

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

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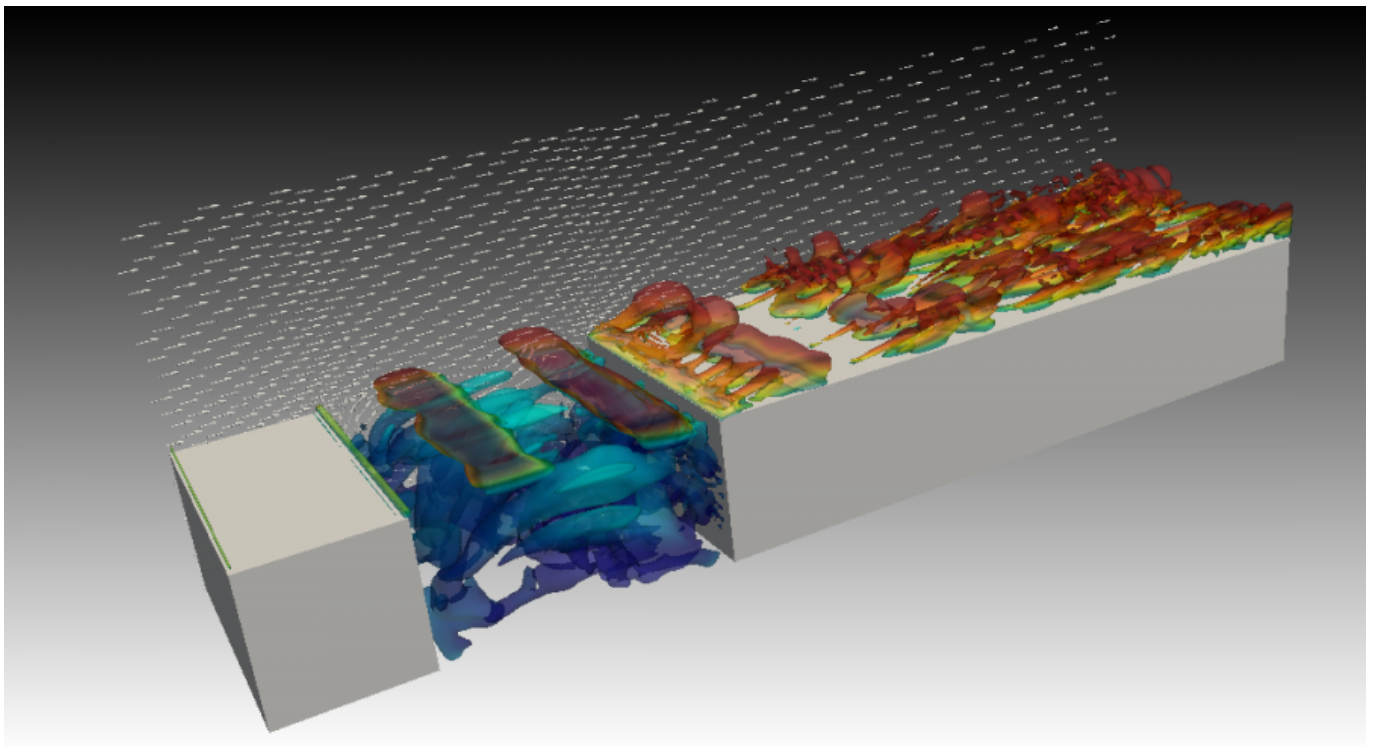
**Date** : July 2020

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

**Location** : DATABASE\_CAVITY3D\_R2\_RE7826\_PER1.0\_DNS/NOFORCINGTERM

**Status** : Free access

**Data size** : ~ 31 Gb



[A video is available here](#)

