



## The Photoconductive Stimulation Device

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# Company Overview

- **Neurosilicon Mission**

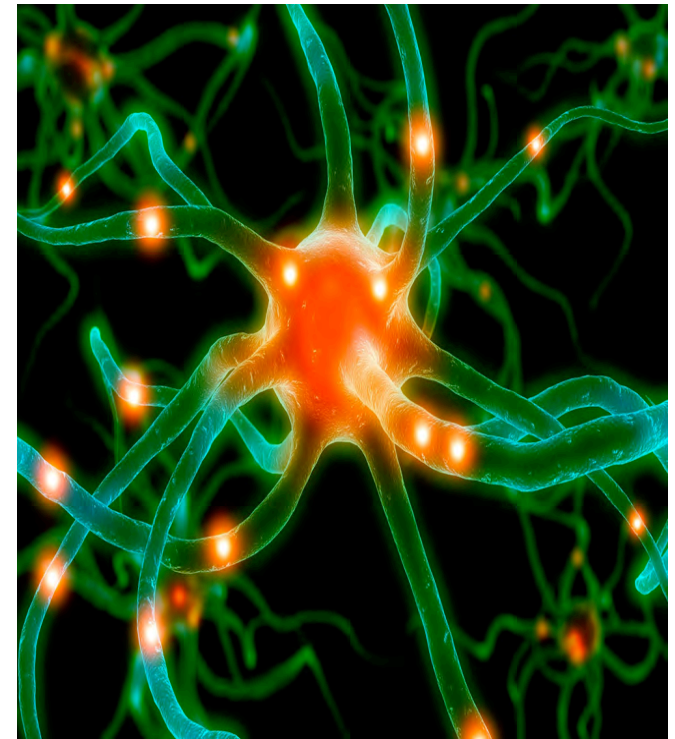
- Neurosilicon develops novel brain-computing interfaces to expand the scientific understanding of the human brain and to revolutionize and improve the effectiveness of drug discovery.

- **Company Background**

- **Founded:** March, 2005
- **Research Base:** University of Calgary (Calgary, Alberta)
- **Lead Product:** Photoconductive Stimulation Device
- **Intellectual Property:** 5 patents filed with the US Patent Office
- **Team:** Multidisciplinary team of neuroscientists and engineers
- **Corporate:** Privately Held

# Nervous Tissue - Neurons

- The body's billions of neurons are the structural units of the nervous system
  - Consist of a body, axon, and dendrites
  - Long-lived, amitotic, and have a high metabolic rate
- Plasma membrane mediates:
  - *Electrical signaling*
  - Cell-to-cell signaling during development



# Nervous System - Communications

- Neurons send signals over long distances by generating and propagating *action potentials*
- *Action potentials result from a brief reversal of membrane potential*
- Action potentials are only generated by excitable cells
  - they do not decrease in strength over distance when adequately insulated
  - **Comprise the principal means of neural communication**
- An action potential in the axon of a neuron is a nerve impulse

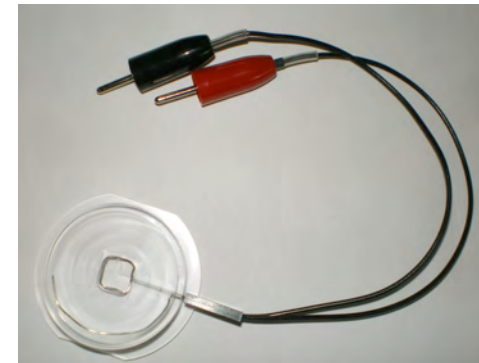
# Photoconductive Stimulation Device

- The Photoconductive Stimulation Device enables neuroscience researchers and pharmaceutical technicians to depolarize dissociated neurons non-invasively and in a highly targeted manner.



# PSD – Technology

- Photoconductive stimulation is a technique that allows the rapid, non-invasive depolarization of excitable cells, such as neurons.
- It can be used to induce action potentials in neurons grown in culture, reproducing a user defined activity pattern.
- Cells are grown on silicon wafers in industry standard 24 well plates, and then mounted in a reusable dish for live observation under a microscope.



# PSD – Technology

- The electronics provided can be used to depolarize the cells at user-definable frequency and intensity.
- This technology provides the researcher with the ability to dynamically study activity dependent phenomena without the requirement for a direct physical link to the cell (such as an electrode or transistor contact).
- The non-invasive, optical targeting allows an extended observation period, dependent only upon the environmental support for the cells.

