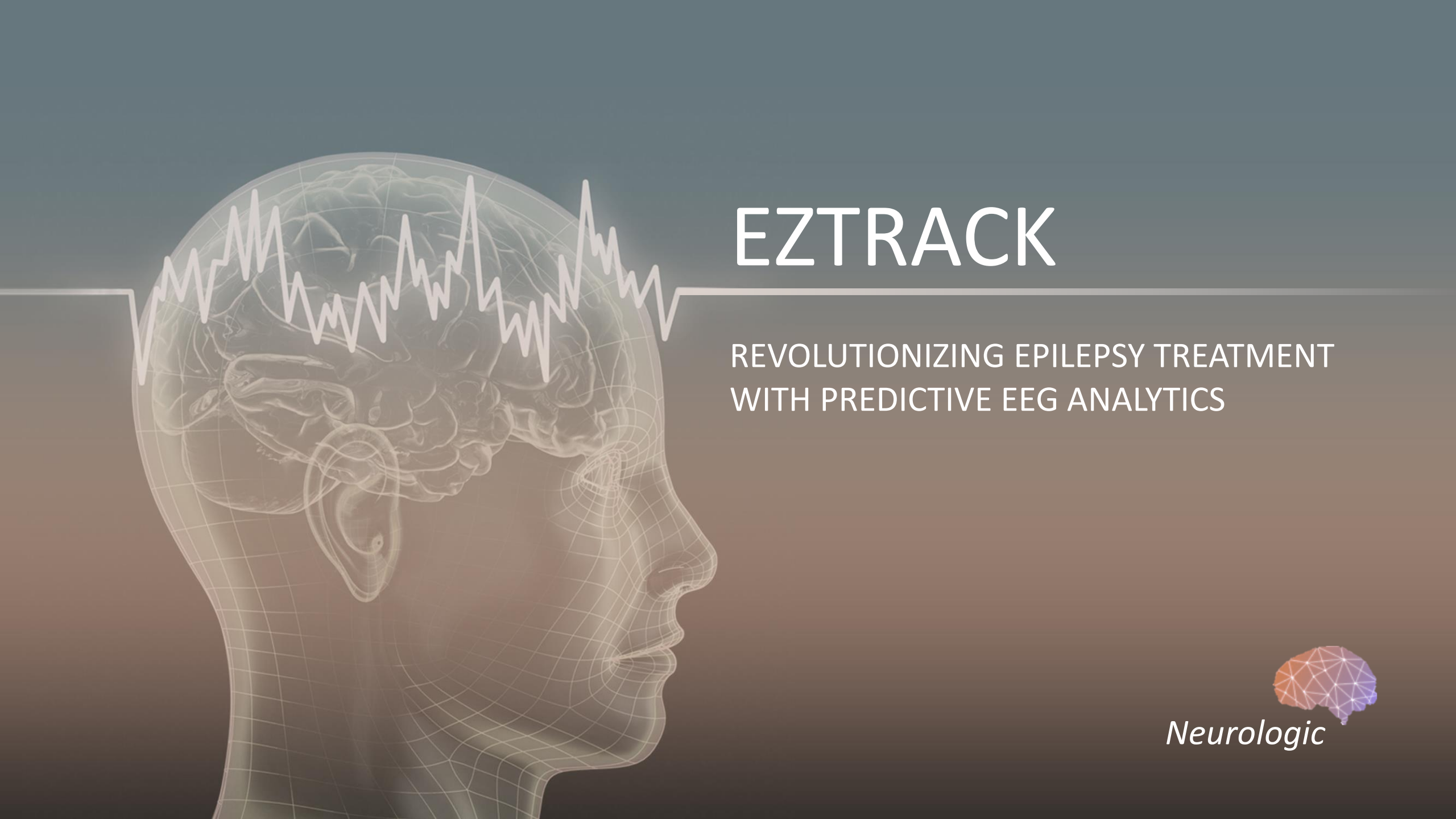
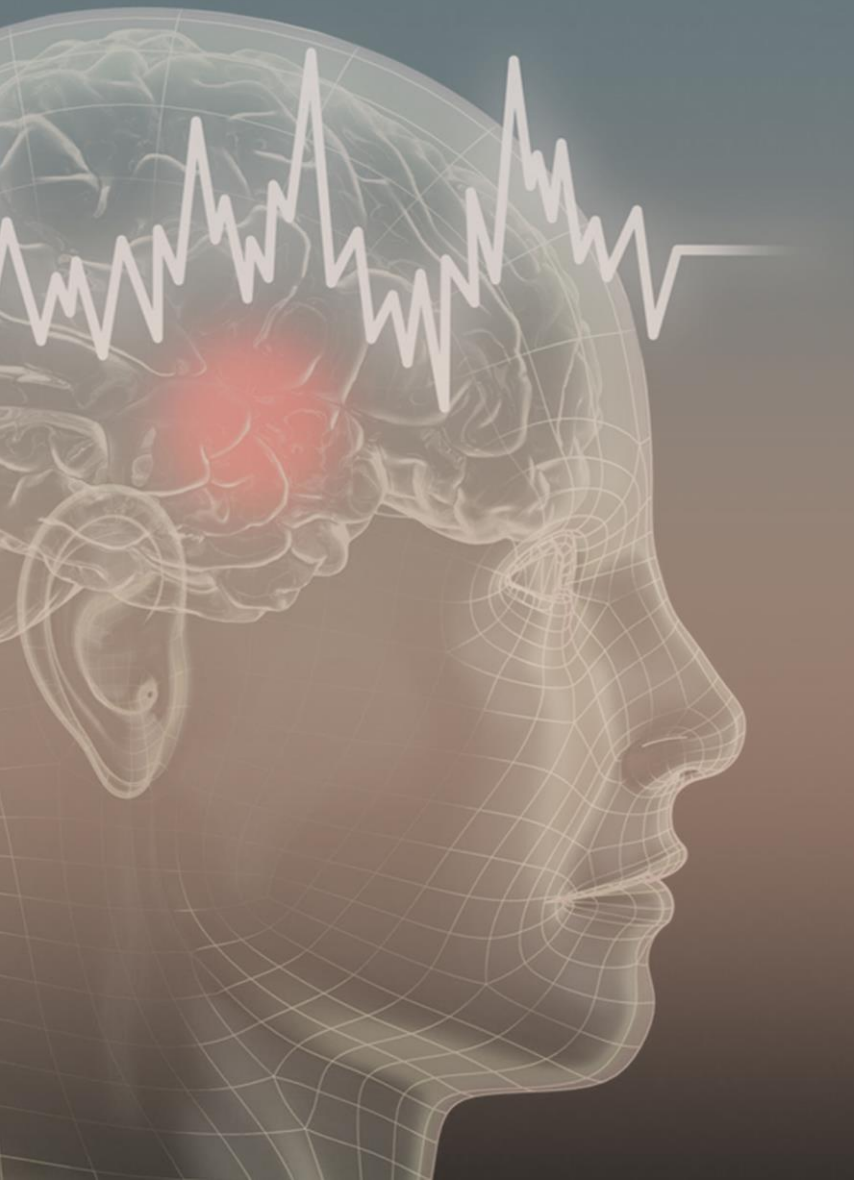


# EZTRACK

REVOLUTIONIZING EPILEPSY TREATMENT WITH PREDICTIVE EEG ANALYTICS

*Neurologic*

# CLINICAL PROBLEM

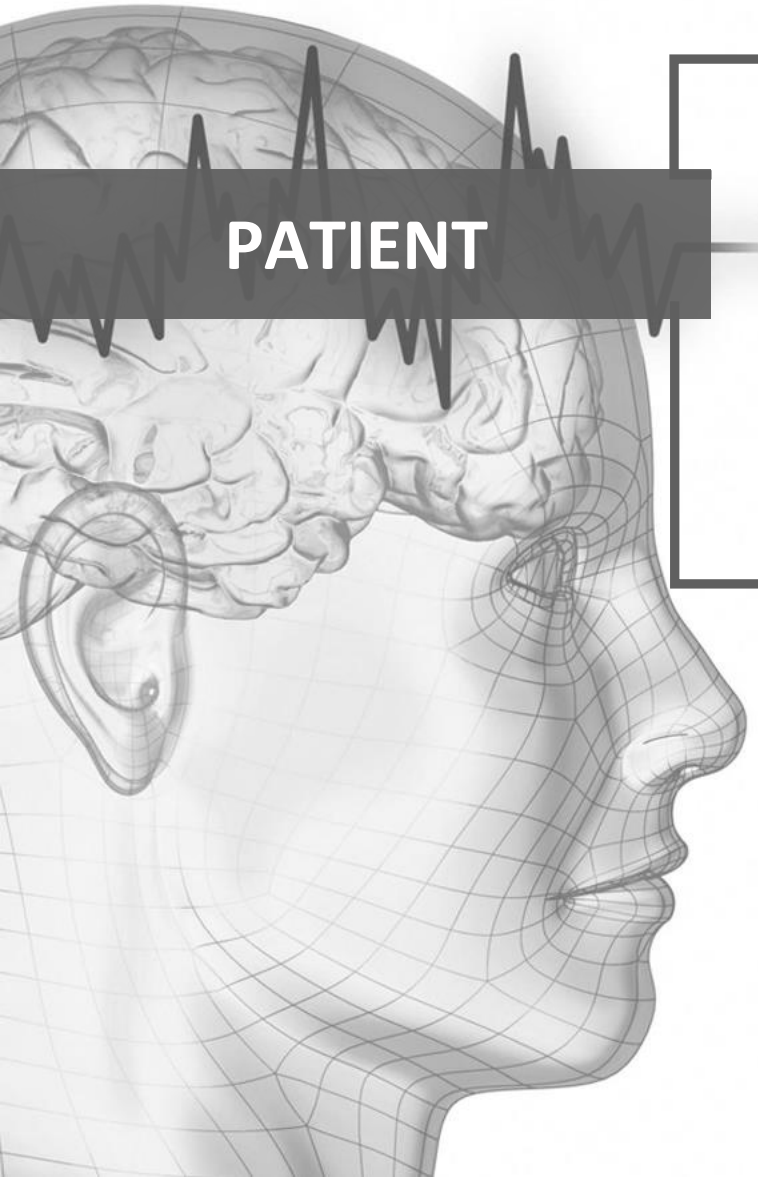


Neurologic

- 40M people suffer from focal epilepsy
- Seizures start in the brain in the Epileptogenic Zone (EZ)
- Cannot be cured with drugs
- Requires accurate identification of the EZ followed by brain surgery to remove the EZ

# VERY LOW SUCCESS RATES

Neurologic




## LOCATE EZ NON-INVASIVELY

- Monitors scalp signals
- Surgeons don’t rely on it
- Indicates hemisphere or lobe of EZ- coarse

## LOCATE EZ INVASIVELY

- Inhumane, lengthy, risky process
- Only 15% of patients elect to do it
- Requires EEG expertise

## SURGERY TO REMOVE THE EZ

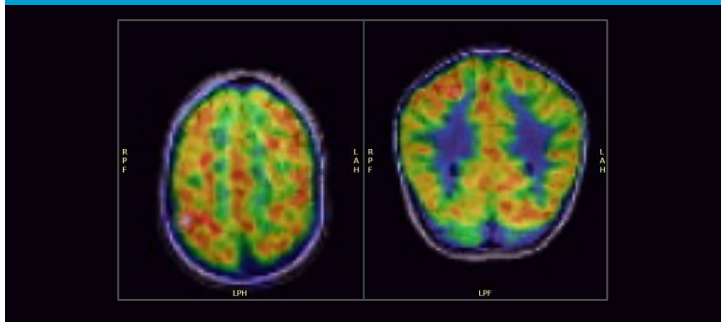
- 30-70% success rates
- Major post-surgery complications if the EZ is not accurately identified

