

**Relationships between MRI anatomy
and electrophysiological spontaneous recordings
in the subthalamic region during stereotactic surgery
for Severe Idiopathic Parkinson's disease.**

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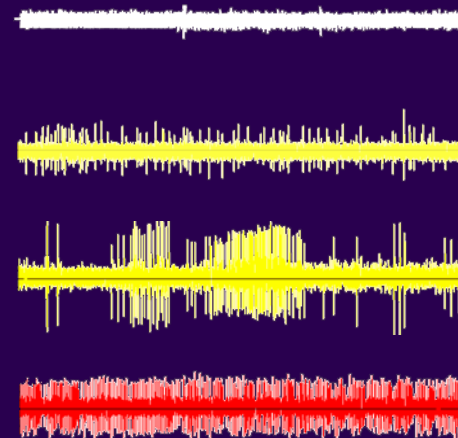
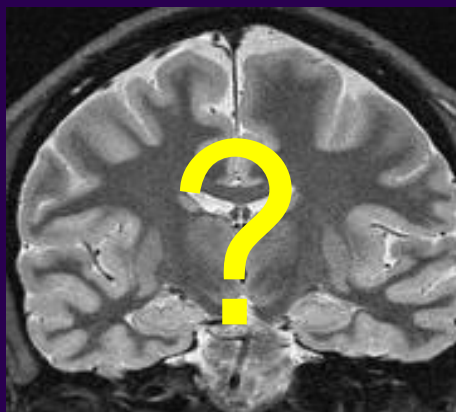
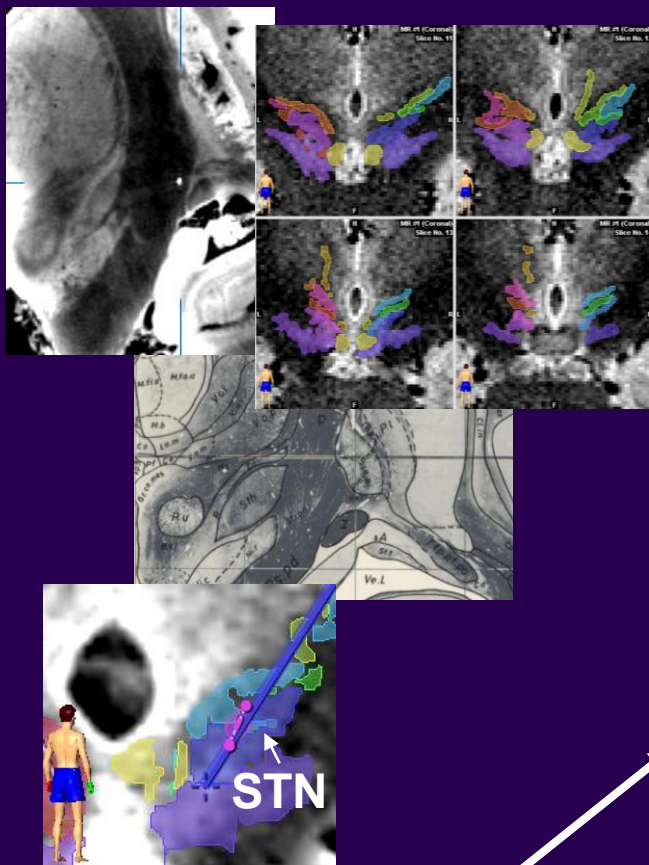
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Question

Accuracy of the « electrophysiological mapping »
to identify the structures during DBS ?

→ to confront electrophysiology
with imaging based anatomy



**Anatomical
mapping**

**Electrophysiological
mapping**

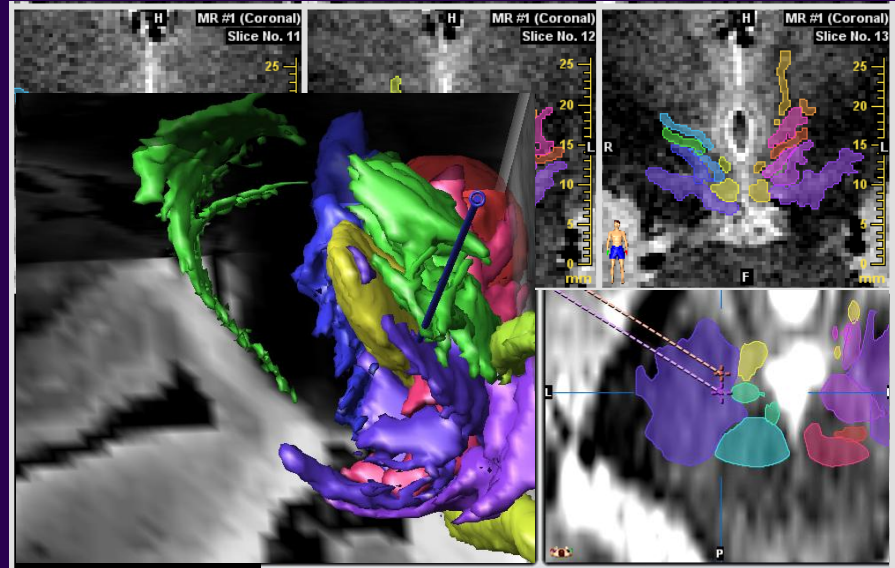
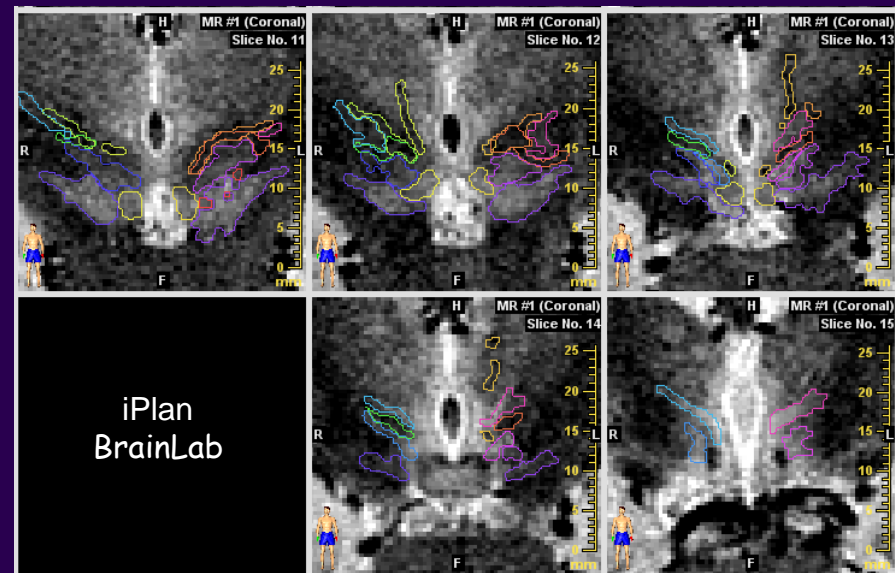
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Material and Methods

