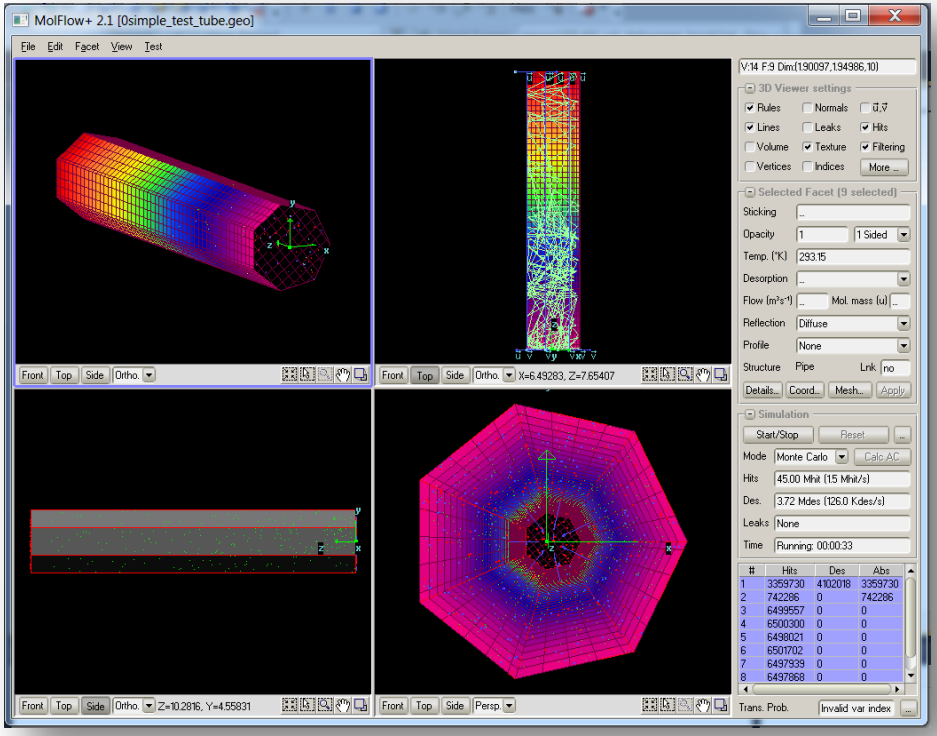
A 10-minute introduction to

Molfow+

A test-particle Monte Carlo simulator for UHV systems



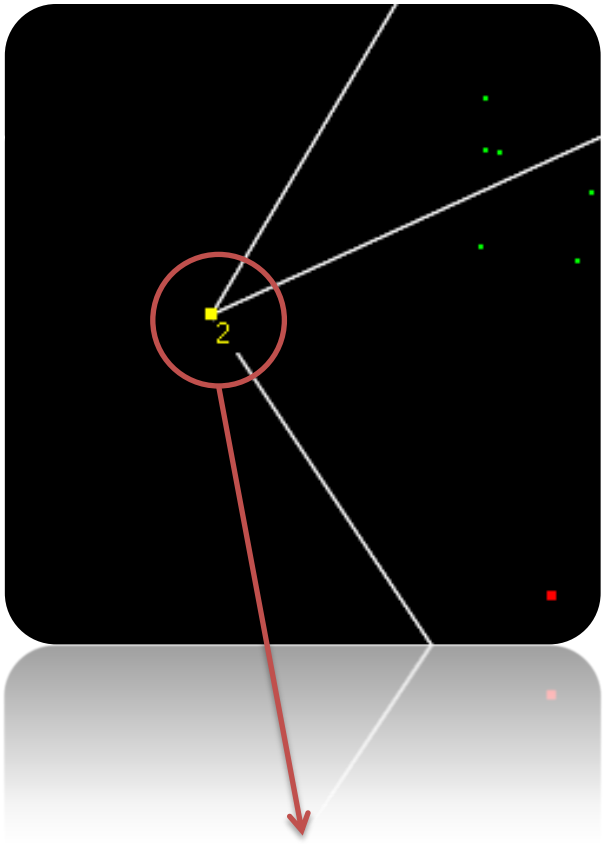
The basics

First, let's learn the Molflow terminology and the interface in a few slides.

Or, if you prefer learning by doing it,

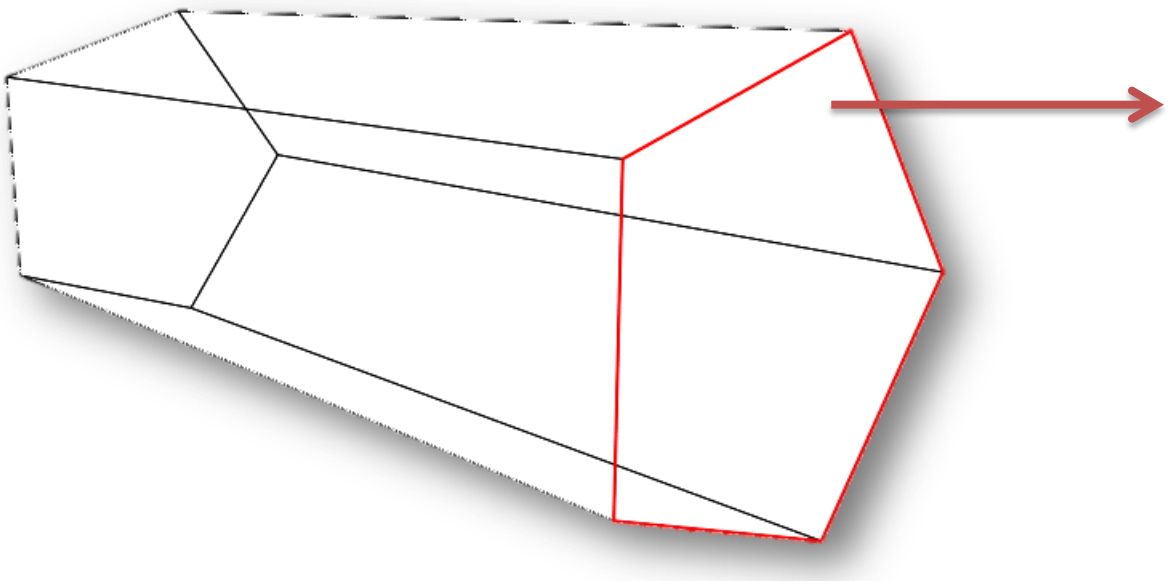
skip to the tutorial part.

Vertex



A vertex is a point in the 3D space.

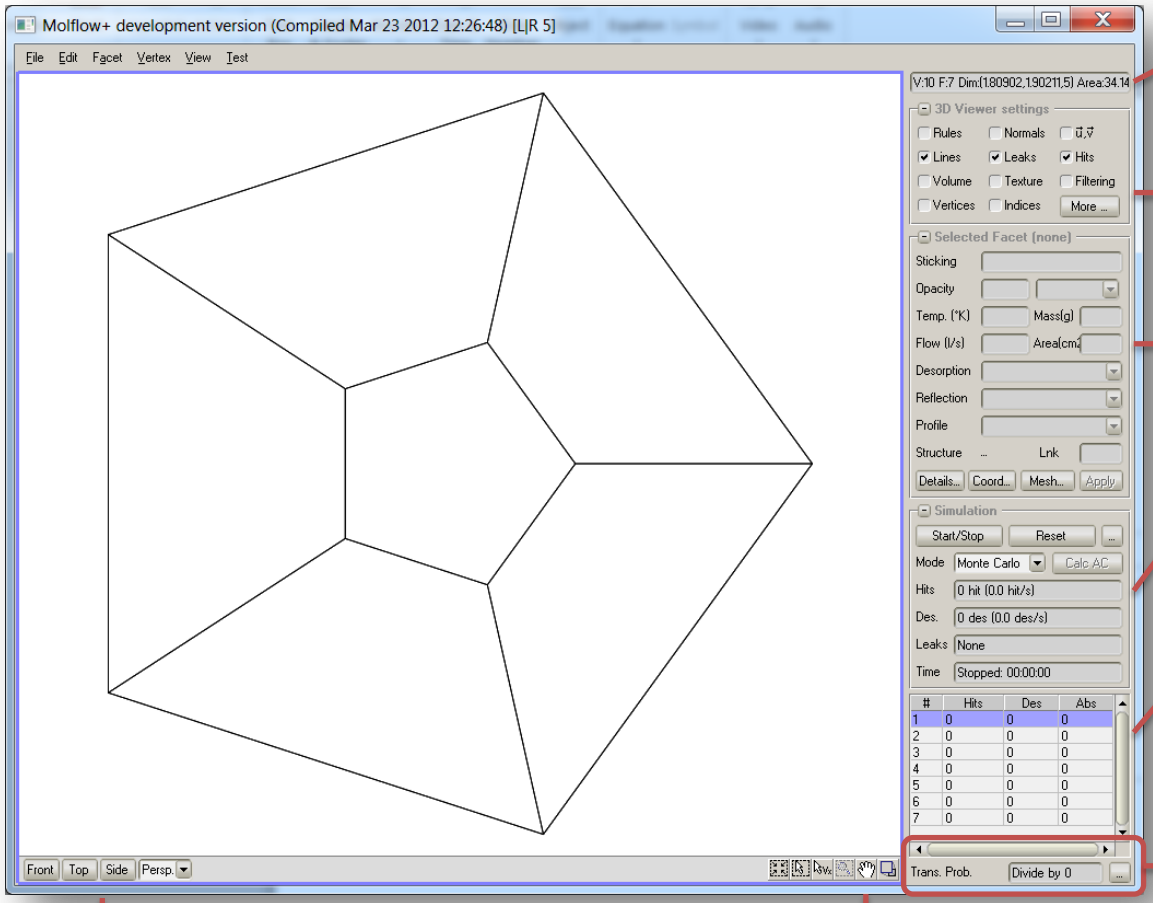
Facet



A facet, also called polygon is a side of our 3D object. It is an outline that connects vertices.

It is an important term in Molflow, as many properties (temperature, outgassing, pumping speed, etc..) are *facet parameters,* which means that they can be adjusted individually for each facet.

