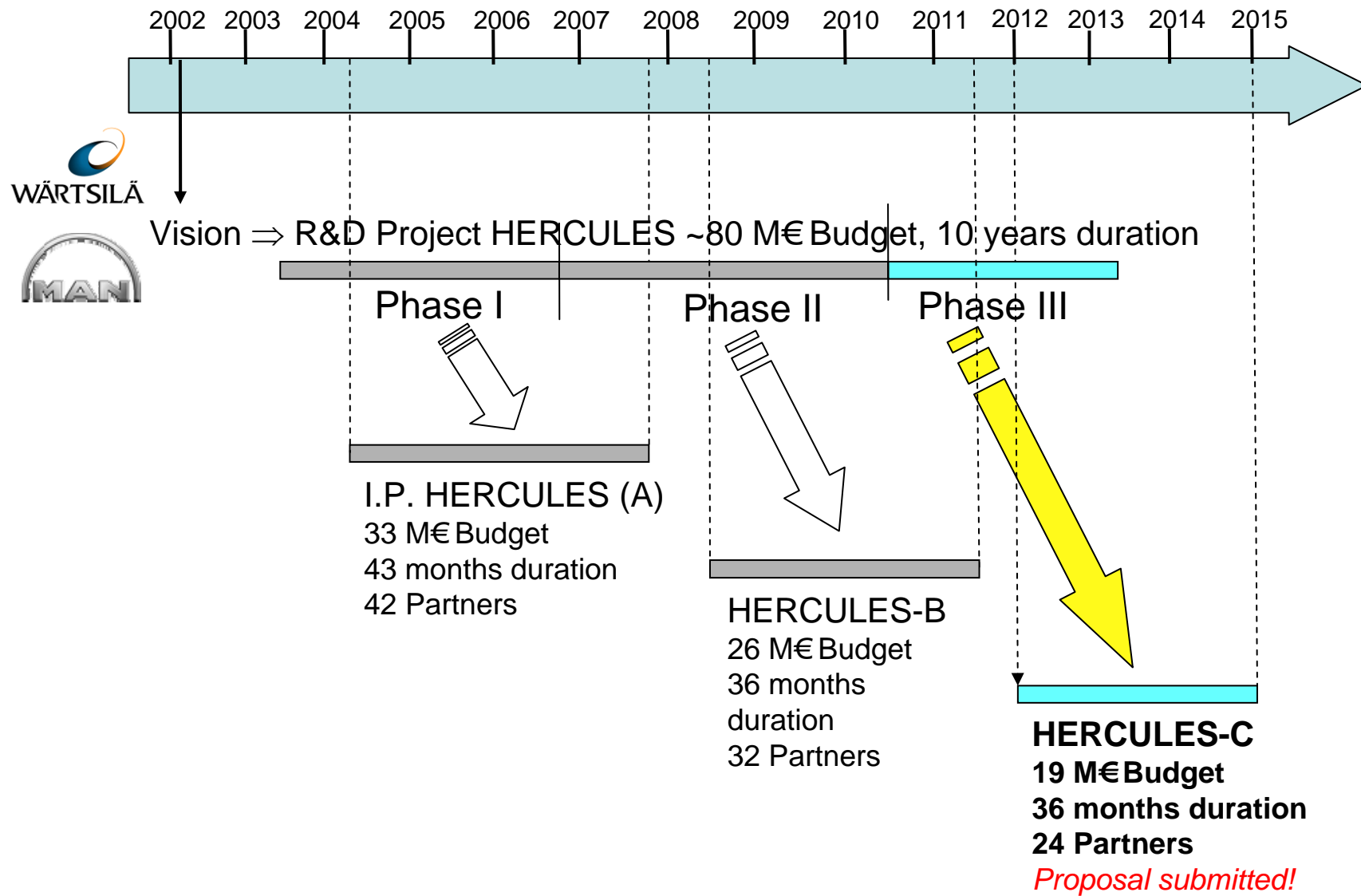

OVERVIEW OF THE HERCULES PROJECT

Prof. Nikolaos P. Kyrtatos
HERCULES Coordinator



HERCULES PROGRAMME TIMELINE

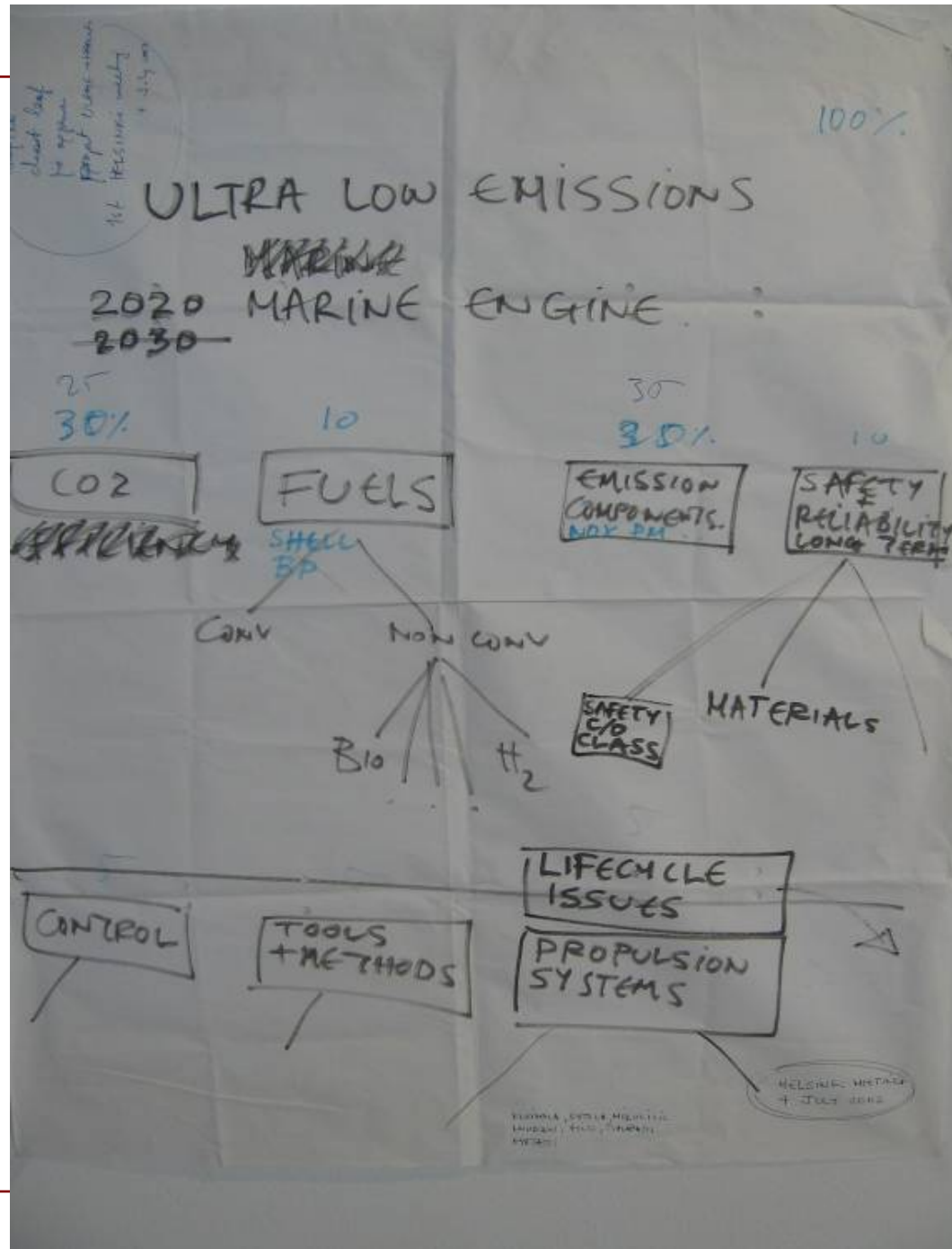


First
MAN – WARTSILA
joint Meeting:

Helsinki, 4th July 2002

Preparation on a long term research
project on marine engines

Historic flipchart page with the
important RTD areas



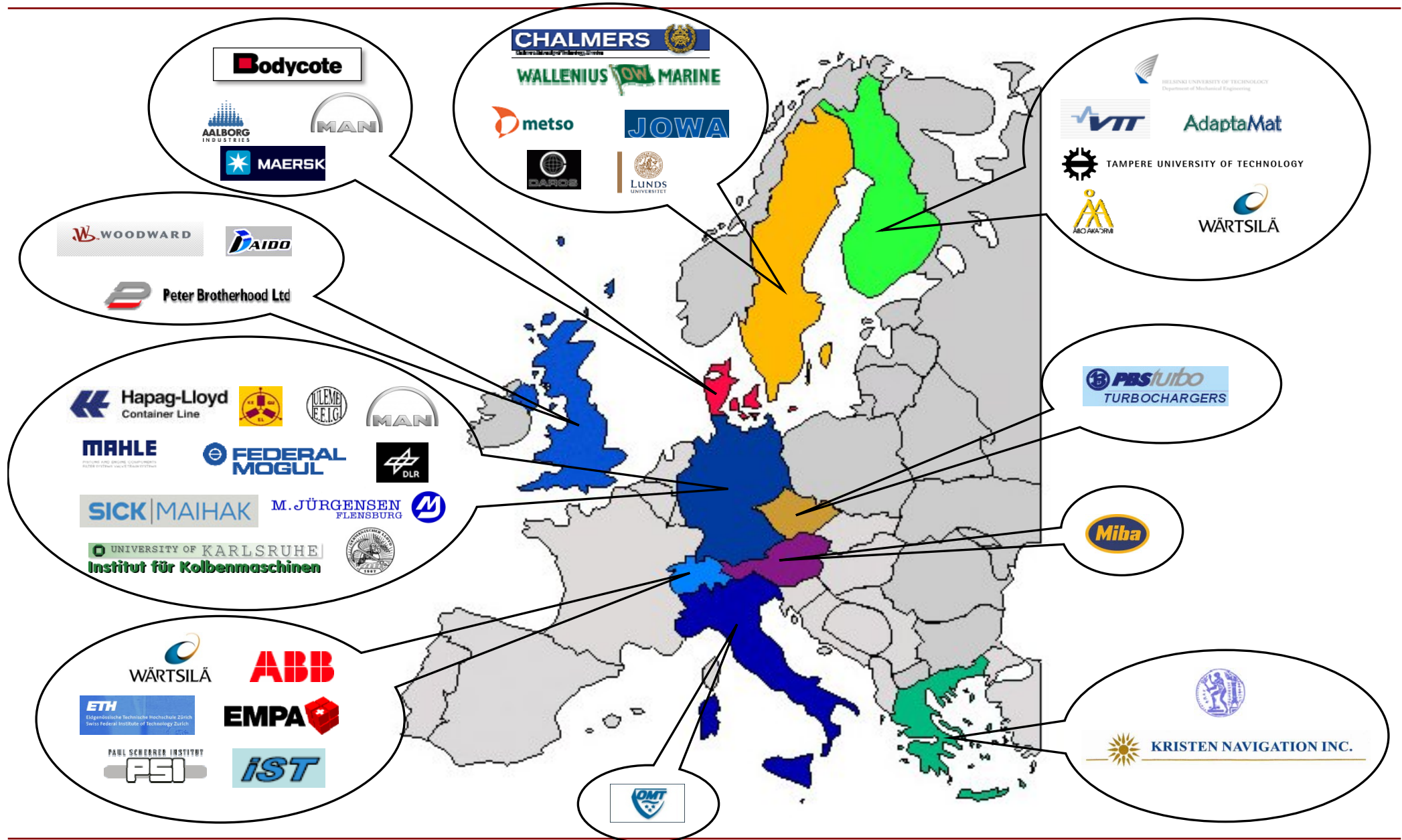


IP-HERCULES(A)

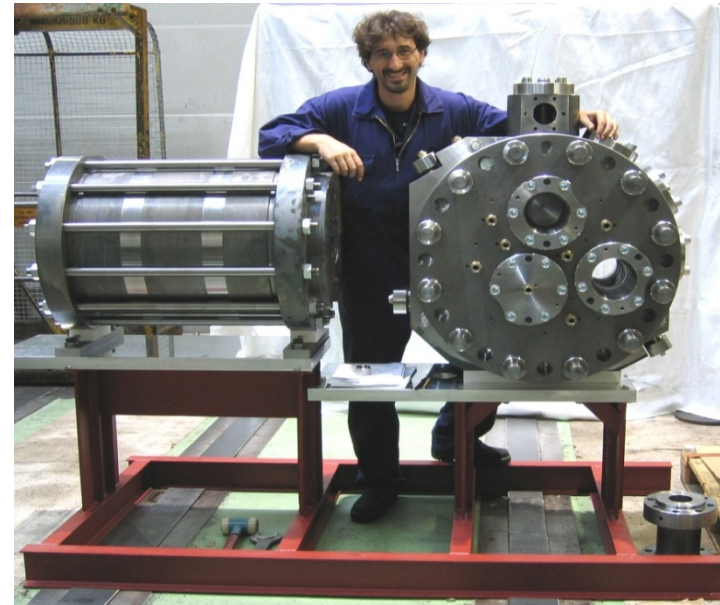
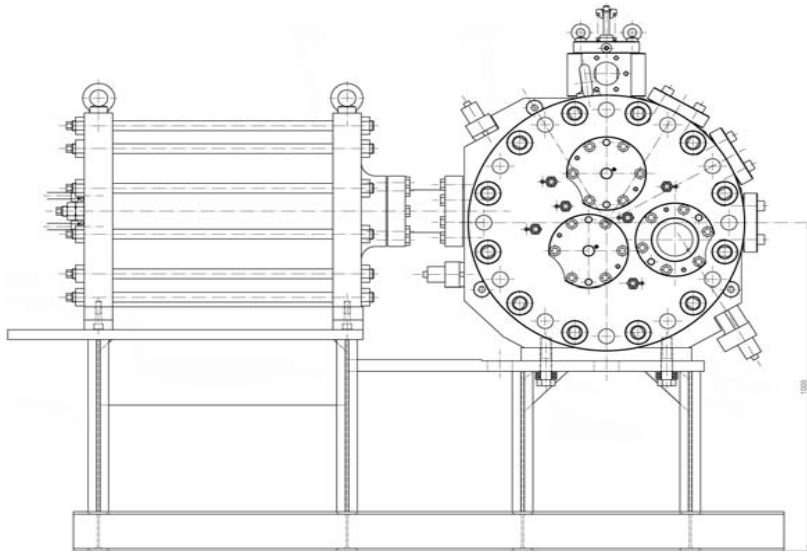
(2004-2007)

