Contents of Work Package WP 02 Advanced Concepts of ICEs

1-WP02-003 (ZV) | Internal-combustion engine concept for a hybrid power unit :

Internal-Combustion Engine Concept for Hybrid Power Unit

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Contents of Work Package WP 02 Advanced Concepts of ICEs

1-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, DrSc.; 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.

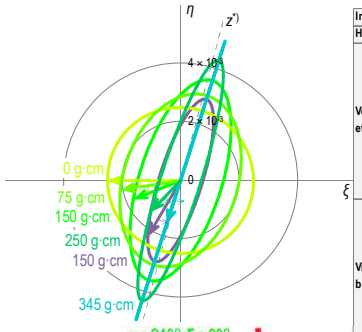
Partial Goals for the Current Period

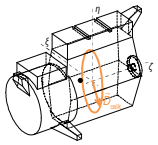
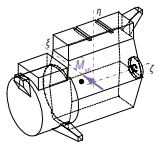
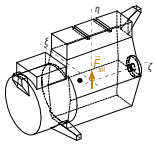
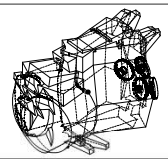
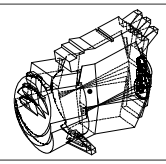
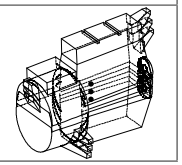
Assembly and testing of the internal-combustion engine concept for hybrid power unit

Activities in WP 02 Advanced Concepts of ICEs
BUT-SA: Internal-combustion engine concept for a hybrid power unit

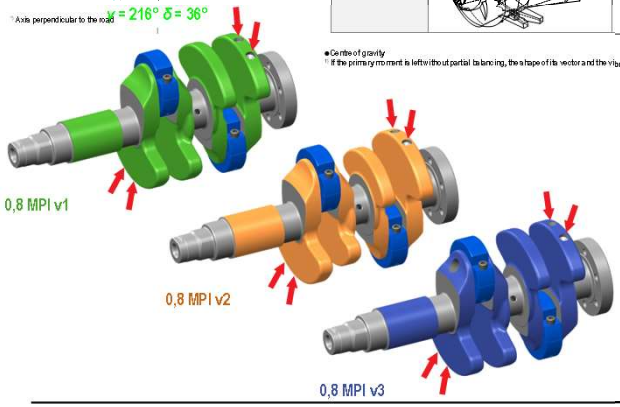
Research and development of crank train

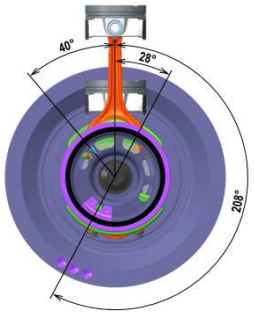
- Two-cylinder engine in three-cylinder engine block
- Saving R&D costs
- New cylinder unit concept (not used on any other engine EA211)
- Qualitatively different sort of vibration

