



Projekt:

reg. č. CZ.02.1.01/0.0/0.0/16_025/0007293

„Modulární platforma pro autonomní
podvozky specializovaných elektrovozidel
pro dopravu nákladu a zařízení“

TENTO VÝSLEDEK BYL FINANČNĚ PODPOŘEN MŠMT A EU

Project: MODULAR PLATFORM FOR AUTONOMOUS CHASSIS OF SPECIALIZED ELECTRIC VEHICLES FOR FREIGHT AND EQUIPMENT TRANSPORTATION
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(European Structural and Investment Funds - Operational Programme Research, Development and Education)



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Motivace

Každý prakticky použitelný dopravní prostředek potřebuje ke své činnosti minimálně jeden elektrický točivý stroj a elektrochemický akumulátor.

Nad to lze uvažovat, zda použít i spalovací motor či palivový článek.

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Výzkumné záměry projektu

Hlavní řešitel projektu: doc. Ing. Michal Petrů, Ph.D.

- **Lehké konstrukce pro autonomní užitkové elektrovozidlo (VZ1)**

Řešitel: Ing. Tomáš Martinec, Ph.D. (Ústav mechatroniky a technické informatiky)

- **Elektropohony a řízení pro autonomní užitková elektrovozidla (VZ2)**

Řešitel: Ing. Robert Voženílek, Ph.D. (Katedra vozidel a motorů)

- **Akumulátory pro autonomní užitková elektrovozidla (VZ3)**

Řešitel: Ing. Pavel Jandura, Ph.D. (Ústav mechatroniky a technické informatiky)

- **Informační systémy a smíšená realita pro autonomní užitková elektrovozidla (VZ4)**

Řešitel: Ing. Jan Kočí (Oddělení modelování procesů a umělé inteligence)

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Vize autonomní platformy

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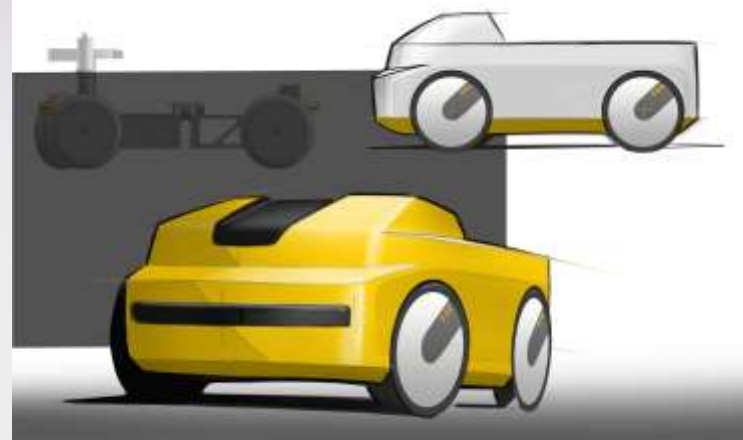


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„0 generace“



testování strategie řízení
„pes sledující člověka“

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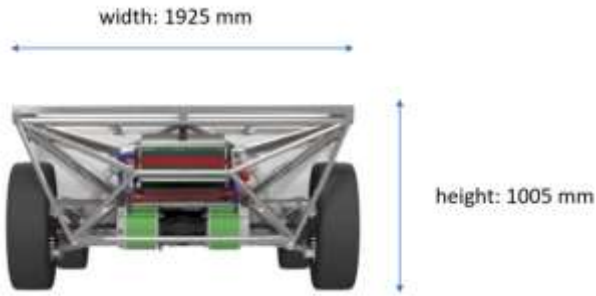


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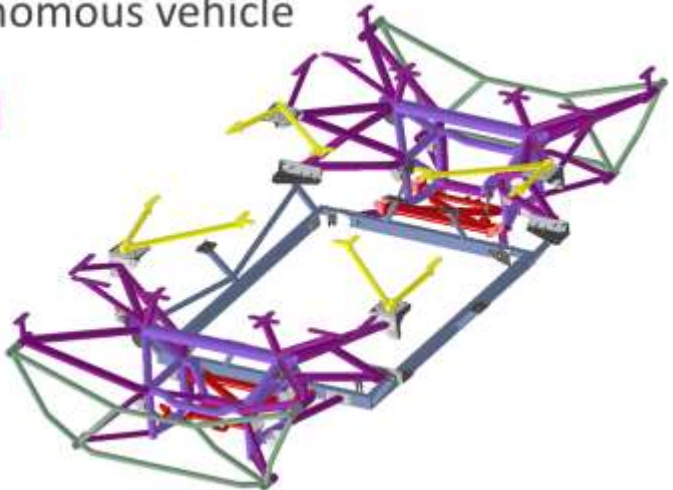


„1 generace“



Frame of the autonomous vehicle

- Main frame →  + 
- Bumper frame → 
- Battery frame → 
- Subframe → 
- Load platform support → 



length: 3850 mm



payload: 1000 kg

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Vybrané výsledky za jednotlivé výzkumné záměry

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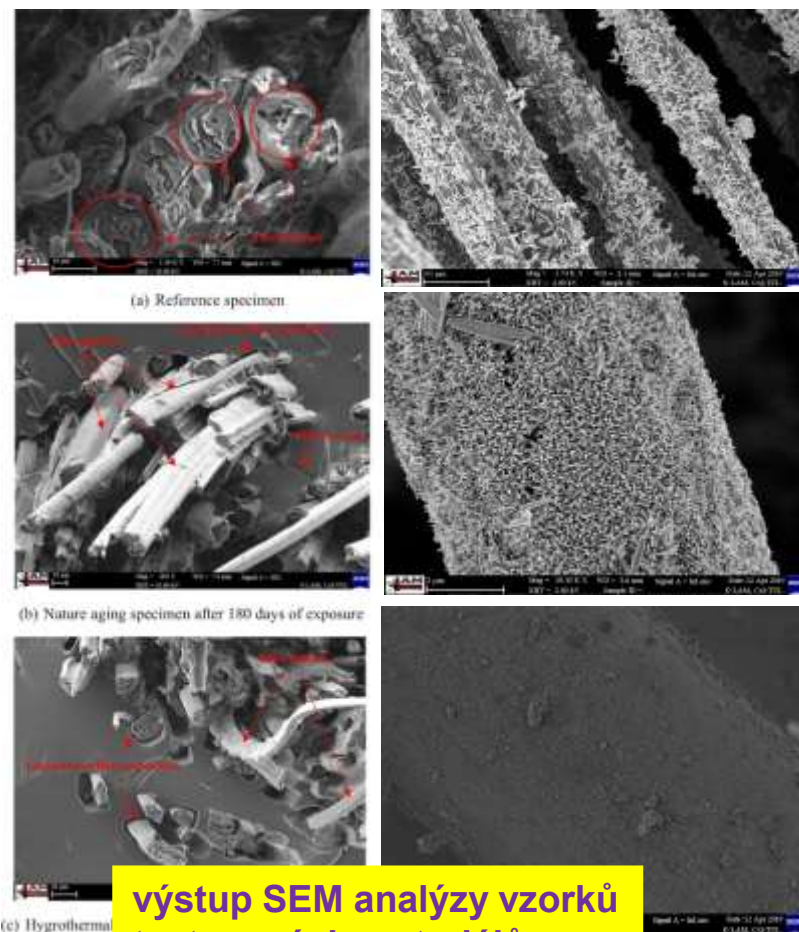
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VZ1 - Lehké konstrukce pro autonomní užitková elektrovozidla

