



Bureau MAURIC

NAVAL ARCHITECTURE &
MARINE ENGINEERING

RESEARCH & DEVELOPMENT
NAVAL HYDRODYNAMICS



Experience with sail assisted propulsion: the ALCYONE

by

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Naval Architect Bureau Mauric

and

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First captain of ALCYONE



Scientific team headed
by Professeur Malavard
and his post doc. student
Bertrand Charrier

Development of the
turbo-sail by the
« Fondation Cousteau »
headed by Jacques
Yves Cousteau

Subsidies by the
french government
and the Pechiney
group.

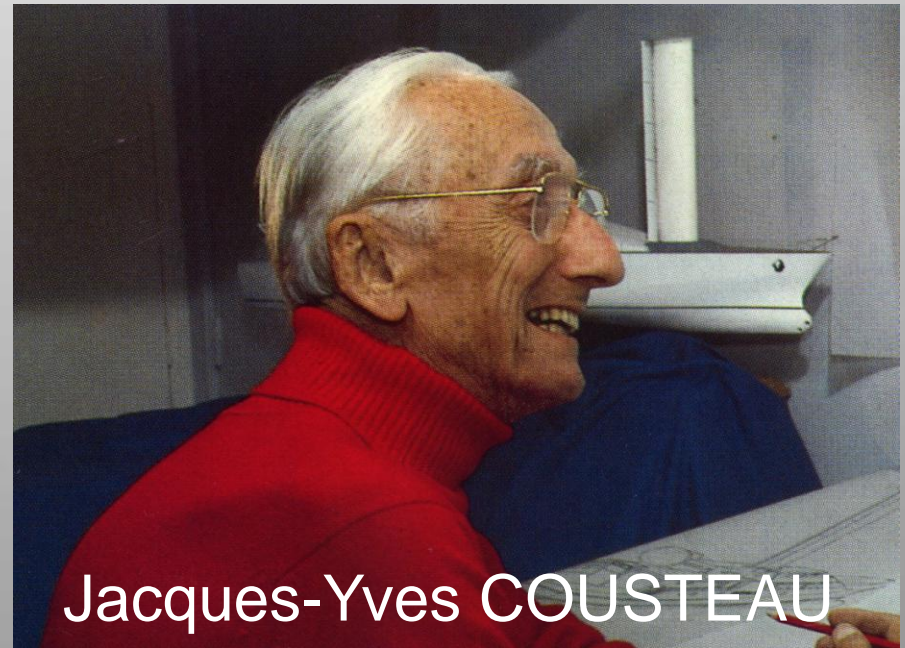


Professor MALAVARD



Bertrand CHARRIER

The three men at the origin of the Turbosail



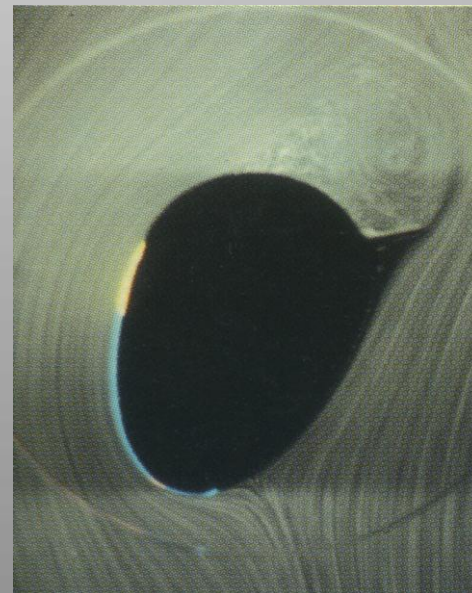
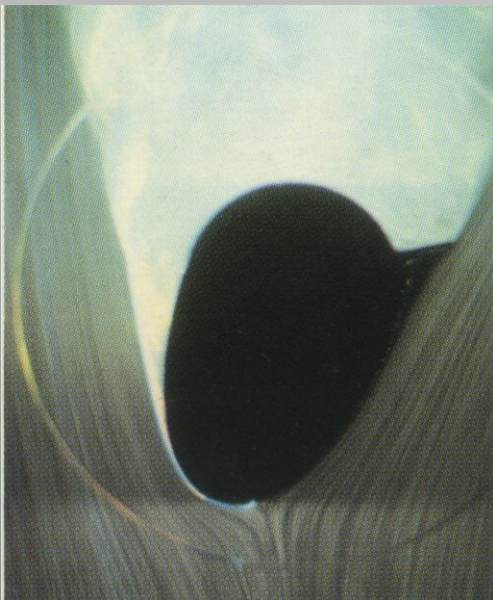
Jacques-Yves COUSTEAU

Bureau Mauric

The turbo-sail principle

Basic idea: build a system that offers a C_z much higher than the soft sail (1 to 1,4), close to the Magnus rotor C_z (8 to 9) but with less complexity than this last one.

