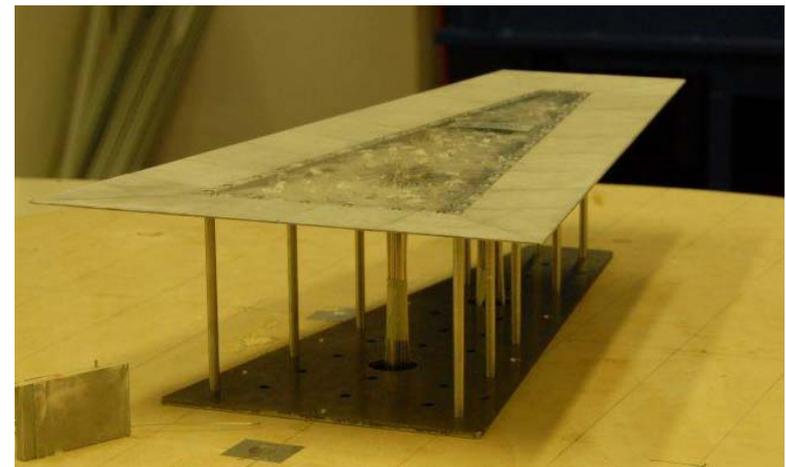


## **Tools for determining wind actions on bluff-bodies**

- 1) Wind-Tunnel Tests**
- 2) CFD Models**
- 3) Full-Scale Measurements**
- 4) Electronic Data Bases**

# WIND TUNNEL TESTS

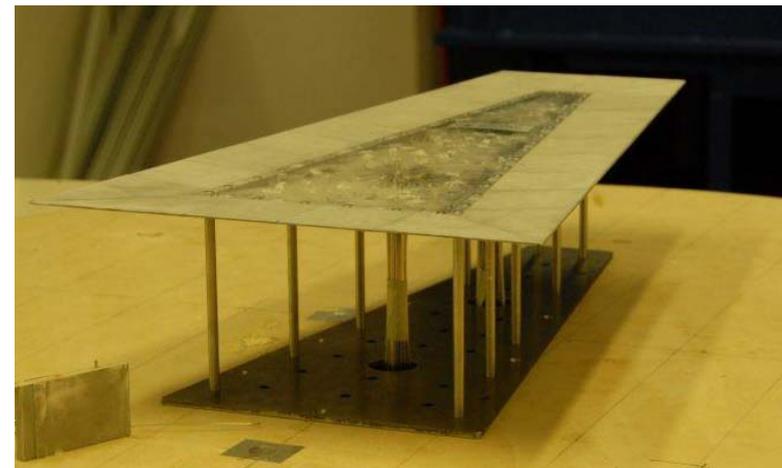
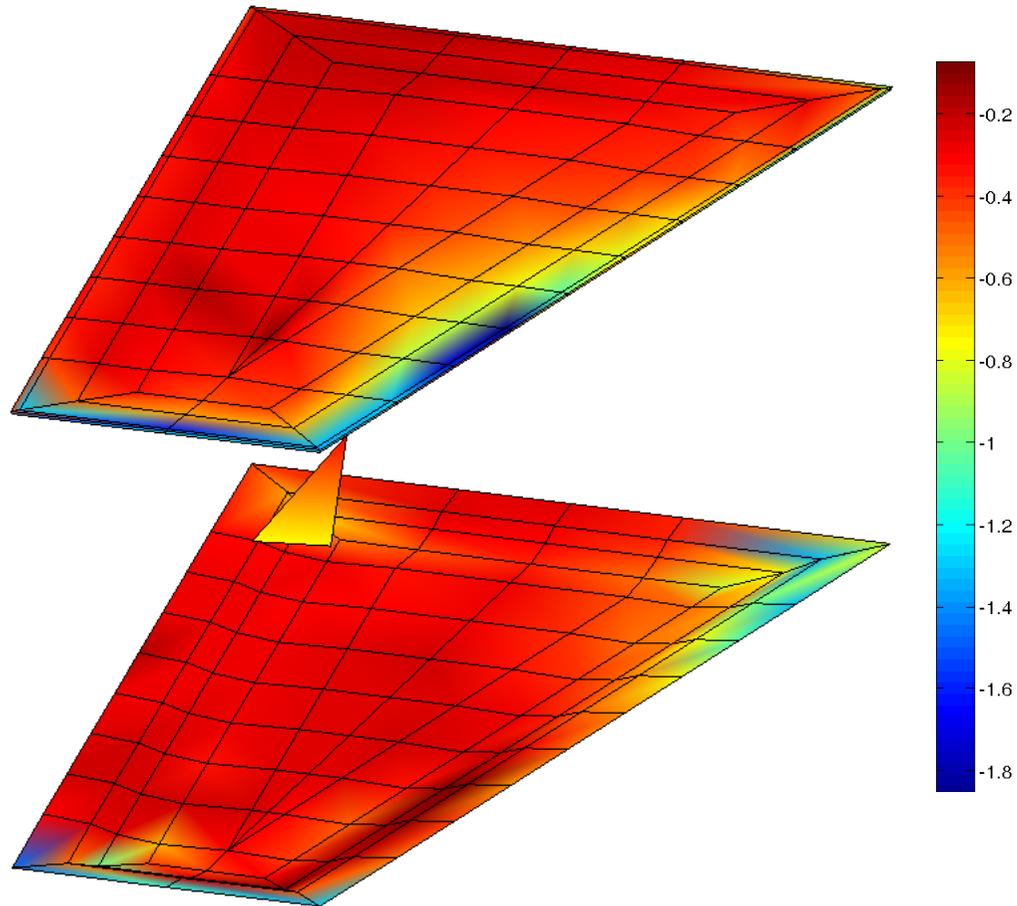
## Pressure taps measurements



