Winterthur Gas & Diesel

HERKULES-2

# Work Package 3: Intermetallics and advanced materials for marine engines

Work package leader:
Dr. Monika Damani
ME / Operations / Winterthur Gas & Diesel Ltd.

# WP3: Intermetallics and advanced materials for marine engines

WP Leader: Monika Damani
WP Deputy: Sebastiaan Bleuanus

## Objectives

**Subproject 3.1:** ***Novel materials for engine applications***

Examine possibilities of using novel materials in engines to facilitate the development of components that enable higher engine loads, hereby increasing efficiency and lower emissions. Ensure proper lifetime performance and durability.

**Subproject 3.2:** ***Novel materials for tubine casing***

Material of turbine casing is reviewed in respect of material and design in order to meet requirements needed for higher exhaust gas temperatures.

## Expected outcome

**Subproject 3.1:** Suitable new materials can be identified for at least two components for higher load operations and longer life time.

**Subproject 3.2:** Performance is improved through material / design optimization.

Partners: Max-Planck-Institut für Eisenforschung GmbH, ABB, Deloro Wear Solutions, WÄRTSILÄ, WIN GD Winterthur Gas & Diesel

## Structure: Partners, roles

**Max Planck Institut für Eisenforschung Düsseldorf:**
Materials selection & optimization; materials investigation and testing activities

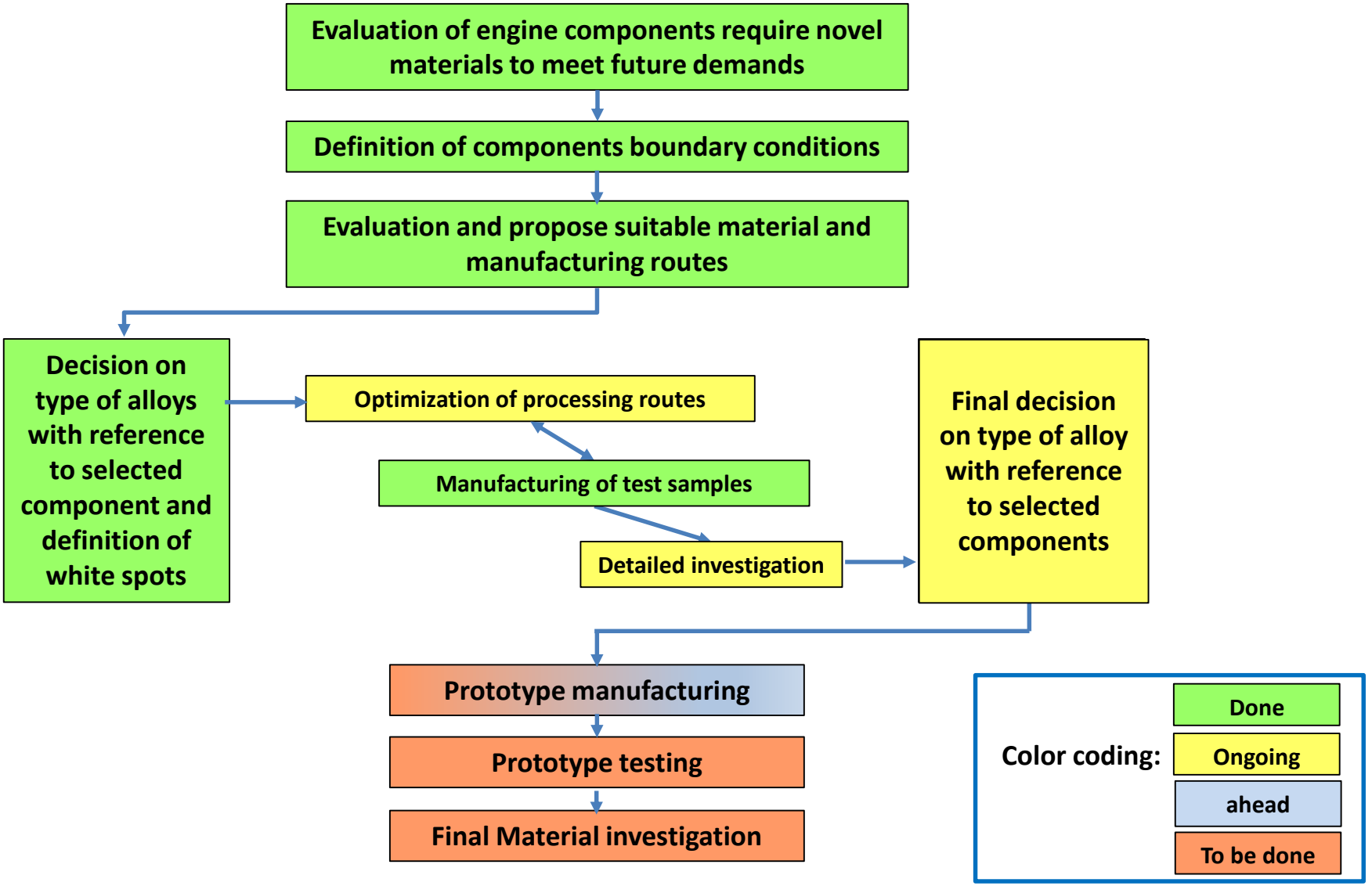
**Deloro Koblenz:**
Materials selection and optimization of processing and joining technologies. Manufacturing of sample materials

