

# Developer's Notes

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Version 6.1.0

by the PsPM team<sup>1</sup>:

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# 1 Introduction

Contributed by Teddy Zhao in April 2023

PsychoPhysiological Modelling, abbreviated as PsPM, is a software package for model-based analysis of psychophysiological signals. PsPM can be accessed through either graphical user interface (GUI) or command lines. PsPM is written in MATLAB language, thus it supports cross platform usages, either Windows, macOS or Linux, and can be easily utilised in customised shell scripts. PsPM is actively updated and maintained by bringing new features and fixing bugs, thus the latest version of PsPM is always encouraged for users. The recommended version of MATLAB for running PsPM is MATLAB 2023a (version 9.14), and the earliest version of MATLAB that could be used for running PsPM is MATLAB 2006a (version 7.2).

## 2 General

Contributed by Dominik R Bach and Teddy Zhao

Reviewed and revised by Teddy Zhao in March 2023

### 2.1 Data files

In PsPM, data and information is stored as `struct` variables and saved as `mat` files. A data `struct` may contain multiple cells, and each cell contains a `struct` with channel specific fields, `infos` and `data`. Specifically, `infos` is a `struct` variable with general information, and `data` is a `cell` array with the data for each channel. Both `infos` and `data` have the following mandatory subfields, whilst `infos` may have some optional subfields that can be defined if necessary, as is shown in **Table 1**.

**Table 1** Description of data fields in PsPM

|           | Field | Subfield     | Description   |
|-----------|-------|--------------|---|
| Mandatory | infos | duration     | The duration of the acquired data, normally defined in seconds                    |
|           |       | data         | The type of the corresponding channel, as defined in the settings.                |
|           |       | header.sr    | the sample rate (or frequency) in 1/second (or Hz), or timestamp units in seconds |
|           |       | header.units | the unit of data, or the 'events'   |
|           |       | data         | the actual data   |
| Optional  | infos | sourcefile   |   |
|           |       | importfile   |   |
|           |       | importdate   |   |
|           |       | sourcetype   |   |
|           |       | recdate      |   |
|           |       | rectime      |   |

In most cases, only the subfield data in the field data will be modified since new results have been generated and are expected to replace the old data. All the other fields, for both data and infos, the content will be kept unchanged. However, some data manipulation functions, for example `pspm_trim`, will update infos to record some file history. Please check the specific descriptions of each function for understanding how data and infos will be updated.

## 2.2 How to add a new import data type

### 2.2.1 Add function

**Function name** `pspm_get_xxx` (where xxx is the data type name).

**Format** `[sts, import, sourceinfo] = pspm_get_xxx(datafile, import).`

The function needs to take an import job and add, for each job.

#### Fields

- Mandatory
  - .data** - the actual data for this channel (column vector)
  - .sr** - the sample rate for this channel (only if `.autosr` enabled in `pspm_init`)
- Optional
  - .marker** For marker channels (timestamps or continuous, see `pspm_get_marker`)



**.markerinfo** See `pspm_get_marker`

**.minfreq** Minimum frequency for pulse channels

**.units** If data units are defined by the recording software

**sts** Set as -1 if import is unsuccessful

**sourceinfo** Contains information on the source file, with field

- .chan** A cell of string descriptions of the imported source channels, e. g. names, or numbers any optional fields that will be added to `infos.source` (e. g. recording date & time, and others)

**Notes for multiple blocks** File formats that support multiple block storage within one file can return cell arrays `import{1:blkno}` and `sourceinfo{1:blkno}`. PsPM will save individual files for each block, with a filename `pspm_fn_blk0x.mat`.

## 2.2.2 Add information to settings

The file `pspm_init` contains a block that defines possible import data types. Add a new field here

```
% Description of data type
% -----
defaults.import.datatypes(1) = ...
struct('short', 'xxx', ... % short name for internal purposes
'long', 'Datatype description', ... % long name for GUI
'ext', '*', ... % data file extension
'funct', @pspm_get_xxx, ... % import function
'chantypes', {{defaults.chantypes.type}}, ... % allowed channel types
'chandescription', 'channel', ... % description of channels for GUI
'multioption', 1, ... % import of multiple channels for GUI
'searchoption', 1, ... % allow channel name search for GUI
'automarker', 0, ... % marker not stored in separate channel
'autosr', 1); % sample rate automatically assigned
```

### Good to know

- The “long” definition is used in the GUI – make sure it’s readable.
- If no event channels can be imported, change `.chantypes`.
- If channels have searchable names in the import file, set `.searchoption = 1`.
- If no channel number needs to be assigned for the marker channel, set `.automarker = 1`.
- If sample rate is contained in import file and determined during import, set `.autosr = 1`.
- If you need external functions – put them into a folder in the ‘import’ subdirectory and add/remove this path within the `pspm_get_xxx` function.

## 2.3 How to add a new channel type

### 2.3.1 Add function

**Function** `pspm_get_xxx` (where `xxx` is the channel type)

**Format** [sts, data] = pspm\_get\_channeltype(import)

### Arguments

**data** Data cell of structure readable by pspm\_load\_data.

**Good to know** For event channels, use the function pspm\_get\_events to convert various event formats into time stamps (see pspm\_get\_marker or pspm\_get\_hb as an example)

## 2.3.2 Add information to settings

Add information on the new channel type and import function to

```
defaults.chantypes(k).type = 'xxx'; % channel type name
defaults.chantypes(k).import = @pspm_get_xxx; % conversion function
defaults.chantypes(k).data = 'xxx'; % 'wave' or 'events'
```

## 2.4 How to add a new GLM type

### 2.4.1 Add information to settings (Example SCR)

```
defaults.glm(1) = ...
struct('modality', 'scr', ... % modality name
'cbf', struct('fhandle', @pspm_bf_scrf, 'args', 1), ...
% default basis function/set
'filter', struct('lpfreq', 5, 'lporder', 1, ...
'hpfreq', 0.05, 'hporder', 1, 'down', 10, 'direction', 'uni'));
% default filter settings
```

### 2.4.2 Add default basis function

**Function** pspm\_bf\_xxx

**Arguments** vector of arguments, first element is time resolution, further arguments as defined in defaults.glm(n).cbf.args.

## 2.5 Warning IDs in PsPM

### 2.5.1 General

- invalid\_input
- invalid\_channeltype
- nonexistent\_file
- channel\_not\_contained\_in\_file
- obsolete\_function
- not\_allowed\_channeltype

- invalid\_data\_structure
- no\_matching\_channels
- unknown\_action
- missing\_data
- out\_of\_range

### 2.5.2 Function specific

- pspm\_load1
  - not\_saving\_data
- pspm\_interpolate
  - option\_disabled
- pspm\_trim
  - marker\_out\_of\_range
- pspm\_find\_channel
  - multiple\_matching\_channels
- pspm\_find\_sounds
  - no\_marker\_chan
  - no\_sound\_chan
- pspm\_get\_scr
  - no\_conversion\_constant
- pspm\_pp
  - invalid\_freq
- pspm\_prepdata
  - no\_low\_pass\_filtering
  - downsampling\_failed
  - nonint\_sr
- pspm\_get\_timing
  - invalid\_vector\_size
  - event\_names\_dont\_match
  - no\_numeric\_vector
  - no\_integers
- pspm\_down
  - rate\_below\_minimum

## **3 List of data formats**

### **3.1 Supported Channel types**

| Data format                                 | SCR | ECG | Heart Rate | Heart Beat | Heart Period | Respiration | Pupil Size | Marker | Custom | Sound channel | Pulse oxymeter | Gaze x/y, l/r |
|---|-----|-----|------------|------------|--------------|-------------|------------|--------|--------|---------------|----------------|---------------|
| CED Spike                                   | ✓   | ✓   | ✓          | ✓          | ✓            | ✓           | ✓          | ✓      | ✓      | ✓             | ✓              | ✓             |
| MATLAB                                      | ✓   | ✓   | ✓          | ✓          | ✓            | ✓           | ✓          | ✓      | ✓      | ✓             | ✓              | ✓             |
| Text  | ✓   | ✓   | ✓          |            | ✓            | ✓           | ✓          | ✓      | ✓      | ✓             | ✓              | ✓             |
| Biopach<br>AcqKnowledge ( $\leq$<br>v3.9.0) | ✓   | ✓   | ✓          | ✓          | ✓            | ✓           | ✓          | ✓      | ✓      | ✓             | ✓              | ✓             |
| Biopac AcqKnowledge<br>(exported)           | ✓   | ✓   | ✓          | ✓          | ✓            | ✓           | ✓          | ✓      | ✓      | ✓             | ✓              | ✓             |
| Labchart (any<br>Version, Windows<br>only)  | ✓   | ✓   | ✓          |            | ✓            | ✓           | ✓          | ✓      | ✓      | ✓             | ✓              | ✓             |
| Labchart exported<br>( $\leq$ v7.1)         | ✓   | ✓   | ✓          |            | ✓            | ✓           | ✓          | ✓      | ✓      | ✓             | ✓              | ✓             |
| Labchart exported<br>( $\geq$ v7.2)         | ✓   | ✓   | ✓          |            | ✓            | ✓           | ✓          | ✓      | ✓      | ✓             | ✓              | ✓             |
| VarioPort                                   | ✓   | ✓   | ✓          |            | ✓            | ✓           | ✓          | ✓      | ✓      | ✓             | ✓              | ✓             |
| Biograph Infiti<br>(exported)               | ✓   |     |            | ✓          |              | ✓           |            |        |        |               |                |               |
| Mindmedia Biotrace<br>(exported)            | ✓   | ✓   | ✓          |            | ✓            | ✓           | ✓          | ✓      | ✓      | ✓             | ✓              | ✓             |
| Brain Vision                                | ✓   | ✓   | ✓          |            | ✓            | ✓           | ✓          | ✓      | ✓      | ✓             | ✓              | ✓             |
| Windaq (wdq)                                | ✓   | ✓   | ✓          | ✓          | ✓            | ✓           | ✓          | ✓      | ✓      | ✓             |                | ✓             |
| Observer XT<br>compatible                   | ✓   | ✓   | ✓          | ✓          | ✓            | ✓           | ✓          | ✓      | ✓      | ✓             | ✓              | ✓             |
| NeuroScan                                   | ✓   | ✓   | ✓          |            | ✓            | ✓           | ✓          | ✓      | ✓      | ✓             | ✓              | ✓             |
| BioSemi                                     | ✓   | ✓   | ✓          |            | ✓            | ✓           | ✓          | ✓      | ✓      | ✓             | ✓              | ✓             |
| Eyelink                                     |     |     |            |            |              |             | ✓          | ✓      | ✓      |               |                | ✓             |
| European Data<br>Format                     | ✓   | ✓   | ✓          | ✓          | ✓            | ✓           | ✓          | ✓      | ✓      | ✓             | ✓              | ✓             |
| Philips Scanphyslog                         |     | ✓   |            |            |              | ✓           |            | ✓      | ✓      |               | ✓              |               |
| SMI   |     |     |            |            | 13           |             | ✓          | ✓      | ✓      |               |                | ✓             |
| ViewPoint                                   |     |     |            |            |              |             | ✓          | ✓      | ✓      |               |                | ✓             |



### 3.2 Further settings

| Data format                                 | Datatype        | File extension | Manufacturer                | Import multiple channels | Search channel names | Automarker | Ask for sampling rate |
|---|-----------------|----------------|-----------------------------|--------------------------|----------------------|------------|-----------------------|
| CED Spike                                   | spike           | .smr           | CED                         | ✓                        | ✓                    |            |                       |
| MATLAB                                      | mat             | .mat           |                             | ✓                        |                      |            | ✓                     |
| Text  | txt             | .txt           |                             | ✓                        | ✓                    |            |                       |
| Biopach<br>AcqKnowledge ( $\leq$<br>v3.9.0) | acq             | .acq           | Biopac                      | ✓                        | ✓                    |            |                       |
| Biopac AcqKnowledge<br>(exported)           | acqmat          | .mat           | Biopac                      | ✓                        | ✓                    |            |                       |
| Labchart (any<br>Version, Windows<br>only)  | labchart        | .adicht        | ADInstruments               | ✓                        | ✓                    | ✓          |                       |
| Labchart exported<br>( $\leq$ v7.1)         | labchartmat_ext | .mat           | ADInstruments               | ✓                        | ✓                    | ✓          | ✓                     |
| Labchart exported<br>( $\geq$ v7.2)         | labchartmat_in  | .mat           | ADInstruments               | ✓                        |                      | ✓          |                       |
| VarioPort                                   | vario           | .vpd           | Becker<br>MediTec           | ✓                        | ✓                    | ✓          |                       |
| Biograph Infiniti<br>(exported)             | biograph        | .txt           | Thought<br>Technology       |                          |                      |            |                       |
| Mindmedia Biotrace<br>(exported)            | biotrace        | .txt           | MindMedia                   |                          |                      | ✓          |                       |
| Brain Vision                                | brainvision     | .eeg           | BrainProducts               | ✓                        | ✓                    | ✓          |                       |
| Windaq (wdq)                                | windaq          | .wdq           | Dataq                       | ✓                        |                      |            |                       |
| Observer XT<br>compatible                   | observer        | .any           | Noldus                      | ✓                        | ✓                    |            |                       |
| NeuroScan                                   | cnt             | .cnt           |                             | ✓                        | ✓                    | ✓          |                       |
| BioSemi                                     | biosemi         | .bdf           |                             | ✓                        | ✓                    | ✓          |                       |
| Eyelink                                     | txt             | .asc           |                             | ✓                        |                      | ✓          |                       |
| European Data<br>Format                     | edf             | .edf           | European<br>Data Format     | ✓                        | ✓                    | ✓          |                       |
| Philips Scanphyslog                         | txt             | .log           | Philips                     | ✓                        |                      |            |                       |
| SMI   | txt             | .txt<br>15     | SensoMotoric<br>Instruments | ✓                        | ✓                    | ✓          |                       |
| ViewPoint                                   | txt             | .txt           | Arrington<br>Research       | ✓                        | ✓                    | ✓          |                       |

Note: Automarkers means no channel number has to be specified because markers are always at the same place.



## 4 GUI

Contributed by Gabriel Gräni and Teddy Zhao.

Revised by Teddy Zhao in February 2022.

### 4.1 MATLABbatch: Getting started

1. Add the trunk folder to the MATLAB path.
2. Type `pspm_init` into the command window (after the execution of the command the folders `pspm_cfg` and `MATLABbatch` should be added to the MATLAB path)
3. Start MATLABbatch by the typing `cfg_ui` into the command window
4. If the item `PsPM` exists in the menu bar of MATLABbatch you can skip steps 5 to 7 and continue at step 8
5. Select `→ File → Add Application`
6. Navigate to the folder `pspm_cfg` on the left hand side of the window and select the file `pspm_cfg.m` on the right hand side `→ Press the button Done`
7. A new item, called `PsPM`, will appear in the upper menu bar.
8. By selecting `PsPM` the desired action can be selected (at the moment, there is only `Data Preparation` `→ {Import, Trim}` available)

#### 4.1.1 Example Function: Trim

This example demonstrates how MATLABbatch can be used to execute a function. For all other functions MATLABbatch behaves in the same manner.

- Select a file by pressing the `Select Files Button` (under `Datafile`)
- Select `Reference` and choose an item in the lower part of the window
- Fill in the desired values in the fields which are marked with `"<-X"`
- After you have chosen a file and filled in all values correctly, you will see a green arrow on the upper left part of the window
- By pressing on the green arrow the selected file will be trimmed according to the filled in values

### 4.2 MATLABbatch: How to

#### 4.2.1 Preliminaries

- Add folder of `MATLABbatch` to the MATLAB path
- Add first application and then load the batch in order to execute a function

#### 4.2.2 Some notes for creating a new application

- Leafs (items) are specified first
- Assigning child items to `.val` or `.values` fields of their parent items
- Root node of a tree is specified last
- Some examples of items:

##### – `cfg_item`

```
item1= cfg_item; % Defines generic configuration item
item1.name= 'Def 1'; % The display name
item1.tag = 'def1'; % The name appearing in the harvested job
% structure. This name must be unique
% among all items in the val field of the
% superior node
item1.val = {true}; % Value of item (optional)
item1.help = {'Help...'}; % Help text
```

##### – `cfg_entry`

```
entry1 = cfg_entry; % Defines entry configuration item
entry1.name = 'Input';
entry1.tag = 'input';
entry1.strtye = 'r'; % Type of values which can be entered
entry1.num = [1 1]; % Expected dimension of the input
entry1.help = {'Help...'};
```

##### – `cfg_choice`

```
choice = cfg_item; % Defines choice configuration item
choice.name = 'Choice';
choice.tag = 'choice';
choice.values = {item1, entry1}; % Defines which items will be
% selectable in the choice menu.
choice.help = {'Help...'};
```

##### – `cfg_exbranch`

```
fct = cfg_exbranch; % Defines the branch that has information
% about how to run this module fct.name = 'Trim';
fct.tag = 'trim';
fct.val = {choice}; % The items that belong to this branch.
% All items must be filled before this
% branch can run or produce virtual
% outputs
```

```
fct.prog = @cfg_run_fct; % A function handle that will be called
% with the harvested job to run the
% computation
```

```
trim.vout = @cfg_vout_fct; % A function handle that will be
% called with the harvested job to
% determine virtual outputs
trim.help = {Help...'};
```

- There exists a number of other item classes. Here is a list of the most important classes: `cfg_item`, `cfg_entry`, `cfg_choice`, `cfg_menu`, `cfg_exbranch`, `cfg_files`, `cfg_branch`, `cfg_repeat`.

