Introductory Neuroscience and Neuro-Instrumentation
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Lecture 47
Wavelet Analysis with VEP (2)

Hello everyone. So, as a part of the wavelet analysis using the VEPs, I was giving a presentation regarding that, so based on that I will just give you a small demonstration of how to do the wavelet analysis.

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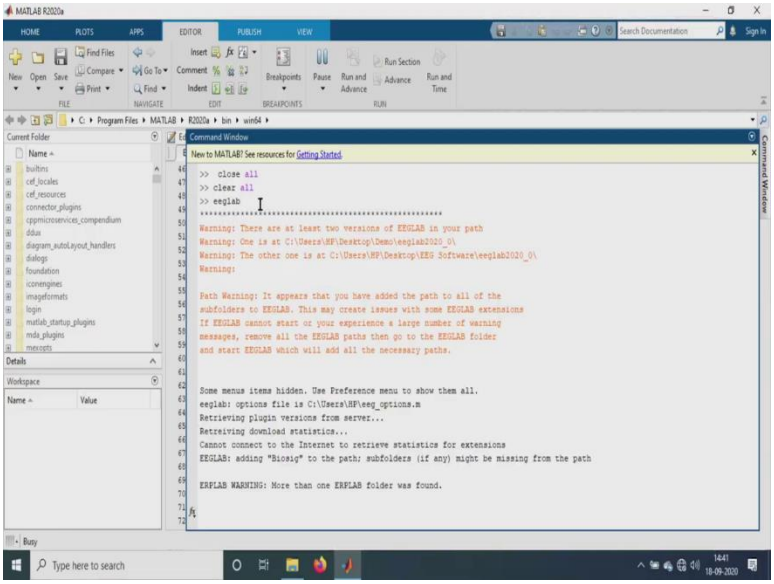

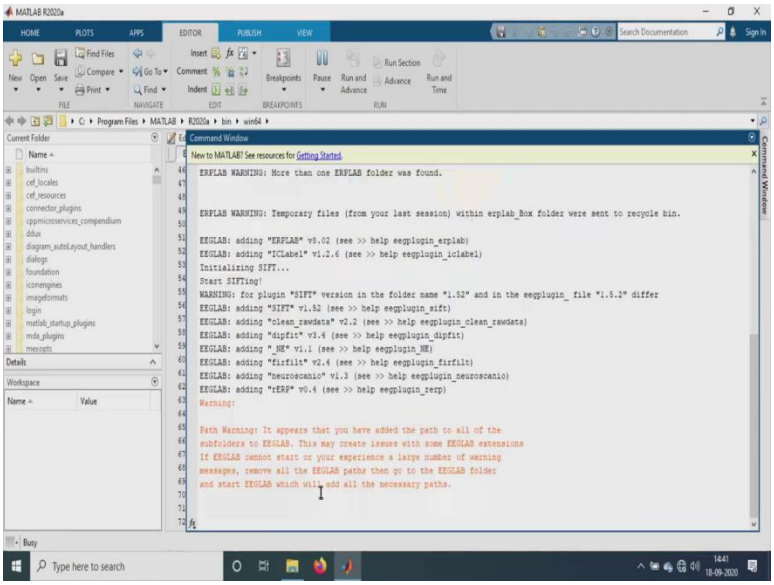

So, first as usual we will do the usual EEG analysis we just open the EEG lab.

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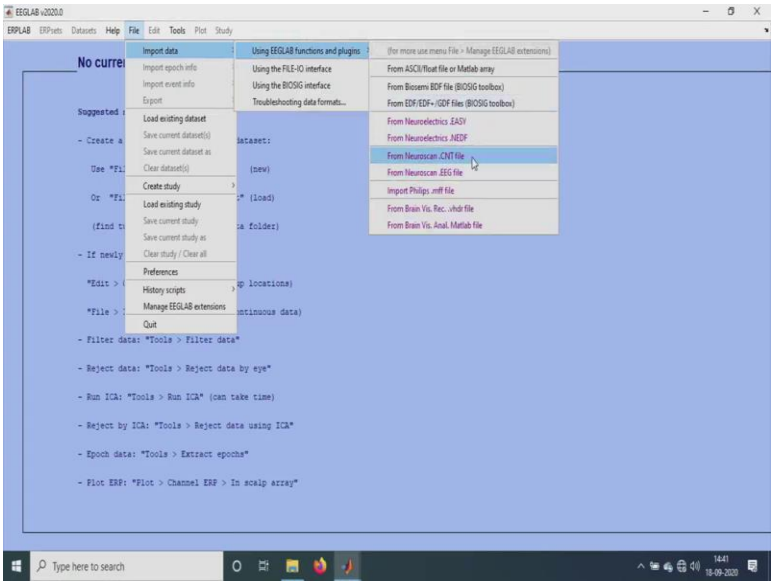
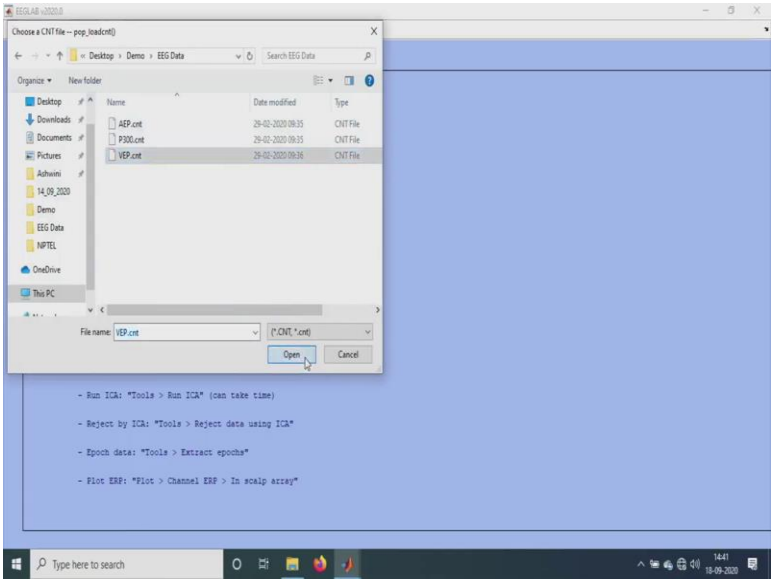
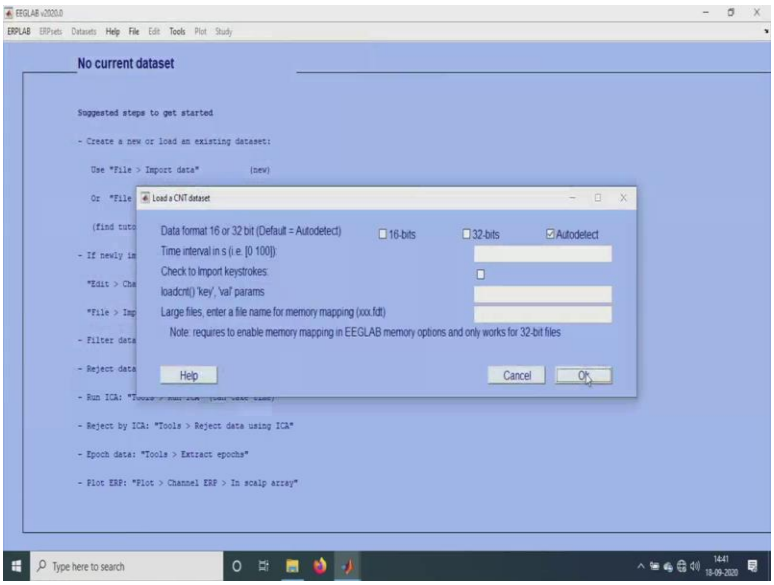
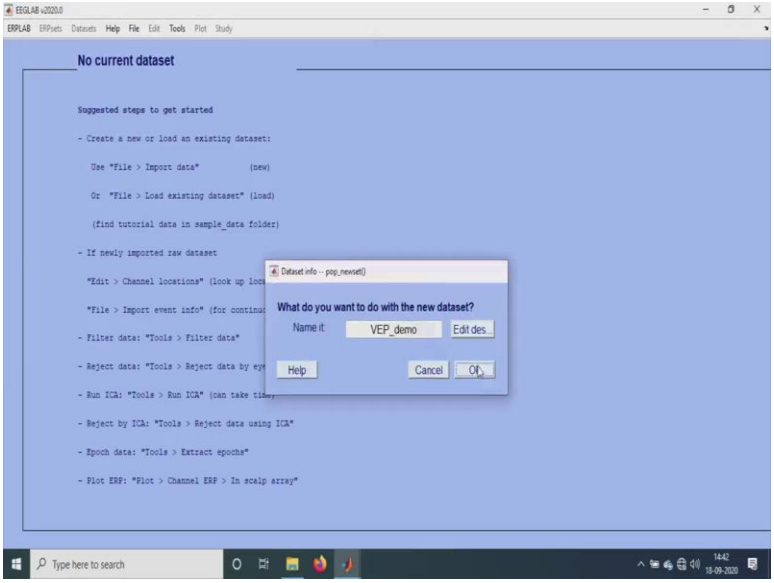
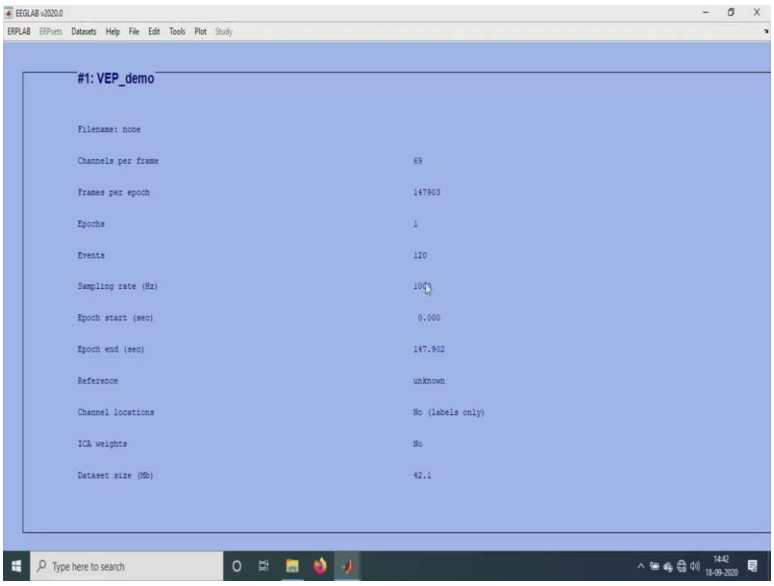





EEGLAB v2020.0
ERPLAB ERPsets Datasets Help File Edit Tools Plot Study
No current dataset
Suggested steps to get started
- Create a new or load an existing dataset:
Use "File > Import data" (new)
Or "File
(find tuto
- If newly im
"Edit > Cha
"File > Imp
- Filter data
- Reject data
- Run ICA: "Tools > Run ICA" (can take time)
- Reject by ICA: "Tools > Reject data using ICA"
- Epoch data: "Tools > Extract epochs"
- Plot ERP: "Plot > Channel ERP > In scalp array"
Load a CNT dataset
Data format 16 or 32 bit (Default = Autodetect)
16-bits
32-bits
Autodetect
Time interval in s (i.e. [0 100]):
Check to import keystrokes:
loadcnt() 'key', 'val' params
Large files, enter a file name for memory mapping (xxx.fdt)
Note: requires to enable memory mapping in EEGLAB memory options and only works for 32-bit files
Help
Cancel
OK
Type here to search
14:41
18-09-2020


EEGLAB v2020.0
ERPLAB ERPsets Datasets Help File Edit Tools Plot Study
No current dataset
Suggested steps to get started
- Create a new or load an existing dataset:
Use "File > Import data" (new)
Or "File > Load existing dataset" (load)
(find tutorial data in sample_data folder)
- If newly imported raw dataset
"Edit > Channel locations" (look up loc
"File > Import event info" (for continu
- Filter data: "Tools > Filter data"
- Reject data: "Tools > Reject data by ey
- Run ICA: "Tools > Run ICA" (can take ti
- Reject by ICA: "Tools > Reject data using ICA"
- Epoch data: "Tools > Extract epochs"
- Plot ERP: "Plot > Channel ERP > In scalp array"
Dataset info -- pop_newset()
What do you want to do with the new dataset?
Name it:
VEP_demo
Edit des...
Help
Cancel
OK
Type here to search
14:42
18-09-2020



So, here I am going to use a VPR data. So, I will just import the CNT file we have being using the CNT file for this VEP, so I will just take a VEP data. So, here we get the, so I just open this VEP demo over here also it is a CNT file so there are 69 channels and here the events are just 120 because there are only 120 events and triggers we have being giving and here the sampling rate is 1000.

So, here this is the place where we have to do the sampling. If we have to do the same procedures for the other data also we have to change the sampling rate.

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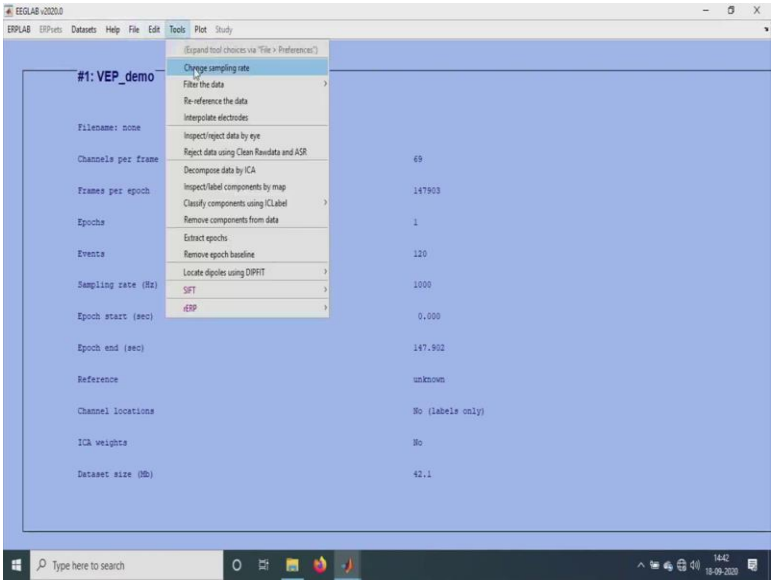

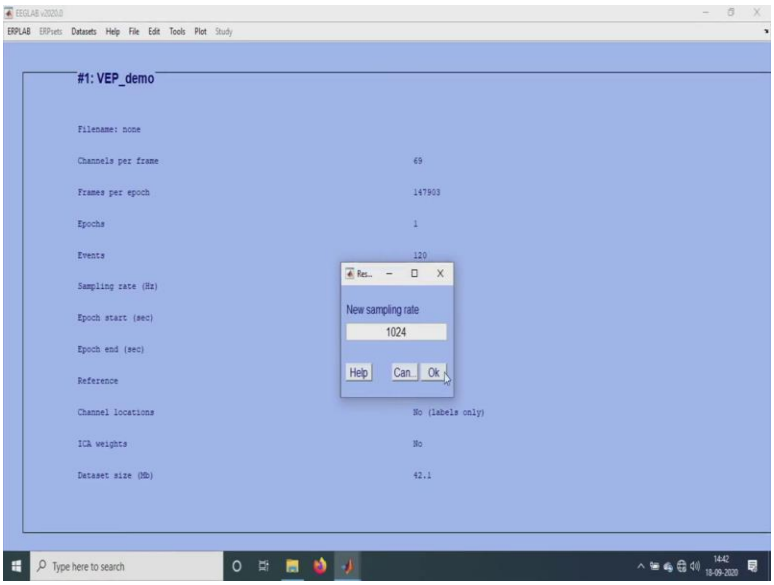

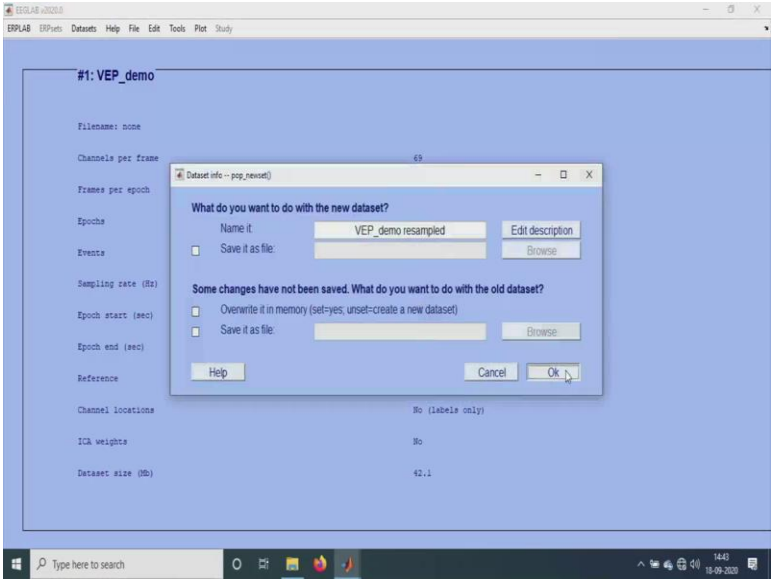

So, since I am just showing example with VEP I am doing this sampling rate change for this particular thing so we just make 1000 to 24 because this is a power of 2 also and we have to obtain this epoch in that range also so that is why we will take a 1024. So, in this case what happens is we will have the sampling rate change to, so it to get re-sampled and we will have a 1024.

