



Contents of Work Package Contents of Work Package WP 02 Advanced Concepts of ICEs

WP02: Advanced Concepts of Internal Combustion Engines

Coordinator of the WP

Czech Technical University in Prague, package leader Doc. Ing. Oldřich Vítek, Ph.D.

Participants of the WP

Škoda Auto – Ing. Václav Uzlík; Brno University of Technology – Prof. Ing. Václav Píštěk, CSc.;
Technical University of Liberec – Ing. Robert Voženílek, Ph.D.

Main Goal of the WP

New concepts of thermal engines and the components used as the main or secondary source of tractive power for both vehicles and distributed heat&power cogeneration. Specific requirements on hybrid ICE. Innovations and new systems for waste energy recovery. Assessment methods for impacts of renewable energy sources on global WTW parameters. Development of testbed equipment for vehicle part testing and methods for assessment of R&D laboratory experiments as a source of calibration data.

Partial Goals for the Current Period

Single-cylinder research engine + initial 3-D CFD testing

Manufacturing of the new crank train parts, valve train design and simulations, ICE assembly.

Module for injection mixture formation, analysis of friction losses and hydraulic system of ICE



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WP02 Official Deliverables:

- 1-WP02-003 (ZV) | Internal-combustion engine concept for a hybrid power unit (• Gfunk - funkční vzorek), SA, BUT

WP02 Milestones:

- 1-WP02-001 | Single-cylinder research engine for testing of unconventional combustion. (• Gfunk - funkční vzorek), CTU, SA
- 1-WP02-002 | Detailed models and SW tools for modeling of advanced ICE concepts. (• R – software), CTU, SA
- 1-WP02-004 | Module for the experimental investigation of port injection mixture formation. (• Gfunk - funkční vzorek), TUL, SA
- 1-WP02-005 | Mule engine for friction loss measurement. (• Gfunk - funkční vzorek), TUL, SA



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WP02 Milestones:

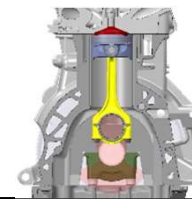
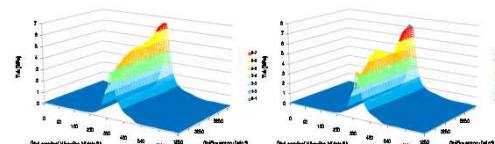
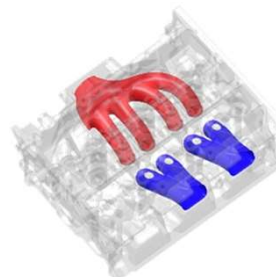
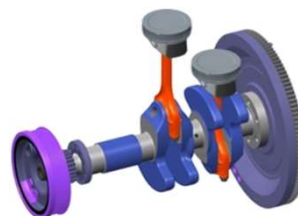
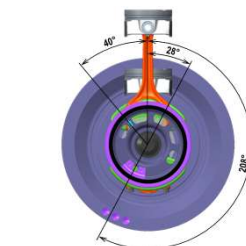
- 1-WP02-006 | Analysis of dynamic phenomena in hydraulic system for variable valve actuation and adjacent lubrication system. (• O - ostatní výsledky)
- 1-WP02-007 | Papers related to advanced internal combustion engines. (• O - ostatní výsledky), CTU, BUT, TUL, SA



Activities in Contents of Work Package WP 02 Advanced Concepts of ICEs

1-WP02-003

- two-cylinder engine in three-cylinder engine block
- saving R&D costs
- new cylinder unit concept (not used on any other engine EA211)
- qualitatively different sort of vibration



- Detailed presentation:

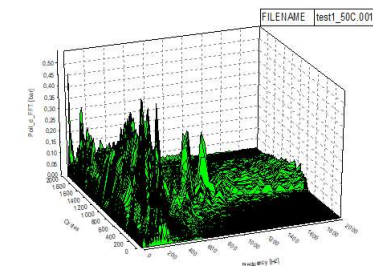
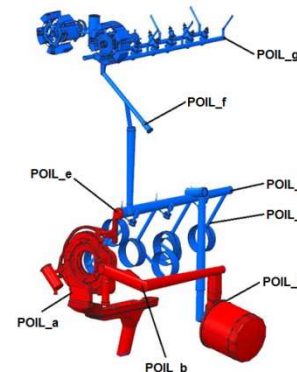
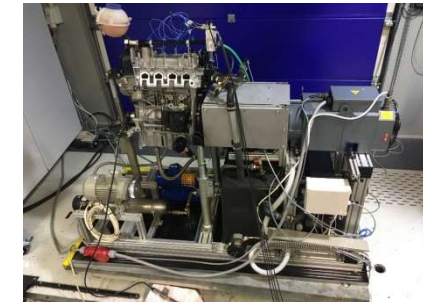
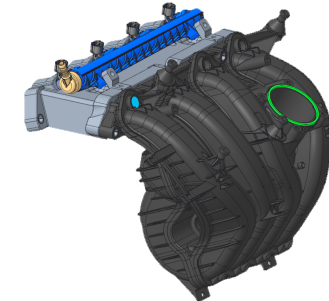
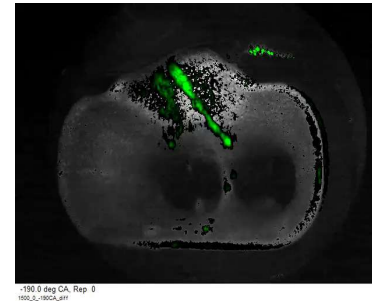
1-WP02_Bozek2020_Drapal-ZV_003.pptx



Activities in Contents of Work Package WP 02 Advanced Concepts of ICEs

1-WP02-004 & 1-WP02-005

- detailed experiments with focus to visualize low-pressure fuel injection
- 2 unique test devices were designed and built to measure FMEP of ICE – they can also be used to accelerate long-term reliability tests
- Detailed presentation:
1-WP02_Bozek2020_Vozenilek-O_004_&_O_005.pptx

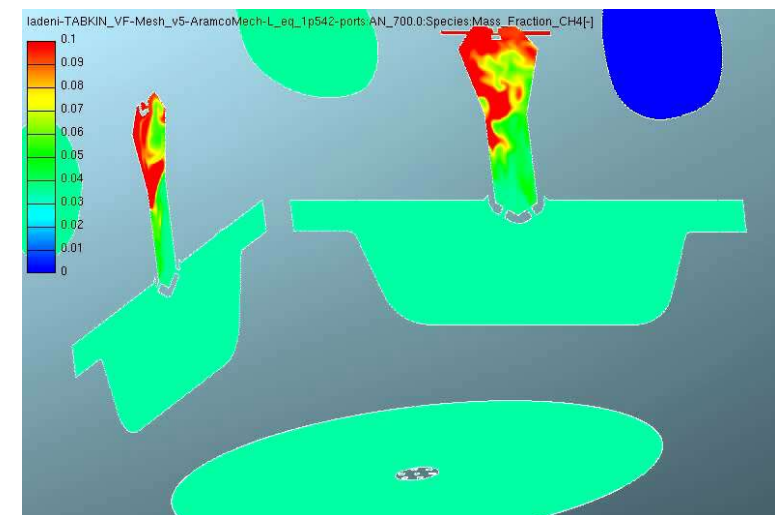
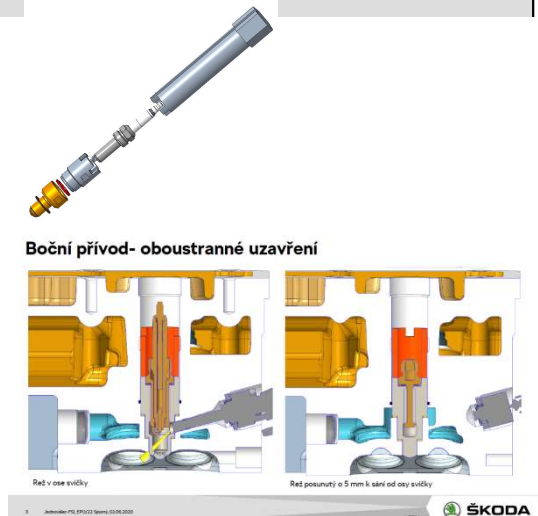
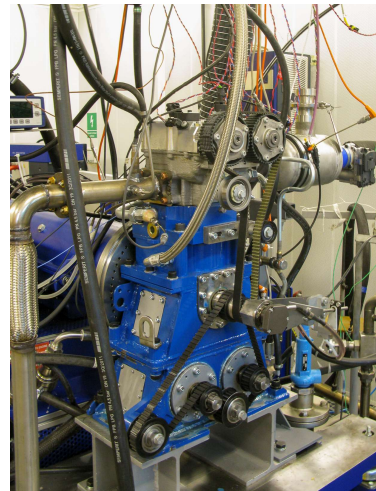