# LOCATING EZ NON-INVASIVELY

## IS TOO COARSE, CAN ONLY PINPONT EZ HEMISPHERE

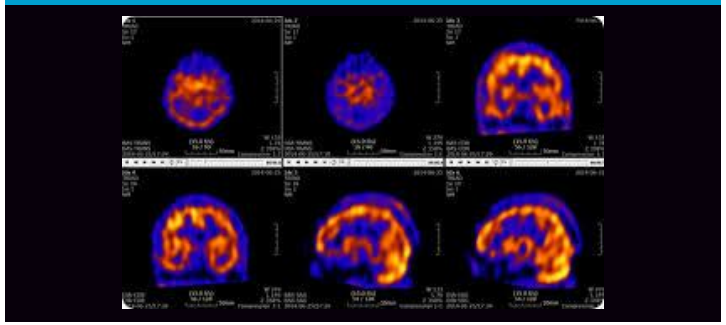
Neurologic

**PET SCAN**

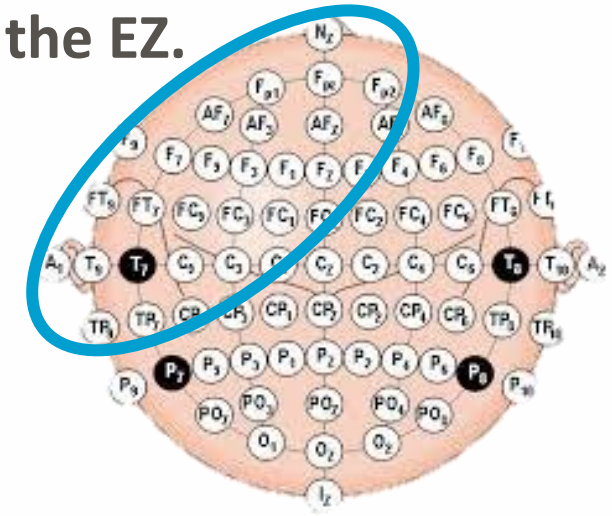


**MRI**

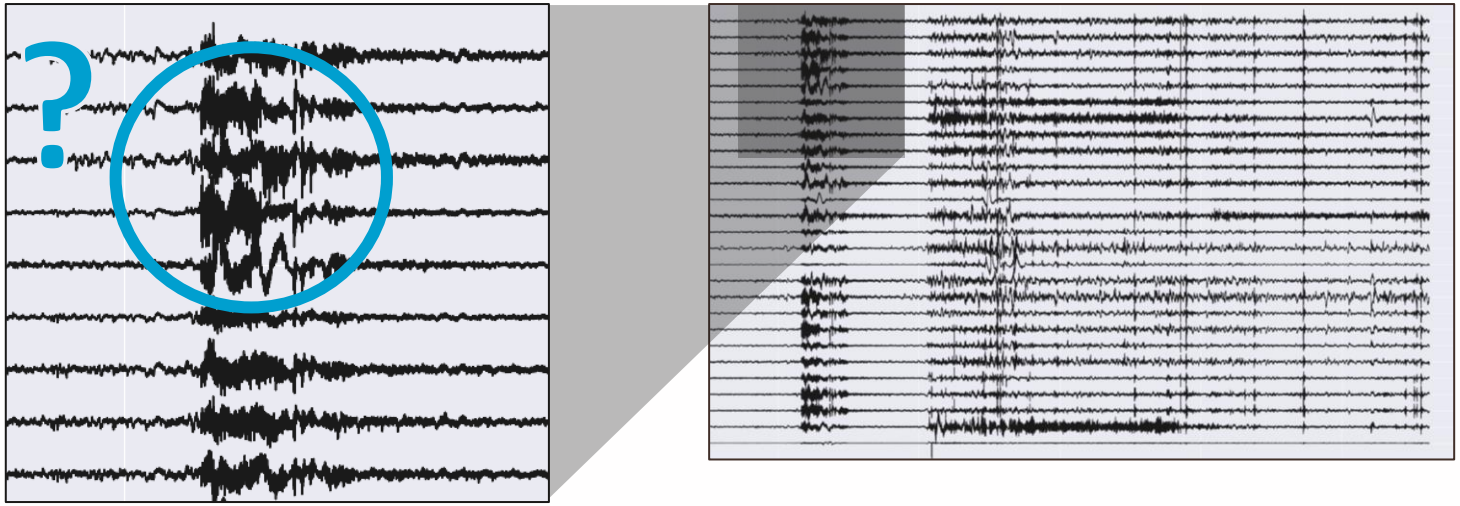
**SPECT**



**Scalp EEG data is too noisy to precisely locate the EZ.**



**SCALP EEG**

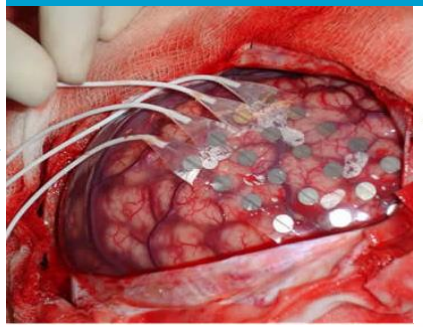


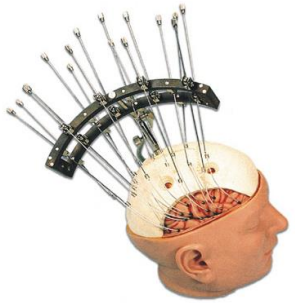
# LOCATING EZ INVASIVELY
## IS OFTEN REQUIRED BUT PRONE TO HUMAN ERROR

Neurologic

**CRANIOTOMY**

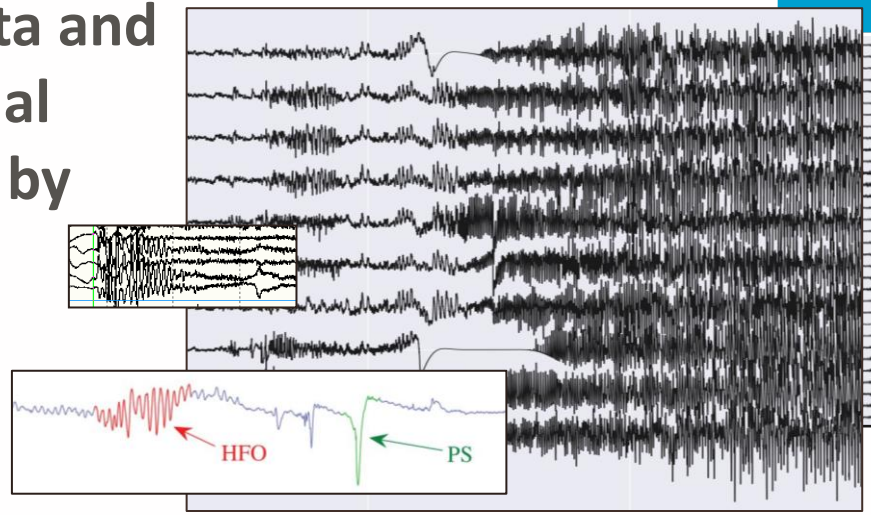
**ELECTRODE IMPLANTATION**



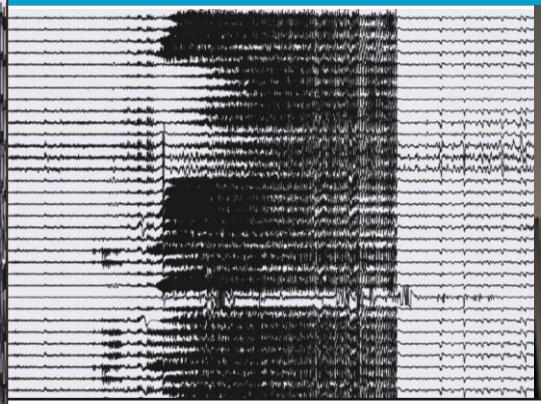


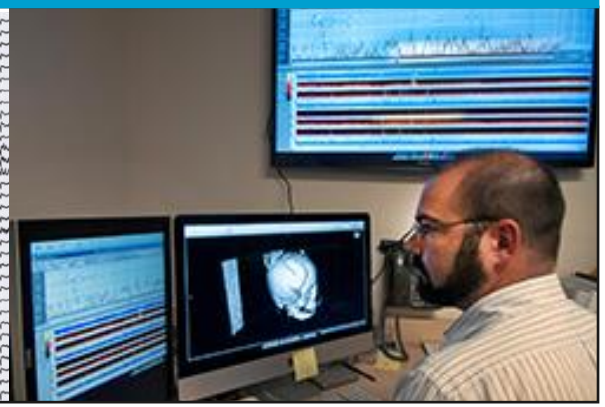
**MONITORING**
(DAYS/WEEKS)

**Clinicians visually inspect hours of EEG data and look for abnormal activity channel by channel.**




**CLINICAL TEAM ATTEMPTS TO LOCALIZE VISUALLY**





# CHALLENGES WITH CURRENT PRACTICE

Neurologic

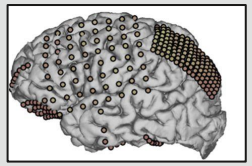
| | |
|---|---|
| **HIGH DEGREE OF PROCESS VARIABILITY** | Electrodes must be implanted in the right place |
| **PROLONGED HOSPITAL STAY** | Requires days to weeks to observe many seizures |
| **SUBJECTIVE DECISION CRITERIA** | No data analytics to interpret signals |
| **OUTCOMES HIGHLY VARIABLE** | only 30-70% success |
| **HIGH RISK, HIGH COST** | Larger brain area removed to compensate for localization uncertainty; infection risk; $200,000 per treatment |

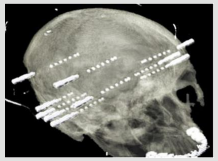
# OUR SOLUTION - EZTRACK

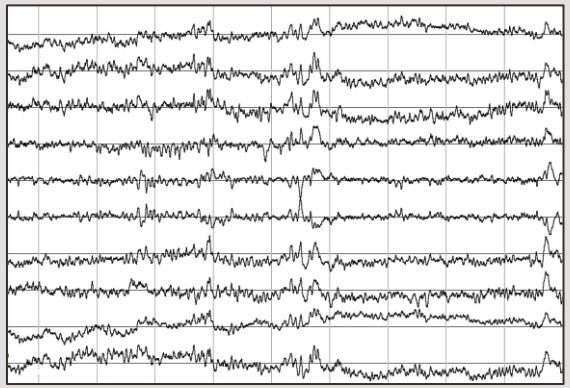
## CONVERTS EEG TO A SIMPLE HEAT MAP TO LOCALIZE EZ

Neurologic

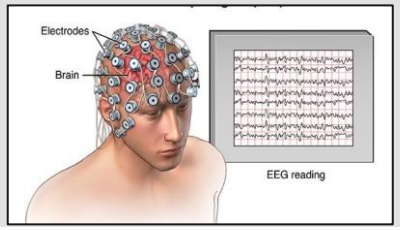
**ECoG** **SEEG**







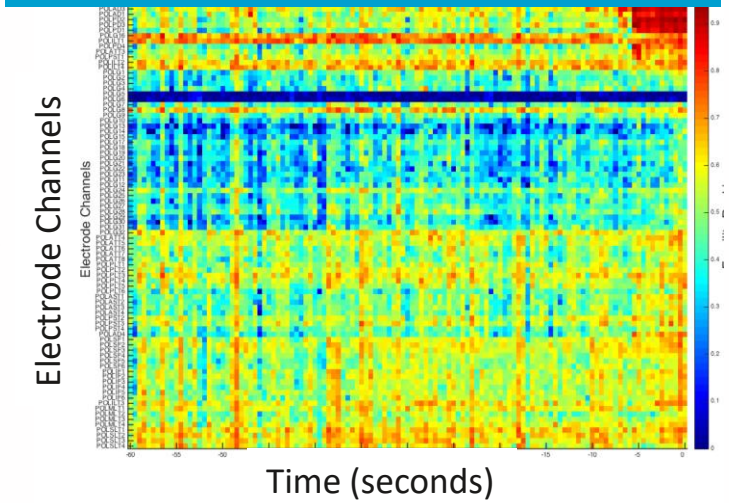
**SCALP EEG**




***EZTRACK***

SMART EEG ANALYTICS: BRAIN NETWORK-BASED MODEL PREDICTIONS

**FRAGILITY MAP**




>20% IMPROVEMENT IN PREDICTED OUTCOMES

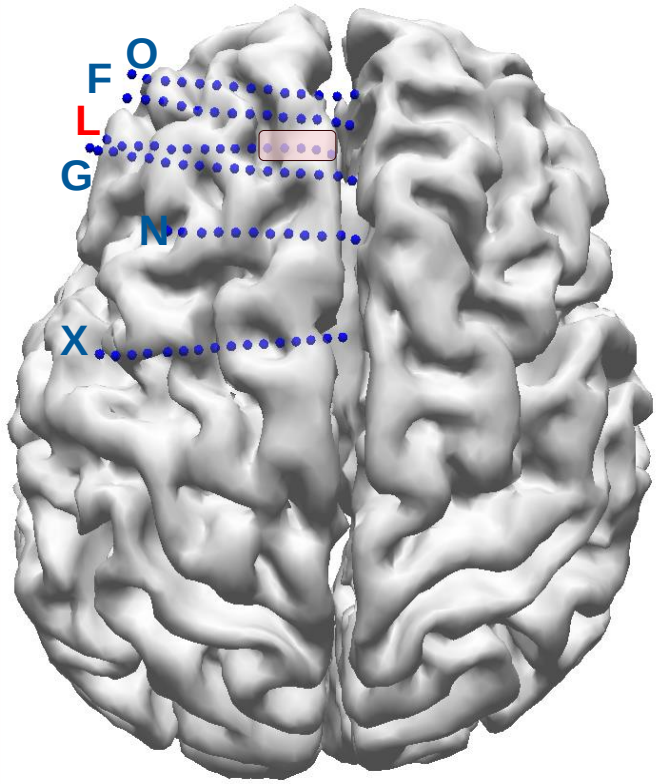
# RETROSPECTIVE STUDIES

Neurologic

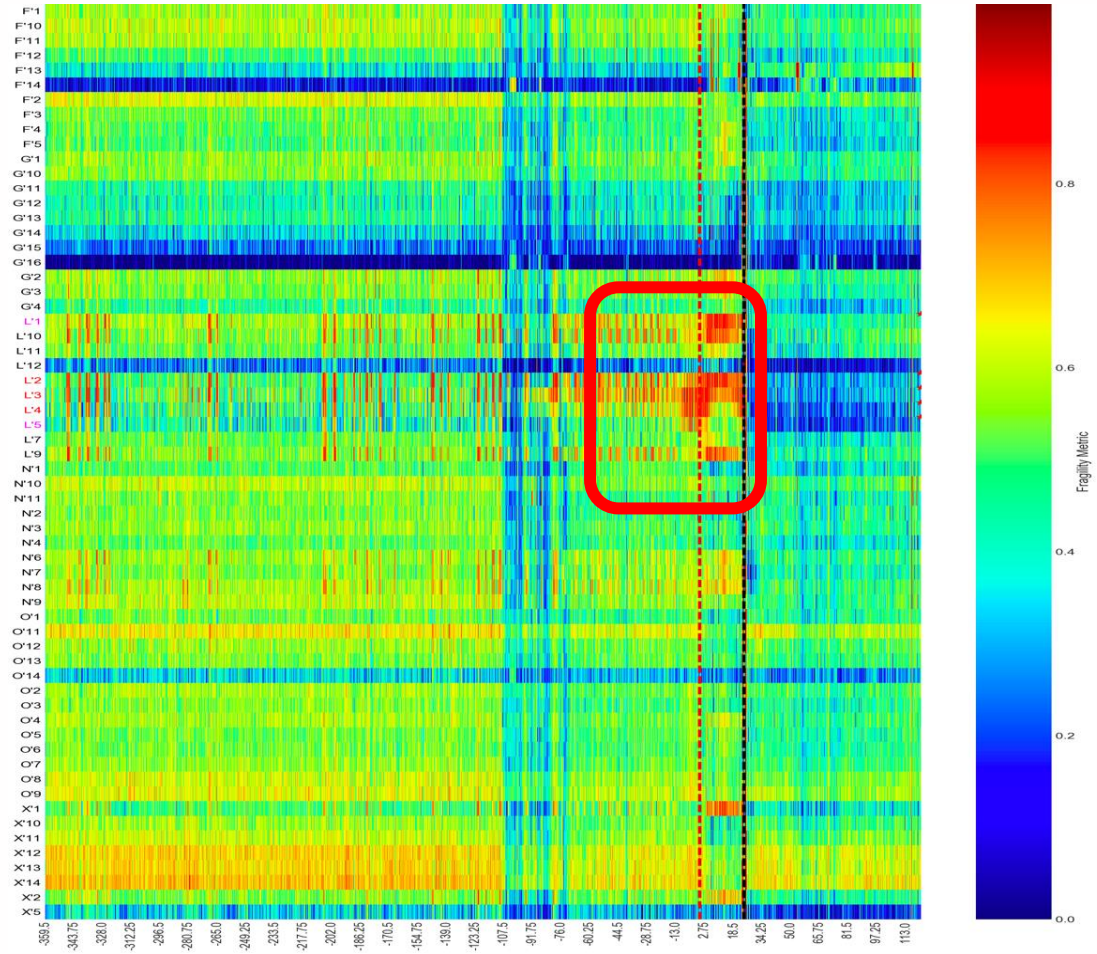


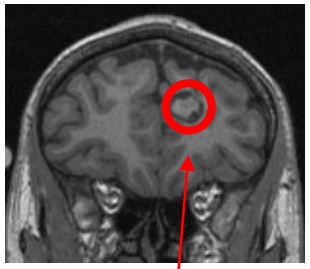

# FRAGILITY MAP AGREES WITH CLINICIAN

## SUCCESSFUL OUTCOME




O': OrbitoFrontal
G': Anterior Cingulate
X': Mid Cingulate
F': Fronto polar
L': Lesion?
N': Sup Frontal gyrus

