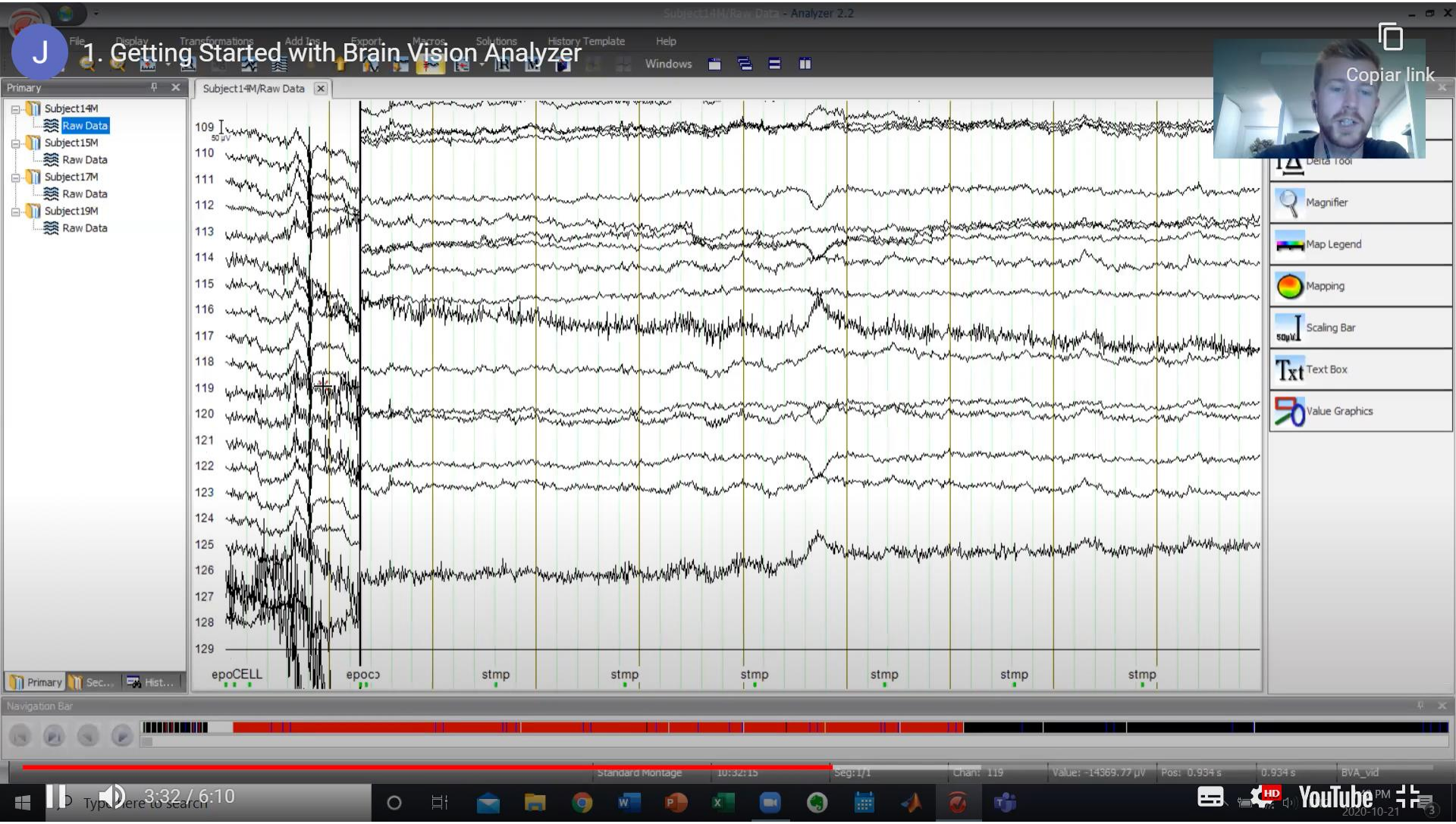
ABRIR ANALYZER:

Dongle – chavinha – driver atualizado?
Abrir programa Analyzer

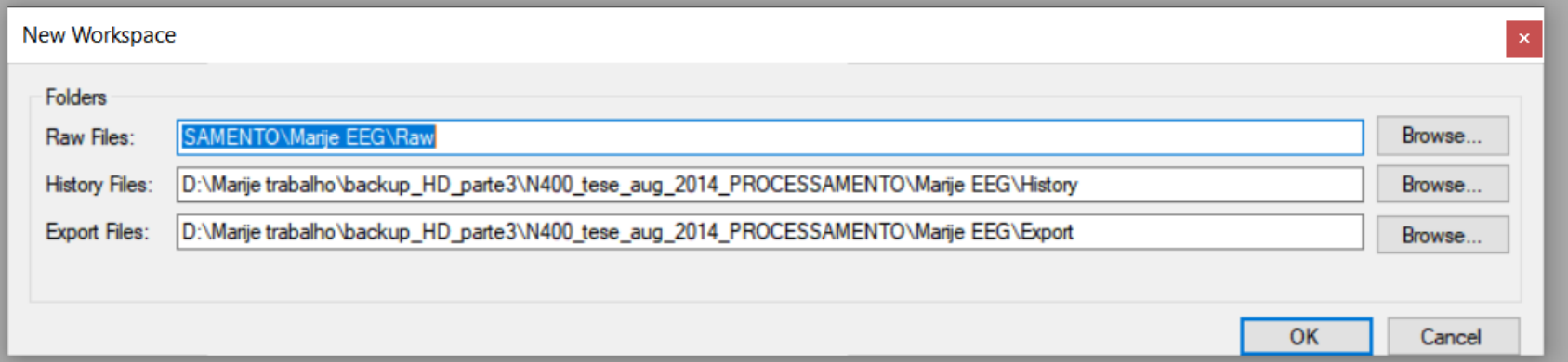
Quando você está trabalhando num computador da rede do laboratório, você pode usar o analyzer sem a chavinha. Só certifique-se que o computador servidor está ligado e com a chavinha/dongle inserida.

Recomendação de material didático no youtube



Montar a estrutura de arquivar:
Criar ‘espaço de trabalho’ – *workspace*

-Raw
-History
- Export



In general, preprocessing is the procedure of transforming raw data into a format that is more suitable for further analysis and interpretable for the user. In the case of EEG data, preprocessing usually refers to **removing noise from the data to get closer to the true neural signals**.

EEG data tends to contain a lot of noise which can obscure weaker EEG signals. Artifacts such as blinking or muscle movement can contaminate the data and distort the picture. Finally, we want to separate the relevant neural signals from random neural activity that occurs during EEG recordings.

http://learn.neurotechedu.com/preprocessing/

there is no universally adopted EEG preprocessing pipeline (...) Below are some questions that might help you choose the more appropriate preprocessing techniques:

- What kinds of artifacts might be present in your data? Which ones do you want to remove, and which ones do you want to flag to be aware of?

-> que método de remoção de artefato?

- Qual a 'grandeza' do seu efeito? Em que frequencia (banda de frequencia você esperaria encontrar seu efeito)

-> que filtros você vai aplicar?

- Quantos dados você tem?
- -> metodos mais quantitativos/automatizados x qualitativos/inspecção
- *(conhecer seu dado)*

Primeiro filtrar ou primeiro cortar canais??

(mas tb history template)
(mas tb manipulações individuais)

Para os 1os três passos (editar canais, filtrar e (eventualmente) referenciar:
Não corte no seu dado, mas olhe onde interessa, claro.

3. Removing Bad Channels and Interpolation

3.1. What is a ‘bad’ channel?

Sometimes EEG data (especially high-density EEG data) will contain ‘bad’ channels that do not provide accurate information. It is important to remove those from analysis early on because keeping that data will affect further analysis. There are a few reasons why a channel might be excluded:

The channel is malfunctioning for some reason
The electrode was improperly placed or didn’t have contact with the scalp (if working with wet electrodes) Two or more channels were bridged

