Introductory Neuroscience and Neuro-Instrumentation
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Indian Institute of Science, Bengaluru
Lecture No. 43
P300 Demonstration with EEGLAB/ERPLAB (2)

Hello everyone. So I was being discussed the P300 demonstration using EEGLAB and ERPLAB. So, I will just start with the demo with the Matlab.

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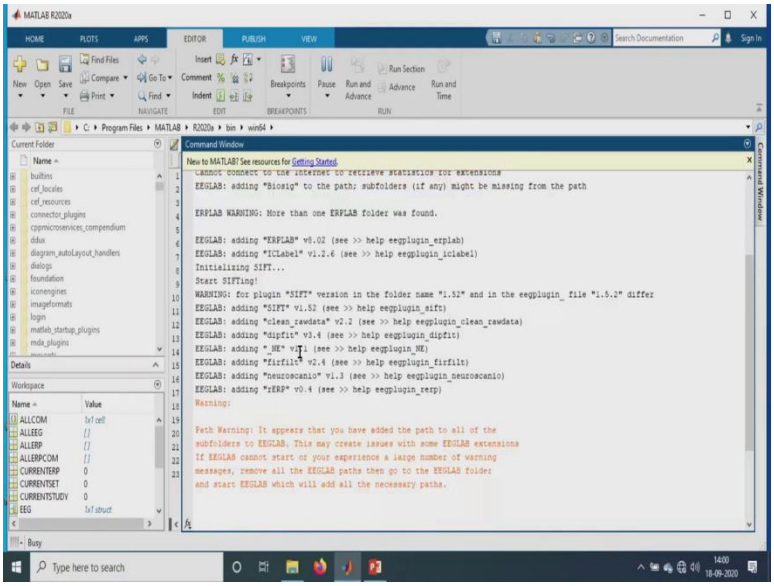

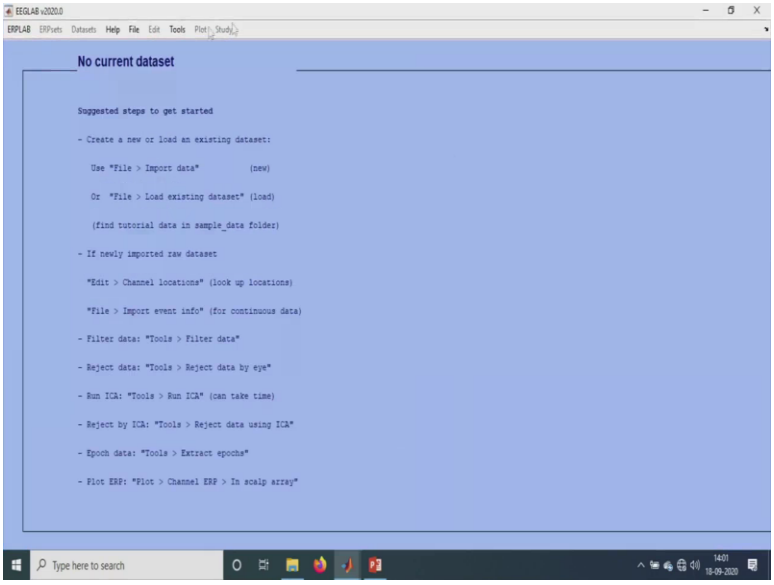

So, as usual, we just initialize the EEGLab and then here also I am using a CNT file obtained from the neuroscan system. So, I will show how the triggers look in this case.

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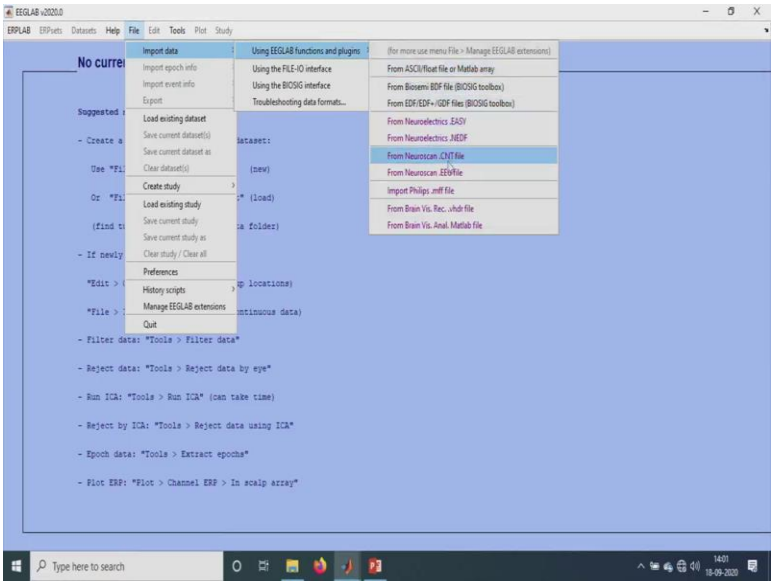

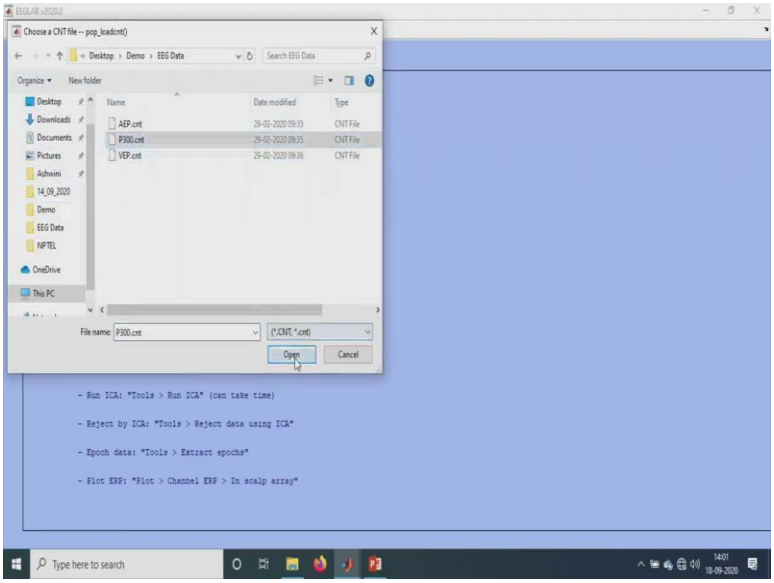

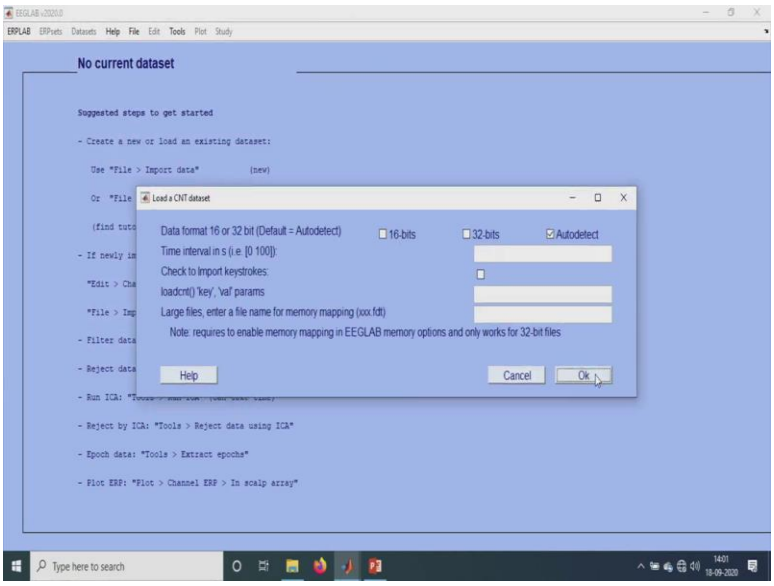

So, I just, first, we have to import the data. Here, I am using the CNT file itself. So, I just click this and then I have the P300 CNT file just open it, I will go with all the default parameters itself.

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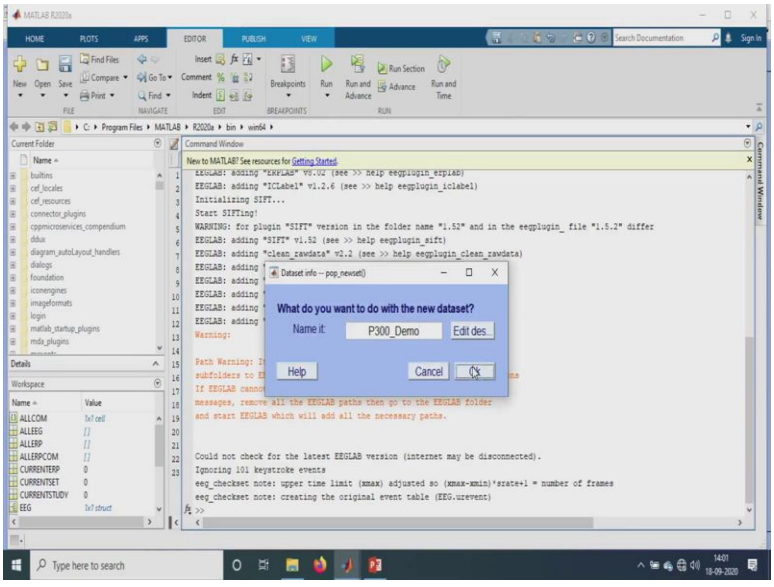

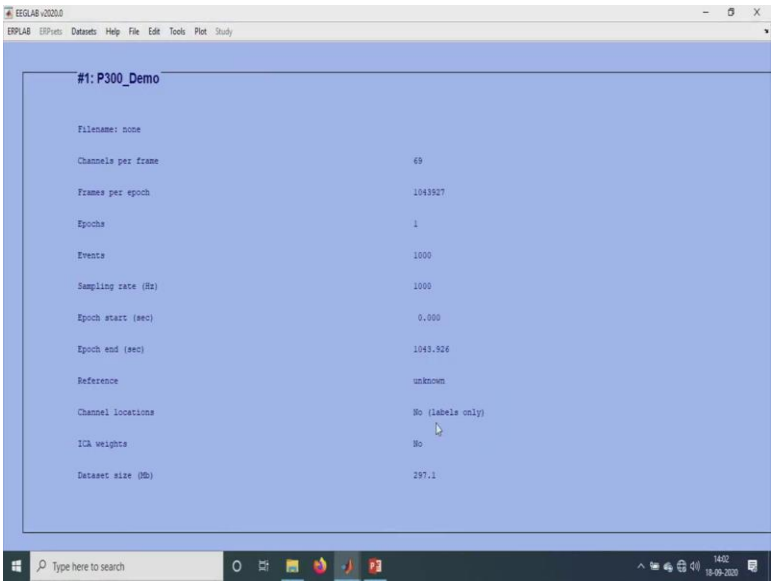

So, here, so over here, we have totally, this is the P300 continuous file. So, here we have the 69 channels including all the trigger channels, all the other channels like the EMG, EEG and everything. Then, we have the epochs, there is no epoching done, so it is similar. Here, the events are 1000. So, as I said, here the 80 percent of these triggers would be standard, that is 800 of them will be standards, 100 of them will be targets and 100 of them will be distracters.

And over here, see the time period, it starts, it is nearly about 1000 millisecond, 1000 or 50 millisecond. So, it takes at least 15 to 20 minutes for this particular experiment to be completed. And then it is huge, because it is having a lot of data, I mean, even the response is also being given so that is why it is a huge data size. Before that, before going to any other step, we have to do the channel locations.

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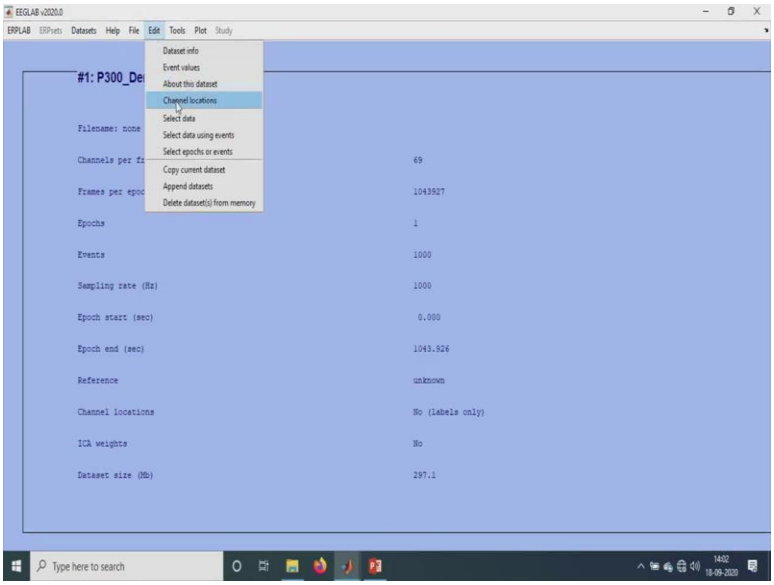

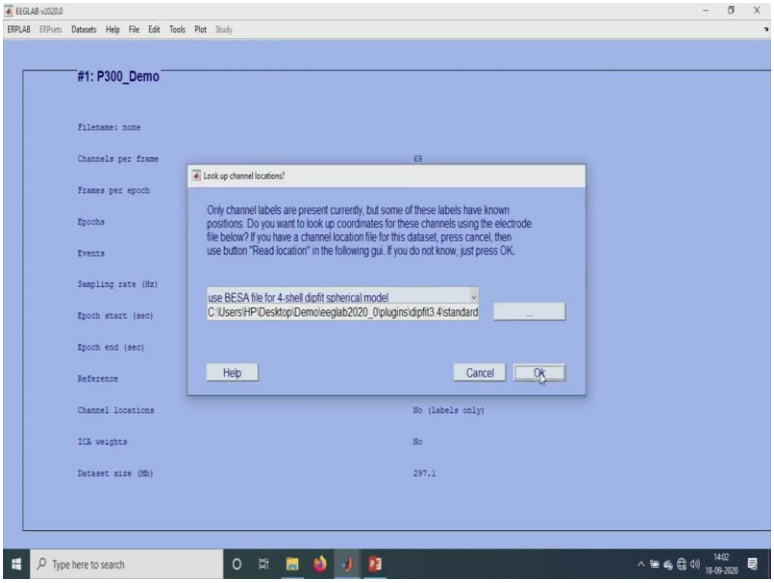

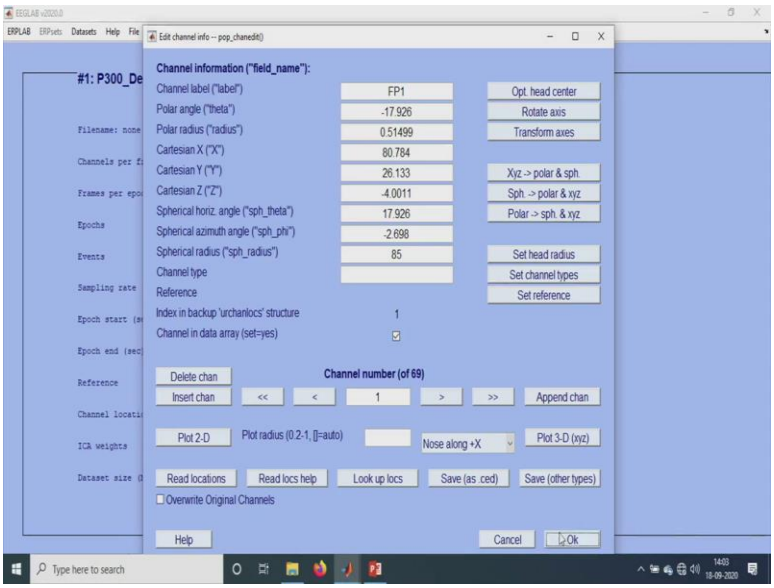

So, here we have the channel locations. Here it is (Berra), the BESA file. It is like the default that is being given. So, it is always the 10-20 system according to that, all this FP1, FP2, CZ, PZ all the electrodes will be given in this and it's like a default channel edit option. So, we will get all the 69 channels being red. So, it is just a default, we can just okay it. So, we have the channel locations been included.

