

Presurgical evaluation of epilepsy

Inspired by the teachings of Kanjana Unnwongse, MD.

Goal of Presurgical evaluation

- To identify the epileptogenic zone, *the area of cortex indispensable for the generation of clinical seizures.*

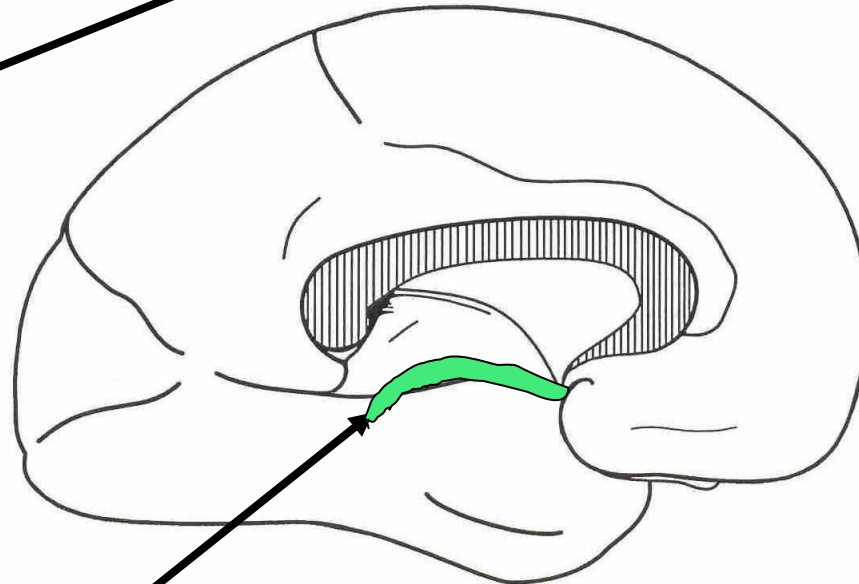
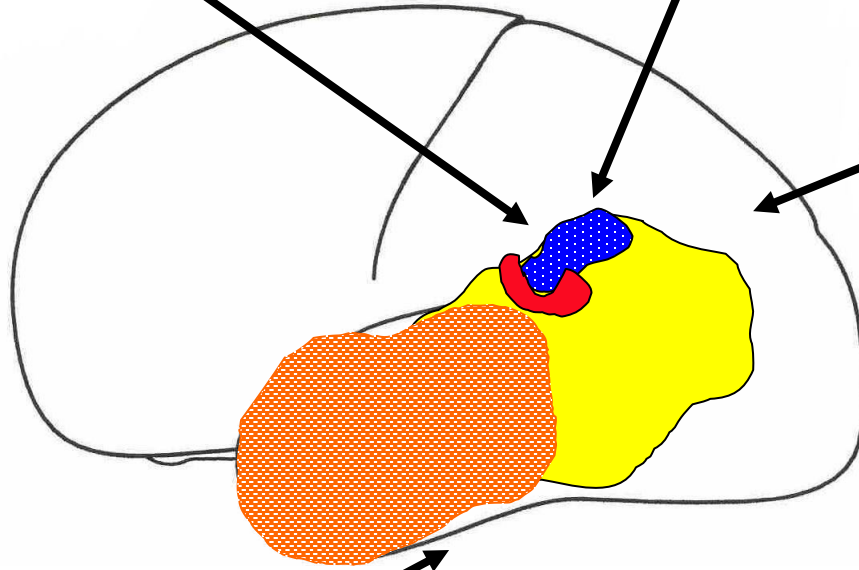


Five Cortical Zones

1. Ictal onset zone defined by **Ictal EEG & ictal SPECT.**

4. Epileptogenic lesion defined by **MRI.**

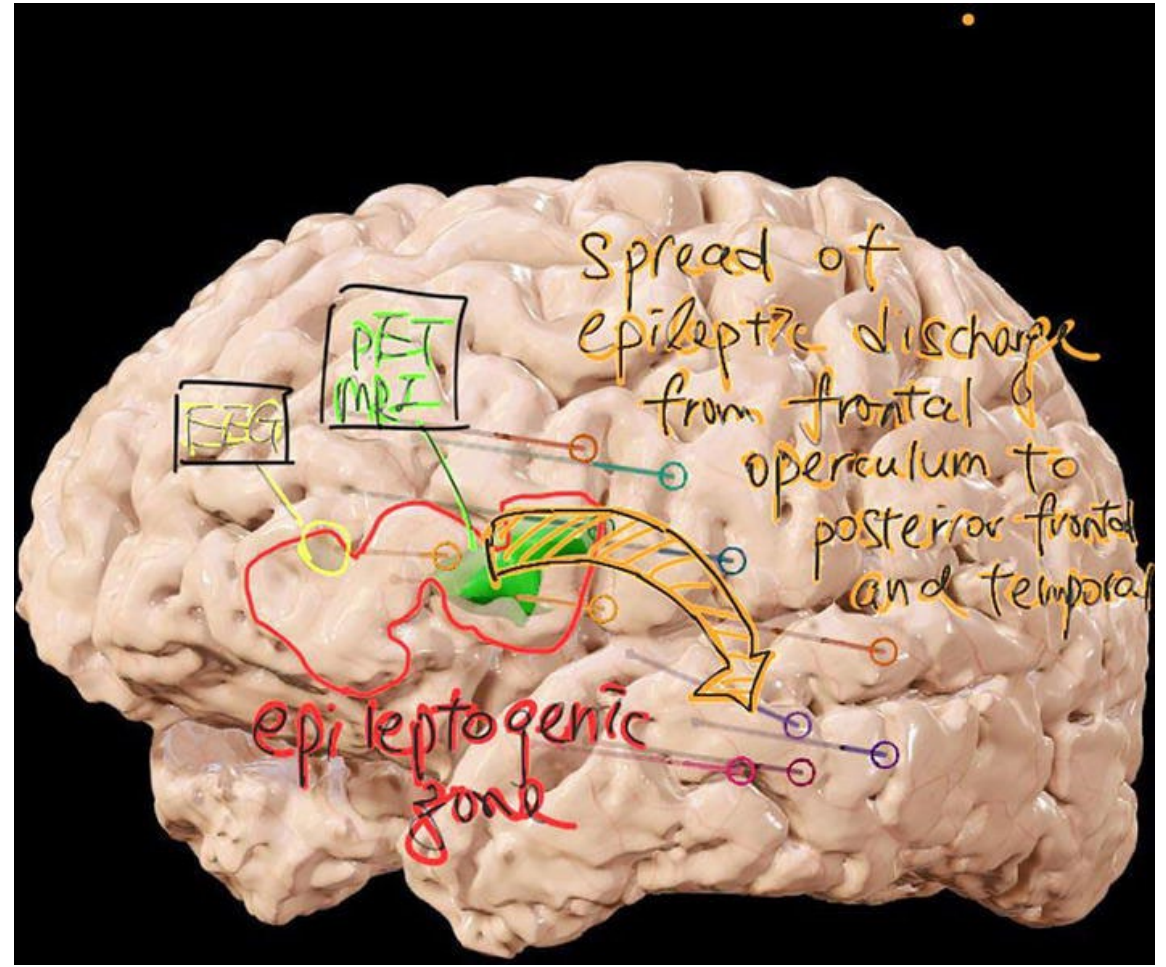
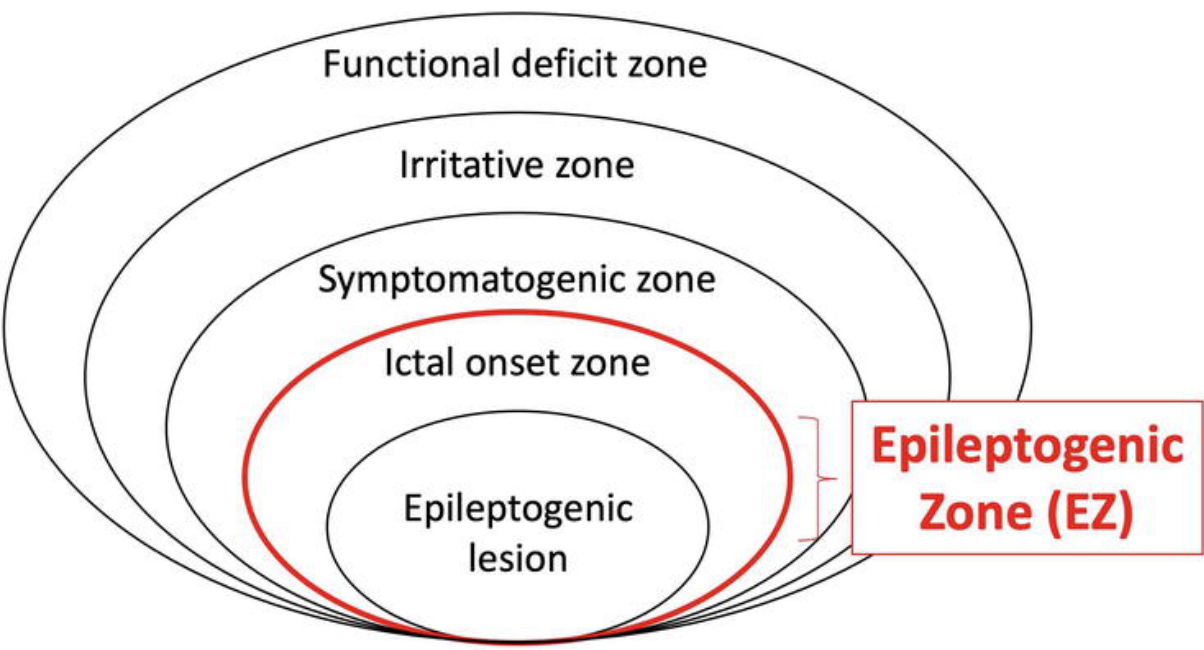
5. Functional deficit zone defined by **Neuro-psy examination, WADA & PET scan.**



2. Irritative zone defined by **Interictal EEG & MEG.**

3. Symptomotogenic zone defined by **Seizure semiology.**

Figure from Foldvary N AES 2009.



History

Seizures

EEG

Neuropsych

Imaging

VideoEEG

Hypothesis

Surg. Plan.

Conclusion

Case Scenario I

- A man, 23 years old.
- Dominant: right Handed
- Education: bachelor degree in engineering
- Occupation: Engineer
- Hometown: Pathumthani



History

Seizures

EEG

Neurology

Imaging

VideoEEG

Hypothesis

Surg. Plan.

Conclusion

Case Scenario I

- Seizure onset
 - At the age of 9 years old
- Aura
 - Feeling a seizure coming on.
- Semiology
 - head turn to the left

History

Seizures

EEG

Neuropsych

Imaging

VideoEEG

Hypothesis

Surg. Plan.

Conclusion

Case Scenario I

- He lost his awareness while he was walking at age of 38 years old. He did not recognize the place he was there at that time. He did not go to the hospital.
- At the age of 43, he lost his awareness again. His cousin noticed he had confusion and both hands picking movements.

Case Scenario I

History

Seizures

EEG

Neuropsych

Imaging

VideoEEG

Hypothesis

SEEG

Surg. Plan.

Conclusion

- 23 years old man, got bachelor degree in engineering. Seizure onset at age of 9 began with a body stiffening, occurring out of sleep. No recalled provoke factors.
- Seizures recurred again 3 times before he was put on AEDs. Current semiology consists of vertiginous aura followed stiffening of legs and arms, and head turning to the left. They usually happened early in the morning with frequency of 2-3 per month

Anti-epileptic Drugs

History

Seizures

EEG

Neurology

Imaging

VideoEEG

Hypothesis

SEEG

Surg. Plan.

Conclusion

Current AEDs

- Carbamazepine 1600 mg/day
- Levetiracetam 3000 mg/day
- Topiramate 400 mg/day
- Lamictal 200 mg/day

Past Medication

- Sodium Valproate (ineffective)

The symptomatogenic zone

The area of **cortex** which, when **activated by an epileptiform discharge**, produces the **ictal symptoms**. It is defined by careful analysis of the ictal symptomatology, with either a thorough seizure history or an analysis of ictal video recordings

PMC Panel

- Aura
- Feeling a seizure coming on.

