

Clinical Neuromodulation Technology

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CASE WESTERN RESERVE
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Financial Conflicts of Interest

Kernel

Boston Scientific Neuromodulation

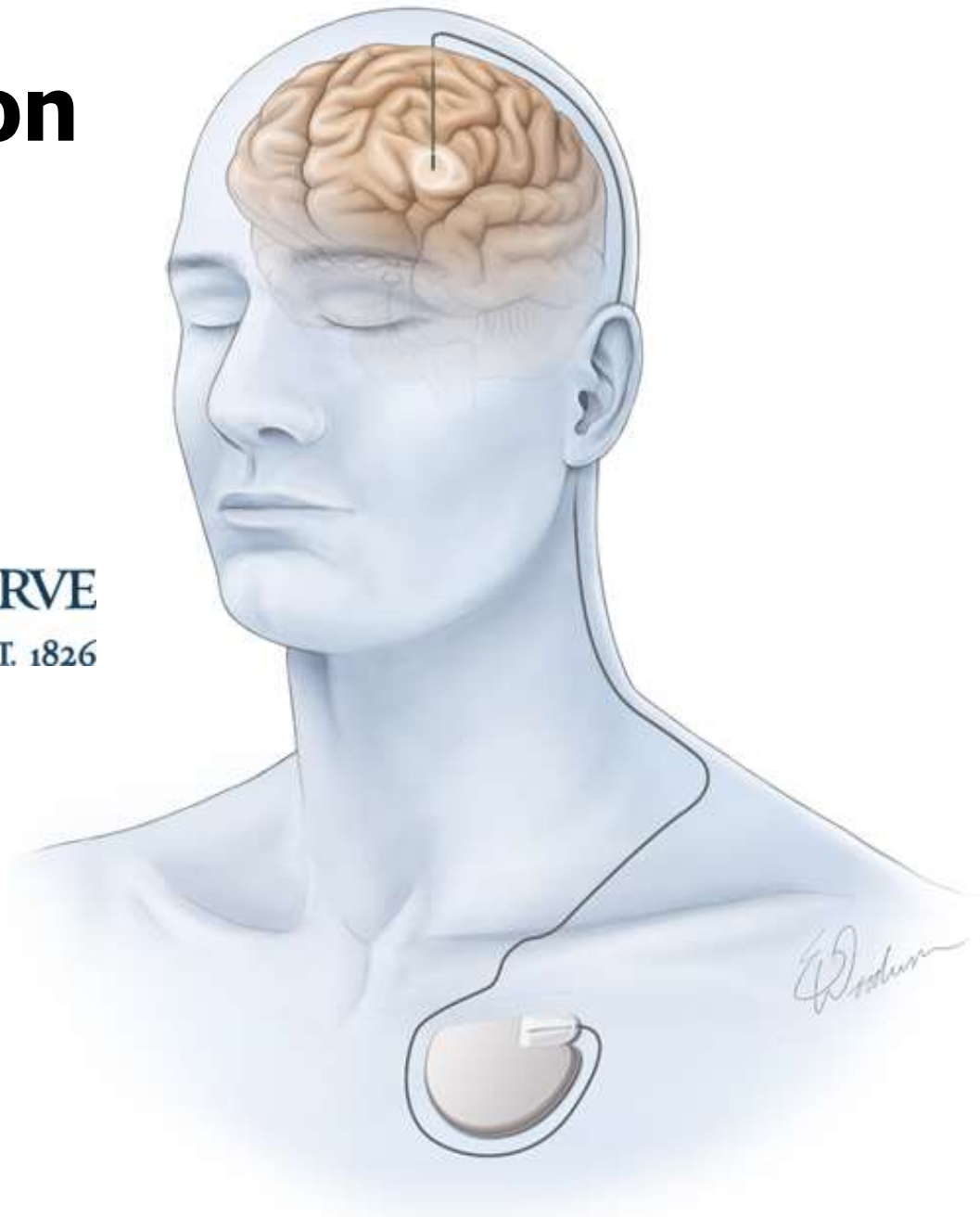
Surgical Information Sciences

Neuros Medical

Autonomic Technologies

Cardionomic

Enspire DBS



Neuromodulation Origins



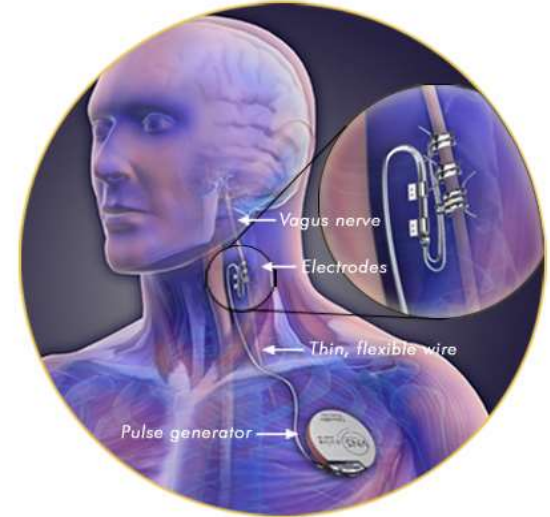
Mortimer & Shealy, circa 1966

Clinical Neuromodulation

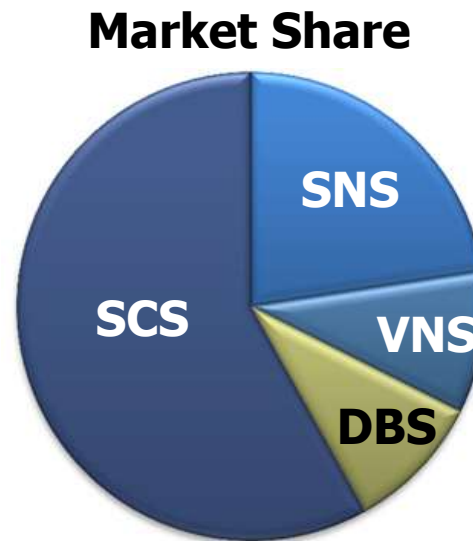
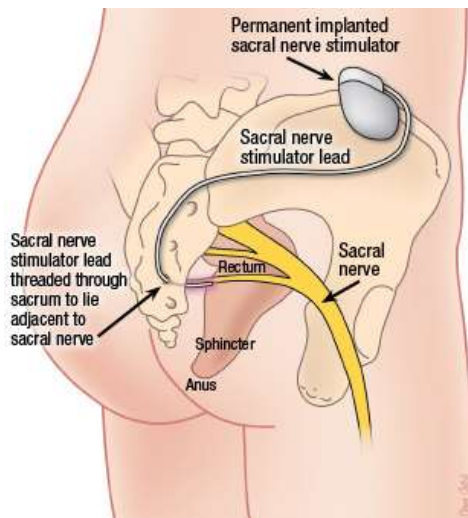
Spinal Cord Stimulation