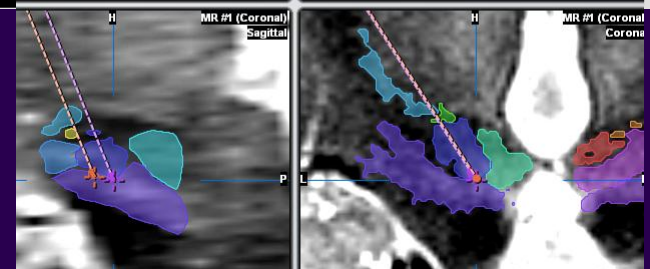
Direct targeting

1. Surrounding of the structures in the subthalamic area:

- SubThalamic Nucleus
- Substantia Nigra
- Rubral putamen
- Zona Incerta
- Red Nucleus
- Peri Rubral Area
- Forel's Field (H1, H2)
- Para Ventricular Area
- Mamillo-Thalamic Bundle

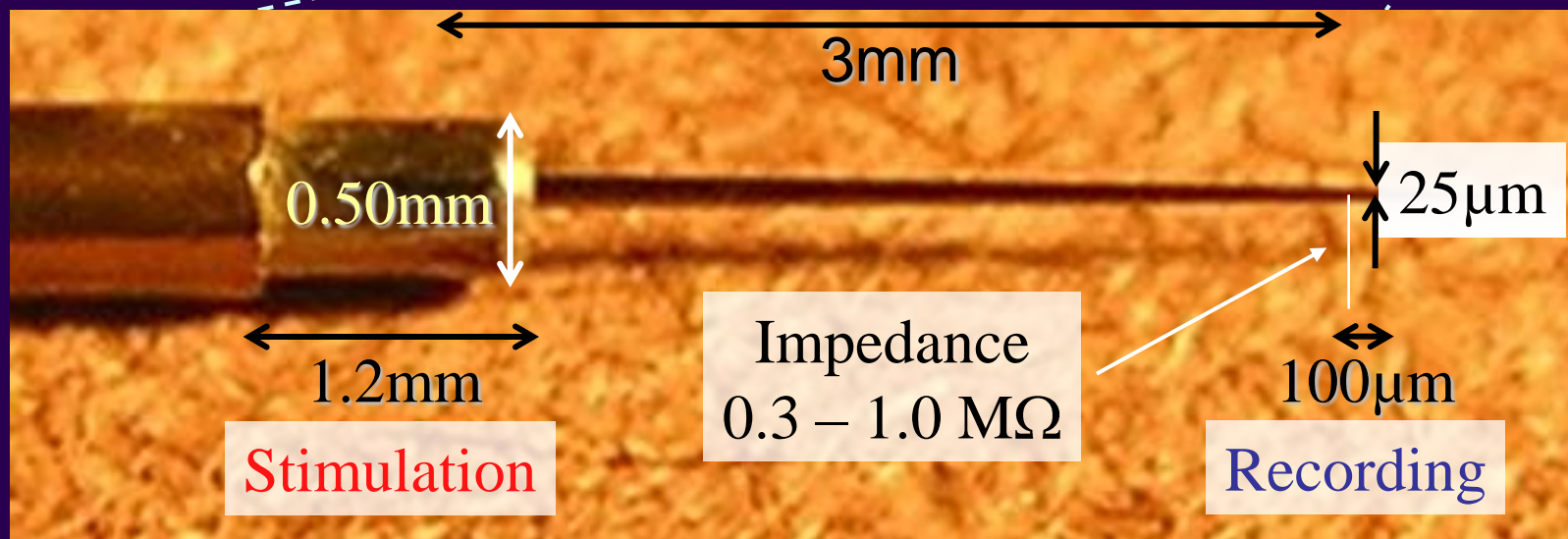


2. Choice of two trajectories per side, separated by 2mm



Exploration electrode

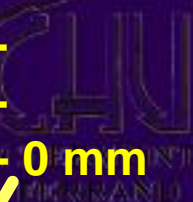
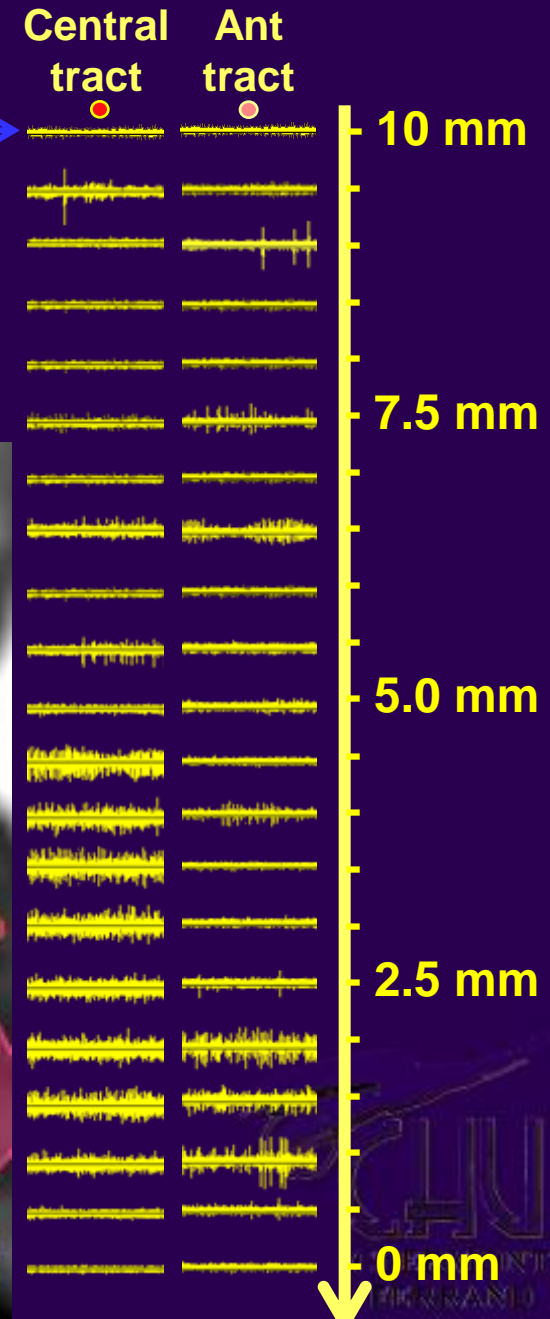
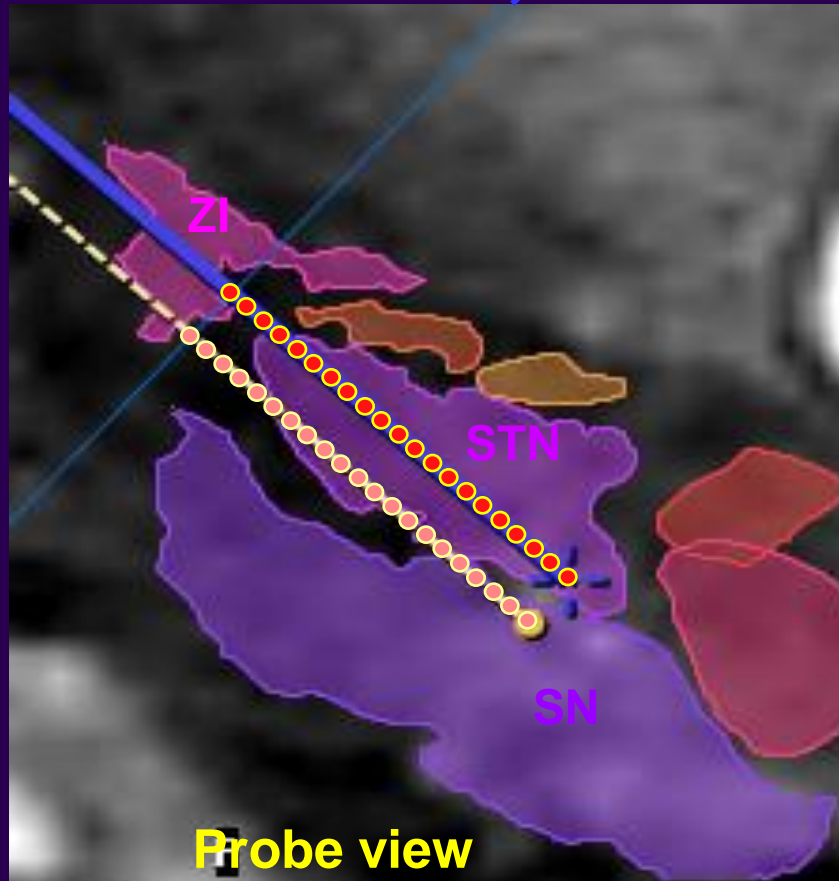
Alpha Omega



