Running MidLineFrontal Theta Neurofeedback with Visual Stimulus

In a typical session, you will call the *nfblab_process* with the *runmode* option set to *baseline* to acquire a baseline of about 1 minute. This will allow Neurofeedbacklab to find bad channels, set up the Artifact Subspace Reconstruction filer, run ICA and find bad components. After the baseline run, you run one or more trial runs (*runmode* option set to *trial*)

See *>>nfblab_process('help', true)* for help

Note: NS crashes when connecting via EGI app starts

Possible Protocol: Check Impedance, Exit NS, Start Program, Check Impedance

How to set up multiple trials and BCILab/exec file?

Theta Chan1

Set Parameters for DenseNet

```
clear all
% Run nfblab for any headset which has LSL
% ----------------------------------------
addpath(fullfile(pwd, '..','..'));
%Based on Hydrocel GSN 130 Net (256)
nChan = 256; % number of channels
Chan = [26,21,47,2,96,170,126]; %Channel Vector Fpz(COM?), FZ, F7, F8, %Cz (Omitted fr
sRate = 1000; % sampling rate
```
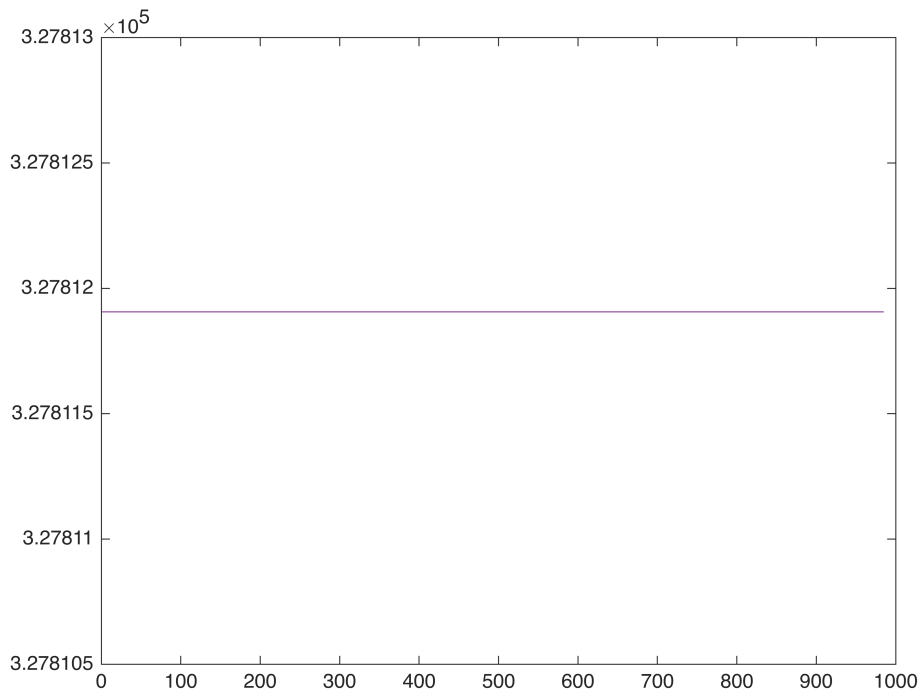
(Optional) Test EEG Connection

