OptogenSIM quickstart manual (for version 1.0, October 29, 2015)

Overview: OptogenSIM is a 3D Monte Carlo simulation platform for optogenetic applications. It provides a 3D simulator for predicting light distribution in heterogeneous brain tissue with high resolution, including a voxel-based 3D Monte Carlo tool custom built for optogenetic light delivery, generic optical properties library for different brain tissues, and a 3D mouse brain atlas segmented with SPM-based tool. For more information please see the primary website (http://loci.wisc.edu/software/optogensim).

For any bugs or issues with installation, the primary author Yuming Liu should be contacted.

1. First the **MATLAB Compiler Runtime** (MCR) needs to be installed. Please make sure MATLAB 2014b MCR for Windows or OS X is installed before running OptogenSIM. The MCR can be freely downloaded from the Mathworks, Inc: Windows64 MCR 2014b or Mac MCR 2014b. At this time Linux has not been tested with OptogenSIM.

2. Download the OptogenSIM standalone_for Windows or OptogenSIM standalone for Mac. Please unzip and then run the application "OptogenSIM". Please note, if you have previously run older releases of OptogenSIM, make sure to delete/rename/move the old 'OSGworking' folder mentioned in step 3, otherwise the new release would not work properly.

    On Windows: double click on "OptogenSIM"

    On OS X: right click on "OptogenSIM"(ctrl-click)----->Show Package Contents ----> Contents---->MacOS---->applauncher (right-click and choose open)

3. After step 1 and 2, an working directory named "OGSworking "will be automatically created under the current system directory whose path will be displayed in the command window. The main user interface will pop-up as below:
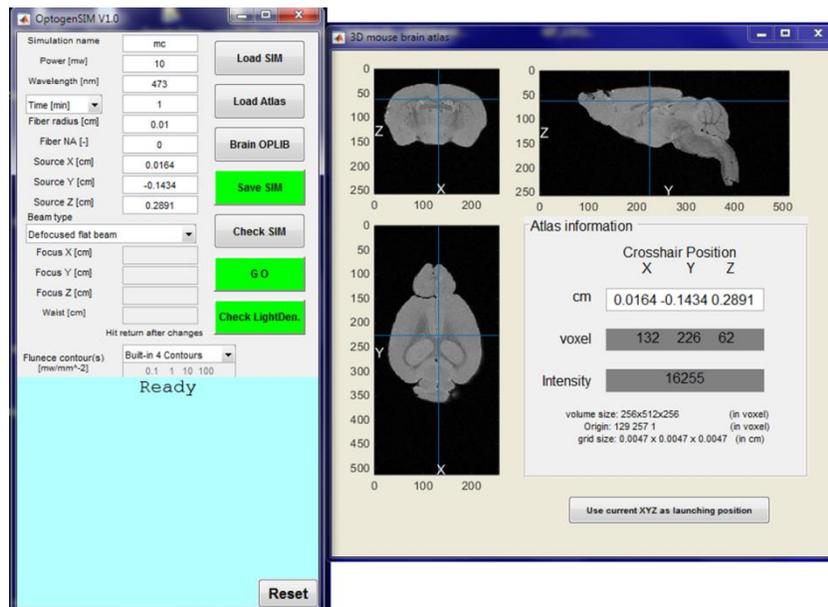
4. The launching position can be changed by clicking on the 3D atlas and then click on the "Use current XYZ as launching position". Other parameters can be entered into the text box or select from the drop-down menus , such as to switch between setting simulation 'Time [min]' or number of photons 'Photons [#]', or

to choose different fiber beam type . In addition, users can use the arrows of upwards/downwards/leftwards/rightwards on the keyboard to browse the atlas.

5. Click on "Save SIM" button to save the current simulation parameters.
6. Click on "GO" to run the simulation. A command line window will pop up to show the progress.
7. After the simulation is done and fluence rate file becomes available, click on the "Check LightDen" to check the light density in the brain. Default output is four built-in contours overlaid on the grayscale atlas as demonstrated below:
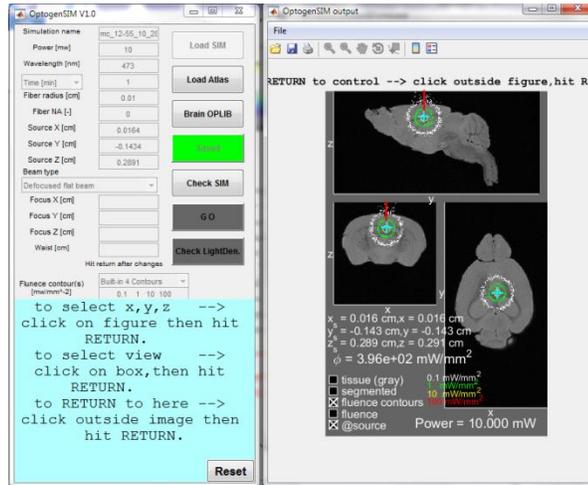
Click on the image then hit RETURN to check the light density at a specified position. To return to the source point, click on the "@source" box. To return to the main interface, click outside the output image then hit RETURN.

