

Pristopi, merilna tehnika in metode pri razvoju izdelkov za zeleno mobilnost

Dr. Martin Furlan | Sektor razvojnih storitev | 2022/03/24

WE SHAPE FUTURE MOBILITY



Približno 160 proizvodnih lokacij v več kot 30 državah na petih celinah

MAHLE globalno

Zaposleni: več kot
72.000 (2020)

Around 160 production
locations in more than
30 countries on five
continents

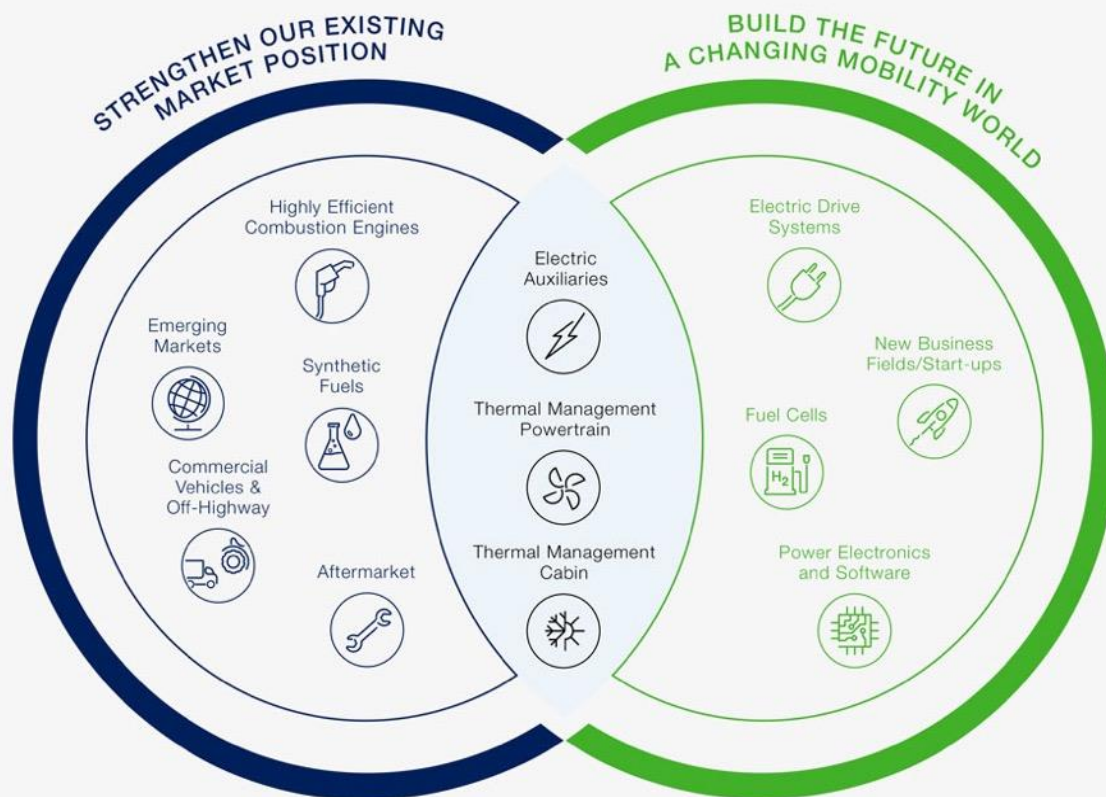


Prodaja: 9,8 milijarde
EUR (2020)

12 večjih razvojnih lokacij z okoli
5.500 razvojnimi inženirji in tehniki
v Nemčiji, Veliki Britaniji, Sloveniji,
Španiji, ZDA, Braziliji, na
Japonskem, Kitajskem in v Indiji

