

Horizon Europe AeroSolfd - Gasoline Vehicle Retrofit

Challenges retrofitting petrol cars with Gasoline particle Filter (GPF)



Innovation



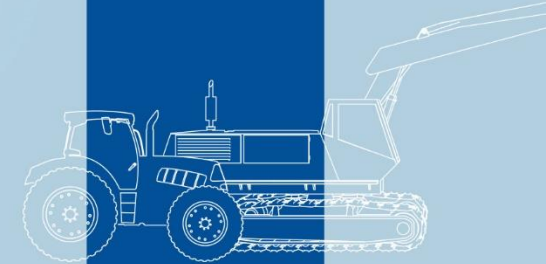
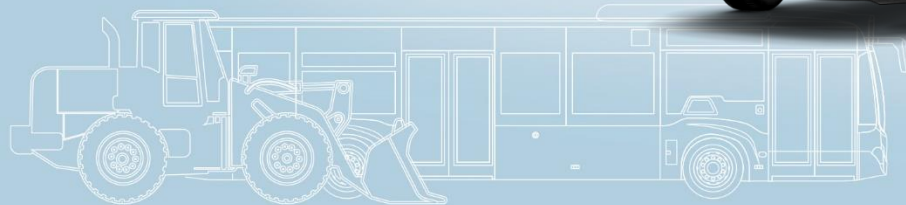
Nachhaltigkeit



Flexibilität



Qualität



Agenda

- HJS tasks and requirements
- Vehicle selection
- Investigation overview
- Design vehicle-specific GPF systems
- GPF installation
- Exhaust gas emissions with and without GPF

HJS tasks and requirements

GPF system design, integration, prototyping and testing

- Vehicle selection based on TÜV-Hessen database with various information about manufacture, vehicle type, year of construction etc.
- Checking the various specific vehicle population and the market share in Germany
- Evaluation of system integration requirements and efforts to install the GPFs
 - Technical database also spare part data analysis unfortunately not sufficient with regards to final installation space and application areas
- Therefore, real underbody inspection required for every single trail vehicle
- Checking the configuration of the original exhaust system, evaluation of installation space and location opportunity
- Checking connections resp. pipe routing, silencer position and connecting points opportunities
- Final GPF design for each variant and prototype manufacturing
- Installation of the GPF systems to the German fleet vehicle incl. data logging system
- Provision of installation manual for Switzerland and Israel
- Logistics like vehicle transfer to test institutes in Germany and Swiss

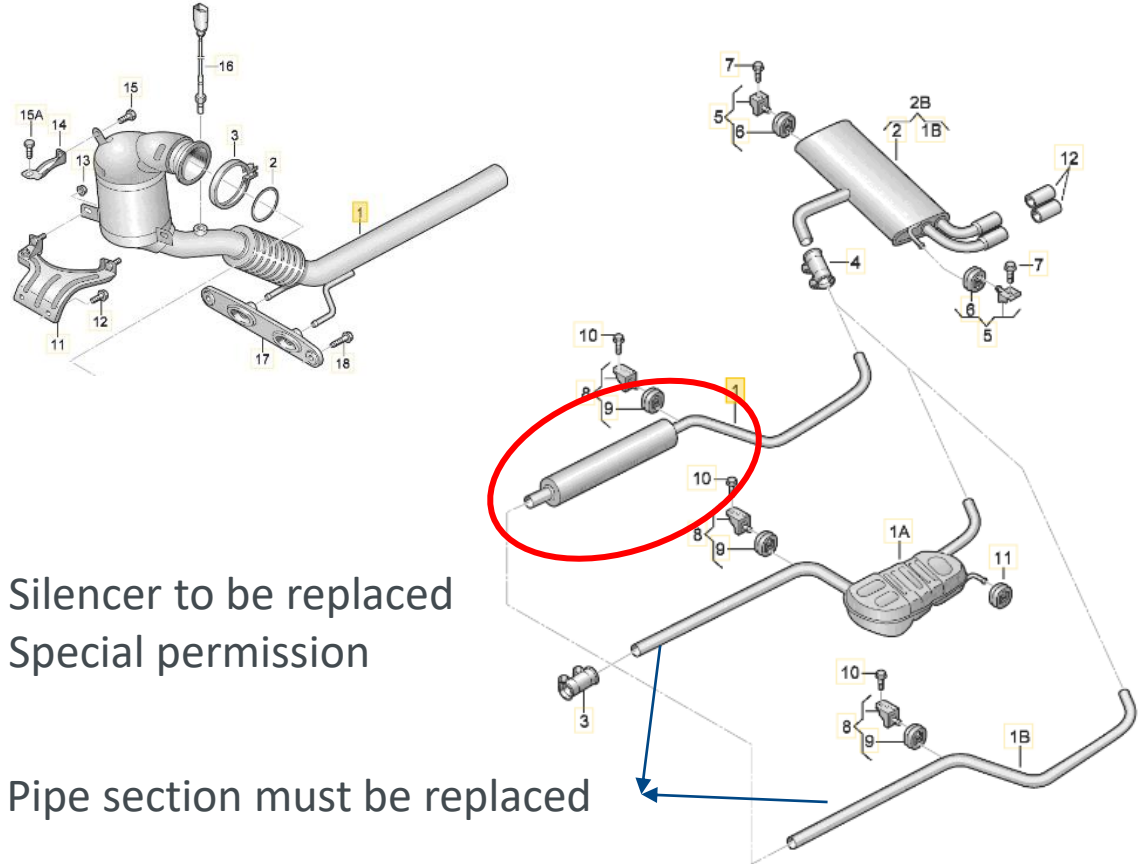
Vehicle selection

List VW Group PC



Anlage 2 / Annex 2 Prüfbericht Nr. / Test report No. TÜH XXX XXX XXX		TÜV Technische Überwachung Hessen GmbH Automotive							
Typ / Type Hersteller / Manufacturer		TBD HJS							
Direct Injection Vehicles YYY				Verwendungsbereich des Partikelminderungssystems Scope of application of particulate reduction system					
Lfd.-Nr. Fahrzeug No. of vehicle	Fzg- Hersteller Vehicle Manufacturer	(Fahrzeugtyp) Gen.-Nr. (Vehicle type) App. No.	Handels- bezeichnung Brand name	Hubraum V _n Capacity cm ³	Nennleistung Normal engine power Kw	Motor-Typ engine type code	Code Variante code of variants	Baujahr von/bis Model year from/to	Abgas- stufe emission class
1	VW Group PC	(AU) E1*2007/46*0623*16 bis 21	VW GOLF	1395	92	CZCA	GAC4CZCAX0	2016	Euro 6b
2	VW Group PC	(AUV) E1*2007/46*0627*16 bis 20	VW GOLF Sportsvan	1395	92	CZCA	SACCZCAX0	2016	Euro 6b
3	VW Group PC	(5N) E1*2001/116*0450*22 bis 29	VW TIGUAN	1395	92	CZDB	ACCZDBX0	2016	Euro 6b
4	VW Group PC	(2K) E1*2001/116*0252*44 bis 47	VW CADDY	1395	92	CZCB	ACCZCBX0	2016	Euro 6b
5	VW Group PC	(3C) E1*2001/116*0307*45	VW PASSAT	1395	92	CZCA	ACCZCAX0	2016	Euro 6b
6	VW Group PC	(5L) E11*2007/46*0010*24	SKODA YETI	1395	92	CZCA	ACCZCAX0	2016-	EURO 6b
7	VW Group PC	(NH) E11*2007/46*0250*13	SKODA RAPID	1395	92	CZCA	LCZCAF1	2016	EURO 6b
8	VW Group PC	(8X) E1*2007/46*0414*17	AUDI A1 SPORTBACK	1395	92	CZCA	SCZCAF1	2016	EURO 6b
9	VW Group PC	(8V) E1*2007/46*0607*19	AUDI A3 SPORTBACK	1395	92	CZCA	SCZCAF1	2016	EURO 6b
10	VW Group PC	(8V) E1*2007/46*0607*18	AUDI A3 LIMOUSINE	1395	92	CZCA	LCZCAF1	2016-	EURO 6b
11	VW Group PC	(5F) E9*2007/46*0094*17 bis 21	SEAT LEON	1395	92	CZCA	BCZCAX0V	2016-	EURO 6b

As of 01.01.2023, **83,466** vehicles are still registered in Germany across all models shown. Design of the exhaust system using the example of a VW Golf 1.4 with the engine code letter CZCA:



⇒ Silencer to be replaced

⇒ Special permission


⇒ Pipe section must be replaced

Vehicle selection

List Peugeot PC



Design of the exhaust system using the example of a Peugeot 5008 1.6 l. As of 01.01.2022, 5,575 vehicles are still registered in Germany across all the models shown.

