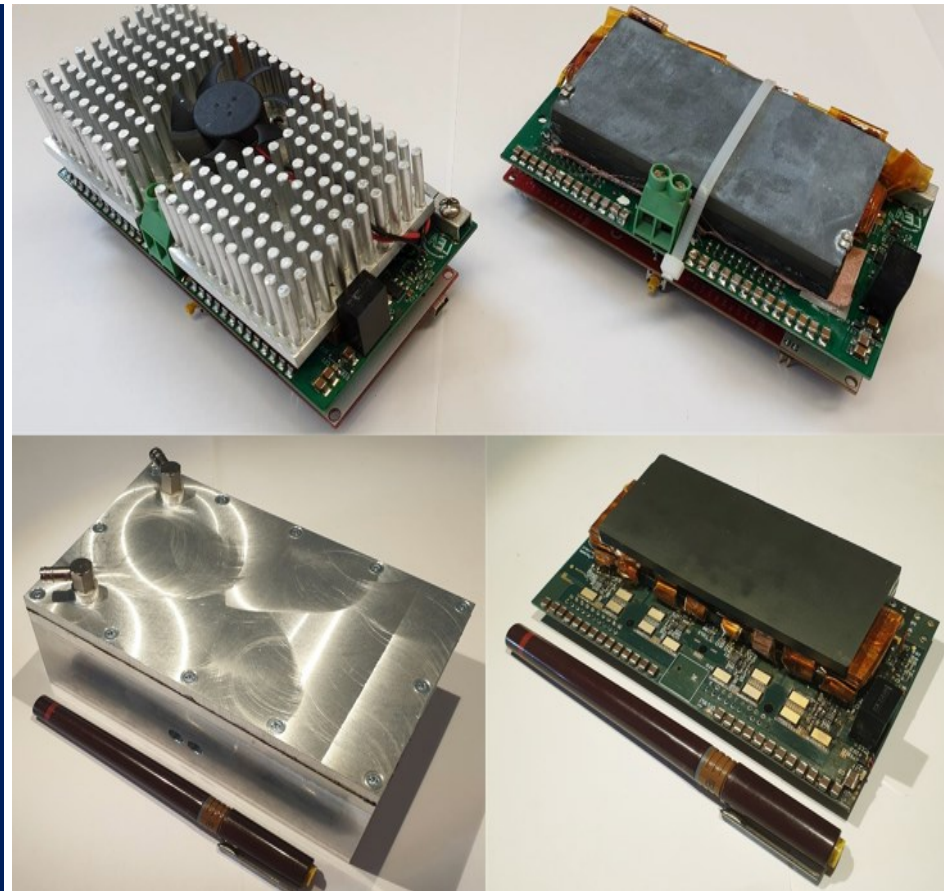




Power Electronics and Electrical Drives
Prof. Dr.-Ing. Joachim Böcker



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Abschlusspräsentation des Semesterprojekts

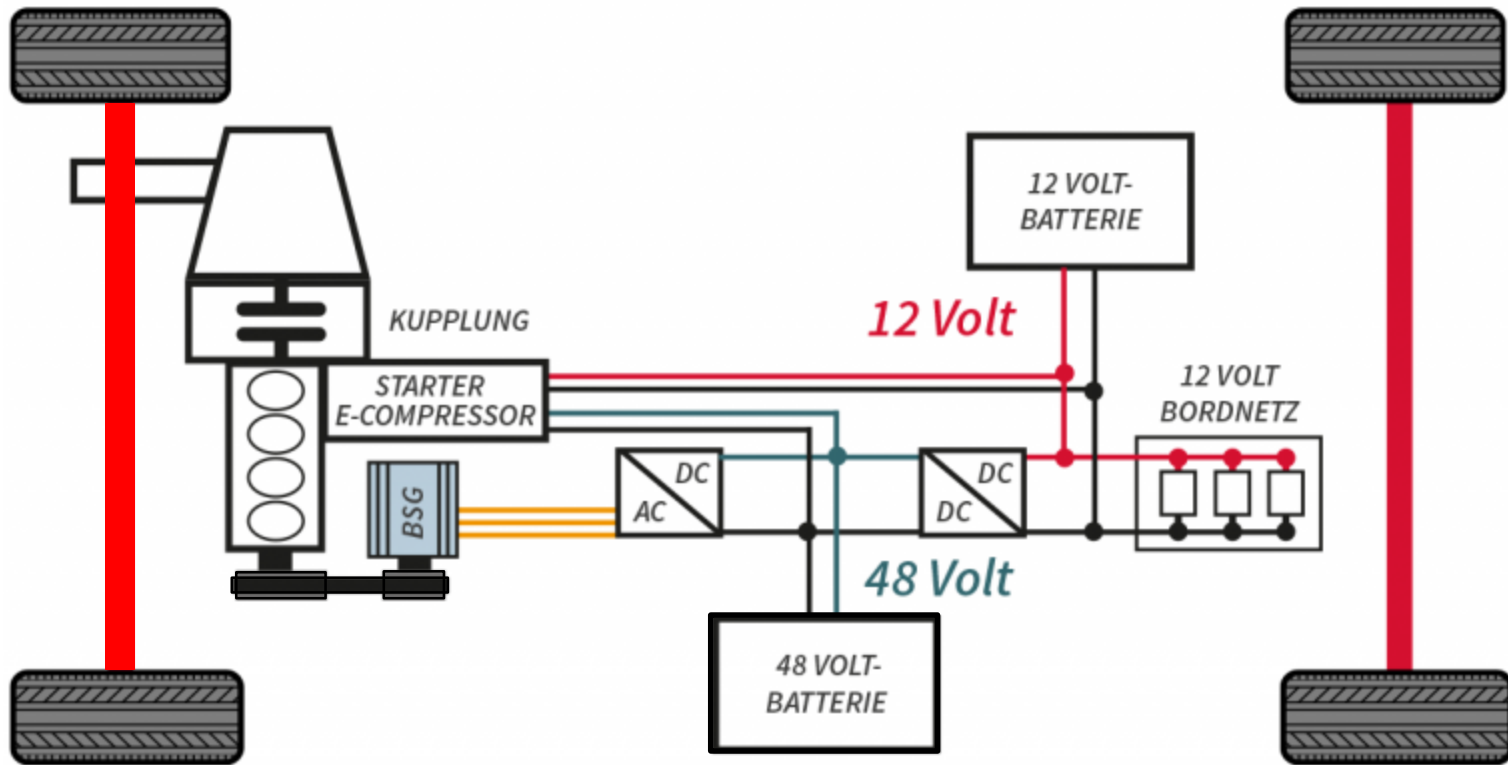
Hochkompakter, hocheffizienter 48 V-12 V DC-DC-Wandler für Elektrofahrzeuge in einem Gehäuse mit Wasserkühlung

Projektgruppe Leistungselektronik

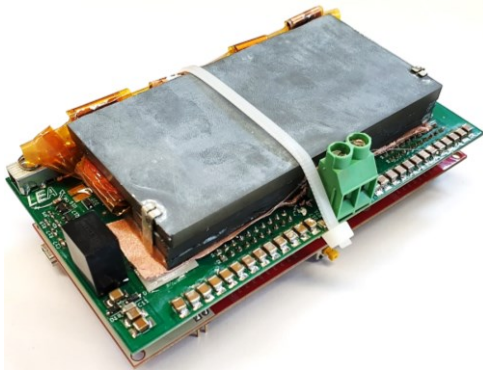
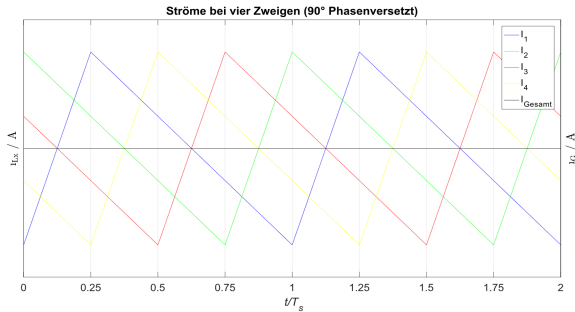
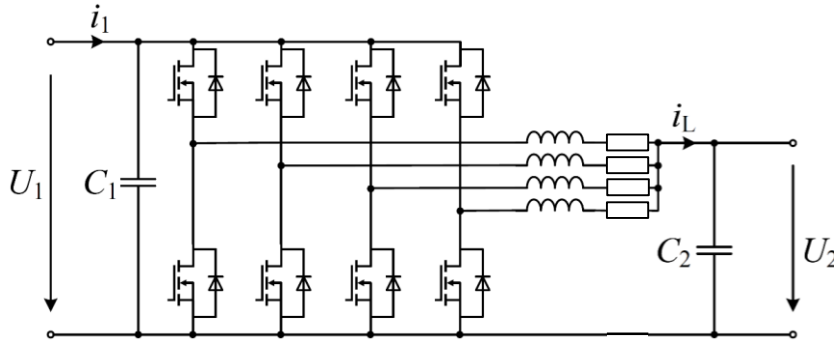
Hendrik Becker, Christian von Germeten, Ismail Sarwar, Hasnain Rajput

- ▶ Einführung
- ▶ Leiterplatten-Modifikation
- ▶ Neuaufbau der Magnetik
- ▶ Gehäuse-Entwurf
- ▶ Messergebnisse

- ▶ Einführung
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- ▶ Gehäuse-Entwurf
- ▶ Messergebnisse



<http://magazine.fev.com/de/der-fev-hecs-ecobrid-mit-48-volt-hybridisierung/>

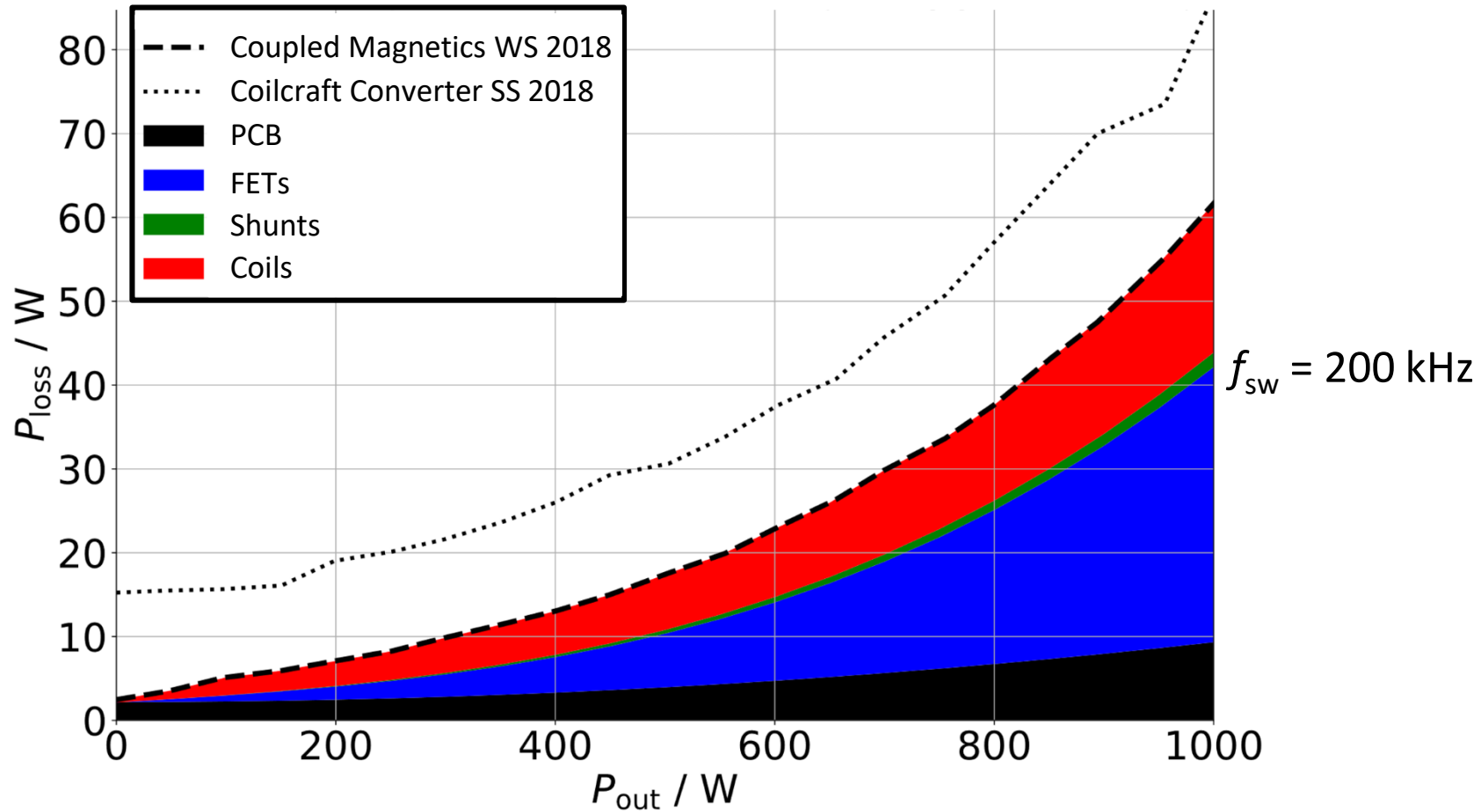


[Fischer u.a 2019]

Eigenschaften

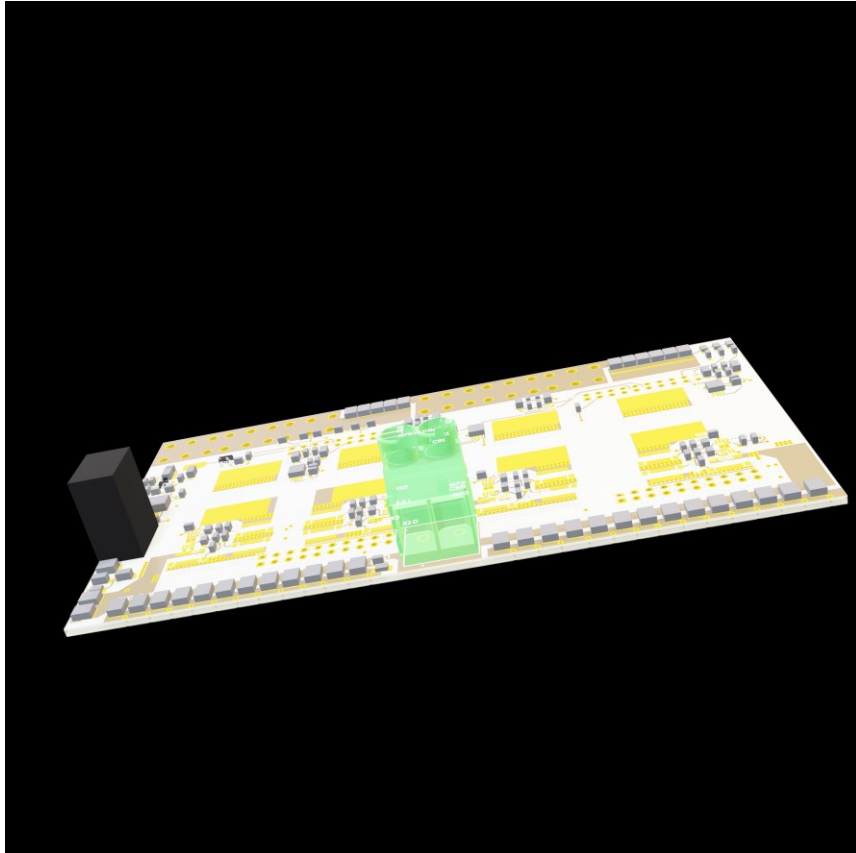
- Ausgangsleistung: 1 kW
- Maximaler Wirkungsgrad: 96,8 %
- Wirkungsgrad bei Volllast: 94,2 %

