

Contents of Work Package 4-WP02 Advanced Automated Design Tools (DASY) - New Developments

4-WP02: Integration of Multiphysics and Digital Twins Technologies into DASY and Operation Reliability

Coordinator of the WP

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Participants of the WP

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Main Goal of the WP

Reduction of the time between the research of the concept and the application of the innovative product on the market.

Creation of parametric 3 D models for automation of interconnection of parametric 3D CAD model of the vehicle powertrain with multi-physics solvers (GT-Suite, AVL Fire, ANSYS Motor CAD, etc.)

Research report summarizes the progress of digital twin creation, key activities at the given tractor class, their demands from the point of view of individual tractor components. Based on this knowledge, it is possible to make optimization of a given component during its development and determine the service harmonogram.

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4-WP02: Integration of Multiphysics and Digital Twins Technologies into DASY and Operation Reliability

Partial Goals for the Current Period

- Creation of parametric 3 D models of charge and exhaust ducts.
- Identification of digital twin creation strategy and key components for evaluation.

Contents of Work Package 4-WP02 Advanced Automated Design Tools (DASY) - New Developments

4-WP02: Integration of Multiphysics and Digital Twins Technologies into DASY and Operation Reliability

Official 4-WP02 Deliverables:

- 4-WP02-001 | **Modules for linking the parametric 3D CAD model of the vehicle powertrain with Multiphysics Simulation Tools**, R-software, XII./2025, CTU 1
- 4-WP02-002 | **Report summarizing the progress of digital twin creation**, O-othe, XII./2025, Zetor 0,3; BUT 0,3; TUO 0,2; UWB RTI 0,2

Activities in 4-WP02 Advanced Automated Design Tools (DASY) - New Developments

4-WP02-001: Modules for linking the parametric 3D CAD model of the vehicle powertrain with Multi-physics Simulation Tools

Planned activities in 2023 -2025

- design and construction of parametric models of charge and exhaust ducts of spark ignition and diesel engines
- design and construction of parametric models of combustion chambers of spark-ignition and diesel engines
- design and construction of parametric models of cooling system of spark ignition and diesel engines
- design and construction of parametric models of the lubrication system of spark-ignition and diesel engines

Activities to be implemented in 2023

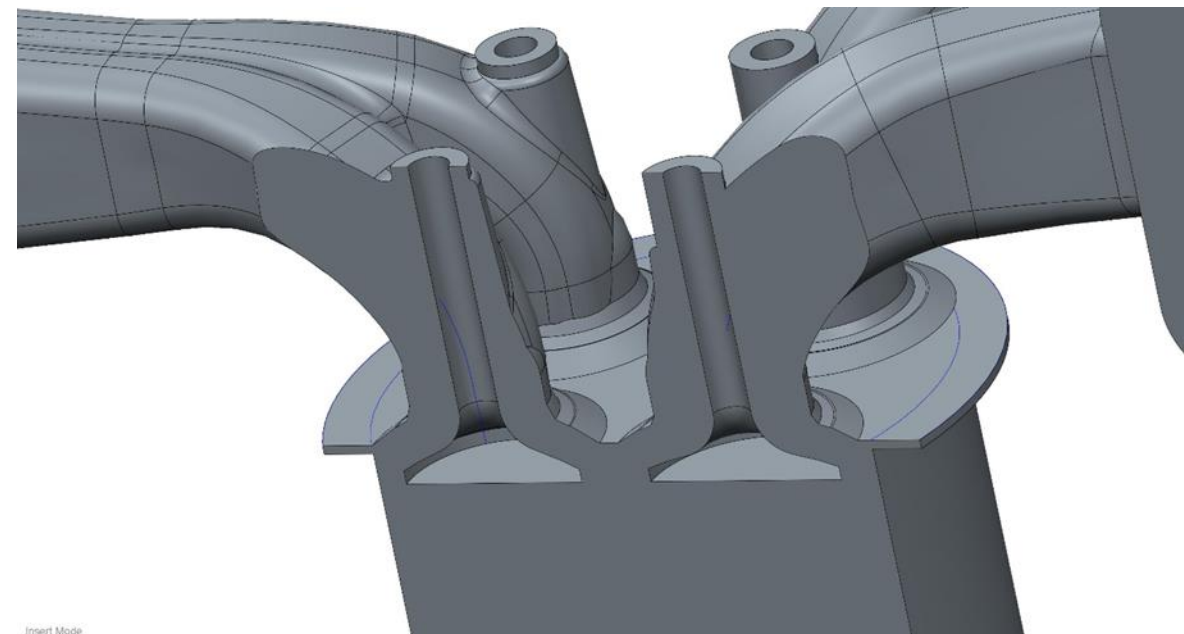
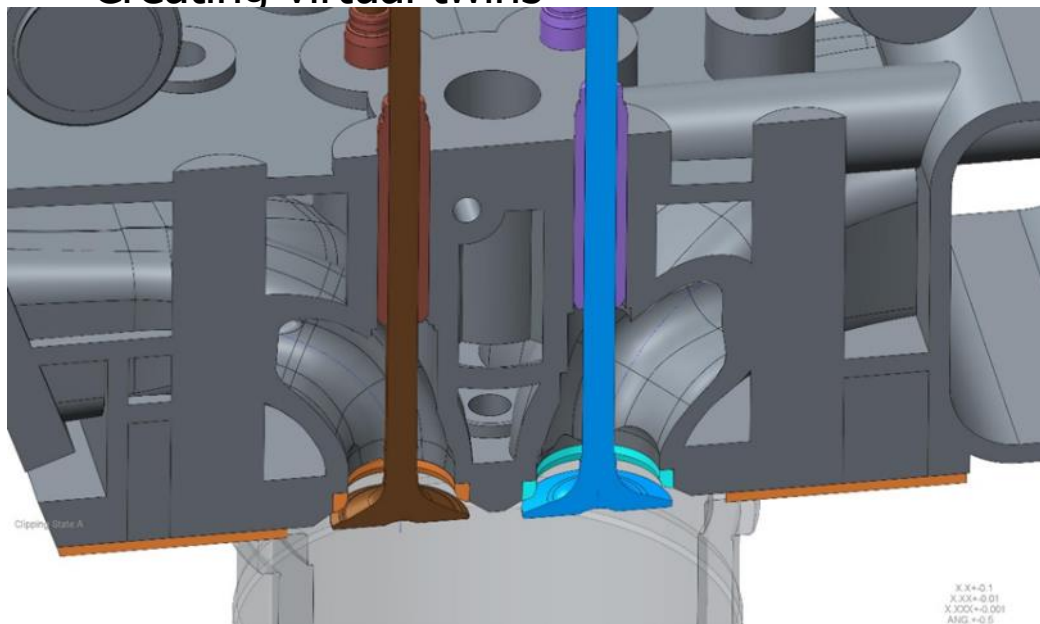
- Analysis of possible types of designs of filling and exhaust ducts of spark ignition engines
- Analysis of possible types of diesel engine intake and exhaust duct designs
- Creation of a parametric model of the charge and exhaust ducts of spark ignition engines
- CREO Flow and AVL-FIRE simulation of charge and exhaust flow
- Measurement of duct flow properties on an aerodynamic test track