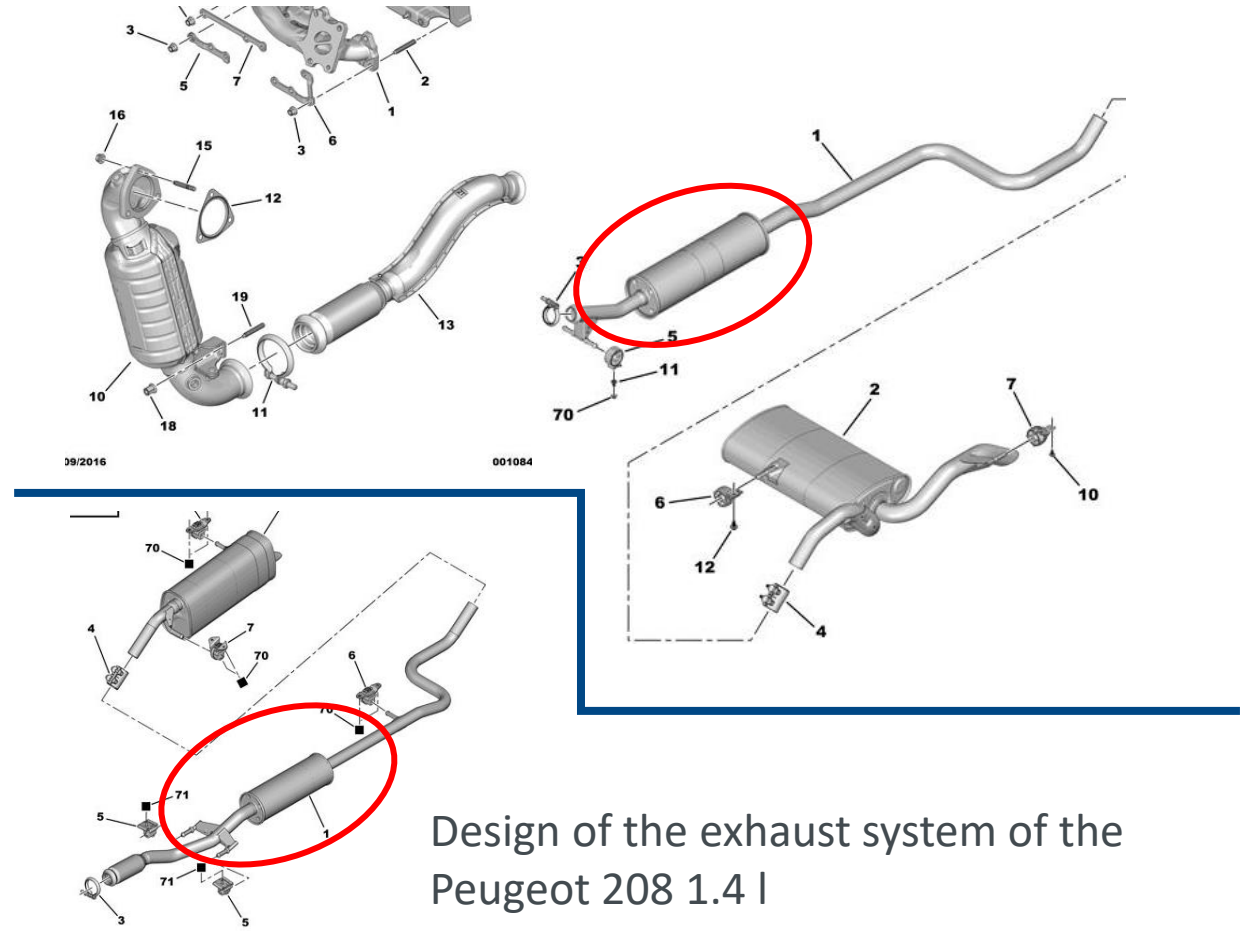
Anlage 2 / Annex 2 Prüfbericht Nr. / Test report No. TÜH XXX XXX XXX	TÜV Technische Überwachung Hessen GmbH Automotive 
Typ / Type Hersteller / Manufacturer	: TBD : HJS

Direct Injection Vehicles
YYY

Verwendungsbereich des Partikelminderungssystems
Scope of application of particulate reduction system

Lfd.-Nr. Fahrzeug No. of	Fzg.- Hersteller Vehicle Manufacturer	(Fahrzeugtyp) Gen.-Nr. (Vehicle type)	Handels- bezeichnung	Hubraum V _h Capacity	Nennleistung Normal engine power Kw	Motor-Typ engine type code	Code Variante code of variant	Baujahr von/bis Model year	Abgas- stufe emission class
1	AUTOMOBILES PEUGEOT	(M) E2*2007/46*0534*0 bis 02	PEUGEOT 3008	1598	121		4	2016	Euro 6b
2	AUTOMOBILES PEUGEOT	(0L) E2*2001/116*0377*23	PEUGEOT 3008	1598	121		EGZ	2016	Euro 6b
3	AUTOMOBILES PEUGEOT	(8) E2*2007/46*0080*31	PEUGEOT 508	1598	121		D5GZ E5GZ	2016	Euro 6b
4	AUTOMOBILES PEUGEOT	(0) E2*2007/46*0004*20	PEUGEOT 5008	1598	121		E5GZ	2016	Euro 6b
5	AUTOMOBILES PEUGEOT	(C) E2*2007/46*0070*31	PEUGEOT 208	1598	121		A5GZ C5GZ	2016	Euro 6b

- ⇒ Silencer to be replaced
- ⇒ Special permission



Design of the exhaust system of the Peugeot 208 1.4 l


Vehicle Selection

List Opel PC



Design of the exhaust system using the Opel Adam 1.4 B14XE engine as an example. The Corsa and Astra models have a comparable exhaust system. According to the KBA, **147,566** vehicles are still registered in Germany as of 01.01.2022.

