

Contents of Work Package 3-WP12: Optimized Design and Operation of Special Vehicle

3-WP12: Optimized Design and Operation of Special Vehicle

Coordinator of the WP

University of Pardubice, prof. Ing. Bohumil Culek, CSc.

Participants of the WP

SVOS, Ltd., Ing. Jaroslav Černý

Main Goal of the WP

Strength optimization of the supporting frame of a specialized vehicle (made of high-strength steel) by non-destructive inspection of weld joints, which significantly reduce fatigue strength if performed poorly.

Energy optimization of the special vehicle's thermal system to ensure the highest possible efficiency.

Partial Goals for the Current Period

The introduction of non-destructive inspection of welds and their surroundings in the production process of the frame of a special vehicle, fabricated from high-strength steel.

Solution of energy losses in the intake and exhaust pipes of the engine unit, optimization of the cooling system of a special vehicle.

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Official 3-WP12 Deliverables:

- 3-WP12-001 | **The procedure of non-destructive control of internal stresses of welded components by the principle of magnetic response**, Ztech, VI./2026, SVOS 1,0
- 3-WP12-002 | **Functional sample of the Energy Optimized of Special Vehicle Cooling System**, G-funk, VI./2026, SVOS 1,0

Activities in 3-WP12: Optimized Design and Operation of Special Vehicle

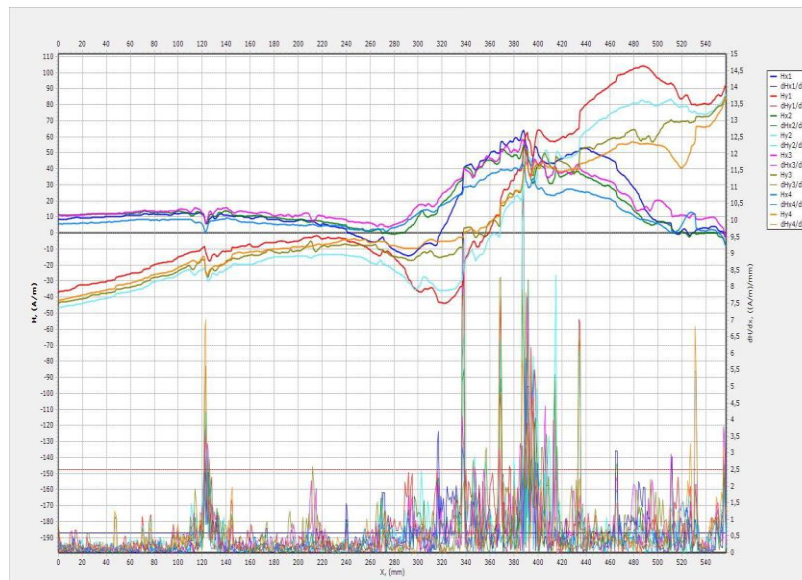
The solution to the V50 result in 2024 consisted in laboratory verification of the MMM (Metal Magnetic Memory - Magnetic Memory of the Material) method used for non-destructive inspection of weld joints of the supporting frame of a special vehicle based on the magnetic response of the material after welding. Based on the results of 2023, when the suitability of using MMM was verified on the pure linear elements, the application was proceeded to a selected chassis structure of a special vehicle. In this initial phase of the MMM application, the frame of the existing chassis (not modified) was used. During the application, problems with the shape and availability of some structural arrangements were solved. Questions were also addressed on how to evaluate the results obtained. The analysis of the initial weld measurements on the existing structure was not completed due to the complexity of the method and, in particular, the complexity of interpreting the results. The method continues to appear to be very promising. For a closer idea are MMM device and examples of measured magnetograms of welded joints shown on the following images.

Activities in 3-WP12: Optimized Design and Operation of Special Vehicle

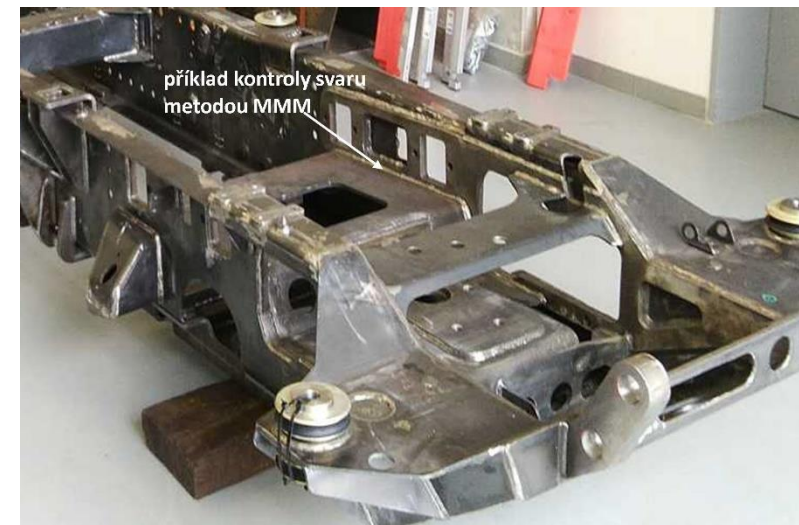
MMM preliminary Application.



