Introductory Neuroscience and Neuro-Instrumentation
Professor. Hema Hariharan
Lecture 38
MMN Demonstration with EEGLAB/ERPLAB

Hello everyone. So, we have doing the MMN we just give a introduction what, how this MMN looks and everything. So, I will just give you how to demo, how to proceed with the EEGLAB and ERPLAB analysis with MMN data. It is a similar steps only but some difference in the event list and all will be there. So, I will just demonstrate as such. So, here we have, we will just have the, I will use the graphical user interface method itself I will just show you how to create the scripts at the end.

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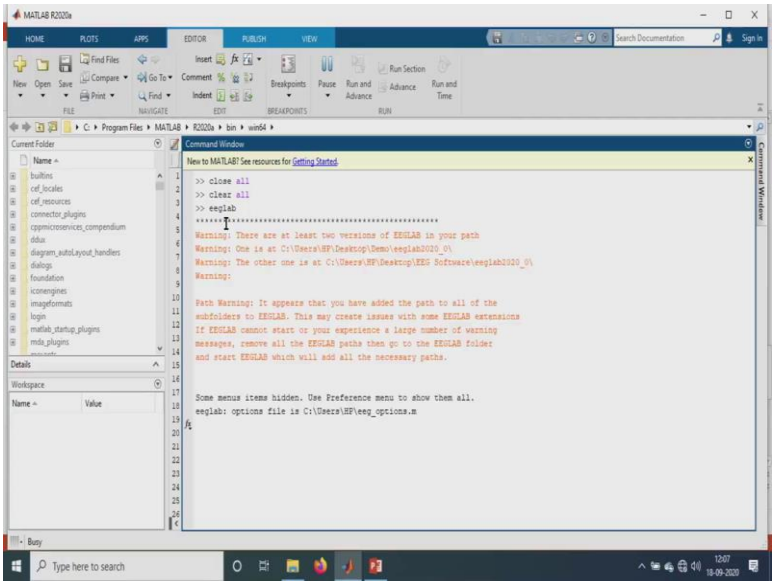

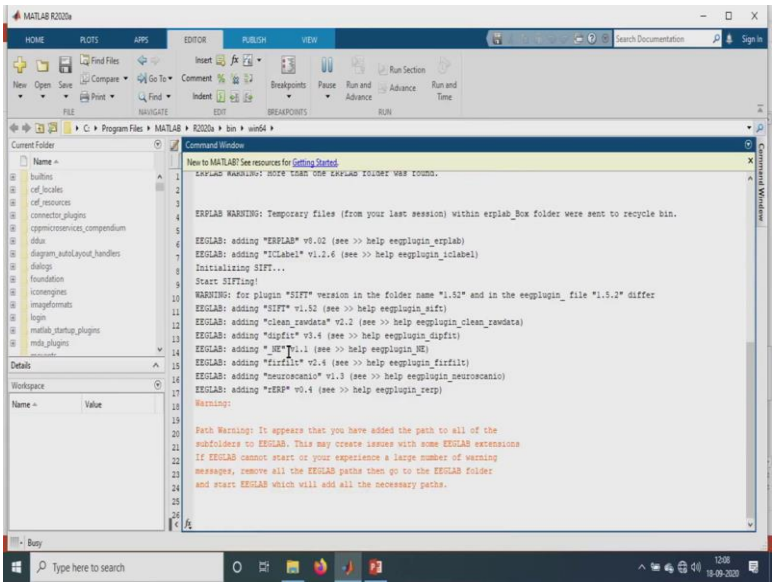

So, here we have the EEGLAB being running, accordingly we have various formats.

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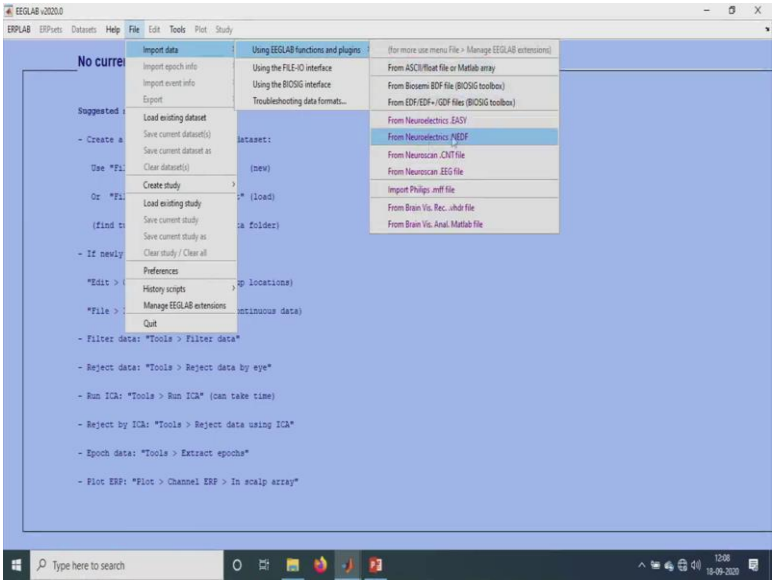

Now, in this experiment, I will use another format of EEG instead of the CNT format, I will use Enobio format of EEG, a min of the MMN file. Like I will take a NEDF file for example. So, here I will just import the MMN data. So, this is this neuro electrics is actually, these are the plugins that are there in all the EEGLAB website itself. You can directly go there and download it and just you have to paste it in the plugins as I have mentioned in the previous demonstration, we have to just paste it over the plugins of that EEGLAB.

So, here we have these are the 2 formats that is being obtained for open BC, the Enobio and all. So, NEDA for EEG.

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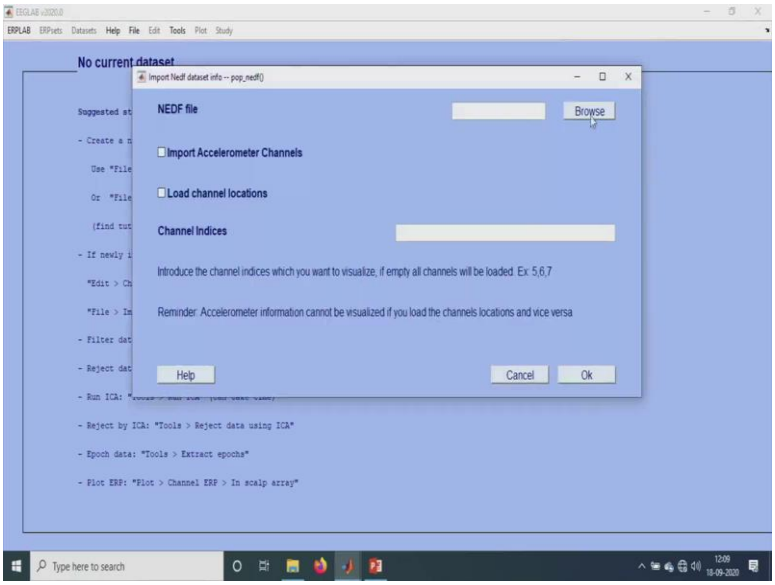

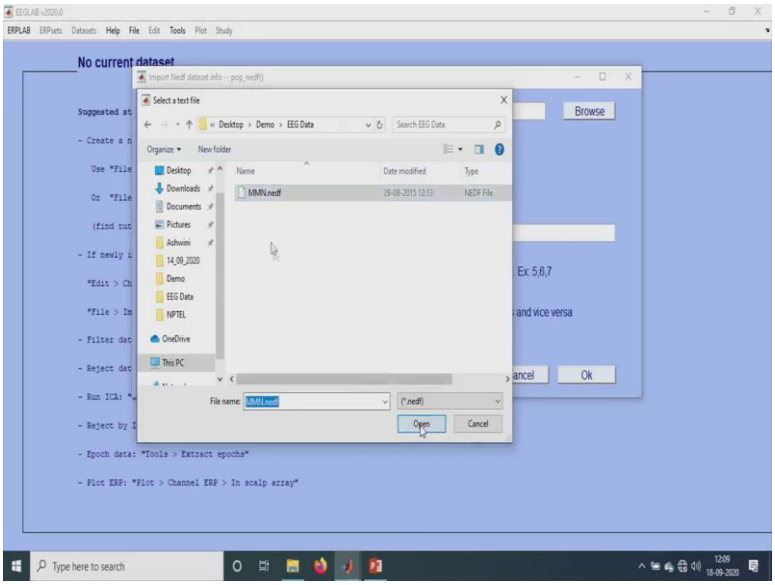

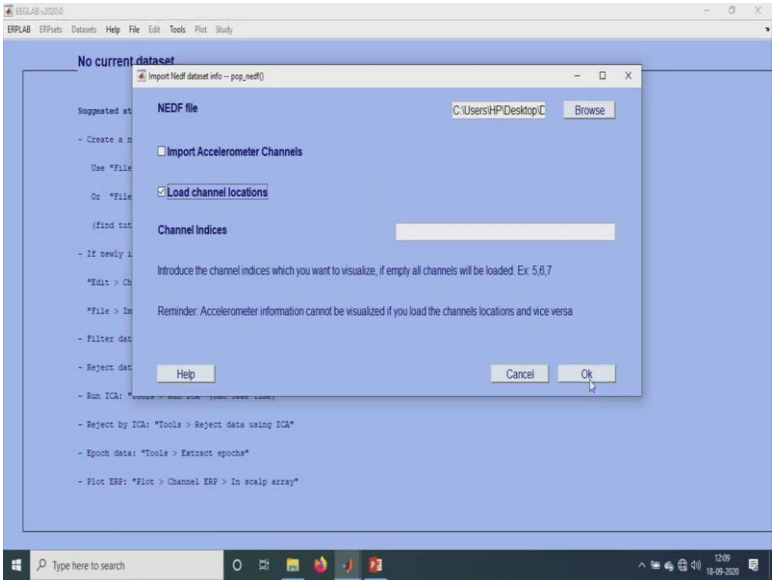

So, I will take this NEDA format over here and I will just take up MMN data, this is the MMN data I am taking over here and here we can have, we can load the channel. So, as I told you in the previous demonstration, I mentioned that we can there be channel locations which where we have to manually do it or sometimes in the in file itself there will be these channel locations present. So, this is one such format in wherein the channel locations are also there along with the continuous data. So, this is a one so just we will load the channel locations and then give an ok.

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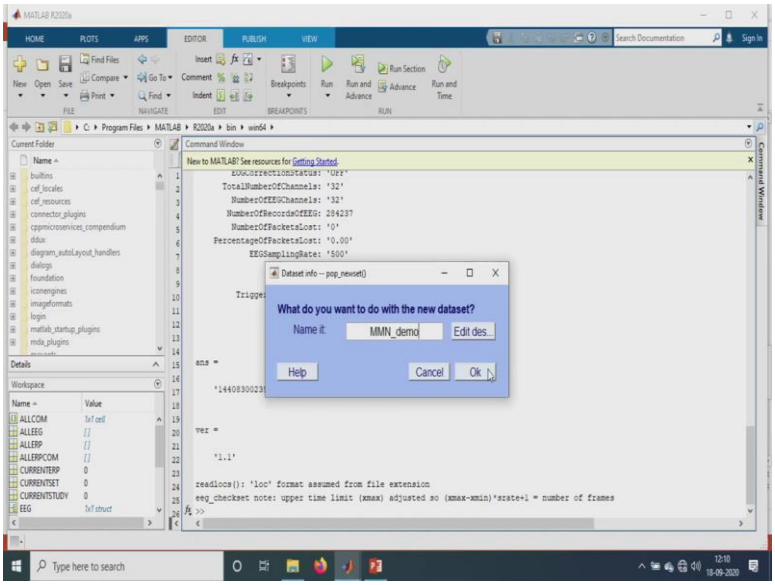

So, here it reads all the functions, and then it will give you the, it will read the locations and everything and I will just name it as MMN, MMN demo, ok.

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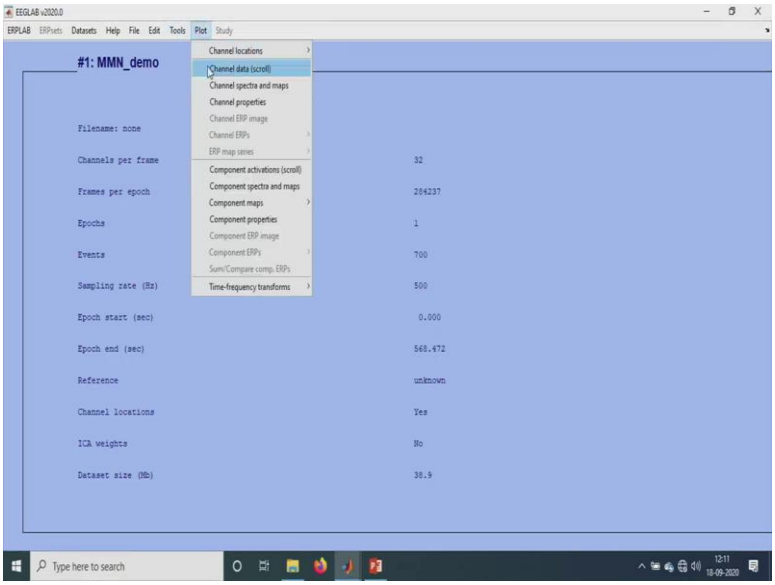

So, here it open as this. So, here in this data format, they are having only 32 channels and then the epochs are from, there is only one epoch because we did not do any epoching yet. So, it is safe for here it is like 1, 568 seconds it is lasting which means that it is more than 15 minutes like that. So, this is the time length of the experiment over here. Here already the channel locations are being included and the events, I will just show you the events and here the sampling rate is 500. We can change this sampling rate I will discuss changing the sampling rate in the wavelet analysis section.

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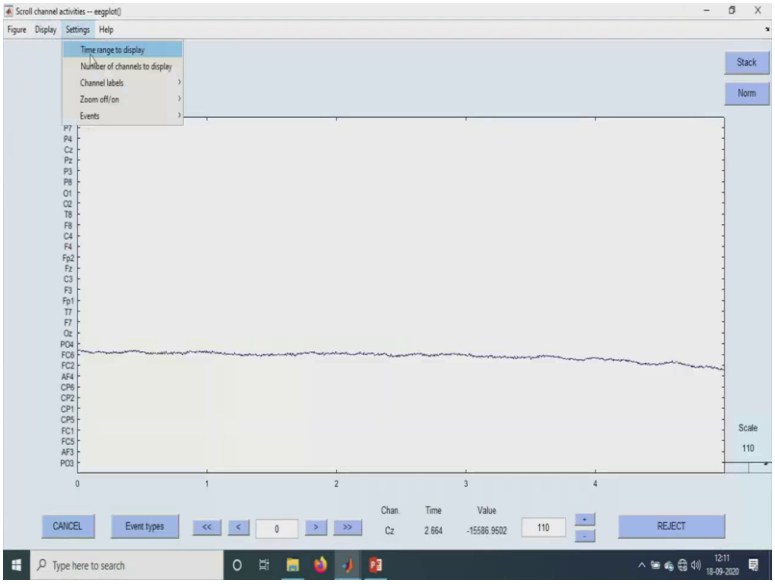

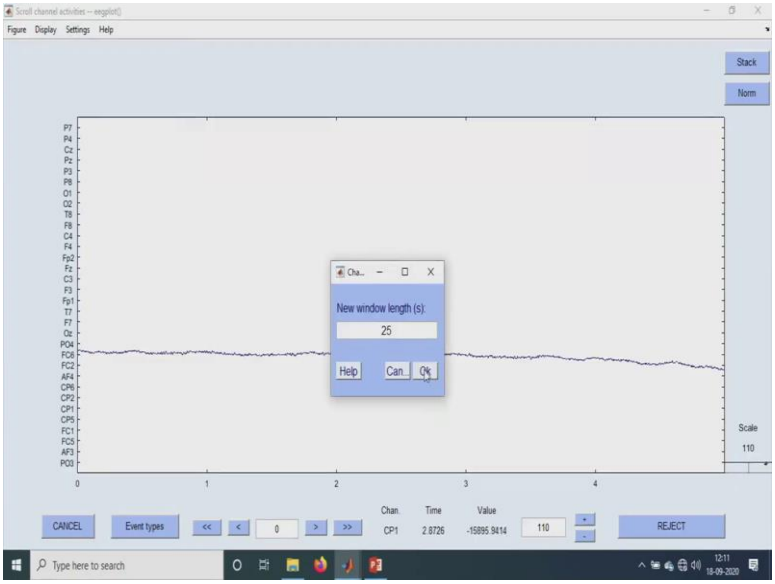

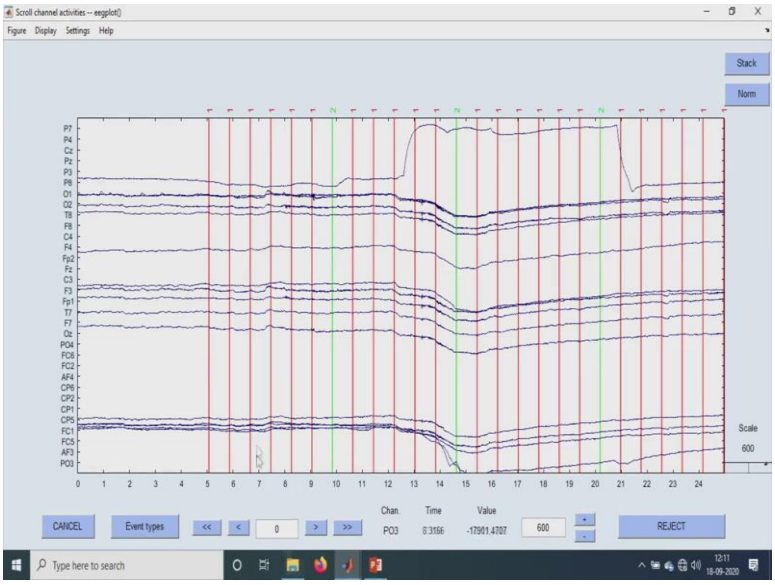

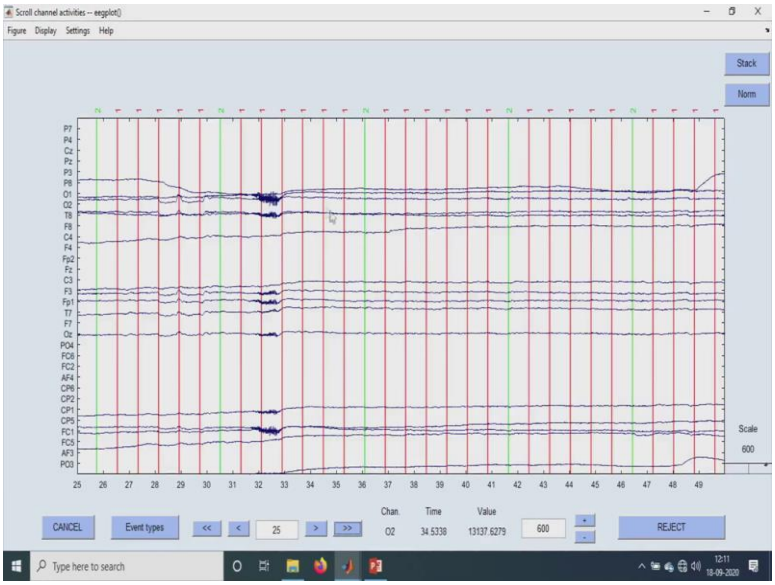

So, here I will just show you how the data looks. So, I will just change the so that we get all the channels. So these are there are only 30, 32 channels only are there, so here if you see there are these are the standards and there is a 1 deviant and there is a standard and then a deviant, standard and a deviant. So, this is how it a and it is a repetitive format. It is not like here there are 6 and here there are 5, not like that. Here all are 6 and 1 deviant, like that it is. This is how it should, the MMN data should look like.