- Vývoj nových materiálů pro výslednou lehkou konstrukci je zaměřen na nové typy polymerních kompozitů s organickou i anorganickou výztuží
- V rámci experimentů byla realizována měření dynamických a rázových vlastností funkčních vzorků s matricí naplněnou nanočásticovými materiály
- Výzkum kompozitů vytvořených z tkanin potažených nano částicemi TiO₂ pro studium fyzikálních, mechanických a termických vlastností (přestup tepla, tepelný odpor, tepelné difuzivity



výstup SEM analýzy vzorků testovaných materiálů

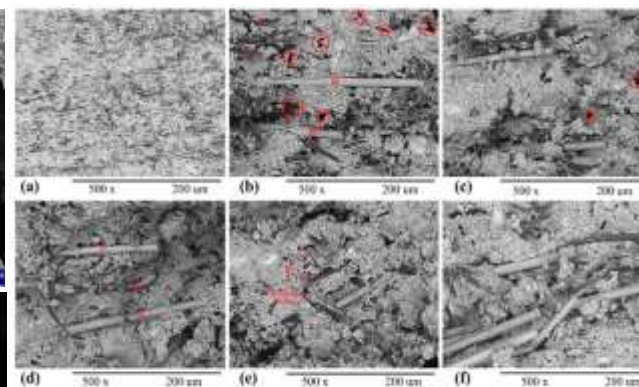
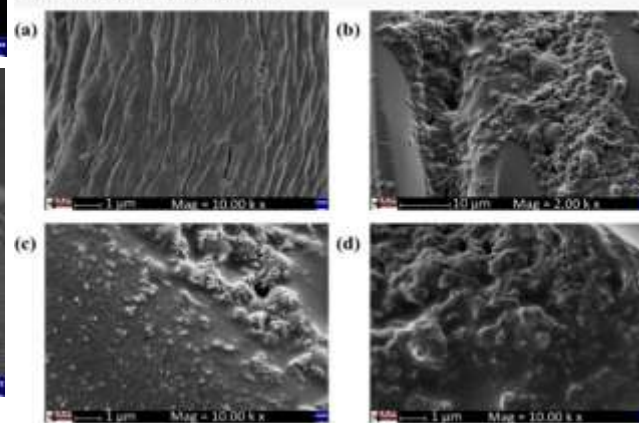


Figure 7. SEM analysis of EB-HRCC samples: (a) reference sample (without BFW), (b) 0.5% BFW + 4% eucalyptus pulp (EP), (c) 1% BFW + 4% EP, (d) 1.5% BFW + 4% EP, (e,f) 2% BFW + 4% EP from different samples respectively.

Figure 2. UHR-SEM analysis of (a) untreated sample, (b) sample C-nZnO 3, (c) sample C-nZnO 5, and (d) sample C-nZnO 7.



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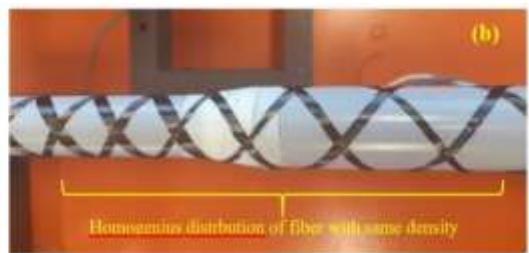
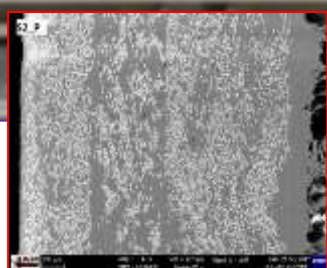
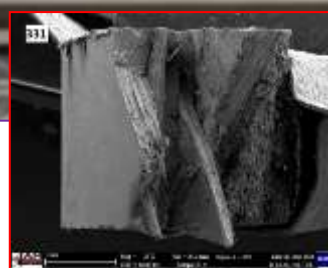
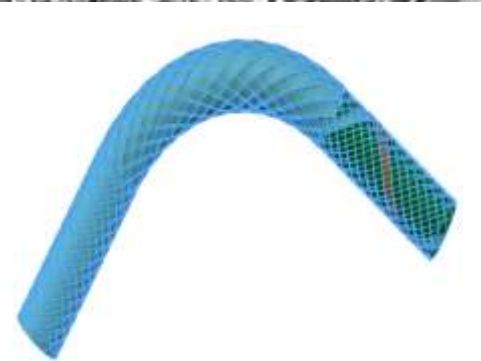
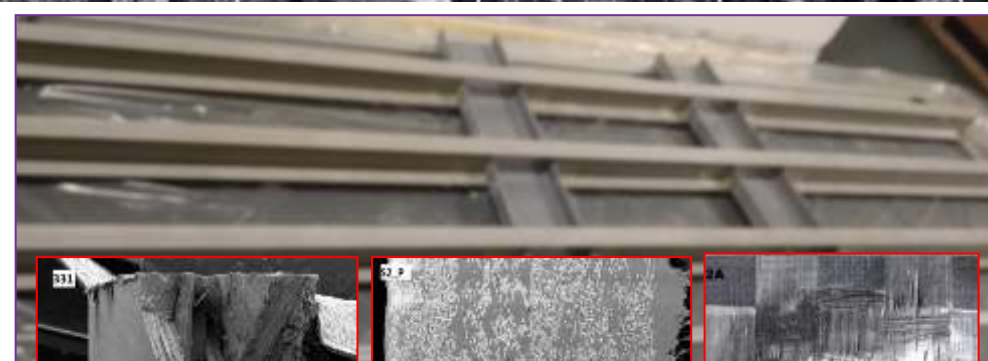