Activities in 4-WP02 Advanced Automated Design Tools (DASY) - New Developments

4-WP02-001: Design and construction of parametric models of charge and exhaust ducts of spark ignition and diesel engines

Why is it necessary

- Cylinder head component arrangement design
- Accelerate geometry transfer between development environments
- Creating virtual twins

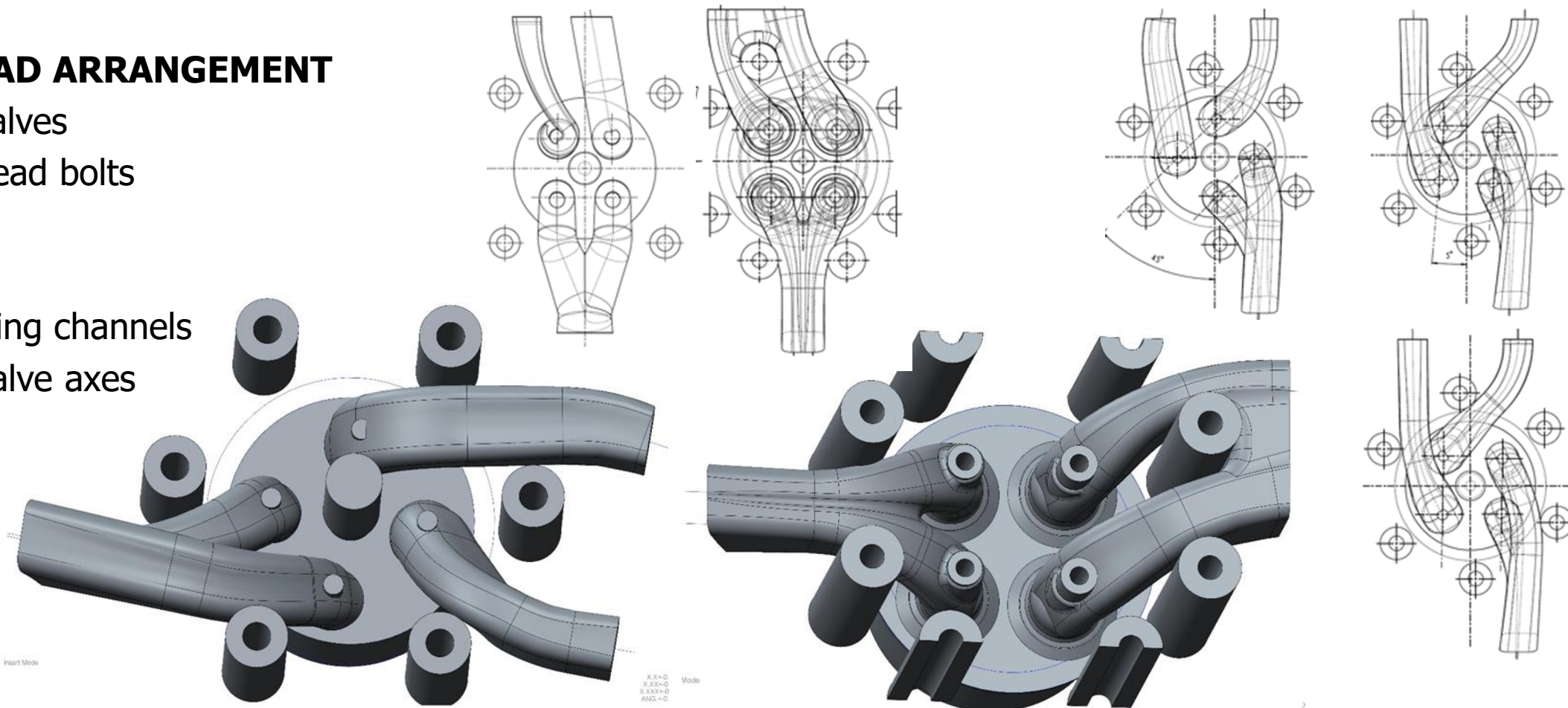


Activities in 4-WP02 Advanced Automated Design Tools (DASY) - New Developments

4-WP02-001: Analysis of possible types of diesel engine intake and exhaust duct designs

CYLINDER HEAD ARRANGEMENT

- number of valves
- number of head bolts
- injectors
- glow plugs
- shapes of filling channels
- rotation of valve axes

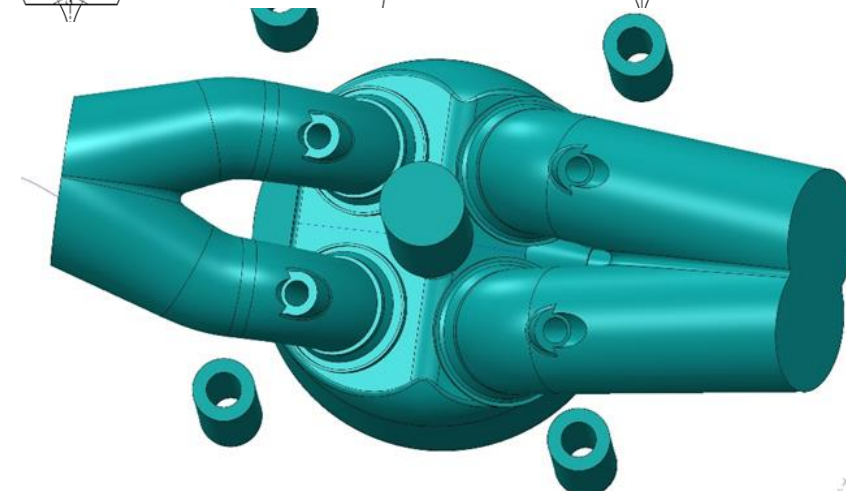
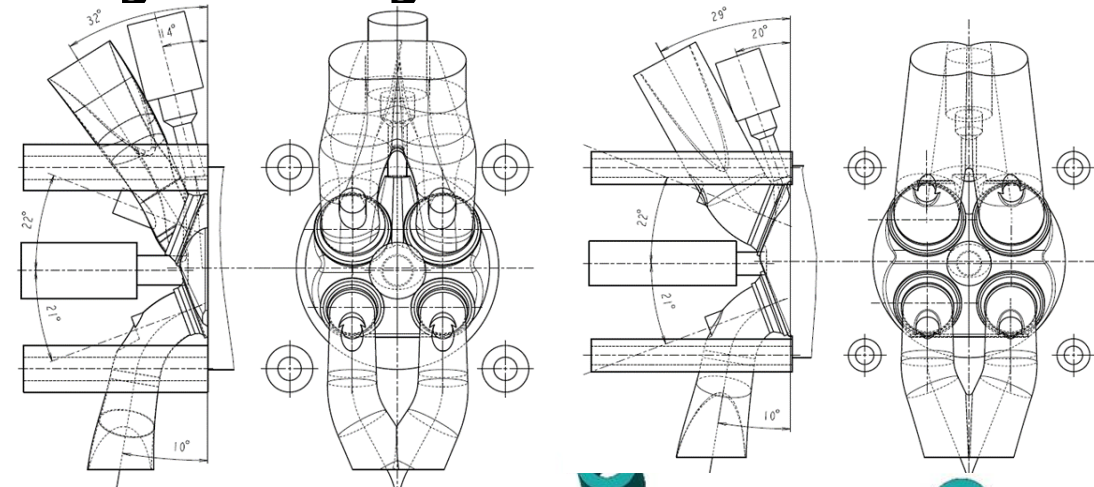
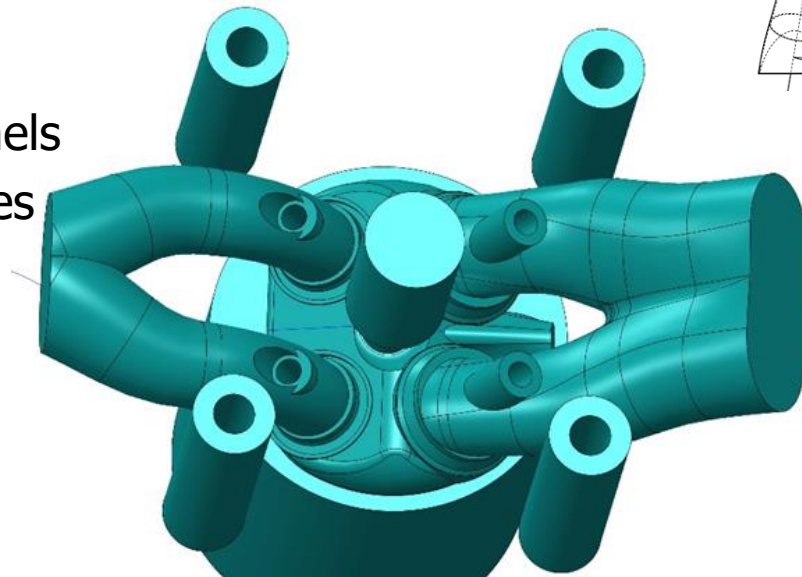