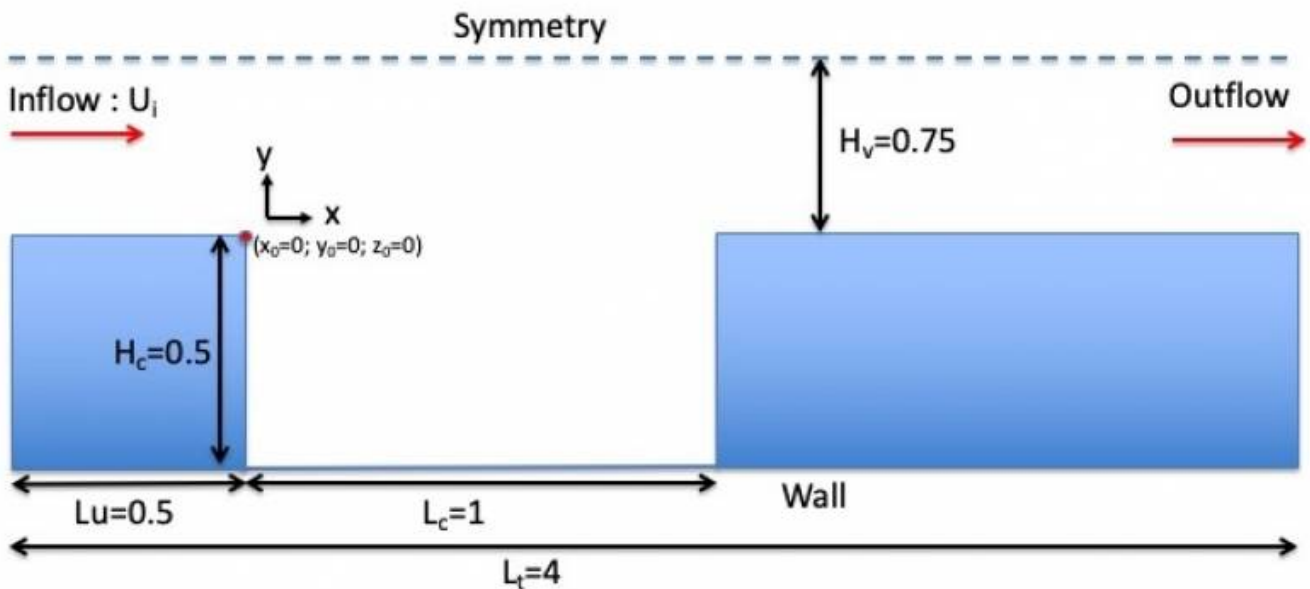
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## Simulation settings

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### 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 ( $\rho_0$ )
- Length : cavity length ( $L_c$ )
- Velocity : inlet bulk velocity ( $U_i$ )
- Dynamic viscosity : dynamic viscosity of the fluid ( $\mu_0$ )
- Reynolds number :  $Re_H = \frac{\rho_0 \cdot U_i \cdot L_c}{\mu_0} = 7826$

## 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  $\delta^* = 8.75 \cdot 10^{-2}$
- 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
  - $\Delta x_{min}^* = 1.0 \cdot 10^{-2} \quad \Delta x_{max}^* = 3.96 \cdot 10^{-2}$  (downstream direction)
  - $\Delta y_{min}^* = 7.5 \cdot 10^{-3} \quad \Delta y_{max}^* = 1.45 \cdot 10^{-2}$  (normal direction)
  - $\Delta z_{min}^* = \Delta z_{max}^* = 1.5625 \cdot 10^{-2}$  (spanwise direction)

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## Data features

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### • 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 : 200 to 400 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 from 210.0 to 400.0 time units
- File name :  $res\_xxxxx\_yyyyyyy.d$  (xxxxx : MPI subdomain ID, yyyyyyy : Time ID)
  - MPI subdomain ID: 0
  - Time ID : from 1 to 760

- **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 400 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 3801
- 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 = 200.0 time units
- Time range per file = 50.0 time units
- Total time range from 200.0 to 400.0 time units
- file name : rst\_xxxxx\_yyyyyyy.d (xxxxxx : MPI subdomain ID, yyyyyyy : Time ID)
  - MPI subdomain ID : 0
  - Time ID : 1 to 4

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## Database organisation

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**Data size** : ~ 9.5 Gb

**Main directory** :

/vol/DATABASE\_MECA/DATABASE\_CAVITY3D\_R2\_RE7826\_PER1.0\_DNS/NOFORCINGTERM

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_t400.tar time units
```

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