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Lehké struktury a nové kompozitní materiály včetně metod pro jejich průmyslovou výrobu

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**Výroba a testování komponent
kompozitního rámu, testy funkčního
vzorku kompozitního boxu pro
uložení baterií pro Generaci 1**

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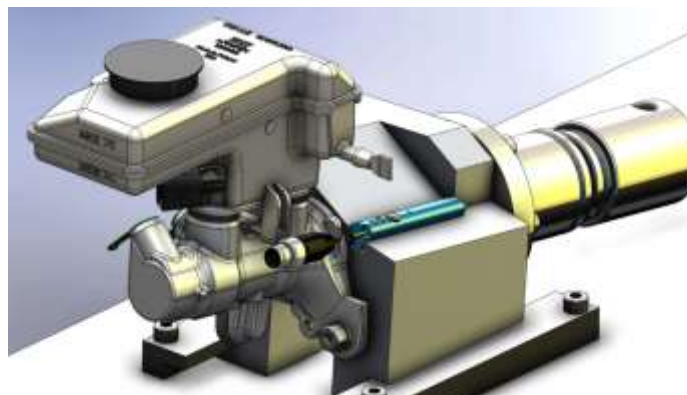


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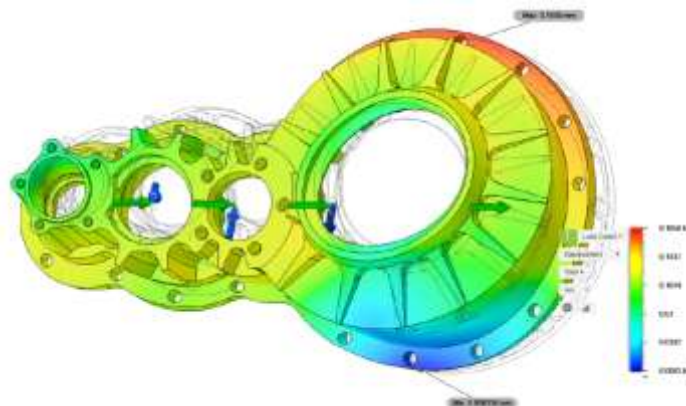




Elektrické hnací ústrojí „generece 1“



Vývoj brzdny systém „generece 1“



Vývoj převodovky „generece 1“

VZ2 - Elektropohony a řízení pro autonomní užitková elektrovozidla

- Vývoj konstrukce nápravy, návrh mechanického převodového ústrojí, návrh elektrického pohonu včetně systému směrového řízení
- Hnací agregát každé nápravy se skládá ze dvou jednostupňových převodovek vlastní konstrukce a dvou střídavých trakčních elektromotorů v režimu elektronického diferenciálu s funkcí torque vectoring
- Vývoj hydraulické části brzdové soustavy vozidla, která bude používána v případě poruchy vozidla jako bezpečnostní.

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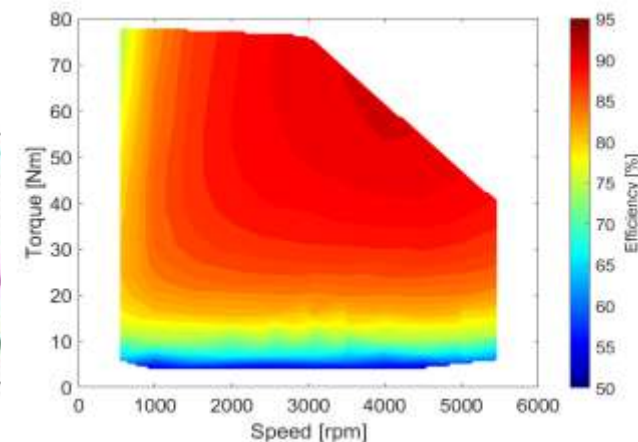
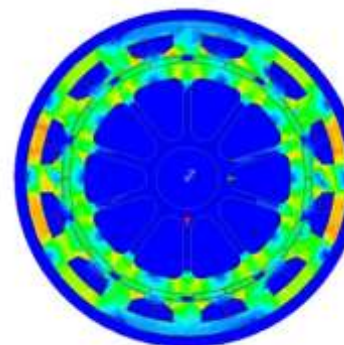
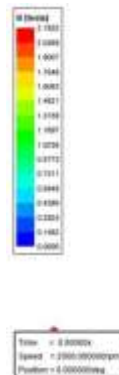
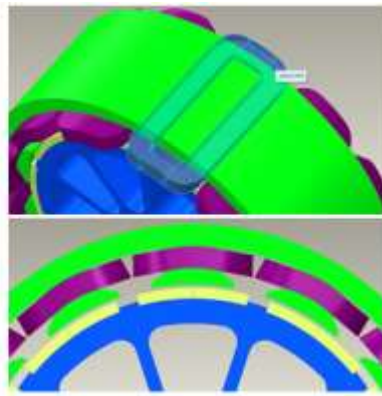
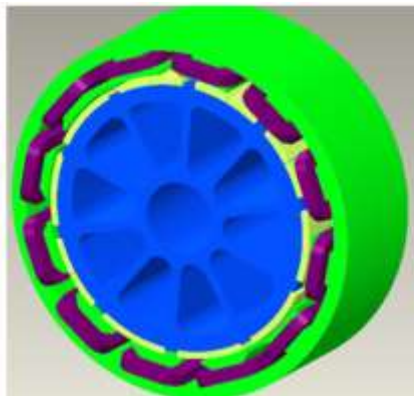


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**Ukázky simulace a testování
magnetické pole ve středu SPM-PMSM
motoru při otáčkách 2000/min**

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Ukázky konstrukce v 3D a montáž funkčního celku nápravy „generace 1“