Activities in 4-WP02 Advanced Automated Design Tools (DASY) - New Developments

4-WP02-001: Analysis of possible types of spark-ignition engine intake and exhaust duct designs

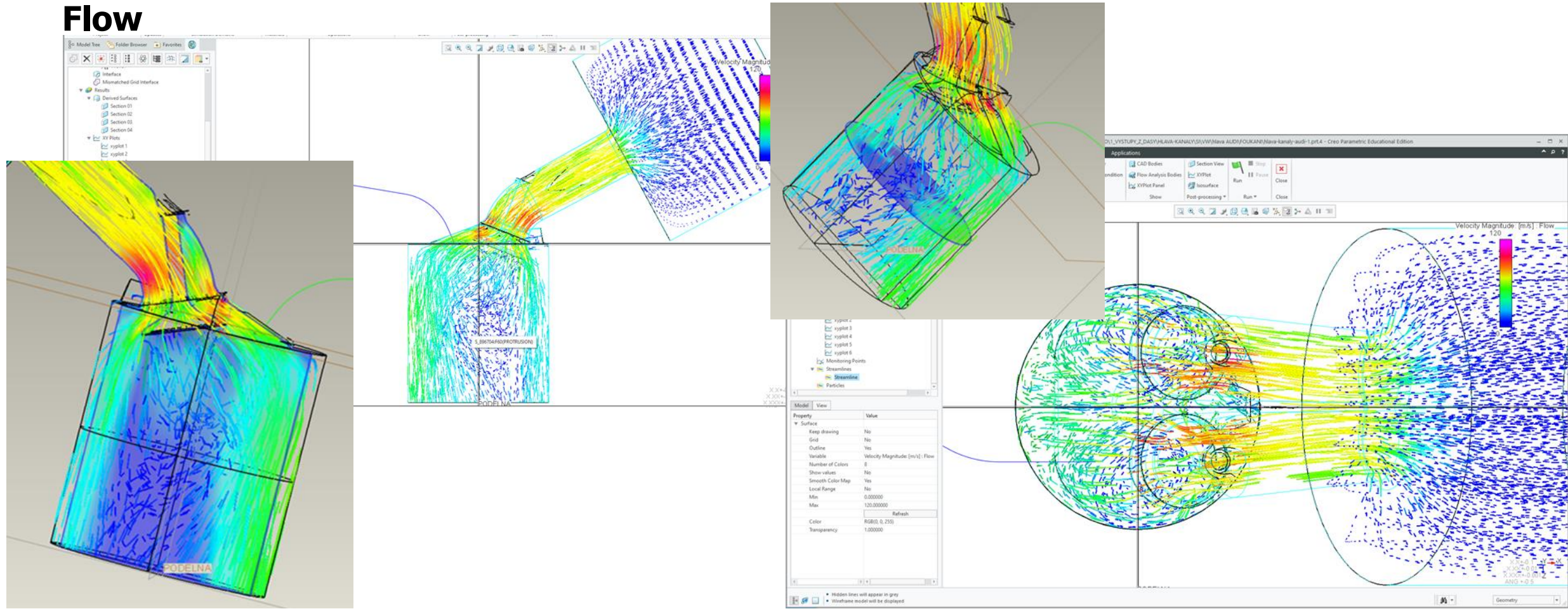
CYLINDER HEAD ARRANGEMENT

- number of valves
- combustion chamber
- number of head bolts
- spark plug
- injector
- shapes of filling channels
- inclination of valve axes



