UNIVERSITÀ DI PISA

PhD *plus* 2014

Creatività, innovazione, spirito imprenditoriale

"Cherubina, il prototipo pisano di vela alare, da e per la Coppa America"

G. Lombardi
Prof. of "Airplanes Aerodynamics"
University of Pisa

GREENCOMMRacing

Technical Coordinator

Scientific Research and Sport

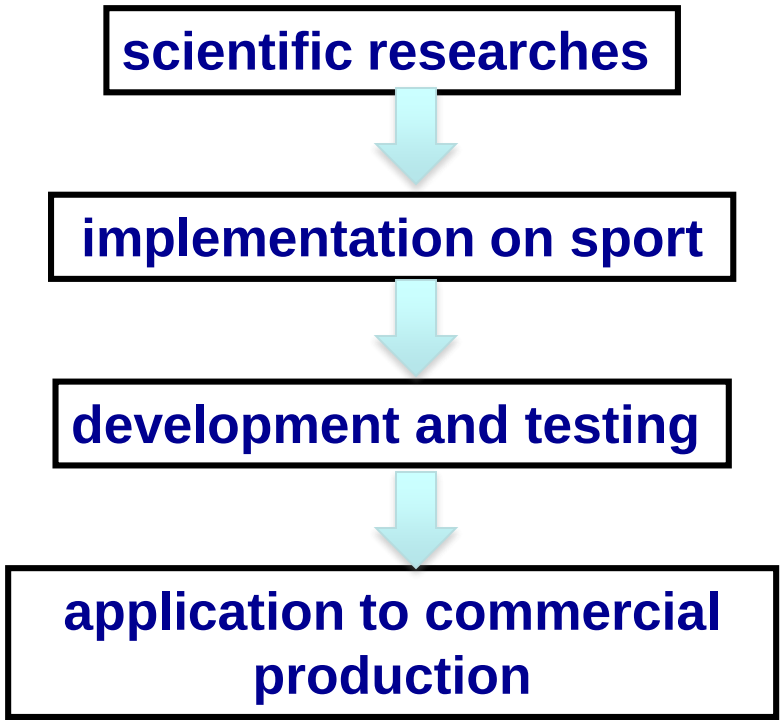
The Sport at high level is a powerful engine for the research, especially for aerodynamics and materials

Typical fields:

- Race cars (F1 on the top)
- Motorbike
- Offshore
- Bicycling
- Sky
- Bob
- Kayak
- .....
- AMERICA'S CUP

It is an important way to connect the basic scientific research to the innovation in the industrial world.

Typical cycle:



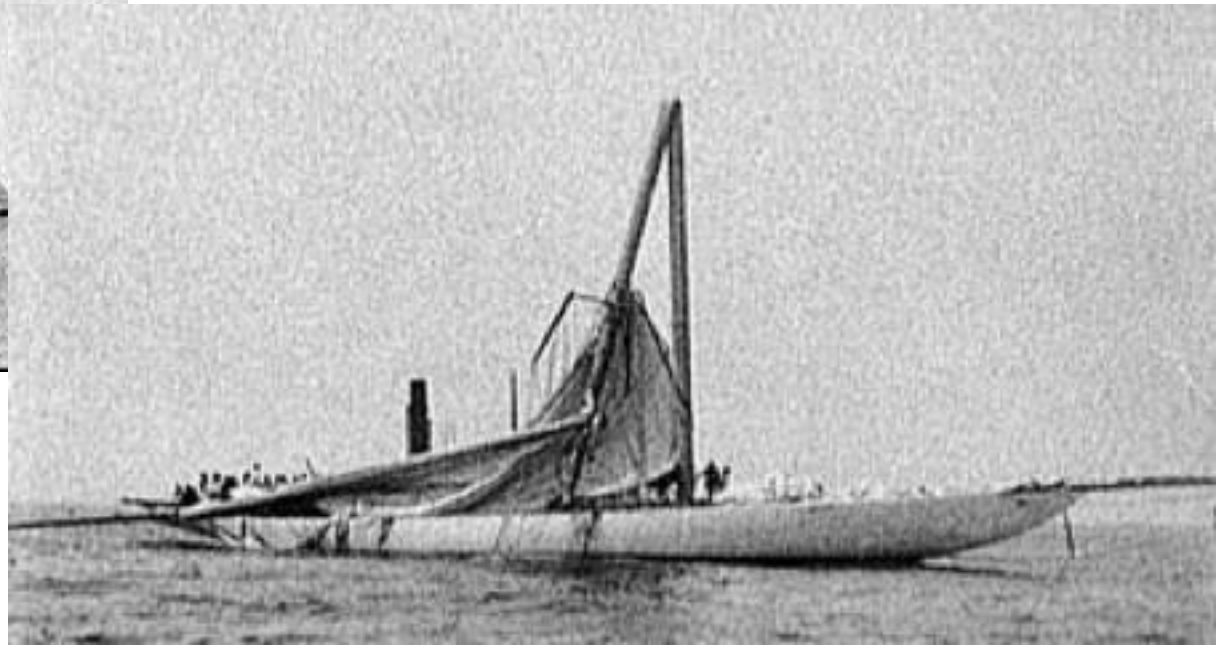
1851 - America’s Cup Origin

The EVOLUTION

Columbia - 1899

America's Cup- 3 characteristics:

- Race between two boats
- "Gigantism"
- Research of the limits

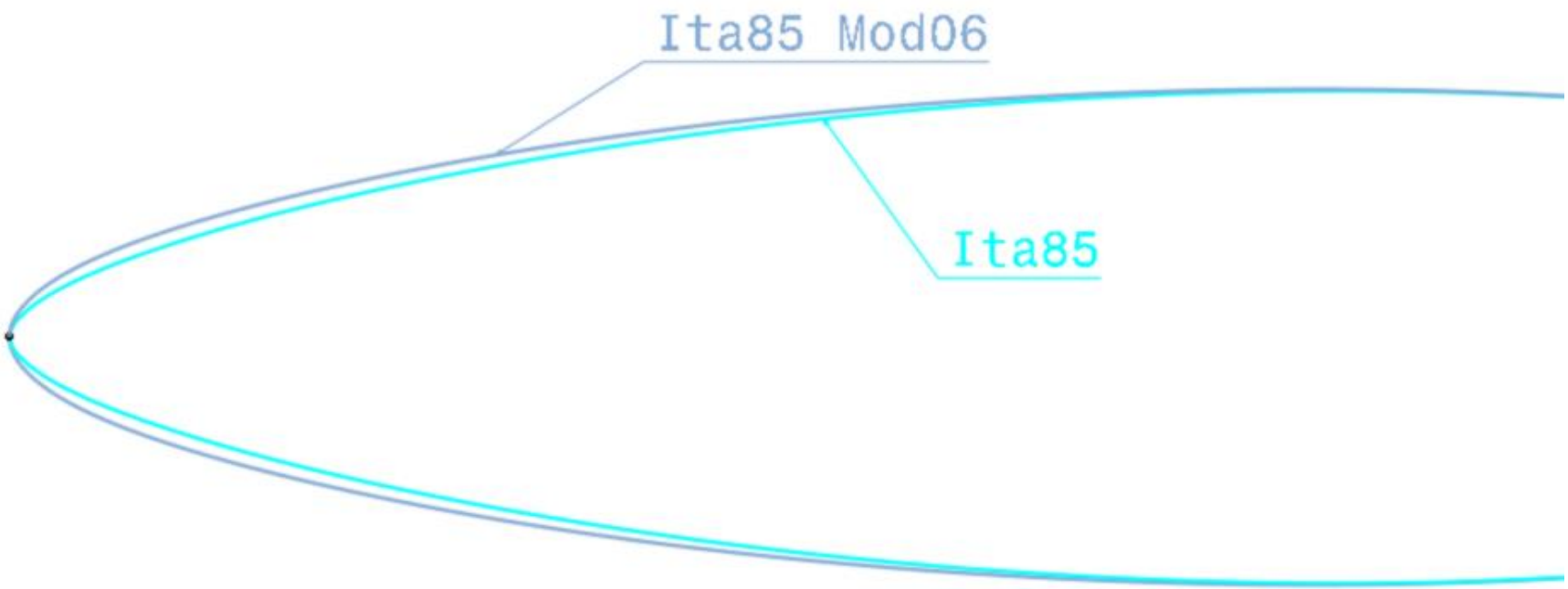


32th AC - 2007

Valencia-+39 in navigazione-Photo:Fabio Taccola/+39

The importance of the research..... details

Daggerboard airfoil modification



About .4 m (the boat is 25 m !)

