OXYSOFT EXPORT TO MATLAB TOOLBOXES

Einsteinweg 17
6662 PW Elst
The Netherlands

T: +31 481 350 980
askforinfo@artinis.com
www.artinis.com

BANK: ABN-AMRO 49.89.67.506
IBAN: NL37 ABNA 0498967506
BIC: ABNANL2A
VAT: NL8106 26 408 B01

Chamber of Commerce
no. 09127900 0000

INTRODUCTION

After having recorded data, the next step is to analysis the data. Many scientist prefer analyzing data in MATLAB (http://www.mathworks.com), because of the possibility to script, batch process and individualize the analysis. There are several MATLAB toolboxes available, which are created and maintained by different institutes around the world. The Artinis function **oxysoft2matlab** converts .oxy3- and oxy4-files to the native MATLAB data format and organizes the data according to the guidelines of these different toolboxes. This document describes how to use the **oxysoft2matlab** function.

STEP 1:

Record and store data in OxySoft.

Note:

If you want to use oxysoft2matlab to convert .oxy3-, .oxy4- (from Oxysoft 3.2.x and onwards) or .oxy5-files (from OxySoft 3.3. onwards), you need to register Oxysoft as a COM-interface in Windows. To do so, open a command window in administrator-mode, change directory to the Oxysoft folder and type 'oxysoft /register'. Contact us for more precise instruction.

If you have not registered Oxysoft as a COM or DCOM-interface (or are not sure about this), please follow the steps in the Appendix.

STEP 2:

Start MATLAB

Open MATLAB and change the directory to the location where the **oxysoft2matlab** file is stored.

STEP 3

Execute the oxysoft2matlab function

In MATLAB, type

>> **oxysoft2matlab**

Note that you can either use the **oxysoft2matlab** function in a script and provide the necessary input arguments yourself (type 'help **oxysoft2matlab**' in MATLAB for more information) or execute the function without specifying any further input. If you have specified the input oxy3-, oxy4- or oxyproj-file in a script (or directly from the command line), then you skip step 4.

For advanced users (import of events):

Some input arguments for **oxysoft2matlab** can be specified in a cell-array. This allows importing several oxy3-files at once, or specifying a combination of oxy3- and oxyproj-files. In the latter case, only those oxy3-files that are specified in the oxyproj-file that are also explicitly specified in the input argument are imported. Note that events added after the measurement are only stored in the oxyproj-file, and thus the **oxysoft2matlab** has to be pointed to the oxyproj-file if those events should be imported to Matlab! Here is an example:

Imagine that you want to import the "Arterial Occlusion" data from the Measurement Examples to MATLAB. If you open the "Measurement Examples" project file, and look at the arterial occlusion data, you will see that there is one defined event "U". This event is indicated by a vertical, blue line at 67 seconds. The blue line indicates, that the timepoint of the event has been added by Oxysoft after the measurement, for example through identification of a change in an AD-channel (trigger-channel). The rationale of Oxysoft is to **never** change data that has once been stored on the hard drive. Therefore, the blue event "U" cannot be added to the oxy3-file that is stored on the disk. Instead, the event is stored in the "Measurement Examples" project file with the extension .oxyproj.

Since the event "U" is not saved in the oxy3-file, the Matlab-import script cannot know about this event. Therefore, you need to let **oxysoft2matlab** know about the oxyproj-file, in which this event is stored. You can do this either by calling **oxysoft2matlab** as usual (without specifying an input argument), and then selecting the oxy3- and the corresponding oxyproj-file (press CTRL while pressing the left mouse button to select more than one datafile), or you can specify the first input argument as a cell-array. In this case it would be

oxysoft2matlab ({'Arterial occlusion.oxy3', 'Measurement Examples.oxyproj'})

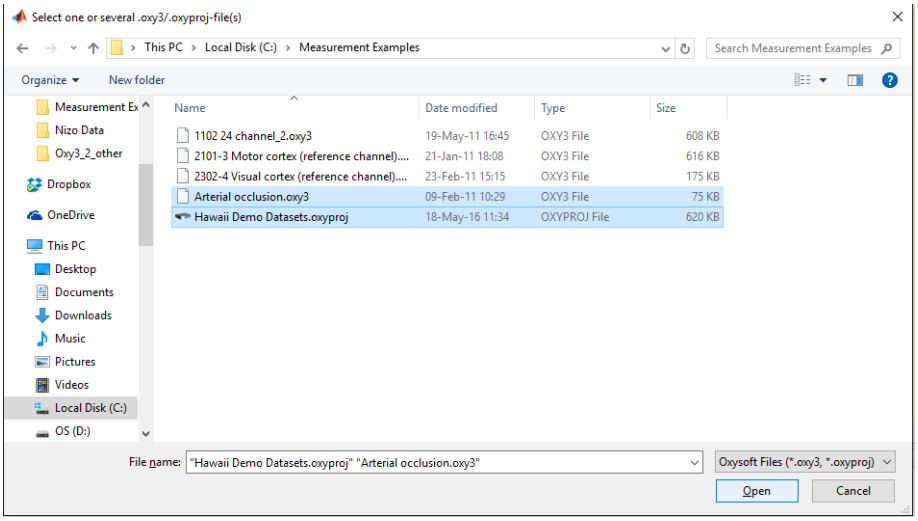

Figure 1 Selecting several oxy3- and oxyproj-files from the selection dialog of Artinis' **oxysoft2matlab**.

