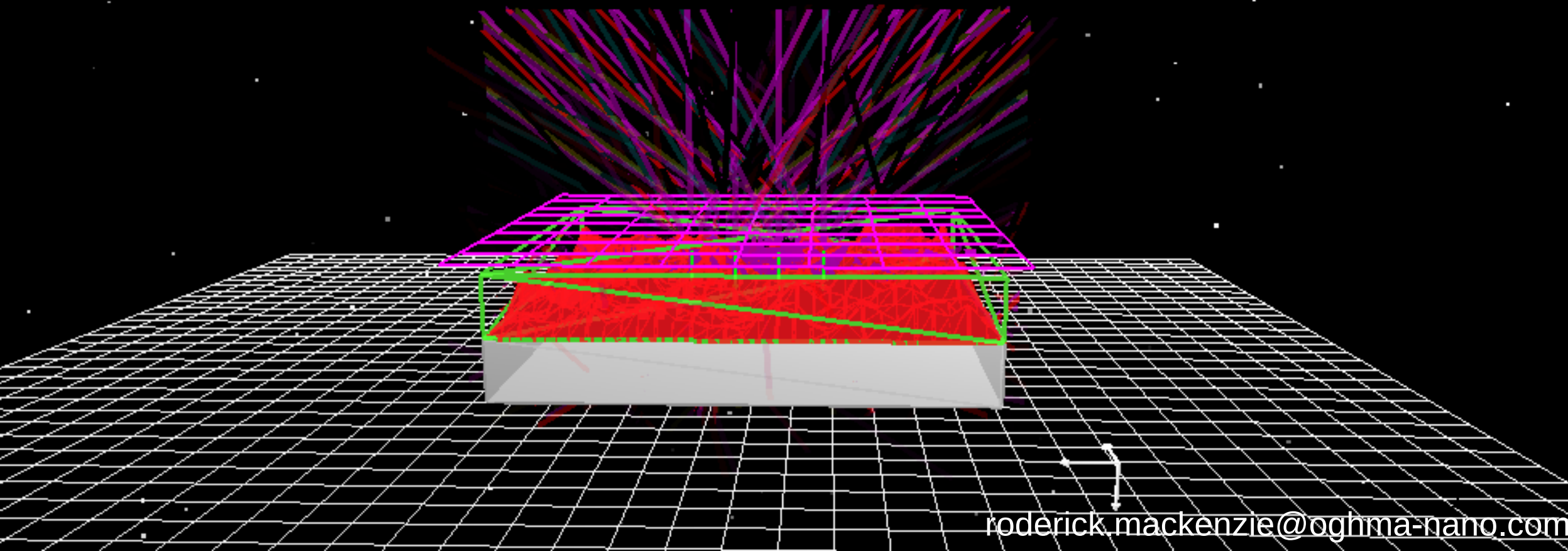
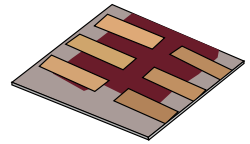
Simulating emission from thin films with OghmaNano



roderick.mackenzie@oghma-nano.com

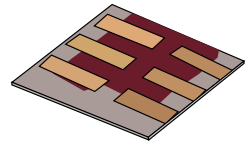
Download the software:



- Download all the software used in this talk from:
  - http://www.oghma-nano.com/download.php

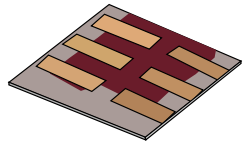
- Please report bugs to:
  - roderick.mackenzie@oghma-nano.com

Outline of the talk

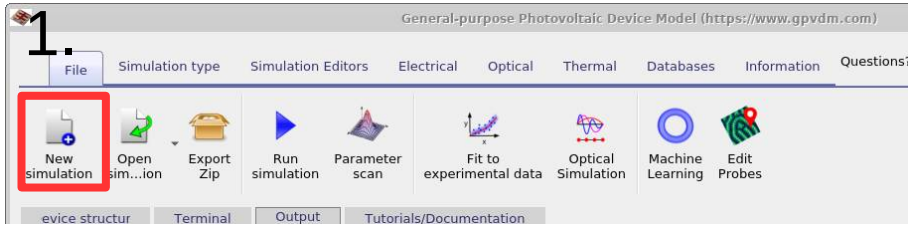


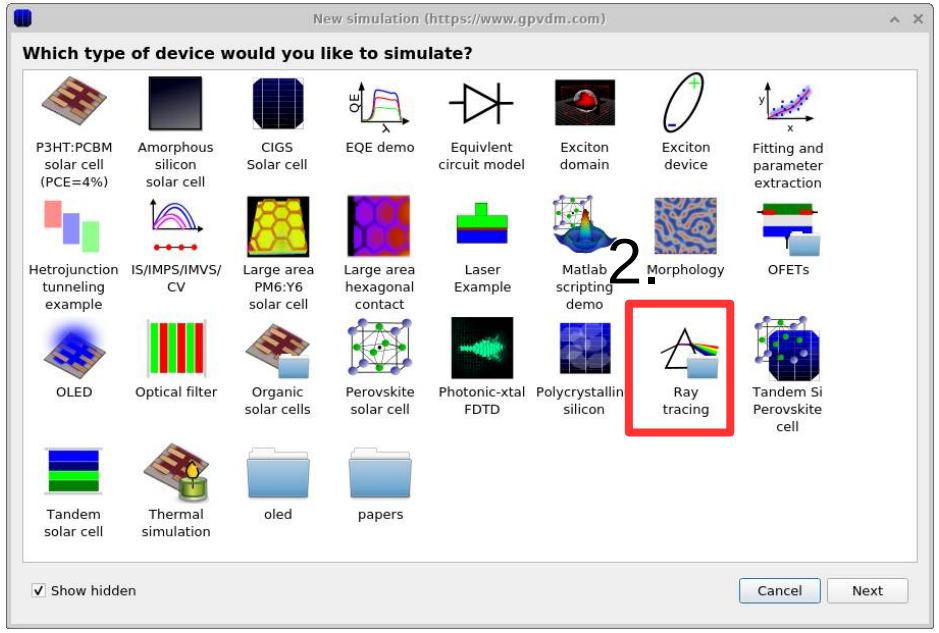
- In this talk we will cover:
  - **Making a new simulation**
  - Adjusting the dimensions of the simulation
  - Optical sources
  - Optical detectors
  - Examining the results
  - Light absorbed in each layer
  - Setting the wavelength range
  - Summary

Make a new simulation



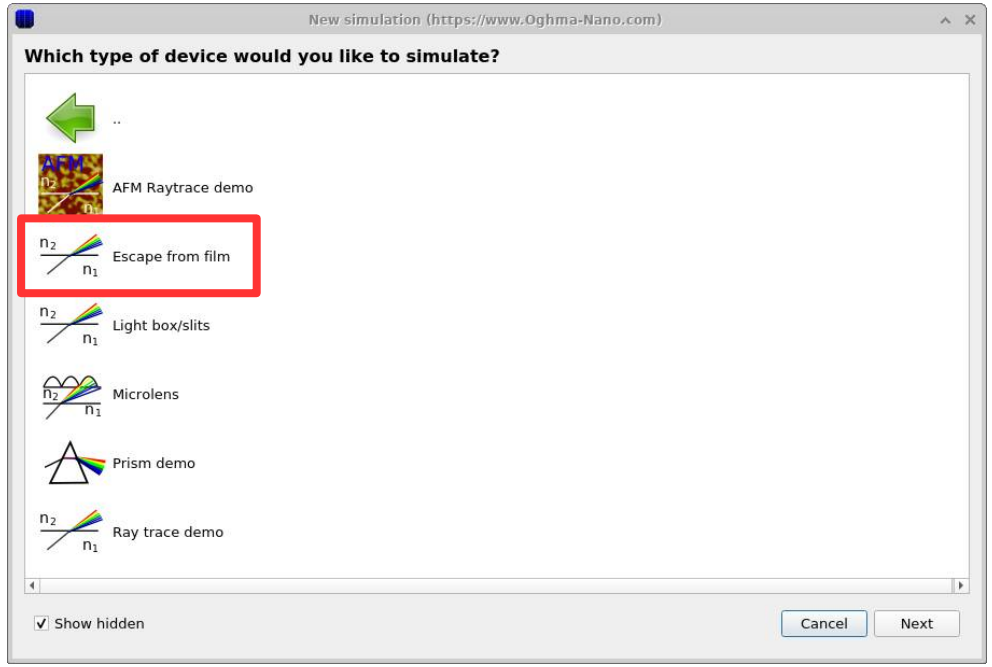
1.





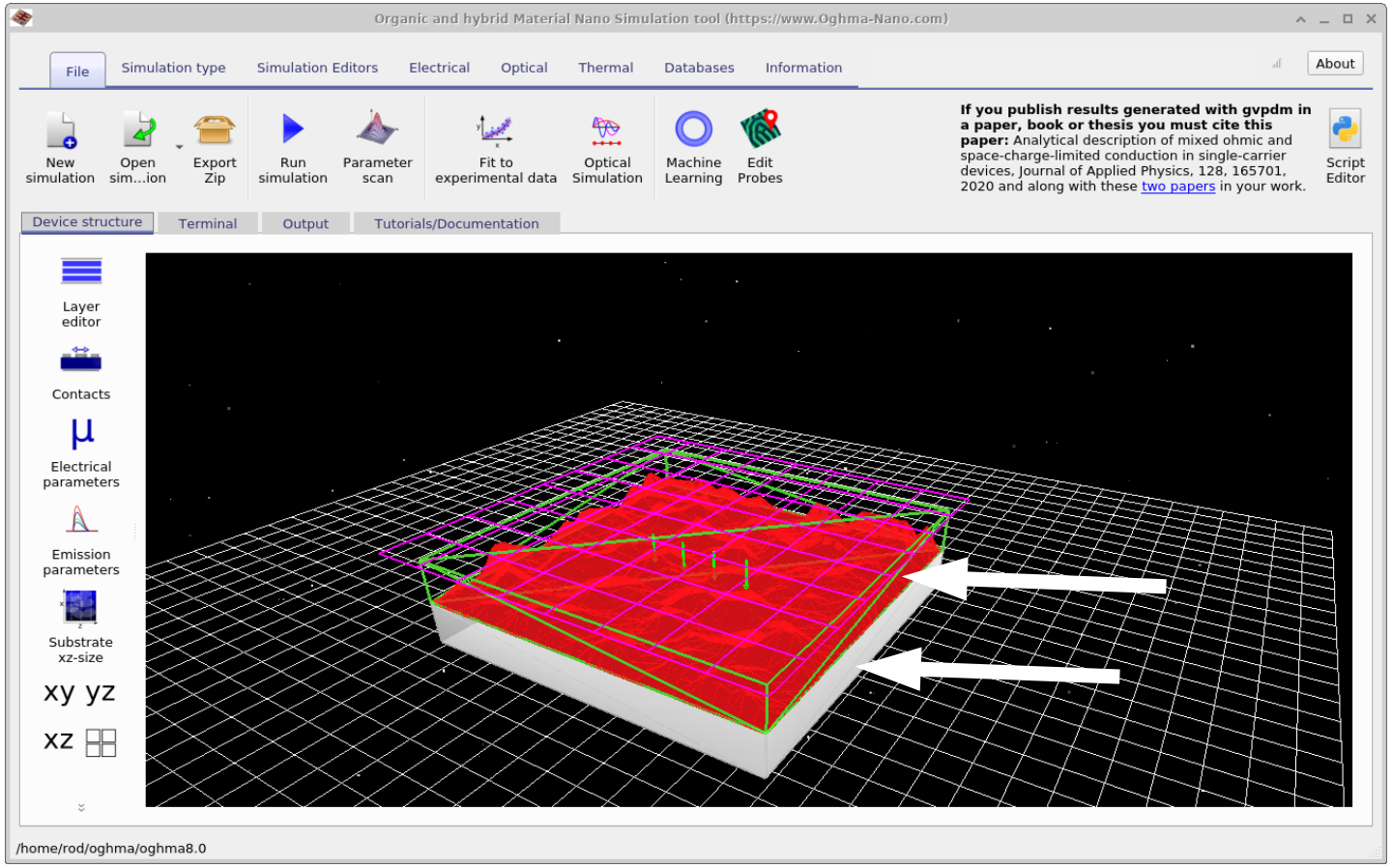
2.

3.