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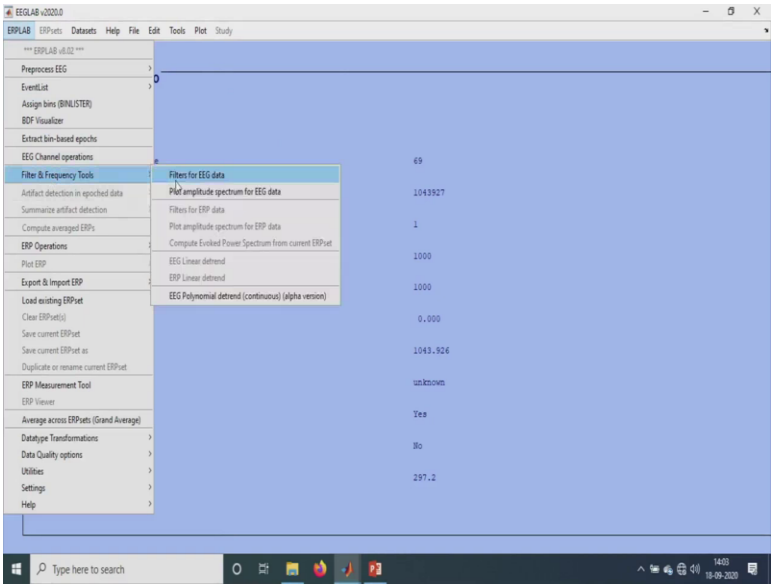

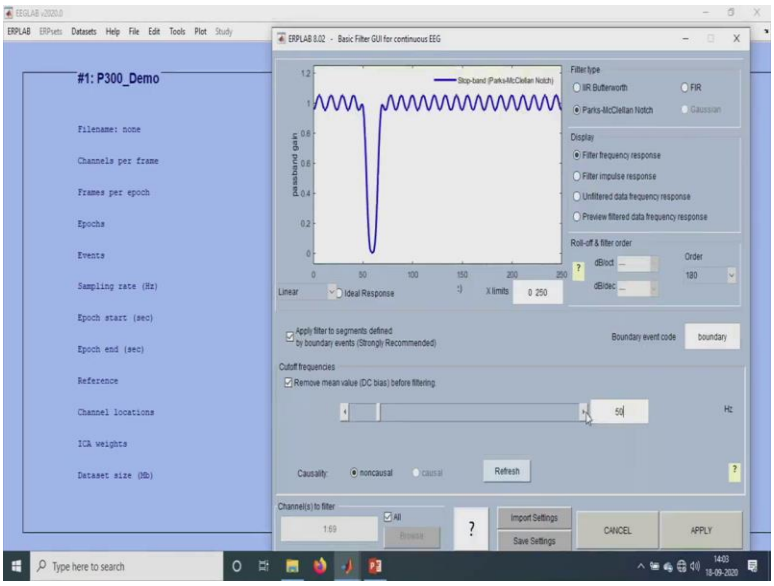

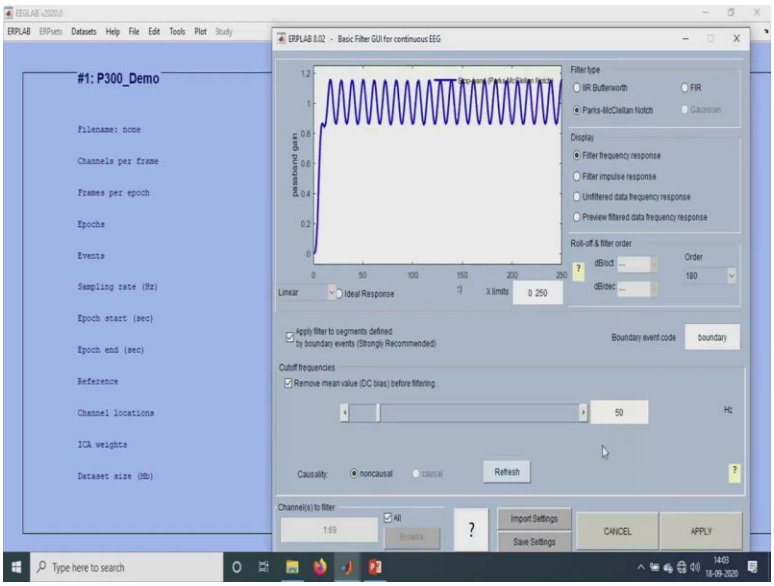

I will just give a small pre-filtering option of this, like I will just do a notch filter of 50 hertz. So, when we do that, our data will look better, good, because it is a raw data and everything, many artifacts and everything will be there. So, all of them will be eliminated. So, it is taking, it is due to a huge data size, it is taking some time for the data analysis, the filtering to be done.

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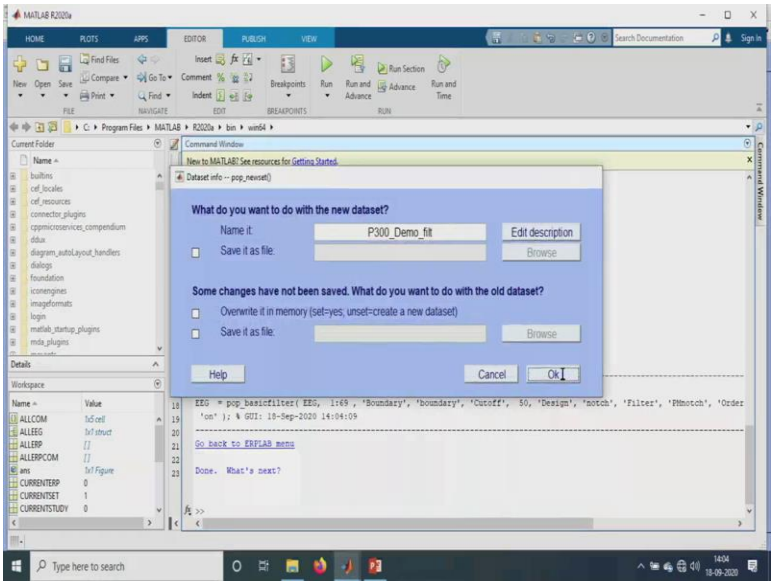

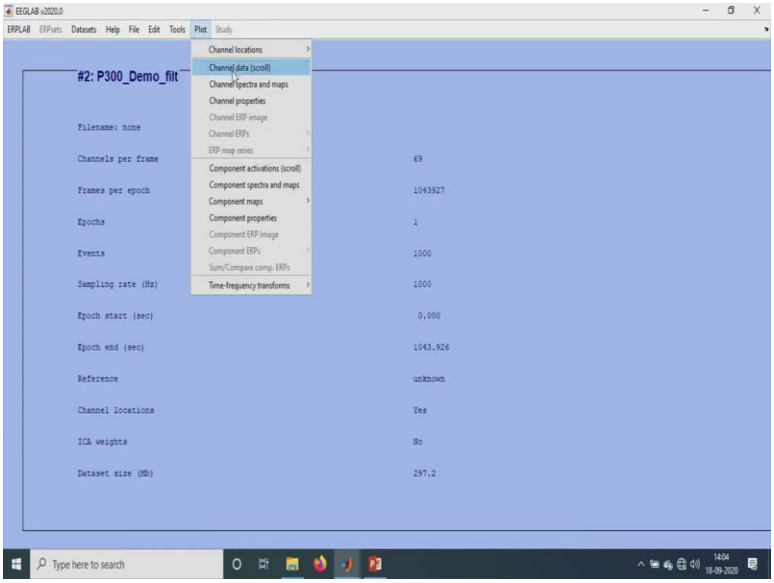

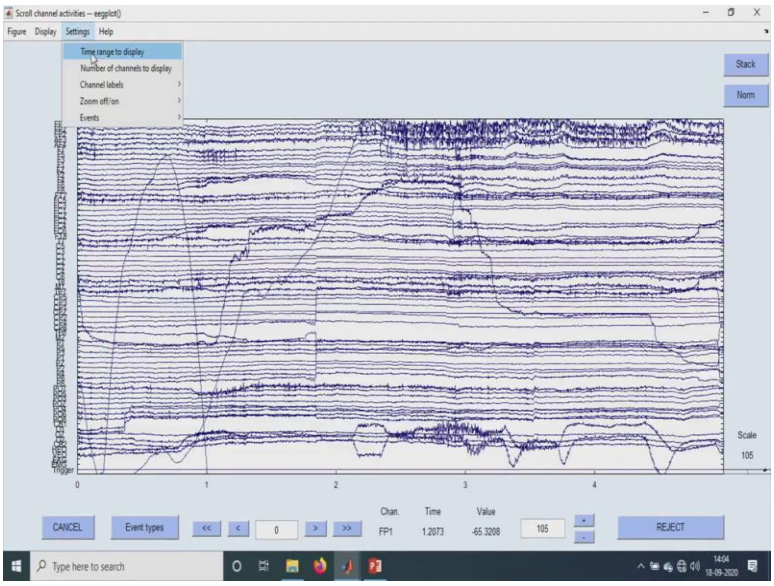
Scroll channel activities -- eegplot()
Figure Display Settings Help
Time range to display
Number of channels to display
Channel labels
Zoom off/on
Events
Stack
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105
Chan. Time Value
FP1 1.2073 -65.3208
CANCEL
Event types
REJECT
Type here to search
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18-09-2020

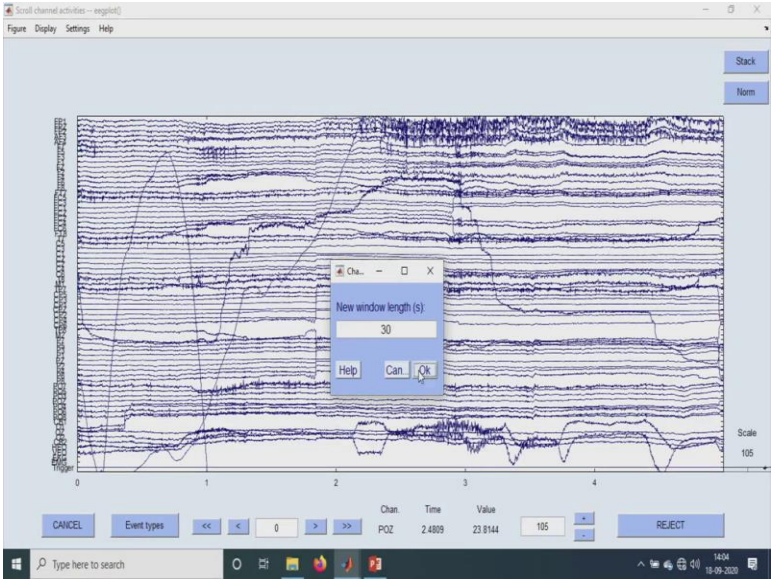
Figure Display Settings Help
Stack
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Event types
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Type here to search
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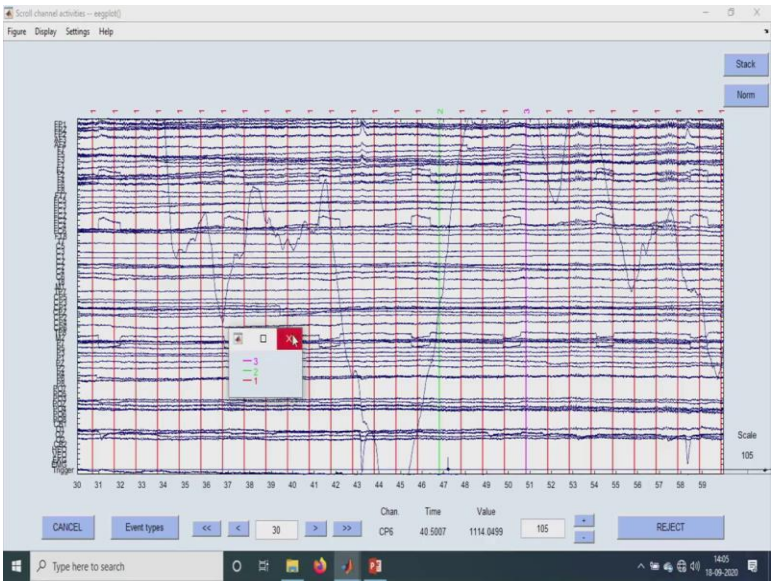

So, here, we have three data sets, three of them, three events are being there. So, we have, we can check that in the scroll data over here. So, now the filtering is being done. I will just show you how it looks in the scroll data. So these are all many artifacts and all are there, which we have to be removed. So, I will just reduce the time frame. So for 30-seconds, I am showing. So over here, if you check, see these ones and all other standards, 2 is the target and over here this 3 is called as the distracter.

So, the red ones, there will be 800 such red lines and 100 of these green and 100 of these violet lines. So, these are the different events that are being there. And actually, we can record the response that is given for this. So, as you see the target, the subject will give a response to this. So that response also can be recorded and been analyzed also, but we mainly want to look for these two and three triggers.