HIGH – EFFICIENCY ENGINE R&D IN COMBUSTION WITH ULTRA-LOW EMISSIONS FOR SHIPS

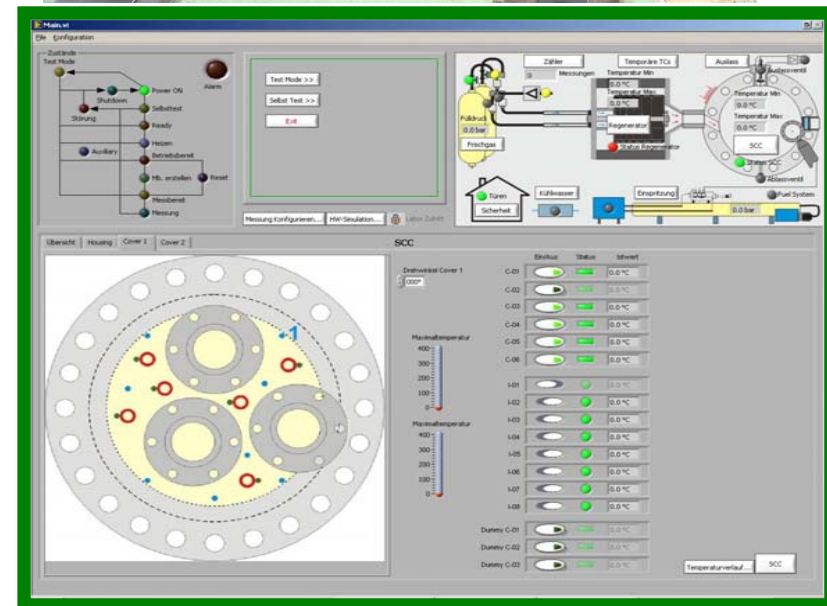
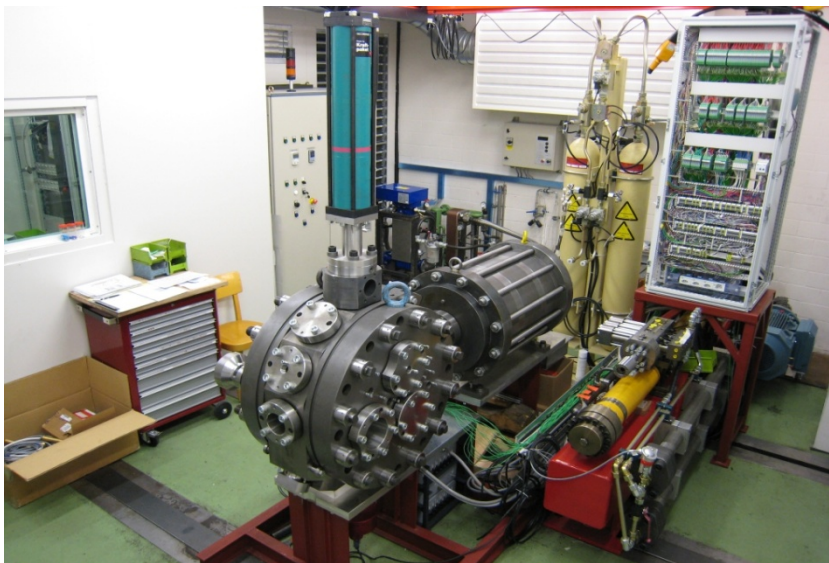
I.P. HERCULES (A) – Consortium



HERCULES (A) TASK 2.1: Combustion process simulation



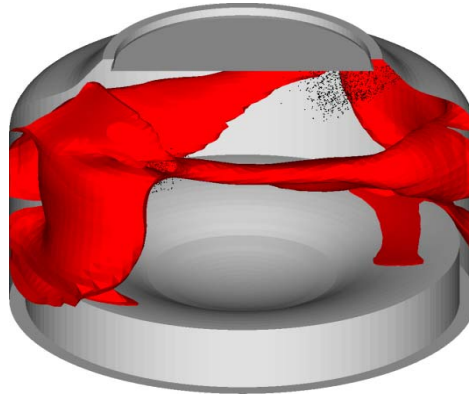
CIMAC 2007 Congress: BP award !



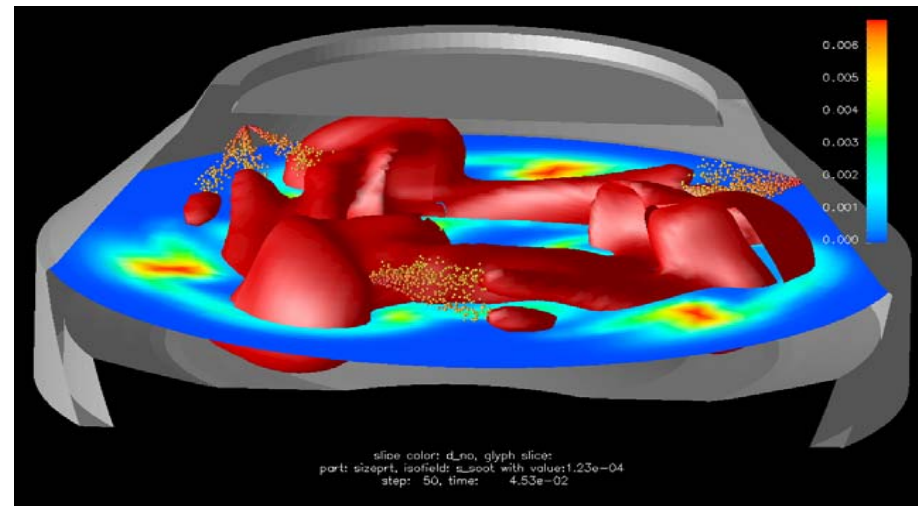
World's largest Spray combustion chamber to simulate in-cylinder conditions

