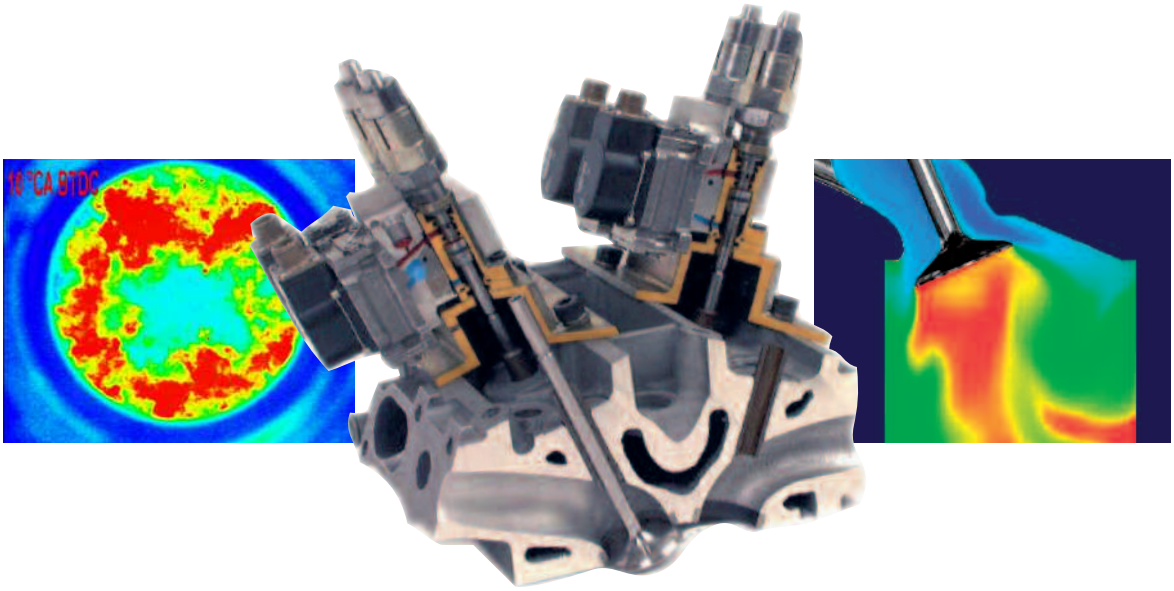
Advanced Engine Combustion Summer School

"From conventional combustion to HCCI and CAI"

Technologies, Modelling, Experimental diagnostics



July 17-28, 2006

IFP School - Rueil-Malmaison, France

Dear Colleague,

The ECO-Engines (Energy Conversion in Engines) Network of Excellence was conceived in 2003 under the European Community Sixth Framework Programme for Research and Technological Development (FP6).

The objectives of the ECO-Engines project are to structure EU research and training in new engine technologies leading to high efficiency, low noise, low CO_2 and near zero pollutant emissions in road transport. In particular, the project will focus on emerging high potential techniques such as HCCI, CAI and CCS, and include alternative and renewable fuels.

Within the project, one workpackage (WP7) is exclusively dedicated to the facets of education and training as described by the ECO-Engines objectives. This Summer School is the direct outcome of the work carried out under WP7, and aims to disseminate the knowledge compiled within ECO-Engines to the broader public. The intended audience includes postgraduate students, professional engineers, scientists and researchers, and representatives of various associations related to the automotive industry.

The group of partners involved in the preparation and undertaking of this Summer School is based on a unique combination of various expertises that cannot be found elsewhere in any single place. In addition these combined expertises are focused on a subject (the new HCCI & CAI combustion processes) that concerns many engine researchers and developers worldwide.

EC funding for the ECO-Engines project concludes in February 2007. It is hoped that industry interest in the project will enable the Network to continue through self-funding. The Summer School is considered as one of the principal benefits of the ECO-Engines project, and it is intended that the school develop into an annual or biannual event. We hope that you will support the continuation of this project through your participation in the 2006 Advanced Engine Combustion Summer School.

Dr Christian Angelberger
ECO-Engines Network Leader

Pierre Duret
WP7 Education and Training Leader

Who should attend

- Students with a Masters level knowledge in engineering (5 years tertiary studies). Registration will be limited to students currently studying at a partner institution within the ECO-Engines network.
- Professional engineers who wish to extend or deepen their knowledge of new engine combustion processes, technologies and experimental techniques, in particular related to the concepts Homogeneous Charge Compression Ignition (HCCI) and Controlled Auto Ignition (CAI).

