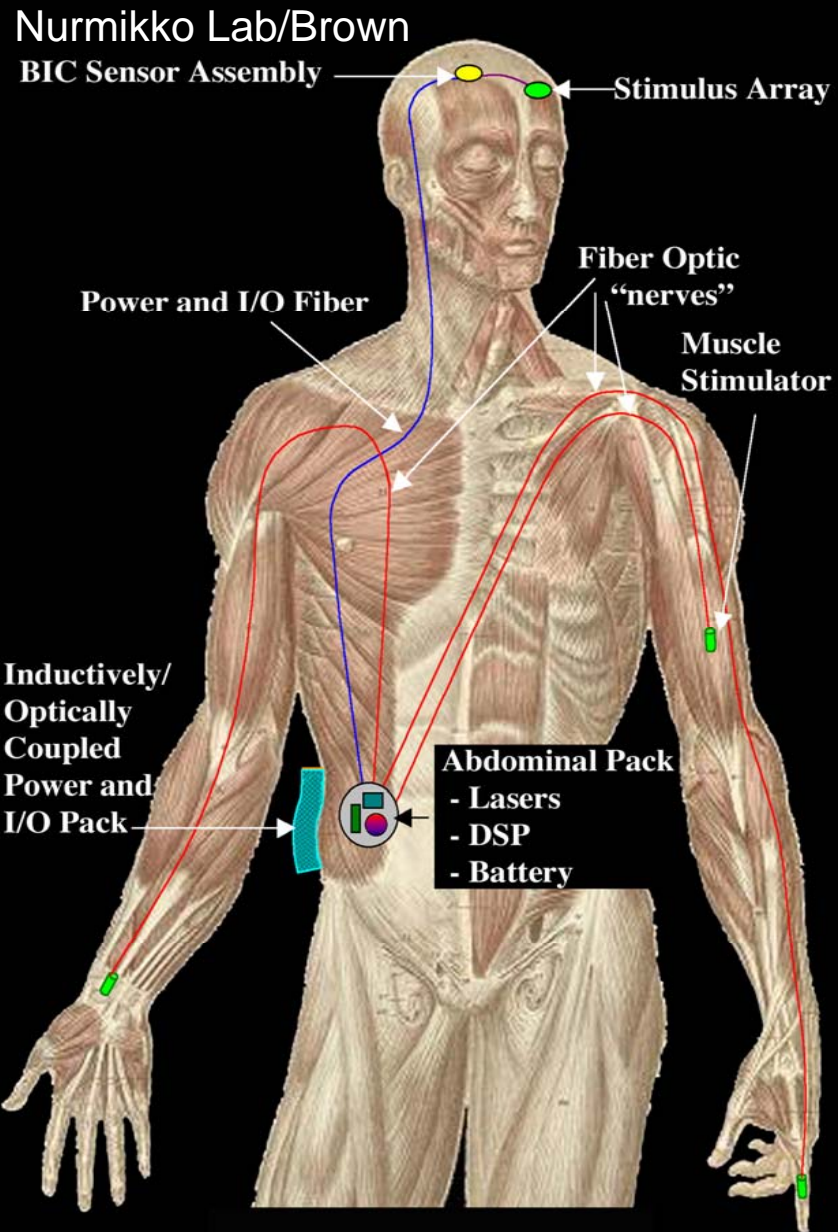
TV Remote
(S3)

Motorized Prosthetic hand courtesy of Liberating Technologies , Inc.
Computer Interface courtesy of RollTalk, Inc.

Neuroprosthetic System: Vision



Brown University
Brain Science
Neurotechnology



FES

Restore



QuickTime™ and a
TFP (Uncompressed) decompressor
are needed to see this picture.



Rehabilitate

Exoskeleton: movement therapy

Replace

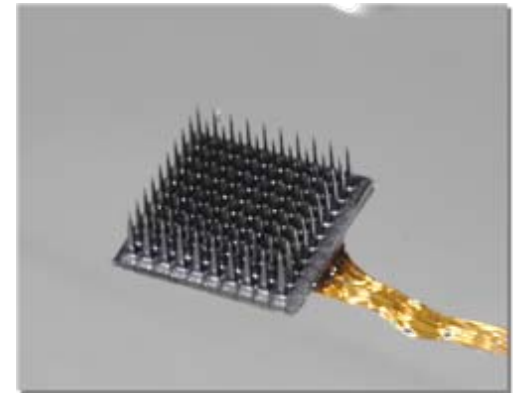
QuickTime™ and a
H.264 decompressor
are needed to see this picture.



