Unsteady Simulations Using SU2

Pointwise® and SU2 Joint Workshop

Sept 29th-30th, 2014

Santiago Padrón

Aeronautics & Astronautics Department (Stanford University)

Note

In these set of slides the animations (movies) will show as a repeated slide and will not playback.

What do these images have in common?

SU2
The Open-Source CFD Code

What do these images have in common?

SU2
The Open-Source CFD Code

Goal: Learn to run unsteady simulations in SU2

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The Open-Source CFD Code

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SU2
The Open-Source CFD Code

Unsteady Flows

Goal: Learn to run unsteady simulations in SU2

SU2
The Open-Source CFD Code

Unsteady Flows

SU2 options

Goal: Learn to run unsteady simulations in SU2

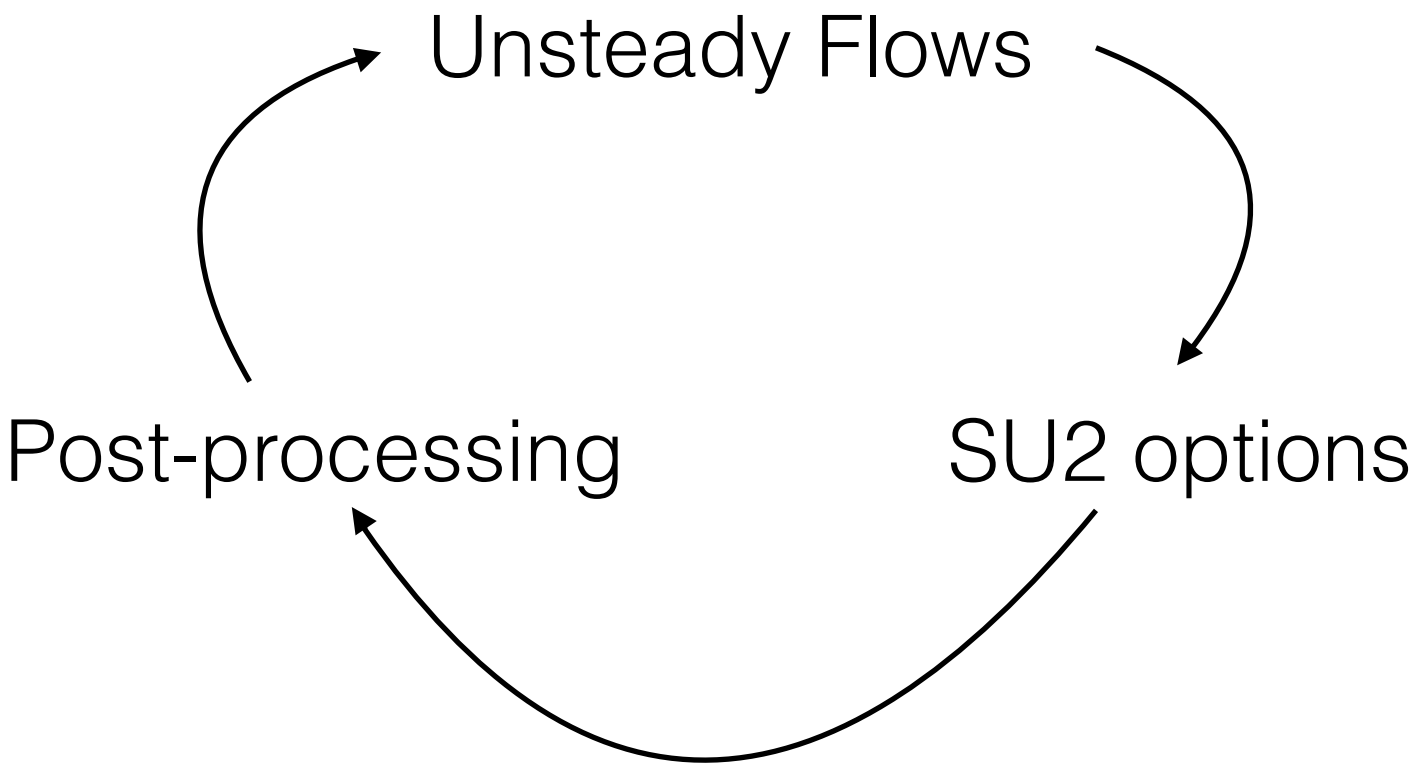
SU2
The Open-Source CFD Code

Unsteady Flows

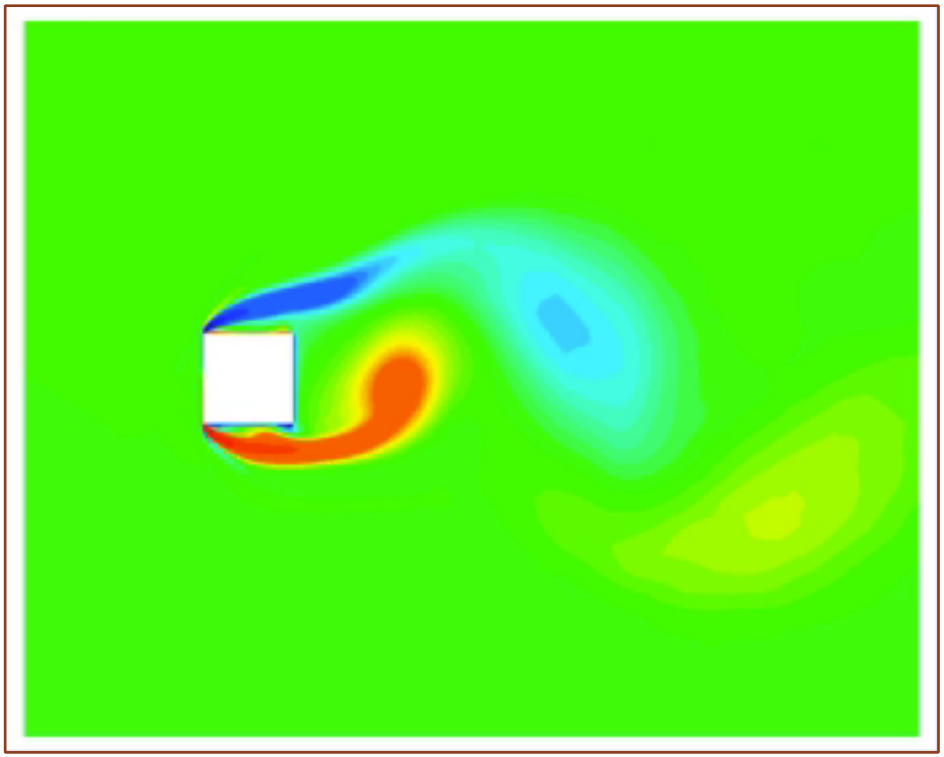