**ABB Baden:**
Evaluation, prototyping and test of new material and test of new materials for advanced turbine case.

**Wärtsilä Finland & Wärtsilä Netherlands:**
WFI: Boundary conditions, material and processing selection; material testing activities incl. rig or engine validation; WNL: Work package deputy and coordination of research activities at partners

**Winterthur Gas & Diesel Ltd.:**
Boundary conditions, material and processing selection; material testing activities incl. rig or engine validation; Project lead and co-ordination of research activities at partners

# Status of Sub-project 3.1: Novel materials for engine application



# Status of Sub-project 3.1: Novel materials for engine application

## First results from materials characterisation:

Different manufacturing routes have been chosen and test samples were made / materials characterisation done

### Status of different testing:


Microstructure from different manufacturing routes & materials

Mechanical properties (mostly done)


Corrosion testing (cold & hot corrosion) partially done, evaluation still pending

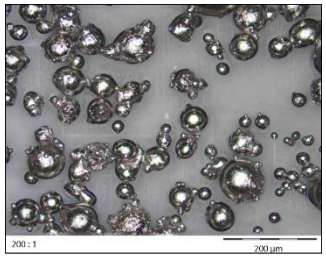
Thermal shock testing - pending (laser for test rig under repair)

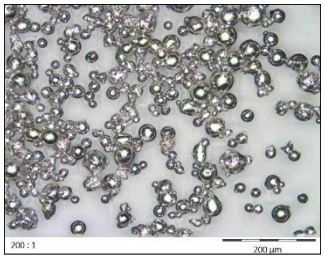
Tribo testing – samples ready / testing pending

# Status of Sub-project 3.1: Novel materials for engine application

## Optimising processing routes:

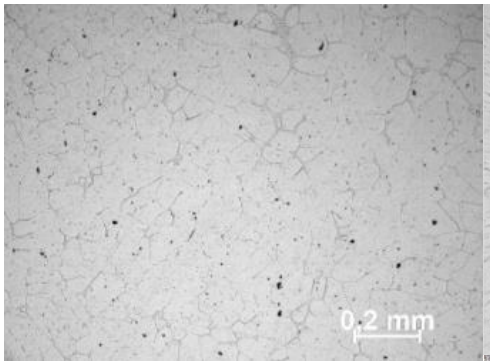
Powder was made in order to facilitate processing methods like welding, thermal spraying or hot isostatic pressing.