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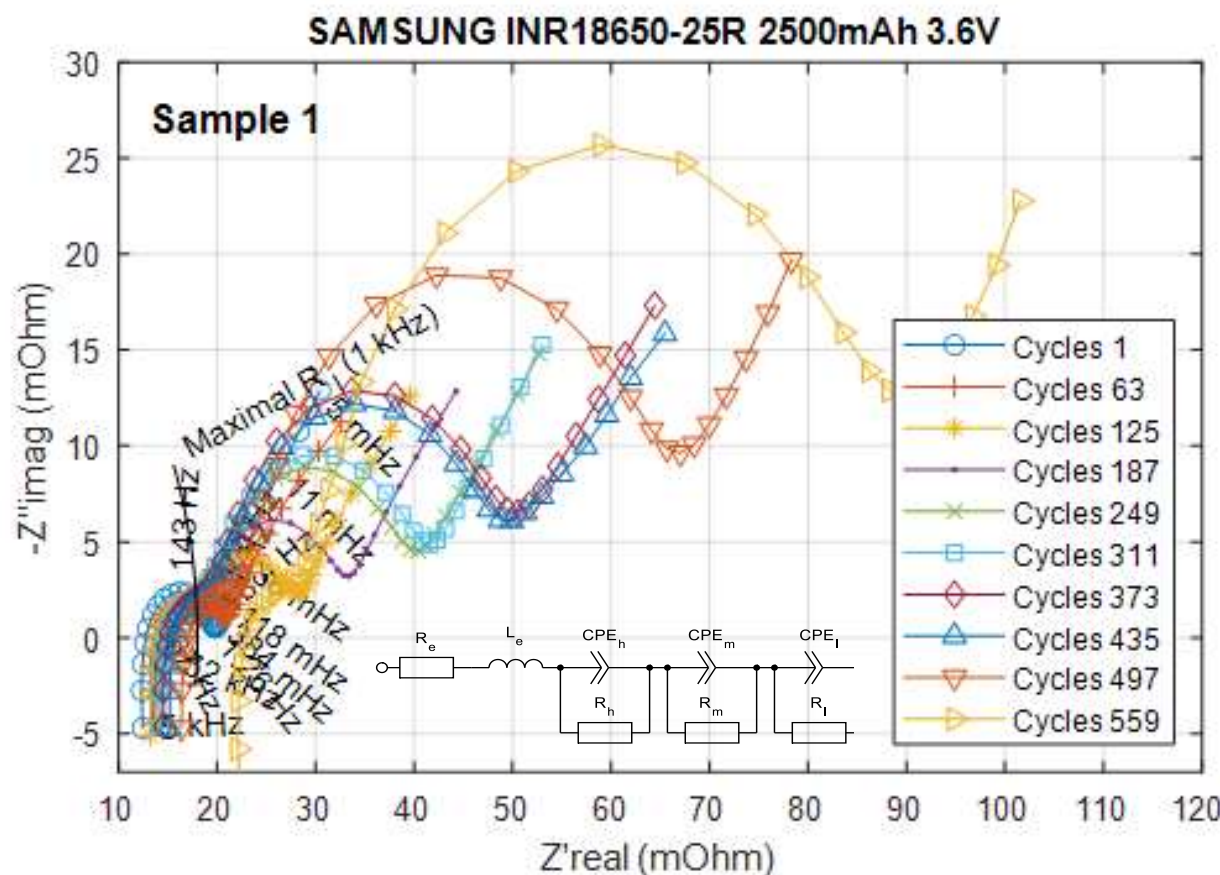


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VZ3 - Akumulátory pro autonomní užítková elektrovozidla



- Využití nejlepších technologií ukládání elektrické energie a jejich přizpůsobení pro konkrétní praktickou aplikaci vč. aplikace vyspělé sensoriky a polovodičových prvků
- Implementace poznatků fungování elektrochemických dějů do řídicích algoritmů komplexního managementu energetického úložiště.
- **Návrh robotického systému dobíjení pro autonomní mobilní platformu**
- Návrh centrální řídicí jednotky autonomní mobilní platformy

Impedanční spektroskopie pro evaluaci SoH elektrochemických článků

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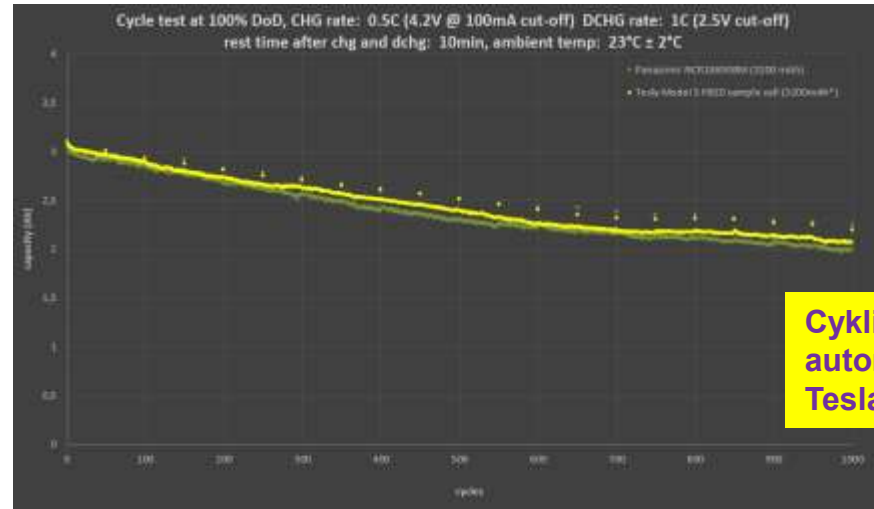


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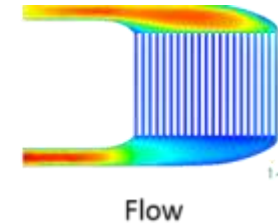
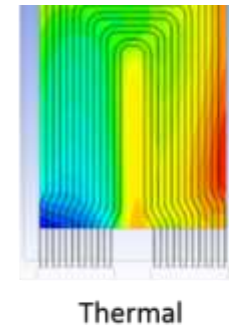
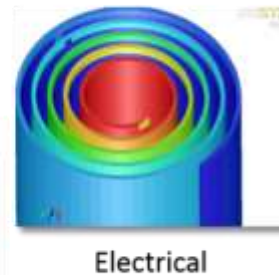
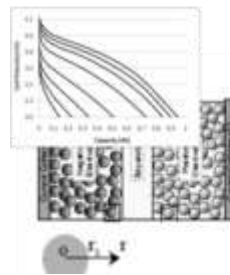




Stand pro
dlouhodobé
testování
cylindrických
článků



Cyklické testy
automotive článků
Tesla, LG, CATL...