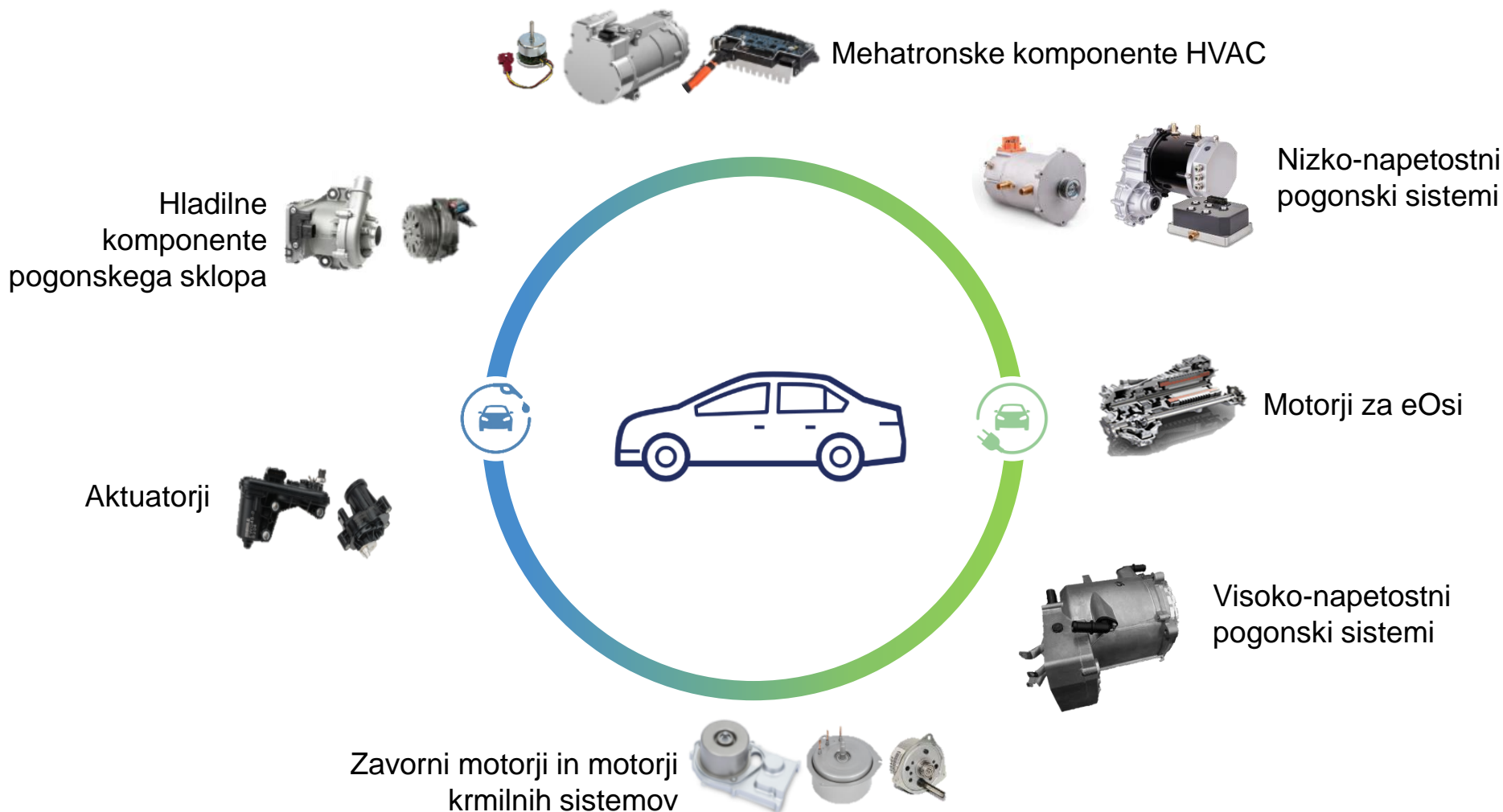
MAHLE in zeleni prehod

Dual Strategy



MAHLE Mechatronics

Izdelki za osebna vozila



MAHLE Mechatronics

Izdelki za srednje-težka in težka vozila



Mehatronske komponente HVAC



Nizko-napetostni pogoni hidravličnih sistemov



Visoko-napetostni pogonski sistemi



Alternatorji



Zaganjalniki



Električna črpalka hladilne tekočine



MAHLE Mechatronics

Izdelki za rokovanje z materiali in za logistiko

Grafični prikazovalniki



DC motor za hidravliko



Motorji krmilnih sistemov

Tipkovnice



CAN vmesniki za krmilne sisteme



Asinhronski motorji za hid. sisteme



Nizko-napetostni pogonski sistemi



Asinhronski vlečni motorji



Krmilnik pogonskega sistema / hidravlike

MAHLE Mechatronics

Izdelki za gradbeno industrijo in kmetijstvo

Alternatorji



Nizko-napetostni pogoni
za hid. sisteme



Visoko-napetostni
pogonski sistemi

Zaganjalniki



Nizko-napetostni pogonski sistemi

MAHLE Mechatronics

Izdelki za majhna motorna vozila

AC generatorji in regulatorji napetosti



Sistemi za vbrizgavanje goriva



Aktuatorji



Vlečni pogoni IPM z ločenim in integriranim krmilnikom



ECU



Vžigalne tuljave in enote CDI/TCI



MAHLE Mechatronics

Izdelki za električna kolesa

Sredinska pogonska enota



Motor pesta



Baterija



Aplikacije



Rešitve HMI

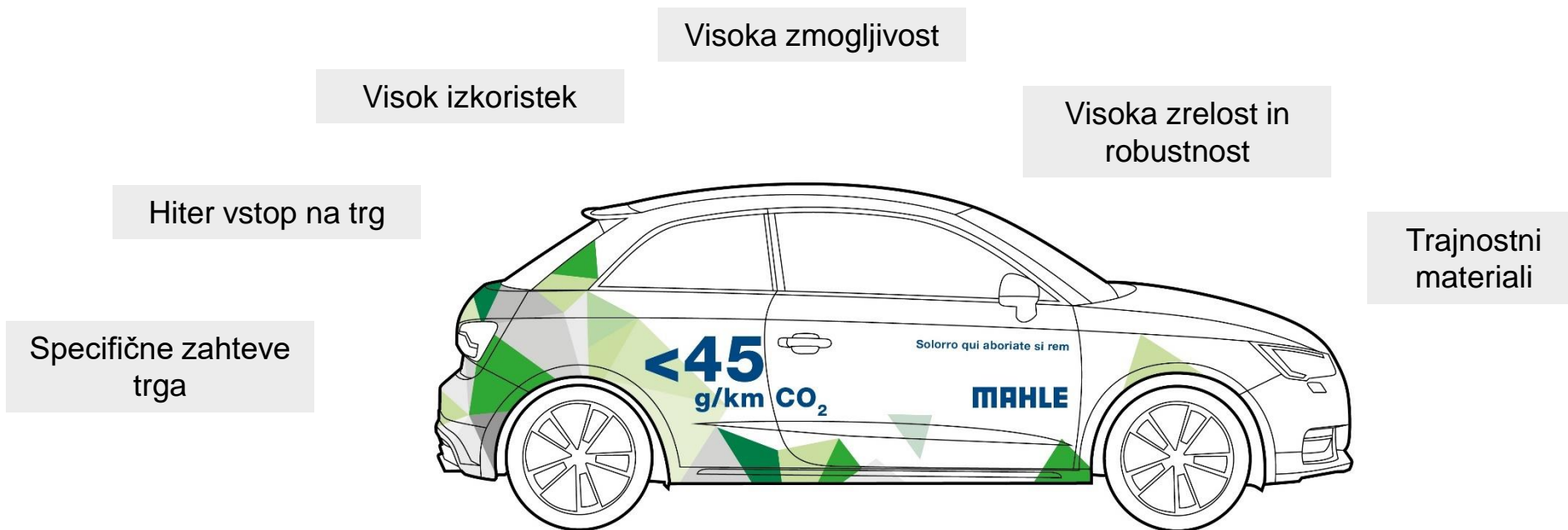


Baterija za podaljšanje
dosega



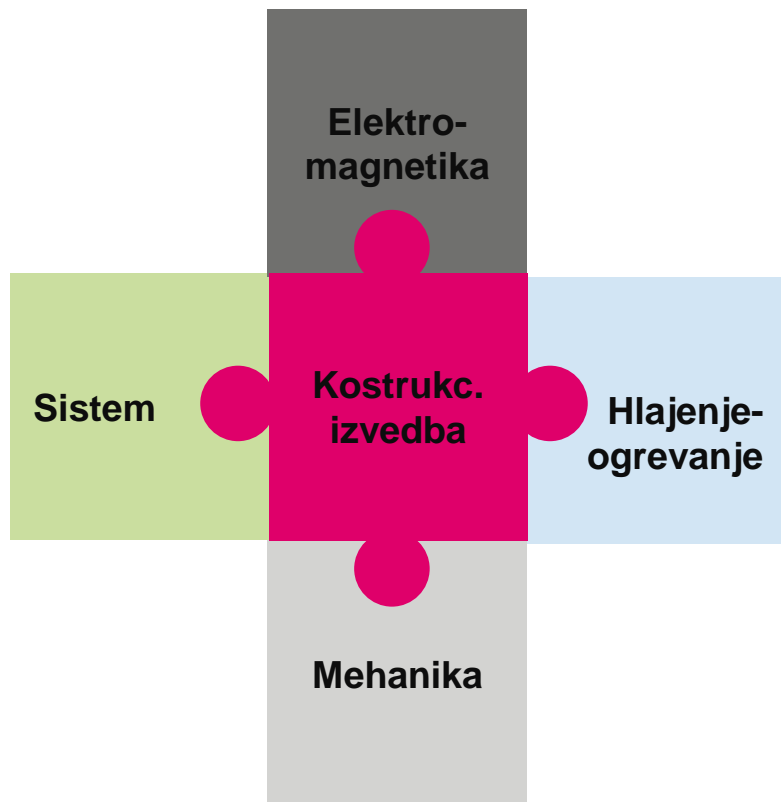
MAHLE izdelki nove mobilnosti

Zahteve trga in e-mobilnosti



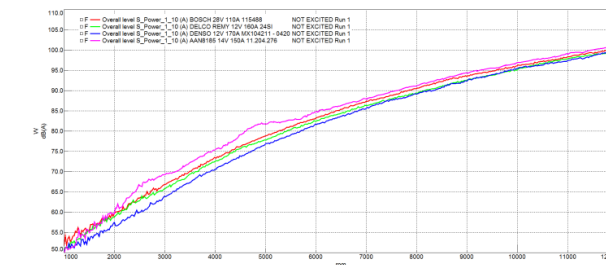
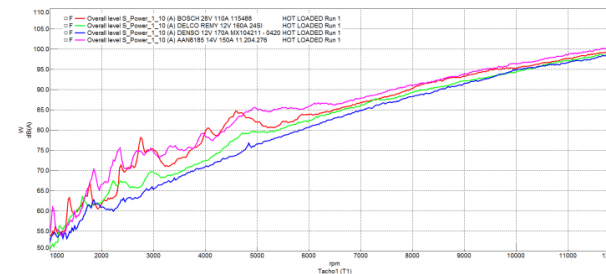
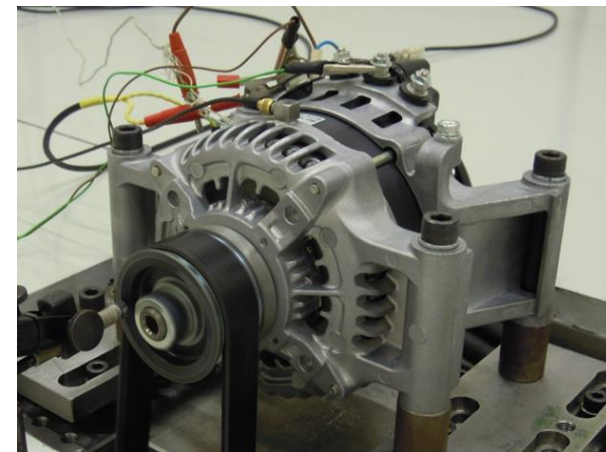
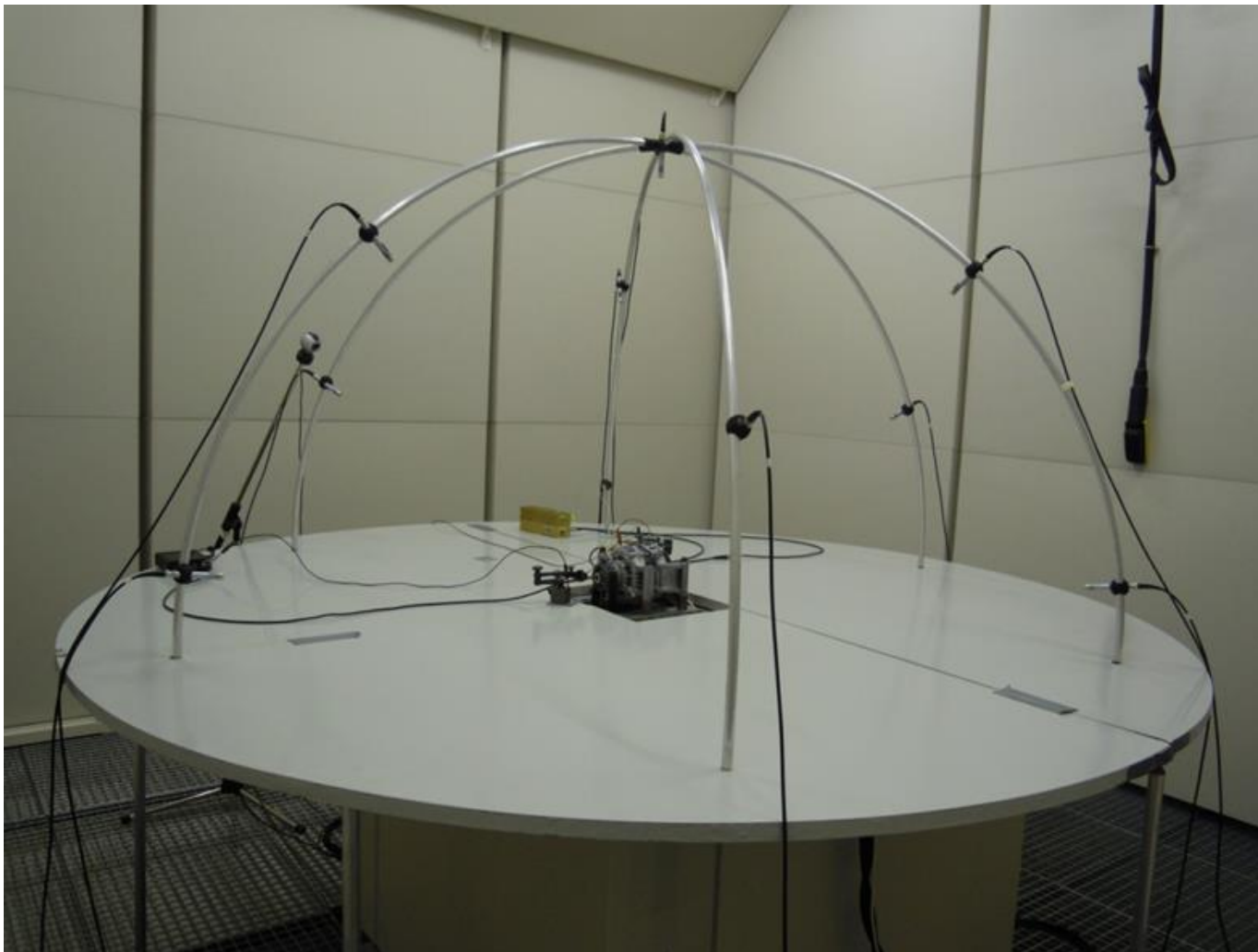
MAHLE izdelki nove mobilnosti

Kompleksnost in izzivi razvoja izdelkov e-mobilnosti



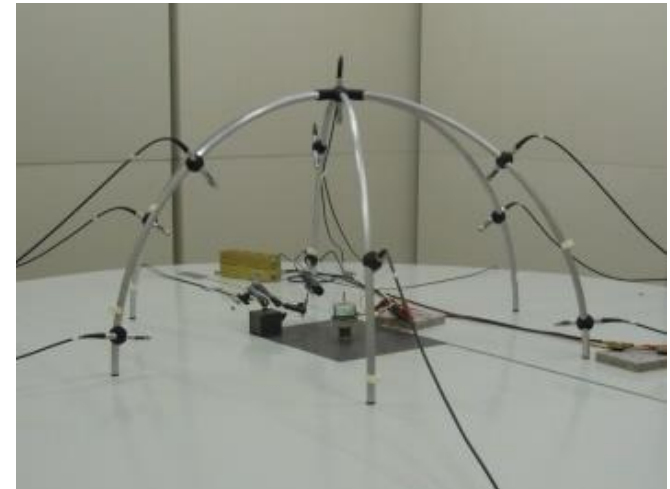
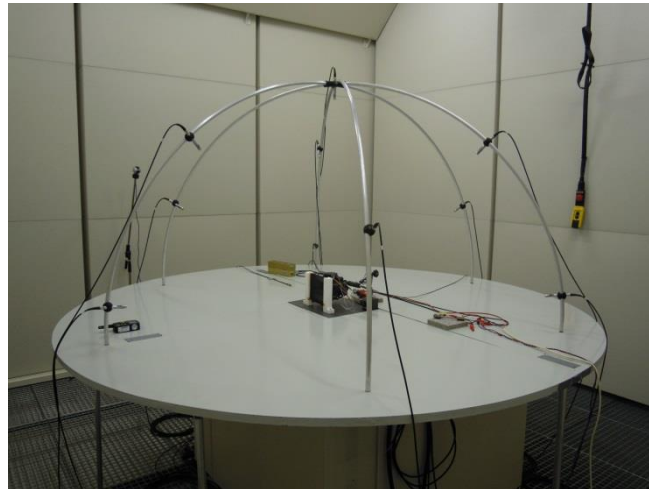
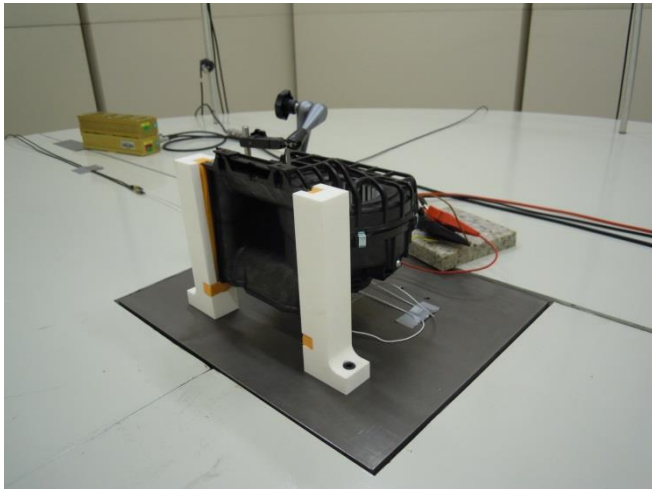
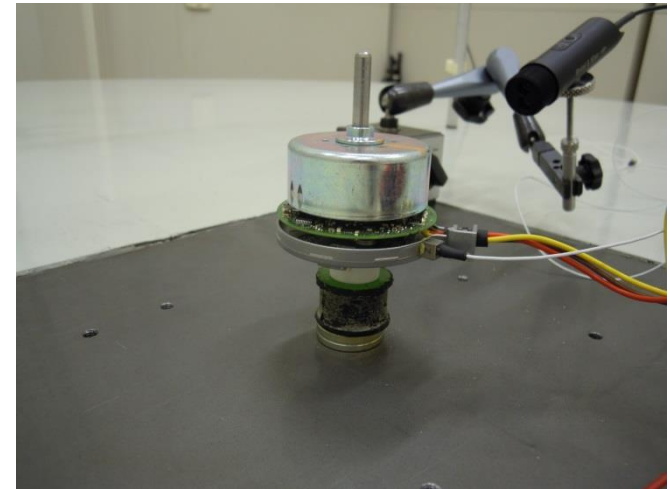
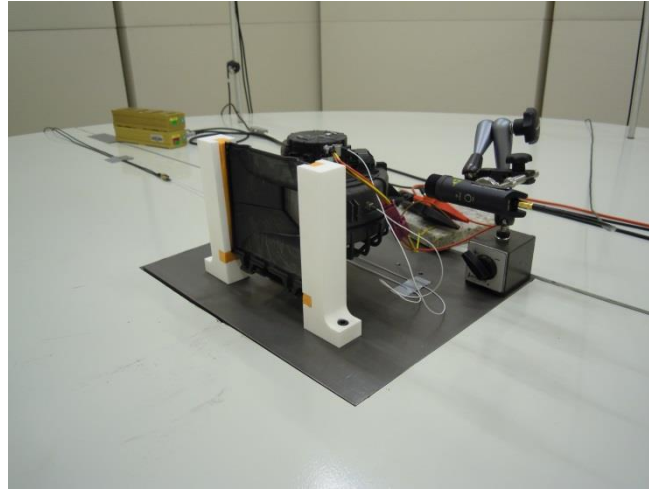
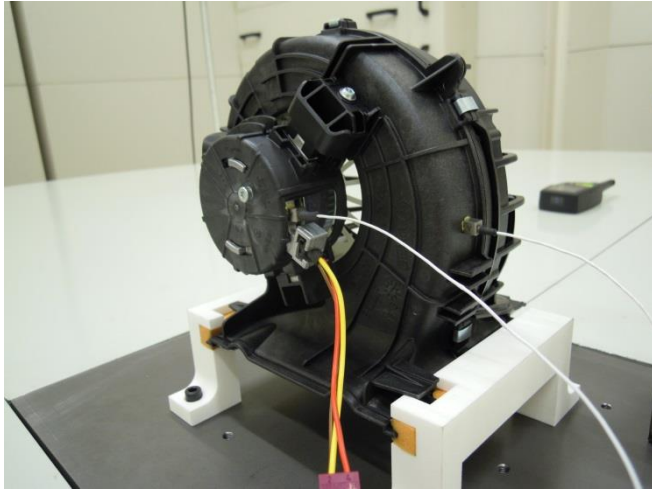
Strukturna dinamika, mehanika, hrup in vibracije, ...

Zvočna moč alternatorja



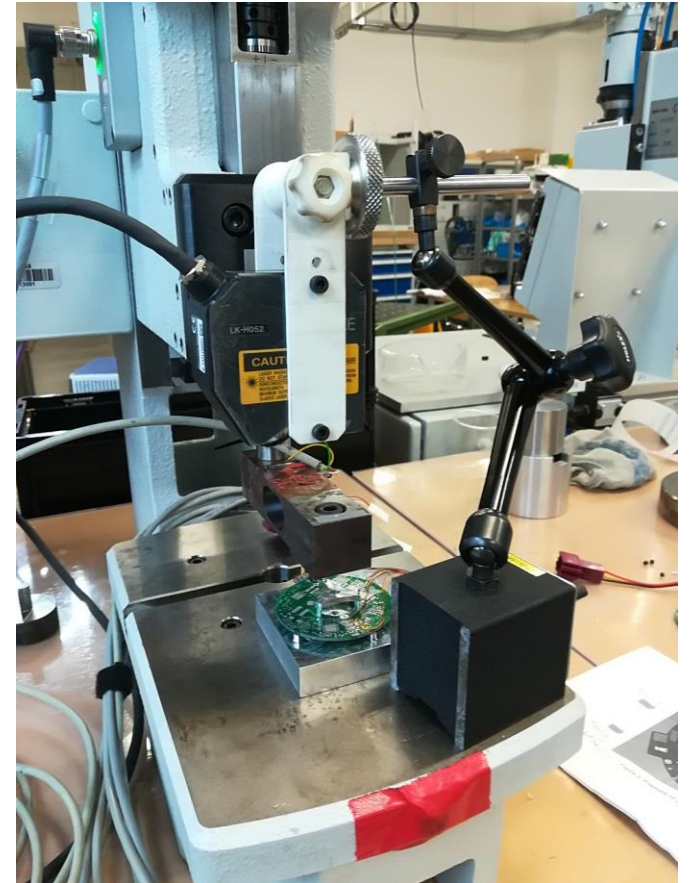
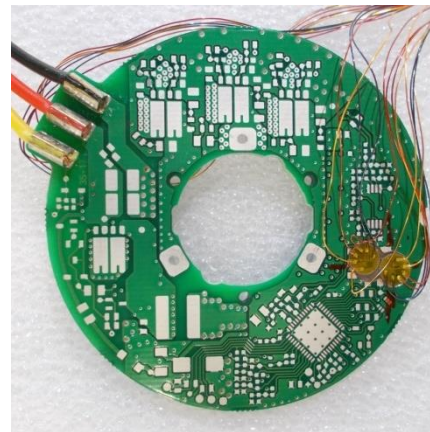
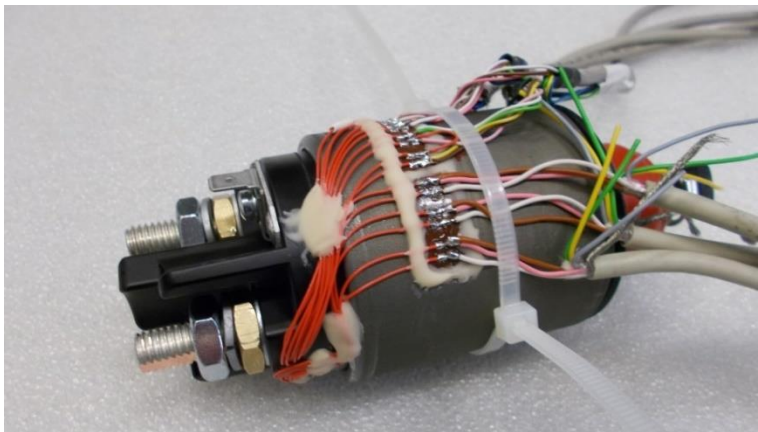
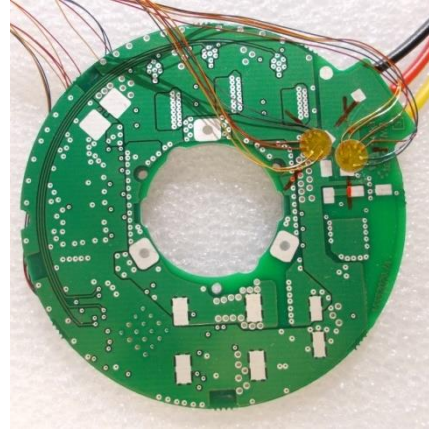
Strukturna dinamika, mehanika, hrup in vibracije, ...

