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CFD Simulations using Feel++

FEZANI LILYA NESRINE

August 25, 2020



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The objectives of this work is to study different flows with Feel++

- Laminar Isotherme Backward Facing Steps Benchmark
- Numerical simulations of flow past three circular cylinders in equilateral-triangular arrangements
- Forces and flow around three side-by-side square cylinders
- Proximity Effects on Characteristics of Flow around Three Inline Square Cylinders

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The results obtained with Feel++ are compared with the results in the articles



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Introduction to Computational Fluid Dynamics

CFD insight



CFD prosses

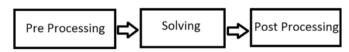


Figure 1.1 The computational fluid dynamics process.

- CFD governing equations In principle, all three parameters must be conserved:
 - Conservation of mass
 - Conservation of momentum
 - conservation of energy

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Presentation

The study was based on a laminar flow around a step laid in a flat channel for two different Reynolds number values: Re = 389 and Re = 1095 at different downstream locations.

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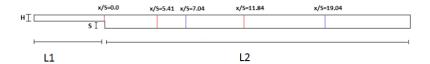
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The geometry associated with the problem is as follows:

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Reattachment length in the laminar flow regin

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Case Re=389

The graph below show the comparison of the theorical solution with simulate flow solution for:

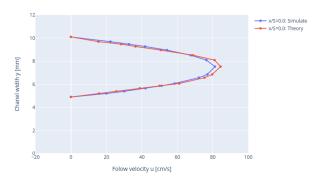
Objectives

•
$$x/S = 0.0$$

The graph below show the comparison of the theorical solution with simulate flow solution for:

Objectives

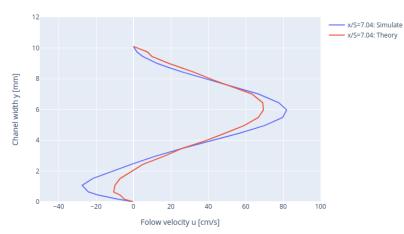
$$x/S = 0.0$$



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Reattachment length in the laminar flow regim

x/S = 5.41



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x/S = 11.84

Case Re=389

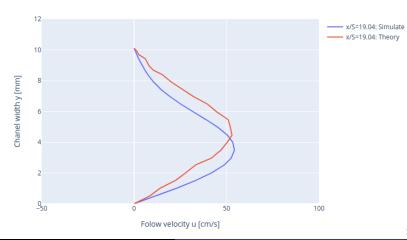
Reattachment length in the laminar flow regime

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eattachment length in the laminar flow regime

x/S = 11.84



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nder in equilaterial triangular arrangement Results Comments Bibliography

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Case Re=389

Reattachment length in the laminar flow regime

Comparaison

According to the results the variance of the model for x/S=0.0, x/S=5.41 and x/S=11.84 corresponds to only 8%,35,05% and 35% of the mean of the observations respectively.

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Reattachment length in the laminar flow reg

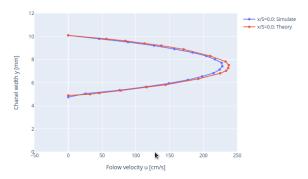
The graph below show the comparison of the theorical solution with simulate flow solution for:

Objectives

•
$$x/S = 0.0$$

The graph below show the comparison of the theorical solution with simulate flow solution for:

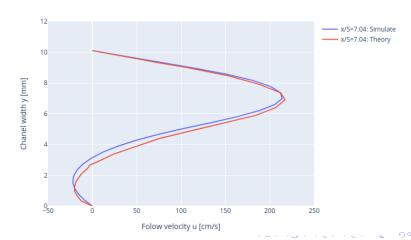
$$x/S = 0.0$$



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$$x/S = 7.04$$



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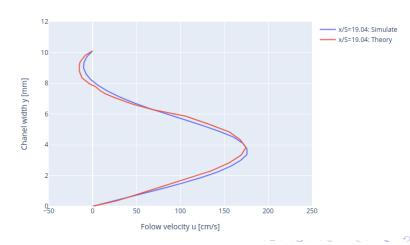
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eattachment length in the laminar flow regime

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x/S = 19.04



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Comparaison

According to the results the variance of the model for x/S=0.0, x/S=7.04 and x/S=19.04 corresponds to only 6.96%,14.80% and 20% of the mean of the observations respectively.

Objectives

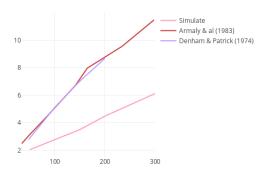
Case Re=389 Case Re=1095 Reattachment length in the laminar flow regime

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Reattachment length in the laminar flow regime

Reattachment length in the laminar flow regime



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Presentation of the test case Mesh

This study is based on the flow of a fluid in front of 3 circular and identical cylinders.