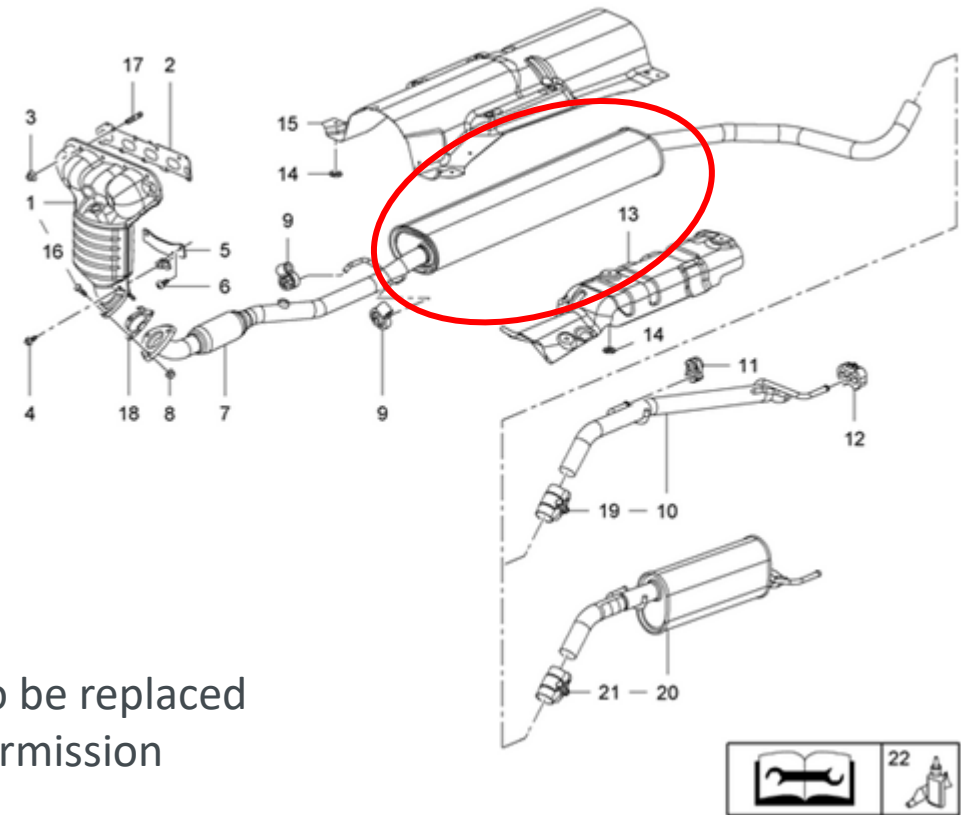
G506 12/10/2012

Anlage 2 / Annex 2 Prüfbericht Nr. / Test report No. TÜH XXX XXX XXX		TÜV Technische Überwachung Hessen GmbH Automotive 
Typ / Type	:	TBD
Hersteller / Manufacturer	:	HJS

Port Fuel Injection Vehicles
YYY

Verwendungsbereich des Partikelminderungssystems
Scope of application of particulate reduction system

Lfd.-Nr. Fahrzeug No. of vehicle	Fzg.- Hersteller Vehicle Manufacturer	(Fahrzeugtyp) Gen.-Nr. (Vehicle type) Appr. No.	Handels- bezeichnung Brand name	Hubraum V _H Capacity cm ³	Nennleistung Normal engine power Kw	Motor-Typ engine type code	Code Variant code of variants	Baujahr von/bis Model year from/to	Abgas-stufe emission class
1	Opel	(S-D) e1*2001/116*0379*35 bis 37	CORSA-E	1398	66	B14XER	**DR	2016	Euro 6b
2	Opel	(S-D) e1*2001/116*0379*35 bis 37	CORSA-E	1398	55	B14XER	**DS	2016	Euro 6b
3	Opel	(S-D) e1*2001/116*0379*35 bis 37	CORSA-E	1398	74	B14XER	**DT	2016	Euro 6b
4	Opel	(S-D) e1*2001/116*0379*35 bis 37	ADAM	1398	64	B14XER	**D1	2016	Euro 6b
5	Opel	(B-K) e1*2007/46*0969*06	ASTRA	1399	74	B14XER	** or ***DC	2016	Euro 6b



- ⇒ Silencer to be replaced
- ⇒ Special permission

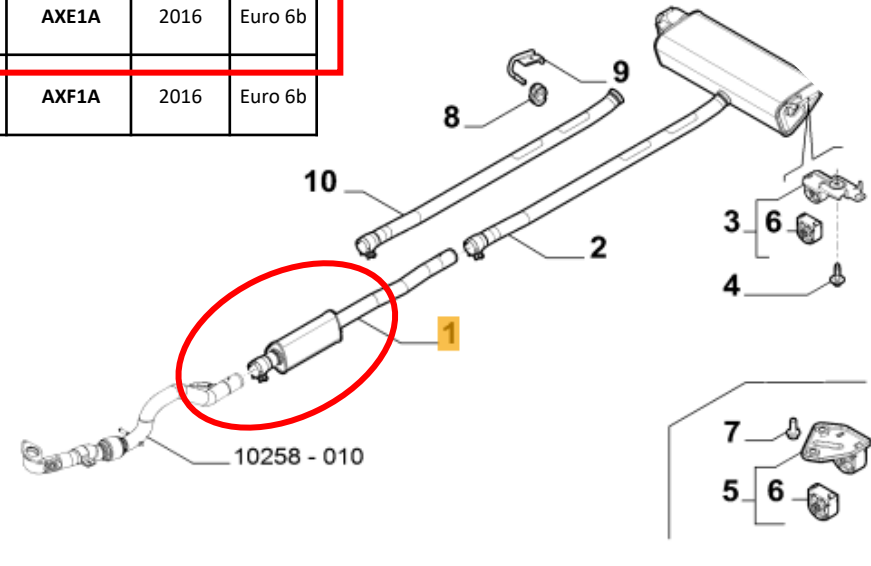
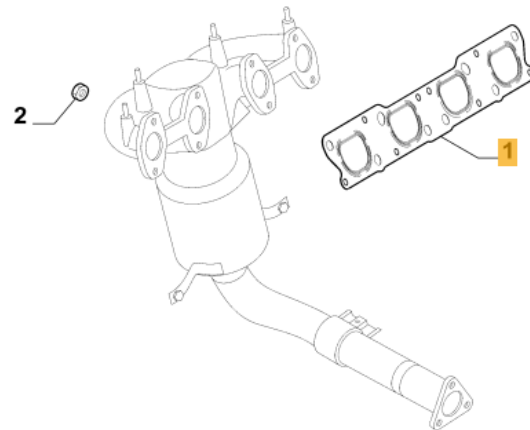


Vehicle selection

List Fiat PC



Lfd--Nr. Fahrzeug No. of vehicle	Fzg.- Hersteller Vehicle Manufacturer	(Fahrzeugtyp) Gen.-Nr. (Vehicle type) Appr.- No.	Injection System	Handels- bezeichnung Brand name	Hubraum VH Capacity VH	Nennleistung Normal engine power	Motor-Typ engine type code	Code Variante code of variants	Baujahr von/bis Model year from/to	Abgas- stufe emission class
					[cm ³]	[kW]				
1	FCA ITALY SPA	-334 e3*2007/46*318*02	PFI	FIAT 500 X	1598	81	1.6 E-torQ 55263842	AXE1A	2016	Euro 6b
2	FCA ITALY SPA	(BU) e3*2007/46*300*05	PFI	Jeep Renegade	1598	81	1.6 E-torQ 55263842	AXF1A	2016	Euro 6b



⇒ Silencer to be replaced
 ⇒ Special permission

Fiat 500 X

Final vehicle selection

Vehicle	License plate number	VIN number	Injection system	Mileage	First registration
VW_Golf_7	MK-ET 450	WVWZZZAUZGP097064	DI	69.850 km	05.04.2016
Opel_Corsa_E	MK-ET 460	W0LOXEP68G4166398	PFI	59.300 km	16.03.2016
Peugeot_3008	MK-ET 470	VF30U5GZTGS069700	DI	85.612 km	27.04.2016
Fiat_500X	MK-ET 480	ZFA3340000P466040	PFI	47.752 km	27.10.2016