Simulační nástroje
Ansys, Matlab

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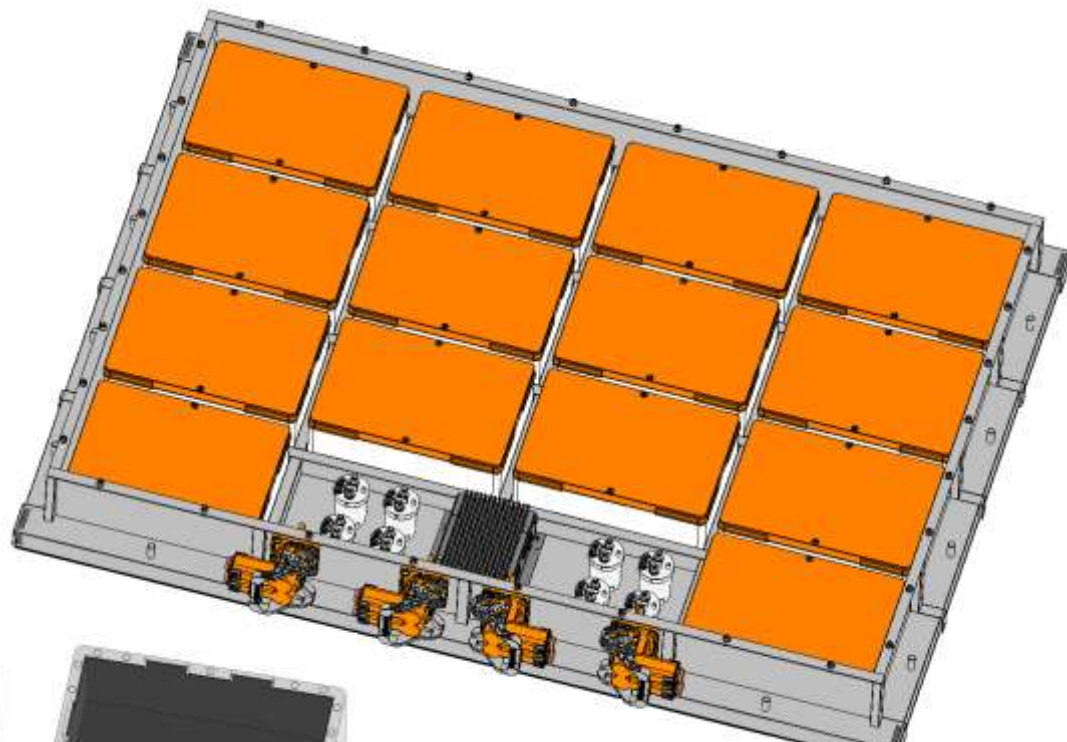


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**Laserové svařování 2 mm Al busbar
na terminály prizmatických článků**



**Vývoj baterie pro platformu
„generace 1“**

Kompozitní bateriový modul

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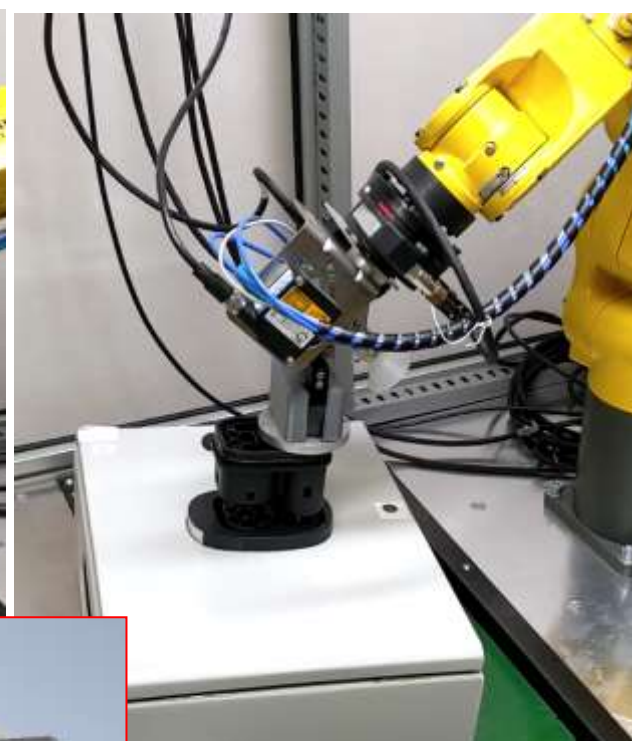
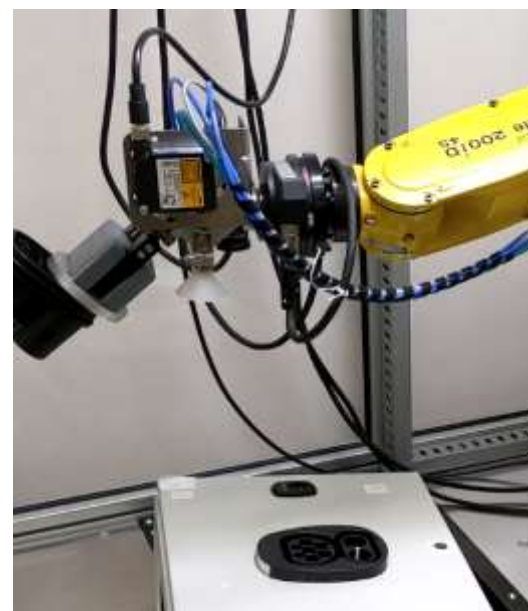


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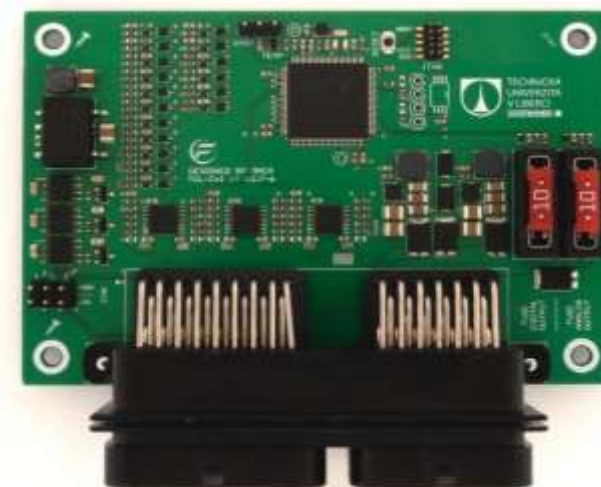
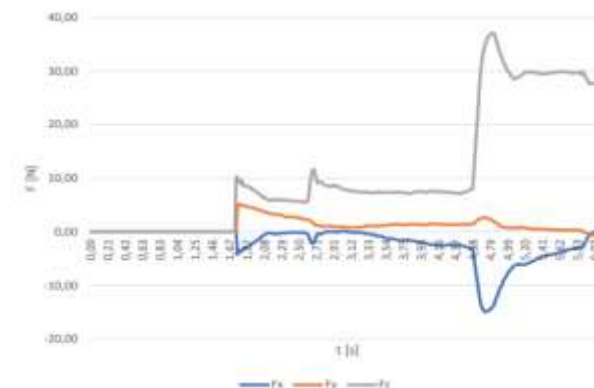


