

Bulgarian Academy of Sciences



**HYDRO- and AERODYNAMICS
CENTRE in VARNA**

www.bshc.bg



Recent Contributions to the Field of Ship Hydrodynamics and Ocean Engineering



БЪЛГАРСКА АКАДЕМИЯ НА НАУКИТЕ

**Institute of Metal Science, Equipment and Technologies with
Hydro- and Aerodynamics Centre “Acad. A. Balevski”**



BULGARIAN SHIP HYDRODYNAMICS CENTRE

Performs **fundamental and applied research, training and education** in ship and floating platform hydrodynamics, aerodynamics, water transport, ocean and coastal engineering, sea and river crisis and disasters, environmental protection, renewable energy sources, national security and defense **in favour of the society.**



Established in 1976 with financial support from UNDP and IMO



**International Towing Tank Association
Membership since 1978
Advisory Council member**

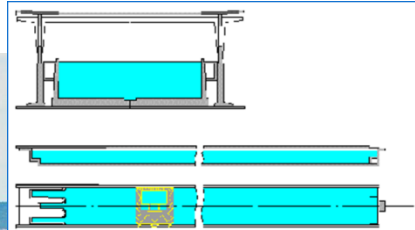


ISO 9001:2015 certified

Experimental Facilities in Varna



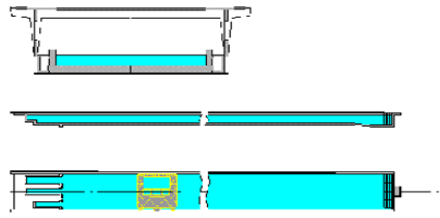
Open Water Area
170 x 160 m



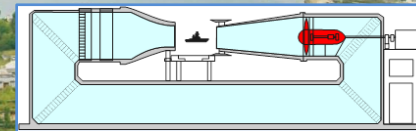
Deep Water Towing Tank
200 x 16 x 6.5 m



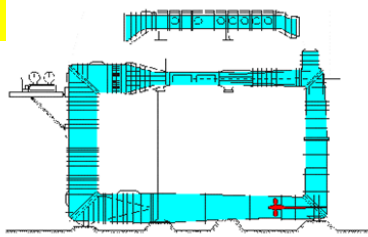
Model workshop
MULTIAX 6 DOF



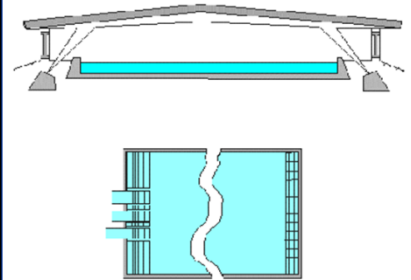
Shallow Water Towing Tank
200 x 16 x <1.5 m



Wind Tunnel
0.8 x 0.5 m



Cavitation Tunnel
Section 1 – 0.6 x 0.6 m
Section 2 – 1.4 x 0.7 m



**Seakeeping and
Maneuvering Basin**
64 x 40 x 2.5 m

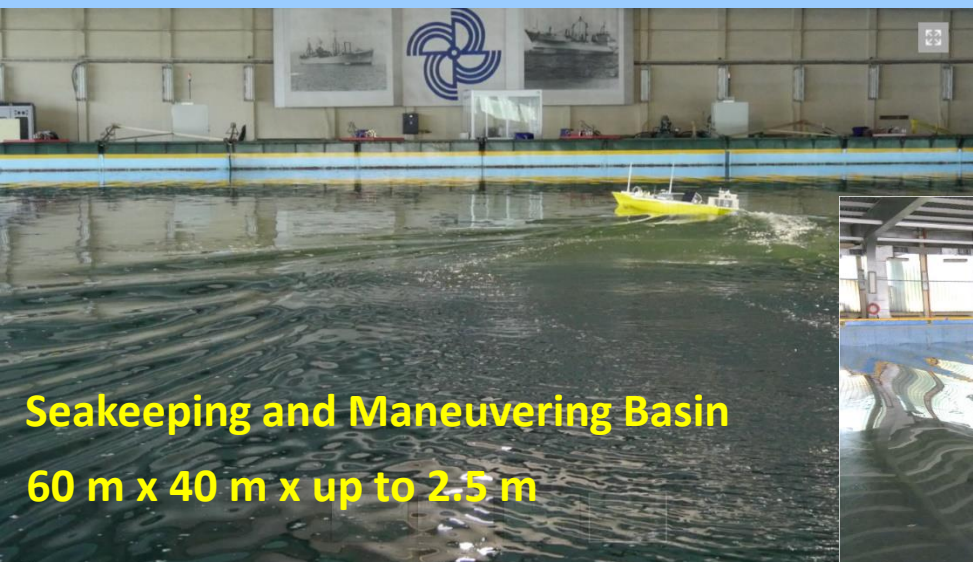


Deep Water Towing Tank



200 m x 16 m x 6.5 m

+ Shallow Water Towing Tank (200 m x 16 m x up to 1.5 m)