8M scanning device



Magnetogram example



*An example of welding inspection using the
MMM method on the existing chassis*

In 2023 the active thermography method was considered, alternatively. A high-quality thermal camera with the required temperature range according to the available documents would show the temperature interface in possible weld defects with sufficient sensitivity. However, due to the fact that it is many times more expensive than the MMM magnetic method and the results would not show a higher quality, this method was abandoned.

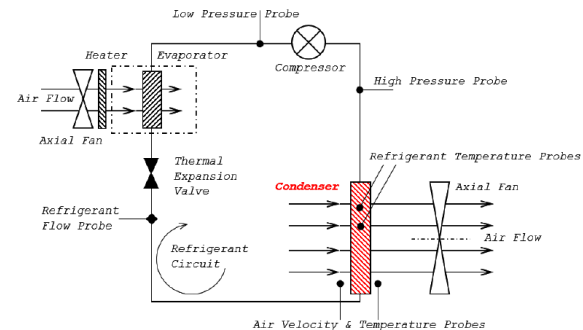
Activities in 3-WP12: Optimized Design and Operation of Special Vehicle

Activities in 3-WP12-002:

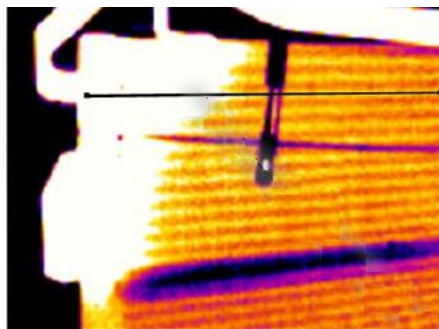
In 2024 was in the laboratory of Faculty assembled a basic of the Functional sample (FS) of cooling system of the special vehicle. After equipping with the necessary measuring elements will be this FS used for experimental verification of the results of the previously performed 3D simulations. This procedure will lead to the engine cooling optimisation and to validation o new developed model of climate condenser.



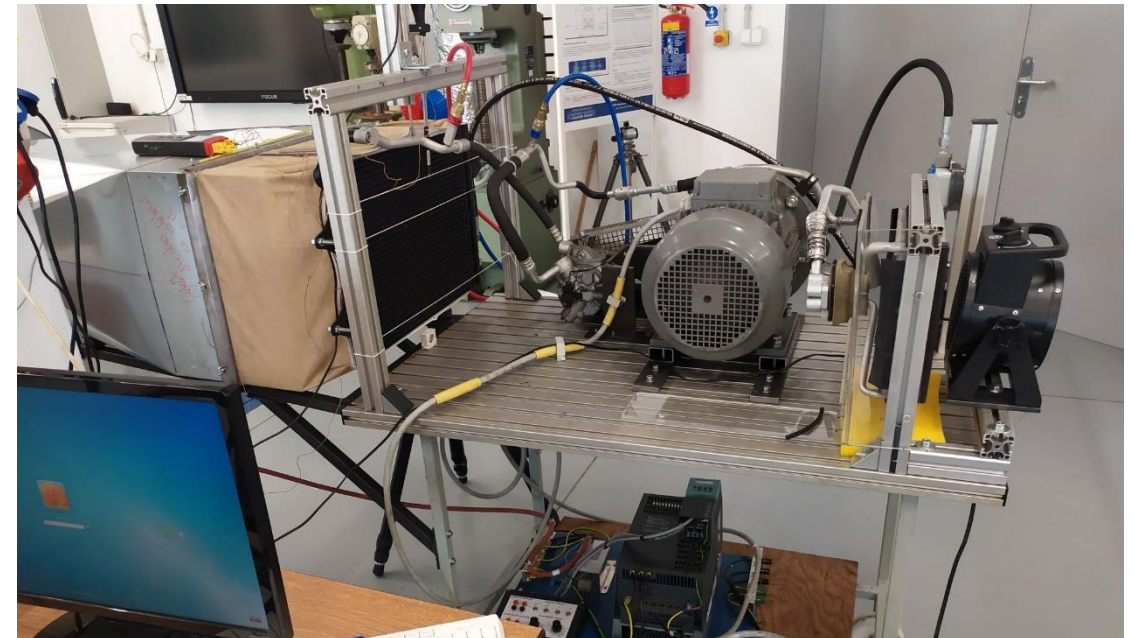
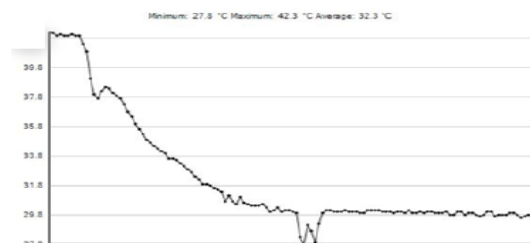
Existing cooling system