Post-processing

SU2 options

Goal: Learn to run unsteady simulations in SU2

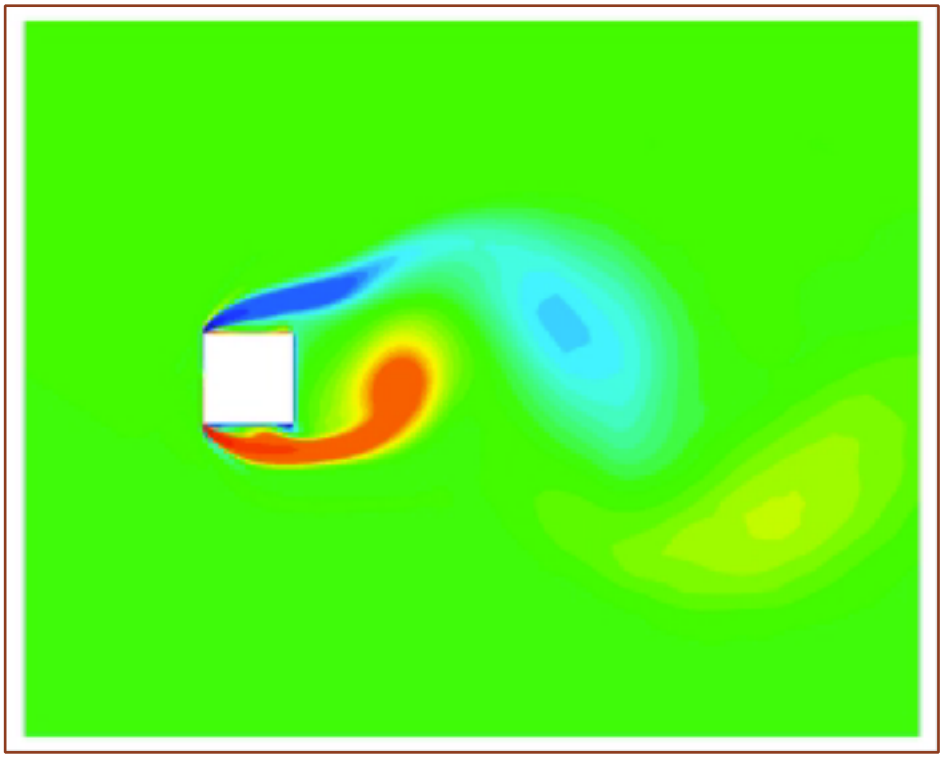


Unsteady flow without grid movement



Manosalvas, 2014

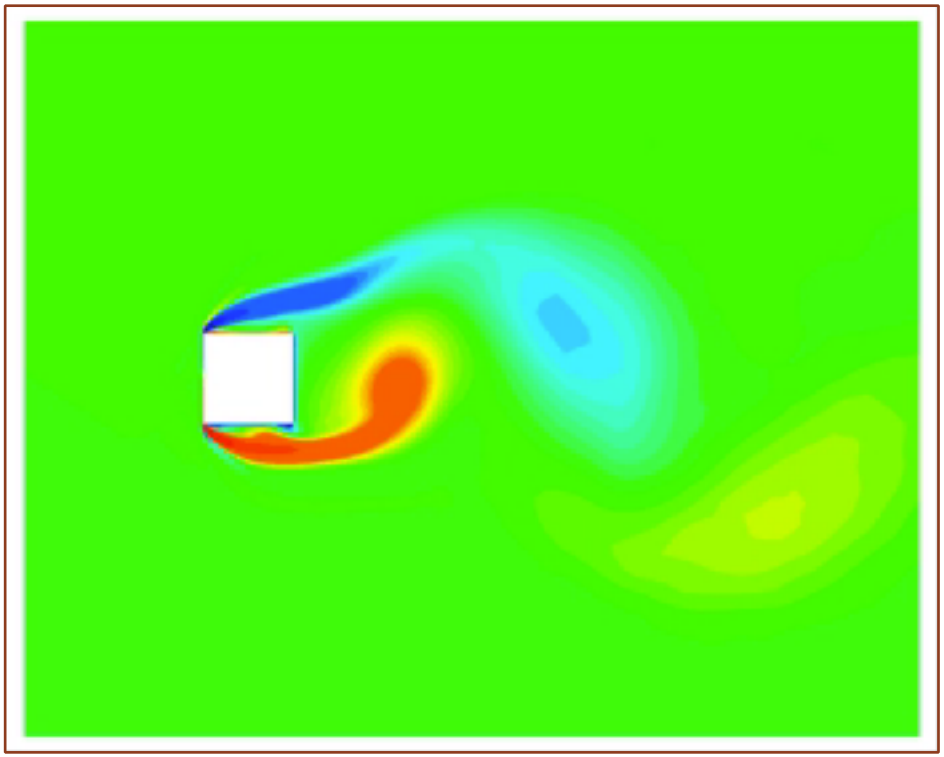
Unsteady flow without grid movement



Manosalvas, 2014

Unsteady flow without grid movement

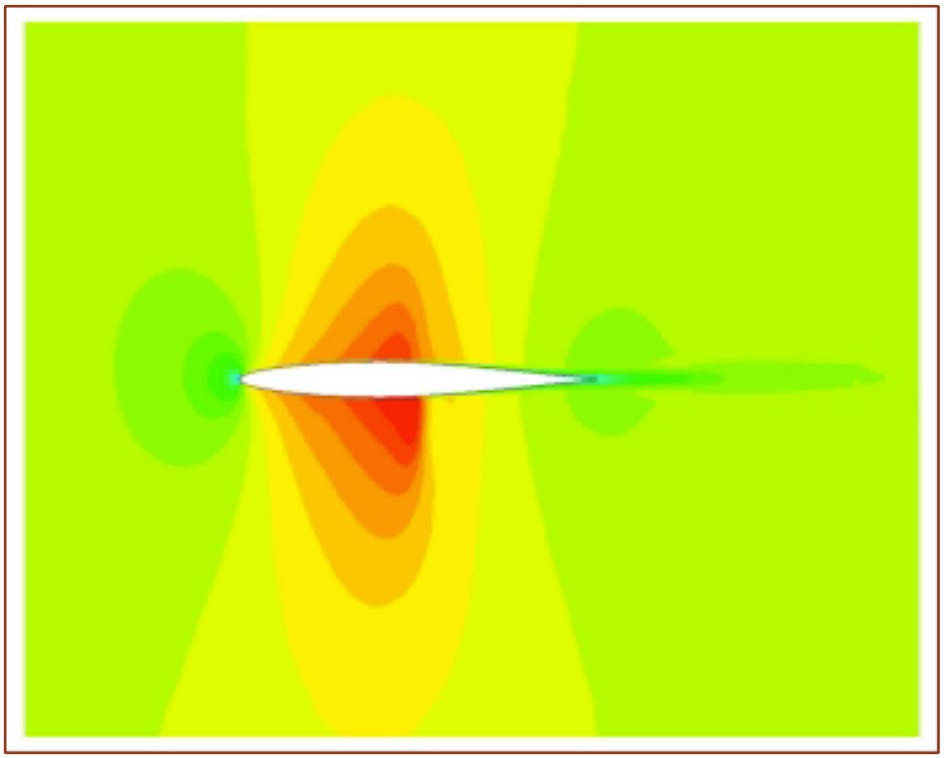
```
% NO, TIME_STEPPING,
%DUAL_TIME_STEPPING-1ST_ORDER
UNSTEADY_SIMULATION=
 DUAL_TIME_STEPPING-2ND_ORDER

%Pick time step
UNST_TIMESTEP= 0.0015
UNST_CFL_NUMBER= 0.0

% How long to run simulation
UNST_TIME= 7.5
EXT_ITER= 999999

% # of inner iterations
UNST_INT_ITER= 200
RESIDUAL_REDUCTION= 4
```



Manosalvas, 2014

Unsteady flow with grid motion

SU2
The Open-Source CFD Code



Palacios, 2013

Unsteady flow with grid motion

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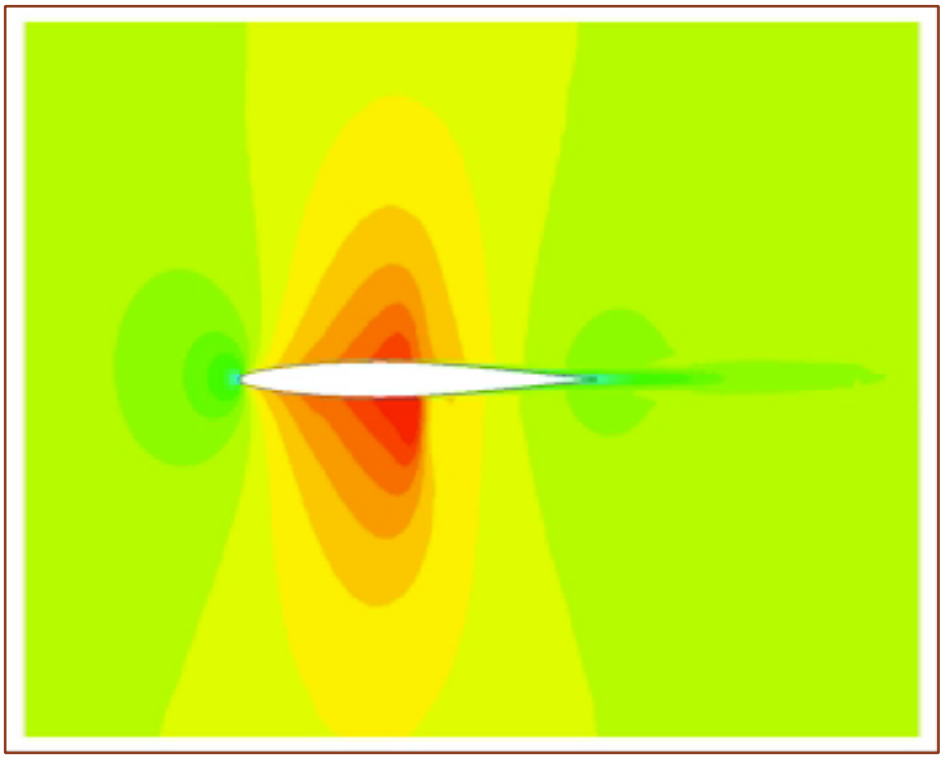
The Open-Source CFD Code

