

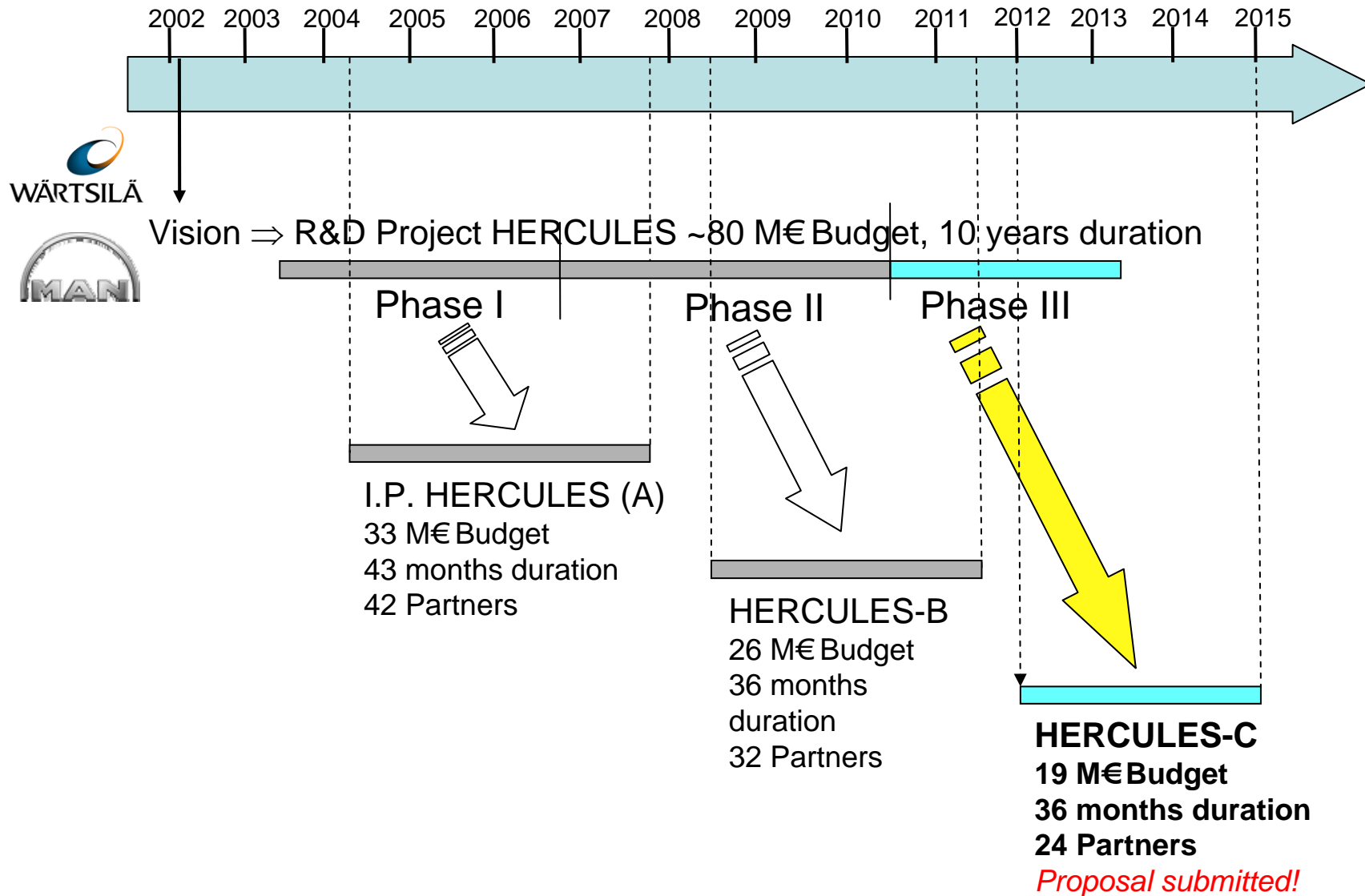
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# OVERVIEW OF THE HERCULES PROJECT

Prof. Nikolaos P. Kyrtatos  
HERCULES Coordinator



# HERCULES PROGRAMME TIMELINE

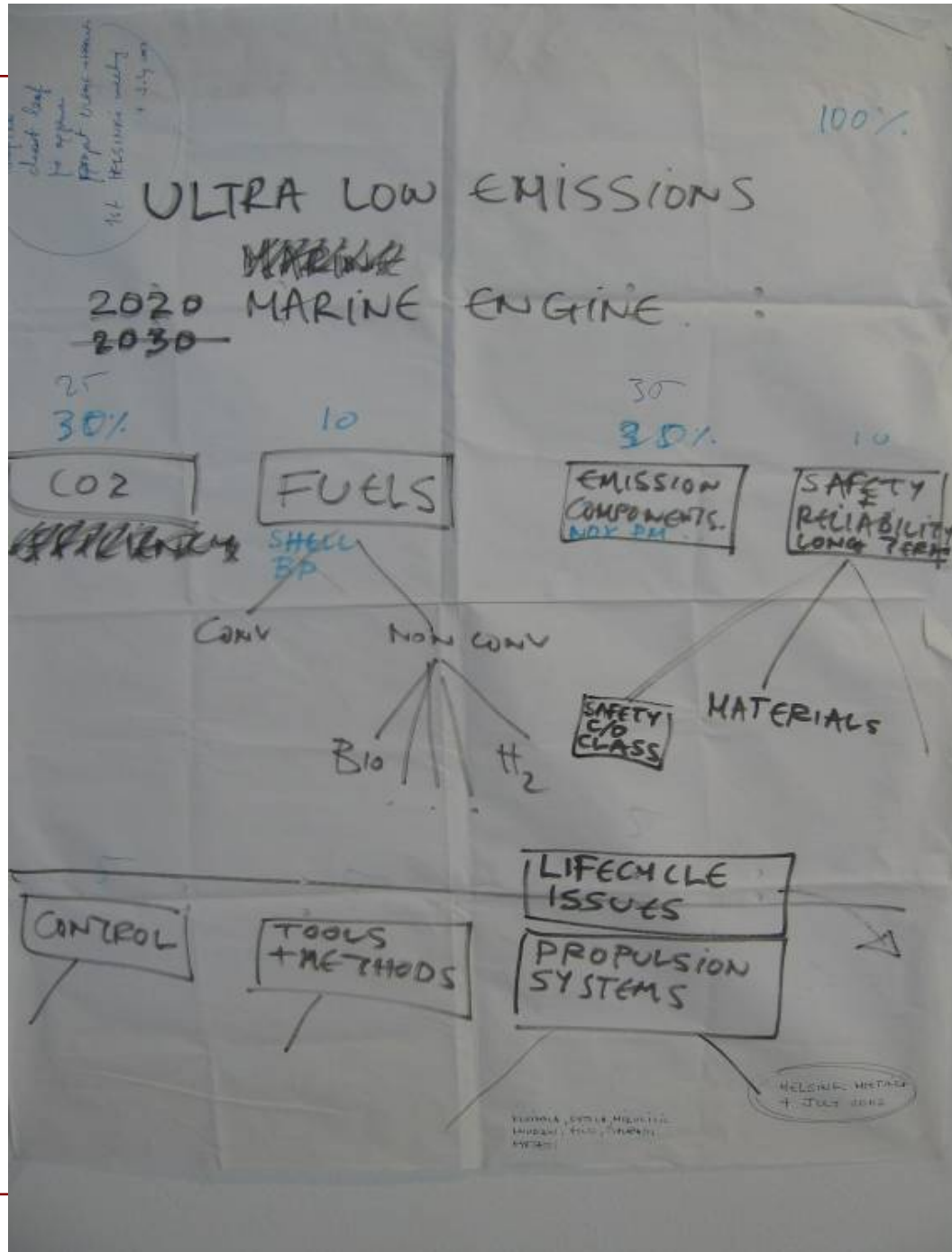


First  
MAN – WARTSILA  
joint Meeting:

