Measuring Techniques for Transonic and Supersonic Flow in Cascades and Turbomachines

Proceedings of 11th Symposium
14-15 September 1992
Universität der Bundeswehr München, Germany

Editor: L. Fottner

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Institut für Strahlantriebe

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Preface

The 11th Symposium on "Measuring Techniques in Transonic and Supersonic Flow in Cascades and Turbomachines" was held from September 14 to 15, 1992 at the Universität der Bundeswehr München in Neubiberg, Germany. This series was initiated at VKI in 1968 with the aim to create outside the normal circuits of large official conferences and meetings a small forum for researchers ready to share their personal experiences in attempting to solve measuring and testing problems in transonic and supersonic turbomachinery flow experiments. The restriction of the participants to a small group of experts (typically 40-50) working actively in this field, the informal and confidential character of the meetings (no written notes of the contributions before the symposium, limited distribution of the bound volume of contributions provided on a voluntary basis after the symposium), the stress put on the free and extensive discussions, and finally the organisation of these biannual meetings by many different research institutes at minimal fees have made these symposia so successful and beneficial for all participants.

The present Symposium was attented by 55 participants from 27 different European organisations; 27 presentations were made covering the following areas:

- Cascade Testing
- Pneumatic Probe Measurements
- Unsteady Pneumatic Probe Measurements
- Transducer Probe Measurements
- Optical Measurement Techniques
- Special Application Problems

All contributors provided written versions of their presentations for this bound volume.

Dr. R. Dvorak from the Institute of Thermomechanics of the Czechoslovak Academy of Sciences in Prague offered kindly to host the next Symposium at his Institute; proposed date: September 1994. We extend to him our best wishes.

Prof. Dr. Leonhard Fottner

Institut für Strahlantriebe
Universität der Bundeswehr München

List of previous meetings

1969 von Karman Institute, Rhode Saint Genèse, Belgium
Transonic cascades, Overpressure, Measurements behind cascades

1971 DFVLR - AVA, Göttingen, Germany
Choice of measurements location, Instationary effects due to shock/boundary-layer interaction

1974 ONERA, Paris, France
Comparison of probe types, Blockage problems due to probes

1976 Ecole Polytechnique Fédérale, Lausanne, Switzerland
Probes, Laser anemometry, New measuring techniques, Instationary effects

1979 Central Electricity Research Laboratories, Leatherhead, United Kingdom
Probe effects, Flow measurements techniques, Loss and deviation problems, Laser anemometer, Wet steam

1981 Laboratoire Mécanique des Fluides, Ecully, France
Probe calibration problems, Measurements and data reduction problems, Optical measurement techniques, Wet steam, Other measurement techniques

1983 Institut für Strahlantriebe und Turboarbeitsmaschinen, RWTH Aachen, Germany
Plane and annular cascades with fixed and vibrating blades, Compressor test rigs, Boundary layer measurements, Optical methods, Wet steam, Probe calibration channels, Probe calibration and probe measurements

1985 Università Degli Studi Genova, Italy
Tunnels, Measurements on turbomachines, Optical techniques, Probe calibration

1988 St Catherine's College, Oxford, United Kingdom
Test facilities, Unsteady flow and high frequency measurements, Optical techniques, Wet steam, Measurement in boundary layers, Heat transfer measurements, Probes and probe calibrations

1990 von Karman Institute, Rhode Saint Genèse, Belgium
Cascade testing, Pressure Probes, Unsteady pressure measurements, Hot wire and hot film measurements, Heat transfer measurements, Optical measurements, Measure ments in short duration wind tunnels, Wet steam

Programme

Monday, 14 September 1992

08.30-09.00 Registration
09.00-09.15 Opening Ceremony

Session 1: Cascade Testing

09.15-09.40 1. A Review on Advanced Methods for Cascade Testing (AGARDograph Nr. 328)
Hirsch, Ch., Vrije Universiteit Brussel, Belgium

09.40-10.05 2. 3D Effects in Nominally 2D Transonic Cascades
Dvorak, R., CSAS, Prague, CFSR

10.05-10.30 3. Some Practical Aspects of Cascade Testing at High Reynolds Number
Willis, G.D.,Truelove, A.H.,GEC Alstholm Warwick,UK

10.30-10.45 Break

Session 2: Pneumatic Probe Measurements

10.45-11.10 4. 3D Pneumatic & 2D Dynamic Probes: Their Development and Subsequent Use in a Transonic Fan
Cherrett, M.A., Bryce, J.D., DRA Farnborough,
Hodson, H.P., Cambr. University, UK

11.10-11.35 5. Calibration, Modeling and Data Evaluation Procedures for Aerodynamic Multihole Pressure Probe Measurements on the Example of a Four Hole Probe
Kupferschmied, P., Gossweiler, Chr.,
ETH Zürich, Switzerland

11.35-12.00 6. Theoretical Determination of the Characteristics of Multi-Hole Pressure Probes Using Panel Methods
Depolt, Th., Koschel, W., RWTH Aachen, Germany