Portello Sail, Milano, Italy

# WIND TUNNEL TESTS

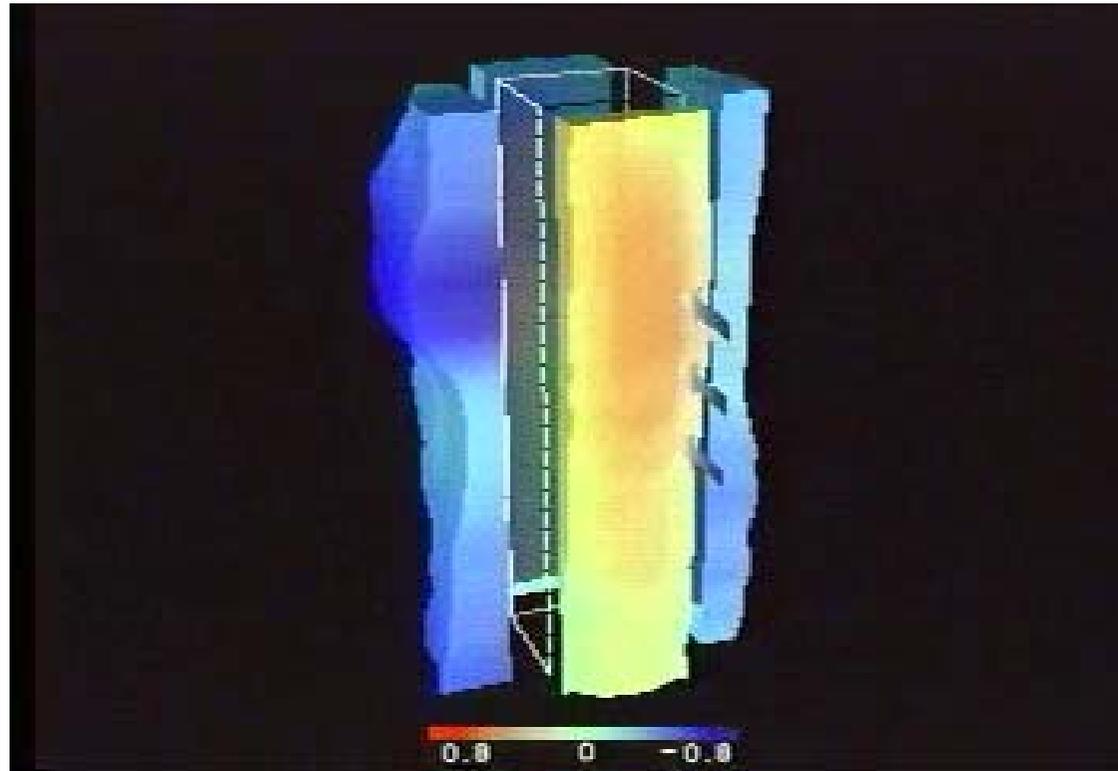
## Pressure taps measurements



Portello Sail, Milano, Italy

# WIND TUNNEL TESTS

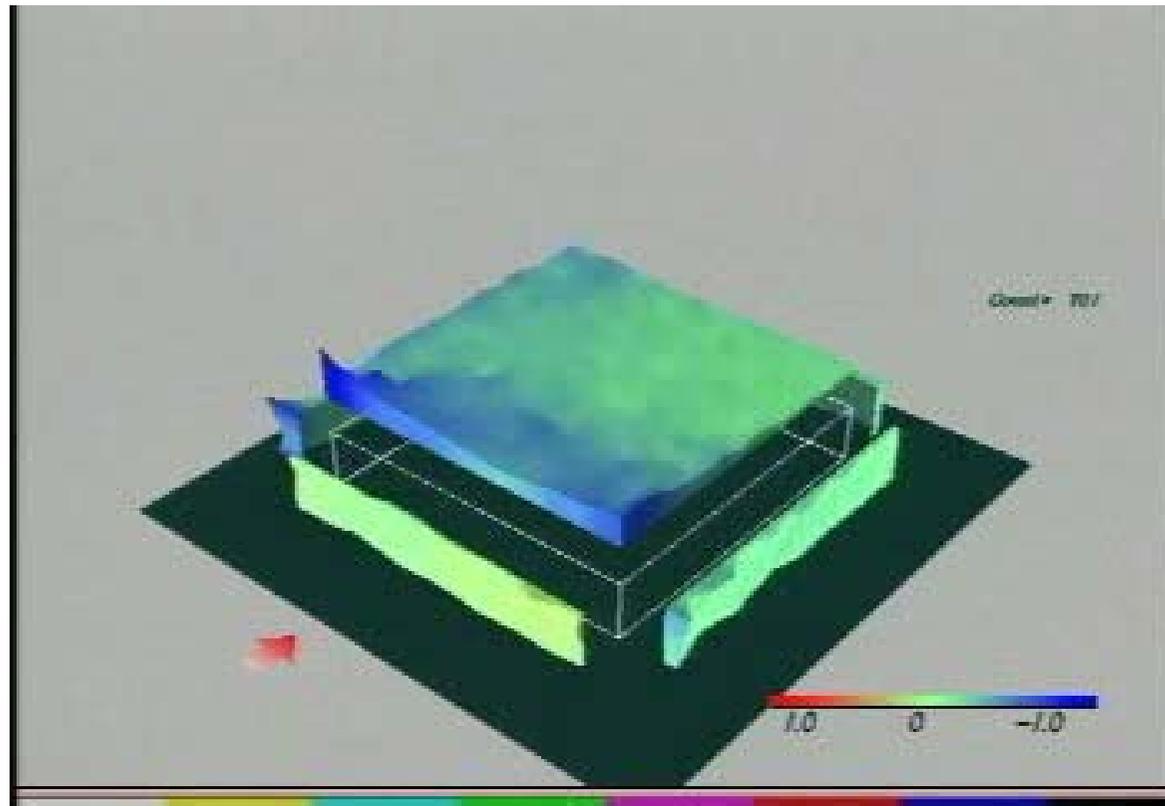
## Pressure taps measurements



Courtesy Shimizu and Tokyo Politechnic University

# WIND TUNNEL TESTS

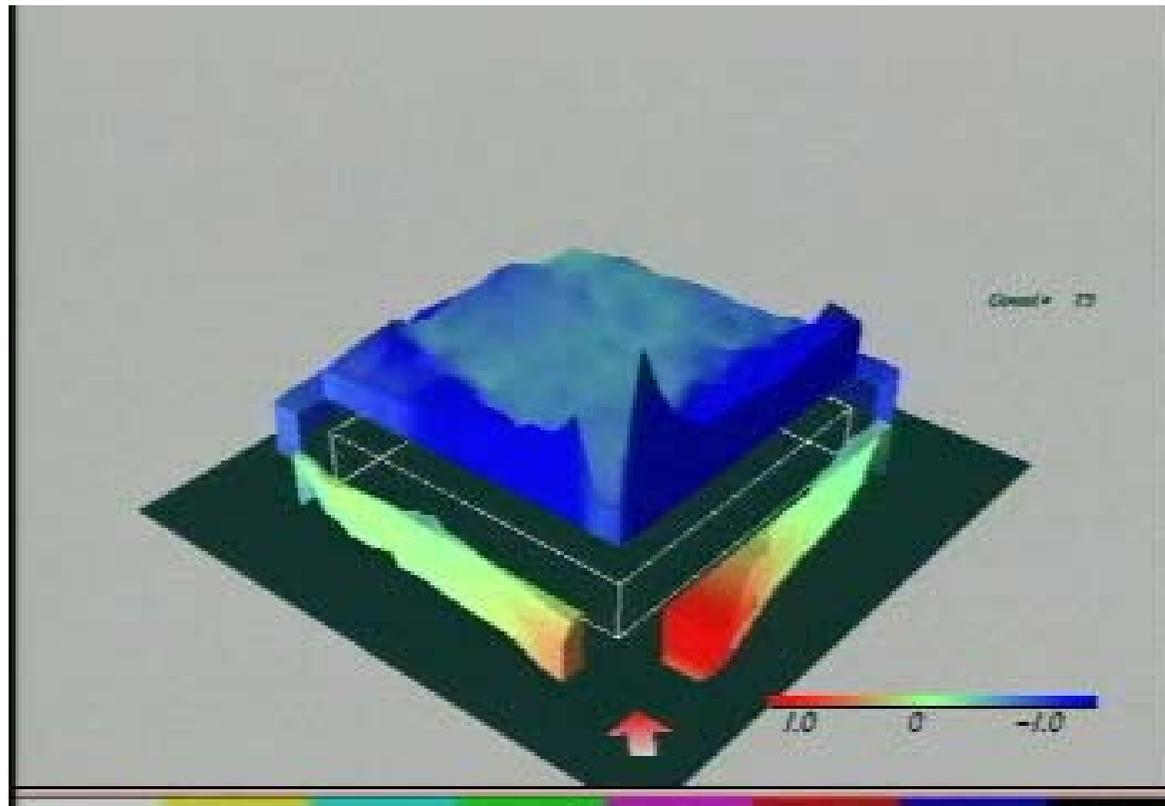
## Pressure taps measurements



Courtesy Shimizu and Tokyo Politechnic University

# WIND TUNNEL TESTS

## Pressure taps measurements



Courtesy Shimizu and Tokyo Politechnic University

# WIND TUNNEL TESTS

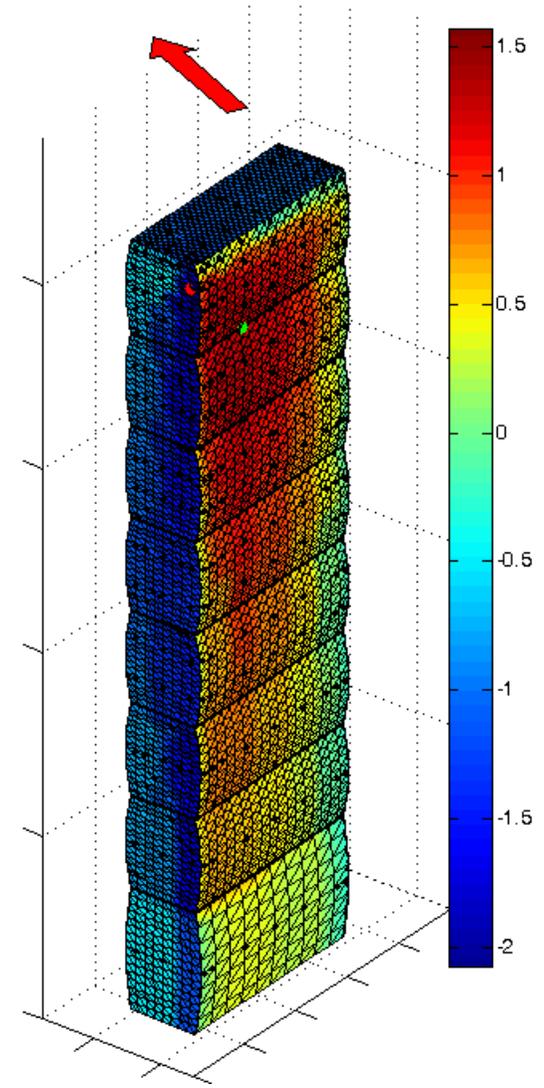
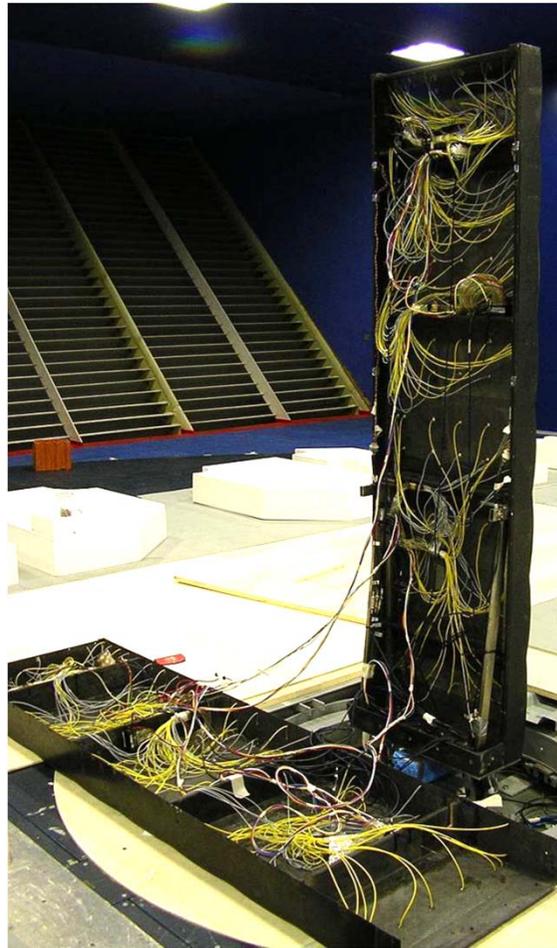
## Pressure taps measurements



