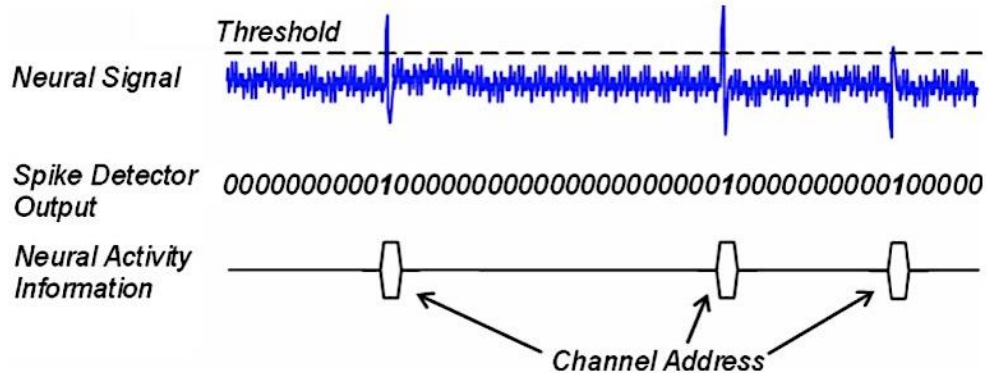
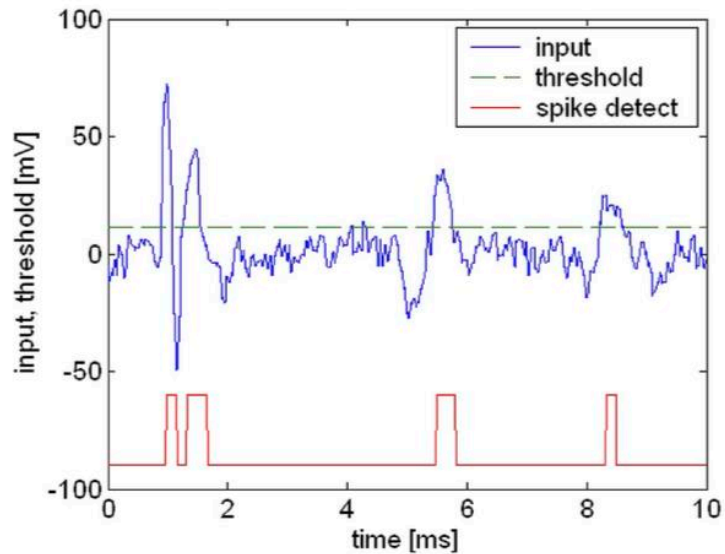


# Neural Interfaces

NX-422  
Neurostimulation

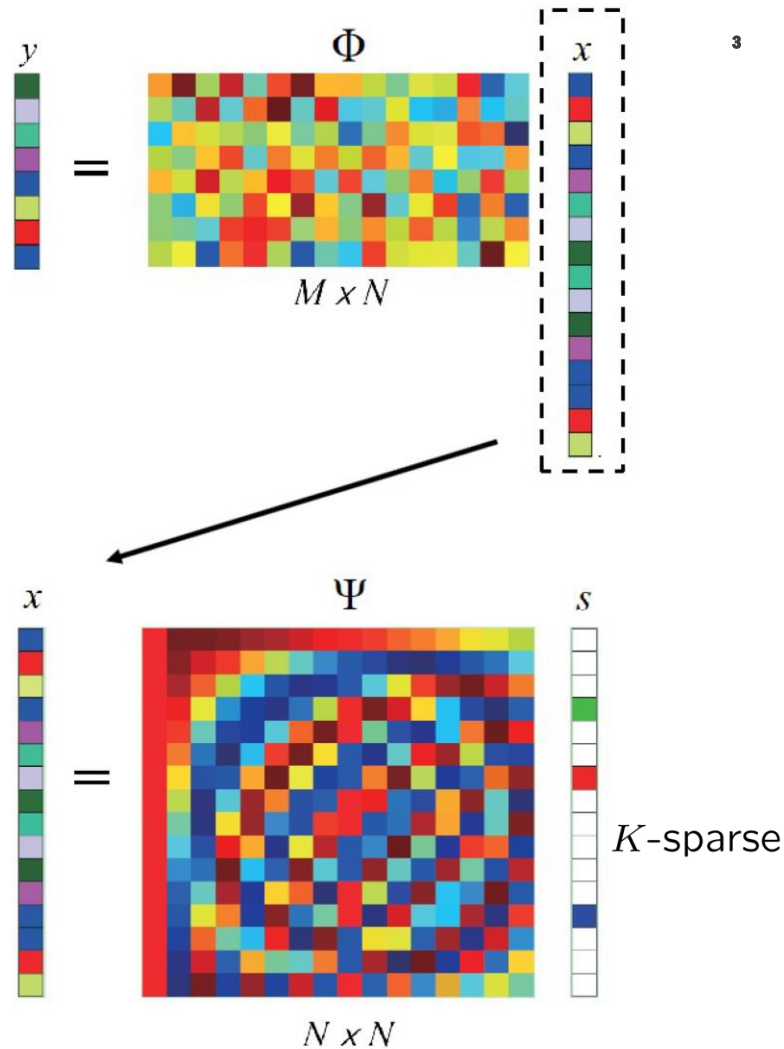
Mahsa Shoaran  
IEM and Neuro-X Institutes