From INSTALL.md, Turn on LSL EGI Amp App first

```
% Turn on Amp via EGIAmpServer-App
lib = lsl_loadlib();
result = nfblab_findlslstream(lib,'EEG','')
```

```
result = 1×1 cell array
    {1×1 lsl_streaminfo}
```

```
inlet = lsl_inlet(result{1});
pause(1);
[chunk,stamps] = inlet.pull_chunk();
pause(1);
[chunk,stamps] = inlet.pull_chunk();
figure; plot(chunk');
```
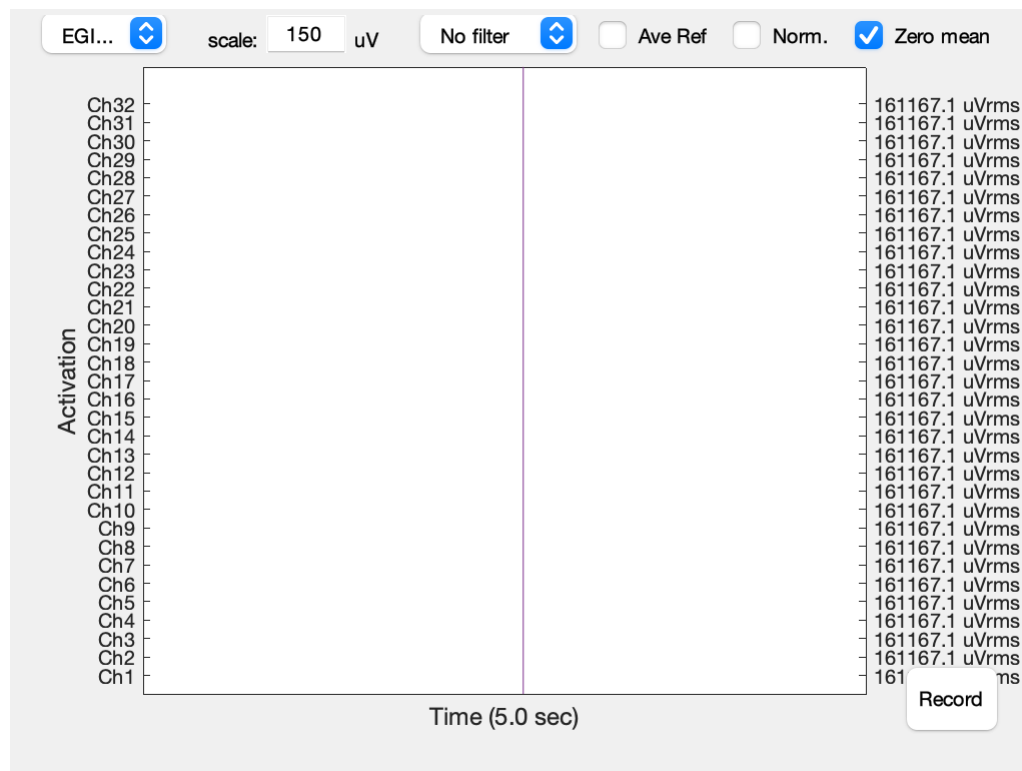
```
vis_stream()
```

Using the slower MATLAB fallback for setdiff(). Consider setting up a compiler to get much improved BCILAB
Looking for a stream with name=EGI NetAmp 0 ...
Opening an inlet...
The number of channels in the steam does not match the number of labeled channel records. Using numbered