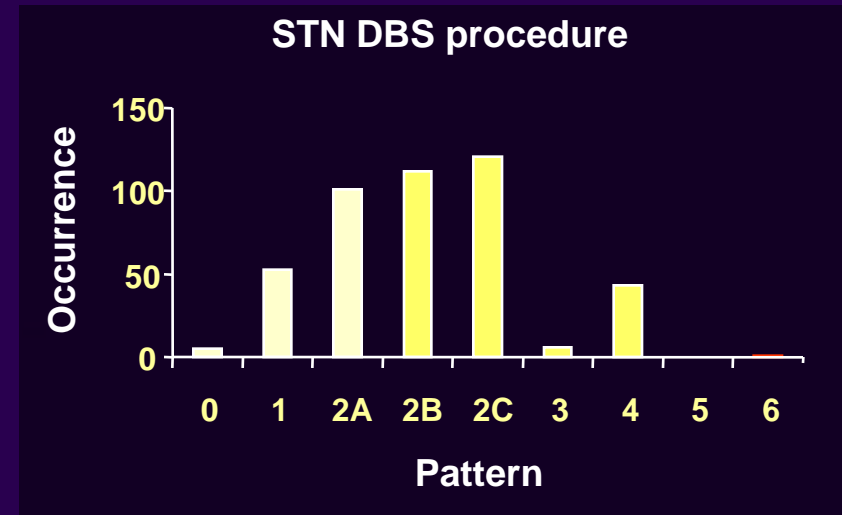
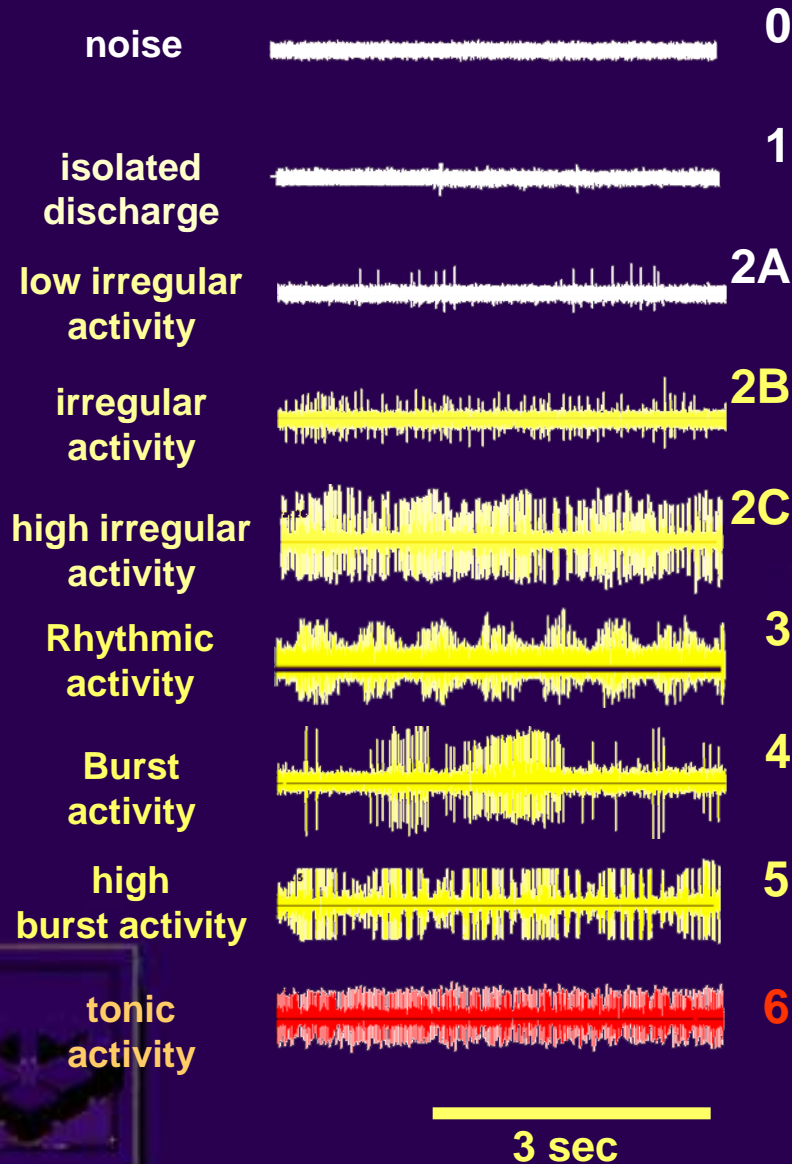
Recording protocol

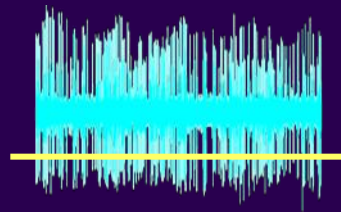
- systematic recording (10mm, 0.5mm step)
- of spontaneous activity
- without searching to isolate neurons
- on 2 trajectories simultaneously (Central and 2mm Anterior)
- during 30 seconds / position