Impressive improvement in the performance

33th AC - feb. 2010

34th AC - 2013

The BOATS

Length 22 m

Beam 14 m

Height from the water 40 m

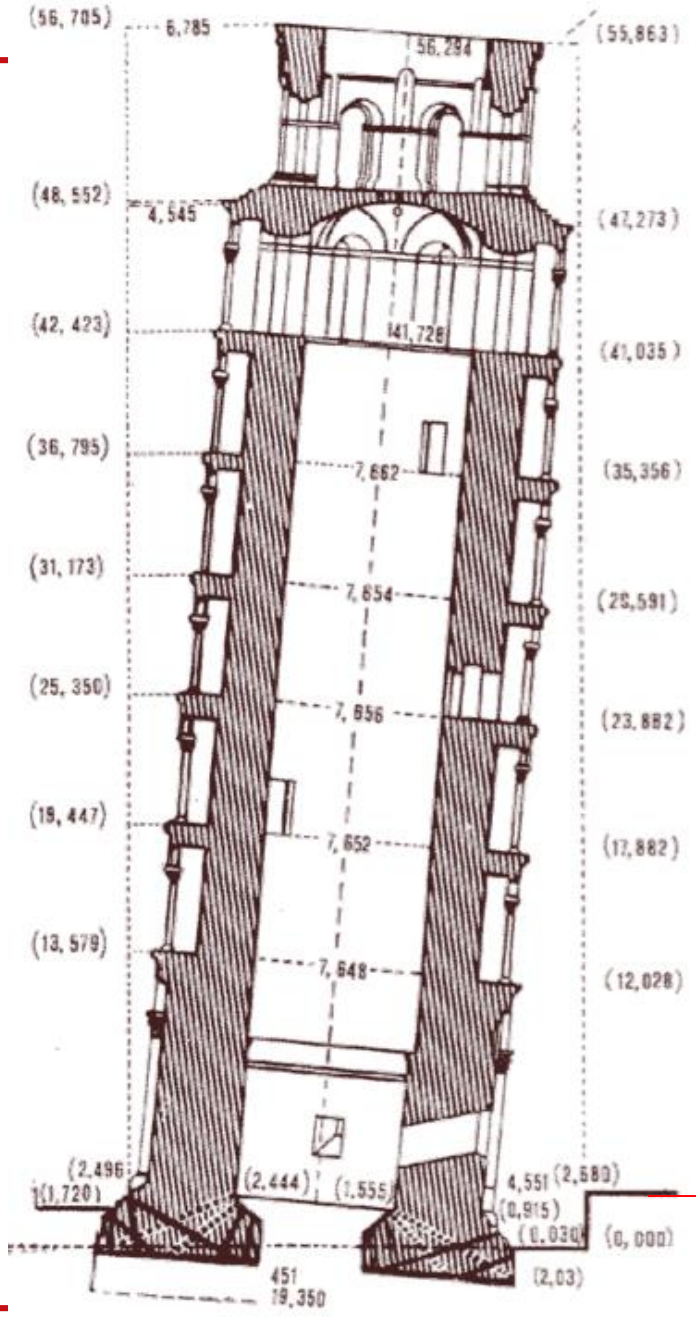
Weight 5800 kg

WING – Surfaces limits

10.6 The **total area** enclosed within the perimeter line of the wing in wing measurement position shall be:

Between **255 and 260 m^2**;

(campo da tennis: 23 x 11 = 253 m^2)


(56, 705)
6,785
56,294
(55,863)
(48, 552)
4,545
(47,273)
(42, 423)
141,728
(41,035)
(36, 795)
7,662
(35,356)
(31, 173)
7,654
(28,591)
(25, 350)
7,656
(23,882)
(18, 447)
7,652
(17,882)
(13, 579)
7,648
(12,028)
(2,496)
(1,720)
(2,444)
(1,555)
4,551
(2,583)
(0,915)
(0,030)
(0, 000)
(2,03)
451
19,350