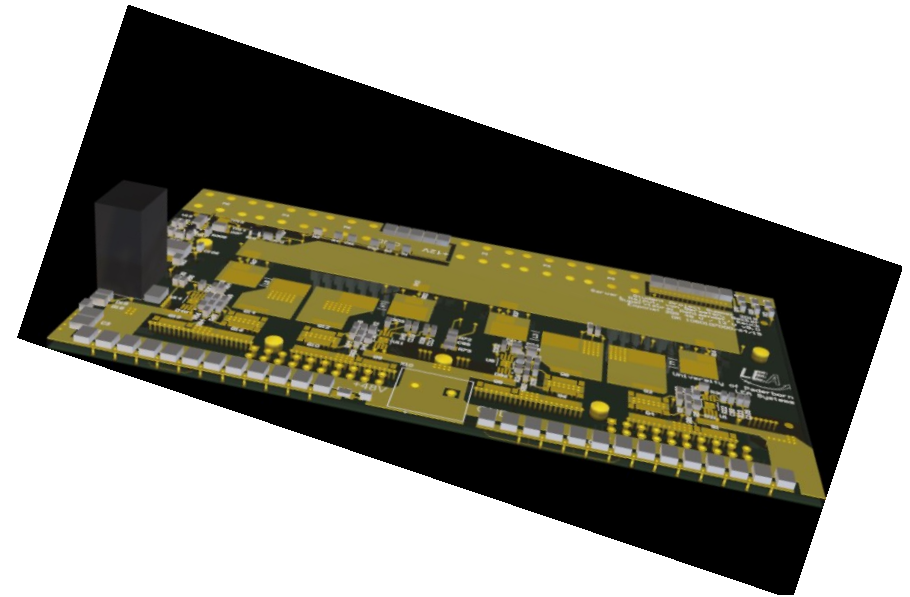
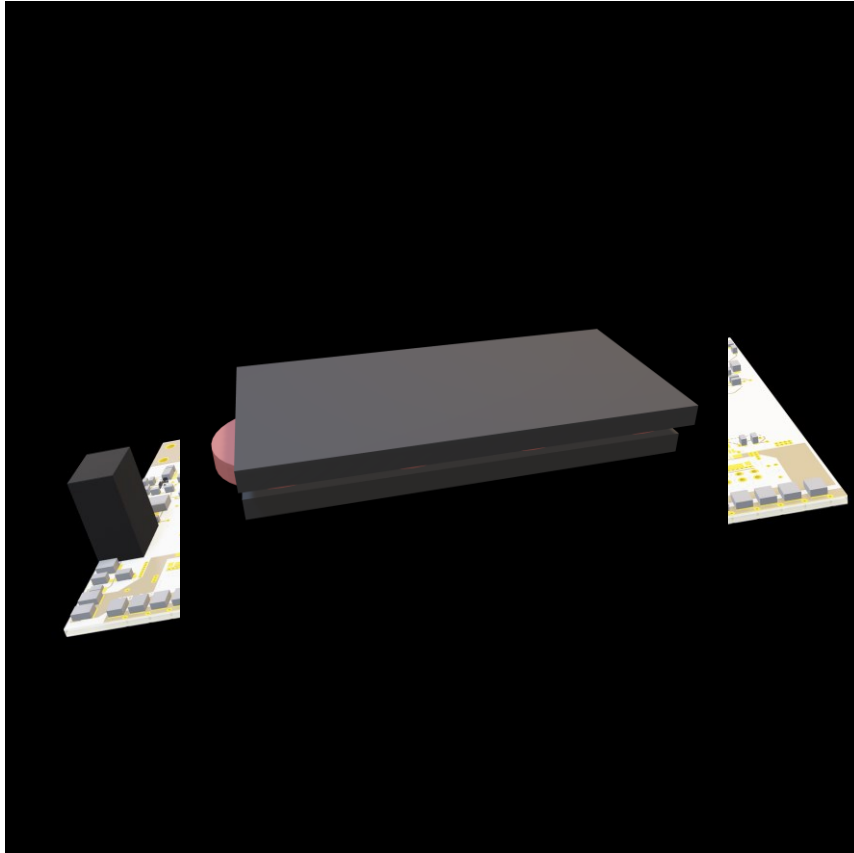
- **Modifikation der Platine**
- **Modifikation der Magnetik**
- **Integration in Gehäuse**

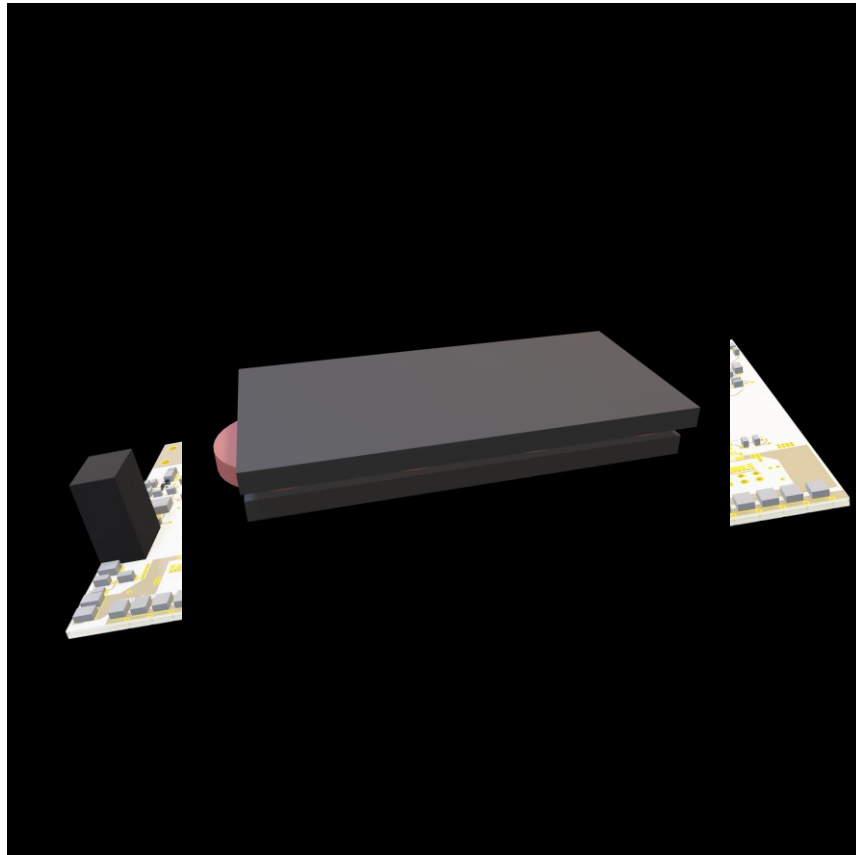


[Fischer u.a 2019]

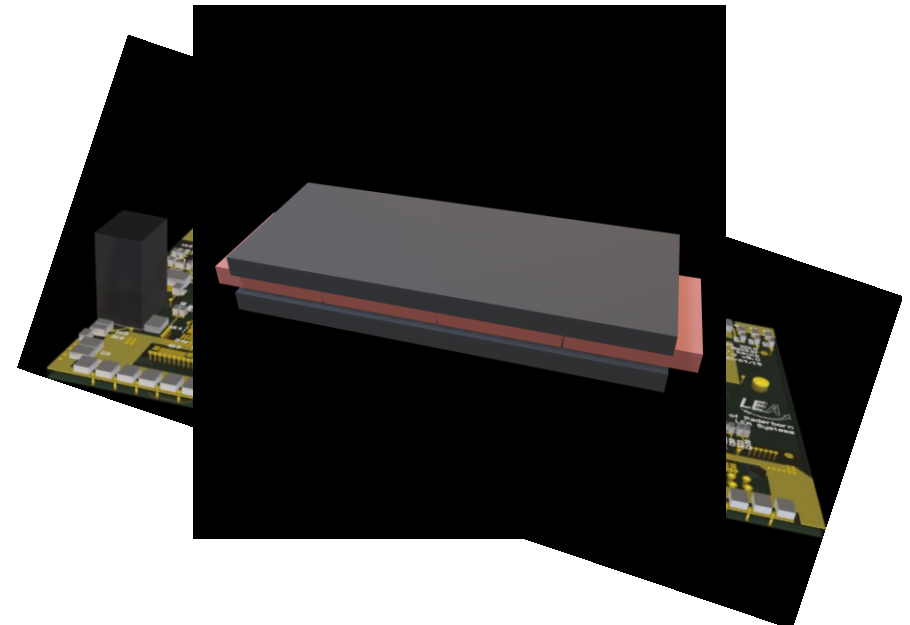
- ▶ Einführung
- ▶ Leiterplatten-Modifikation
- ▶ Neuaufbau Magnetik
- ▶ Gehäuse-Entwurf
- ▶ Messergebnisse

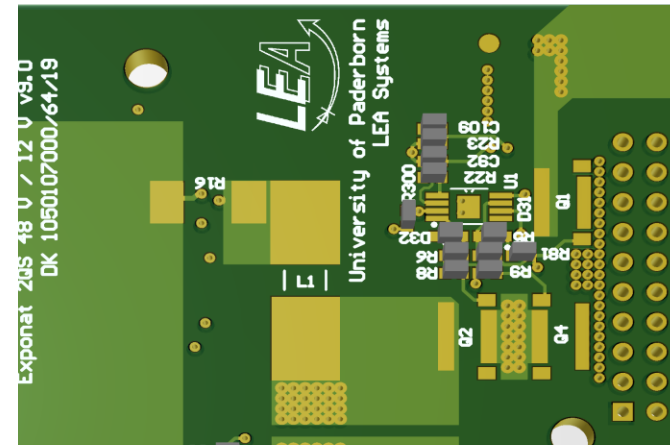
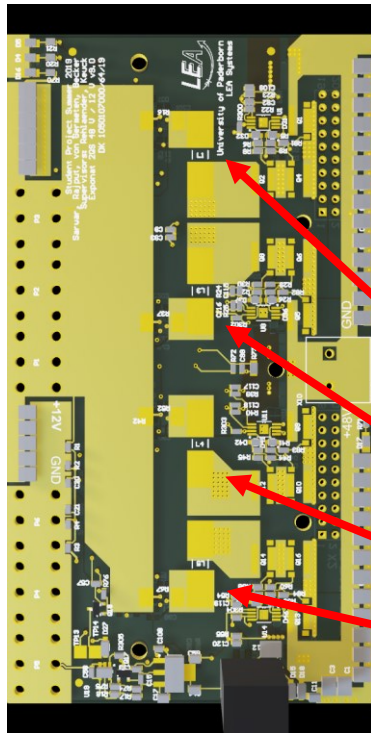






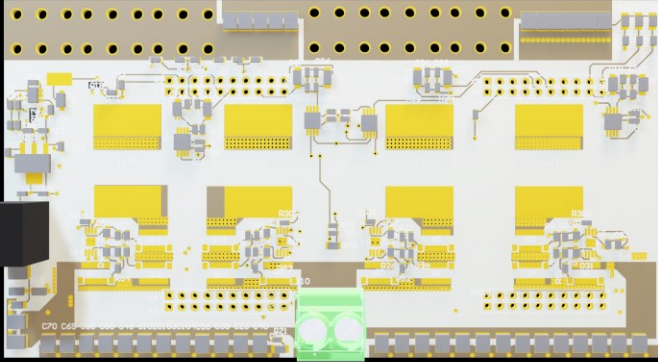
Projektgruppe SS-2019



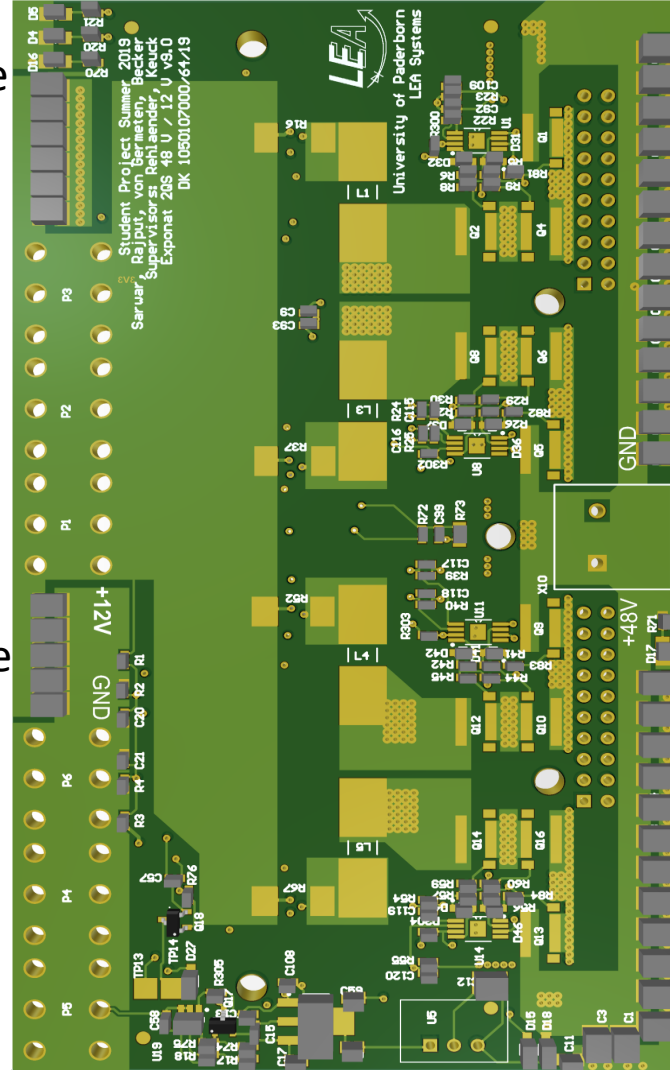
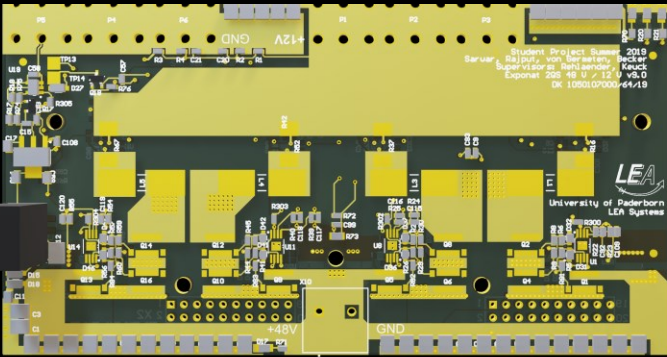


- Spulenanschlüsse um 90° gedreht
- Näher zu den MOSFETs verschoben
 - Besserer Anschluss der Spulen

