

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

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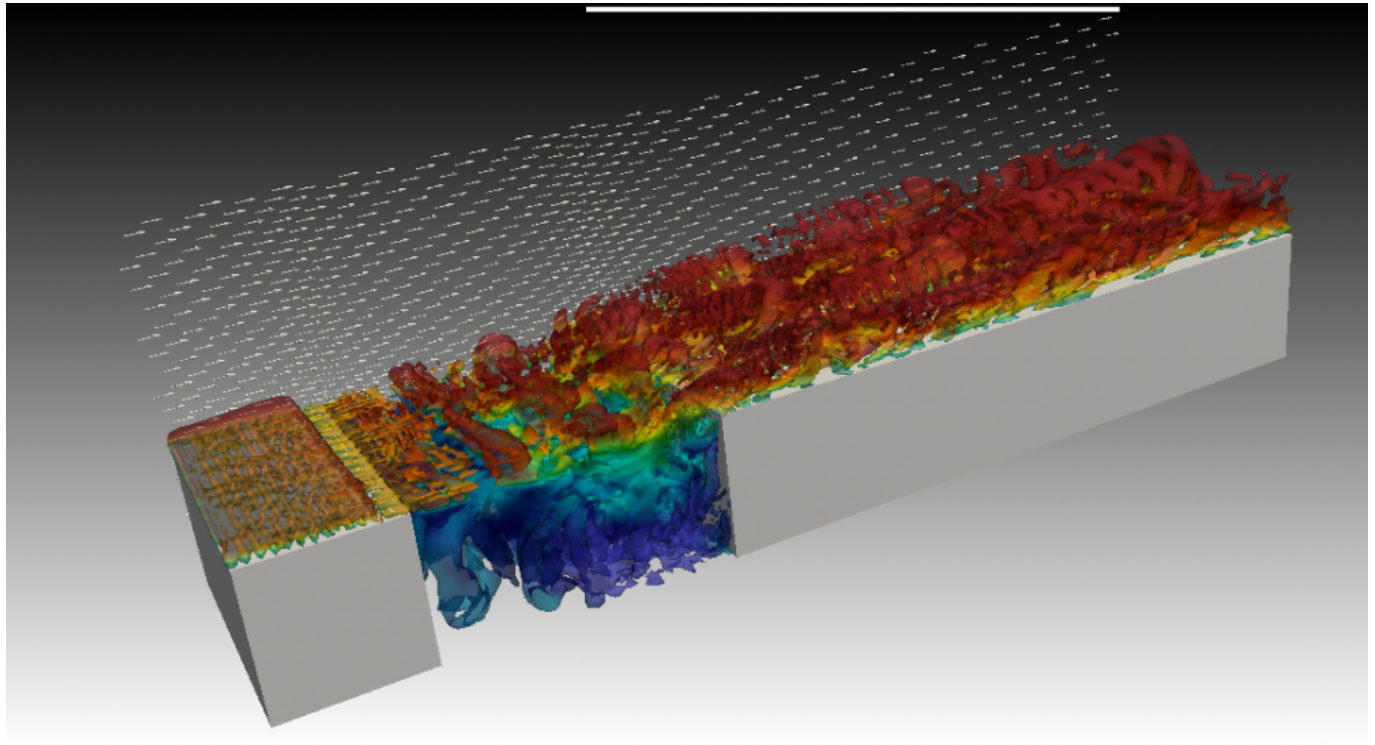
Date : July 2020

Simulation type : DNS ([Sunfluidh code](#))

