2008 의용생체공학개론 실습

- 일　정 (May 22, Thursday)
  - 강사: 김진원(02-880-8342)
  - 2:30 ~ 3:10(40분) 이론 강의
  - 3:10 ~ 3:40(30분) In vivo recording 시현
  - 3:40 ~ 3:50(10분) Lab tour

- 과제물 제출
  - 5/29일 수업시간에 조교(이중재)에게 제출

– 2008 의용생체공학개론 실습

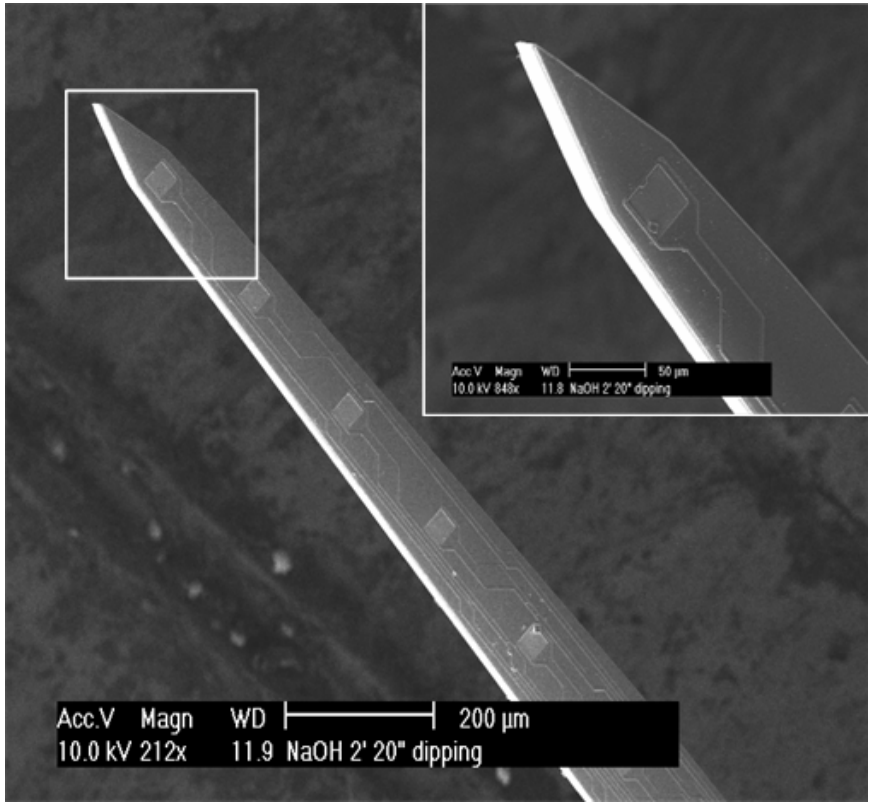
Plexon MAP System을 이용한
Neural Signal Recording