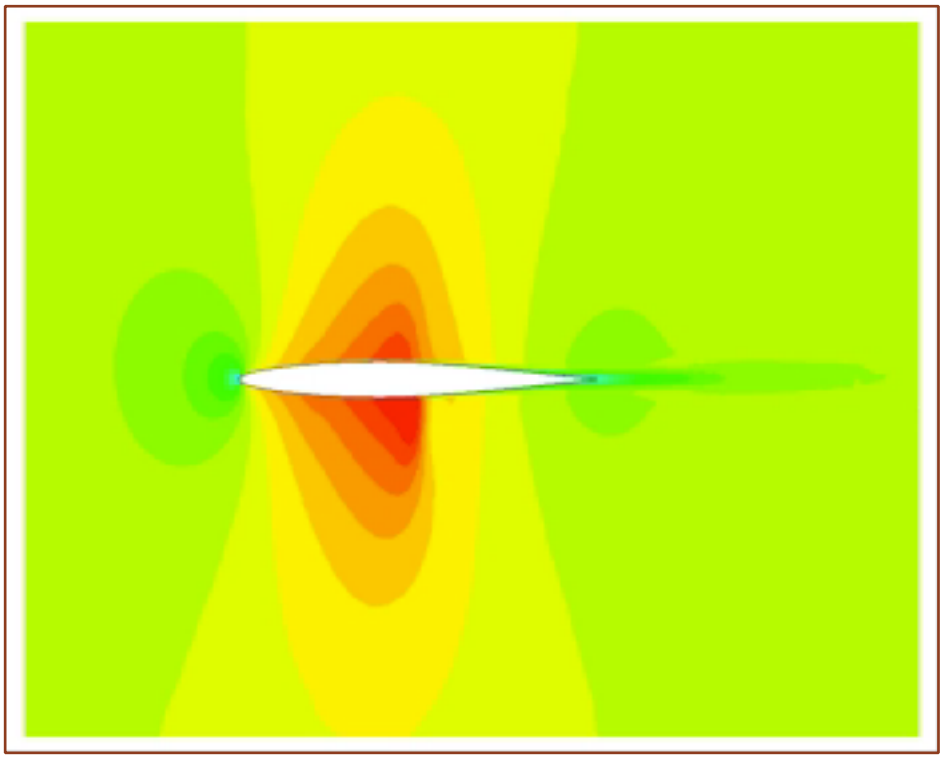


Palacios, 2013

Unsteady flow with grid motion

SU2
The Open-Source CFD Code

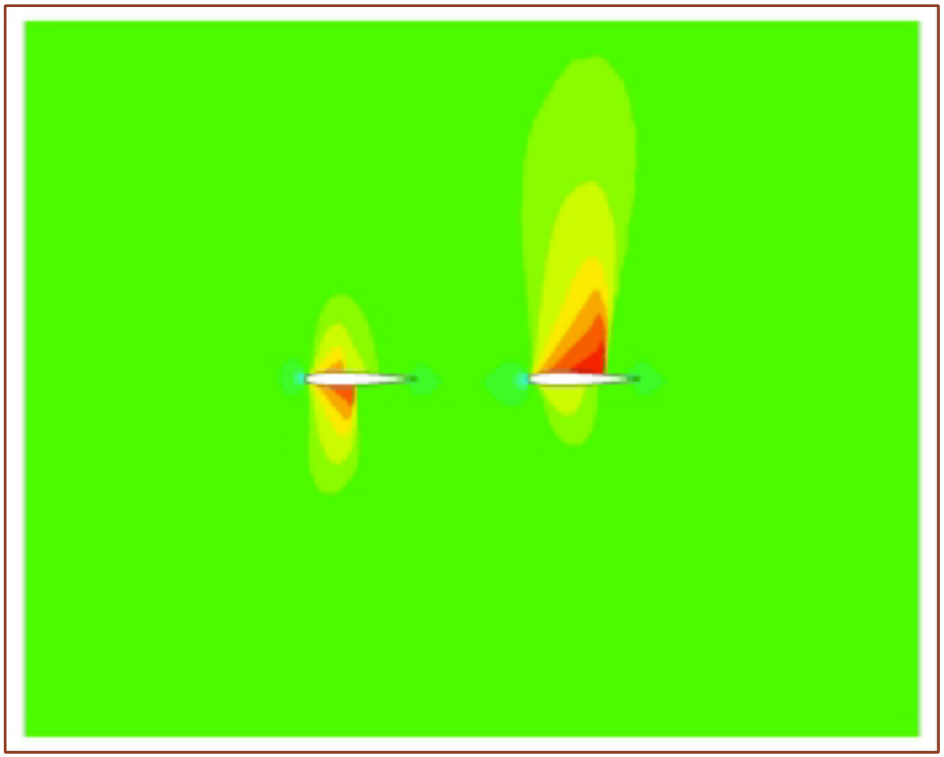
```
GRID_MOVEMENT= YES

GRID_MOVEMENT_KIND=
    RIGID_MOTION

MOTION_ORIGIN_X= 0.248
MOTION_ORIGIN_Y= 0.0

%Pitching angular freq.
PITCHING_OMEGA_Z= 106.69842

%Pitching amplitude (deg)
PITCHING_AMPL_Z= 1.01
```



Palacios, 2013

Multiple surfaces moving requires DEFORMING option

SU2
The Open-Source CFD Code



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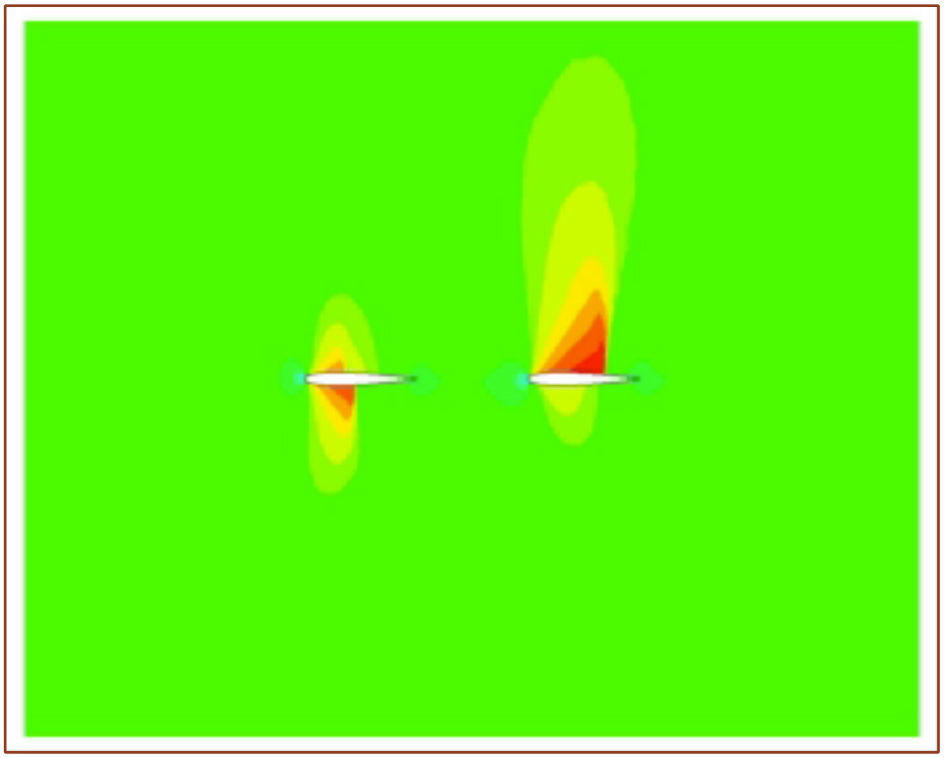
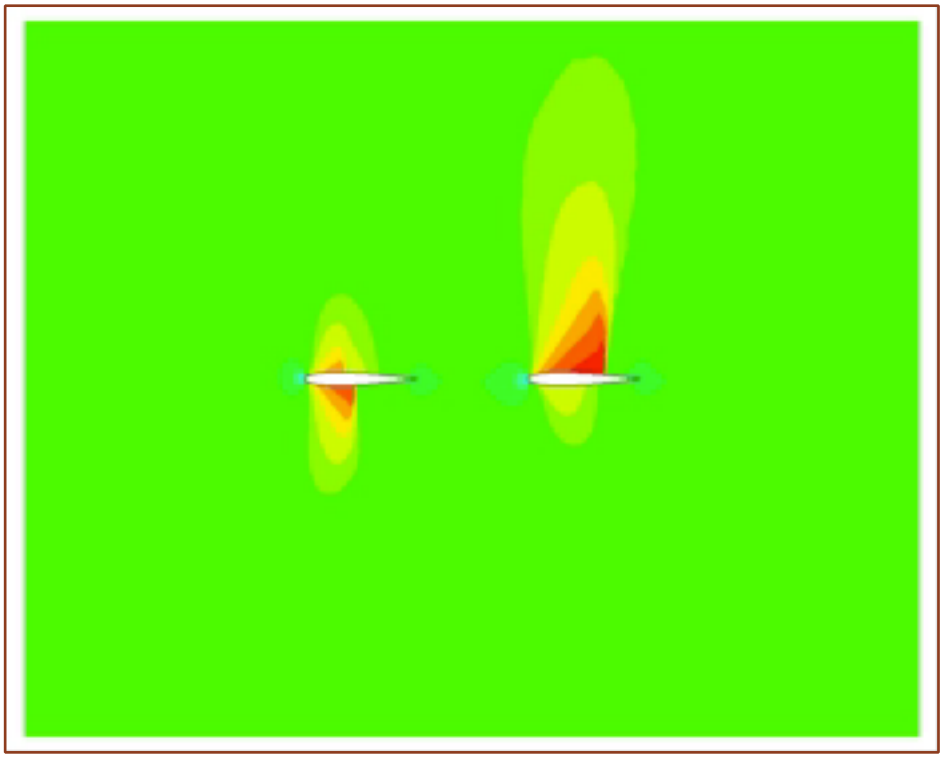


Multiple surfaces moving requires DEFORMING option

```
GRID_MOVEMENT= YES
GRID_MOVEMENT_KIND=
    DEFORMING DEFORMING

MARKER_MOVING=
    (airfoil_1, airfoil_2)

MOTION_ORIGIN_X= -1.25  0.75
MOTION_ORIGIN_Y=   0.0   0.0

PITCHING_OMEGA_Z= 106.7 53.35
PITCHING_AMPL_Z= 1.01 -5.0

MARKER_MONITORING=
    (airfoil_1, airfoil_2)

%Iteration history output
CONV_FILENAME= history
```



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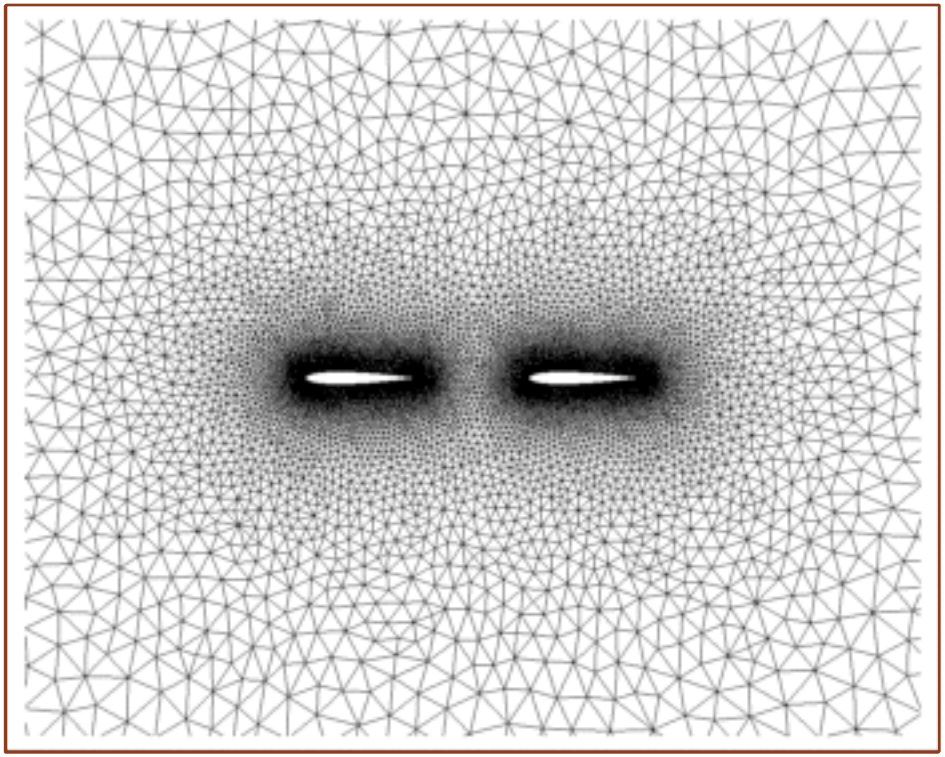