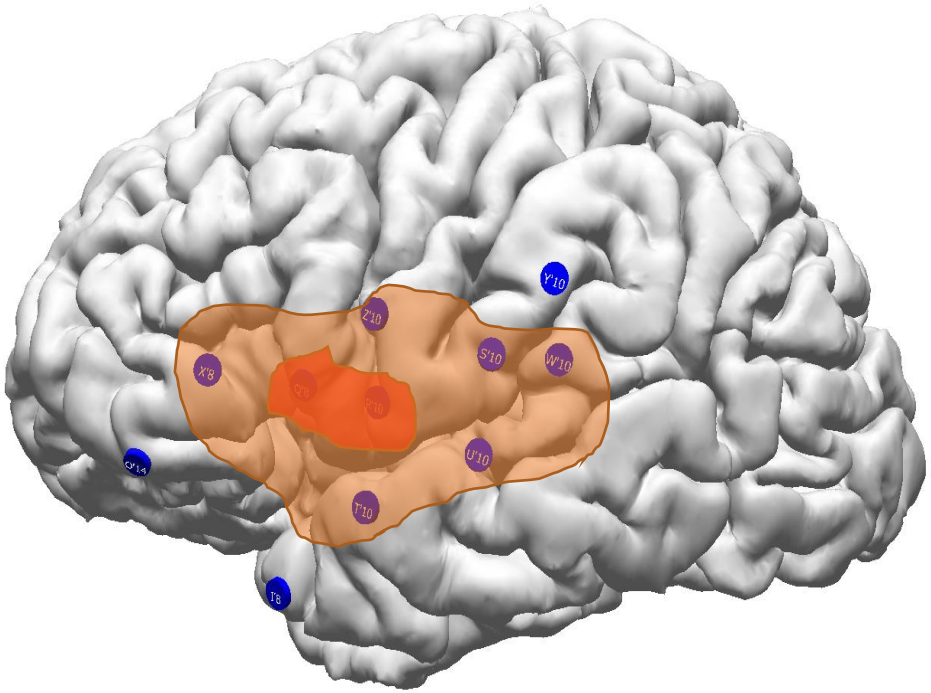



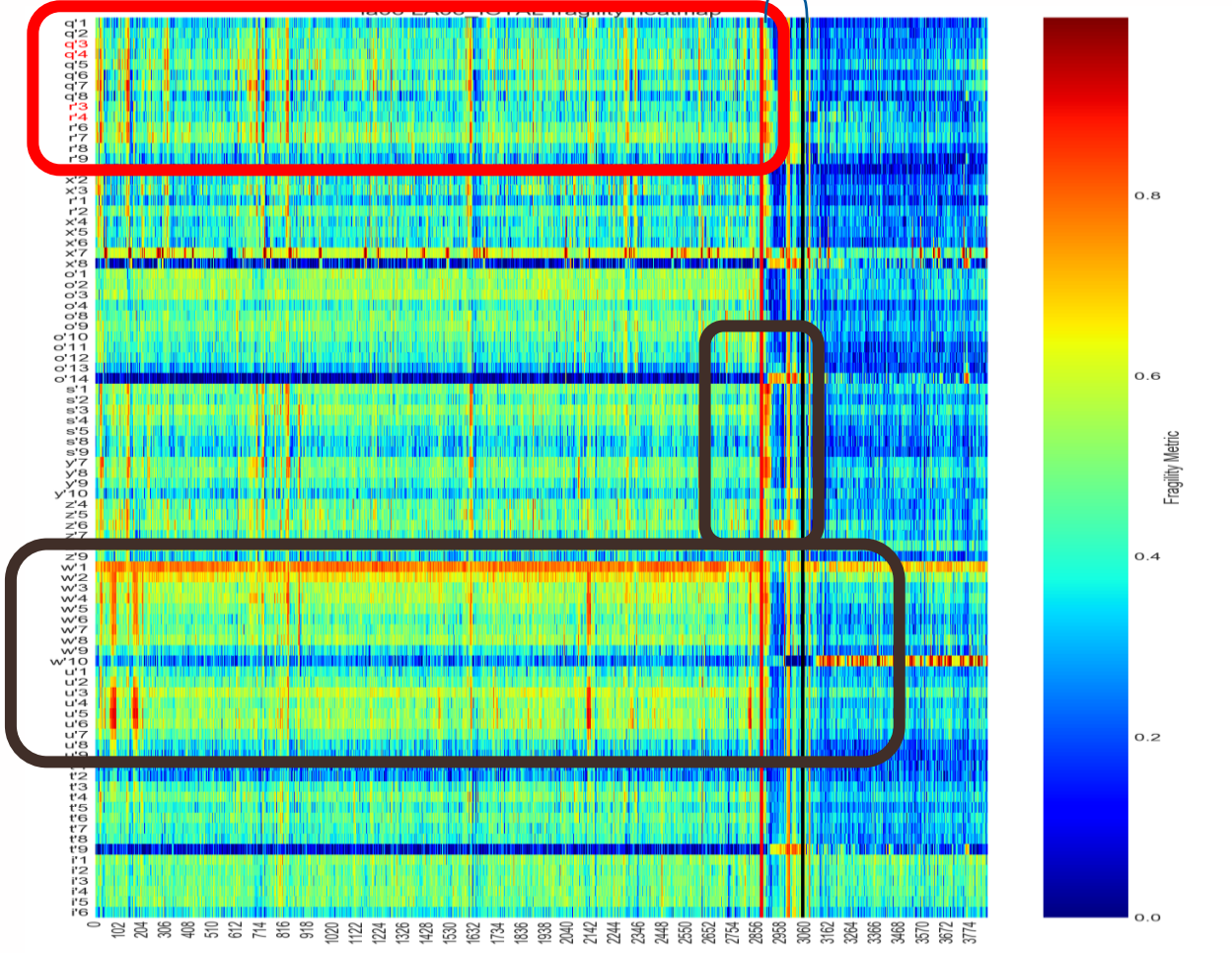



Targeted laser ablation

# FRAGILITY MAP DISAGREES WITH CLINICIAN

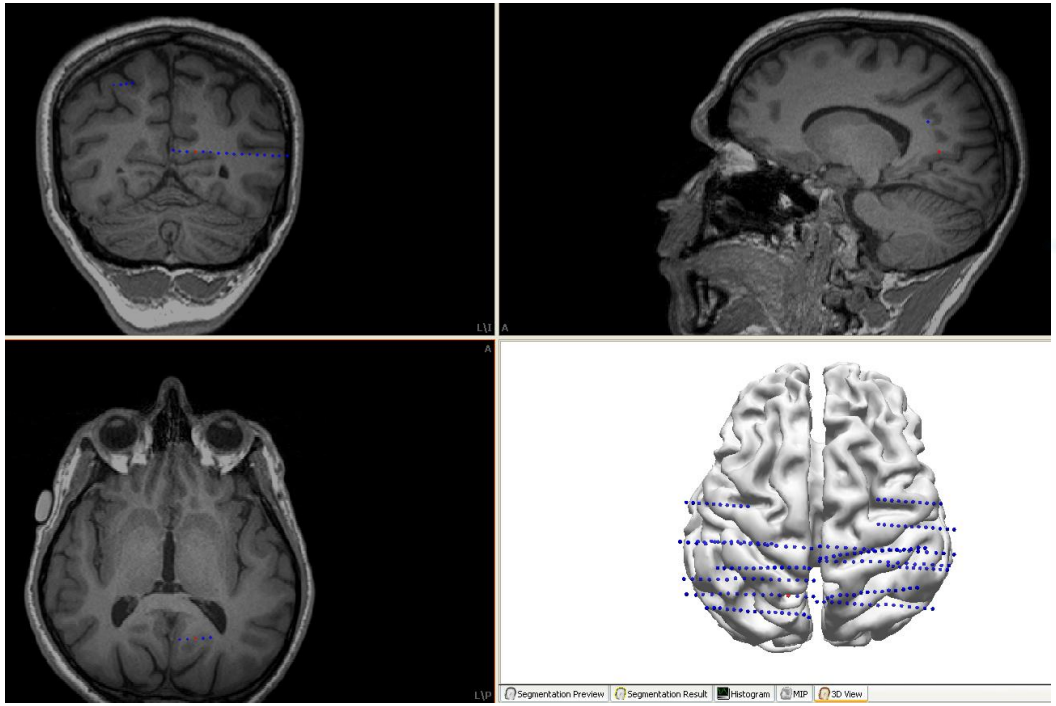
## FAILED OUTCOME

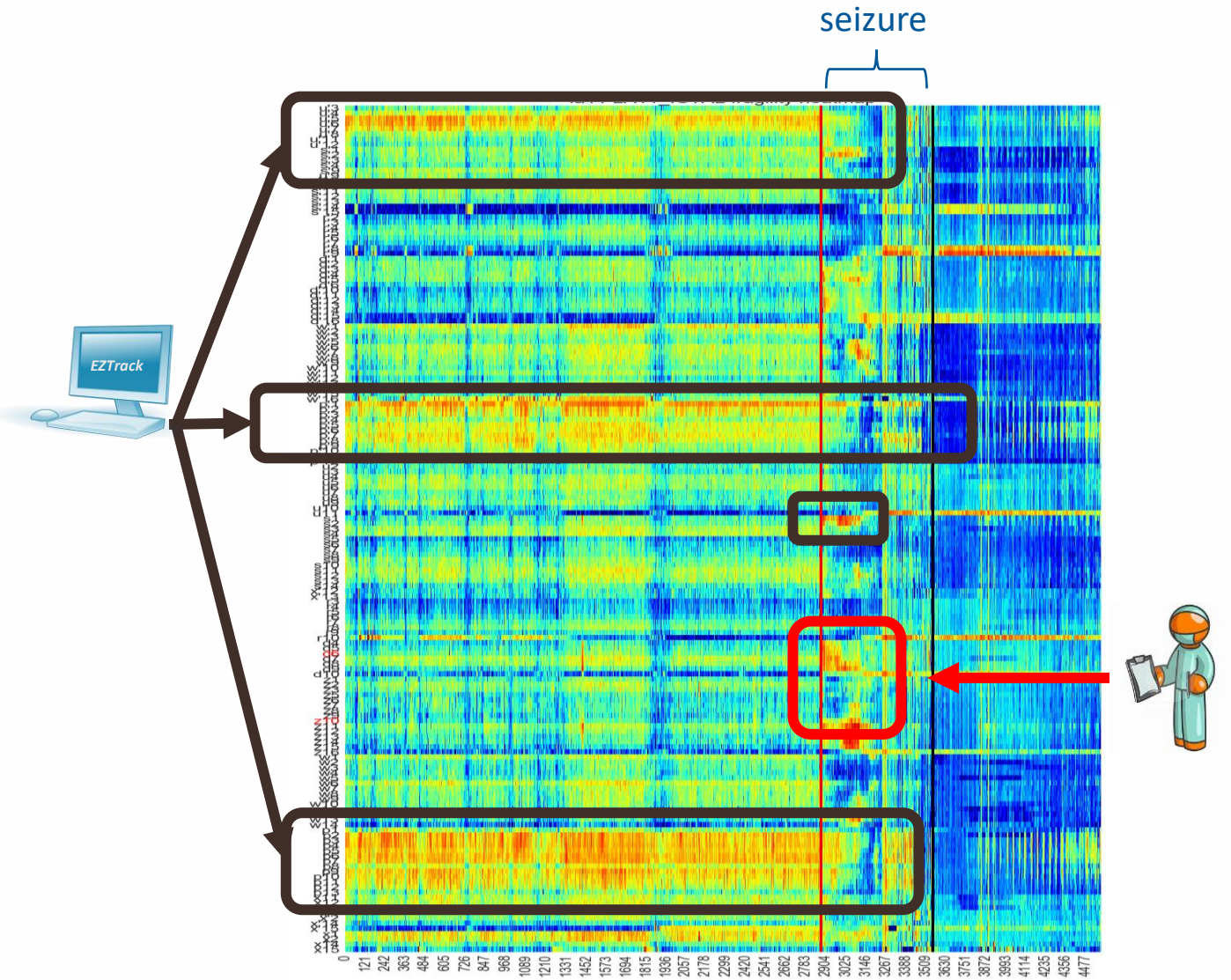


# FRAGILITY MAP DISAGREES WITH CLINICIAN

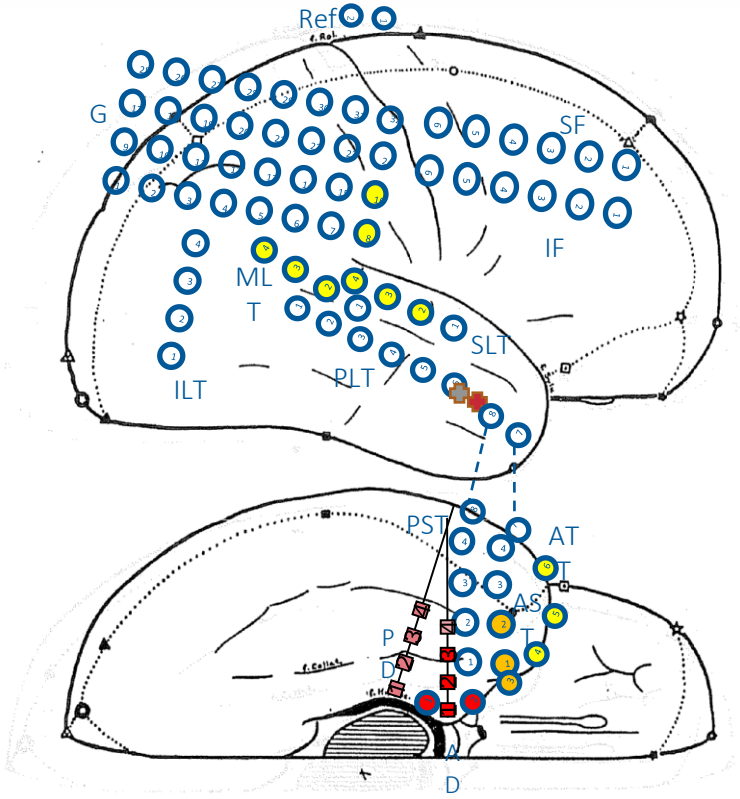
## FAILED OUTCOME



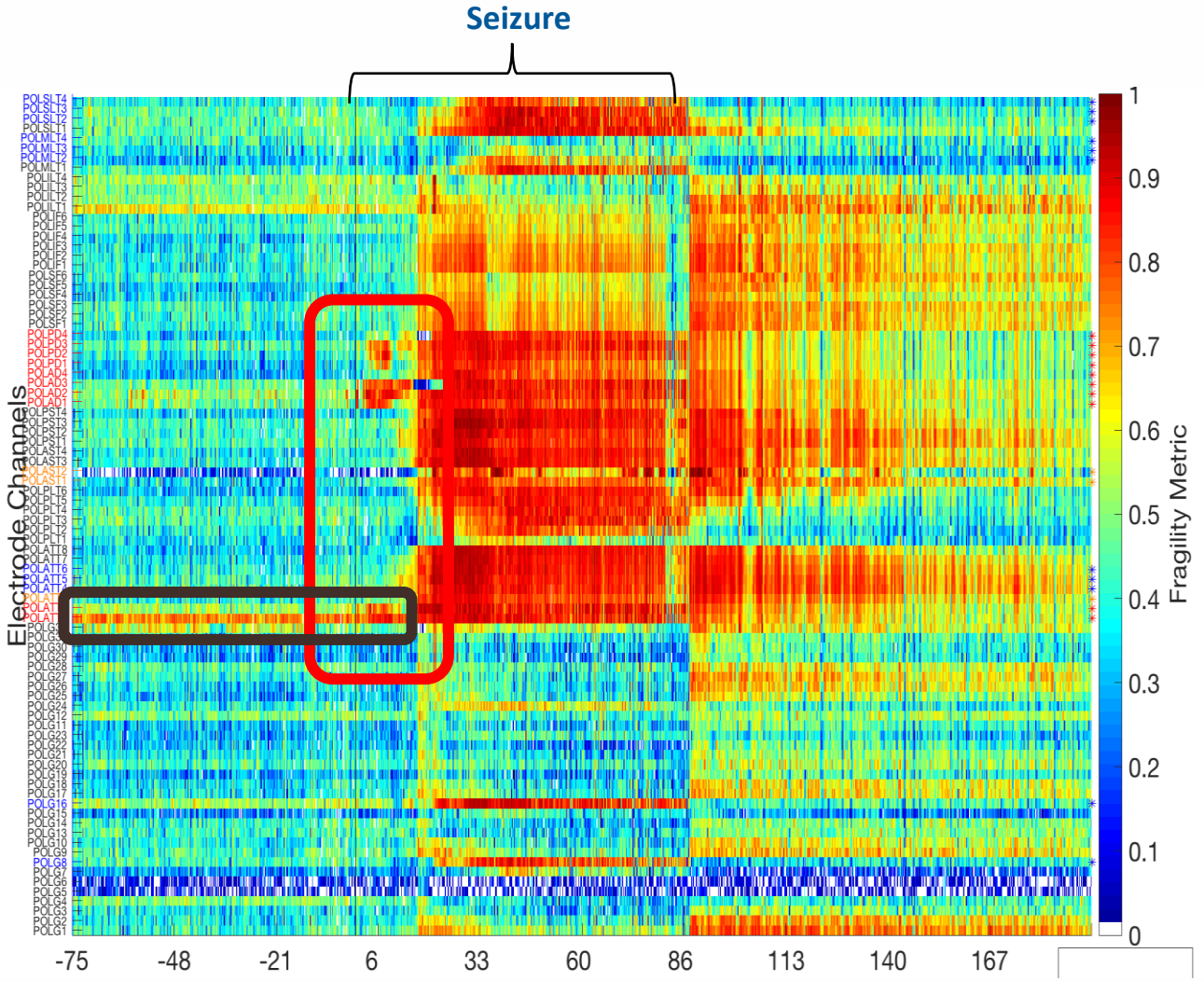