2008. 5.22

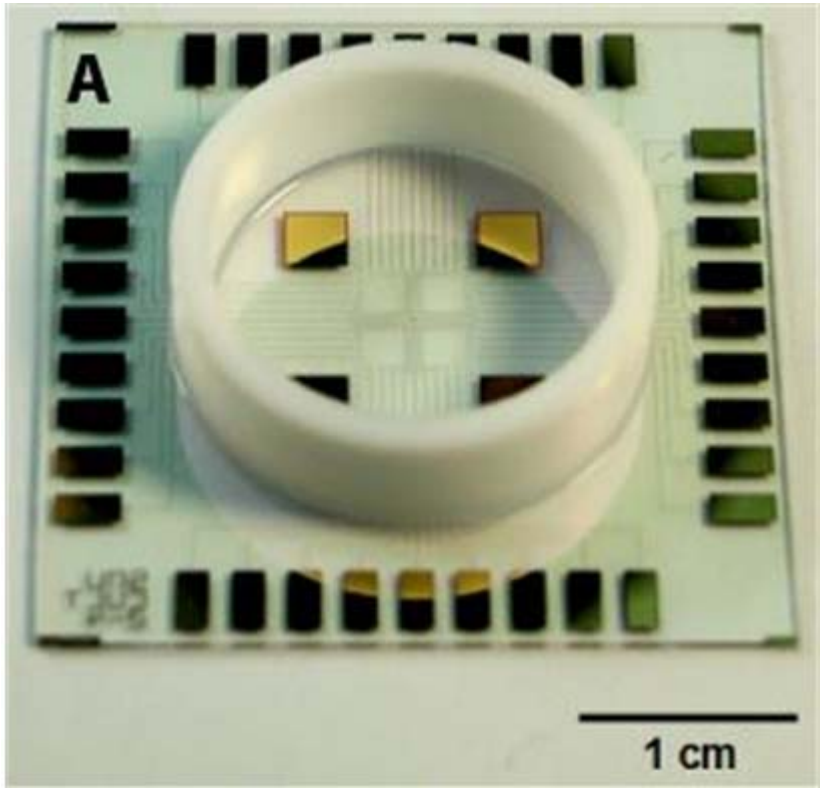
Contents

- Electrode & impedance
- Plexon System
- Neural Signal

SNU Probe



Depth Type Electrode
- GEN 3 probe



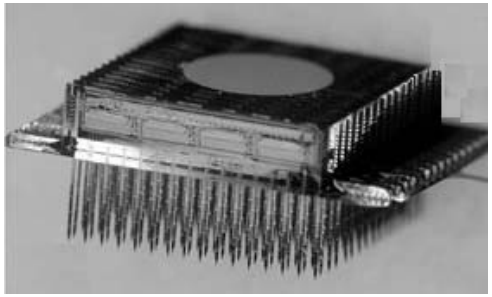
Planar Type Electrode
- CULT 2 MEA

Ref: 1. "A high-yield fabrication process for silicon neural probes", Seung Jae Oh, Jong Keun Song, Jin Won Kim, and Sung June Kim, IEEE Trans. Biomed. Eng., vol. 53, no. 2, pp. 351-354, Feb. 2006

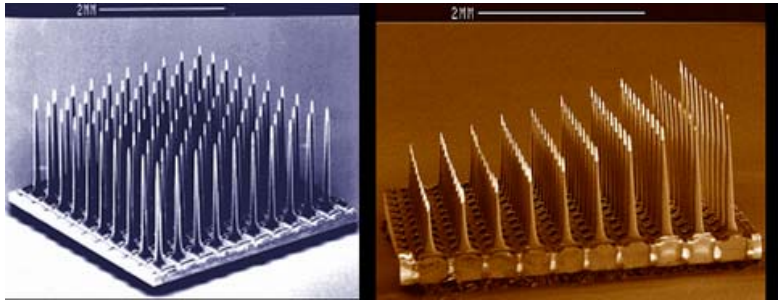
2. "Low-Density Neuronal Networks Cultured using Patterned Poly-L-Lysine on Microelectrode Arrays", Sang Beom Jun, Matthew R. Hynd, Natalie Dowell-Mesfin, Karen L. Smith, James N. Turner, William

Shain, Sung June Kim, Journal of Neuroscience Methods, Vol. 160, No. 2, 15 Mar 2007, Pages 317-326

