KTH ROYAL INSTITUTE
OF TECHNOLOGY

Heavy Duty DISI Gas Exchange Requirements with Renewable Fuels

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Objective

- High efficiency HD SI engines with stoichiometric operation
  - Simple after treatment and control
  - Low noise engines
  - Low emissions after catalyst light off
  - Reduced capital costs

- Diesel power density in SI engines requires high knock tolerance

Literature Review

Mahendar, Senthil Krishnan, Anders Erlandsson, and Ludvig Adlercreutz.
"Challenges for Spark Ignition Engines in Heavy Duty Application: a Review."
SAE technical paper ***2018-01-0907***

- Three methods of reducing knock
  - Higher octane - Renewable fuels (Ethanol and Methanol)
  - Dilution using EGR maintaining $\lambda = 1$
  - Higher in-cylinder turbulence levels at spark timing

Literature Review

- Alcohol + EGR + fast burn bowl → Effect on limiting knock? Can this achieve 25 bar BMEP in HD SI operation?

- Ethanol + EGR → mixed results for ethanol combustion stability
  Methanol + EGR → Lack of results
  Effect of inlet temperature to reduce COV is of interest

- Particle number of alcohol + EGR → no data available.
  Mechanism for EGR reduction of solid particle number → unclear

- LD strategy of high compression ratio not feasible due to knock
  Miller timing with high expansion ratio could extend BMEP with high efficiency

Future Work: Experiment - Phase 1

Focus on generating combustion and knock data for 1D simulations

Effect of:

- EGR and Lambda
- Full Load and Part load
- Ethanol and Methanol

Parameters:

- 13 CR
- Central Spark Plug
- Port Fuel Injection
- 30% Squish Piston Bowl

Fast Burn Bowl in Phase 2 Experiments

Ongoing Study:

Piston Shape Selection

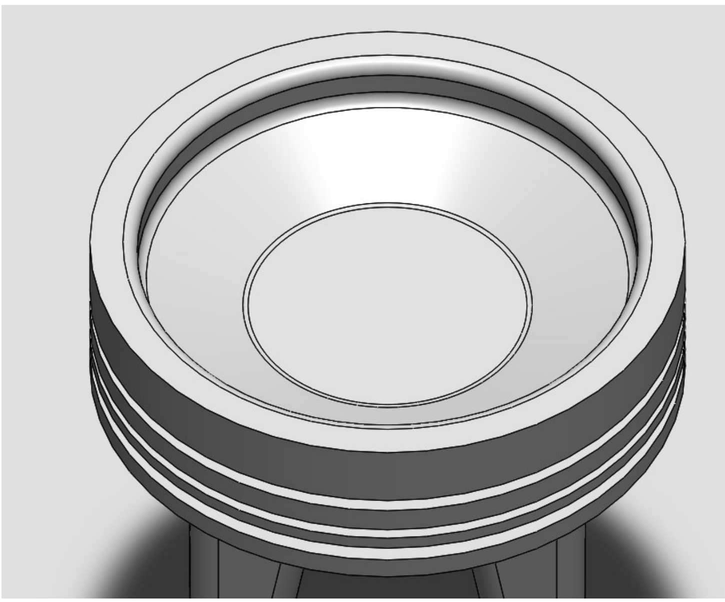
Pre-Study for Experiment Phase 2

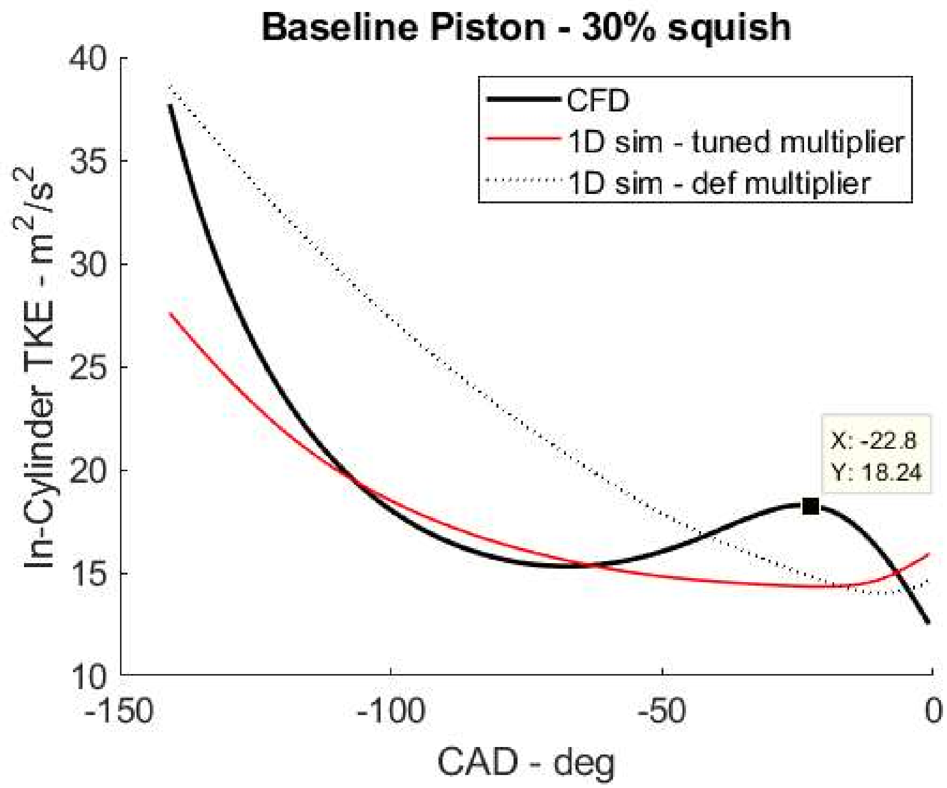
In collaboration with: *Nicola Giramondi*