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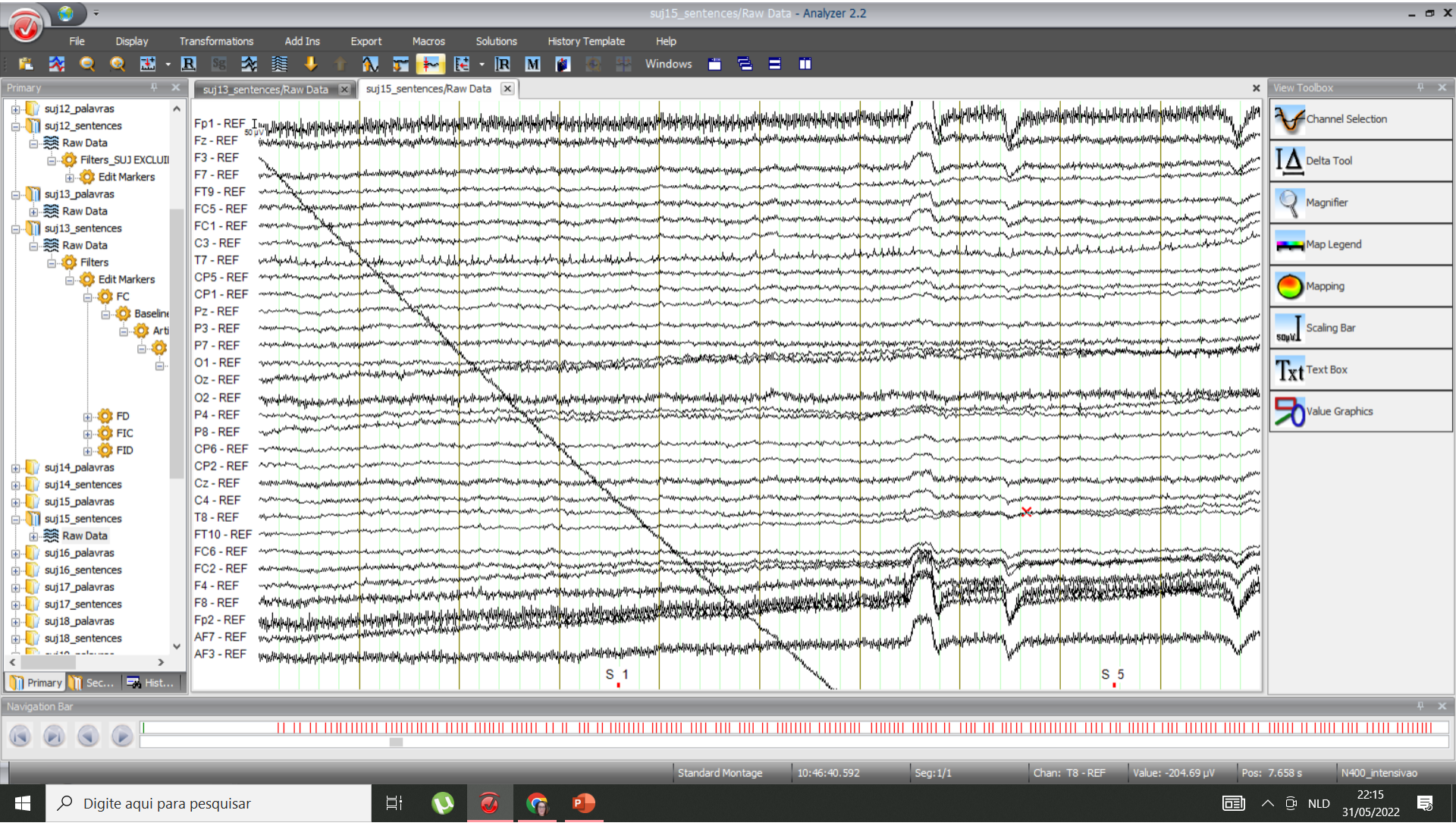
The electrode was improperly placed or didn’t have contact with the scalp
(if working with wet electrodes) Two or more channels were bridged
(if working with wet electrodes) The electrode got saturated.

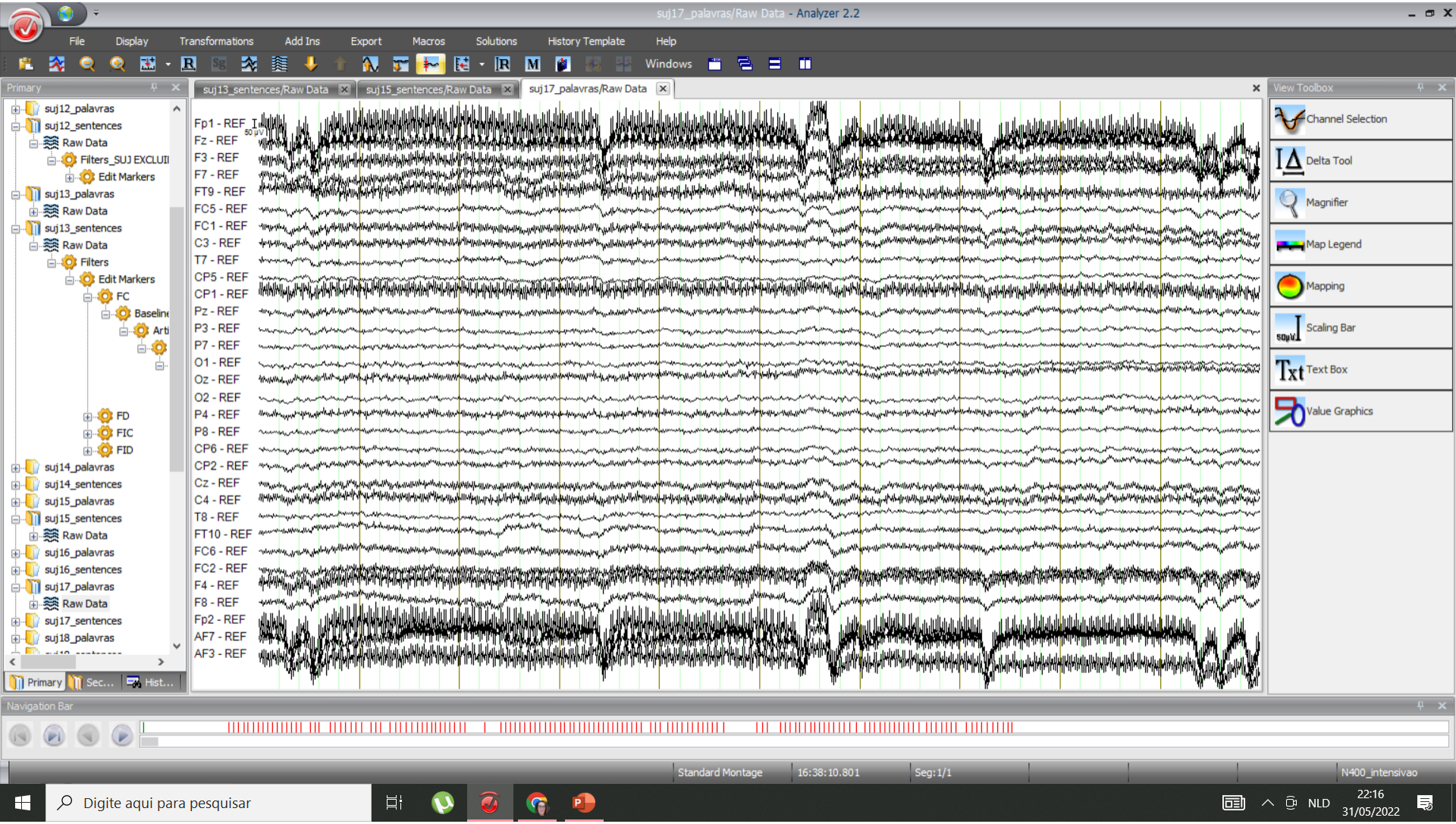
3.2. How to spot a bad channel

You can detect bad channels even before you have finished collecting the data. For example, if you know one of the channels was not functioning properly or if you noticed that one of the electrodes lost contact with the scalp during the experiment, you can mark it to be excluded from analysis.

The most common way of detecting bad channels after the data has been collected is by visualizing the raw data.

Now you can look for channels that either have no signal (a flat line) or seem significantly noisier than others.