- Very thick profile
- Aspirated profile to avoid boundary layer separation
- Trailing edge movable foil



The turbo-sail construction



- High aspect ratio sail
- The sail and the flap are movable and can be orientated.

Results showed C_z of up to 5 in lateral wind conditions.



The turbo-sail construction

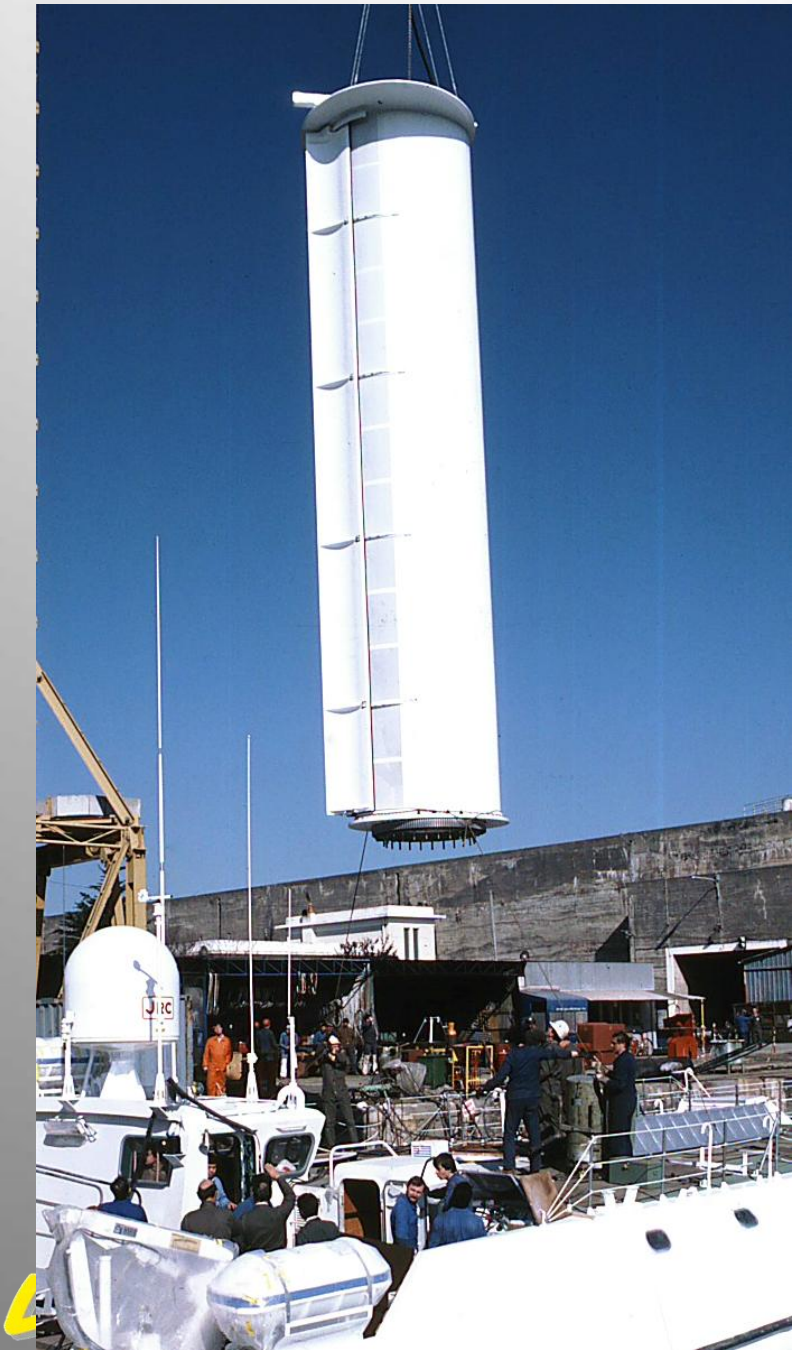


- Ventilation at the top.



The turbo-sail installation

- All aluminium cylinder
- Large roller bearing crown at the basis



Historic reference



Prototype turbo-sail
boat : the « Moulin
à vent » modified
for turbo-sail
installation in 1982