For more information call the help function in MATLAB (e.g. `help cfg_item`)

**Note** The inputs to each module have to be described in a tree-like structure.

During data entry, there is no way to change the tree structure based on input data. Add application to the configuration tree by default

### 4.2.3 Add application to the configuration tree by default

In the following it is shown how an application can be added to the menu bar of MATLABbatch by default (without adding it every time MATLABbatch is started)

- Start MATLABbatch and add the application `cfg_configui` in the folder `MATLABbatch/cfg_configui`.
- Put Generate code into the Module list by selecting `ConfigUI` → `Generate code` in the menu bar
- Fill out all the input fields on the right side:
  - Output filename: This file will contain the whole menu structure, validity constraints and links to run time code of the application.
  - Output directory: All files which are created by the ConfigUI will be stored into this directory (choose a directory which is added to the MATLAB path)
  - Root node of config: Name of the root node of the application's configuration tree
  - Options:
    1. Create Defaults File: Yes
    2. Create `mlbatch_appcfg` File: Yes
    3. Create Code for `addpath()`: No
- Finally press the green arrow on the upper left side of the batch editor
- As no error occurred 3 new files (`{Output filename}.m`, `{Output filename}_def.m`, `cfg_mlbatch_appcfg.m`) should be created and added into the folder `{Output directory}`.
- Each time MATLABbatch is started, it will search for any `cfg_mlbatch_appcfg.m` file (this file contains the names of the configuration files) and will add the corresponding application to the batch editor.

### 4.2.4 Add modules to module list

**Example** Module Import and Trim will be added to the module list

```

arg1 = 'scr.prep.import_data';
arg2 = 'scr.prep.trim';
mod_cfg_id1 = cfg_util('tag2mod_cfg_id',arg1);
mod_cfg_id2 = cfg_util('tag2mod_cfg_id',arg2);
cjob = cfg_util('initjob');
mod_job_id1 = cfg_util('addtojob', cjob, mod_cfg_id1);
mod_job_id2 = cfg_util('addtojob', cjob, mod_cfg_id2);
cfg_util('harvest', cjob, mod_job_id1);
cfg_util('harvest', cjob, mod_job_id2);
cfg_ui('local_showjob', cfg_ui, cjob);

```

#### 4.2.5 Changes

- In the function `private/cfg_onscreen` at line 36 `figure(fg);` is commented out in order to prevent the appearance of the GUI for a short time if the function `cfg_ui('Visible', 'off')` is called.

### 4.3 MATLABbatch: changing help texts and fieldnames

#### 4.3.1 File structure of MATLABbatch GUI

There exist two files per function: 1 configuration file and 1 run file. The configuration file defines the structure of the corresponding function in the MATLABbatch GUI whereas the run file firstly gathers all entered values and secondly calls the corresponding SCR function. Both types of files are located in the subfolder `pspm_cfg`. The name of a configuration or a run file consists of two parts. The prefix of a configuration filename is called `pspm_cfg_` whereas the filename of a run file begins with `pspm_cfg_run`. The second part of the filename is named after the function name (eg. for the function `pspm_import.m` → `pspm_cfg_import.m`, `pspm_cfg_run_import.m`).

#### 4.3.2 Edit help texts and fieldname

In order to change any help text or fieldname in a MATLABbatch GUI function the corresponding configuration file has to be opened. For each item in a MATLABbatch GUI function a struct variable which contains several struct fields is defined in the configuration file.

- **Help text** The field `.help` defines the help text of the item which can be edited in order to change the help text. As soon as MATLABbatch has been closed and opened again, the changes in the help text will be visible in MATLABbatch GUI.
- **Fieldname** The fieldname of an MATLABbatch GUI item is defined by the struct field `.tag`. In case a fieldname of an item should be changed be careful to verify if no other item, which has the same root node, hold the same fieldname. Otherwise MATLABbatch will not work properly. After the fieldname of an item has been changed the run file (`pspm_cfg_run_functionname.m`) of the corresponding function has to be adapted as well in order to ensure that the function call in the run file is done properly.

## 4.4 GUI Development Progress

MATLAB GUIDE <https://uk.mathworks.com/help/matlab/migrate-guide-apps.html> was originally used as the framework for designing the GUI of PsPM. However, the framework suffers from the risk that plots may be unexpectedly displayed on such figures since they need to be called by users' command lines. At the same time, GUIDE based GUI will lose support from Mathworks in a future release of MATLAB. Consequently, PsPM is currently slowly being migrated to the new UI designing framework, MATLAB AppDesigner. Instead of creating .fig files, the new AppDesigner frameworks will create .mlapp files. The .mlapp file can be created natively through the new MATLAB GUI guide. Alternatively, it can be generated by converting the classic GUIDE based .fig file through the feature *migration*.

The main GUI has been recreated by using AppDesigner in PsPM version 6.1, where the function lists inherited from the legacy of GUIDE-based GUI. The code has been re-sorted out in MATLAB by following the coding style of AppDesigner. A typical button corresponds to the function shown below

```
function
button_Callback(app, event)
switch event.Value
case 'A'
action;
end
end
```

The new GUI is currently using the colour #7f2534 for styling. The main typeface for UI design is Segoe UI, San Francisco (or Helvetica Neue for pre-macOS Yosemite) and DejaVu Sans for Windows, macOS and Linux, respectively.

## 5 Test Environment

Contributed by Linus Rüttimann, Tobias Moser and Teddy Zhao.

Revised and updated by Teddy Zhao in February 2022.

### 5.0.1 Unittest: General implementation

In PsPM the MATLAB Unit Testing Framework is used for testing of functions. For each tested function there is a MATLAB class with the name `functionname_test`, which contains the unittests for that specific function. Additionally there is a documentation page for each of the test classes, where information about the unittests can be found.

To run the unittests of a test class, an object of the class has to be created

```
| testCase = functionname_test.
```

where `testCase` is an arbitrary object name and `functionname_test` is the name of a test class. Then all the unittest that are contained in the test class can be run with

```
| testCase.run.
```

A specific unittest can be run with

```
| testCase.run(unittest_name').
```

Remember that a new test class object must be generated each time the test class has been changed.

### 5.0.2 parameterised test classes

Parameterised test classes is a feature provided by the MATLAB test case class. A test class is parameterised when it has

- Test parameters defined (within the property section)
- Test methods implementing the defined test parameters

Each function implementing test parameters will be called multiple times with each possible parameter combination (which is determined by MATLAB). Thus parameterised classes allow to write single tests for different parameter combinations. If one of the following test cases is a parameterised test class, it will be mentioned accordingly.

## 5.1 Align Channels

### 5.1.1 Overview

**Testclass** `pspm_align_channels_test`

**Format** `[sts, data, duration] = pspm_align_channels(data, induration)`

### 5.1.2 Setup

This test uses data stored in ImportTestData/ecg2hb/tpspm\_s102\_s1.mat

### 5.1.3 Testcases

#### Invalid input

**Function name** invalid\_input(this)

**Description** Checks for warnings given invalid inputs.

#### Lower optional duration

**Function name** lower\_optional\_duration(this)

**Description** Passes an optional duration that is less than the maximum duration of all channels in the input to pspm\_align\_channels.

#### Tests

1. Assert that lower optional duration has no effect on the output.
2. Check if all of the returned channels have the same duration.

#### Same optional duration

**Function name** same\_optional\_duration(this)

**Description** Passes an optional duration that is equal to the maximum duration of all channels in the input to pspm\_align\_channels and does the exact same checks as in lower duration case.

#### Higher optional duration

**Function name** higher\_optional\_duration(this)

**Description** Passes an optional duration that is higher than the maximum duration of all channels.

#### Tests

1. Assert that durations of all returned channels is the same as the passed optional duration.

### Max duration is passed in marker channel

**Function name** `max_duration_is_given_in_events(this)`

**Description** Passes the maximum duration in marker channel to `pspm_align_channels`.

#### Tests

1. Assert that all returned channels are aligned to the maximum duration passed in marker channel.

### Various case checks

#### Function names

`only_one_channel_longer_others_same(this)`

`only_one_channel_shorter_others_same(this)`

`increasing_channel_lengths(this)`

`two_same_others_shorter(this)`

**Description** In each of these cases check if the returned channels have the same duration that is equal to the maximum duration of all input channels.

## 5.2 Butter

### 5.2.1 Overview

**Testclass** `pspm_butter_test`

**Function** `[sts, b, a] = pspm_butter(order, freqratio, pass)`

### 5.2.2 Testcases

#### Invalid input

**Function name** `invalid_input(this)`

**Description** Checks for warnings, if the input arguments are invalid and if the signal processing toolbox is installed.



## Tests

| Input  | Expected warning   |
|--|--------------------|
| pspm_butter() [no input]                                     | ID:invalid_input   |
| pspm_butter(1,1,'abc') [pass not equal to 'high' or 'low']   | ID:invalid_input   |
| pspm_butter(2,1) ['Signal processing toolbox is missing' #1] | ID:toolbox_missing |
| pspm_butter(1,1) ['Signal processing toolbox is missing' #2] | ID:toolbox_missing |

## 5.3 pspm\_bf\_test

### 5.3.1 Overview

**Testclass** pspm\_bf\_test

**Format** [bs, x] = pspm\_bf\_<specific function name>

### 5.3.2 Setup

This test class is parameterised.

**Method setup parameters** These parameters define which function should be tested.

**Basis function** Specifies the basis functions to test (without the pspm\_bf\_ prefix). The current basis function to test is then called via `this.bf()`;

**Test parameters** These are parameters which define what kind of data or option should be passed to each basis function.

|                     |  |
|---------------------|--|
| <b>Time res log</b> | Specifies for the basic test different time resolutions (argument 'td') which a basis function should be able to handle (as long as $td \leq \text{duration}$ ). The values are logarithmic and have to be translated before passed to the basis function. |
|---------------------|--|

### 5.3.3 Testcases

#### Invalid input

**Function name** invalid\_input(this)

**Description** Checks for warnings, if the input arguments are invalid.

Tests

| Input   | Expected warning |
|---|------------------|
| this.bf() [no parameters]                         | ID:invalid_input |
| this.bf(dur+1) [pass 'td' > duration of function] | ID:invalid_input |
| this.bf(0) [invalid time resolution]              | ID:invalid_input |

## Basic

**Function name** test\_basic(this, time\_res\_log)

**Description** Test for different requirements to verify whether the current basis function is valid or not.

**Tests**

1. Test with  $td = 0.1$ , verify that no warning is issued and determine the duration
2. Test with  $td = 0.01$  and check if the new duration is equal to the duration calculated before.
3. Test if function runs through without warning and that the time vector begins at  $\leq 0$ .
4. Test if the function runs through without warning with  $td = 10^{\text{time\_res\_log}}$  (as long as  $td < \text{duration}$ )

## 5.4 pspmm\_convert\_unit

### 5.4.1 Overview

**Testclass** pspmm\_convert\_unit\_test

**Function** [sts, converted] = pspmm\_convert\_unit(data, from, to)

### 5.4.2 Setup

**Constants** inch\_to\_cm = 2.54

### 5.4.3 Testcases

#### Invalid input

**Function name** invalid\_input(testCase)

**Description** Pass invalid from or to metrics and check if warnings are issued.

## Valid input

**Function name** `valid_input(this)`

**Description** Pass various valid inputs and compare results to manually calculated ones.

## Tests

1. If empty input data is passed, result is also empty.
2. Convert single cm value to m.
3. Various unit conversion checks:
  - (a) Conversion between same units (cm to cm)
  - (b) mm to km and km to mm conversions
  - (c) inch to cm conversions
4. Negative value conversions
5. Convert single dimensional array with multiple elements.
6. Convert each element in 3D array.

## 5.5 pspm\_ecg2hb

### 5.5.1 Overview

**Testclass** `pspm_ecg2hb_test`

**Format** `[sts,pt_debug] = pspm_ecg2hb(fn, chan, options)`

### 5.5.2 Setup

#### Constants

- `testdata{0}.chan_struct = struct('nr', 1, 'name', 'ecg');`
- `testdata{0}.filename = 'ImportTestData\ecg2hb\test_ecg77.mat';`
- `testdata{0}.num_channels = 1`
- `testdata{1}.chan_struct = struct('nr', 3, 'name', 'ecg');`
- `testdata{1}.filename = 'ImportTestData\ecg2hb\tpspm_s102_s1.mat';`
- `testdata{1}.num_channels = 5`
- `backup_suffix = '_backup';`
- `options = struct('semi', 0);`

### 5.5.3 Testcases

#### Invalid input arguments

**Function name** `invalid_input(this)`

**Description** Pass invalid input arguments and check if the warnings are as expected.

| Tests | Input   | Expected warning           |
|-------|---|----------------------------|
|       | <code>pspm_ecg2hb()</code> [no arguments]   | ID:invalid_input           |
|       | <code>pspm_ecg2hb(1)</code> [invalid file name]   | ID:invalid_input           |
|       | <code>pspm_ecg2hb(this.fn, 'bla')</code> [invalid channel (text)]                                       | ID:invalid_input           |
|       | <code>pspm_ecg2hb(this.fn, 1)</code> [invalid channel type]   | ID:not_allowed_channeltype |
|       | <code>o.twthresh = 'bla'; pspm_ecg2hb(this.fn, this.chan.nr, o)</code> [invalid twthresh (text)]        | ID:invalid_input           |
|       | <code>o.minHR = 202; pspm_ecg2hb(this.fn, this.chan.nr, o)</code> [invalid minHR (> default_maxHR)]     | ID:invalid_input           |
|       | <code>o.minHR = 202; o.maxHR = 19; pspm_ecg2hb(this.fn, this.chan.nr, o)</code> [invalid minHR > maxHR] | ID:invalid_input           |
|       | <code>o.maxHR = 19; pspm_ecg2hb(this.fn, this.chan.nr, o)</code> [invalid maxHR (< default_minHR)]      | ID:invalid_input           |
|       | <code>o.debugmode = 5; pspm_ecg2hb(this.fn, this.chan.nr, o)</code> [invalid debugmode (not in [0,1])]  | ID:invalid_input           |
|       | <code>o.semi = 5; pspm_ecg2hb(this.fn, this.chan.nr, o)</code> [invalid semi (not in [0,1])]            | ID:invalid_input           |

#### Valid input arguments

**Function name** `valid_input(this)`

**Description** Pass valid input arguments and check if there are no warnings.

| Tests | Input   | Expected warning |
|-------|---|------------------|
|       | <code>pspm_ecg2hb(this.fn, this.chan.nr, this.options)</code>   | -                |
|       | <code>pspm_ecg2hb(this.fn, this.chan.name, this.options)</code> | -                |
|       | <code>this.test_added_data()</code>                             | -                |

### 5.5.4 Other Methods

#### Test for added data

**Function name** test\_added\_data()

**Description** Check if added hb channels show an expected behaviour.

| Tests   | (for | each           | channel) |
|---|------|----------------|----------|
| Tested Value                                      |      | Expected Value |          |
| Sampling rate                                     |      | 1              |          |
| Unit  |      | 'events'       |          |
| Channel type                                      |      | 'hb'           |          |
| Amount of data points in data                     |      | > 1            |          |
| Heartbeat indices are monotonically increasing    |      | True           |          |
| Maximum number of heartbeats per second           |      | < 5            |          |
| Data is distributed equally (standard deviation)  |      | < 2s           |          |
| Time between end of recording and last data point |      | < 60s          |          |

## 5.6 pspm\_filtfilt

### 5.6.1 Overview

**Testclass** pspm\_filtfilt\_test

**Format** y = pspm\_filtfilt(b,a,x)

### 5.6.2 Testcases

#### Invalid input

**Function name** invalid\_input(this)

**Description** Checks for warnings, if the input arguments are invalid.

| Tests | Input  | Expected warning |
|-------|--|------------------|
|       | pspm_filtfilt() [no input]   | ID:invalid_inpu  |
|       | pspm_filtfilt([1:10],[1:20],[1:10]) [data length less than 3 times filter order] | ID:invalid_inpu  |

## 5.7 pspm\_find\_channel

### 5.7.1 Overview

**Testclass** pspm\_find\_channel\_test

**Format** chan = pspm\_find\_channel(headercell, chantype)

## 5.7.2 Testcases

### Invalid input arguments

**Function name** invalid\_inputargs(this)

**Description** Checks for warnings, if the input arguments are invalid.

**Setup** headercell = {'heart', 'scr', 'pupil'};

#### Tests

| Input   | Expected warning           |
|---|----------------------------|
| pspm_find_channel('str','scr') [no headercell]        | ID:invalid_input           |
| pspm_find_channel(headercell, 'str')                  | ID:not_allowed_channeltype |
| pspm_find_channel(headercell, 4) [no string chantype] | ID:invalid_input           |

### Valid Input Arguments

**Function name** valid\_inputargs(this)

**Description** Checks for correct return value if the input arguments are valid

**Setup** headercell = {'heart', 'scr', 'pupil', 'mark', 'gsr', 'eda'};

#### Tests

| Input   | Exp. Output | Expected warning                           |
|---|-------------|--|
| pspm_find_channel(headercell, 'pupil')                | 3           |  |
| pspm_find_channel(headercell, 'resp')                 | 0           | ID:no_matching_channels                    |
| pspm_find_channel(headercell, 'scr')                  | -1          | ID:multiple_matching_channels              |
| pspm_find_channel(headercell, {'mark', 'str', 'bla'}) | 4           |  |
| pspm_find_channel(headercell, {'call', 'str', 'me'})  | 0           | no matching channel, but no warning        |
| pspm_find_channel(headercell, {'scr', 'gsr', 'eda'})  | -1          | multiple matching channels, but no warning |

## 5.8 pspm\_extract\_segments

### 5.8.1 Overview

**Testclass** pspm\_extract\_segments\_test



**Description** Checks for equality of produced segments by `pspm_extract_segments` with manually computed segments.

**Tests**

1. Generate segments from test data.
2. Test if function call worked `WarningFree`
3. Test if variable `segments` exists in output
4. Test if correct number of segments were produced
5. Test each segment holds correct data

**Test manual mode with durations**

**Function name** `test_manual_duration(this,nr_trial,nan_ratio)`

**Description** Checks for equality of produced segments by `pspm_extract_segments` with manually computed segments.

**Tests**

1. Generate segments from test data.
2. Test if function call worked `WarningFree`
3. Test if variable `'segments'` exists in output
4. Test if correct number of segments were produced
5. Test each segment holds correct data

**Test auto mode with GLM using marker onsets**

**Function name** `test_auto_mode_glm_with_markers(this)`

**Description** Runs `pspm_extract_segments` with a particular GLM model stored in `ImportTestData/fitted_model` and compares the results to manually calculated results.