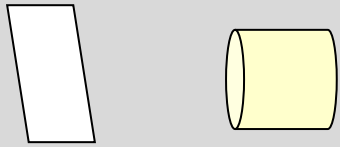
Design vehicle-specific GPF systems

- Checking original underbody arrangement
- Execution of 3D Scans
- System design incl. technical drawings
- Definition of manufacturing procedures
- Prototype manufacturing
- System installation
- Particulate Number evaluation with and without GPF
- Sound level check with and without GPF
- General emissions testing

Canning, (housing) and Integration Process

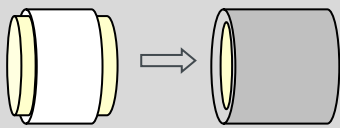
Canning

Support Mat

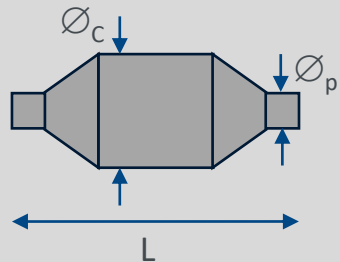


GPF-Substrate

Mat is fixed around the substrate



Both is stuffed into a housing

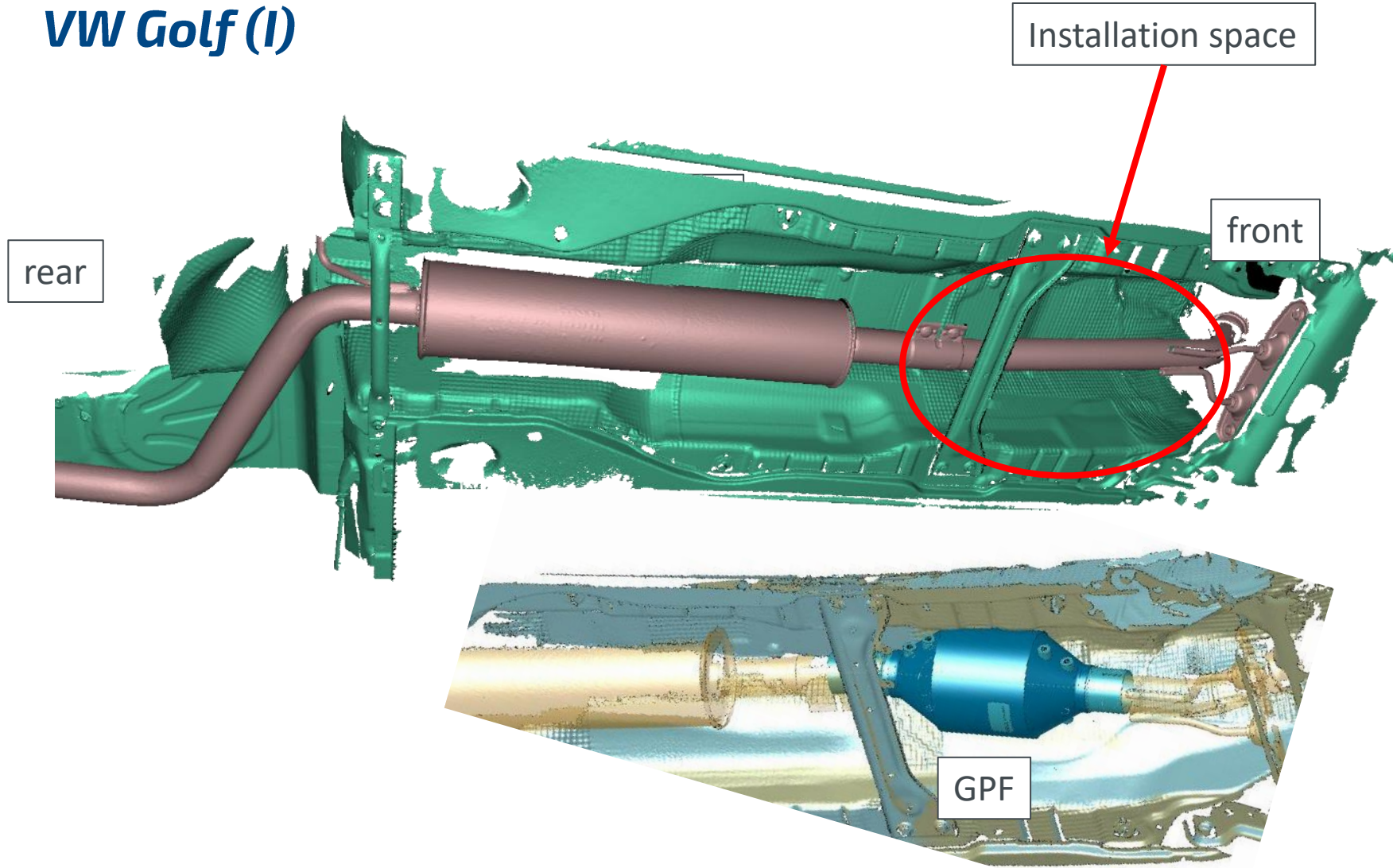


Cones and pipes welding

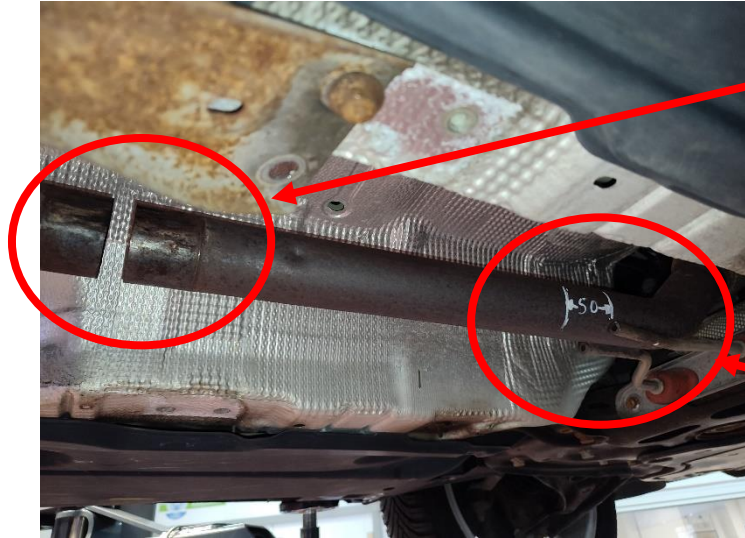
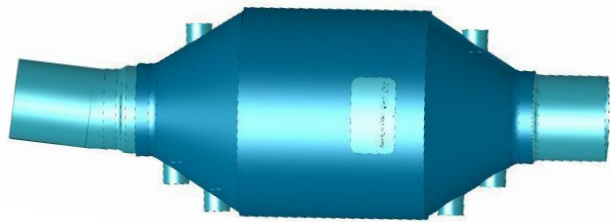
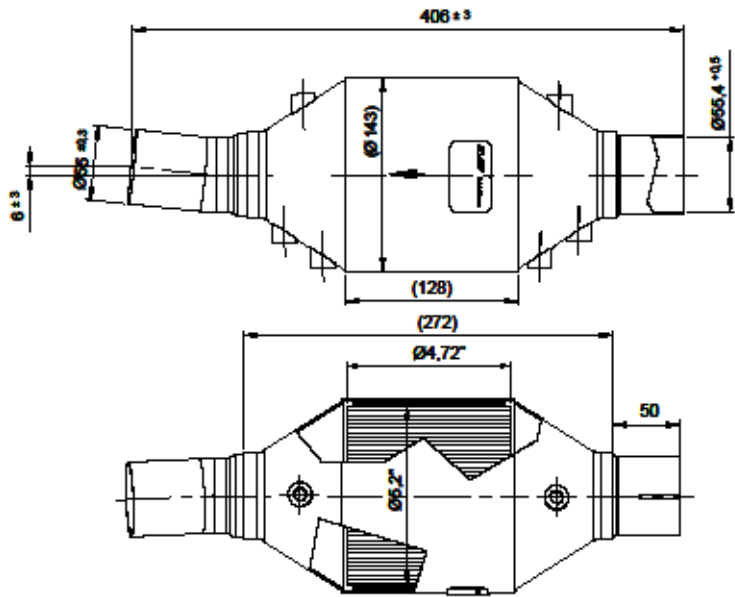
Integration