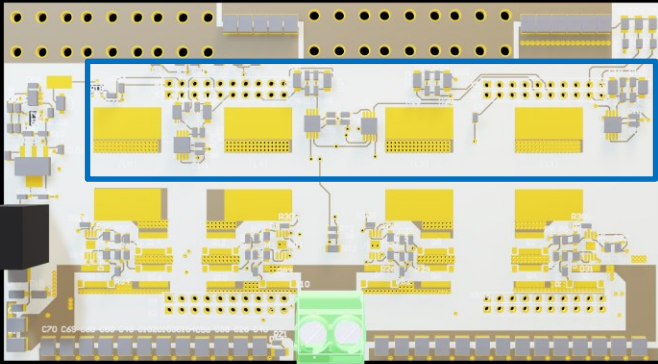
Seite 18



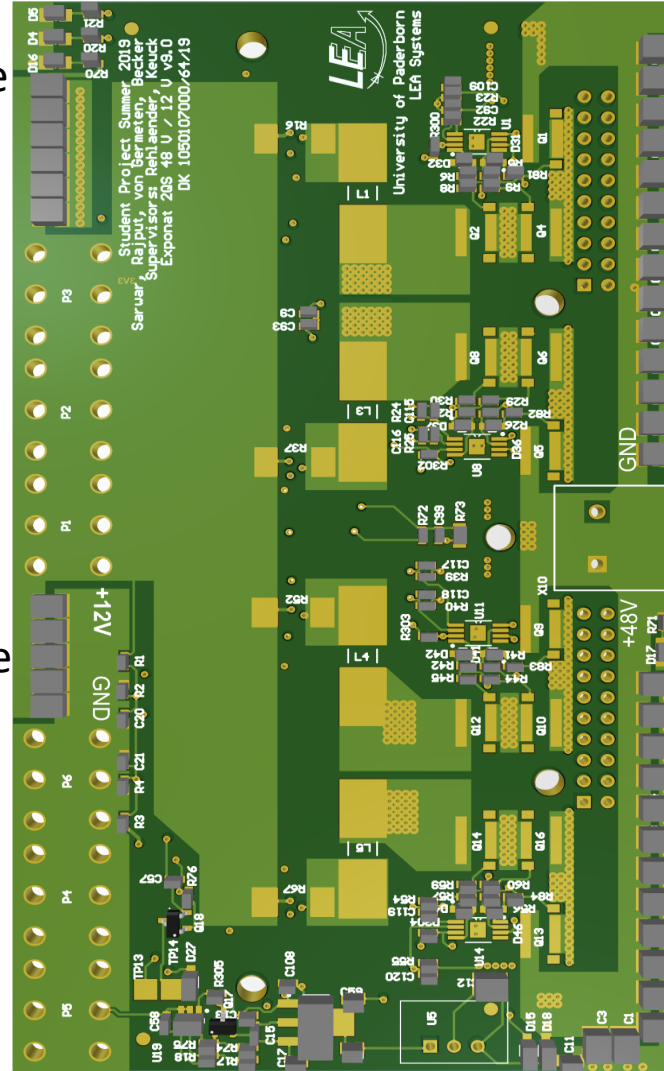
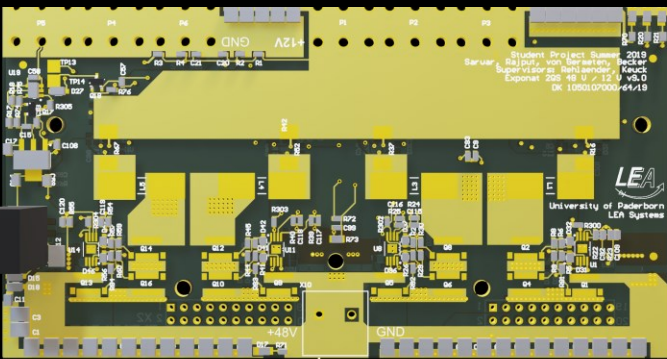
Seite 19



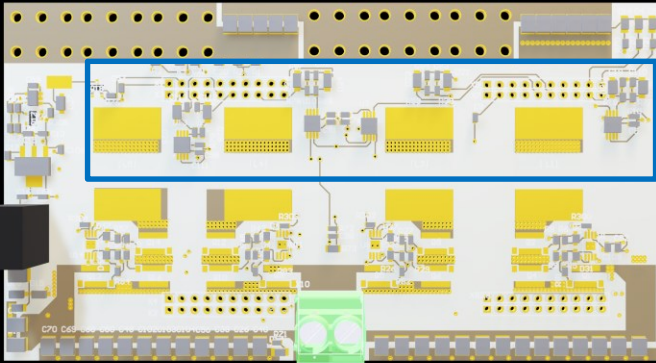
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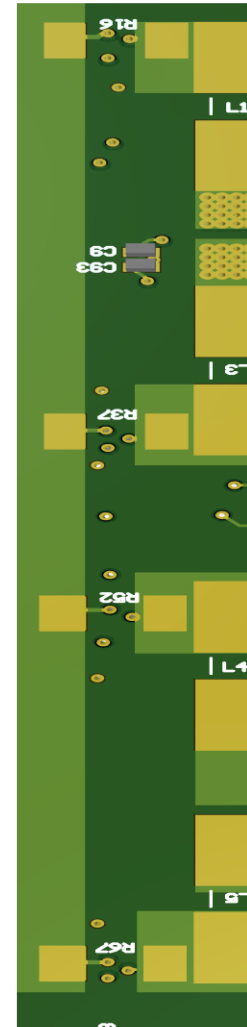
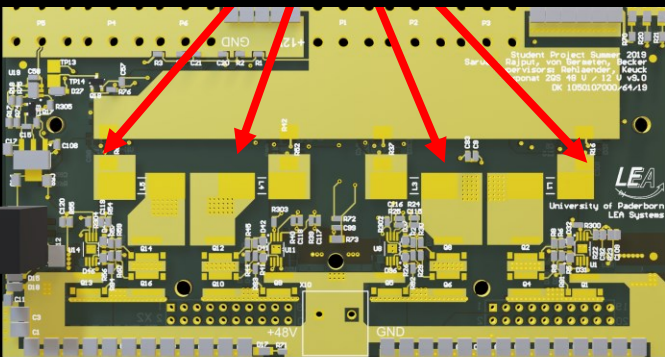
Seite 19



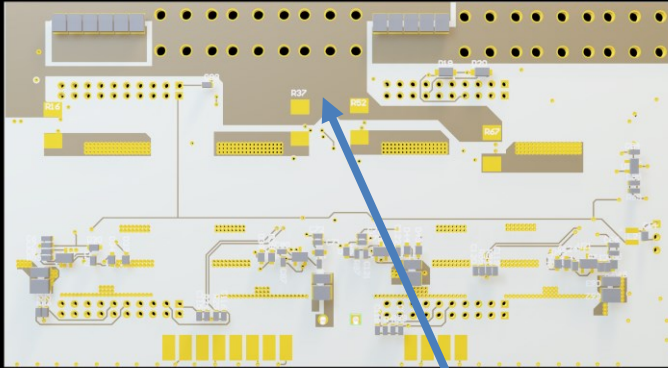
Seite
18



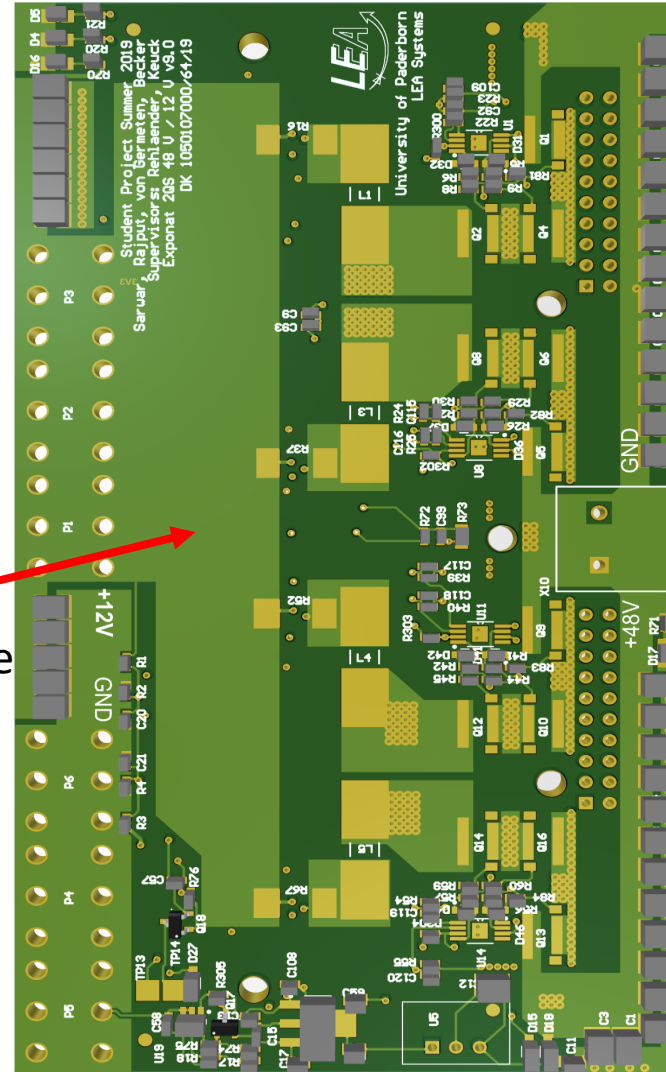
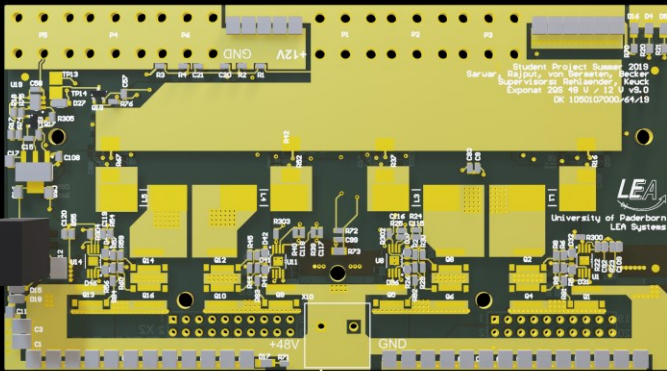
Reverse
Seite
19



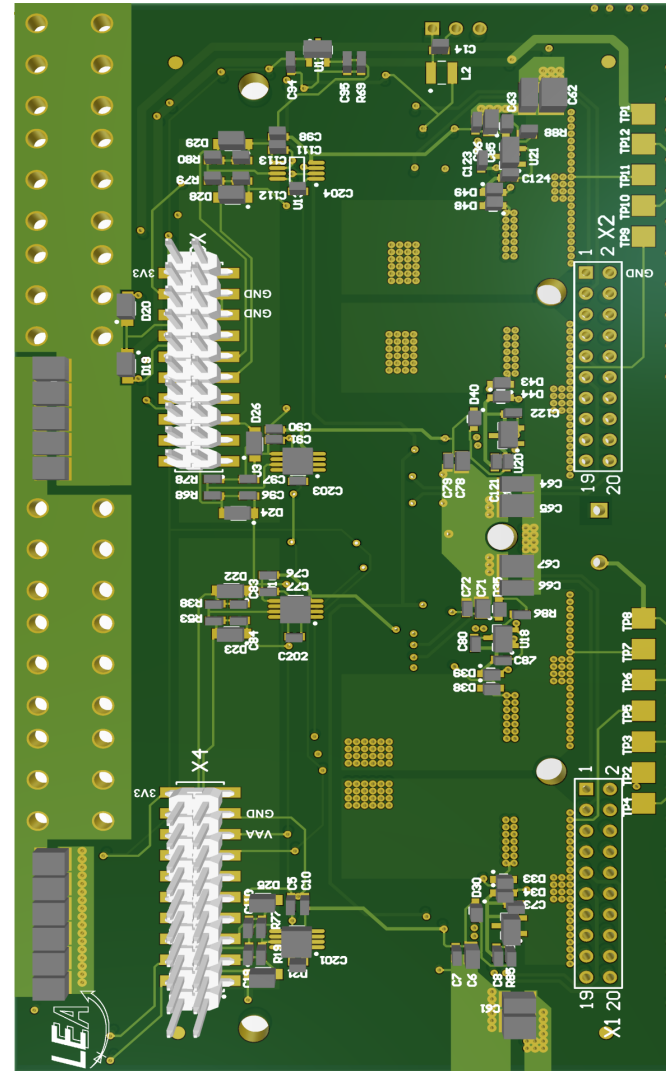
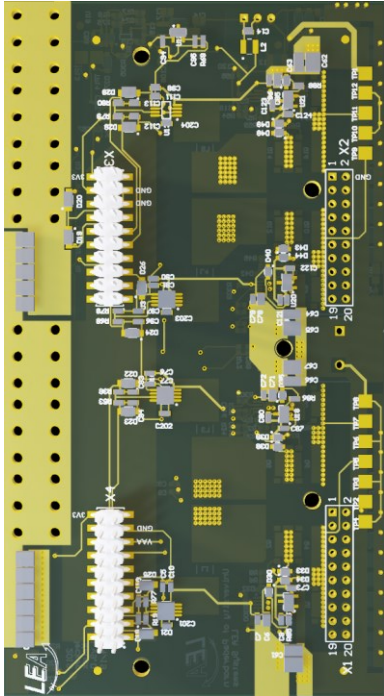
Seite
15-18



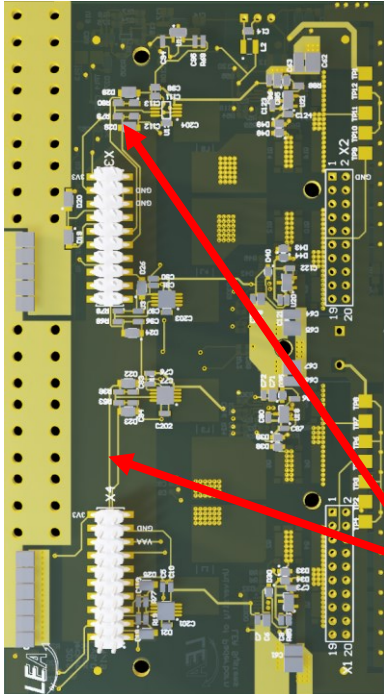
Seite
19



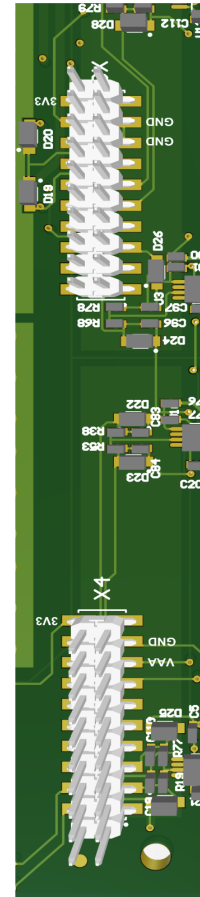
Rückseite
SS-19



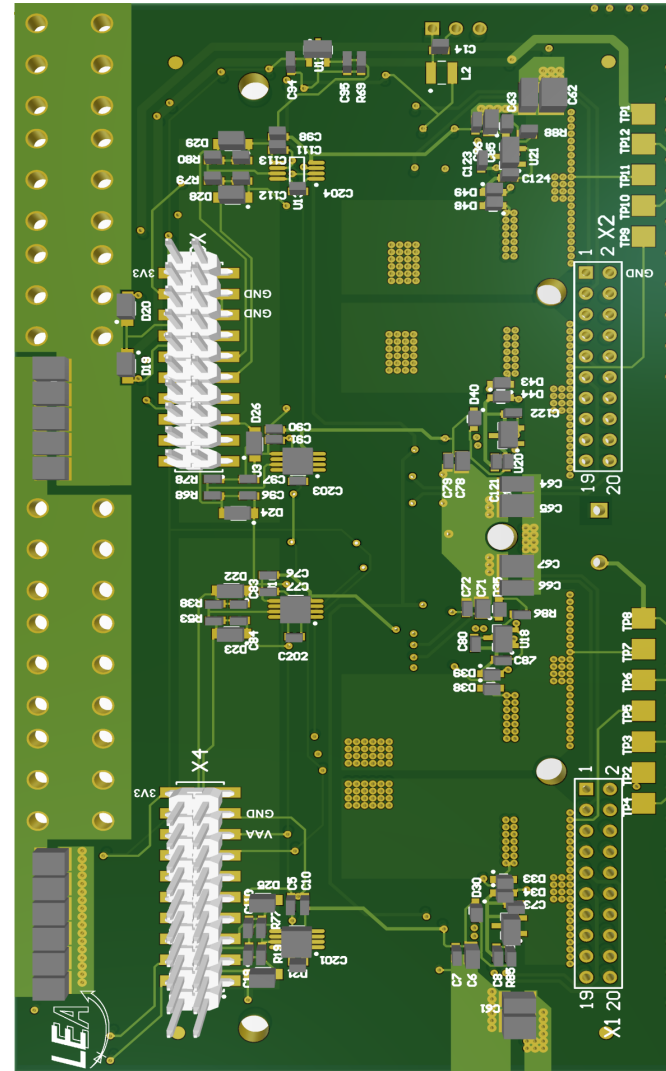
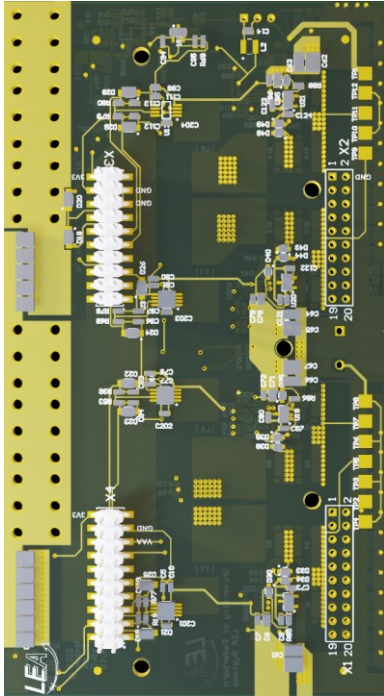
Rückseite
SS-19