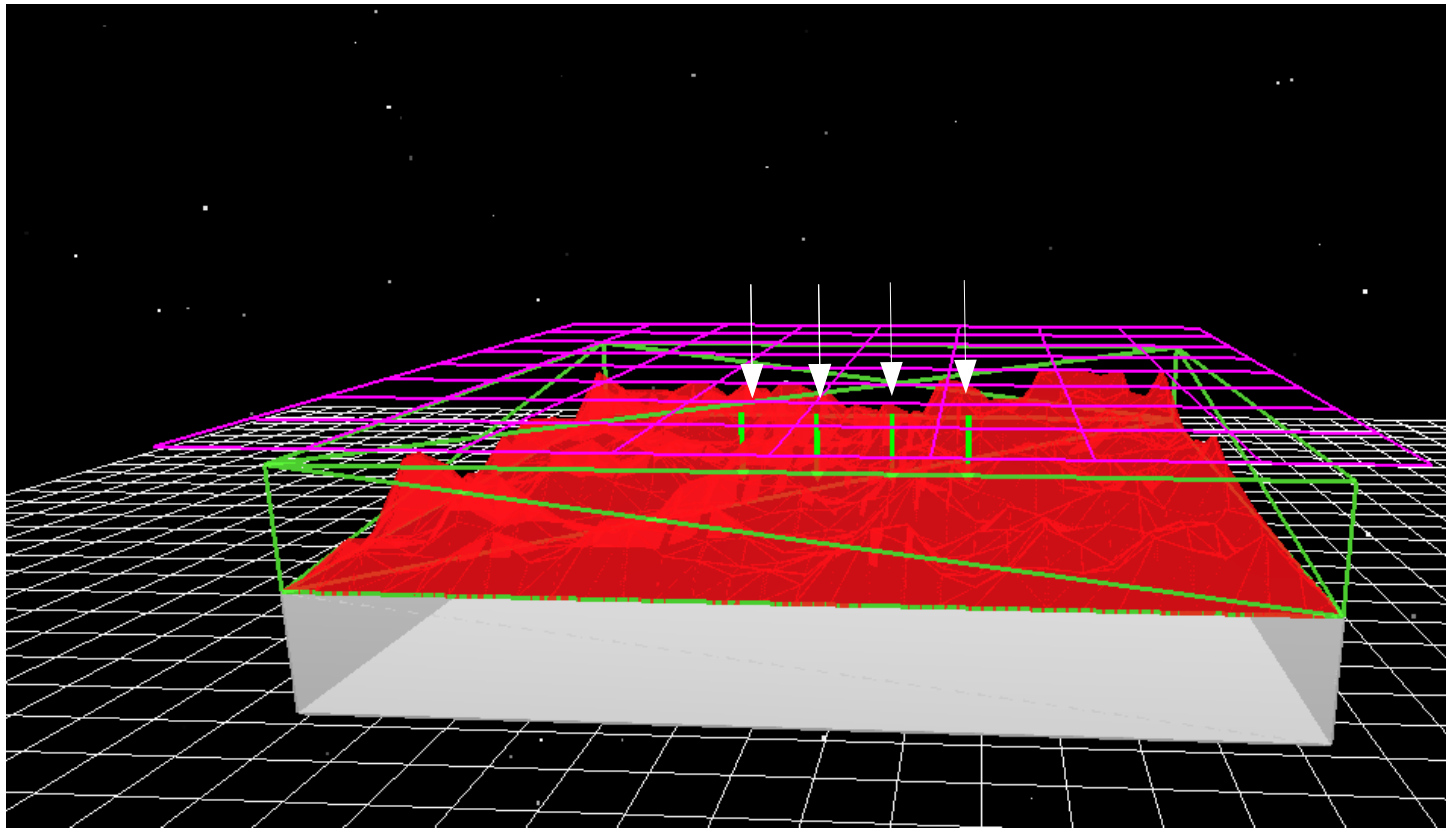
- Save this example to your home directory.

You should get a window like this



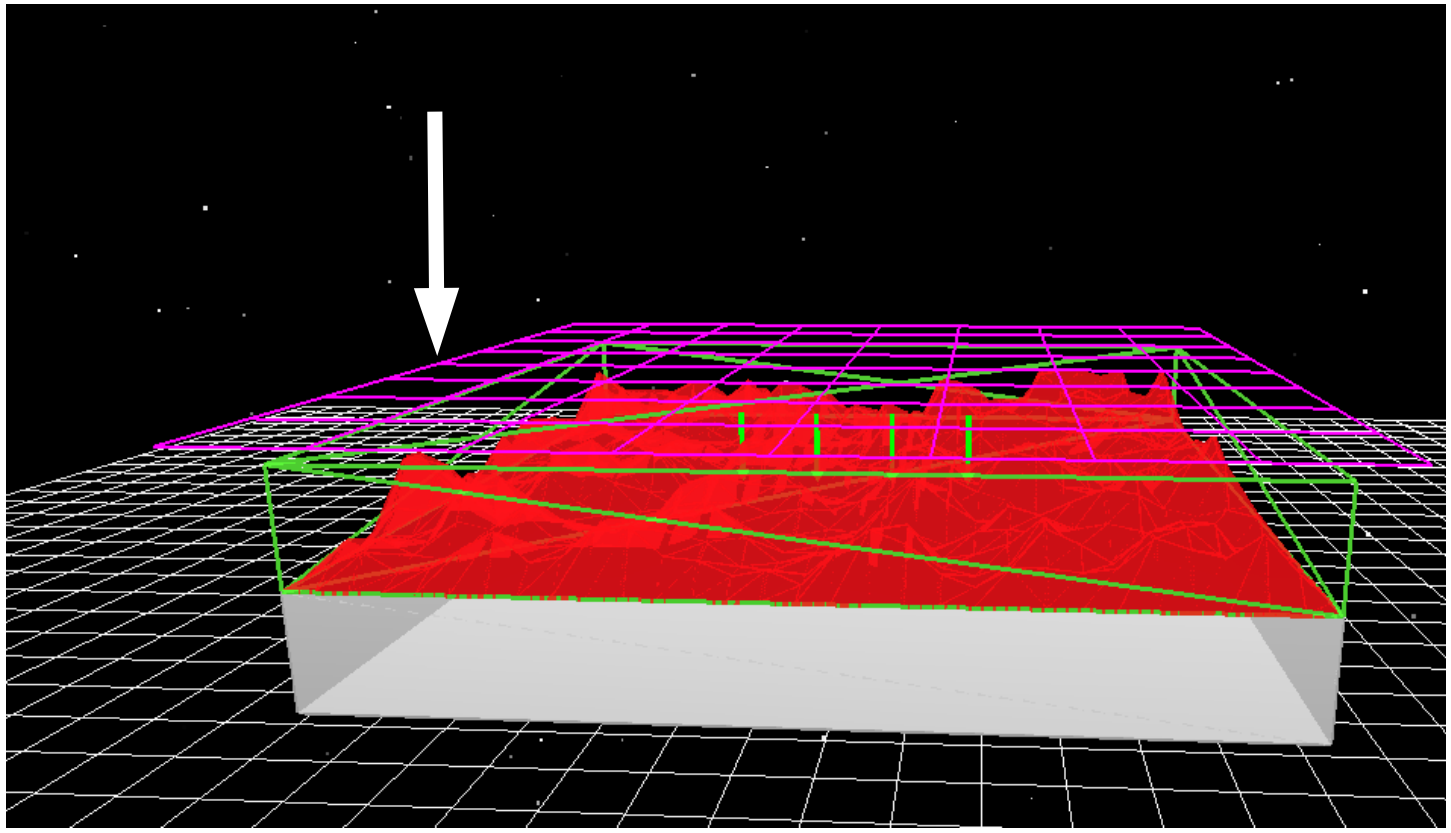
- You Can see…
- The oxide layer in Red and gray, these are both ZnO.
- The gray box represents the substrate.
- The red region represents the substrates rough surface.

You should get a window like this



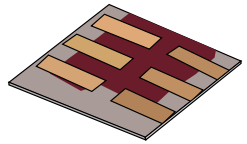
- The light sources represented by green arrows.

You should get a window like this



- The ‘detector’ is represented with a purple grid.
- This is equivalent to a CCD camera.
- The mesh represents the number of pixels. In this case 8x8.

Outline of the talk



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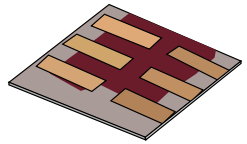
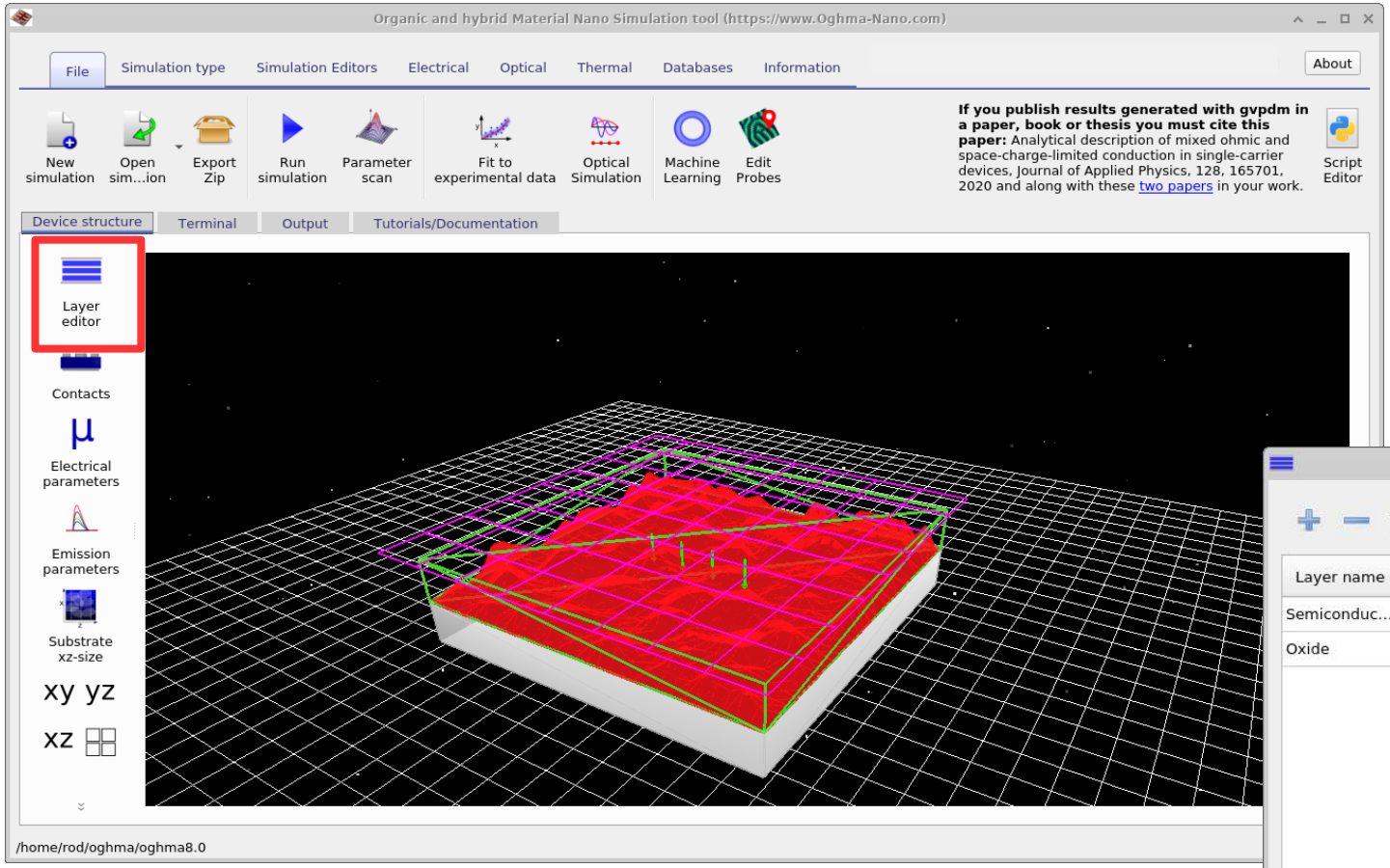
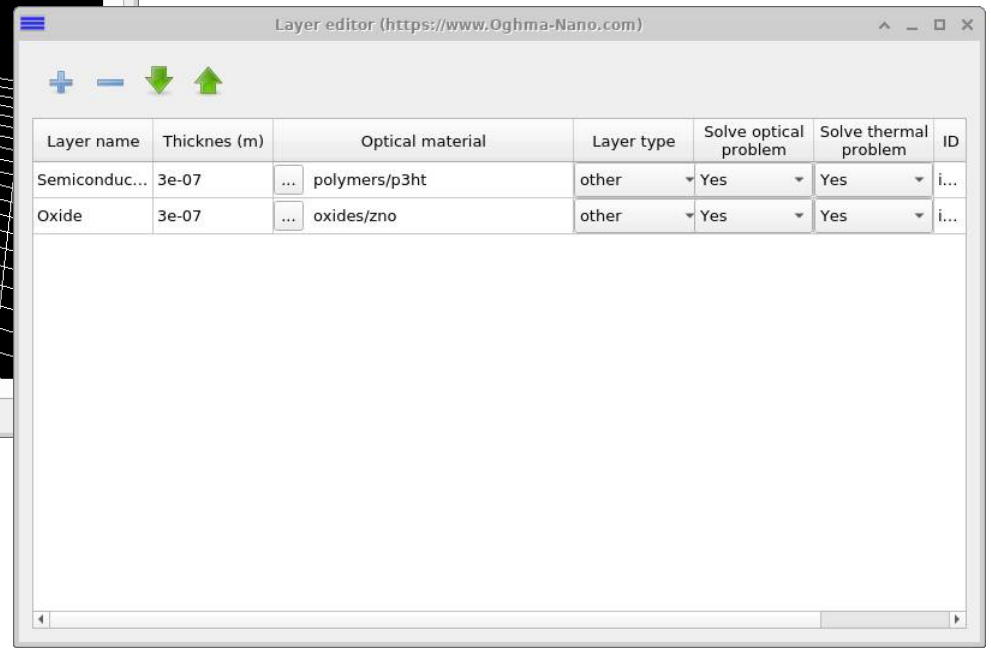
Layer heights can be adjusted in the layer editor