suj17_palavras/Raw Data - Analyzer 2.2
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suj15_sentences/Raw Data
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Fz - REF
F3 - REF
F7 - REF
FT9 - REF
FC5 - REF
FC1 - REF
C3 - REF
T7 - REF
CP5 - REF
CP1 - REF
Pz - REF
P3 - REF
P7 - REF
O1 - REF
Oz - REF
O2 - REF
P4 - REF
P8 - REF
CP6 - REF
CP2 - REF
Cz - REF
C4 - REF
T8 - REF
FT10 - REF
FC6 - REF
FC2 - REF
F4 - REF
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AF3 - REF
View Toolbox
Channel Selection
Delta Tool
Magnifier
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Mapping
Scaling Bar
Text Box
Value Graphics
Navigation Bar
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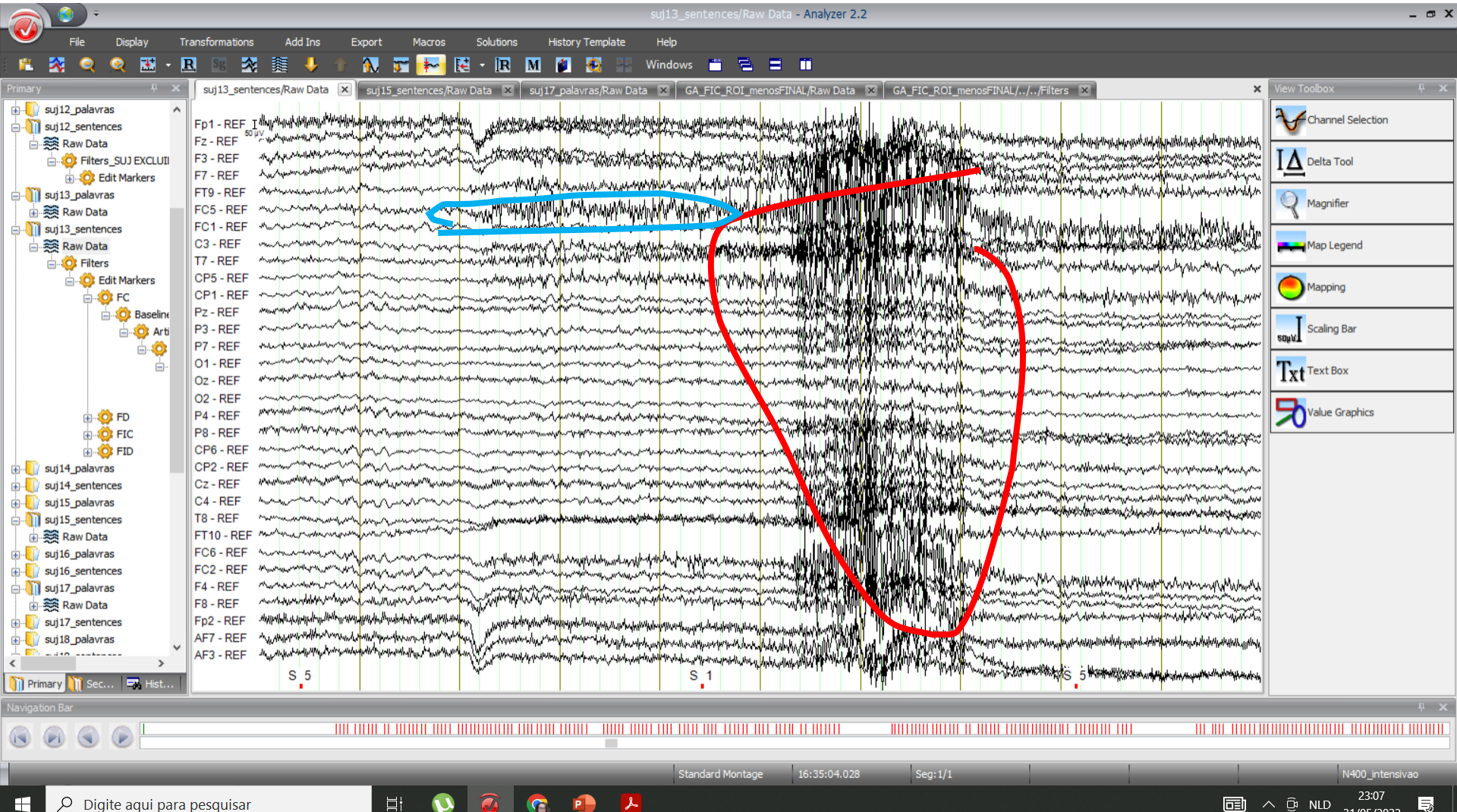
16:38:10.801
Seg:1/1
N400_intensivao
Digite aqui para pesquisar
NLD
22:16
31/05/2022

Note that the decision to remove a channel post-hoc because of high noise level can be a bit arbitrary - use your experience and judgement to determine how much noise is appropriate.

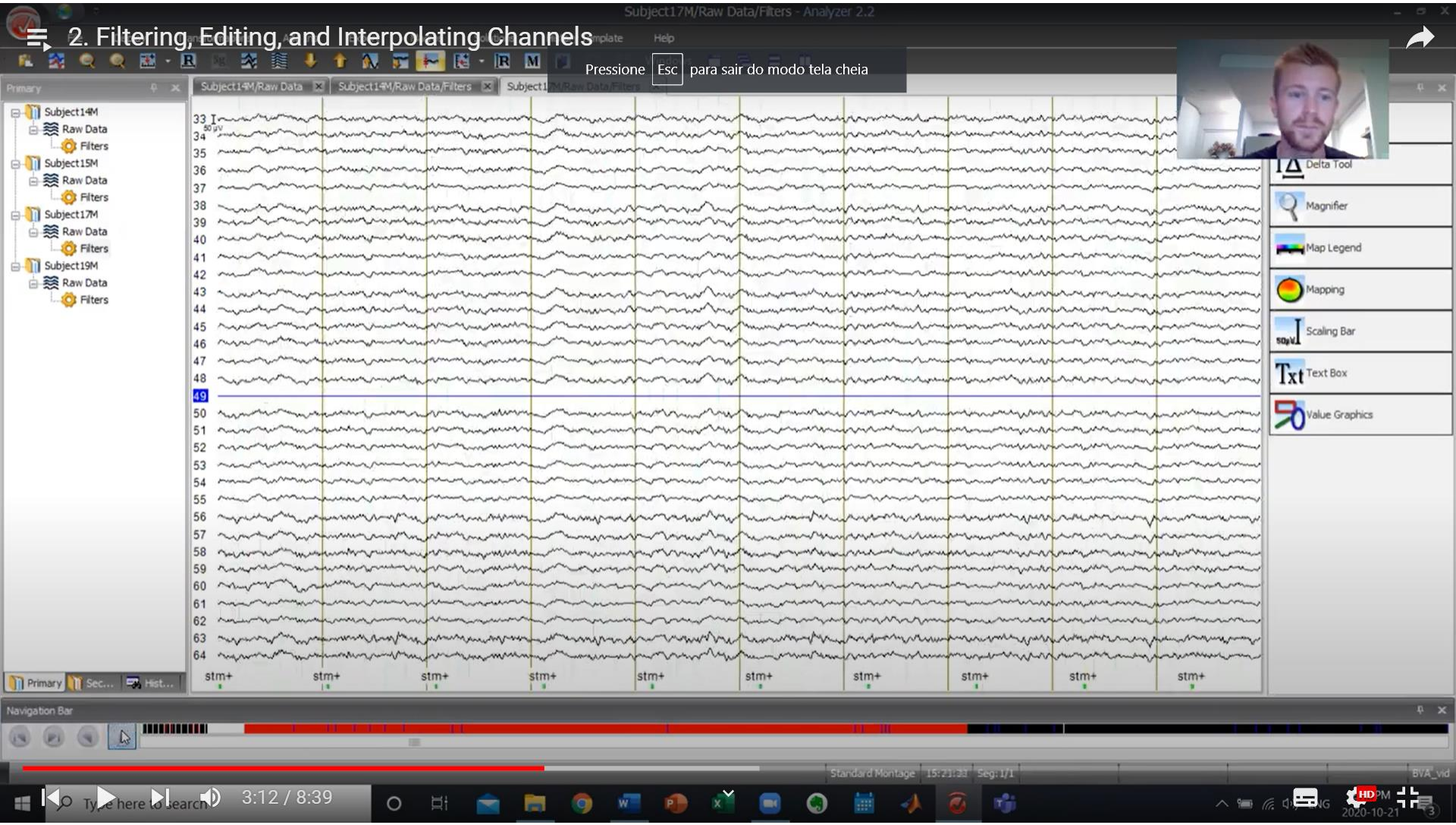
Como chegar à decisão?

