DBS Programming

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PFNCA 3/24/18

Disclosure

- The University of Maryland has received research funding form InSightec and the Focused Ultrasound Surgery Foundation

Goal Of DBS: Improvement without Side Effects

- Symptoms improved by surgery:
  - Tremor
  - Slowness (Bradykinesia)
  - Stiffness (Rigidity)
  - Gait freezing due to being off
  - Dyskinesias and Dystonias

Motor fluctuations improved allowing function at best level without interference by dyskinesias

Side effects of stimulation depend on BRAIN LOCATION

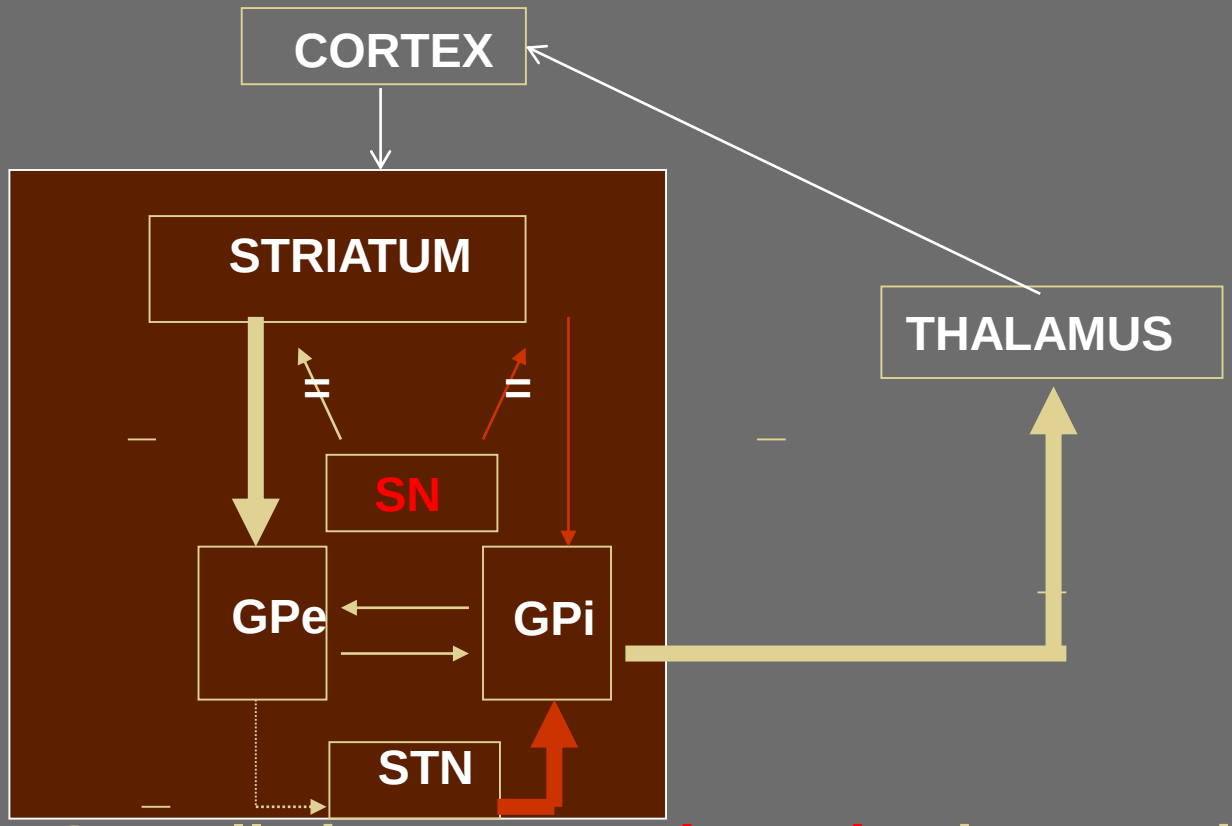
DBS Brain Locations

Thalamus – Severe Tremor

STN – PD with Fluctuating Response to Medical Therapy

GPI - PD with Fluctuations, Severe Dyskinesias, Dystonia

Normal Brain Function Has a Balance of Activity



When the SN cells become underactive in PD, other areas (STN and GPI)become overactive. DBS tries to RESTORE THIS BALANCE

