3D shear-layer driven cavity flow with forcing term at $Re_{L_c}= 7826$

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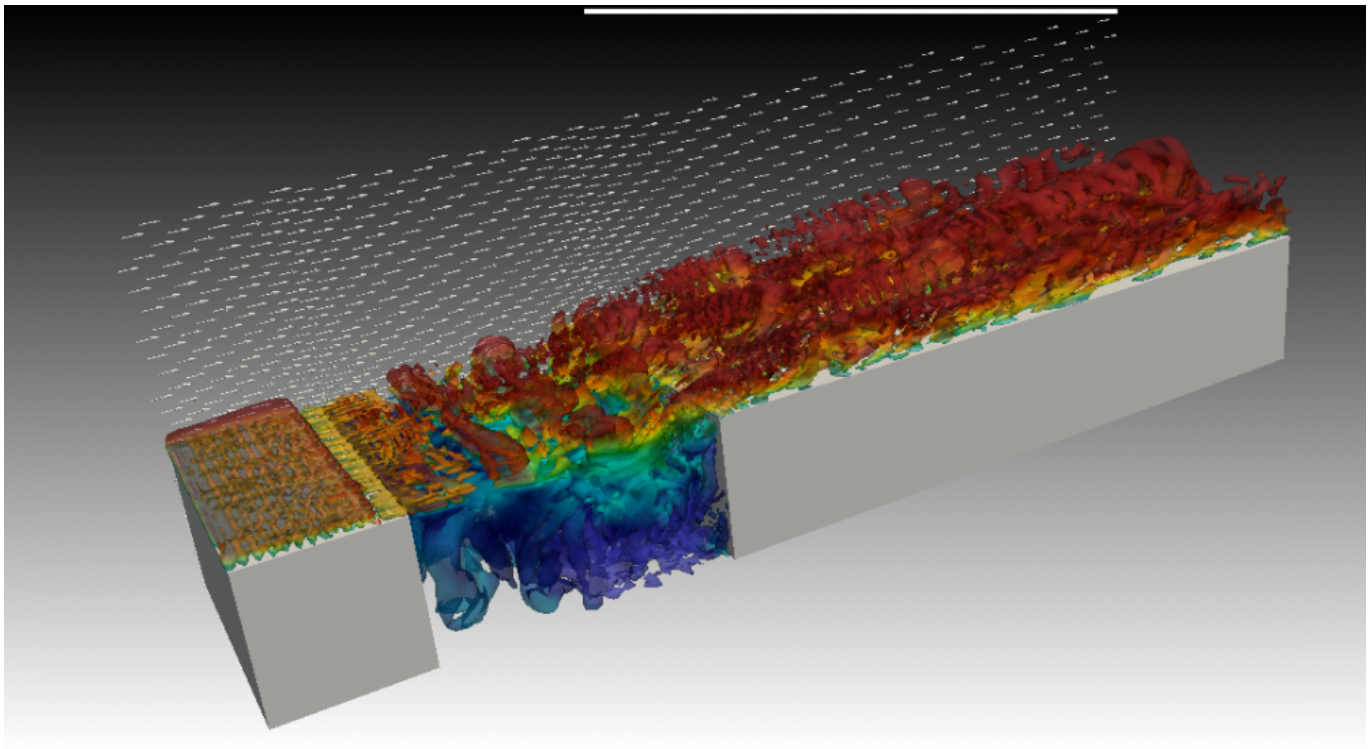
Simulation type : DNS (code Sunfluidh – Sunfluidh code)
Location : DATABASE_CAVITY3D_R2_RE7826_PER1.0_DNS/FORCINGTERM
Status : Free access for laboratory members, on request for external members
Data size : ~ 8.6 Gb



