

Implementation of a turbulence generator based on an actuator disk

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TURBULENCE IN WIND ENERGY

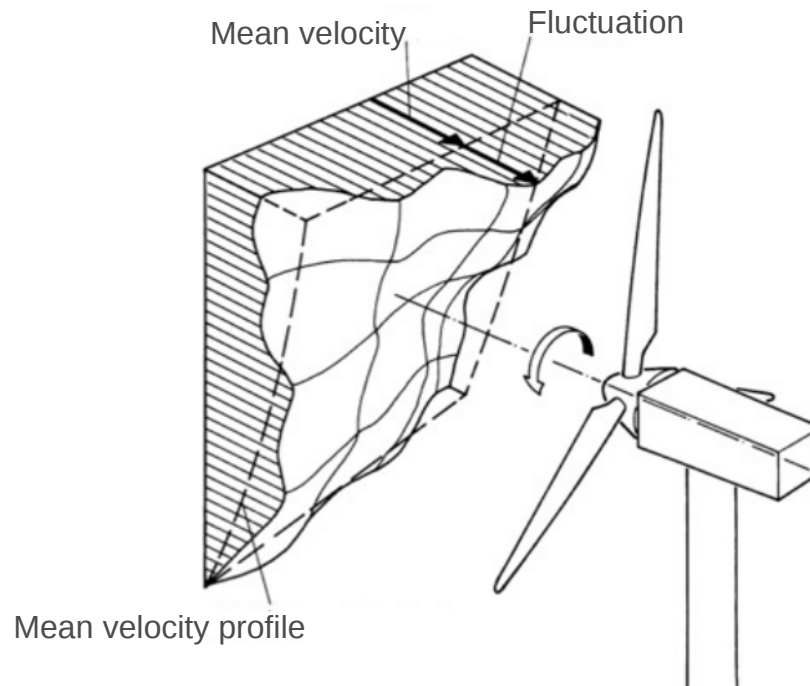
Turbulence are velocity fluctuations in short time scales. It is caused by:

- Terrain & atmospheric effects → Atmospheric Boundary Layer
- Wakes from other turbines

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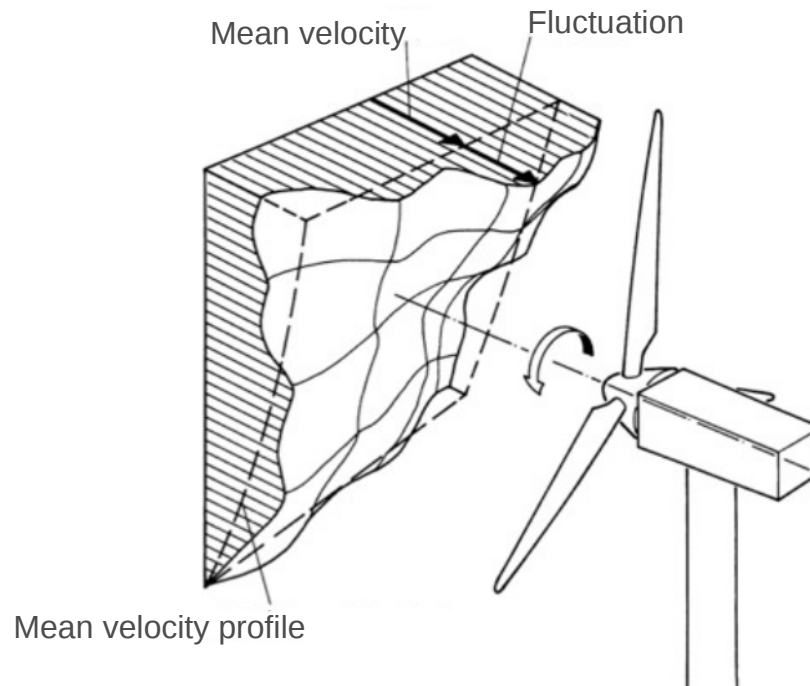
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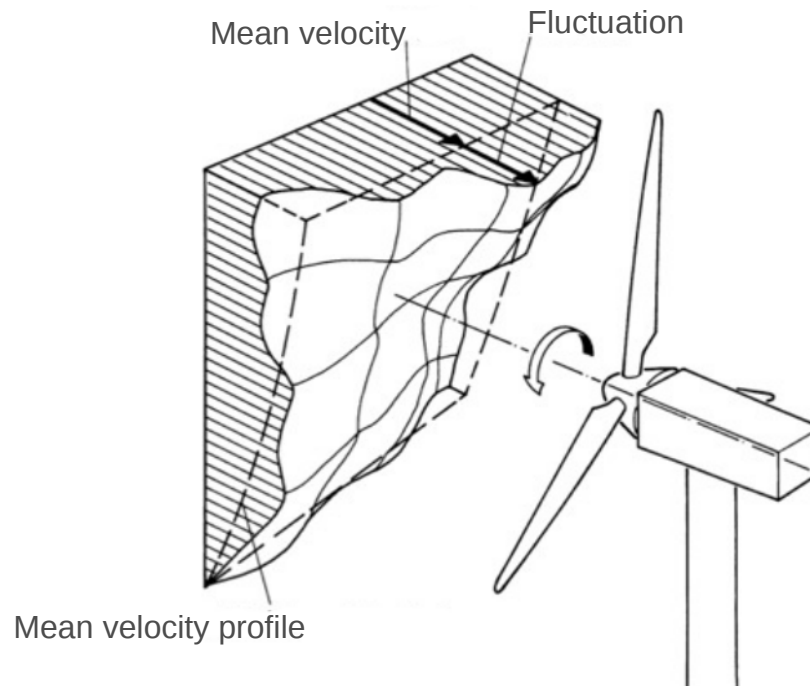
Why is turbulence important:

- Design loads
- Fatigue

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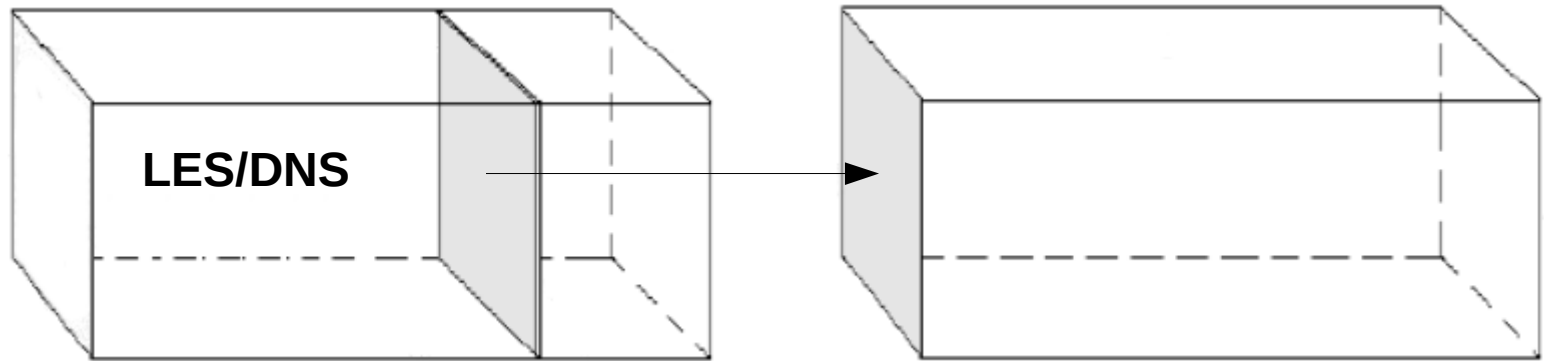