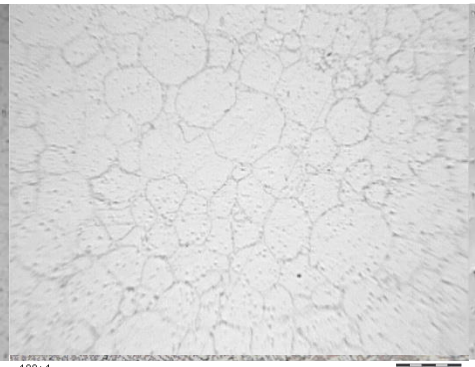


- ❑ Powder morphology not optimal
- ❑ Fracture with small partical size needed to be sieved out
- ❑ Dense samples achieved from all processing routes

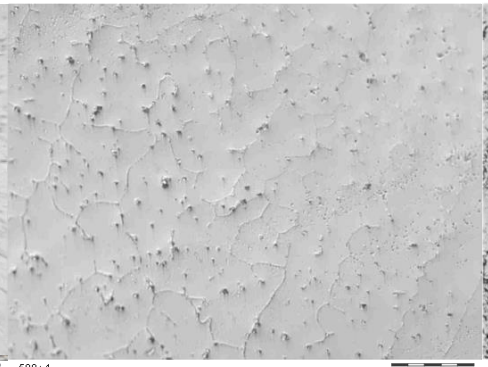
## Microstructures resulting from different manufacturing routes:



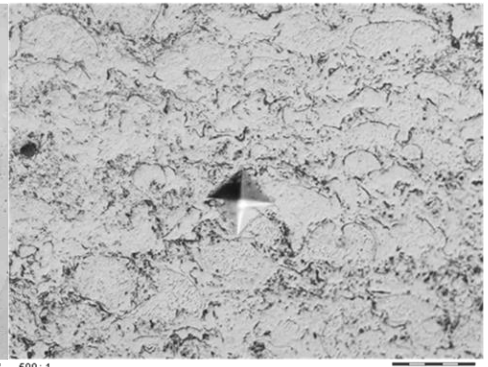

As-Cast sample




HIP (from powder)




Welding (from powder)




Thermal spray (from powder)

# Status of Sub-project 3.1: Novel materials for engine application

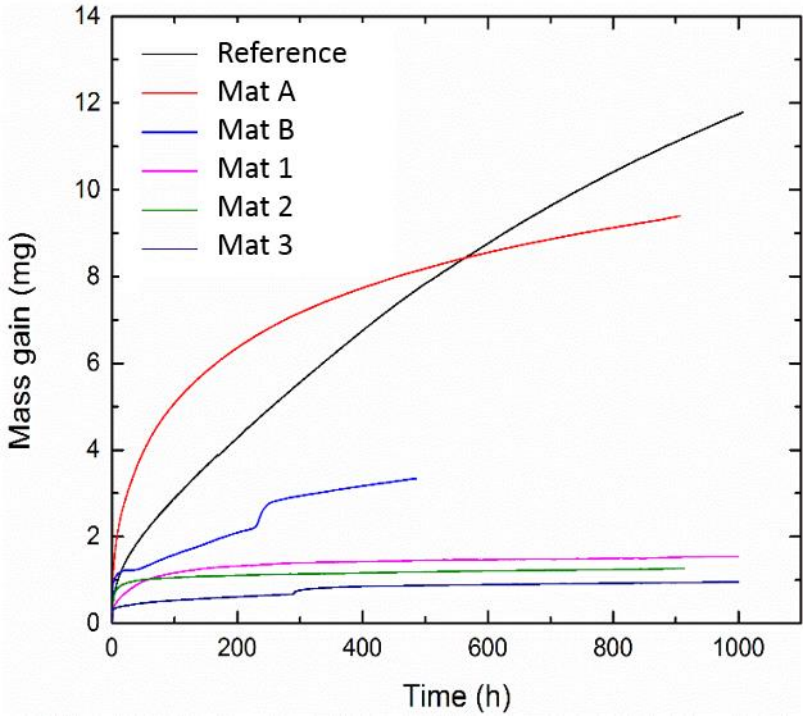
**Optimizing manufacturing routes:** Castings made of Mat 1 with different parameters

