陽明交大
NYCU

NBA
Laboratory of Neuroimage Biomarker Analysis

fNIRS訊號處理 - Homer3

教育訓練工作坊

http://www.ym.edu.tw/~cflu/CFLu_course_fnirsWorkshop.html

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國立陽明交通大學
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講習內容安排

- 9:00~10:20 fNIRS原理簡介&實驗設計
- 10:30~12:00 NIRSport2硬體介紹&操作
- 12:00~13:30 用餐與休息
- **13:30 ~14:50 Homer 3訊號處理**
- 15:10~16:00 基礎統計分析&GLM

HOMER & ATLASVIEWER

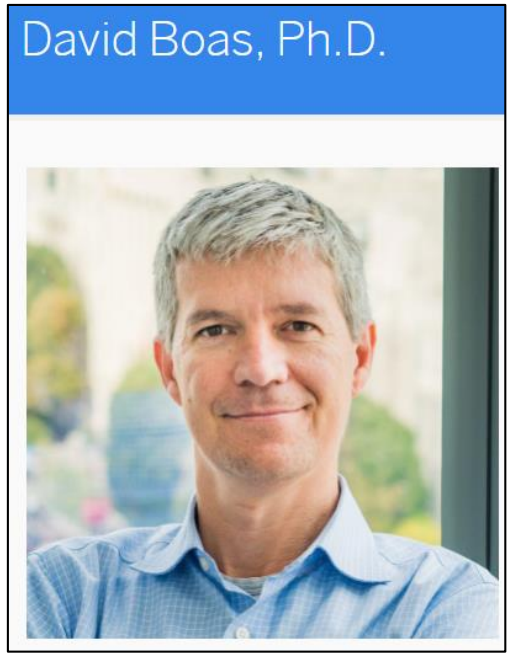
https://openfnirs.org/software/homer/

Homer3 and **AtlasViewer** are MATLAB applications that provide an open-source platform for the analysis and display of fNIRS data.

Homer3 is the latest installment in the HOMER software series. It builds upon Homer2 by enabling custom processing scripts at subject and group levels. This will enable more powerful statistical analyses of these results results. Homer3 also implements the **Shared NIR Data Format (SNIRF)** that has been developed and adopted by a broad consortium of software and hardware developers.

Huppert, T., Diamond, S., Franceschini, M., Boas, D. (2009). HomER: a review of time-series analysis methods for near-infrared spectroscopy of the brain.

BU College of Engineering



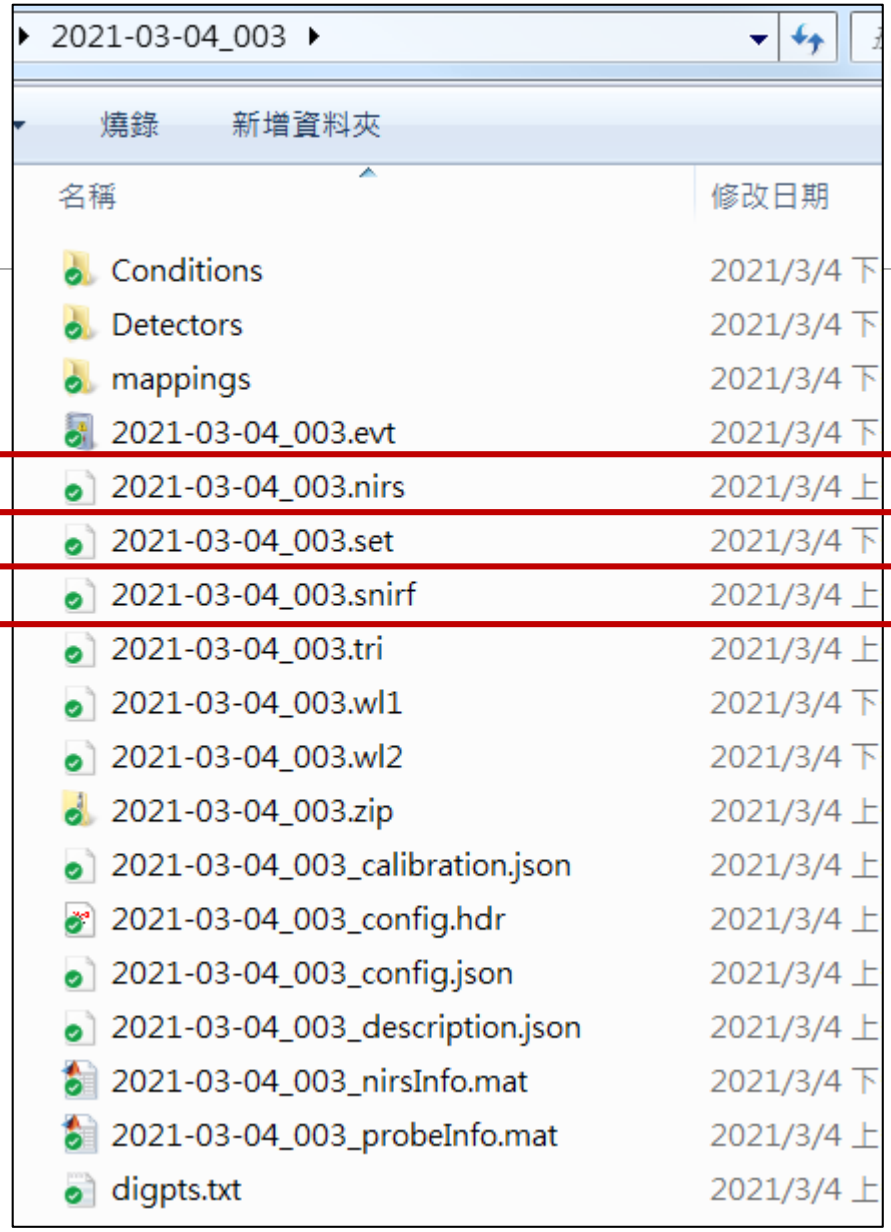
Professor (BME, ECE)
Director of Neurophotonics Center

Demo data

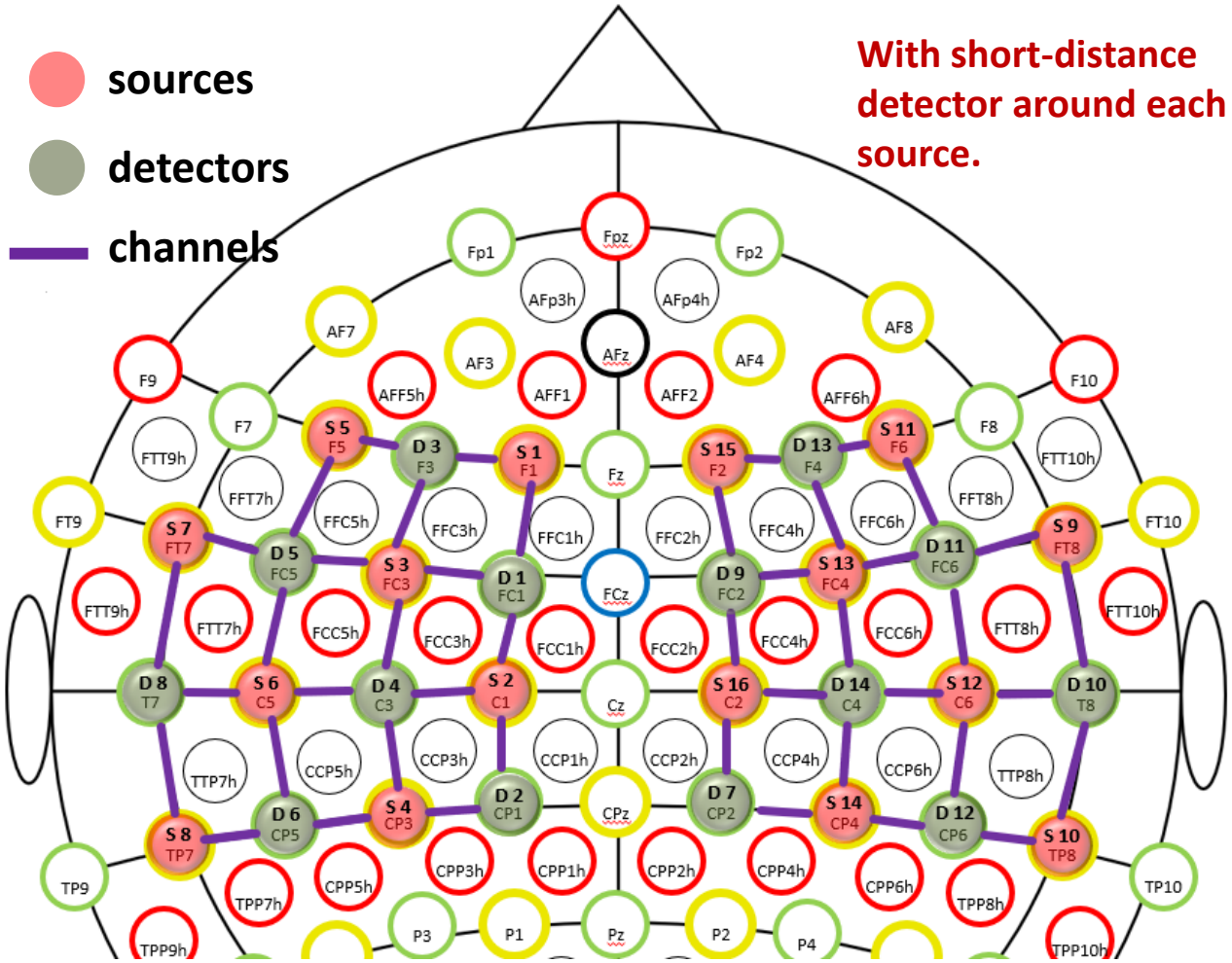
Recorded by NIRx NIRSport2 model.

Homer2 fNIRS data format (*.nirs, old)

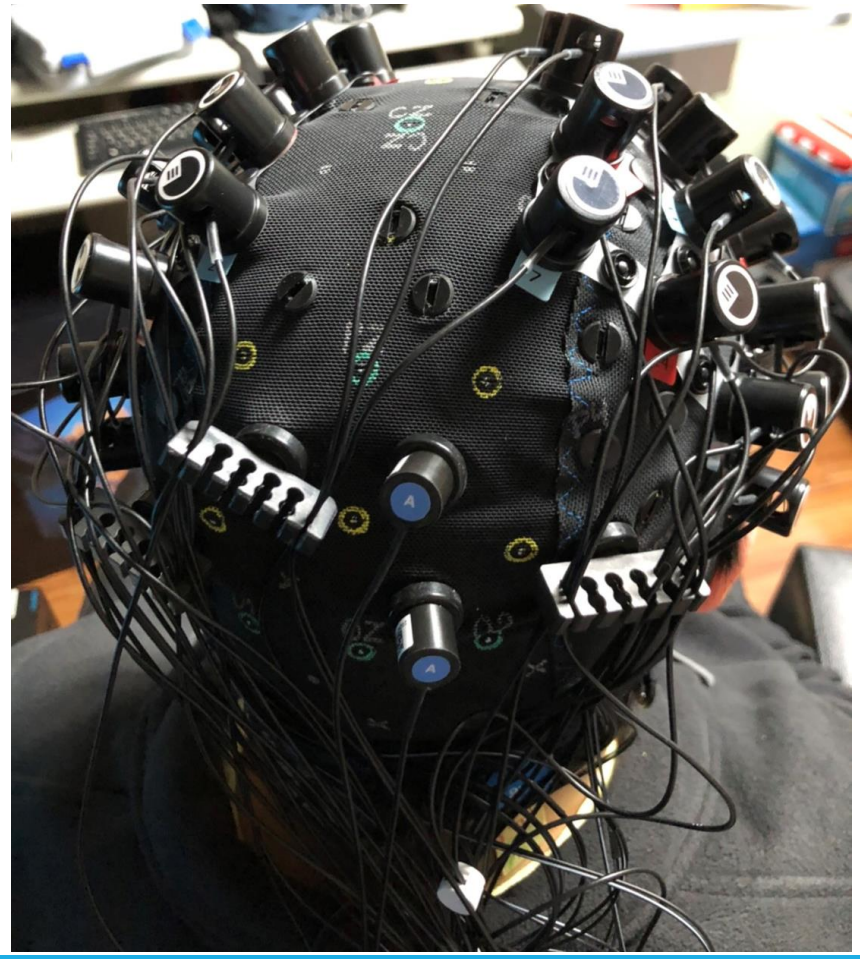
Homer3 fNIRS data format (*.snirf, new)



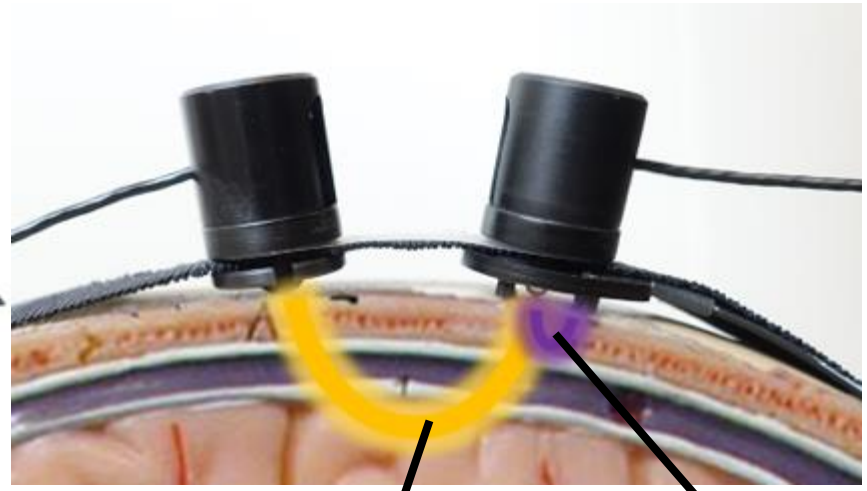
Source-Detector (SD) Layout



With short-distance detector around each source.