Run Baseline

With *nfblab_process.m* with the *runmode* option set to *baseline* to acquire a baseline of about 1 minute

```matlab
% Run nfblab for MUSE using psychotoolbox for visual feedback
% The psychophysics toolbox need to be installed
% The color of a square changes based on theta power
% ----------------------------------------------------
addpath(fullfile(pwd, '..','..'));

options = { ...
    'chans'                 Chan ...
    'chanmask'              eye(length(Chan)) ...
    'srate'                 250 ...
    'srateHardware'         sRate ...
    'filtFlag'              false ...
    'runmode'               'baseline' ...
    'baselineSessionDuration'  60 ...
    'pauseSecond'           0.2 ...
    'asrFlag'               false...
    };
nfblab_process(options{:});
```

```
Looking up software version (commit hash)
Could not look up software version; Loading software version from file.
Warning: commit file not found, cannot log software version
*********************
*********************
** NEUROFEEDBACKLAB **
*********************
*********************

Version: fatal: n (git commit)

Type "help nfblab_process" for basic parameter help
Type "nfblab_process('help', true)" for more advanced parameter help
Refer to online documentation and protocols for more information.

HPF has cutoff of 1.0 Hz, transition bandwidth of 0.5 Hz and its order is 3.0
*********************
* session parameters *
*********************
    runmode                 'baseline'
    warnsrate               0
    fileNameAsr             'data_nfblab_2023-10-25_13-48_asr_filter.mat'
    fileNameOut             'data_nfblab_2023-10-25_13-48.mat'
    fileNameRaw             'data_nfblab_2023-10-25_13-48_raw.set'
    TCPIP                   0
    TCPport                 9789
    pauseSecond             0.2
    baselineSessionDuration 60
    sessionDuration         3600
    help                    0
    checkglobalmsg
*********************
* input parameters *
*********************
    lsltype                 'EEG'
    lslname
```

```
    chans                   [26 21 47 2 96 170 126]
    srate                   250
    chanlocs
    srateHardware           1000
    windowSize              250
    windowInc               63
    chanmask                [1 0 0 0 0 0;0 1 0 0 0 0;0 0 1 0 0 0 0;0 0 0 1 0 0 0;0 0 0 0 1 0 0;0 0 0
*********************
* preproc parameters *
*********************
    filtFlag                0
    badchanFlag             0
    asrFlag                 0
    asrCutoff               20
    icaFlag                 0
    averefFlag              0
    chanCorr                0.65
*********************
* measure parameters *
*********************
    freqrange               [3.5 6.5]
    freqdb                  1
    freqprocess             1 functions to compute on frequencies provided
    loretaFlag              0
    loreta_file
    normfile
    normagerange
    nfft                    250
    preset                  'default'
*********************
* feedback parameters *
*********************
    feedbackMode            'dynrange'
    threshold
    thresholdMem
    thresholdMode           'go'
    thresholdWin            180
    thresholdPer            0.8
    dynRange                [16 29]
    dynRangeInc             0.0333
    dynRangeDec             0.01
    maxChange               0.05
    capdBchange             1000
    feedbackfield           'thetaChan1'
    diary
    funcinit
    funcfeedback            'nfblab_feedback_simpleplot'
    funcend
Warning: Name is nonexistent or not a directory: /Users/samanthapitts/Documents/MATLAB/
neurofeedbacklab-master/src/liblsl-Matlab
Warning: Name is nonexistent or not a directory: /Users/samanthapitts/Documents/MATLAB/
neurofeedbacklab-master/src/liblsl-Matlab/bin
Feedback "Ready" sent to client (if any)
Loading the library...
Resolving an EEG stream...
Opening an inlet...
Now receiving chunked data...
Feedback "Ready" sent to client (if any)
Decoding option runmode: baseline
*********************
* session parameters *
*********************
    runmode                 'baseline'
    warnsrate               0
```

```
    fileNameAsr                'data_nfblab_2023-10-25_13-48_asr_filter.mat'
    fileNameOut                'data_nfblab_2023-10-25_13-48.mat'
    fileNameRaw                'data_nfblab_2023-10-25_13-48_raw.set'
    TCPIP                      0
    TCPport                    9789
    pauseSecond                0.2
    baselineSessionDuration    60
    sessionDuration            3600
    help                       0
    checkglobalmsg
********************
* input parameters *
********************
    lsltype                    'EEG'
    lslname
    chans                      [26 21 47 2 96 170 126]
    srate                      250
    chanlocs
    srateHardware              1000
    windowSize                 250
    windowInc                  63
    chanmask                   [1 0 0 0 0 0 0;0 1 0 0 0 0 0;0 0 1 0 0 0 0;0 0 0 1 0 0 0;0 0 0 0 1 0 0;0 0 0
**********************
* preproc parameters *
**********************
    filtFlag                   0
    badchanFlag                0
    asrFlag                    0
    asrCutoff                  20
    icaFlag                    0
    averefFlag                 0
    chanCorr                   0.65
**********************
* measure parameters *
**********************
    freqrange                  [3.5 6.5]
    freqdb                     1
    freqprocess                1 functions to compute on frequencies provided
    loretaFlag                 0
    loreta_file
    normfile
    normagerange
    nfft                       250
    preset                     'default'
**********************
* feedback parameters *
**********************
    feedbackMode               'dynrange'
    threshold
    thresholdMem
    thresholdMode              'go'
    thresholdWin               180
    thresholdPer               0.8
    dynRange                   [16 29]
    dynRangeInc                0.0333
    dynRangeDec                0.01
    maxChange                  0.05
    capdBchange                1000
    feedbackfield              'thetaChan1'
    diary
    funcinit
    funcfeedback               'nfblab_feedback_simpleplot'
    funcend
```

```
Starting new session...
eeg_checkset note: upper time limit (xmax) adjusted so (xmax-xmin)*srate+1 = number of frames
Feedback "Streaming" sent to client (if any)
Feedback "Streaming" sent to client (if any)
Feedback "Streaming" sent to client (if any)
Feedback "Streaming" sent to client (if any)
Feedback "Streaming" sent to client (if any)
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Feedback "Streaming" sent to client (if any)
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Feedback "Streaming" sent to client (if any)
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Feedback "Streaming" sent to client (if any)
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Feedback {"thetaChan1":54.464142956910031,"threshold":"","value":54.464142956910031,"statechange":false,"
Feedback "Streaming" sent to client (if any)
Ending session...
Saving Baseline file data_nfblab_2023-10-25_13-48_asr_filter.mat
Feedback "paused" sent to client (if any)
Quitting...
```