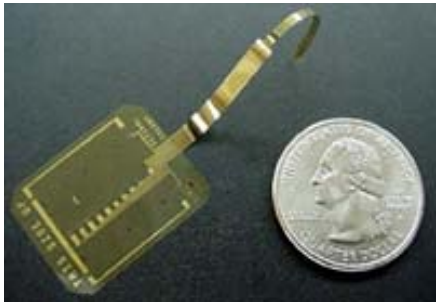
Other Electrodes



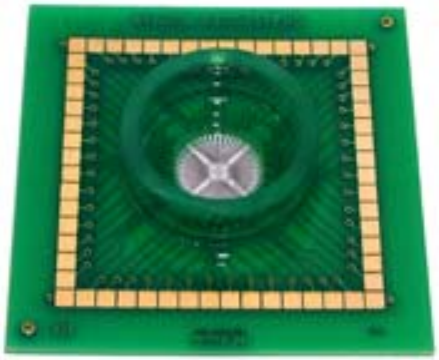
Michigan Probe



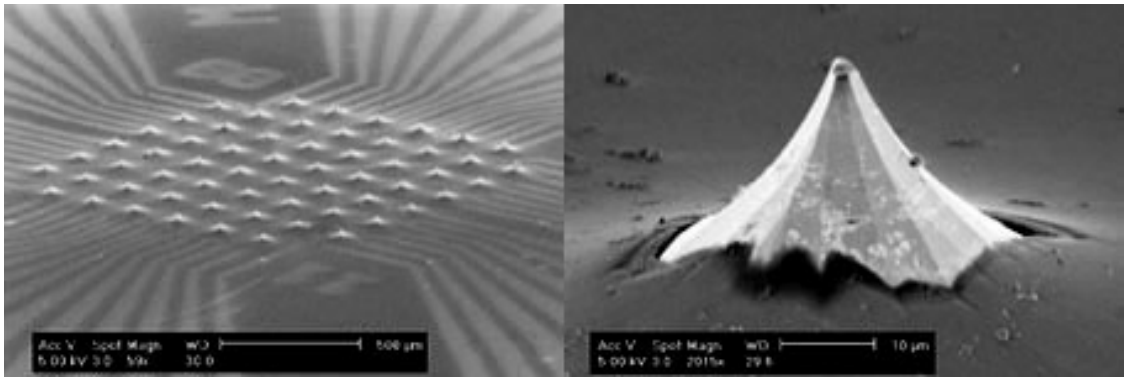
Utah Probe



Flexible Probe

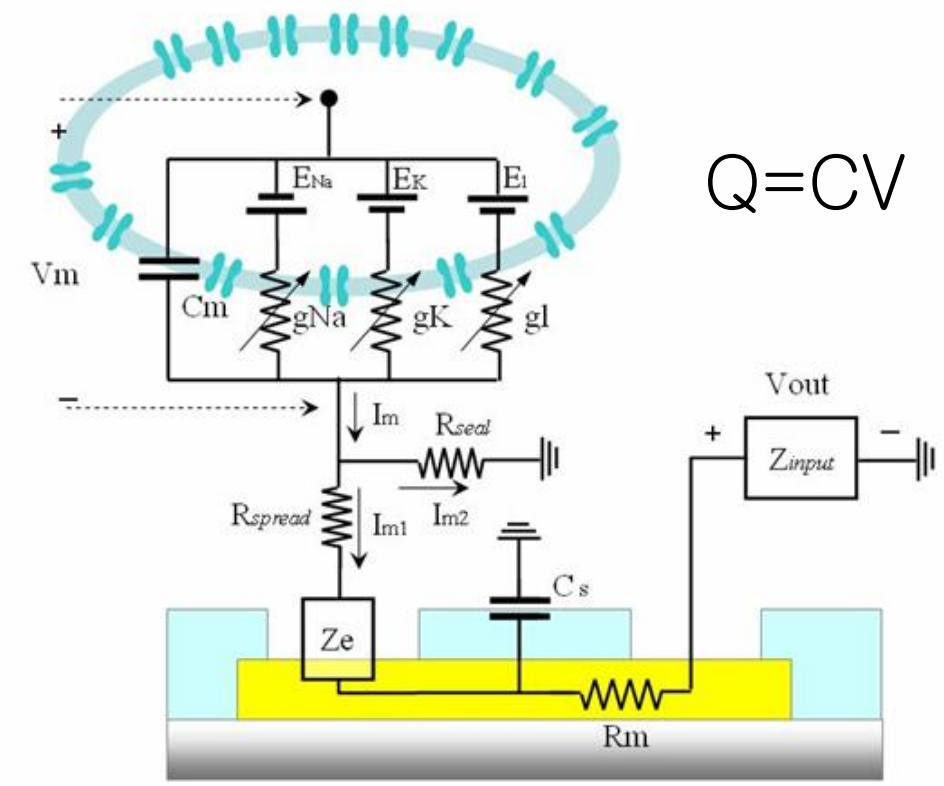


Multichannel systems
- 60_100 MEA



Multichannel systems
- 3D Electrode

Impedance of recording site



Schematic diagram of extracellular recording

Q=CV

※ 전극의 임피던스는 대체로 수백kΩ

※ 전극 표면은 항상 깨끗하게 유지되어야 한다.