Mould preheated and oven switched off

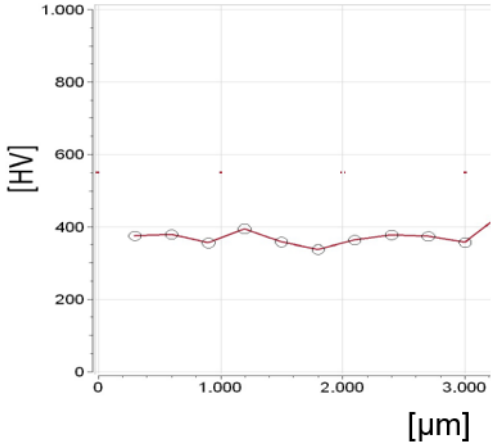
Mould preheated and controlled cooling

# Status of Sub-project 3.1: Novel materials for engine application

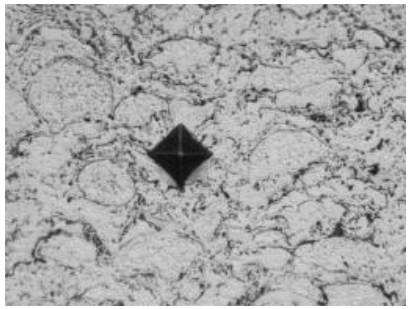
## Selected results from materials characterisation done:




Corrosion behaviour (in oxidizing atmosphere)



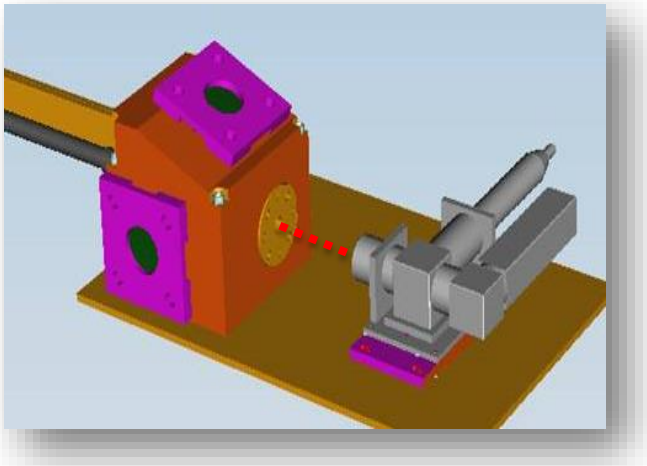

Hardness profile of thermal spray layer (Mat 2)



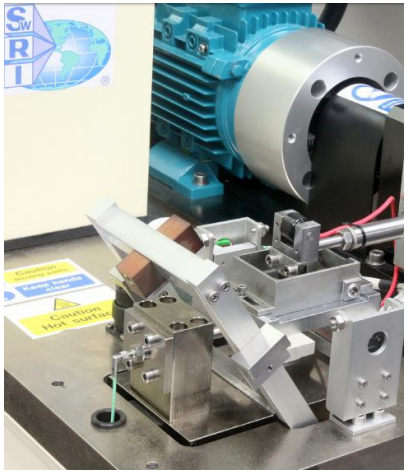
# Status of Sub-project 3.1: Novel materials for engine application


**Planned next activities:**

- ❑ Evaluation of samples from corrosion test
- ❑ Thermal cycling
- ❑ Tribo testing & sample evaluation



*Thermal cycling test rig*



*Tribo tester: CPT*

**Milestone 2:** Decision on type of alloy/part combination due in December 2016 - most likely 1-2 months delayed due to delay in material characterisation