## Tests

1. Test if length of the returned cell array (from now on called `segments`) is the same as the number of conditions
2. Test if shape of data arrays in each element of `segments` agrees with the passed durations and number of onsets.
3. Test if `segments.trial_idx` agrees with input data.
4. Test if statistics calculated manually from `segments.data` is the same as `segments.mean` and `segments.std`.
5. Compute each statistic field in each element of `segments` manually using the input data and compare the results to `segments`.

### Test auto mode with GLM using second onsets

**Function name** `test_auto_mode_glm_with_seconds(this)`

**Description** Do the exact same tests as in `test_auto_mode_glm_with_markers` but this time using seconds to specify onsets.

### Test auto mode with DCM

**Function name** `test_auto_mode_dcm(this)`

**Description** Runs `pspm_extract_segments` with a particular DCM model stored in `ImportTestData/fitted_model` and compares the results to manually calculated results. In order to get meaningful condition statistic information this test function assigns the same trial name to certain groups of trials.

**Note** Since in DCM case onsets are calculated using trial start and end seconds of DCM trials, there is no second/marker distinction in DCM test.

**Tests** Do the exact same tests as in `test_auto_mode_glm_with_markers` by adapting the computation steps to DCM case.

## 5.9 pspm\_find\_sounds

### 5.9.1 Overview

**Testclass** `pspm_find_sounds_test`

**Format** `[sts, infos] = pspm_find_sounds(file, options)`

### 5.9.2 Setup

This test class is parameterised. The test data is generated by the function itself and when needed, files will be written to `testdatafile<variable_nr>.mat`.

**Test parameters** These are parameters which define what kind of data should be passed to `pspm_find_sounds` and which options should be set.

|                       |   |
|-----------------------|---|
| <b>Channel output</b> | Specifies whether 'all' found markers or only 'corrected' markers should be returned.   |
| <b>Max delay</b>      | Varies the max delay option and defines how far away a marker at most can be.   |
| <b>Min delay</b>      | Varies the min delay option and defines how far away a marker at least should be.   |
| <b>Threshold</b>      | Defines the minimum size of a marker to be recognized as a marker event. Passed in percent of the maximum amplitude of the recorded data.   |
| <b>Resample</b>       | Defines whether the function should resample (and interpolate) the data to a higher sample rate in order to get more exact marker findings. |
| <b>Channel action</b> | Defines whether a newly created marker channel should replace the existing marker channel or should be added as a new marker channel.       |

### 5.9.3 Testcases

#### Invalid input

**Function name** `invalid_input(this)`

**Description** Checks for warnings, if the input arguments are invalid.

**Tests**

| Input   | Expected warning  |
|---|-------------------|
| <code>pspm_find_sounds('')</code>   | ID:file_not_found |
| <code>pspm_find_sounds(fn)</code> [invalid pspm file]                               | ID:invalid_input  |
| <code>pspm_find_sounds(fn)</code> [pspm file without a 'snd' channel]               | ID:no_sound_chan  |
| <code>pspm_find_sounds(fn, o)</code> [invalid values for positive integer fields]   | ID:invalid_input  |
| <code>pspm_find_sounds(fn, o)</code> [invalid values for positive numeric fields]   | ID:invalid_input  |
| <code>pspm_find_sounds(fn, o)</code> [invalid values for logic fields]              | ID:invalid_input  |
| <code>pspm_find_sounds(fn, o)</code> [invalid channel ids for channel fields]       | ID:out_of_range   |
| <code>pspm_find_sounds(fn, o)</code> [enabled diagnostics without a marker channel] | ID:no_marker_chan |
| <code>pspm_find_sounds(fn, o)</code> [invalid values for channelaction]             | ID:invalid_input  |
| <code>pspm_find_sounds(fn, o)</code> [invalid values for roi]                       | ID:invalid_input  |
| <code>pspm_find_sounds(fn, o)</code> [maxdelay < mindelay]                          | ID:invalid_input  |

**Test add channel**

**Function name** `test_add_channel(this, channeloutput, max_delay, resample, channelaction)`

**Description** Test add channel with different options. Diagnostics is always enabled, Channel output, Max delay, Resample and Channel action are varied. Once `pspm_find_sounds` is complete, the function tests if the returned data has the expected format.

**Tests**

1. Generate data with channel snd and marker; and count amount of reference markers
2. Set

- (a) options according to test parameters
- (b) diagnostics to 1
- 3. Test if function runs through without warning
- 4. Test if returned data has the correct format
- 5. Test if channels has been added or replaced
- 6. Test if added channel has correct amount of data

### **Test region count**

**Function name** test\_region\_count(this)

**Description** Test region of interest in combination with expected sound count.

#### **Tests**

- 1. Generate data with channel 'snd' and 'marker'
- 2. Test if function finds the function finds all markers in the whole file
- 3. Test if function finds all the markers in the whole file with initial threshold 1
- 4. Test if function finds half of the markers in half of the file

### **Test threshold**

**Function name** test\_threshold(this, threshold)

**Description** Vary the threshold option and test whether the functions returns the expected data.

#### **Tests**

- 1. Generate data with channel 'snd' and 'marker'
- 2. Set
  - (a) threshold according to test parameter
  - (b) diagnostics to 1
- 3. Test if function runs through without warning
- 4. Test if returned data has the correct format

## Test plot

**Function name** test\_plot(this, threshold)

**Description** Test if the plot functions return the expected data and runs through without warning.

### Tests

1. Generate data with channel snd and marker
2. Set
  - (a) plot to 1
  - (b) diagnostics to 1
3. Test if function runs through without warning
4. Test if returned data has the correct format

## 5.10 pspm\_find\_valid\_fixations

### 5.10.1 Overview

**Testclass** pspm\_find\_valid\_fixations\_test

**Format** [sts, out\_file] = pspm\_find\_valid\_fixations(fn, options)

### 5.10.2 Setup

This test class is parameterised. The test data is generated by the function itself and when needed, files will be written to testdatafile<variable\_nr>.mat.

**Test parameters** These are parameters which define what kind of data should be passed to pspm\_find\_valid\_fixations and which options should be set.

|                       |   |
|-----------------------|---|
| <b>Distance</b>       | Used for gaze validation; defines the distance between eyes and screen.   |
| <b>Aspect used</b>    | Used for gaze validation; defines the aspect ratio set in the software.   |
| <b>Aspect actual</b>  | Used for gaze validation; defines the aspect ratio of the hardware.   |
| <b>Screen size</b>    | Used for gaze validation; defines the size of the screen in inches.   |
| <b>Eyes</b>           | Is used for data generation and tells the function for which eyes data should be generated.   |
| <b>Channel action</b> | Defines whether to 'add' or 'replace' existing channels.  |
| <b>Newfile</b>        | Defines whether to create a new file or extend the existing file.   |
| <b>Overwrite</b>      | Defines whether to overwrite the existing file or not.  |
| <b>Interpolate</b>    | Defines whether to interpolate NaN values in validated channels or not.   |
| <b>Missing</b>        | Defines whether to create a channel which holds information about which positions have been set to NaN (and may have been interpolated afterwards). |
| <b>Work eye</b>       | Defines which eyes should be used for fixation validation.  |
| <b>Work chans</b>     | Defines which channels should be set to NaN during invalid fixations.   |

### 5.10.3 Testcases

#### Invalid input

**Function name** `invalid_input(this)`

**Description** Checks for warnings, if the input arguments are invalid.

## Tests

| Input  | Expected warning |
|--|------------------|
| <code>pspm_find_valid_fixations()</code>   | ID:invalid_input |
| <code>pspm_find_valid_fixations('a')</code>  | ID:invalid_input |
| <code>pspm_find_valid_fixations(fn, options) [invalid options.validate_fixations]</code>         | ID:invalid_input |
| <code>pspm_find_valid_fixations(fn, options) [invalid options.box_degree]</code>                 | ID:invalid_input |
| <code>pspm_find_valid_fixations(fn, options) [invalid options.screen_settings]</code>            | ID:invalid_input |
| <code>pspm_find_valid_fixations(fn, options) [missing fields for options.screen_settings]</code> | ID:invalid_input |
| <code>pspm_find_valid_fixations(fn, options) [invalid options.aspect_actual]</code>              | ID:invalid_input |
| <code>pspm_find_valid_fixations(fn, options) [invalid options.aspect_used]</code>                | ID:invalid_input |
| <code>pspm_find_valid_fixations(fn, options) [invalid options.bitmap]</code>                     | ID:invalid_input |
| <code>pspm_find_valid_fixations(fn, options) [invalid options.display_size]</code>               | ID:invalid_input |
| <code>pspm_find_valid_fixations(fn, options) [invalid options.display_size]</code>               | ID:invalid_input |
| <code>pspm_find_valid_fixations(fn, options) [invalid options.fixation_point]</code>             | ID:invalid_input |
| <code>pspm_find_valid_fixations(fn, options) [invalid options.channel_action]</code>             | ID:invalid_input |
| <code>pspm_find_valid_fixations(fn, options) [invalid options.newfile]</code>                    | ID:invalid_input |
| <code>pspm_find_valid_fixations(fn, options) [invalid options.overwrite]</code>                  | ID:invalid_input |
| <code>pspm_find_valid_fixations(fn, options) [invalid options.interpolate]</code>                | ID:invalid_input |
| <code>pspm_find_valid_fixations(fn, options) [invalid options.missing]</code>                    | ID:invalid_input |
| <code>pspm_find_valid_fixations(fn, options) [invalid eyes]</code>                               | ID:invalid_input |
| <code>pspm_find_valid_fixations(fn, options) [invalid options.channels]</code>                   | ID:invalid_input |

## Test work chans

**Function name** test\_work\_chans(this, work\_chans)

**Description** Tests whether the option 'channels' actually works on the specified channels or not.

### Tests

1. Generate data with

**distance** 500  
**aspect\_used** 16:9  
**aspect\_actual** 4:3  
**screen\_size** 20  
**eyes** 'lr'

2. Set options with

**overwrite** 1  
**channels** work\_chans  
**channel\_action** 'add'

3. Test if function runs through without warning
4. Test if sts==1
5. Test if specified work\_chans are added as new processed channels

## Test work eye

**Function name** test\_work\_eye(this, work\_eye)

**Description** Test whether the option 'eyes' actually works on the specified eyes or not.

### Tests

1. Generate data with

**distance** 500  
**aspect\_used** 16:9  
**aspect\_actual** 4:3  
**screen\_size** 20



**eyes** 'lr'

2. Set options with

**overwrite** 1

**eyes** work\_eye

**channel\_action** 'add'

3. Test if function runs through without warning
4. Test if sts==1
5. Test if specified eyes have been processed accordingly and test if not specified eyes have ignored.

### Test missing

**Function name** test\_missing(this, missing)

**Description** Test whether for each a a new missing channel is created if missing is specified as true.

### Tests

1. Generate data with

**distance** 500

**aspect\_used** 16:9

**aspect\_actual** 4:3

**screen\_size** 20

**eyes** 'lr'

2. Set options with

**overwrite** 1

**missing** missing

**channel\_action** 'add'

3. Test if function runs through without warning
4. Test if sts==1
5. Depending on the status of 'missing', test if there are any missing channels or if there is no missing channel

## Test interpolate

**Function name** test\_interpolate(this, interpolate)

**Description** Test whether data is interpolated during periods which are set to NaN by the function.

### Tests

1. Generate data with

**distance** 500  
**aspect\_used** 16:9  
**aspect\_actual** 4:3  
**screen\_size** 20  
**eyes** 'lr'

2. Set options with

**overwrite** 1  
**interpolate** interpolate  
**channel\_action** 'add'

3. Test if function runs through without warning
4. Test if sts==1
5. Depending on the status of 'interpolate' test whether there are some NaN values or if NaN periods have been interpolated accordingly.

## Test overwrite

**Function name** test\_overwrite(this, overwrite)

**Description** Test if files are overwritten, if specified with 'overwrite' option.

### Tests

1. Generate data with

**distance** 500  
**aspect\_used** 16:9  
**aspect\_actual** 4:3  
**screen\_size** 20

**eyes** 'lr'

2. Set options with

**overwrite** 1  
**interpolate** interpolate  
**channel\_action** 'add'

3. Test if function runs through without warning
4. Test if sts==1
5. Test if file has been overwritten or not (tests, if there are any new channels).

### **Test channel action**

**Function name** test\_channel\_action(this, channel\_action)

**Description** Test if channels are added or replaced (according to channel\_action).

#### **Tests**

1. Generate data with

**distance** 500  
**aspect\_used** 16:9  
**aspect\_actual** 4:3  
**screen\_size** 20  
**eyes** 'lr'

2. Set options with

**overwrite** 1  
**channel\_action** channel\_action

3. Test if function runs through without warning
4. Test if sts==1
5. Test if channels have been added or replaced (tests, if there are any new channels).

### **Test newfile**

**Function name** test\_newfile(this, newfile)

**Description** Test whether the output is written to a newfile or to the input file.

#### Tests

1. Generate data with

```
distance 500
aspect_used 16:9
aspect_actual 4:3
screen_size 20
eyes 'lr'
```

2. Set options with

- (a) overwrite = 1
- (b) if newfile enabled
  - i. search for new file name
  - ii. set options.newfile to new file name
- (c) if newfile is disabled, set options.newfile to ''

3. Test if function runs through without warning

4. Test if sts==1

5. Test if returned outputfile equals the specified newfile or not (depending on the value of 'newfile')

#### Test gaze validation

**Function name** test\_gaze\_validation(this, distance, screen\_size, aspect\_actual, aspect\_used, eyes)

**Description** Test whether gaze validation is done correctly.

#### Tests

1. Generate data with the according function parameters

2. Iterate to returned degree values generated by the generation function

- (a) set function options
  - i. overrewrite = 1
  - ii. validate\_fixation =1
  - iii. screen\_settings and distance to function call settings

- iv. missing = 1
- (b) depending on the specified degree, test whether function runs through without warnings or not
- (c) load outputfile and test if (according to degree expectation) gaze validation has been done or not

## Test bitmap validation

**Function name** test\_bitmap\_validation(this, distance, resolution, eyes)

**Description** Test whether bitmap validation is done correctly.

### Tests

1. Generate data with the according function parameters
2. Iterate to returned bitmaps generated by the generation function
  - (a) Set function options
 

**missing 1**
  - (b) Depending on the specified number of valid fixations in the bitmap, test whether function runs through without warnings or not.
  - (c) Load outputfile and test if (according to bitmap expectation) bitmap validation has been done or not.

## 5.11 pspm\_gaze\_pp

### 5.11.1 Overview

**Testclass** pspm\_gaze\_pp\_test

**Function** pspm\_gaze\_pp preprocesses gaze signals, gaze x and gaze y channels at % the same time.

### 5.11.2 Testcases

#### Invalid input

**Function name** invalid\_input(this).

**Description** Check if the input is valid.

### Tests

1. Test if input as a number is invalid.
2. Test if input as a string is invalid.
3. Test if combining two identical channels is invalid.
4. Test if combining an invalid channel is invalid.