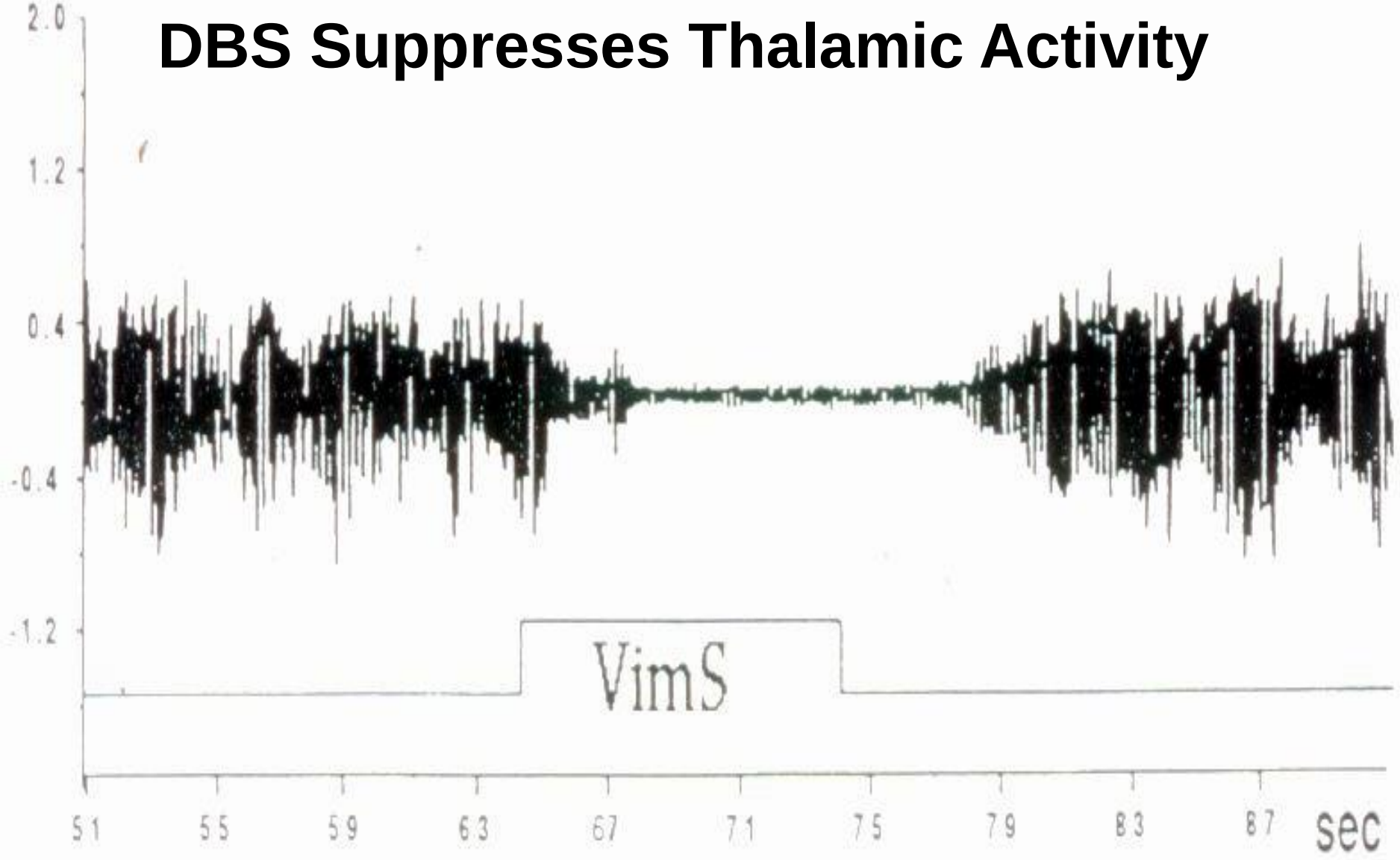
How Does DBS Work?

Still Controversial, since electrical stimulation usually evokes function rather than suppresses it

DBS – Clinical response similar to a older surgical lesion.

Does high frequency (>100Hz) stimulation disrupt the normal pattern of firing pattern of nerve cells - a “jamming” signal?