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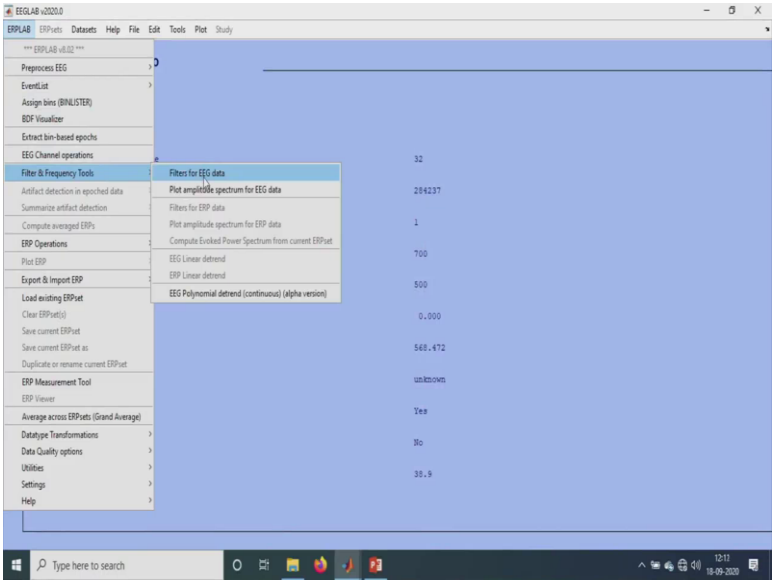

So, before doing any analysis further, we just do a pre-processing step of the filtering.

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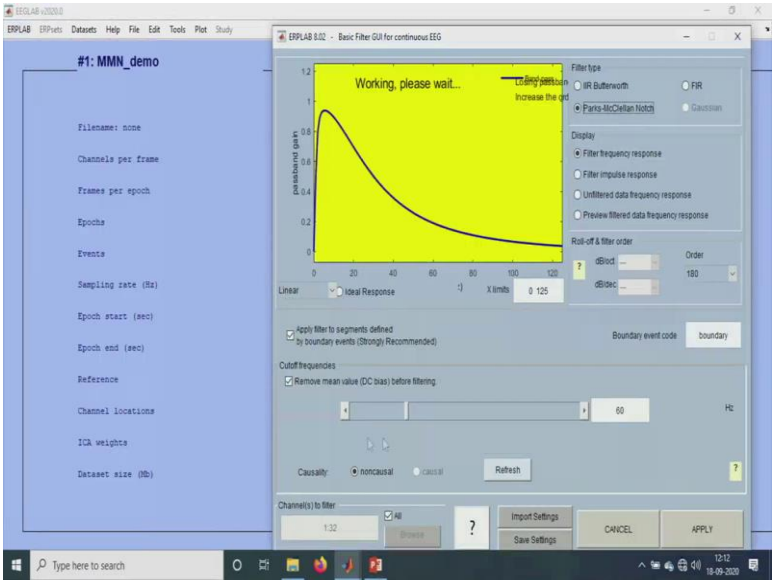

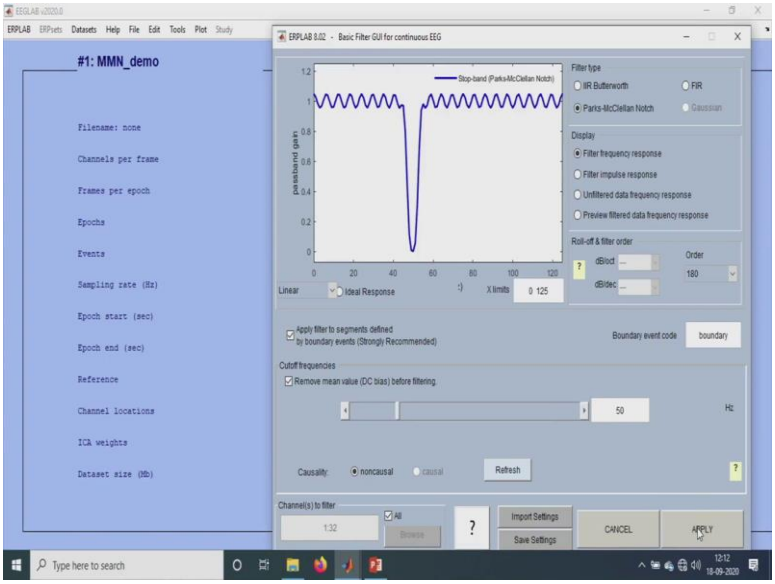

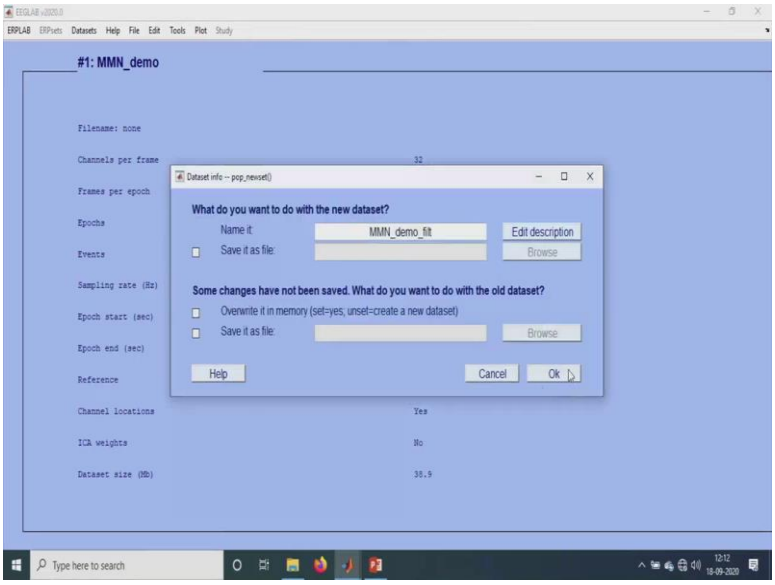

So, here we take again a notch filter as usual. And put a 50. So, this is the usual step as I told you. So, if after look, after doing the filtering, maybe the data will be looking even better. So, I will just show you the thing.

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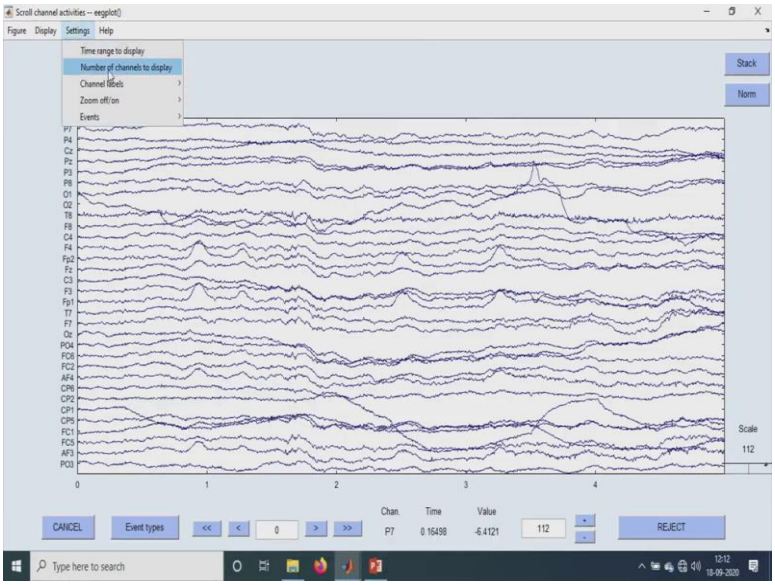

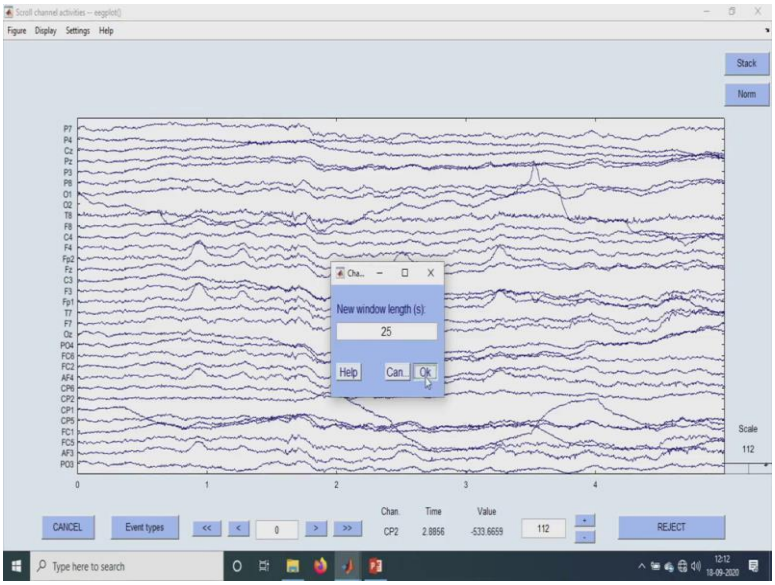

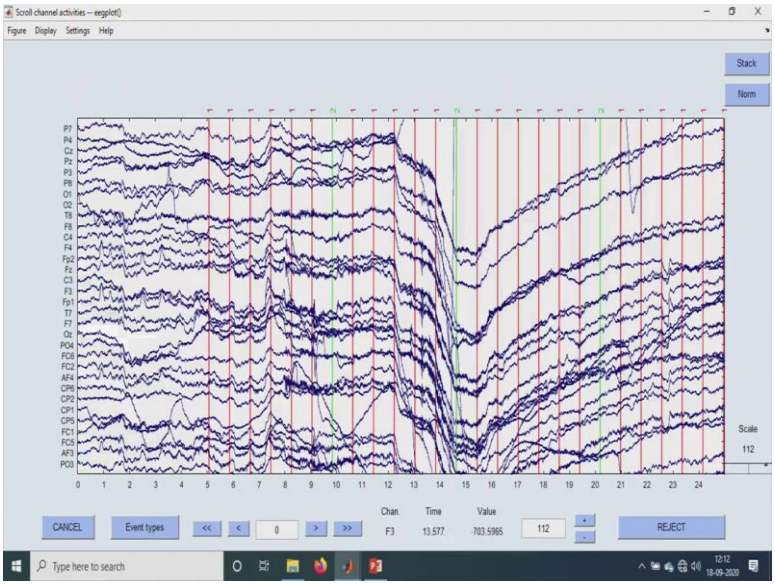

So, here see the proper, the after filtering itself, there is a proper seen of the all the channels have been shown properly and we can change the number window length or like we can make it 20, 25 like that. And also we can visualize the channels.

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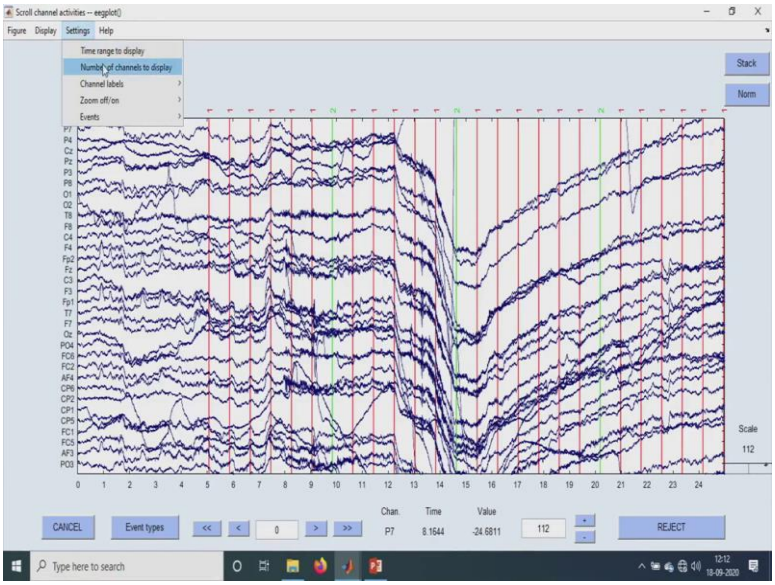

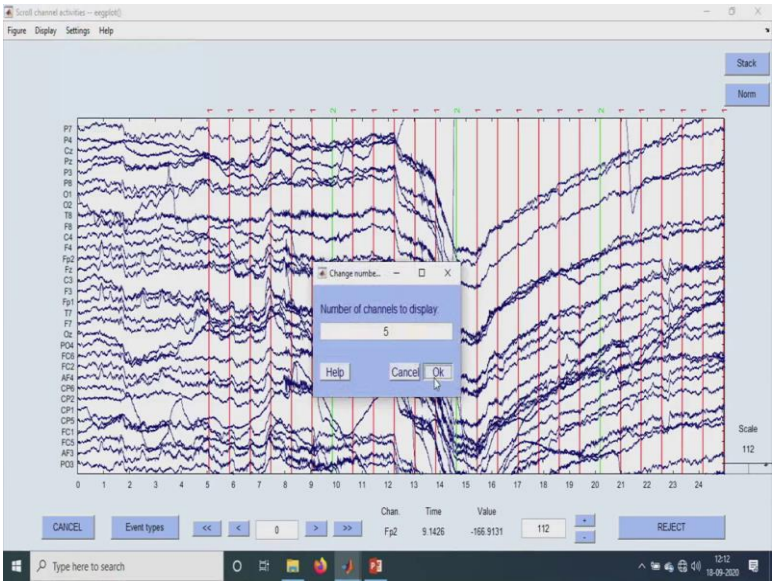
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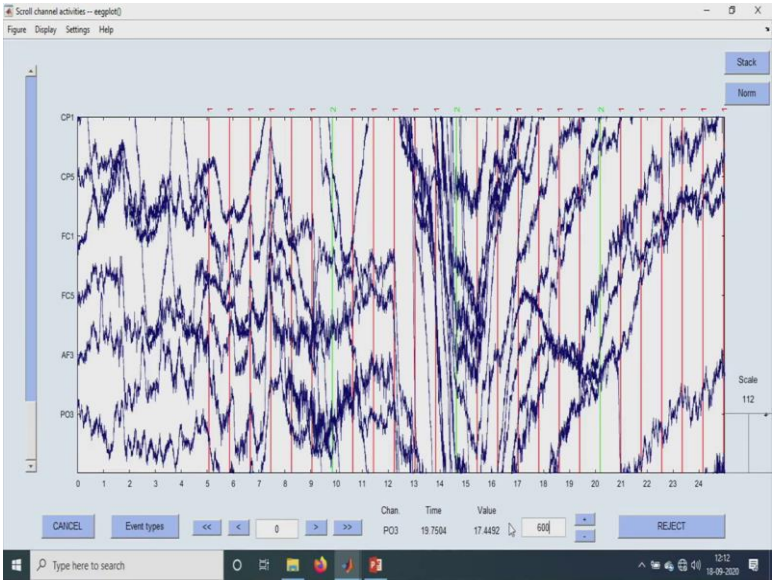
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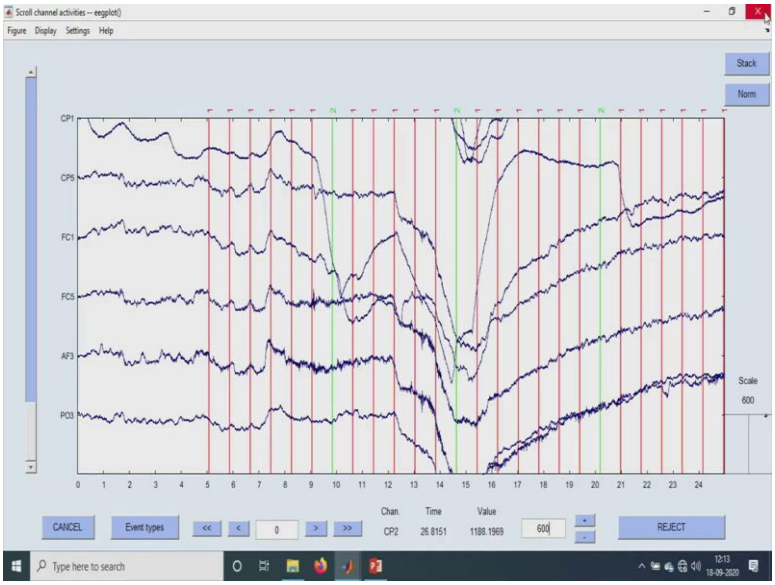
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For example, now I want only 2-4-5 channels to be seen at a stretch means we can do that also. So, we can change the amplitude accordingly like I wanted to be a very less amplitude. So, we will get a proper visualization of how it looks like this. So, this is just a pre-processing step of notch filter I said ahead. Before that, after this we have to do create the event list. So, here we have two events as I told you, one is there to standard event and the deviant, those are the two events that are been there.