Varun Venkataraman

Piston Shape Selection

Pre-Study for Experiment Phase 2

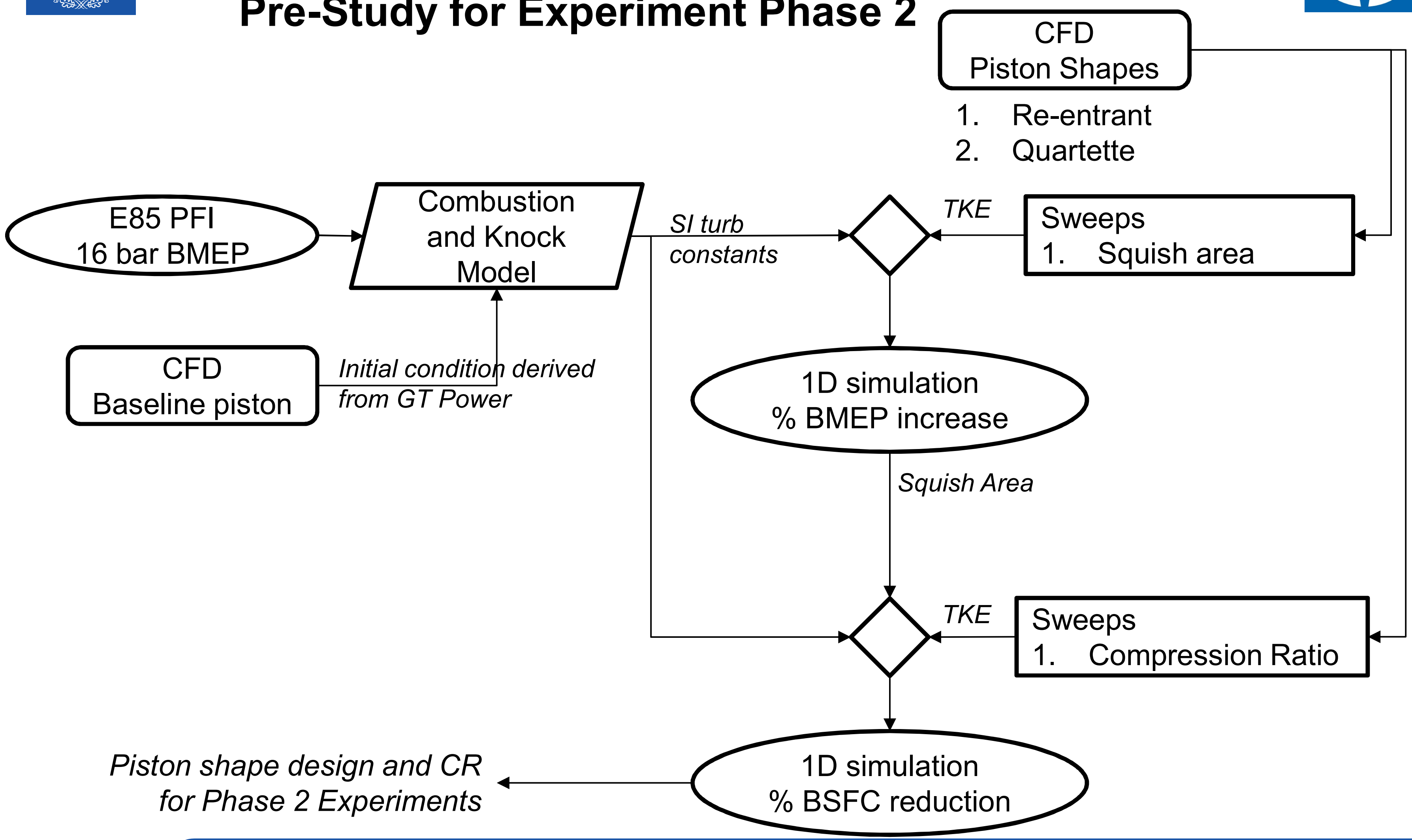




TKE with respect to CAD will be imposed in GT power for modelling piston shapes

Piston Shape Selection

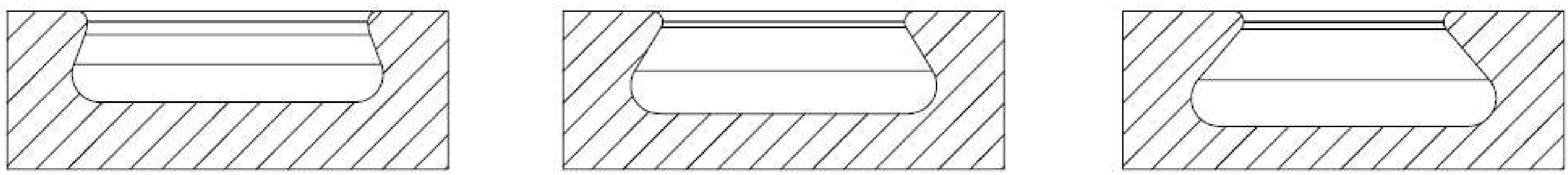
Pre-Study for Experiment Phase 2



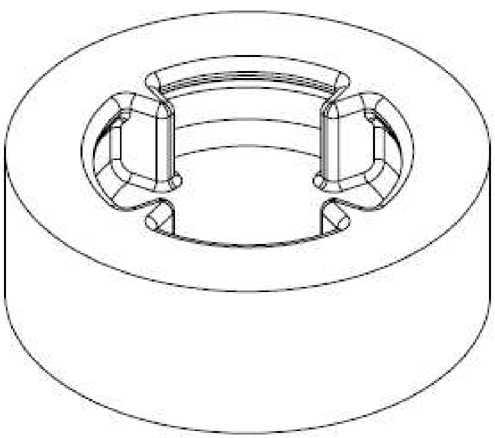
Piston Shape Selection

Pre-Study for Experiment Phase 2

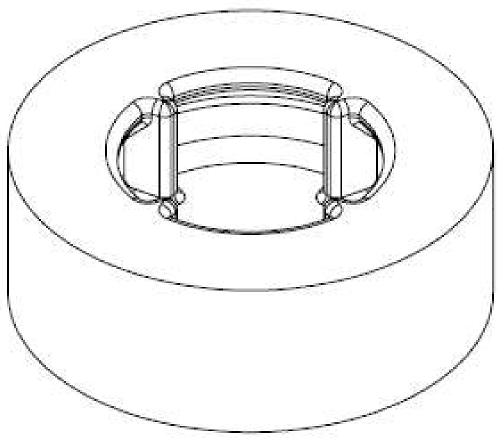
Re-Entrant



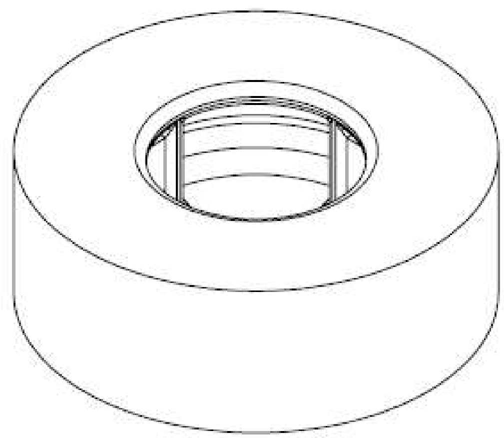
Quartette



SQUISH AREA: 60%



SQUISH AREA: 70%



SQUISH AREA: 80%

Piston Shape Selection

Pre-Study for Experiment Phase 2

- The effect of two different swirl breakdown mechanisms will be captured on combustion speed and knock
- An indication of the more efficient shape, squish area and the potential benefit can be expressed by this study
- Which shape is less dependent on clearance height and swirl level?

Competence Center for Gas Exchange

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