# FRAGILITY MAP AGREES WITH CLINICIAN

## SUCCESSFUL OUTCOME



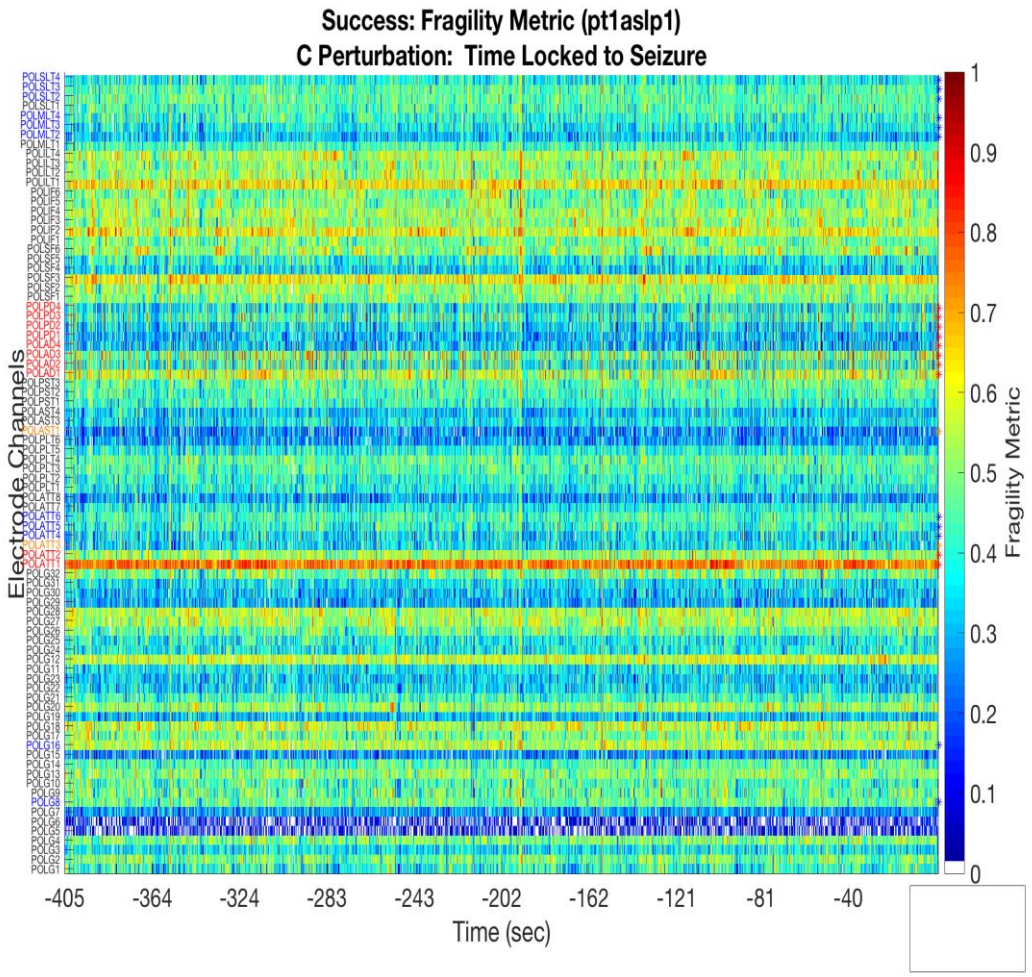


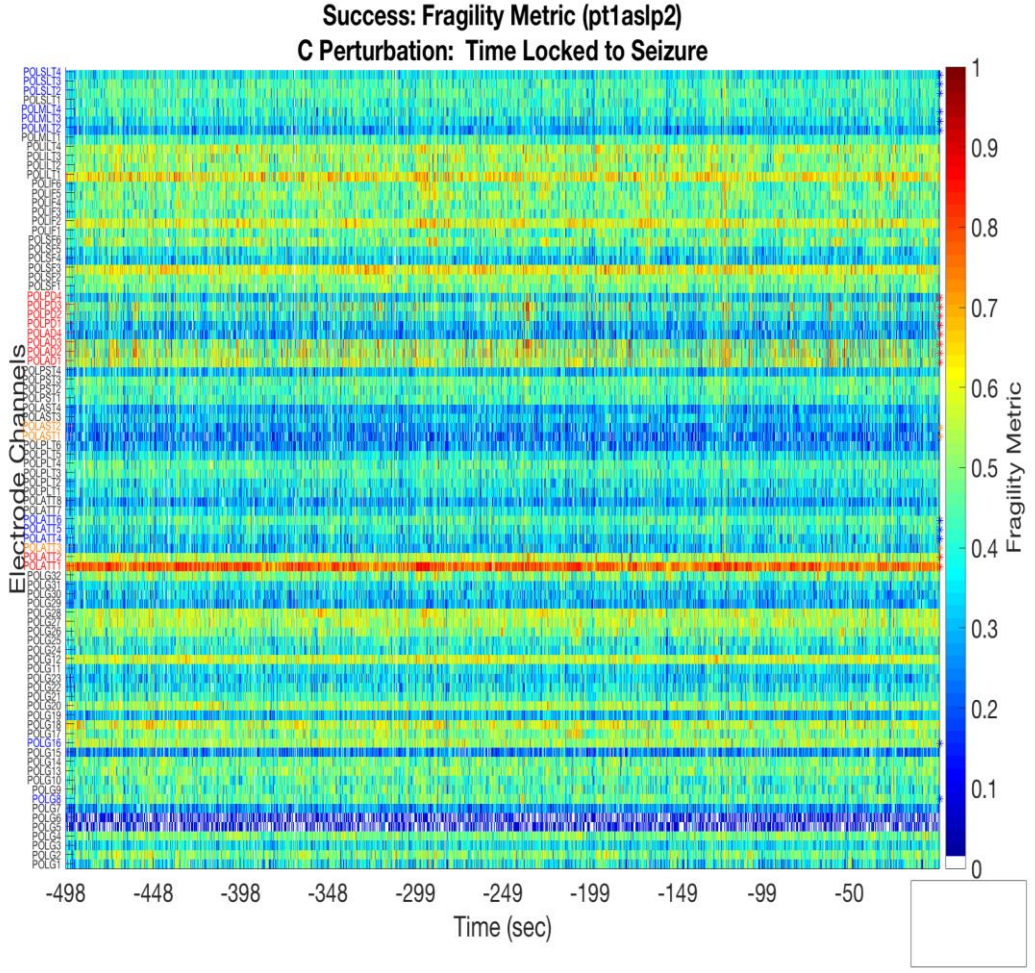
- onset
- early spread
- late spread



# FRAGILITY MAP DURING SLEEP

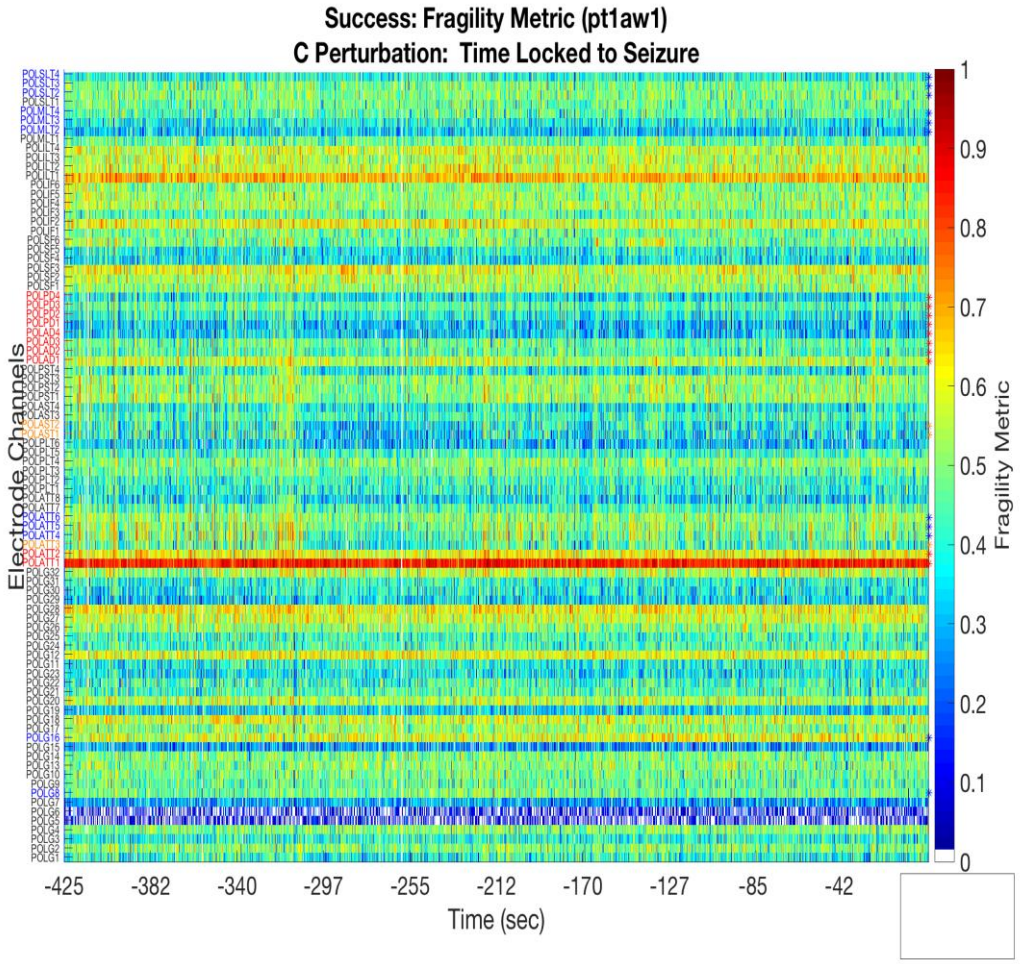
## NO SEIZURE

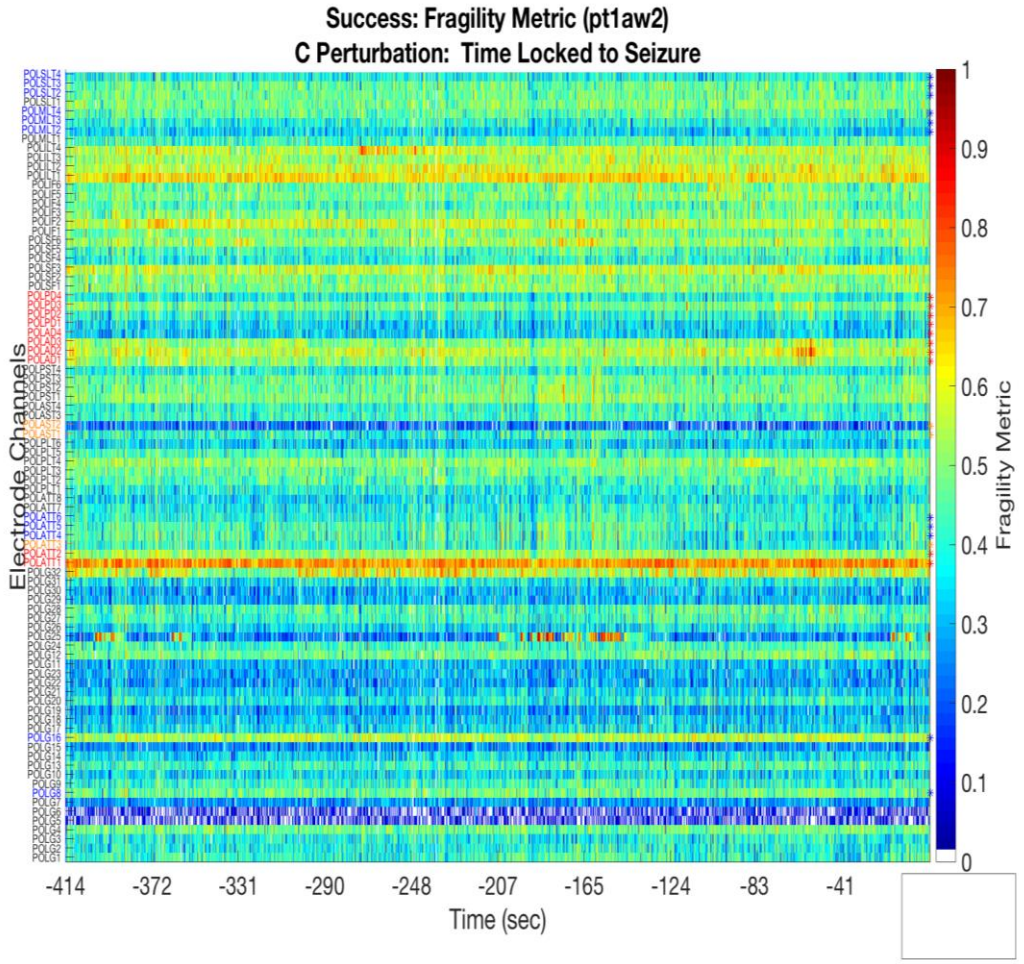


# FRAGILITY MAP DURING WAKE

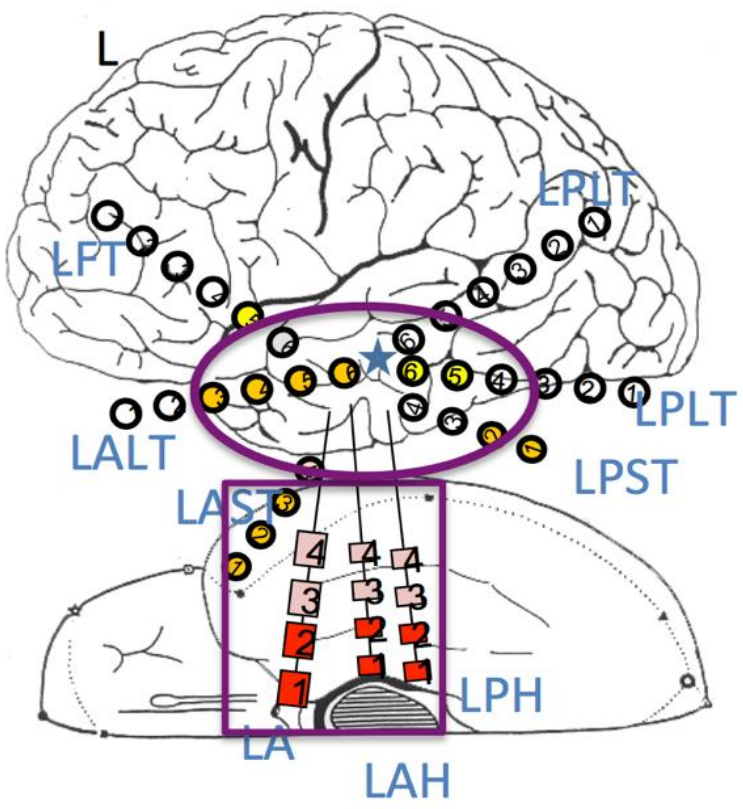
