

**MEASURING TECHNIQUES
FOR TRANSONIC AND SUPERSONIC FLOWS
IN CASCADES AND TURBOMACHINES**

**Proceedings of 10th Symposium
VKI September 17-18, 1990**

Editors : C.H. Sieverding, T. Arts



von Karman Institute for Fluid Dynamics

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Preface

The 10th Symposium on "Measuring Techniques in Transonic and Supersonic Flow in Cascades and Turbomachines" was held from September 17 to 18, 1991 at the von Karman Institute, Rhode Saint Genèse, Belgium. 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 bi-annual meetings by many different Research Institutes at minimal fees have made these symposia so successful and beneficial for all participants.

The present Symposium was attended by 44 participants from 26 different European organisations; 28 presentations were made covering the following areas :

- cascade testing
- pressure probes
- unsteady pressure measurements
- hot wire and hot film measurements
- heat transfer measurements
- optical measurements
- measurements in short duration wind tunnels
- wet steam

All contributors, save three, provided written versions of their presentations for this bound volume which we wanted to be a particularly nice edition as a souvenir of the 10th Symposium.

Professor Dr. Ing. L. Fottner from the Universität der Bundeswehr in München, Germany, offered kindly to host the next Symposium at his Institute; proposed date : September 1992. We extend to him our best wishes.

C.H. Sieverding

T. Arts

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, 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 di 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

PROGRAM

Session 1 - Cascade Testing

EXPERIMENTAL DETERMINATION OF THE INLET FLOW ANGLE OF TRANSONIC CASCADES
W. Steinert

AERODYNAMIC MEASUREMENTS IN TURBINE CASCADES AT HIGH MACH NUMBER
C. Osnaghi & A. Perdichizzi

APPLICATION OF ADAPTIVE WALLS IN CASCADE WIND TUNNELS
H-J. Rehder

PANDA - A NEW DATA ACQUISITION SYSTEM FOR WAKE AND PROFILE PRESSURE DISTRIBUTION
MEASUREMENTS AT THE HIGH SPEED CASCADE WIND TUNNEL
G. Wilfert, M. Ladwig, L. Fottner

Session 2 - Unsteady Pressure Measurements

TEMPERATURE ERROR COMPENSATION APPLIED TO PRESSURE MEASUREMENTS TAKEN WITH
MINIATURE SEMICONDUCTOR PRESSURE TRANSDUCERS IN A HIGH SPEED RESEARCH
COMPRESSOR
M.A. Cherrett

INVESTIGATING THE PERFORMANCE OF MINIATURE SEMI-CONDUCTOR PRESSURE TRANSDUCERS
FOR USE IN FAST RESPONSE AERODYNAMIC PROBES
R.W. Ainsworth & J.L. Allen

THE USE OF PIEZO RESISTIVE SEMI-CONDUCTOR PRESSURE TRANSDUCERS FOR FAST
RESPONSE PROBE MEASUREMENTS IN TURBOMACHINERY
C. Gossweiler, H.J. Humm, P. Kupferschmied

Session 3 - Hot Wire Measurements

A HOT WIRE MEASURING TECHNIQUE FOR MEAN VELOCITY AND REYNOLDS STRESS
COMPONENTS IN COMPRESSIBLE FLOW
A. Perdichizzi, M. Ubaldi, P. Zunino

THERMAL ANEMOMETER MEASUREMENT OF THREE DIMENSIONAL VELOCITY AND TURBULENCE IN
TURBOMACHINES - A CRITICAL REVIEW -
N.C. Baines

COMPARISONS BETWEEN TURBULENCE SPECTRA MEASURED WITH FAST RESPONSE PRESSURE
TRANSDUCERS AND HOT WIRES
R.W. Moss & M.L.G. Oldfield

Session 4 - Hot Film Measurements

EXPERIMENTAL INVESTIGATION WITH HOT-FILM GAUGES MOUNTED ON A SINGLE BLADE IN
TRANSONIC FLOW
C.A. Poensgen, H.E. Gallus, H.D. Schulz, K.D. Broichhausen, T. Schroeder

BOUNDARY LAYER TRANSITION DETECTION ON SUCTION SIDES OF HIGH-DEFLECTION TURBINE
BLADE CASCADES
F. Pittaluga & G. Benvenuto

Session 5 - Optical Measurements

BOUNDARY LAYER TRANSITION DETECTION IN TRANSONIC FLOWS BY LASER TRANSIENT VELOCIMETRY

R. Decuyper, M.L. Riethmuller, R. Leblanc, V. Mercier

A SIMPLE, NON-INTRUSIVE TECHNIQUE FOR QUANTITATIVE FLOW TRACKING

R.G. Dominy

LASER-2 FOCUS MEASUREMENTS AT A HIGH SPEED CASCADE WIND TUNNEL

R. Kurz

Session 6 - Pressure Probes

AN INVESTIGATION INTO THE INFLUENCE OF THE DIFFERENT CALIBRATION COEFFICIENTS UPON MEASUREMENTS WITH AERODYNAMIC PRESSURE PROBES

S. Cabitza & N. Mandas

DEVELOPMENT OF A CALIBRATION BENCH FOR SMALL ANEMOCLINOMETER PROBES

R. Gaillard

INVESTIGATION ON MINIMIZING BLOCKAGE EFFECTS OF MULTI-HOLE PRESSURE PROBES IN TRANSONIC FLOW

Th. Depolt, F. Vinnemeier, W. Koschel

THE PROBLEM OF STATIC PRESSURE MEASUREMENT IN TURBOMACHINERY ANNULI USING TRAVERSABLE INSTRUMENTATION

P.D. Smout

Session 7 - Heat Transfer Measurements

LIQUID CRYSTAL MEASUREMENT TECHNIQUES FOR HEAT TRANSFER AND SURFACE FLOW

T.V. Jones

NAPHTHALINE TECHNIQUE FOR HEAT TRANSFER MEASUREMENTS *

H.P. Berg

THE SWOLLEN POLYMER TECHNIQUE FOR HEAT TRANSFER PROBLEMS - DIFFICULTIES AND ACHIEVEMENTS

N. Hay & D. Lampard

SURFACE TEMPERATURE MEASUREMENTS BY USE OF LIQUID CRYSTALS

T. Arts, A. Ottavy, G. H. Junkhan

MEASUREMENTS OF FORCED CONVECTION COEFFICIENT IN HOLES OF SMALL L/D RATIOS *

G. Simon, Ph. Lemasson, A. Peerhossaini, J.P. Bardon

Session 8 - Measurements in Short Duration Wind Tunnels

TURBINE NOZZLE GUIDE VANE EXIT AREA TRAVERSING IN A SHORT DURATION LIGHT PISTON TEST FACILITY

S.P. Harasgama & K.S. Chana

DEVELOPMENT OF A HIGH SPEED ROTATING PROBE TRAVERSE SYSTEM USING OPTO-ELECTRONIC DATA TRANSMISSION

C.H. Sieverding, T. Angeli, C. Vanhaeverbeek, G. Schulze

* no printed contribution received

Session 9 - Wet Steam

COMPARISON BETWEEN TRANSONIC VELOCITY MEASUREMENT AND CALCULATION IN A LOW
PRESSURE STEAM TURBINE
A.R. Laali & E. Landrieux

HIGH SPEED SCHLIEREN FILM OF THE FLOW IN A CASCADE STEAM TUNNEL **
C. Zimmermann

HIGH SPEED SCHLIEREN FILM OF THE FLOW IN A CASCADE STEAM TUNNEL *
D. Hosenfeld

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