

**13th International Symposium
on Unsteady Aerodynamics,
Aeroacoustics and Aeroelasticity
of Turbomachines 2012**

(ISUAAAT 13)

**Tokyo, Japan
11-14 September 2012**

ISBN: 978-1-62993-146-3

Invited Papers

- I-1 **Chuichi Arakawa** Recent development and challenges of wind turbine CFD N/A
- I-2 **Janusz Piechna** Compact wave energy conversion systems in turbomachinery N/A
- I-3 **Chunill Hah** Development and application of Large Eddy Simulation for the control of unsteady flows in turbomachinery N/A
- I-4 **Ivor Day** Stall and Surge: The Past and the Future N/A
- I-5 **Mehdi Vahdati** THE MECHANISM OF AEROELASTIC INSTABILITY IN TRANSONIC FANS 1
- I-6 **Li He** Concurrent blade design optimization for both aerothermal and aeromechanic performance N/A
- I-7 **Tony Arts** Research at VKI on heat transfer and aerodynamics in internal cooling channels, both fixed and in rotation 16
- I-8 **Ethirajan Rathakrishnan** Corrugated Limiting Tab for Jet Mixing 36
- I-9 **Damian Vogt** Current Research on Turbomachinery Flutter within the EU Collaborative Research Project "FUTURE" N/A

Keynote Paper

- K **Hafiz Atassi** History of the International Symposia on Unsteady Aerodynamics, Aeroacoustics, and Aeroelasticity in Turbomachines N/A

Day 1

Session 1 Wind turbines, Wave energy

- S1-1 Koji Okamoto** (JP9) PORT CONDITION EFFECTS ON WAVE ROTOR INTERNAL FLOW DYNAMICS 48
- S1-2 Manabu Takao** (JP8) PERFORMANCE ESTIMATION OF A TWIN UNIDIRECTIONAL IMPULSE TURBINE FOR WAVE ENERGY CONVERSION 56

Session 2 Flutter, Forced response, Non-synchronous vibration

- S2-1 Stephen Clark** (US1) THE IDENTIFICATION OF FLUID MODES USING PROPER ORTHOGONAL DECOMPOSITION FOR NON-SYNCHRONOUS VIBRATION IN TURBOMACHINERY 61
- S2-2 Caetano Peng** (UK7) Studies of Non-Synchronous Vibration and Effects of Vane Stagger Variation LEO on Rotor Forced Response of an Axial Compressor 73
- S2-3 Mizuho Aotsuka** (JP18) NUMERICAL ANALYSIS OF FORCED RESPONSE OF HIGH PRESSURE COMPRESSOR CASCADE 82
- S2-4 Atsushi Tateishi** (JP19) MULTIMODE FLUTTER ANALYSIS BASED ON TIME-DOMAIN FLUID-SOLID INTERACTION SIMULATION AND SYSTEM IDENTIFICATION 87
- S2-5 Florian Fruth** (SW5) HARMONIC FORCE VARIATION DUE TO CHANGE IN BLADE COUNT RATIO -PHYSICAL INTERPRETATION 96
- S2-6 Hu Guotun** (CN4) AN IMMERSSED BOUNDARY METHOD FOR SIMULATING AN OSCILLATING AIRFOIL 108

Session 3 CFD, Aeroelastic modelling

- S3-1 Julien Marty** (FR2/FR3) HIGH FIDELITY PREDICTION OF SEPARATION-INDUCED TRANSITION ON HIGH-LIFT LOW-PRESSURE TURBINE -PART I : REYNOLDS AVERAGED NAVIER-STOKES VS. LARGE-EDDY SIMULATIONS, /-PART II : UNSTEADY FLOW AND SPECTRAL ANALYSIS 119
- S3-2 Antoine Placzek** (FR1) EFFICIENT COUPLING STRATEGIES FOR THE NUMERICAL PREDICTION OF THE AEROELASTIC DAMPING BASED ON NONLINEAR TIME-INTEGRATED FLOW SIMULATIONS 142