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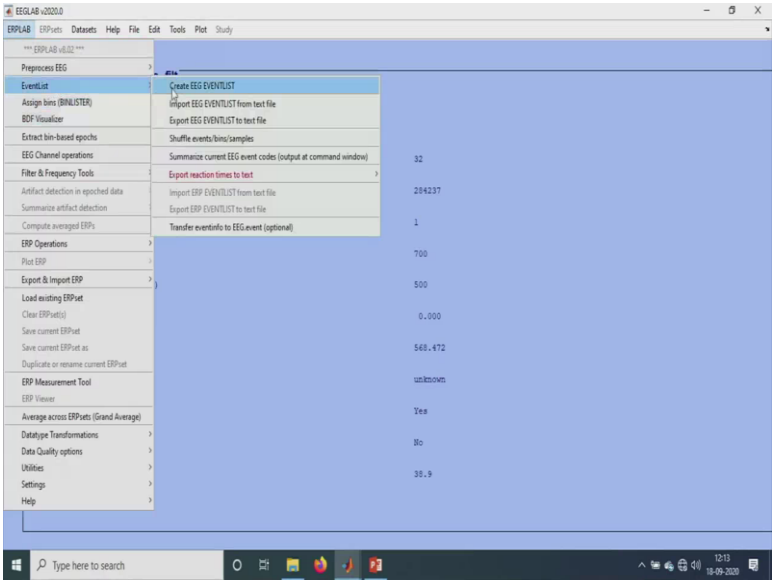

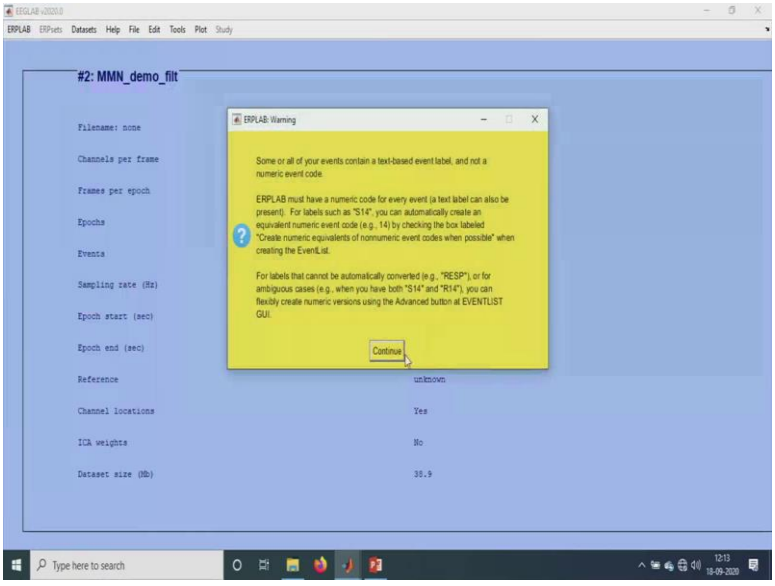

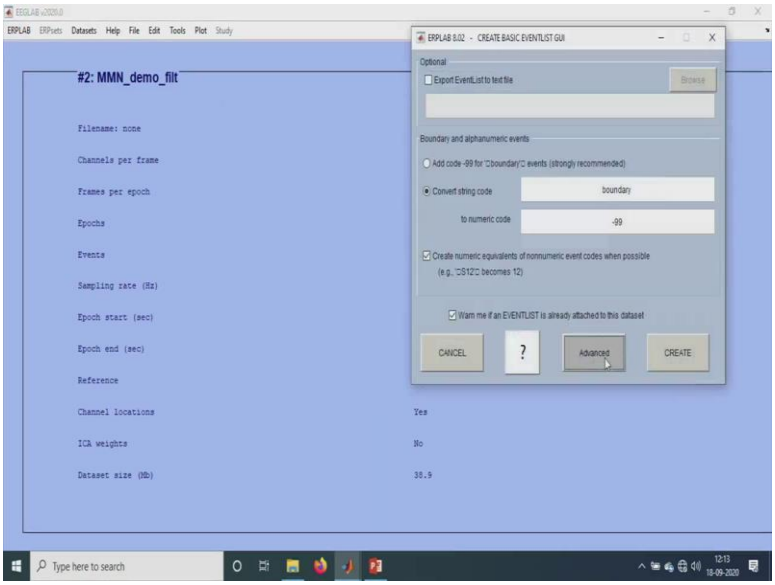

So, first, we have to do the event list, so we have to create the event list accordingly. And then we have to do how it looks.

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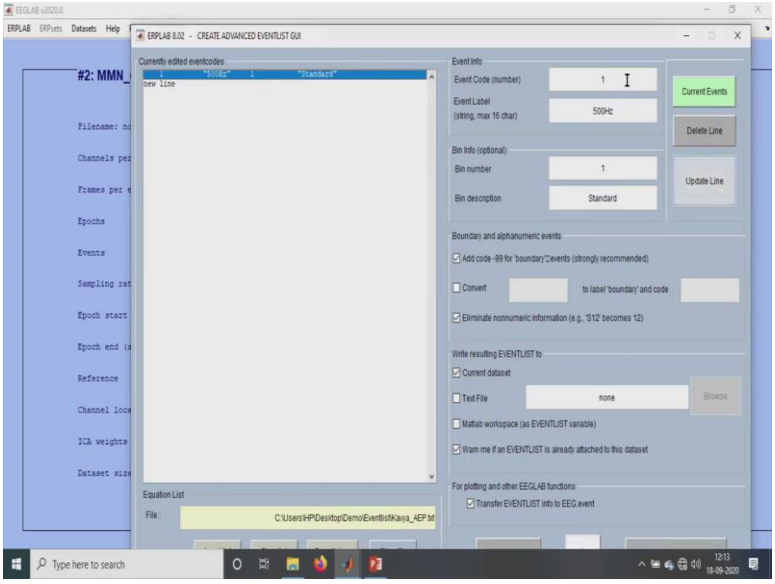

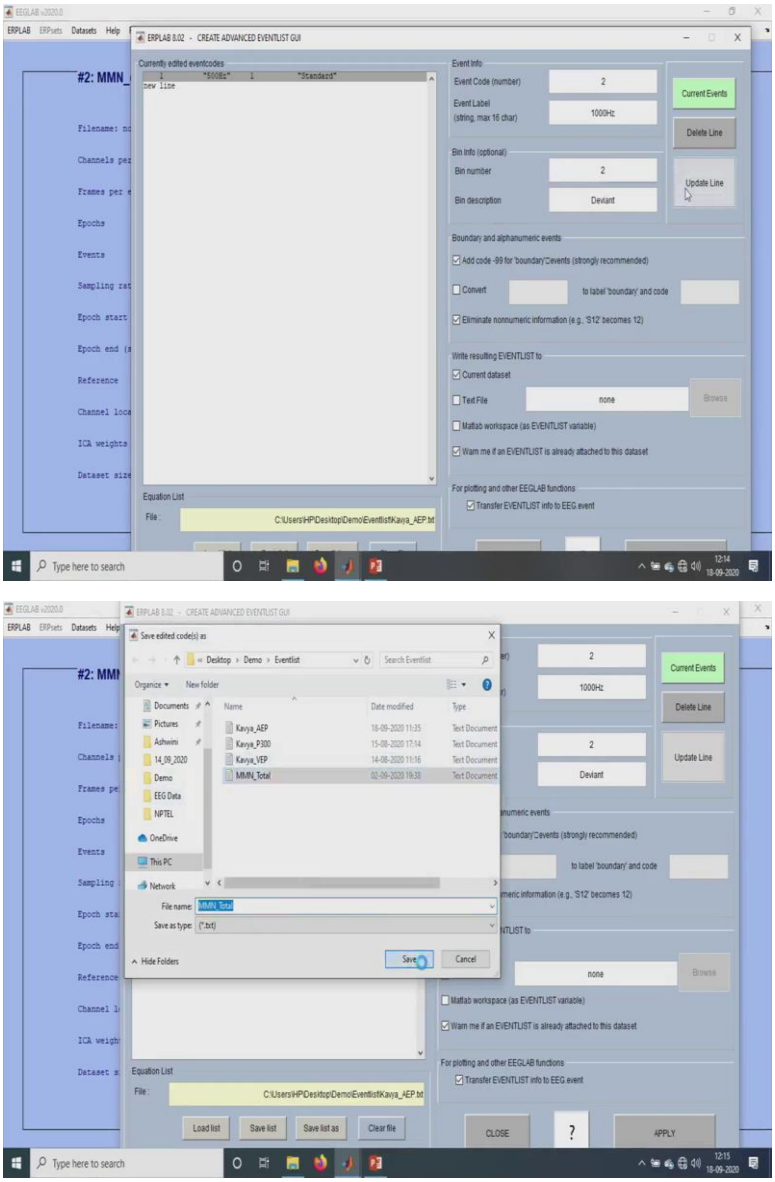

So, first, there are there is one event wherein which is actually a 500, which is a 500 hertz and we just name it as the first event and it is called as a standard. So, let it be where we will name it as a standard. And then we update. So, this is one, this is one event. For the next event, we will make it 2 because there are 1 and 2 events, so here this is the 1000 hertz and then we have we may name it as the second bin and here we will name the bin description as deviant we have the deviant stimulus trigger.

So, here we do, so this is how the event list has been created. And then we can save this as MMN, however, you want you can save it in that format. So, I just save it as MMN total. So, this is how the event list has been created. Now what happens is all the total, all the events in that, all these 1s and 2s will be replaced by bin 1, bin2 with these standards and deviants and everything. So, we will just apply that.

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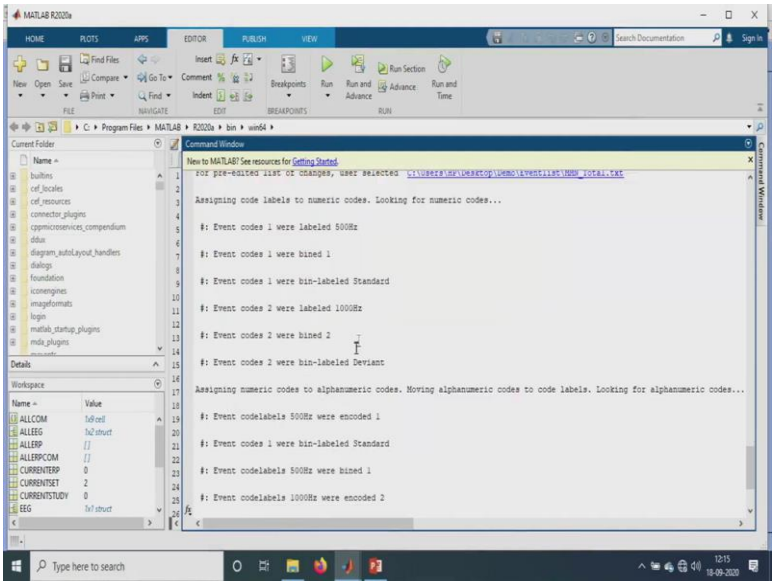

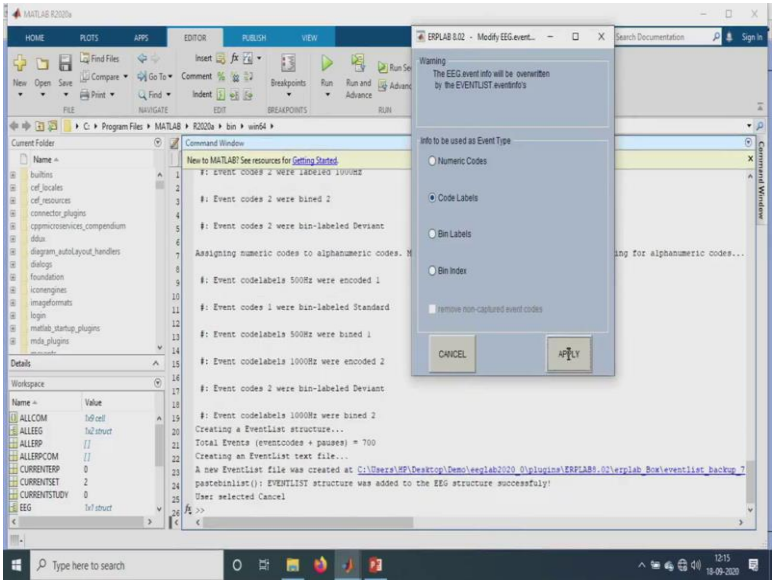

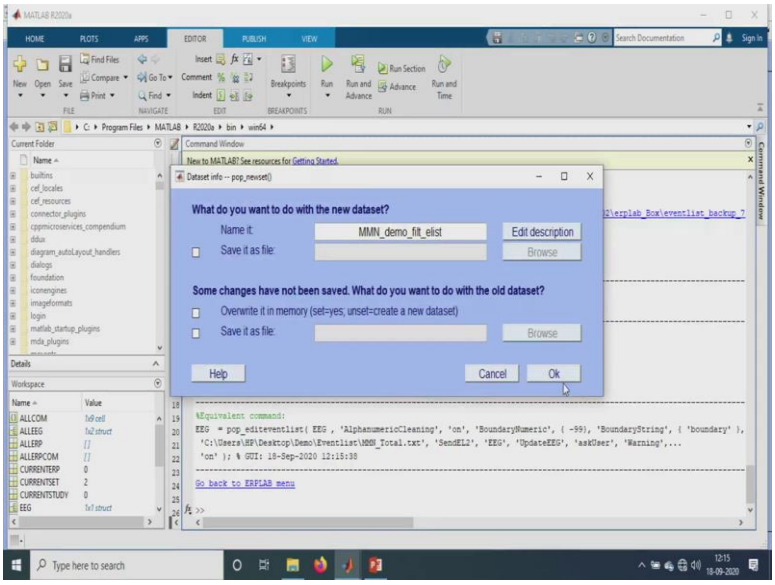

So, while doing it will create all the bins. So, here is the pre-processing how it looks in the command window, so here it creates the two events for 1500 hertz and for 1000 hertz for the standard and deviant specifically and then we name it in the form of code labels and we just apply it and it will create an event list, so we just do that. So in this way we have made the event list. Now, as I told you we have to do the epoching as well. So, as I told everywhere we have to do that epoching step in all the ERPs.

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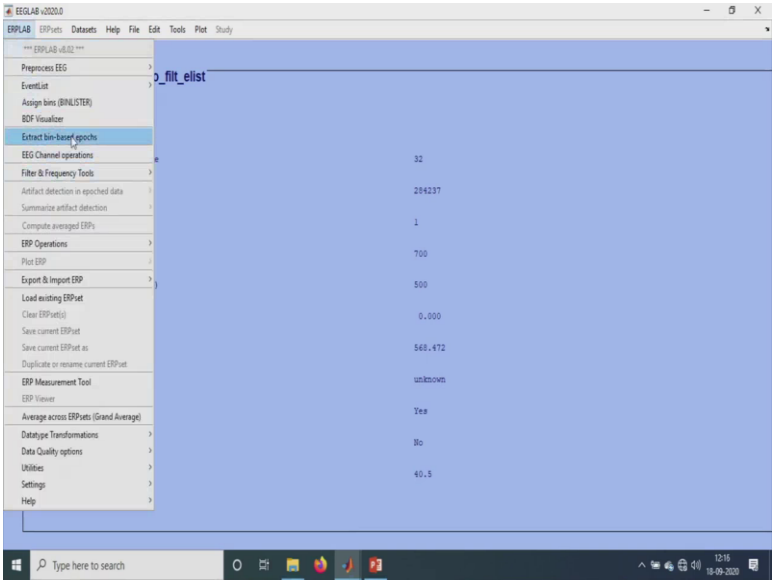

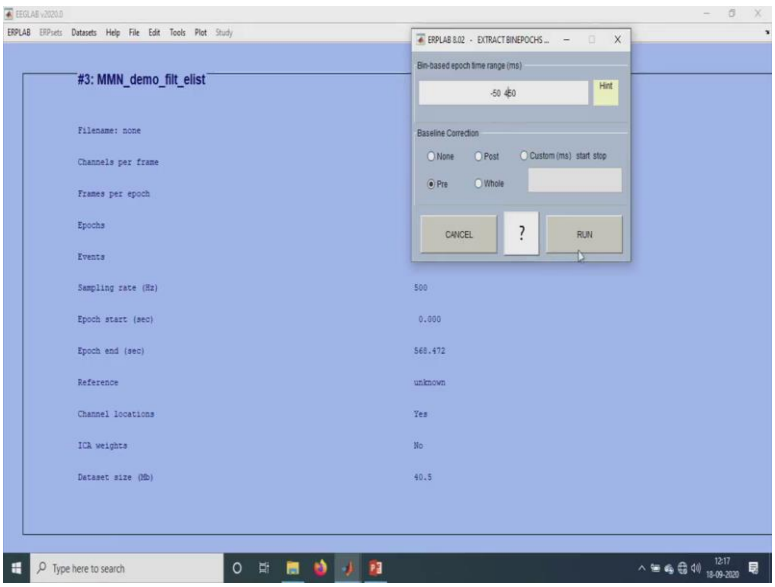

So, what happens we have to do the epoching, we have to do the bin based epoch. So, here also we wanted we just may keep up baseline correction of minus 50 because we just do not want as soon as how the as soon as the trigger starts, how the waveform changes we do not

want to know, we just want to have a small baseline correction of how it looks before the trigger starts. So, we keep minus 50.

Usually, how much ever range we take, 10 percent of that we have to keep it in as a baseline correction. So, if you are taking for 1000 seconds means, 10 percent of that 100 milliseconds of baseline correction you have to keep, so I just keep a default as minus 50 for any AEP any ERPs as such. So, I take as I told you for MMN, it is from minus it is like 150 to 300 in that range the MMN will be there. So, that is why we will keep a range of about 400 or 450 like that so that we will get a proper, we can visualize all the MMNs properly, for that purpose only we do this. So, I will just run it.

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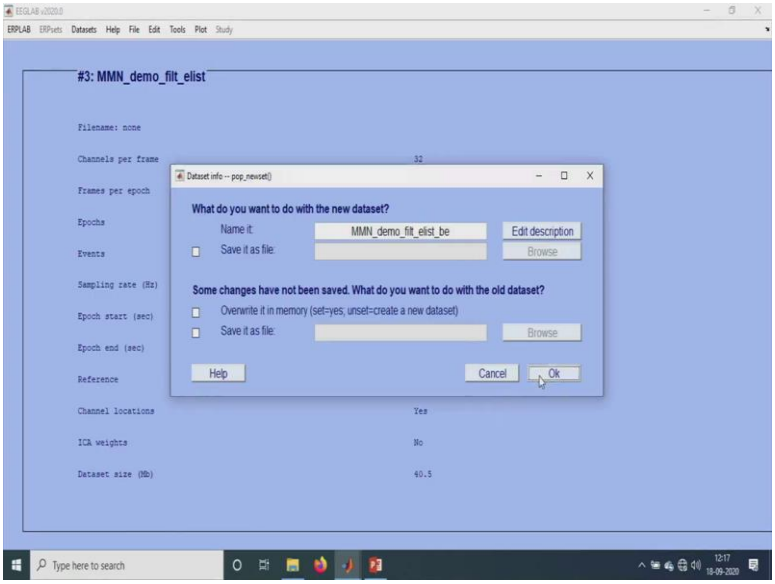

So, what happens is it will run in such a manner that it will get epoched in that particular frame time range. So, the bins have been created. So, if you see here there are 500, 700 events which means total of all the standards and deviants together there are 700 events. In that 700 events, we have made the 700 epochs also which starts from minus 50 to 500, to 450 millisecond. So, this is how we do the epoching.

