Research Institute of the French Naval Academy

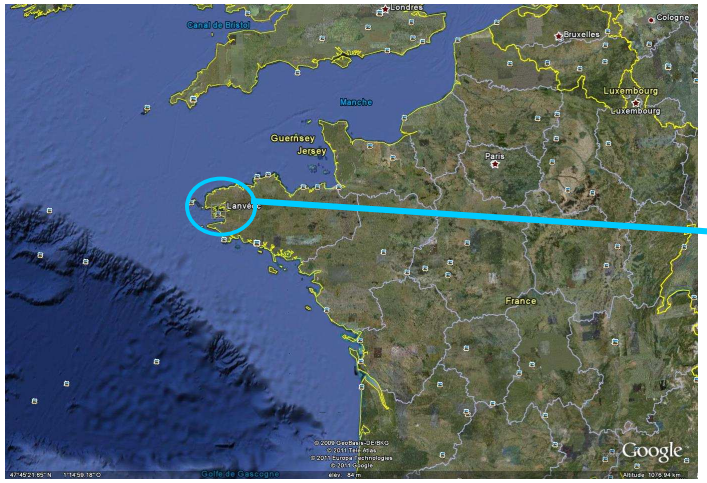
Institut de Recherche de l'Ecole Navale

BCRM BrestCC 600 F29240 BREST Cedex 9

FRANCE

Department of Mechanical and Energy Engineering

French Naval Academy



Located in Brittany, Western France

French Naval Academy

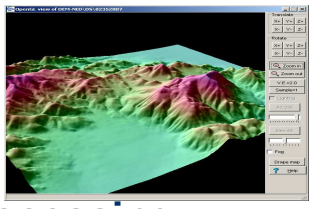
Research Institute of FNA

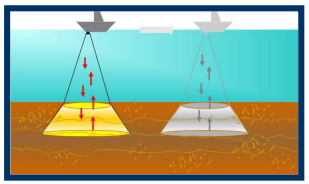
Research Institute of FNA

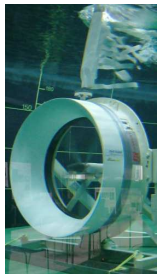
Research Institute of FNA

Research Institute of FNA

- **Purpose**
  - To provide the high level scientific training of the French Navy cadets (~100 per year) and of Master degree civilian students
  - To develop high level open basic researches for maritime applications
- **Staff : ~ 65 people**
  - 20 Academics, 25 PhD students, 20 technical and administrative staff
- **Three Research Department**
  - GIS for Maritime Applications
  - Underwater Acoustics and Signal Processing
  - Mechanical and Energy Engineering

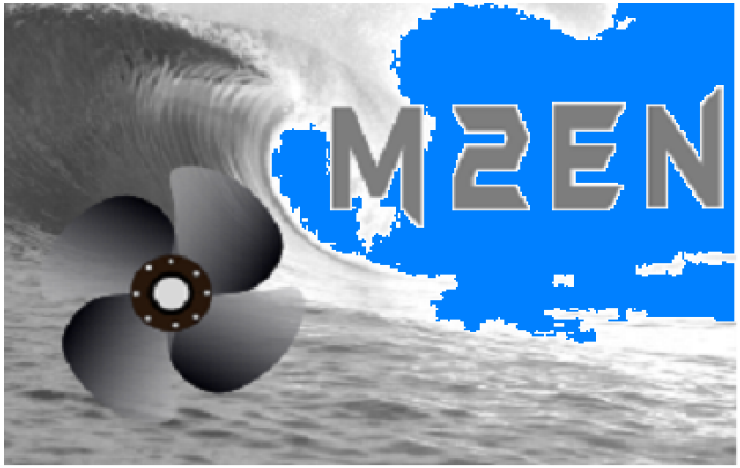






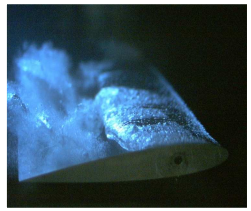
IRENAV

Department of Mechanical and Energy Engineering

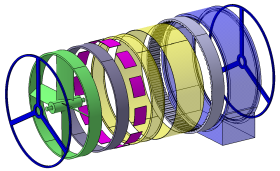


Mechanical and Energy Engineering Dept

- 10 Academics, ~10 PhD students
- Expertise : fluid mechanics, mechanics and electrical engineering