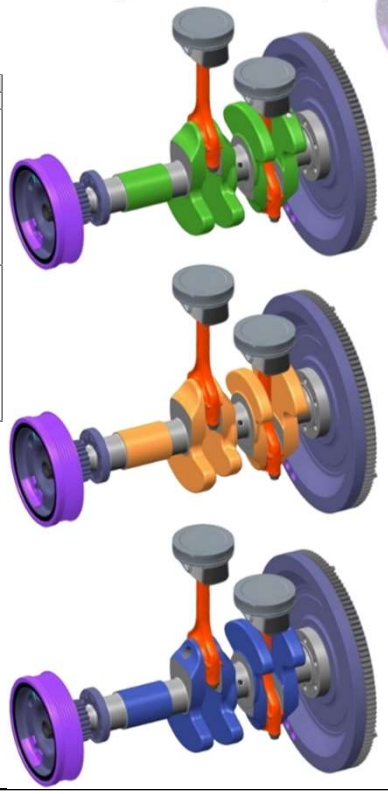


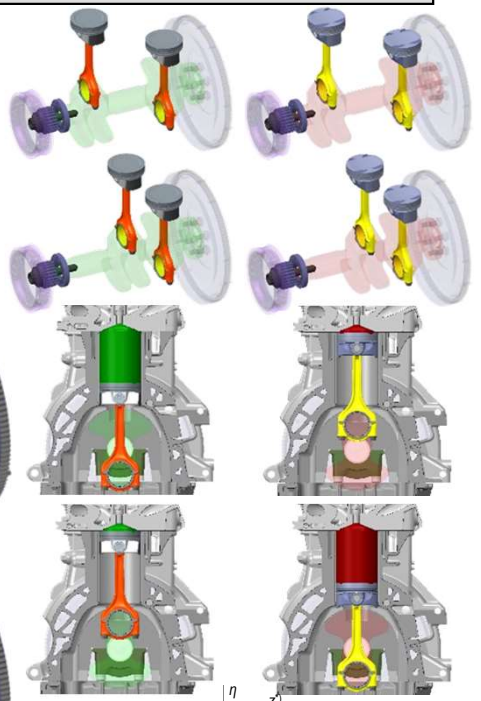
Inertia effect	Partially balanced primary moment[1]	Partially balanced secondary moment	Secondary force
Harmonic order	1	2	2
Vector of inertia effect			
Vibration caused by inertia effect			

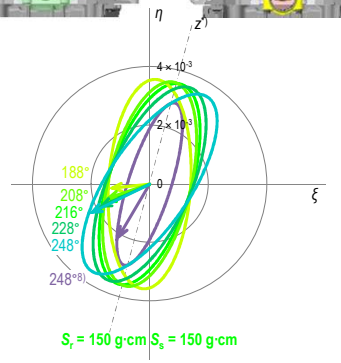
● Centre of gravity
[1] If the primary moment is left without partial balancing, the shape of its vector and the vibrations caused by it is similar to that of the secondary moment.







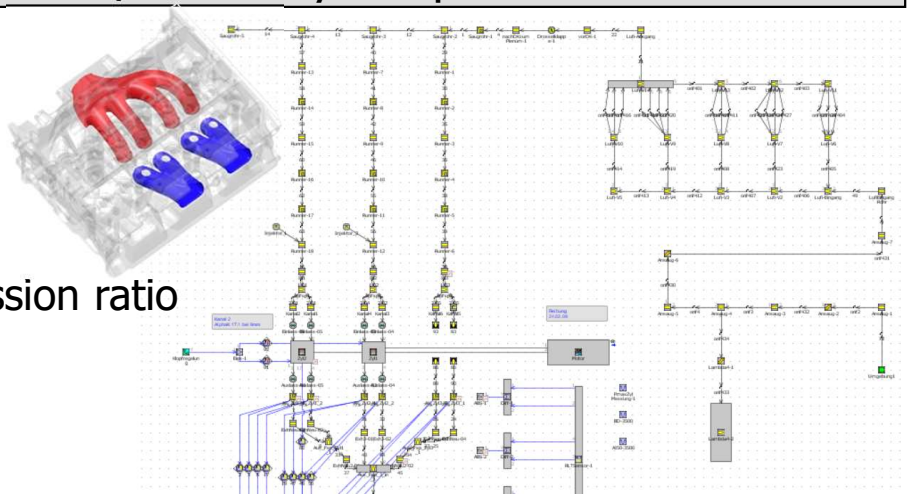


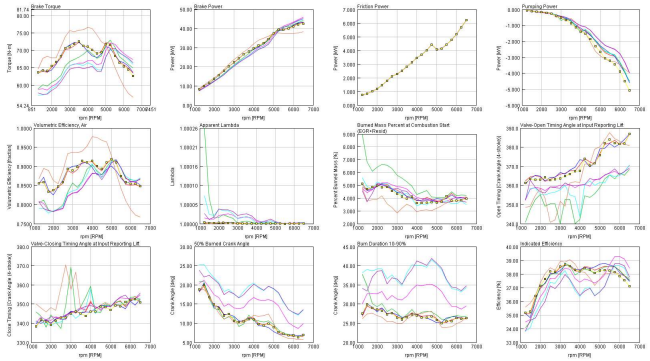


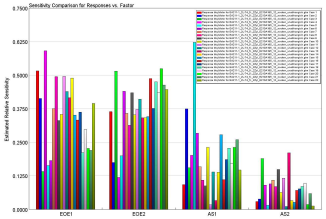
Activities in WP 02 Advanced Concepts of ICEs
BUT-SA: Internal-combustion engine concept for a hybrid power unit