### Preprocessed channel

**Function name** `preprocessed_channel(this).`

**Description** Check if preprocessing a single channel is successful.

### Tests

1. Test if gaze\_x\_r can be pre-processed successfully.
2. Test if gaze\_x\_l can be pre-processed successfully.
3. Test if gaze\_y\_r can be pre-processed successfully.
4. Test if gaze\_y\_l can be pre-processed successfully.

### Check upsampling rate

**Function name** `upsampling_rate(this)`

**Description** Check the upsampling rate after gaze\_pp.

### Check channel combining

**Function name** `channel_combining(this).`

**Description** Test if combining two appropriate channels is successful.

### Tests

1. Test if combining gaze\_x\_r and gaze\_x\_l is successful.
2. Test if combining gaze\_y\_r and gaze\_y\_l is successful.

## 5.12 pspm\_get\_ecg

### 5.12.1 Overview

**Testclass** pspm\_get\_ecg\_test

**Function** [sts, data] = pspm\_get\_ecg(import)

### 5.12.2 Testcases

#### Test

**Function name** test(this).

**Description** Test if all fields are returned correctly.

#### Tests

1. Test if sts==1.
2. Test if data.data is equal to import.data.
3. Test if data.header.chantype is 'ecg'.
4. Test if data.header.units is equal to import.units.
5. Test if data.header.sr is equal to import.sr.

## 5.13 pspm\_get\_events

### 5.13.1 Overview

**Testclass** pspm\_get\_events\_test

**Function** [sts, import] = pspm\_get\_events(import)

### 5.13.2 Testcases

#### Check warnings

**Function name** check\_warnings(this)

**Description** Checks for warnings, if the field '.markers' is missing or contains invalid content.

|              | Input                 | Expected warning         |
|--------------|-----------------------|--------------------------|
| <b>Tests</b> | Missing marker field  | ID:nonexistent_field     |
|              | import.marker = 'foo' | ID:invalid_field_content |

## Timestamps

**Function name** timestamps(this)

**Description** Checks for correct output if the input is timestamp data.

### Tests

1. Test if sts==1.
2. Test if the length of the output data is equal to the length of the input data.

## Continuous

**Function name** continuous(this)

**Description** Checks for correct output if the input is continuous data.

### Tests

1. Perform three tests with different settings

Tests:

- (a) Test if sts==1.
- (b) Test if the length of the field 'markerinfo' is equal to the length of the output data.
- (c) Test if the length of the output data is equal to the expected number of pulses in the input data.

Settings

- (a) flank='both' (default)
- (b) flank='both' & data\_offset=50
- (c) flank='ascending'
- (d) flank='descending'
- (e) inverted input signal
- (f) signal with angular flanks
- (g) check with



2. Additional test for setting (b): Test if data offset has been removed in the output data.
3. Additional test for setting (c) and (d): Test if positions returned by output data correspond to flank changes in the input data.
4. Test if markerinfo is not set if it has been set before.

## 5.14 pspm\_get\_eyelink

### 5.14.1 Overview

**Testclass** pspm\_get\_eyelink\_test

**Function** [sts, data] = pspm\_get\_eyelink(import)

### 5.14.2 Methods

#### Set import values

**Function** [import\_struct, channel\_types] = set\_import\_values(this)

**Description** Helperfunction, which creates an import data set and the expected channel data set

#### Verify basic data structure

**Function name** verify\_basic\_data\_structure(this, data, sourceinfo, channel\_types)

**Description** Tests if the returned data structure is valid and match a given expected pattern.

#### Tests

1. Test if all channels are numeric
2. Test if recorded time and date have a valid format
3. Test if blink channels have correct unit
4. Test if pupil channels have either 'diameter' or 'area' as unit
5. Test if channels labeled with 'position' have unit 'pixel'
6. Test if channels labeled with 'blink' have unit 'blink'

### 5.14.3 Testcases

#### test\_multi\_session

**Function name** test\_multi\_session(this)

**Description** Test if the returned data structure fits into the pattern of a multi session data set.

**Tests**

1. Calls 'set\_import\_values(this)' to get import data set and expected channel data set.
2. passes returned sets to 'verify\_basic\_data\_structure()'.

**test\_two\_eyes**

**Function name** test\_two\_eyes(this)

**Description** Test if the returned data structure fits into the pattern of a two eyes data set.

**Tests**

1. Calls 'set\_import\_values(this)' to get import data set and expected channel data set.
2. Passes returned sets to 'verify\_basic\_data\_structure()'.

**test\_one\_eye**

**Function name** test\_one\_eye(this)

**Description** Test if the returned data structure fits into the pattern of a one eye data set.

**Tests**

1. Create an import data set and the expected channel data set and pass it to 'verify\_basic\_data\_structure()'.

**test\_track\_dist**

**Function name** test\_track\_dist(this)

**Description** Test if the returned data structure fits into the pattern of a two eyes data with eyelink\_trackdist set.

### Tests

1. Call 'set\_import\_values(this)' to get import data set and expected channel data set.
2. Overwrite some import data and channel data.
3. Pass returned sets to 'verify\_basic\_data\_structure()'.

## 5.15 pspm\_get\_hb

### 5.15.1 Overview

**Testclass** pspm\_get\_hb\_test

**Format** [sts, data] = pspm\_get\_hb(import)

### 5.15.2 Testcases

#### Test

**Function name** test(this)

**Description** Test if all fields are returned correctly.

#### Tests

1. Test if sts==1.
2. Test if data.data is equal import.data
3. Test if data.header.chantype is 'hb'
4. Test if data.header.units is 'events'
5. Test if data.header.sr==1

## 5.16 pspm\_get\_hr

### 5.16.1 Overview

**Testclass** pspm\_get\_hr\_test

**Function** [sts, data] = pspm\_get\_hr(import)

### 5.16.2 Testcases

#### Test

**Function name** test(this)

**Description** Test if all fields are returned correctly.

**Tests**

1. Test if sts==1.
2. Test if data.data is equal import.data
3. Test if data.header.chantype is 'hr'
4. Test if data.header.units is equal import.units
5. Test if data.header.sr is equal import.sr

## 5.17 pspm\_get\_marker

### 5.17.1 Overview

**Testclass** pspm\_get\_marker\_test

**Function** [sts, data] = pspm\_get\_marker(import)

### 5.17.2 Testcases

**Test**

**Function name** test(this)

**Description** Test if all fields are returned correctly.

**Tests**

1. Test if sts==1.
2. Test if data.data is equal to import.data.
3. Test if data.header.chantype is 'marker'.
4. Test if data.header.units is 'events'.
5. Test if data.header.sr==1.

## 5.18 pspm\_get\_pupil

### 5.18.1 Overview

**Testclass** pspm\_get\_pupil\_test

**Function** [sts, data] = pspm\_get\_pupil(import)

### 5.18.2 Testcases

#### Test

**Function name** test(this)

**Description** Test if all fields are returned correctly

#### Tests

1. Test if sts==1.
2. Test if data.data is equal import.data
3. Test if data.header.chantype is 'pupil'
4. Test if data.header.units is equal to import.units
5. Test if data.header.sr is equal import.sr

## 5.19 pspm\_get\_resp

### 5.19.1 Overview

**Testclass** pspm\_get\_resp\_test

**Function** [sts, data] = pspm\_get\_resp(import)

### 5.19.2 Testcases

#### Test

**Function name** test(this)

**Description** Test if all fields are returned correctly

#### Tests

1. Test if sts==1
2. Test if data.data is equal import.data
3. Test if data.header.chantype is 'resp'
4. Test if data.header.units is equal import.units
5. Test if data.header.sr is equal import.sr

## 5.20 pspm\_get\_scr

### 5.20.1 Overview

**Testclass** pspm\_get\_scr\_test

**Function** [sts, data] = pspm\_get\_scr(import)

### 5.20.2 Testcases

There are three test functions. One for the case that no transfer parameters are defined, one for the case that the transfer parameters are defined in a struct and one for the case that they are defined in a .mat file. They are all performing the following tests, plus eventually some individual tests.

#### Tests

1. Test if sts==1
2. Test if the field data.data exists
3. Test if the field data.data is not empty
4. Test if the field data.header.units exists
5. Test if the field data.header.sr exists
6. Test if the field data.header.chantype exists
7. Test if data.header.sr is equal to import.sr
8. Test if data.header.chantype is 'scr'

#### No transfer parameters

**Function name** no\_transferparams(testCase)

**Description** Test if all fields are returned correctly, if no transfer parameters are defined.

**Additional Tests** No additional tests

#### Struct transfer parameters

**Function name** stuct\_transferparams(testCase)

**Description** Test if all fields are returned correctly, if the transfer parameters are defined in a struct.

### **Additional Tests**

1. Check for warning if the conversion constant (`import.transfer.c`) is not defined
2. Checks that there are no warnings if `import.transfer.Rs` or `import.transfer.offset` is not defined.

### **File transfer parameters**

**Function name** `file_transferparams(testCase)`

**Description** Test if all fields are returned correctly, if the transfer parameters are defined in a `.mat` file.

### **Additional Tests**

1. Check for warning if the transfer parameter file doesn't exist.

## **5.21 pspm\_get\_timing**

### **5.21.1 Overview**

**Testclass** `pspm_get_timing_test`

### **Functions**

- `[sts, multi] = pspm_get_timing('onsets', intiming, timeunits)`
- `[sts, events] = pspm_get_timing('markervalues', markerinfo, names)`
- `[sts, epochs] = pspm_get_timing('epochs', epochs)`
- `[sts, events] = pspm_get_timing('events', events)`

### **5.21.2 Testcases**

#### **Invalid input arguments**

**Function name** `invalid_inputargs(this)`

**Description** Checks for warnings, if the input arguments are invalid.

| <b>Tests</b>  |                                  |
|---|----------------------------------|
| <b>Input</b>  | <b>Expected warning</b>          |
| <code>pspm_get_timing('epochs')</code><br>[missing input var]   | ID:invalid_input                 |
| <code>pspm_get_timing('onsets', 'str')</code> [no timeunits var]  | ID:invalid_input                 |
| <code>pspm_get_timing('foo')</code> [unknown format]  | ID:invalid_input                 |
| <code>pspm_get_timing('onsets', intiming, 'samples')</code> [two sessions with nonmatching number of conditions]                      | ID:number_of_elements_dont_match |
| <code>pspm_get_timing('onsets', intiming, 'samples')</code> [two sessions with nonmatching condition names]                           | ID:event_names_dont_match        |
| <code>pspm_get_timing('onsets', intiming, 'samples')</code><br>[intiming.onsets{1} is no numeric vector]                              | ID:no_numeric_vector             |
| <code>pspm_get_timing('epochs', fn_mat, 'samples')</code> [epochs is not an integer array]  | ID:no_integers                   |
| <code>pspm_get_timing('markervalues', markerinfo)</code> [no markervalue and no name ]  | ID:invalid_input                 |
| <code>pspm_get_timing('markervalues', markerinfo, markervalue, names)</code><br>[markervalue is not of numeric type nor a cell array] | ID:invalid_input                 |
| <code>pspm_get_timing('markervalues', markerinfo, markervalue, names)</code><br>[markervalue and names are not of the same length]    | ID:invalid_input                 |

## Case Epochs

**Function name** `case_epochs(this)`



**Description** Checks the function in 'epochs' mode.

**Function** [sts, epochs] = pspm\_get\_timing('epochs', epochs)

#### Test 1 (matfile input)

**Input** mat file with variable: epochs = [1 4; 2 5; 3 6]  
Check if sts==1 and if the return value is equal the input array.

#### Test 2 (spm input)

**Input** mat file with variable: onsets{1} = [1 2 3]'; onsets{2} = [4 5 6]';  
Check if sts==1 and if the return value is equal [onsets{1}, onsets{2}].

#### Test 3 (textfile input)

**Input** textfile with variable: epochs = [1 4; 2 5; 3 6]  
Check if sts==1 and if the return value is equal the input array.

#### Test 4 (matrix input)

**Input** matrix: epochs = [1 4; 2 5; 3 6]  
Check if sts==1 and if the return value is equal the input array.

#### Case onsets

**Function name** case\_onsets(this)

**Description** Checks the function in 'onsets' mode.

**Function** [sts, multi] = pspm\_get\_timing('onsets', intiming, timeunits)

#### Test 1

**Input** A .mat file with the following variables

- names = {'name1', 'name2'};
- onsets = {[1 2], [3 4]};
- pmod.name = {'name3', 'name4'};
- pmod.param = {[2 3], [4 5]};
- pmod.poly = {2, 2};
- save(fn\_mat, 'names', 'onsets', 'pmod');

**Function call** [sts, outtiming] = pspm\_get\_timing('onsets', fn\_mat, 'samples');

**Tests** Check if sts==1, if onsets and names are unchanged and if outtiming.pmod.param == {[2 3], [4 9], [4 5], [16 25]}

## Test 2

**Input** A .mat file with the variables

- names = {'name1', 'name2'};
- onsets = {[1 2 3], [3 4 5]}; durations = {[3 4 5]', [5 6 7]'};
- pmod.name = {'name3', 'name4'};
- pmod.param = {[2 3 4], [4 5 6]};
- pmod.poly = {2, 1};

**Function call** [sts, outtiming] = pspm\_get\_timing('onsets', fn\_mat, 'samples');

**Tests** Check if sts==1, if onsets, names and durations are unchanged and if outtiming.pmod.param == {[2 3 4], [4 9 16], [4 5 6]}.

## Case events

**Function name** case\_events(this)

**Description** Checks the function in 'events' mode.

**Function** [sts, epochs] = pspm\_get\_timing('events', events)

Check the function if input is a one element cell array and a multiple element cell array.

Check for warnings (ID:invalid\_vector\_size) if elements have more than two columns and if not all elements have the same number of rows.

## 5.22 pspm\_get\_<datatype>

### 5.22.1 Overview

The datatype import functions are all tested in a similar way. The individual testclasses must inherit the class 'pspm\_get\_superclass', from which they inherit the main test function 'valid\_datafile'. They also have to implement the property 'fhandle', which is a function handle to the specific import function.

The tests are performed with the sampledata files that are listed in the SampleDataMasterList.docx file (as at 18.11.2013).

**Superclass** pspm\_get\_superclass

### Testclasses

- `pspm_get_acq_test`
- `pspm_get_acqmat_test`
- `pspm_get_biograph_test`
- `pspm_get_biosemi_test`
- `pspm_get_biotrace_test`
- `pspm_get_brainvis_test`
- `pspm_get_edf`
- `pspm_get_labchartmat_ext_test`
- `pspm_get_labchartmat_in_test`
- `pspm_get_mat_test`
- `pspm_get_obs_test`
- `pspm_get_spike_test`
- `pspm_get_superclass`
- `pspm_get_txt_test`
- `pspm_get_vario_test`
- `pspm_get_eyelink_test`

**Function** `[sts, import, sourceinfo] = pspm_get_<datatype>(datafile, import)`

#### 5.22.2 Notes

#### 5.22.3 Setup

**Define testcases** In this method the testcases are defined and the testdata is generated (if needed). Each testcase is a cell in the cellarray 'testcases'. Each testcase has the following fields:

- `.pth`: the path to the samplefile
- `.import`: the input variable

For datatypes which support blocks there has to be an additional field:

- `.numofblocks`

#### 5.22.4 Testcases

##### Valid datafile

**Function name** `valid_datafile(this)`

**Description** The main test function, for tests with valid inputdata. It tests all testcases equally.

## Tests

1. Test if `sts==1`.
2. If the datatype supports blocks, test if the number of blocks is correct.
3. Test if number of elements of the returned 'import' variable is correct.
4. Test if each importjob has a field 'data', that is a numeric vector.
5. Test if each importjob has a field 'sr', that is a number.
6. Test if each importjob has a field 'type'.
7. Test if all event importjobs have a field 'marker'.
8. Test if all importjobs have duration below 1h.
9. Test if all importjobs have a samplerate between 1 and 10000 for continuous channels or between  $10^{-6}$  and 1 for timestamp channels.

## Invalid datafile

**Function name** `invalid_datafile(this)`

**Description** The main test function, for tests with invalid inputdata.

**Tests** If the datatype supports multiple channels: Check for warning when trying to import a channel, that is not contained in the file ('ID:channel\_not\_contained\_in\_file').

## 5.23 pspm\_get\_acq

In this section we describe the testcases specific to `pspm_get_acq` apart from generic `pspm_get` tests.

### 5.23.1 Overview

**Testclass** `pspm_get_acq_test`

**Function** `[tss, import, sourceinfo] = pspm_get_acq(datafile, import)`

### 5.23.2 Testcases

**get\_acq should return the exact same data as Acqknowledge exported mat file**

**Function** `get_acq_returns_same_data_as_acqknowledge_exported_mat(this)`

**Description** The data obtained by using `pspm_get_acq` should be identical with the data obtained by using `export .mat` file functionality in Acqknowledge software.