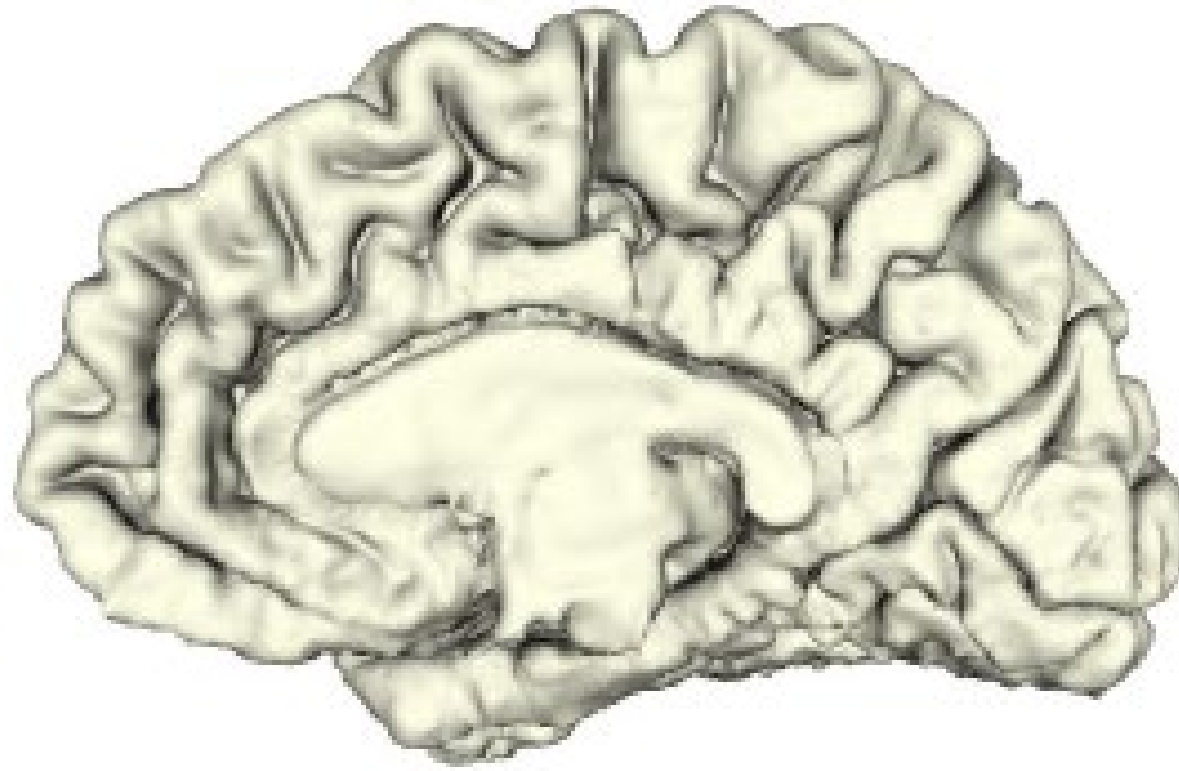
- Semiology

Complexed motor seizure → left head versive seizure

Symptomatogenic zone defined by
Seizure semiology.



Five Cortical Zones



Adapt Figure from Foldvary N AES 2009.

Interictal EEG

- Sharp wave, Regional ,right fronto-temporal max FT10 (100%)
- Intermittent slow, Regional, left fronto-temporal area

History

Seizures

EEG

Neuropsych

Imaging

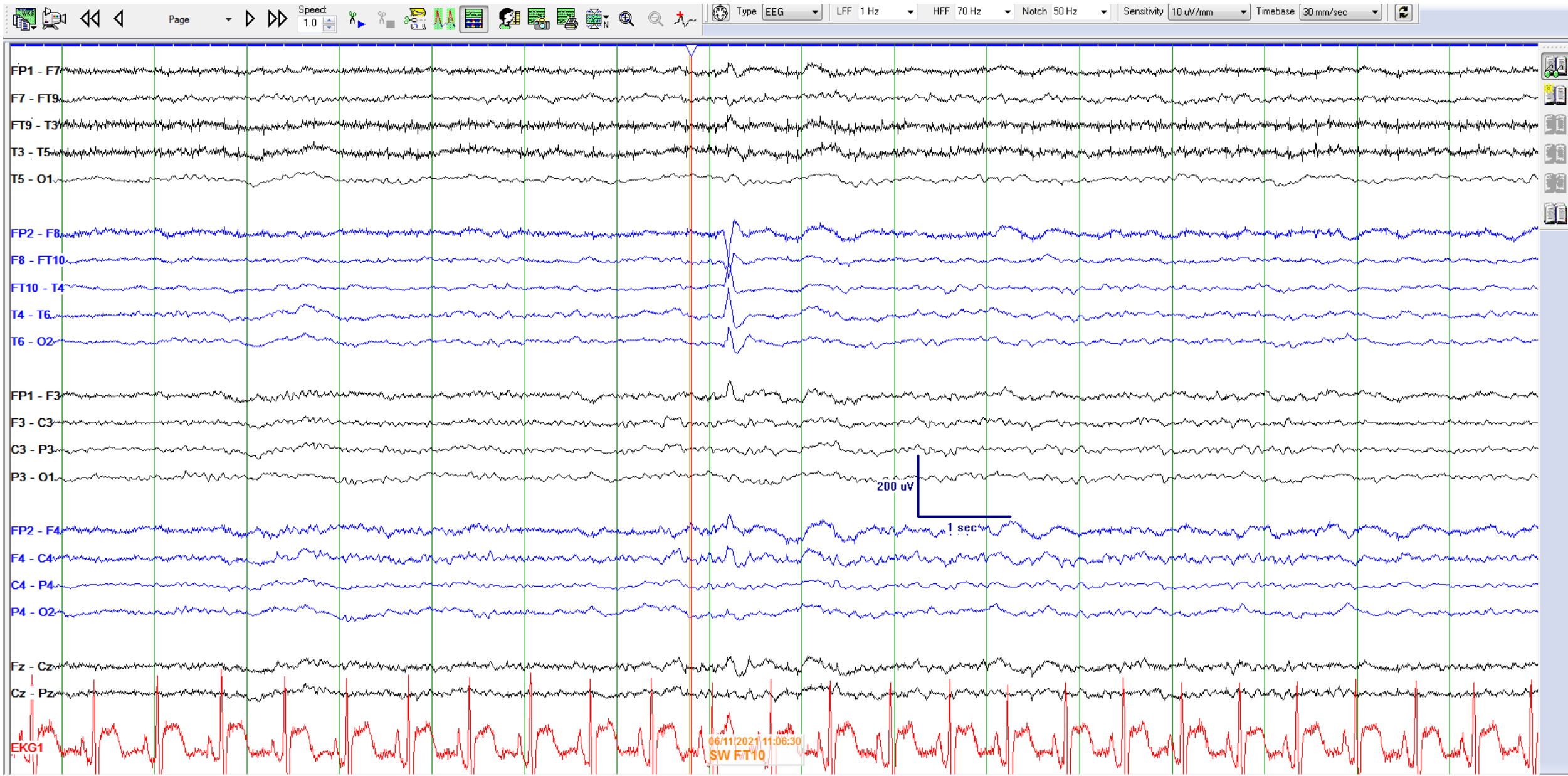
VideoEEG

Hypothesis

Surg. Plan.

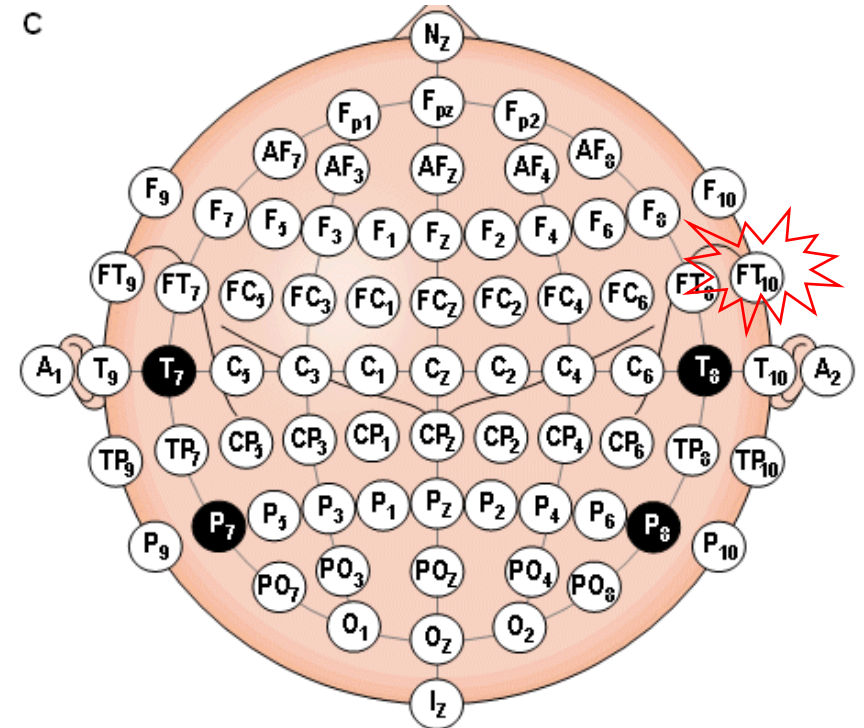
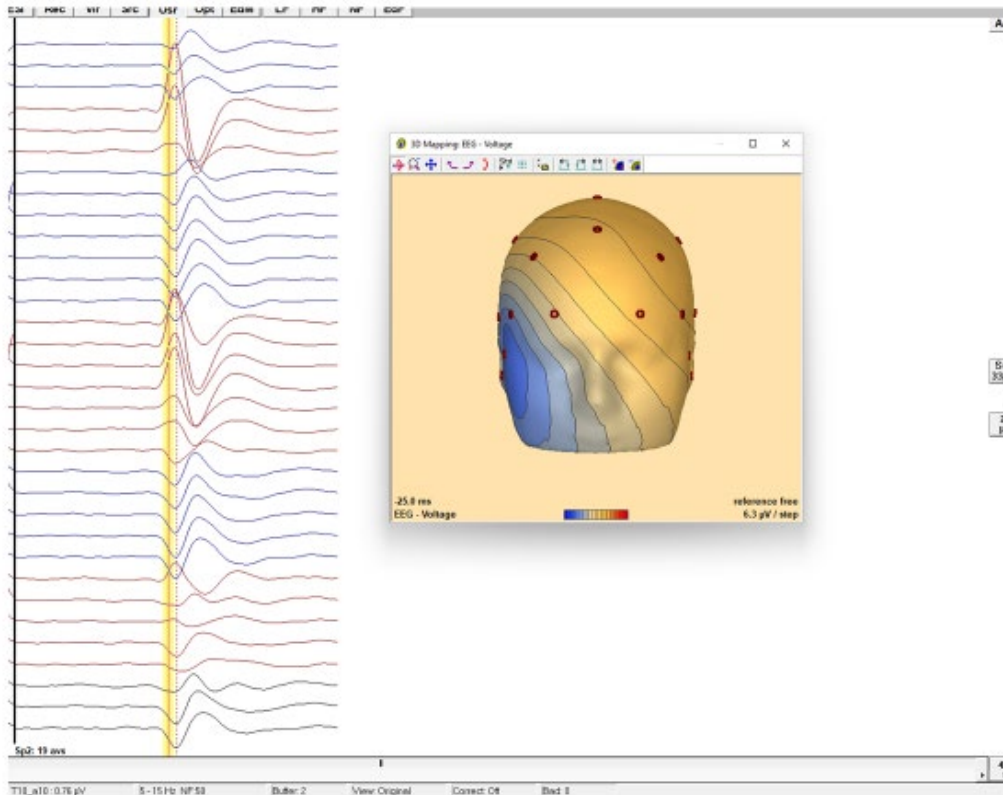
Conclusion