The interface



Geometry properties
- Shows information about the geometry size, number of vertices and facets

View settings
- Change view settings for the current *viewer* (see next slide)

Facet parameters
- Change facet properties
- Access further features (mesh, coordinates,…)

Simulation control
- Start/stop/reset simulation
- View simulation statistics

Facet list
- See the number of hits on each facet
- Select facets (multiple: hold CTRL)

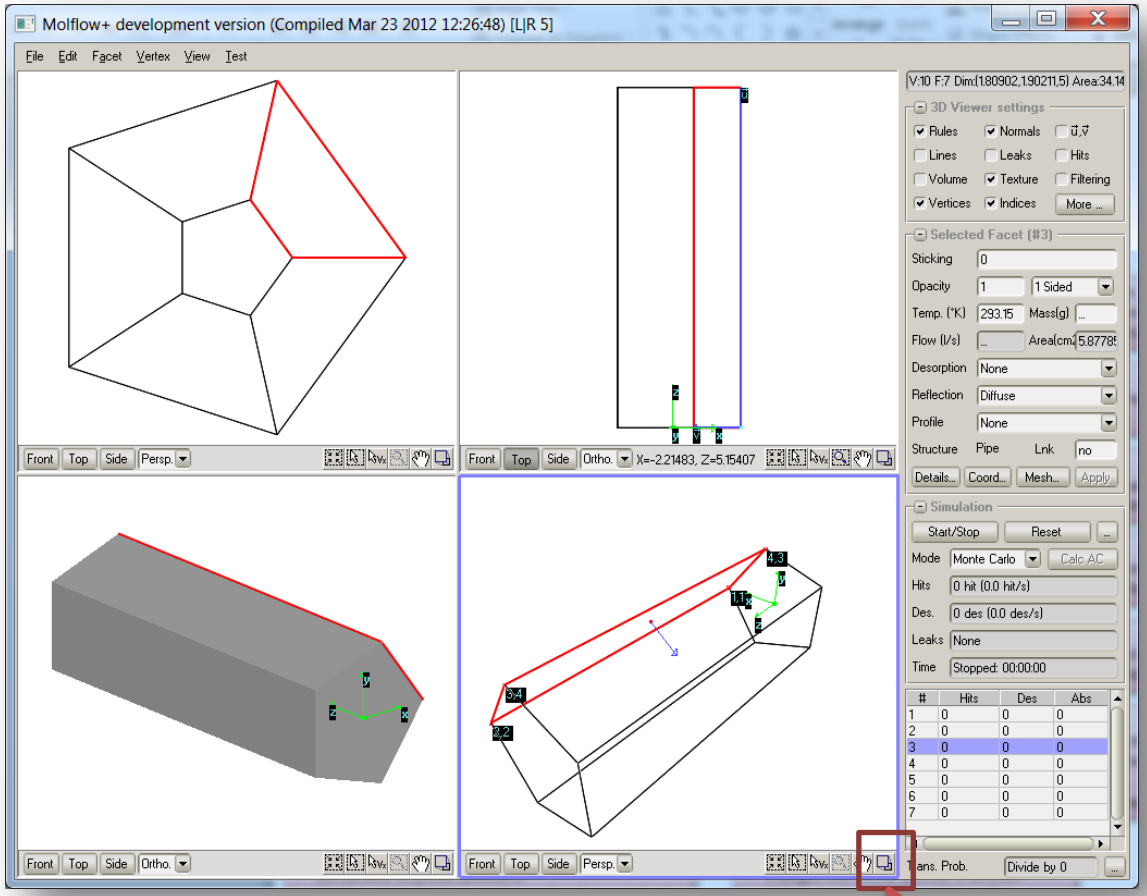
Formulas
- A list of formulas that get calculated as the simulation runs (transmission probability for example)
- Use Edit / Formulas menu to add / remove

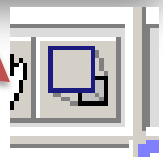
View Selector
- Set camera to preset positions
- Change projection type (orthographic / perspective)

Tool Selector
- Changes the mouse pointer's function
- Will be explained later in this guide

The viewers

Molflow allows you to use four different *viewers*, each of them can have different settings and different camera angles. The active viewer is marked by the thick violet outline





Expand button
Use this to maximize the current viewer

Camera control

Left click
To select a facet / a vertex, depending on the tool used (next slide)

Holding ALT and dragging with the left mouse button also moves the camera

Press and hold
the mousewheel to drag the camera

Scroll
The mousewheel to zoom in/out

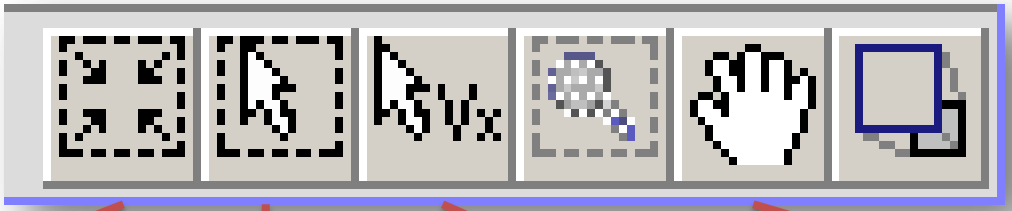
Holding CTRL scrolls slower, holding SHIFT scrolls faster

Hold and drag
the right mouse button to rotate the camera

Holding CTRL and dragging with the right button also zooms in/out

Viewer Tools

To select things



Autoscale
Click to fit the whole geometry on in the viewer

Facet selector
Default setting. If you click several times on the screen, facets under your mouse pointer get selected in a cycle.

You can also **draw a selection box** by holding the left button to select facets inside the box.

CTRL-click: subtract from selection
SHIFT-click: add to selection

Vertex selector
Click near a vertex on the screen: the vertex closest to your pointer gets selected.

You can also **draw a selection box** by holding the left button to select vertices inside the box.

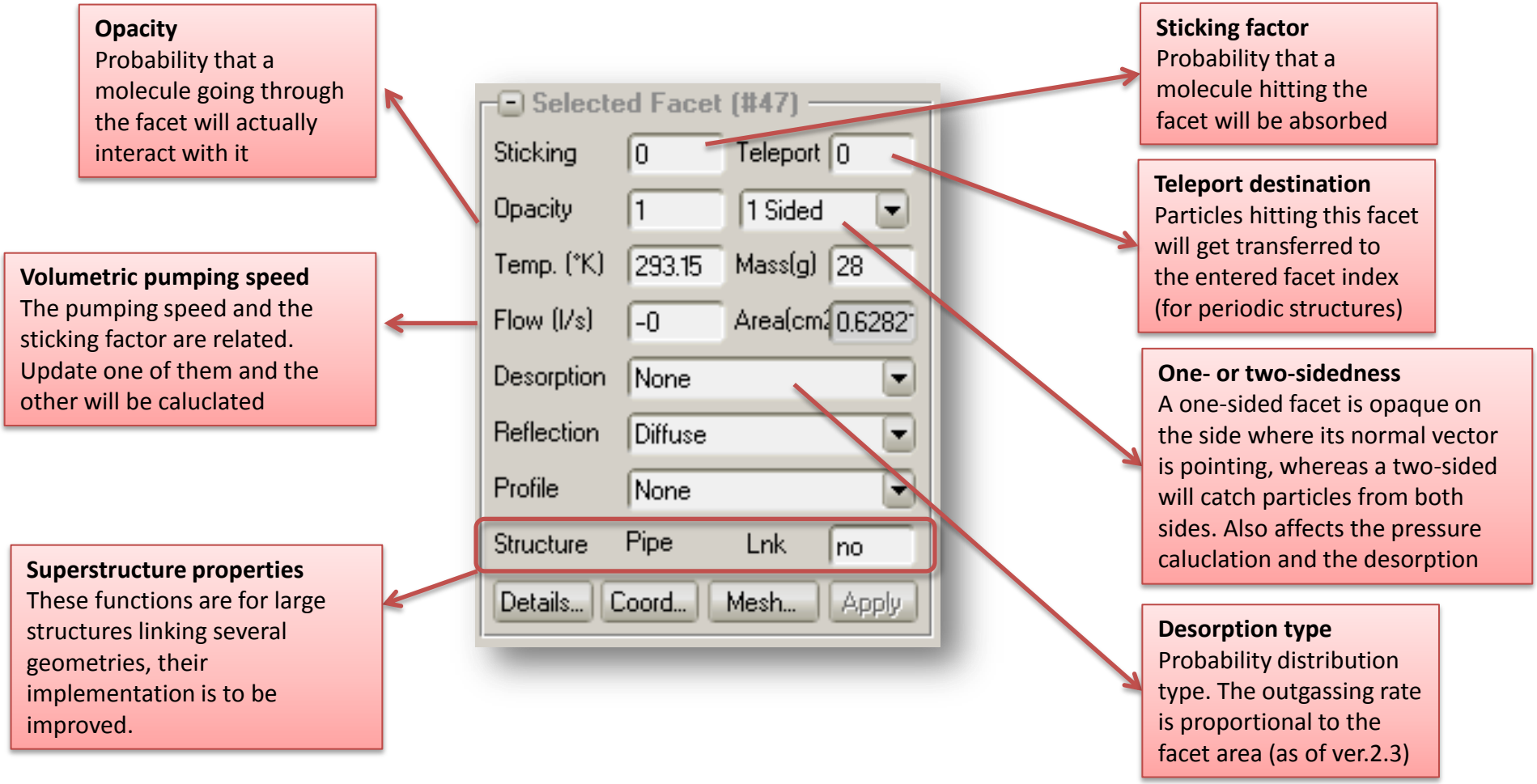
CTRL-click: subtract from selection
SHIFT-click: add to selection

Hand tool
Now deprecated by middle mouse button drag.

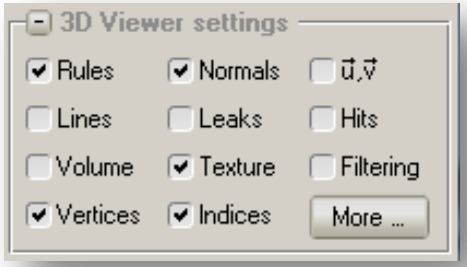
If selected, you can move the camera by dragging with the left mouse button.