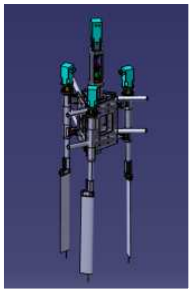


- Two Main Axes of research
  - Axe 1 : Hydrodynamics for Naval Applications
    - Basic researches on hydrodynamics: Flow over lifting and bluff bodies, cavitation, turbulence, Fluid– Structure Interaction, Hydrodynamics instabilities, Experimentation, Computation.



RIM-DRIVEN PROJECT

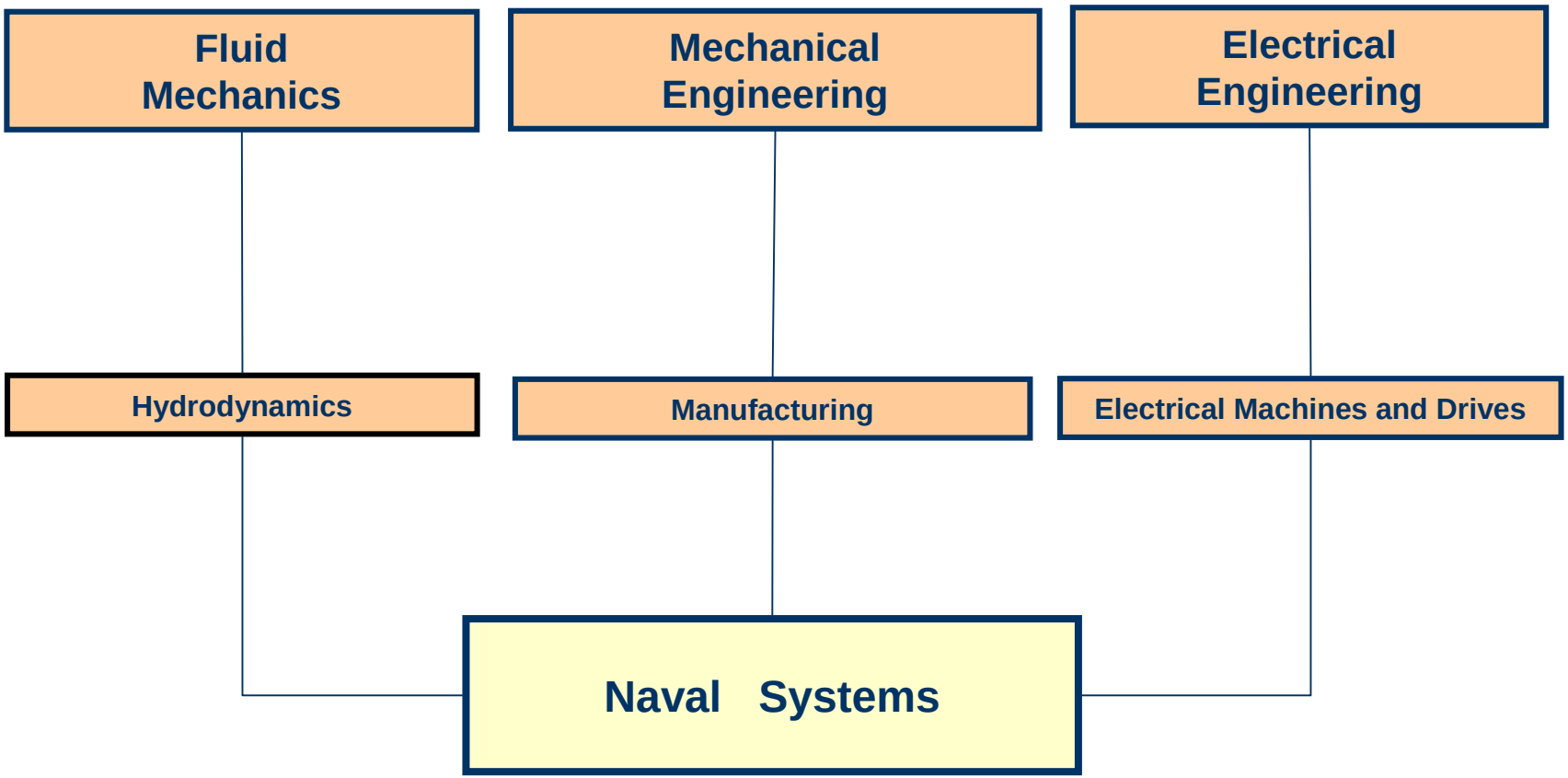
  - Axe 2 : Energy conversion
    - Optimal design of electrical machines for naval propulsion and Marine Renewable Energy harnessing
    - Marine Renewable Energy : Marine Current Turbine
      - RIM-Driven Project : unconventional structure of integrated PM generator and turbine
      - SHIVA Project : Active variable pitch cross flow current turbines