Presentation of the test case Mesh

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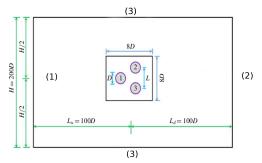
Objectives

The arrangement of the cylinders in the calculation area is shown in the figure below

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Presentation of the test case Mesh

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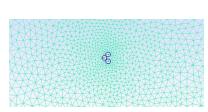


Presentation of the test case Mesh

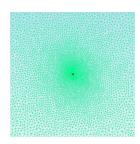
The mesh has been developed with tighter meshes close to the cylinder and downstream of the cylinder in order to be able to finely detect the flow value fields.

Objectives

The mesh has been developed with tighter meshes close to the cylinder and downstream of the cylinder in order to be able to finely detect the flow value fields.



zoom-in view of the previous mesh



Generated mesh for case

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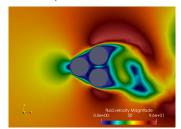
Comments Bibliography

■ 1.0 < *L/D* ≤ 1.4

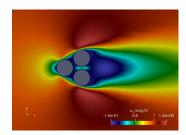
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■ 1.0 < *L/D* ≤ 1.4



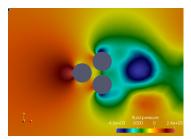
Velocity magnitude



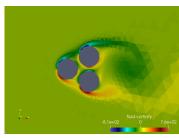
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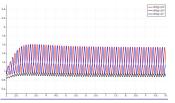


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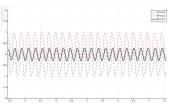


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Time histories of lift coef

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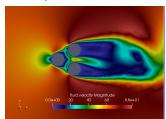
■ 1.4 < *L/D* ≤ 1.9

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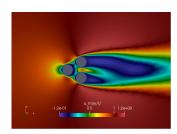
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■ 1.4 < *L/D* ≤ 1.9

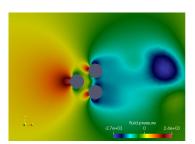


Velocity magnitude

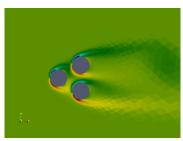


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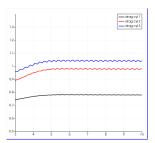
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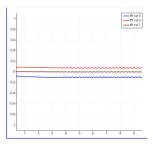
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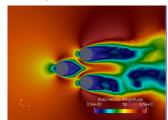
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■ 1.9 < *L/D* ≤ 2.5

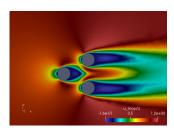
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■ 1.9 < *L/D* ≤ 2.5



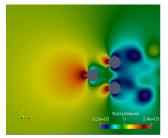
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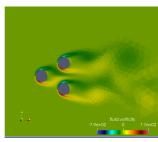
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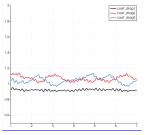


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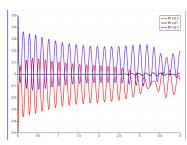
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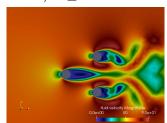
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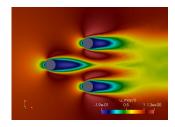
■ $2.5 < L/D \le 2.8$ and $3.4 < L/D \le 4.1$

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■ $2.5 < L/D \le 2.8$ and $3.4 < L/D \le 4.1$



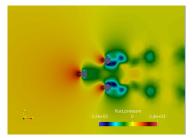


Velocity magnitude

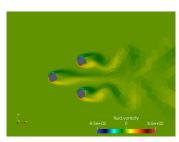
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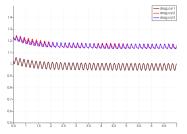
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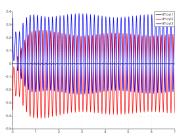
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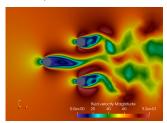
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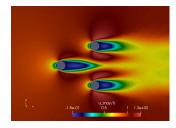
■ $2.8 < L/D \le 3.4$ and $4.1 < L/D \le 4.5$

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■ $2.8 < L/D \le 3.4$ and $4.1 < L/D \le 4.5$



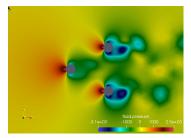


Velocity magnitude

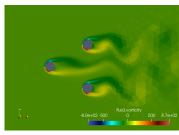
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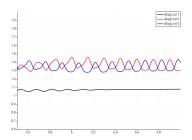


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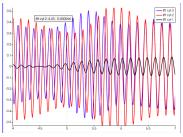
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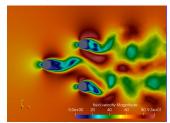
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■ $4.5 < L/D \le 6$

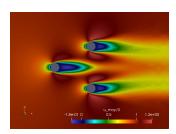
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■ $4.5 < L/D \le 6$



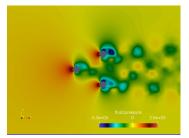
Velocity magnitude



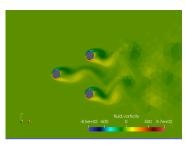
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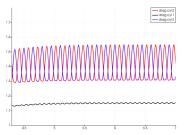


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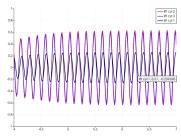
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