12.00-13.00 Lunch

13.00-13.25 7. Computerized Balancing of a Wedge Shaped Probe
Johanßen, O.,
Universität der Bundeswehr Hamburg, Germany

13.25-13.50 8. Experimental Tests of Transonic Nozzles in Linear Cascades Carried out by Traversing Probe
Cabitza, S., Mandas, N., Universita di
Cagliari, Italy

Session 3: Unsteady Pneumatic Probe Measurements

13.50-14.15 9. The Dynamic Response of Capillary Tubes for Use in Miniature Pressure Probes
Bohn, D., Schnittfeld, Th., RWTH Aachen, Germany

14.15-14.30 Break

14.30-14.55 10. Aerodynamic Design Criteria for Fast Response Probes
Humm, H.J., Verdegaal, J.I.,
ETH Zürich, Switzerland

14.55-15.20 11. Experimenting with Fast Response Aerodynamic Probe Geometries
Ainsworth, R.W., Stickland, A.D.,
Oxford University, UK

15.20-15.45 12. Fast Response Aerodynamic Probe Measurements in a Turbulent Pipe Flow
Gossweiler, Chr., Herter, D., Kupferschmied, P.,
ETH Zürich, Switzerland

16.00-17.00 Visit of the Jet Propulsion Laboratory

17.00-19.00 Bavarian Cocktail

Tuesday, 15 September 1992

Session 4: Transducer Probe Measurements

09.00-09.25 13. Relative Total Pressure Measurements Downstream of a Transonic Annular Cascade
Sieverding, C.H., Denos, R., VKI Brussels, Belgium

09.25-09.50 14. Temperature Error Compensation of a Miniature Semiconductor Pressure Transducer and First Results of Measurements Taken in a Ducted Propfan Rotor
Maass, M., DLR Köln, Germany

09.50-10.15 15. Unsteady Pressure Response to an Oscillating Normal Shock Wave in a Nozzle
Ott, P., Bölcs, A., Fransson, T.H., EPF Lausanne, Switzerland

10.15-10.40 16. The Experimental Set-Up of a Triple-Sensor Anemometry and its Controlling System at the High-Speed Cascade Wind Tunnel
Wunderwald, D., Wilfert, G., Fottner, L.,
Universität der Bundeswehr München, Germany

10.40-11.00 Break

Session 5: Optical Measurement Techniques

11.00-11.25 17. Coupled Optical Velocity and Pressure Measurements in a Supersonic Flow
Janssens, G., Labbe, J., Lemoine, F., Leporcq, B.,
ONERA, Chatillon, France

11.25-11.50 18. Boundary-Layer Separation and Transition Visualized by Liquid Crystal Coating
Starken, H., Steinert, W., DLR Köln, Germany

11.50-12.15 19. Developments in Flow Tracing Using Miniature Lasers
Dominy, R.G., University of Durham, UK

12.15-13.00 Lunch

13.00-13.25 20. Intra-Blade Quantitative Transonic Flow Measurements at the DRA Pyestock Isentropic Light Piston Facility Using Particle Image Velocimetry
Chana, K.S., Matthews, I.W., DRA Farnborough, UK
Bryanston-Cross,P.J.,Funnes-Gallanzi,M., Warwick University, Coventry,

13.25-13.50 21. New Developments in the Laser-2-Focus Technique for Non-Intrusive Velocity Measurements in Gasturbine Components
Schodl, R., Förster, W., DLR Köln, Germany

13.50-14.15 22. A Study of Some Measurement Errors in L2F-Velocimetry
Kost, F., DLR Göttingen, Germany

14.15-14.40 23. Optical Fibre Fabry-Perot Interferometers for Calorimetric Heat Transfer Gauges
Kidd,S.R.,Barton,J.S.,Jones,J.D.C., Heriot-Watt University, Edinburgh,
Chana,K.S., Matthews,I.W., DRA Farnborough, UK

14.40-15.00 Break

15.00-15.25 24. The Automatic Numerical Processing of Interferometric Transonic Flow Measurements
Wehner, M., EPF Lausanne, Switzerland
Bryanston-Cross, P., Judge, T.R., Chenggen, C., Warwick University, UK

Session 6: Special Application Problems

15.25-15.50 25. AW-System - An Interactive Environment for the Evaluation of Large Time Series
Herter, D., Chrisander, N.O., Gossweiler, Chr., ETH Zürich, Switzerland

15.50-16.15 26. Unsteady Temperature Measurements During Surge in a Highly Loaded High Pressure Compressor
Michel, A., Heider, G., Heckenmüller, A., MTU München GmbH, Germany

16.15-16.40 27. Measuring Experiences with a Wet Steam Turbine
Schmidt, R.G.,
Universität der Bundeswehr Hamburg, Germany

16.40-17.00 Closing Remarks

Index by Author (followed by paper number)

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