OBELAB

NIRSIT LITE

Analysis Tool Manual

Amendments

Version	Amendment Date	Details	Miscellaneous
2.0	19.11.22	Compatible with Version 2.0	
3.0	20.06.12	Compatible with Version 3.0	
3.0.5	20.09.21	Bug fix and Function update	
3.0.7	21.01.14	Layout modified and Bug fix	
3.0.9	21.02.24	GLM function modified	
3.1.0	21.03.19	2nd level GLM and Preprocessing function modified	

Contents

1. Starting NIRSIT Lite Analysis Tool

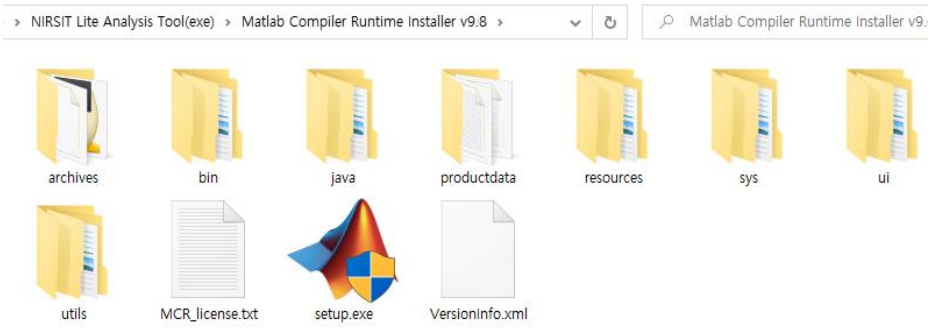
1.1 Installing MATLAB Compiler Runtime v.9.8

You can download MATLAB Compiler Runtime v.9.8, which is shown as R2020a(9.8), directly from https://kr.mathworks.com/products/compiler/matlab-runtime.html.

If MATLAB Compiler Runtime v.9.8 is already installed in your PC under C:\Program Files\MATLAB\MATLAB Runtime\v98, please skip this step.

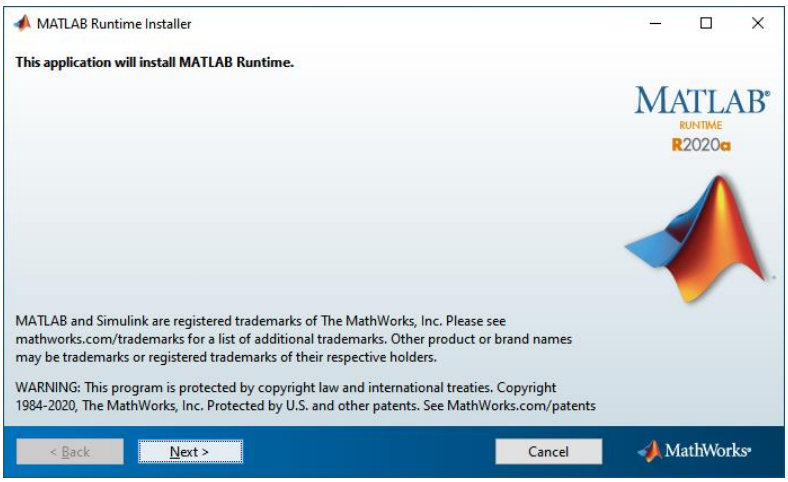
1.1.1 Double-click 'setup.exe' icon shown below

Unpack and execute 'setup.exe' file in the folder as shown below.



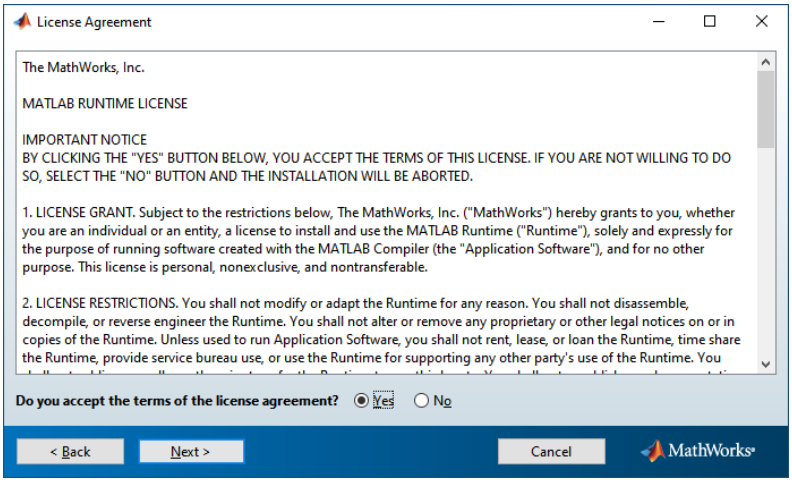
1.1.2 Installation Process

1. After the main screen appears on the PC, please wait for a few seconds.
2. Click **Next** button shown on screen.

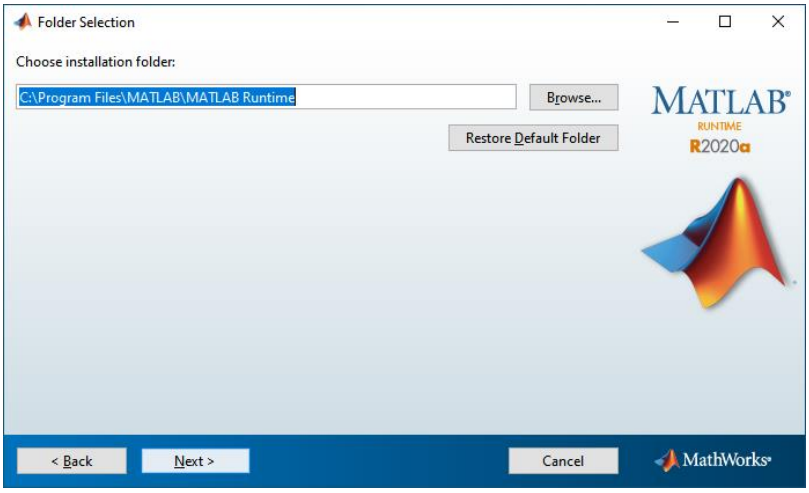


0

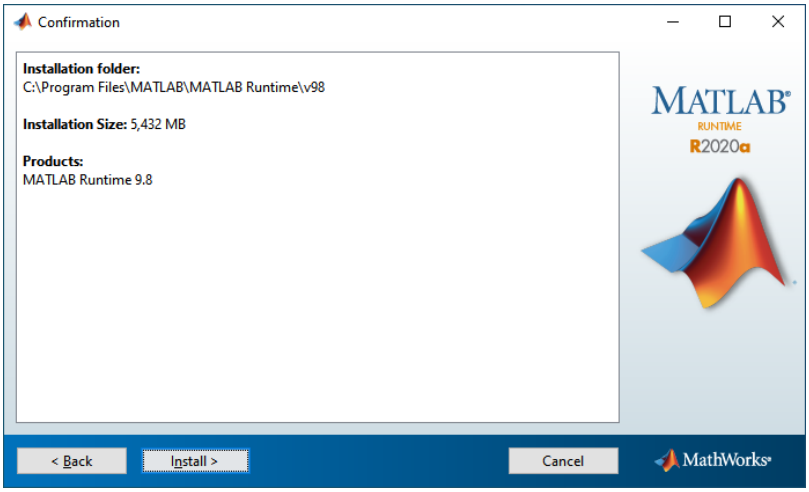
3. Click **Yes** button to agree to the terms and conditions of the license



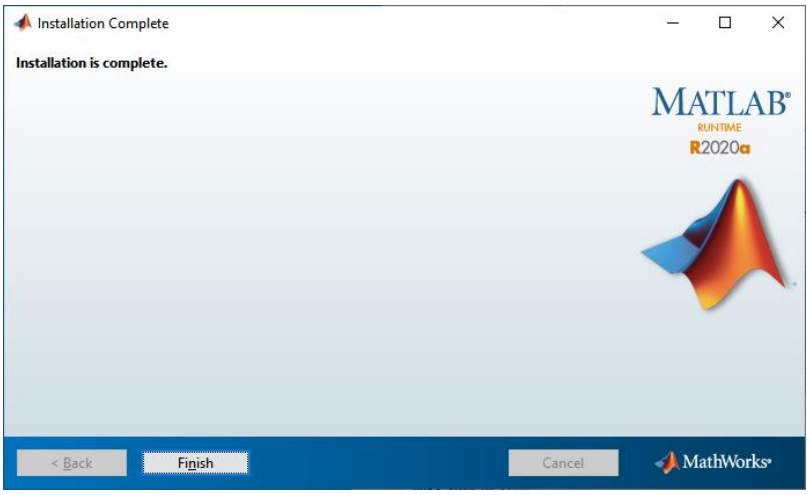
4. If User already has a Matlab Runtime installed, please skip this step. If User needs to re-install Matlab Runtime, click **Install** button for installation.



5. Proceed with the installation.



6. Please wait until installation is complete and Installation Complete shows up on screen. Click **Finish** button.



1.2 Setting up NIRSIT Lite Analysis Tool Default Folder

NIRSIT Lite Analysis Tool creates folders that designate save location in Default Folder. User can relocate NIRSIT Lite Analysis Tool from the Default Folder to a folder of one's choice.

1.2.1 Copying 'NIRSIT Lite Analysis Tool.exe' File

Please make a copy of 'NIRSIT_Lite_Analysis_Tool_v3.0.exe' file.

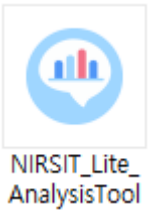
1.2.2 Pasting onto User Folder

User can create 'NIRSIT Lite Analysis Tool' folder and then paste a copy of 'NIRSIT_Lite_Anlaysis_Tool_v3.0.exe' file in the designated folder

This folder is now the Default Folder for the Analysis Tool.

1.3 Executing NIRSIT Lite Analysis Tool

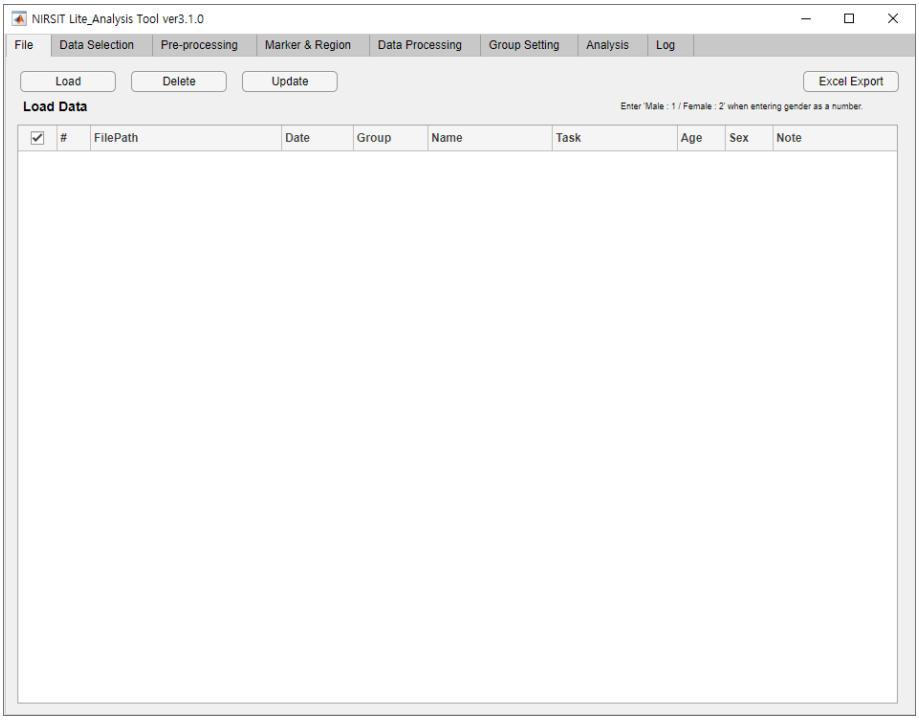
1.3.1 Double click 'NIRSIT_Lite_Analysis_Tool_v3.1.0.exe' icon as shown below



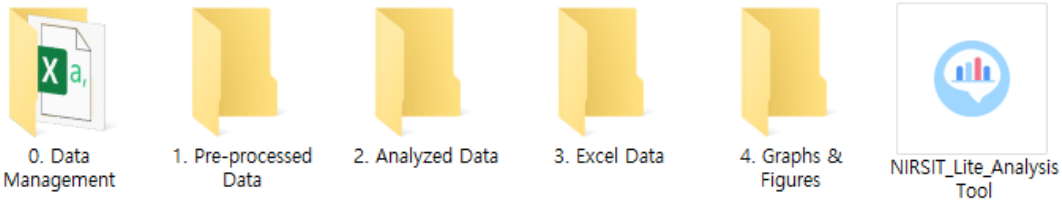
1.3.2 Loading Screen

Please wait for a few minutes after the Loading Screen is turned off. Start Screen will show up momentarily.

1.3.3 Start Screen



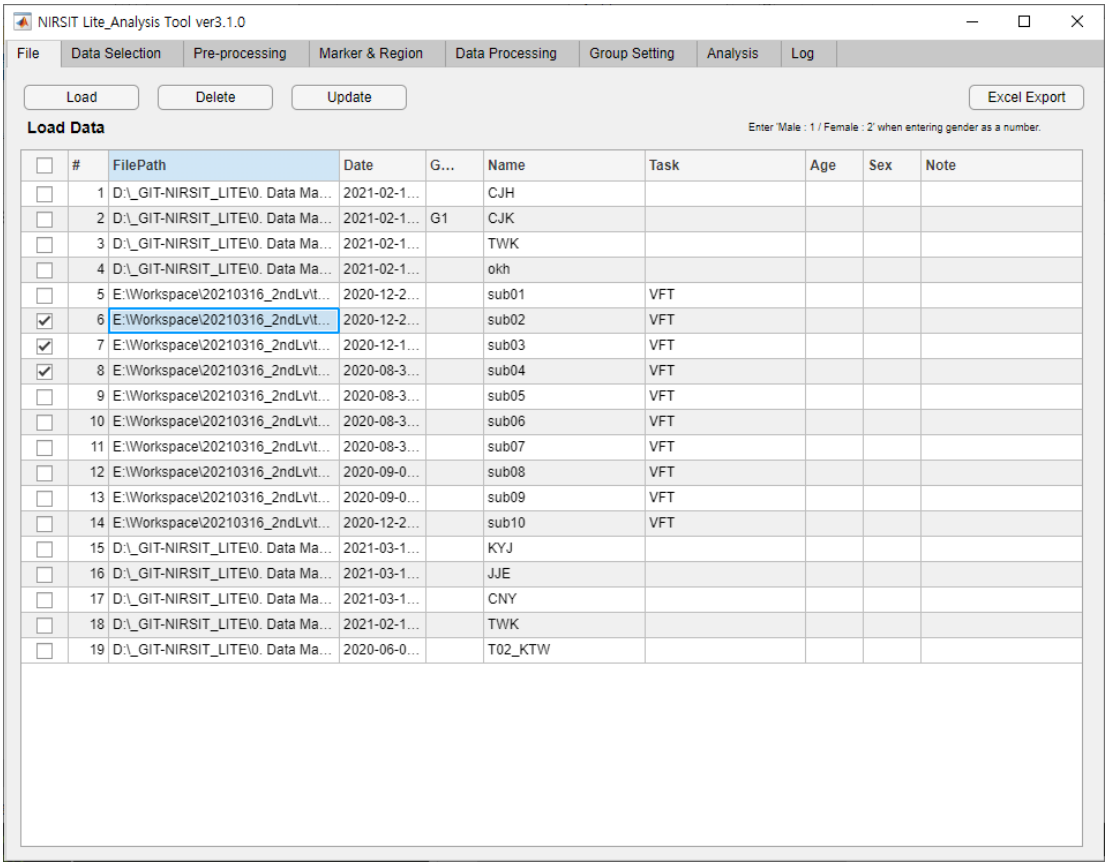
1.3.4 User will find five folders created in the Default Folder



2. Analysis Tool Outline

NIRSIT Lite Analysis Tool is composed of eight (8) Tabs. Each Tab enables User to analyze, save, and handle the measured data easily. Chapter 2 explains how each Tab in the Analysis Tool functions and how it can be used.

2.1 File Tab



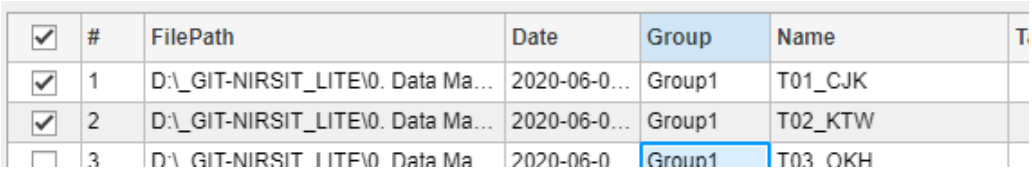
User can utilize File Tab shown above to retrieve data and enter relevant information.

Load Data Table that shows up when User clicks File Tab, is automatically updated via 'load_data_list_csv' in the '0. Data Management' folder, and includes all previously loaded data list.

2.1.1 Adding Data

User can load DB file of the measured data from NIRSIT Lite by clicking **Load** button on the screen. DB file is then converted to mat file in '0. Data Management\Today's Date (ex: 2020_03_21)' folder, so User can retrieve data in mat file format as well. User will need to change the FilePath 'load_data_list.csv' manually if User wants to change the name of '0. Data Management\Today's Date (ex: 2020_03_21)' folder.

2.1.2 Deleting List



	#	FilePath	Date	Group	Name	T
☑	1	D:_GIT-NIRSIT_LITE\0. Data Ma...	2020-06-0...	Group1	T01_CJK	
☑	2	D:_GIT-NIRSIT_LITE\0. Data Ma...	2020-06-0...	Group1	T02_KTW	
☐	3	D:_GIT-NIRSIT_LITE\0. Data Ma	2020-06-0	Group1	T03_OKH	

User can delete certain data by selecting the data to be deleted by clicking Select check box in Load Data Table and clicking **Delete** button.

2.1.3 Updating List

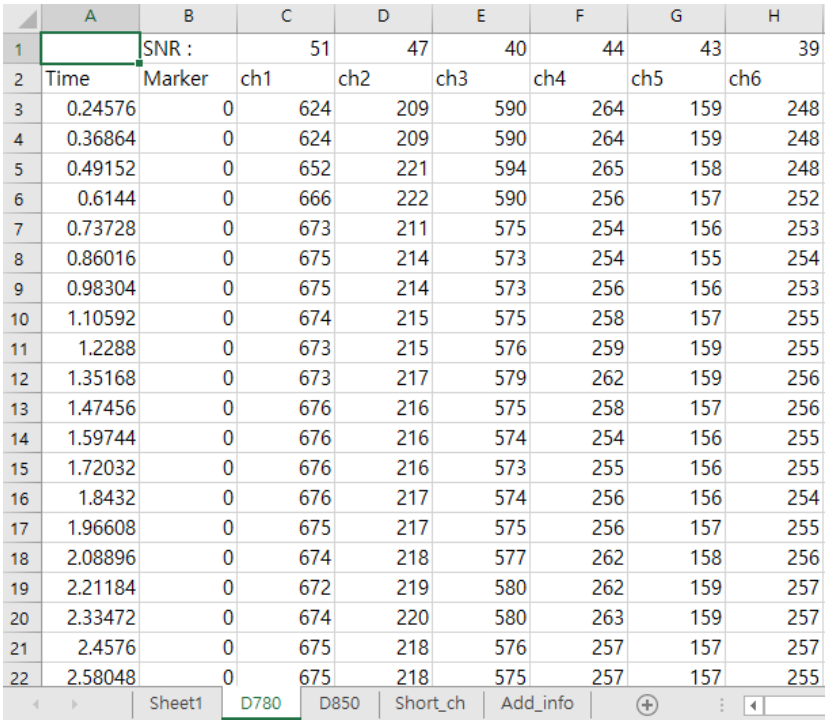
User can enter and update relevant information corresponding to a certain data directly in Load Data Table or revise 'load_data_list.csv' located in '0. Data Management' folder by entering data information and clicking **Update** button.

Take extra care NOT to make any changes to the FilePath.

2.1.4 Extracting Excel Data

User can extract raw data in excel format. Select data from Load Data Table that needs to be extracted and click **Excel Export** button. Given sufficient time, the data will be extracted in excel format and User will find a newly-formed xlsx file with a file name starting with 'Raw_Export' in '3. Excel Data\Today's Date (ex: 2020_03_21)' folder.

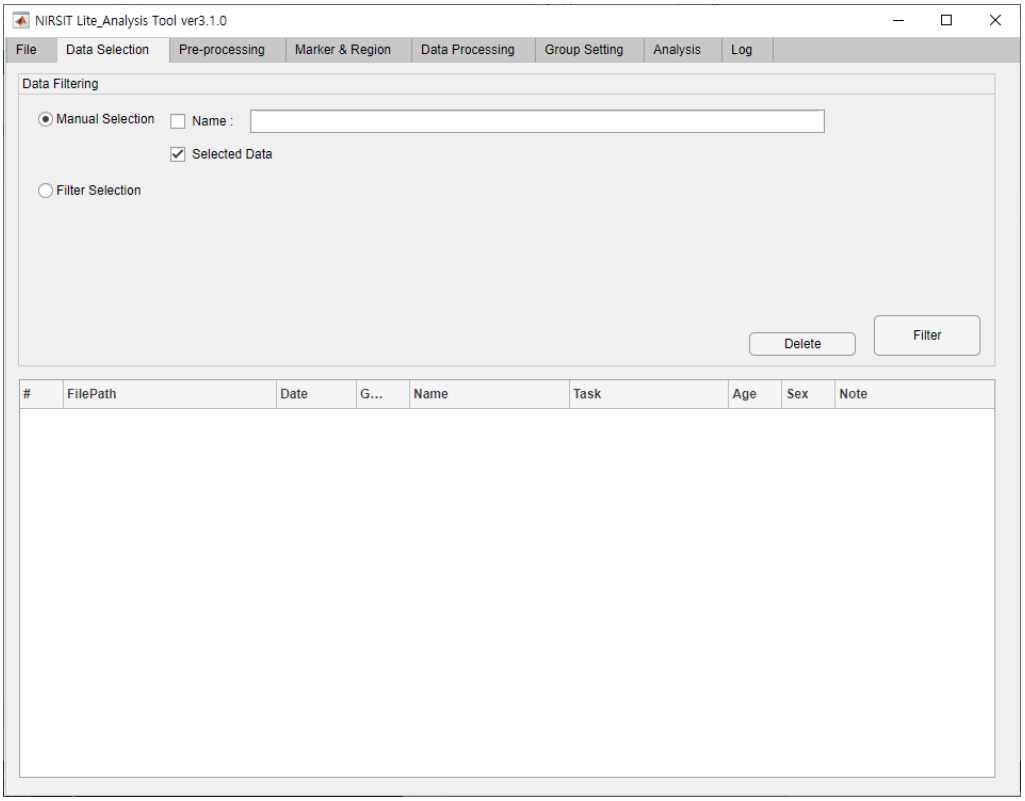
Excel data is saved in multiple sheets, as shown below.



	A	B	C	D	E	F	G	H
1		SNR :	51	47	40	44	43	39
2	Time	Marker	ch1	ch2	ch3	ch4	ch5	ch6
3	0.24576	0	624	209	590	264	159	248
4	0.36864	0	624	209	590	264	159	248
5	0.49152	0	652	221	594	265	158	248
6	0.6144	0	666	222	590	256	157	252
7	0.73728	0	673	211	575	254	156	253
8	0.86016	0	675	214	573	254	155	254
9	0.98304	0	675	214	573	256	156	253
10	1.10592	0	674	215	575	258	157	255
11	1.2288	0	673	215	576	259	159	255
12	1.35168	0	673	217	579	262	159	256
13	1.47456	0	676	216	575	258	157	256
14	1.59744	0	676	216	574	254	156	255
15	1.72032	0	676	216	573	255	156	255
16	1.8432	0	676	217	574	256	156	254
17	1.96608	0	675	217	575	256	157	255
18	2.08896	0	674	218	577	262	158	256
19	2.21184	0	672	219	580	262	159	257
20	2.33472	0	674	220	580	263	159	257
21	2.4576	0	675	218	576	257	157	257
22	2.58048	0	675	218	575	257	157	255

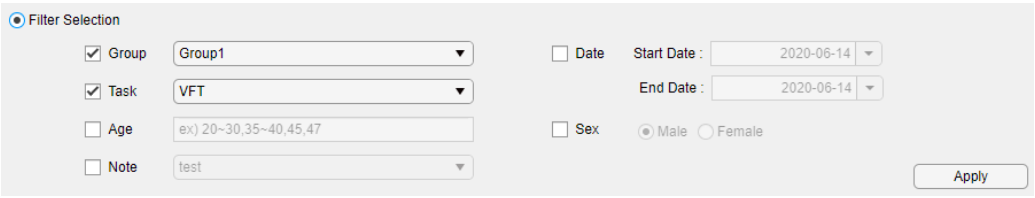
Sheet1 D780 D850 Short_ch Add_info

2.2 Data Selection Tab



This Data Selection Tab shown above allows User to choose and apply different options for analyzing the data set selected among loaded data from File Tab.

2.2.1 Setting Option via Filter Selection



User may filter data by applying multiple options shown on the screen.

Information entered by User previously under File Tab will show up and be updated in Group, Task, and Note box.

- Age: User can enter age information by setting a range (ex: '30~35'), age specific (ex: '31, 33, 35') or both (ex: '30~35, 40').
- Date: Select Start Date and End Date by clicking the desired date shown in the pop-up calendar.

2.2.2 Setting Option via Manual Selection

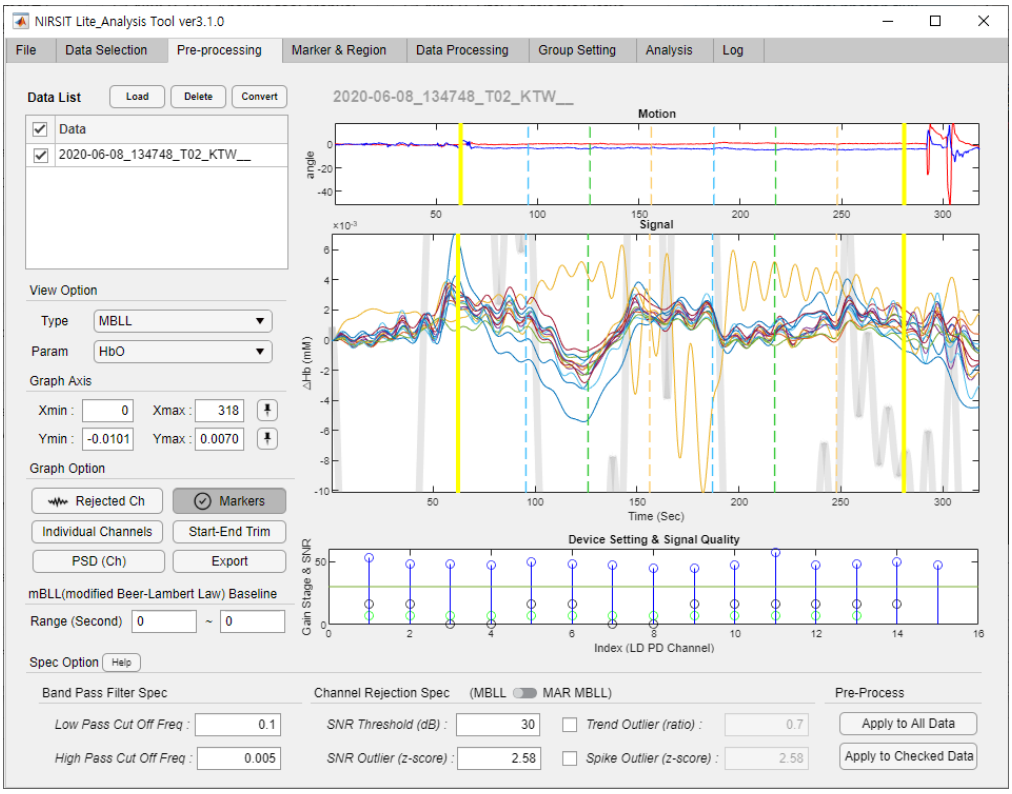
User can utilize this setting when the number of data to be filtered is small.