Vagus Nerve Stimulation



Sacral Nerve Stimulation

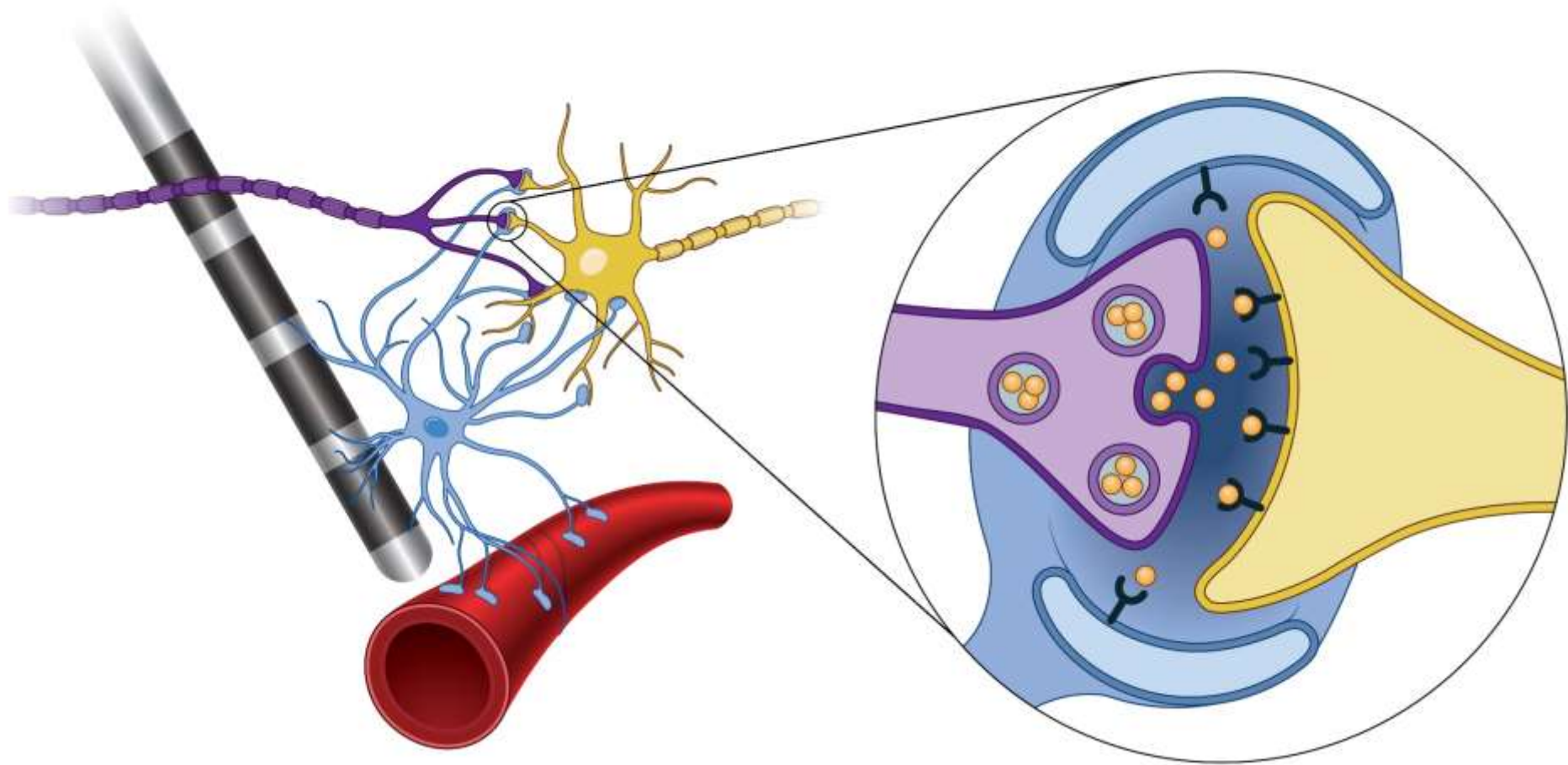


Market Size
~\$5B/year

Deep Brain Stimulation



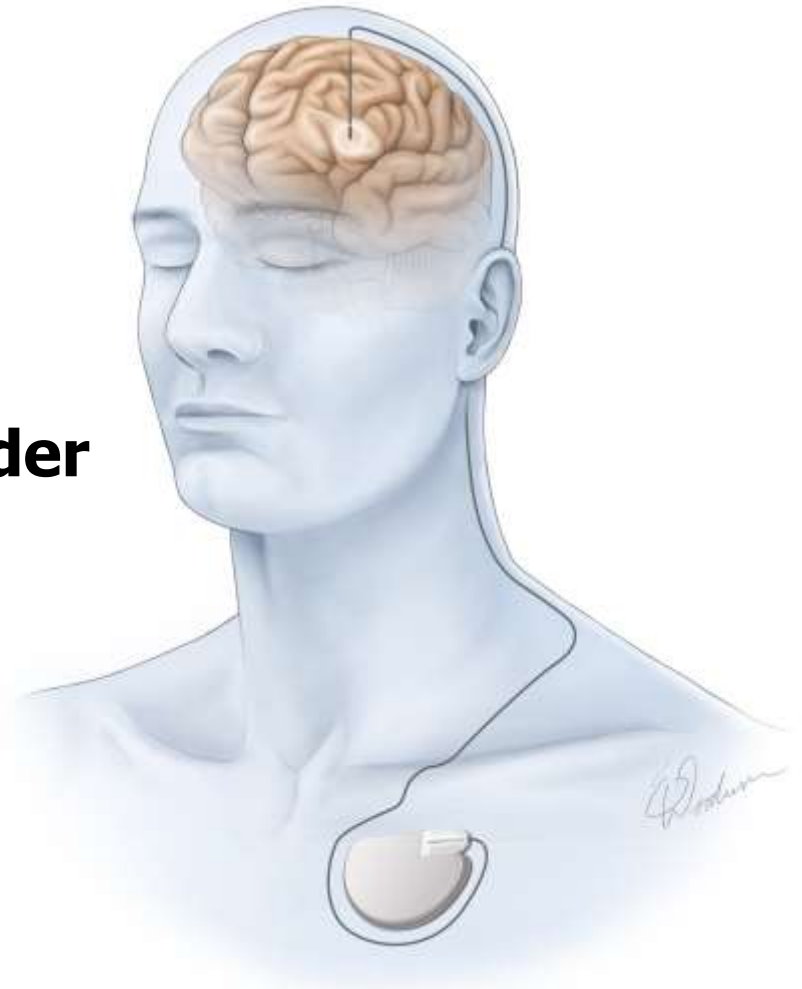