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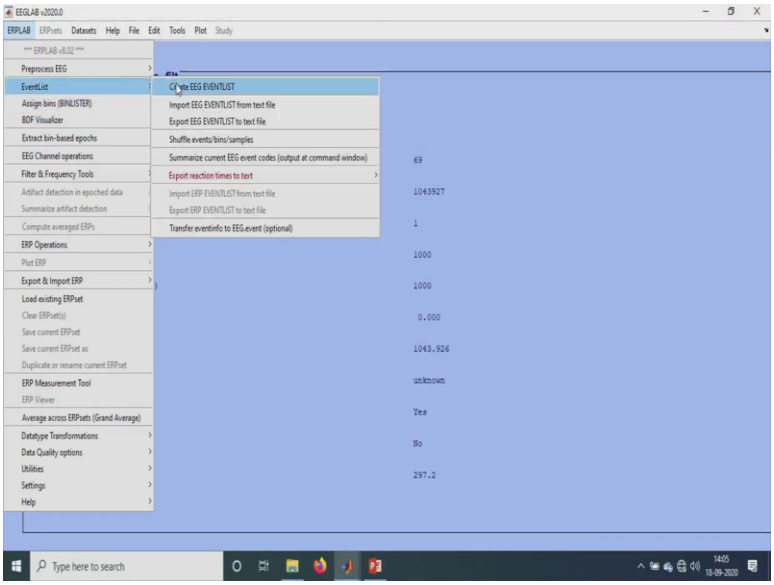
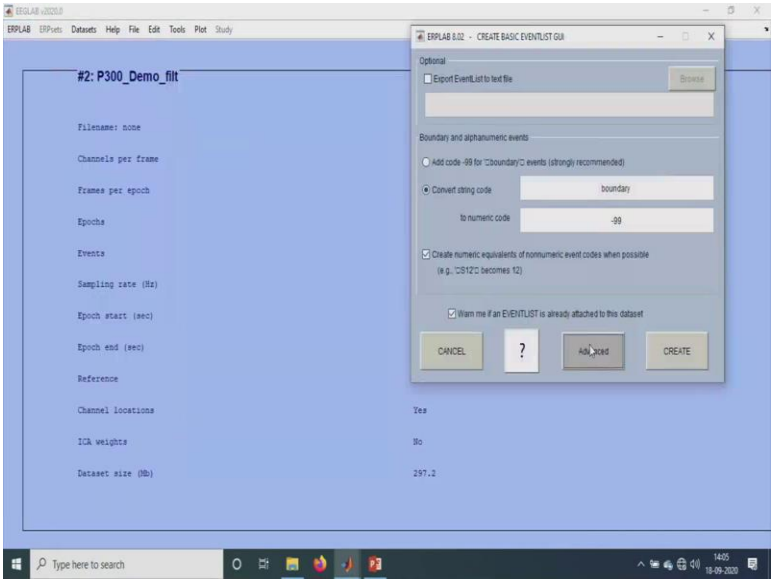
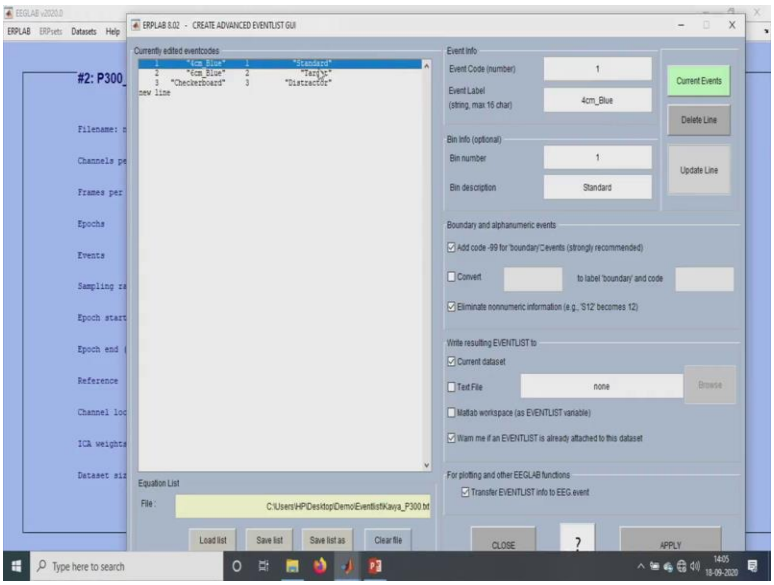
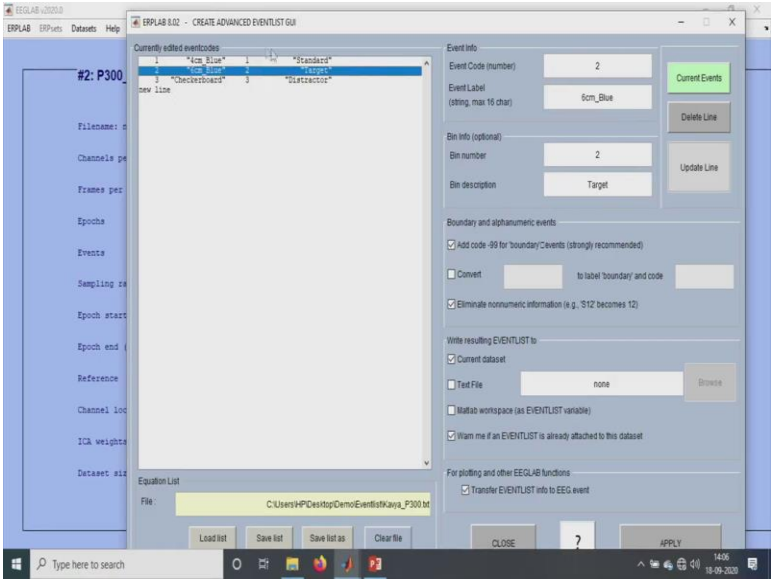





ERPLAB 8.02 - CREATE ADVANCED EVENTLIST GUI
Currently edited eventcodes
1 "4cm_Blue" 1 "Standard"
2 "4cm_Blue" 2 "Target"
3 "Checkerboard" 3 "Distractor"
new line
Event info
Event Code (number)
1
Event Label
(string, max 16 char)
4cm_Blue
Current Events
Delete Line
Update Line
Bin info (optional)
Bin number
1
Bin description
Standard
Boundary and alphanumeric events
Add code -99 for 'boundary' events (strongly recommended)
Convert
to label 'boundary' and code
Eliminate nonnumeric information (e.g., 'S12' becomes 12)
Write resulting EVENTLIST to
Current dataset
Text File
none
Browse
Matlab workspace (as EVENTLIST variable)
Warn me if an EVENTLIST is already attached to this dataset
For plotting and other EEGLAB functions
Transfer EVENTLIST info to EEG event
Equation List
File :
C:\Users\HP\Desktop\Demo\EventlistKavya_P300.txt
Load list
Save list
Save list as
Clear file
CLOSE
?
APPLY
Type here to search
14:05
18-09-2020


ERPLAB 8.02 - CREATE ADVANCED EVENTLIST GUI
Currently edited eventcodes
1 "4cm_Blue" 1 "Standard"
2 "4cm_Blue" 2 "Target"
3 "Checkerboard" 3 "Distractor"
new line
Event info
Event Code (number)
2
Event Label
(string, max 16 char)
6cm_Blue
Current Events
Delete Line
Update Line
Bin info (optional)
Bin number
2
Bin description
Target
Boundary and alphanumeric events
Add code -99 for 'boundary' events (strongly recommended)
Convert
to label 'boundary' and code
Eliminate nonnumeric information (e.g., 'S12' becomes 12)
Write resulting EVENTLIST to
Current dataset
Text File
none
Browse
Matlab workspace (as EVENTLIST variable)
Warn me if an EVENTLIST is already attached to this dataset
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Equation List
File :
C:\Users\HP\Desktop\Demo\EventlistKavya_P300.txt
Load list
Save list
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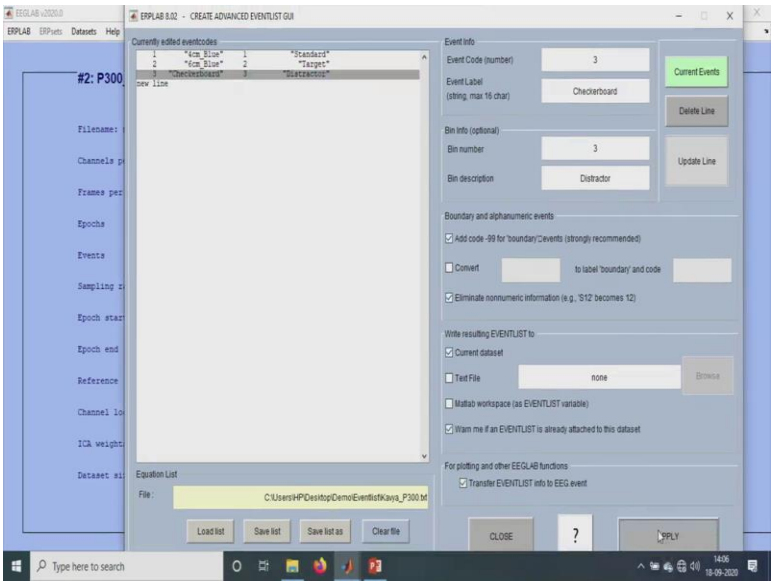

So, next, I will just do, with the event analysis, event list. So just, we have to go and create the event list. So, I have already done the event list. So here the first one, it goes for the, the first trigger, it is a 4-centimeter blue ball and we just number it as a first bin and then it is a standard.

The next one is the 6-centimeter blue ball, which is, which I had been put a bin number of 2 and then I do -- I keep the description as the target, because the 6-centimeter blue ball is the target and the checkerboard is the distractor. So, we name accordingly and number the bin values and the bin event codes accordingly and then apply it. So, what happens is all those ones, twos, threes and all will -- with B1, B2, B3 so it will be renamed in that manner.

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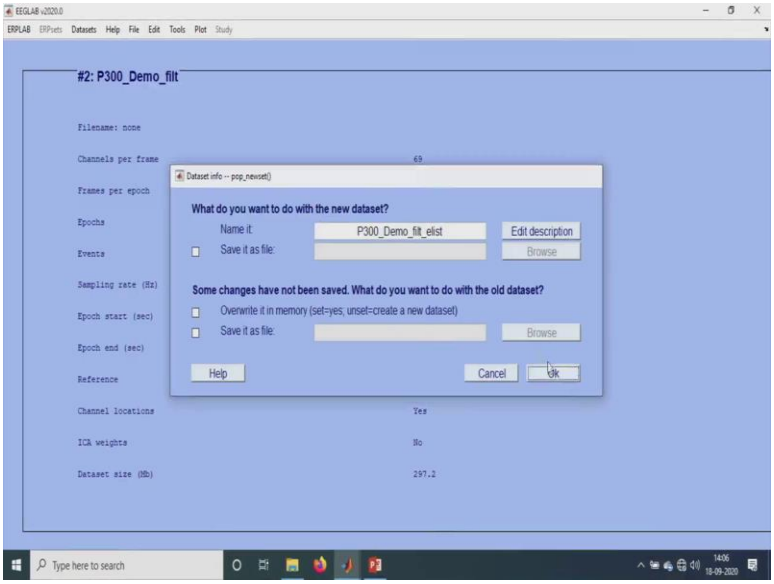

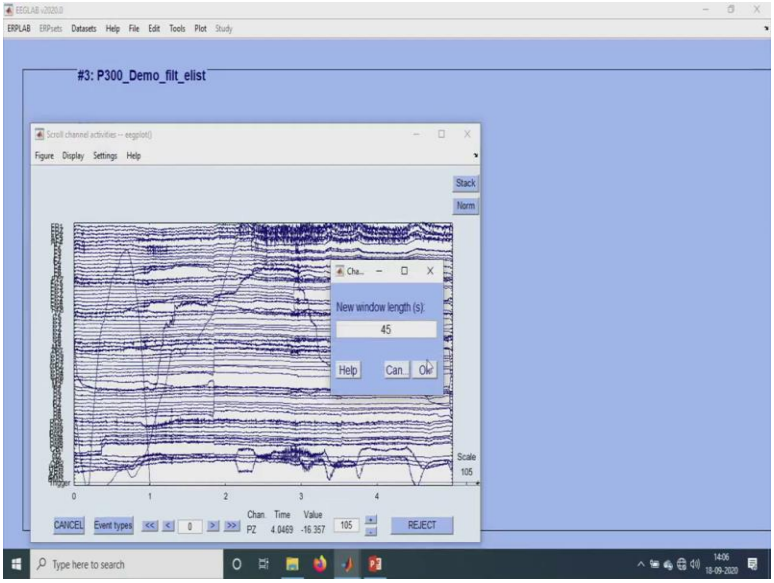

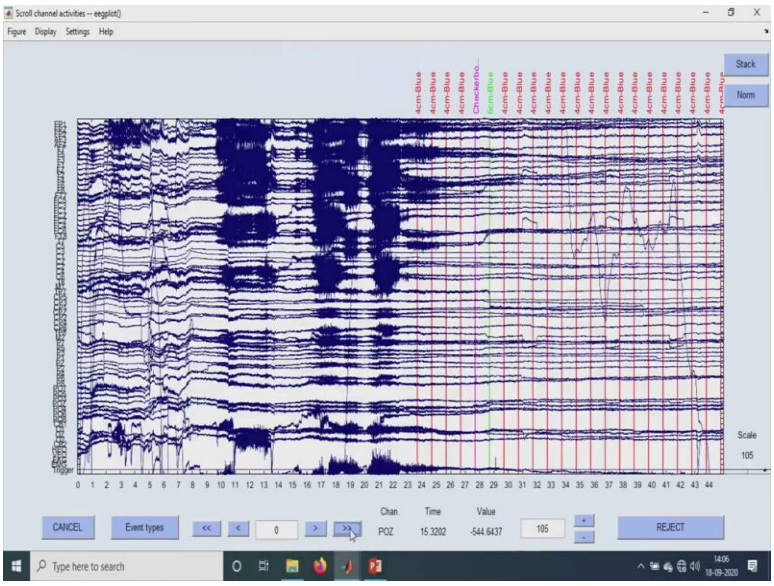

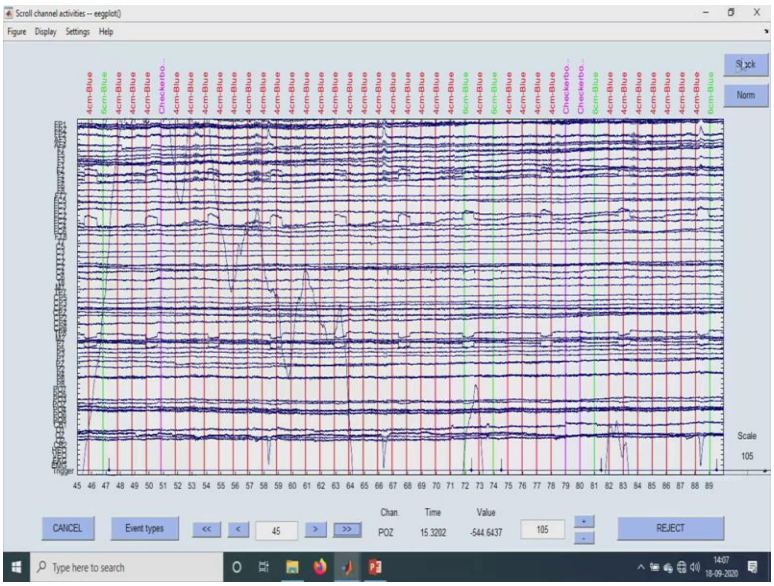

So, here in this way, we have created the event list. So, now if you check the scroll data, you will find that all the things would have been changed. So, I will just change it to -- so, here all of them would be changed with the blue ball, checkerboard, the green, the 4-centimeter and all. So, it just differentiates these are the different stimuli that has been there like that. So, it changes, it has changed all the names.