Facet parameters

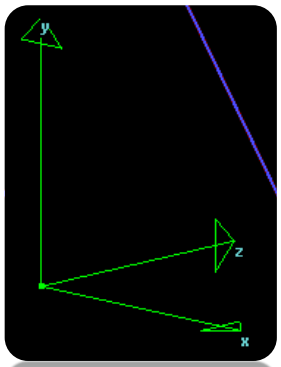
So these are parameters can be set facet-by-facet:



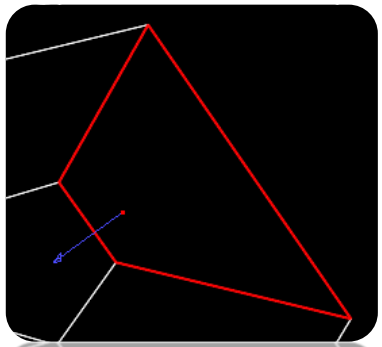
Viewer parameters



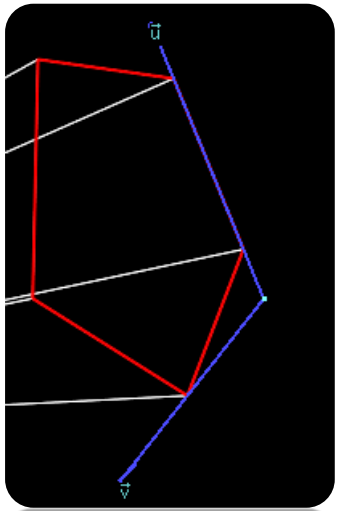
Rules
Toggle the base vectors of the coordinate system



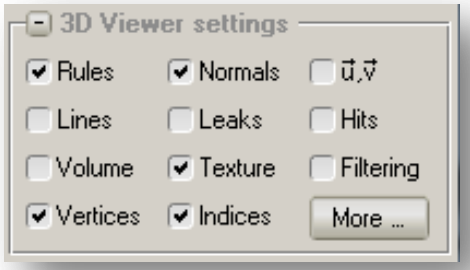
Normals
Show the orientation of the facet (interesting in case of 1-sided facets)



U, V vectors
The own 2D coordinate system of the selected facet



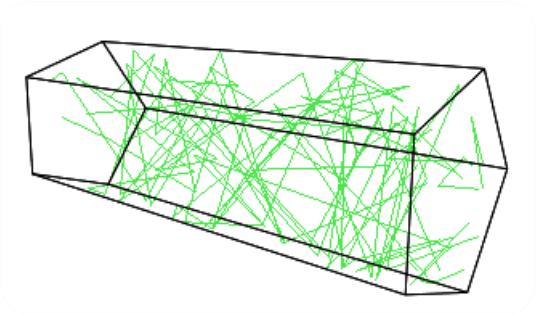
Viewer parameters

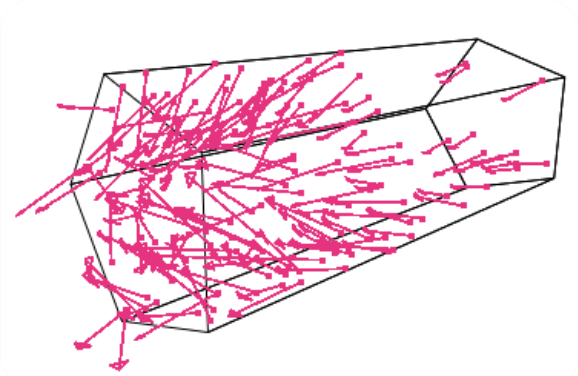


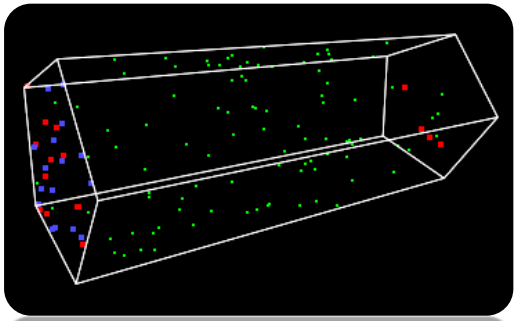
Lines
Particle trajectories

Leaks
If a molecule escapes from the system, show where the last hit occurred and in what direction the molecule rebounded before leaving

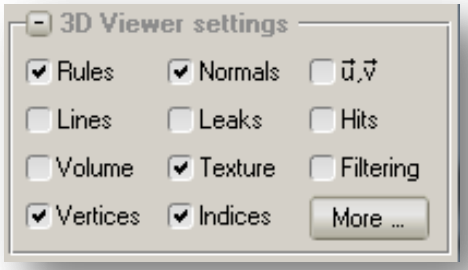
Hits
Particle collisions with facets.
Red: Absorption
Blue: Desorption
Green: Reflection / Transparent pass



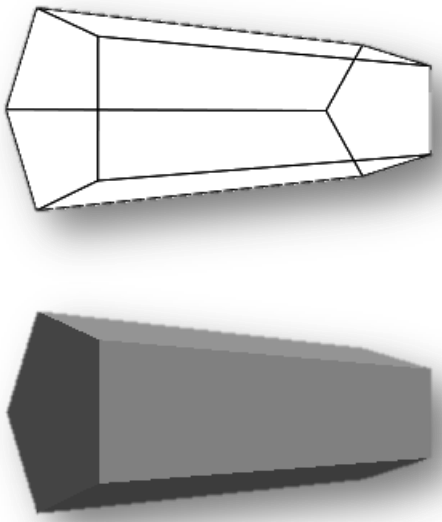




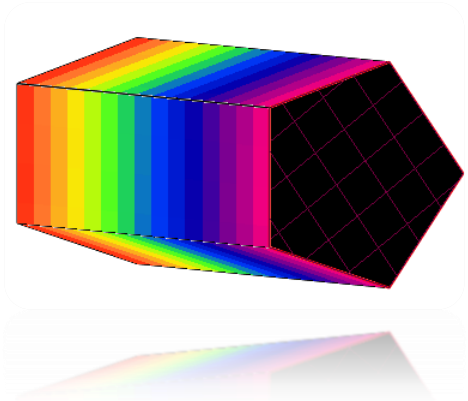
Viewer parameters



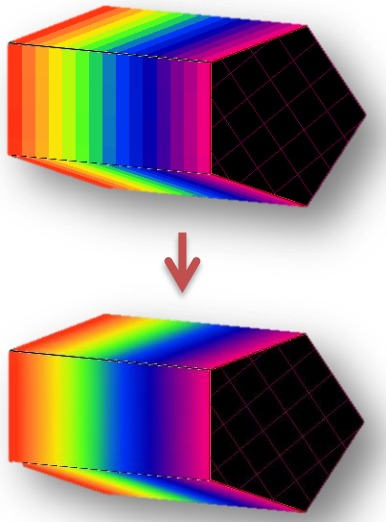
Volume
Switch between volumetric or wireframe view mode



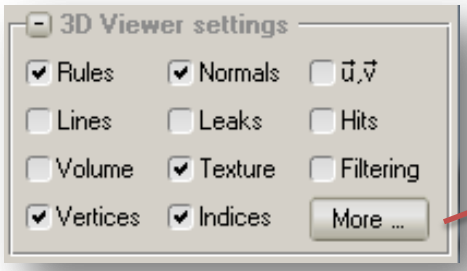
Texture
Show or hide textures (see later)



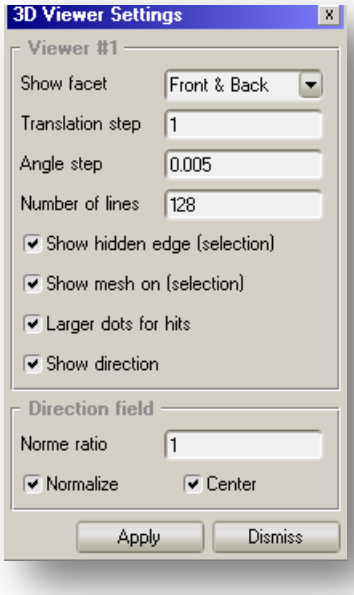
Filtering
Apply a Gauss filter to textures



Viewer parameters



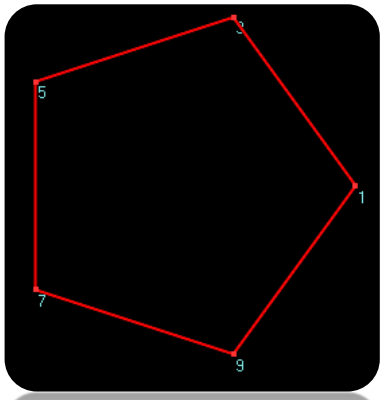
Further options…



Not part of this quick start guide.