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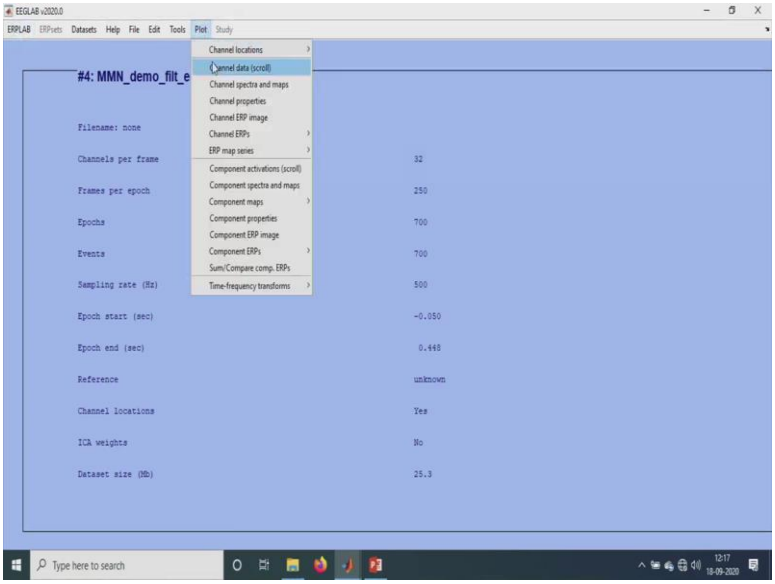

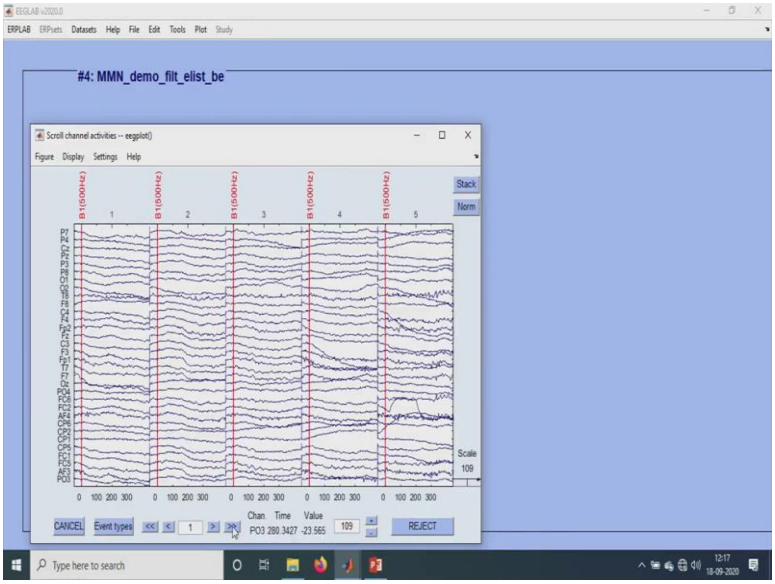

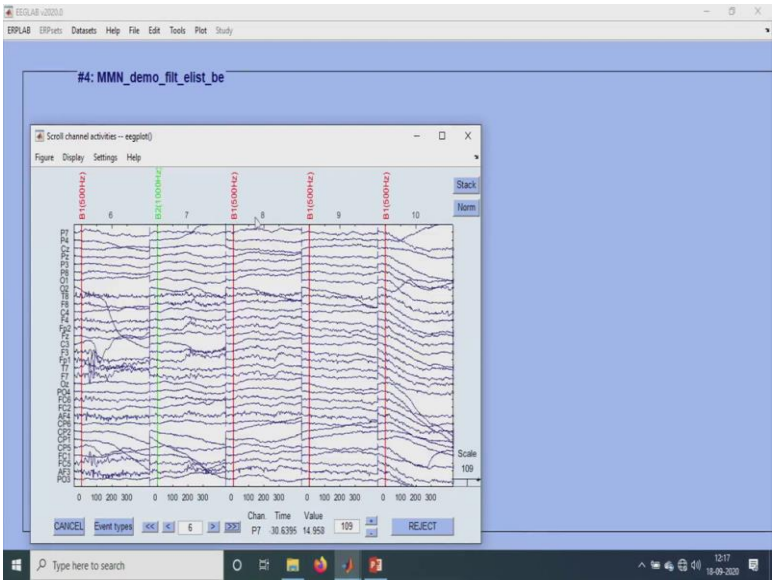

After this, I will just show you how this epoch looks. So, here we have seen all this, these are the bin 1s all the standards and followed by the a deviant, standard and a deviant like this.

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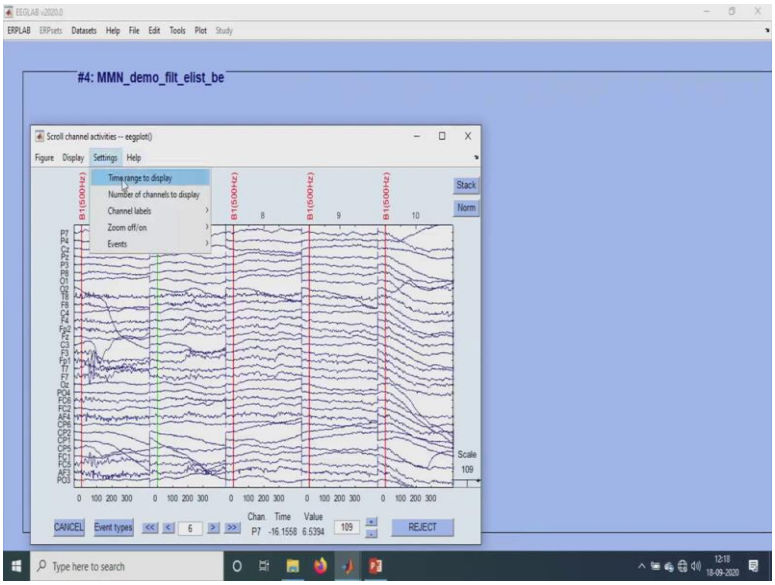

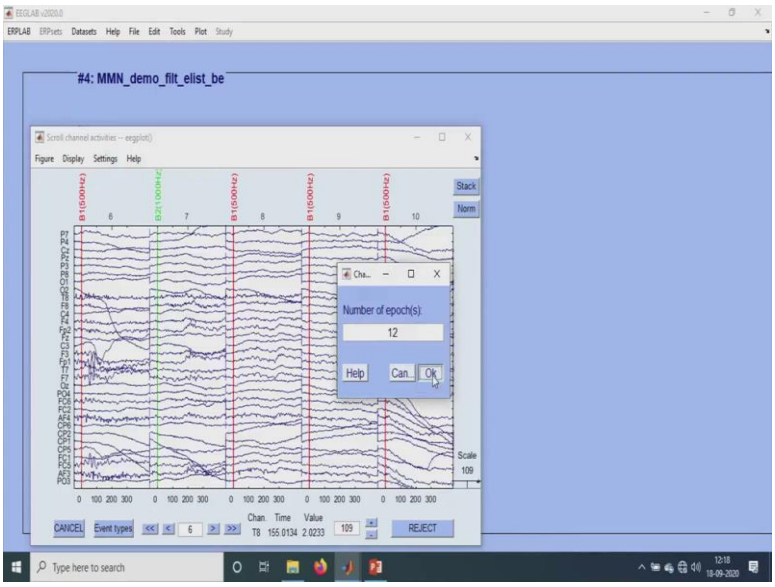

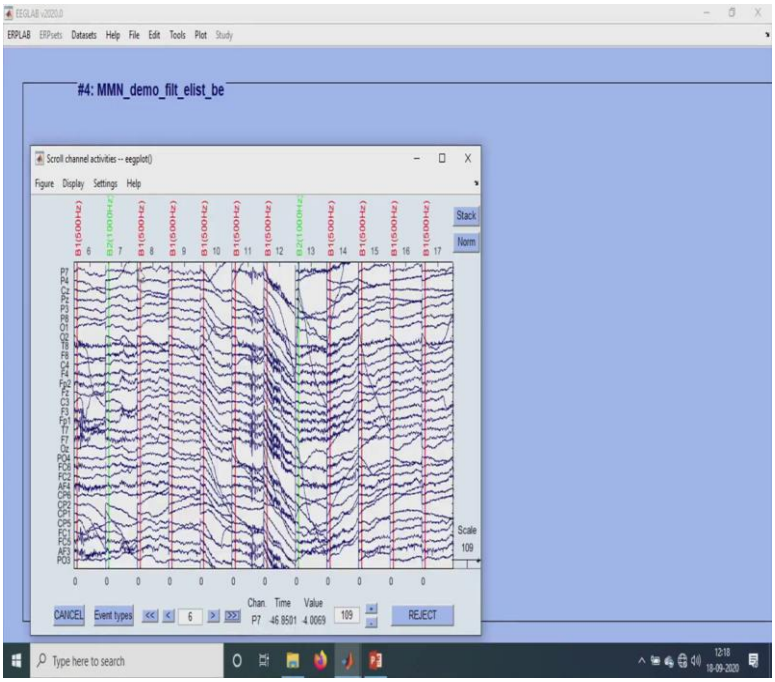

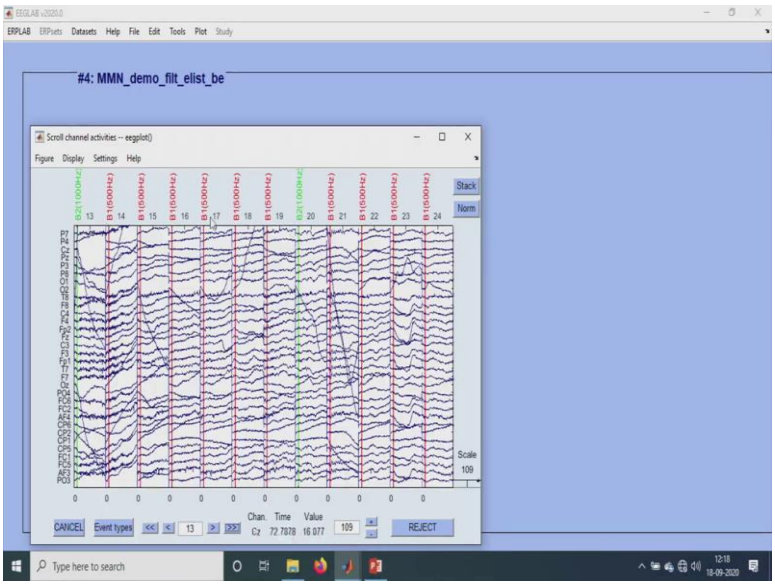

So, I will just show a for about 12. So, over here we have, so here if you see there are deviant followed by the standards, a deviant and the standards like that. So, this is how the MMN should look like. Now, what happens is when you do the averaging, only these bin 2s will together it will get average and all the bin 1s will together get averaged. So, like that we will get two averages of both the bins.

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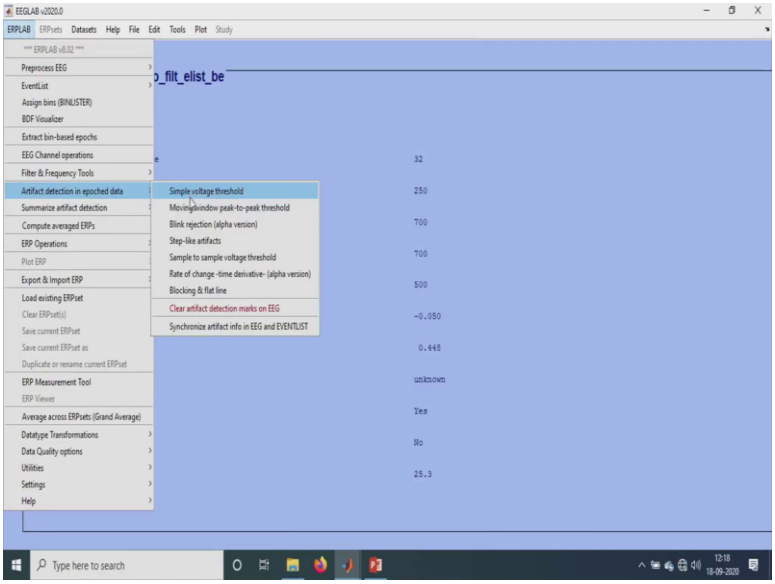
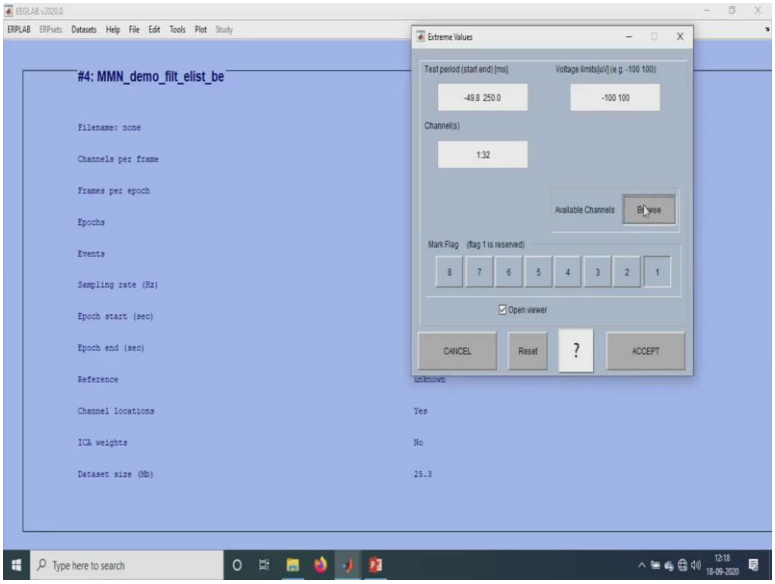
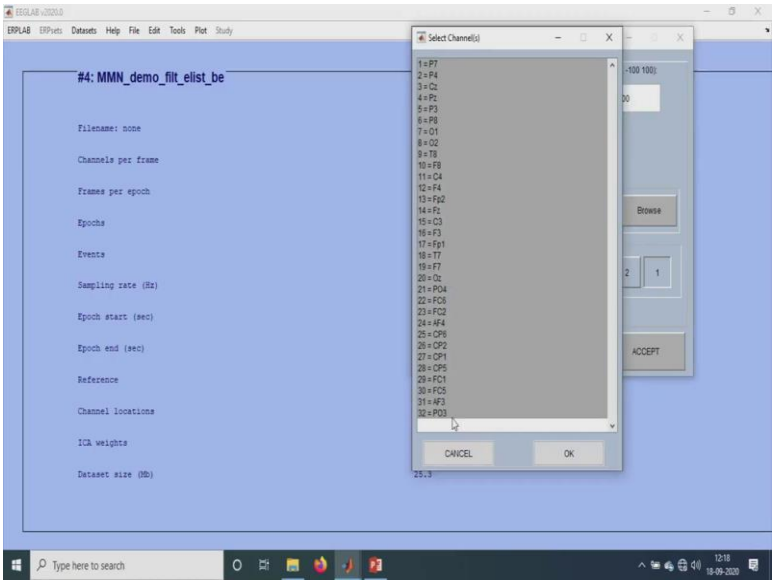


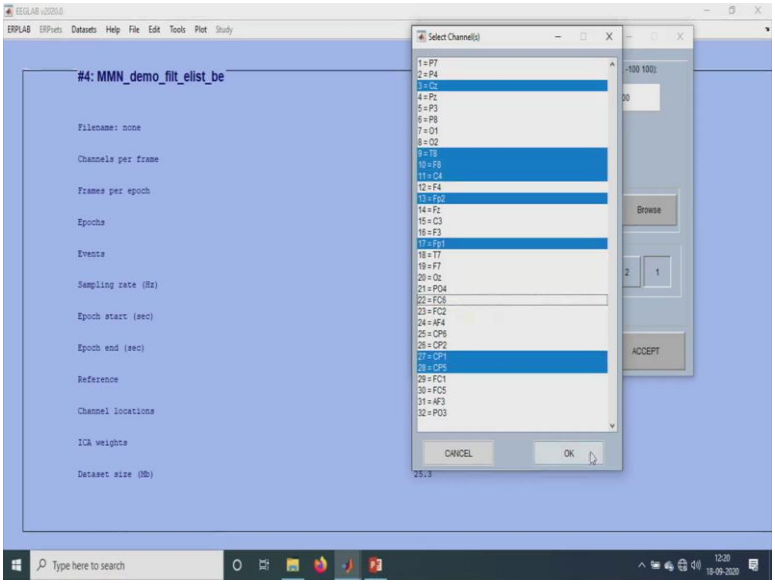


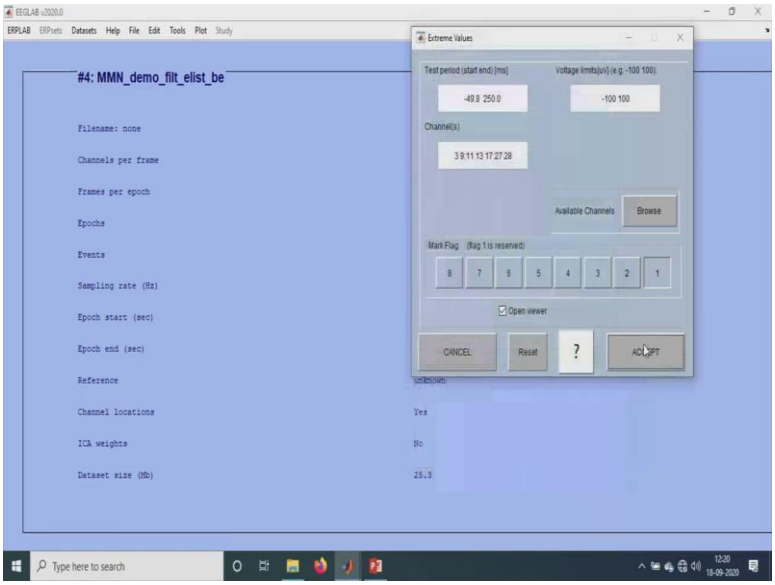


Next I will just show you how to do the artifact rejection. So, artifact rejection as I told it should be always the voltage threshold. Now, in this we cannot take all the channels because here in this there is no separate trigger channel is not there. In the previous demonstration as I showed in the CNT, the trigger channels was separate and other EEG, EMG channels and all will separate so we just excluded that we did only the other electrodes together. But in this all the channels, all the EMGs, all the triggers everything are in the channels itself.

So, for that reason what we have to do is we have to just select few the actual areas where for example only the frontal, frontal electrodes or the frontal central electrodes and all of this the place where MMN is maximum seen.

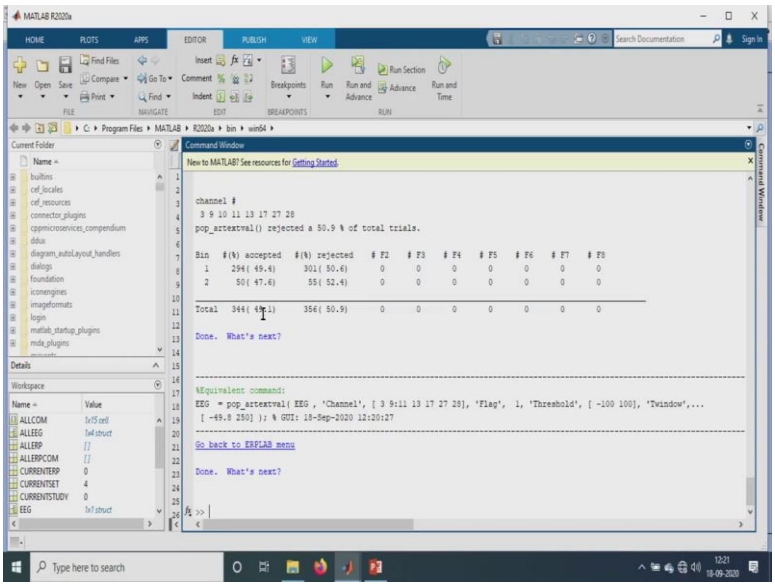
(Refer Slide Time: 12:13)

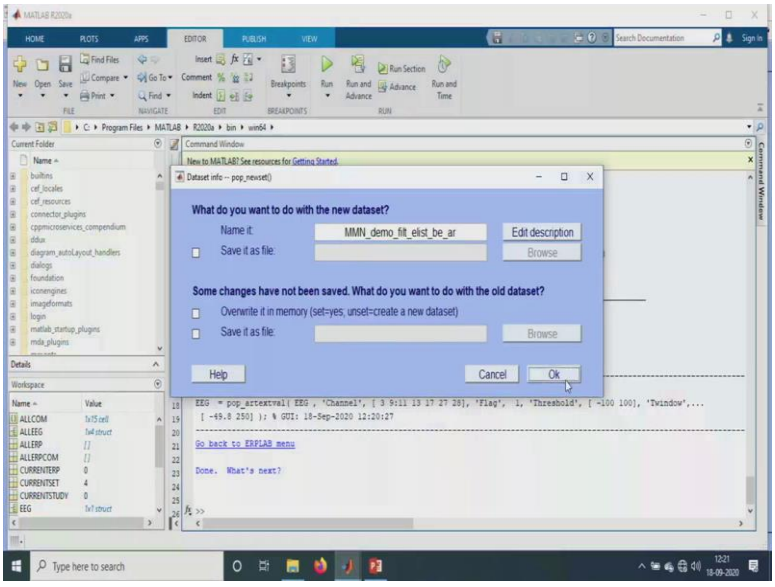




So, we just take those electrodes alone like all these, these are the frontal electrodes and these are some parietal electrodes that are there. So, only these few electrodes, only those electrodes we will be taking I will just take all these electrodes 4, 5, 9 electrodes as such and only these only for these channels I will do the artefact rejection, not the others because others are not mean the MMN has more specifically seen in these electrodes rather than the others. So, I will just take that and I accept it.