### Steps

1. Load data stored in `ImportTestData/acq/impedance_acq.acq` and `ImportTestData/acq/impedance_mat.mat` separately.
2. Compare the first channel of `impedance_mat` with the first channel of data obtained by calling `pspm_get_acq` on `impedance_acq`.

## 5.24 pspm\_glm

### 5.24.1 Overview

**Testclass** `pspm_glm_test`

**Function** `glm = pspm_glm(model, options)`

There are seven testcase functions. One invalid input arguments test and test 1 to 6. Tests 1 to 5 are of the same kind. There are one or multiple testcases per test function, have a look at the testcase description for more information. In these tests only Kronecker delta functions are used as basis functions, furthermore all conditions, pmods and nuisance regressors are pairwise orthogonal. The data is also not down sampled and not filtered. With these limitations it's easy to calculate the data vectors and the expected stats. For each testcase it is then tested:

- If `numel(glm.names)` has the expected value.
- If `numel(glm.stats)` has the expected value.
- If `glm.stats` has the expected value (with a tolerance of 1%).

In test 6 the default basis functions are used, and not all conditions and pmods are orthogonal. The data is down sampled and low and high pass filtered. In exchange the stats are not tested for correct values, just for the correct number of elements. The properties `'shiftbf'` and `'norm'` are `TestParameters`, which means that this testclass is parameterised. All functions implementing these parameters (Test 1 to Test 5) are called several times with all the different values and combinations of the mentioned parameters.

### 5.24.2 Testcases

#### Invalid input arguments

**Function name** `invalid_input (this)`

**Description** Checks for warnings, if the input arguments are invalid.

## Tests

| Input  | Expected warning                 |
|--|----------------------------------|
| <code>pspm_glm(model)</code> [no timeunits field]  | ID:invalid_input                 |
| <code>pspm_glm(model)</code> [no timeunits var]  | ID:invalid_input                 |
| <code>pspm_glm(model)</code> with <code>model.timeunits = 'foo'</code> [no valid timeunits field]              | ID:invalid_input                 |
| <code>pspm_glm(model)</code> with <code>model.timing = zeros(10,2)</code> [no valid timing field]              | ID:invalid_input                 |
| <code>pspm_glm(model)</code> with <code>model.modality = 'foo'</code> [no valid modality field]                | ID:invalid_input                 |
| <code>pspm_glm(model)</code> with <code>model.channel = 'scr'</code> [no valid channel field]                  | ID:invalid_input                 |
| <code>pspm_glm(model)</code> with <code>model.norm = 'no'</code> [no valid norm field]                         | ID:invalid_input                 |
| <code>pspm_glm(model)</code> with <code>model.filt.down = 'none'</code> [filt.down is not numeric]             | ID:invalid_input                 |
| <code>pspm_glm(model)</code> with <code>model.bf.fhandle = 'foohandle'</code> [non existing bf]                | ID:invalid_fhandle               |
| <code>pspm_glm(model)</code> with <code>numel(model.datafile) != numel(model.timing)</code>                    | ID:number_of_elements_dont_match |
| <code>pspm_glm(model)</code> with <code>model.missing</code> is struct [non valid missing field]               | ID:invalid_input                 |
| <code>pspm_glm(model)</code> with <code>numel(model.datafile) != numel(model.missing)</code>                   | ID:number_of_elements_dont_match |
| <code>pspm_glm(model)</code> with <code>model.nuisance</code> is struct [non valid nuisance field]             | ID:invalid_input                 |
| <code>pspm_glm(model)</code> with <code>numel(model.datafile) != numel(model.nuisance)</code>                  | ID:number_of_elements_dont_match |
| <code>pspm_glm(model)</code> with no R variable in the nuisance file   | ID:invalid_input                 |
| <code>pspm_glm(model)</code> with R variable in the nuisance file that has not the same length as the datafile | ID:number_of_elements_dont_match |

## Test 1

**Format** `test1(this, shiftbf)`

**Description** Basic test with one basis function, one session, no nuisance regressors, no missings and one condition. Timeunits are seconds.

## Testcases

1. no pmods

2. one pmod
3. two pmods

## Test 2

**Format** test2(this, shiftbf)

**Description** Test with one basis function, one session, no nuisance regressors, no missings and two conditions. Timeunits are seconds.

### Testcases

1. no pmods
2. first condition: no pmods; second condition: one pmod
3. first condition: one pmod; second condition: two pmods

## Test 3

**Format** test3(this, shiftbf)

**Description** Test with one basis function, one session, two nuisance regressors (1Hz cosinus, 1Hz sinus), no missings, one condition and no pmods. Timeunits are seconds.

**Testcases** Only one testcase.

## Test 4

**Format** test4(this, shiftbf)

**Description** Test with one basis function, two sessions, no nuisance regressors, no missings and one condition.

### Testcases

1. timeunits are seconds
2. timeunits are samples
3. timeunits are markers

## Test 5

**Format** test5(this, shiftbf)

**Description** Test with two basis functions, one session, no nuisance regressors and one condition. Timeunits are seconds.

**Testcases**

1. no missings
2. with missings

**Test 6**

**Format** test6(this)

**Description** Test with default basis function and non-orthogonal conditions and pmods.

**Testcase** Default basis functions, no nuisance regressors, no missings, two sessions and two conditions. Timeunits are seconds.

- first condition: two pmods (with  $\text{pmod}(1).\text{poly}\{1\} = 2$  and  $\text{pmod}(1).\text{poly}\{2\} = 3$ )
- second condition: no pmods

**Test 7**

**Format** test\_extract\_missing(this, cutoff, nan\_percent)

**Description** Test with one basis function, one session, no nuisance regressors, no missings and three conditions. Timeunits are seconds.

**Testcases** for all combinations of the test parameters cutoff and nan\_percent.

- glm vector stats\_missing has the appropriate length according to the number of conditions.
- percentages in glm vector stats\_missing contains the expected value.
- glm vector stats\_exclude has the appropriate length according to the number of conditions.
- glm vector stats\_exclude contains the expected condition which should be excluded.

## 5.25 pspm\_hb2hp

### 5.25.1 Overview

**Testclass** pspm\_hb2hp\_test

**Function** [sts, infos] = pspm\_hb2hp(fn, sr, chan, options)



### 5.25.2 Testcases

#### Invalid input

**Function name** `invalid_input(this)`

**Description** Checks for warnings, if the input arguments are invalid.

#### Tests

| Input   | Expected warning     |
|---|----------------------|
| <code>pspm_hb2hp()</code> [no input]  | ID:invalid_input     |
| <code>pspm_hb2hp(2)</code> [not a string filename]  | ID:invalid_input     |
| <code>pspm_hb2hp('abc')</code> [no sample rate]   | ID:invalid_input     |
| <code>pspm_hb2hp('abc','abc')</code> [not a string sample rate]                           | ID:invalid_input     |
| <code>pspm_hb2hp('abc',2,'abc')</code> [not a numeric channel]                            | ID:invalid_input     |
| <code>pspm_hb2hp(files{1},100)</code> [call of <code>pspm_load_data</code> fails]         | ID:invalid_input     |
| <code>pspm_hb2hp(files{2}, 100)</code> [not enough points for <code>interp1</code> ]      | ID:too_strict_limits |
| <code>pspm_hb2hp(files{3},100,[],options)</code> [ <code>pspm_write_channel</code> fails] | ID:invalid_input     |

## 5.26 pspm\_import

### 5.26.1 Overview

**Testclass** `pspm_import_test`

**Function** `outfile = pspm_import(datafile, datatype, import, options)`

### 5.26.2 Testcases

#### Invalid input arguments

**Function name** `invalid_inputargs(this)`

**Description** Checks for warnings, if the input arguments are invalid.

**Tests**

| Test No. | Input   | Expected warning       |
|----------|---|------------------------|
| 1        | pspm_import(datafile, datatype)<br>[no import variable]                   | ID:invalid_input       |
| 2        | pspm_import(datafile, datatype,<br>'foo') [no cell/struct import<br>var.] | ID:invalid_input       |
| 3        | pspm_import(datafile, 'foo',<br>import) [invalid channeltype]             | ID:invalid_channeltype |
| 4        | pspm_import(5, datatype,<br>import) [no char filename]                    | ID:invalid_input       |

**Invalid import variable structure**

**Function name** invalid\_import\_struct(this)

**Description** Checks for warnings, if the structure of the import variable is invalid.  
Tests

| Test No. | Input                                       | Expected warning         |
|----------|---|--------------------------|
| 1        | Multiple channel, though not supported      | ID:invalid_import_struct |
| 2        | Not allowed channeltype                     | ID:invalid_import_struct |
| 3        | No sr given, though autosr is not supported | ID:invalid_import_struct |
| 4        | Nonexistent file                            | ID:nonexistent_file      |

**One datafile**

**Function name** one\_datafile(this)

**Description** Checks the function, if datafile is a string (import of one datafile) and all inputs are correct. The outfile is checked with the pspm\_load\_data function. The tests are performed with a spike samplefile and a labchartmat\_in samplefile (to check the handling of blocks).

**Multiple datafiles**

**Function name** multiple\_datafiles(this)

**Description** Checks the function, if datafile is a cell array of strings (import of multiple datafiles) and all inputs are correct. The outfiles are tested with the pspm\_load\_data function.

## 5.27 pspm\_interpolate

### 5.27.1 Overview

**Testclass** pspm\_interpolate\_test

**Function** [sts, outdata] = pspm\_interpolate(indata, options)

### 5.27.2 Setup

This test class is parameterised. The test data is generated by the function itself and when needed, files will be written to datafile<variable\_nr>.mat.

**Test parameters** These are parameters which define what kind of data should be passed to pspm\_interpolate and which options should be set.

|                        |   |
|------------------------|---|
| <b>Amount</b>          | Specifies how many elements in data (for <code>pspm_interpolate</code> ) should have.   |
| <b>Datatype</b>        | Specifies what type of data should be generated.<br><br><b>struct</b> a valid data struct will be generated<br><b>inline</b> a numeric vector will be generated<br><b>file</b> a valid scr file will be generated<br><b>all</b> all types will sequentially be generated until amount is reached  |
| <b>Chans</b>           | If datatype is not inline this specifies how many and which type of data channels the generated data should have. In a second field it also defines which of these channels should be interpolated (this will be passed later in <code>options.channels</code> ).   |
| <b>Nan method</b>      | Specifies how NaN values will be put into the data.<br><br><b>start</b> range is 1+offset:<random number before the center><br><b>center</b> range is <radnom number before the center>:<random number after the center><br><b>end</b> range is <random number after the center>:end-offset<br><br>The offset is 1 if 'extrap' is not defined. This is needed because if there is no data at the end or beginning of the data, the function is unable to interpolate (unless extrapolation is activated). |
| <b>Extrap</b>          | Is either true or false and activates or deactivates the extrapolation.   |
| <b>Interp method</b>   | Specifies the interpolation method.   |
| <b>Newfile</b>         | True or false and tells the function to either create a file or add the data as new channel.  |
| <b>Overwrite</b>       | True or false and tells the function to either overwrite an existing file or not.   |
| <b>Replace channel</b> | True or false and tells the function to either replace the given channels with the interpolated data or to add the interpolated data as new channel.  |

### 5.27.3 Testcases

#### Invalid input

**Function name** `invalid_input(this)`

**Description** Checks for warnings, if the input arguments are invalid.

**Tests**

| Test No. | Input   | Expected warning          |
|----------|---|---------------------------|
| 1        | pspm_interpolate() [no arguments]   | ID:missing_data           |
| 2        | pspm_interpolate({{}}) [data is not char, struct, numeric]  | ID:invalid_input          |
| 3        | pspm_interpolate({}) [data empty]   | ID:missing_data           |
| 4        | pspm_interpolate(struct()) [invalid struct]   | ID:invalid_data_structure |
| 5        | pspm_interpolate(invalid_data) [file which does not exist]  | ID:nonexistent_file       |
| 6        | pspm_interpolate(valid_data, options) [options.channels is larger than valid_data]                          | ID:invalid_input          |
| 7        | pspm_interpolate(valid_data, options) [options.channels is not numeric]                                     | ID:invalid_input          |
| 8        | pspm_interpolate(valid_data, options) [options.method is invalid]   | ID:invalid_input          |
| 9        | pspm_interpolate(valid_data, options) [options.newfile is invalid]  | ID:invalid_input          |
| 10       | pspm_interpolate(valid_data, options) [options.extrapolate is invalid]                                      | ID:invalid_input          |
| 11       | pspm_interpolate(valid_data, options) [options.overwrite is invalid]  | ID:invalid_input          |
| 12       | pspm_interpolate(valid_data, options) [options.replace_channels is invalid]                                 | ID:invalid_input          |
| 13       | pspm_interpolate(invalid_data, options) [try to interpolate an events channel]                              | ID:invalid_channeltype    |
| 14       | pspm_interpolate(invalid_data) [try to interpolate with nan from beginning and without extrapolation]       | ID:option_disabled        |
| 15       | pspm_interpolate(invalid_data, options) [try to interpolate with nan from beginning and with extrapolation] | ID:out_of_range           |
| 16       | pspm_interpolate(invalid_data) [try to interpolate with nan from end and without extrapolation]             | ID:option_disabled        |
| 17       | pspm_interpolate(invalid_data, options) [try to interpolate with nan from end and with extrapolation]       | ID:out_of_range           |

## Test datatypes

**Function name** `test_datatypes(this, datatype, amount, chans)`

**Description** Tries to interpolate with different datatypes, amount of data, channels.

### Steps

1. Generate data with datatype, amount, 'center', chans, false
2. Test if function issues no warnings
3. Test if `sts==1`
4. Test if size of outdata equals the size of the data
5. Test if channels to be interpolated have no more NaNs
6. Test if channels not to be interpolated still contain NaNs

## Test interpolation variations

**Function name** `test_interpolation_variations(this, interp_method, extrapol, nan_method)`

**Description** Tries to interpolate with different interpolation methods while varying options.`extrapolate` and the `nan_method`.

### Tests

1. Generate data with 'inline', 1, nan\_method, {'scr'}, [], extrapol
2. Test if function issues no warnings
3. Test if `sts==1`
4. Test if size of outdata equals the size of the data
5. Test if data has no more NaNs

**Special case** When extrapolation is on and `nan_method` is 'start' and `interp_method` is 'previous' or `nan_method` is 'end' and `interp_method` is 'next'. This should issue a warning because this is not possible (e.g. interpolate with previous value when first NaN is at the beginning of the data set).

1. Generate data as above
2. Test if function issues a warning.

## Test no nan

**Function name** test\_no\_nan(this)

**Description** Test whether function works even if there is nothing to interpolate.

### Tests

1. Generate data struct() with pspm\_test\_data\_gen()
2. Test if function issues no warnings
3. Test if sts==1
4. Test if size of outdata equals the size of data
5. Test if outdata equals data
6. Test if data has no NaNs

## Test write

**Function name** test\_write(this, newfile)

**Description** Vary the option newfile and test whether new file is created correctly or data is correctly added to a new channel.

### Tests

1. Generate data with 'file', 2, 'center', {'scr', 'scr', 'scr'}, [1,3], false
2. Test if function issues no warnings
3. Test if sts==1
4. Test if size of outdata equals the size of data
5. Test if outdata does not equal data

### New files only

1. Test if new file exists
2. Load old and new file and test if size of data is equal
3. Verify that interpolated channels in the new file are NaN free



### **Added to existing file only**

1. Test if all returned values are numeric (new channel ids)
2. Verify that the added channels are NaN free
3. Test if added channels match the size of the original data channels

### **Test overwrite**

**Function name** `test_overwrite(this, overwrite)`

**Description** Vary overwrite and test whether files are overwritten or not.

#### **Tests**

1. Generate data with 'file', 2, 'center', {{'scr', 'scr', 'scr'}, [1,2,3]}, false
2. Create files with expected filenames
3. Test if function issues no warning
4. Test if sts==1
5. According to overwrite test if file has been overwritten or not

### **Test replace channel**

**Function name** `test_replace_channel(this, replace_channels)`

**Description** Vary replace\_channel and test whether channels are overwritten or not.

#### **Tests**

1. Generate data with 'file', 2, 'center', {{'scr', 'scr', 'scr'}, [1,2,3]}, false
2. Test if function issues no warnings
3. Test if sts==1
4. Test if size of outdata equals the size of data
5. Test if outdata does not equal data
6. According to replace\_channel test whether returned channel ids correspond to replaced channels or correspond to added channels.

## 5.27.4 Other methods

### Generate data

Has all of the Test parameters as parameter implemented and accordingly generates the data. It calls put nan to insert NaN values into the data. The generated data is returned as data to the calling function. Also all return values are stored in the property testdata (for cleanup data).

### Cleanup data

Sits in MethodTeardown and is called once the test class has finished all tests. It then removes all the datafiles which can be found in the property 'testdata'.

### Verify NaN free

Helper function to verify whether the data is NaN free or not. It copes with two states. Either a channel should have been interpolated, then it shouldn't contain any NaN values or a channel should not have been interpolated, then the channel should still contain NaN values.

