DIN - DEPARTMENT OF INDUSTRIAL ENGINEERING

PhD Course in Mechanics and Advanced Engineering Sciences (DIMSAI)

PHD STUDENT POSTER - AY *2016/2017* Curriculum number *II* Cycle *XXXI*

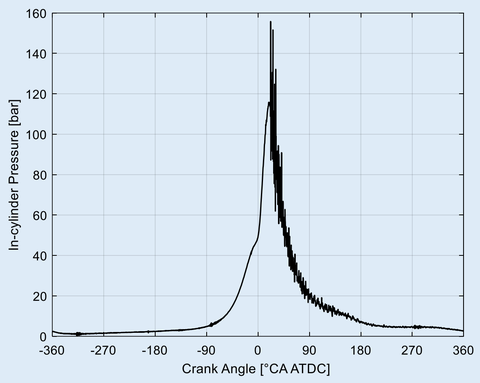
Candidate: *Nahuel Rojo* **Supervisor:** *Nicolò Cavina*

Knocking Combustion Control

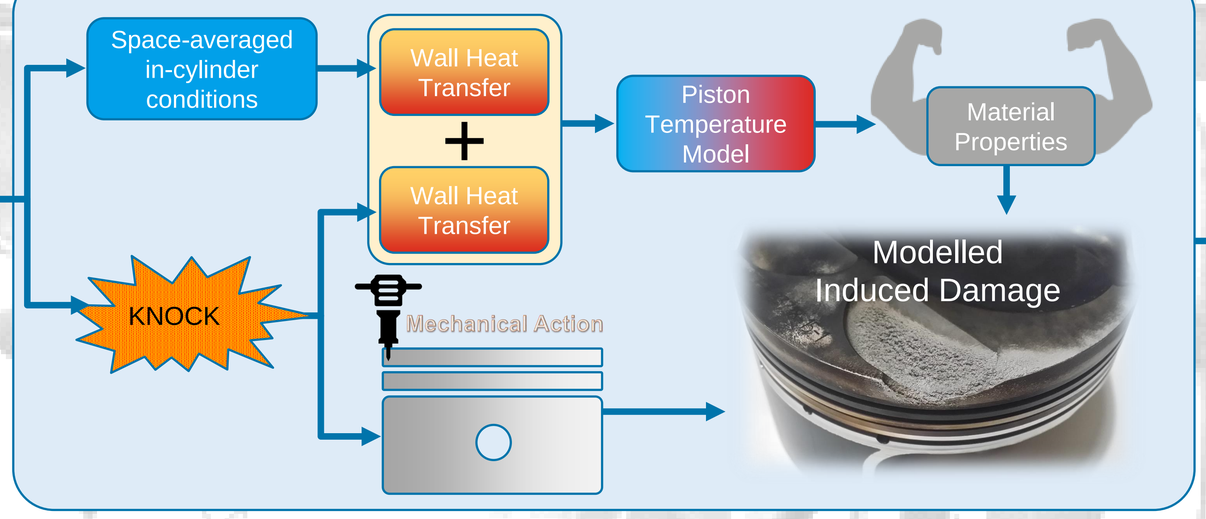
Research topic is focused on the combustion analysis and control. The main activity is oriented to the development of a real-time knock control model able to maximize combustion efficiency by predicting piston damage.