Electroceuticals



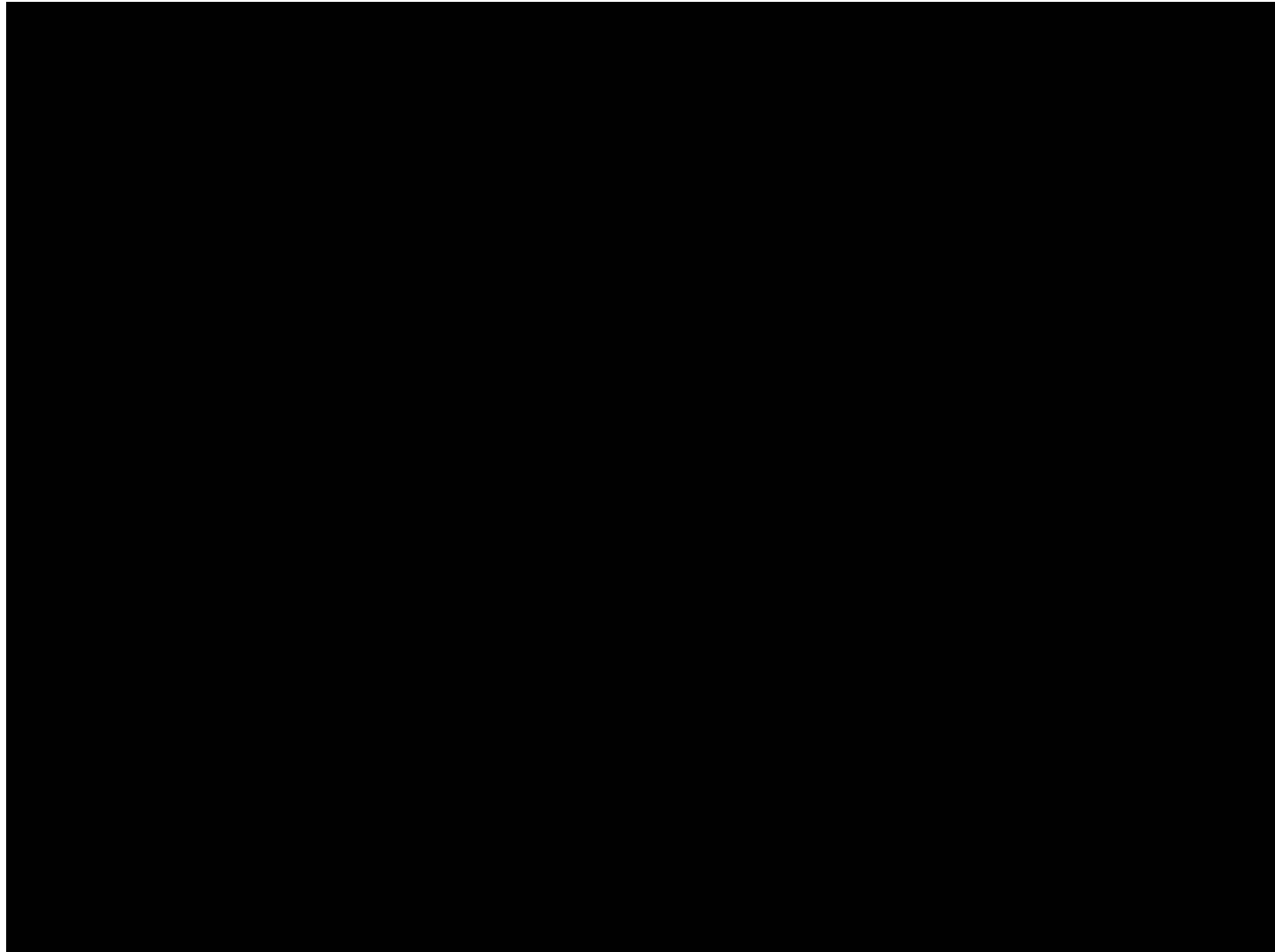
Clinical Deep Brain Stimulation

Parkinson's Disease
Essential Tremor
Dystonia
Obsessive-Compulsive Disorder
Depression
Epilepsy
and more...

