

**HSVA-Bericht Nr. 1660 (K 25-05)**

**PROTIP – Untersuchung zur Entstehung und  
Beseitigung von Propeller Tip Vortex Bursting**

**Teil B : Anhang**

**Schlussbericht  
zum Forschungsvorhaben**

**Förderkennzeichen 03SX148**

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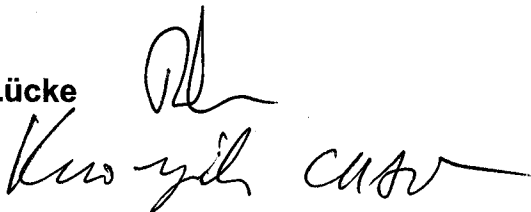
**Förderkennzeichen 03SX148**

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Hamburg, Januar 2006

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**HAMBURGISCHE SCHIFFBAU-  
VERSUCHSANSTALT GmbH**



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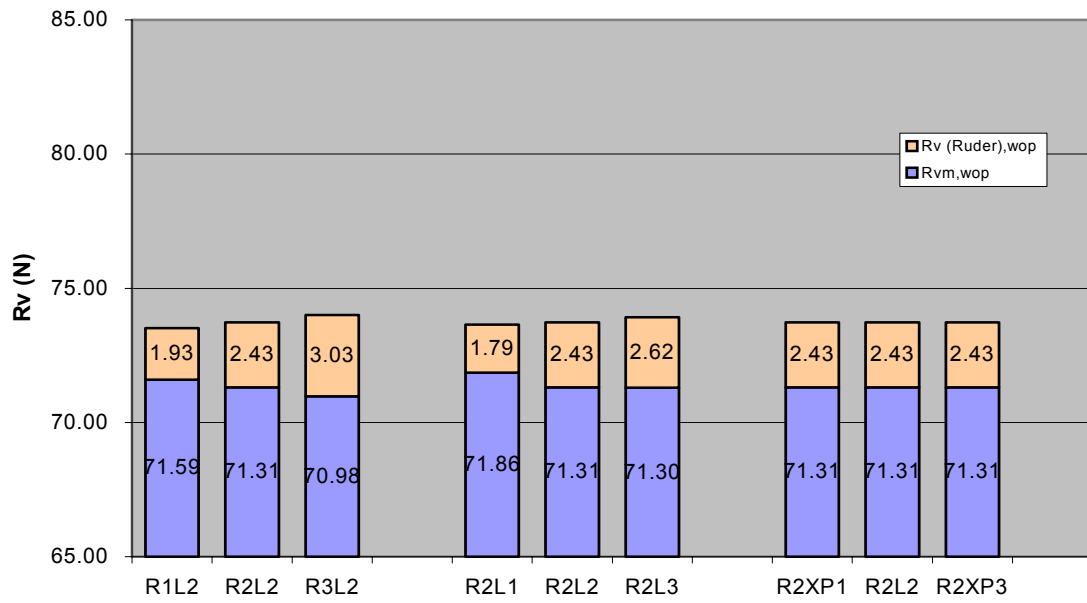
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## **Anhang : CD mit Hochgeschwindigkeits -Videoaufnahmen**

**Table 1: Rv (N) vs. Ruderdicke, Ruderlage bzw. Propellerlage**



**Table 2: Rv,sp (N) vs. Ruderdicke, Ruderlage bzw. Propellerlage**

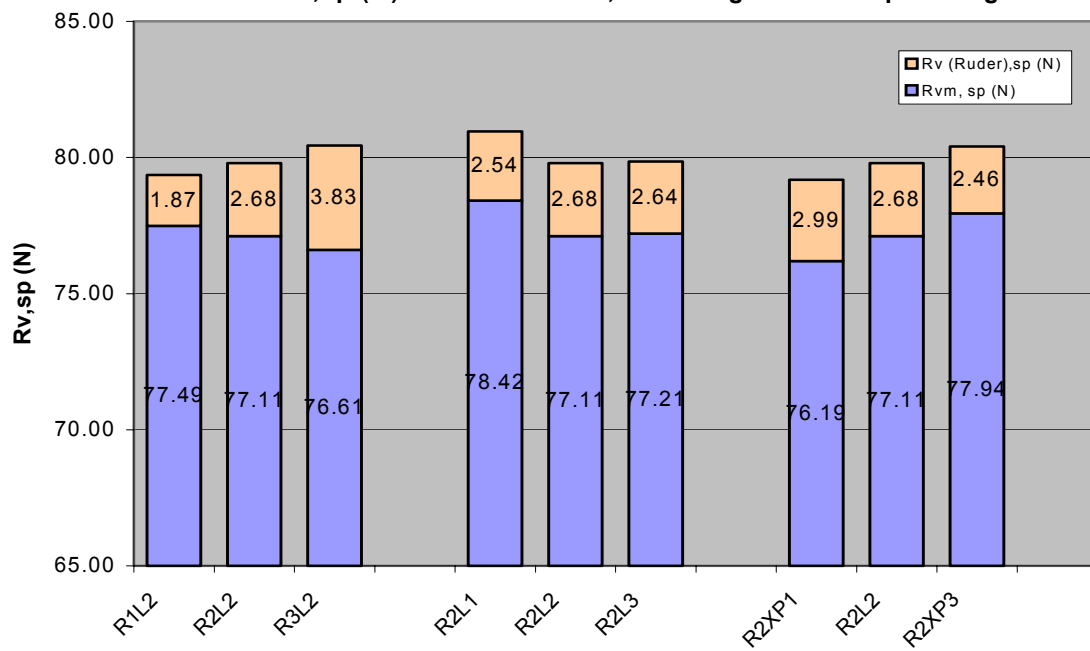
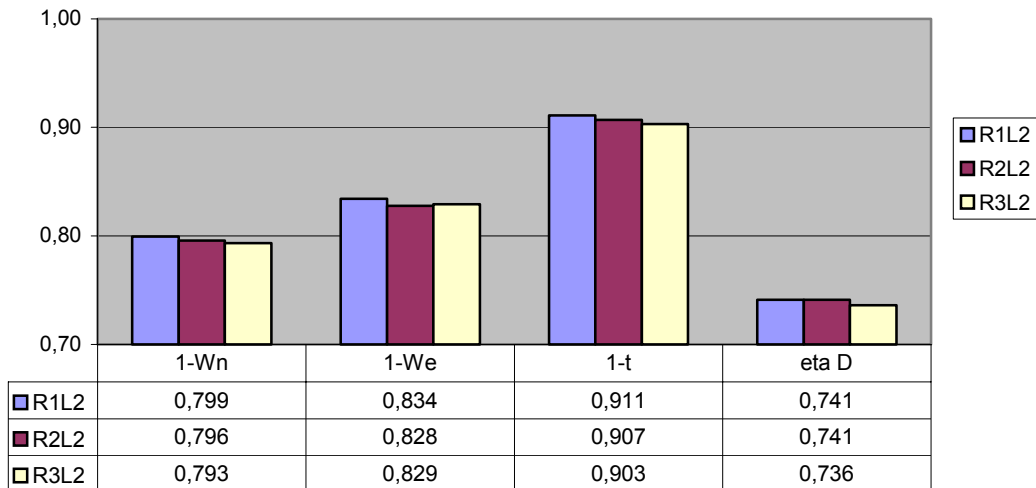
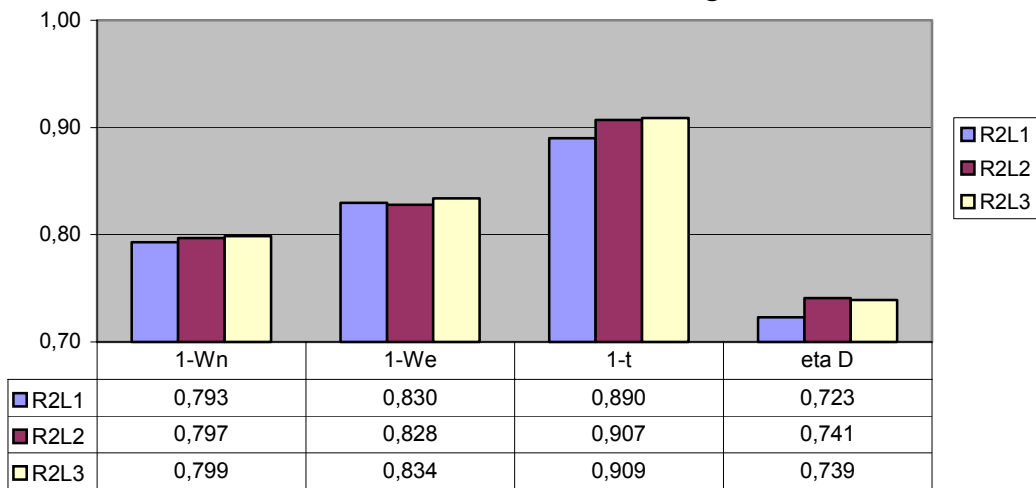


Tabelle 1, 2 : Einfluss der Ruderdicke- Lage und Propellerlage auf den Widerstand

**Table 3: Einfluss der Ruderdicke**



**Table 4: Einfluss der Ruderlage**



**Table 5: Einfluss der Propellerlage**

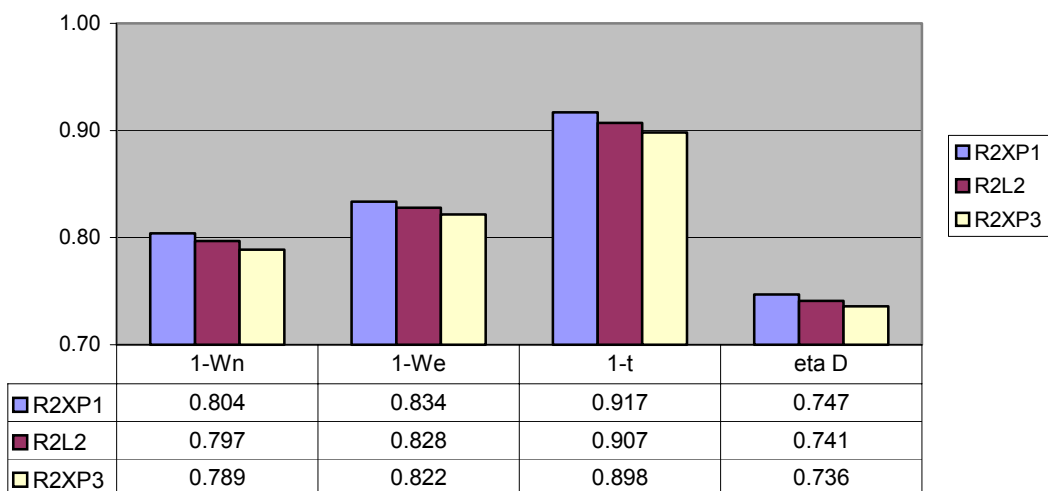


Tabelle 3-5 : Einfluss der Ruderdicke- Lage und der Propellerlage auf die Propulsionsergebnisse



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BMBF  
 Prepared by JR Date 11.05.2005

| Report  
 | WP  
 | Table

Ro-Ro Ship

Propeller 1

Scale 25.68

Test No. 05-287/01-284  
 Test Date 09.05.2005

Draught = 6.950 m  
 Displacement = 19690 m<sup>3</sup>

Model condition: with asymmetric rudder with bulb and headbox  
 ----- rudder positioned 0.6 m aft of station 0  
 propeller spacer diameter 62.0mm x 54.2mm

TRIAL PREDICTION

Head wind 4.344 m/s ^ BF 3

V [KTS]	FN [-]	RT [KN]	T [KN]	PE [KW]	PD [KW]	ETAD [-]	N [RPM]
20.00	.2323	765	899	7873	10902	.722	103.1
20.50	.2381	808	953	8521	11861	.718	105.9
21.00	.2439	853	1008	9217	12868	.716	108.7
21.50	.2498	901	1064	9968	13914	.716	111.5
22.00	.2556	952	1120	10780	15006	.718	114.3
22.50	.2614	1008	1181	11665	16206	.720	117.2
23.00	.2672	1068	1248	12632	17555	.720	120.2
23.50	.2730	1131	1328	13679	19175	.713	123.5
24.00	.2788	1200	1428	14810	21196	.699	127.3

Conversion with

-----  
 DRT, related to RF ... = 3.0 %      RHO air.... = 1.2255 kg/m<sup>3</sup>  
 AV ..... = 790 m<sup>2</sup>      CAA ..... = .85

TRIAL CONDITIONS: Clean smooth hull, deep calm water,  
 ----- no current

Tabelle 6 : Propulsionsergebnisse, Prop1

Hamburgische |  
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 Anstalt GmbH |

BMBF  
 Prepared by JR Date 11.05.2005

| Report  
 | WP  
 | Table

Ro-Ro Ship

Propeller 1

Scale 25.68

Test No. 05-287/01-284  
 Test Date 09.05.2005

Draught = 6.950 m  
 Displacement = 19690 m3

Model condition: with asymmetric rudder with bulb and headbox  
 ----- rudder positioned 0.6 m aft of station 0  
 propeller spacer diameter 62.0mm x 54.2mm

HULL EFFICIENCY ELEMENTS  
 -----

Trial conditions, Head wind 4.344 m/s ^ BF 3

V [KTS]	FN [-]	ADVC [-]	THDF [-]	WFT [-]	ETAH [-]	ETAO [-]	ETAR [-]	ETAD [-]	CTH [-]
20.00	.2323	.832	.149	.153	1.005	.696	1.032	.722	.789
20.50	.2381	.830	.152	.153	1.000	.695	1.033	.718	.796
21.00	.2439	.828	.154	.152	.998	.694	1.033	.716	.802
21.50	.2498	.827	.153	.152	.999	.694	1.034	.716	.807
22.00	.2556	.826	.150	.152	1.002	.693	1.034	.718	.811
22.50	.2614	.825	.147	.151	1.005	.692	1.034	.720	.817
23.00	.2672	.823	.145	.150	1.007	.691	1.034	.720	.824
23.50	.2730	.819	.148	.149	1.001	.690	1.033	.713	.837
24.00	.2788	.813	.160	.148	.986	.687	1.033	.699	.860

REMARK: The coefficients are valid for identity of KT.  
 -----

Corrections: (1-WFTS)/(1-WFTM) = 1.050  
 -----

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 Anstalt GmbH |

BMBF  
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| Report  
 | WP  
 | Table  
 |

Ro-Ro Ship

Propeller 2

Scale 25.68

Test No. 05-288/01-284  
 Test Date 09.05.2005

Draught = 6.950 m  
 Displacement = 19690 m3

Model condition: with asymmetric rudder with bulb and headbox  
 ----- rudder located 0.6 m aft of station 0  
 shaft spacer diameter 62mm x 54.2mm  
 propeller cap 27.8 mm

TRIAL PREDICTION

-----  
 Head wind 4.344 m/s ^ BF 3

V	FN	RT	T	PE	PD	ETAD	N
[KTS]	[-]	[KN]	[KN]	[KW]	[KW]	[-]	[RPM]
20.00	.2323	765	889	7873	10736	.733	103.1
20.50	.2381	808	940	8521	11648	.732	105.9
21.00	.2439	853	994	9217	12618	.730	108.7
21.50	.2498	901	1050	9968	13646	.730	111.5
22.00	.2556	952	1108	10780	14732	.732	114.3
22.50	.2614	1008	1167	11665	15883	.734	117.1
23.00	.2672	1068	1229	12632	17112	.738	119.9
23.50	.2730	1131	1302	13679	18573	.736	123.1
24.00	.2788	1200	1394	14810	20408	.726	126.7

Conversion with

-----  
 DRT, related to RF ... = 3.0 %      RHO air.... = 1.2255 kg/m3  
 AV ..... = 790 m2      CAA ..... = .85

TRIAL CONDITIONS: Clean smooth hull, deep calm water,  
 ----- no current

Tabelle 8 : Propulsionsergebnisse, Prop1

Hamburgische		BMBF		Report
Schiffbau-				WP
Versuchs-		Prepared by JR		Table
22		Date 11.05.2005		
Anstalt GmbH				

Ro-Ro Ship

Propeller 2

Scale 25.68

Test No. 05-288/01-284

Draught = 6.950 m

Test Date 09.05.2005

Displacement = 19690 m<sup>3</sup>

Model condition: with asymmetric rudder with bulb and headbox  
 -----  
 rudder located 0.6 m aft of station 0  
 shaft spacer diameter 62mm x 54.2mm  
 propeller cap 27.8 mm

HULL EFFICIENCY ELEMENTS

-----  
 Trial conditions, Head wind 4.344 m/s ^ BF 3

V	FN	ADVC	THDF	WFT	ETAH	ETAO	ETAR	ETAD	CTH
[KTS]	[-]	[-]	[-]	[-]	[-]	[-]	[-]	[-]	[-]
20.00	.2323	.829	.139	.156	1.019	.695	1.036	.733	.786
20.50	.2381	.827	.141	.155	1.017	.694	1.036	.732	.790
21.00	.2439	.826	.142	.155	1.016	.694	1.037	.730	.796
21.50	.2498	.824	.142	.155	1.016	.693	1.038	.730	.803
22.00	.2556	.822	.140	.156	1.018	.692	1.038	.732	.810
22.50	.2614	.820	.137	.156	1.023	.691	1.039	.734	.816
23.00	.2672	.819	.131	.156	1.029	.690	1.039	.738	.822
23.50	.2730	.816	.131	.155	1.029	.689	1.039	.736	.833
24.00	.2788	.811	.139	.154	1.017	.687	1.039	.726	.851

REMARK: The coefficients are valid for identity of KT.  
-----

Corrections: (1-WFTS)/(1-WFTM) = 1.051

Tabelle 9 : Propulsionsergebnisse, Prop2

Hamburgische Schiffbau-Versuchs- 32 Anstalt GmbH	BMBF Prepared by JR Date 11.05.2005	Report WP Table
--	--	-----------------------

Ro-Ro Ship

Propeller 3

Scale 25.68

Test No. 05-289/01-284  
Test Date 09.05.2005

Draught = 6.950 m  
Displacement = 19690 m<sup>3</sup>

Model condition: with asymmetric rudder with bulb and headbox  
-----  
rudder located 0.6 m aft of station 0  
shaft spacer diameter 62mm x 54.2mm  
propeller cap 27.8 mm

TRIAL PREDICTION  
-----

Head wind 4.344 m/s ^ BF 3

V [KTS]	FN [-]	RT [KN]	T [KN]	PE [KW]	PD [KW]	ETAD [-]	N [RPM]
20.00	.2323	765	883	7873	10604	.742	102.8
20.50	.2381	808	933	8521	11506	.741	105.6
21.00	.2439	853	986	9217	12467	.739	108.3
21.50	.2498	901	1042	9968	13482	.739	111.1
22.00	.2556	952	1100	10780	14572	.740	113.9
22.50	.2614	1008	1164	11665	15809	.738	117.0
23.00	.2672	1068	1232	12632	17162	.736	120.0
23.50	.2730	1131	1305	13679	18636	.734	123.2
24.00	.2788	1200	1394	14810	20390	.726	126.8

Conversion with

-----

DRT, related to RF ... =	3.0 %	RHO air.... =	1.2255 kg/m3
AV .....	= 790 m2	CAA .....	= .85

TRIAL CONDITIONS: Clean smooth hull, deep calm water,  
----- no current

Tabelle 10 : Propulsionsergebnisse, Prop3

Hamburgische |  
 Schiffbau- |  
 Versuchs- |  
 33  
 Anstalt GmbH |

BMBF  
 Prepared by JR Date 11.05.2005

| Report  
 | WP  
 | Table

Ro-Ro Ship

Propeller 3

Scale 25.68

Test No. 05-289/01-284  
 Test Date 09.05.2005

Draught = 6.950 m  
 Displacement = 19690 m3

Model condition: with asymmetric rudder with bulb and headbox  
 ----- rudder located 0.6 m aft of station 0  
 shaft spacer diameter 62mm x 54.2mm  
 propeller cap 27.8 mm

HULL EFFICIENCY ELEMENTS

-----  
 Trial conditions, Head wind 4.344 m/s ^ BF 3

V [KTS]	FN [-]	ADVC [-]	THDF [-]	WFT [-]	ETAH [-]	ETAO [-]	ETAR [-]	ETAD [-]	CTH [-]
20.00	.2323	.827	.133	.160	1.031	.696	1.034	.742	.788
20.50	.2381	.826	.134	.159	1.030	.696	1.034	.741	.792
21.00	.2439	.825	.135	.159	1.029	.695	1.034	.739	.797
21.50	.2498	.823	.135	.160	1.029	.694	1.034	.739	.804
22.00	.2556	.821	.134	.160	1.031	.694	1.035	.740	.811
22.50	.2614	.819	.134	.158	1.029	.693	1.035	.738	.818
23.00	.2672	.817	.133	.157	1.028	.692	1.035	.736	.827
23.50	.2730	.814	.133	.156	1.027	.690	1.035	.734	.837
24.00	.2788	.810	.140	.154	1.017	.688	1.038	.726	.852

REMARK: The coefficients are valid for identity of KT.  
 -----

Corrections: (1-WFTS)/(1-WFTM) = 1.053  
 -----

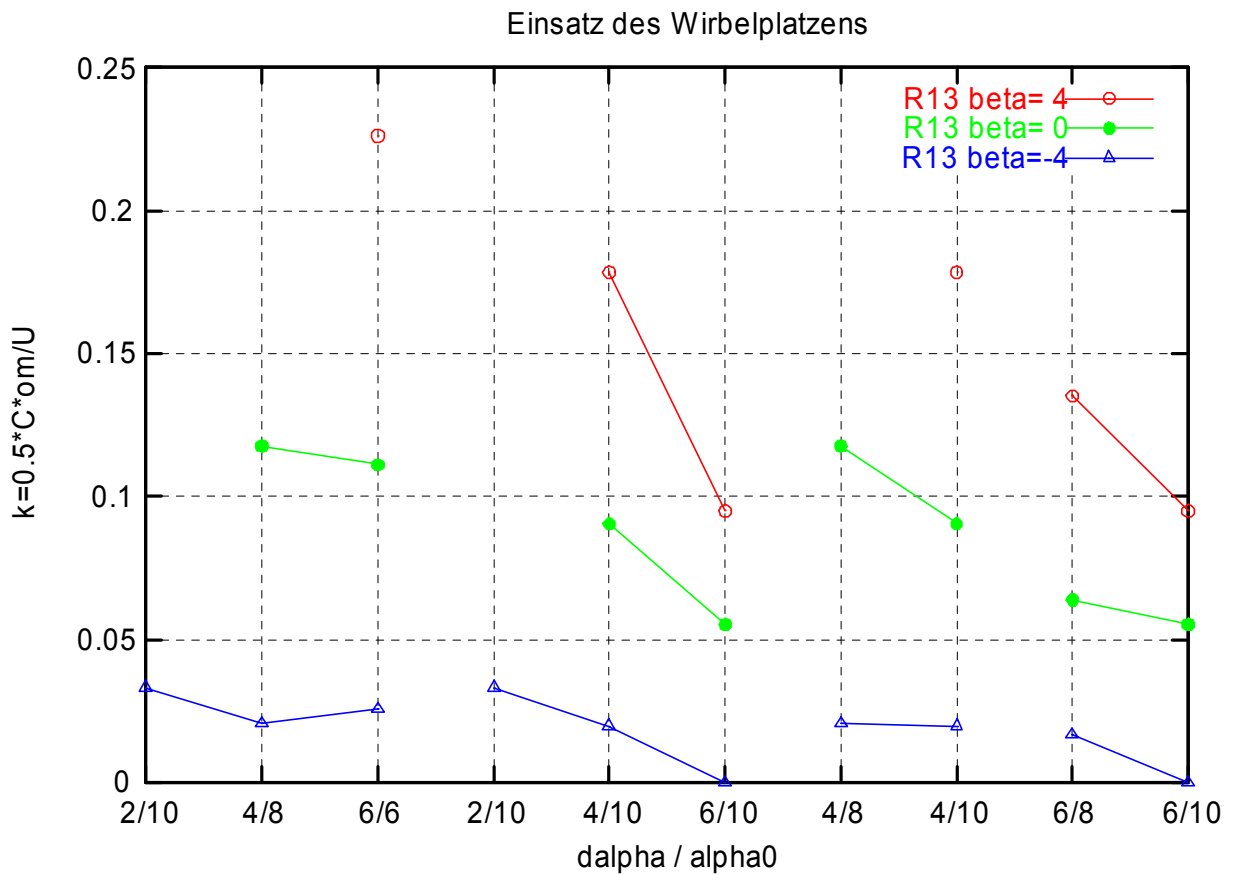
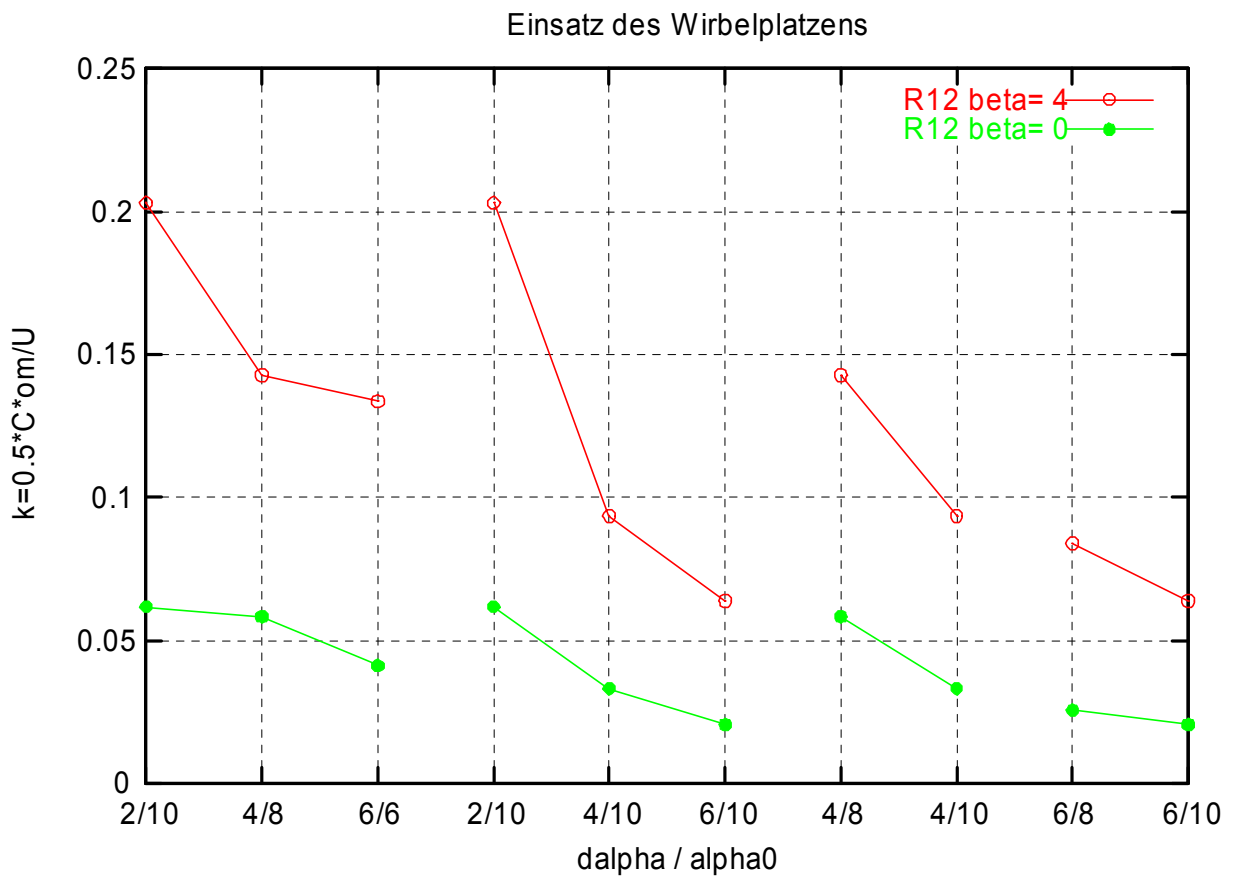


Abbildung 1 : Einsatz des Wirbelplatzens, R13



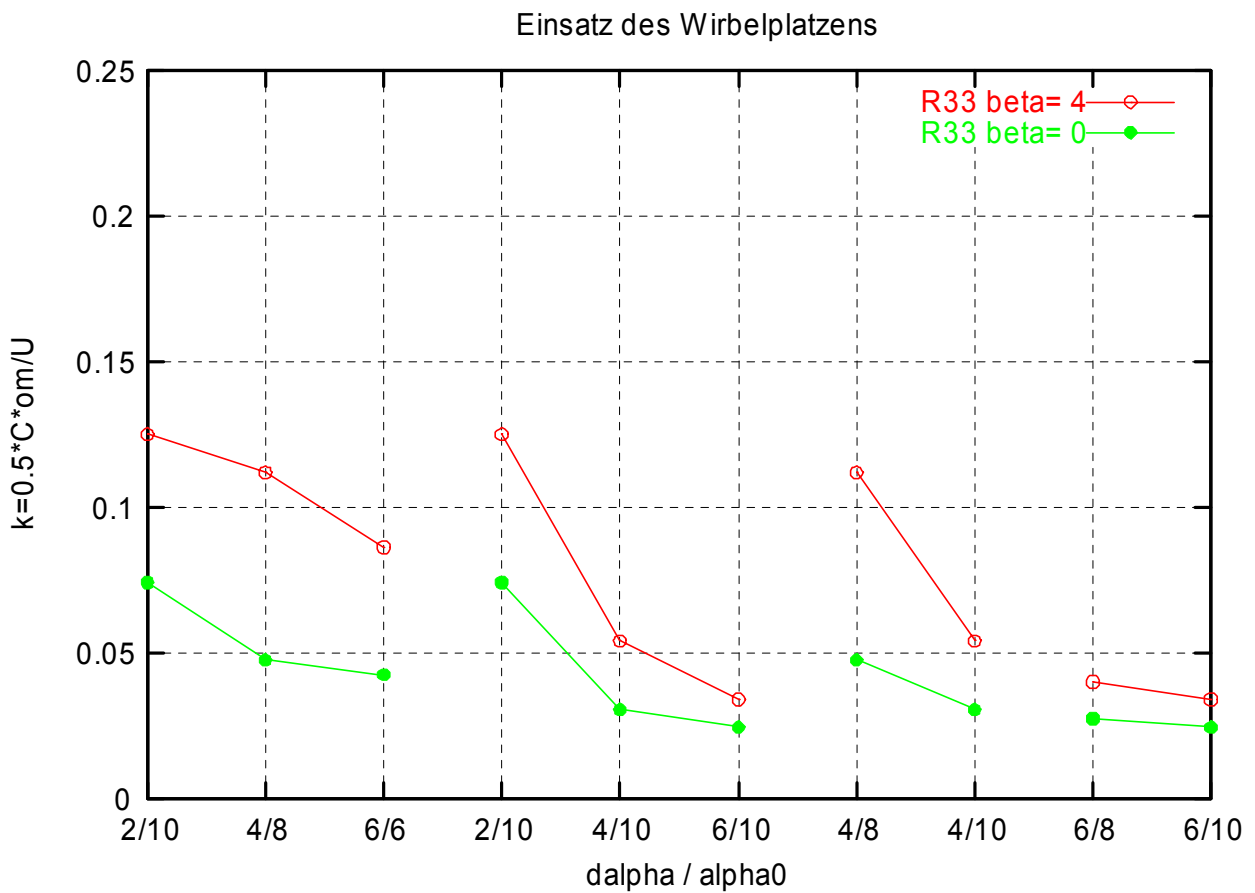
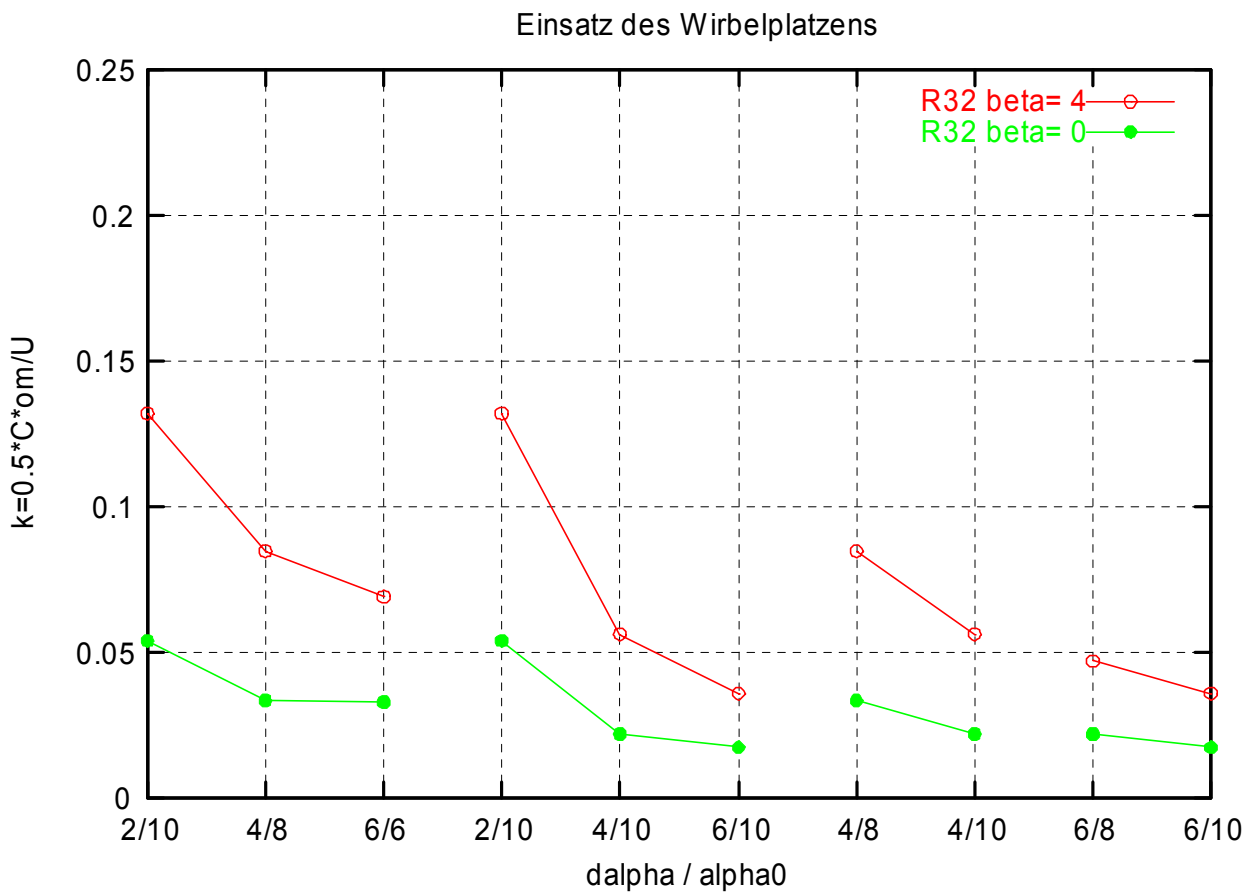


Abbildung 2 : Einsatz des Wirbelplatzens, R32, R33

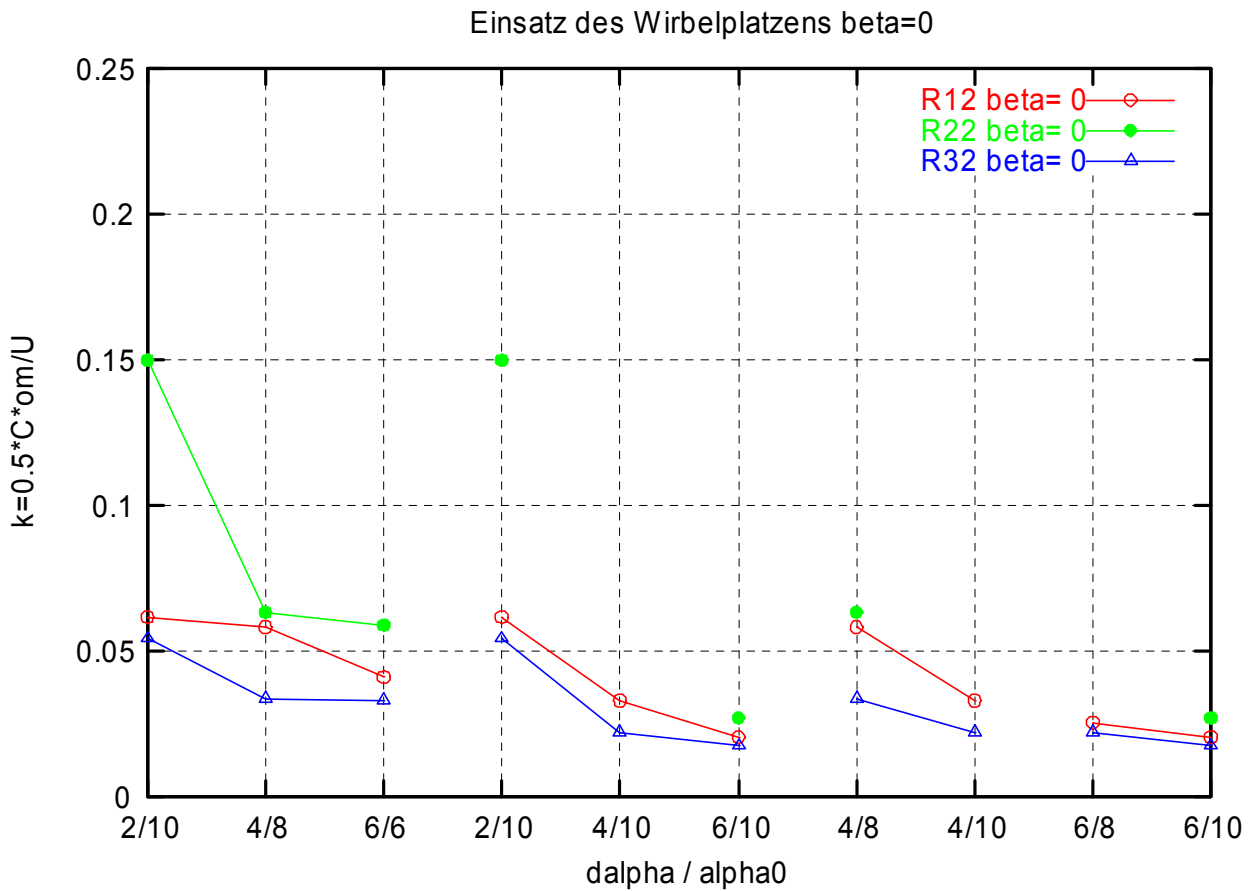
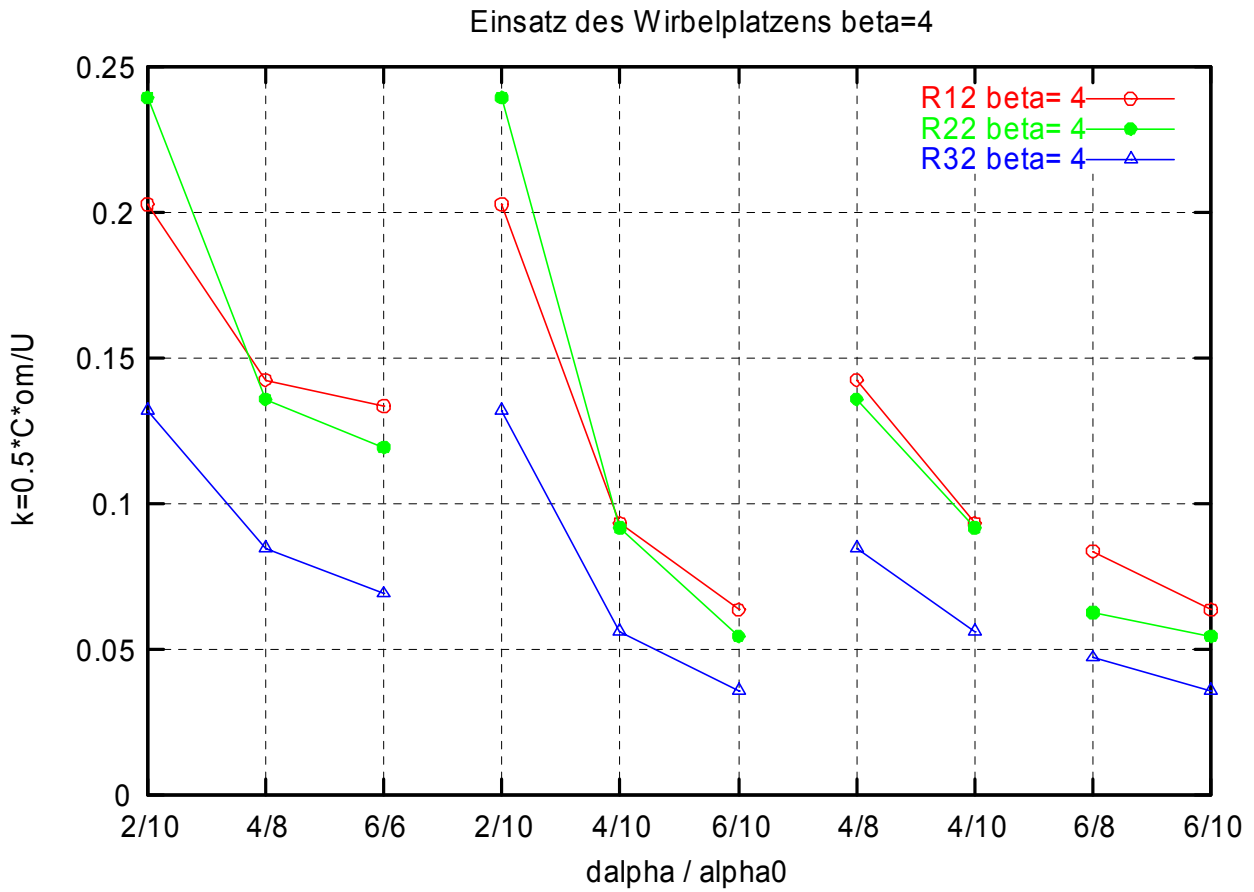


Abbildung 3 : Einsatz des Wirbelplatzens, R12, R22, R23

Einsatz des Wirbelplatzens beta=4

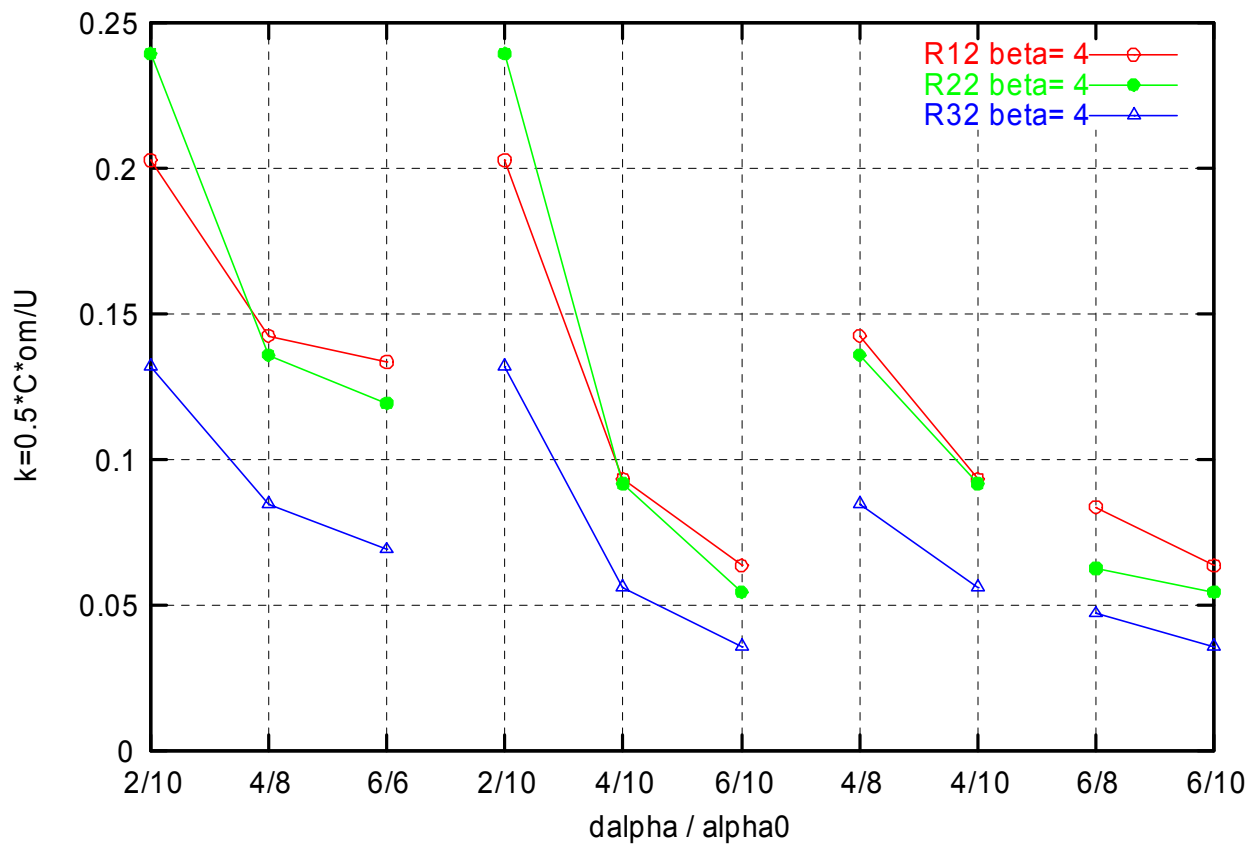


Abbildung 4 : Einsatz des Wirbelplatzens, R12, R22, R23

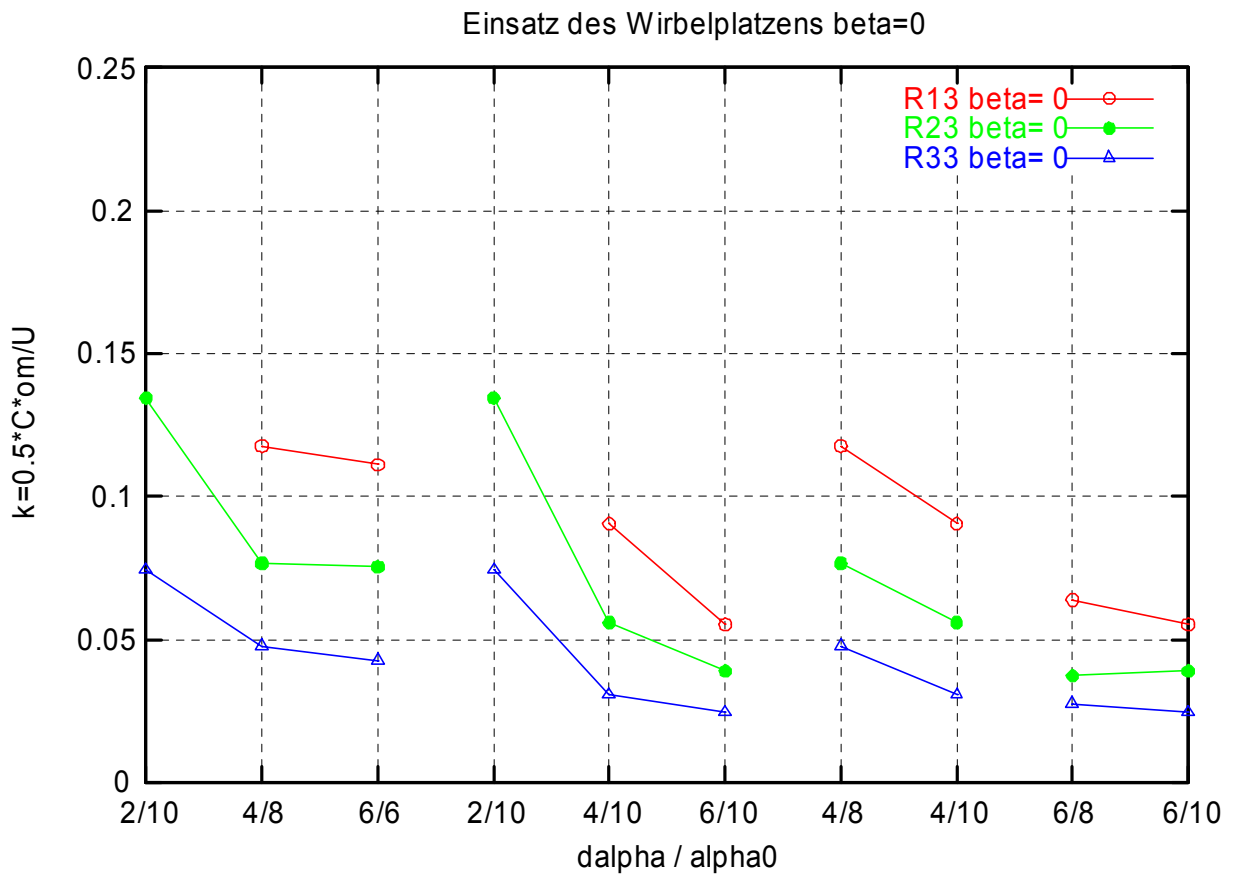
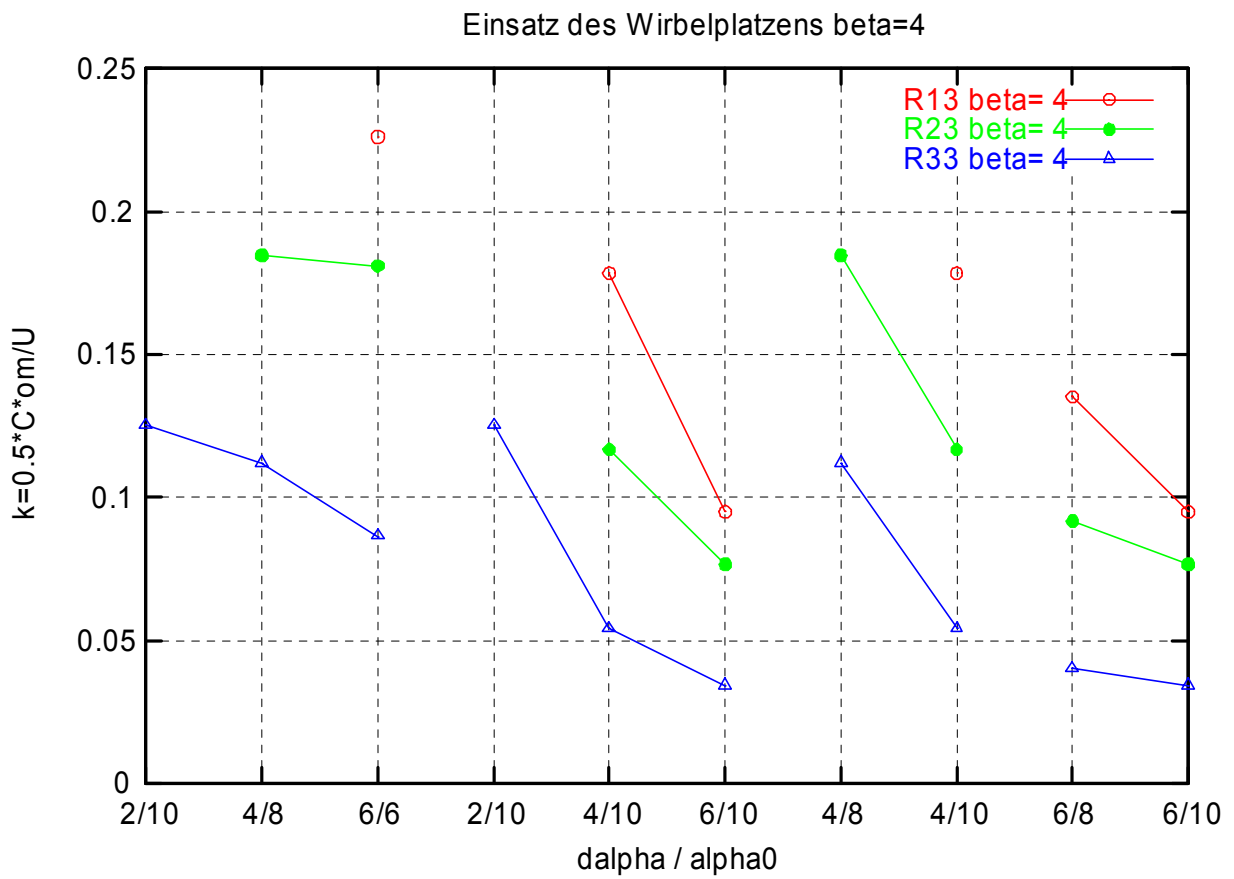


Abbildung 5 : Einsatz des Wirbelplatzens, R13, R23, R33

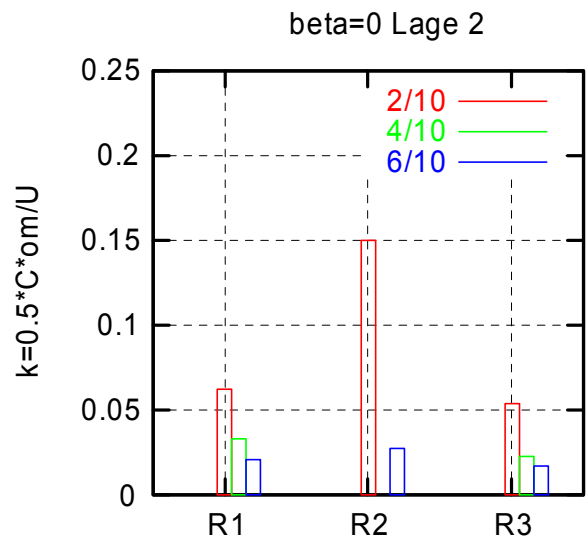
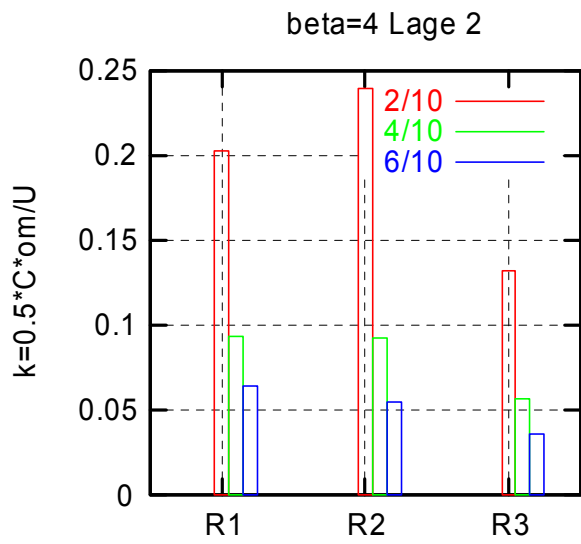
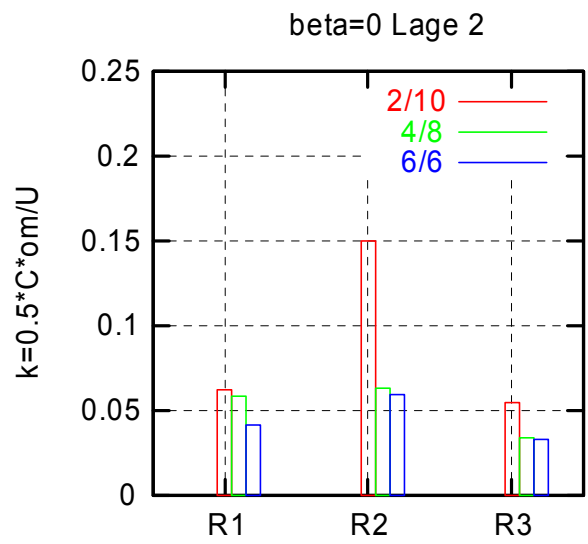
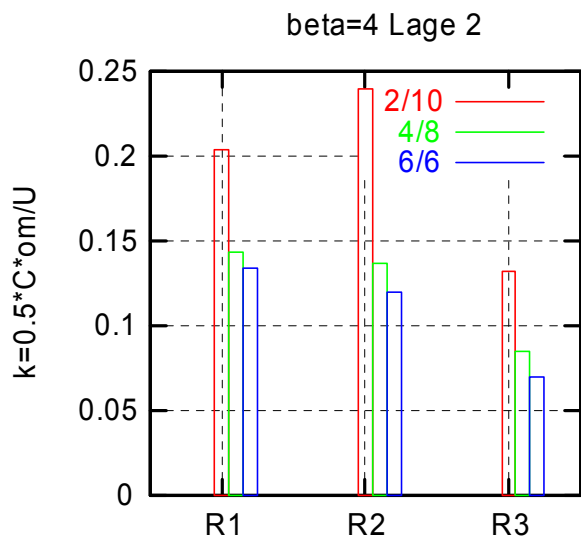


Abbildung 6 : Einsatz des Wirbelplatzens, Lage 2

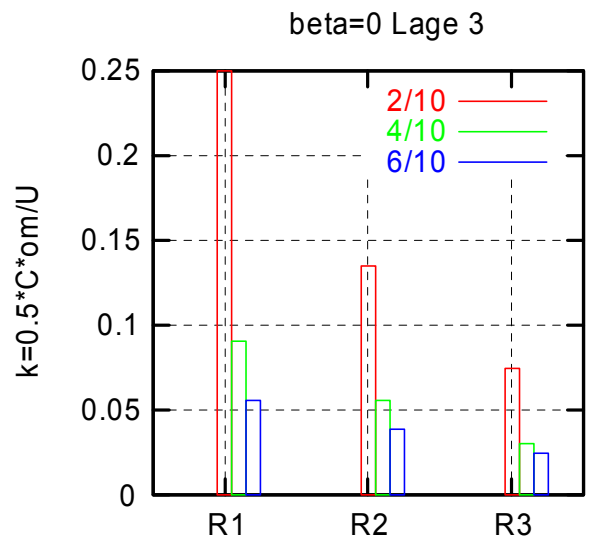
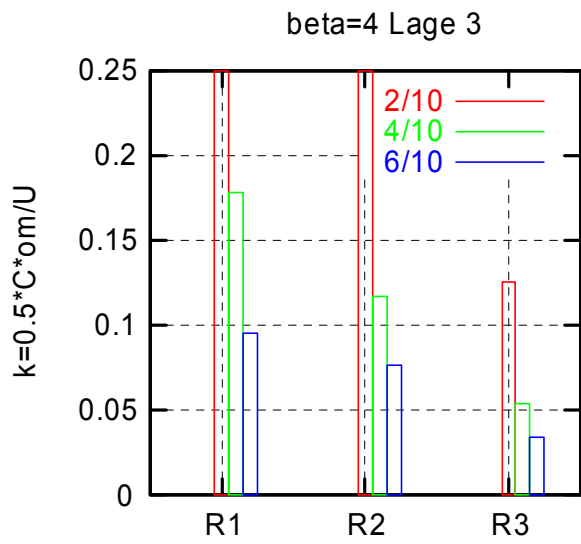
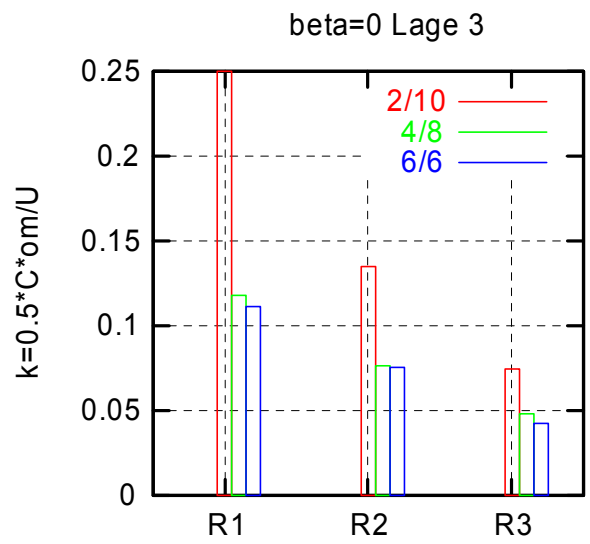
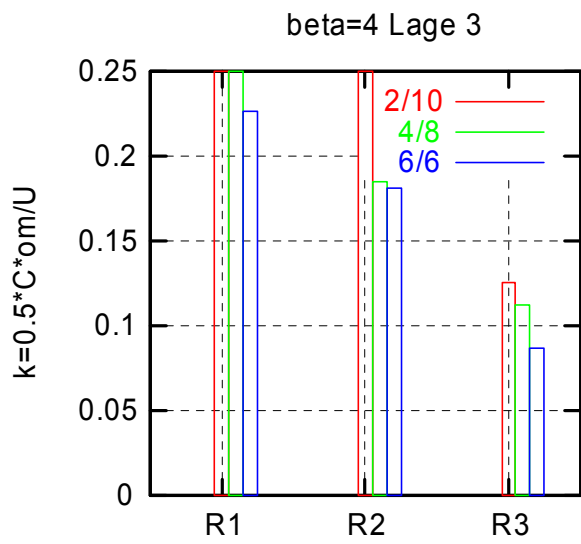


Abbildung 7 : Einsatz des Wirbelplatzens, Lage 3

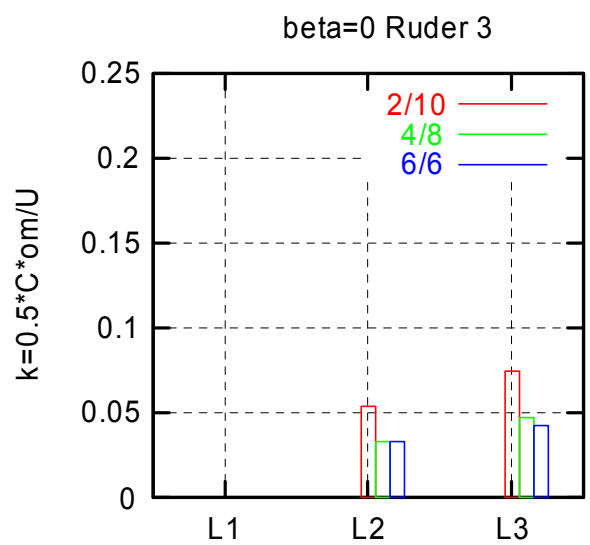
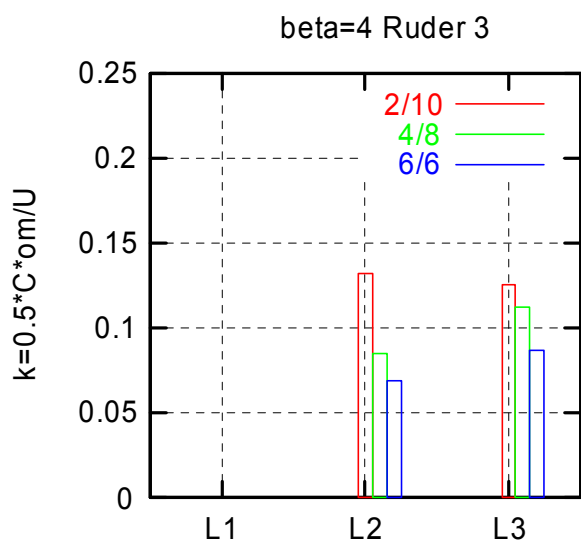
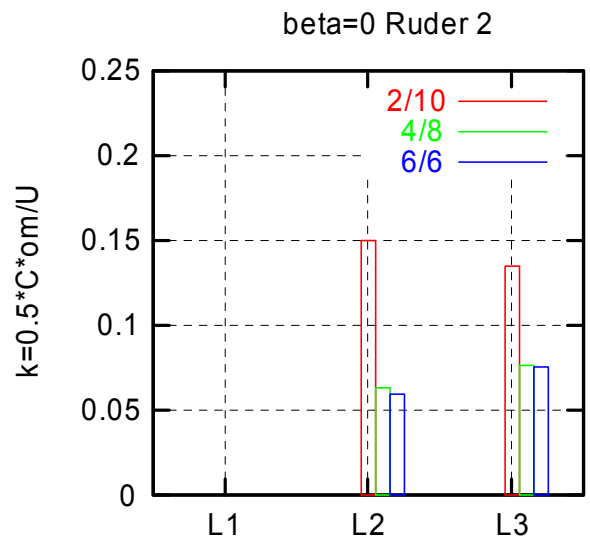
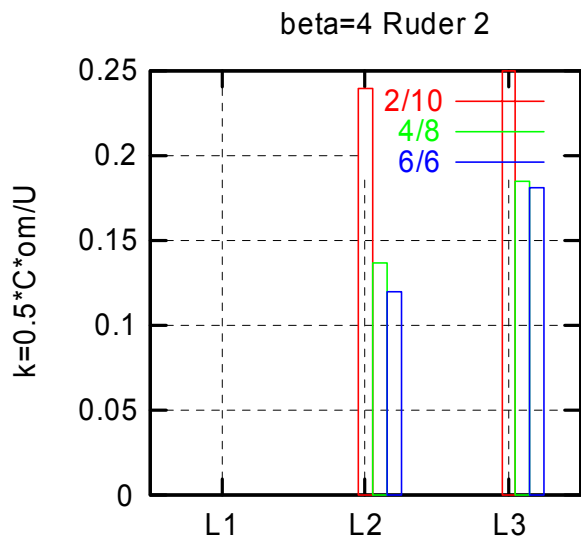
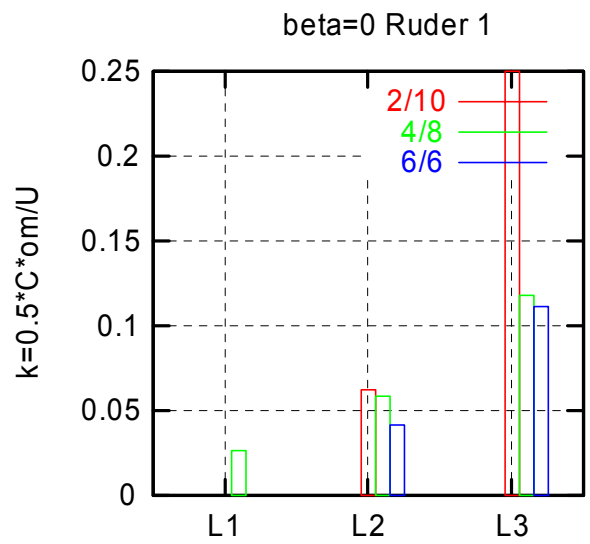
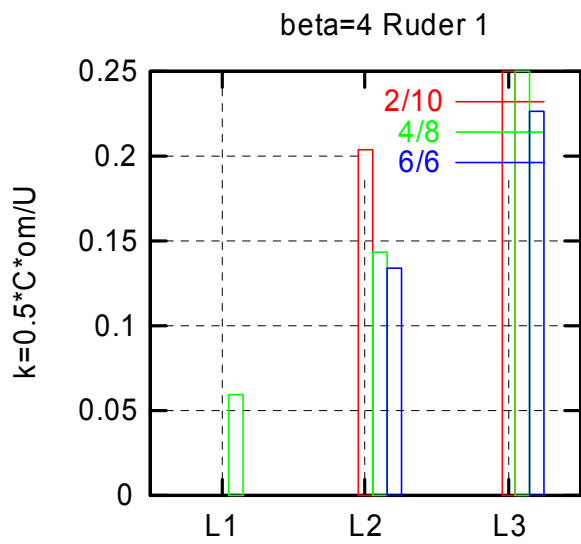