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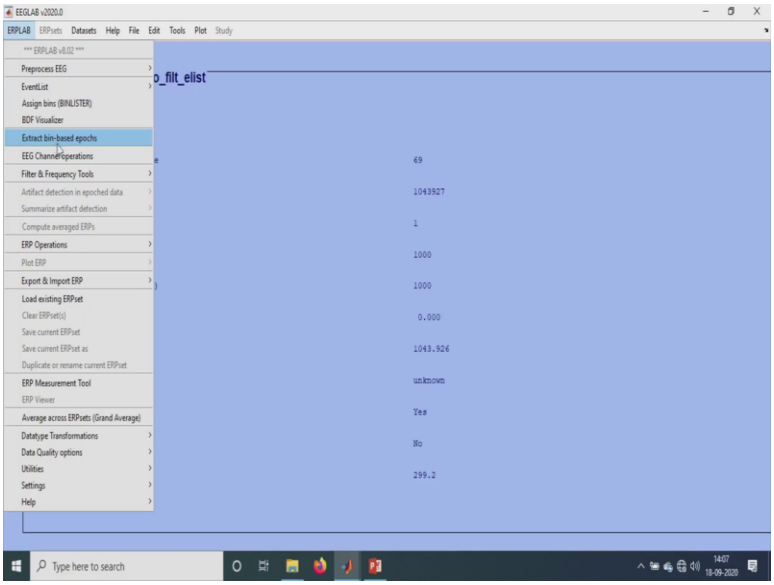

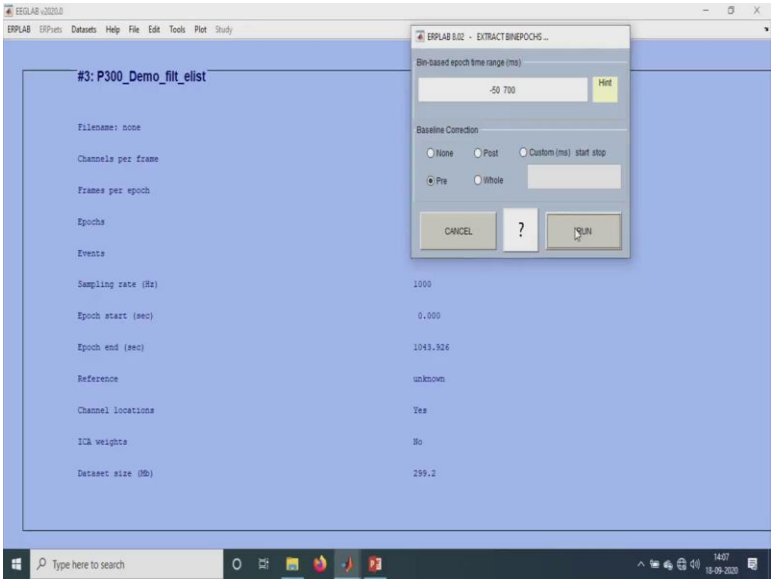

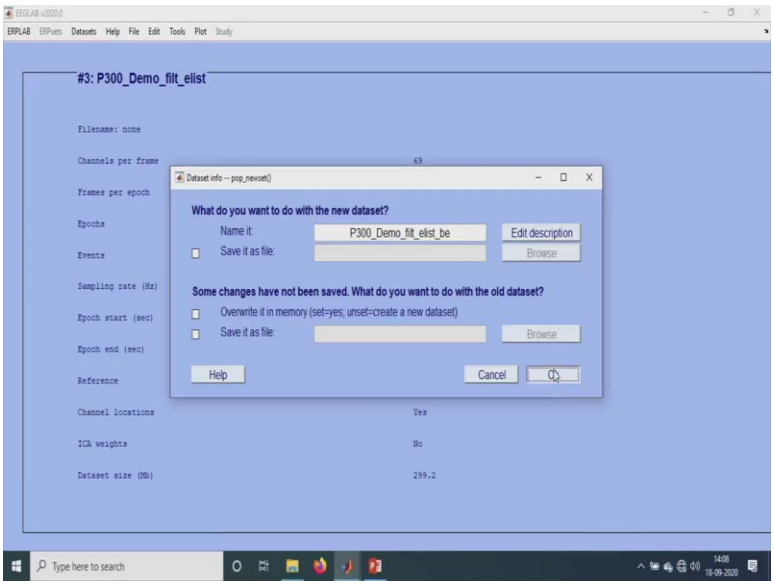

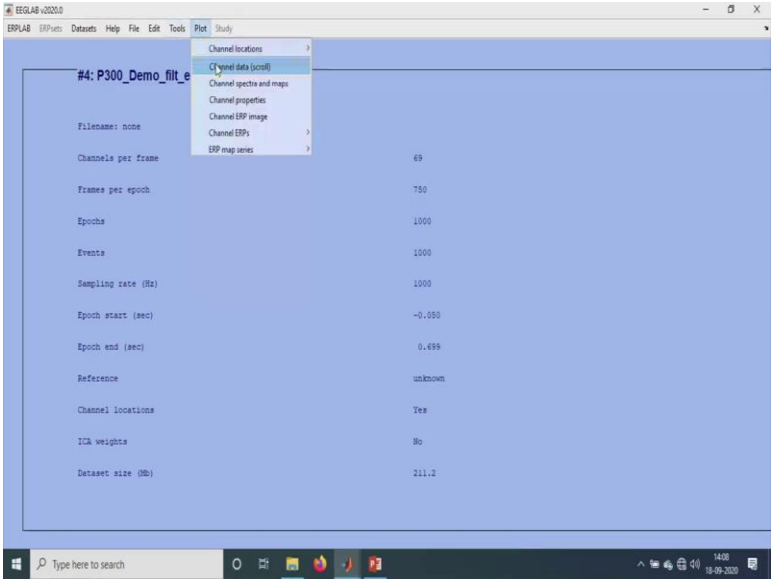

Next, we will be doing the epoching. So, as I have mentioned before, epoching means, we want to cut short a timeframe. Now, I do not want the whole of the continuous data for a particular trigger, I require only a required timeframe alone. So, for P300, it is in the, it starts from 300 only. So that is why I keep a range of about 700, 750 like that 700 maybe. So anyways, however it is, we have to keep a small baseline correction for any ERP.

So, we keep a 10 percent of 700, it can be minus 70 or I am just keeping as minus 50 just to check how the waveform looks before the trigger is being started. So, we just run it and we have to, we will get a -- so there are 1,000 events means there will be 1,000 epochs that will be created. So, that is how it should be. So, here we have the dataset being obtained for after doing

the bin paste epochs. So here, if you see, it has been changed to 1,000 epochs. Now, after doing these epochs, I will just again show you how it looks.

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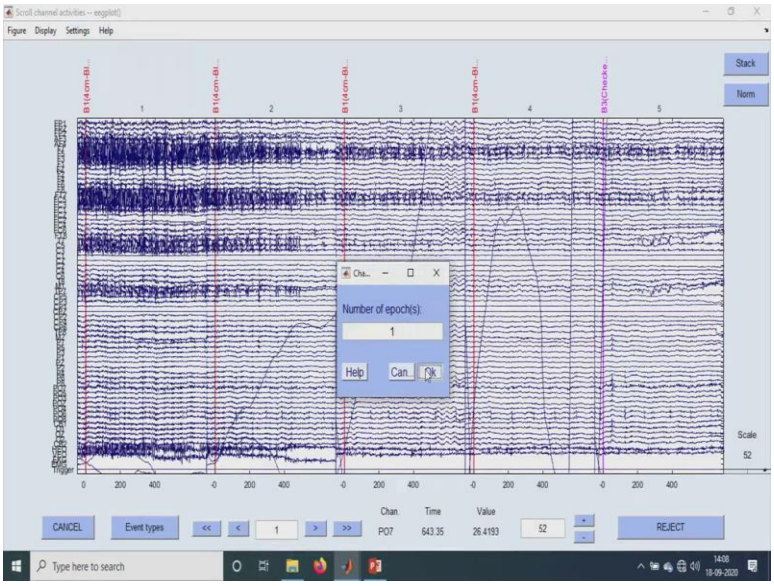

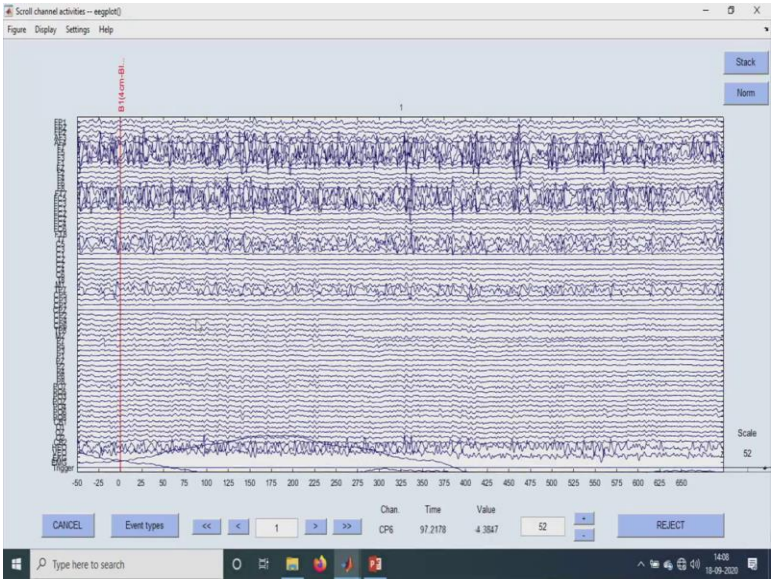

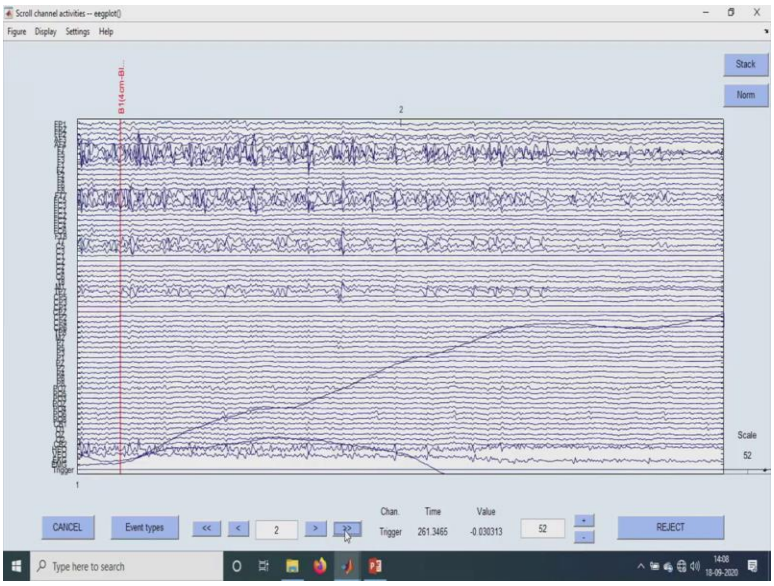

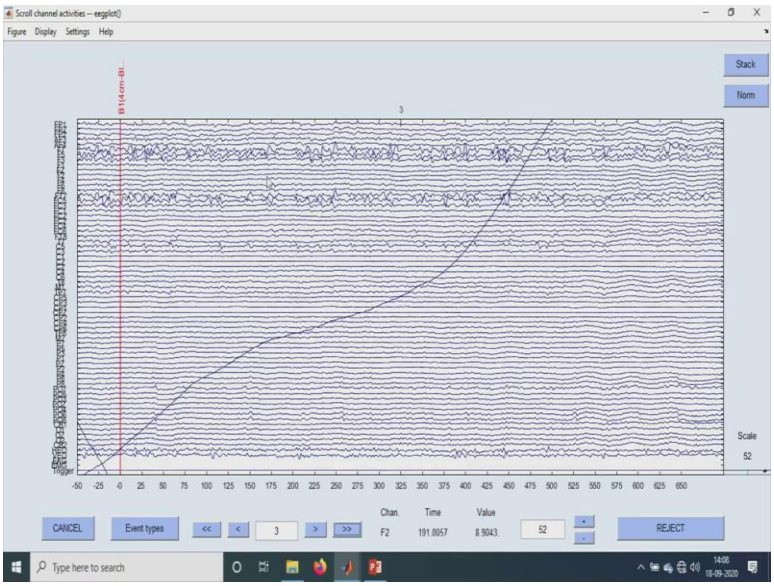

So, these are the each epochs. From this to the next one is called as 1 epoch. So, here we have I will just show you 1 epoch alone. So, it is from minus 50 to 700. So, this is one epoch. Similarly, we can get for all the bin values. So these are the first bins, we can go for even the others, even we can change the channel display also, but for now we do not require that and all.