## NO SEIZURE

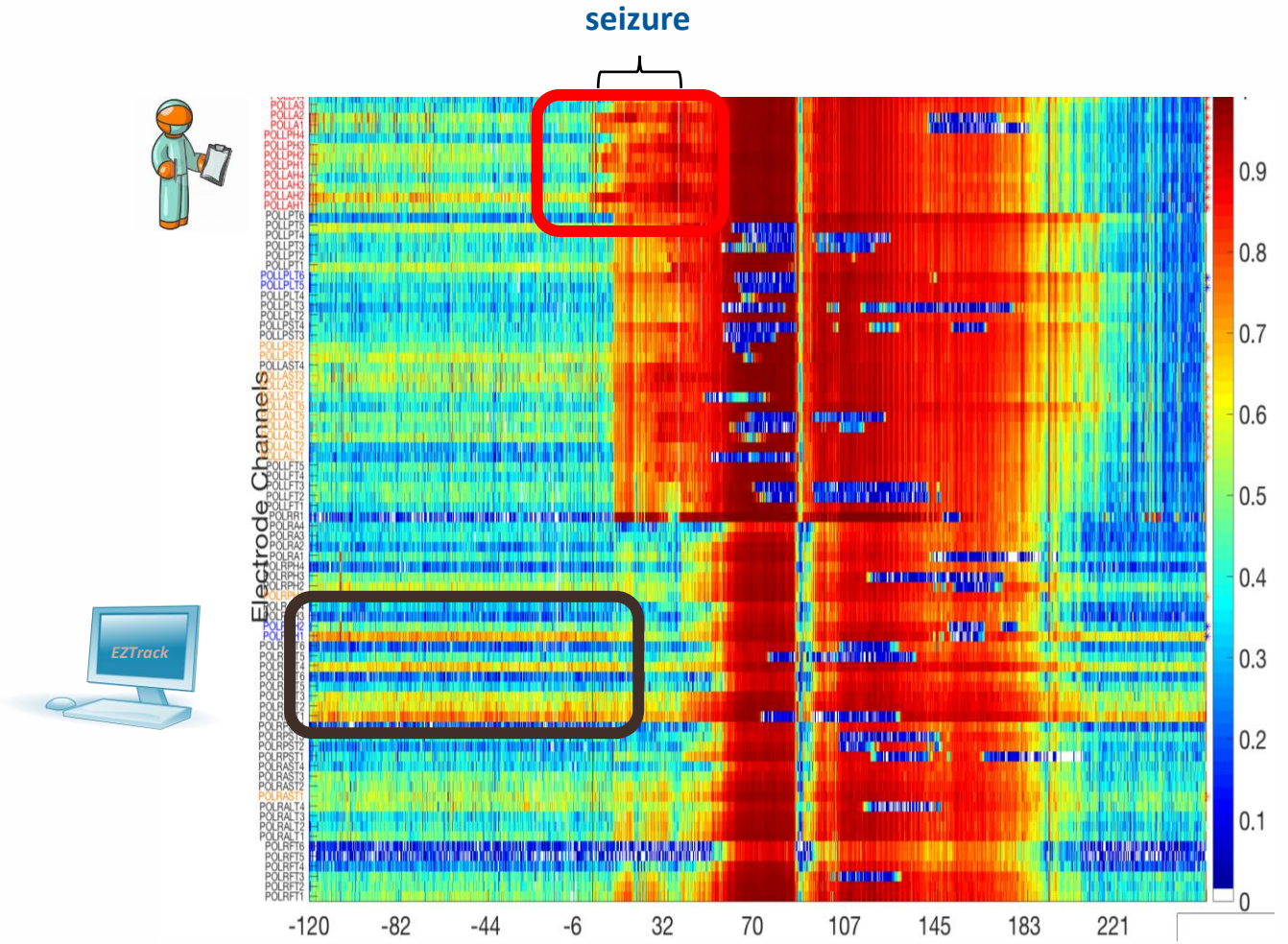


# FRAGILITY MAP DISAGREES WITH CLINICIAN

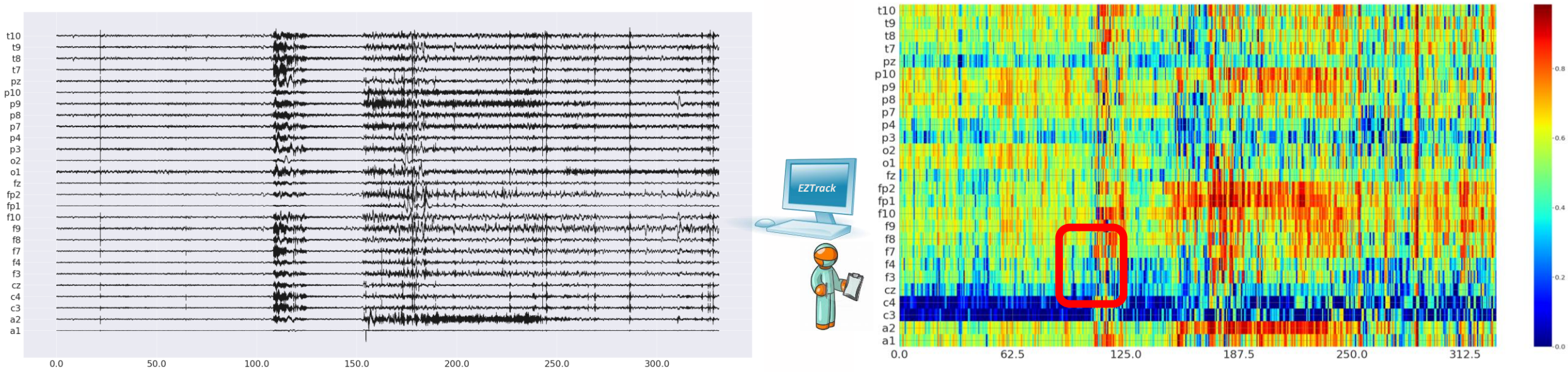
## FAILED OUTCOME



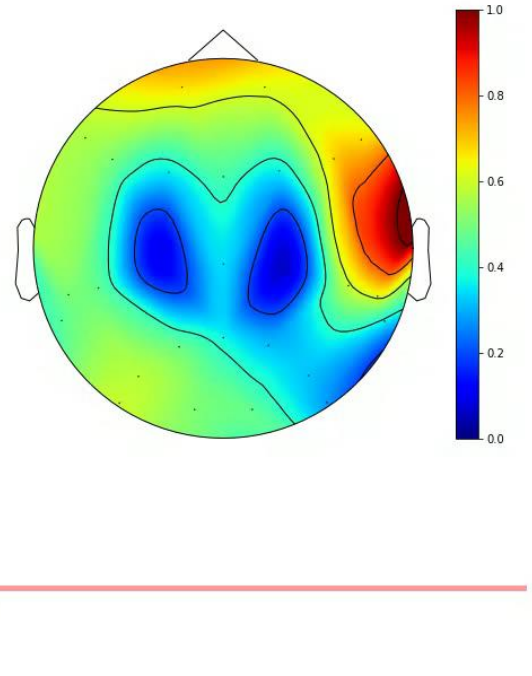
# FRAGILITY MAP FOR SCALP

## SUCCESSFUL OUTCOME



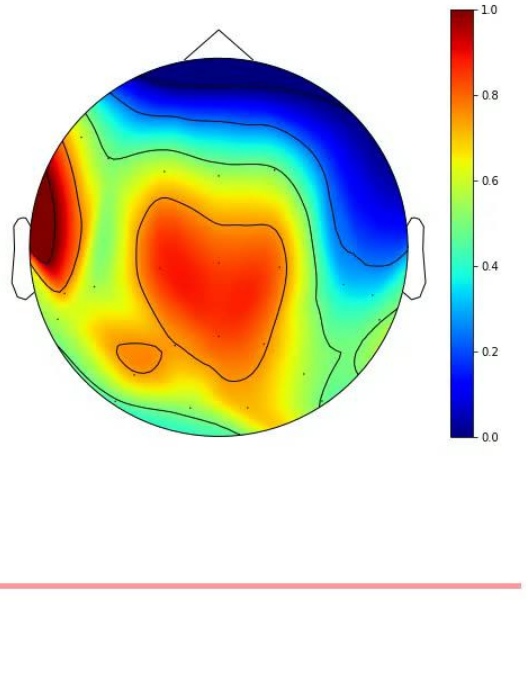
# FRAGILITY MAP FOR SCALP
## SUCCESSFUL OUTCOME