HERCULES (A) TASK 2.2: Emission formation simulation

Isosurface representation of predicted soot for
4T50ME-X two-stroke engine



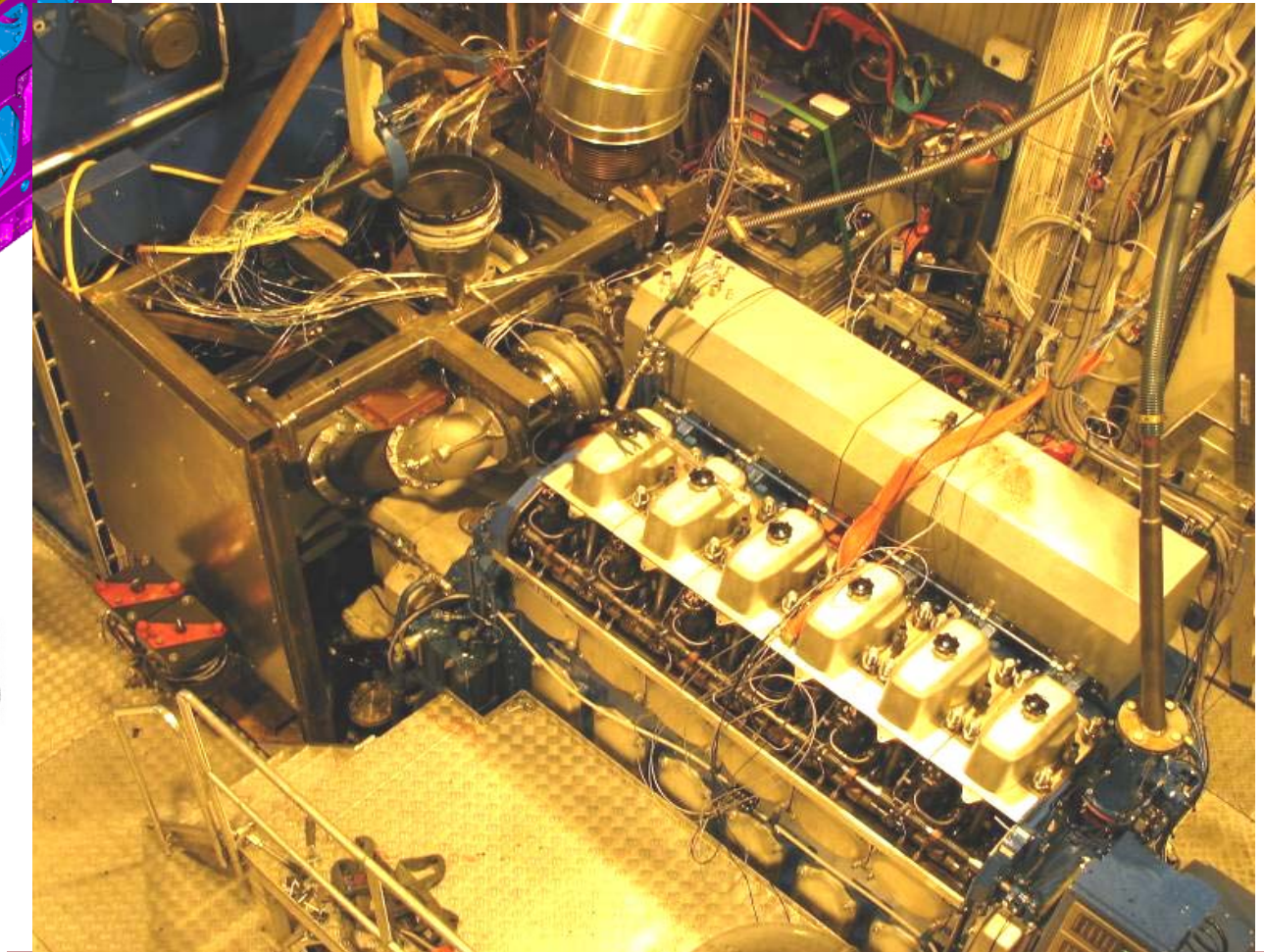
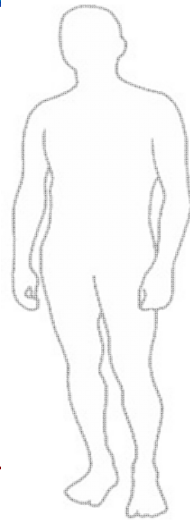
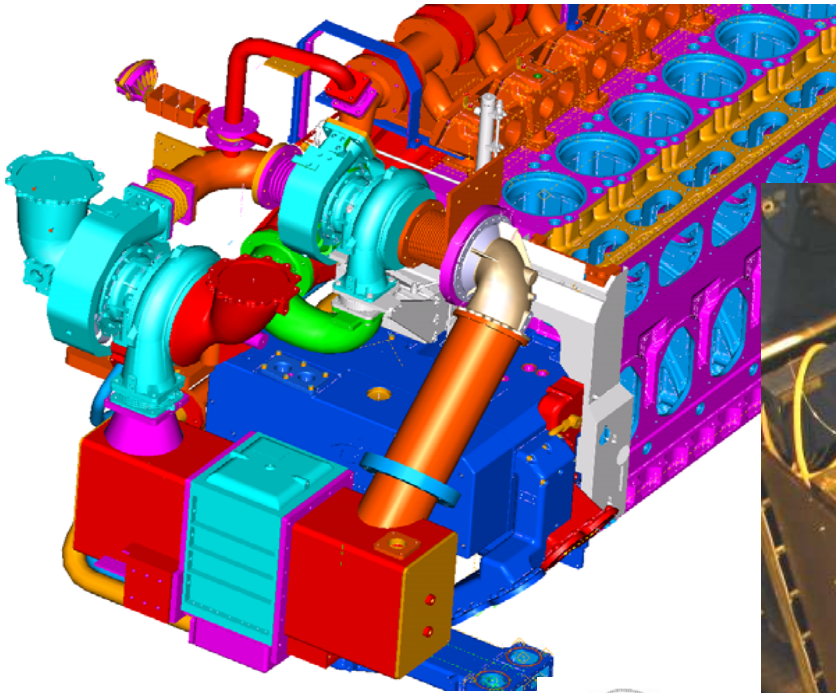
New flamelet soot model CFD predictions of combustion inside marine engine



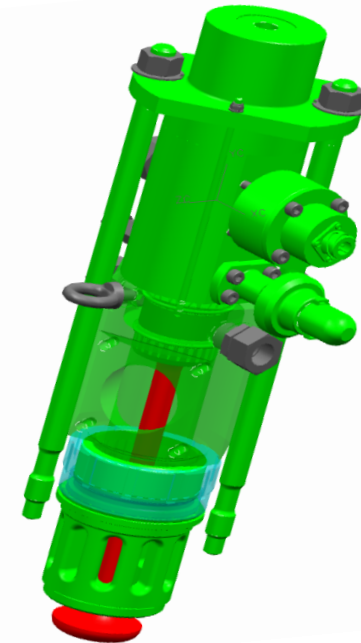
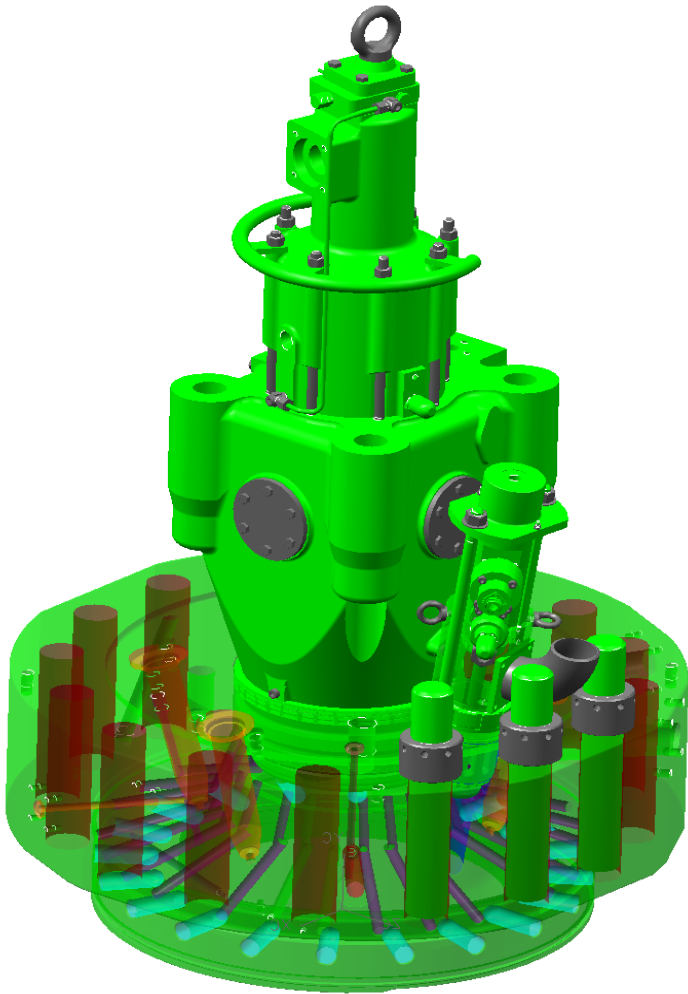
HERCULES (A) TASK 3.1: Variable turbocharging

Two-stage turbocharged 4-stroke engine

CIMAC 2007 Congress: Best paper award !