Historical Area, Milano Fair

# WIND TUNNEL TESTS

## Pressure taps measurements



Historical Area, Milano Fair

# WIND TUNNEL TESTS

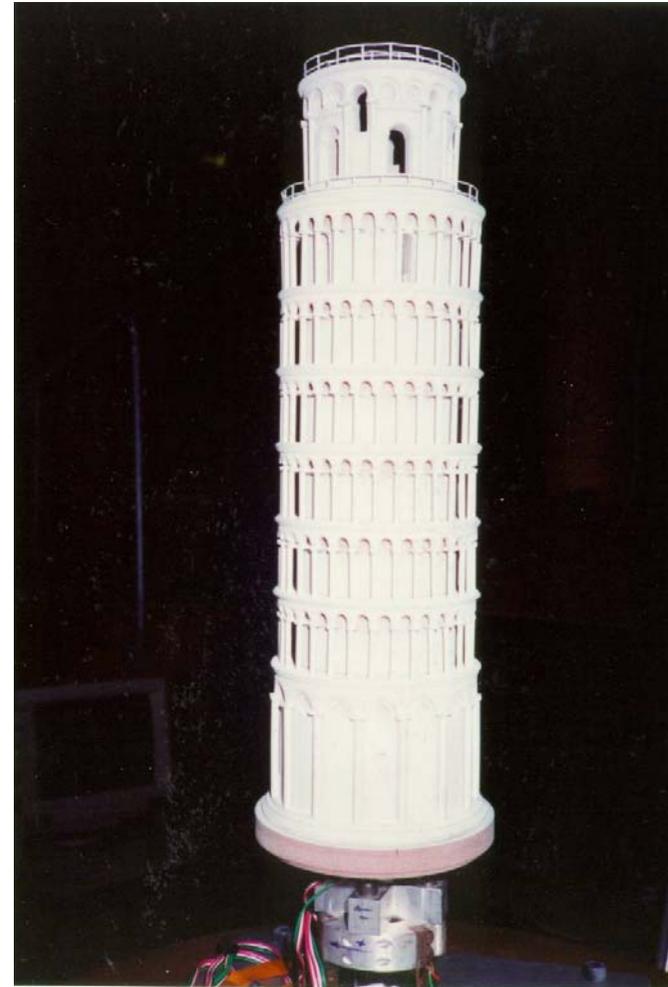
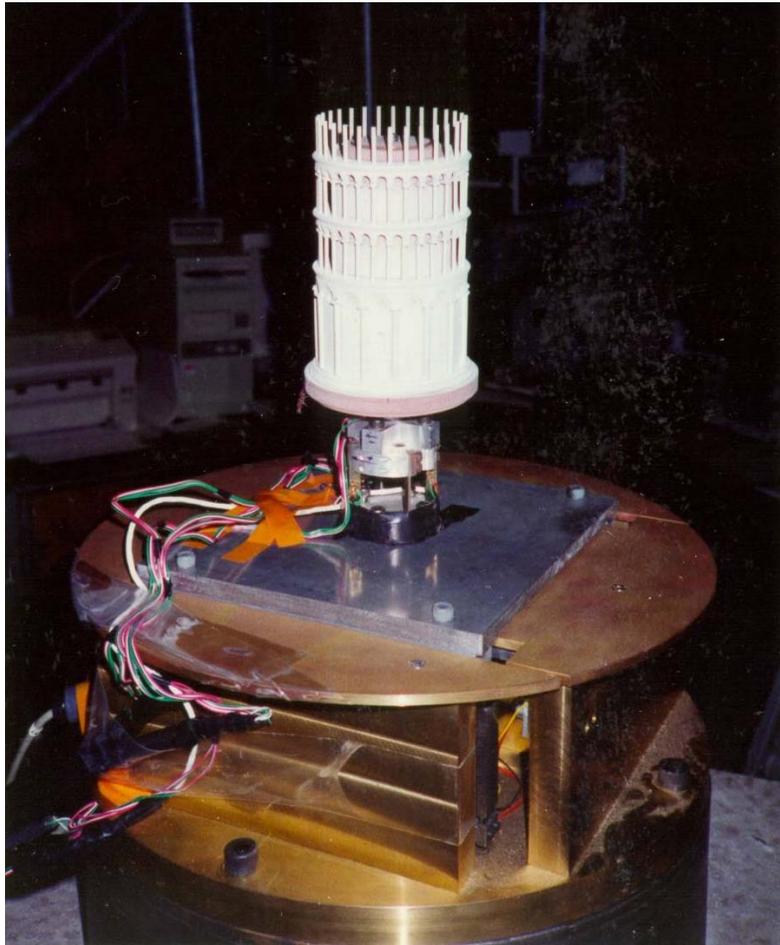
## Force balance tests