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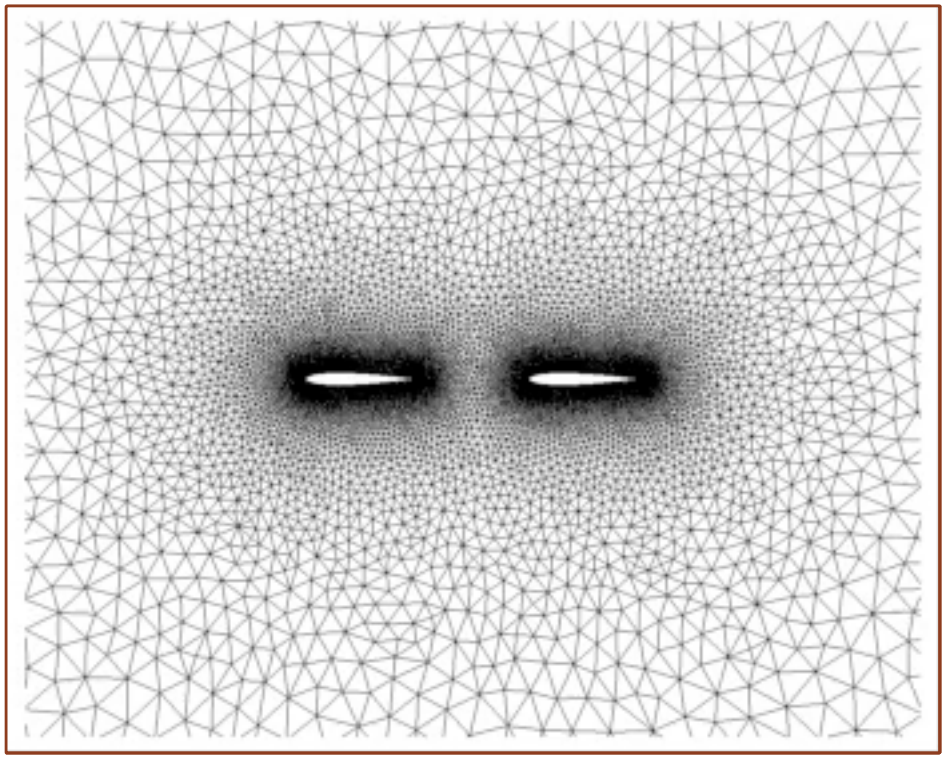

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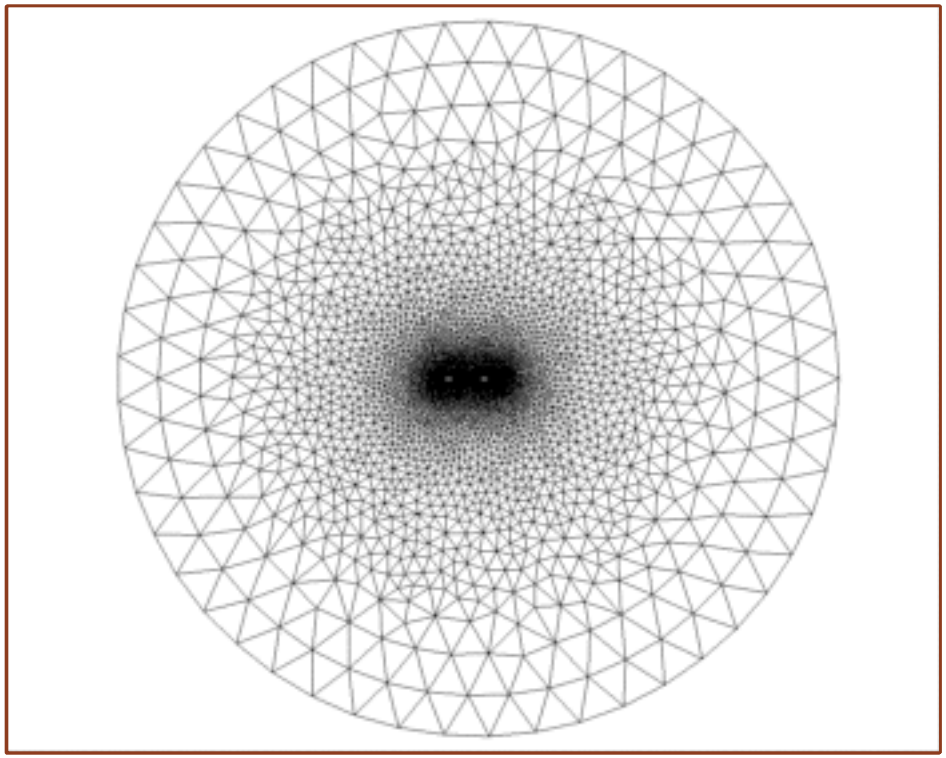

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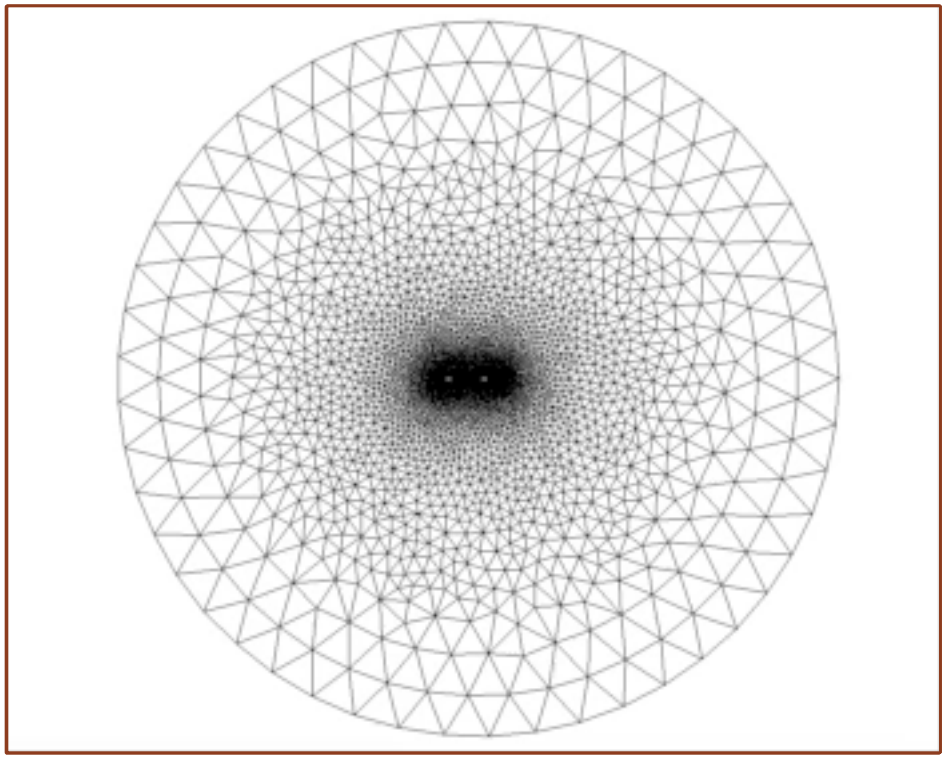

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The Open-Source CFD Code

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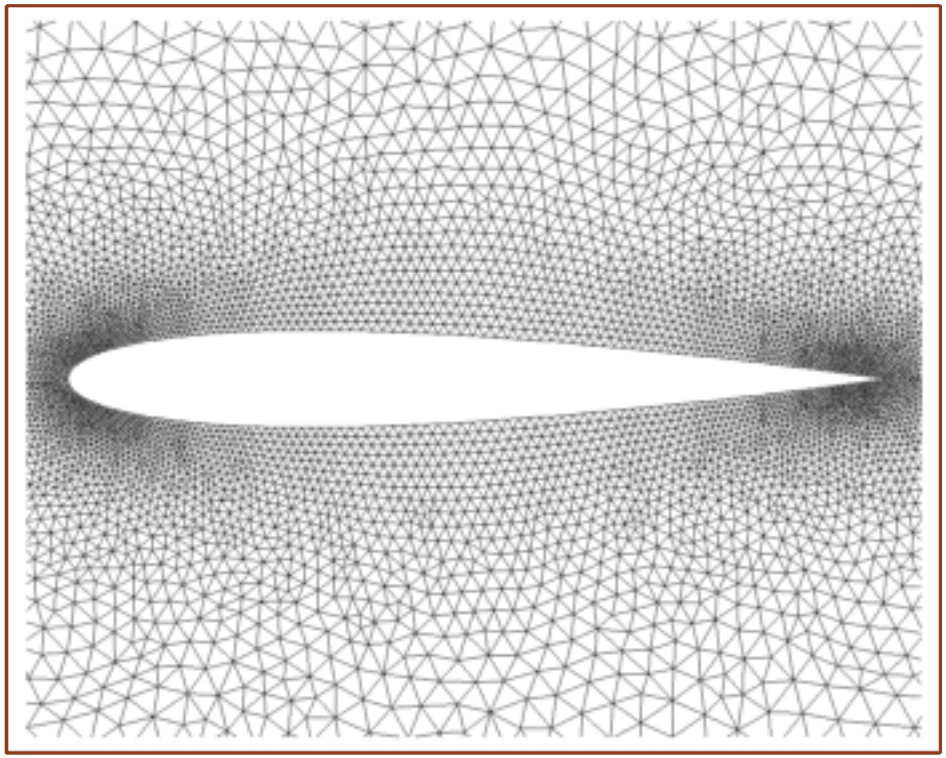