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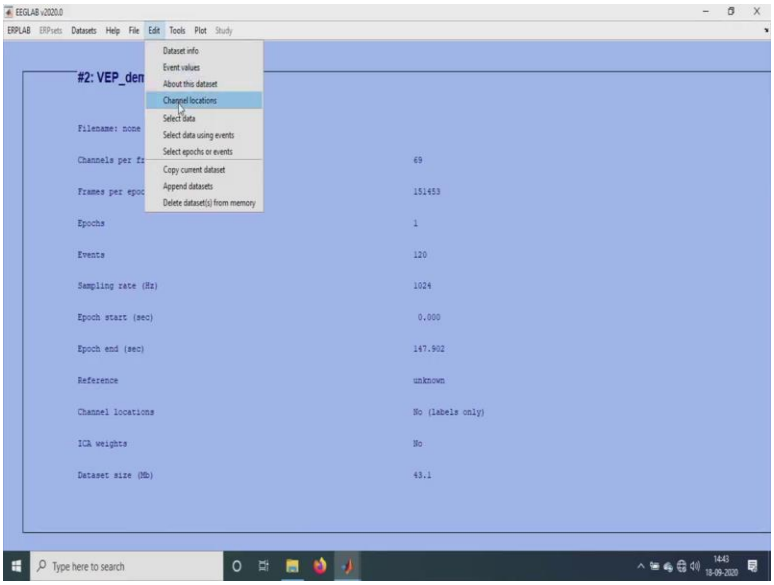

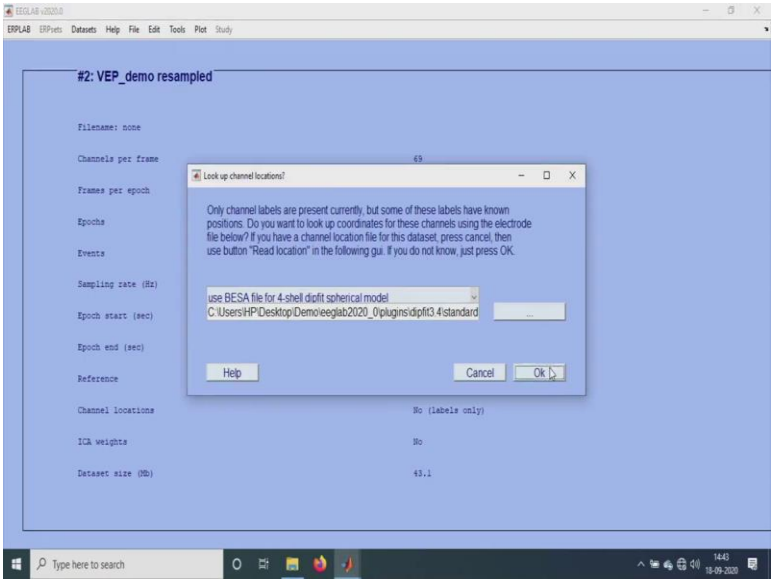

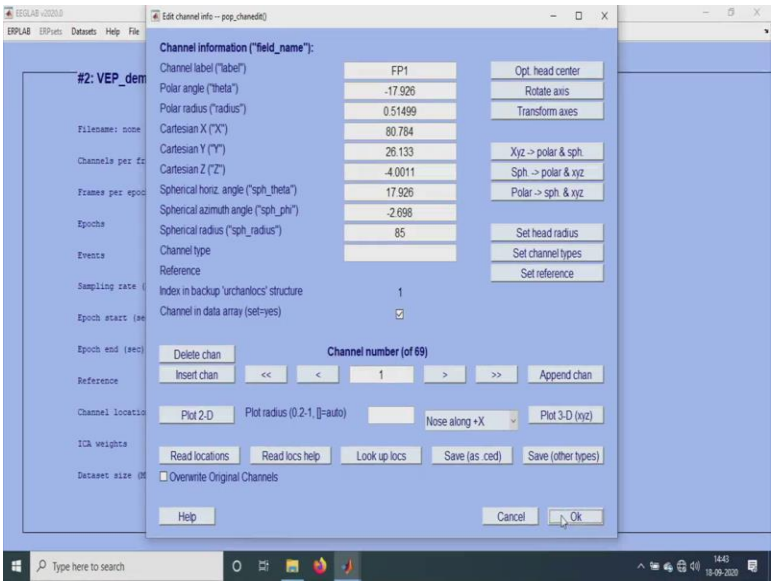

So, here there is a re-sampled data before doing any step we have to add the channel locations. So, we do the a usual step of putting the channels, if it was any other data they would have the channel locations inside the a the channel, I mean in the continuous data itself. So, here we have to externally add the default channel locations. So, this is how it is being done.

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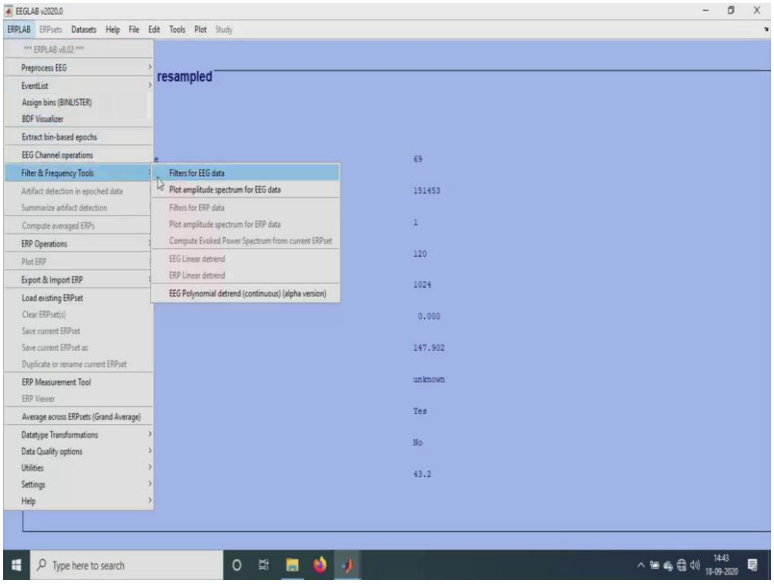
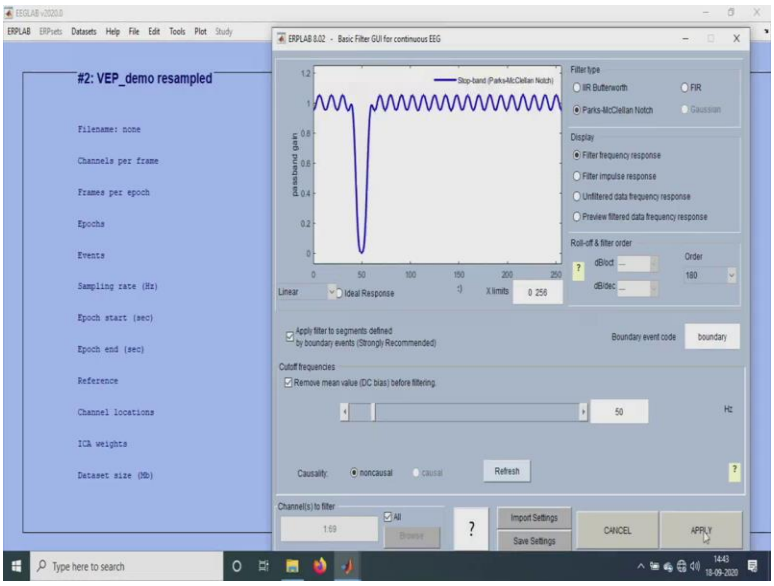
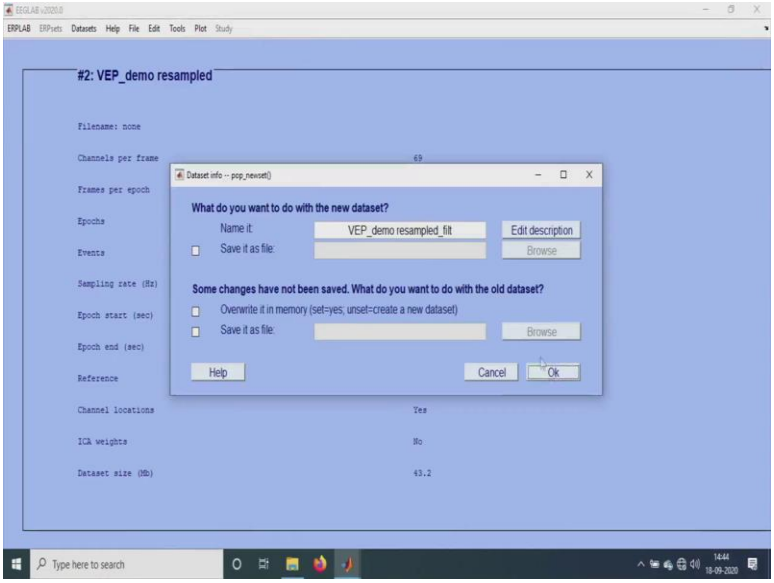
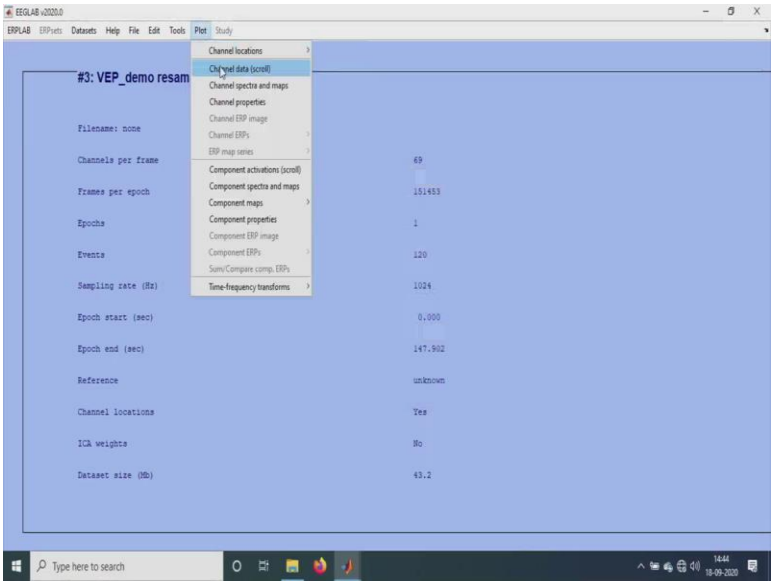


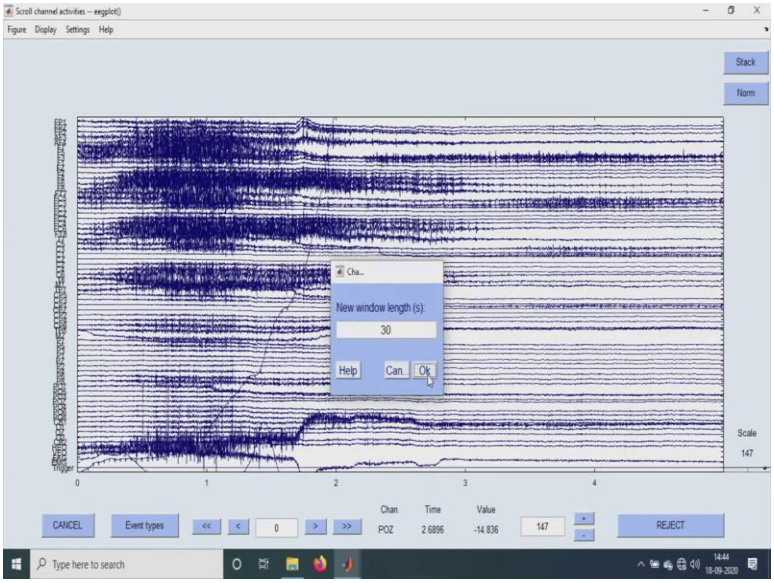


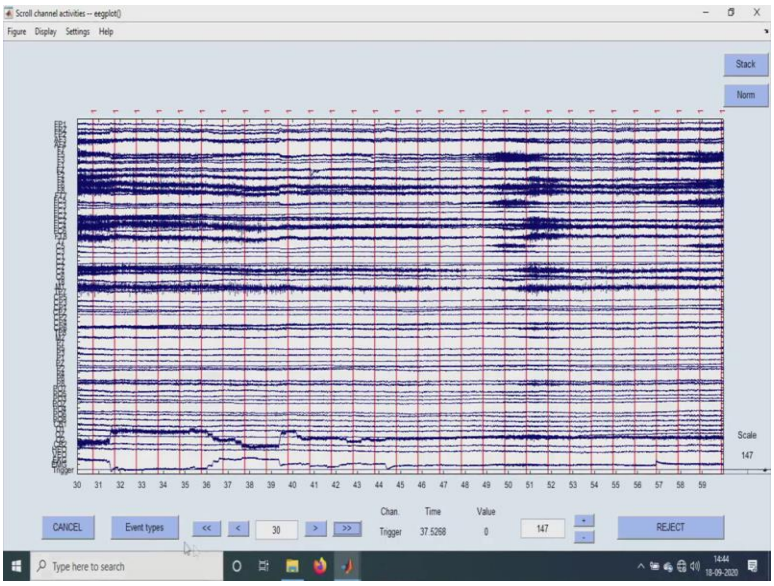


So, here we have the channel location being included and after this I just give you a pre-filtering step we have to do that is a notch filter. So, we does do the a notch filter. So, in a notch filter it will get re filtered so based on that filter we can after that I will show you how the triggers look in VEP.

(Refer Slide Time: 3:12)







So, this is the, we will do the scroll data analysis over here. So, over here this is are the initial responses which have very having a lot of artifacts. So, I will just change the display 30. So, here this the red once all this red once are the a data, the triggers, the VEP triggers that is being obtained. So, here only one trigger option is there, so this is about the VEP. So, here we have to create this alone this once event list we have to create.

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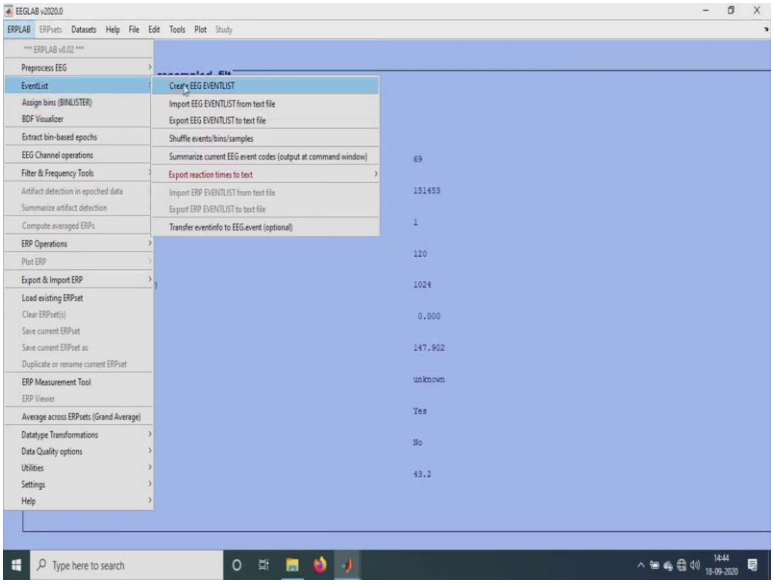
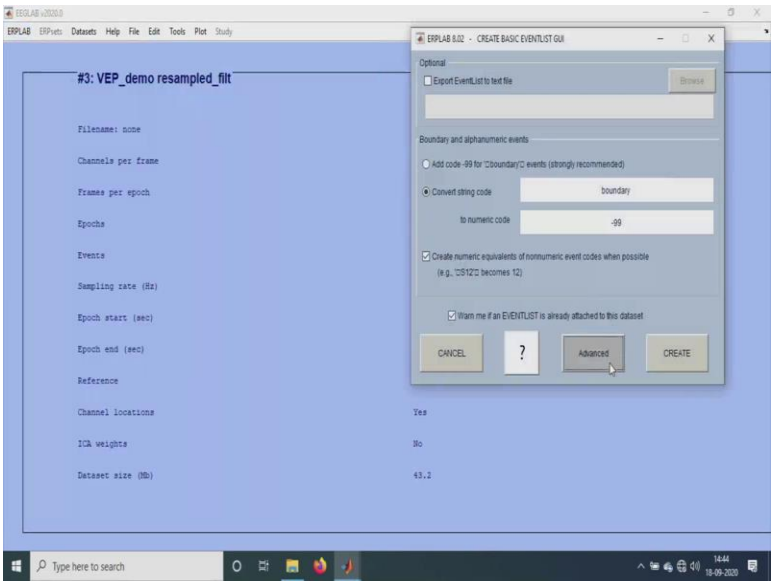
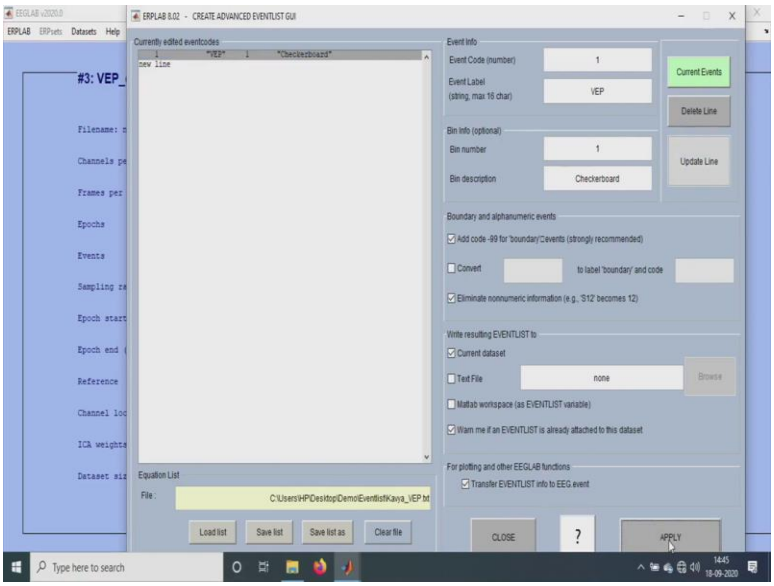
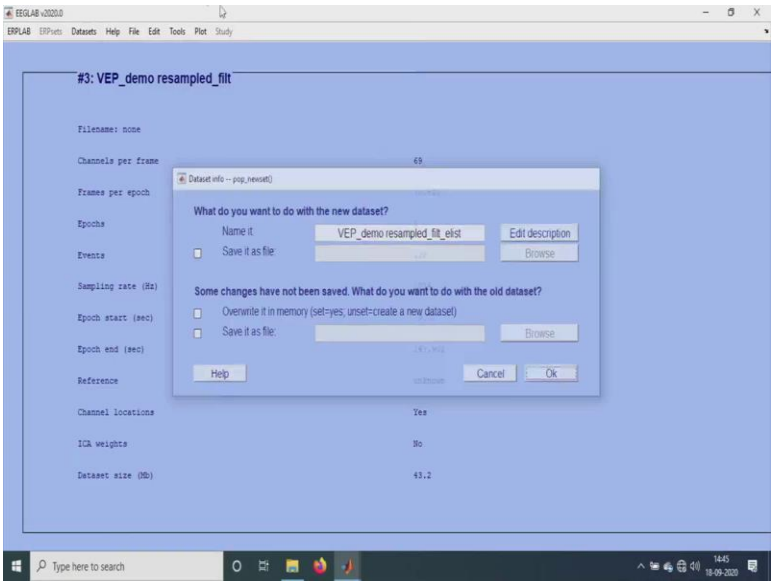