- Distinguir distorção temporária de constante

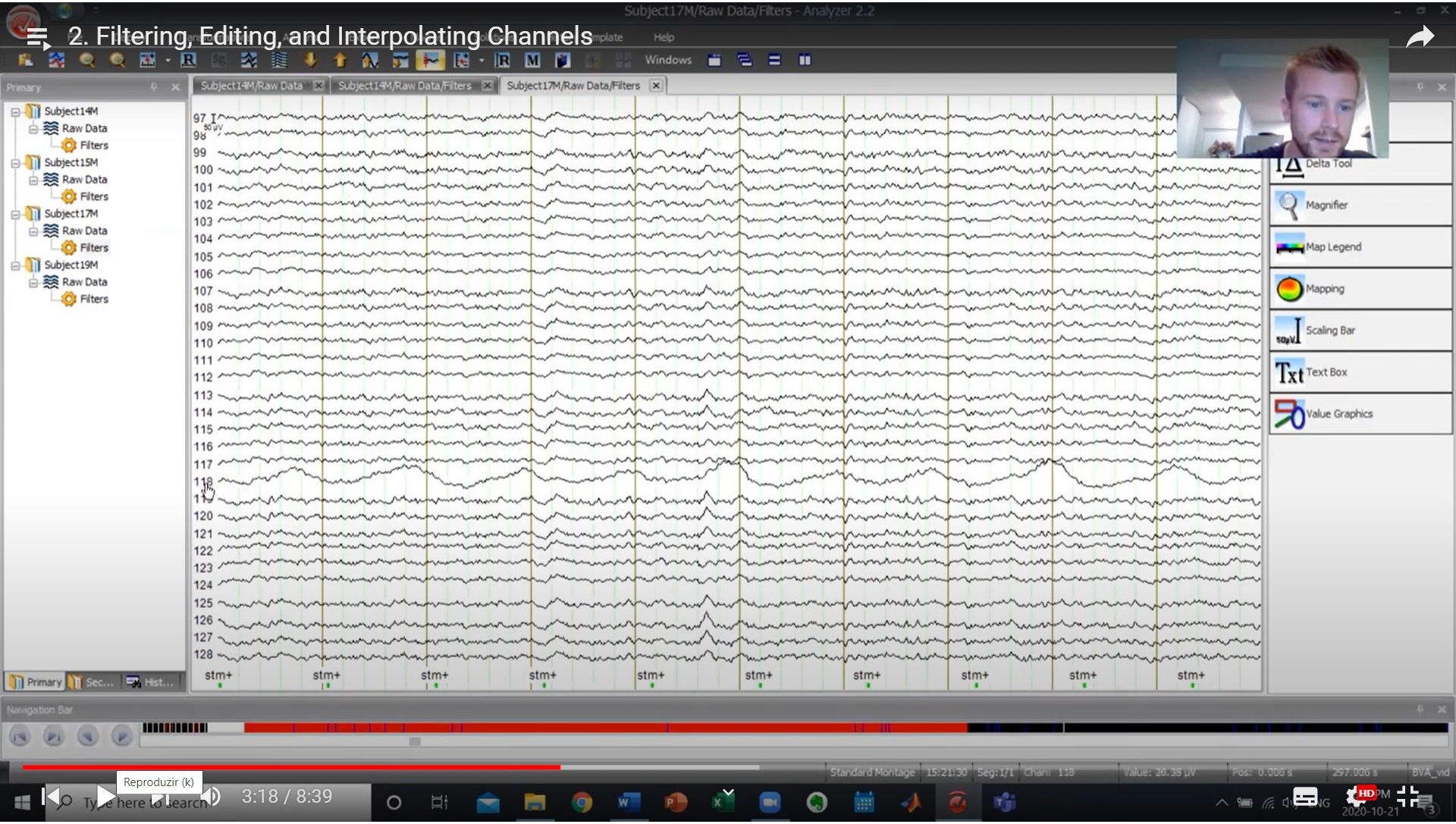


Como chegar à decisão?

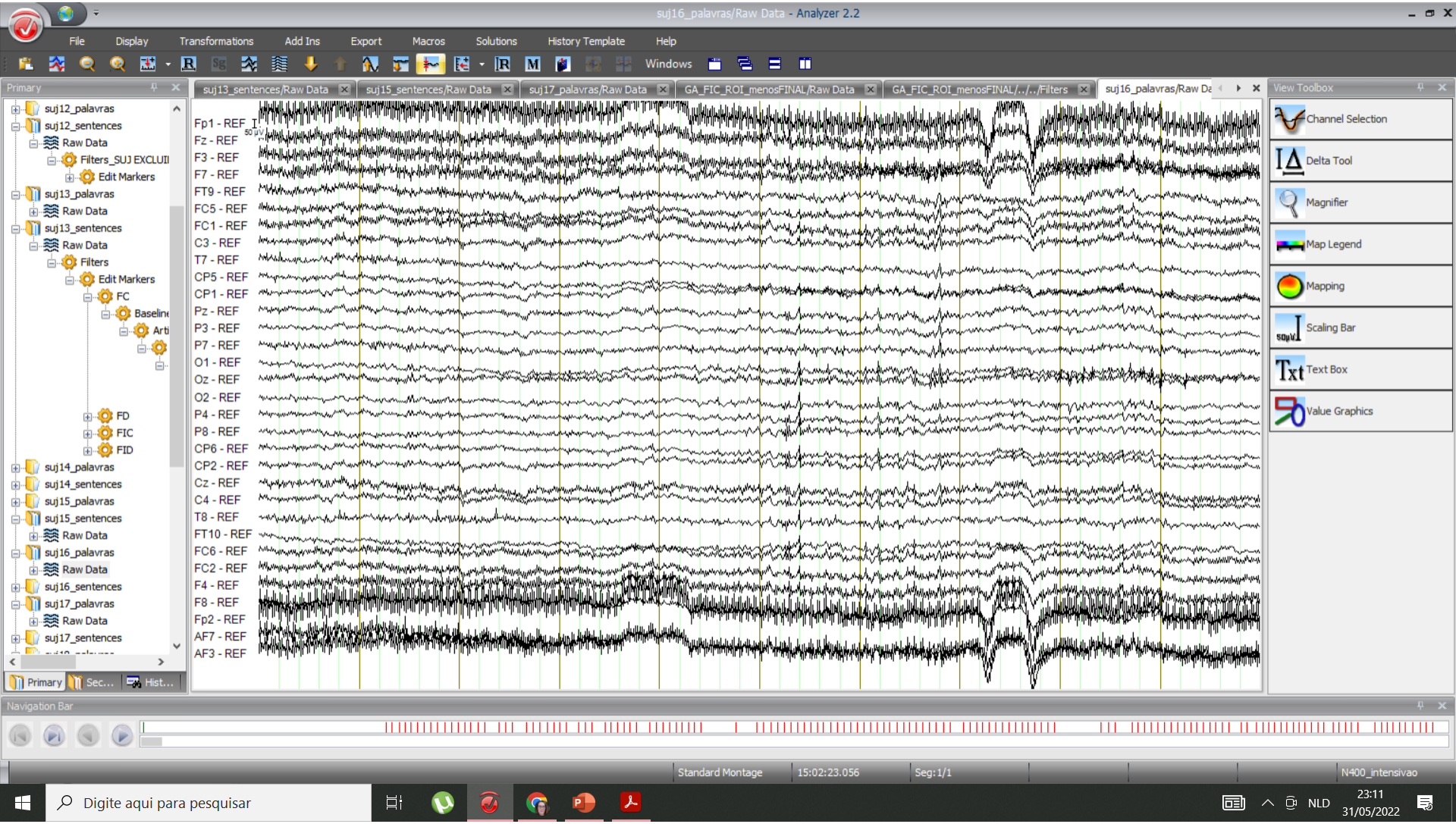
- Canal não gravou



- Canal mostra um padrão atípico



- Canal é ruidoso

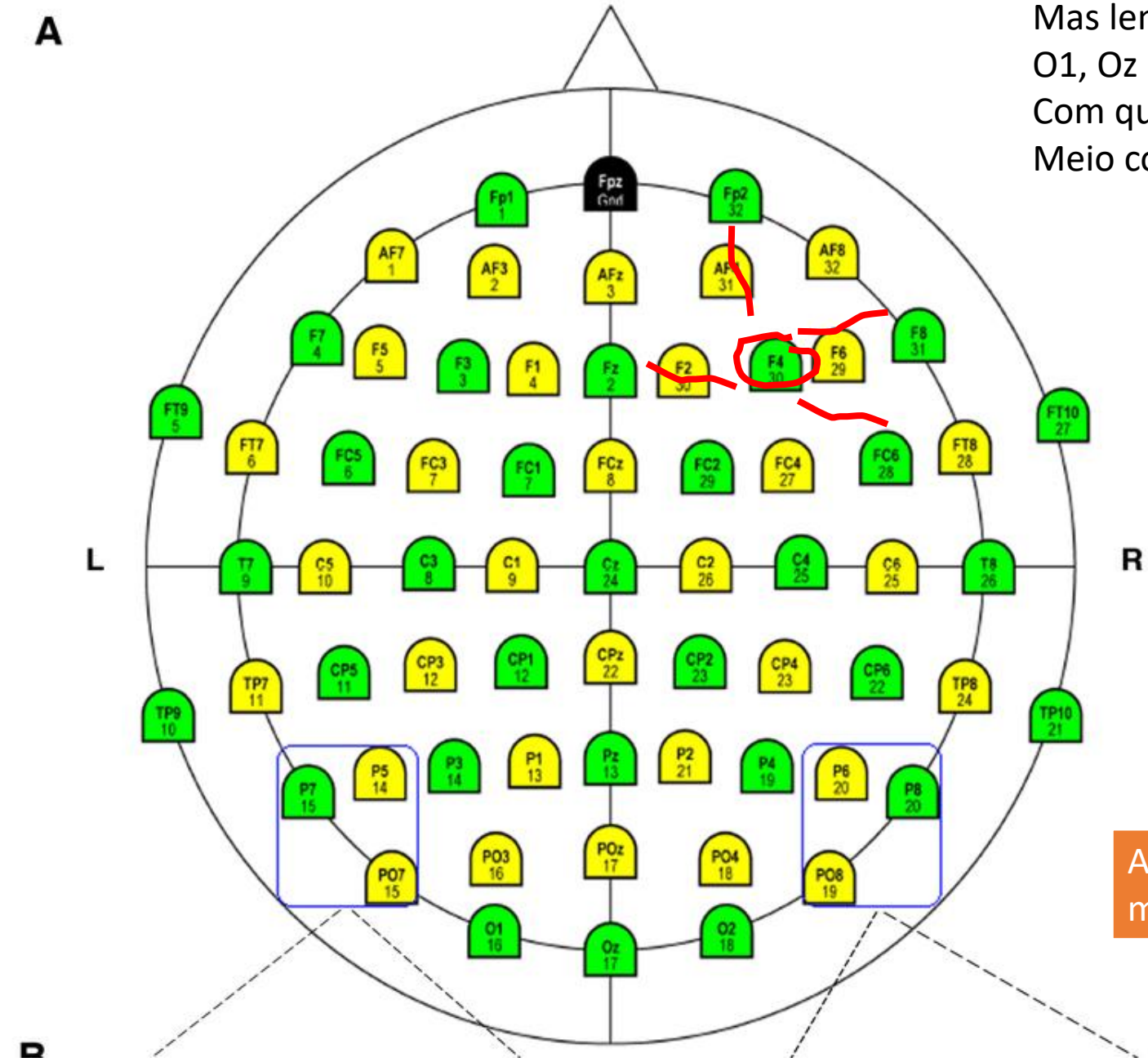


Edit channels (Analyzer)

Depois -> Interpolate channels

it is common practice to interpolate data for the bad channels based on the data from the good channels. Interpolation is a way of filling in the missing data based on the other data available.