Zvočna moč HVAC elektromotorja

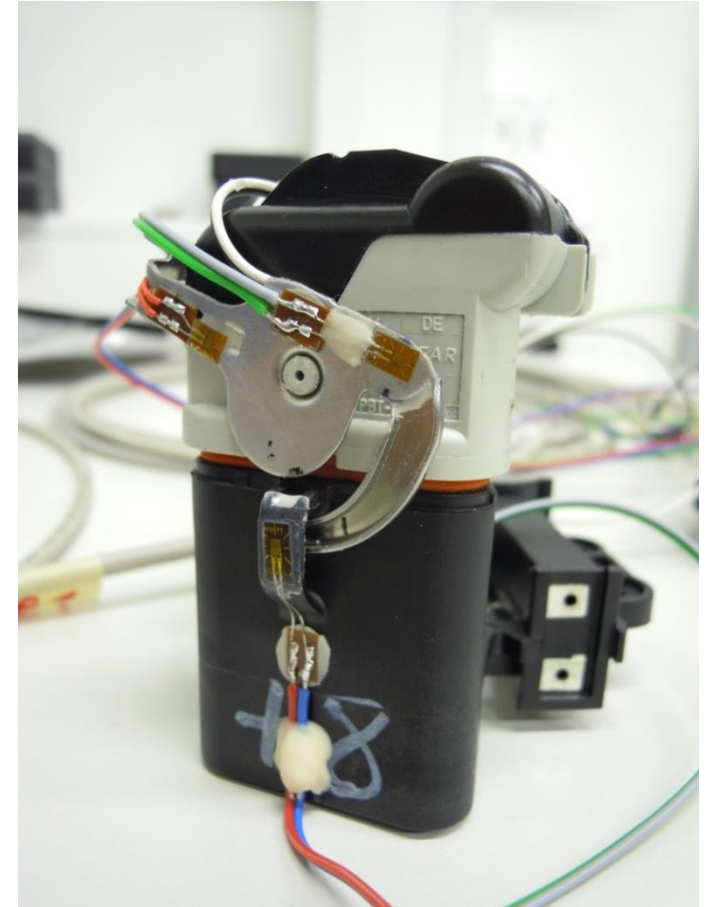
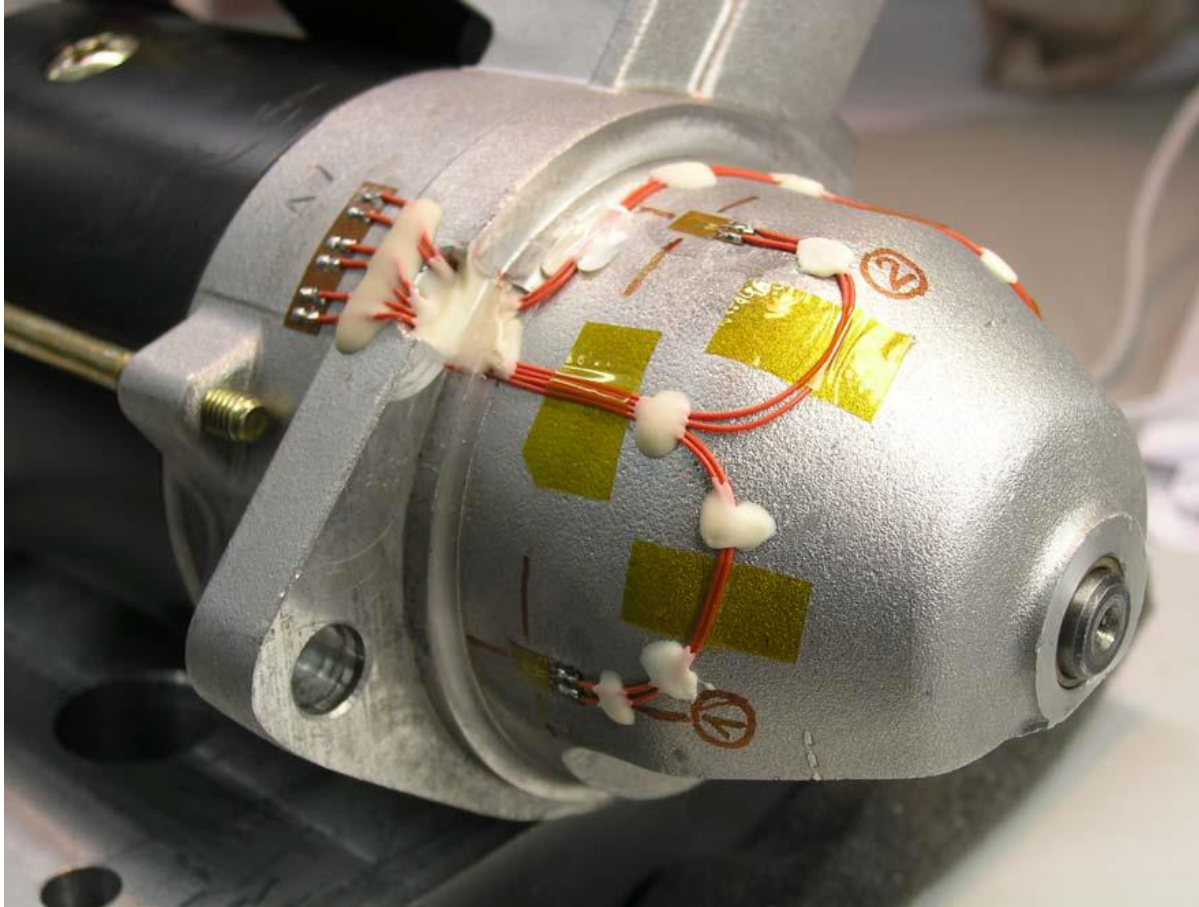


Strukturna dinamika, mehanika, hrup in vibracije, ...

Deformacije

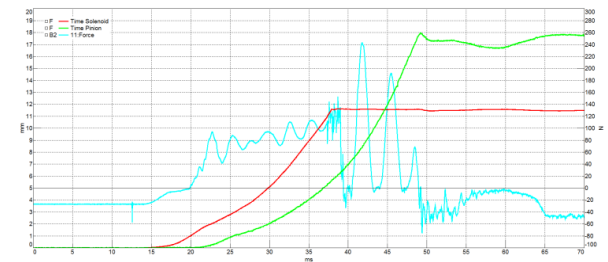
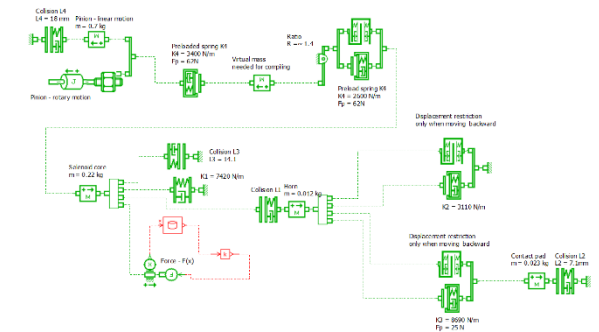
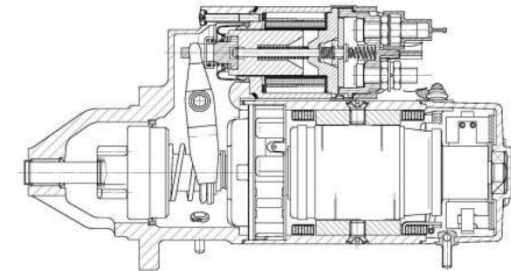
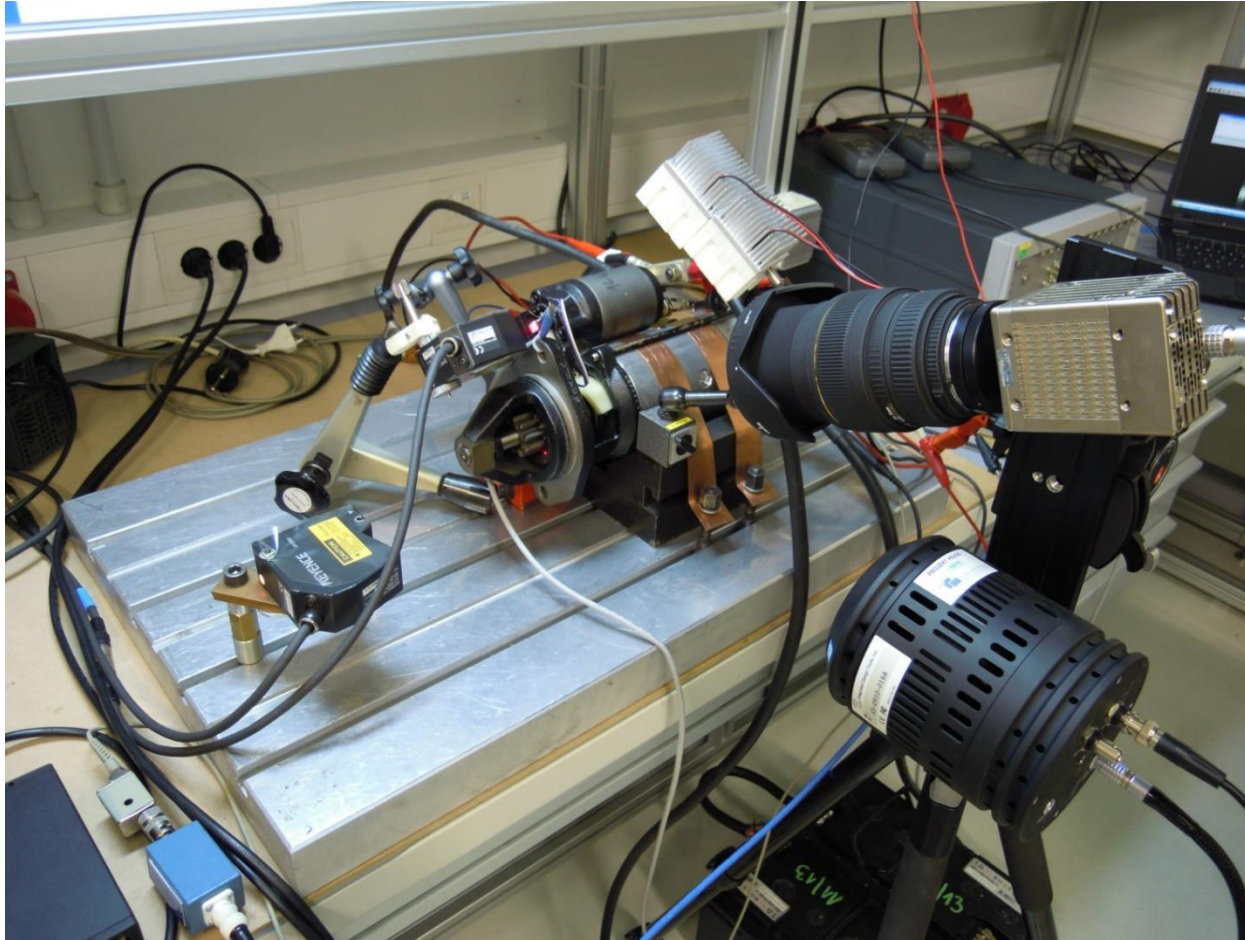


Strukturna dinamika, mehanika, hrup in vibracije, ... Deformacije



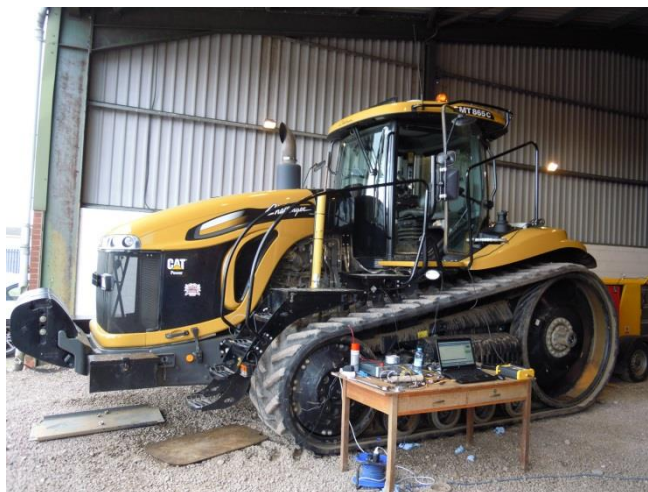
Strukturna dinamika, mehanika, hrup in vibracije, ...

Vklop stikala zaganjalnika – hitra kamera



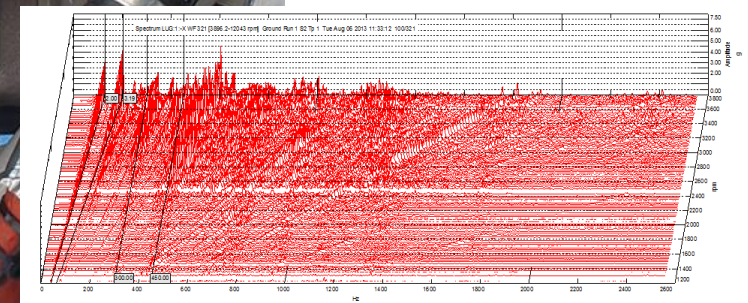
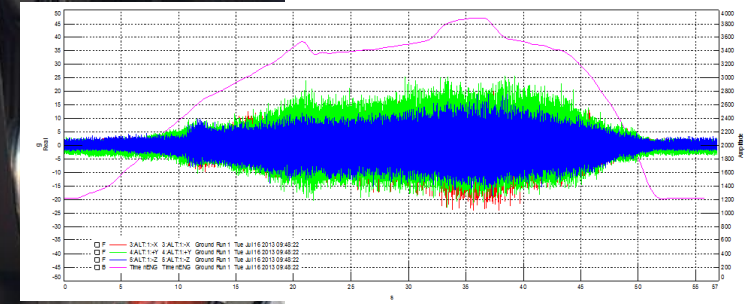
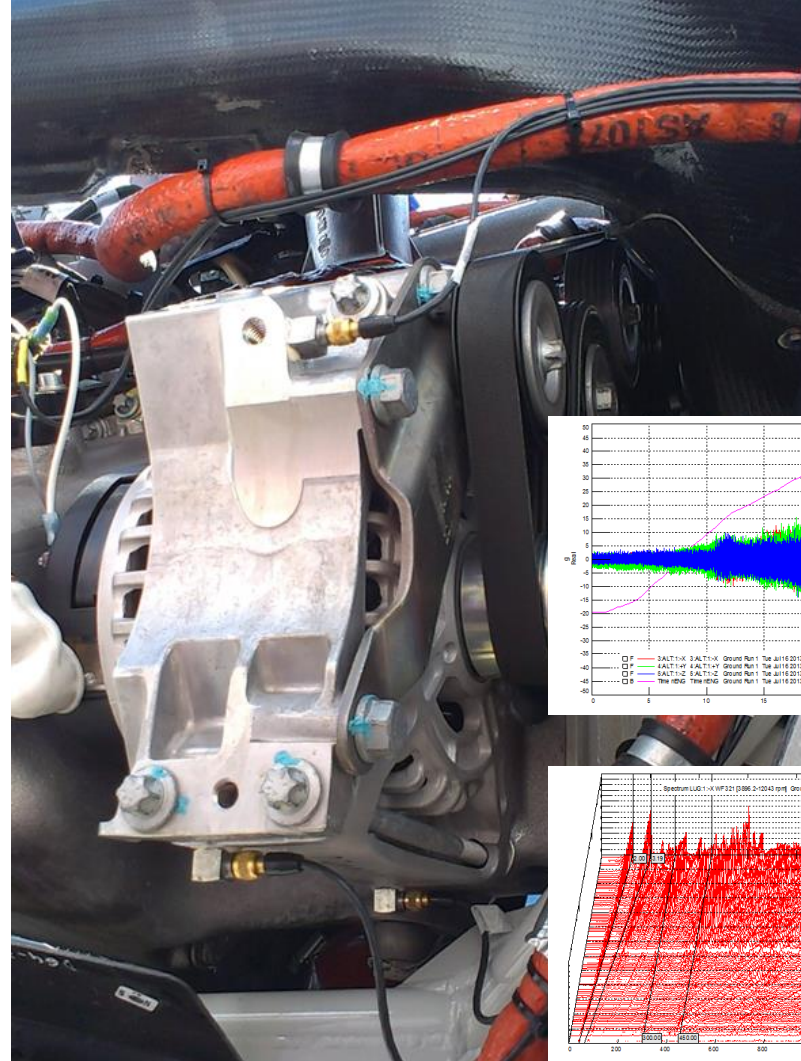
Strukturna dinamika, mehanika, hrup in vibracije, ...