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Ukázka průběhu sil při zasouvání EV konektoru CCS typ 2 s využitím force torque sensoru



Univerzální řídicí jednotka platformy

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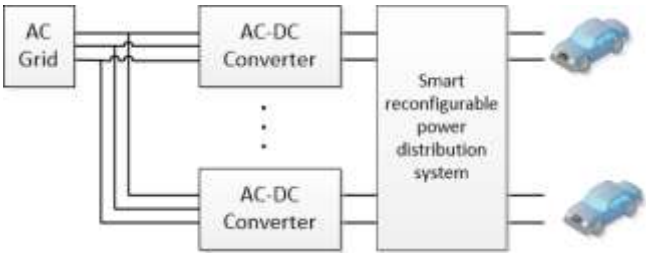


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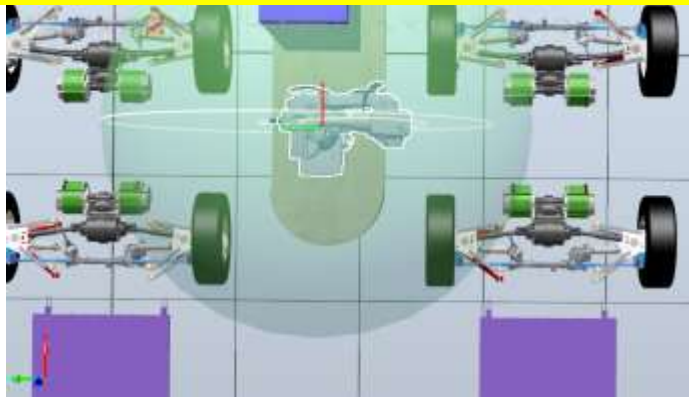




Elektronika DC nabíjecí stanice pro platformu



Koncept robotického dobíjení platformy



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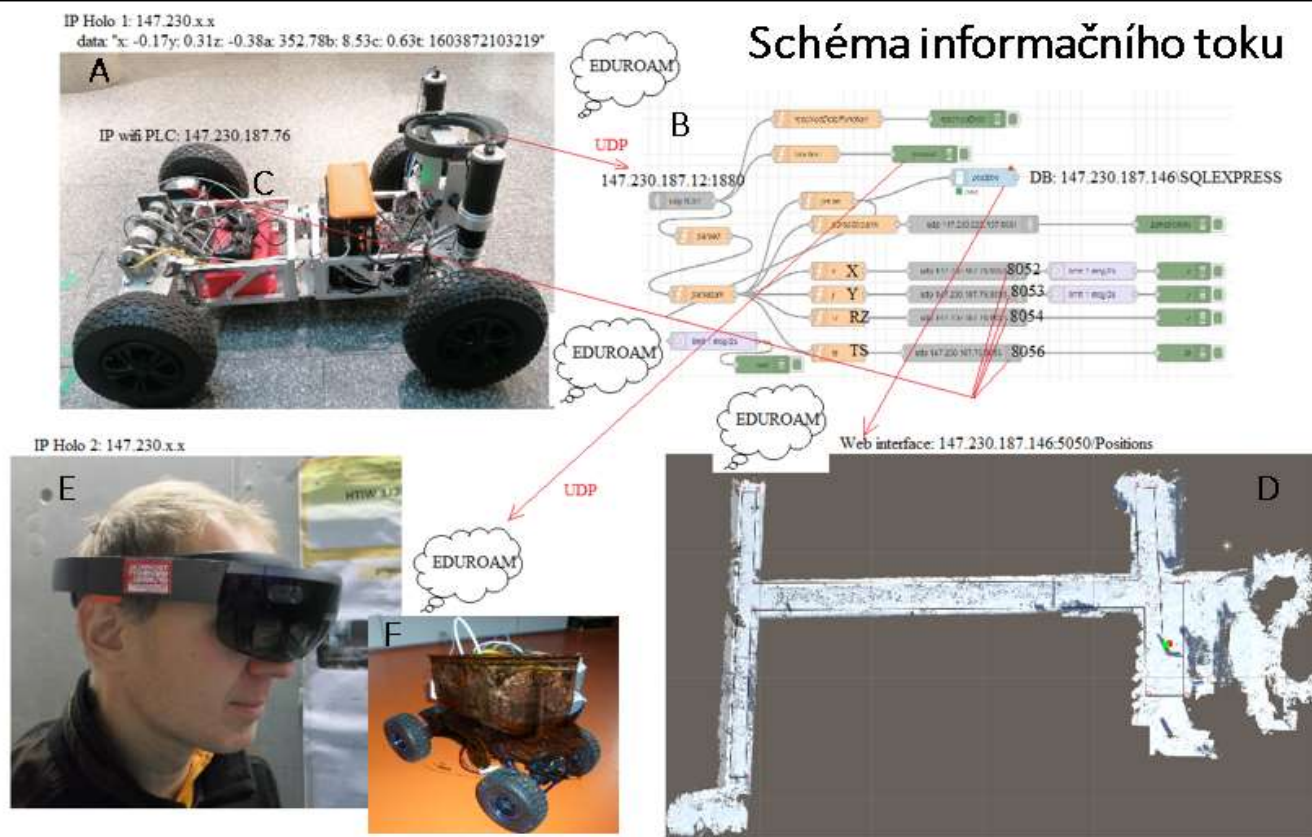




