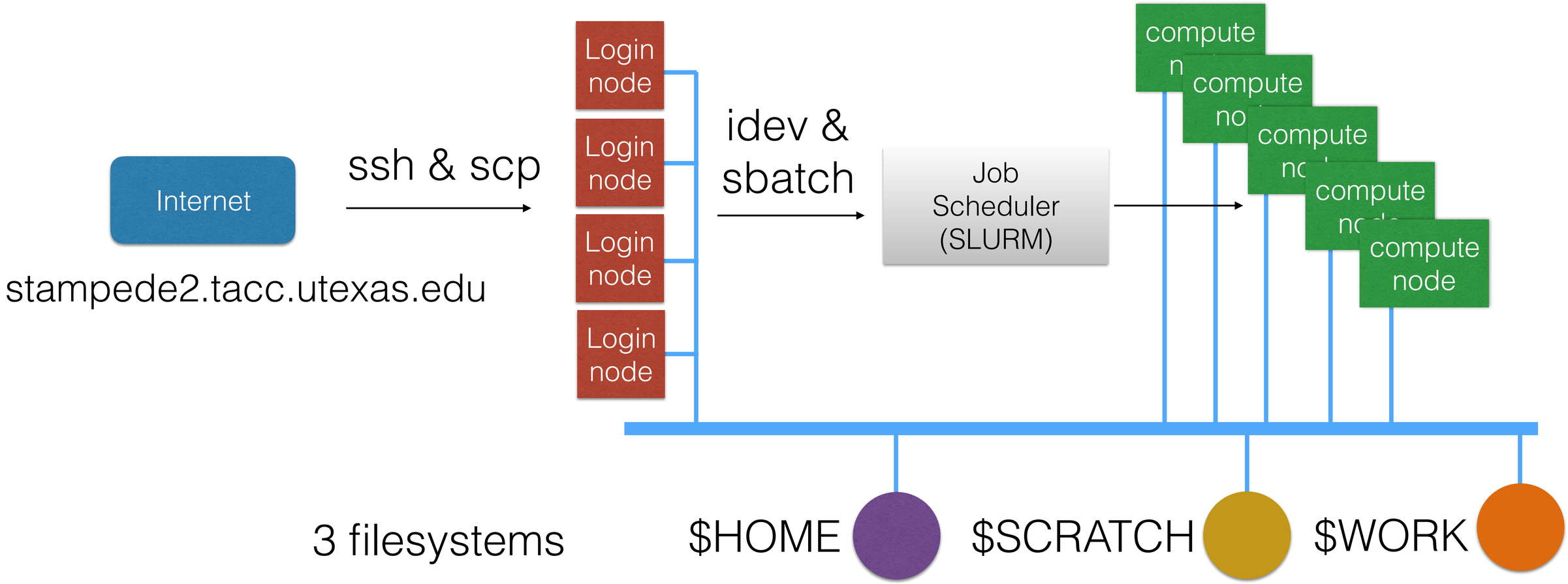
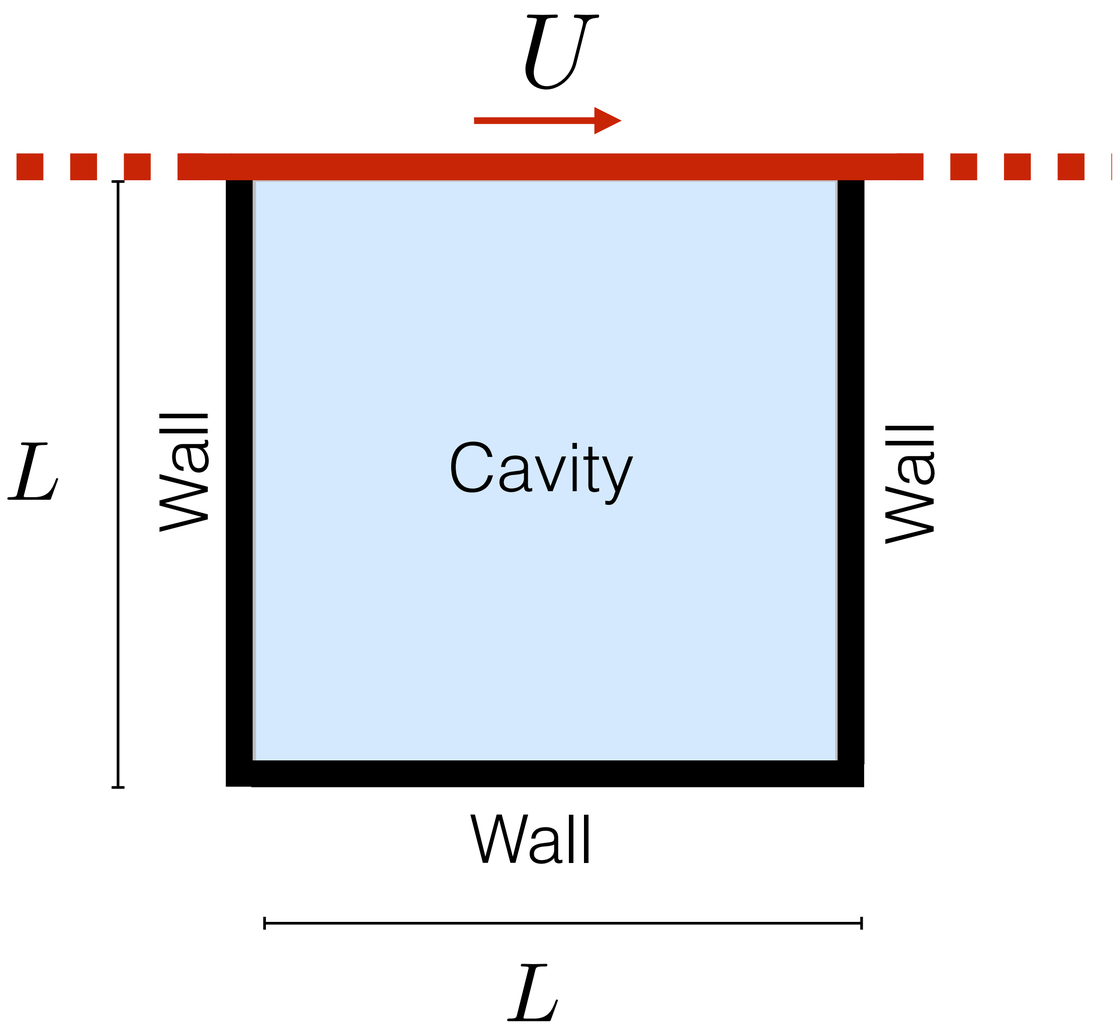
Stampede2 at TACC