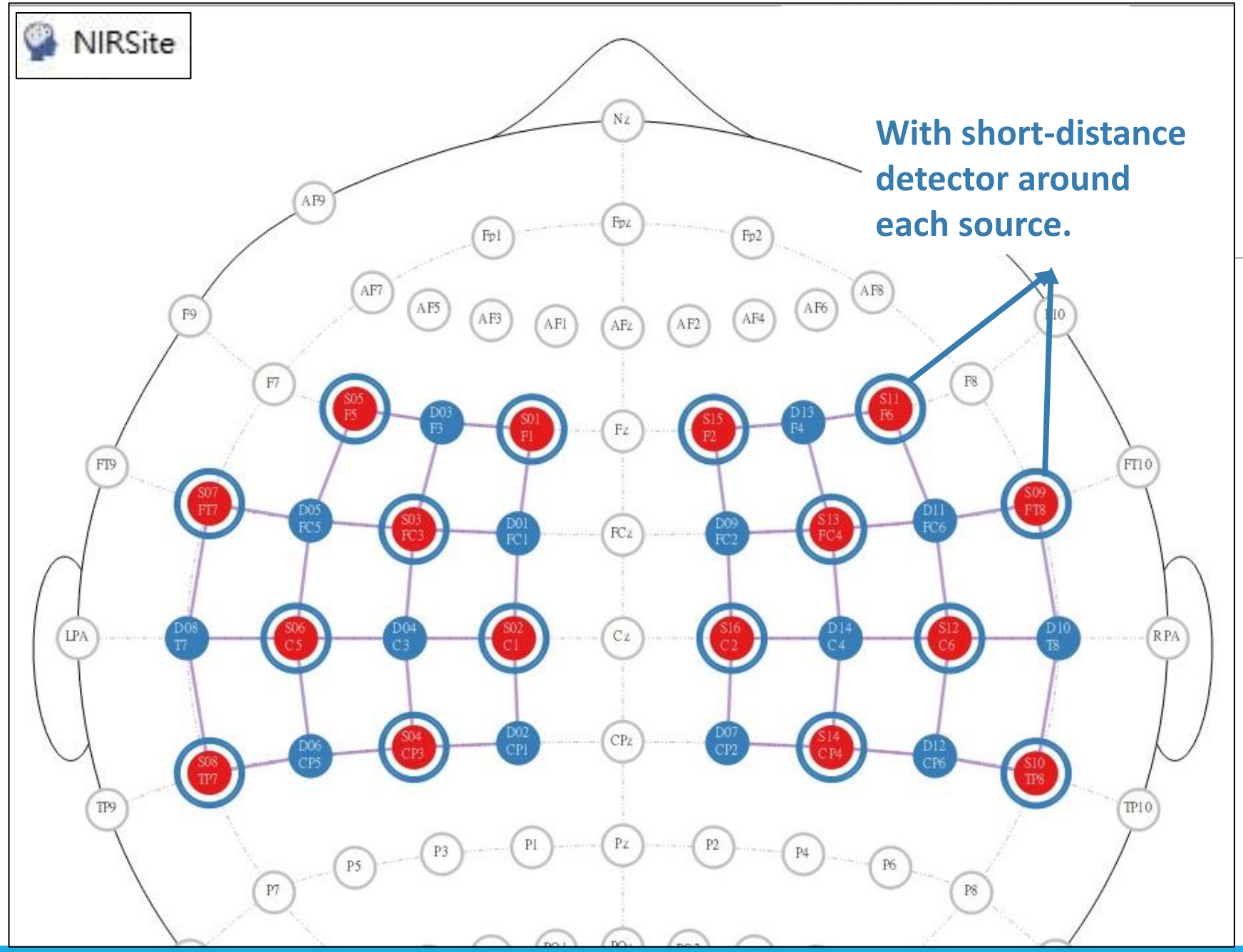


Short-Distance Detector (SDD) Setup



Mainly from cortex
With partly coverage of scalp

SDD: Mainly from scalp

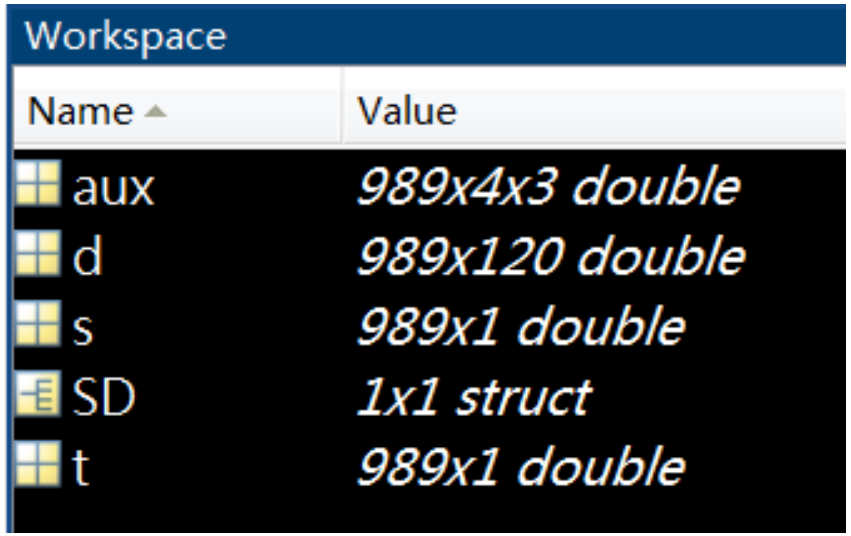

NIRSite
With short-distance detector around each source.
Nz
Fp1
Fpz
Fp2
AF9
AF7
AF5
AF3
AF1
AFz
AF2
AF4
AF6
AF8
F9
F7
F8
F10
FT9
FT10
LPA
RPA
TP9
TP10
P7
P5
P3
P1
Pz
P2
P4
P6
P8
S05 F5
D03 F3
S01 F1
Fz
S15 F2
D13 F4
S11 F6
S07 FT7
D05 FC5
S03 FC3
D01 FC1
FCz
D09 FC2
S13 FC4
D11 FC6
S09 FT8
D08 T7
S06 C5
D04 C3
S02 C1
Cz
S16 C2
D14 C4
S12 C6
D10 T8
S08 TP7
D06 CP5
S04 CP3
D02 CP1
CPz
D07 CP2
S14 CP4
D12 CP6
S10 TP8

Load old HOMER2 (*.nirs) Data Format

MATLAB mat-file format

```
>> load('2021-03-04_003.nirs','-mat')
```

aux: auxiliary signal
d: dual-wavelength signals for all channels
s: event time points
t: time axis in second
SD: source/detector geometry
SD.ml: lists of source-detector channels



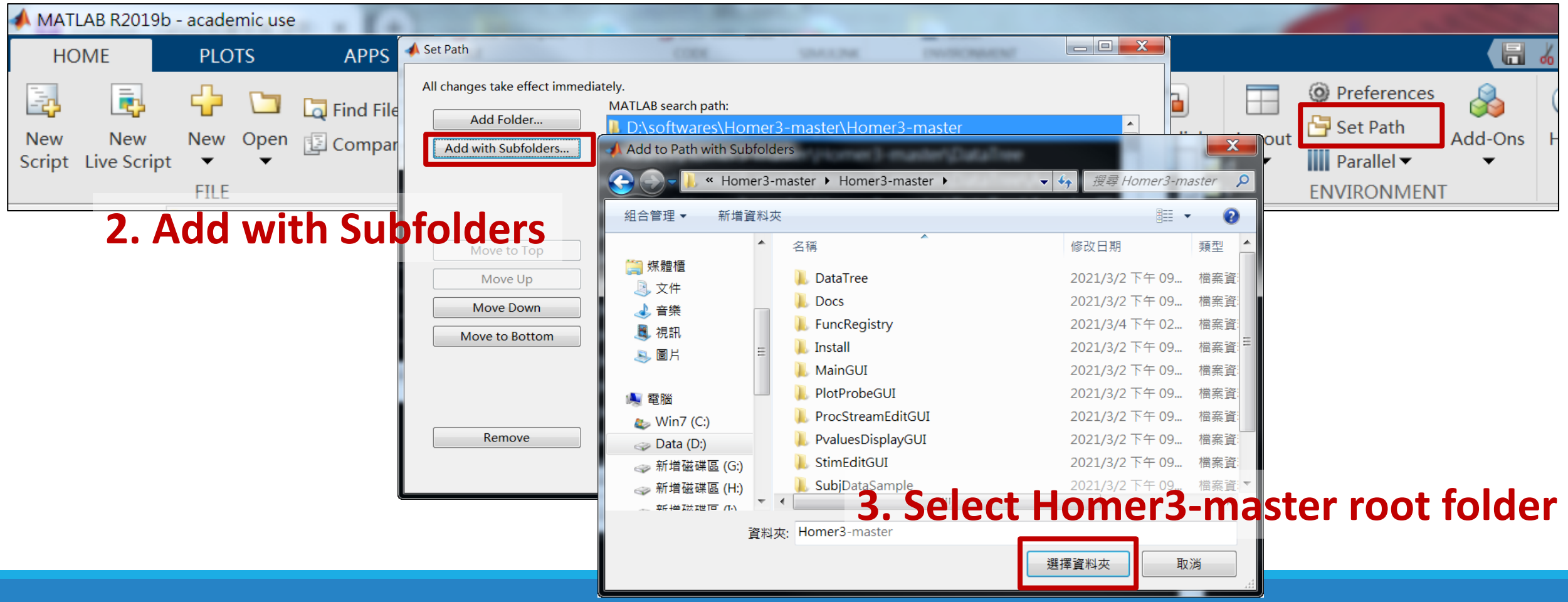
.SD file format

Describes the 2D source/detector geometry

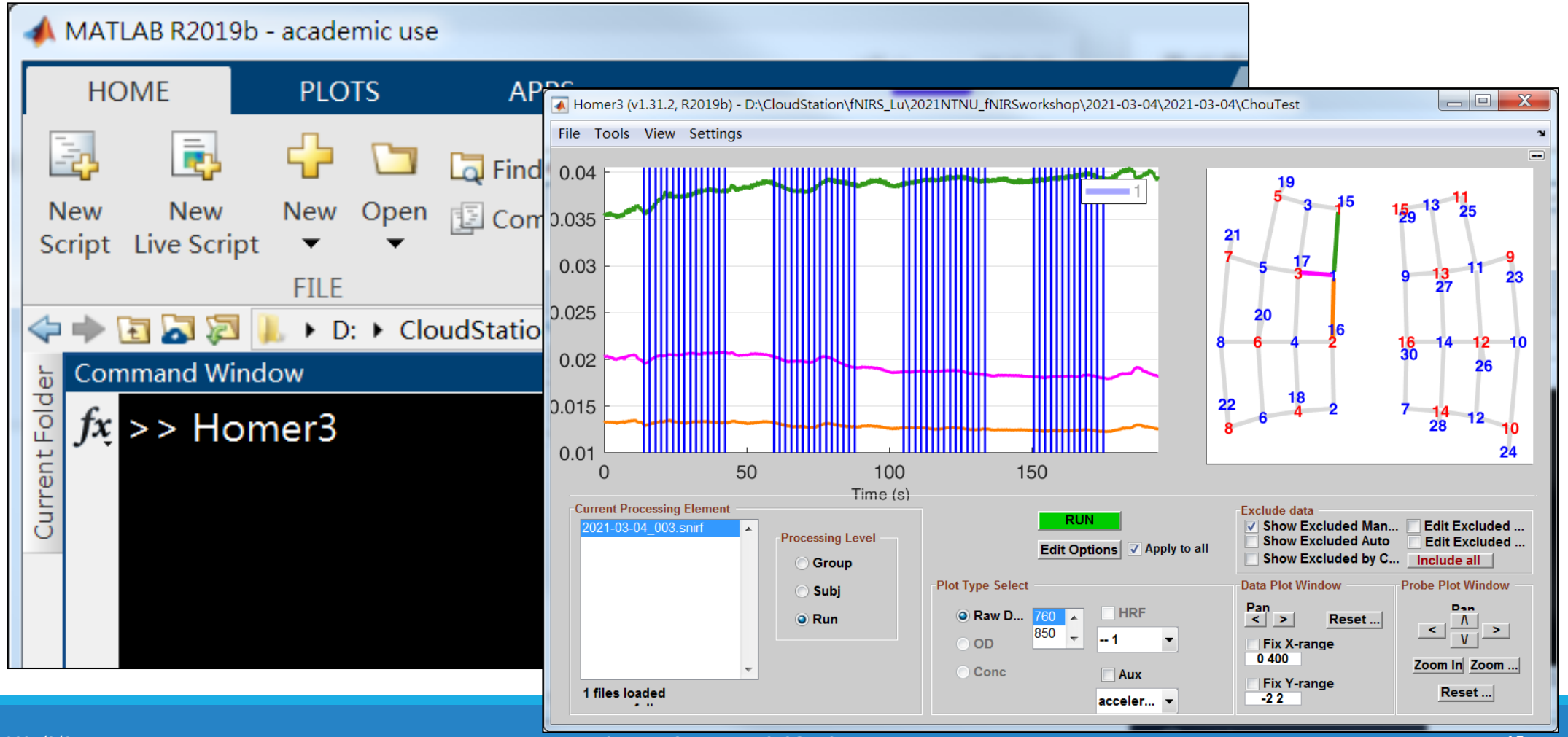
Matlab .sd file containing the structured variable **SD** with the following fields:

Field	Definition	Size	Example
Lambda	Wavelengths used for data acquisition	$1 \times n_{Wavelengths}$	[690 830]
nSrcs	Number of sources	1 × 1	1
nDets	Number of detectors	1 × 1	2
SrcPos	Array of source coordinates	nSrcs × 3	[0 0 0]
DetPos	Array of detector coordinates	nDets × 3	[30 0 0; 0 30 0]
MeasList	List of measurement channels column 1 source idx; column 2 detector idx; column 3 unused; column 4 wavelength idx	$n_{Channels} \times 4$	[1 1 1 1; 1 2 1 1; 1 1 1 2; 1 2 1 2]

Install Homer3



Initialize Homer3



http://www.ym.edu.tw/~cflu/Homer3-master.zip

Errors when initializing Homer3

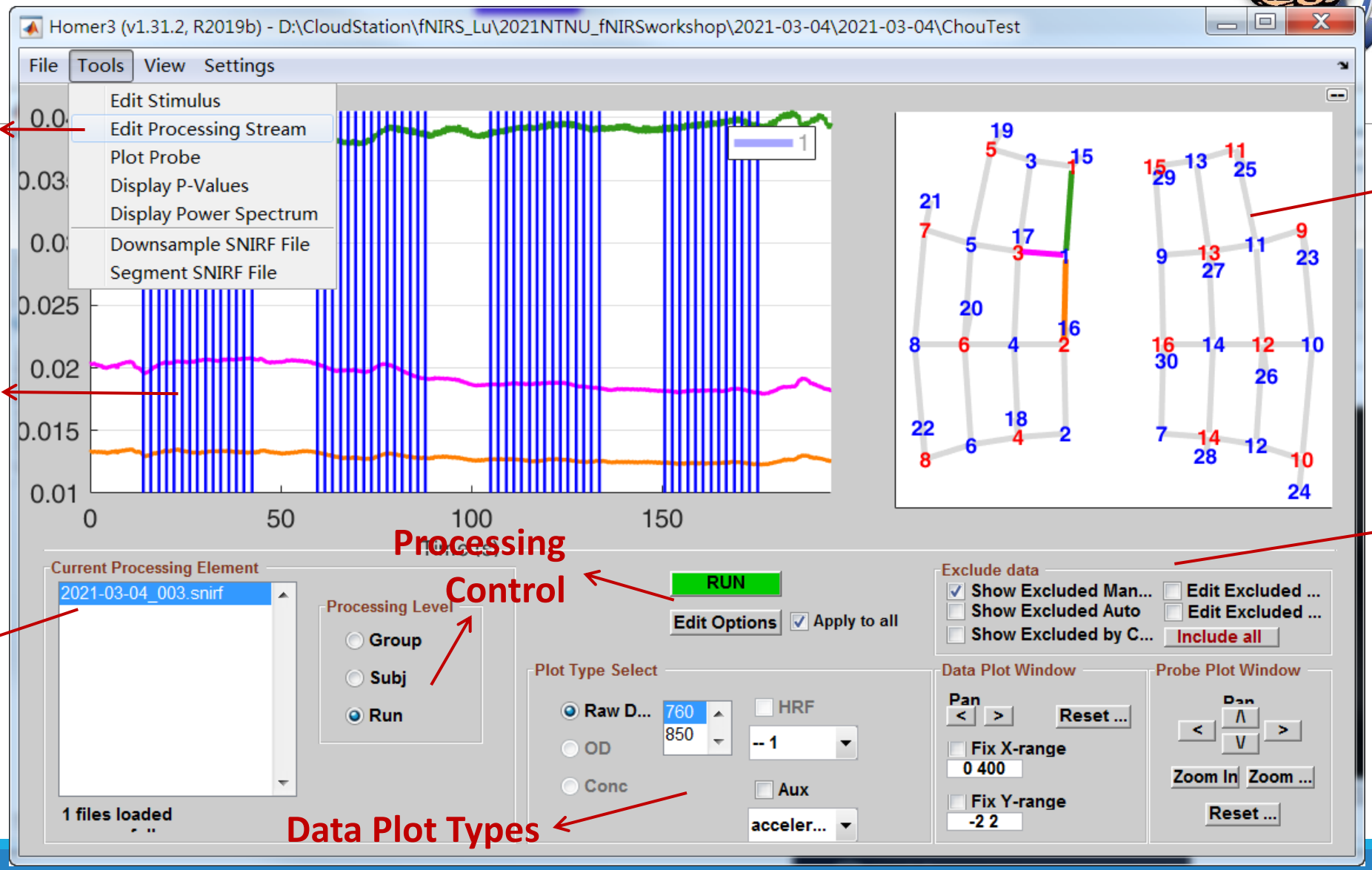
Error using datetime (line 636)
Could not recognize the date/time format of '**28-二月-2021 02:43:55**' using the locale 'zh_TW'. You can specify a format using the 'InputFormat' parameter.

Error in **FuncRegClass**/DateLastModified (line 397)
if datetime(file.date,'locale','system') > lastdt

Error using datetime (line 636)
Could not recognize the date/time format of '**03-三月-2021 15:15:10**' using the locale 'zh_TW'. You can specify a format using the 'InputFormat' parameter.