(Refer Slide Time: 12:57)



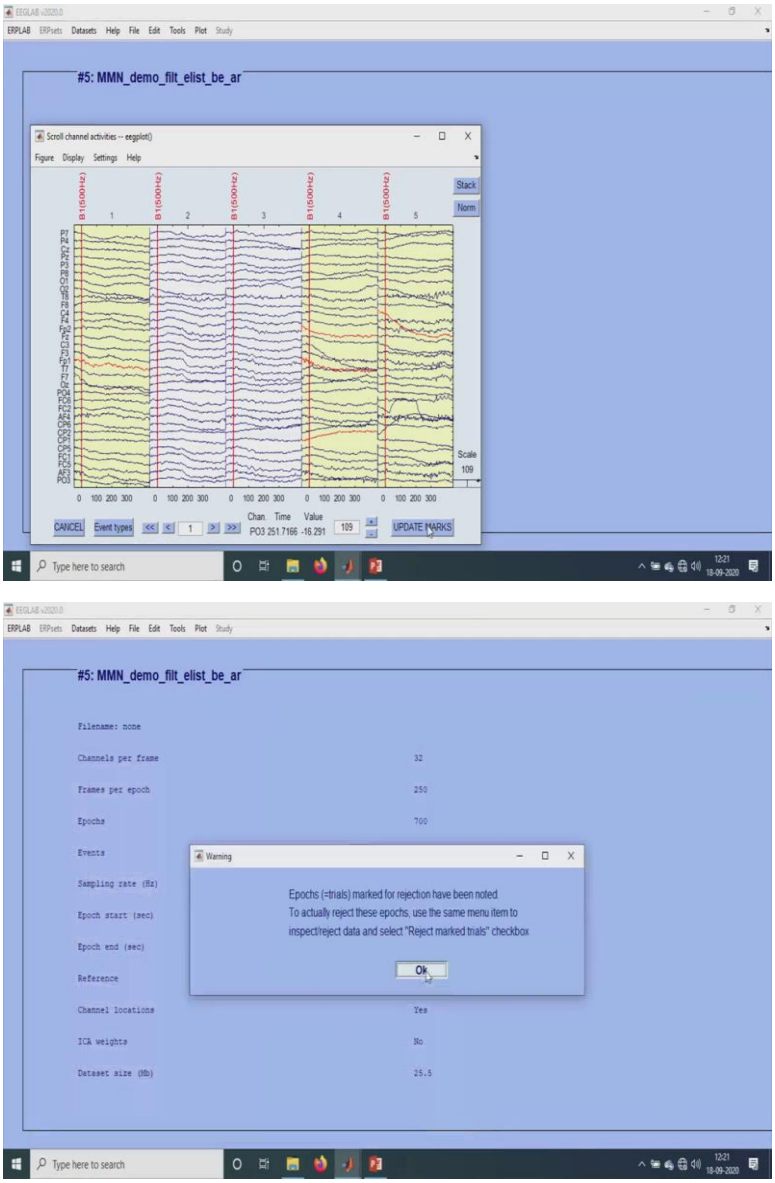


So, if you go in the back and see, you will see how many of them are being rejected and how many of them are being accepted. So, over here if you see like it is like a 50-50. So, if I had selected the whole of EEG all the channels, if all the channels would have been rejected, all

the epochs would have been rejected. So, here there are 2 bins, in that some 100 of them are for standards and the remaining were for the deviants.

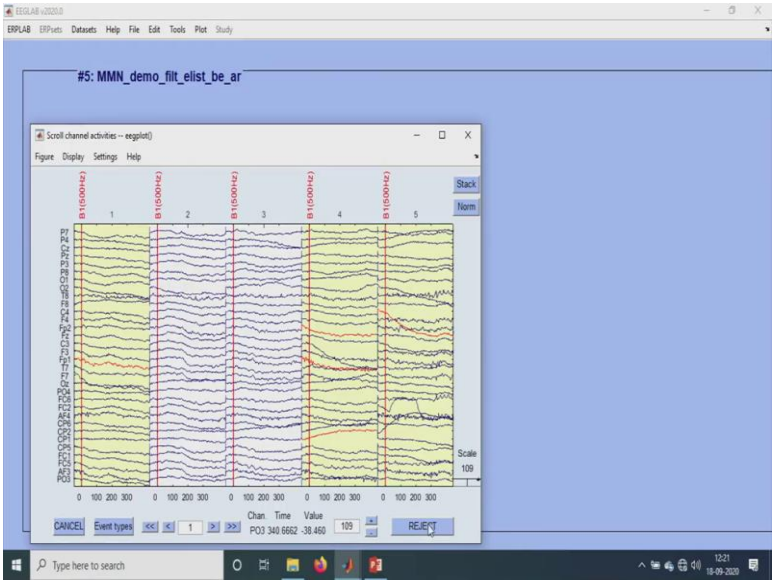
So, then we will just do this, so here we get the accept these many of them are being accepted. So, we have to get at updated in our this one also. So, we just do that.

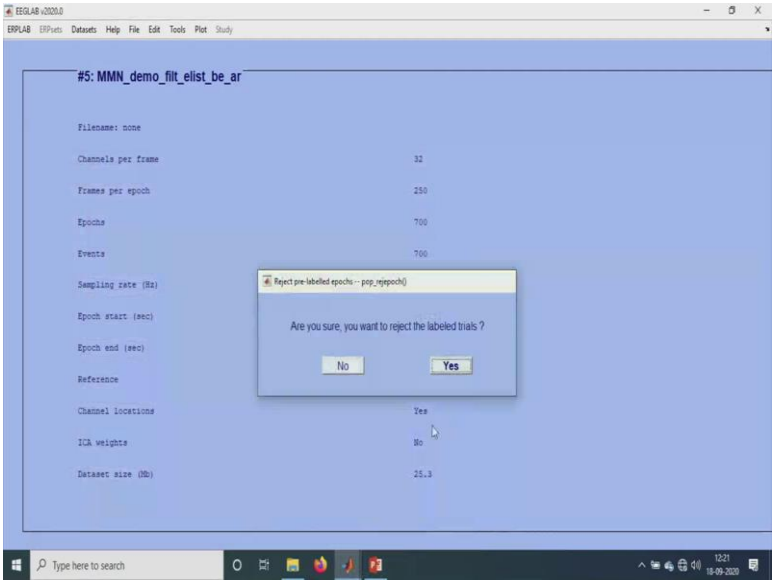
(Refer Slide Time: 13:42)

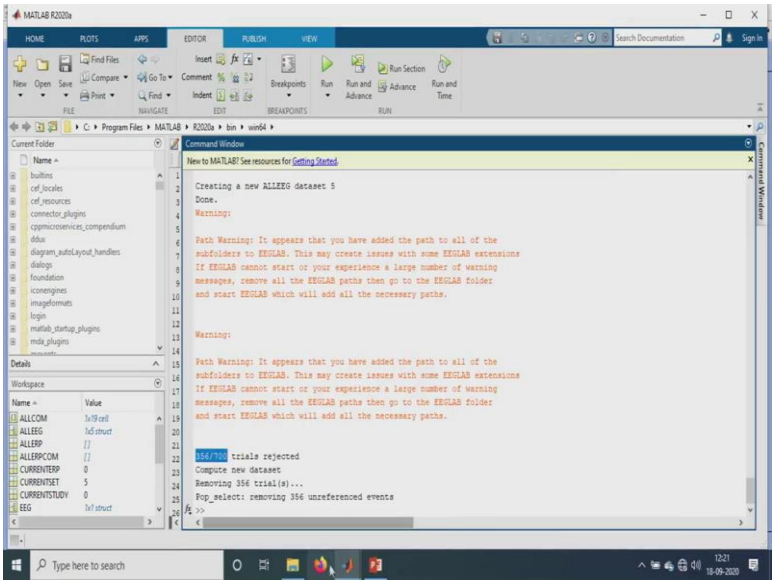


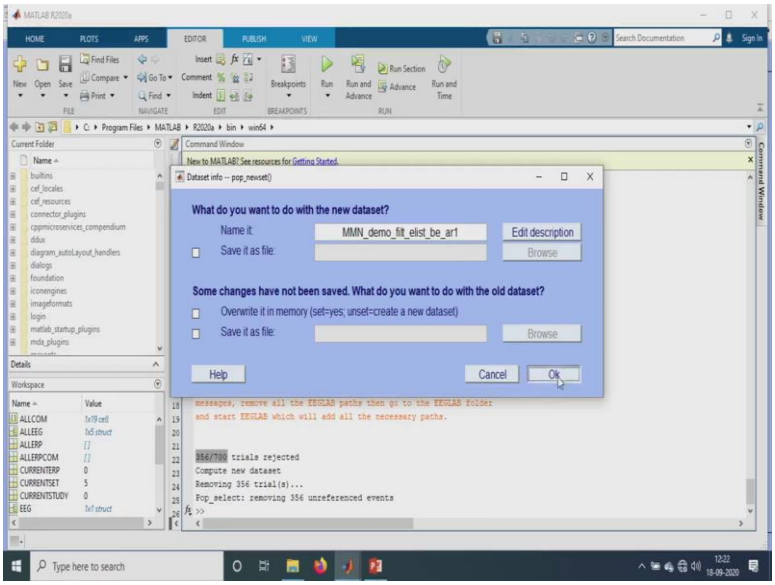
Then here in this yellows, the yellow one which is being highlighted in yellow, they are the ones which are is having the those are going to be rejected. So, we just update these marks. And then we go as I showed in the previous demo also like we have to go to these tools and inspect and then we just reject the marked trials.

(Refer Slide Time: 14:08)



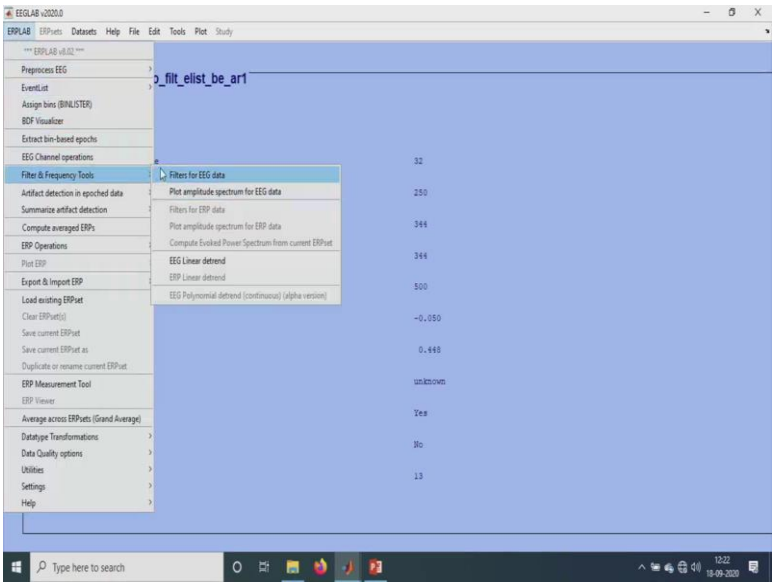


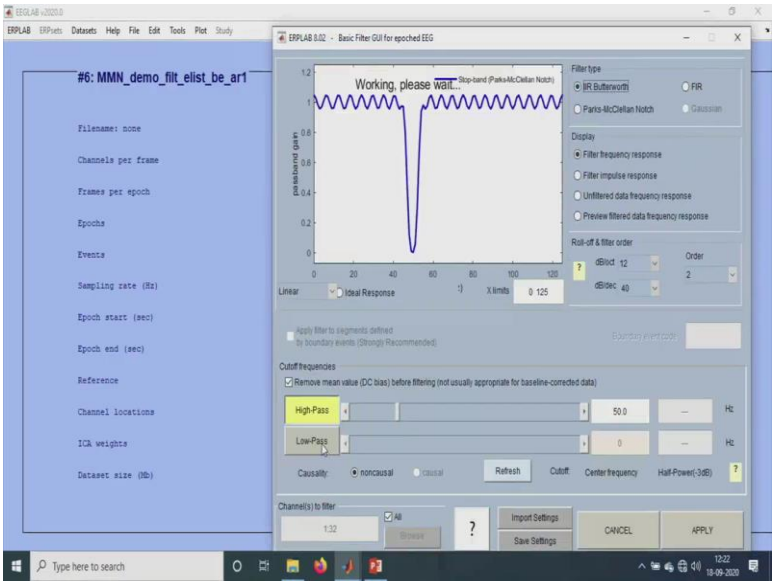




So, all these yellow marked try, these are the all yellow all these highlighted ones are the marked one and that will get rejected. So, we will get a see over here we can see that out of 700, these many trials have would been rejected, has been rejected. So, we will get a new dataset. So that is how it looks.

(Refer Slide Time: 14:34)

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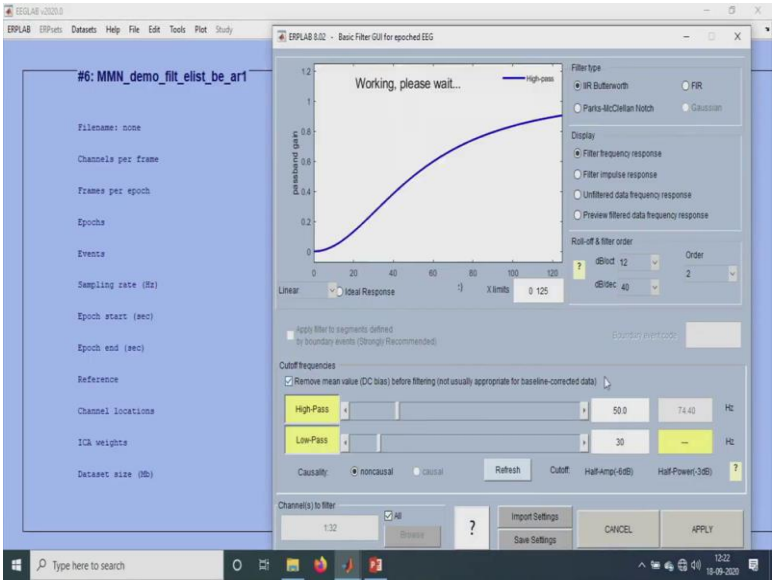
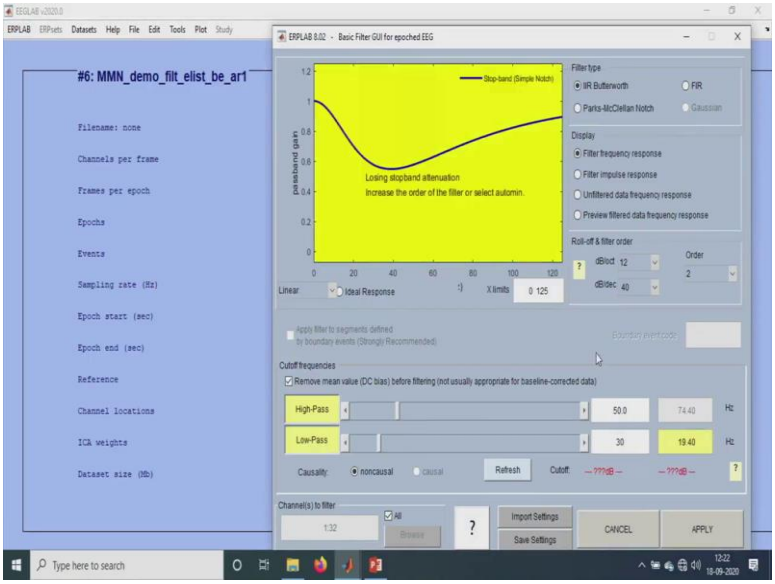
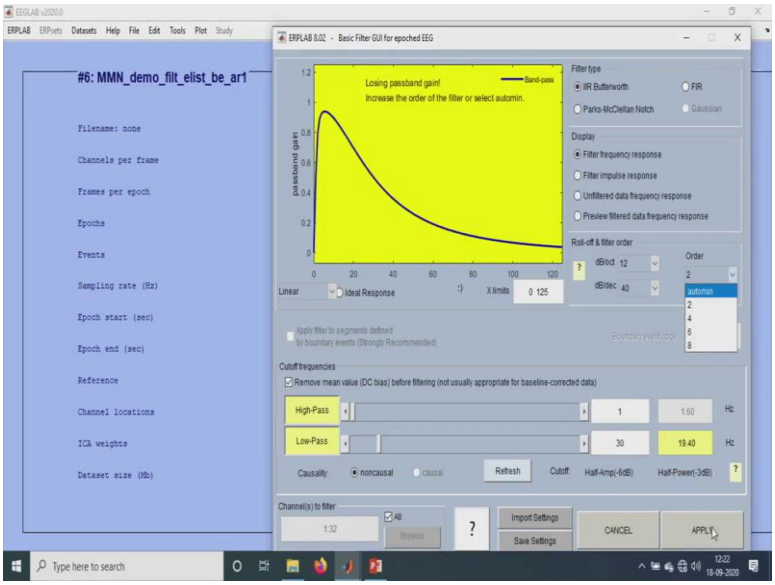
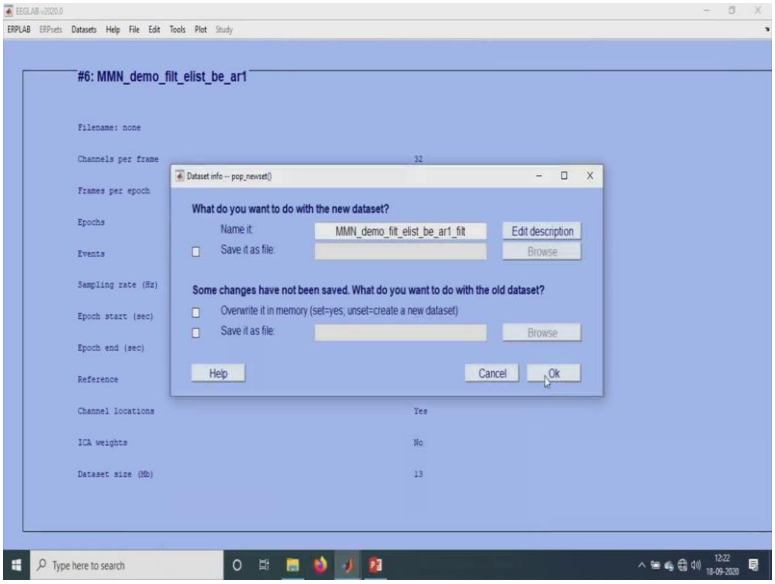
Filename: none
Channels per frame
Frames per epoch
Epochs
Events
Sampling rate (Hz)
Epoch start (sec)
Epoch end (sec)
Reference
Channel locations
ICA weights
Dataset size (Mb)
ERPLAB 8.02 - Basic Filter GUI for epoched EEG
Working, please wait...
Stop-band (Parks-McClellan Notch)
passband gain
Filter type
IIR Butterworth
FIR
Parks-McClellan Notch
Gaussian
Display
Filter frequency response
Filter impulse response
Unfiltered data frequency response
Preview filtered data frequency response
Roll-off & filter order
dBoct 12
dBdec 40
Order
2
Linear
Ideal Response
X limits 0 125
Apply filter to segments defined by boundary events (Strongly Recommended)
Boundary event code
Cutoff frequencies
Remove mean value (DC bias) before filtering (not usually appropriate for baseline-corrected data)
High-Pass
50.0
Hz
Low-Pass
0
Causality: noncausal causal
Refresh
Cutoff: Center frequency Half-Power(-3dB)
Channel(s) to filter
1:32
All
Browse
Import Settings
Save Settings
CANCEL
APPLY
Type here to search
12:22
18-09-2020