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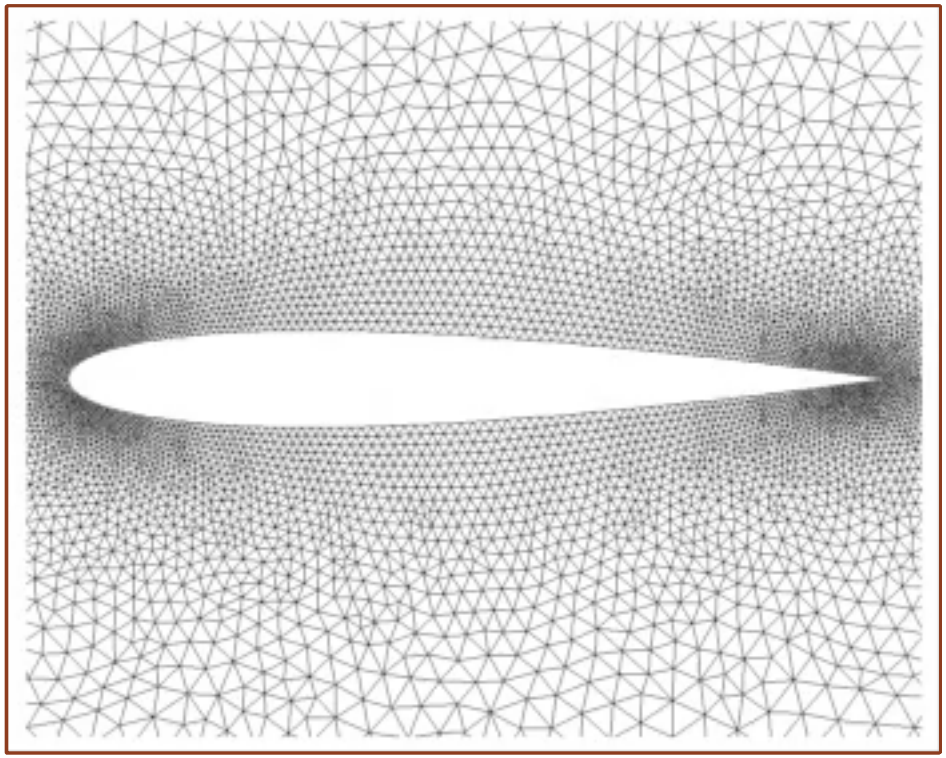

SU2
The Open-Source CFD Code

Demo looking at history file.

Unsteady flow caused by a gust

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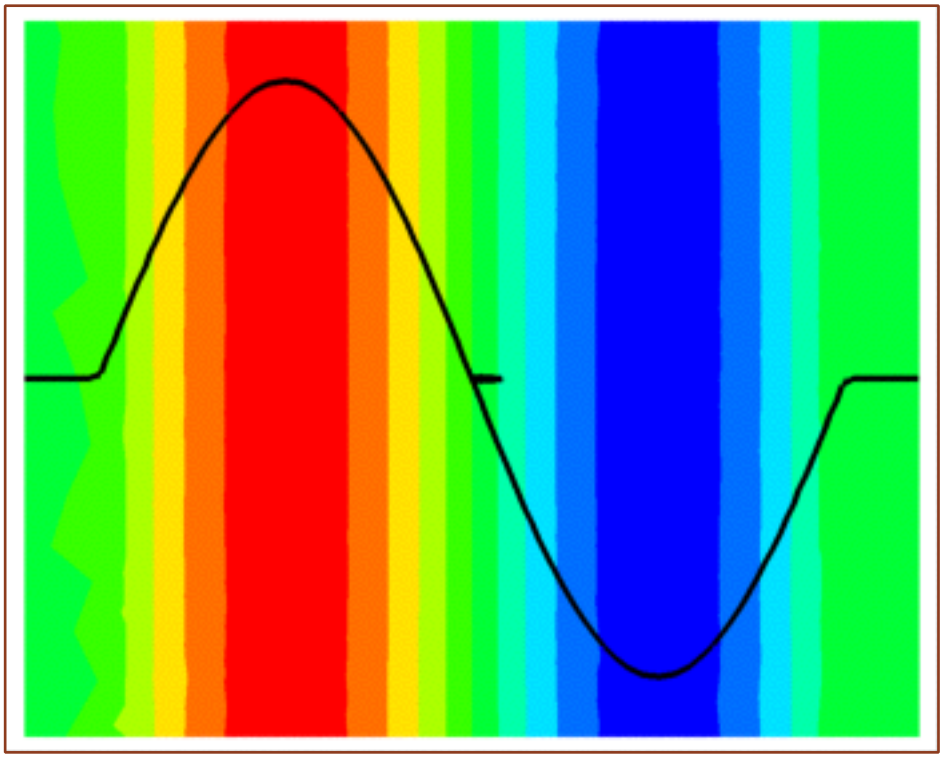
The Open-Source CFD Code



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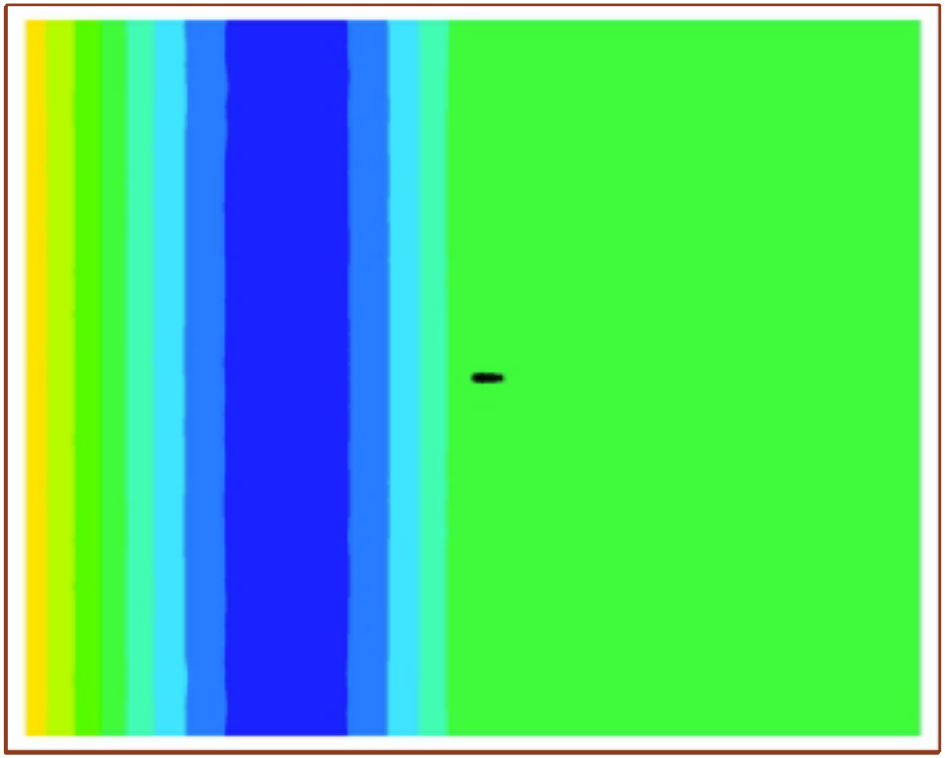

