Competence Center for Gas Exchange

CCGEx

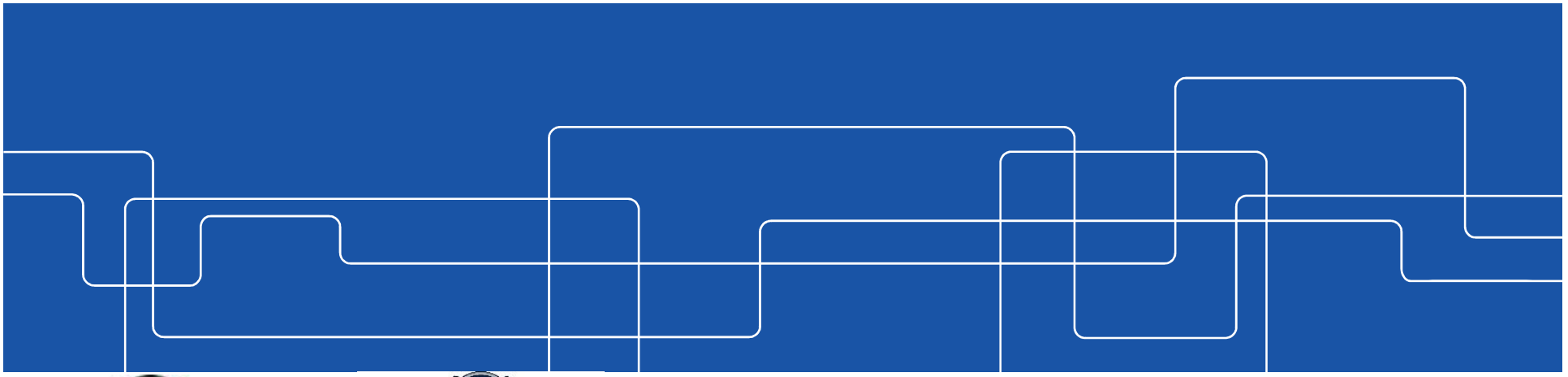
”Charging for the future”

Energimyndigheten SCANIA VOLVO VOLVO BorgWarner

KTH ROYAL INSTITUTE
OF TECHNOLOGY

Research Area: HOTSIDE

Coordinator: Mihai Mihaescu



Overview: HOTSIDE

GOAL — Maximize heat and pressure recovery from the exhaust gas flow

STRATEGY — From physics-based understanding, build knowledge of the unsteady exhaust flow interaction with the turbine, waste-heat-recovery systems and exhaust

TOOLS

- Integrated high-fidelity simulations with predictive models
  - riments
  - em models

- Flow characterization & heat transfer effects
- System optimization incl. ICE, Turbo, WHR

Exhaust valve strategies (ICE)
Ted Holmberg, PhD stud
1D Gas Dynamics / On engine Exp

CFD, manifold & turbine (Mek)
Shyang Maw Lim, PhD stud
High-fidelity LES, models

Industry Input
Volvo Cars (engine maps)
Borg Warner (geometry, maps) SCANIA & Volvo GTT

Activities

HT 2018
exhaust valve strategy

pulsed flow characteristics

HT 2018

Internal Combustion Engine

Exhaust port & valve (CICERO)
Marcus Winroth, PhD stud
Exp. Fluid Mechanics

Exhaust engine manifold

back pressure

HT 2018

Turbine resp

- upstream flow instabilities
- exhaust valve strategy used
- heat transfer effects
- turbine maps / torque / efficiency

Turbomachinery design, 2D (ICE)
Nicholas Anton, Ind PhD stud (SCANIA) **HT 2019**
2D simulations & turbo aero-design

HOTSIDE: Overall aims

- Improve understanding of the pulsating flows in complex manifolds
  - high-fidelity simulations / experiments
  - intermittent flows effects on heat transfer
- Quantify the characteristics of the pulsating flow and effect on turbocharger's efficiency
  - different exhaust valve strategies (1D/3D/Exp)
  - different turbine designs (1D + 3D aerodesign)
- Improve understanding of heat transfer and heat transfer related losses for unsteady, pulsating, hot flows in complex manifolds
- Develop better calibrated 1D models and reduced order models