#6: MMN_demo_filt_elist_be_ar1
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)
ERPLAB 8.02 - Basic Filter GUI for epoched EEG
Working, please wait...
High-pass
passband gain
Filter type
IIR Butterworth
FIR
Parks-McClellan Notch
Gaussian
Display
Filter frequency response
Filter impulse response
Unfiltered data frequency response
Preview filtered data frequency response
Roll-off & filter order
dBoct 12
dBdec 40
Order
2
Linear
Ideal Response
X limits 0 125
Apply filter to segments defined by boundary events (Strongly Recommended)
Boundary event code
Cutoff frequencies
Remove mean value (DC bias) before filtering (not usually appropriate for baseline-corrected data)
High-Pass
50.0
74.40
Hz
Low-Pass
30
Causality: noncausal causal
Refresh
Cutoff: Half-Amp(-6dB) Half-Power(-3dB)
Channel(s) to filter
1:32
All
Browse
Import Settings
Save Settings
CANCEL
APPLY
Type here to search
12:22
18-09-2020

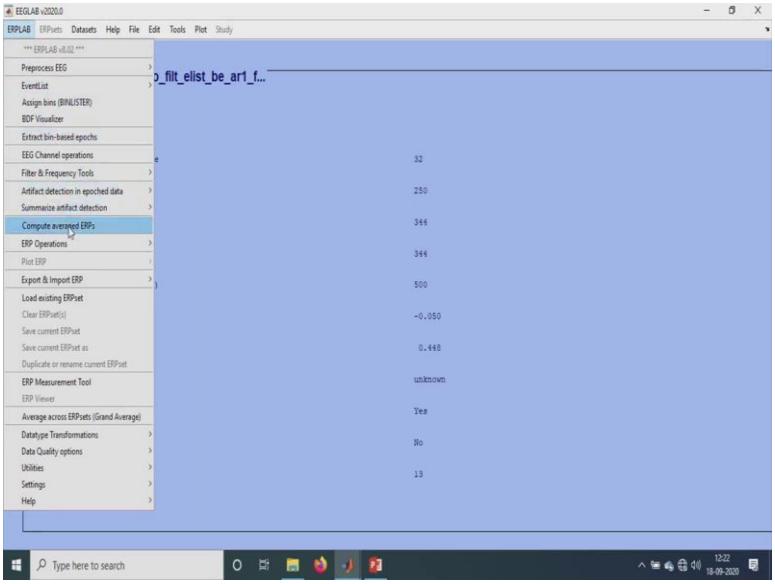

#6: MMN_demo_filt_elist_be_ar1
Filename: none
Channels per frame
Frames per epoch
Epochs
Events
Sampling rate (Hz)
Epoch start (sec)
Epoch end (sec)
Reference
Channel locations
ICA weights
Dataset size (Mb)
ERPLAB 8.02 - Basic Filter GUI for epoched EEG
Stop-band (Simple Notch)
passband gain
Losing stopband attenuation
Increase the order of the filter or select automin.
Filter type
IIR Butterworth
FIR
Parks-McClellan Notch
Gaussian
Display
Filter frequency response
Filter impulse response
Unfiltered data frequency response
Preview filtered data frequency response
Roll-off & filter order
dBoct 12
dBdec 40
Order
2
Linear
Ideal Response
X limits 0 125
Apply filter to segments defined by boundary events (Strongly Recommended)
Boundary event code
Cutoff frequencies
Remove mean value (DC bias) before filtering (not usually appropriate for baseline-corrected data)
High-Pass
50.0
74.40
Hz
Low-Pass
30
19.40
Causality: noncausal causal
Refresh
Cutoff: --- ???dB --- --- ???dB ---
Channel(s) to filter
1:32
All
Browse
Import Settings
Save Settings
CANCEL
APPLY
Type here to search
12:22
18-09-2020

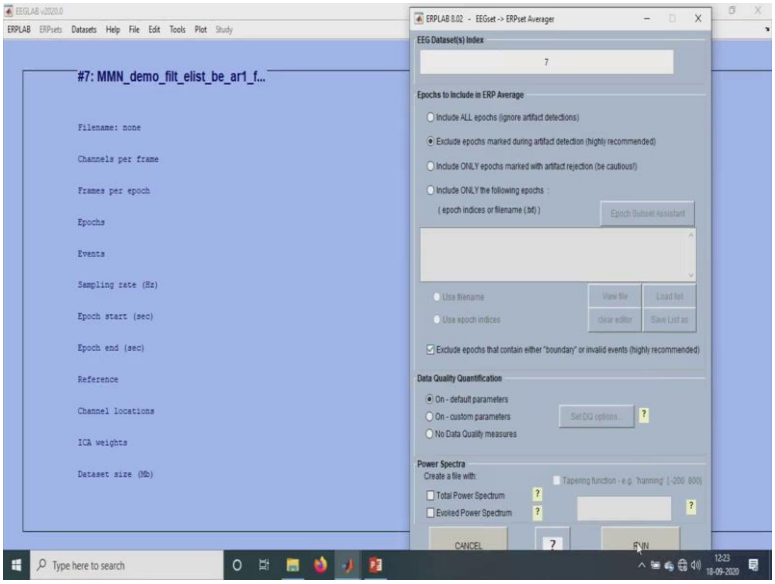




And after this our regular step is filtering. So, we will do a bandpass filter. After doing the bandpass filter, we will do the remaining other averaging ERPs and everything. So, it should be always 1 to 30, we can change it. Here we have the order, we can change it or we can even change the high passband and the low passband and everything. So, we just apply it and then we will get the averaged, the filtered dataset.

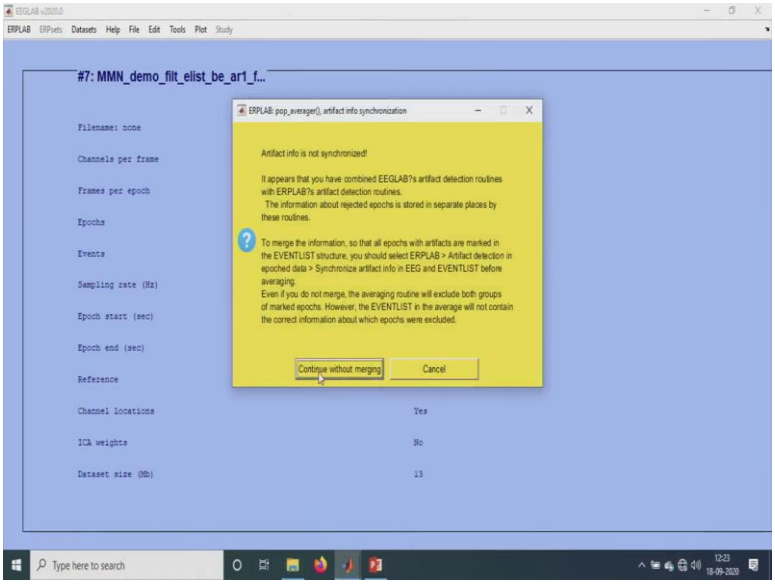
(Refer Slide Time: 15:10)

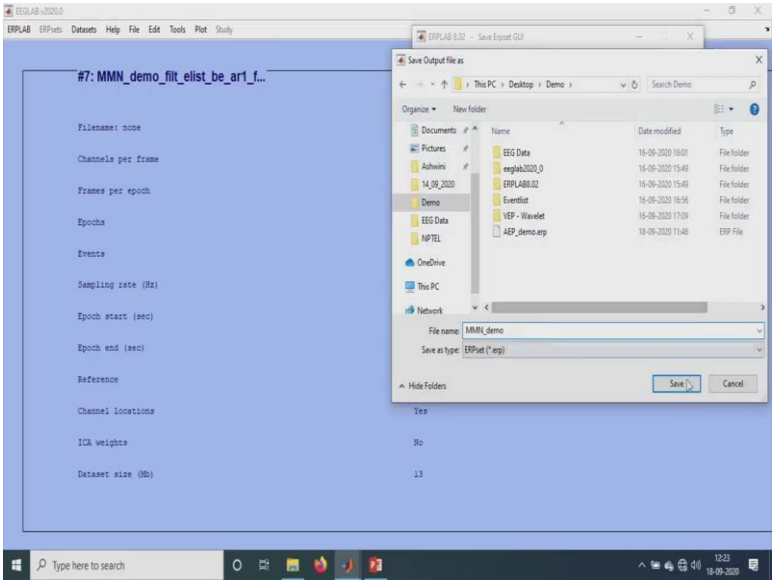


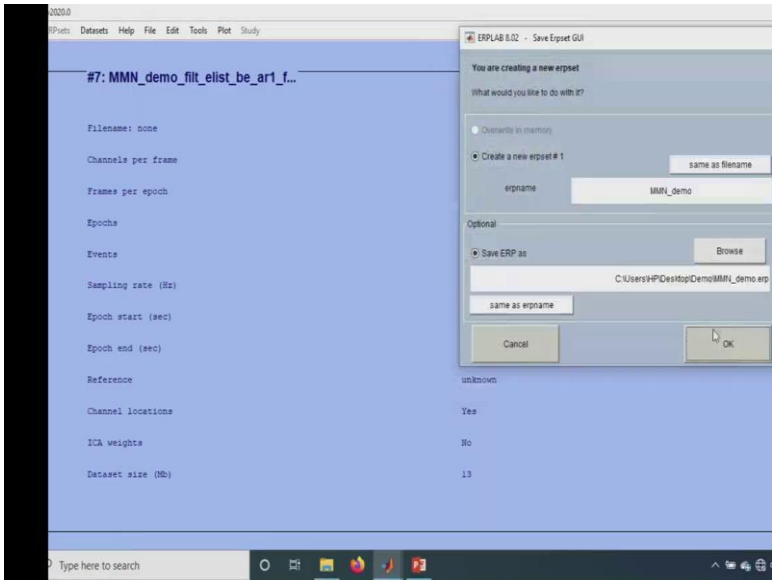


So, we have one now, as I told you there are 2 bins now we have a bin 1 and a bin 2. So, bin 1 is for the standard and bin 2 is for the deviant. So, we will further do the averaging of those two bins. So, here in this seventh dataset after doing all the steps filtering, event list, epoching, artefact rejection and then filter, rejecting the rejected artefacts and then finally filter, we will get a just these many, this 344, only these many channels, I mean only these many epochs have been created, of that few of them are for bin 1s and few are from bin 2 and they will be separately averaged. So, we will be doing that step in this ERP set average.

(Refer Slide Time: 16:01)

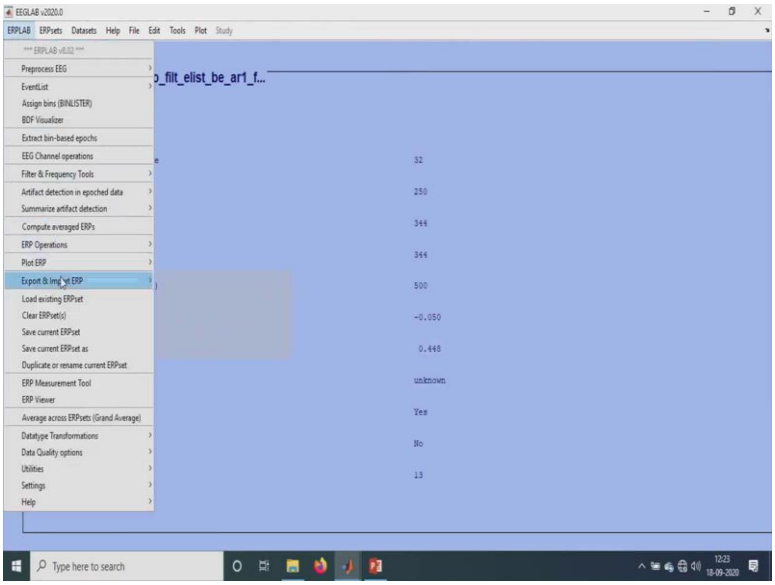


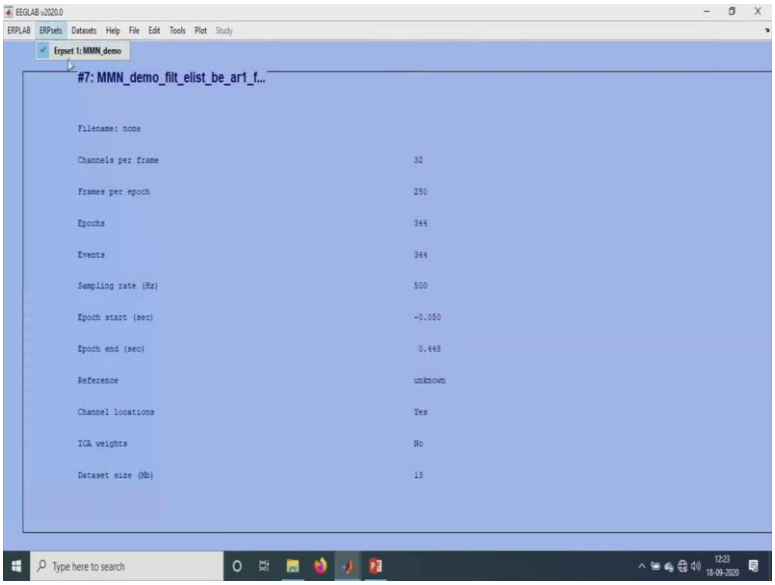


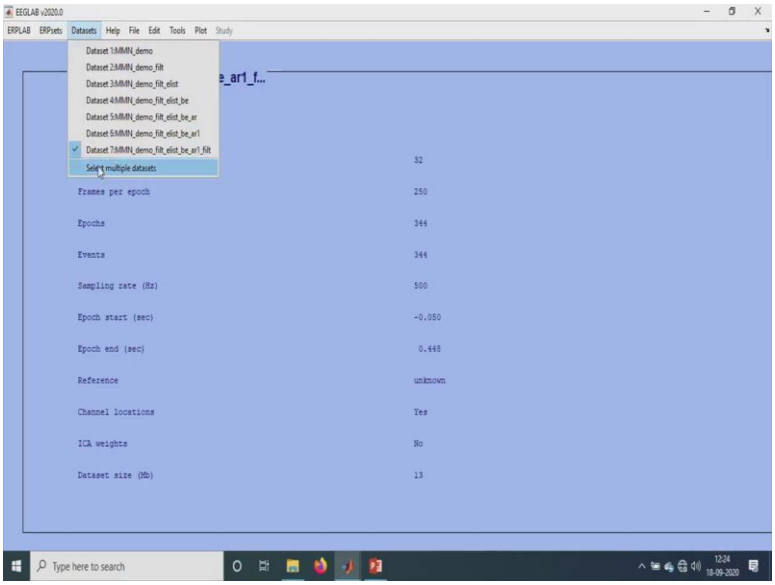


So, here it is just a pop up saying that about the emerging merging. So, we will just name the MMN. So, here we have the MMN demo I will just save it in this format. I will just show you how it looks with just two events, two bins it shows actually.

(Refer Slide Time: 16:24)

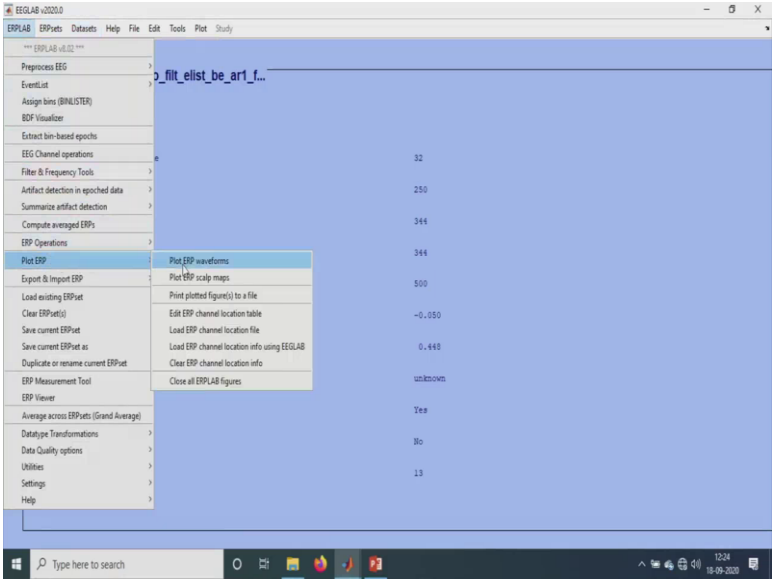


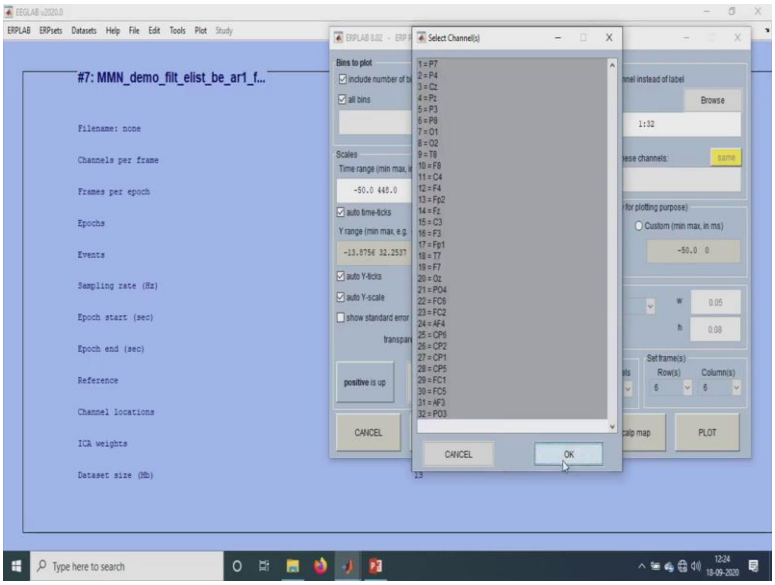


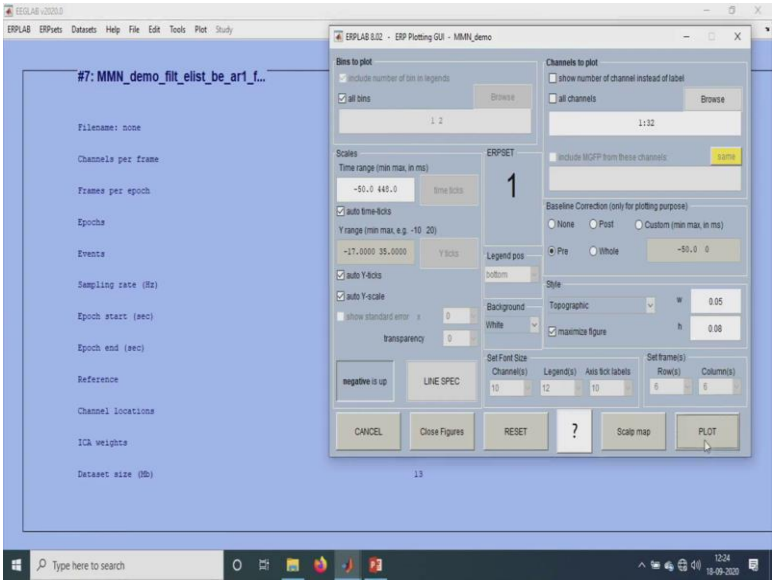


So, here we have the MMN demo is been generated. So these are the till now whatever we were doing it was being data, this dataset was being obtained over here.