Activities in Contents of Work Package WP 02 Advanced Concepts of ICEs

1-WP02-001 & 1-WP02-002

- focus is on unconventional combustion modes while using gasoline fuel => lean operation with very fast ROHR
- experimental and simulation R&D
- more info in 1-WP03-001





Fulfillment of goals and deliverables of Contents of Work Package WP 02
Advanced Concepts of ICEs

Dosažené a pro prosinec 2020 = závěr projektu = již zpracované cíle, výstupy/výsledky (funkční vzorky, SW, patenty, publikace) na 1-2 snímkách

Current State of Deliverables, Milestones and Fulfillment of Goals

dle popisu výsledků a obsahu milníků v BoJOBNAC_2019-01-

23_Appendix_SP1_SP2v8.pdf, avšak s rozumem interpretujte relevantní část výsledků (do webového formuláře v odborné části zprávy samozřejmě musíme vyplňovat to, co je v projektu, ale pro přednášku to interpretujte logičtěji): **cíle jsou obecné záměry (snížení spotřeby paliva prostřednictvím nižších mechanických ztrát), milníky jsou souborem dílčích výsledků**

List of Due Deliverables and Their Added Value

výsledky jsou „materializací“ splnění cílů, přijatelných (a později přijatých) pro RIV

Doplňte i finanční (zvýšení obrátu, zisku, zaměstnanosti) a nefinanční přínosy (konkurenceschopnost, možnost dalšího rozvoje, trvalá udržitelnost investic ...) dopadů řešení projektu (odhad).



Fulfillment of goals and deliverables of Contents of Work Package WP 02
Advanced Concepts of ICEs

Current State of Deliverables, Milestones and Fulfillment of Goals

- 1-WP02-003 (ZV) | Internal-combustion engine concept for a hybrid power unit (• Gfunk - funkční vzorek), SA, BUT – **finished:**
 - Activities focused on crank train and valve train. Both thermodynamic sensitivity studies and design one were carried out to find optimal concept of ICE in hybrid vehicle.
- 1-WP02-001 | Single-cylinder research engine for testing of unconventional combustion. (• Gfunk - funkční vzorek), CTU, SA – **finished:**
 - Single-cylinder research ICE was built (cooperation with Skoda Auto) and initial experiments were performed in VTP Roztoky lab. Multi-fuel (gasoline/CNG/hydrogen) setup is being prepared.



Fulfillment of goals and deliverables of Contents of Work Package WP 02 Advanced Concepts of ICEs

Current State of Deliverables, Milestones and Fulfillment of Goals

- 1-WP02-002 | Detailed models and SW tools for modeling of advanced ICE concepts. (• R – software), CTU, SA – **in progress & no major delays:**
 - Geometry data are available, final meshing was done. Different combustion models have been tested. Experimental data from single-cylinder ICE are available => different combustion modes/regimes (based on applied multi-fuel setup) were and will be tested/evaluated.
- 1-WP02-004 | Module for the experimental investigation of port injection mixture formation. (• Gfunk - funkční vzorek), TUL, SA – **finished:**
 - Design proposal was prepared and parts were manufactured. Testing was performed in 2020.