Abbildung 8 : Einsatz des Wirbelplatzens, R1, R2, R3

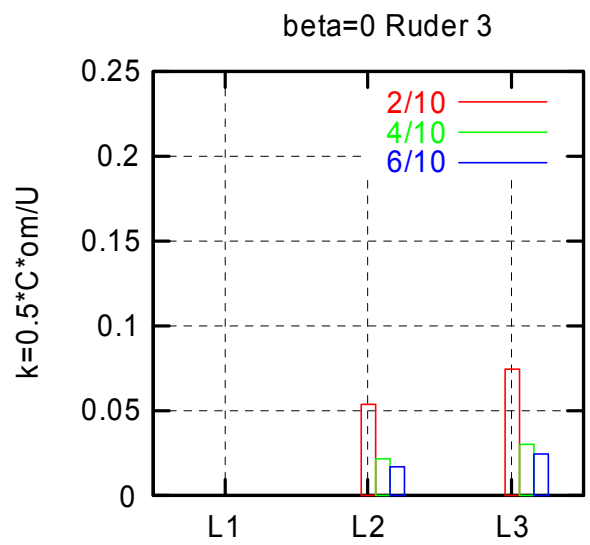
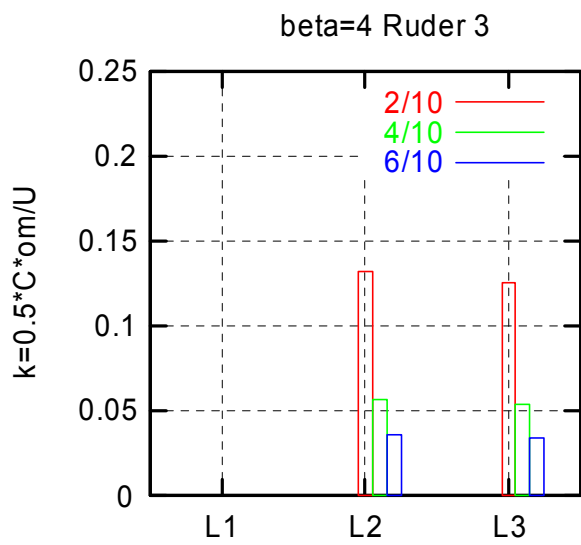
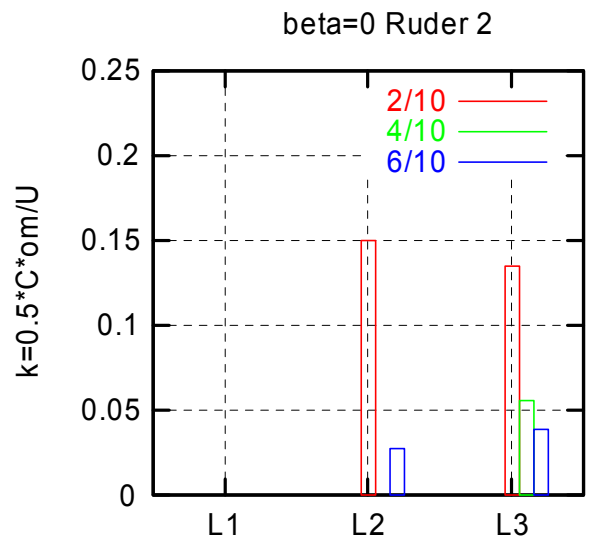
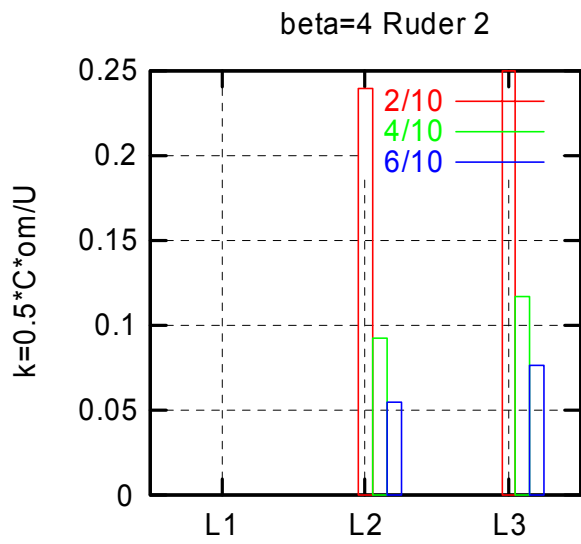
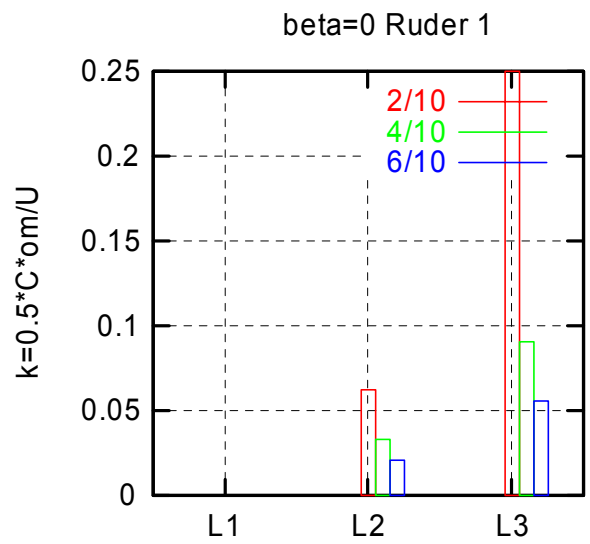
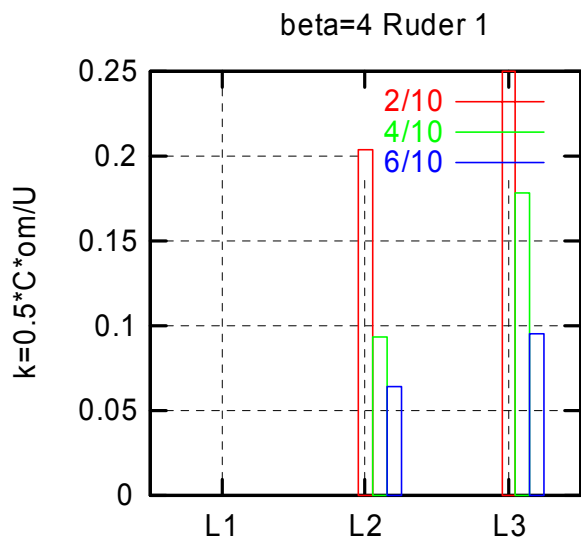


Abbildung 9 : Einsatz des Wirbelplatzens, R1, R2, R3



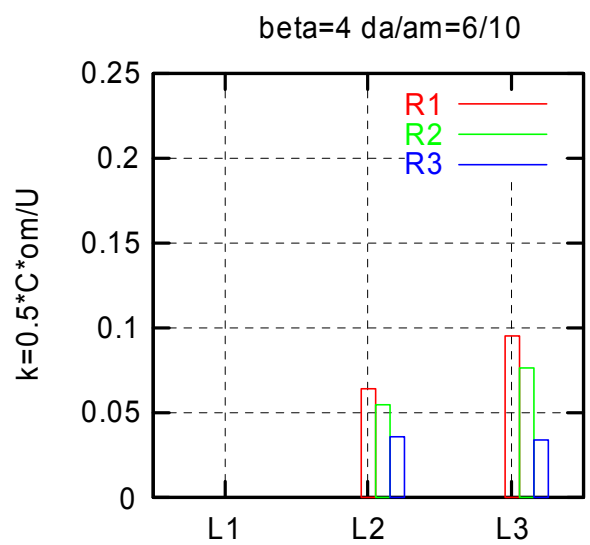
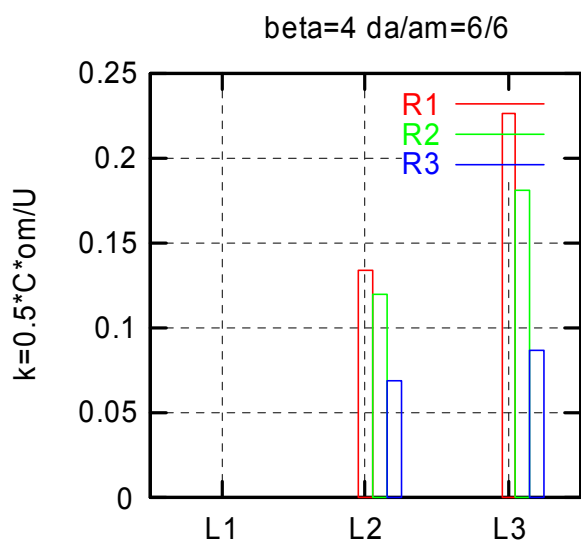
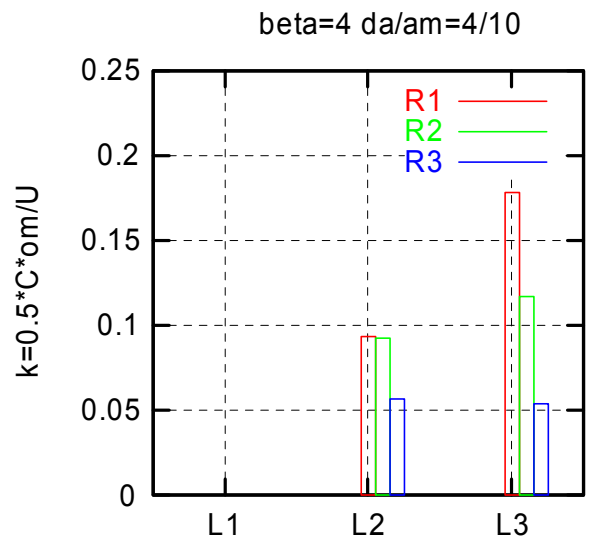
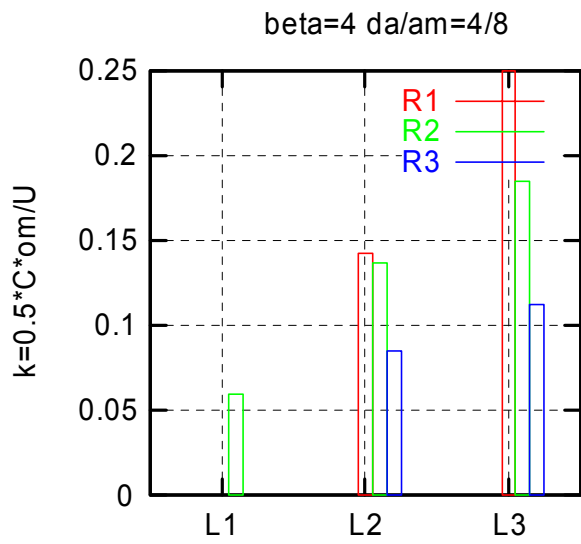
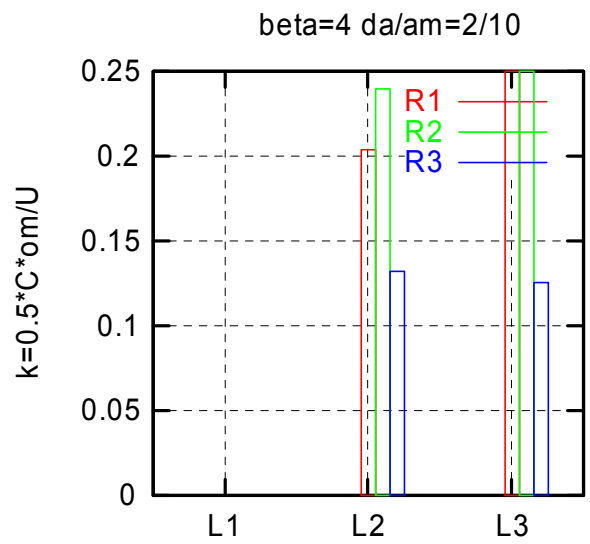
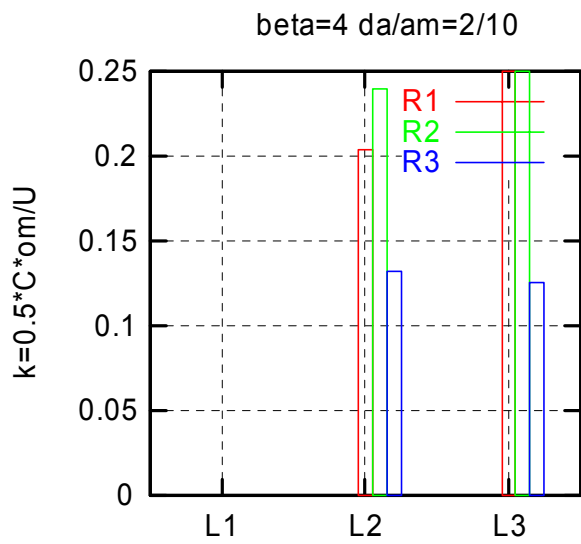


Abbildung 10 : Einsatz des Wirbelplatzens, L1, L2, L3

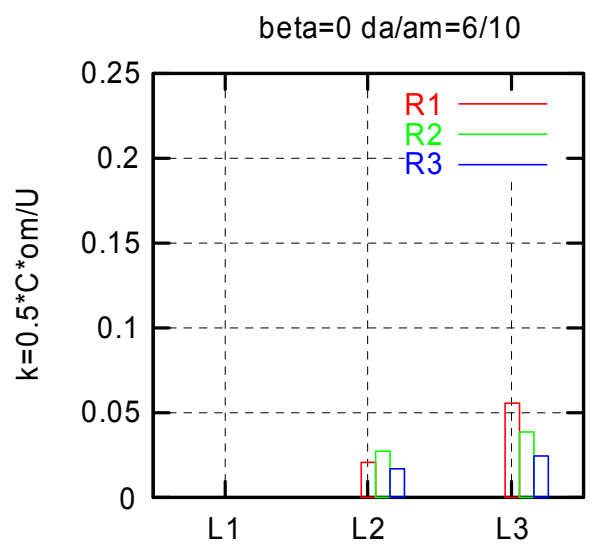
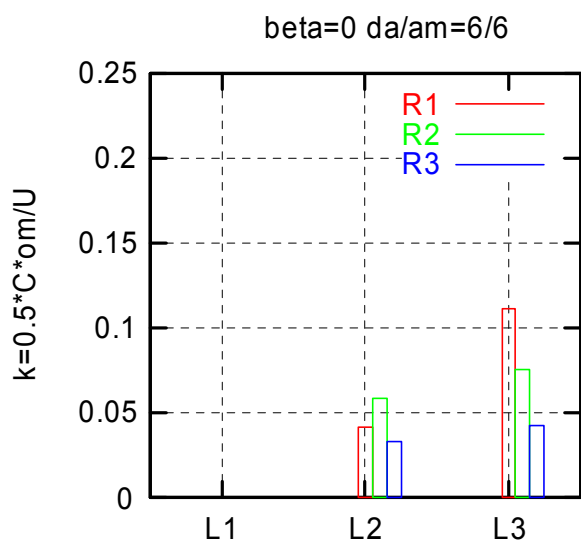
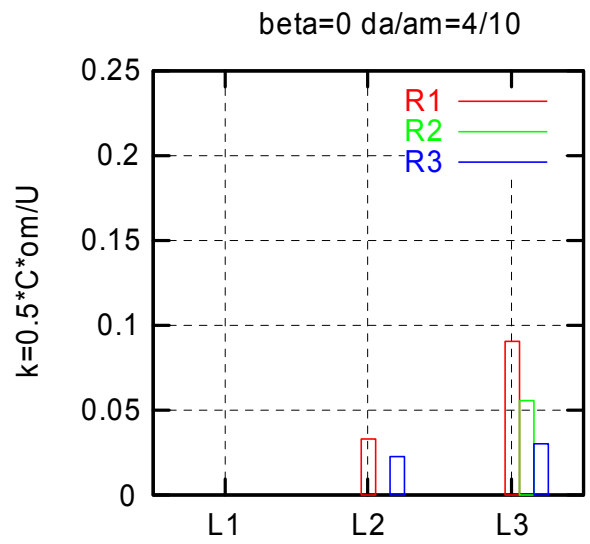
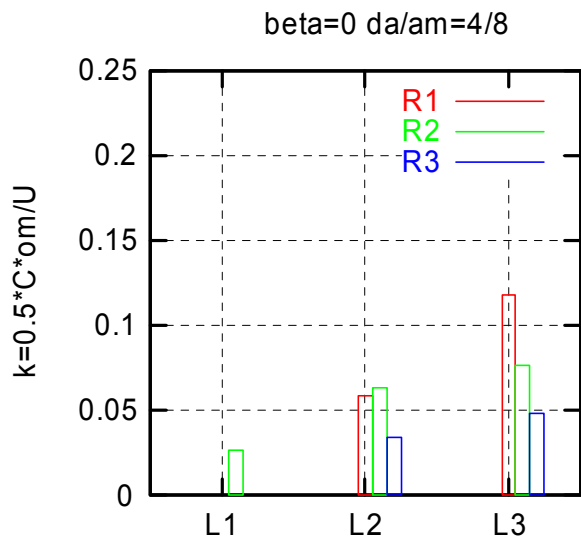
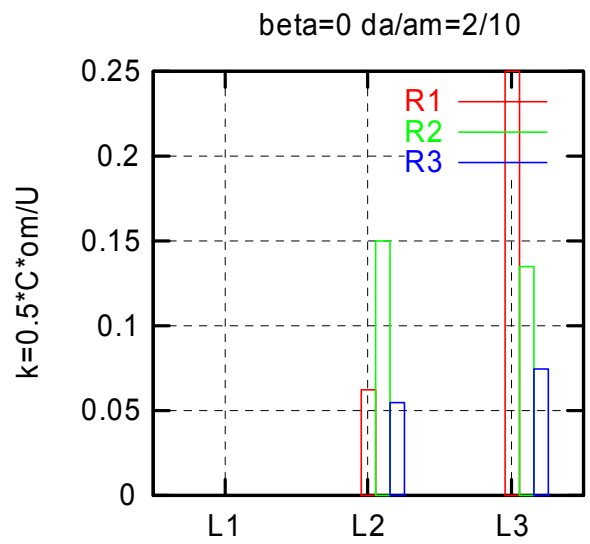
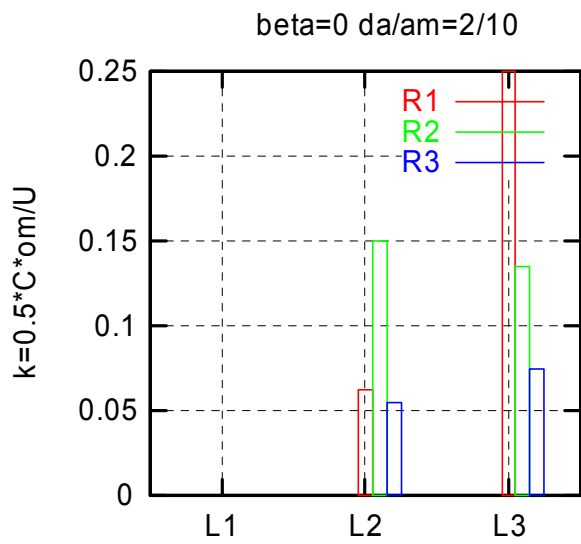


Abbildung 11 : Einsatz des Wirbelplatzens, L1, L2, L3

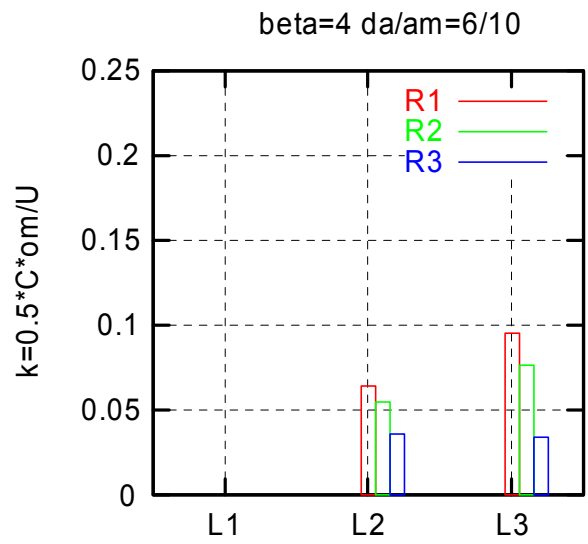
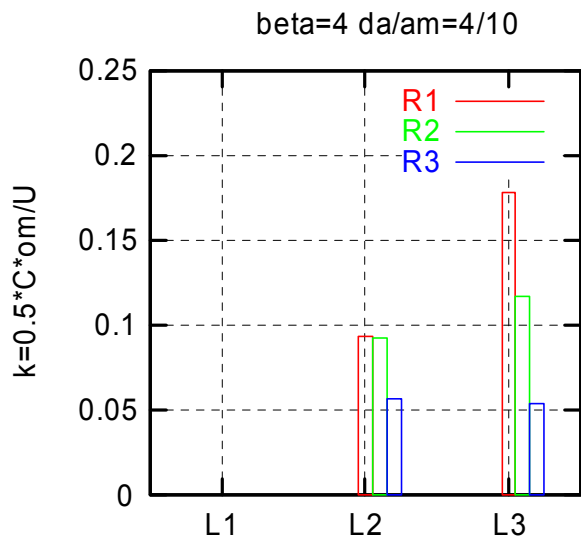
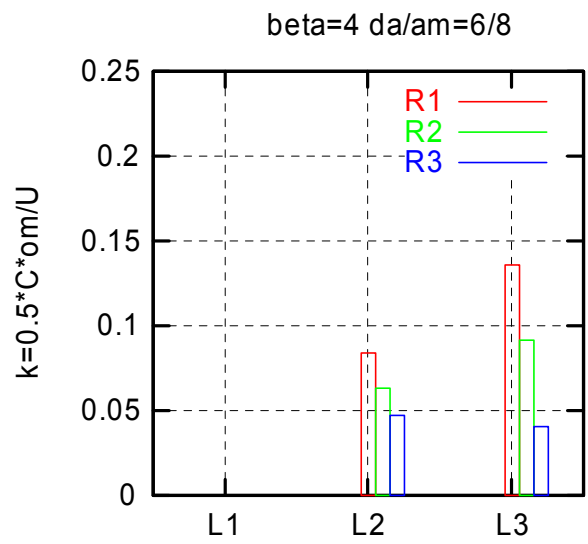
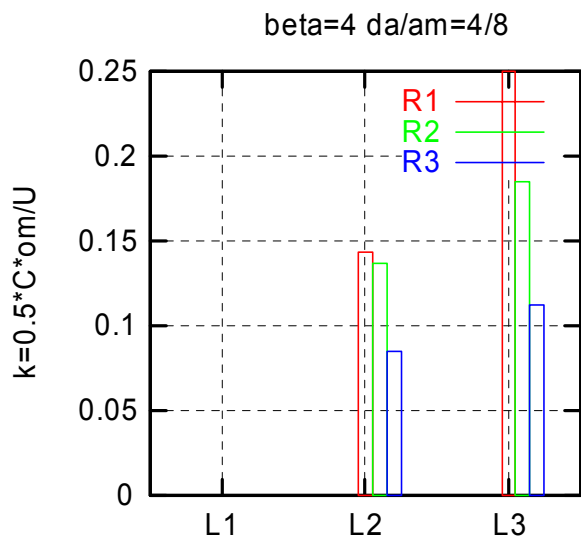


Abbildung 12 : Einsatz des Wirbelplatzens, L1, L2, L3

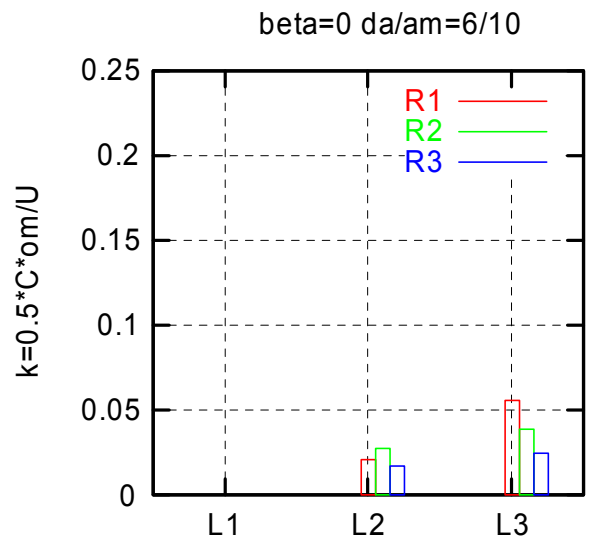
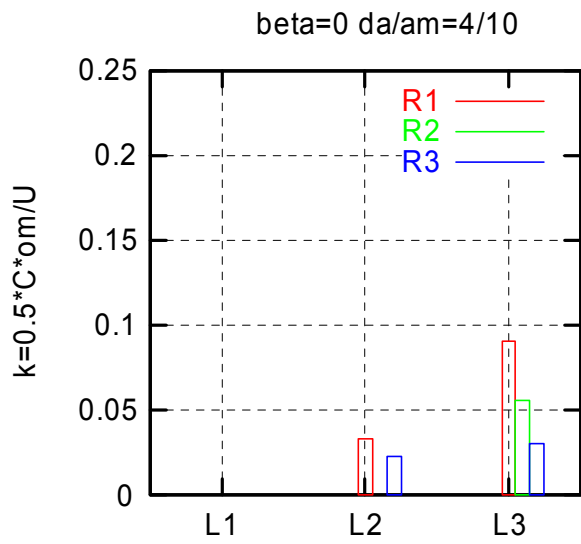
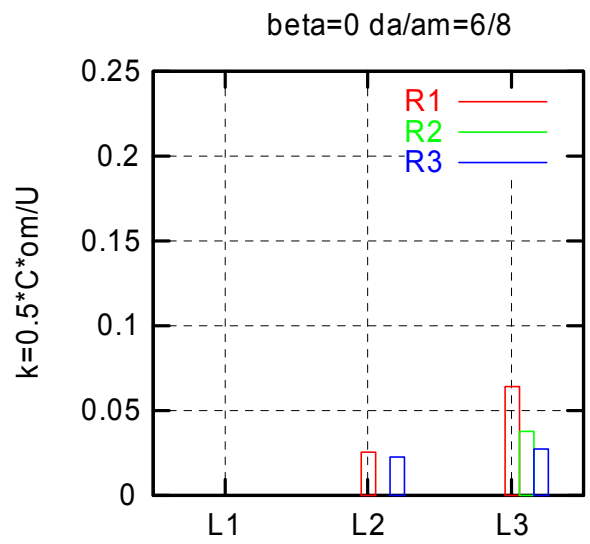
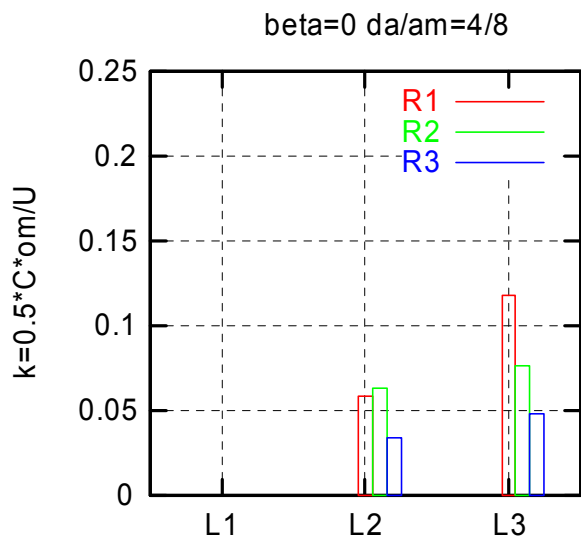
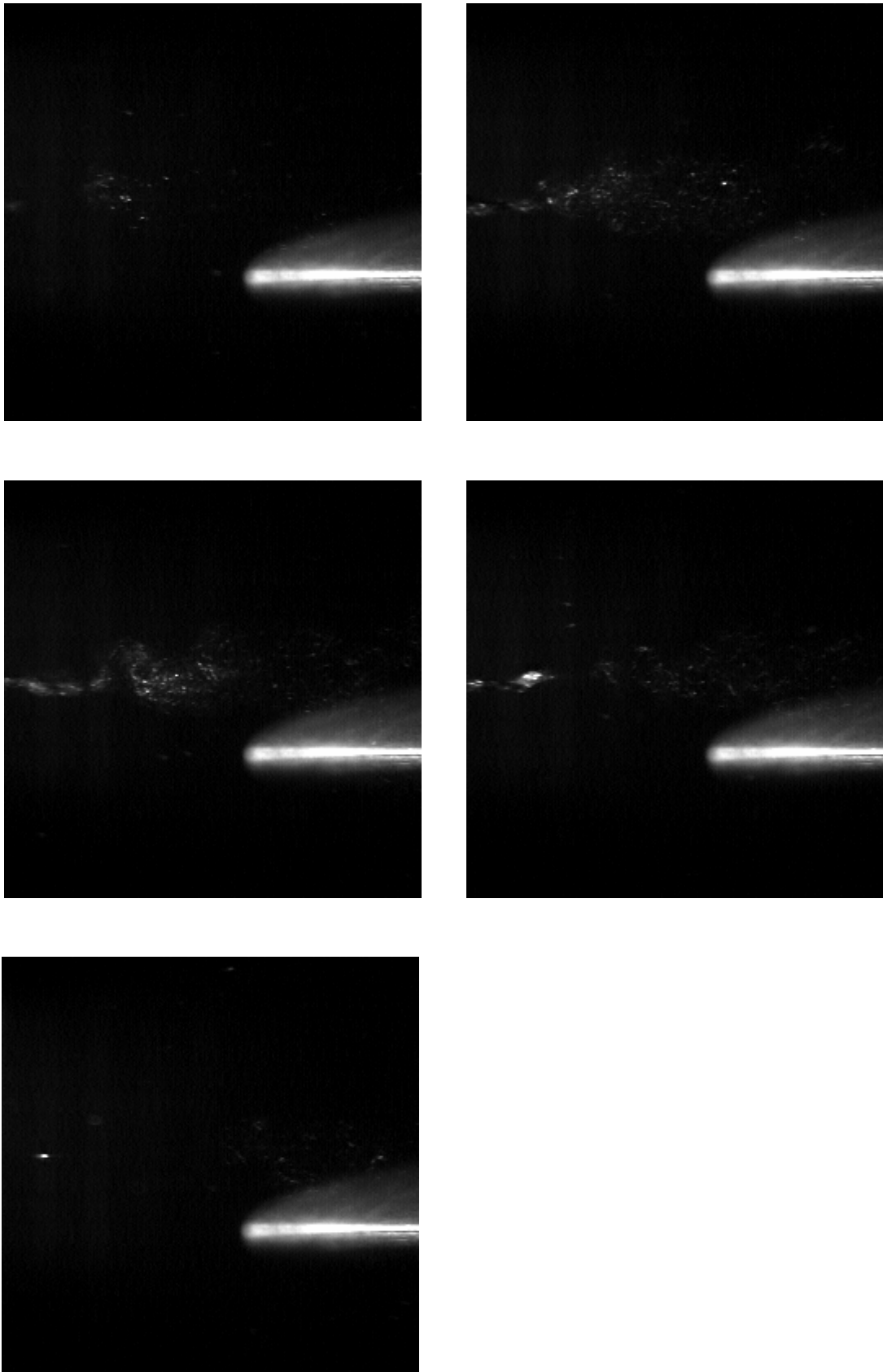
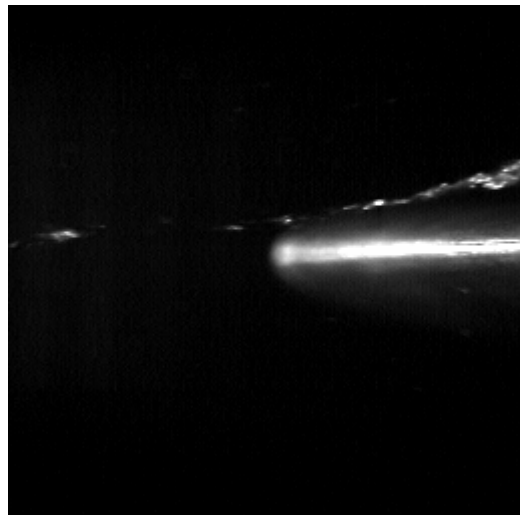
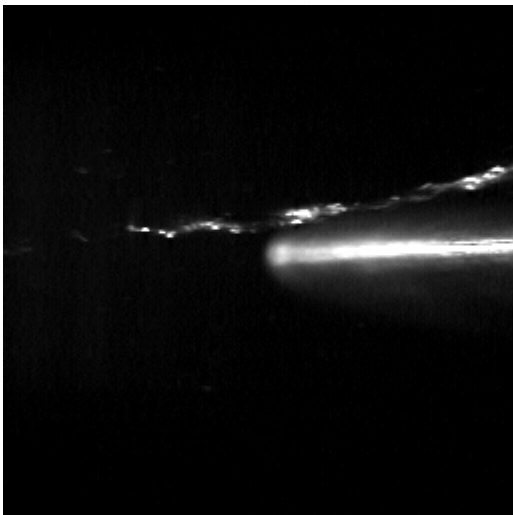
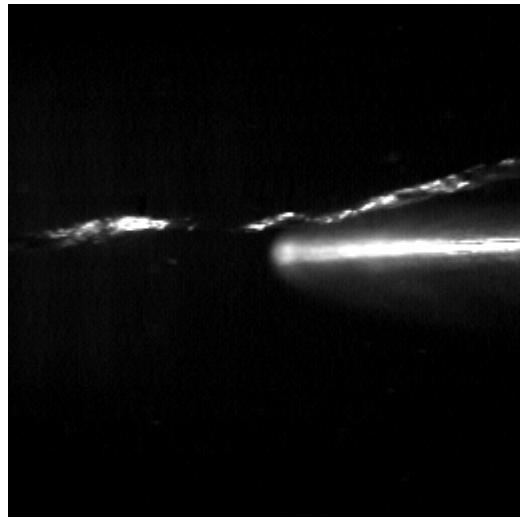
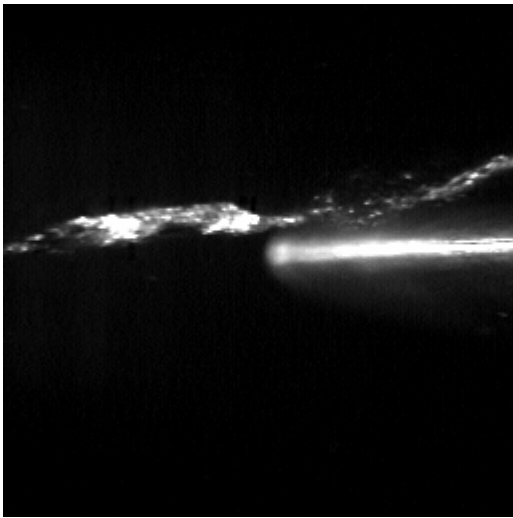
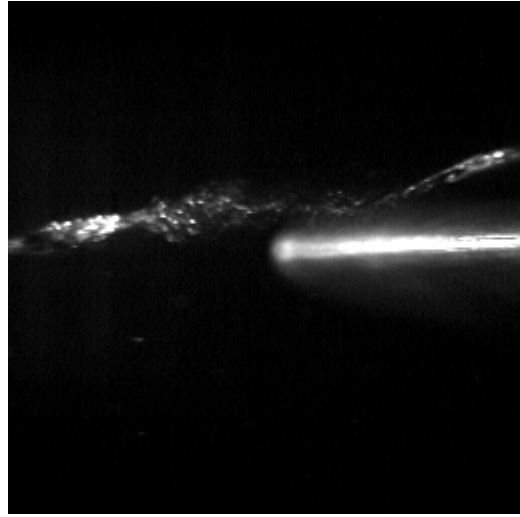
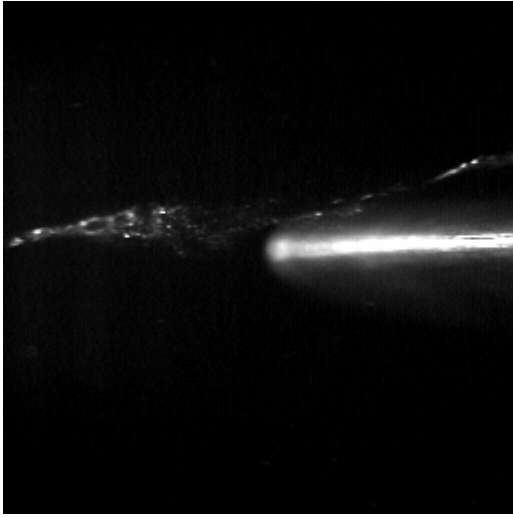


Abbildung 13 : Einsatz des Wirbelplatzens, L1, L2, L3



$t=0.35$   $0.4$   $0.5$   $0.55$   $0.578$   $0.6$  [s]

Abbildung 14 : wing5010060-150-R12M40-30



$t/T=0.35 \ 0.4 \ 0.5 \ 0.55 \ 0.578 \ 0.6$  [s]

Abbildung 15 : wing5010060-150-R12P40-30



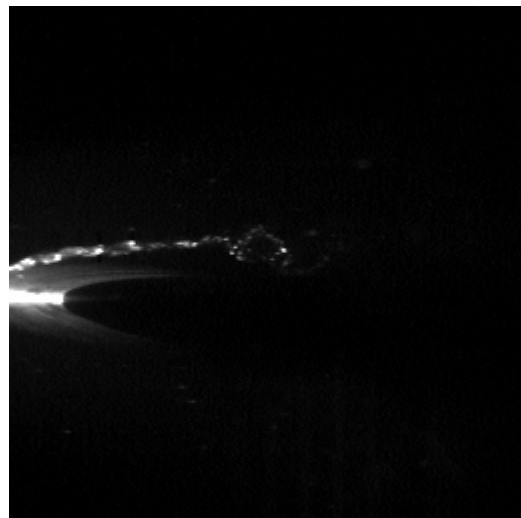
$\alpha=12.0^\circ, \beta=-4.0^\circ$



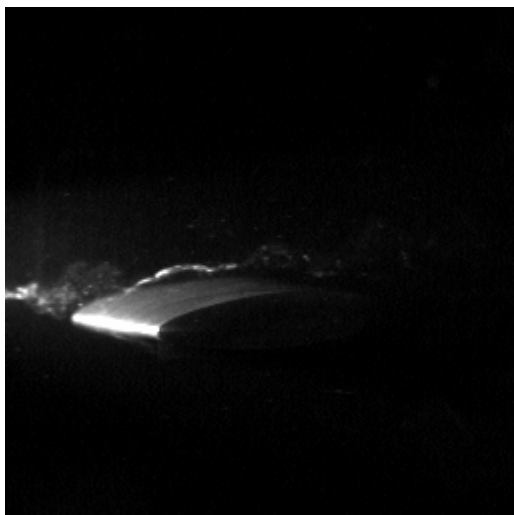
$\alpha=12.0^\circ, \beta=4.0^\circ$



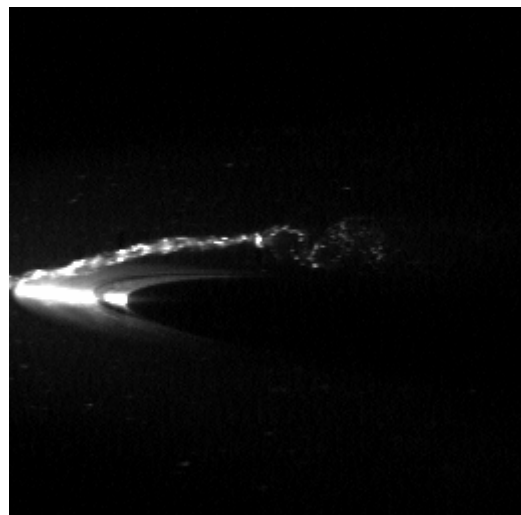
$\alpha=14.0^\circ, \beta=-4.0^\circ$



$\alpha=14.0^\circ, \beta=4.0^\circ$

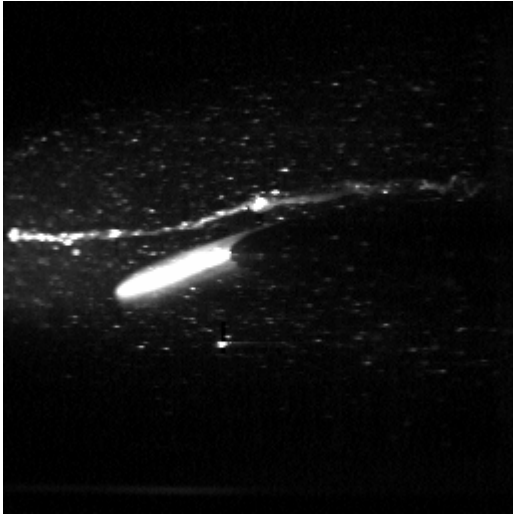


$\alpha=16.0^\circ, \beta=-4.0^\circ$

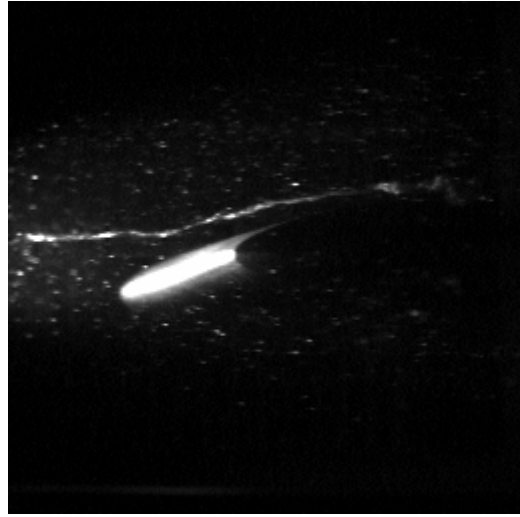


$\alpha=16.0^\circ, \beta=4.0^\circ$

Abbildung 16 : wing501200-1600-000-R13-30-TE



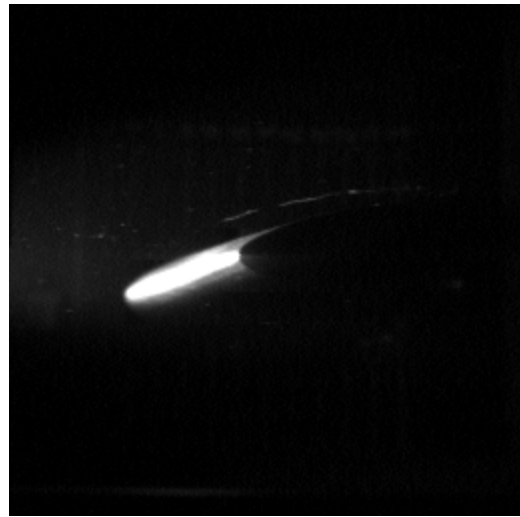
$\sigma=2.0$



$\sigma=2.5$



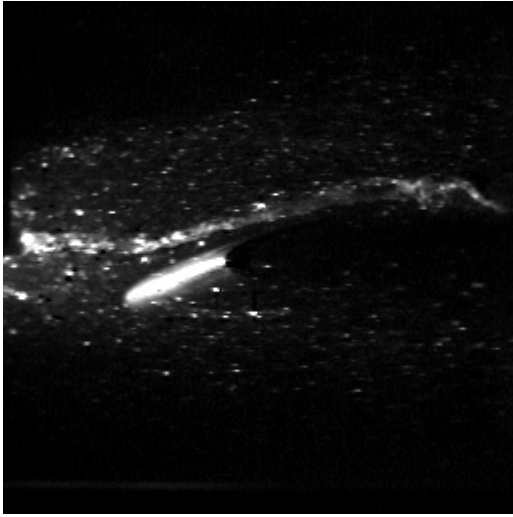
$\sigma=3.0$



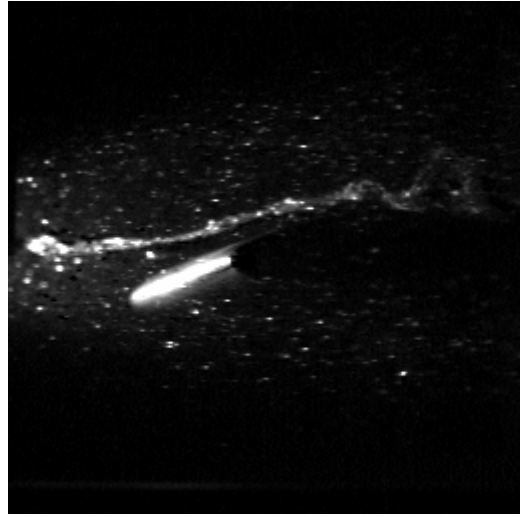
$\sigma=3.5$

Abbildung 17 : wing501200-000-R33M40

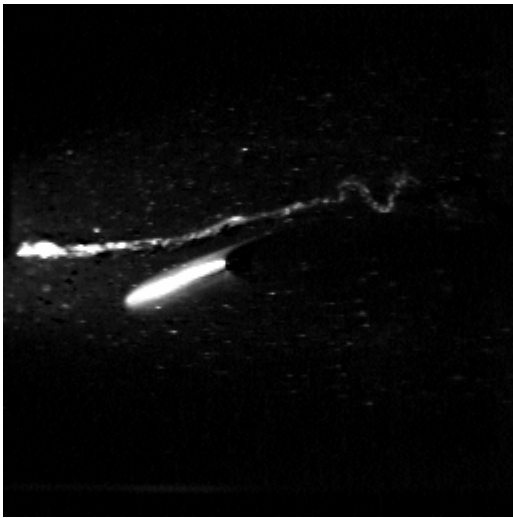




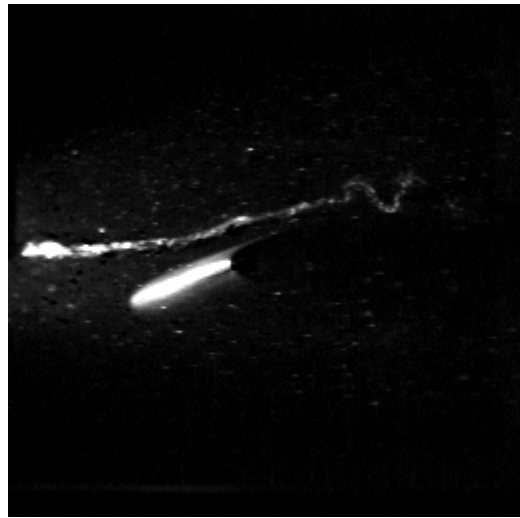
$\sigma=2.0$



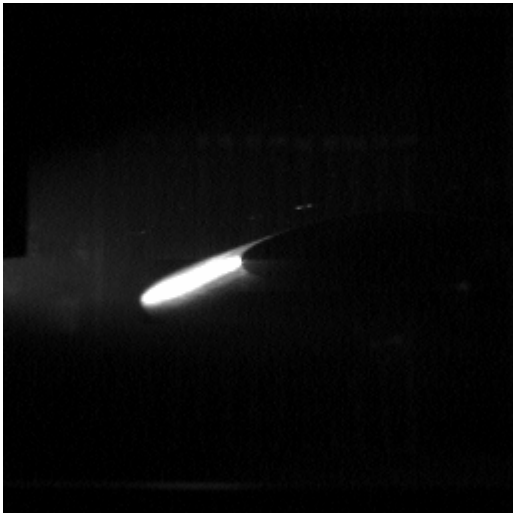
$\sigma=2.5$



$\sigma=3.0$

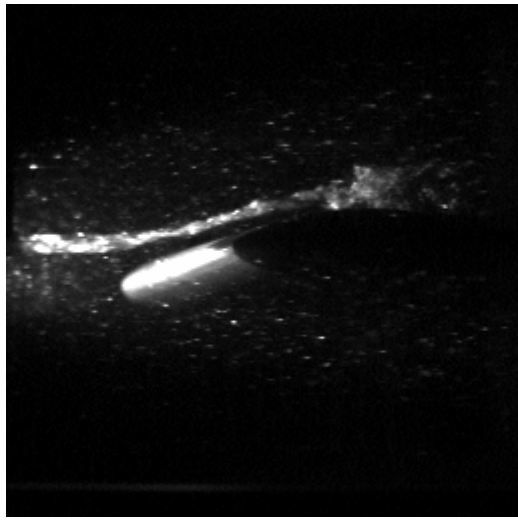


$\sigma=3.5$



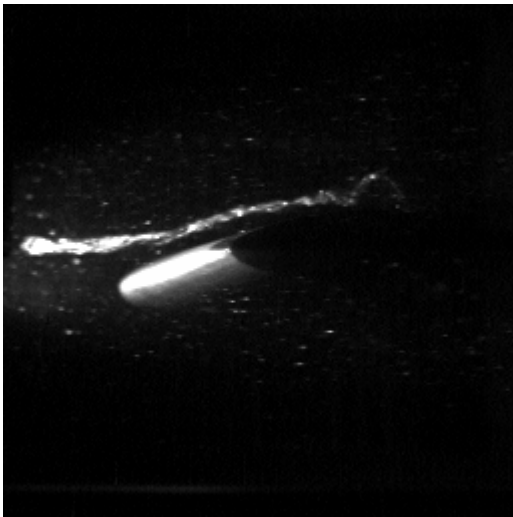
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Abbildung 18 : wing501600-000-R33M40

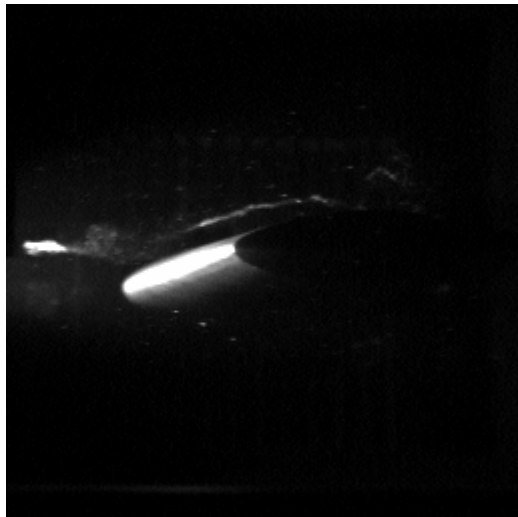


$\sigma=2.5$

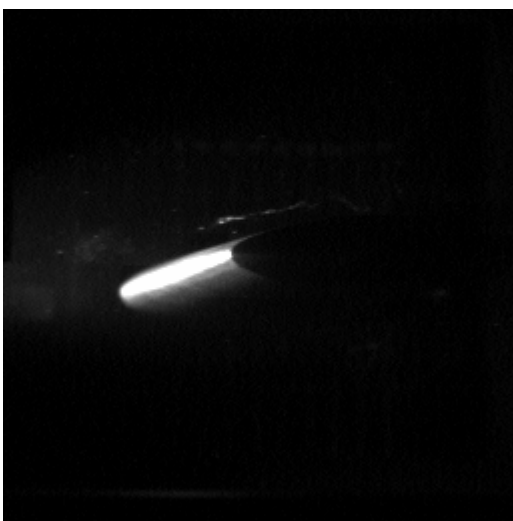
$\sigma=2.0$



$\sigma=3.0$

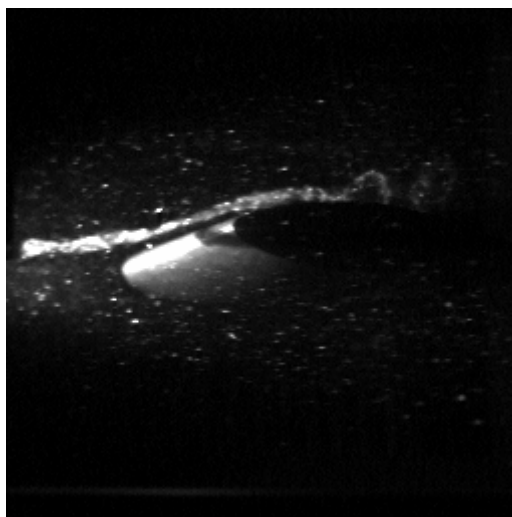


$\sigma=3.5$



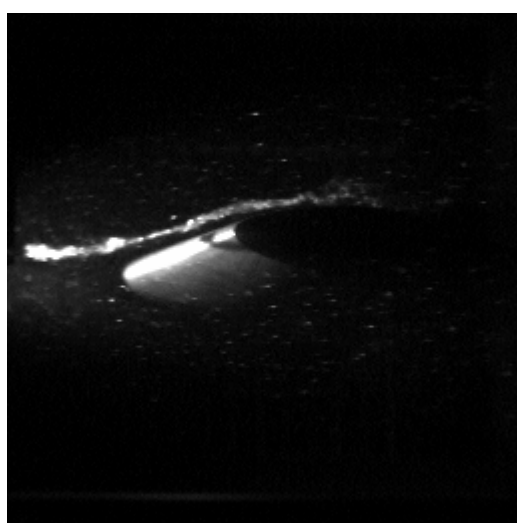
$\sigma=4.0$

Abbildung 19 : wing501600-000-R33-00

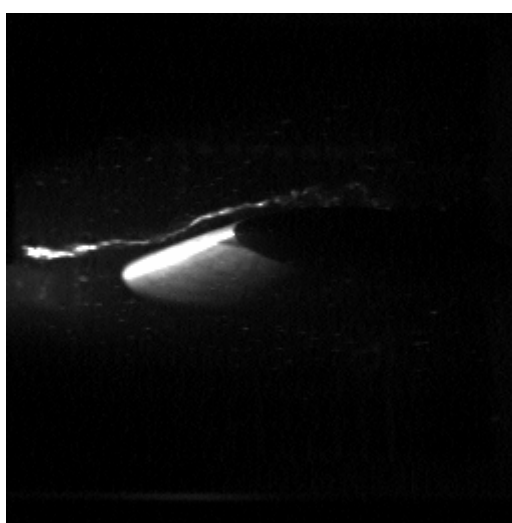


$\sigma=2.5$

$\sigma=2.0$



$\sigma=3.0$

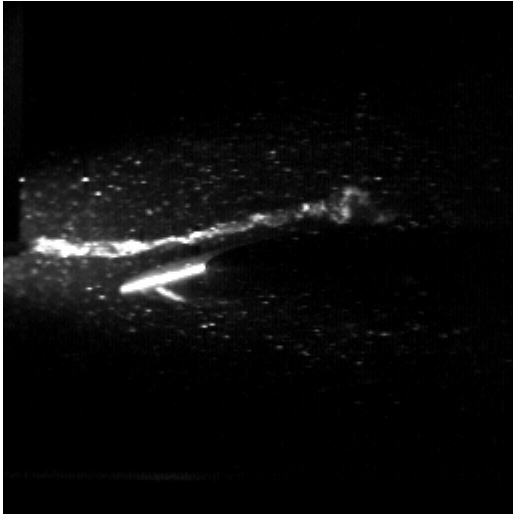


$\sigma=3.5$

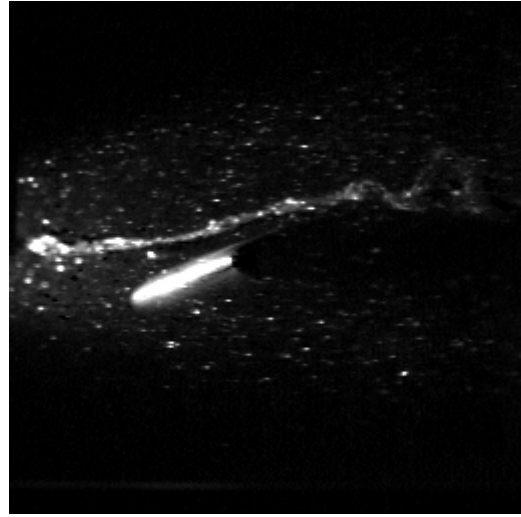


$\sigma=4.0$

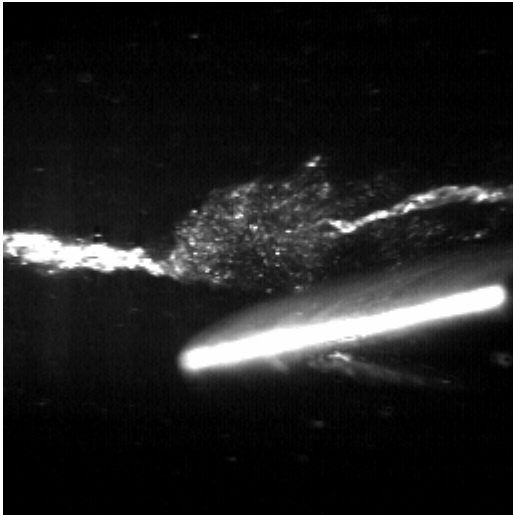
Abbildung 20 : wing501600-000-R33P40



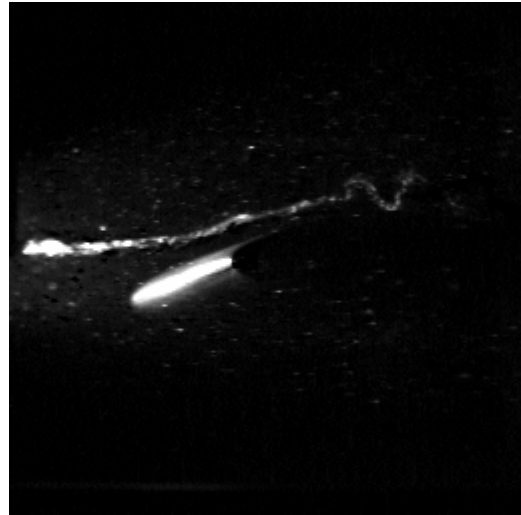
R13,  $\sigma=2.5$



R33,  $\sigma=2.5$



R13,  $\sigma=3.0$

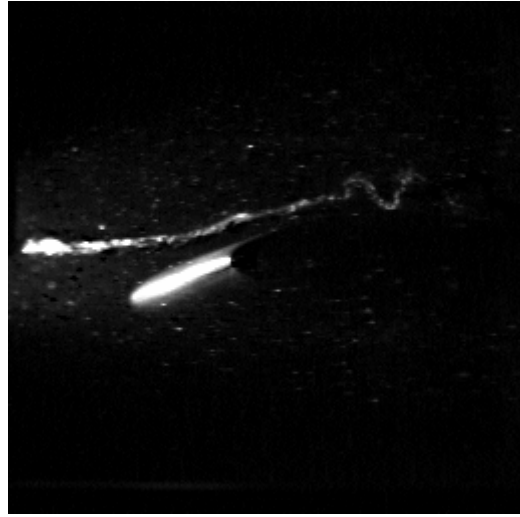


R33,  $\sigma=3.0$

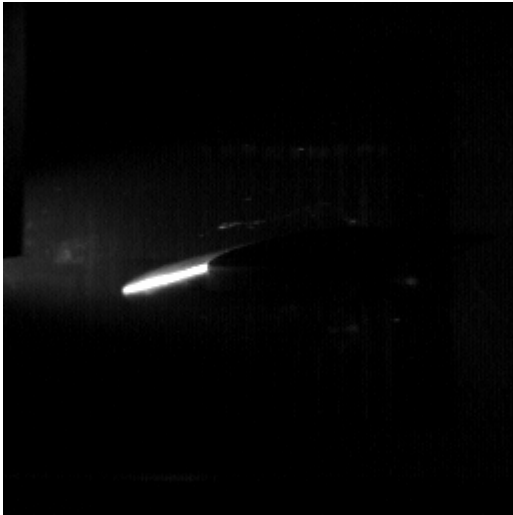
Abbildung 21 : wing501600-000-R13-R33M40  $\sigma=2.5-3.0$



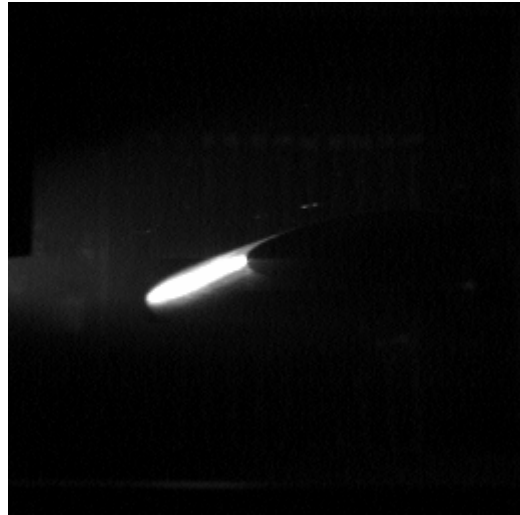
R13,  $\sigma=3.5$



R33,  $\sigma=3.5$



R13,  $\sigma=4.0$



R33,  $\sigma=4.0$

Abbildung 22 : wing501600-000-R13-R33M40,  $\sigma=3.5-4.0$

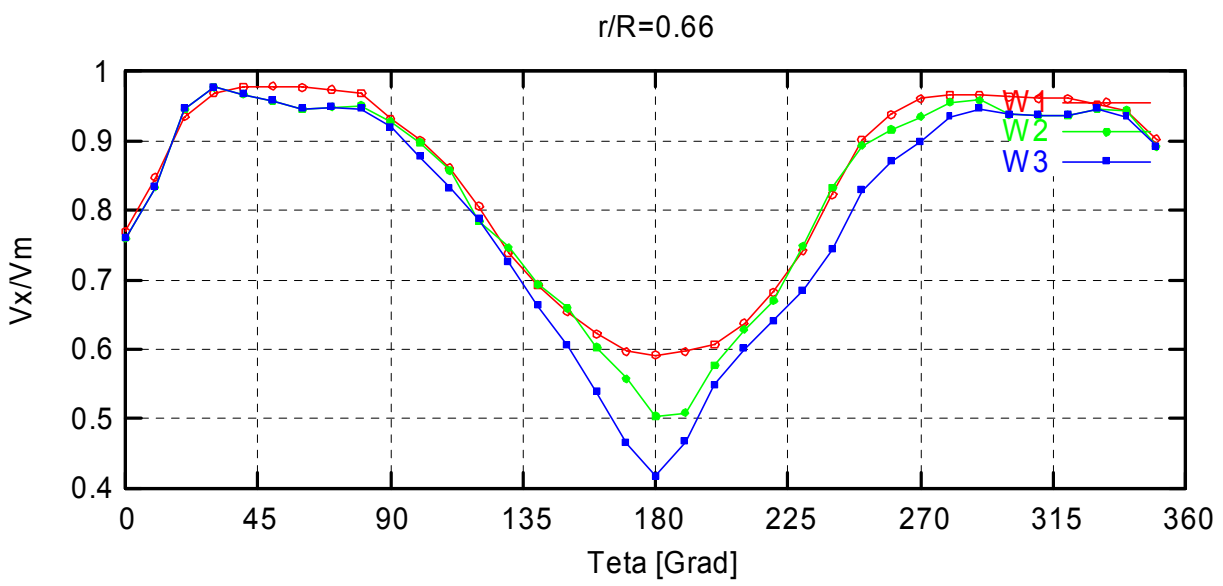
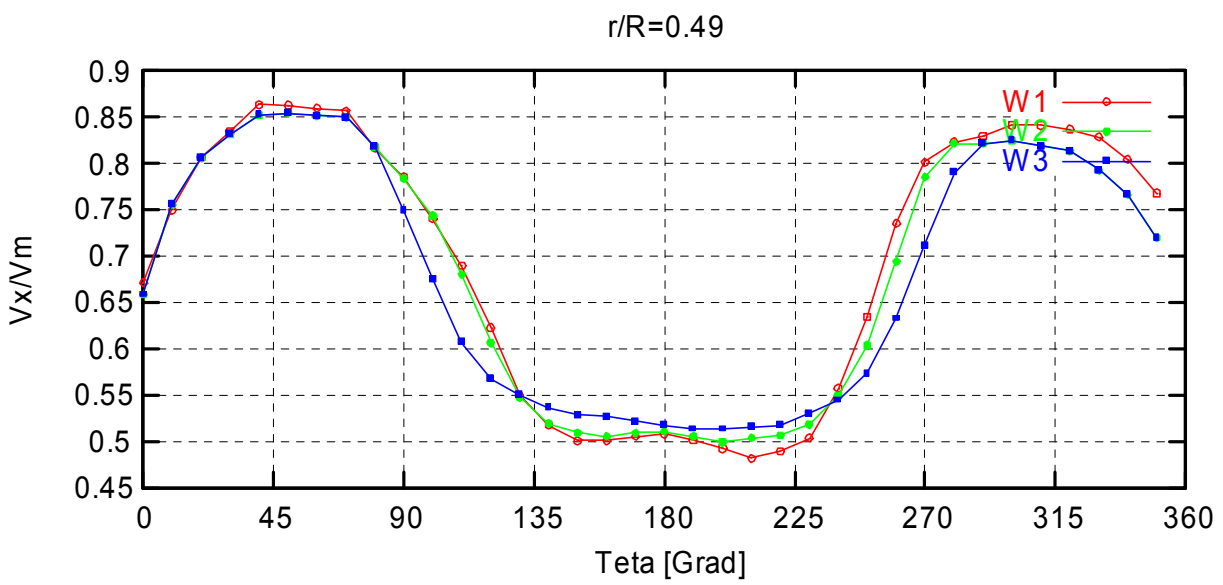
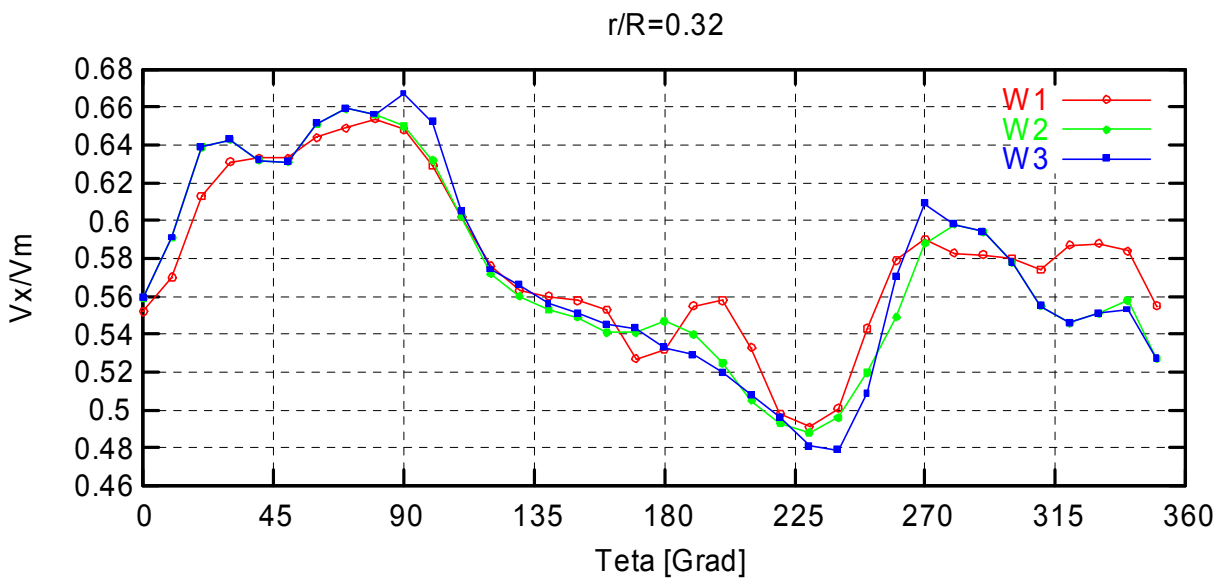