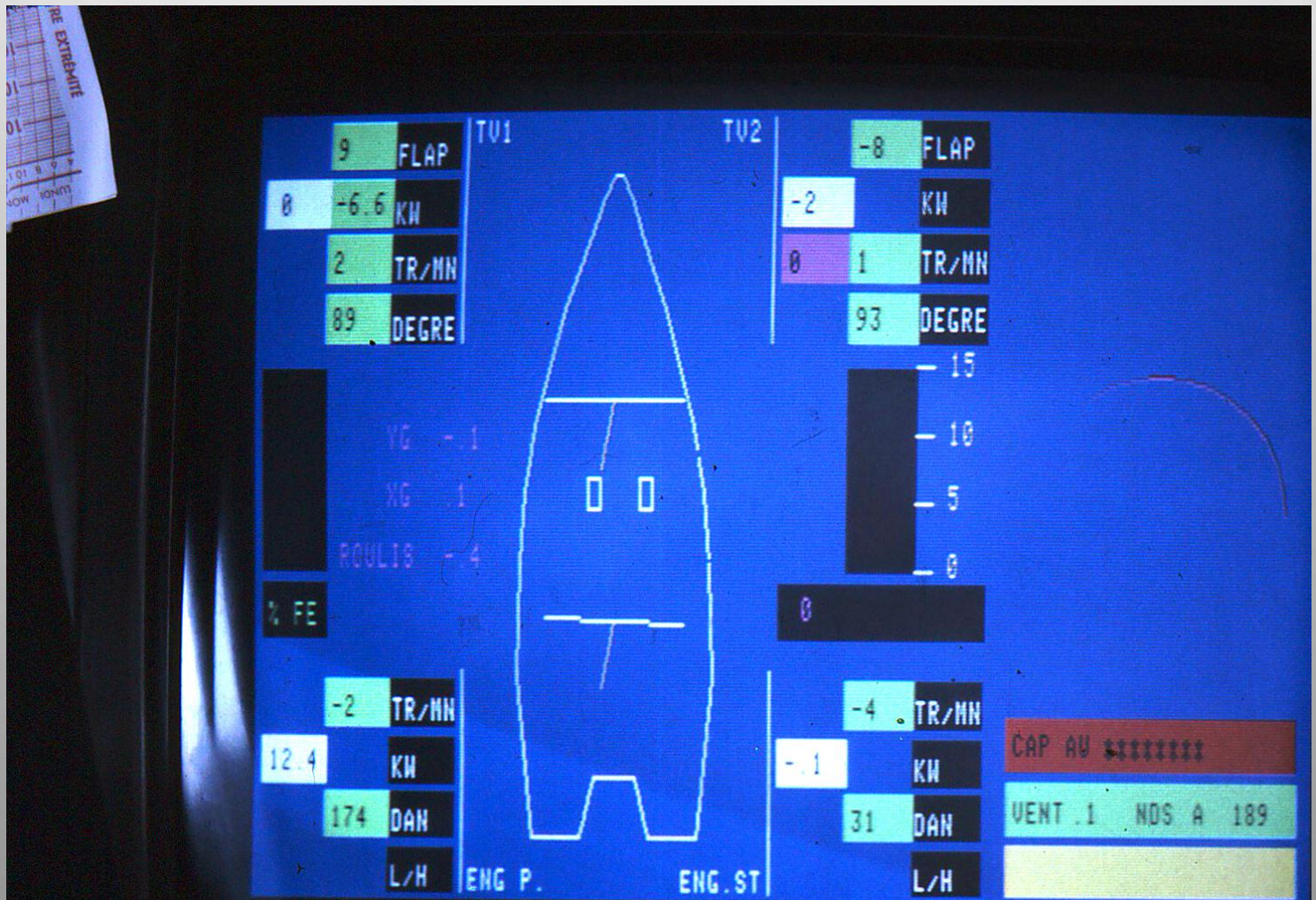


- The Moulin à vent was an existing “SOLARIS” catamaran, bought by the “Fondation Cousteau” to be an experimental platform for the Turbo-sail development.
- The experiments took place on an inland sound, the “Etang de Berre” close to Marseille airport.



- The results were really impressive with a strong propulsive power, developed by the 30m² Turbo-sail, that succeeded in moving this heavy catamaran of 42 tons up to a speed of 8 knots.
- Some interface to tune automatically the sail was developed at that time.