Test equipment scheme



Refrigerant phase section measurement

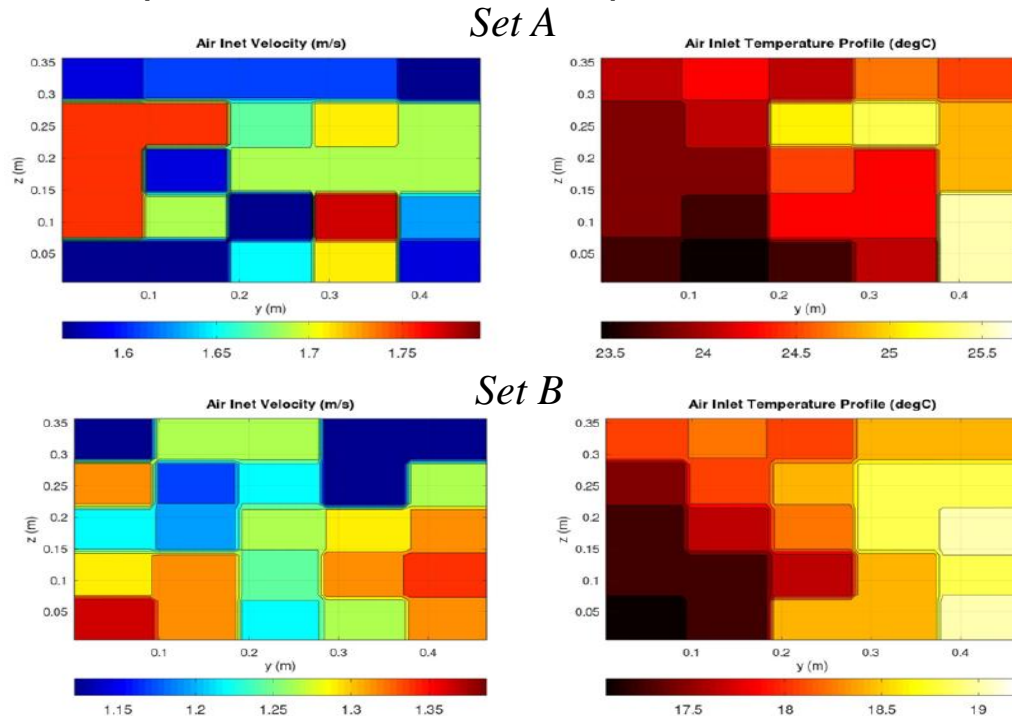


FS – Overview to basic assembly

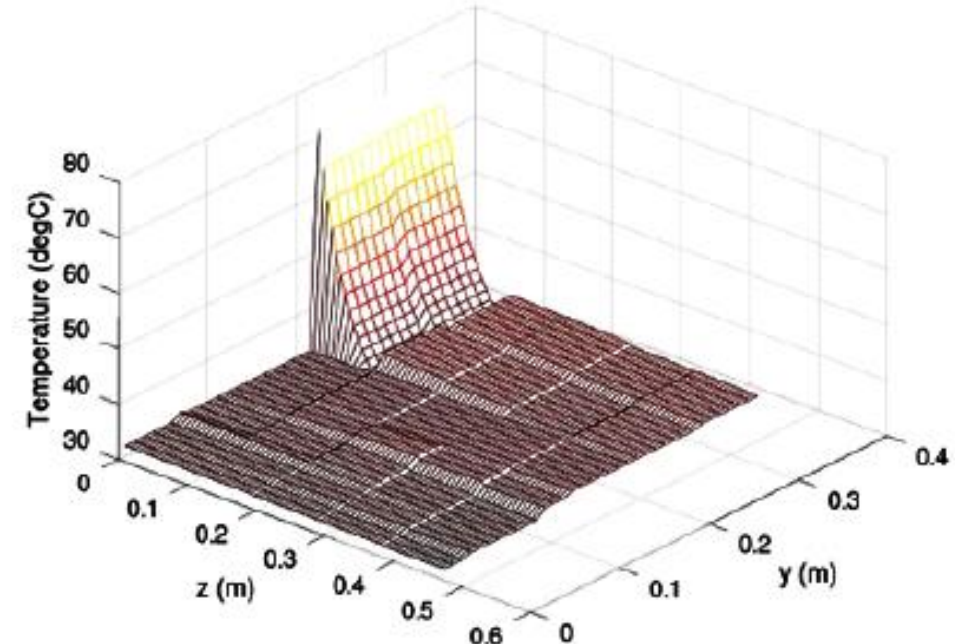
Activities in 3-WP12: Optimized Design and Operation of Special Vehicle