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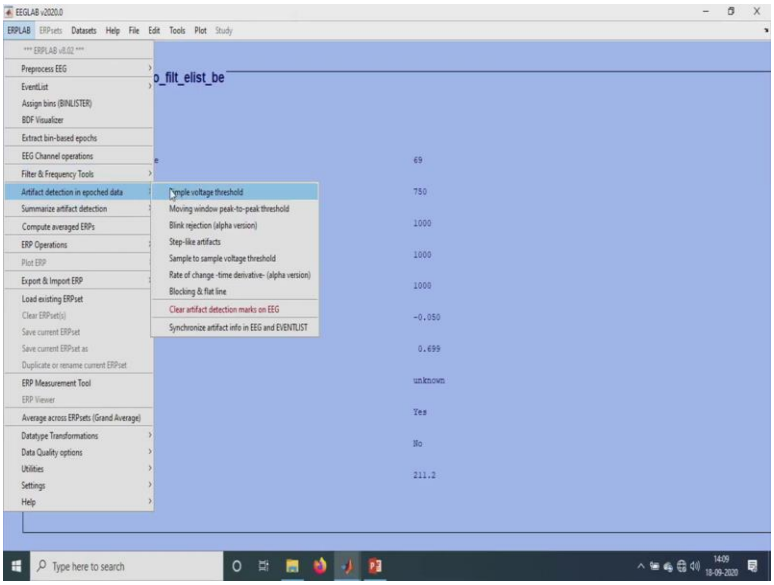

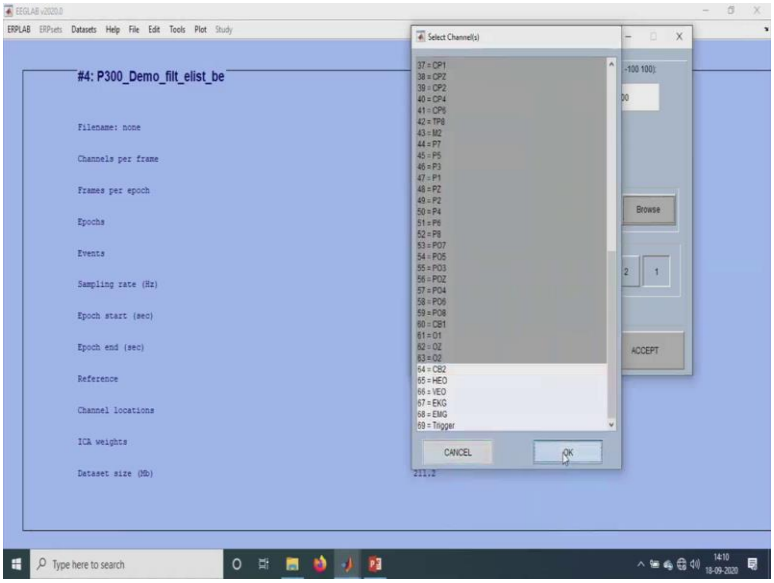

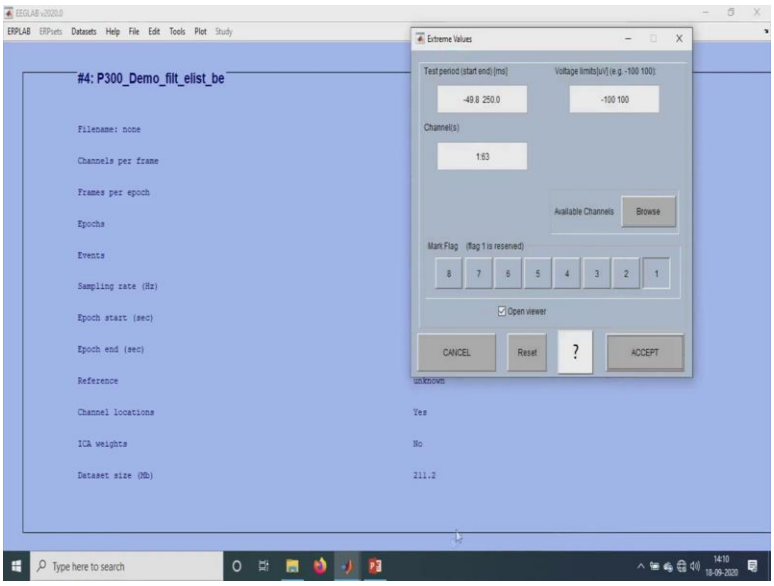

Okay. So, next after doing this epoching, next we have to work is the artifact rejection. So, here in this experiment, it is nearly for about 15 to 20 minutes. So obviously, there will be a lot of blinks and various other, various other artifacts like muscle artifacts, muscular movements or any neck movement anything can be there.

So, here also we take a simple voltage threshold. So, all of these artifacts will be in the range of minus 100 to 100 microvolts alone. Here in this case, as I mentioned in the previous for the MMN, in that the trigger channels was not there, was included in that file itself. So, that is why we had to, we just selected the channels of our interest. In this case, we have the trigger channel separate.

So we can take the whole set of all these channels, excluding the trigger and the EMG, EKG, these VEO channels and all. So, all these channels are the one which is due to the artifact, so that and all, we do not include in the artified deduction, because we want all these to be removed. So, that is why we do not select all these. So, we just select the 64 channels alone and accept it.

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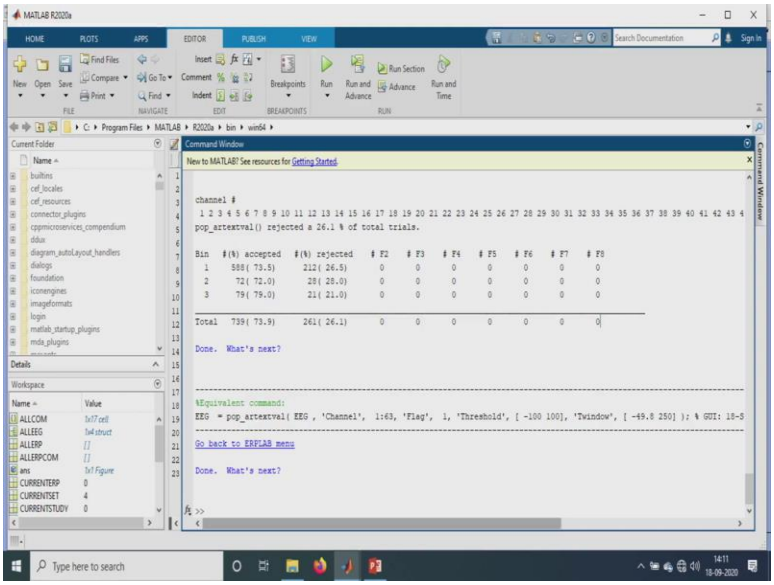

So here, if you check here, if you check in this. Yeah. So, here, totally there were 800, totally 800 standards will be there. Of that only these many of them have been rejected and this one these many have been accepted. So, this particular -- these numbers that has been accepted is the one which we average to obtain the ERP. So, this is the, this is the code that has been used for the artifact rejection code.

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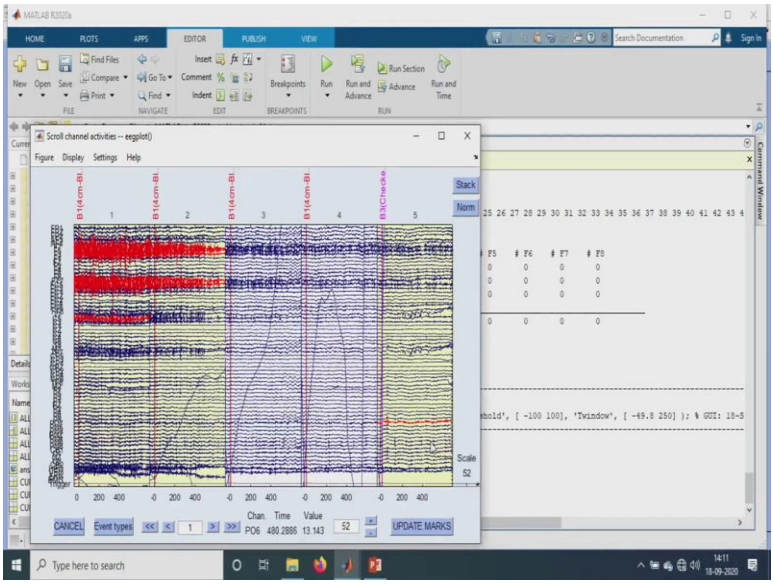
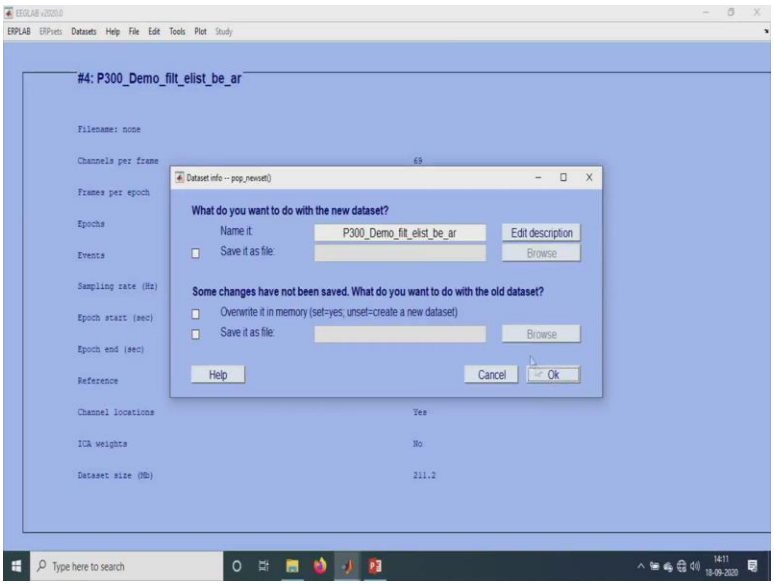
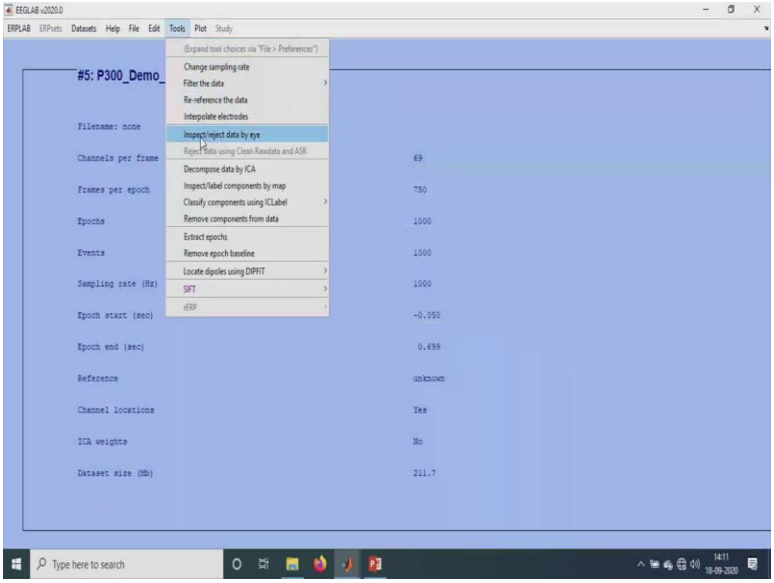
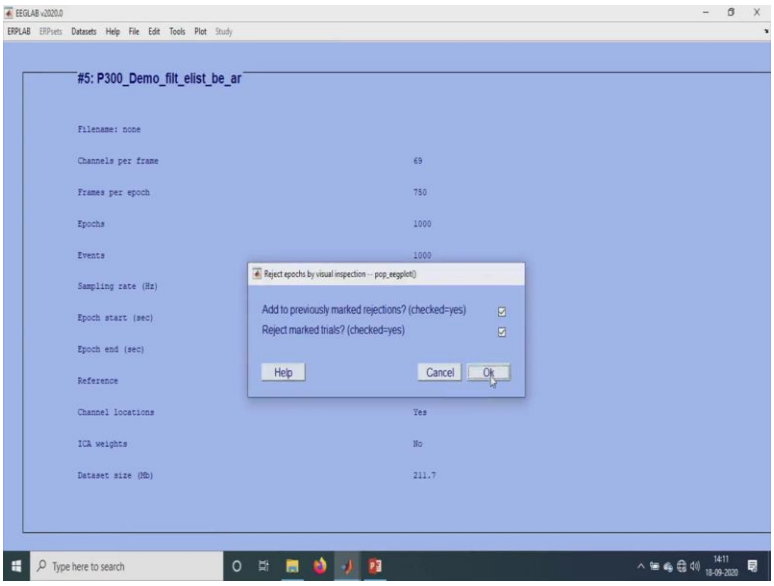



EEGLAB v2020.0
ERPLAB ERPsets Datasets Help File Edit Tools Plot Study
#4: P300_Demo_filt_elist_be_ar
Filename: none
Channels per frame 69
Frames per epoch
Epochs
Events
Sampling rate (Hz)
Epoch start (sec)
Epoch end (sec)
Reference
Channel locations Yes
ICA weights No
Dataset size (Mb) 211.2
Dataset info -- pop_newset()
What do you want to do with the new dataset?
Name it: P300_Demo_filt_elist_be_ar
Edit description
Save it as file:
Browse
Some changes have not been saved. What do you want to do with the old dataset?
Overwrite it in memory (set=yes; unset=create a new dataset)
Save it as file:
Browse
Help
Cancel
Ok
Type here to search
14:11
18-09-2020


EEGLAB v2020.0
ERPLAB ERPsets Datasets Help File Edit Tools Plot Study
#5: P300_Demo_
(Expand tool choices via "File > Preferences")
Change sampling rate
Filter the data
Re-reference the data
Interpolate electrodes
Inspect/reject data by eye
Reject data using Clean Rawdata and ASR
Decompose data by ICA
Inspect/label components by map
Classify components using ICLabel
Remove components from data
Extract epochs
Remove epoch baseline
Locate dipoles using DIPFIT
SIFT
dERP
Filename: none
Channels per frame 69
Frames per epoch 750
Epochs 1000
Events 1000
Sampling rate (Hz) 1000
Epoch start (sec) -0.050
Epoch end (sec) 0.699
Reference unknown
Channel locations Yes
ICA weights No
Dataset size (Mb) 211.7
Type here to search
14:11
18-09-2020



So, here if you see these red lines, this red colour or the highlight ones, they are the one which is being rejected. So, we just update the marks over here and we reject it later. So, here in these tools, if you get the -- we can inspect this particular, we can just mark all that updated marks and we can just remove all of them.