Prosthetic Hand

Neural Interface for *Epilepsy*: *Potential Applications*

- Short Term: Improved localization - higher resolution
- Long Term:
 - Warning device
 - • Seizure control device
 - Improved understanding of abnormal activity at new level (single cells, ensembles, and action-field potential relationships)

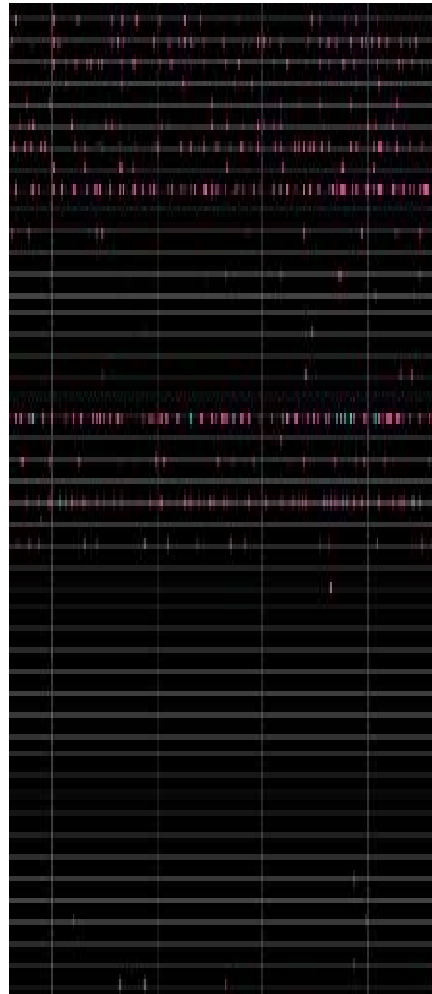
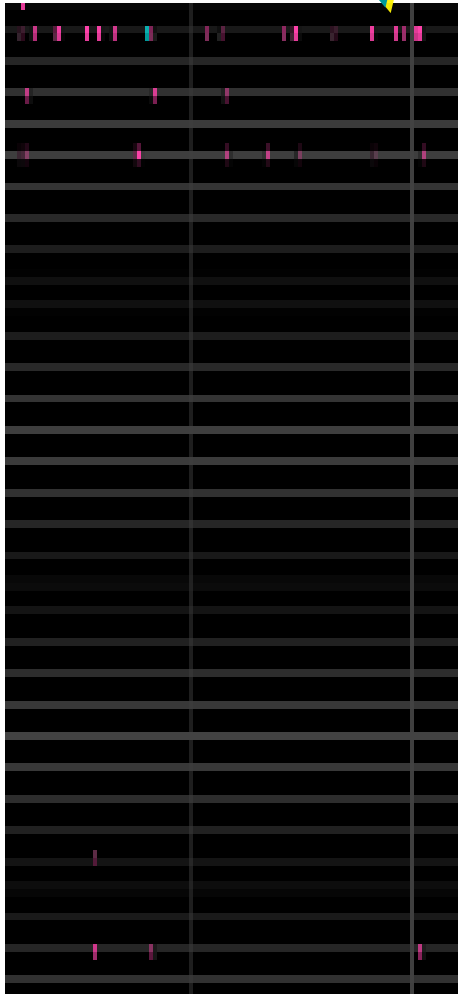


Neuroport

Data from: Shevon Emerson and collaborators, Columbia U

spikes

Coherence



Before

?