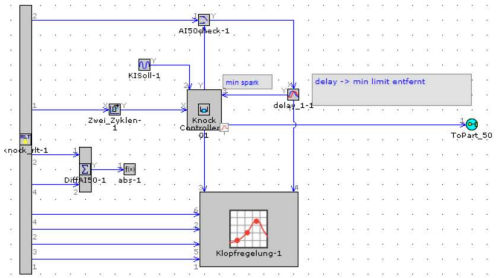
Thermodynamic simulations

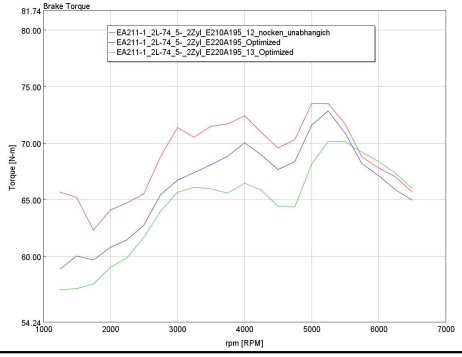
- Validated computational model
- Predictive model of knocking
- Influence of intake and exhaust manifold
- Optimization of valve timing and compression ratio

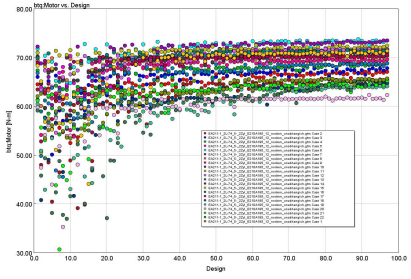


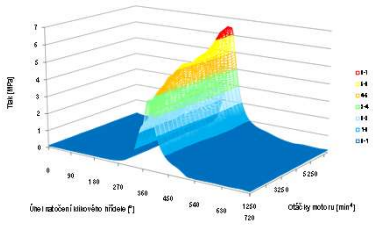


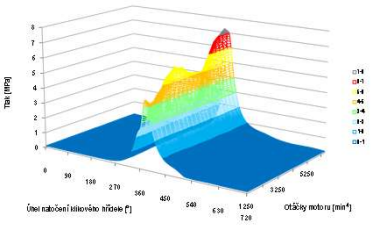








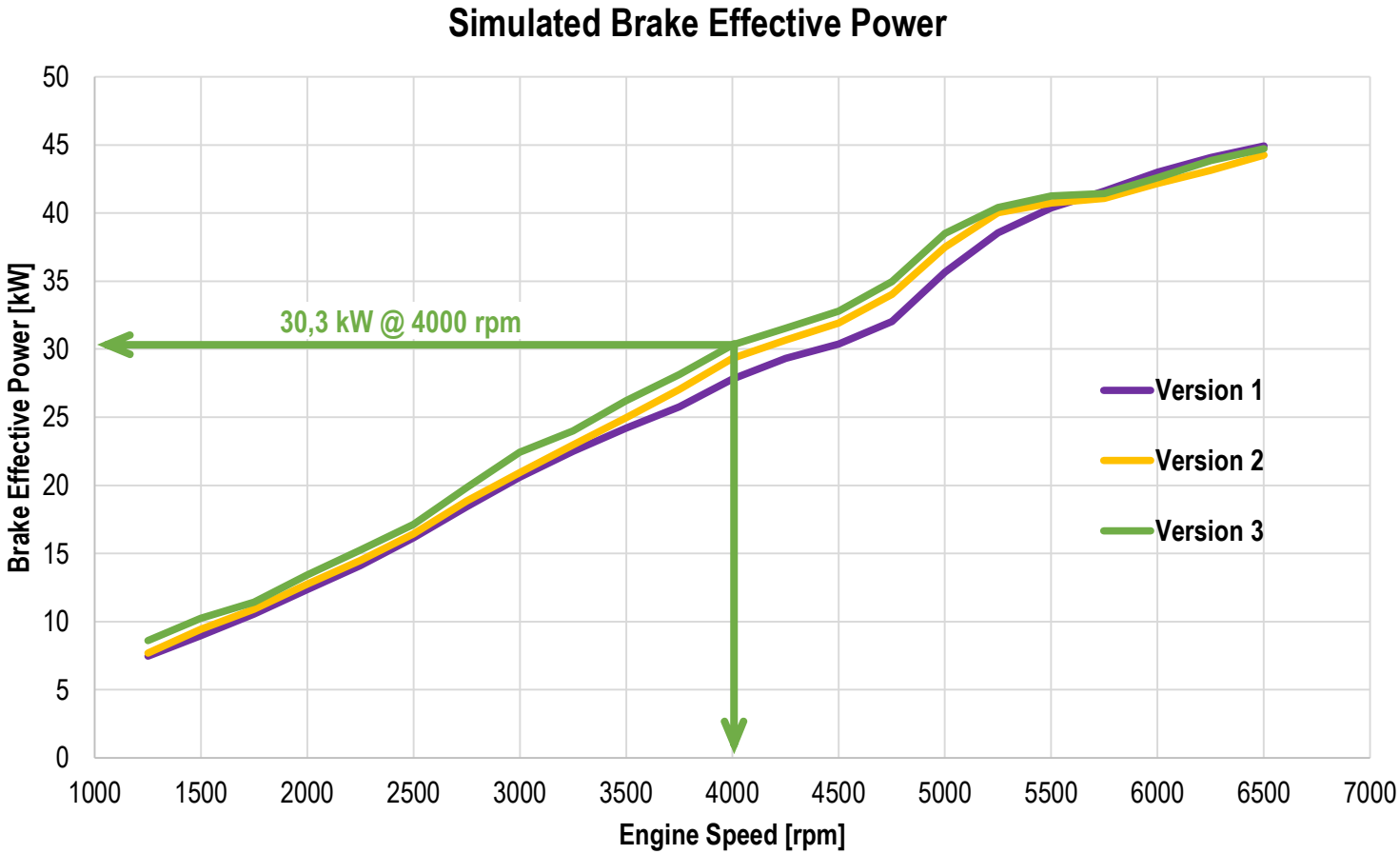




Activities in WP 02 Advanced Concepts of ICEs
BUT-SA: Internal-combustion engine concept for a hybrid power unit