Helsinki, 4<sup>th</sup> July 2002

Preparation on a long term research  
project on marine engines

Historic flipchart page with the  
important RTD areas



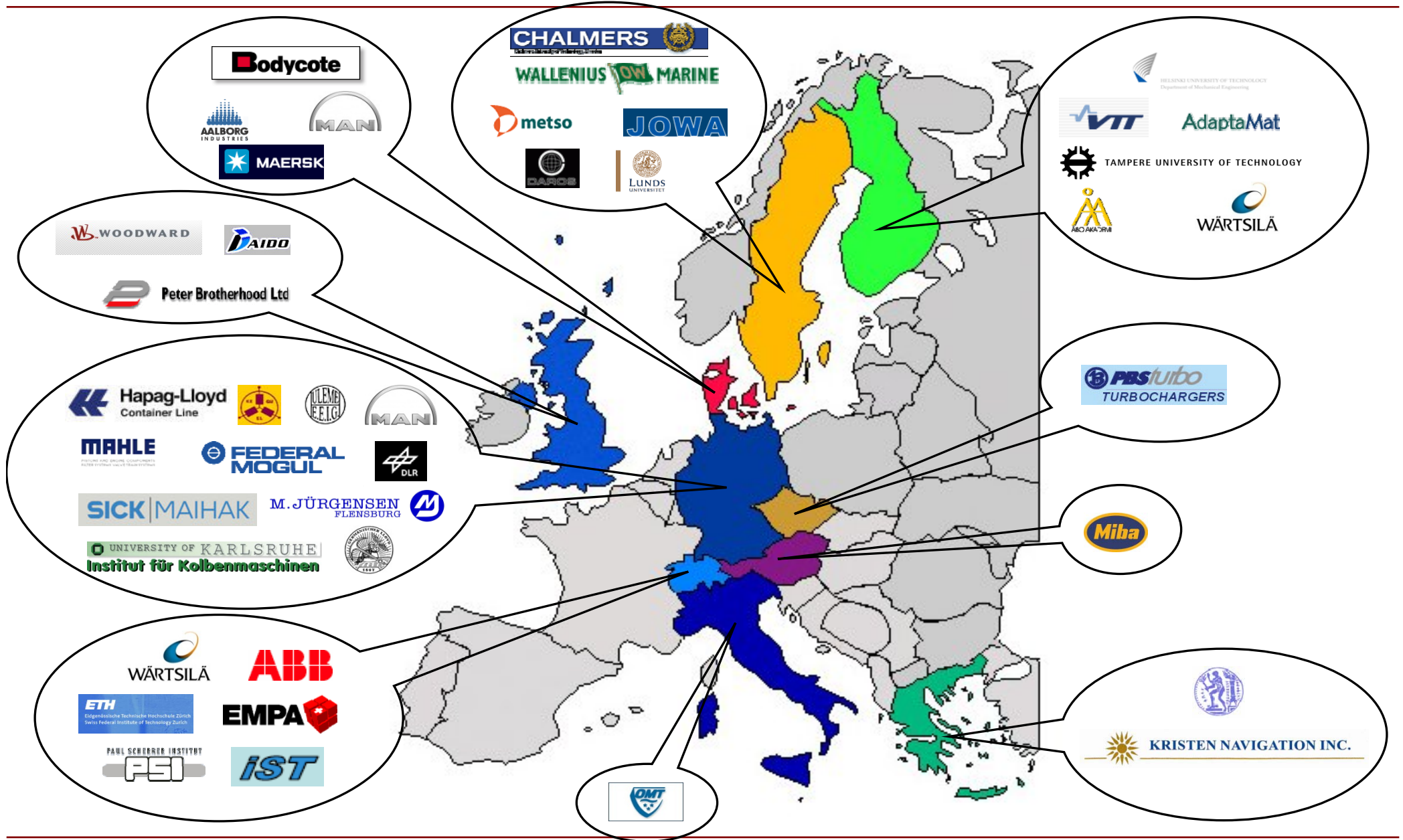


# IP-HERCULES(A)

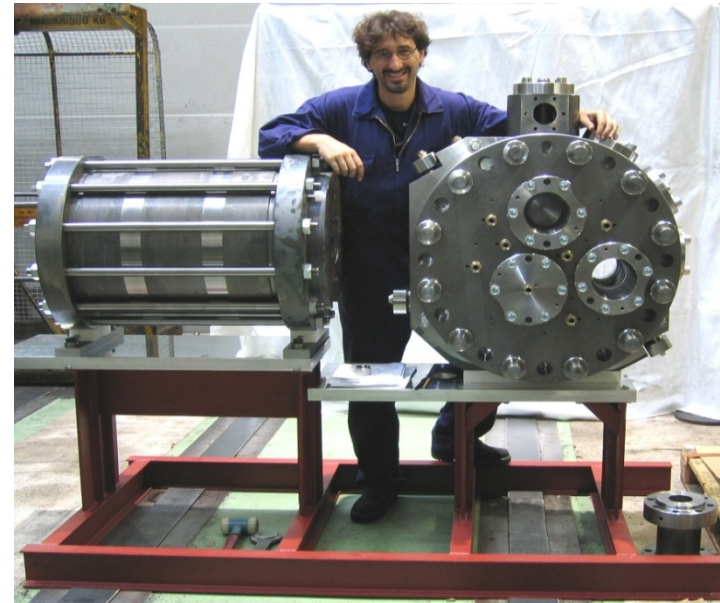
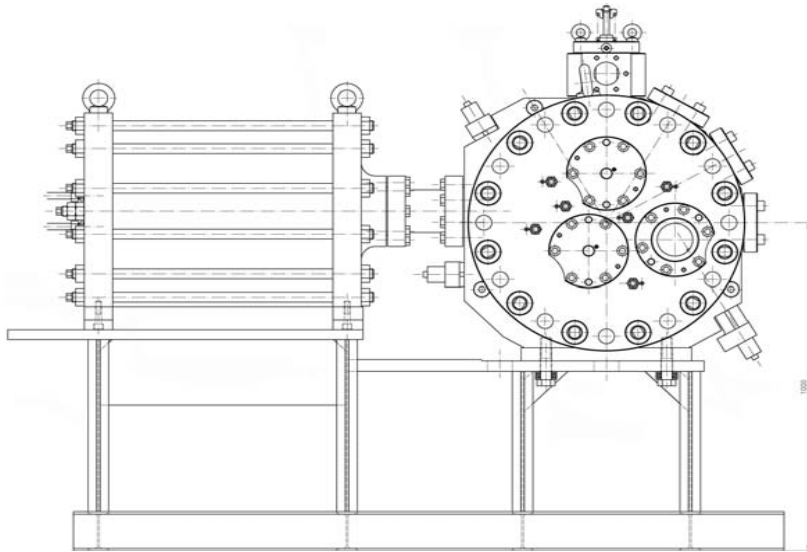
## (2004-2007)