User can retrieve data by manually entering name of the data User would like to analyze or by clicking **Select** button from File Tab.

2.2.3 Checking Selected Data

User can press **Apply** button and check Selected Data Table. Selected Data will be saved in standard mat format under '1. Pre-processed Data\Today's Date (ex.2020_03_21)' folder. User can modify the file name, but in case of auto save, the selected data will be saved under the file name that includes today's date.

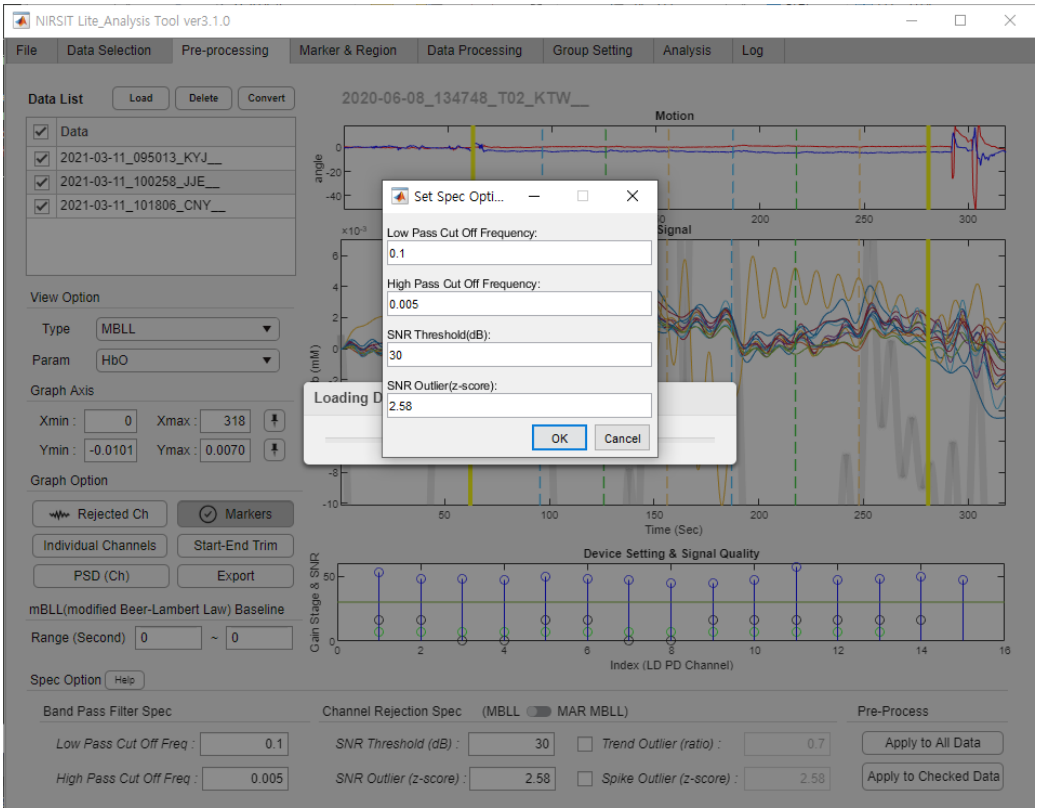
2.3 Pre-Processing Tab



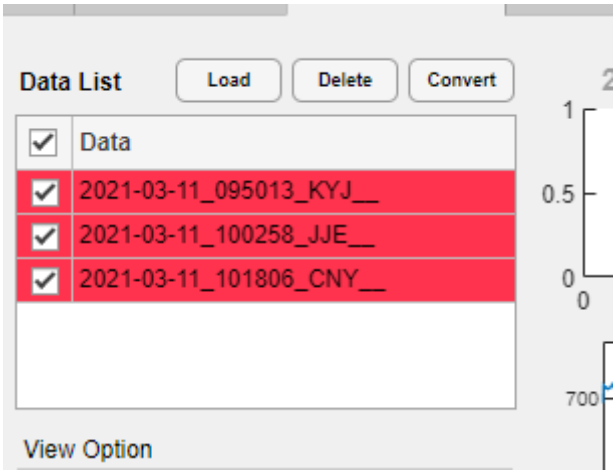
In this Pre-Processing Tab, User can check the status of pre-processed data selected from Data Selection Tab. Loading Pre-Processing Tab requires time, as it calculates and saves each data set in the form of mbll. Please wait until Pre-Processing Tab loading is complete.

For further analysis process, User can check and change the status of each data using this Pre-Processing Tab.

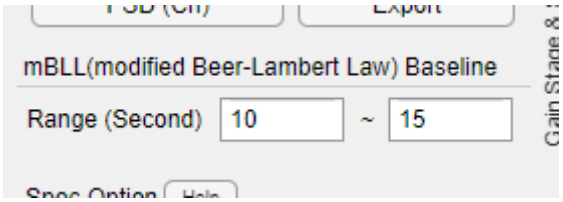
Before entering the Pre-Processing Tab, User can set up Band Pass Filter Spec and Channel Rejection Spec.

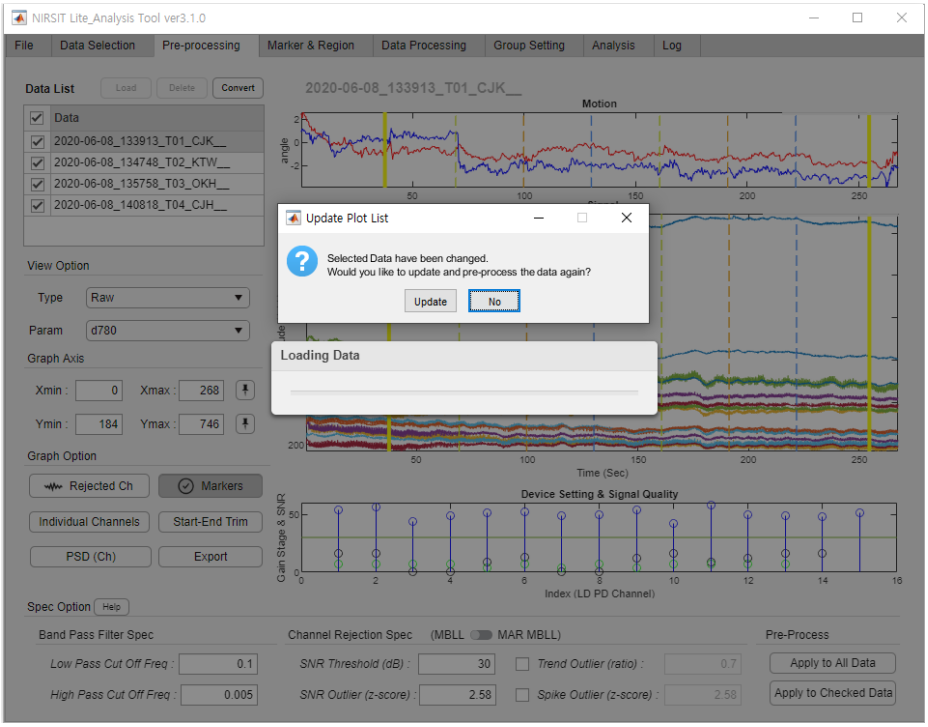


If you didn't proceed pre-processing, data will appear with red background color.



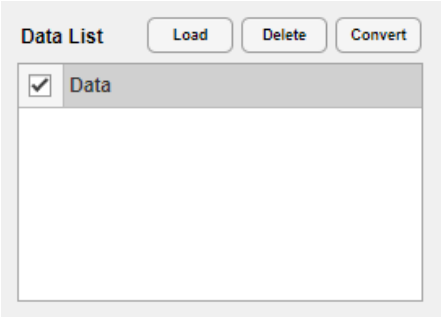
After 'Set Spec Option', you can re-calculate mBLL (modified Beer-Lambert Law) with new baseline (initial photon flux) which has average of the range (default: 10s~15s of your data).





And, if you modified data list in 'Data Selection' tab, 'Pre-processing' tab would ask you to change with the updated data.

Also, if you clear all data in 'Data Selection' tab, data list will be cleared and you can use manual load function in 'Pre-processing' tab.



In this 'Load' button, you can load only pre-processed data which performed this tool.

Wih 'Convert' button, you can convert NIRSIT Lite data into Homer2, NIRS-SPM, and SPM-fNIRS data form.

2.3.1 Data Plot

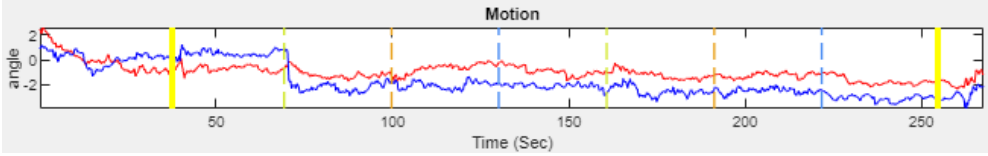
User can plot data by changing Plot List and Option.

Under Plot List, the selected data from Data Selection Tab will show up under list of file names [Measured Date_Name_Task_Group], for example, 2020_06_08_147450_jkc_VFT_Group1.

Under Option, User can select data type from Raw / Filtered Raw / MBLL / MAR_MBLL. User can select parameters from D780 / D850 and HbO / HbR in accordance with the data type selected.

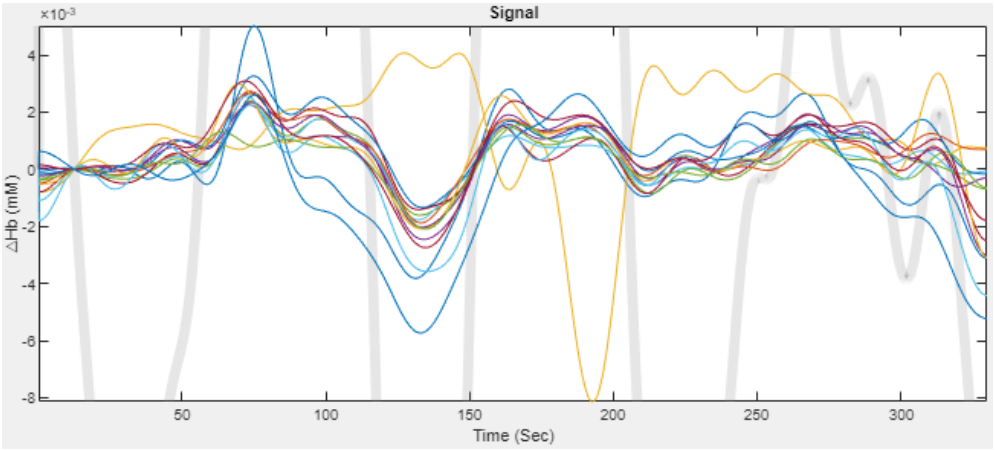
Icons  will show up on the top right corner of the Graph section when User places the mouse on the Graph. User can export the Graph, enlarge or move the Graph by using the icons (henceforth, this applies to all axes).

- Motion Graph



Motion Graph shows movement of the Subject. Red line in the graph indicates movement in the x axis (head movement left and right) and blue line indicates movement in the z axis (head movement up and down).

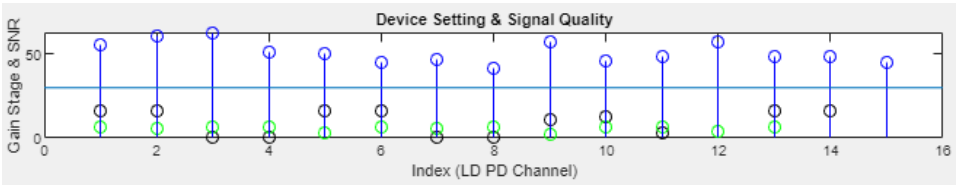
- Signal Graph



Signal Graph section plots Time Series Graph. Rejected channels are shown in bold but light-gray lines.

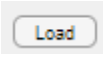
Markers are shown in dotted vertical lines. Markers 100 and 101 are usually assigned to denote Start Task and End Task. Markers 100 and 101 are shown in yellow bold vertical line.

- Device Setting & Signal Quality Graph



Device Setting & Signal Quality Graph section shows the quality of the measured signal by stem plotting. Each color circle has the following meaning: Black circle = ld_gain / Green circle = pd_gain / Red circle = snr_780 / Blue circle = snr_850

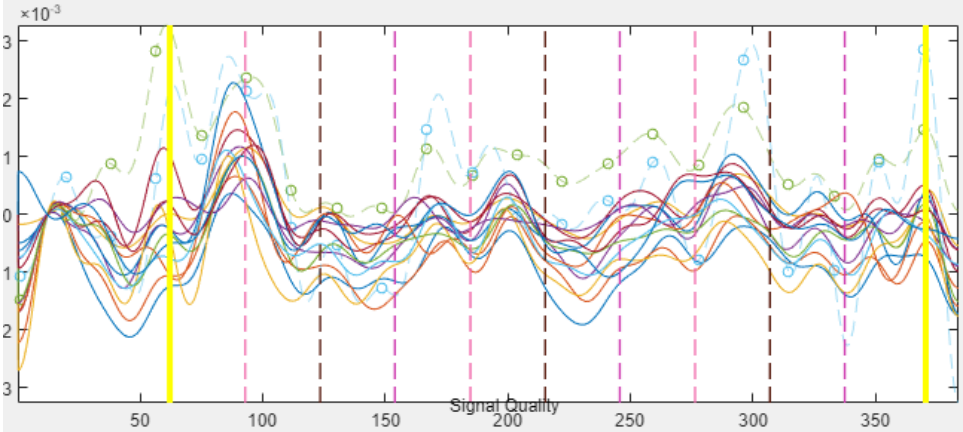
2.3.1.1 Loading Pre-Processed Data

User can load the data in '1. Pre-processed Data\Today's Date (ex.2020_03_21)' folder by clicking 

Load button next to Plot List. If the data was loaded through Data Selection Tab, it cannot be re-loaded. User can import prior data only by restarting the Analysis Tool. All information regarding channel rejections or marker modifications are saved.

2.3.1.2 Rejecting Channels Manually from Graph

User can click each signal graph on Time Series Graph, and such signal will show up as dotted line. User can click again to undo the signal selection in question, or click on multiple signals and make them dotted lines.



When User places the mouse on the graph,  icon will appear on the top right corner. User can click the icon and the dotted line signals will be regarded as rejected channels.

If User wishes to undo the rejection, click and select those rejected channels and click  revert icon.

2.3.1.3 Showing Graph Legend

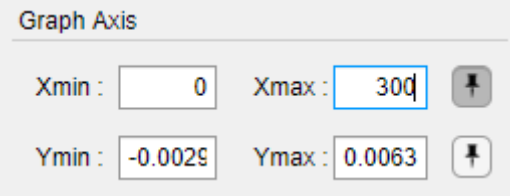
User can see the relevant graph legend for Motion Graph and Device Setting & Signal Quality Graph by placing the mouse on these graphs, at which time  legend icon will appear on top right corner. User can click on the icon to see the legend relevant to the graph.

2.3.2 Graph Option

2.3.2.1 Making Changes in Graph Axis

User can modify or fix the axis of Time Series Graph.

User can click **Push** button () shown on right to fix the axis. User can click the button to apply the fixed axis to multiple data sets. Please refer to the image shown below:



2.3.2.2 Showing Rejected Channel / Marker on Time Series Graph

User can click **Rejected Ch** (

) button to delete and erase Rejected Channels from the graph.

User can click **Markers** (

) button to delete and erase Markers from the graph.

2.3.2.3 Trimming Data

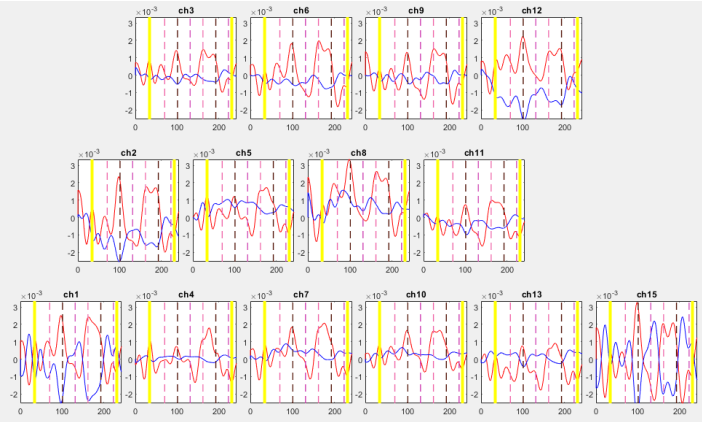
User can click **Start-End Trim** button to cut and trim the data that User wishes to analyze. Trimming can only be performed either at the start of the data or the end of the data, but not on the data in the middle. Once the data is trimmed, MBLL calculation will run again and the relevant MBLL data will be saved.

If the Subject takes off the device NIRSIT Lite during the measurement process before User clicks **Measure Finish**, then most of the channels will be recognized as rejected channels. Therefore, User must trim the end portion of the data to avoid the entire data being recognized as rejected channels, and use the newly trimmed data for analysis.

2.3.2.4 Plotting Region-Specific Channel-Specific Time Series Graph

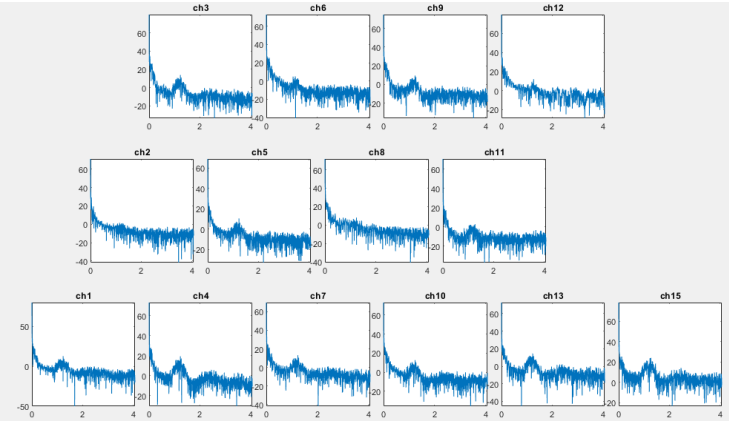
User can use **Individual Channels** button to plot Time Series Graph by region and by channel. In this case, no graph will be plotted in the region where Rejected Channel is located.

Applying the same graph axis, the individual channels are shown by region and by channel, where red line denotes d780 and HbO and blue line denotes d850 and HbR.



2.3.2.5 Power Spectrum Density (PSD) Plot

User can plot regional channel-specific Power Spectrum Density by clicking **PSD (Ch)**.



2.3.3 Extracting Multiple Graph and Excel Data

User can click **Export** button to extract multiple Subjects' data both in the form of graph and excel data simultaneously. User can choose multiple data to be extracted from the window screen as shown below:

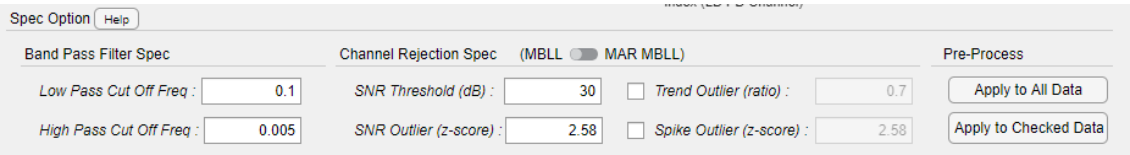
Graph and excel data will be saved automatically in '3. Excel Data\Today's Date (ex.2020_03_21)' folder and '4. Graph & Figure\Today's Date (ex.2020_03_21)' folder, respectively.

Excel data is extracted in the form of a Sheet with the label 'MBLL_Export_' attached in front. Graph is extracted in both Time Series Graph format and regional channel-specific Time Series Graph format. User can directly save other types of graph by clicking button.

2.3.4 Changing Spec Option

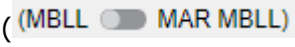
Spec Option value that was entered initially is set as default as shown below. User can change and apply other values in Spec Option. Values in Trend Outlier and Spike Outlier can be set by

clicking the check box next to Trend Outlier and Spike Outlier and clicking **Apply** button. **Help** button allows User to visualize Channel Rejection Spec function.



If User changes each Spec Option and press **Apply to All Data** button, then all data is updated in accordance with the changed Spec Option. If **Apply to Checked Data** button is pushed, selected data in Data List table will be processed.

Channel Rejection Option

0. **Default**: Any channel that contains data that has a negative value, or data that has a value of 0 after MBLL calculation is treated as a rejected channel. MBLL type can be changed using the switch (

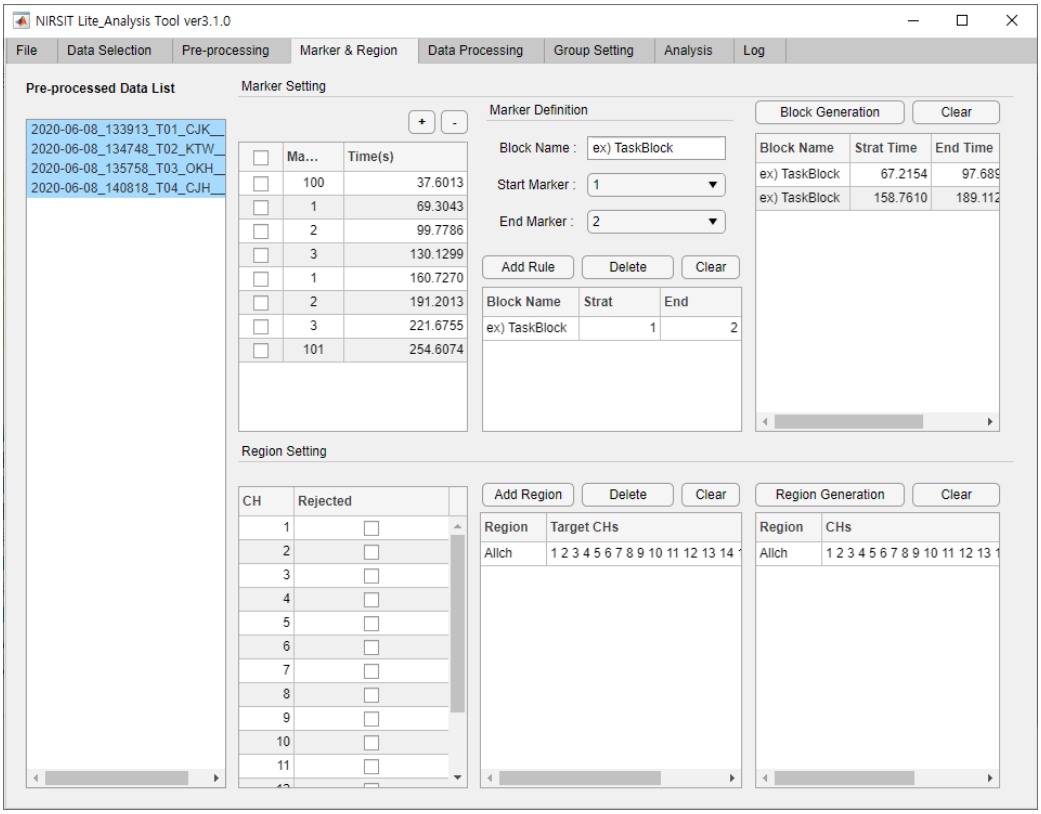
).

1. **SNR Outlier (SNR Thd)**: User can calculate SNR value for channel specific raw data of the entire region within 10 second window size, and search for any Section that has SNR value lower than that of SNR Threshold. The average computed from SNR value of Section in question and SNR value of the entire region is defined as Z-score. If such Z-score is higher than the SNR Outlier (z-score), then it will be treated as a rejected channel. If there are too many sections with low SNR value, the analysis tool will delete this individual channel.

2. **Trend Outlier**: The analysis tool calculates the time periods where an individual channel MBLL data has a higher deviation value than 2 sigmas as compared to the average value. Any channel that has a longer time period than the value set in Trend Outlier (ratio) is treated as a rejected channel.

3. **Spike Outlier**: The analysis tool calculates the z-score from the average value obtained from MBLL data. If an individual channel has a z-score that is higher than Spike Outlier (z-score), then the channel will be treated as a rejected channel.

2.4 Marker & Region Tab



2.4.1 Marker Setting

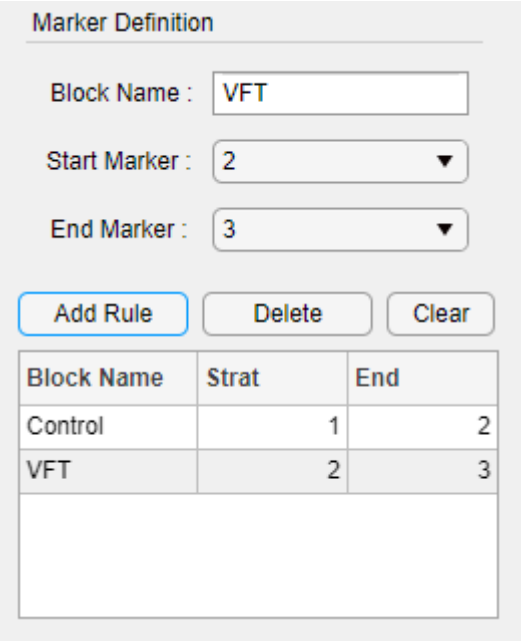
User can create Blocks by using the Markers. User can set Block sections in the selected data by defining Markers and pressing **Block Generation** button.

2.4.1.1 Marker Modification

User can redefine Markers by changing, deleting, or adding Marker setting. User can select a Marker to be deleted by clicking the Check box and clicking  button. User can add a Marker by clicking  button. A new row will be created on top of the Marker list, where you can input a new Marker. When applied, it will be reshuffled to correspond to the time order.

2.4.1.2 Marker Definition

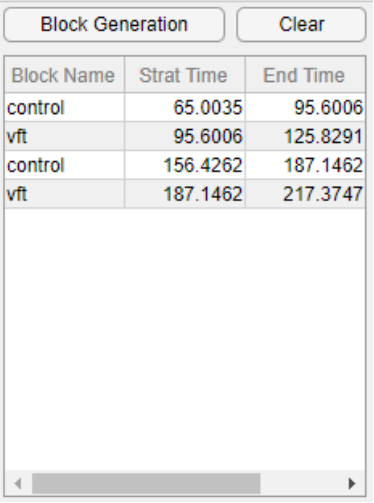
User can define Marker by setting Block Name, Start Time, and End Time. Press **Add Rule** button after setting is complete. If any of the settings have been put in incorrectly, User can re-define the rule by clicking **Clear** or **Delete** button and deleting the incorrect definition.



User must check to make sure the markers are put in appropriately when adding a rule. Please note that if multiple markers are selected, only the data marker that was first selected will be applied and shown.

2.4.1.3 Block Generation

User can create Block in accordance with the previously set rule by clicking **Block Generation** button. Please make sure the Start Time and End Time Markers have been set up in accordance with the rule. If it has been set incorrectly, press **Clear** button, adjust the rule, and create Block again.



2.4.2 Region Setting

User can check rejected channels in a data and select the region that User would like to analyze. User must set up the Region Setting in order to proceed to the next analysis process.