There are a few ways of interpolating EEG data, but by far the most common is interpolation by spherical splines. -> ou pega média de canais ao redor



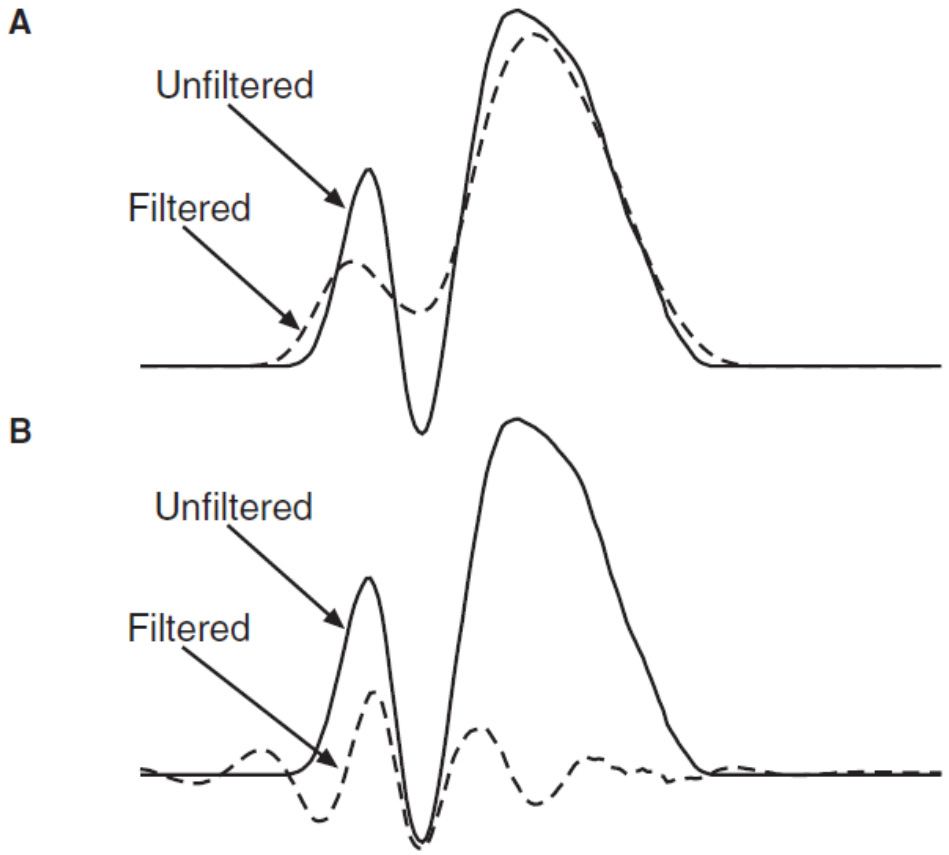
Mas lembre ontem?
O1, Oz e O2 estavam ruins?
Com que canal vai interpolar?
Meio complicado!

Anote essas modificações!

Filtragem

Any waveform can be decomposed into a set of sine waves of various frequencies and phases, and the waveform can be reconstructed by simply summing these sine waves together. Filters are usually described in terms of their ability to suppress or pass various different frequencies. The most common types of filters are: (1) low-pass filters, which attenuate high frequencies and pass low frequencies; (2) high-pass filters, which attenuate low frequencies and pass high frequencies; (3) bandpass filters, which attenuate both high and low frequencies, passing only an intermediate range of frequencies; and (4) notch filters, which attenuate some narrow band of frequencies and pass everything else.

filters can significantly distort
ERP waveforms, changing the amplitude and timing of the ERP components and adding artifactual peaks. (Luck, 2002)

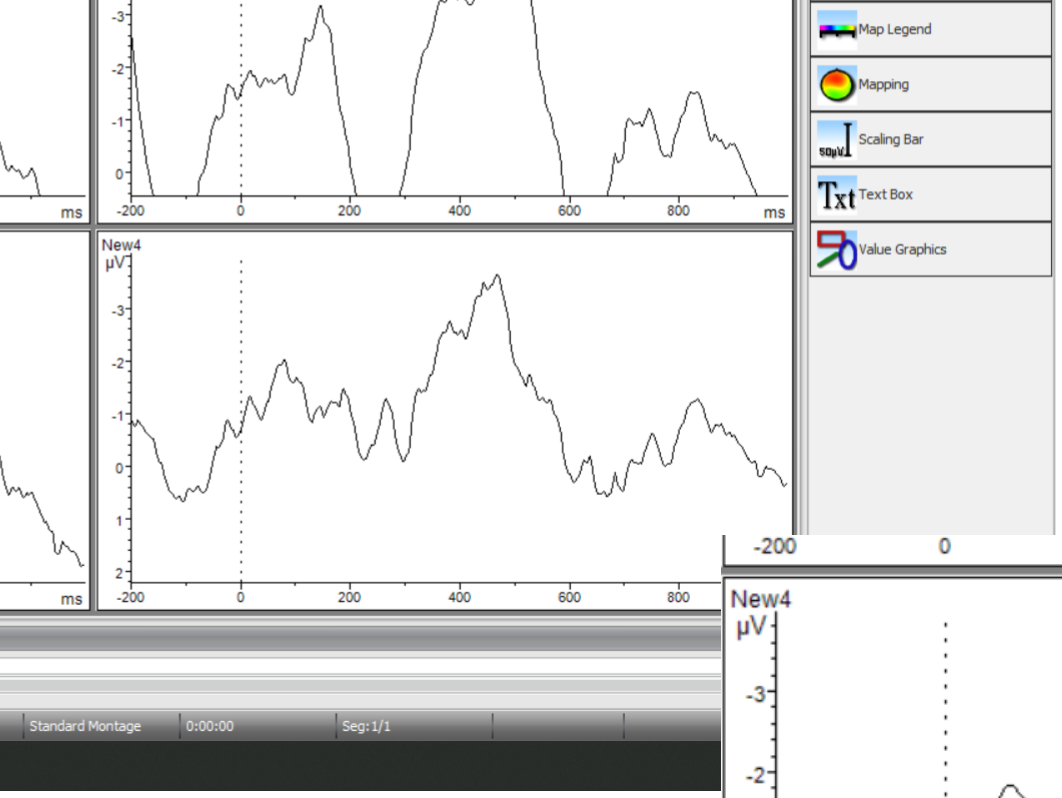


Luck's recommendations:

- "First, keep Hansen's Axiom in mind: There is no substitute for clean data"
- "Second, during the amplification and digitization process, you should do as little filtering as possible. It's always possible to filter the data more offline, but you can never really ''unfilter'' data that have already been filtered."
- For experiments with highly cooperative subjects (e.g., college students), I would recommend using a high-pass filter of 0.01 Hz. Some amplifiers allow you to do no high-pass filtering at all (these are called DC recordings)" -> if you use a higher high-pass cutoff, be aware that this is distorting your data somewhat and reducing the amplitude of the lower frequency components, such as the P3 and N400 waves.

Actichamp: Maximum bandwidth of the EEG channels: DC up to 7,500 Hz

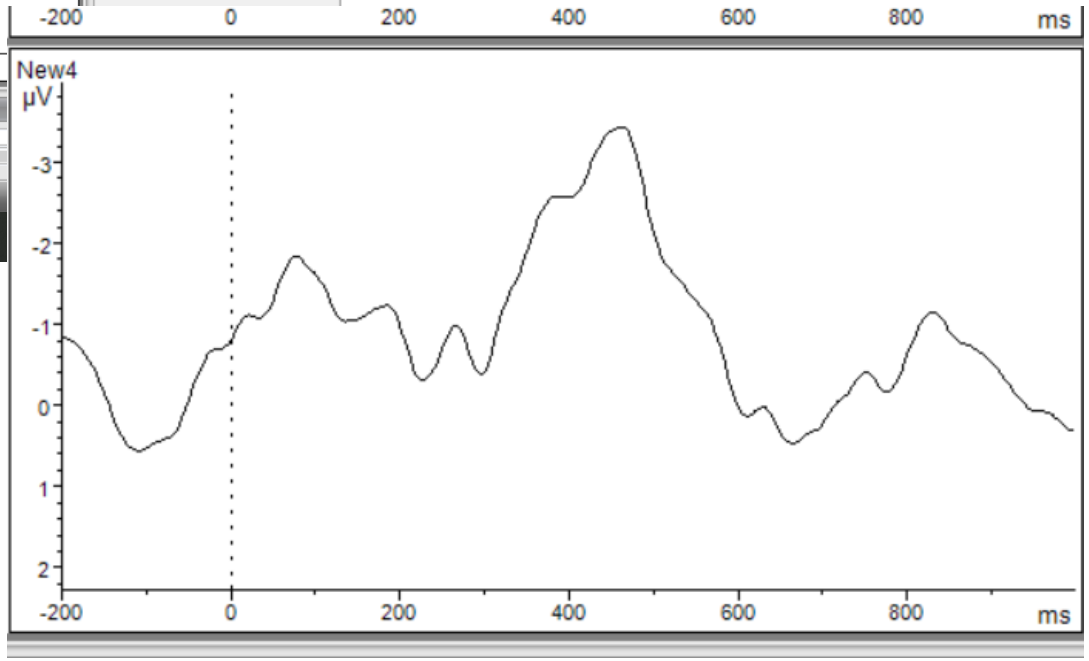
- During amplification, you should avoid using a notch filter (also called a line-frequency filter) to reduce line-frequency noise. These filters can cause substantial distortion of the ERP waveform.
- My third recommendation is to keep offline filtering to a minimum. (…) a low-pass filter with a half-amplitude cutoff somewhere between 20 and 40 Hz (…) can dramatically improve the appearance of the ERP waveforms when you plot them, and the temporal distortion should be minimal (...) This sort of filtering will also be helpful if you are using **peak amplitude** or **peak latency** measures, but it is unnecessary if you are using **mean amplitude** or **fractional area latency** measures (see chapter 6 for more details).