The “lid-driven cavity”

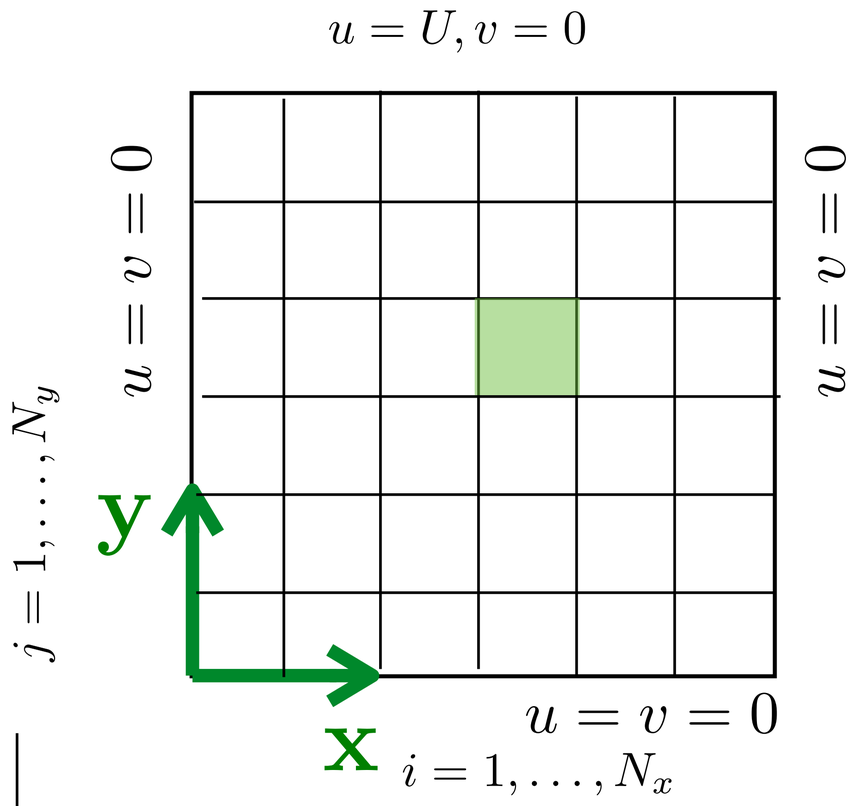


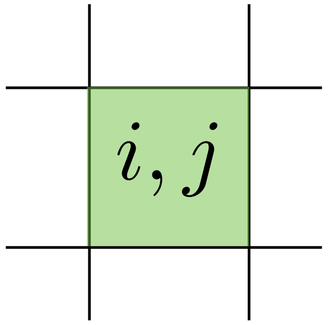
- A canonical, **two-dimensional**, **steady** **incompressible** flow
- Fully characterized by the Reynolds number

$$\mathrm{Re} = UL/\nu$$

- Many solutions available!

The CFD model of the flow





An indexed “control volume”, where u and v are uniform

- Define a Cartesian coordinate system
- Partition the cavity into $N_x \times N_y$ (indexed) square “control volumes”
- Define appropriate boundary conditions
- Solve the equations to find u and v inside each control volume

Running an OF simulation

- **Step 1.** Copy over the tutorial
- **Step 2.** Generate the mesh (**blockMesh** utility)
- **Step 3.** Run the simulation (**icoFoam** solver)
- **Step 4**. Extract the results (**sample** utility)
- **Step 5.** Post-process the results (e.g. compute force on the lid, etc.)