Thermodynamic simulations and optimization

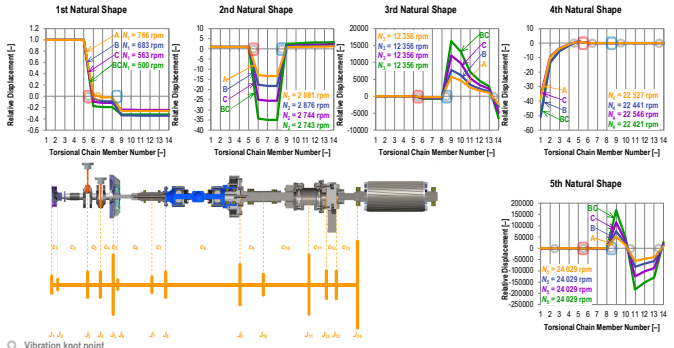
- Achieving performance target in simulations

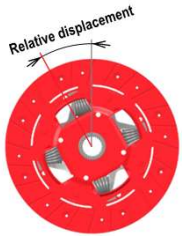


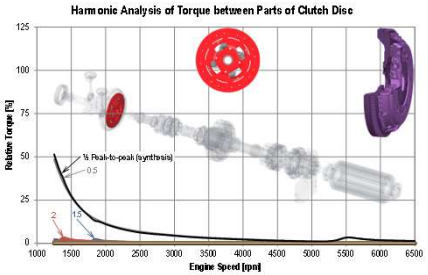
Activities in WP 02 Advanced Concepts of ICEs
BUT-SA: Internal-combustion engine concept for a hybrid power unit

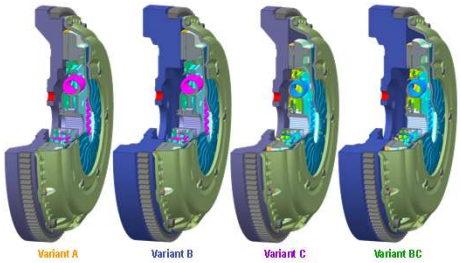
Engine dynamics

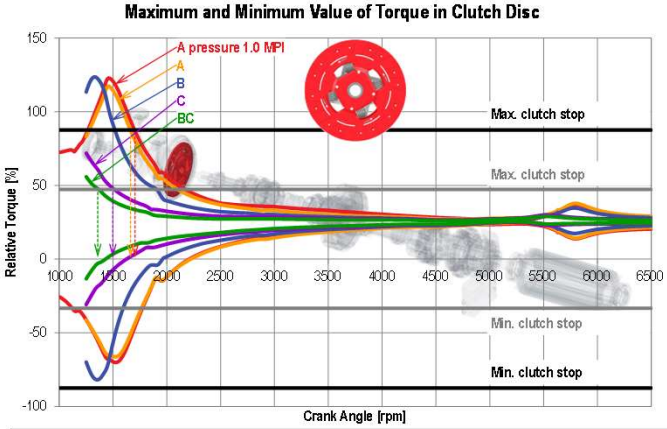
- Connection of concept engine to dynamometer
- Natural frequencies and shapes
- Forced vibration simulated in frequency domain
- Simulations in time domain