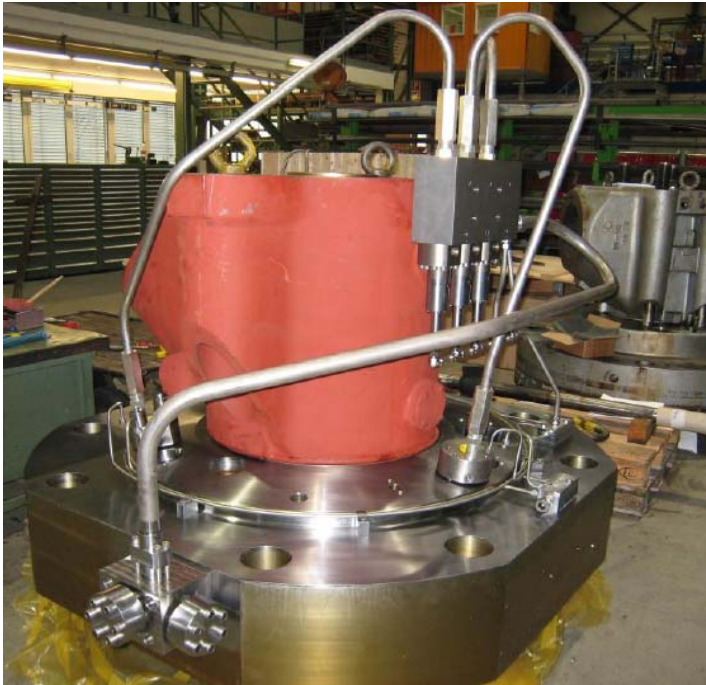


HERCULES (A) TASK 7.2: Emission reduction methods



CGR cylinder cover comprising
CGR- Combustion Gas
Recirculation valve

HERCULES (A) DEMONSTRATION / TASK 6.1: Water injection techniques



DWI Direct Water Injection system onboard
“Maersk Montana”





(2008-2011)
HIGHER – EFFICIENCY ENGINE
WITH ULTRA-LOW EMISSIONS
FOR SHIPS

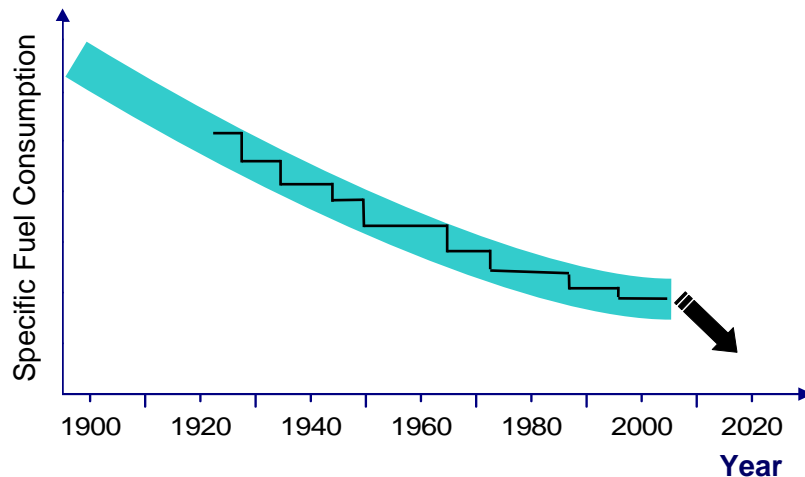




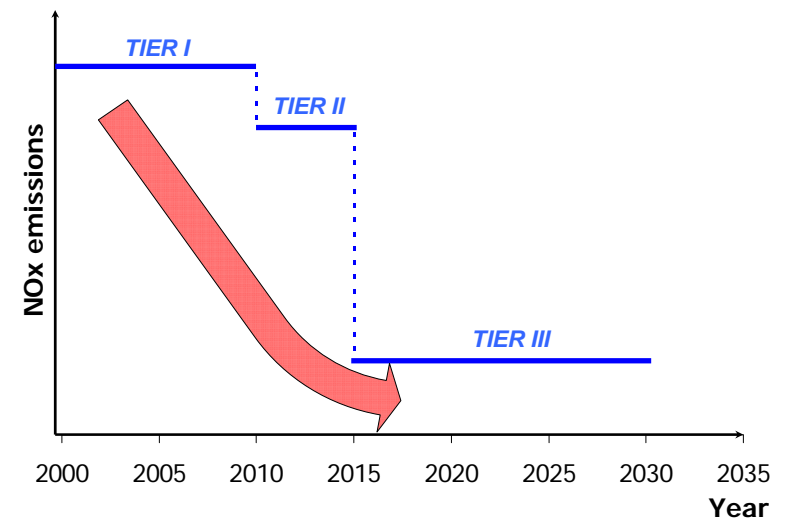
HERCULES-B (2008 – 2011)

Higher Efficiency Engine with Ultra Low Emissions for Ships

Towards 10% reduction in SFC



Towards ULTRA-LOW Emissions



HERCULES-B VISION	Year 2020
Reduction of fuel consumption and CO ₂ emissions	-10%
Reduction of NOx (Relative to IMO 2000 standard)	-70%
Reduction of other emission components (PM, HC)	-50%