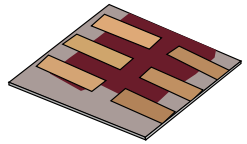


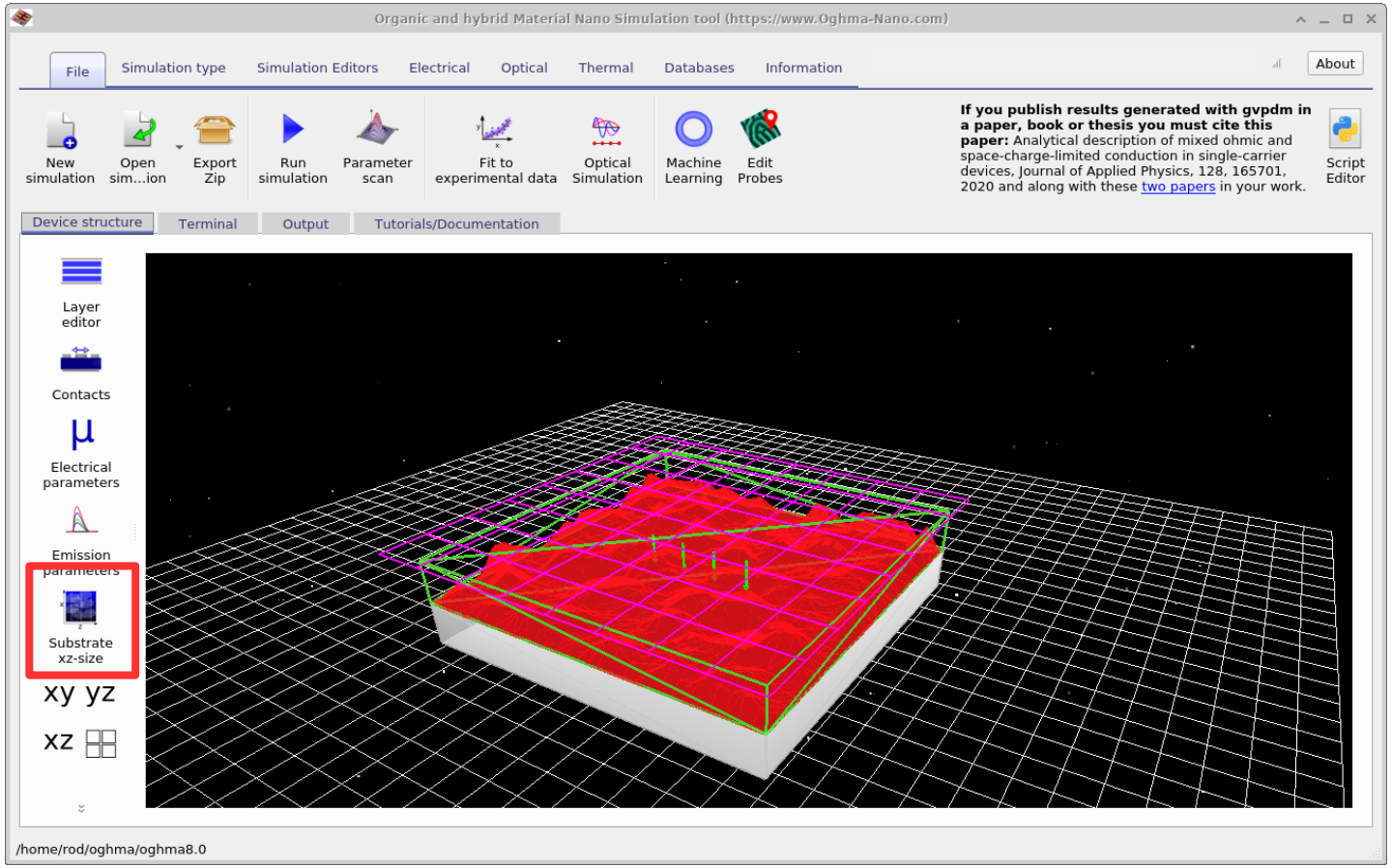




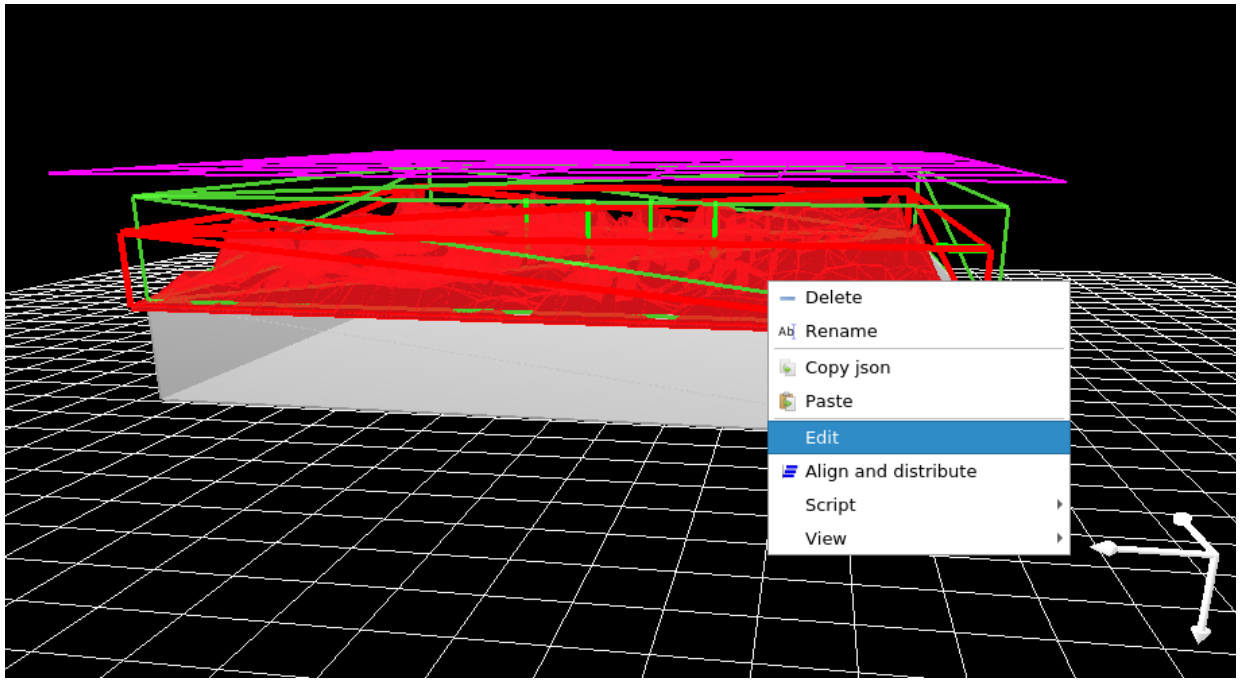
- Each simulation is comprised of layers these can be configures in the layer editor.

The size of the substrate can be adjusted in the Substrate xz-size editor.

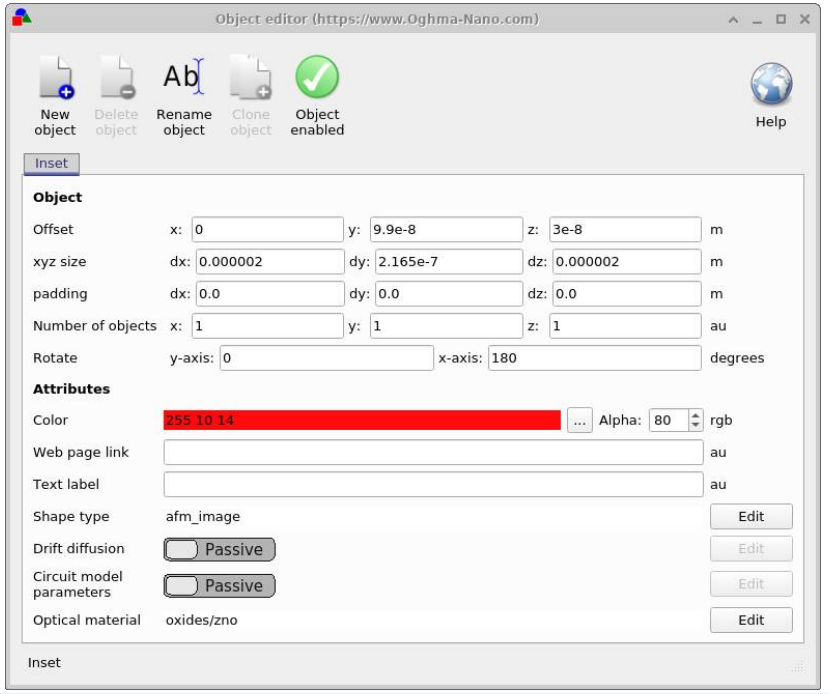




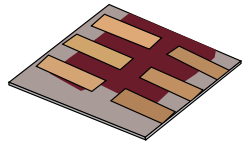
The properties of the rough layer can be changed using the Object editor

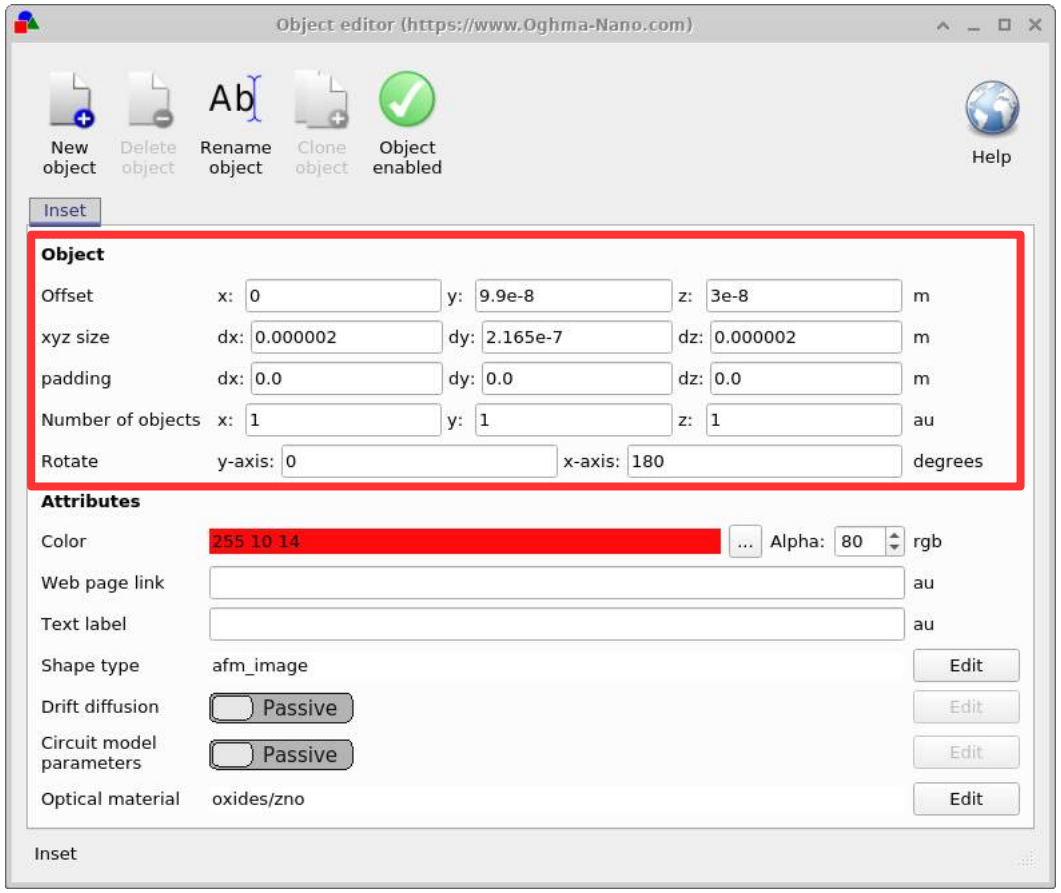


- In each layer you can define irregular shaped objects.
- Right click on the rough layer and select edit to bring up the object editor.
- In this case the “Insert” object lives inside the top or “Semiconductor” layer



The Object editor can be used to change it's physical size, position and orientation:





- **Offset:** The z,y,z position of the object within the layer

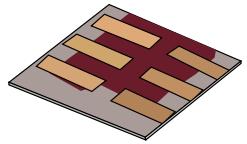
- **xyz size:**The size of the object

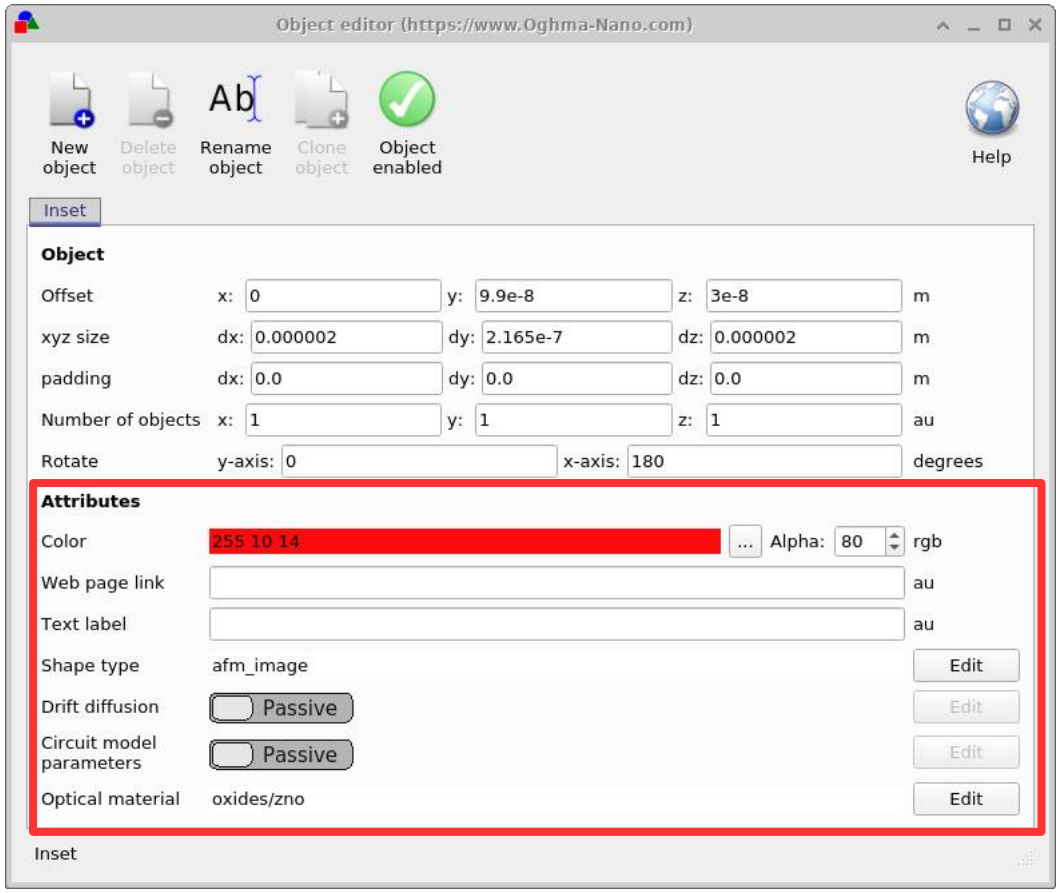
- **Padding:** The object can be replicated multiple times in the zyx directions to form periodic
  - structures this gives the space between objects.