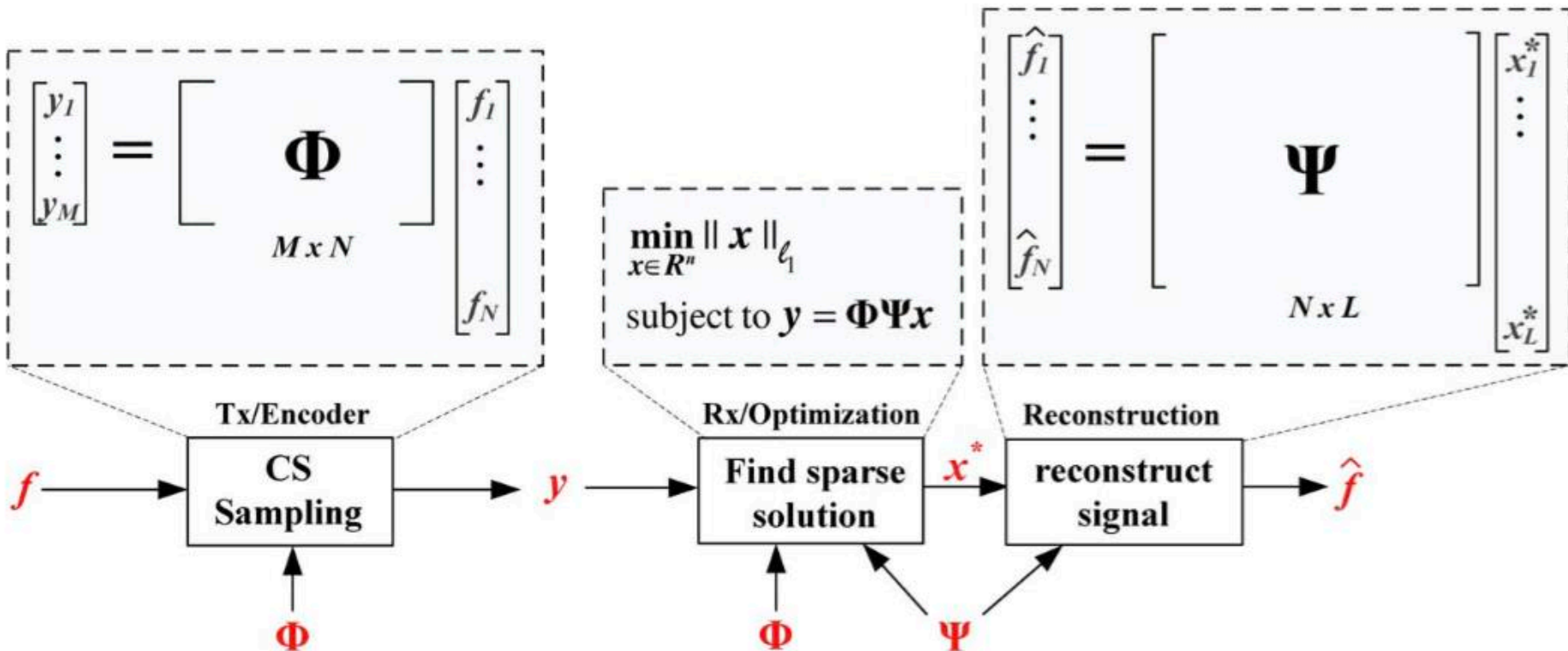
## ■ Spike Detection

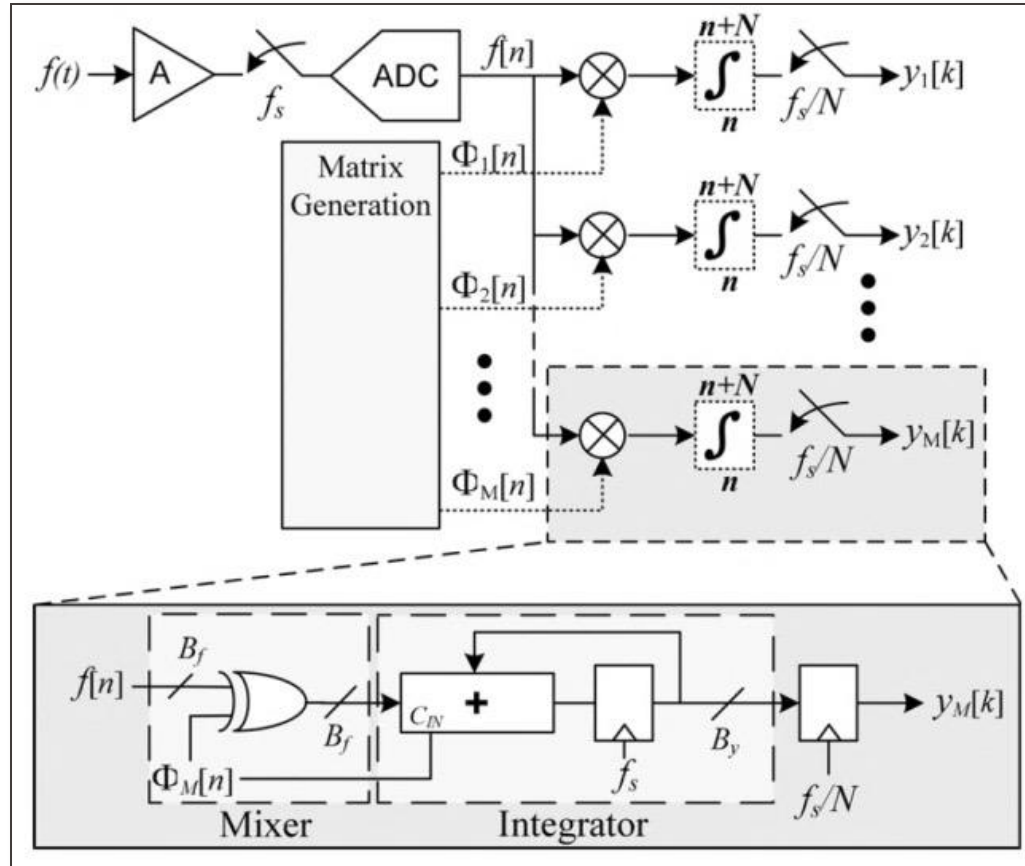


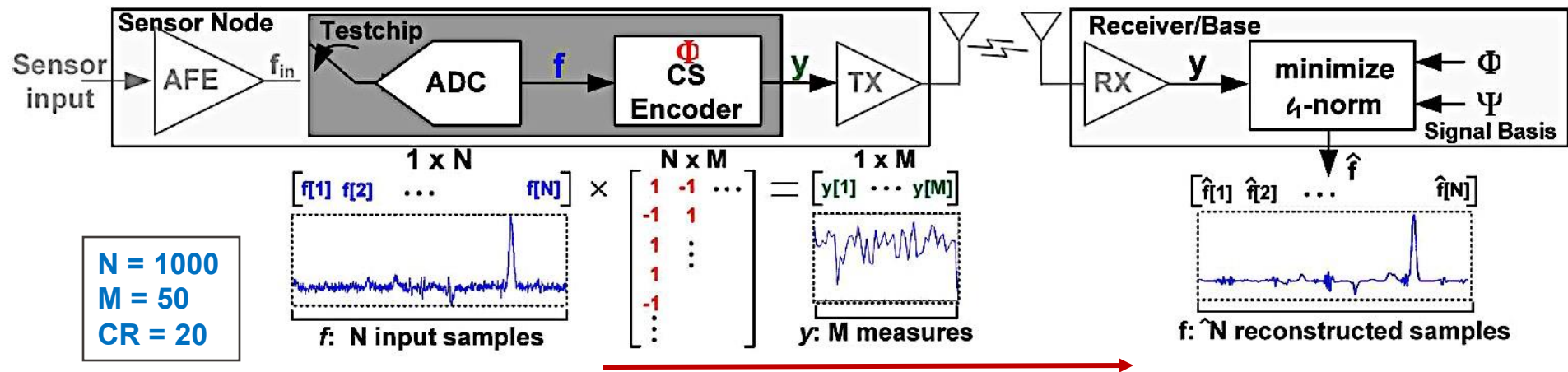
# Recap: Compressive Sensing

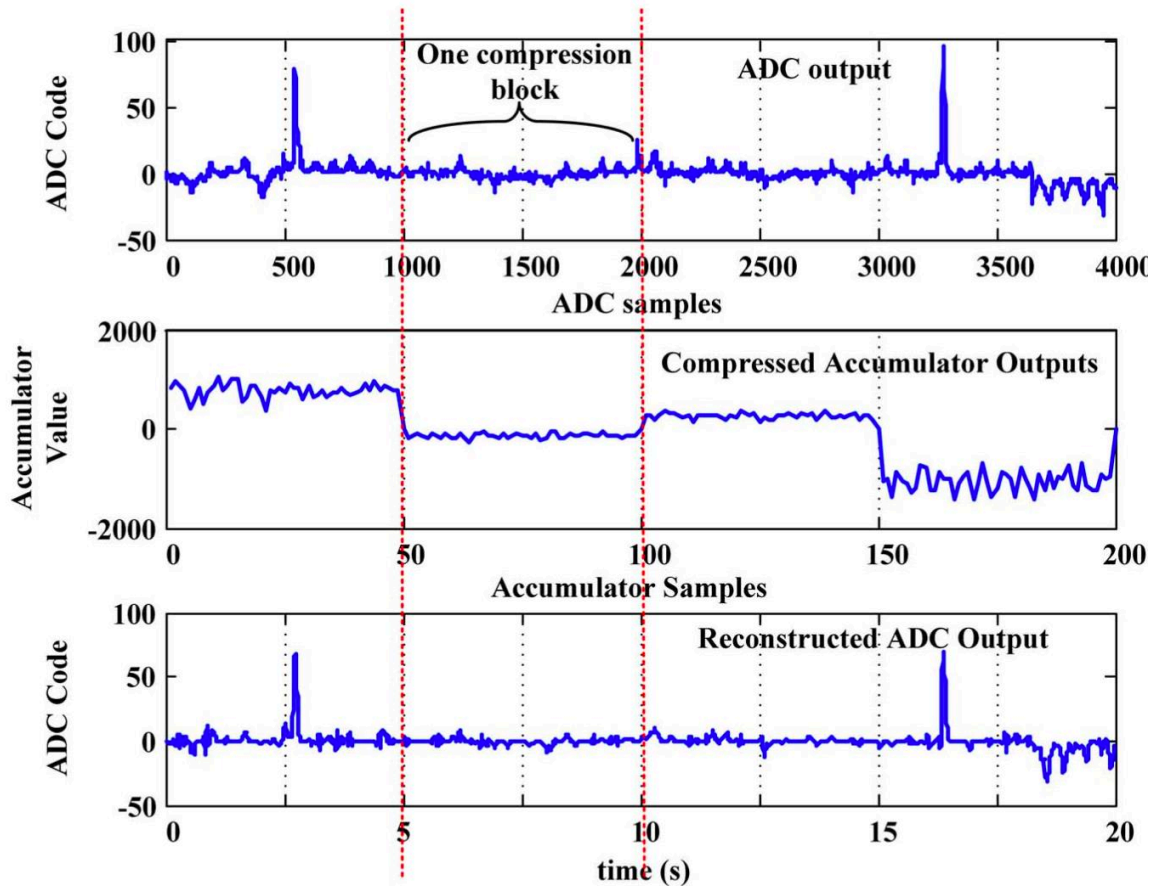
- Given a signal's sparsity, it may be reconstructed with fewer samples than the sampling theorem requires
- Low cost, generality
- Measurement matrix with random 0/1



