



Objective

Ensure operatability and reliability of wet gas compressor concepts through;

- *Specification;*
 - *Fluid variation and behaviour*
 - *Performance flexibility,*
 - *Mechanical robustness*

- *Testing;*
 - *Inert versus actual fluid,*
 - *Performance range and stability*
 - *Mechanical integrity*

- *Operation;*
 - *Variation in operating conditions*
 - *Condition monitoring*
 - *Stability, Surge and Performance Control*



PhD Projects

- *Multiphase Pump Performance, Viscous Fluid and Stability*
- *Wet Gas Pressure Recovery - Diffuser Performance*
- *Compressor Integration - Transient Behaviour at Trip*
- *Gas Turbine Online Water Wash (Wet Compression)*
- *Wet Gas Compressor Performance (HC fluid)*
- *Optimum Gas Compression and Transportation*
- *Wet Gas Surge Stability and Range*
- *Gas Turbine Intake Filters Performance*
- *Wet Gas Compressor Transient Analysis**
- *Turbo Expander Performance and Control**
- *Wet Gas Compressor Performance Correction**



Impeller Rig Design



Impeller Rig

Rig main data

- *Variable speed electric motor; 450 kW, 500 – 11000 rpm*
- *Adjustable components for testing different impeller and diffuser geometries and configurations*
- *Impeller tip diameter range 300 – 500 mm*
- *Diffuser window for visual observation*
- *Vibration and fast response dynamic pressure sensors*
- *Digital torque meter integrated with the coupling*
- *Injection module: up to 50 kg water/s – single annular nozzle*



Impeller Rig

Operating Conditions

- *Fluid; Air and water*
Future; Exxol and nitrogen
Future; Reduced density ratio. New gas and liquid
- *Dry and wet at atmospheric condition*
Future; 4 bar suction, 8 bar discharge
- *Temperature* *15 to 35 C*
- *Gas mass fraction* *1.0 – 0.5*
- *Gas volume fraction* *1.0 – 0.99 (0.97)*
- *Gas volume flow* *0.9 – 1.7 m³/s*
- *Rotational speed* *5.000 - 11.000 rpm*
- *Liquid flow regime at inlet; Dispersed, annular, and segregated*



Impeller Rig

Instrumentation

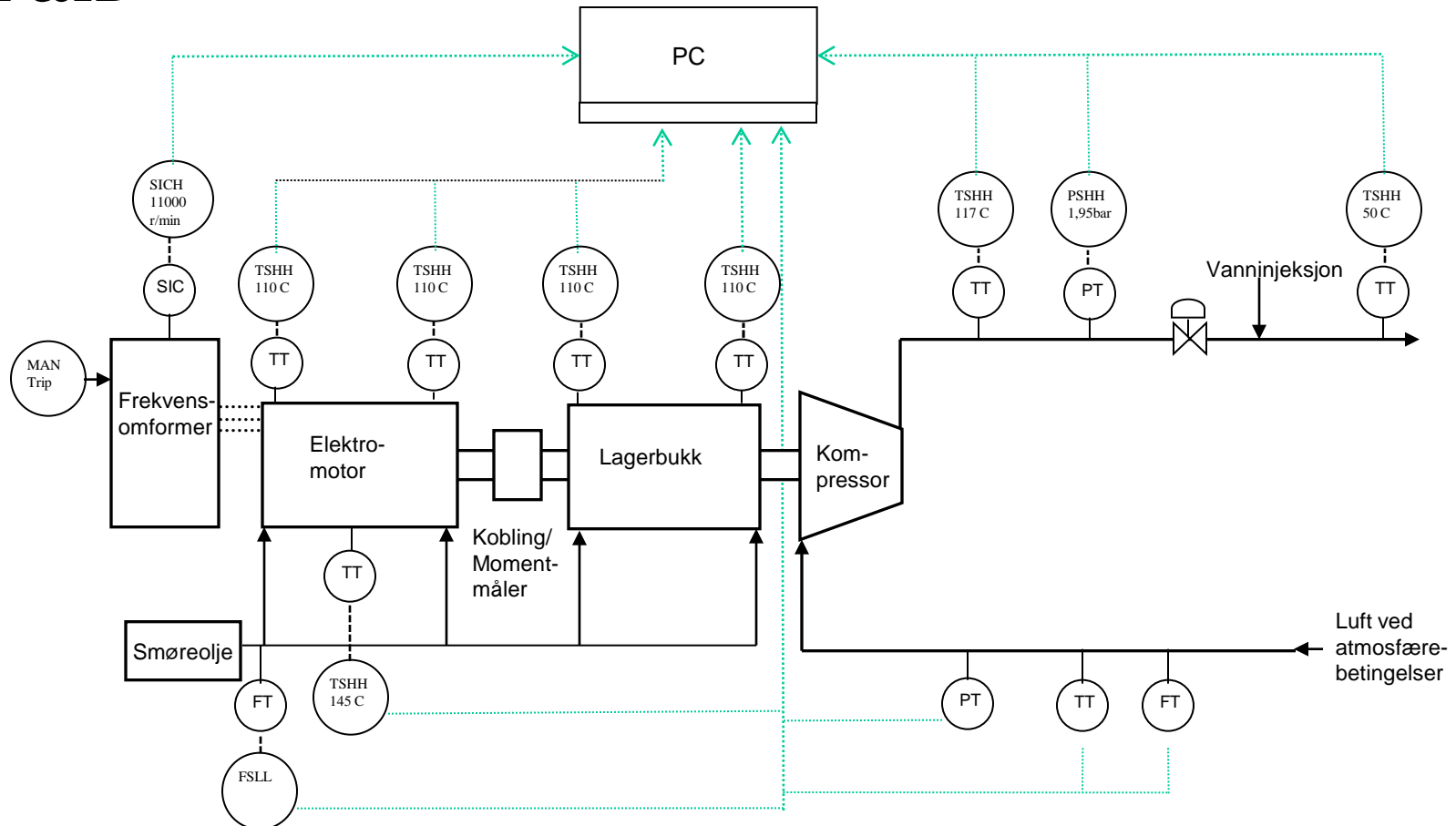
- ***Instrumentation according to ASME PTC10***
- ***Static to static, suction to discharge pressure and temperature measurements***
Future; Stagnation and total conditions
- ***PXI system for data sampling***
- ***Basic performance instrumentation (1 Hz sampling)***
- ***Vibration and fast response dynamic pressure sensors***
 - ***Accelerometers for machinery protection and experimental investigation and 4 FRDP sensors located at inlet, outlet and diffuser***
 - ***20 kHz synchronous sampling***