Activities in 3-WP12-002:

In order to validate the proposed AC condenser model that has been developed, two separate sets of measurements were conducted, referred to as Set A and Set B. Each set of measurements was carried out under distinct but constant and steady-state conditions and repeated three times.



Example of Air Inlet (velocity and temperature)



3D visualization of air outlet temperature (SET A)

Fulfillment of goals and deliverables of 3-WP12: Optimized Design and Operation of Special Vehicle

Current State of Deliverables, Milestones and Fulfillment of Goals

3-WP12-001 | The procedure of non-destructive control of internal stresses of welded components by the principle of magnetic response, Ztech, VI./2026, SVOS 0.8; UPa 0.2

- The MMM system was verified in the matter of non-destructive inspection of weld joints
 - verification was done using welds on a previously manufactured special vehicle support frame
- Fulfillment of the goal - the creation of a verified technology for the inspection of welded joints - not threatened.

3-WP12-002 | Functional sample of the Energy Optimized of Special Vehicle Cooling System, G-funk, VI./2026, SVOS 0.8; UPa 0.2

- The basic mechanical assembly of the FS of cooling system of the special vehicle was built.
- The development of a new model of the climate condenser continued.
- Fulfillment of the goal – creation of a functional sample of an energy-optimized cooling system – not threatened.

Fulfillment of goals and deliverables of 3-WP12: Optimized Design and Operation of Special Vehicle

List of Due Deliverables and Their Added Value

3-WP12-001 | The procedure of non-destructive control of internal stresses of welded components by the principle of magnetic response, Ztech, VI./2026, SVOS 0.8; UPa 0.2

Non-destructive inspection of welds will lead to higher strength quality of the supporting frame of a special vehicle and thus to its greater competitiveness.

3-WP12-002 | Functional sample of the Energy Optimized of Special Vehicle Cooling System, G-funk, VI./2026, SVOS 0.8; UPa 0.2

An optimized cooling system will lead to a lower energy demand of a specialized vehicle and thus to its lower operating costs. Reducing operating costs has a positive impact on the environment

Current contribution of 3-WP12: Optimized Design and Operation of Special Vehicle

Assessment of the Contribution of Deliverables

- The MMM non-destructive inspection of weld joints is applicable to all welded structures, the synergy can be to: 3-WP10, 4-WP05, 4-WP9, 4-WP10 and potential is for other projects in Transport 2030, Horizon-CL4.
- Energy optimization of the cooling system of a special vehicle has possible connection to 1-WP02 and potential for other projects is in Transport 2030.

Current contribution of 3-WP12: Optimized Design and Operation of Special Vehicle

Assessment of the Formal/Administrative Goals of the Work Package

Completion of goals is not threatened in 2024. Both partners, the University of Pardubice and the company SVOS, are performing their tasks according to plan.

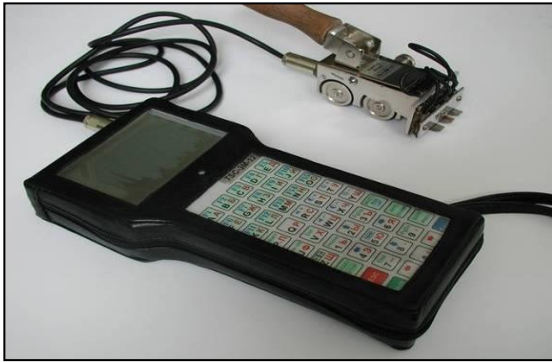
Current contribution of 3-WP12: Optimized Design and Operation of Special Vehicle