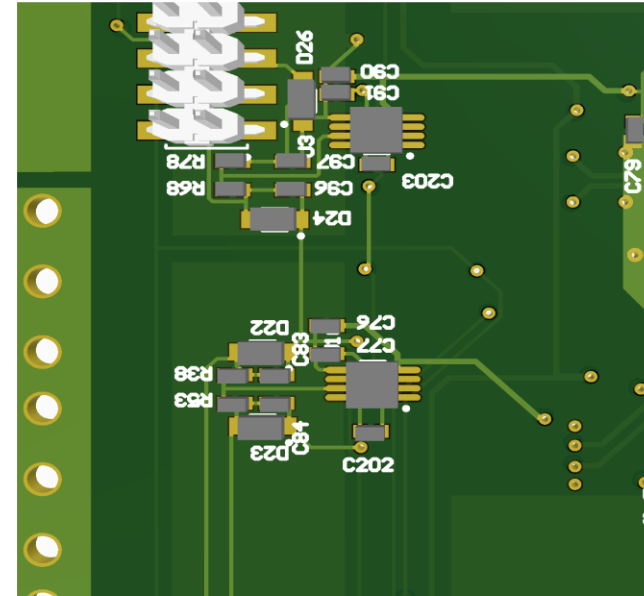
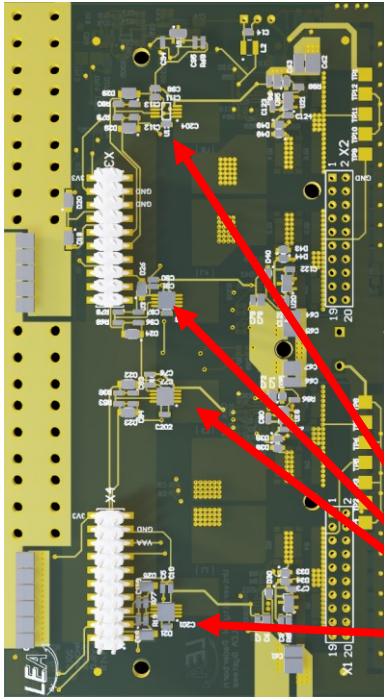


- SMD Steckleisten auf der Rückseite

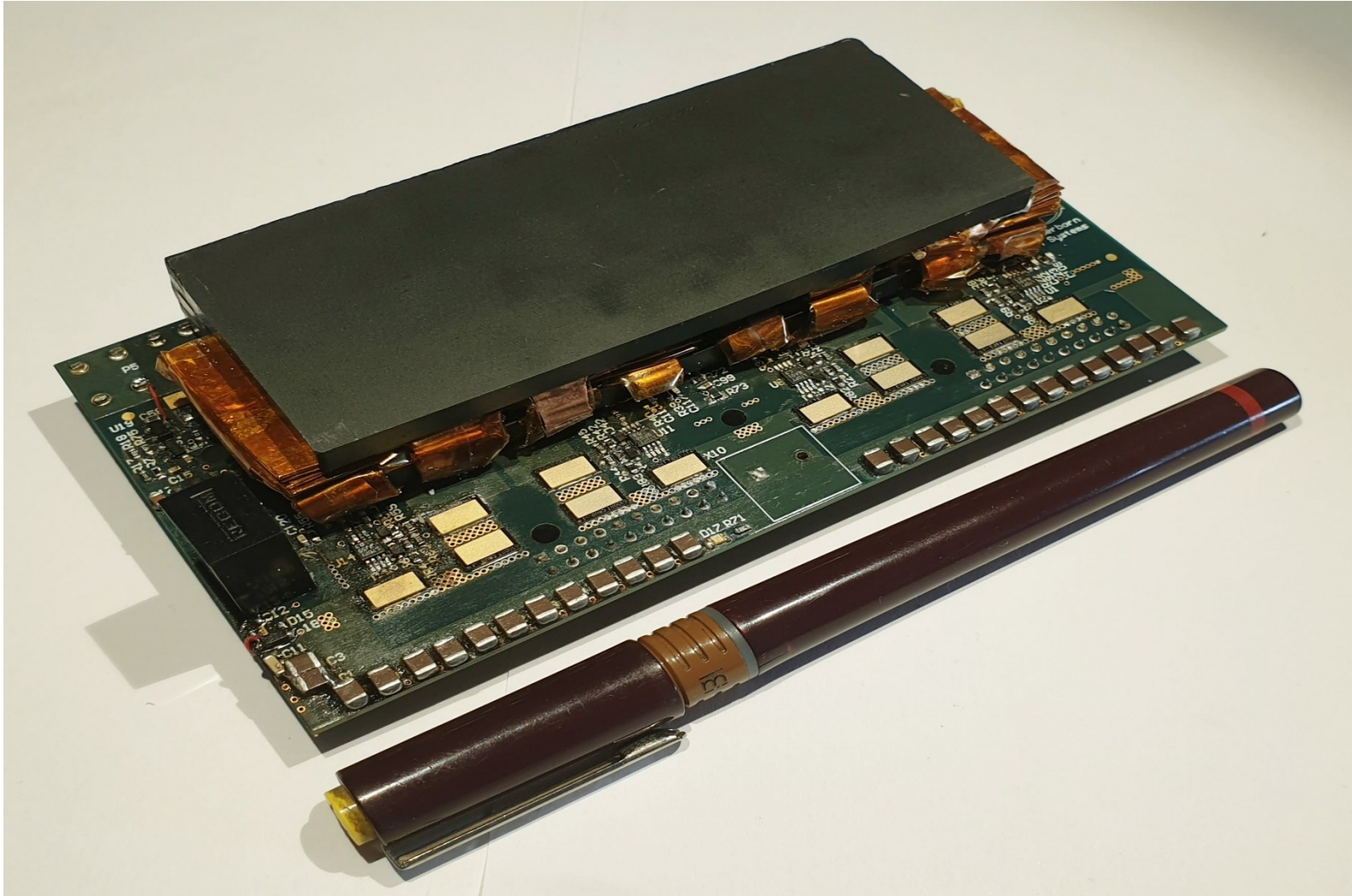


Rückseite
SS-19

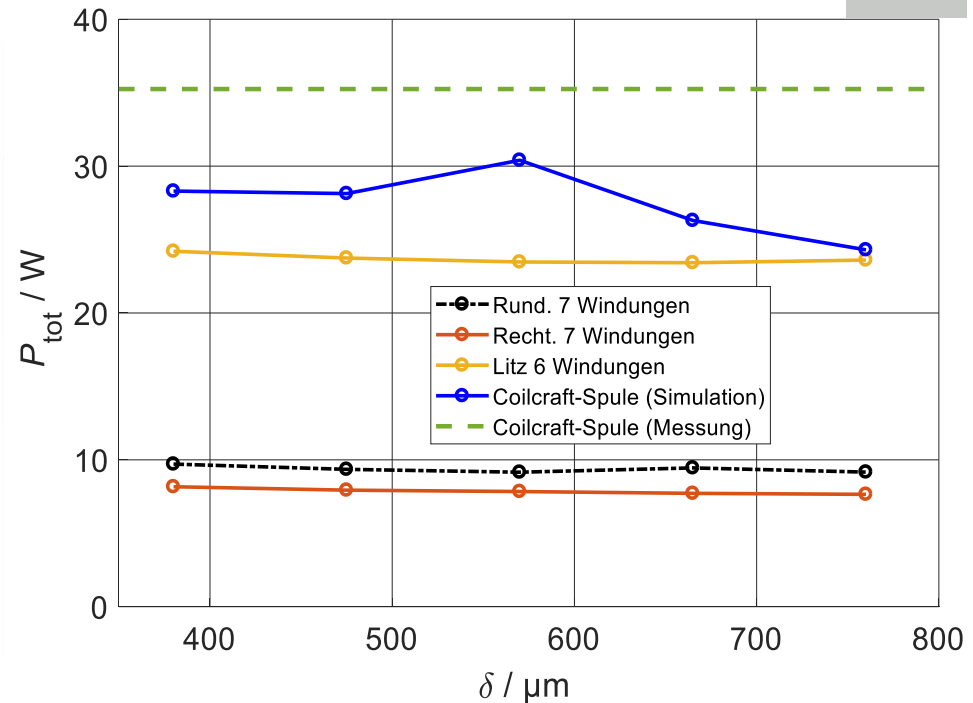
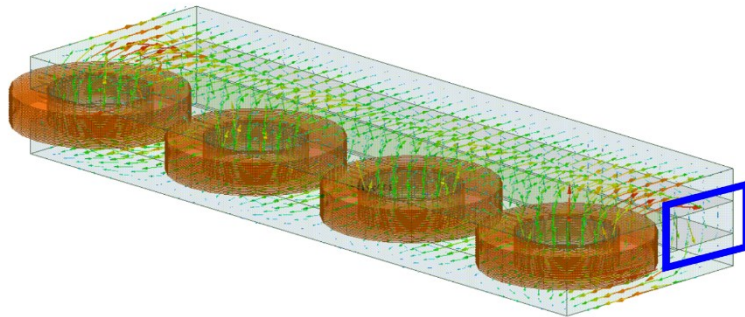




- Strommessung auf der Rückseite



- ▶ Einführung
- ▶ Leiterplatten-Modifikation
- ▶ Neuaufbau der Magnetik
- ▶ Gehäuse-Entwurf
- ▶ Messergebnisse

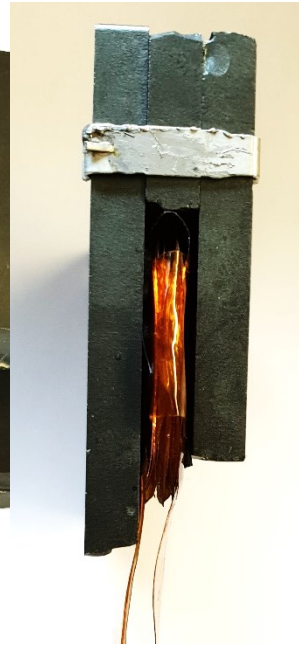
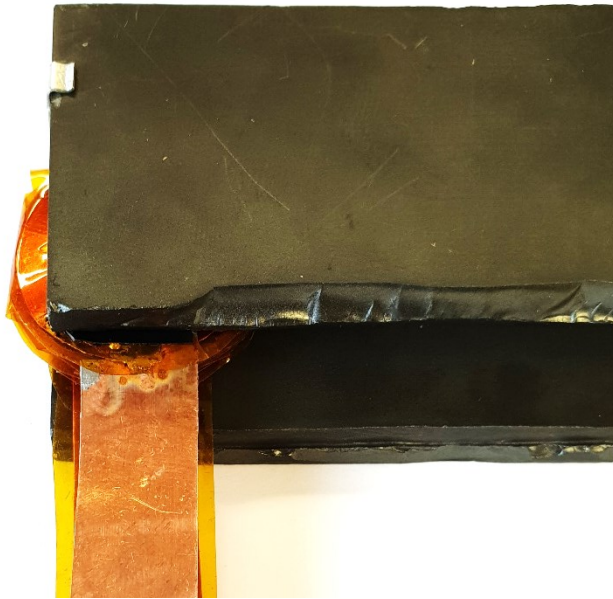


Ausgangspunkt: Simulationen der Vorgruppe WS 18

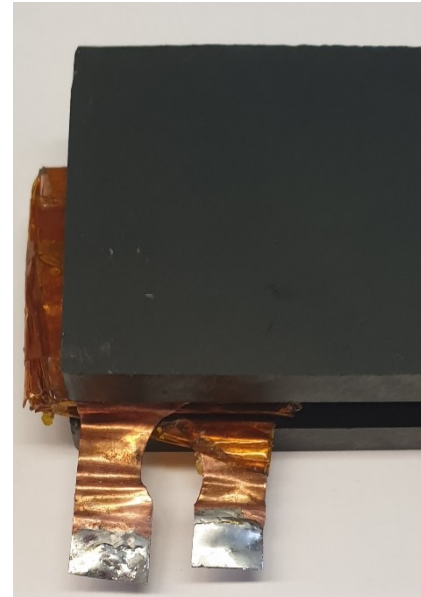
- Rückleiter kann verkleinert werden (blaues Rechteck)
- Außenschenkel können gekürzt werden
- Spulen mit rechteckiger Form verlustärmer

[Fischer u.a 2019]

Ferrit mit Spule
WS 2018



Ferrit mit Spule
SS 2019

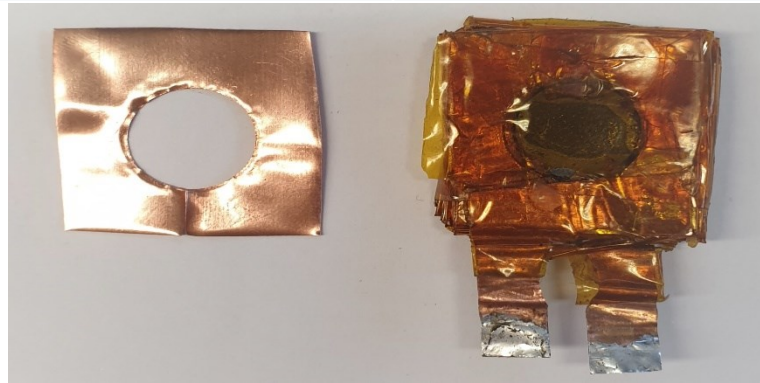


Ausgangspunkt: Simulationen der Vorgruppe WS 18

- Rückleiter kann verkleinert werden (blaues Rechteck)
- Außenschenkel können gekürzt werden
- Spulen mit rechteckiger Form verlustärmer

[Fischer u.a 2019]