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

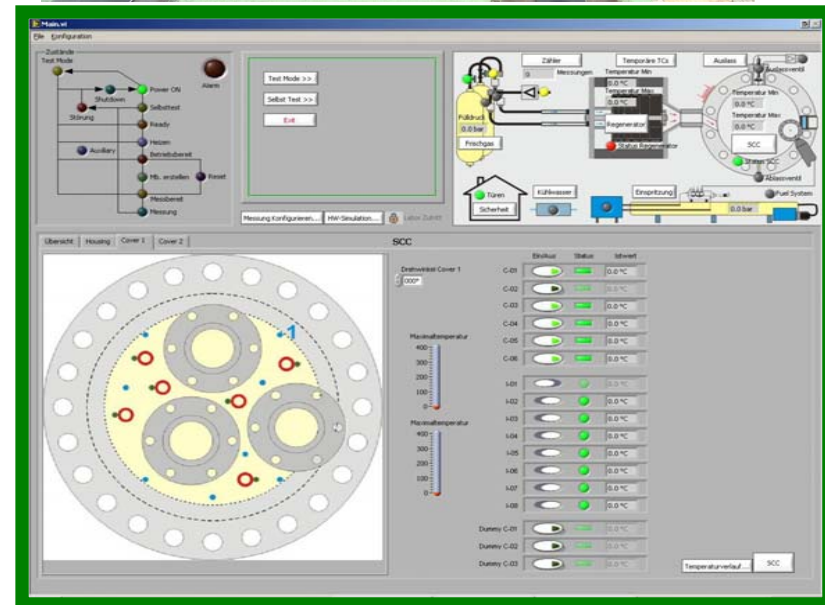
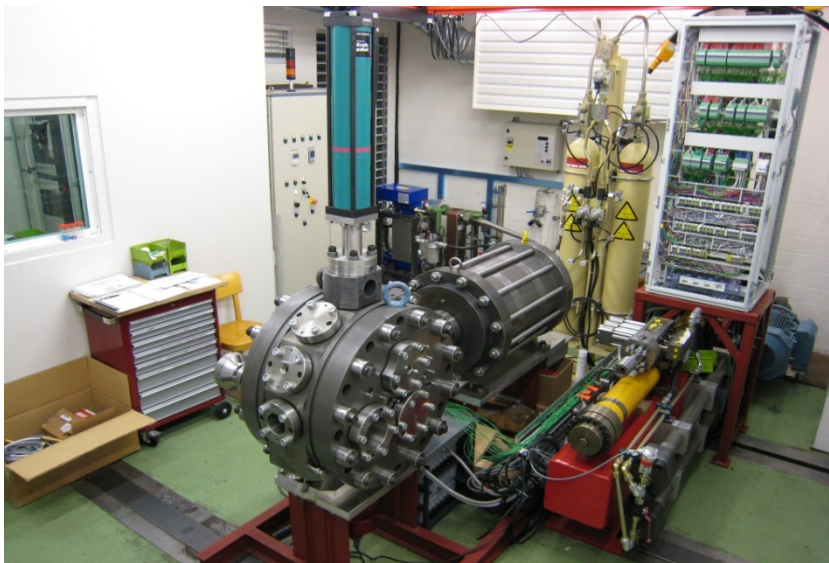
# I.P. HERCULES (A) – Consortium



# HERCULES (A) TASK 2.1: Combustion process simulation



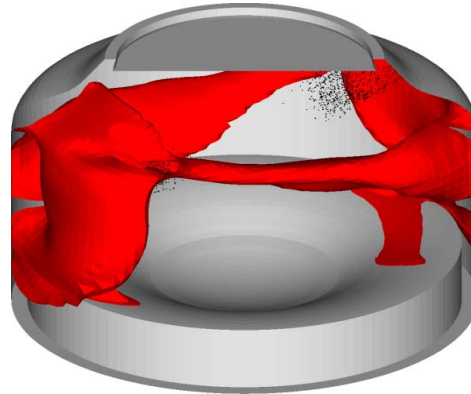
CIMAC 2007 Congress: BP award !



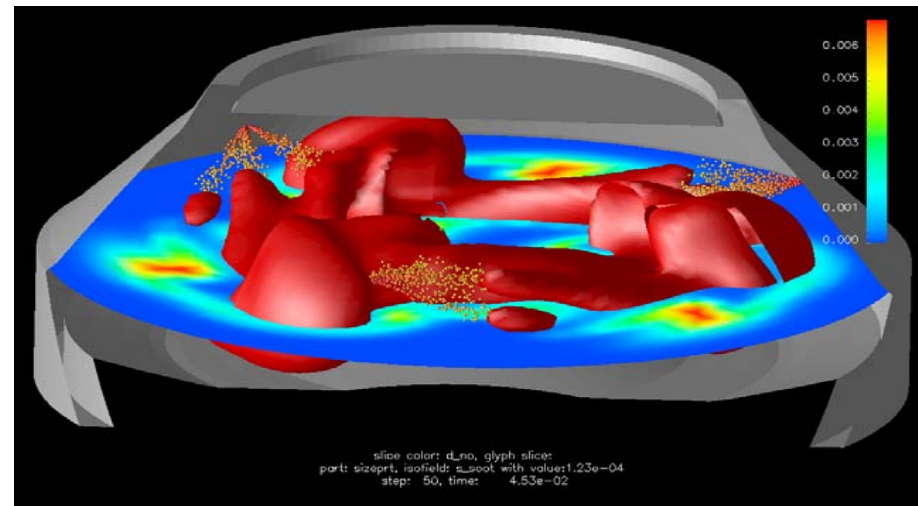
World's largest Spray combustion chamber to simulate in-cylinder conditions