Activities in 4-WP02 Advanced Automated Design Tools (DASY) - New Developments

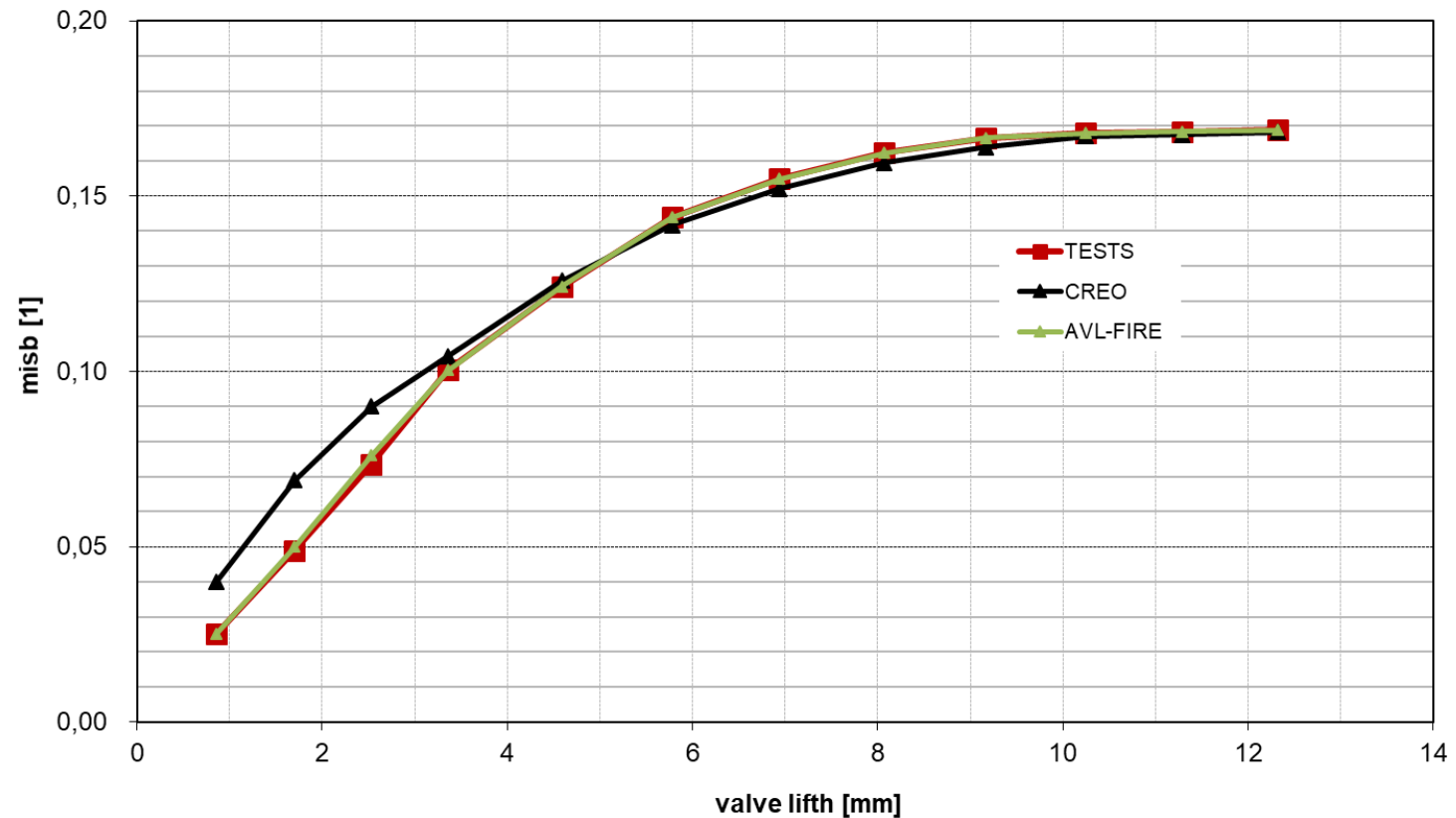
4-WP02-001: Simulating the flow through the filling and exhaust channels in CREO Flow



Activities in 4-WP02 Advanced Automated Design Tools (DASY) - New Developments

4-WP02-001: Comparison of simulations with tests

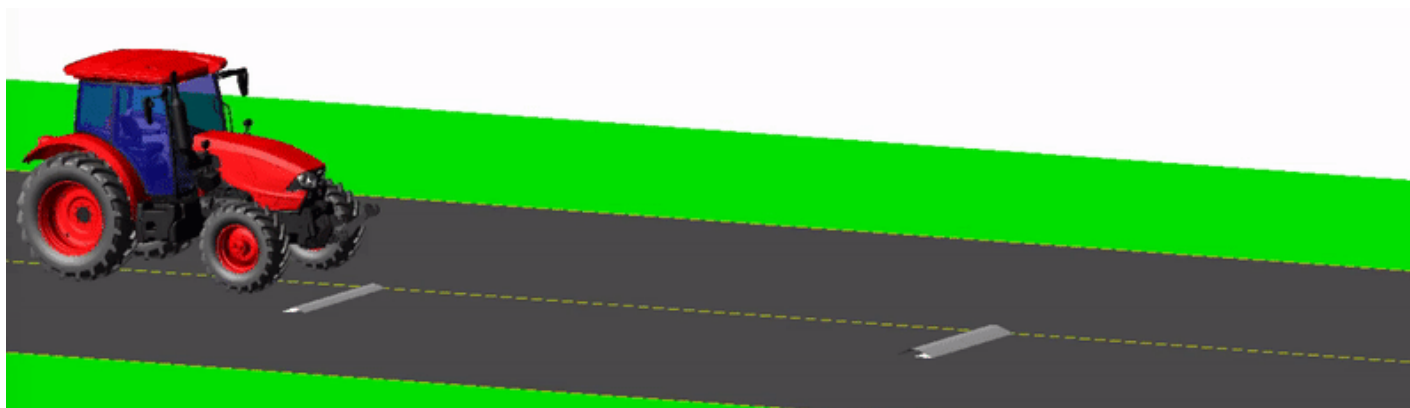
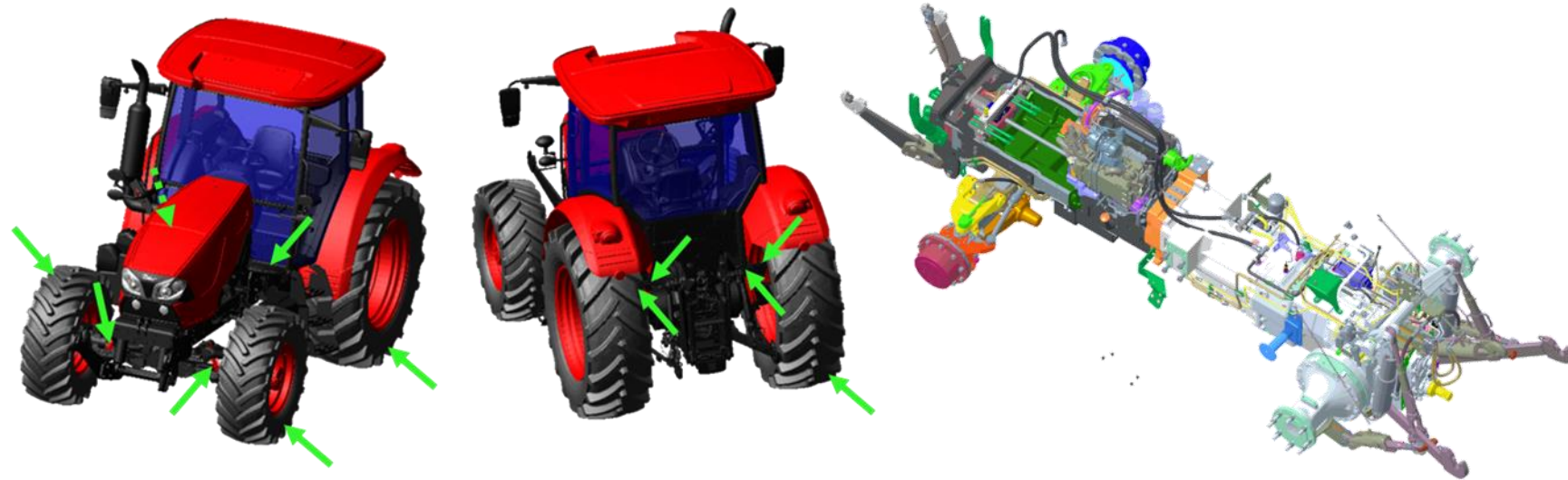
Discharge coefficient $misb = \mu\sigma\beta$