Abbildung 23 : Vergleich der axialen Komponente der Nachstromfelder (W2=Original)

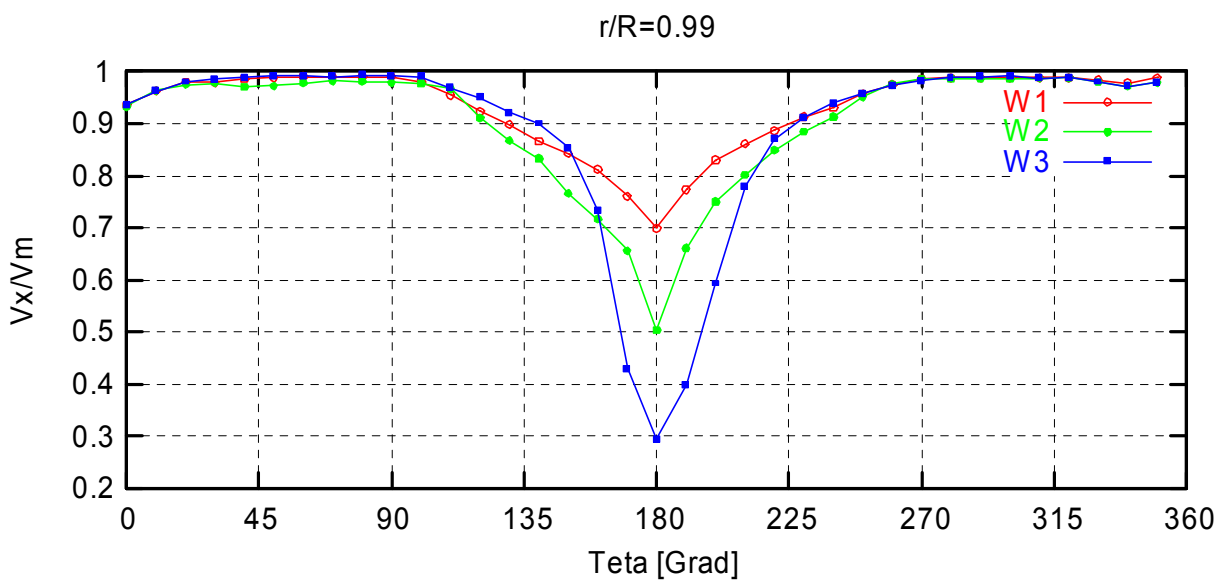
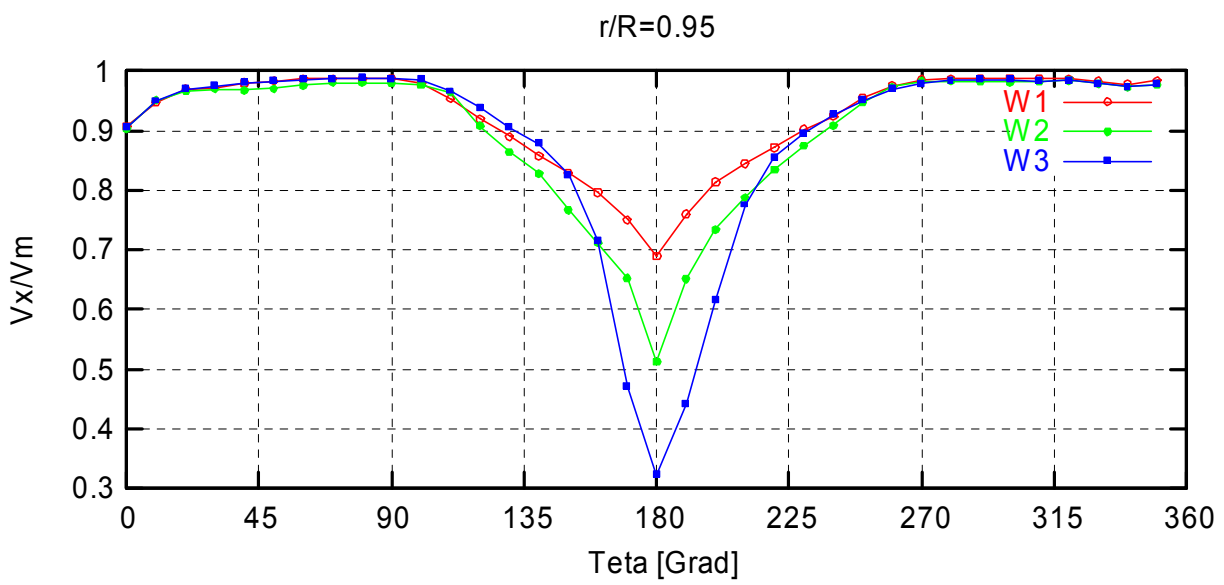
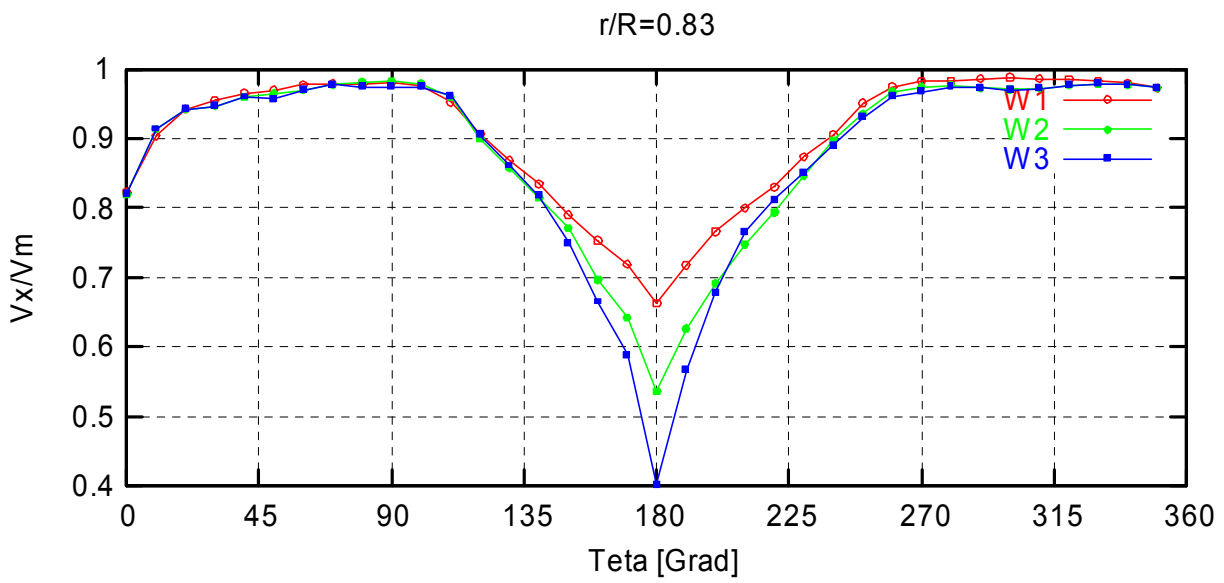
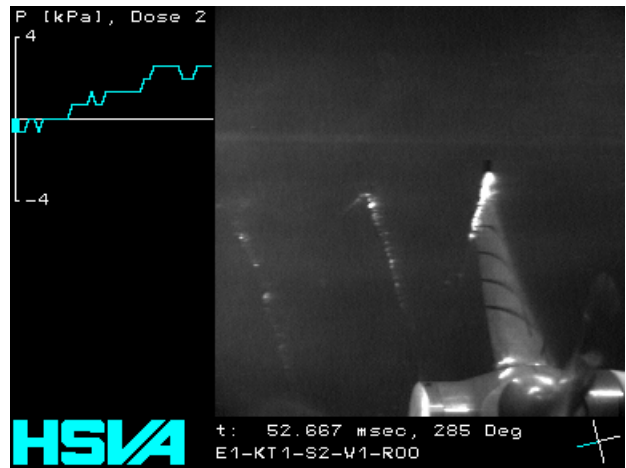


Abbildung 24 : Vergleich der axialen Komponente der Nachstromfelder (W2=Original)