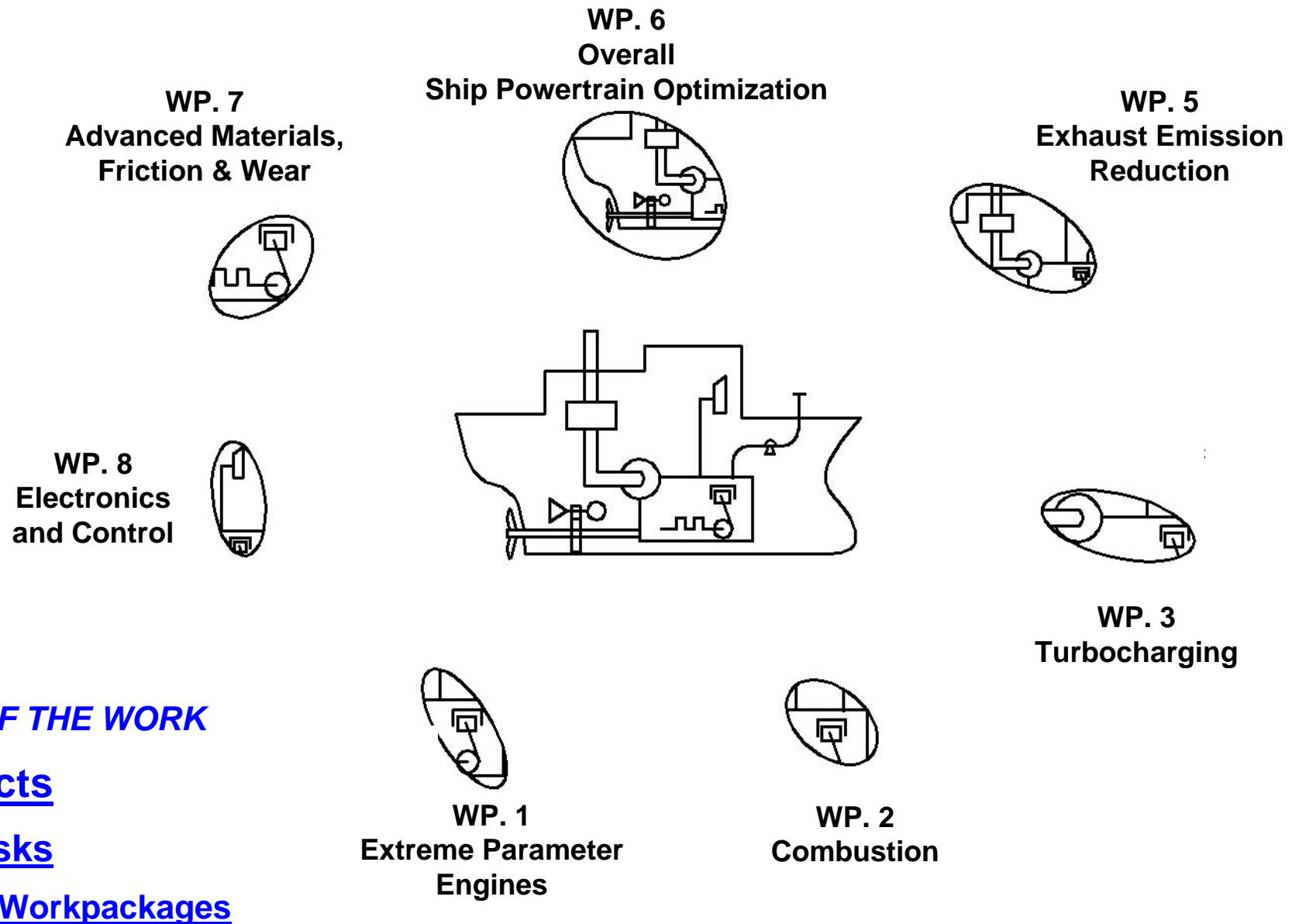
HERCULES - B – Consortium



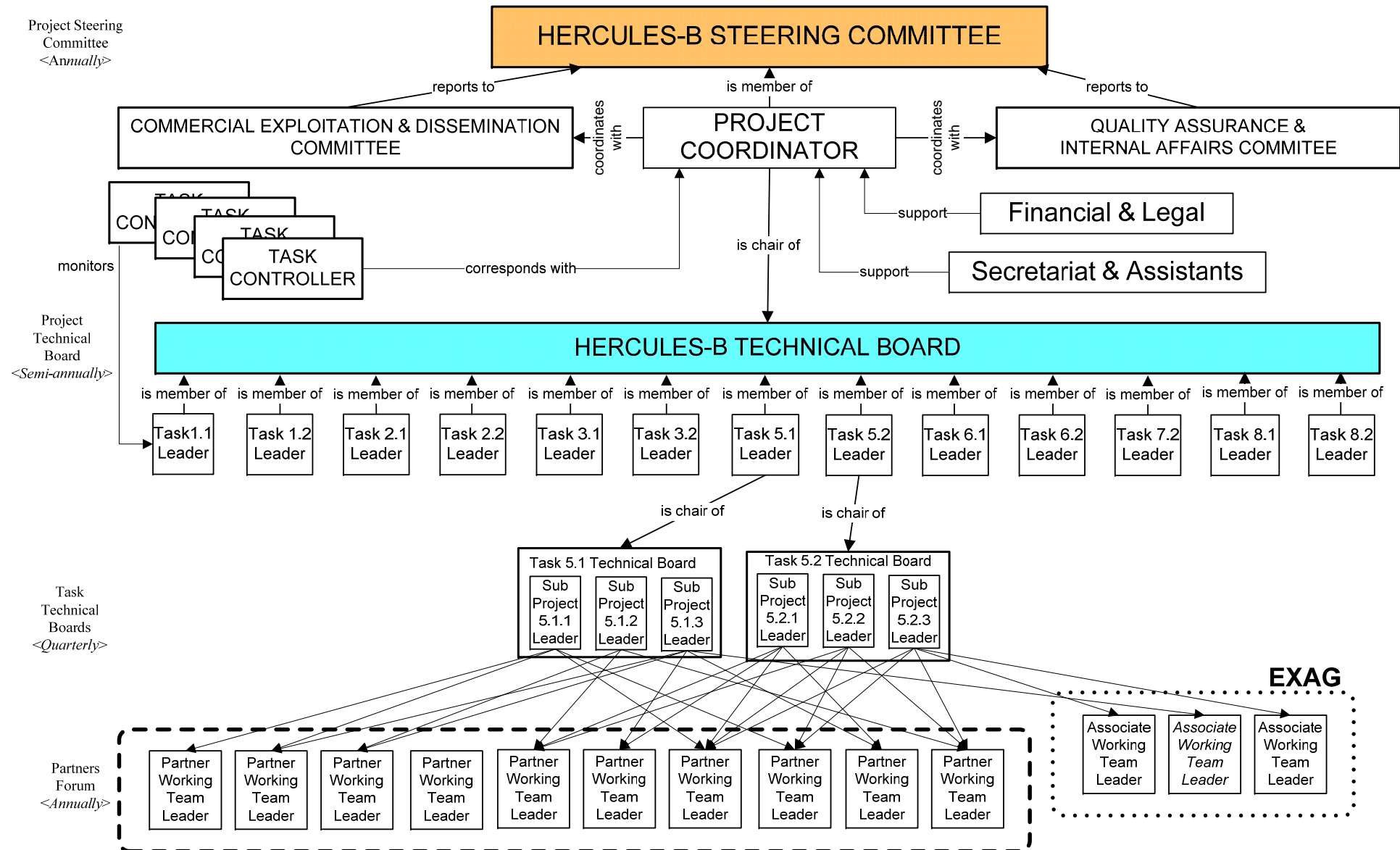
32 Partners.

Industrial 60% - Universities/Research Inst. 40%

Overview of HERCULES-B Workpackages



HERCULES-B Management



Task 2.1: Combustion process modeling and development

Objectives:

- ❑ To investigate with CFD and propose improved combustion concepts
- ❑ To acquire reference data to use as model input as well as validation
- ❑ To develop and/or adapt CFD tools and simulation methods