Acknowledgment

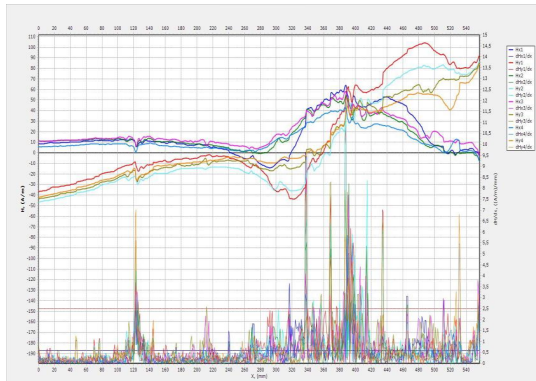
This research has been realized using the support of Technological Agency, Czech Republic, programme National Competence Centres II, project # TN02000054 Božek Vehicle Engineering National Center of Competence (BOVENAC).

Výtah prací 2023-2024 za 4-WP10: Optimalizace návrhu a provoz speciálního vozidla

UPCE+SVOS: Use of MMM for weld inspection

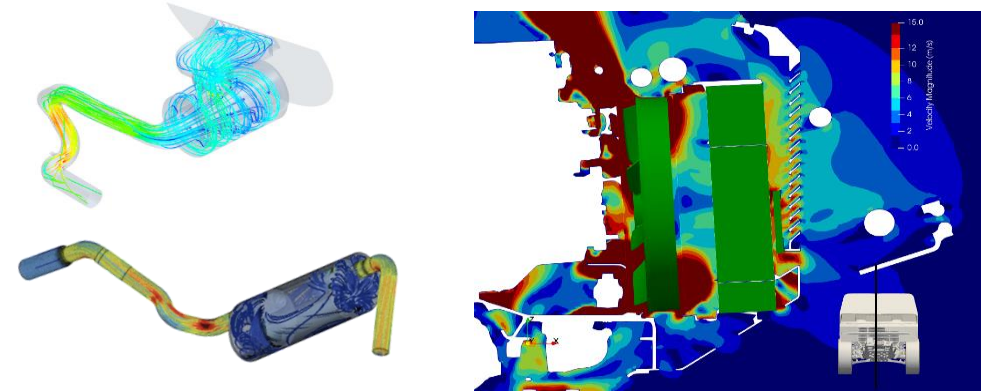


Úvod do magnetické paměti materiálu, analýza metod, předběžné testy

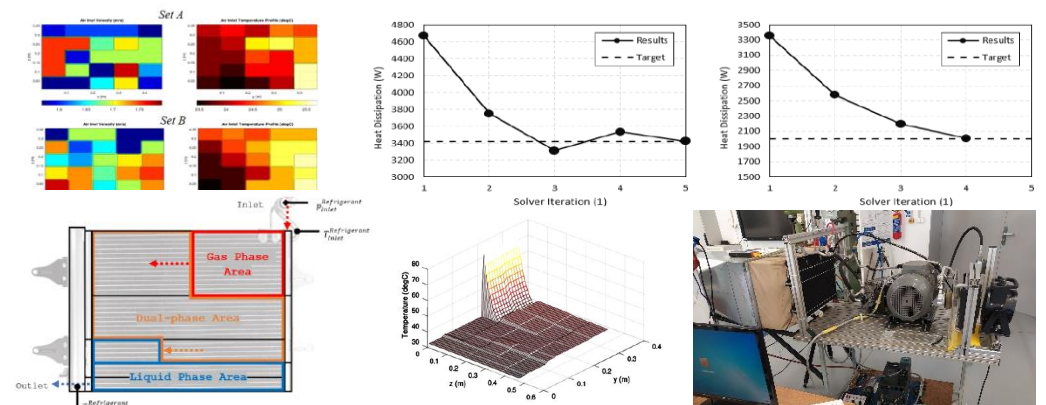


První testy na skutečném speciálním vozidle (stávající konstrukce), analýza výsledků, možná interpretace výsledků, použití na skořepinách, kontroly svarů

UPCE+SVOS: Design and operation of cooling system



Numerické simulace sacího a výfukového systému, optimalizace chlazení motoru



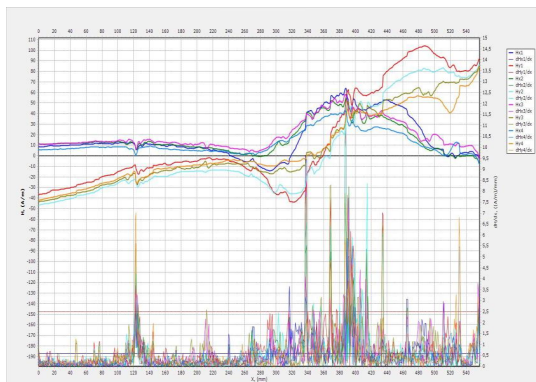
Základní sestava komponent funkčního vzorku chladicího systému motoru a optimalizace tepelného toku