Activities in 4-WP02 Advanced Automated Design Tools (DASY) - New Developments

4-WP02-002: Report summarizing the progress of digital twin creation

- Modal analysis
 - Modal neutral files
- Harmonic analysis
 - Damping
- Stress-strain analysis
- Dynamic analysis
- ROM model



Activities in 4-WP02 Advanced Automated Design Tools (DASY) - New Developments

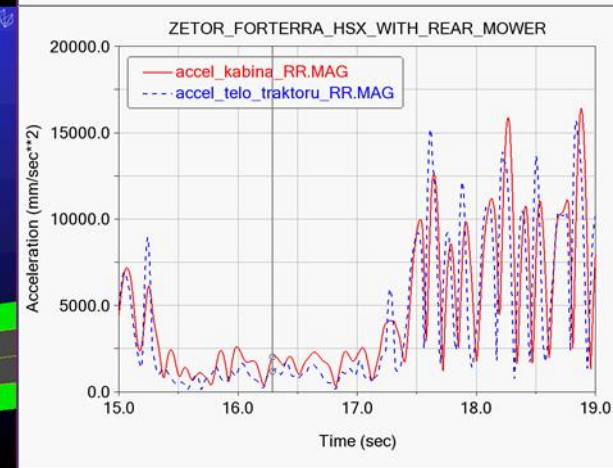
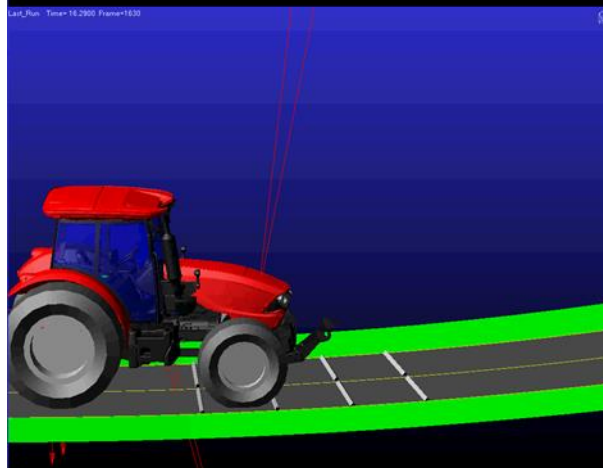
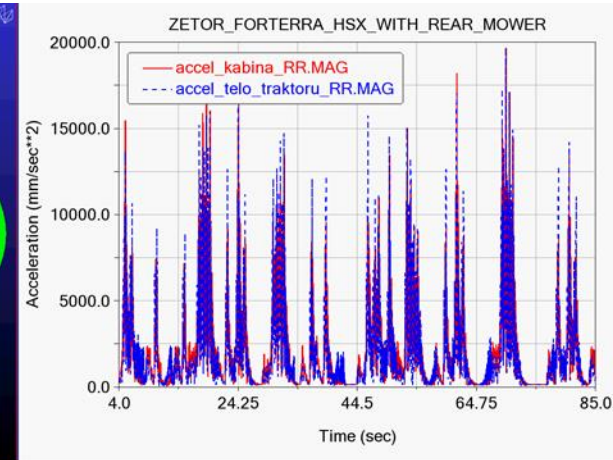
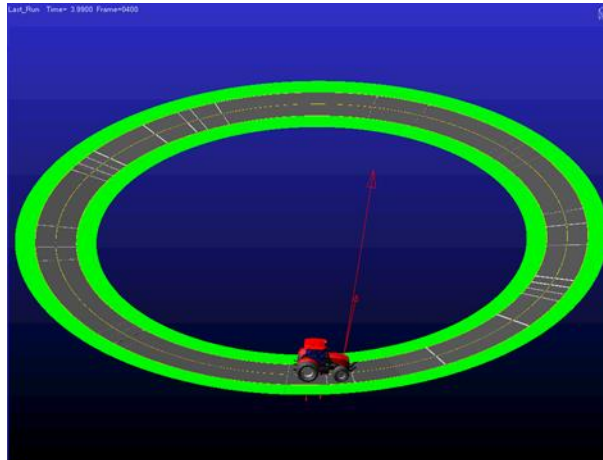
4-WP02-002: Report summarizing the progress of digital twin creation

- Simplified control mechanism
- Independent front axle suspension
- Adjustable three-point hitch
- Rear differential
- Cabin suspension
- Tire model PAC2002



Activities in 4-WP02 Advanced Automated Design Tools (DASY) - New Developments

4-WP02-002: Report summarizing the progress of digital twin creation



Fulfillment of goals and deliverables of 4-WP02 Advanced Automated Design Tools (DASY) - New Developments

Current State of Deliverables and Fulfillment of Goals

- 4-WP02-001 | Modules for linking the parametric 3D CAD model of the vehicle powertrain with Multi-physics Simulation Tools, R-software, XII./2025, CTU 1 – **in progress & no major delays:**
 - Design and construction of parametric models of charge and exhaust ducts of spark ignition and diesel engines.
- 4-WP02-002 | Report summarizing the progress of digital twin creation , O-othe, XII./2025, Zetor 0,3; BUT 0,3; TUO 0,2; UWB RTI 0,2 – **in progress & no major delays:**
 - Creation of multibody model, perform initial sensitivity study.

Fulfillment of goals and deliverables of 4-WP02 Advanced Automated Design Tools (DASY) - New Developments

List of Due Deliverables and Their Added Value

- **4-WP02-001** – offer the two stage group for smaller engines allows PBST to keep its position on the market. PBST expects 2% increase of turn-over and about 1% CO2 emission decrease.
- **4-WP02-002** – enables to increase effectivity at development phase of tractor.

Current contribution of 4-WP02 Advanced Automated Design Tools (DASY) - New Developments

Assessment of the Contribution of Deliverables

- Thermodynamics of very high boosted ICEs with low NOx level – 1-WP02, 1-WP03, 1-WP05 and potential NCK2 (BOVENAC) project.
- Transient response and low mechanical losses – 1-WP02 and potential NCK2 (BOVENAC) project.
- Oil circuit performance including interaction with rotor – 1-WP05 and potential NCK2 (BOVENAC) project.
- Hybridization (of high efficiency turbochargers) – 1-WP01 and potential NCK2 (BOVENAC) project.
- Validation of computational model by using data from 3-WP11.