- Impedance 가 너무 낮으면 계면에 유도되는 전압이 너무 작다.
- Impedance 가 너무 높으면 Signal loss & thermal noise 발생

Selectivity vs. Sensitivity

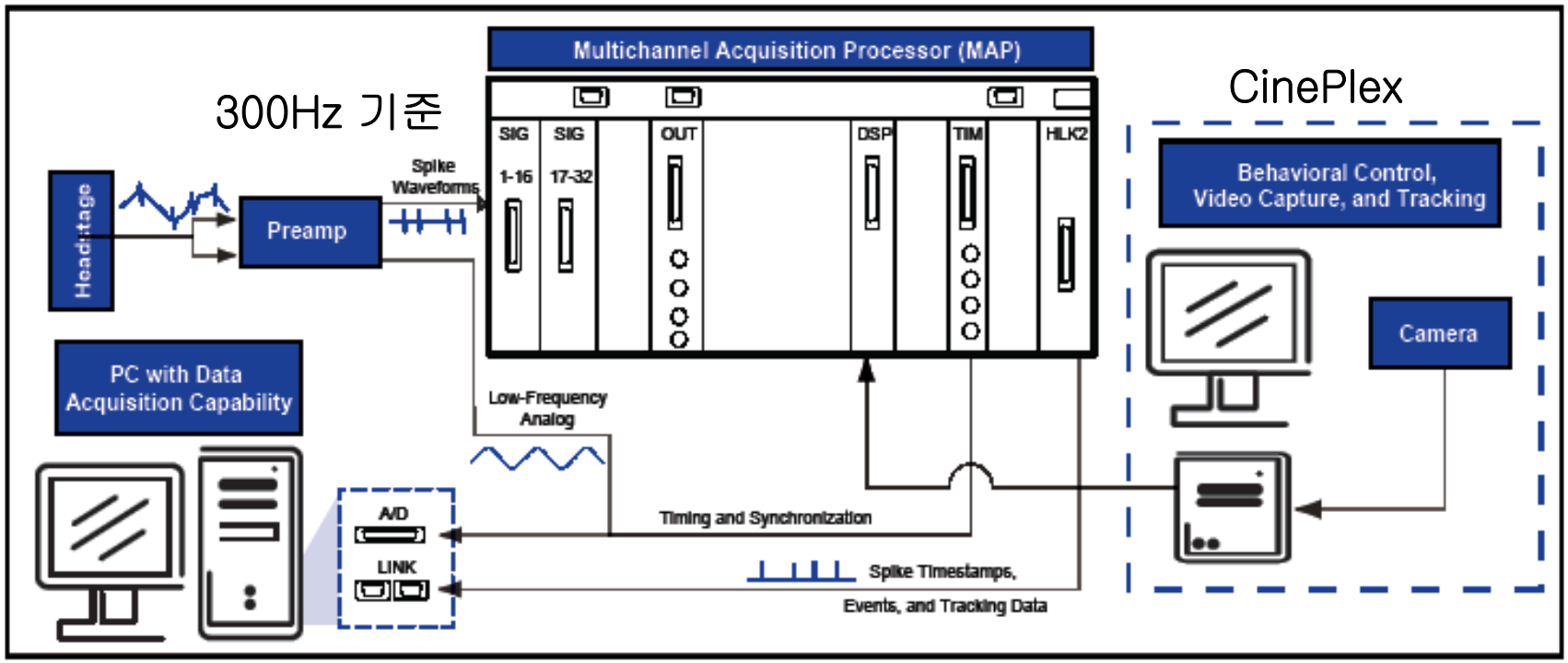
- Sensitivity (minimum detectible signal): Noise를 줄이기 위하여는 낮은 Site Impedance 가 필요하다.
- Selectivity (minimum number of units (cells) recordable): Impedance 를 낮추기 위해 Site 의 크기를 크게하면 Single unit Recording 을 할 수 없음.
- 극복방법
  - 표면 Roughness 증가(Pt-black, Carbon nanotube 등)
  - Seal Resistance 증가(patchclamp 등)