Inter-Ictal EEG

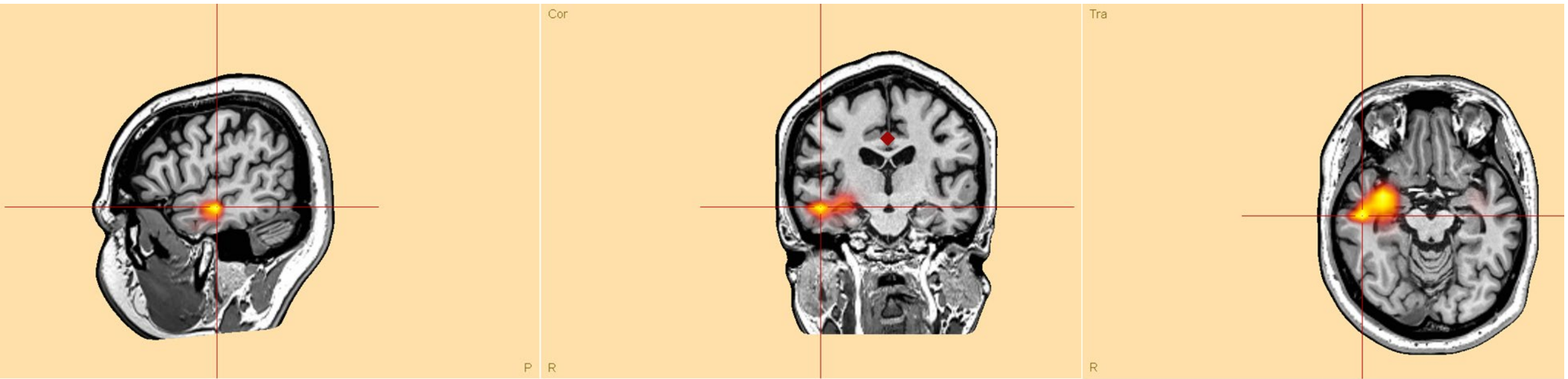


Interictal EEG

- Sharp wave, regional right fronto-temporal (100%) FT10
- Intermittent slow, regional right fronto-temporal



Interictal source localization



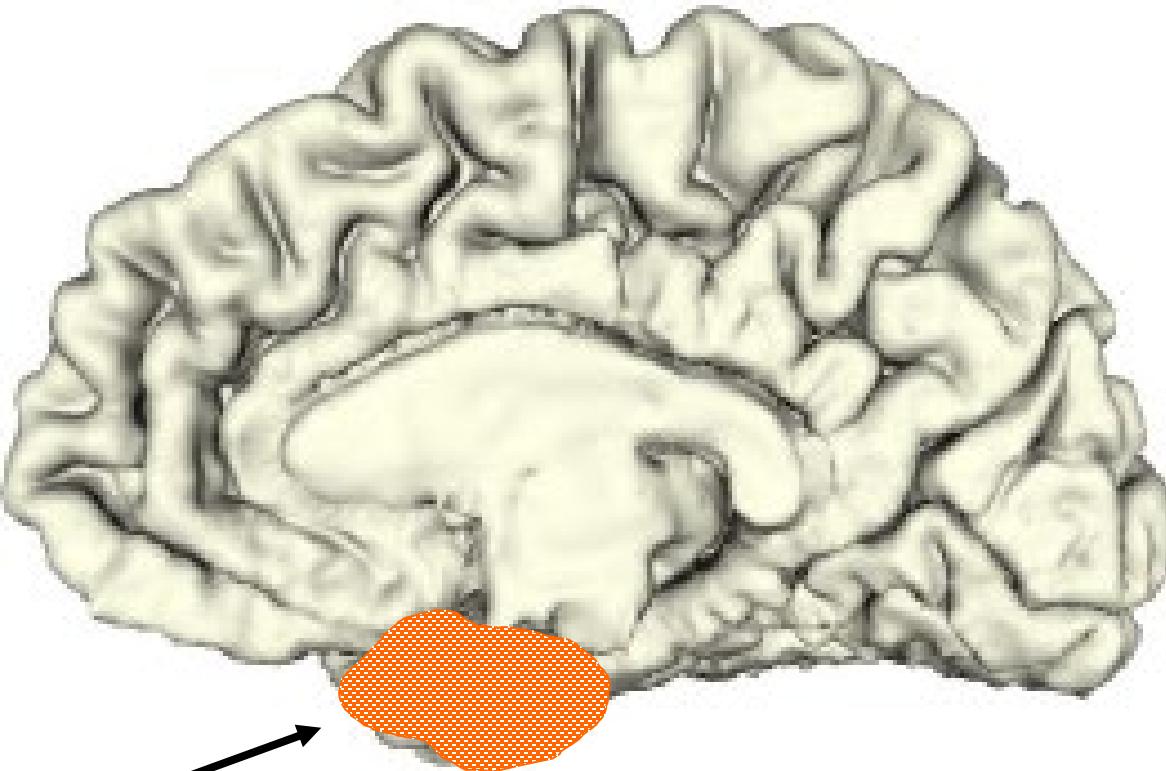
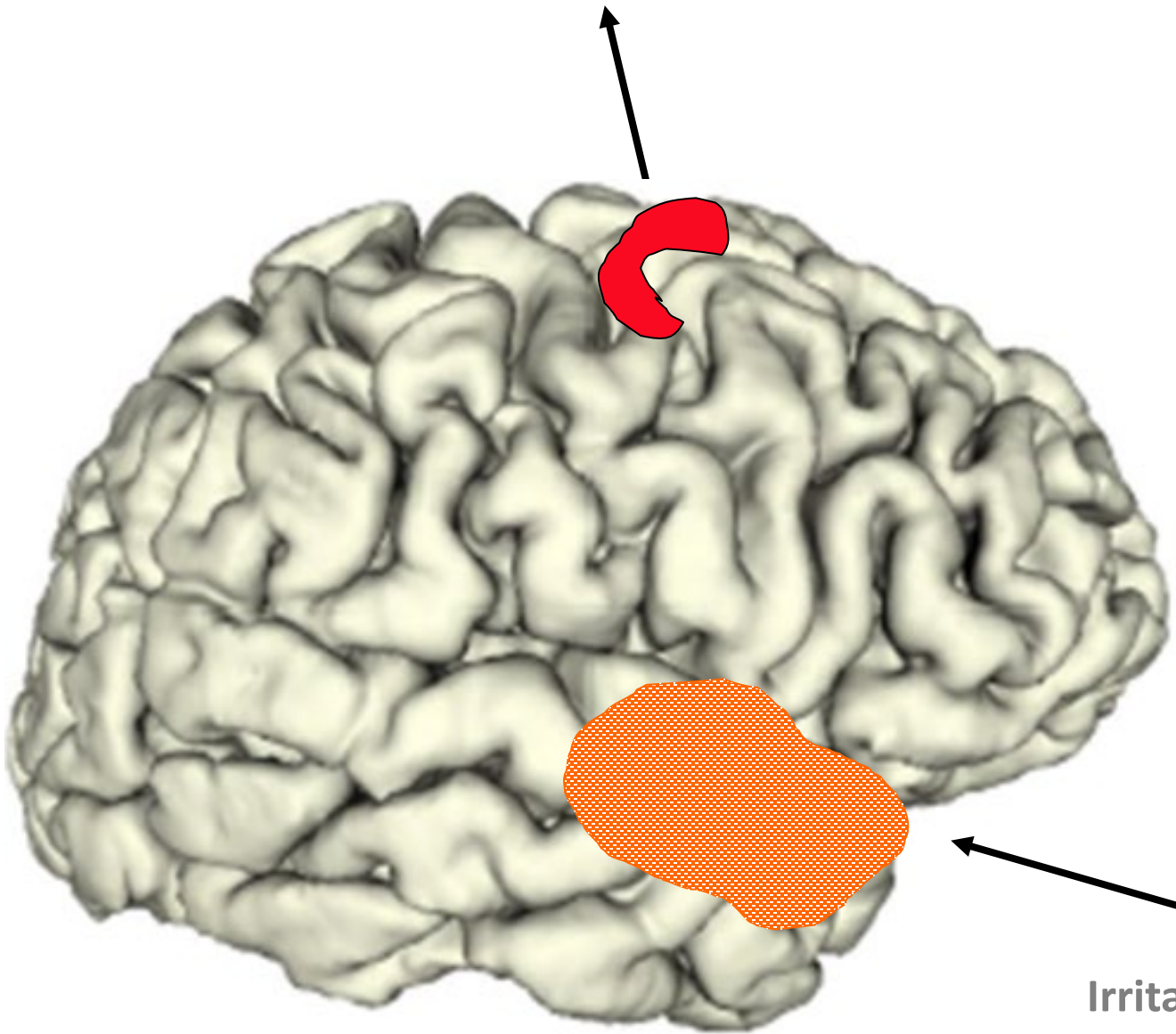
The irritative zone

- The area of cortical tissue that generates interictal electrographic spikes. The irritative zone is measured by EEG (scalp or invasive), magnetoencephalography (MEG) or functional MRI (fMRI) triggered by interictal spikes. These can be considered as 'miniseizures'

The irritative zone ≠ The Ictal Onset Zone

Five Cortical Zones

Symptomatogenic zone defined by Seizure semiology.



Irritative zone defined by Interictal EEG & MEG.



Classification

Video EEG monitoring

(8-12 February 2016)

Clinical seizure : Complex motor seizure → left head versive turning

→ generalized tonic-clonic seizures (3 seizures)

• **Lateralization**: Left face tonic

• **EEG seizure** : Regional right fronto-temporal MAX FT10

History

Seizures

EEG

Neurology

Imaging

VideoEEG

Hypothesis

Surg. Plan.

Conclusion

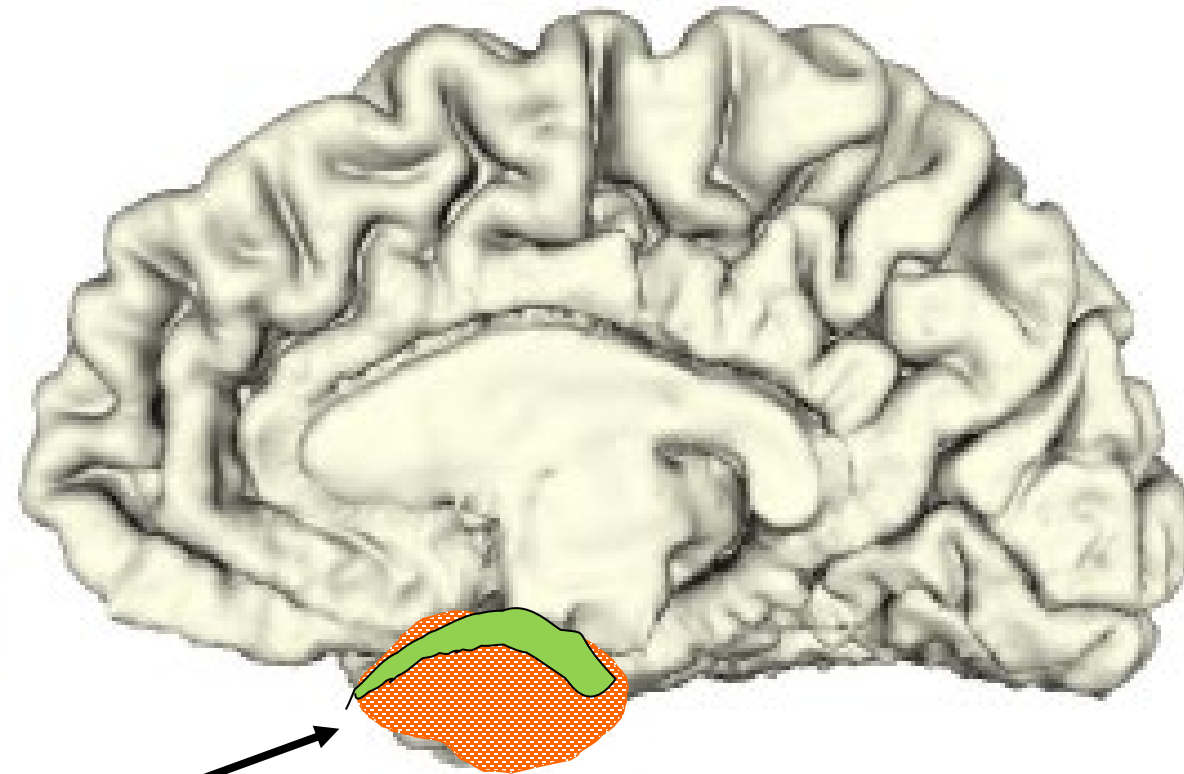
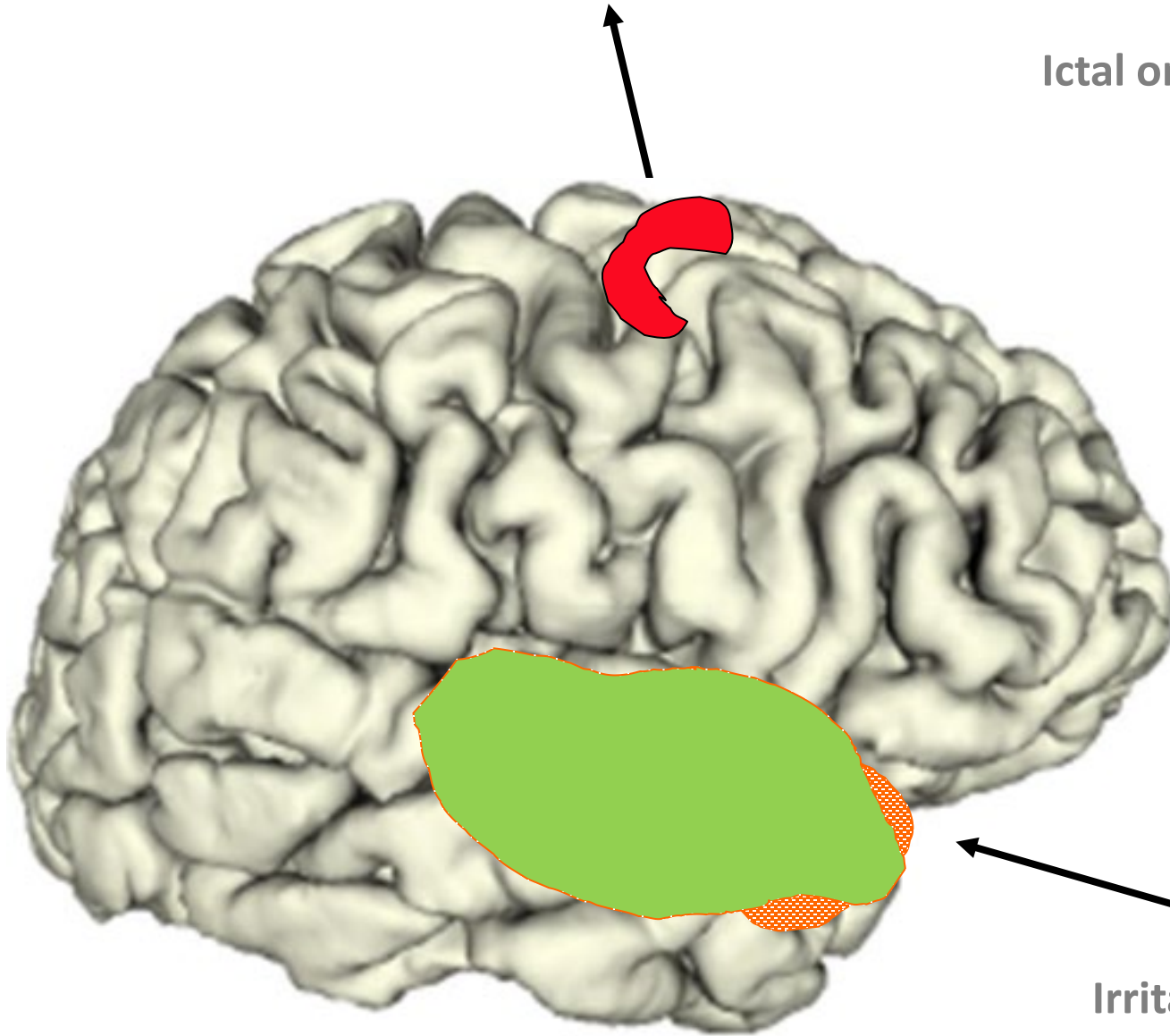
The seizure onset zone