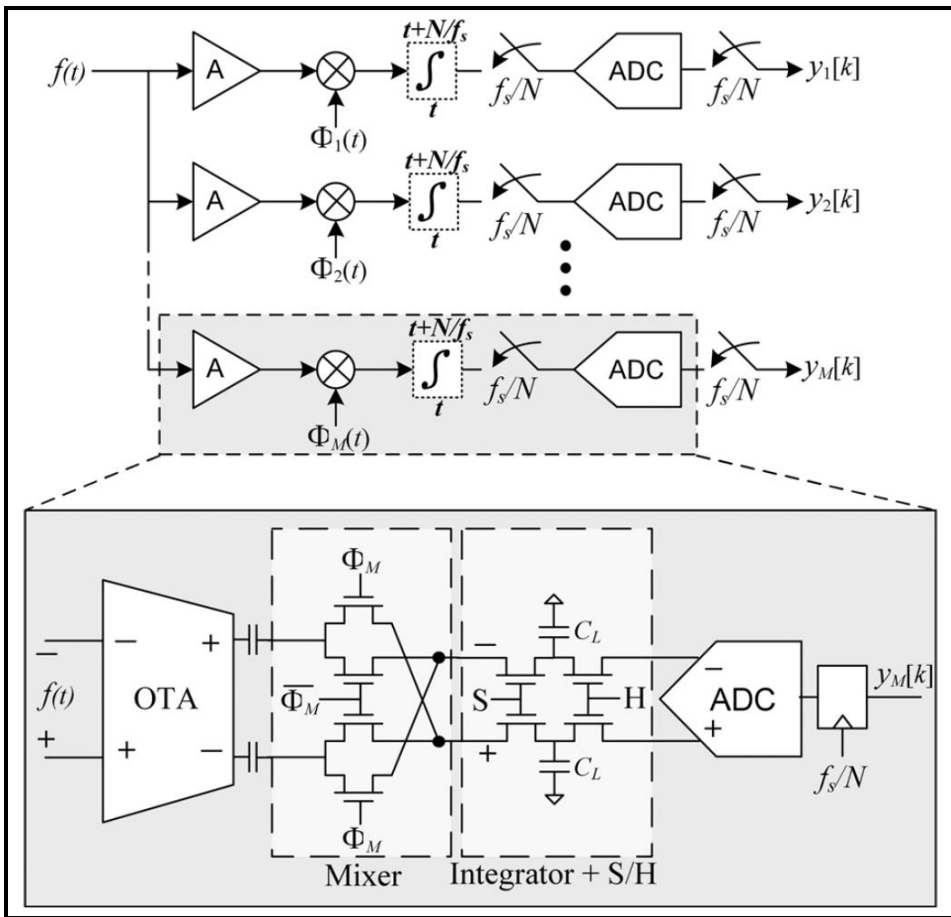




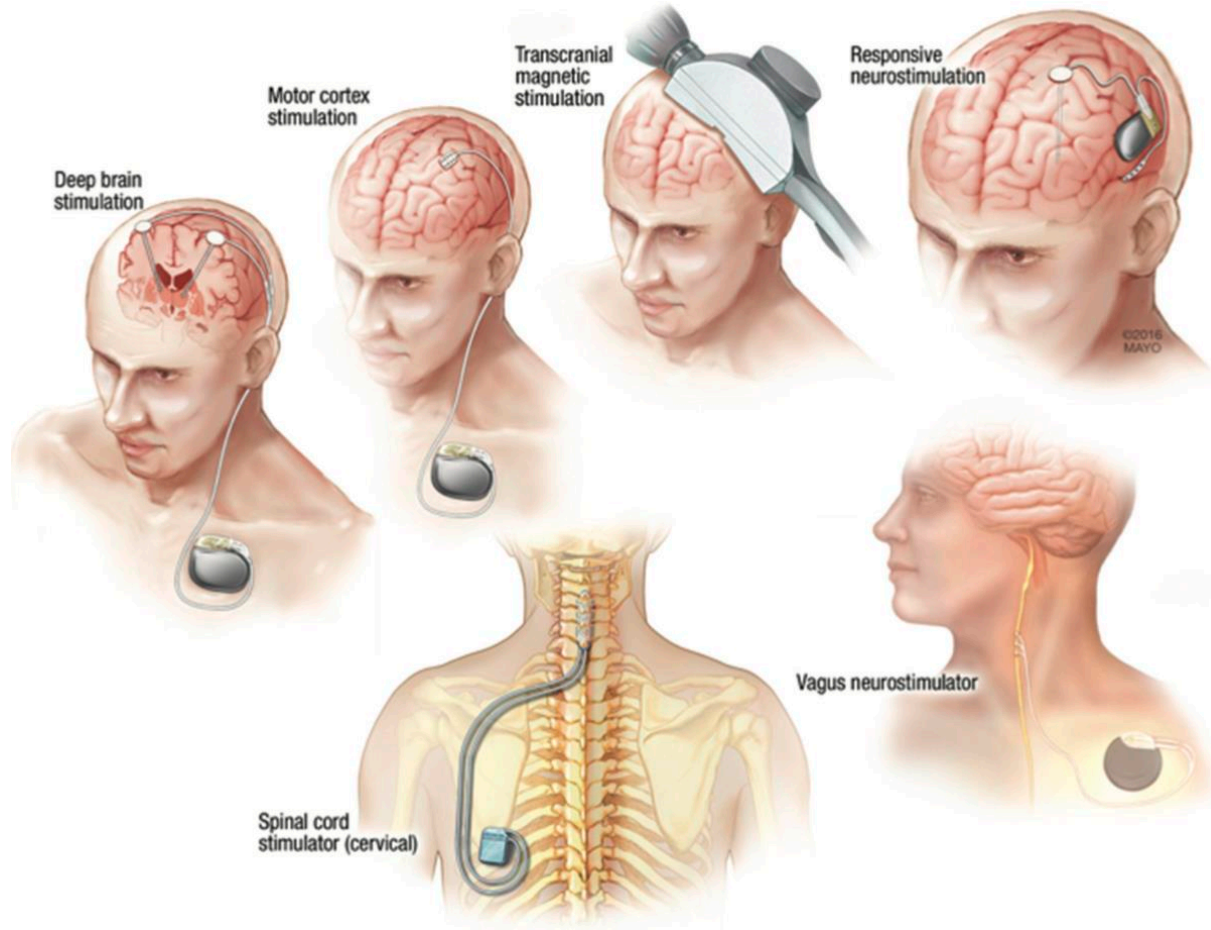




# Compressive Sensing Hardware - Analog



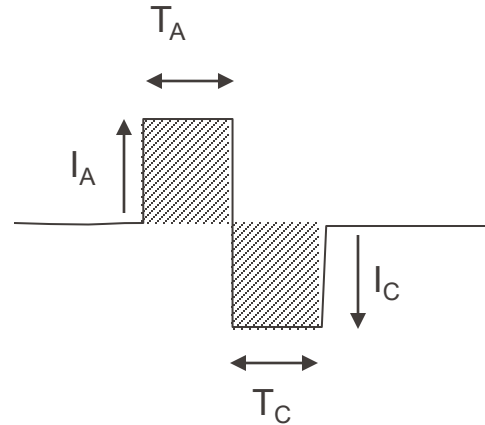
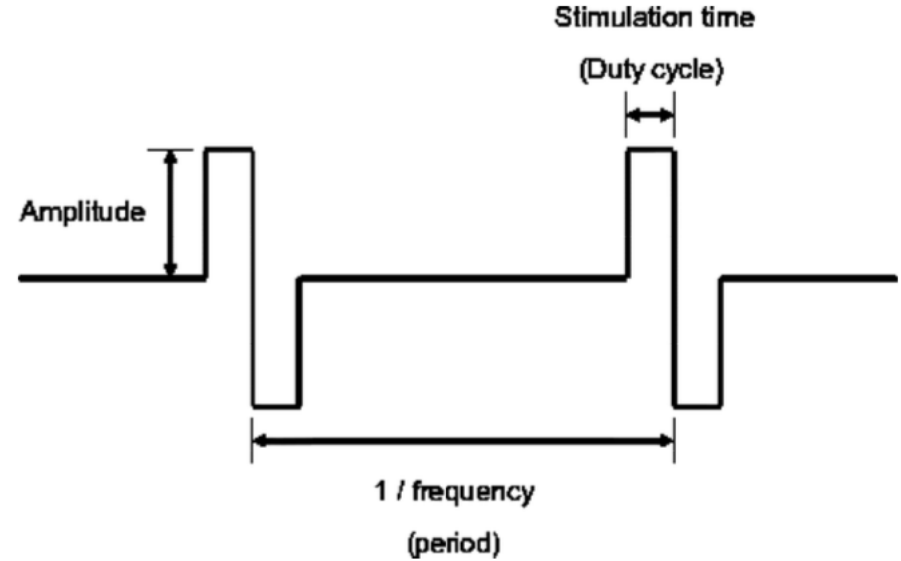
# Neurostimulation (Neuromodulation)



- To prevent electrode corrosion, charge balanced pulses used
- Can be either cathodic or anodic first
- Need not be same length as long as:

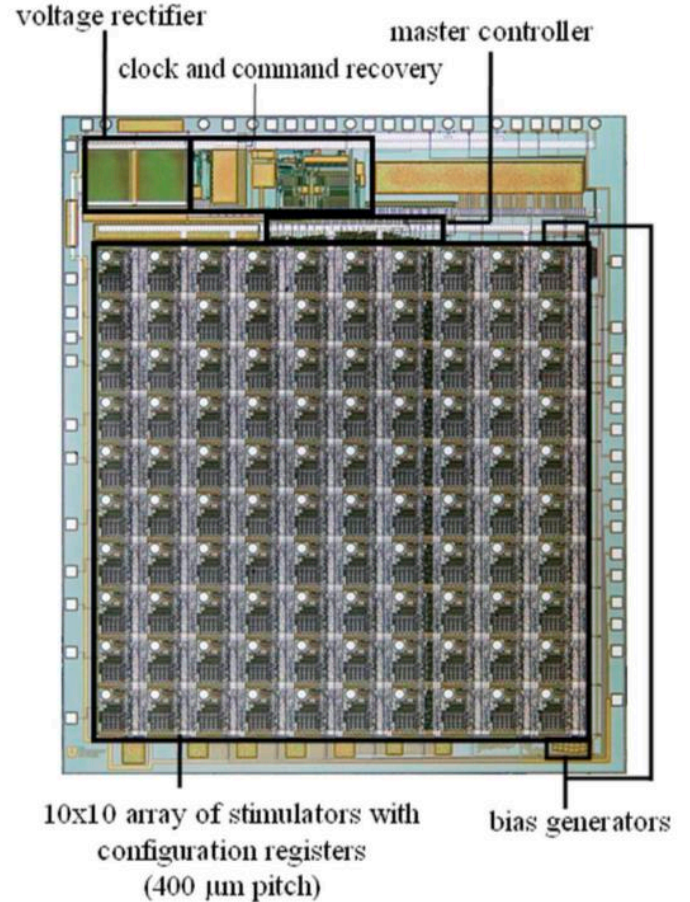
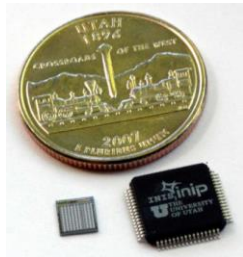
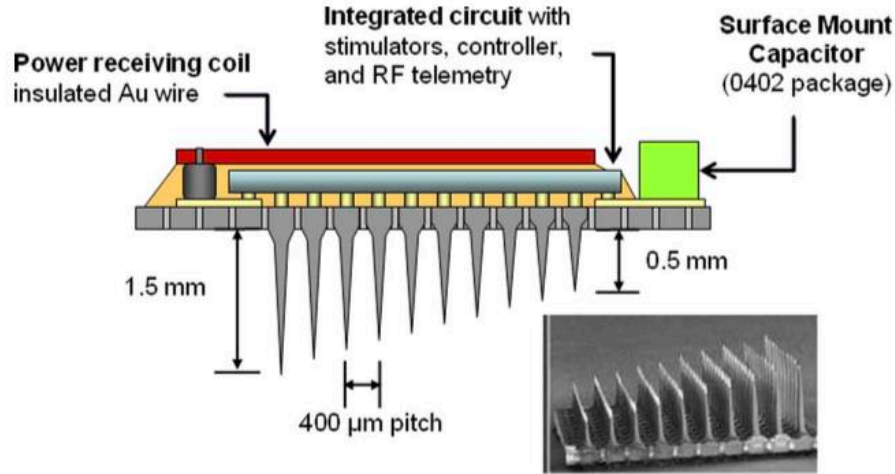
$$Q_A = Q_C$$

$$T_A I_A = T_C I_C$$



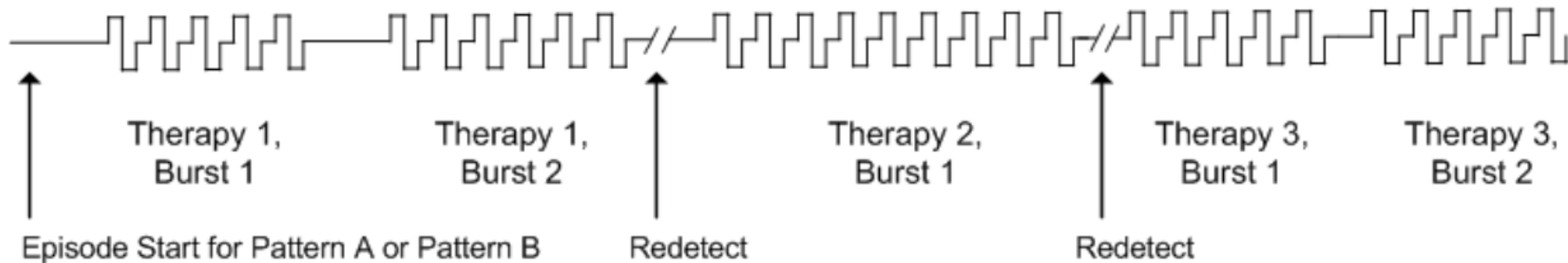
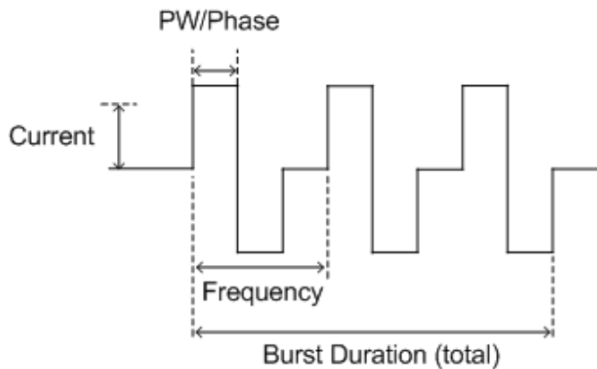
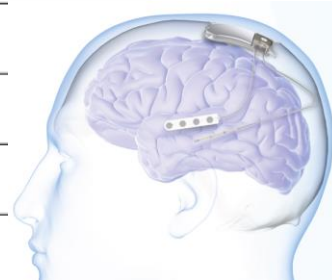
- Voltage-controlled stimulation (VCS)
- **Constant-current stimulation (CCS)**