Plexon MAP System

- Real time으로 neuron으로부터 spike signal 과 EEG field signal 을 획득하고 분류, 분석하는 neuroscience & electrophysiology system이다.
- electrode로부터 spike signal를 acquisition하고 이러한 spike signal을 실시간으로 sorting 하는 메인 unit인 **MAP와 sort client**를 중심으로 EEG signal(field potential)을 acquisition하는 **NI board** 그리고 video tracking을 위한 **Cineplex**, 그리고 signal 과 video file을 통합시키고, 특정event를 입력시키는 **Cineplex Markup**을 가지는 다기능 통합 시스템이다
- **Client**라고 불리는 다양한 data 분석 software를 가지고 있기에 유저로 하여금 많은 정보의 다양한 분석을 가능하게 한다 (ex: PEC, Grid Monitor, Graphic Activity Content, Front End, NEX)

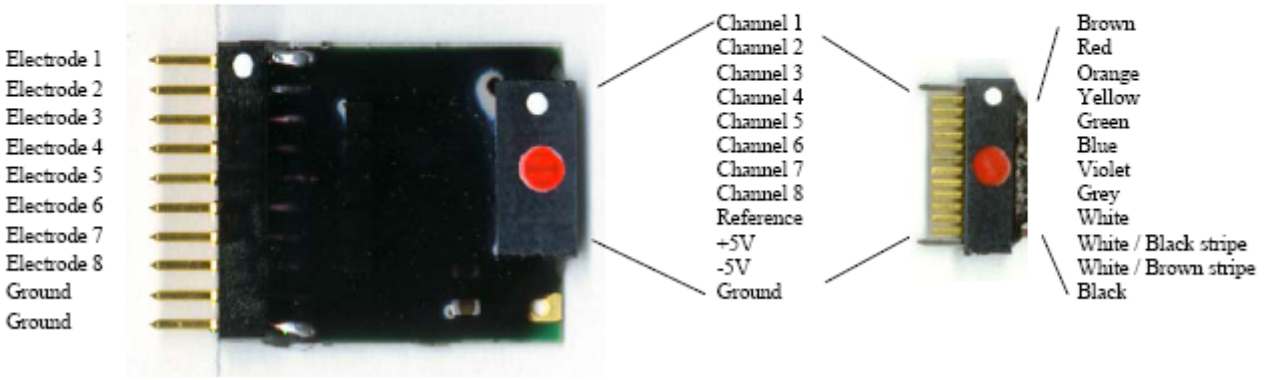
System Block Diagram

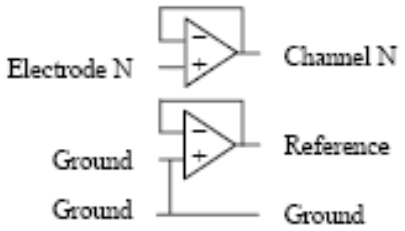
MAP

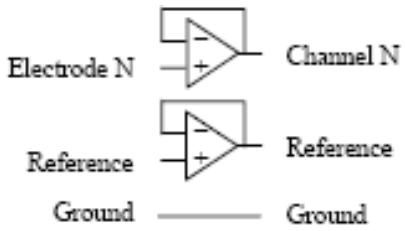


Headstage

HSP-8

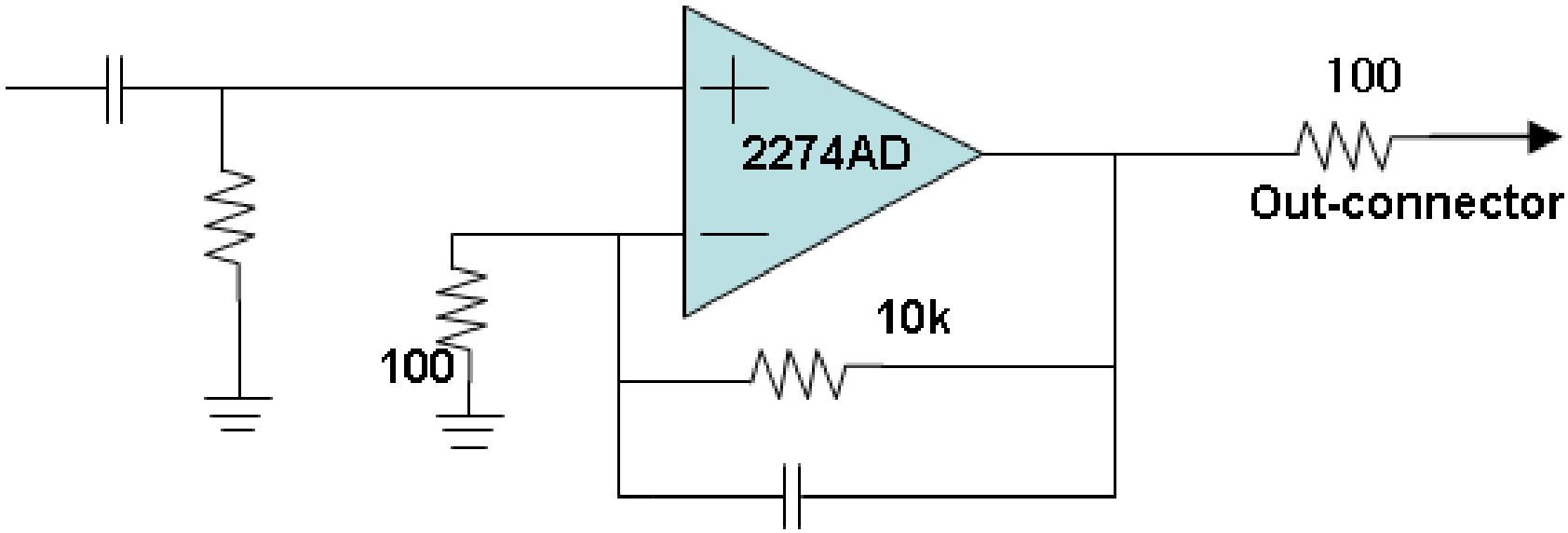






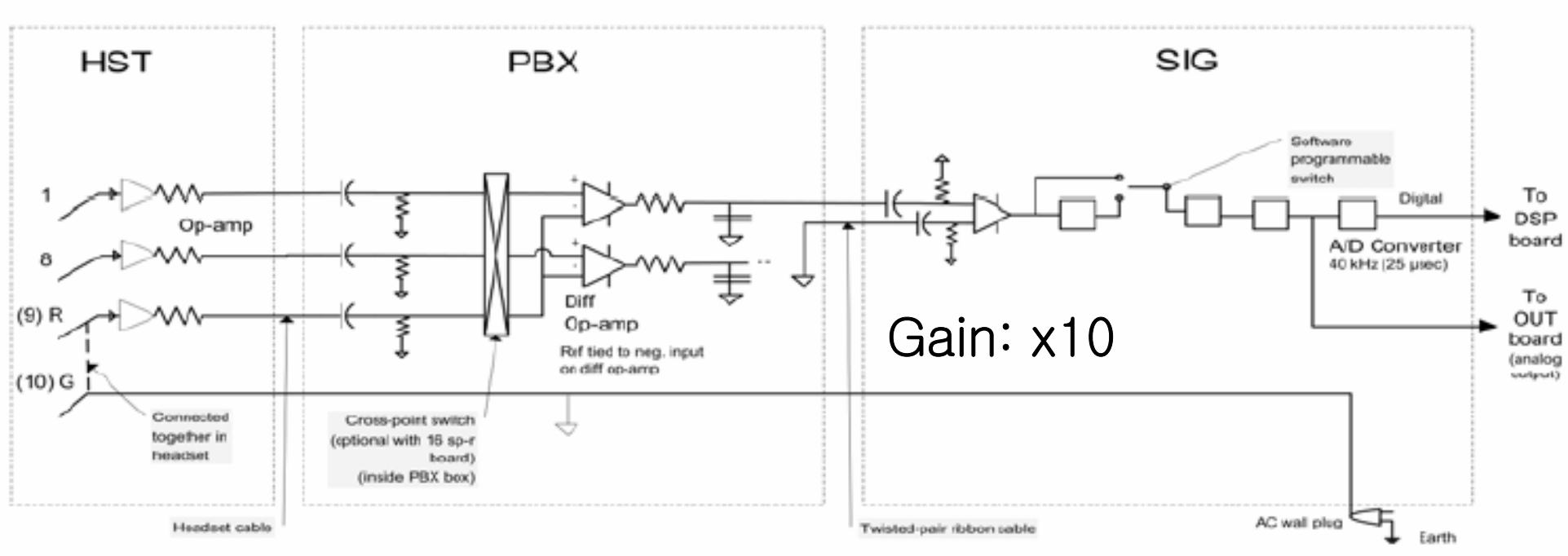
Gain: x1

PreAmplifier



Gain: x100

Circuit Diagram



Noise 제거

- Noise와 Neural signal은 다음과 같이 구분된다.