Error in **RegistriesClass**/IsValid (line 363)
if obj.funcReg(ii).DateLastModified() > datetime(regfile.date,'locale','system')

Homer3 User Interface



Processing Setup

Data Plot

File List

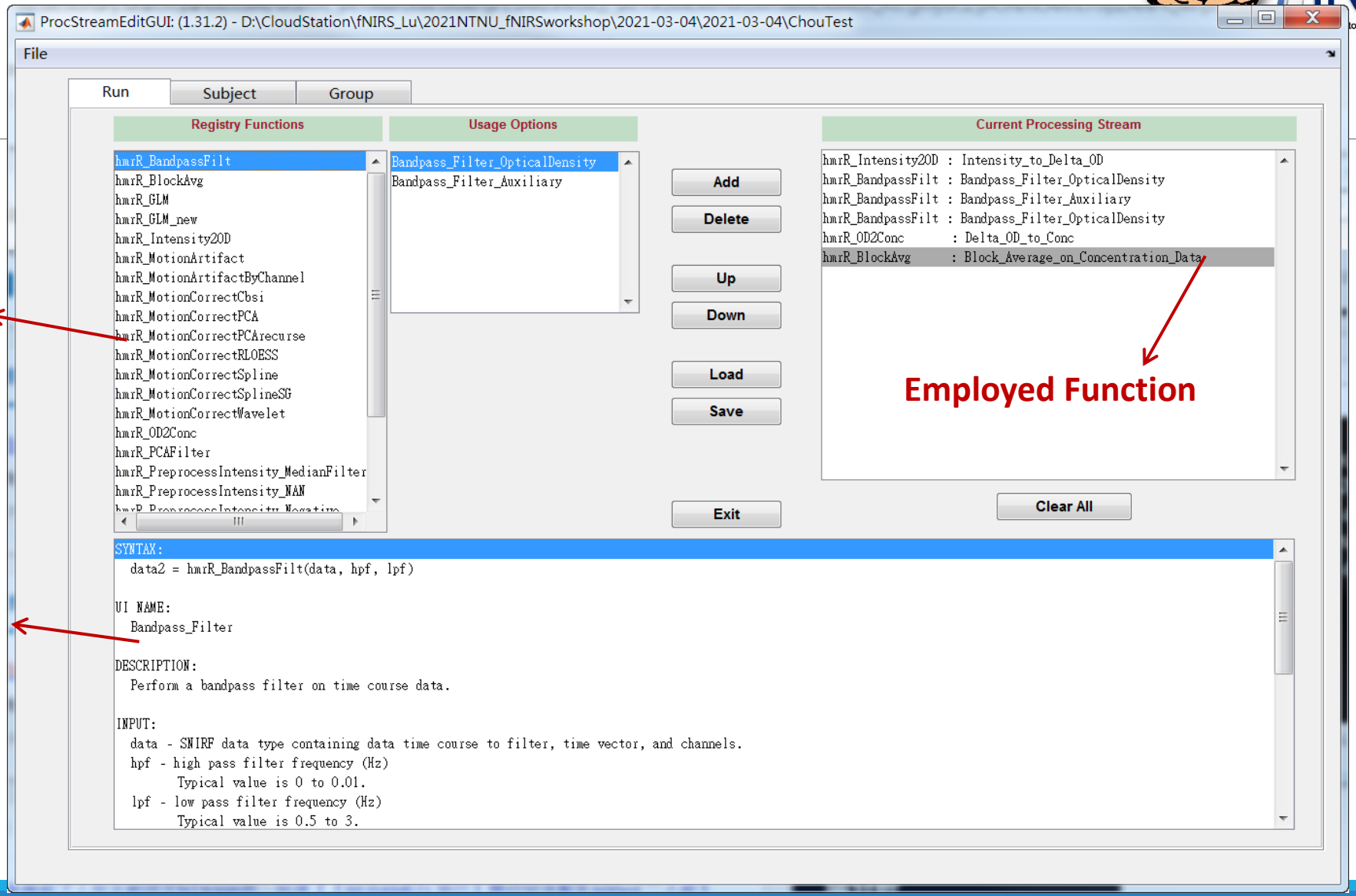
Processing Control

Data Plot Types

Probe Plot

Display Control

ProcStreamEditGUI



Function Library

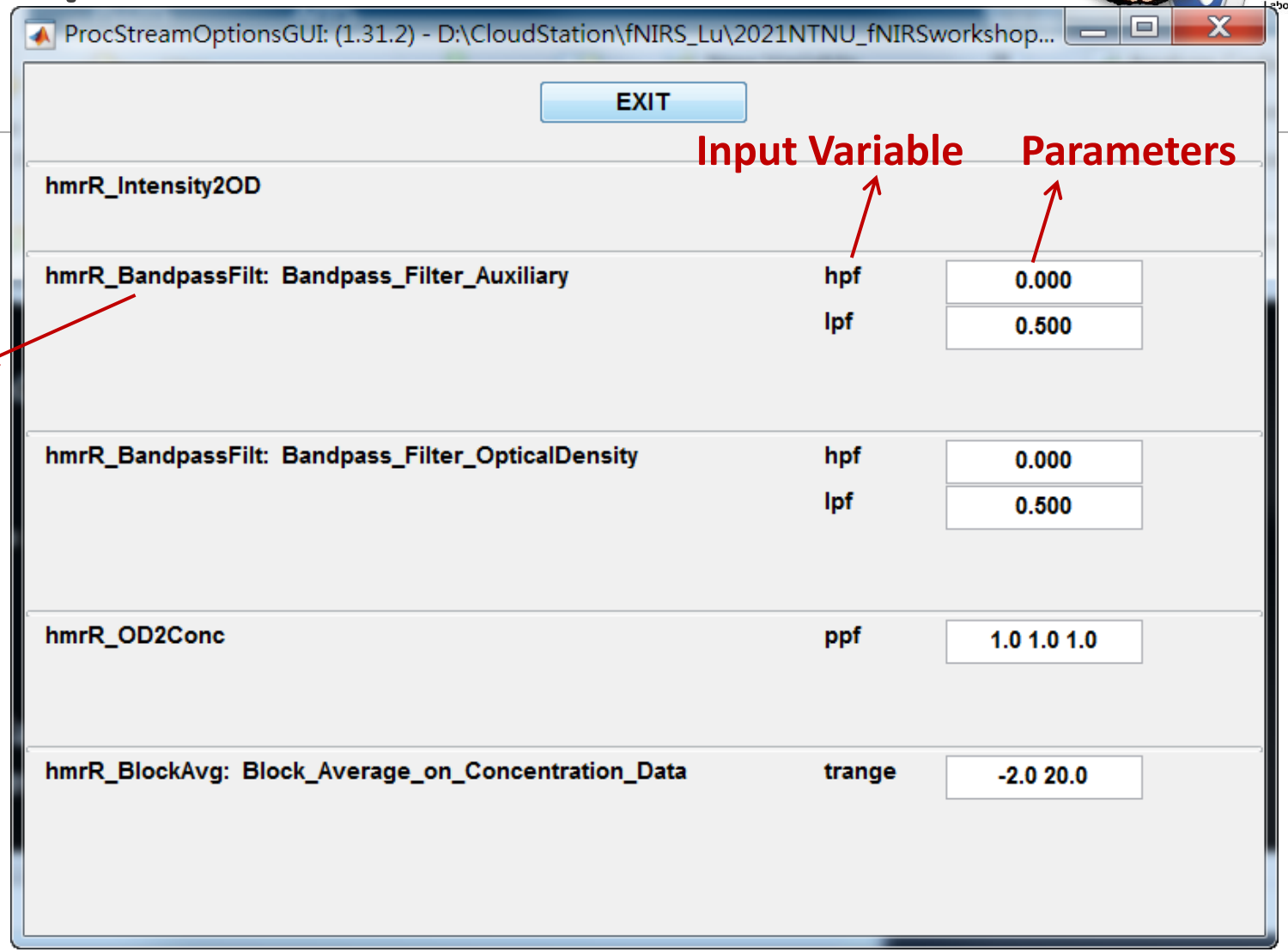
Function Description

Employed Function

ProcStreamOptionsGUI

Processing Control

→ Options



Homer File formats

Probe source-detector geometry : ***.sd** files

fNIRS experimental data : ***.nirs** files (old Homer2)

fNIRS experimental data : ***.snirf** files (new Homer3)

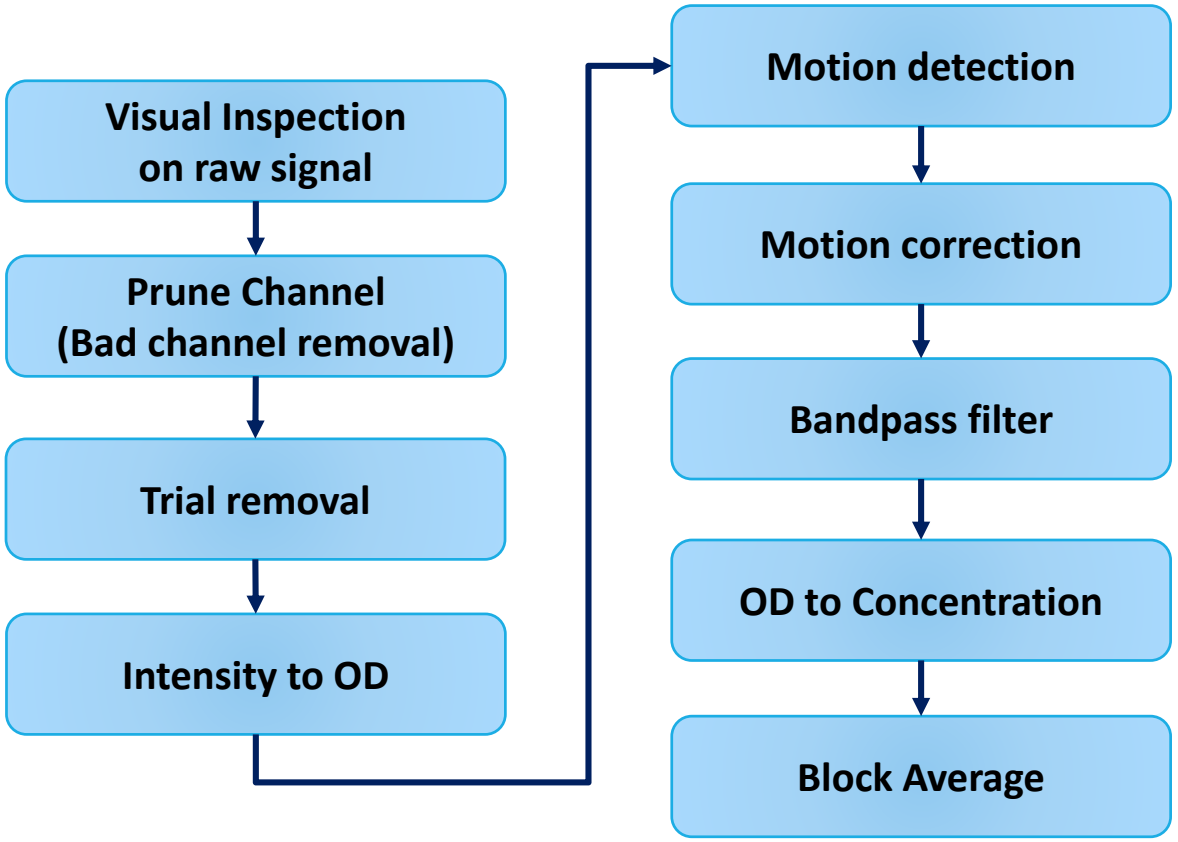
Data processing stream : ***.cfg** files