(Refer Slide Time: 16:34)

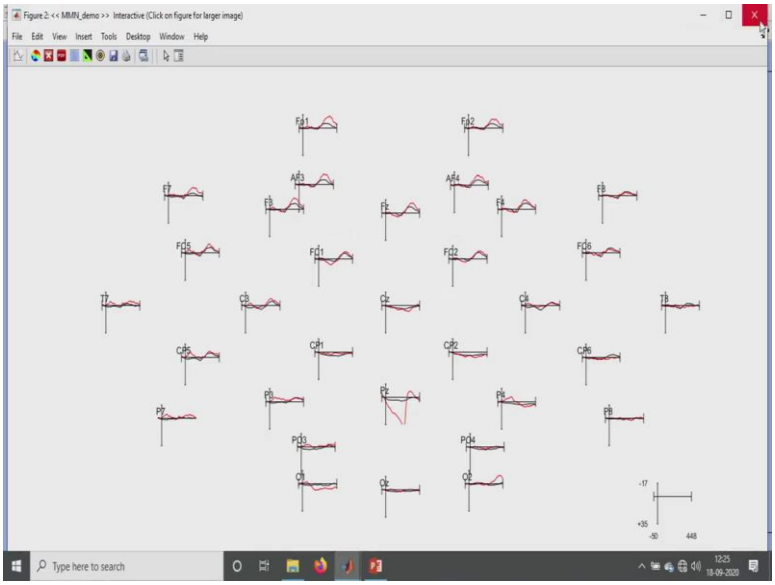






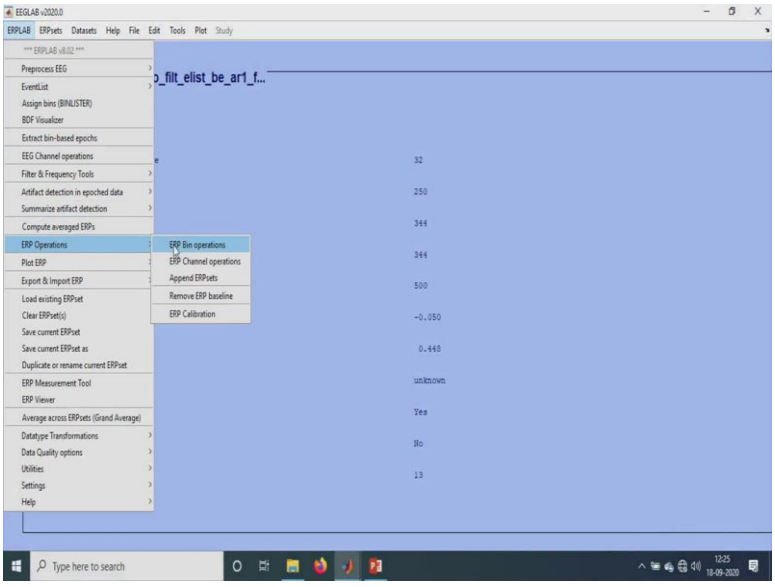
Next I will just show a plot of this. In this plot we do not want much of these channels, I will just take a few of them like the central and frontal part, so actually I will show everything. And then I will just show a topographic manner how it looks. So, in the topographic sense if you say and here also we should take since it is a MMN like it is a mismatch negativity, so it is always should be a negative up but we have not made the MMN yet. This is just the two bins like the standard and the deviant separately we have epoched and kept, averaged and kept.

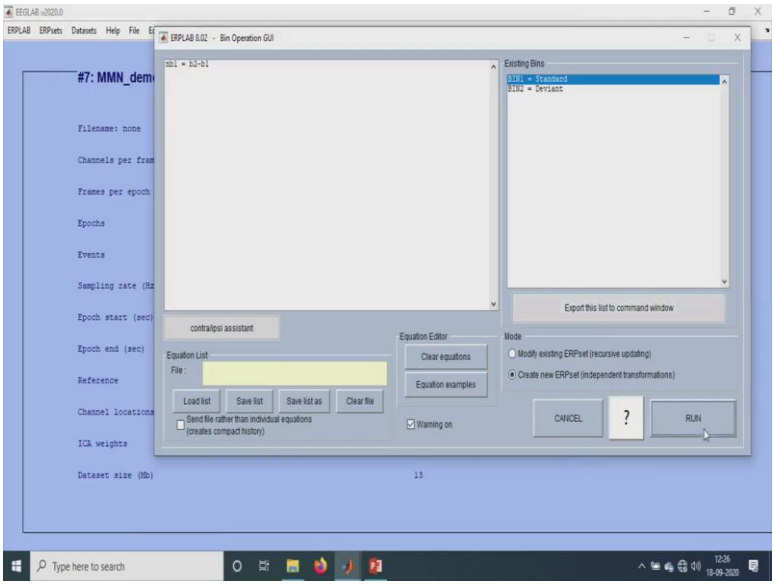
(Refer Slide Time: 17:27)



So, here the red ones would be the, so if you see over here the red ones will are the deviants and the black, the black line over here, the black waveform is the standard. So, this is how it looks. Now, we have to do the subtraction between deviant and standard then only you will get the proper MMN data. So, I will just do that operation now. So, this is just to show that this is how it looks with just standard and deviant together it looks in this manner.

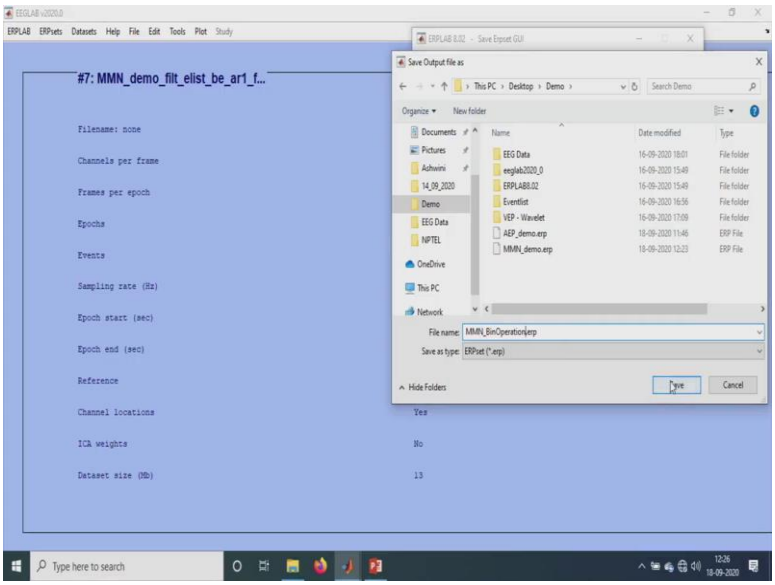
(Refer Slide Time: 18:05)

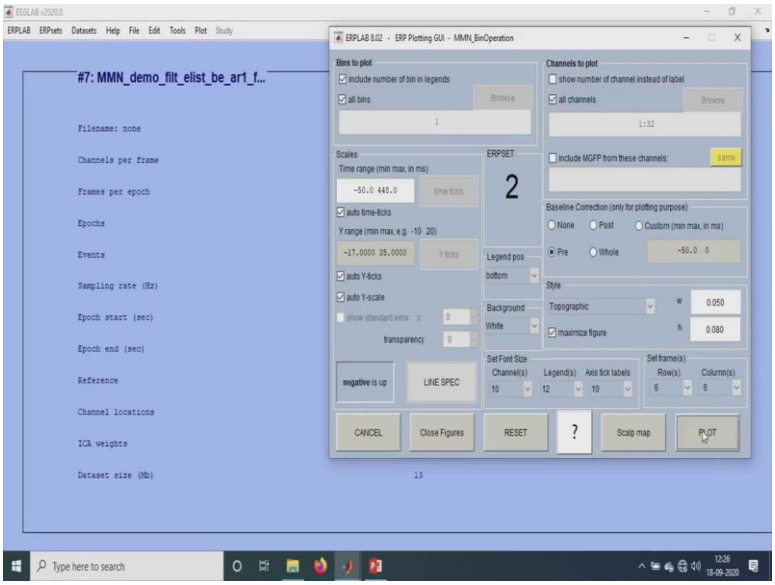




I will show you how to do the bin operation. So, here we have the ERP operations, in this, we have to take a bin, the bin operation function. So, here we can do this is the two bin we have, we have to do the bin 2 minus bin 1. So, it will we can make it either in a in the current dataset itself we can d or we can create a new dataset also. So, I will just do new data set. So, this is how it does, b2 minus b1 and I just run it.

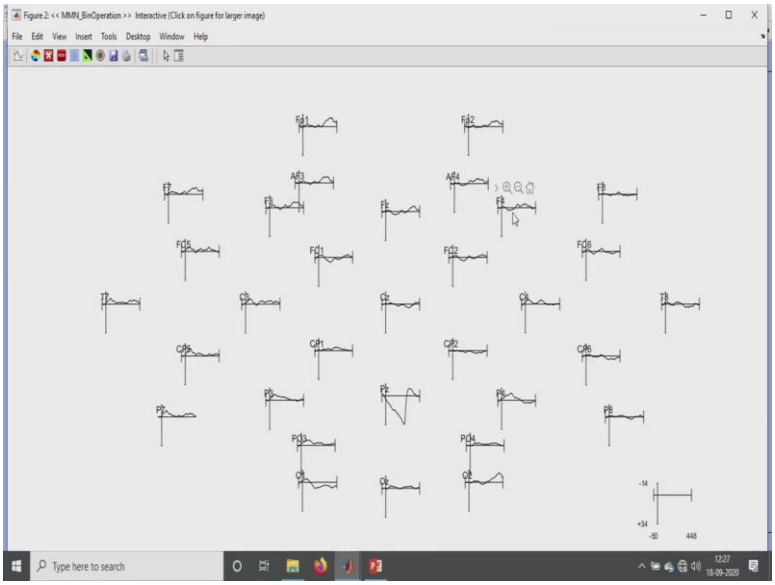
(Refer Slide Time: 18:35)

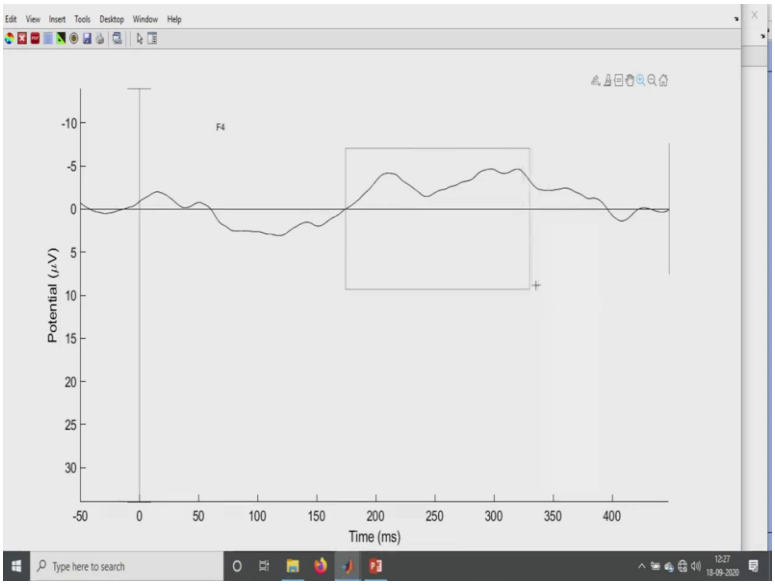


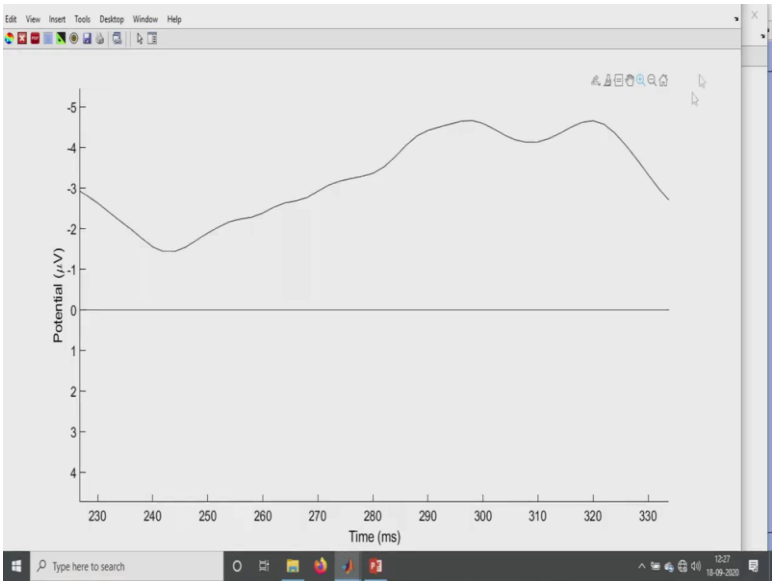


So, it will give you the bin. So, I just write it as a bin operate, bin operation and I just save it and I will show you how does it look after the do, after doing the bin operation how it looks. So, this is how the bin operation is being done and then I will just show you the bins.

(Refer Slide Time: 19:10)





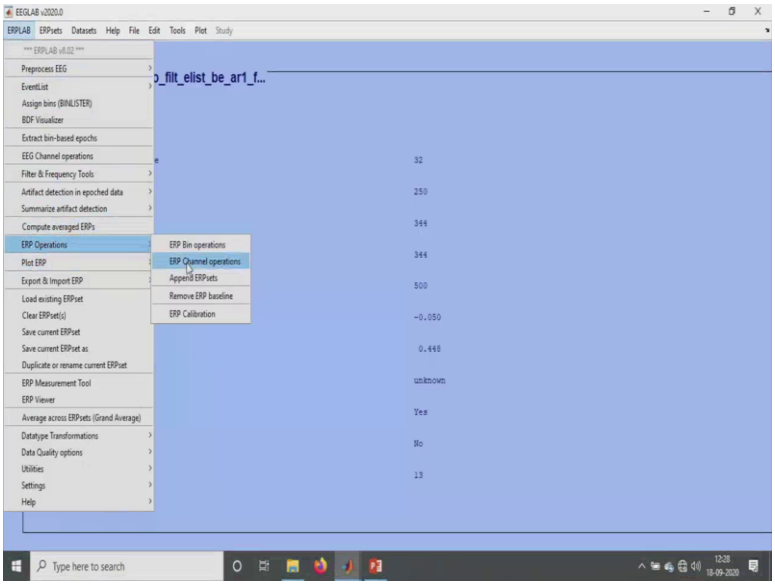


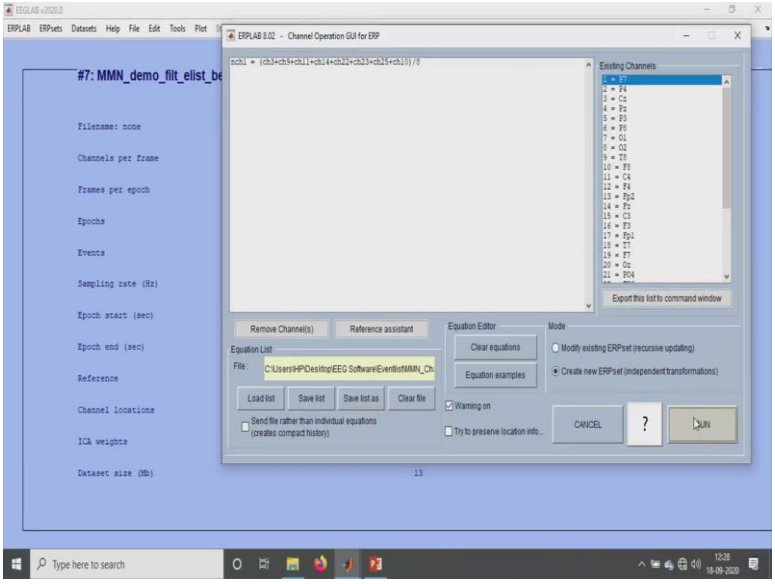
So, over here if you see this part, this is the actual part of the brain wherein the proper MMN should be looking, we should get. So, I will just show you this particular electrode. So, over here if you see it is this particular hump over here, this particular negative over here, this is called as the proper MMN. So, it should be actually from minus 50 to 300, in this range only but we are obtaining this in this range over here, this particular peak, this part this is called as this is called as the MMN for us.