Current contribution of 4-WP02 Advanced Automated Design Tools (DASY) - New Developments

Assessment of the Formal/Administrative Goals of the Work Package

	CTU	BUT	Zetor	TUO	UWB RTI
Finances (reporting/spending)	OK	OK	OK	OK	OK
Commercialization (the whole organization)	OK	OK	OK	OK	OK
Deliverables	OK	OK	OK	OK	OK

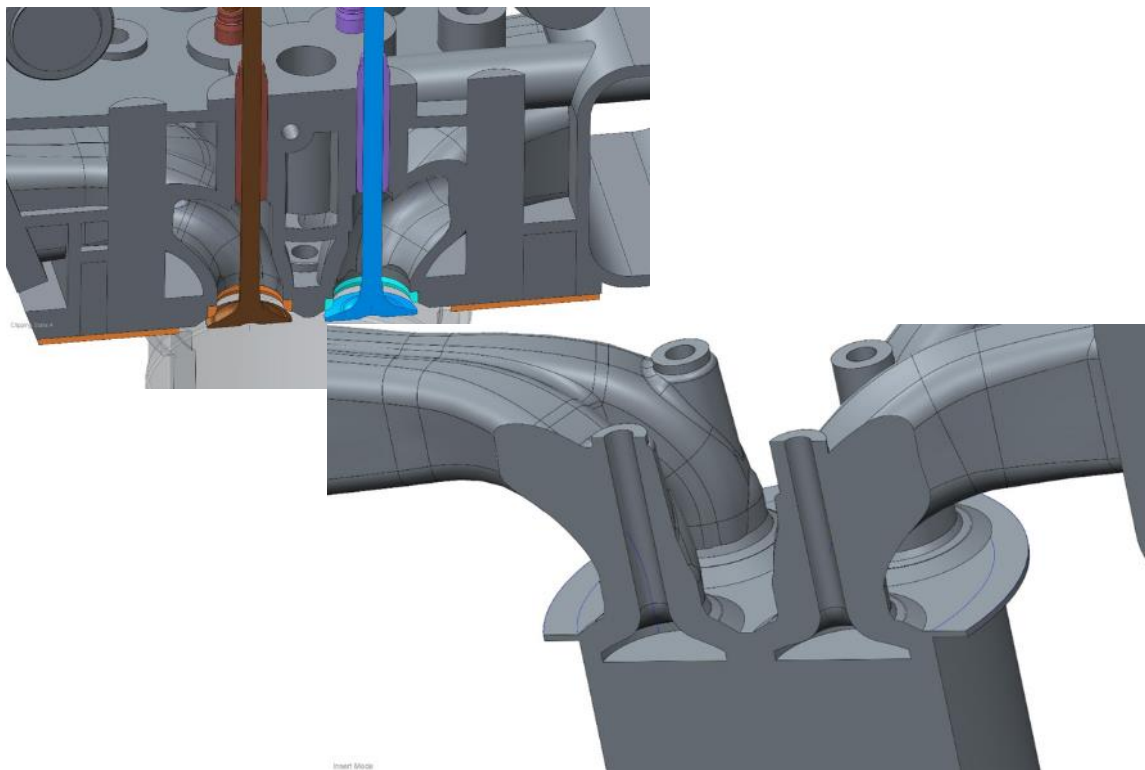
Current contribution of 4-WP02 Advanced Automated Design Tools (DASY) - New Developments

Acknowledgment

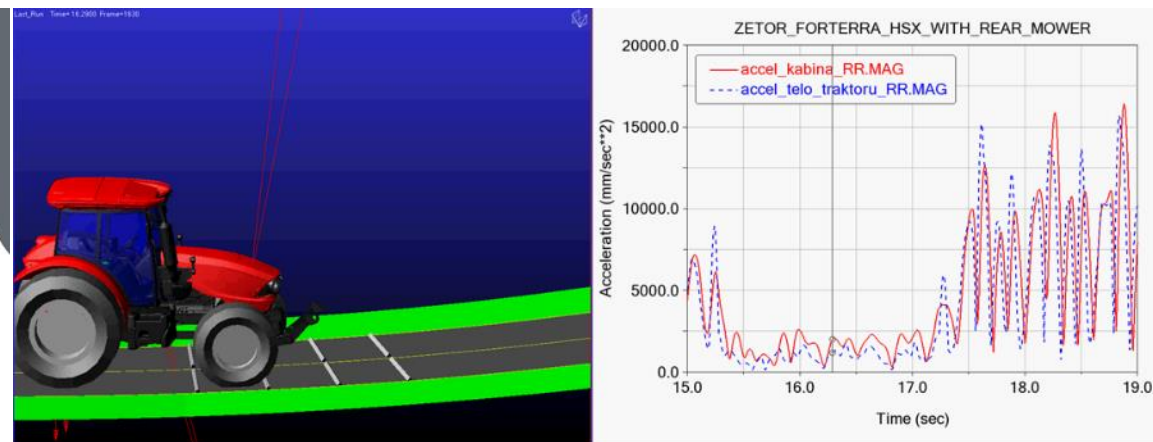
This research has been realized using the support of Technological Agency, Czech Republic, programme National Competence Centres II, project # TN02000054 Božek Vehicle Engineering National Center of Competence (BOVENAC).

Výtah z prací 2023-2025 na 4-WP02 Pokročilé automatizované návrhové nástroje (DASY) - nový vývoj

Návrh a konstrukce parametrických modelů plicích a výfukových kanálů zážehových a vznětových motorů