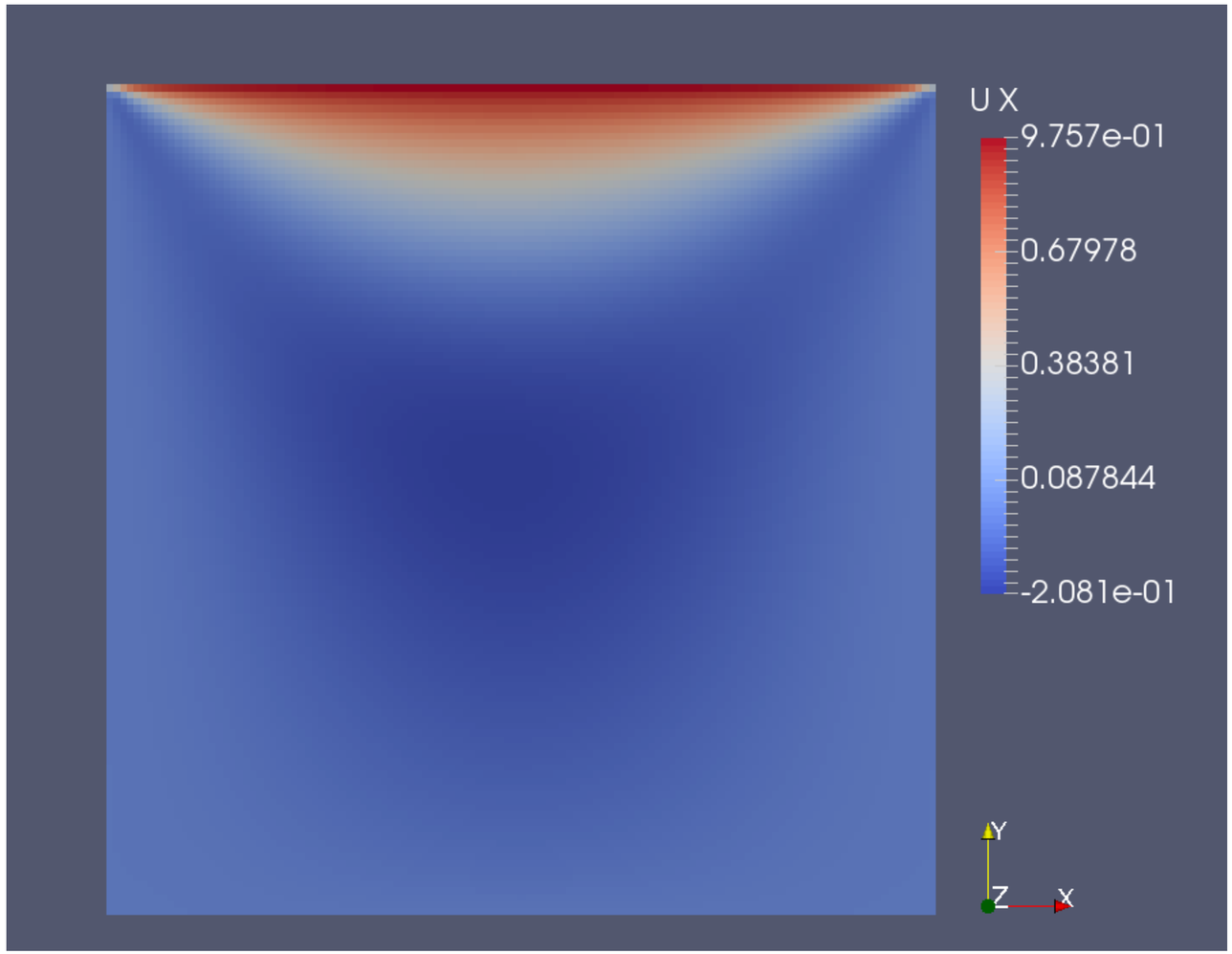
Running the solution

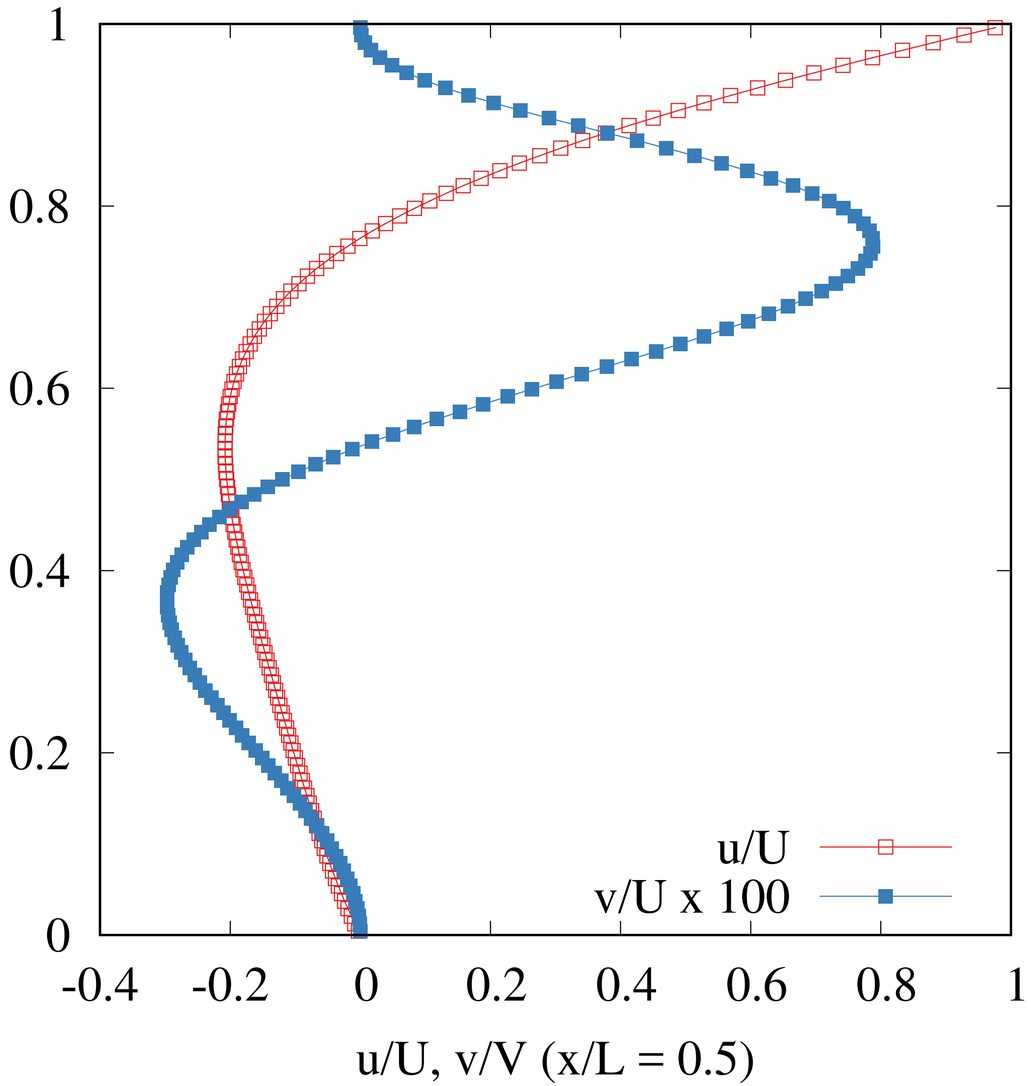
- While the solution we seek is **steady**, we are advancing the solution in time according to the **unsteady** equations from an initial “guess” solution