# HERCULES (A) TASK 2.2: Emission formation simulation

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



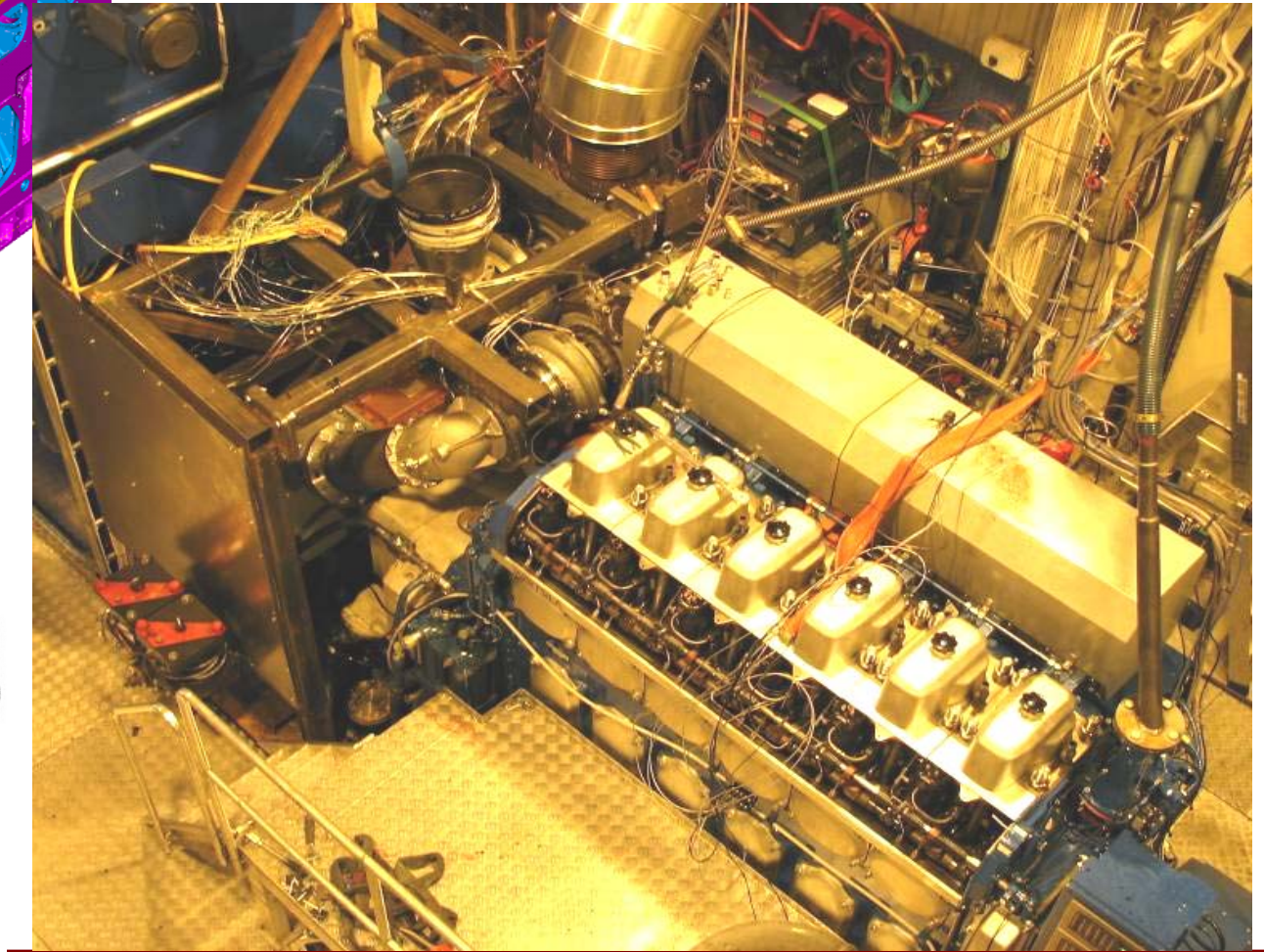
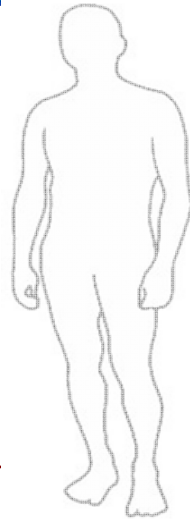
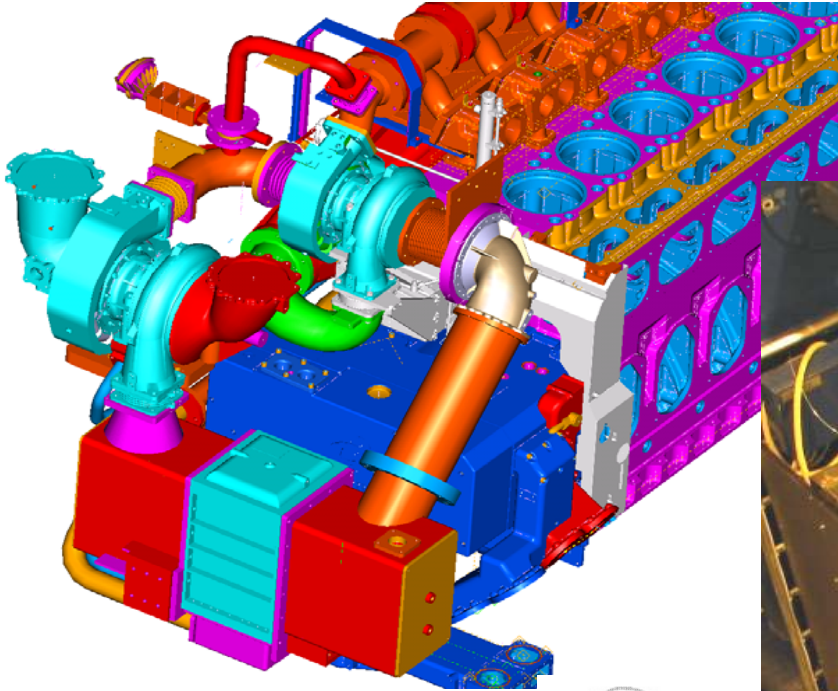
New flamelet soot model CFD predictions of combustion inside marine engine



# HERCULES (A) TASK 3.1: Variable turbocharging

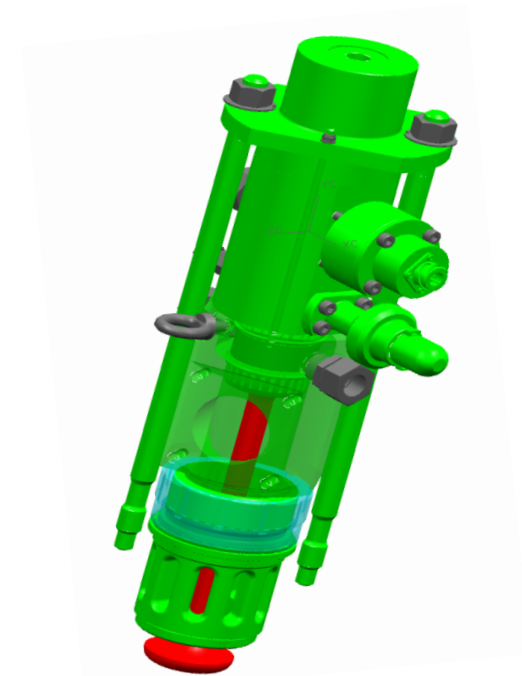
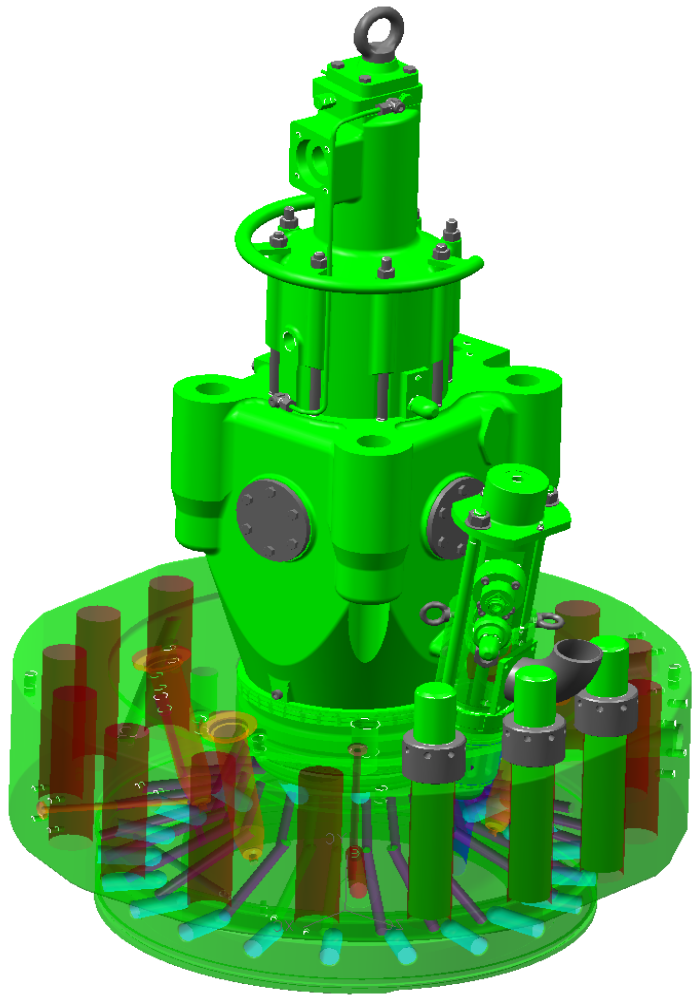
Two-stage turbocharged 4-stroke engine