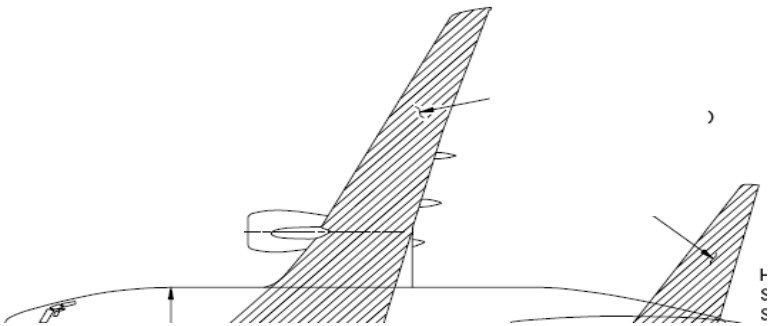

AC72

AIRBUS A-380

Wing semispan 37 m

BOEING 737

Wing semispan 12,3 m



America's Cup and Scientific Research

The America's Cup was always at the top as performance requirements

It is essential an extraordinary development in several fields:

- **Aerodynamics**
- **Materials**
- **Electronics**
- **Data management**
- **Technologies**
- **Human resources**

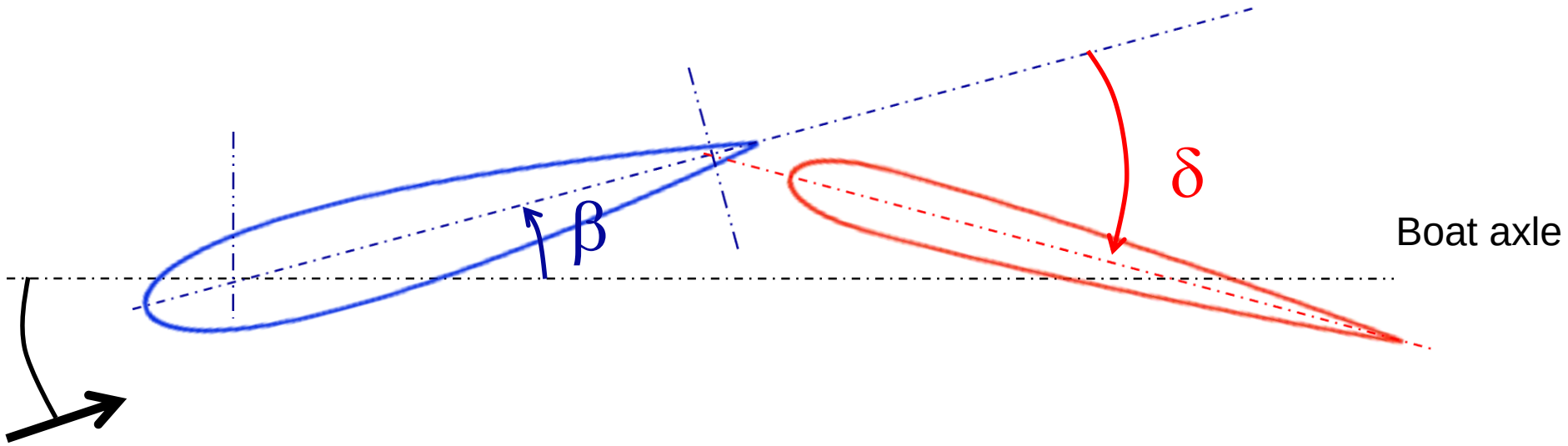
In particular, with the Wing-Foiling-cat, we have a completely new and extremely challenging problem.

THE POTENTIAL RETURN, IN TERMS OF INDUSTRIAL PRODUCTS AND SUSTAINABILITY EFFECTS, IS ENORMOUS.