Sail interface



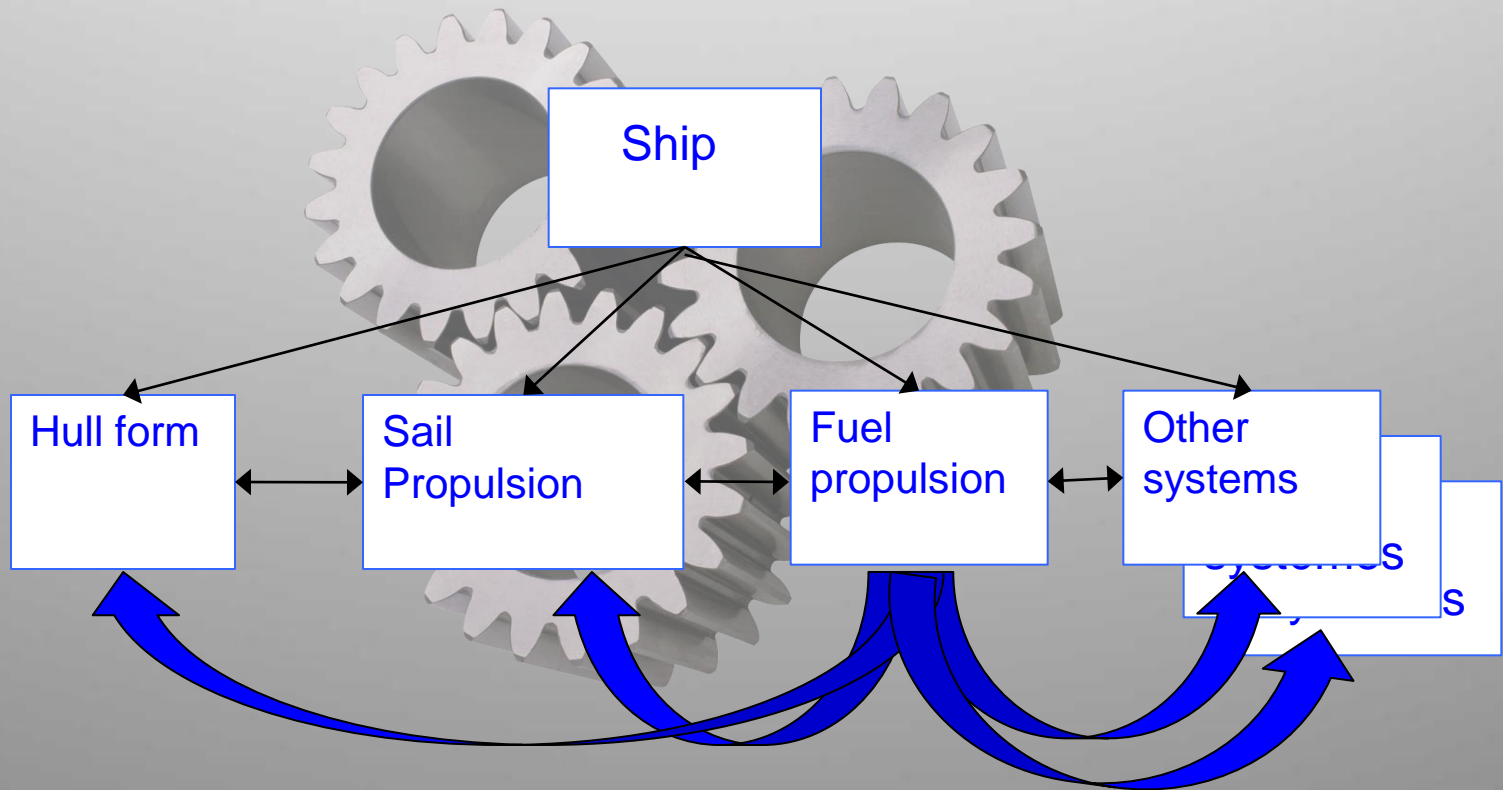
- However, the successful experimental “Moulin à vent” showed its limit in a transatlantic crossing where the sail finally collapsed.
- The “Moulin à vent” was just an experimental platform, that fulfilled his role, and not a real ocean going boat.
- The Cousteau society needed a real ocean-going boat for its expedition.



- Ocean-going small boat of about 30/35m that could be affordable for the Cousteau society budget.
- Our principle was to design a ship specifically suited for the Turbosail, to bring a system as a WHOLE,
- And NOT to simply adapt a ship to the turbosail propulsion



CONSIDER THE SHIP AS A SYSTEM OF SYSTEMS



Our ideas were :

- ✓ to avoid the heel under sail
- ✓ To give a flat and flush deck at the basis of the turbosail to increase the effective aerodynamic aspect ratio
- ✓ To go for a twin sails configuration to have a low center of sail area, to avoid building difficulties, to have a balanced boat.