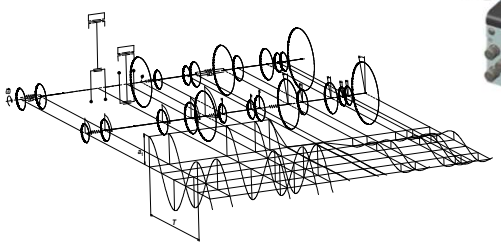


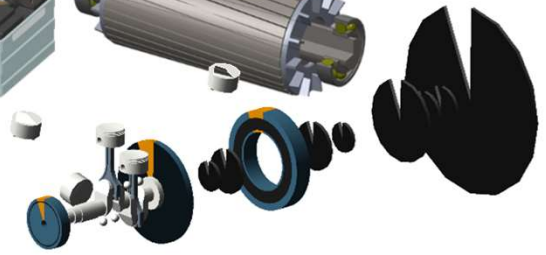










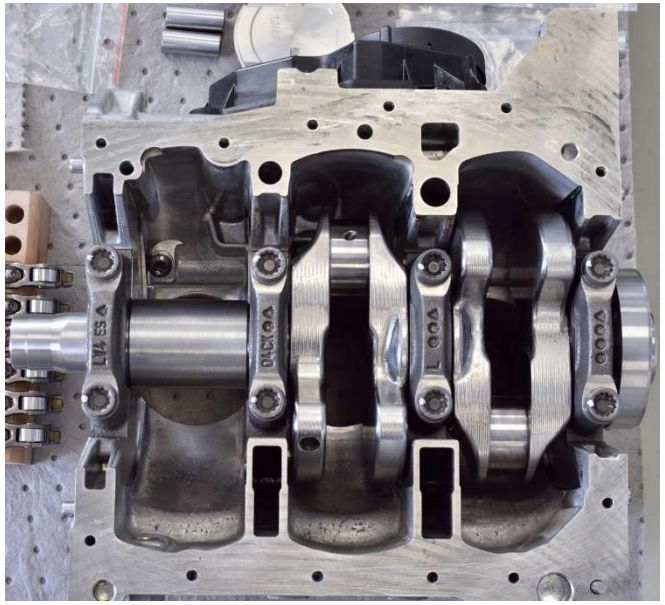
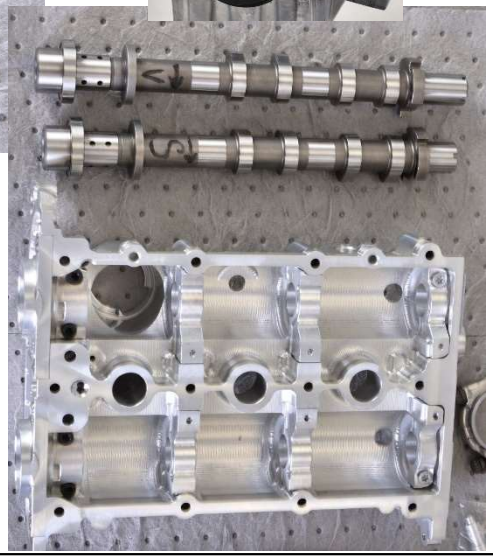


Activities in WP 02 Advanced Concepts of ICEs
BUT-SA: Internal-combustion engine concept for a hybrid power unit

Manufacturing of functional specimen parts

- Crank train, valve train etc.