# Status of Sub-project 3.1: Novel materials for engine application

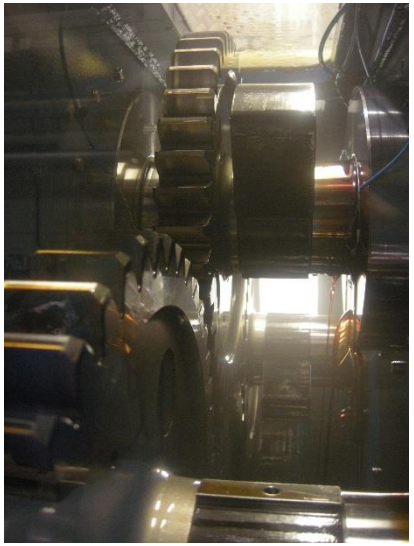
**Achievements, advanced bearing materials:**

The following activities below have been completed so far:

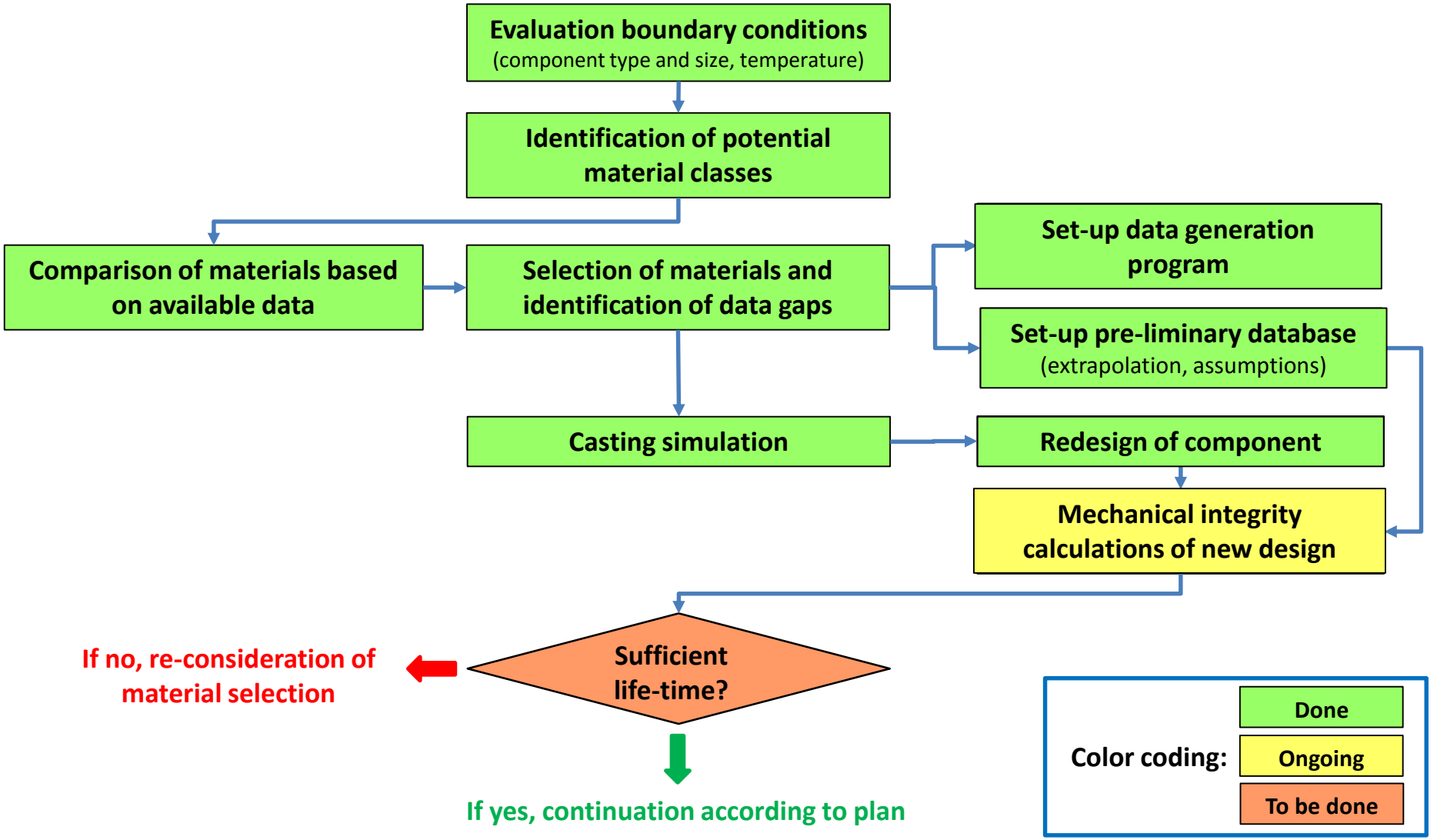
- Finalized assembly of rig
- Oil feeding concept selected for durability comparison tests
- Completed oil system and calibration of instrumentation
- Multi-metal bearings first tests on rig started