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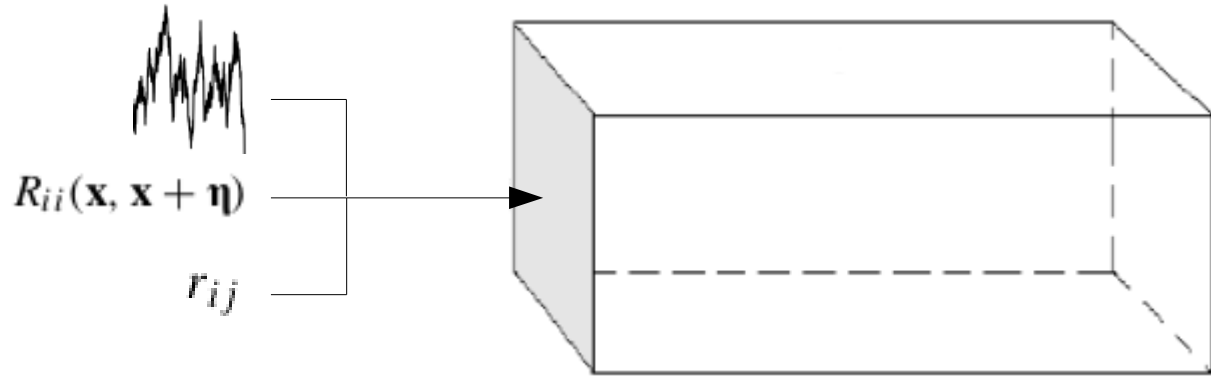
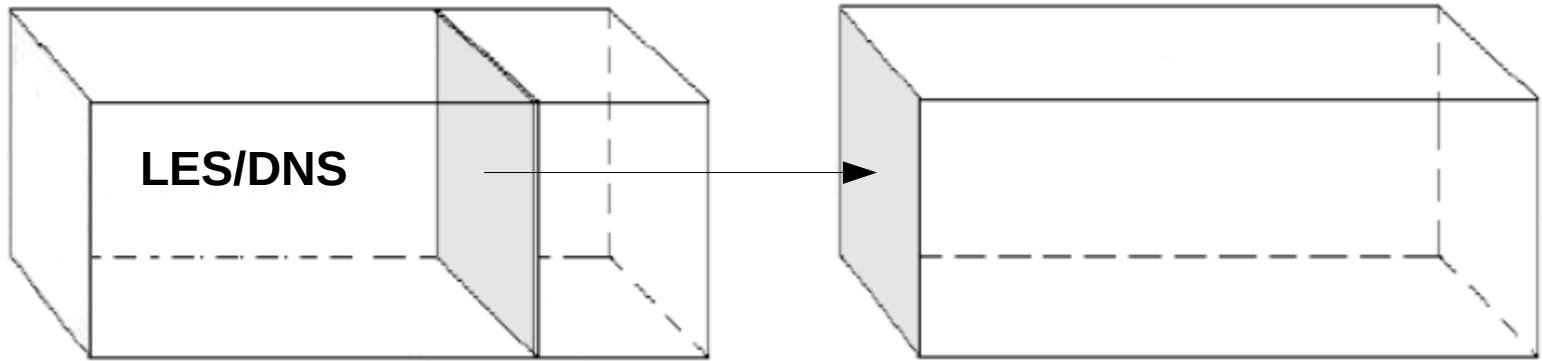
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**TURBULENCE GENERATION IN
SIMULATIONS IMPORTANT**

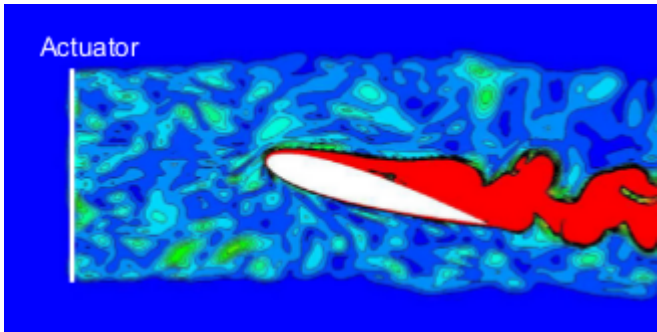
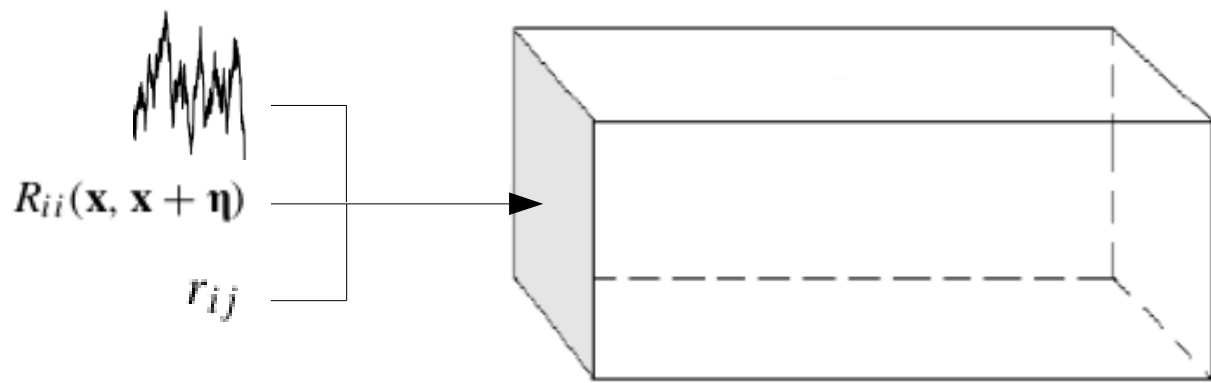
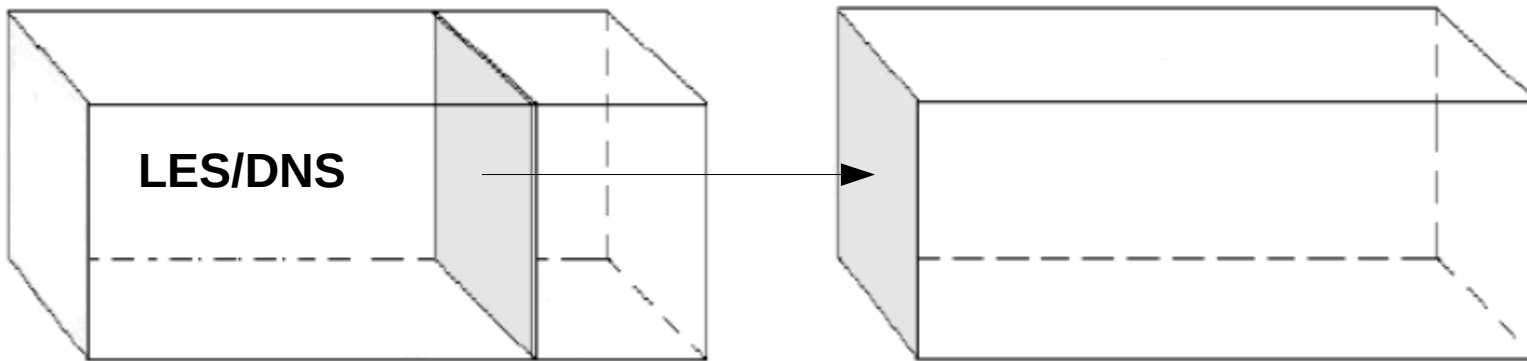
COMMON TURBULENT GENERATION METHODS