Session 4 Rotor/stator interaction, Multi stage flows

- S4-1 Victor Saren** (RU1) ROTOR-STATOR INTERACTION IN AXIAL TURBOMACHINES 152
- S4-2 Romuald Rzadkowski** (PL1/PL2) UNSTEADY FORCES ACTING ON ROTOR BLADES IN SEVEN AND HALF STAGE / DIRECT INTEGRATION METHOD IN AEROELASTIC ANALYSIS OF ROTOR BLADE OF FIRST STAGE COMPRESSOR 166
- S4-3 Ryszard Szczepanik** (PL3) AEROELASTIC BEHAVIOUR OF ROTOR BLADES OF A FIRST STAGE COMPRESSOR IN CASE OF FOREIGN OBJECT IN ENGINE INLET 183
- S4-4 Felix Holzinger** (DE3) COMMISSIONING OF THE FUTURE COMPRESSOR 190
- S4-5 Martin Lange** (DE4) TIP AND HUB CLEARANCE VORTEX DEVELOPMENT DUE TO ROTOR-STATOR INTERACTIONS IN AXIAL COMPRESSORS 201
- S4-6 Artyom Romanov** (UK9) EXACT LINEARIZATION OF ONE-DIMENSIONAL TURBOMACHINERY PERFORMANCE MODEL 213
- S4-7 Mai Yamagami** (JP5) UNSTEADY EFFECTS ON SPANWISE MIXING PHENOMENA IN A MULTISTAGE AXIAL FLOW COMPRESSOR 225
- S4-8 Masaya Suzuki** (JP22) NUMERICAL INVESTIGATION ON PARTICLE MOTION IN ROTOR-STATOR INTERACTION FIELD OF AXIAL COMPRESSOR 233

Day 2

Session 5 Flow instability, Control, Casing treatment

- S5-1 Nobuyuki Yamaguchi** (JP2) A STUDY ON THE STAGNATION-STALL BOUNDARIES BASED ON ANALYTICALLY-EVALUATED SURGE CONDITIONS IN AXIAL FLOW COMPRESSORS 243
- S5-2 Nur Uddin** (NO1) A COMPRESSOR SURGE CONTROL SYSTEM: COMBINATION ACTIVE SURGE CONTROL AND SURGE AVOIDANCE 255
- S5-3 Koichi Yonezawa** (JP16) NUMERICAL INVESTIGATION OF STALL SUPPRESSION OF AN AXIAL FLOW FAN WITH AN AIR-SEPARATOR 262
- S5-4 Takahiro Nishioka** (JP13) MODAL-TYPE STALL INCEPTION IN AN AXIAL FLOW FAN 272
- S5-5 J. Anton Streit** (DE1) Trading Excessive Stall Margin for Efficiency: An Alternative Approach to Axial-Slot Casing Treatments for Transonic Compressors 280
- S5-6 Dakun Sun** (CN7) EFFECT OF ADVANCED CASING TREATMENT ON THE SUPPRESSION OF PRECURSOR OF ROTATING STALL IN TRANSONIC COMPRESSORS 290
- S5-7 Virginie Anne Chenaux** (CH1) Aeroelasticity at reversed flow conditions - experimental investigations of an oscillating annular compressor cascade 302

Session 6 Transonic compressor flows

- S6-1 Sebastian Leichtfuss** (DE7) AERODYNAMIC AND AEROELASTIC INVESTIGATION OF A TRANSONIC COMPRESSOR RIG 311
- S6-2 Simon Martin** (FR7) A NUMERICAL STUDY OF MECHANISMS FOR TRANSONIC STALL FLUTTER 321
- S6-3 Junichi Kazawa** (JP17) NUMERICAL INVESTIGATIONS OF ROTOR BLADE FLUTTER CHARACTERISTICS IN JAXA'S FAN TEST RIG 334
- S6-4 Clas Andersson** (SW1) AEROELASTIC INSTABILITY OF A TRANSONIC COMPRESSOR NEAR STALL 344
- S6-5 Jan Ostlund** (SW3) DESIGN AND PRE-TEST ANALYSES OF THE TRANSONIC FLUTTER RESEARCH COMPRESSOR FOR FUTURE 353