# PSD – Highlights

- Non-invasive electrical stimulation can be done without causing damage to the cells
- Optical targeting of specific neurons to be depolarized
- Allows for the controlled variation of frequency and duration of stimulation
- Short or long term non-invasive cell specific stimulation
- Replaces pharmacological agonist stimulation, which does not allow for targeting and repetitive depolarization
- The depolarization of a user-defined area of a dissociated culture, not just those cells positioned on an electrode

# PSD – Highlights

- A means for increasing the flexibility of protocol design by having more control over which cells are depolarized and when
- For controlled cell stimulation in combination with voltage sensitive dyes
- Depolarize cells with specific patterns of excitation, which allows for detailed investigation of excitable cells over time
- Significantly reduces the time and skill level required to obtain excitation, in that electrophysiology techniques and equipment are not required

## PSD – Key Features

- Hippocampal/Cortical cultures are optimized for growth on silicon wafers
- The photoconductive effect alters the conductivity of silicon with exposure to light
- Illuminate an area as small as ~50 microns
- Stimulation protocols can be from 0.1 Hz up to 100 Hz and up to ~ 17 volt pulse across entire surface of wafer
- Activity can be detected by fluo-4 or voltage sensitive dyes
- Concurrent electrophysiological recordings using standard methods demonstrate high frequency stimulation possible

## PSD – Key Features

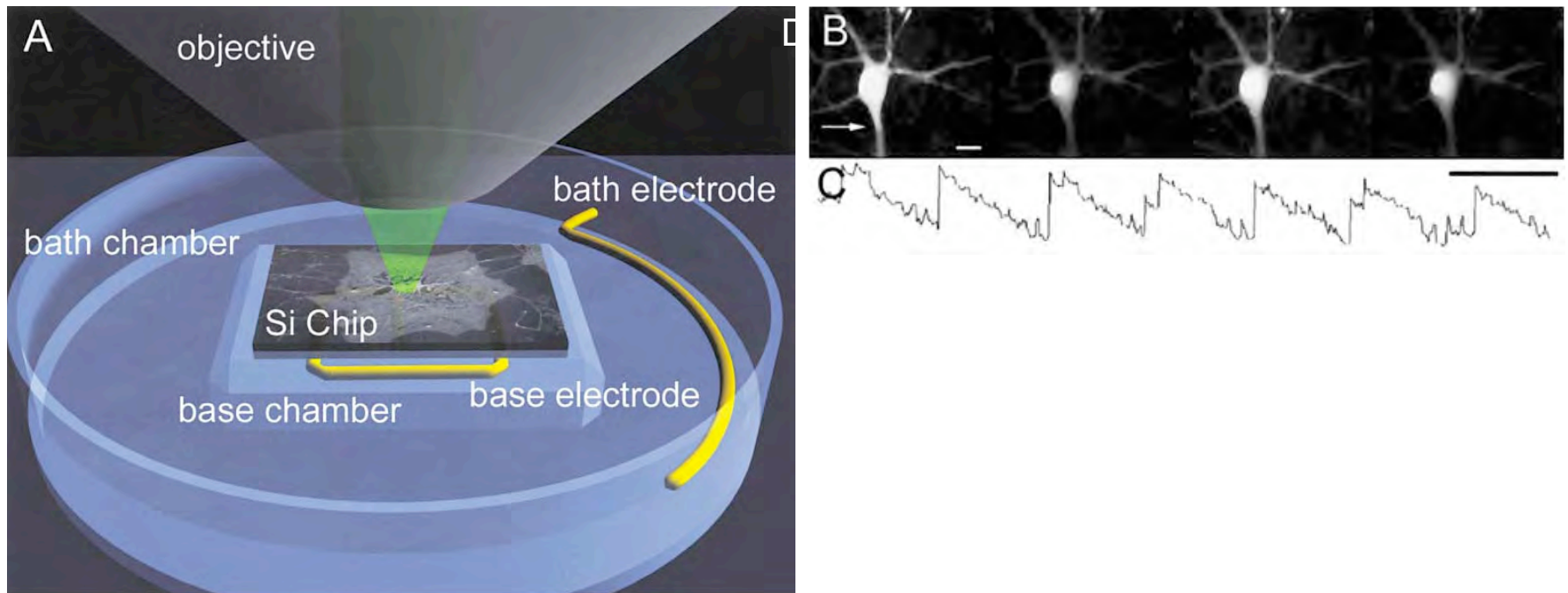
- Only illuminated neuron(s) depolarize on-demand
- Study cellular response by standard protocols or live imaging
- Non-invasive, preserves cytoskeleton, physiologically benign
- Cell specific (demonstrated by FM loading)
- Concurrent electrophysiological recordings demonstrate high frequency stimulation possible
- Stimulation can result in controlled synaptic and network remodeling
- Networks formed have complex activity patterns