Low-pass (passa baixo)

(*ou high cutoff)*

Para visualização, não para análise



*** Filters ***
Butterworth Zero Phase Filters
Low Cutoff: ---
High Cutoff: 15 Hz, 12 dB/oct
Notch Filter: ---

“My fourth recommendation is to avoid using high-pass filters altogether (except during data acquisition, as described above). High-pass filters are much more likely than low-pass filters to cause major distortions of your ERP waveforms that might lead you to draw incorrect conclusions about your data.”

(contrário ao cara no video que corta logo 1Hz)

- *Eu faria:*

**** Filters ****
Butterworth Zero Phase Filters
Low Cutoff: ---
High Cutoff: 30 Hz, 12 dB/oct
Notch Filter: 60 Hz
(foge a lógica filtrar 60Hz de novo?)

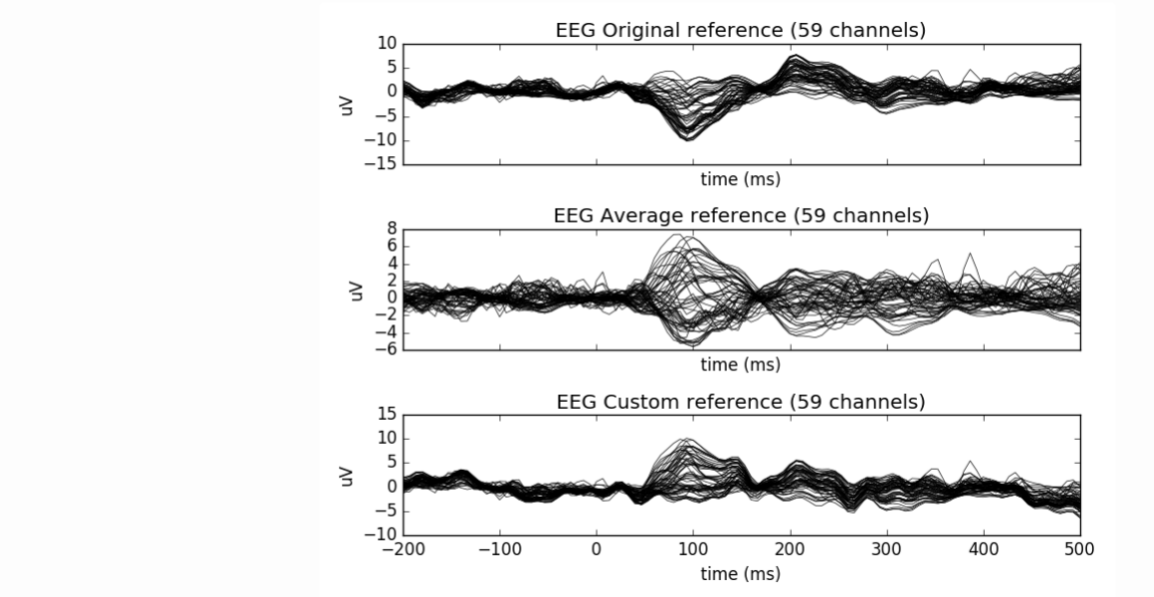
long-latency ERP components consist
primarily of power under about 30 Hz, making a 30–100 Hz cutoff appropriate and allowing high-frequency muscle activity to be filtered without much distortion of the underlying ERP waveform.
However, there is almost always some overlap between the frequencies in the ERP waveform and in the noise, and some filter induced distortion is therefore inevitable.

“There is no substitute for good data.”

Re-referencing

6.1. What is referencing?

In EEG data, the voltage for each electrode is recorded relative to other electrodes. The ‘reference’, which can be one or a combination of electrodes, is what the voltage will be relative to. This means that neural activity at the reference electrode will also be reflected in all the other electrodes, which could contaminate your signal. This also means that your choice of reference will have a critical impact on your data, as illustrated below:



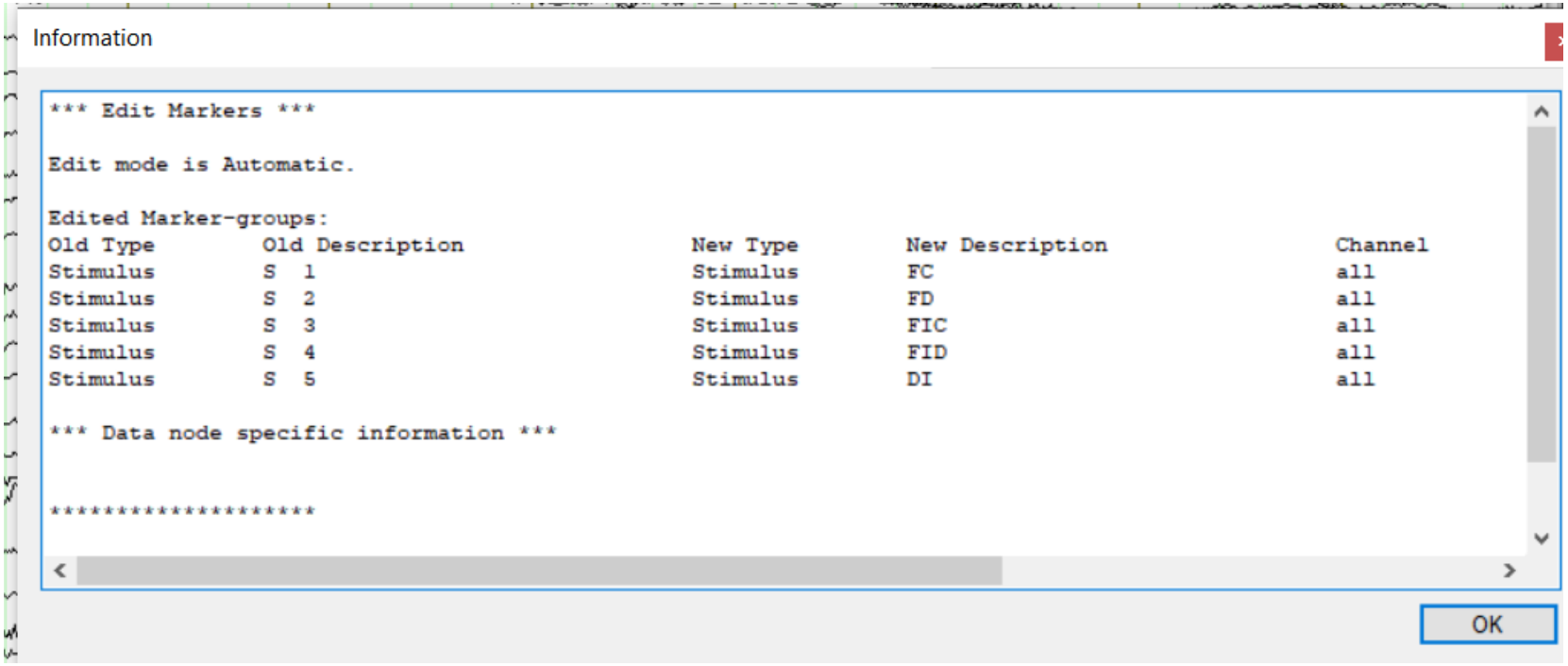
How are references chosen?
When picking a reference, it is important that the electrode(s) that you're selecting as a reference have as little influence on the locations of your signal of interest as possible. In practice, this means that either the references are **located far away** from the signal of interest or **an average of several electrodes** is used.

Some common choices of reference include:
•**Mastoids** Either one of the mastoids or the average of the two mastoids can be used.
•The average of the two **earlobes** is also commonly used, for similar reasons as the mastoids.
•Cz (the central electrode) is frequently chosen **when looking at activity that is distant from that location.**
•The average of all electrodes (also known as Common Average Reference). However, using this reference only makes sense with systems that have **enough channels so that the overall activity averages to 0 [somando neg e pos]**. If you have less than 32 channels, consider using a different reference instead.