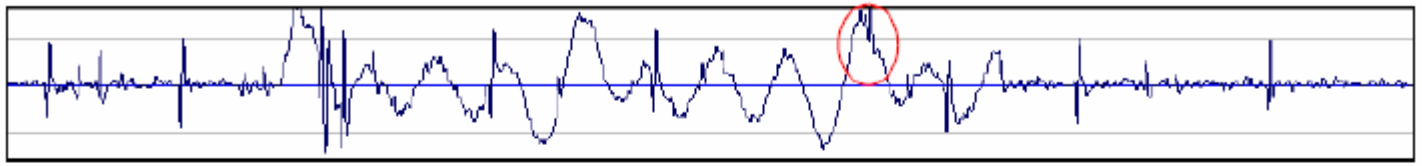
  1) Low-frequency signals : Local Field Potentials(LFP)가 예이다. 일반적으로 Signal spectrum이 200Hz이하이다.

  2) Mid-band signals : spike waveforms 이 예이다. 일반적으로 Signal spectrum 이 300Hz~5000Hz이다.

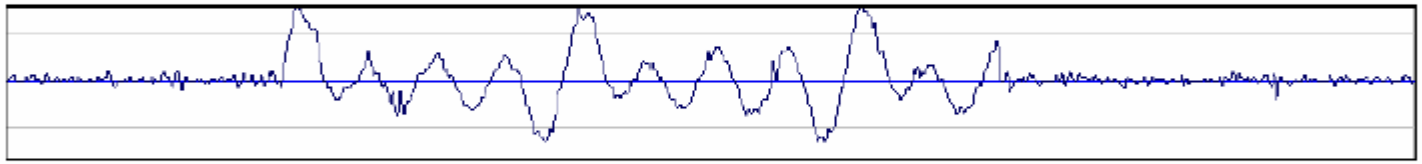
Artifacts 제거

- "Ref 2"라는 software 를 이용한 방법 (noise가 없다고 생각되는 channel을 template로 지정)
- Reference Electrode (ground로부터 분리하여)를 사용한 하드웨어적인 방법

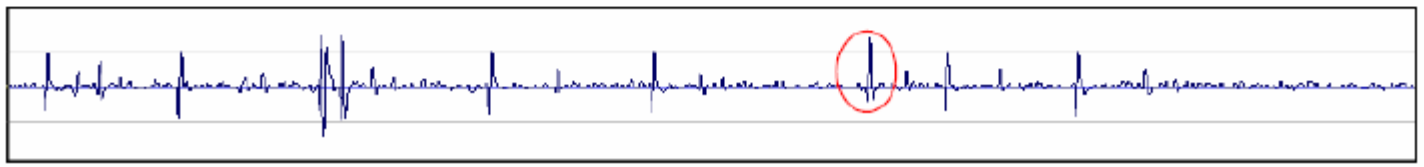
Channel 1: Spikes with a chewing artifact