Facilities

CAVITATION TUNNEL



Measuring section	Dimensions, m			Other parameters	
	Length	Breadth	Depth		
Section No.1	2.6	0.6	0.6	Min. cavitation number Max. flow velocity	0.2 14 m/s
Section No.2	6.0	1.4	0.7	Max. flow velocity Max. model length	4.5 m/s 5m



Seakeeping and Maneuvering Basin
60 m x 40 m x up to 2.5 m

BSHC RESEARCH ACTIVITIES

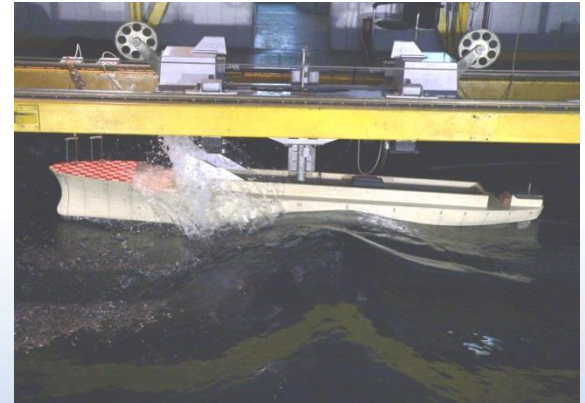
Ship Powering Performance



Ship Maneuvering



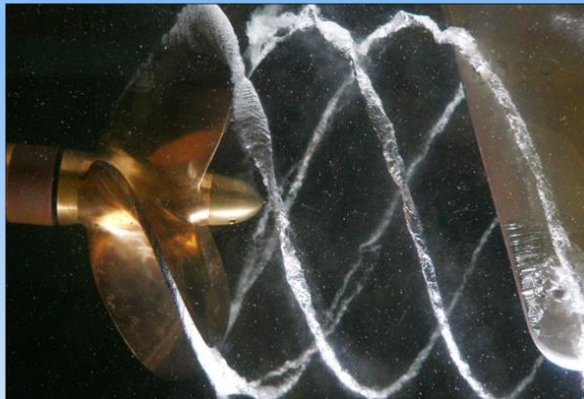
Ship Seakeeping



Powering in Shallow Water



Propellers & Cavitation



Aerodynamics

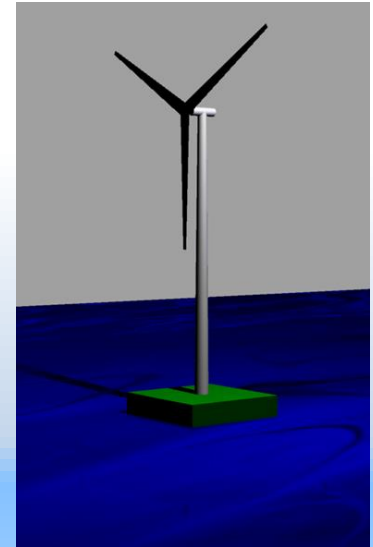
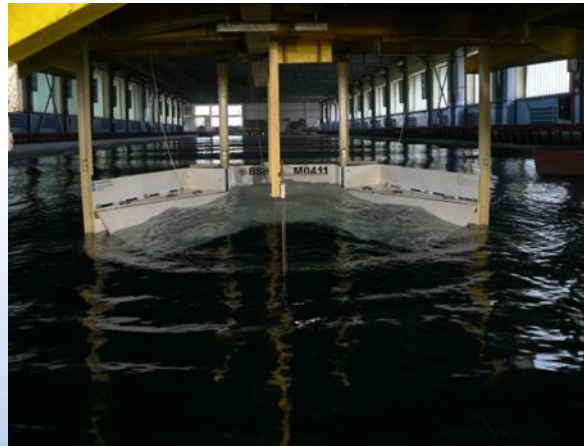