Fulfillment of goals and deliverables of Contents of Work Package WP 02 Advanced Concepts of ICEs

Current State of Deliverables, Milestones and Fulfillment of Goals

- 1-WP02-005 | Mule engine for friction loss measurement. (• Gfunk - funkční vzorek), TUL, SA – **finished**:
 - Experimental device was built and initial measurements were carried out. Detailed testing was performed in 2020.
- 1-WP02-006 | Analysis of dynamic phenomena in hydraulic system for variable valve actuation and adjacent lubrication system. (• O - ostatní výsledky) – **finished**:
 - Initial analysis was performed and experiments were proposed and performed – this includes detailed setup (e.g., sensor locations) to improve quality of analysis.



Fulfillment of goals and deliverables of Contents of Work Package WP 02 Advanced Concepts of ICEs

Current State of Deliverables, Milestones and Fulfillment of Goals

- 1-WP02-007 | Papers related to advanced internal combustion engines.
(• O - ostatní výsledky), CTU, BUT, TUL, SA – **2019/2020:**
 - PROCHÁZKA, R., DITTRICH, A., **Measuring mechanical losses of piston combustion engine by spinning at various working pressures in engine cylinders**, The 8th international conference on mechanics and materials in design, University of Bologna, September 4 - 6, 2019, Bologna, Italy
 - DRÁPAL, L., DLUGOŠ, J., VOPAŘIL, J., **Simulation of torsional dynamics of a two-cylinder internal-combustion engine connected to a dynamometer**. In: MAGA, D., ed., 19th Mechatronika 2020. Prague: Czech Technical University in Prague, 2020, will be published on 2nd December 2020 (indexed in Web of Science and Scopus).



Fulfillment of goals and deliverables of Contents of Work Package WP 02 Advanced Concepts of ICEs

List of Due Deliverables and Their Added Value

- **1-WP02-003 (ZV)** – Results are useful in development of production parts, especially hybrid and range extender power train; R&D of ICE with low number of cylinders (know-how); building a technology demonstrator.
- **1-WP02-001 + 1-WP02-002** – possibility of R&D using both simulations and experiments – main focus is on unconventional combustion modes (reducing fuel consumption, CO₂ and pollutants).
- **1-WP02-004** – improved knowledge of port fuel injection system which allows for better future design(s).
- **1-WP02-005** – faster and more reliable experimental verification of different designs from FMEP point of view (including selected subassemblies – e.g., piston one).
- **1-WP02-006** – detection of critical locations & operation of ICE hydraulic system.
- **1-WP02-007** – improving TUs 'visibility'.



Fulfillment of goals and deliverables of Contents of Work Package WP 02
Advanced Concepts of ICEs

Assessment of the Contribution of Deliverables

- Thermodynamics of lean mixture combustion while using scavenged pre-chamber – 1-WP03, 1-WP06.
- ICE for hybrid vehicle – relation to 1-WP01 and possibly 1-WP03 (advanced combustion mode(s)).
- Commercial activities with Skoda Auto with TUs (CTU, BUT, TUL).



Current contribution of Contents of Work Package WP 02 Advanced Concepts of ICEs

Thank you for you attention

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All the help has been gratefully appreciated.



Appendices to Contents of Work Package WP 02 Advanced Concepts of ICEs

Appendices

Pokud jsou zapotřebí pro elektronickou formu sborníku. Nebudou prezentovány při přednášce.

Rozsah libovolný do celkového pdf rozsahu presentace 10 MB.