EEGLAB v2020.0
ERPLAB ERPsets Datasets Help File Edit Tools Plot Study
#3: VEP_demo resampled_filt
Filename: none
Channels per frame
Frames per epoch
Epochs
Events
Sampling rate (Hz)
Epoch start (sec)
Epoch end (sec)
Reference
Channel locations
ICA weights
Dataset size (Mb)
Yes
No
43.2
ERPLAB 8.02 - CREATE BASIC EVENTLIST GUI
Optional
Export EventList to text file
Browse
Boundary and alphanumeric events
Add code -99 for 'boundary' events (strongly recommended)
Convert string code
boundary
to numeric code
-99
Create numeric equivalents of nonnumeric event codes when possible
(e.g., 'S12' becomes 12)
Warn me if an EVENTLIST is already attached to this dataset
CANCEL
?
Advanced
CREATE
Type here to search
14:44
18-09-2020


ERPLAB 8.02 - CREATE ADVANCED EVENTLIST GUI
Currently edited eventcodes
1 "VEP" 1 "Checkerboard"
new line
Event Info
Event Code (number)
1
Event Label
(string, max 16 char)
VEP
Current Events
Delete Line
Update Line
Bin info (optional)
Bin number
1
Bin description
Checkerboard
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_VEP.txt
Load list
Save list
Save list as
Clear file
CLOSE
?
APPLY
Type here to search
14:45
18-09-2020



So, first we have to do that process of creating the EEG event list so here we use an advanced option and here we load accordingly that. So, this is the VEP so here the first one first one indicates the trigger name that is a 1. And 1 is event code the event type which was there, we labeled let us VEP and then we put a bin number as 1 and then we do a checkerboard description is that it is a checkerboard.

So, this is the event list and we just apply we just have to enter it over here and update line, so it will get added and you can just save it for future purposes also and then you just apply it. So, what happens is all this event which was named as 1 it will now named as bin 1 or it will be named as checkerboard something like that.

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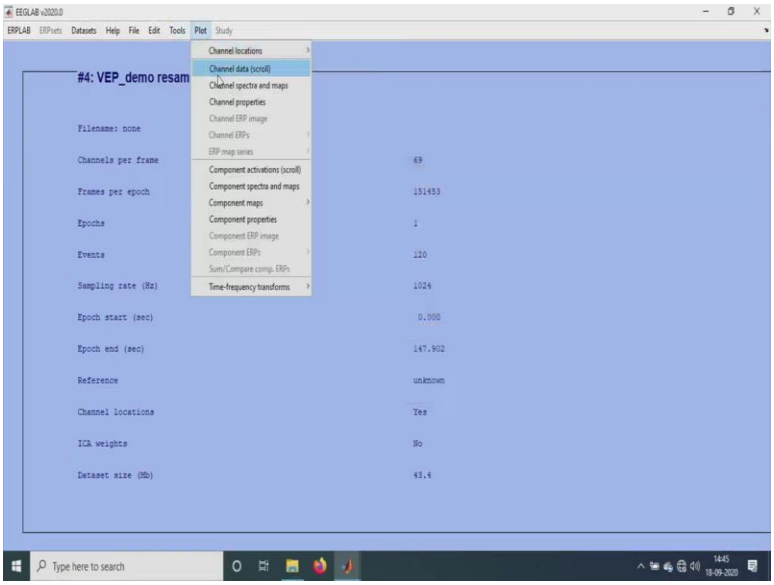
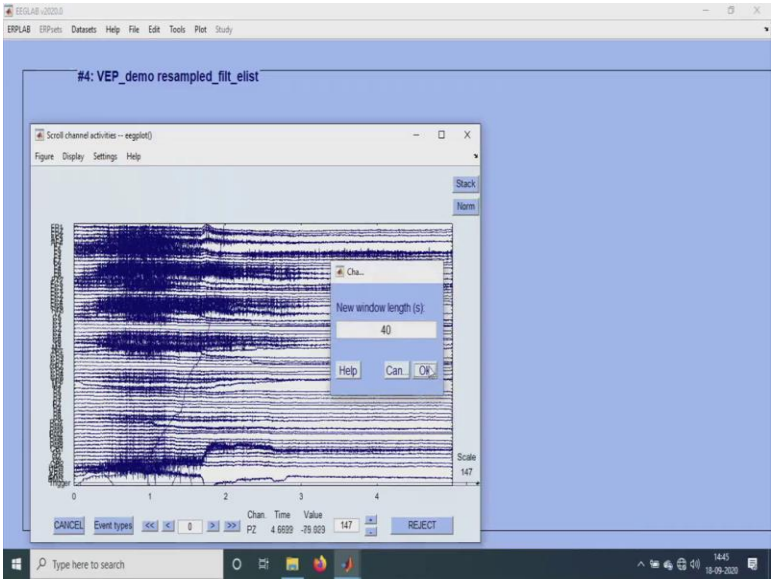
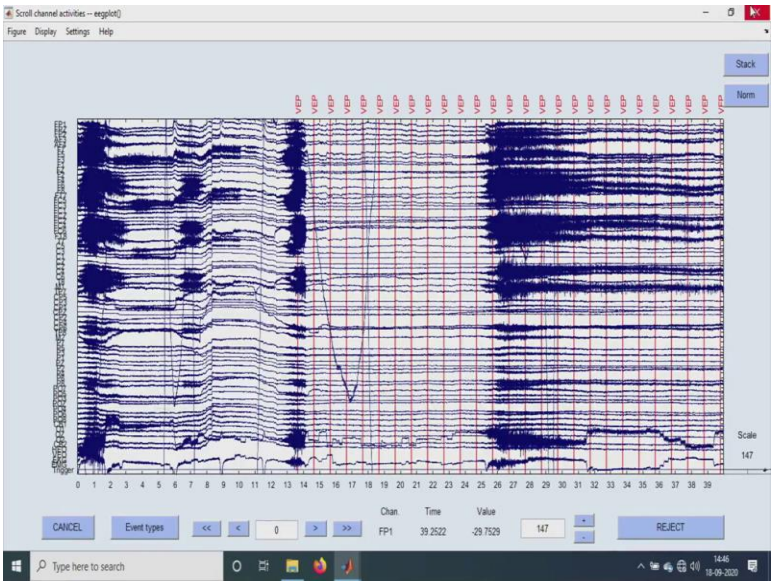
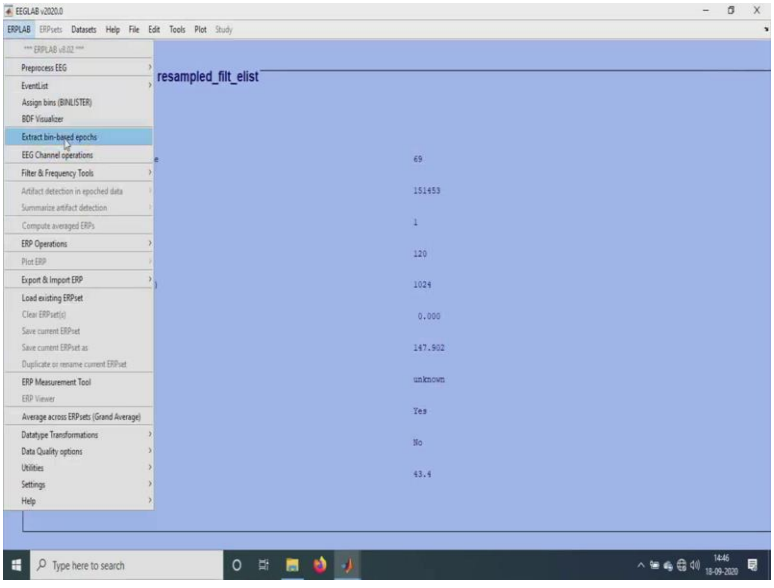


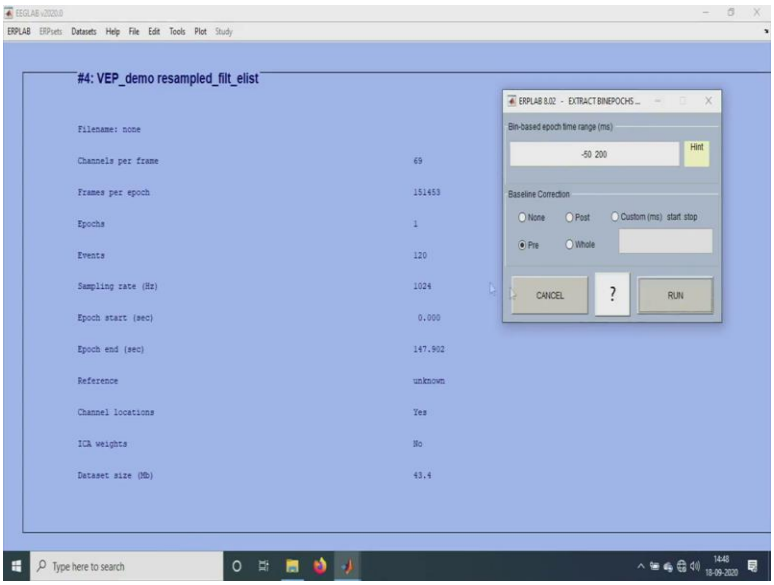


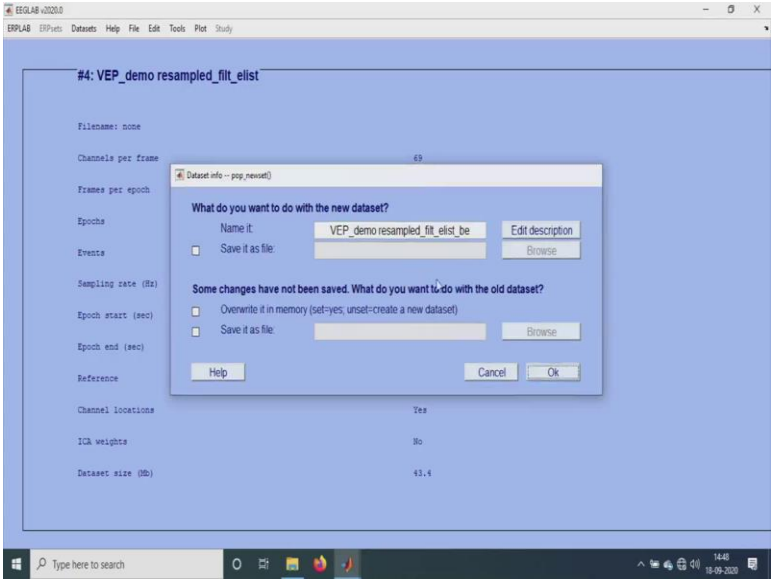


So, I will just show you how it has been changed now. So, followed by this there should be an epoching that is being done. So, here all of them are been named as VEPs now all the ones are being changed to VEP. So, this is this is why we do the event list options in order to make the program understand that this once are nothing but the triggers of our interest.

(Refer Slide Time: 5:23)







So, next is a bin the, bin epoch. So, epoching means to be done. So, now what has happened is we have to be very precise about the this now next, now in this case for wavelet we have to consider this frames per epoch also because we want the frames per epoch also to be in the range of, in the powers of 2. So, since we have given this 1024 what happens is we will get the epochs if you do from minus 1000 to 1000 what happens is this whole thing will be given in that particular range in 1 2 seconds we will have this particular.

Now what happens is we wanted only a particular part of interest that is just till 200 maximum not more than that so what happens is we just want the first quadrant so first 45, first 25 percent of the sample is only we are taking. So, we take from minus 50 to 200 so that we get the 25

percent of 2 and this 1204. So, it will be then, we will get a frames per epoch, that means friends 1 epoch for that reason only we are doing the epoching in this range.

So, if you wanted in P300 means, we will take from minus 50 to 700 so that you will get in that range and also we will get in the powers of 2 as well. So, that is why we take like first quadrant kind of thing we will take in this section. So, if we run it what happens is, now all these we will have 120 epochs, along with that each epochs will be, each epochs will have 256 data points. So, this is why we did that particular epoch range.

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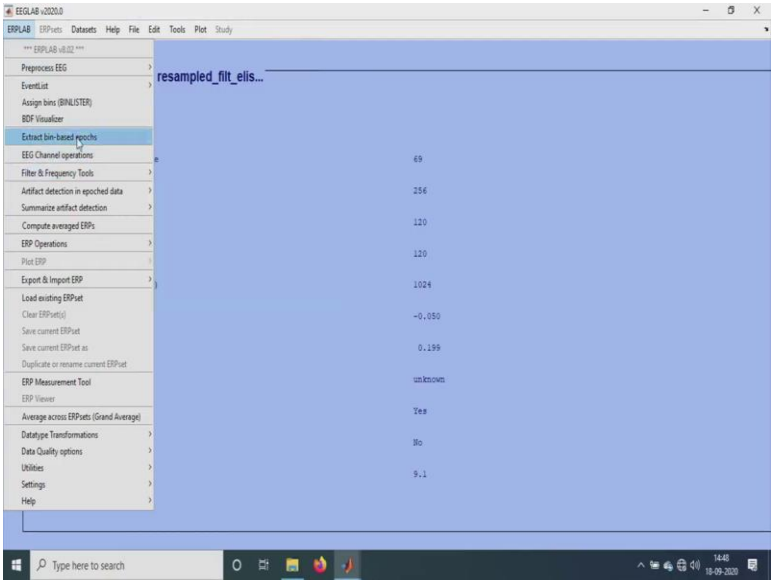

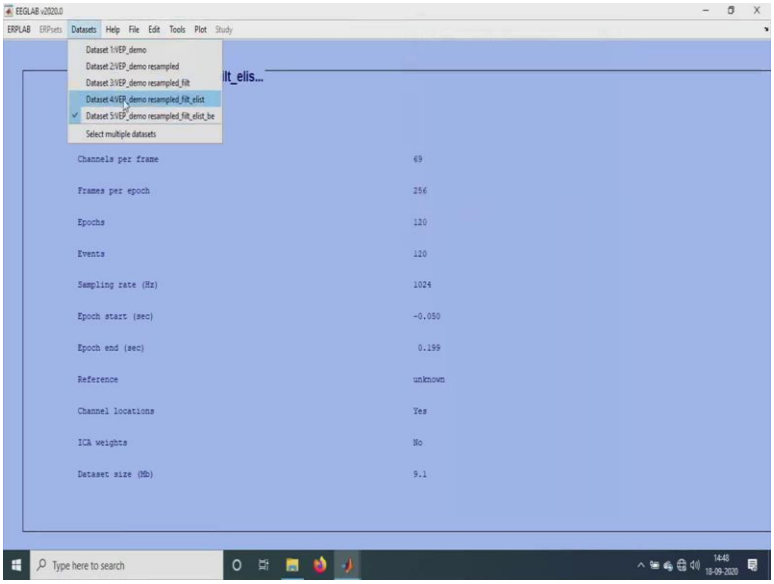

So, we if we suppose if we do a different for example, now if I change the epoch, for and I am just doing it like, I will go back to this event list after creating event list.