Module O (general principles of new generation engine combustion processes) assumes a basic knowledge of internal combustion engines as follows:

- fundamentals of engine operation – thermodynamics, fluid mechanics, heat and mass transfer,
- pollutant formation,
- energy resources and greenhouse effect gases reduction context.

Modules A (engine technologies), B (modelling and combustion chemistry) and C (experimental techniques) assume a reasonable understanding of engine combustion processes (SI, Diesel, CAI, HCCI). Attendance at Module O will be sufficient in this regard. In addition, an early university level of chemistry and physics is beneficial to the understanding of modules B and C.

Syllabus

Module O
General principles of new generation engine combustion processes

Module A
Engine technologies associated with new generation engine combustion processes

Module B
Modelling of new generation engine combustion processes

Module C
Experimental techniques for new generation engine combustion processes

	Monday 17 July	Tuesday 18 July	Wednesday 19 July	Thursday 20 July	Friday 21 July
8:30 AM				Registration	
9:00 AM		Module O	Module O	Module A	Module A
10:00 AM	Registration				
11:00 AM	Welcome address				
12:00 PM	Lunch				
1:30 PM	Module O	Module O	Module O	Module A	Module A
5:00 PM	Cocktails				
7:00 PM		Dinner			

	Monday 24 July	Tuesday 25 July	Wednesday 26 July	Thursday 27 July	Friday 28 July
8:30 AM			Registration		
9:00 AM		Module B	Module C	Module C	Module C
10:00 AM	Registration				
12:00 PM	Module B				
1:30 PM	Lunch				Lunch & Closing address
2:30 PM	Module B	Module B	Module C	Module C	
7:00 PM				Dinner	

Module O
General principles of new generation engine combustion processes

July 17-19, 2006

Welcome and introduction to ECO-Engines project
Dr Christian Angelberger, ECO-Engines Network Leader
Pierre Duret, WP7 Education and Training Leader

Introduction
- Overview of current automotive engines
- Overview of the emission and greenhouse gas legislation
- The NOx versus CO_2 efficiency dilemma of today's DI gasoline and diesel engines

Overview – new combustion systems
- Motivation for developing new combustion techniques
- The 2-stroke engine ATAC/TS/AR combustion processes leading to HCCI
- Introduction to HCCI/CAI
- Other innovative combustion processes: dilute operation, H_2 enrichment, ignition enhancement, etc.

Homogeneous Charge Compression Ignition – HCCI
- Principles of diesel combustion engines leading to HCCI combustion
- System requirements for HCCI combustion: fuel injection, turbocharging, etc.
- Performance results, overview of several HCCI systems

Controlled Auto Ignition – CAI
- Principles of spark ignition engines leading to CAI combustion
- System requirements for CAI: EGR, air fuel ratio, etc.
- Performance results, overview of current CAI systems

Fuelling for new combustion systems
- Alternative fuels
- Fuel effects on HCCI/CAI combustion

Module A
Engine technologies associated with new generation engine combustion processes

July 20-21, 2006

Introduction to engine technologies
- Why is higher engine management flexibility needed?
- Overview of new and available technologies: their potential and impact on HCCI/CAI combustion
- Turbocharging, supercharging and EGR systems for advanced combustion engines

Variable Compression Ratio (VCR)
- Introduction to VCR – main principles, characteristics, thermodynamic potential
- Overview of the past and recent VCR systems
- Advantages, drawbacks, technological constraints and economical issues of VCR systems
- Example of detailed thermodynamic analysis of selected VCR systems

Variable Valve Actuation (VVA)
- Introduction to VVA – motivation and basic principles
- Standard and novel applications of VVA with potential for HCCI/CAI use
- Overview of various VVA systems

Engine control for advanced combustion processes

- Main principles and characteristics of innovative control technologies and systems
- Control differences between HCCI and current diesel engines
- Actuators, sensors, control of HCCI/CAI engines, mode switch
- Potential for cycle to cycle closed-loop control of combustion

After-treatment for advanced combustion processes

- HCCI/CAI exhaust gases characteristics
- After-treatment technologies and HCCI/CAI engines – their potential and current issues
- Future emission legislations and advanced combustion engines