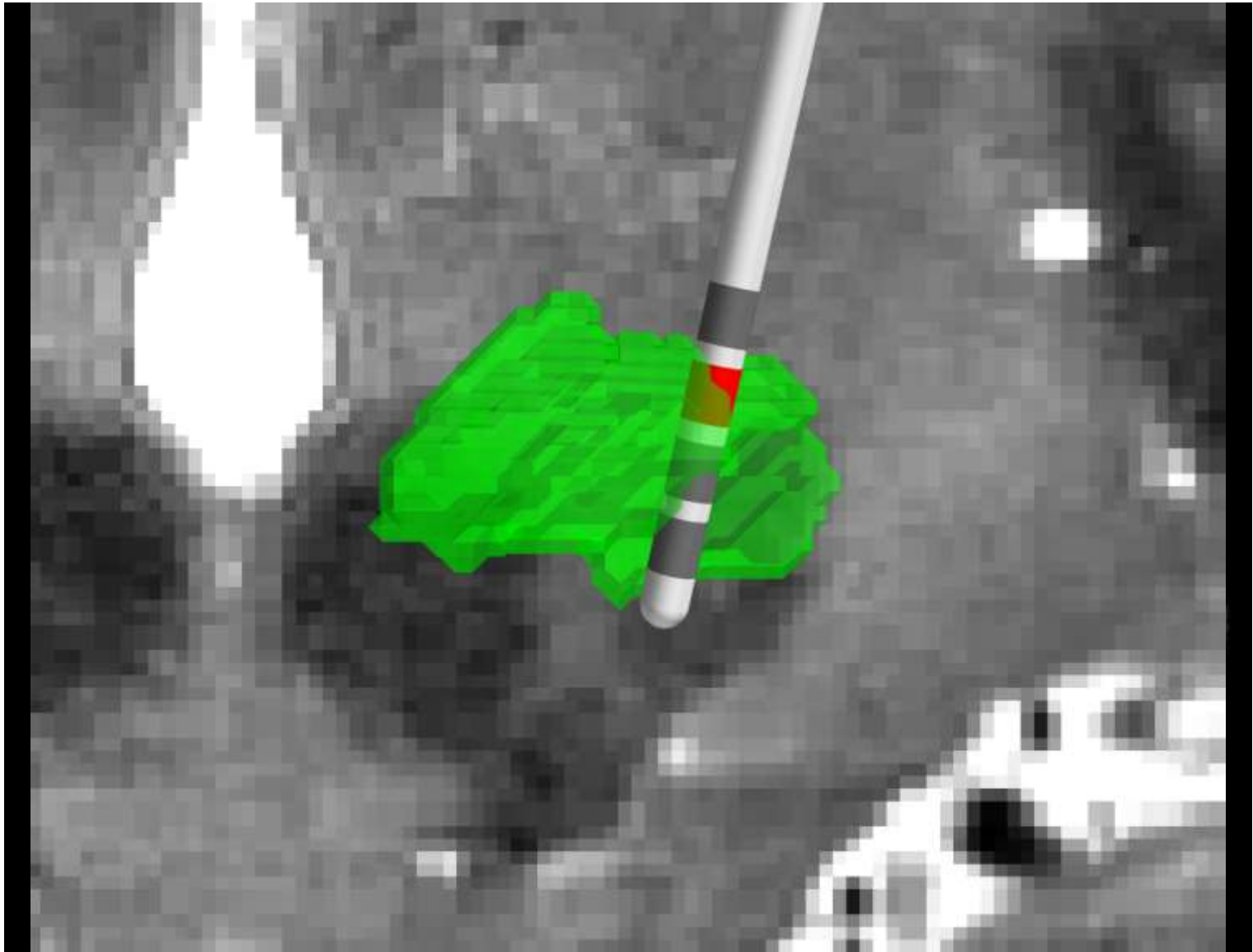
~150,000 DBS patients



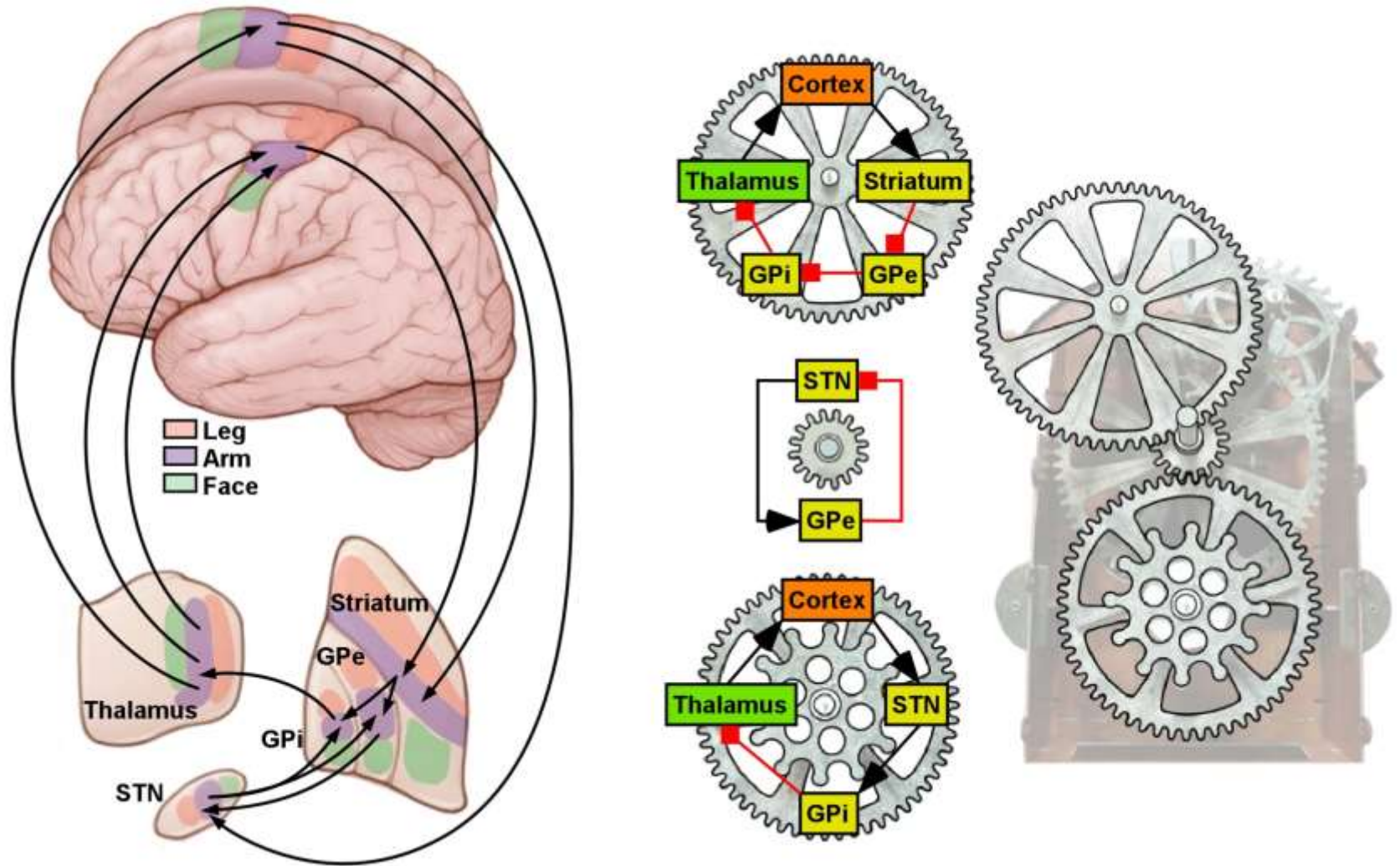
Deep Brain Stimulation



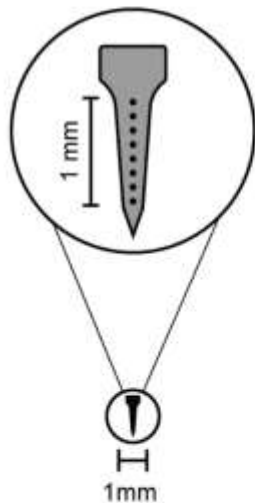
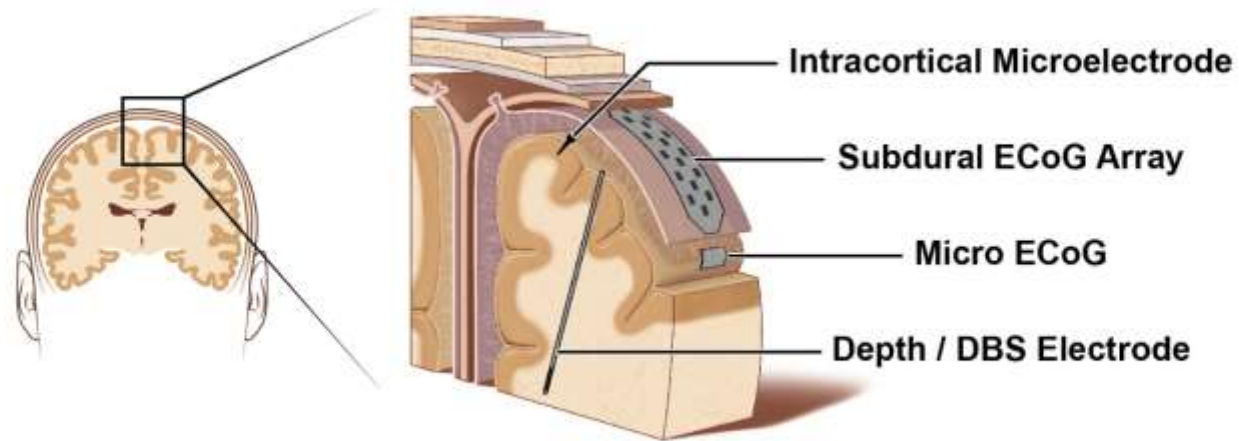
Subthalamic Nucleus DBS