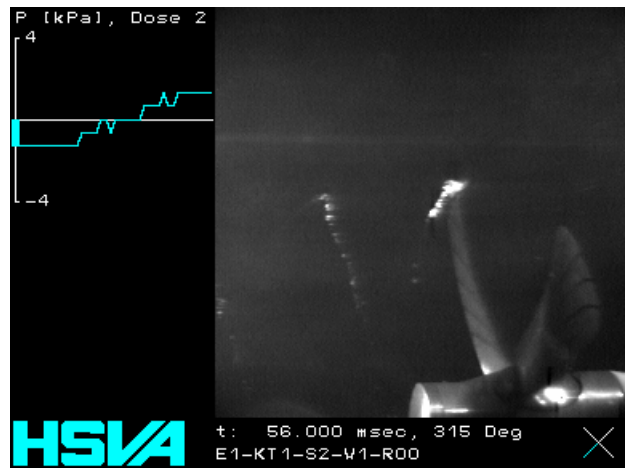
0° / Bild 231



15° / Bild 238



30° / Bild 245



45° / Bild 253



60° / Bild 260



75° / Bild 268

Abbildung 25 : E1-KT1-S2-W1-R00





0° / Bild 224



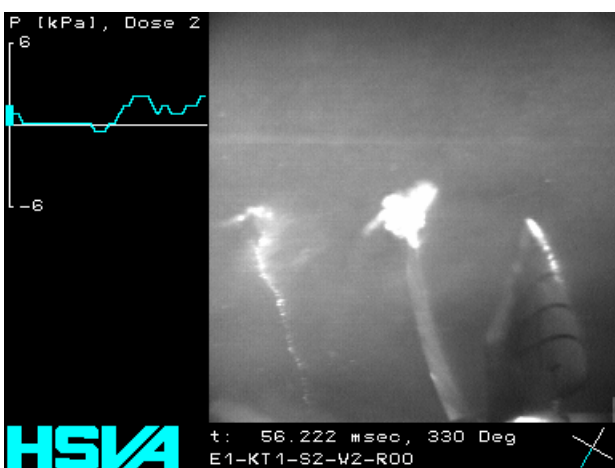
15° / Bild 232



30° / Bild 239



45° / Bild 247

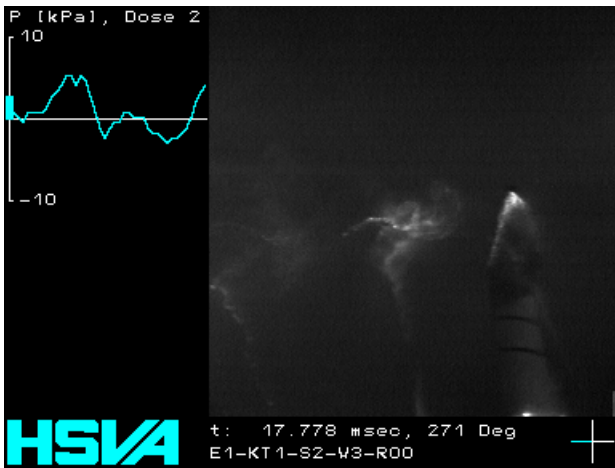


60° / Bild 254

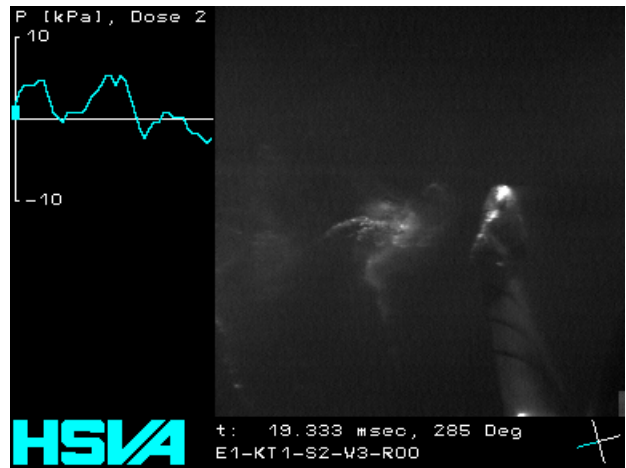


75° / Bild 261

Abbildung 26 : E1-KT1-S2-W2-R00



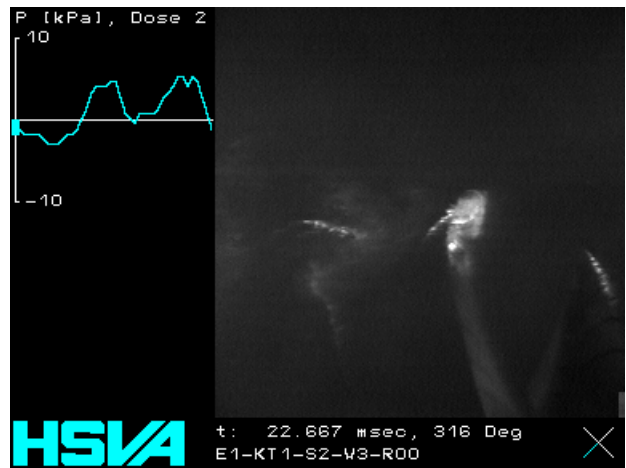
0° / Bild 81



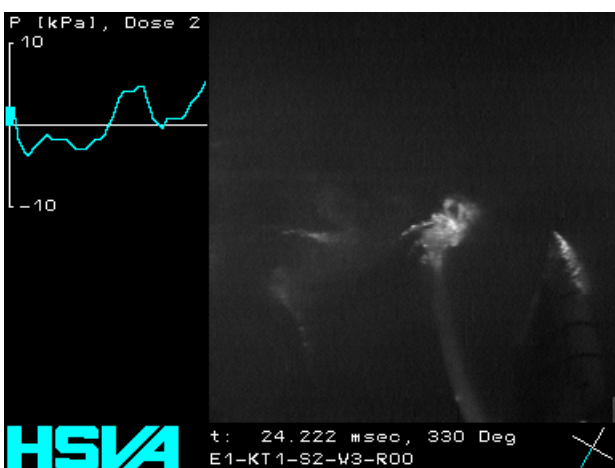
15° / Bild 89



30° / Bild 96



45° / Bild 103



60° / Bild 110

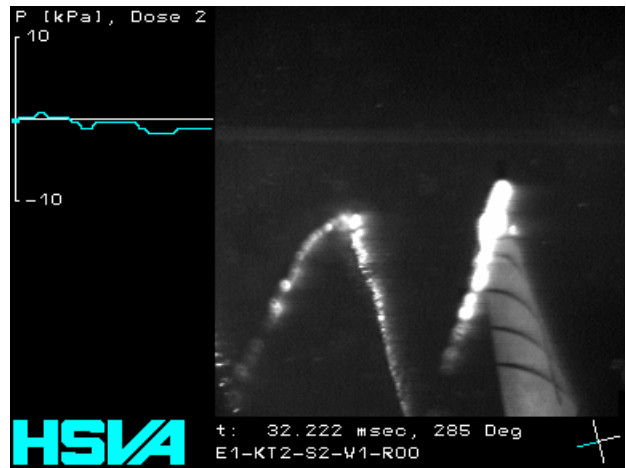


75° / Bild 117

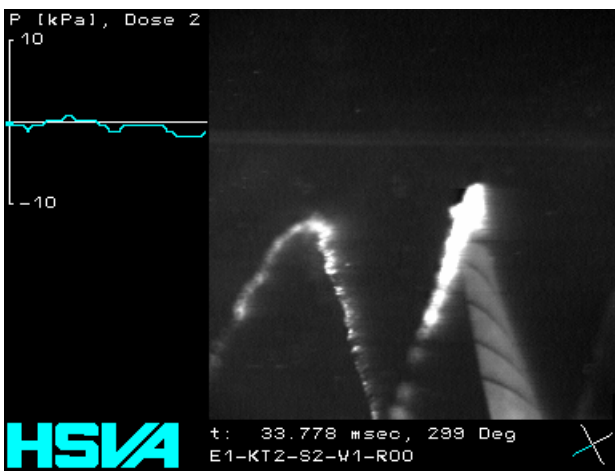
Abbildung 27 : E1-KT1-S2-W3-R00



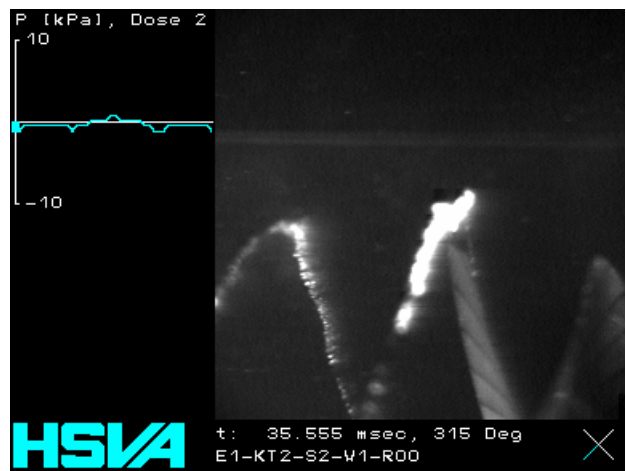
0° / Bild 139



15° / Bild 146



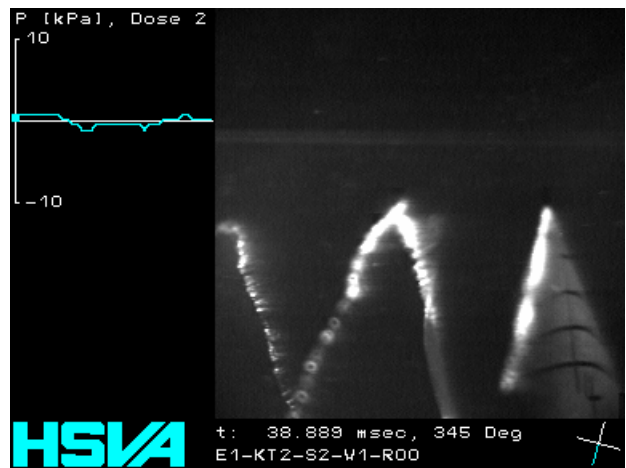
30° / Bild 153



45° / Bild 161

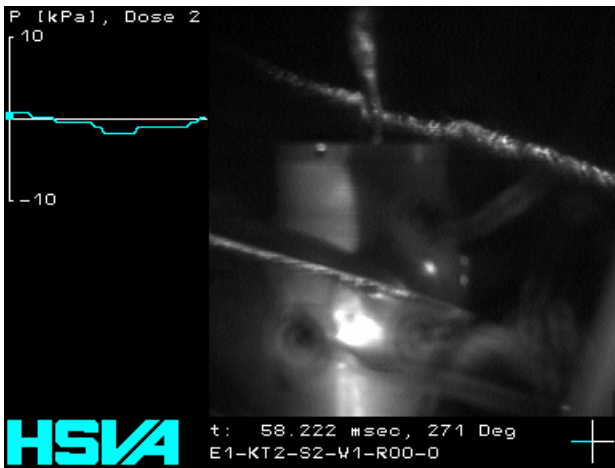


60° / Bild 168

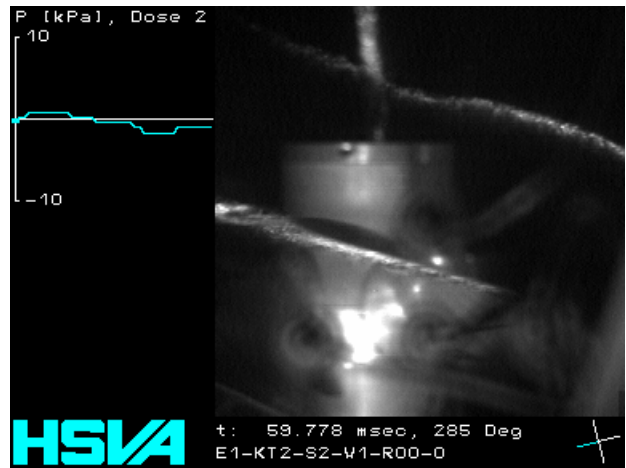


75° / Bild 176

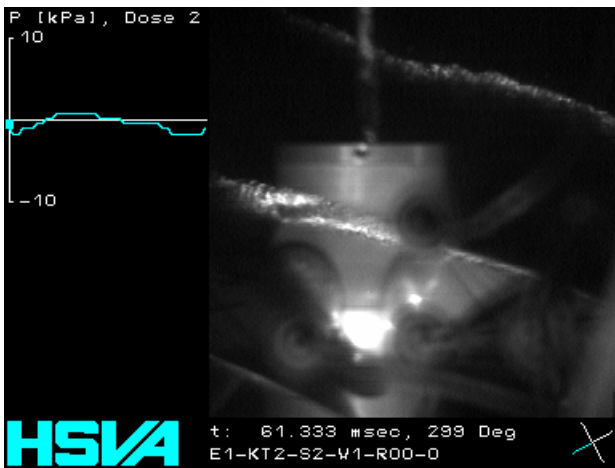
Abbildung 28 : E1-KT2-S2-W1-R00



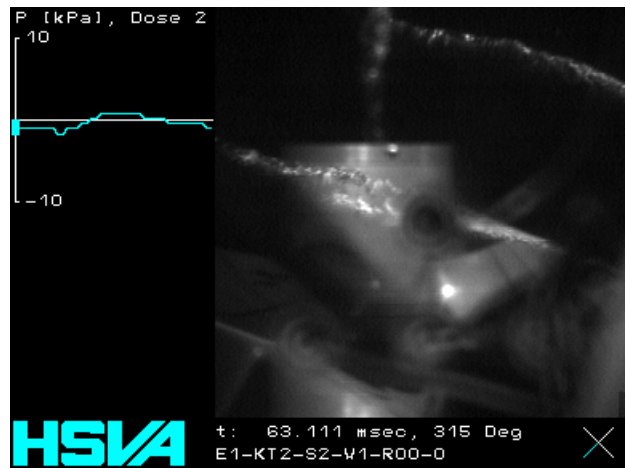
0° / Bild 263



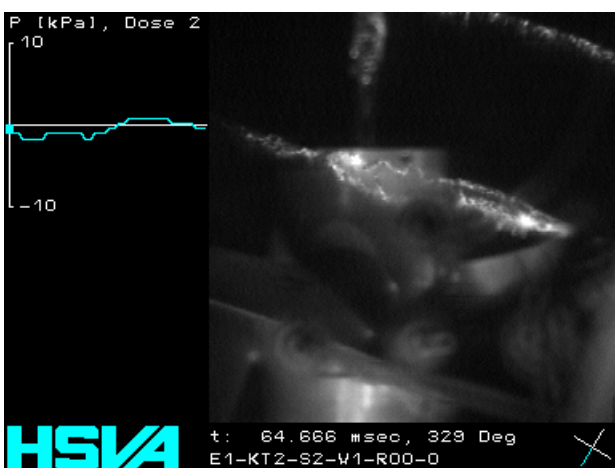
15° / Bild 270



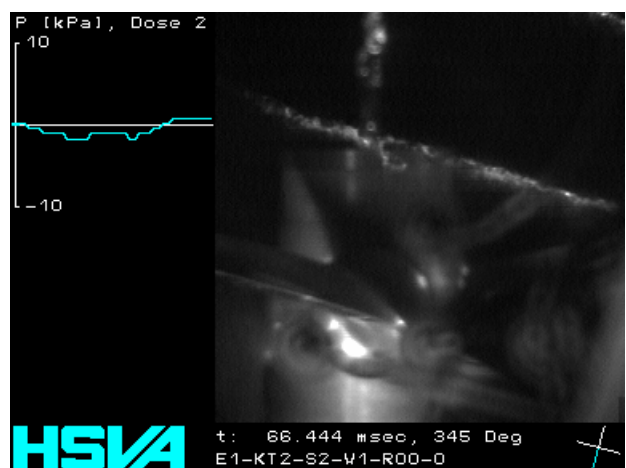
30° / Bild 277



45° / Bild 285

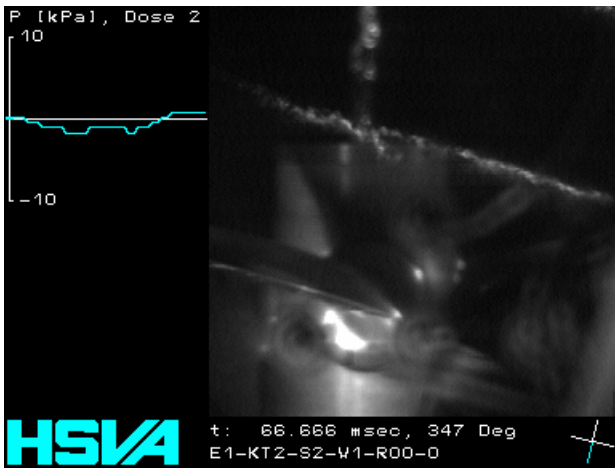


60° / Bild 292

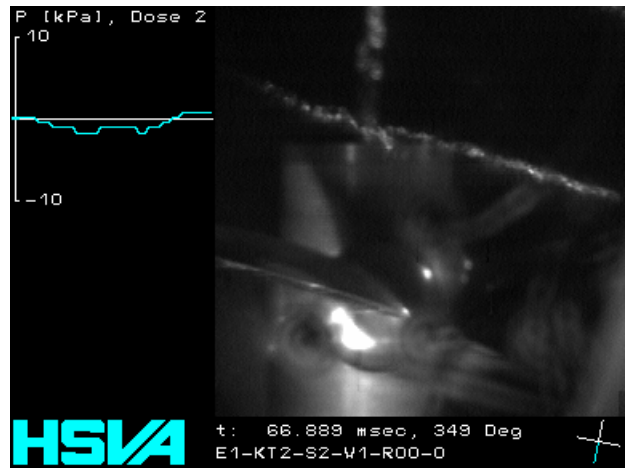


75° / Bild 300

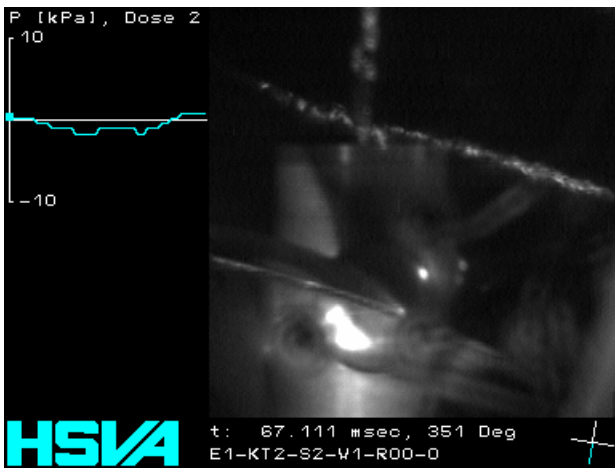
Abbildung 29 : E1-KT2-S2-W1-R00-Oben



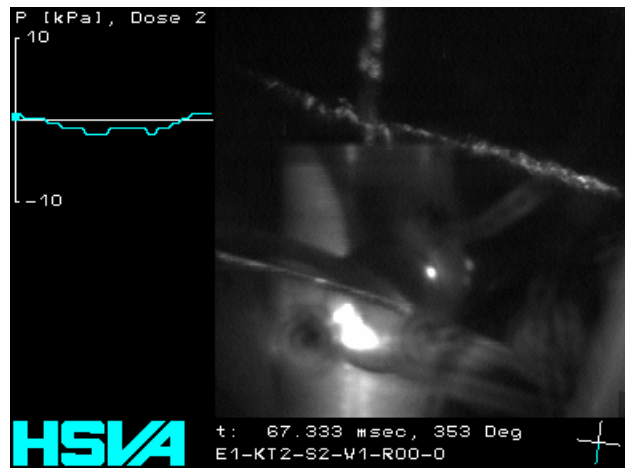
77° / Bild 301



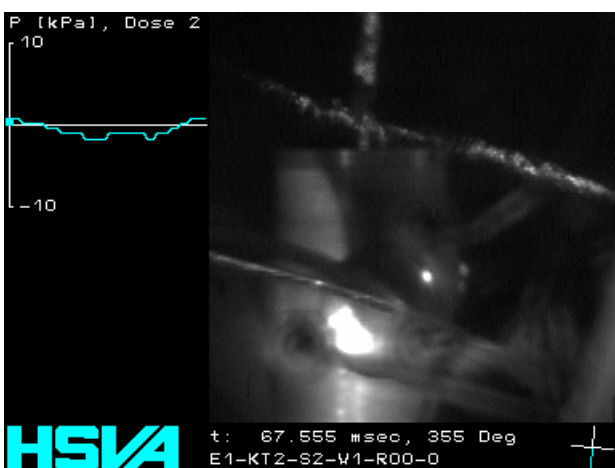
79° / Bild 302



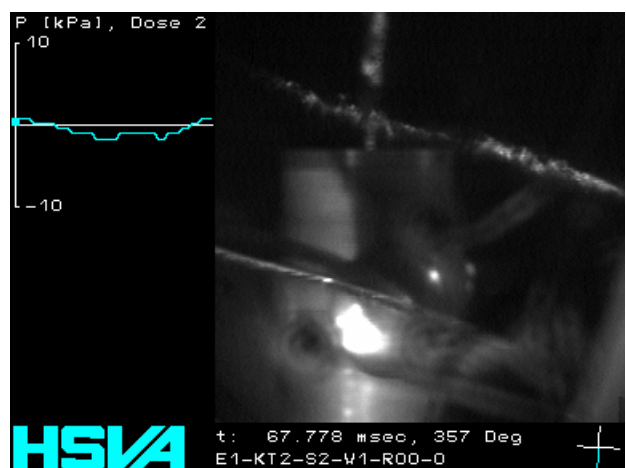
81° / Bild 303



83° / Bild 304

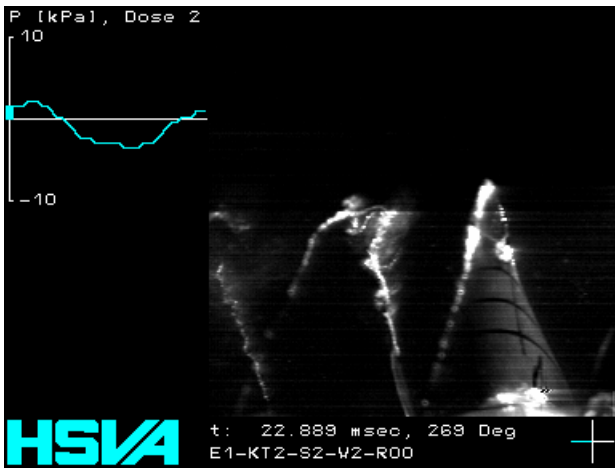


85° / Bild 305

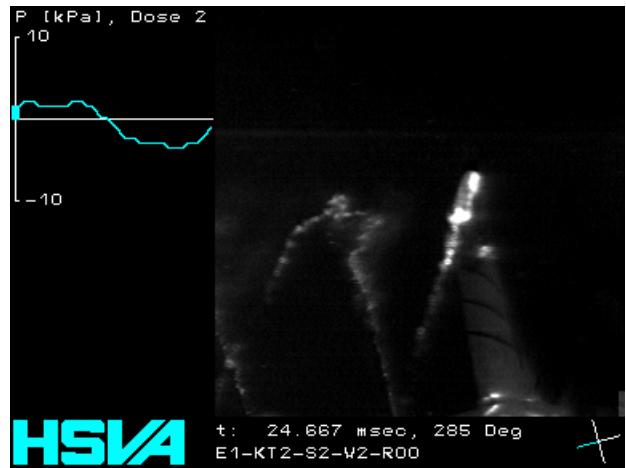


87° / Bild 306

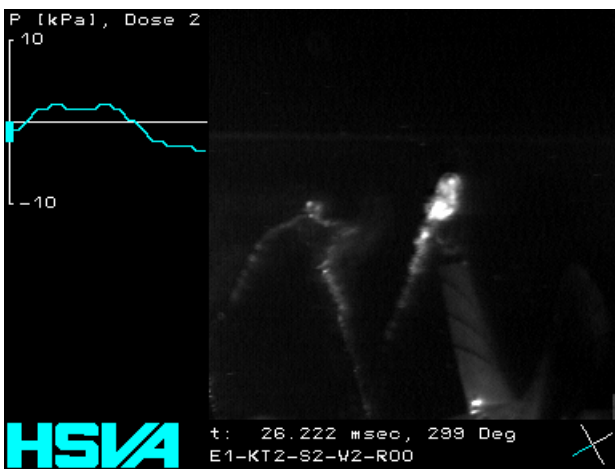
Abbildung 30 : E1-KT2-S2-W1-R00-Oben



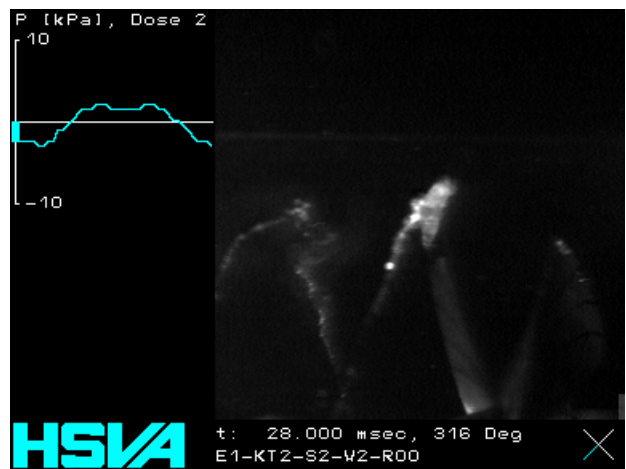
0° / Bild 104



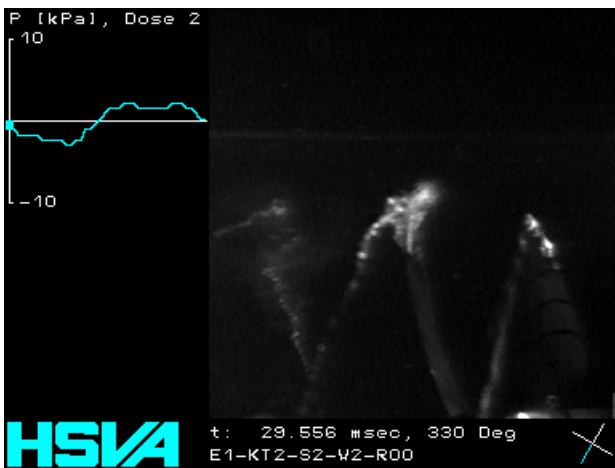
15° / Bild 112



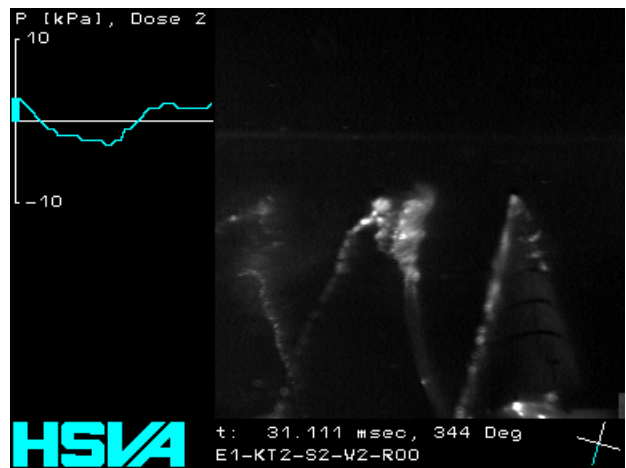
30° / Bild 119



45° / Bild 127

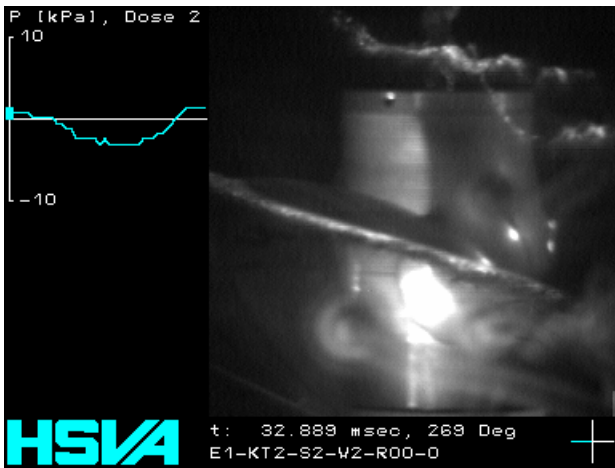


60° / Bild 134



75° / Bild 141

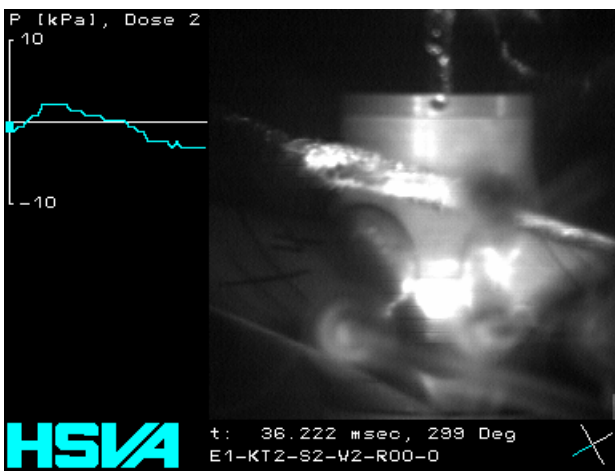
Abbildung 31 : E1-KT2-S2-W2-R00



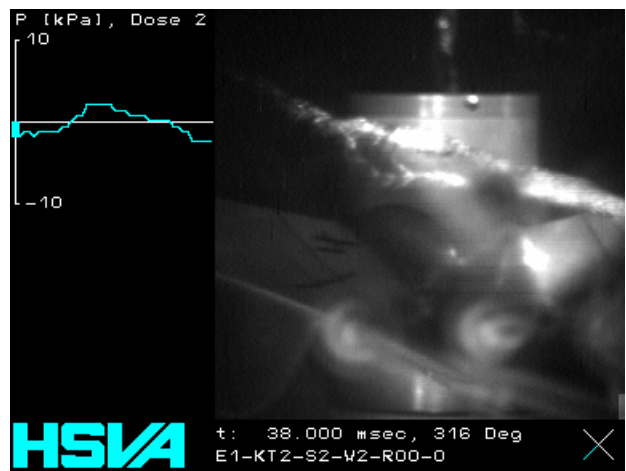
0° / Bild 149



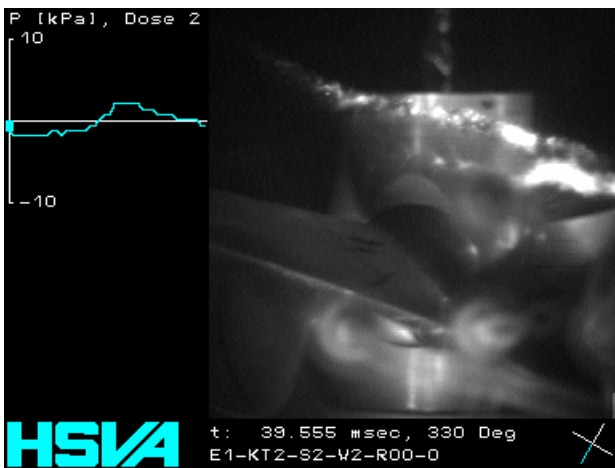
15° / Bild 157



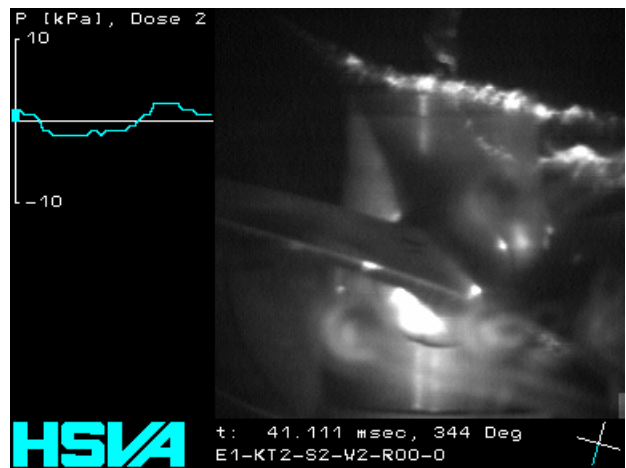
30° / Bild 164



45° / Bild 172

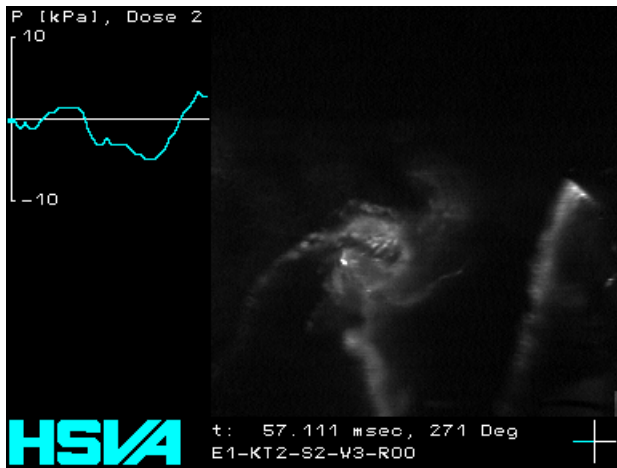


60° / Bild 179

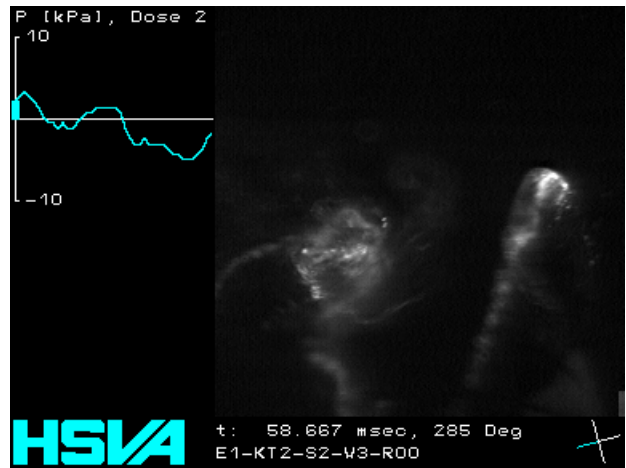


75° / Bild 186

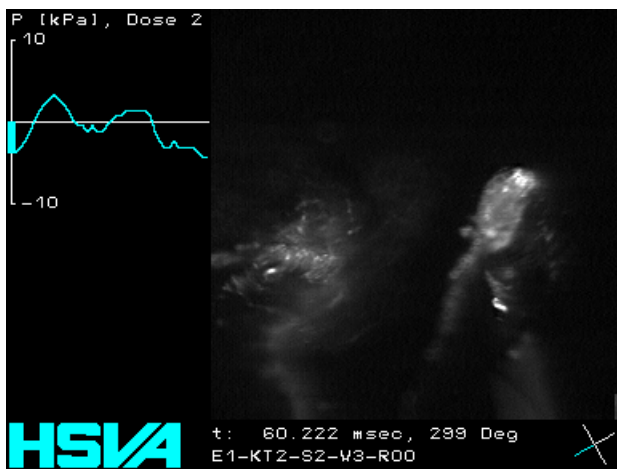
Abbildung 32 : E1-KT2-S2-W2-R00-Oben



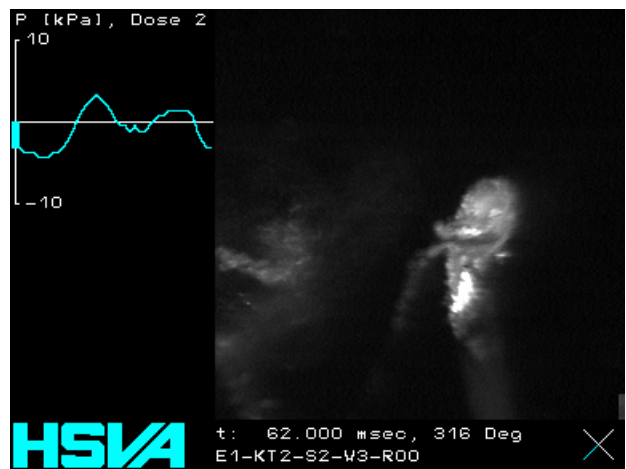
0° / Bild 258



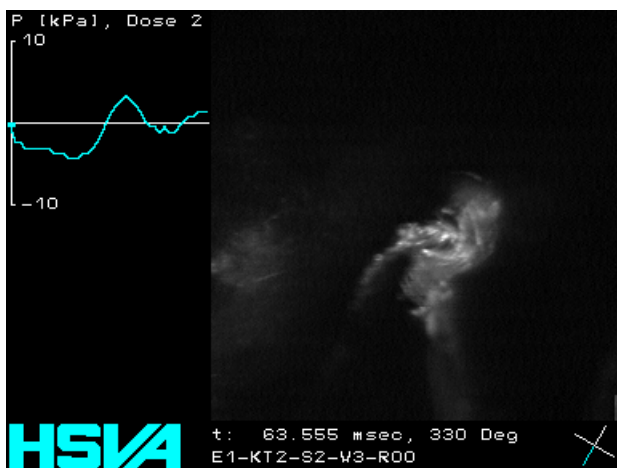
15° / Bild 265



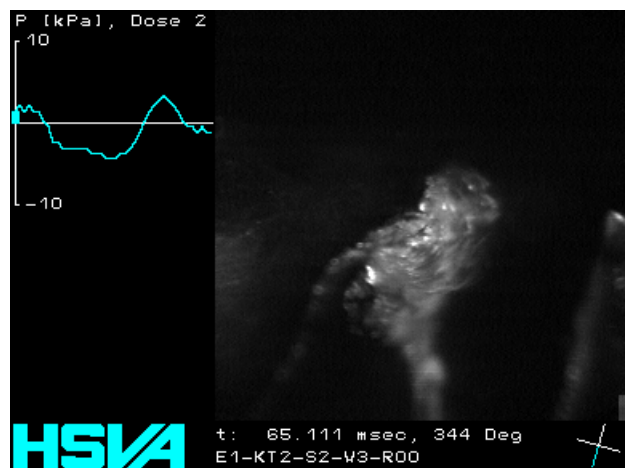
30° / Bild 272



45° / Bild 280



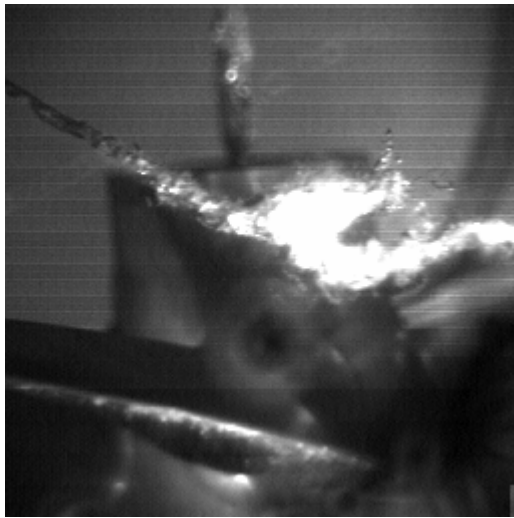
60° / Bild 287



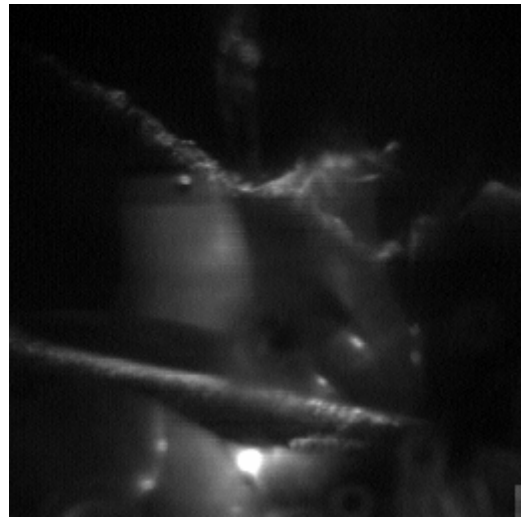
75° / Bild 294

Abbildung 33 : E1-KT2-S2-W3-R00

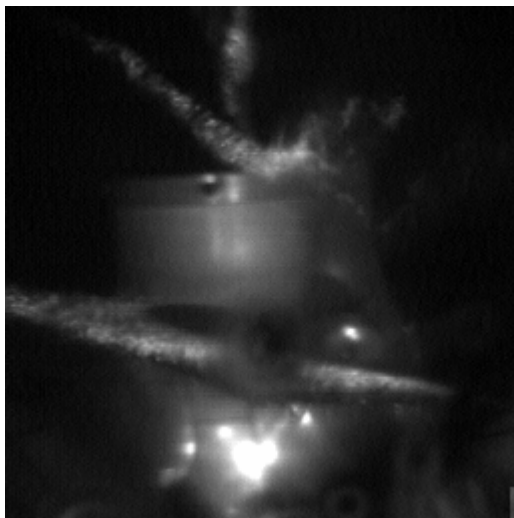




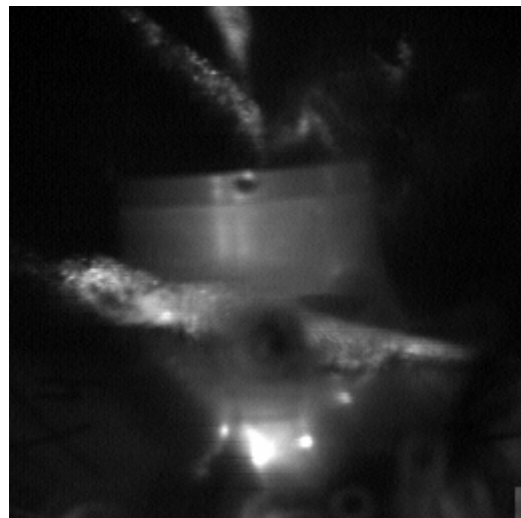
0° / Bild 283



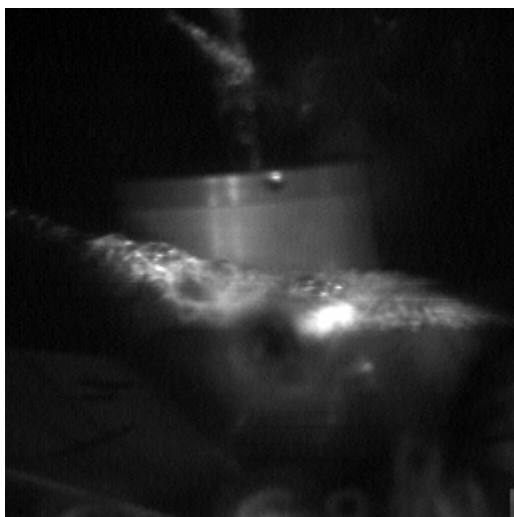
15° / Bild 290



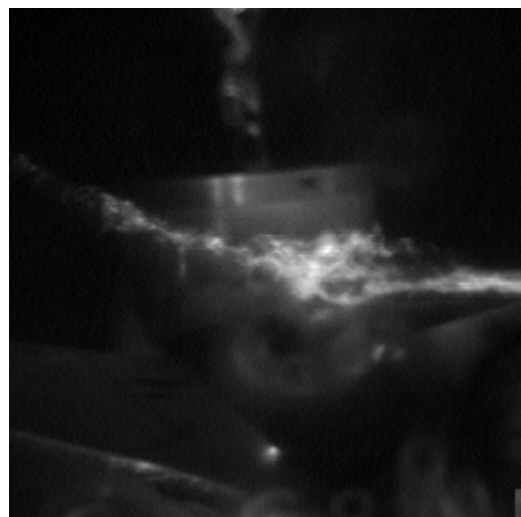
30° / Bild 297



45° / Bild 304

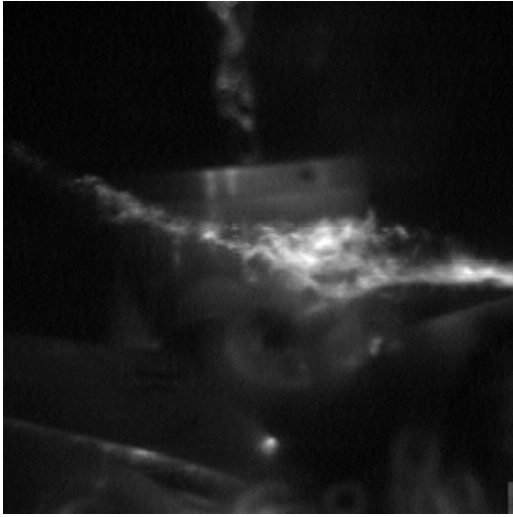


60° / Bild 311

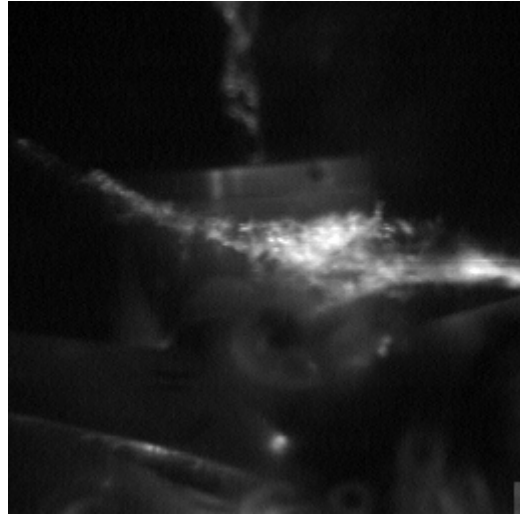


75° / Bild 318

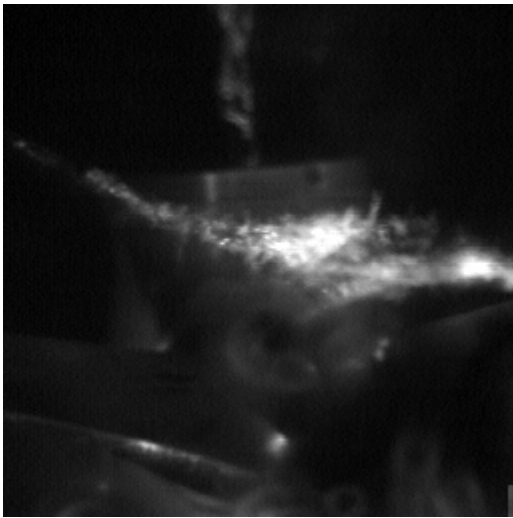
Abbildung 34 : E1-KT2-S2-W3-R00-Oben



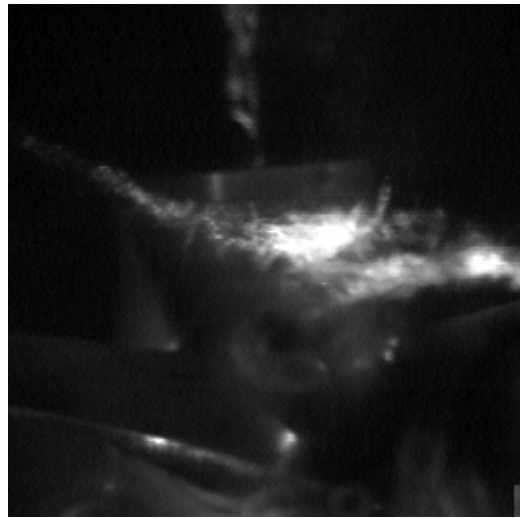
77° / Bild 319



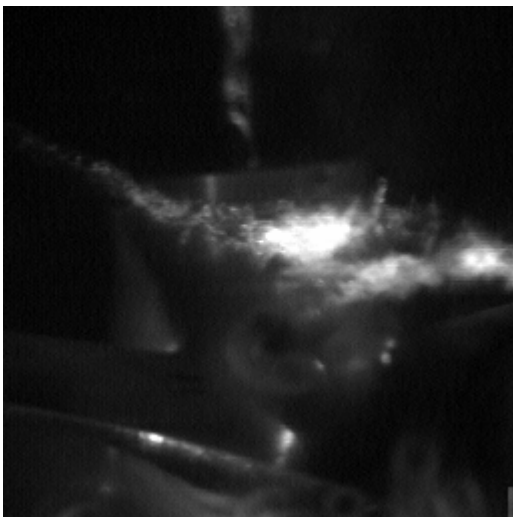
79° / Bild 320



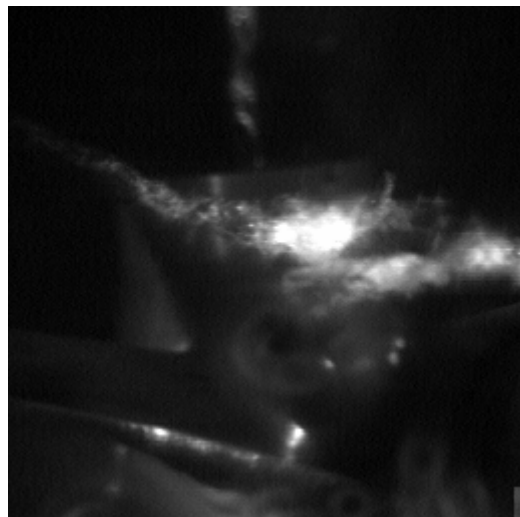
81° / Bild 321



83° / Bild 322

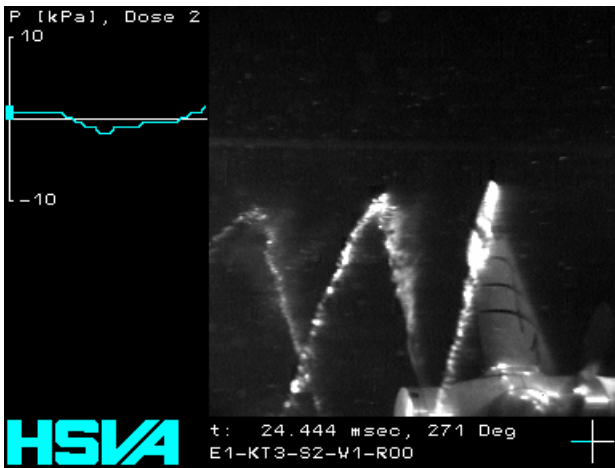


85° / Bild 323

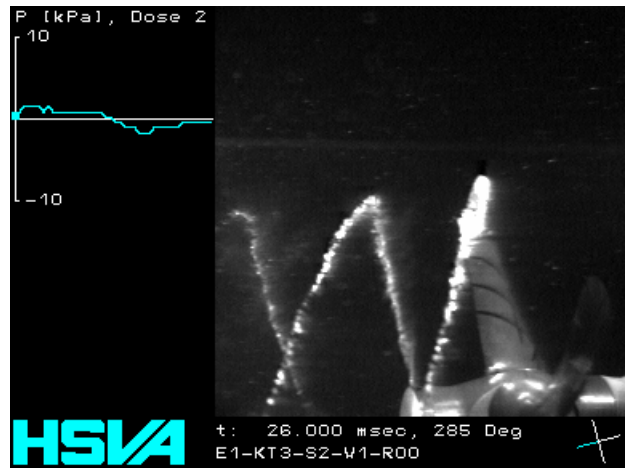


87° / Bild 324

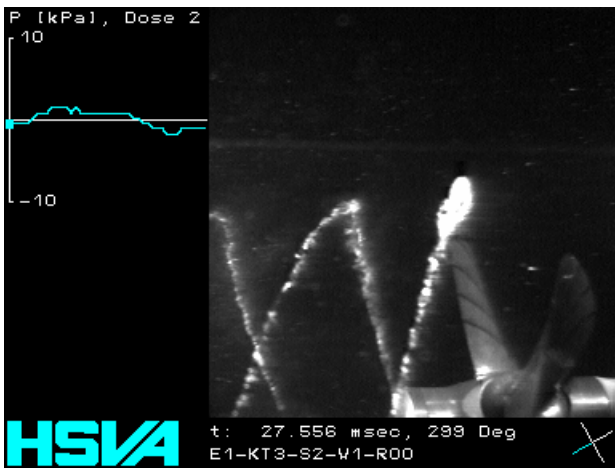
Abbildung 35 : E1-KT2-S2-W3-R00-Oben



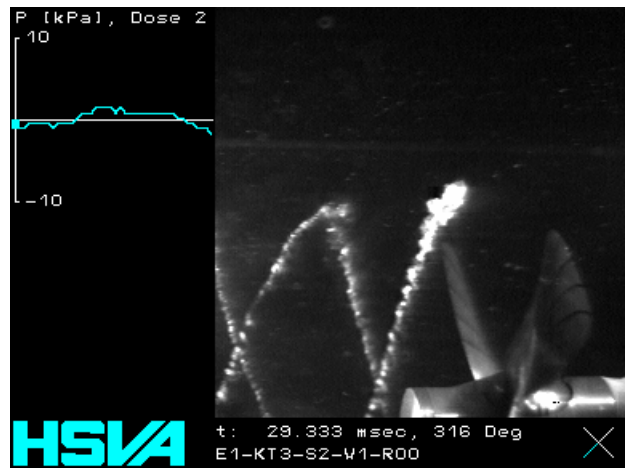
0° / Bild 111



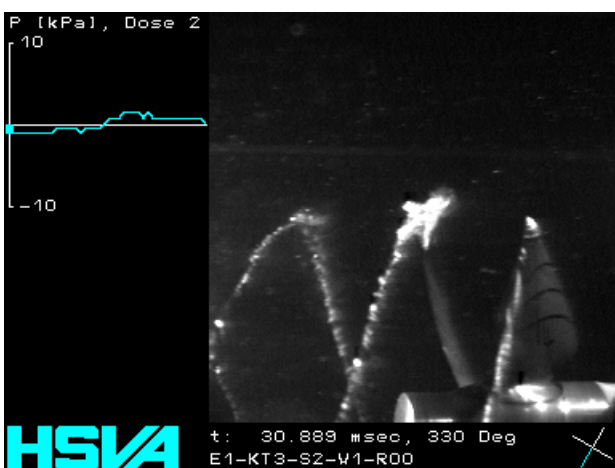
15° / Bild 118



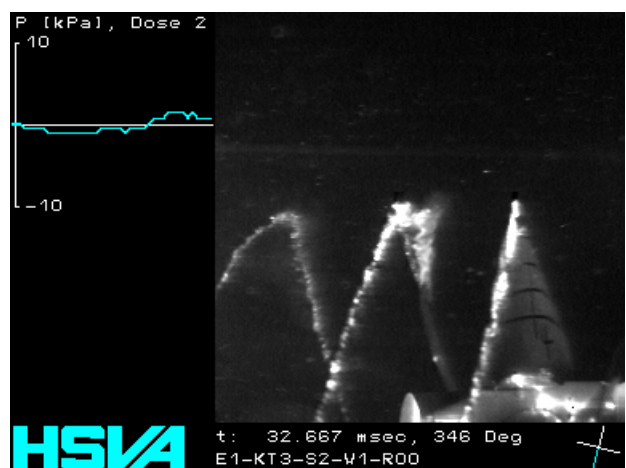
30° / Bild 125



45° / Bild 133

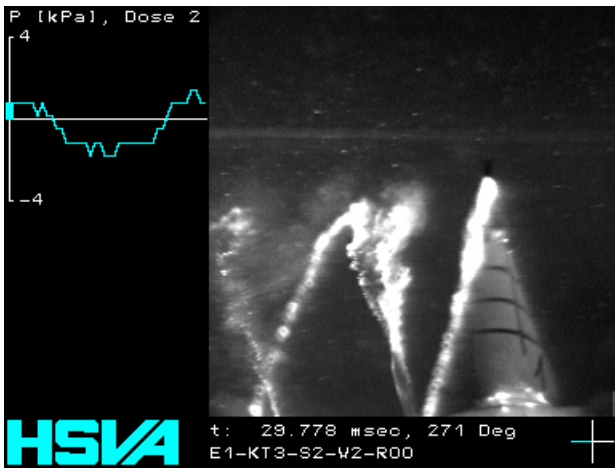


60° / Bild 140

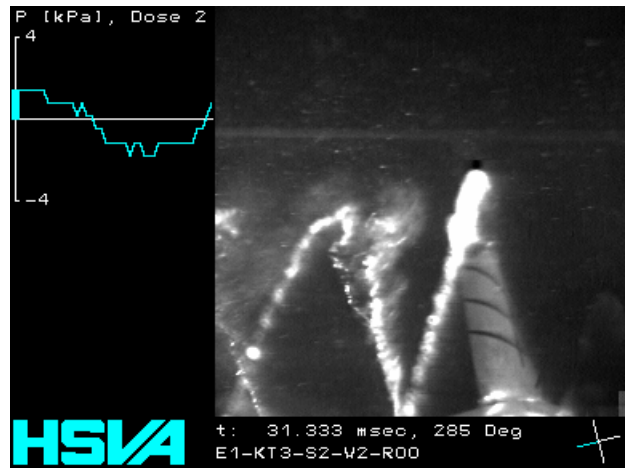


75° / Bild 148

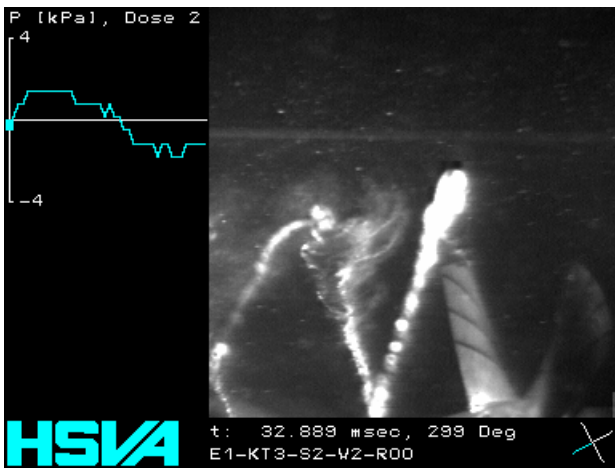
Abbildung 36 : E1-KT3-S2-W1-R00



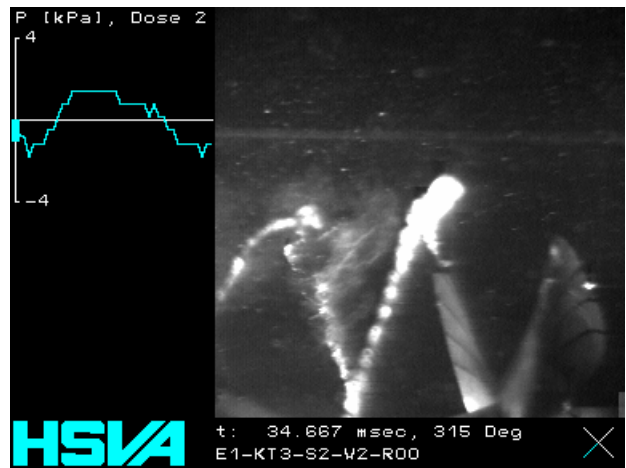
0° / Bild 131



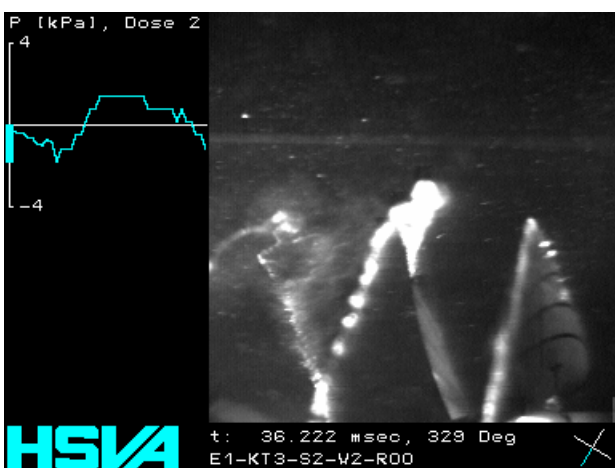
15° / Bild 142



30° / Bild 149



45° / Bild 157

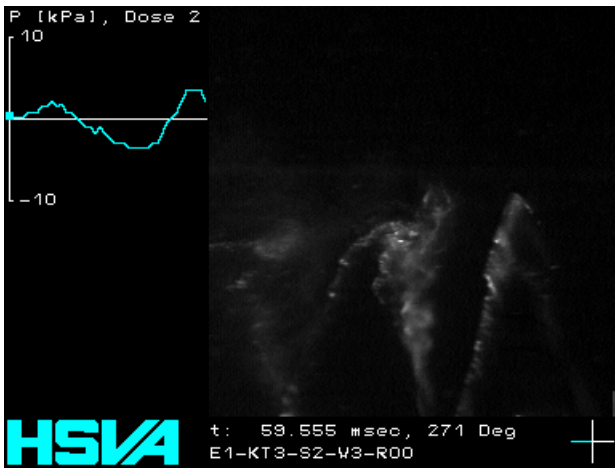


60° / Bild 164

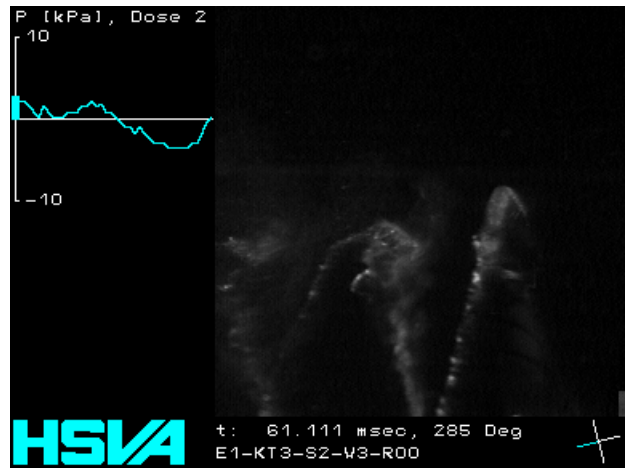


75° / Bild 171

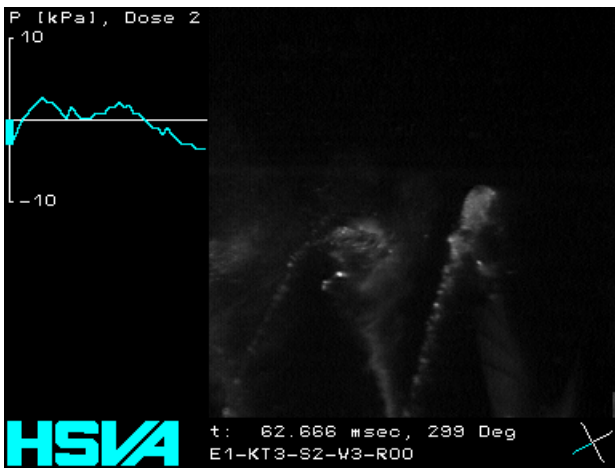
Abbildung 37 : E1-KT3-S2-W2-R00



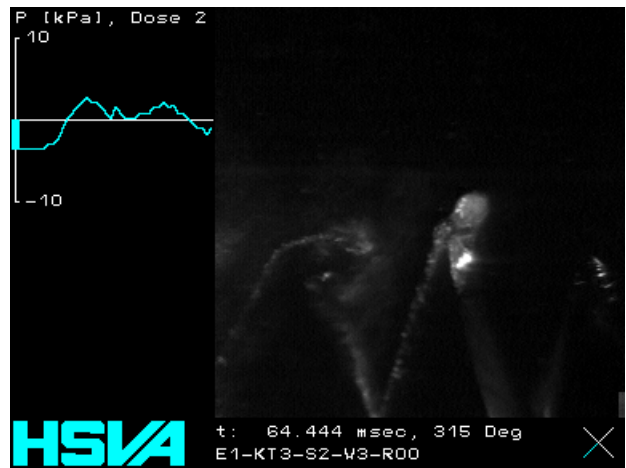
0° / Bild 269



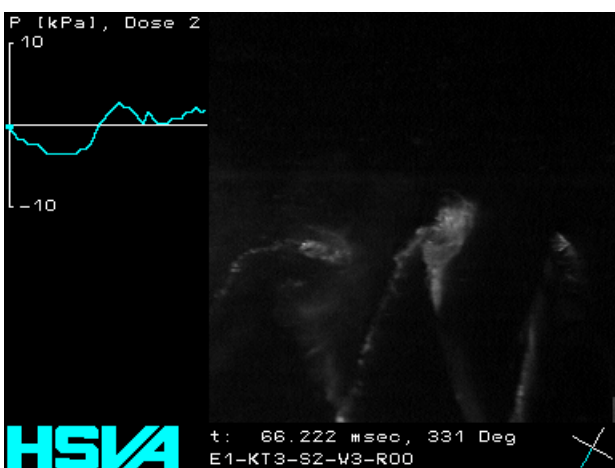
15° / Bild 276



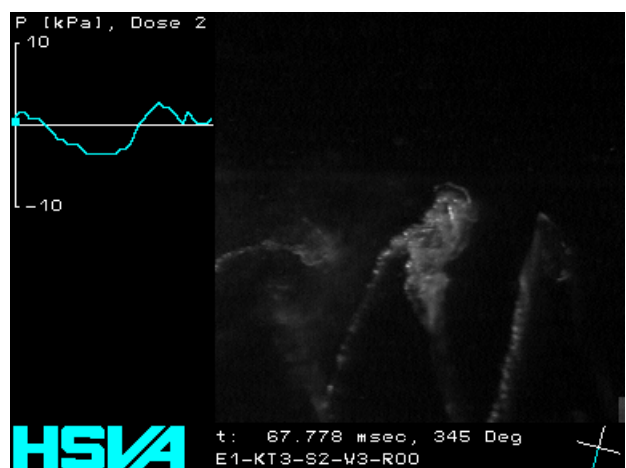
30° / Bild 283



45° / Bild 291



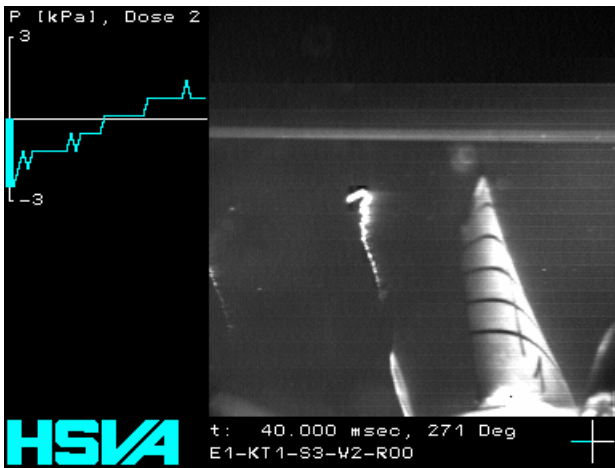
60° / Bild 299



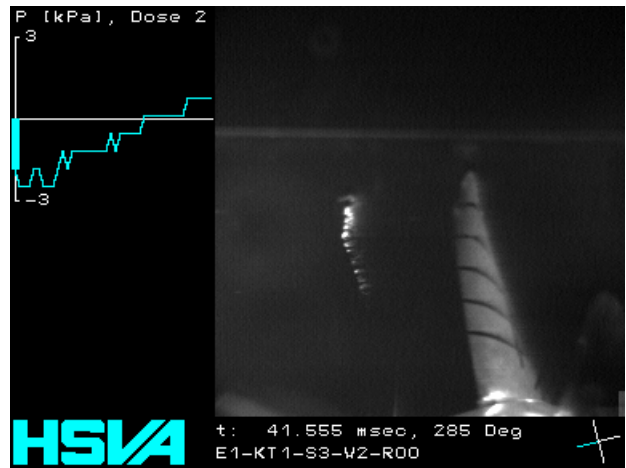
75° / Bild 306

Abbildung 38 : E1-KT3-S2-W3-R00

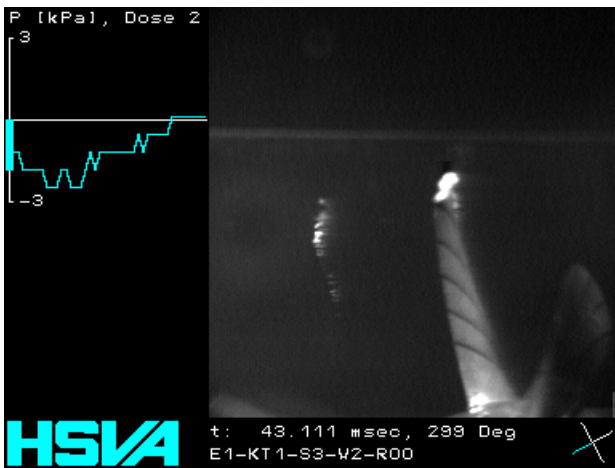
# Einfluss der Kavitationszahl



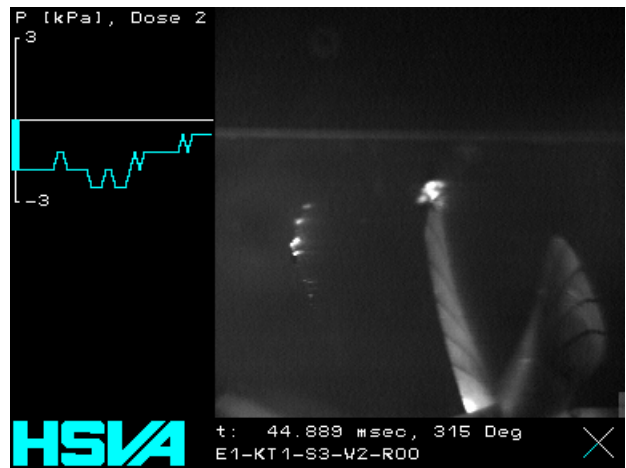
0° / Bild 181



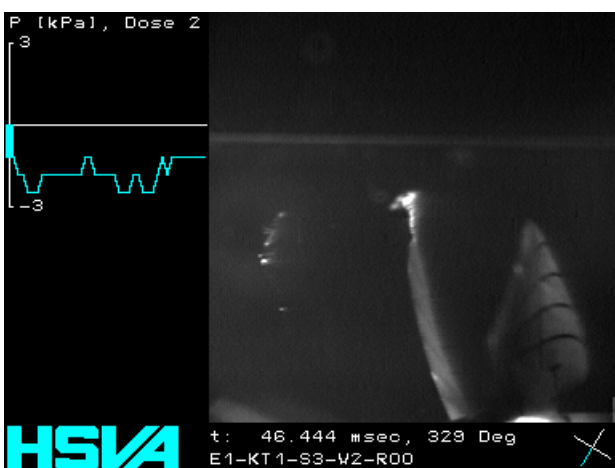
15° / Bild 188



30° / Bild 195



45° / Bild 203

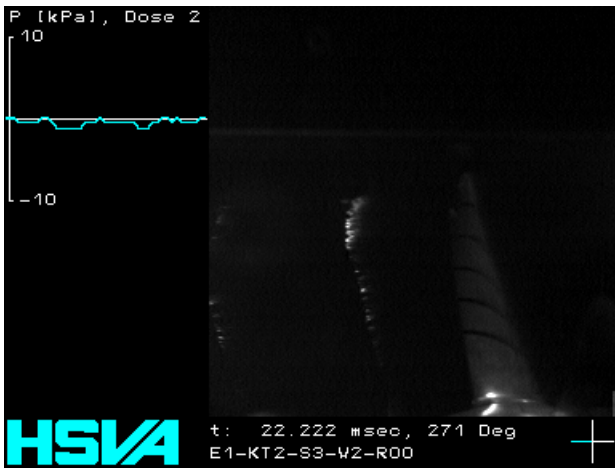


60° / Bild 210

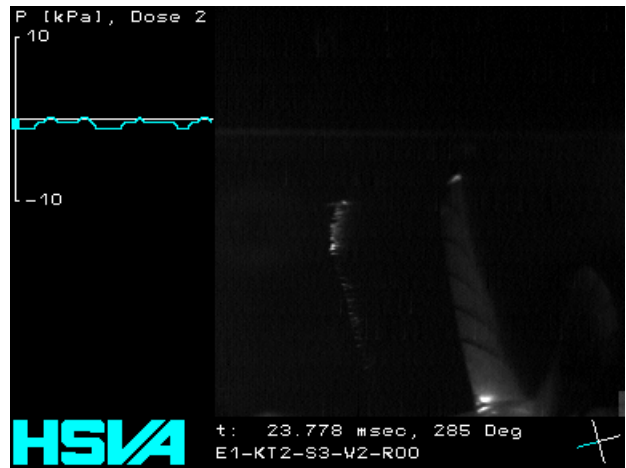


75° / Bild 218

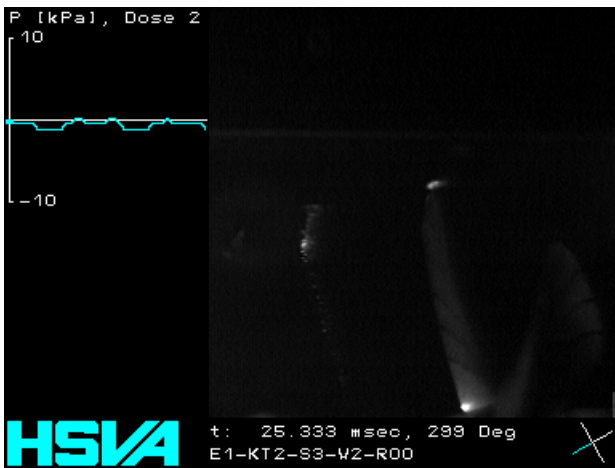
Abbildung 39 : E1-KT1-S3-W2-R00



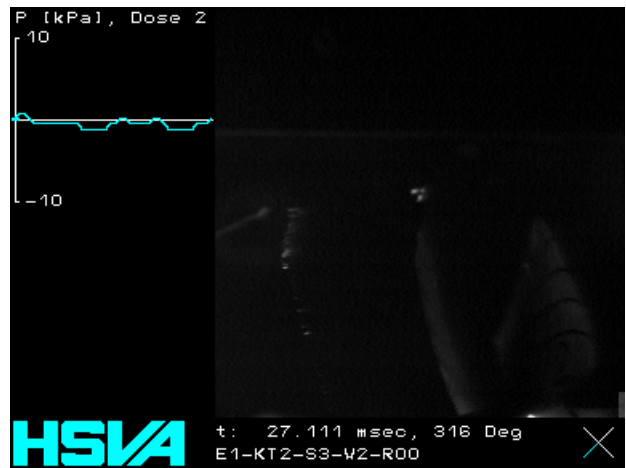
0° / Bild 101



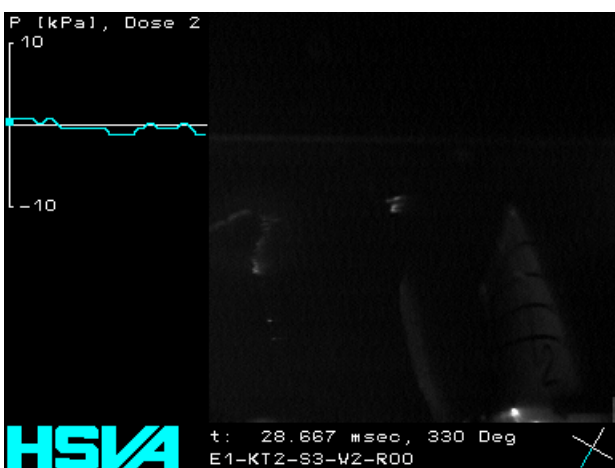
15° / Bild 108



30° / Bild 115



45° / Bild 123



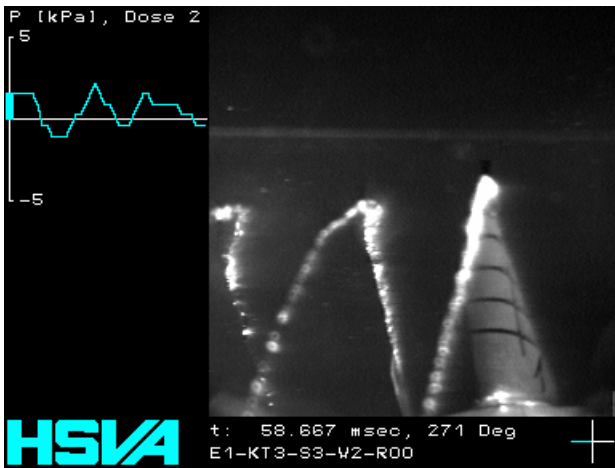
60° / Bild 130



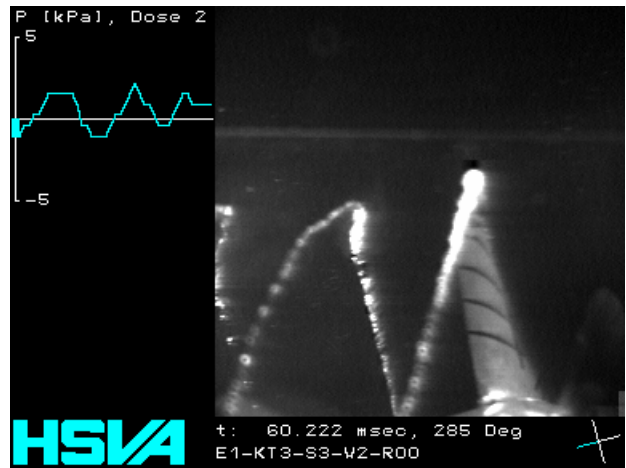
75° / Bild 137

Abbildung 40 : E1-KT2-S3-W2-R00

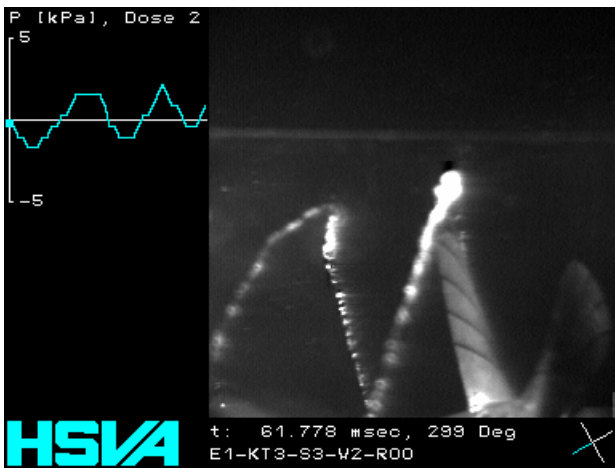




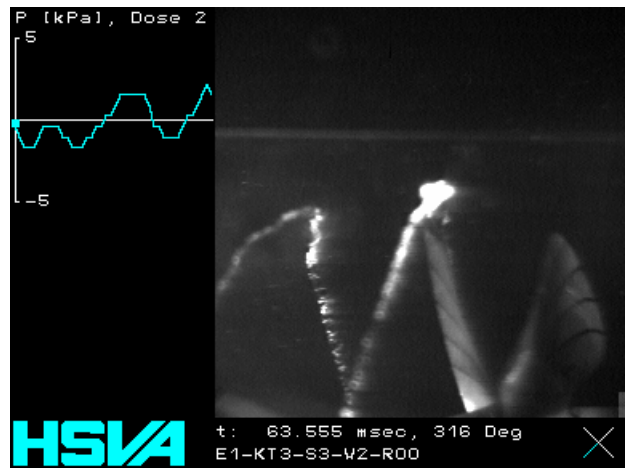
0° / Bild 265



15° / Bild 272



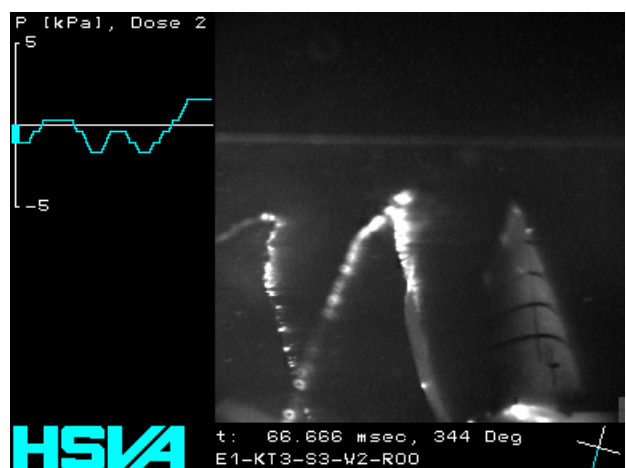
30° / Bild 279



45° / Bild 287

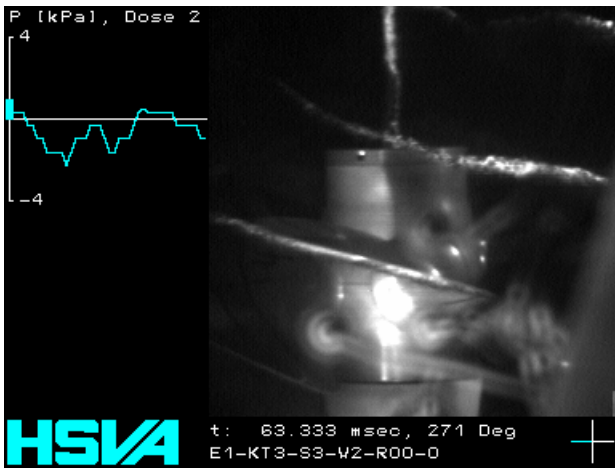


60° / Bild 294

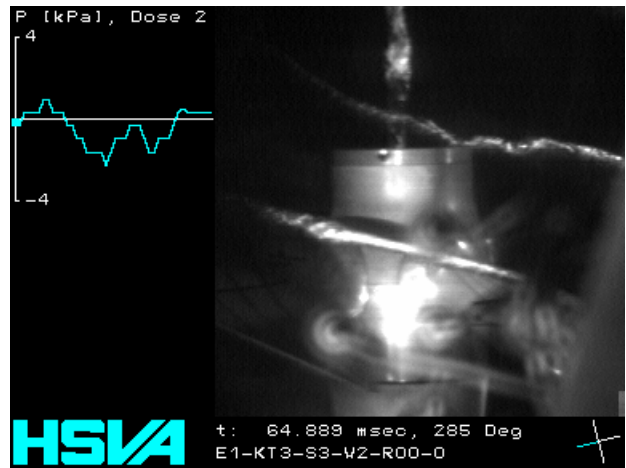


75° / Bild 301

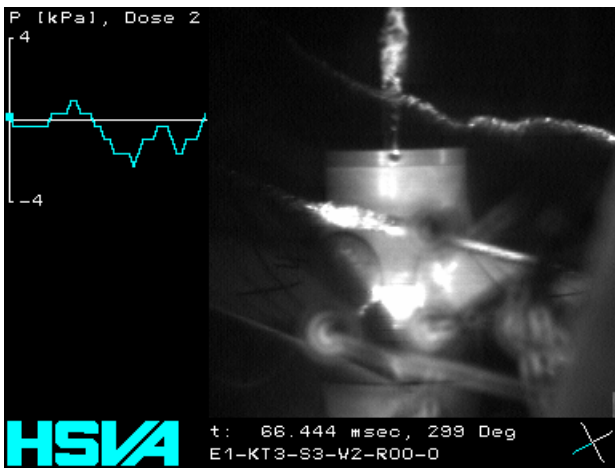
Abbildung 41 : E1-KT3-S3-W2-R00



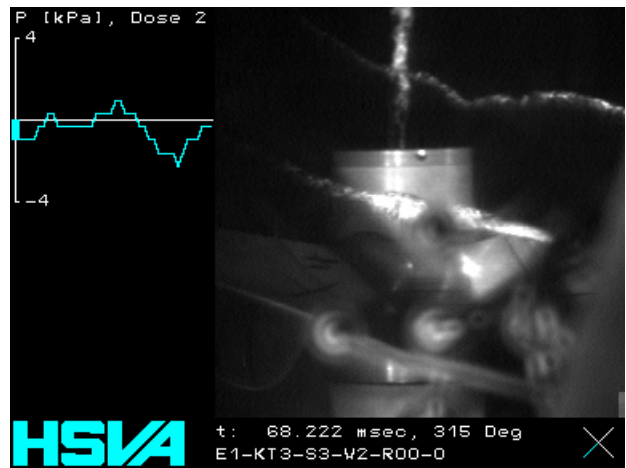
ca 0° / Bild 286



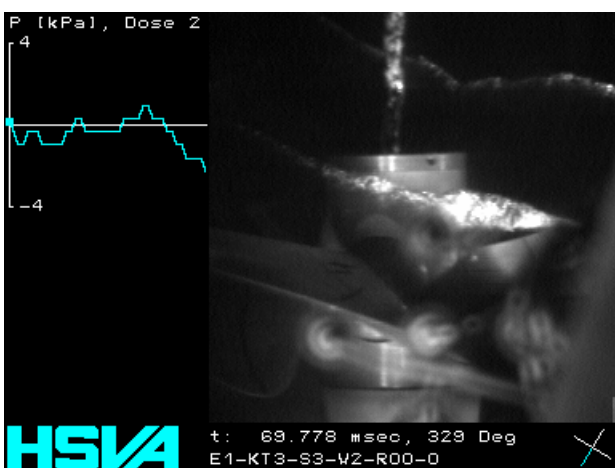
15° / Bild 293