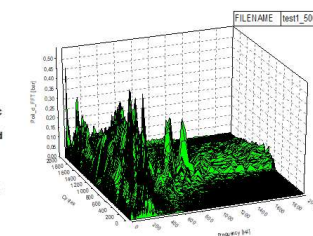
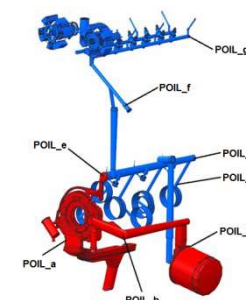
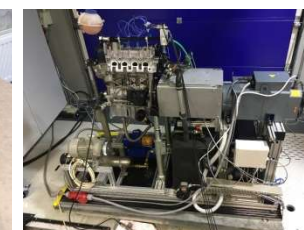
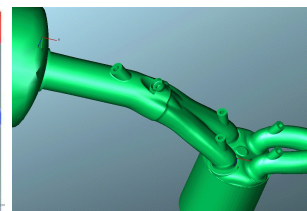
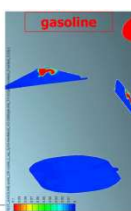
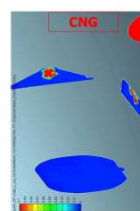
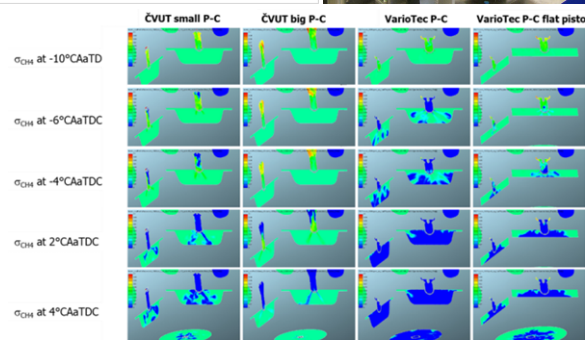
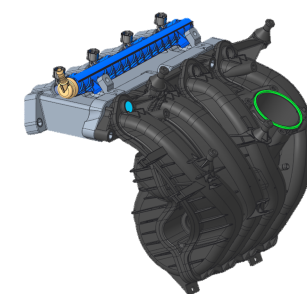
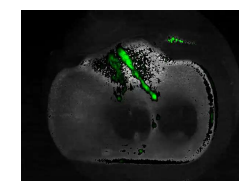
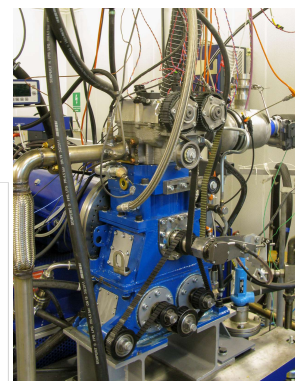
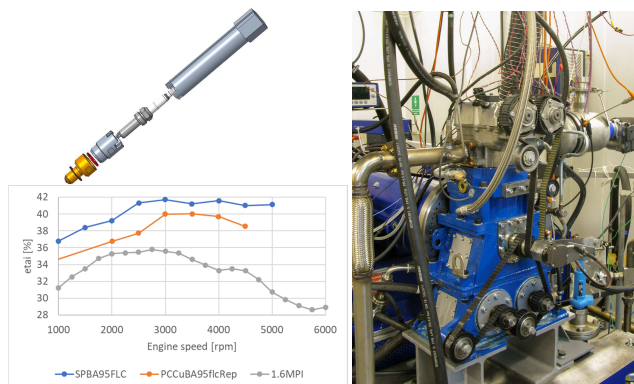
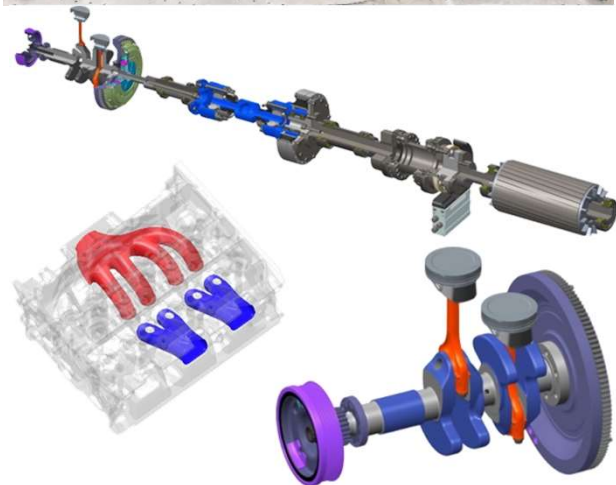