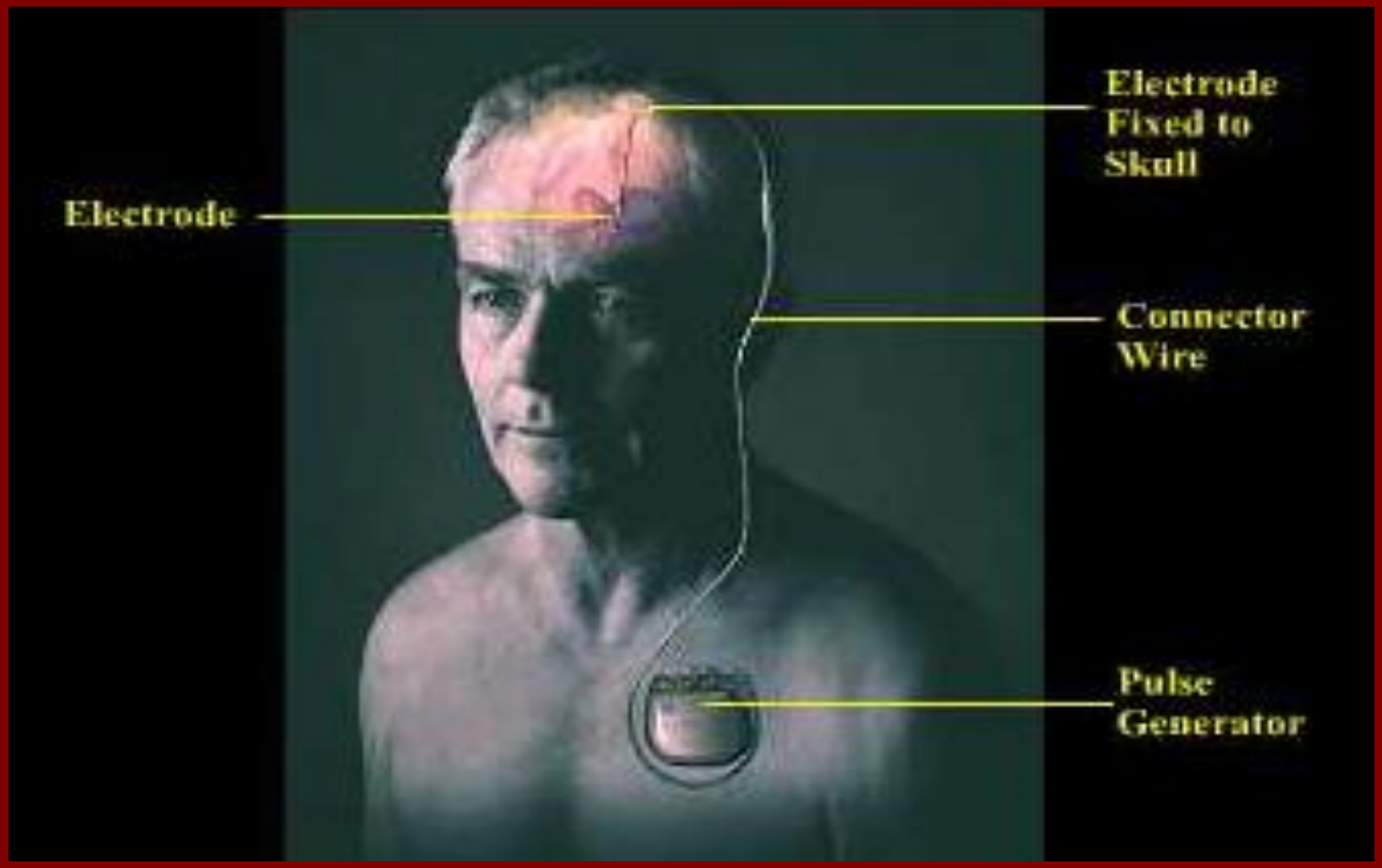
DBS Suppresses Thalamic Activity



DBS Replaced Older Surgery for PD

- **No *intentional* destruction of brain tissue**
- **Can adjust stimulus parameters**
- **Can perform bilateral operations**