### Fragility Map






### Raw EEG



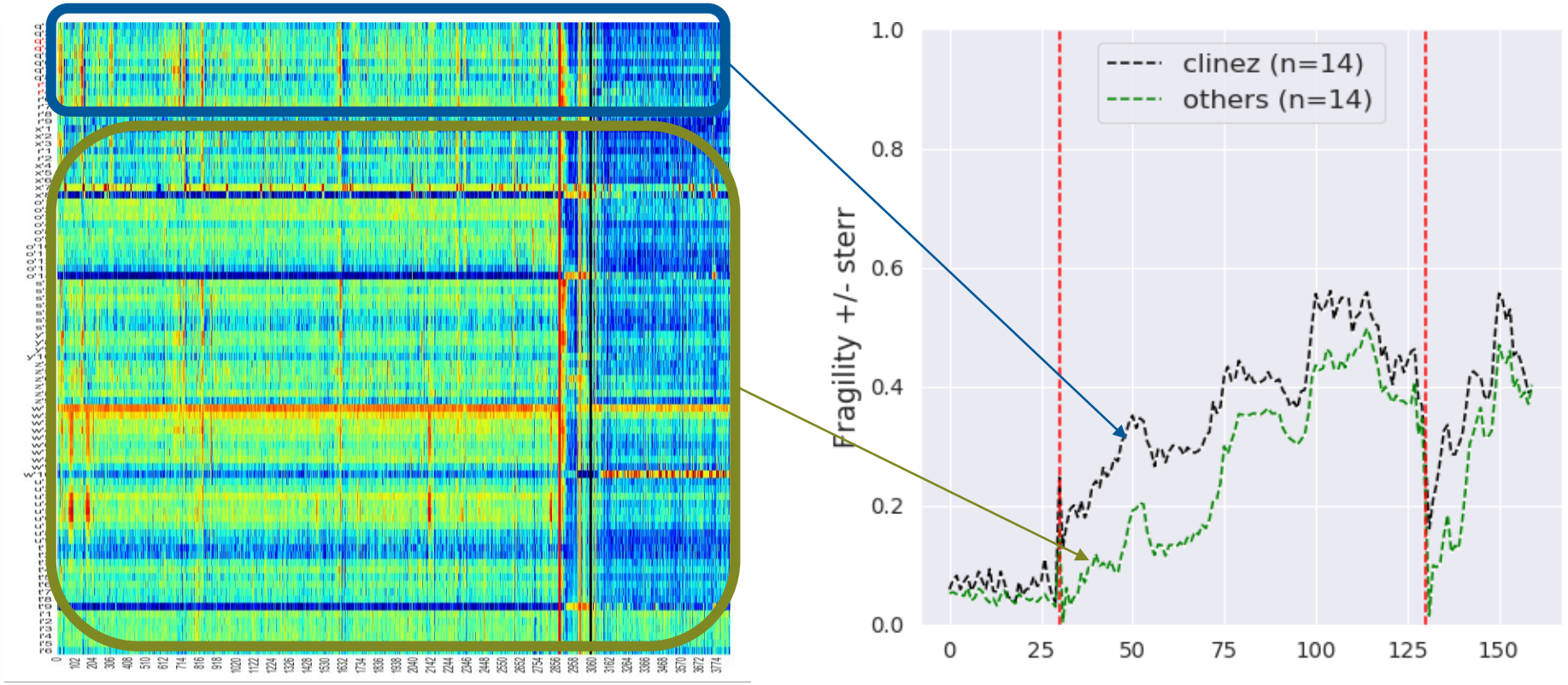
# DOES FRAGILITY TELL US SOMETHING NEW?

Neurologic

# FRAGILITY OF CLINICAL EZ VERSUS REST

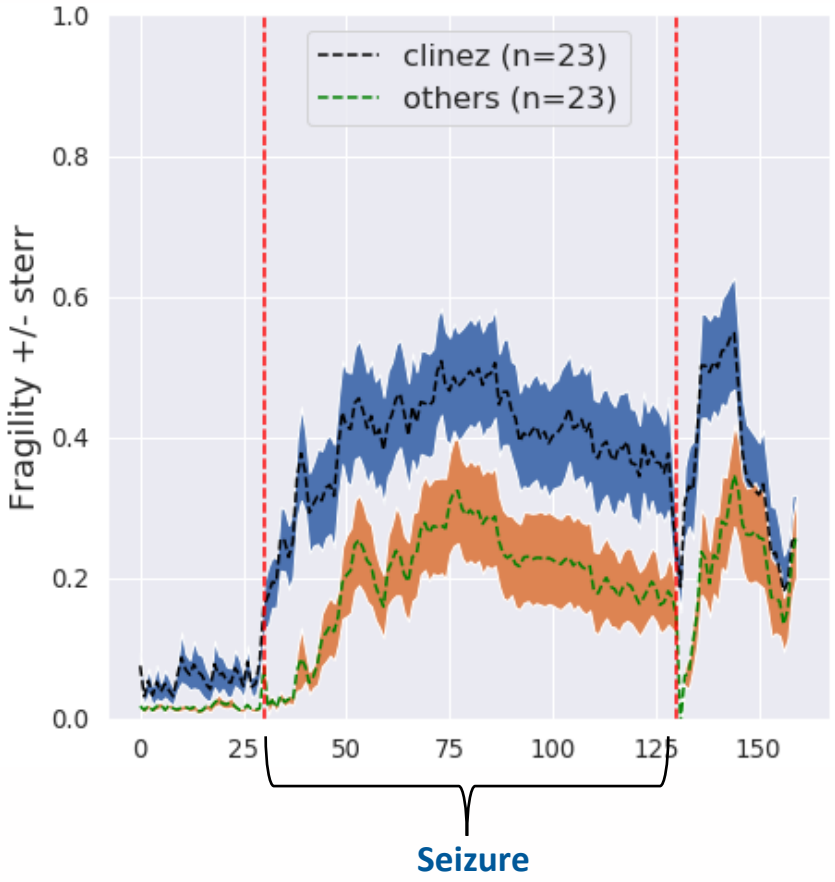
Neurologic

Clinically annotated EZ

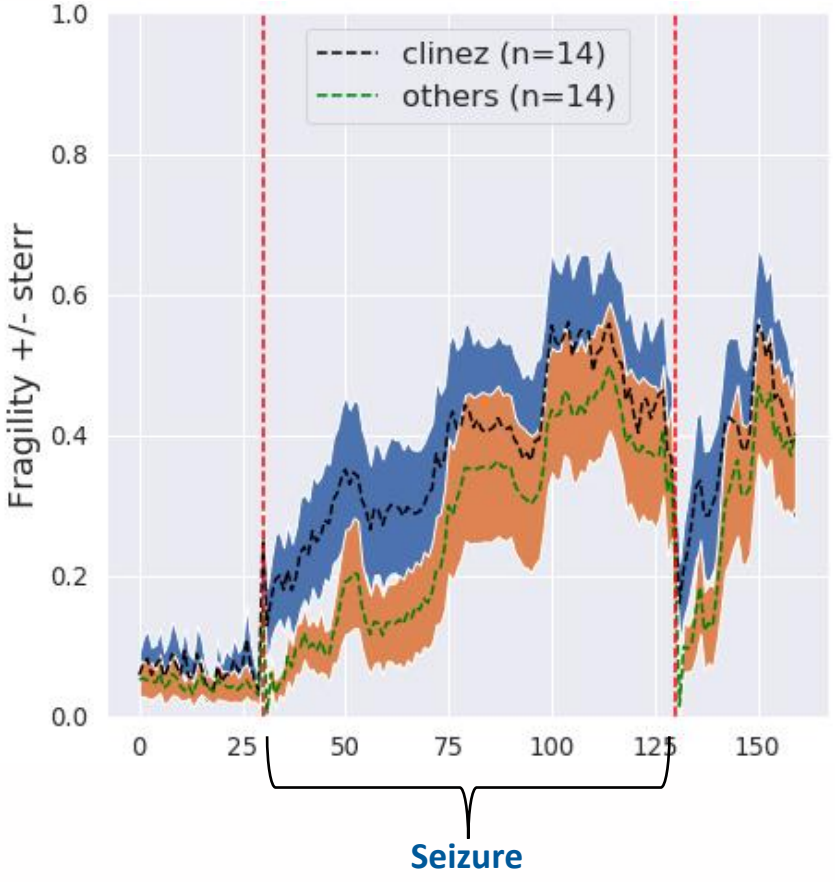


# FRAGILITY OF CLINICAL EZ VERSUS REST

## Success Cases



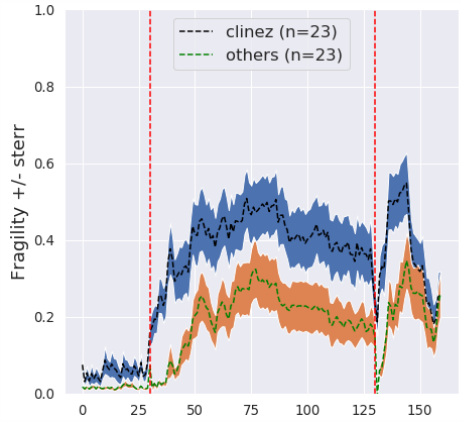

## Failed Cases

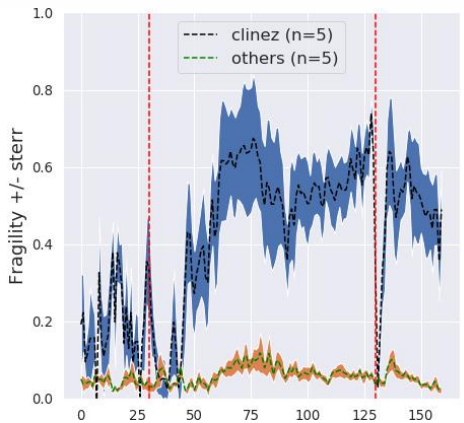


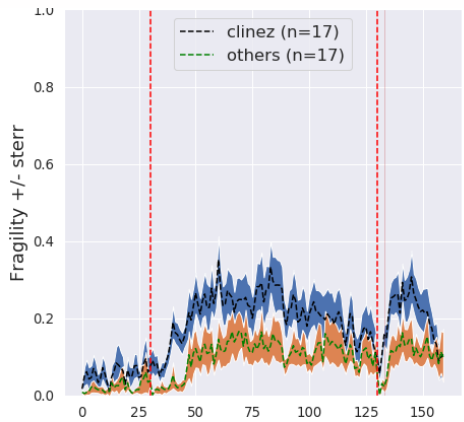
# FRAGILITY OF CLINICAL EZ VERSUS REST

Neurologic

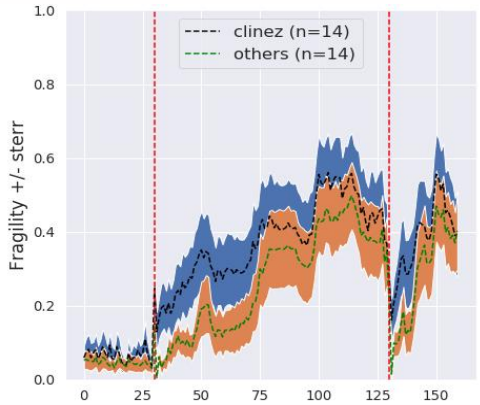
Successes

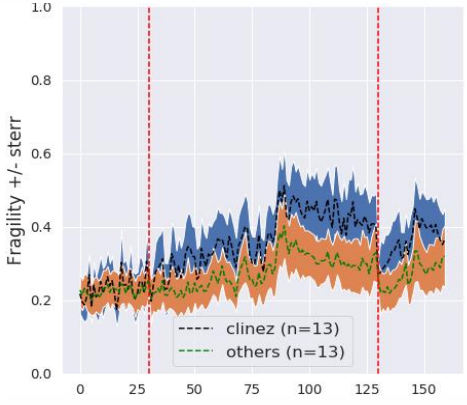


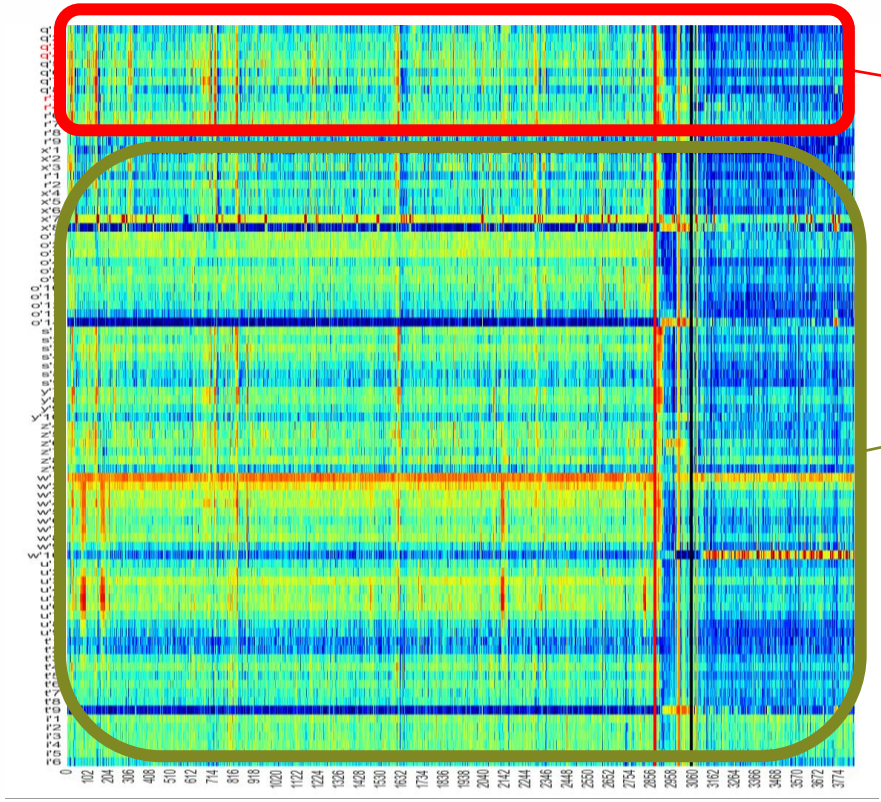

Failures



# FRAGILITY OF CLINICAL EZ VERSUS REST

Neurologic



clinically annotated EZ (CEZ)

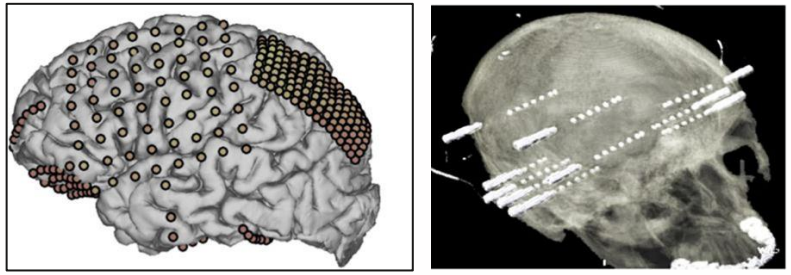
Rest

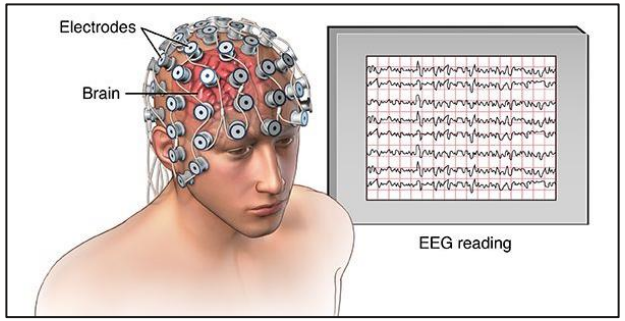
$$FR = \frac{\text{mean fragility of CEZ}}{\text{mean fragility of rest}}$$