Session 7 Radial flow turbomachinery

- S7-1 Rudolf Izmaylov** (RU2/RU3) UNSTEADY FLOW IN CENTRIFUGAL COMPRESSOR NUMERICAL MODELLING AND EXPERIMENTAL INVESTIGATION / SMALL WIND TURBINE AERODYNAMICS: OLD WINE IN NEW BOTTLE 361
- S7-2 Zhongguo Sun** (CN5) EXPERIMENTAL STUDY ON THE EFFECT OF ROTOR/STATOR INTERACTION WITH DIFFERENT NUMBER OF STATOR BLADES 381
- S7-3 Yoshinobu Tsujimoto** (JP14) Effects of Acoustic Resonance on Phase Resonance in a Centrifugal Fan 388
- S7-4 Wataru Sato** (JP20) A STUDY ON UNSTEADY AERODYNAMIC EXCITATION FORCES ON RADIAL TURBINE BLADE DUE TO ROTOR-STATOR INTERACTION 400
- S7-5 Isao Tomita** (JP23) UNSTEADY STALL PHENOMENA IN CENTRIFUGAL COMPRESSOR FOR TURBOCHARGER 408

Day 3

Session 8 Turbine unsteady flows

- S8-1 Bidur Khanal** (UK6) COMPUTATIONAL INVESTIGATIONS ON THE UNSTEADY AEROTHERMAL BEHAVIOUR OF AN HP TURBINE STAGE 414
- S8-2 Roque Corral Garcia** (ES2) PHYSICS OF VIBRATING LOW-PRESSURE TURBINE AIRFOILS 423
- S8-3 Ken-ichi Funazaki** (JP1) Studies on Two-Dimensional Contouring of High-Lift Turbine Airfoil Suction Surface as Separation-Control Device: Effects of Reynolds number and Flow Disturbances 433
- S8-4 Richard Sandberg** (UK1) ASSESSING THE SENSITIVITY OF TURBINE CASCADE FLOW TO INFLOW DISTURBANCES USING DIRECT NUMERICAL SIMULATION 444
- S8-5 Nenad Glodic** (SW2) INFLUENCE OF TIP CLEARANCE MODELLING IN PREDICTIONS OF AEROELASTIC RESPONSE IN AN OSCILLATING LPT CASCADE 456

Session 9 Turbine flutter, Blade row interaction

- S9-1 Sina Stapelfeldt** (UK3) A METHOD FOR MODELLING FLOW PAST NON-AXISYMMETRIC CONFIGURATIONS ON REDUCED PASSAGE COUNTS 467
- S9-2 Derek Micallef** (DE6) THREE-DIMENSIONAL VISCOUS FLUTTER ANALYSIS IN A TURBINE CASCADE UNDER SUPERSONIC FLOW CONDITIONS 478
- S9-3 Andrew Wheeler** (UK2) DIRECT NUMERICAL SIMULATIONS OF A TRANSONIC TURBINE TIP FLOW 487
- S9-4 Shuichi Ozaki** (JP7) EXPERIMENTAL AND NUMERICAL INVESTIGATIONS OF THE INFLUENCES OF AXIAL GAP BETWEEN BLADE ROWS ON PRESSURE FLUCTUATION 497
- S9-5 Mohammad Rahmati** (UK4) MULTI-ROW INTERFERENCE EFFECTS ON BLADE AEROMECHANICS IN COMPRESSOR AND TURBINE STAGES 509

Session 10 Steam turbine flows, Rocket turbine

- S10-1 Paul Petrie-Repar** (AU1) ESTABLISHMENT OF A STEAM TURBINE FLUTTER TEST CASE 520
- S10-2 Tomomi Nakajima** (JP3) PREDICTION OF THE UNSTEADY FORCE FOR TURBINE BUCKETS (THE EFFECTS OF BUCKET TURNING ANGLE AND THE THICKNESS OF NOZZLE TRAILING EDGE) 525
- S10-3 Tadashi Tanuma** (JP10) NUMERICAL INVESTIGATIONS OF UNSTEADY AERODYNAMIC FORCES ON THE LAST STAGE ROTATING BLADES IN A LARGE-SCALE STEAM TURBINE 537
- S10-4 Luying Zhang** (UK5) ANALYSIS OF ROTATING AERODYNAMIC INSTABILITY AND ITS AEROELASTIC COUPLING IN STEAM TURBINE LAST STAGE 539
- S10-5 Tobias Kalkkuhl** (DE8) UNSTEADY FLOW DUE TO PARTIAL ADMISSION IN A STEAM TURBINE CONTROL STAGE 549
- S10-6 Yuki Tokuyama** (JP6) Unsteady Flow Field and Structural Response Response in a Turbine Stage of a Rocket Engine 559