Vibracije na strojih, vozilih, plovilih, letalih, ...

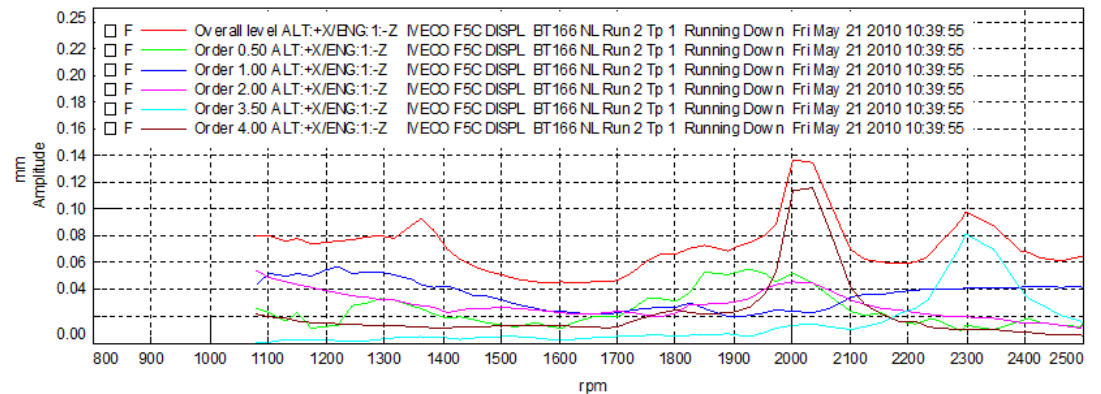
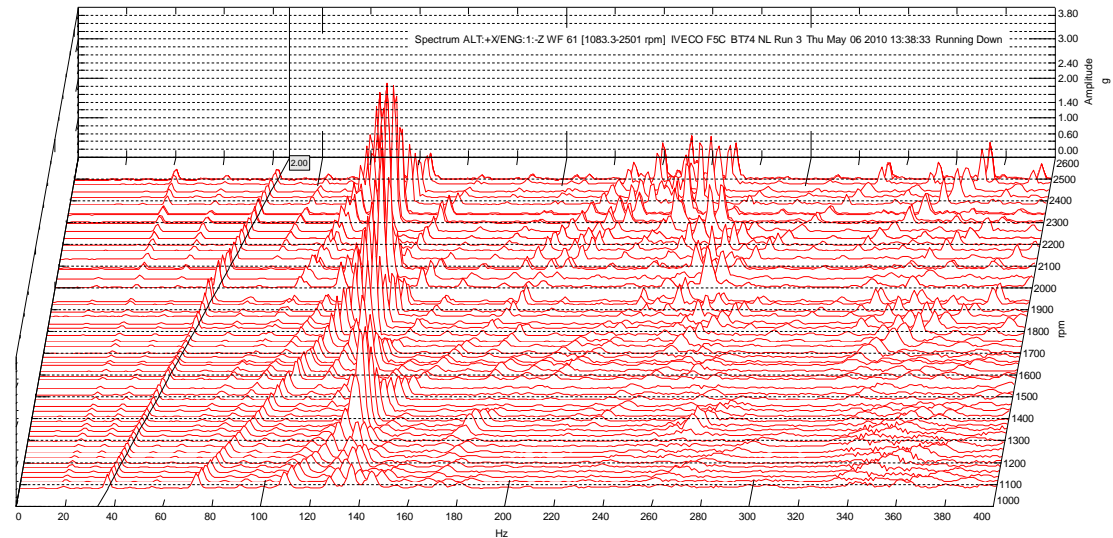


Strukturna dinamika, mehanika, hrup in vibracije, ...

Vibracije na strojih, vozilih, plovilih, letalih, ...

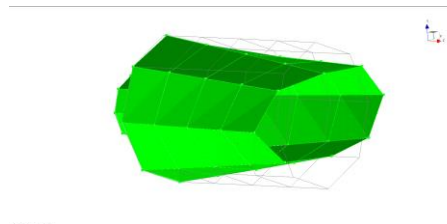
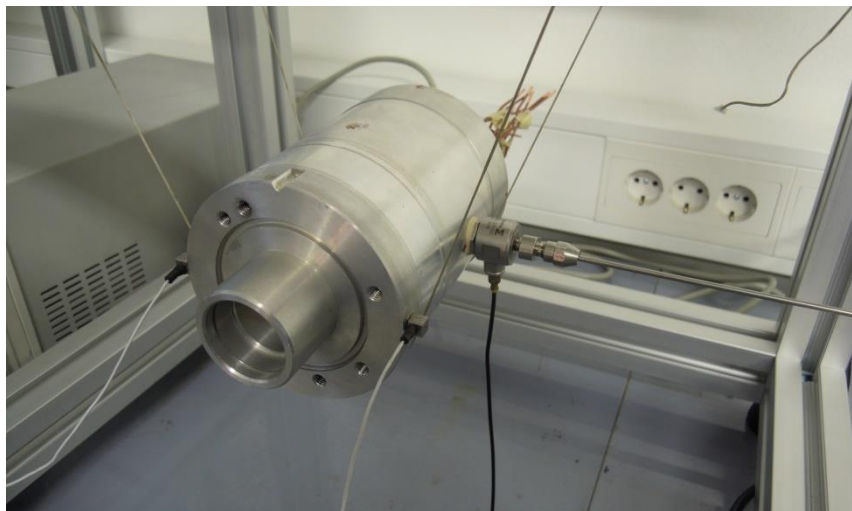


Strukturna dinamika, mehanika, hrup in vibracije, ... Torzijske vibracije na MZN

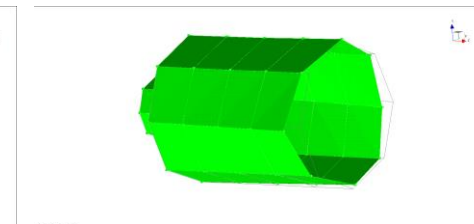


Strukturna dinamika, mehanika, hrup in vibracije, ...

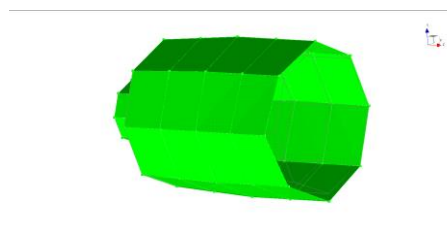
Eksperimentalna modalna analiza



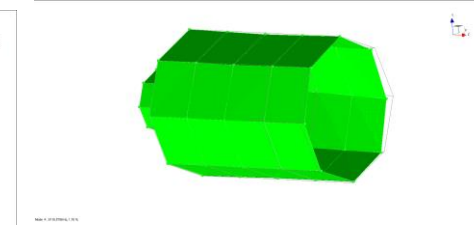
1053 Hz



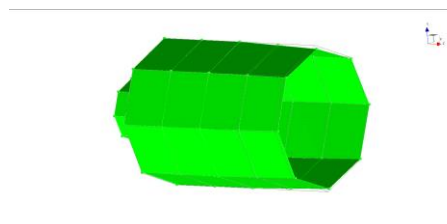
2203 Hz



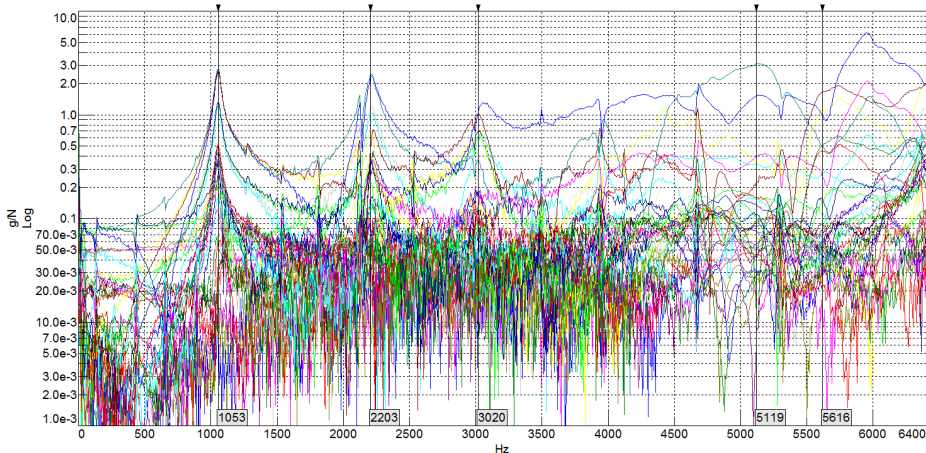
3020 Hz



5119 Hz

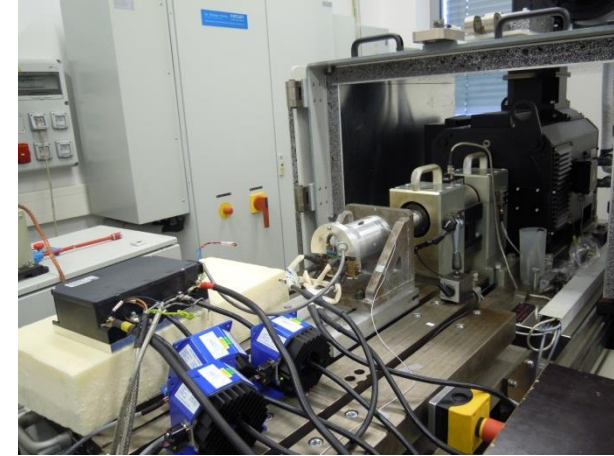
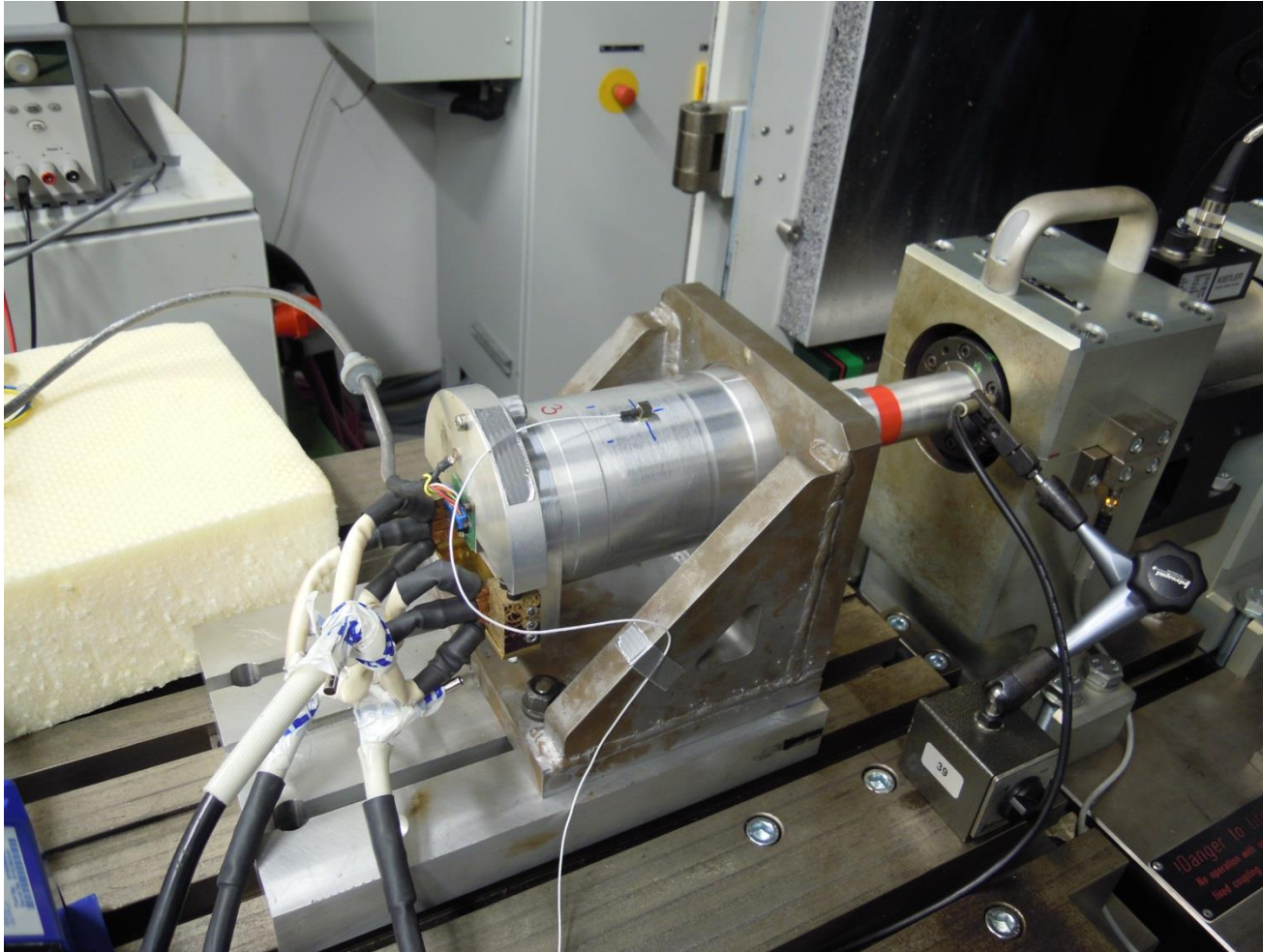


5616 Hz



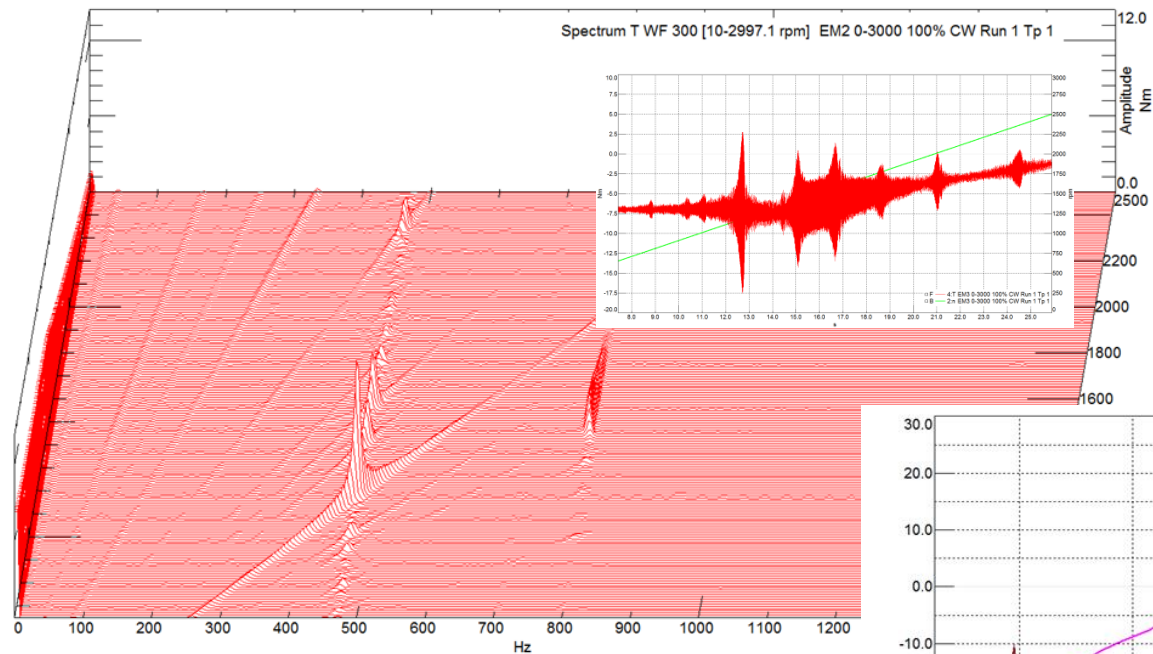
Strukturna dinamika, mehanika, hrup in vibracije, ...