BSHC RESEARCH ACTIVITIES

Offshore Floating Platforms



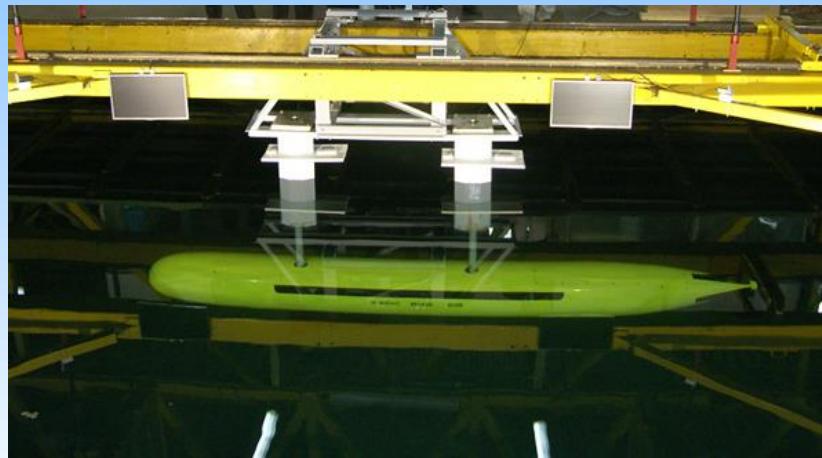
Marine Energy Conversion Devices



Aquaculture Structures

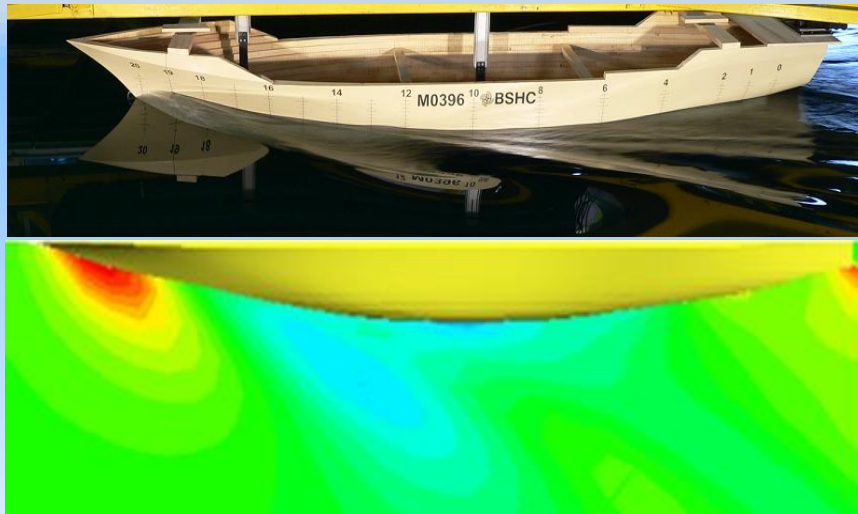
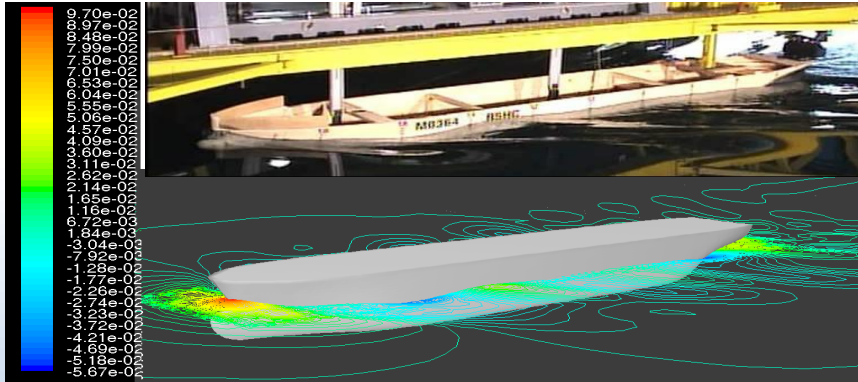