Historical Area, Milano Fair

# WIND TUNNEL TESTS

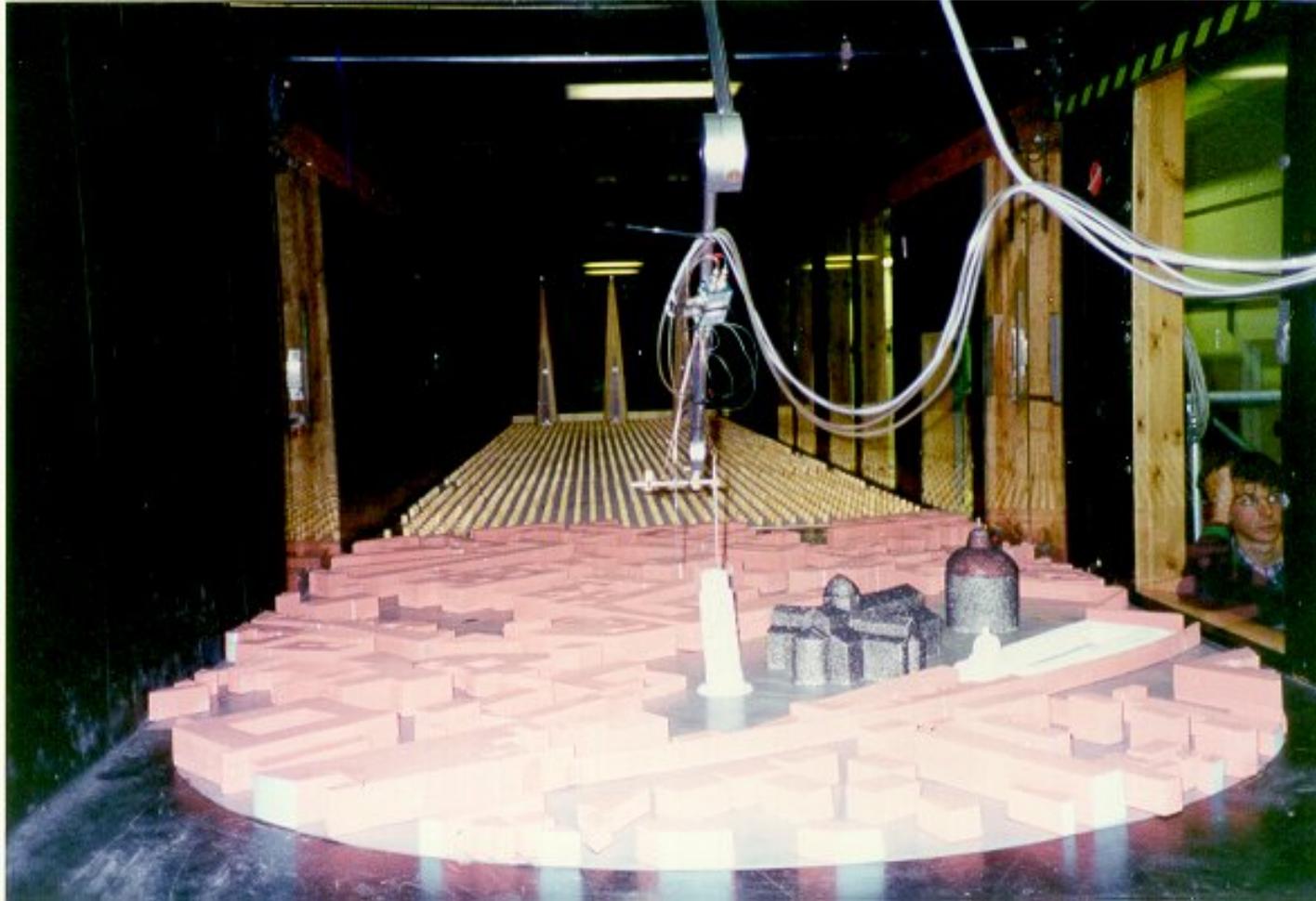
## Force balance tests



Leaning Tower of Pisa

# WIND TUNNEL TESTS

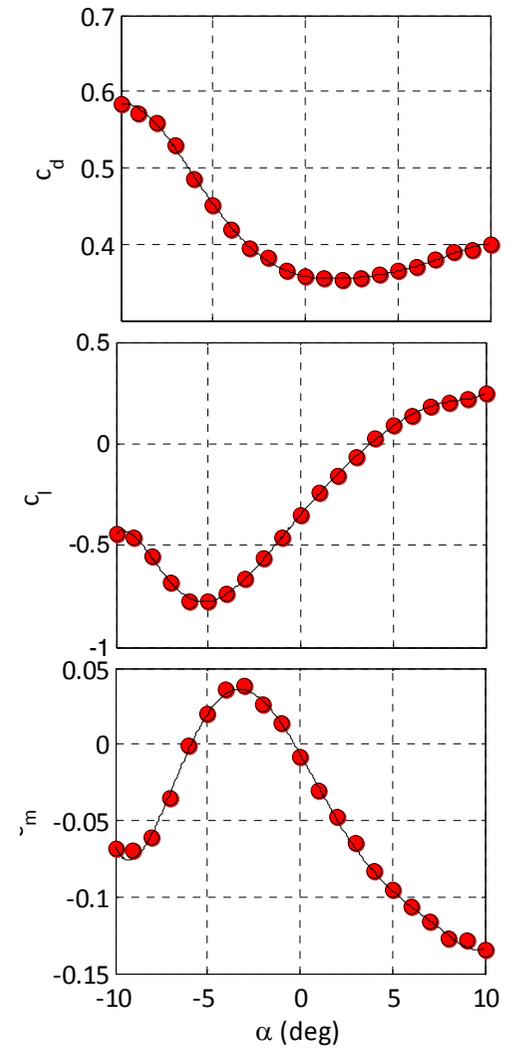
## Force balance tests



Leaning Tower of Pisa

# WIND TUNNEL TESTS

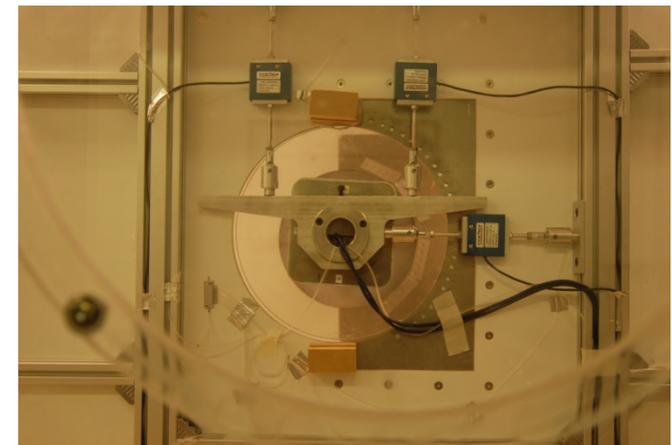
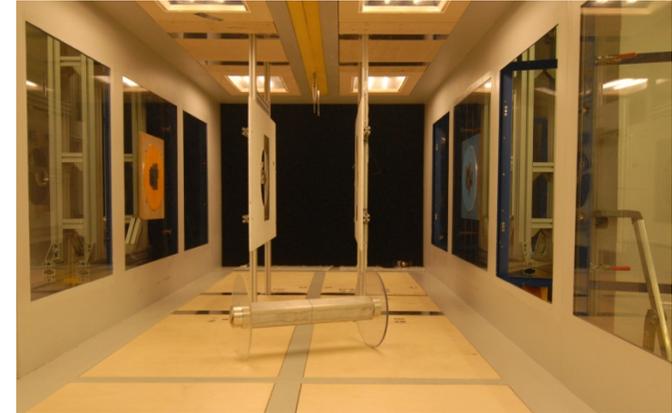
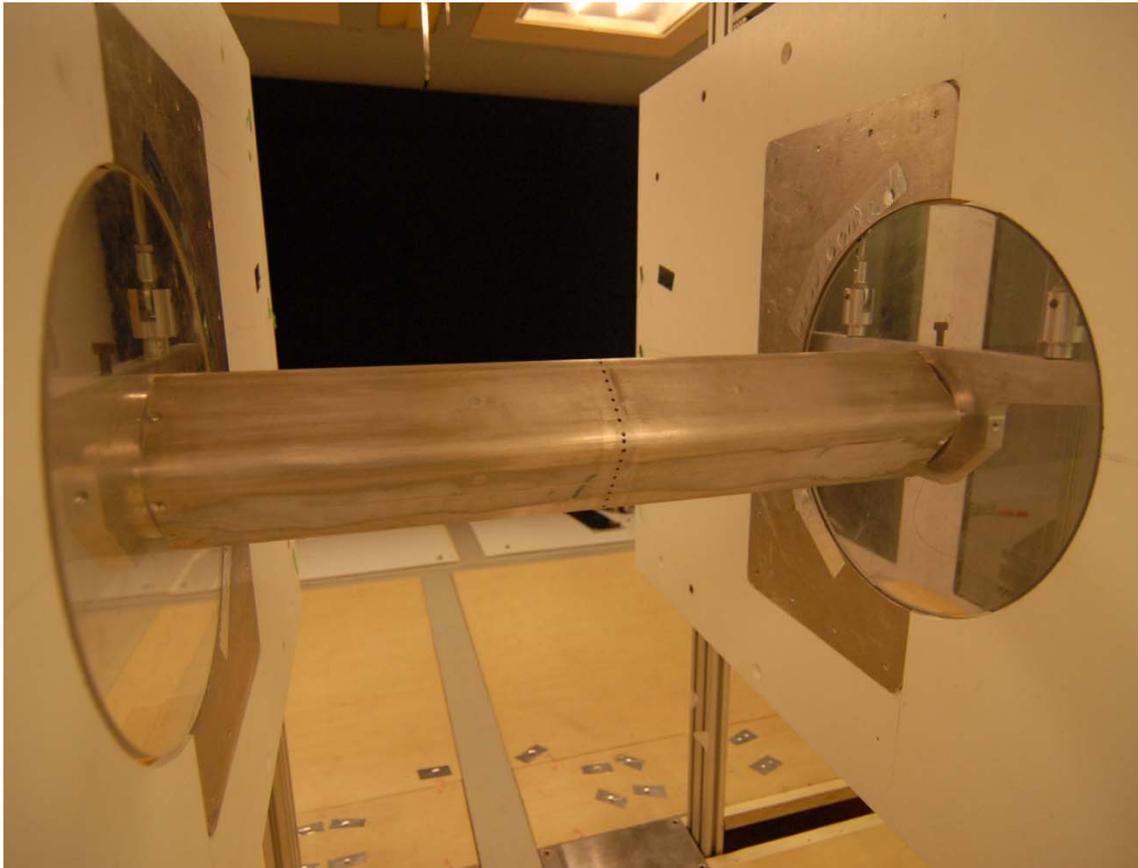
## Force balance tests