**Planned next activities:**

- Baseline bearing rig testing: different sizes, rpm levels, oil temperatures
- Multi-metal bearing rig testing: different sizes, rpm levels, oil temperatures
- Comparison of durability of bronze bearings and multi-metal bearings



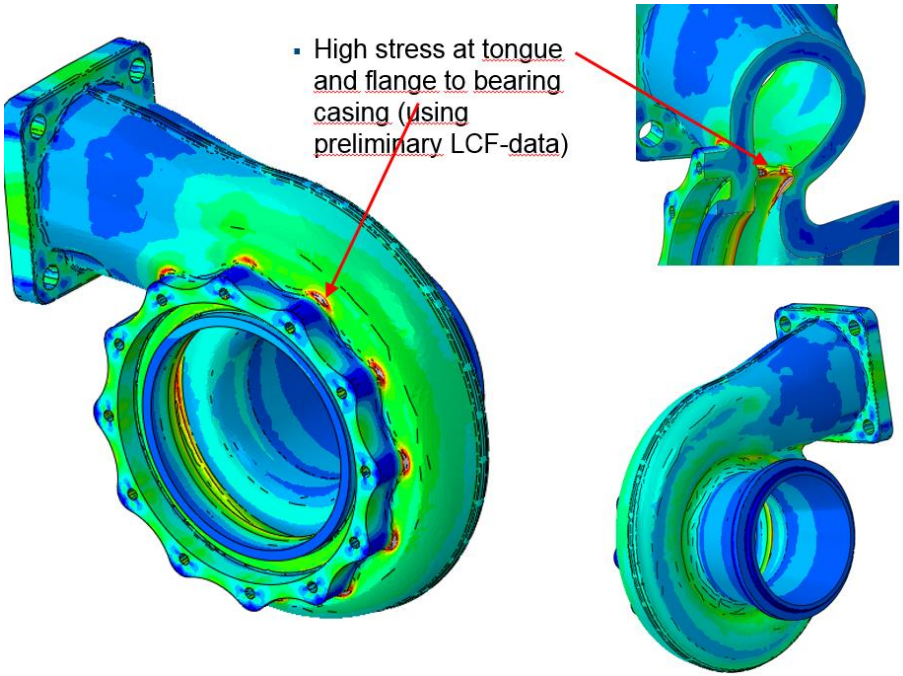
# Status of Sub-project 3.2: Novel materials for turbine casing



# Status of Sub-project 3.2: Novel materials for turbine casing

**Work already done:**

- Decision on casting type, requirements are defined
- Decision on manufacturing method
- Material classes identified
- Review of availability of required material data
- Preliminary material database setup
- Casting simulation
- Parametrisation of CAD-model
- Defintion of load profile
- Elimination of stress hot-spots




**Next planned activities:**

- Completion of experimental material characterisation
- Production of prototype casings
- Qualification tests

# Load Profile for life-time assessment (cruise ship or equivalent application)

Maximal gas temperature at turbine inlet: TTE = 800°C

The profile consists of a start up, full load for 40 hours and a shut down.