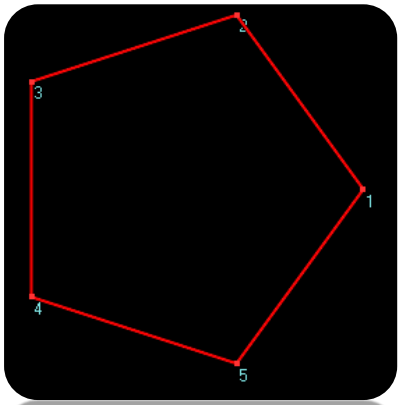
Vertices

Shows the identifier of vertices on selected facets



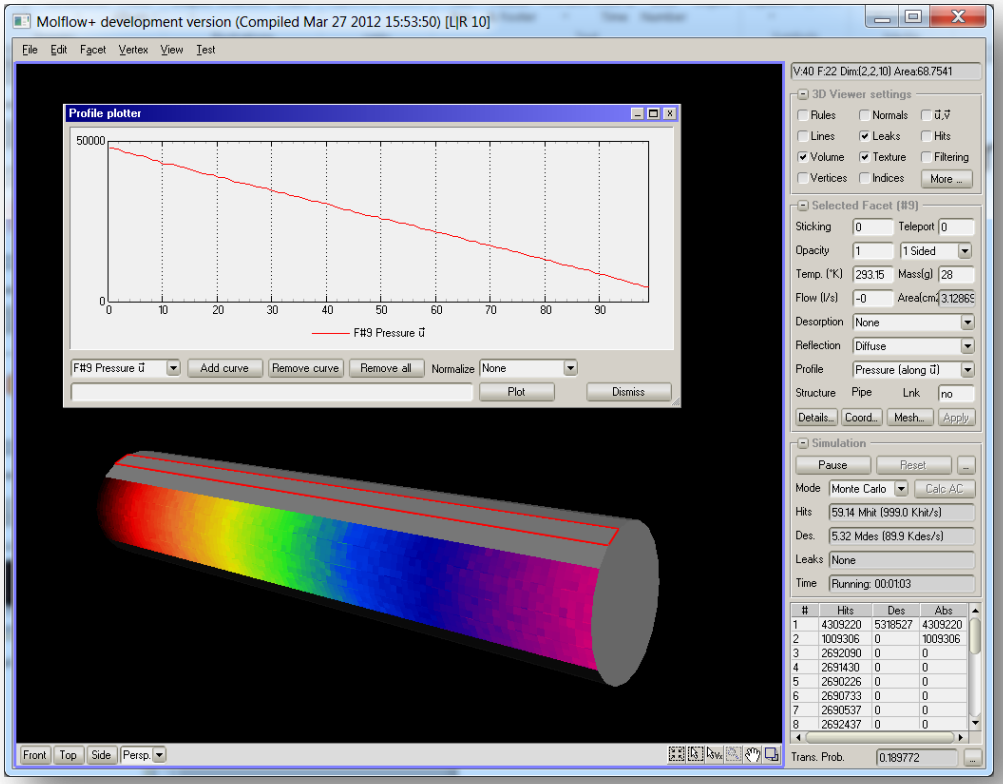
Indices

Shows the index of vertices on a given facets (starting from 1 for each facet)



Tutorial: a simple pipe

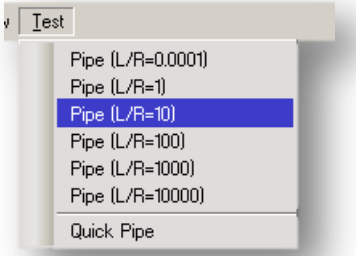
In this example, we'll calculate the transmission probability and the pressure distribution of a pipe.



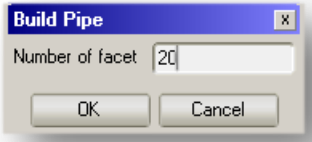
All steps of this tutorial are demonstrated in a video on the website.

Create geometry

- From the Test menu, choose a test pipe with L/R ratio of 10



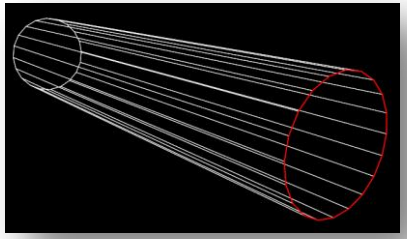
- Let its surface consist of 20 facets:



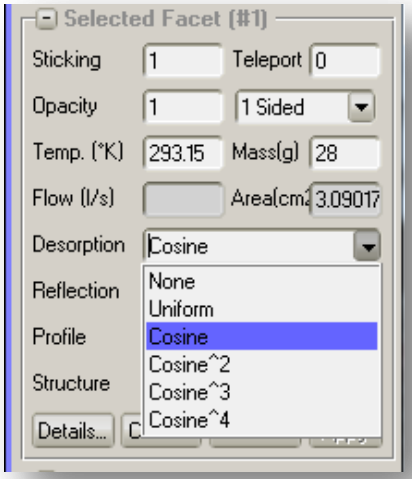
- Note that test pipes have some parameters set by default. Nevertheless, we'll set them again, for the sake of learning how to do it.

Define gas inlet

- Click on one end of the pipe. Keep clicking without moving the mouse until the top facet is selected (red outline):



- On the right (facet parameters), change “Desorption” to cosine and sticking to 1:



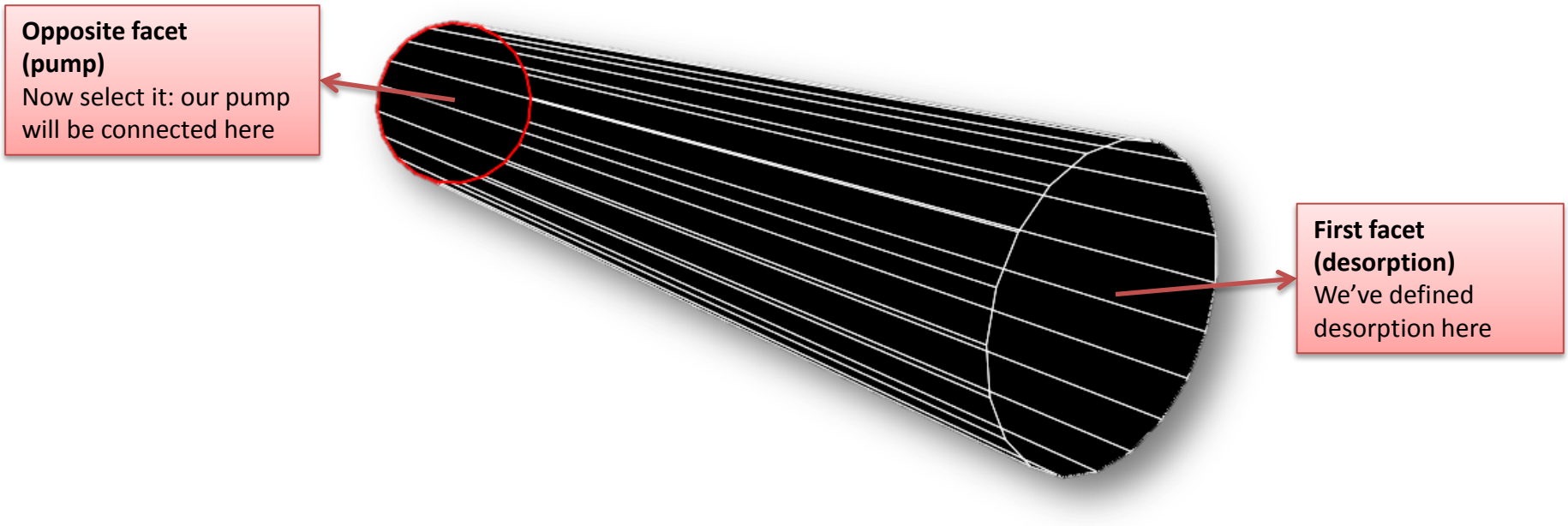
- Click 

Define gas inlet

- What we just did:
  - Defined that particles will desorb from one end of the pipe
  - And by setting sticking to 1, if a particle gets back to the inlet, it will be “absorbed”: removed from the system

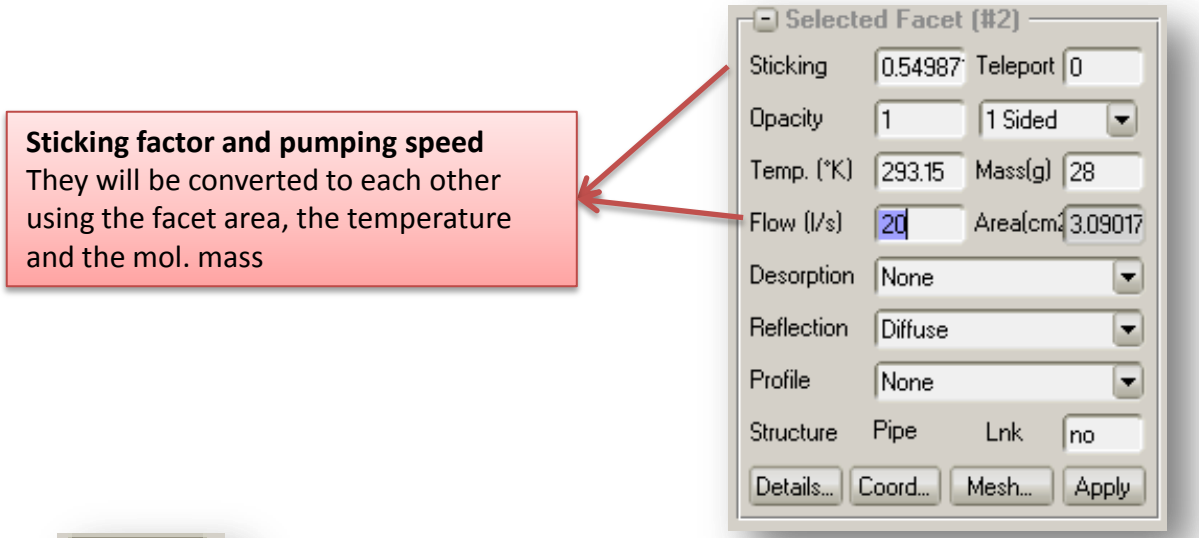
Define pumping

- Now select the opposite side of the tube



Define pumping

- Now we can define the volumetric pumping speed in the facet parameters:

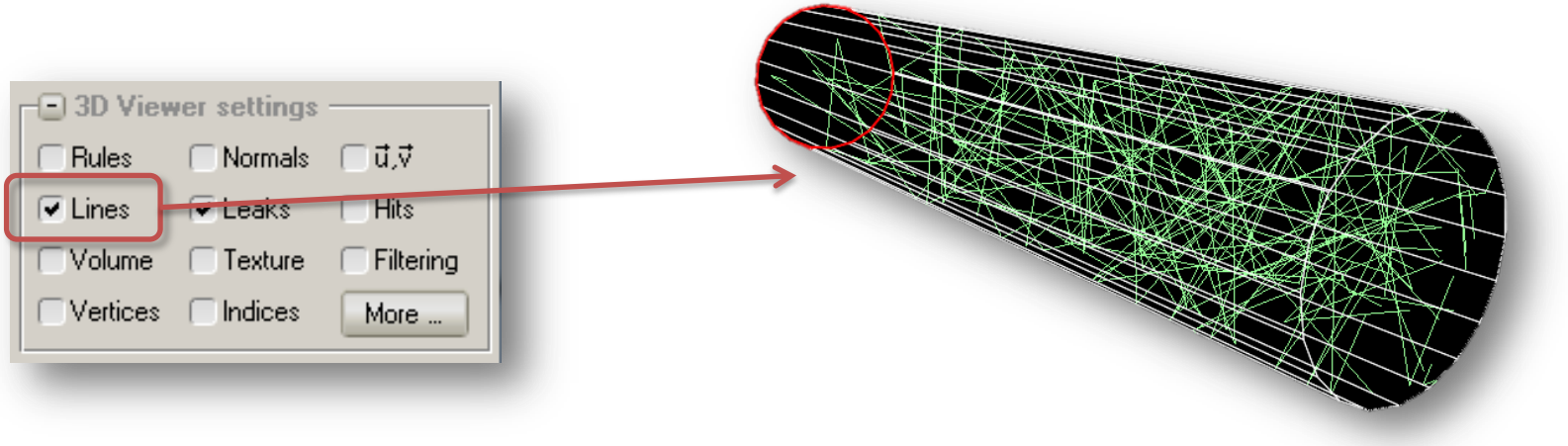


- Click 

Begin simulation

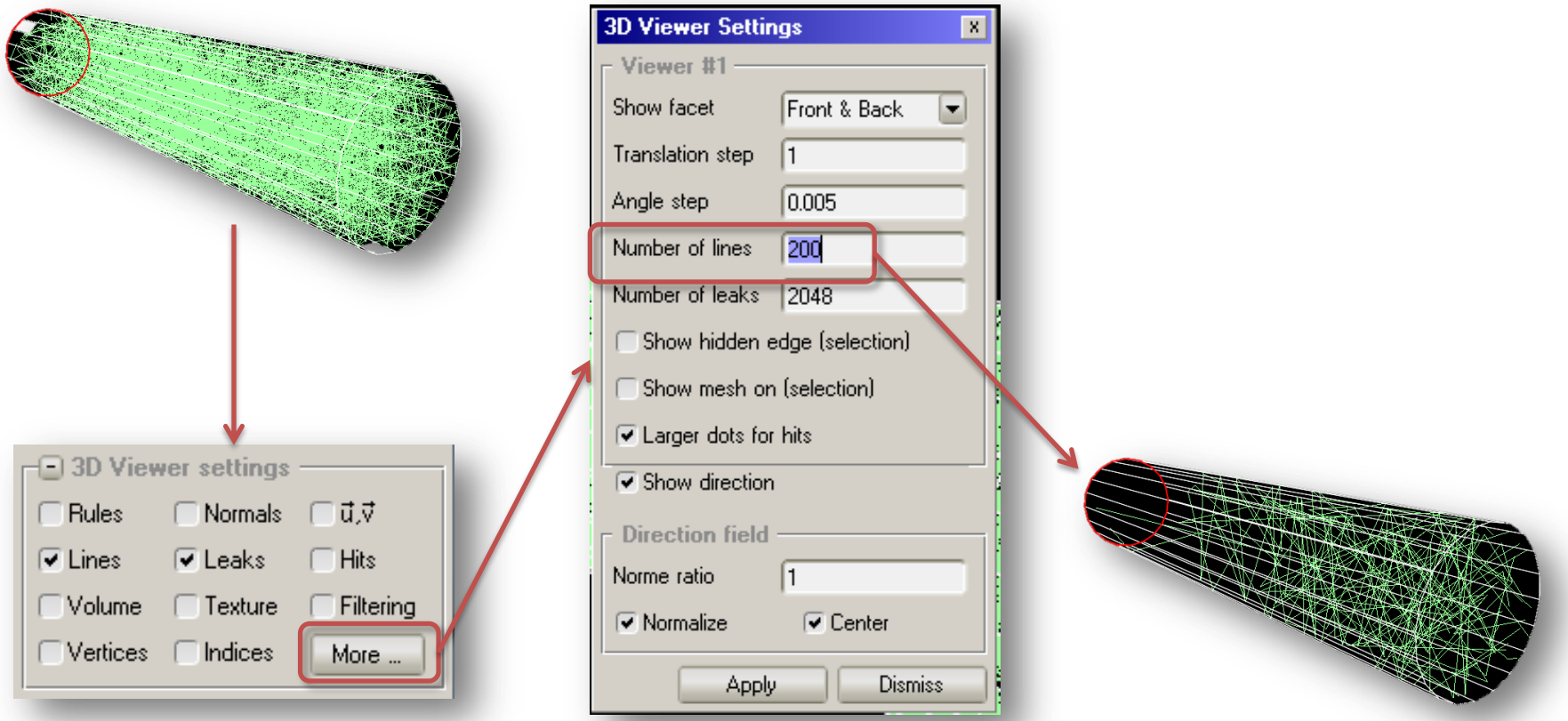
- Now our simple system is ready. Launch the simulation by clicking

- The simulation is now running. If you enable “Lines” at the viewer parameters, you can visualize the trajectories of the particles:



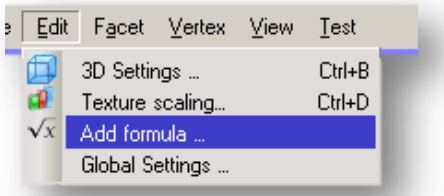
Quick hint

- If too many lines are displayed, reduce them at the viewer parameters:



Transmission probability

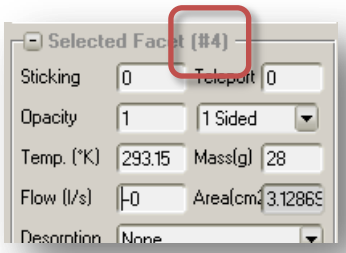
- Now that we have a running simulation, let's calculate some data. To do that, open the formula editor:



- Write "tarnsmission ratio" as formula name, and "A1/D2" as the formula. This means *"number of absorbed molecules on facet #1/number of desorbed molecules from facet #2"*. Click 

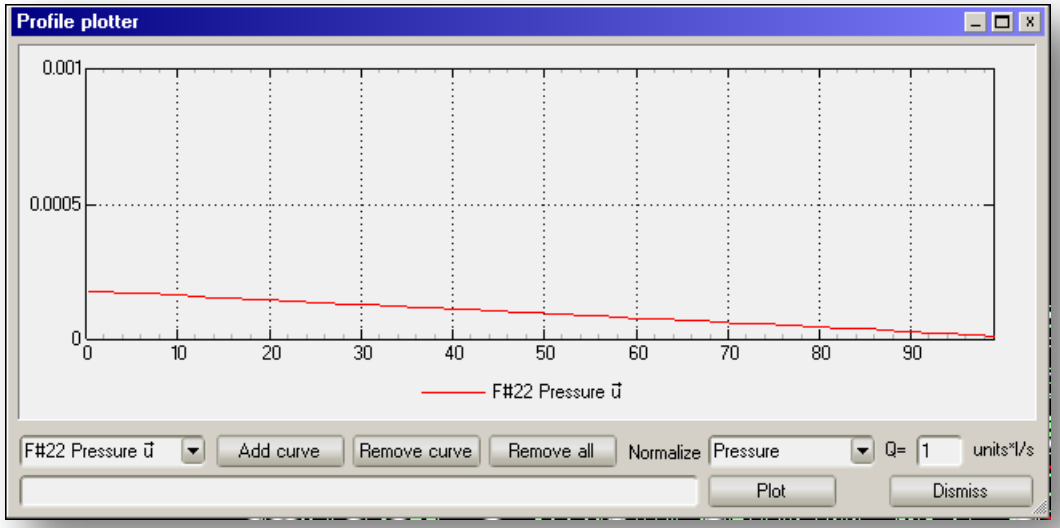
. Now you will see the calculated formula on the lower right corner: 

- Hint: the above formula might be "A2/D1", depending on which facet you defined as for desorption. You can find out a facet's number by selecting it, and reading the title of the facet parameters editor:



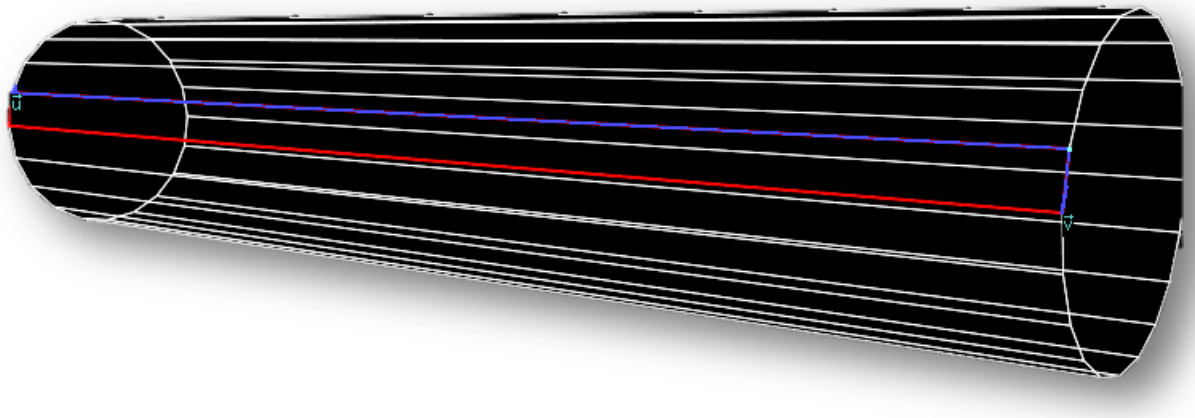
Pressure profile

- Now we'll visualize the pressure along the side of the tube.