Serra Footbridge, Milano, Italy

# WIND TUNNEL TESTS

## Force balance tests



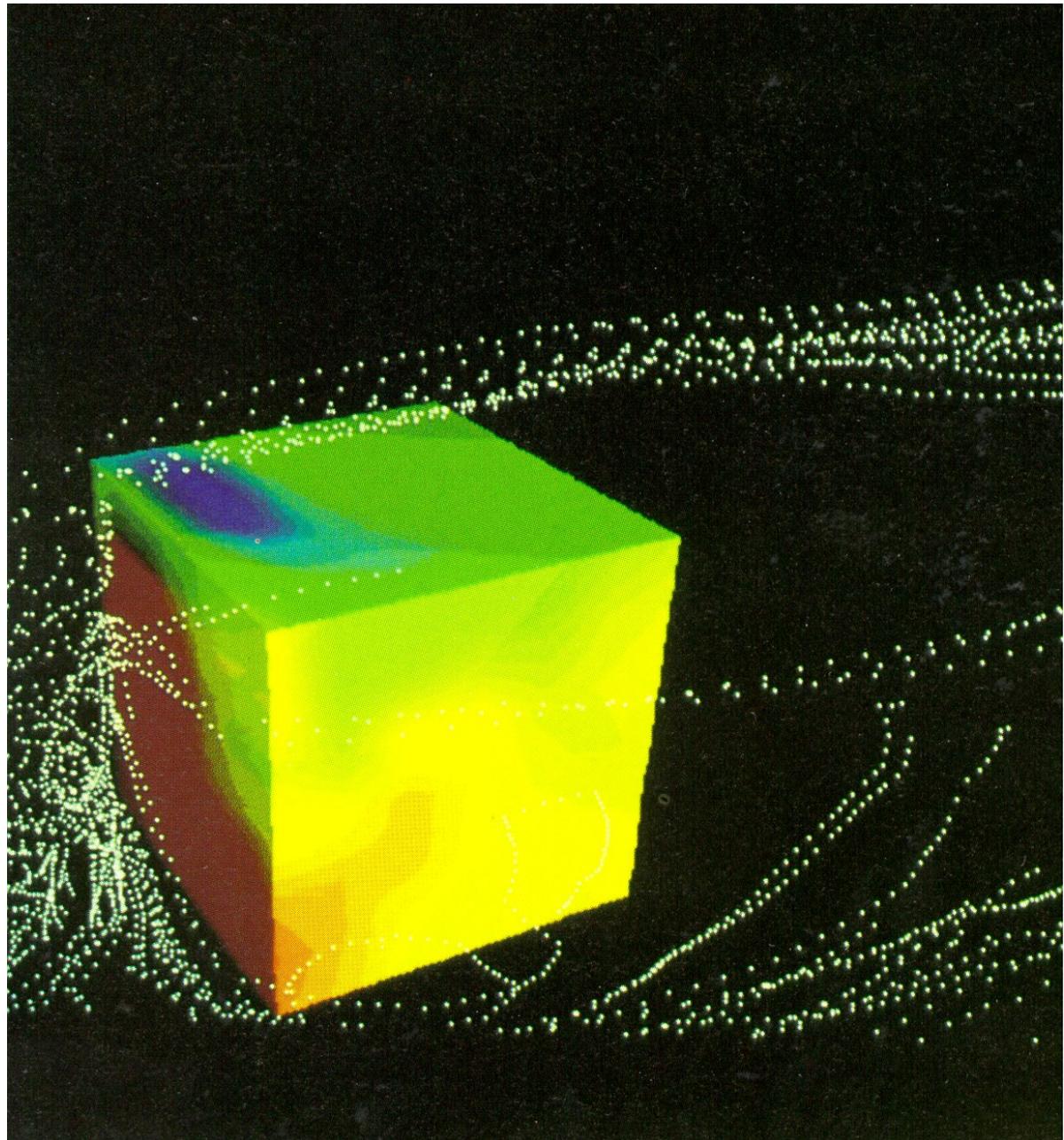
Varesine “Megafame”, Milano, Italy

# CFD MODELS

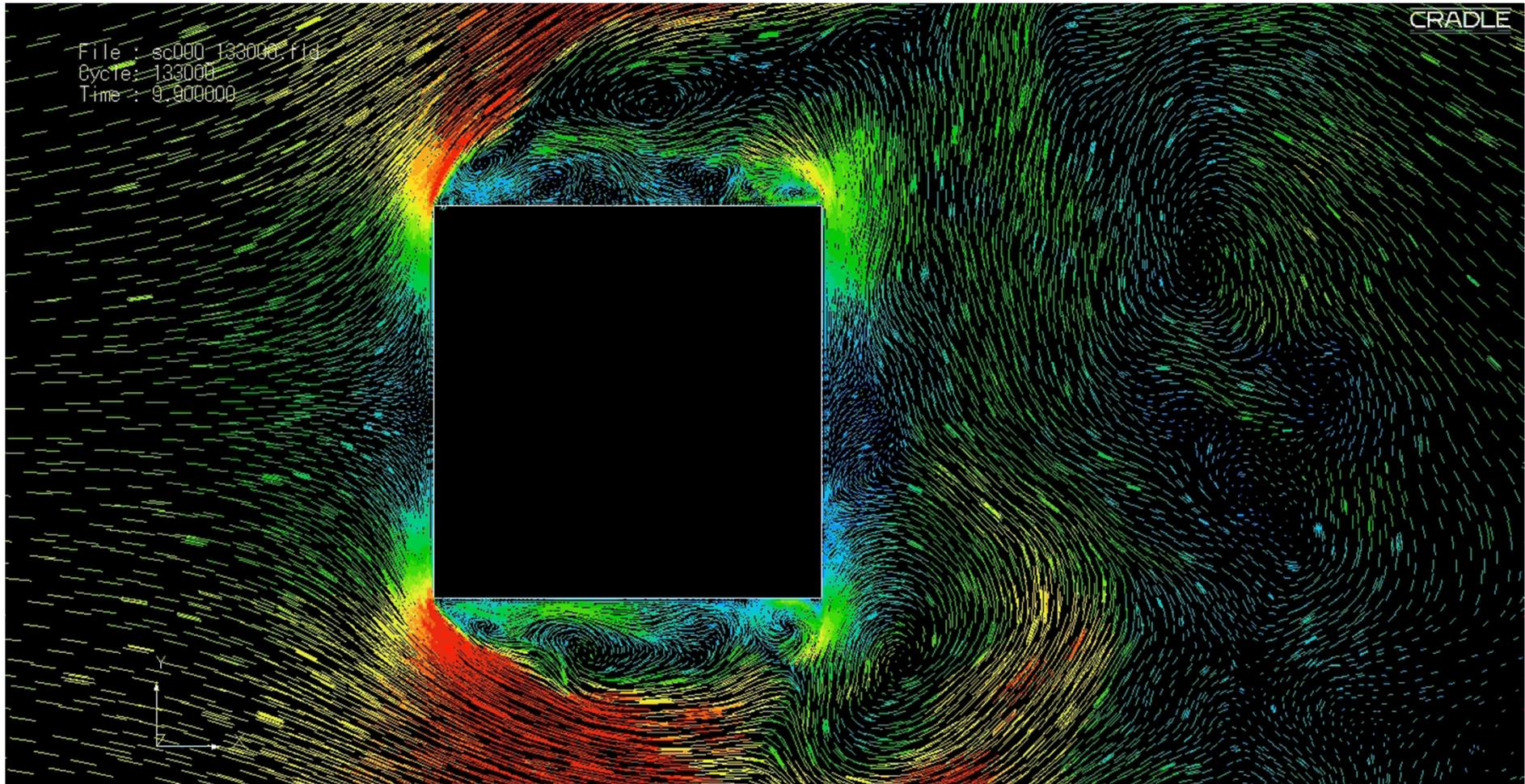
RANS

LES

.....