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

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DWI Direct Water Injection system onboard  
“Maersk Montana”





## **HERCULES-B**

**(2008-2011)**

**HIGHER – EFFICIENCY ENGINE  
WITH ULTRA-LOW EMISSIONS  
FOR SHIPS**

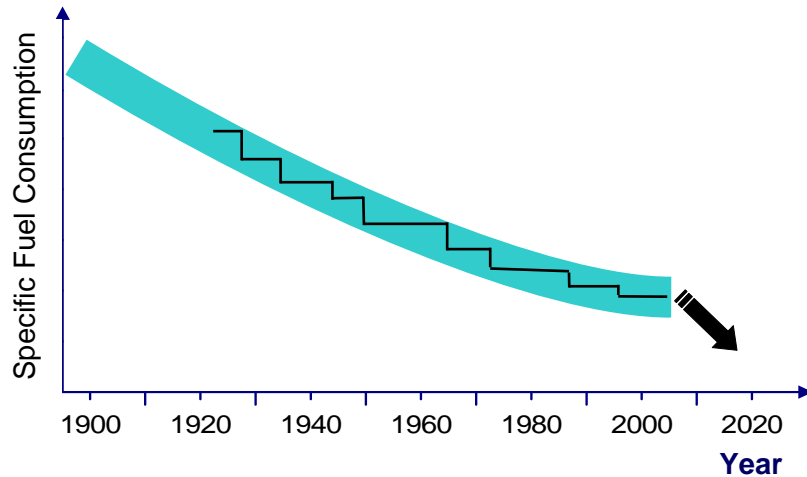




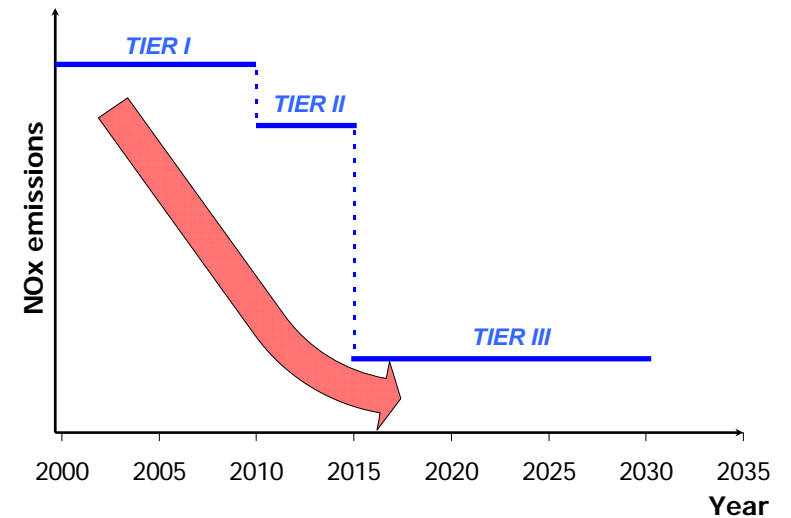
## HERCULES-B (2008 – 2011)

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 <sub>2</sub> emissions	-10%
Reduction of NOx (Relative to IMO 2000 standard)	-70%
Reduction of other emission components (PM, HC)	-50%