STEP 4

Locate and select the .oxy3-, .oxy4- or oxy5-file on your hard drive.

If you have not specified the location of the .oxy3-, oxy4-, oxy5- or oxyproj-file in the command line call, an explorer window will open, where you can locate and select the .oxy3-, .oxy4-, .oxy5- or oxyproj-file you want to use.

Step 5:

Choose the toolbox in which you want to import your data.

Currently, there are five options available. If you do not want to use any specific MATLAB toolbox, you can select the '**rawOD**' option, which will return the raw optical densities of the measurement. If you want to obtain relative changes in oxygenated and deoxygenated blood, you can select '**oxy/dxy**' instead. Both these options constitute a relatively unformatted data export. The function will also extract additional information such as relative optode positions, differential path length factor, values of additional channels, TSI (if possible), etc. Please check any export thoroughly if it is correct!

If you want to use a specific toolbox, you can currently choose from three options:

NIRS-SPM / SPM-fNIRS

The option 'nirs-spm' will compute the relative changes in oxygenated and deoxygenated blood, and organize your data according to NIRS-SPM guidelines (which is the same as for the SPM-fNIRS toolbox). The **oxysoft2matlab** function will also extract the channel configuration, which is a .txt-file containing information about which transmitters and receivers make up which channel. For orientation purposes, a figure will open up showing the individual indices of the receivers, transmitters and channels in NIRS-SPM

convention (this is very important for co-registration, see also below!). In addition, all events in the oxy3/4-data are extracted and stored with the data. The 'nirs-spm' options results in three data files to be stored:

<filename>_converted_data.mat
Contains the data in nirs-spm format.

<filename>_multiple_conditions.mat
Contains information about the timing and names of events during the recording

<filename>_ch_config.txt
Contains information about the channel configuration.

Homer2

If you want to use HOMeR2 as a toolbox, you can select the 'nirs option. Homer requires data of raw optical densities. The **oxysoft2matlab** function will extract information about channel positions, including which transmitters and receivers make up which channel. All information is stored in one data file, named <filename>.nirs. This file contains all relevant data structures for Homer2. According to Homer convention, files from the same experiment and different subjects (and sessions) should be saved as <subjectid>_run<n>.nirs. This allows Homer2 to automatically associate individual experimental sessions (here called "run") with each subject.

Homer2

If you want to use HOMeR3 as a toolbox, you can select the 'snirf option. Homer requires data of raw optical densities. The **oxysoft2matlab** function will extract information about channel positions, including which transmitters and receivers make up which channel. All information is stored in one data file, named <filename>.snirf. This file contains all relevant data structures for Homer3. According to Homer convention, files from the same experiment and different subjects (and sessions) should be saved as <subjectid>_run<n>. snirf. This allows Homer2 to automatically associate individual experimental sessions (here called "run") with each subject.

Note: You can also read in .nirs files in Homer3. It will transform the file to snirf-format by itself.

NAP

If you want to use the NAP-toolbox, select 'NAP', for which only the relative change in oxygenated, deoxygenated and total hemoglobin are required. Data for the three individual transformations will be stored as <filename>_Oxy.mat, <filename>_Deoxy.mat, <filename>_Total.mat, respectively.

STEP 6 (OPTIONAL) Import 3D MNI-coordinates from Oxysoft

For NIRS-SPM and AtlasViewer (Homer2 plugin), obtaining the exact 3D-positions of the optodes on the subject's head is essential for precise measurements. In Oxysoft, this can either be done using a manual approximation or using a Polhemus digitizer (see manual). Once digitized, the 3D-positions can be imported to MATLAB in a format that is understandable for NIRS-SPM or AtlasViewer.

You can retrieve the projected positions of the channels from Oxysoft by following these instructions:

1. Right click on the 3D plot in Oxysoft and select "Show MNI coordinates".
2. Activate the "Output to MS Excel file" option on the lower right, go to the "MS Excel" tab and select the output file.
3. Go back to the "Calculation" tab and click on "Calculate". Then, the Excel file is created.