A video is available here

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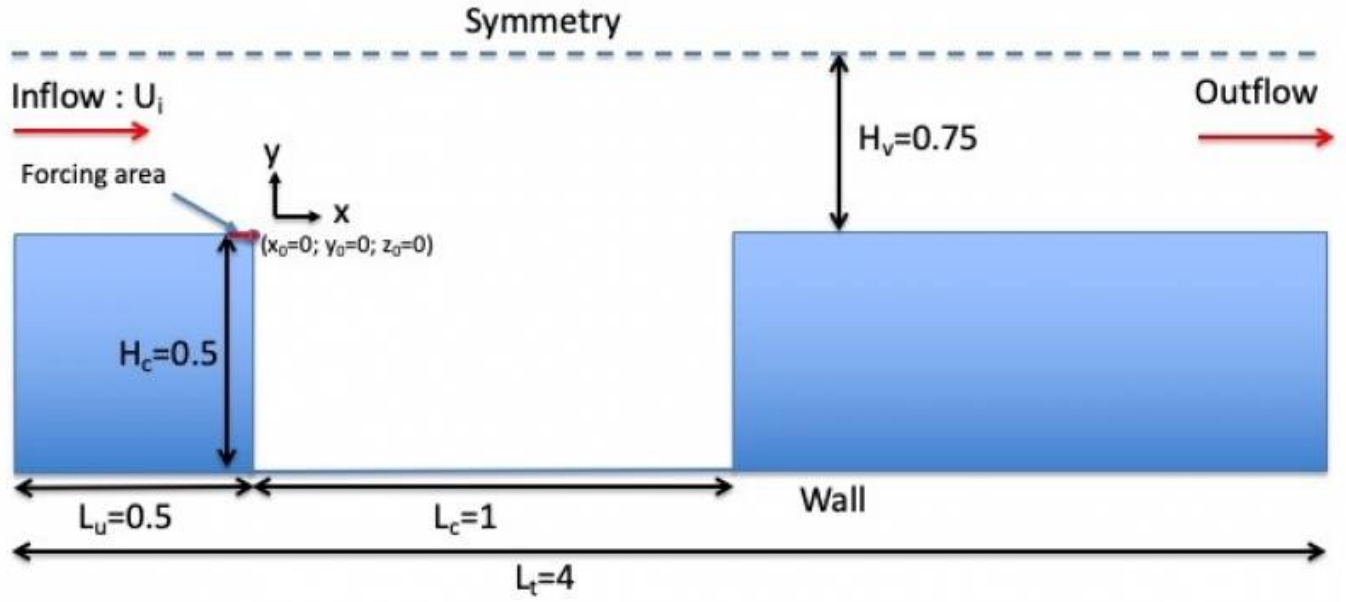
Simulation settings

2D sketch



Referential : cartesian geometry

1. axes :
    - x(i) : downstream direction
    - y(j) : normal direction
    - z(k) : spanwise direction
2. origin :
    - $x_0= 0$: upstream edge of the cavity
    - $y_0= 0$: upstream edge of the cavity
    - $z_0= 0$: upstream edge of the cavity, at the mid-span location

Reference scales

- Density : mass density of the fluid (ρ_0)
- Length : cavity length (L_c)
- Velocity : inlet bulk velocity (U_i)
- Dynamic viscosity : dynamic viscosity of the fluid (μ_0)
- Reynolds number : $Re_{L_c}= \frac{\rho_0.U_i.L_c}{\mu_0}= 7826$

Non-dimensionalised data

- velocity : $U^*=\frac{U}{U_i}$
- density : $\rho^*= \rho/\rho_0= 1$
- coordinates : $x*=\frac{x}{L_c}$, $y^*=\frac{y}{L_c}$, $z^*=\frac{z}{L_c}$

Computational domain

1. **Domain scope**
    - Downstream direction(x) : $L^*= 4.0$
    - Normal direction (y) : $H_t^*= 1.25$
    - Spanwise direction (z) : $l^*= 1.0$

- upstream vein length : $L_u^*= 0.5$
- cavity height : $H_c^*= 0.5$

2. **Boundary conditions**
   - Inlet : Blasius' profile at $X_{in}^*= -0.5$. Boundary layer thickness $\delta^*= 8.75 \, 10^{-2}$
   - Outlet : Orlansky's type at $X_{out}^*= 3.5$
   - Wall conditions : floor and cavity walls
   - Periodicity : lateral ends of the domain (spanwise direction)
   - Symmetry plan : top of the domain
3. **Spatial resolution**
   - Grid : $192 \times 128 \times 64$ per subdomain (1.572.864 cells over the domain)
   - About cell-size
     - $\Delta x_{min}^*= 1.0 \, 10^{-2} \quad \Delta x_{max}^*= 3.96 \,10^{-2}$ (downstream direction)
     - $\Delta y_{min}^*= 7.5 \, 10^{-3} \quad \Delta y_{max}^*= 1.45 \,10^{-2}$ (normal direction)
     - $\Delta z_{min}^*=\Delta z_{max}^*= 1.5625 \, 10^{-2}$ (spanwise direction)

Forcing term modeling

- Location : In front of the uptream edge of cavity
- Zone area : brick volume : $0.1 \times 7.5 \, 10^{-3} \times 1$, center located at : ($-0.05, 3.75 \,10^{-3},0$)
- forcing term modeled with the pseudo-penalty approach (Pasquetti et al., Applied Numerical Mathematics 58 (2008))
  - force applied in the zone area defined as : $\vec{f}= \frac{U_0-U(i,j)}{\tau}$
  - $\tau \approx \delta t$ (the numerical time step)