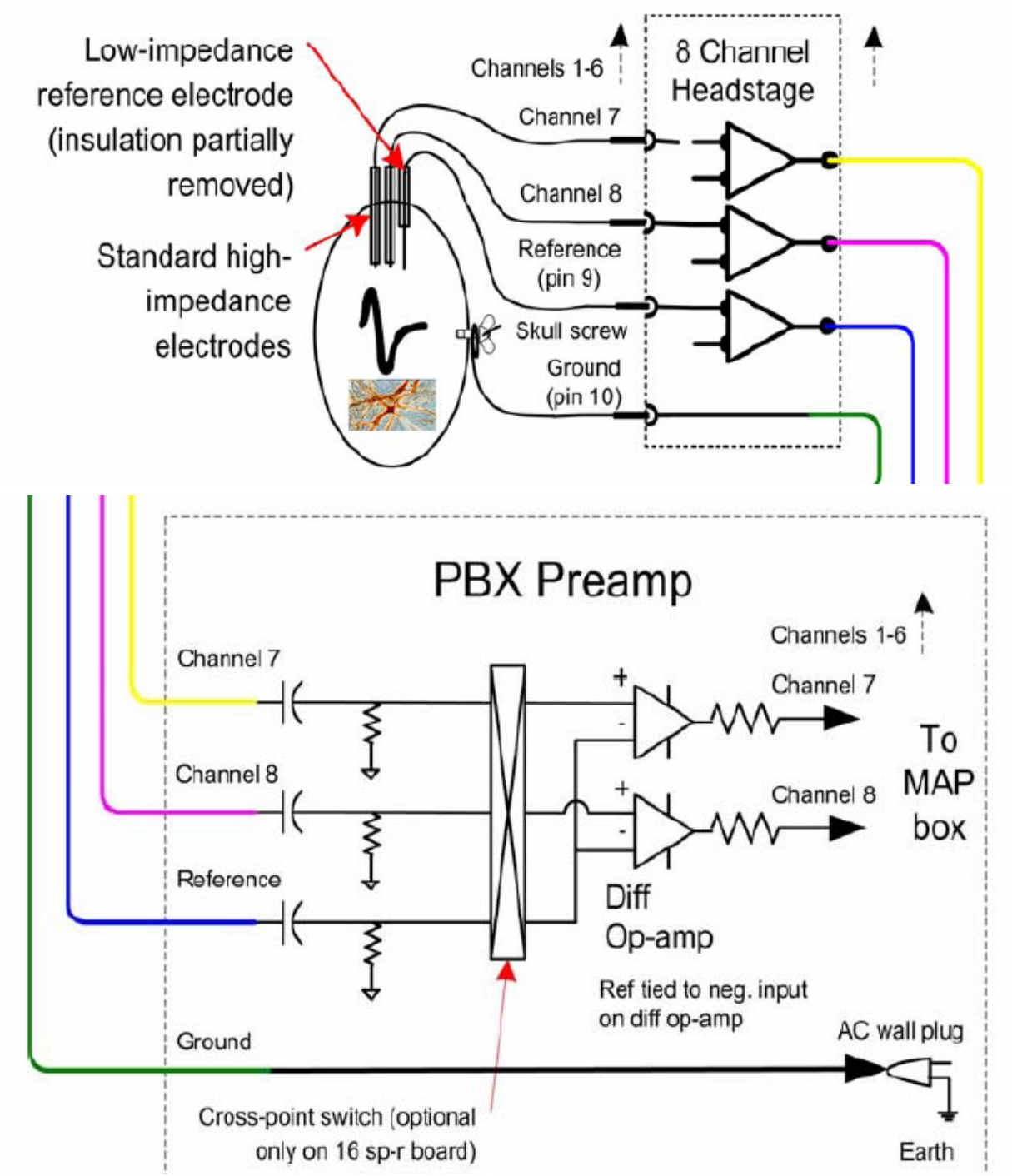


Channel 2: Artifact only with no spikes (not connected to a neural signal source)