Then, you need to go back to MATLAB and call the function **oxysoftMNIImport**. For NIRS-SPM, this function will need the just created Excel file as input and either the "..._optode_order.txt" or the "..._channel_order.txt" file created from the NIRS-SPM output of **oxysoft2matlab**. To be consistent, save the result as_"..._3D_channel_positions.txt" in a similar fashion as the NIRS-SPM files are named. For AtlasViewer, you do not require any additional input files and the export will be stored as digpts.txt

STEP 7
Start the toolbox or use the data in your own script

The data has now been exported to native MATLAB format and can be loaded using the load function in MATLAB, or imported in the selected MATLAB toolbox. Of course, you can also use your own scripts to analyze the data in MATLAB instead of using a toolbox.

NIRS-SPM

Start the NIRS-SPM toolbox by typing

>> NIRS-SPM

In the NIRS-SPM window, you can now skip the 'Convert' step, and immediately continue with the 'Spatial registration' step. Note however that you require the positions of the channels in MNI space. The individual channels in NIRS-SPM are reordered with respect to your original measurement. The **oxysoft2matlab** function will show you the original receiver-, transmitter- and channel-labels together with the newly assigned index. Your digitized positions should be in the same order as now in NIRS-SPM. If you have not digitized your optodes, you can select 'Optodes' in the NIRS-SPM coregistration window and select the <filename>_ch_config.txt file that was created by **oxysoft2matlab**. This allows NIRS-SPM to know which optodes make up which channel. You can then continue to specifying the MNI coordinates of the optodes. If you have followed the optional Step 6 using **oxysoftMNIImport**, you can instead select "Channels" instead of "Optodes", and click on "Select the file to contain MNI coordinates of NIRS channels" and then select the file "...3D_channel_positions.txt". Then, you **have** to project the coordinates to the brain before viewing them, so click on "Project MNI Coordinate to Rendered Brain".

t +31 481 350 980
w www.artinis.com
e askforinfo@artinis.com

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When you are done with the spatial coregistration, you select 'Specify 1st Level'. Here, you need to select the <filename>_converted_data.mat file that was created by **oxysoft2matlab**. The SPM directory can be any folder on your hard drive and will contain the output of this step. After clicking on 'specification', NIRS-SPM asks you to specify your design. It you want to model all events in your data, you can load the <filename>_multiple_conditions.mat file here, that was created by **oxysoft2matlab**. The events are specified in seconds in that file. Note however that most likely, you do not want to model all events, and in return include additional regressors. These decisions are however up to the researcher and personal preferences. From here onwards, all your data is imported in NIRS-SPM and you can use the toolbox as described in the NIRS-SPM manual. For SPM-fNIRS similar steps as above apply as the two toolboxes are closely similar (but SPM-fNIRS is newer and still being maintained).

Homer

To start the HOMeR toolbox, type:

>> Homer2_UI

(or Homer3_UI for Homer3)

Via the File menu, you can select the directory in which you stored your exported .nirs-files. Homer will automatically read all .nirs-file in that directory, therefore it would be wise to adhere to the Homer convention how to organize and name .nirs-files (see Homer manual). Afterwards, you will see the channel configuration of your recording in the upper right of the screen. In Homer, receivers are called 'detector' and labelled as numbers, and transmitters are called 'source' and labelled as letters. For further information on how to use the toolbox, please see the Homer2 manual.

Important: Homer uses a different convention to compute optical densities (natural logarithm vs. base 10 logarithm) and also how to display data (Homer always subtracts the average activity in the whole data segment). Keep this in mind when verifying the correctness of the export!

NAP

The NAP-toolbox can be started by typing

>> nap

in the command window. The data that was converted using **oxysoft2matlab** can be loaded by clicking on the 'view' button in the lower left corner. For further use of the NAP toolbox, see the NAP manual.

Step 8

Happy matlab'ing!

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Appendix

Register Oxysoft as a COM Application (see
https://www.dropbox.com/s/dgh4qfmi3czidr1/registering_oxysoft_as_com_app.mp4?dl=0)

a. For this, open the command window as an administrator (e.g. search for cmd.exe, right click -> Run as administrator)
b. Then, go to the folder where the oxysoft.exe is located (for me it's in C:\Program Files (x86)\Artinis Medical Systems BV\Oxysoft 3.0.103)
c. Type
d. Oxysoft /register
e. And press Enter. The command will silently be executed and then return.

If everything went well, you can find that Oxysoft is now registered in as a component application. You can check this by going to Control Panel -> Administative Tools Component Services, then extend, Component Services, Computers, My Computer, DCOM config and look whether "Oxysoft" is in the list (the list is ordered alphabetically, so best scroll down to P, and then look up. Note also that in above linked video, it might say 'Oxydaq' rather than 'Oxysoft' – that is because the video is old) .

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