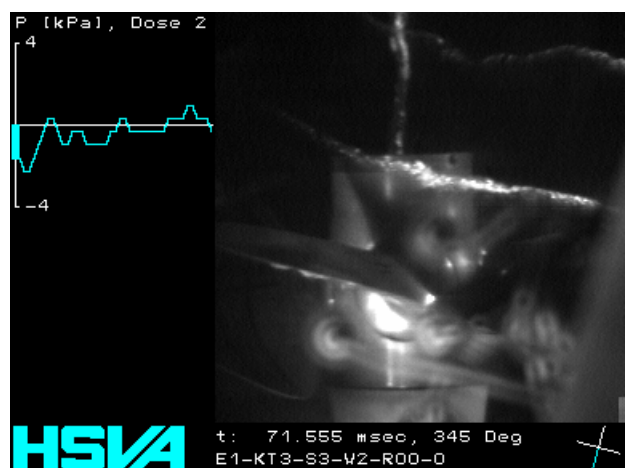
30° / Bild 300



45° / Bild 308



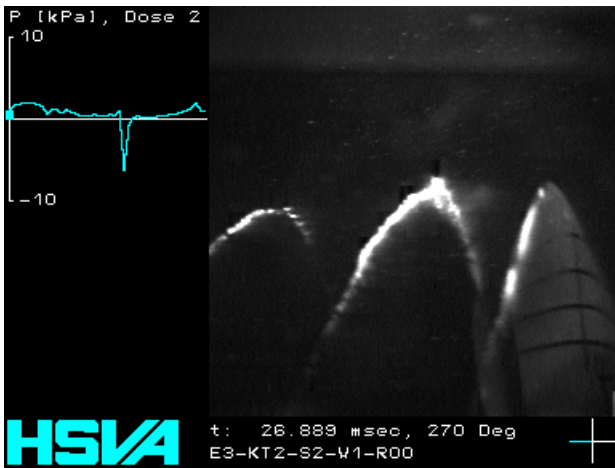
60° / Bild 315



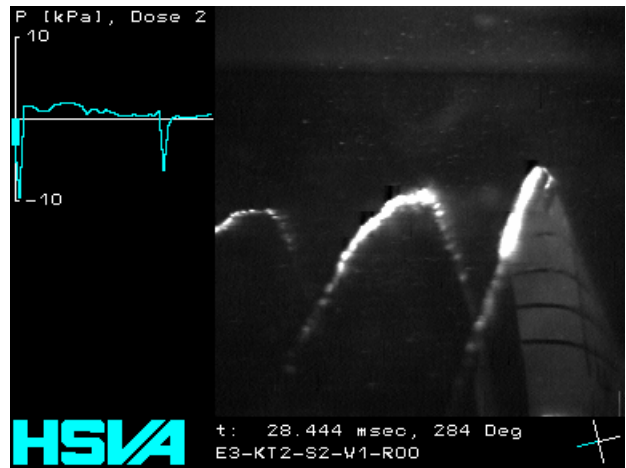
75° / Bild 323

Abbildung 42 : E1-KT3-S3-W2-R00-Oben

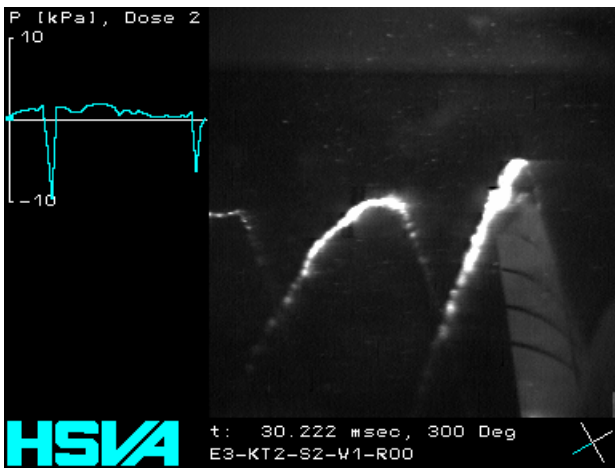
# Einfluss der Steigung



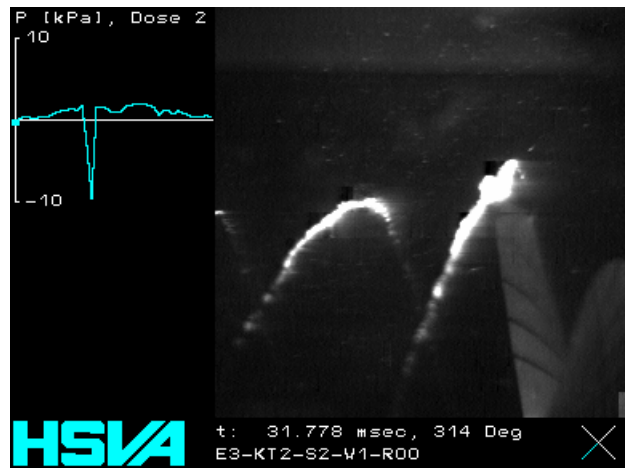
0° / Bild 122



15° / Bild 129



30° / Bild 137



45° / Bild 144

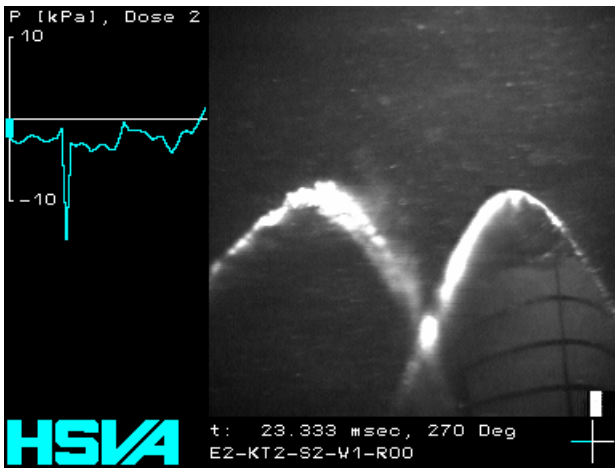


60° / Bild 152

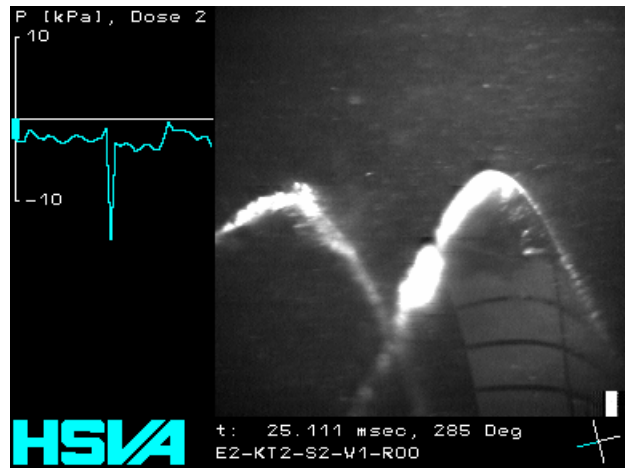


75° / Bild 159

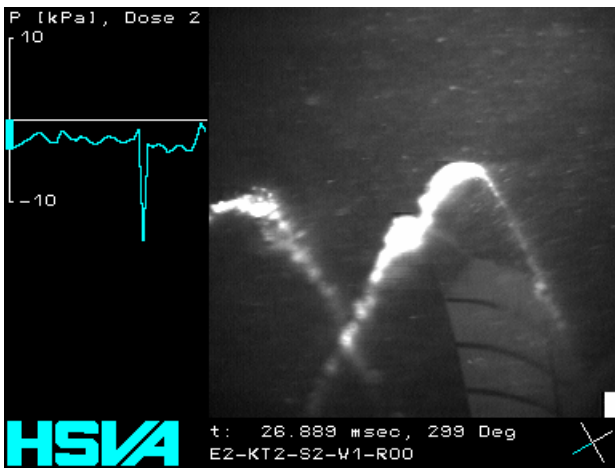
Abbildung 43 : E3-KT2-S2-W1-R00, E-3°



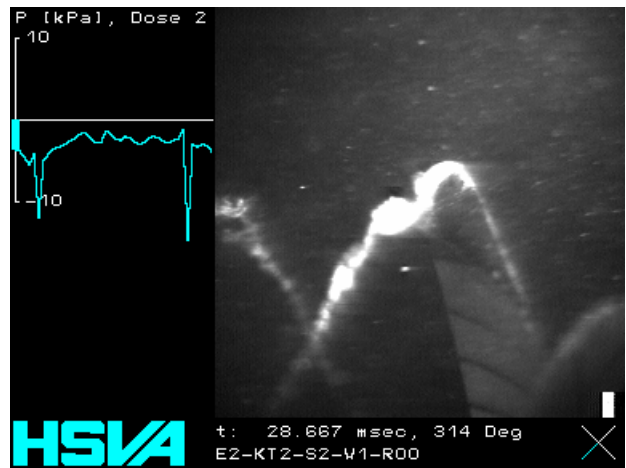
0° / Bild 106



15° / Bild 114



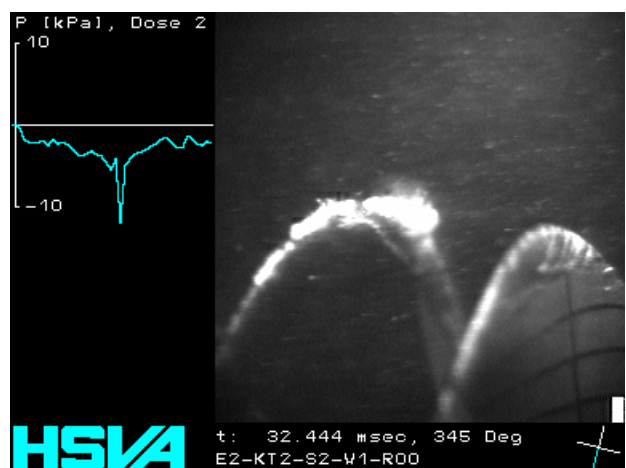
30° / Bild 122



45° / Bild 130

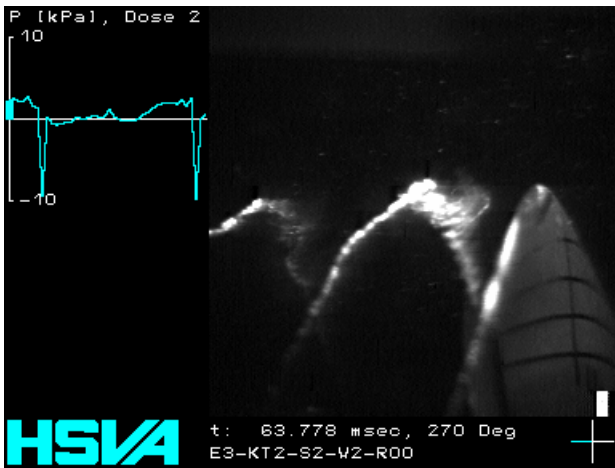


60° / Bild 138

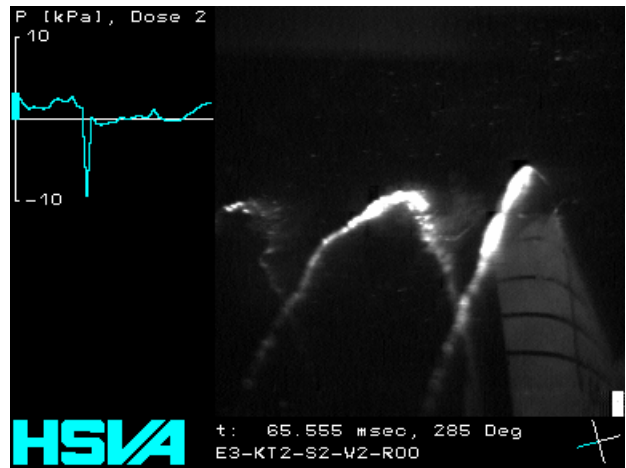


75° / Bild 147

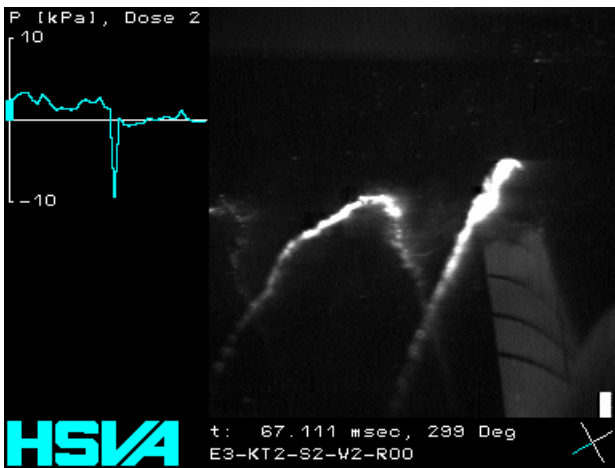
Abbildung 44 : E2-KT2-S2-W1-R00, E+3°



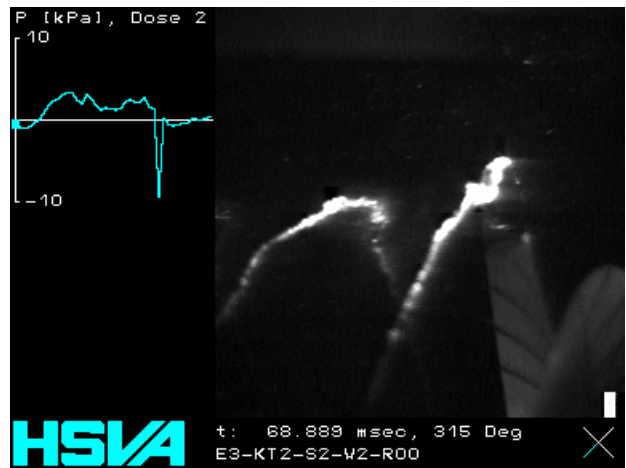
0° / Bild 288



15° / Bild 296



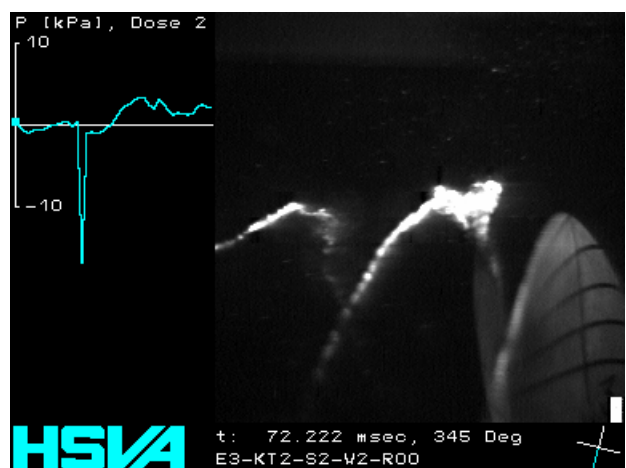
30° / Bild 303



45° / Bild 311

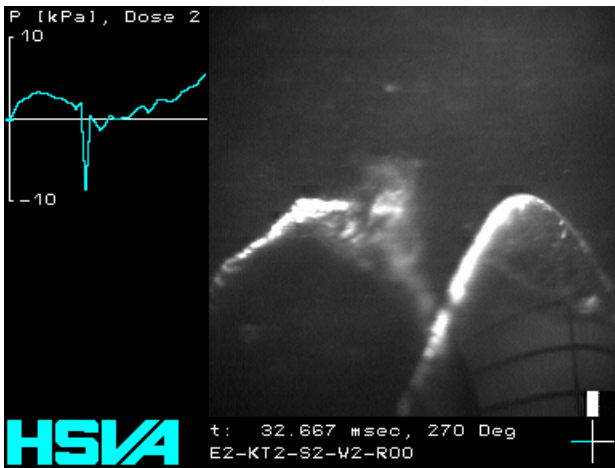


60° / Bild 318

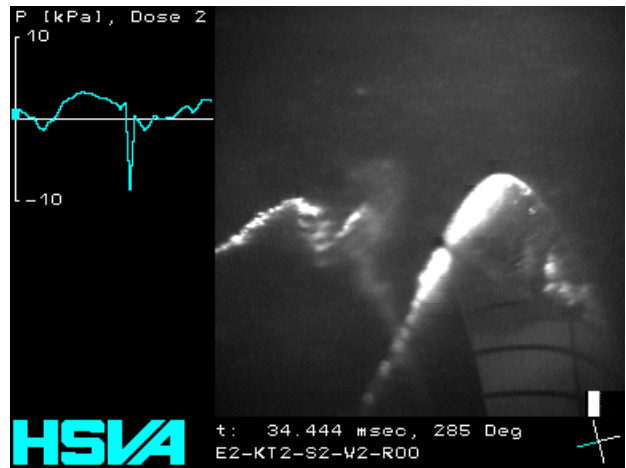


75° / Bild 326

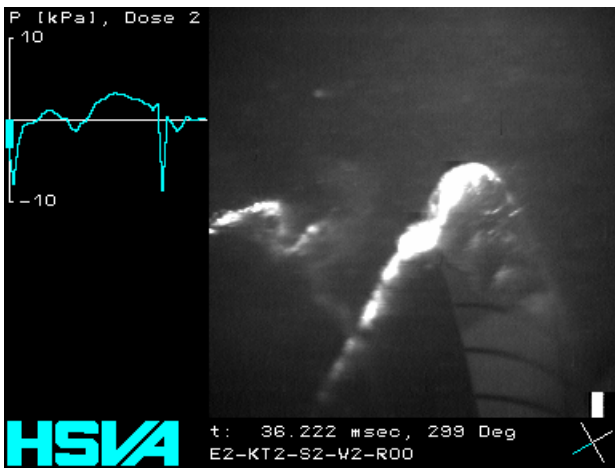
Abbildung 45 : E3-KT2-S2-W2-R00, E-3°



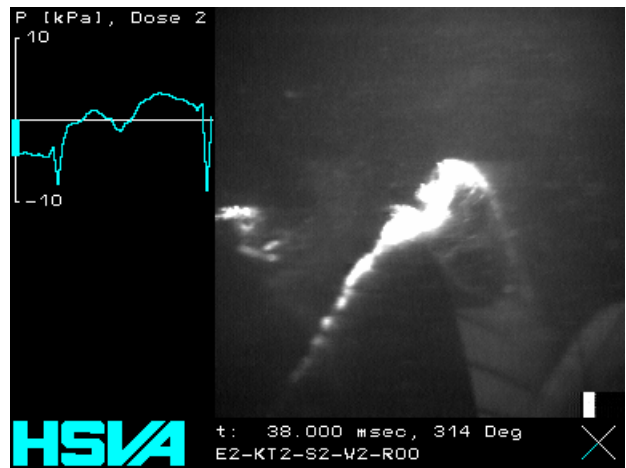
0° / Bild 148



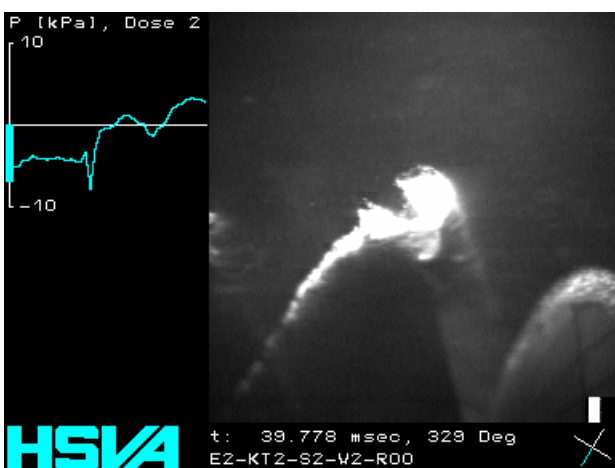
15° / Bild 156



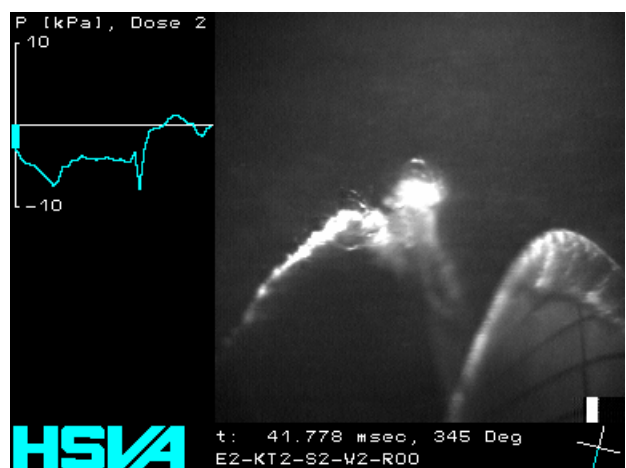
30° / Bild 164



45° / Bild 172



60° / Bild 180

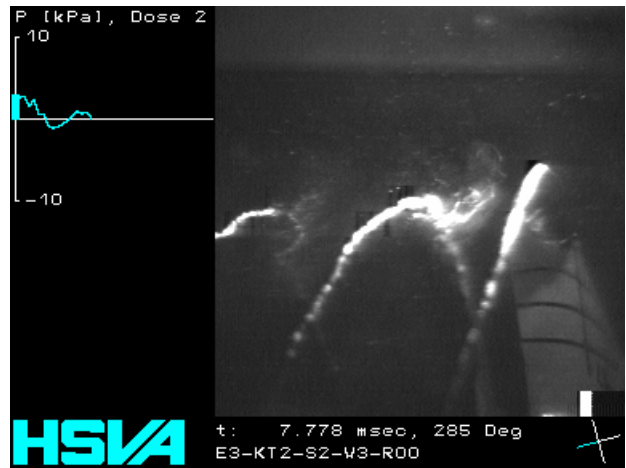


75° / Bild 189

Abbildung 46 : E2-KT2-S2-W2-R00, E+3°



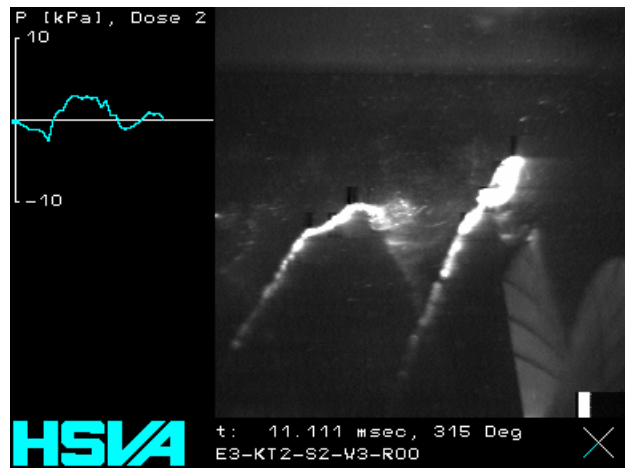
0° / Bild 29



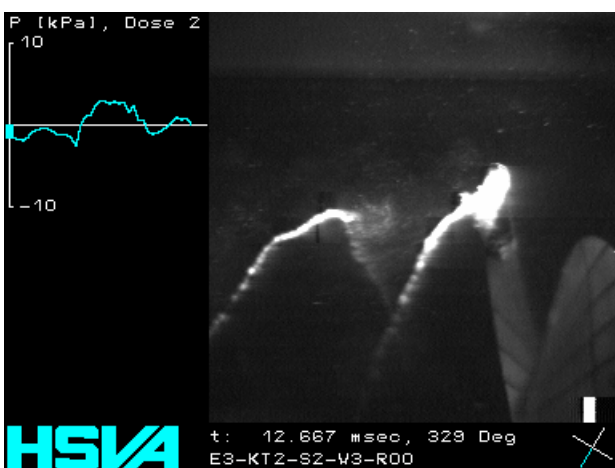
15° / Bild 36



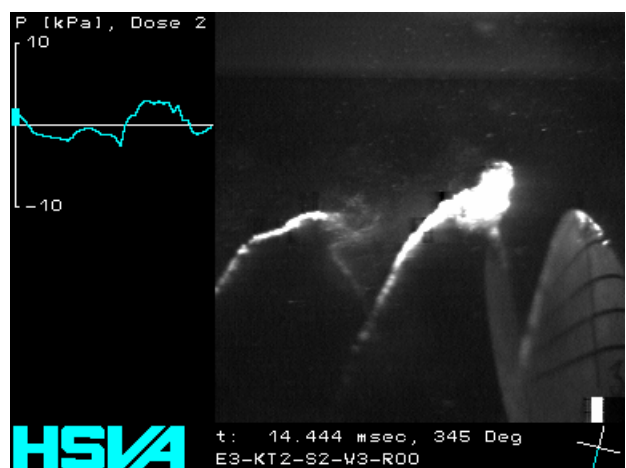
30° / Bild 43



45° / Bild 51



60° / Bild 58



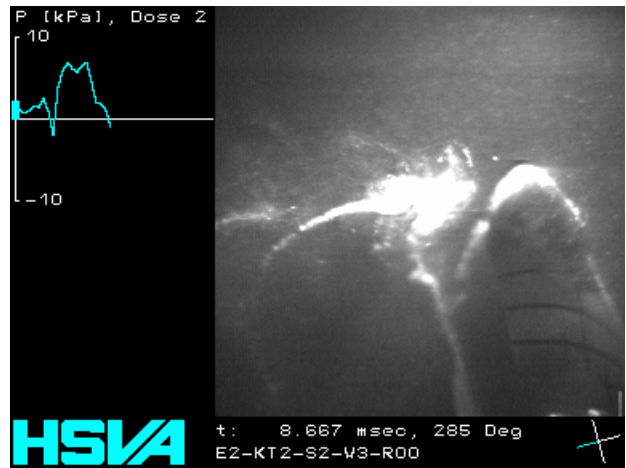
75° / Bild 66

Abbildung 47 : E3-KT2-S2-W3-R00, E-3°

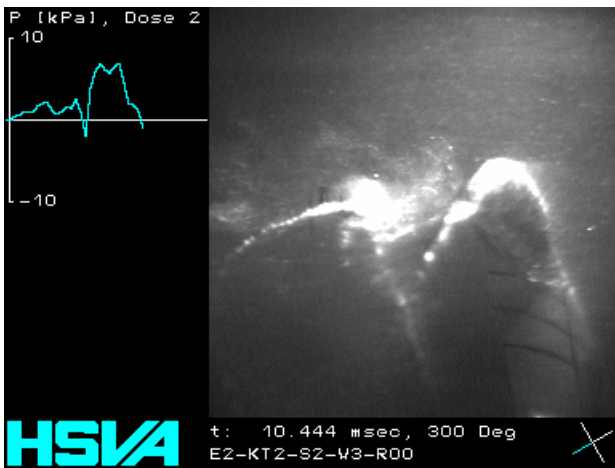




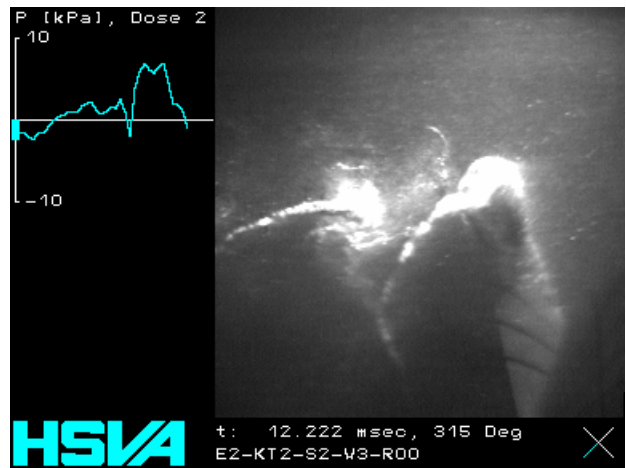
0° / Bild 32



15° / Bild 40



30° / Bild 48



45° / Bild 56



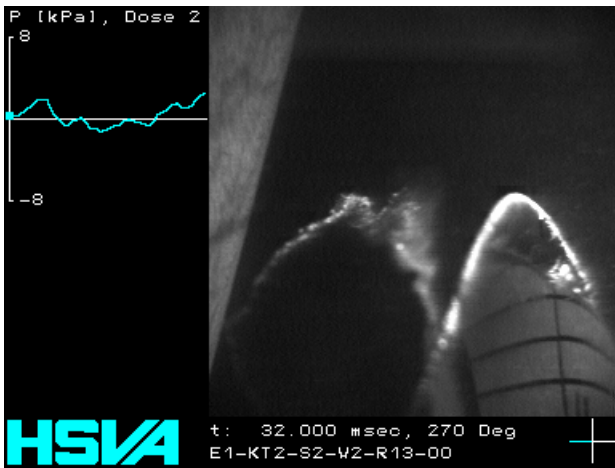
60° / Bild 64



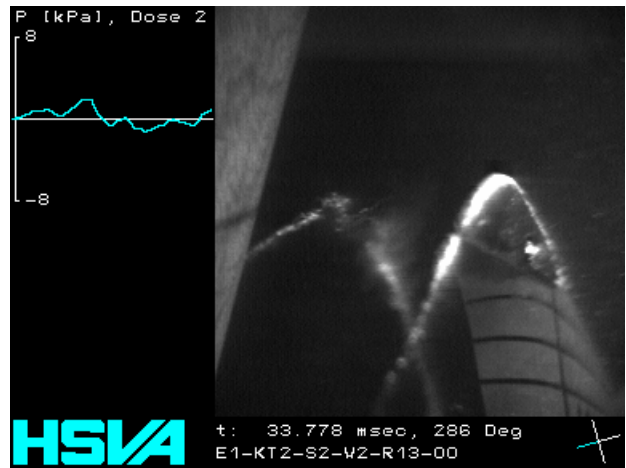
75° / Bild 73

Abbildung 48 : E2-KT2-S2-W3-R00, E+3°

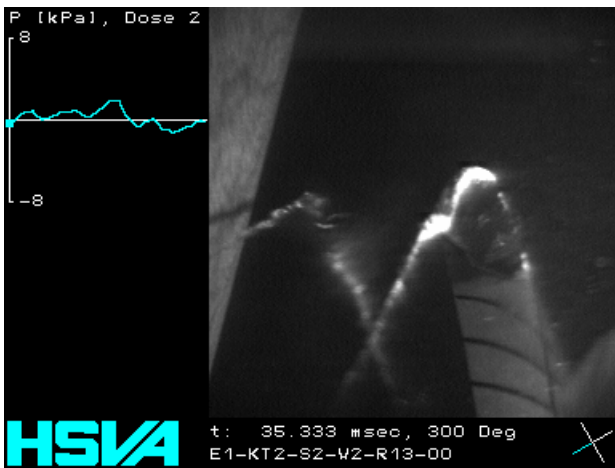
# Einfluss des Ruders



0° / Bild 145



15° / Bild 153



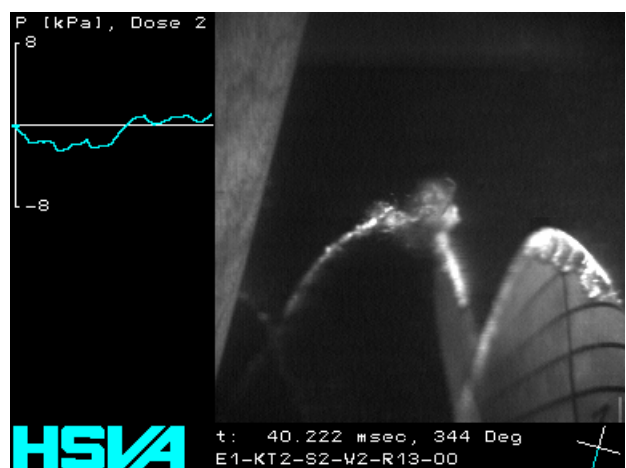
30° / Bild 160



45° / Bild 167

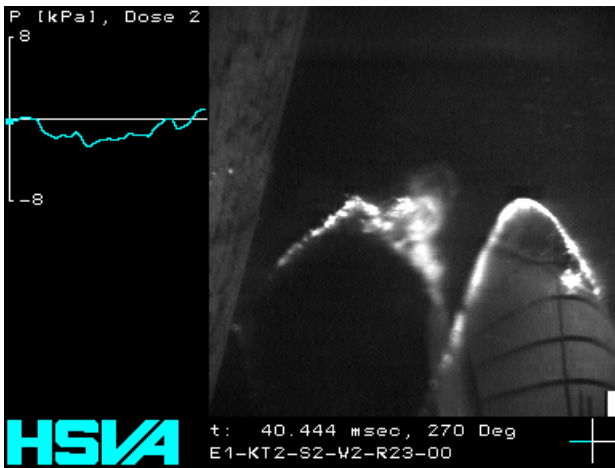


60° / Bild 175



75° / Bild 182

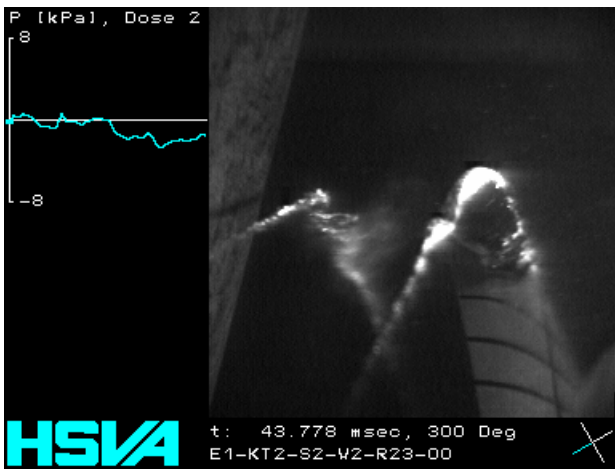
Abbildung 49 : E1-KT2-S2-W2-R13-00



0° / Bild 183



15° / Bild 190



30° / Bild 198



45° / Bild 205

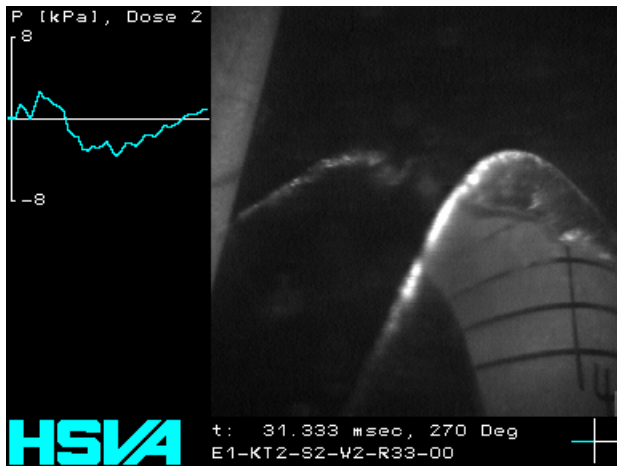


60° / Bild 213

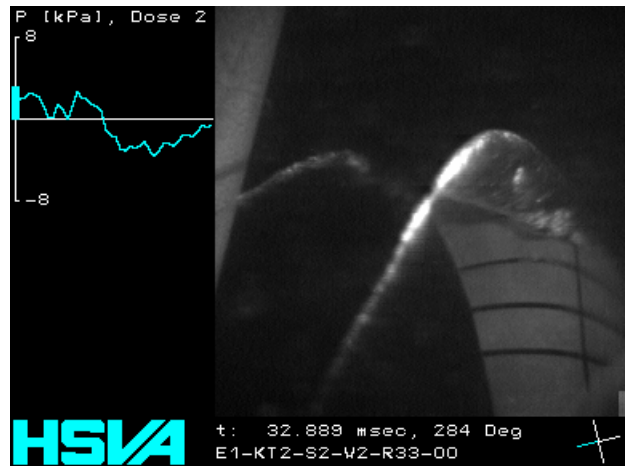


75° / Bild 220

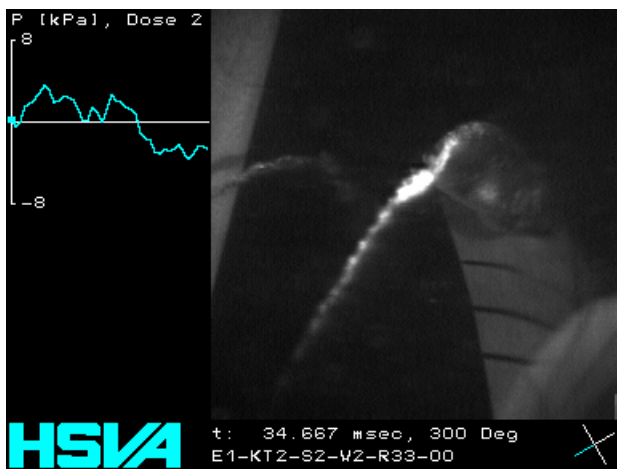
Abbildung 50 : E1-KT2-S2-W2-R23-00



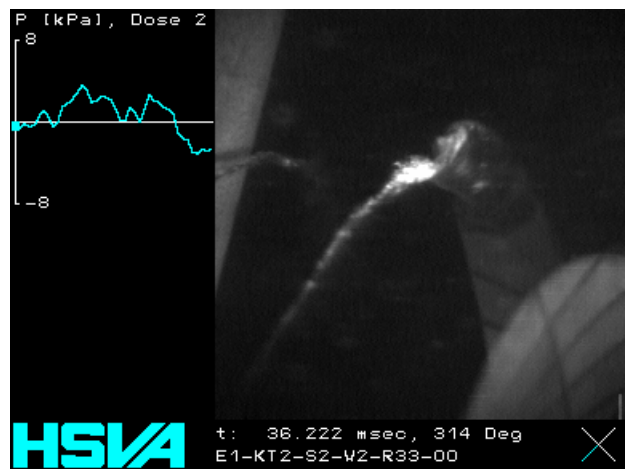
0° / Bild 142



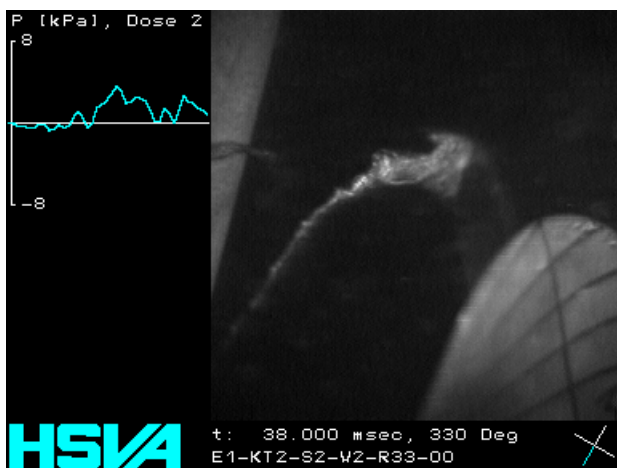
15° / Bild 149



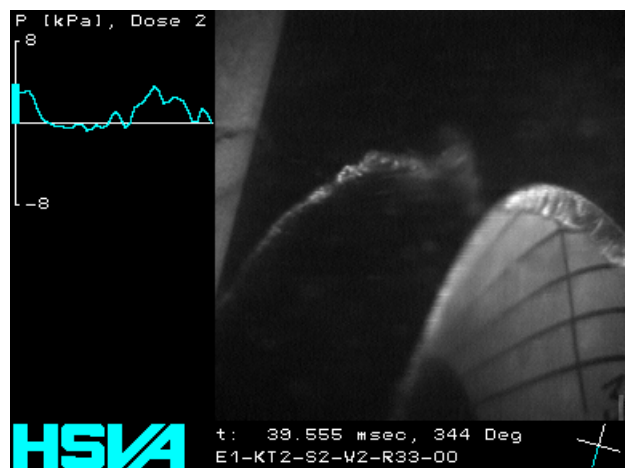
30° / Bild 157



45° / Bild 164

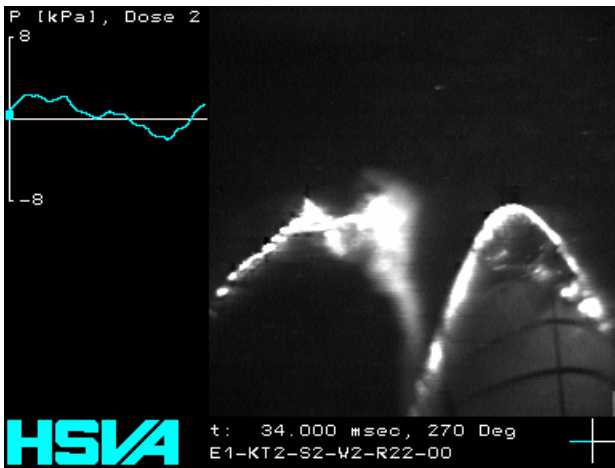


60° / Bild 172

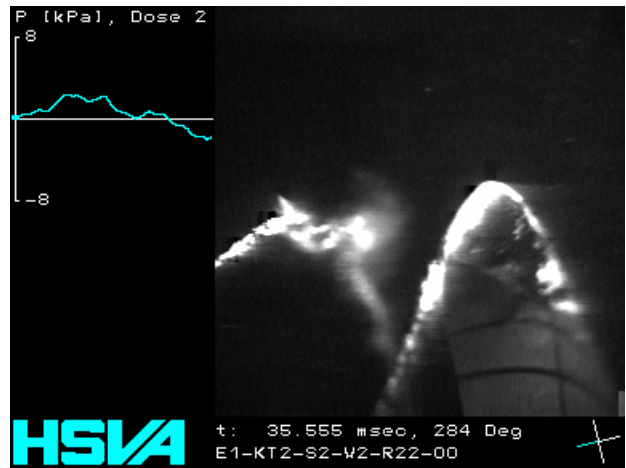


75° / Bild 179

Abbildung 51 : E1-KT2-S2-W2-R33-00



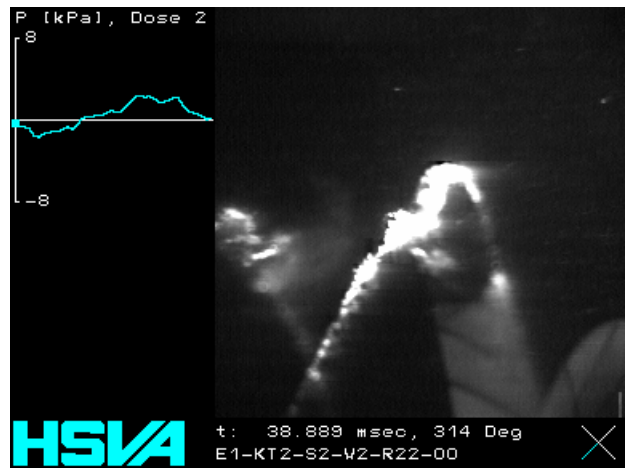
0° / Bild 154



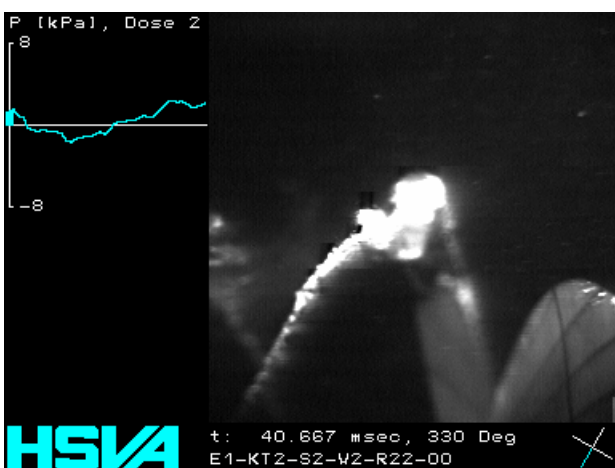
15° / Bild 161



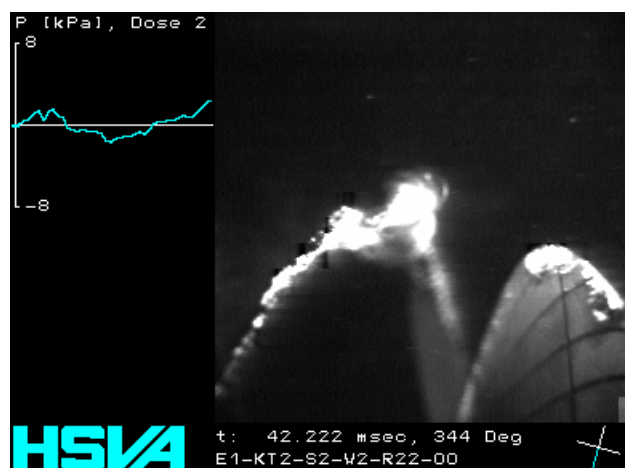
30° / Bild 169



45° / Bild 176

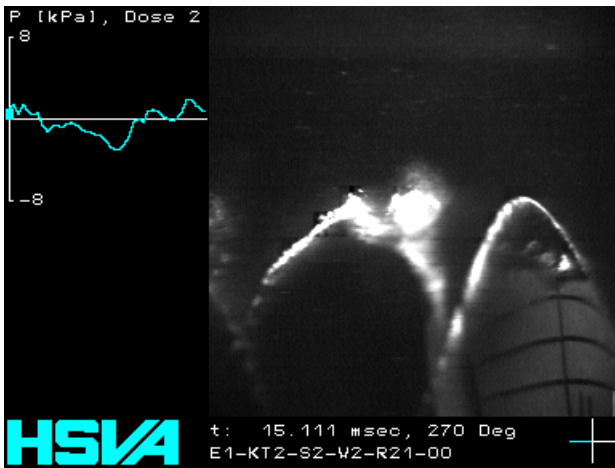


60° / Bild 184

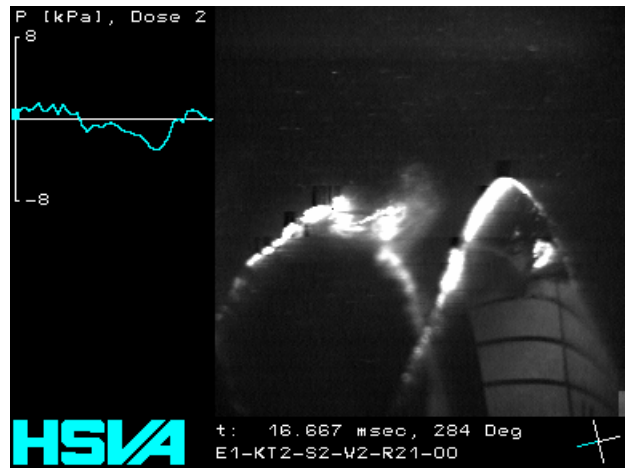


75° / Bild 191

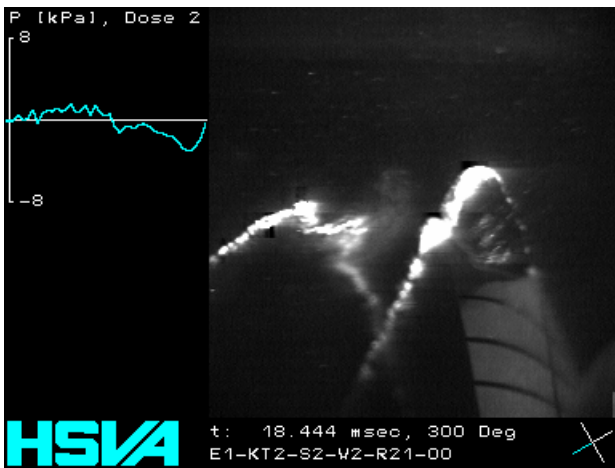
Abbildung 52 : E1-KT2-S2-W2-R22-00



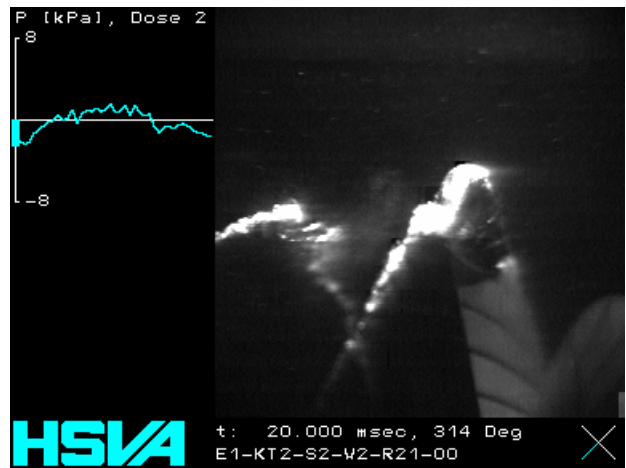
0° / Bild 69



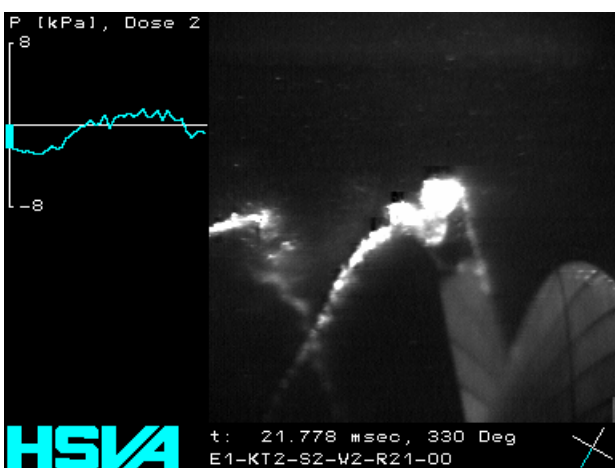
15° / Bild 76



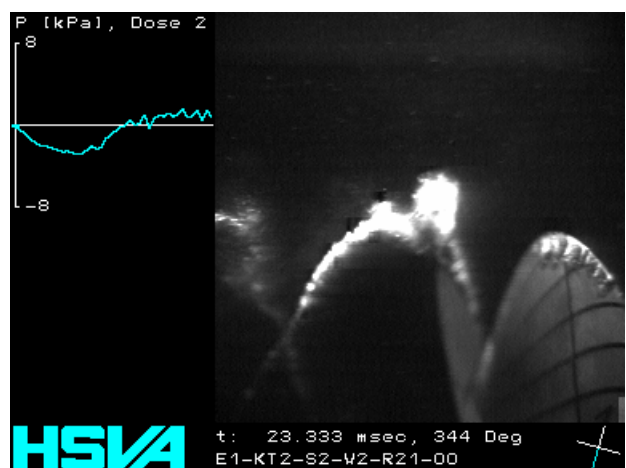
30° / Bild 84



45° / Bild 91

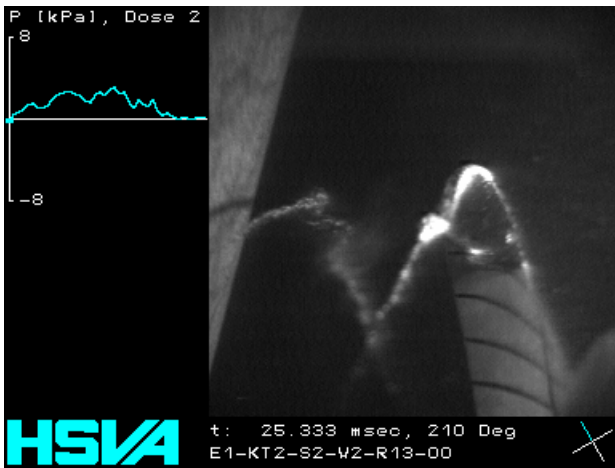


60° / Bild 99



75° / Bild 106

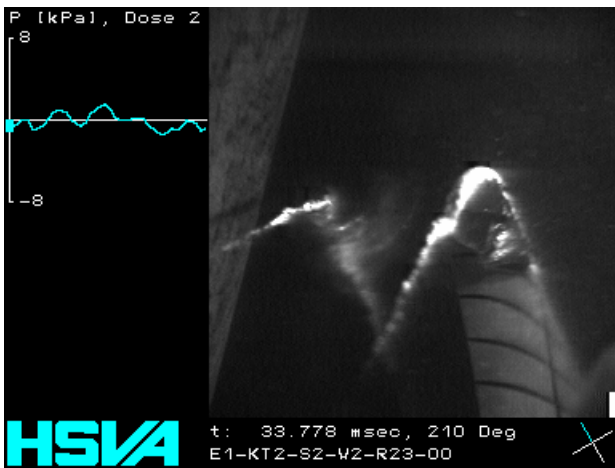
Abbildung 53 : E1-KT2-S2-W2-R21-00



R13, 30° / Bild 115



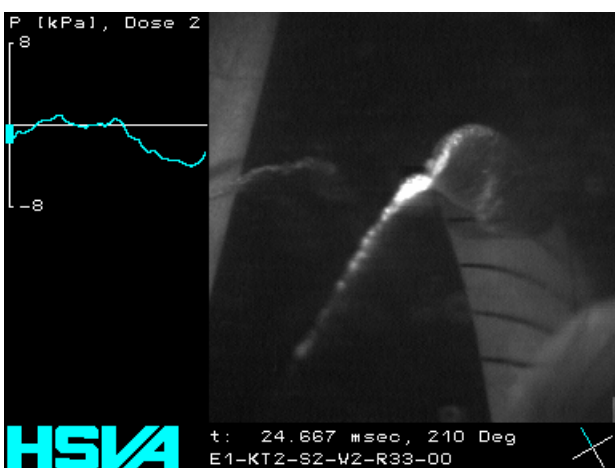
R13, 60° / Bild 130



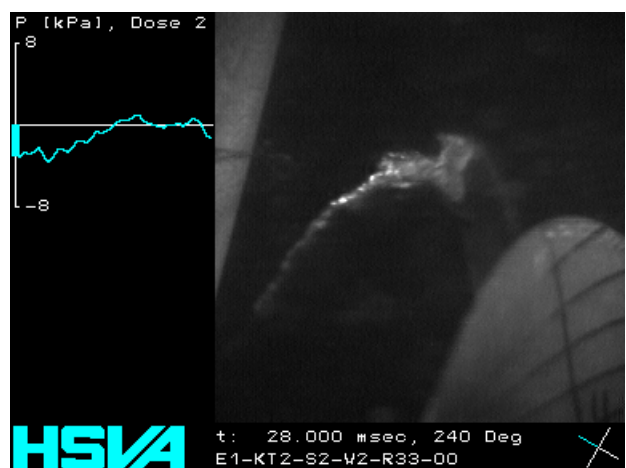
R23, 30° / Bild 153



R23, 60° / Bild 168



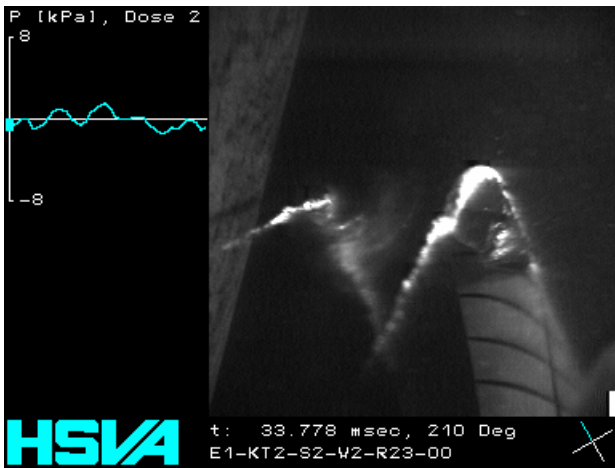
R33, 30° / Bild 112



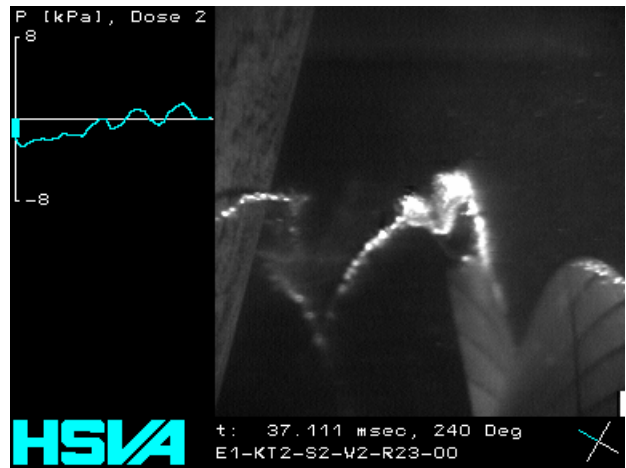
R33, 60° / Bild 127

Abbildung 54 : E1-KT2-S2-W2-Rudervariation

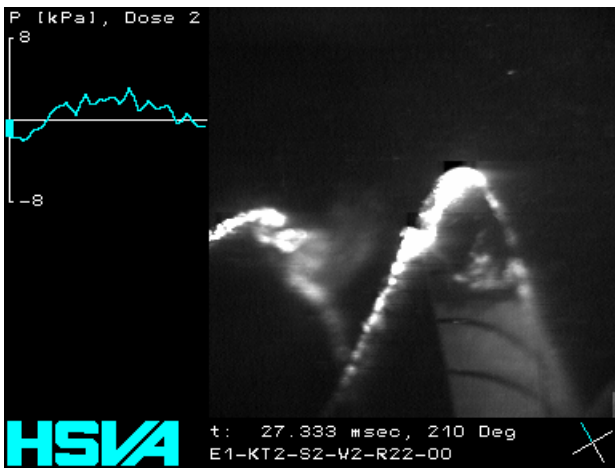




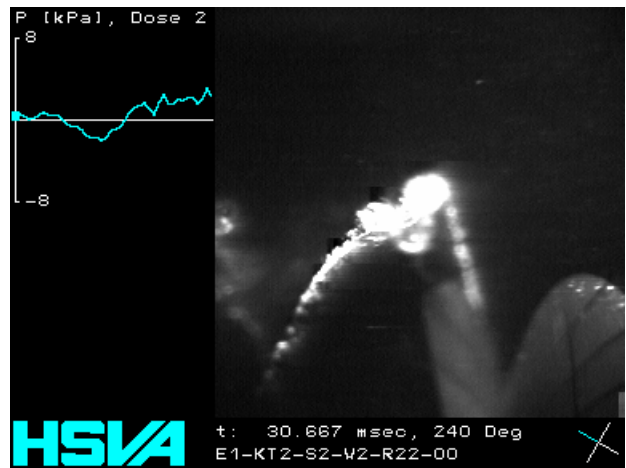
R23, 30° / Bild 153



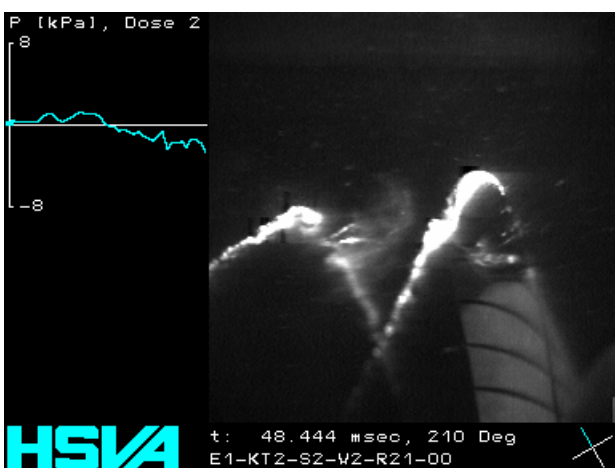
R23, 60° / Bild 168



R22, 30° / Bild 124



R22, 60° / Bild 139



R21, 30° / Bild 219



R21, 60° / Bild 234

Abbildung 55 : E1-KT2-S2-W2-Lagenvariation

## Ergebnisse der Druckschwankungsmessungen

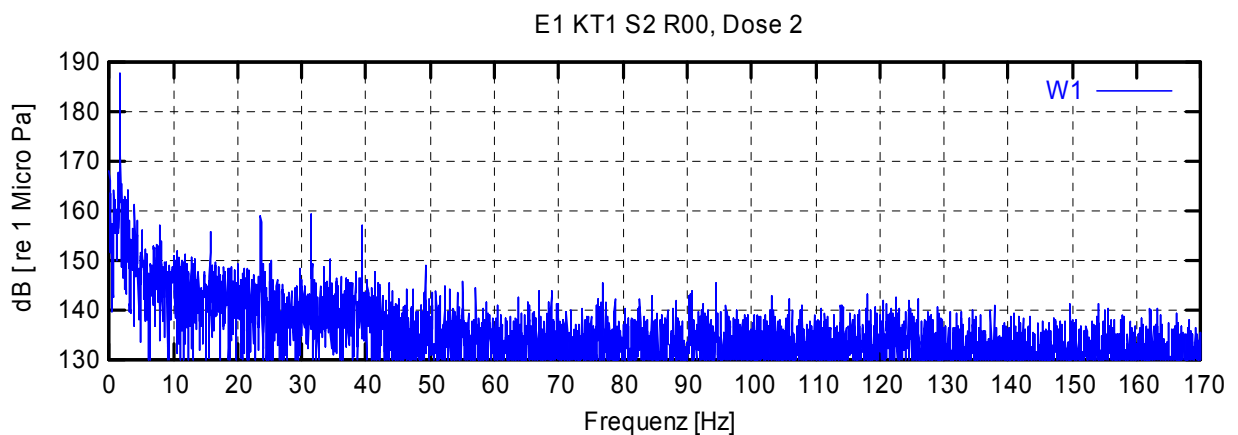
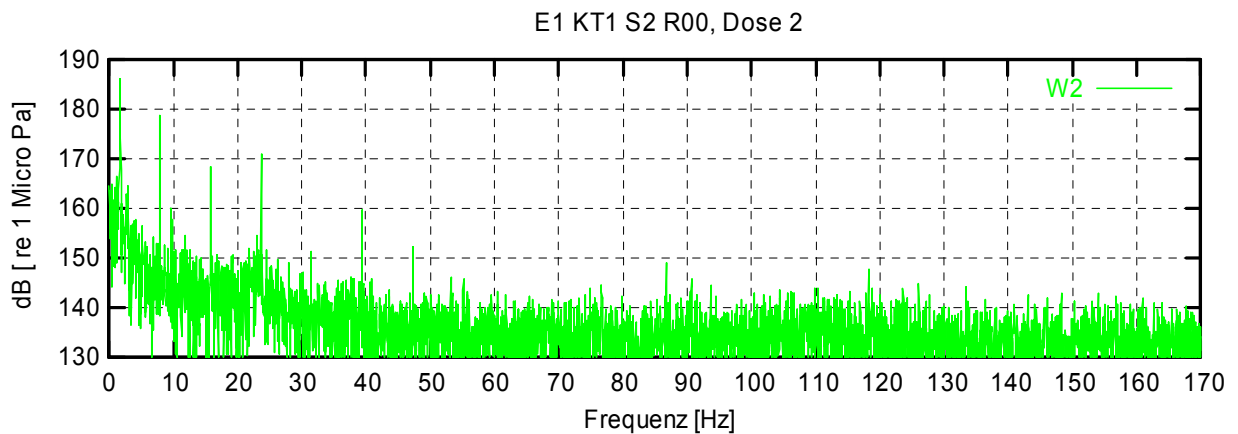
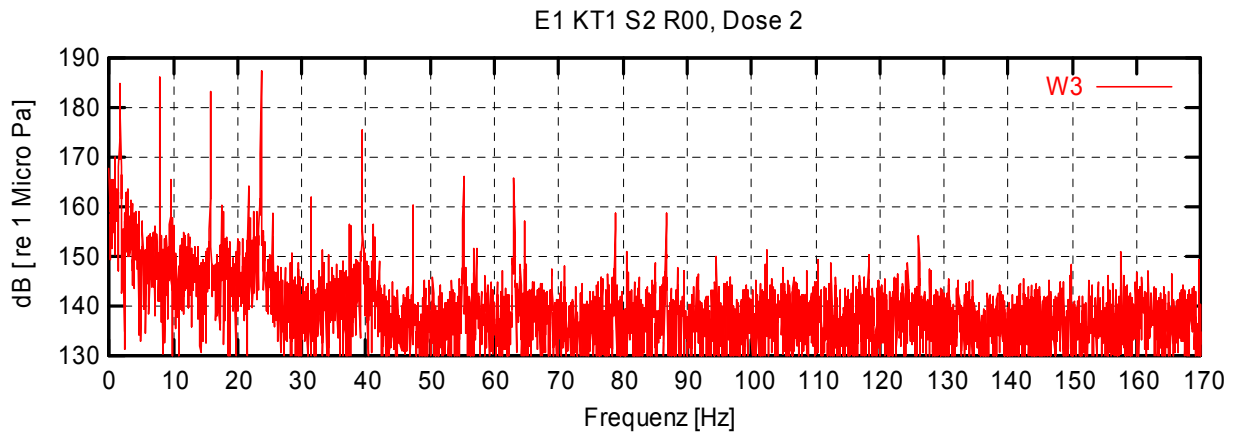
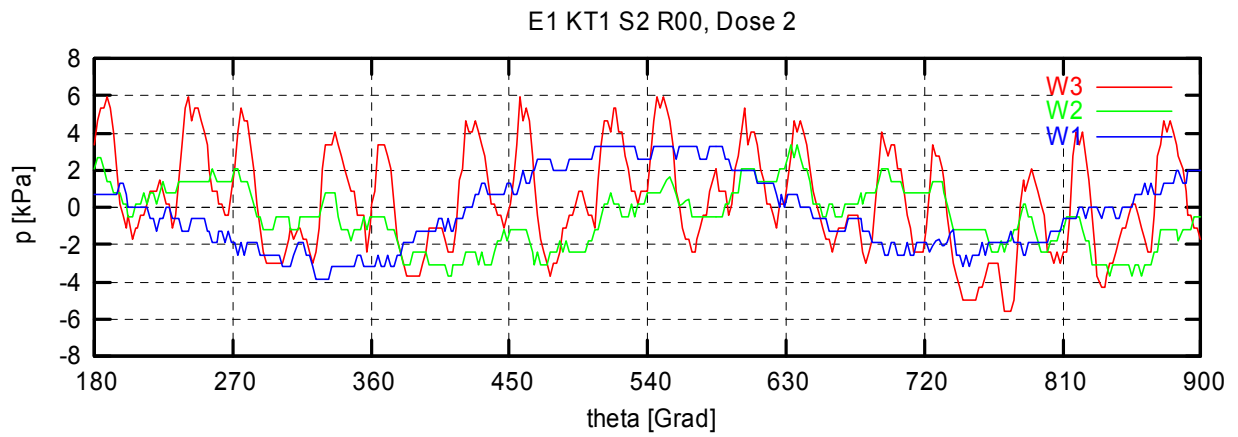


Abbildung 56 : FFT, E1-KT1-S2-R00

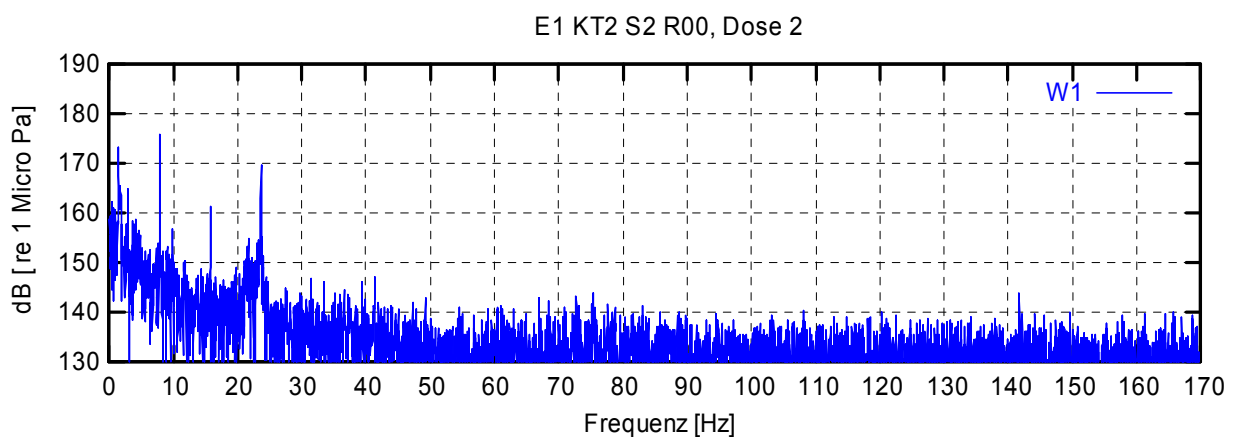
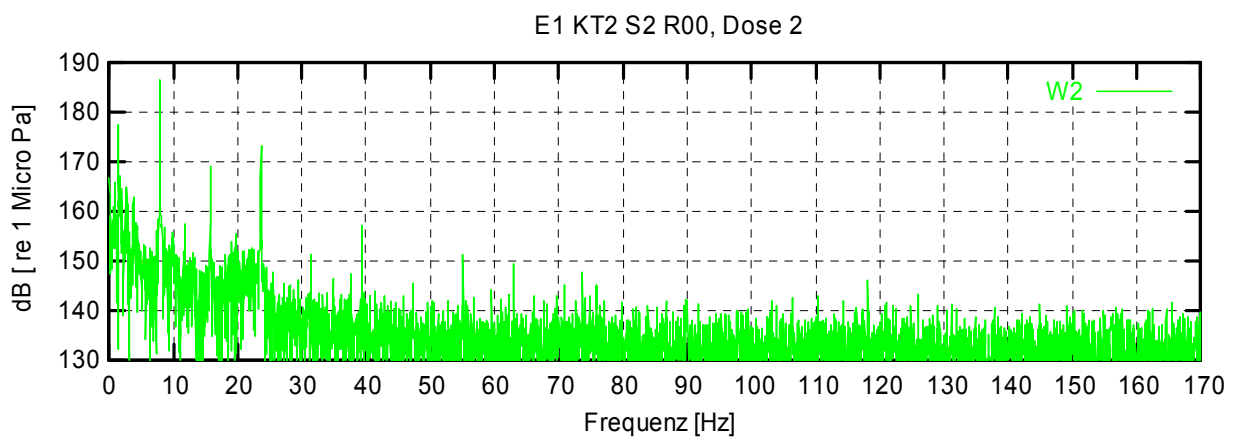
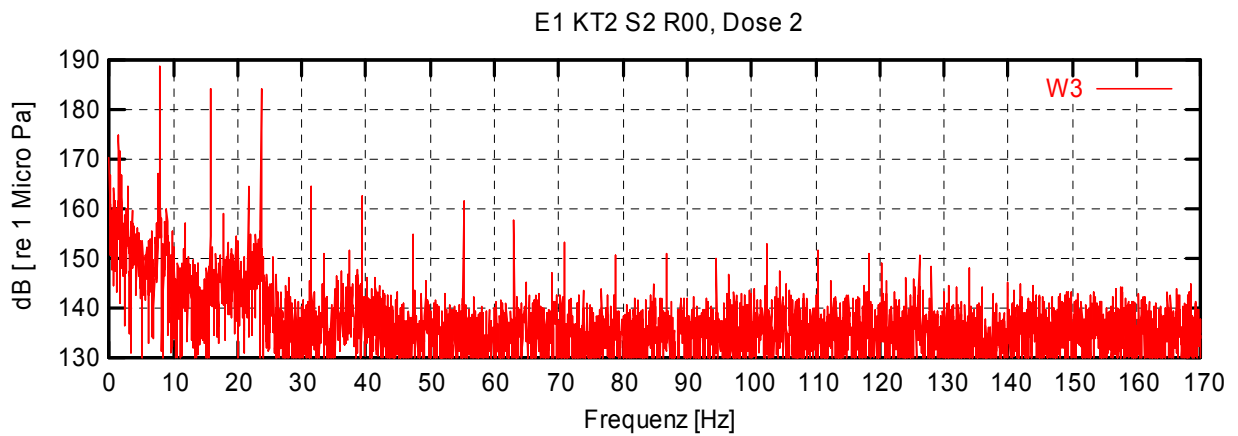
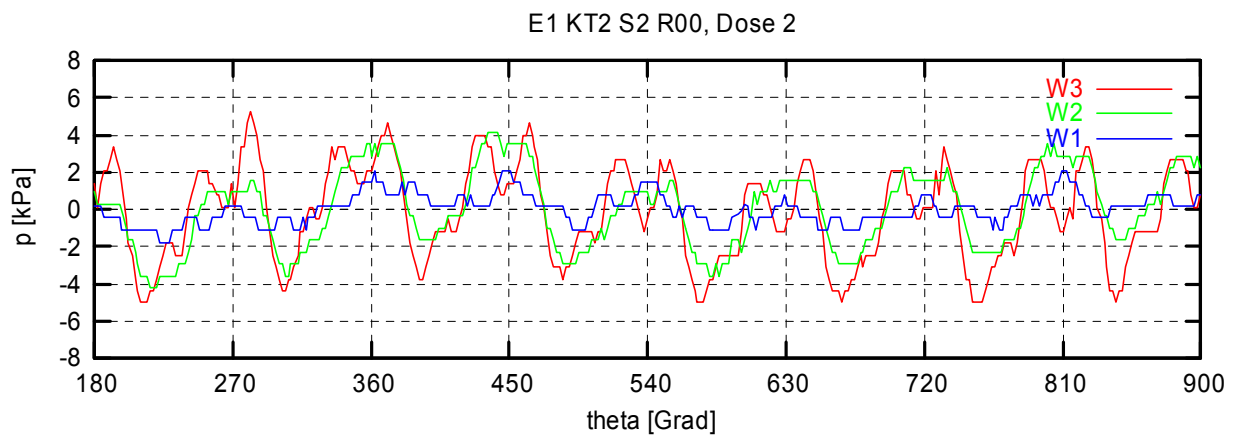


Abbildung 57 : FFT, E1-KT2-S2-R00

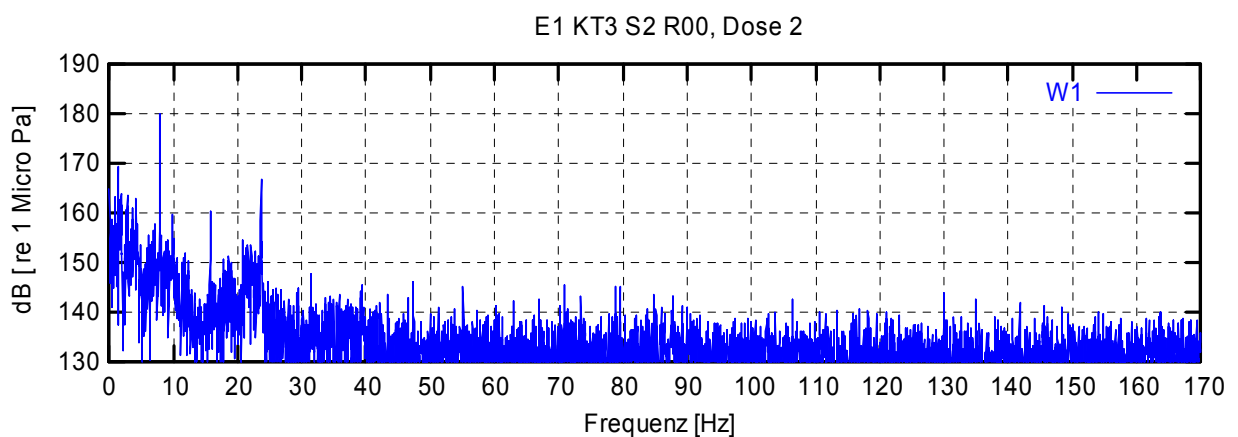
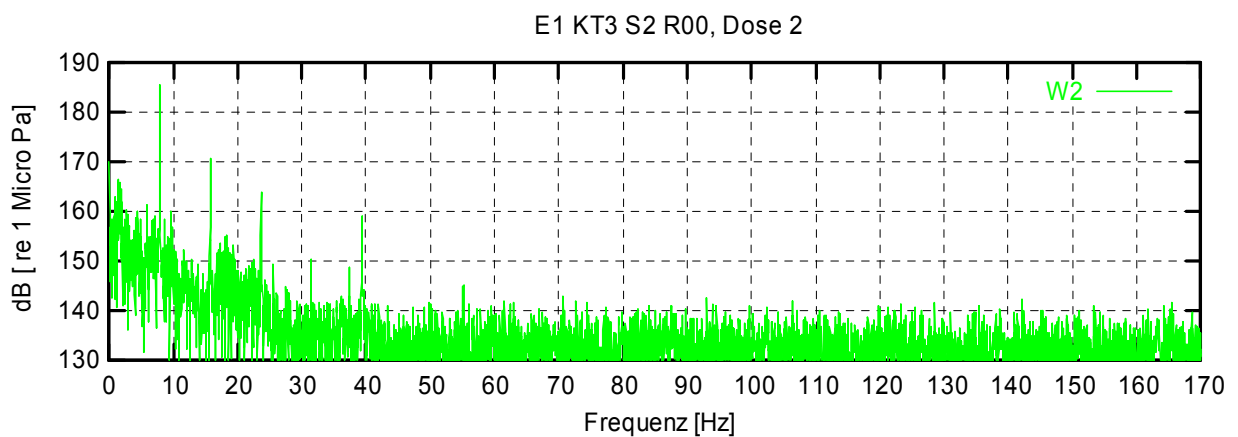
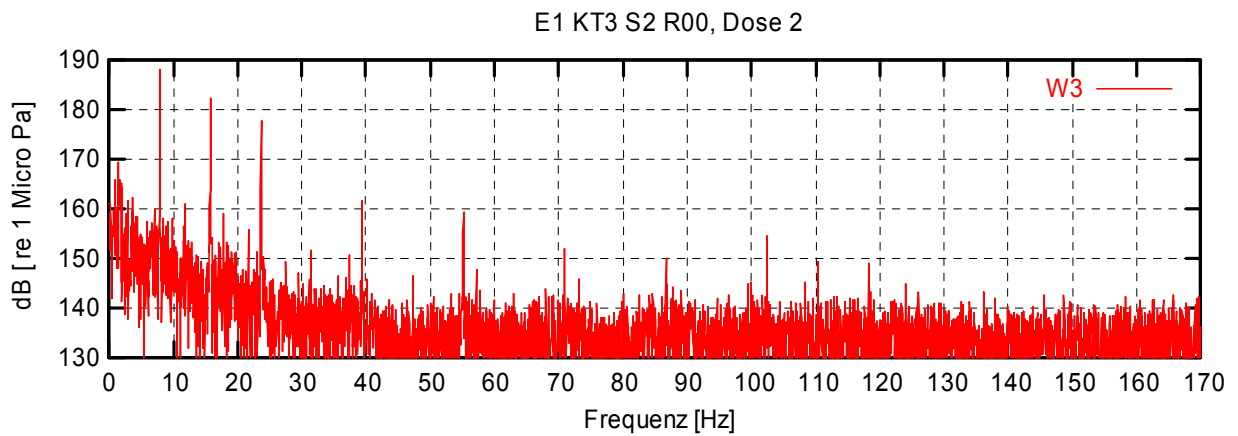
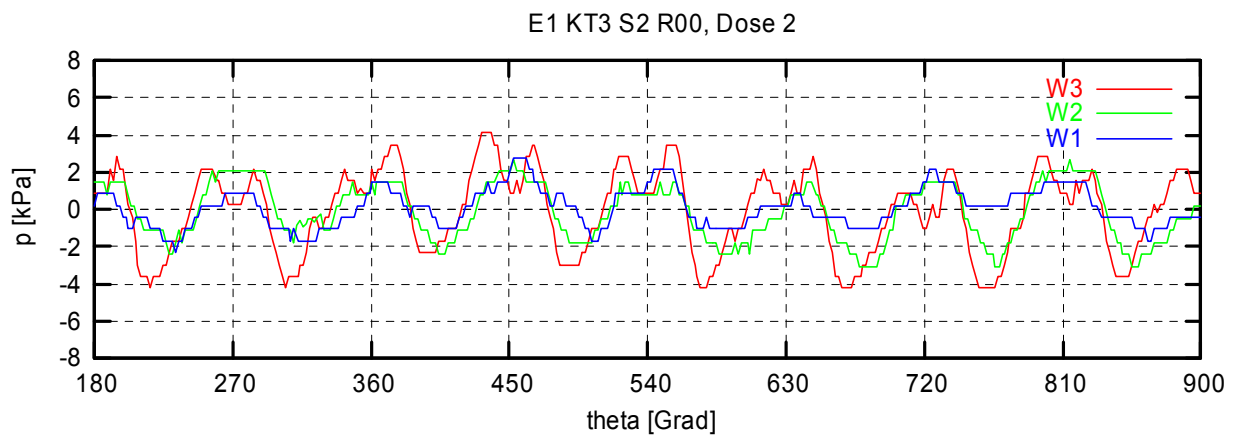


Abbildung 58 : FFT, E1-KT3-S2-R00

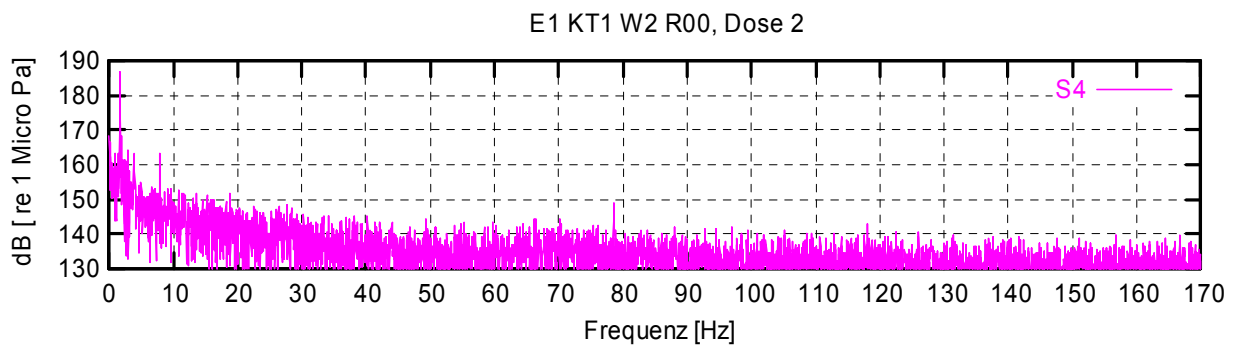
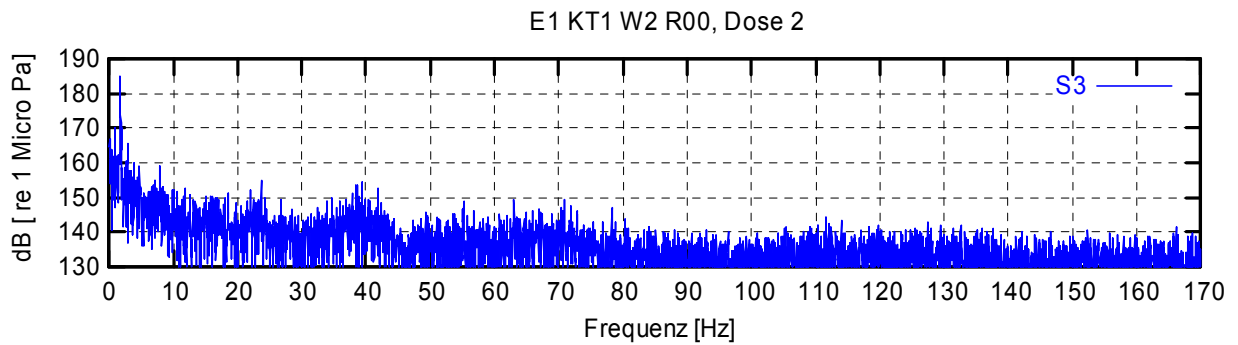
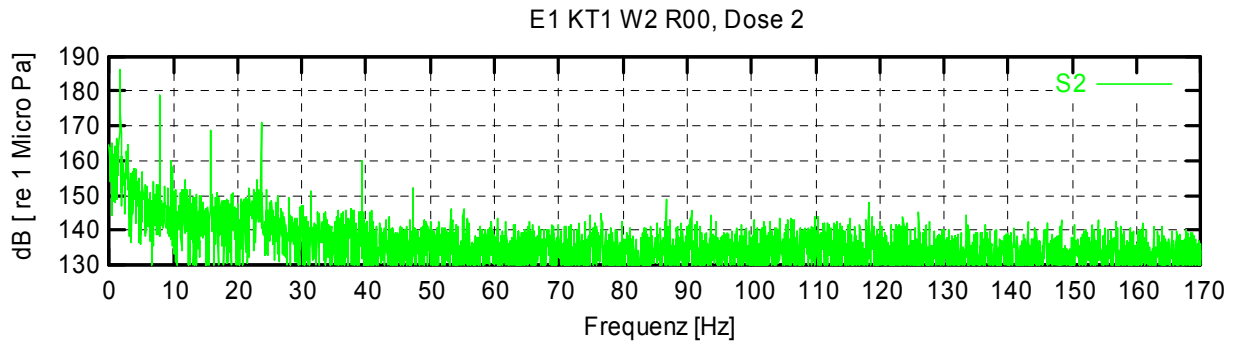
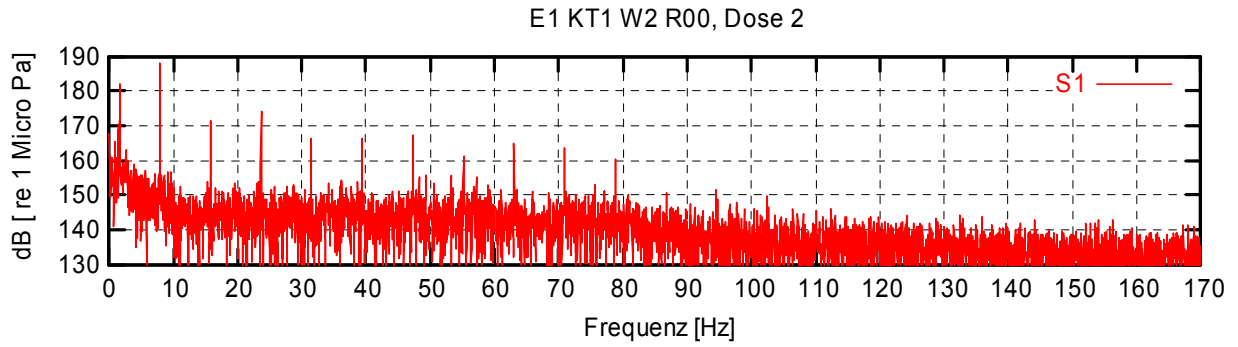
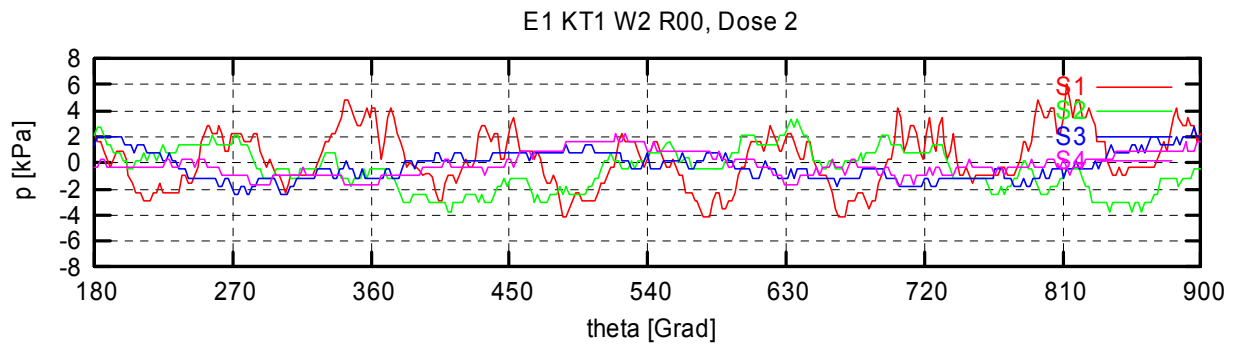


Abbildung 59 : FFT, E1-KT1-W2-R00

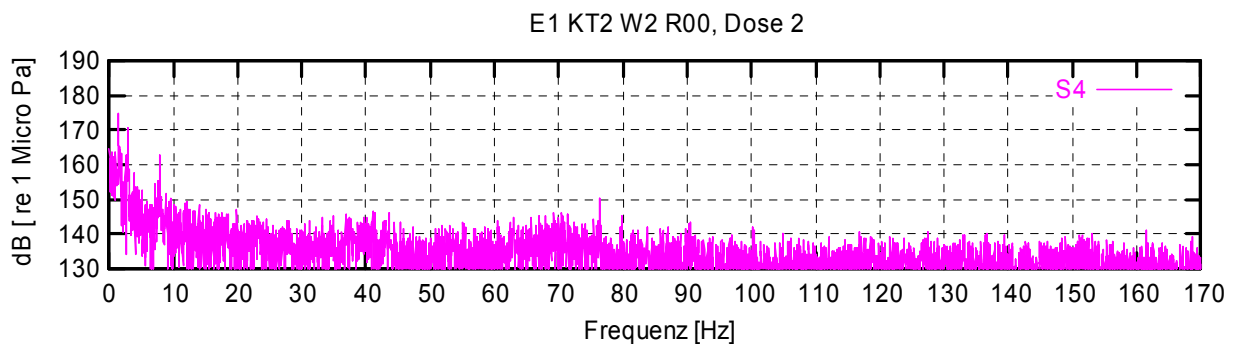
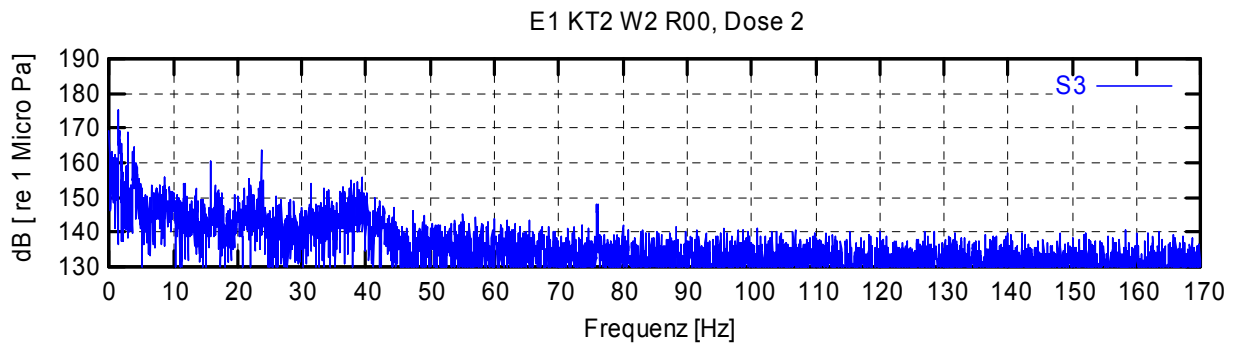
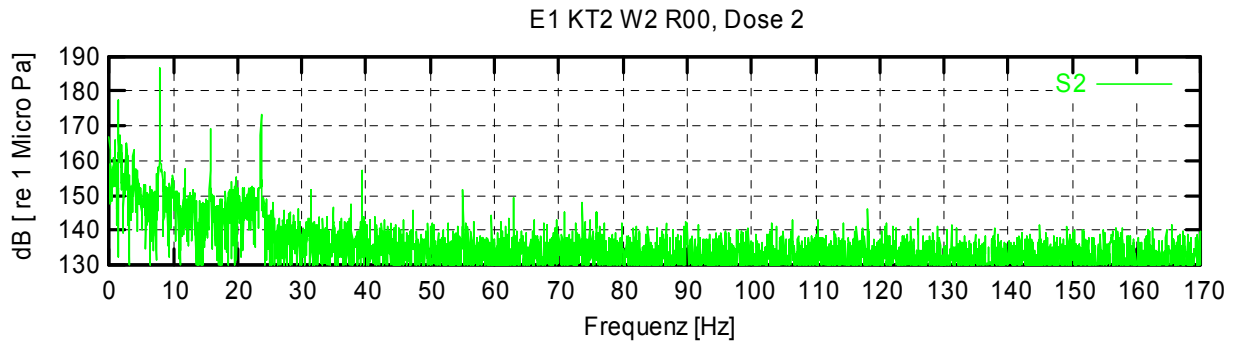
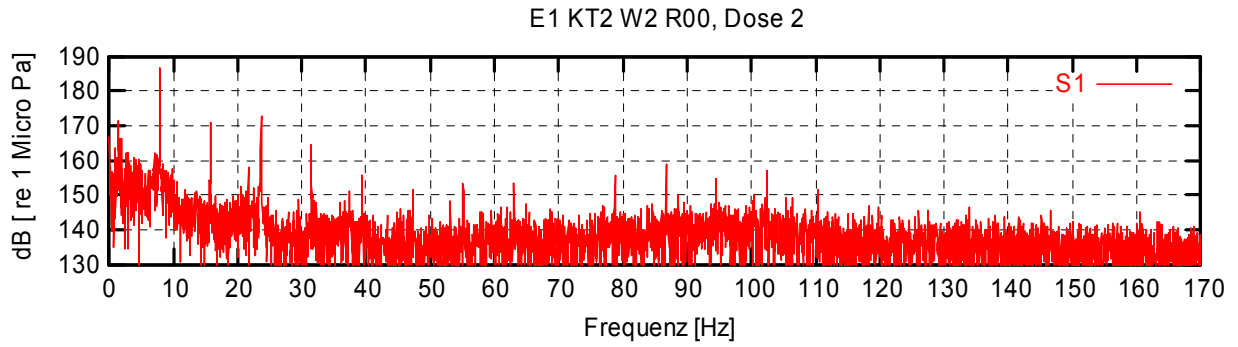
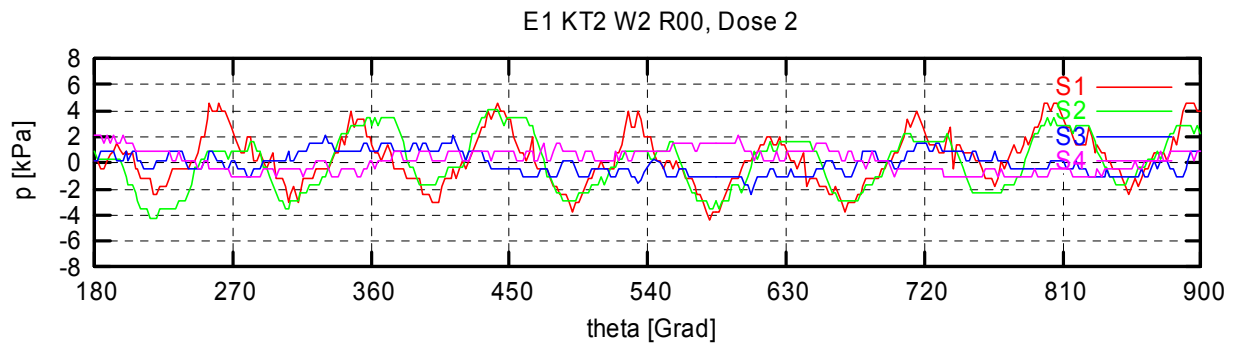


Abbildung 60 : FFT, E1-KT2-W2-R00

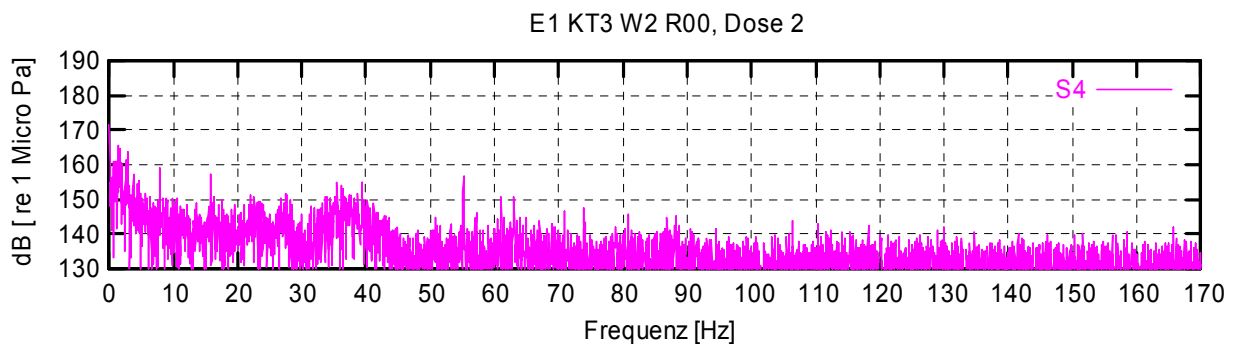
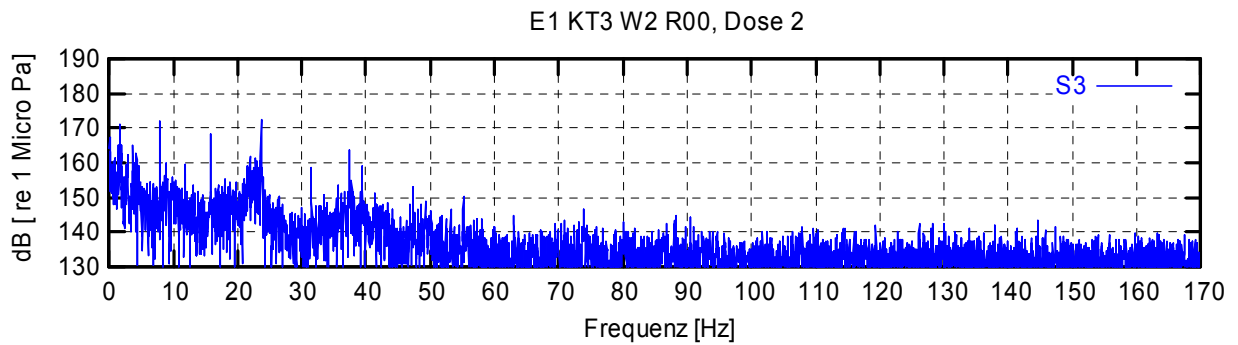
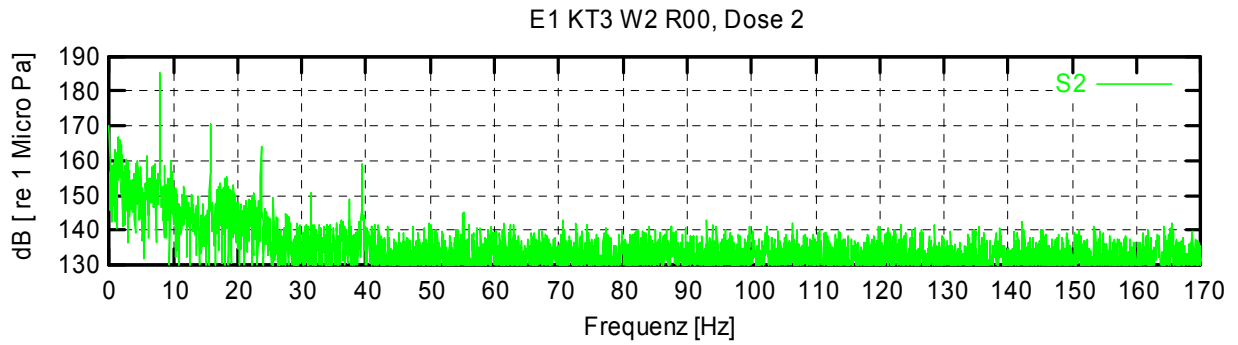
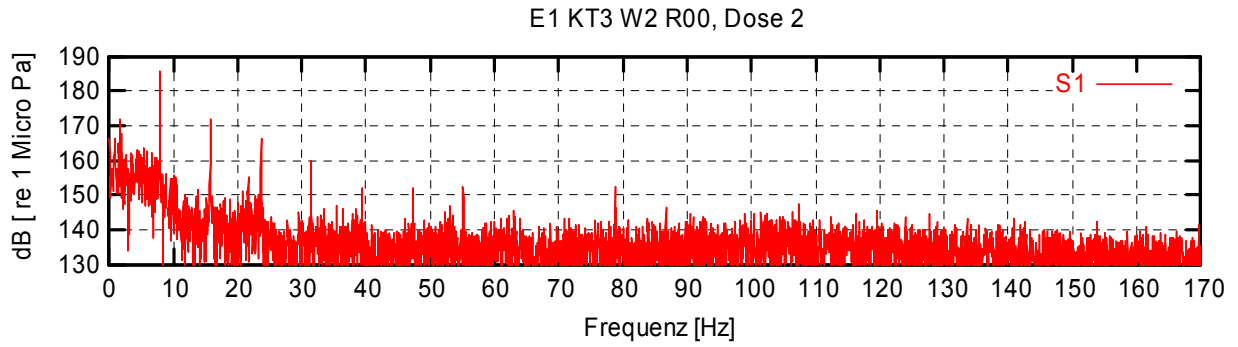
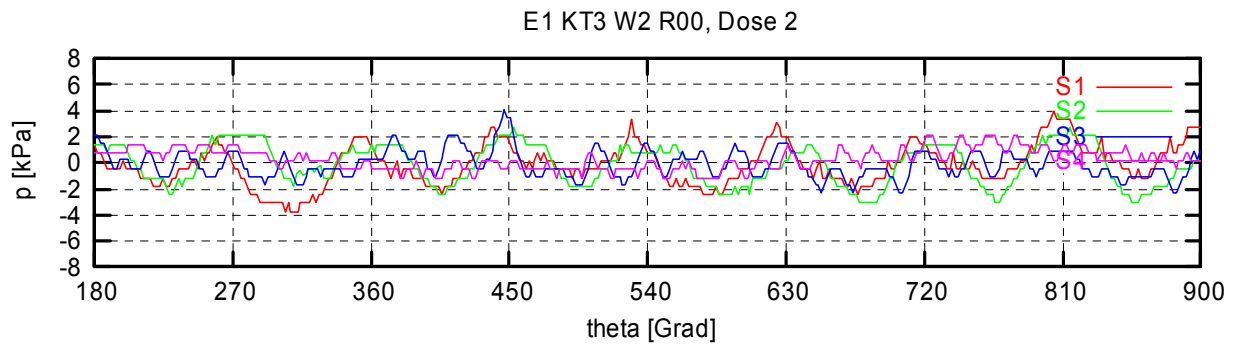


Abbildung 61 : FFT, E1-KT3-W2-R00



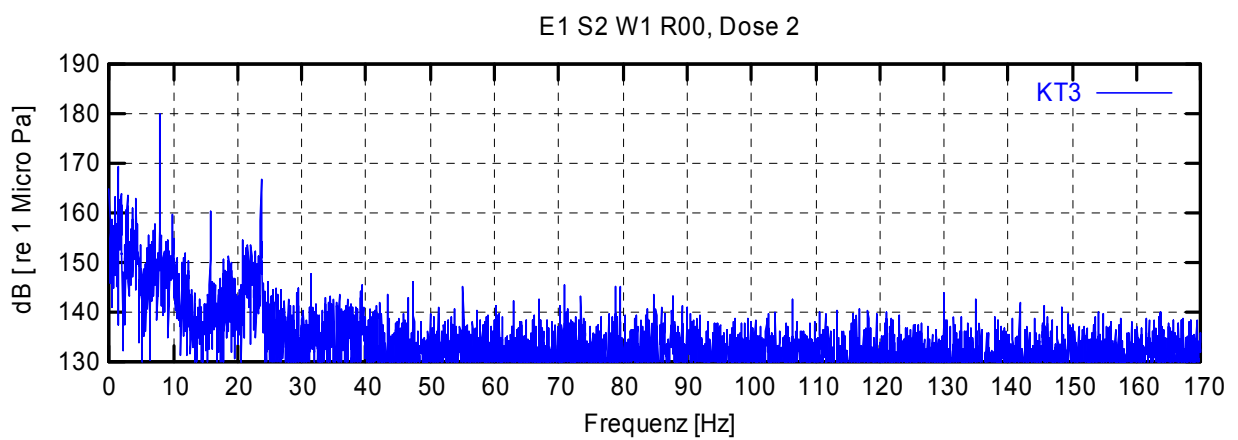
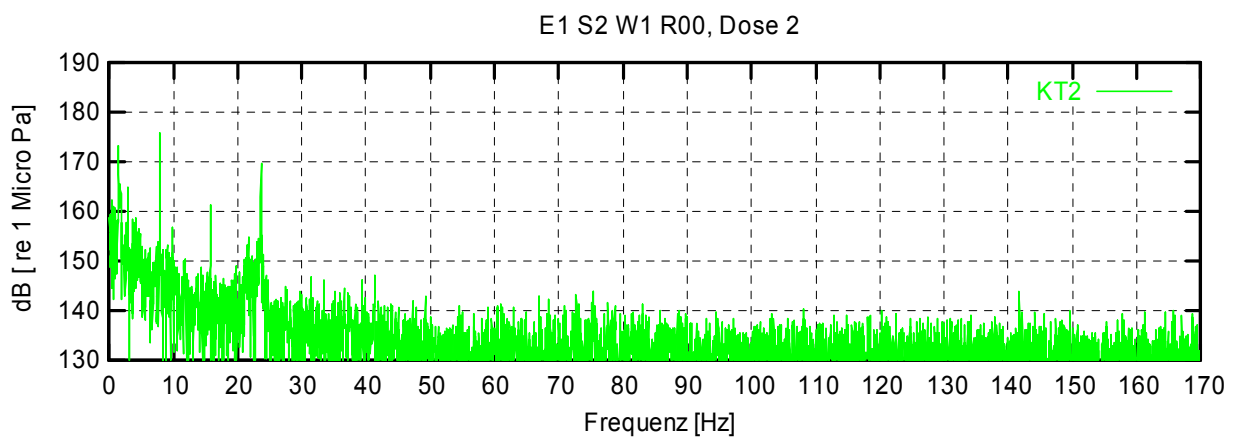
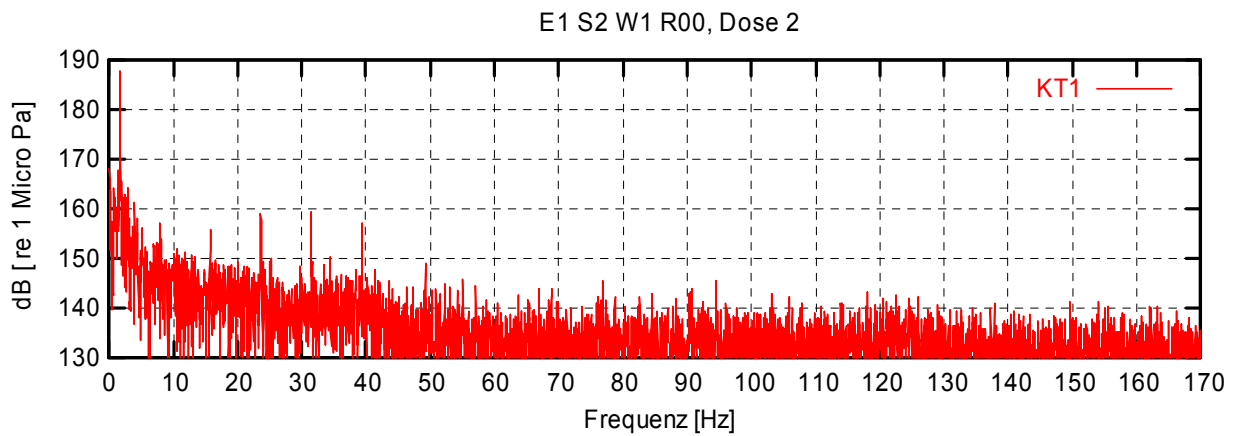
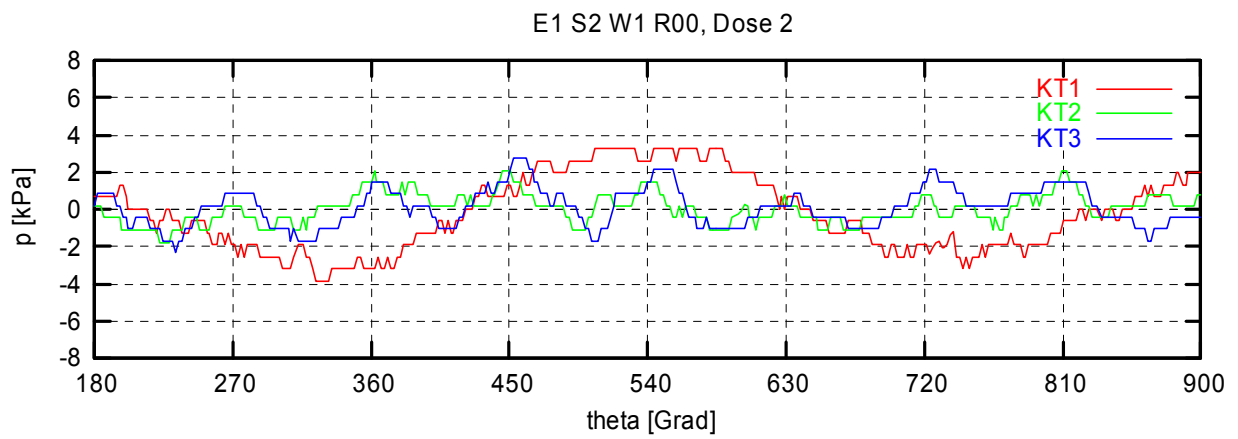