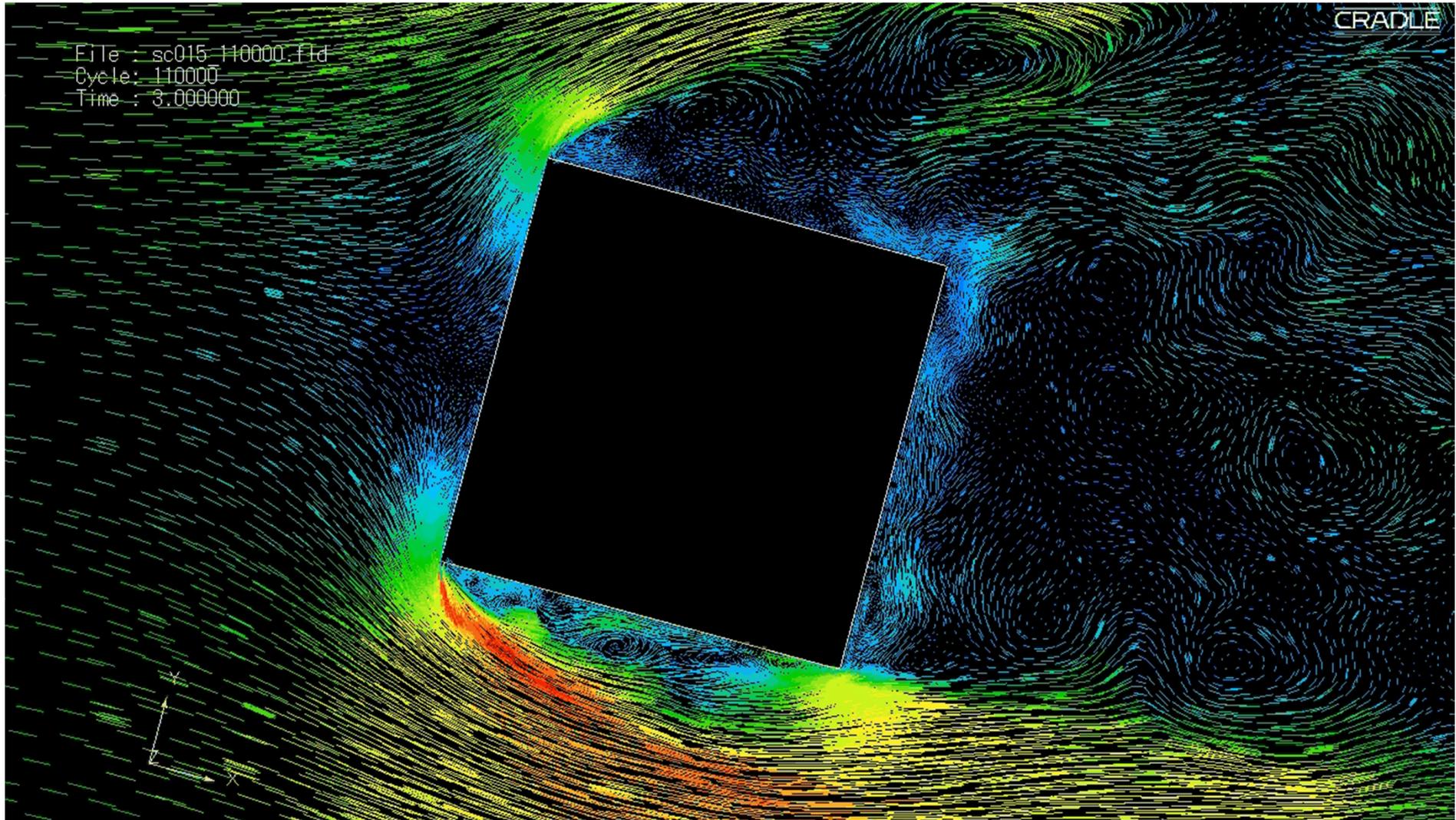


# CFD MODELS



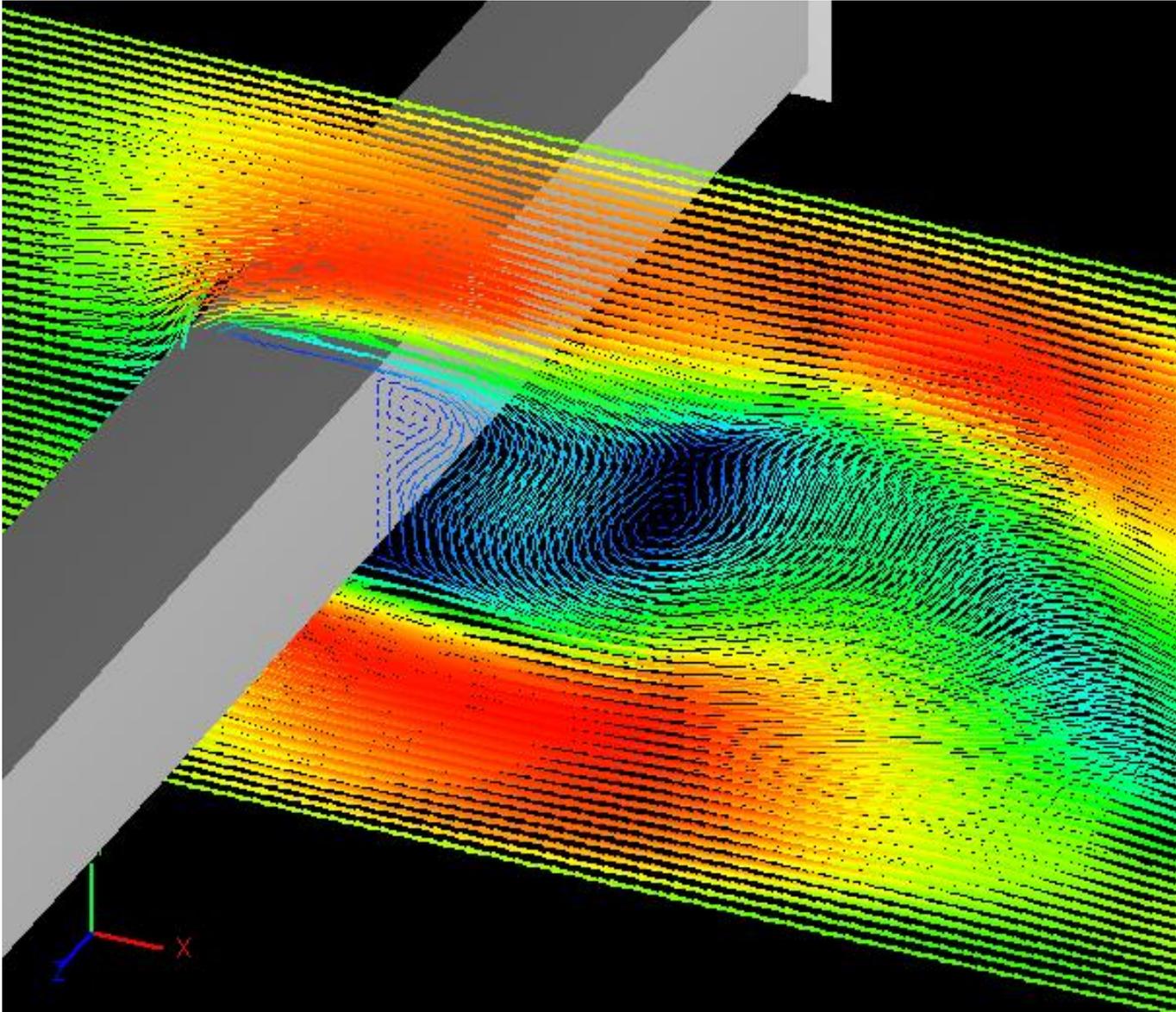
Square section building – wind direction 0 degrees