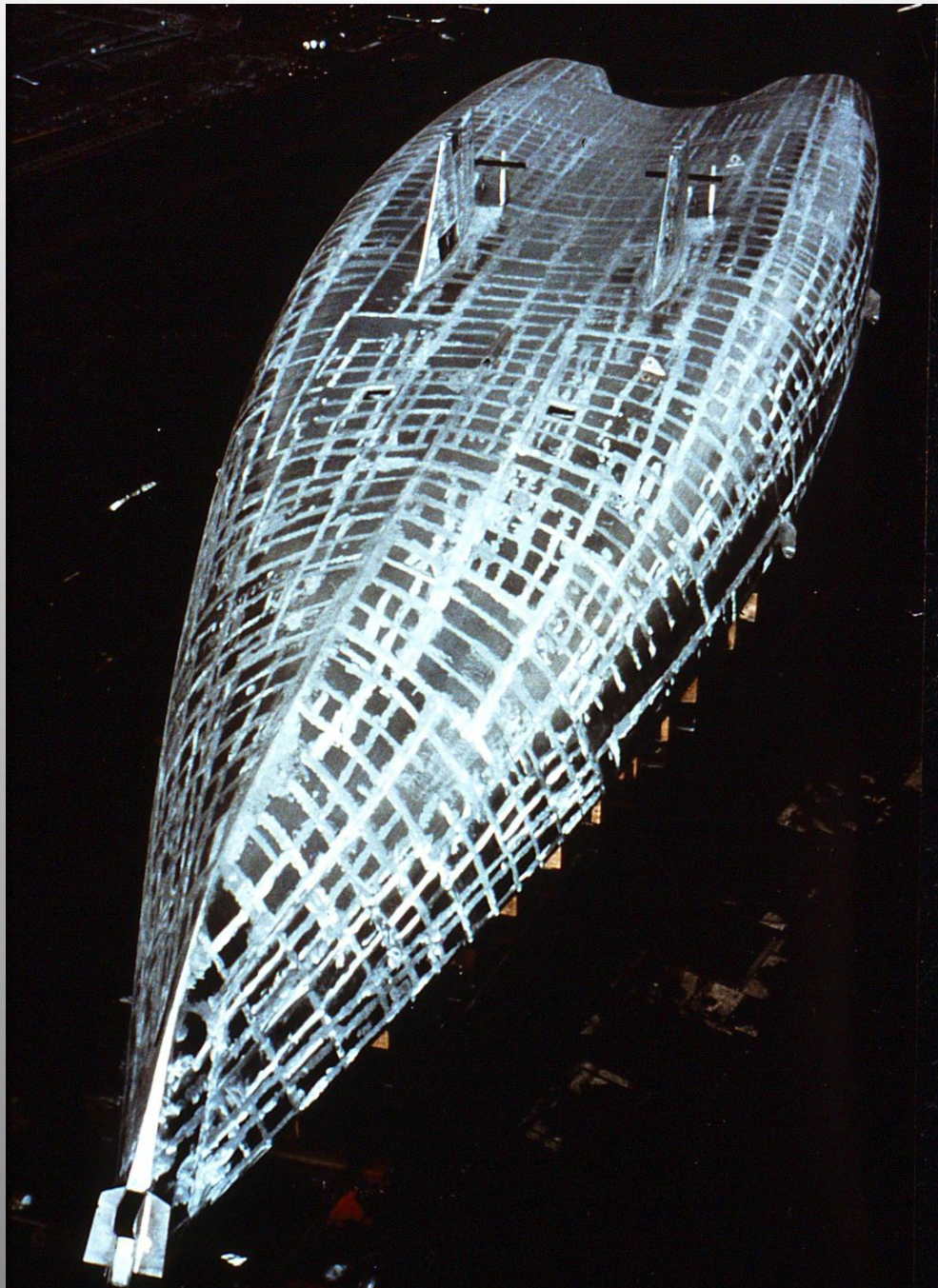


- Elimination of the conventional monohull in the design competition: lack of deck surface, heel under sail, superstructure obstruction.
- The new boat should be either:
 - A catamaran
 - Or an unconventional monohull
- A catamaran was proposed but its design was not chosen because of fragile construction and problems in turbosail installation in the middle of the two hulls.
- Trimaran solution not considered at that time.



- Bureau MAURIC proposed an unconventional monohull, a mix of catamaran and monohull having:
- Some of the catamaran advantages:
 - ✓ High GM => low heel under sail
 - ✓ Large deck area, especially aft
 - ✓ Reduced draft
- Some of the monohull advantages :
 - ✓ One piece construction more reliable and lighter than the twin hull design.
 - ✓ Low sensitivity to weight increase