SHIVA PROJECT

Contact : jacques-andre.astolfi@ecole-navale.fr or jean-frederic.charpentier@ecole-navale.fr

Synoptic of activities

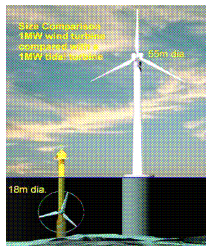


Topics

Axe 1
Hydrodynamics
Complex flow, Cavitation,
Fluid Structure Interaction

Axe 2
Energy Conversion
Modelization and Conception of electromechanical System
Marine Renewable Energy

Naval Engineering



Basic research → **Applications**

Cavitation tunnel

test section : 0.2x0.2x 1 m³, 60m¨³ fresh water
Velocity : 3 – 12 m/s, Pressure : 0.1– 3 bars

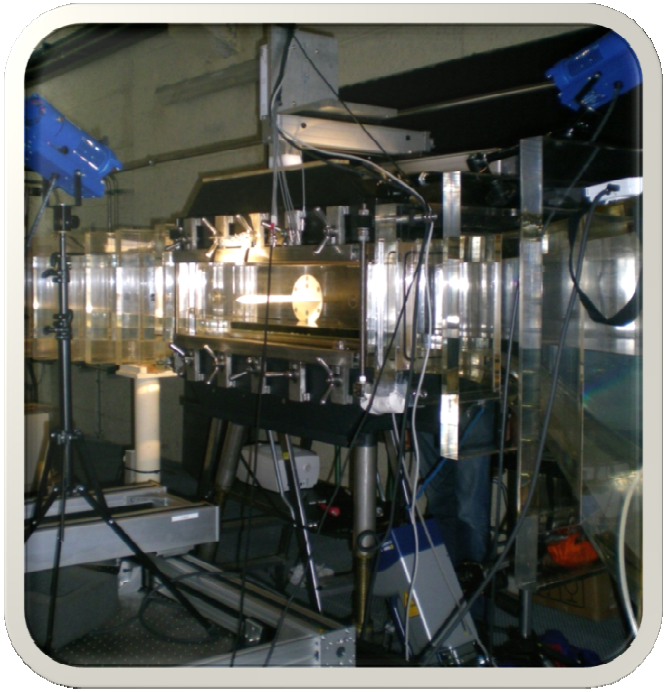
Main Instrumentation

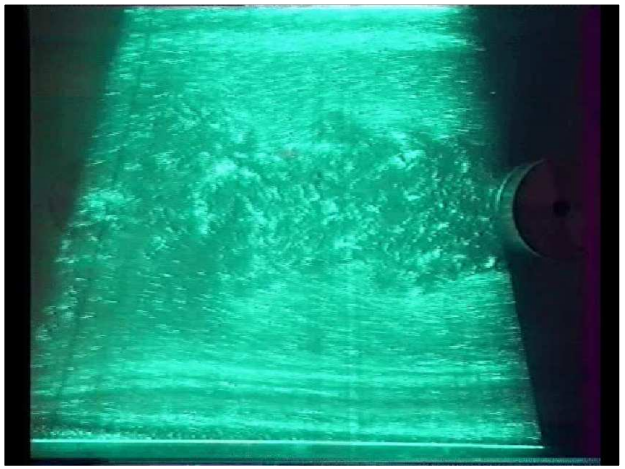
2D LDV, 2D PIV

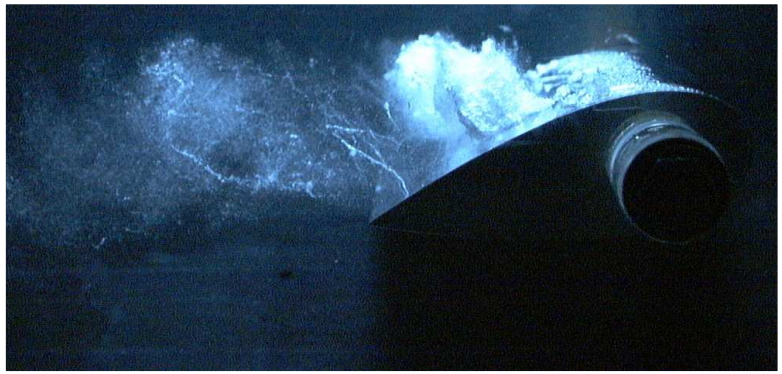
strain gauge Balance

Laser Vibrometer

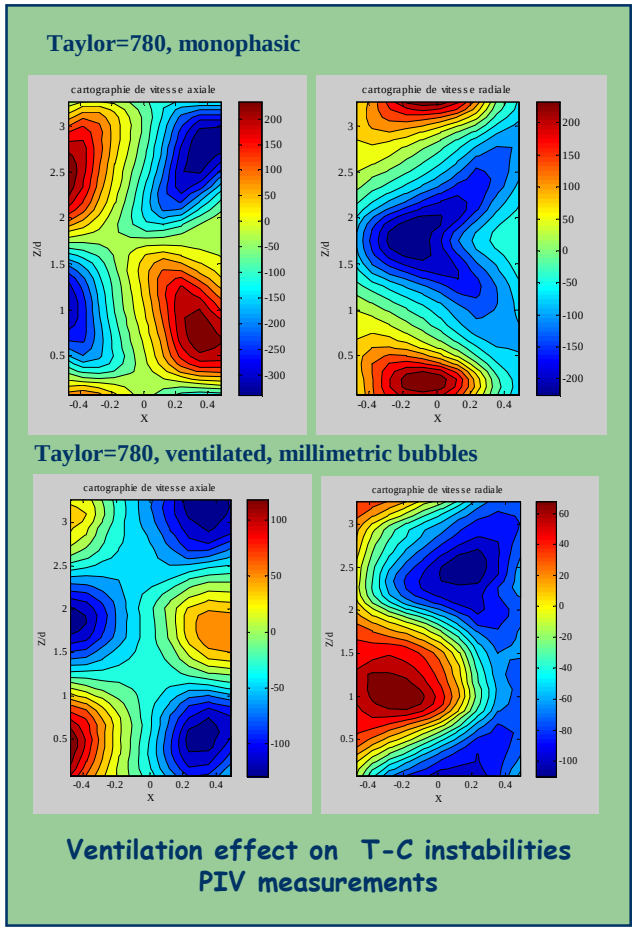
High speed camera







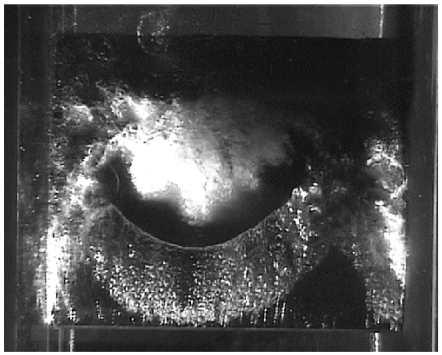
Diphasic Taylor-Couette flow



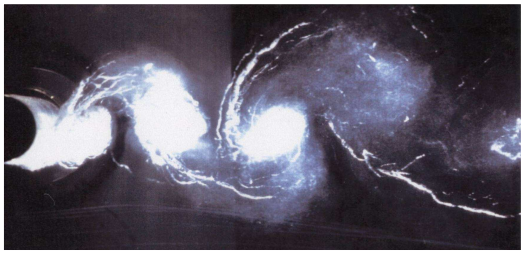
To study flow instabilities and transition to turbulence in diphasic flow
One of the largest device in the world