## 5.28 pspm\_load1

### 5.28.1 Overview

**Testclass** pspm\_load1\_test

**Function** [sts, data, mdltype] = pspm\_load1(fn, action, savedata, options)

### 5.28.2 Setup

The datafile fn is referring to a datafile which was generated with pspm\_load1\_test.generate\_testdata(this). The function is part of the test object and generates models for all of the available model types (defined in settings.first). The models are created with data generated with pspm\_testdata\_gen. Two files belong to each model: model\_<modeltype><variable\_nr>.mat (fn) and dummy\_<modeltype><variable\_nr> (dfn). The model file on the one hand is the actual model file while on the other hand, the dummy file is a copy of the model file, used by the test to manipulate the test data.

**Generated aquisition data (pspm\_testdata\_gen)** data{1}.chantype = 'scr';  
data{2}.chantype = 'hb';  
The duration of the channels is 100s.

**Generated GLM model** model.timing{1}.names = {'a';'b';'c'};  
model.timing{1}.onsets = {[10, 20, 30], [15, 25, 35], [18, 28, 38]};

**Generated DCM & SF model** model.timing{1} = [10,20; 23,38; 40,70];  
model.condition{1}.name = {'a';'b'};  
model.condition{1}.index = [1;2];

### 5.28.3 Testcases

#### Invalid model structure (general)

**Function** `invalid_model_tructure_general(this)`

**Description** Tries to pass invalid data structures, and tests for certain warnings. Applys to all available modeltypes.

Tests

| Input                     | Expected warning          |
|---------------------------|---------------------------|
| empty model file          | ID:invalid_data_structure |
| missing field 'modelfile' | ID:invalid_data_structure |
| missing field 'modeltype' | ID:invalid_data_structure |
| missing field 'modality'  | ID:invalid_data_structure |
| missing field 'stats'     | ID:invalid_data_structure |
| missing field 'names'     | ID:invalid_data_structure |

#### Invalid model structure (specific)

**Function** `invalid_model_structure_general(this)`

**Description** Tries to pass invalid data structures, and tests for certain warnings. Model specific.

| Tests   | for                       | GLM |
|---|---------------------------|-----|
| Input   | Expected warning          |     |
| field 'stats' is not an n x 1 vector                      | ID:invalid_data_structure |     |
| unequal amount of numbers and parameters in field 'stats' | ID:invalid_data_structure |     |
| options.zscored = 1 & action = 'cond'                     | ID:invalid_input          |     |

| Tests   | for                       | DCM | & | SF |
|---|---------------------------|-----|---|----|
| Input   | Expected warning          |     |   |    |
| unequal size for fields in 'trlnames' and rows in 'stats' | ID:invalid_data_structure |     |   |    |
| missing field 'trlnames'                                  | ID:invalid_data_structure |     |   |    |
| unequal size for fields in 'names' and columns in 'stats' | ID:invalid_data_structure |     |   |    |
| action = 'recon'  | ID:invalid_input          |     |   |    |

| Tests   | for | DCM              |
|---|-----|------------------|
| Input   |     | Expected warning |
| options.zscored = 1 & pspm_load1(dfn, 'none', {}, options)  |     | ID:invalid_input |
| options.zscored = 1 & pspm_load1(dfn, 'cond', {}, options)  |     | -                |
| options.zscored = 1 & pspm_load1(dfn, 'stats', {}, options) |     | -                |

| Tests  | for | GLM | & | SF               |
|--|-----|-----|---|------------------|
| Input  |     |     |   | Expected warning |
| options.zscored = 1 & pspm_load1(dfn, 'cond', {}, options) |     |     |   | ID:invalid_input |

#### Action 'none'

**Function** test\_action\_none(this)

**Description** Test for all modeltypes if action 'none' matches the expected behaviour.

#### Tests

1. Basic function test
2. Test if returned data is empty.

#### Action 'stats'

**Function** test\_action\_stats(this)

**Description** Test for all modeltypes if action 'stats' matches the expected behaviour.

#### Tests for all

1. Basic function test
2. Returned data contains field 'stats'
3. Returned data contains field 'names'

#### Tests for DCM & SF

1. Returned data contains field 'trlnames'
2. Returned data contains field 'condnames'

#### Action 'cond'

**Function** test\_action\_cond(this)

**Description** Test for all modeltypes if action 'cond' matches the expected behaviour.

**Tests for all**

1. Basic function test
2. Returned data contains field 'stats'
3. Returned data contains field 'names'

**Tests for DCM & SF**

1. Returned data contains field 'trlnames'
2. Returned data contains field 'condnames'

**Action 'recon'**

**Function** test\_action\_recon(this)

**Description** Test for all modeltypes if action 'recon' matches the expected behaviour.

**Tests for GLM**

1. Basic function test
2. Returned data contains field 'stats'
3. Returned data contains field 'names'

Tests for DCM & SF already done in specific structure test.

**Action 'savecon'**

**Function** test\_action\_savecon(this)

**Description** Test for all modeltypes if action 'savecon' matches the expected behaviour. Generates a number, passes it within the 'savecon' struct and tests if the number is returned correctly.

### **Tests**

1. Basic function test
2. Returned data contains field 'con'
3. Field 'con' contains field 'test'
4. Field 'con.test' is equal to the randomly generated number

### **Action 'con'**

**Function** test\_action\_con(this)

**Description** Test for all modeltypes if action 'con' matches the expected behaviour. Tests if the in 'savecon' generated field test is still returned.

### **Tests**

1. Basic function test
2. Returned data contains field 'con'
3. Field 'con' contains field 'test'.

### **Action 'all'**

**Function** test\_action\_all(this)

**Description** Test for all modeltypes if action 'all' matches the expected behaviour.

### **Tests**

1. Basic function test
2. Returned data is not empty.

### **Action 'save'**

**Function** test\_action\_save(this)

**Description** Test for all modeltypes if action 'save' matches the expected behaviour. Test with options.overwrite = 1. Generates random number and writes it into field 'test' in model structure.

## Tests

1. Basic function test
2. Model structure contains field 'test'
3. Field 'test' in model structure equals to the randomly generated number.

## Options

**Function** test\_options(this)

**Description** Test for all modeltypes if options passed with options structure cause the expected behaviour. Does also work with a randomly generated number in <model struct>.test to test whether the data is written or not.

### Tests for all

1. overwrite = 0 returns warning ID:not\_saving\_data and field 'test' in model struct does not match generated number
2. overwrite = 1 field 'test' in returned model struct does match generated number

### Tests for DCM with overwrite = 1

1. zscored = 0 & action = 'stats'
  - (a) Basic function test
  - (b) Returned data.stats is not zscored
2. zscored = 1 & action = 'stats'
  - (a) Basic function test
  - (b) Returned data.stats is zscored
3. zscored = 0 & action = 'cond'
  - (a) Basic function test
  - (b) Returned data is different when calling with zscored = 1 & action = 'cond' (should not zscore, when not specified)

## 5.28.4 Other methods

**Remove testdata** Removes all the test data generated by the test class. It is called once the class is finished with testing.

**Basic function test** Is called in each test after the tested function has been called. It does two checks:

- Returned modeltype matches the modeltype stored in the returned model structure
- Returned status sts==1

## 5.29 pspm\_load\_data

Reviewed and updated by Teddy on 19 April 2022

### 5.29.1 Overview

**Testclass** pspm\_load\_data\_test

**Function** [sts, infos, data, filestruct] = pspm\_load\_data(fn, chan)

### 5.29.2 Setup

If not otherwise declared, the input variable fn is referring to a datafile which was generated with pspm\_testdata\_gen and consists out of the following channels:

```
data{1}.chantype 'scr';
data{2}.chantype 'marker';
data{3}.chantype 'hr';
data{4}.chantype 'hb';
data{5}.chantype 'marker';
data{6}.chantype 'resp';
data{7}.chantype 'scr';
```

The duration of the channels is 10s.

### 5.29.3 Testcases

#### Invalid input arguments

**Function name** invalid\_inputargs(testCase)

**Description** Checks for warnings, if the input arguments are invalid.



**Tests**

| # | Issue                       | Input        | Expected warning |
|---|-----------------------------|--------------|------------------|
| 1 | No filename                 | /            | ID:invalid_input |
| 2 | No char filename            | 1            | ID:invalid_input |
| 3 | Negative channel number     | fn, -1       | ID:invalid_input |
| 4 | No allowed ch type          | fn, 'foobar' | ID:invalid_input |
| 5 | Missing field in foo struct | fn, foo      | ID:invalid_input |
| 6 | Invalid channel option      | fn, {1}      | ID:invalid_input |
| 7 | Struct has no infos field   | struct       | ID:invalid_input |
| 8 | Nonexisting channel         | fn, 250      | ID:invalid_input |

**Invalid datafile**

**Format** invalid\_datafile(testCase)

**Description** Checks for warnings, if the datafile is invalid.

**Tests**

| #  | Issue  | Input | Expected warning          |
|----|--|-------|---------------------------|
| 1  | non-existent datafile  |       | ID:nonexistent_file       |
| 2  | missing 'infos' variable                                     |       | ID:invalid_data_structure |
| 3  | missing 'data' variable                                      |       | ID:invalid_data_structure |
| 4  | missing 'data' field in 'data{2}'                            |       | ID:invalid_data_structure |
| 5  | missing 'header' field 'data{3}'                             |       | ID:invalid_data_structure |
| 6  | missing 'sr' field in 'data{7}.header'                       |       | ID:invalid_data_structure |
| 7  | data{4} is a nx2 vector (instead of a nx1 vector)            |       | ID:invalid_data_structure |
| 8  | the length of data{1}.data is incompatible with the duration |       | ID:invalid_data_structure |
| 9  | An entry of data{2}.data is larger than 'duration'           |       | ID:invalid_data_structure |
| 10 | data{5} has an non-existent chantype ('scanner')             |       | ID:invalid_data_structure |
| 11 | duplicates (9) with struct chan input                        |       | ID:invalid_data_structure |

**Return all channels**

**Function name** valid\_datafile\_0(testCase)

**Description** Checks the function, if all channels shall be returned (chan = 0).

**Return all channels (struct input)**

**Function name** valid\_datafile\_1(testCase)

**Description** Checks the function, if all channels shall be returned (chan = 0) and the input is a struct.

#### **Return one channel**

**Function name** valid\_datafile\_2(testCase)

**Description** Checks the function, if only one channel shall be returned (chan = 2).

#### **Return multiple channels**

**Function name** valid\_datafile\_3(testCase)

**Description** Checks the function, if multiple channels shall be returned (chan = [3 5]).

#### **Return scr channels**

**Function name** valid\_datafile\_4(testCase)

**Description** Checks the function, if only the scr channels shall be returned.

#### **Return event channels**

**Function name** valid\_datafile\_5(testCase)

**Description** Checks the function, if only the event channels shall be returned.

#### **Save data**

**Function name** valid\_datafile\_6(testCase)

**Description** Checks the function, if data is to be saved (chan struct).

### **5.30 pspm\_pp**

#### **5.30.1 Overview**

**Testclass** pspm\_pp\_test

**Format** newfile = pspm\_pp('median', datafile, n, channelnumber) or newfile = pspm\_pp('butter', datafile, freq, channelnumber)

### 5.30.2 Testcases

#### Invalid input

**Format** invalid\_input(this)

**Description** Checks for warnings, if the input arguments are invalid.

#### Tests

| # | Issue                   | Parameters of the function | Expected warning |
|---|-------------------------|----------------------------|------------------|
| 1 | No frequency            | 'butter', 'file'           | ID:invalid_input |
| 2 | No valid first argument | 'foo', 'file', 100         | ID:invalid_input |
| 3 | Freq below 20           | 'butter', 'file', 19       | ID:invalid_input |

#### Median test

**Function name** median\_test(this)

**Description** Checks medianfilter functionality

**Setup** Testfile with 3 channels (scr, hb, scr).

#### Tests

1. Filter one channel [Input: newfile = pspm\_pp('median', testfile, 50, 3)]
  - i. Check if sts == 1, when data is loaded with pspm\_load\_data.
  - ii. Check if newfile has the same number of channels as testfile
2. Filter multiple channel [Input: newfile = pspm\_pp('median', testfile, 50)]
  - i. Check if sts == 1, when data is loaded with pspm\_load\_data.
  - ii. Check if newfile has the same number of channels as testfile

#### Butterworth filter test

**Function name** butter\_test(this)

**Description** Checks Butterworth filter functionality

**Setup** Testfile with 3 channels (scr, hb, scr).

#### Tests

1. Filter one channel [Input: newfile = pspm\_pp('butter', testfile, 40, 3)]
  - i. Check if sts == 1, when data is loaded with pspm\_load\_data.
  - ii. Check if newfile has the same number of channels as testfile
2. Filter multiple channel [Input: newfile = pspm\_pp('butter', testfile, 40)]
  - i. Check if sts == 1, when data is loaded with pspm\_load\_data.
  - ii. Check if newfile has the same number of channels as testfile

## 5.31 pspm\_prepdata

### 5.31.1 Overview

**Testclass** pspm\_prepdata\_test

**Function** [sts, outdata, newsr] = pspm\_prepdata(data, filt)

### 5.31.2 Testcases

#### Invalid input

**Function name** invalid\_input(this)

Description

Checks for warnings, if the input arguments are invalid.

| Input   | Expected warning |
|---|------------------|
| pspm_prepdata([1 NaN 3], filt) [NaN values in data]         | ID:invalid_input |
| pspm_prepdata([1 2 3]) [no filt variable]                   | ID:invalid_input |
| pspm_prepdata(data, filt) [filt has no horder field]        | ID:invalid_input |
| pspm_prepdata('foo', filt) [no numeric data]                | ID:invalid_input |
| pspm_prepdata(data, filt) [with lpfreq = 'foo' (not valid)] | ID:invalid_input |

Tests

#### Hipassfilter test

**Function name** hipassfilter\_test(this)

**Description** Checks hipassfilter functionality (without downsampling)

### **Setup**

```
data rand(1000,1)
filt.sr 100
filt.lpfreq 'none'
filt.lporder 1
filt.hpfreq 20
filt.hporder 1
filt.down 'none'
```

### **Tests**

1. Unidirectional tests [**filt.direction** = 'uni']
  - i. Check if **sts** == 1
  - ii. Check if **newsr** == **filt.sr**
  - iii. Check if **outdata** is empty
  - iv. Check if **length(outdata)** == **length(data)**
2. Unidirectional tests [**filt.direction** = 'bi']
  - i. Check if **sts** == 1
  - ii. Check if **newsr** == **filt.sr**
  - iii. Check if **outdata** is empty
  - iv. Check if **length(outdata)** == **length(data)**

### **Lowpassfilter test**

**Function name** lowpassfilter\_test(this)

**Description** Checks hipassfilter functionality (without downsampling)

### **Setup**

```
data rand(1000,1)
filt.sr 100
filt.lpfreq 40
filt.lporder 1
```

**filt.hpfreq** 'none'

**filt.hporder** 1

**filt.down** 'none'

**Tests** Same tests as in `hipassfilter_test`. Additionally there is a check for a warning if `filt.lpfreq` is higher (or equal) than the nyquist frequency

| Input  | Expected warning         |
|--|--------------------------|
| <code>pspm_prepdata(data, filt) [filt.sr = 100; filt.lpfreq = 60]</code> | ID:no_low_pass_filtering |

### Bandpassfilter test

**Function name** `bandpassfilter_test(this)`

**Description** Checks bandpassfilter functionality (without downsampling).

#### Setup

**data** `rand(1000,1)`

**filt.sr** 200

**filt.lpfreq** 99

**filt.lporder** 1

**filt.hpfreq** 20

**filt.hporder** 1

**filt.down** 'none'

**Tests** Same tests as in `hipassfilter_test`.

### Integer samplerate ratio downsampling test

**Function name** `int_sr_ratio_downsample_test(this)`

**Description** Checks downsampling functionality, if the ratio between `filt.sr` and `filt.down` is an integer.

### Setup

```
ratio 2 % ratio between filt.sr and filt.down
filt.down 100
filt.sr ratio*filt.down
filt.lpfreq 40
filt.lpporder 1
filt.hpfreq 'none'
filt.hporder 1
filt.direction 'uni'
and data = rand(filt.sr * 10,1).
```

### Tests

1. Check if sts == 1
2. Check if newsr == filt.down
3. Check if outdata is empty
4. Check if ratio\*length(outdata) == length(data)

## 5.32 pspm\_process\_illuminance

### 5.32.1 Overview

**Testclass** pspm\_process\_illuminance\_test

**Function** [sts, out] = pspm\_process\_illuminance(ldata, sr, options)

### 5.32.2 Setup

This test class is parameterised. The test data is generated by the function itself and when needed, files will be written to datafile<variable\_nr>.mat.

**Test parameters** These are parameters which define what kind of data should be passed to `pspm_process_illuminance` and which options should be set.

`bf_dur` Defines the duration of the basis function.

`bf_offset` Defines the offset of the basis function.

`dur` Defines the duration of the generated dataset.

`sr` Defines the samplerate of the generated dataset.

`n_times` Defines how many datasets should be generated.