Development of a control-oriented knock damage model

PRESSURE SIGNAL ANALYSIS

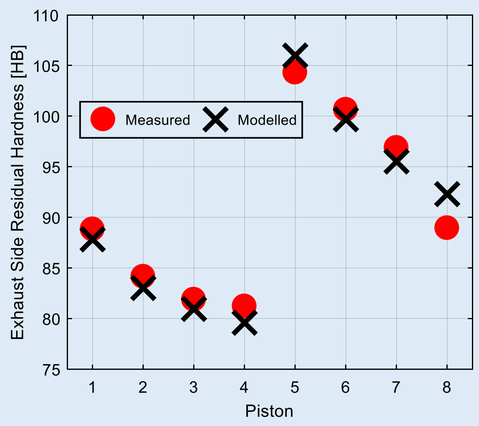


KNOCK DAMAGE MODEL

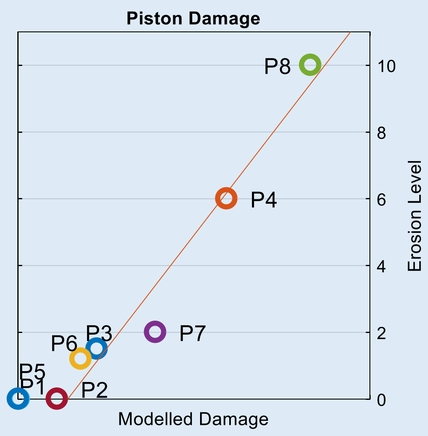


Maximum Engine Efficiency, while preserving reliability

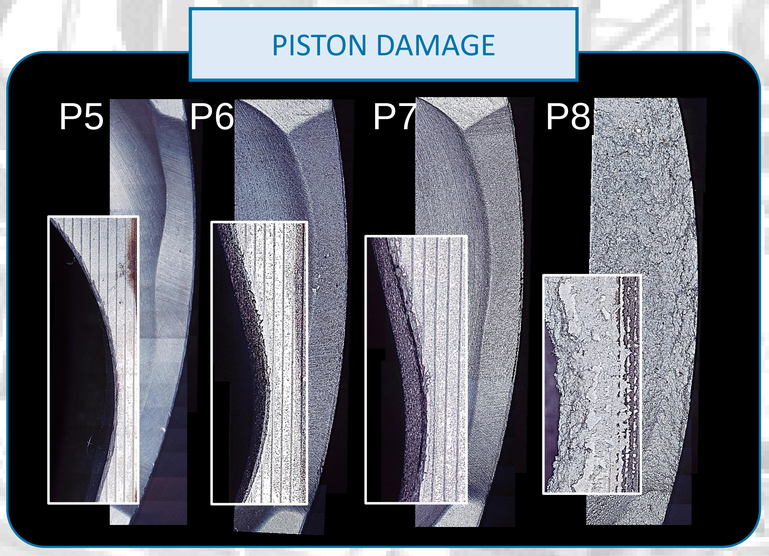
PISTON TEMPERATURE MODEL CALIBRATION



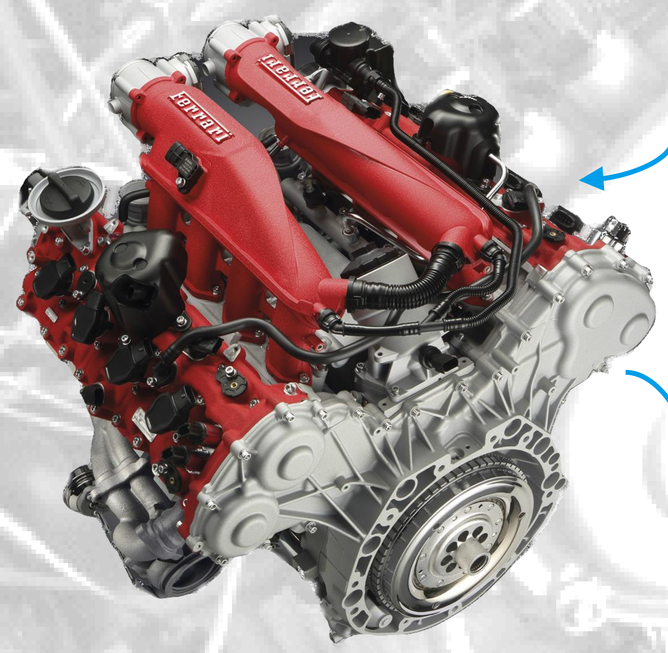
PISTON DAMAGE MODEL CALIBRATION



PISTON DAMAGE



Closed-loop Spark Advance Control



Electronic Control Unit

Spark Advance Angle Correction — via CAN Bus

Rapid Control Prototype

Knock Intensity, Combustion phasing… — via CAN Bus

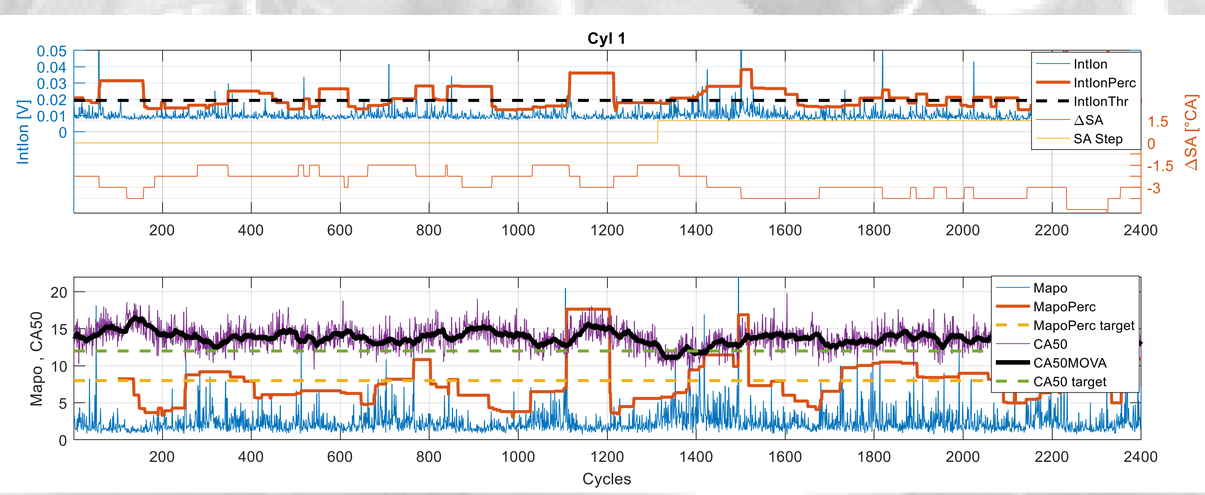
Real Time Indicating Cycle-by-cycle Combustion Parameters

In-cylinder Pressure Signal or Ionization Current Signal

Implemented Spark Advance control strategies:

- Combustion phasing optimization in knock-free and knock-limited operation, using either pressure or ionization current signals
- Knock intensity control based on knock damage model

Ion current-based control, knock-limited operation



Comparison between pressure and Ion current-based SA control performance