2.4.2.1 Adding Region

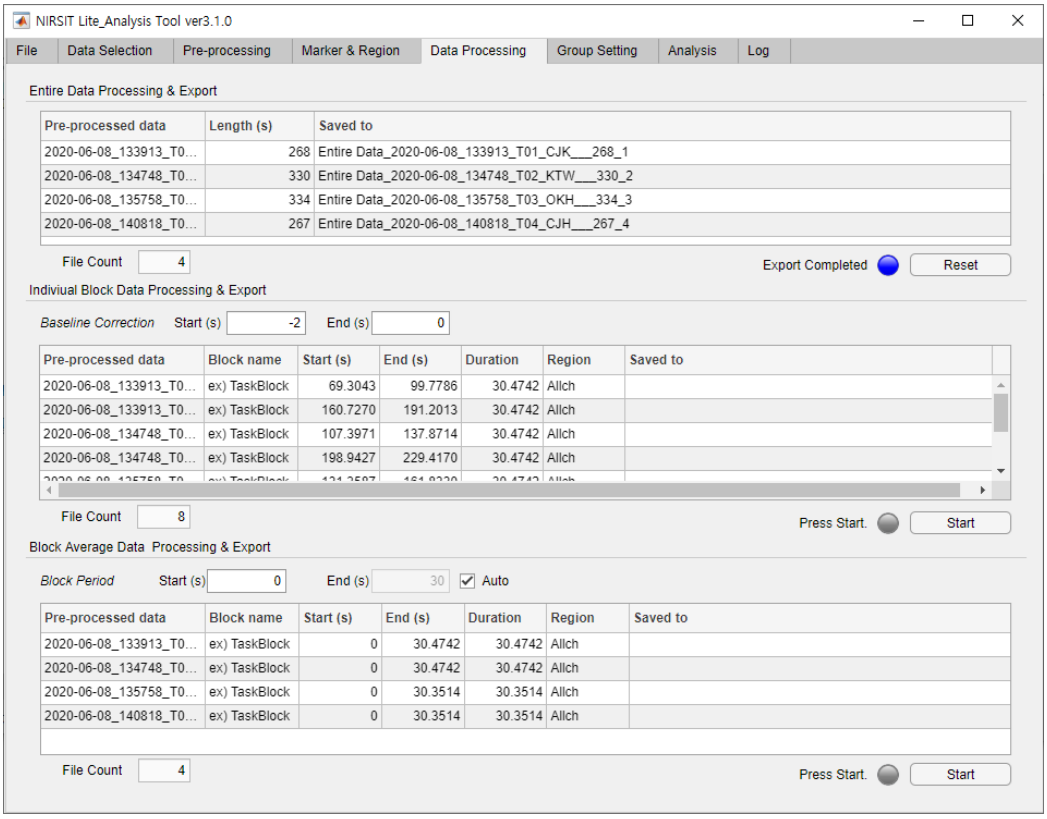
User can add a data region by clicking **Add Region** button. User can use a default region setting, which is All-channel. Otherwise, User can select either Right-channel or Left-channel, or customize the setting to create a region.

- Right-ch: Channels from 1 to 7 corresponding to right hemisphere
- Left-ch: Channels from 9 to 15 corresponding to left hemisphere

2.4.2.2 Generating Region

User can click **Region Generation** button and the screen will show the channel numbers from the data, that are enabled in accordance with the rule already set up and applied, without the rejected channels.

2.5 Data Processing Tab



Data Processing Tab shows the data format that can be extracted based on the Block and Region set up in the Block Setting Tab.

Unless Block and Region is specifically set by User, entire data will be extracted.

Clicking **Start** button will allow the data to be saved in accordance with the previously set up values and the data will be calculated along with the connectivity and GLM that would be used in Plot.

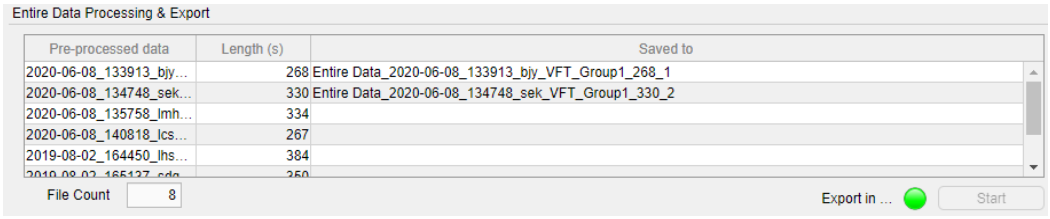
The data will be saved in '2. Analyzed Data\Today's Date (ex.2020_03_21)' folder and the data will be extracted and be used in Group Setting Tab and Analysis Tab.

User can confirm the number of data extracted from this process.

2.5.1 Entire Data Processing & Export

User can save the data chosen from Data Selection Tab in Entire Data form (Entire Data Processing).

Clicking **Start** button will enable save process and the saved data will be updated under the file names as shown below under the column labeled 'Saved To'.



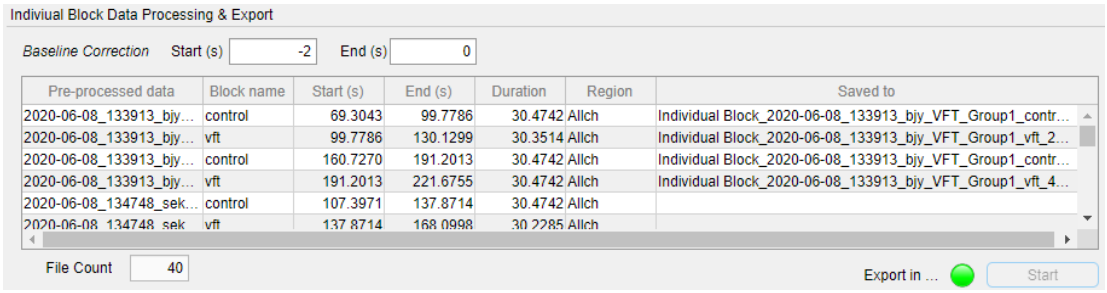
Once the exporting and saving process is complete, the blue light (Export Complete) will show up.

2.5.2 Individual Block Data Processing & Export

User can save each Block by cutting the Block as set up by Marker & Region Tab.

Baseline correction is implemented before every Block begins, and the default value is the average value calculated during the two (2) seconds prior to Block Start Time.

User can start the data saving process by clicking **Start** button and the same will be saved under the column labeled 'Saved To'.



Once saving process is complete, the blue light (Export Complete) will show up.

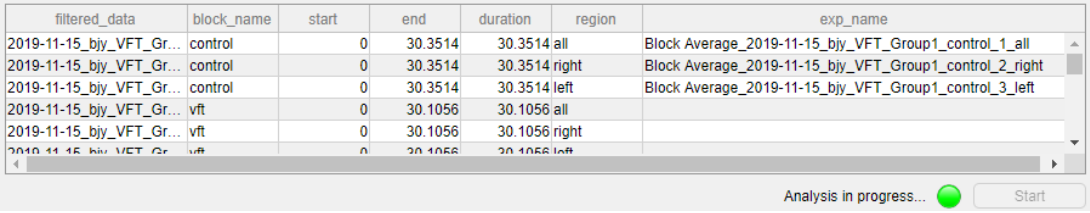
2.5.3 Block Average Data Processing & Export

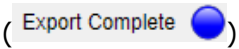
User can average and save multiple data which have same Block name and same Region.

User cannot average multiple data if the data time durations vary. Therefore, User should set up Block Period in order to utilize Block Average Data Processing and Export. Clicking **Auto**

button will enable trimming and averaging multiple data to align with the shortest data out of all applicable multiple data. Please note that User may disable **Auto** check and set up Block Period manually, but this can cause unintended error if any of the applicable data has insufficient data length.

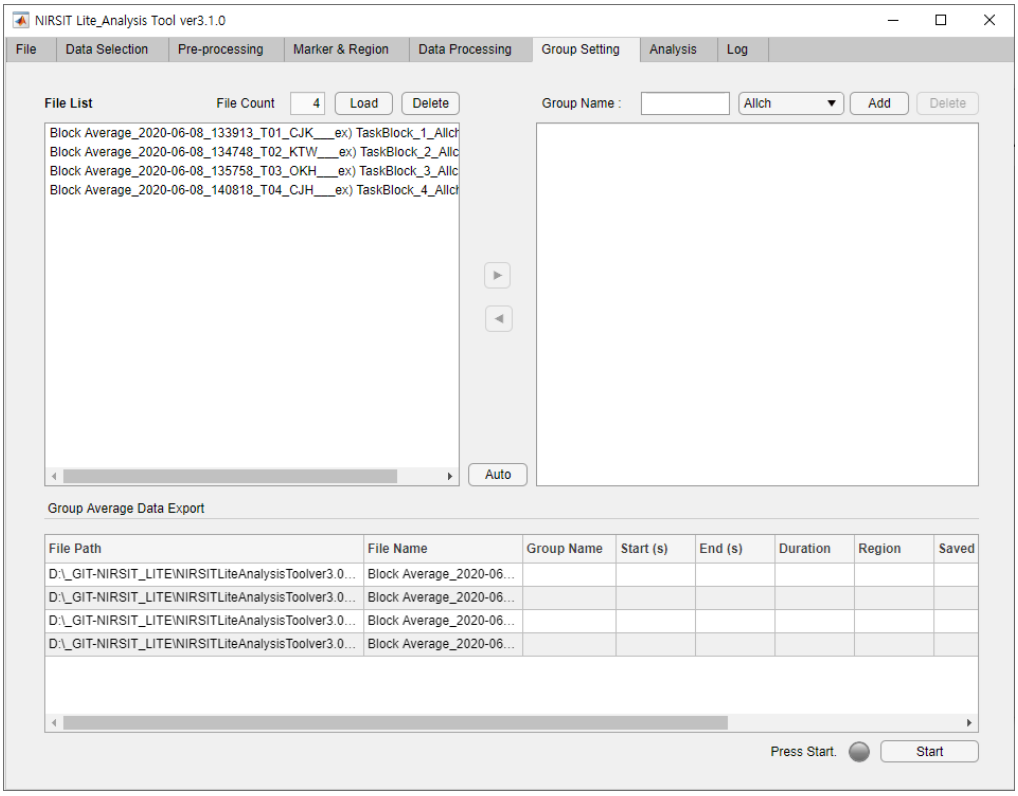
User can save the Block Average Data by clicking **Start** button, and the saved name will show in the column labeled 'Saved To'.



Once saving process is complete, the blue light (

) will show up.

2.6 Group Setting Tab



User can group multiple data and average them.

Group Data is created by utilizing Individual Block Data and Block Average Data saved in '2. Analysis Data' folder.

Therefore, if User uploads a new Analysis Tool, User can create Group Data by extracting the data that was used previously from Group Setting Tab.

2.6.1 Loading File List

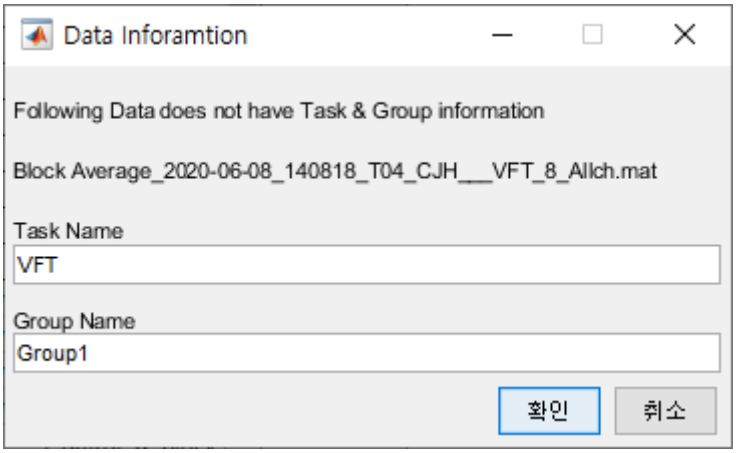
User can import data saved in '2. Analyzed Data' folder by clicking **Load** button. User can import data whose name starts with 'Individual Block_' or 'Block Average_'.

User can see the loaded data, along with the location of the file in the Table below.

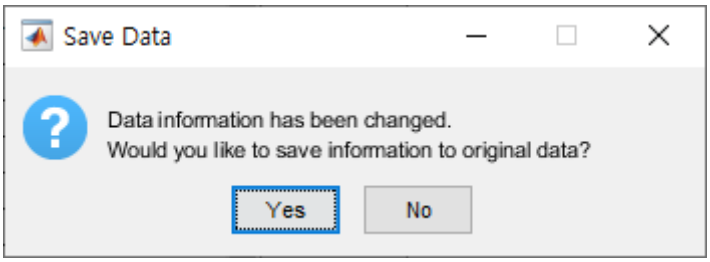
User can delete the data from the list by clicking **Delete** button.

2.6.2 Creating Group Using Auto

User can create Group automatically by selecting Individual Block Data and Block Average Data. But if the task or group are undefined, user should input the information.



And when the information changes, the user has to decide to overwrite the data.

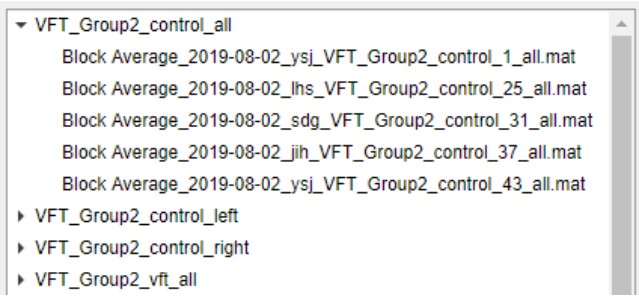


Loaded data will be recognized by its name, and will be grouped automatically under Task, Group, Block, and Region. They will appear in the right side of the Tree window.

Simultaneously, the designated Group Name will appear in the Table ('Group Name' column) as shown below.

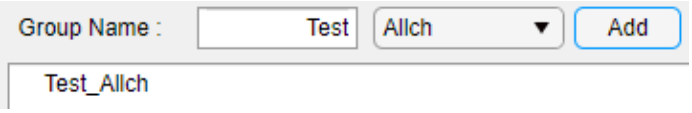
File Path	File Name	Group Name	Start (s)	End (s)	Duration	Region
D:\OBELA...	Block Average_2020-06-...	VFT_Grou...	0	30	30	Allch
D:\OBELA...	Block Average_2020-06-...	VFT_Grou...	0	30	30	Allch
D:\OBELA...	Block Average_2020-06-...	VFT_Grou...	0	30	30	Allch

By clicking ▶ in the Tree window, User can check the names of each data file grouped under a specific Group Name.

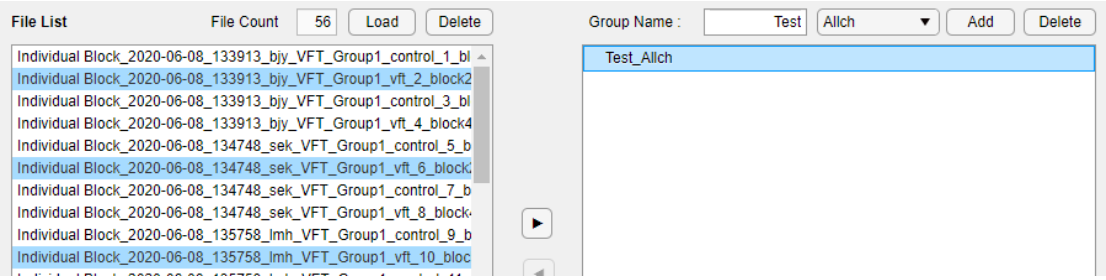


2.6.3 User Directly Creating Group Name

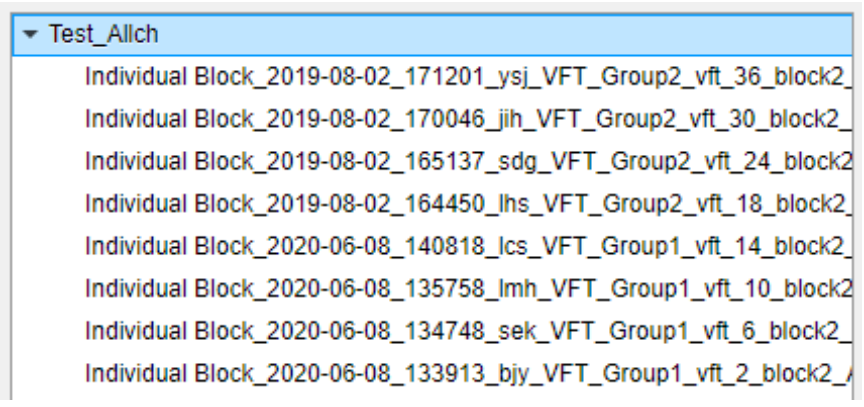
1. User can enter Group Name and press **Add** button to create a new Group.



2. From the left-side Data List window, User can select the data files that User would like to add to the Group Name, and from the right-side Tree window, User can select the Group Name under which User would like to add the data files.



3. User can click  button in the middle to add the selected data files into the Group Name. User can check and confirm whether the seleted data files have been added into the Group Name correctly.



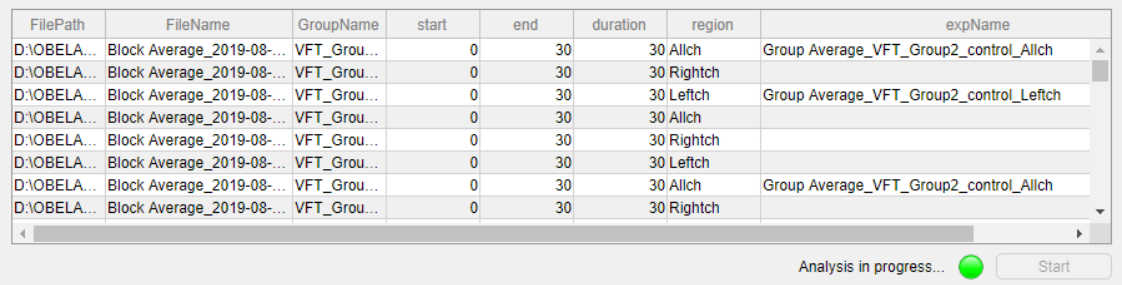
4. If User wishes to use Tree Window to delete the data files that have already been added into the Group Name, User can select those data files and click  in the middle and send them out into the Data List window.

5. If User wishes to delete the Group Name altogether, select the Group Name and click **Delete** button for deletion. Data files selected will be moved to the Data List window automatically.

2.6.4 Group Average Data Export

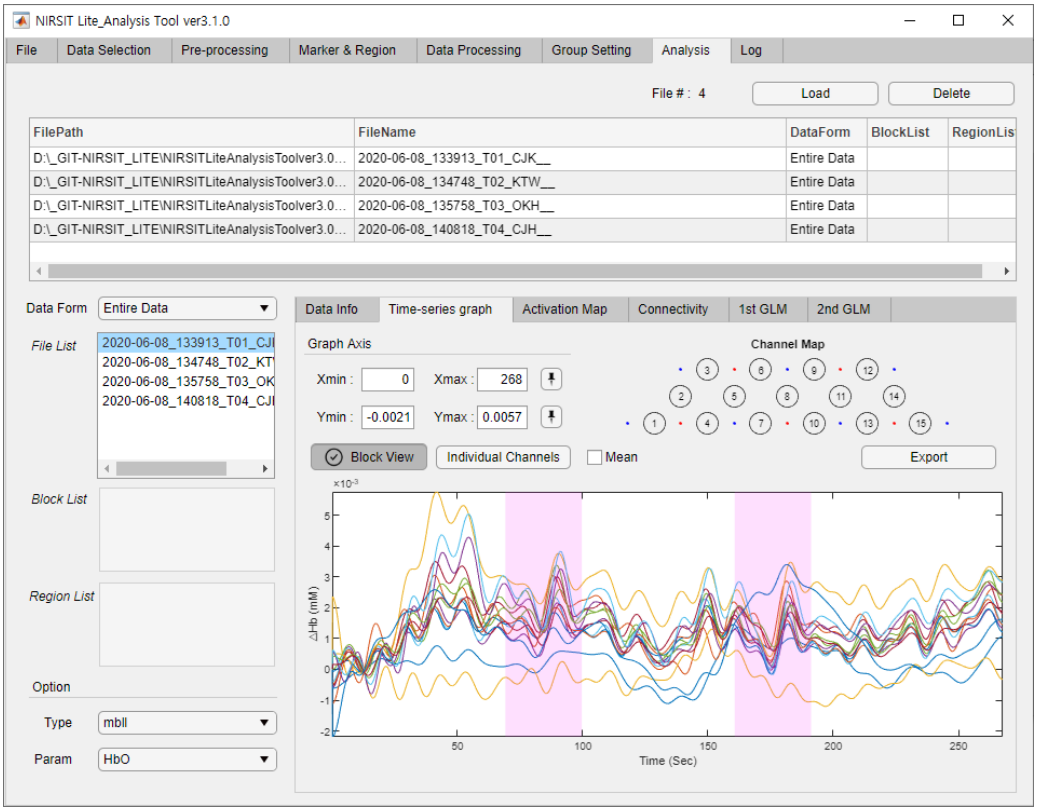
Group Average Data Export allows the User to average and save each data under the Group Name.

User can start the saving process by clicking **Start** button. It will be saved in '2. Analyzed Data\Today's Date (ex.2020_03_21)' folder. The saved data will show up under the column labeled 'Saved To'.



Once saving process is complete, the blue light (Export Complete) will show up.

2.7 Analysis Tab



User can retrieve saved data in '2. Analyzed Data' folder and plot them in various ways.

As with Group Setting Tab, User can plot and save previously extracted data from Analysis Tab even after a new analysis tool has been loaded.

2.7.1 Loading Data

User can retrieve saved data from '2. Analyzed Data' folder by clicking **Load** button. Loaded data will be recognized by its name, and will be shown in Table format under Data Form, Group, Block, and Region.

User can create a Select window by arranging each option in the Table. User can select the data of one's choice and plot the same in a convenient manner.

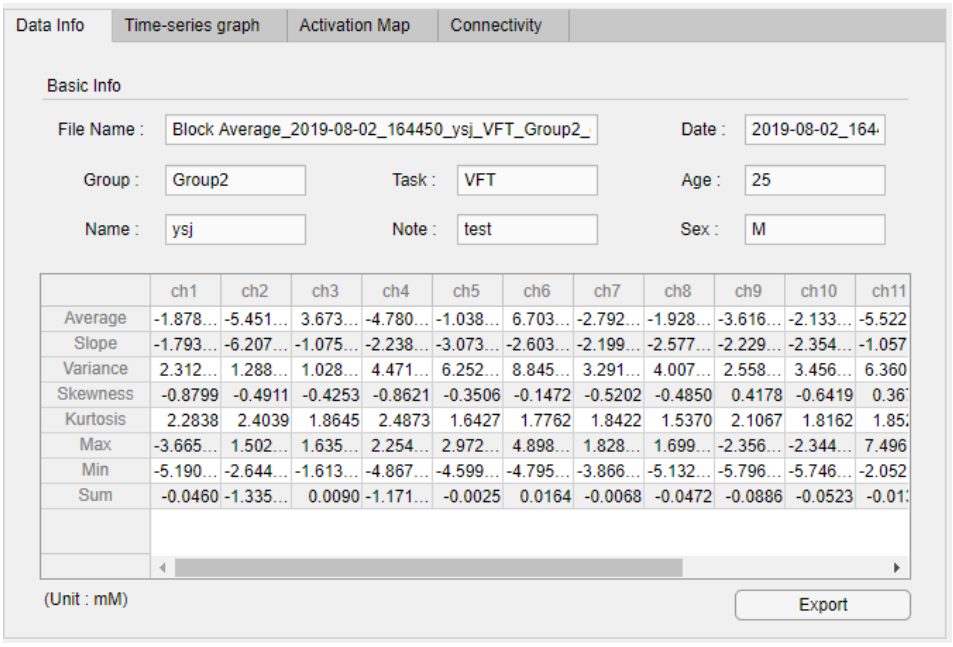
List activation pattern changes in accordance with the Data Form. In case of Entire Data, User can only choose data from File List. In case of Individual Block and Group Average Data, User can choose data from File List and Region List. In case of Block Average Data, User can access data from updated Block List as well.

Under Option, User can choose a Type from MBLL / MAR_MBLL and choose from Parameter HbO / HbR relevant to the chosen Type.

2.7.2 Data Info Tab

Data Info Tab shows information regarding the selected data. It includes not only basic information regarding the data set up in File Tab but it also includes calculated data, such as Average, Slope, Variance, Skewness, Kurtosis, Max, Min, Sum values.

- Data Info Tab does not provide any value in the case of Entire Data.



2.7.2.1 Export

User can select **Export** and the data in Data Form in question are shown in the File List. User can select all data to be extracted and click **OK** button. This will allow values to be extracted in excel format under '3. Excel Data\Today's Date (ex.2020_03_21)' folder automatically.

Selected Data Form and Block, Region use names such as 'Data Info_Block Average_control_all.xlsx'. 'mbll_HbO' is differentiated by the sheet name.

In the case of Rejected Channel, it is extracted as a blank.

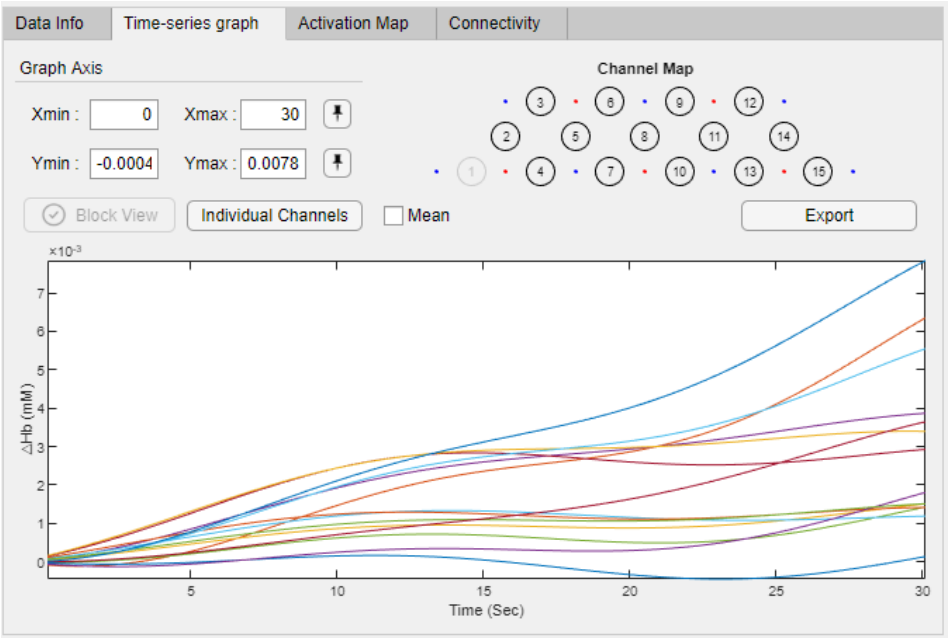
filename	date	group	name	task	age	sex	note						
Block Ave	2020-06-0	group_2	T03_OKH	VFT			테스트						
	1	2	3	4	5	6	7	8	9	10	11	12	
avg	0.001129	0.002112	-0.00057	0.000731	0.000881	0.000611	0.000873	0.00087	0.000735	0.001708	0.001173	0.000759	0.001
slope	1.24E-05	2.56E-05	-1.1E-05	7.57E-06	4.45E-06	5.27E-06	7.63E-06	9.47E-06	2.26E-06	1.46E-05	7.76E-06	3.1E-06	1.09E
variance	8.86E-07	3.37E-06	6.78E-07	2.93E-07	1.13E-07	1.42E-07	2.96E-07	4.61E-07	6.08E-08	1.1E-06	3.18E-07	6.84E-08	6.2E
skewness	0.910716	0.215404	-0.06594	0.208924	-0.83874	0.279989	0.019127	0.334134	-0.40159	-0.12099	-0.56337	-0.97897	-0.06
kurtosis	2.510366	1.536413	1.279785	1.609014	2.891058	1.965467	1.564034	1.723862	3.417541	1.521192	2.054946	3.620325	1.457
max	0.003245	0.005097	0.000461	0.001581	0.001348	0.001307	0.001631	0.002073	0.001274	0.003053	0.001874	0.001204	0.002
min	3.25E-05	-0.00011	-0.00161	4.83E-06	6.19E-05	2.18E-05	2.76E-05	2.37E-06	8.02E-05	4.56E-05	4E-05	5.62E-05	2.99E
sum	0.276598	0.517516	-0.13848	0.179021	0.215813	0.149663	0.213789	0.213042	0.18007	0.418512	0.28749	0.185933	0.297

filename	date	group	name	task	age	sex	note						
Block Ave	2020-06-0	group_2	T04_CJH	VFT			테스트						
	1	2	3	4	5	6	7	8	9	10	11	12	
avg		0.002349	0.00083	0.002288	0.000559	0.00101	0.002218	-1E-04	0.001066	0.002454	0.000391	0.000947	0.002
slope		2.42E-05	4.24E-06	1.54E-05	3.69E-06	3.06E-06	8.73E-06	-1.6E-06	3.36E-06	1.18E-05	5.68E-06	4.62E-06	2.09E
variance		3.06E-06	1.1E-07	1.25E-06	9.98E-08	1.1E-07	6.17E-07	4.03E-08	1E-07	8.51E-07	2.12E-07	1.29E-07	2.24E
skewness		0.387452	-0.56867	-0.53443	0.241126	-1.43201	-1.36707	-0.47036	-1.56772	-1.11489	1.363787	-0.92317	-0.00
kurtosis		2.377109	3.099944	2.098348	3.36577	3.908663	3.476866	1.895003	4.463698	2.961258	4.325195	3.059491	2.172
max		0.006352	0.001507	0.003865	0.001423	0.001329	0.002924	0.000162	0.001409	0.003397	0.001804	0.001508	0.005
min		-0.00012	4.69E-05	6.16E-05	-1.7E-05	7.77E-05	0.000141	-0.00045	0.000108	0.000157	-0.00013	6.02E-05	1.53E
sum		0.575551	0.203451	0.560615	0.136884	0.247416	0.543291	-0.02443	0.261228	0.601341	0.095807	0.232108	0.628

Sheet1 mbll_HbO

2.7.3 Time-series Graph Tab

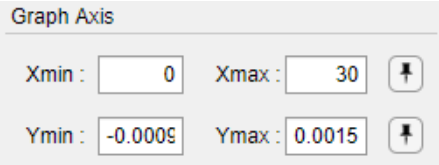
Time-Series Graph Tab shows Time-Series Graph of the selected data.