Module B
Modelling of new generation engine combustion processes

July 24-25, 2006

Introduction and overview of modelling methods

- Computational modelling
- Turbulence, spray combustion, kinetics-flow interactions
- Overview of the existing modelling approaches for HCCI/CAI
- Assumptions, advantages and disadvantages of the various modelling approaches

Fuels oxidation chemistry and chemical kinetic mechanisms

- Chemistry fundamentals: reaction rate, types of reactions, surface reactions, NOx and soot formation
- Low, intermediate and high-temperature oxidation of hydrocarbons
- Exploration limits, methane and hydrogen oxidation
- Single-step, generalised, detailed and reduced kinetic mechanisms
- Automatic generation, optimisation and validation of simplified kinetic mechanisms

Auto-ignition modelling

- Combustion physics and auto-ignition chemical schemes aspects, auto-ignition delays and ignition limits (HCCI in particular, alternative fuels auto-ignition characteristics)
- Mixture formation and engine parameters effects on auto-ignition (EGR, additives, etc.)

Overview of commercial codes and Internet resources

- Detailed CFD, engine cycle simulators, and advanced models
- Understanding and interpretation of predictions from a large range of commercial codes

Module C
Experimental techniques for new generation engine combustion processes

July 26-28, 2006

Introduction to measurement techniques

- Nomenclature, important characteristics and spectroscopy
- Optical access in engines

Conventional techniques

- Optical diagnostics (Schlieren, flame emission, absorption)
- Sampling methods (in-cylinder sampling, exhaust gas measurements)

Laser-based diagnostics

- Introduction to laser diagnostics (characteristics of laser-based methods, instrumentation)
- Flow diagnostics (particle-image velocimetry, laser Doppler anemometry, phase Doppler anemometry)
- Techniques for species (laser-induced fluorescence, Raman scattering)
- Techniques for temperature (Rayleigh scattering, coherent anti-stokes Raman scattering, laser-induced fluorescence, IR absorption, thermographic phosphors)
- Spray diagnostics/particle diagnostics (laser-induced fluorescence, Mie scattering, ballistic imaging, laser-induced incandescence)

Contributing institutions

IFP, France (Mr Pierre Duret, Dr Deanna Wang)
www.ifp.fr, www.ifp-school.com

IFP is a scientific research and industrial development centre active in the domains of oil, gas, engines, and new energy and environmental technologies. IFP is recognized as a European centre of excellence in the field of advanced engine combustion, with pioneering work in two- and four-stroke gasoline CAI combustion, and the NADI concept for Diesel HCCI. IFP was the initiator and co-ordinator of 5 EC RTD projects within the FP5 SPACE cluster that explored the HCCI/CAI processes in detail. IFP education and training is carried out through the IFP School which covers all fields of IFP expertise. Each year, around 500 students graduate from the school, of which approximately half come from one of 40 countries.

Brunel University, United Kingdom (Prof Hua Zhao, Dr Tom Ma)
www.brunel.ac.uk

Brunel University is located in West London near the London Heathrow airport. Named after the famous British engineer, Isambard Kingdom Brunel, Brunel University is well known for its engineering research. The combustion engines research group at Brunel University is one of the largest and most active research groups on combustion engines and their fuels in the UK, having participated in several EU, industrial and government sponsored projects. The engines labs are equipped with the state-of-the-art engine testing equipment and laser diagnostic techniques, and current research topics cover advanced combustion engines, their fuels, in-cylinder flow and combustion modelling and diagnostics.

Lund Institute of Technology, Sweden (Prof Per-Erik Bengtsson, Dr Edward Blurock, Dr Joakim Bood, Dr Gladys Moréac, Dr Mattias Richter)
www.forbrf.lth.se

Lund University is the biggest University in Scandinavia with around 35,000 students. Lund Institute of Technology (Lunds Tekniska Högskola – LTH) is the biggest faculty within the University. The LTH partner within WP7 is the Division of Combustion Physics at the Department of Physics with around 40 people, mainly researchers. There are 2 major research fields: laser-based techniques and chemical kinetics. In the field of laser-based techniques, new laser diagnostics tools are developed, characterized and applied to combustion systems. In the area of chemical kinetics, detailed chemical mechanisms are developed and reduced to smaller mechanisms via different strategies applicable to practical combustion systems. The Division of Combustion Physics is part of the Lund Combustion Centre, the Lund Laser Centre, the Swedish National Centre for Combustion Science and Technology (CECOST) and a European Large Scale Facility in which researchers are funded by the EC to carry out advanced combustion experiments.