- This means that you need to decide how long to run the simulation for.

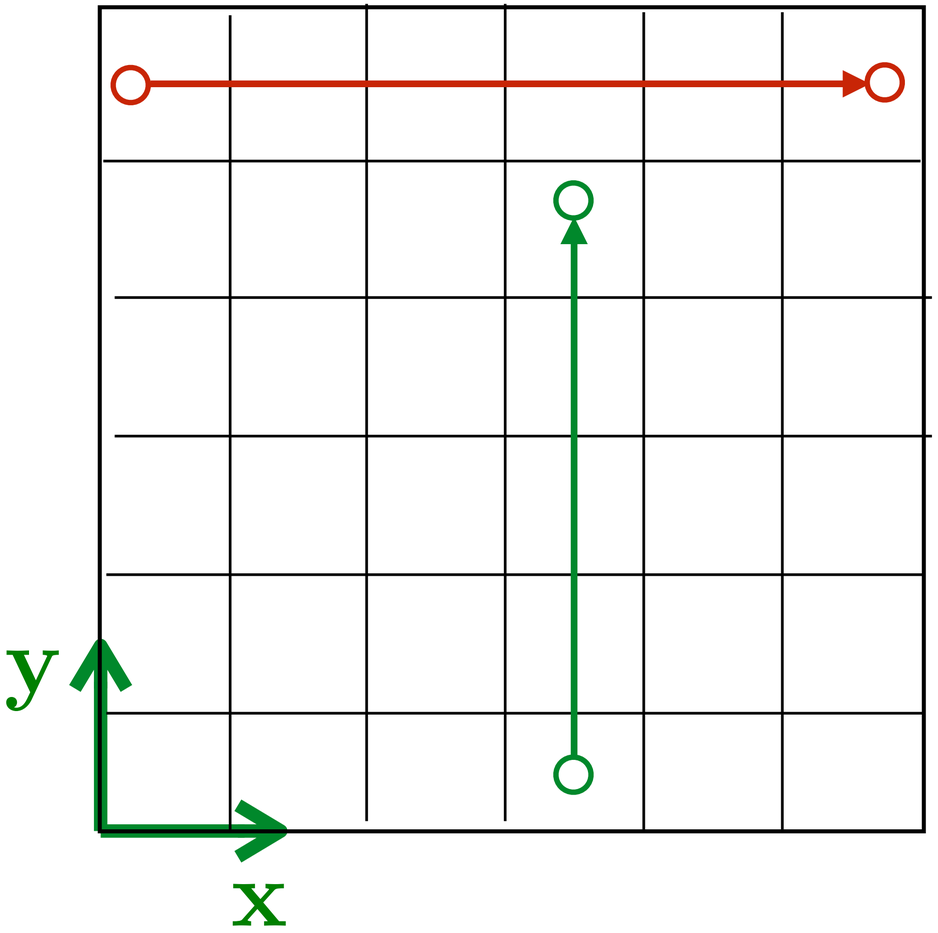
    - It is customary to plot results sampled from two instants in time and compare. Do the result change in time? If not, the solution has **converged to the steady solution**

How does the velocity look like?