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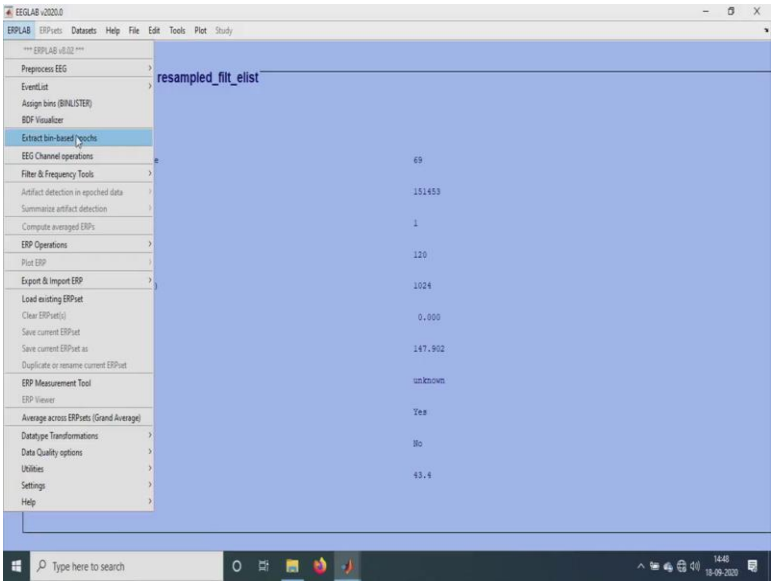

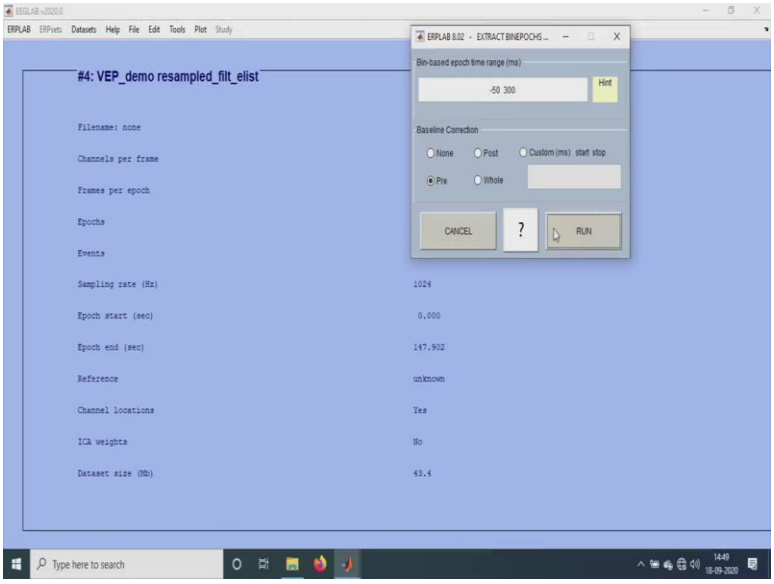

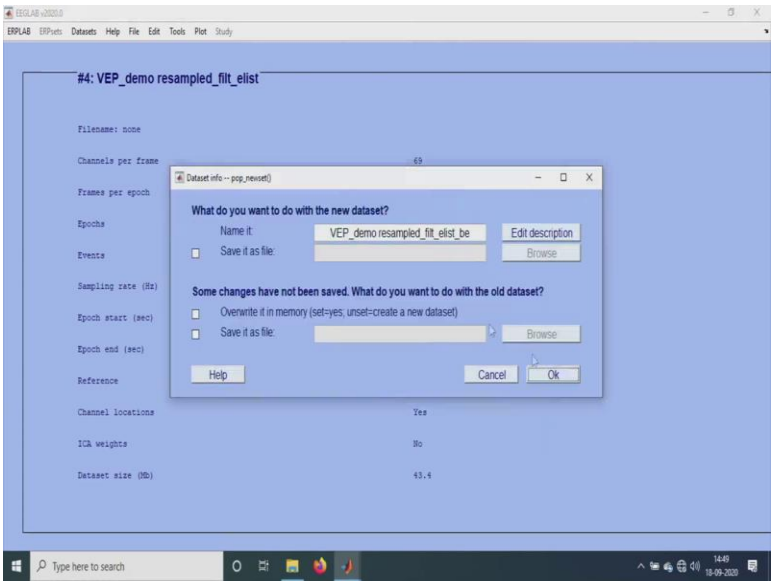

So, now I am doing a the bin based epoch. Now, what I do is I just do not, now if I do not do this particular range for example, I am doing something like 300 for example, so now here we have 350 data points will be coming. So, if I just run in this manner what happens is we would not get the powers of 2 in here in the frames per epochs. So, it will be changed. It will become like say if 358, it has become.

So, we do not want to be in this range, we want always to be in the powers of 2. So, for that reason only we are doing it in this as I mentioned over here I have done in this case. So, this is just I gave a demo that we have to, why we have to do from minus 50 to 200, why I did I just

explained over here. So, that we get this 2 to the power n in this range we get our data point, datasets we get. So, this is about the event epoching.

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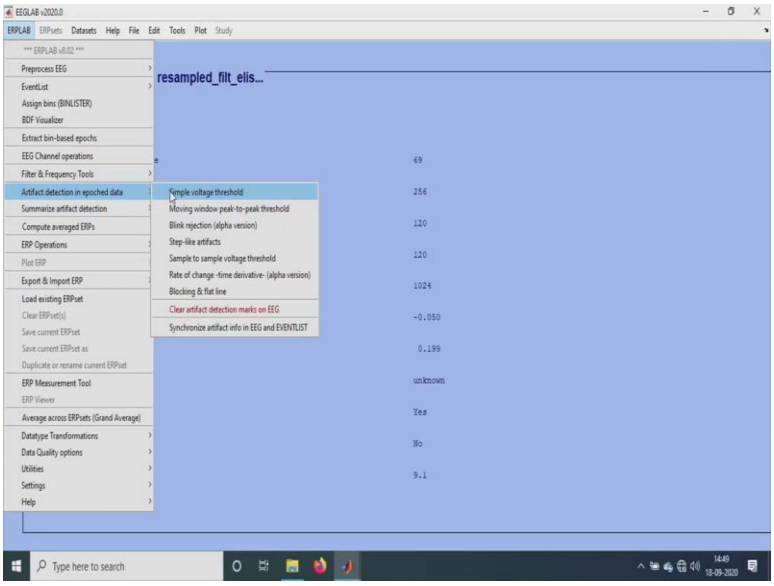

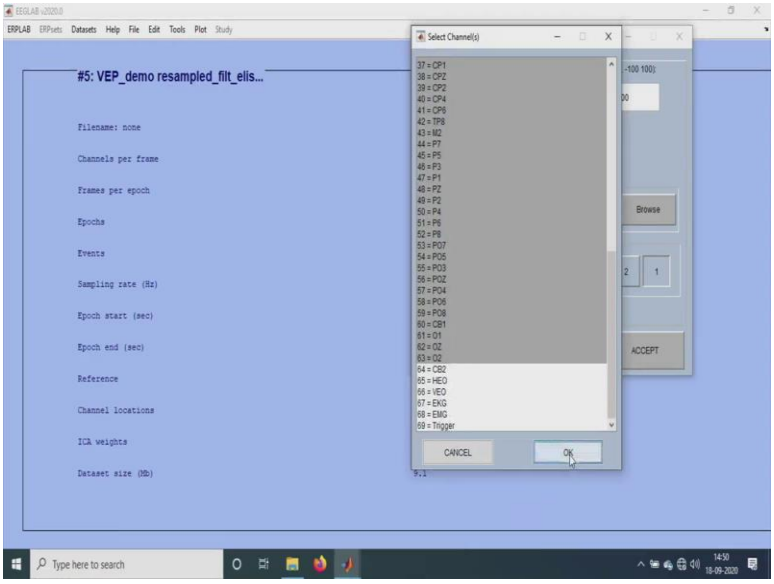

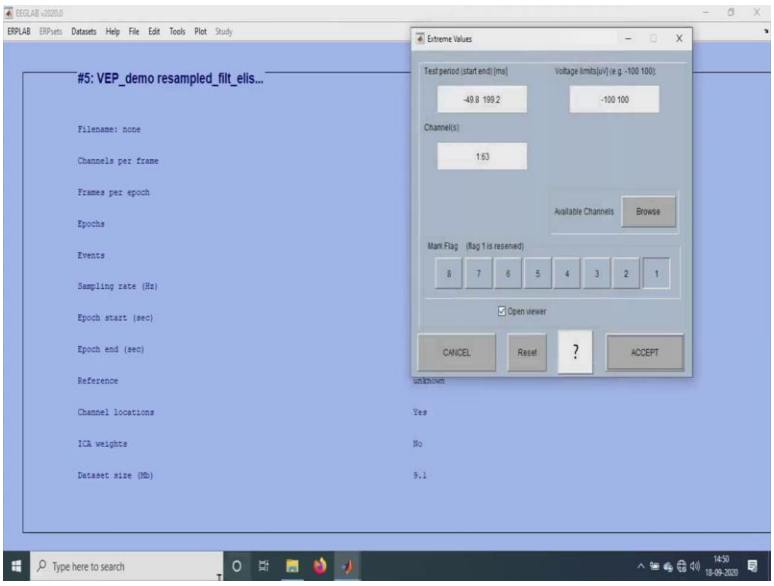

Next we have to do is the usual step that is the artifacts detection that is also the voltage threshold. Even this the time period of, our experiment time period is less only but still we have to remove all our artifacts. So, here we take, this is a 64 channel, so I am just removing all the trigger and EMG, HEO, VEO channels and everything. So, and then we accept it.

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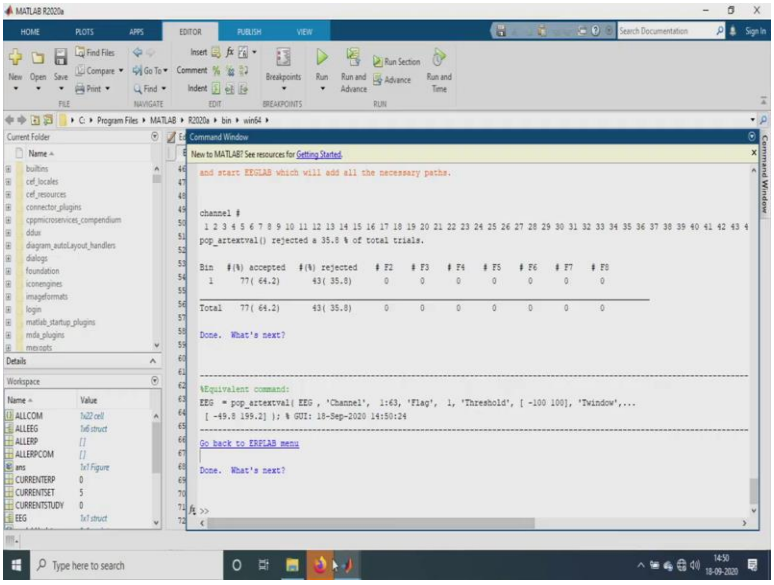
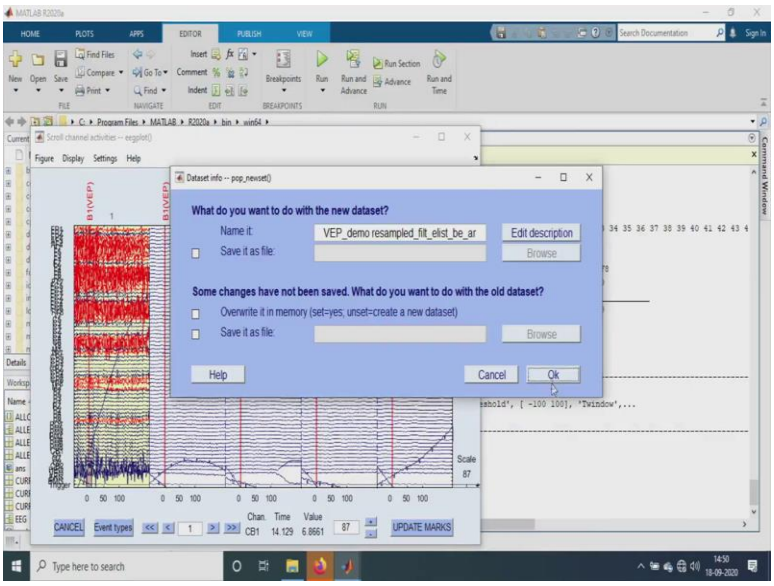
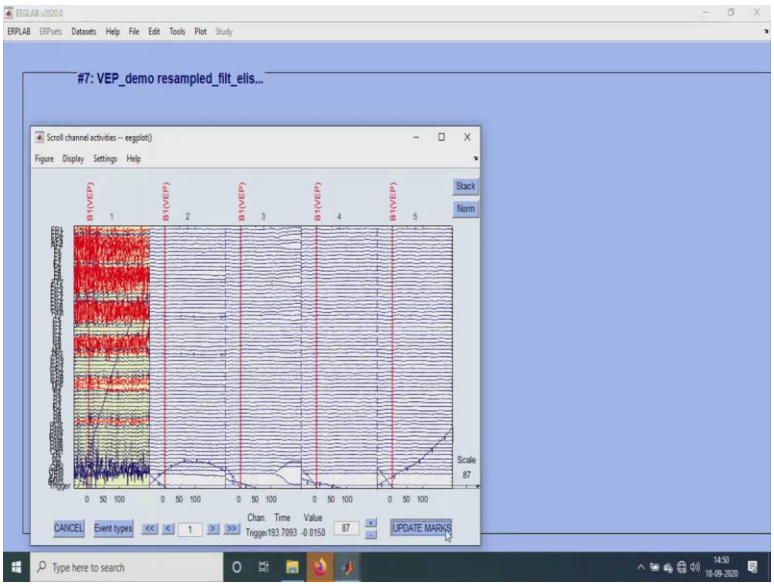
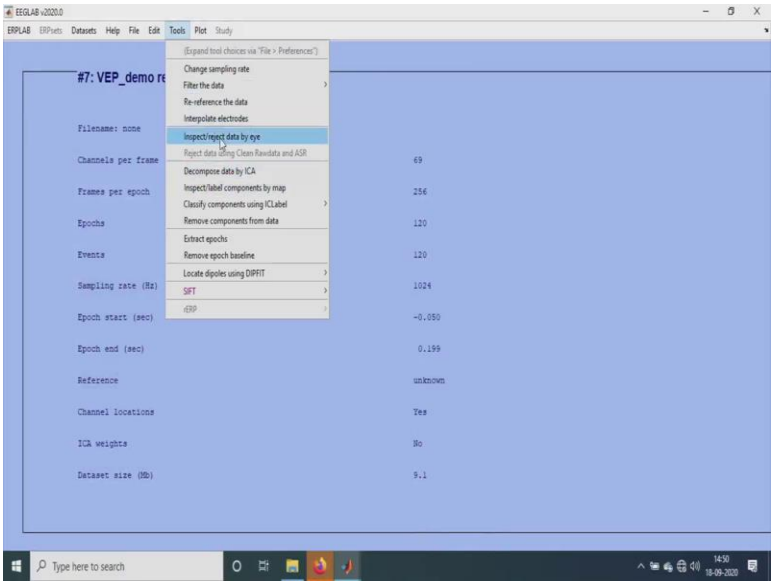


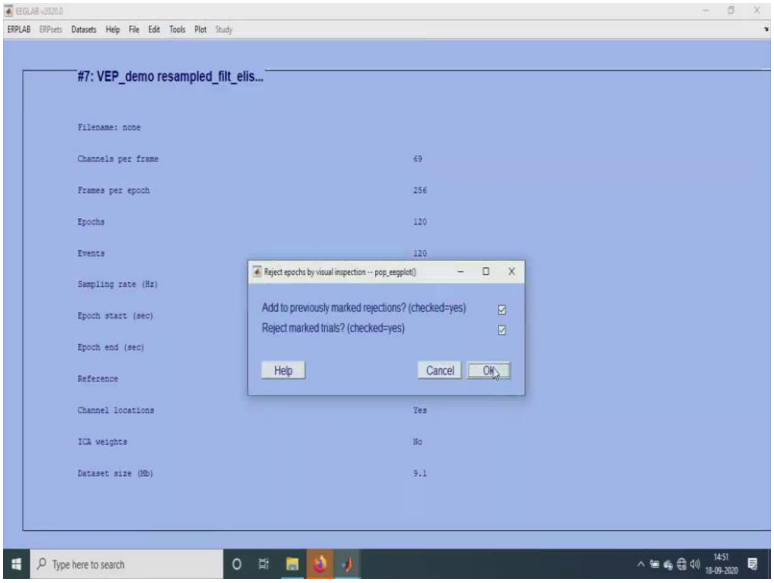


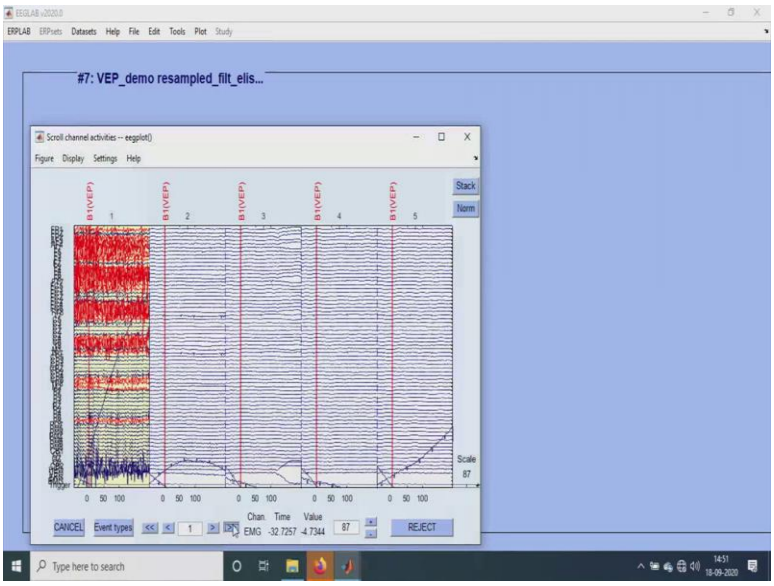


So, if we can check over here, if we check all the these many of them will be are been rejected and this one, the 77 of them have being accepted. So, that is why even though it is a small this one, there will be a lot of artifacts is still being there. So, here we have to update, we have the artifacts rejected dataset is being created. Followed by we have to just update these marks so that we can reject it all the rejected epochs can be removed.