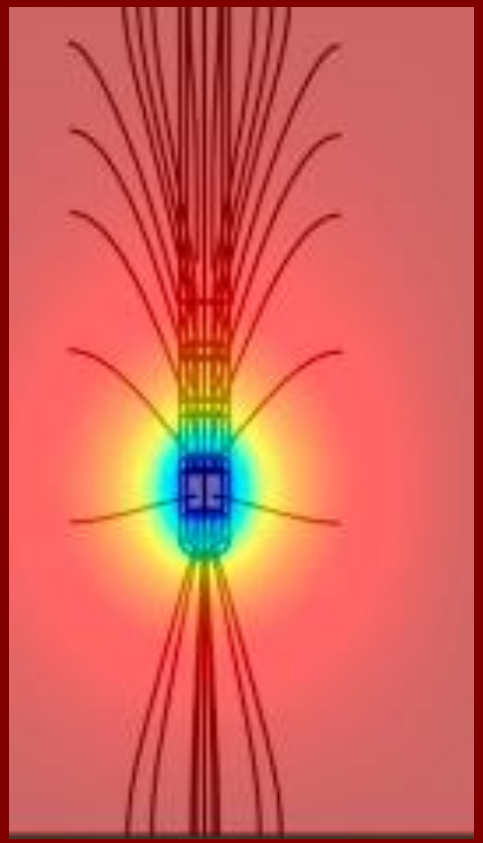
DBS – The Basics



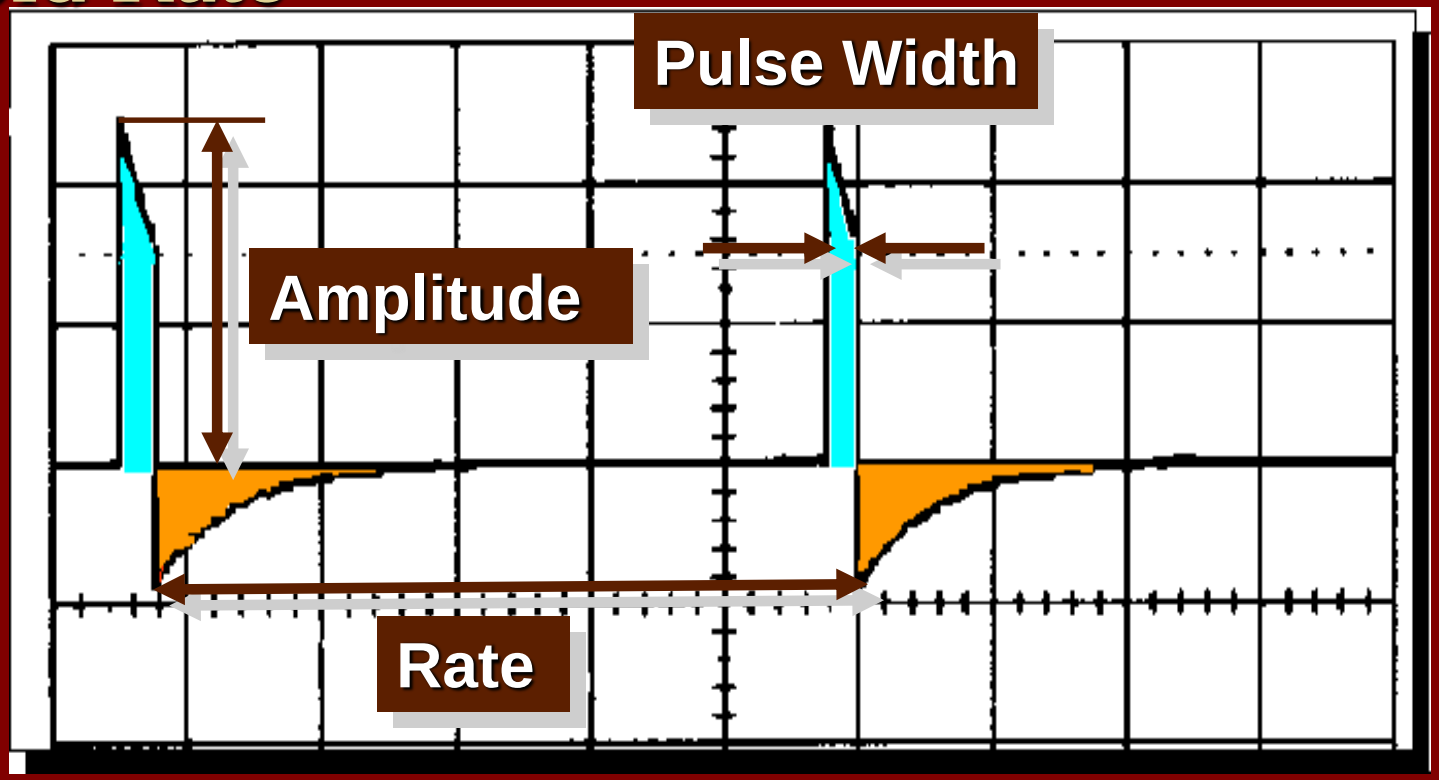
The electrode is implanted in brain, fixed to skull by a cap and runs underneath the skin to the pacemaker like pulse generator implanted in the chest

DBS and High School Physics

- Electrical current must flow in a loop (circuit) between a positive and negative pole
- Current (I) = Voltage/ressistance
- Stimulation usually occurs at the negative pole (cathode)
- Total current = pulse current X pulse width X pulse frequency

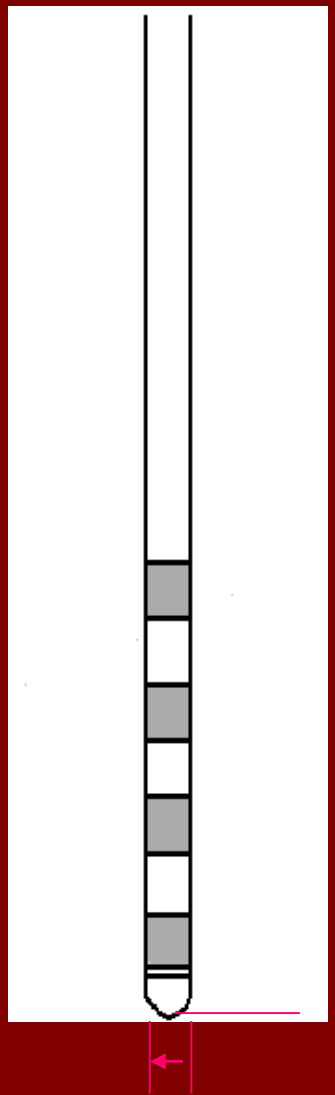


DBS Sends Out Pulses of Electricity at a Rapid Rate



Total Stimulation = Pulse Current X Pulse Width X Pulse Rate (Frequency)