- the area of the cortex from which clinical seizures are (actually) generated,
- The seizure onset zone is most commonly localized by either scalp or invasive EEG techniques
- the location of the seizure onset zone can also be determined by ictal single photon emission computed tomography (SPECT)

Five Cortical Zones

Symptomatogenic zone defined by
Seizure semiology.

Ictal onset zone defined by Ictal EEG



Irritative zone defined by
Inter-ictal EEG & MEG.

MRI 3T Result

History

Seizures

EEG

Neuropsy

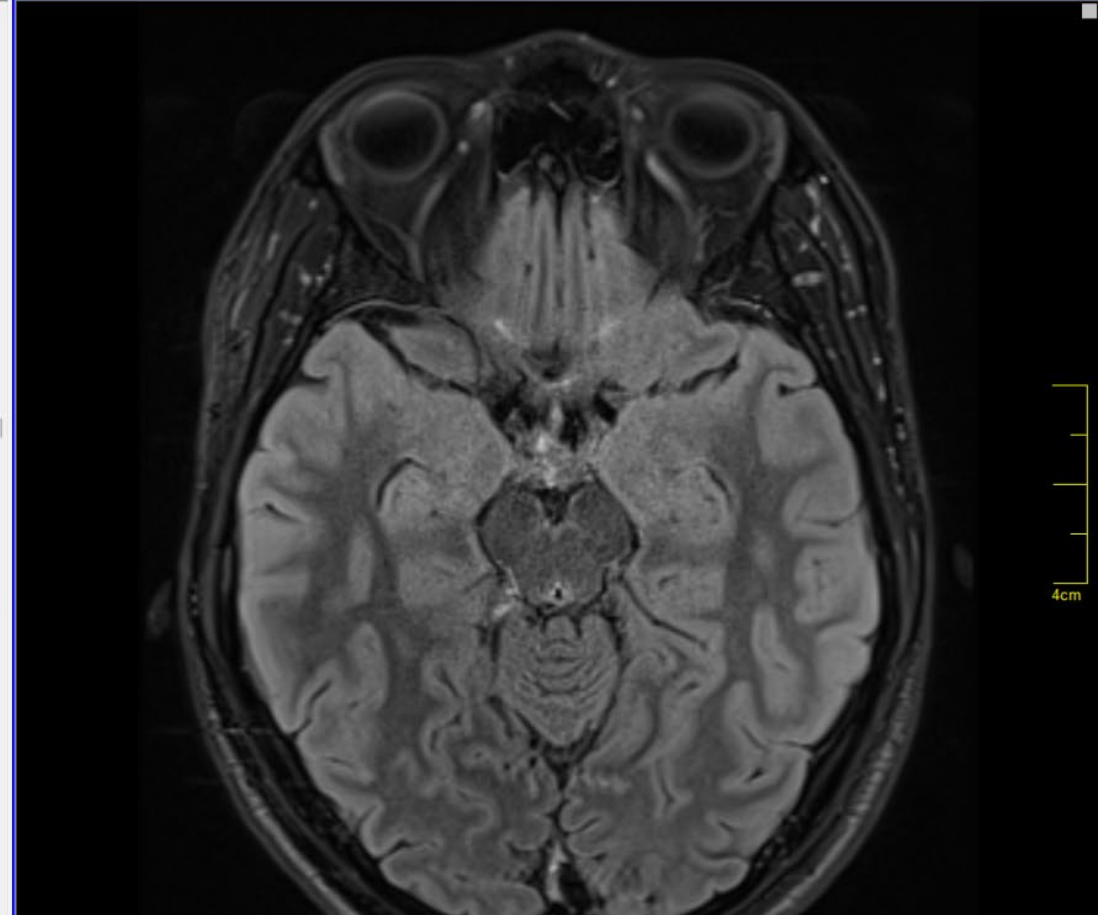
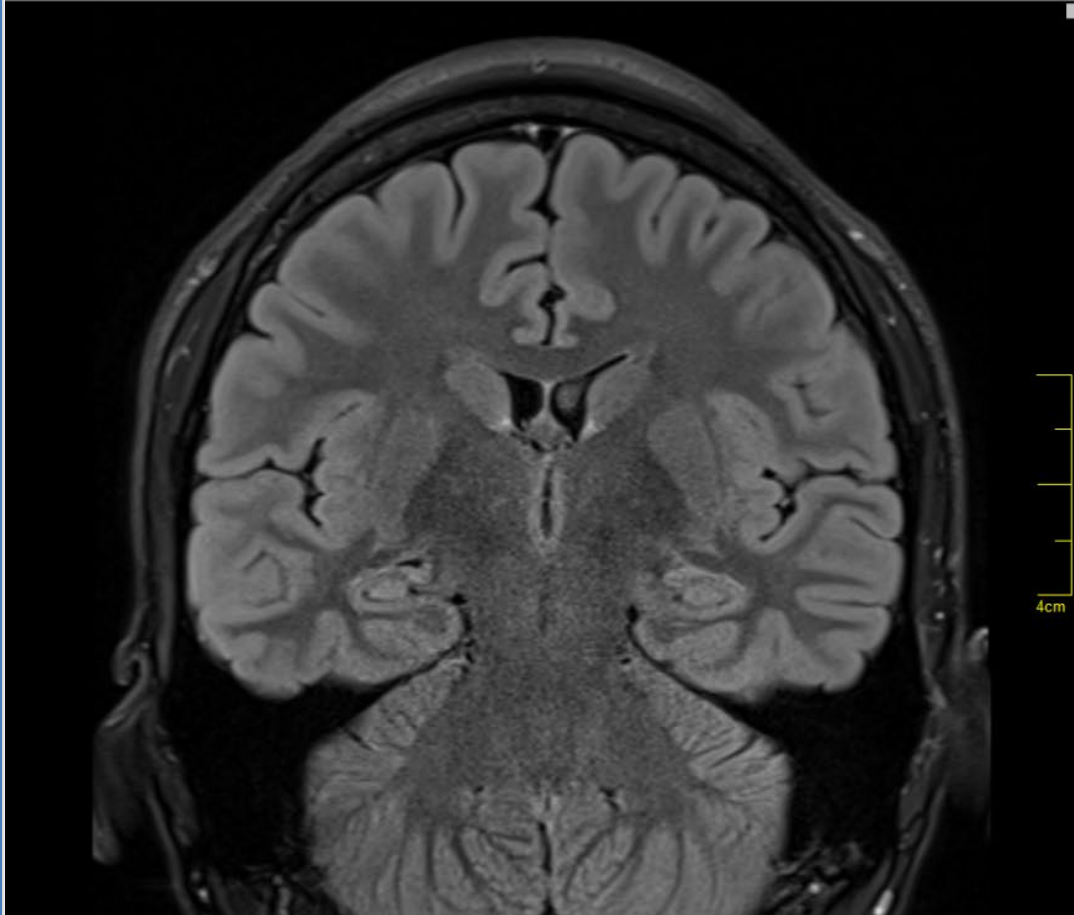
Imaging

VideoEEG

Hypothesis

Surg. Plan.

Conclusion



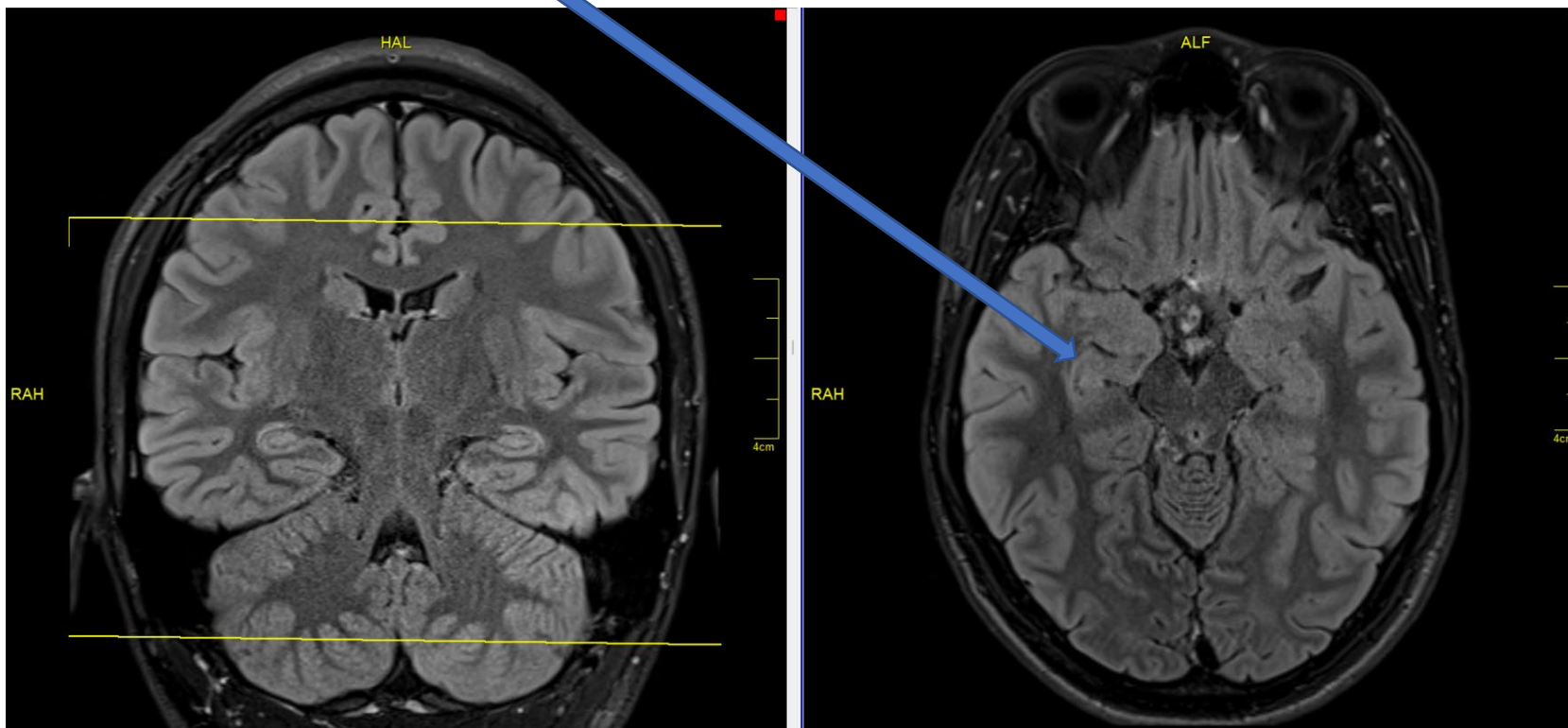
MRI 3T Result

- **MRI T3**

November 2015

Suspected right hippocampal sclerosis

PMC results: widening of right choroidal fissure, smaller right hippocampus without signal change