- on-line description
- off-line analysis

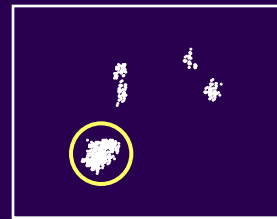


On-line classification during surgery

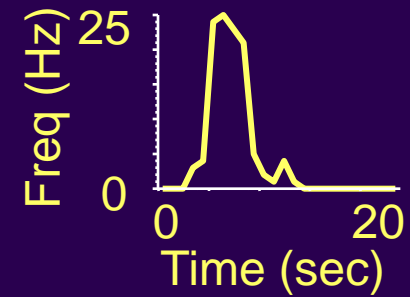




**Pre processing
(threshold)**



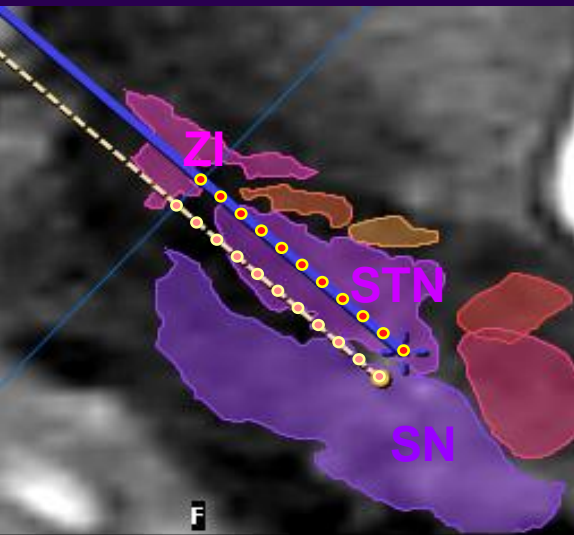
**Classification
(PCA)**



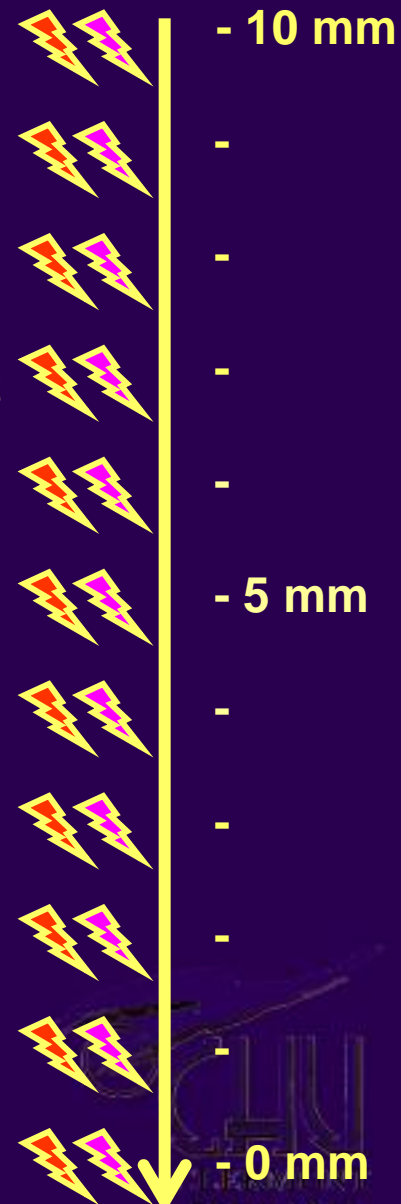
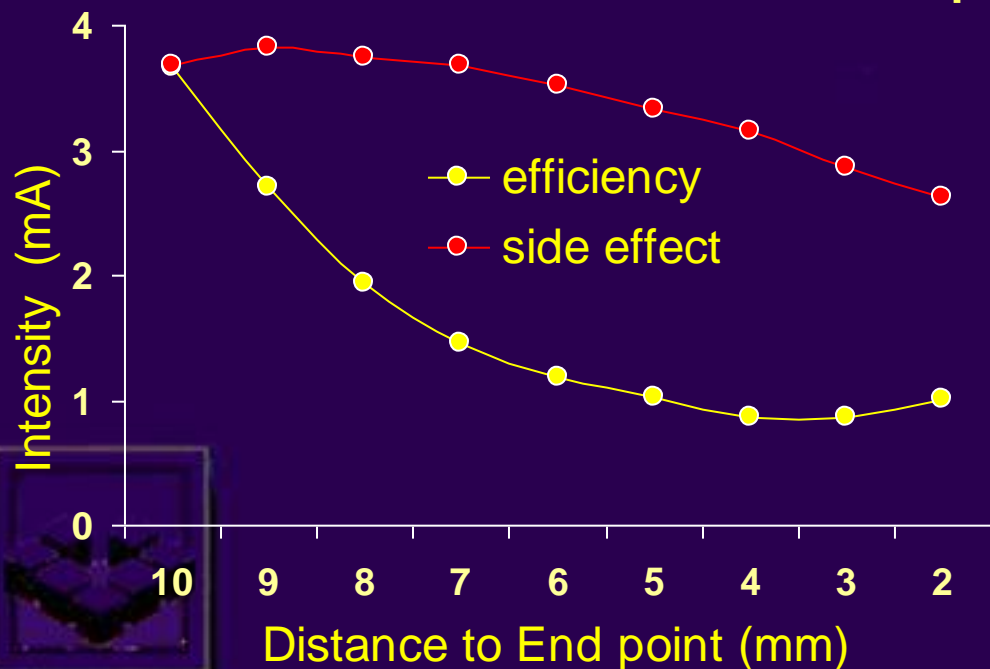
Analysis



Stimulation



- Stimulation (10mm, 1mm step)
- 130 Hz, 0.06 msec
- ↗ intensity from 200 μ A to 4 mA
- Threshold leading to a maximal clinical improvement
- Threshold leading to an adverse effect
- Stimulation = key point for DBS electrode placement



10 parkinsonians (mean age 62 yo)

38 trajectories (19 STN)