`mode` Defines the whether the dataset should be written to a file, kept as inline variable or should be a mix of both. Can be either 'file', 'inline' or 'mixed'.

`overwrite` Defines whether existing files should be overwritten or not.

### 5.32.3 Testcases

#### Invalid input

**Function name** `invalid_input(this)`

**Description** Checks for warnings, if the input arguments are invalid.

**Tests**



| Test No. | Input  | Expected warning     |
|----------|--|----------------------|
| 1        | pspm_process_illuminance() [no arguments]                                      | ID:invalid_input     |
| 2        | pspm_process_illuminance([]) [empty data]                                      | ID:missing_data      |
| 3        | pspm_process_illuminance(1:10) [missing samplerate]                            | ID:invalid_input     |
| 4        | pspm_process_illuminance(1:10, 'a') [invalid ssamplerate]                      | ID:invalid_input     |
| 5        | pspm_process_illuminance({1:10}, 1) [cell, no cell]                            | ID:invalid_input     |
| 6        | pspm_process_illuminance(1:10, {1}) [no cell, cell]                            | ID:invalid_input     |
| 7        | pspm_process_illuminance({1:10, 10:10}, {1}) [different sized cells]           | ID:invalid_input     |
| 8        | pspm_process_illuminance({1:10, 'a'}, {1,2}) [invalid file]                    | ID:non_existent_file |
| 9        | pspm_process_illuminance({1:10, 1:10}, {1, 'a'}) [invalid samplerate]          | ID:invalid_input     |
| 10       | pspm_process_illuminance({1:10}, {1}, 'o') [wrong options]                     | ID:invalid_input     |
| 11       | pspm_process_illuminance({1:10}, {1}, opt)[wrong transfer settings]            | ID:invalid_input     |
| 12       | pspm_process_illuminance({1:10}, {1}, opt)[wrong duration]                     | ID:invalid_input     |
| 13       | pspm_process_illuminance({1:10}, {1}, opt)[wrong offset]                       | ID:invalid_input     |
| 14       | pspm_process_illuminance({1:10}, {1}, opt)[wrong outputfile]                   | ID:invalid_input     |
| 15       | pspm_process_illuminance({1:10}, {1}, opt)[format of ldata and opt.fn differs] | ID:invalid_input     |
| 16       | pspm_process_illuminance({1:10}, {1}, opt)[opt.overwrite is not boolean]       | ID:invalid_input     |

### Test options

**Function name** test\_options(this, sr, dur, bf\_dur, bf\_offset)

**Description** Tries out different combination options to process the generated illuminance data.

### Tests

1. Generate data with `sr` and `dur`
2. Set options according to `bf_dur` and `bf_offset`
3. Set expected warning according to `sr*dur` and `sr*bf_dur`
  - (a) expect empty data if `sr*dur < 1`
  - (b) expect `invalid_input` if `sr*bf_dur < 1`
  - (c) otherwise expect no warning
4. Test if issued warning equals expected warning
5. Test if `sts` equals expected value
6. Test if amount of data elements of input and output data is equal

### Test multi

**Function name** `test_multi(this, n_times, mode)`

**Description** Generates `n` sets of illuminance data and passes it to `pspm_process_illuminance`.

#### Steps

1. Generate data with 10 (`sr`), 100 (`dur`), `n_times` (amount), `mode`
2. Test if `pspm_process_illuminance` issues no warning
3. Test if `sts==1`
4. For `n_times == 1`, test if out has 10×100 data points
5. For `n_times ~= 1`, test if output has same size as input

### Test overwrite

**Function name** `test_overwrite(this, overwrite)`

**Description** Generate illuminance file and test overwrite behaviour.

#### Tests

1. Generate data with 10 (`sr`), 100 (`dur`), 1 (amount), 'file'
2. Test if `pspm_process_illuminance` issues no warning
3. Test if `sts==1`
4. Test if existing file was overwritten or not

#### 5.32.4 Other methods

**Generate lx** Has some of the Test parameters as parameter implemented and accordingly generates the lx data. According to the calling arguments the output is a cell of files and data vectors. All generated files will be stored in the property 'datafiles'. They will be removed once all tests have finished.

**Cleanup** Located in MethodTeardown and is called once the test class has finished all tests. It then removes all the datafiles which can be found in the property 'datafiles'.

### 5.33 pspm\_pulse\_convert

#### 5.33.1 Overview

**Testclass** pspm\_pulse\_convert\_test

**Function** wavedata = pspm\_pulse\_convert(pulsedata, resamplingrate, samplingrate)

#### 5.33.2 Testcases

##### Invalid input

**Function name** invalid\_input(testCase)

**Description** Pass invalid input arguments and test if the error message is correct.

##### Tests

| Input  | Expected warning |
|--|------------------|
| pspm_pulse_convert()                                     | ID:invalid_input |
| pspm_pulse_convert(10 <sup>-3</sup> * (1:10000)')        | ID:invalid_input |
| pspm_pulse_convert(10 <sup>-3</sup> * (1:10000)', 10000) | ID:invalid_input |

##### Valid input

**Function name** valid\_input(testCase)

**Description** Pass generated, valid data and test if function issues no warning.

### Steps

1. Test function without downsampling the data
2. Test function with downsampling the data

## 5.34 pspm\_ren

### 5.34.1 Overview

**Testclass** pspm\_ren\_test

**Function** out\_newfilename = pspm\_ren(filename, newfilename)

### 5.34.2 Testcases

#### Invalid input

**Function name** invalid\_input (this)

**Description** Checks for warnings, if the input arguments are invalid.

#### Tests

| Input  | Expected warning |
|--|------------------|
| pspm_ren('fn') [no newfilename]  | ID:invalid_input |
| pspm_ren({'fn1', 'fn2'}, {'rfn1', 'rfn2', 'rfn3'}) [non same size cell arrays] | ID:invalid_input |

#### Char Valid Input

**Function name** char\_valid\_input (this)

**Description** Checks the function if the input variables are of type char. It uses pspm\_load\_data to check the files.

### Steps

1. Check if `out_newfilename = newfilename`
2. Check if `sts==1` (of `pspm_load_data` output)
3. Check if the field `'infos.rendata'` exists
4. Check if the field `'infos.newname'` exists
5. Check if the original file has been deleted

### Cell Valid Input

**Function name** `cell_valid_input (this)`

**Description** Checks the function if the input variables are of type cell. It uses `pspm_load_data` to check the files.

**Tests** The inputs are two-element cell arrays. For both elements the same tests as in the `char_valid_input` function are performed individually.

## 5.35 pspm\_resp\_pp

### 5.35.1 Overview

**Testclass** `pspm_resp_pp_test`

**Function** `sts = pspm_resp_pp(fn, sr, chan, options)`

### 5.35.2 Testcases

#### Regression Test against Revision r660

**Function name** `compare_results_to_results_obtained_from_r660_version(this)`

**Description** In r660, there was a bug found in `pspm_resp_pp` that caused it to crash with index out of bounds error on inputs containing some edgecase. This test specifically checks whether the fixed version returns the same results as the version before the bugfix on data that didn't cause a crash.

### Tests

1. Check if the returned channel types have the same name and ordering
2. Check if the returned data is the same

## 5.36 pspm\_scr\_pp

### 5.36.1 Overview

**Testclass** pspm\_scr\_pp\_test

**Properties** ...

**Format** ...

## 5.37 pspm\_split\_sessions

### 5.37.1 Overview

**Testclass** pspm\_split\_sessions\_test

**Properties** expected\_number\_of\_files = 3

**Format** newdatafile = pspm\_split\_sessions(datafile, markerchannel, options)

### 5.37.2 Setup

For the tests a testdatafile with three channels is used (duration is 100s). The markerchannel data is

```
data = [1 4 9 12 30 31 34 41 43 59 65 72 74 80 89 96]'
```

Hence if MAXSN==10 and BRK2NORM==3 (default values), the datafiles should be split into 3 files. If different values are being used, update the property 'expected\_number\_of\_files' of the testclass object accordingly.

### 5.37.3 Testcases

#### Invalid input

**Function name** invalid\_input (this)

**Description** Checks for warnings, if the input arguments are invalid.

**Tests**

| Input  | Expected warning |
|--|------------------|
| <code>pspm_split_sessions()</code> [no filename]                               | ID:invalid_input |
| <code>pspm_split_sessions (2)</code> [no string filename]                      | ID:invalid_input |
| <code>pspm_split_sessions ('fn', 'foo')</code> [no numeric marker channel no.] | ID:invalid_input |

## One datafile

**Function name** `one_datafile(this)`

**Description** Checks the function if the variable 'datafile' is of type char (one datafile). The markerchannel number is not assigned explicitly.

### Steps

1. Check if the file has been split into 'expected\_number\_of\_files' files For each output file the following tests are performed:
2. Check if `sts == 1`, when data is loaded with `pspm_load_data`.
3. Check if number of channels is correct.
4. Check if the field `infos.slitdate` exists
5. Check if the field `infos.splitsn` exists
6. Check if the field `infos.splitfile` exists.

## Multiple datafiles

**Function name** `multiple_datafiles(this)`

**Description** Checks the function if the variable 'datafile' is of type cell (two datafiles). The markerchannel number is assigned explicitly.

**Tests** For both datafiles the same tests as in the `one_datafile` function are performed individually. Additionally it is tested if the number of input files does match the number of output files.

## 5.38 pspm\_trim

Reviewed and updated by Teddy on 19 April 2022

### 5.38.1 Overview

**Testclass** pspm\_trim\_test

**Function** newdatafile = pspm\_trim(datafile, from, to, reference, options)

### 5.38.2 Setup

If not otherwise declared, the input variable fn is referring to a datafile which was generated with pspm\_testdata\_gen and consists of the following channels

**data{1}.chantype** 'scr'

**data{2}.chantype** 'marker'

**data{3}.chantype** 'hr'

**data{4}.chantype** 'hb'

**data{5}.chantype** 'marker'

**data{6}.chantype** 'resp'

**data{7}.chantype** 'scr'

The duration of the data recording is 10s.

### 5.38.3 Testcases

#### Invalid input arguments

**Function name** invalid\_inputargs(testCase)

**Description** Checks for warnings, if the input arguments are invalid.

**Tests**



| Input  | Expected warning |
|--|------------------|
| <code>pspm_trim(testCase.fn, [1 2], 5, 'marker')</code> [invalid from parameter] | ID:invalid_input |
| <code>pspm_trim(testCase.fn, 0, 'bla', 'marker')</code> [invalid to parameter]   | ID:invalid_input |
| <code>pspm_trim(testCase.fn, 0, '[]', 'marker')</code> [invalid to parameter]    | ID:invalid_input |
| <code>pspm_trim(fn, 0, 5)</code> [no reference]                                  | ID:invalid_input |
| <code>pspm_trim(fn, 0, 5, 6)</code> [no char or 2-element numeric reference]     | ID:invalid_input |
| <code>pspm_trim(fn, 0, 5, 'bla')</code> [invalid char reference]                 | ID:invalid_input |
| <code>pspm_trim(fn, 0, 5, [-1 5])</code> [invalid numeric start reference]       | ID:invalid_input |
| <code>pspm_trim(fn, 0, 5, [5 4])</code> [invalid numeric start/end reference]    | ID:invalid_input |

### Testing 'marker' as reference

- **Function name**
  - `marker_tests(testCase)`
- **Description**
  - A wrapper function for tests with reference = 'marker'. It executes the methods `markertest_k`, where the testcases are defined.

#### markertest\_1

- **Description**
  - from and to are set so that the trimming points are out of the range `[0,duration]`. Hence the data should not be trimmed.
- **Expected warning**
  - ID: `marker_out_of_range`
- **Input**
  - `pspm_trim(fn, -20, 20, 'marker')`

#### markertest\_2

- **Description**
  - from and to are set so that the trimming points are exactly `(0, duration)`. Hence the data should not be trimmed.

- **Input**
  - from -1 \* marker(1)
  - to duration - marker(end)
  - then `pspm_trim(fn, from, to, 'marker')`

### **markertest\_3**

- **Description**
  - from and to are set so that the trimming points in the range [0,duration].
- **Input**
  - `pspm_trim(fn, 1, -2, 'marker')`

### **Testing 'file' as reference**

- **Function name**
  - `file_tests(testCase)`
- **Description**
  - A wrapper function for tests with reference = 'file'. It executes the methods `filetest_k`, where the testcases are defined.

### **filetest\_1**

- **Description**
  - from and to are set so that the trimming points are out of the range [0,duration]. Hence the data should not be trimmed.
- **Expected warning**
  - ID: `marker_out_of_range`
- **Input**
  - `pspm_trim(fn, -12.5, 50, 'marker')`

### **filetest\_2**

- **Description**
  - from and to are set so that the trimming points are exactly (0, duration). Hence the data should not be trimmed.
- **Input**
  - `pspm_trim(fn, 0, duration, 'marker')`

### **filetest\_3**

- **Description**

- from and to are set so that the trimming points in the range [0, duration].

- **Input**

- `pspm_trim(fn, 2.1, duration - 2.5, 'marker')`

### **Numeric reference tests**

- **Function name**

- `num_tests(testCase)`

- **Description**

- A wrapper function for tests with reference = [a b] (a, b are two integers with a<b). It executes the methods `markertest_k`, where the testcases are defined.

### **numtest\_1**

- **Description**

- from and to are set so that the trimming points are out of the range [0,duration]. Hence the data should not be trimmed.

- **Expected warning**

- ID: `marker_out_of_range`

- **Input**

- `pspm_trim(fn, -20, 20, [2 14])`

### **numtest\_2**

- **Description**

- from and to are set so that the trimming points are exactly (0, duration). Hence the data should not be trimmed.

- **Input**

- `from = -1 * marker(3)`
- `to = duration - marker(8)`
- then `pspm_trim(fn, from, to, [3 8])`

### **numtest\_3**

- **Description**

- from and to are set so that the trimming points in the range [0, duration].

- **Input**

- `pspm_trim(fn, -1.5, 2, [2 7])`

## **numtest\_4**

- **Description**

- Second reference point is out of the marker range; from is set to 'none'. Hence the data should not be trimmed.

- **Expected warning**

- ID: marker\_out\_of\_range

- **Input**

- `pspm_trim(fn, 'none', 0, [1 (numel(marker) + 1)])`

## **Multiple file reference tests**

- **Function name**

- `multiple_files(testCase)`

- **Description**

- The input variable datafile is either a cell array of two filenames or a cell array of two structs. In both cases it is tested whether the return value is also a cell array of two filenames and whether both files are trimmed correctly.

## **Option tests (marker channel number option)**

- **Function name**

- `marker_chan_num_option_test(testCase)`

- **Description**

- Tests if the option marker\_chan\_num is working correctly. There are two tests:
  1. Checks for a warning if the selected channel is no marker channel.
  2. Checks if the selected channel is actually used.

## **5.39 pspm\_write\_channel**

### **5.39.1 Overview**

**Testclass** `pspm_write_channel_test`

**Format** `[sts] = pspm_write_channel(fn, newdata, action, options)`

### **5.39.2 Setup**

**Testdatafile** The testdatafile is a class property. It is generated by the function `generate_testdatafile()` once the test class is setup. Changes made by a test to the testdatafile won't be reverted. Thus some test functions rely on the changes made by another test function. Therefore the functions may not work properly if called individually.

**Structure** Created with `generate_testdatafile()`.

`data{1}.chantype 'scr';`

`data{2}.chantype 'marker';`

`data{3}.chantype 'scr';`

The sampling rate is 100Hz and the duration is 500s.

### 5.39.3 Testcases

#### Invalid input

**Function name** `invalid_input(this)`

**Description** Checks for warnings, if the input arguments are invalid.

#### Tests

| Input  | Expected warning          |
|--|---------------------------|
| <code>pspm_write_channel()</code> [no parameter]   | ID:invalid_input          |
| <code>pspm_write_channel(1)</code> [fn is a number]  | ID:invalid_input          |
| <code>pspm_write_channel('some_file', [])</code> [no action passed]  | ID:unknown_action         |
| <code>pspm_write_channel('some_file', [], '')</code> [empty action passed]   | ID:unknown_action         |
| <code>options.channel = 'some invalid channel'</code><br><code>pspm_write_channel('some_file', [], 'add', options)</code> [invalid channel]              | ID:invalid_input          |
| <code>options.channel = -1</code><br><code>pspm_write_channel('some_file', [], 'add', options)</code> [negative channel]                                 | ID:invalid_input          |
| <code>options.channel = 0</code><br><code>pspm_write_channel('some_file', [], 'delete', options)</code> [no channel and no data given]                   | ID:invalid_input          |
| <code>options.channel = 0</code><br><code>pspm_write_channel('some_file', [], 'add', options)</code> [empty newdata]                                     | ID:invalid_input          |
| <code>options.channel = 0</code><br><code>pspm_write_channel('some_file', 1:3, 'add', options)</code> [newdata is not cell and not struct]               | ID:invalid_input          |
| <code>options.channel = 1:5</code><br><code>pspm_write_channel(this.testdatafile, [], 'delete', options)</code> [more given channels than in file exist] | ID:invalid_input          |
| <code>options.channel = 'ecg';</code><br><code>pspm_write_channel(this.testdatafile, [], 'delete', options)</code>                                       | ID:no_matching_channels   |
| <code>pspm_write_channel(this.testdatafile, gen_data.data{1}, 'add')</code> [generated data has the wrong format (two rows in one channel)]              | ID:invalid_data_structure |

## Action 'add'

**Function name** `test_add(this)`

**Description** Checks if action 'add' behaves as expected. A new channel with chantype = 'hb', sr = 200 and duration = 500 is generated.