Location : DATABASE_CAVITY3D_R2_RE7826_PER1.0_DNS/FORCINGTERM

Status : Free access

Data size : ~ 8.6 Gb

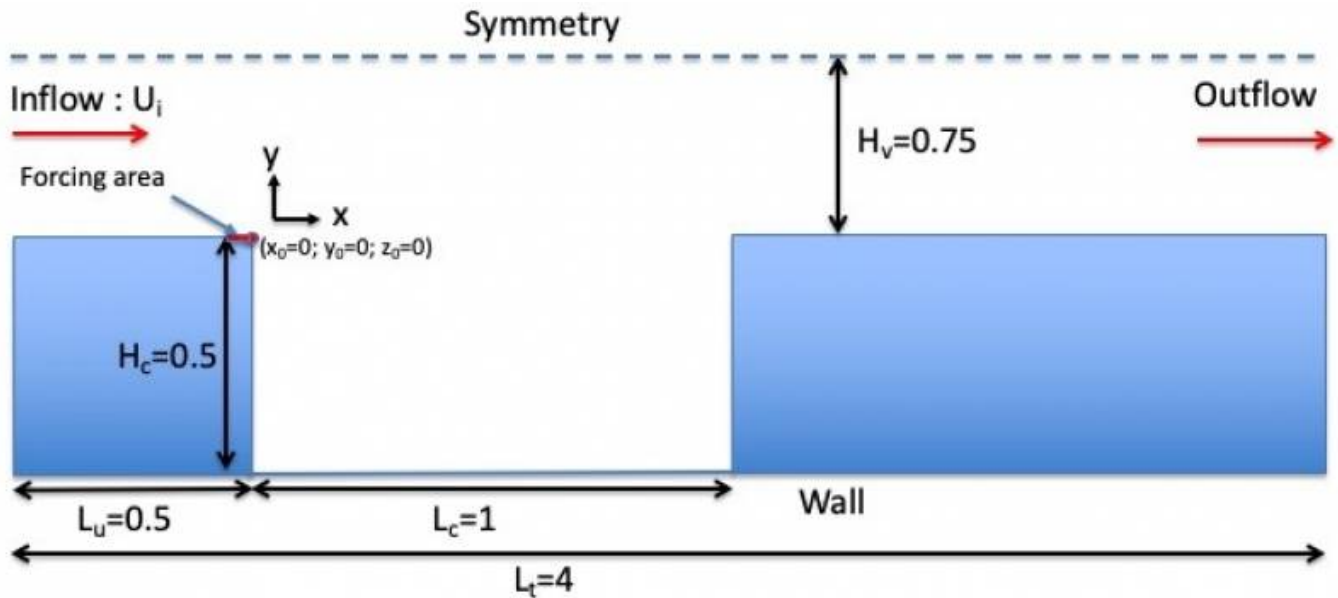


[A video is available here](#)

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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 : $\rho^* = \frac{\rho}{\rho_0} = 1$
- 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 $\delta^* = 8.75 \times 10^{-2}$
- 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
 - $\Delta x_{min}^* = 1.0 \times 10^{-2}$ quad $\Delta x_{max}^* = 3.96 \times 10^{-2}$ (downstream direction)
 - $\Delta y_{min}^* = 7.5 \times 10^{-3}$ quad $\Delta y_{max}^* = 1.45 \times 10^{-2}$ (normal direction)
 - $\Delta z_{min}^* = \Delta z_{max}^* = 1.5625 \times 10^{-2}$ (spanwise direction)

Forcing term modeling

- Location : In front of the upstream edge of cavity
- Zone area : brick volume : $0.1 \times 7.5 \times 10^{-3} \times 1$, center located at : $(-0.05, 3.75 \times 10^{-3}, 0)$
- forcing term modeled with the pseudo-penalty approach (Pasquetti et al., Applied Numerical Mathematics 58 (2008))
 - force applied in the zone area defined as : $\vec{f} = \frac{U - U_i - U(i,j)}{\tau}$
 - $\tau \approx \delta t$ (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 $z=0.0$)
 - $X_i=0.2$, $X_j= -0.3$, $X_k= 0.0$
 - $X_i=0.5$, $X_j= -0.3$, $X_k= 0.0$
 - $X_i=0.8$, $X_j= -0.3$, $X_k= 0.0$
 - $X_i=0.1$, $X_j= 0.05$, $X_k= 0.0$
 - $X_i=0.5$, $X_j= 0.05$, $X_k= 0.0$
 - $X_i=0.9$, $X_j= 0.05$, $X_k= 0.0$
 - $X_i=1.0$, $X_j= 0.05$, $X_k= 0.0$

- 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 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 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 : $z=-3.390625 \cdot 10^{-2}$
 - slice ID : 2 - normal orientation : spanwise - location : $z=-2.234375 \cdot 10^{-2}$
 - slice ID : 3 - normal orientation : spanwise - location : $z=-7.8125 \cdot 10^{-2}$
 - slice ID : 4 - normal orientation : spanwise - location : $z=7.8125 \cdot 10^{-2}$
 - slice ID : 5 - normal orientation : spanwise - location : $z=2.234375 \cdot 10^{-2}$
 - slice ID : 6 - normal orientation : spanwise - location : $z=3.390625 \cdot 10^{-2}$
 - 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 ($\langle U_i \rangle$) and pressure ($\langle P \rangle$)
 - Mean fields of quadratic quantities ($\langle P^2 \rangle$, $\langle U_i U_j \rangle$)
 - 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 rst_XXXXX_yyyyyyy.d
/RESTART_AR : backup/restart archive save.tar at 260.0 time units
```

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