Impeller Rig

P&ID

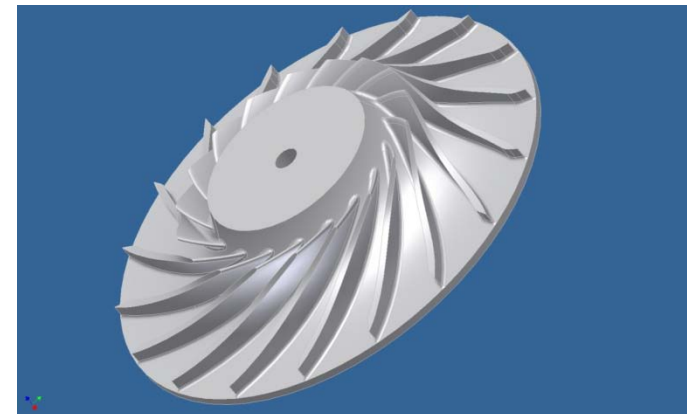




Impeller Rig

Impeller design I

- *NTNU impeller;*
 - *Designed, fabricated and tested*
 - *Removable shroud*
 - *Prepared for visualisation slots*
 - *Diffuser visualisation slots installed*
 - *Design data;*
 - *Tip diameter* *0.455 mm*
 - *Inlet hub diameter:* *173.9 mm*
 - *Tip width:* *14 mm*
 - *Diffuser ratio:* *1.7*