- **Number of objects:** Times the object is repeated in each direction.

- **Rotate:** rotation of the object in degrees

The Object editor can be used to change it’s physical attributes



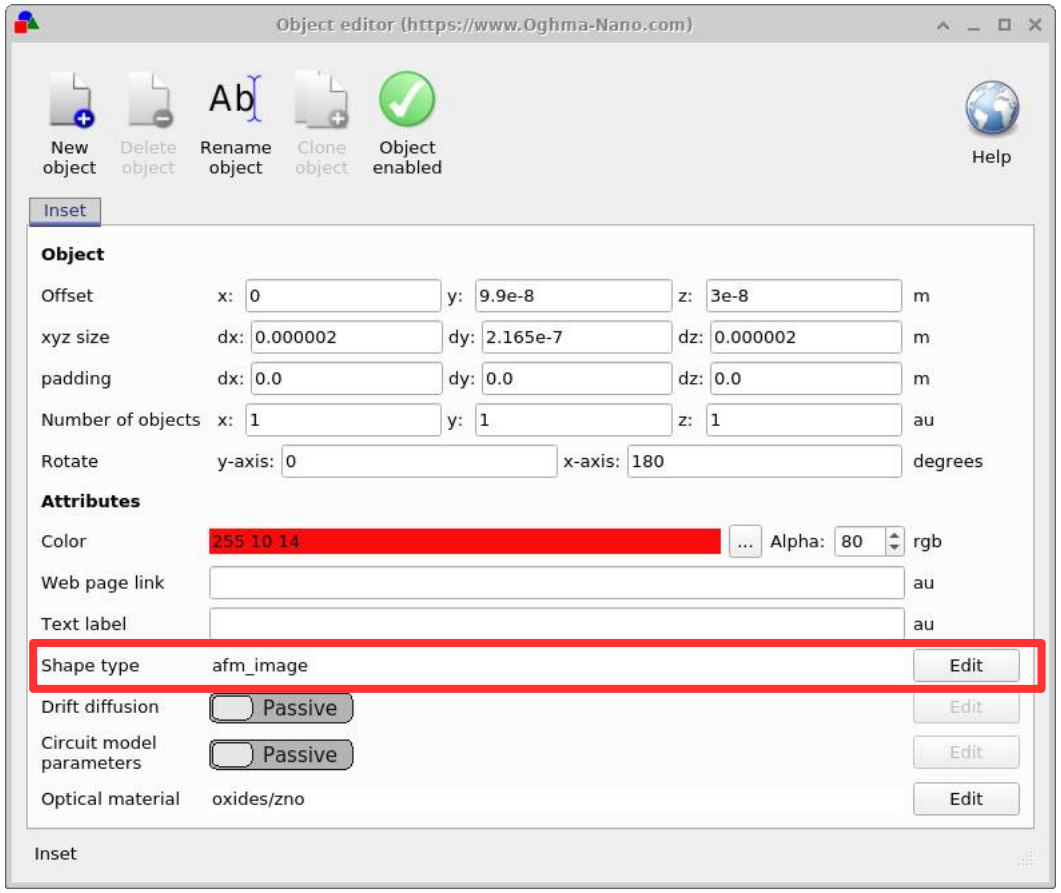


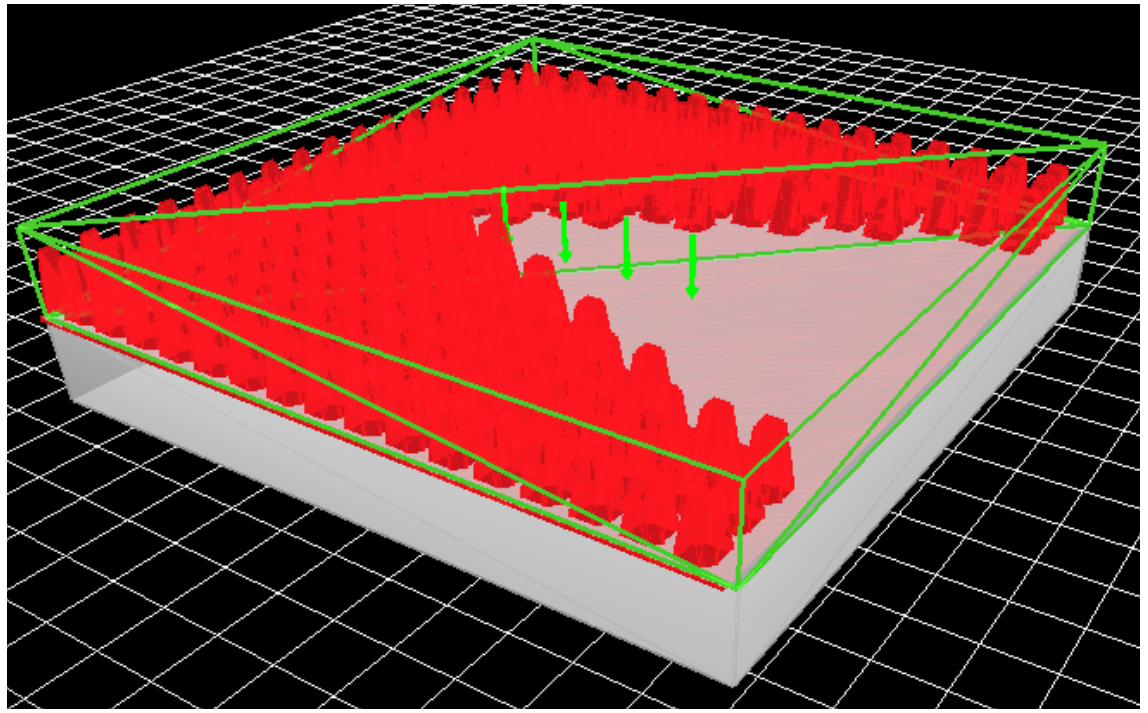
- **Color:** Physical color of the object

- **Shape type:** The 3D shape of the object selected from the shape database.

- **Optical material:** The objects n/k data.

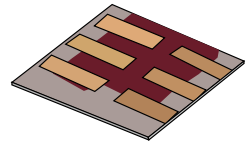
The Object editor can be used to change it’s physical attributes





- Try changing shape_type to photonic_xtal and see what happens to the shape of the object.

Outline of the talk



- In this talk we will cover:
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  - Optical detectors
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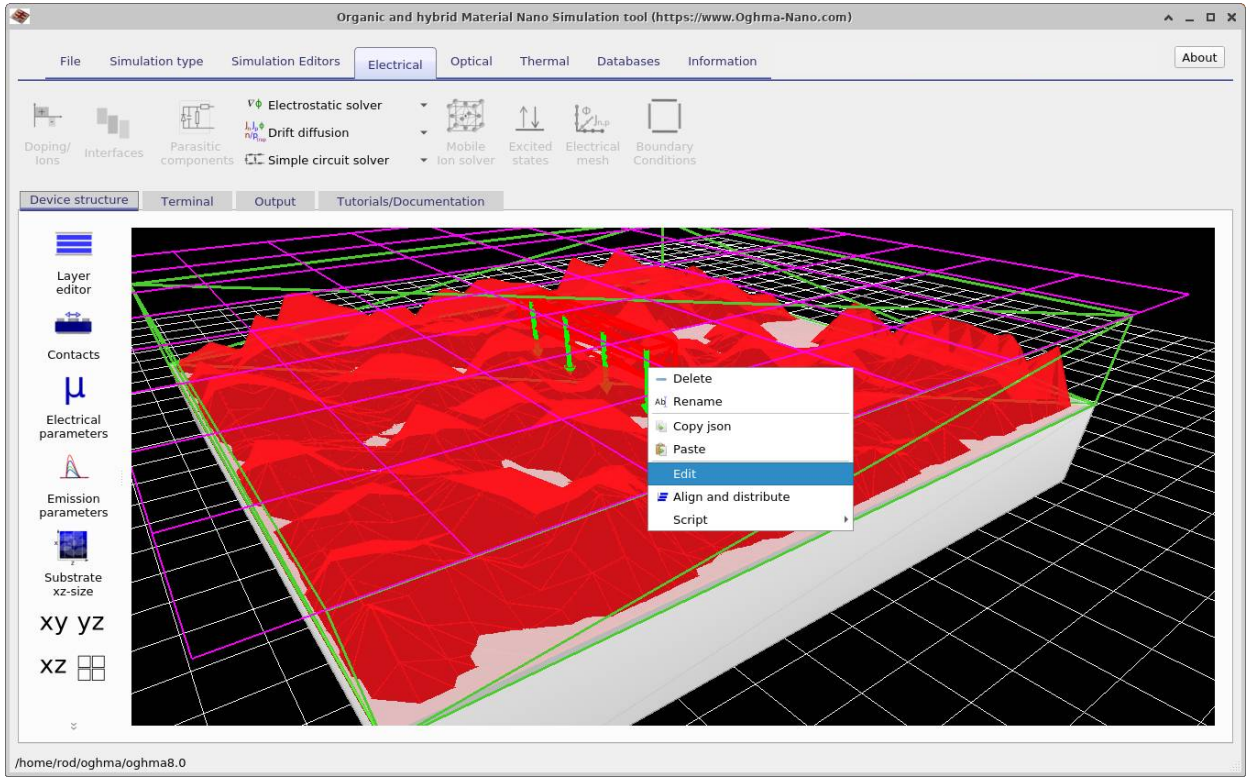
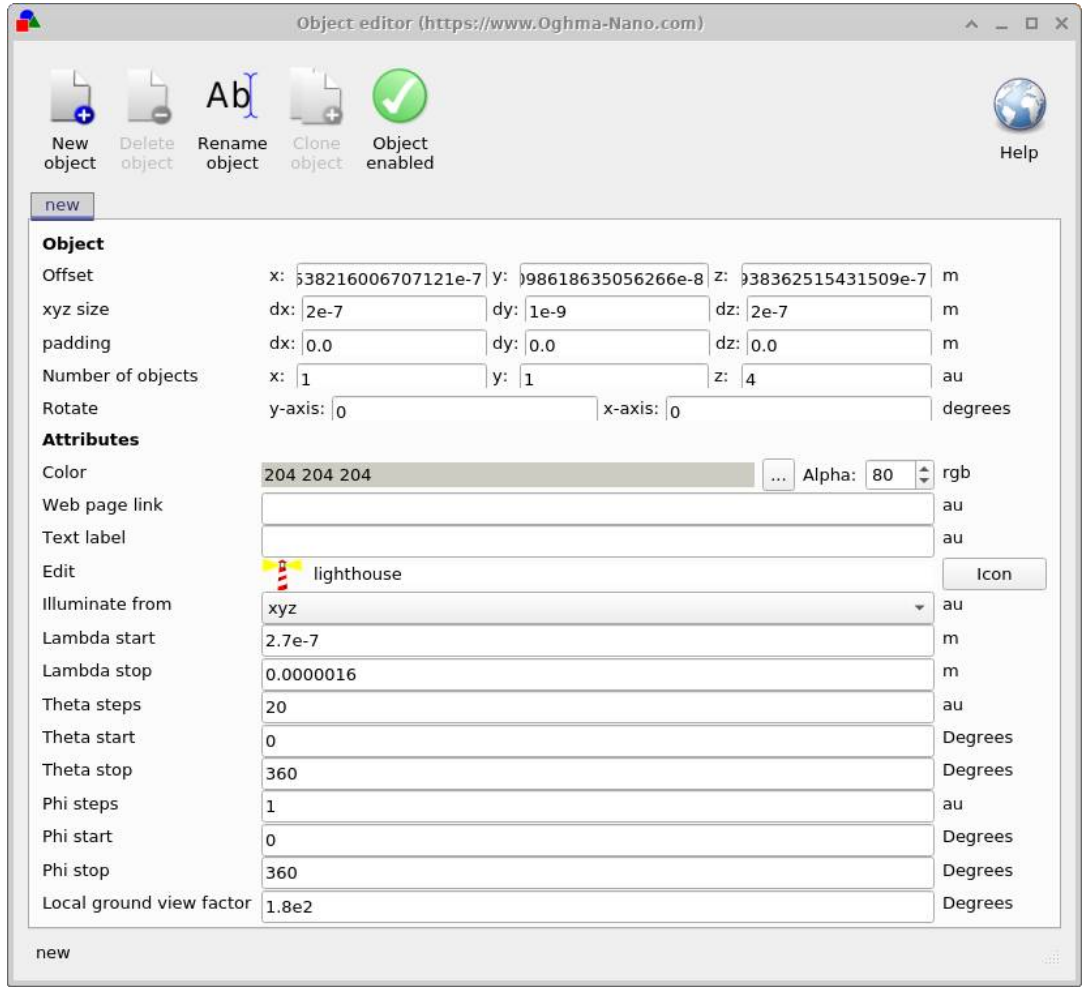
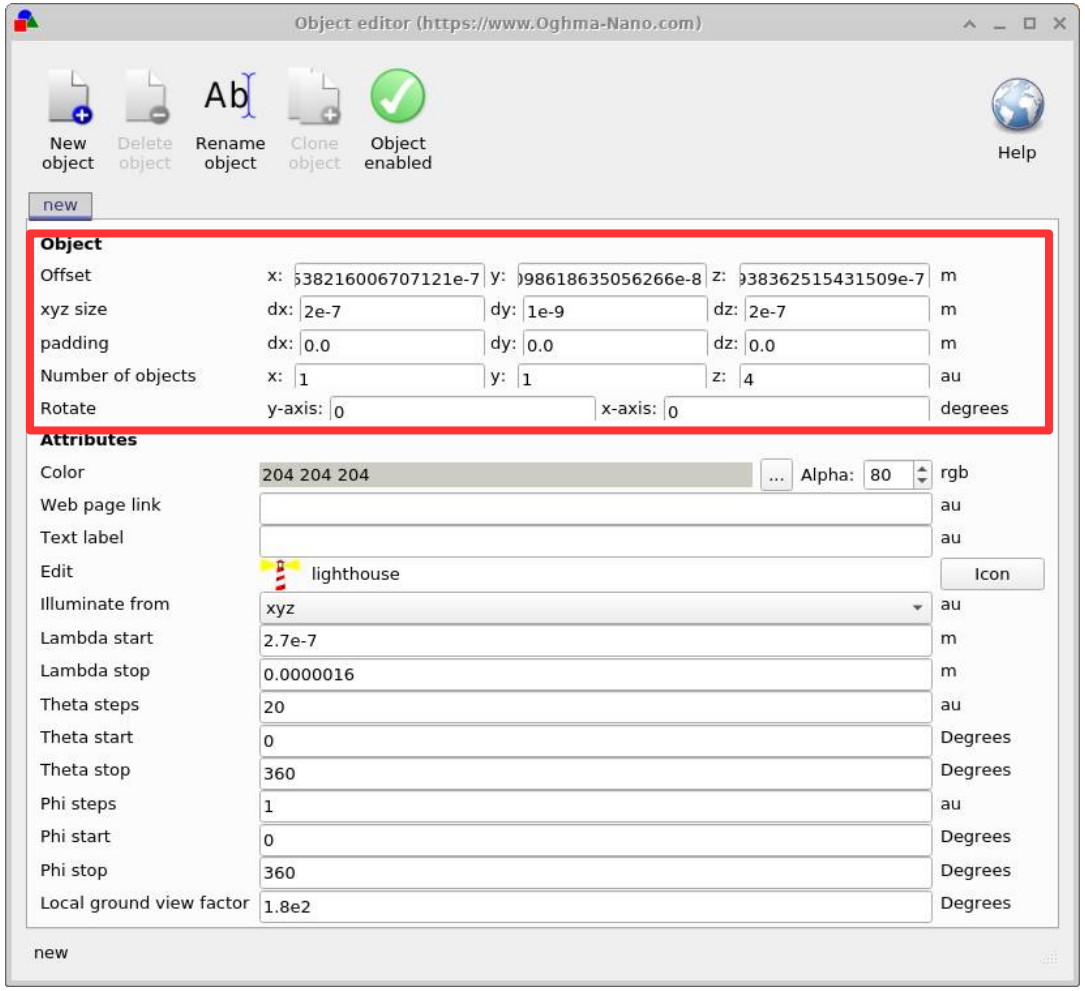
Optical sources