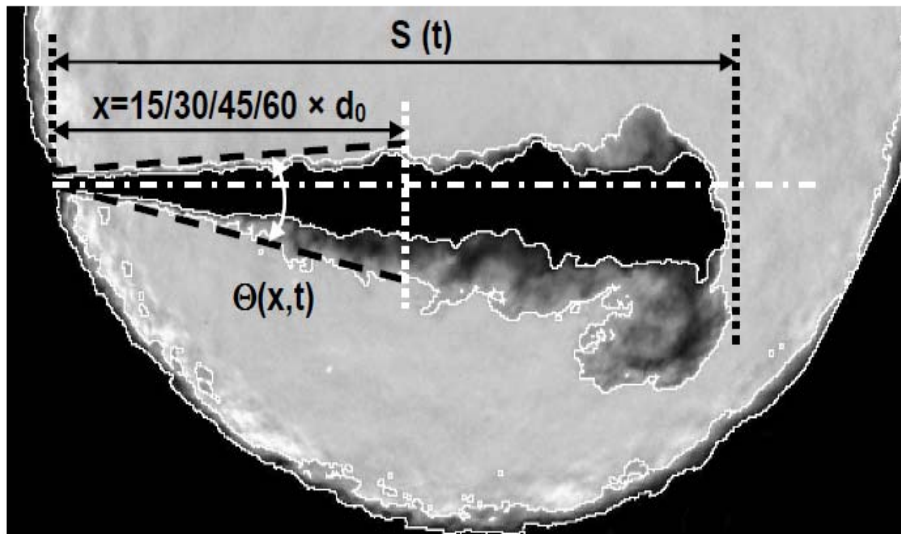
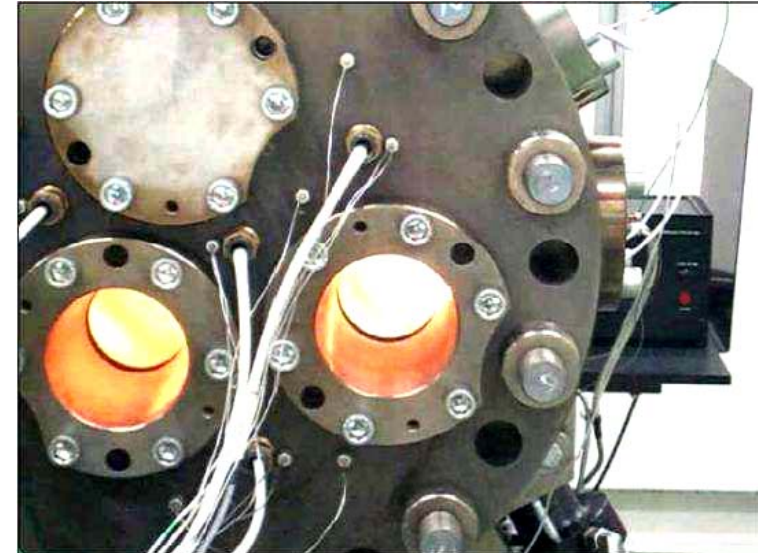
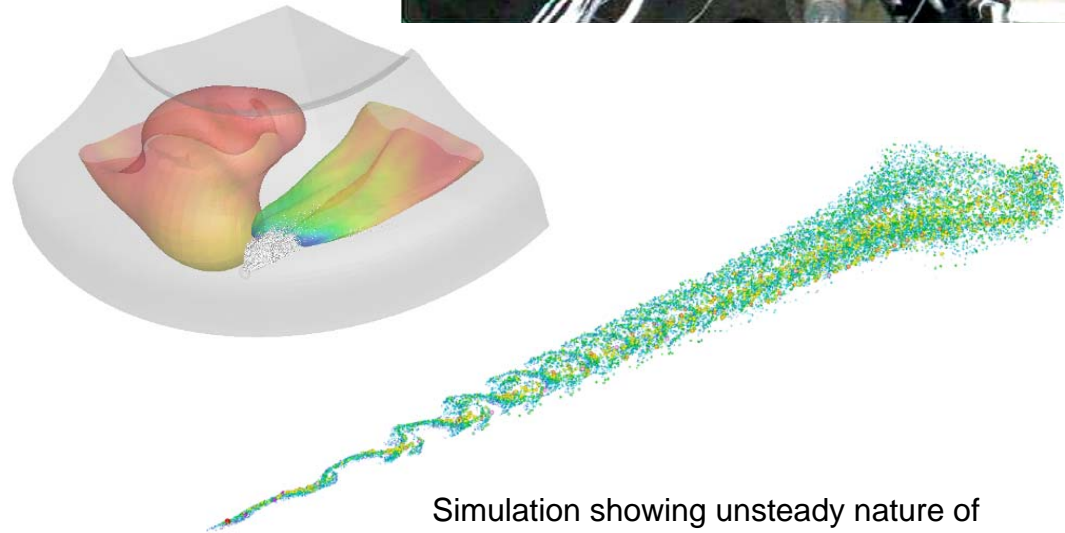


Fig. 6: Analysis of spray penetration and cone angles



Simulation showing unsteady nature of spray development (Large Eddy Simulation)

Partners:



Task 2.2: Experimental and numerical combustion analysis

Objectives:

To develop optical methods for studying flow, spray and combustion inside both 4-stroke and 2-stroke marine engines, and for transient emission measurements.

Optical cylinder cover for 2- stroke

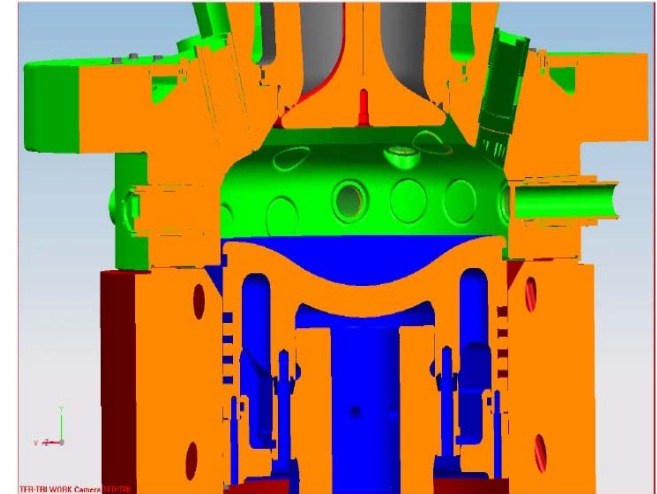
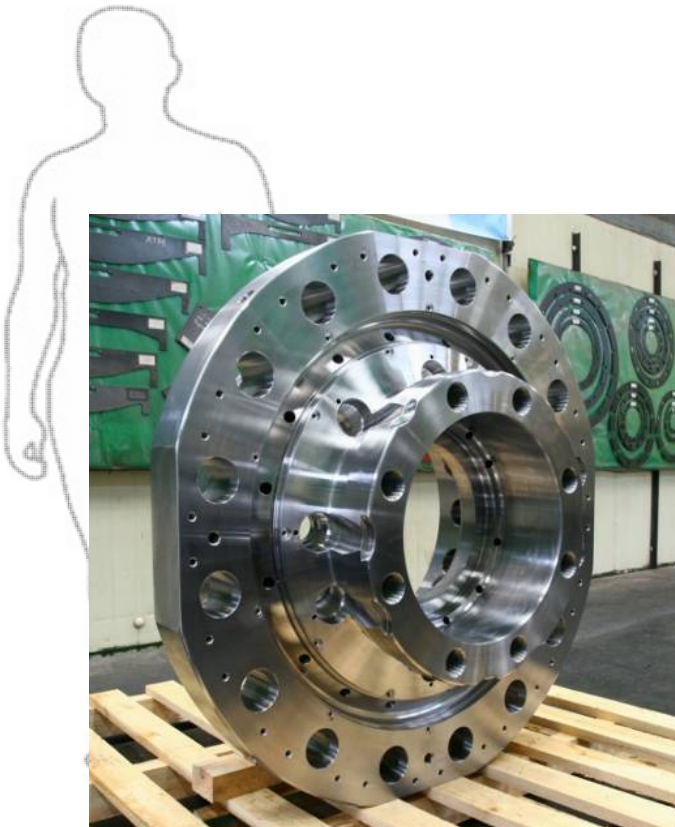


Figure 5.14: CAD drawing of the optical cover mounted on the engine.



Partners:    