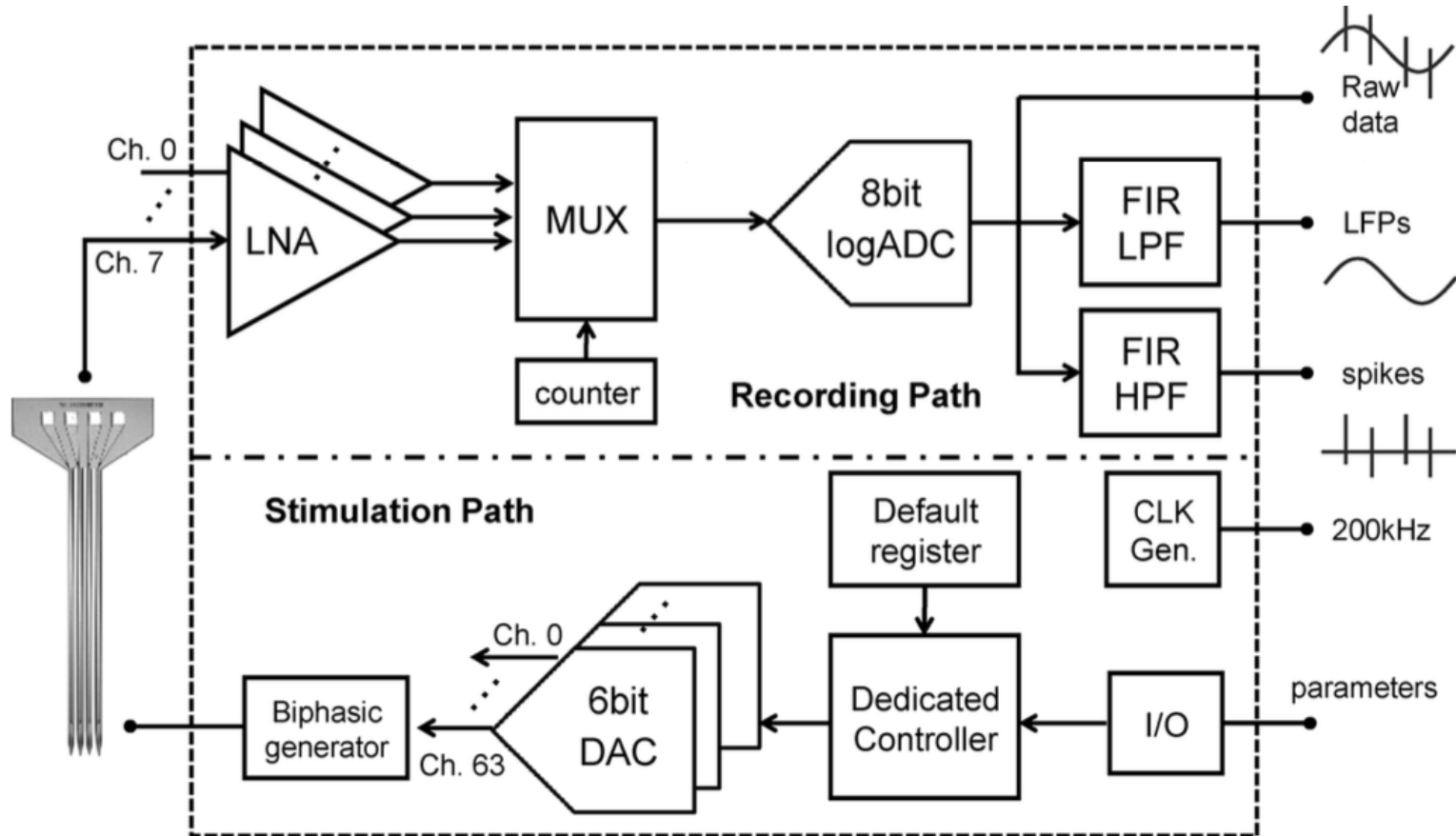
# Neural Stimulator Chip



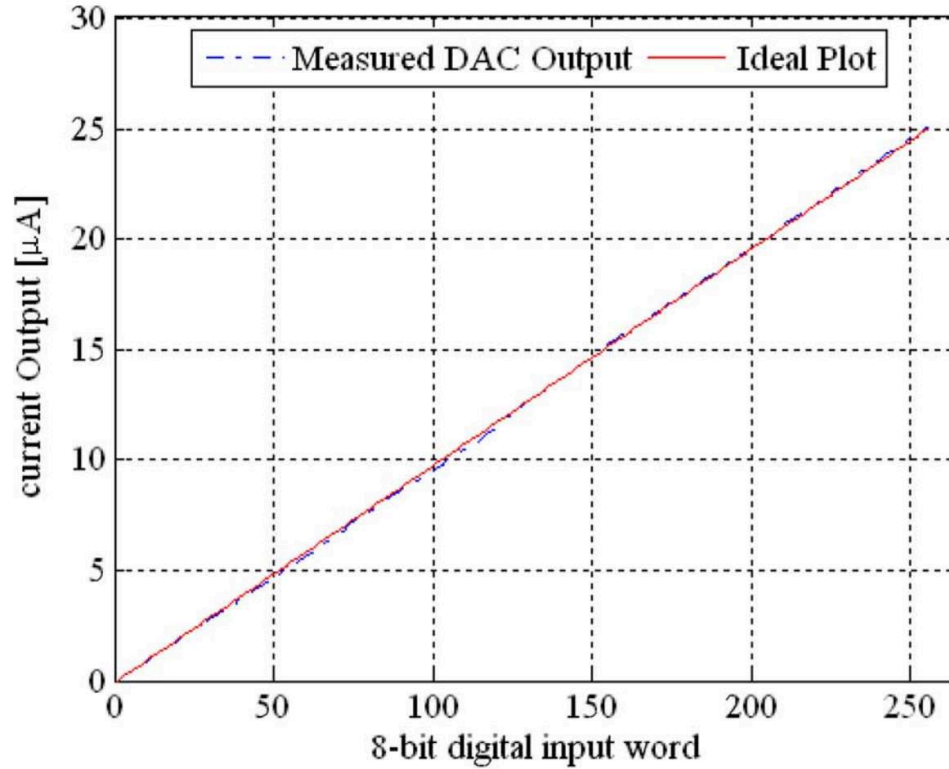
## Recommended Initial Responsive Therapy Settings