# CFD MODELS

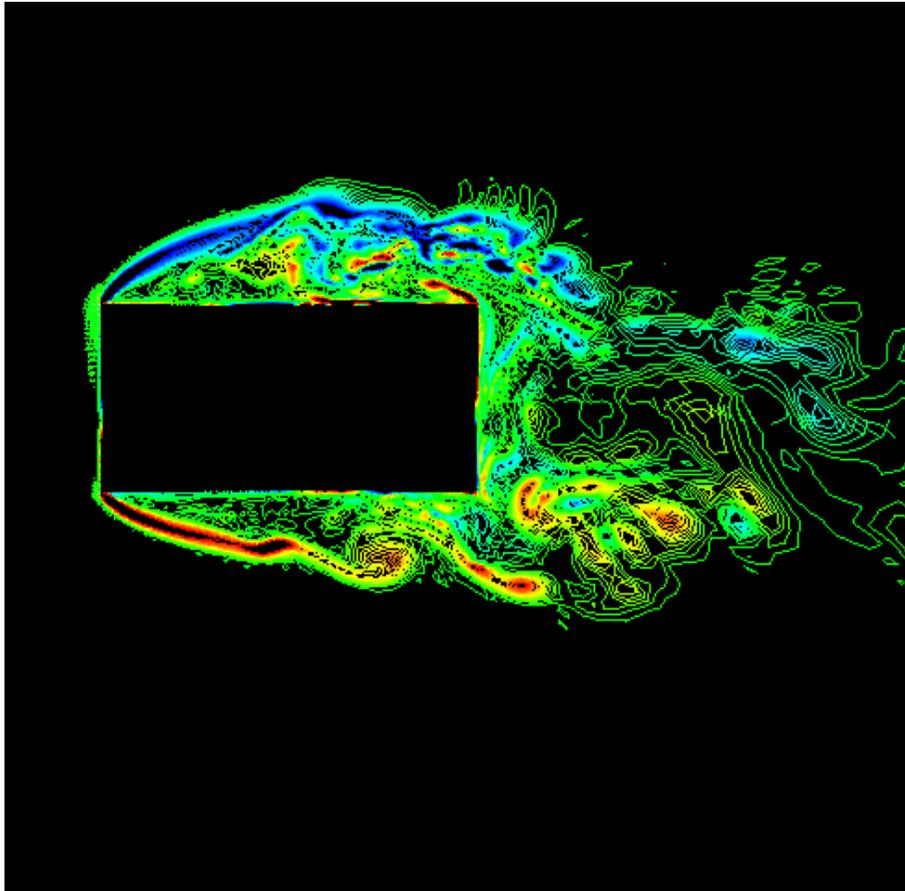


Square section building – wind direction 15 degrees

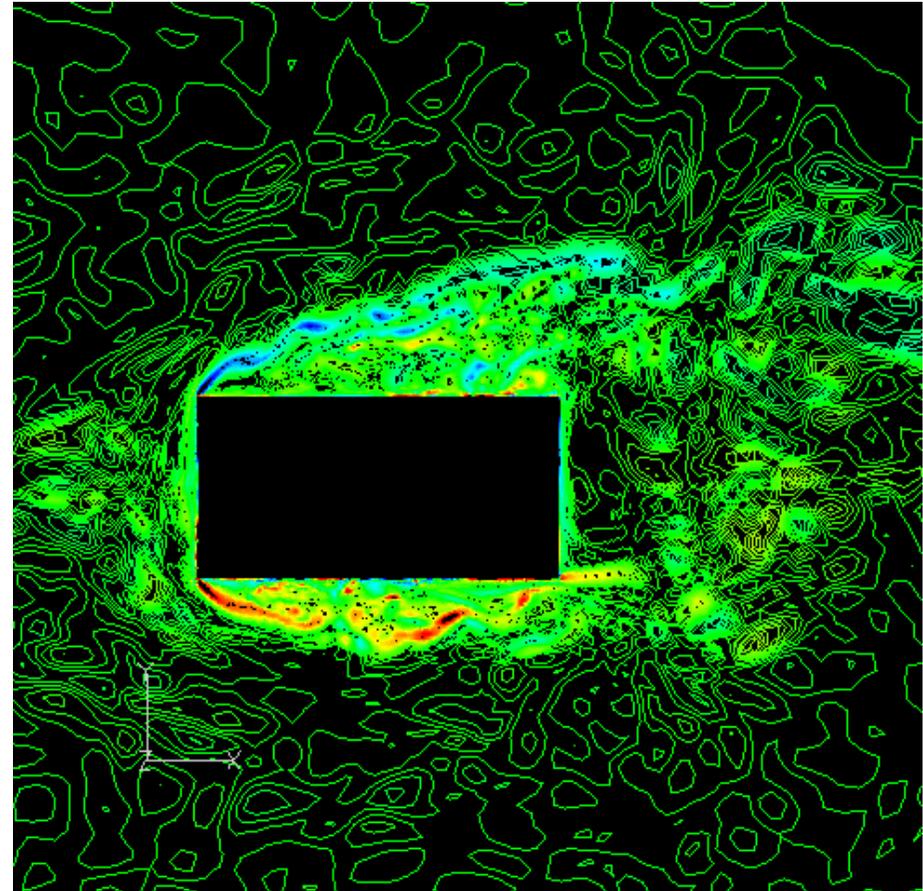
# CFD MODELS



# CFD MODELS



Uniform flow



Turbulent flow

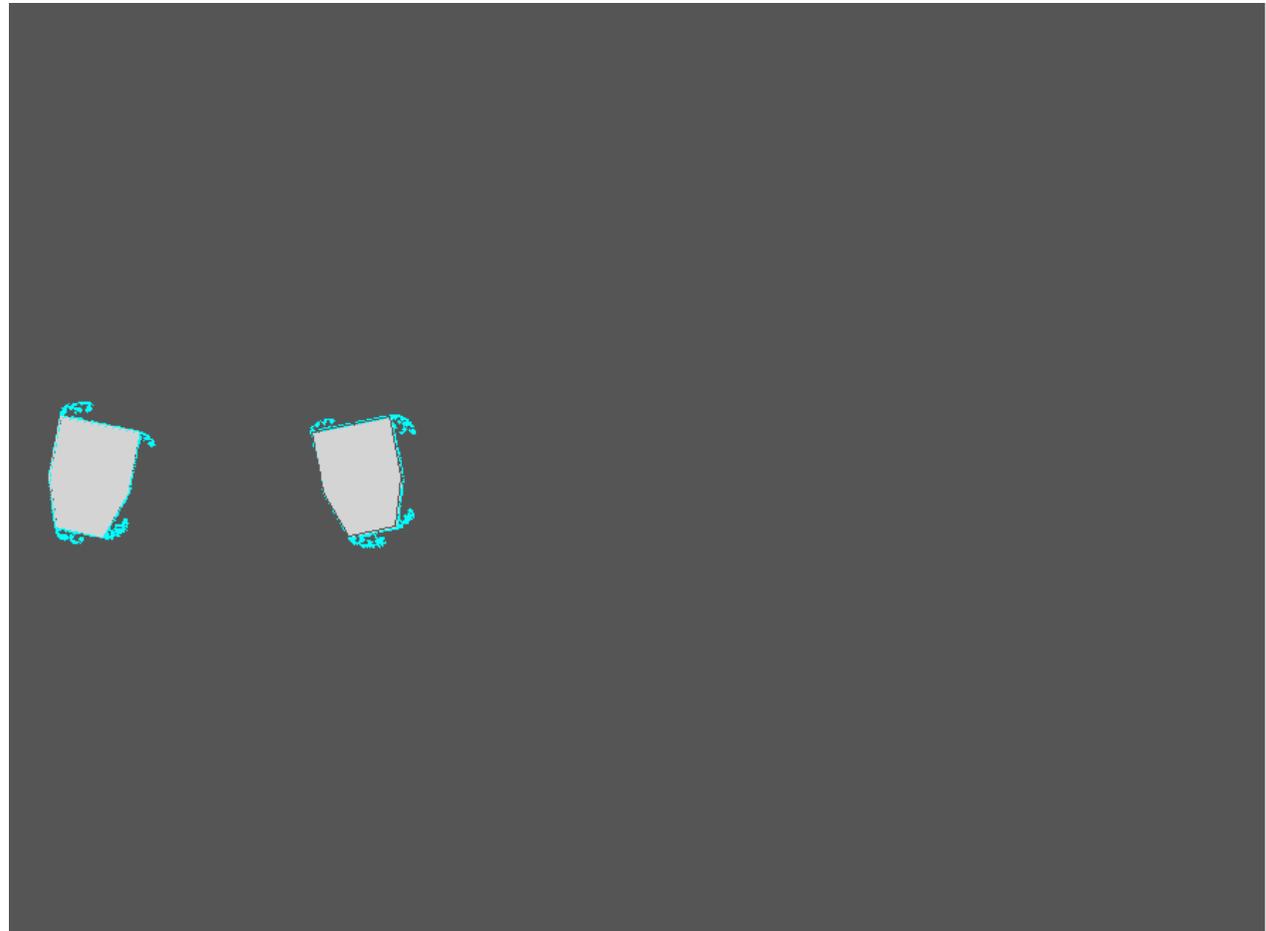
Vorticity contours

# CFD MODELS

RANS

LES

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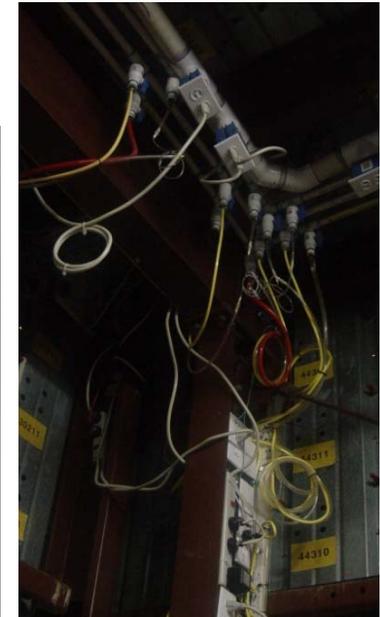
Lupu Bridge, Shanghai, China

## FULL-SCALE MEASUREMENTS



Shionomisaki Wind Effect Laboratory of Kyoto University

# FULL-SCALE MEASUREMENTS



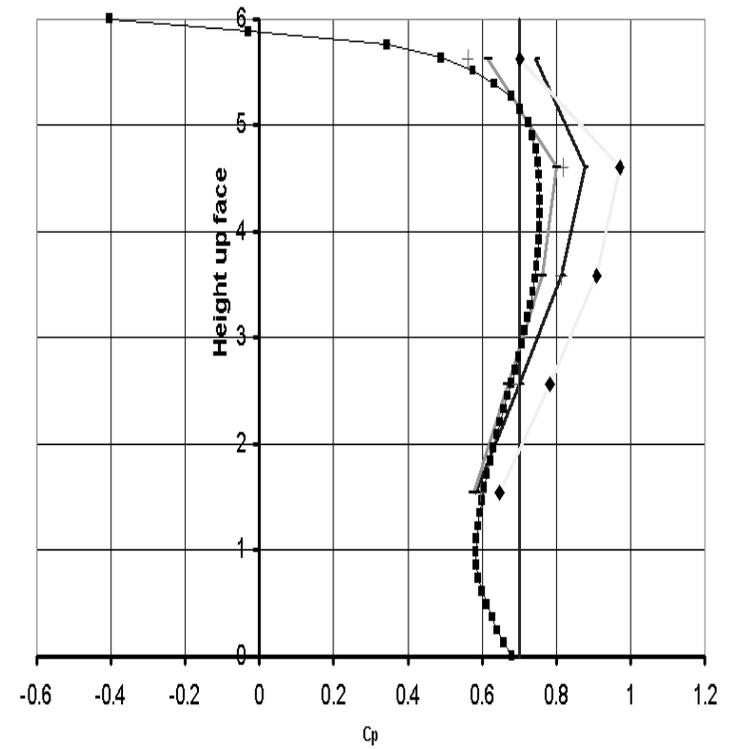
Wind Engineering Research Station, Lubbock, Texas