- Close to engine for temperature capture
- Keep silencer for noise absorption (yes/no)
- Cutting point definition
- Pipe routing direction
- Pipe and cone diameter
- Fastening part and components
- Flange or pipe connectors
- Exchange of decoupling part (bellow)

VW Golf (I)

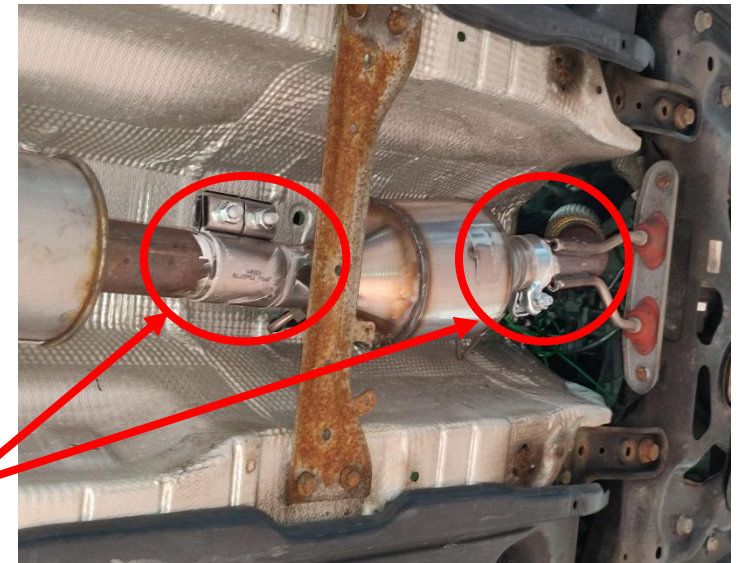


VW Golf (II)



Remove original pipe connector

Saw cut area



GPF is fixed with two new pipe connectors

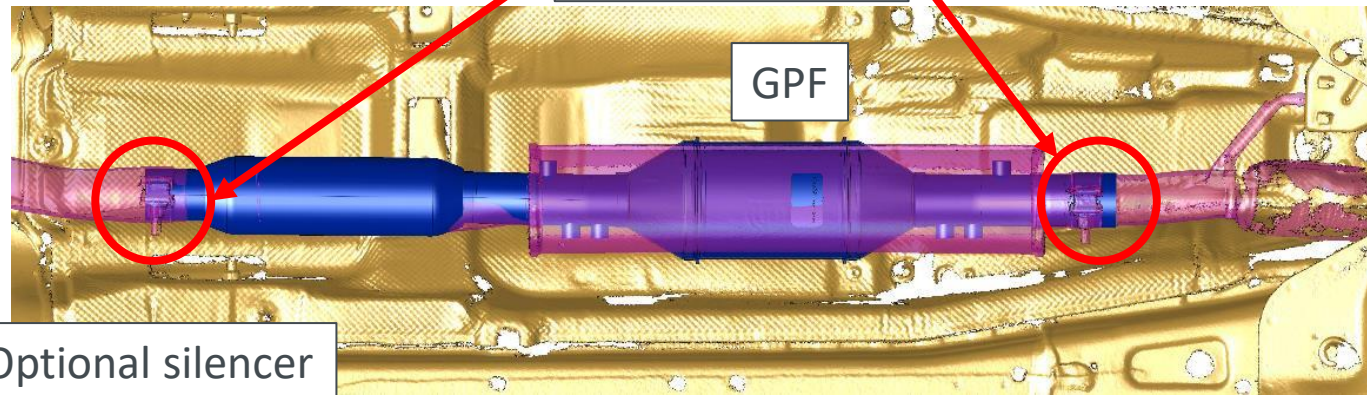
Fiat 500X (I)



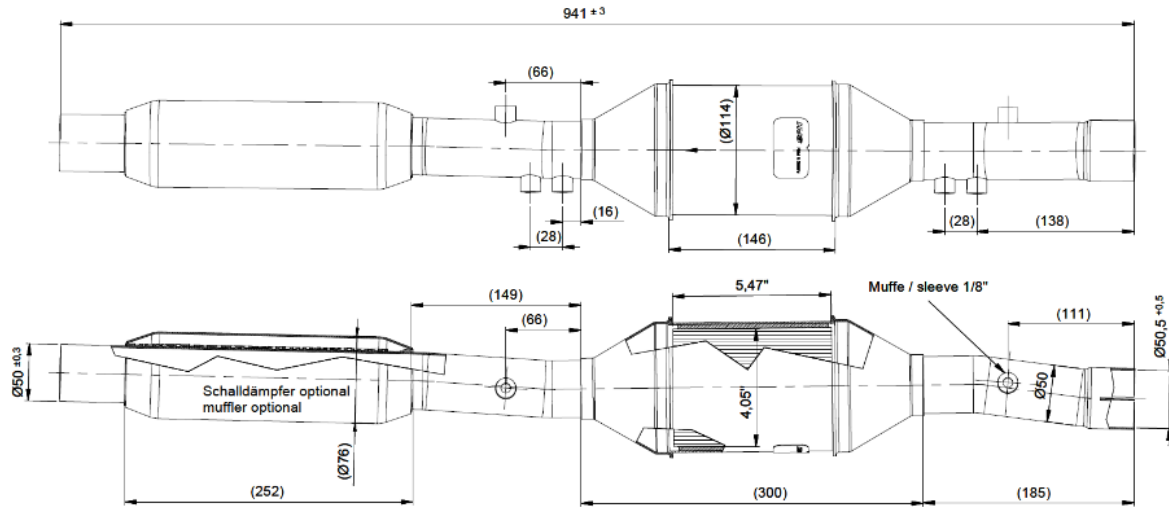
underbody photo original



pipe connectors

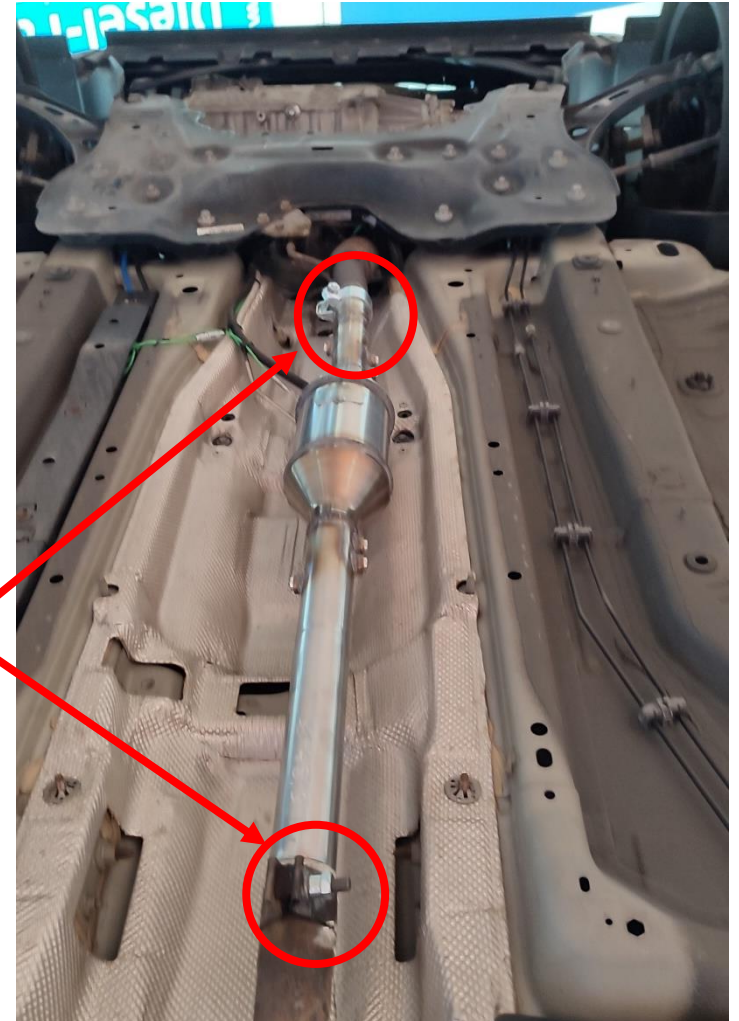


Fiat 500X (II)