2.7.3.1 Changing Graph Axis

User can change or fix each axis.

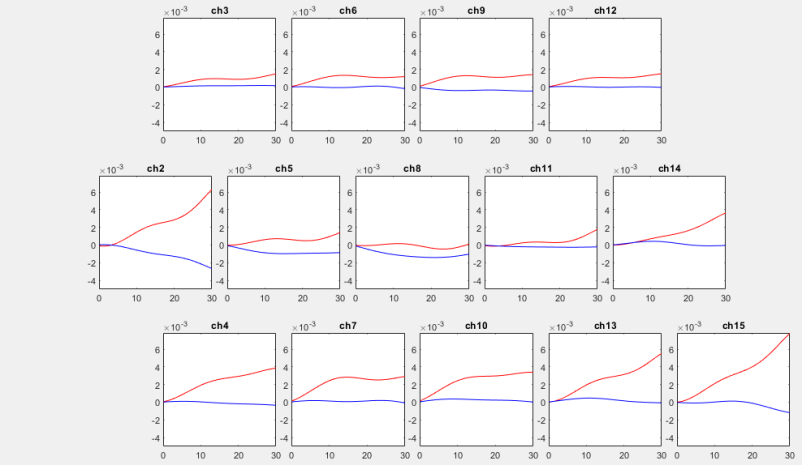
User can fix the axis by pressing button on the right. User can use the button to fix the axis of multiple data.



2.7.3.2 Time Series Graph Plot by Channel Region

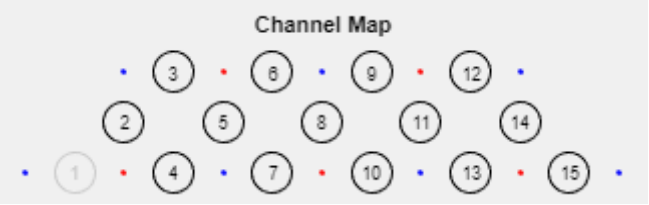
User can extract Time-Series Graph by channel location using **Individual Channels** button.

No plotting is available for the rejected channel location. HbO is shown in red line and HbR is shown in blue line in accordance with the fixed graph axis.



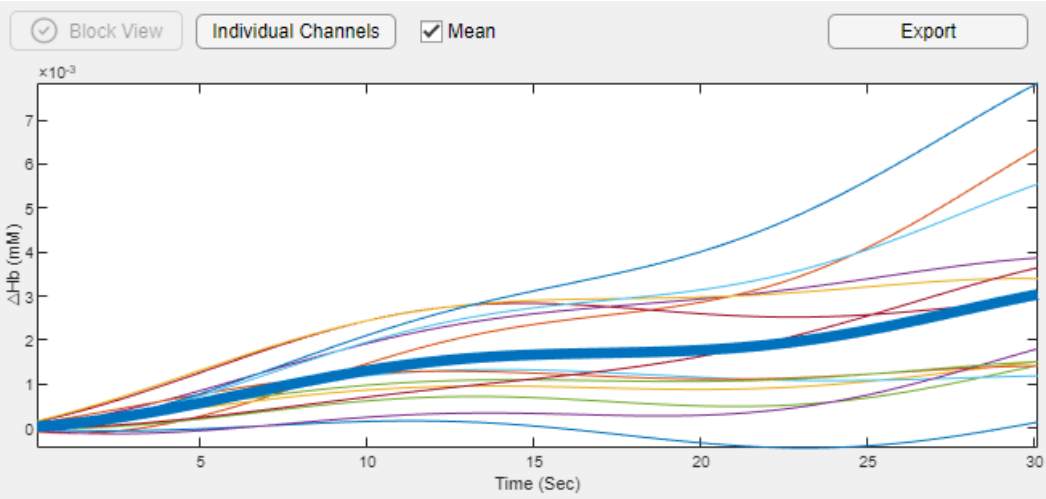
2.7.3.3 Checking Rejected Channel Location

Information on rejected channel can be seen on the right side which is indicated in light gray, as shown below.



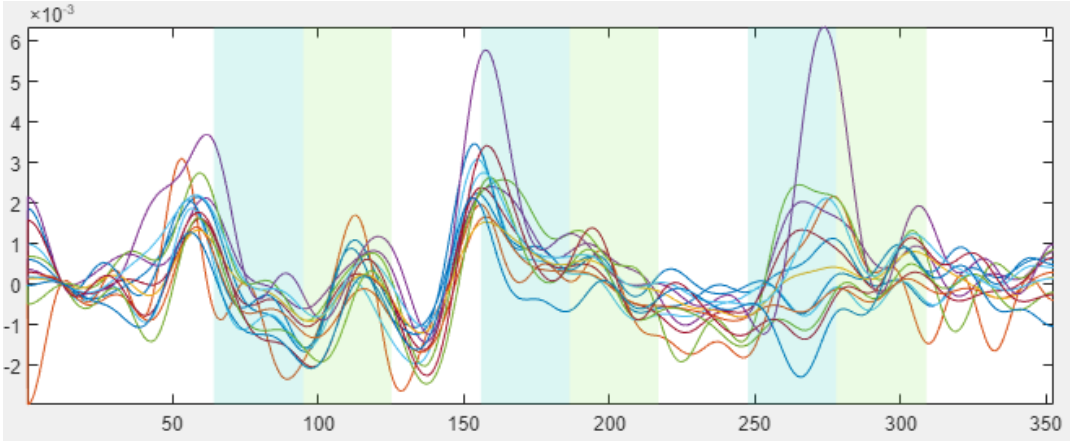
2.7.3.4 Displaying Average Line

By checking the box next to Mean, User can display an Average Line based on the average value of all individual channels. The Average Line is displayed in bold line in randomly chosen color.



2.7.3.5 Displaying Block View

User can display Block sections in Export Data. User can turn on or turn off **Block View** button. When turned on, the sections with same Block name will show up in same background color. The background color changes randomly when the Analysis Tool is reloaded. User can change the background color by placing the mouse on the graph and clicking button.

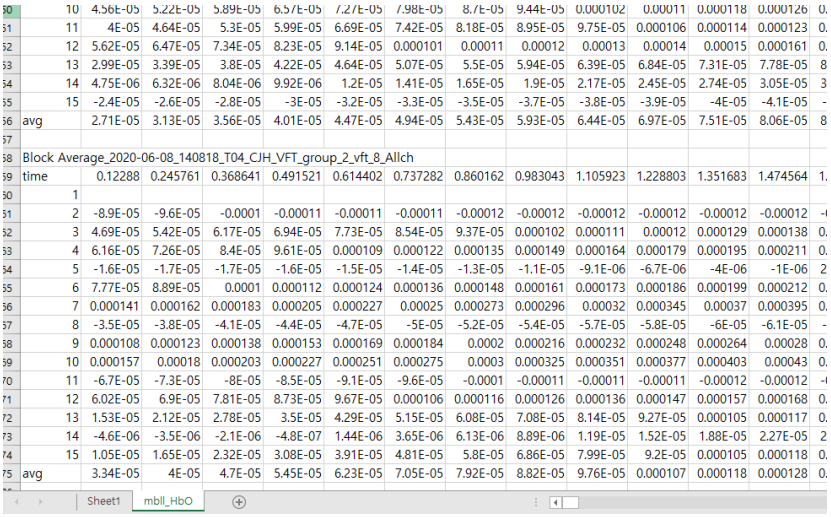


2.7.3.6 Export

User can extract graph and excel data of several Subjects using **Export.** Graph and excel data are saved automatically in '3. Excel Data\Today's Date (ex.2020_03_21)' folder and '4. Graphs & Figures\Today's Date (ex.2020_03_21)' folder, respectively.

Selected Data Form and Block, Region from the excel data export use names such as 'Time Series Data_*Block Average_control_all*.xlsx'. 'mbll_HbO' is differentiated by the sheet name. User can find the data from multiple Subjects organized sequentially in one sheet.

Column(s) corresponding to data from Rejected Channel(s) are shown as blank, and the Average value is shown in the last row



60	10	4.56E-05	5.22E-05	5.89E-05	6.57E-05	7.27E-05	7.98E-05	8.7E-05	9.44E-05	0.000102	0.00011	0.000118	0.000126	0.
61	11	4E-05	4.64E-05	5.3E-05	5.99E-05	6.69E-05	7.42E-05	8.18E-05	8.95E-05	9.75E-05	0.000106	0.000114	0.000123	0.
62	12	5.62E-05	6.47E-05	7.34E-05	8.23E-05	9.14E-05	0.000101	0.00011	0.00012	0.00013	0.00014	0.00015	0.000161	0.
63	13	2.99E-05	3.39E-05	3.8E-05	4.22E-05	4.64E-05	5.07E-05	5.5E-05	5.94E-05	6.39E-05	6.84E-05	7.31E-05	7.78E-05	8
64	14	4.75E-06	6.32E-06	8.04E-06	9.92E-06	1.2E-05	1.41E-05	1.65E-05	1.9E-05	2.17E-05	2.45E-05	2.74E-05	3.05E-05	3
65	15	-2.4E-05	-2.6E-05	-2.8E-05	-3E-05	-3.2E-05	-3.3E-05	-3.5E-05	-3.7E-05	-3.8E-05	-3.9E-05	-4E-05	-4.1E-05	-
66	avg	2.71E-05	3.13E-05	3.56E-05	4.01E-05	4.47E-05	4.94E-05	5.43E-05	5.93E-05	6.44E-05	6.97E-05	7.51E-05	8.06E-05	8
67														
68	Block Average_2020-06-08_140818_T04_CJH_VFT_group_2_vft_8_Allch													
69	time	0.12288	0.245761	0.368641	0.491521	0.614402	0.737282	0.860162	0.983043	1.105923	1.228803	1.351683	1.474564	1.
70	1													
71	2	-8.9E-05	-9.6E-05	-0.0001	-0.00011	-0.00011	-0.00011	-0.00012	-0.00012	-0.00012	-0.00012	-0.00012	-0.00012	-(
72	3	4.69E-05	5.42E-05	6.17E-05	6.94E-05	7.73E-05	8.54E-05	9.37E-05	0.000102	0.000111	0.00012	0.000129	0.000138	0.
73	4	6.16E-05	7.26E-05	8.4E-05	9.61E-05	0.000109	0.000122	0.000135	0.000149	0.000164	0.000179	0.000195	0.000211	0.
74	5	-1.6E-05	-1.7E-05	-1.7E-05	-1.6E-05	-1.5E-05	-1.4E-05	-1.3E-05	-1.1E-05	-9.1E-06	-6.7E-06	-4E-06	-1E-06	2
75	6	7.77E-05	8.89E-05	0.0001	0.000112	0.000124	0.000136	0.000148	0.000161	0.000173	0.000186	0.000199	0.000212	0.
76	7	0.000141	0.000162	0.000183	0.000205	0.000227	0.00025	0.000273	0.000296	0.00032	0.000345	0.00037	0.000395	0.
77	8	-3.5E-05	-3.8E-05	-4.1E-05	-4.4E-05	-4.7E-05	-5E-05	-5.2E-05	-5.4E-05	-5.7E-05	-5.8E-05	-6E-05	-6.1E-05	-
78	9	0.000108	0.000123	0.000138	0.000153	0.000169	0.000184	0.0002	0.000216	0.000232	0.000248	0.000264	0.00028	0.
79	10	0.000157	0.00018	0.000203	0.000227	0.000251	0.000275	0.0003	0.000325	0.000351	0.000377	0.000403	0.00043	0.
80	11	-6.7E-05	-7.3E-05	-8E-05	-8.5E-05	-9.1E-05	-9.6E-05	-0.0001	-0.00011	-0.00011	-0.00011	-0.00012	-0.00012	-(
81	12	6.02E-05	6.9E-05	7.81E-05	8.73E-05	9.67E-05	0.000106	0.000116	0.000126	0.000136	0.000147	0.000157	0.000168	0.
82	13	1.53E-05	2.12E-05	2.78E-05	3.5E-05	4.29E-05	5.15E-05	6.08E-05	7.08E-05	8.14E-05	9.27E-05	0.000105	0.000117	0.
83	14	-4.6E-06	-3.5E-06	-2.1E-06	-4.8E-07	1.44E-06	3.65E-06	6.13E-06	8.89E-06	1.19E-05	1.52E-05	1.88E-05	2.27E-05	2
84	15	1.05E-05	1.65E-05	2.32E-05	3.08E-05	3.91E-05	4.81E-05	5.8E-05	6.86E-05	7.99E-05	9.2E-05	0.000105	0.000118	0.
85	avg	3.34E-05	4E-05	4.7E-05	5.45E-05	6.23E-05	7.05E-05	7.92E-05	8.82E-05	9.76E-05	0.000107	0.000118	0.000128	0.

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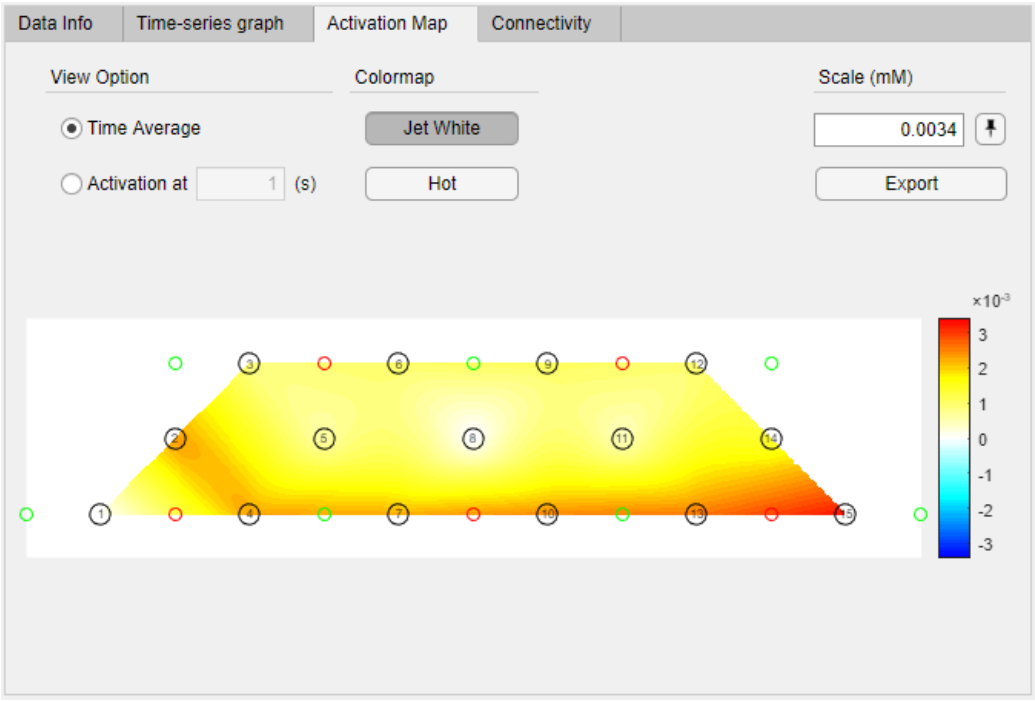
In case of graph, it is saved under the existing file name, with 'Time Series (Ch) Graph' pre-fixed to the existing name.

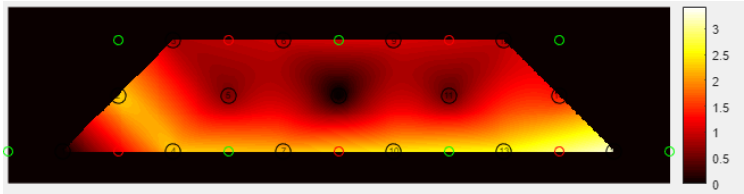
2.7.4 Activation Map Tab

Activation Map Tab shows the Activation Map of the selected data.



2.7.4.1 Creating Color Map

User can select from either **Jet White** or **Hot** when creating Color Map. In case of **Jet White**, Color Map shows (Blue-White-Red) indicating both positive value and negative value. In case of **Hot**, Color Map shows (Black-Red-White) indicating only the positive value.



Color Map max value can be changed or fixed by automatic updating Scale entry.

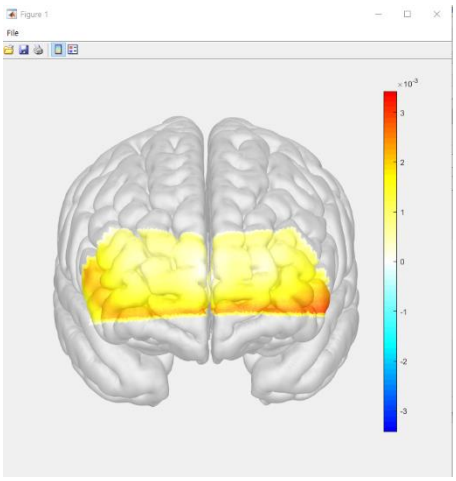
User can fix the Color Map max value by pressing button on the right. User can use the button to fix the Color Map max of multiple data.

2.7.4.2 Changing View Option

User can create Activation Map by averaging the data within the entire time duration section OR by selecting value applicable to one single time spot. When selecting a single time spot, make sure to check the length of the data.

2.7.4.3 Extracting 3D Brain Mapping

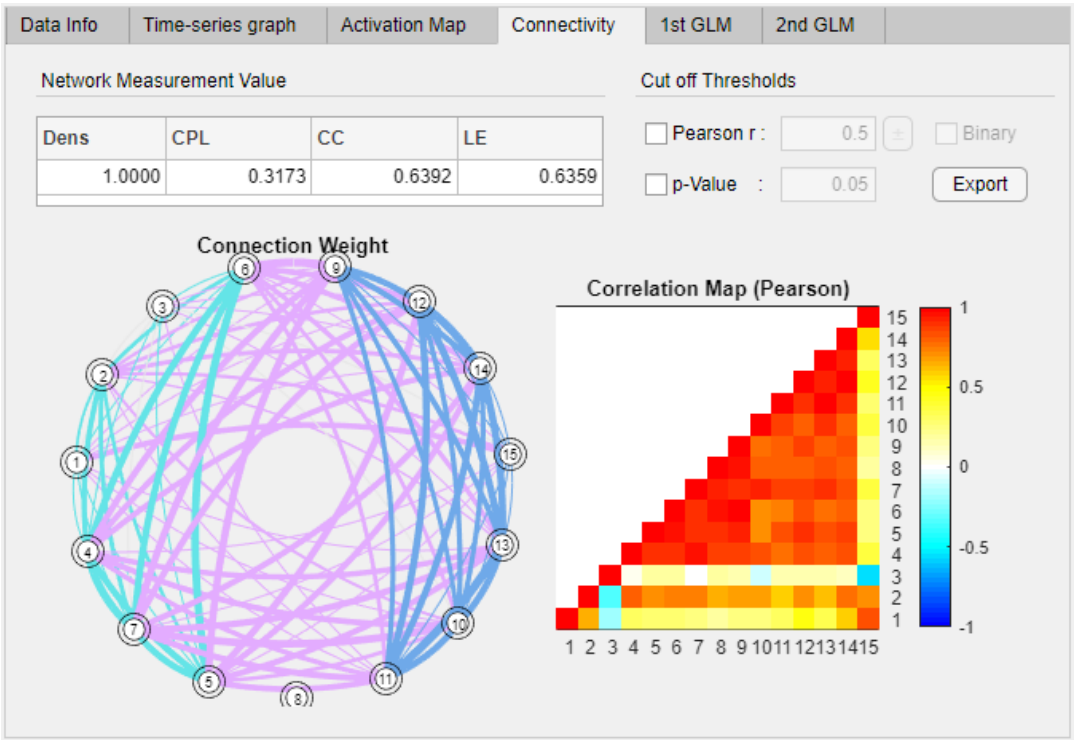
User can place the mouse on Activation Map graph, at which time 3D icon will appear. Click icon, and the brain image will be extracted in accordance with the color map that has the same view option and scale. Place the mouse again on the image and click to move the brain image in 3D format.



2.7.4.4 Export

User can apply **Export** to extract Activation Map of data from multiple Subjects simultaneously. The data is saved in '4. Graphs & Figures\Today's Date (ex.2020_03_21)' folder with 'Activation Map 2D_' or 'Activation Map 3D_' prefixed to the preexisting file name.

2.7.5 Connectivity Tab



Connectivity Tab shows Connectivity of the selected data.

You can find more details of Graph Theory analysis below paper.

Ref: Rubinov M, Sporns O. Complex network measures of brain connectivity: uses and interpretations. Neuroimage. 2010 Sep;52(3):1059-1069

Network Measurement Value

Dens (Density): Density is the fraction of present connections to possible connections.

CPL (Characteristic Path Length): The characteristic path length is the average shortest path length in the network.

CC (Clustering Coefficient): The clustering coefficient is the fraction of triangles around a node and is equivalent to the fraction of node's neighbors that are neighbors of each other.

LE (Local Efficiency): The local efficiency is the global efficiency (see below) computed on node neighborhoods, and is related to the clustering coefficient.

2.7.5.1 Changing Threshold

User can change the value of Threshold after clicking the check box next to Threshold. Network Measure Value and the relevant image is updated in accordance with the Threshold.

Features extracted from Connectivity are Density, Characteristic Path Length, Clustering Coefficient, and Local Efficiency values that are cut in accordance with the Threshold.

And with ± button, user can select positive and negative of the thresholding value. If user typed '0' in threshold value, it shows all the positive/negative value.

2.7.5.2 Connection Weight Image and Correlation Map

Connectivity among individual channels from selected data can be shown in two (2) kinds of images.

In case of Connection Weight, if the connectivity is stronger between two channels, it is shown in red bold line, so that User can determine the condition of the connections at a glance.

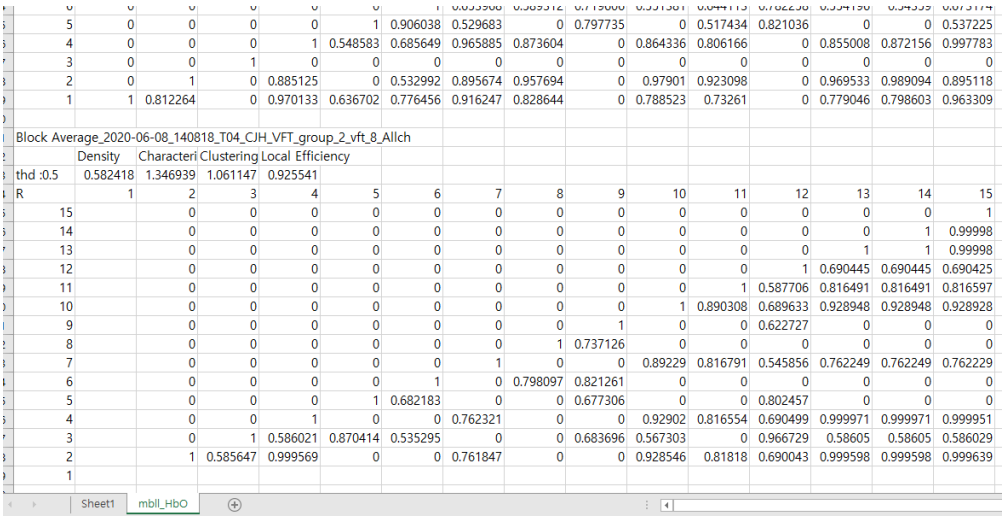
In case of Correlation Map, if the connectivity is stronger between two channels, pixel region corresponding to each channel is shown in red. Rejected channel does not have an index, so that corresponding location (row/column) is shown in white color.

If User clicked the check box next to Threshold, all pixels. whose value is less than the Threshold, is shown in white. If User clicked the check box next to Binary, the value is shown either in 0 or 1, and in white or black only on the Correlation Map.

2.7.5.3 Export

User can extract graph and excel data of several Subjects using **Export.** Graph and excel data are saved automatically in '3. Excel Data\Today's Date (ex.2020_03_21)' folder and '4. Graphs & Figures\Today's Date (ex.2020_03_21)' folder, respectively.

Selected Data Form and Block, Region from the excel data export use names such as 'Connectivity Data_*Block Average_control_all*.xlsx'. 'mbll_HbO' is differentiated by the sheet name. Network Measure Value and Correlation Map data (R) are extracted in accordance with the cut off Threshold. User can see that data from multiple Subjects are organized sequentially in one sheet.