(Refer Slide Time: 10:04)






EEGLAB v2020.0
ERPLAB ERPsets Datasets Help File Edit Tools Plot Study
#7: VEP_demo resampled_filt_elis...
Scroll channel activities -- eegplot()
Figure Display Settings Help
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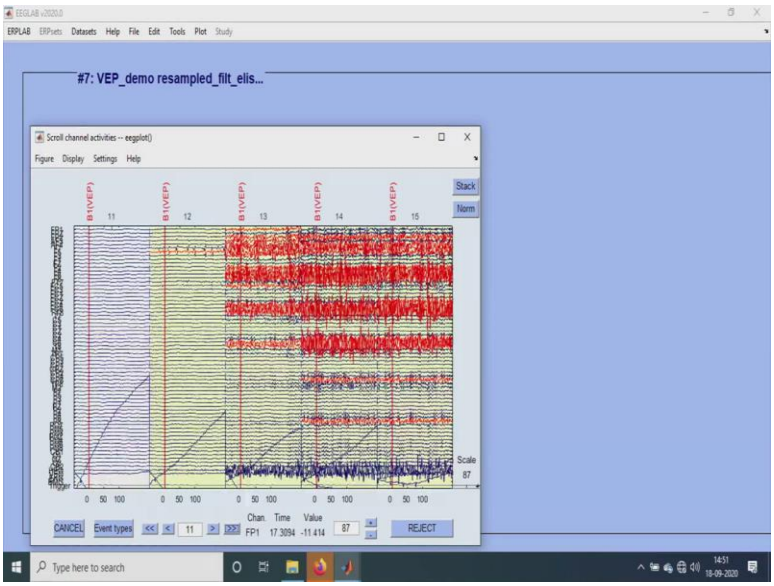
18-09-2020


EEGLAB v2020.0
ERPLAB ERPsets Datasets Help File Edit Tools Plot Study
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Scroll channel activities -- eegplot()
Figure Display Settings Help
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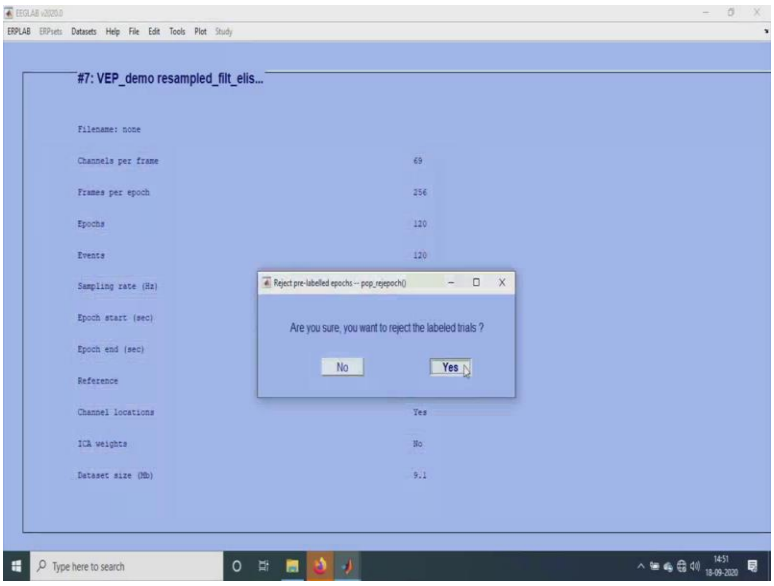
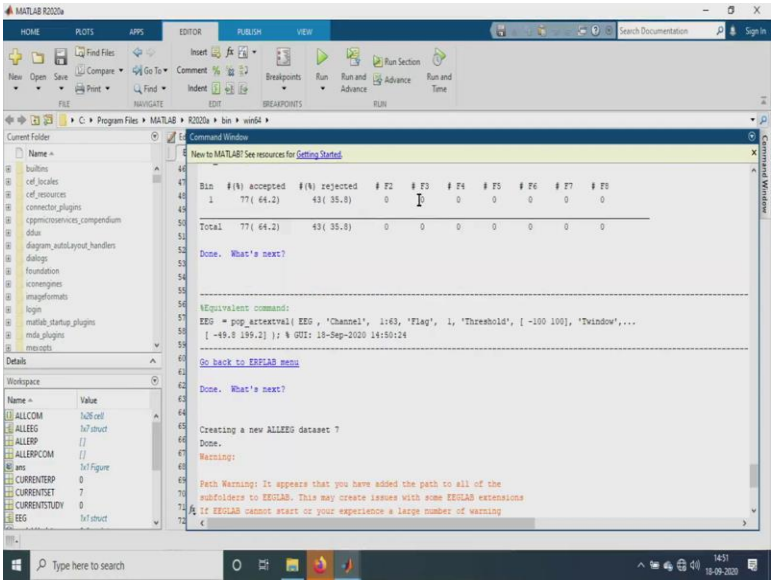
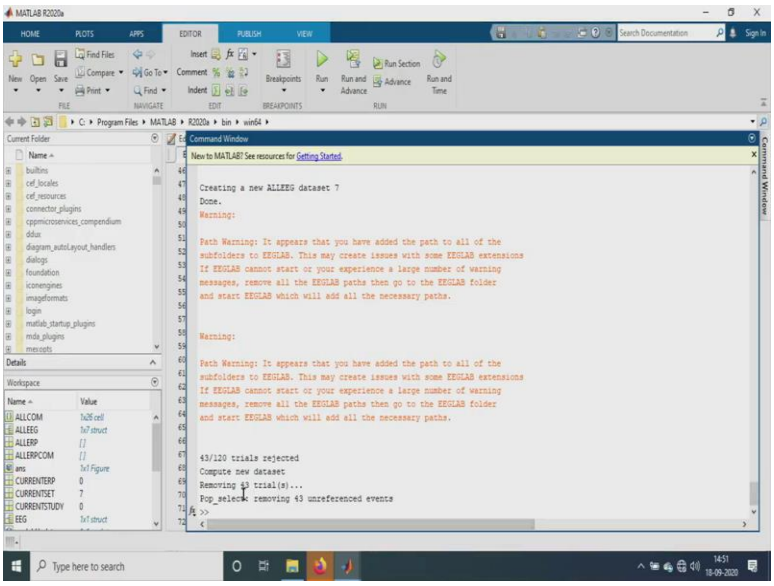
18-09-2020



So, we just remove as the usual step. So, here all these channels, if you go further there will be various other channels also will be there which has been remarked as problem. So, I mean which has been marked as being rejected. So, just rejected based on that.

(Refer Slide Time: 10:28)





So, if you see of total 120 epochs, 77 was accepted and 43 was being rejected. And we rejected those 43 trials from the whole dataset.

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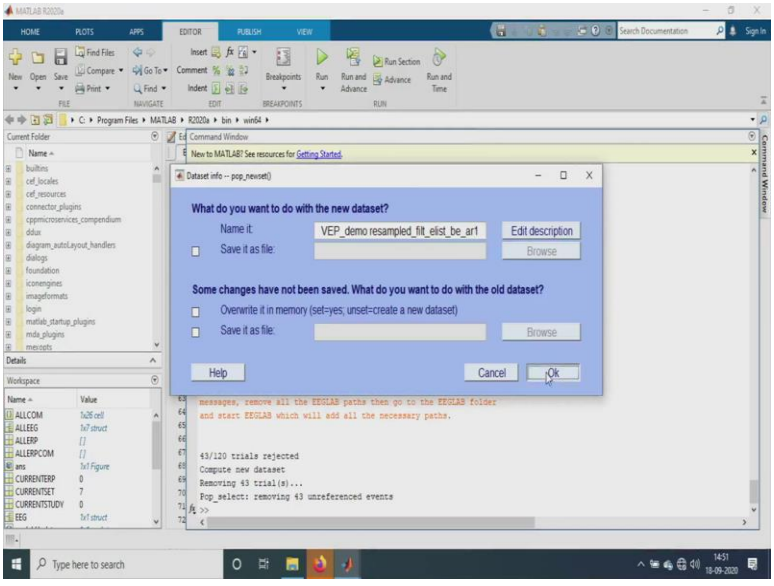

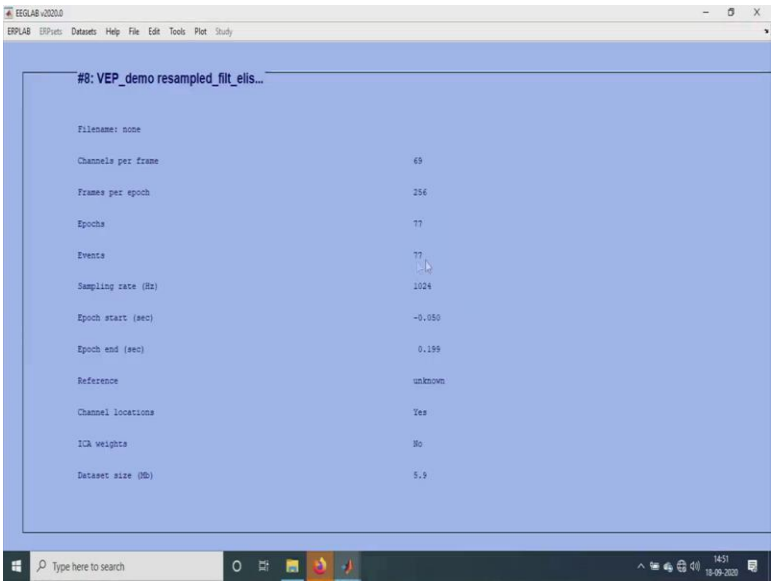

So, now when we create a new dataset it will be having just the 77 epochs alone. Now, what does this 256 actually mean is that, for 1 epoch, there will be 256 data points. Similarly, so if there are so for total of 77 epochs there will be 256 into 77 that many epochs, that many data points will be there. That is the, that is our interest that is why we are using this particular, that is the meaning of this particular this frames per epoch means that only.

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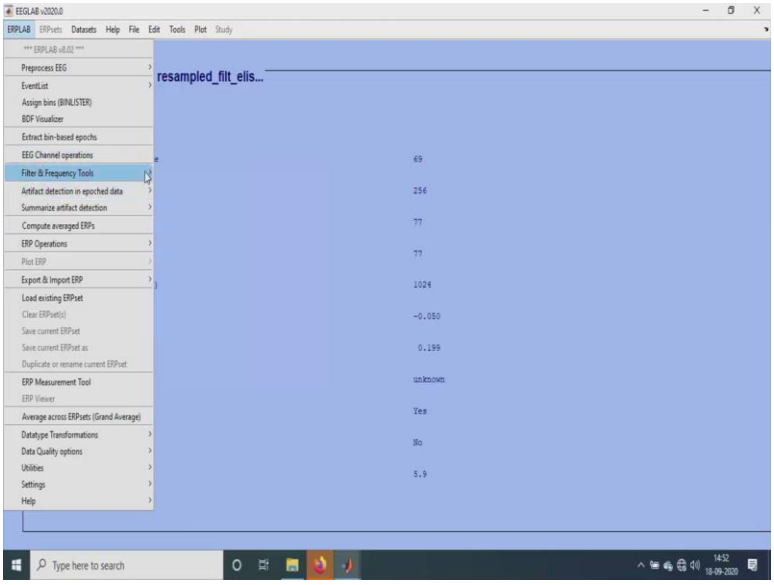
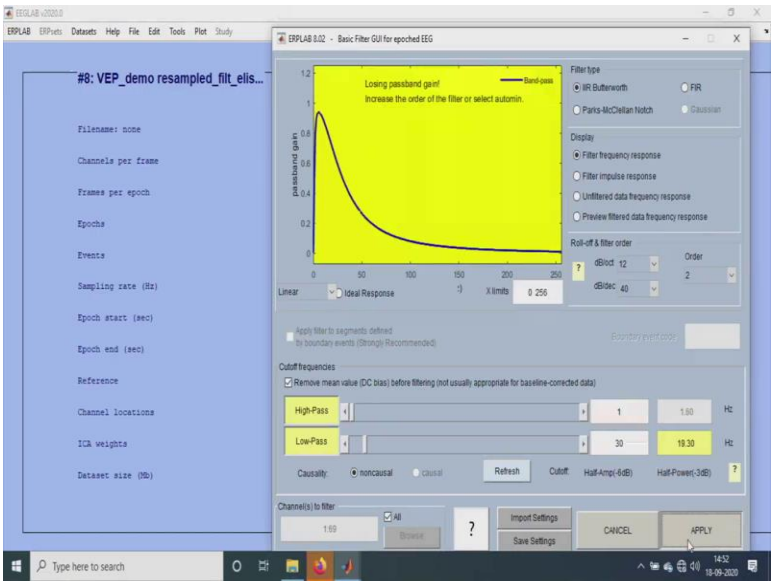
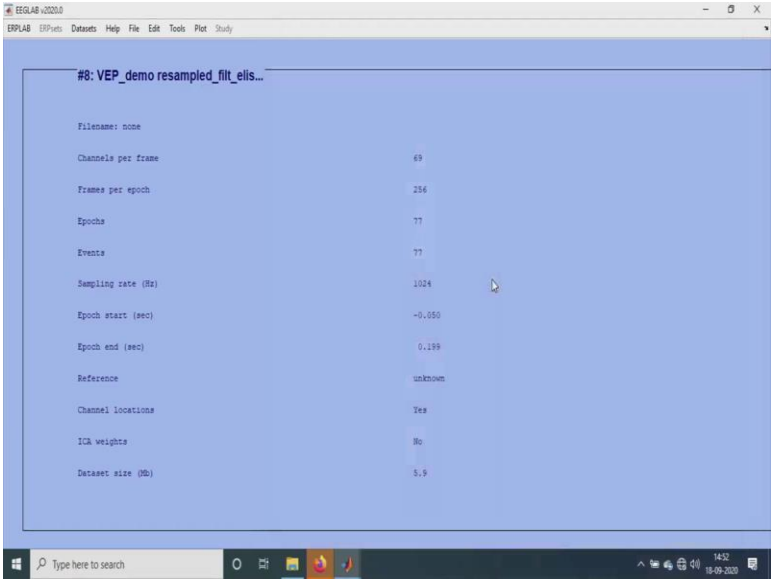
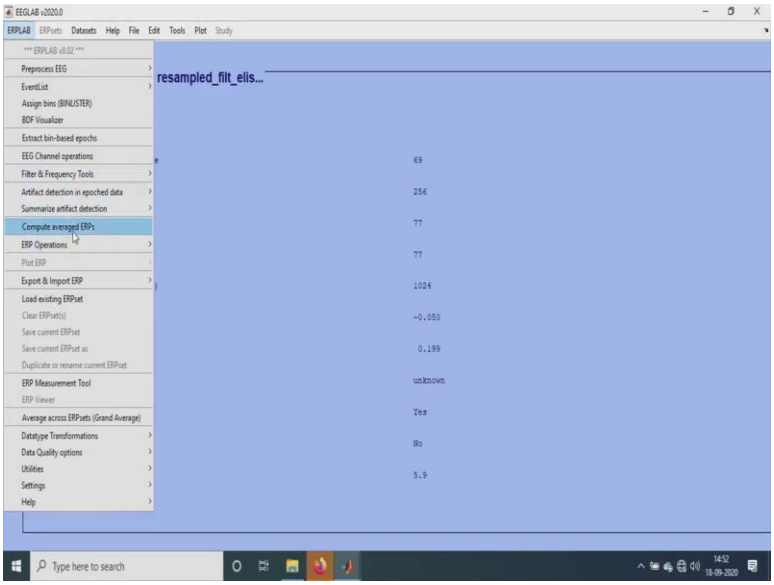