Tvorba výpočtového modelu včetně úvodní citlivostní studie

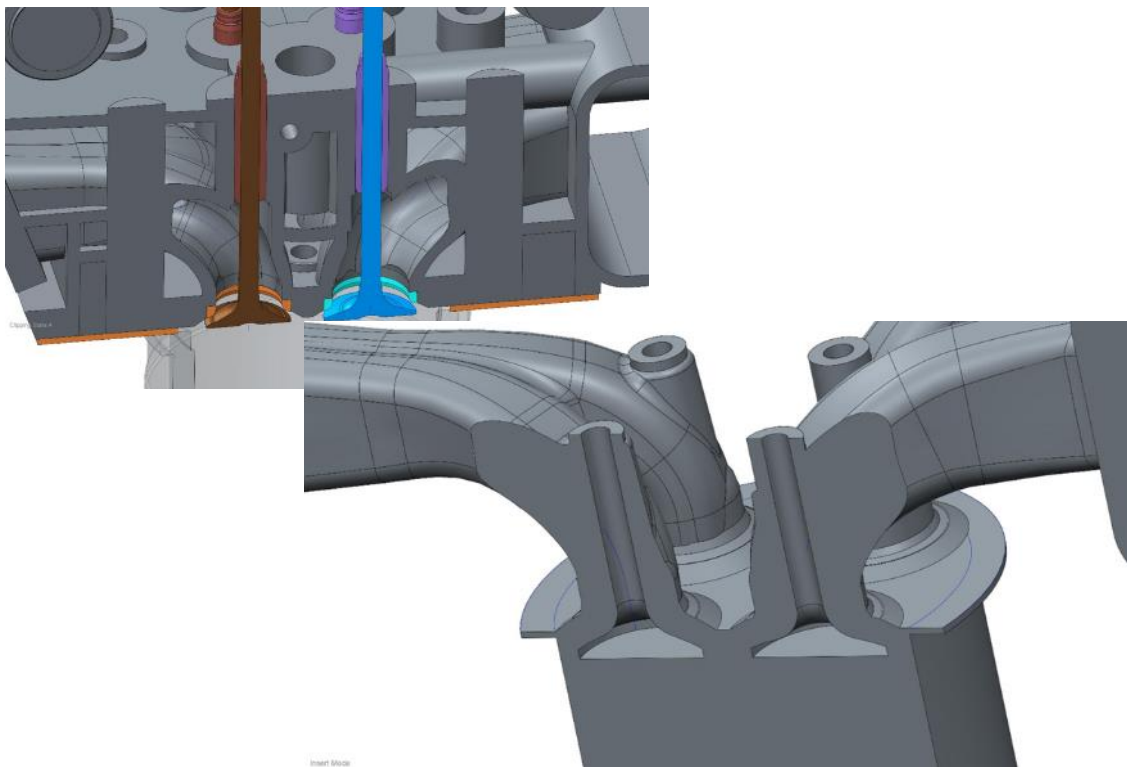


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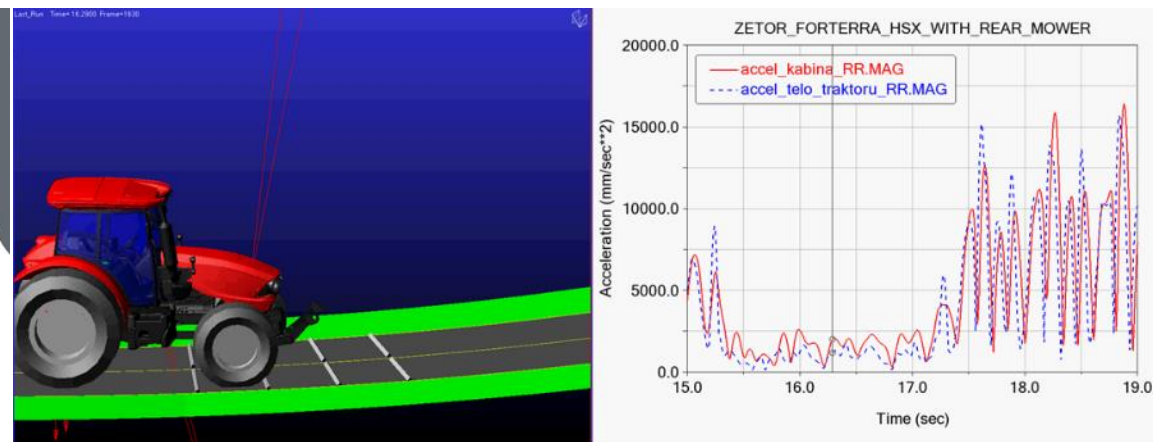
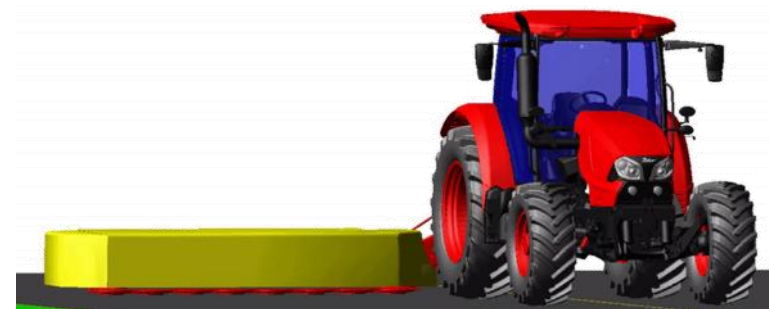
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Results of 4-WP02 Advanced Automated Design Tools (DASY) - New Developments–Achieved 2023-2025

Design and construction of parametric models of charge and exhaust ducts of spark ignition and diesel engines