Rereference?

Segmentar

Para segmentar, eu preciso saber qual é o significado dos marcadores.



Prepare uma tabela, cheque, cheque e double check!!!
Neste momento um erro é catastrófico.

Segmentar (para cada condição)

*** Segmentation ***
Segmentation relative to reference marker positions
Reference markers:
   Stimulus   FC
Advanced Boolean Expression:

Segment size and position relative to reference markers:
Start: -200.00 ms, End: 1000.00 ms, Length: 1200.00 ms
Allow overlapped segments? Yes
Skip bad intervals?   Yes

Data was cached to a persistent file.
Cache content will be calculated on request.

*** Data node specific information ***

Number of segments: 30

Rejeição de artefato

Artefatos, exemplos:

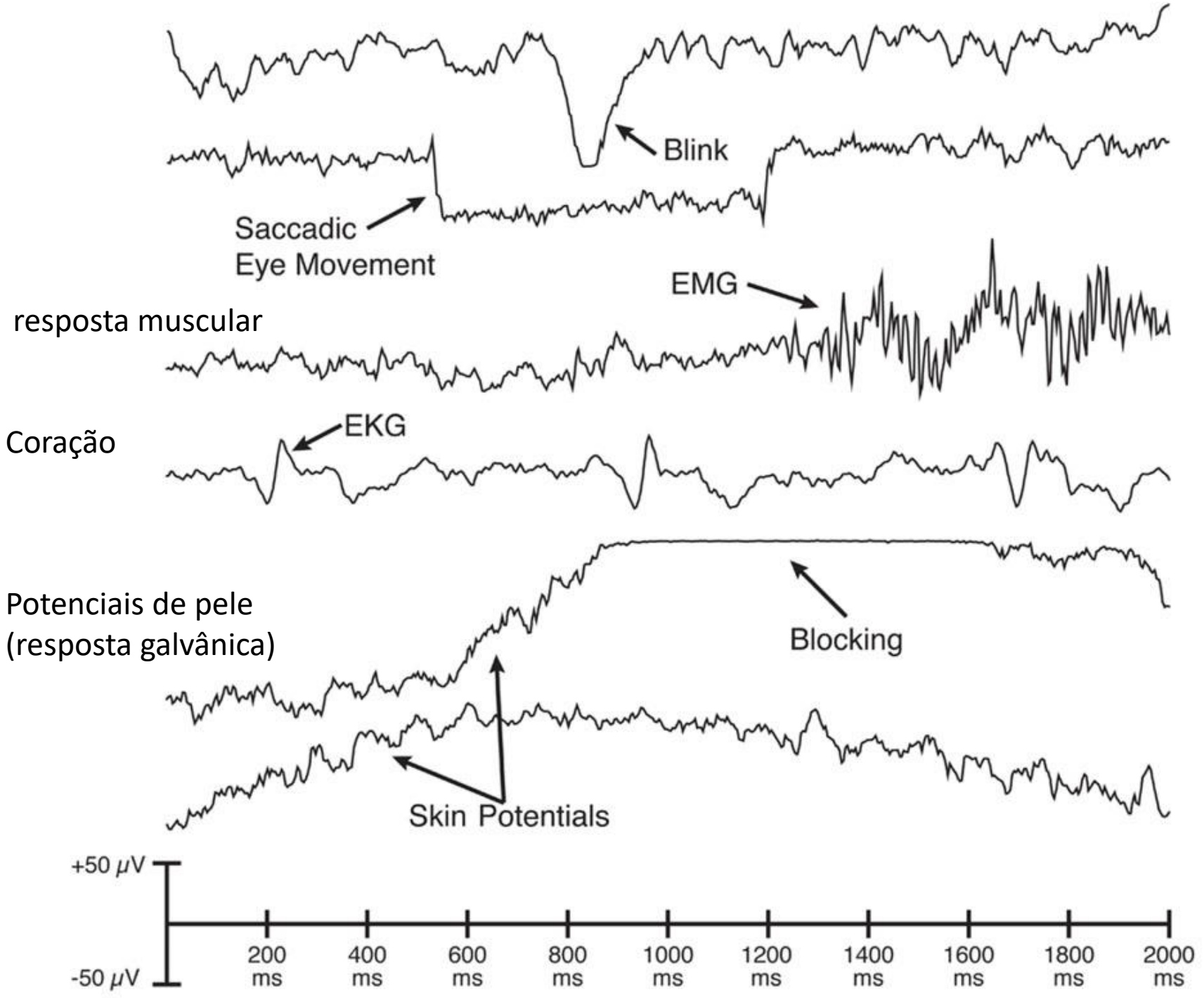
- **ambientais:**
  ex. 60 Hz, da rede elétrica (NOTCH filter)

"The influence of environmental artifacts can also be somewhat reduced by using active electrodes (electrodes that have an additional low-noise amplifier inside)"

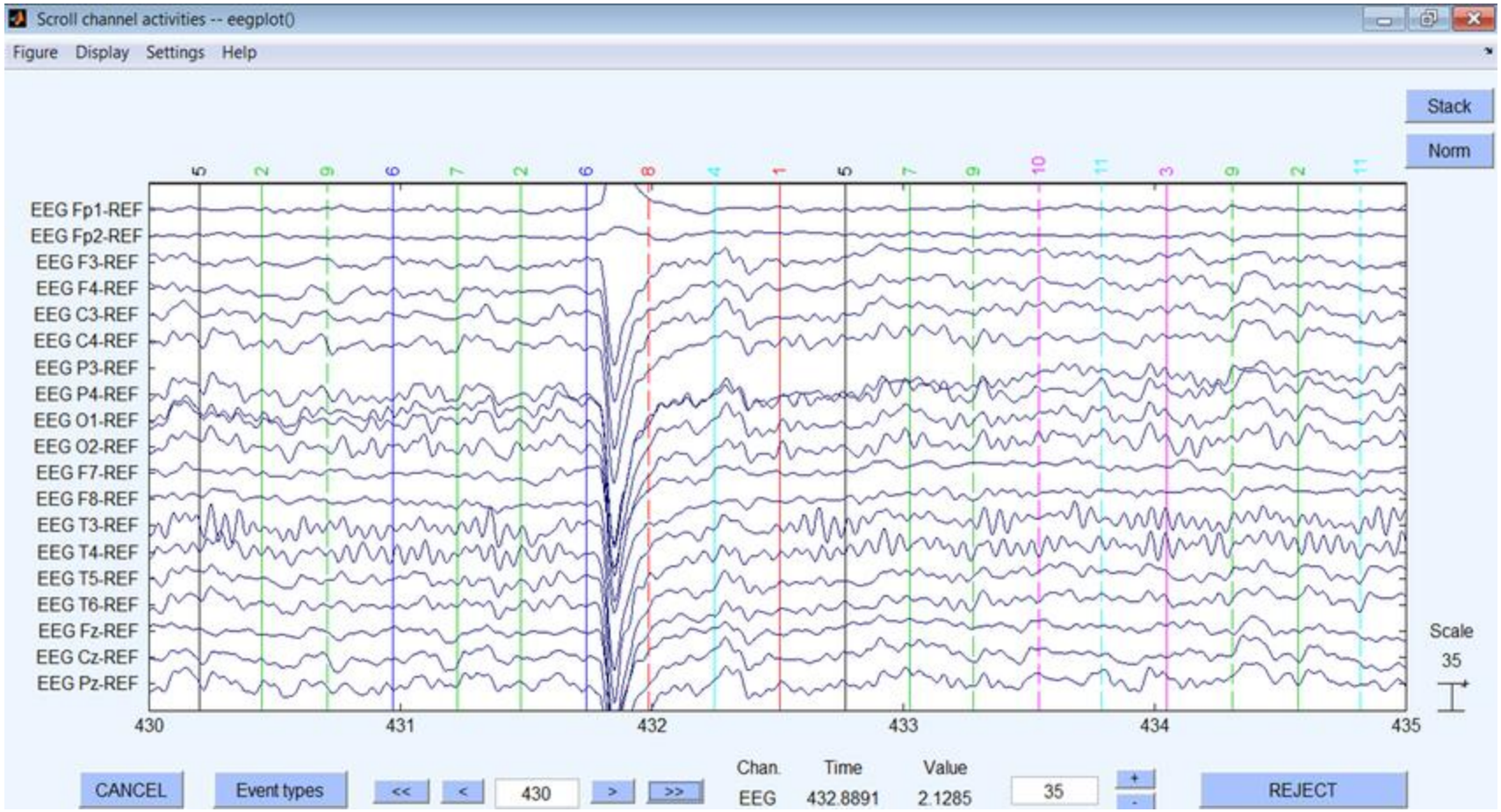
- **biológicos:**

"blinks, eye movements, head movements, heart beats and muscular noise. It is possible to detect those artifacts if you have access to other biometric data, for example, accelerometer, electrooculogram (EOG) or eye tracking data for eye movement artifacts, accelerometer data for head movement artifacts and electrocardiogram (ECG) data for heartbeat artifacts."