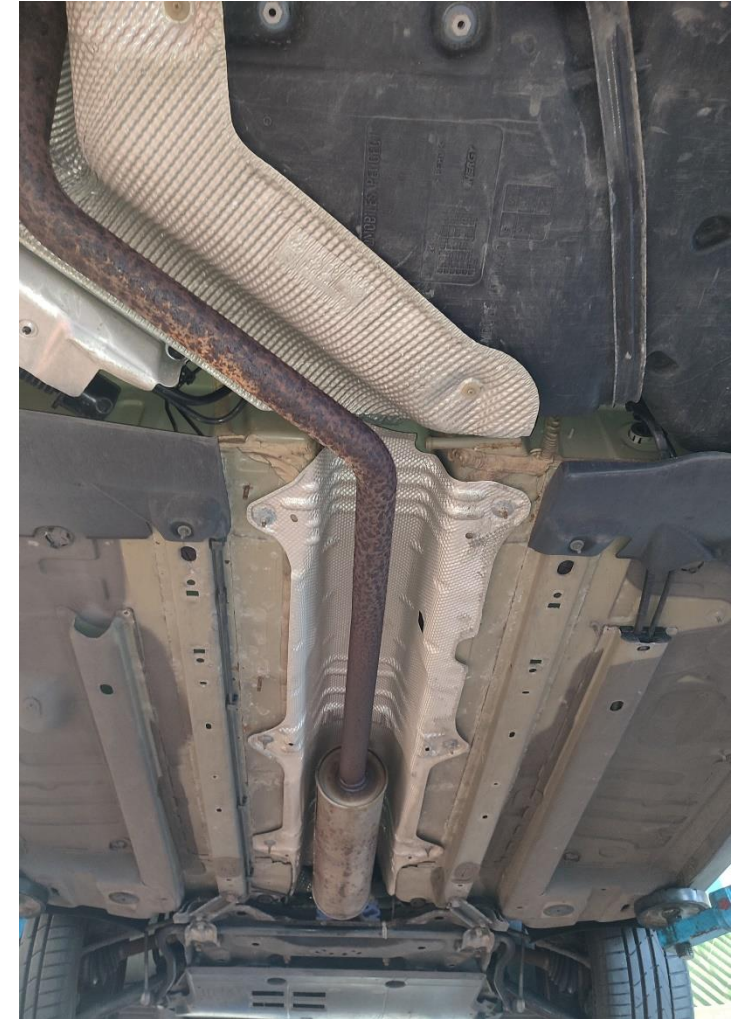
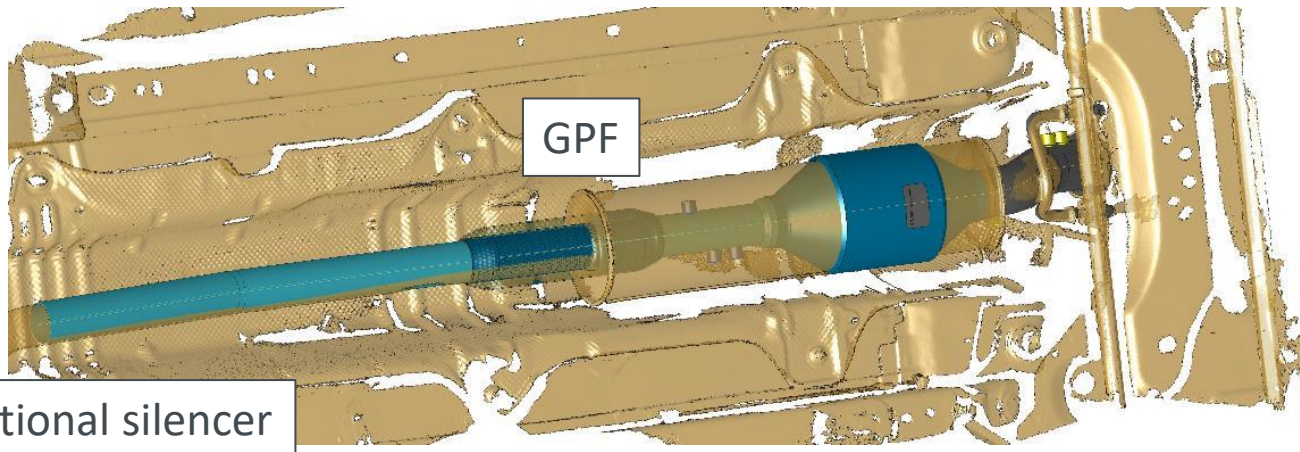
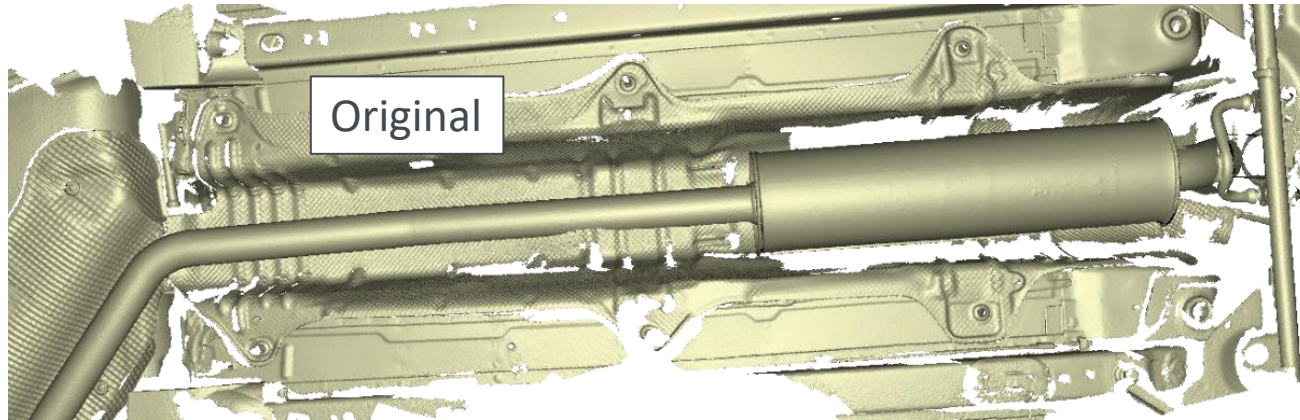
Optional silencer