The activity on the AC72

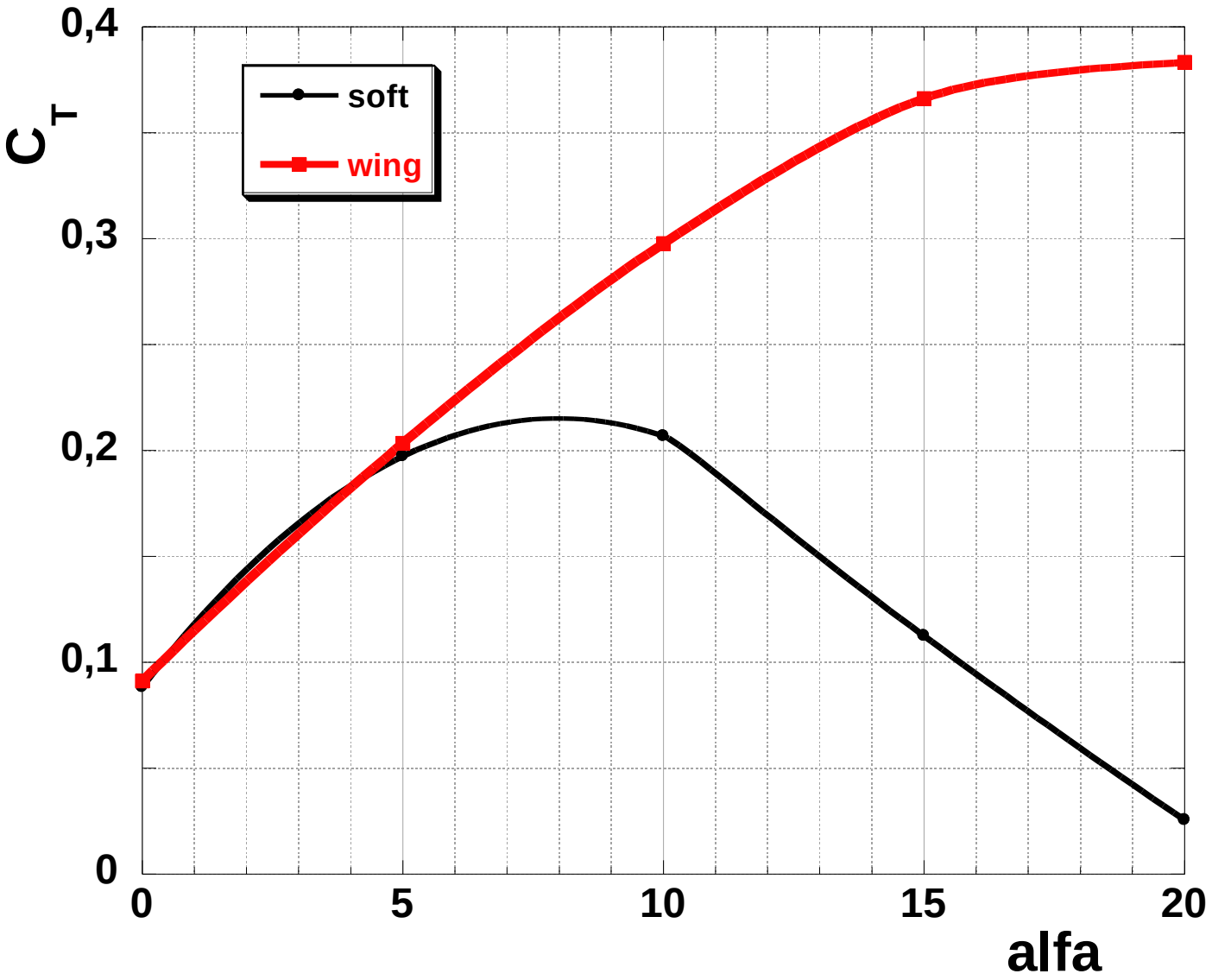
- **Preliminary analysis**
- **Set-up of the evaluation procedures**
- **Numerical procedure**
- **Optimisation procedure**
- **Aeroelastic analysis procedure for the wing**
- **VPP**
- **Stability Analysis of the configuration**

AC 45 WING (small class for studies)



