

3D forward-facing step flow at $Re_H = 8000$ (laminar inflow)



Database in progress ... it is currently uncompleted

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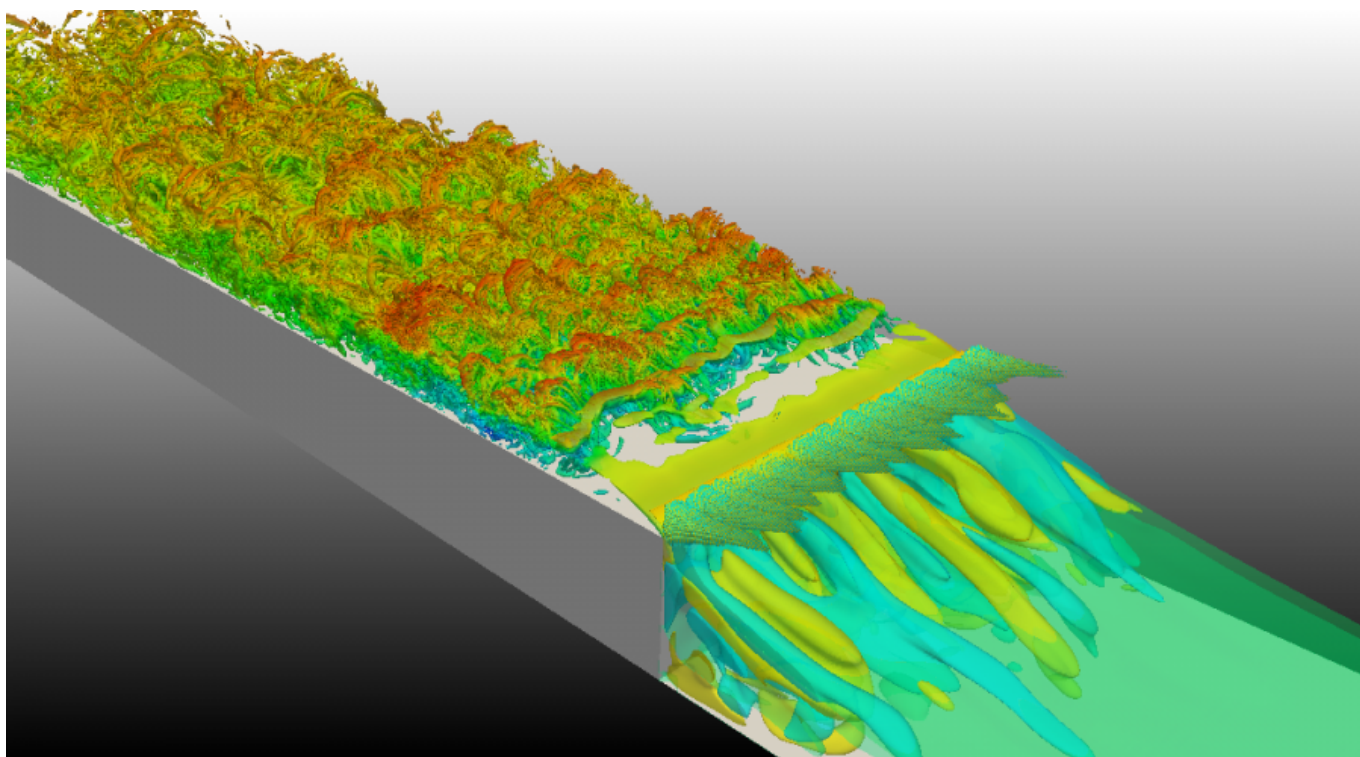
Date : August 2020