Results of 4-WP10: Optimized Design and Operation of Special Vehicle – achieved 2023 -2024

UPCE+SVOS: Use of MMM for weld inspection

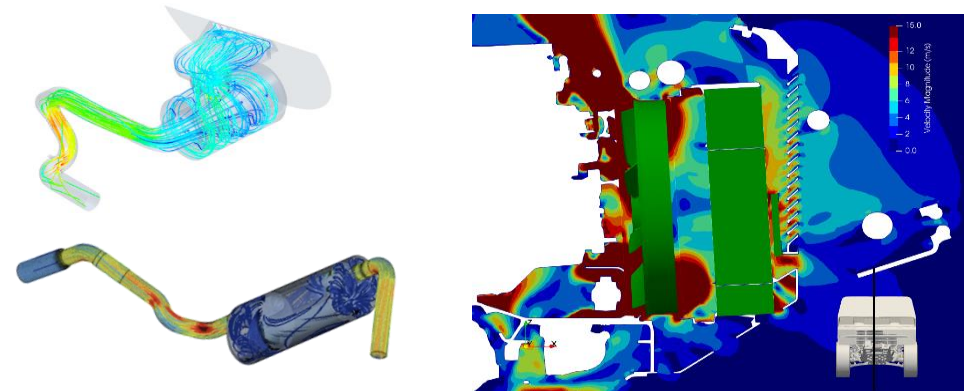


Introduction to Magnetic Memory of the Material, Method analysis, preliminary tests

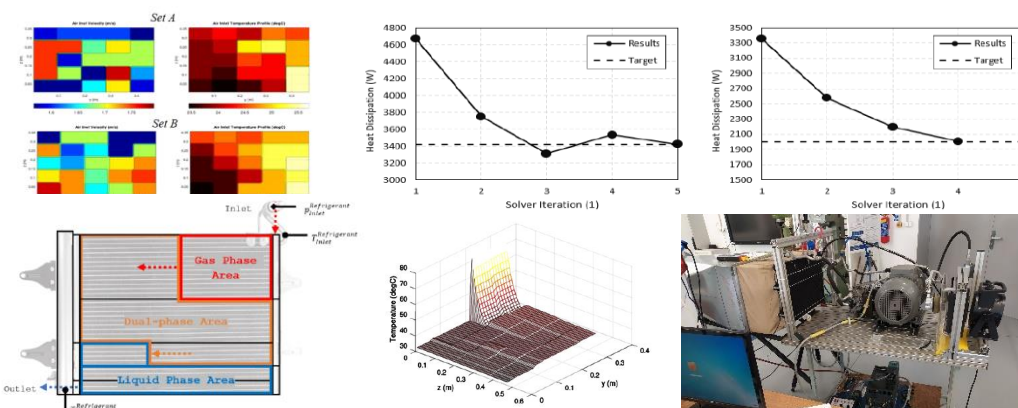


First tests on real special vehicle (existing construction), results analysis, possible interpretation of results, use on shells, weld inspections

UPCE+SVOS: Design and operation of cooling system

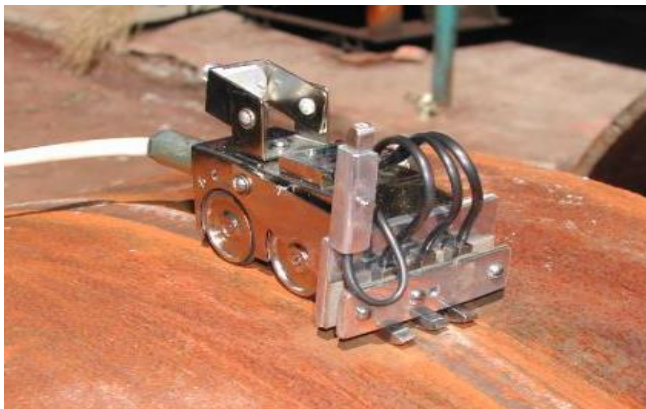


Numeric simulations of air intake and exhaust system, optimization of engine cooling



Basic assembly of components of a FS of the engine cooling system and heat flow optimization