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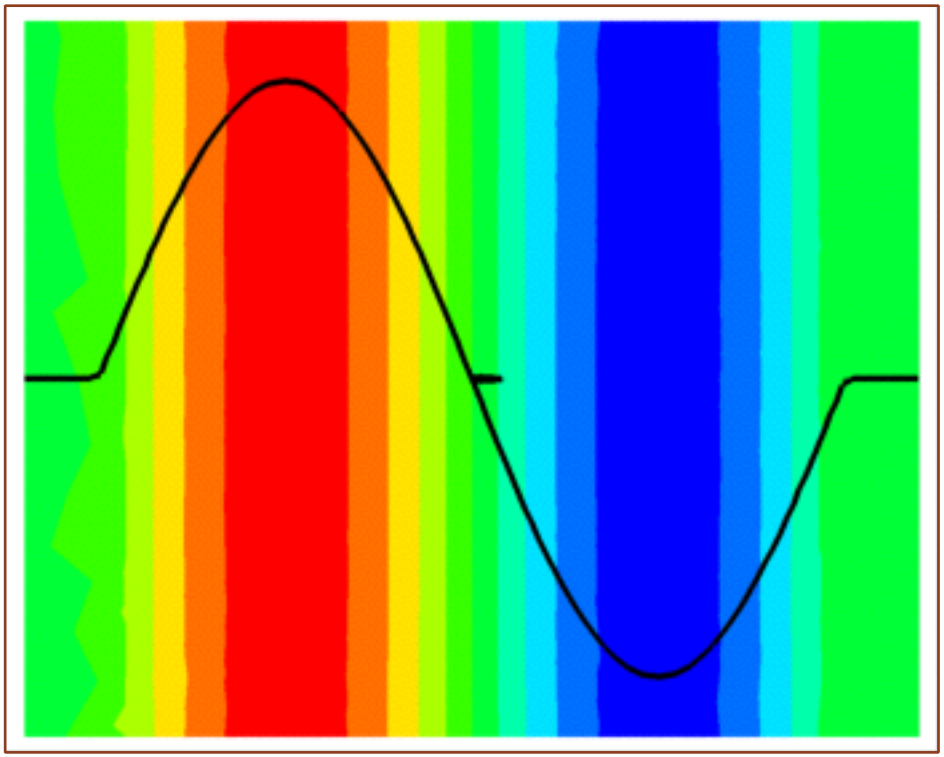
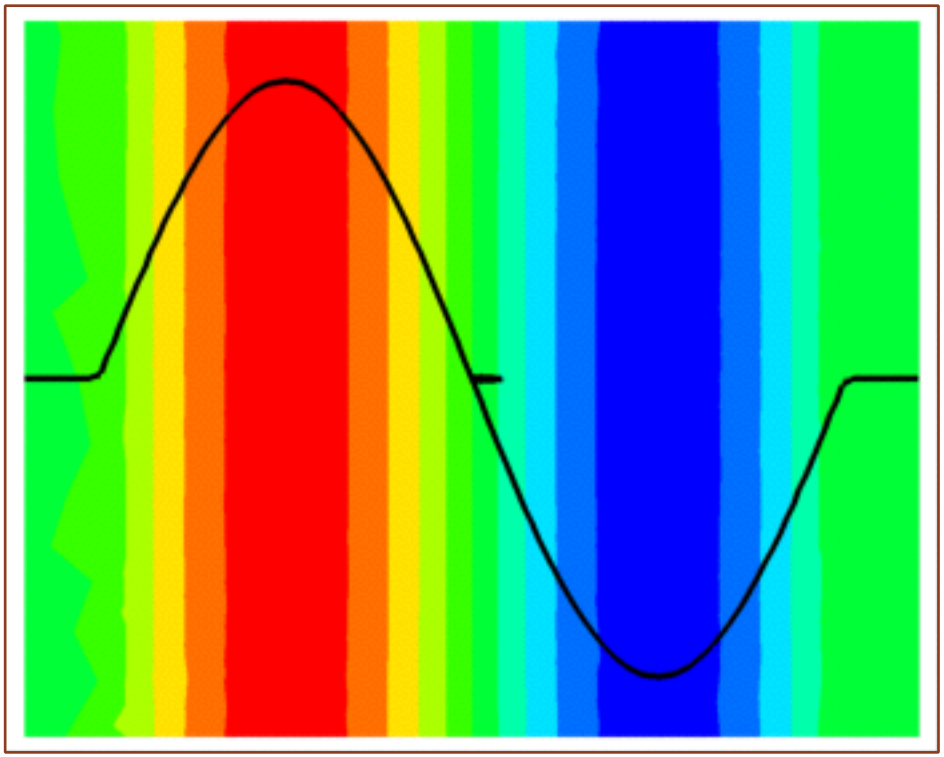


Unsteady flow caused by a gust

SU2
The Open-Source CFD Code

```
GRID_MOVEMENT= YES [Required]

WIND_GUST= YES

GUST_TYPE= SINE

GUST_DIR= Y_DIR

GUST_WAVELENGTH= 25.0

GUST_PERIODS= 1.0

GUST_AMPLITUDE= 2.31633

GUST_BEGIN_TIME= 0.0

GUST_BEGIN_LOC= -25.0
```



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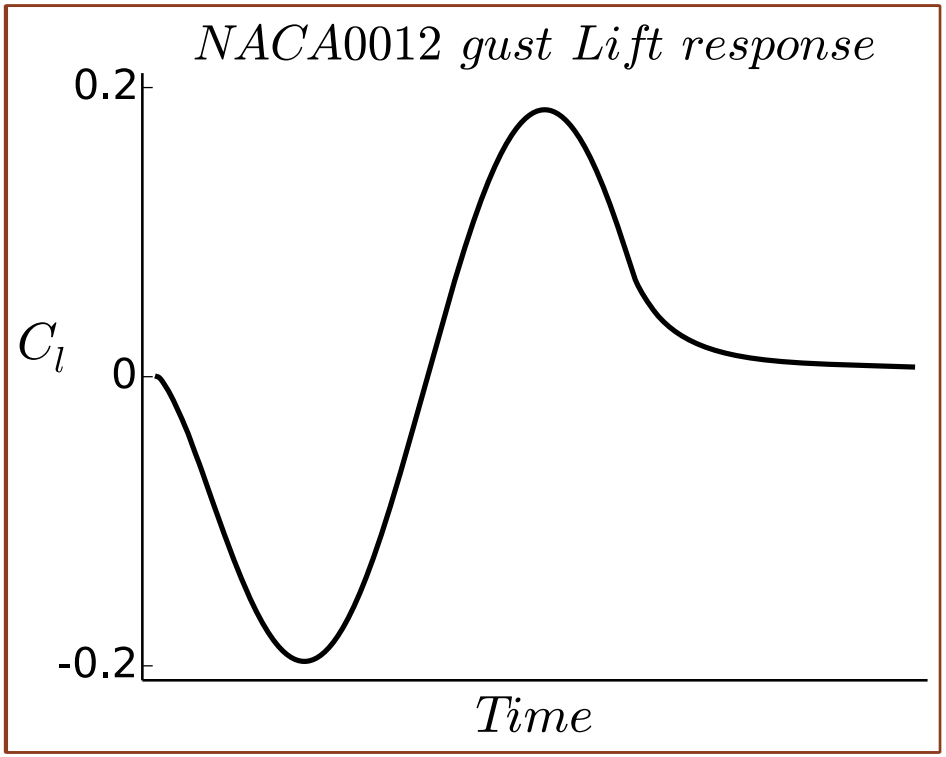
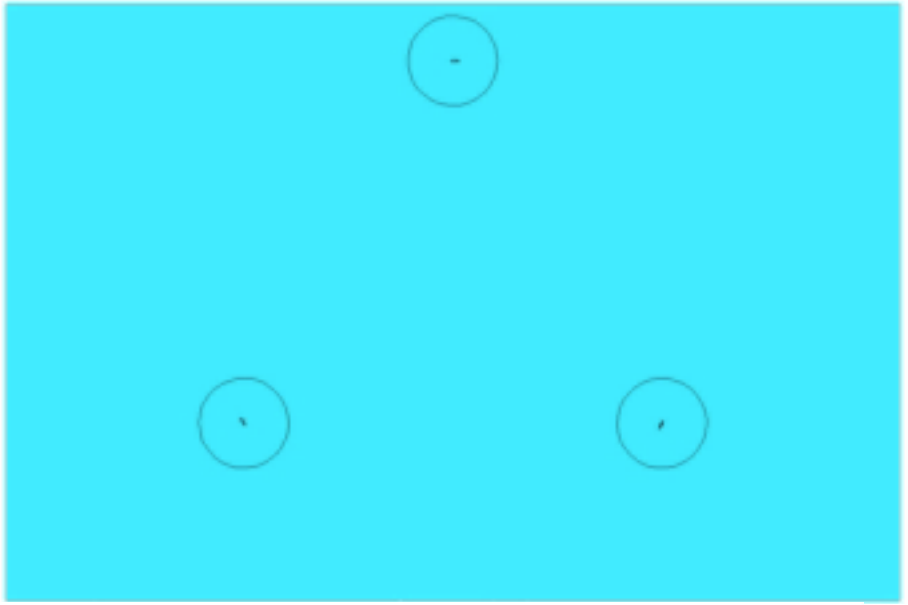
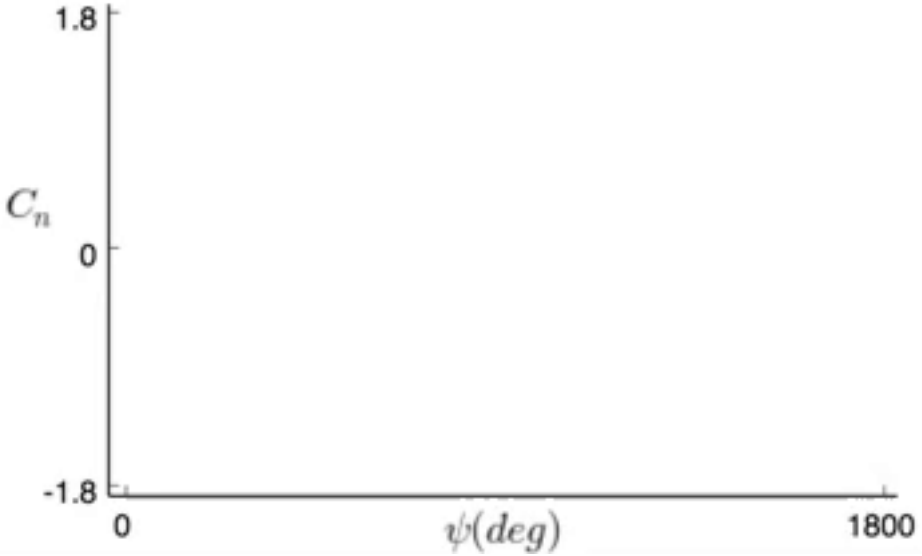