During

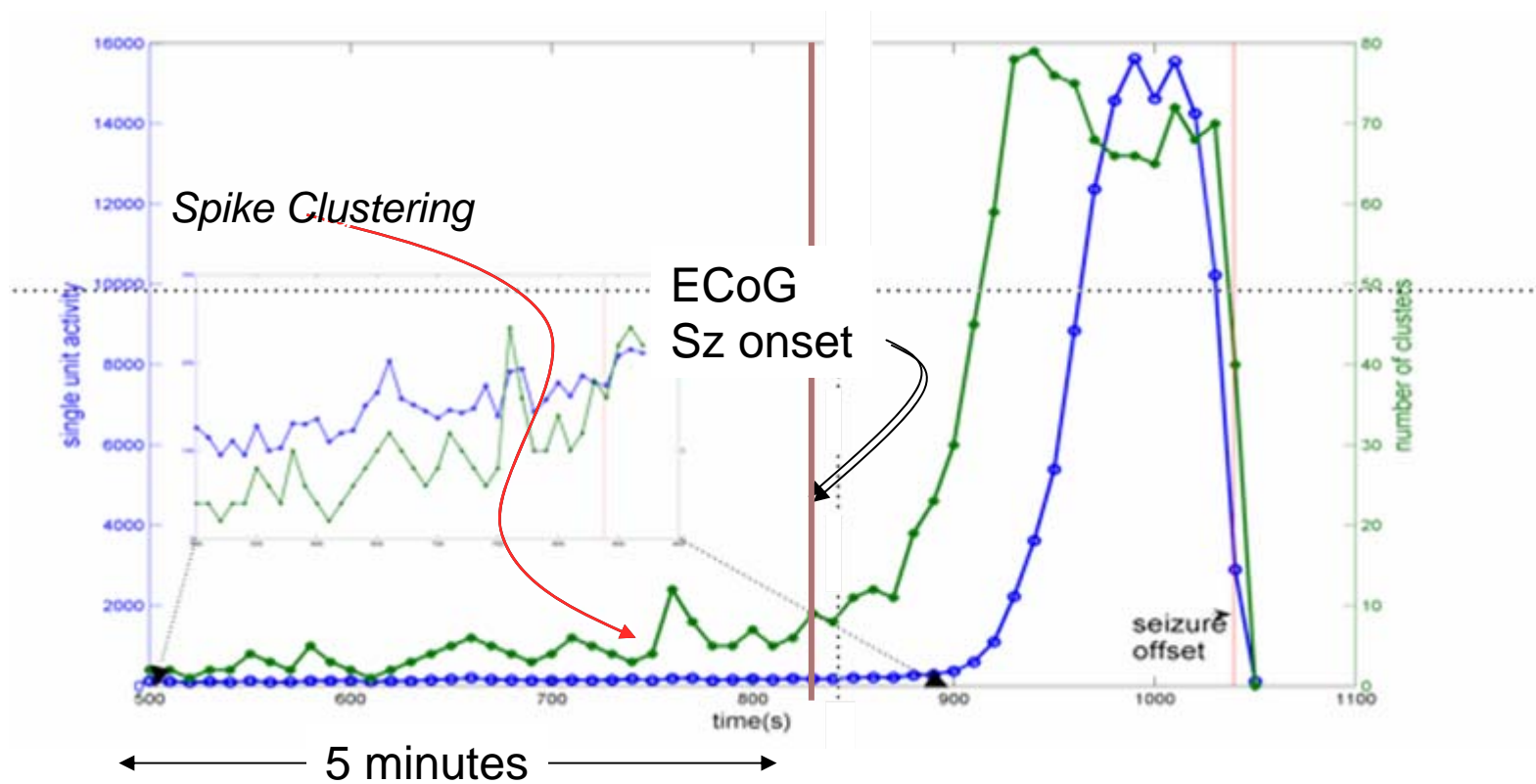
QuickTime™ and
TIFF (Uncompressed)
are needed to see the

Action Potentials in Epilepsy

QuickTime™ and a
Microsoft Video 1 decompressor
are needed to see this picture.