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

Location : DATABASE_FORWARDFACINGSTEPFLOW1_RE8000_DNS

Status : Restricted access

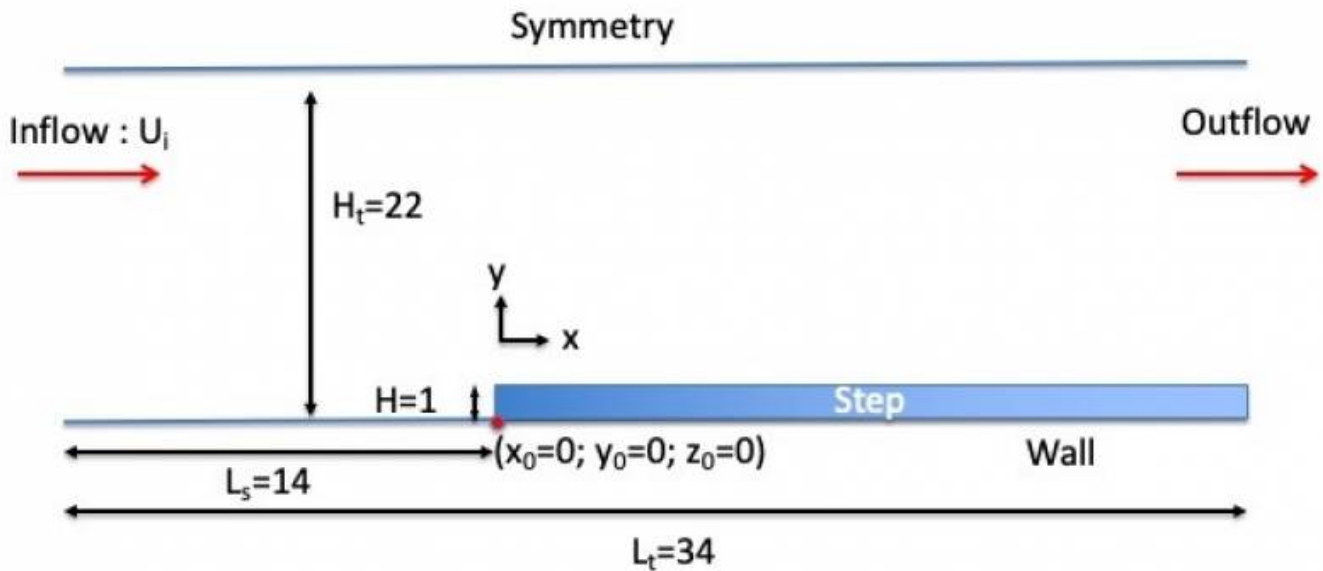
Data size : ~ 3.2 Tb



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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 :
 - $x_0 = 0$: the step
 - $y_0 = 0$: the bottom wall of the domain
 - $z_0 = 0$: the left side of the computational domain

Reference scales

- Density : mass density of the fluid (ρ_0)
- Length : step height (H)
- Velocity : inlet bulk velocity (U_i)
- Dynamic viscosity : dynamic viscosity of the fluid (μ_0)
- Reynolds number : $Re_H = \frac{\rho_0 \cdot U_i \cdot H}{\mu_0} = 8000$

Non-dimensionalised data

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

Computational domain

1. Domain scope
 - Downstream direction (x) : $L^* = 34.0$
 - Normal direction (y) : $H_t^* = 22.0$
 - Spanwise direction (z) : $l^* = \pi$

- Step position : $L_s^* = 14.0$
- Step height : $H^* = 1$

2. Boundary conditions

- Inlet : Blasius' profile at $X_{in}^* = -14.0$, $\delta_{in} = \frac{H}{3}$ (boundary layer's thickness)
- Outlet : Orlansky's type at $X_{out}^* = 20.0$
- Wall conditions : Top and low walls of the domain
- Periodicity : lateral ends of the domain

3. Domain decomposition (200 MPI subdomains)

- Along the downstream direction :
 - 15 (between the inlet and the outlet, above the step)
 - 10 (between the inlet and the step)
- Along the normal direction : 4
- Along the spanwise direction : 4
- 2D sketch of domain decomposition in a plan $\{xy\}$ (MPI process distribution (1))


```

1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 0 0 0 0 0 0 0 0 0 0
      
```

4. Spatial resolution

- Grid : $128 \times 192 \times 96$ per subdomain (471.859.200 cells over the domain)
- About cell-size
 - $\Delta x_{min}^* = 1.0 \times 10^{-2} \quad \Delta x_{max}^* = 2.5 \times 10^{-2}$ (downstream direction)
 - $\Delta y_{min}^* = 1.5 \times 10^{-3} \quad \Delta y_{max}^* = 7.5 \times 10^{-2}$ (normal direction)
 - $\Delta z_{min}^* = \Delta z_{max}^* = 8.18123 \times 10^{-3}$ (spanwise direction)