underbody photo GPF

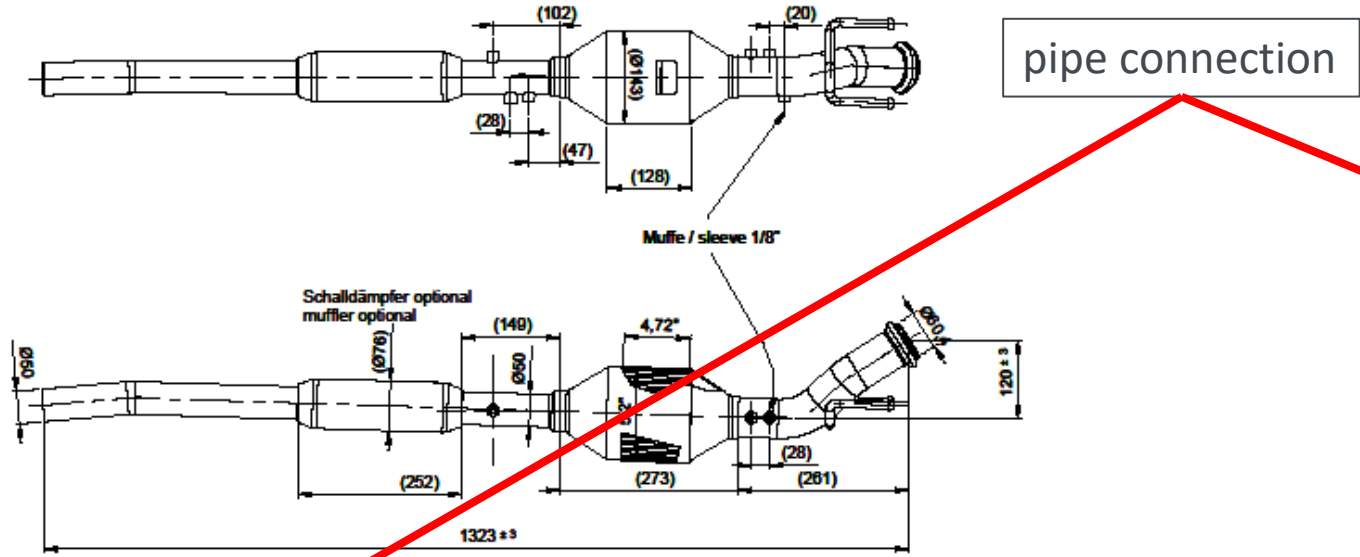


pipe connectors

Peugeot 3008 (I)



Peugeot (II)



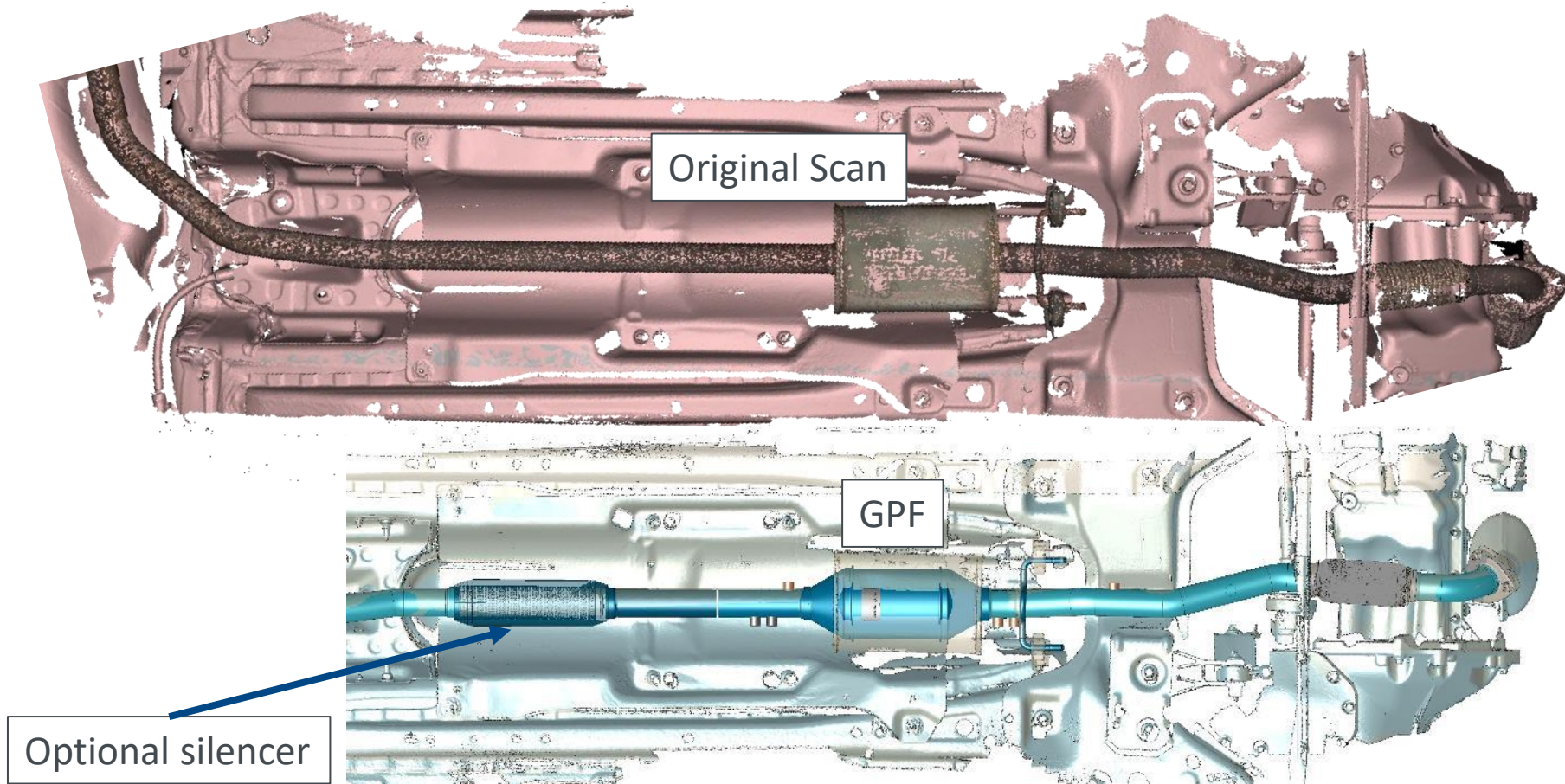
pipe connection



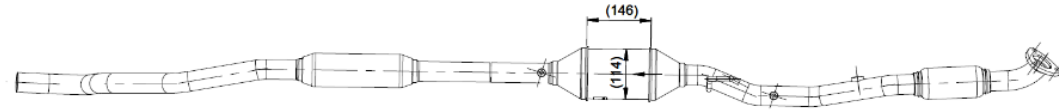
Clamp connection

Optional silencer

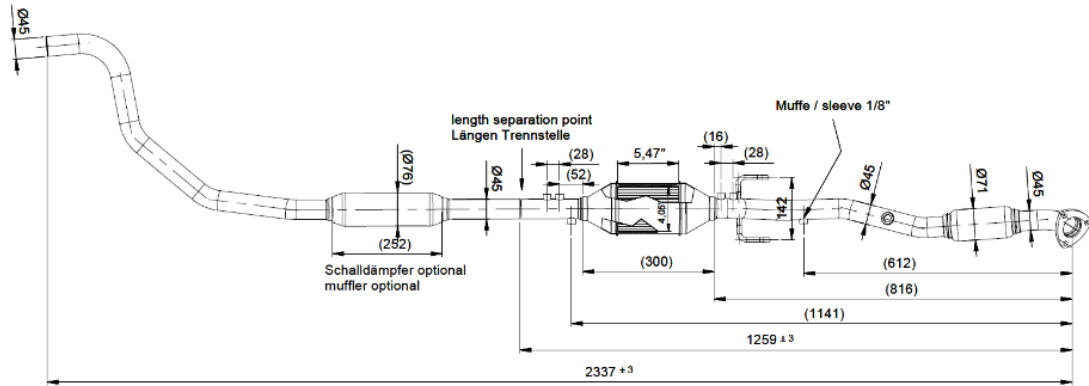
Opel Corsa (I)