Apparent Wind

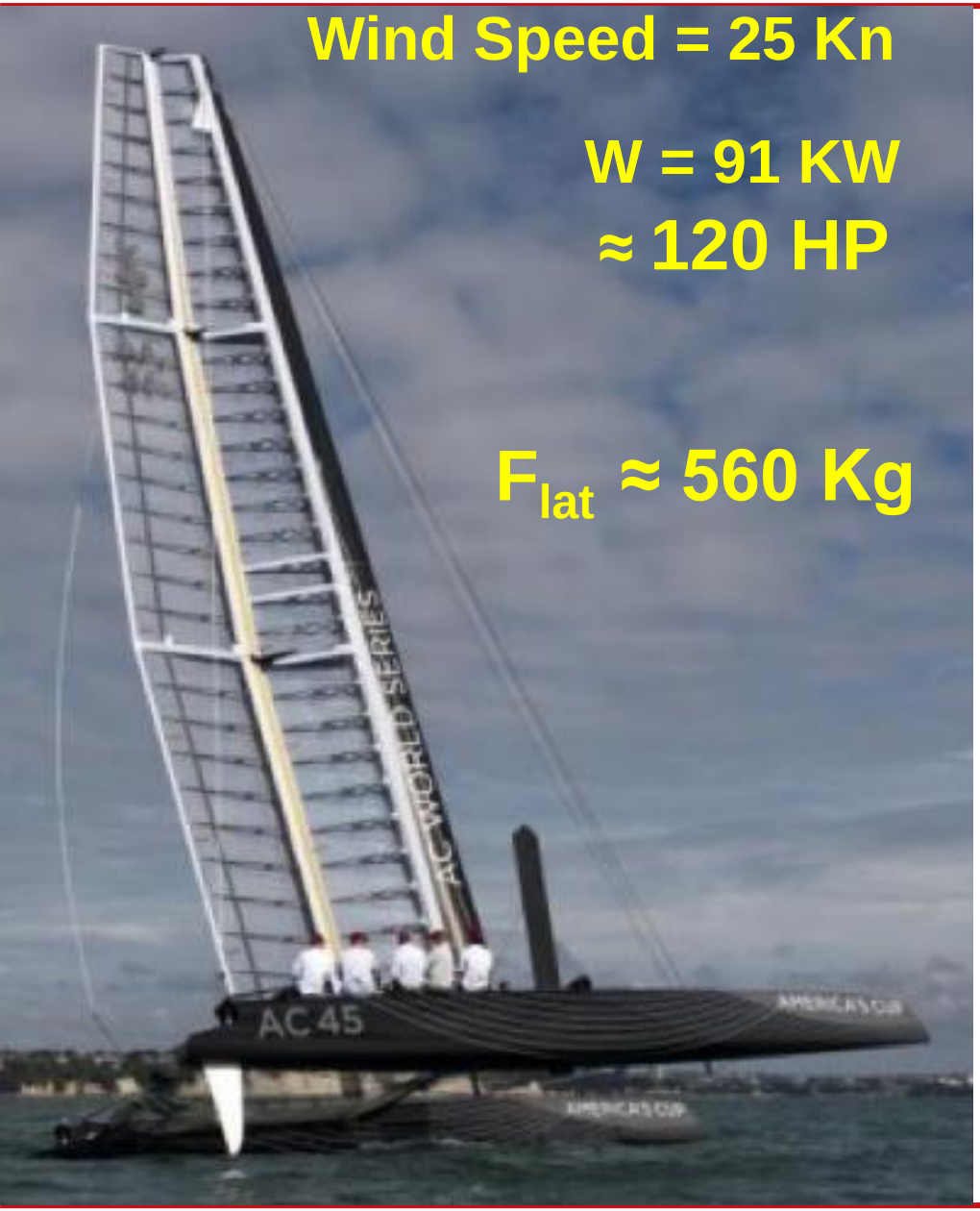
Traction



Note: completely different set-up !

The involved power

AC 45



Wind Speed = 25 Kn

W = 91 KW
≈ 120 HP

F_{lat} ≈ 560 Kg

Only WING – Real angle 115°

$$F_P = 5700\ N$$

$$V_B = 16\ m/s\ (31\ Kn)$$

$$W = F_P \times V_b = 91\ KW$$

Therefore.....

AC 45

the involved lateral force (AC 45)

F_{lat} 560 Kg:

A couple of BEARS !

AC72 (prel. Estimate)

Wind Speed = 25 Kn

560 KW

≈ 750 HP

F_{lat} ≈ 2500 Kg

Only WING – Real angle 115°

F_P = 28000 N

V_B = 20 m/s (39 Kn)

$W = F_P \times V_b$ = 560 KW

Therefore.....