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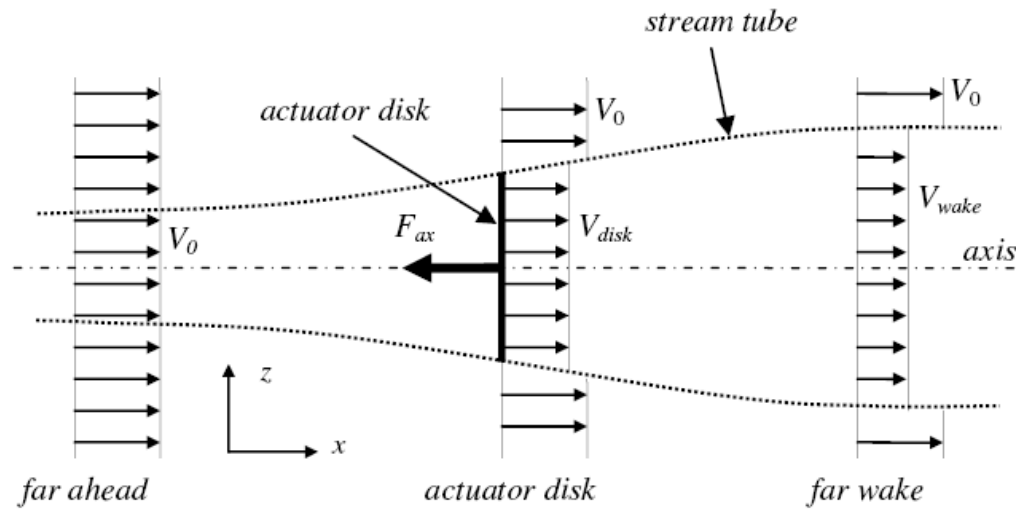


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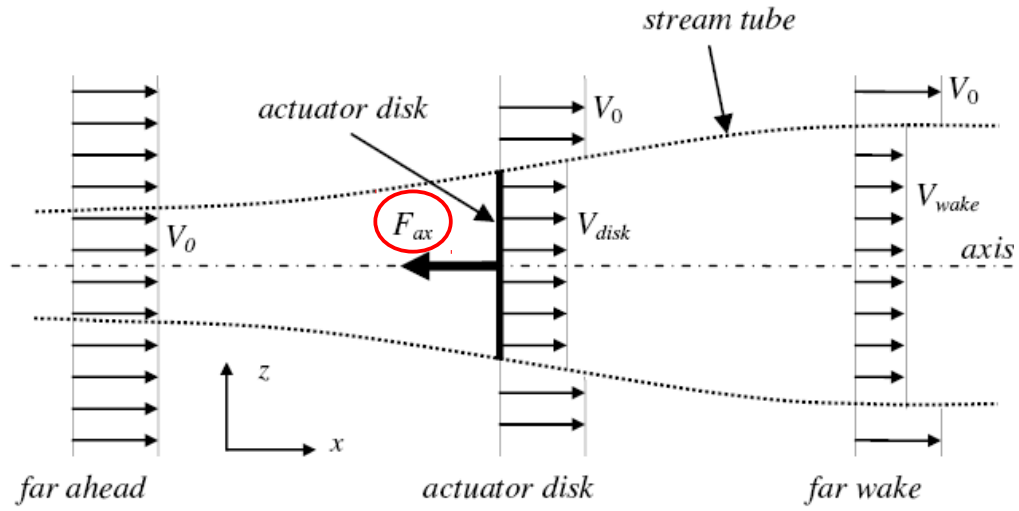