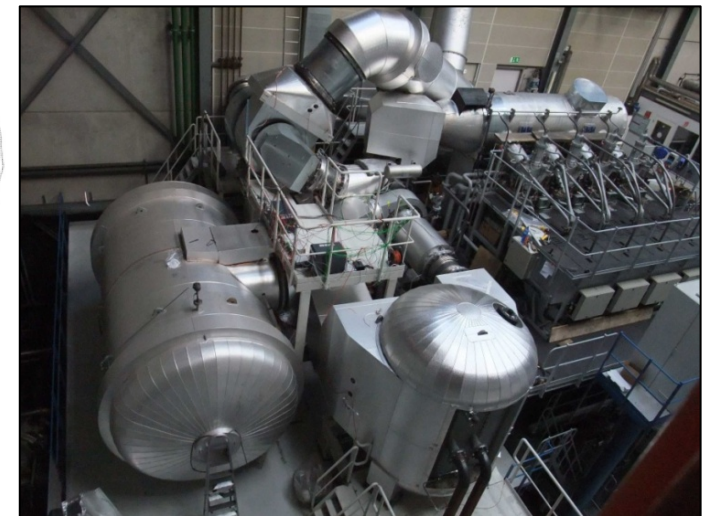
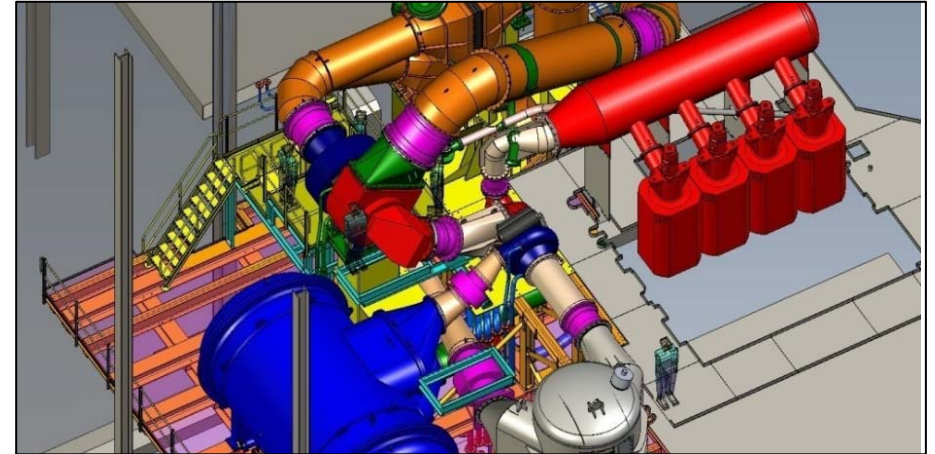
Task 3.1: High efficiency and low emission TC concepts

Objectives:

Realisation of serial high pressure turbo-charging systems and development of control methods



4-stroke prototype engine with 2-stage turbocharging system



2-stroke installation

Partners: **ABB** **ETH**
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zürich

PAUL SCHERRER INSTITUT
PSI



TAMPERE UNIVERSITY OF TECHNOLOGY

WÄRTSILÄ



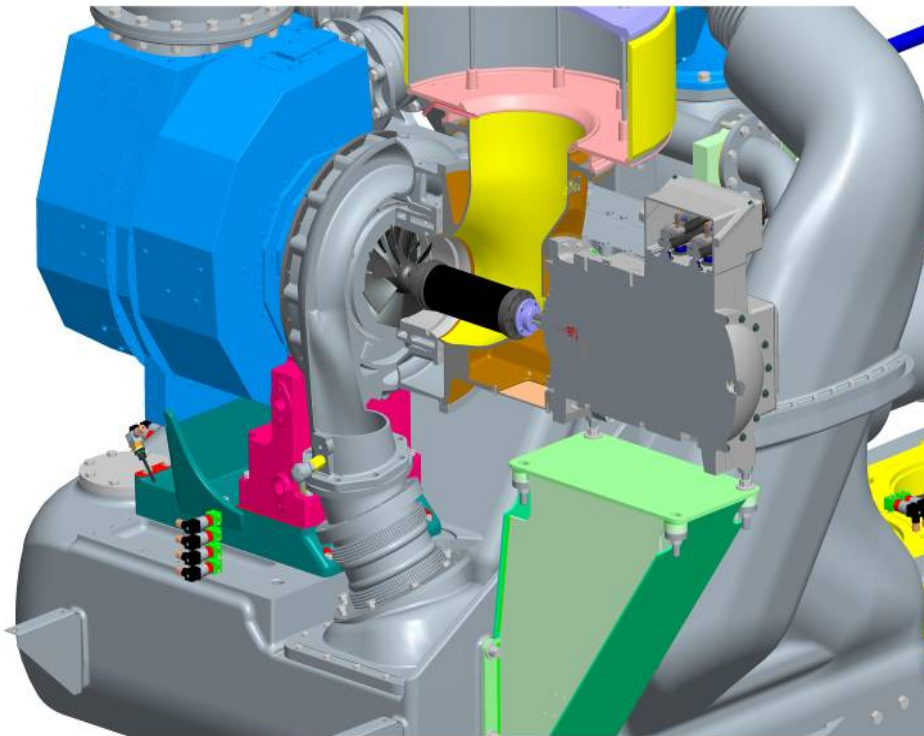
Task 3.2: Advanced intelligent turbocharger

Objectives:

Two-stage turbocharging for 2-/4-stroke marine diesel engines,
operation at 30 bar PME

2-stroke engines: PTI/PTO, VTA, SFOC reduction by 2-3%,

4-stroke engines: VTA, PTI, NO_x reduction of 50%



Turbocharger with variable
compressor inlet guide vanes



Turbocharger with variable
turbine nozzle vanes

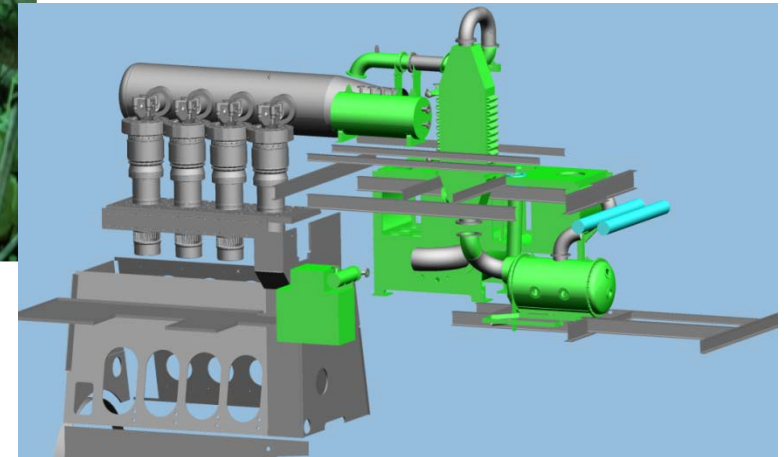
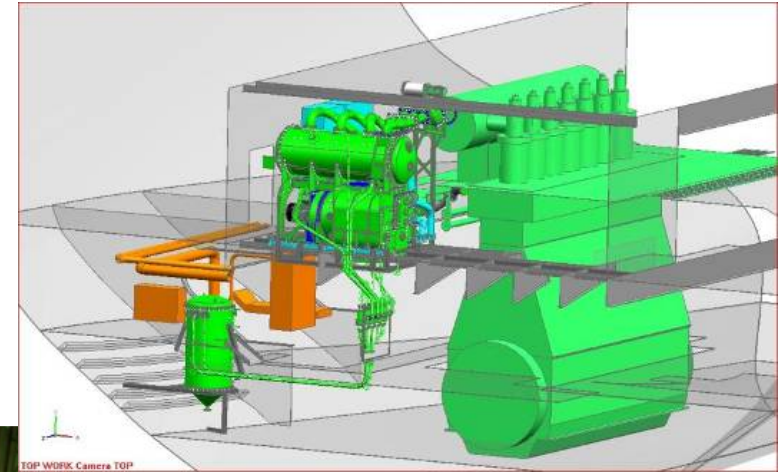
Partners:



Task 5.2: Emission reduction - Exhaust Gas Recirculation and After-treatment

Objectives:

- Reduce NO_x with 80% by use of EGR on 2-stroke diesel engine and service test of EGR system.
- Development and test of CGR system and High Pressure Boiler.
- Dry scrubbing investigation.
- SCR investigation and test on 4-stroke diesel engine.



High pressure boiler

Partners:



Conclusions

- MAN + WARTSILA jointly participate in large-scale R&D project
- Competitors can work side-by-side in basic research
- *Pre-requisite*: Well-defined structure and management procedures

HERCULES-A (2004-2007) *Broad range of technologies examined*

HERCULES-B (2008-2011) *Specific novel technologies, efficiency & emissions*

⋮

HERCULES Continuation ? (2012 ...) *Integration and optimisation*