•The optical sources are the green arrows, you can edit them by right clicking on them and selecting edit.

Optical sources: Position



- The position of the optical source can be set here. It can also be set by dragging the arrows:

- **Offset:** The z,y,z position of the object within the layer

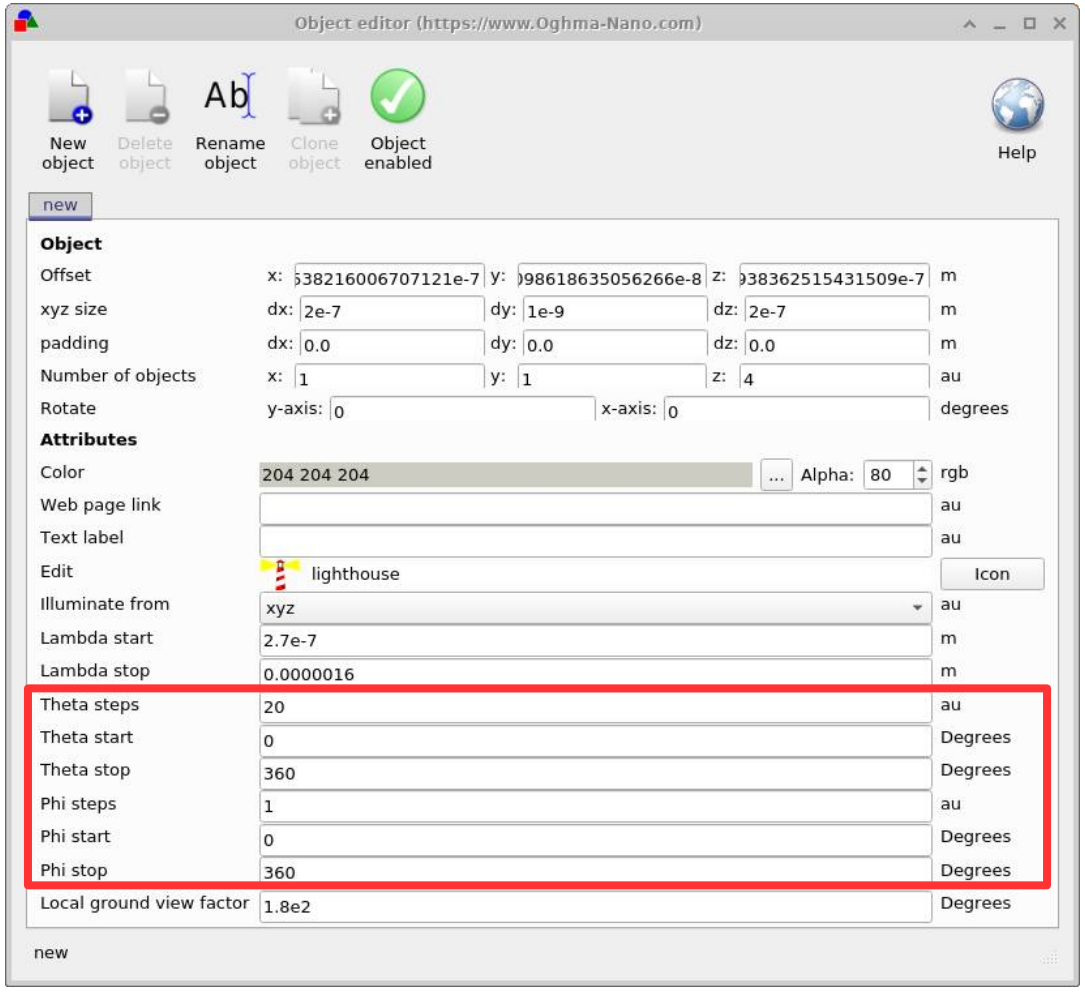
- **xyz size:** The size of the object

- **Padding:** The object can be replicated multiple times in the zyx directions to form periodic structures this gives the space between objects

- **Number of objects:** Times the object is repeated in each direction

- **Rotate:** rotation of the object in degrees

Optical sources: Emission direction



- The parameters in the red box control from in which direction the rays are emitted and how many rays are emitted. Options are:

- **Theta steps:**

- **Theta start:**

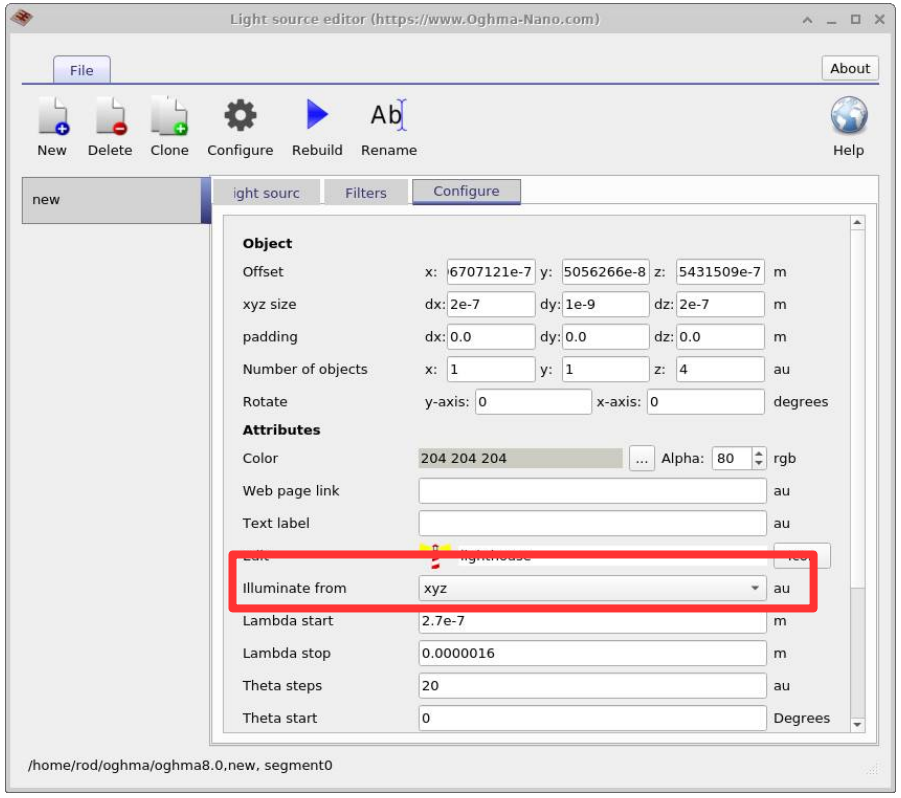
- **Theta stop:**

- **Phi steps:**

- **Phi start:**

- **Phi stop:**

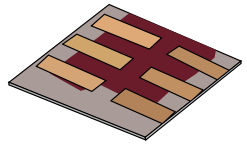
Optical sources



- Optical sources can also be accessed from the ‘Light sources’ button.

- Illuminate from: Changes where the light source is placed. For ray tracing simulations you want to choose “xyz”.

Outline of the talk



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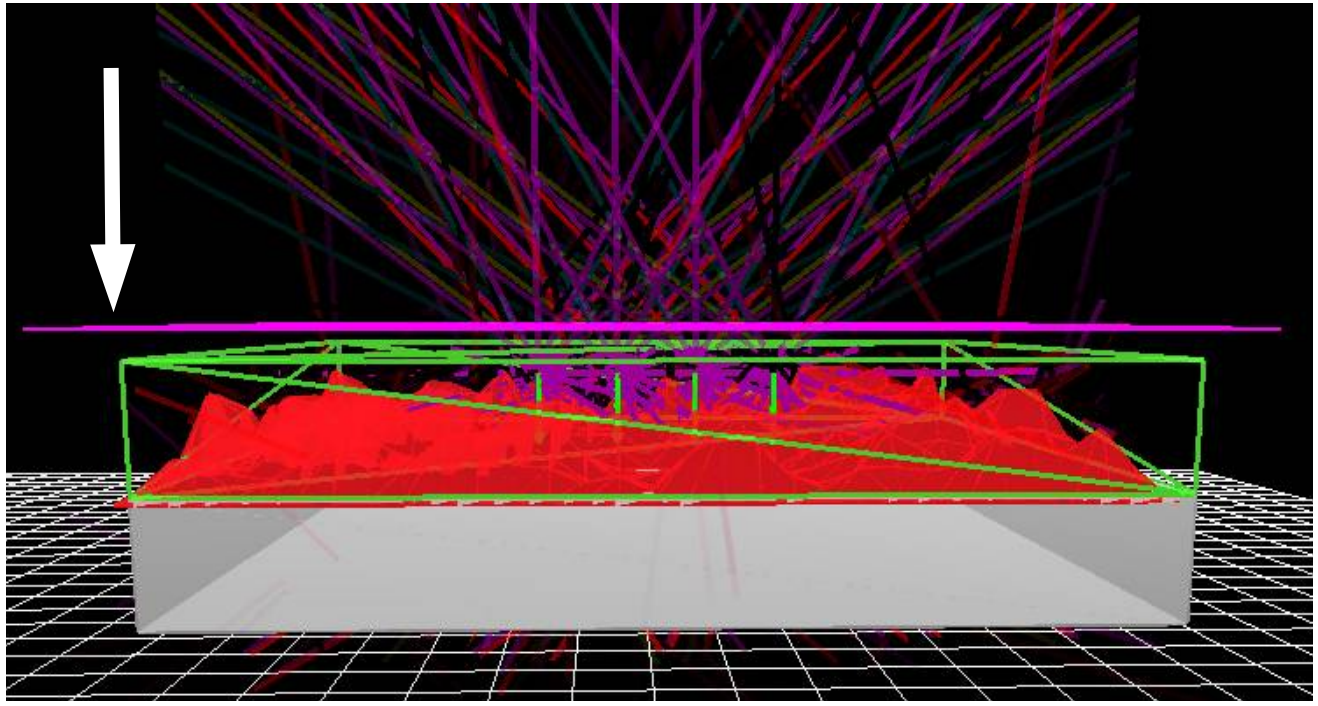
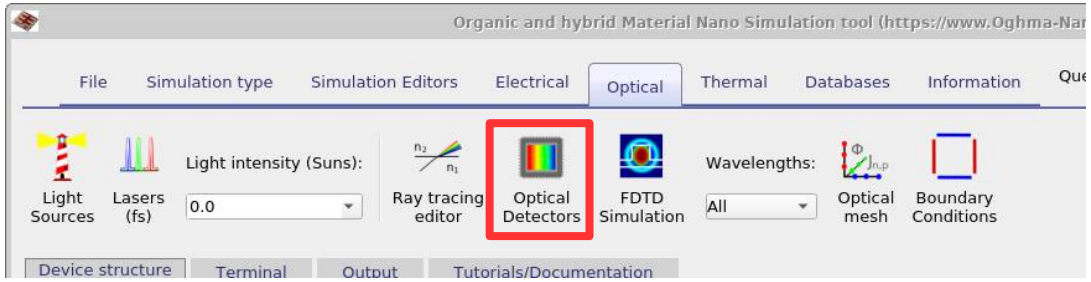
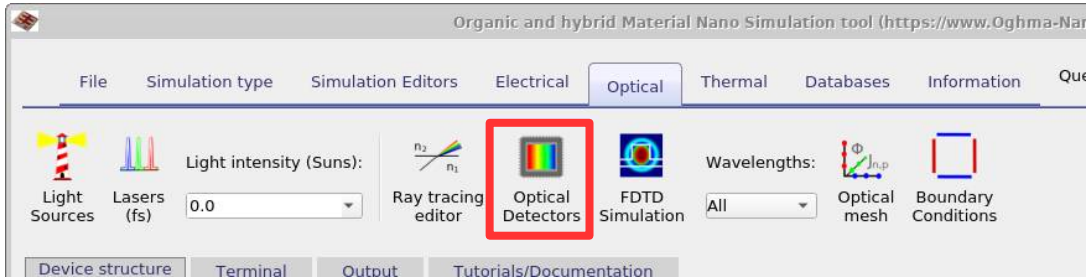
Optical detectors