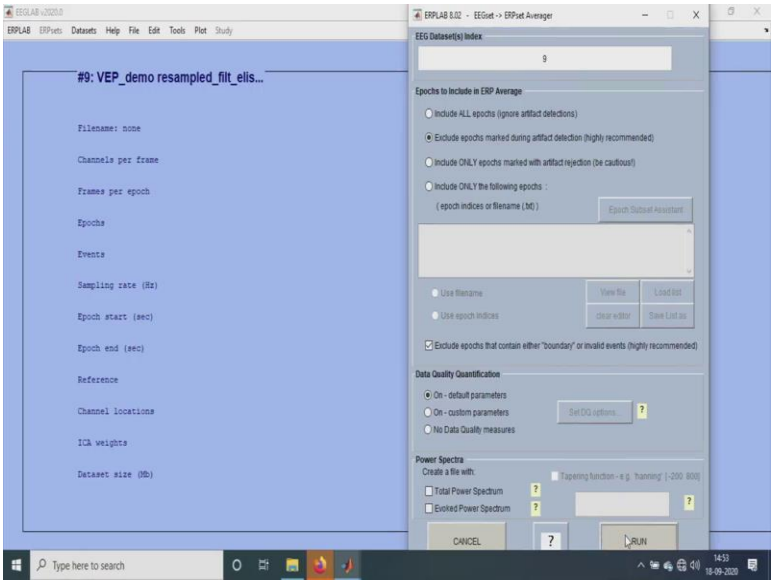


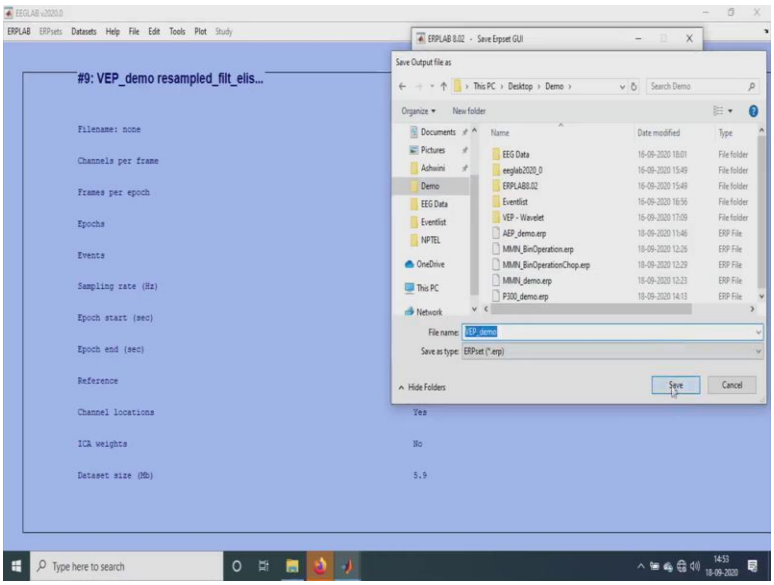


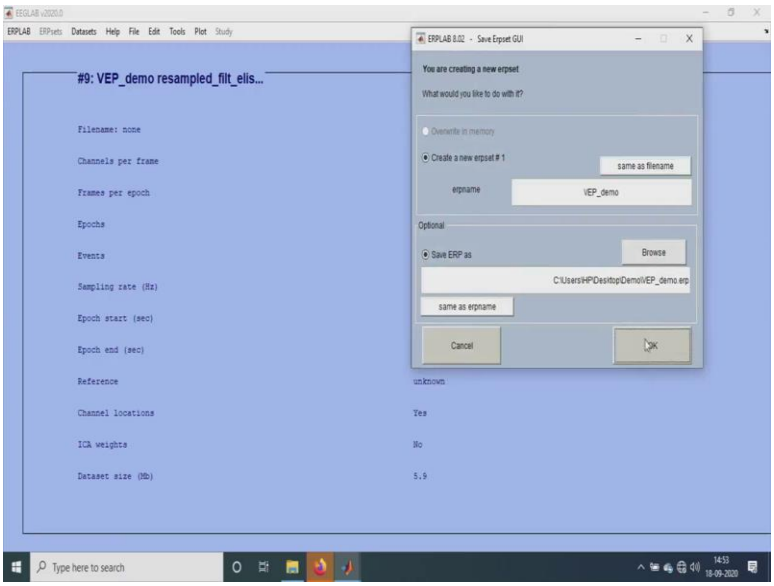
Now, next after artifacts rejection, the next step is on filtering the data, again we use the Butterworth filters. Similarly, with 1 to 30 and then we just do the filtering. So, here we have the filtered dataset.

(Refer Slide Time: 11:49)



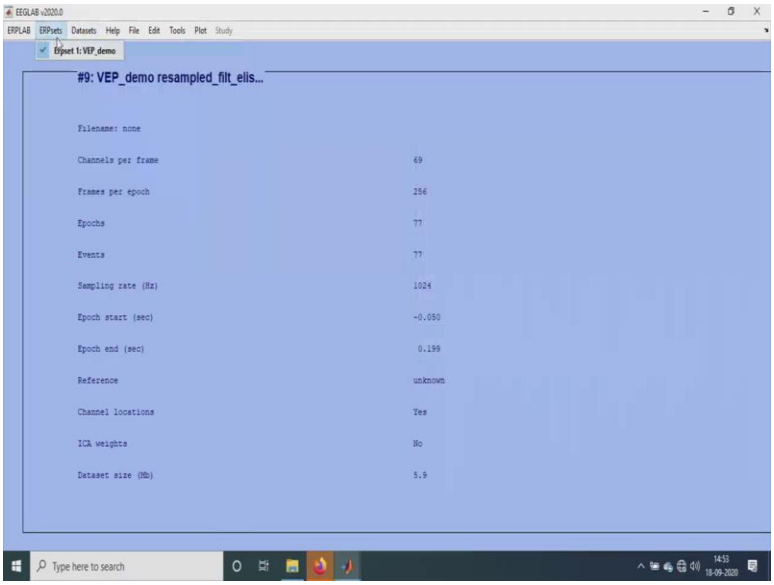


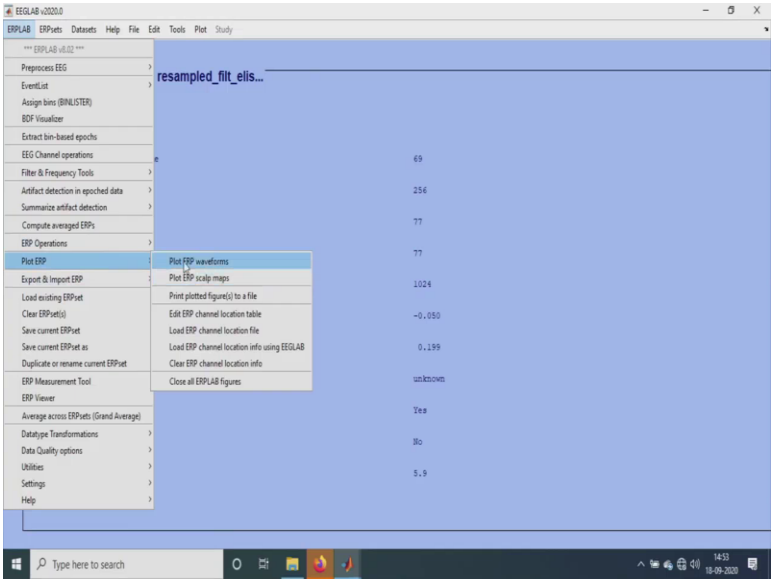


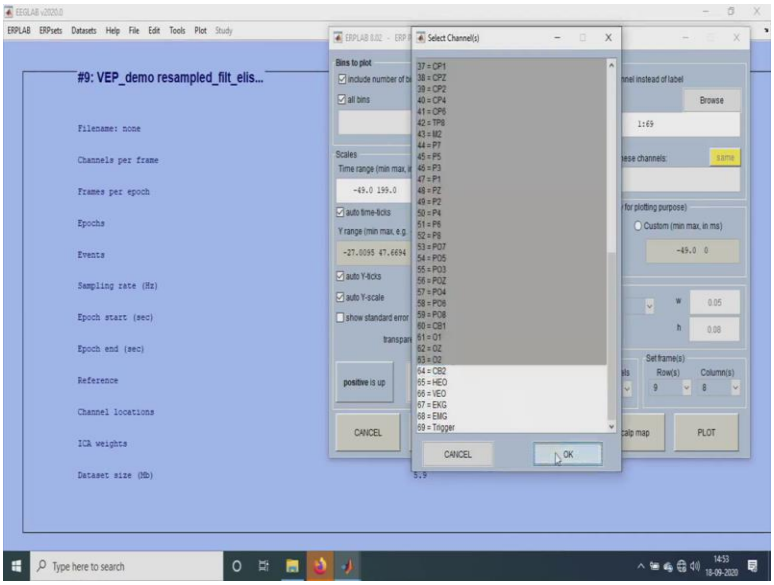


After doing this particular step, next is the averaging it. So, as I have mentioned before, the averaging is being done for, since we are working in a very few microvolts of data. So, what happens is just a single epoch is not at all enough for analyzing it. So, we just do the this average of the whole 77 to get the proper analyzed ERP. So, we just make it as VEP. So, here we making the data, ERP set.

(Refer Slide Time: 12:28)



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Channels per frame
Frames per epoch
Epochs
Events
Sampling rate (Hz)
Epoch start (sec)
Epoch end (sec)
Reference
Channel locations
ICA weights
Dataset size (Mb)
Select Channel(s)
37 = CP1
38 = CPZ
39 = CP2
40 = CP4
41 = CP6
42 = TP8
43 = M2
44 = P7
45 = P5
46 = P3
47 = P1
48 = PZ
49 = P2
50 = P4
51 = P6
52 = P8
53 = PO7
54 = PO5
55 = PO3
56 = POZ
57 = PO4
58 = PO6
59 = PO8
60 = CB1
61 = O1
62 = OZ
63 = O2
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67 = EKG
68 = EMG
69 = Trigger
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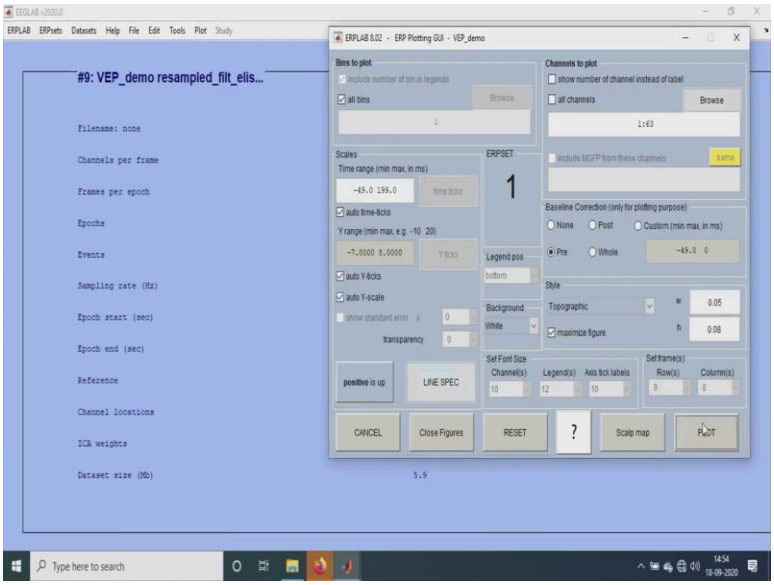
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Channels per frame
Frames per epoch
Epochs
Events
Sampling rate (Hz)
Epoch start (sec)
Epoch end (sec)
Reference
Channel locations
ICA weights
Dataset size (Mb)
ERPLAB 8.02 - ERP Plotting GUI - VEP_demo
Bins to plot
Channels to plot
ERPSET
Scales
Time range (min max, in ms)
Baseline Correction (only for plotting purpose)
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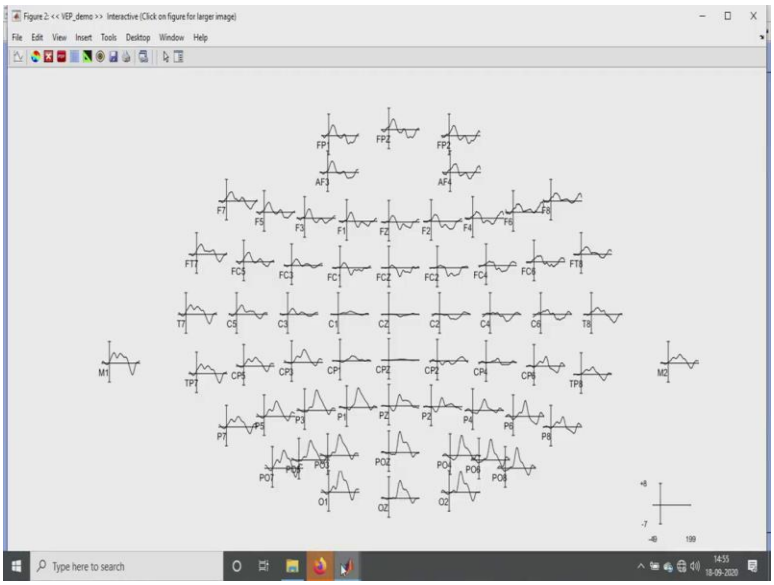
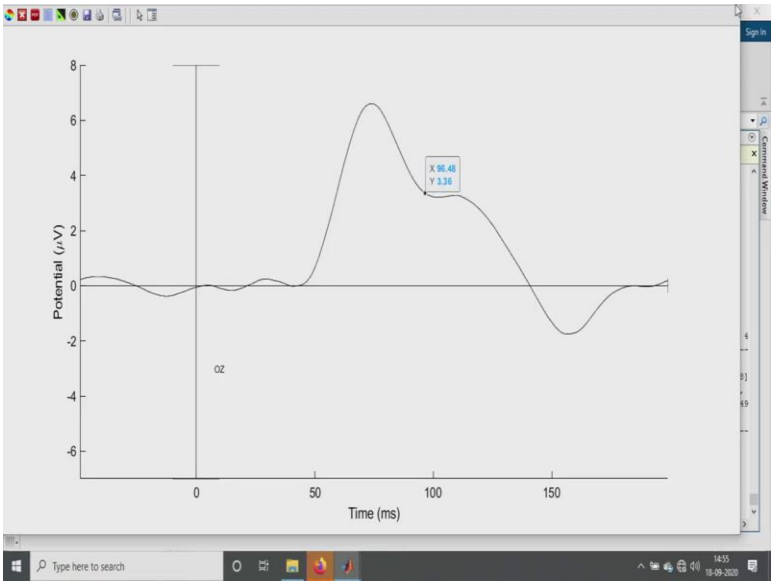


So, here ERP set is being created. Now, we will just visualize it, here there is no any bin operation or channel operation because there is just one bin left there. So, we just have, if you want we can do any channel operation like for a particular way, if you want only the occipital region of the brain alone to be averaged together, then you can just take the bin, channel operation can be done. But I am just going to show an individual response of how it looks. Here also we take a negative up.

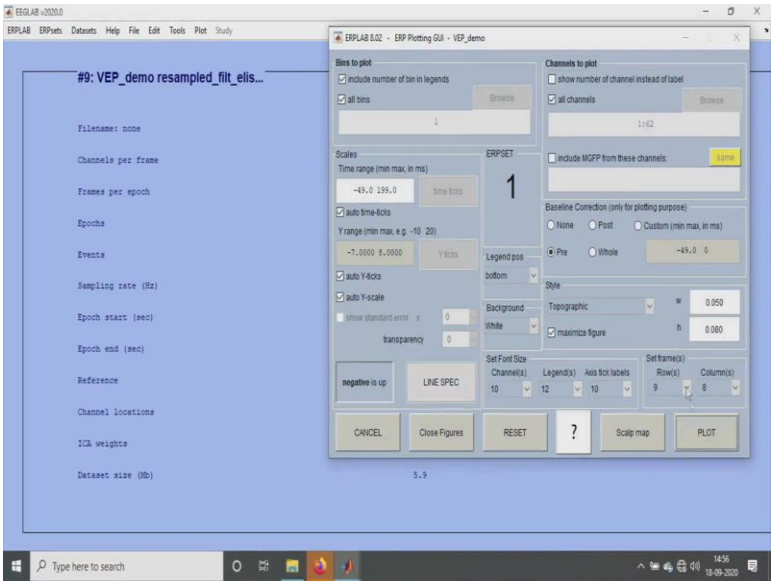
Or we can take a positive up also anything is fine, so I just take it a topographic analysis of it so that you get a proper, so we have done the ERP lap. So, this is the proper, so here also we see the reversal taking place, it is a bit less only but yet there is a reversal. So, here it starts itself from this top, from here it is like from down it is going up, so that is like a reversal taking place and this is the main this particular region, this occipital area is the main place wherein we get the visual VEP, visual evoked potential. So, we can actually make it a positive up or negative up anyways this is fine.

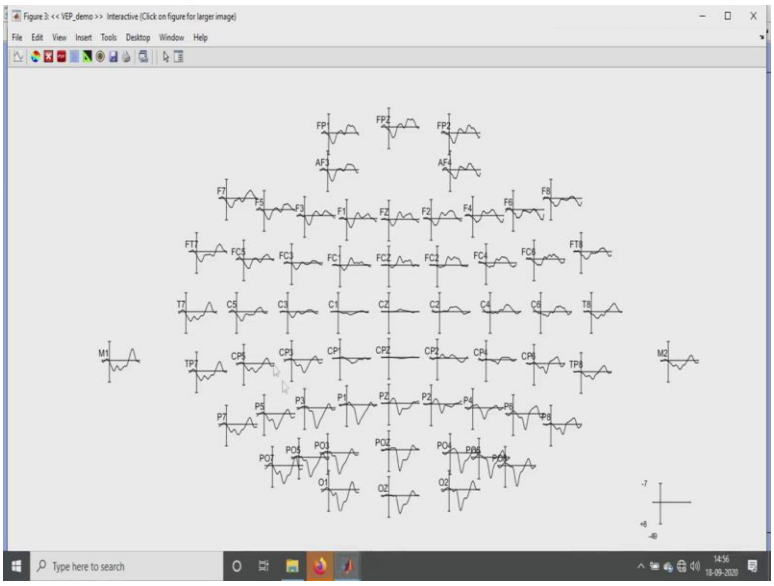
(Refer Slide Time: 14:04)



So, here if you see this is how the AEP is looking, it is a bit different but then the as I told you the amplitude and the latencies are the interest of our, that is the point of our interest. So, here this is the positive up, the negative up, it is coming in this region, actually this is a bit weird I mean it is a quite a different dataset you can get. So, here we can see a proper N1 P1 peak, N1 peak and all. So, always a P, we can first check is the N1 peak. I think it is better to do a negative up.