Popis infrastruktury a informačních toků

VZ4 - Informační systémy a smíšená realita pro užitková elektrovozidla

Schéma informačního toku



- Výzkum IoT technických prostředků pro počítačové vidění a navigaci v reálném prostoru, pro sběr telemetrických dat, několikastupňové vyhodnocení dat
- Technologie rozšířené reality AR Microsoft HoloLens byla integrována do do řízení modulární platformy. Zrychlení přenosu dat z MS HoloLens na MSSQL server.
- koncept plánování dráhy s využitím tzv. mapy ohodnocení (cost map) experimentálního prostoru a techniky optimálních rychle prozkoumávajících náhodných stromů (RRT)

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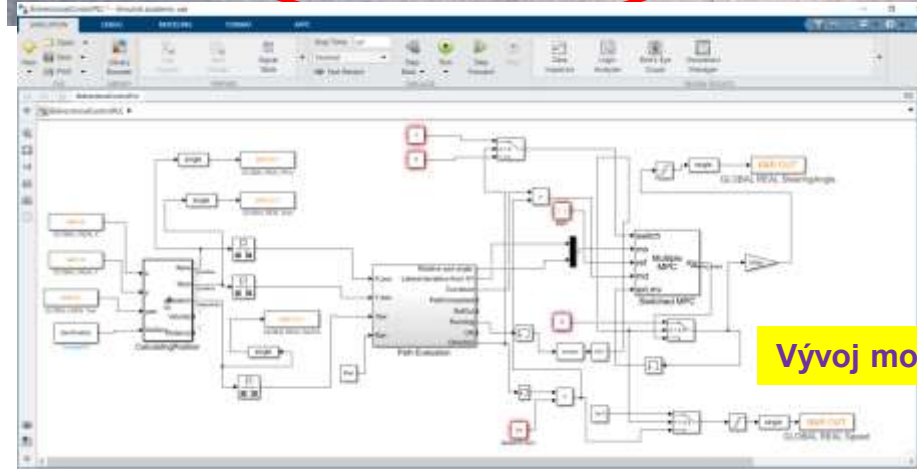


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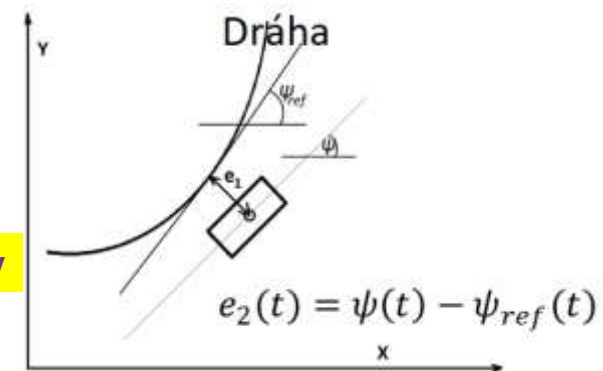
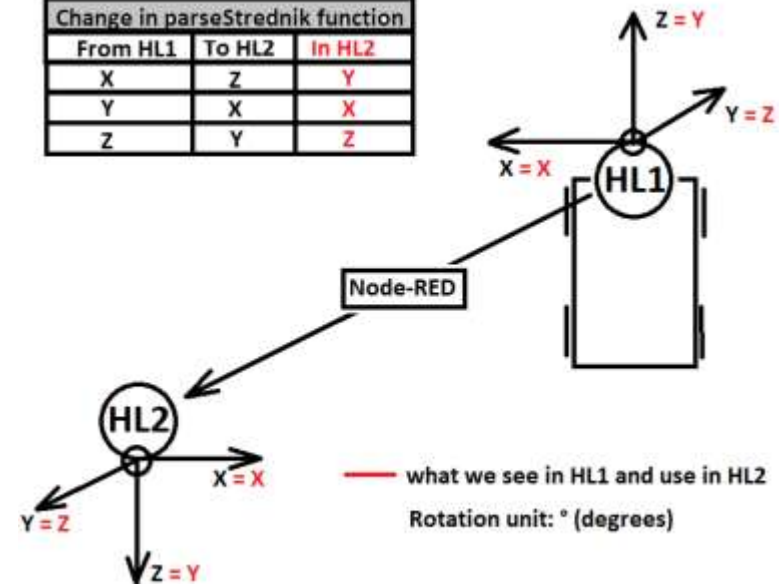


Příklad augmentovaného vozíku s nářadím na platformě „generace 0“



Vývoj modelů řízení platformy

Change in parseStrednik function		
From HL1	To HL2	In HL2
X	Z	Y
Y	X	X
Z	Y	Z



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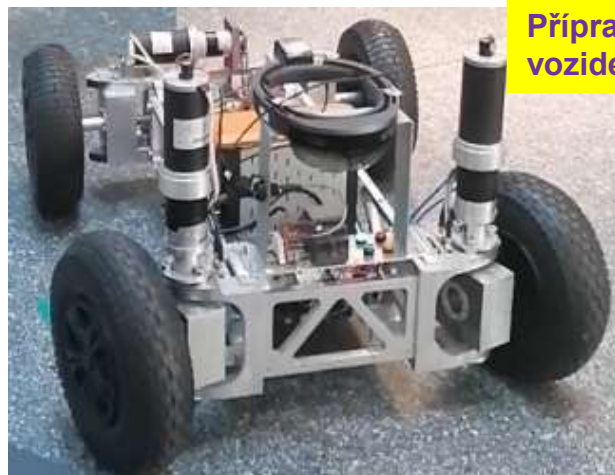


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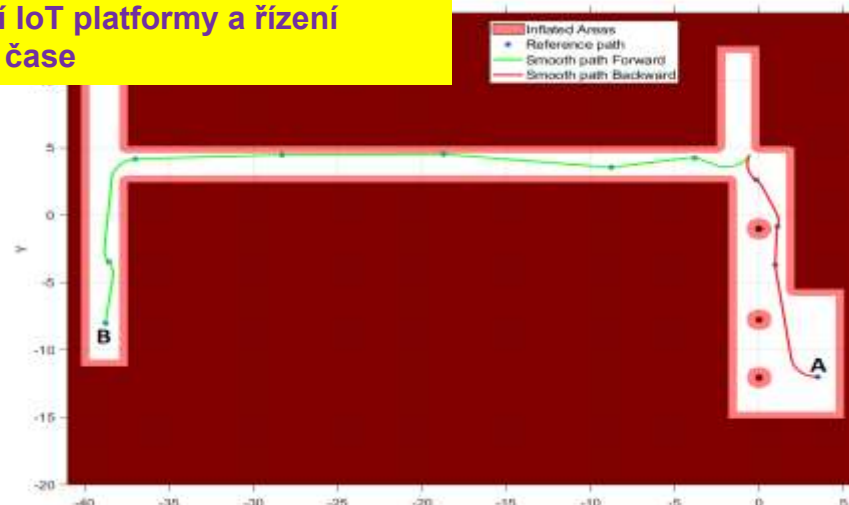