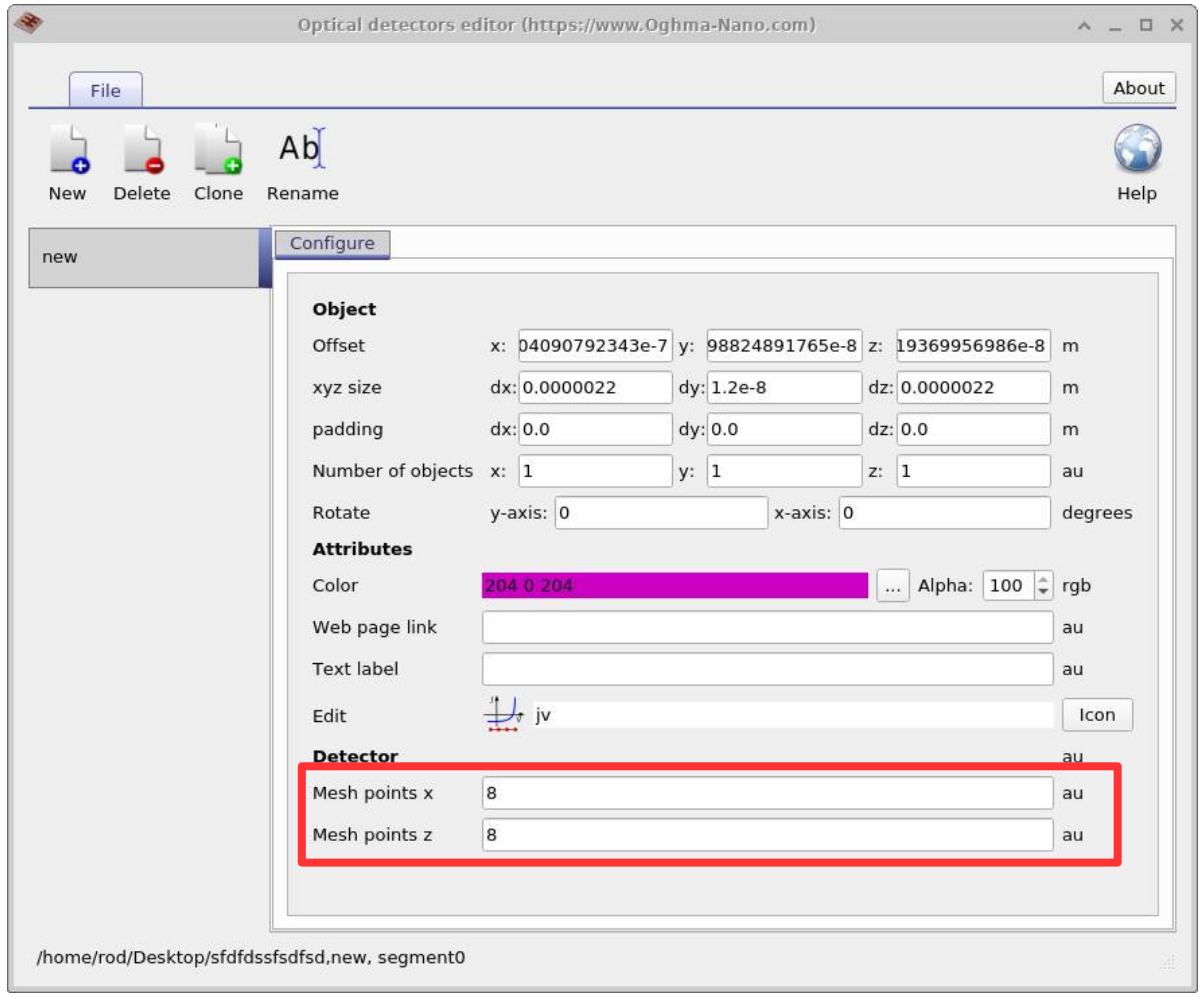


- Optical detectors are used to detect light.
- You can think of them as CCD cameras.
- They are normal objects so can be moved and rotated.
- Either right click->Edit to change their properties or access them through the optical tab.

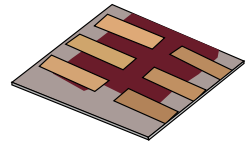
Optical detectors



- The resolution of the detector can be set in the detector window.



Outline of the talk



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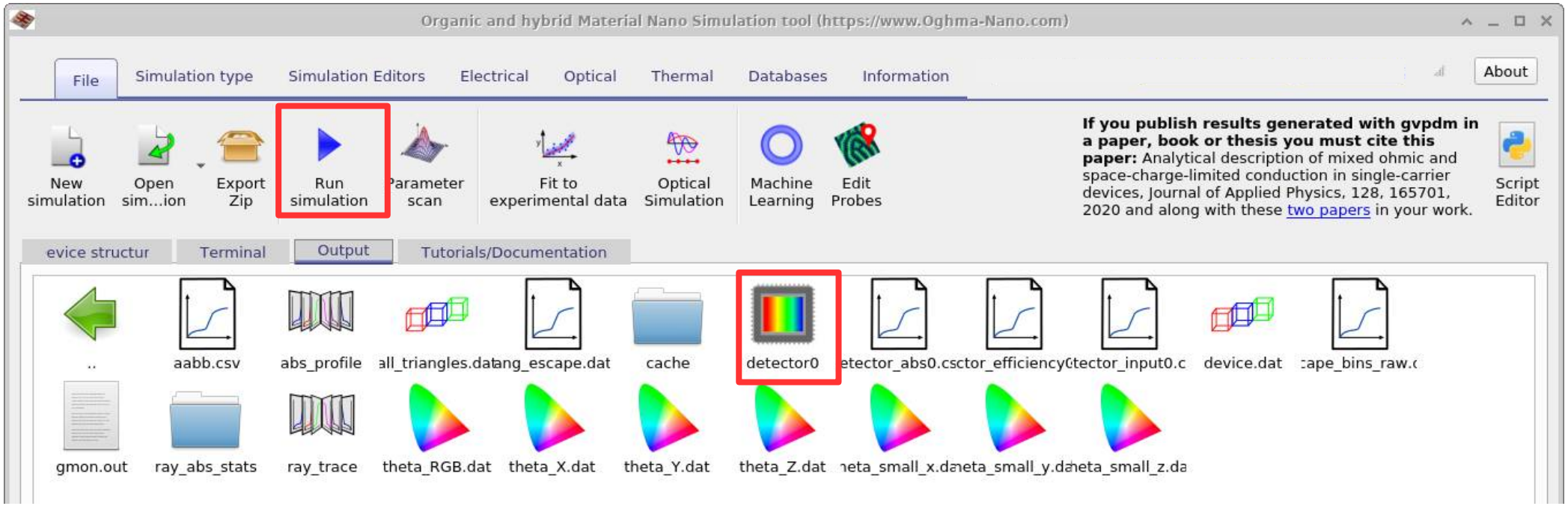
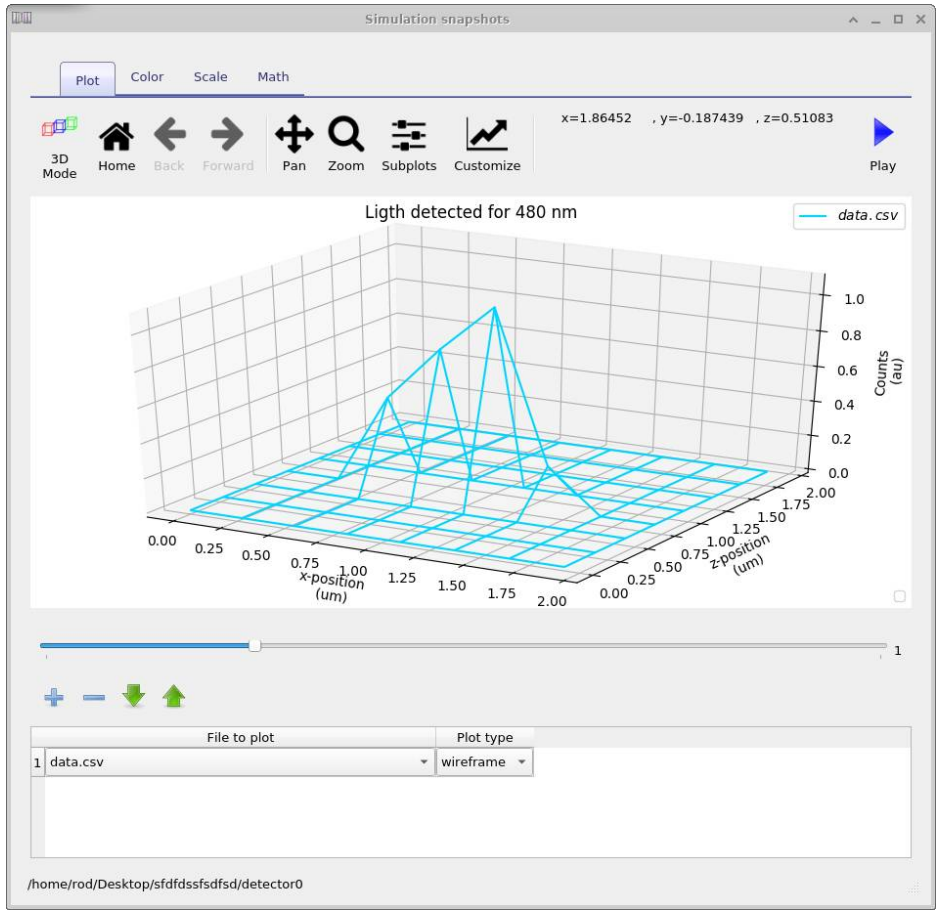
Optical detectors:
Run the simulation and double click on detector0



•Detector0 contains the output from the detector, if you had more than one detector there would be detector1,2,3 etc..

Detectors

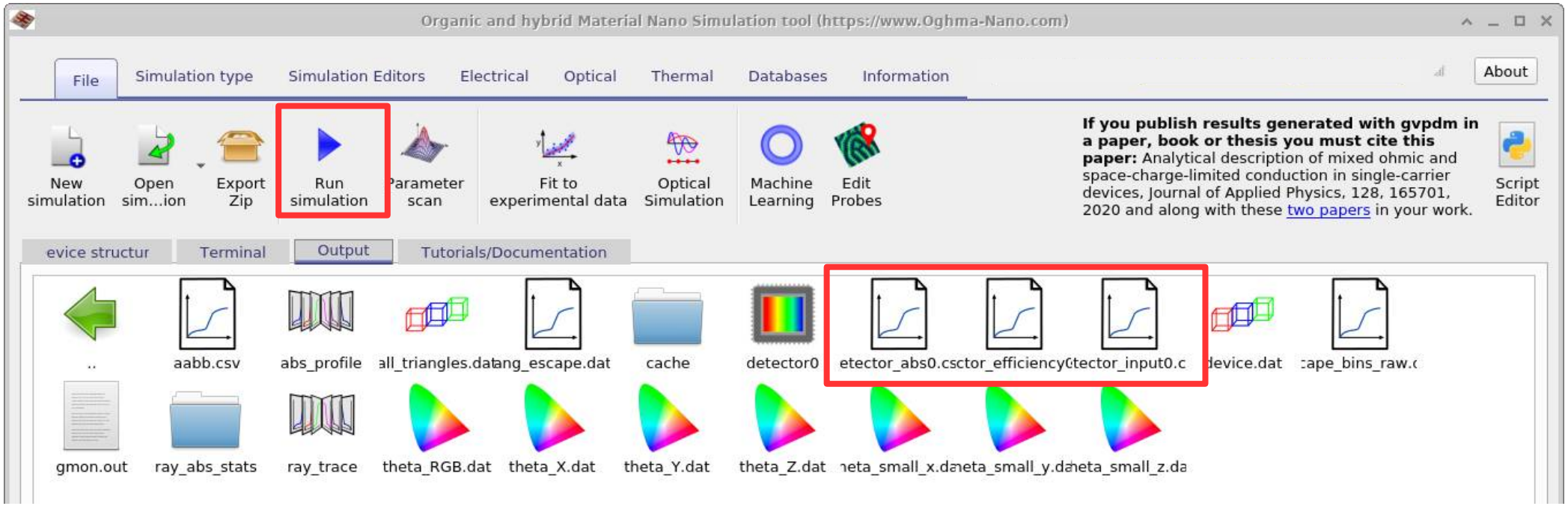


- The detector0 file contains the spatial distribution of where the light hit the detector.