History

Seizures

EEG

Neuropsych

Imaging

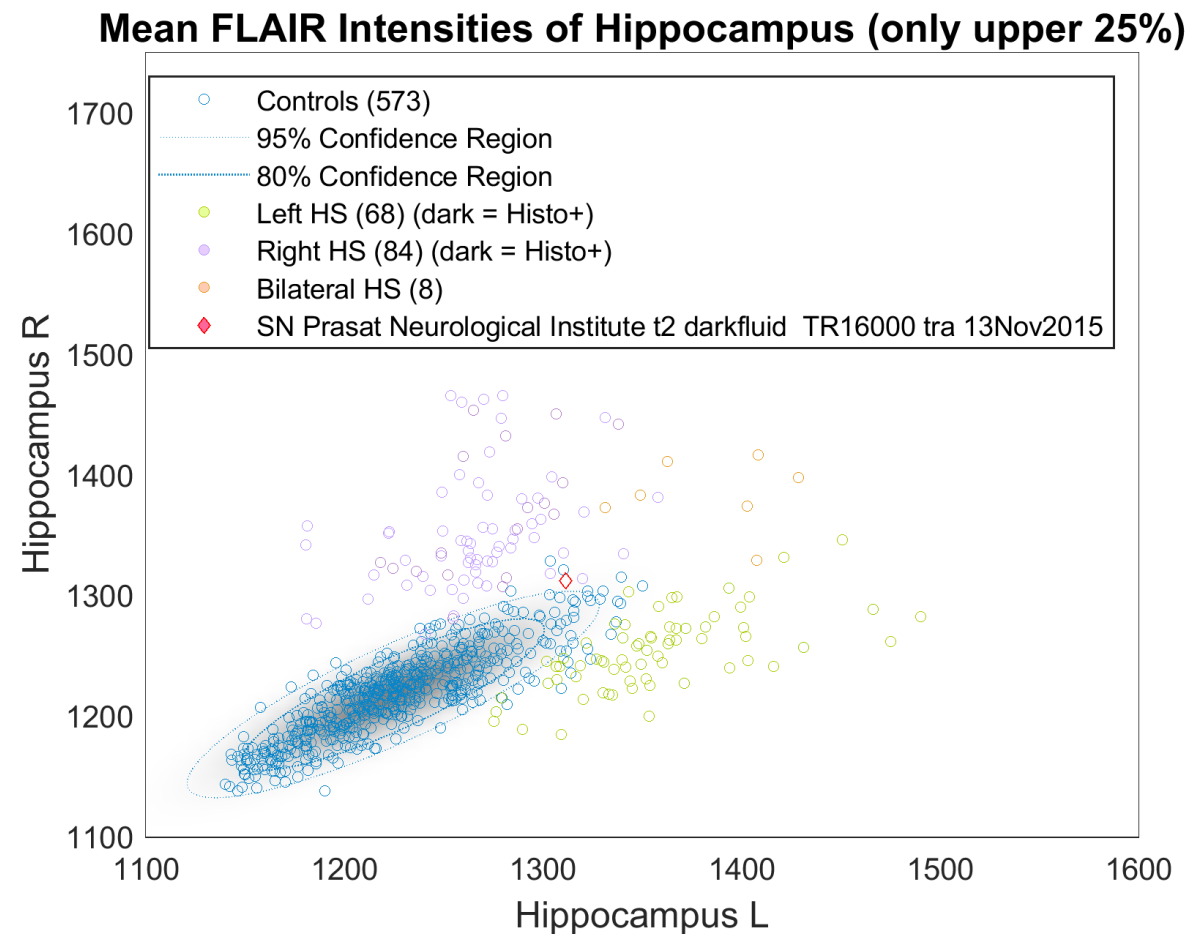
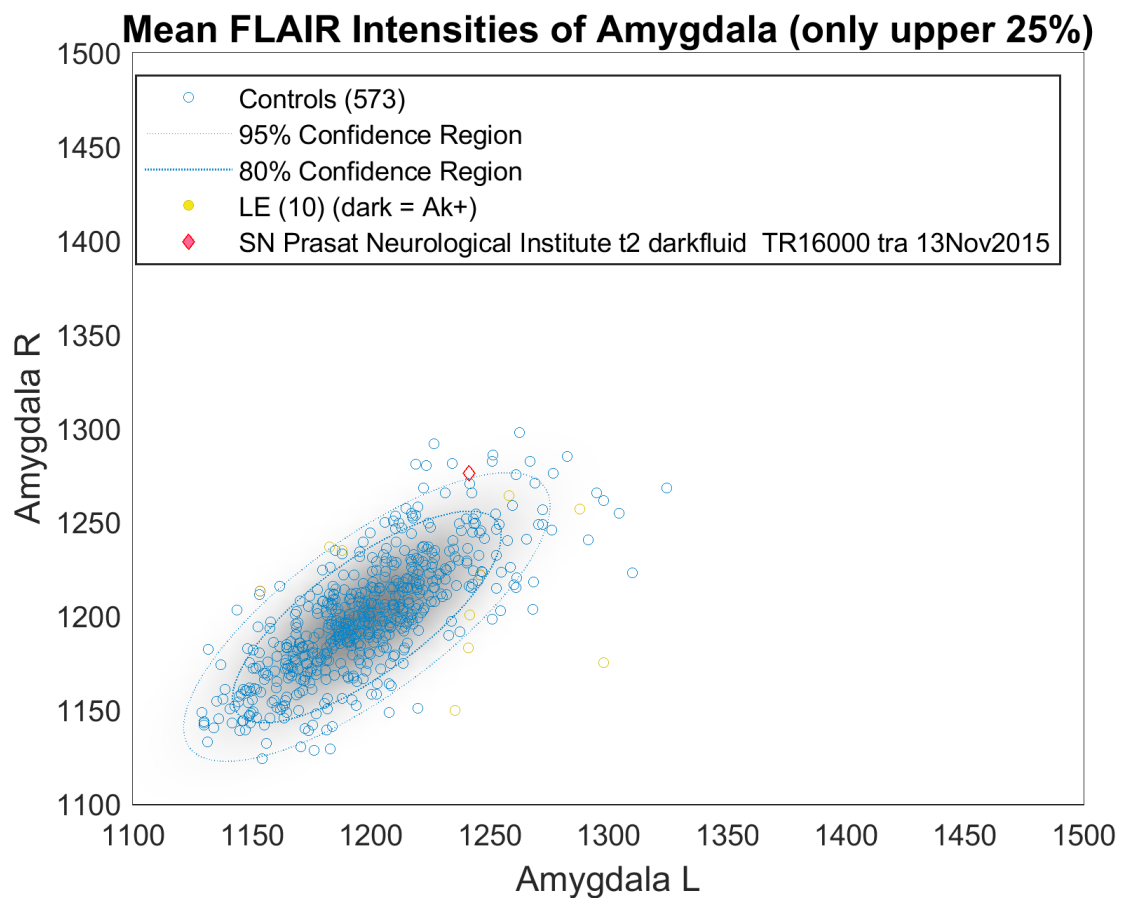
VideoEEG

Hypothesis

Surg. Plan.

Conclusion

MRI 3T Result Hippo/Amygdala FLAIR intensities



The epileptogenic lesion

- radiographic lesion that is the cause of the epileptic
- seizures. high resolution MRI.

not all lesions seen in a patient with epileptic seizures are epileptogenic

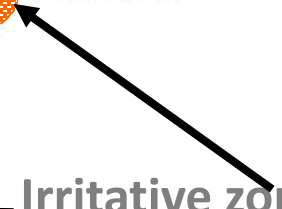
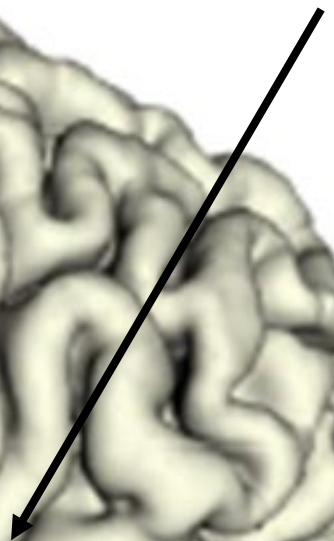
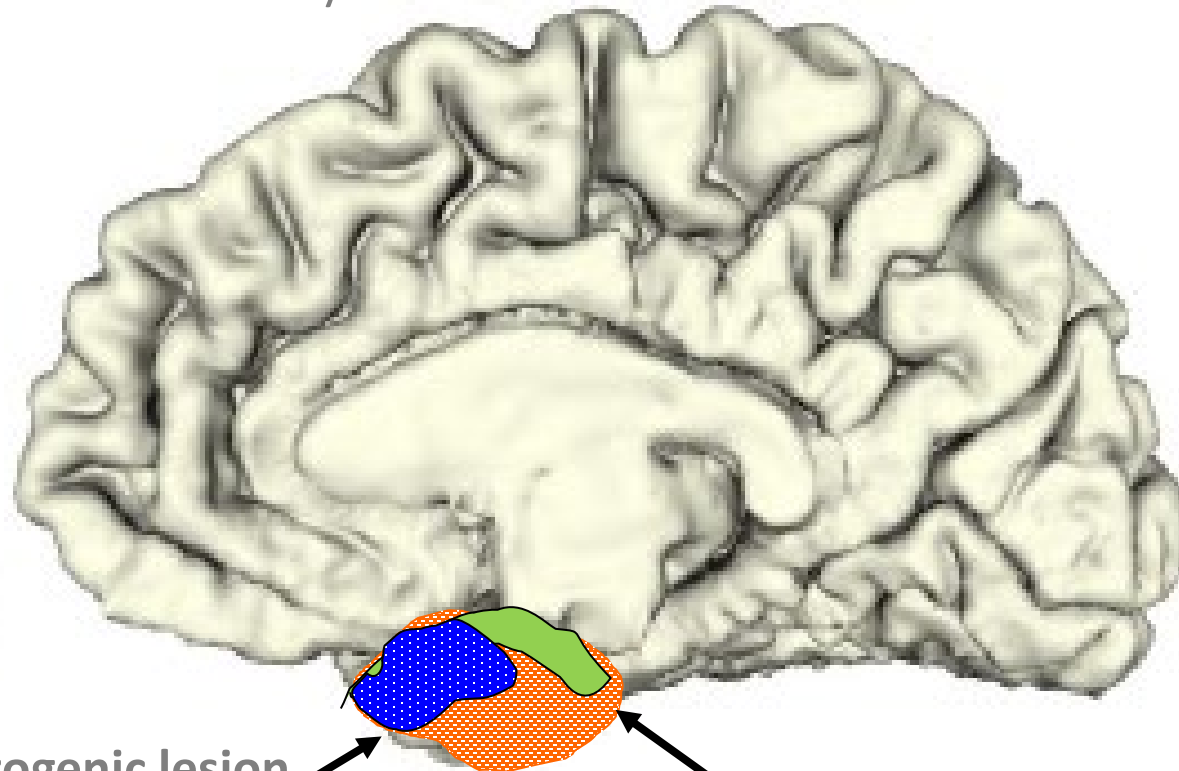
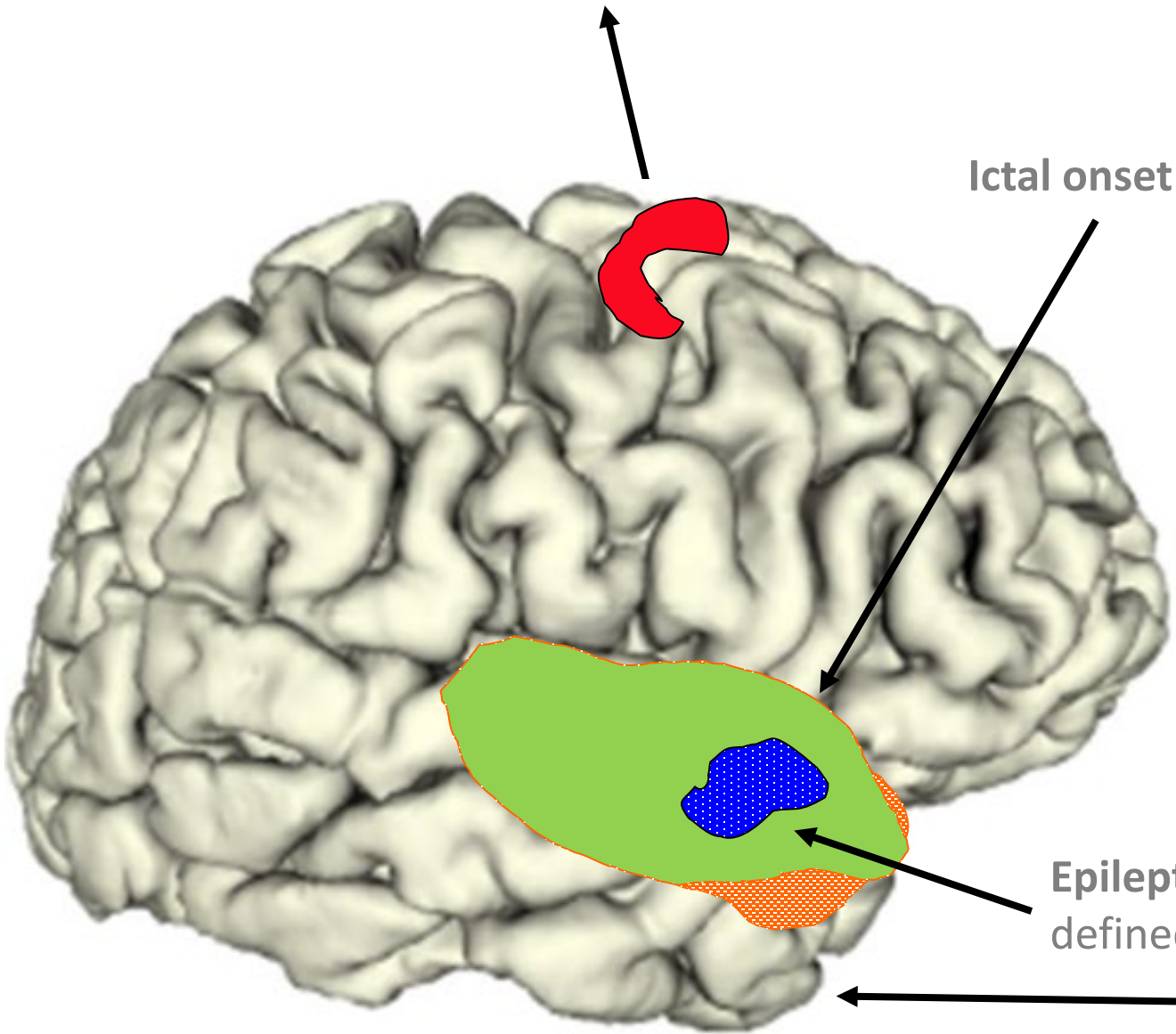
Five Cortical Zones