Gilling, PhD Thesis Aalborg University, 2009

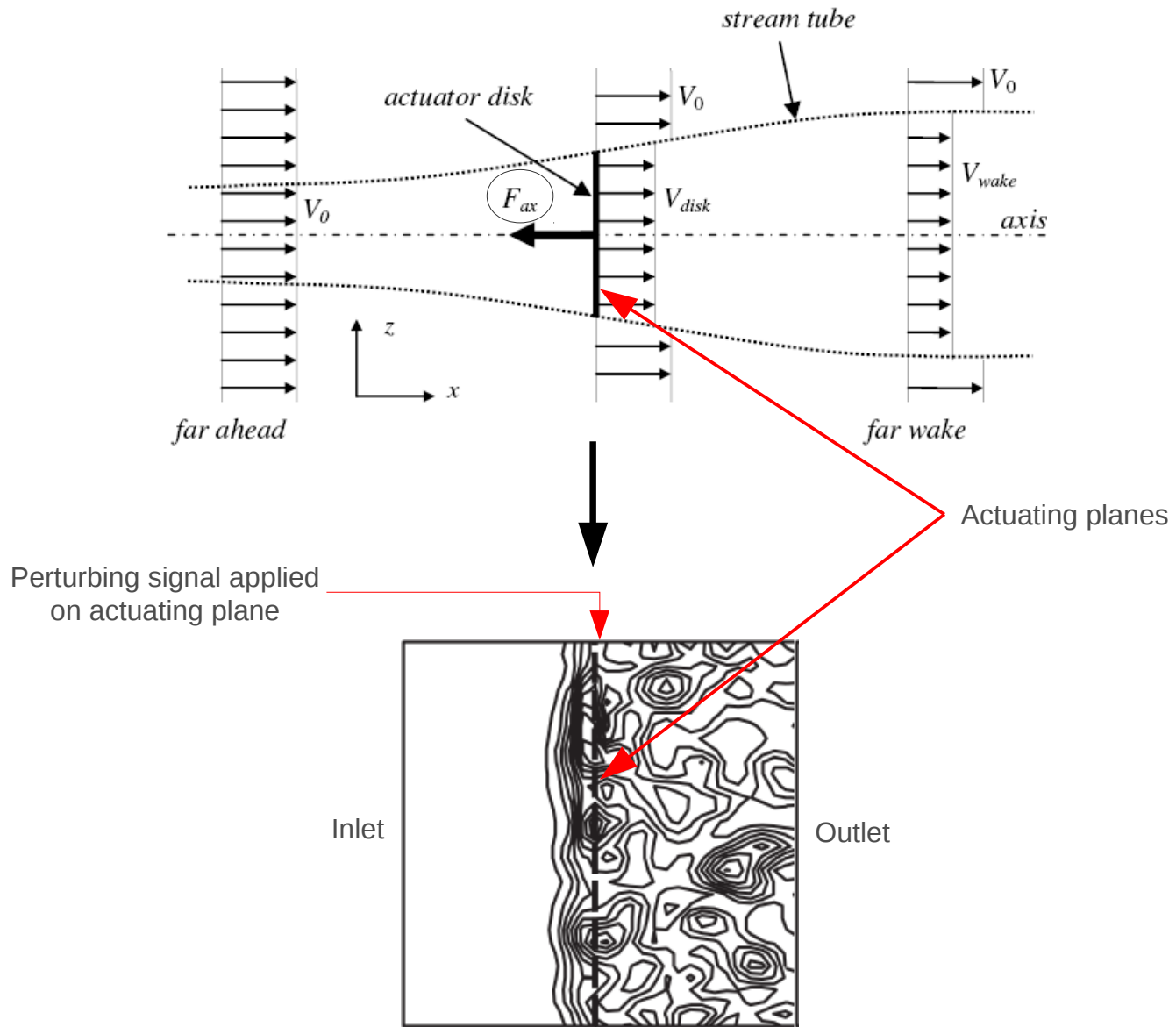
ACTUATION PRINCIPLE



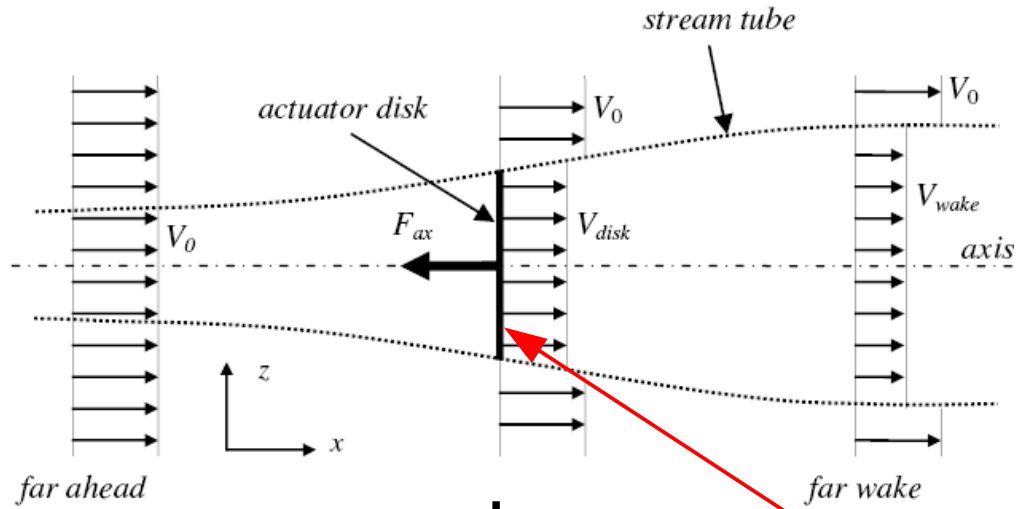
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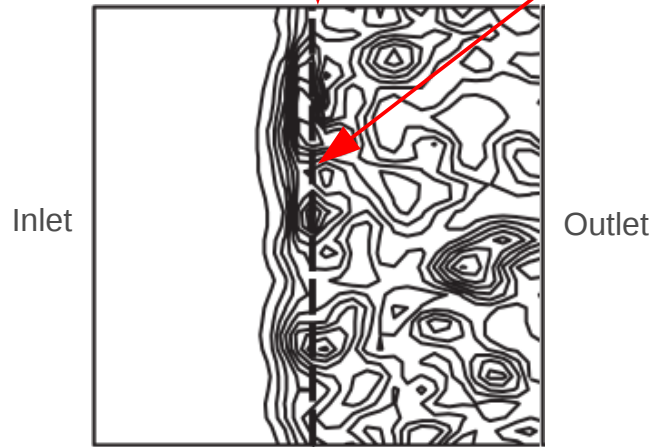
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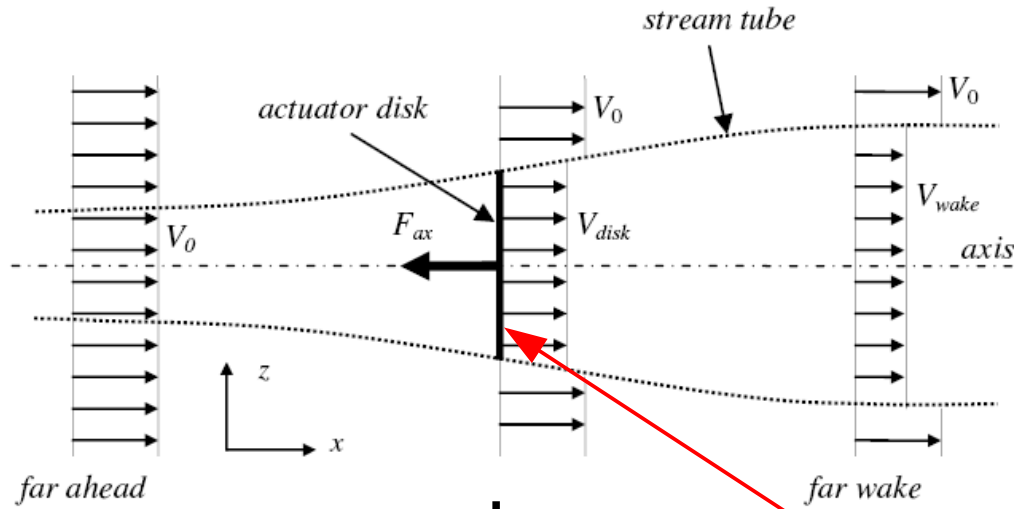
Actuating planes

Perturbing signal applied on actuating plane

Ornstein - Uhlenbeck
Random walk with tendency
to reference value

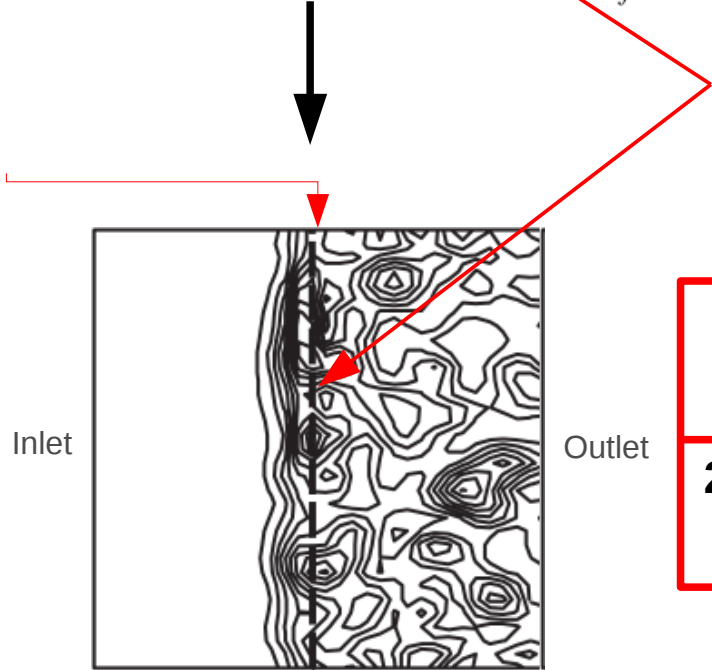


ACTUATION PRINCIPLE



Perturbing signal applied on actuating plane

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Random walk with tendency to reference value



1. GENERATE TURBULENCE
2. ACHIEVE CERTAIN FLOW PROPERTIES

IMPLEMENTATION

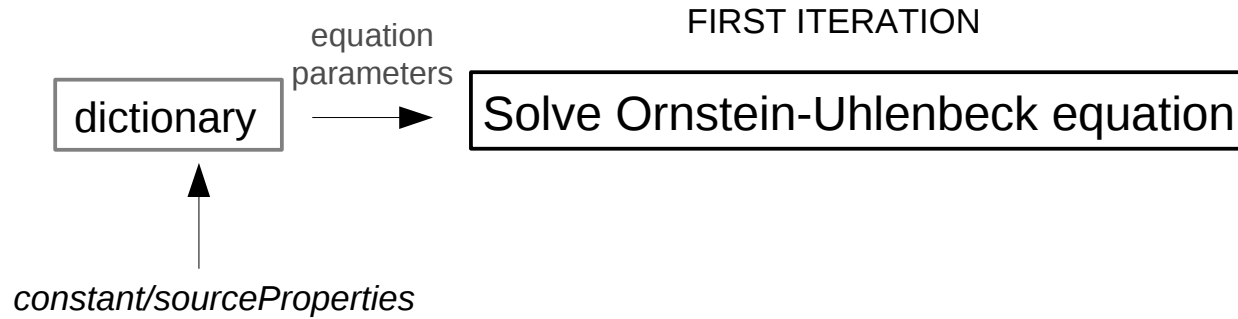
- Modified class : *actuationDiskSource*