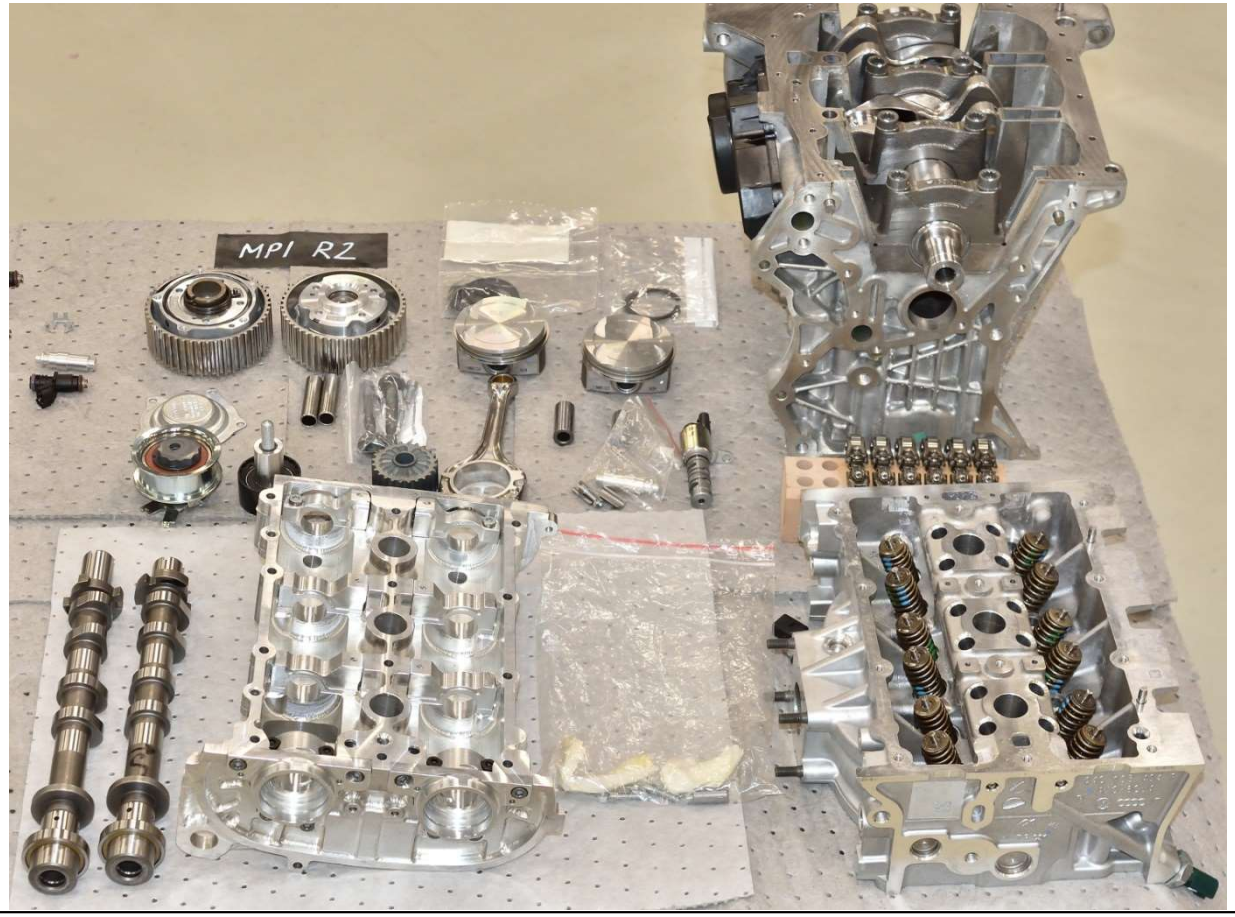


Activities in WP 02 Advanced Concepts of ICEs
BUT-SA: Internal-combustion engine concept for a hybrid power unit

Manufacturing of the functional specimen parts

- Engine component parts



Activities in WP 02 Advanced Concepts of ICEs
BUT-SA: Internal-combustion engine concept for a hybrid power unit

Conclusions

- With respect to the required performance parameters and installation space conditions, a two-cylinder internal-combustion engine concept is chosen.
- The crank train is designed so that the power unit has the lowest possible vibrations with respect to the absence of a balancing shaft.
- The arrangement of a two-cylinder engine in a three-cylinder block for research purposes makes it possible at this stage of the project to reduce the cost of manufacturing expensive functional samples of the engine block and cylinder head.
- With the help of an advanced thermodynamic computational model of the engine and subsequent optimizations of the gas exchange process, the required engine performance parameters are achieved.
- After all the necessary new parts have been manufactured, the functional sample of the engine is ready for testing on a dynamometer.
- The developed cylinder unit is, after the necessary modifications, suitable for real two-cylinder and multi-cylinder engines of hybrid drive units in serial and parallel configuration.

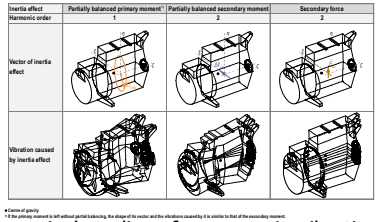
Activities in WP 02 Advanced Concepts of ICEs
BUT-SA: Internal-combustion engine concept for a hybrid power unit

Thank you for you attention

This research has been realized using the support of Technological Agency, Czech Republic, programme National Competence Centres, project # TN01000026 Josef Bozek National Center of Competence for Surface Vehicles.