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Data features

- **Time series from probes**
  - Physical quantities : velocity components along x, y and z directions (u,v,w) and pressure (p)
  - 11 probes
  - Time step= 0.0525 time unit
  - Time range : 25.02 to 259.96 time units
  - Locations (In vertical mid-plan at $z=0.0$)
    - Xi=0.2 , Xj= -0.3 , Xk= 0.0
    - Xi=0.5 , Xj= -0.3 , Xk= 0.0
    - Xi=0.8 , Xj= -0.3 , Xk= 0.0
    - Xi=0.1 , Xj= 0.05 , Xk= 0.0
    - Xi=0.5 , Xj= 0.05 , Xk= 0.0
    - Xi=0.9 , Xj= 0.05 , Xk= 0.0
    - Xi=1.0 , Xj= 0.05 , Xk= 0.0

    - File name (per physical quantity) : x_ins_yyyyy.d with x= u,v,w,p and 'yyyyy' the MPI subdomain ID

- **3D snapshots**
    - Instantaneous fields : velocity components in x, y and z directions (U,V,W) and pressure (P)
    - Recording rate : 0.25 time unit
    - Time range from from 210.0 to 260.0 time units
    - File name : res_xxxxx_yyyyyyy.d (xxxxx : MPI subdomain ID, yyyyyyy : Time ID)
        - MPI subdomain ID: 0
        - Time ID : from 39 to 239

- **2D slices**
    - Instantaneous fields : velocity components in x, y and z directions (U,V,W) and pressure (P)
    - Recording rate : 0.05 time units
    - Time range from from 210 to 260 time units
    - File name : slice_n_idir_xxxxx_yyyyyyy.d (n : slice number ID, idir : normal orientation= 1: x(i), 2: y(j), 3: z(k), xxxxx : MPI subdomain ID, yyyyyyy : Time ID)
        - MPI subdomain ID: 0
        - Time ID : from 1 to 1001
    - 8 slices
        - slice ID : 1 - normal orientation : spanwise - location : $z=-3.390625 \,10^{-2}$
        - slice ID : 2 - normal orientation : spanwise - location : $z=-2.234375 \,10^{-2}$
        - slice ID : 3 - normal orientation : spanwise - location : $z=-7.8125 \,10^{-2}$
        - slice ID : 4 - normal orientation : spanwise - location : $z=7.8125 \,10^{-2}$
        - slice ID : 5 - normal orientation : spanwise - location : $z=2.234375 \,10^{-2}$
        - slice ID : 6 - normal orientation : spanwise - location : $z=3.390625 \,10^{-2}$
        - slice ID : 7 - normal orientation : normal - location : $y=-0.25$
        - slice ID : 8 - normal orientation : normal - location : $y=0.03$

- **Statistics**
    - fields : (i,j : indexes of direction x, y or z)
        - Mean fields of velocity components (<Ui>) and pressure (<P>)
        - Mean fields of quadratic quantities (<P2>, <UiUj>)
    - Time average computation
    - Time startup = 210.0 time units
    - Time range per file = 50.0 time units
    - Total time range from 180.0 to 510.0 time units
    - file name : rst_xxxxx_yyyyyyy.d (xxxxx : MPI subdomain ID, yyyyyyy : Time ID)
        - MPI subdomain ID : 0
        - Time ID : 1

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Database organisation

Data size : ~ 8.6 Gb

Main directory :
/vol/DATABASE_MECA/DATABASE_CAVITY3D_R2_RE7826_PER1.0_DNS/FORCINGTERM
For more details about files, see the wiki doc of Sunfluidh

Directories & files

```
  /GRID : contains all ASCII files about grid setup
     input data file         : data_meshgen.d
     report on grid features : report_meshgen.d
     grid files for sunfluidh: maillx.d, mailly.d, maillz.d
     check files (ASCII)     : check_mesh_I.d,check_mesh_J.d,check_mesh_K.d
                               (3 columns : indices, cell-face coordinates,
cell size)
  /DATASETUP       : ASCII files
   input data file for sunfluidh : input3d.dat
   velocity profile (Blasius' boundary layer) at the inlet :
inlet_velocity_profile.dat
  /TIMESERIES : contains time series recorded over the time range
[200,513.3]
                ASCII files : x_ins_00000_full.d   with x= u,v,w,p
  /SNAPSHOTS  : snapshots binary files res_xxxxx_yyyyyyy.d
  /STATISTICS : statistics binary files files rst_xxxxx_yyyyyyy.d
  /RESTART_AR : backup/restart archive save.tar at 260.0 time units
```

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