Hydrodynamics

- Basic research on complex flows developing on lifting surfaces and bluff bodies in water :
  - To understand complex flows : **cavitation, turbulence, high Reynolds number flow, boundary layer, vortex flow, wake, flow instabilities**,…
  - Experimental and numerical studies



Unstable cavitating flow
on a lifting surface, top view

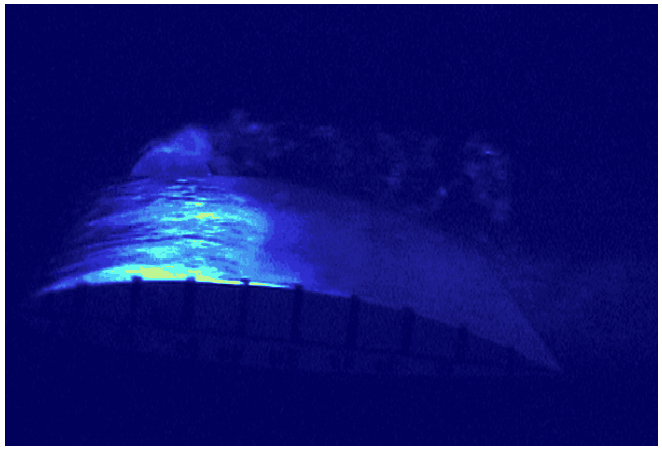


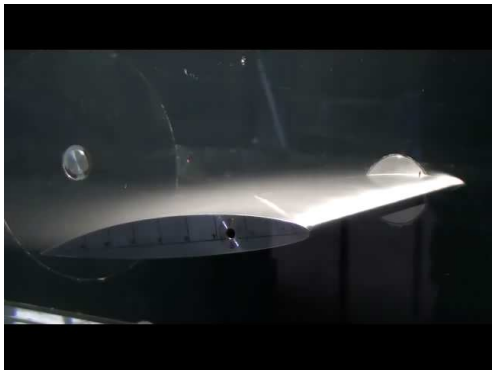
Cavitating wake downstream a
cylinder, side view