Výťah z prací 2019-2020 na WP 02 Koncepty pokročilých spalovacích motorů

ŠA + VUT: motor pro hybrid

ŠA + ČVUT: výzkum spalování

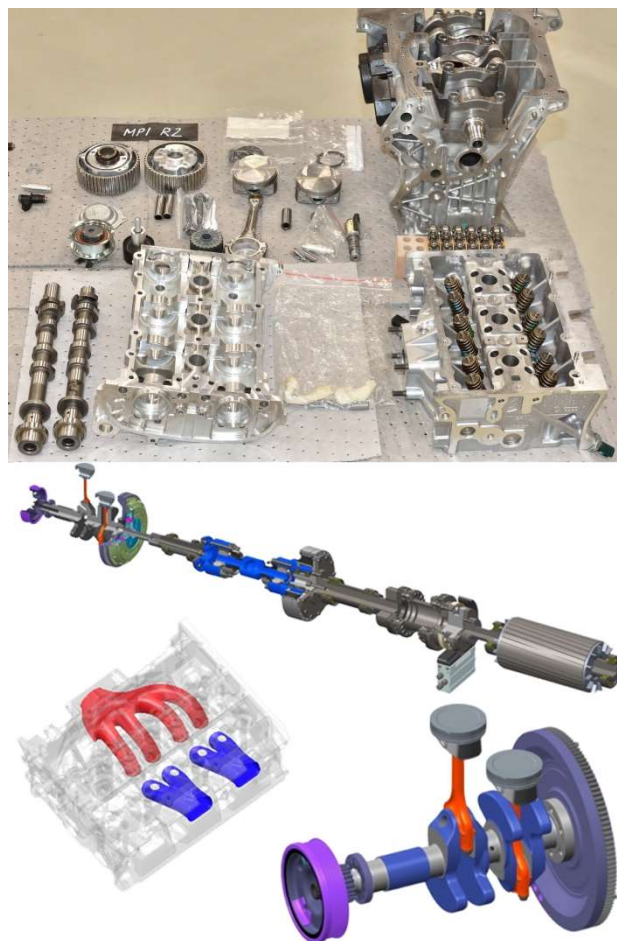
ŠA + TUL: experimentální výzkum



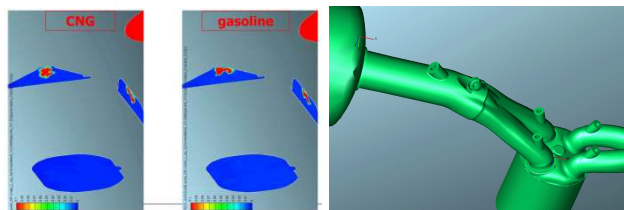
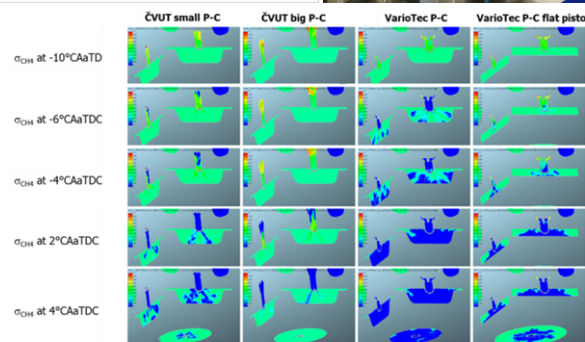
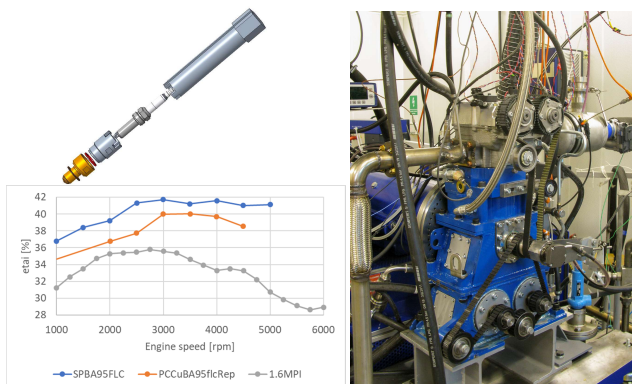


Results of Contents of Work Package WP 02 Advanced Concepts of ICEs – Achieved 2019-2020

SA + BUT: ICE for hybrids



SA + CTU: combustion R&D



SA + TUL: experimental R&D

