Session 9: 3-D Visualization with Fury

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PhysiCell Project

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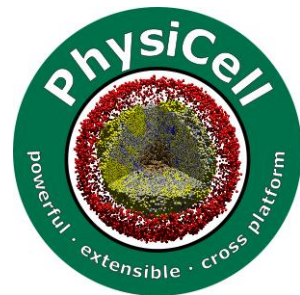
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https://github.com/heberlr/PhysiCell-Fury/tree/dev_heber

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Fury 3D viewer

Fury is a free and open-source library for Scientific Visualization and 3D animations. The library is available via PyPI (Python Package Index) or Anaconda package system (https://pypi.org/project/fury).

You can install Fury using pip command:

```
pip install fury # to install fury
```

Due the simplicity of working with meshes, we used the PyVista module to plot the surfaces of the substrates. **PyVista** is a helper module for the Visualization Toolkit (VTK) that takes a different approach on interfacing with VTK through NumPy and direct array access.

You can install PyVista using pip command:

```
pip install pyvista # to install pyvista
```

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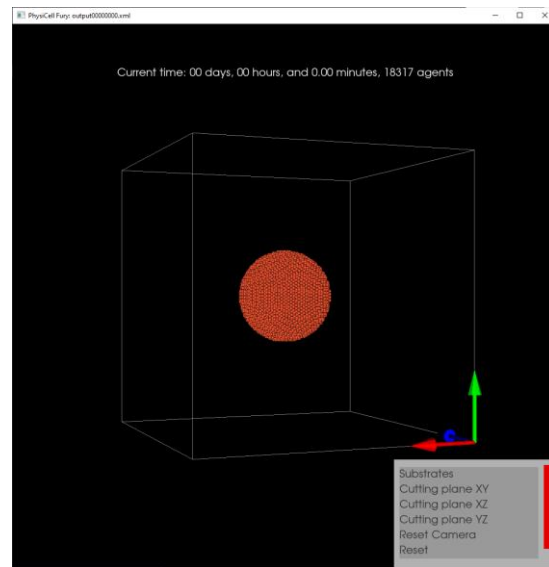**PhysiCell.org**
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Viewer options

Options to run the python script:

```
- python fury3D.py path_source_folder # to take 3D snapshots from the all frames in the
  source folder. (useful for making movies)
```

```
- python fury3D.py path_source_folder frame_ID # to interact with the scene.
```

When the Fury window appears, you can see the menu options:

- <u>Substrates</u>: select the substrate to visualize in Pyvista.
- <u>Cutting plane XY</u>: define the range on the z-axis to cut.
- <u>Cutting plane XZ</u>: define the range on the y-axis to cut
- <u>Cutting plane YZ</u>: define the range on the x-axis to cut
- <u>Reset Camera</u>: reset camera to default position.
- <u>Reset</u>: reset the cuties and show all the cells.
- <u>Snapshot</u>: save a Snapshot_*.jpg file in the source folder

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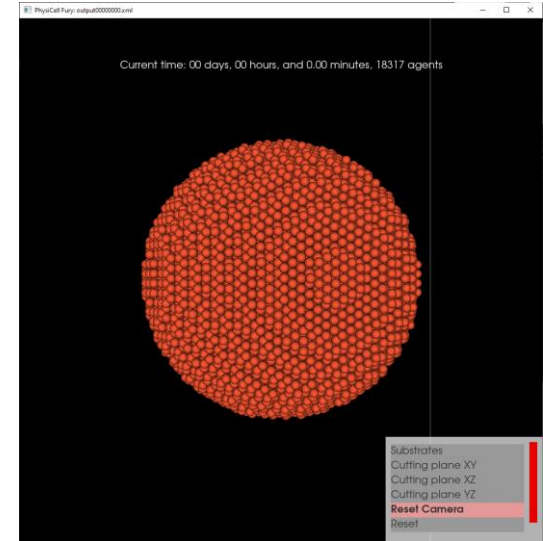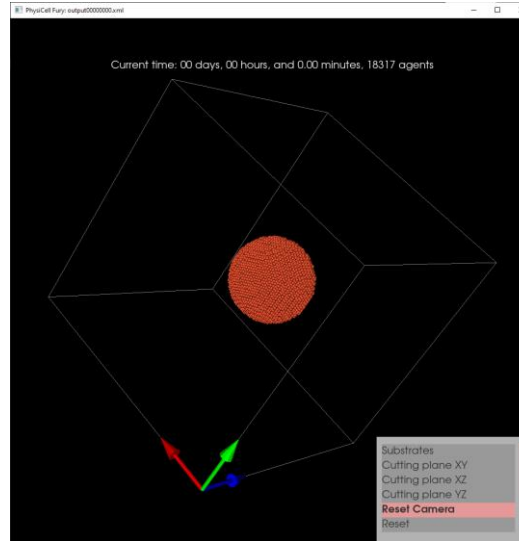**@PhysiCell**

Interacting with 3D PhysiCell data

In the main folder run by terminal:
`python fury3D.py output_immune 0`

Rotation: hold the left button of the mouse and drag.