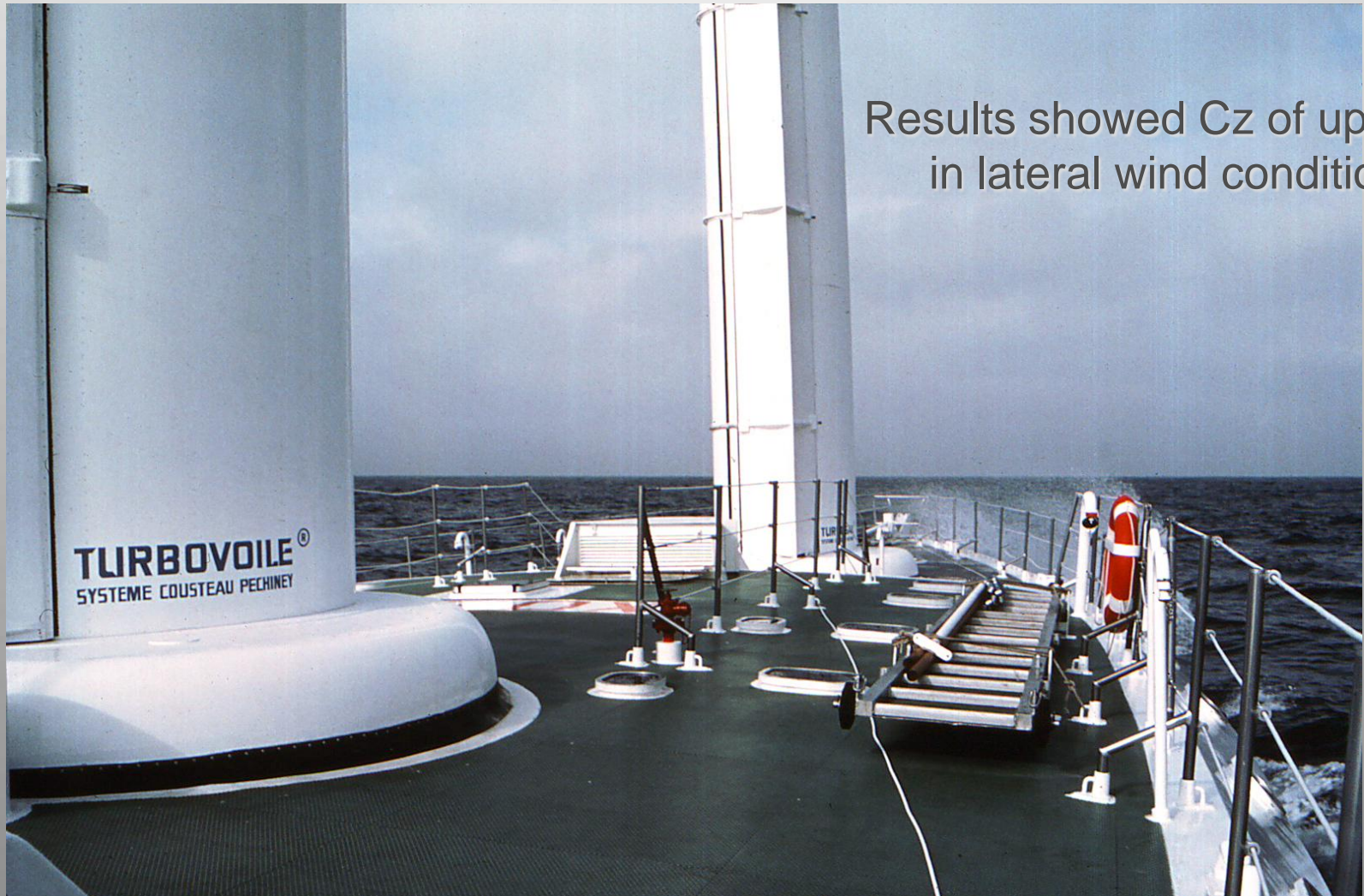


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- Main characteristics
 - LOA = 31.10m
 - B=8,92m
 - Depth=2,60m
 - Draft under keel =2,34m
- Schooner rig with two identical sails of 10m high and 21 m² each:
- Twin auxiliaries engines of 156 hp . Twin generators set
- Extreme long range due to hybrid sail/fuel propulsion(GO capacity 20 m³)



The Alcyone under sail



Results showed C_z of up to 5
in lateral wind conditions.



- The ship intact stability was checked using different regulations, such as :
 - the standard OMI “severe wind and roll criterion”
 - the severe US Navy criteria with 80 knots wind.
- She satisfies both criteria and was approved by the french Administration
- This result is mainly due to the aspiration stopping that result in a decrease of the drag coefficient to the value $C_x = 0,4$ (incidence zero)



- Real exploration capacity with 5 cabins(12 persons), workshop, divers room and shower
- Small crane and tender located aft
- Generous scantling - Rugged construction - not a pleasure boat
- Bureau Veritas class -"Special boat"
- Full load weight of about 80 tons