# PSD – Technical Details

- Fully contained, easy to use electronics base
- Programmable stimulation protocols to set amplitude, frequency and pulse width of stimulation
- Calibration system to take into account environmental and biological factors in the cellular culture
- Hand-held, fits easily into any bench-top environment
- Operates with any standard up-right microscope

# PSD – Technical Details

- (A) The PSD substrate harboring the neuronal culture is immersed in external bath solution with the light source from the microscope
- (B) 4 representative video frames from a series captured at one frame per 100 ms in response to photoconductive stimulation
- (C) Changes in fluorescence intensity (arbitrary units) during a 7 s clip of 1 Hz stimulation



<sup>1</sup>Remodeling of Synaptic Actin Induced by Photoconductive Stimulation. Cell, Volume 107, Issue 5; M. Colicos, B. Collins, M. Sailor, Y. Goda

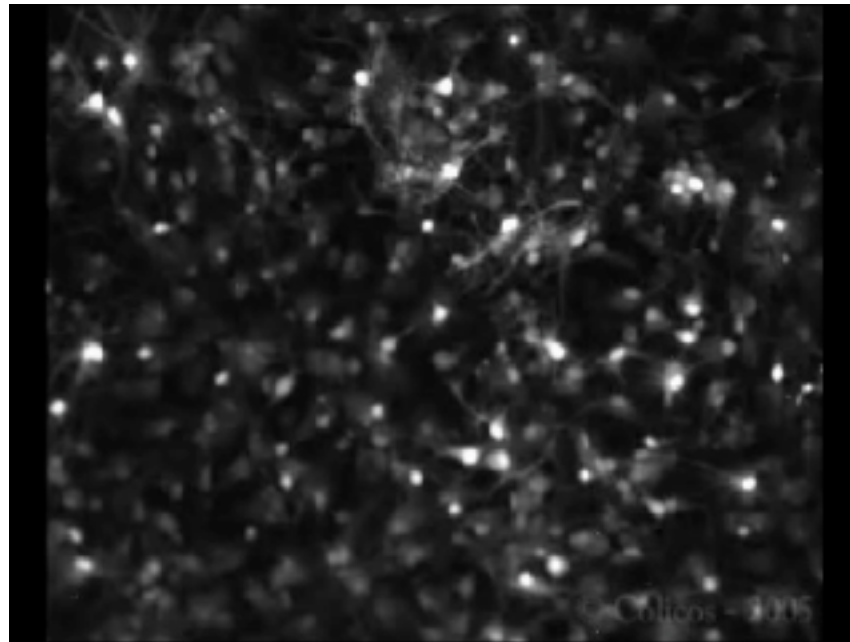
## PSD – Technical Details (continued)

- The animation displays the Photoconductive process



# PSD – Technical Details (continued)

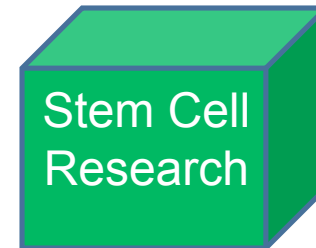
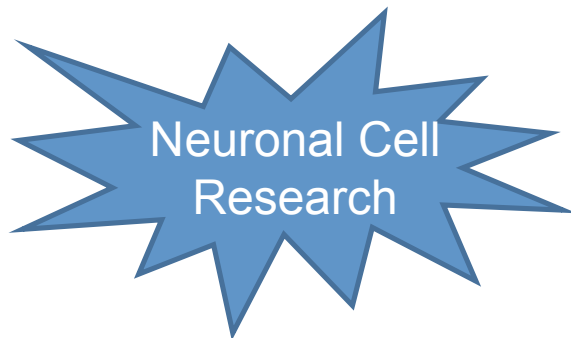
- The movie clip displays cells firing



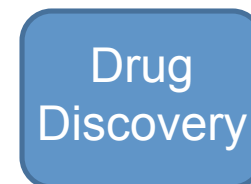
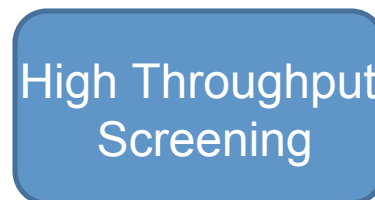
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# PSD Applications