A DBS Lead has at least 4 separate stimulation sites

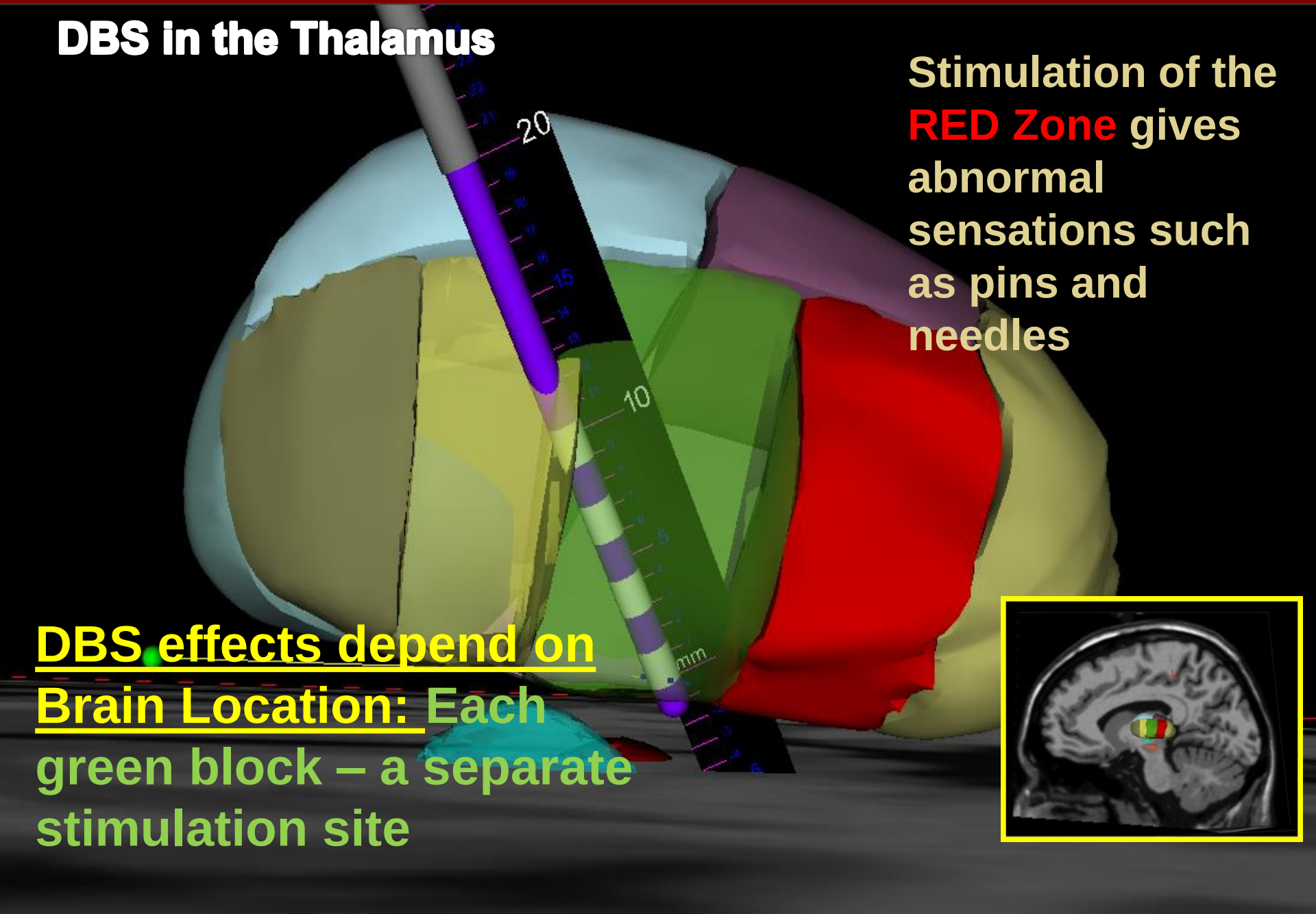


Intraoperative Test Stimulation

- After lead is implanted in the brain target but before it is locked in place
- Confirmation of lead location
- Hand-held pulse generator attached to the DBS
- Optimal placement low current (threshold) for relief of PD signs, but high current threshold before stimulation side effects.

Think of current like an electrical medication

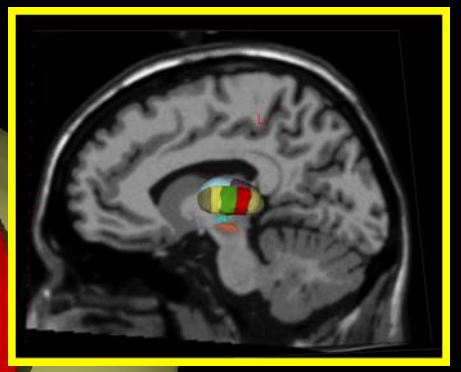
DBS in the Thalamus



Stimulation of the **RED Zone** gives abnormal sensations such as pins and needles