Day 4

Session 11 Jet noise, Airfoil acoustics

- S11-1** **Arun Kumar Perumal** (IN1) Truncated Triangular Tabs for Supersonic Jet Control 570
- S11-2** **Shantanu Srivastava** (IN2) Limiting Tab for Square Jet Control 579
- S11-3** **Yuanyuan Gu** (CN1) A BOUNDARY INTEGRAL EQUATION TO PREDICT THE AERODYNAMIC NOISE SCATTERED BY IMPEDANCE BOUNDARY 591
- S11-4** **Zhang Qunlin** (CN2) AEROACOUSTIC MULTI-FREQUENCY INTEGRAL COMPUTATION ACCELERATED BY RETRACTED SERIES EXPANSION METHOD 597
- S11-5** **Tsutomu Oishi** (JP12) EXPERIMENTAL AND COMPUTATIONAL STUDY ON JET NOISE REDUCTION DEVICES SUCH AS NOTCHED, CHEVRON AND MICROJETS 602

Session 12 Turbo noise, Acoustic control

- S12-1** **Michaela M. Logue** (US2) Annular cascade response to nonuniform inflows and validation with experiments 610
- S12-2** **Hidekazu Kodama** (JP4) EXPERIMENTAL AND ANALYTICAL INVESTIGATION OF ACOUSTIC INTERACTION BETWEEN FAN ROTOR AND STATOR 618
- S12-3** **Shinya Kusuda** (JP11) FAN TONE NOISE DUE TO INTERACTION OF ROTOR BLADES WITH THE POTENTIAL DISTURBANCE OF A PYLON 626
- S12-4** **Michael Bartelt** (DE9) DESIGN METHODOLOGY AND EXPERIMENTAL VALIDATION OF AN AEROACOUSTIC TEST RIG FOR TURBOMACHINERY APPLICATIONS 638
- S12-5** **Xiwen Dai** (CN8) NONLINEAR ACOUSTIC PROPERTIES OF A HELMHOLTZ RESONATOR WITH GRAZING FLOW 650
- S12-6** **Yutaro Suzuki** (JP21) EXPERIMENTS ON ADAPTIVE ANTI-NOISE CONTROL FOR FAN NOISES 656

Session 13 Blade Vibration, BLISK, Mistuning, Friction

- S13-1** **Sangjoon Shin** (KR1) AEROELASTIC ANALYSIS OF A TURBINE BLADE USING TRANSFORM TECHNIQUES AND A NON-UNIFORM BEAM MODEL 663
- S13-2** **David Rockel** (DE5) NEW POSSIBILITIES OF BLADE MISTUNING BY THE USE OF ADDITIVE MANUFACTURING TECHNOLOGIES 667
- S13-3** **Majid Mesbah** (BE1) INVESTIGATION OF COMPRESSOR BLADE VIBRATIONS DUE TO SUBHARMONIC AERODYNAMIC EXCITATIONS 678
- S13-4** **Florent Payer** (FR4) U-RANS CALCULATION OF AERODYNAMIC DAMPING AND EXCITATION FOR FORCED RESPONSE PREDICTION 686
- S13-5** **Carlos Martel** (ES1) ASYMPTOTIC DESCRIPTION OF FLUTTER AMPLITUDE SATURATION BY NONLINEAR FRICTION FORCES 694
- S13-6** **Tomokazu Miyakozawa** (UK8) Pre-Laboratory-Rig Test Friction Damping Simulations of Stators and Rotors of an Axial Compressor 702
- S13-7** **Markus May** (DE10) MODEL UPDATING FOR THE AEROELASTIC ROM OF A MODERN BLISK 710