Turbocharger Laboratories **Compressor Performance Investigations**



Research Objective

The increase in emission restrictions and the demand for fuel economy is driving the trend in downsizing automobile engines. In this context highly adapted turbochargers gain significant importance. To face this challenge an analytical loss prediction tool for radial compressors is developed at the Institute of Gas Turbines and Aerospace Propulsion at Technische Universität Darmstadt.

Experiment

The test setup is designed as an open loop system where the compressor section can be controlled independently from the turbine section. The maximum turbine massflow rate is 0.65 kg/sec at an inlet pressure of 450 kPa. A heating unit allows inlet temperatures of up to 300°C. To evaluate compressor performance, thermodynamic properties are measured upand downstream of the compressor via static pressure holes and total temperature probes.



Numerical Simulations

The aim of numerics is to gain more information about the flow phenomena in the compressor passage as well as to understand the physics of the interaction of the compressor domains. For complementing the steady state numerics with instationary flow phenomenas, transient calcu-



lations are performed on the institut's cluster and high performance computers. This allows the simulation of local instabilities and their resulting losses which ultimately leads to better matching of numerical and experimental data.



Analytical Model

In order to avoid timeconsuming CFD calculations in the preliminary radial compressor design process, analytical 1D correlations are performed in a loss prediction tool. The flow is simplified as a twozone model, where the interaction and the

losses of the high momentum jet and the low momentum wake are implemented. The aim of the analytical model is to optimize specific geometrical dimensions in order to improve the characteristic behaviour in different operating conditions. Moreover it is important to get information about the limits of the compressor map. The empirical constants in the analytical approach are calibrated by the experimtal data and the numerical results.