Processed data files : **groupResults.mat**

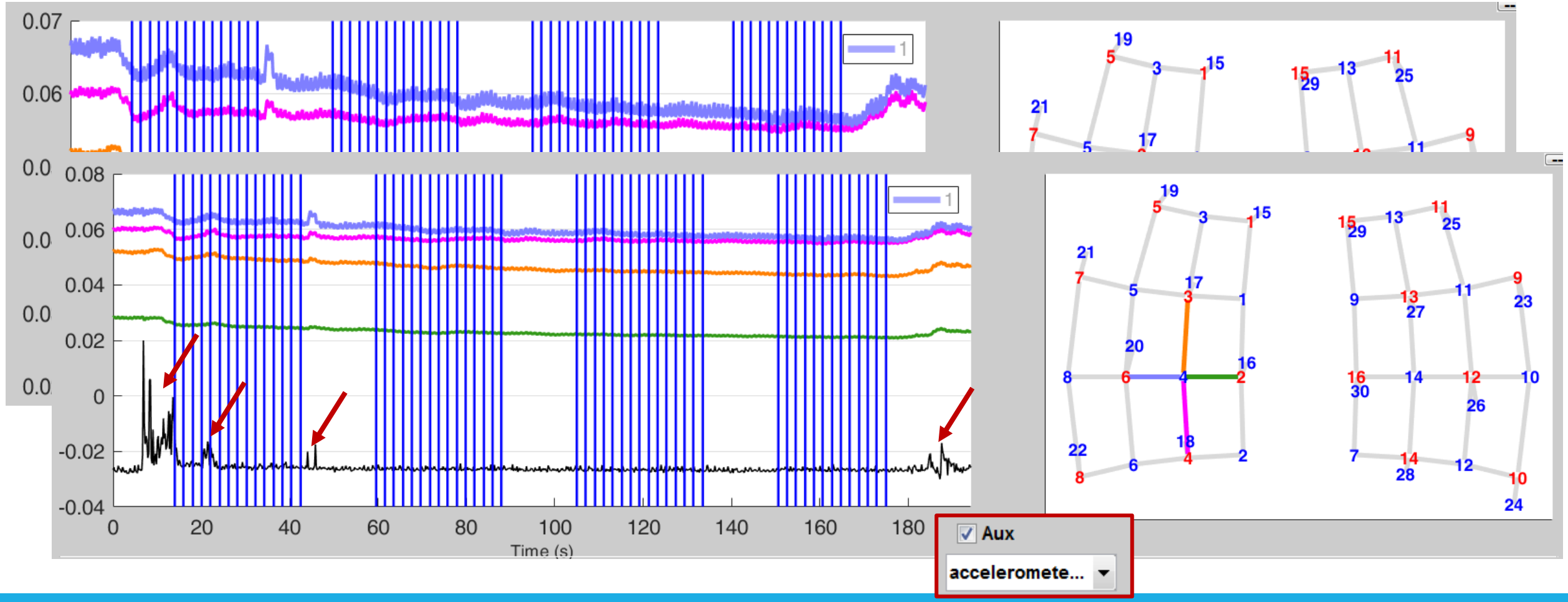
訊號處理流程

fNIRS signal processing

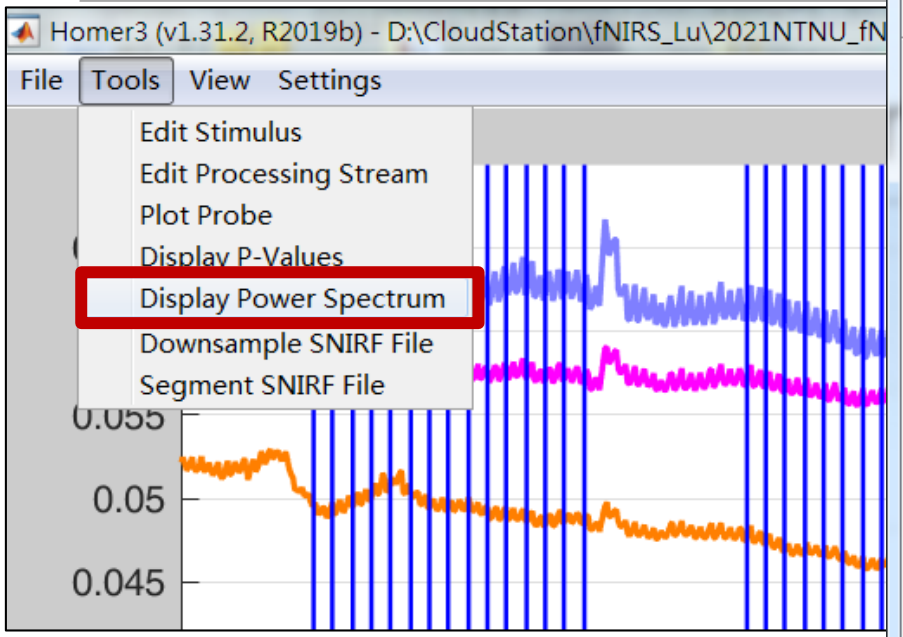
fNIRS Signal Processing Flow

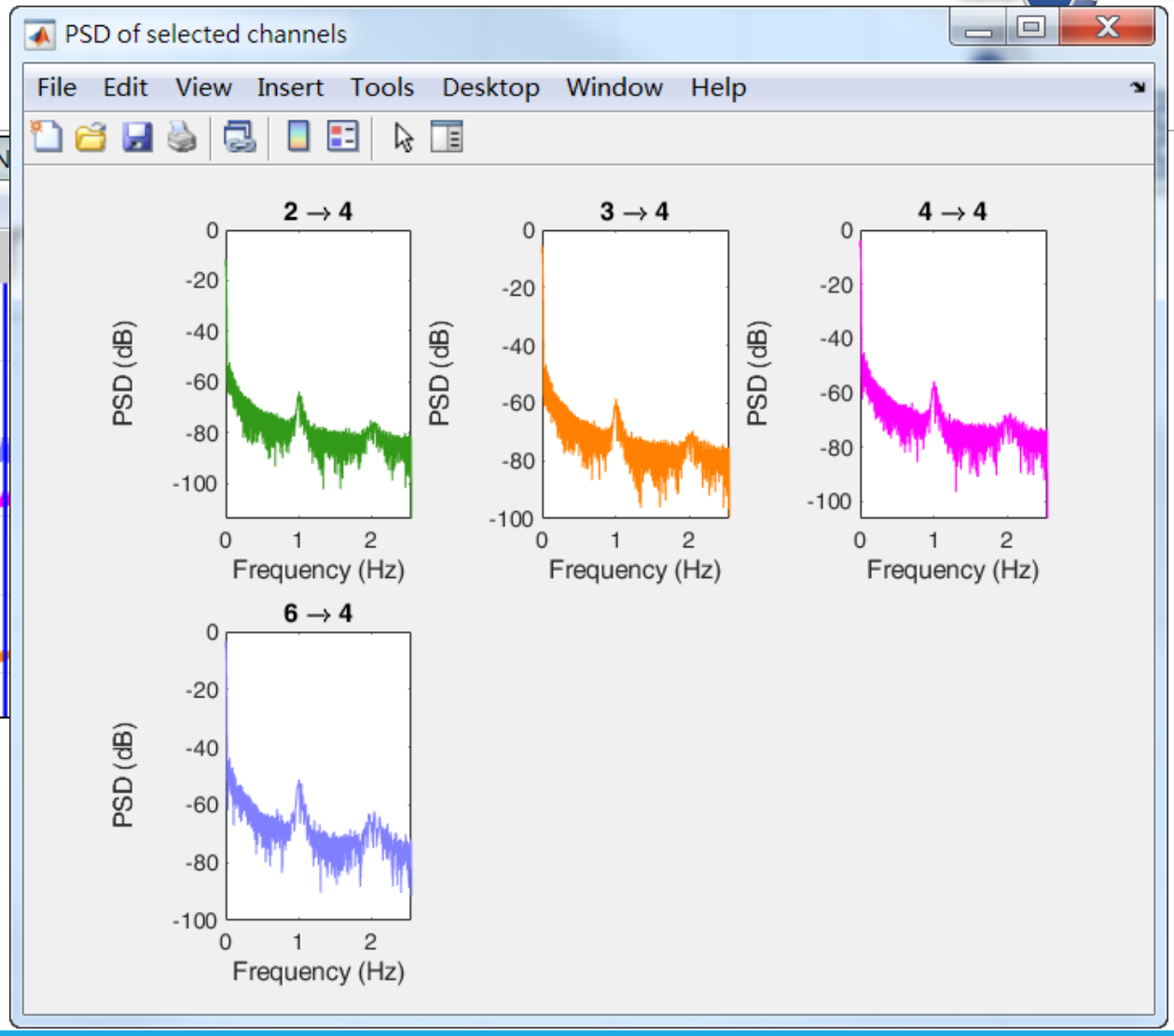


Visual Inspection



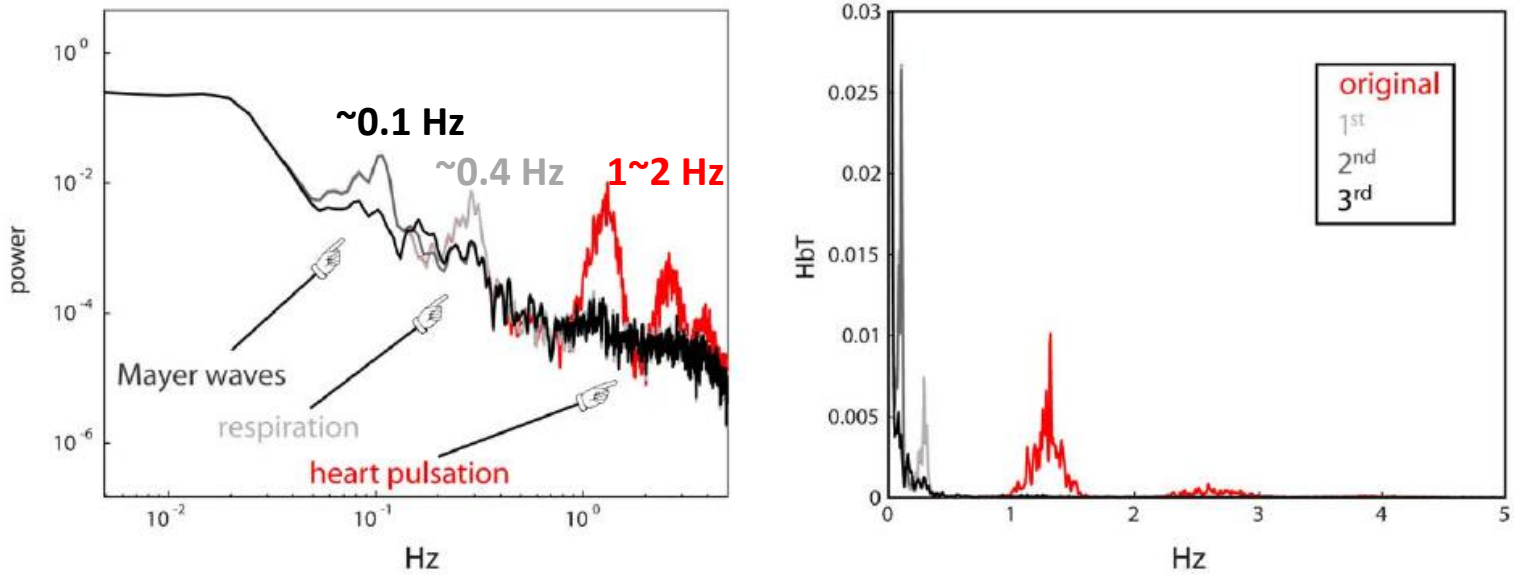
Visual Inspection





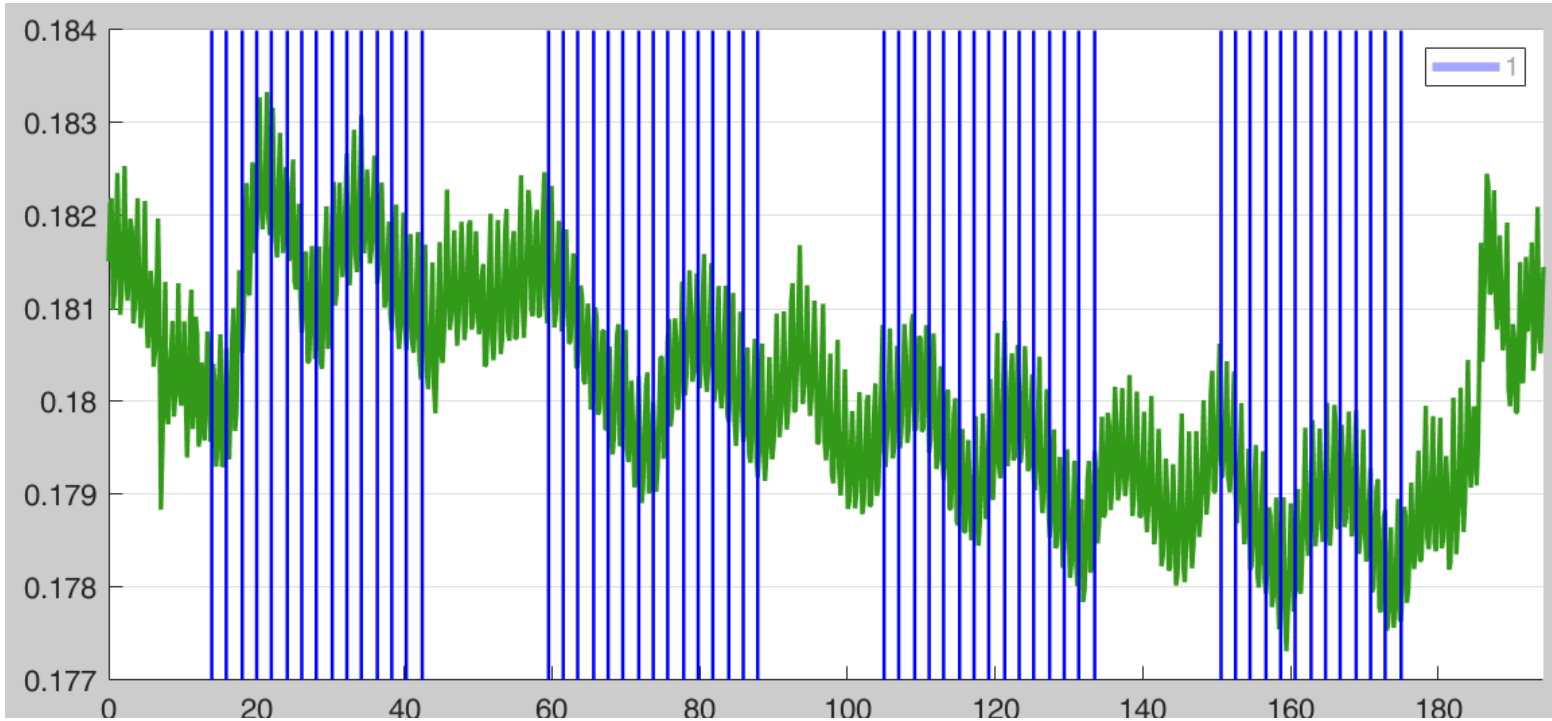
Physiological components

- Heartbeat, respiration, and blood pressure (Mayer waves)

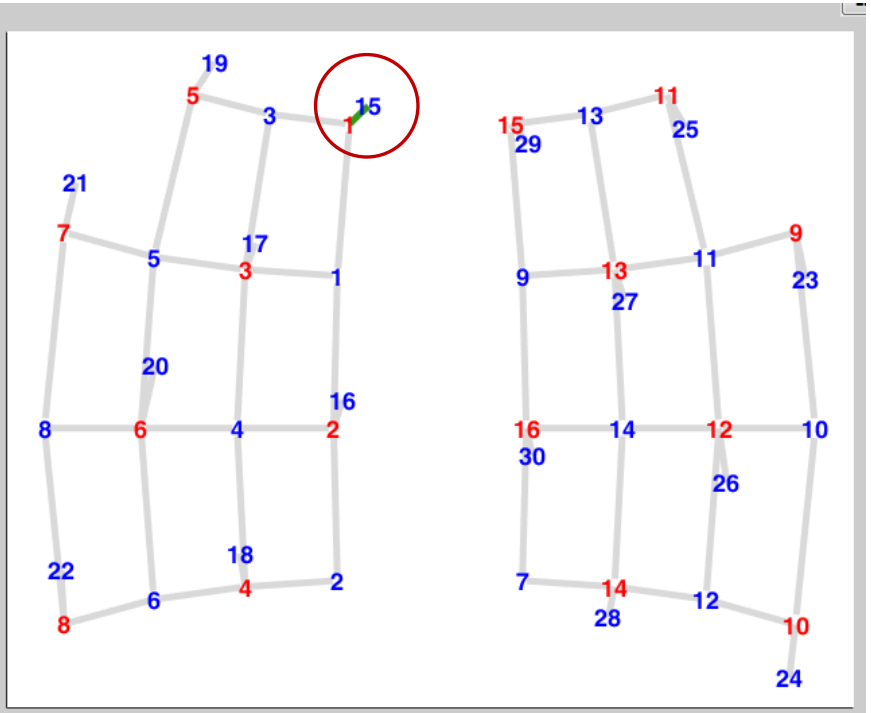


Fekete et al., 2011.