Politecnico di Milano, Italy (Dr Matteo Perotti, Prof Aldo Coghe)
www.polimi.it

With 7 campuses and more than 40,000 students, the Politecnico di Milano (POLIMI) is the largest technical university in Italy. Established in 1863 it is now ranked as one of the most outstanding European universities in engineering, architecture and industrial design, and in many disciplines it is regarded as a leading research institution worldwide. There is a close and prolific relationship between POLIMI and the economic and manufacturing sectors, resulting in a significant amount of experimental research and technology transfer. POLIMI is also actively involved in several research and training projects with numerous highly regarded universities in Europe, North America and Pacific Asia. Within this framework, POLIMI was involved in 2 EC RTD projects within the FP5 SPACE cluster that explored in detail the HCCI/CAI combustion processes.

Reaction Engineering Solutions, United Kingdom (Dr Amit Bhave)
www.resolutionsltd.com

Reaction Engineering Solutions Ltd. (RESL) is a product- and service- based SME spun out from the University of Cambridge and the Lund Institute of Technology in 2001. RESL focuses on developing practical, efficient computational solutions for tackling problems in the fields of combustion engineering, engine and emissions modelling, and nanoparticle dynamics. Together with our partners, we are actively involved in simulating advanced combustion modes (e.g. HCCI/CAI), and in gaining better insight into the intrinsically complex emissions (e.g. CO, soot) using novel numerical tools.

Universität Duisburg-Essen, Germany (Prof Dr Christof Schulz, Dr Boris Kock)
www.vug.uni-duisburg.de

The Institute for combustion and gas dynamics (IVG, Dept. of Mechanical Engineering) of the University of Duisburg-Essen has been active for many years in the fields of combustion chemistry and laser diagnostics. Research is performed in several key areas, including reaction kinetics and dynamics of processes relevant to combustion and nanoparticle formation. In the group, novel laser-based in-situ diagnostics techniques have been developed and applied not only to these studies, but also to allow quantitative measurements (including two-dimensional imaging) of transient species concentrations, temperatures, flow velocities, spray characteristics and their cross correlation in practical devices with the view to a better understanding of combustion processes such as fuel-air mixing, temperature, NOx and particulate formation in engines.

Université Pierre et Marie Curie - Paris VI, France (Dr Luis Le Moyne, Prof Philippe Guibert, Ms Zeynep Serinyel)
www.lmp.jussieu.fr

UPMC (or Paris VI) welcomes over 30,000 students and 4,000 researchers in medicine, biology, chemistry and physics making it one of the largest scientific European universities with a tradition of scientific excellence. Its Laboratory for Physical Mechanics (LMP) has carried out research in engines, combustion physics and chemistry for more than half a century, focusing on experimental techniques and new combustion processes. Its staff offers lectures in engines and alternative combustion modes from the bachelor to doctorate level, and also professional training and practices on the engine test benches. The LMP is also involved in productive collaborations with teaching institutions of the highest level in France, Germany and Spain, and with several European industrial partners.

Universidad Politécnica de Valencia, Spain (Prof José Pastor, Dr José M. García, Dr José M. Luján)
www.cmt.upv.es

The Universidad Politécnica de Valencia, founded in 1971, is a technical university in Spain with around 38,000 students and a teaching staff of 2,500. The research group CMT-Motores Térmicos was founded in 1979 and is very actively involved in many R&D projects which are supported by both private companies and public funds, including several European research programmes.
Research areas include the analysis of diesel and HCCI combustion, as well as many other subjects related to thermo-fluid-dynamic processes such as air management, turbulent noise, engine control, predictive maintenance and experimental techniques for engine research.

Warsaw University of Technology, Poland (Prof Andrzej Teodorczyk)
www.pw.edu.pl

Warsaw University of Technology (WUT) is a research intense, doctoral level academic institution focused on undergraduate and graduate programs almost exclusively in engineering and applied sciences.
With over 30,000 students served by over 2,000 professors and instructors, Warsaw University of Technology is the largest and the highest ranking engineering university in Poland.
The origins of WUT date back to 1826. There are 17 faculties covering almost all fields of engineering and applied science. The WUT partner in the ECO-Engines project is the Division of Aircraft Engines.
This research group is extremely experienced in the field of experimental studies and numerical modelling of combustion, explosions and detonations with the focus on internal combustion engine processes and safety related phenomena.