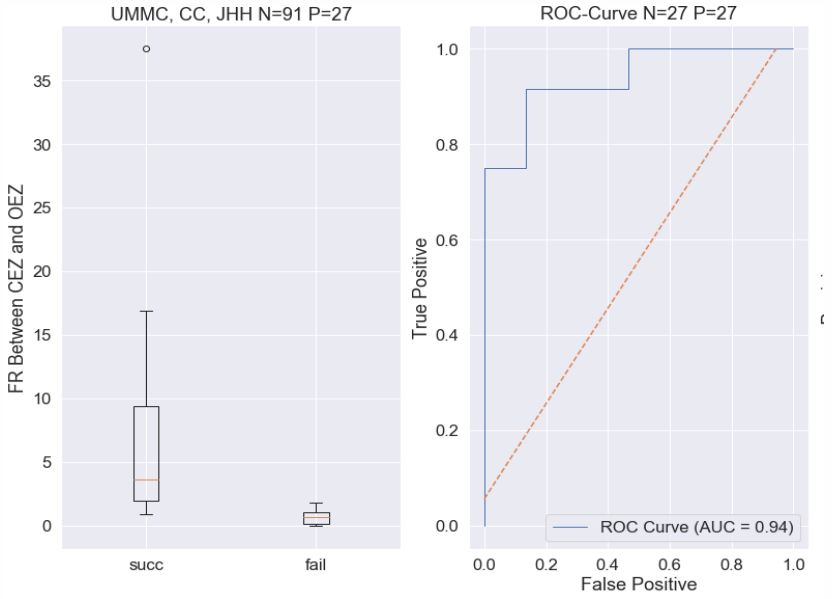
***Hypothesis: Fragility ratio (*FR) is high for successes and low for failures**

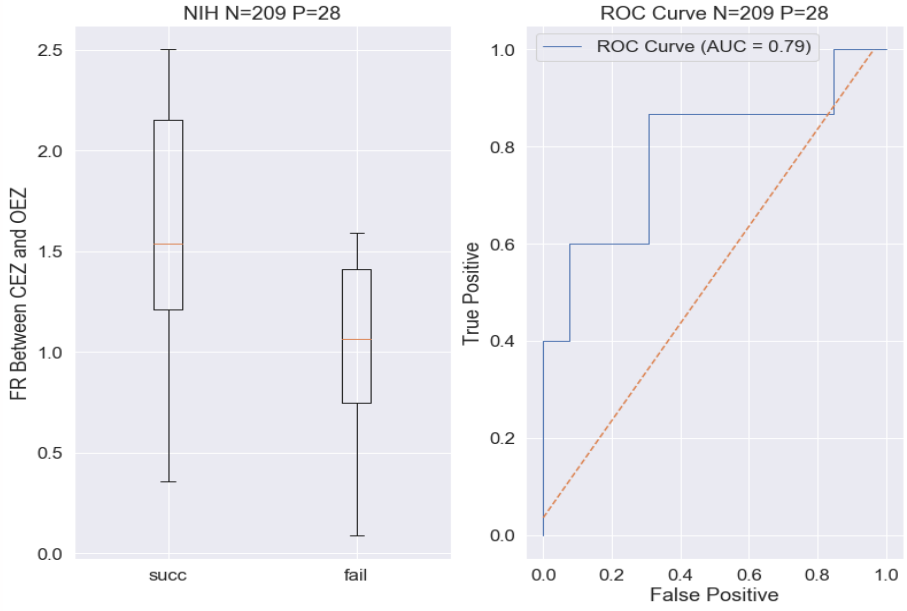
# FRAGILITY RATIO PREDICTS OUTCOMES

Neurologic





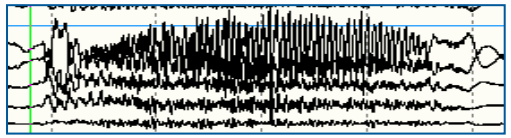



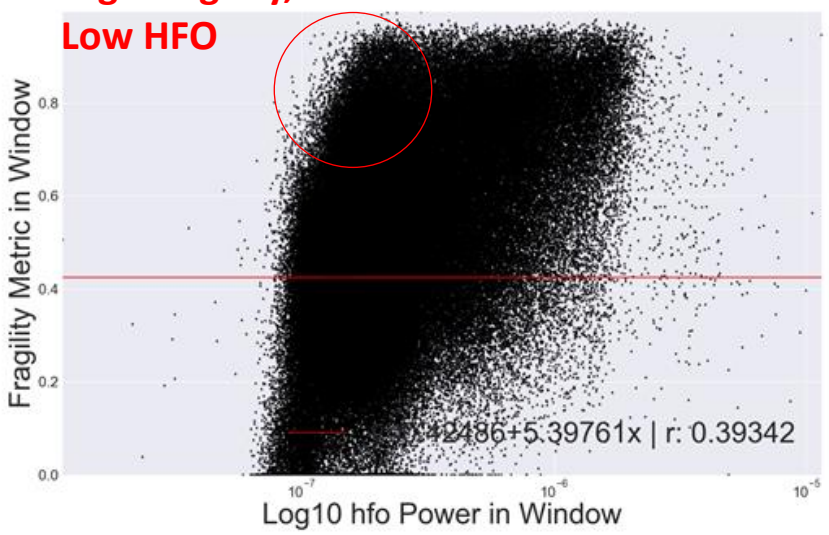



# FRAGILITY IS NOT THE SAME AS CLINICAL EEG SIGNATURES

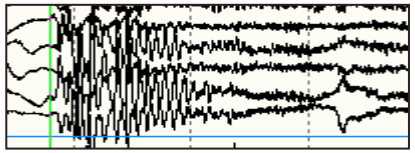
Neurologic

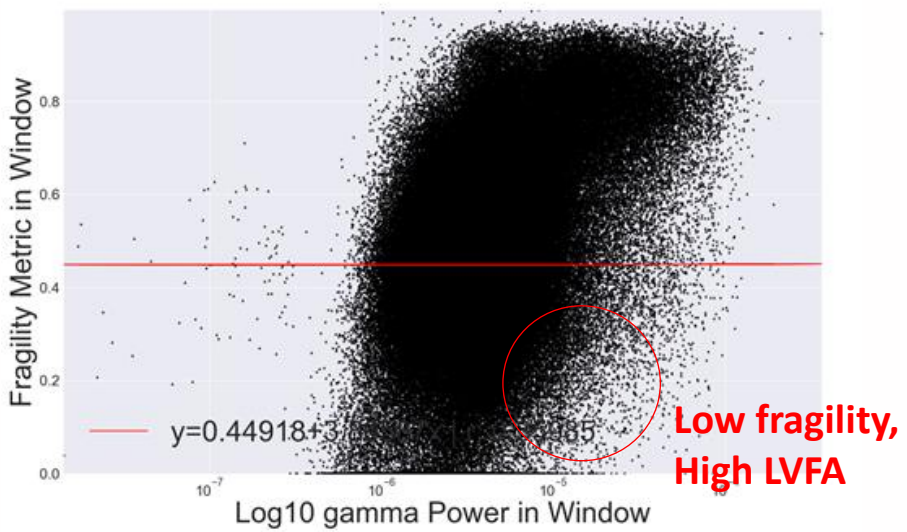
## High Frequency Oscillations (HFOs)






## Low Voltage Fast Activity (LVFA)





# $500+M/YEAR REVENUE OPPORTUNITY (NORTH AMERICA)

Neurologic

| | |
|---|---|
| 5 | **# of clinics that treat 80% of all epilepsy patients** (Cleveland Clinic, Jefferson Hospital, Massachusetts General, Mayo Clinic, Emory Hospital) |
| 170,000 | **# scans per year for all 5 clinics (scalp and invasive)** |
| $3,500 | **estimated price per EZTrack scan (similar to MRI pricing model)** |
| $500+M | **Annual revenue opportunity**<br>**SaaS based model** |

# RAISING $200K FOR NEXT MILESTONES

Neurologic

## GET FDA 510K APPROVAL

- Required to perform prospective trails at Jefferson Hospital,
  Cleveland Clinic

## PRODUCTIZE THE SOLUTION

- Productize user interface
- Integrate into the clinical workflow

## BUSINESS DEVELOPMENT

- Develop collateral
- Approach next set of potential customers - Massachusetts General, Mayo Clinic, Emory Hospital

# TEAM NEUROLOGIC

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| | |
|---|---|
| **Sridevi Sarma, PhD**<br>President & Cofounder | • Electrical Engineer (MIT)<br>• Associate Professor, Biomedical Engr (JHU)<br>• Complex Systems, Data Science, Neuroscience |
| **Jorge Gonzalez-Martinez, MD PhD**<br>Cofounder & Domain Expert | • Epilepsy Surgery (world leader)<br>• Neuroscience (University of São Paulo) |
| **Adam Li**<br>Cofounder & Acting CTO | • Biomedical Engineer (JHU)<br>• Bioinformatics |
| **Bobby Norton**<br>Product Manager | • Computer Science<br>• Tested Minds - Co-Founder and Principal Consultant |
| **John Gale, PhD**<br>Advisor | • Biology, PhD (Kent State)<br>• Electrophysiology, Neuromedical devices |

# Technology

# Observation: seizure occurs in an *unstable* network

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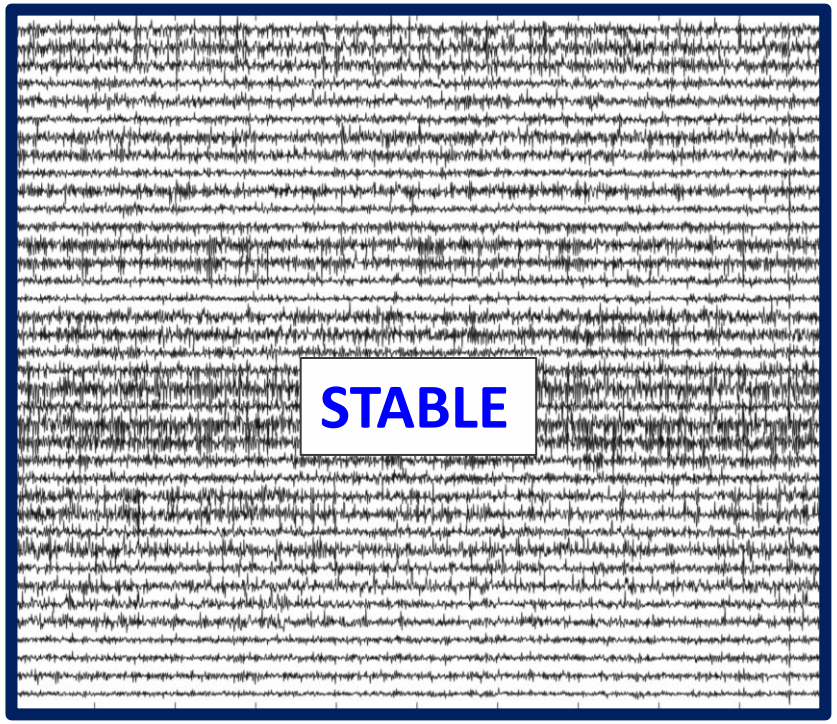
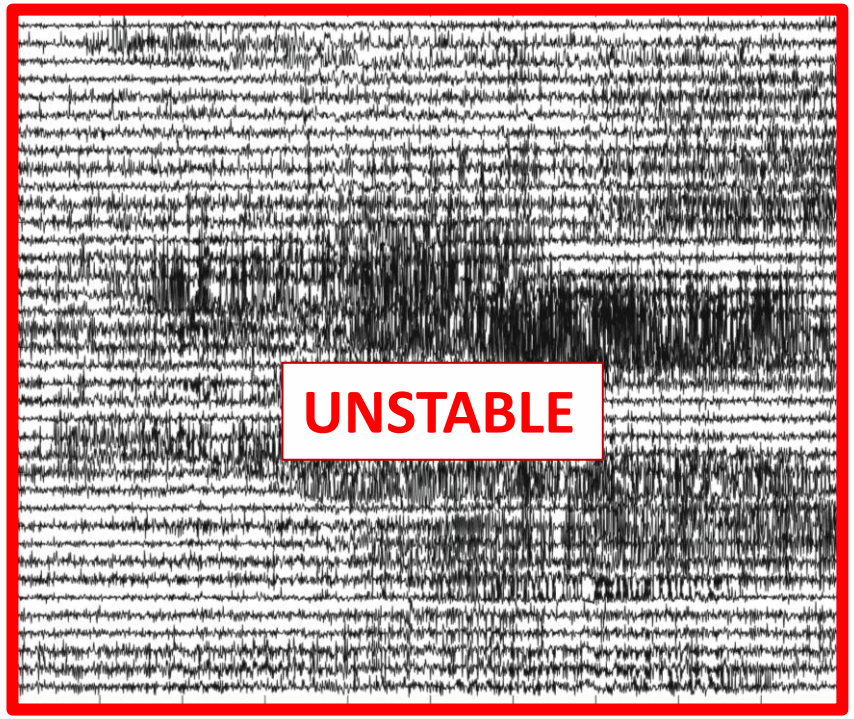
**Non-Seizure**