Save Filename

```
trial = 6
```

```
trial = 6
```

```
filename = sprintf('jo_ws10_25_23_%d.mat',trial);
save(filename)
%consider average reference? req for freq?%%
```

Run Single Trial and Save Result

With *nfblab_muse_pscychotoolbox.m*

```
% Run nfblab for MUSE using psychotoolbox for visual feedback
% The psychophysics toolbox need to be installed
% The color of a square changes based on theta power
% ---------------------------------------------------
addpath(fullfile(pwd, '..','..'));


options = { ...
    'chans'              Chan ...
    'chanmask'           eye(length(Chan)) ...
    'srate'              sRate ...
    'srateHardware'      sRate ...
    'filtFlag'           false ...
    'runmode'            'trial' ...
    'sessionDuration'  300 ...  %5min; longer data chunks
    'pauseSecond'        0.2 ...
    'badchanFlag'        false ...
    'icaFlag'            false ...
    'asrFlag'            false ...
    'freqrange'          { [4 8] [8 12] [8 10] [10 12] [18 22] [4 10] [12 15] [20 ]
    'feedbackMode'       'dynrange' ...
    'funcinit'           'nfblab_feedback_psychootoolbox_init' ...
    'funcfeedback'       'nfblab_feedback_psychootoolbox_process' ...
    'funcend'            'nfblab_feedback_psychootoolbox_end' ...
    };

nfblab_process(options{:});
```

```
Looking up software version (commit hash)
Could not look up software version; Loading software version from file.
Warning: commit file not found, cannot log software version
*********************
*********************
** NEUROFEEDBACKLAB **
*********************
*********************

Version: fatal: n (git commit)

Type "help nfblab_process" for basic parameter help
Type "nfblab_process('help', true)" for more advanced parameter help
Refer to online documentation and protocols for more information.

HPF has cutoff of 1.0 Hz, transition bandwidth of 0.5 Hz and its order is 3.0
```

```
********************
* session parameters *
********************
    runmode                  'trial'
    warnsrate                0
    fileNameAsr              'data_nfblab_2023-10-25_13-34_asr_filter.mat'
    fileNameOut              'data_nfblab_2023-10-25_13-34.mat'
    fileNameRaw              'data_nfblab_2023-10-25_13-34_raw.set'
    TCPIP                    0
    TCPport                  9789
    pauseSecond              0.2
    baselineSessionDuration  60
    sessionDuration          300
    help                     0
    checkglobalmsg
********************
* input parameters *
********************
    lsltype                  'EEG'
    lslname
    chans                    [26 21 47 2 96 170 126]
    srate                    1000
    chanlocs
    srateHardware            1000
    windowSize               1000
    windowInc                250
    chanmask                 [1 0 0 0 0 0 0;0 1 0 0 0 0 0;0 0 1 0 0 0 0;0 0 0 1 0 0 0;0 0 0 0 1 0 0;0 0 0
********************
* preproc parameters *
********************
    filtFlag                 0
    badchanFlag              0
    asrFlag                  0
    asrCutoff                20
    icaFlag                  0
    averefFlag               0
    chanCorr                 0.65
********************
* measure parameters *
********************
    freqrange                [4 8] ,[8 12] ,[8 10] ,[10 12] ,[18 22] ,[4 10] ,[12 15] ,[20 30]
    freqdb                   1
    freqprocess              1 functions to compute on frequencies provided
    loretaFlag               0
    loreta_file
    normfile
    normagerange
    nfft                     1000
    preset                   'default'
********************
* feedback parameters *
********************
    feedbackMode             'dynrange'
    threshold
    thresholdMem
    thresholdMode            'go'
    thresholdWin             180
    thresholdPer             0.8
    dynRange                 [16 29]
    dynRangeInc              0.0333
    dynRangeDec              0.01
    maxChange                0.05
    capdBchange              1000
    feedbackfield            'thetaChan1'
```