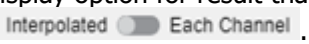
5	0	0	0	0	1	0.906038	0.529683	0	0.797735	0	0.517434	0.821036	0	0	0.537225
4	0	0	0	1	0.548583	0.685649	0.965885	0.873604	0	0.864336	0.806166	0	0.855008	0.872156	0.997783
3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
2	0	1	0	0.885125	0	0.532992	0.895674	0.957694	0	0.97901	0.923098	0	0.969533	0.989094	0.895118
1	1	0.812264	0	0.970133	0.636702	0.776456	0.916247	0.828644	0	0.788523	0.73261	0	0.779046	0.798603	0.963309

Block Average_2020-06-08_140818_T04_CJH_VFT_group_2_vft_8_Allch															
	Density	Characteri	Clustering	Local Efficiency											
thd :0.5	0.582418	1.346939	1.061147	0.925541											
R	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
15		0	0	0	0	0	0	0	0	0	0	0	0	0	1
14		0	0	0	0	0	0	0	0	0	0	0	0	1	0.99998
13		0	0	0	0	0	0	0	0	0	0	0	1	1	0.99998
12		0	0	0	0	0	0	0	0	0	0	1	0.690445	0.690445	0.690425
11		0	0	0	0	0	0	0	0	0	1	0.587706	0.816491	0.816491	0.816597
10		0	0	0	0	0	0	0	0	1	0.890308	0.689633	0.928948	0.928948	0.928928
9		0	0	0	0	0	0	0	1	0	0	0.622727	0	0	0
8		0	0	0	0	0	0	1	0.737126	0	0	0	0	0	0
7		0	0	0	0	0	1	0	0	0.89229	0.816791	0.545856	0.762249	0.762249	0.762229
6		0	0	0	0	1	0	0.798097	0.821261	0	0	0	0	0	0
5		0	0	0	1	0.682183	0	0	0.677306	0	0	0.802457	0	0	0
4		0	0	1	0	0	0.762321	0	0	0.92902	0.816554	0.690499	0.999971	0.999971	0.999951
3		0	1	0.586021	0.870414	0.535295	0	0	0.683696	0.567303	0	0.966729	0.58605	0.58605	0.586029
2		1	0.585647	0.999569	0	0	0.761847	0	0	0.928546	0.81818	0.690043	0.999598	0.999598	0.999639
1															

Sheet1 mbll_HbO

In case of graph, it is saved under the existing file name, with 'Connectivity_' pre-fixed to the existing name. Connection Weight and Correlation Map are extracted for each data set.

2.7.6 1st GLM Tab

User can select only Entire Data when using 1st GLM Tab. It receives contrast vector from the selected data to show GLM result. And with 'FPC (False Positive Correction)' option, p-value can be corrected. Also, user can select display option for result that interpolated or individual channel T/cB map with switching button 

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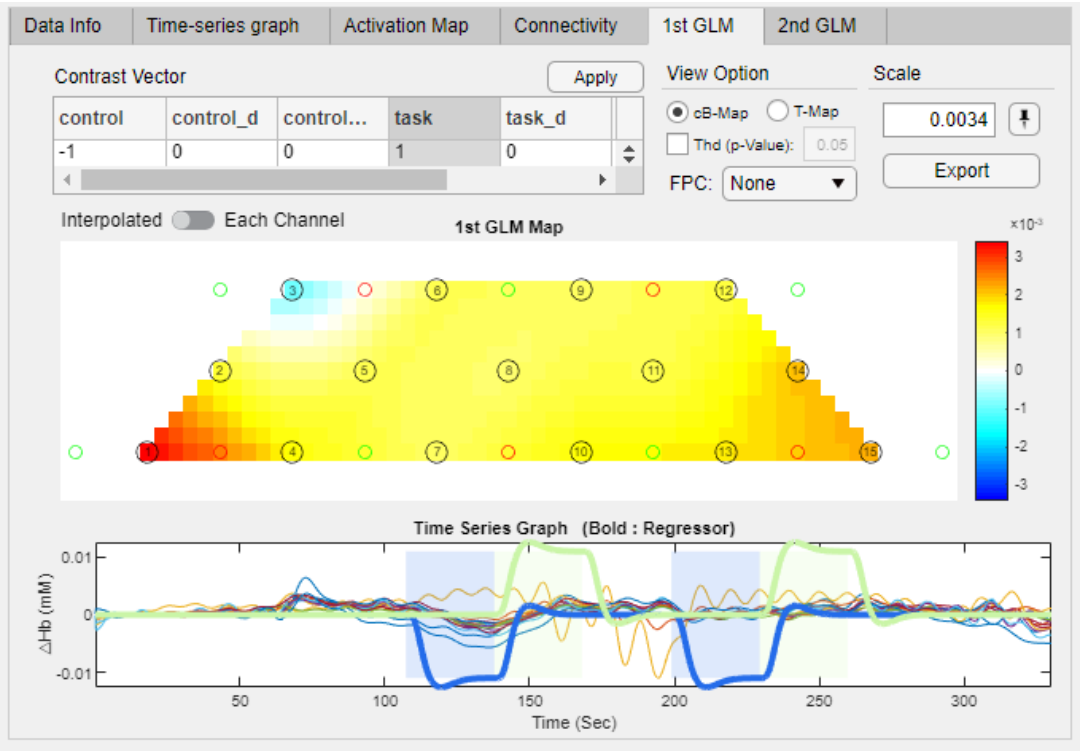
For more details about GLM, please refer to the online resource "Human Brain Function" with a link below.

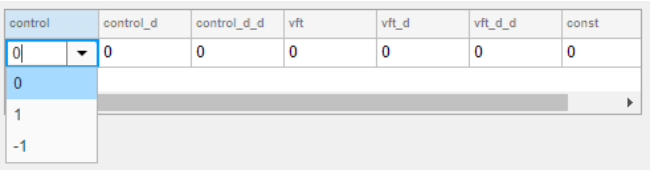
(https://www.fil.ion.ucl.ac.uk/spm/doc/books/hbf2/)

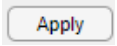
The result is updated and saved in data.



2.7.6.1 Applying Contrast Vector

A Table can be formed for each Block Name. Such Table is used to input Contrast Vector. '_d' denotes deriv. All of the value is initially set up as 0. Therefore, User must change the input value as deemed appropriate. Values (0, 1, -1) will show up when User double clicks the column. User can choose from values (0, 1, -1).

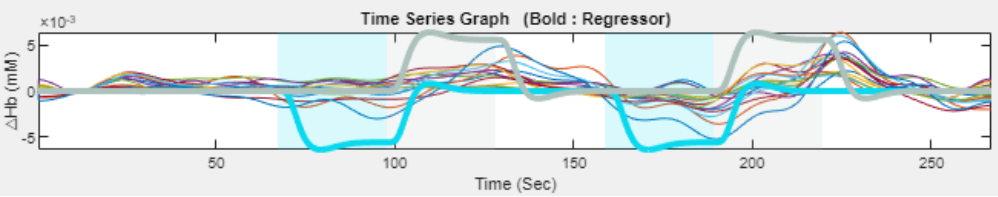


User can click 

Apply button to plot GLM result from all data sets on File List in accordance with the Contrast Vector input.

2.7.6.2 Regressor Graph

Regressor input in Time Series Graph is shown on the same graph. Regressor is normalized by the data's maximum value, and is shown in bold line in the same color as the background color of the Block. If User wishes to change the background color of the Block, place the mouse on the graph and click icon. Regressor involving deriv is shown in dotted line (--, :).



2.7.6.3 1st GLM Map

User can select from cB map / T-value map. In the same way as Activation Map, User can change the Scale and modify Color Map Max value or fix the value by clicking button.

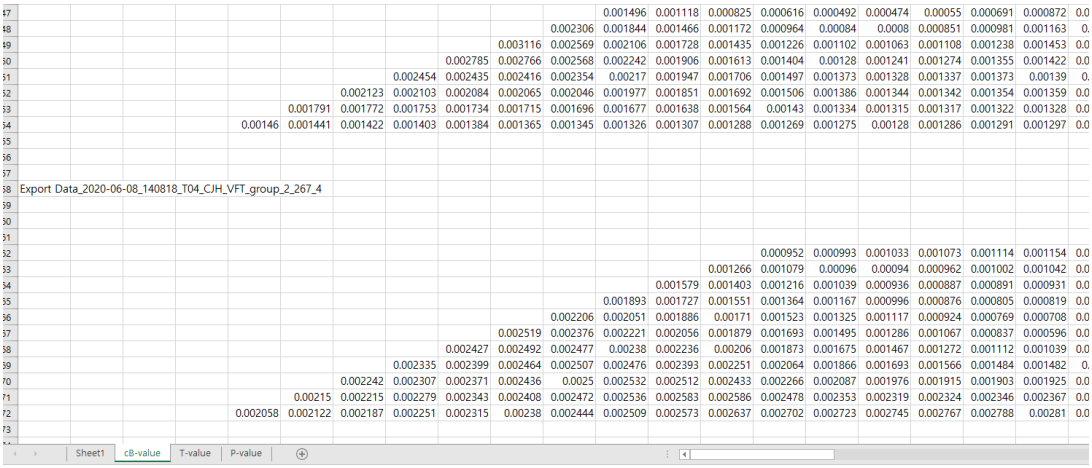
In case of P-value, if User clicks the check box next to Thd, any pixel with a value higher than 0.05 will be regarded as 0 and it will not show on the map.

User can extract 3D brain image of GLM Map by placing the mouse on GLM Map and clicking 3D icon.

2.7.6.4 Export

User can apply **Export** to extract cB, t, p value in excel data from multiple Subjects simultaneously. The graph and excel data are saved automatically in '3. Excel Data\Today's Date (ex.2020_03_21)' folder and '4. Graphs & Figures\Today's Date (ex.2020_03_21)' folder, respectively.

A file is created as '1st GLM Data_contrast vector_*-1 0 0 1 0 0 0_mbll_HbO*.xlsx' using both Contrast Vector name and Option name. For each sheet, cB-value, T-value, P-value pixel value is extracted, and User can see that data from multiple Subjects is organized sequentially in one sheet.

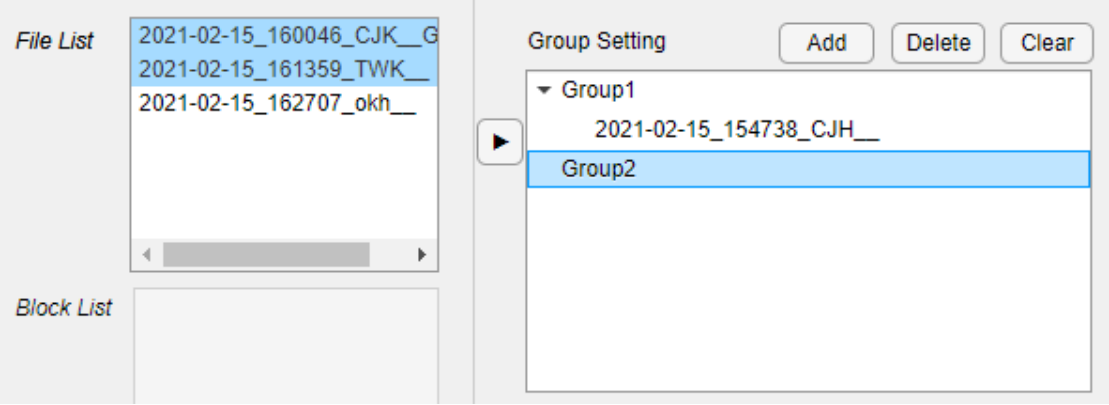


In case of graph, it is saved under the existing file name with '1st GLM Plot_2D(3D)' prefixed and contrast vector postfixed to the existing name. User can select from cB-Map / T-Map, and 2D image and 3D image can be extracted.

2.7.7 2nd GLM Tab

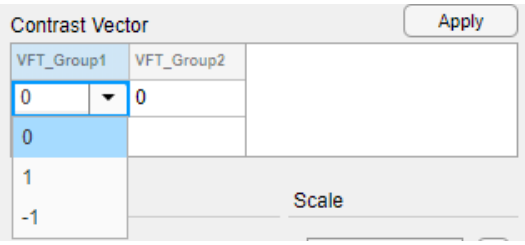
User can select Entire Data only when using 2st GLM Tab. It receives contrast vector from the selected data and cB value from 1st GLM calculation to show GLM result.

Make sure that 1st GLM process has already been completed prior to starting 2nd GLM. And if you did'nt make groups for your data, make groups with 'Add' and ▶ button with clicking data and a group you made.



2.7.7.1 Applying Contrast Vector

User can find the groups included from Group Setting section, and input contrast vector for 2nd GLM. Just like in the case of 1st GLM, User can double click the column as shown below and choose from values (0, 1, -1).



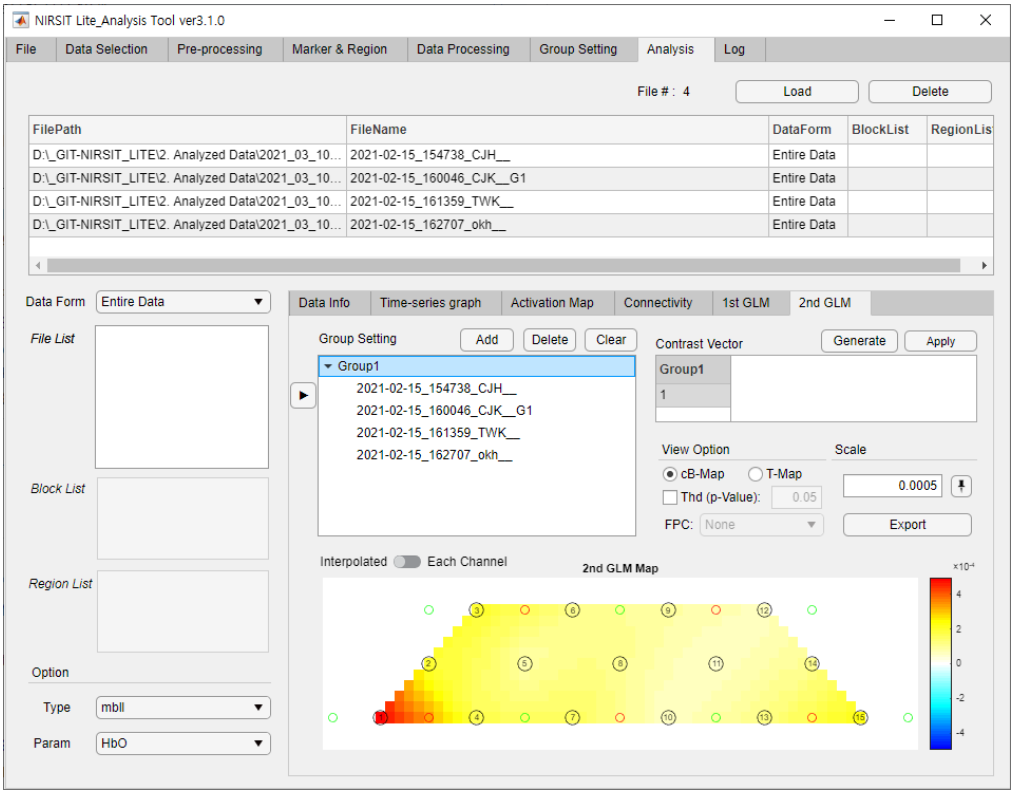
User can click Apply **Apply** button to plot 2nd GLM result in accordance with the Contrast Vector input.

2.7.7.2 2nd GLM Map

User can select from cB map / T-value map. In the same way as Activation Map, User can change the Scale and modify Color Map Max value or fix the value by clicking 📌 button.

In case of P-value, if User clicks the check box next to Thd with FPC option, any pixel with a value higher than 0.05 will be regarded as 0 and it will not show on the map.

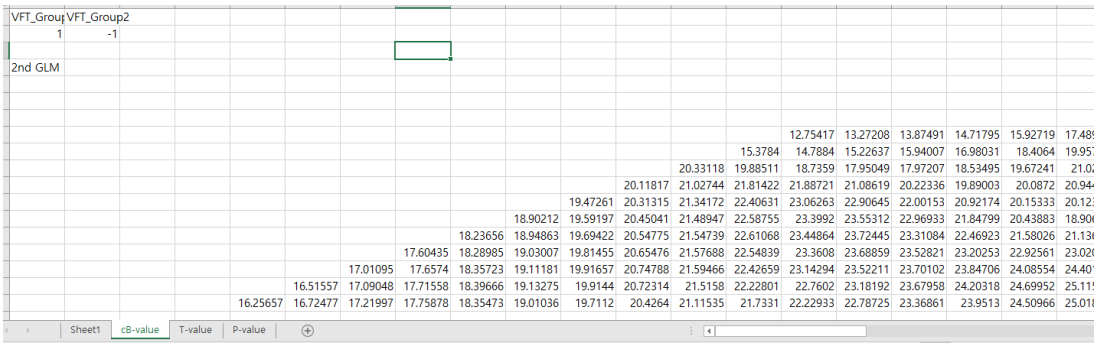
User can extract 3D brain image of GLM Map by placing the mouse on GLM Map and clicking  3D icon.



2.7.7.3 Export

User can apply **Export** to extract image and cB, t, p value in excel data from multiple Subjects simultaneously. The graph and excel data are saved automatically in '3. Excel Data\Today's Date (ex.2020_03_21)' folder and '4. Graphs & Figures\Today's Date (ex.2020_03_21)' folder, respectively.

A file is created as '2nd GLM Data_contrast vector_*1 -1_mbll_HbO*.xlsx' using both Contrast Vector name and Option name. For each sheet, cB-value, T-value, P-value pixel value is extracted

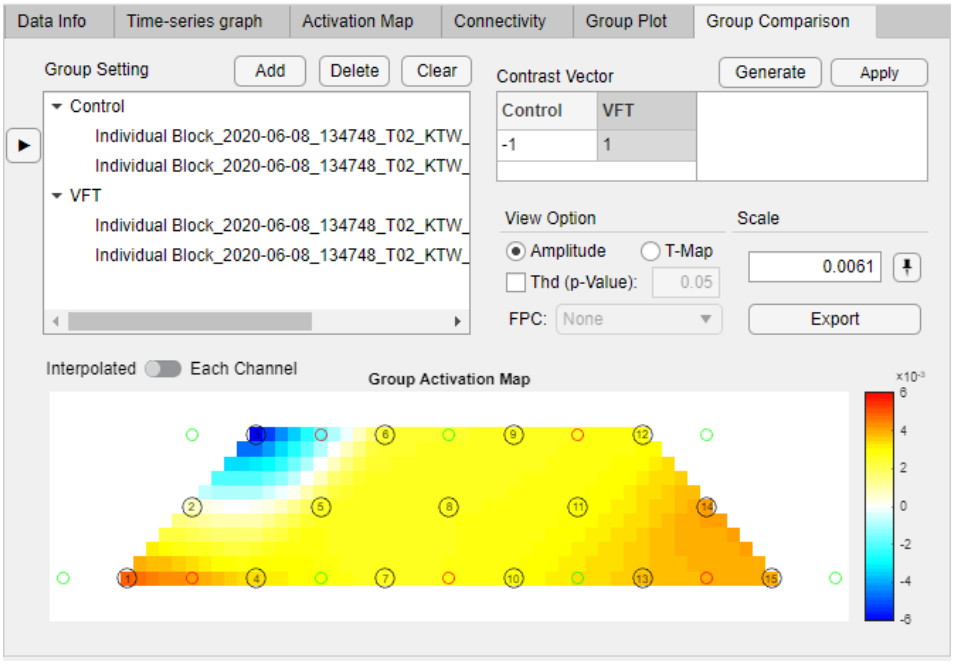


In case of graph, it is saved under the existing file name with '2nd GLM Plot_2D(3D)' prefixed and contrast vector postfixed to the existing name. User can select from cB-Map / T-Map, and 2D image and 3D image can be extracted.

2.7.8 Group Comparison Tab

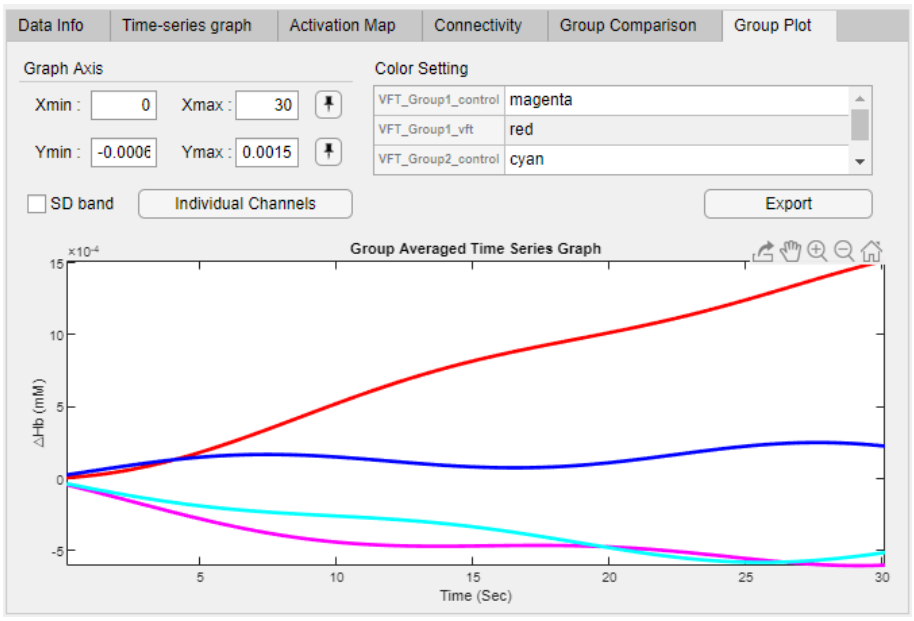
Group Comparison Tab shows up only when Group Average is selected. The screen is almost identical to that of 2nd GLM Tab, and User can compare group comparison result based on contrast vector calculated from selected groups and signal values.

Execution process is the same as the process used in 2nd GLM.



2.7.9 Group Plot Tab

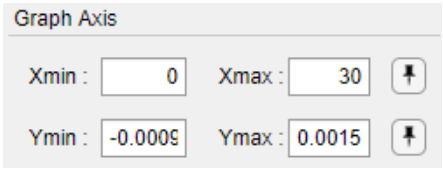
Group Plot Tab shows up only when Group Average is selected. Time Series Graph of each group channel average is also shown.



2.7.9.1 Changing Graph Axis

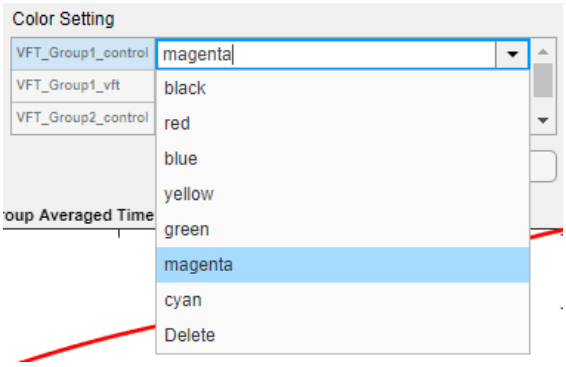
User can change or fix each axis.

User can fix the axis by pressing  button on the right. User can use the button to fix the axis of multiple data.



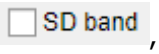
2.7.9.2 Setting Color

User can select a color for a graph line using Color Setting section. For each group in Table, User can designate a graph color for each group. If User selects **Delete**, the graph of that specific group does not show on the screen.

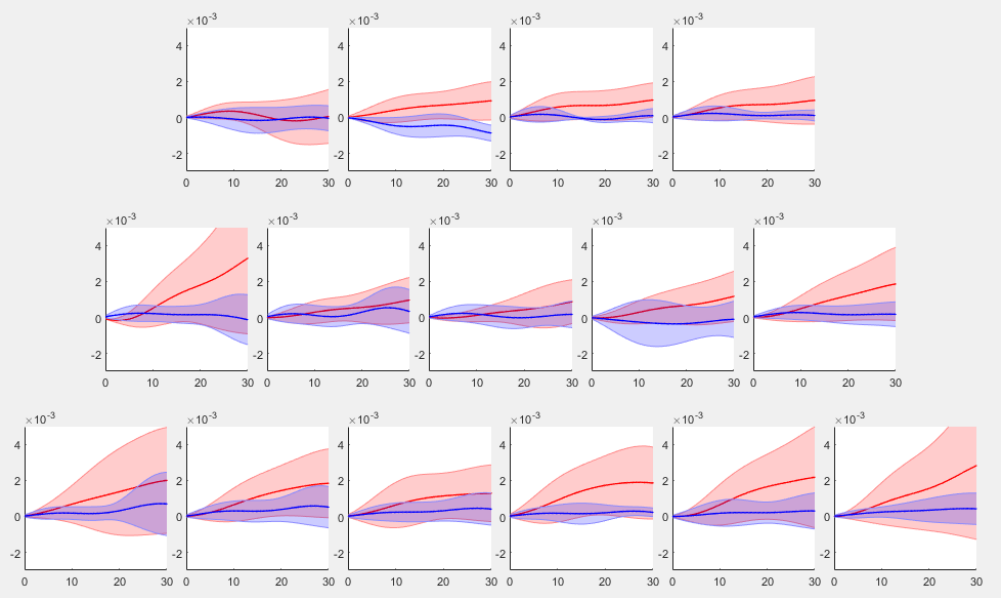


2.7.9.3 Plotting Time Series Graph by Channel by Region

User can retrieve channel by channel Time-Series Graph by clicking **Individual Channels** button.

The graph will be extracted in accordance with the axis values set by User. If User clicks check box next to SD (Standard Deviation) band 

, then the standard deviation of data in the selected group will be plotted as well.



2.7.9.4 Export

User can apply **Export** to extract graph and excel data. The graph and excel data are saved automatically in '3. Excel Data\Today's Date (ex.2020_03_21)' folder and '4. Graphs & Figures\Today's Date (ex.2020_03_21)' folder, respectively.

A file is created as 'Group Time Series Data_*all*.xlsx'. User can find that each group channel average value is extracted in time series.

	0.12288	0.245761	0.368641	0.491521	0.614402	0.737282	0.860162	0.983043	1.105923	1.228803	1.351683
VFT_Group1_control	-4.9E-05	-5.6E-05	-6.2E-05	-6.9E-05	-7.5E-05	-8.2E-05	-8.9E-05	-9.6E-05	-0.0001	-0.00011	-0.00012
VFT_Group1_vft	5.58E-06	7.09E-06	8.75E-06	1.06E-05	1.25E-05	1.46E-05	1.68E-05	1.92E-05	2.18E-05	2.45E-05	2.73E-05
VFT_Group2_control	-3.2E-05	-3.6E-05	-4E-05	-4.4E-05	-4.8E-05	-5.2E-05	-5.6E-05	-6E-05	-6.4E-05	-6.8E-05	-7.2E-05
VFT_Group2_vft	2.09E-05	2.37E-05	2.64E-05	2.93E-05	3.21E-05	3.49E-05	3.77E-05	4.05E-05	4.33E-05	4.62E-05	4.9E-05

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In case of graph, it is saved under the existing file name with 'Group Time Series (Ch) Graph_' prefixed to the existing name. Time Series Graph and Time Series Graph by channel by region is also extracted.

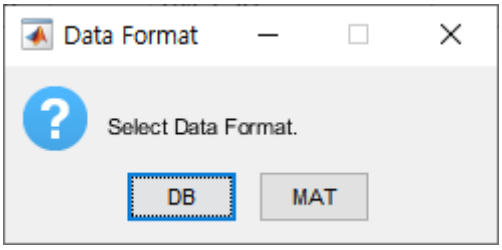
3. Processing Data Analysis

Chapter 3 explains the process step by step so that User may become familiar with Tabs and Features laid out in Chapter 2.