- In this case it hit in the center so we get a peak in the center.

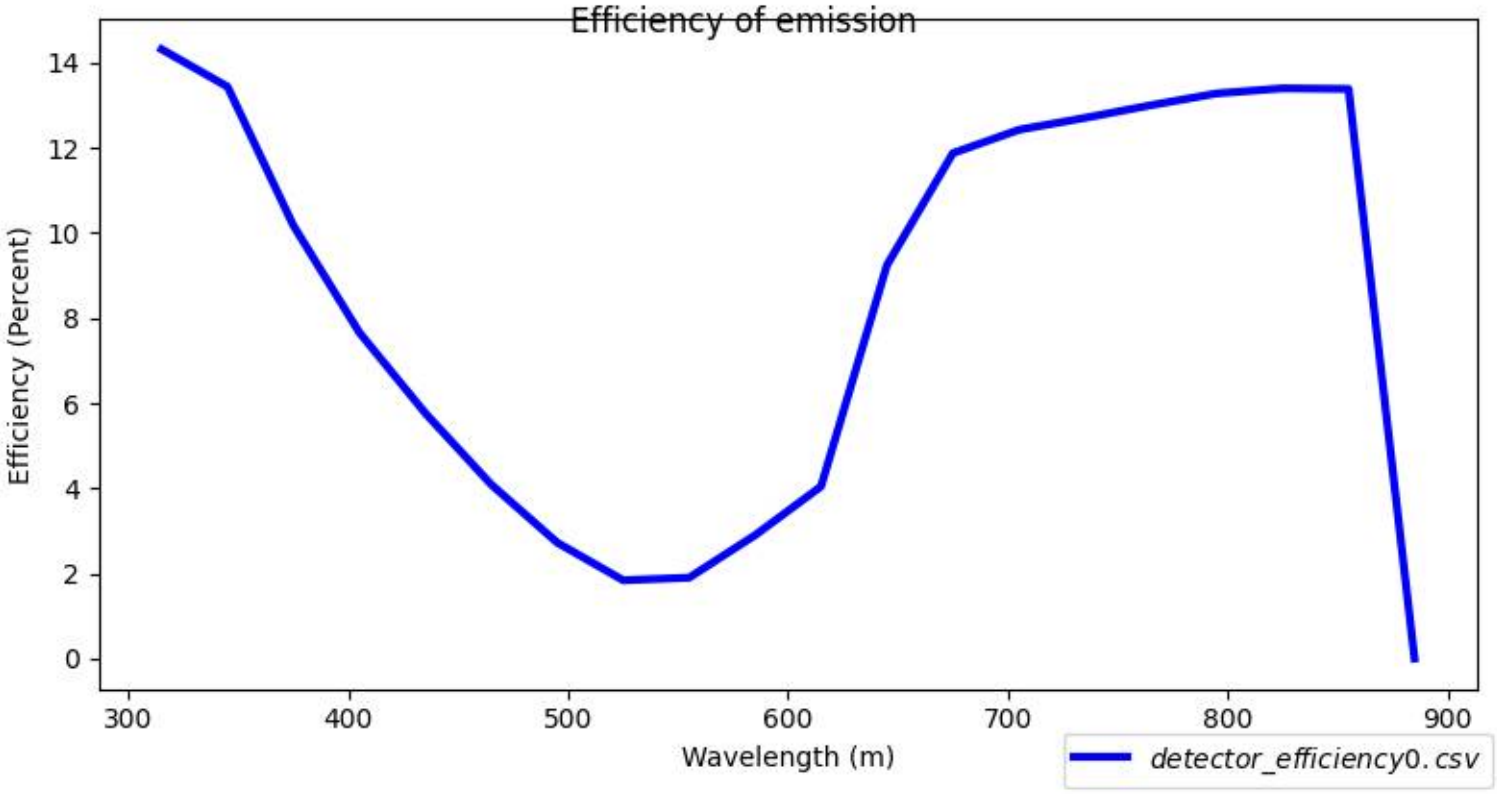
- Try playing with the values of theta and phi and see what happens

Optical detectors



- There are also three files called:
  - detector_abs0: The number of counts detected by the detector
  - detector_efficiency0: The collection efficiency of the detector
    =light detected(lambda)/light emitted(lambda)

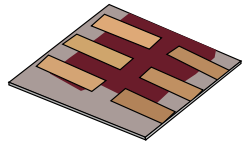
Optical detectors:
The light efficiency should look like this



- This represents how efficiently emitted light is captured by the detector.

- Try moving the light source around and see what influence this has on the detected light.

Outline of the talk



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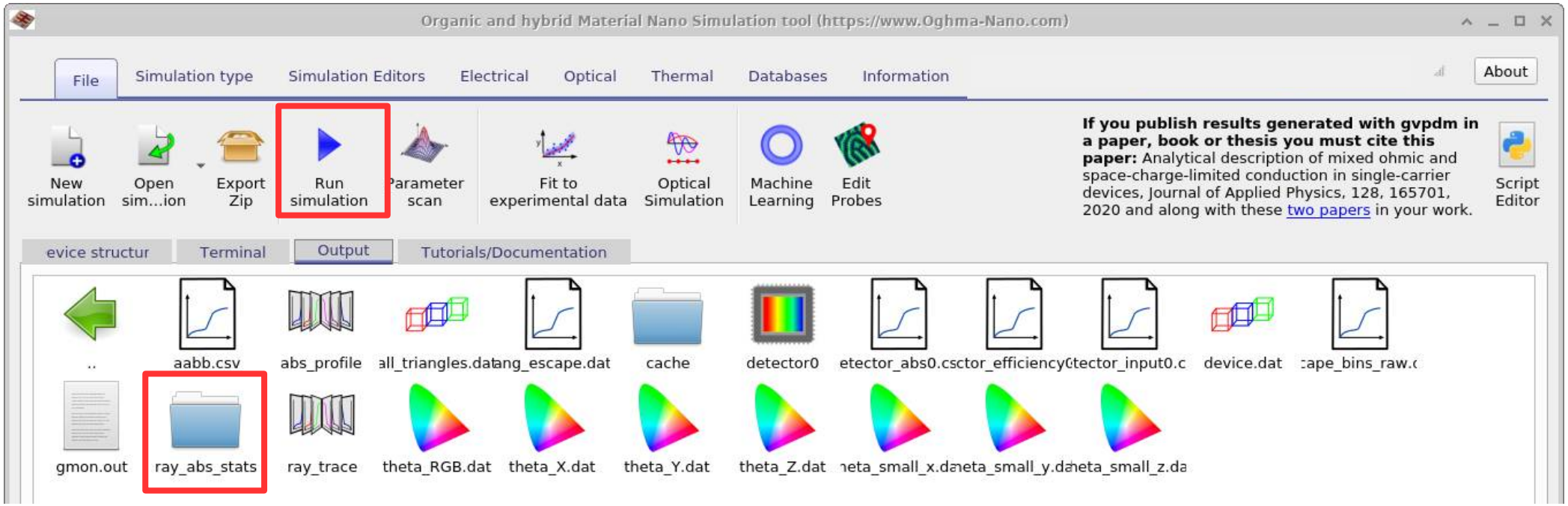
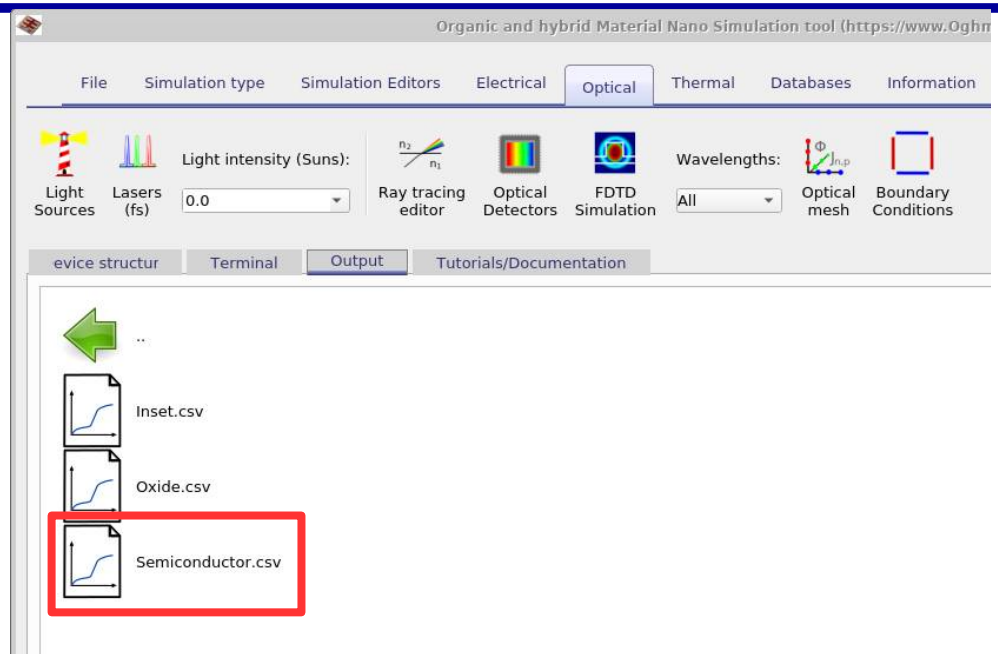
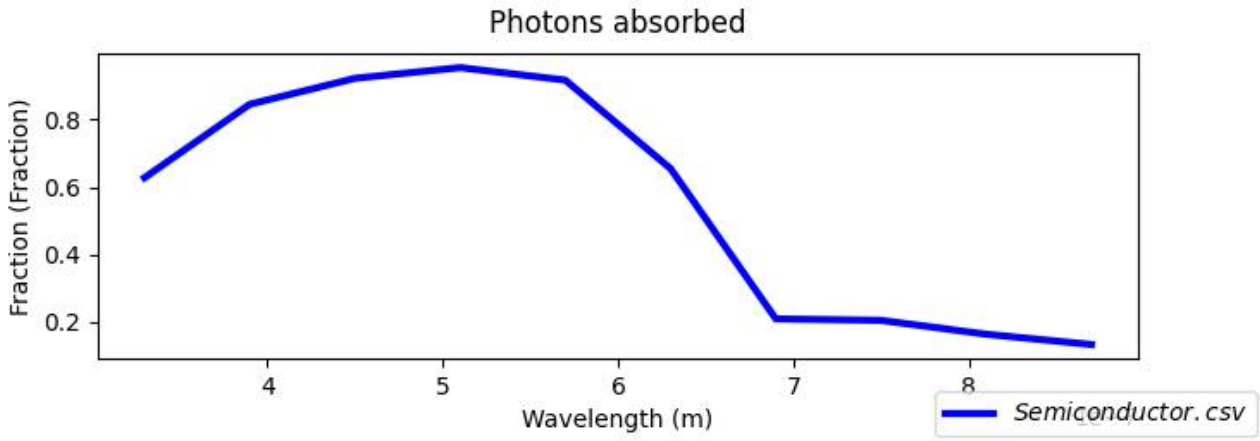
Fraction of light absorbed by each layer

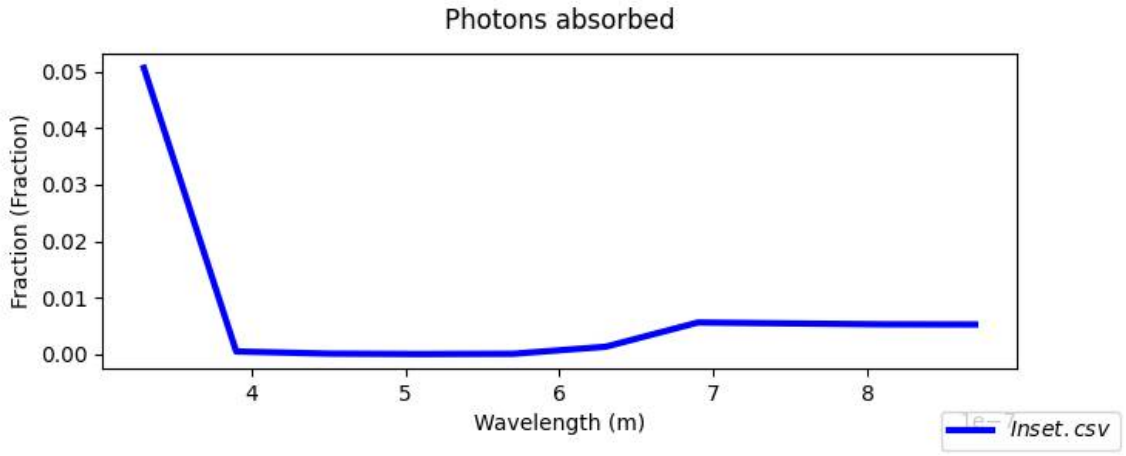


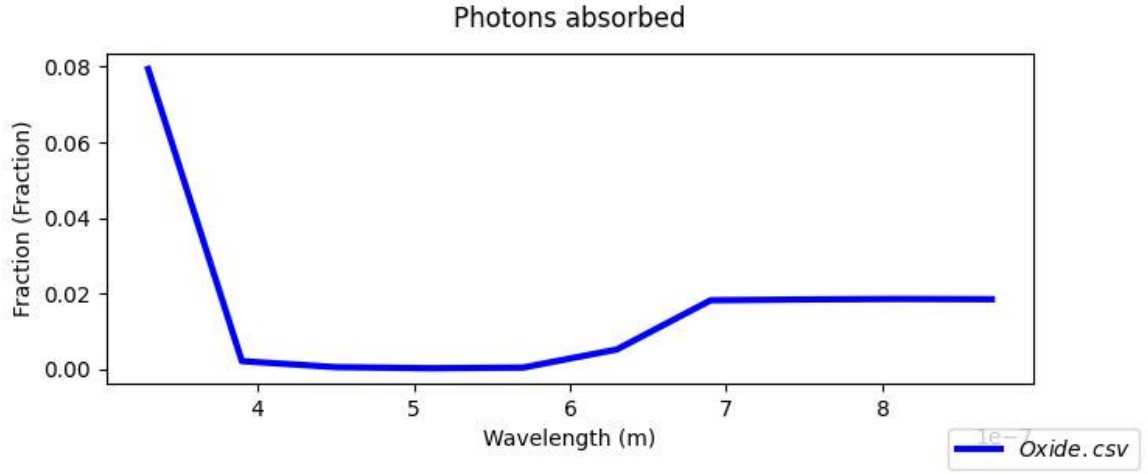
•The folder: ray_abs_stats contains statistics about what happened to the light in each layer.