11

```
    diary
    funcinit                    'nfblab_feedback_psychootoolbox_init'
    funcfeedback                'nfblab_feedback_psychootoolbox_process'
    funcend                     'nfblab_feedback_psychootoolbox_end'
Warning: Name is nonexistent or not a directory: /Users/samanthapitts/Documents/MATLAB/
neurofeedbacklab-master/src/liblsl-Matlab
Warning: Name is nonexistent or not a directory: /Users/samanthapitts/Documents/MATLAB/
neurofeedbacklab-master/src/liblsl-Matlab/bin
Could not execute feedback function, try running it as a script
PTB-INFO: Retina display. Enabling panel fitter for scaled Retina compatibility mode.


PTB-INFO: This is Psychtoolbox-3 for Apple macOS, under Matlab 64-Bit (Version 3.0.19 - Build date: May  1
PTB-INFO: OS support status: macOS version 13 Intel is minimally tested and supported.
PTB-INFO: Type 'PsychtoolboxVersion' for more detailed version information.
PTB-INFO: Most parts of the Psychtoolbox distribution are licensed to you under terms of the MIT License,
PTB-INFO: some restrictions. See file 'License.txt' in the Psychtoolbox root folder for the exact licensin

PTB-INFO: For information about paid support, support memberships and other commercial services, please ty
PTB-INFO: 'PsychPaidSupportAndServices'.

PTB-INFO: Installation of the PsychtoolboxKernelDriver is strongly recommended if you care about precise v
PTB-INFO: onset timestamping or timing. See 'help PsychtoolboxKernelDriver' for installation instructions.


PTB-INFO: OpenGL-Renderer is Intel Inc. :: Intel(R) Iris(TM) Plus Graphics OpenGL Engine :: 2.1 INTEL-20.6
PTB-INFO: Renderer has 1536 MB of VRAM and a maximum 5376 MB of texture memory.
PTB-INFO: VBL startline = 1280 , VBL Endline = -1
PTB-INFO: Beamposition queries unsupported or defective on this system. Using basic timestamping as fallba
PTB-INFO: Timestamps returned by Screen('Flip') will be therefore less robust and accurate.
PTB-INFO: Measured monitor refresh interval from VBLsync = 8.392395 ms [119.155499 Hz]. (119 valid samples
PTB-INFO: Small deviations between reported values are normal and no reason to worry.
PTB-WARNING: ================================================================================================
PTB-WARNING: DESKTOP COMPOSITOR IS ACTIVE! ALL FLIP STIMULUS ONSET TIMESTAMPS WILL BE VERY LIKELY UNRELIAB
PTB-WARNING: STIMULUS ONSET TIMING WILL BE UNRELIABLE AS WELL, AND GRAPHICS PERFORMANCE MAY BE REDUCED!
PTB-WARNING: DO NOT USE THIS MODE FOR RUNNING REAL EXPERIMENT SESSIONS WITH ANY REQUIREMENTS FOR ACCURATE
PTB-WARNING: ================================================================================================

WARNING: Couldn't compute a reliable estimate of monitor refresh interval! Trouble with VBL syncing?!?


----- ! PTB - ERROR: SYNCHRONIZATION FAILURE ! -----

One or more internal checks (see Warnings above) indicate that synchronization
of Psychtoolbox to the vertical retrace (VBL) is not working on your setup.

This will seriously impair proper stimulus presentation and stimulus presentation timing!
Please read 'help SyncTrouble' for information about how to solve or work-around the problem.
You can force Psychtoolbox to continue, despite the severe problems, by adding the command
Screen('Preference', 'SkipSyncTests', 1); at the top of your script, if you really know what you are doing


PTB-INFO: Psychtoolbox imaging pipeline starting up for window with requested imagingmode 33793 ...
PTB-INFO: Will use 8 bits per color component framebuffer for stimulus drawing.
PTB-INFO: Enabling panel fitter. Providing virtual framebuffer of 800 x 600 pixels size.
PTB-INFO: Will use 8 bits per color component framebuffer for stimulus post-processing (if any).
ans = 10
Feedback "Ready" sent to client (if any)
Loading the library...
Resolving an EEG stream...
Opening an inlet...
Now receiving chunked data...
Feedback "Ready" sent to client (if any)
Decoding option runmode: trial
```

```
********************
* session parameters *
********************
    runmode                 'trial'
    warnsrate               0
    fileNameAsr             'data_nfblab_2023-10-25_13-34_asr_filter.mat'
    fileNameOut             'data_nfblab_2023-10-25_13-34.mat'
    fileNameRaw             'data_nfblab_2023-10-25_13-34_raw.set'
    TCPIP                   0
    TCPport                 9789