# HERCULES - B – Consortium

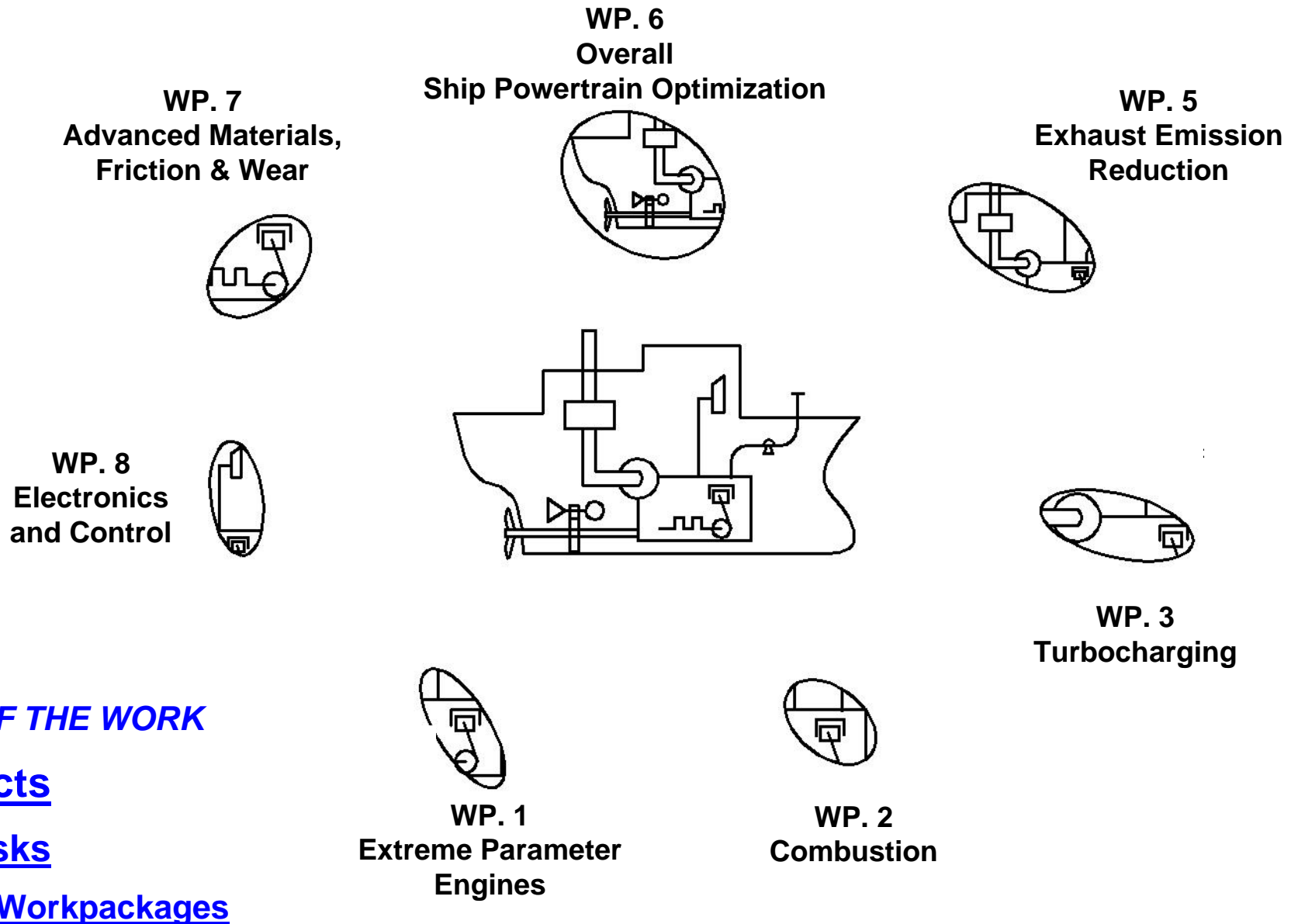


32 Partners.

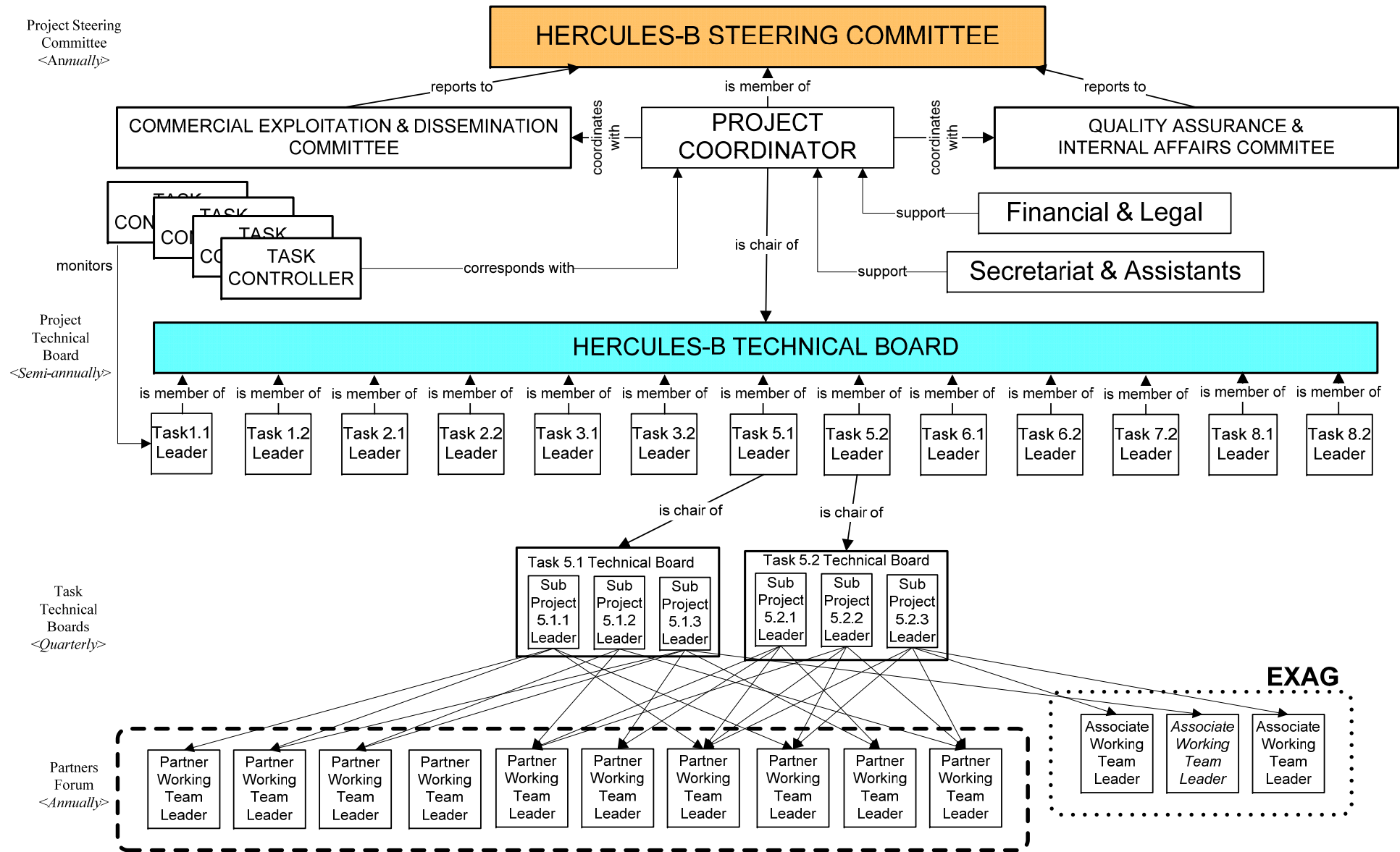
Industrial 60% - Universities/Research Inst. 40%