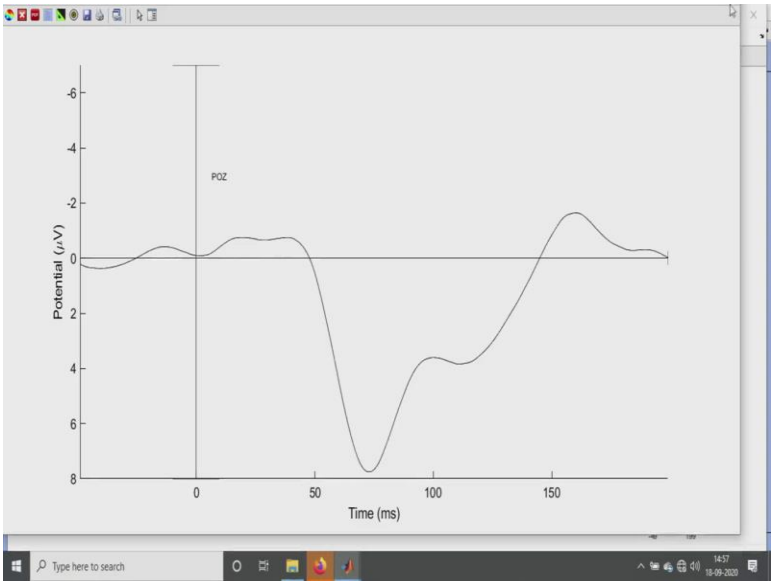
(Refer Slide Time: 15:02)





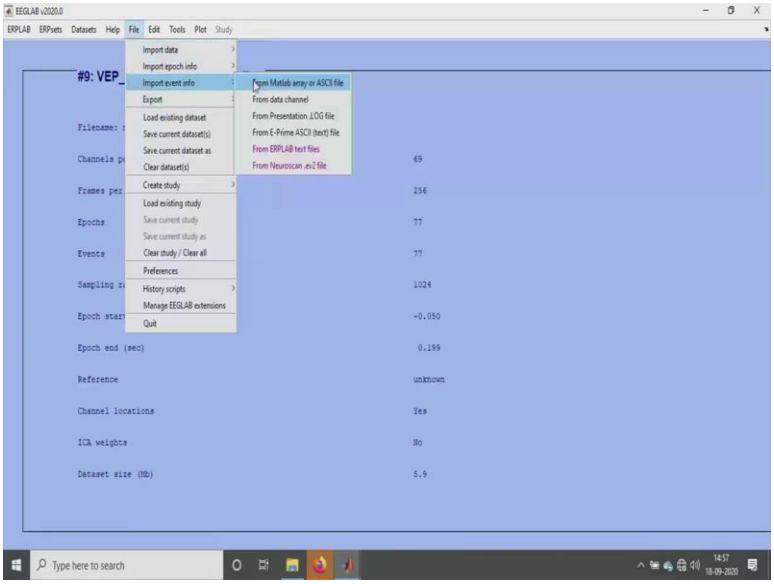
We added a positive up in the previous thing I will do a negative up and check how it looks. Negative up is a bit better because we are mostly checking the negative peaks more so that is why the negative up is better. So, anyway this is how the VEP looks. Now, next I have to make you I mean I have to show is about the how to the wavelet analysis. So, here in this case we can directly so as I told you there are 77 epoch and there are 256 data points for each epoch so what happens is we will have totally a 77 into 256 that many number of data points we will be obtaining.

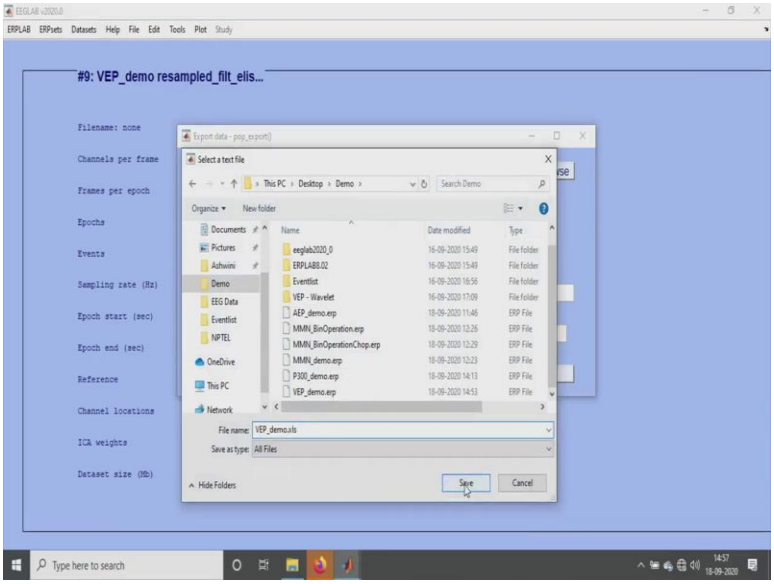
(Refer Slide Time: 15:55)

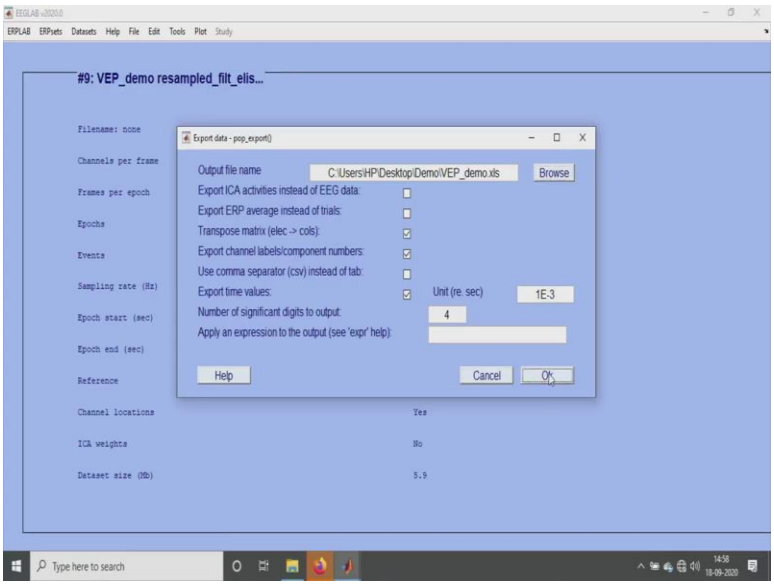


So, this is supposed to dip and this is a negative up and again a positive. So, this is this should be the N1 response actually and this should be the P1 response followed by the so this is how it should look like, it is not a proper VEP but this is how it should look like there is a proper N1 P1 response that is been obtained. So, this is how it should look like.

(Refer Slide Time: 16:27)

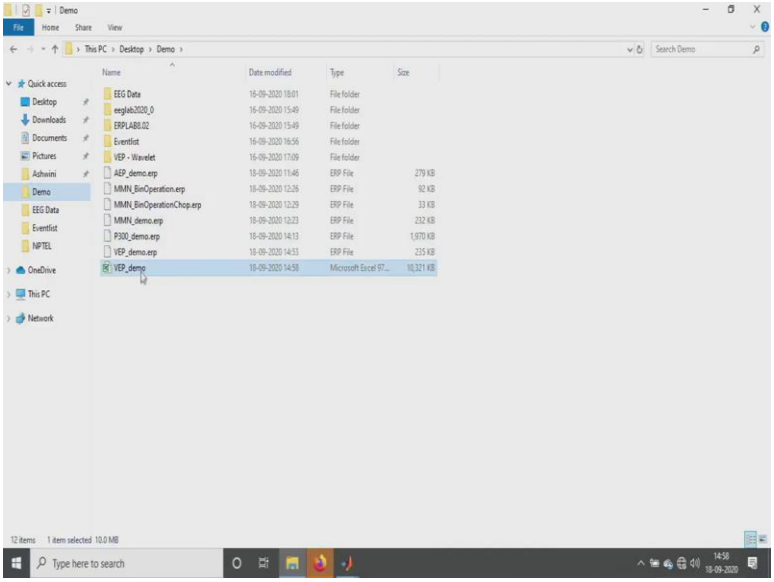


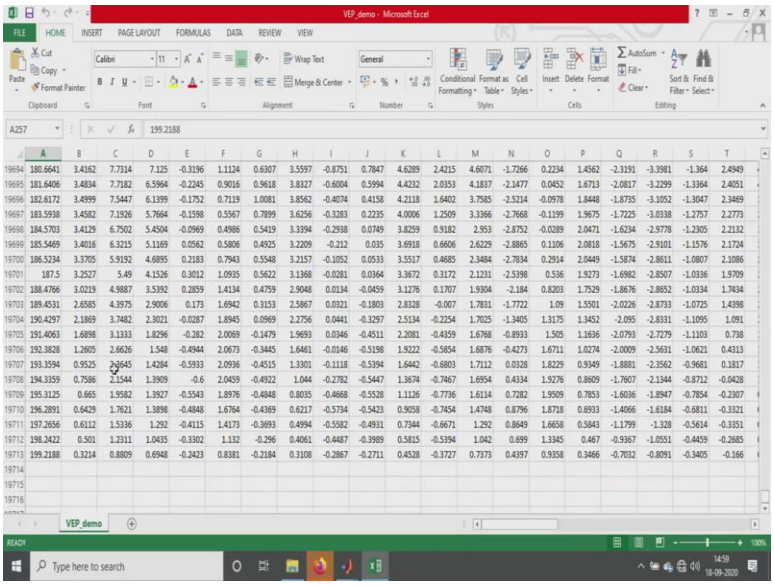




Anyways, so I will just do the exporting now so we can just go into files and do the exporting of the data so when we export in this manner what happens is we can we can just change the extension. So, we just put as excel sheet so we can just save it in this manner how we can have a word digital I mean how many data points, how many decimal points late afterword's you want everything you can take it, you can do the transfers everything that also can be done. So, I just save it.

(Refer Slide Time: 17:02)




VEP_demo - Microsoft Excel
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VEP_demo
READY
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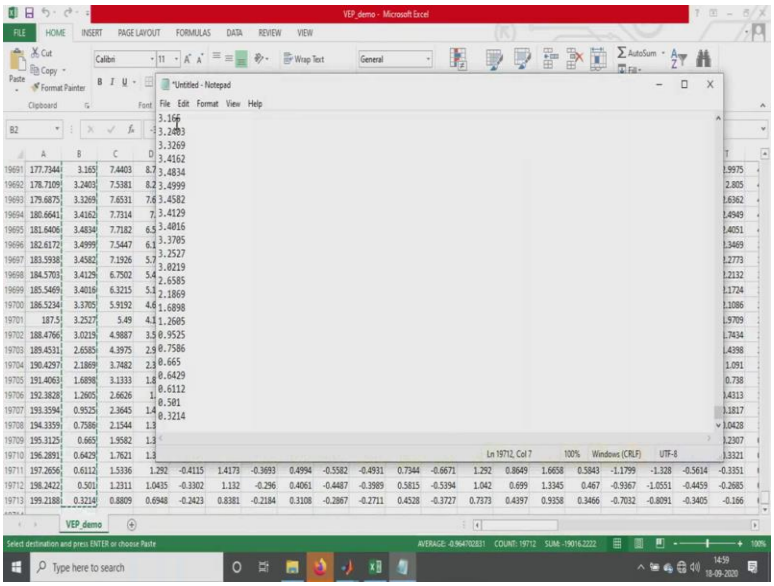
14:59 18-09-2020


VEP_demo - Microsoft Excel
*Untitled - Notepad
File Edit Format View Help
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3.4016
3.3705
3.2527
3.8219
2.6585
2.1869
1.6898
1.2605
0.9525
0.7586
0.665
0.6429
0.6112
0.501
0.3214
Ln 19712, Col 7 100% Windows (CRLF) UTF-8
VEP_demo
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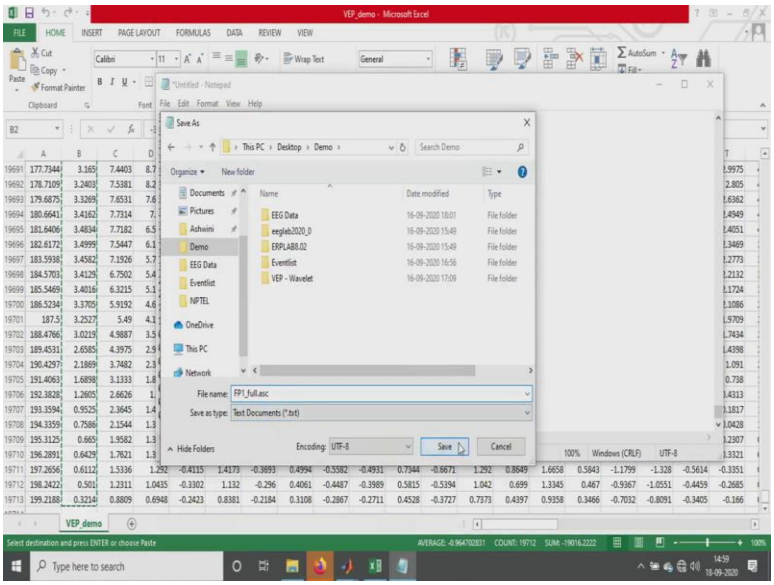

So, as we save we will have the VEP being saved in excel this is the exported data now. Now if you open this we will have the whole of the whole for each electrode and for from minus 50 to 200 so there are 256 so if you see there are only 256 samples for one epoch. So, similarly there will be for 77 epoch there will be the whole data set so there will be so totally 1917 so this many data points are there for the whole ERP set.

So, here in this we can just copy the whole of a whole of a row copy it and put in a notepad and then you can just save it as a for example I will just save it as FP1 and I will just put the extension as ASCII format because always the wavelet analysis it shod be saved in this ASCII format so that is why we just put in this way. If you want negative up if you want a negative up this is all the positive up data points that is being there, if you want negative up we have to just multiply the whole of this data sheet minus 1 so that you will get whole of it as a negative up version.

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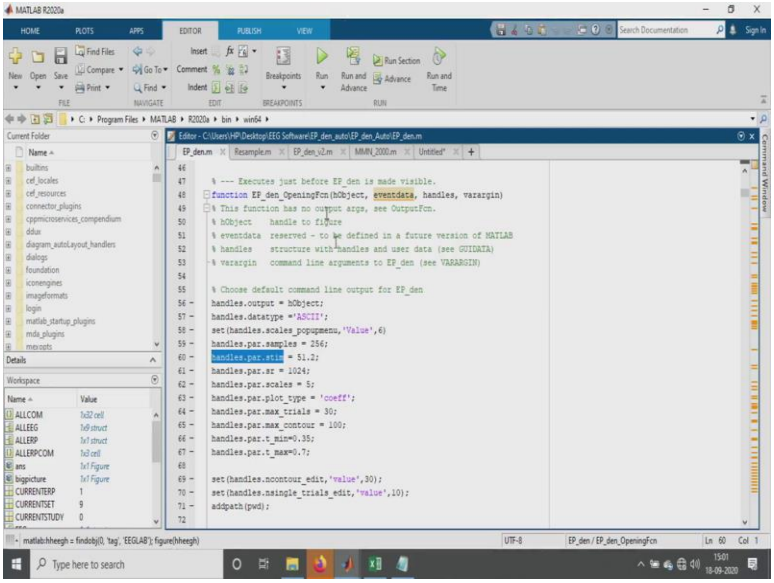

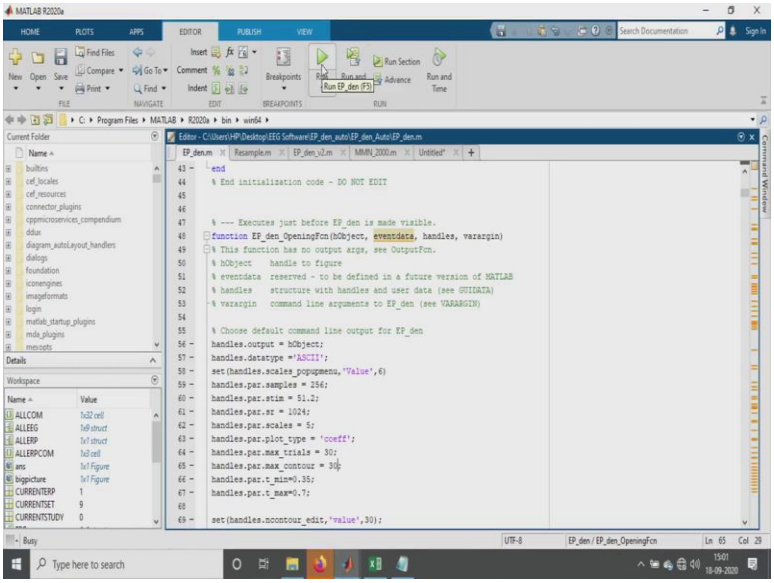

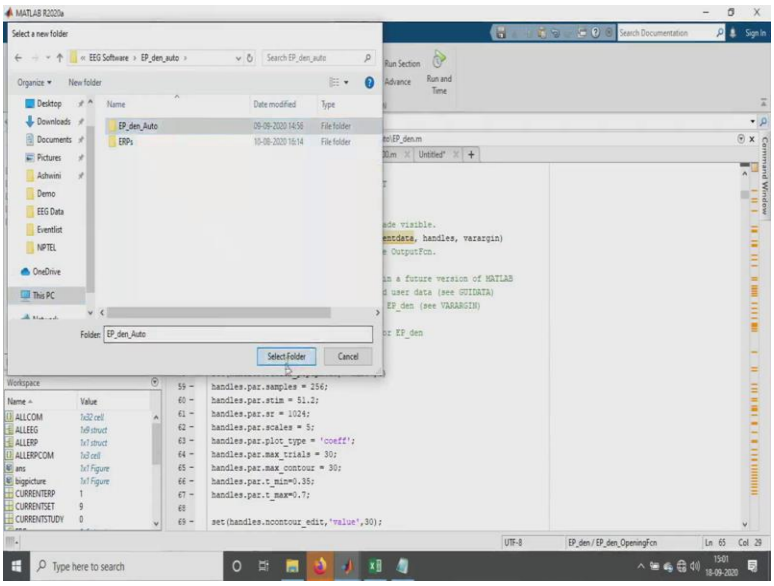

So, next I will just show you the data this is the Matlab code for the wavelet analysis. So, here these 3 are the main important parameters that you have to check about. So, here these are the nap sample size, so here the sample numbers which means that for each epoch there are 256 samples. So, for we will put that as 256 over here and this particular thing that is called as a sampling rate and for over case the sampling rate is 2, 201024 so that we enter in that manner.