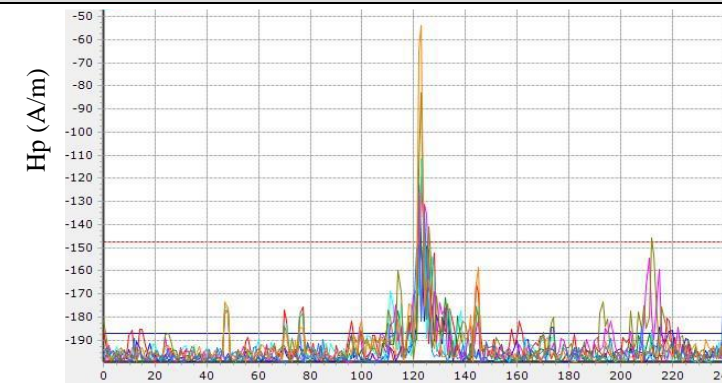
Výťah prací 2024 za 3-WP12: Optimalizace návrhu a provoz speciálního vozidla



MMM sonda 8M

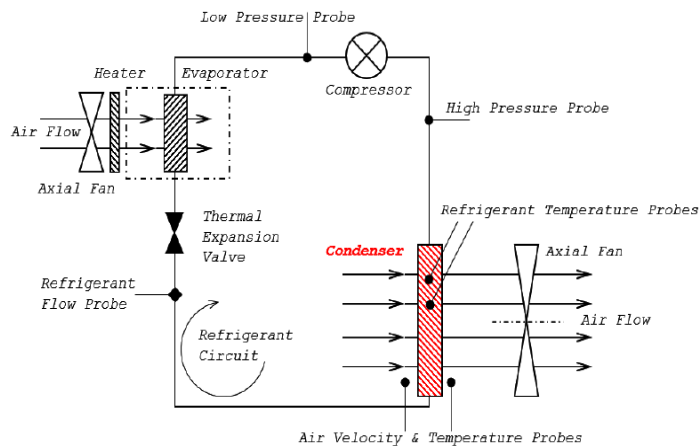


Kontrola svařeného rámu speciálního vozidla metodou MMM

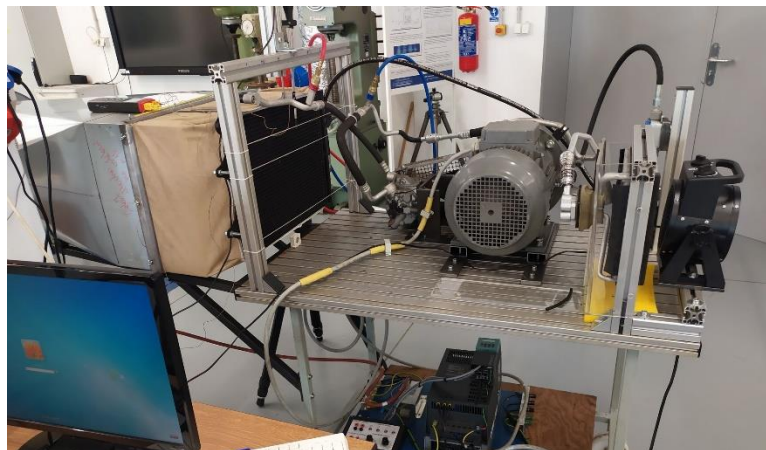


L (mm)

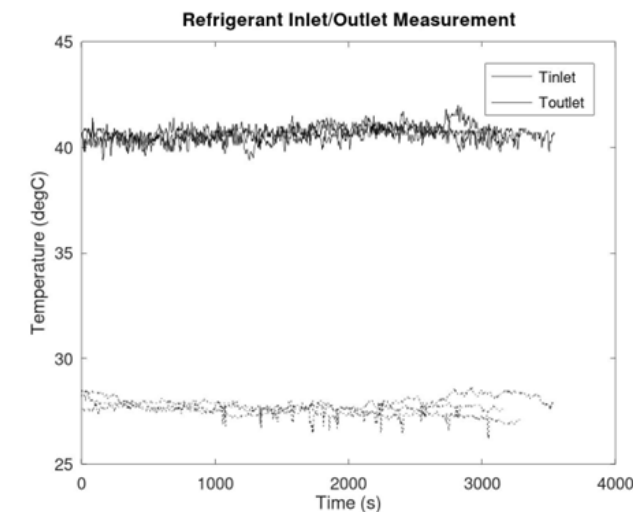
Magnetogram – intenzita magnetického pole svarového spoje



