Återkopplad Diesel II
The project

- Project Name: “Återkopplad Diesel del 2”
- Start: 2016-01-01
- End: 2018-03-31
- Project chairholders:
  - Scania CV AB
  - Lunds Universitet
- Program: Energi och Miljö
- Energy Agency funding: 2 724 250 SEK
- Supervisors: Ola Stenlåås (Scania) and Per Tunestål (LTH)
Index

• The Project In-Context
• Overview
• Goals and Results
Index

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The project in context

• The EU roadmap for transportation scenario*
  – by 2050
    – Reduce 60% GHG emissions in the transport sector of 1990 levels
  – by 2030
    – 20% of GHG compared to 2008 levels
    – > 40% cuts in GHG emissions (1990 levels)
    – > 27% share for renewable energy
    – > 27% improvement in energy efficiency

* A Roadmap for moving to a competitive low carbon economy in 2050
Index

• The Project In-Context
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Overview
Is there other option with a lower penalty on efficiency?
Overview

- dPmax
- Pmax
- CAD
- TDC
- P
- HR
- Inj
Overview

*Optimal Traces for maximum efficiency with constraints on emissions and pressure
Overview

...In reality
The deviations can be reduced by adjusting the injection in-cycle [Zander, 2010]
Overview

What is the physical behavior?

What is the pilot behavior?  How does it affect the main injection?
Overview

Can we estimate the pilot behavior?
What can be done to optimize the main injection knowing the pilot behavior?
Overview – Research approach

What is the physical behavior?

**What is the pilot behavior?**
SAE 2017-01-0718: "Investigation of small Pilot Combustion in a Heavy Duty Diesel Engine"

**How does affect the main injection?**
SAE 2017-01-0708: "Influence of small Pilot on Main Injection in a Heavy Duty Diesel Engine"
Overview – Research approach

Can we estimate the pilot behavior? Submitted to SAE WCX 2018: "Cylinder Pressure based Virtual Sensor for In-Cycle Pilot Mass Estimation"
Overview – Research approach

What can be done to optimize the main injection knowing the pilot behavior?  
To be submitted to SAE WCX 2018
Overview – Research approach

0.2CAD ~ 30\mu s@1200RPM
Index

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Goals & Results

• **Goal**: Improve the efficiency and reduce emissions.

• **How?**: Reducing the wide margins of the performance variability due to the external factors and adapt the engine behavior to them

• Which are the external factors that affect the behavior variability?

• How can their effect be estimated?

• How shall the system be controlled and adapted to reduce its variability?
The variance was proved to be a function of cylinder-to-cylinder variations and also due to cycle-to-cycle variations.
Goals & Results - SAE 2017-01-0718

- Pilot injection uncertainty

- Combustion of pilot injection
  - What is the variance in the trigger of pilot auto-ignition?
  - Which variables affect the variance of pilot auto-ignition?
  - How does the operating conditions affect the variance of pilot auto-ignition

- Effect of previous cycle on pilot combustion
Goals & Results - SAE 2017-01-0708

Effect of interaction mode on main injection timing and combustion

1. Main injection ignition delay
2. Combustion duration before the center of combustion
3. Premixed combustion
4. Combustion duration
Goals & Results - SAE 2017-01-0708

- Effect of interaction mode on main injection timing and combustion
  1. Main injection ignition delay
  2. Combustion duration before the center of combustion
  3. Premixed combustion
  4. Combustion duration

- Effect of interaction mode on engine emissions and performance
  1. NOx
  2. Efficiency
  3. Maximum Pressure
  4. Maximum Pressure Raise Rate
Can we estimate the injected mass before its combustion is finished? → Yes!

Can it even be estimated when the combustion is incomplete or not triggered? → Yes!

With which accuracy?

→ An initial uncertainty of ±3mg can be reduced to ±0.45mg

→ Already at the HR peak, the uncertainty can be reduced to ±0.5mg

How robust is the estimation? How do the operating conditions affect the estimation?

→ A linear parametrization can be used in an extensive range of operating conditions

→ The estimation is robust, only sensitive to the parameters that affect the HR measurement
Goals & Results – Ongoing Work

→ Quantifying the efficiency improvement potential of the previous results
THANK YOU!