# 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

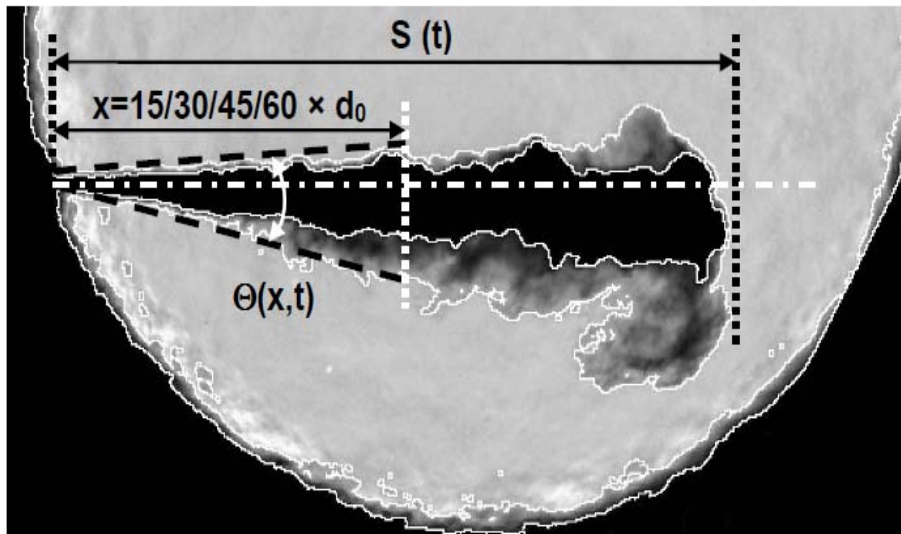
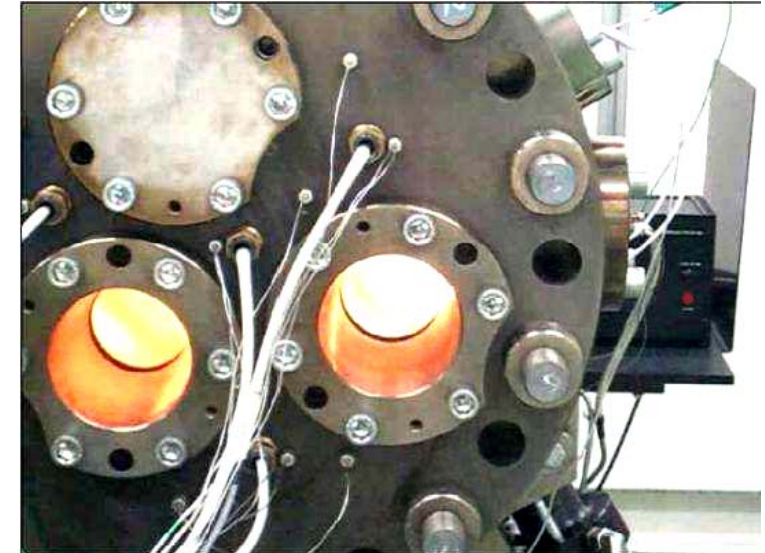
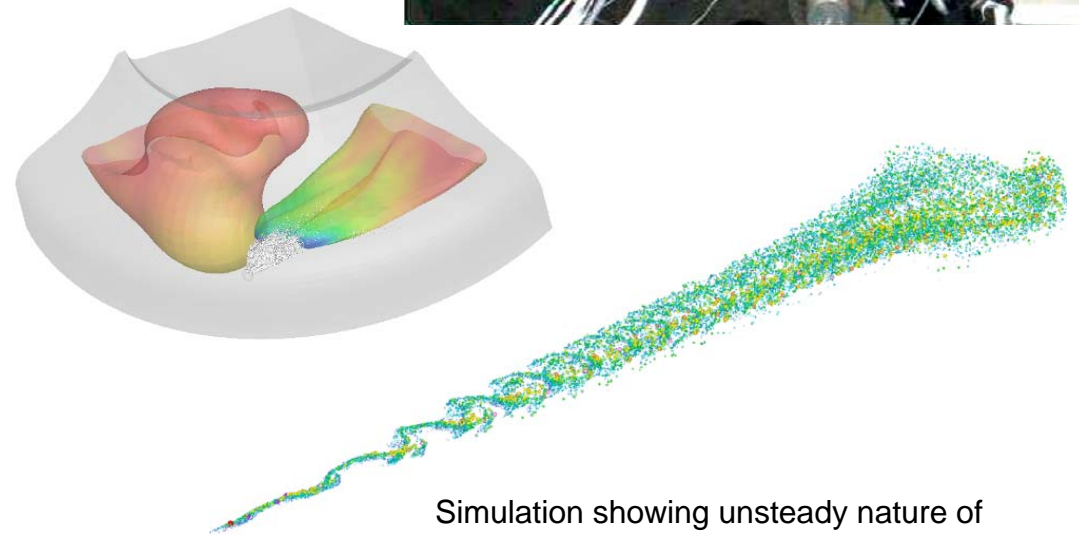


Fig. 6: Analysis of spray penetration and cone angles



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

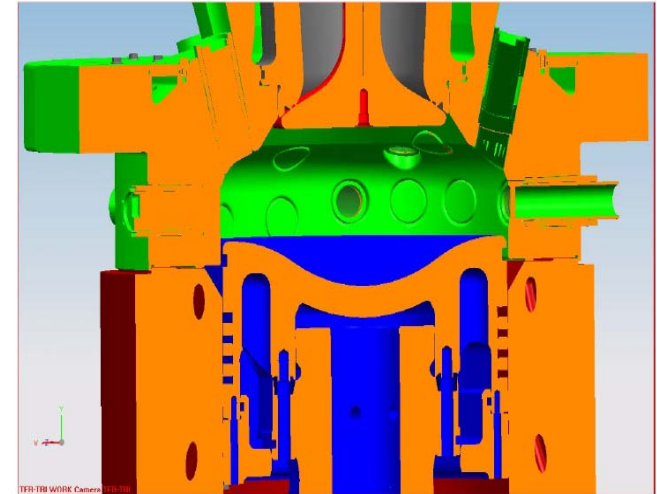
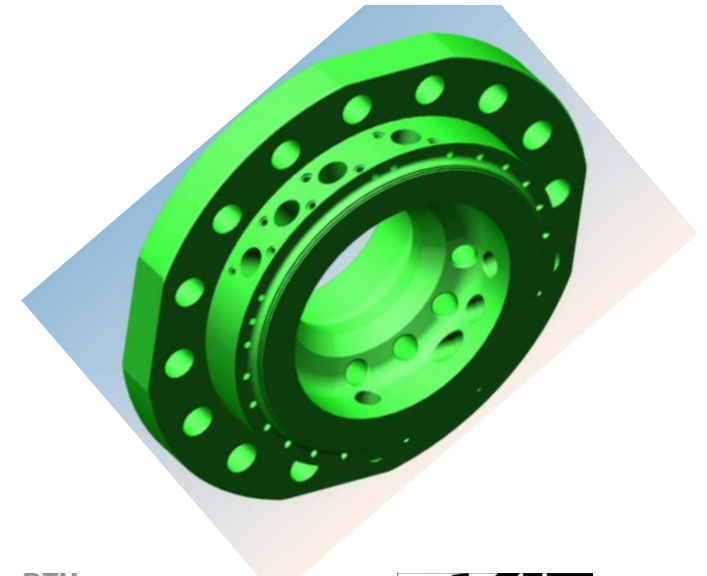


Figure 5.14: CAD drawing of the optical cover mounted on the engine.



Partners:    