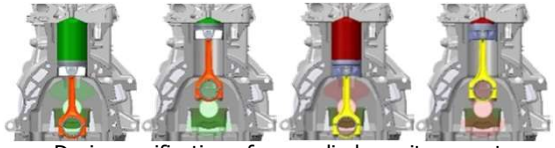
All the help has been gratefully appreciated.

Results of 1-WP02 Advanced Concepts of ICEs achieved in 2019–2020 (cooperation between BUT and ŠKODA AUTO)

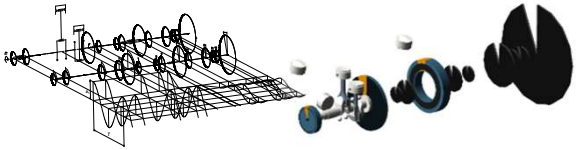


Theoretical studies of power train vibrations

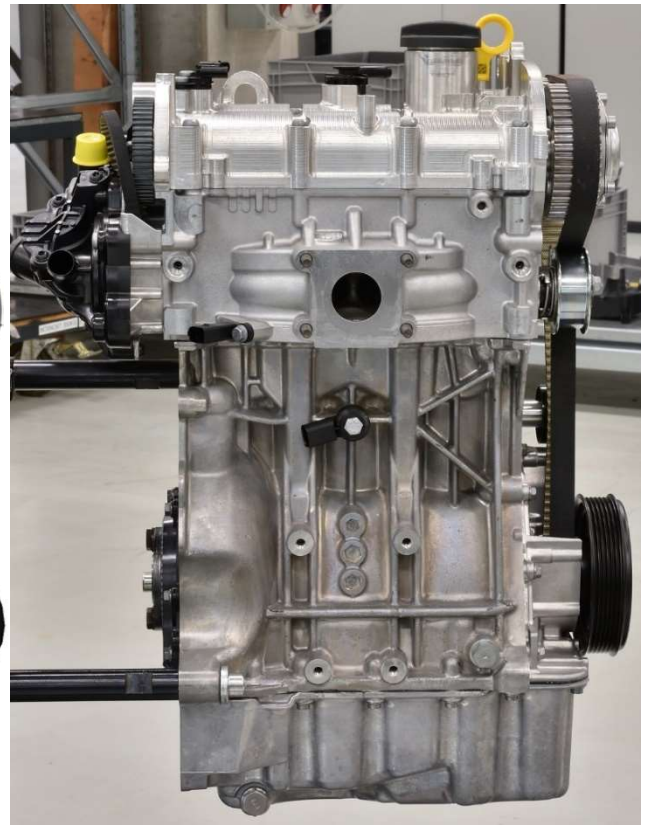
Crank train design variants



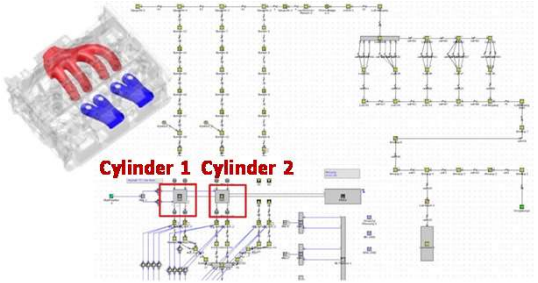
Design verification of new cylinder unit concept



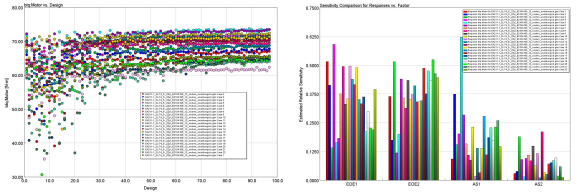
Computational models of engine dynamics



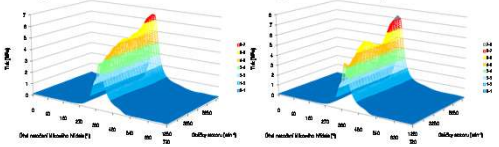
Functional specimen: internal-combustion engine concept for a hybrid power unit