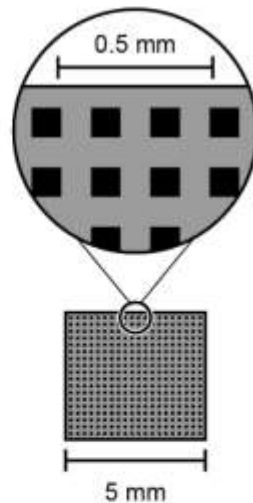
DBS Network Modulation



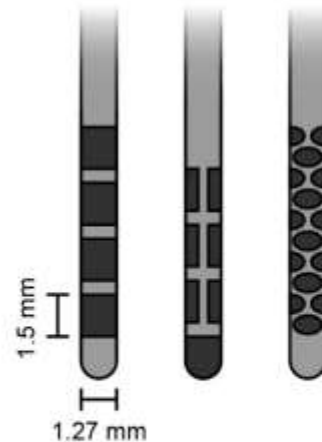
Intracranial Electrodes



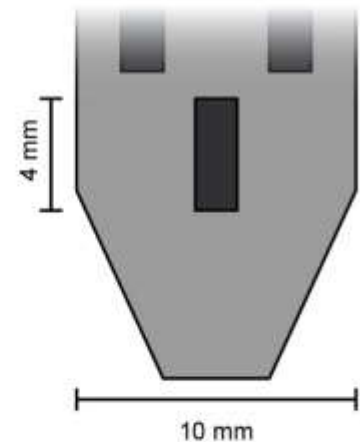
**Intracortical
Microelectrode**



Micro ECoG

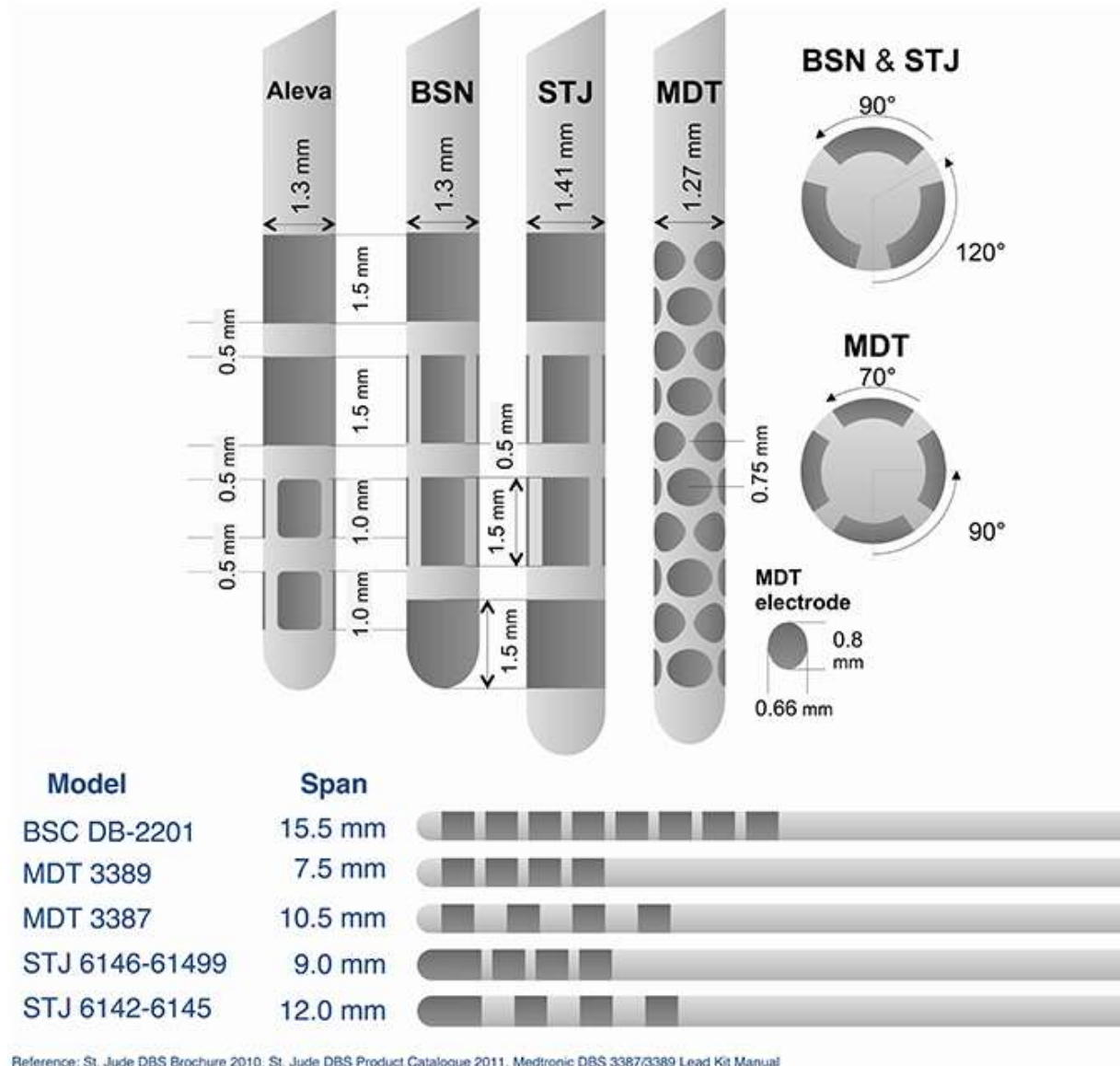


Depth / DBS Electrodes

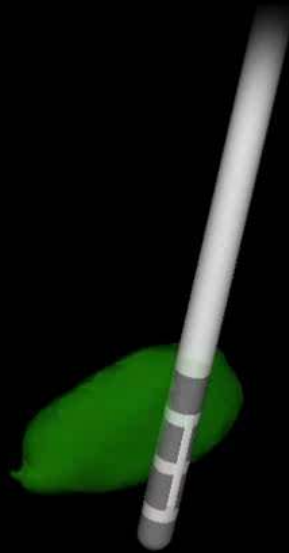


Subdural ECoG Array

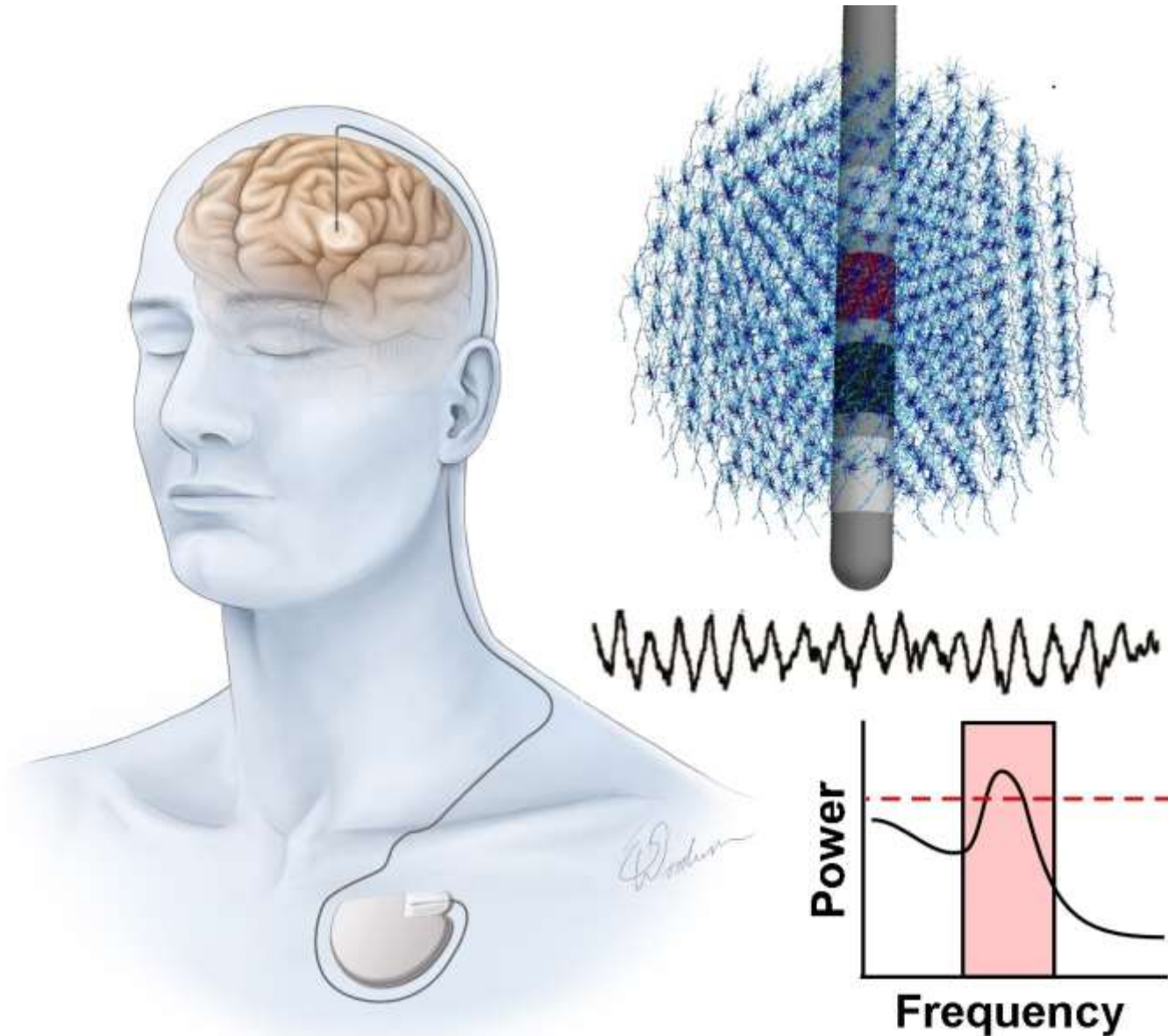
Directional DBS Electrodes



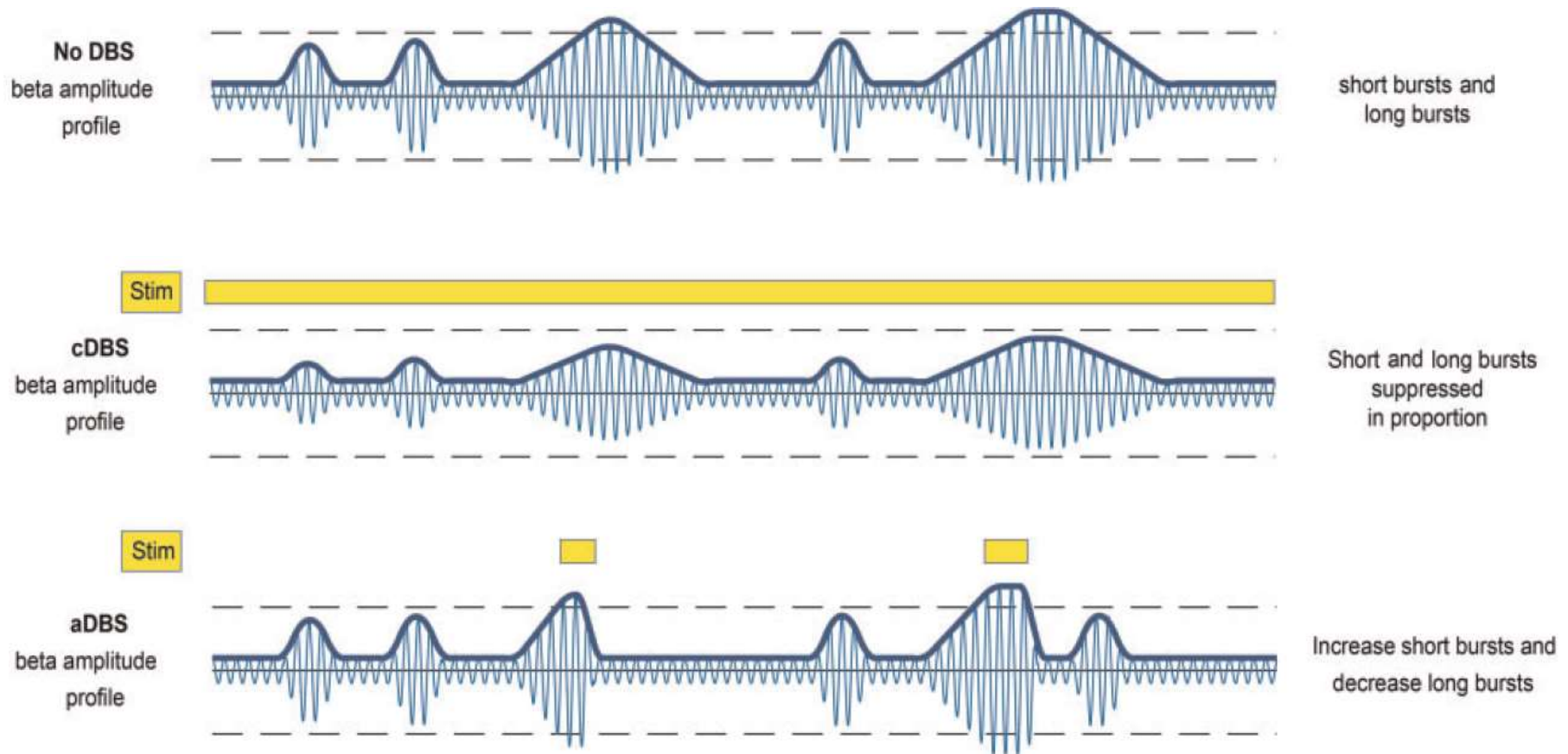