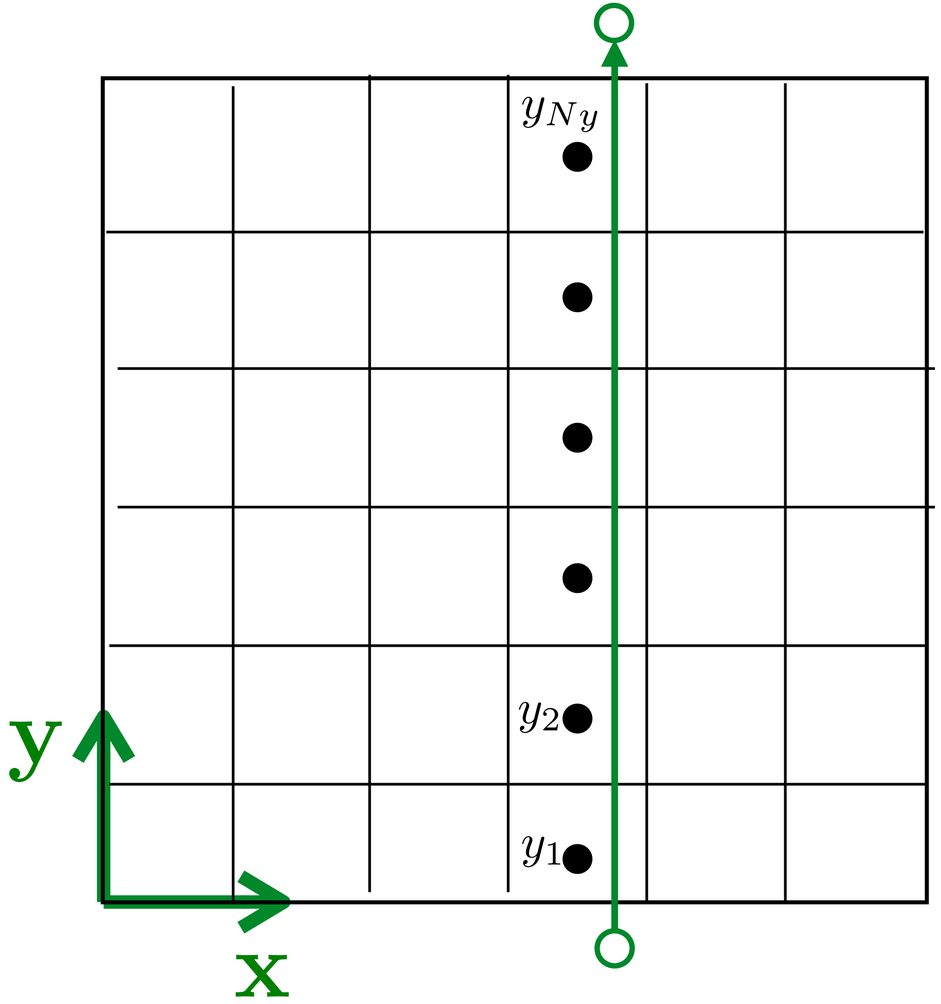


Sampling the solution…



- Always remember: “the solution (two velocity components) is uniform (i.e. constant) in over control volume”
- OpenFOAM allows to “extract” data (the solution) along “lines” with user-defined properties