FIRST ITERATION

Solve Ornstein-Uhlenbeck equation

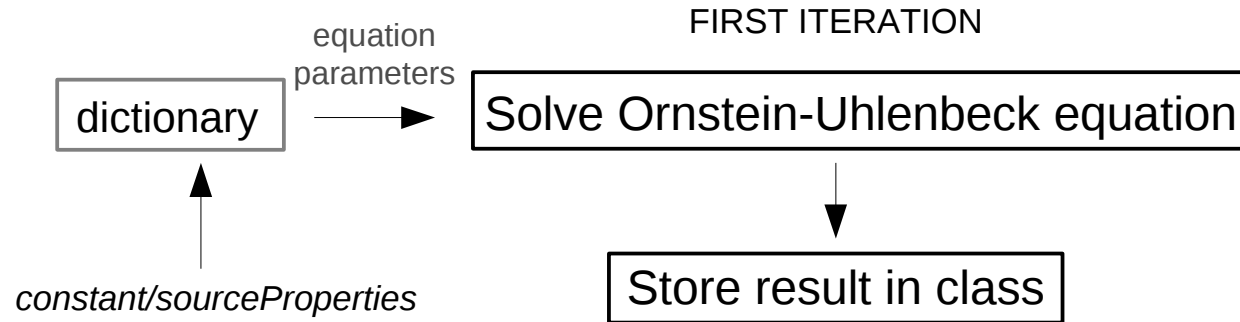
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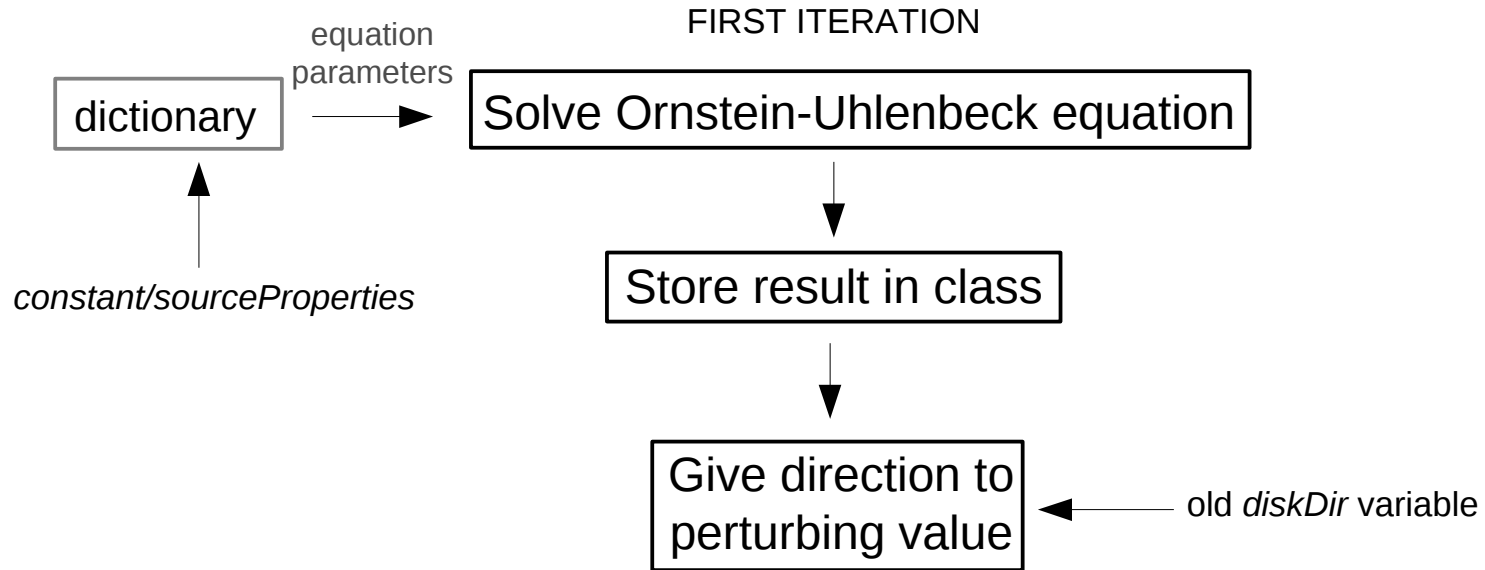
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