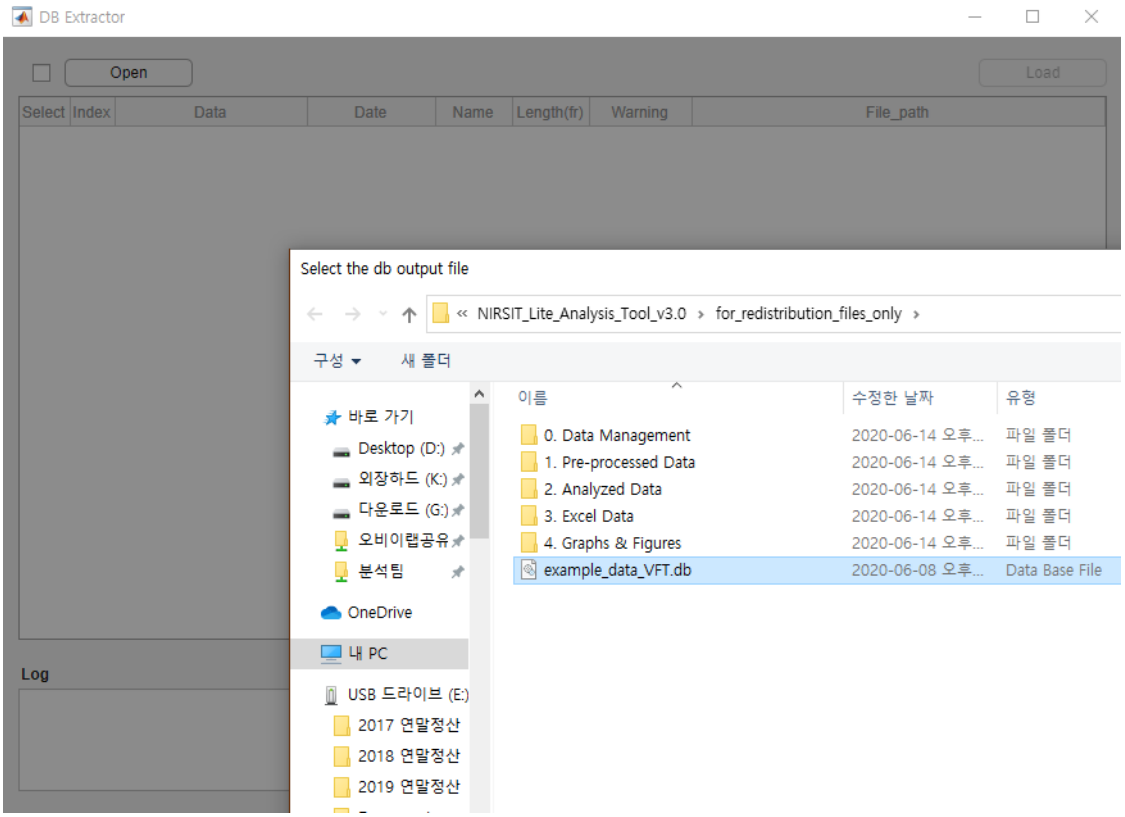
3.1 Importing Data

3.1.1 Importing DB Data

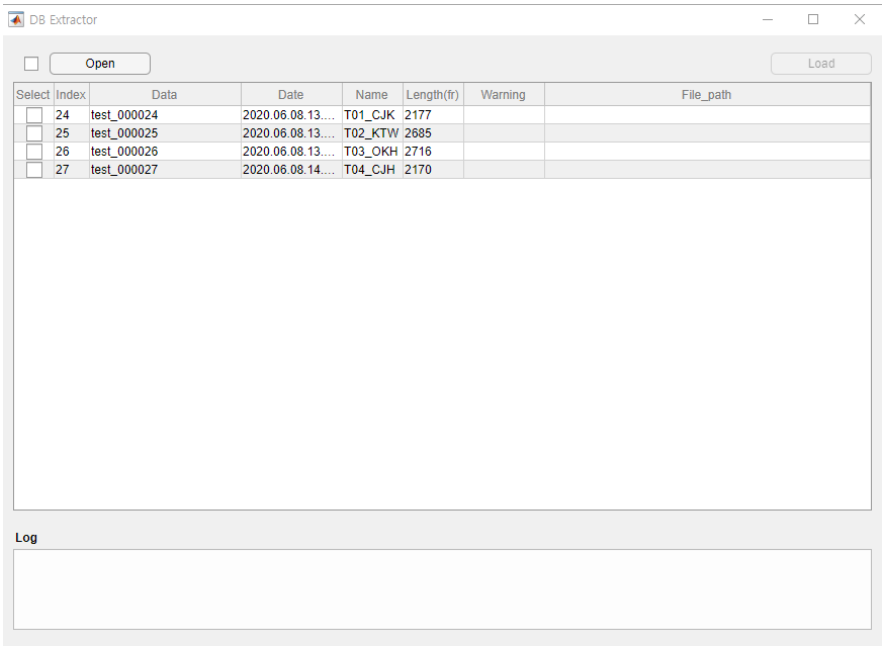
1. User can click **Load** button in Data Tab.



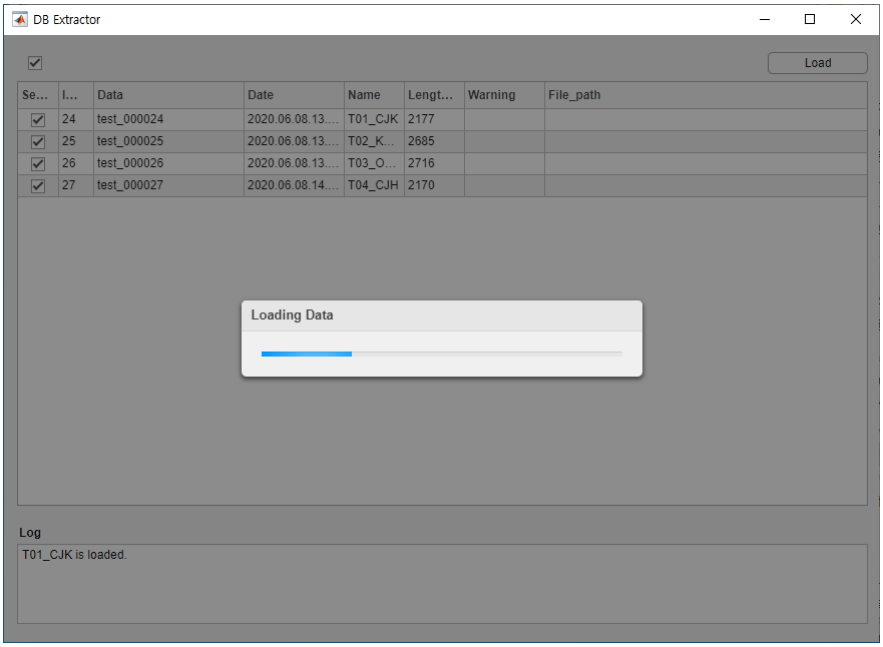
2. User can select DB to load DB files. DB Extractor window and data selection window will appear.



3. User can load .db file by clicking **Open** button. Please note that File Path for all db files must be written in English. No other language, for example, Korean, is not allowed. If the data length is too short, warning signal will show up and the data in question will not be extracted. If the data has no gain value information from the device, or if the data is shorter or longer than the db data, a warning signal will show up, but User can nevertheless extract the data in question.



4. User can select data to be extracted and press **Load** button. A check box next to **Open** button on the screen, when clicked, allows User to select all data in the list.



5. DB Extractor window closes, and the selected data are updated in the Analysis Tool.

3.1.2 Entering Additional Data Information

User can enter data information by accessing 'load_data_list.csv' file in '0. Data Management' folder. User can also enter information into the Analysis Tool manually.

1. User can change and save 'load_data_list.csv' file shown as below.

file_path	date	group	name	task	age	sex	note
D:₩OBELA	2020-06-0	Group1	bjy	VFT	27	F	test
D:₩OBELA	2020-06-0	Group1	sek	VFT	30	M	test
D:₩OBELA	2020-06-0	Group1	lmh	VFT	30	M	test
D:₩OBELA	2020-06-0	Group1	lcs	VFT	29	M	test

- Caution when entering additional information

  ✓ Do not change or modify File Path unless the file storage path or name of the mat file is changed.

  ✓ Date should be entered in the following format: 'yyyy-mm-dd_hhmmss'. The _hhmmss is used to identify individual data.

  ✓ For Group and Task, User can only use English alphabet with no space in between, and the name cannot start with a number. If User starts Group or Task name with a number, the Analysis Tool will insert 'Group' or 'Task' in front of the number automatically when saving such information. If there is a space in between any text, such space will be converted to '_' automatically.

  ✓ User can enter numbers and/or alphabet text in Group, Name, Task, Note section.

  ✓ User can enter numbers only in Age section.

  ✓ Following can be entered to indicate Sex

  ◆ Male: Male, Man, M, male, man, m

  ◆ Female: Female, Woman, F, W, female, woman, f, w

  Once the data is updated, Sex information will be indicated either as F or M.

  ✓ User must save the information in csv format. Do NOT save in .xlsx format.

  ✓ User can leave sections blank, but we recommend that each section be filled with information.

2. User can return to the Analysis Tool and check all information by pressing **Update** button.

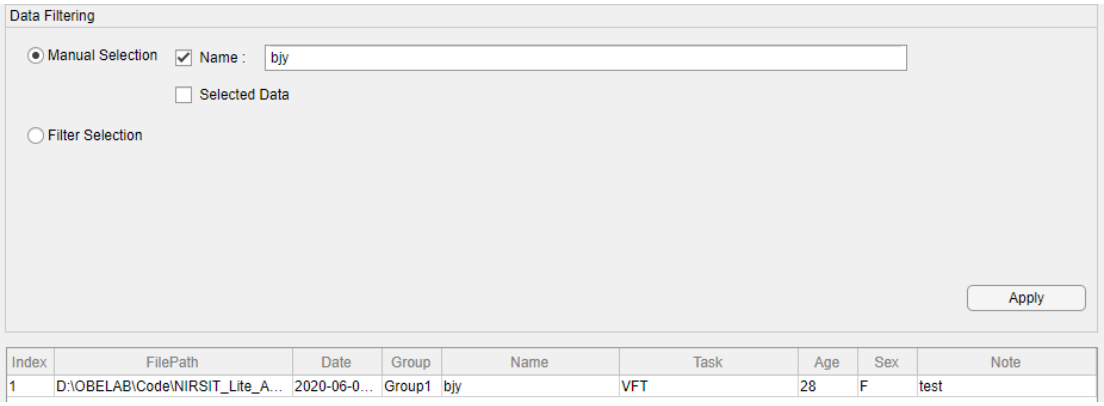
3.2 Filtering Data to Be Analyzed

User can select Data Selection Tab. Data Selection Tab allows User to choose conditions to be applied in analysis through filtering. Following are a few examples of data filtering.

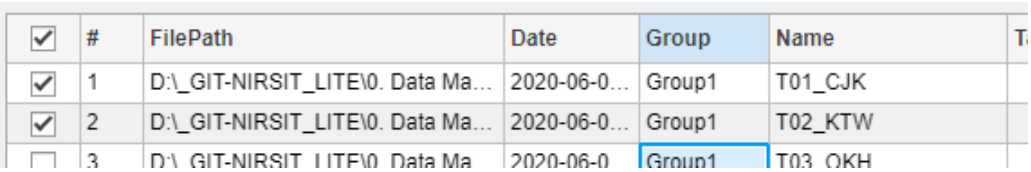
3.2.1 Filtering via Manual Selection

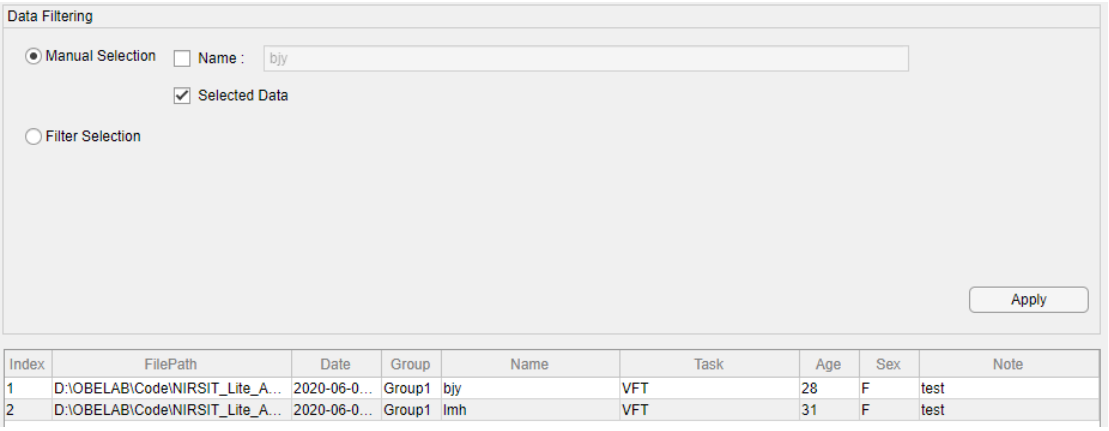
1) User can enter the name directly and process data filtering.

User can click **Name** and enter a specific name in Manual Selection.



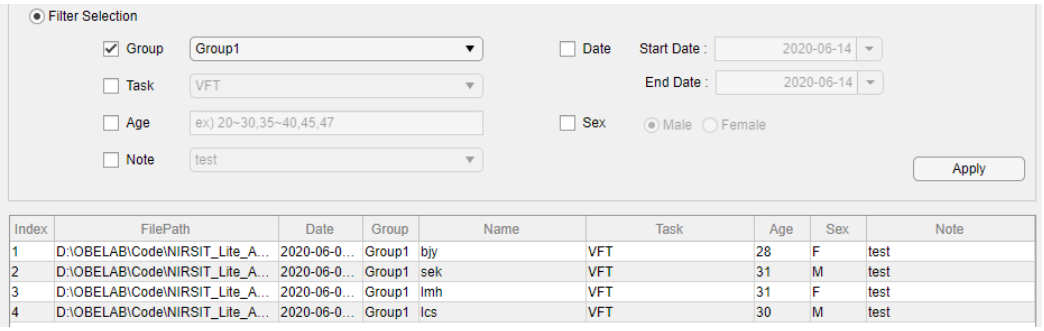
2) User can select data from File Tab and click **Selected Data** for data filtering.



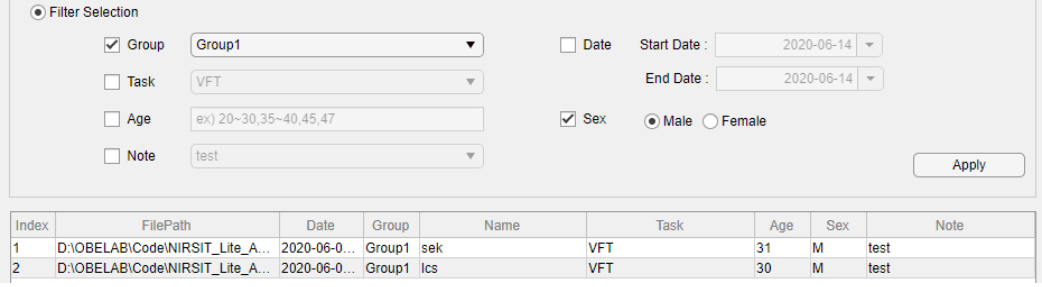


3.2.2 Filtering via Filter Selection

1) User can select a group (Group 1) that would be filtered.



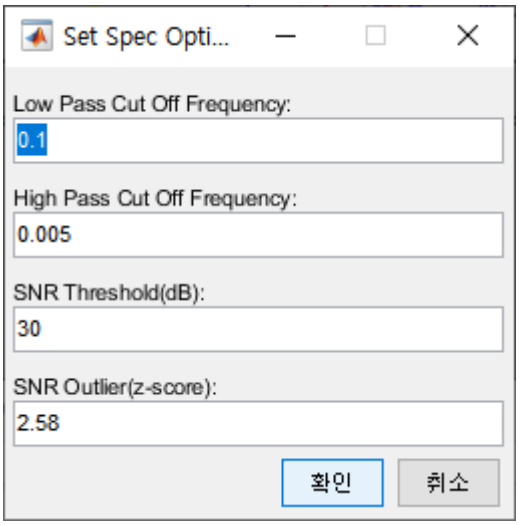
2) User can select a group (Group 1) and Sex (Male) to be filtered.



- One or more options can be selected at the same time. If there is no applicable data, User can assign new options.

3.3 Check Data

User can select Pre-Processing Tab.

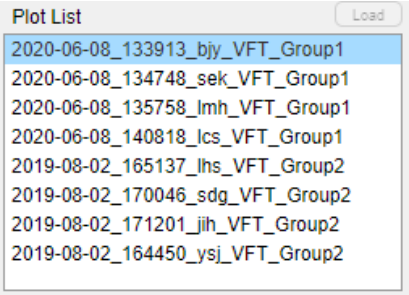


User can set up Band Pass Filter Spec and Channel Rejection Spec. Press **OK** button and wait until the data is calculated and the loading is complete.

3.3.1 Changing Option

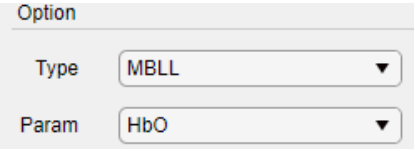
It is important that User makes sure that the data has been accumulated correctly. Please check all data to see whether the channels look good and that there was not much movement by the Subject when measurement was taken. User can apply additional Channel Rejection Option through this process.

1. User can check the data by clicking each data set from the Plot List.

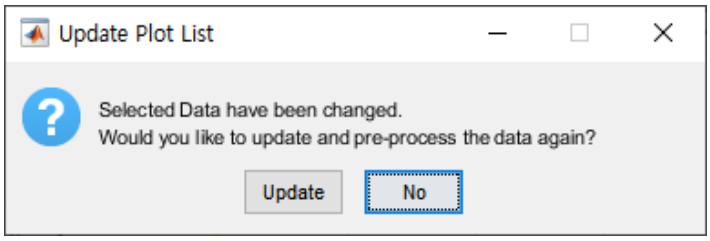


2. From Type, User can check data by changing it to Filtered Raw / MBLL / MAR_MBLL.

3. From Param, User can check data by changing it to D780 / D850 or HbO / HbR.

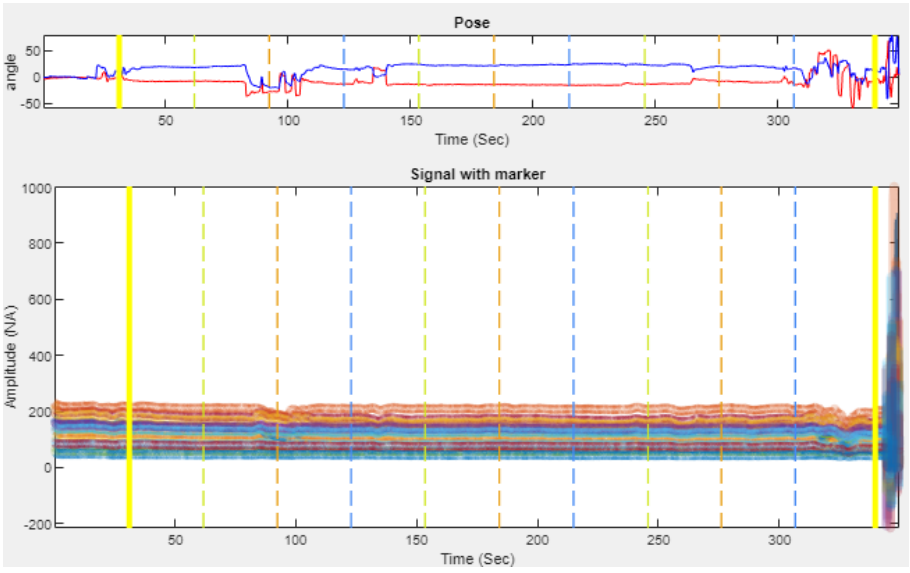


4. If the data changes in Plot List through Data Selection, the following message shows up, and Update button performs pre-processing with new data.

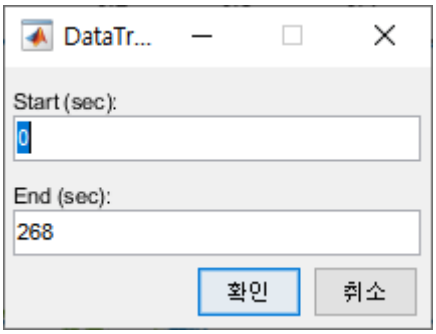


3.3.2 Trimming Data

1. User can click **Start-End Trim** button to trim a data set that has abnormal measurement data either in the start of the time duration or the end of the time duration.



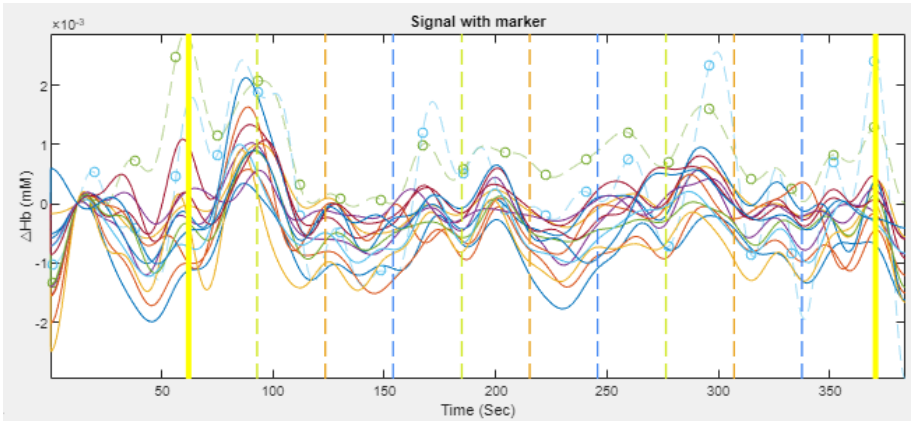
2. User can enter the Start Second (sec) and End Second (sec) to designate the length of data User would like to use.



3. Data will be trimmed but it doesn't perform pre-processing again.

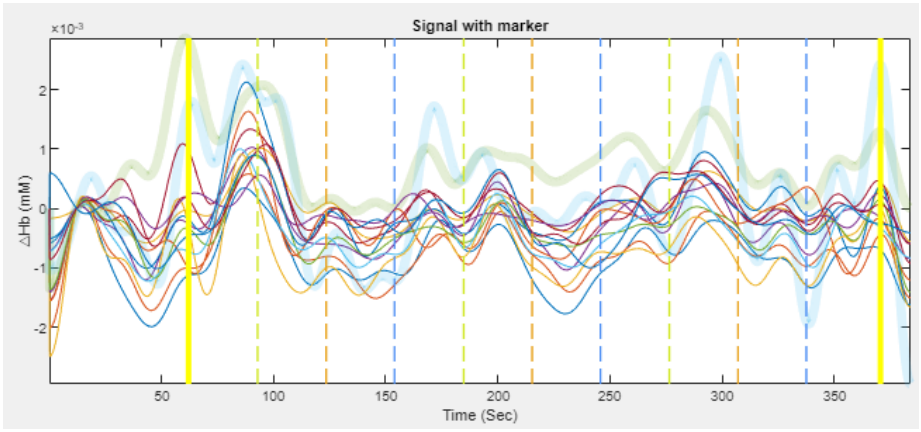
3.3.3 Rejecting Channels

1. User can select channels to be rejected. User may choose more than one channel.

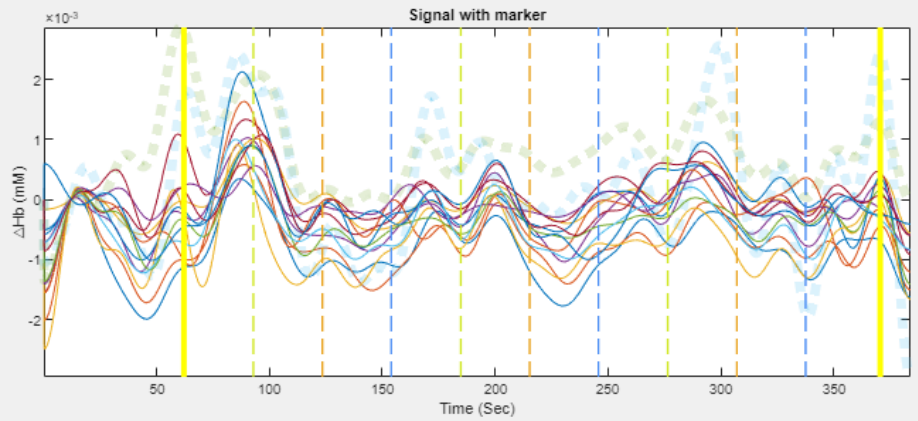


2. Place the mouse on the graph and click  icon.

3. Selected channels will show up as bold and light-colored lines.

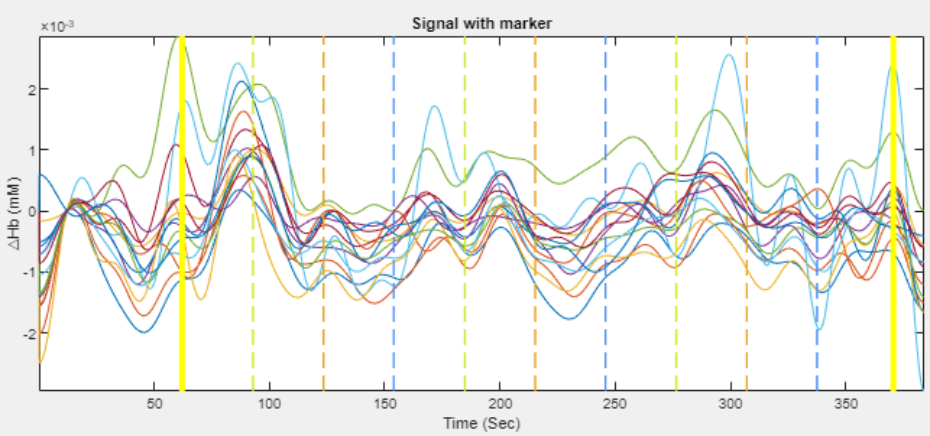


4. If User wants to undo rejection, please select the channels that need to be revived. User may choose more than one channel.



5. Place the mouse on the graph and click undo button.

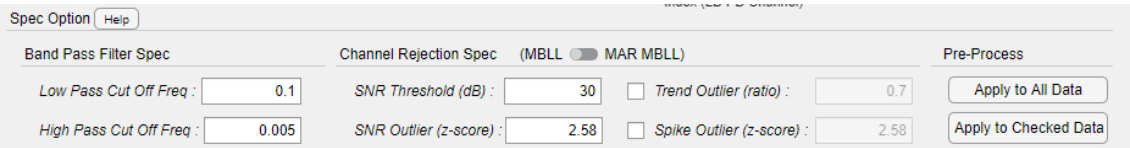
6. User can find that the dotted and light colored lines representing rejected channels have reverted back to standard lines.



3.3.4 Resetting Spec Option

User can input different values for Band Pass Filter Spec and Channel Rejection Spec.

Click the check box next to Trend Outlier and Spike Outlier and input value and click **Apply** button. User can find detailed information about each option by clicking **Help** button.

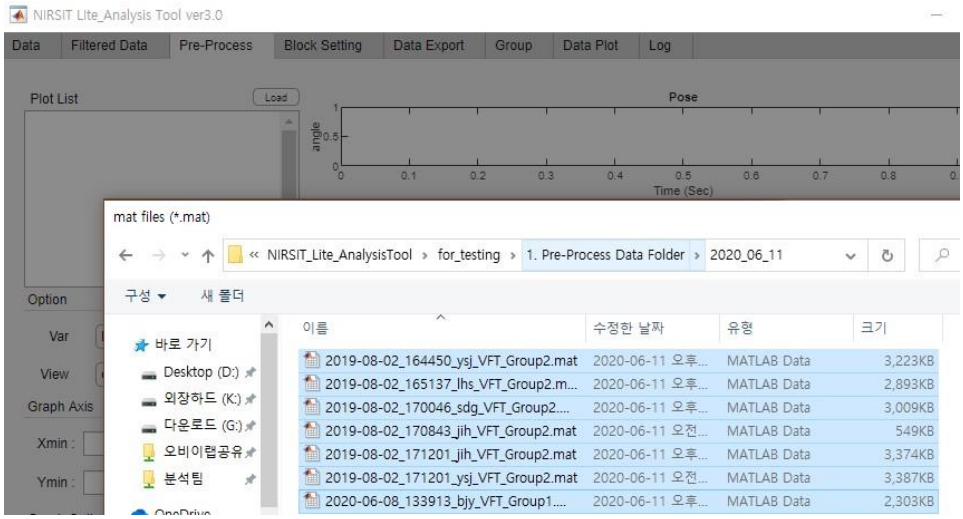


3.3.5 Retrieving Data Before Data Processing

User can retrieve saved data set under prior options if it is before Data Export through Data Processing Tab. User can also perform Data Export under new setting by retrieving saved data set under prior options.