Submarines

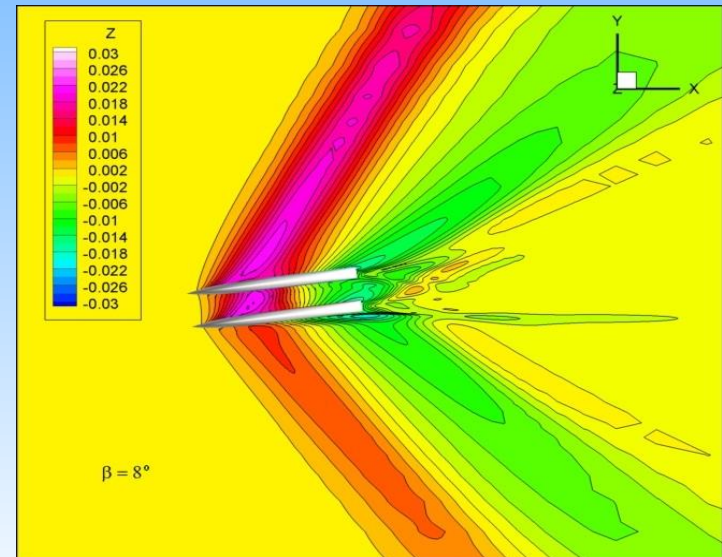
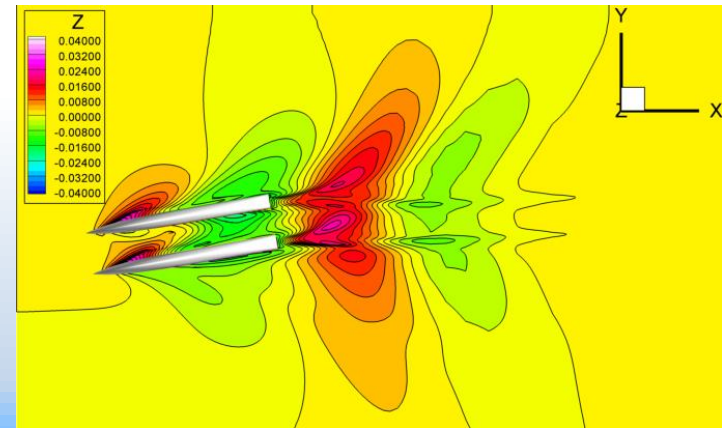


Computational Fluid Dynamics (CFD)

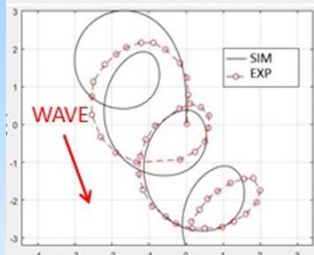
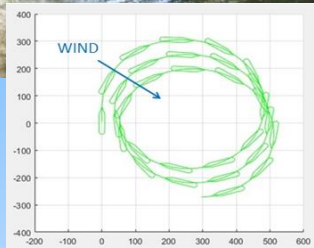
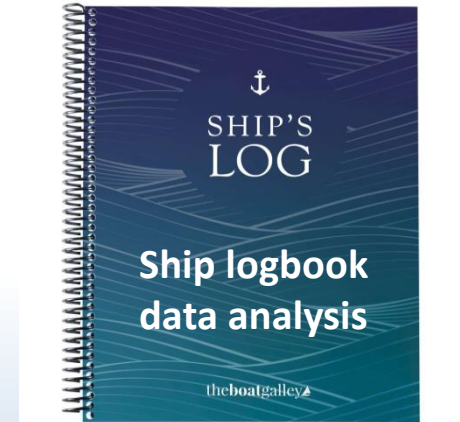
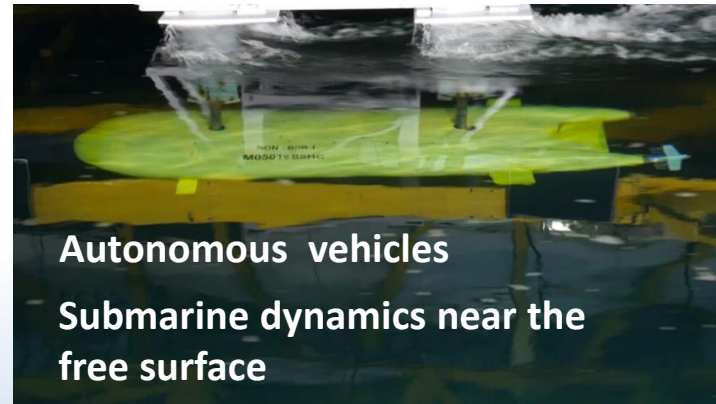
Flow modeling near a ship hull form



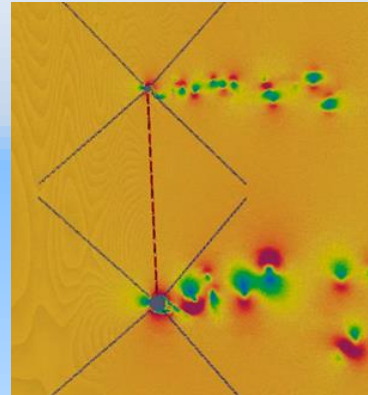
High-speed catamaran advancing with drift in waves