- **outros:** ex. ondas alfa


Blink
Saccadic
Eye Movement
EMG
resposta muscular
EKG
Coração
Potenciais de pele
(resposta galvânica)
Blocking
Skin Potentials
+50 μV
-50 μV
200 ms
400 ms
600 ms
800 ms
1000 ms
1200 ms
1400 ms
1600 ms
1800 ms
2000 ms

piscada


Scroll channel activities -- eegplot()
Figure Display Settings Help
Stack
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EEG Fp1-REF
EEG Fp2-REF
EEG F3-REF
EEG F4-REF
EEG C3-REF
EEG C4-REF
EEG P3-REF
EEG P4-REF
EEG O1-REF
EEG O2-REF
EEG F7-REF
EEG F8-REF
EEG T3-REF
EEG T4-REF
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EEG T6-REF
EEG Fz-REF
EEG Cz-REF
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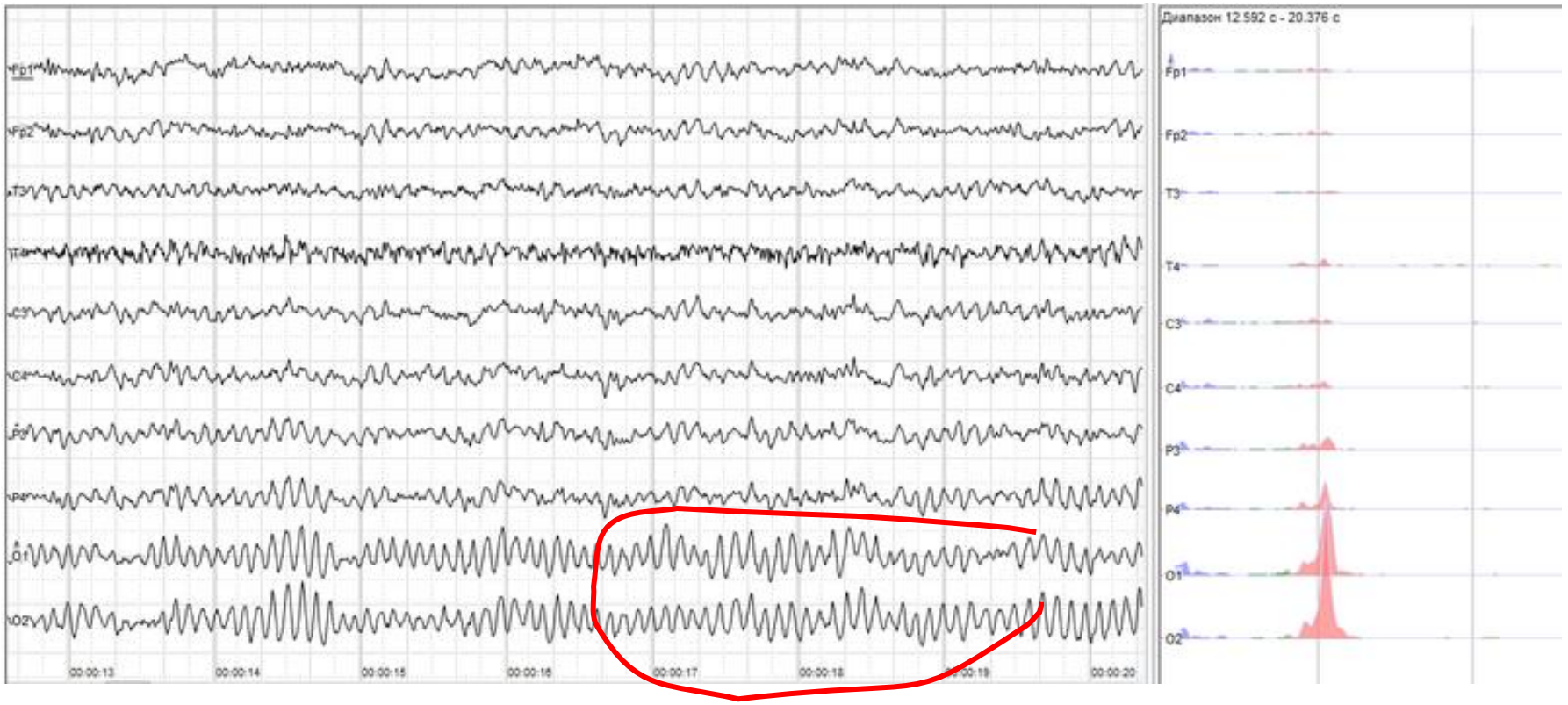
alfa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00:00:18
00:00:19
00:00:20

No youtube:

- Método de subtração (de piscada medida)
- Rejeição de artefato baseado em níveis de microV

Nós faremos manualmente, mas com a ajuda da detecção (interessante tb *teste – indica %)*

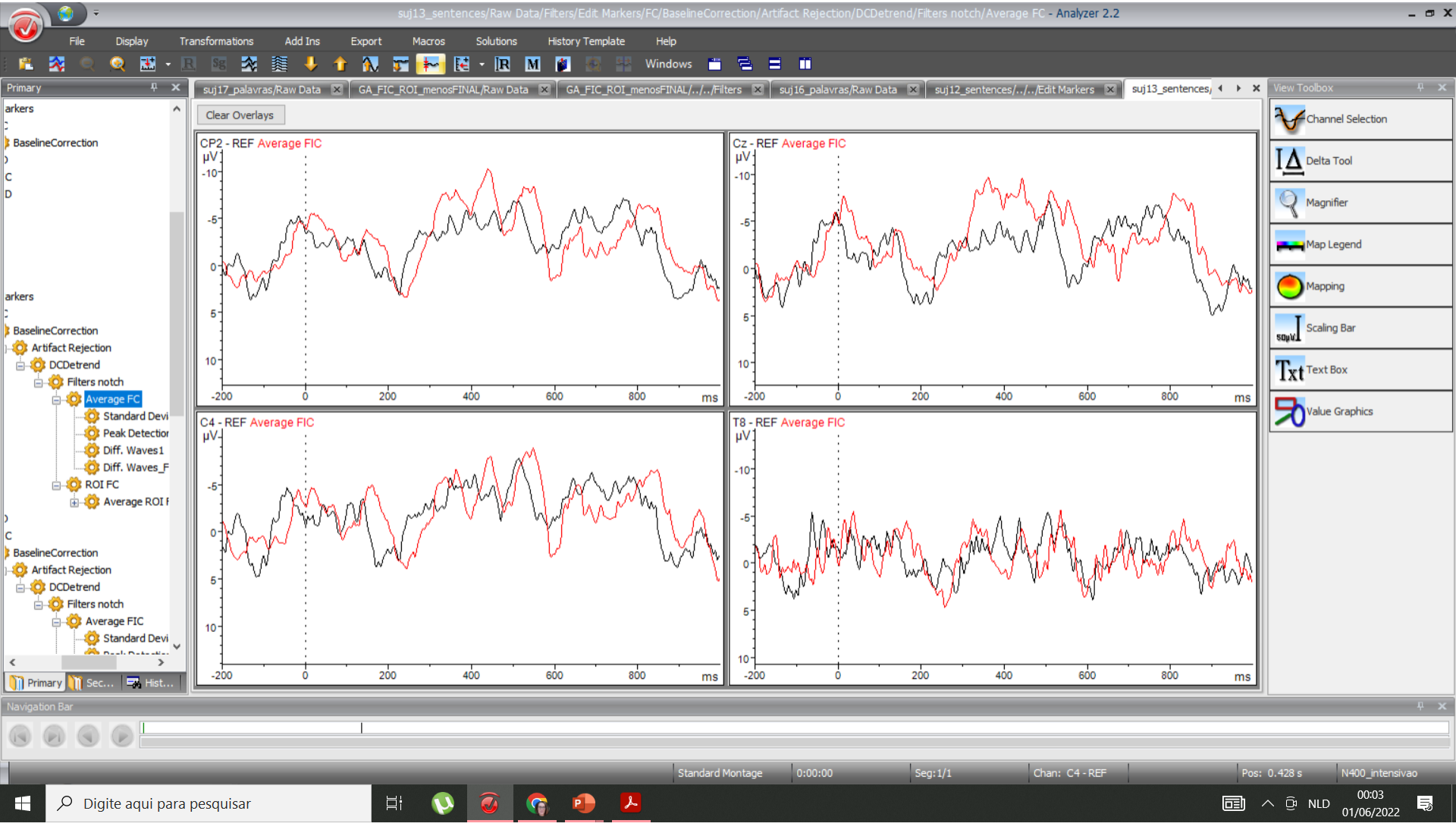
- *Ele faz retirar piscada - baseline correction – depois artefact rejection*

- *Eu fiz baseline correction – depois artefact rejection (incluindo piscada)*

Gostei da explicação dos níveis de limiares do Jonah Kember, mas nós faremos inspecção semi-automática.

Average por participant

(lembrar de inverter escala, no file-preferences)



Average por participant -> ROI (region of Interest usando Pooling)

New2: C1 C2
CP1 CP2 CPz Cz

New 4: O1 O2 Oz
PO3 PO4 POz