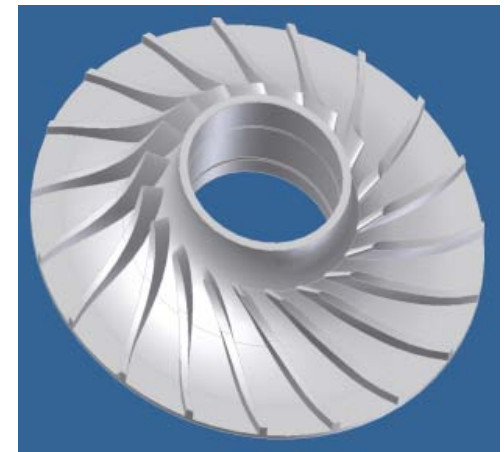


Impeller Rig

Impeller design II

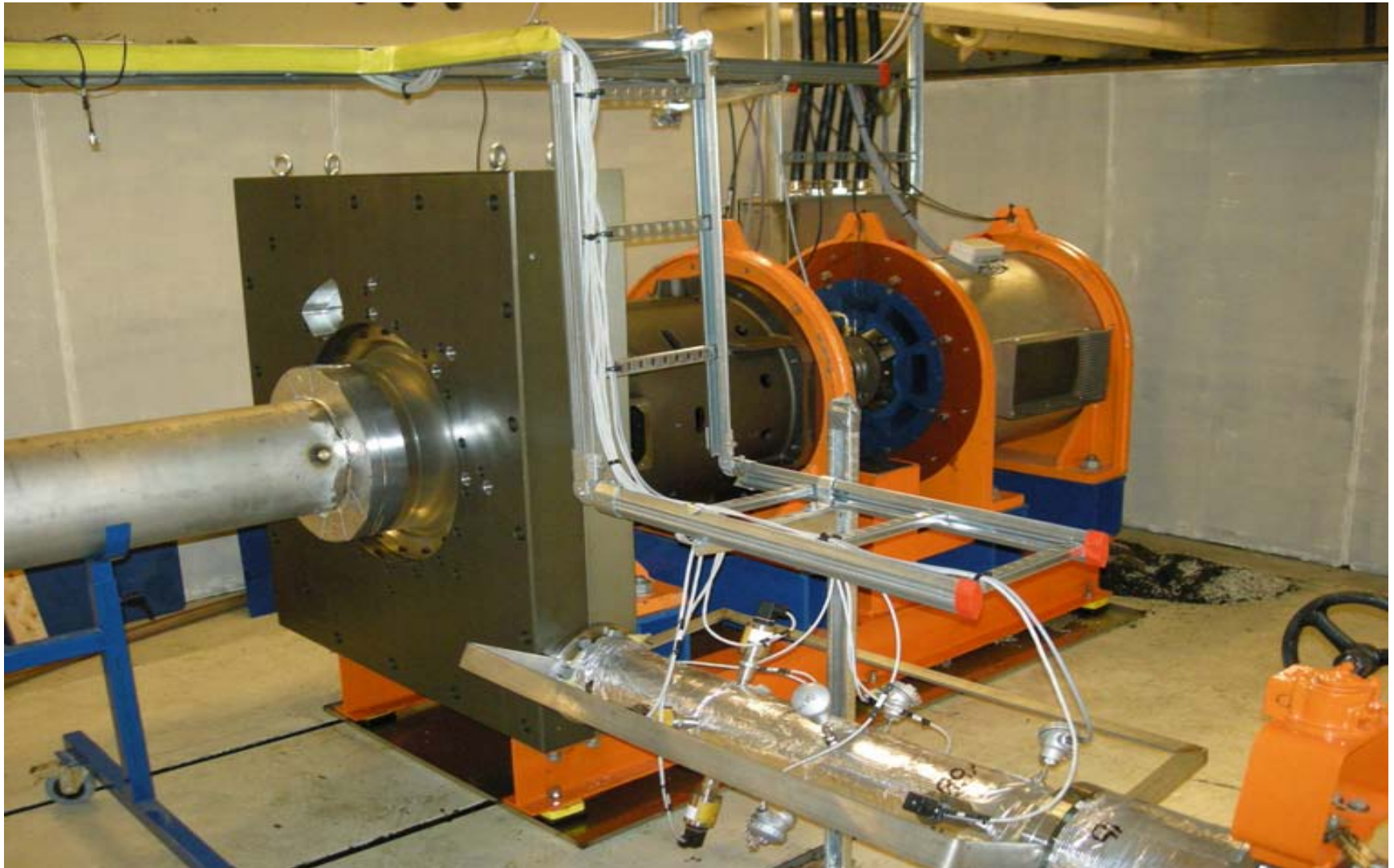
- *Industrial impeller;*
 - *Designed, fabricated and tested at 11 000 rpm*
 - *Removable shroud*
 - *Prepared for visualisation slots*
 - *Diffuser visualisation slots installed*
 - *Design data;*

• <i>Hub diameter</i>	<i>146 mm</i>
• <i>Shroud diameter</i>	<i>195 mm</i>
• <i>Tip diameter</i>	<i>384.6 mm</i>
• <i>Tip width</i>	<i>7.18 mm</i>
• <i>Diffuser ratio</i>	<i>1.93</i>





Impeller Rig





Research Activities



Wet Gas Thermal Equilibrium
Flow visualisation
Wet Gas Cascade Tests
Thermodynamic and Fluid Property Fundamentals
Performance Correction
Computational Fluid Dynamics (CFD)
Wet Gas Surge and Staility