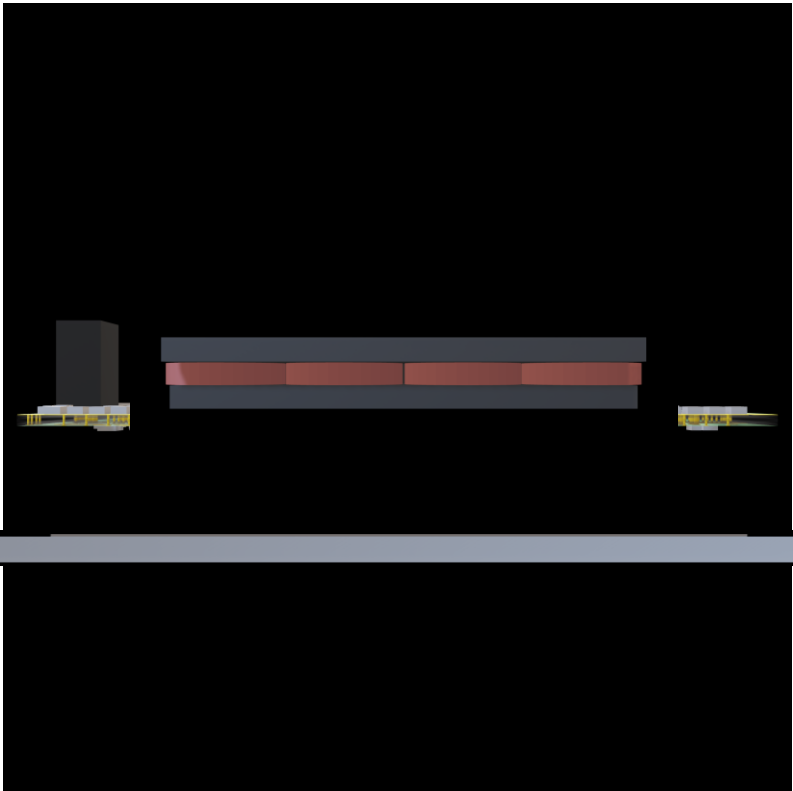
Ferrit Material	N95
Kerndurchmesser	12 mm
Windungsdurchmesser Innen	14 mm
Kantenlänge Außen	28 mm
Kupferstärke der Windungen	400 μm (2 x 200 μm)
Windungen	7
Luftspalt	500 μm



- Isolation zwischen Windungen mit Kaptonfolie

- ▶ Einführung
- ▶ Leiterplatten-Modifikation
- ▶ Neuaufbau der Magnetik
- ▶ Gehäuse-Entwurf
- ▶ Messergebnisse

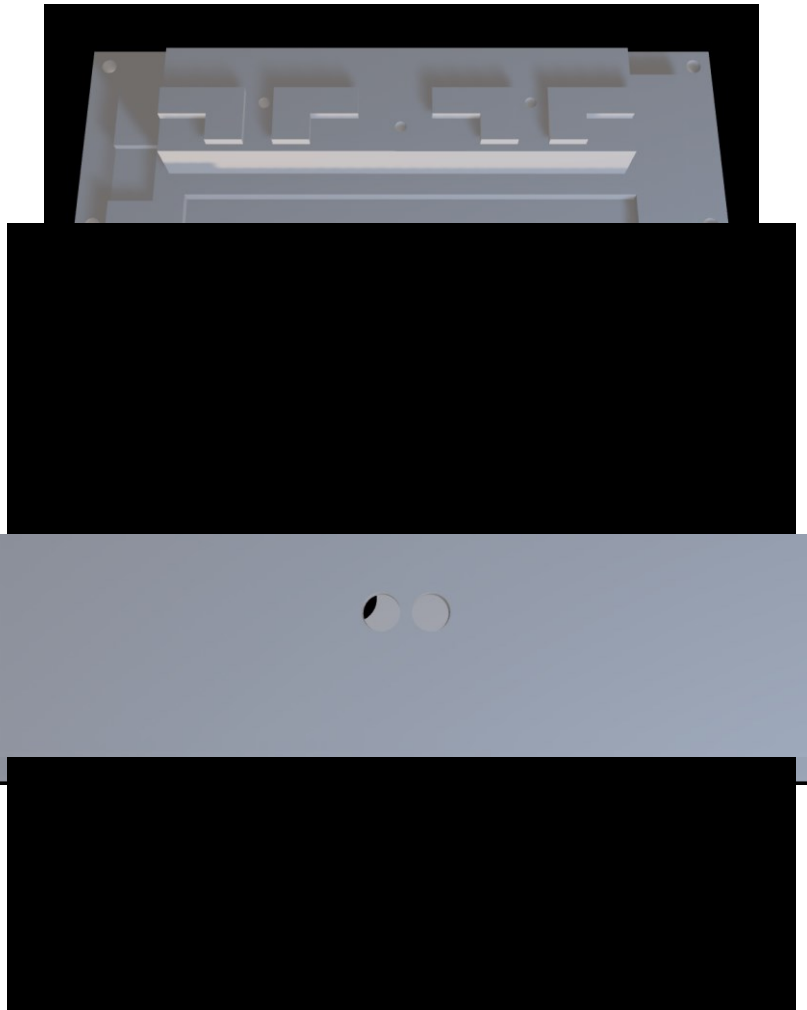
- Entwurf mittels *Solidworks*
- Material: Aluminium
- Volumen: 0,73 dm³
- Bestehend aus 3 Komponenten
 - Unterboden
 - Rahmen
 - Kühlkörper



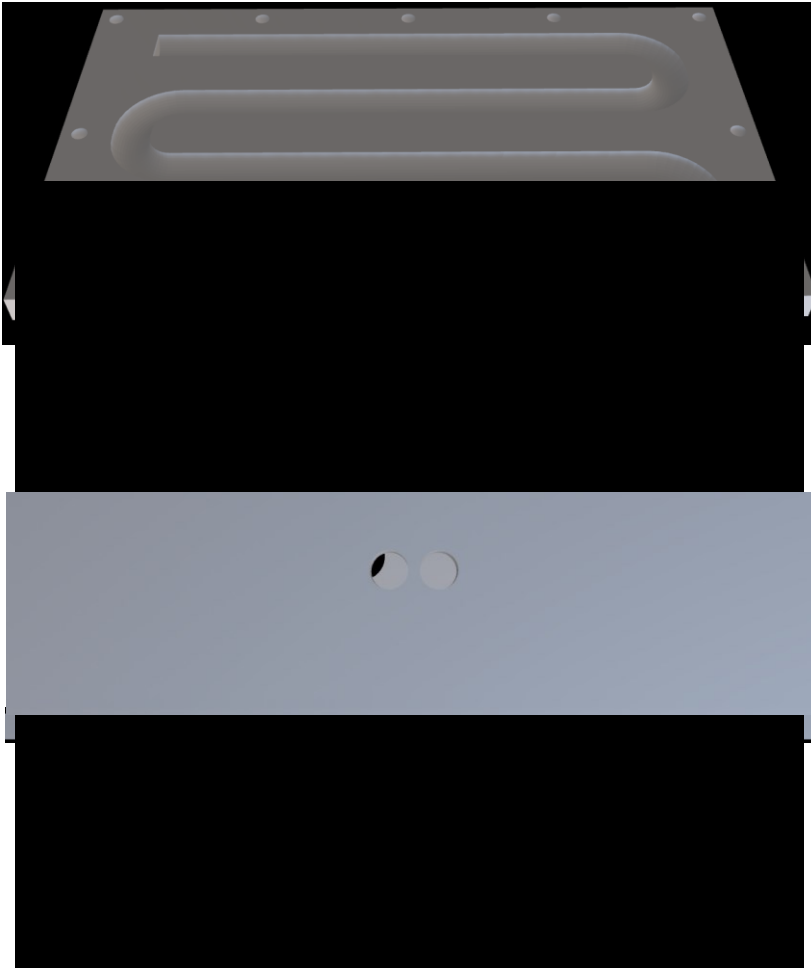
- Entwurf mittels *Solidworks*
- Material: Aluminium
- Volumen: 0,73 dm³
- Bestehend aus 3 Komponenten
 - Unterboden
 - Rahmen
 - Kühlkörper



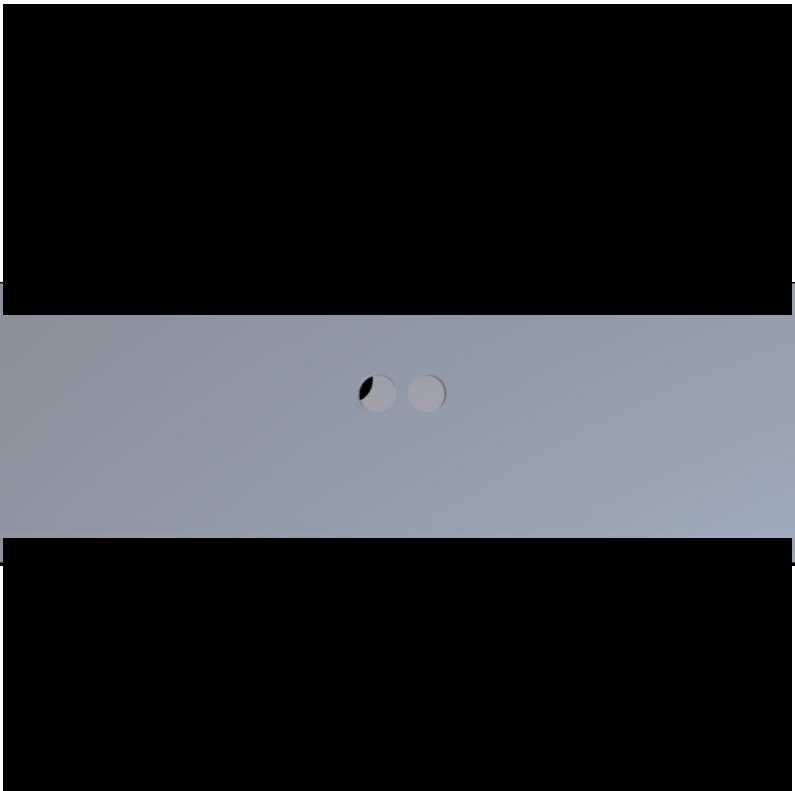
- Entwurf mittels *Solidworks*
- Material: Aluminium
- Volumen: $0,73 \text{ dm}^3$
- Bestehend aus 3 Komponenten
 - Unterboden
 - Rahmen
 - Kühlkörper



- Entwurf mittels *Solidworks*
- Material: Aluminium
- Volumen: $0,73 \text{ dm}^3$
- Bestehend aus 3 Komponenten
 - Unterboden
 - Rahmen
 - Kühlkörper



- Entwurf mittels *Solidworks*
- Material: Aluminium
- Volumen: 0,73 dm³
- Bestehend aus 3 Komponenten
 - Unterboden
 - Rahmen
 - Kühlkörper

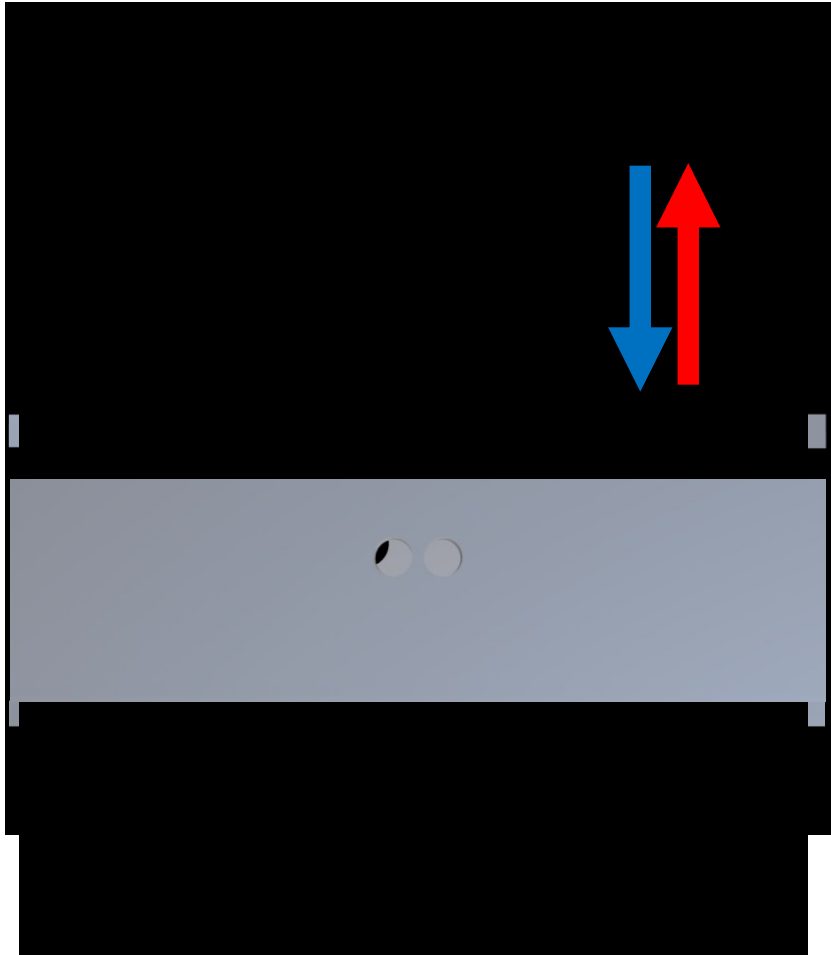




- Entwurf mittels *Solidworks*
- Material: Aluminium
- Volumen: $0,73 \text{ dm}^3$
- Bestehend aus 3 Komponenten
 - Unterboden
 - Rahmen
 - Kühlkörper

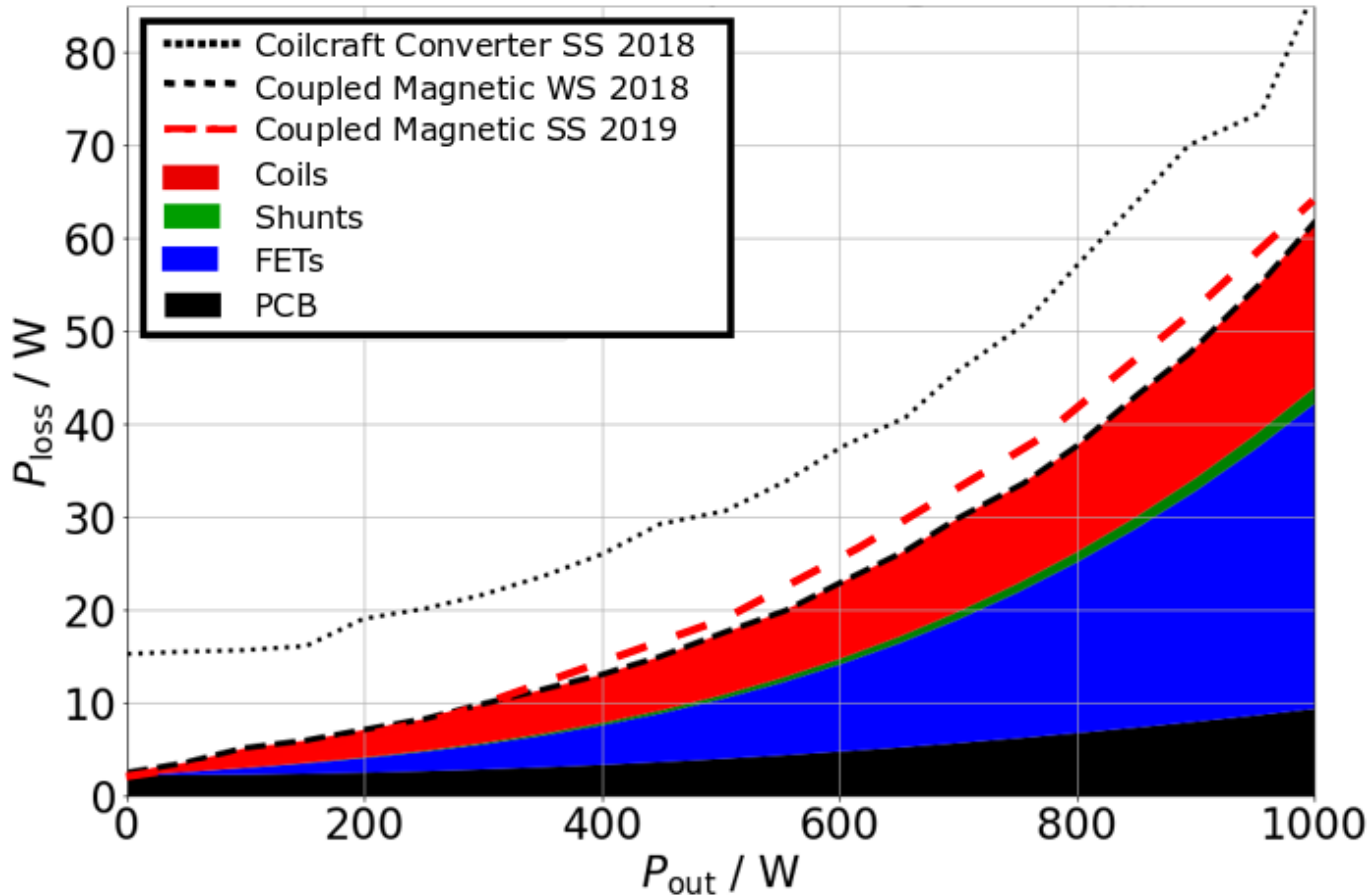
- Entwurf mittels *Solidworks*
- Material: Aluminium
- Volumen: $0,73 \text{ dm}^3$
- Bestehend aus 3 Komponenten
 - Unterboden
 - Rahmen
 - Kühlkörper