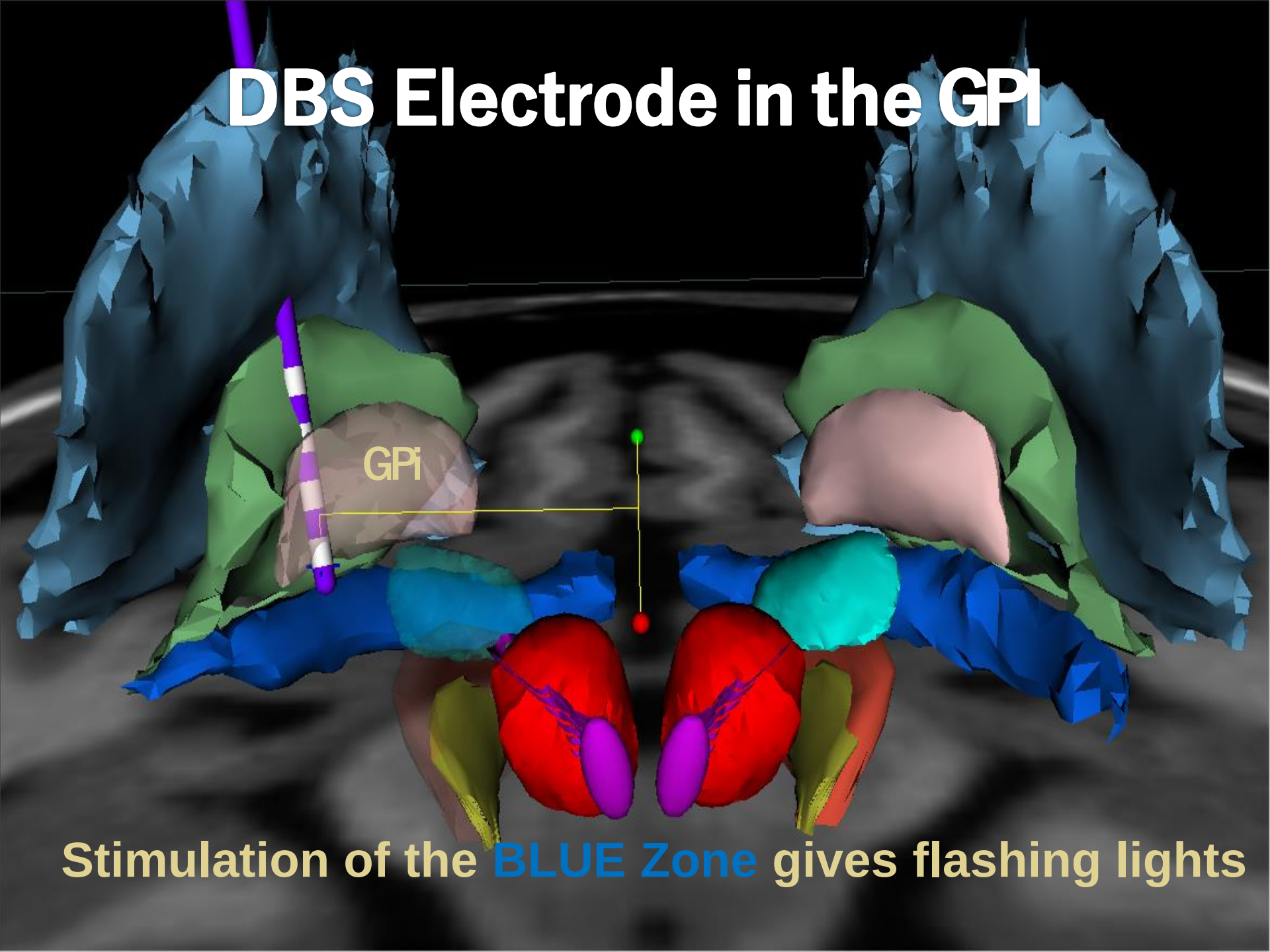
DBS effects depend on Brain Location: Each green block – a separate stimulation site

DBS in the STN in BLUE

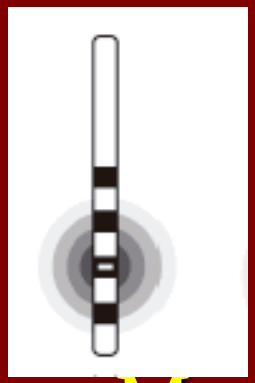


Stimulation of the Copper Zone gives muscle twitching and pulling

DBS Electrode in the GPI

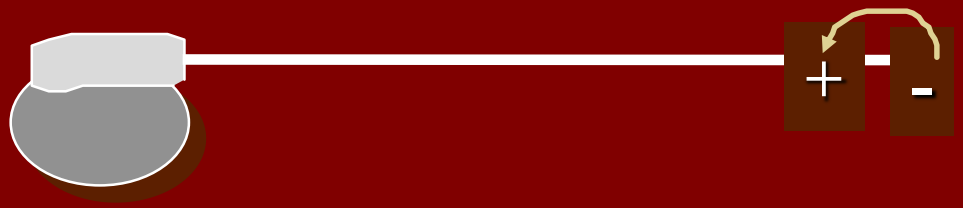


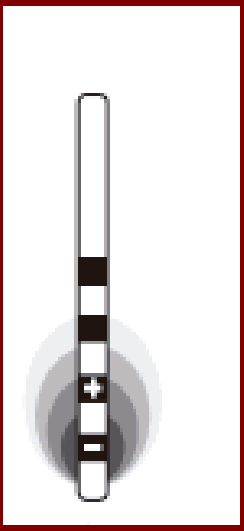
Stimulation of the BLUE Zone gives flashing lights