And then this stimulus over here is actually nothing but how far you want the axis to move up and down so that is been given by this stim parameter over here now in our case we have taken from minus 50 to 200 millisecond that is the time range we have taken. So, just minus 50 that for that range we have it should be just this much only like we have to divide this by 15 like that so it will be you will get 51.2 so that we can set a data set from minus 50 to 200.

So, I will just have given this, then this is nothing but the contour plots and the trial numbers that is just to. So, I will just run this particular dataset, even this also we have to do the path, the event, the set path we have to give here also. So, we can just download these, this particular thing we can download from anywhere I mean in the website actually.

So, from there we have to then give the in this set path we have give this particular folder so that you can just and then you have to open this and you have to make the changes accordingly and then you have to run this set because some parameters in this is required to be opened in this way.

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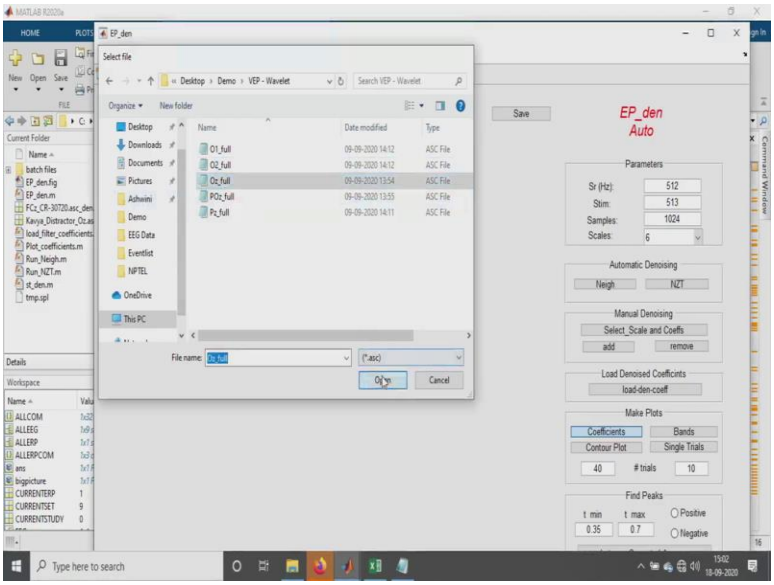

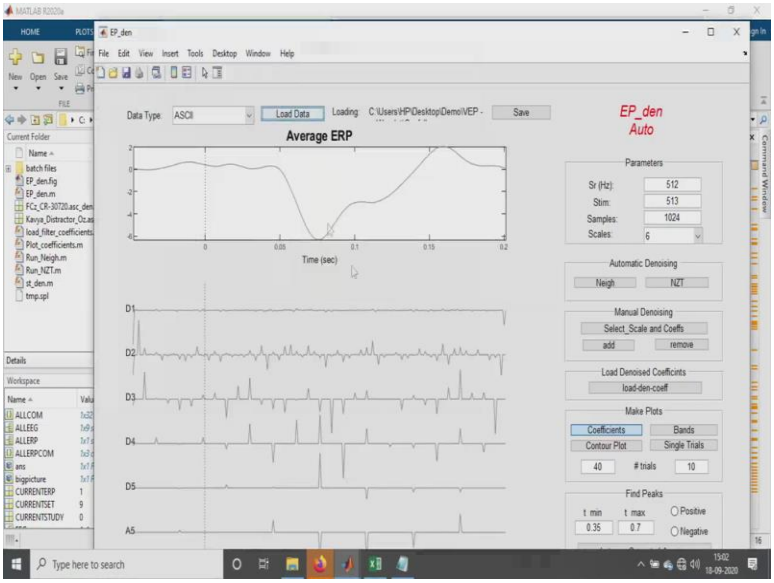

So, we will just load this particular I have already made few of this occipital region electrode and all. So, I have just made some of them like I, just showed now that ASCII file has been made for those. So, I will just open this OZ, so if you see, here so this and this, they are both almost the same. These two are almost the same. So, this is called as wavelet, this is the wavelet software that is being used and here we have the, these are the different the wavelet coefficients as I mentioned before. So, each of these coefficient which will move across all the ERPs, ERP averages and that will obtain this particular waveform in this format.

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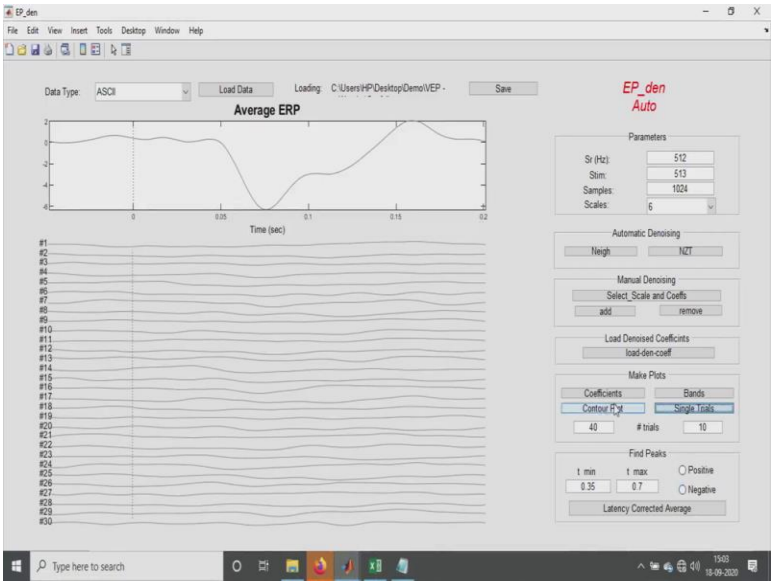

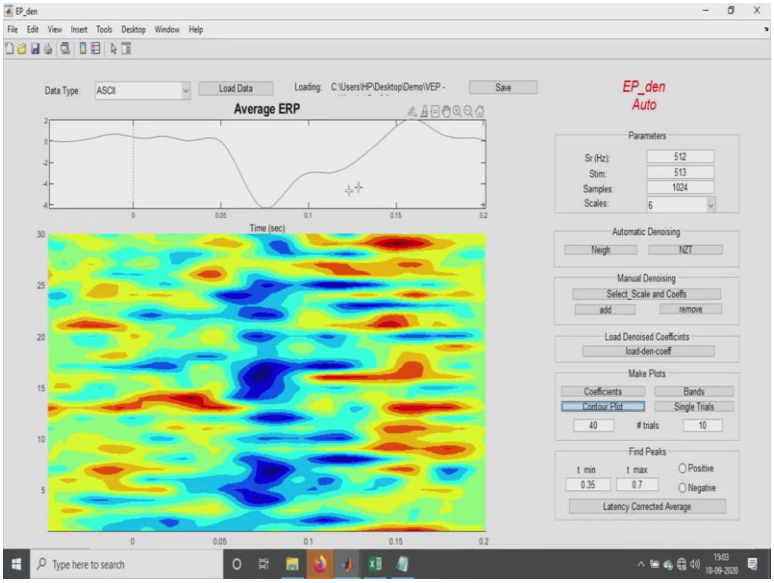

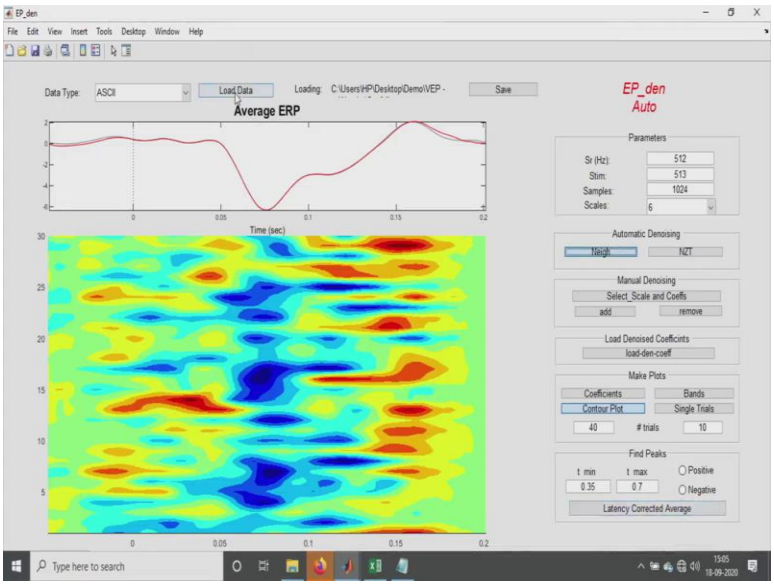

So, here these are the single trials, for each trial, it looks in this manner. So, like there are nearly 77 trials, so like this it looks. This is the contour plot that is being obtained for this. So, here this is the proper negative and this is always a negative, here even though it is shown as two, I mean positive up and negative down, actually I have imported a data which is being a negative up. So, this is how, this is actually the positive peak and positive peak is given as the responses, in blue response and this is the red response that is being obtained.

Now these are the automatic denoising that is being there, the neighboring as well as the MZT, these are the 2 advanced denoising algorithms which is actually being mentioned in detail in their Quiroga paper. So, when we do this, we will have a particular, this. So, it is almost completely overlapping over the system. This red color before the one which was there, that was the original dataset which we given and after doing the denoising, we have obtained the red colored waveform which gives the denoised dataset.

So, here we can clearly see that the blue colors is the positive peak and the red colors is the negative peak that is being obtained. So, basically, this will be the N1 response and this will be the P1 response and the followed by then there will be a P2 response. So, here we can get as you move up, sometimes what happens is there will be the coloration will be reducing. So, here it is dark and here it will be much lesser or like that it happens, which means that there is a habituation occurring. So, this is about the wavelet.

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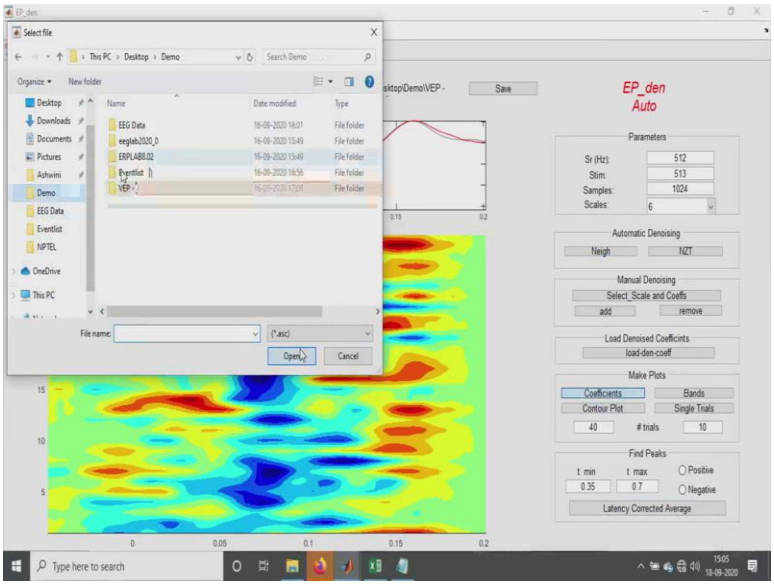

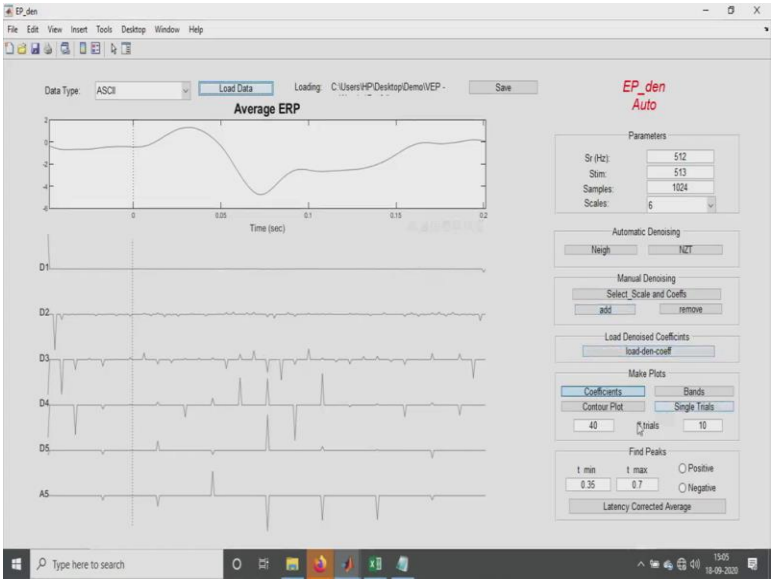

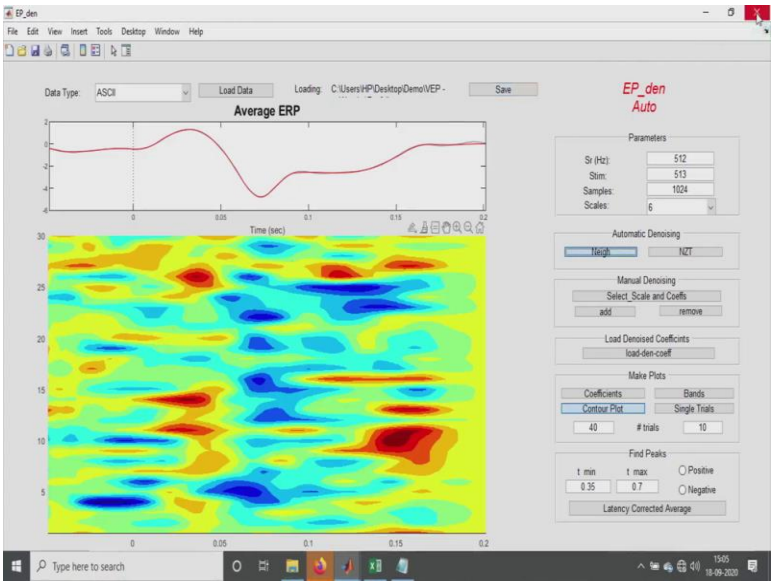

So here similarly we can create various datasets or I will just show you for PZ also. So, this is another one ASCII file I have being given, I have been made. So, here also we have the we can create the contour plot. So, here it is not much prominently seen because it is not so prominently seen in this also, so but after denosing may be you will have a proper response being obtained. So, see here this is a negative and this is the positive peak like that.

So, this is how the wavelet analysis work with respect to the Quiroga paper, they have mentioned. So there this is about the wavelet analysis that is being done using this EP_den software. There are various other parameters which we can change and work about it like the time, the time maximum time, minimum, the contours, the trials or even we can change the sampling rate, the sample size accordingly everything can be done. So, that is about the wavelet analysis and using the VEPs.

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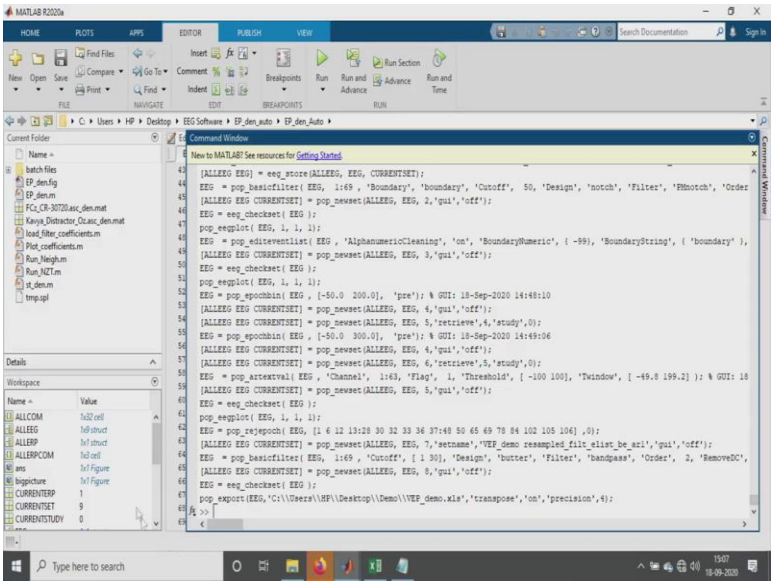

And then even in this also we can have the similar approach of getting the codes and all for this. So, we can just copy-paste, add loops, add any other things and all so that for each subject, for all the subjects we can do the similar analysis, even we can create some codes in Matlab itself so that the datas, this EEG Excel sheets and all can be converted into ASCII files, column based ASCII files so that and all an advanced Matlab approach, it is like an advanced, people who are problem in Matlab, they can do this type of playing with the numbers like that with Matlab and all. So, that is about the wavelet analysis using the VEP.