mes Kühlmittel





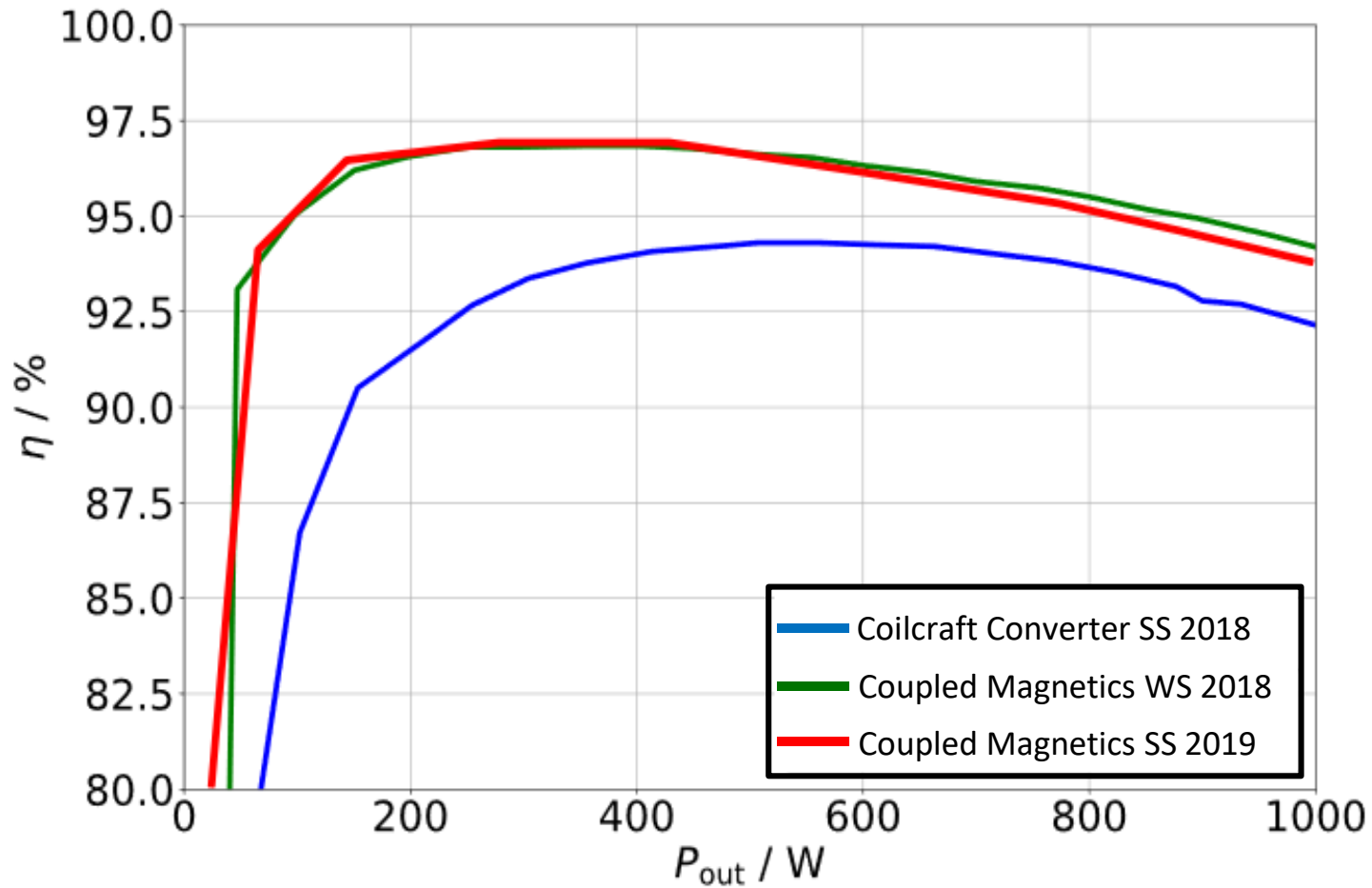
- ▶ Einführung
- ▶ Leiterplatten-Modifikation
- ▶ Neuaufbau der Magnetik
- ▶ Gehäuse-Entwurf
- ▶ Messergebnisse



$f_{sw} = 200 \text{ kHz}$

vgl. [Fischer u.a 2019]

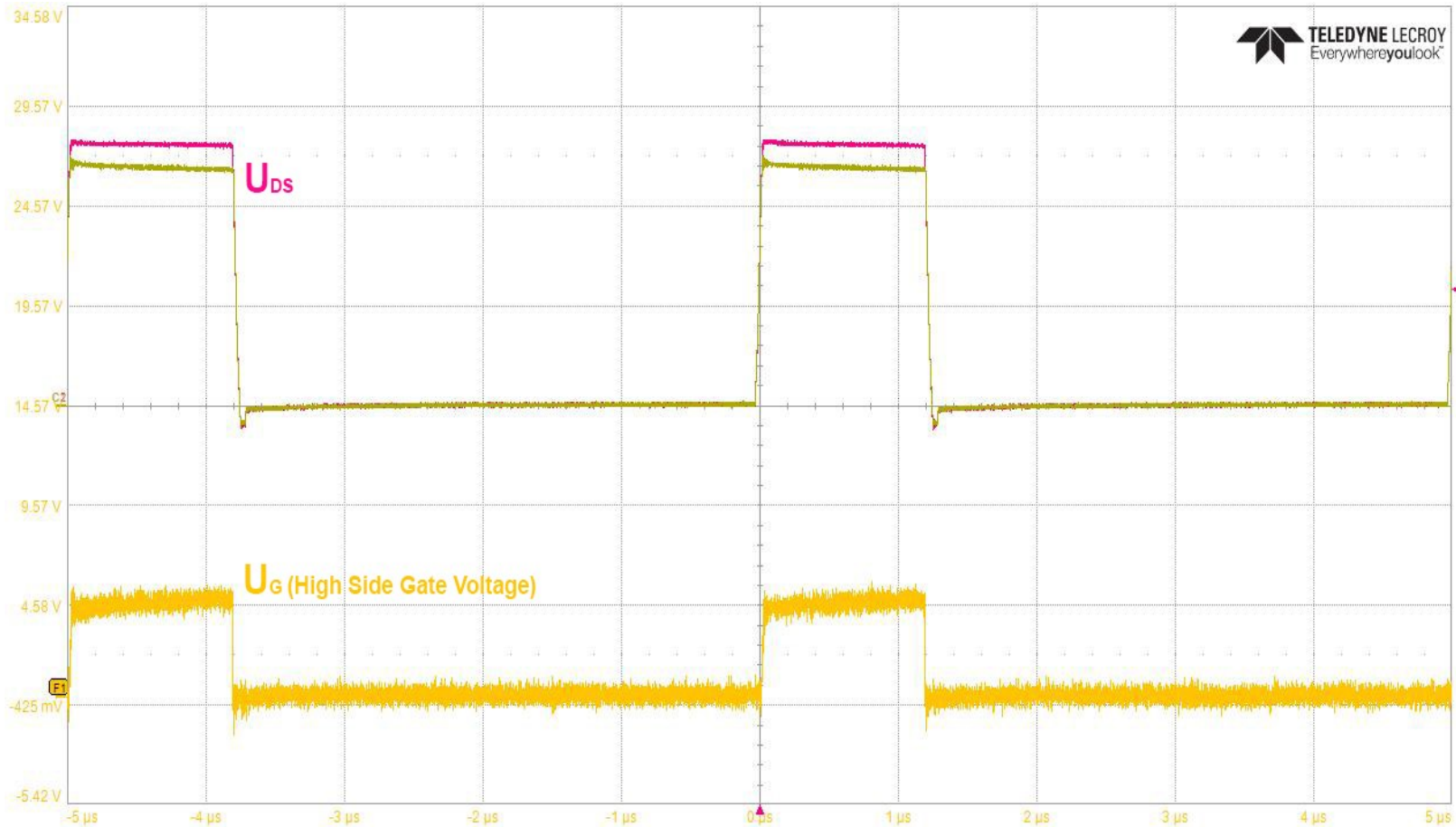
*Approximierung der Verluste ab $I_{out}=72 \text{ A}$
-> $P_{out}=864\text{W}$



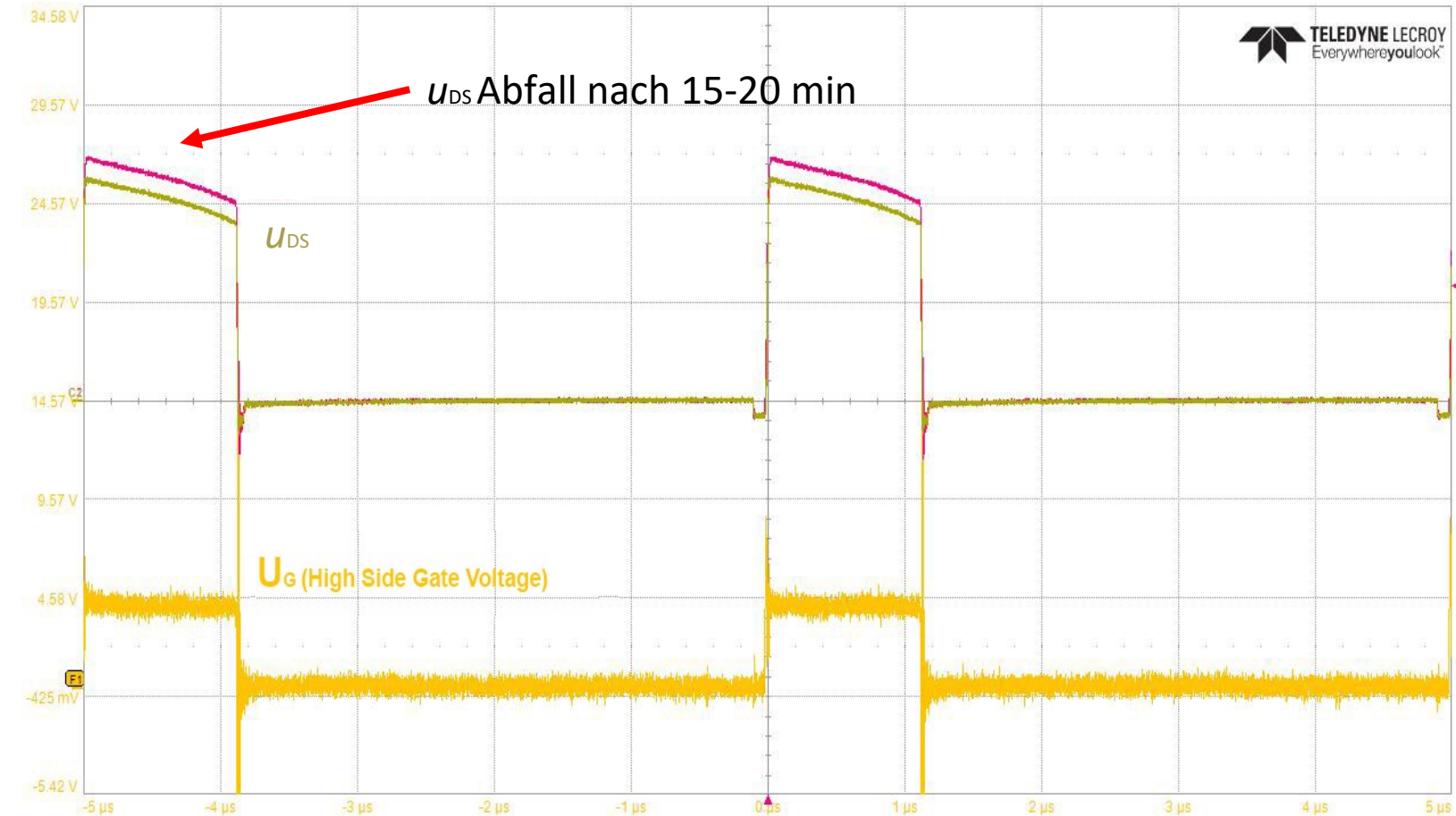
$f_{sw} = 200 \text{ kHz}$

vgl. [Fischer u.a 2019]

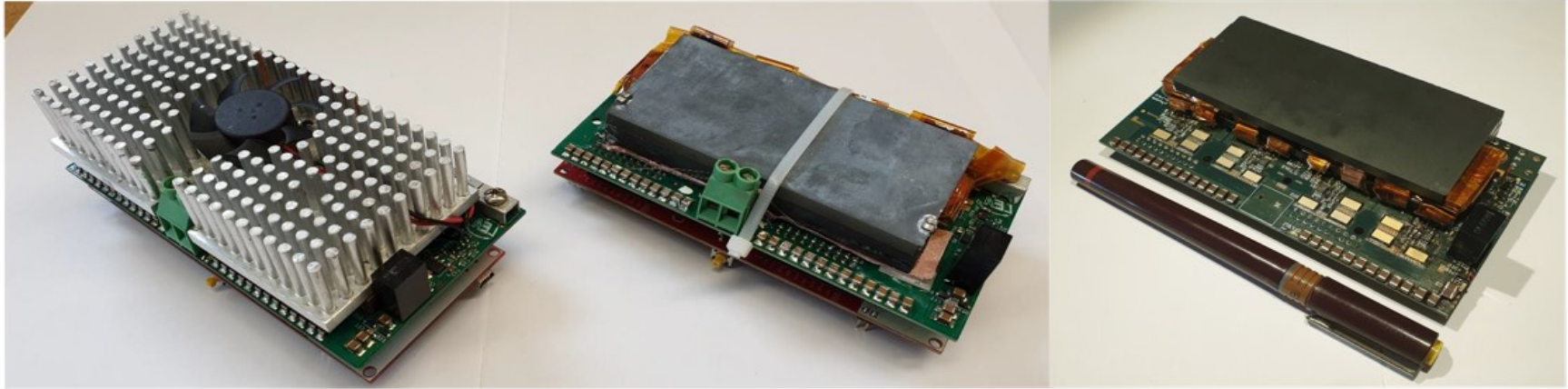
*Approximierung der Effizienz ab $I_{out}=72 \text{ A}$
-> $P_{out}=864\text{W}$