Abbildung 62 : FFT, E1-S2-W1-R00

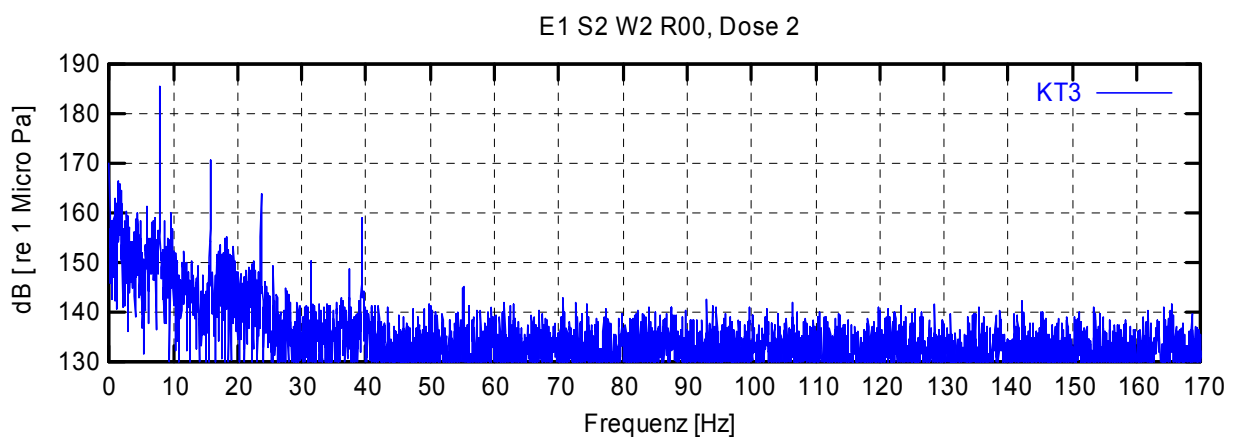
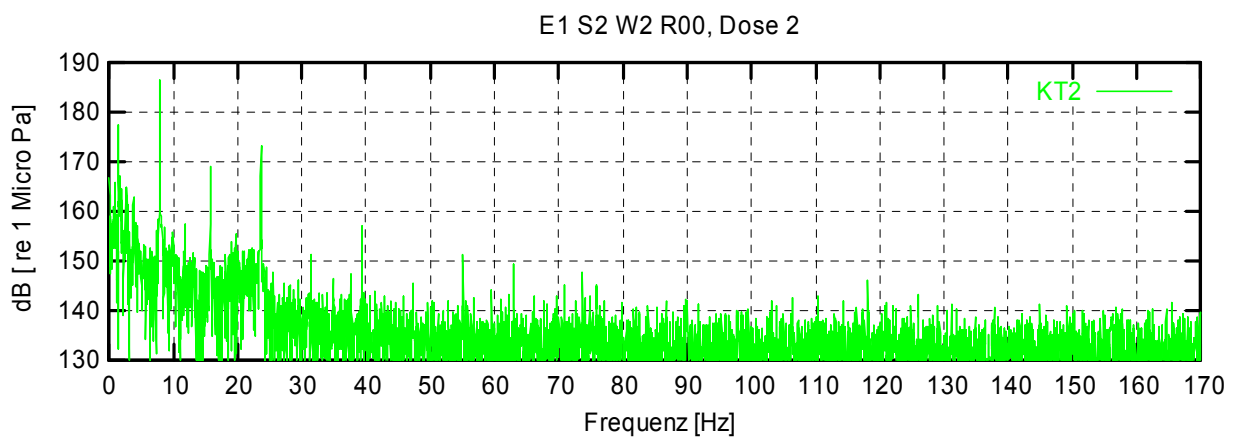
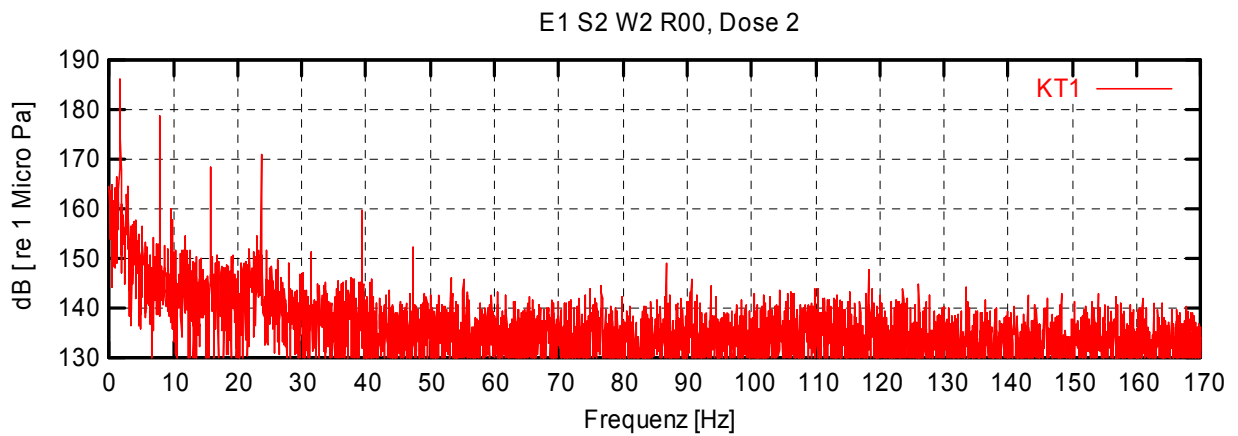
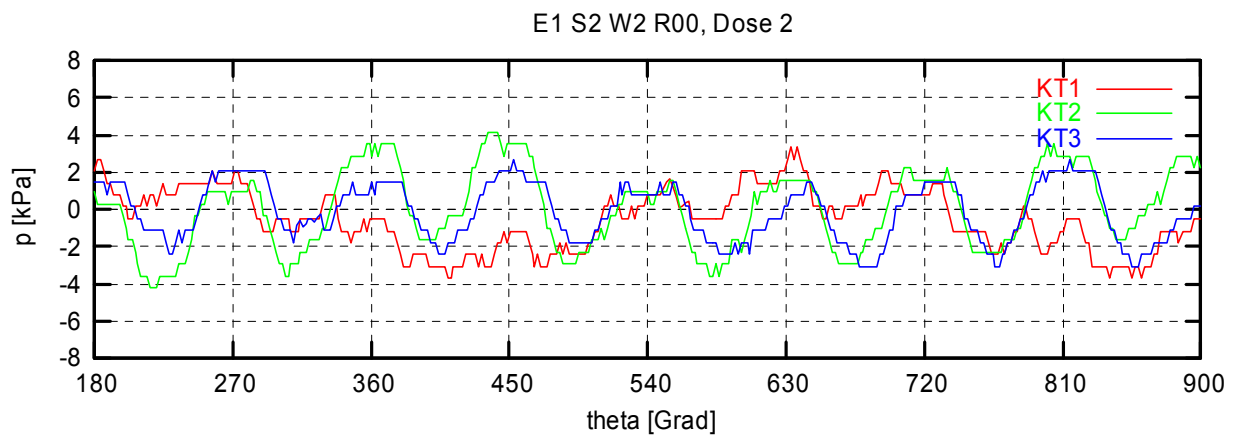


Abbildung 63 : FFT, E1-S2-W2-R00

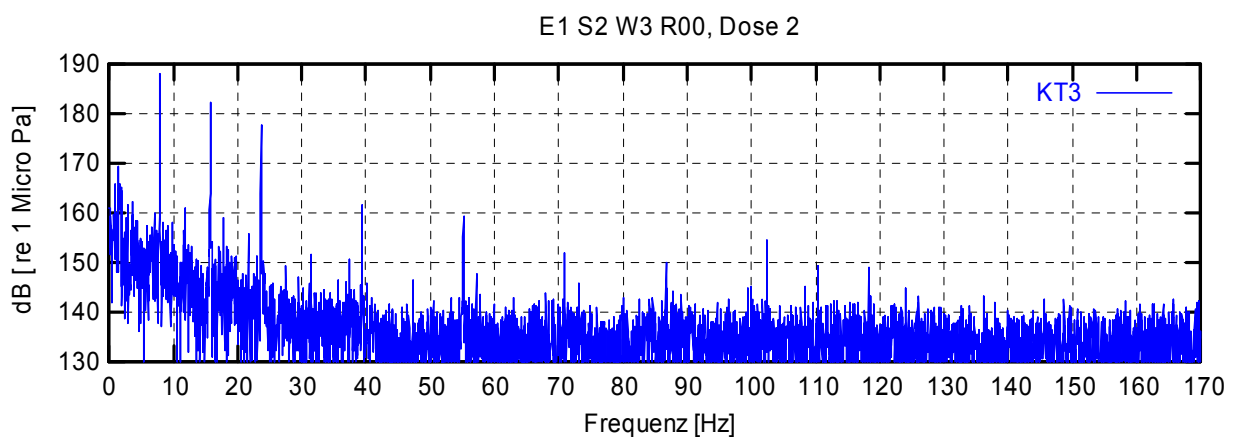
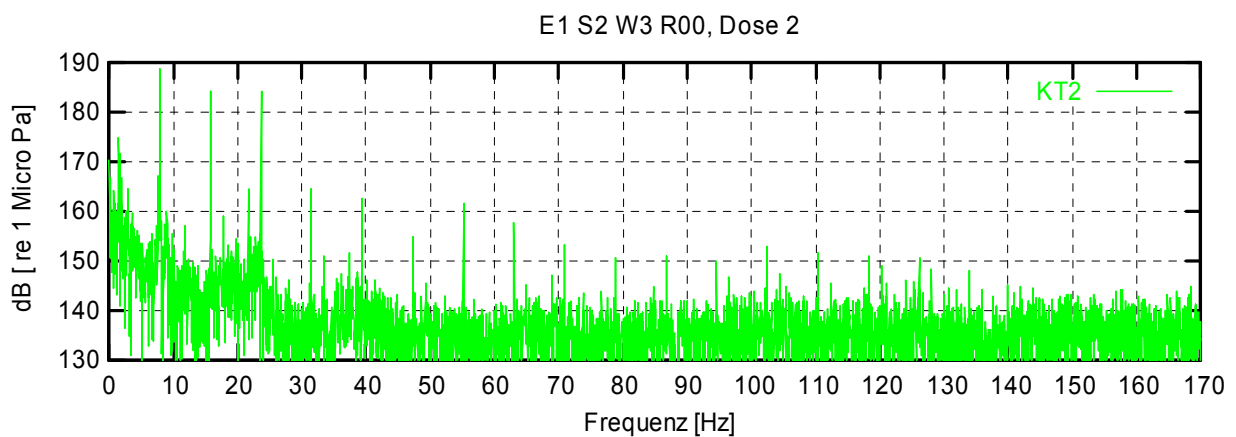
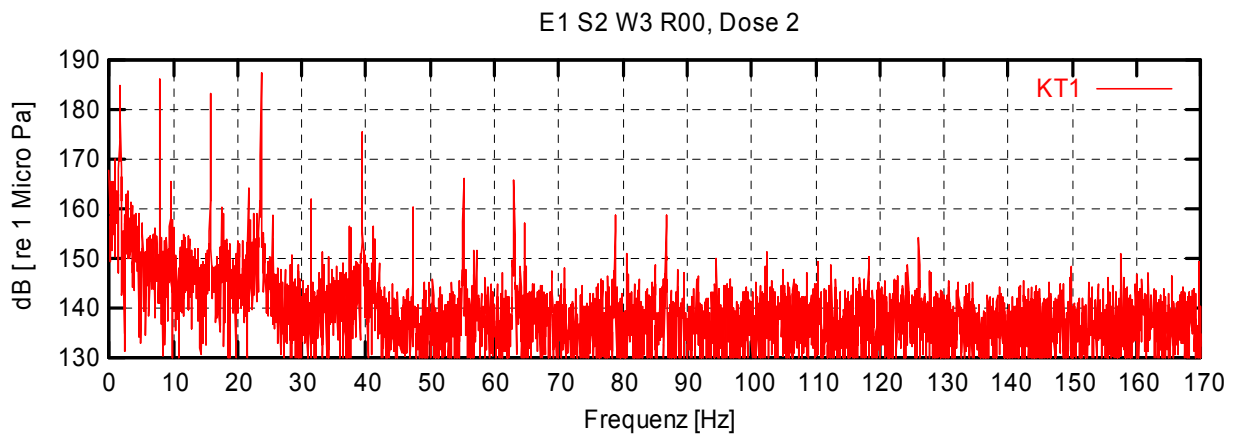
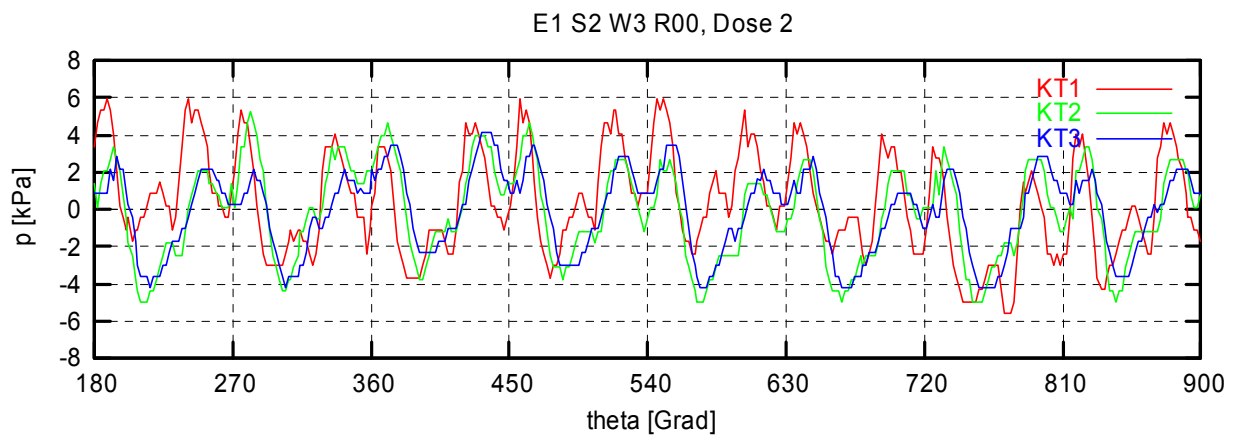


Abbildung 64 : FFT, E1-S2-W3-R00

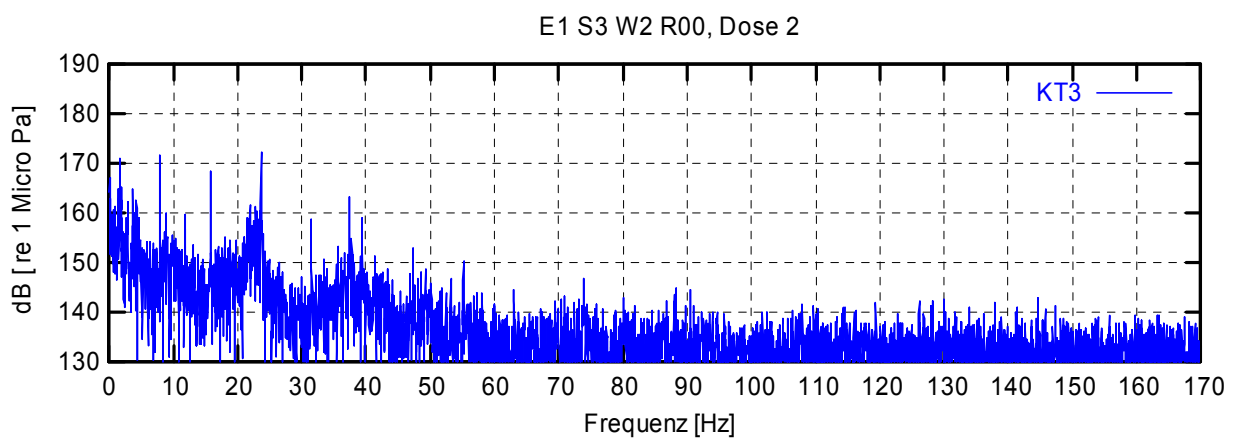
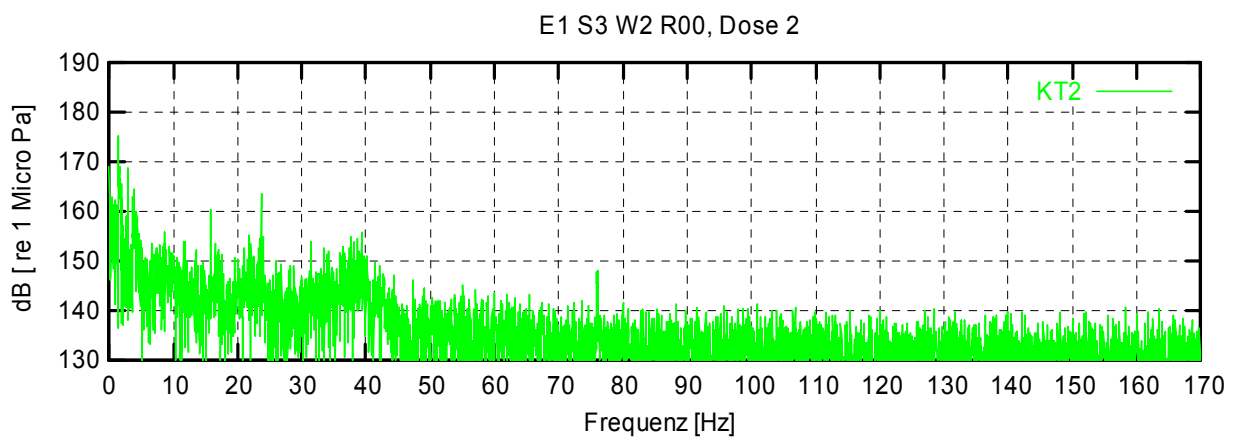
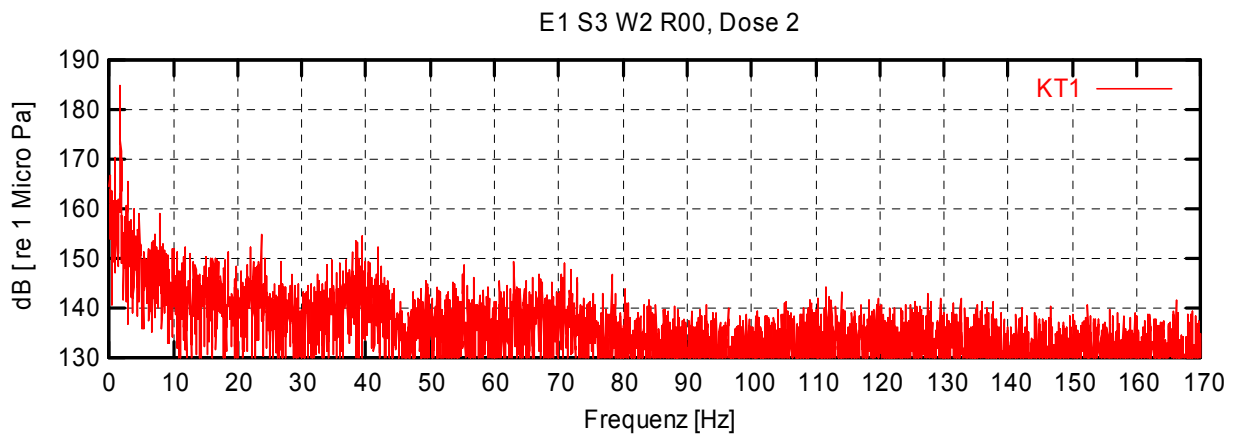
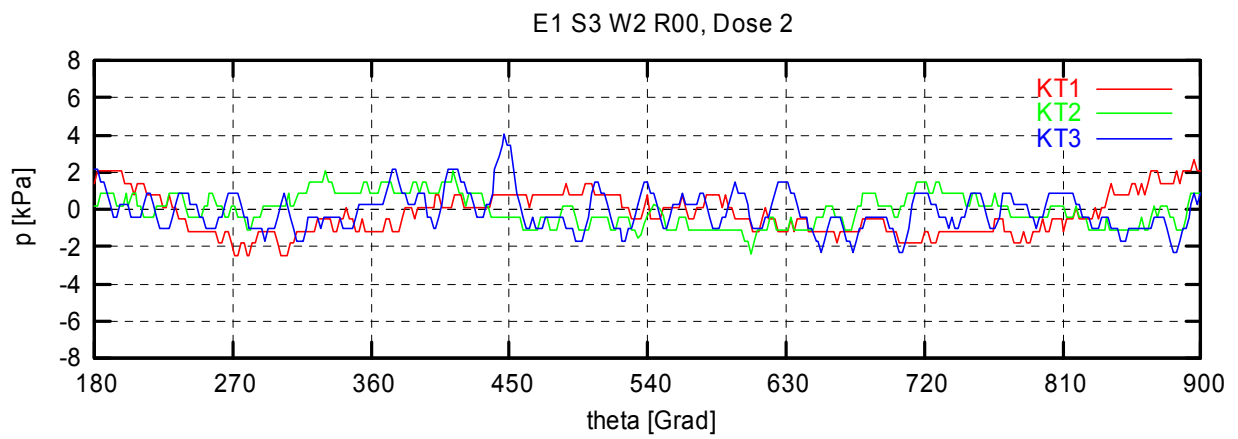


Abbildung 65 : FFT, E1-S3-W2-R00

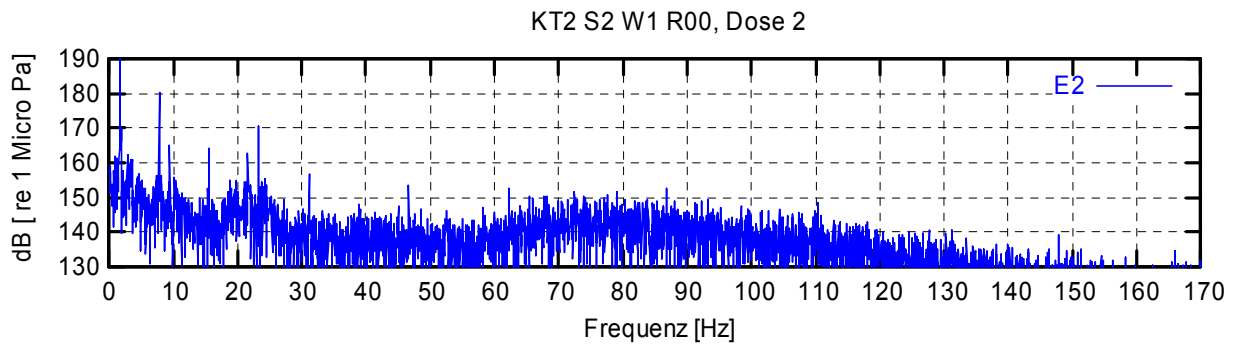
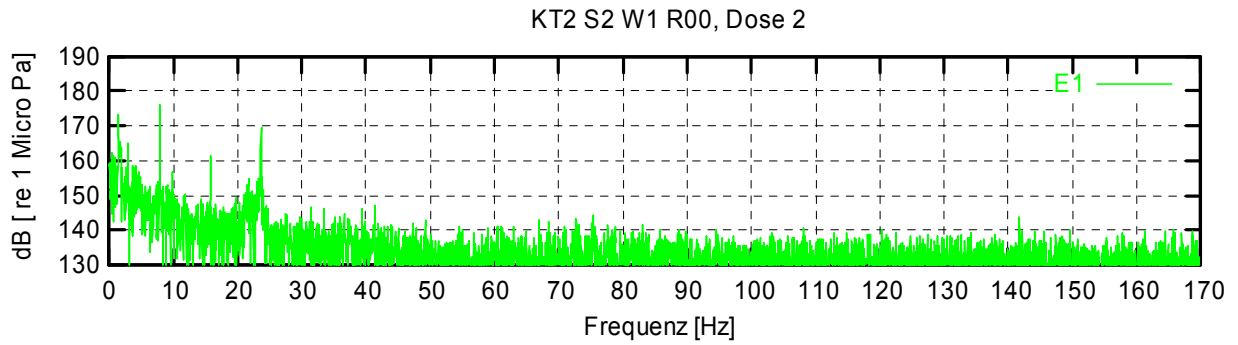
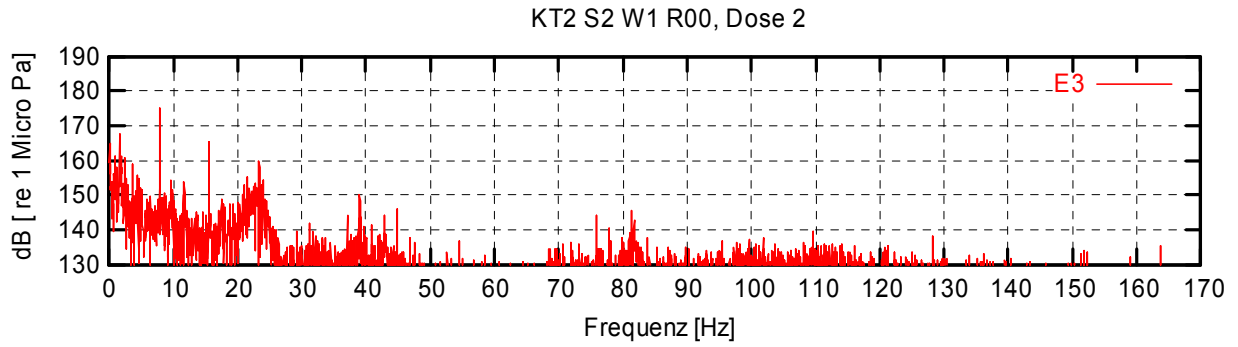
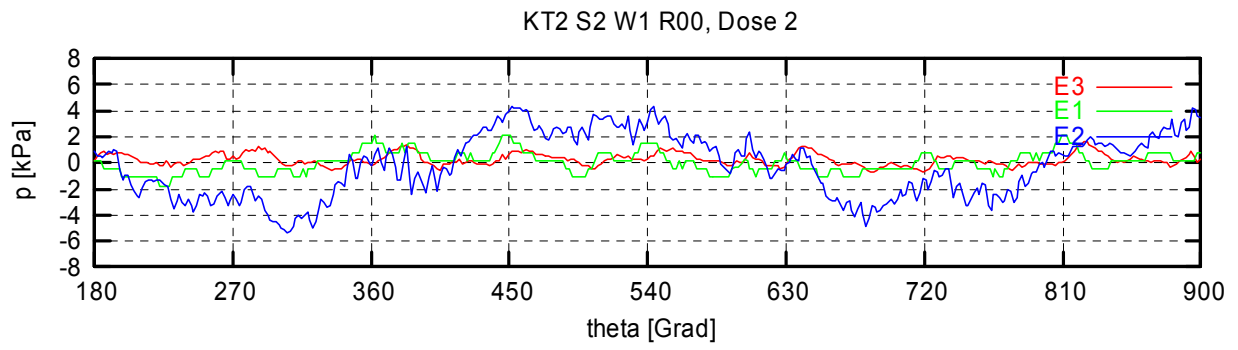


Abbildung 66 : FFT, KT2-S2-W1-R00

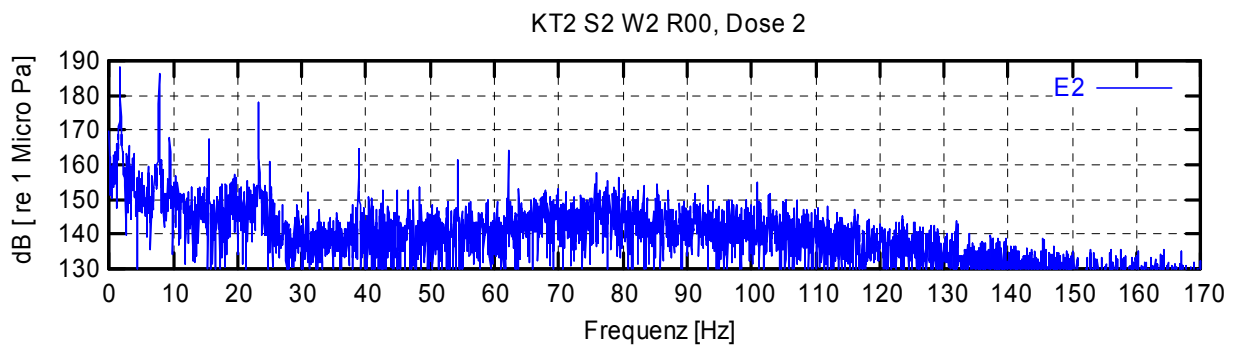
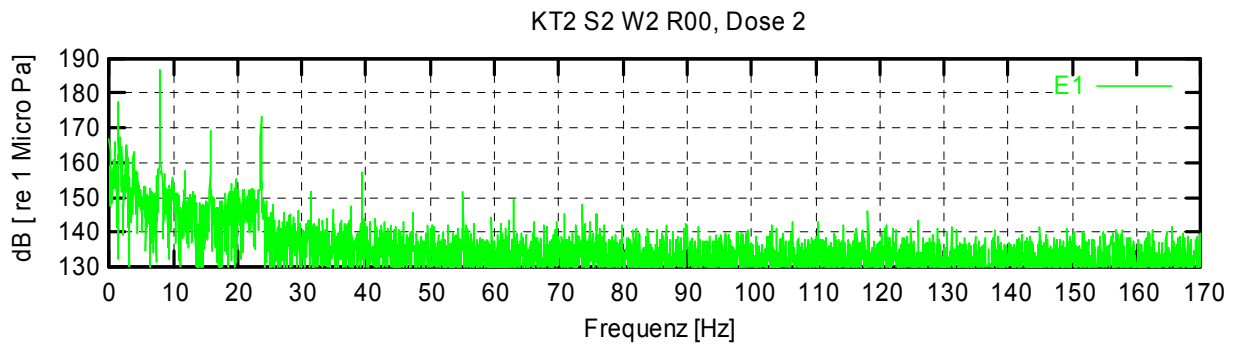
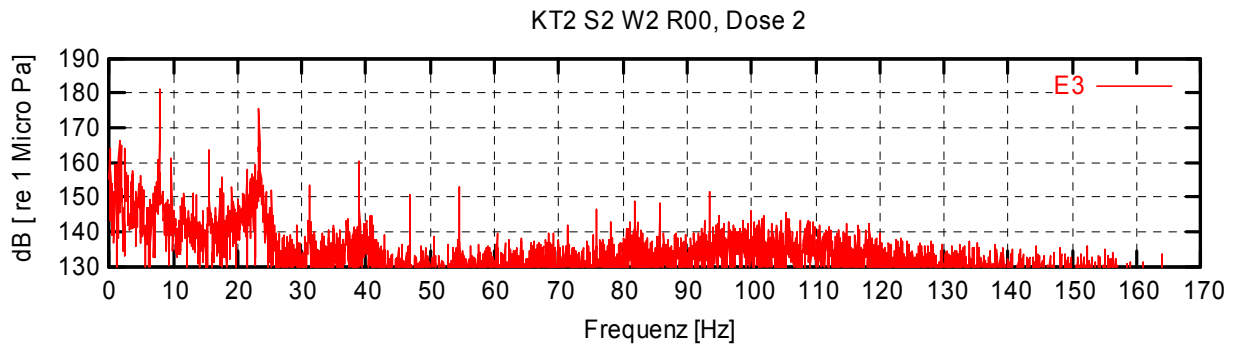
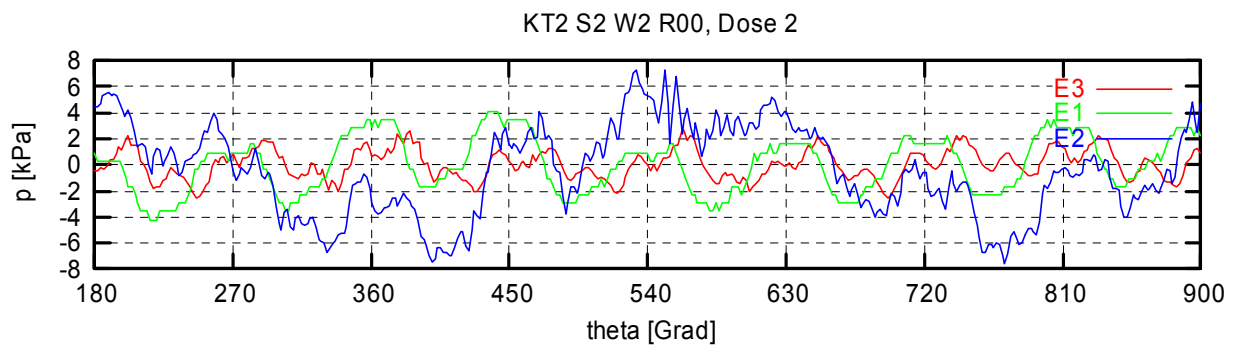


Abbildung 67 : FFT, KT2-S2-W2-R00

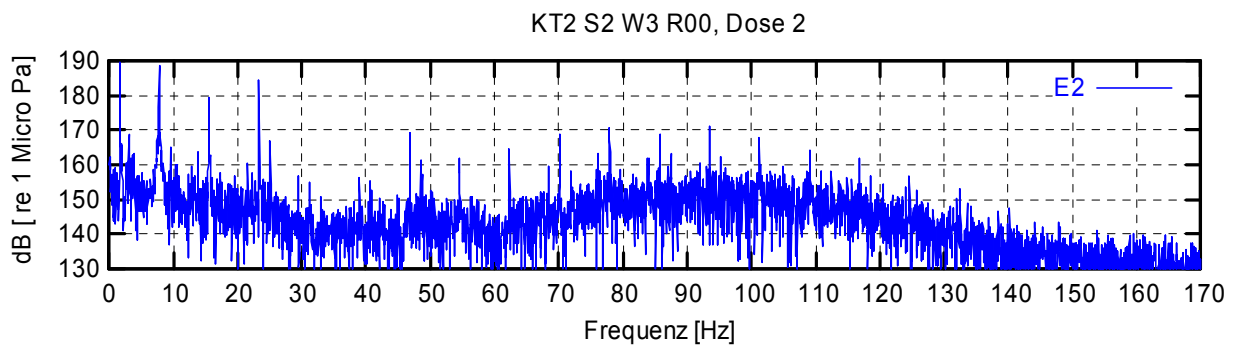
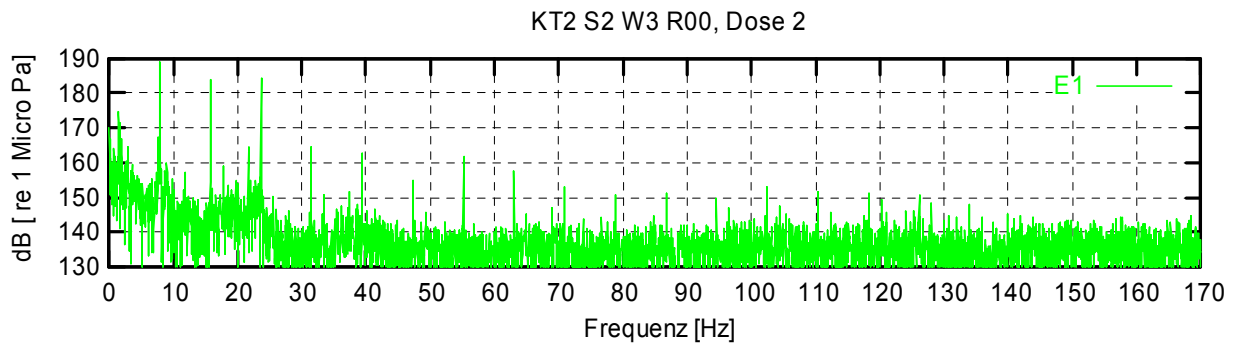
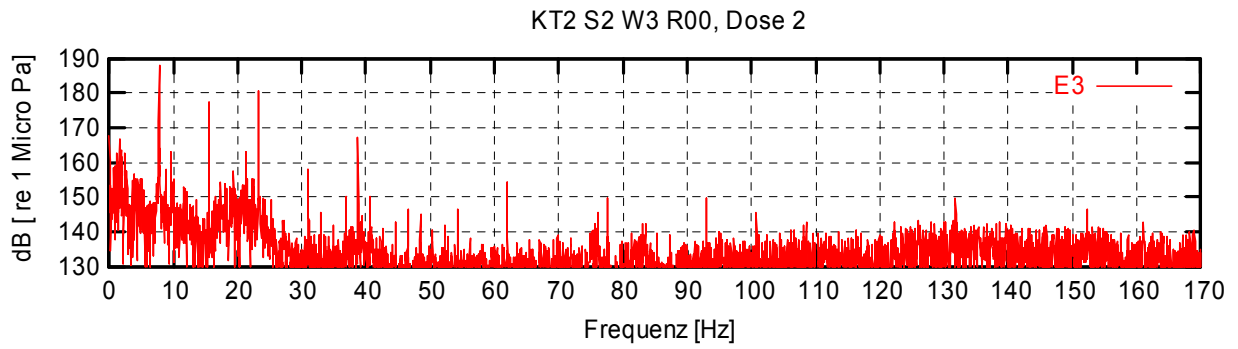
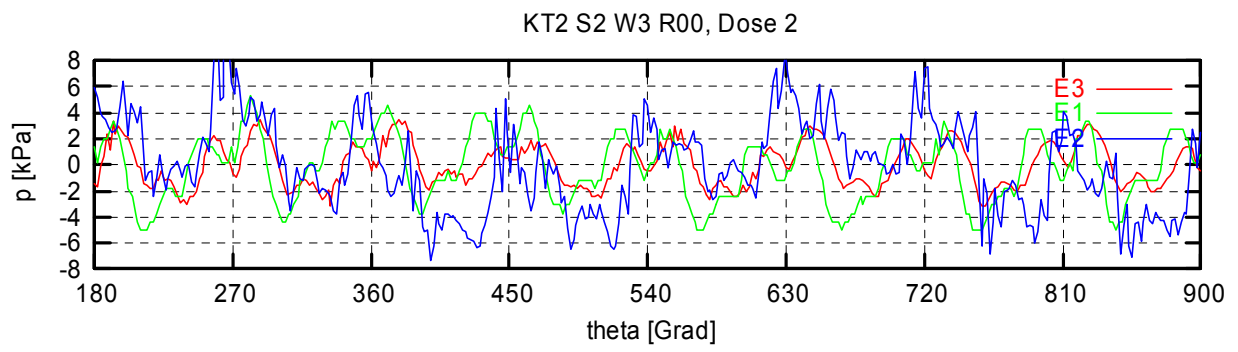


Abbildung 68 : FFT, KT2-S2-W3-R00

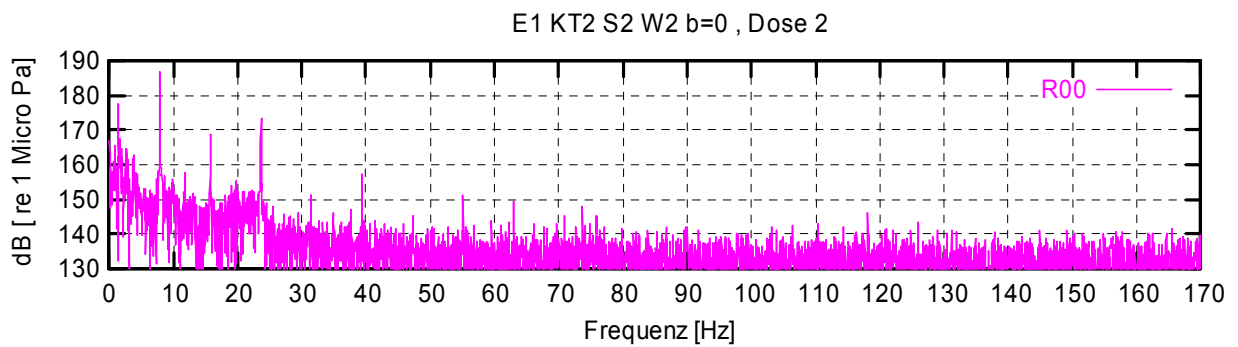
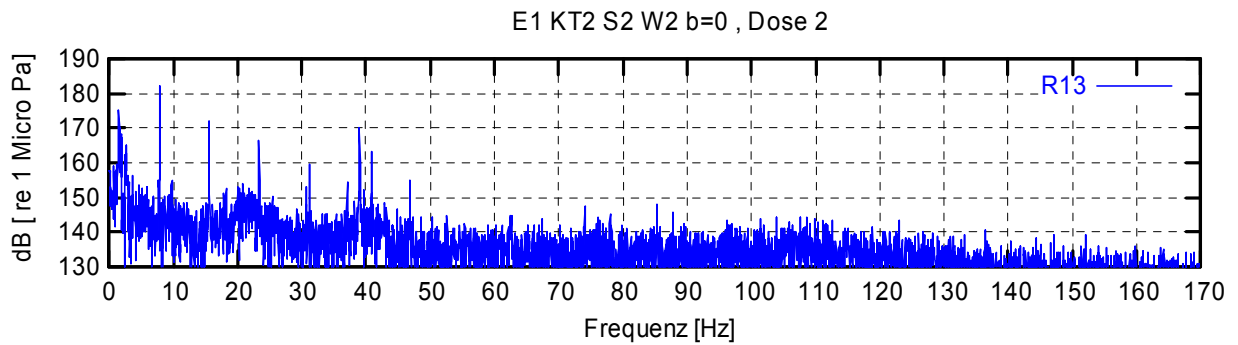
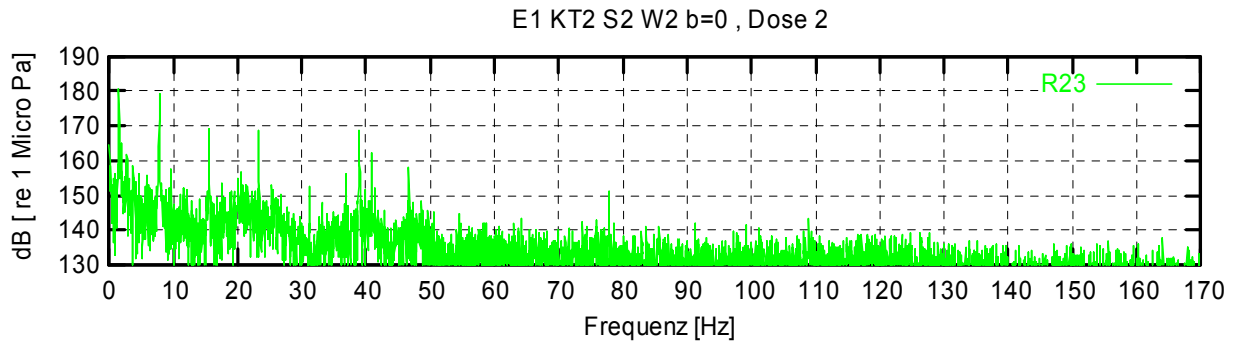
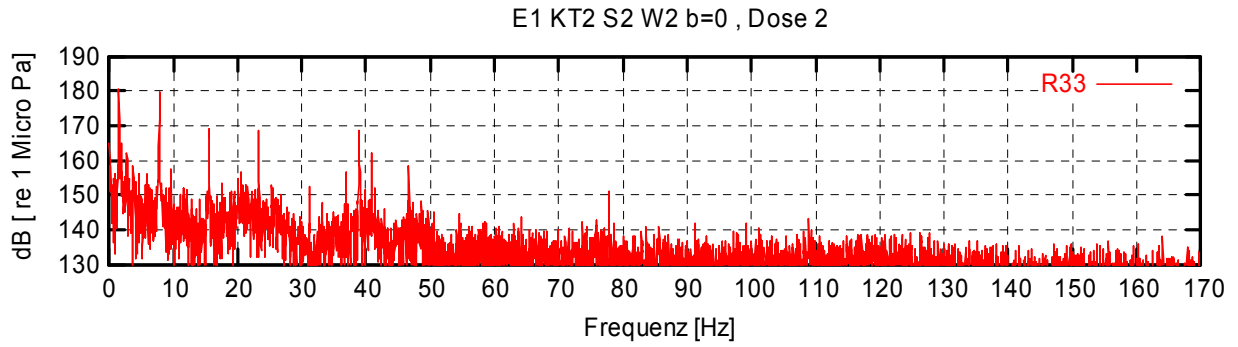
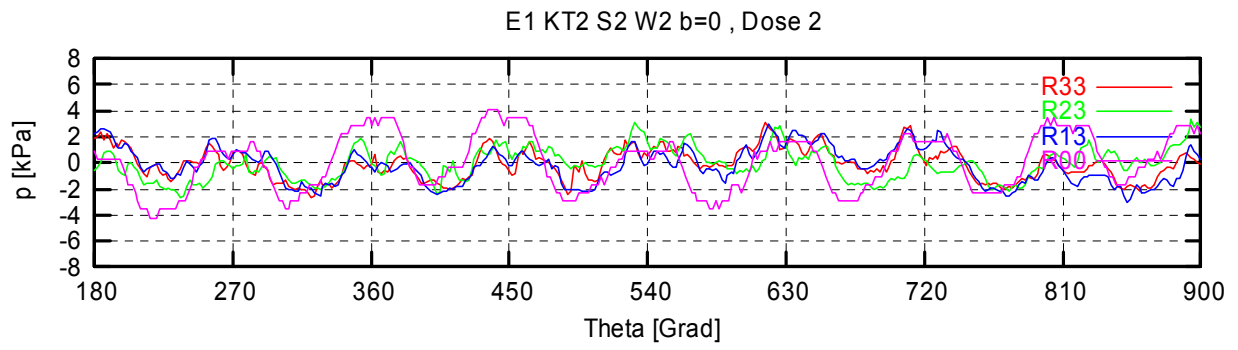


Abbildung 69 : FFT, KT2-S2-W2



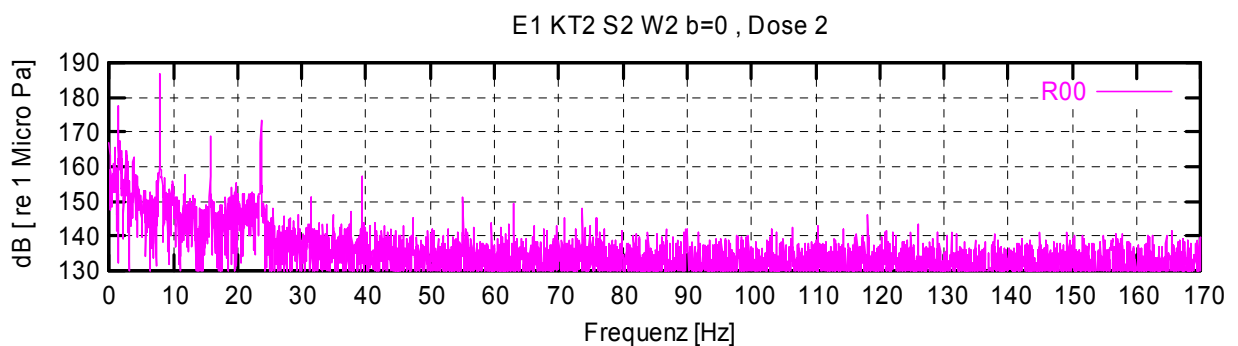
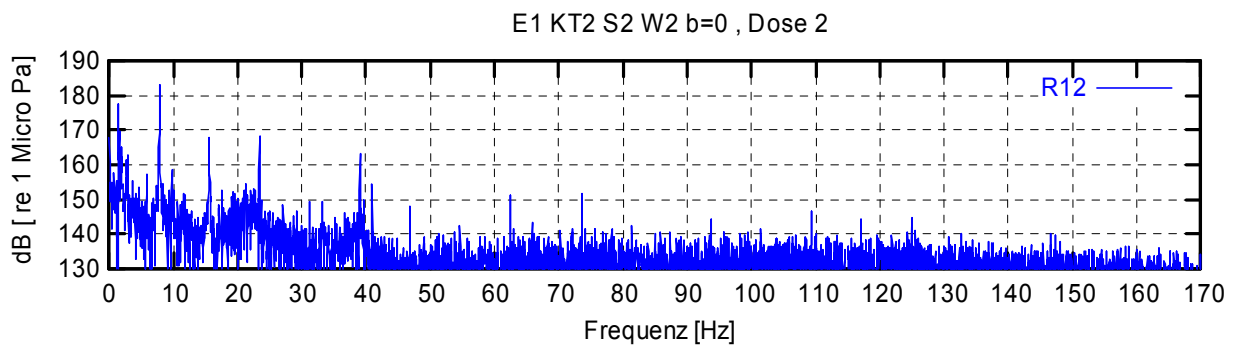
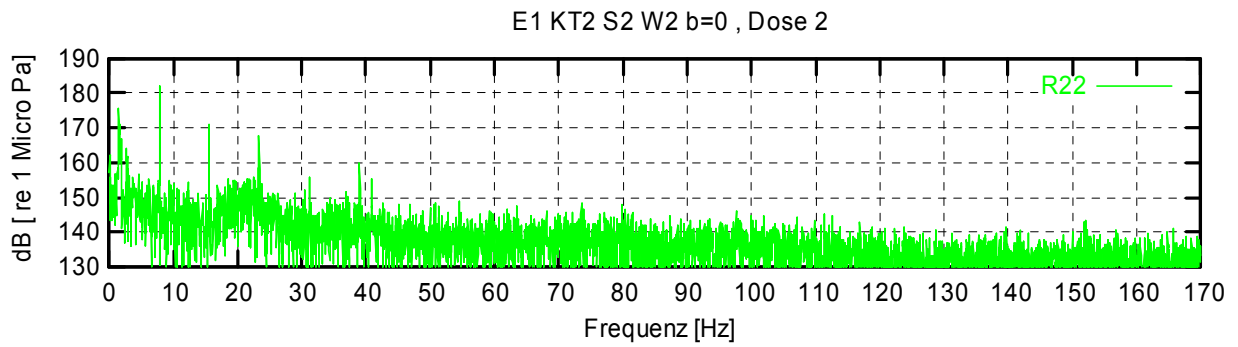
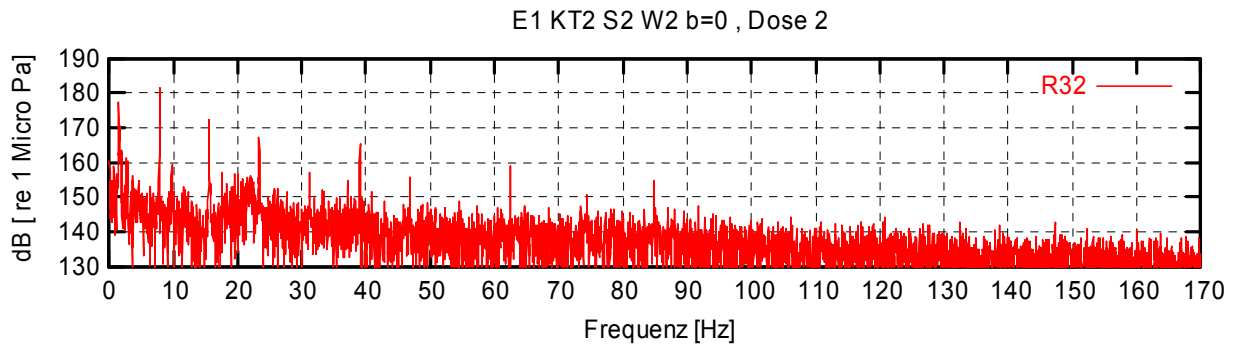
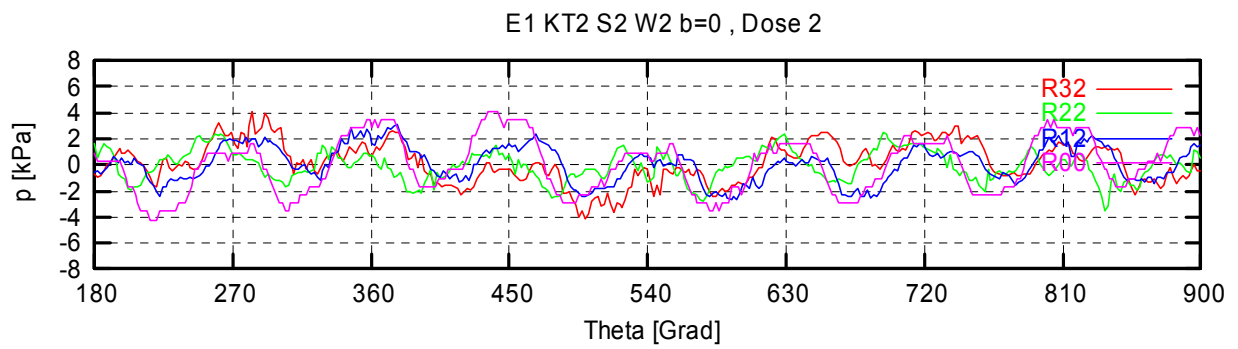


Abbildung 70 : FFT, KT2-S2-W2

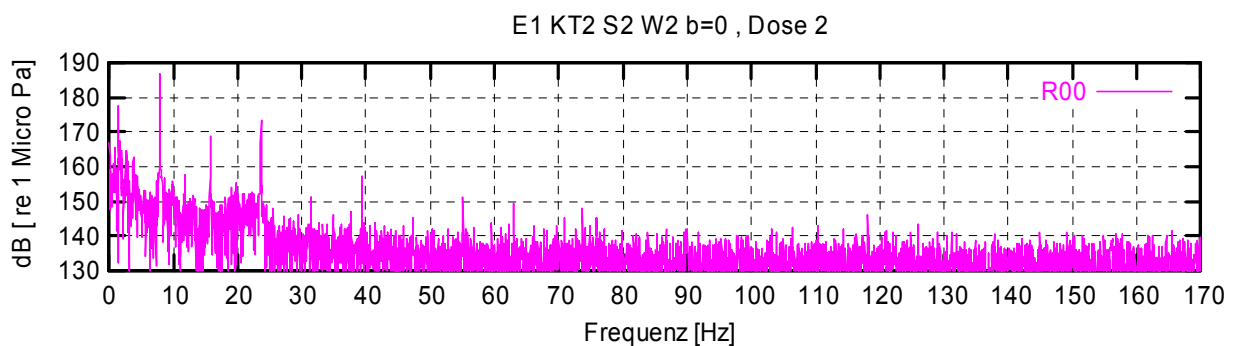
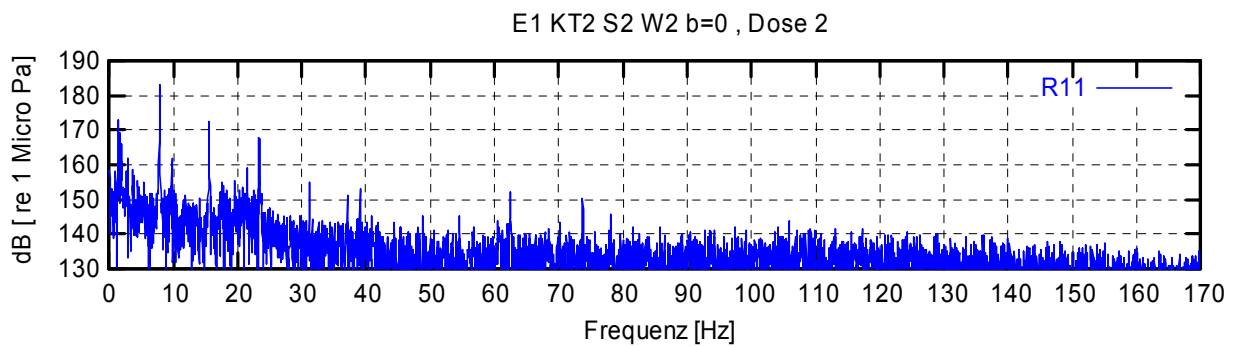
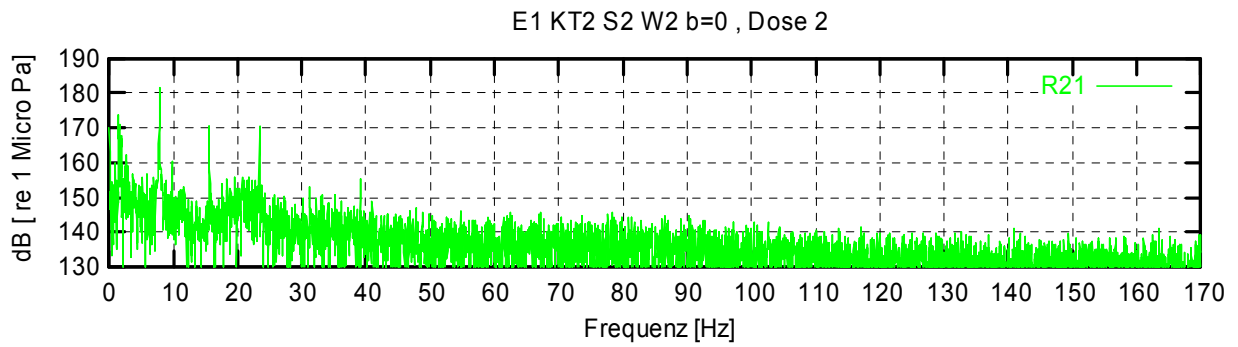
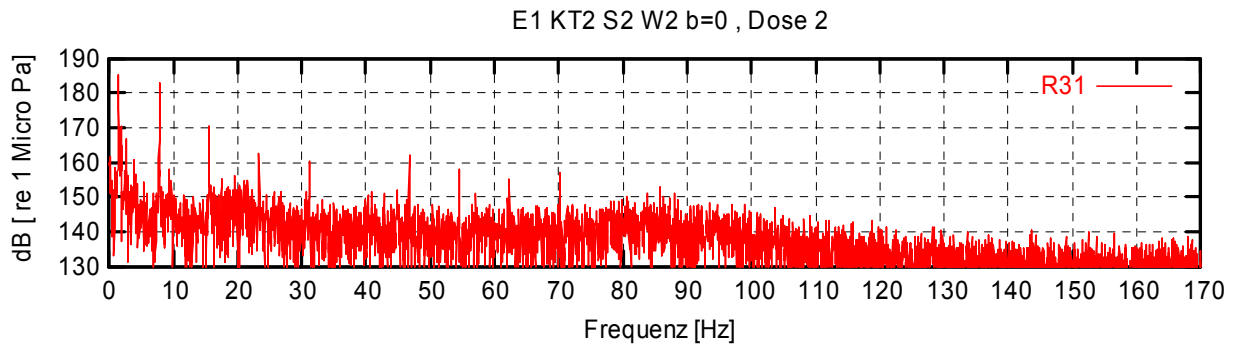
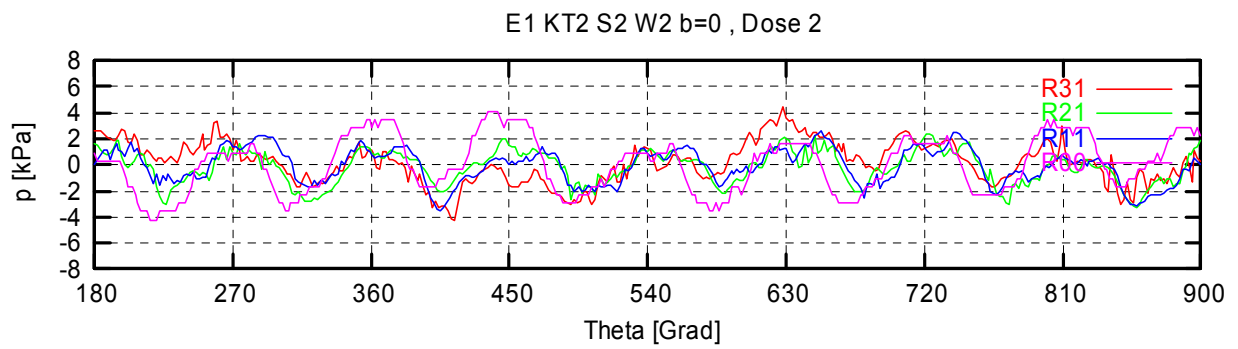


Abbildung 71 : FFT, KT2-S2-W2

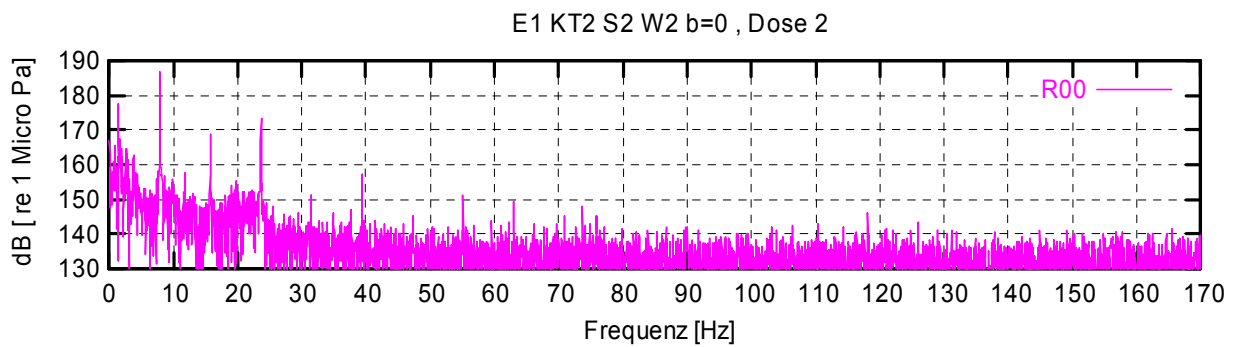
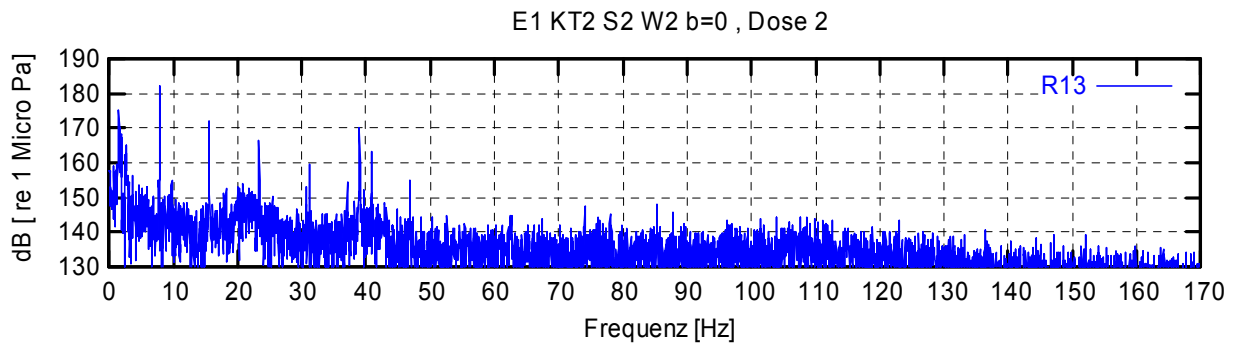
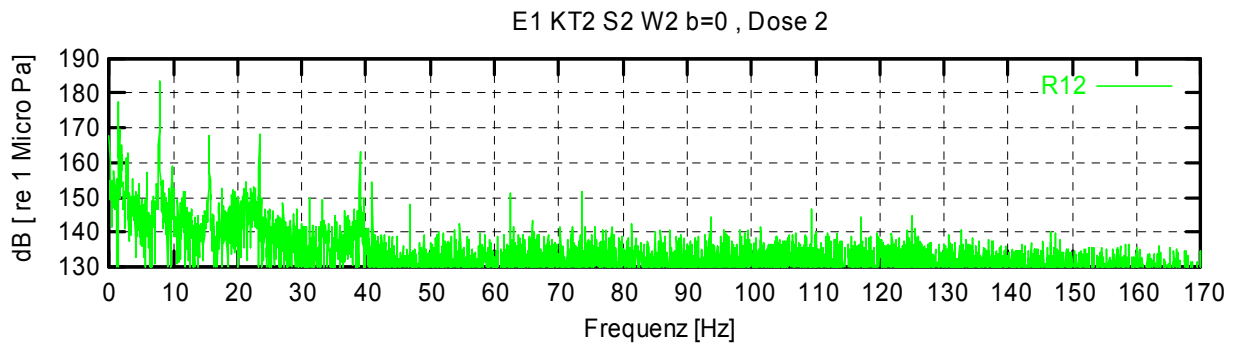
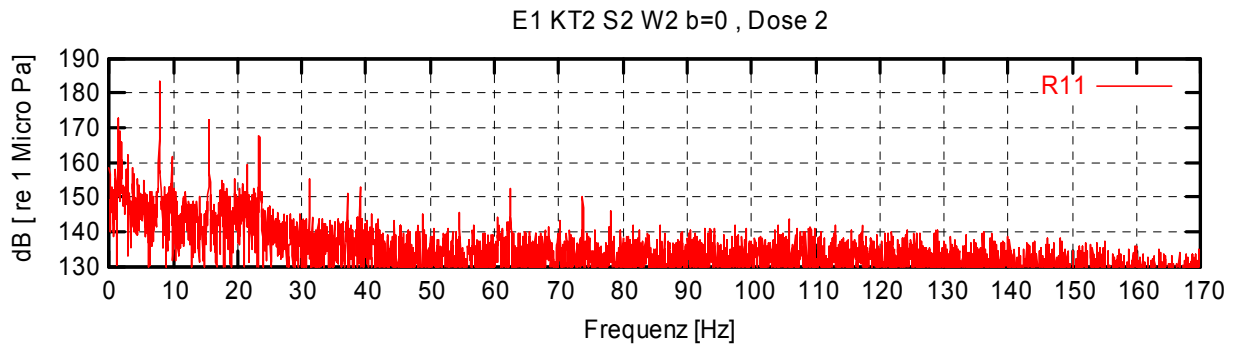
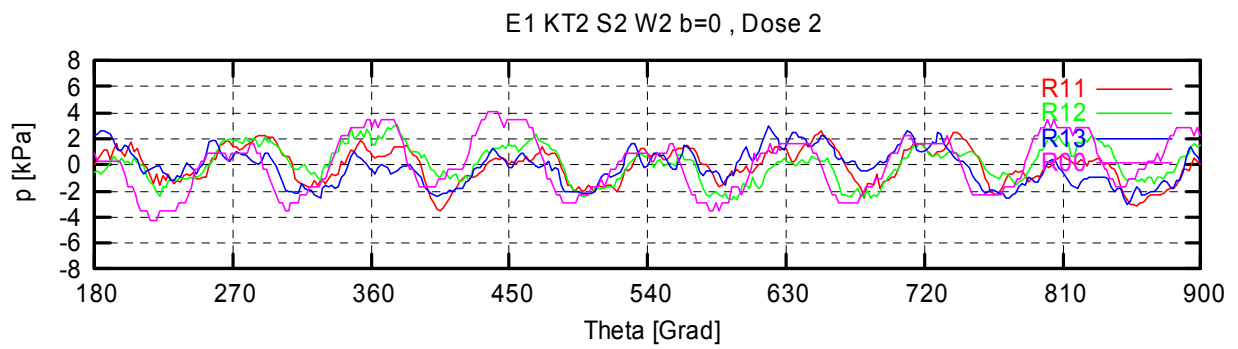