Fraction of light absorbed by each layer









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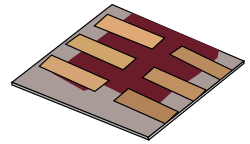

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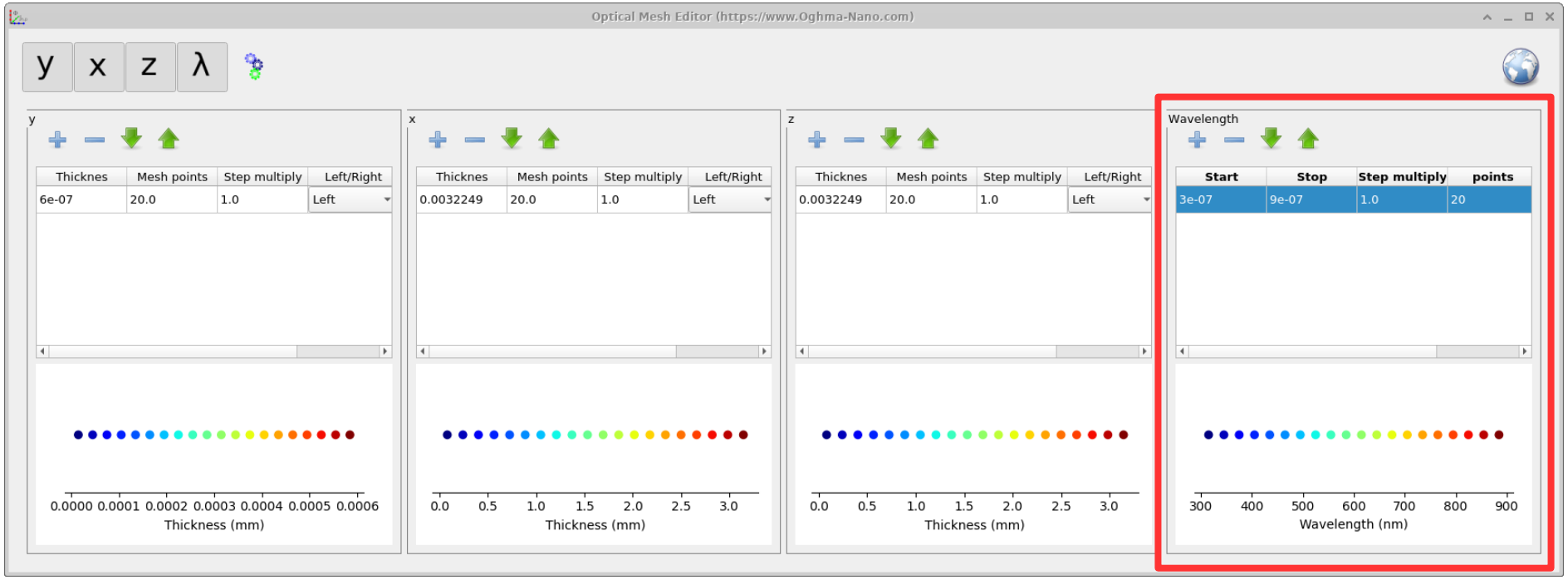
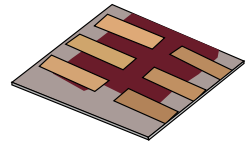
Setting up the wavelength mesh



- This selects the number of wavelength points to be simulated.

- We are scanning from 300nm to 900nm in 20 steps.

Outline of the talk



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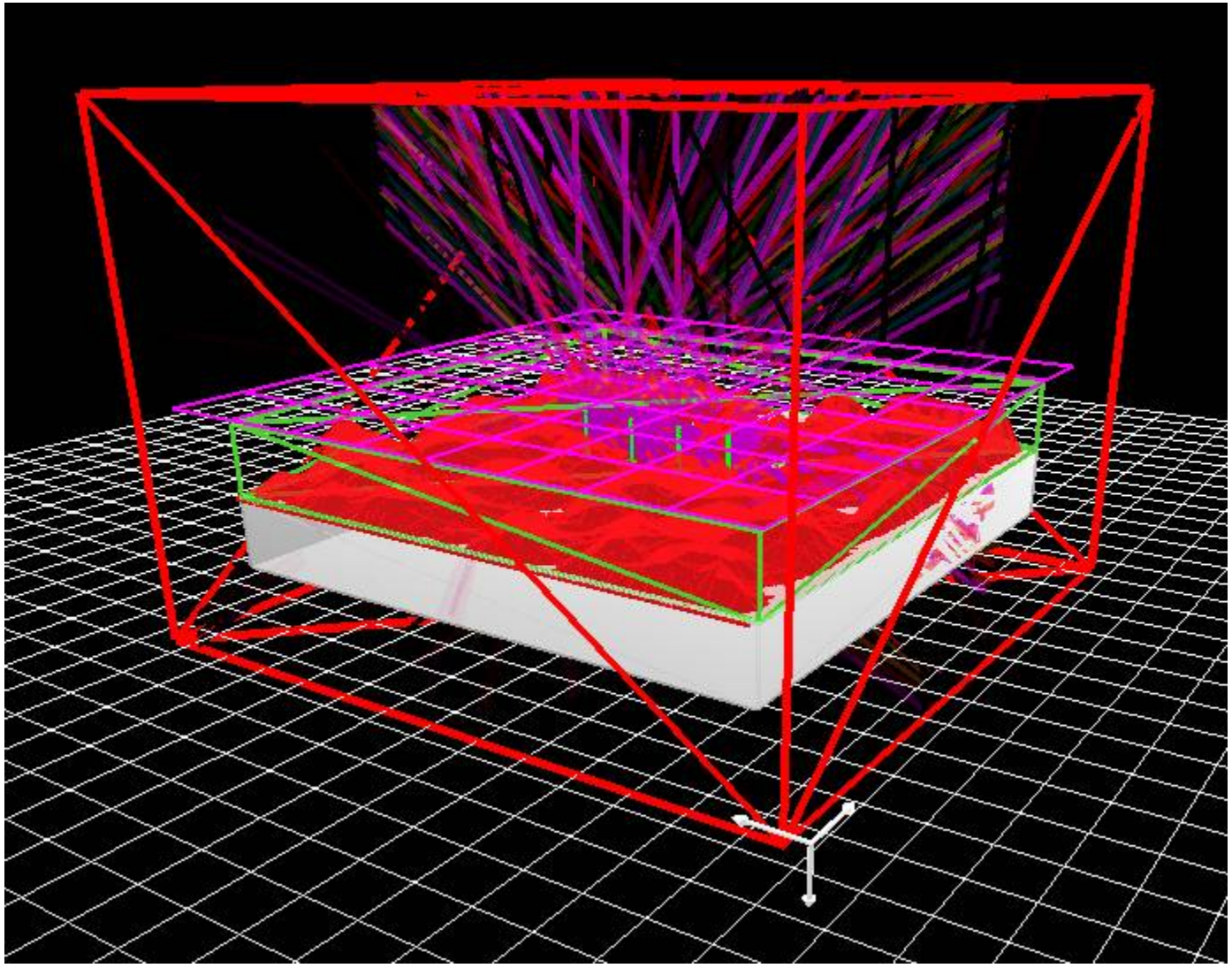
  - Optical sources
  - Optical detectors
  - Examining the results
  - Light absorbed in each layer
  - Setting the wavelength range
  - **The simulation world**
  - Summary

The simulation world

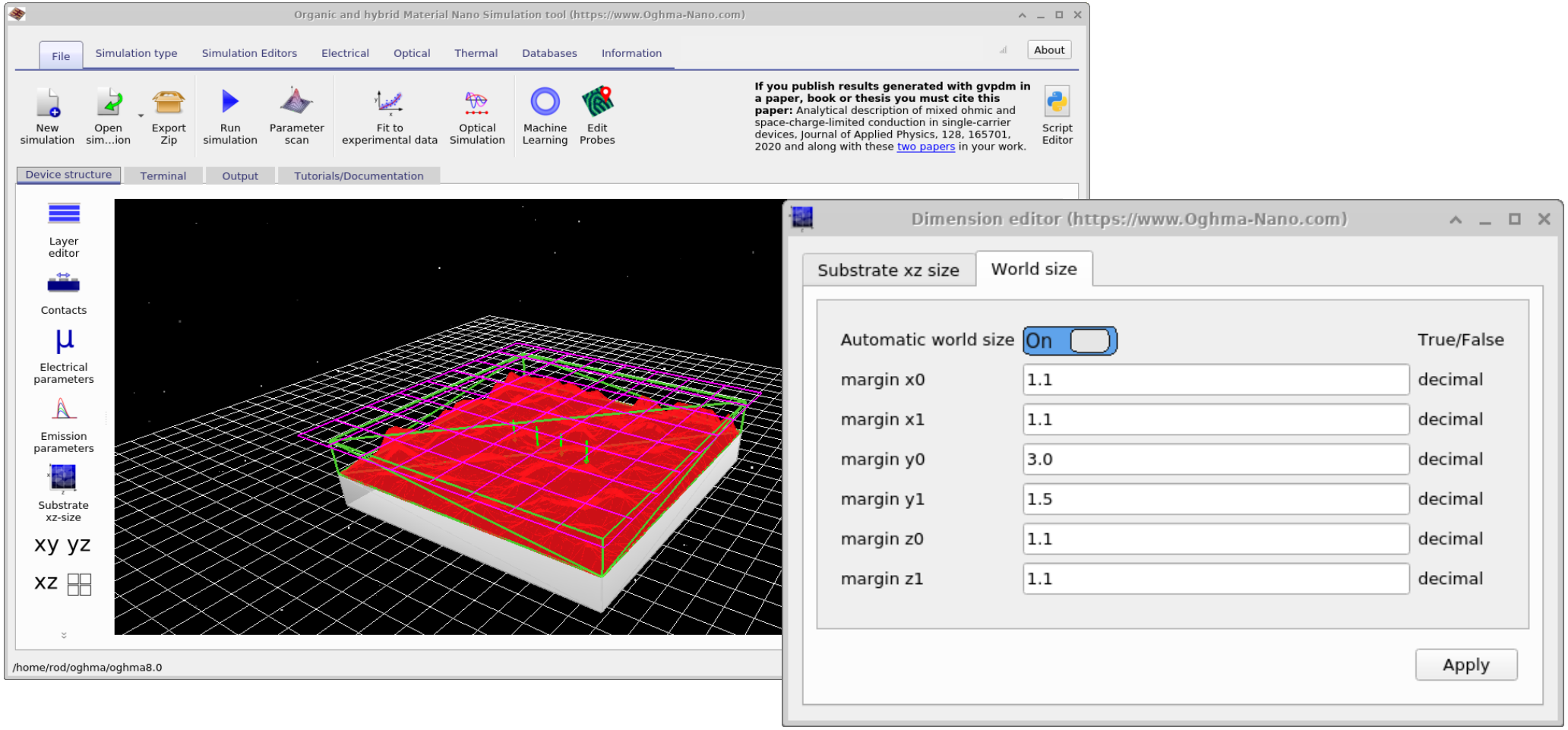


•All optical and electrical interactions must happen in the simulation world box.

•You can see the extent of the world by clicking on a black area of the simulation and selecting view→show world box.

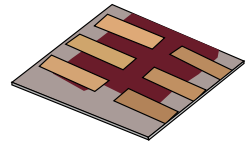
•If you want to change the size of the world box you can do it through the substrate size button.

Changing the size of the world box.



- Values above 1.0 increase the size of the world box.

Outline of the talk



- In this talk we will cover:
  - Making a new simulation
  - Adjusting the dimensions of the simulation
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  - The simulation world
  - **Summary**