Vibracije in nihanje navora na EPS elektromotorju

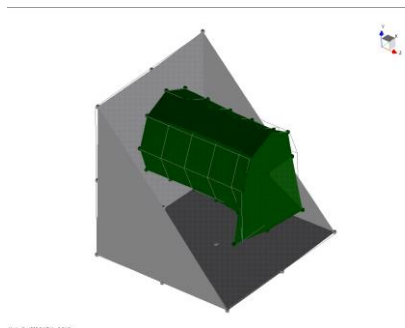
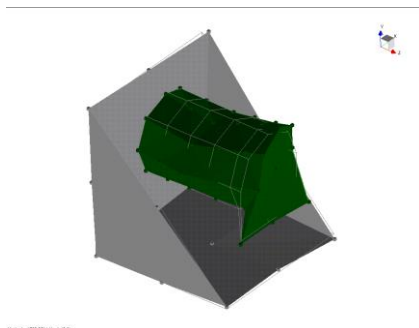
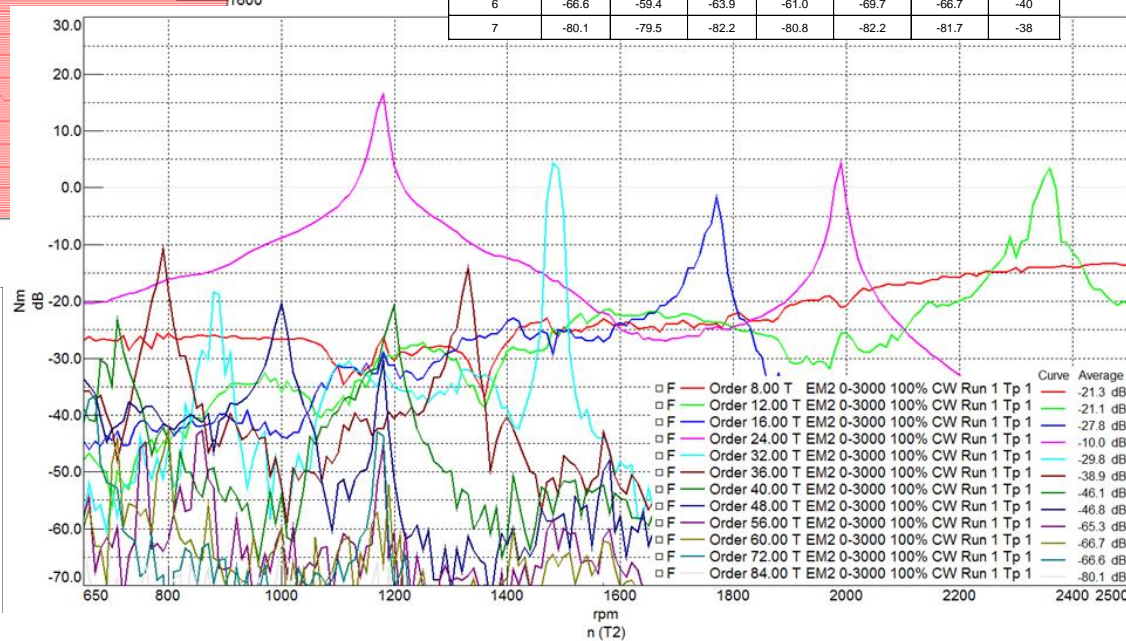


Strukturna dinamika, mehanika, hrup in vibracije, ...

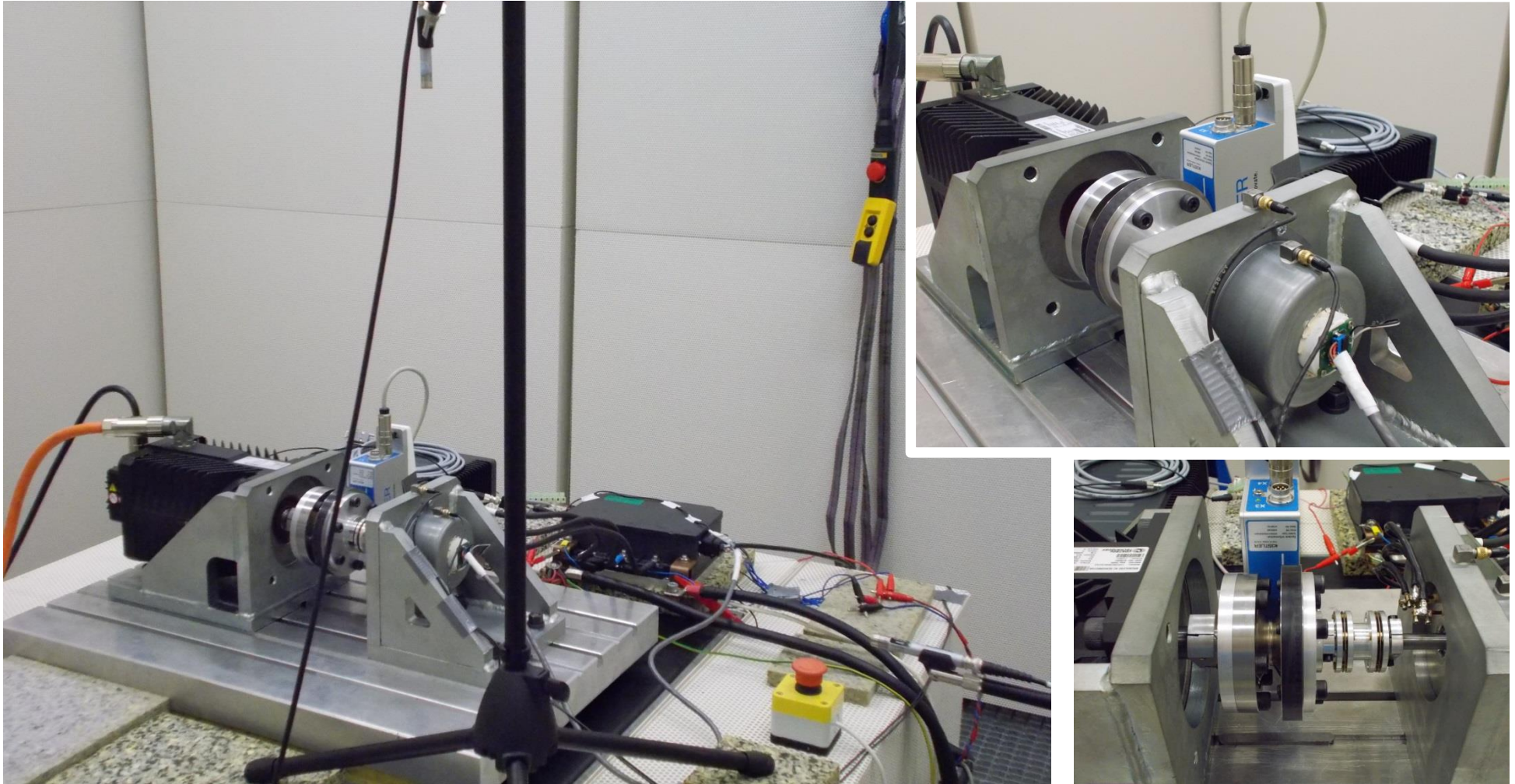
Vibracije in nihanje navora na EPS elektromotorju



2pN th order	Torque Ripple [dB*]						
	100% CW	100% CCW	60% CW	60% CCW	30% CW	30% CCW	Limit
1	-21.3	-18.3	-22.7	-19.9	-30.6	-22.8	-35
2	-27.8	-27.2	-24.6	-27.0	-31.6	-37.3	-30
3	-10.0	-8.3	-14.1	-10.5	-14.6	-13.4	-20
4	-29.8	-28.8	-43.5	-44.5	-49.3	-45.1	-29
5	-46.1	-47.4	-53.0	-50.3	-50.0	-51.4	-32
6	-46.8	-41.5	-48.5	-52.4	-50.4	-52.8	-33
7	-65.3	-63.5	-67.3	-60.1	-67.3	-66.7	-36
NsN th order	Torque Ripple [dB*]						
	100% CW	100% CCW	60% CW	60% CCW	30% CW	30% CCW	Limit
1	-21.1	-13.2	-10.5	-14.9	-12.8	-19.7	-27
2	-10.0	-8.3	-14.1	-10.5	-14.6	-13.4	-20
3	-38.9	-38.1	-39.4	-45.8	-39.9	-43.2	-25
4	-46.8	-41.5	-48.5	-52.4	-50.4	-52.8	-33
5	-66.7	-65.2	-69.1	-62.8	-68.6	-66.9	-33
6	-66.6	-59.4	-63.9	-61.0	-69.7	-66.7	-40
7	-80.1	-79.5	-82.2	-80.8	-82.2	-81.7	-38

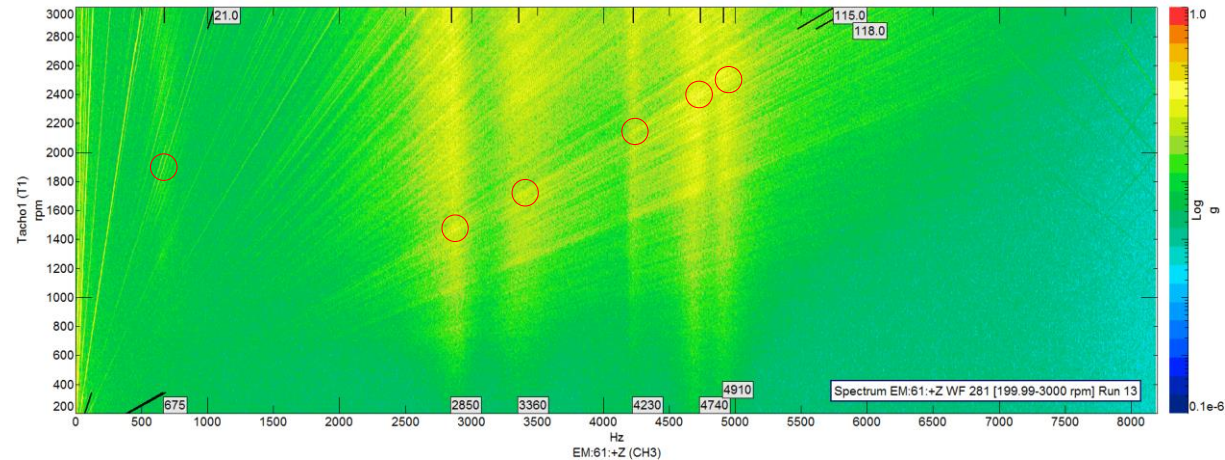
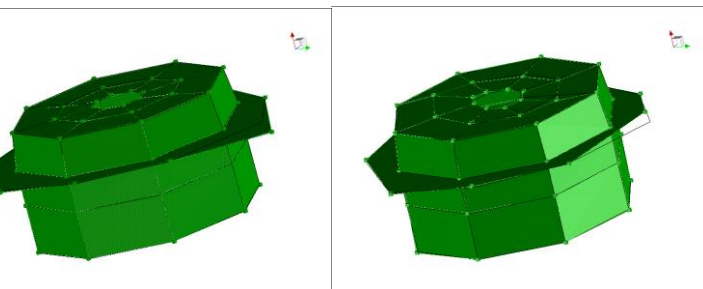
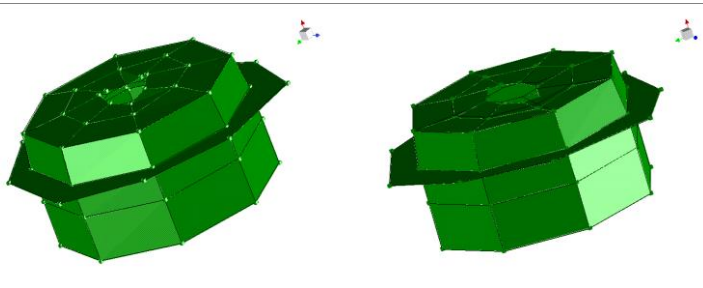
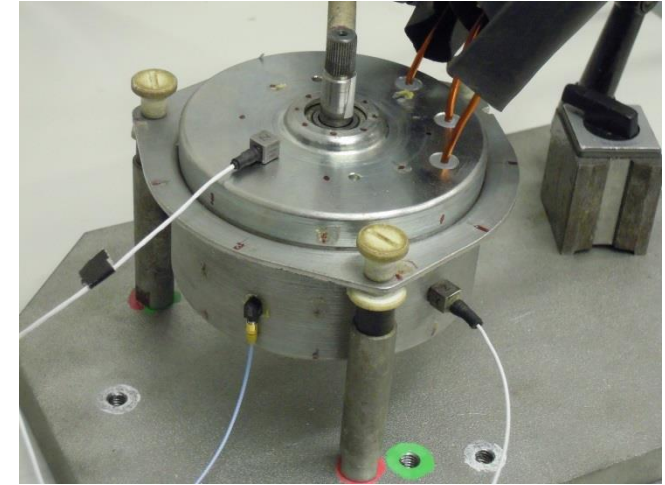
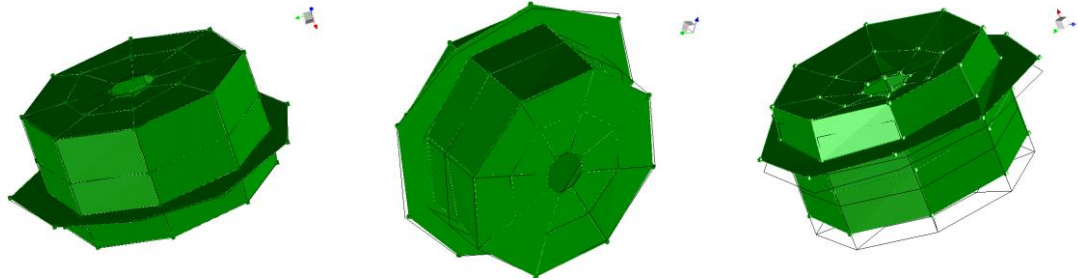


Strukturna dinamika, mehanika, hrup in vibracije, ... Vibracije in nihanje navora na EBS elektromotorju