Abbildung 72 : FFT, KT2-S2-W2

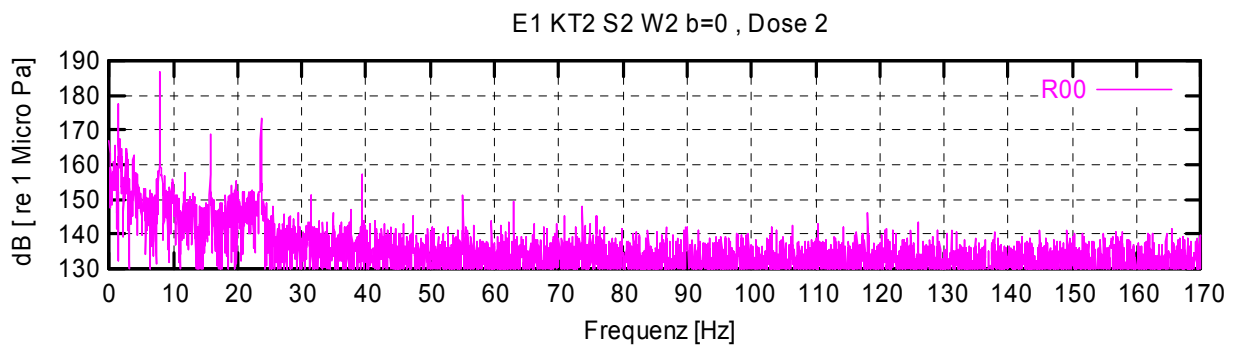
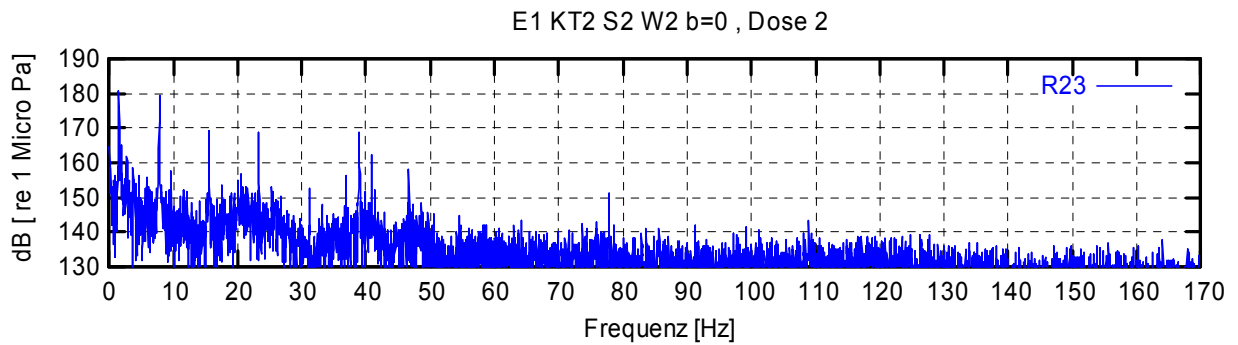
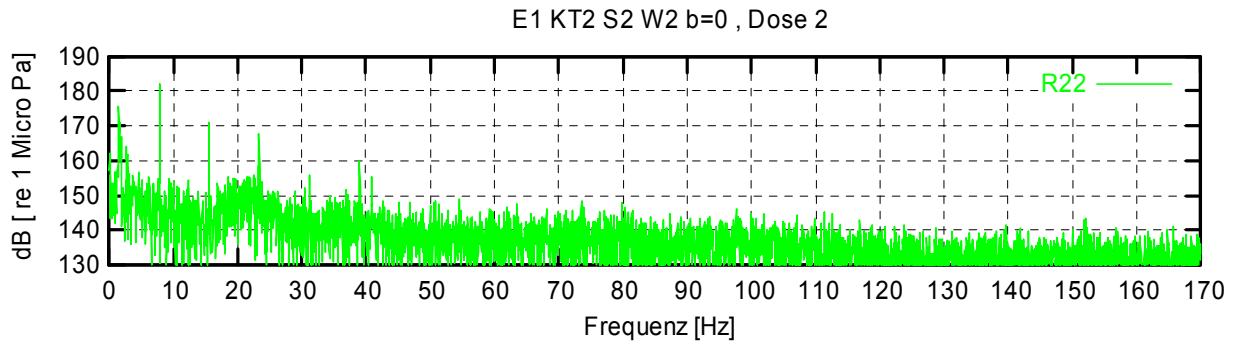
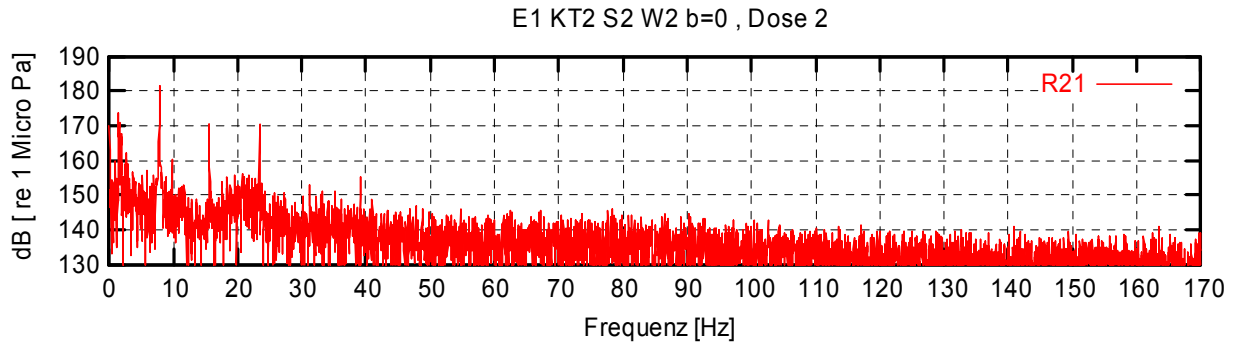
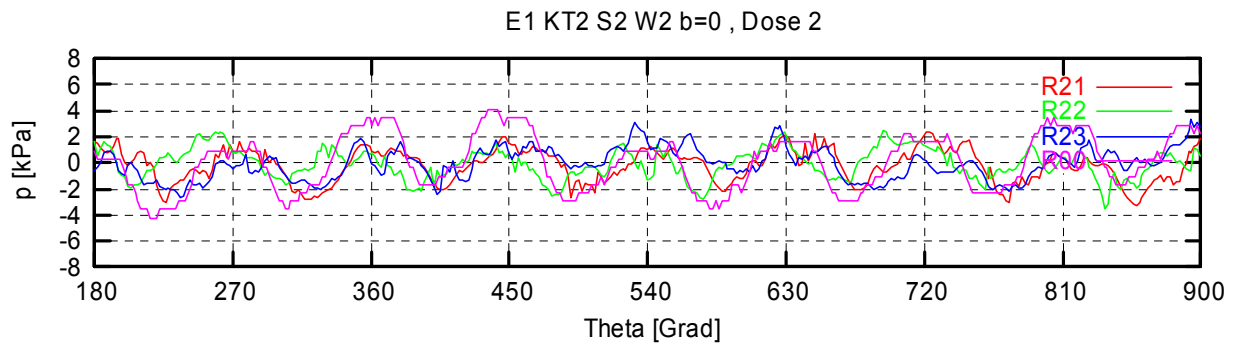


Abbildung 73 : FFT, KT2-S2-W2

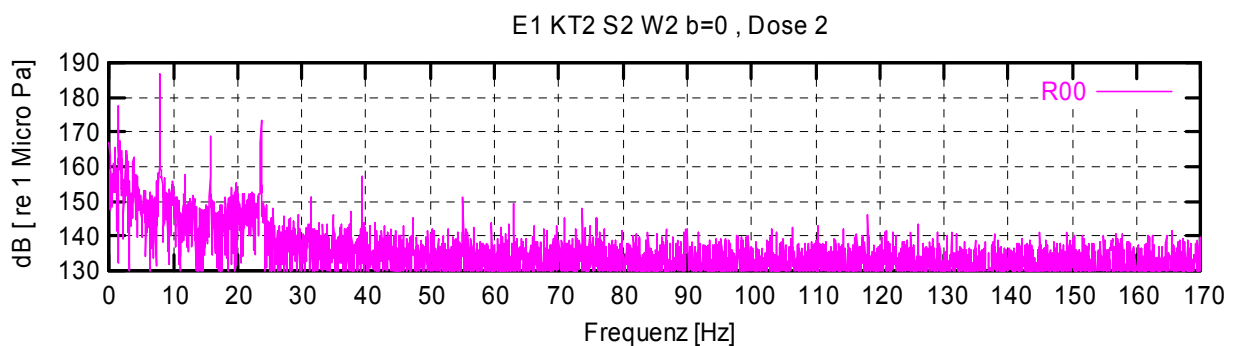
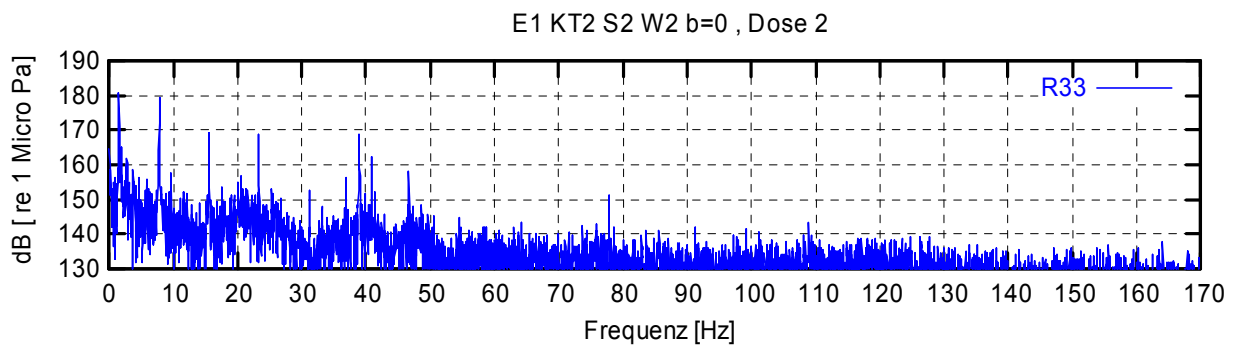
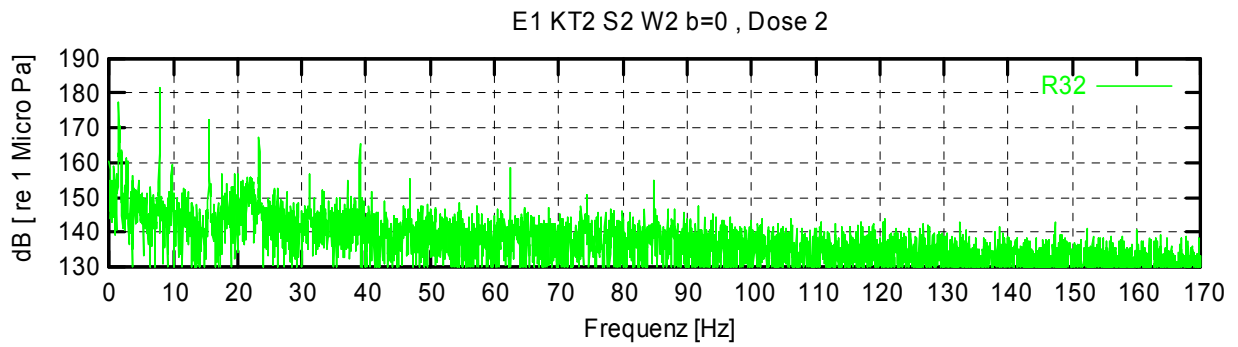
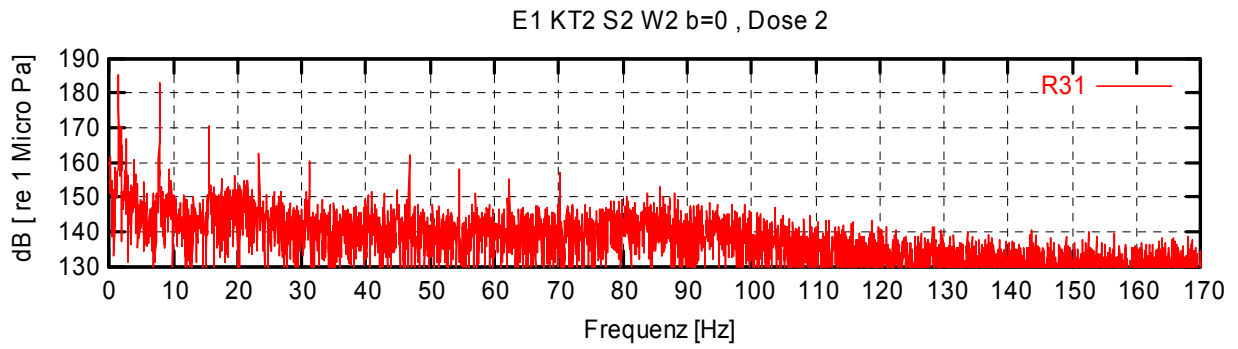
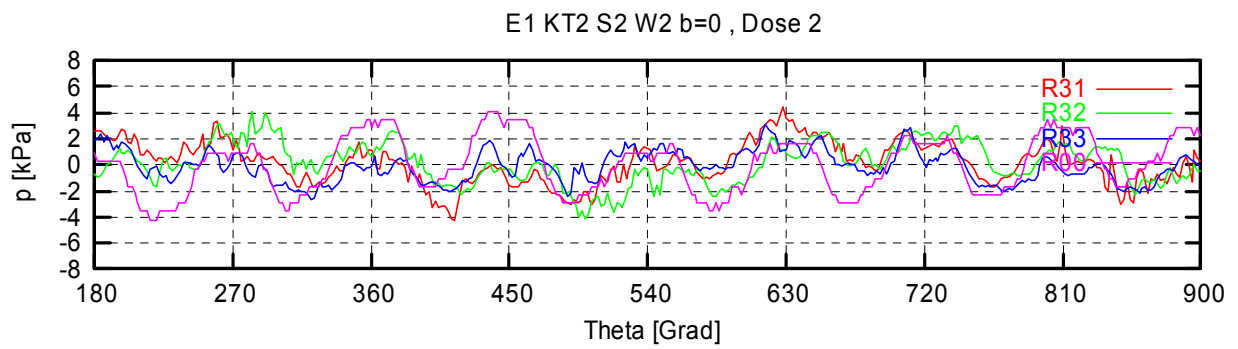


Abbildung 74 : FFT, KT2-S2-W2

# **Berechnungen**

## CFD-Ergebnisse

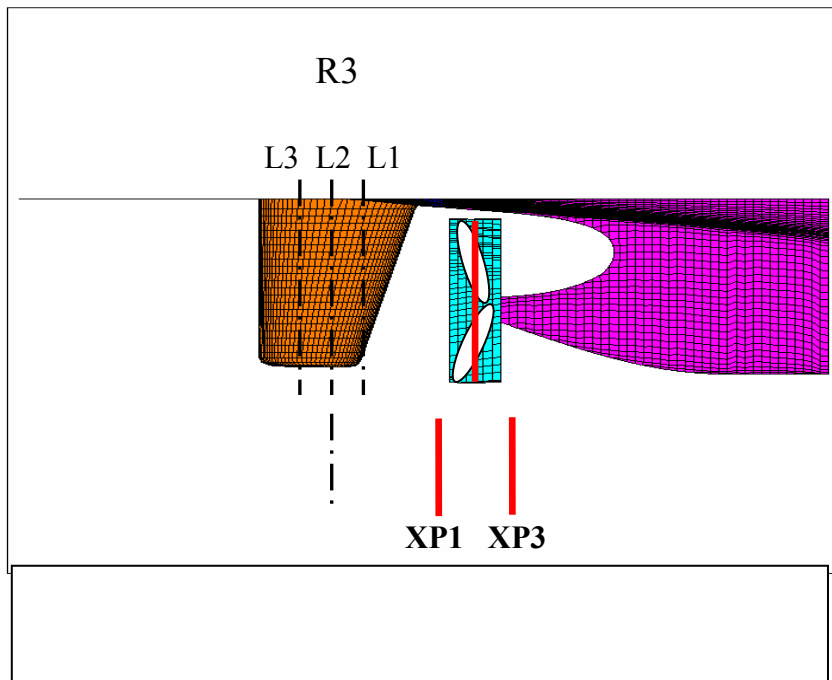


Abbildung 75 : Untersuchung der Wechselwirkung zwischen dem Ruder und dem Propeller



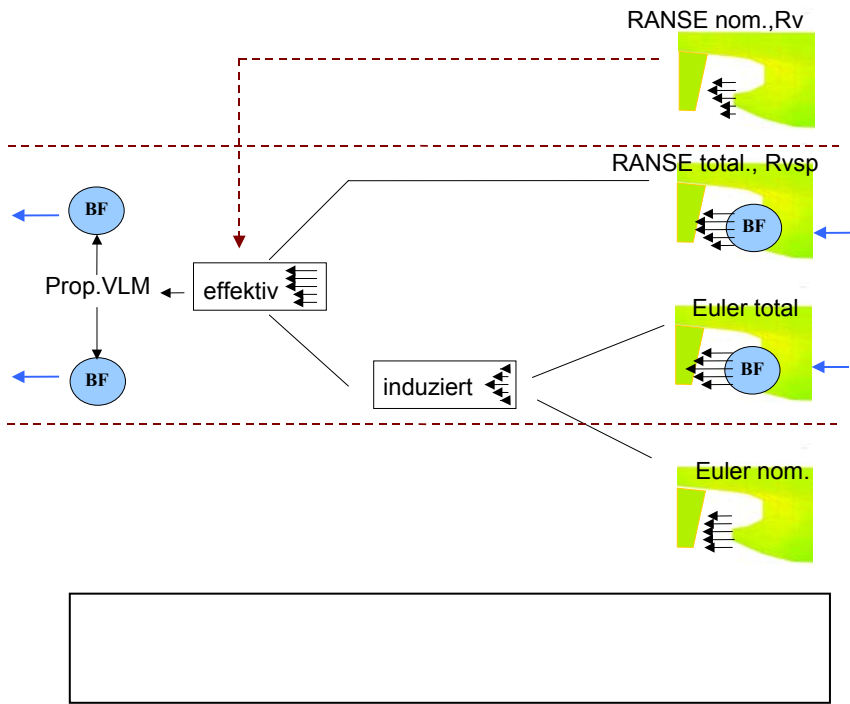


Abbildung 76 : Numerische Propulsionsversuche

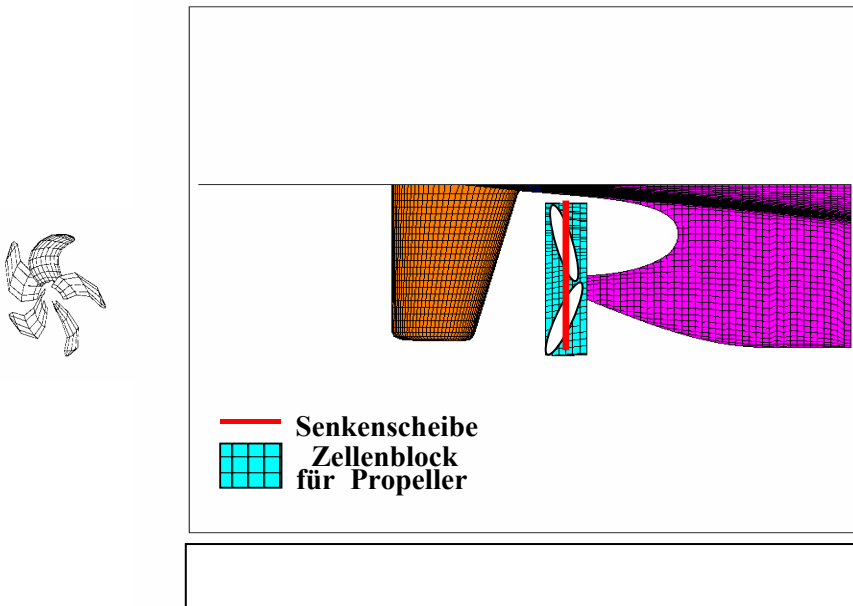


Abbildung 77 : Zellenblock für propeller 'body forces'

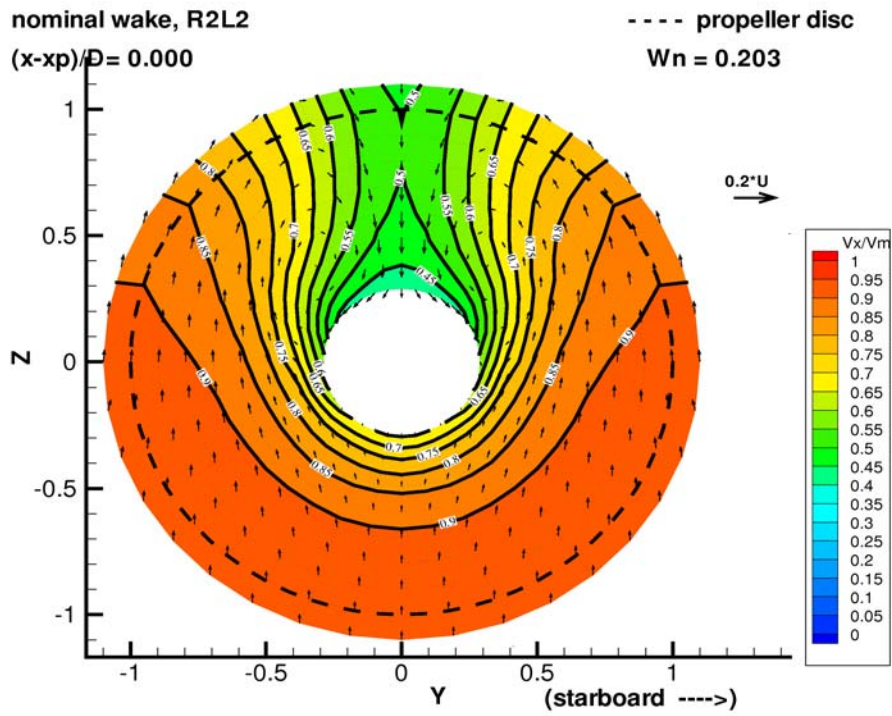


Abbildung 78 : Berechnete nominelle Nachstromverteilung

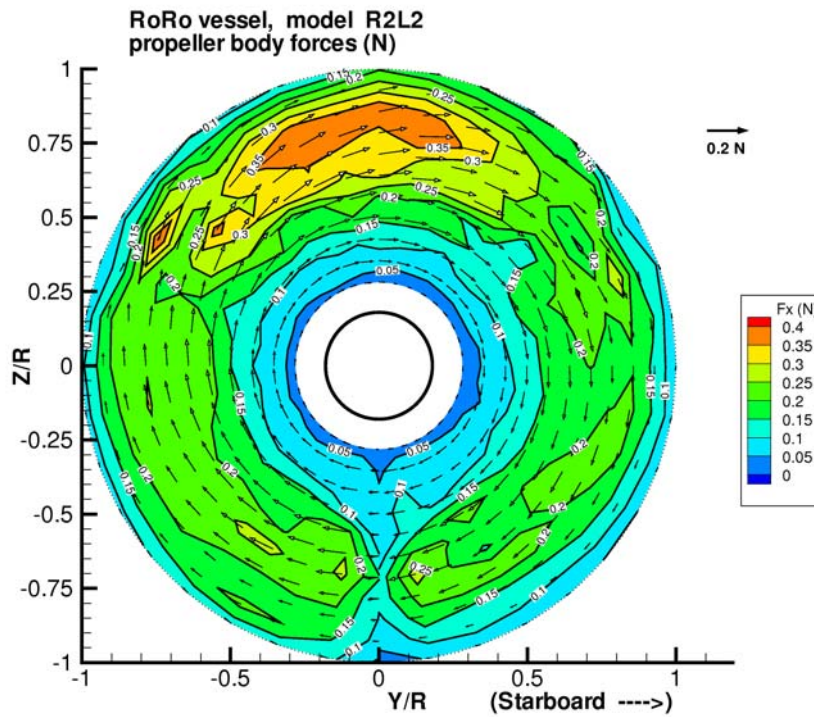


Abbildung 79 : Verteilung der gesamten Propellerkräfte

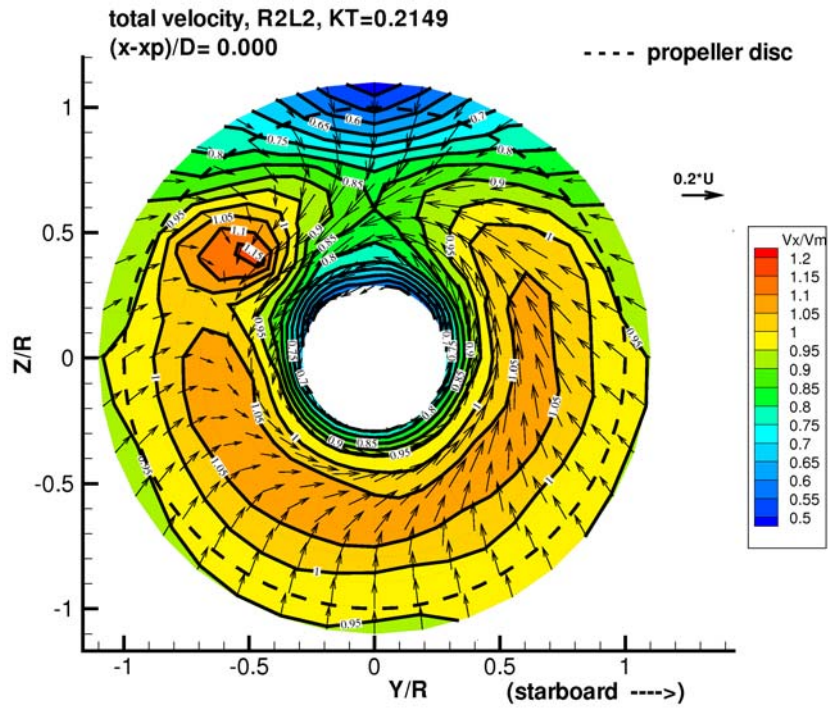


Abbildung 80 : Verteilung der totalen Geschwindigkeiten

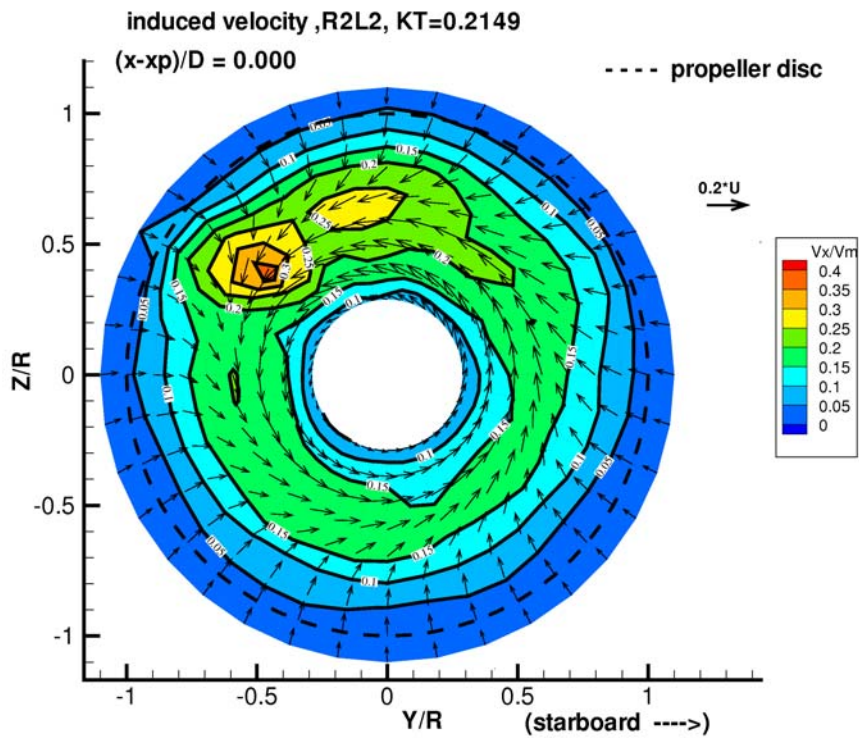


Abbildung 81 : Die vom Propeller induzierten Geschwindigkeiten

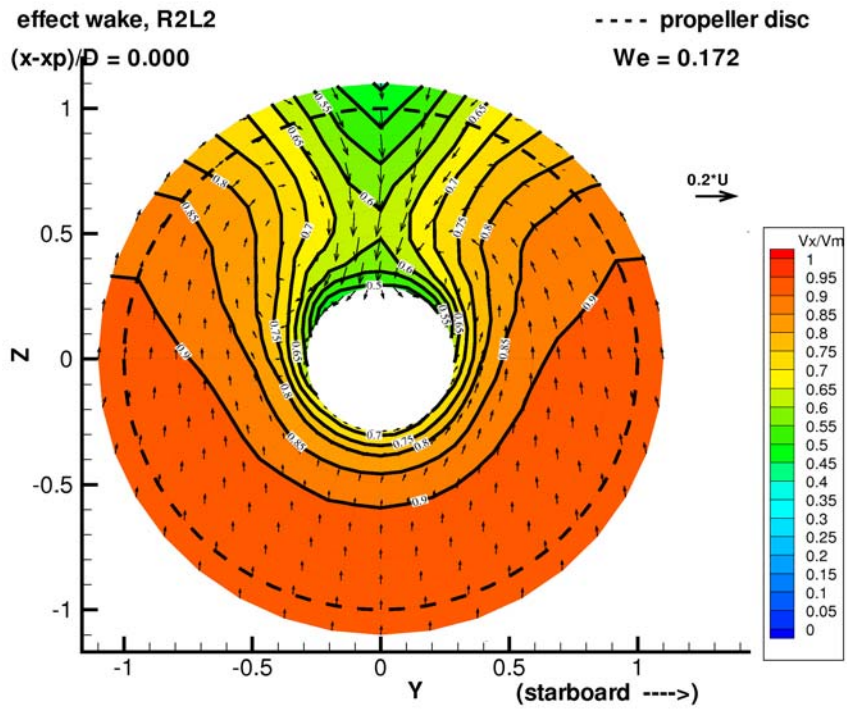


Abbildung 82 : Effektive Nachstromverteilung in der Propellerebene

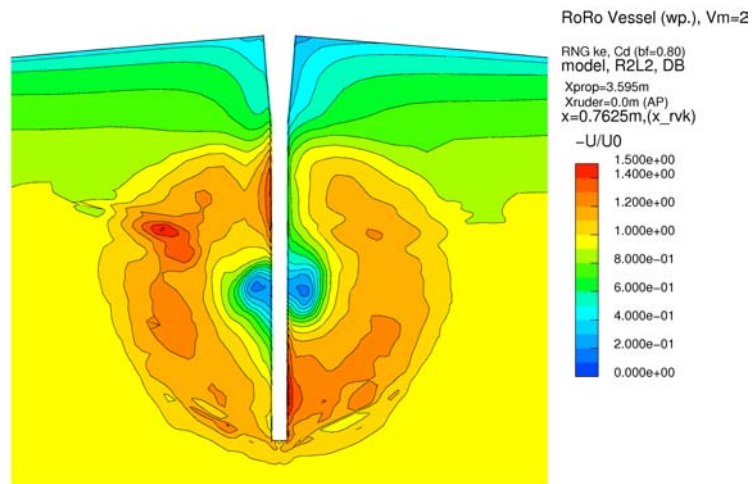


Abbildung 83 : Verteilung der axialen Komponente der totalen Geschwindigkeit in der Ebene an der Rudervorderkante

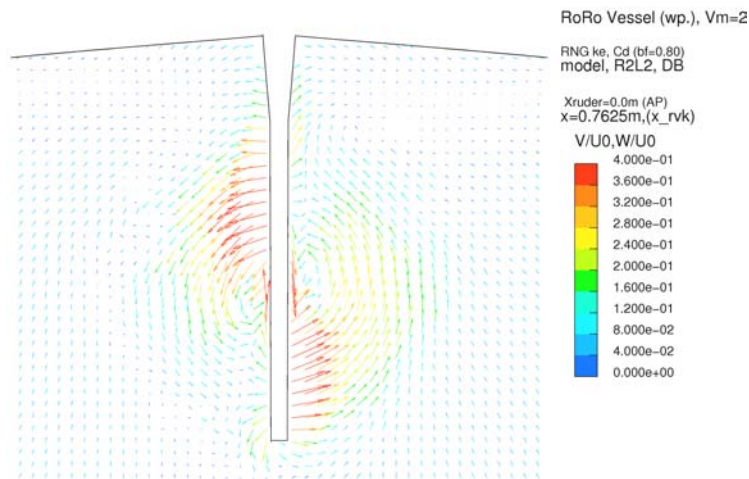


Abbildung 84 : Verteilung der queren Komponente der totalen Geschwindigkeit in der Ebene an der Rudervorderkante

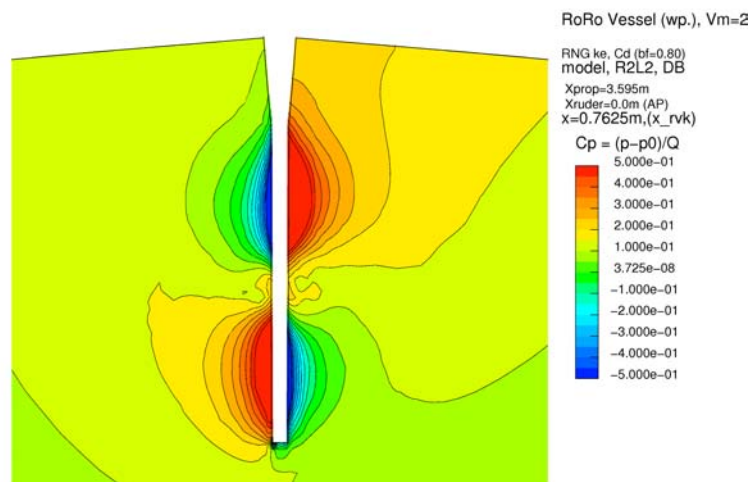


Abbildung 85 : Das Druckfeld in der Ebene an der Rudervorderkante

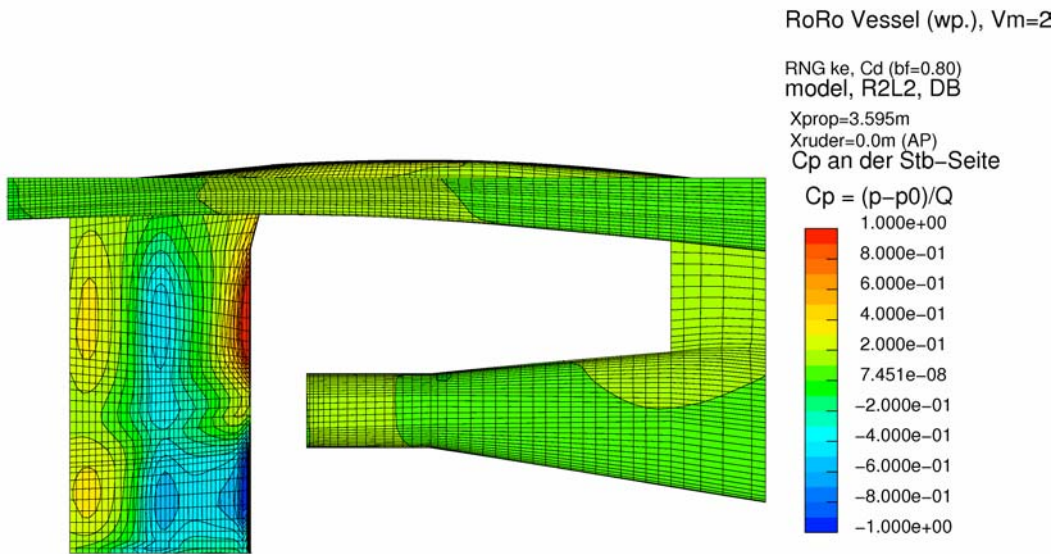


Abbildung 86 : Druckverteilung an der Steuerbordseite des Hinterschiffs

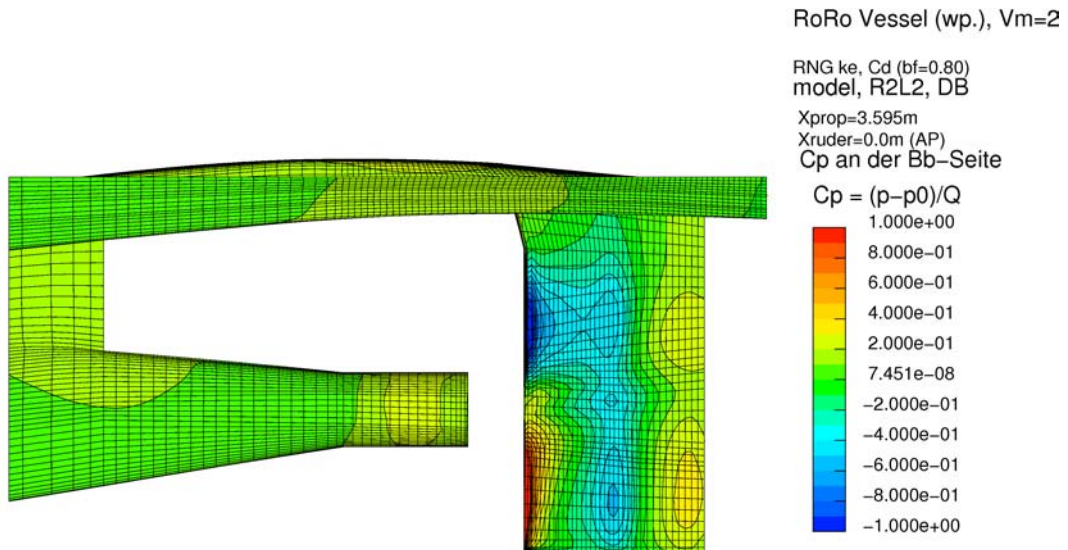
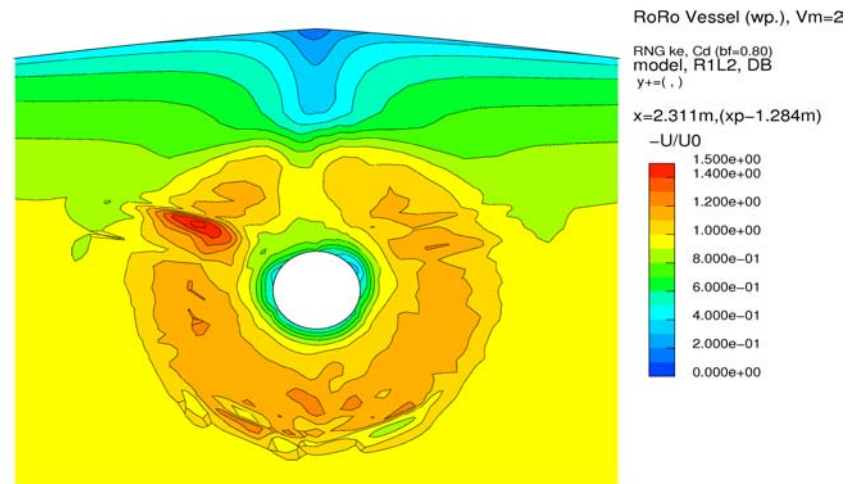
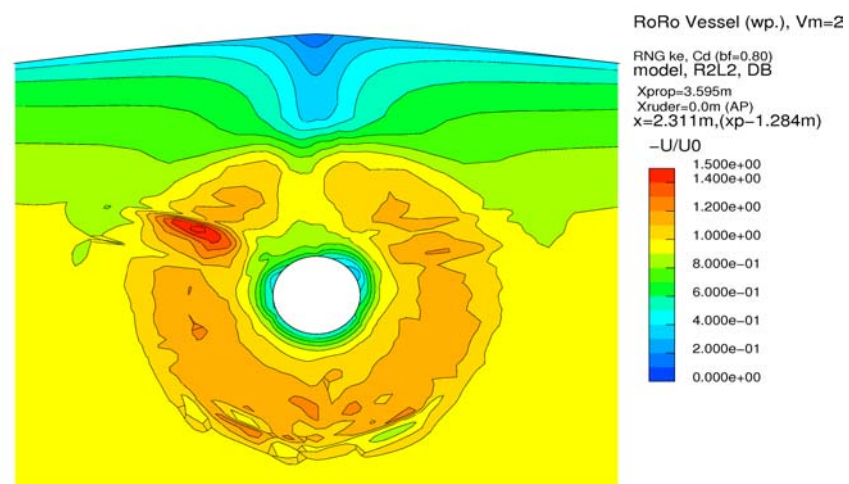


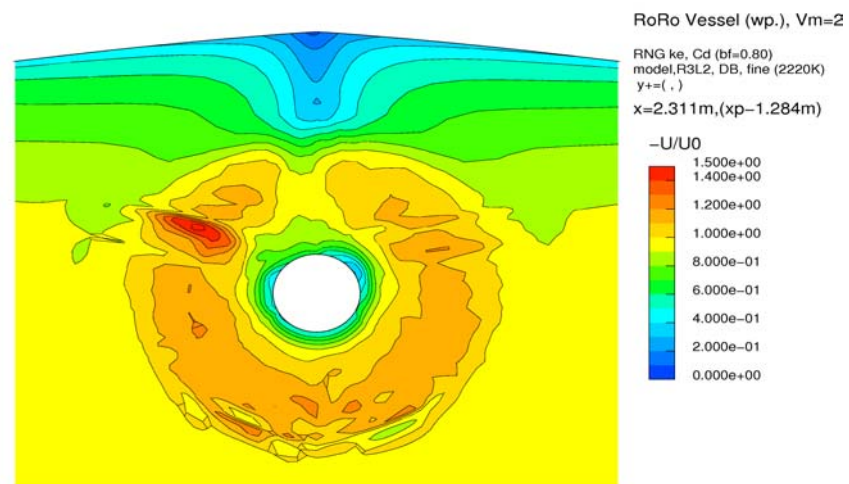
Abbildung 87 : Druckverteilung an der Backbordseite des Hinterschiffs



Ruder 1 :  $t/C = 0.16$  (oben) /  $0.144$  (unten)



Ruder 2 :  $t/C = 0.20$  (oben) /  $0.18$  (unten)



Ruder 3 :  $t/C = 0.25$  (oben) /  $0.225$  (unten)

Abbildung 88 : Einfluss der Ruderdicke auf die axiale Totalgeschwindigkeit in der Ebene 0.05m hinter dem Modelpropeller

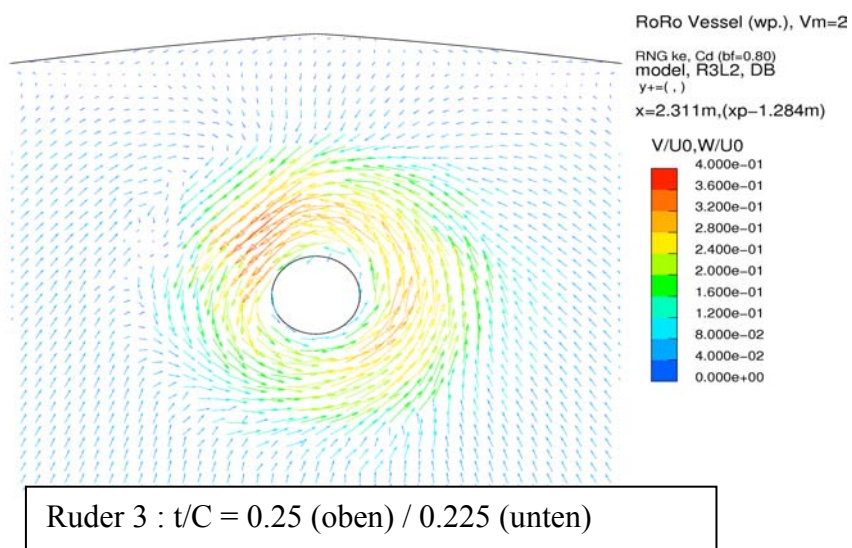
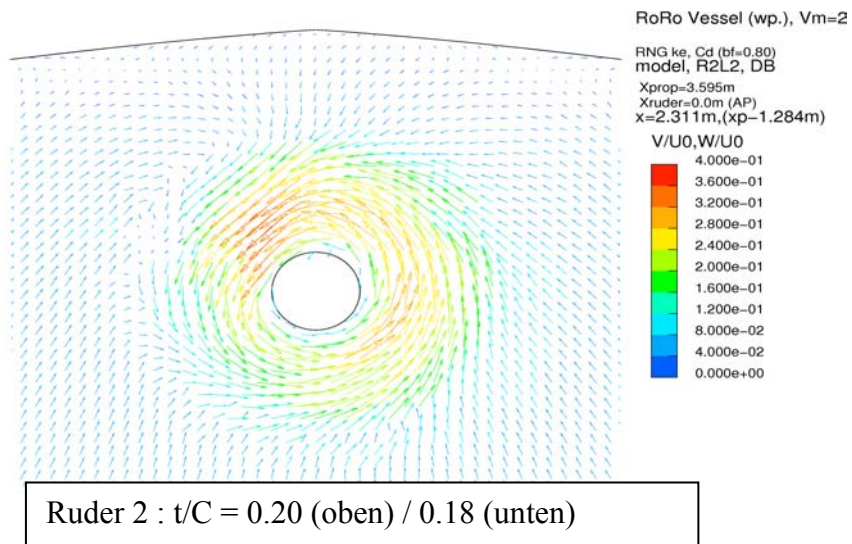
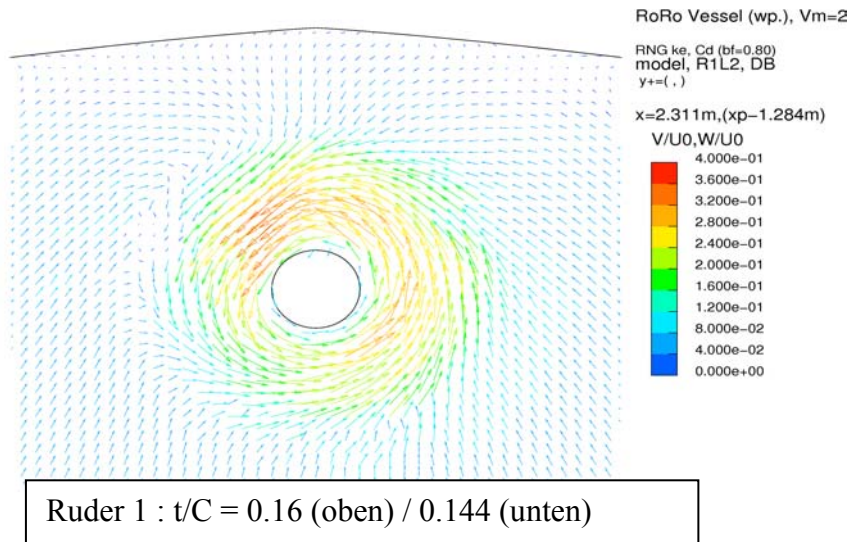
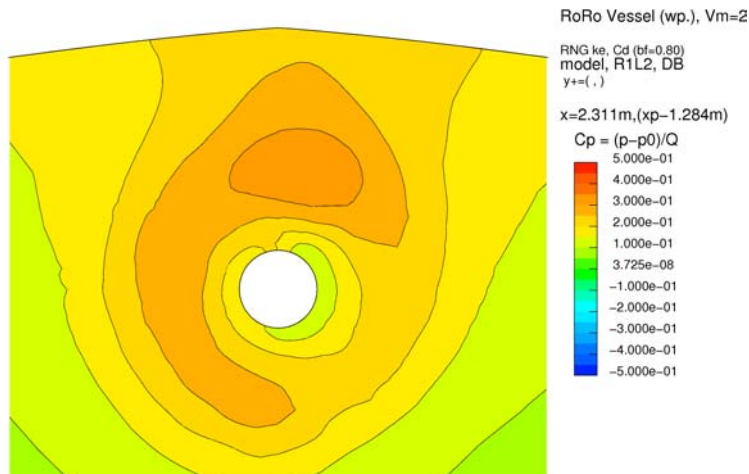
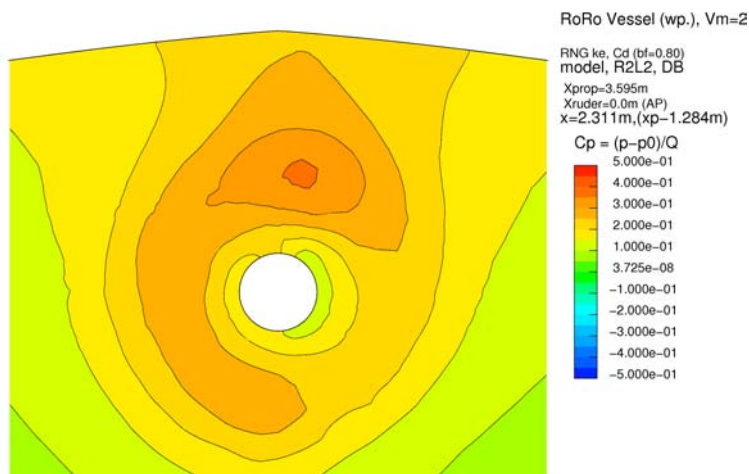


Abbildung 89 : Einfluss der Ruderdicke auf die Querkomponente der Totalgeschwindigkeit in der Ebene 0.05m hinter dem Modelpropeller

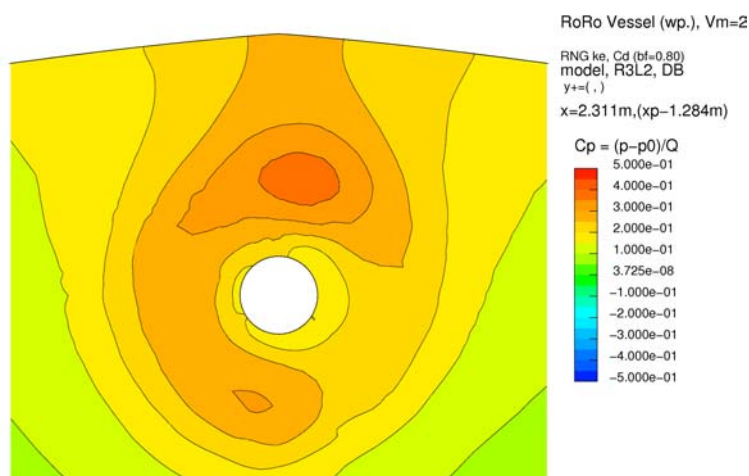




Ruder 1 : t/C = 0.16 (oben) / 0.144 (unten)

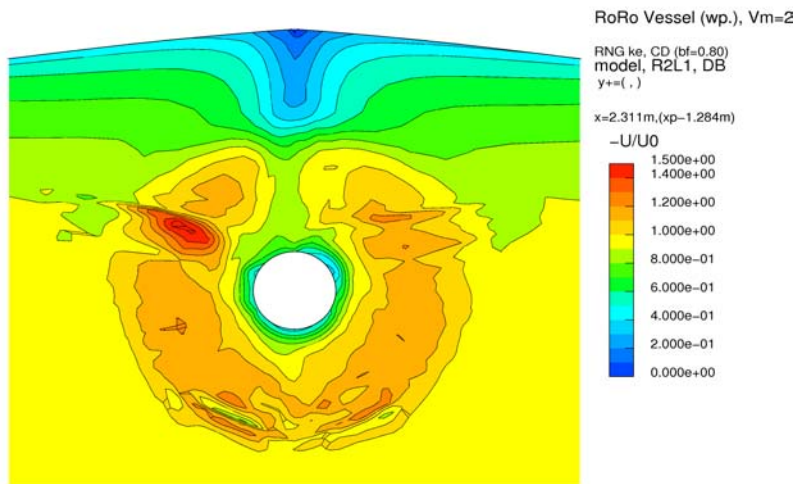


Ruder 2 : t/C = 0.20 (oben) / 0.18 (unten)

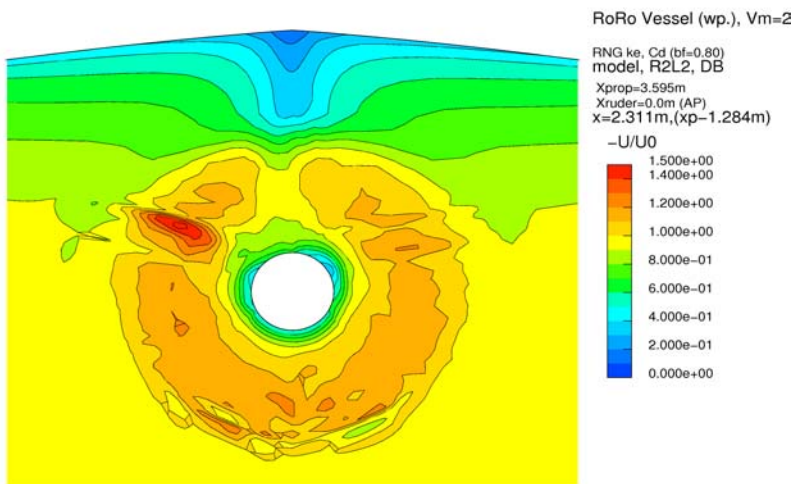


Ruder 3 : t/C = 0.25 (oben) / 0.225 (unten)

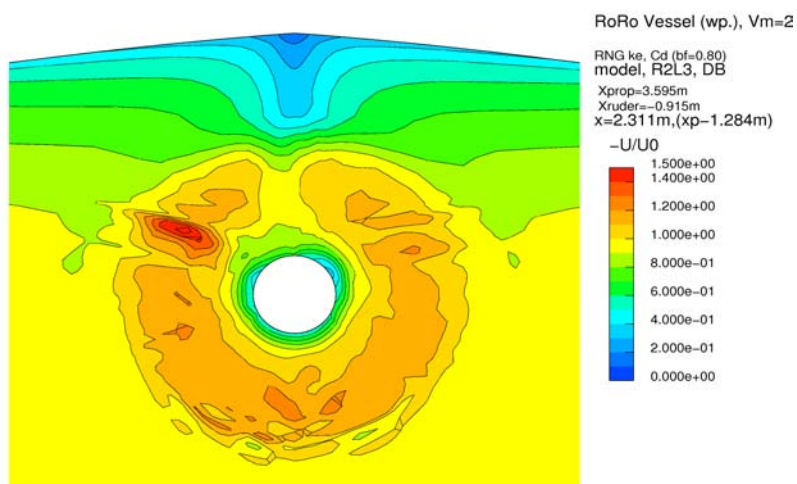
Abbildung 90 : Einfluss der Ruderdicke auf das Druckfeld



Ruder 2, Lage 1 : 0.88R hinter der Propellerebene

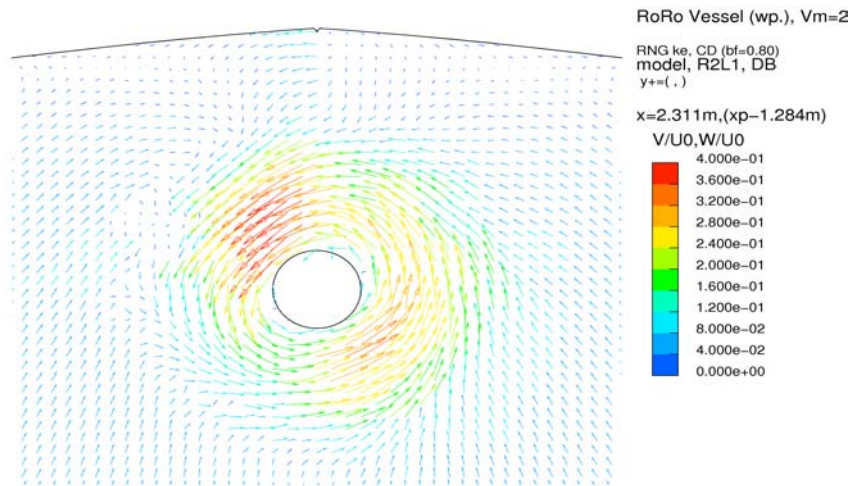


Ruder 2, Lage 2 : 1.18R hinter der Propellerebene

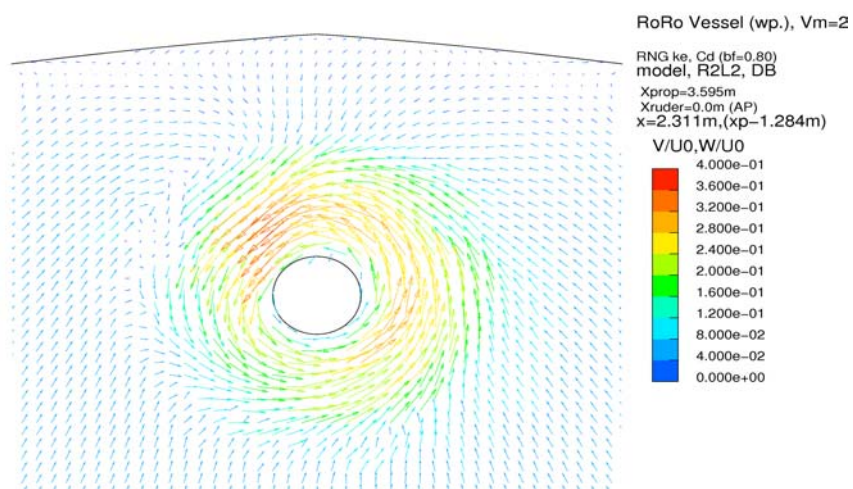


Ruder 2, Lage 3 : 1.48R hinter der Propellerebene

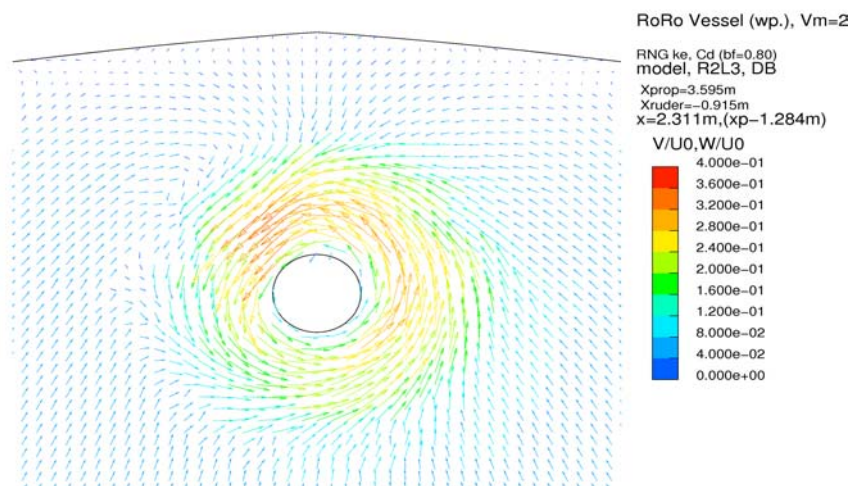
Abbildung 91 : Einfluss der Ruderlage auf die axiale Totalgeschwindigkeit in der Ebene 0.05m hinter dem Modelpropeller



Ruder 2, Lage 1 : 0.88R hinter der Propellerebene

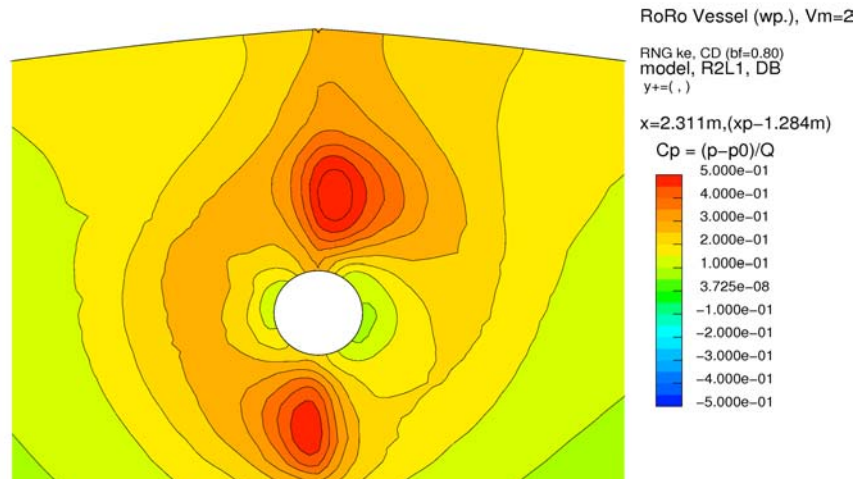


Ruder 2, Lage 2 : 1.18R hinter der Propellerebene

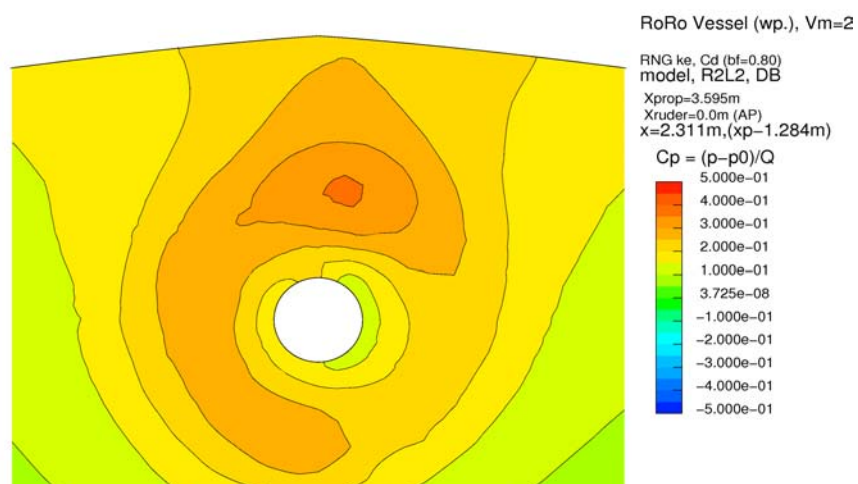


Ruder 2, Lage 3 : 1.48R hinter der Propellerebene

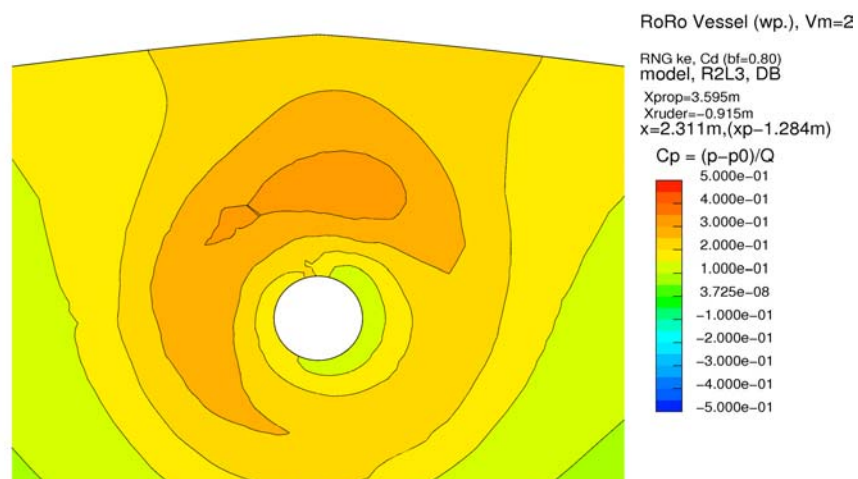
Abbildung 92 : Einfluss der Ruderlage auf die Querkomponente der Totalgeschwindigkeit in der Ebene 0.05m hinter dem Modelpropeller



Ruder 2, Lage 1 : 0.88R hinter der Propellerebene

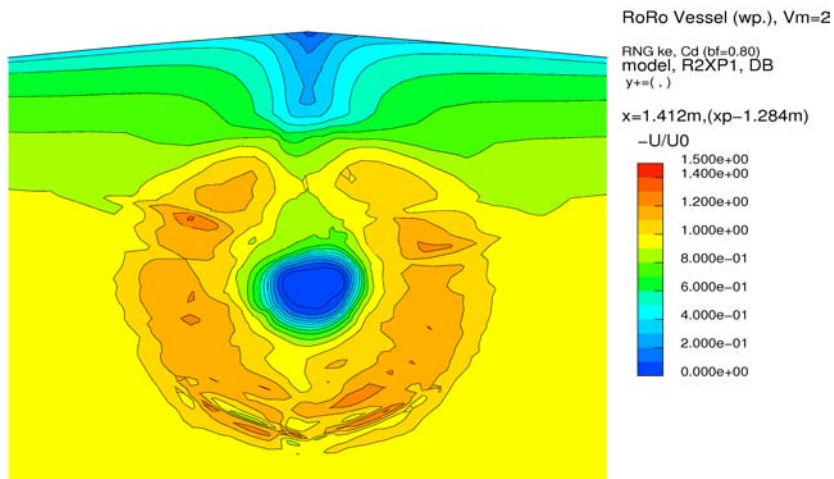


Ruder 2, Lage 2 : 1.18R hinter der Propellerebene

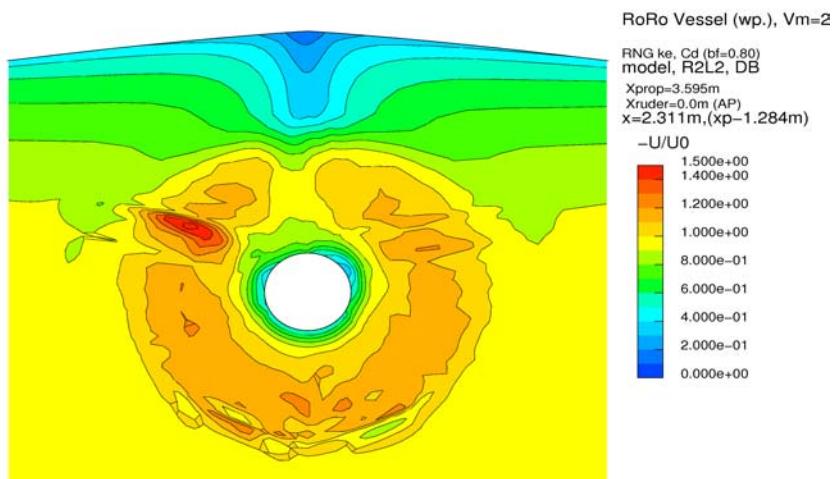


Ruder 2, Lage 3 : 1.48R hinter der Propellerebene

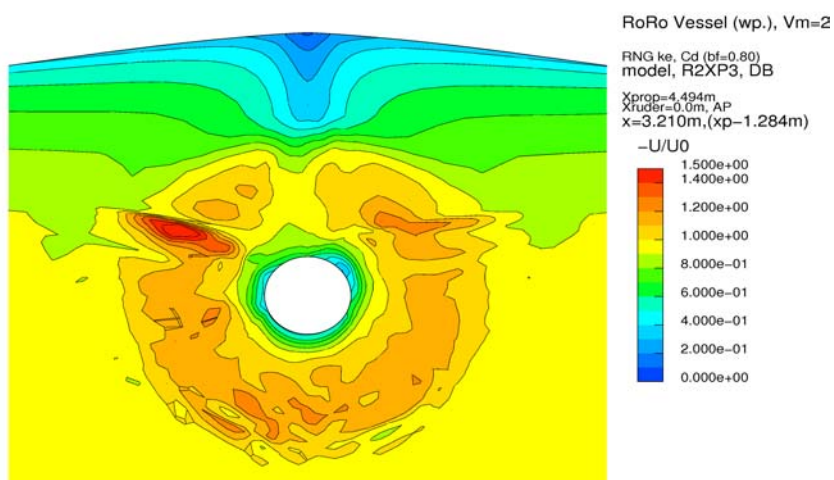
Abbildung 93 : Einfluss der Ruderlage auf das Druckfeld in der Ebene 0.05m hinter dem Modelpropeller