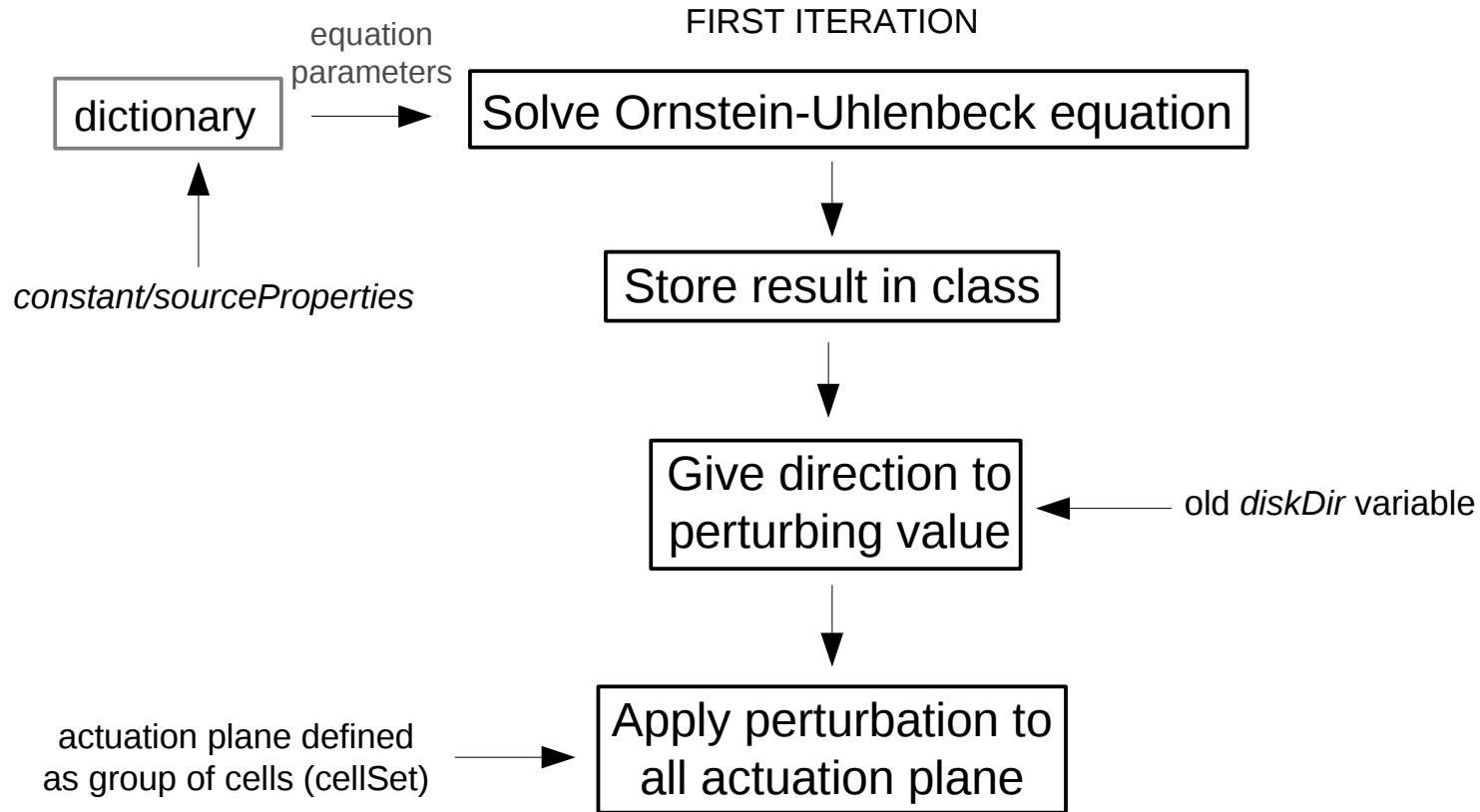
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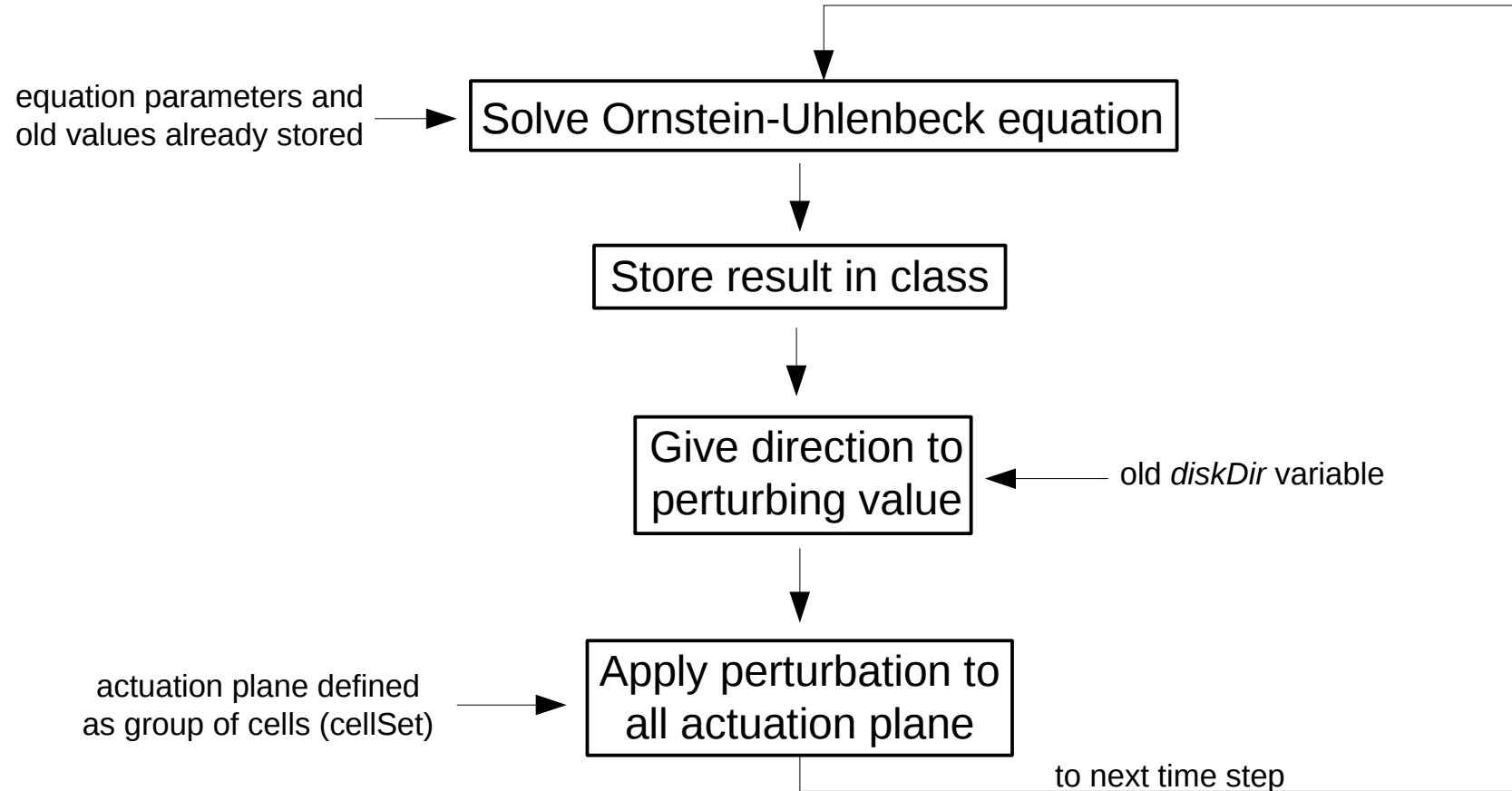
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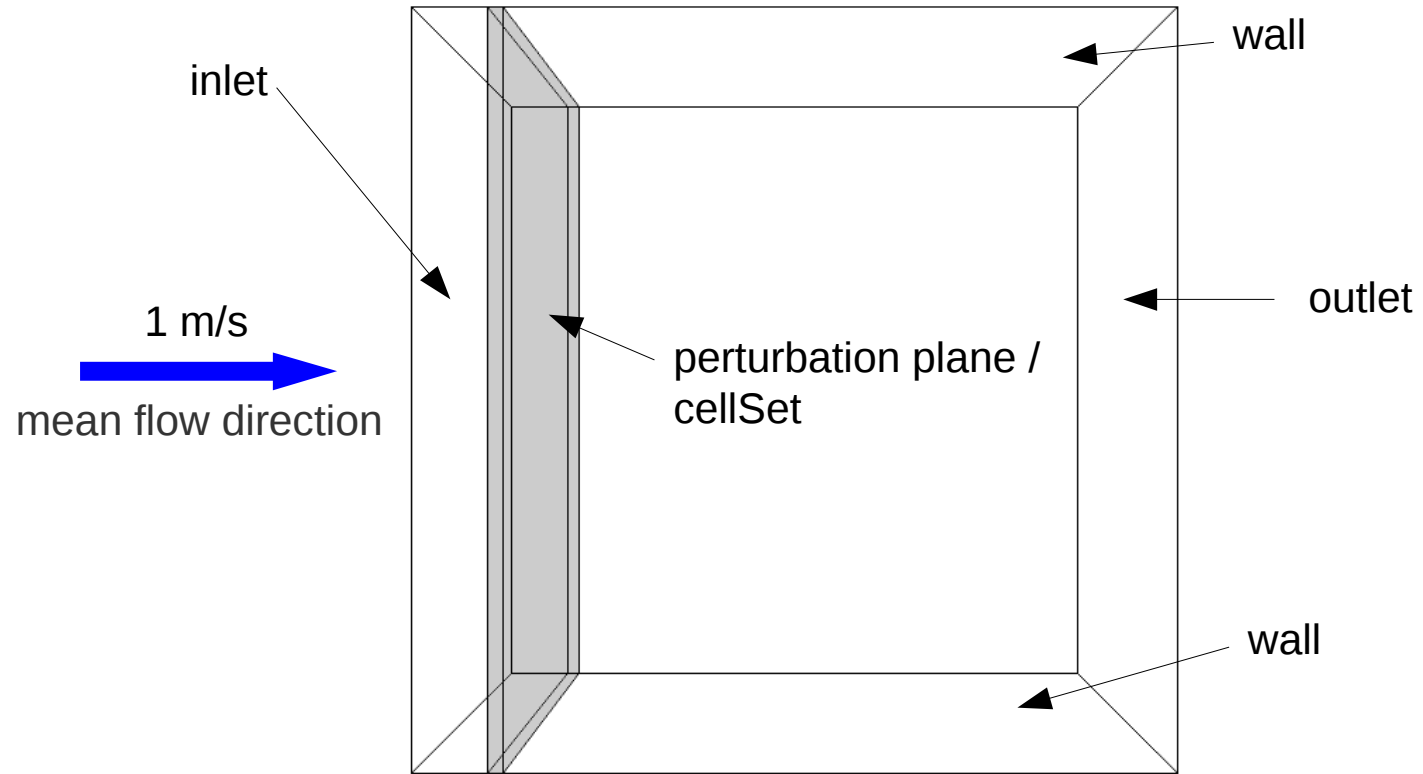