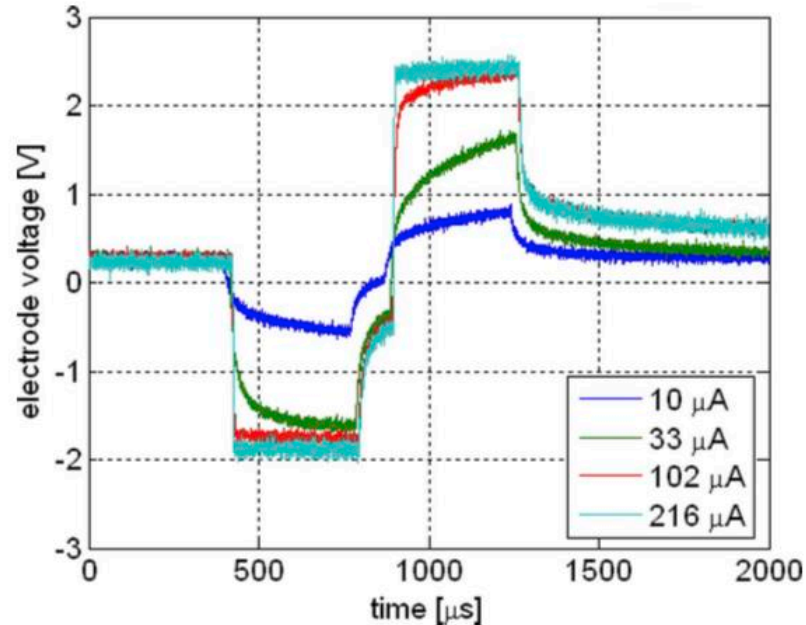
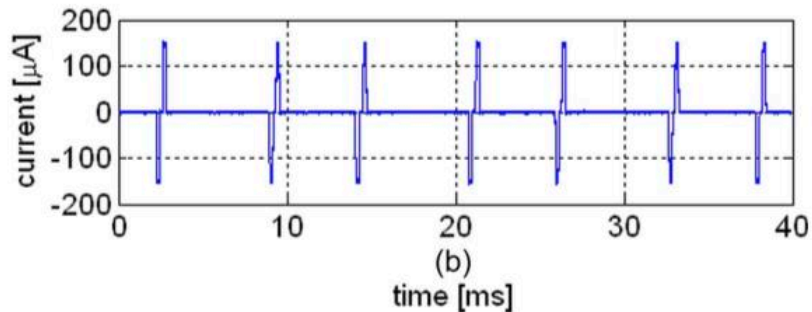
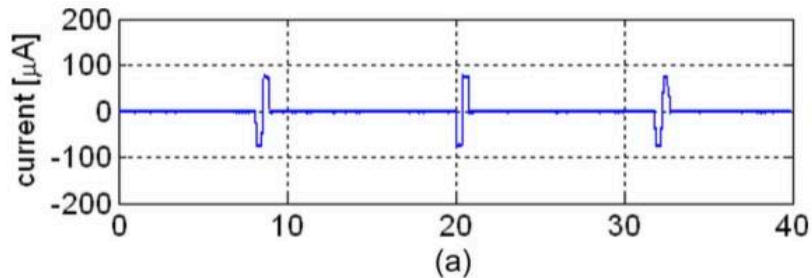
Frequency	200 Hz
Pulse Width	160 $\mu$ s
Burst Duration	100 ms
Current	1.0 mA and adjusted as necessary
Electrodes	Those from which patterns of interest are observed





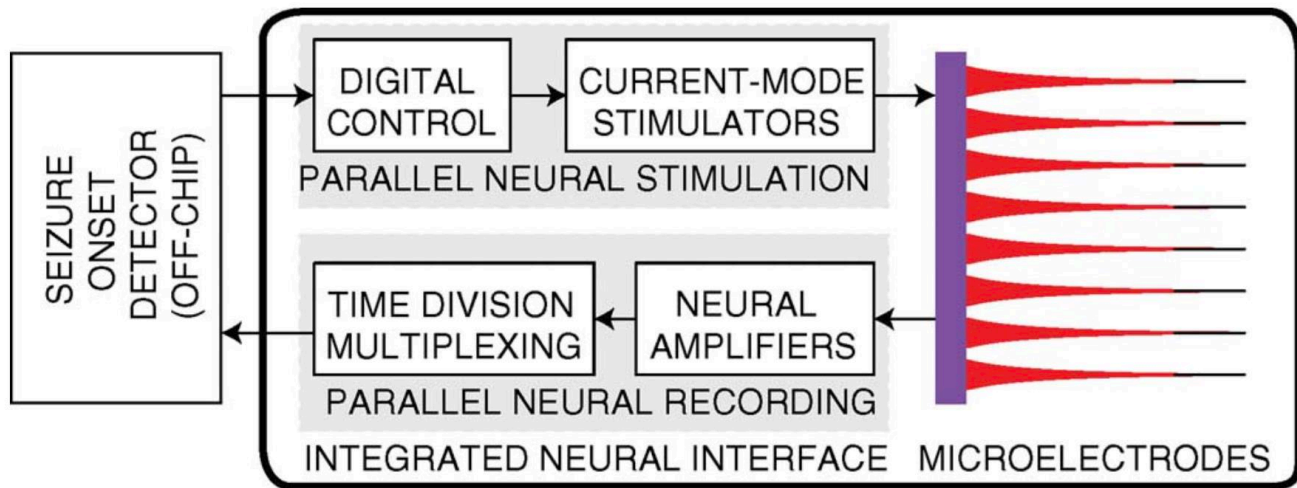
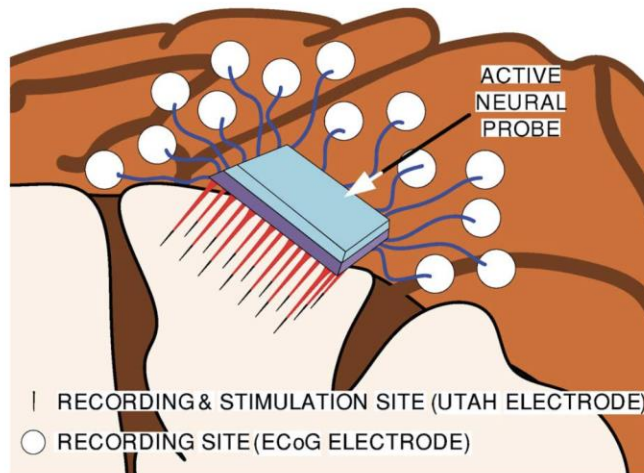




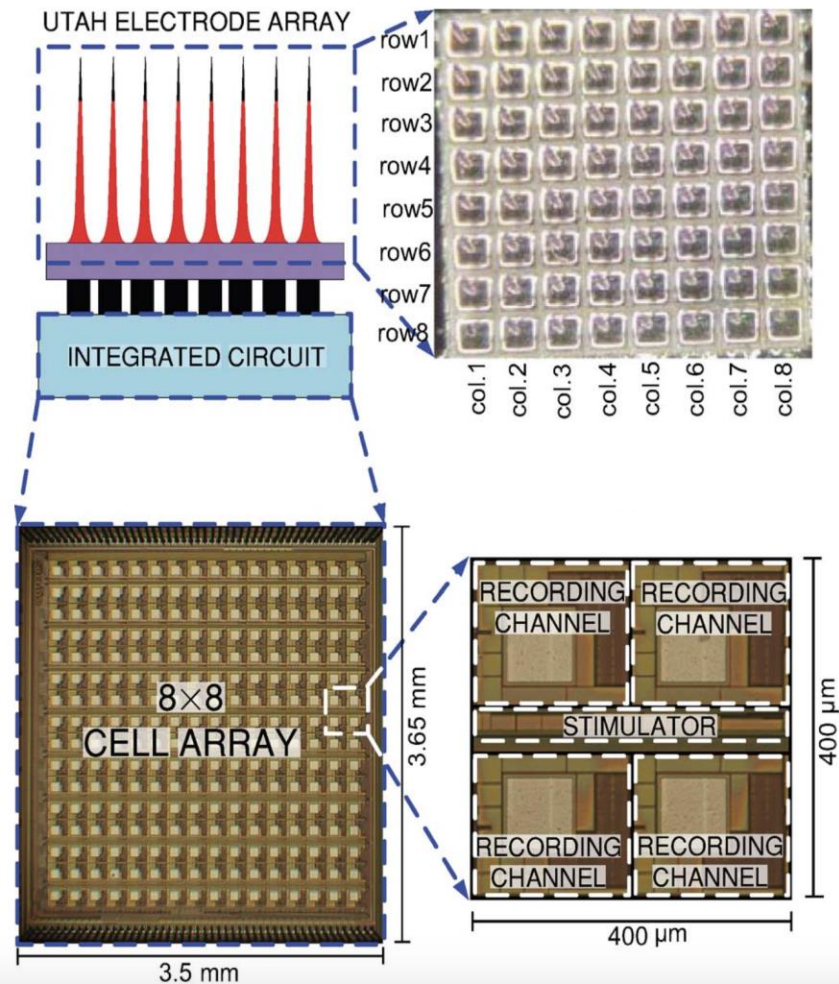
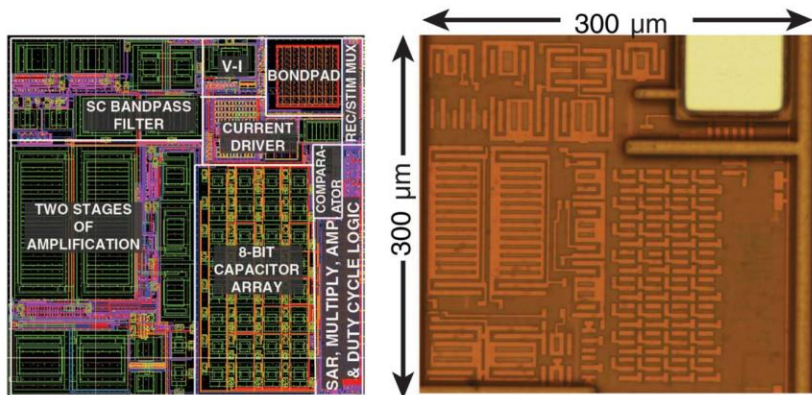