Directional Current-Steering



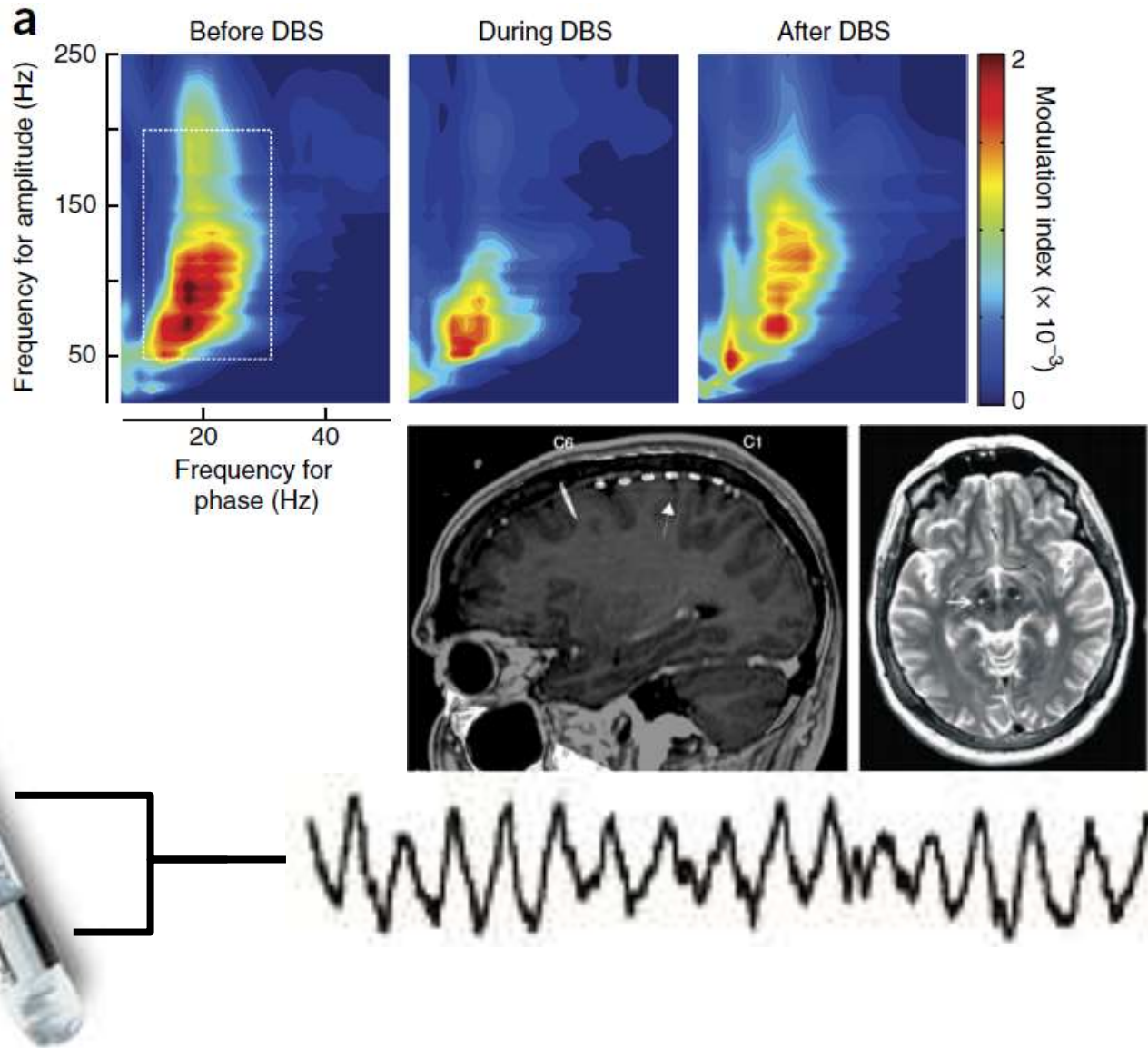
Adaptive DBS



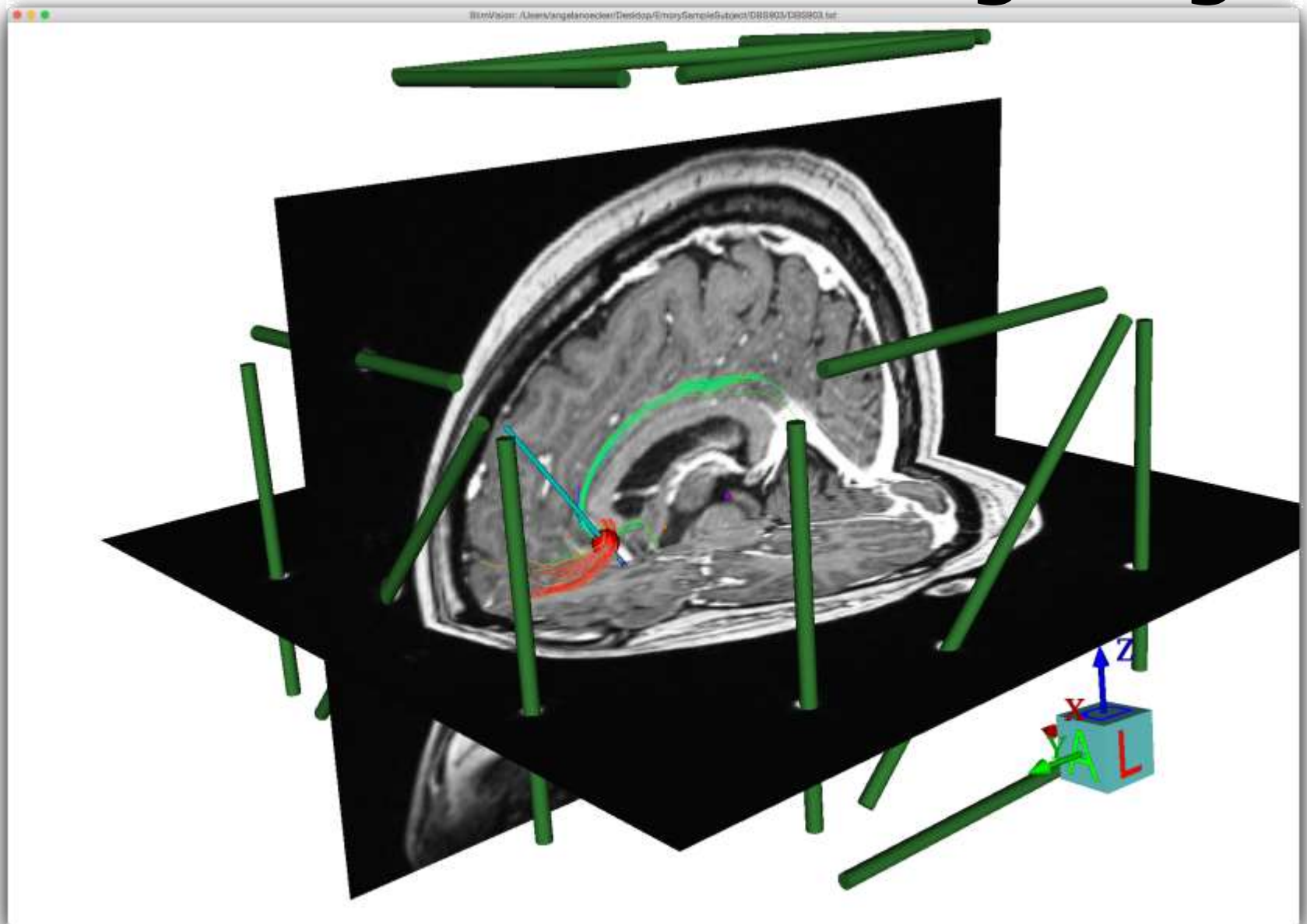
Adaptive DBS Control Systems



Learning the Language



Connectomic DBS Targeting



Next Generation Hardware



DARPA - SUBNETS

Conclusions

- **Intracranial stimulation/recording has wide-ranging therapeutic value and potential.**
 - Today movement disorders
 - Tomorrow psychiatric disorders
- **Device technology is expanding rapidly, accelerating scientific understanding of human brain circuits.**
 - Learning how to communicate with the brain
 - Learning where to put the electrodes
- **As we transition from devices with ~ 10 to ~ 100 electrodes, the bandwidth for bidirectional communication will dramatically increase.**
 - When do we begin infringing upon autonomy?

Acknowledgements

Current Lab Members

- **Ross Anderson, Ph.D.**
- **Sinem Balta-Beylergil, Ph.D.**
- **Kelsey Bower**
- **AmirAli Farokhniaee, Ph.D.**
- **Anneke Frankemolle**
- **Kabi Gunalan, Ph.D.**
- **Bryan Howell, Ph.D.**
- **Nick Mailing, Ph.D.**
- **Angela Noecker**
- **Sarah Ozinga, Ph.D.**
- **Suraj Thyagaraj, Ph.D.**

Financial Support

- **National Institutes of Health**
 - **Principal Investigator**
 - **R01 NS059736**
 - **R01 NS085188**
 - **R01 NS086100**
 - **R01 MH102238**
 - **R01 MH106173**
 - **Co-Investigator**
 - **P50 NS098573**
 - **R03 MH111320**