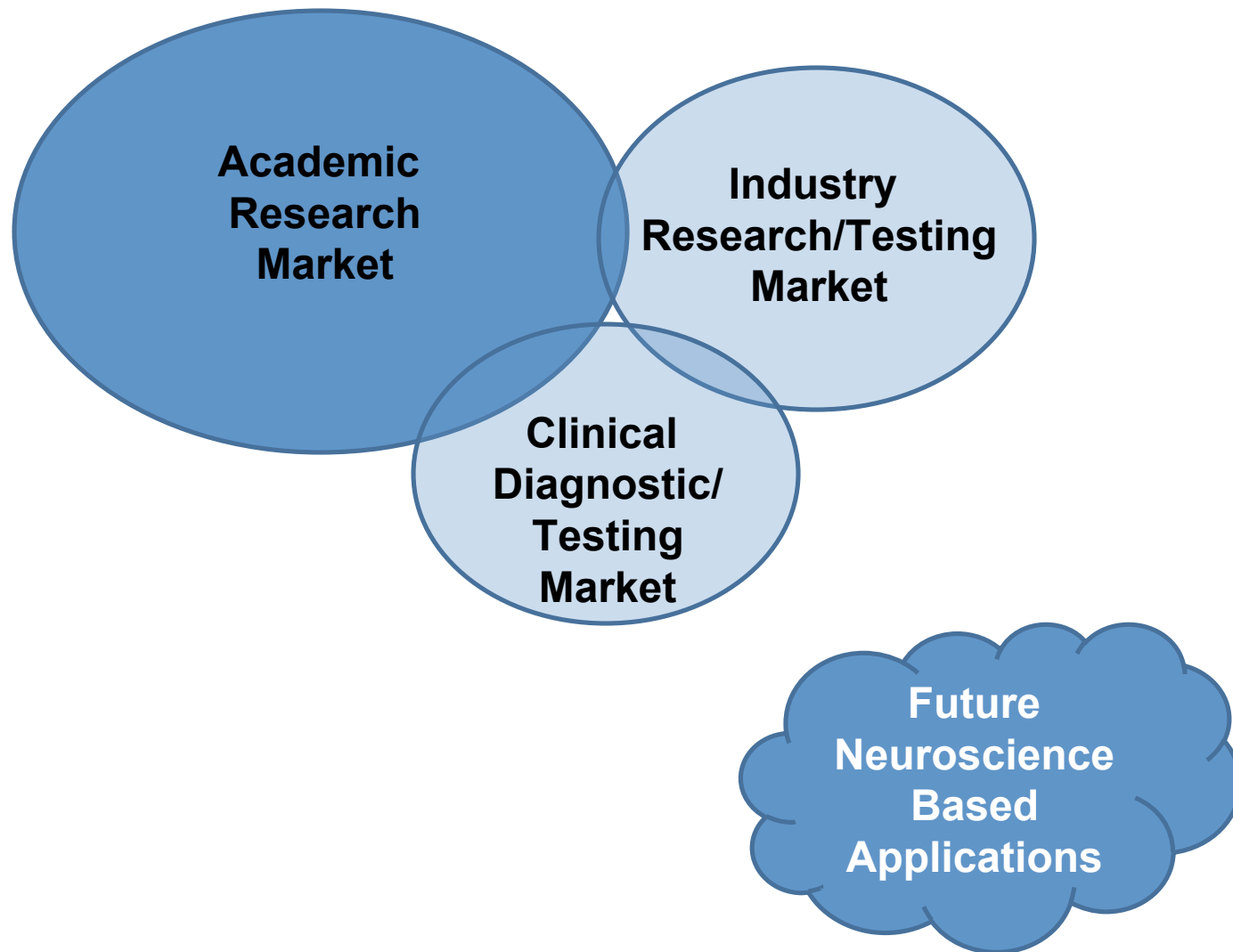
- Life Science Research Applications



- Applications Beyond the Bench



# PSD Markets



# Future

- PSD prototype device was aided by AMIF
- PSD developed before ACAMP
  - would have benefited from ACAMP support
- Currently utilizing Alberta based companies for certain aspects of PSD manufacture
- Assemble and test in house
  - Looking at outsourcing to turn key manufacturers in Canada
- Other products in the pipeline developed via AMIF and UofC Faculty of Medicine may utilise ACAMP