Stimulator frequency range	31	130	1000	Hz	1 ms period step
Stimulator amplitude range	0	99	135	$\mu\text{A}$	3 $\mu\text{A}$ step
Stimulator pulse-width range	5	60	320	$\mu\text{s}$	5 $\mu\text{s}$ step

# Sensing and Neurostimulation

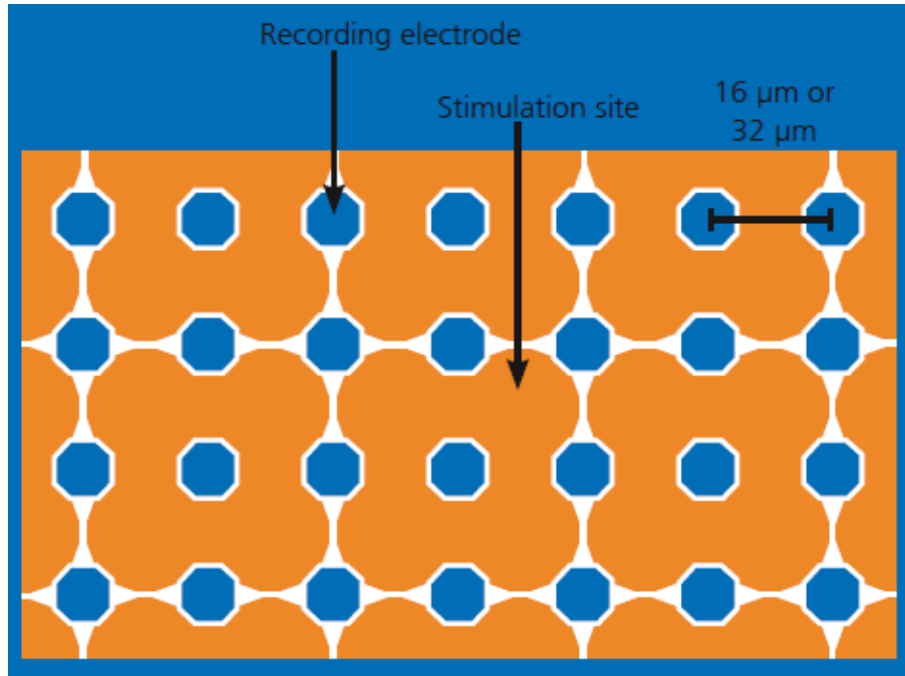


# Sensing and Neurostimulation



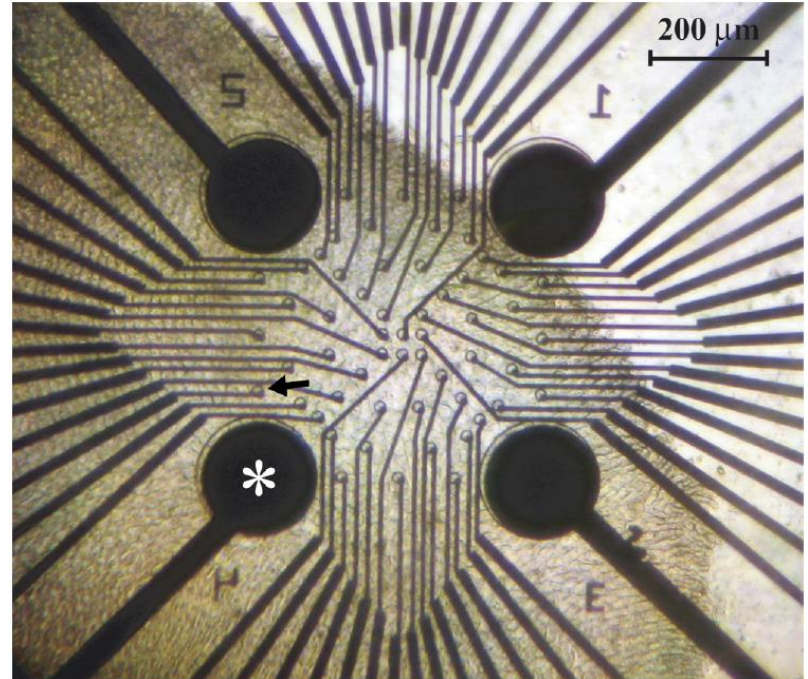
## CMOS-MEA5000-System

4225 recording, 1024 stimulating



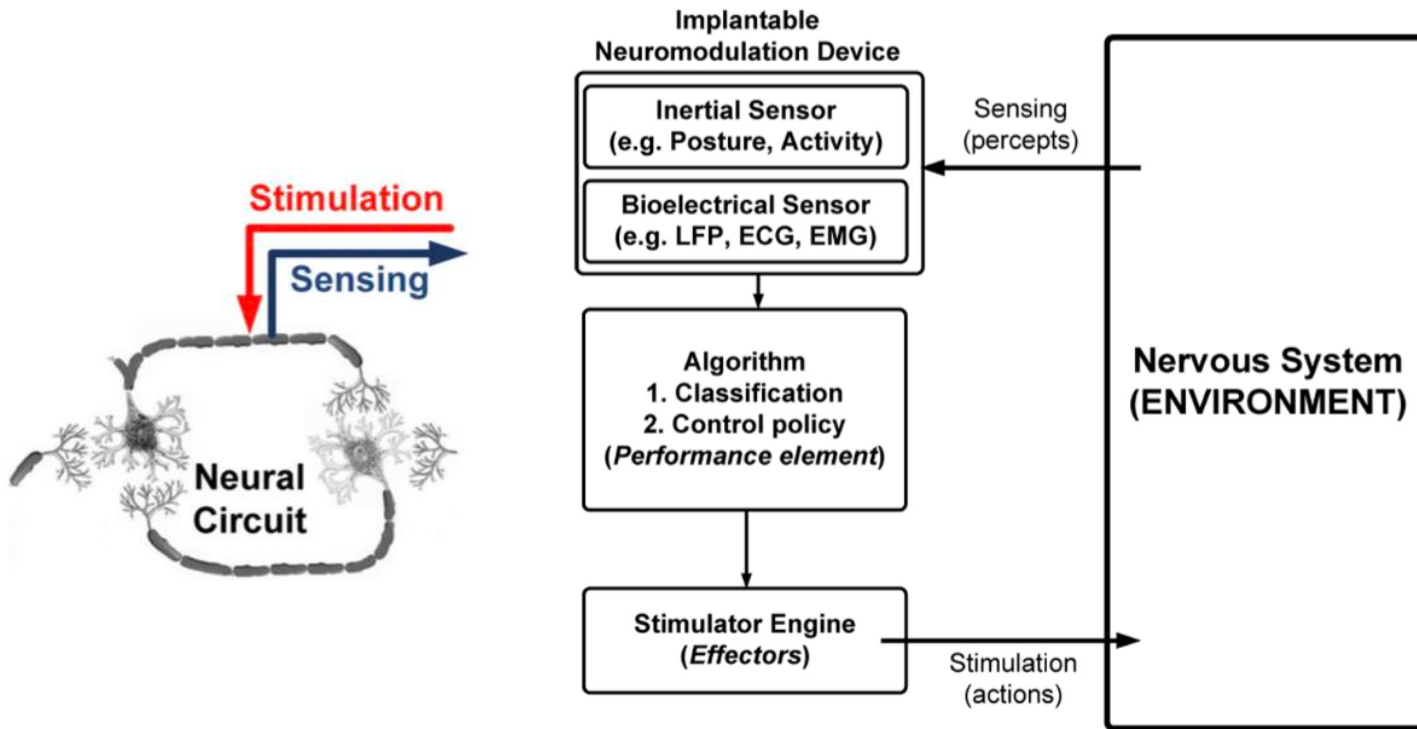
## High-density MEA

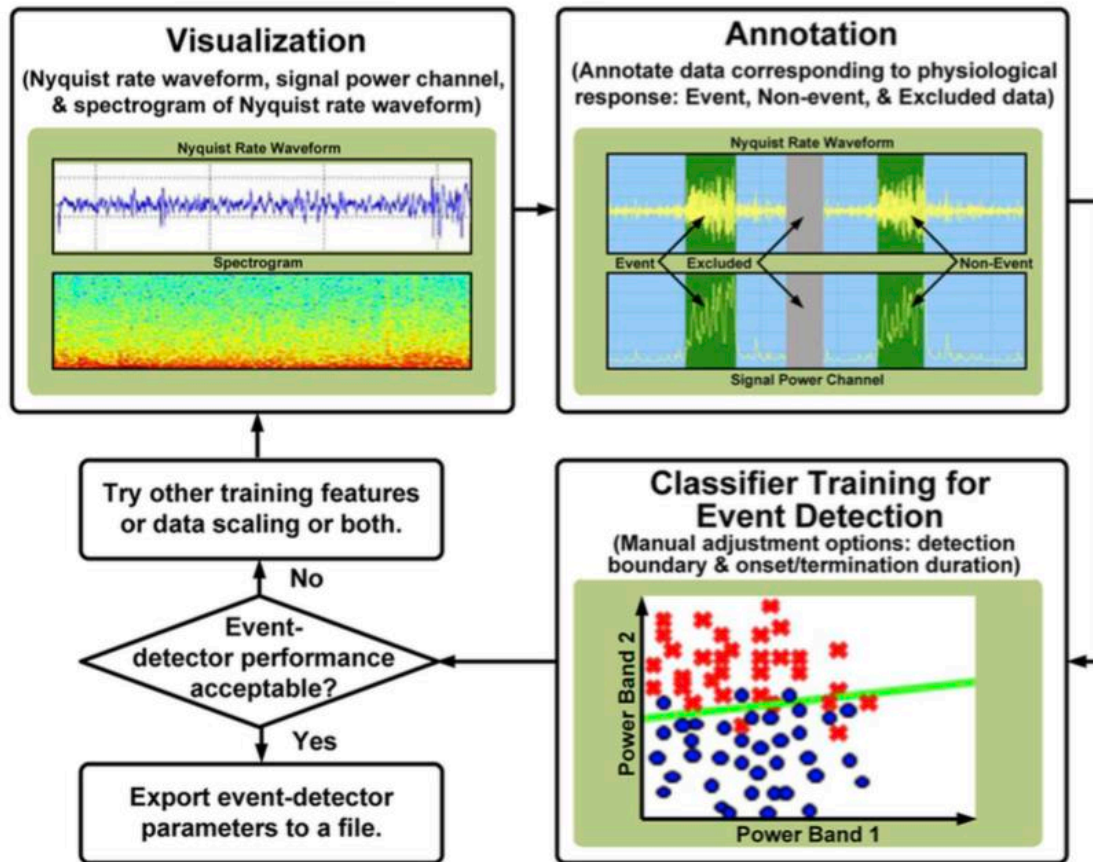