Electrode Configuration

- Monopolar
  - the electrode of the lead functions as the negative pole, while the IPG functions as the positive pole – giving a wide spread of current – more effective
- Bipolar
  - two or more lead electrodes function as the positive and negative poles for more restricted current spread – less side effects





Initial Programming

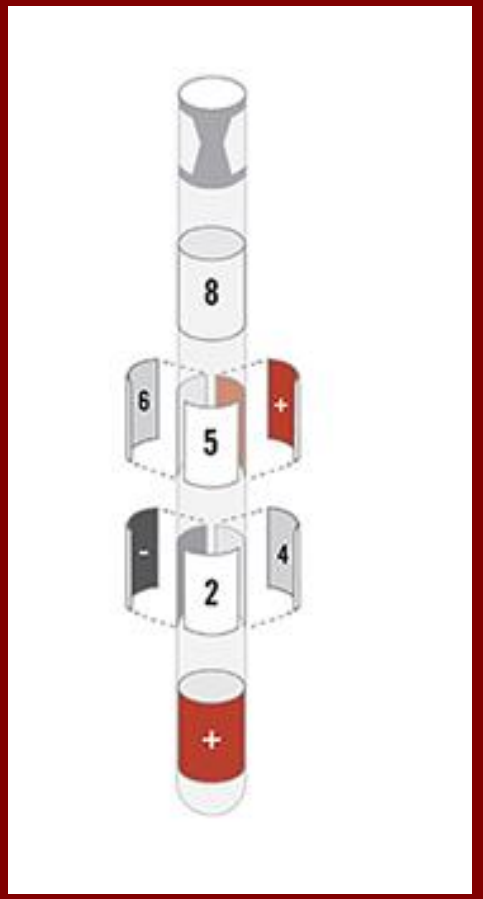
- Check impedances – are the contacts working
- Gradually raise current (Voltage or mAmps) for each contact in monopolar mode and observe for increasing benefit. Continue to increase current and observe for possible side effects. The contact with the most benefit without side effects is the one to use
- Possible side effects
  - Distortion of speech
  - Twitching pulling of throat, face, limbs
  - Dyskinesias
  - Double vision
  - Unusual sensations
  - Mood changes

Optimizing DBS Programming

- Bipolar setting may give fewer side effects
- Higher frequencies (above 150 CPS/HZ) may give better tremor control
- Increasing pulse width (above 90 micoseconds) may give better control without side effects.
- Lower frequency (below 100CPS) may help “on” freezing

New Kids on the Block: St. Jude/Abbott and Boston Scientific Join Medtronic in the Field after 20 Years

- All have constant current settings; for more consistence stimulation?
- St. Jude: First “directional” leads for better targeting?
- Boston Scientific with independent contacts and power sources



DBS Requires a Working Team

1. Neurosurgeon places the hardware – Dr. Howard Eisenberg
2. Radiologist help identify the target - Dr. Deraj Gandhi
3. Psychiatry evaluation and support – Dr. David Glovinsky
4. Psychology evaluation and support - Lynne Gratton
5. Neurologist/physiologist –identifies the brain target in the OR – Dr. Paul Fishman
6. Company Representatives support the technology –Medtronic, Abbott, Boston Scientific
7. Programming team – Drs. Fishman, Savitt, von Coellm
8. Nurse Coordinator – Shari Powell for patient supoport, education programming
9. Movement Disorder Team –Drs. Shulman, Reich, Fellows- Dr. Rezvani and Cheng medical management
10. Patient and family for follow-up, patient control and management of the implanted technology

Patient Control Device: Power with Responsibility

- Turning on and off –conserve battery, and for procedure
- Adjust current (Voltage, amperage, pulse width or frequency) – raise for more benefit, lower for less side effects
- “A” and “B” programmed settings for different situations (walking or talking)
- Within the limits from your programming provider