**Seizure**



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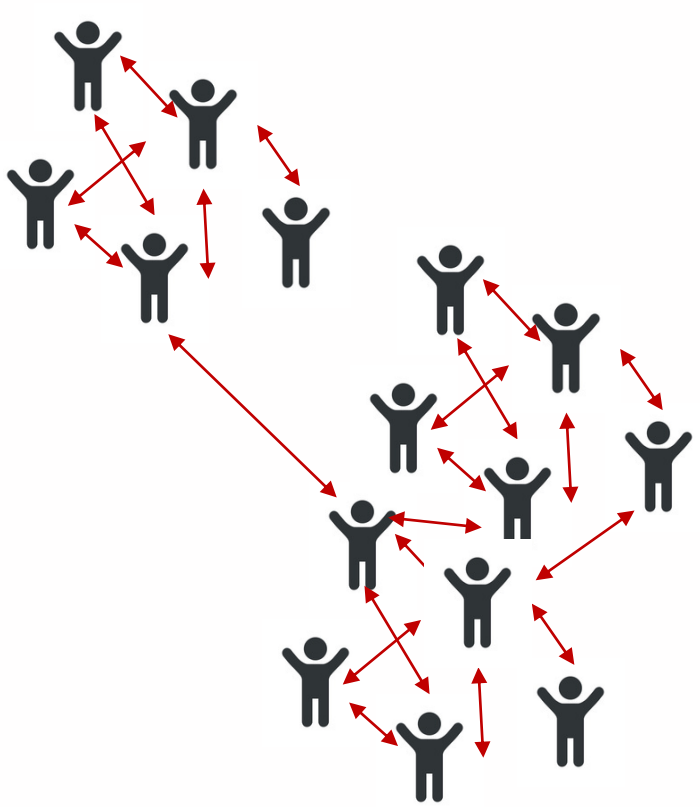
Node 1



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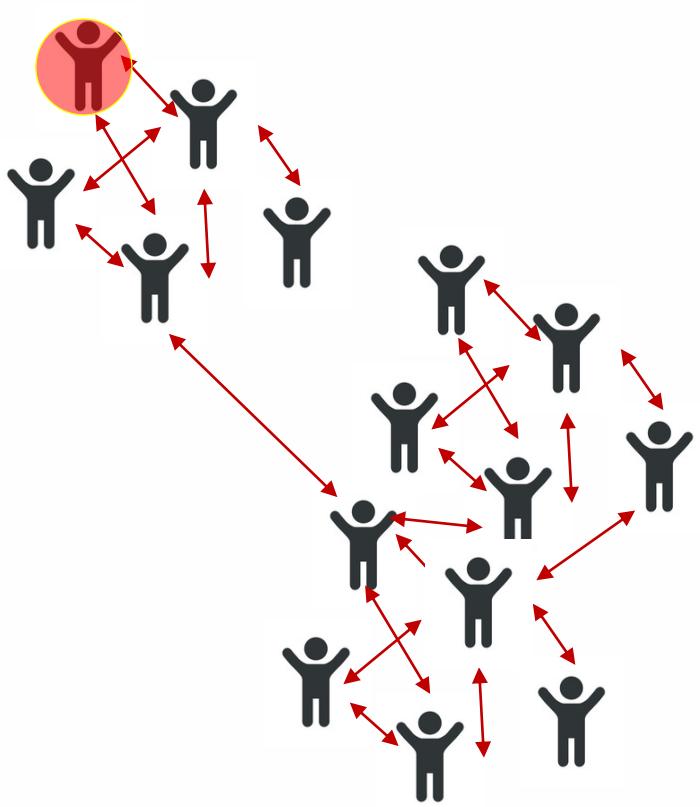
Node 1



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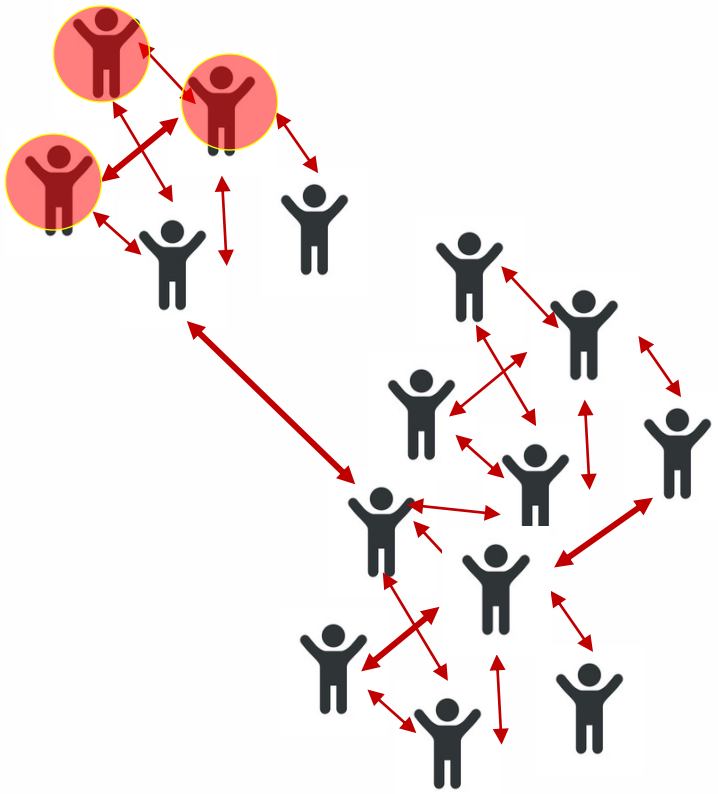
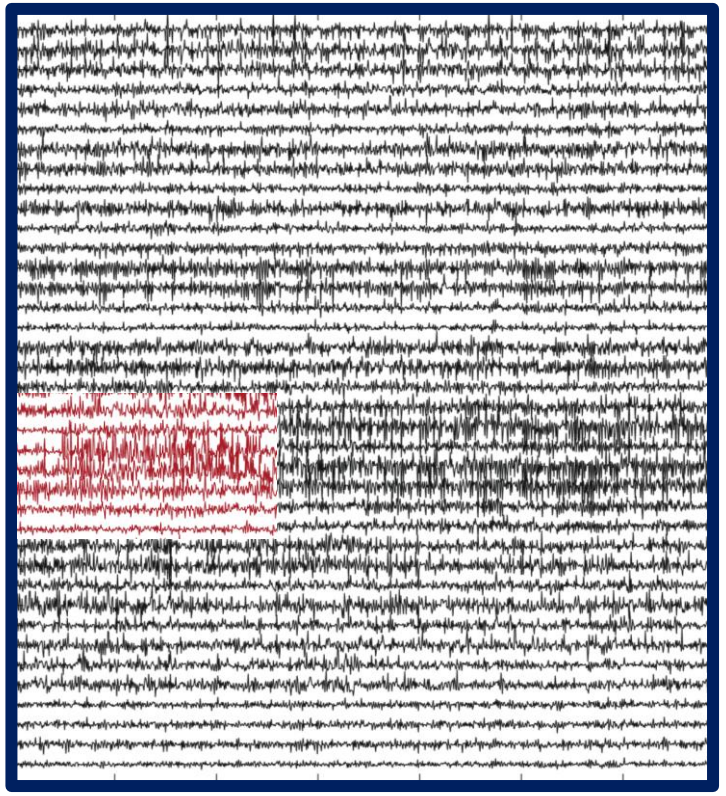
Node 1





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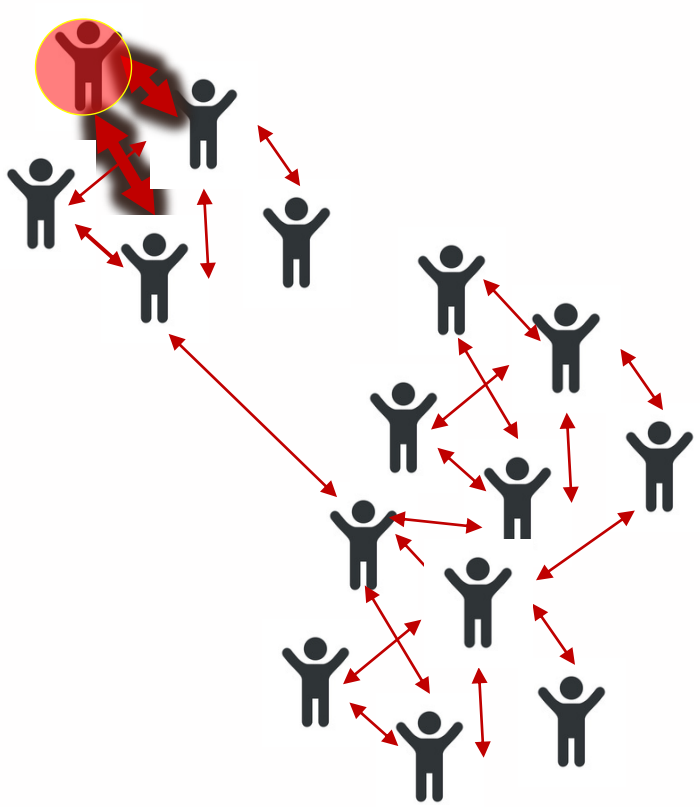
Node 1



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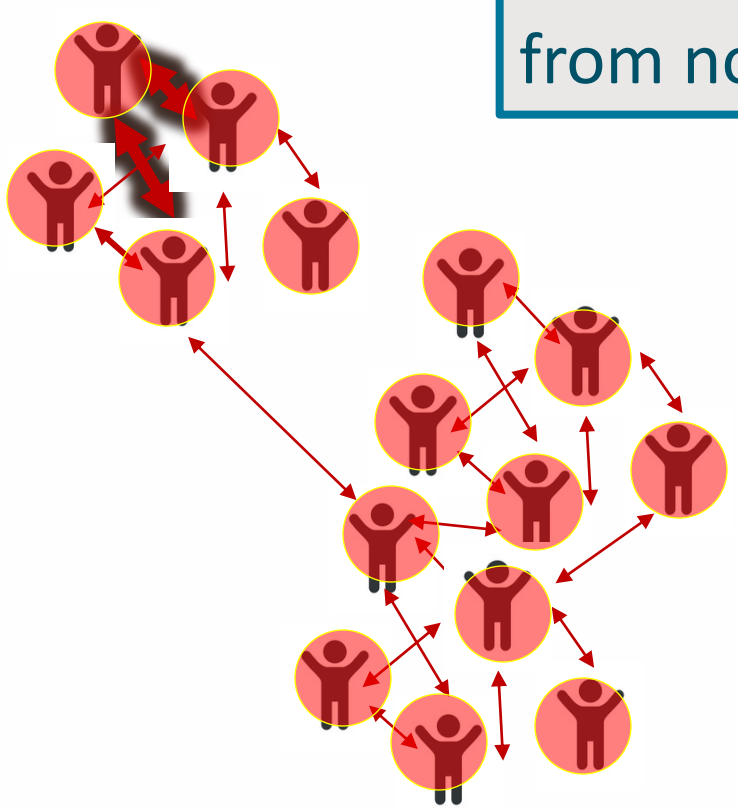
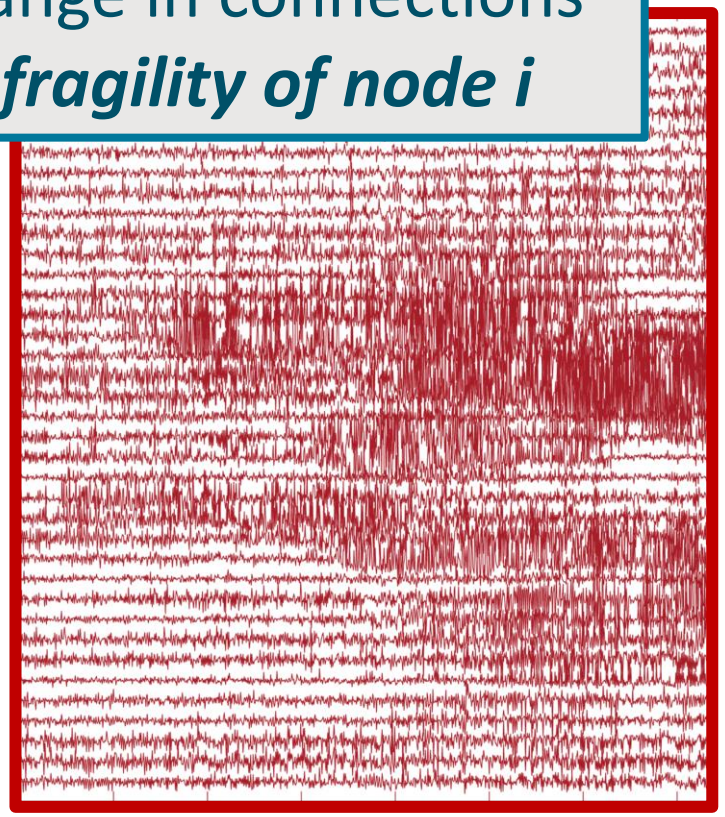
Node 1



amount of change in connections from node i = ***fragility of node i***



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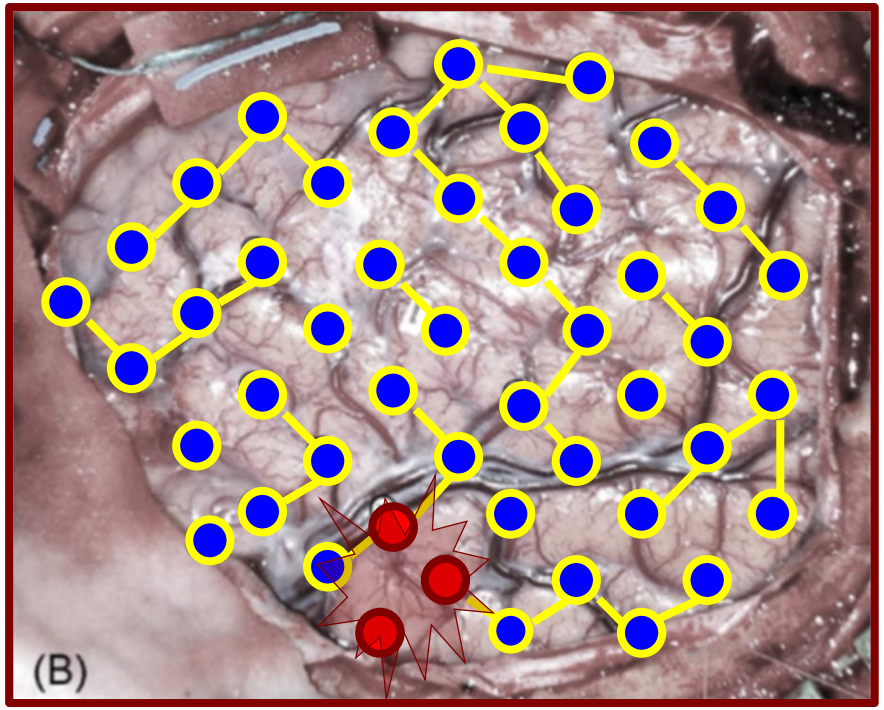
The most *fragile* nodes in the epileptic network correspond to the epileptogenic zone.



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Thank You