56 recording, 4 stimulating



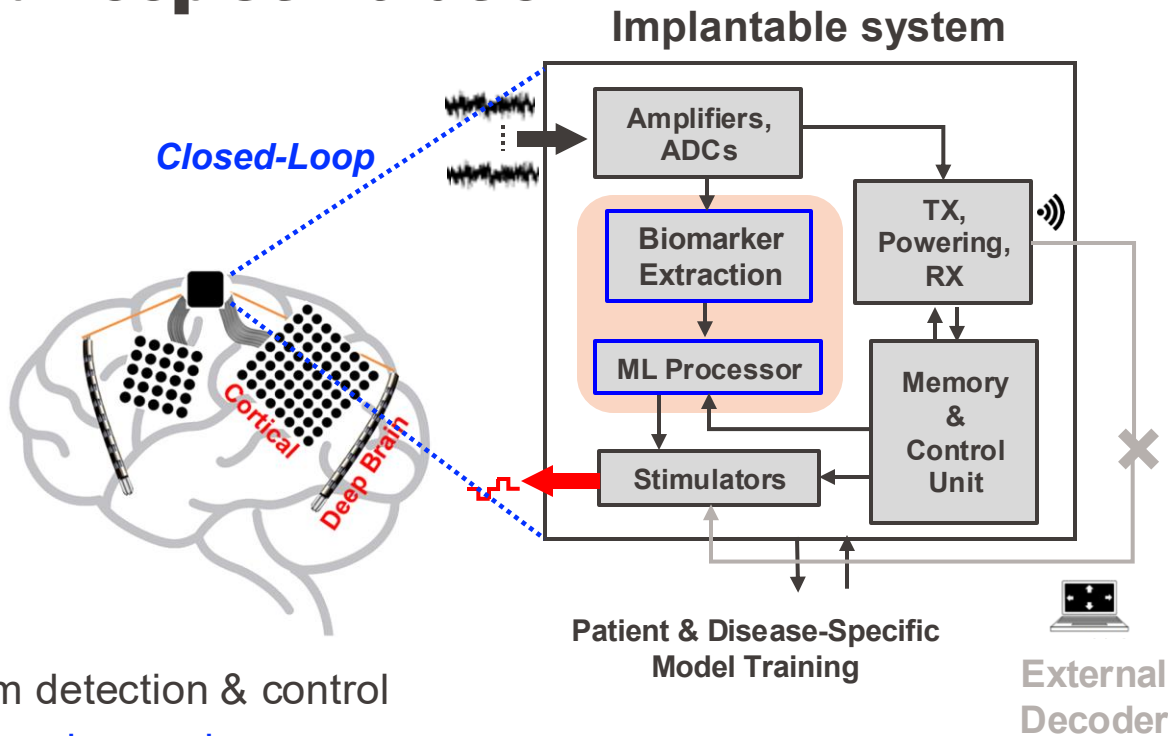
## Drawbacks of Open-Loop Stimulation:

- Continuous pulse delivery regardless of the ongoing brain activity
- High energy consumption and potential side effects from stimulation





- ✓ Effective, low-latency intervention
- ✓ Reduced telemetry power
- ✓ Better security & privacy



**Application:** Neurological symptom detection & control

- Epilepsy, movement disorders, depression, ...
- Sensory feedback, restoring movement, ...