…continued

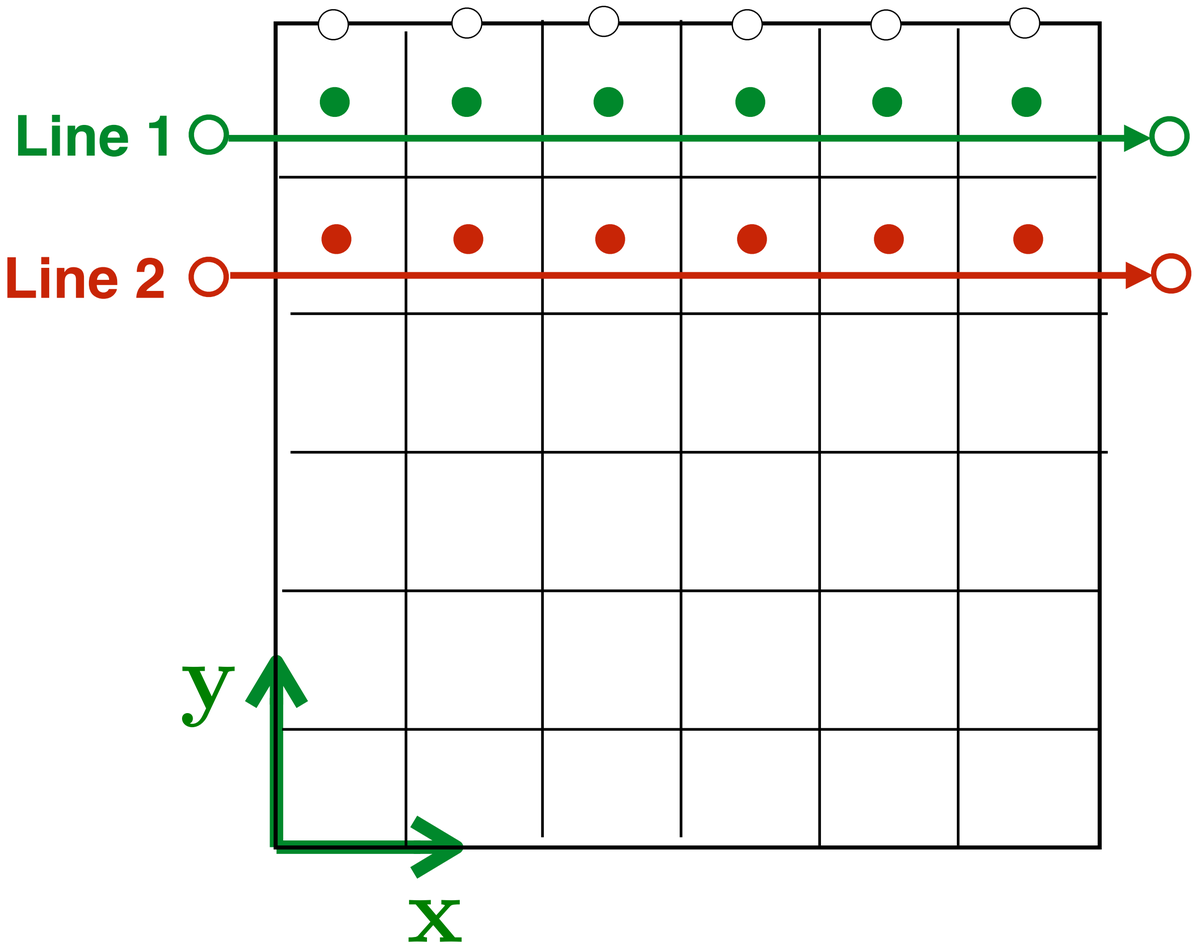


- The sampling utility of OpenFOAM will return the data in ASCII tabular form (MATLAB can read it)
- **First three columns:** x,y,z coordinates of control volumes traversed by line
- **Remaining columns:** variable (vector components if applicable), e.g. u and v, in the traversed control volumes

Things to keep in mind

- If you need/want to start fresh, copy over the $FOAM_TUTORIALS/incompressible/icoFoam/cavity folder
- Start with small grids and problems. They run faster with more turn-around
- Think about what you are trying to do and sketch a plan on a piece of paper before “hitting” the keyboard
- Give yourselves plenty of time on this first assignment

Extracting stress $\partial u/\partial y$ at lid



- Extract $u(i, N_y)$ along line 1
- Extract $u(i, N_y - 1)$ along line 2
- Use extracted data and $u(i, y/L = 1) = U$ to fit a parabola $u_i(y) = a_i y^2 + b_i y + c$ at each x location
- Take the derivative and evaluate at $y = L$