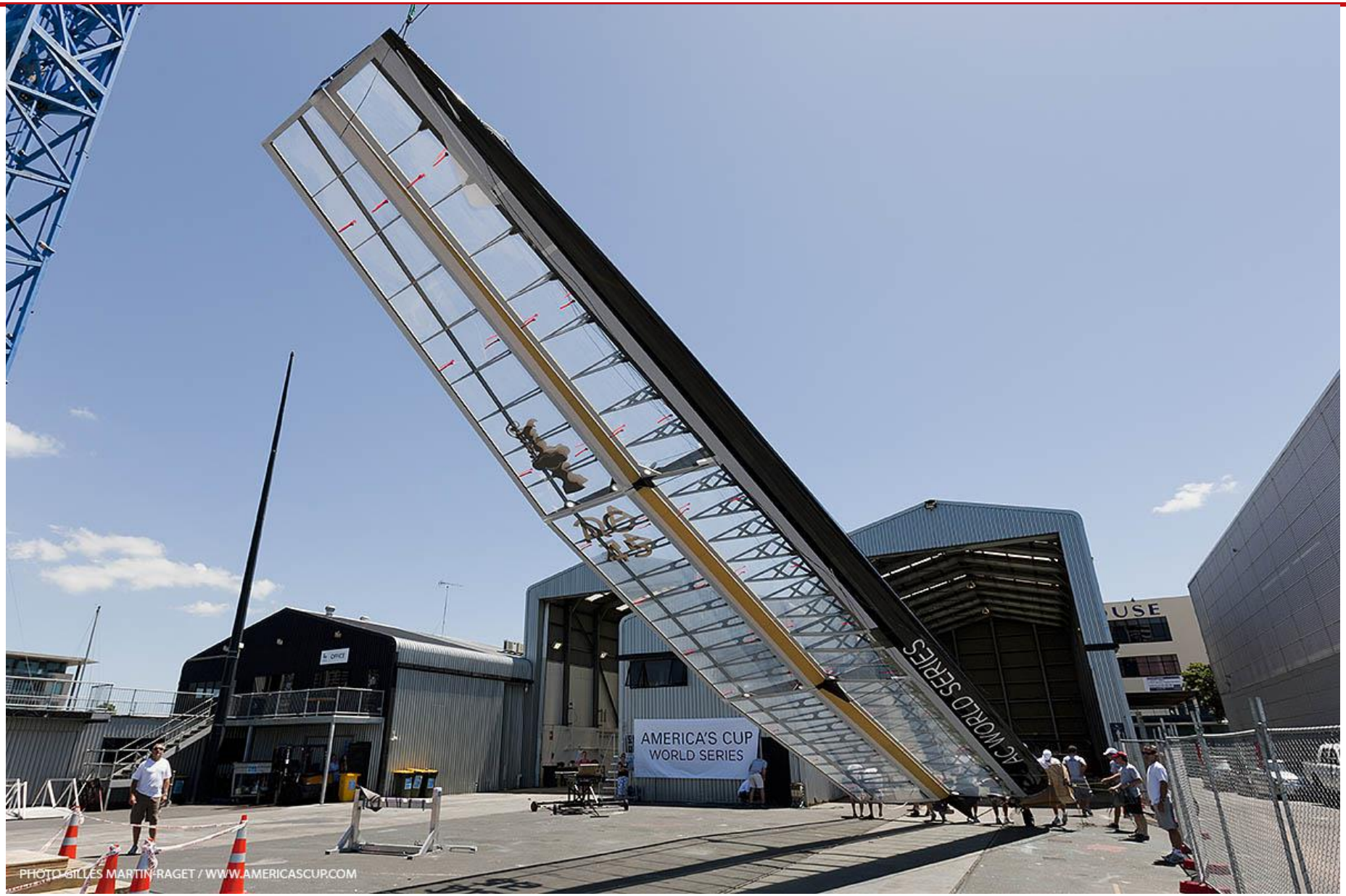
AC 72

the involved lateral force (AC 72)

F_{lat} 2500 Kg:

An elephant ! (...but small..)

At this point it could fly like an airplane.....



At this point it could appear a wild horse.....

A new approach for the show...