Pressure profile

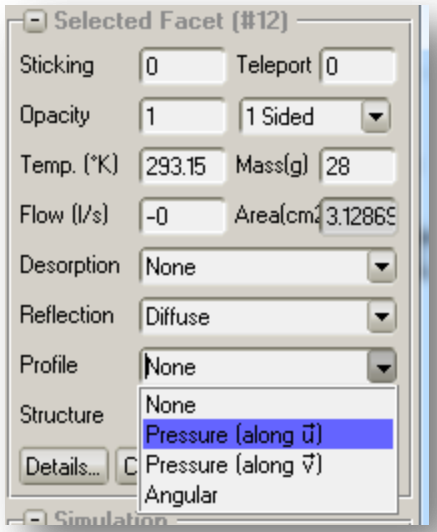
- Select a side facet, and turn on the “u,v” vector display in the viewer parameters:



- As we can see, the **u** vector is directed along the length of the tube

Pressure profile

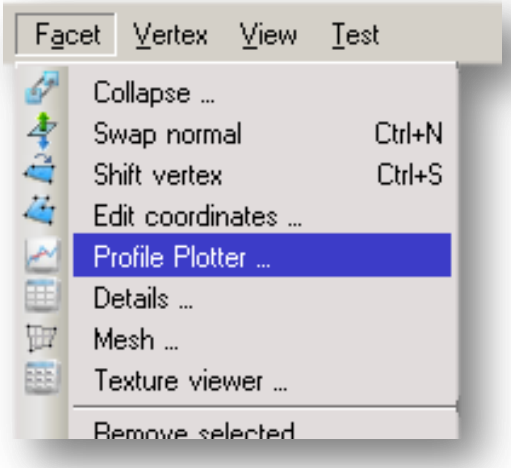
- On the facet parameters, choose “pressure along **u**” in the profile settings:



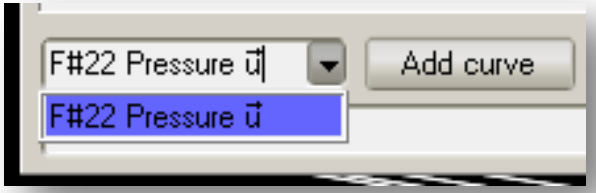
- This instructs Molflow to calculate the pressure along the axis **u**

Pressure profile

- To view the pressure, open profile plotter:

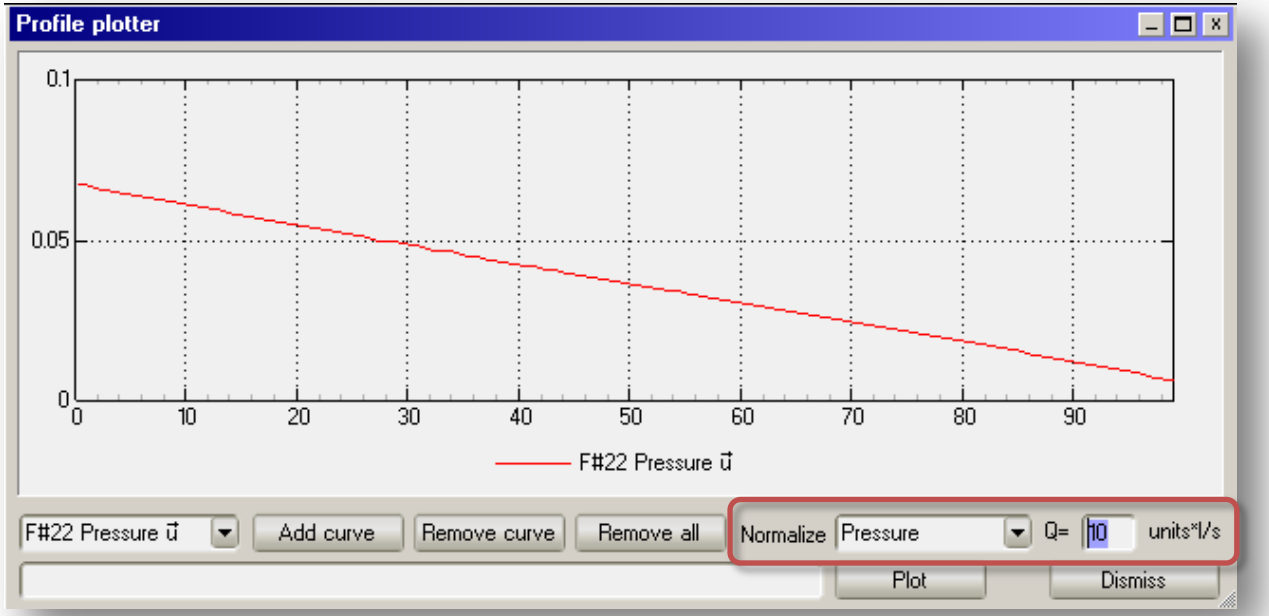


- Then choose the profile you just set (bottom left), and click Add Curve



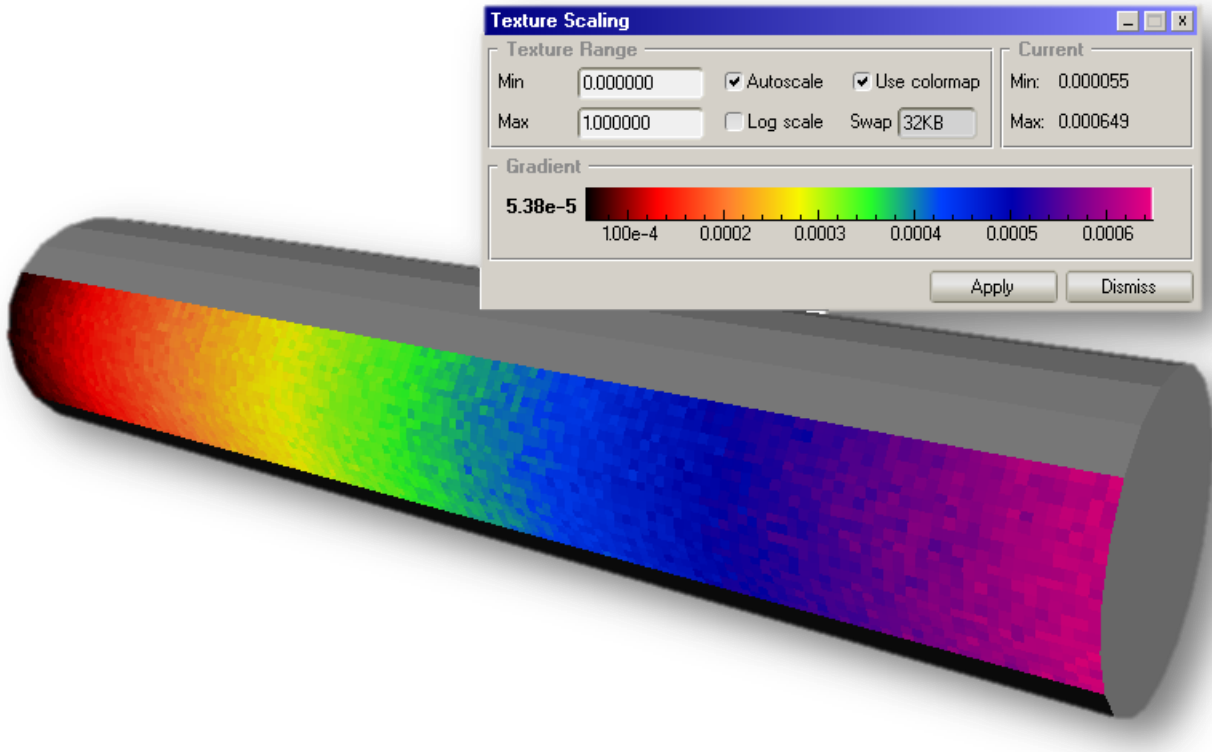
Pressure profile

- To calculate the pressure in (for example) *mbars*, choose “pressure” under normalize options and enter the total outgassing in *mbar*liter/sec:



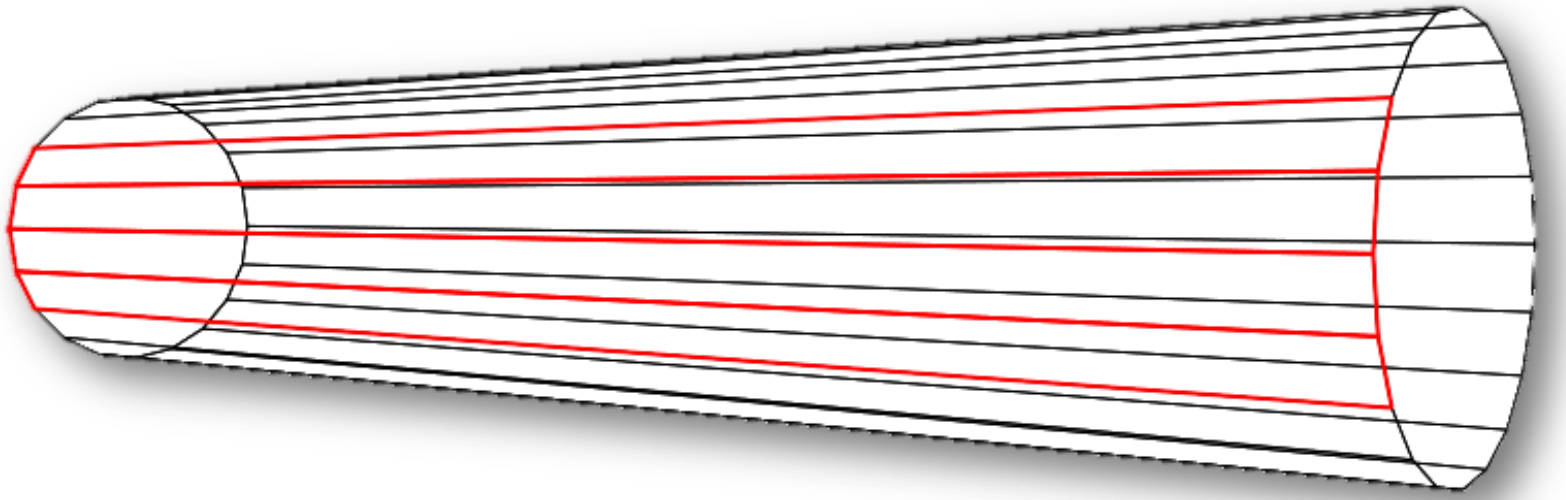
Adding a Texture

- Textures are an other way to visualize local pressure information. We will add them now.