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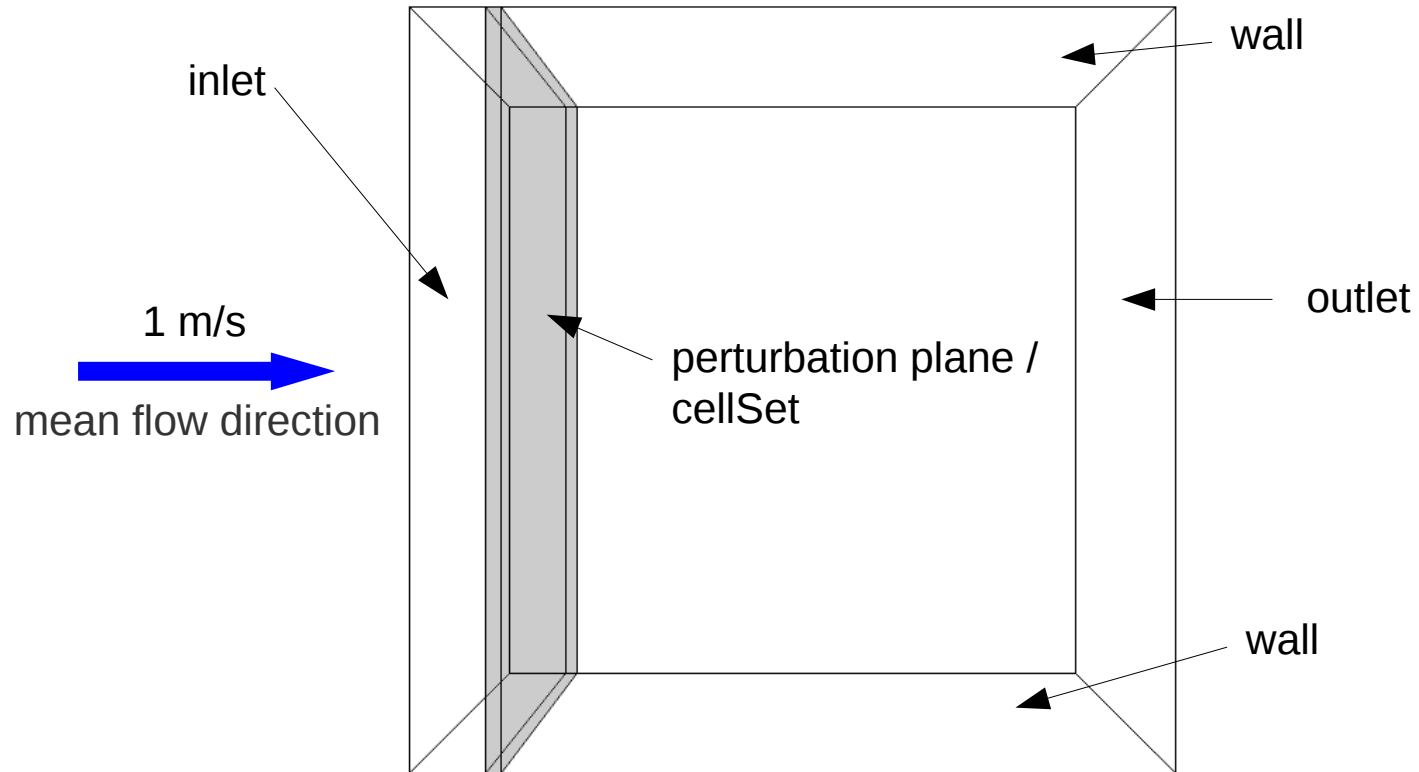
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SIMULATION CHARACTERISTICS