View Short-Distance Channels



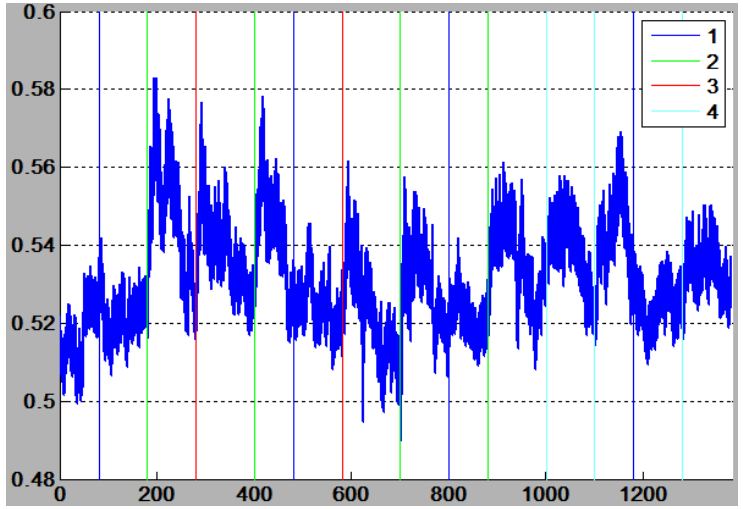
S1-D15

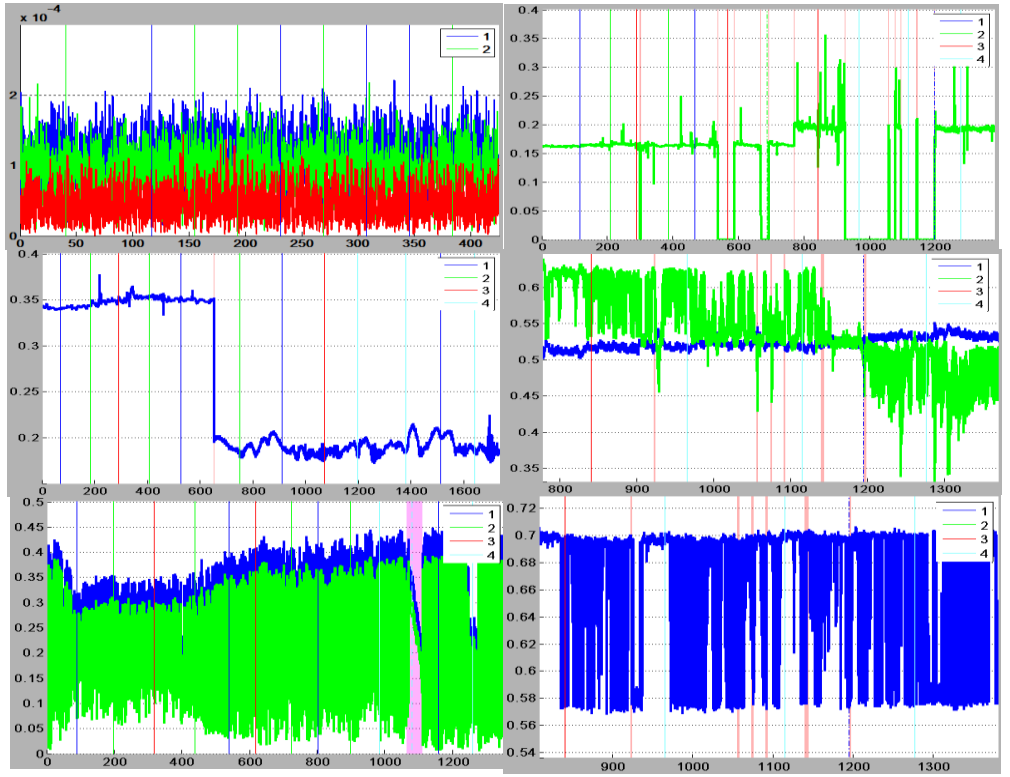


Visual Inspection

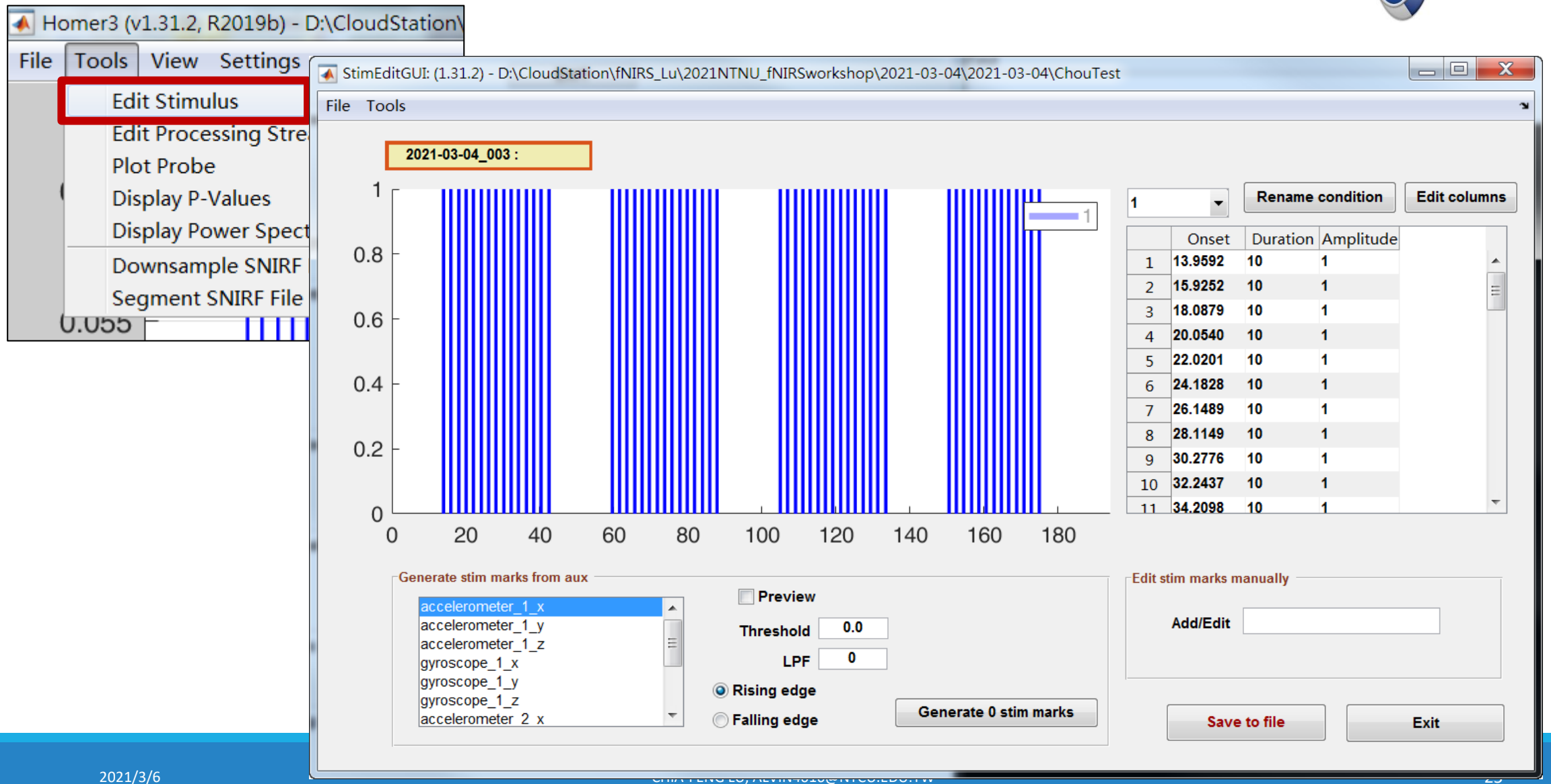
Bad signal quality ➔

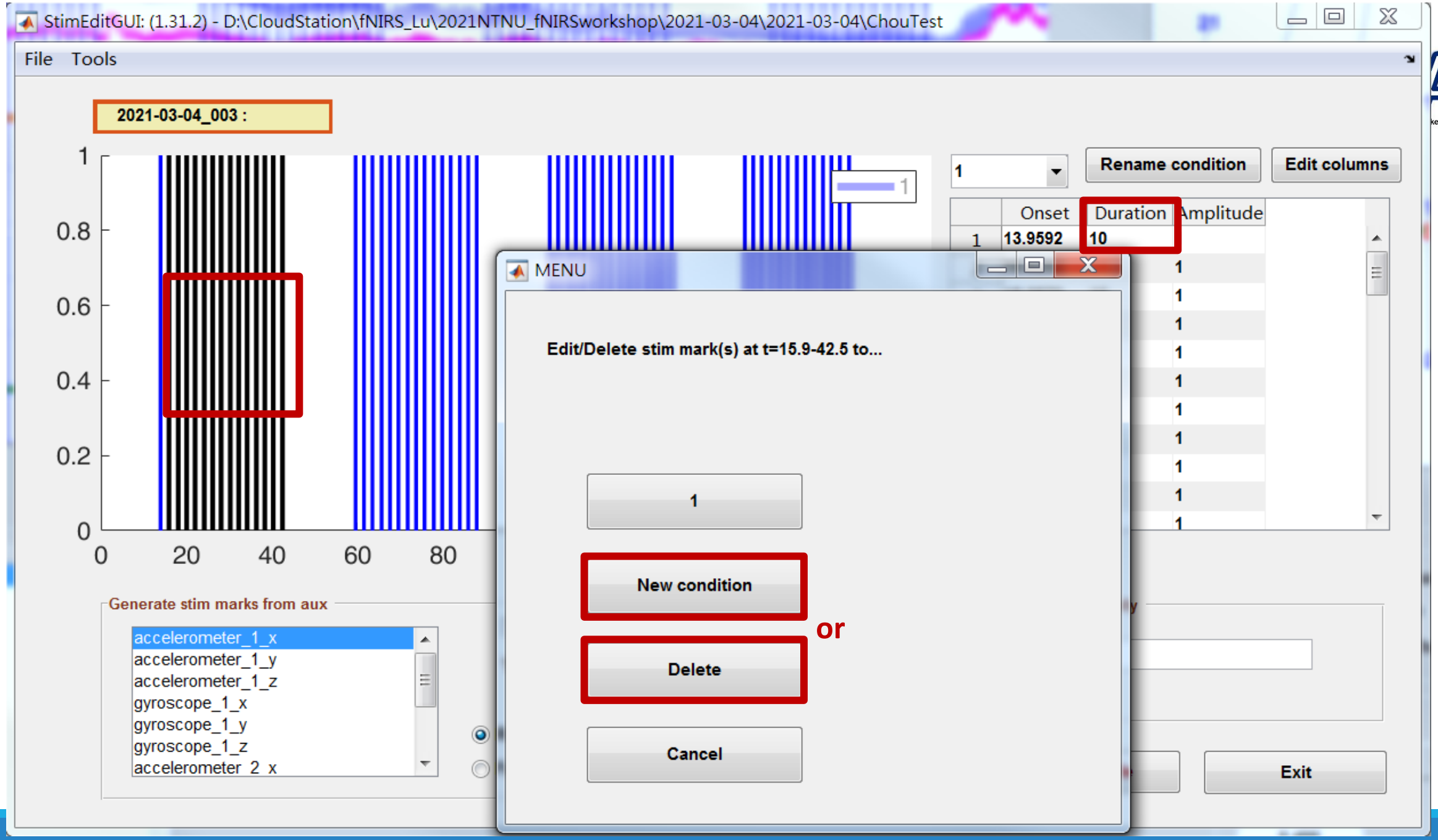
Sufficient signal quality

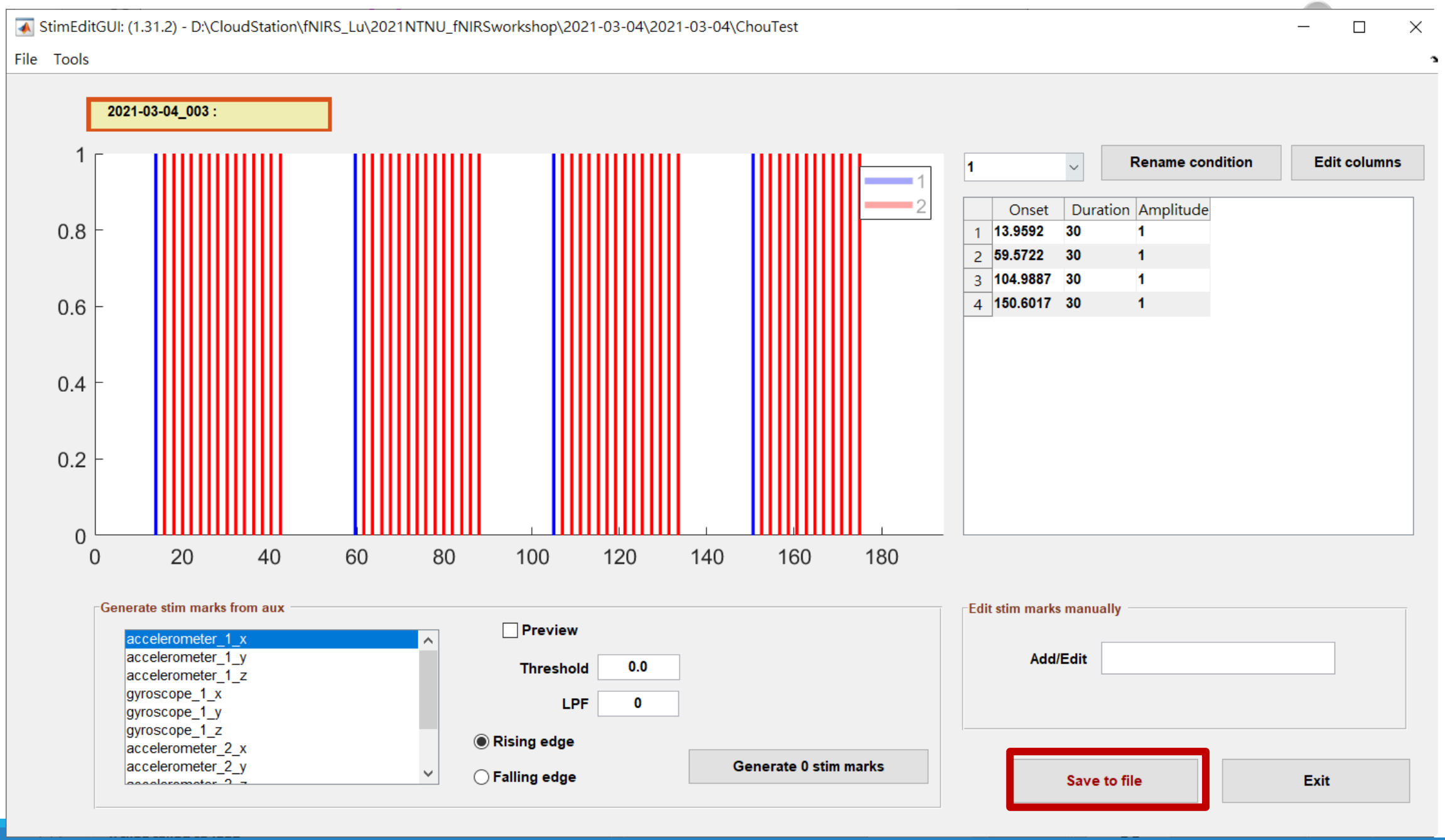


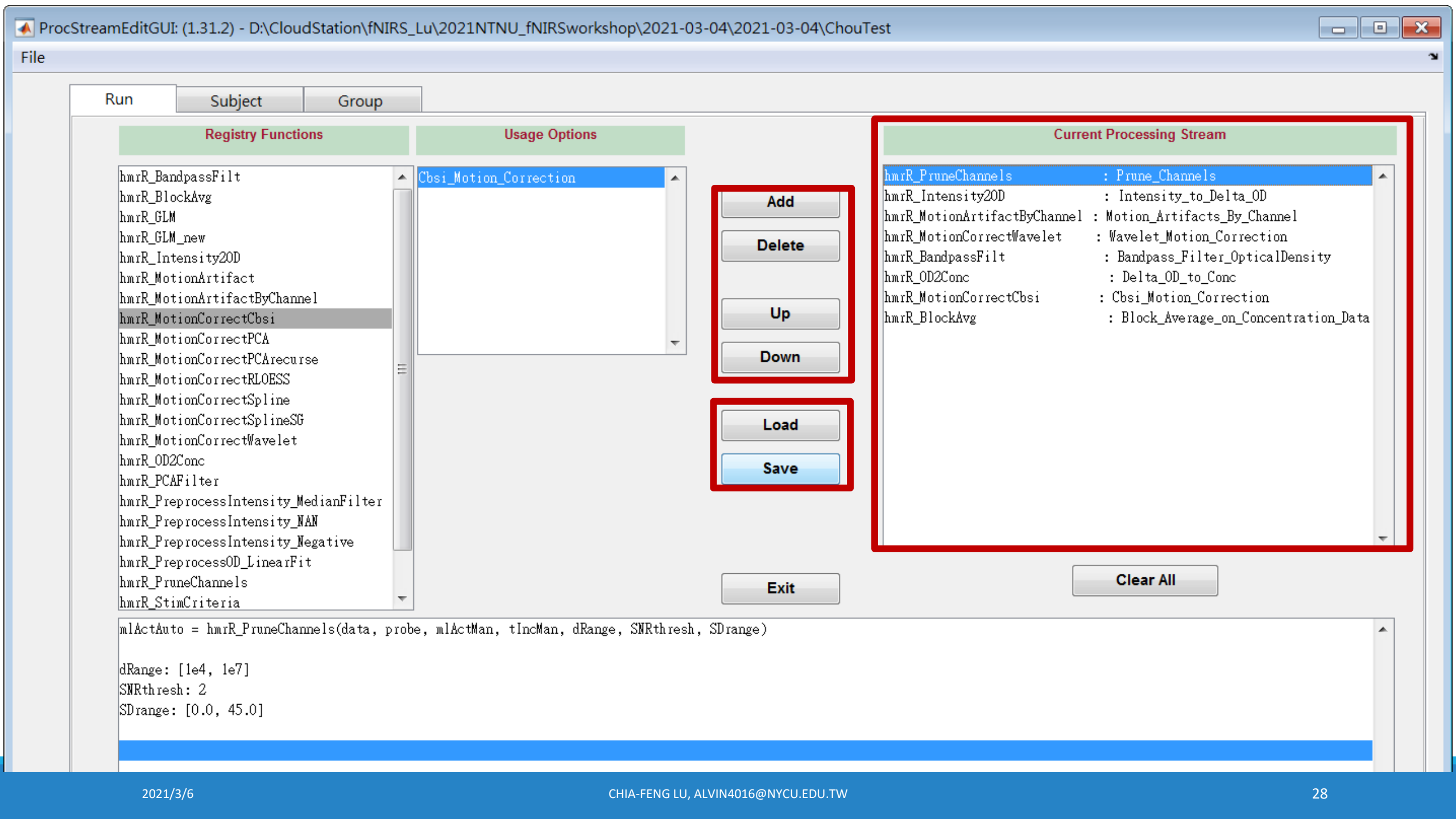


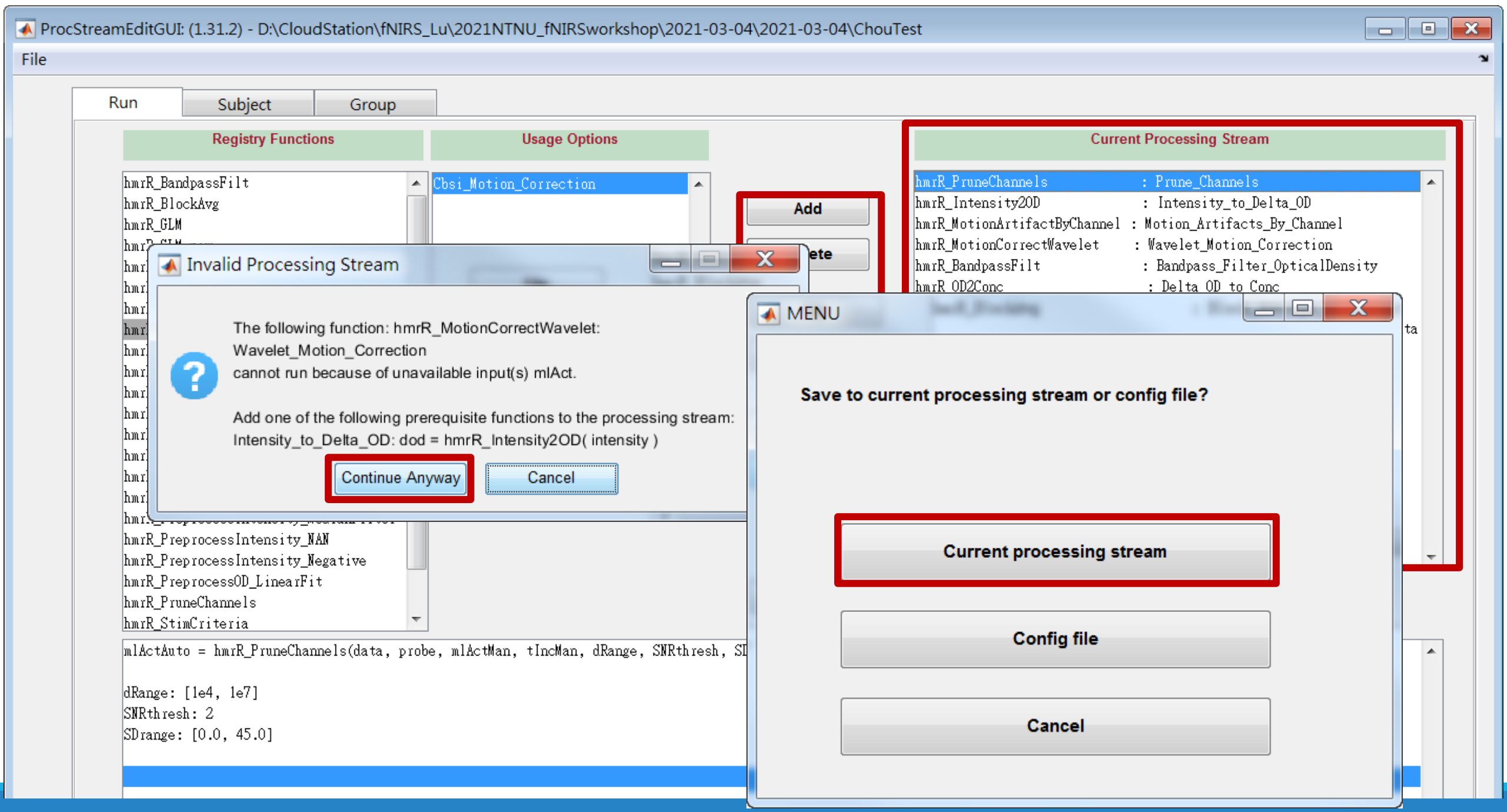
Edit (Add/Delete) Stimulate Marks




StimEditGUI: (1.31.2) - D:\CloudStation\fNIRS_Lu\2021NTNU_fNIRSworkshop\2021-03-04\2021-03-04\ChouTest
File Tools
2021-03-04_003 :
Rename condition
Edit columns
Onset
Duration
Amplitude
13.9592
10
MENU
Edit/Delete stim mark(s) at t=15.9-42.5 to...
1
New condition
or
Delete
Cancel
Generate stim marks from aux
accelerometer_1_x
accelerometer_1_y
accelerometer_1_z
gyroscope_1_x
gyroscope_1_y
gyroscope_1_z
accelerometer_2_x
Exit