1. Click **Load** button in the right of Plot List found under Pre-processing Tab.

2. Select the data set from '1. Pre-processed Data' and start loading.



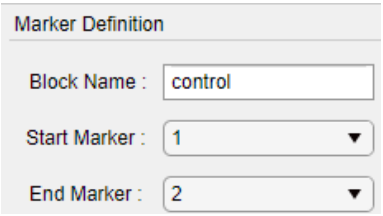
3. Please double check to make sure that the retrieved data set is in accordance with the prior options.

3.4 Setting up Block and Region

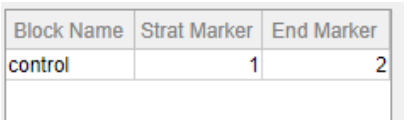
User can select Marker & Region Tab.

3.4.1 Creating Block

1. User can enter Block Name and set up Start Marker and End Marker.

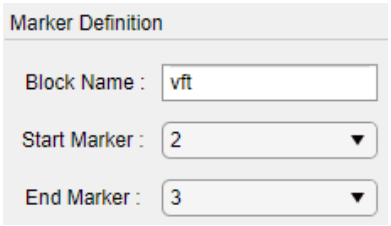


2. Click **Add Rule** button and update the Table below.



Block Name	Strat Marker	End Marker
control	1	2

3. User can enter a new Block Name and set up Start Marker and End Marker.



4. User can check Table by clicking **Add Rule**. User can repeat the same process to add multiple rules.

Block Name	Strat Marker	End Marker
control	1	2
vft	2	3

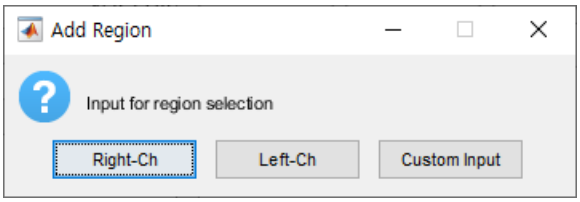
5. User can click **Block Generation** button once adding rule(s) process is complete.

Block Name	Strat Time	End Time
control	65.0035	95.6006
vft	95.6006	125.8291
control	156.4262	187.1462
vft	187.1462	217.3747

6. User can check to see if the Block is added in accordance with the Markers location.

3.4.2 Creating Region

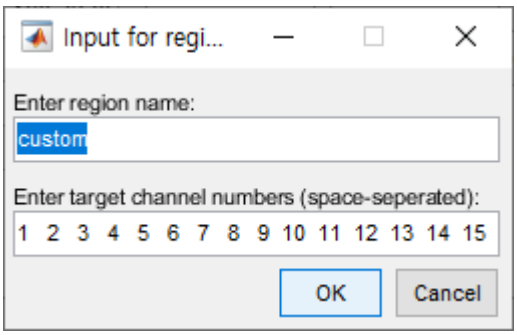
1. User can click **Add Region** button.



2-1. User can add channel by default.

User can choose from Right-Ch or Left-Ch.

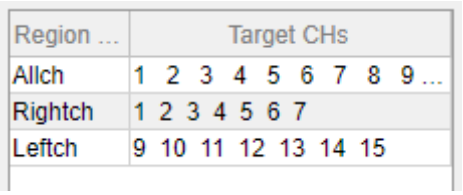
2-2. User can add a channel by customizing entry using **Custom Input** button.



User can enter channels to be added by entering Region Name manually.

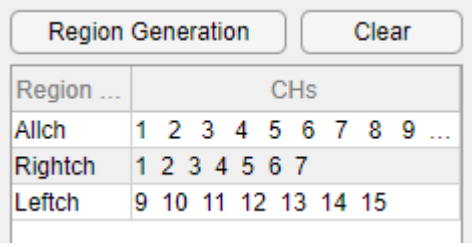
Channels can be sorted by space bar.

3. User can check added Region.



Region ...	Target CHs
Allch	1 2 3 4 5 6 7 8 9 ...
Rightch	1 2 3 4 5 6 7
Leftch	9 10 11 12 13 14 15

4. User can create Region for each data set by clicking **Region Generation** button.



Region Generation Clear

Region ...	CHs
Allch	1 2 3 4 5 6 7 8 9 ...
Rightch	1 2 3 4 5 6 7
Leftch	9 10 11 12 13 14 15

3.5 Extracting Data

1. User can select Data Processing Tab.

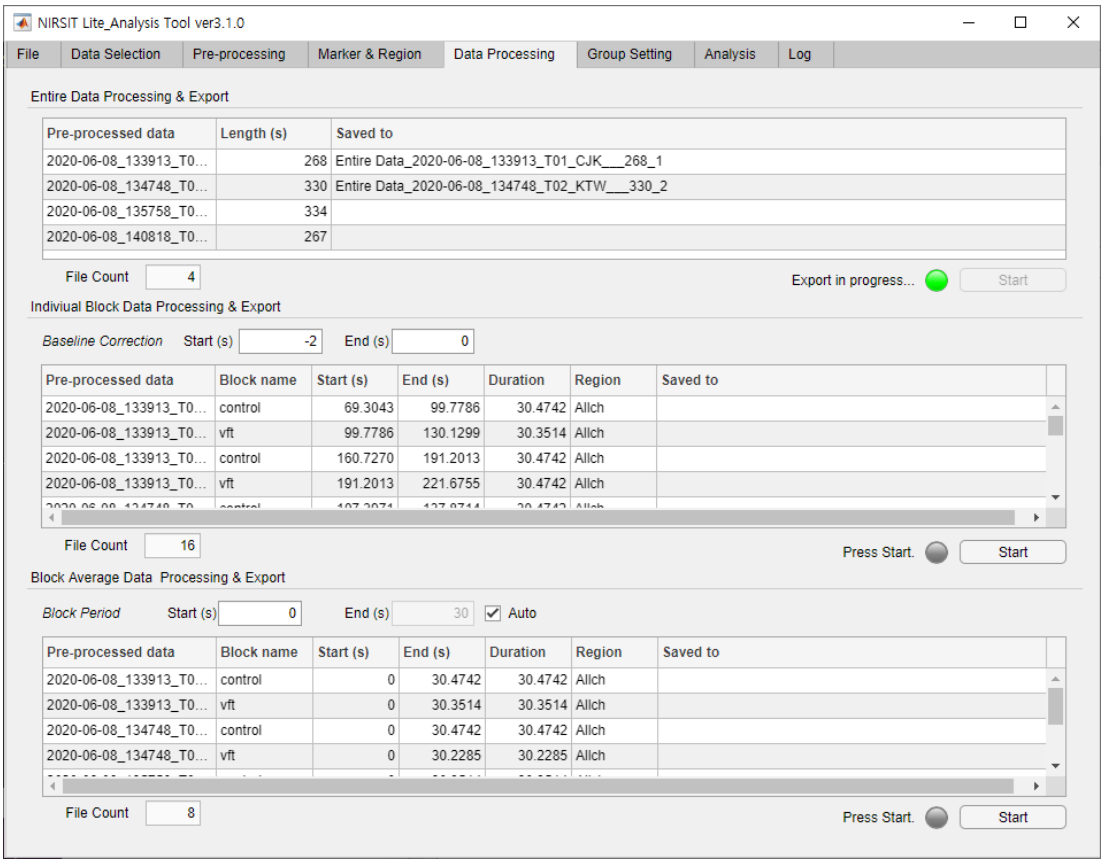
2. User can check to see if the previously set up Block and Region have been applied appropriately to the data.

3. User can check values in Baseline Correction set up and Block Period set up. User can unlock Auto check on Block Period and input a value so that the input value applies to all region. User can also change the End value in the Table for Block Average Data. Please note that error message may come up if the data length of the last Block Period is too short.

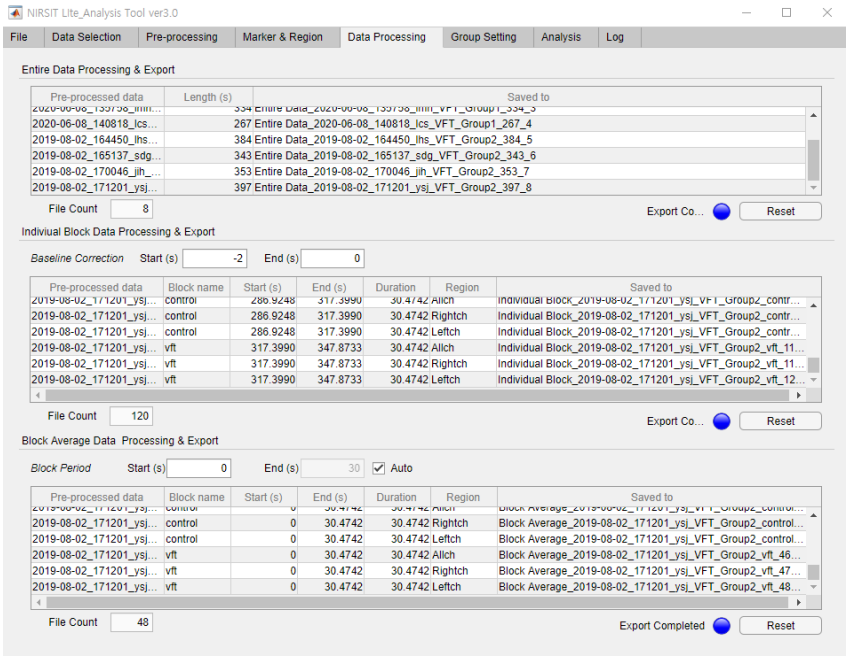
   User needs to confirm the number of data sets to be extracted and whether the data extraction format is correctly chosen, and then click **Start** button.

   In the case of Individual Block Data, the data extraction is performed for all number of cases combined together. Thus, please select carefully as needed.

   If no Block is assigned within the data set, only Entire Data will be extracted.



4. Make sure blue lights are turned on beside the data format that User selected and clicked **Start** button.



5. User can check the extracted data from '2. Analyzed Data\Today's Date (ex.2020_03_21)' folder.

3.6 Creating Group

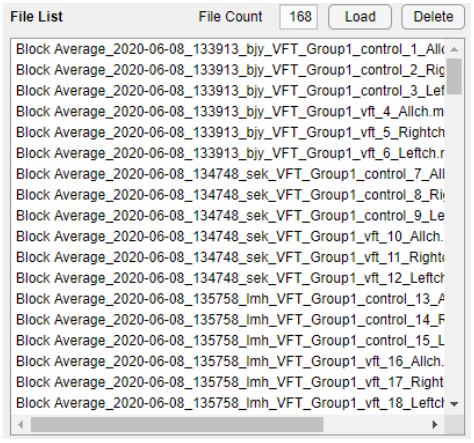
3.6.1 Loading Data

After Data Processing is complete, User can go to Group Setting Tab and the data will be loaded onto File List automatically.

1. If another data set needs to be added, please click **Load** button.

2. User can retrieve Individual Block Data or Block Average Data.

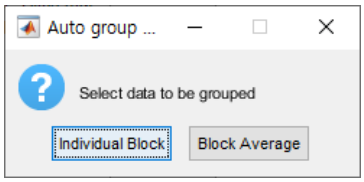
3. The data is added and updated in File List.



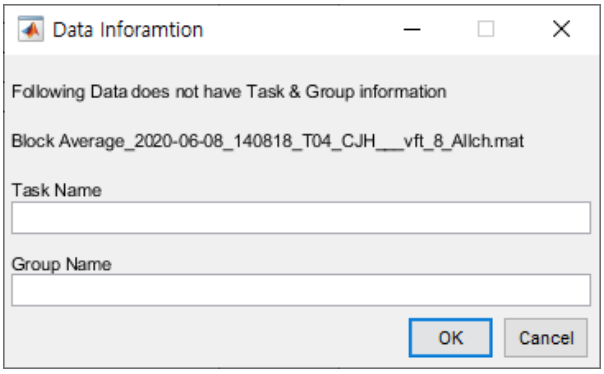
3.6.2 Creating Group

1. User can click **Auto** button.

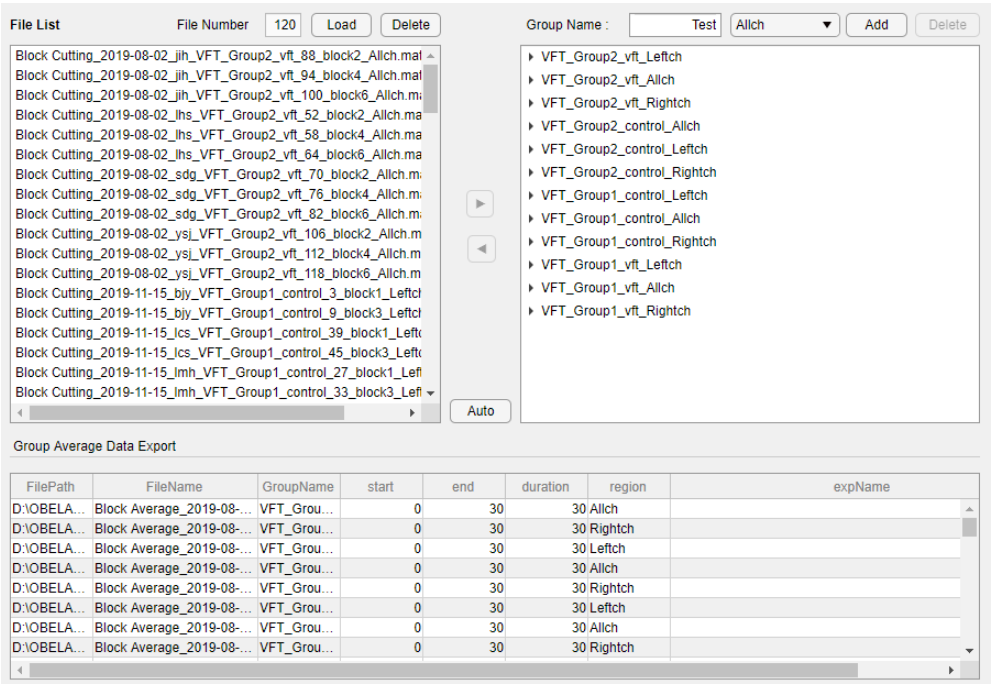
2. User can select data format to be used in creating Group.



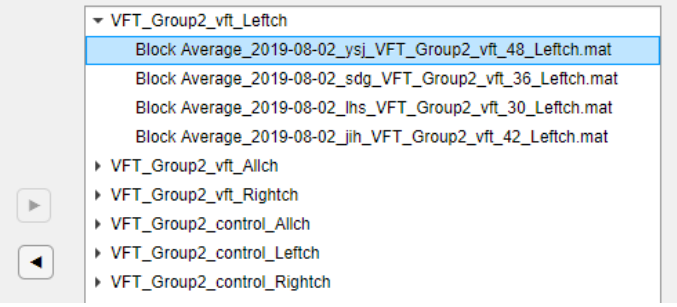
3. **Auto** function needs Task name and Group name for data. If this information doesn't exist, user has to input.

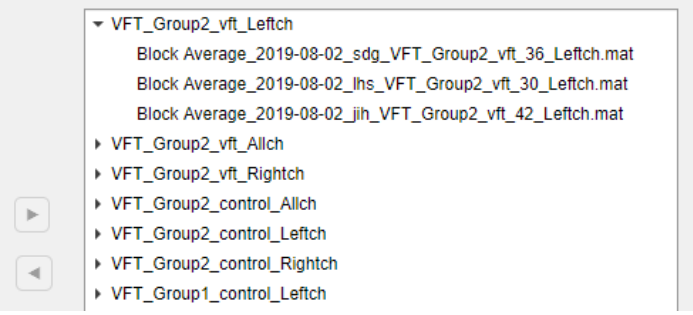


4. User can check the Group created automatically.

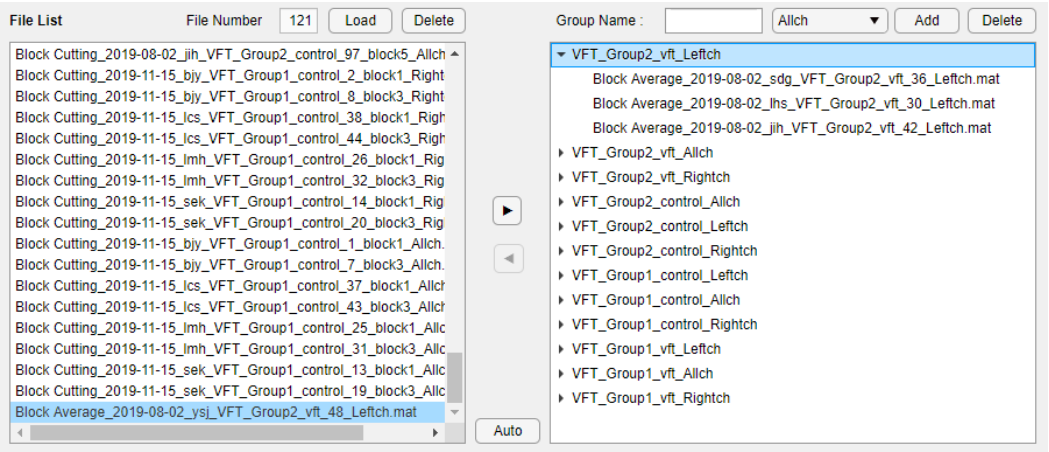


5. If User wishes to exclude certain data from created Group, select those data to be excluded and click ◄ button so that the data is not added in Group averaging.

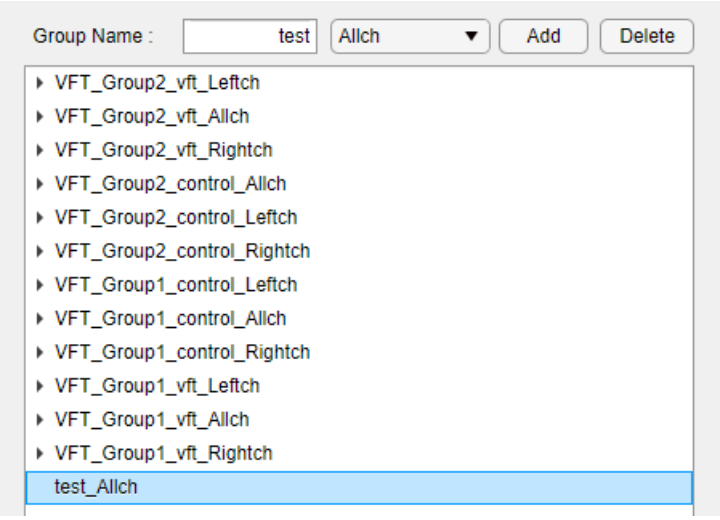




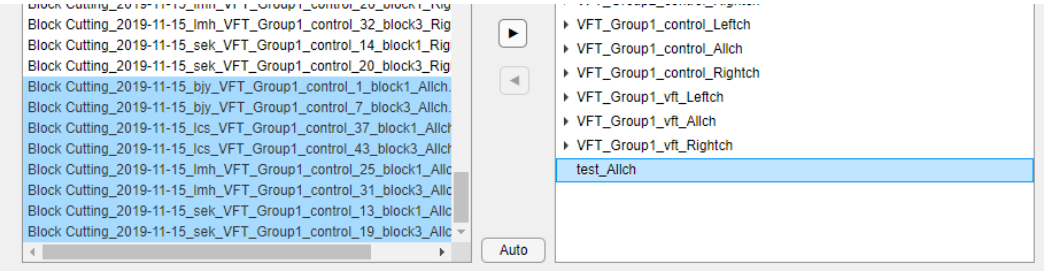
6. If User wishes to add the already excluded data into the Group, User can select Group Name and click ► button.

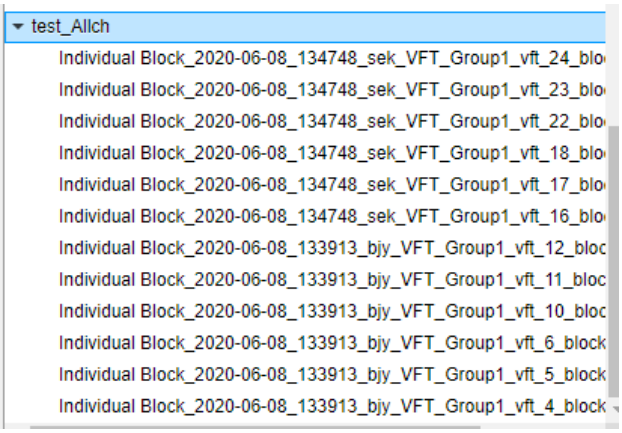


7. If User wishes to create a Group manually, User can enter Group Name and press **Add** button.



8. User can select data that User would like to add to the Group by selecting the data by clicking  button and grouping them.





3.6.3 Extracting Group Average Data

1. User can check the Group Name in Table to confirm whether the Group was created successfully.

FilePath	FileName	GroupName	start	end	duration	region
D:\OBELA...	Block Average_2019-08-...	VFT_Grou...	0	30	30	Allch
D:\OBELA...	Block Average_2019-08-...	VFT_Grou...	0	30	30	Rightch
D:\OBELA...	Block Average_2019-08-...	VFT_Grou...	0	30	30	Leftch
D:\OBELA...	Block Average_2019-08-...	VFT_Grou...	0	30	30	Allch
D:\OBELA...	Block Average_2019-08-...	VFT_Grou...	0	30	30	Rightch
D:\OBELA...	Block Average_2019-08-...	VFT_Grou...	0	30	30	Leftch
D:\OBELA...	Block Average_2019-08-...	VFT_Grou...	0	30	30	Allch
D:\OBELA...	Block Average_2019-08-...	VFT_Grou...	0	30	30	Rightch

2. Press **Start** button.

3. Make Sure blue light is turned on beside Export Complete.

File Path	File Name	Group Name	Start (s)	End (s)	Duration	Region	Saved to
D:\OBELA...	Block Average_2020-06-...	VFT_Grou...	0	30	30	Allch	Group Average_VFT_Group1_control_Allch
D:\OBELA...	Block Average_2020-06-...	VFT_Grou...	0	30	30	Rightch	Group Average_VFT_Group1_control_Rightch
D:\OBELA...	Block Average_2020-06-...	VFT_Grou...	0	30	30	Leftch	Group Average_VFT_Group1_control_Leftch
D:\OBELA...	Block Average_2020-06-...	VFT_Grou...	0	30	30	Allch	Group Average_VFT_Group1_vft_Allch
D:\OBELA...	Block Average_2020-06-...	VFT_Grou...	0	30	30	Rightch	Group Average_VFT_Group1_vft_Rightch
D:\OBELA...	Block Average_2020-06-...	VFT_Grou...	0	30	30	Leftch	Group Average_VFT_Group1_vft_Leftch
D:\OBELA...	Block Average_2020-06-...	VFT_Grou...	0	30	30	Allch	Group Average_VFT_Group1_control_Allch
D:\OBELA...	Block Average_2020-06-...	VFT_Grou...	0	30	30	Rightch	Group Average_VFT_Group1_control_Rightch

Export Completed Reset

4. User can check once again to confirm extracted data in '2. Analyzed Data\Today's Date (ex.2020_03_21)' folder.

3.7 Analyzing and Plotting Data

User can click Analysis Tab.

The Analysis tool loads the data set onto File List after Data Processing when it is displayed on Analysis Tab.

User can retrieve data from '2. Analyzed Data' folder by clicking **Load** button.

In the case of Analysis Tab, if User wishes to check the applicable options for data plotting, please return to Chapter 2 of this Manual and check the options User can choose from.

The following are examples explaining how User can utilize the data extraction feature.

3.7.1 Selecting Data

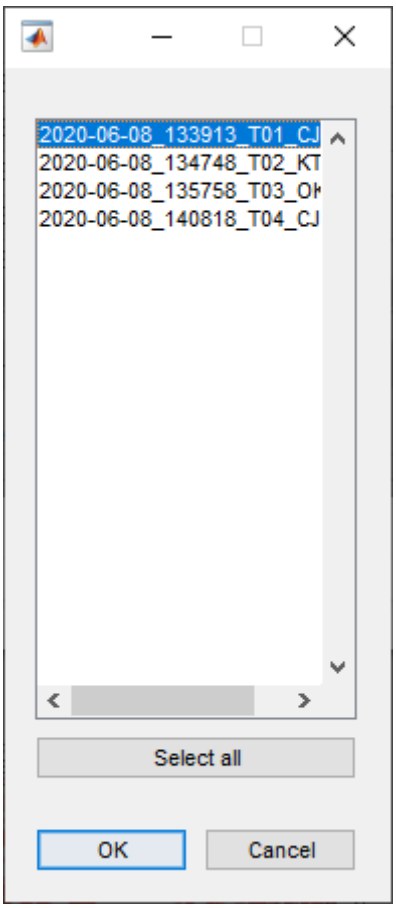
1. User can change Data Form.

2. User can check the change in data by changing Type/Param in the Drop Box.

3. Because there are many options to choose from, User must double check to see if the options selected have been applied appropriately to the data set in question.

3.7.2 Changing Analysis Tab

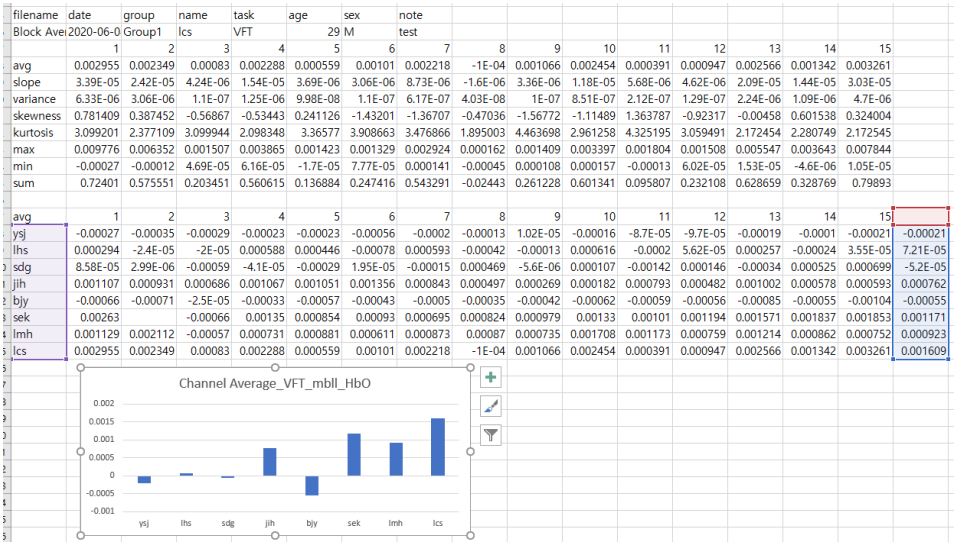
1. User can select the data to be plotted.
2. User can check the data plot that shows up by clicking each sub tabs under Analysis Tab.
3. User can press **Export** button to retrieve image or data of the data file in question.
4. User can select the data to be extracted. If all data should be extracted, User can press **Select All** button.



5. User can check the excel data in '3. Excel Data\Today's Date (ex.2020_03_21)' file and the image in '4. Graphs & Figures\Today's Date (ex.2020_03_21) file. Once the data set has been saved, User can change the name from Today's Date to a different name. Saving by default in analysis tool will result in a name with Today's Date as the new name.

3.7.3 Utilizing Information in Data Info

User can extract channel by channel average value from Block Average Data excel sheet and create a bar graph as shown below.