Symptomatogenic zone defined by Seizure semiology.

Ictal onset zone defined by Ictal EEG

Epileptogenic lesion defined by MRI.

Irritative zone defined by Inter-ictal EEG & MEG.



MWS- Version III

History

Seizures

EEG

Neuropsych

Imaging

VideoEEG

Hypothesis

Surg. Plan.

Conclusion

Primary Indexes	Index scores	Qualitative
Full scale IQ	75	Borderline
Verbal IQ	87	Low Average
Perceptual Reasoning	73	Borderline

Primary Indexes	Index scores	Qualitative
Auditory Immediate	89	Low Average
Visual Immediate	97	Average
Immediate Memory	91	Average
Auditory delayed	97	Average
Visual Delayed	69	Extremely low
Auditory Recognition Delayed	80	Low Average
General memory	84	Borderline
Working Memory	69	Extremely low

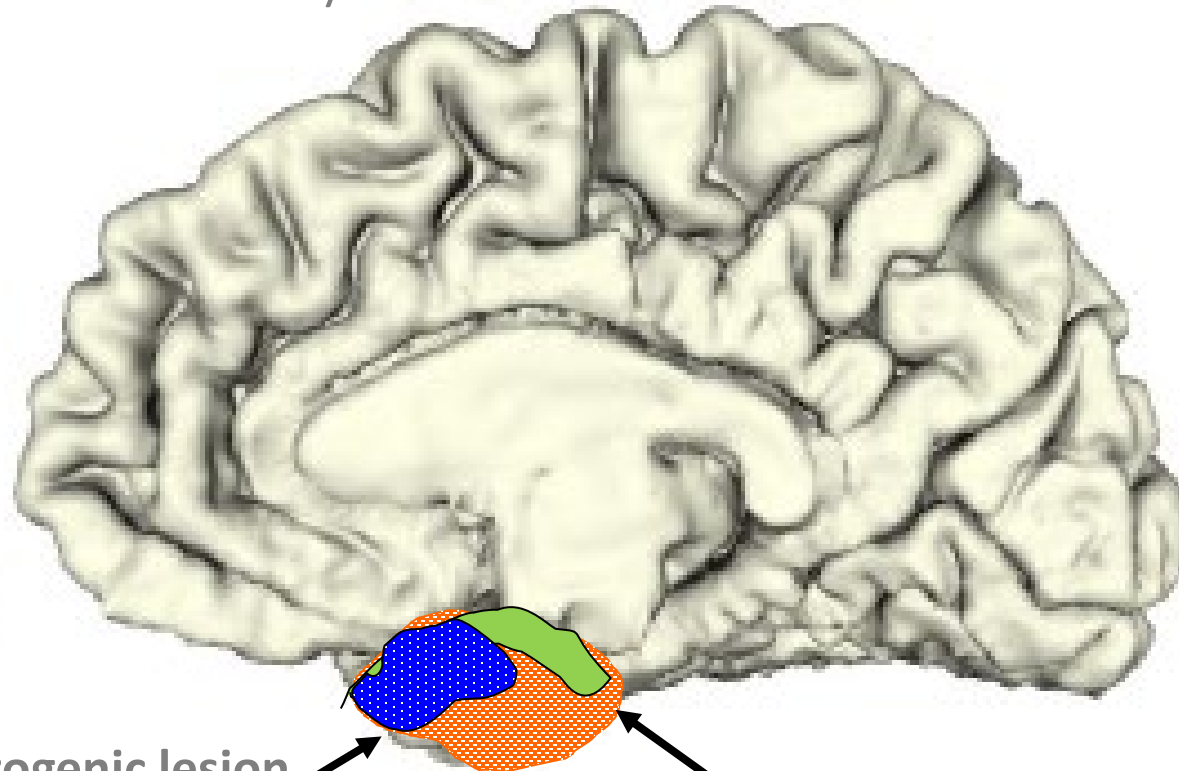
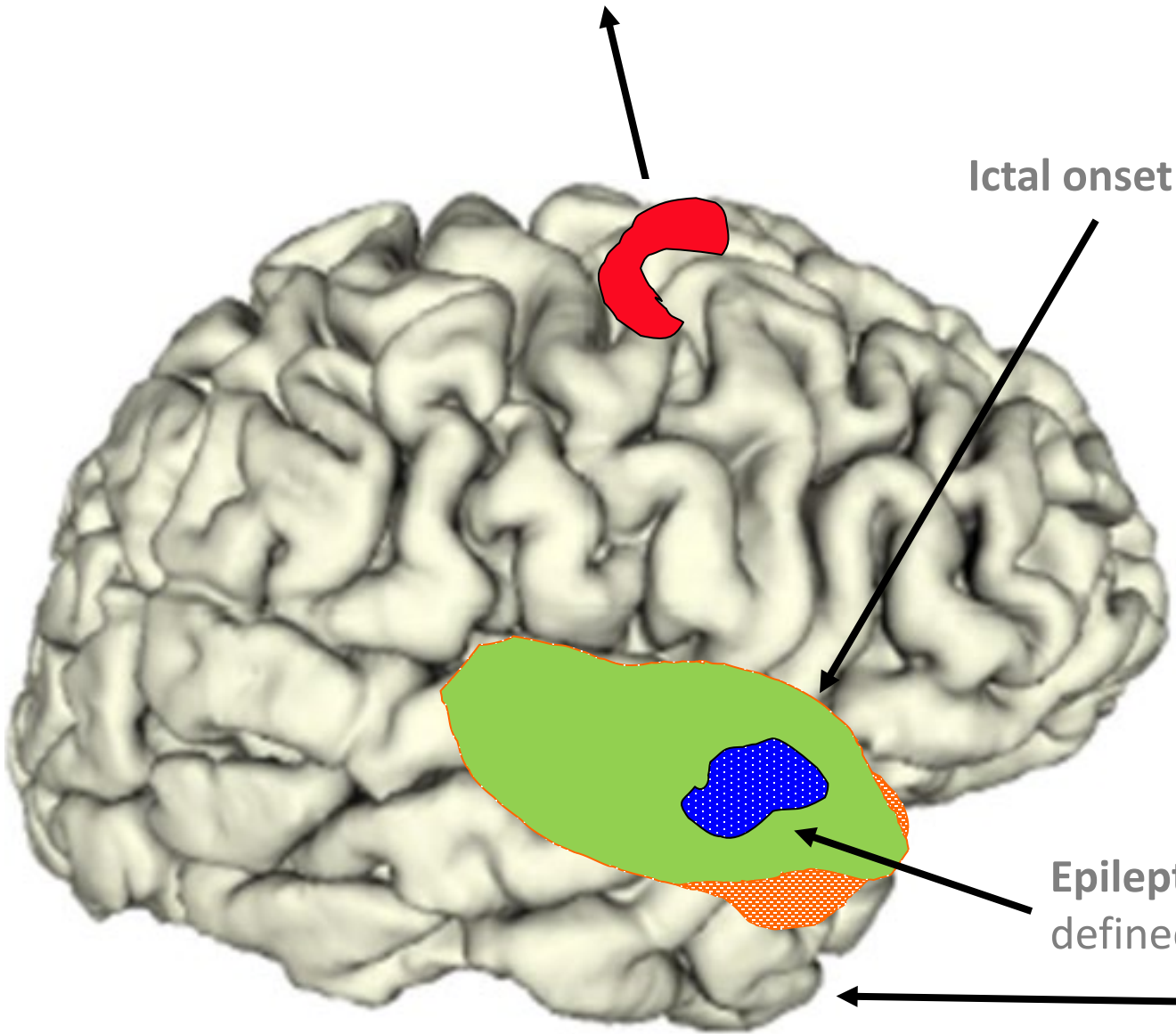
Five Cortical Zones

Symptomatogenic zone defined by Seizure semiology.

Ictal onset zone defined by Ictal EEG

Epileptogenic lesion defined by MRI.

Irritative zone defined by Inter-ictal EEG & MEG.