Move camera: hold shift + the left button of the mouse and drag.

Zoom: hold right button of the mouse and drag or use the scroll button of the mouse.

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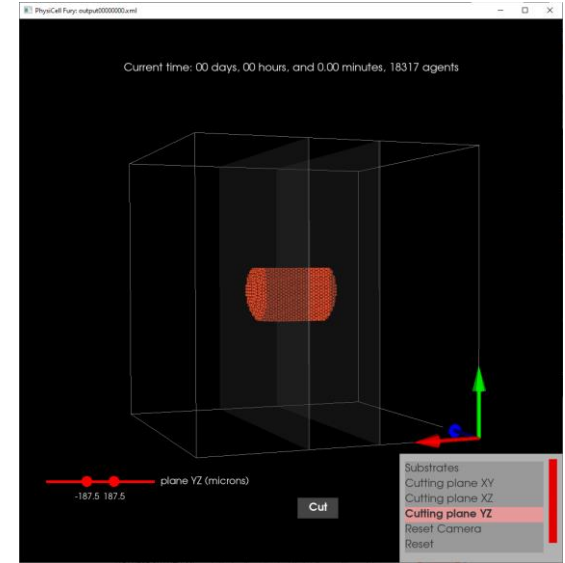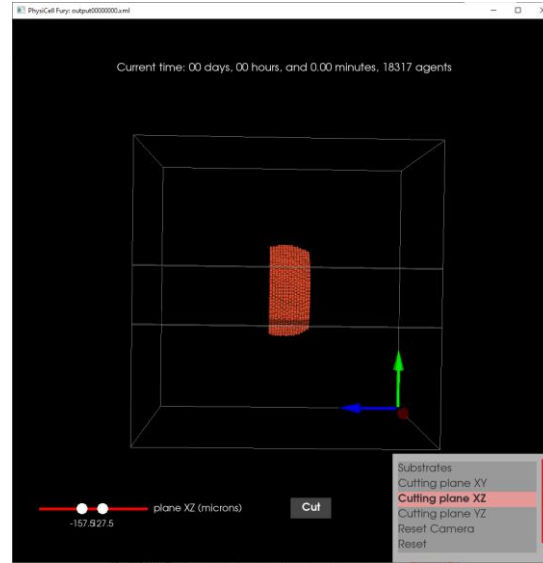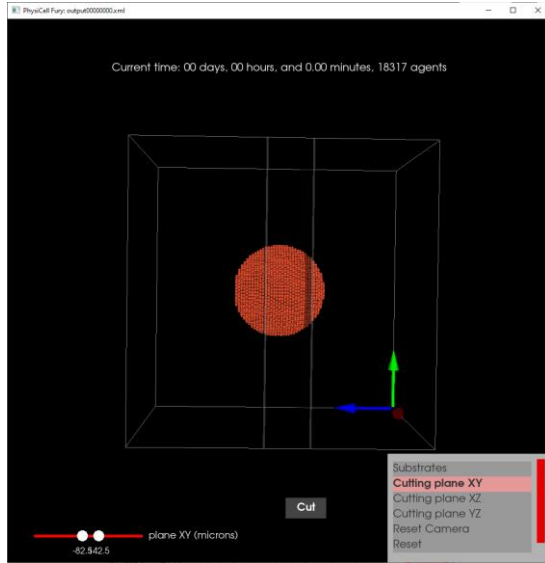SCHOOL OF INFORMATICS, COMPUTING, AND ENGINEERING