Measure	P1:period(C4)	P2:pkpk(C4)	P3:---	P4:---	P5:---	P6:---	P7:---	P8:---
value	--	15.6 mV						
status	∅	✓						
C1	DC1M	C2	DSQ DC1M	F1	(C2-C1)			
	20.0 V/div		20.0 V/div		5.00 V/div			
	0 mV offset		0 mV offset		1.00 μs/div			
Tbase	0.00 μs	Trigger	C2	DC				
	1.00 μs/div	Auto	23.4 V					
	25 kS	2.5 GS/s	Edge	Positive				



Measure	P1:period(C4)	P2:pkpk(C4)	P3:---	P4:---	P5:---	P6:---	P7:---	P8:---
value	--	16.0 mV						
status	∅	✓						
C1	DC1M	C2	DSQ DC1M	F1	(C2-C1)			
20.0 V/div	20.0 V/div	5.00 V/div						
0 mV offset	0 mV offset	1.00 μs/div						
Tbase	0.00 μs	Trigger	C2	DC				
1.00 μs/div	Auto	23.4 V						
25 kS	2.5 GS/s	Edge	Positive					



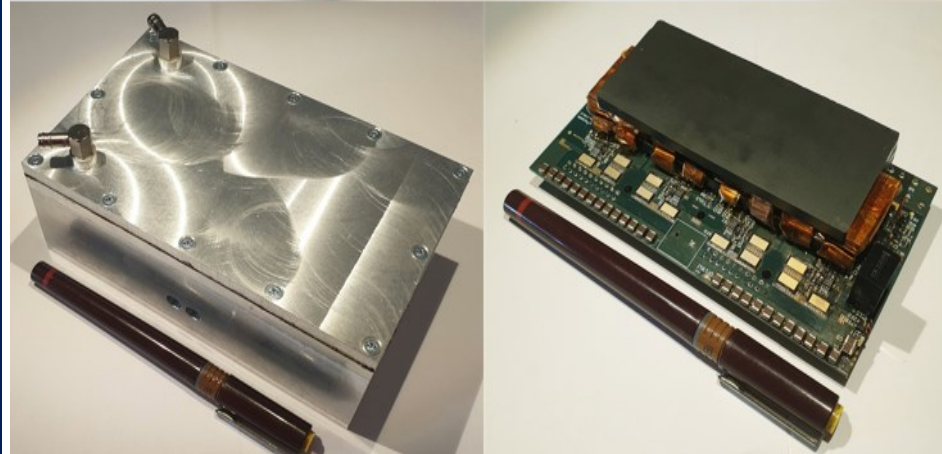
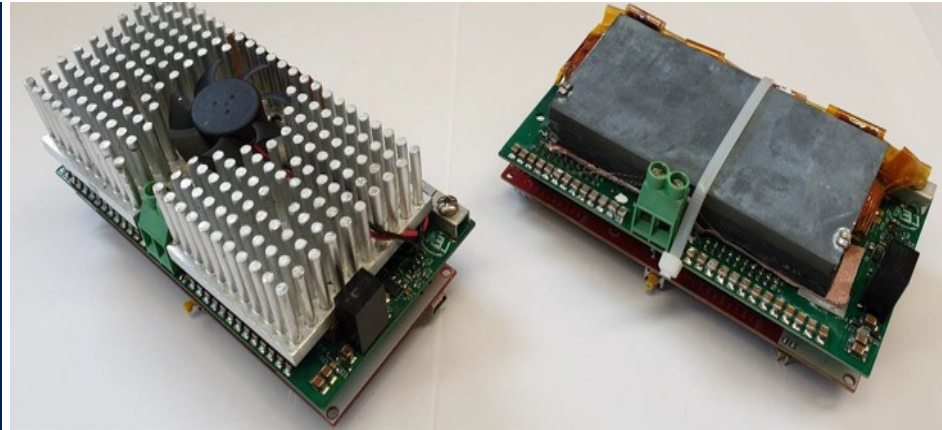
	Coilcraft-Spule	Gekoppelte Magnetik WS18	Gekoppelte Magnetik SS19	Veränderung WS18->SS19
η_{\max}	94,3 %	96,8 %	97 %	+0,2 %
$\eta_{1 \text{ kW}}$	92,2 %	94,2 %	94 %*	-0,2 %*
$P_{\text{loss}, 1 \text{ kW}}$	85 W	62 W	63,28 W*	+1,28 W*

[Fischer u.a 2019]

* approximiert

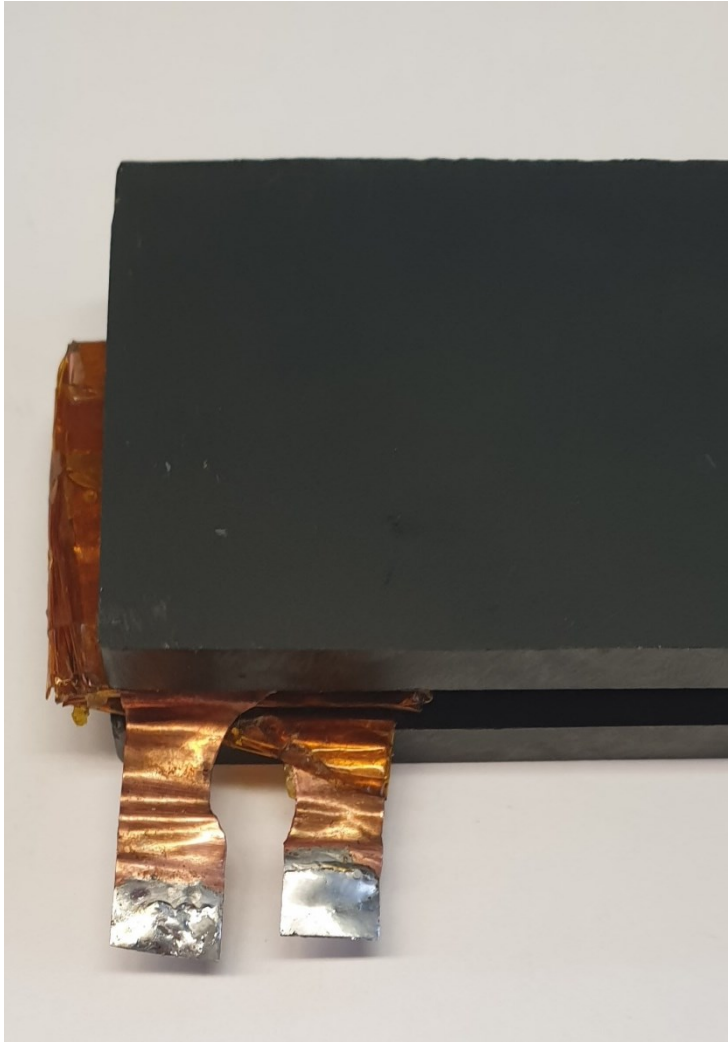


Power Electronics and Electrical Drives
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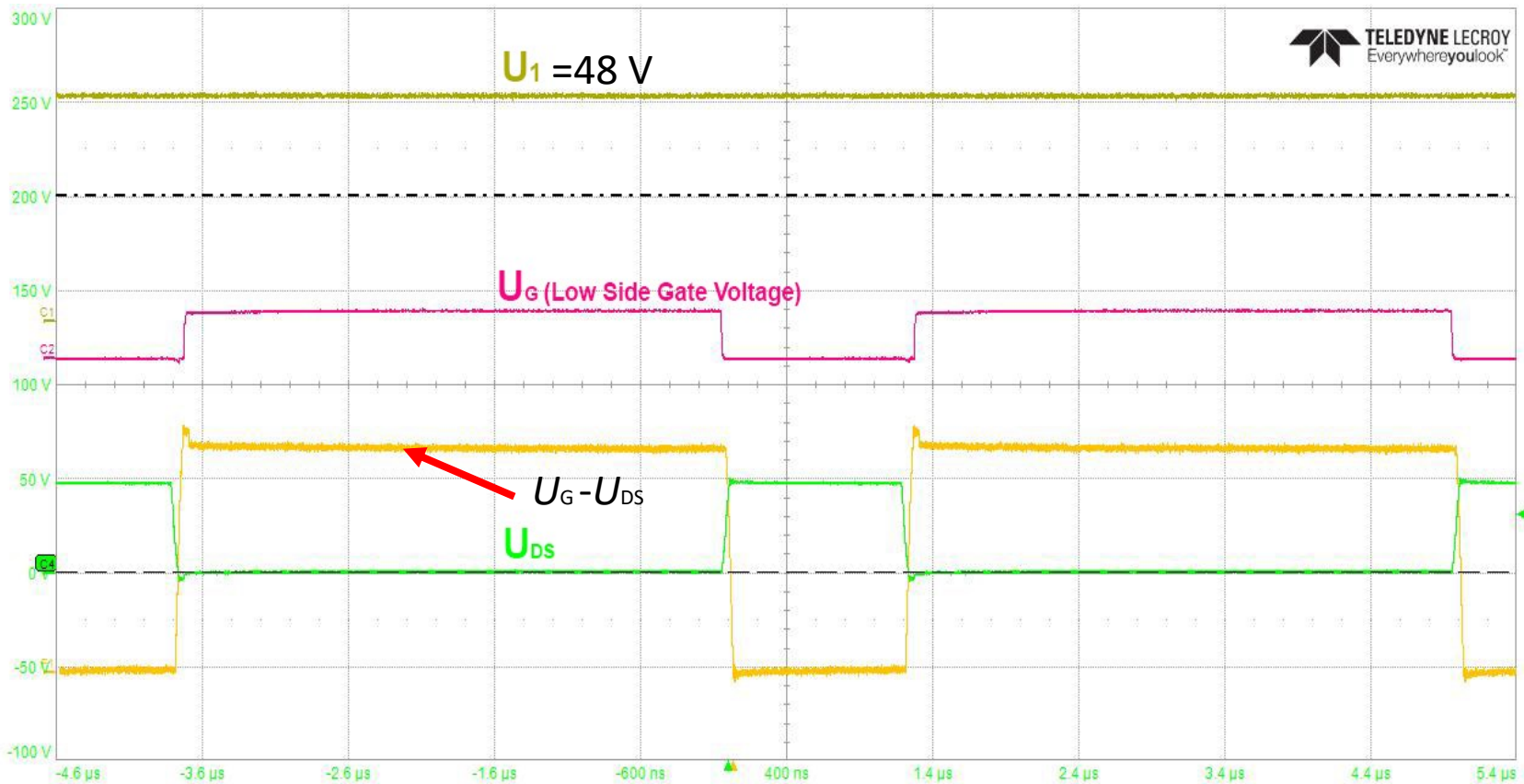
PADERBORN UNIVERSITY
The University for the Information Society

Vielen Dank für Ihre Aufmerksamkeit!



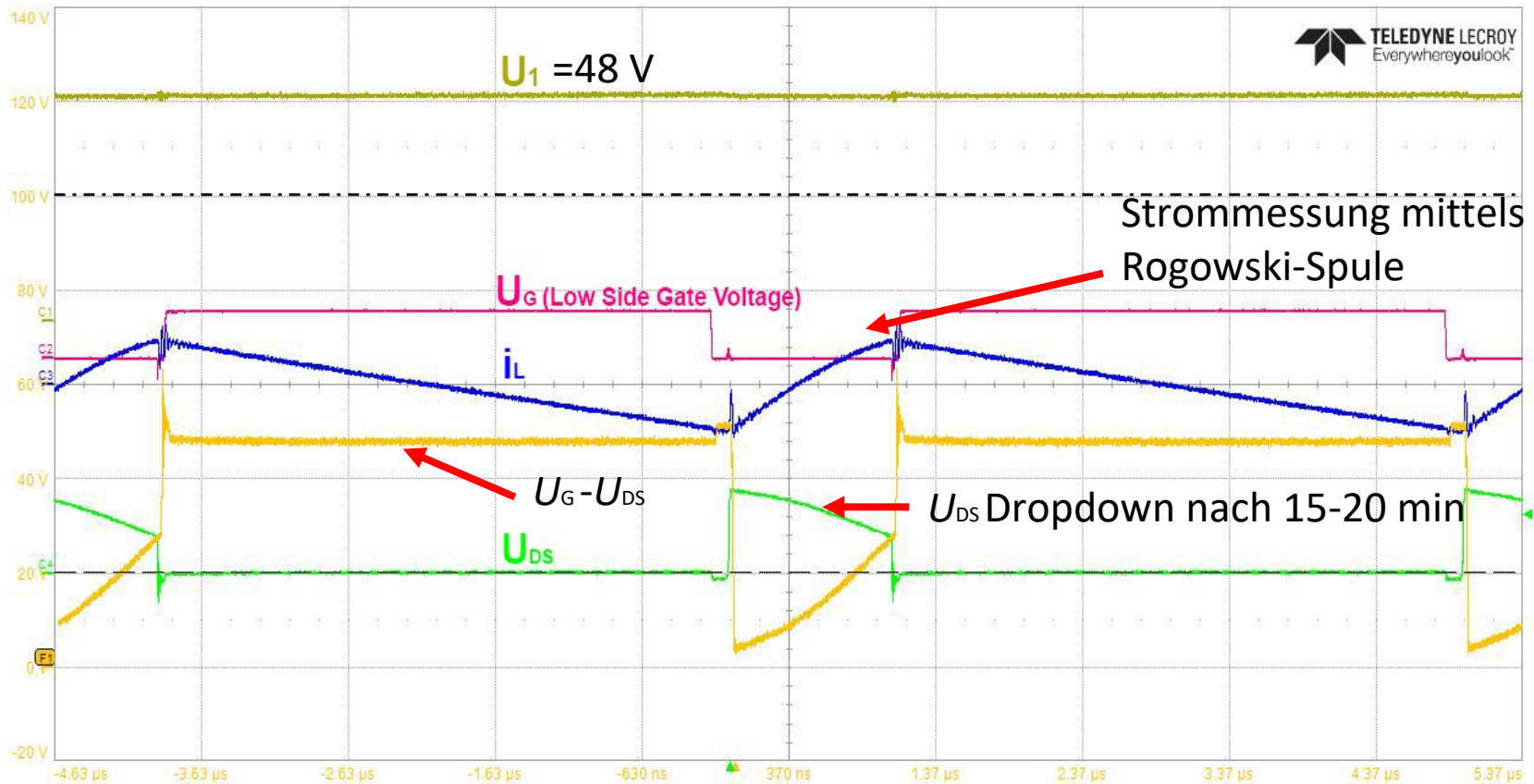
Induktivität 200 kHz [μF]		Widerstand 200 kHz [m Ω]		Widerstand DC [m Ω]	
SS 19	WS 18	SS 19	WS 18	SS 19	WS 18
16,77	16,7	185,4	189	0,96	5,5
16	17,7	116,6	188	0,63	5,7
16,2	15,7	196,9	174	0,91	5,3
15	16,9	106,8	170	0,66	5,2

[Fischer u.a 2019]



Measure	P1:period(C4)	P2:pkpk(C4)	P3:---	P4:---	P5:---	P6:---	P7:---	P8:---
value	5.000155 μ s	54.6 V						
status								
C1	DC1M	C2	DSQ	DC1M	C4	DC1M	F1	(C1-C4)
20.0 V/div	10.0 V/div	50.0 V/div	20.0 V/div					
13.600 V	2.800 V	-100.00 V	1.00 μ s/div					
26.6 V	17.3 V	200.5 V	101.3 V					
53.6 V	22.8 V	0.0 V	21.1 V					
Δy	-80.2 V	Δy	-40.1 V	Δy	-200.5 V	Δy	-80.2 V	