Data: Shevon, Emerson et al., Columbia
Cyberkinetics

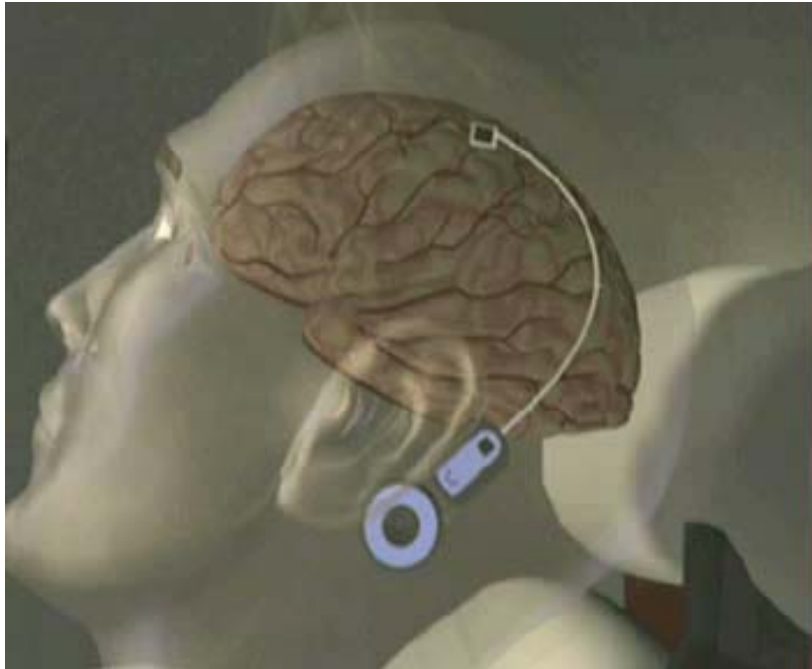
Early Signs of Impending Events (very preliminary!)



Clustering algorithm

Data from Shevon Emerson and collaborators , Columbia U

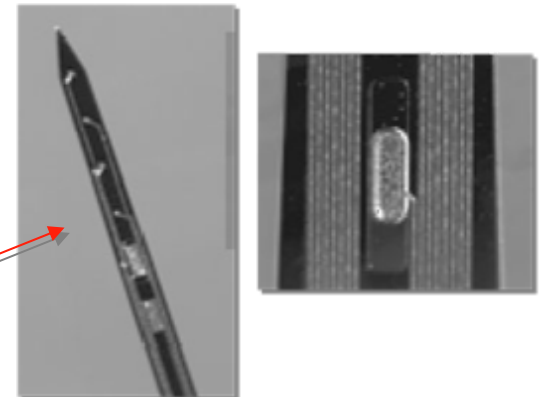
Control of Seizure Activity?



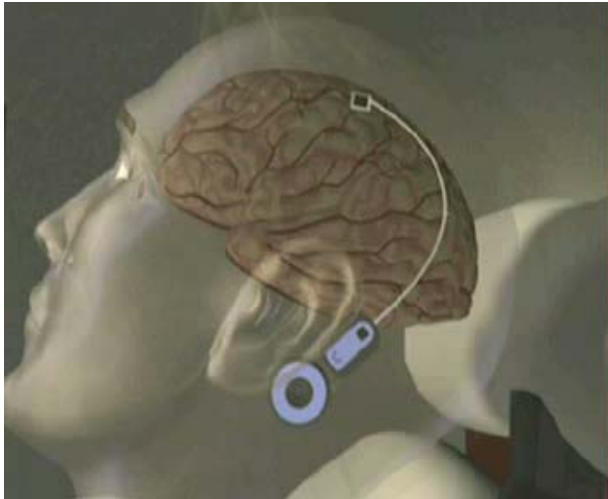
Drug delivery via
microfluidic pump

Daryl Kipke, U. Michigan

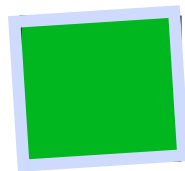
<http://www.mnf.umich.edu/SSEL/Projects/index.aspx?mid=5&sid=11&pid=82>