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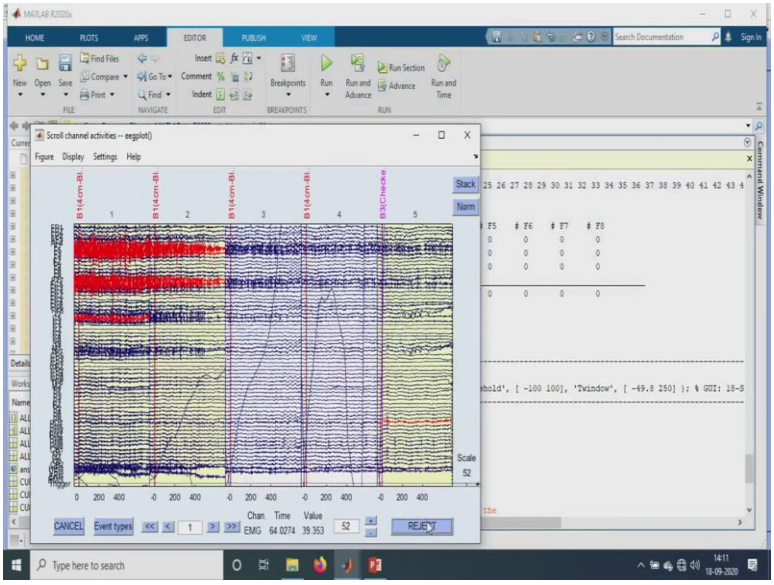

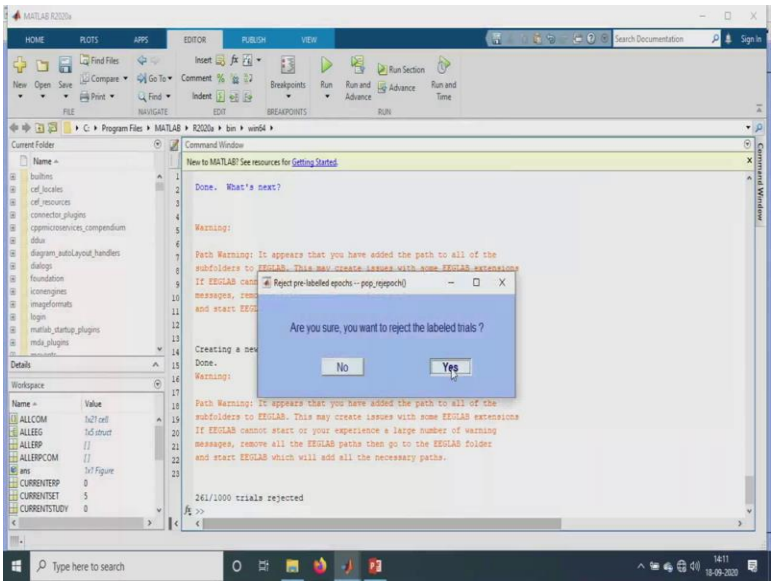

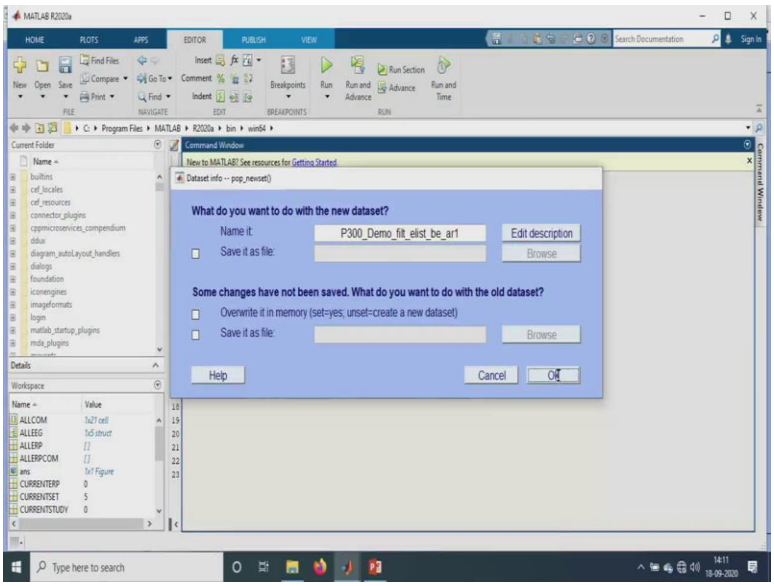

So, as I showed you here, there are nearly 261 of them are being rejected. So from the main dataset, all those have to be rejected. So, here we just reject all of them. So, here all those 261 of them will be rejected and a new dataset will be, we rename it in this format. So, we will get a new dataset with the rejected, after rejecting all the artifacts.

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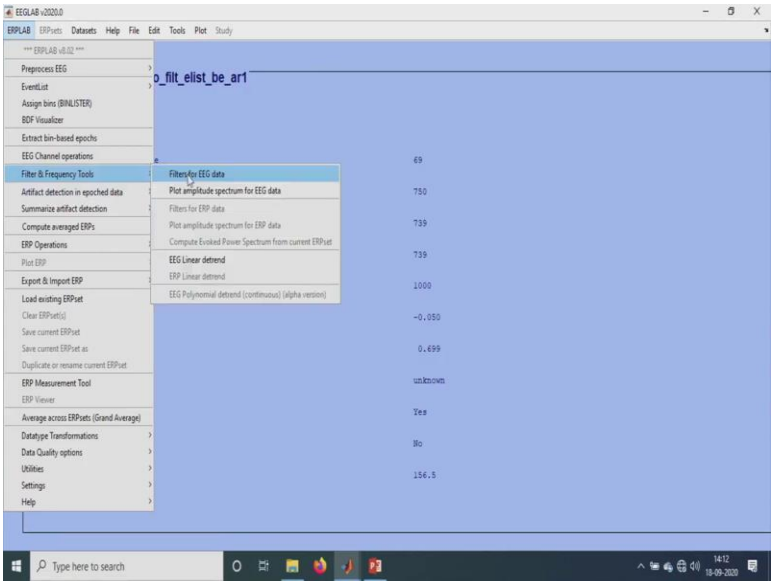

Then, after this also there is a small step of filtering again. So, again we do the filters, using the BandPass filter.

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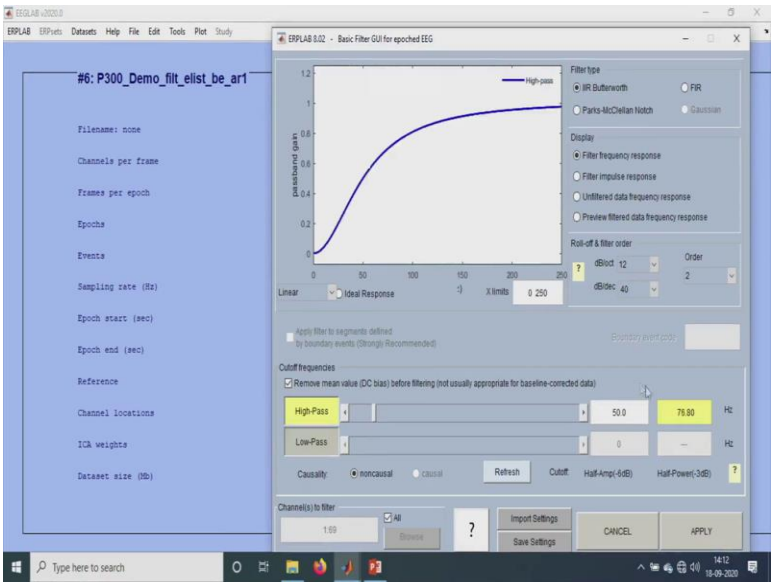
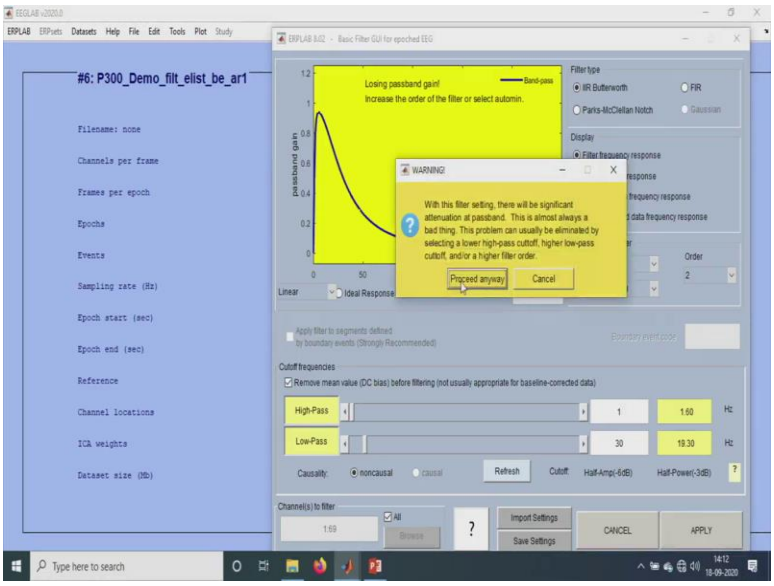
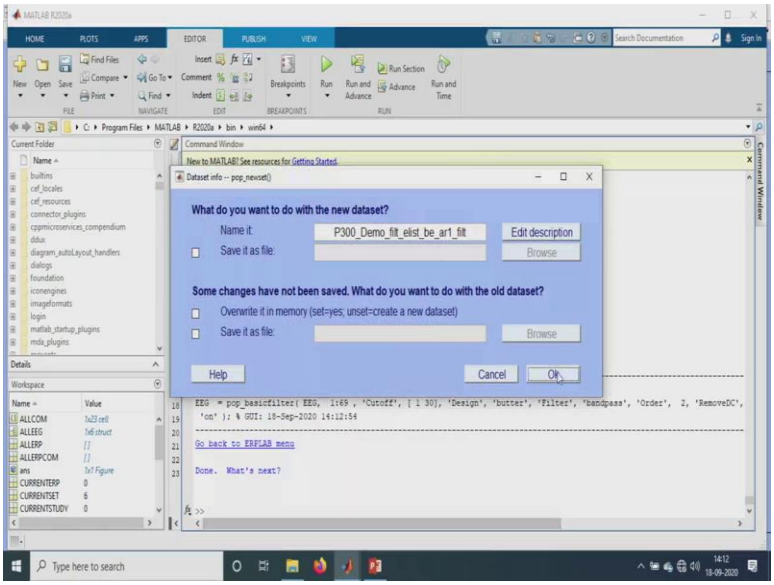
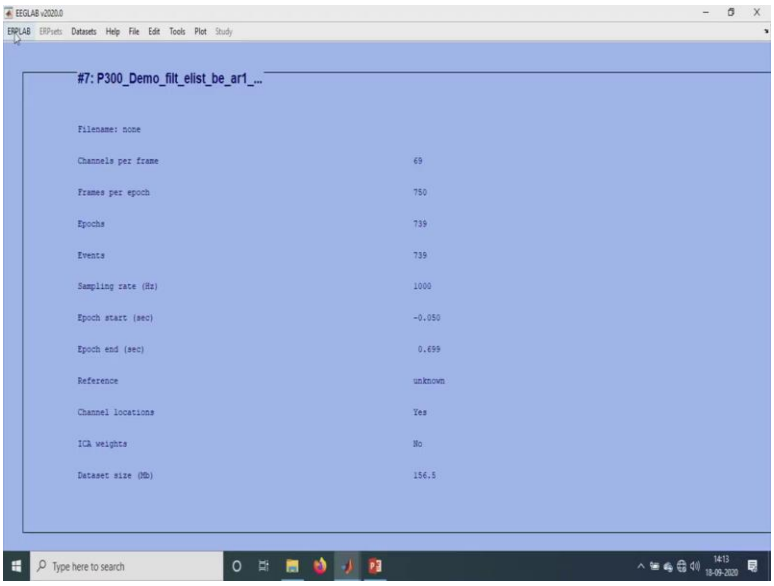




So, it has always the same from one. It is always the same from 1 to 30 that is always been kept. We can change, actually this yellow band gain and all is being coming, that is not, it is just that we have to change the low pass filter or we can change the order. But this is the default like for almost all the ERPs 1 to 30 will be the proper filter parameter, bandpass filter. So, we just do the filtering.

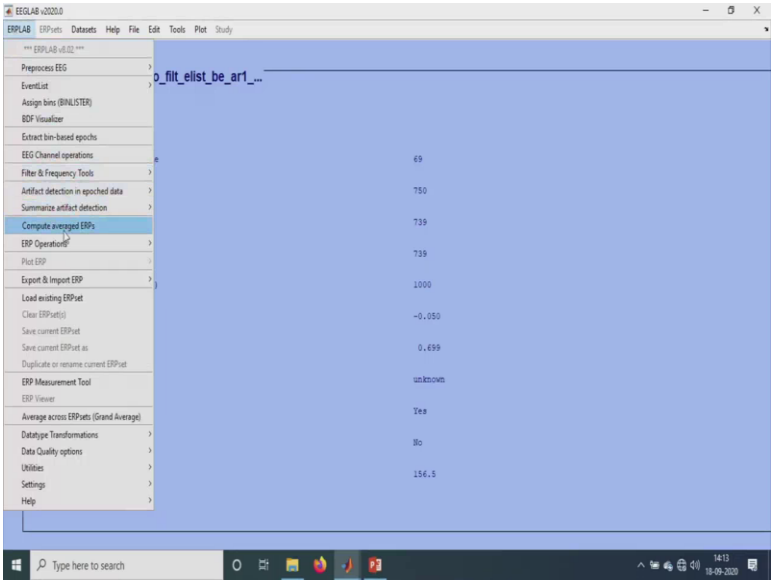
(Refer Slide Time: 12:19)

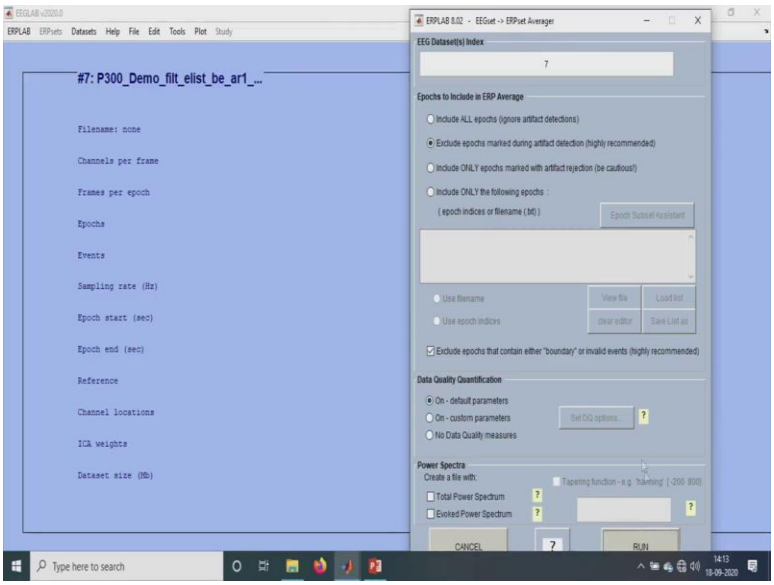


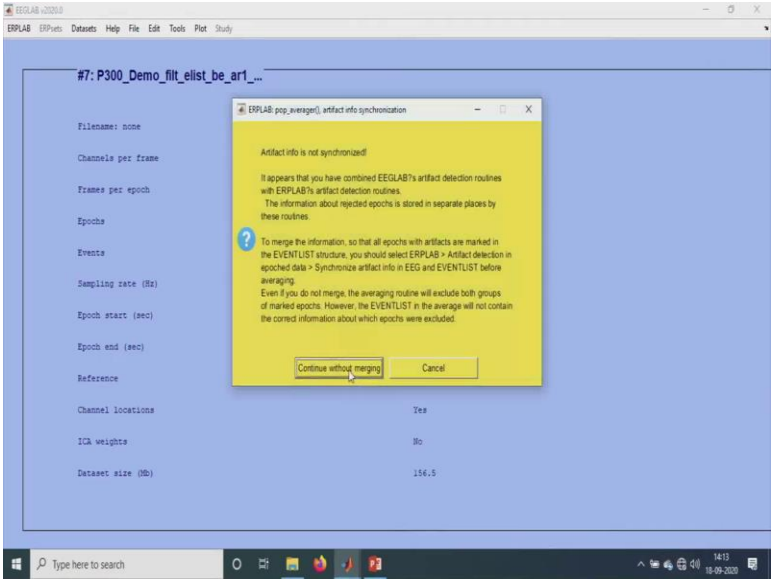


So, it does for all the epochs continuously, so nearly 150, 750 epochs have been there for it. So it does the filtering for all of them and then finally we get the filtered dataset. So, here we have all the filtering done and only these many epochs have been there. Now these epochs are now further being averaged to get the different bins.