Channel 1 - Channel 2: reference applied to remove the artifact



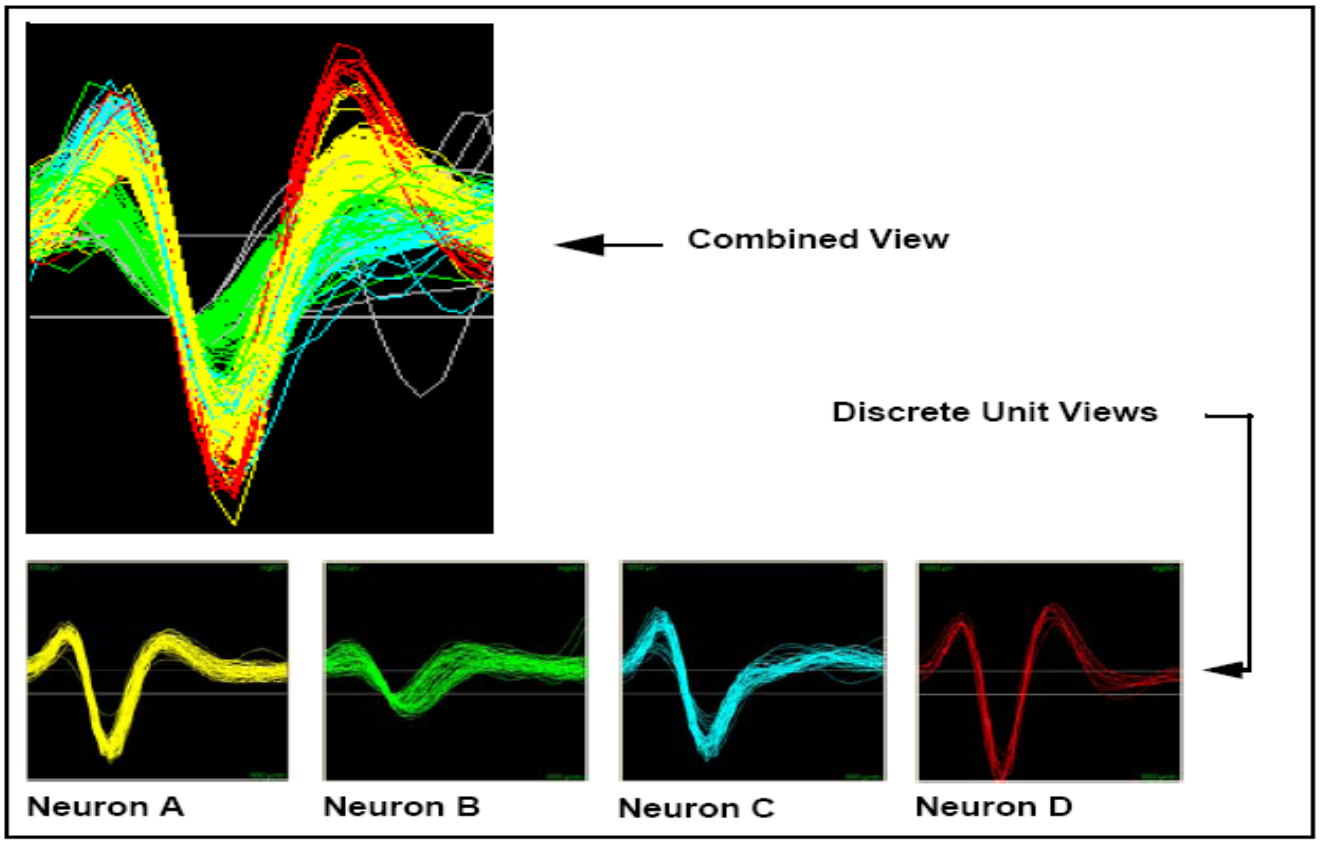

Low-impedance reference electrode (insulation partially removed)
Standard high-impedance electrodes
Channels 1-6
8 Channel Headstage
Channel 7
Channel 8
Reference (pin 9)
Skull screw
Ground (pin 10)
PBX Preamp
Channels 1-6
Channel 7
Channel 8
Reference
Ground
Diff Op-amp
Ref tied to neg. input on diff op-amp
To MAP box
AC wall plug
Earth
Cross-point switch (optional only on 16 sp-r board)

Neural Spike 와 Noise 의 구별

- Neural response 는 SNR이 나빠서 noise로 부터 분리하기 어렵다.
- Spike 를 확인하는 방법
  - Multichannel Recording을 이용한 방법
    - Stimulation 위치로부터 recording 위치들 사이의 거리 차이에 위한 Spike 의 time delay 확인
  - Ion channel blocker 사용

Spike Sorting

- you must be able to accurately assign spikes to specific neurons with a high degree of reliability.

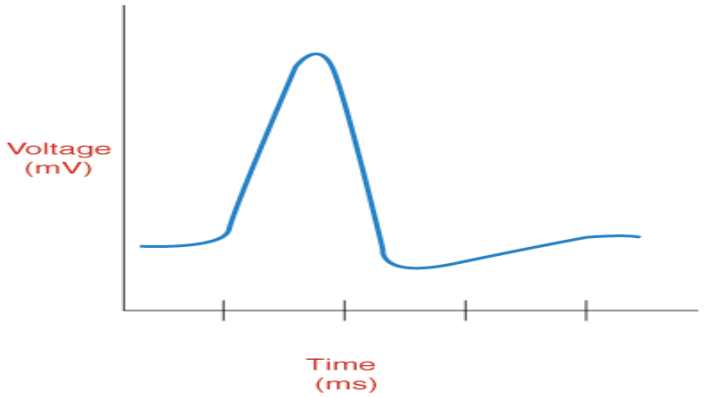


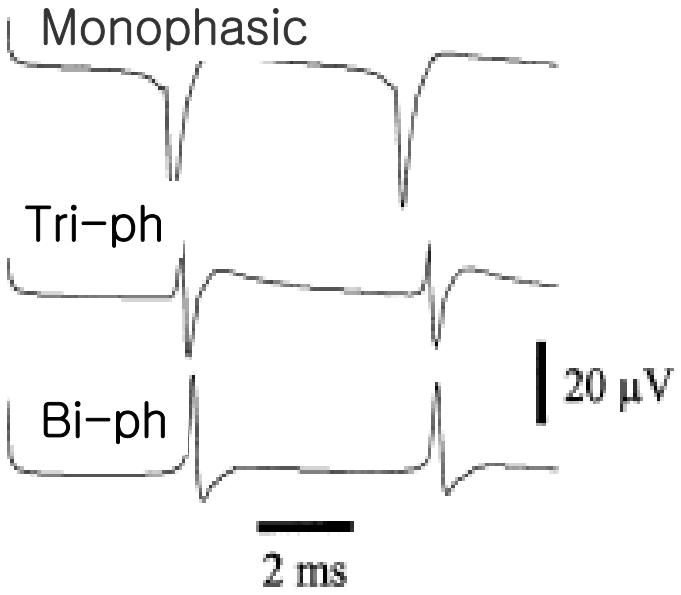
Spike 의 Waveform

- 실제 recording 을 해보면 다양한 모양의 신경신호가 측정된다.

<원인>

- 세포에서 기인하는 내재적인 요인과 recording electrode-reference electrode간의 seal정도에 따르는 외부적인 요인이 있다.
- Reference 1. Science New Series Vol 252, No 5010 (May 31, 1991), 1289-1293: A Neuron Silicon Junction: A Retzius Cell of the Leech on an Insulated Gate Field effect transistor
- Reference 2: Extracellular potentials in low-density dissociated neuronal cultures,Enric Claverol-Tinture *, Jerome Pine,Journal of Neuroscience Methods 117 (2002) 13/21





– The End –

Thank you for your attention