Cavitation

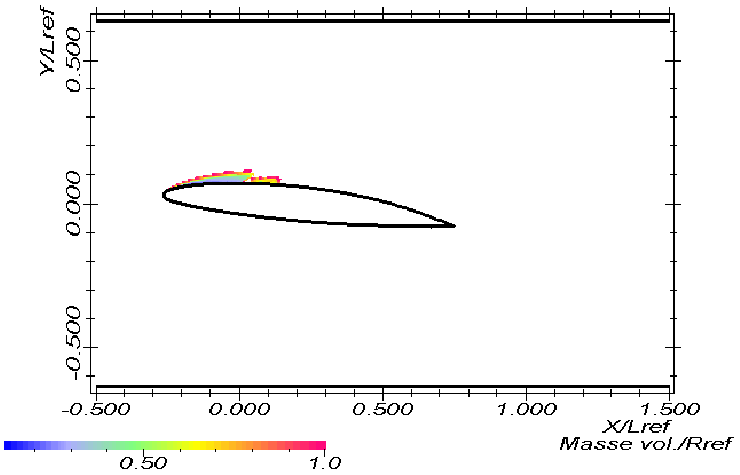
Unsteady Cavitating Flow on hydrofoil

Experiment



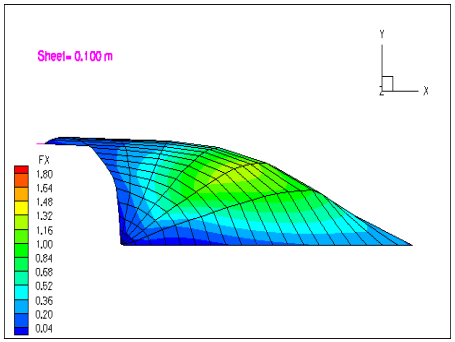


Computation



Fluid Structure Interaction

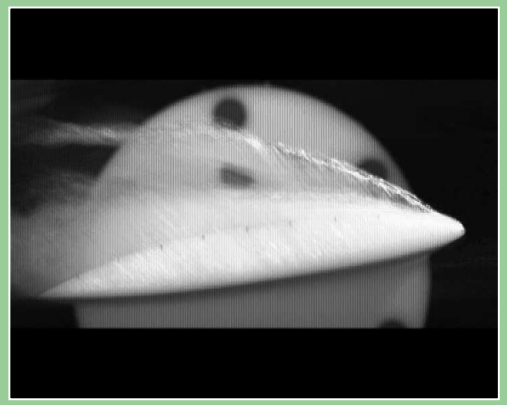
- Basic research on physics of coupling between flow and adjacent flexible structures :
  - Fluid-structure interaction is where fluid flow exerts pressure on a solid structure causing it to deform such that it causes :
    - Structure deformation :
      - propeller blade, sails…
    - Flow Induced Vibration
    - Live time of structure
  - Numerical Coupling Strategy ?
  - Experimental and numerical studies