	Control		CA50MFB **Mean**	CA50MFB **Std**
Knock-free	Open Loop	-	20.4	1.41
	Pressure	MFB50 target: 20	20	1.48
	ION		19.41	1.48
	Open Loop	-	15.56	1.22
	Pressure	MFB50 target: 15	15.02	1.39
	ION		15.03	1.39

			MapoPerc **Mean**	MapoPerc **Std**	MapoPerc***EQ*** **Mean**
Knock-limited	Pressure	Knock target: 4	5.2	1.64	-
	ION		3.9	1.48	5.38
	Pressure	Knock target: 8	8.75	3	-
	ION		6.85	2.6	9.5

References:

Cavina, N., Rojo, N., Ceschini, L., Balducci, E. et al., "Investigation of Knock Damage Mechanisms on a GDI TC Engine," SAE Technical Paper 2017-24-0060, 2017, ISSN 0148-7191

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Cavina, N., Rojo, N., Poggio, L., Calogero, L. et al., "Investigation on Pre-Ignition Combustion Events and Development of Diagnostic Solutions Based on Ion Current Signals," SAE Int. J. Engines 10(4):1518-1523, 2017, ISSN 1946-3944

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IL PRESENTE MATERIALE È RISERVATO AL PERSONALE DELL'UNIVERSITÀ DI BOLOGNA E NON PUÒ ESSERE UTILIZZATO AI TERMINI DI LEGGE DA ALTRE PERSONE O PER FINI NON ISTITUZIONALI