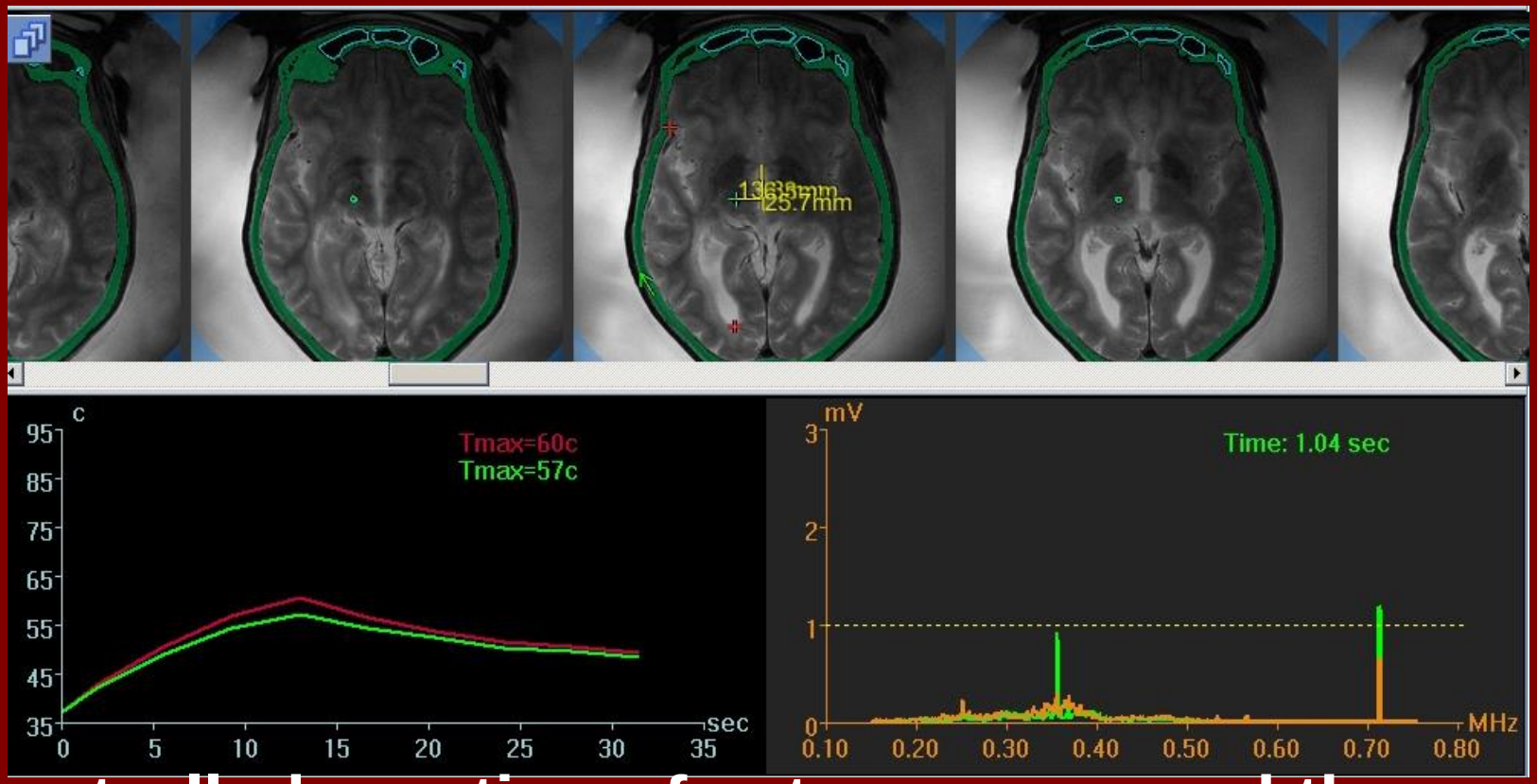
DBS Technology Also Brings New Issues

- **Implanted foreign body – risk of infections**
- **Equipment failures**
- **Battery replacement**
- **Cost of equipment**
- **Possible electromagnetic interference**
- **Time and effort needed for programming**

New Trick for an Old Dog – Focused Ultasound

- Pre-DBS – Destruction of overactive brain target by surgical placement of a microwave heating probe
- Now - Destruction of overactive brain target by MRI guided Focused Ultrasound without surgery

MRI measures brain temperature after each sonic treatment in real time



Controlled creation of a temporary and then permanent lesion monitoring brain temperature and patient response for both symptom relief and side effects

DBS and FUS: Similarities & Differences

DBS

- "Standard Care"(>150K patients)
- Head Frame
- Patient cooperation needed with pain or discomfort (*)
- Surgical placement of system with known risks of bleeding or infection
- Adjustable device to maximize long-term benefit, but needing programming, battery replacement with chance of malfunction
- Treats both sides

FUS

- Experimental for PD(50 patients)
- Head Frame
- Patient cooperation needed with pain or discomfort
- Non-Surgical local brain destruction with unknown risks
- One time treatment – no device, no battery, but no opportunity (currently) for adjustment if persistent side effects or loss of benefit
- Treats one side (for now)

The Pivotal Trial of FUS Pallidotomy for PD

- Prior to DBS, many PD patients underwent stereotactic thermal destruction of the globus pallidus interna (GPI)
- DBS to the same region is widely done for PD patients dose fluctuations and bothersome involuntary movements - dyskinesias.
- Can FUS targeting the GPI give similar improvement without surgery?

FUS Pallidotomy for PD: Looking for Mr. and Ms. Right

- On L-dopa with significant wearing off and bothersome ***dyskinesias***
- Asymmetric symptoms where treatment of ***one side of the body would be worthwhile***
- Still responding to L-dopa and still walking when L-dopa “kicks in”
- No prior DBS

First Trial of FUS Pallidotomy for PD Now Complete

- 22 patients (15 at Maryland)
- No severe side effects
- Promising level of improvement with FDA approval for a large (110 patients) multi-center, sham (delayed treatment) controlled study
- Univ. of Maryland is the coordinating center
- ***GPI on One side will be treated***