StimEditGUI: (1.31.2) - D:\CloudStation\fNIRS_Lu\2021NTNU_fNIRSworkshop\2021-03-04\2021-03-04\ChouTest
File
Tools
2021-03-04_003 :
1
2
Rename condition
Edit columns
Onset Duration Amplitude
1 13.9592 30 1
2 59.5722 30 1
3 104.9887 30 1
4 150.6017 30 1
Generate stim marks from aux
accelerometer_1_x
accelerometer_1_y
accelerometer_1_z
gyroscope_1_x
gyroscope_1_y
gyroscope_1_z
accelerometer_2_x
accelerometer_2_y
Preview
Threshold 0.0
LPF 0
Rising edge
Falling edge
Generate 0 stim marks
Edit stim marks manually
Add/Edit
Save to file
Exit


ProcStreamEditGUI: (1.31.2) - D:\CloudStation\fNIRS_Lu\2021NTNU_fNIRSworkshop\2021-03-04\2021-03-04\ChouTest
File
Run
Subject
Group
Registry Functions
Usage Options
Current Processing Stream
hmrR_BandpassFilt
hmrR_BlockAvg
hmrR_GLM
hmrR_GLM_new
hmrR_Intensity2OD
hmrR_MotionArtifact
hmrR_MotionArtifactByChannel
hmrR_MotionCorrectCbsi
hmrR_MotionCorrectPCA
hmrR_MotionCorrectPCArecurse
hmrR_MotionCorrectRLOESS
hmrR_MotionCorrectSpline
hmrR_MotionCorrectSplineSG
hmrR_MotionCorrectWavelet
hmrR_OD2Conc
hmrR_PCAFilter
hmrR_PreprocessIntensity_MedianFilter
hmrR_PreprocessIntensity_NAN
hmrR_PreprocessIntensity_Negative
hmrR_PreprocessOD_LinearFit
hmrR_PruneChannels
hmrR_StimCriteria
Cbsi_Motion_Correction
Add
Delete
Up
Down
Load
Save
Exit
hmrR_PruneChannels : Prune_Channels
hmrR_Intensity2OD : Intensity_to_Delta_OD
hmrR_MotionArtifactByChannel : Motion_Artifacts_By_Channel
hmrR_MotionCorrectWavelet : Wavelet_Motion_Correction
hmrR_BandpassFilt : Bandpass_Filter_OpticalDensity
hmrR_OD2Conc : Delta_OD_to_Conc
hmrR_MotionCorrectCbsi : Cbsi_Motion_Correction
hmrR_BlockAvg : Block_Average_on_Concentration_Data
Clear All
mlActAuto = hmrR_PruneChannels(data, probe, mlActMan, tIncMan, dRange, SNRthresh, SDrange)
dRange: [1e4, 1e7]
SNRthresh: 2
SDrange: [0.0, 45.0]


ProcStreamEditGUI: (1.31.2) - D:\CloudStation\fNIRS_Lu\2021NTNU_fNIRSworkshop\2021-03-04\2021-03-04\ChouTest
File
Run
Subject
Group
Registry Functions
Usage Options
Current Processing Stream
hmrR_BandpassFilt
hmrR_BlockAvg
hmrR_GLM
hmrR_PreprocessIntensity_NAN
hmrR_PreprocessIntensity_Negative
hmrR_PreprocessOD_LinearFit
hmrR_PruneChannels
hmrR_StimCriteria
Cbsi_Motion_Correction
Add
hmrR_PruneChannels : Prune_Channels
hmrR_Intensity2OD : Intensity_to_Delta_OD
hmrR_MotionArtifactByChannel : Motion_Artifacts_By_Channel
hmrR_MotionCorrectWavelet : Wavelet_Motion_Correction
hmrR_BandpassFilt : Bandpass_Filter_OpticalDensity
hmrR_OD2Conc : Delta_OD_to_Conc
Invalid Processing Stream
The following function: hmrR_MotionCorrectWavelet:
Wavelet_Motion_Correction
cannot run because of unavailable input(s) mlAct.
Add one of the following prerequisite functions to the processing stream:
Intensity_to_Delta_OD: dod = hmrR_Intensity2OD(intensity)
Continue Anyway
Cancel
MENU
Save to current processing stream or config file?
Current processing stream
Config file
Cancel
mlActAuto = hmrR_PruneChannels(data, probe, mlActMan, tIncMan, dRange, SNRthresh, SD
dRange: [1e4, 1e7]
SNRthresh: 2
SDrange: [0.0, 45.0]

Stephen Tucker Admin

Feb 03, 2021 12:23 am

(@sstucker) Active Member Joined: 7 months ago

Posts: 13

Hi Nicollette,

https://openfnirs.org/community/homer3-forum/issue-with-homer3-update/

The feature which checks the processing stream order (which is unfinished and will ultimately have a "CONTINUE ANYWAY" button to avoid your situation) is not implemented in the master branch of the Homer3 repository, only in a few feature branches. Are you sure you downloaded the right version?

David Boas Registered

Feb 03, 2021 12:07 pm

(@dboas) Joined: 6 months ago

Posts: 67

We are making lots of fixes to homer 3 right now... it will stabilize in a few weeks.
Sorry for the inconvenience.

Motion Correction Techniques

Spline interpolation — **Scholkmann et al., 2010**

- hmrMotionCorrectSpline.m

Principal component analysis (PCA) — **Zhang et al., 2005**

- hmrMotionCorrectPCA.m

Wavelet filtering — **Molavi and Dumont, 2012**

- hmrMotionCorrectWavelet.m

Correlation-based signal improvement (CBSI) — **Cui et al., 2010**

- hmrMotionCorrectCbsi

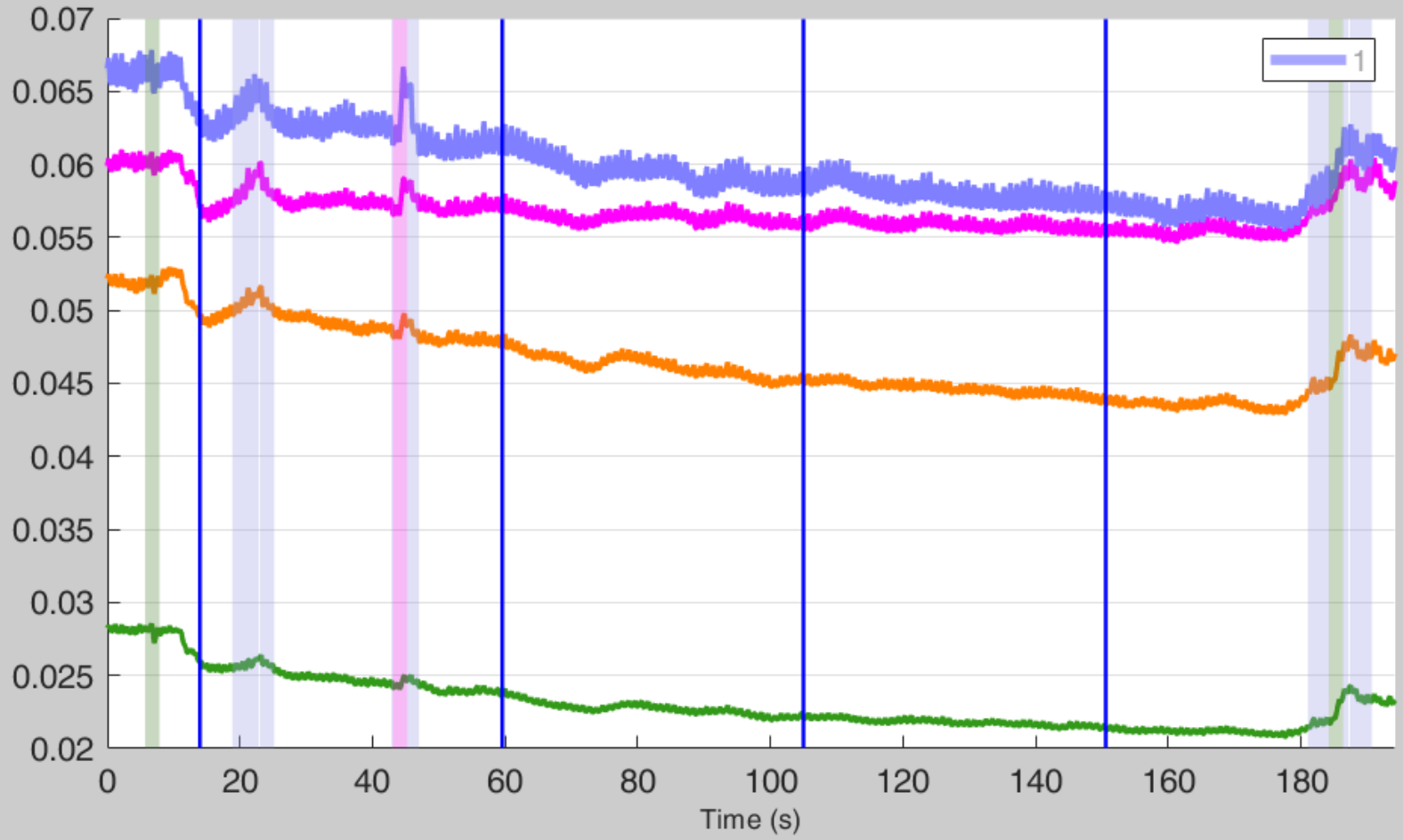
Edit Options

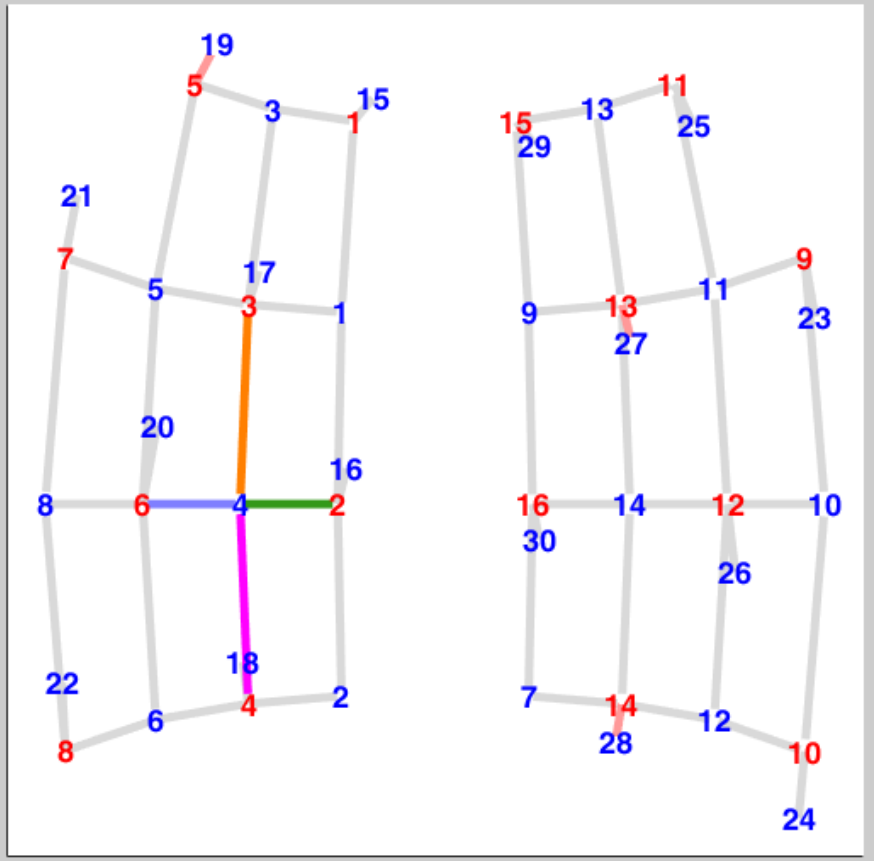
ProcStreamOptionsGUI: (1.31.2) - D:\CloudStation\fNIRS_Lu\2021NTNU_fNIRSwor...

EXIT

hmrR_PruneChannels	dRange	1e-02 1e+00
	SNRthresh	2
	SDrange	0.0 45.0
hmrR_Intensity2OD		
hmrR_MotionArtifactByChannel	tMotion	0.5
	tMask	1.0
	STDEVthresh	5.0
	AMPthresh	0.05
hmrR_MotionCorrectWavelet	iqr	1.50
	turnon	1
hmrR_BandpassFilt: Bandpass_Filter_OpticalDensity	hpf	0.010
	lpf	0.030
hmrR_OD2Conc	ppf	1.0 1.0 1.0
hmrR_MotionCorrectCbsi	turnon	1
hmrR_BlockAvg: Block_Average_on_Concentration_Data	trange	-5.0 35.0