General Information

Venue and date

The ECO-Engines Summer School will be held at the IFP School in Rueil-Malmaison (France) on 17-28 July 2006. All attendees are responsible for their own transport arrangements. Rueil-Malmaison is located approximately 10 km west of Paris.
Detailed travel information can be found at access map. (http://www.ifp.fr/IFP/en/contacts/ah01_01.htm#rueil)

The ECO-Engines Summer School will endeavour to cater to the access requirements of all attendees. If you have any particular mobility needs, please let us know in advance.

Official language

English

Visa

You may need a visa to enter France from some countries outside the European Union. Please contact the French embassy or consulate in your country, or your travel agency, to determine whether you need a visa.

Attendance fees

Registration will be accepted only for full modules. Prices listed below are in Euros (€), 19,60% VAT included. The fees include all handouts, reference material, luncheons, breaks, cocktail and dinners when relevant.
The ECO-Engines Summer School gratefully acknowledges the support of the Tuck Foundation, who has agreed to cover a majority of the Summer School costs for the students. In order to be eligible for these reduced fees, students must enclose a copy of their student card with their registration.

	Module O General principles	**Module A** Engine technologies	**Module B** Combustion modelling	**Module C** Experimental techniques
Professionals	1000 €	600 €	600 €	900 €
Students	200 € to attend all 4 modules			

ECTS (European Credits Transfer System)

Each module has been assigned 1 ECTS credit (4 ECTS credits in total for the whole programme).
As no examinations will be held, students must attend all lectures to be awarded the ECTS credit for that module. Please note that it is the student's responsibility to verify that their home institution will accept ECTS credits from the ECO-Engines Summer School.

To register

Please complete the enclosed registration form (one per participant) and send it to the administrative secretariat Com'on dit. To be accepted, the registration form must be accompanied by the relevant payment (and copy of the student card if relevant). Upon receipt of the registration form and the payment, the administrative secretariat will send each participant a letter of confirmation of participation.

Registration is limited to 90 people for Module O and 60 people each for Modules A, B and C. Since attendance is limited, we strongly suggest that you register as early as possible.

Payment

All fees are payable in Euros only:

- by cheque
- by bank transfer
- by credit card (Visa, Eurocard-Mastercard)

Terms of cancellations

The administrative secretariat Com'on dit must be notified of any cancellation by letter or fax.

- Before 15 June 2006 all cancellations will be subject to a 200 € processing fee.
- After 15 June 2006 refunds will not be issued.

Accommodation

All professional attendees are responsible for their own accommodation arrangements. Reservations should be made directly with the hotel. Several hotels located in the area of Rueil-Malmaison are listed here for your convenience:

Hotel	Tel./Fax	Single/Double	Breakfast
Hotel Ibis** 16, boulevard de l'Hopital Stell 92500 Rueil-Malmaison	+33 1 47 32 96 96 +33 1 47 49 01 90	98/98 €*	6,50 €
Quality Rueil Centre Cardinal*** 1, place Richelieu 92500 Rueil-Malmaison	+33 1 47 08 20 20 +33 1 47 08 35 84	112/136 €*	included
Hotel des Arts*** 3, boulevard du Maréchal Joffre 92500 Rueil-Malmaison	+33 1 47 52 15 00 +33 1 47 14 90 19	92/101 €*	included
Quality Rueil/La Défense*** 20, avenue Albert 1er 92500 Rueil-Malmaison	+33 1 47 32 20 92 +33 1 47 49 69 87	113/137 €*	included

* **Attendees should request the IFP corporate rate when reserving their accommodation in order to obtain the prices quoted above.**

For students, accommodation has been arranged with the Etap Hotel – 147 boulevard National in Rueil-Malmaison, Tel. +33 8 92 68 12 78 – Fax +33 1 41 96 93 67 (15 minutes walk from IFP). The accommodation (including breakfast) in twin rooms will be provided by the Tuck Foundation. Students may nominate a roommate if they wish. They may also choose to occupy a single room by paying 26 € per night.

Contacts

Administrative secretariat (registration, accommodation, payment)
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ECO-Engines website
http://project.ifp.fr/eco-engines