Testovací sestava



Základní sestava komponent funkčního vzorku chladicího systému motoru



Průběh teplot chladiva na vstupu a výstupu z klima kondenzátoru

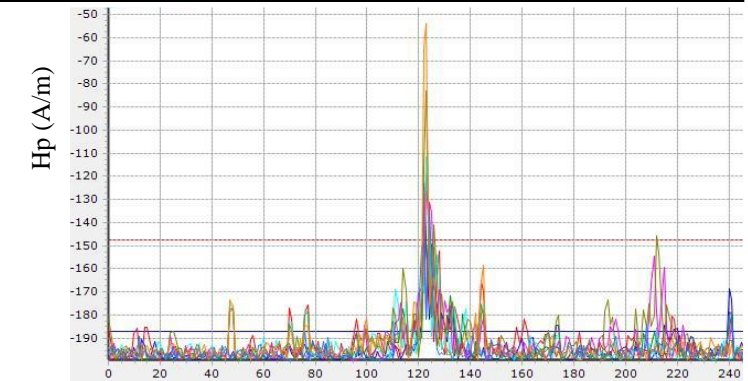
Results of 3-WP12: Optimized Design and Operation of Special Vehicle – achieved 2024



8M scanning device

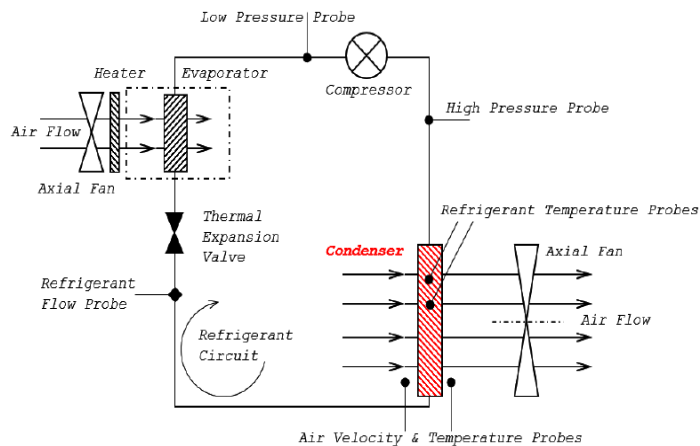


Inspection of the welded frame of a special vehicle by the method MMM

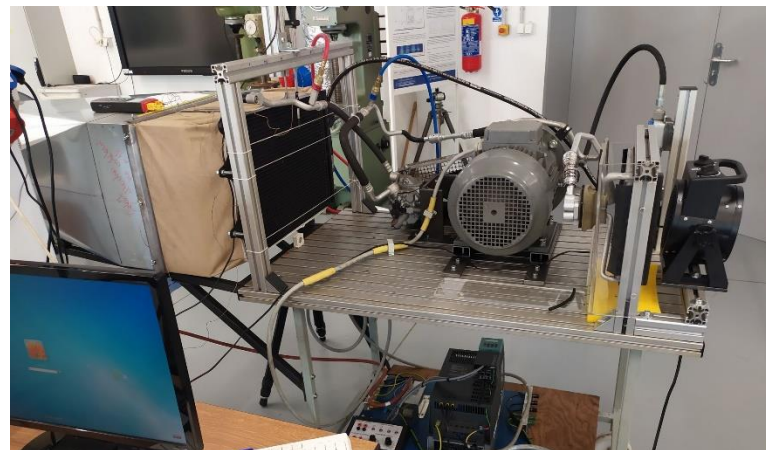


L (mm)

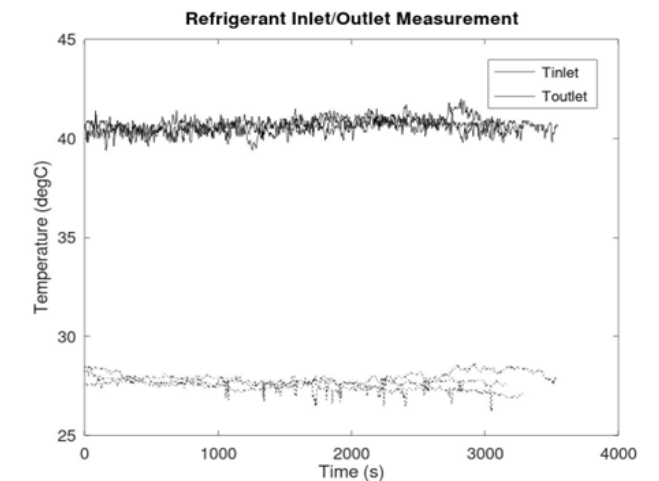
Magnetogram – intensity of the magnetic field of the weld joint



Test equipment scheme



Basic assembly of components of a FS of the engine cooling system



Temperature progress of the coolant at the inlet/outlet of the conditioning condenser