# FULL-SCALE MEASUREMENTS



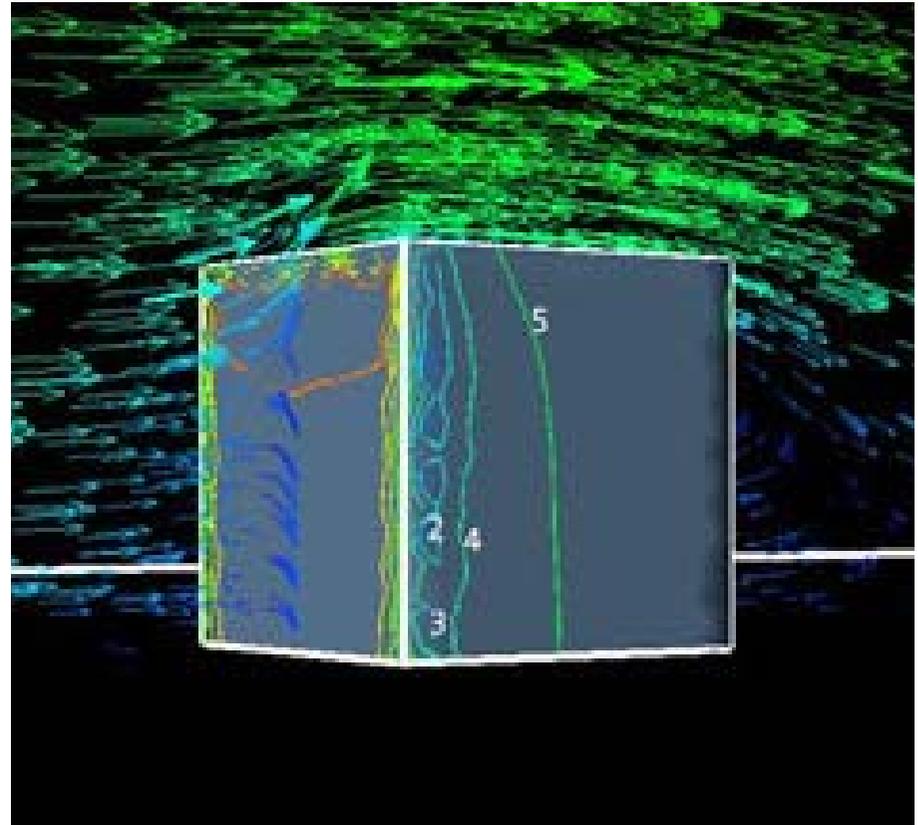
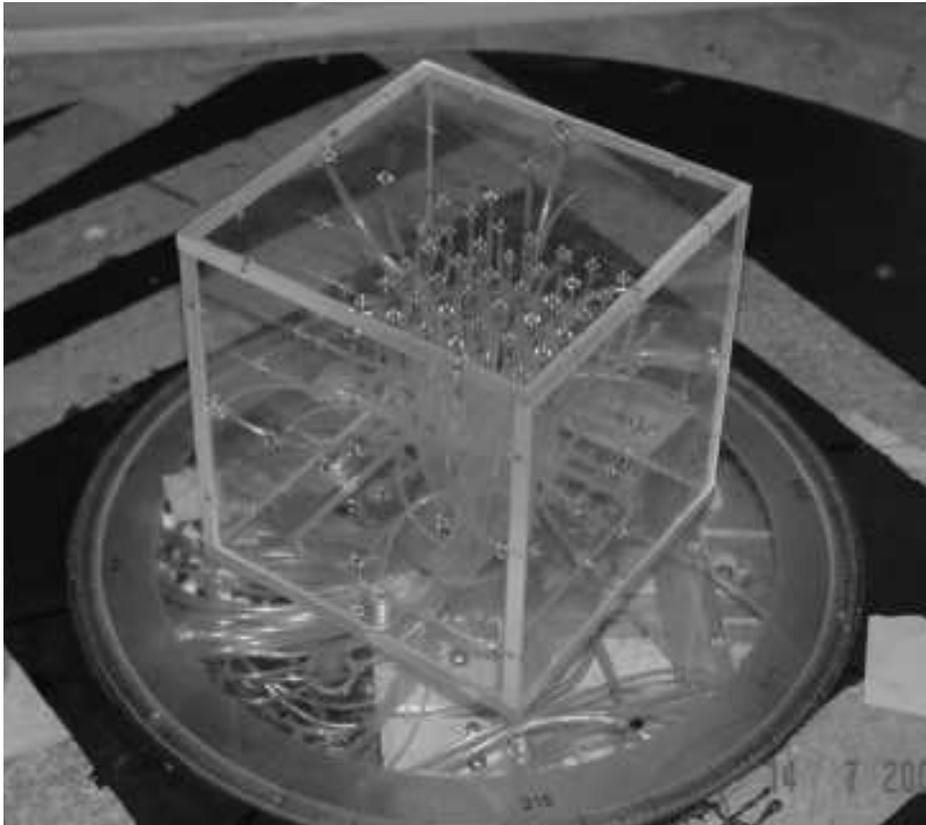
Silsoe Research Institute, U.K.

# FULL-SCALE MEASUREMENTS



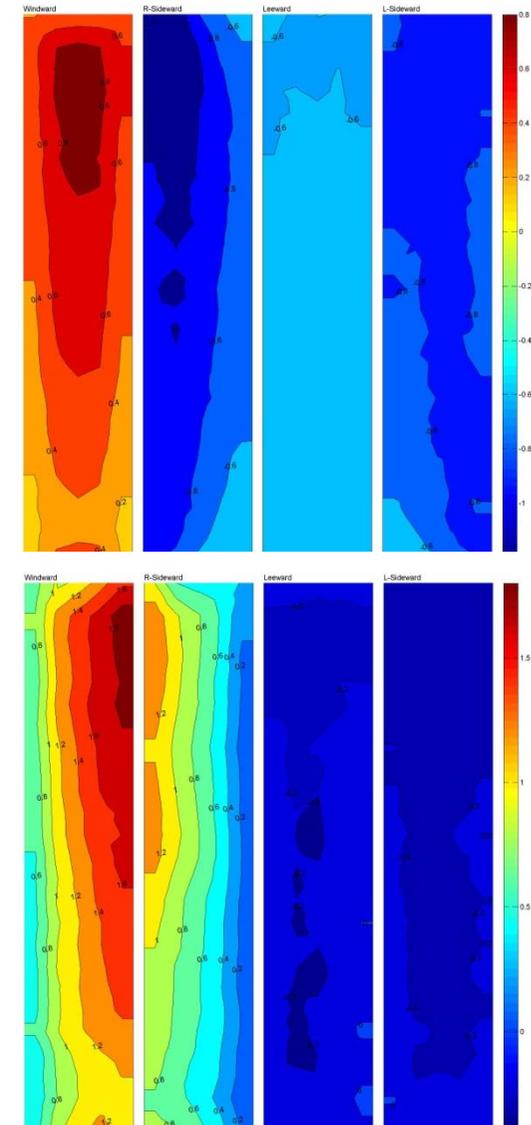
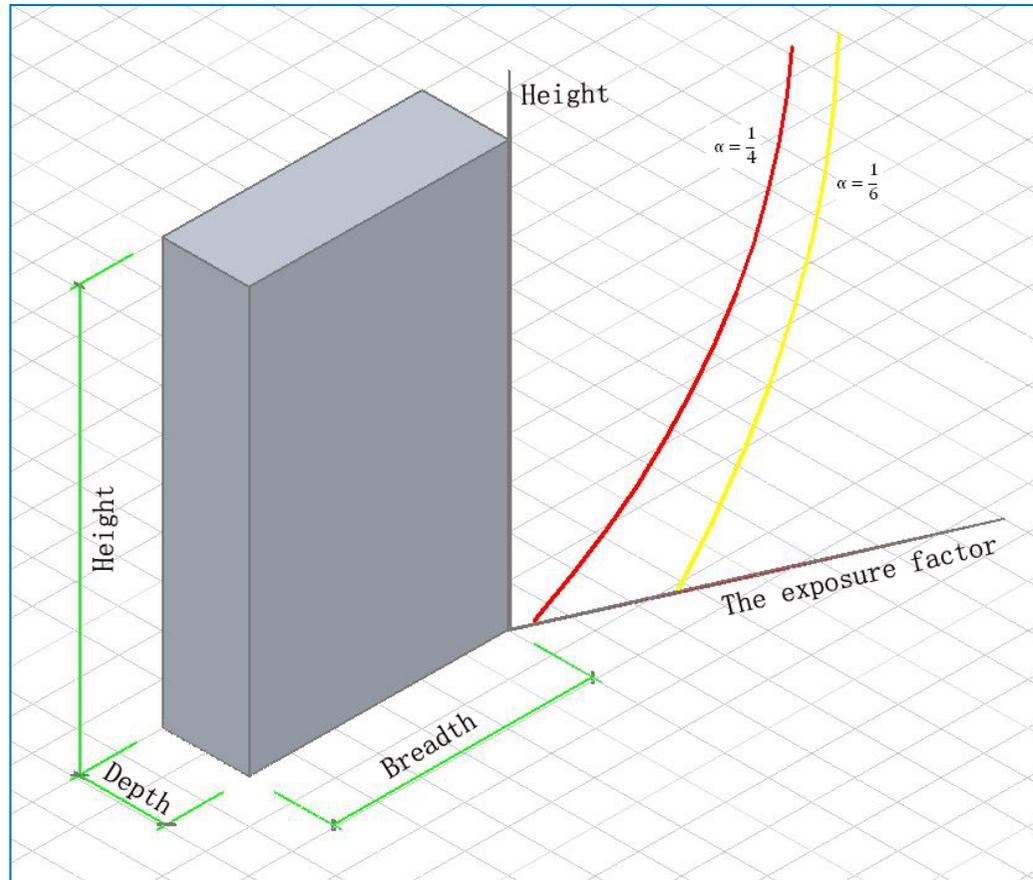
Silsoe Research Institute, U.K.

# COMPARISON BETWEEN DIFFERENT TOOLS



Silsoe Research Institute, U.K.

# ELECTRONIC DATA BASES



GCOE – TPU – Aerodynamic Data Base, Tokyo, Japan

# ELECTRONIC DATA BASES

**Step 1: Select Shape of Interest**

01 D=2" B=6"      02 D=3" B=6"      03 D=4" B=6"

04 D=4" B=4"      05 D=6" B=4"      06 D=6" B=3"

07 D=6" B=2"      08 4" 4"      09 D=4" 60° B=6"

**Step 2: Select Height of Interest**

16"      20"      24"

**Step 3: Select BL condition of Interest**

Open      Urban

**Notre Dame Modeling Laboratory**

Model #	1	2	3	4	5	6	7	8	9
Shape									
D:B [in.]	2:6	3:6	4:6	4:4	6:4	6:3	6:2	4:4	4:6 (60°)

NatHaz Aerodynamic Data Base, Notre Dame, Indiana, U.S.