The Cousteau society fleet

Bureau Mauric

Sailing with the ALCYONE

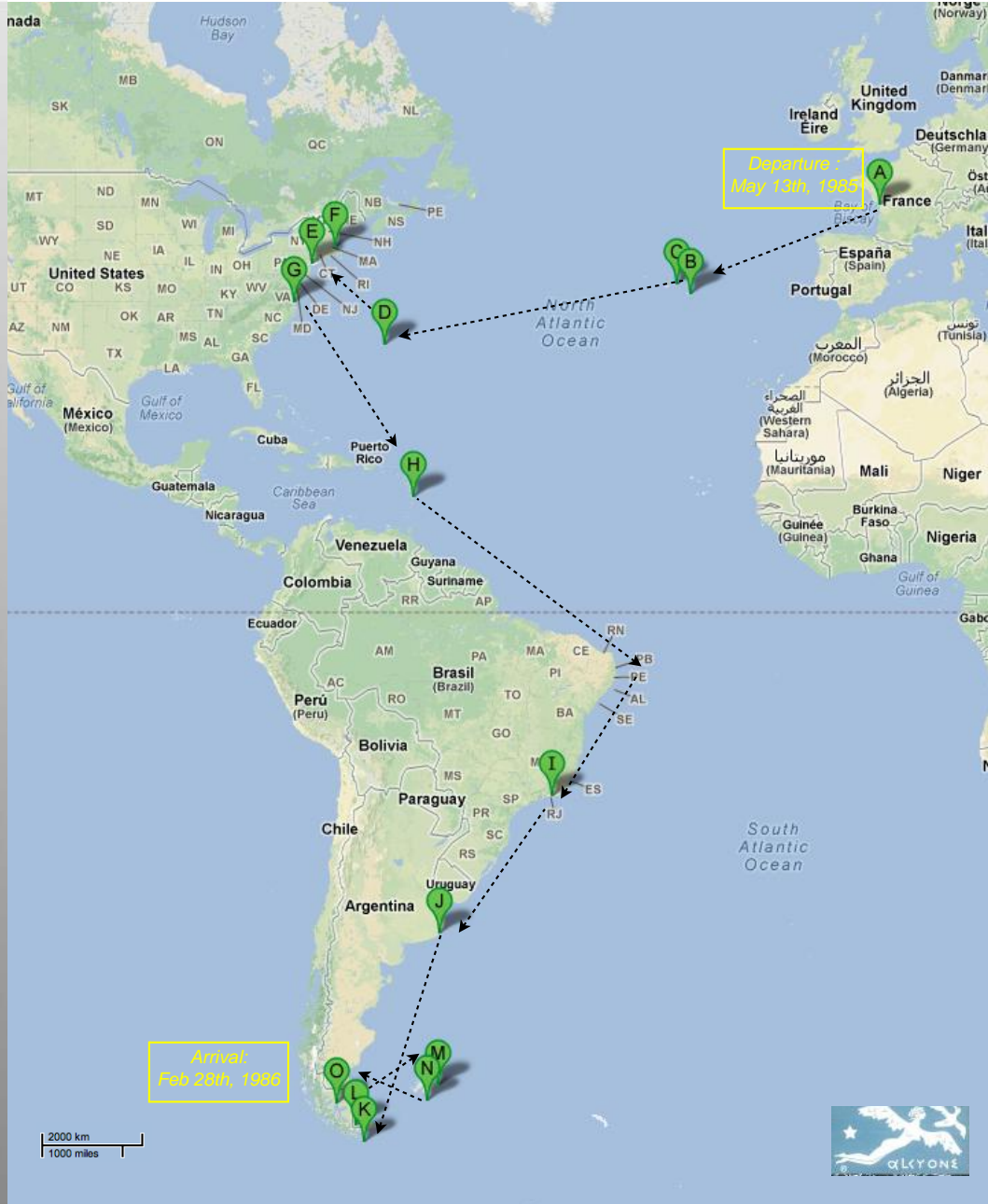
- The Atlantic crossing and the fantastic welcome of the city of NEW-YORK
- The South experience : Falklands islands, storm crossing.....
- The Cap Horn and Ushuaia
- Other sailings



ALCYONE FIRST TRIP 1985-1986

March 31st, 1985 – Alcyone's launching at La Rochelle harbor (France) & l'ap; sm l'by l'Mrs Cousteau

April 5th, 1985 – Bernard Deguy las Commandant & install; on board the first Turbosail!



A May 13th Departure from La Rochelle (France) to the USA

B May 19th Arrival, Sao Miguel, Ponta Delgada, Azores (1434 miles loch)

C May 26th, departure from Terciera (Azores) to Bermuda

D June 5th : Arrival St Georges (Bermuda), 1924 miles loch

June 12th, departure for the USA

E June 17th, arrival at New York (800 miles loch)

F Arrival at Woodhole (North of Boston)

G June 26th : Norfolk (=> 14 october) «Gloria» cyclone! Sept 26th

H October 26th Arrival at «La Marquise»

I November 16th : Arrival at «Rio de Janeiro, Brazil»

J December 1st: Mar del Plata (Buenos Aires, Argentina) 6400 miles from Norfolk

K December 5th Departure to Cap Horn, Chili

L December 11th: Ushuaia, El Fin del Mundo, Argentina

M January 1st, 1986 Port Stanley (Falkland)

N January 8th : Beauchène Island (Falklands)

O February 28th BD leaves Alcyone at Punta Arena, Chili, Magellan canal



Alcyone sailing along cap Horn



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ALCYONE TRIP 1998 Mer Caspienne