(Refer Slide Time: 12:43)







So, here we have to do the average epoching. So, only the seventh dataset. We can actually take all the datasets also. But we do not want the filtered, or the ones with artifacts, the ones without the filtering and all, we do not require those dataset. So, we just take the single, this last dataset, which we have done with, which we have completed everything. So, we just run it and this is a small error about the desynchronization but doesn't not matter.

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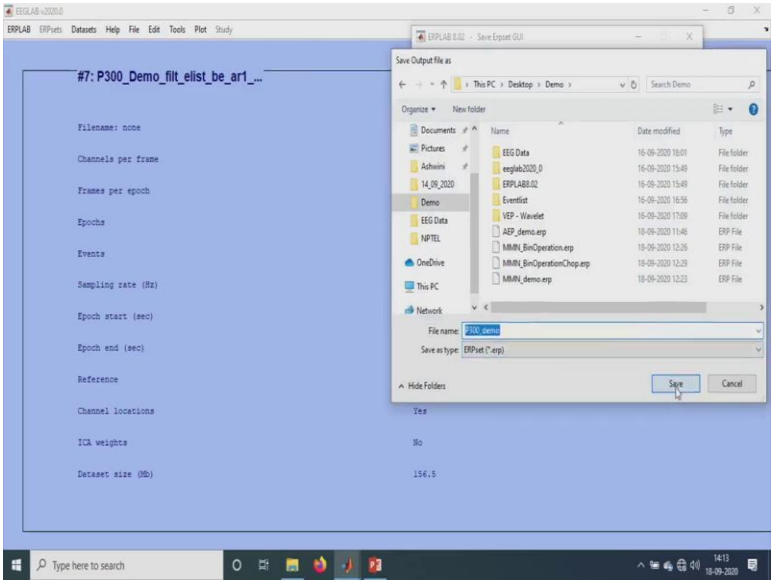

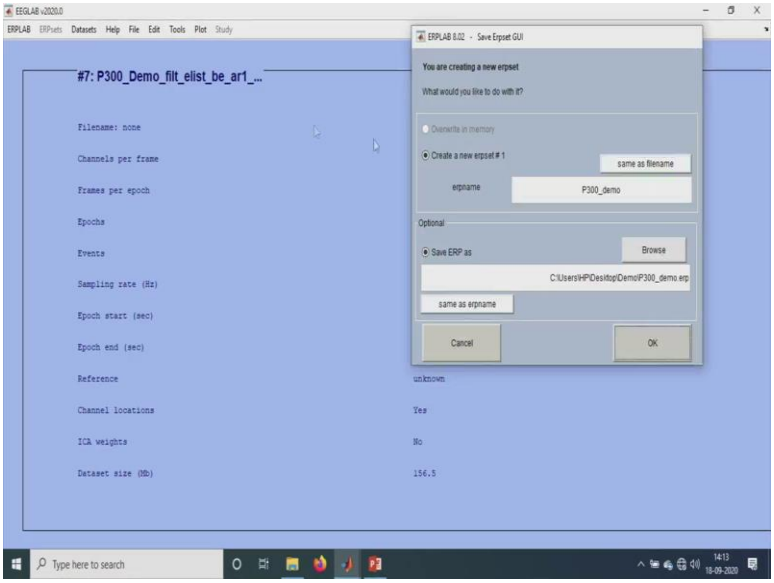

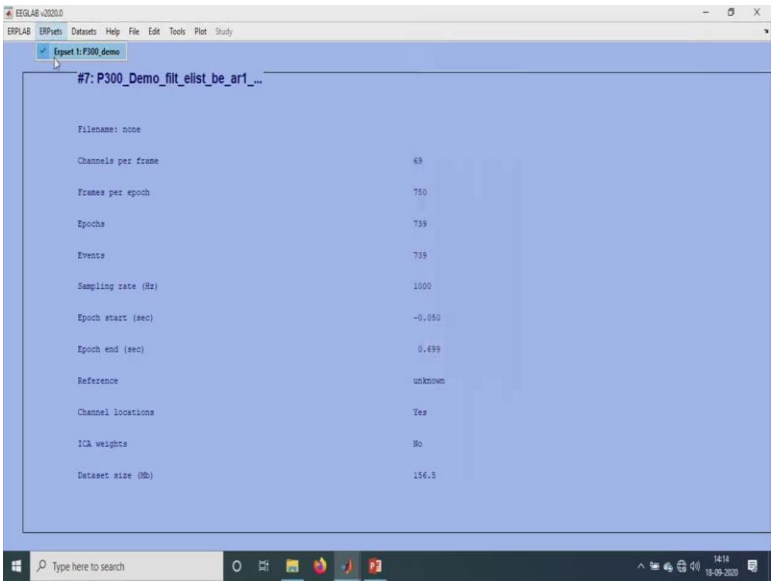

Now, we just name it as P300 demo ERP. So, here as I do that, the ERP set will be here it comes. So, here this is the P300 data that has been obtained.

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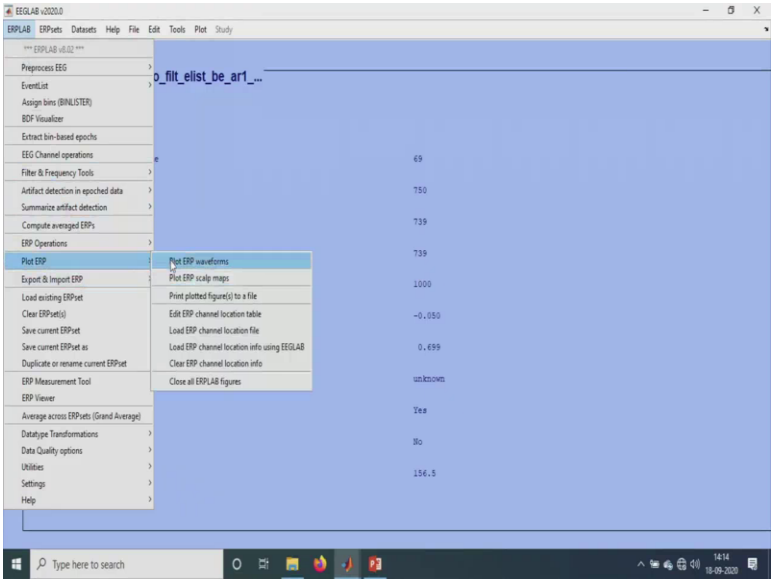
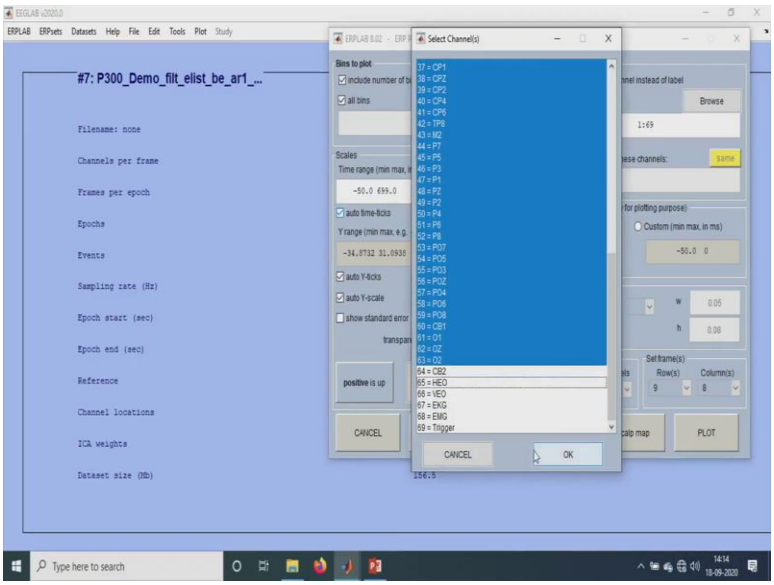
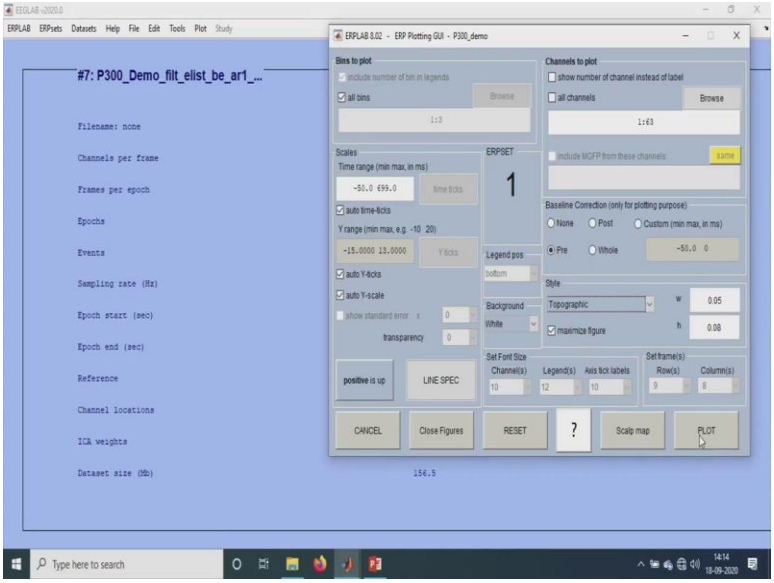
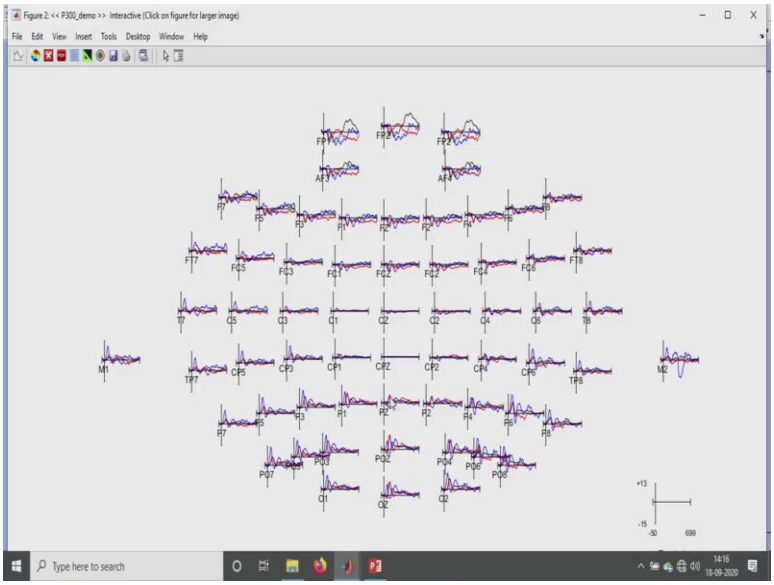






So, next we can just plot all of this together. So, this is how it looks and we do not want these trigger channels as I said. So, these are something that is not required. So, here in this case, it is a P300 response, so that is why we want the positive to be up because the positive peaks will be obtained in this case. So we just take the default and we have from minus 50 to 700 we can actually change these values also. But if you take the autoscale itself, but then, it will give a proper, it gives a default itself. I will show the topography, so that we can see how it looks amongst the head and how it looks.

(Refer Slide Time: 14:27)



So, here, there will be three bins will be obtained, one is for the standard, another one is for the distractor, another one is for the target. So, it takes some time for it to be done. So, for P300, usually it will be in this particular region, the most responses will be obtained like the parietal, central parietal like that.

And if I, if you see that from the midline electrodes as you move from the most, I mean from the nasion to the anion, what happens is that there is a reversal that is taking place, all here it is all the negatives and here it is all the positives up. So, that is the difference. That is why, we say that the brain is acting like a magnet. So, for our interest, we have to get in the parietal region. So I will just show you in this, it is taking some time to get loaded.