## Tests

1. Load condition before and after and pass it to 'Verify write'

### Action 'add transposed'

**Function name** test\_add\_transposed(this)

**Description** Checks if action 'add' behaves as expected, when data has the wrong dimensions. A new channel with chantype = 'rs', sr = 200 and duration = 500 is generated.

#### Tests

1. Transpose generated data
2. Load condition before and after and pass it to 'Verify write'

### Action 'replace'/'add'

**Function name** test\_replace\_add(this)

**Description** Checks if action 'replace' behaves as expected. A new channel with chantype = 'hr', sr = 10 and duration = 500 is generated.

#### Tests

1. Running pspm\_write\_channel with action = 'replace' should issue 'ID:no\_matching\_channels' (channeletype should not exist before) and then instead add the channel
2. Load condition before and after and pass it to 'Verify write'

### Action 'replace'

**Function name** test\_replace(this)

**Description** Checks if action 'replace' behaves as expected. A new channel with chantype = 'hr', sr = 20 and duration = 500 is generated.

#### Tests

1. Load condition before and after and pass it to 'Verify write'
2. Test if 'hr' channel has sample rate 20

### Action 'delete' (one channel)

**Function name** test\_delete\_single(this)

**Description** Checks if action 'delete' behaves as expected. In this test only one channel will be deleted. To test the delete algorithm there will be 7 channels added which are then also used for `test_delete_multi(this)`. The particular channels are then identified by the sample rate which corresponds to the channel id \* 10.

### Tests

1. Delete channel with `chantype = 'hr'` in `newdata.header.chantype`
  - (a) Verify write
  - (b) Ensure only one channel has been deleted
  - (c) Test if there is no more channel with `chantype = 'hr'`
2. Delete channel with channel number in `options.channel`
  - (a) Verify Write
  - (b) Ensure only one channel has been deleted
3. Test the delete algorithm
  - (a) Remove 'resp' channel with `options.delete = 'last'`
    - i. Verify write
    - ii. Ensure only one channel has been deleted
    - iii. Test if last channel was deleted
  - (b) Remove 'resp' channel with `options.delete = 'first'`
    - i. Verify write
    - ii. Ensure only one channel has been deleted
    - iii. Test if last entry was not deleted

### Action 'delete' (multiple channels)

**Function name** `test_delete_multi(this)`

**Description** Checks if action 'delete' behaves as expected. In this test only multiple channels will be deleted. This test relies on the changes made to the testdatafile by other test functions in this class.

### Tests

1. Delete channel 1 and 2 from testdatafile
  - (a) Verify write
  - (b) Ensure two channels have been deleted



2. Delete all 'resp' channels from testdatafile
  - (a) Verify write
  - (b) Test if datafile contains no more 'resp' channels

#### 5.39.4 Other methods

**Verify write** Is called after `pspm_write_channel` has been called (action = 'add' or action = 'replace') and tests if data was written and a new history entry was made.

##### Tests

1. if action == 'add', test if there is a new channel
2. if action == 'replace', test if there is still the same amount of channels
3. if action == 'delete', test if there have been as many channels deleted as given in `outinfofos.channel`
4. test if history has a new entry
5. search for channels with same chantype as added channel (should be only one channel)
6. test if number of data elements in new channel and added channel is equal
7. test if new channel and added channel have same 'sr'.

## 6 External Functions and Tools

### 6.1 VB (Variational Bayes) inversion algorithm by Jean Daunizeau

**Updated October 2014**

**VBA\_ReDisplay.m** Fixed try-catch syntax in various places by adding a comma after “try” to avoid warning in MATLAB > 2007

**VBA\_inv.m** In line 42, added warning off/on to suppress the warning `Matrix is singular, close to singular or badly scaled. Results may be inaccurate. RCOND = NaN.`

**Updated October 2016**

**VBA\_ReDisplay.m** Fixed try-catch syntax in various places by adding a comma after “try” to avoid warning in MATLAB > 2007

**VBA\_inv.m** In line 48: added warning off/on to suppress the warning `“Matrix is singular, close to singular or badly scaled. Results may be inaccurate. RCOND = NaN.”`

**VBA\_NLStateSpaceModel.m** Added resetting warning to preceeding state.

## 7 GitHub Actions

Contributed by Teddy Zhao

Updated in March 2022

GitHub Actions is a Continuous Integration (CI) environment for testing GitHub repository, which is now used for testing and maintaining PsPM. GitHub Actions is deeply implemented in GitHub, thus there is no further website or facility needed for running GitHub Actions for PsPM.

### 7.1 Repositories

Until March 2022, code and test data are separately stored in GitHub, in *PsPM* and *PsPM-data*, respectively. Both of *PsPM* and *PsPM-data* are under the *bachlab* account. *PsPM* is a public repository allowing group members and public visitors to check the code and propose issues. *PsPM-data* is a private repository allowing only group members to check the data and propose issues. This is because *PsPM-data* has some research data that may not be appropriate for public visitors. It could be a good idea to find another cloud storage service with University's approval to store research data. *PsPM-data* has all the required test data for running testsuit of *PsPM*. To run testsuit of *PsPM*, it must be guaranteed that *PsPM-data* is accessible.

### 7.2 Workflow

To guide the actions of GitHub Actions, a workflow script as a `.yaml` file is required, which should be stored at `~/bachlab/PsPM/.github/workflow`. The workflow has been prepared and tested to be running well for maintaining *PsPM*. The explanations of key scripts are show below.

#### Step 1 Import PsPM

```
- name: Check out repository code
  uses: actions/checkout@v2
```

This step imports the source code of *PsPM* to the server, in our case, a Ubuntu server.

#### Step 2 Import PsPM-data

```
- name: Add test data
  uses: actions/checkout@v2
  with:
    repository: bachlab/PsPM-data
    token: ${ secrets.PSPM_PAT }
    path: ImportTestData
```

This step imports the test data in *PsPM-data* to the server. The details of the token is introduced in the next section.

#### Step 3 Setup MATLAB

```
- name: Setup MATLAB
  uses: matlab-actions/setup-matlab@v1.0.1
```

#### Step 4 Setup testing script

```
- name: Run script
  id: pspm_test_main
  uses: matlab-actions/run-command@v1
  with:
    command: addpath('test'), addpath('src'), pspm_test_github_actions
```

The script of testing *PsPM* has been optimised for GitHub Actions, which is saved as `pspm_test_github_actions`. Further modifications should be done here.

#### Step 5 Save records

```
- name: Check status
  id: check_status
  uses: andstor/file-existence-action@v1
  with:
    files: "success.txt"
```

This step return a document `success.txt` if the script does not return any error, indicating the code has passed the test suit.

#### Step 6 Return success

```
- name: Return running success
  if: ${{ steps.check_status.outputs.files_exists == 'true' }}
  run: exit 0
```

#### Step 7 Return failure

```
- name: Return running failure
  if: ${{ steps.check_status.outputs.files_exists != 'true' }}
  run: exit 1
```

### 7.3 Token

Tokens are required to perform GitHub Actions for *PsPM* as the data repository is stored as private. The steps for generating and implementing tokens are described as below.

**Step 1** Generate a Personal Access Token (PAT) at <https://github.com/settings/tokens>, name it as `PSPM_PAT` with required privileges.

**Step 2** In the YAML file, the script for running GitHub Actions, make sure the PAT file has been mentioned appropriately, like

```
token: ${{ secrets.PSPM_PAT }}
```

**Step 3** In the settings of *PsPM* repository, which can be found at <https://github.com/bachlab/PsPM/settings/secrets/>, make sure *Repository Secrets*, which is under *Actions Secrets*, has contained `PSPM_PAT`. This operation requires your privilege to access the setting profiles of the corresponding repository.

**Step 4** Similar to Step 3, in the settings of *PsPM-data* repository, which can be found at <https://github.com/bachlab/PsPM-data/settings/secrets/actions>, make sure *Repository Secrets*, which is under *Actions Secrets*, has contained `PSPM_PAT`. This operation requires your privilege to access the setting profiles of the corresponding repository.

Now the script should be running ok. Please note the PAT must be updated regularly due to security concerns.

## 8 List of Functions

| Function Name       | Main Author(s) | Test Function | Test Document |
|---------------------|----------------|---------------|---------------|
| f_SCR               | DB & JD        | -             | -             |
| f_SF                | DB             | -             | -             |
| g_SCR               | DB             | -             | -             |
| pspm                | DB             | x             | x             |
| scr                 | DB             | x             | x             |
| pspm_align_channels | DB             | x             | x             |
| pspm_axpos          | DB             | -             | -             |
| pspm_bf_brf         | SK & DB        | -             | -             |
| pspm_bf_FIR         | DB             | -             | -             |
| pspm_bf_Fourier     | DB             | -             | -             |
| pspm_bf_hprf        | DB             | -             | -             |
| pspm_bf_hprf_e      | TM             | -             | -             |
| pspm_bf_hprf_fc     | TM             | -             | -             |
| pspm_bf_hprf_fc_f   | TM             | -             | -             |
| pspm_bf_lcrf_gm     | TM             | -             | -             |
| pspm_bf_ldrf_gm     | TM             | -             | -             |
| pspm_bf_ldrf_gu     | TM             | -             | -             |
| pspm_bf_psr_f_fc    | TM             | -             | -             |
| pspm_rarf_e         | TM             | -             | -             |
| pspm_rarf_fc        | TM             | -             | -             |
| pspm_rfrrf_e        | TM             | -             | -             |
| pspm_rprf_e         | TM             | -             | -             |
| pspm_bf_scrf_f      | DB             | -             | -             |
| pspm_bf_scrf        | DB             | -             | -             |
| pspm_bf_spsrf_box   | LC             | -             | -             |
| pspm_bf_spsrf_gamma | LC             | -             | -             |
| pspm_butter         | DB             | X             | X             |

|                            |     |   |   |
|----------------------------|-----|---|---|
| pspm_compute_visual_angle  | LC  | - | - |
| pspm_con1                  | DB  | - | - |
| pspm_con2                  | DB  | - | - |
| pspm_contrast              | DB  | - | - |
| pspm_convert_area2diameter | TM  | - | - |
| pspm_convert_au2mm         | TM  | - | - |
| pspm_convert_illum2lum     | TM  | - | - |
| pspm_convert_lux2cdm2      | TM  | - | - |
| pspm_convert_mm2visdeg     | TM  | - | - |
| pspm_convert_pixel2unit    | LC  | - | - |
| pspm_convert_unit          | TM  | x | x |
| pspm_convert_visangle2sps  | LC  | - | - |
| pspm_data_editor           | TM  | - | - |
| pspm_dcm_inv               | DB  | - | - |
| pspm_dcm                   | DB  | - | - |
| pspm_denoise_spike         | DB  | - | - |
| pspm_display               | PCP | - | - |
| pspm_down                  | DB  | x | - |
| pspm_downsample            | DB  | - | - |
| pspm_ecg2hb                | PCP | x | x |
| pspm_ecg2hb_amri           | EY  | x | - |
| pspm_ecg_editor            | TM  | - | - |
| pspm_exp                   | DB  | x | - |
| pspm_extract_segments      | TM  | x | x |
| pspm_filtfilt              | DB  | x | x |
| pspm_find_channel          | DB  | x | x |
| pspm_find_data_epochs      | TM  | - | - |
| pspm_find_sounds           | SG  | x | x |
| pspm_find_valid_fixations  | TM  | x | x |
| pspm_get_acq_bioread       | TM  | x | x |
| pspm_get_acq               | DB  | x | x |

|                          |         |   |   |
|--------------------------|---------|---|---|
| pspm_get_acqmat          | DB      | x | x |
| pspm_get_biograph        | DB      | x | x |
| pspm_get_biosemi         | DB      | x | x |
| pspm_get_biotrace        | DB      | x | x |
| pspm_get_blink_l         | TM      | - | - |
| pspm_get_blink_r         | TM      | - | - |
| pspm_get_brainvis        | DB      | x | x |
| pspm_get_cell            | DB      | - | - |
| pspm_get_cnt             | DB      | - | - |
| pspm_get_custom          | TM      | - | - |
| pspm_get_ecg             | DB      | x | x |
| pspm_get_edf             | TM      | x | x |
| pspm_get_events          | DB      | x | x |
| pspm_get_eyelink         | CK & TM | x | x |
| pspm_get_gaze_x_l        | TM      | - | - |
| pspm_get_gaze_y_l        | TM      | - | - |
| pspm_get_gaze_x_r        | TM      | - | - |
| pspm_get_gaze_y_r        | TM      | - | - |
| pspm_get_hb              | DB      | x | x |
| pspm_get_hp              | DB      | - | - |
| pspm_get_hr              | DB      | x | x |
| pspm_get_labchartmat_ext | DB      | x | x |
| pspm_get_labchartmat_in  | DB      | x | x |
| pspm_get_marker          | DB      | x | x |
| pspm_get_markerinfo      | DB      | - | - |
| pspm_get_mat             | DB      | x | x |
| pspm_get_obs             | LR      | x | x |
| pspm_get_physlog         | TM      | - | - |
| pspm_get_pupil           | DB      | x | x |
| pspm_get_pupil_l         | TM      | - | - |
| pspm_get_pupil_r         | TM      | - | - |



|                       |    |   |   |
|-----------------------|----|---|---|
| pspm_get_resp         | DB | x | x |
| pspm_get_rf           | DB | - | - |
| pspm_get_saccade_l    | LC | - | - |
| pspm_get_saccade_r    | LC | - | - |
| pspm_get_scr          | DB | x | x |
| pspm_get_smi          | EY | - | - |
| pspm_get_sps          | LC | - | - |
| pspm_get_spike        | DB | x | x |
| pspm_get_sound        | TM | - | - |
| pspm_get_timing       | DB | x | x |
| pspm_get_txt          | DB | x | x |
| pspm_get_vario        | DB | x | x |
| pspm_get_viewpoint    | EY | - | - |
| pspm_get_wdq          | DB | - | - |
| pspm_get_wdq_n        | TM | x | x |
| pspm_glm_recon        | DB | - | - |
| pspm_glm              | DB | x | x |
| pspm_hb2hp            | DB | x | x |
| pspm_hb2hr            | DB | - | - |
| pspm_import           | DB | x | x |
| pspm_init             | DB | - | - |
| pspm_interpolate      | TM | x | x |
| pspm_jobman           | GG | - | - |
| pspm_job_create       | DB | - | - |
| pspm_load_data        | DB | x | x |
| pspm_load1            | DB | x | x |
| pspm_load_single_chan | EY | - | - |
| pspm_merge            | DB | - | - |
| pspm_overwrite        | TZ | - | - |
| pspm_path             | EY | x | - |
| pspm_peakscore        | DB | - | - |

|                            |    |   |   |
|----------------------------|----|---|---|
| pspm_pp                    | DB | x | x |
| pspm_ppg2hb                | SG | - | - |
| pspm_predval               | DB | - | - |
| pspm_prepdata              | DB | x | x |
| pspm_process_illuminance   | TM | x | - |
| pspm_pulse_convert         | DB | x | - |
| pspm_pupil_correct_eyelink | EY | x | - |
| pspm_pupil_correct         | EY | x | - |
| pspm_pupil_pp              | EY | x | - |
| pspm_pupil_pp_options      | EY | - | - |
| pspm_quit                  | DB | - | - |
| pspm_ren                   | DB | x | x |
| pspm_resp_pp               | DB | - | - |
| pspm_rev_con               | DB | - | - |
| pspm_rev_dcm               | DB | - | - |
| pspm_rev_glm               | DB | - | - |
| pspm_rev2                  | DB | - | - |
| pspm_review                | GG | - | - |
| pspm_segment_mean          | TM | - | - |
| pspm_scr_pp                | TZ | x | x |
| pspm_sf_auc                | DB | - | - |
| pspm_sf_dcm                | DB | - | - |
| pspm_sf_mp                 | DB | - | - |
| pspm_sf_scl                | DB | - | - |
| pspm_sf_theta              | DB | - | - |
| pspm_sf                    | DB | - | - |
| pspm_sf_get_theta          | DB | - | - |
| pspm_show_arms             | DB | - | - |
| pspm_spike_convert         | DB | - | - |
| pspm_split_sessions        | LR | x | x |
| pspm_transfer_function     | DB | - | - |

|                            |    |   |   |
|----------------------------|----|---|---|
| pspm_time2index            | TZ | x | x |
| pspm_trim                  | DB | x | x |
| pspm_version               | TM | - | - |
| pspm_write_channel         | TM | x | x |
| set_blinks_saccades_to_nan | EY | x | - |

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