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Příprava adaptivní IoT platformy a řízení vozidel v reálném čase



Průběh zakřivené sledování dráhy v prvních pokusech



Průběh sledování dráhy po úpravě struktury komunikace a řídicího systému

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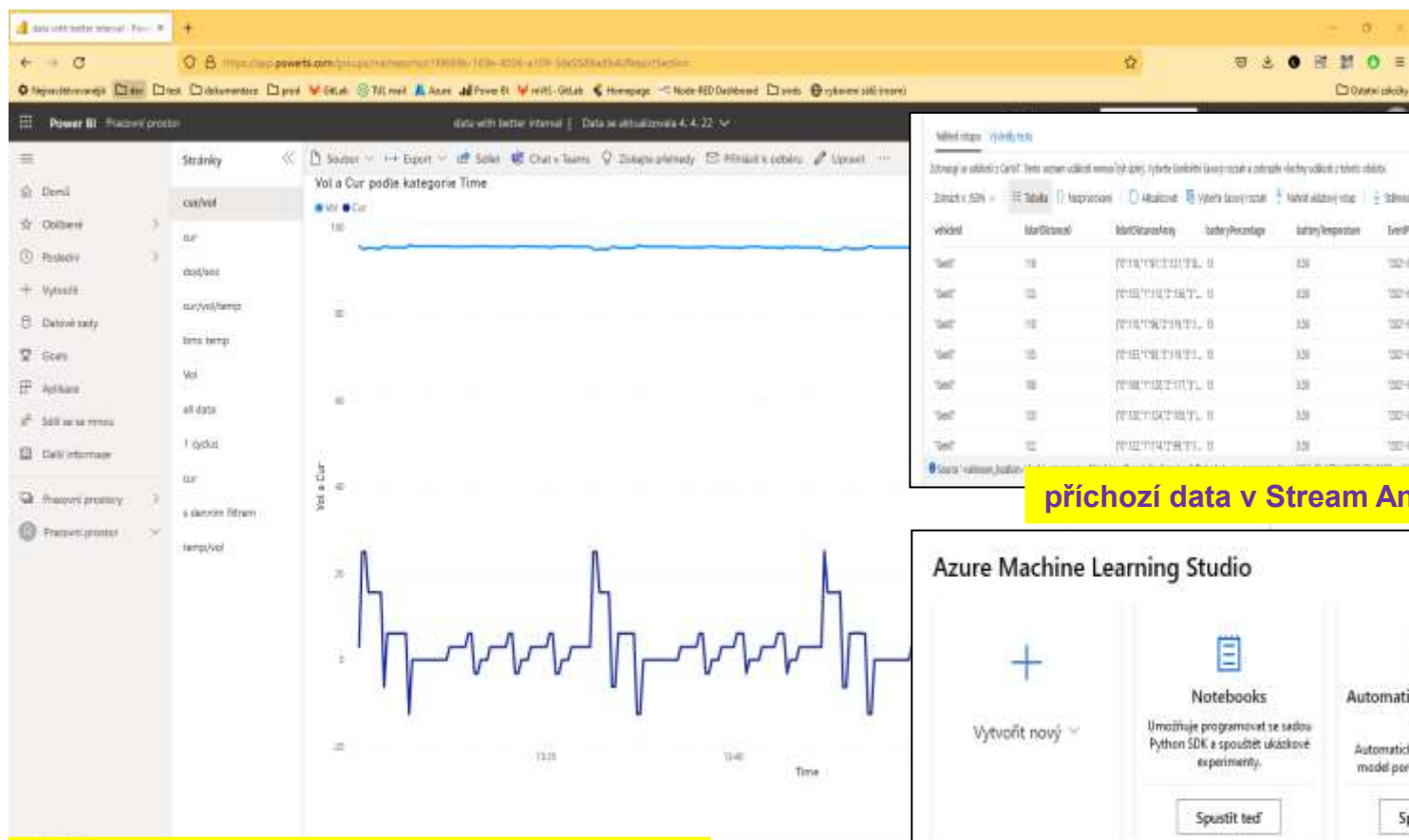


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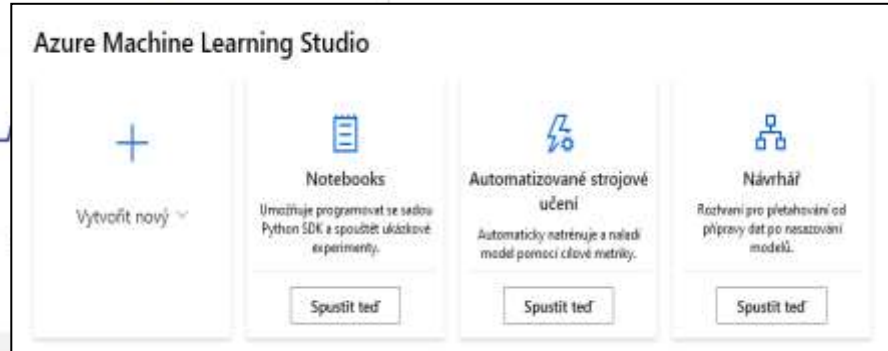
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přichází data v Stream Analytics v tabulce

data cyklování baterie pro prediktivní údržbu



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Dosažené výsledky projektu

Řešení projektu umožnilo navýšení kompetencí výzkumníků TUL v oblasti autonomního řízení, IoT a AR aplikací, bateriových systémů, elektrických pohonů a konstrukcí z lehkých materiálů.

- Výstupem projektu je k datu 9/2022 více než 230 výsledků vědy a výzkumu v podobě impaktovaných publikací včetně knižních kapitol, mezi tyto výsledky patří i množství funkčních vzorků a více než 4 podané mezinárodní patentové přihlášky.
- Bylo uzavřeno více než deset memorand o porozumění s významnými průmyslovými partnery, uspořádány odborné semináře, stáže a jedna mezinárodní konference.

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Díky za pozornost

TENTO VÝSLEDEK BYL FINANČNĚ PODPOŘEN MŠMT A EU

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