Wind turbine response to an extreme gust

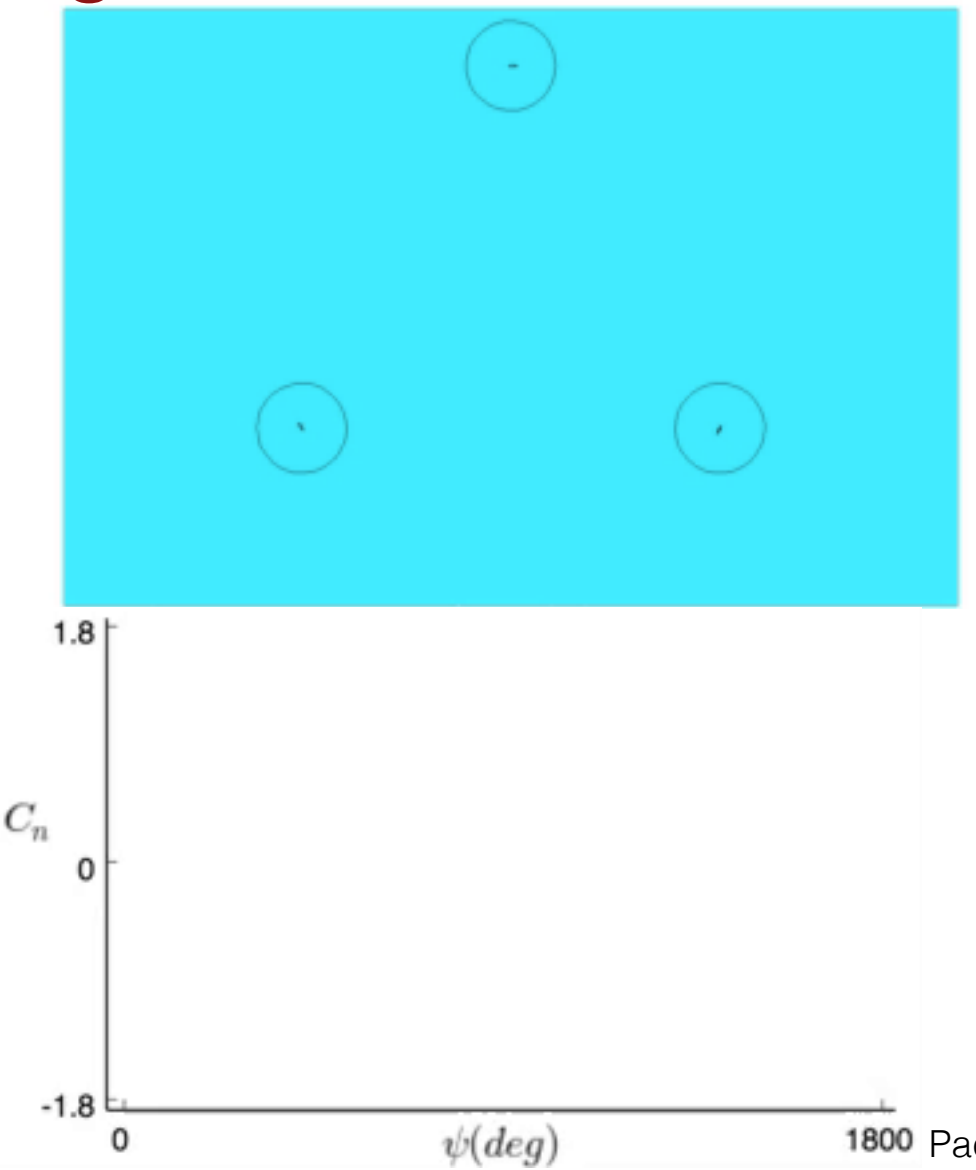




aerospacedesignlab

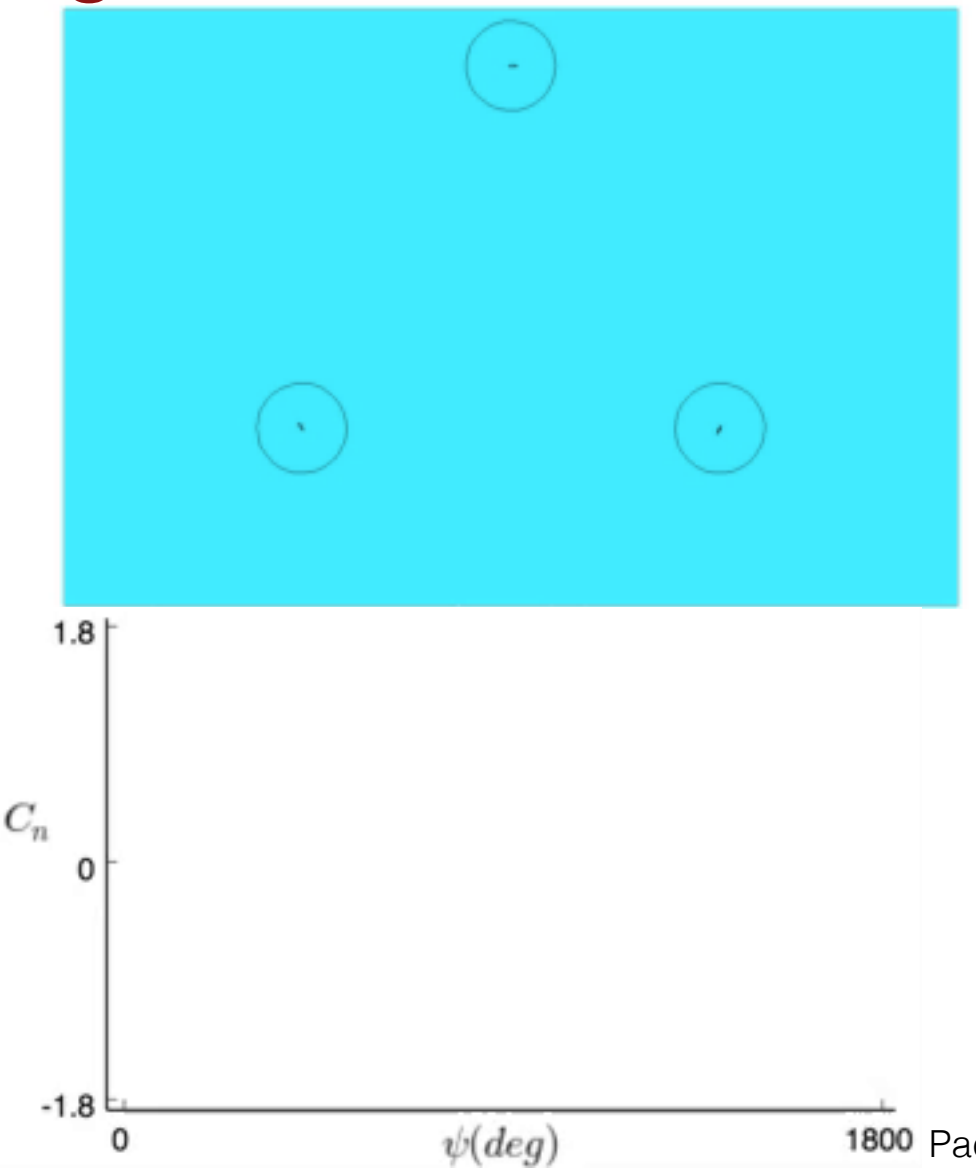
Padrón, 2014

Wind turbine response to an extreme gust



Padrón, 2014

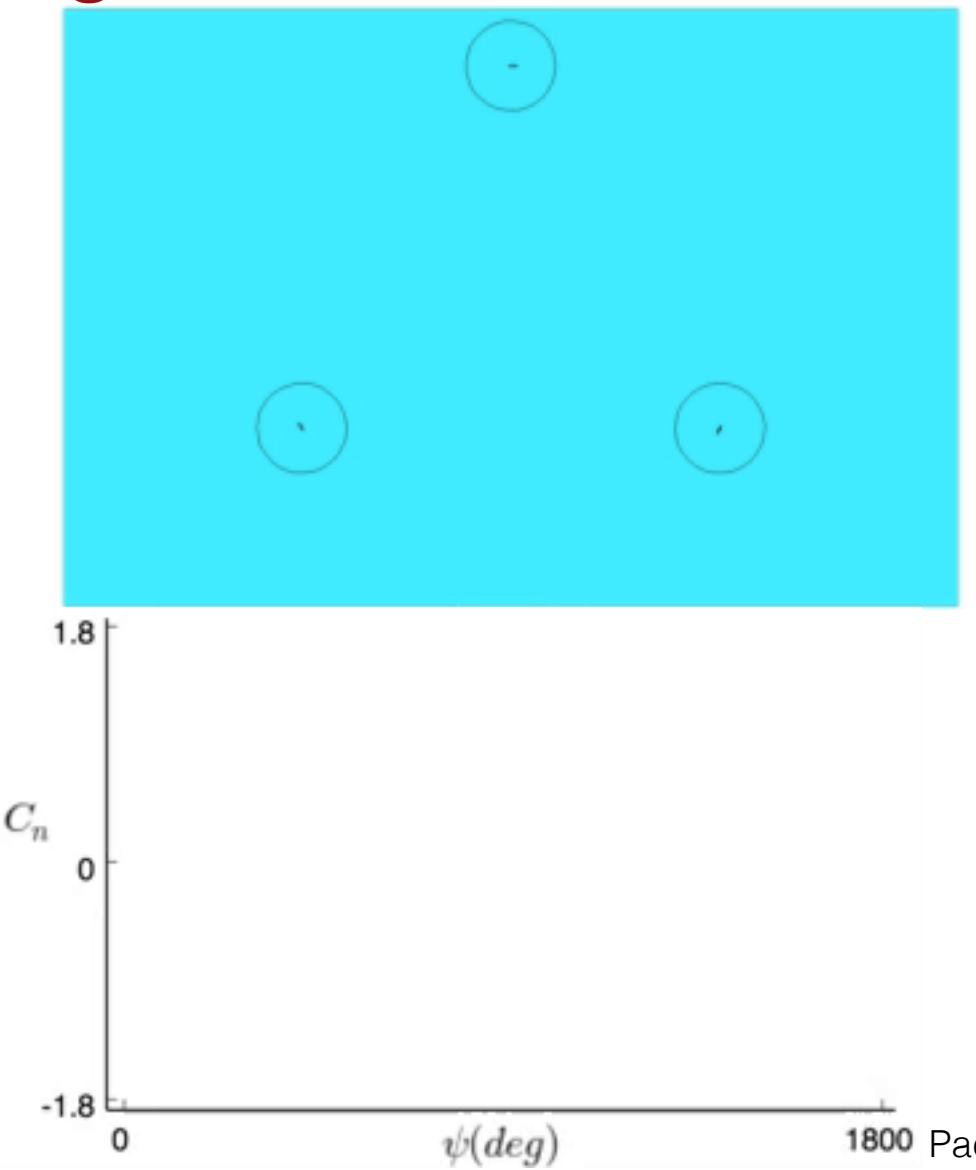
Wind turbine response to an extreme gust



Padrón, 2014

Wind turbine response to an extreme gust

```
MACH_MOTION=
    0.125
```



aerospacedesignlab

Padrón, 2014

How do you make the movies?