The functional deficit zone

- This is defined as the area of cortex that is functionally abnormal in the interictal period. (direct result of the destructive effect of the lesion functionally mediated, i.e. abnormal neuronal transmission)

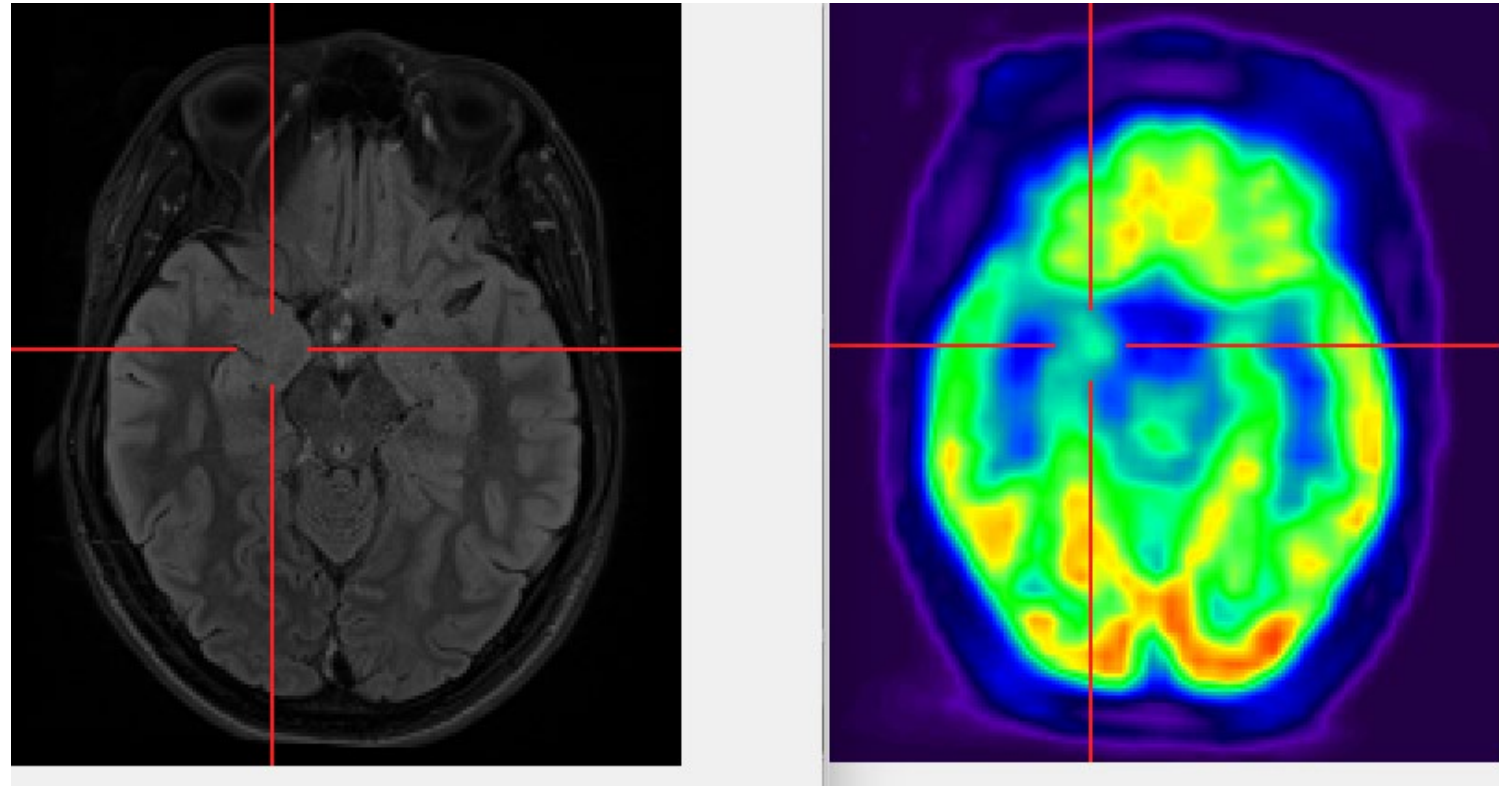


Case Scenario

- Do we have enough to plan surgery?
- If not, what do we need?

FDG-PET

- **FDG PET HYPOMETABOLISM AT RIGHT MESIAL AND LATERAL TEMPORAL**



History

Seizures

EEG

Neurology

Imaging

VideoEEG

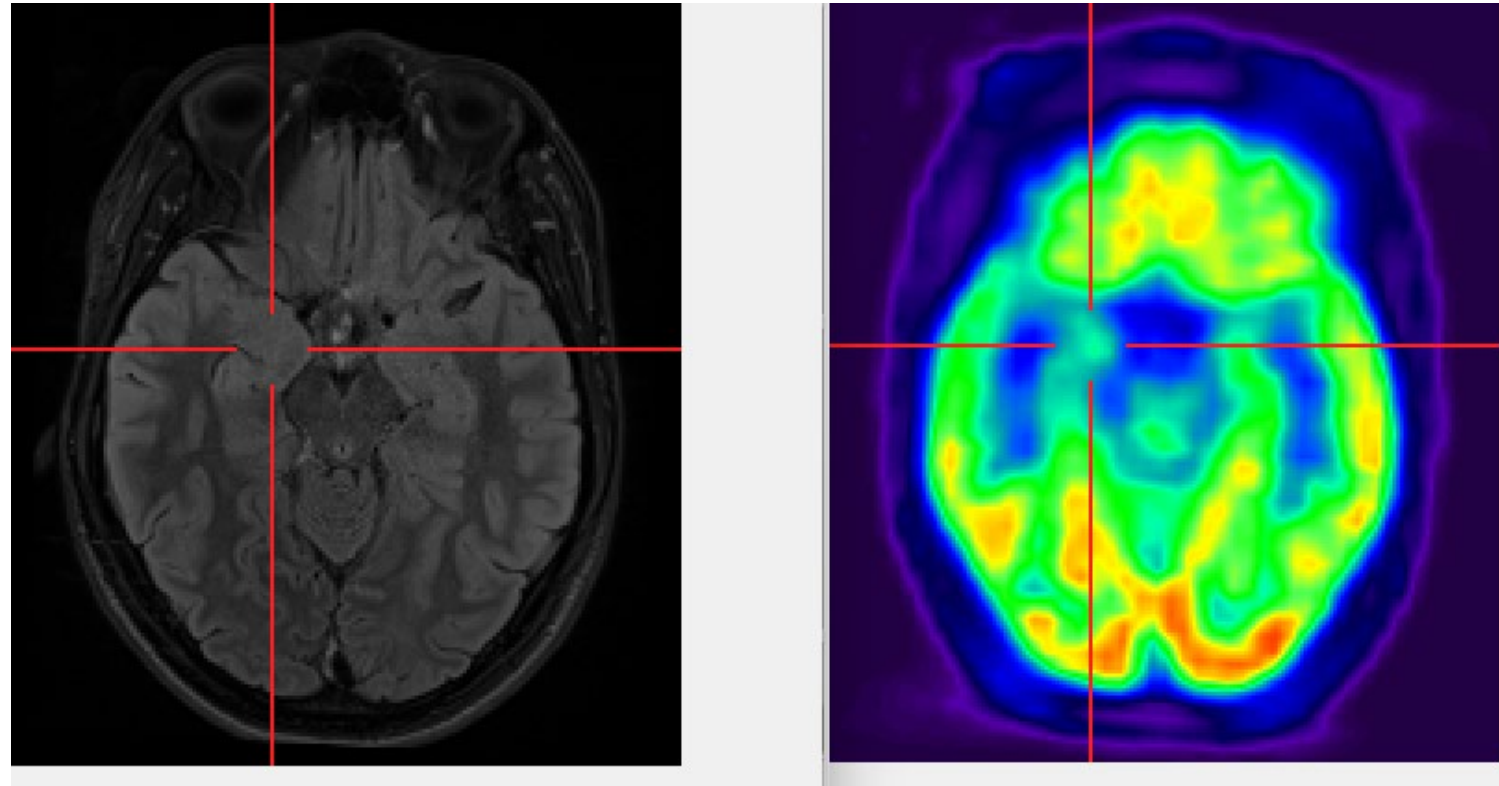
Hypothesis

Surg. Plan.

Conclusion

FDG-PET

- **FDG PET HYPOMETABOLISM AT RIGHT MESIAL AND LATERAL TEMPORAL**



History

Seizures

EEG

Neurology

Imaging

VideoEEG

Hypothesis

Surg. Plan.

Conclusion

Five Cortical Zones

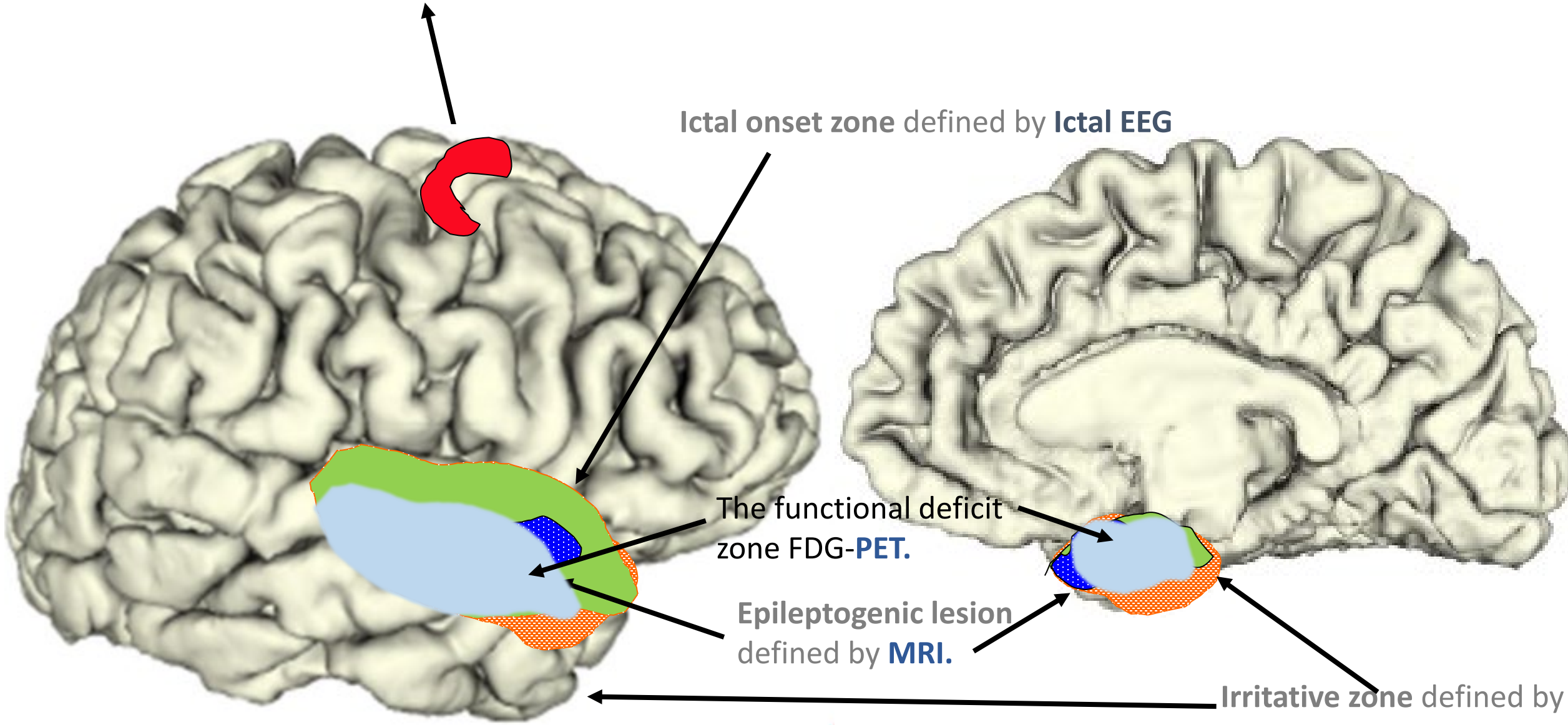
Symptomatogenic zone defined by Seizure semiology.

Ictal onset zone defined by Ictal EEG

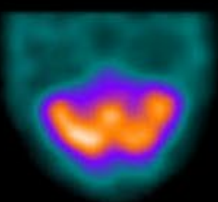
The functional deficit zone FDG-PET.

Epileptogenic lesion defined by MRI.

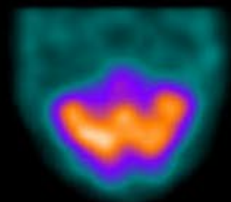
Irritative zone defined by Inter-ictal EEG & MEG.