Opel Corsa (II)



Flange connection
in the front

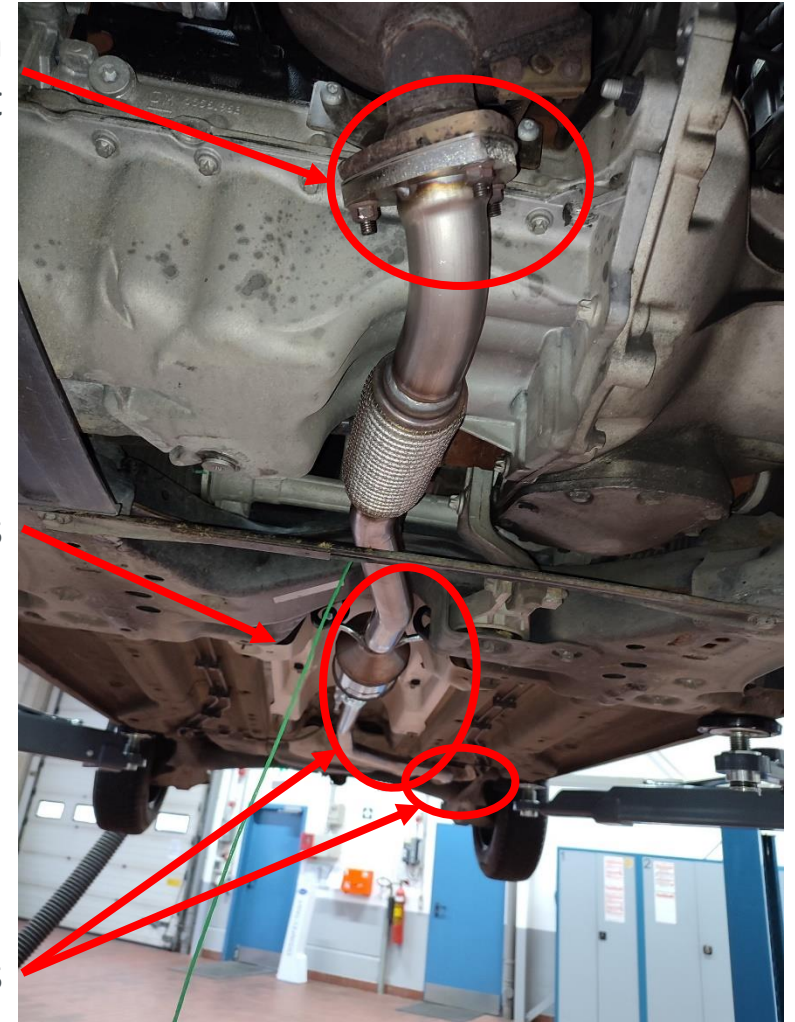


GPF brackets



Optional silencer

Pipe connectors



Data (I) – Sound Pressure Level and Exhaust Emission Test (AU)

Protokoll der Abnahmemessung vor und nach
Ein- und Ausbau des GPF (HJS-Prüfprotokoll)



Art der Messung: Eingangskontrolle vor Filterausbau
 nach Filtereinbau nach Filterausbau
 Halbzeit Flottenversuch (Kontrollmessung)

Partikelfilter	
Hersteller (Marke)	-
Typ	-
Identifikation	-
Einbaudatum	-
Datalogger	
Typ	-
Fahrzeug	
Hersteller	Volkswagen
Typ	Golf 7
Baujahr	2016
Fahrgestellnummer	WVWZZZAUZGP097064
Km-Stand	70.053
Motor	
Hersteller	Volkswagen
Typ	CZCA, Benzin, 4-Zyl. Reihe
Baujahr	2016
Nennleistung	63 [kW]
Emissionsmessung (bei 2.000 1/min)	
PN	79,100 [# /cm ³]
CO	0,017 [Vol-%]
CO ₂	15,1 [Vol-%]
O ₂	0,00 [Vol-%]
λ	0,999
NO _x	[ppm]
OBD-Auslesung	Fehlerfrei
Lärmmessung	
Lärmmessung im Nahfeld 45°/0,5 m bei Motordrehzahl	73,9 [dB(A)] 3.750 [1/min]
PN-Messgerät	
Hersteller	AVL DiTest GmbH
Typ	AVL Counter
Lärmmessgerät	
Hersteller	Brüel & Kjaer
Typ	Type 2240; SN: 00340823
Bemerkungen	
Prüfer (Firmenstempel)	Unterschrift des Prüfers
Datum:	

Sound Pressure Level

SPL = Sound Pressure Level			Income inspection		After GPF installation	
			1	2	1	2
Vehicle	ID plate	Chassis number	SPL [dB (A)]	SPL [dB (A)]	SPL [dB (A)]	SPL [dB (A)]
Corsa_E	MK-ET 460	W0L0XEP68G4166398	78,6	78,4	77,2	76,9
Fiat_500	MK-ET 480	ZFA3340000P466040	76,8	76,0	87,7	87,7
Peugeot_3008	MK-ET 470	VF30U5GZTGS069700	76,3	76,7	77,7	77,9
VW_Golf_7	MK-ET 450	WVWZZZAUZGP097064	73,9	73,8	72,7	72,7

Exhaust Emission Test (AU)

			Income inspection				After GPF installation			
Vehicle	ID plate	Chassis number	CO [Vol-%]	CO ₂ [Vol-%]	O ₂ [Vol-%]	λ [-]	CO [Vol-%]	CO ₂ [Vol-%]	O ₂ [Vol-%]	λ [-]
Corsa_E	MK-ET 460	W0L0XEP68G4166398	0,000	15,270	0,270	1,012	0,018	15,370	0,160	1,006
Fiat_500	MK-ET 480	ZFA3340000P466040	0,079	15,360	0,050	0,999	0,052	15,370	0,060	1,000
Peugeot_3008	MK-ET 470	VF30U5GZTGS069700	0,040	15,370	0,000	0,995	0,000	15,560	0,040	1,001
VW_Golf_7	MK-ET 450	WVWZZZAUZGP097064	0,017	15,100	0,000	0,999	0,012	15,480	0,000	0,996

Data (II) - PN Measurement

			Income Inspection				After GPF installation					
			Without load= Air condition OFF		Measurement 01		Measurement 02		Measurement 01		Measurement 02	
			With load= Air condition ON		Without Load	With Load	Without Load	With Load	Without Load	With Load	Without Load	With Load
Vehicle	ID plate	Chassis number	PN [# /cm ³]	PN [# /cm ³]	PN [# /cm ³]	PN [# /cm ³]	PN [# /cm ³]	PN [# /cm ³]	PN [# /cm ³]	PN [# /cm ³]		
Corsa_E	MK-ET 460	W0L0XEP68G4166398	3.700	1.700	2.700	1.600	300	100	300	200		
Fiat_500	MK-ET 480	ZFA3340000P466040	2.800	8.900	3.500	13.200	100	500	200	300		
Peugeot_3008	MK-ET 470	VF30U5GZTGS069700	5.000	37.000	4.900	34.400	200	500	300	400		
VW_Golf_7	MK-ET 450	WVWZZZAUZGP097064	79.100	185.000	51.900	169.000	200	300	100	100		

Thank you very much !

HJS
Emission Technology



- Wide range of Emission Control Technologies
- Specialist in combustion engine exhaust aftertreatment
- Air Pollution Control Technologies
- Sintered Metal Filter (SMF®) manufacturing
- High competence in research and development
- Flexible production structures and capacities



Hubertus Borgmeier | +49 170 913 36 21
hubertus.borgmeier@hjs.com