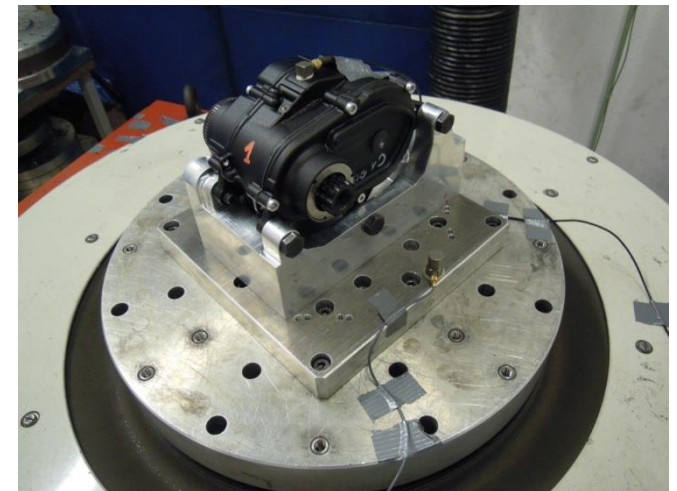
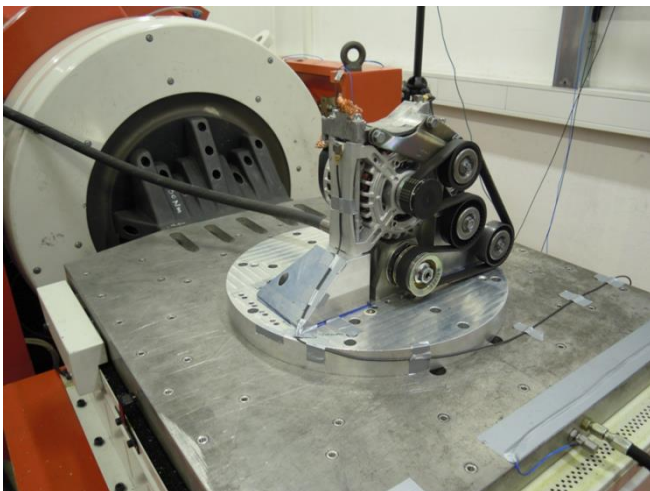
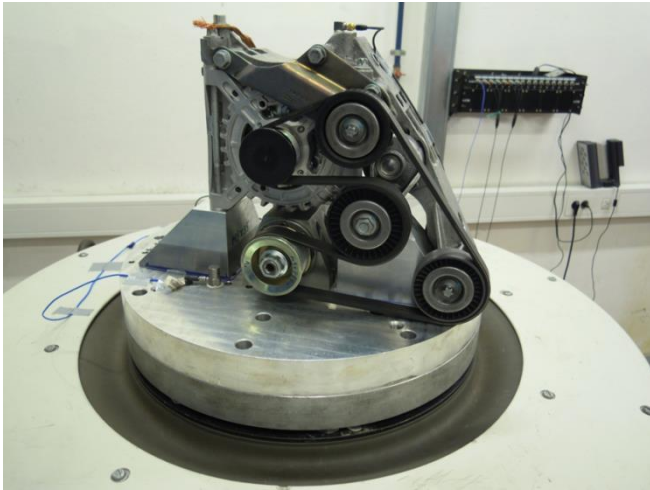
Strukturna dinamika, mehanika, hrup in vibracije, ...

Vibracije in nihanje navora na EBS elektromotorju



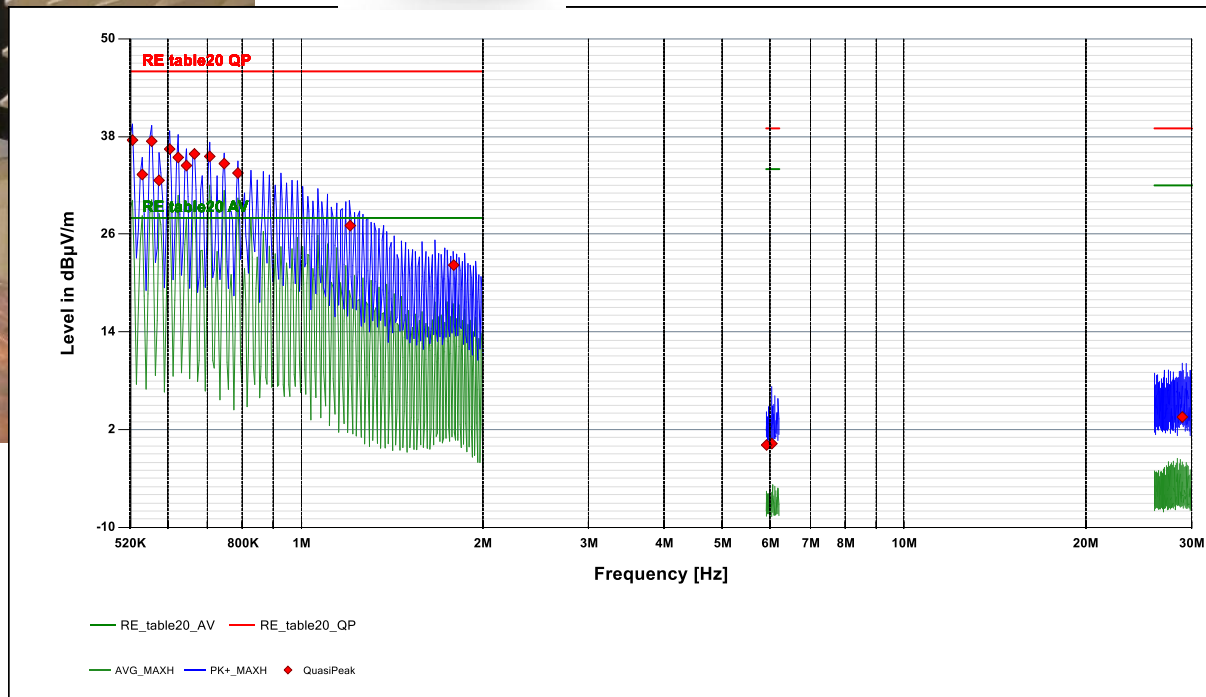
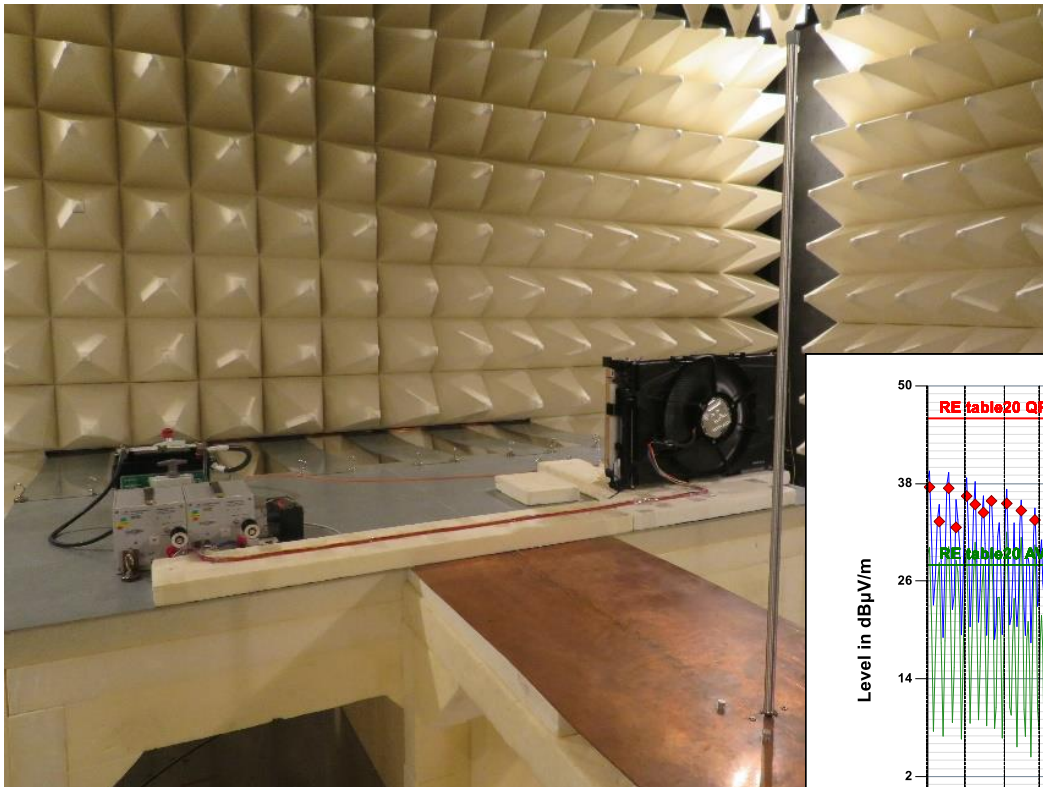
Strukturna dinamika, mehanika, hrup in vibracije, ...

Vibracijska preizkušanja



Elektromagnetna združljivost

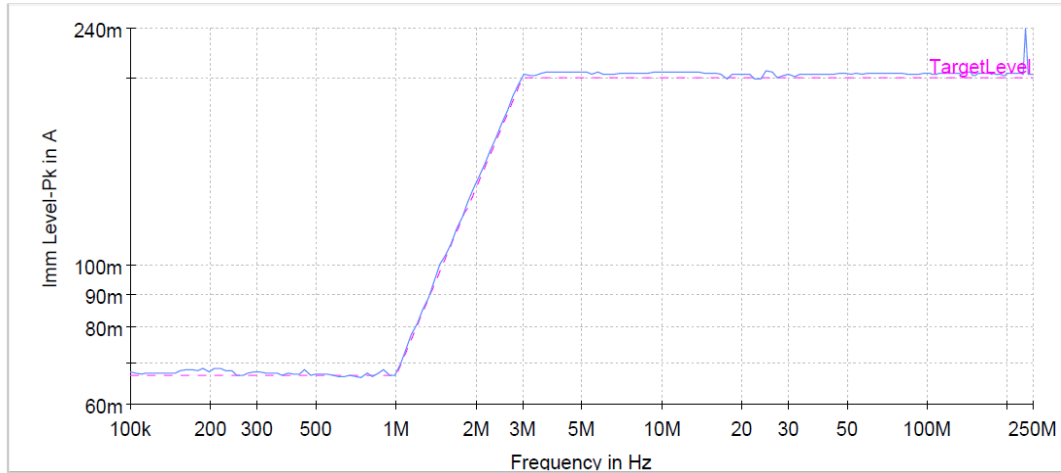
Sevalne emisije



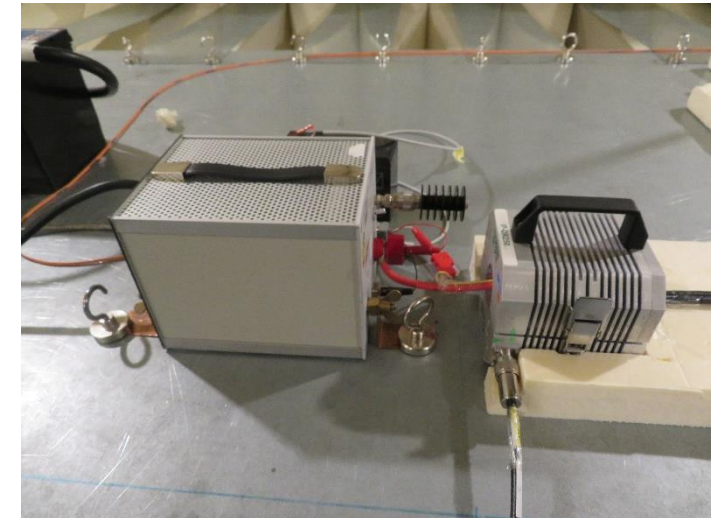
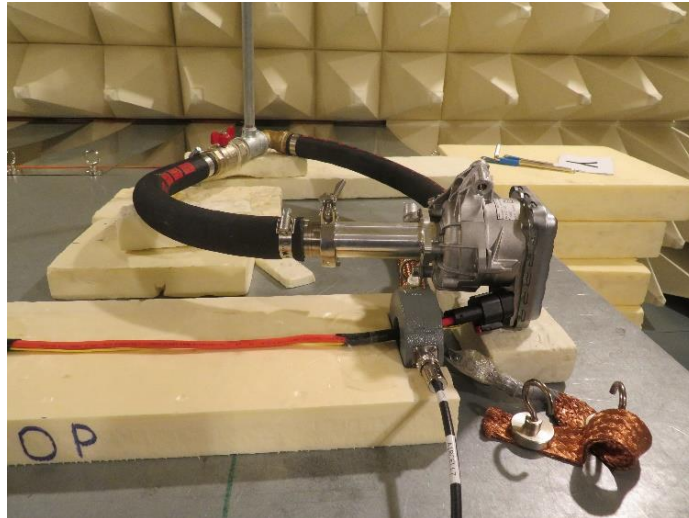
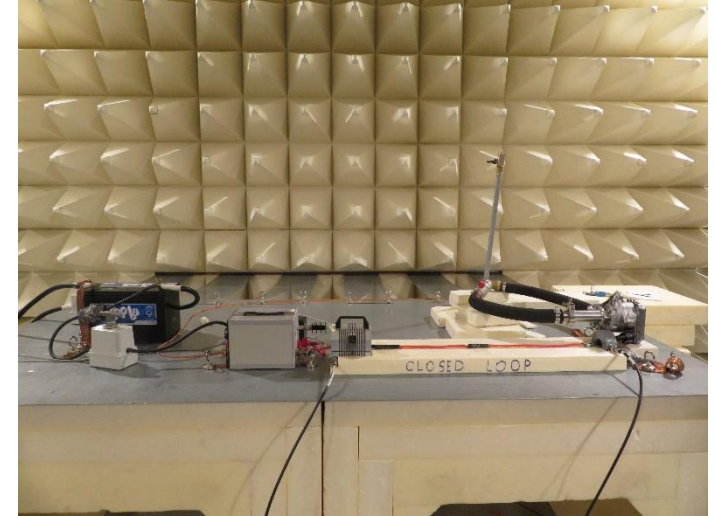
Elektromagnetna združljivost