INNOVATIVE RESEARCH

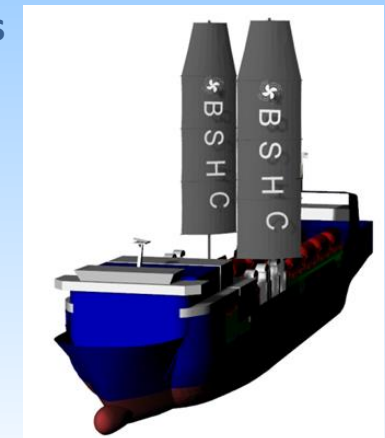
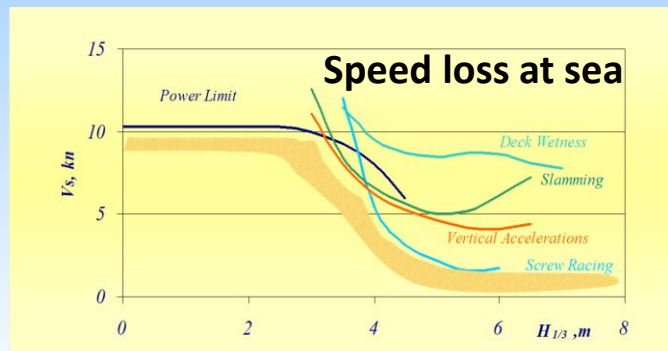
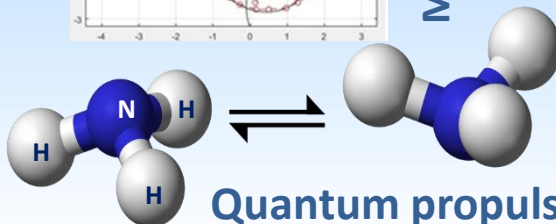


Maneuvering in adverse conditions



Marine energy conversion

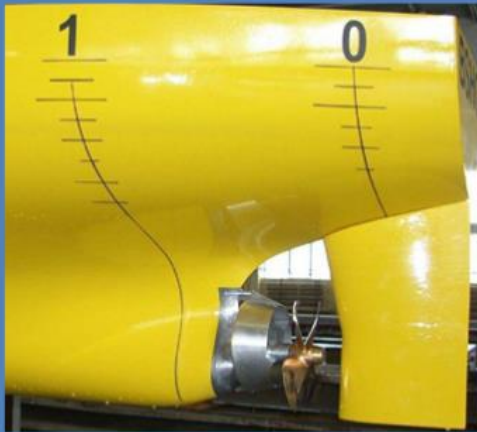
Wind-Assisted Ships





90+ test programs related to energy-saving devices

Experimental validation of performance and final stage optimization



Becker-Mewis Duct



PBCF



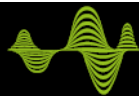
PROMAS System

Commercial projects



Funded by
the European Union

CoPropel - Horizon Europe (2022 - 2025)



Low Vibration

High damping performance absorbs vibrations and reduces underwater radiated noise



Lightweight

50-60% lighter than current solutions



High Performance

12-15% lower energy consumption creating a reduced environmental impact



High Strength

Improved reliability due to greater fatigue resistance



Reduced Cavitation

Mitigating against noise, damage to components, vibrations and a loss of efficiency

About CoPropel

The CoPropel project is bringing together 4 research institutes, 4 industrial partners and a certification bureau to develop, mature and optimise technologies to deliver marine propellers made from advanced composite materials.

Consortium

The CoPropel consortium includes:

- University of Ioannina (UIO)
- Danaos Shipping Company Limited (DAN)
- Bureau Veritas Marine and Offshore Register International (BV)
- MECA Group (MECA)
- Loiretech Ingenierie (LRT)
- The Bulgarian Ship Hydrodynamics Centre (BSHC)
- Glafoos Marine Ltd (GME)
- TWI Limited (TWI)
- Brunel University London (BUL)

Composite propellers





NATO RTO Award for Scientific Achievements on

Numerical and Experimental Investigations of a High-Speed Catamaran in Harsh Environments

The BSHC team, led by Prof. Milanov incorporated within NATO Working Group AVT-161



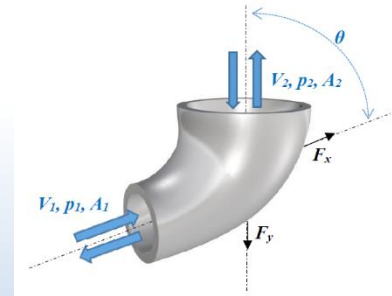
Wave-Energy Drive (WE-Drive)



Improve the weather factor by using the energy of ship motions in waves to counter the added resistance

A flow through a pipe bend creates a reaction force

Pitch motions can create an oscillating flow through an open-to-sea curved compartment