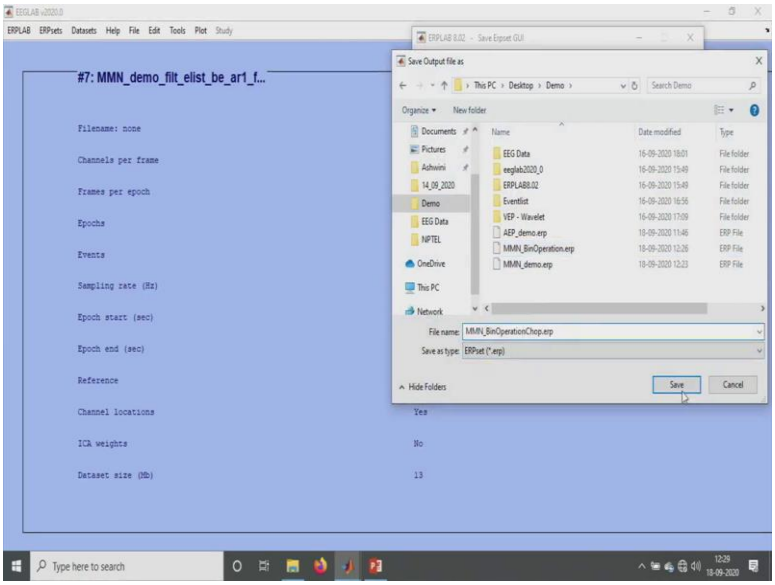
So, we can check what is the data points also, how it looks and everything. So, this is the classic MMN response which is being obtained between so minus like 152-300 in this range it is being obtained this point, this is the place where it is. So, we can what we can do is, we can directly do all the channel operations also. Like we can just take the average of only these particular this area as I showed in the p presentation, it was that blue area was the place

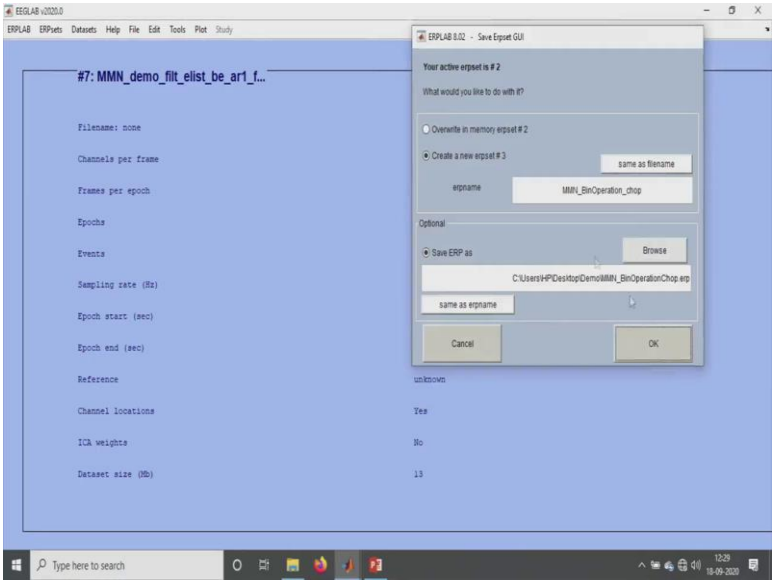
where the MMN should be there which is in this part, this is the actual area where it should be there. So, we can do the channel operation in that way also.

(Refer Slide Time: 20:50)









So, I have already that being done. So, here if you do the channel operation, so here I have done the channel operation over here like we have to do for the front, we h to select which channels is for this front frontal central left side, the right side of the brain, so we will just select all them, all of them and just average it. This is an equation that I made earlier, so we can just select and add and do the averaging. And if you run you will get a channel operated one. So, just do a, we are chopping it to a particular part of the brain.

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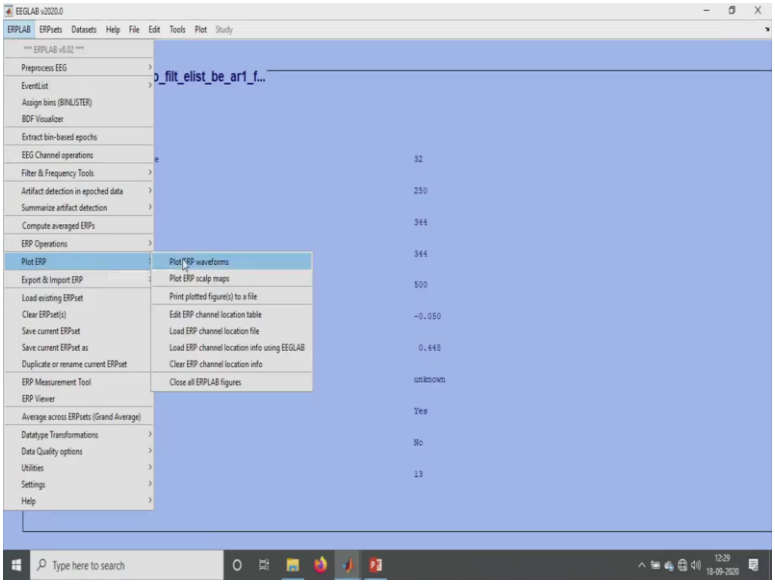

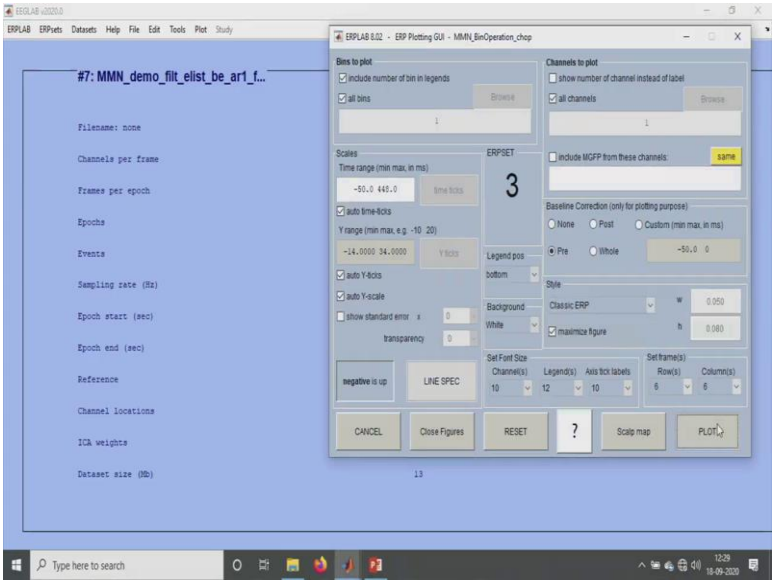

So, I will just do that and I will show you. There will be just one channel and one bin which just shows one of the ERP.

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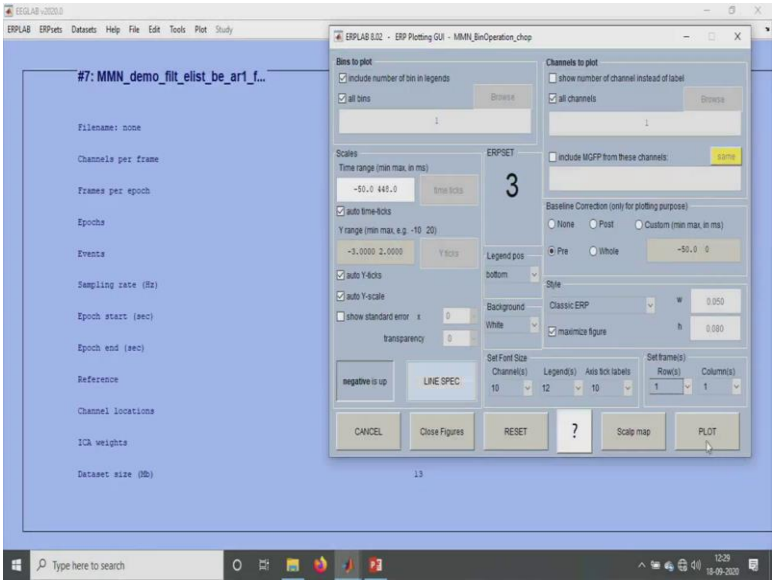

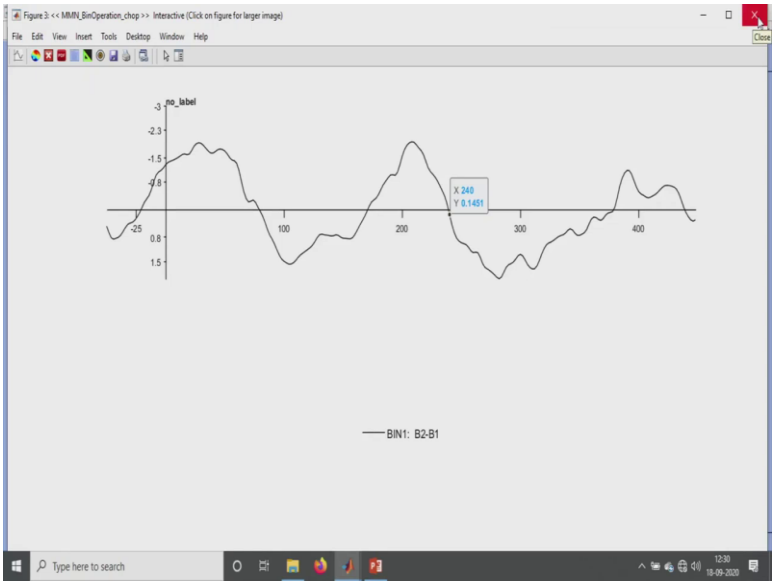

One minute, I will just make it a bigger, we will make it negative up always because as I told you it is a negative peak. So, here this is this particular this is called as the MMN here. From here to here, that is the proper MMN so it starts from about, it starts from about 170 and it ends in this particular point.

So, if you do all these operations we will be able to clearly see the MMN response. So, this part and this part is not necessary for an MMN study. So, only we have to concentrate from this part to this part that is the place where you have to find the MMN response.

So, after, doing the channel operation and the bin operation, we will be able to get the proper MMN result. Now for the same similar way there will be a lot of subjects, for many subjects we will do this similar data analysis. So, if you do all those analysis together and we can

perform a grand average, we will be getting the statistical analysis we can do the T test and other Enova and everything and all and we can see how the standard, so how the SEM look like and all we can find out.

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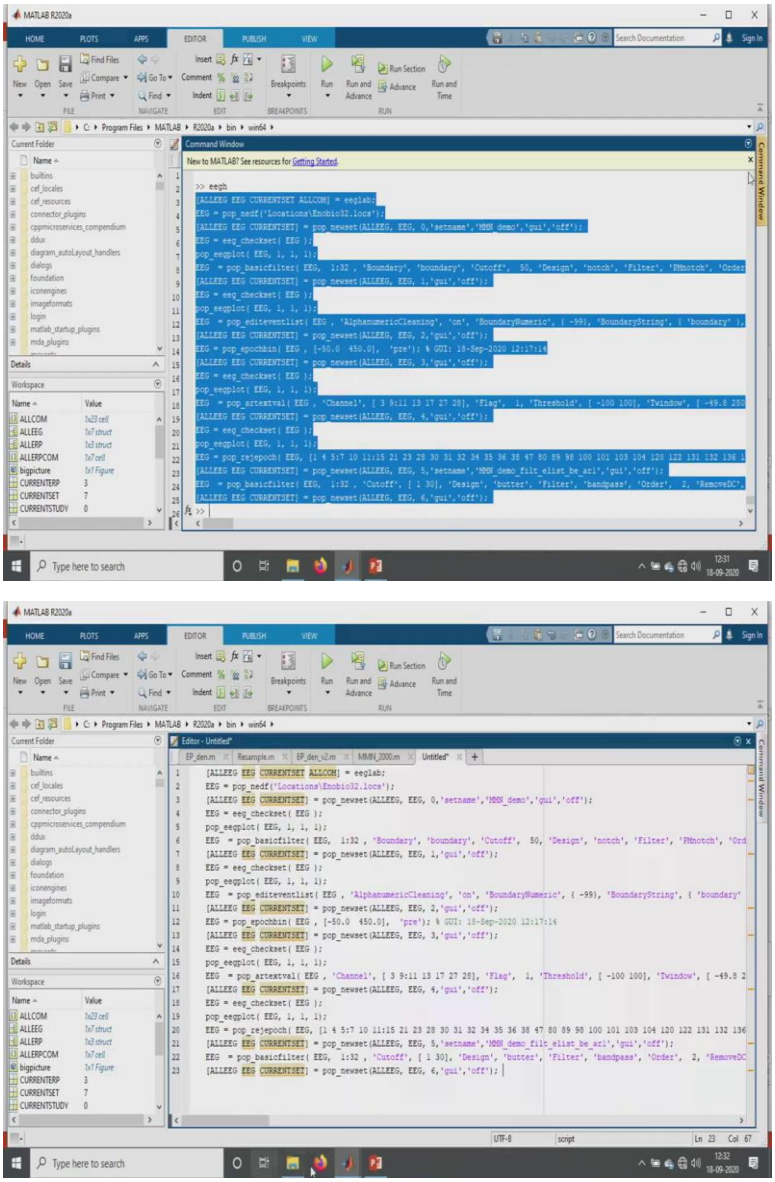

Another important step I had to mention about is the scripting as I told you. Here, we can whatever steps we have being doing till now, it will be there as a history, it will be there in the EEG history. So, if we just do eegh if you put if we just put this eegh command over here, we will get what all other codes which we have been obtained for all the codes required to do all the other analysis.

For example, for the now, this is the loading the dataset and then we can just do we did the notch filtering and then here this is the event list creation and then we did the epoching. So,

like that all the, how a sequentially how we had done, we will get the proper scripts. So, we will we can just copy this and paste it accordingly in our editor or every anywhere and then we can just name it accordingly and you need to just for multiple data analysis and all, we can just use this particular dataset.

The only thing we have to just change the subject name or the name of the data file, accordingly we have to change and obtain the result. So, this is just a step that I missed in the previous demonstration. So, this is how we do the MMN analysis.

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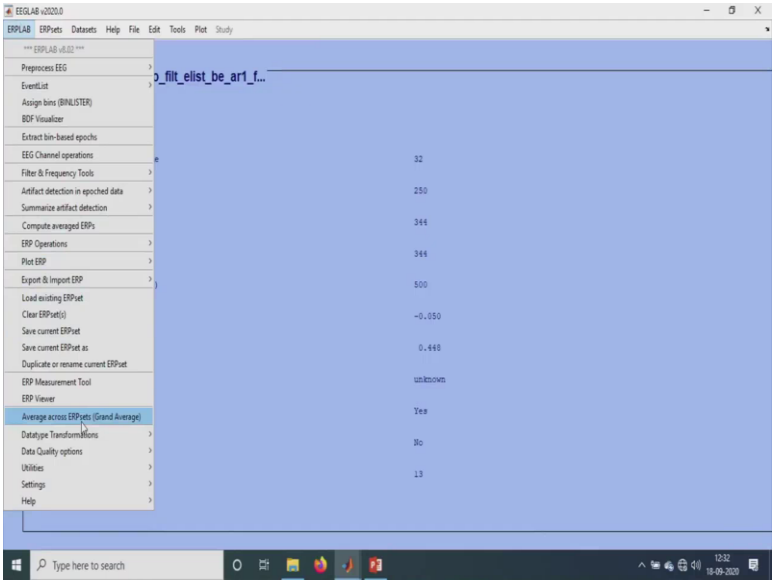

So, as then as I told you this is the step where we can do the grand averages of you have multiple subjects, all the datas you have together, we can collect all these ERPs together and finally do a grand averages together. But the main important step about these grand averages is it, is that we have to keep the data, the processing constant like it should be all the filters should be the same, all the epoching, the time range everything should be the same. If you are not do, a different time ranged one together for epoching, that is not possible. Even the sampling rate also should be the same for both the for doing the grand averages.

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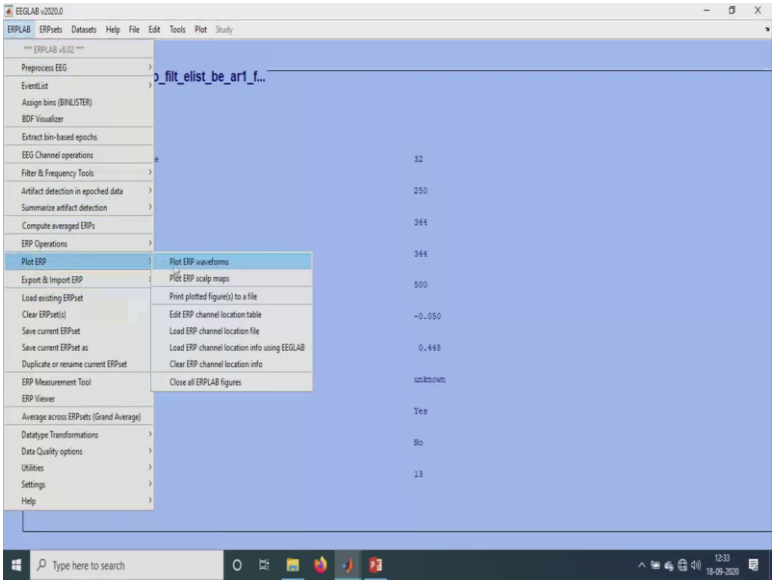

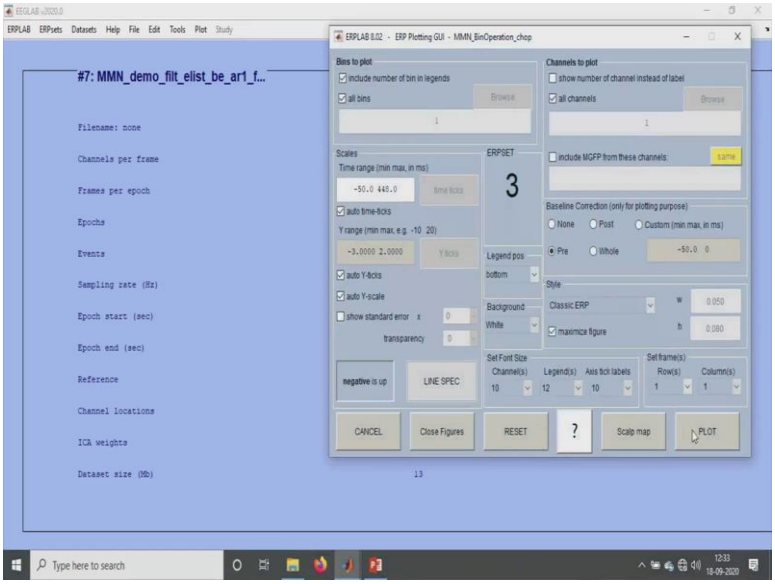

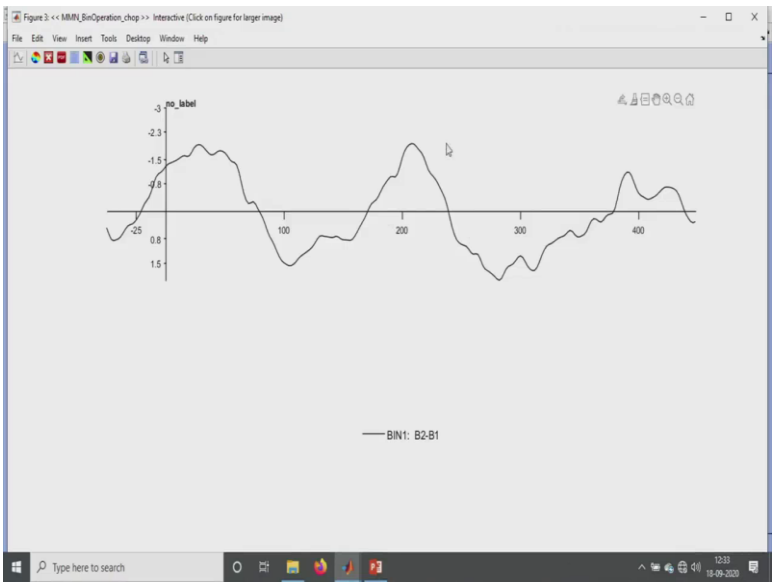

So, there that is all about the MMN. So, this is the MMN data, it is classic MMN data. So, the next demonstration or the next presentation I would be giving is about the P300 and how to do its demonstration and analysis.