Thermodynamics simulation model



Optimization of valve timing and compression ratio



Manufacturing of engine component parts

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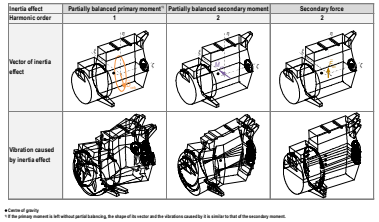
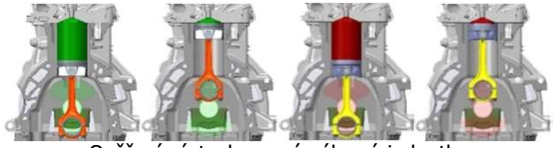
Výtah z prací v rámci 1-WP02 Pokročilé koncepty spalovacích motorů za léta 2019–2020 (spolupráce VUT v Brně a ŠKODA AUTO)

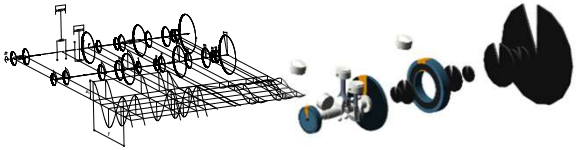


Teoretické studie vibrací pohonné jednotky

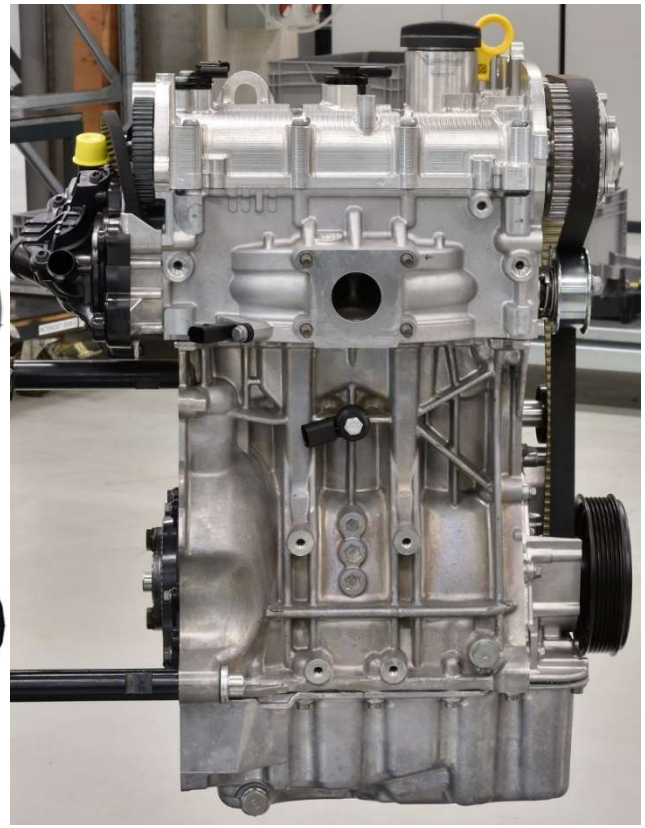
Konstrukční varianty klikového mechanismu



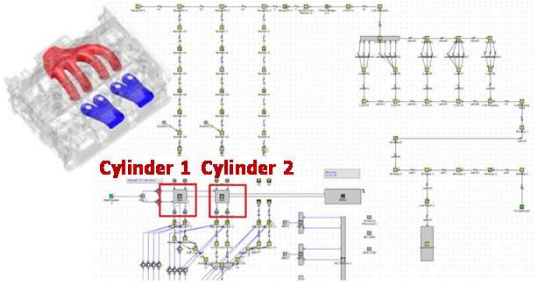
Ověření zástavby nové válcové jednotky



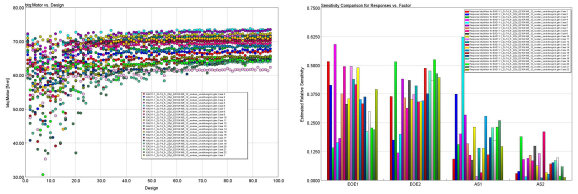
Výpočtové modely dynamiky motoru



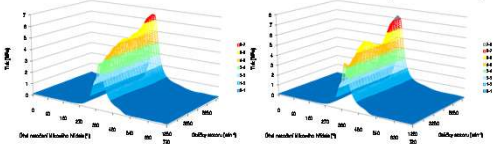
Funkční vzorek: koncept spalovacího motoru pro hybridní pohonné jednotky



Výpočtový model termodynamiky motoru



Optimalisace časování ventilů a velikosti kompresního poměru



Výroba nových dílů funkčního vzorku motoru

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