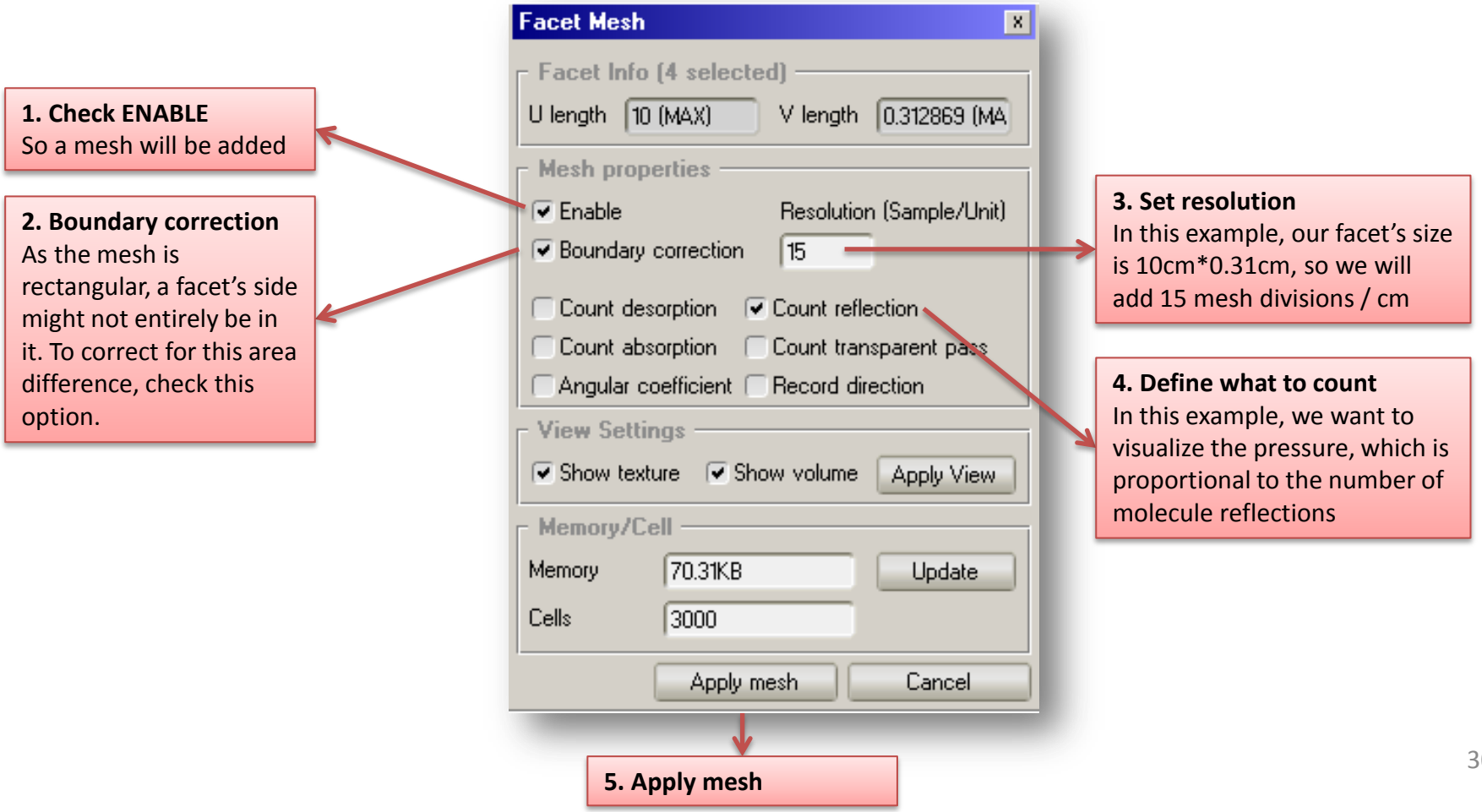
Adding a Texture

- Select a few (or all) facets where you'd like to view the pressure. Select multiple facets by holding the SHIFT key, unselect by holding the CTRL key:



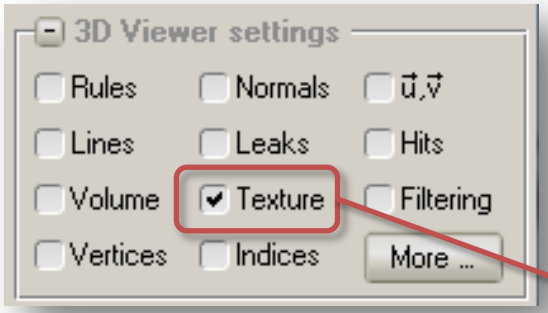
Adding a Texture

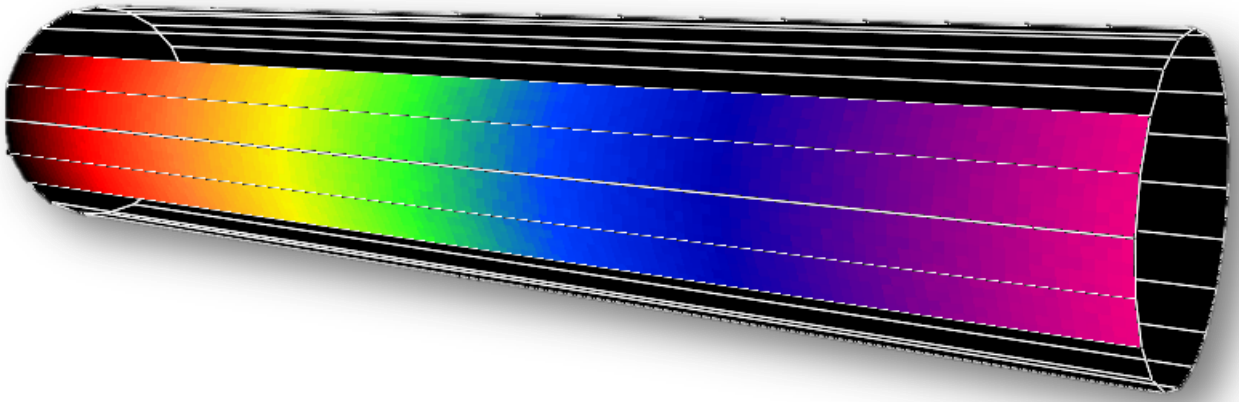
- Add a MESH. A mesh splits the facet into little blocks where the pressure is individually calculated. Click Mesh... in Facet editor:



Adding a Texture

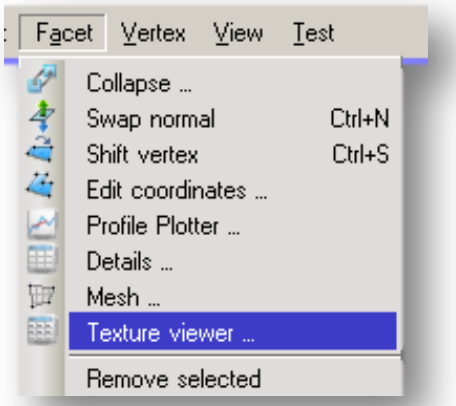
- Turn on “Texture” in the viewer parameters to see the texture:



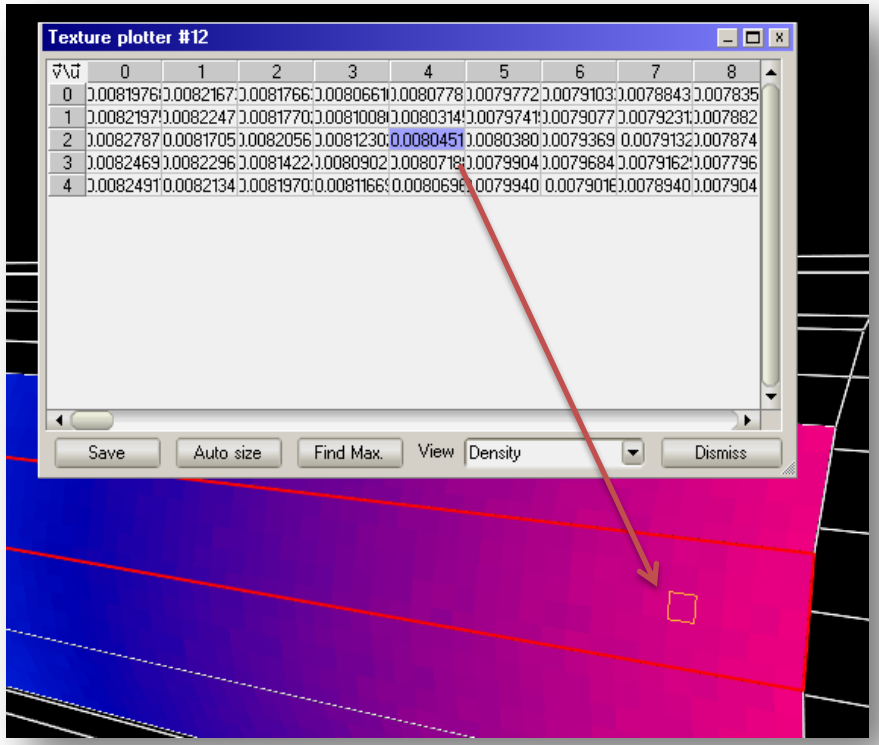


Adding a Texture

View texture block values by selecting a facet with mesh and opening the Texture Viewer:

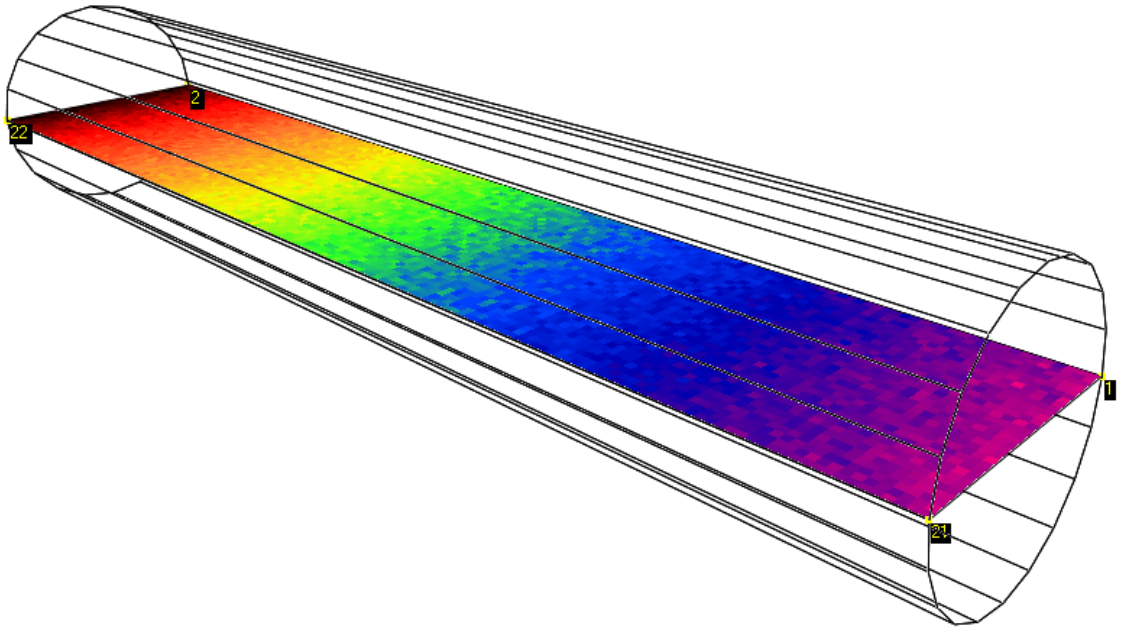


Selected cells' position will be outlined on the facet:



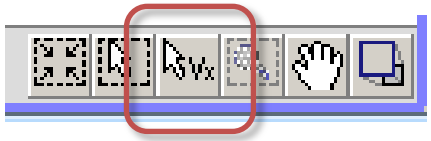
Advanced: add a polygon

- Now that we've covered the basics, here's a useful feauture. To visualize the pressure in the center of the tube, we will add a "dummy" polygon.

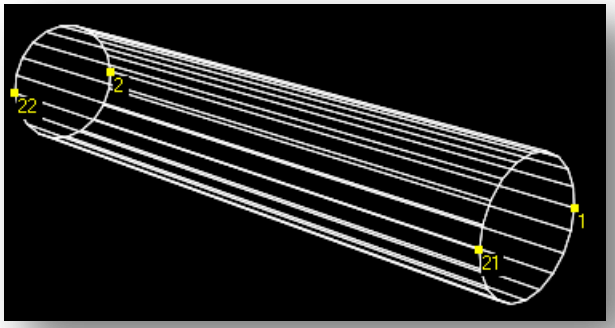


Select vertices

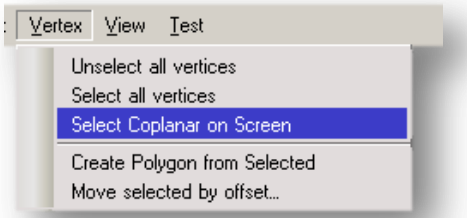
- Choose the vertex selector tool. Notice that the mouse cursor is now different.



- Select 4 vertices that will be the edges of the new polygon:

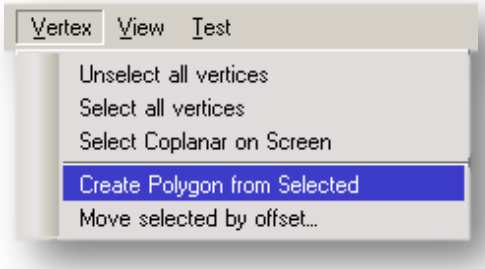


- Hint: after selecting 3 vertices (that define a plane), you can use the “Select coplanar” function to find the fourth:

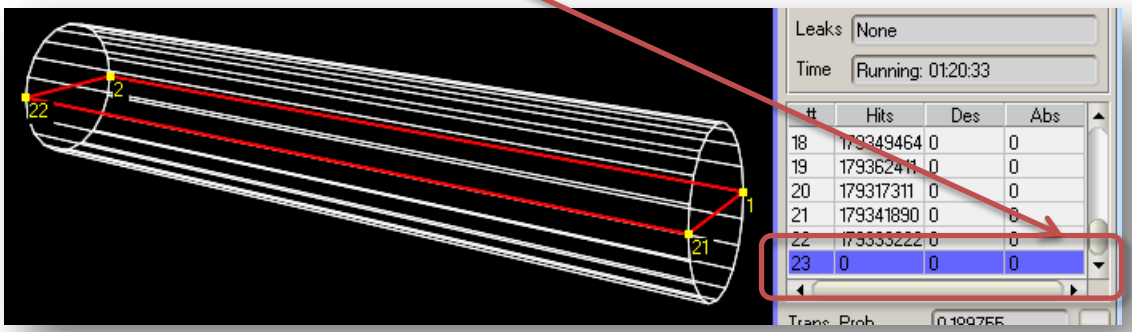


Create the dummy polygon

- Now that we have the four edges selected, click “create polygon from selected”:

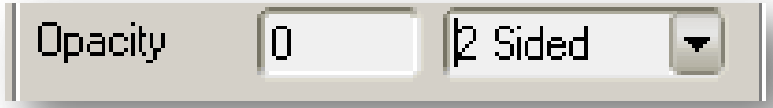


- Molflow creates a new facet. One way to easily select it is to click on the last entry in the facet list on the right:

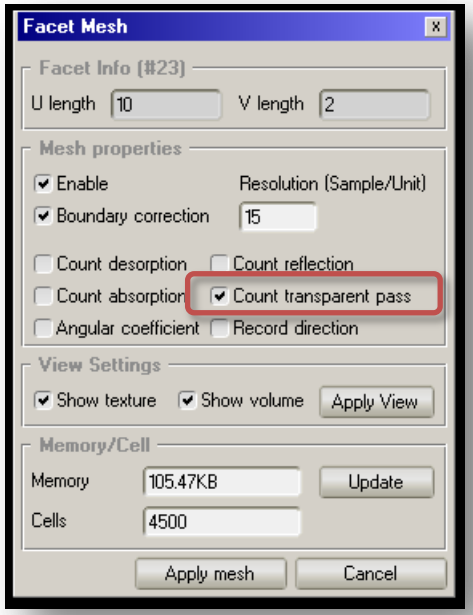


Set facet parameters

- As this is a dummy facet, we want to tell Molflow that it shouldn't change our simulation. To do this, set the opacity to 0, and set the facet as 2-sided (to count particles from up and from down as well):

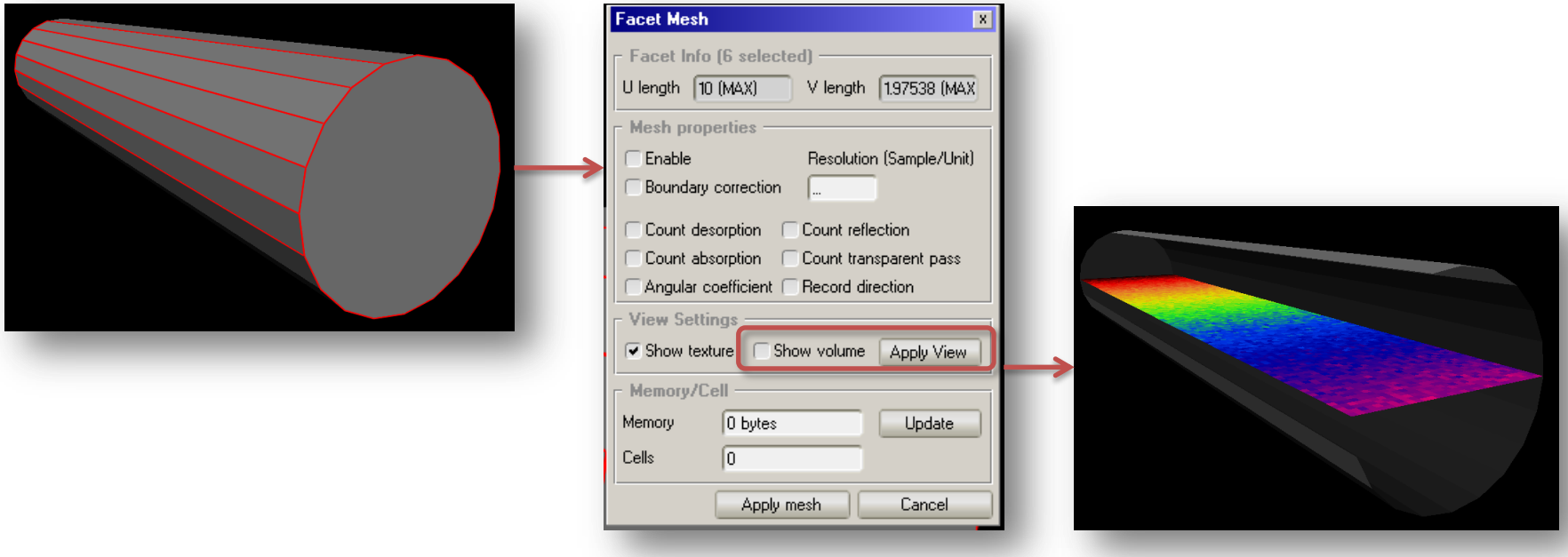


- And the last step is to add a mesh that counts transparent passes:



Done!

- That's it! Start the simulation, and don't forget to enable the "Texture" option in the viewer parameters.
- One last trick: if you want to see the volume of a structure, while seeing the inside as well, turn off the "Volume visible" property of some facets, so they will become transparent:



The end

- Stuck at one point?
- Found a bug?
- Have a suggestion?

Tell your ideas on the website, where you can also find a video tutorial.

(currently http://cern.ch/test-molflow)