Vsiljevanje RF toka

Imm Level-Pk

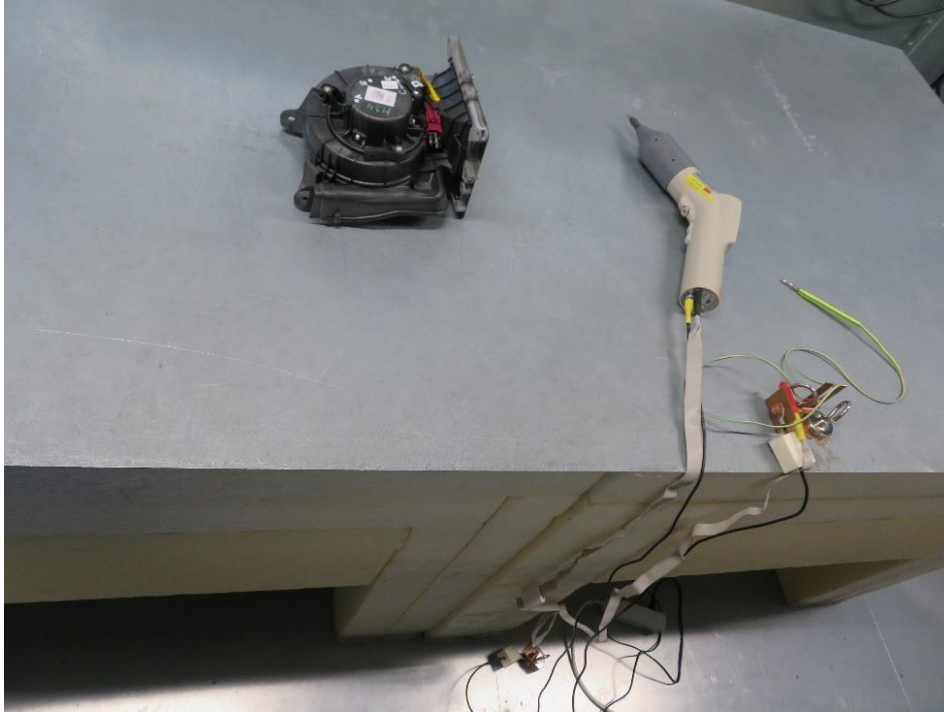


--- Limit ○ Thres. Imm. Level — Imm Level-Pk

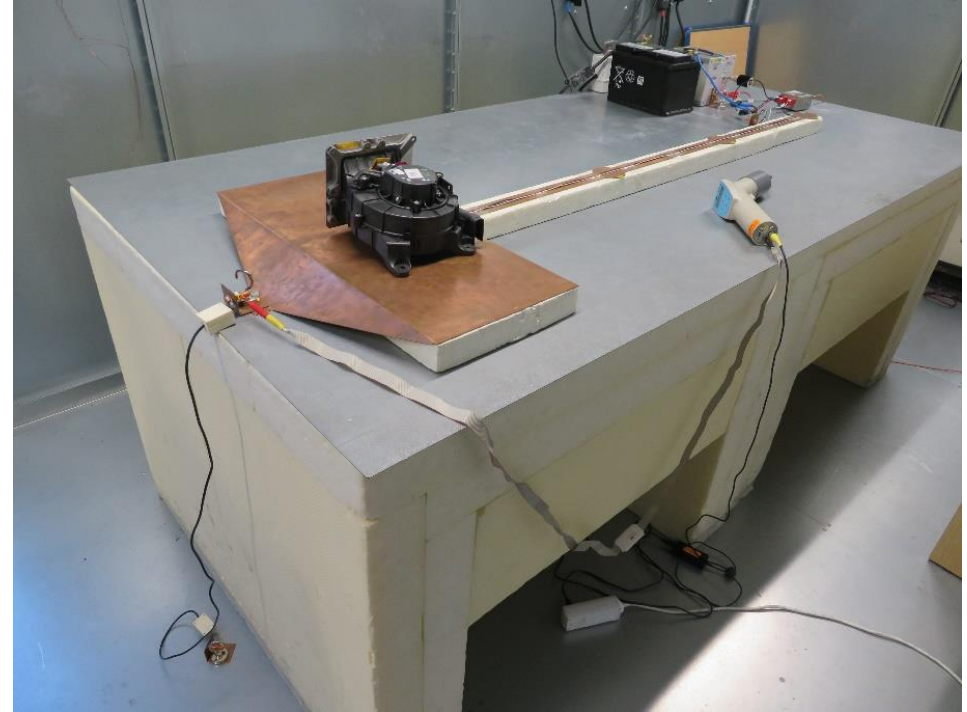


Elektromagnetna združljivost

Elektrostatične razelektritve

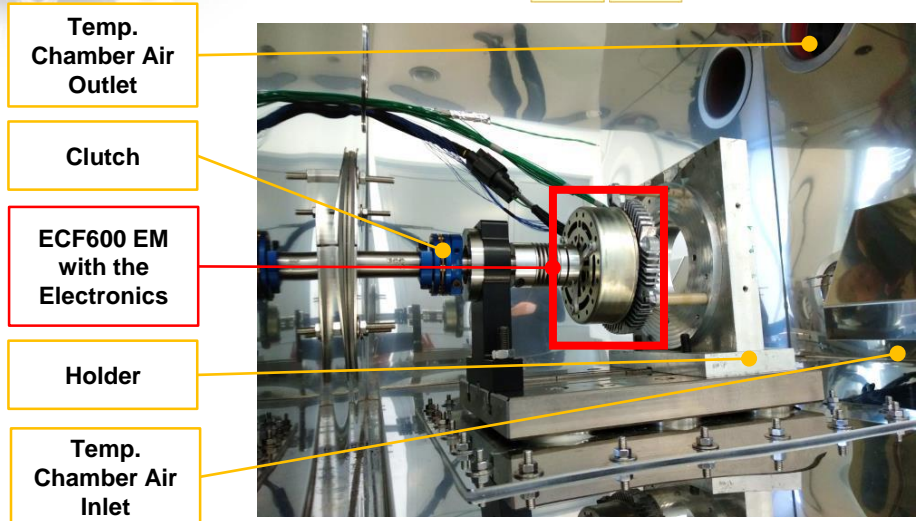
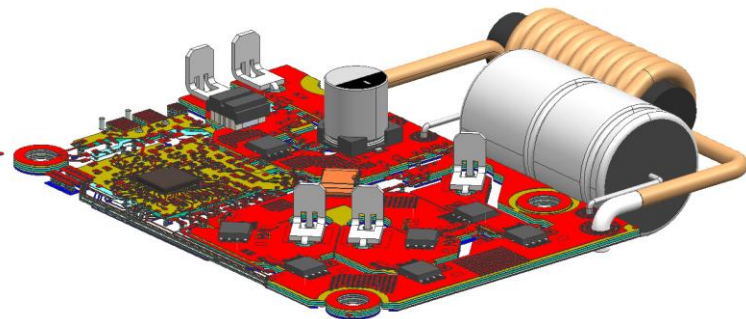
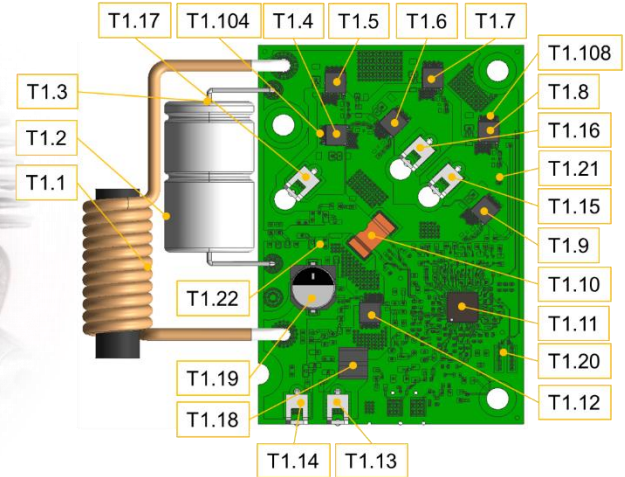
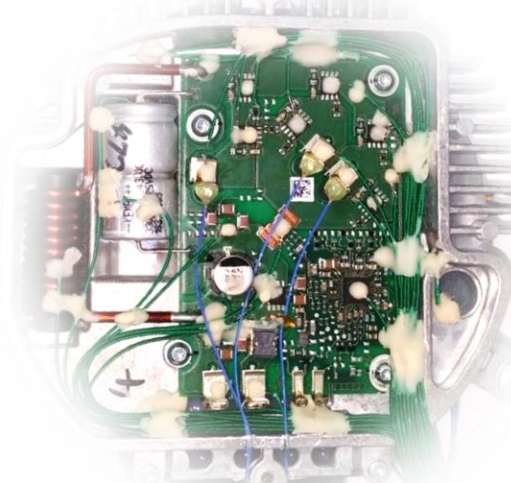
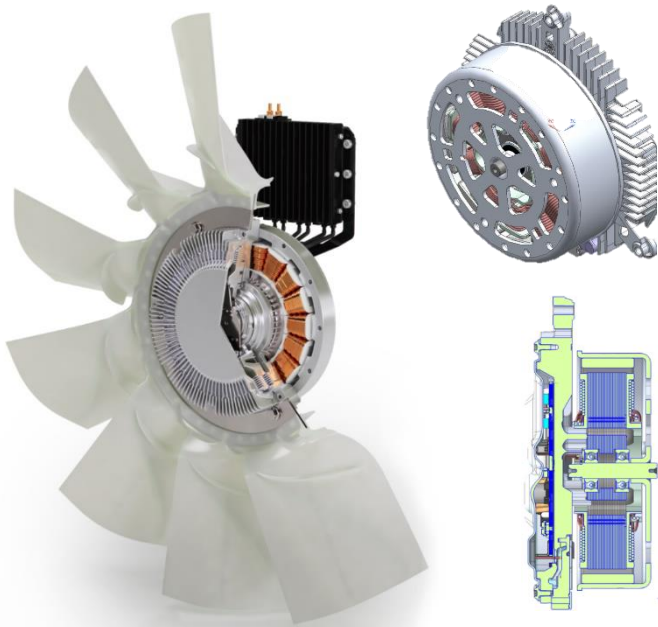


ESD - Rokovanje



ESD – Sistemski nivo

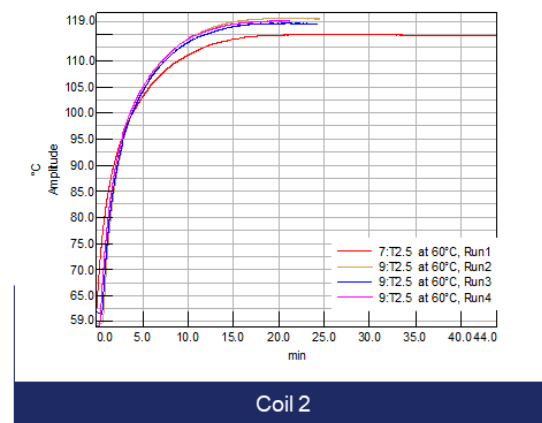
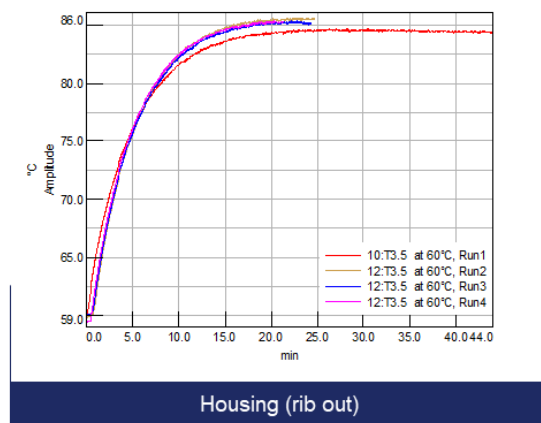
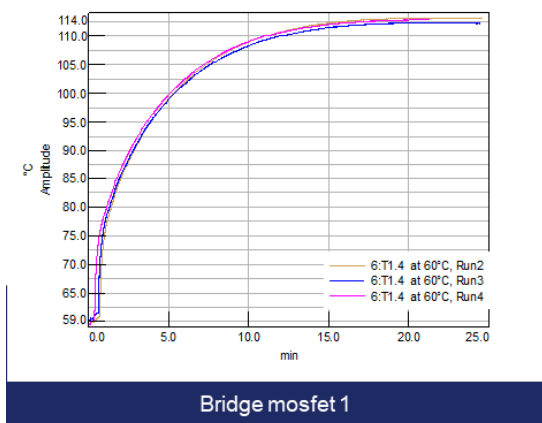
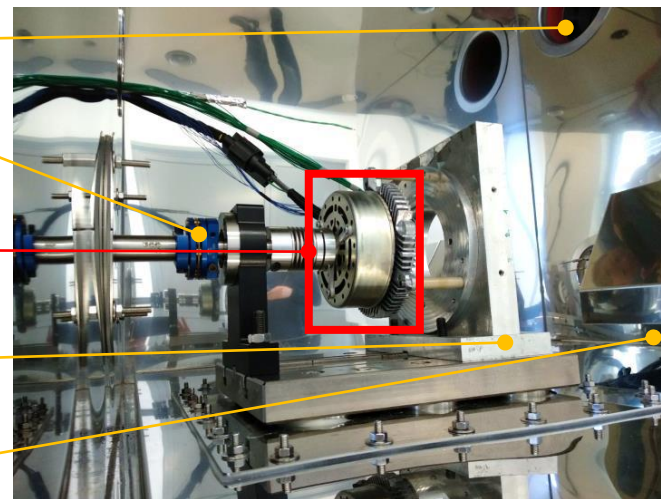
Zmogljivost, izkoristek, elektro-magnetika, ... Temperature na sistemu (EM+ECU) za hlajenje



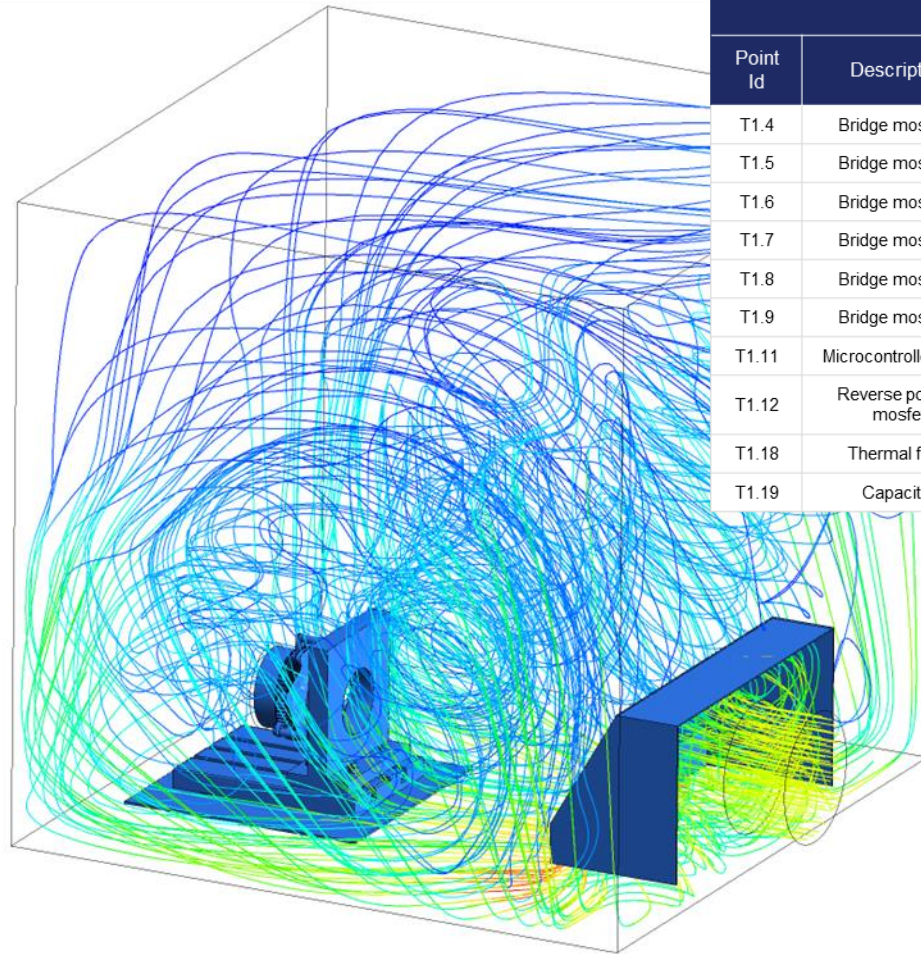
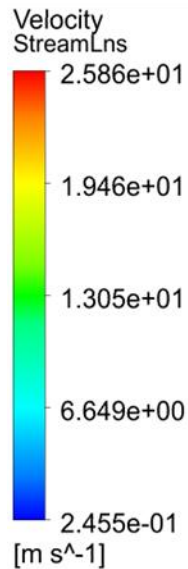
Zmogljivost, izkoristek, elektro-magnetika, ... Temperature na sistemu (EM+ECU) za hlajenje



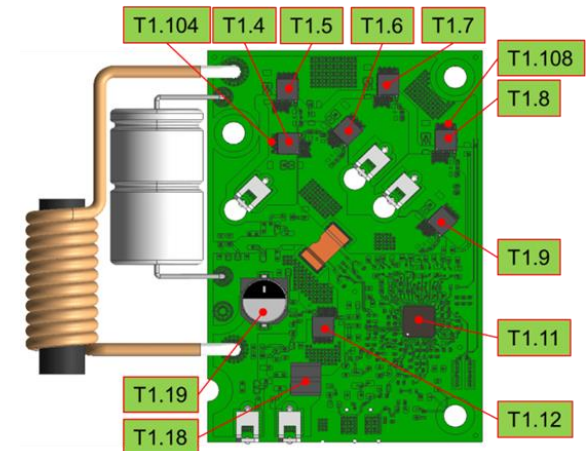
- Temp. Chamber Air Outlet
- Clutch
- ECF600 EM with the Electronics
- Holder
- Temp. Chamber Air Inlet