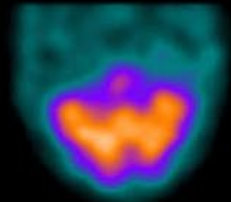
14



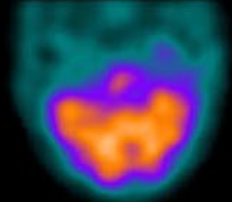
15



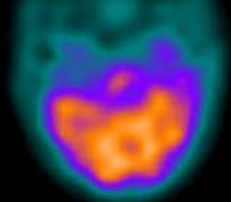
16



17



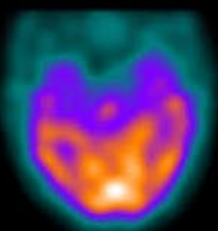
18



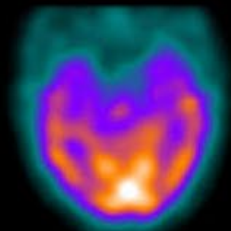
19



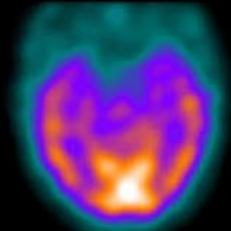
20



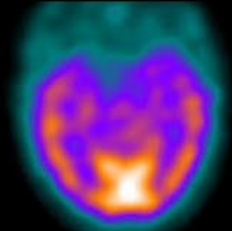
21



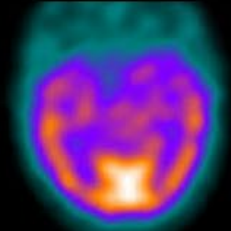
22



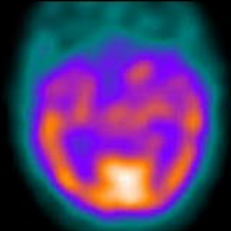
23



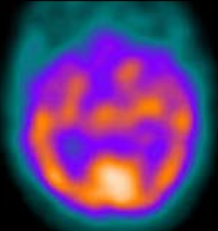
24



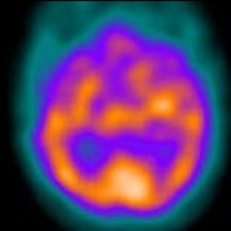
25



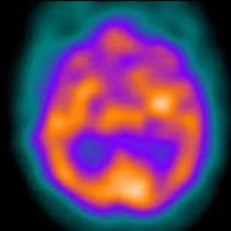
26



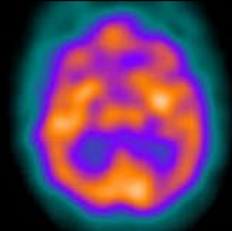
27



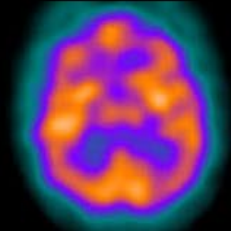
28



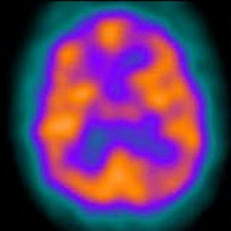
29



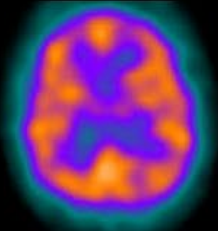
30



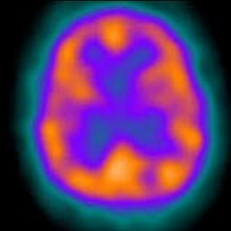
31



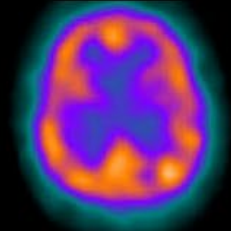
32



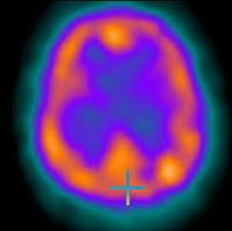
33



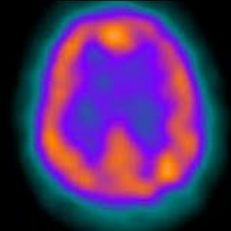
34



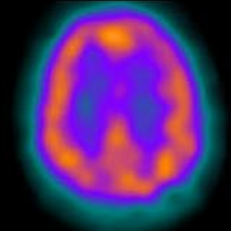
35



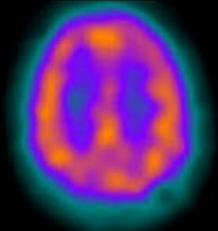
36



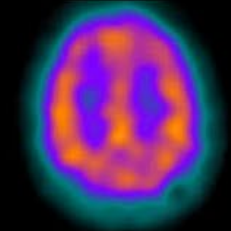
37



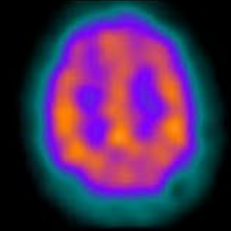
38



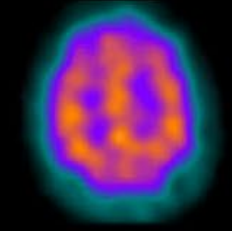
39



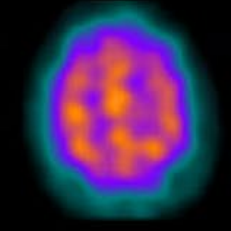
40



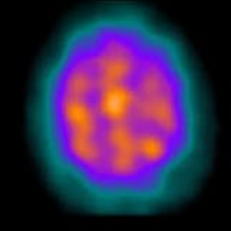
41



42



43



Interictal SPECT

- The study reveals relatively decreased activity at the right temporal lobe. The rest of brains appear unremarkable.

Five Cortical Zones

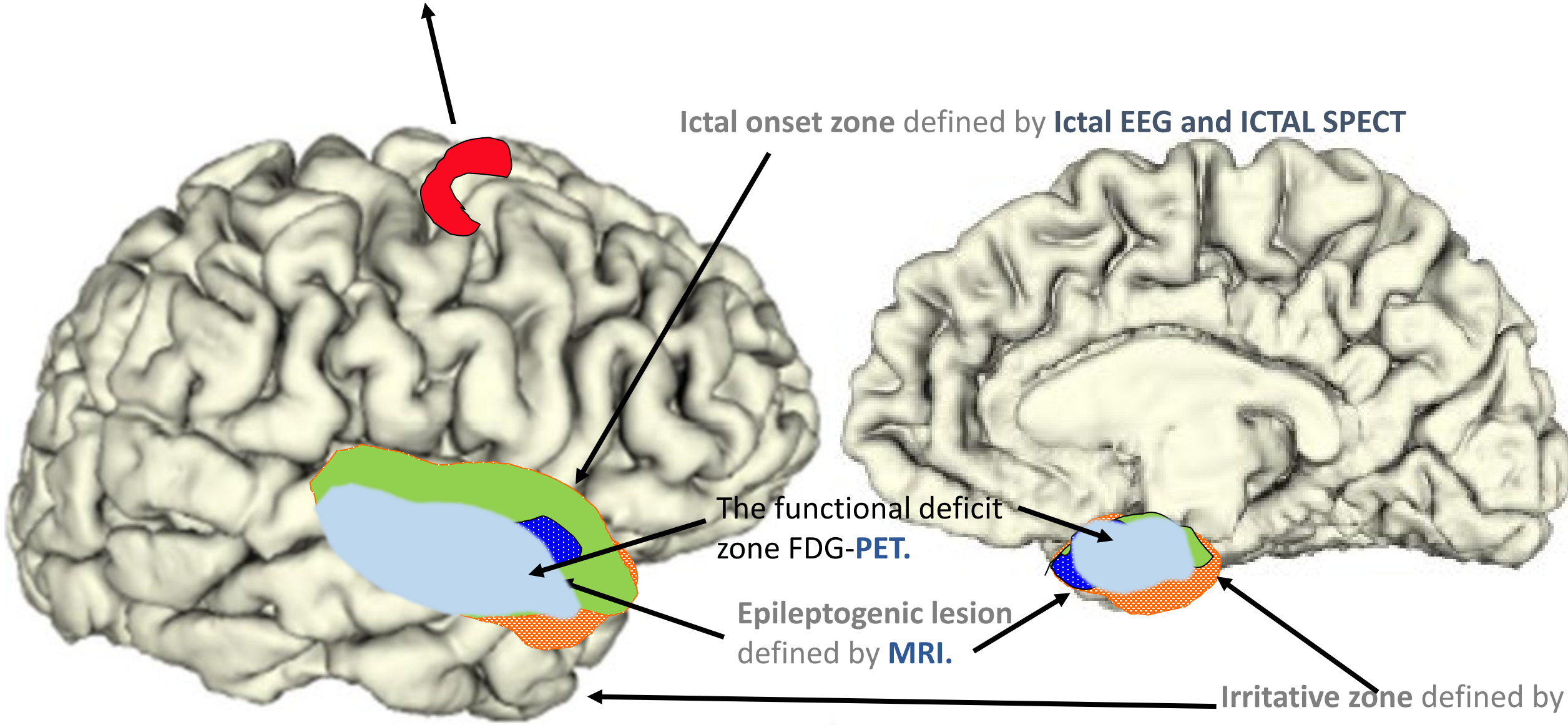
Symptomatogenic zone defined by Seizure semiology.

Ictal onset zone defined by Ictal EEG and ICTAL SPECT

The functional deficit zone FDG-PET.

Epileptogenic lesion defined by MRI.

Irritative zone defined by Inter-ictal EEG & MEG.



From Pre-surgical evaluation

History

Seizures

EEG

Neuropsych

Imaging

VideoEEG

Hypothesis

Plan.

Conclusion

Irritative zone	: right fronto-temporal (FT10)
Symptomatogenic zone	: temporal lobe spread to dorsal frontal
Functional deficit zone	: hypometabolism on FDG-PET
	: IQ 97 (average) Neuro-psy Asymmetrical
Seizure onset zone	: EEG-seizure → Right frontal-temporal (F10)

Possible epileptogenic lesions:

1. Mild right mesial temporal sclerosis (MRI by neuroradiologist)

Etiology

Possible Temporal-lobe epilepsy associated with early Hippocampal sclerosis

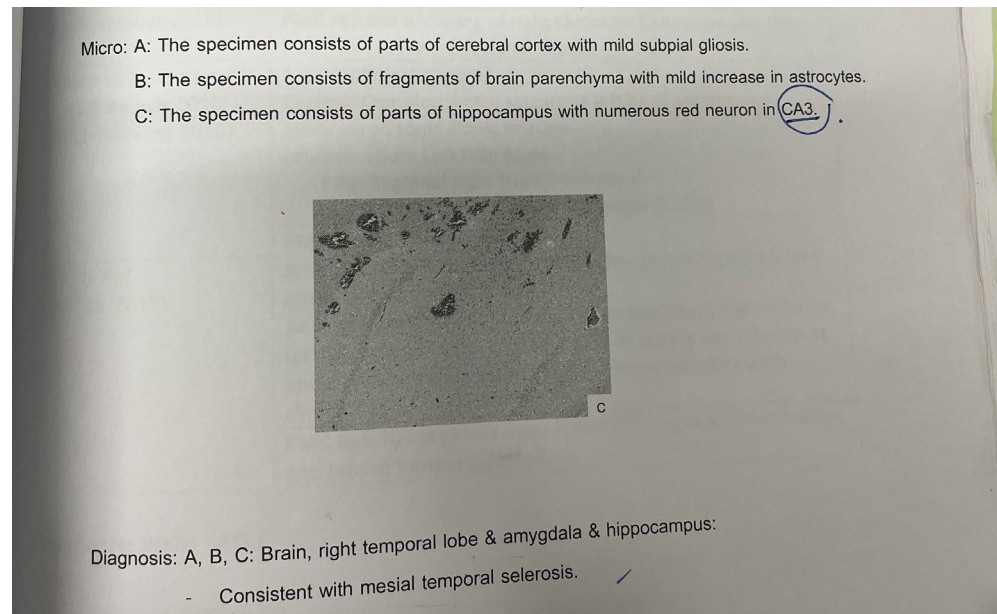


Case Scenario

- Do we have enough to plan surgery?
- If not, what do we need?

Seizure History (Cont.)

- After PMC discussion (21 March 2017), he underwent right anterior temporal lobectomy.
- Pathology was consistent with mesial temporal sclerosis





Case Scenario

Surgical procedure & outcome

- Right temporal lobectomy The pathological findings demonstrated numerous red neuron in CA3 and gliosis consistent with hippocampal sclerosis.

The epileptogenic zone

the area of cortex that is indispensable for the generation of epileptic seizures. It may include an actual epileptogenic zone, which is the cortical area generating seizures before surgery

The seizure free status of the patient after surgery however, only confirms that the epileptogenic zone has been included in the resected cortex

Rosenow F, Lüders H. Presurgical evaluation of epilepsy. Brain. 2001

Philippe Kahane. Definition and localization of the epileptogenic zone. Epileptic Disord 2006