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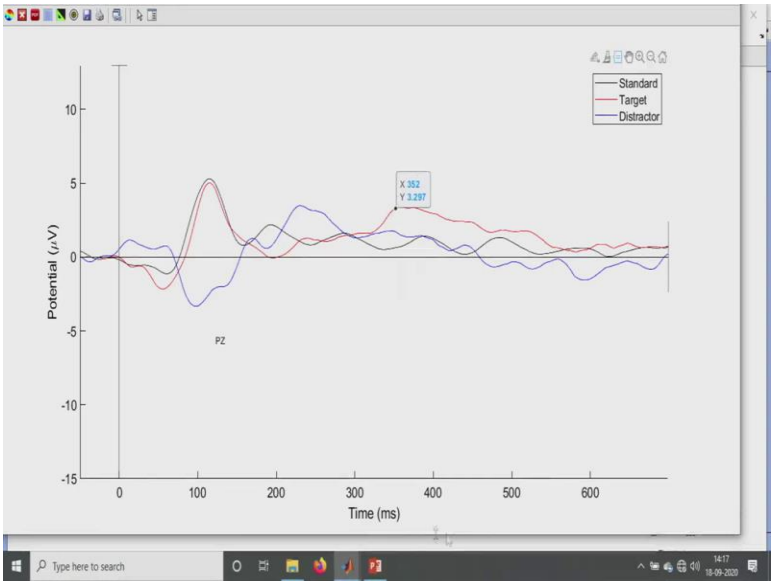
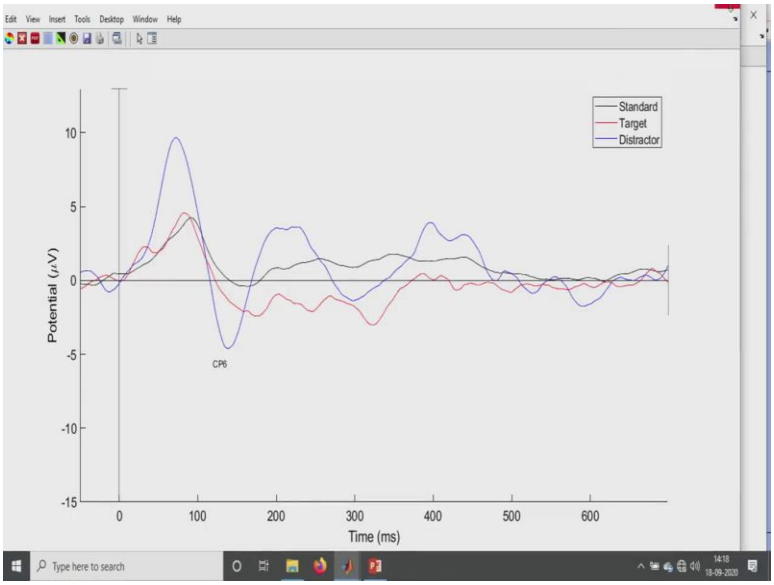


So, this is the black line over here it is a standard. So, the standard, it actually gives, over here, it gives usually AEP, BEP responses and all it will give, even this target also will give. The main -- our P3a, P3b components starts from here, yes, this is the P300, the P300 starts in this particular part. So, this is the P300 response over here.

The red colour is actually the target which gives the P3b that is the later part of it and this is the P3a that has been obtained. So, it is all coming and from 300 to in that range it is obtained. So, this is for a PZ. Similarly, we can obtain, we can get for the other responses also. So, if I say so this is the P300 response.

If I consider, this is a P3a, if P3b, so here, see it is in the 5, it is in the range of 352 in this milli-seconds it is being obtained. So, this is a classic example of a P300 response that is being obtained. So, similarly, we can get for the other electrodes also. For example, even in the occipital also, the visual lobes and all the occipital lobes are the main place where the visual responses has been obtained. So we can even check-in that areas as well. So, basically this, if the parietal, central-parietal, so I will just show you some central-parietal for example this.

(Refer Slide Time: 17:14)



So, here we can get a proper response. So here this is the P3a and P3b that has been obtained. And then, if we have to check always from 250 plus, like that you have to obtain. So, this a proper AEP peak or BEP peak, that has been obtained over here. So, this is a classic example of all those P300 responses.

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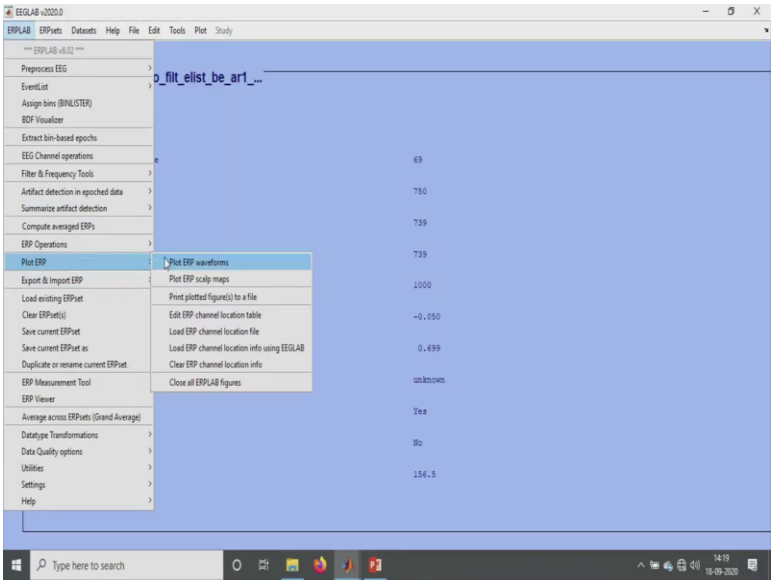

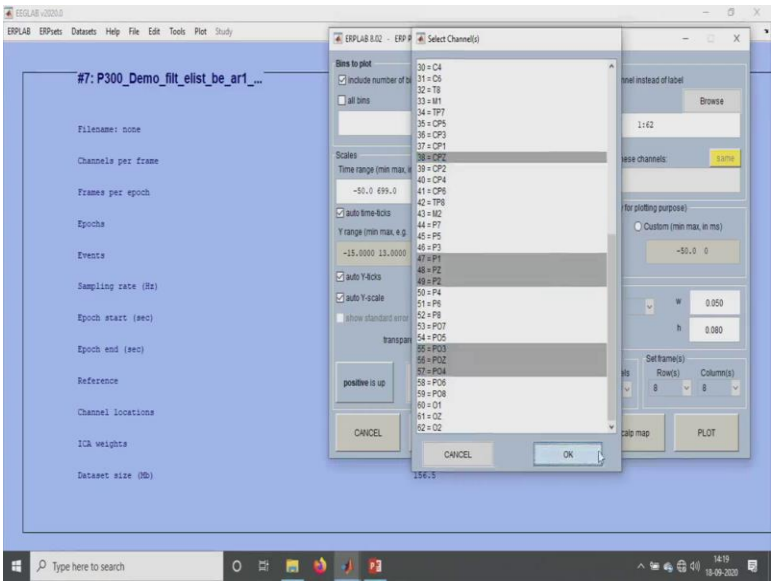

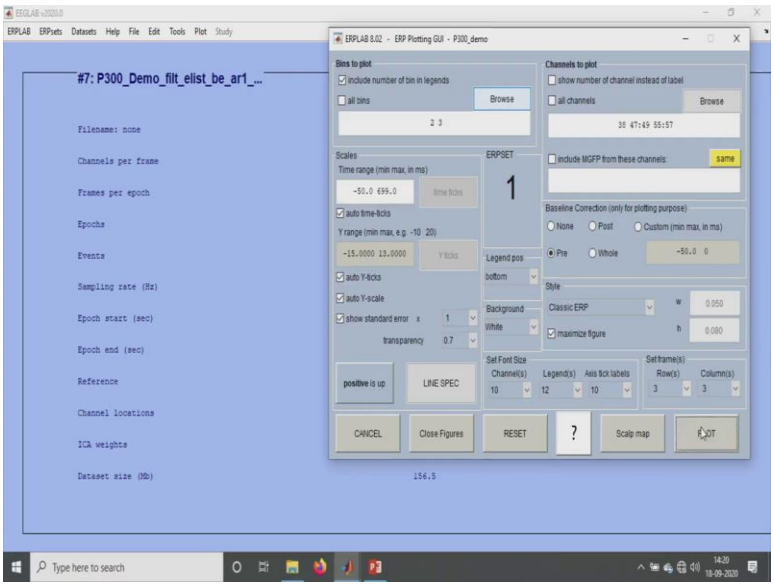

Now, if we -- here, we can export also, this export option we can do. But what happens is we cannot export as separately based on the bins. Now, I cannot separate, separately the distractors alone or separately the target, separately the standards, together we cannot do that.

So, we have to give the, while doing the event list itself, we have to separately give that while doing the event list we have to separately do the bins -- the events we have to select and accordingly we can do the preprocessing steps and then we can export the separate like the target separately, the distractor separately.

So, everything can be separated only when we do this event list separately. In this case, we have given all the events we have been given as one event list itself. So, if we want to separate the targets and the distractors we have to do along like that. So, if you want, you have -- actually for P300 response, we mainly look only the target and distractors. So we can just select this target and distractors alone.

And if you want, we do not want all the electrode channels. If you do not want them, you just want only the parietal electrodes, so we just take the parietal electrodes only. So, we can just take along like that. If you do not want the topography, you just want a straight line graph and that also you can do. So, it is always positive up. And if you want the standard errors of mean, also we can give so that you get accuracy of how the data looks and how variable our data, how accurate the data is, so that we can obtain.

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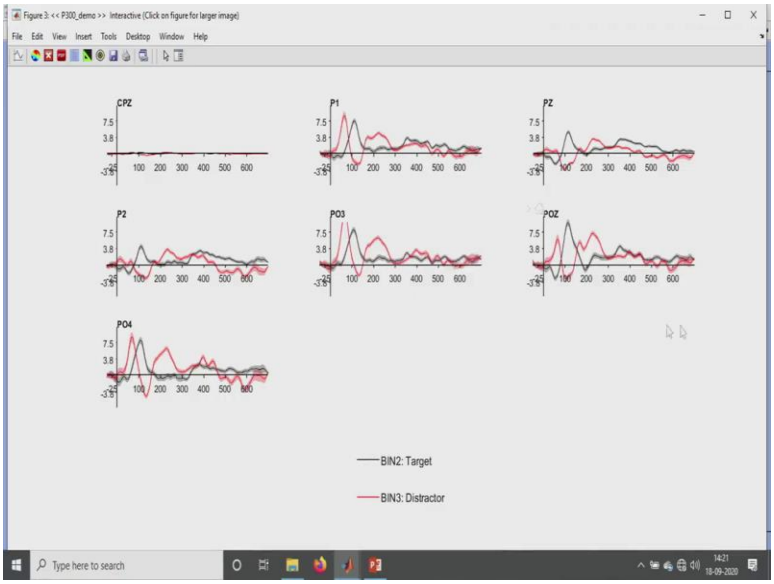

So, here we can see a proper, the red one is the distractor and black one is the target. So, here we have the proper P300 response, that has been obtained in these, these are the peaks that has been obtained. So, here this, the parietal and mostly in parietal, the occipital parietal, in these areas only you will have a proper response.

Since the CPZ is less because in the center, then the midpoint of the head, as I told you, there was a flipping happening, so that is why in the mid electrodes, it is becoming a bit constant or it

is like very less. But it is there but it is a bit less that is it. So, here we can like this, if we can so this is how the P300 response looks like.

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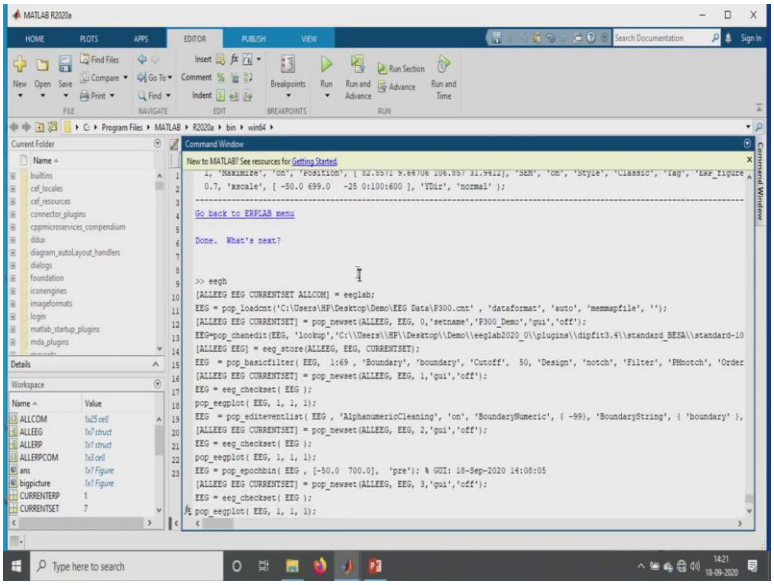

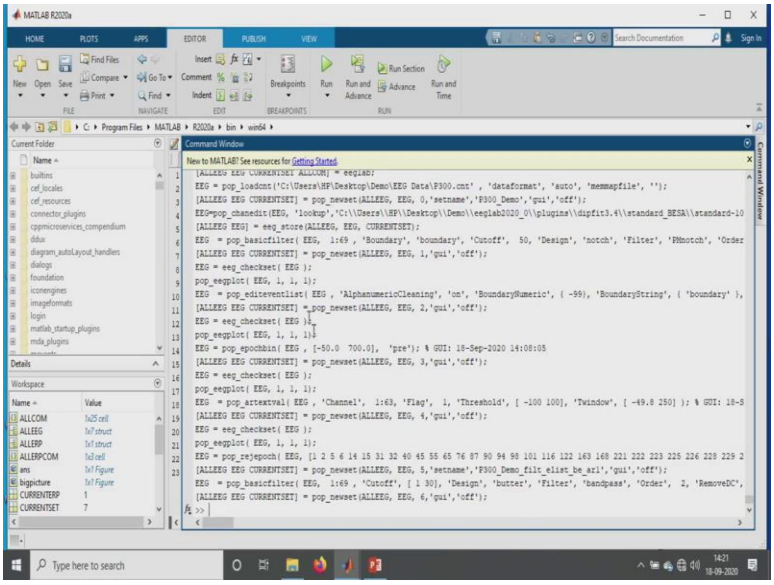

And similarly, we can do the scripting also can be done in this way. So, we just have to put a command as EEGH, so that we will be getting the history of whatever we did. So, here we have all the, all of them which we did. So, first we loaded the CNT sample, then, the channel location which we added, then this filtering, then we plotted all those graphs to check how the triggers and all look like.

So, all of them every, each and every step that we have been done, it will give you in this format. So, we can just copy this and paste in our other place, in our editor and then we can just change the subject, the name of the subject and then we can just change the ERP names and everything and we can obtain the different, for different, the multiple subject analysis, we cannot keep doing each and every subject the same procedure.

So, for one subject if you do this analysis using this GUI and then if you obtain the script and then finally after that you can just, for many beginners and all can just do, doing this manner. If they are well-versed in EEG, in Matlab and all, where they can add loops and everything and finally they can do for multiple subjects they can do the analysis. So, that is about the P300 response. So, the next, I will be giving an overview about the wavelet analysis and I am using, over there, I will be using about the VEPs as a ERP. Thank you.