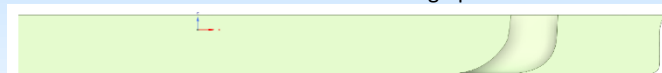
The reaction force has an average horizontal component pointing forward

WE-Drive may supplement the extra engine power needed in a seaway

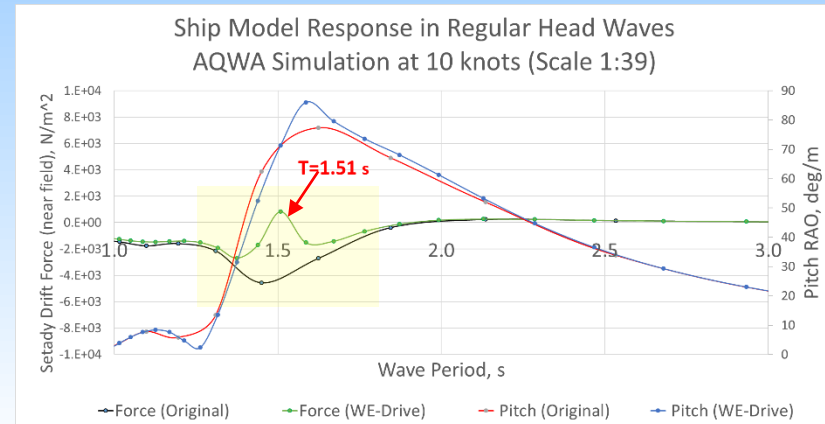
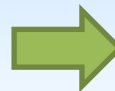
The efficiency (EEDI) may be improved by 11% - 18% depending on ship type & displacement



Initial design point



Optimized WE-Drive (modeFrontier & AQWA)



Quantum Drive (Q-Drive)



A propulsion method based on quantum tunneling - no chemical or nuclear reactions

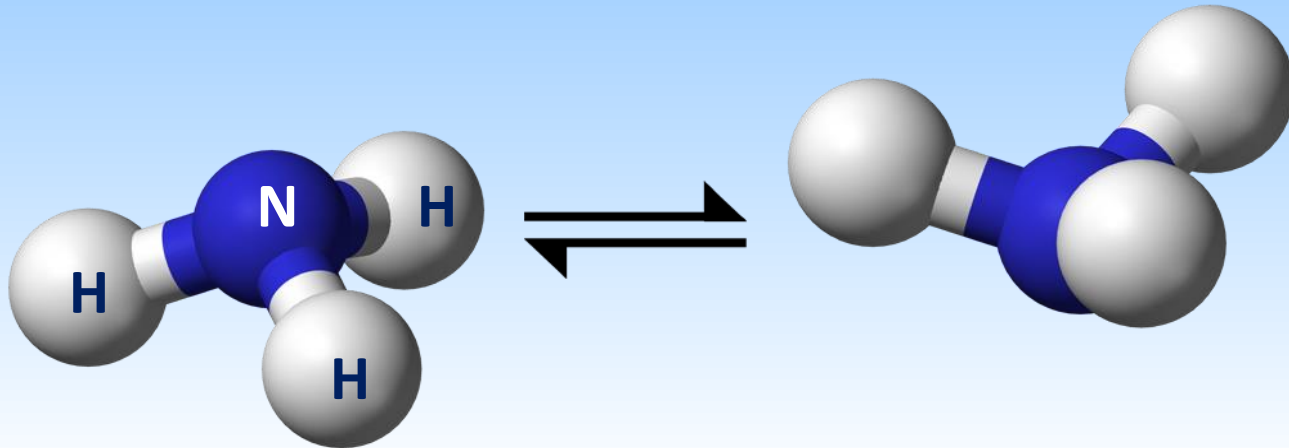
The Ammonia molecule (NH_3) resembles a piston – why burn it ?!

The nitrogen atom (N) tunnels ~30 billion times a second -
the Nitrogen Inversion phenomenon was used in masers and the first atomic clocks

The NH_3 molecule is polar, and the micro-pistons can be oriented with an external electrostatic field, with a NIR laser and mechanically (turbine flow)

From micro to macro:

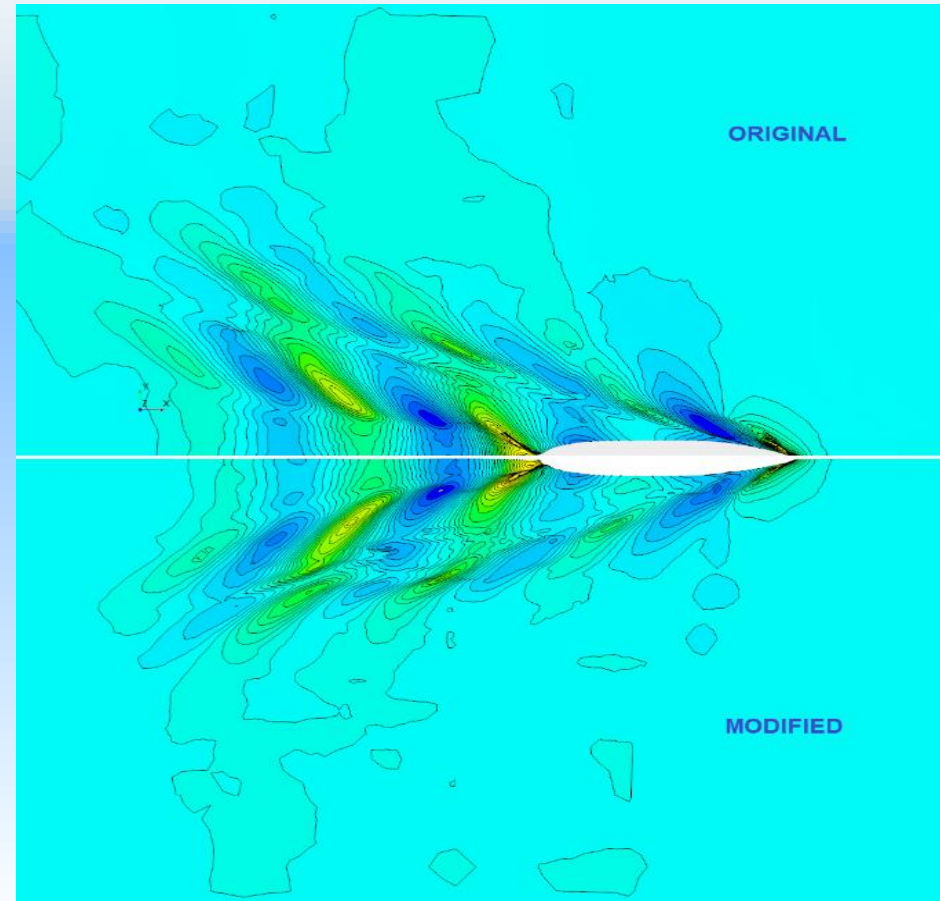
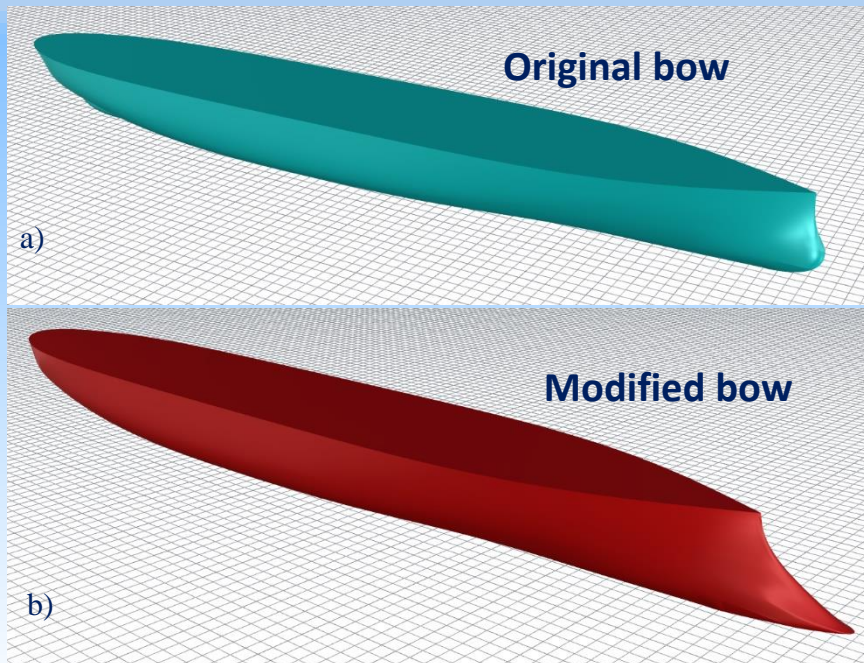
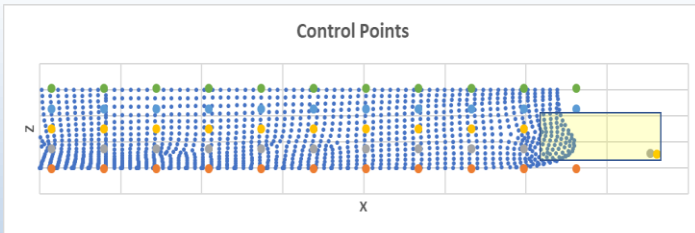
The collisions of $\sim 10^{20}$ oriented molecular “pistons” may produce a propulsive force