    pauseSecond             0.2
    baselineSessionDuration 60
    sessionDuration         300
    help                    0
    checkglobalmsg
********************
* input parameters *
********************
    lsltype                 'EEG'
    lslname
    chans                   [26 21 47 2 96 170 126]
    srate                   1000
    chanlocs
    srateHardware           1000
    windowSize              1000
    windowInc               250
    chanmask                [1 0 0 0 0 0 0;0 1 0 0 0 0 0;0 0 1 0 0 0 0;0 0 0 1 0 0 0;0 0 0 0 1 0 0;0 0 0
********************
* preproc parameters *
********************
    filtFlag                0
    badchanFlag             0
    asrFlag                 0
    asrCutoff               20
    icaFlag                 0
    averefFlag              0
    chanCorr                0.65
********************
* measure parameters *
********************
    freqrange               [4 8] ,[8 12] ,[8 10] ,[10 12] ,[18 22] ,[4 10] ,[12 15] ,[20 30]
    freqdb                  1
    freqprocess             1 functions to compute on frequencies provided
    loretaFlag              0
    loreta_file
    normfile
    normagerange
    nfft                    1000
    preset                  'default'
********************
* feedback parameters *
********************
    feedbackMode            'dynrange'
    threshold
    thresholdMem
    thresholdMode           'go'
    thresholdWin            180
    thresholdPer            0.8
    dynRange                [16 29]
    dynRangeInc             0.0333
    dynRangeDec             0.01
    maxChange               0.05
    capdBchange             1000
    feedbackfield           'thetaChan1'
```

```
    diary
    funcinit                    'nfblab_feedback_psychootoolbox_init'
    funcfeedback                'nfblab_feedback_psychootoolbox_process'
    funcend                     'nfblab_feedback_psychootoolbox_end'
```
Warning: Name is nonexistent or not a directory: /Users/samanthapitts/Documents/MATLAB/
neurofeedbacklab-master/src/liblsl-Matlab
Warning: Name is nonexistent or not a directory: /Users/samanthapitts/Documents/MATLAB/
neurofeedbacklab-master/src/liblsl-Matlab/bin
Starting new session...
eeg_checkset note: upper time limit (xmax) adjusted so (xmax-xmin)*srate+1 = number of frames
Feedback "Streaming" sent to client (if any)
Feedback "Streaming" sent to client (if any)
Feedback "Streaming" sent to client (if any)
Feedback "Streaming" sent to client (if any)
Feedback "Streaming" sent to client (if any)
Feedback {"thetaChan1":69.9627852653817,"threshold":"","value":69.9627852653817,"statechange":false,"feedb
Feedback "Streaming" sent to client (if any)
Feedback {"thetaChan1":70.44992163005935,"threshold":"","value":70.44992163005935,"statechange":false,"fee
Feedback {"thetaChan1":69.388423241575239,"threshold":"","value":69.388423241575239,"statechange":false,"
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Feedback "Streaming" sent to client (if any)
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Feedback {"thetaChan1":58.153210967689134,"threshold":"","value":58.153210967689134,"statechange":true,"fe
Feedback {"thetaChan1":56.346082441045112,"threshold":"","value":56.346082441045112,"statechange":true,"fe
Feedback "Streaming" sent to client (if any)
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Feedback {"thetaChan1":63.287961631875653,"threshold":"","value":63.287961631875653,"statechange":true,"fe
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Feedback "Streaming" sent to client (if any)
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Feedback {"thetaChan1":61.154863622515251,"threshold":"","value":61.154863622515251,"statechange":true,"fe
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```

Feedback "Streaming" sent to client (if any)
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Feedback "Streaming" sent to client (if any)
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Feedback {"thetaChan1":62.395734863052958,"threshold":"","value":62.395734863052958,"statechange":false,"
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Save Filename

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trial = 5

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save(filename)
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