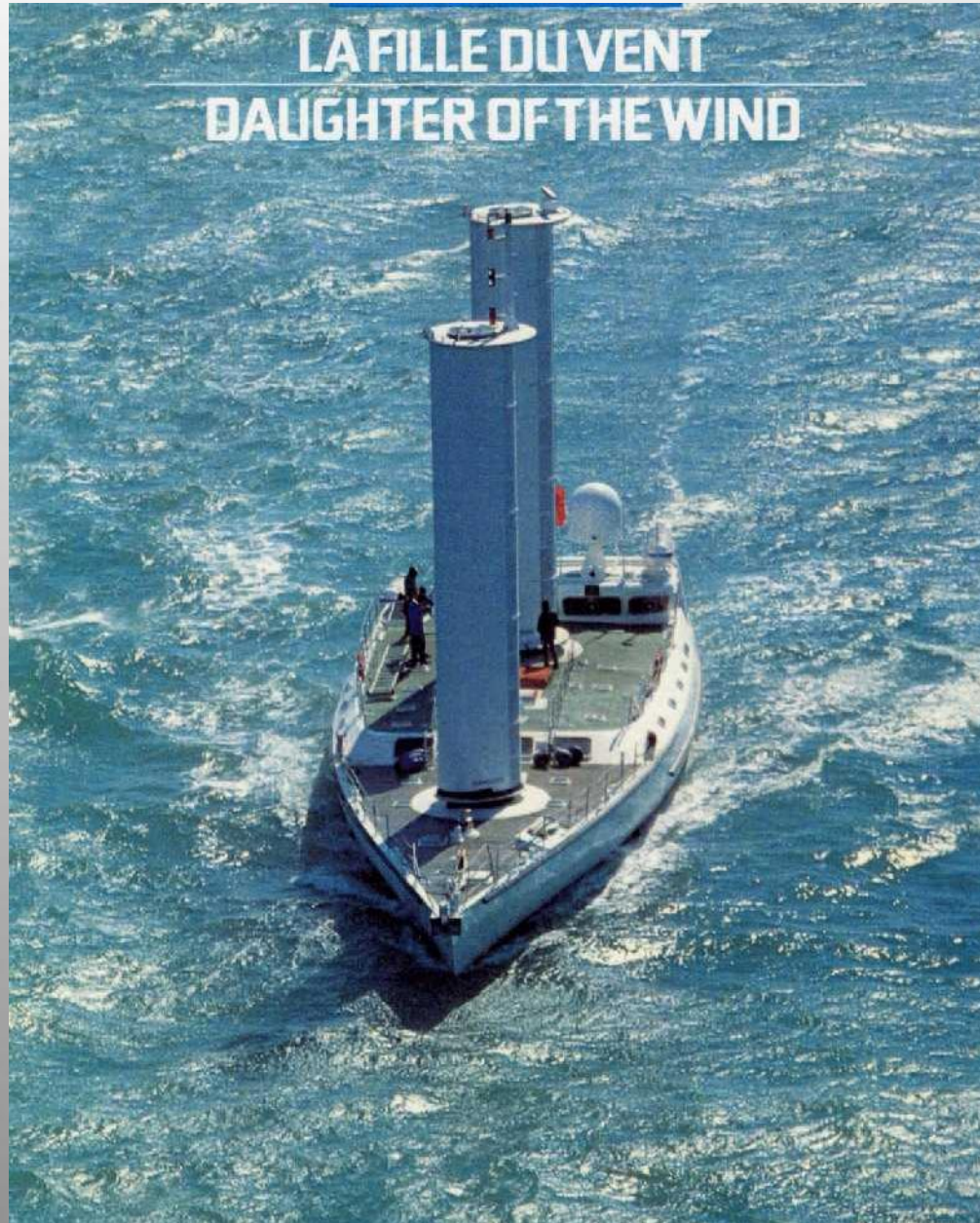
Journey which allowed the Cousteau team to verify the quality of the water of the Caspian Sea, invited by Russia and Iran, through Unesco

May 17th, 1998: Bernard Deguy arrived to take the command of Alcyone in Cape Town (present in the harbor since 3 years)

- A **May 17th:** Departure from **CAPE TOWN** (South Africa) to **Istanbul!**
- B **May 20th:** **DURBAN**, (South Africa)
- C **May 27th:** **MAYOTTE** (French dep)
- D **June 8th:** **DJIBOUTI** (Djibouti)
- E **June 14th:** **SUEZ**, (Gouvernorat Port-Saïd, Égypte) +
- F **June 22th:** **ISTANBUL** (Turkey)
- G **July 4th:** **NOVOROSIISK**, (Russie)
- H **July 5th:** **ROSTOV sur le DON**, (Russie)
- I **July 11th:** **VOLGOGRAD**, (Russie) !!!!!!!!!!!!!
- J **July 12th:** **ASTRAKHAN**, (Russie)
- K **July 17th:** **BAKOU**, (Azerbaïdjan)
- L **August 15th:** **ASTRAKHAN** (Russie)
- M **August 22th:** **ASTRAKHAN** to **VOLGOGRAD**
- N **August 25th:** **ROSTOV sur le DON**, (Russie)
- O **August 29th:** **NOVOROSIISK**, (Russie)
- P **August 31st:** **ISTANBUL** (Turkey)
- Q **September 12th:** **La ROCHELLE**, (France)



LA FILLE DU VENT DAUGHTER OF THE WIND



Some unexpected quality appeared also....the ship and the hull are beautiful !!



- Some conclusions of the sailing experience:
 - ✓ The efficiency of the sail assisted propulsion
 - ✓ The capacity to sail and survive in heavy weather
 - ✓ The capacity of the hull as an exploration ship



A possible future: large commercial ships

Arguments in favor of adaptation on large commercial ships:

- Efficient sea proven propulsor
- Fully automatic- no extra crew
- No rotating part
- Reasonably priced
- Could be reefed by modulating fan speed

Requirements for the ship:

- Good initial stability
- Some deck area available
- Keep visibility from the bridge
- Not too many obstructions on the deck for aerodynamics



- Turbosail is a Cousteau society registered trade mark
- Photos by Bernard Deguy

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