Computational model creation including initial sensitivity study

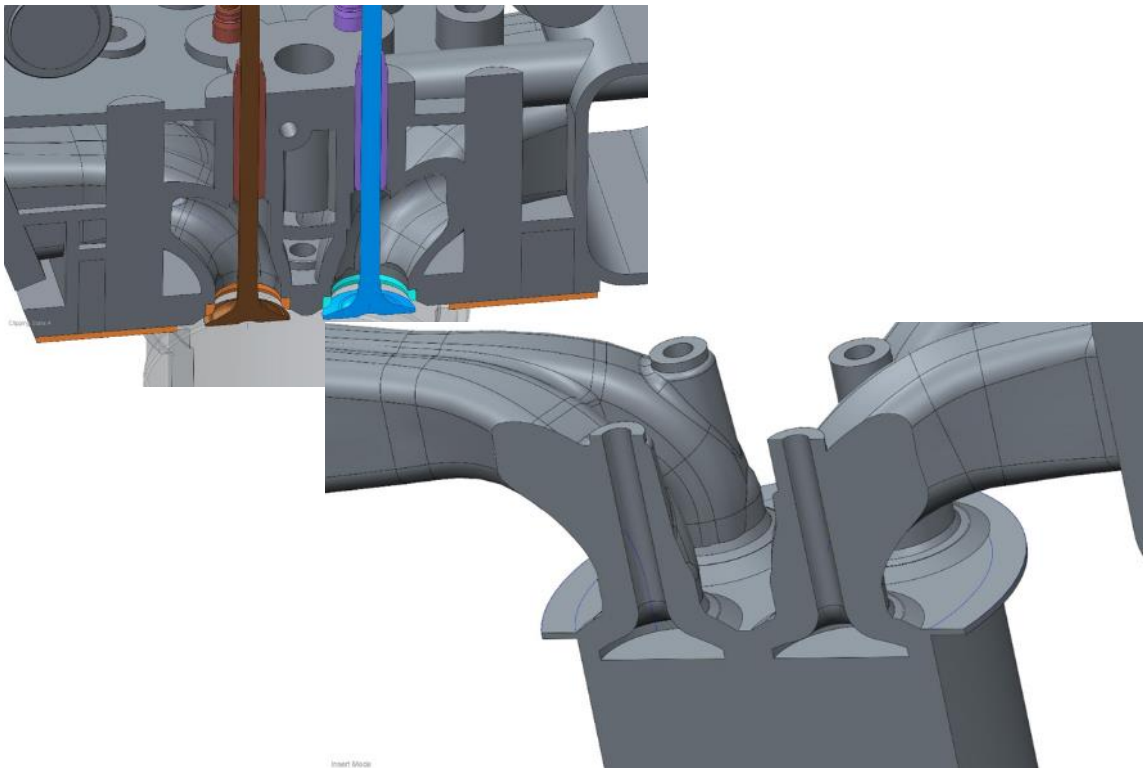


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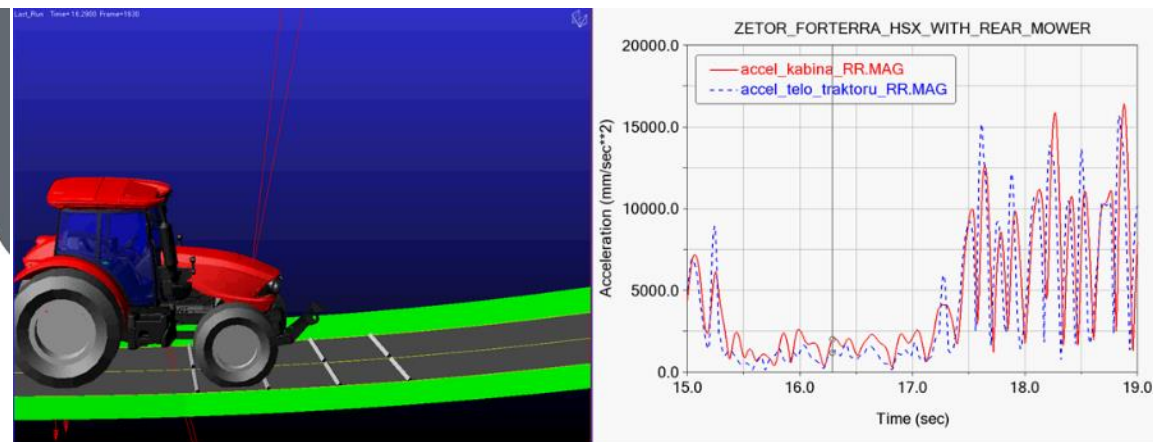
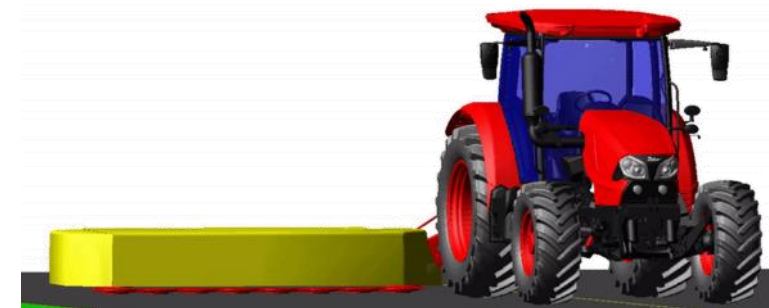
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Výtah z prací 2023 na 4-WP02 Pokročilé automatizované návrhové nástroje (DASY) - nový vývoj

Návrh a konstrukce parametrických modelů plicích a výfukových kanálů zážehových a vznětových motorů



Tvorba výpočtového modelu včetně úvodní citlivostní studie

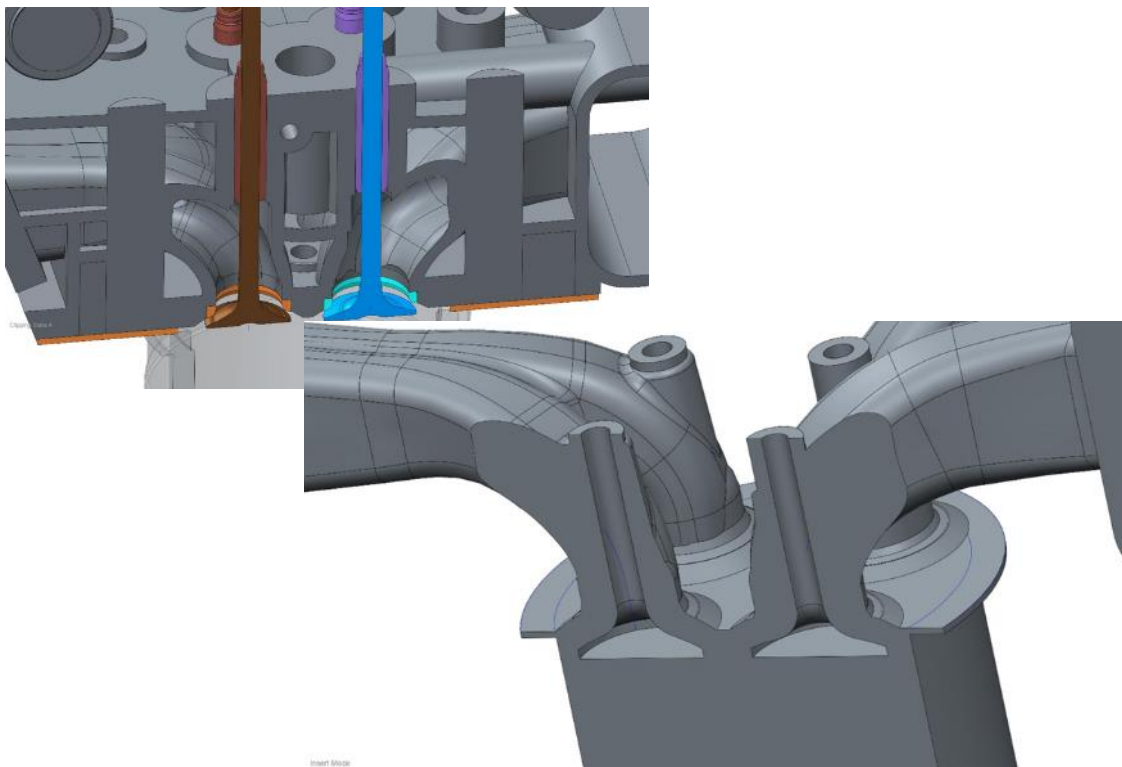


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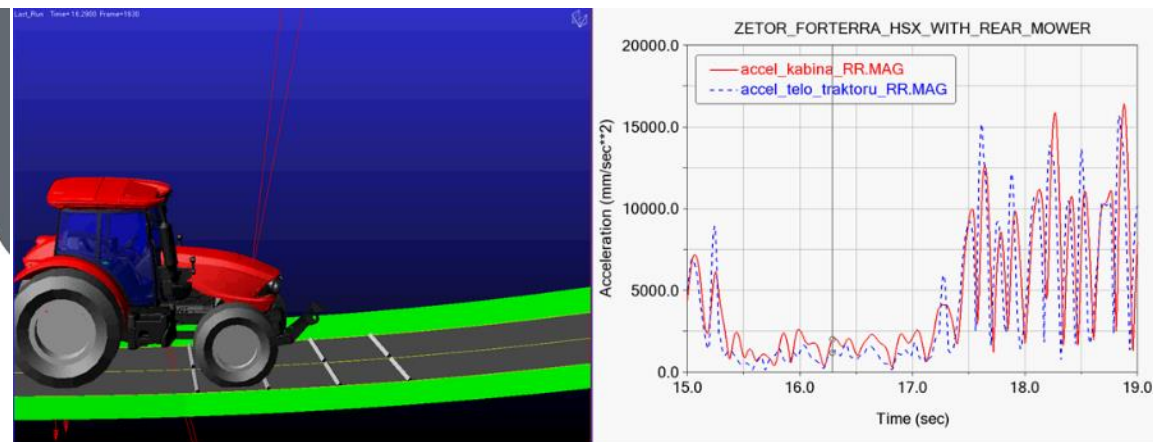
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Results of 4-WP02 Advanced Automated Design Tools (DASY) - New Developments–Achieved 2023

Design and construction of parametric models of charge and exhaust ducts of spark ignition and diesel engines



Computational model creation including initial sensitivity study



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