Zmogljivost, izkoristek, elektro-magnetika, ... Temperature na sistemu (EM+ECU) za hlajenje



Point Id	Description	Measurement	Prediction	Measurement	Prediction
		T [°C] @80°C ambient	T [°C] @80°C ambient	T [°C] @100°C ambient	T [°C] @100°C ambient
T1.4	Bridge mosfet 1	139,7	136,1	148,8	146,7
T1.5	Bridge mosfet 2	137,7	136,2	147,2	146,1
T1.6	Bridge mosfet 3	138,6	134,8	148,1	145,4
T1.7	Bridge mosfet 4	137,0	134,8	146,8	144,9
T1.8	Bridge mosfet 5	136,2	134,7	146,1	144,6
T1.9	Bridge mosfet 6	125,5	131,6	137,5	142,8
T1.11	Microcontroller SoC	120,8	117,6	134,0	135,7
T1.12	Reverse polarity mosfet	135,0	127,5	144,7	141,4
T1.18	Thermal fuse	126,5	115,8	139,7	133,4
T1.19	Capacitor	122,2	115,2	136,3	132,7



Zmogljivost, izkoristek, elektro-magnetika, ... Moč, izkoristek, navor, ... - merilna oprema



Nominal Power	250 kW
Peak Power	312 kW
Nominal Torque	500 Nm
Peak Torque	625 Nm
Operating Speed	21.000 rpm
High Voltage	1.000 V, 800 A, 320 kW



Nominal Power	50 kW
Peak Power	64 kW
Nominal Torque	100 Nm
Peak Torque	120 Nm
Operating Speed	25.000 rpm
High Voltage	500 A, 500 V 450 A, 690 V 180 A, 1.000 V

Zmogljivost, izkoristek, elektro-magnetika, ... Moč, izkoristek, navor, ... - merilna oprema



Nominal Power 81 kW

Peak Power kW

Nominal Torque 670 Nm

Peak Torque Nm

Operating Speed 6.000 rpm

High Voltage 650 V, 400 A



Nominal Power 45 kW

Peak Power 60 kW

Nominal Torque 150 Nm

Peak Torque 180 Nm

Operating Speed 8.000 rpm

High Voltage 100 V, 400 A

Zmogljivost, izkoristek, elektro-magnetika, ... Vzdržljivost, ... - merilna oprema, »Back to Back«



Temperature range -40°C to 160 °C

Humidity range 10 % to 95 % RH

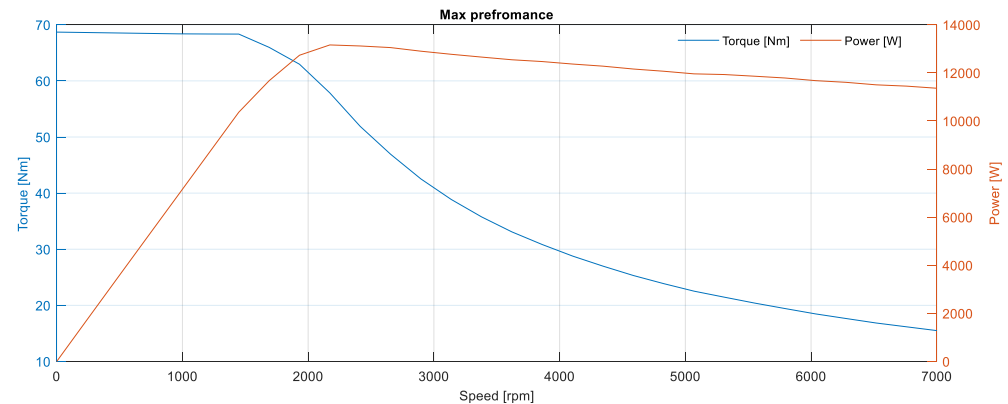
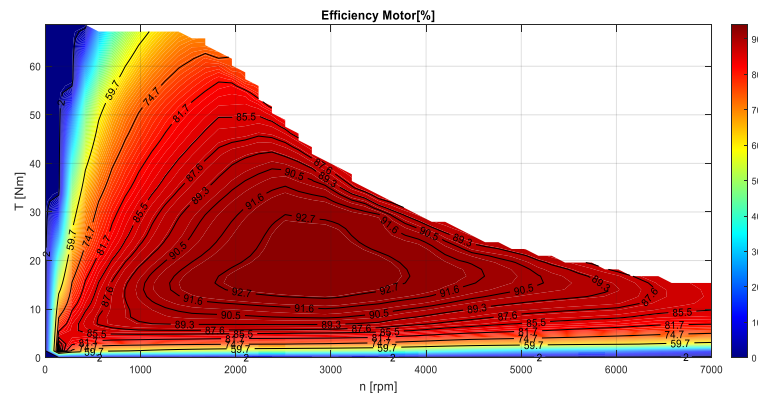
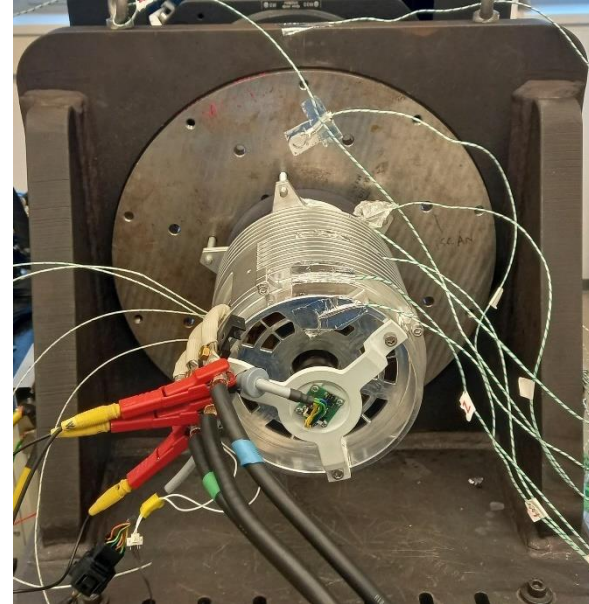
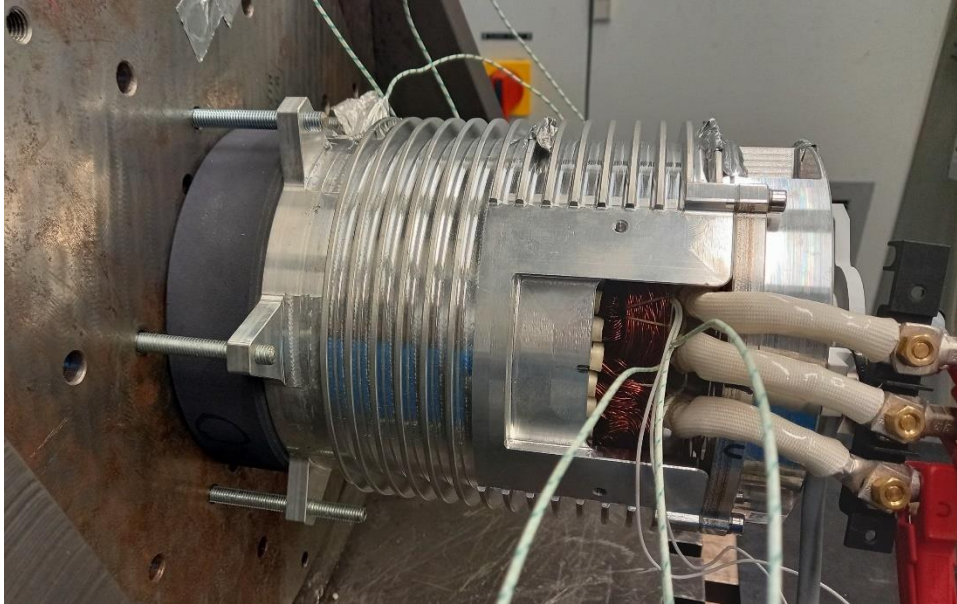
Mechanical power 100 kW:100 kW
(mot:gen)

Peak Torque 500 Nm

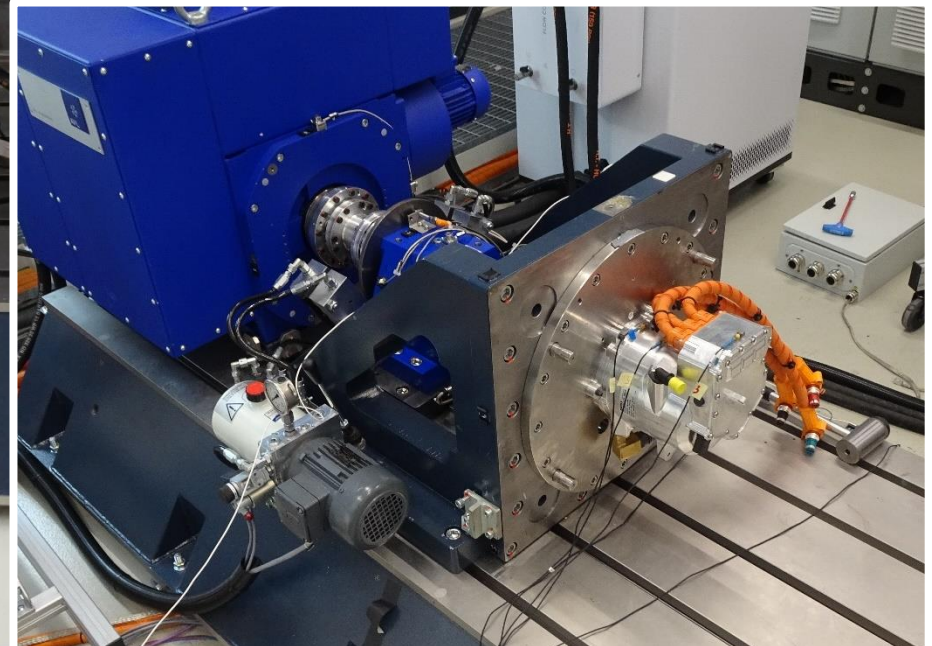
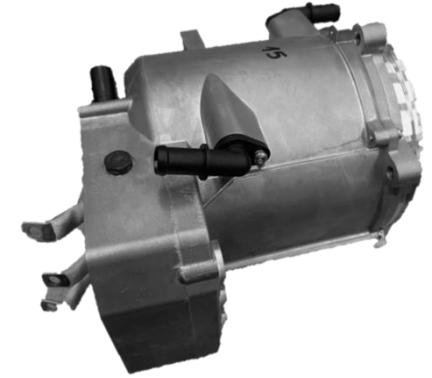
Operating Speed 0 - 20.000 rpm

High Voltage 600 V DC, 500 A DC

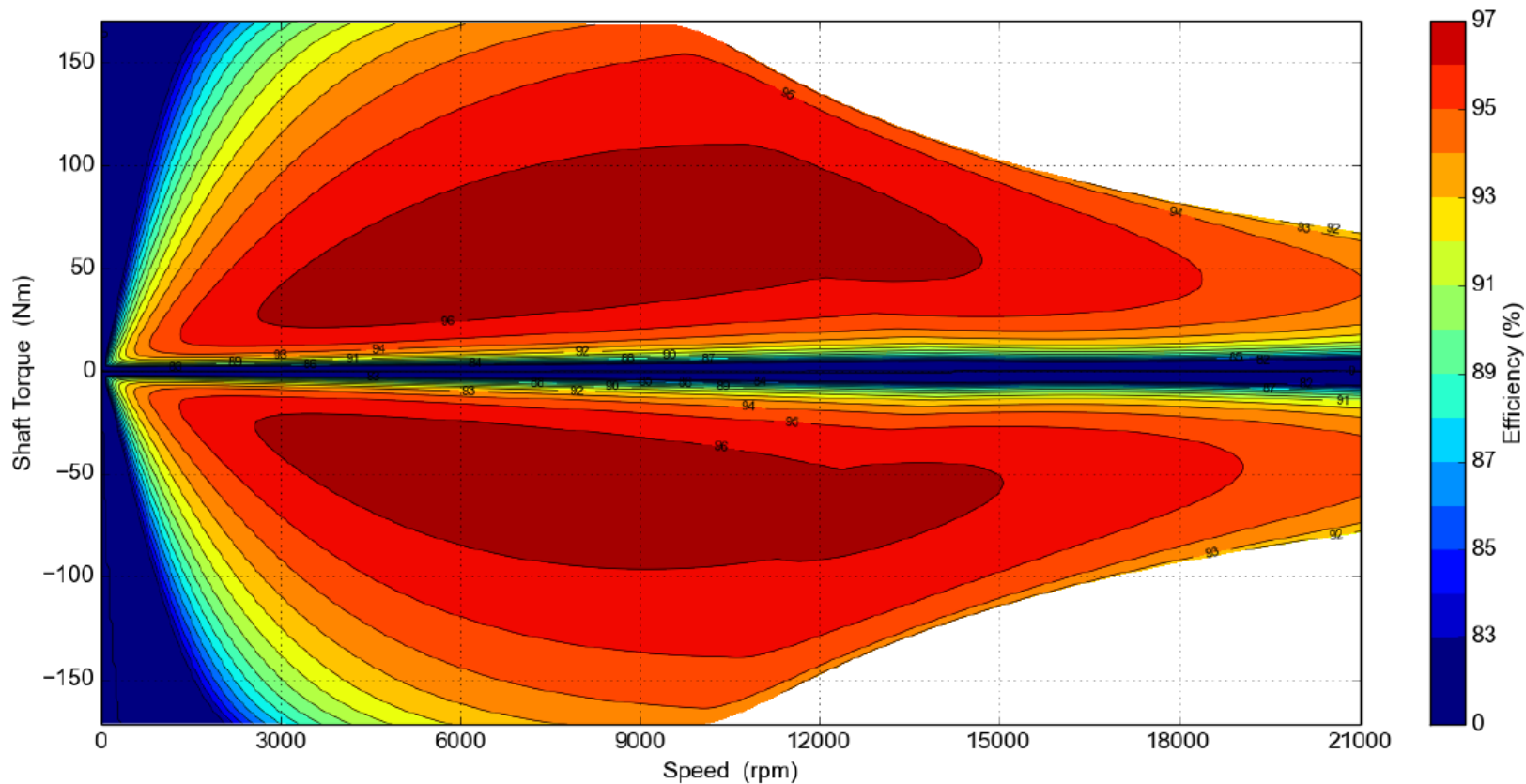
Zmogljivost, izkoristek, elektro-magnetika, ... Moč, izkoristek, navor, ... e-pogona za dvokolesnik



Zmogljivost, izkoristek, elektro-magnetika, ... Moč, izkoristek, navor, ... e-pogona za avtomobil



Zmogljivost, izkoristek, elektro-magnetika, ... Moč, izkoristek, navor, ... e-pogona za avtomobil



Izzivi e-mobilnosti in meritev

- Nenehno povečevanje gostote moči
 - Povečevanje napetosti
 - Povečevanje vrtilne hitrosti
 - Novi materiali
 - ...
- Standardizacija meritev in preizkušanj na globalnem nivoju
- Modularna gradnja
- Združevanje oz. sočasnost procesov razvoja, testiranja in industrializacije
- Cena izdelka, razvoja, preizkušanj, meritev in opreme