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Data features

- **Time series from probes** : U,V,W,P (velocity components & pressure)
 - Physical quantities : velocity components along x, y and z directions (u,v,w) and pressure (p)
 - 5 probes
 - Time step = 0.0126 time unit
 - Time range : 188.37 to 396.87 time units
 - Locations (In vertical plan at $z=1.57$)
 - $X_i = -0.250$, $X_j = 0.250$, $X_k = 1.57$ - MPI Subdomain ID :
 - $X_i = 0.125$, $X_j = 1.125$, $X_k = 1.57$ - MPI Subdomain ID :
 - $X_i = 1.000$, $X_j = 1.125$, $X_k = 1.57$ - MPI Subdomain ID :
 - $X_i = 1.000$, $X_j = 1.250$, $X_k = 1.57$ - MPI Subdomain ID :
 - $X_i = 4.000$, $X_j = 1.125$, $X_k = 1.57$ - MPI Subdomain ID :
- 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)
- first dataset :
 - Recording rate : **0.9** time units
 - Time range from 189.877 to 303.877 time units
 - File name : res_XXXXX_YYYYYYY.d (XXXXX : MPI subdomain ID, YYYYYY : Time ID)
 - MPI subdomain ID: from 0 to 199
 - Time ID : from 69 to 195
- second dataset :
 - Recording rate : **0.3** time units
 - Time range from 303.877 to 396.877 time units
 - File name : res_XXXXX_YYYYYYY.d (XXXXX : MPI subdomain ID, YYYYYY : Time ID)
 - MPI subdomain ID: from 196 to 199
 - Time ID : from 196 to 505

- **2D slices**

- Instantaneous fields : velocity components in x, y and z directions (U,V,W) and pressure (P)
- Recording rate : 0.3 time units
- Time range from 189.877 to 396.877 time units
- 3 slices are considered :
 - slice 1 : normal direction k - position : z= 1.57 - MPI subdomains ID :
 - MPI subdomains ID : 1 to 197 with a stride of 4
 - slice 2 : normal direction x - position : x=-0.01
 - MPI subdomains ID : 64 to 79
 - slice 3 : normal direction y - position : y= 1.30
 - MPI subdomains ID : 4 to 7
 - MPI subdomains ID : 20 to 23
 - MPI subdomains ID : 36 to 39
 - MPI subdomains ID : 52 to 55
 - MPI subdomains ID : 68 to 71
 - MPI subdomains ID : 80 to 83
 - MPI subdomains ID : 92 to 95
 - MPI subdomains ID : 104 to 107
 - MPI subdomains ID : 116 to 119
 - MPI subdomains ID : 128 to 131
 - MPI subdomains ID : 140 to 143
 - MPI subdomains ID : 152 to 155
 - MPI subdomains ID : 164 to 167
 - MPI subdomains ID : 176 to 179
 - MPI subdomains ID : 188 to 191
 - File name : slice_n_idir_XXXXX_YYYYYYY.d (n : slice number ID, idir : direction= 1: x(i), 2: y(j), 3: z(k), XXXXX : MPI subdomain ID, YYYYYY : Time ID)
 - MPI subdomain ID: ??
 - Time ID : from 748 to ??

- **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 and space average computation (along the spanwise direction)
- Time startup = 200.0 time units
- Time range per file = 10.0 time units
- Total time range from 200.0 to 390 time units
- file name : rst_XXXXX_YYYYYYY.d (XXXXX : MPI subdomain ID, YYYYYYY : Time ID)
 - MPI subdomain ID : from 0 to 49 (MPI process rank where results about space average computation are stored)
 - Time ID : from 1 to 19

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Database organisation

Data size : ~ 5.2 Tb

Main directory :

/vol/DATABASE_MECA/RESTRICTED_ACCESS/DATABASE_FROWARDFACINGSTEPFLOW1_RE8000_DNS

For more details about files, see the [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: mailx.d, mailly.d, mailz.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
data file for MPI subdomain distribution (MPI graphical topology):
data_mpi_subdomain_layout.dat
/TIMESERIES              : contains time series recorded over the time range
[188.37,??]
                           ASCII files : x_ins_YYYYY.d with x= u,v,w,p
                           time series files are sliced in storage directories CAS-
MPI200-n (n from 130 to ??)
/SNAPSHOTS               : snapshots binary files res_XXXXX_YYYYYYY.d with a
recording rate of 0.9 time unit
                           files stored in archive files : res_YYYYYYY.tar for each
time ID
/SNAPSHOTS_FS            : snapshots binary files res_XXXXX_YYYYYYY.d with a
recording rate of 0.3 time unit
                           files stored in archive files : res_YYYYYYY.tar for each
time ID
/STATISTICS              : statistics binary files files rst_XXXXX_YYYYYYY.d
                           files stored in archive files : res_z.tar , z is an ID
  
```

```
number (from 1 to ??)
/SLICES      : slice binary files slice_n_idir_XXXXX_YYYYYYY.d
               files stored in archive files : slices_z.tar , z is an ID
number (from 131 to ??)
/RESTART_AR  : backup/restart archive save.tar at time ??
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