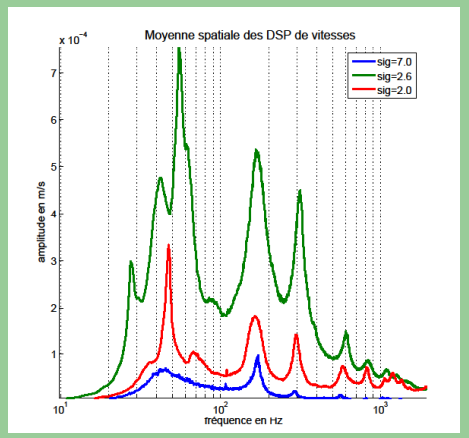


Fluid Structure Interaction

Cavitation Induced Vibration

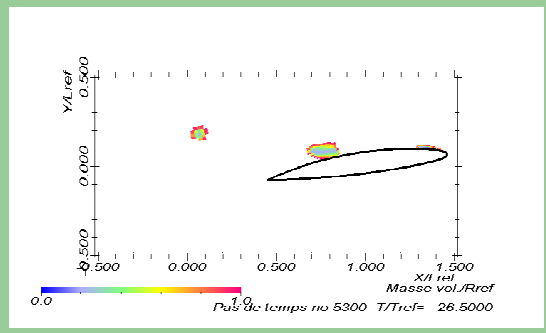
Experiments



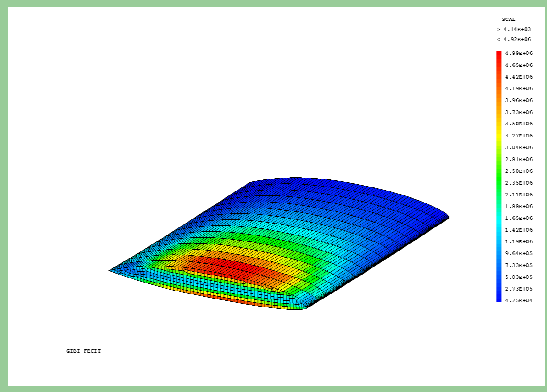


Vibration spectrum in cavitating flow

Computation



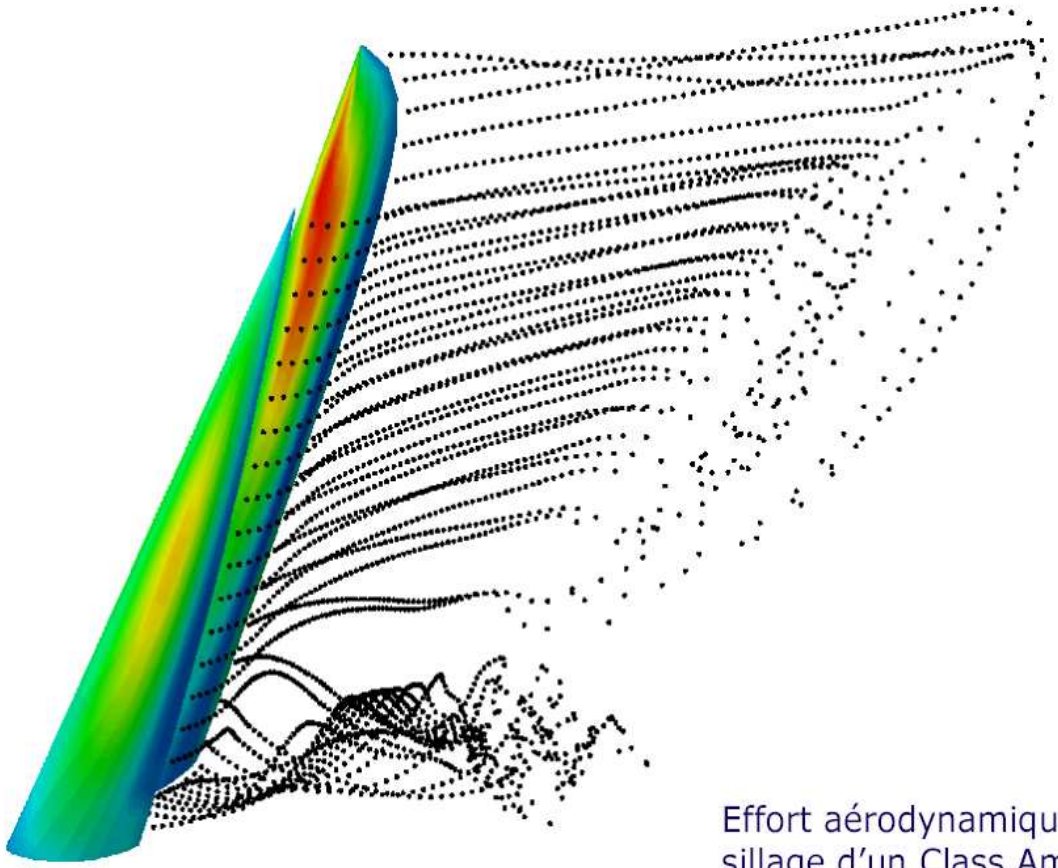
coupling



Structure dynamics

Fluid Structure Interaction

Flow Structure Interaction applied to Sailing

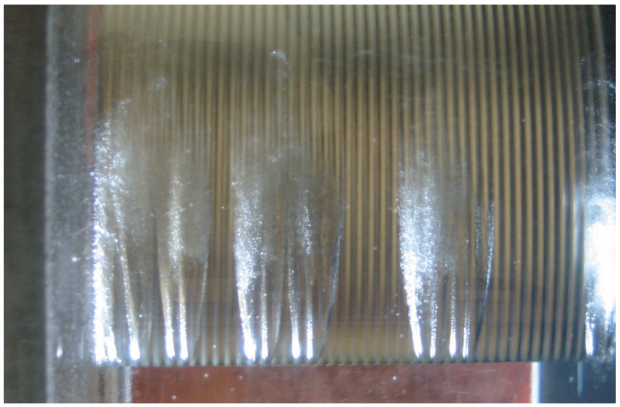


Effort aérodynamique,
sillage d'un Class America

Fluid Structure Interaction

Integrated Design of Marine Propeller

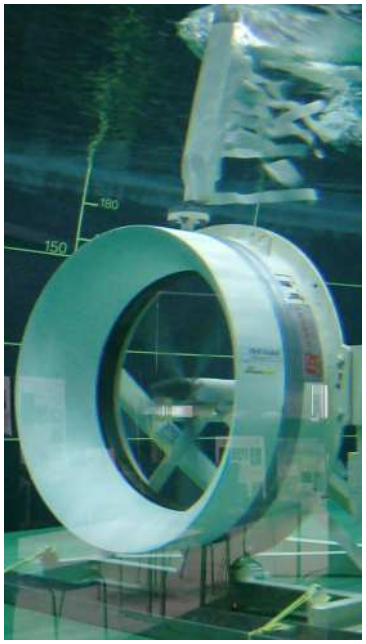
- Basic research on milling strategies for propeller blade manufacturing :
  - Surface roughness, ridge orientation…
  - Impact on manufacturing cost and performances of propeller ….
  - Experimental and numerical studies



Cavitation on longitudinal ridges on a lifting surface

Electromechanical Conversion

- Basic and applied research on innovative propulsion or energy conversion systems based on electrical machines and drives :
  - Conception and Optimization of unconventional electrical machines:
    - multiphase machine, Pods, RIM …
  - Marine Renewable Energy Converters:
    - marine currents …
  - Coupled physics : hydrodynamics and electrical engineering
  - Experimental and numerical studies