SU2
The Open-Source CFD Code

Your Awesome Movie!

How do you make the movies?

SU2
The Open-Source CFD Code

```
% NO, TIME_STEPPING,
%DUAL_TIME_STEPPING-1ST_ORDER
UNSTEADY_SIMULATION=
 DUAL_TIME_STEPPING-2ND_ORDER

WRT_SOL_FREQ= 10
WRT_SOL_FREQ_DUALTIME= 10

% PARAVIEW
OUTPUT_FORMAT= TECPLOT

% Write the restart file
RESTART_FLOW_FILENAME=
    restart_flow.dat

% Output file flow variables
VOLUME_FLOW_FILENAME= flow
```

Your Awesome Movie!

SU2
The Open-Source CFD Code

Demo looking at flow solutions for movie.

How to perform an unsteady restart?

SU2
The Open-Source CFD Code

How to perform an unsteady restart?

SU2
The Open-Source CFD Code

Original simulation

```
UNSTEADY_SIMULATION=
 DUAL_TIME_STEPPING-2ND_ORDER

WRT_SOL_FREQ_DUALTIME= 10

% Write the restart file
RESTART_FLOW_FILENAME=
    restart_flow.dat

EXT_ITER= 100
```

How to perform an unsteady restart?

SU2
The Open-Source CFD Code

Original simulation

```
UNSTEADY_SIMULATION=
 DUAL_TIME_STEPPING-2ND_ORDER

WRT_SOL_FREQ_DUALTIME= 10

% Write the restart file
RESTART_FLOW_FILENAME=
    restart_flow.dat

EXT_ITER= 100
```


restart_flow_00010.dat,
restart_flow_00020.dat,
…
restart_flow_00099.dat

How to perform an unsteady restart?

SU2
The Open-Source CFD Code

Original simulation

```
UNSTEADY_SIMULATION=
 DUAL_TIME_STEPPING-2ND_ORDER

WRT_SOL_FREQ_DUALTIME= 10

% Write the restart file
RESTART_FLOW_FILENAME=
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EXT_ITER= 100
```
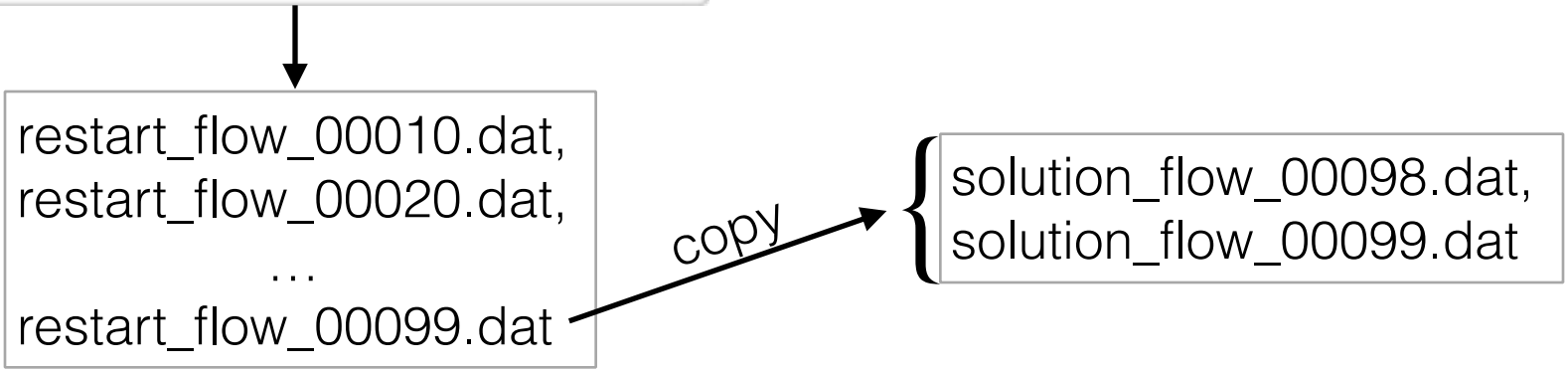



How to perform an unsteady restart?

SU2
The Open-Source CFD Code

Original simulation

```
UNSTEADY_SIMULATION=
 DUAL_TIME_STEPPING-2ND_ORDER

WRT_SOL_FREQ_DUALTIME= 10

% Write the restart file
RESTART_FLOW_FILENAME=
    restart_flow.dat

EXT_ITER= 100
```

restart_flow_00010.dat,
restart_flow_00020.dat,
…
restart_flow_00099.dat

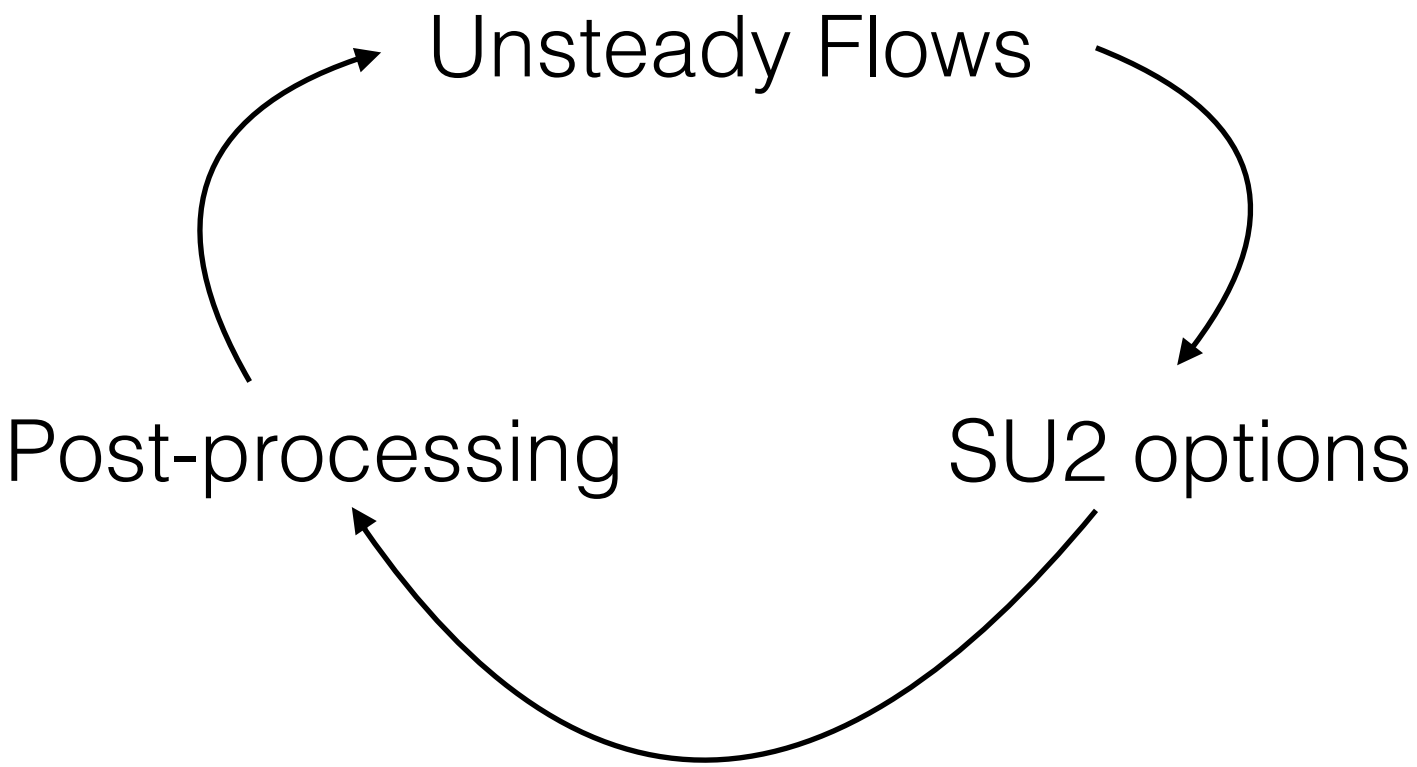
copy

Restart simulation

```
RESTART_SOL= YES

UNST_RESTART_ITER= 100

% Load the restart file
SOLUTION_FLOW_FILENAME=
    solution_flow.dat

% Run 100 more iterations
EXT_ITER= 200
```

solution_flow_00098.dat,
solution_flow_00099.dat

Goal: Learn to run unsteady simulations in SU2



What will you design/ simulate in SU2?

SU2
The Open-Source CFD Code

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Your Awesome Simulation!

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