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Cutting plane

To clip the cells on the microenvironment, we need to select the cutting plane, change the range on the slider and click the button cut. Here, we utilize the cutting planes perpendicular to the x, y, and z-axis.
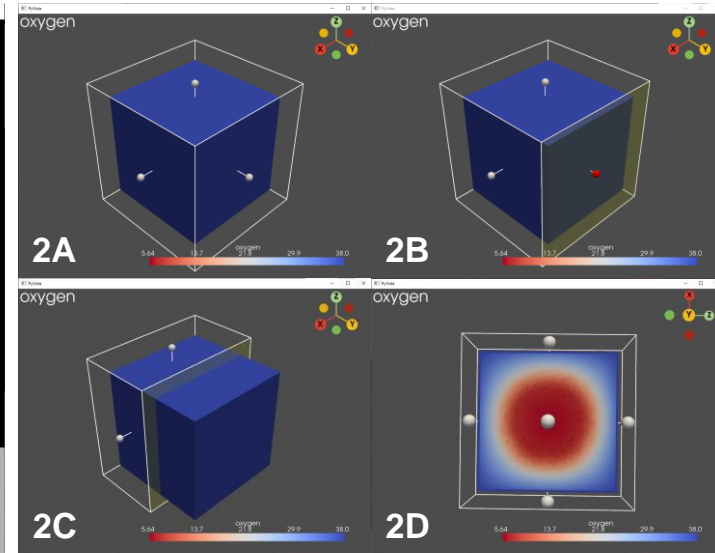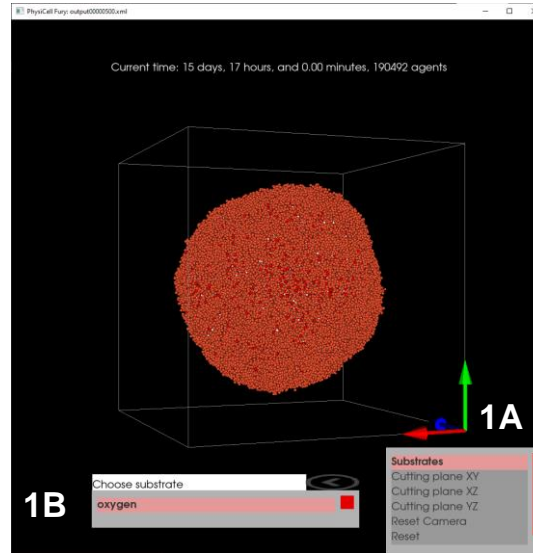
Visualizing the substrate: oxygen

To see heterogeneous substrates surface, let's run another frame of the immune model. In terminal run:
```
python fury3D.py output_immune 50
```

1) Click on Substrates in the menu options (*Figure 1A*).
2) On the drop-down list, select oxygen (*Figure 1B*).
3) A PyVista window will open with the value of oxygen concentration in each voxel of the domain (*Figure 2A*).
4) Click on the circle on the tip of axis and drag to cut the domain (*Figure 2B and 2C*).
5) Rotate the scene using the top right axis, by clicking and dragging. (*Figure 2D*).

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Visualizing the substrate: immunostimulatory factor