NBA
ratory of Neuroimage Biomarker Analysis





Current Processing Element

2021-03-04_003.snirf

Processing Level

Group

RUN

Edit Options

Apply to all

Exclude data

Show Excluded Manual

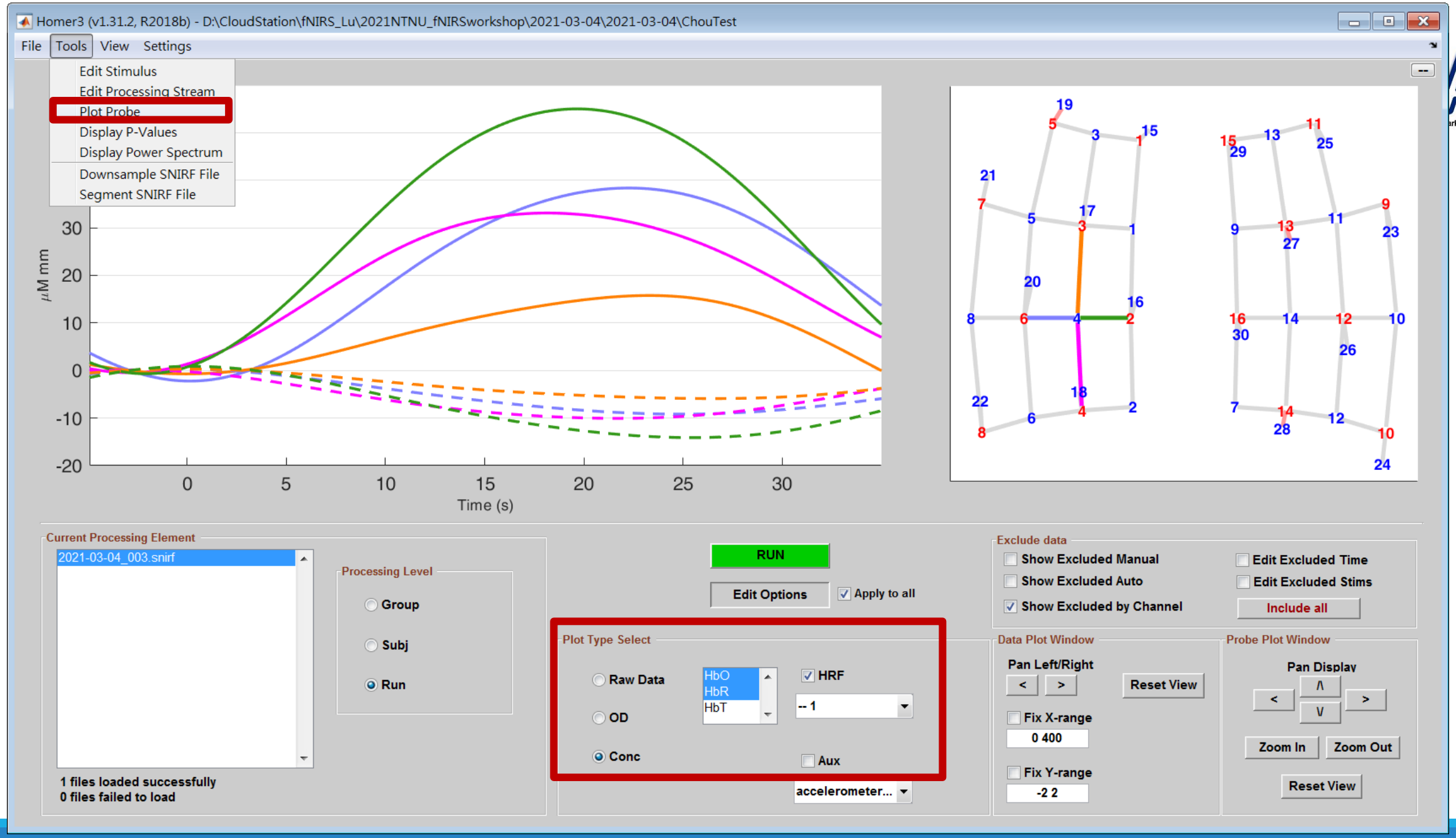
Show Excluded Auto

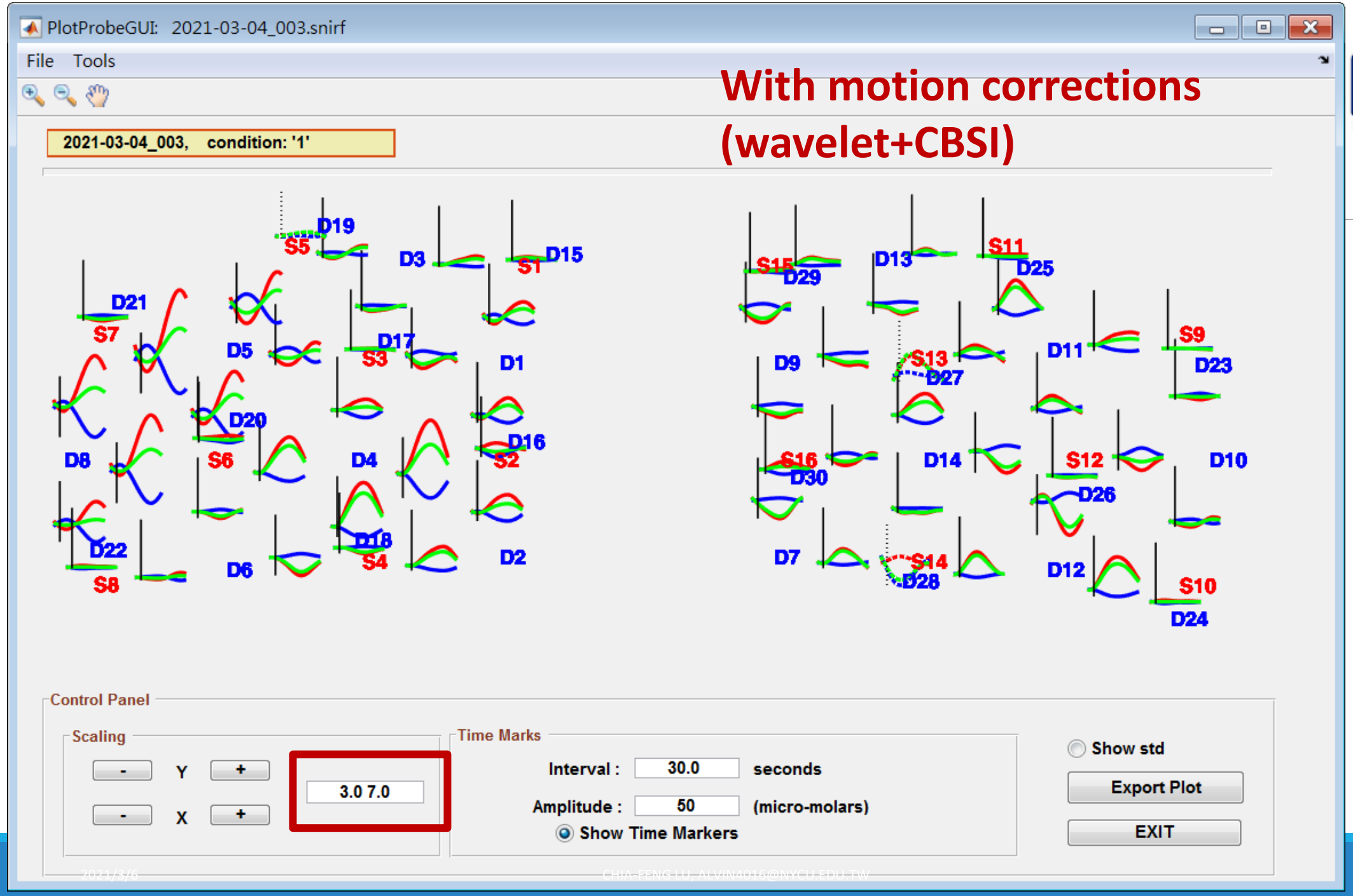
Show Excluded by Channel

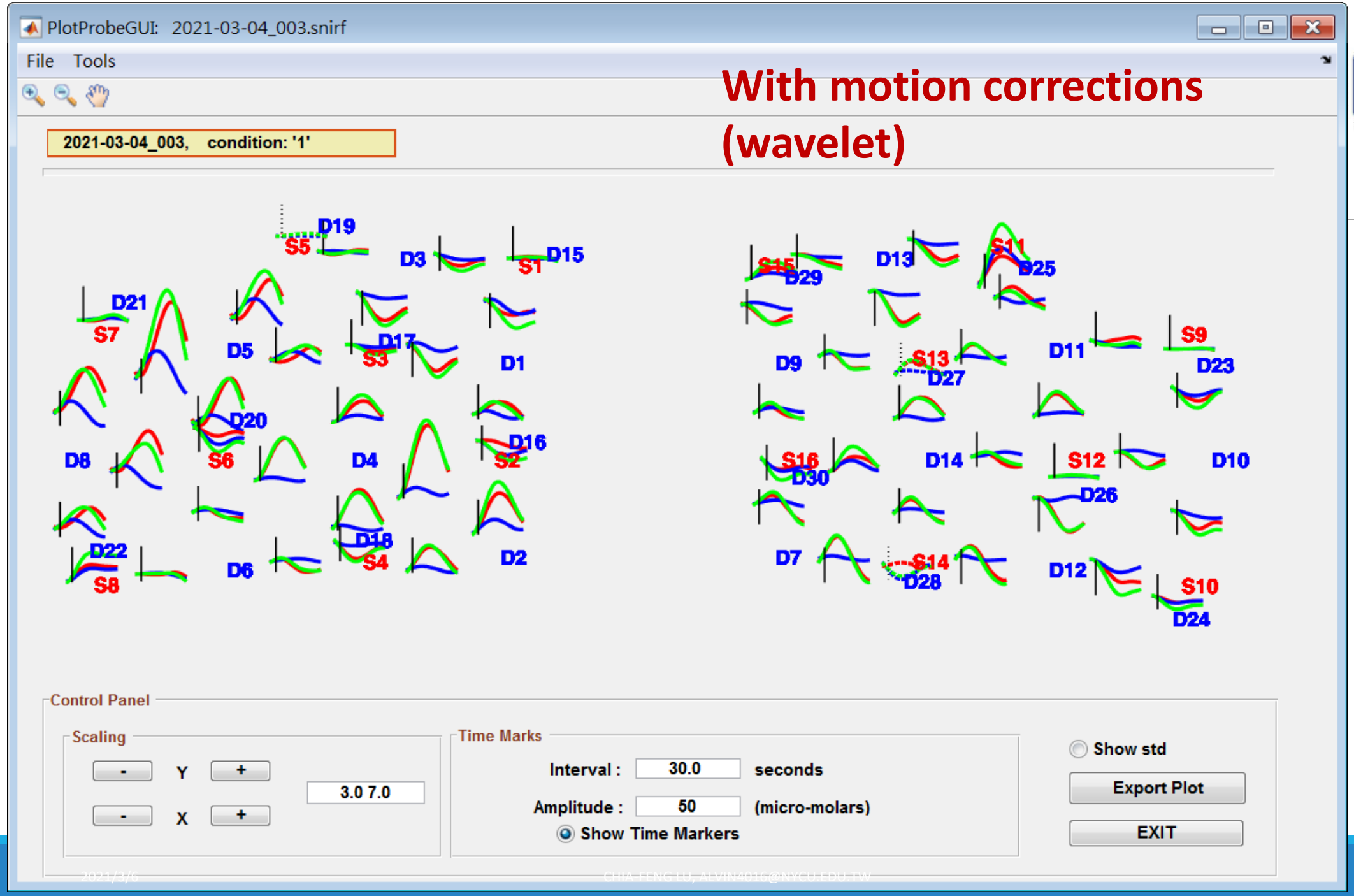
Edit Excluded Time

Edit Excluded Stims

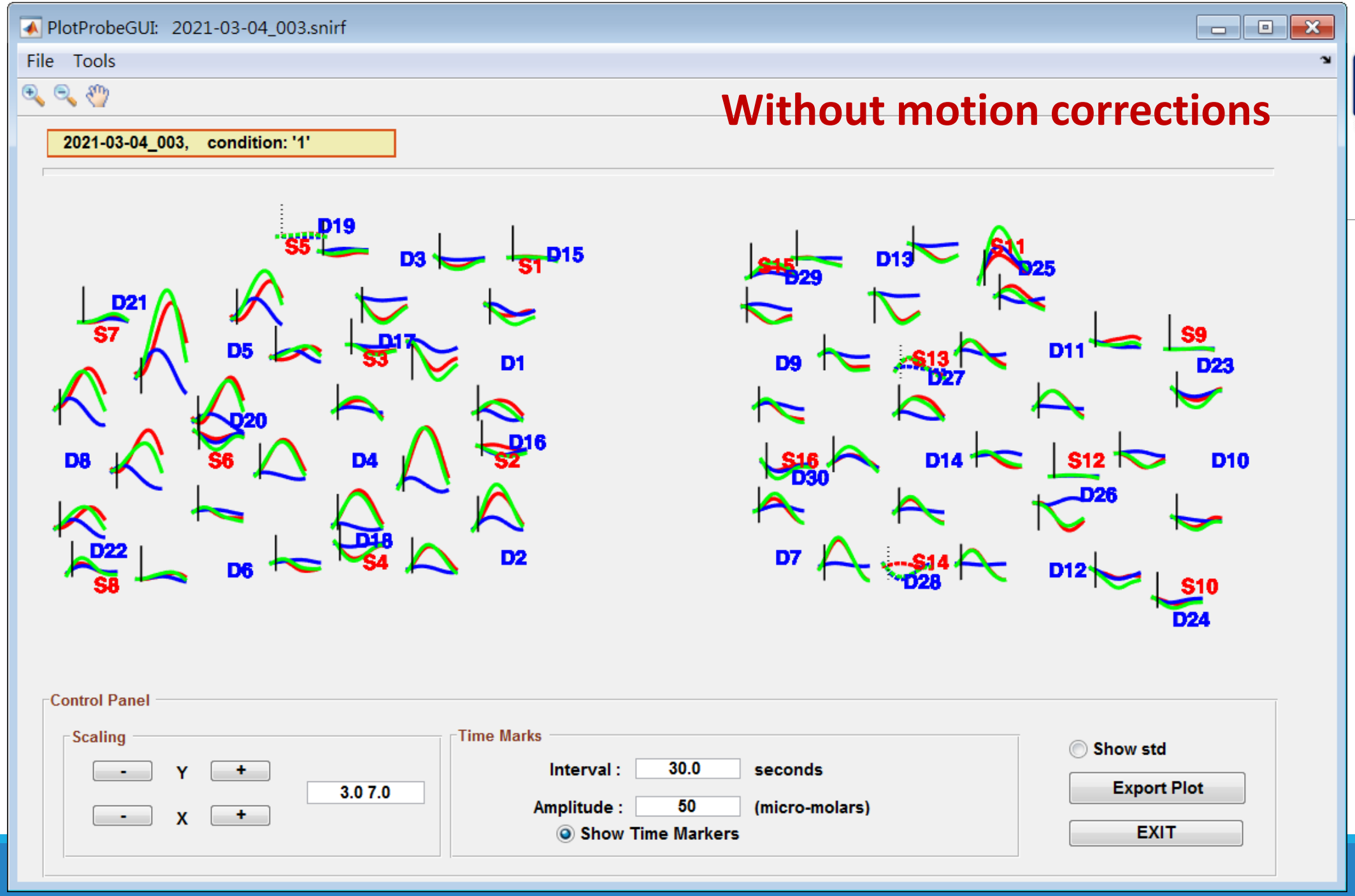
Include all


Homer3 (v1.31.2, R2018b) - D:\CloudStation\fNIRS_Lu\2021NTNU_fNIRSworkshop\2021-03-04\2021-03-04\ChouTest
File
Tools
View
Settings
Edit Stimulus
Edit Processing Stream
Plot Probe
Display P-Values
Display Power Spectrum
Downsample SNIRF File
Segment SNIRF File
μM mm
Time (s)
Current Processing Element
2021-03-04_003.snirf
1 files loaded successfully
0 files failed to load
Processing Level
Group
Subj
Run
RUN
Edit Options
Apply to all
Plot Type Select
Raw Data
OD
Conc
HbO
HbR
HbT
HRF
-- 1
Aux
accelerometer...
Exclude data
Show Excluded Manual
Show Excluded Auto
Show Excluded by Channel
Edit Excluded Time
Edit Excluded Stims
Include all
Data Plot Window
Pan Left/Right
Reset View
Fix X-range
0 400
Fix Y-range
-2 2
Probe Plot Window
Pan Display
Zoom In
Zoom Out
Reset View


PlotProbeGUI: 2021-03-04_003.snirf
File Tools
2021-03-04_003, condition: '1'
With motion corrections
(wavelet+CBSI)
D19
S5
D3
S1
D15
D21
S7
D5
S3
D17
D1
D20
D16
D8
S6
D4
S2
D22
D18
S4
D2
S8
D6
S15
D29
D13
S11
D25
D9
S13
D27
D11
S9
D23
S16
D30
D14
S12
D10
D26
D7
S14
D28
D12
S10
D24
Control Panel
Scaling
-
Y
+
-
X
+
3.0 7.0
Time Marks
Interval :
30.0
seconds
Amplitude :
50
(micro-molars)
Show Time Markers
Show std
Export Plot
EXIT