The RIM Marine Curent Turbine

Electromechanical Conversion

Active Pitch Control Vertical Marine Current Turbine : SHIVA Project

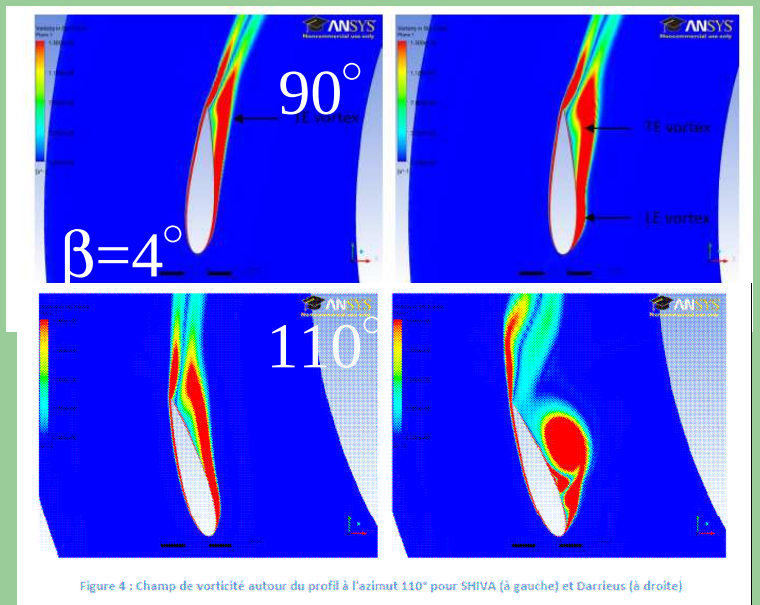


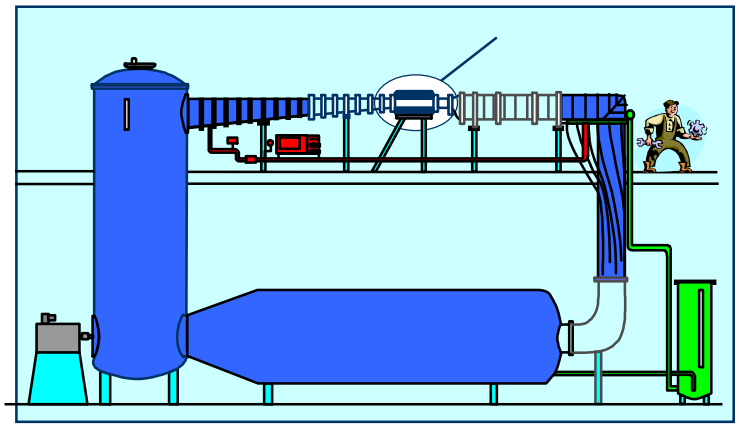
Figure 4 : Champ de vorticité autour du profil à l'azimut 110° pour SHIVA (à gauche) et Darrieus (à droite)

Figure 5 : Champ de vorticité autour du profil à l'azimut 130° pour SHIVA (à gauche) et Darrieus (à droite)

SHIVA DARRIEUS

Experimental devices

- Main laboratory devices :
  - Hydrodynamic tunnel
    - Instrumentation : 2D LDV, 2D PIV, balance, vibration systems..
  - 5-axes high speed milling machine (since 2004)
  - Experimental test device for multiphase machine (2005)
  - Marine Current Turbines (RIM, SHIVA)



60 m³ water, test section : 0.2x0.2x 1 m³,
Velocity : 3 – 15 m/s, Pressure : 0.1– 3 bars

5 X High Speed Milling Machine

Links

Naval academy website :
http://www.ecole-navale.fr/

Virtual visit of the french naval academy
http://www.ecole-navale.fr/Visite-virtuelle-de-l-ecole-navale.html

Next event :
http://www.ecole-navale.fr/Journee-Sciences-Navales-2012.html

Research Institute Website :
http://www.ecole-navale.fr/-RECHERCHE-.html

Contact

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Sailing at the Naval Academy

Cadets at the Naval Academy

Welcome to the Naval Academy