796 systematic recordings

336 neurons

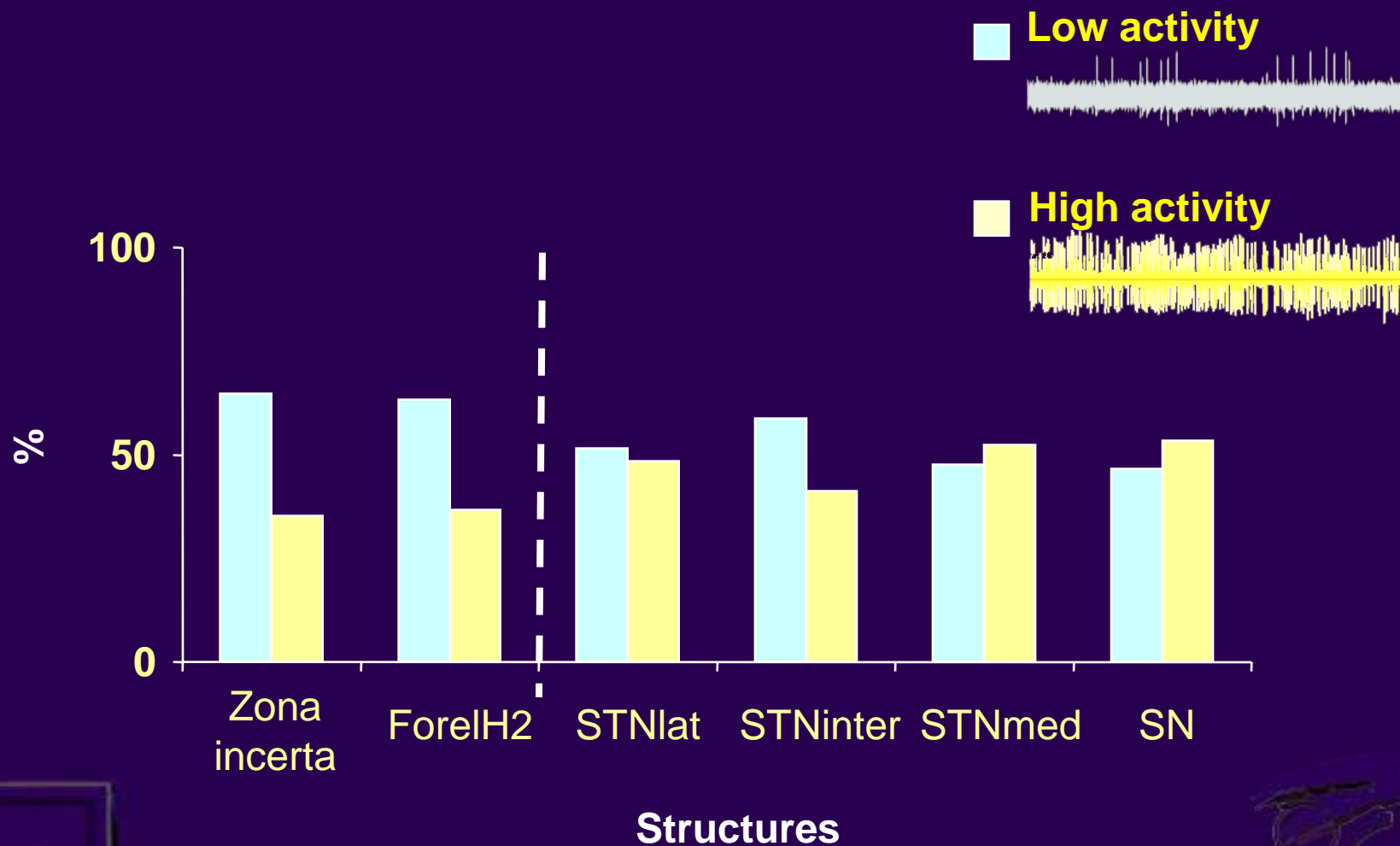
Mean improvement on the motor score with stimulation ON (part III of UPDRS): 63.6%,
 $p \leq 0.001$



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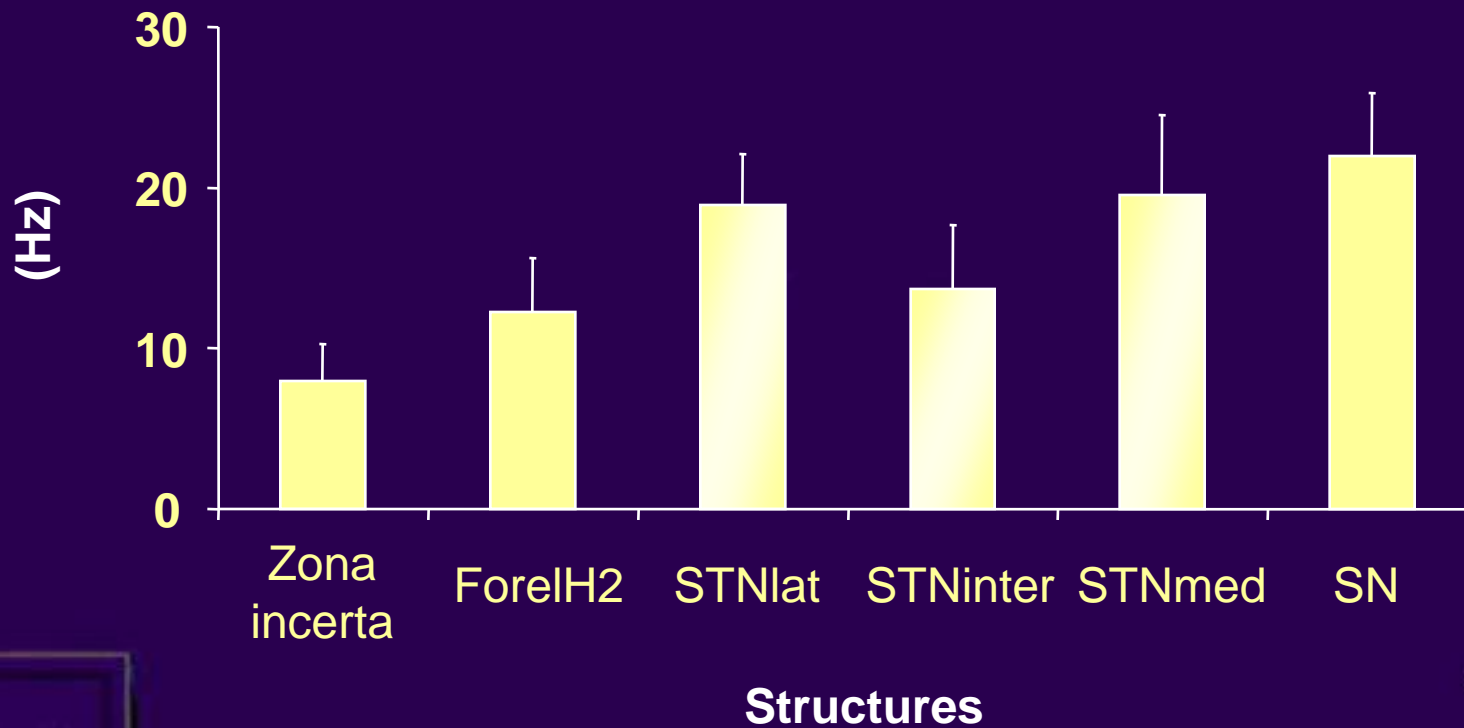
Results