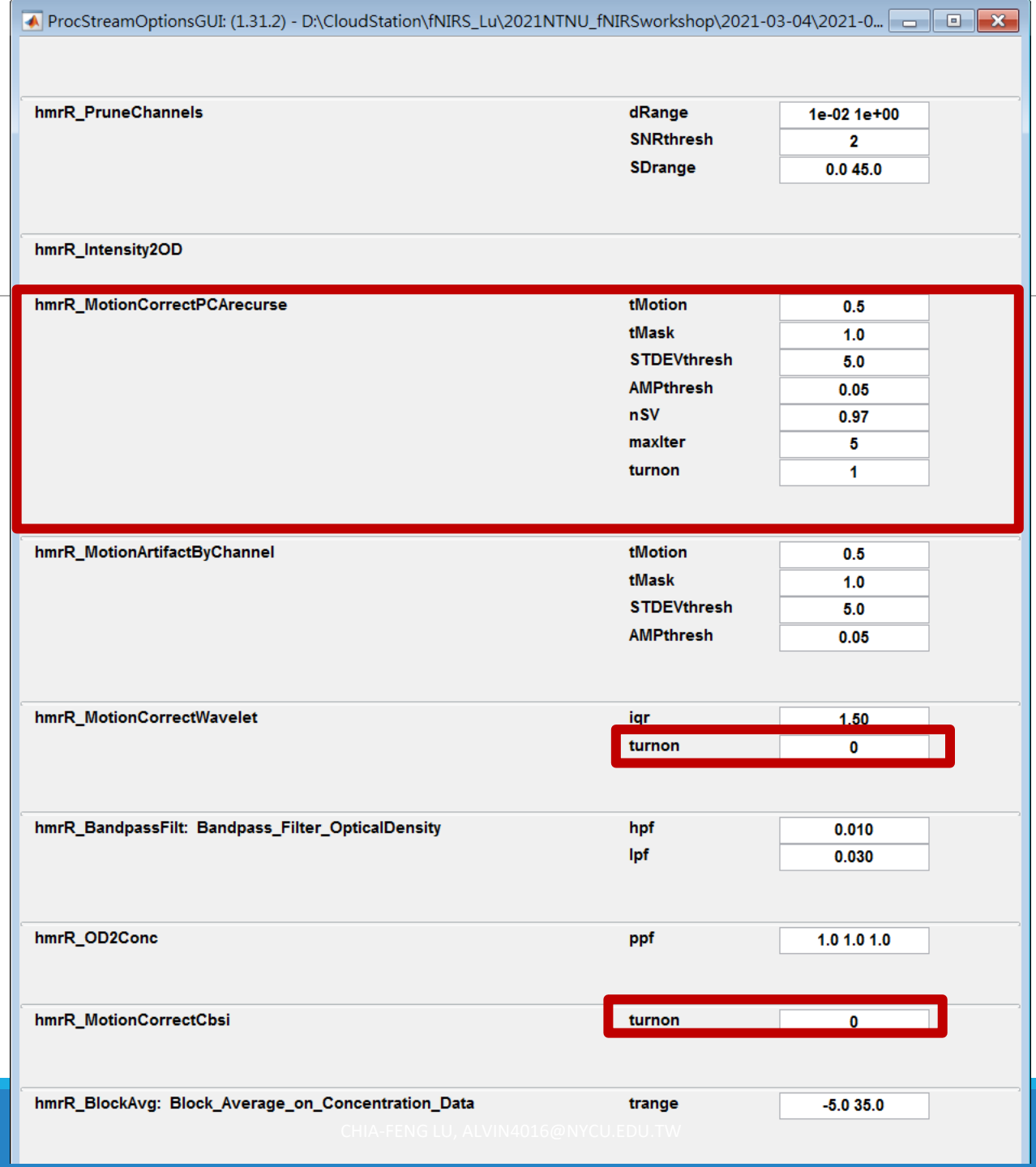


NBA
Laboratory of Neuroimage Biomarker Analysis

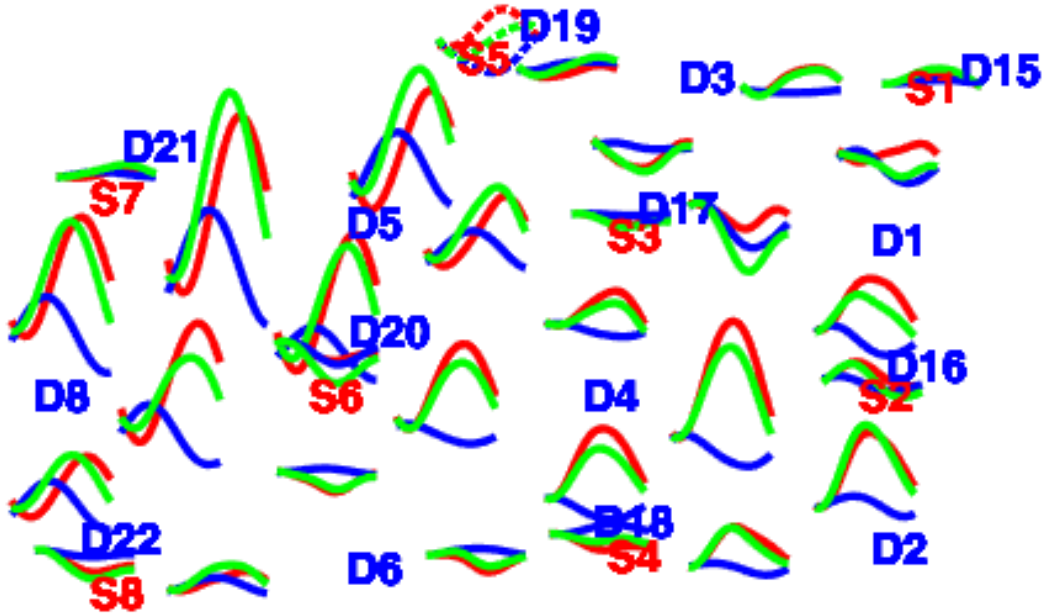


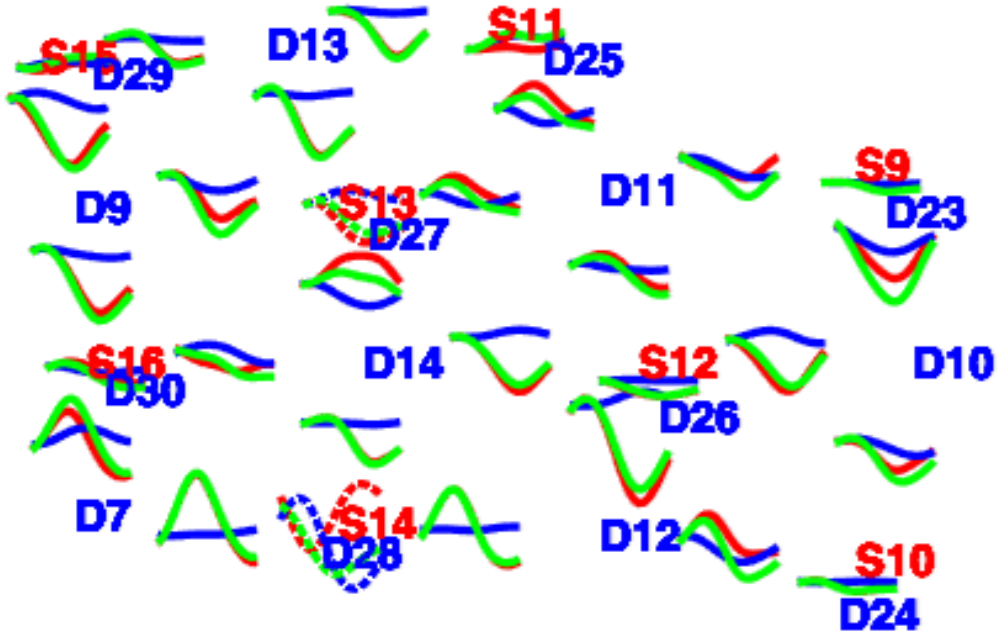
Without motion corrections

NBA
Laboratory of Neuroimage Biomarker Analysis


ProcStreamOptionsGUI: (1.31.2) - D:\CloudStation\fNIRS_Lu\2021NTNU_fNIRSworkshop\2021-03-04\2021-0...
hmrR_PruneChannels
dRange 1e-02 1e+00
SNRthresh 2
SDrange 0.0 45.0
hmrR_Intensity2OD
hmrR_MotionCorrectPCArecurse
tMotion 0.5
tMask 1.0
STDEVthresh 5.0
AMPthresh 0.05
nSV 0.97
maxIter 5
turnon 1
hmrR_MotionArtifactByChannel
tMotion 0.5
tMask 1.0
STDEVthresh 5.0
AMPthresh 0.05
hmrR_MotionCorrectWavelet
iqr 1.50
turnon 0
hmrR_BandpassFilt: Bandpass_Filter_OpticalDensity
hpf 0.010
lpf 0.030
hmrR_OD2Conc
ppf 1.0 1.0 1.0
hmrR_MotionCorrectCbsi
turnon 0
hmrR_BlockAvg: Block_Average_on_Concentration_Data
trange -5.0 35.0

Motion correction by targeted recursive PCA





Without Motion corrections

Intensity to OD

↓

Bandpass filter
(HPF = 0.01, LPF = 0.1)

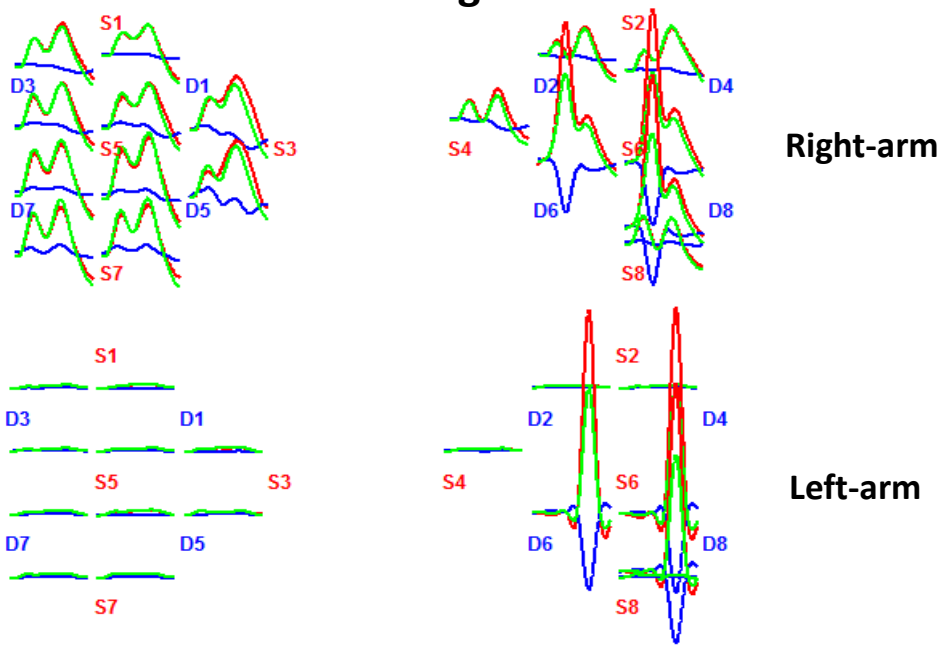
↓

OD to Conc

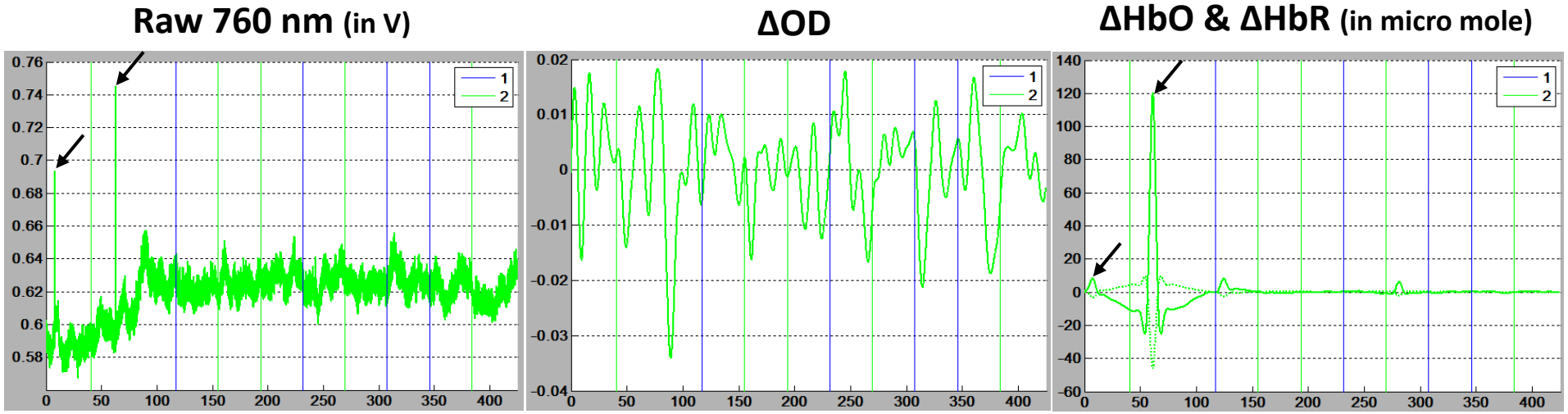
↓

Block Average
(-5 30)

Block Averages



Motion artifacts in S6-D4



Corrected by Spline Correction

Intensity to OD

↓

Motion Artifacts By Channel
(0.5, 3.0, 10.0, 5.0)

↓

Spline Motion Correction
(0.99)

↓

Bandpass filter
(HPF = 0.01, LPF = 0.1)

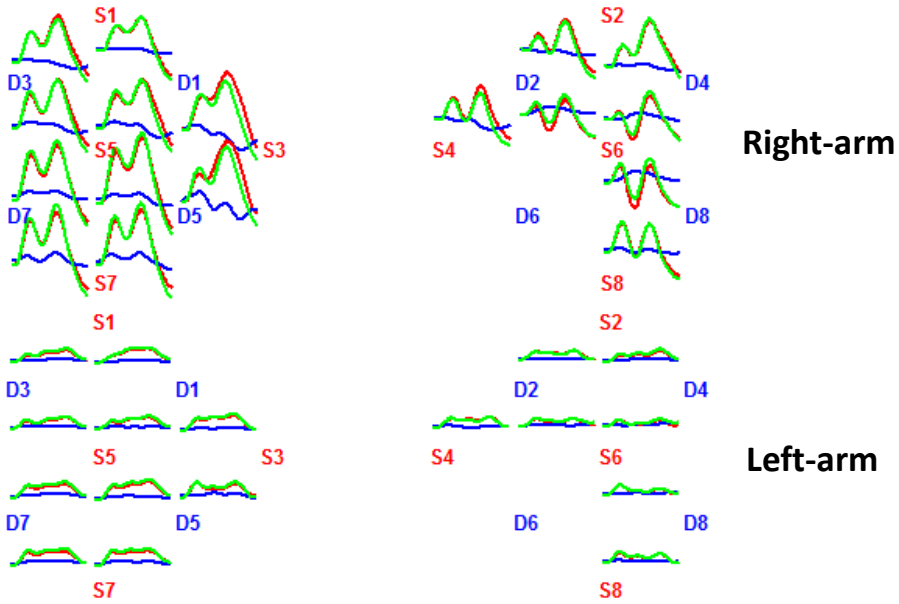
↓

OD to Conc

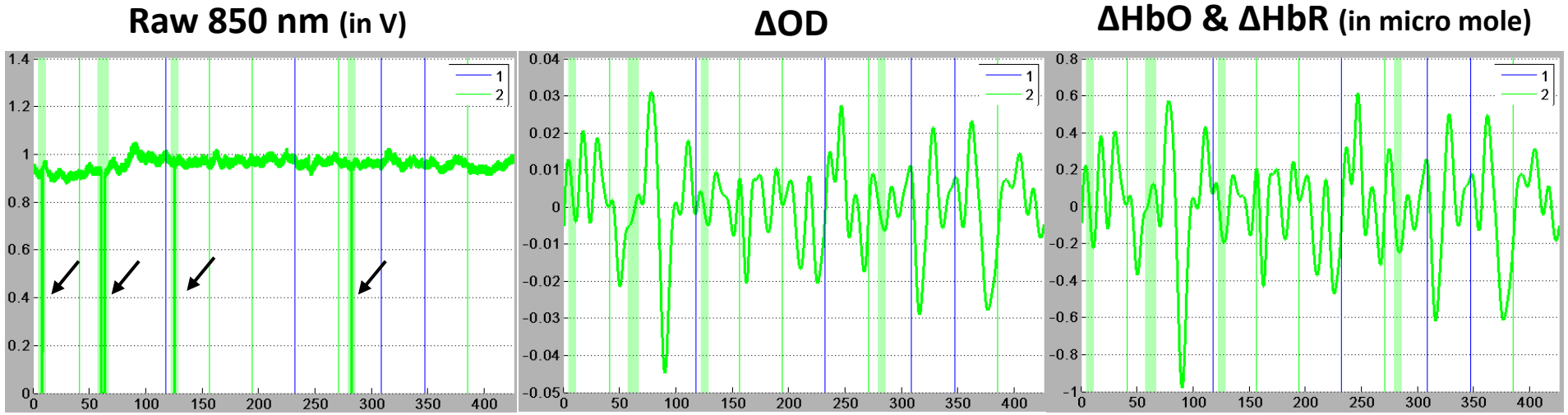
↓

Block Average
(-5 30)

Block Averages

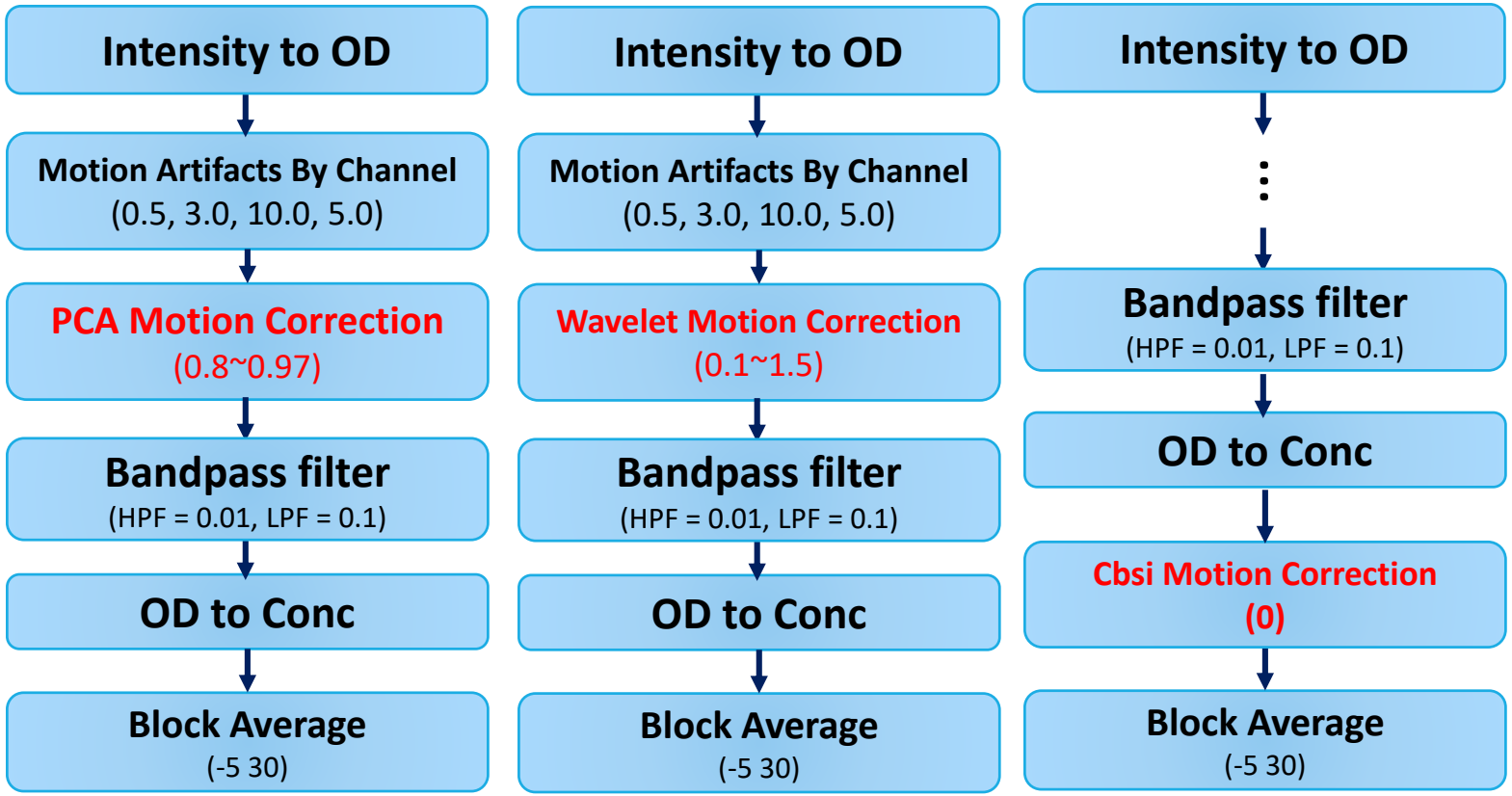


Spline Corrected Signals



1: for right-arm
2: for left-arm

Recommended Processing Flows



盧家鋒 Chia-Feng Lu, PhD

Q & A

Thanks for your attention :)