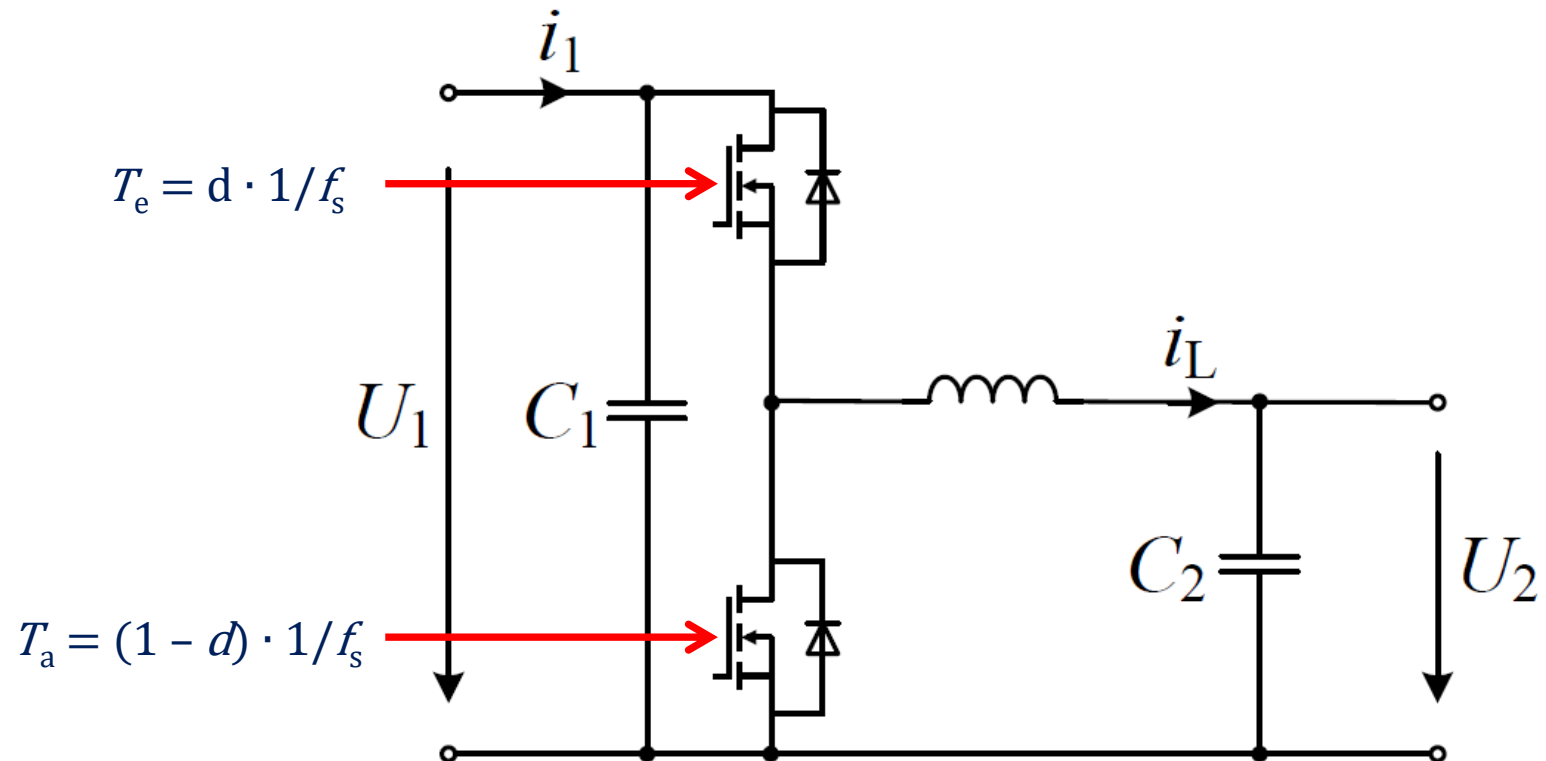
Tbase	-400 ns	Trigger	C4	DC
	1.00 μ s/div	Stop	31.5 V	
	25 kS	2.5 GS/s	Edge	Positive



Measure	P1:period(C4)	P2:pkpk(C4)	P3:---	P4:---	P5:---	P6:---	P7:---	P8:---
value	5.000306 μs	60.2 V						
status	r.							
C1	DC1M	C2 DSQ DC1M	C3 DC1M	C4 DC1M	F1 (C1-C4)			
	20.0 V/div	10.0 V/div	200 mV/div	50.0 V/div	20.0 V/div			
	13.600 V	2.800 V	0.00 mV	-100.00 V	1.00 $\mu\text{s}/\text{div}$			
	26.6 V	17.3 V	402 mV	200.5 V	100.2 V			
	-53.6 V	-22.8 V	-400 mV	0.0 V	20.0 V			
Δy	-80.2 V	-40.1 V	-802 mV	-200.5 V	-80.2 V			

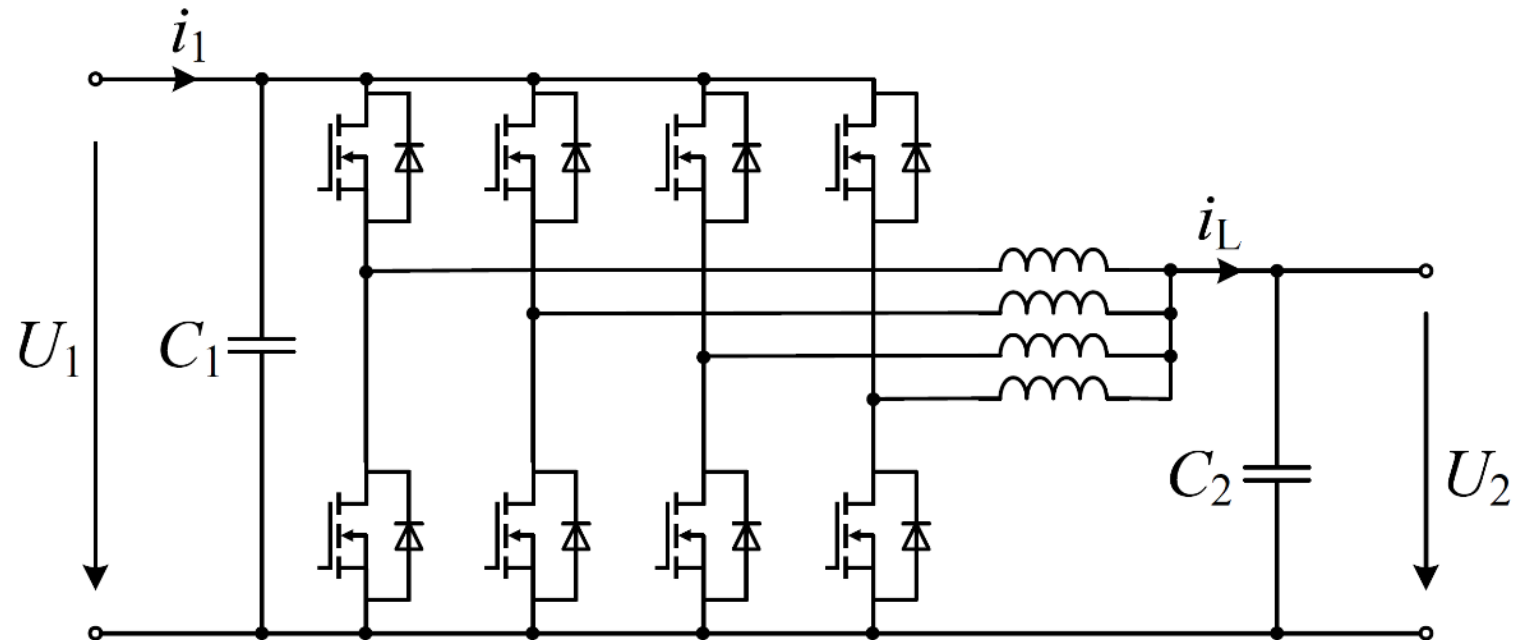
Tbase	-400 ns	Trigger	C4 DC
	1.00 $\mu\text{s}/\text{div}$	Single	31.5 V
	25 kS	2.5 GS/s	Edge Positive

Tiefsetzsteller

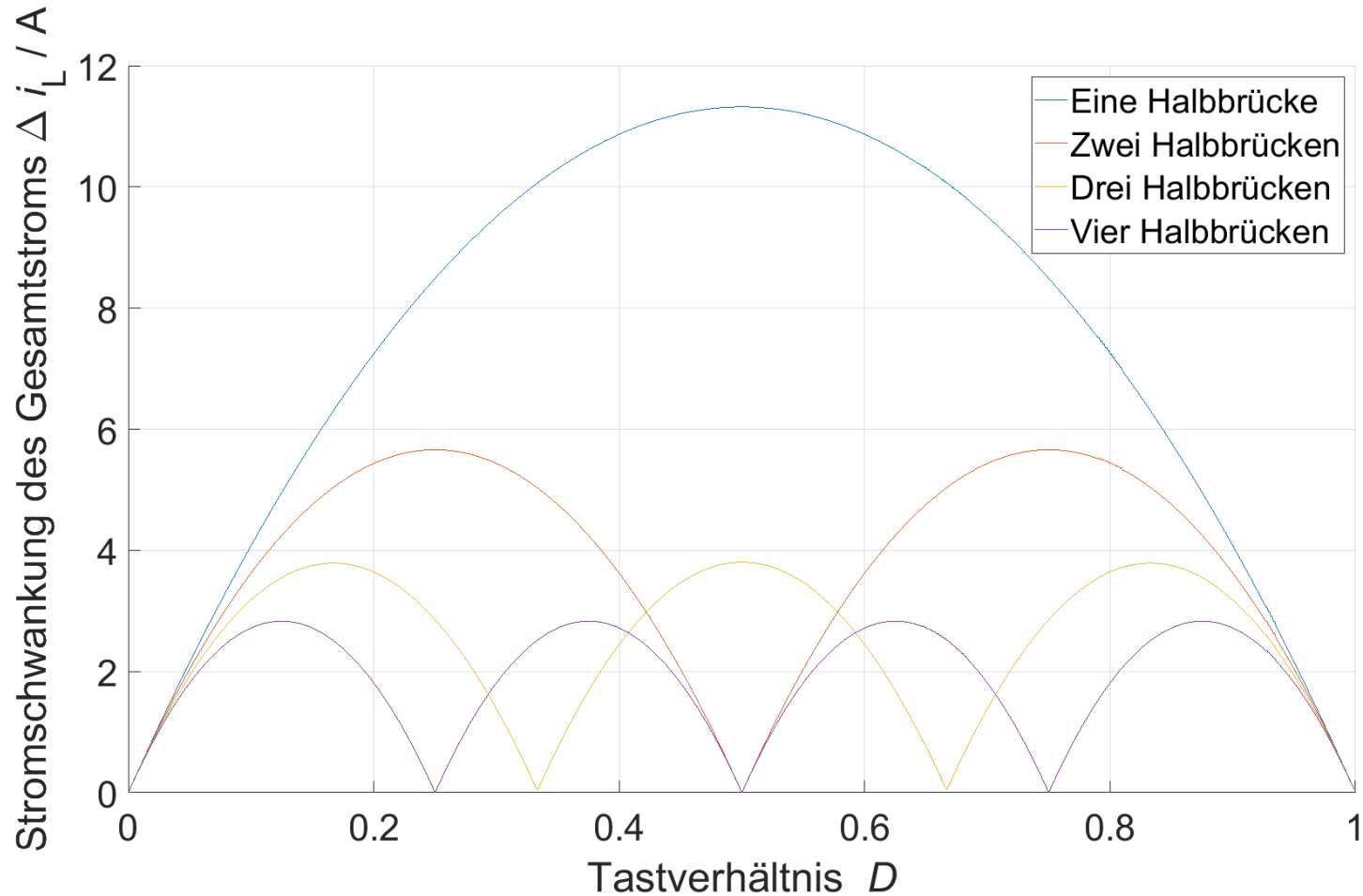


$$d = \frac{U_2}{U_1} = \frac{12 \text{ V}}{48 \text{ V}} = 0,25$$

Schaltungstopologie

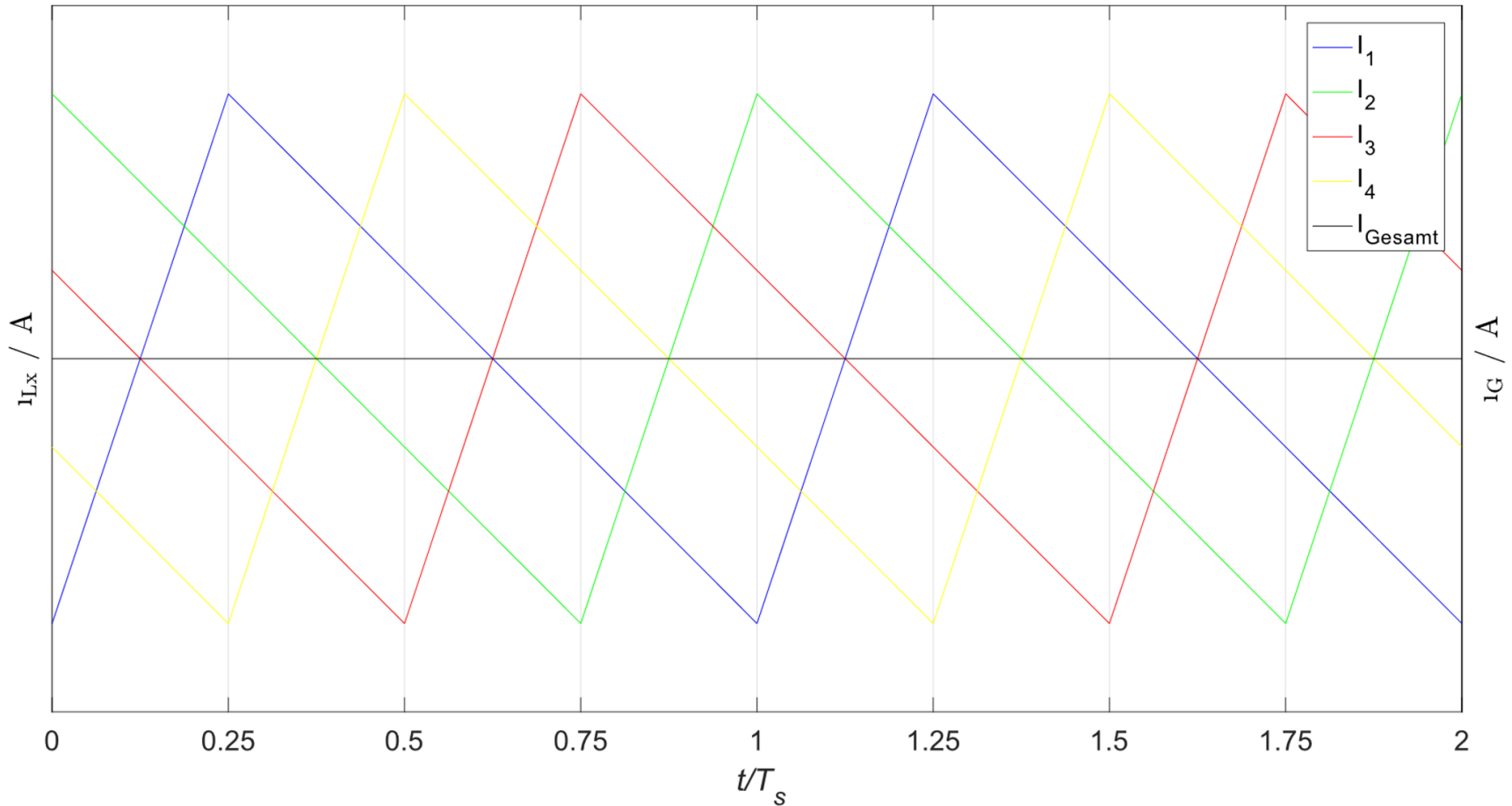


Stromrippel



Stromrippel

Ströme bei vier Zweigen (90° Phasenversetzt)



Stromrippel