On line classification



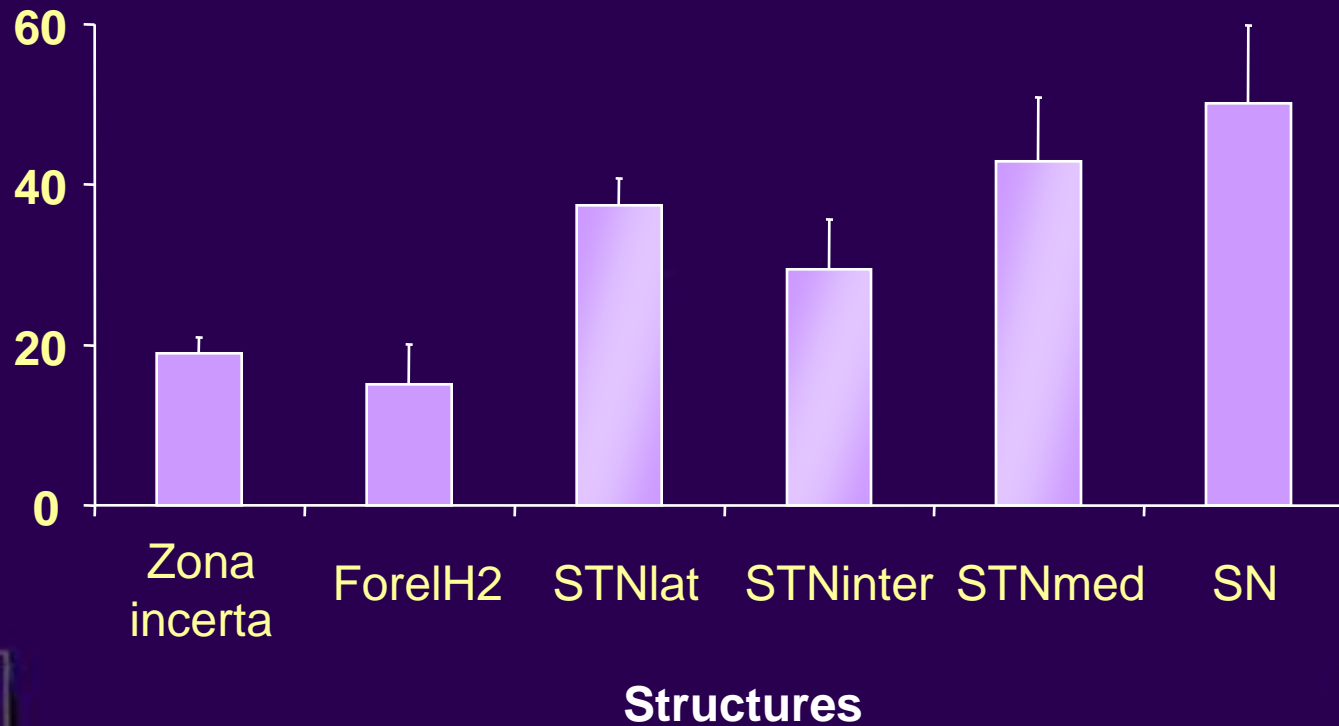
Qualitative analysis

Neurons mean frequency



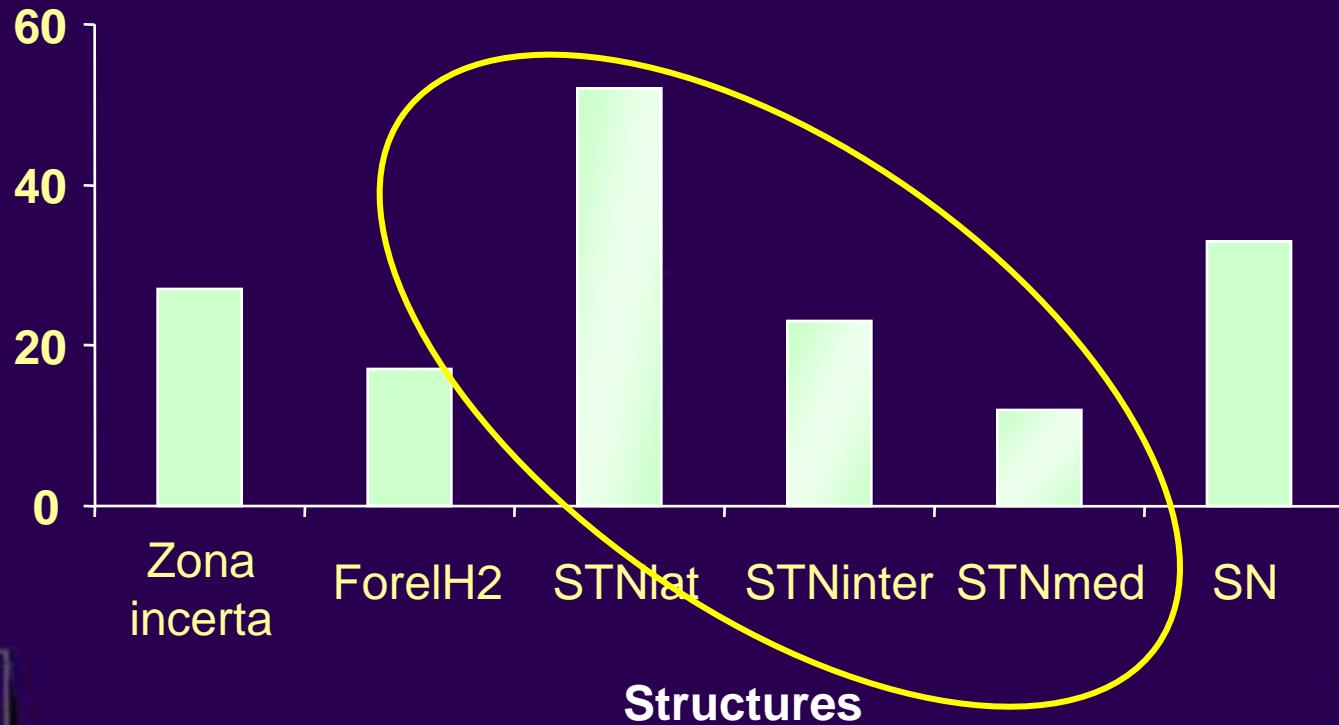
Qualitative analysis

Number of bursts / min



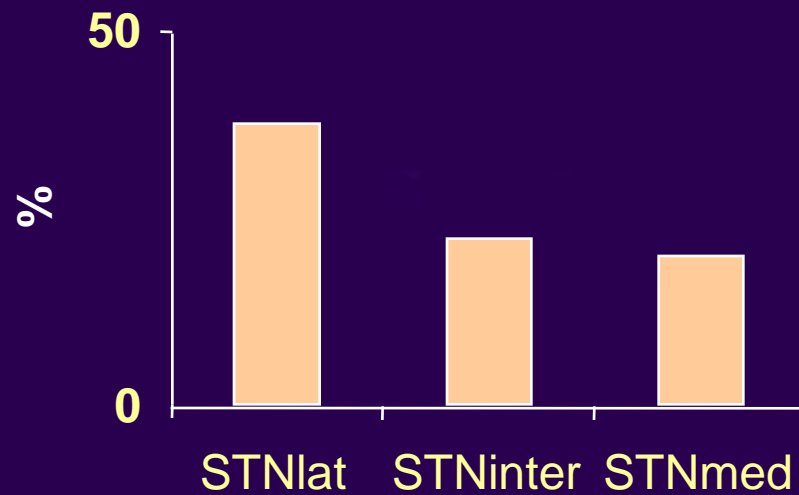
Quantitative analysis

Number of recordings
with neuronal activity



Quantitative analysis

**Number of recordings with neuronal activity/
number of recordings**



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Discussion

STN: mean firing rate

Result of the study: 17.64 2.24 Hz

Magnin, Neuroscience 2000	41 21 Hz
Rodriguez-Oroz, Brain 2001	33.12 16.64 Hz
Benazzouz, Mov Disord 2002	42.30 22.00 Hz
Theodosopoulos, Mov Disord 2003	34 14 Hz

- **Systematic recording is not isolation of neurons: this approach does not allow to optimize signal/noise ratio.**



- **Quite good relationships between MRI anatomy and electrophysiological spontaneous recordings in the subthalamic region during stereotactic surgery for Severe Idiopathic Parkinson's disease :**
 - on line classification: majority of low activity in white matter
 - neuronal mean frequency: continuous increase from ZI to SN
 - burst activity: in STN and SN
 - nb of recordings with spontaneous neuronal activity: lateral STN
- **Others evaluations are required: evoked neuronal activity...**
- **But, per-operative clinical assessment with acute stimulation remains the key point for DBS electrode placement.**



Conclusion

- **Anatomical boundaries and unitary recordings seem to be linked.**
- **We found a slightly high number of spontaneously active neurons in the lateral STN which is also known as a good surgical target for DBS in severe PD.**



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**I wish to thank all the members of the multidisciplinary team
for movement disorder surgery and
the associated research teams.**

Thank you for your attention.