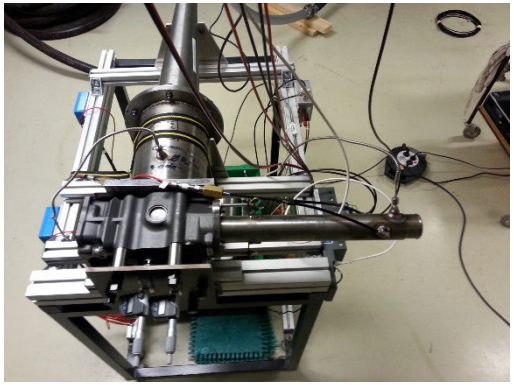
Doctoral students:
Marcus Winroth, (Exp), Mek-CICERO
Ted Holmberg (GT-Power, Exp), ICE
Shyang Maw Lim, (CFD), Mek
Nicholas Anton (Turbo design), Scania

Reference group:
Habib Aghaali, Volvo Cars
Mattias Ljungqvist, Volvo Cars
Martin Bauer, Volvo GTT
Fredrik Rahm, Volvo GTT
Per-Inge Larsson, Scania
Marc Gugau, Borg Warner

HOTSIDE: Individual projects

Gas Dynamics at the Exhaust Valves and Ports
Doctoral student:
Marcus Winroth (Exp), Mek-CICERO

Supervisors:
Henrik Alfredsson, Ramis Örlü



Valve Strategies and Exhaust Pulse Utilization
Doctoral student:
Ted Holmberg (1D modeling, Exp), ICE

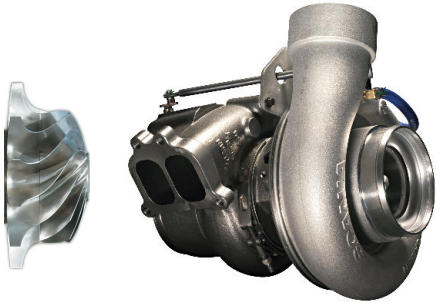
Supervisors:
Andreas Cronhjort, Anders Christiansen Erlandsson

Flow and Heat-transfer in a Turbocharger Radial Turbine
Doctoral student:
Shyang Maw Lim (CFD), Mek

Supervisors:
Mihai Mihaescu, Anders Dahlkild, Christophe Duwig

Engine Optimized Turbine Design
Ind. Doctoral student:
Nicholas Anton (Aero-design, Exp), SCANIA

Supervisors:
Anders Christiansen Erlandsson, Magnus Genrup, Per-Inge Larsson



HOTSIDE: Highlights

- Validation & Verification phase for the CFD solver was completed
- Discharge coefficient has a strong dependency on both valve opening speed and pressure ratio; quasi-steady assumption used for modeling exhaust flow in the port is incorrect
- Evaluation of the adiabatic and diabatic turbine performance under continuous flow conditions and some pulsating flow conditions (VCC data)
- Assessment of exergy destroyed by heat transfer under continuous flow conditions

HOTSIDE: Near-future Plans

- Lic. seminars: Shyang Maw Lim (Jan 2017); Marcus Winroth (Jan 2017)
- Dynamic measurements of the discharge coefficient: dynamic valve experiments with a double valve set-up; assess the influence of different valve lift profiles; complementary 1D simulations
- Detailed unsteady computational efforts on the BorgWarner turbine integrated with the manifold with Boundary Conditions provided by Volvo Cars (VEP-HP engine; different exhaust valve strategies)
- Quantify the associated losses and impact on turbine performance
- Funding opportunities, e.g. Marie Sklodowska-Curie actions, Innovative Training Networks (ITN/ETN); H2020-MSCA-ITN-2017

Competence Center for Gas Exchange

CCGEx

"Charging for the future"

Energimyndigheten SCANIA VOLVO VOLVO BorgWarner