Closed Loop Control Concept: Electrical Stimulation

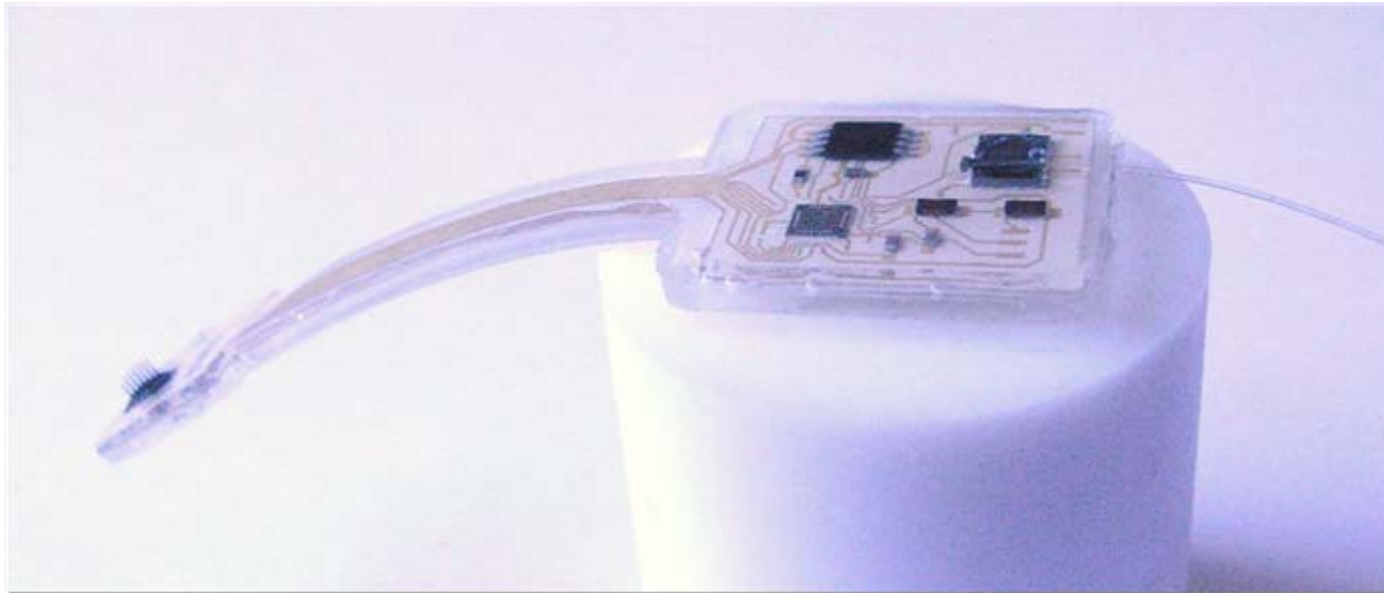


QuickTime™ and a
Animation decompressor
are needed to see this picture.



Cyberkinetics (concept)

Fully Implantable Neural Sensor Prototype



Pending support:
NIBIB/NICHD (NCMRR)

A. Nurmikko Lab

'Smart' Neural Interface Platform: Applications

Stimulating

Sensing

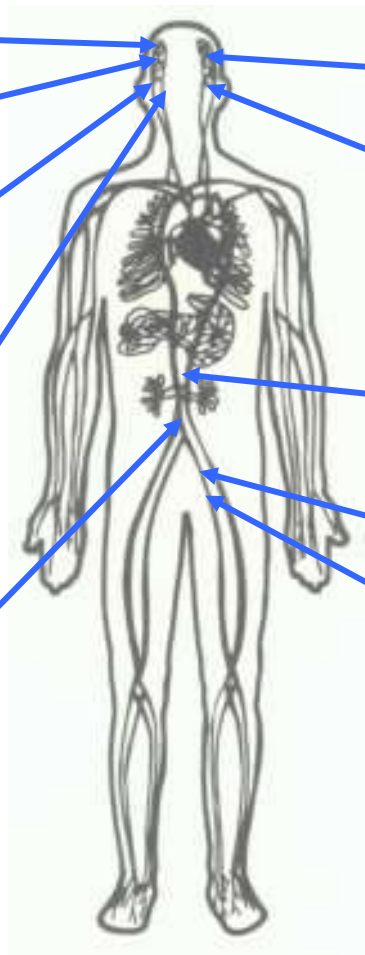
BrainGate – Communication

BrainGate - FES

Epilepsy

Depression

Pain



Vision - Cortical

Hearing – Cortical

Neural Repair

Neural Driven Drug Delivery

Incontinence

Sexual Dysfunction

QuickTime™ and a Animation decompressor are needed to see this picture.

From: Ron Emerson, MD
Columbia Univ/CKI

Plus: Unprecedented access to human brain function at the neuron level

QuickTime™ and a
TIFF (Uncompressed) decompressor
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