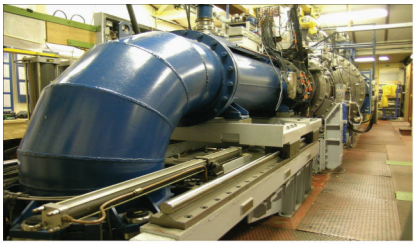
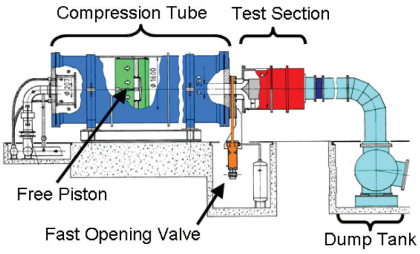
AERO-THERMAL PERFORMANCE OF HP TURBINES

The quest for higher performances in modern aero-engines requires the understanding of the complex flow field experienced by the gas turbine stages. Although the aero-thermal performance can be estimated by using a number of loss correlations, the relationship between turbine performance and all design parameters is not yet fully comprehended particularly regarding unsteady flow field interactions. Therefore, the experimental verification of the turbine performance is a crucial step in the development of a new turbine.

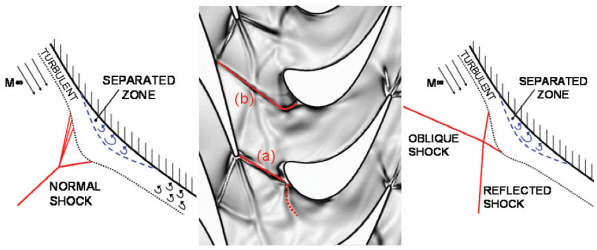
The turbine testing is carried out in von Karman Institute compression tube facility. This short duration facility is able to simulate the aero-thermal performance of the high pressure turbines in a larger scale. It reproduces independently temperature ratios, Reynolds and Mach numbers of the actual engine conditions in a cost-effective way.





BLADE ROW INTERACTIONS

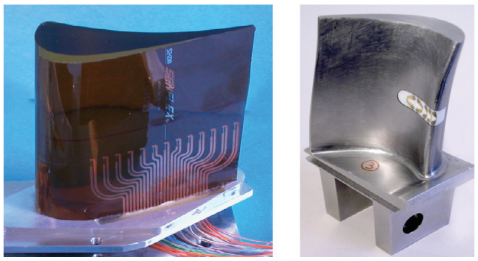
In highly loaded turbine stages the nozzle guide vane exit flow is often transonic. The design of efficient turbines requires thus a thorough understanding of the unsteady interactions effects. A dedicated measurement campaign and numerical research have revealed that the main loss is generated due to the vane shock interactions with the boundary layer on the rotor airfoils.



Some shock pattern in turbines

COOLING STUDIES

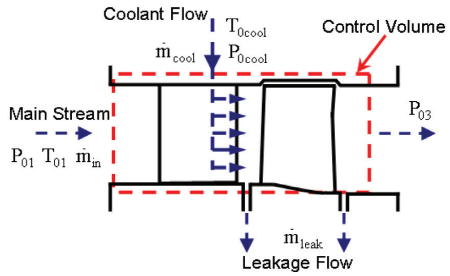
The correct estimation of the external heat transfer around the blade rows is the first step to predict hot-section-component life. Experimental data still remains the reference for the designers. Experiments were performed to address the effects of the stator rim leakage. For transonic turbines, it has been identified that efficiency improvements are achieved at low ejection rates.



Thin-film gauges for thermal research

EFFICIENCY MEASUREMENT

The efficiency of modern gas turbines has already exceeded 90 %. Since aerodynamic irreversibility and heat transfer are present, small margin remains for the enhancement. In order to resolve the slight improvement in efficiency using experimental techniques, the uncertainty level of the performance measurements should be sufficiently low to resolve the small variations due to the new aerodynamic designs. This target level of accuracy requires careful and simultaneous measurements of several quantities such as temperature, pressure and mass flow rate at different sectors of turbine.



Turbine efficiencies at design and off-design conditions

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