The “Stadium” Races

AC45 - capsize

AC 72


ORACLE


Artemis Racing


Fly
Emirates
OMEGA
SKYY
NESPRESSO
NEW ZEALAND
CAMPER
OMEGA

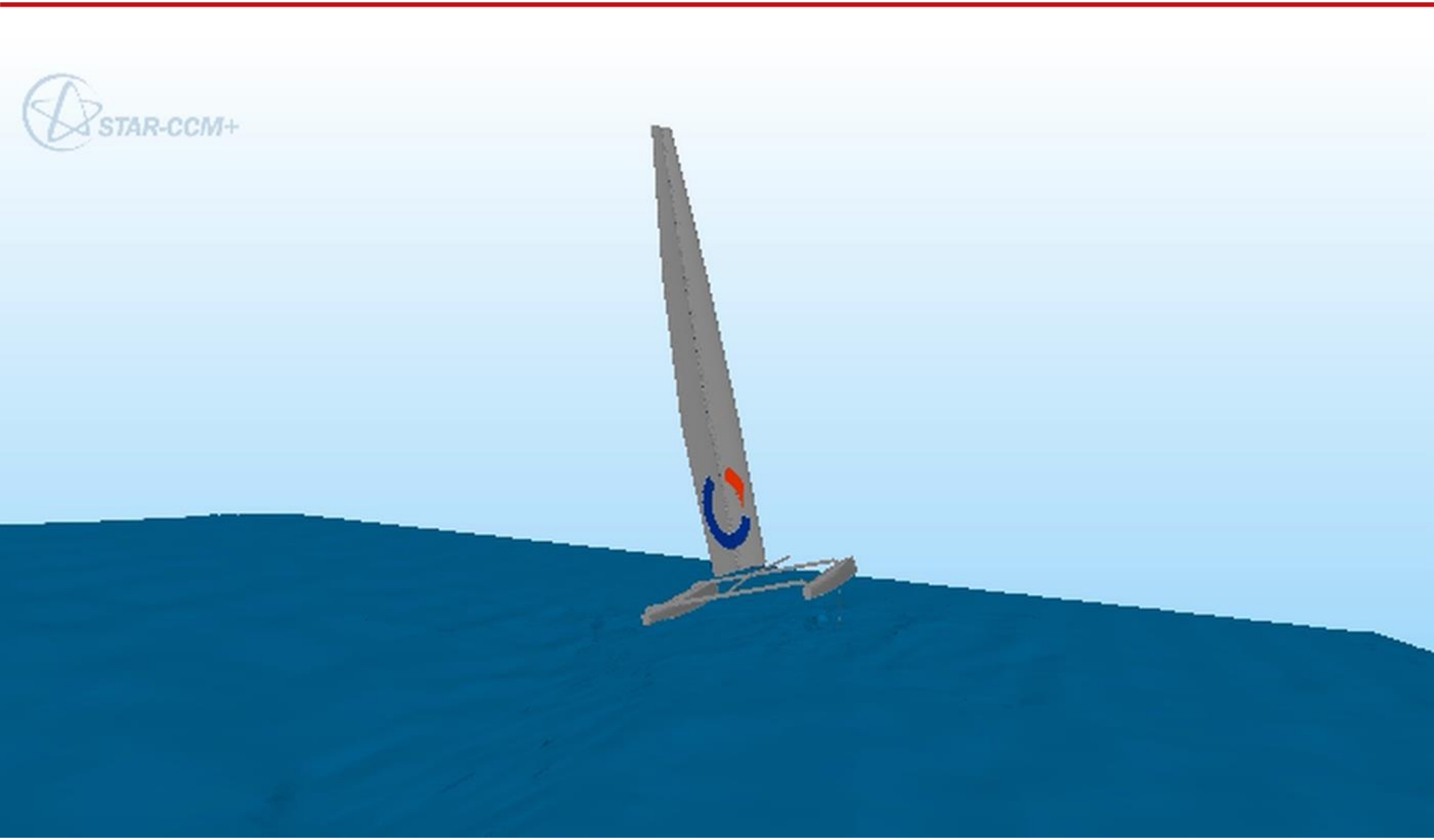

Fly
Emirates
Fly
Emirates
NESPRESSO
NEW ZEALAND
CAMPER
OMEGA


LUNA ROSSA
PRADA


PUMA


OMEGA
COMPER
NEW ZEALAND
NESPRESSO

Reserch: CFD



METHODOLOGIES for RESEARCH and DESIGN

From Aeronautical world !

Resource for Research

Team New Zealand

Estimated total cost **100 MEuro**

For Research and development **30 MEuro**

	ETNZ
TOTAL	117
Sailing Team	15
Design Team	37
Shore Team	36
Support	29

Example of application of the result of the research to an object of “normal” use

- Length = 4,60 m
- Width = 2,10 m
- Sail Surface = 33 m²

Development and tests on small dimensions

Object:

- **Experience of the students in a top level application**
- **Feedback of the ideas to AC project**

Thank You