Ram-shaped bulbous bow

Automatic optimization of the ship hull form lowers the total resistance by 9%

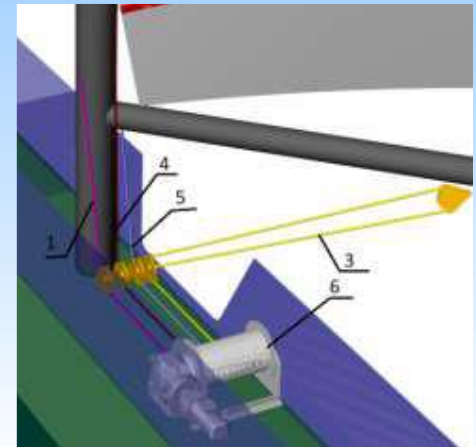
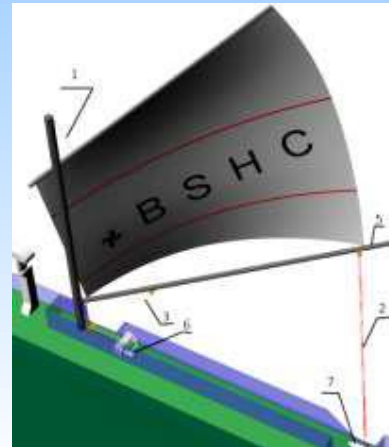
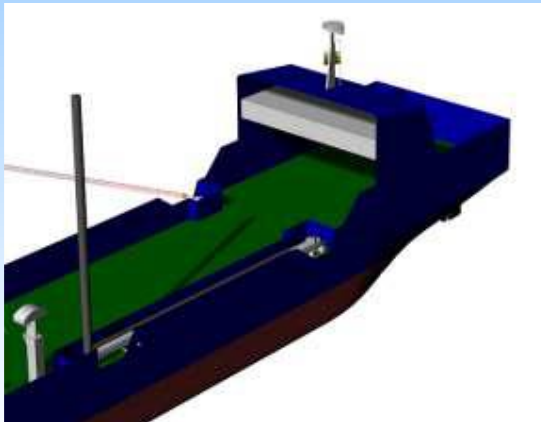


BSHC - Varna



Wind-assisted ship with a soft sail

Estimated 11% efficiency increase for a realistic vessel along the Varna-Poti route

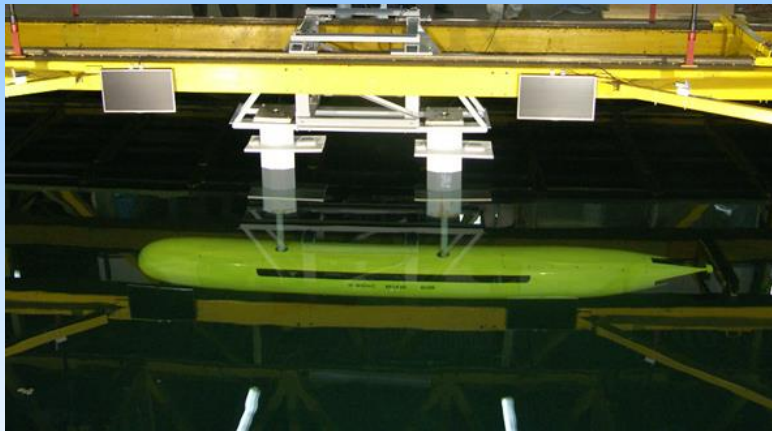


BSHC - Varna

Development of an Autonomous Underwater Vehicle



- 3.7 m x 0.5 m
- 100 kg payload,
- 500 km range @ 4-5 knots
- Up to 50 m water depth



BSHC INTERNATIONAL RELATIONS

Commercial research services – 120 projects in the last 10 years

**Becker Marine Systems (Germany),
Keppel FELS (Singapore),
Hyundai Mipo, SUNGDONG,
Hanjin Heavy Industry, DSEC,
DELTA MARINE, Ulstein,
Sedef Shipyard, RMK Marine,
DESAN Shipyard,
CNR - Lion,
Israel Shipyard Ltd.,
Spliethoff's - Netherlands,
EXMAR Offshore,
Maybank Industries,
Glosten Associates,
Flanders Hydraulics Research,
SINTEF, Rolls-Royce AB,
Stone Marine Propulsion, DCNS
Lorient, VICUS, etc.,**