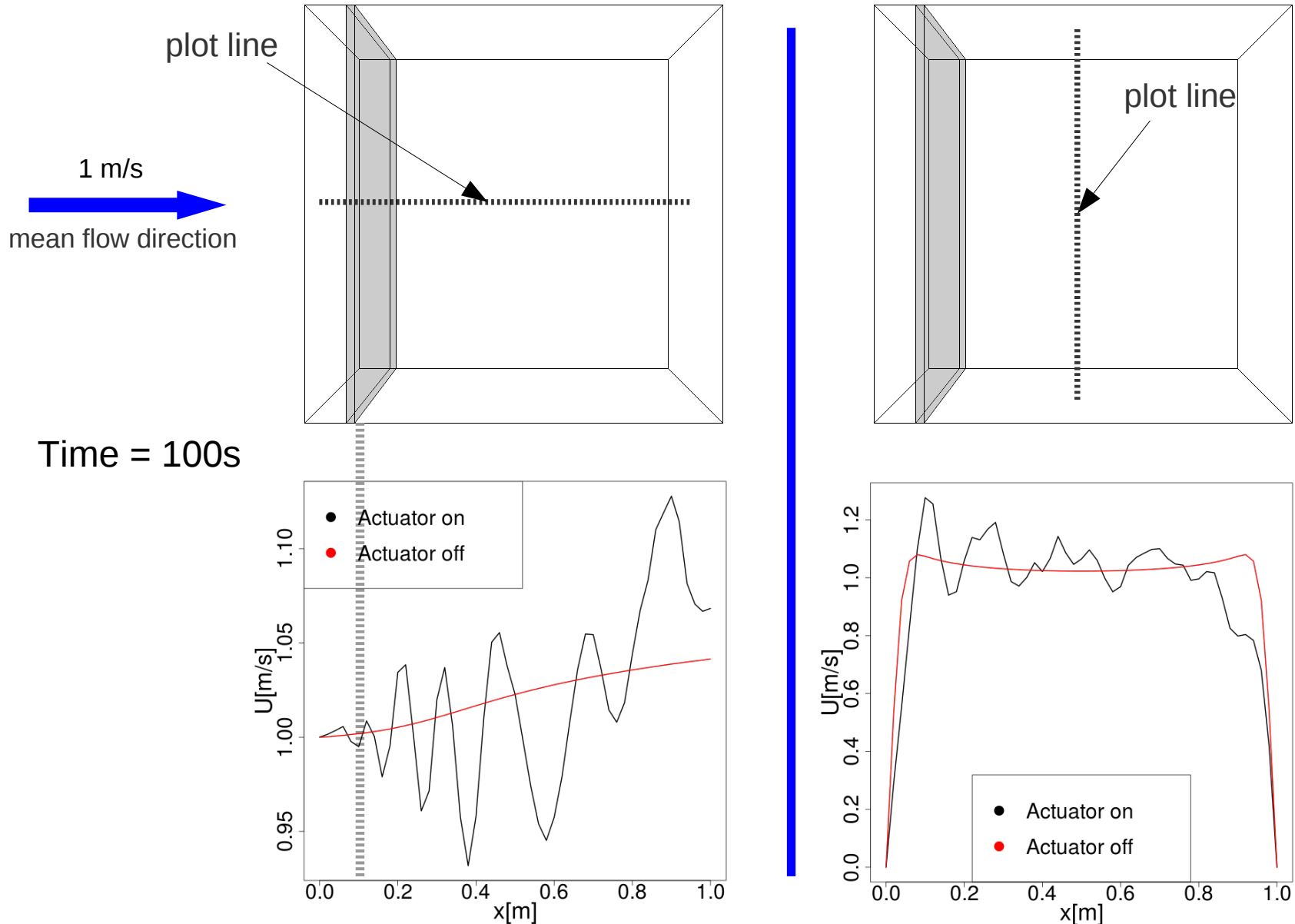


SIMULATION CHARACTERISTICS



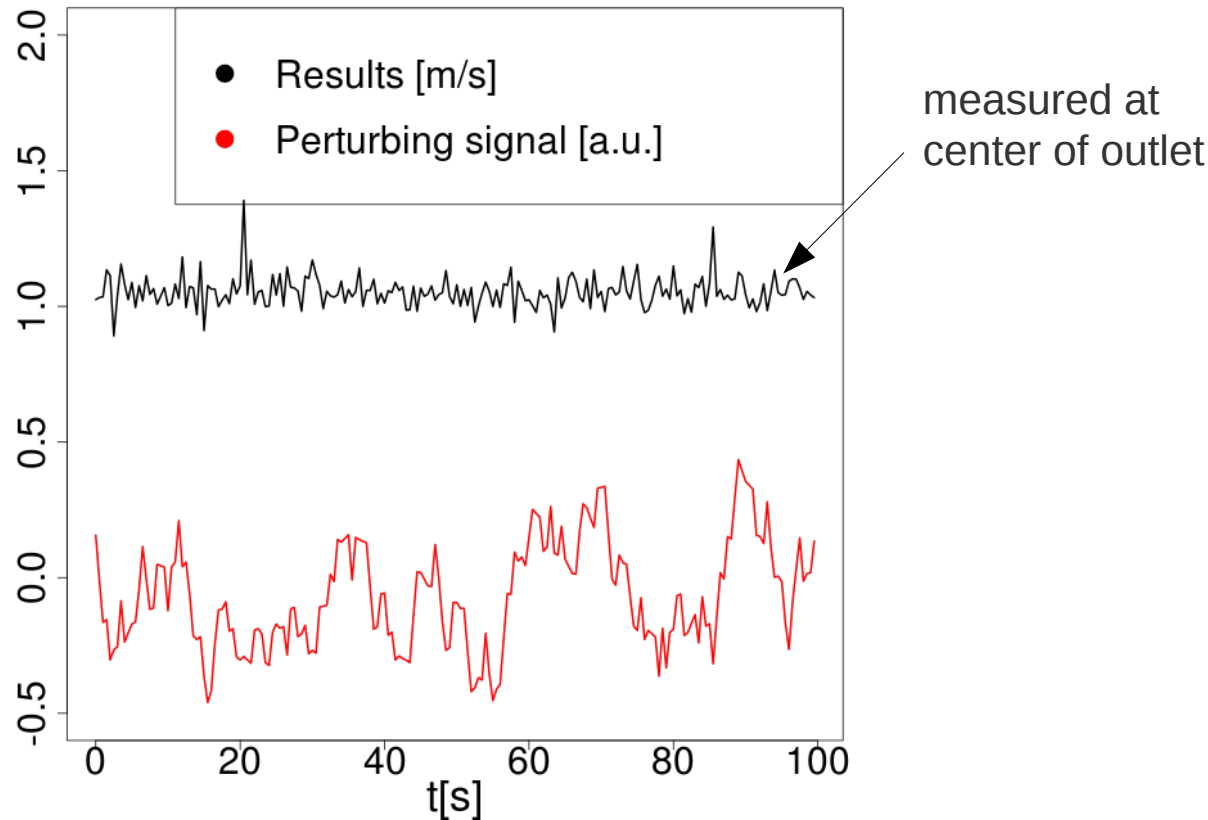
- Domain dimensions : 1 x 1 x 1 m
- Perturbation plane at 0.1m of inlet
- Number of cells: 50 x 50 x 50
- Reynolds number: 100000
- Solver used: *pimpleFoam*
- Turbulence model: LES
- Simulation time: 100s
- Variable *timeStep* with fixed *Courant*

RESULTS - Turbulence generation



RESULTS - Flow properties

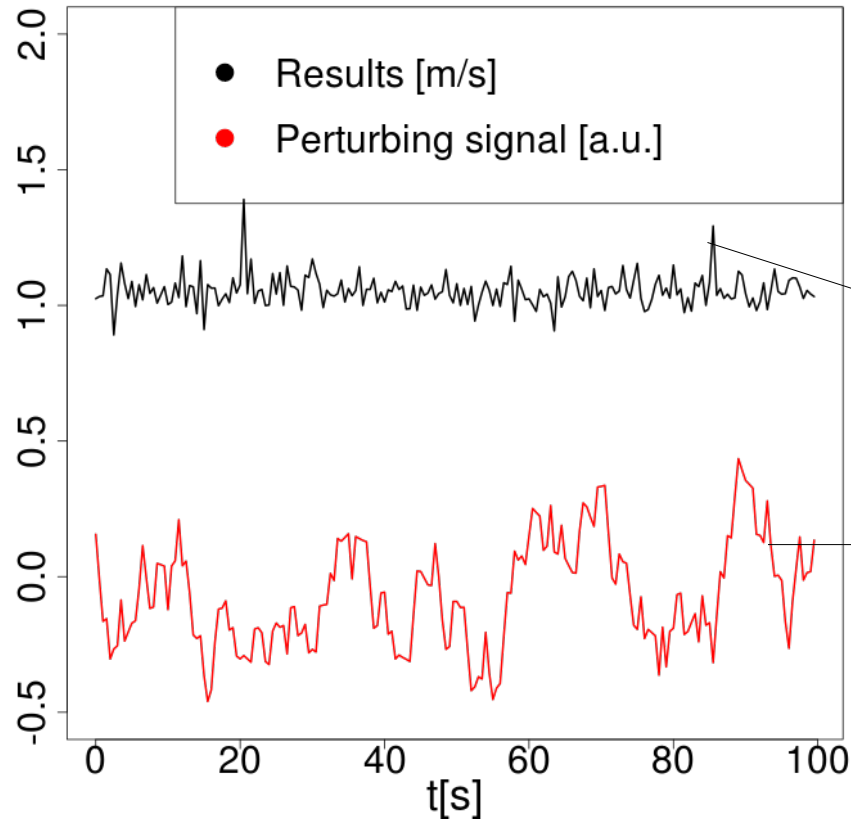
- Comparison between perturbing signal and simulation fluctuations



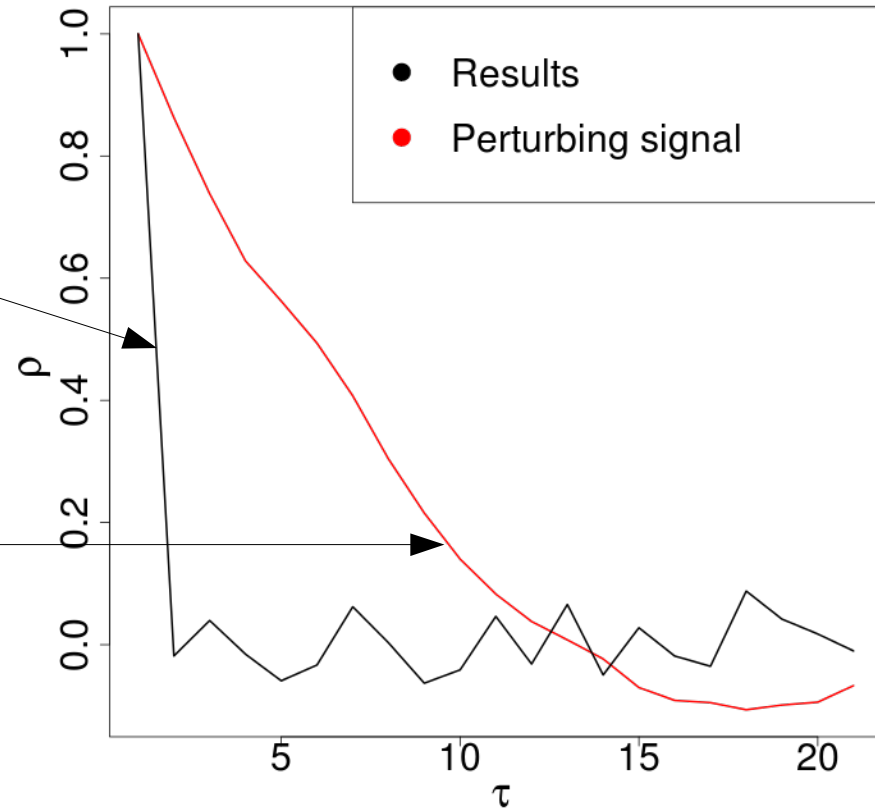
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RESULTS - Flow properties

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- Signals do not have same nature

CONCLUSIONS AND FUTURE WORK

Conclusions:

- Modified *actuationDisk* class successful on creating turbulence
- Output signal does not hold actuator signal characteristics

Future research lines

- Variation of perturbing signal over actuator plane
- Try changes in domain size and number of cells
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