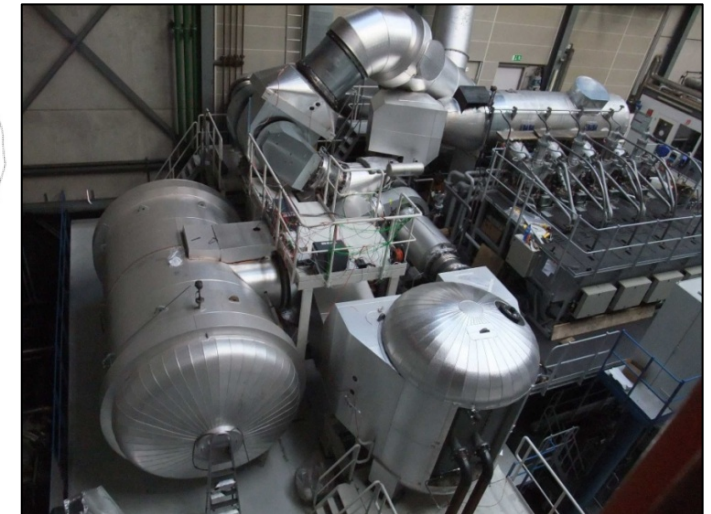
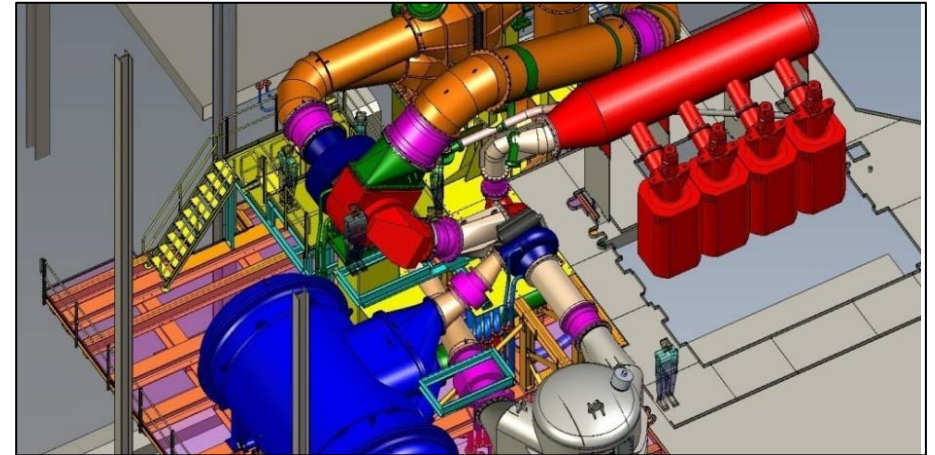
## Task 3.1: High efficiency and low emission TC concepts

### 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**



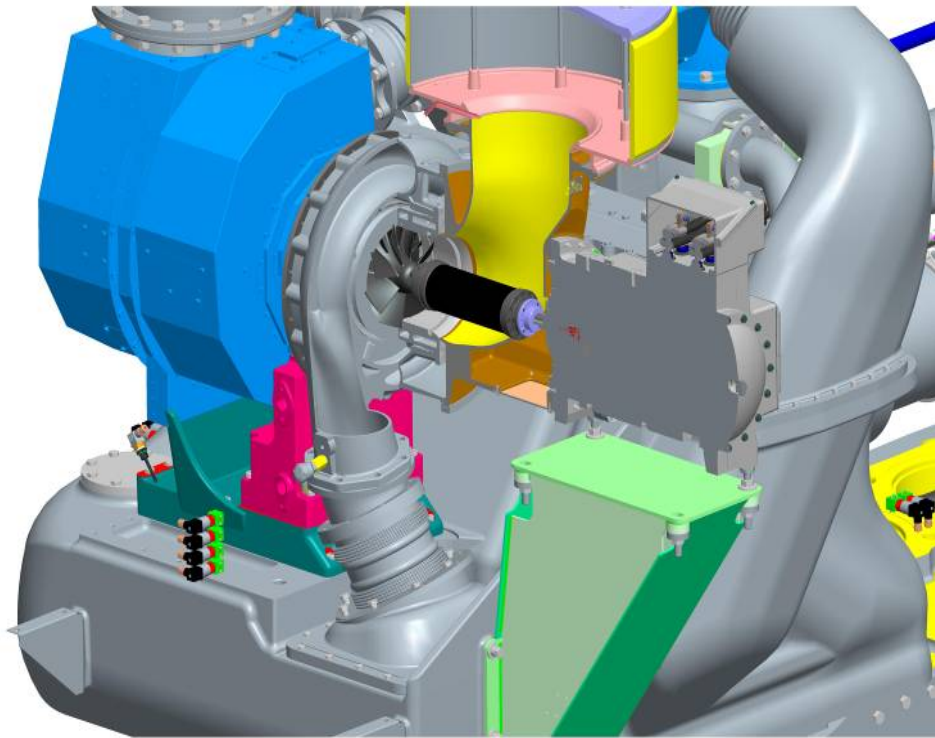
## Task 3.2: Advanced intelligent turbocharger

### Objectives:

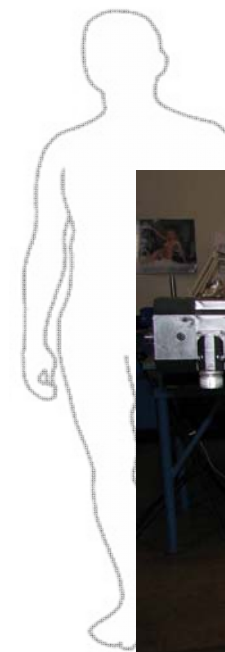
Two-stage turbocharging for 2-/4-stroke marine diesel engines,  
operation at 30 bar PME

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

4-stroke engines: VTA, PTI, NO<sub>x</sub> reduction of 50%



Turbocharger with variable  
compressor inlet guide vanes



Turbocharger with variable  
turbine nozzle vanes

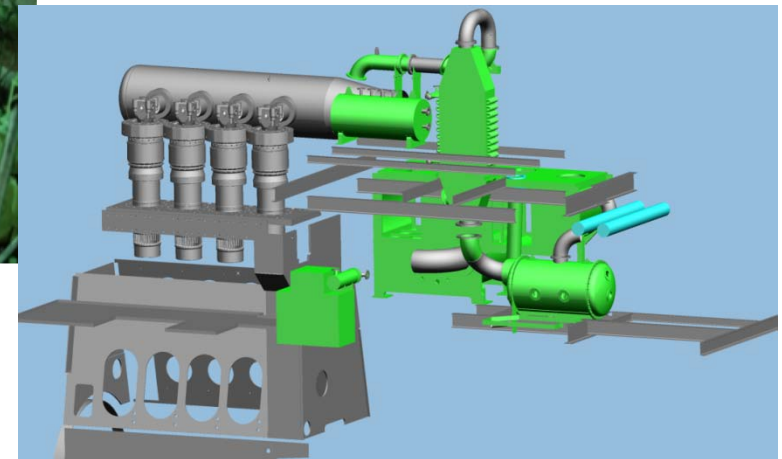
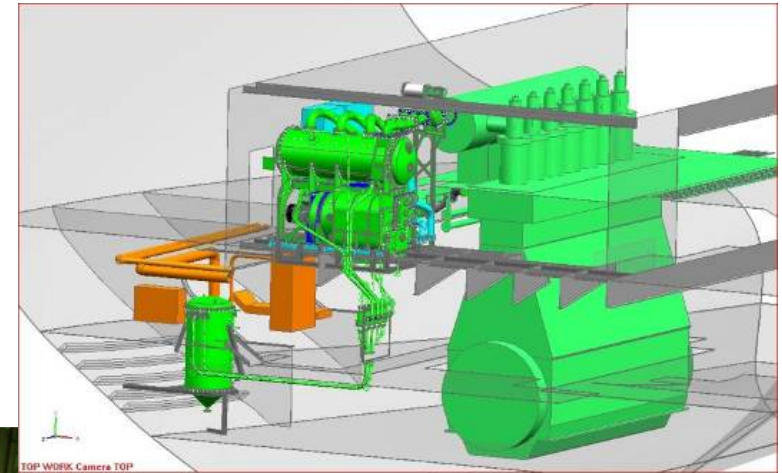
Partners:



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

## Objectives:

- Reduce  $\text{NO}_x$  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

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- 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*