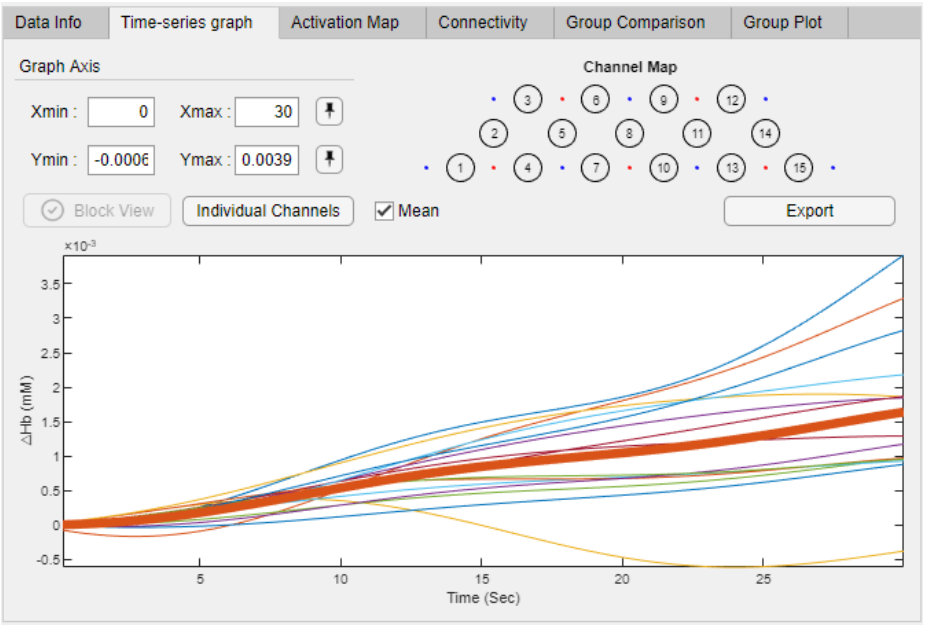


filename	date	group	name	task	age	sex	note									
Block Ave	2020-06-0	Group1	lcs	VFT	29	M	test									
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
avg	0.002955	0.002349	0.00083	0.002288	0.000559	0.00101	0.002218	-1E-04	0.001066	0.002454	0.000391	0.000947	0.002566	0.001342	0.003261	
slope	3.39E-05	2.42E-05	4.24E-06	1.54E-05	3.69E-06	3.06E-06	8.73E-06	-1.6E-06	3.36E-06	1.18E-05	5.68E-06	4.62E-06	2.09E-05	1.44E-05	3.03E-05	
variance	6.33E-06	3.06E-06	1.1E-07	1.25E-06	9.98E-08	1.1E-07	6.17E-07	4.03E-08	1E-07	8.51E-07	2.12E-07	1.29E-07	2.24E-06	1.09E-06	4.7E-06	
skewness	0.781409	0.387452	-0.56867	-0.53443	0.241126	-1.43201	-1.36707	-0.47036	-1.56772	-1.11489	1.363787	-0.92317	-0.00458	0.601538	0.324004	
kurtosis	3.099201	2.377109	3.099944	2.098348	3.36577	3.908663	3.476866	1.895003	4.463698	2.961258	4.325195	3.059491	2.172454	2.280749	2.172545	
max	0.009776	0.006352	0.001507	0.003865	0.001423	0.001329	0.002924	0.000162	0.001409	0.003397	0.001804	0.001508	0.005547	0.003643	0.007844	
min	-0.00027	-0.00012	4.69E-05	6.16E-05	-1.7E-05	7.77E-05	0.000141	-0.00045	0.000108	0.000157	-0.00013	6.02E-05	1.53E-05	-4.6E-06	1.05E-05	
sum	0.72401	0.575551	0.203451	0.560615	0.136884	0.247416	0.543291	-0.02443	0.261228	0.601341	0.095807	0.232108	0.628659	0.328769	0.79893	
avg	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
ysj	-0.00027	-0.00035	-0.00029	-0.00023	-0.00023	-0.00056	-0.0002	-0.00013	1.02E-05	-0.00016	-8.7E-05	-9.7E-05	-0.00019	-0.0001	-0.00021	-0.00021
lhs	0.000294	-2.4E-05	-2E-05	0.000588	0.000446	-0.00078	0.000593	-0.00042	-0.00013	0.000616	-0.0002	5.62E-05	0.000257	-0.00024	3.55E-05	7.21E-05
sdg	8.58E-05	2.99E-06	-0.00059	-4.1E-05	-0.00029	1.95E-05	-0.00015	0.000469	-5.6E-06	0.000107	-0.00142	0.000146	-0.00034	0.000525	0.000699	-5.2E-05
jih	0.001107	0.000931	0.000686	0.001067	0.001051	0.001356	0.000843	0.000497	0.000269	0.000182	0.000793	0.000482	0.001002	0.000578	0.000593	0.000762
bjy	-0.00066	-0.00071	-2.5E-05	-0.00033	-0.00057	-0.00043	-0.0005	-0.00035	-0.00042	-0.00062	-0.00059	-0.00056	-0.00085	-0.00055	-0.00104	-0.00055
sek	0.00263		-0.00066	0.00135	0.000854	0.00093	0.000695	0.000824	0.000979	0.00133	0.00101	0.001194	0.001571	0.001837	0.001853	0.001171
lmh	0.001129	0.002112	-0.00057	0.000731	0.000881	0.000611	0.000873	0.00087	0.000735	0.001708	0.001173	0.000759	0.001214	0.000862	0.000752	0.000923
lcs	0.002955	0.002349	0.00083	0.002288	0.000559	0.00101	0.002218	-1E-04	0.001066	0.002454	0.000391	0.000947	0.002566	0.001342	0.003261	0.001609

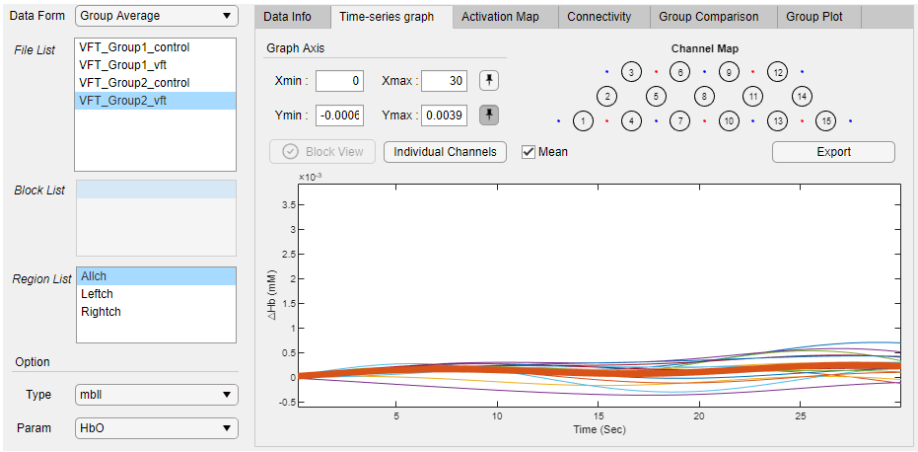
3.7.4 Checking Time-Series Graph

User can compare Time Series Graphs of Group Average Data. For precise comparison, the axis values are fixed.

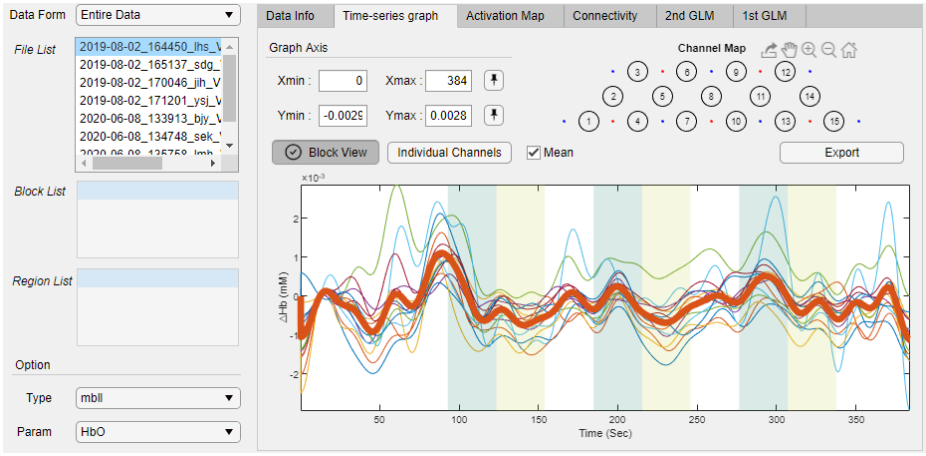
(Time Series Graph during Verbal Fluency Task (VFT) by Group 1)



(Time Series Graph during VFT by Group 2)



User can plot Entire Data, along with the Block Periods marked, and check the entire data.

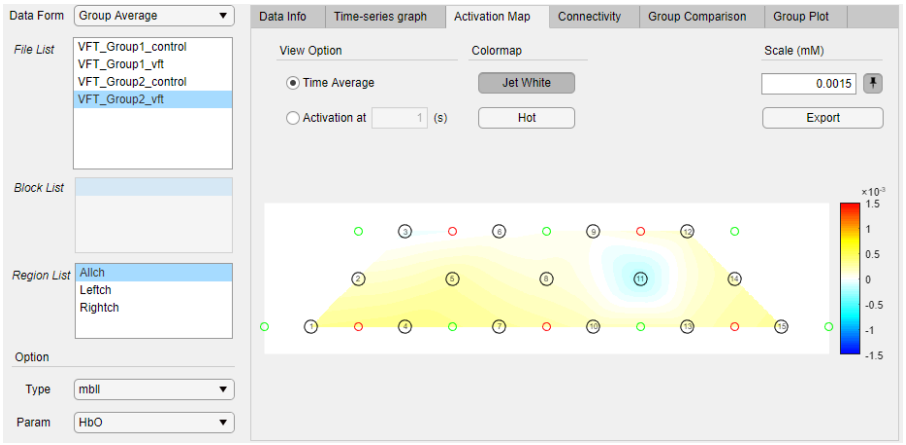


3.7.5 Comparing Activation Map

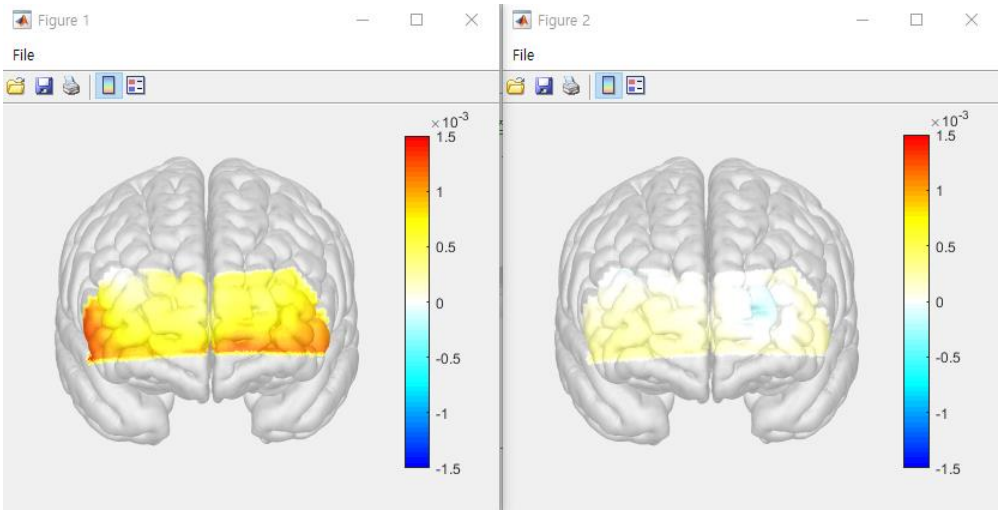
User can compare Activation Map of Group Average Data. For precise comparison, the axis values are fixed.

(Activation Map during VFT by Group 1)

(Activation Map during VFT by Group 2)



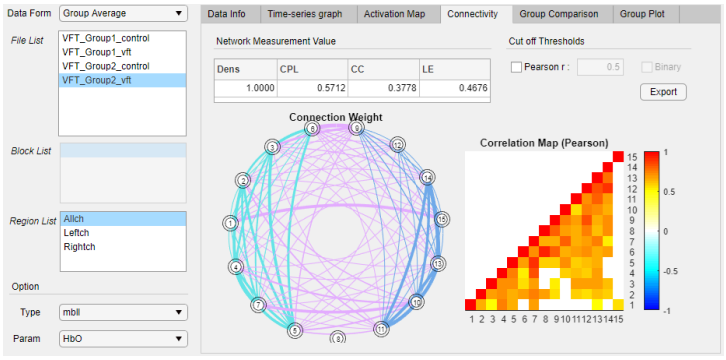
(Comparison after extracting data as 3D Image)



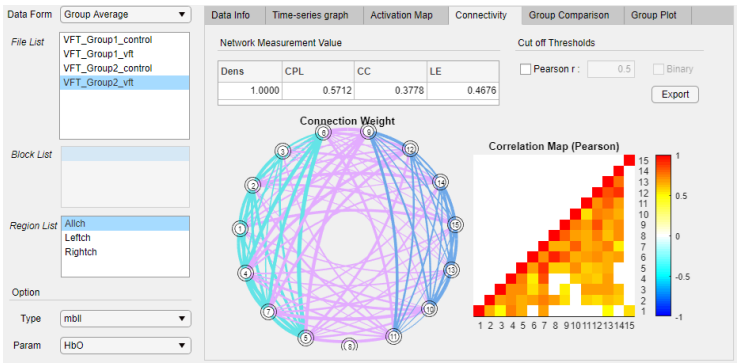
3.7.6 Comparing Connectivity

User can compare Connectivity of Group Average Data.

(Connectivity Result during VFT by Group 1)



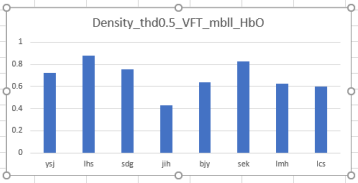
(Connectivity Result during VFT by Group 2)



User can set up Threshold and extract Density value from Block Average Data excel sheet and create a bar graph as shown below.

Block Average_2020-06-08_140818_lcs_VFT_Group1_vft_8_Allch															
	Density	Characteri	Clustering	Local Efficiency											
thd :0.5	0.6	1.337778	1.059034	0.932997											
R	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
14	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.99998
13	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0.99998
12	0	0	0	0	0	0	0	0	0	0	0	1	0.690445	0.690445	0.690425
11	0	0	0	0	0	0	0	0	0	0	1	0.587706	0.816491	0.816491	0.816597
10	0	0	0	0	0	0	0	0	0	1	0.890308	0.689633	0.928948	0.928948	0.928928
9	0	0	0	0	0	0	0	0	1	0	0	0.622727	0	0	0
8	0	0	0	0	0	0	0	1	0.737126	0	0	0	0	0	0
7	0	0	0	0	0	0	1	0	0	0.89229	0.816791	0.545856	0.762249	0.762249	0.762229
6	0	0	0	0	0	1	0	0.798097	0.821261	0	0	0	0	0	0
5	0	0	0	0	1	0.682183	0	0	0.677306	0	0	0.802457	0	0	0
4	0	0	0	1	0	0	0.762321	0	0	0.92902	0.816554	0.690499	0.999971	0.999971	0.999951
3	0	0	1	0.586021	0.870414	0.535295	0	0	0.683696	0.567303	0	0.966729	0.58605	0.58605	0.586029
2	0	1	0.585647	0.999569	0	0	0.761847	0	0	0.928546	0.81818	0.690043	0.999598	0.999598	0.999639
1	1	0.98606	0.587954	0.985384	0	0	0.775669	0	0	0.934419	0.851166	0.694635	0.985413	0.985413	0.985456

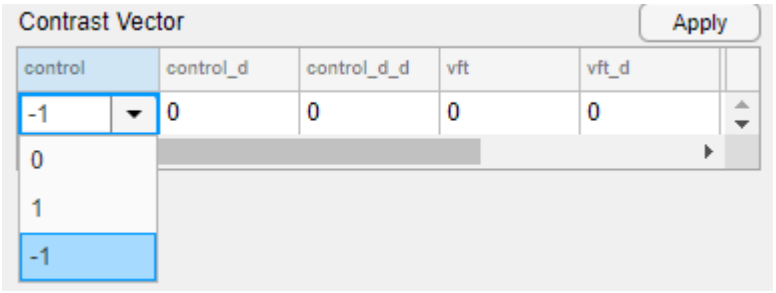
thd :0.5	Density
ysj	0.72381
lhs	0.87619
sdg	0.752381
jih	0.428571
bjy	0.638095
sek	0.824176
lmh	0.628571
lcs	0.6

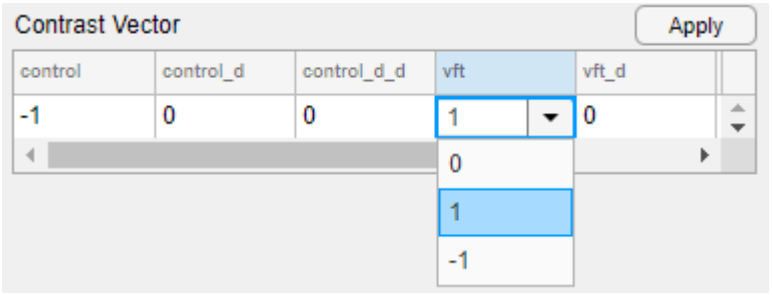


3.7.7 Example: 1st GLM

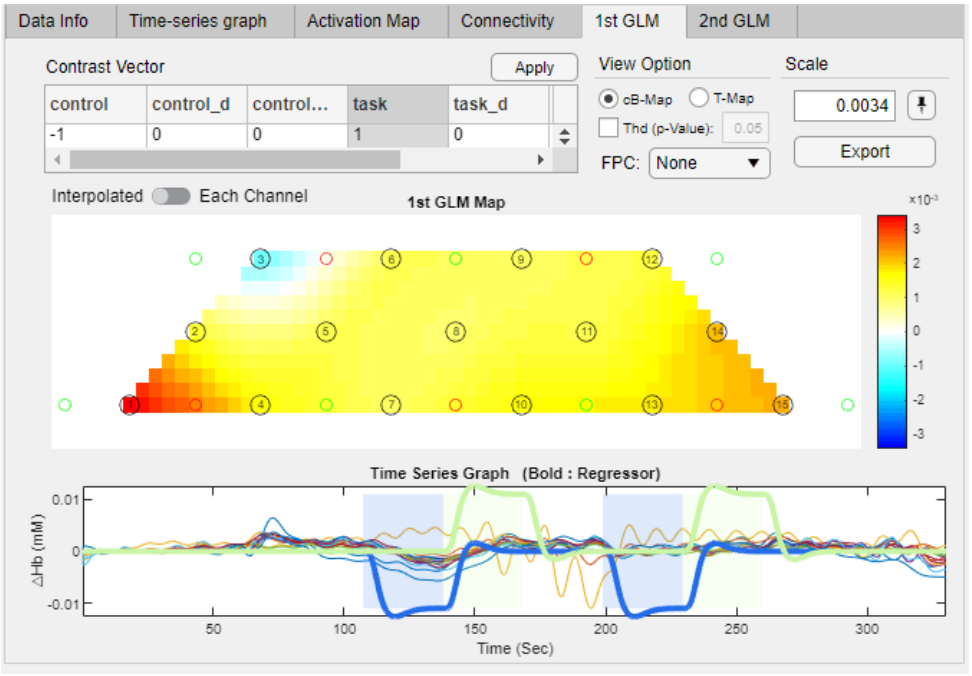
1. Select Entire Data and click 1st GLM Tab.

2. Double click Table and input Contrast Vector value.





3. Once the input is complete, click **Apply** button.



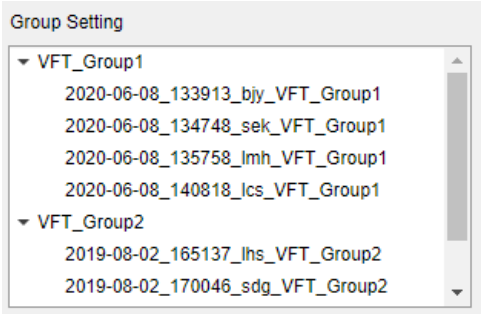
4. User can double check GLM Map by changing File List. (3D image extraction is also possible)

5. User can utilize cB-value by extracting the same.

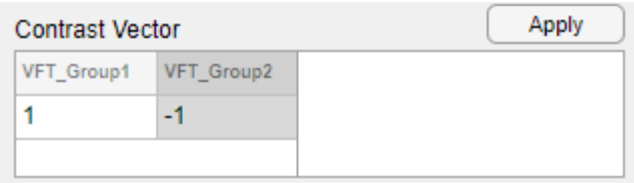
3.7.8 Example: 2nd GLM

1. User can click 2nd GLM Tab for the data that has already gone through 1st GLM process.

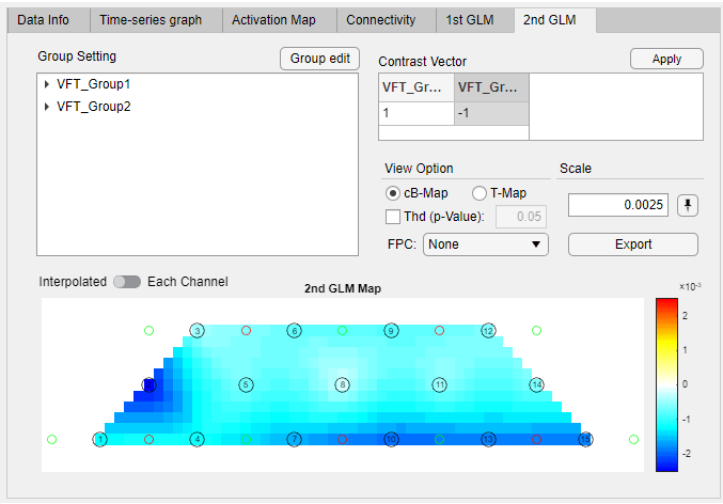
2. Please check the Group Setting result. The groups will be created automatically by Task name and Group name.



3. Double click the table and input Contrast Vector value.



4. Once the input is complete, click **Apply** button.



5. User can check the 2nd GLM result of Group 1 and Group 2. (3D image extraction is also possible)

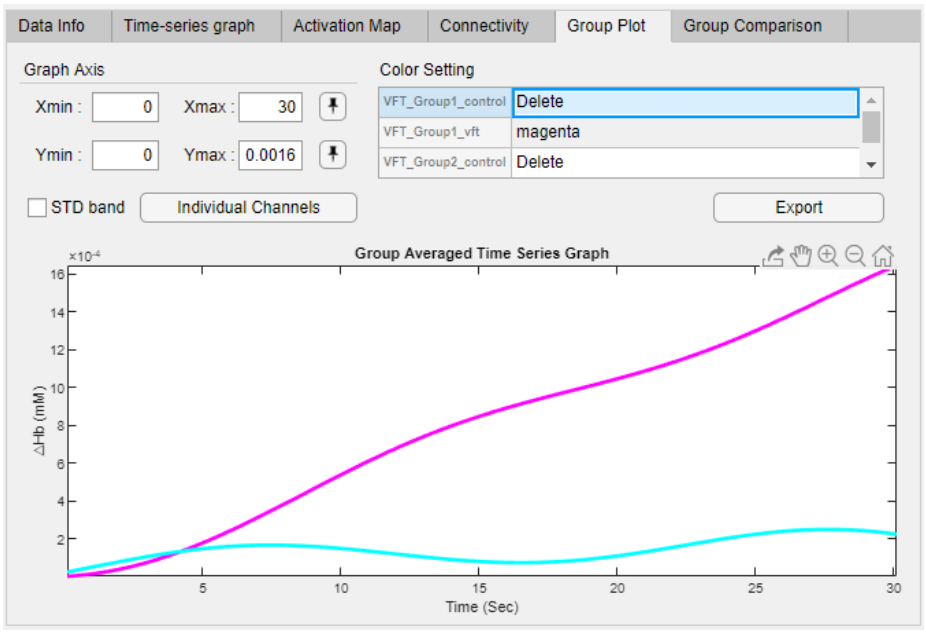
6. User can utilize cB-value by extracting the same.

3.7.9 Time-Series Graph Group Comparison

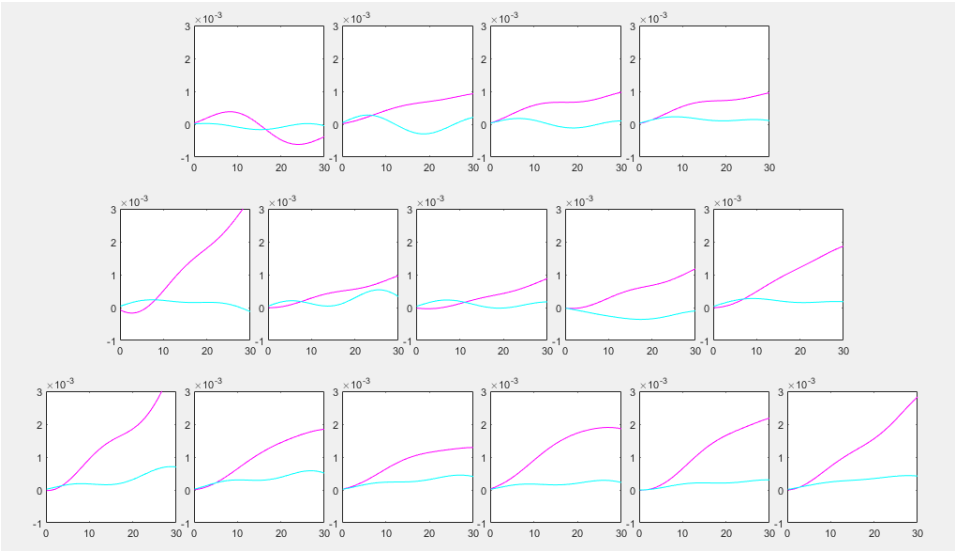
1. Select Group Average Data and click Group Plot Tab.

2. User can find that each channel average value in Group Average Data is plotted in lines. Initially, all lines will be shown in black, so User can designate different color line for each Group.

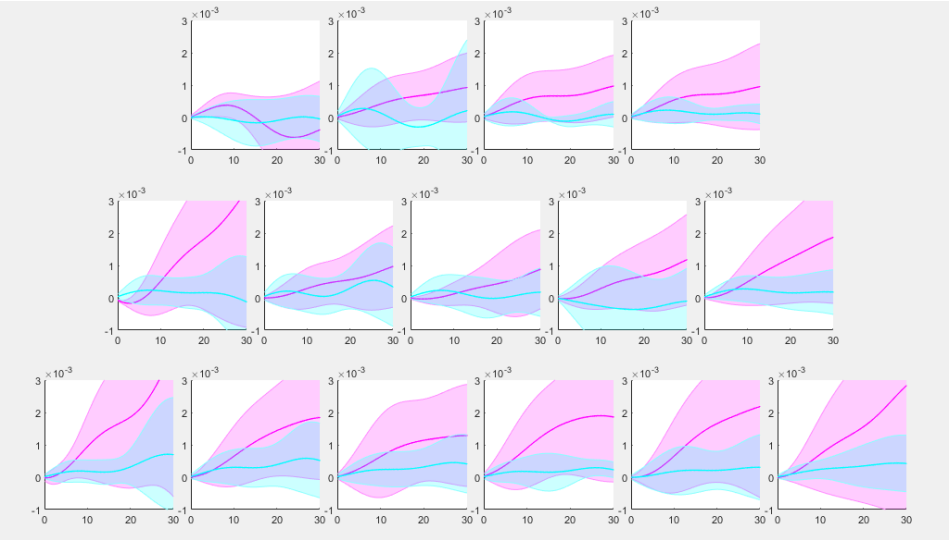
3. For instance, to compare VFT period between Group 1 and Group 2, User can change Group1_vft color to 'magenta', and Group2_vft color to 'cyan', and the remaining graph can be deleted.



4. User can check the data by channel by region by clicking **Individual Channels** button. It is advised that the y axis be modified or fixed accordingly.



5. By placing a check in the check box next to STD band, User can extract the following.



OBELAB