8. To view a specified iso-fluence contour, select that option from the main interface, and then click on the "Check LightDen" button. A demonstrated output is shown below.
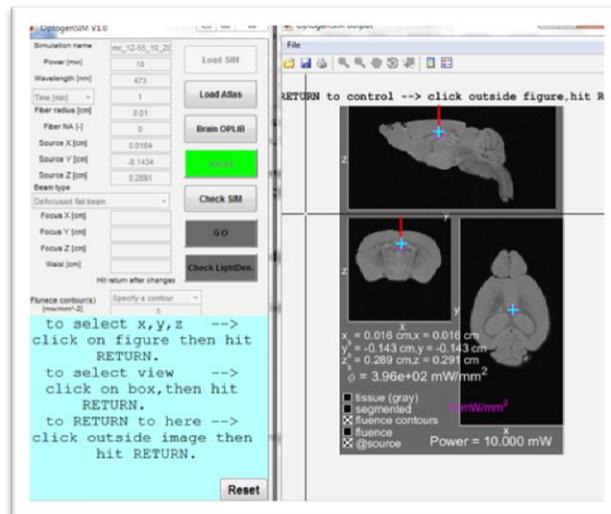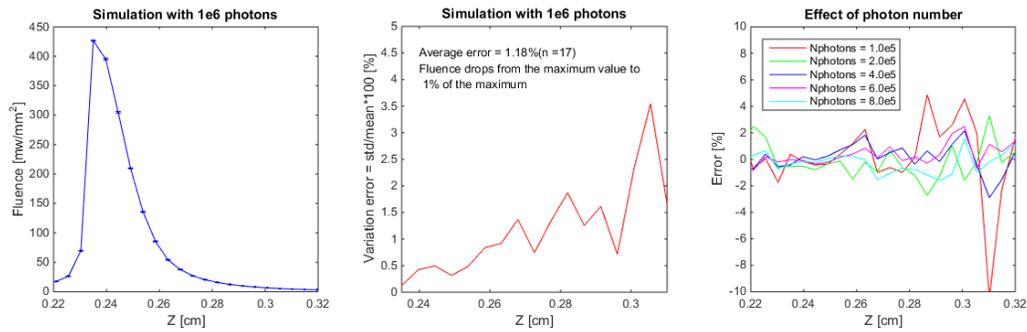

The user can adjust the power and re-display contours without having to re-run a new Monte Carlo simulation .

10 Click on "Reset" button to start over.

Quickstart Tips (please email any additional ones or questions to <u>the author</u>):

Q1: How many photons should be enough?

A1: 200,000 photons should be a good number to start with as shown in the following test.

Test on the effect of the number of photons(Nphotons). Nphotons was set to 1e5, 2e5, 4e5, 8e5 and 1e6, respectively. Five simulations were run for each Nphotons. The left column shows the mean and standard deviation of the fluence attenuation along the z direction of the fiber with Nphotons = 1e6. The middle column shows the statistical variation error for Nphotons = 1e6. The right column shows the error analysis for the mean fluence with each Nphotons with respect to the mean fluence with Nphotons = 1e6. The error at each point was calculated as

$$100 \times \left(mean(\phi(z)_{Nphotons}) - mean(\phi(z)_{1e6 \ photons}) \right) / mean(\phi(z)_{1e6 \ photons})$$, where Nphotons = 1e5, 2e5, 4e5, or 8e5.

Other stimulation parameters: fiber position (0.087, 0.024, 0.2347), wavelength = 473nm, fiber diameter=200 μm , NA=0, and beam profile type= uniform beam. This figure shows that increasing Nphotons can yield more accurate prediction at positions far from the fiber tip e.g. when z > 0.3 (Z of fiber tip = 0.2347), but with fluence errors are similar at positions near the fiber tip for e.g. [0.22 0.30] range for all the Nphotons tested except for Nphotons = 1e5. In brief, Nphotons >= 200,000 would be a good start for a real application.

Q2: How fast is this program?

A2: The program has not been carefully benchmarked. However informally we observed that the computational speed was very different across different computers or different operating systems. In our early testing of the machines at LOCI OptogenSIM runs faster on Mac than on Windows. In a test, to launch 1 million photons, it took **2.79** minutes for a MacBook Air (OS X version 10.9.5, 1.3 GHz Intel Core i5 processor, 4GB memory) to complete , but took **11.54** minutes for a Dell laptop Latitude E7440 (Windows 7, Intel core i5-4300U, 1.9GHz, 2.5GHz, 16GB memory) to complete the same simulation. Also we noted that in Windows, restarting the computer to clear the memory before running OptogenSIM could dramatically increase the speed (e.g. ~5-fold faster).

Q3: What might cause OptogenSIM to not start properly?

A3: Firstly, make sure the MATLAB MCR 2014b or V8.4 is installed. Another thing is, if you ever ran the older release, make sure to delete/rename/move the old 'OSGworking' folder mentioned in step3 before opening 'OptogenSIM', otherwise the new release could not work properly.

Q4: How can other rodent atlases be used in OptogenSIM?

A4: The atlas to be used should be first segmented into the tissue types that are included in the generic tissue library. We have tested the simulation on an average mouse brain atlas and an average rat brain atlas as mentioned in the <u>LOCI website</u> and can incorporated them into OptogenSIM in the future after the license issue is resolved.