On similar way, you can set the dispersion of immunostimulatory factor on microenvironment.
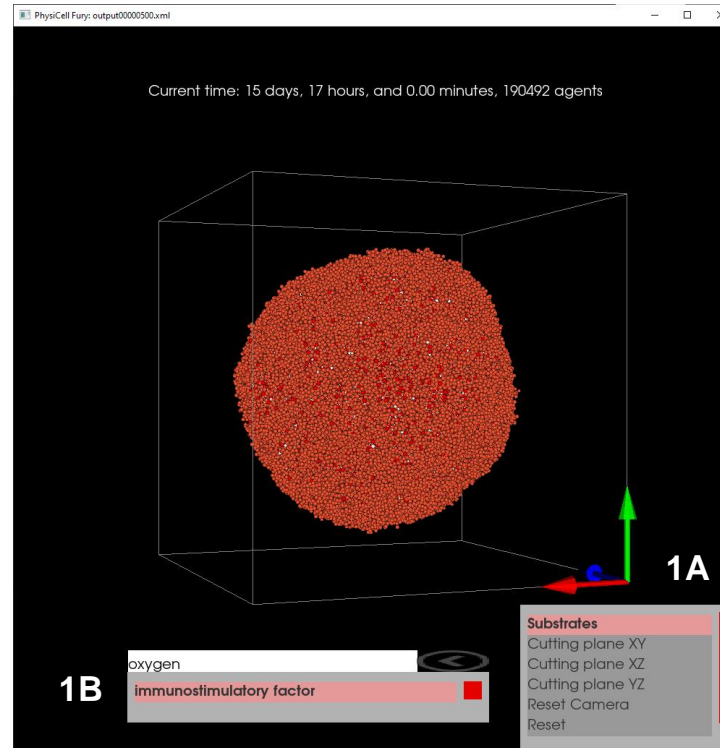1) Click on Substrates in the menu options (*Figure 1A*).
2) On the drop-down list, select immunostimulatory factor (*Figure 1B*).
3) A PyVista window will open with the value of immunostimulatory factor in each voxel of the domain (*Figure 2A*).
4) Cutting and rotating the scene you can see the interior value of immunostimulatory factor (*Figure 2B*).
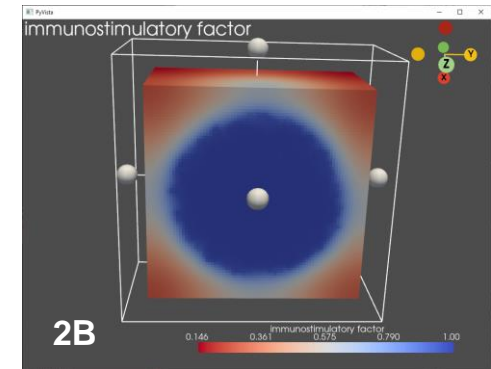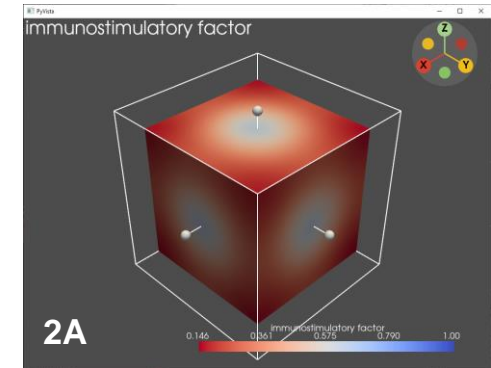
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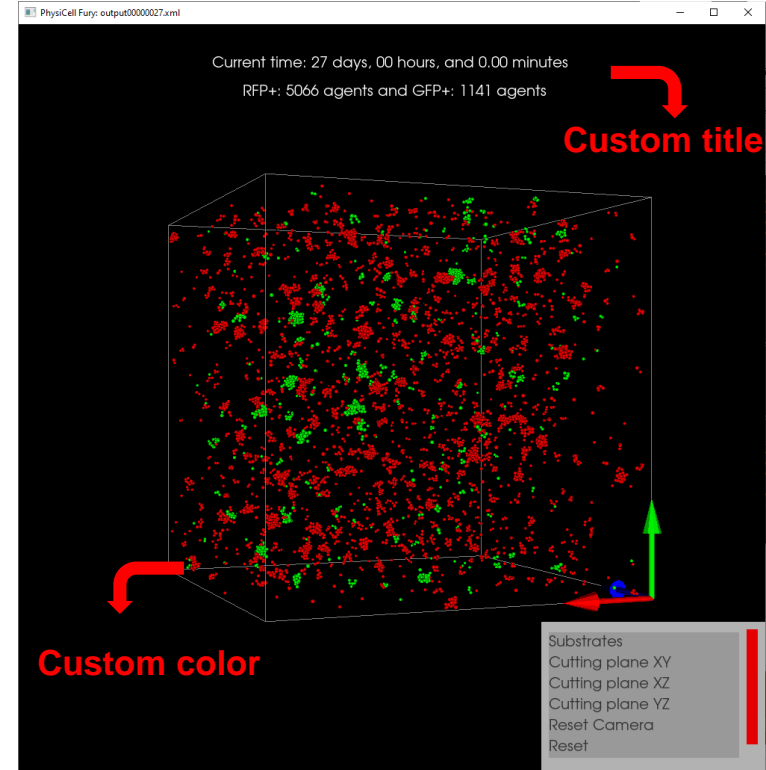**PhysiCell.org**
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Custom cell coloring and title

Usually, you need to coloring the cells according some specific features and see different population sizes in the title.

```
def my_custom_coloring_function(df_cells): … return Colors
```

```
def my_custom_header_function(mcds): … return title_text
```

In this 3D viewer, you can customize your own coloring and title functions. To check one example of it, run this example:

```
python My_fury3D.py output_metastasis 27
```

Script bugs:
-Snapshot: when taking the snapshot, the viewer abruptly closes.
-Substrates: when closing the Pyvista window, the viewer abruptly closes.

PhysiCell Fury: output00000027.xml

Current time: 27 days, 00 hours, and 0.00 minutes

RFP+: 5066 agents and GFP+: 1141 agents

Custom title

Custom color

Substrates
Cutting plane XY
Cutting plane XZ
Cutting plane YZ
Reset Camera
Reset

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Others 3D visualization options

- Matlab
  - Blog Post - (http://www.mathcancer.org/blog/working-with-physicell-snapshots-in-matlab/)

- POVRay
  - Blog Post - (http://www.mathcancer.org/blog/povwriter/)

- Simularium
  - Tutorial - (https://github.com/simularium/simulariumio/blob/main/examples/Tutorial_physicell.ipynb)

- ParaView
  - Blog Post - (http://www.mathcancer.org/blog/paraview-for-physicell-part-1/)

We hope this repository will grow to include contributions from the PhysiCell community:

(https://github.com/PhysiCell-Tools/vis3D)

Funding Acknowledgements

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