Propellerlage 1 : 0.88R vor dem hinteren Lot (R2XP1)

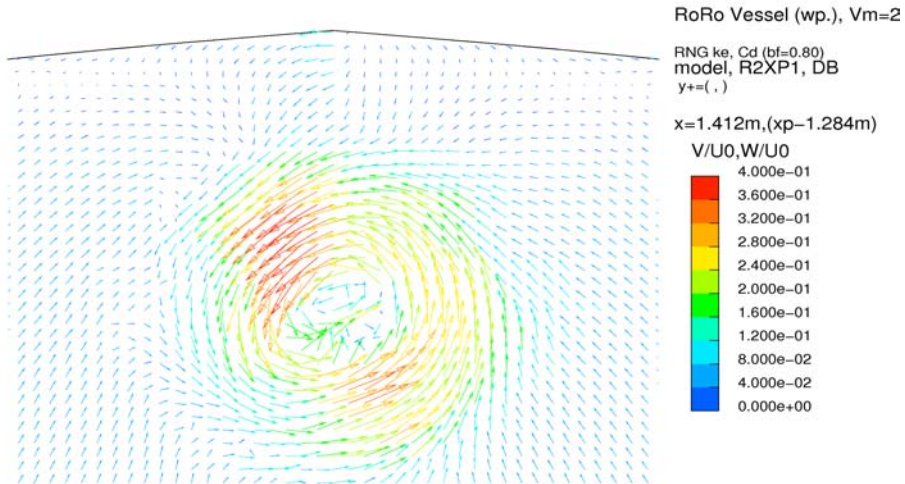


Propellerlage 2 : 1.18R vor dem hinteren Lot (R2L2)

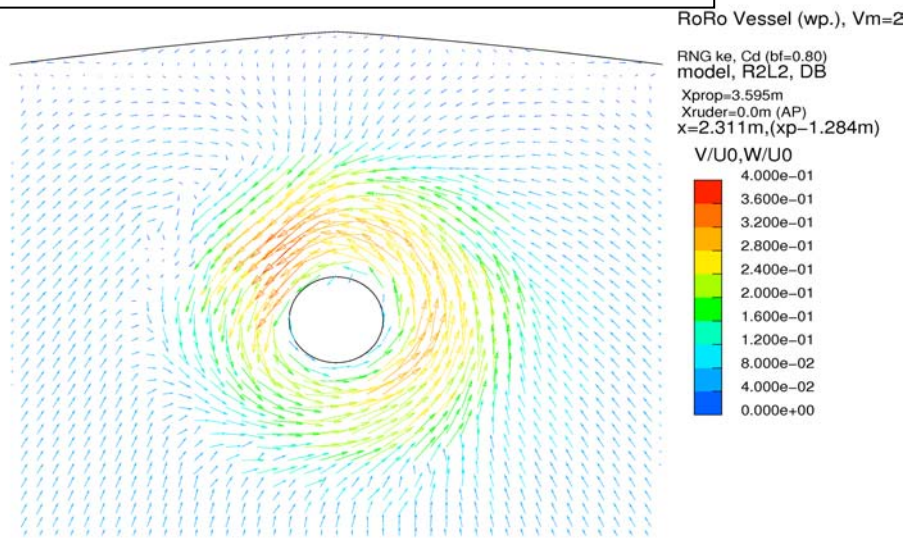


Propellerlage 3 : 1.48R vor dem hinteren Lot (R2XP3)

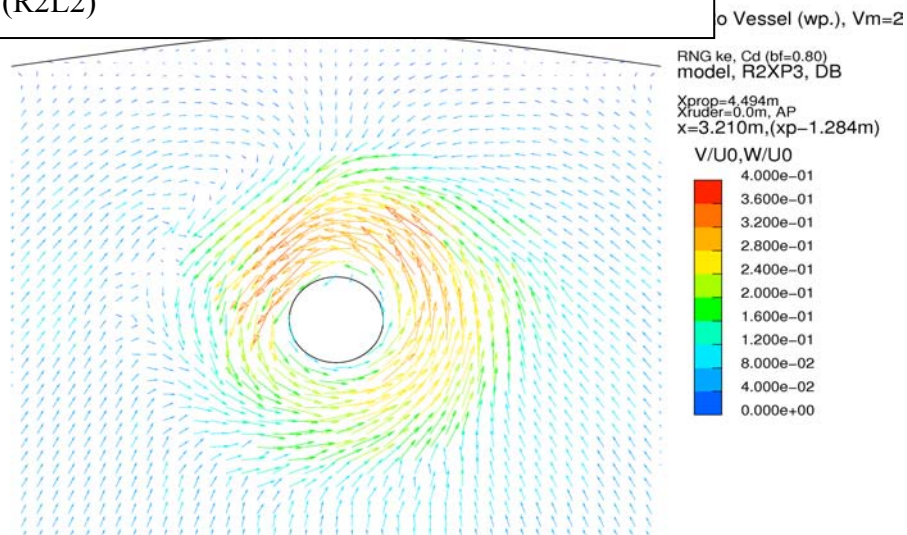
Abbildung 94 : Einfluss der Propellerlage auf die axiale Totalgeschwindigkeit in der Ebene 0.05m hinter dem Modellpropeller



Propellerlage 1 : 0.88R vor dem hinteren Lot  
 (R2XP1)

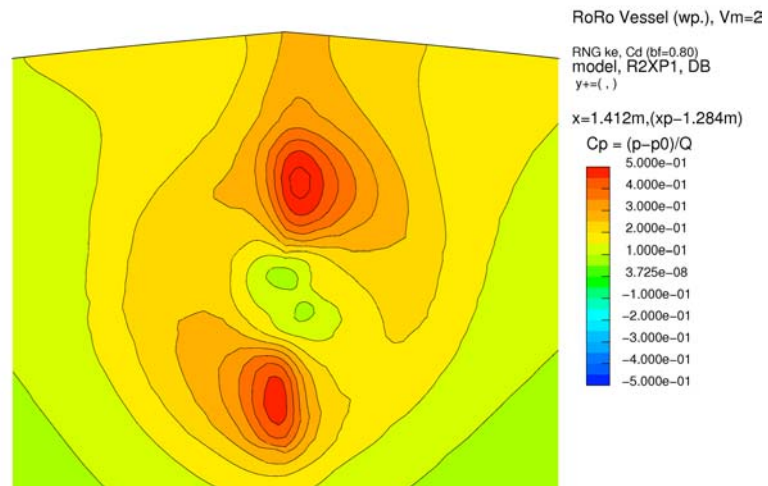


Propellerlage 2 : 1.18R vor dem hinteren Lot  
 (R2L2)

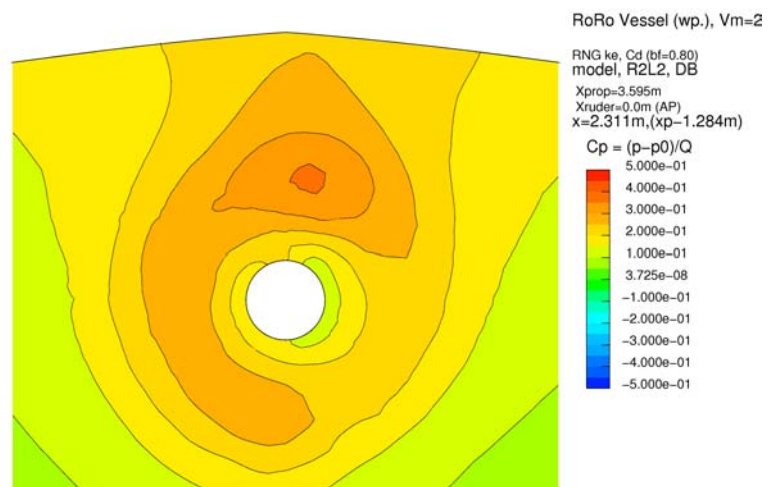


Propellerlage 3 : 1.48R vor dem hinteren Lot  
 (R2XP3)

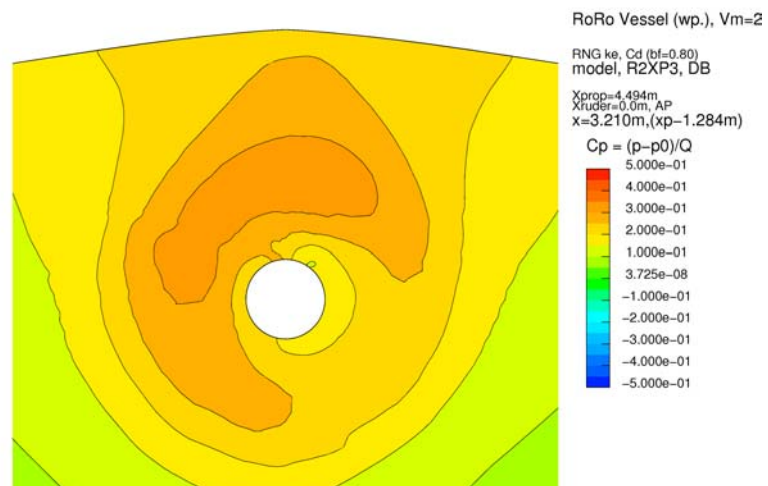
Abbildung 95 : Einfluss der Propellerlage auf die Querkomponente der Totalgeschwindigkeit in der Ebene 0.05m hinter dem Modelpropeller



Propellerlage 1 : 0.88R vor dem hinteren Lot (R2XP1)



Propellerlage 2 : 1.18R vor dem hinteren Lot (R2L2)



Propellerlage 3 : 1.48R vor dem hinteren Lot (R2XP3)

Abbildung 96 : Einfluss der Propellerlage auf das Druckfeld in der Ebene 0.05m hinter dem Modelpropeller

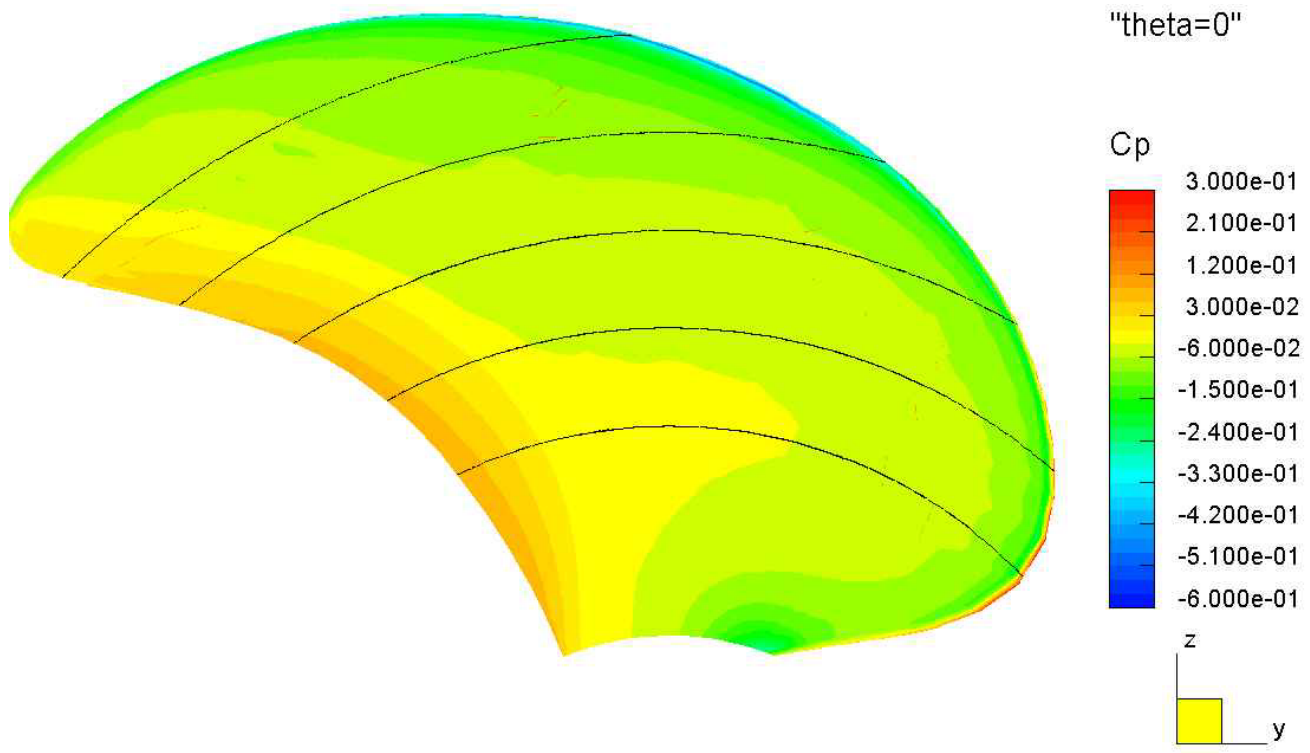
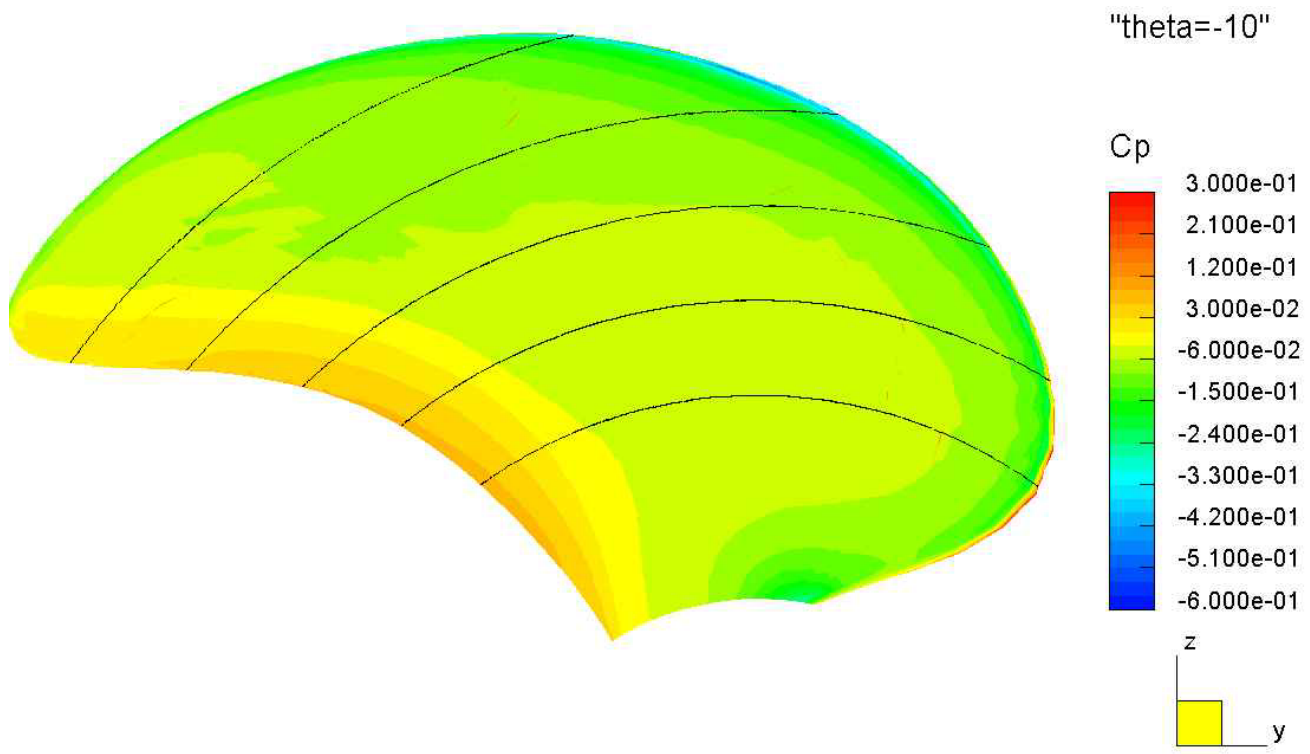


Abbildung 97 : Cp-Verteilung auf dem Propellerblatt, W2, Theta=-10°/0°



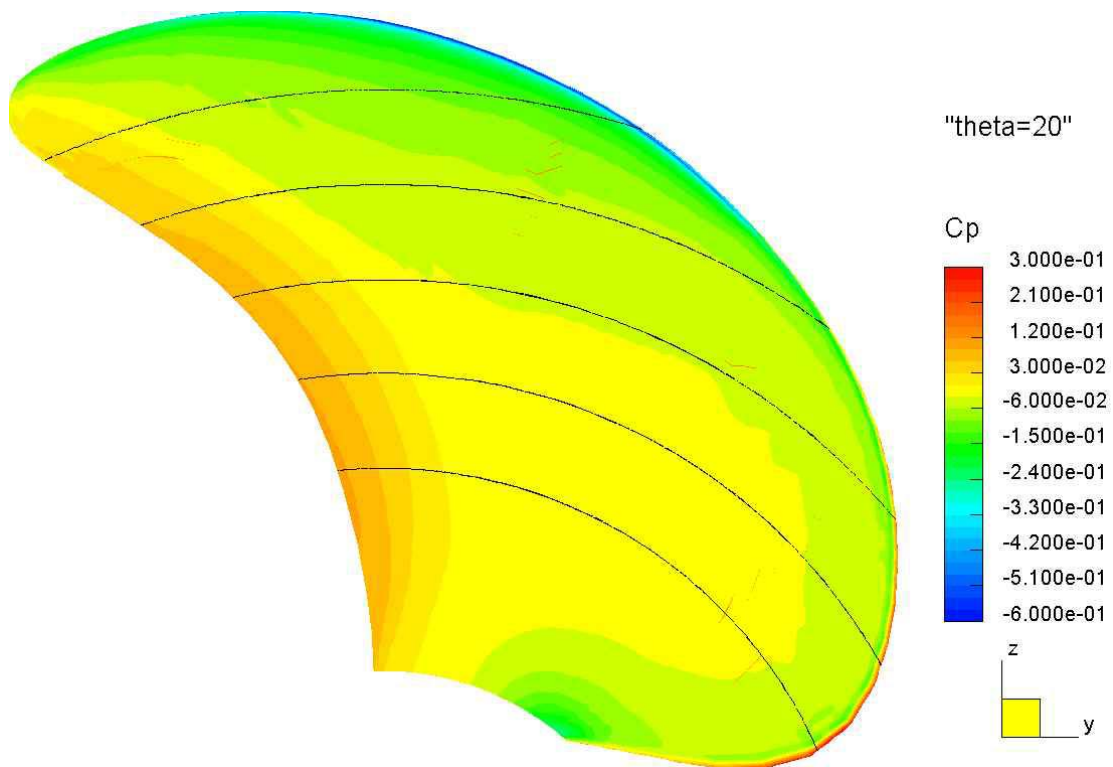
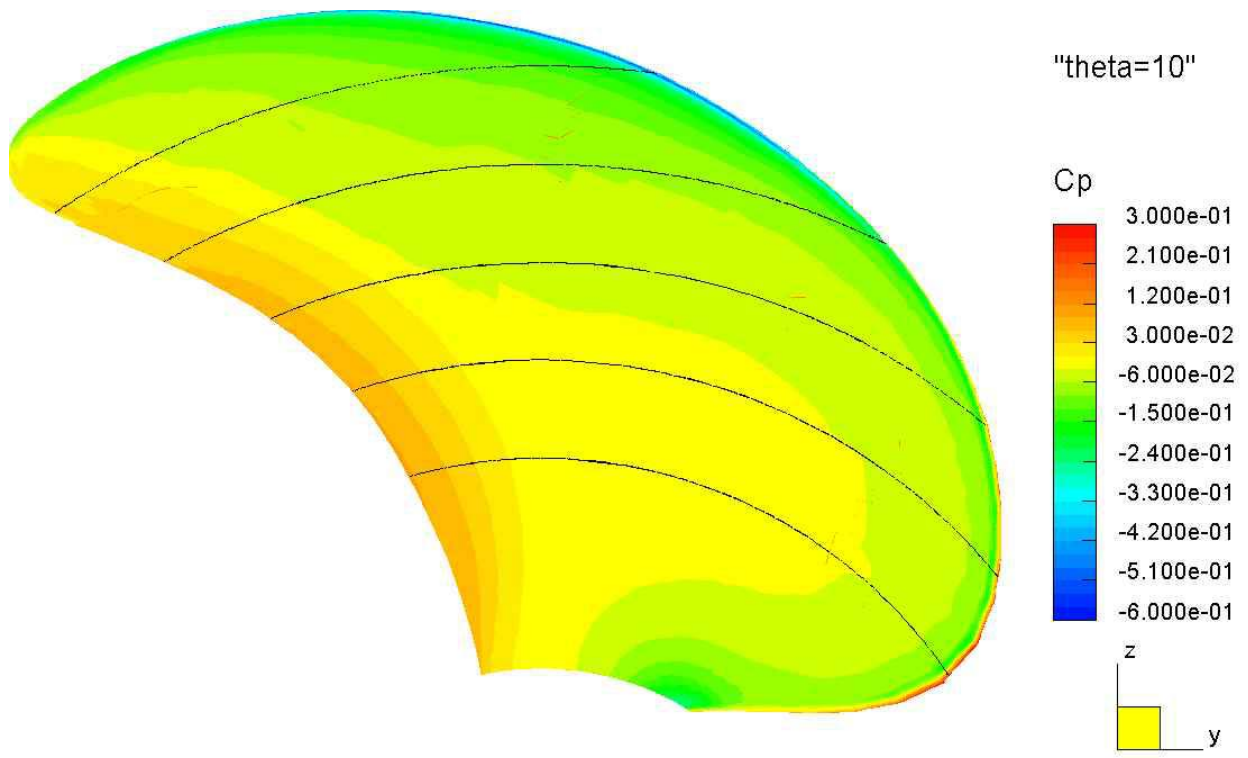


Abbildung 98 : Cp-Verteilung auf dem Propellerblatt, W2, Theta=10°/20°

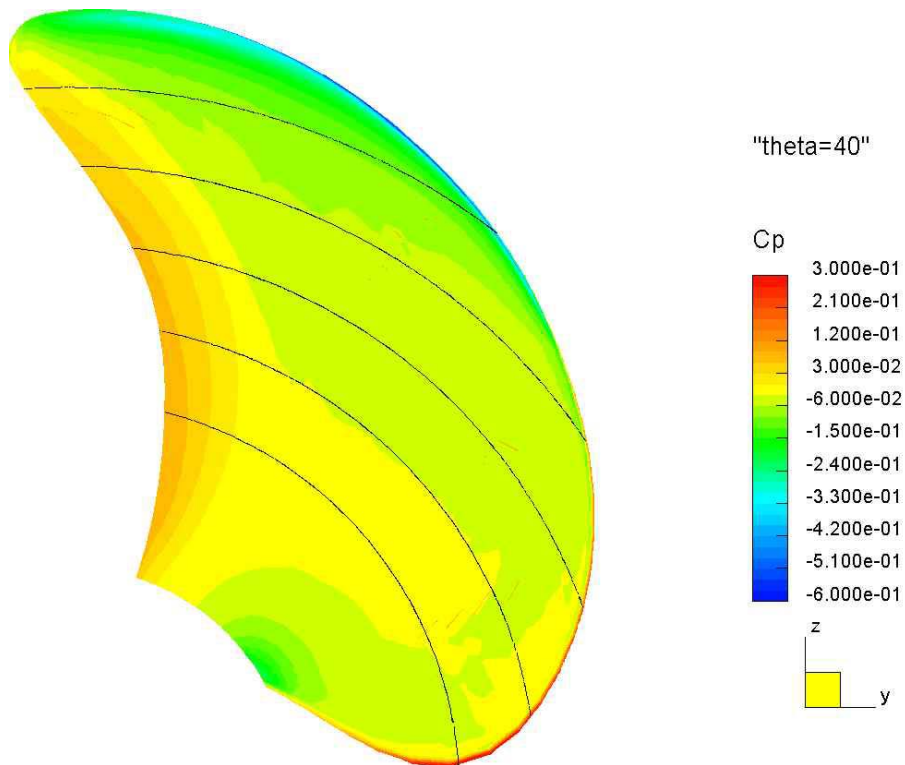
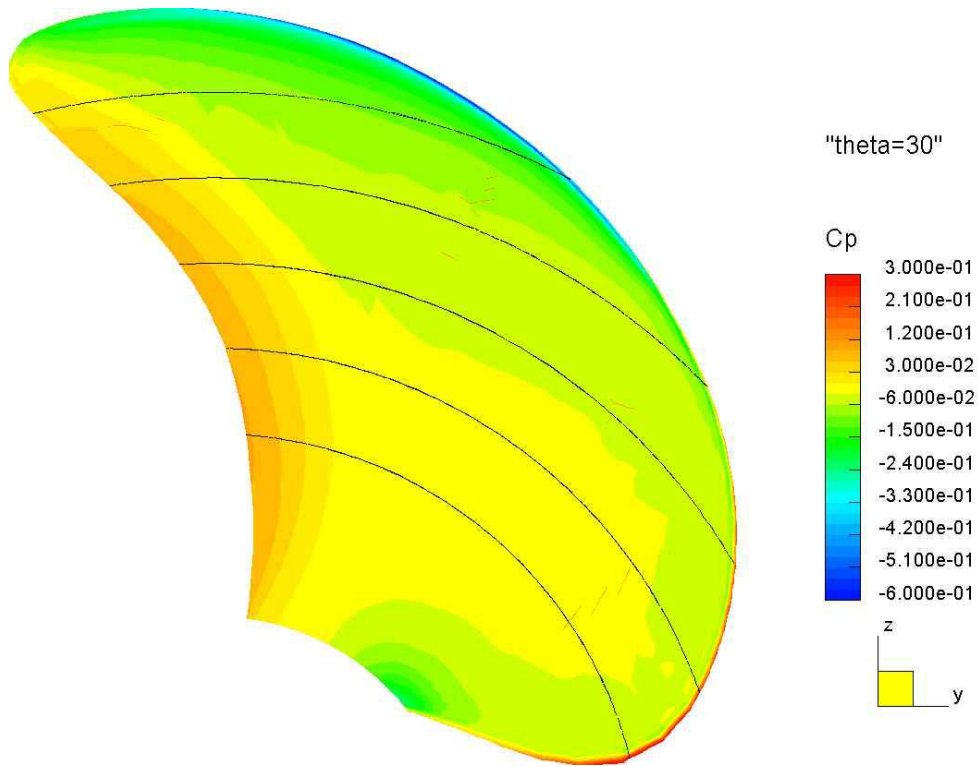
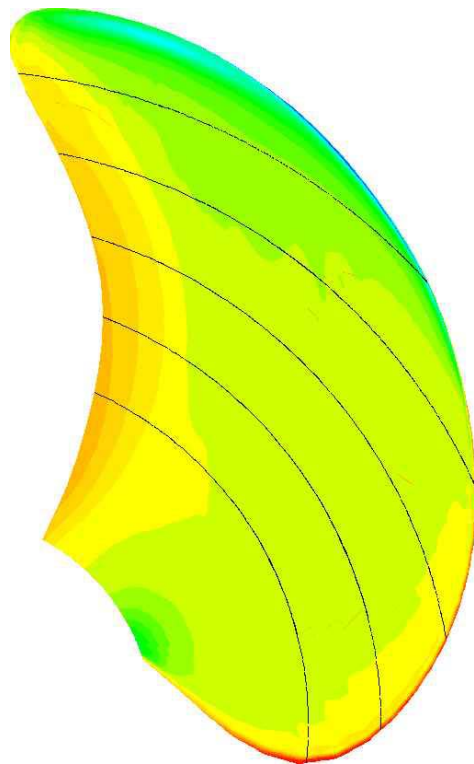
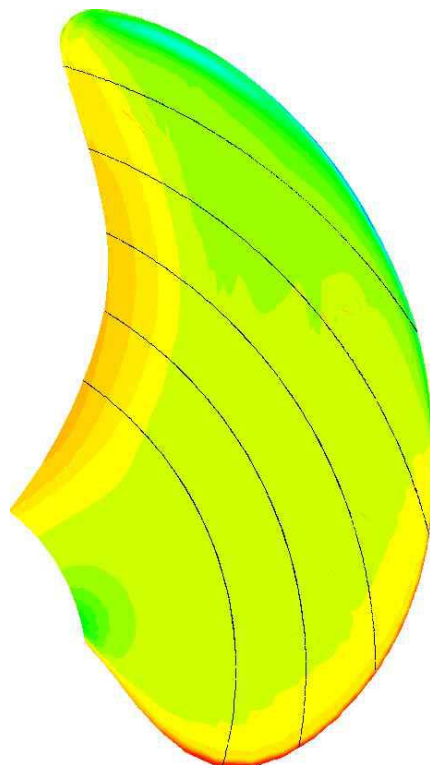
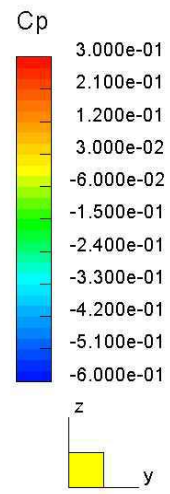


Abbildung 99 : Cp-Verteilung auf dem Propellerblatt, W2, Theta=30°/40°



"theta=50"



"theta=60"

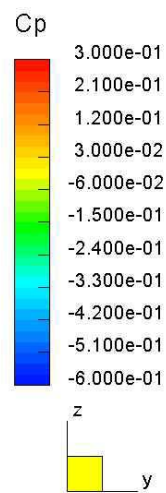


Abbildung 100 : Cp-Verteilung auf dem Propellerblatt, W2, Theta=50°/60°

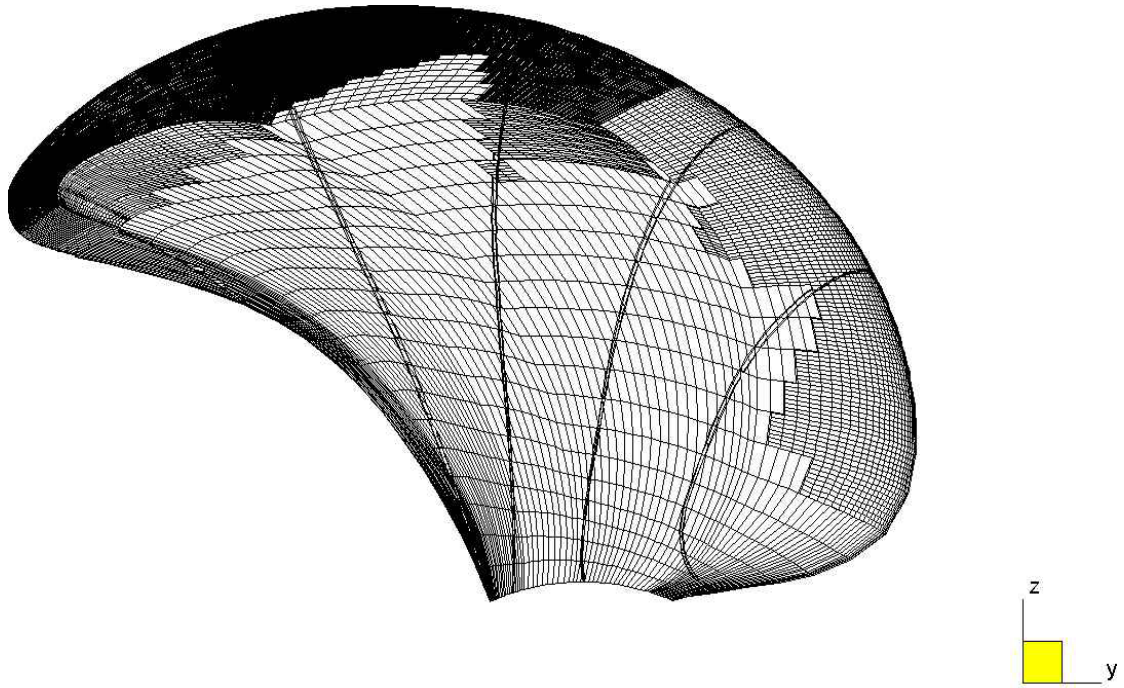


Abbildung 101 : Gittertopologie des Propellerflügels samt Schnittkurven der Schnittebenen,  
 $x/R = -0.2 / 0.1 / 0.0 / 0.1 / 0.2$

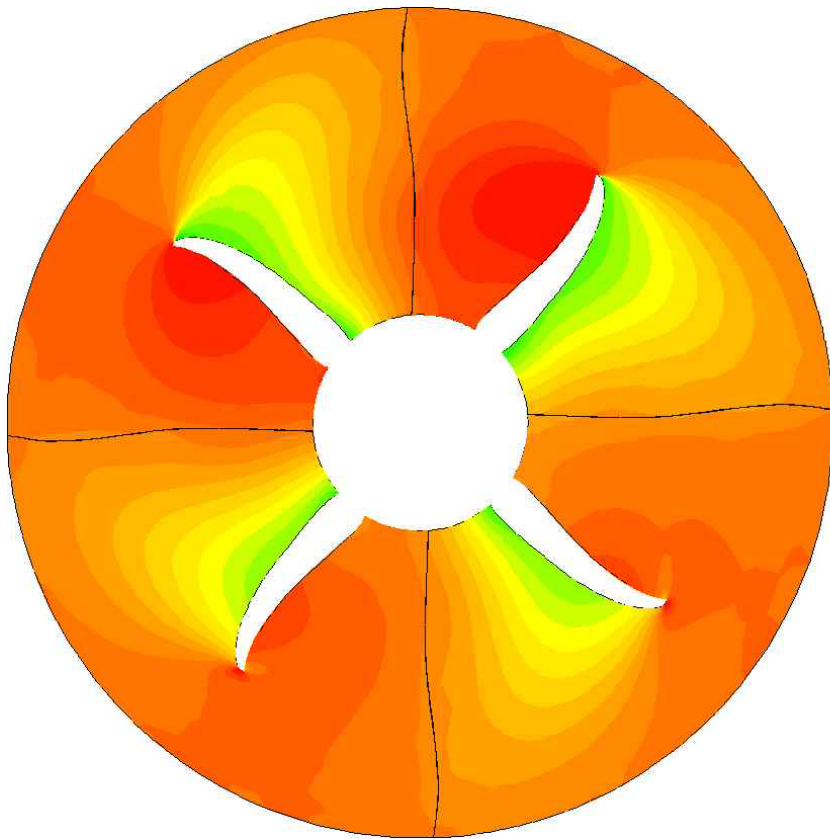
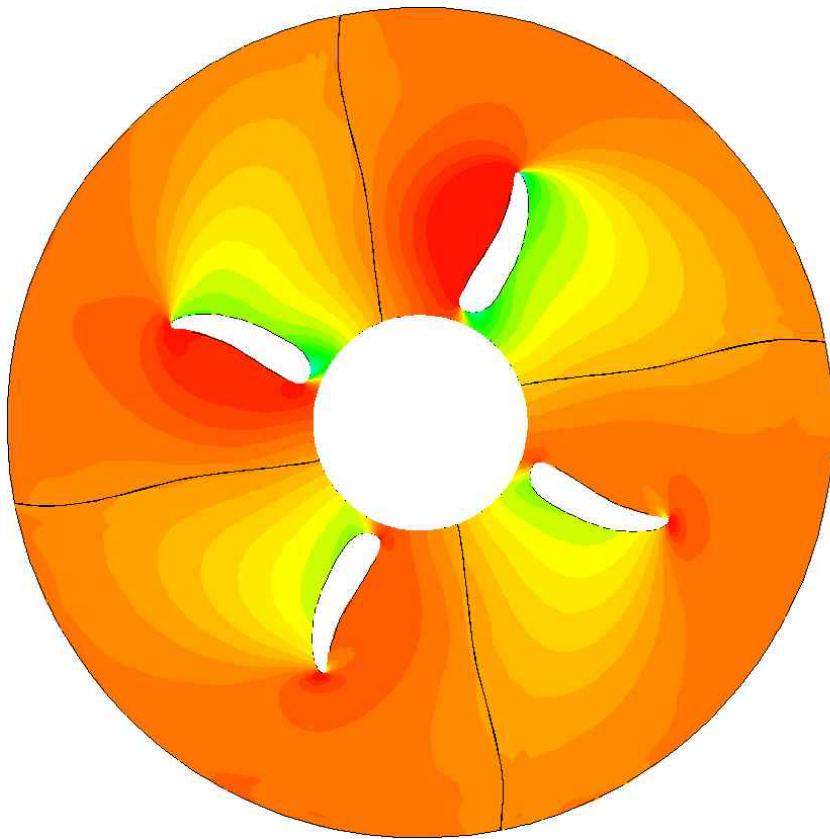
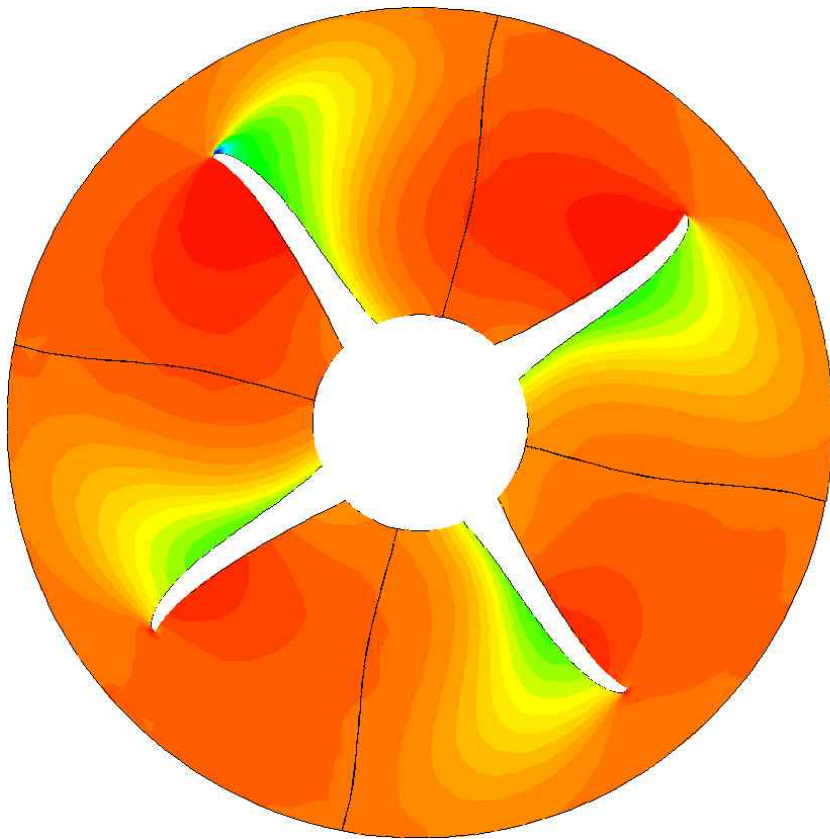
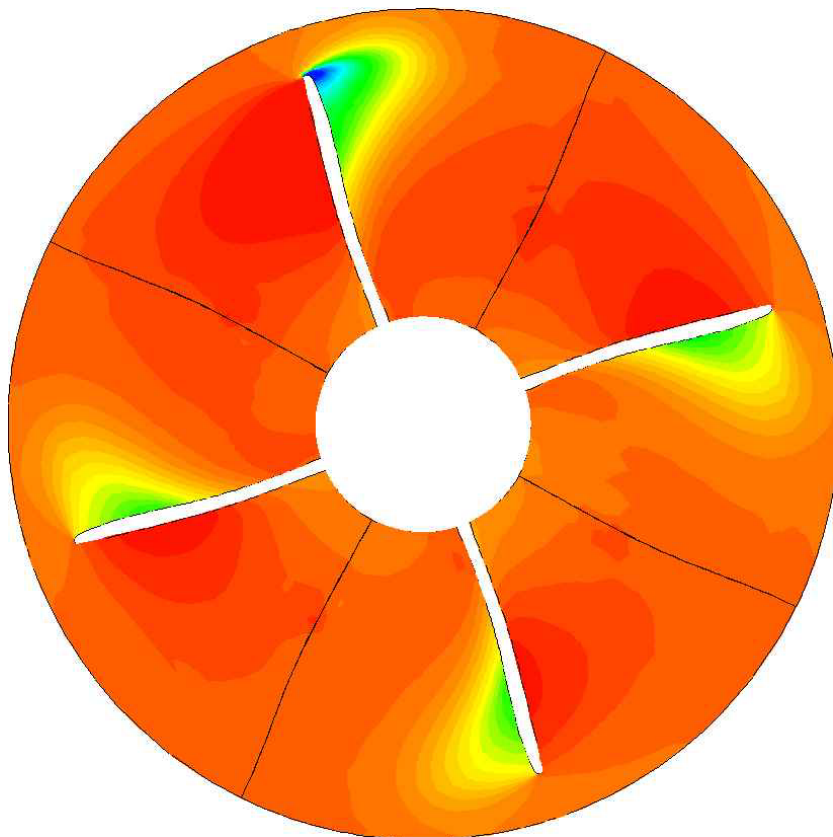
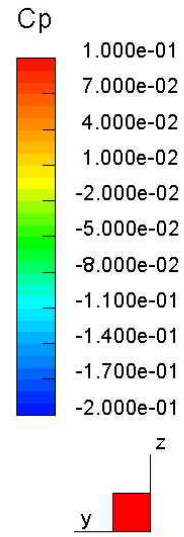


Abbildung 102 : Cp-Verteilung, Theta=40°, W2, x/R=0.2 / 0.1



"theta=40 x/R=0.0"



"theta=40 x/R=-0.1"

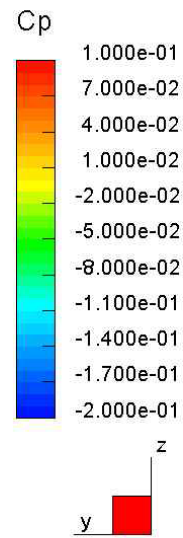


Abbildung 103 : Cp-Verteilung, Theta=40°, W2, x/R=0 / -0.1

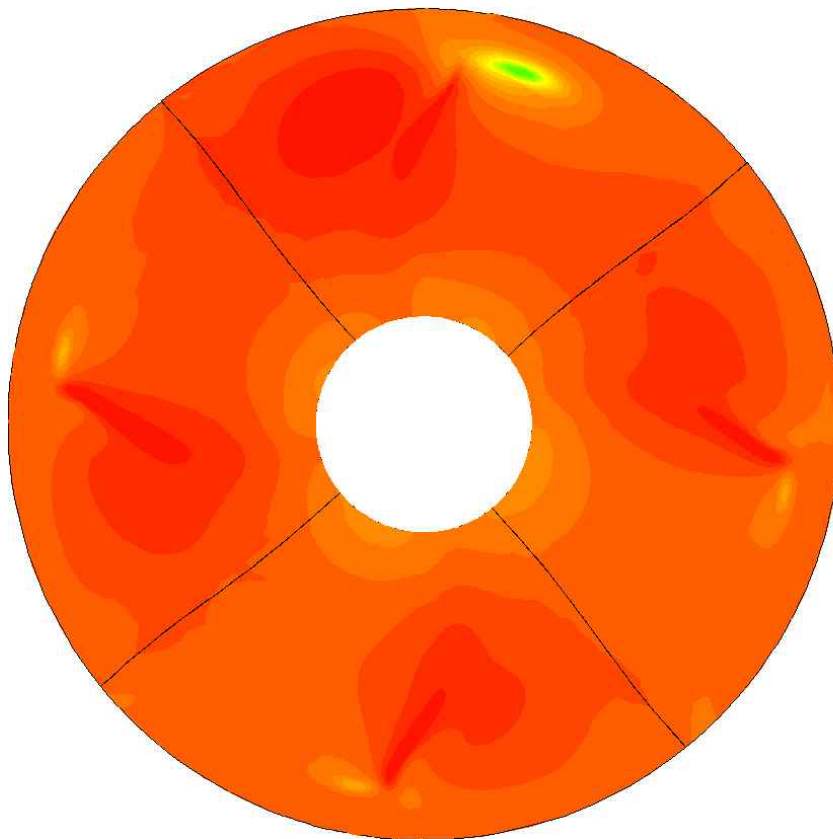
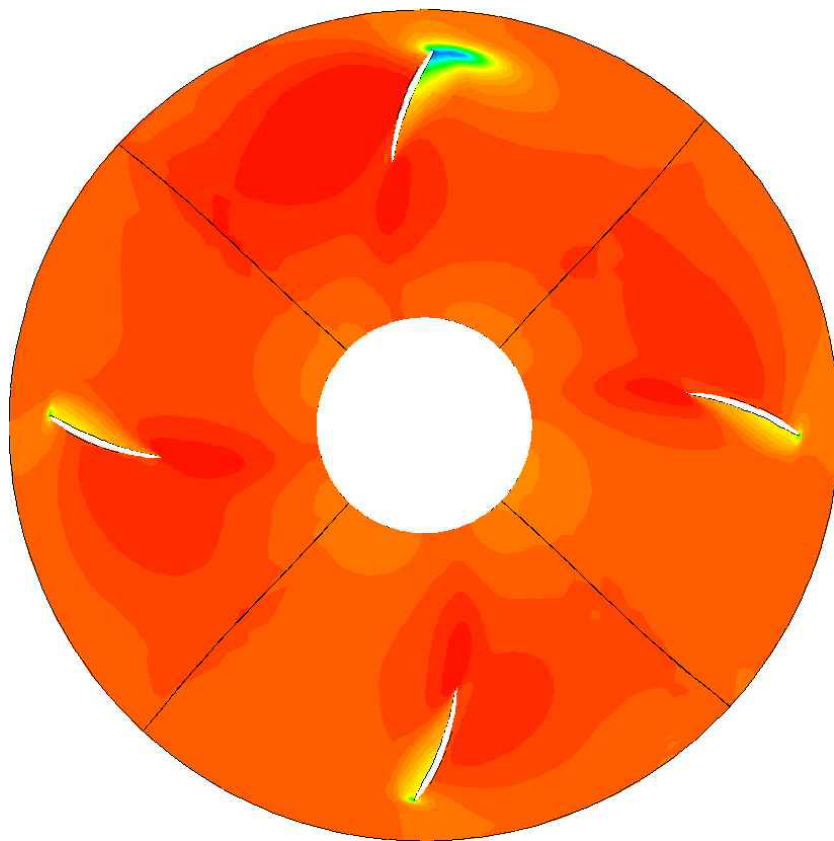
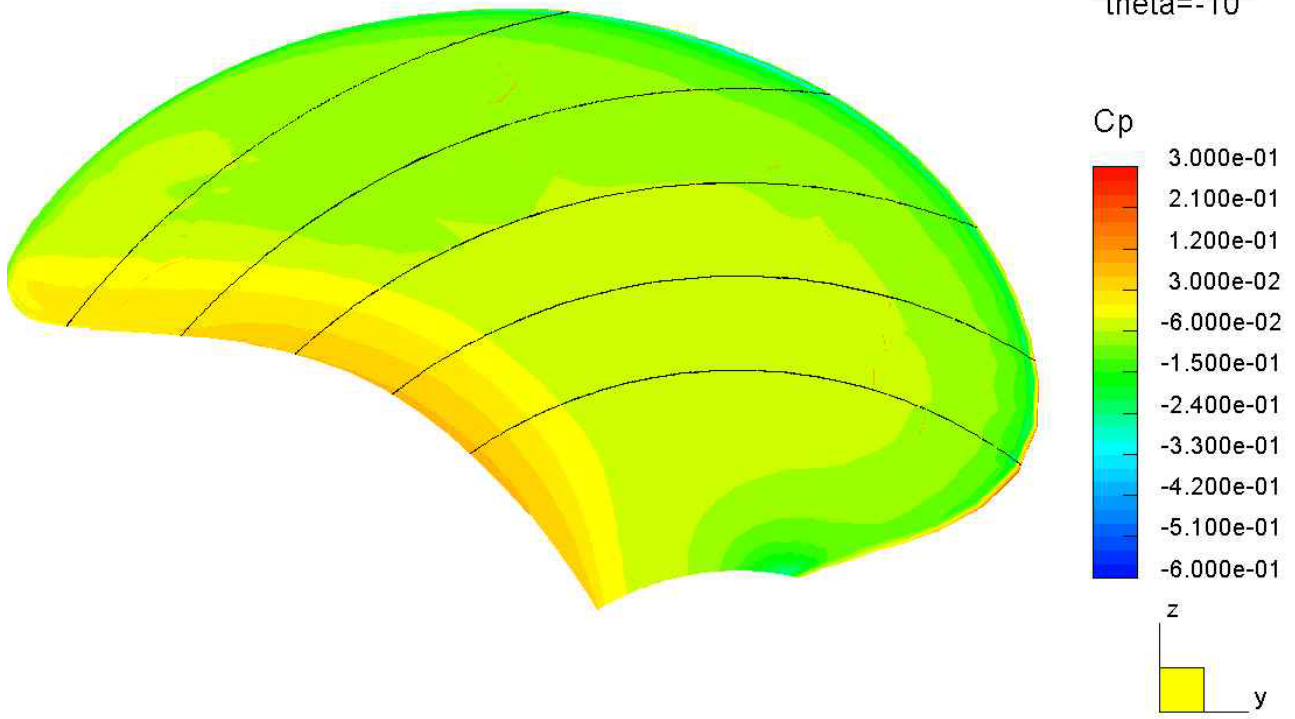


Abbildung 104 : Cp-Verteilung, Theta=40°, W2, x/R=-0.2 / -0.25

"theta=-10"



"theta=0"

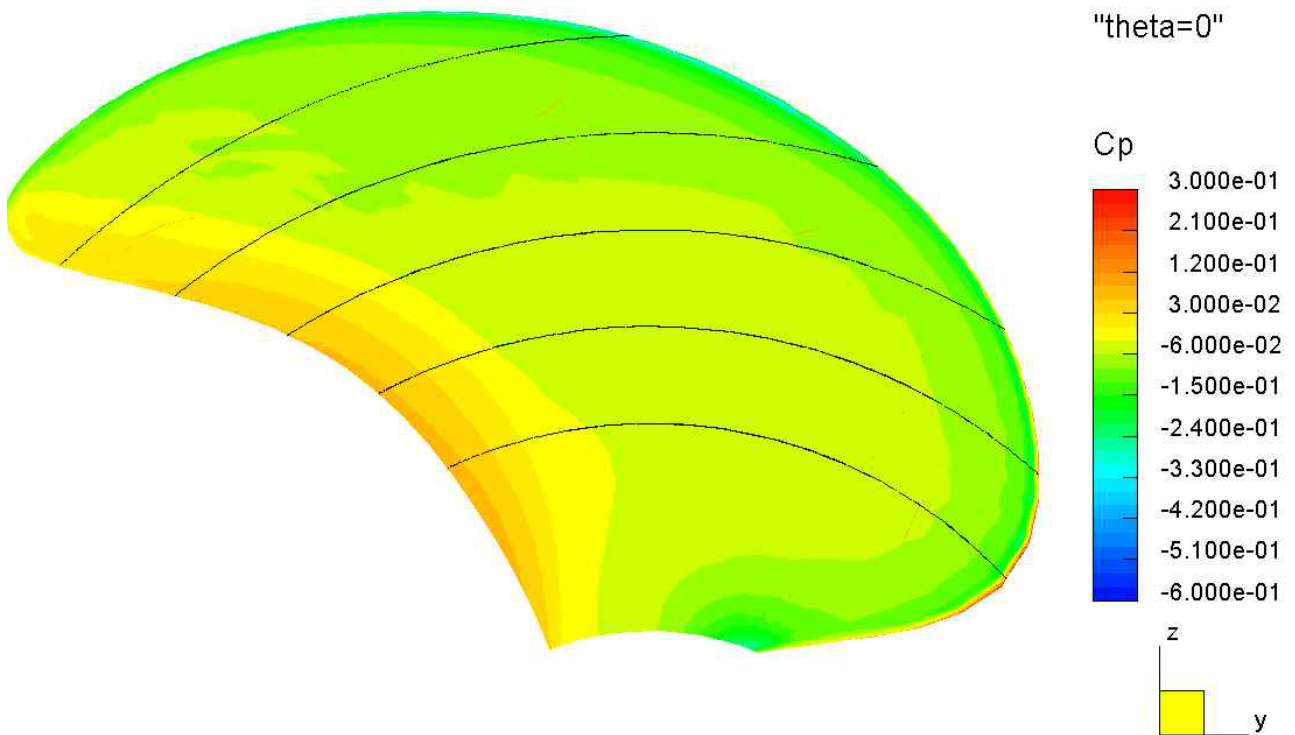


Abbildung 105 : Cp-Verteilung auf dem Propellerblatt, W1, Theta=-10°/0°



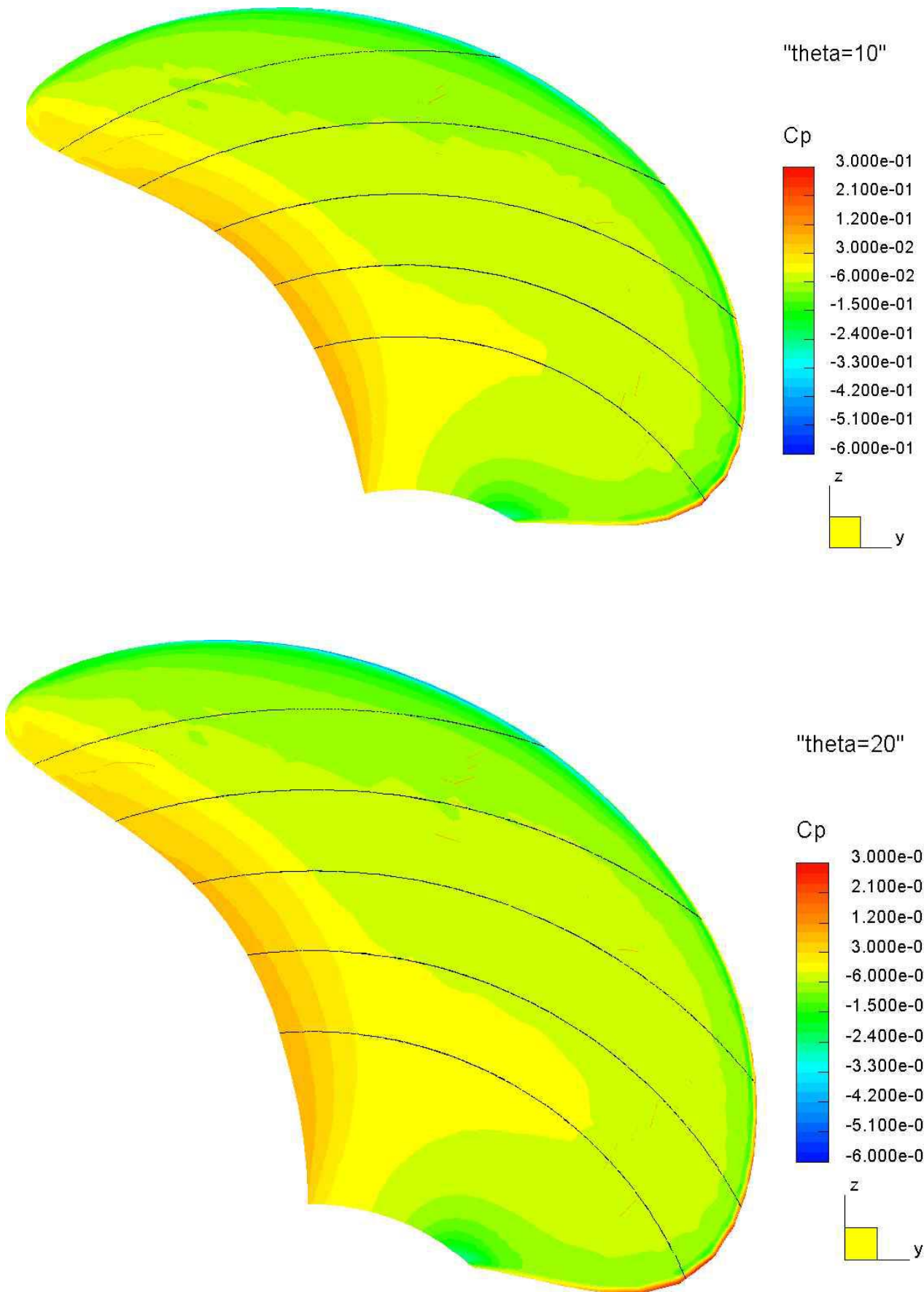


Abbildung 106 :  $C_p$ -Verteilung auf dem Propellerblatt, W1,  $\theta = 10^\circ/20^\circ$

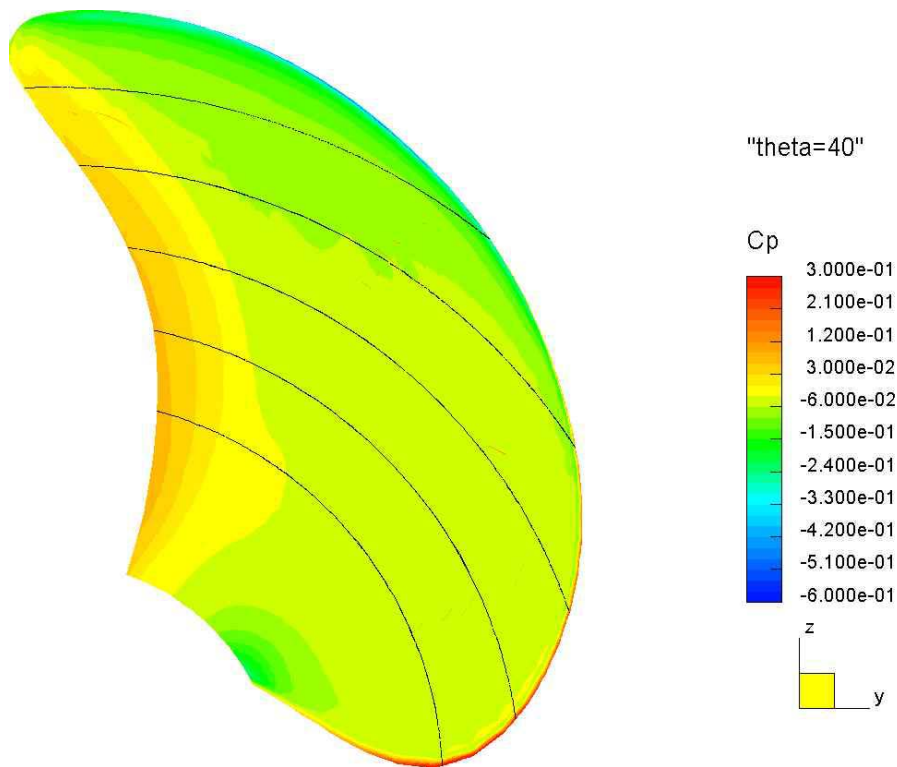
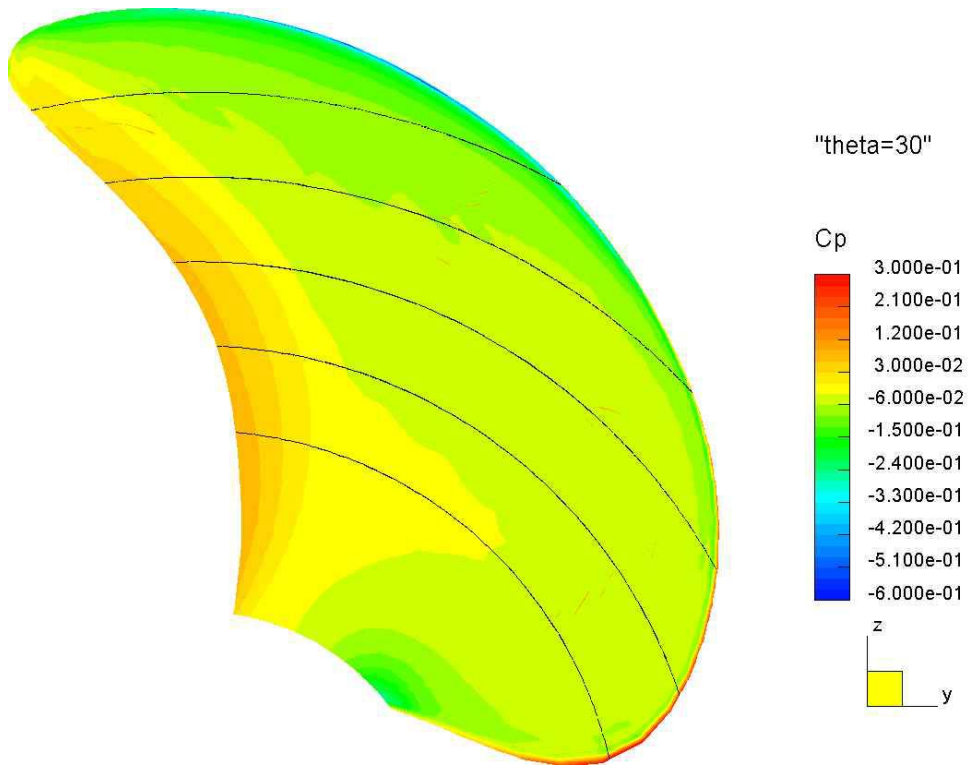
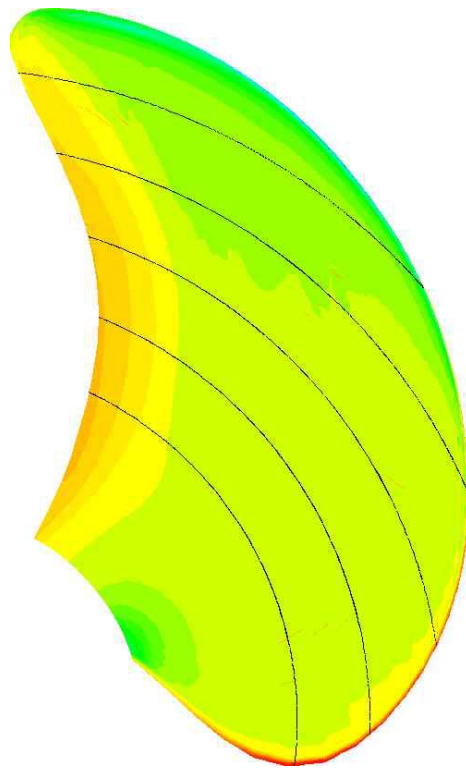
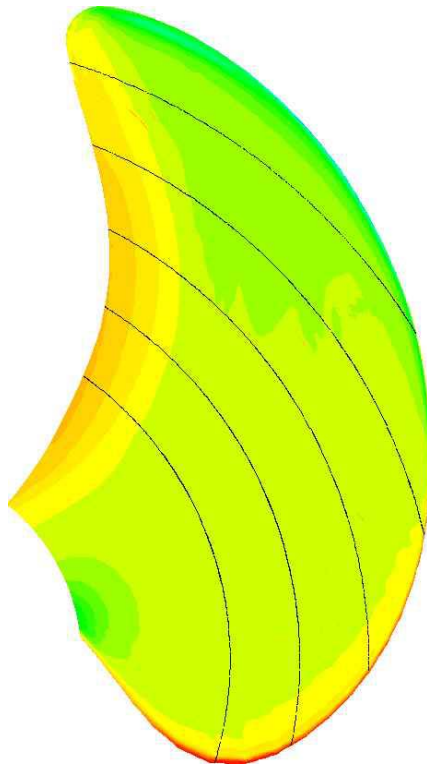
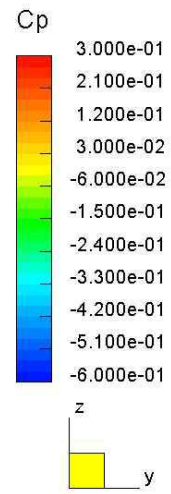


Abbildung 107 : Cp-Verteilung auf dem Propellerblatt, W1, Theta=30°/40°



"theta=50"



"theta=60"

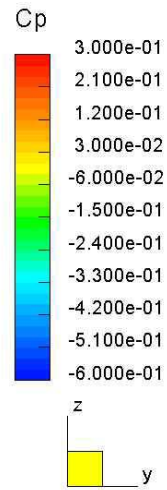


Abbildung 108 : Cp-Verteilung auf dem Propellerblatt, W1, Theta=50°/60°

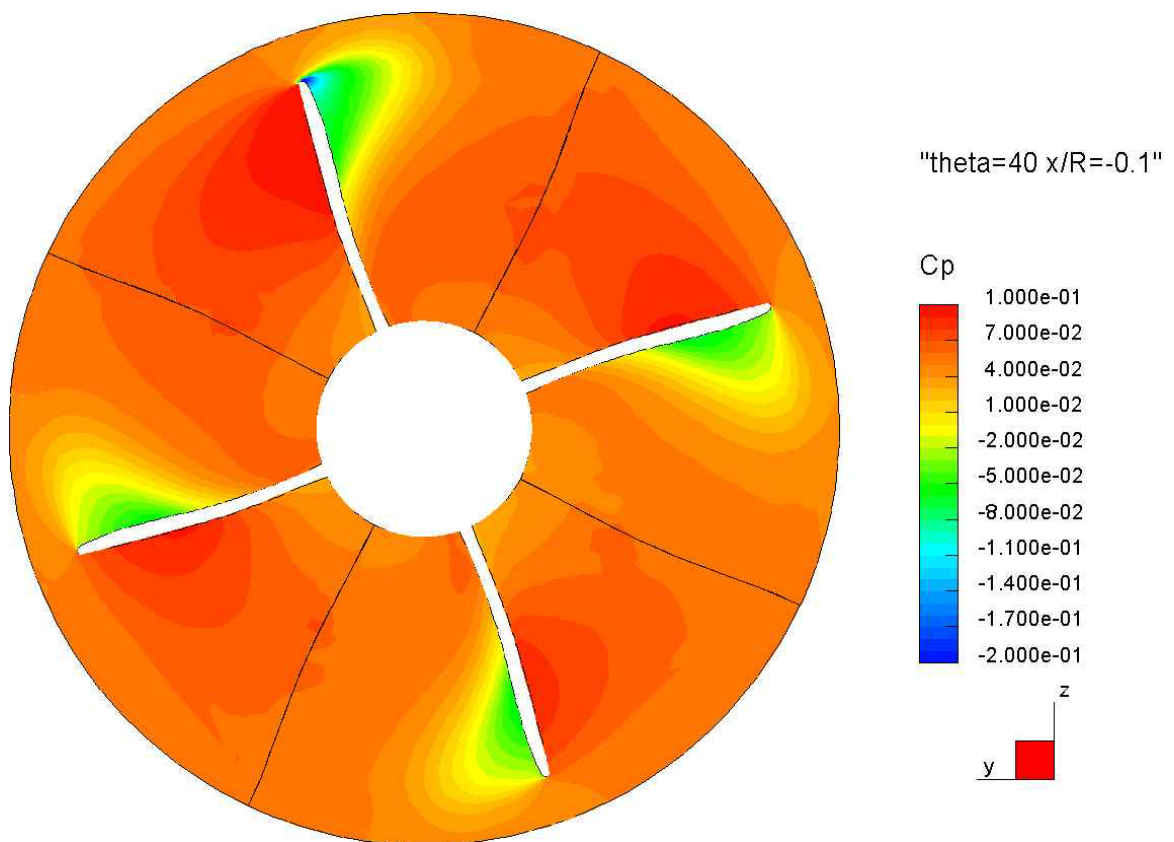
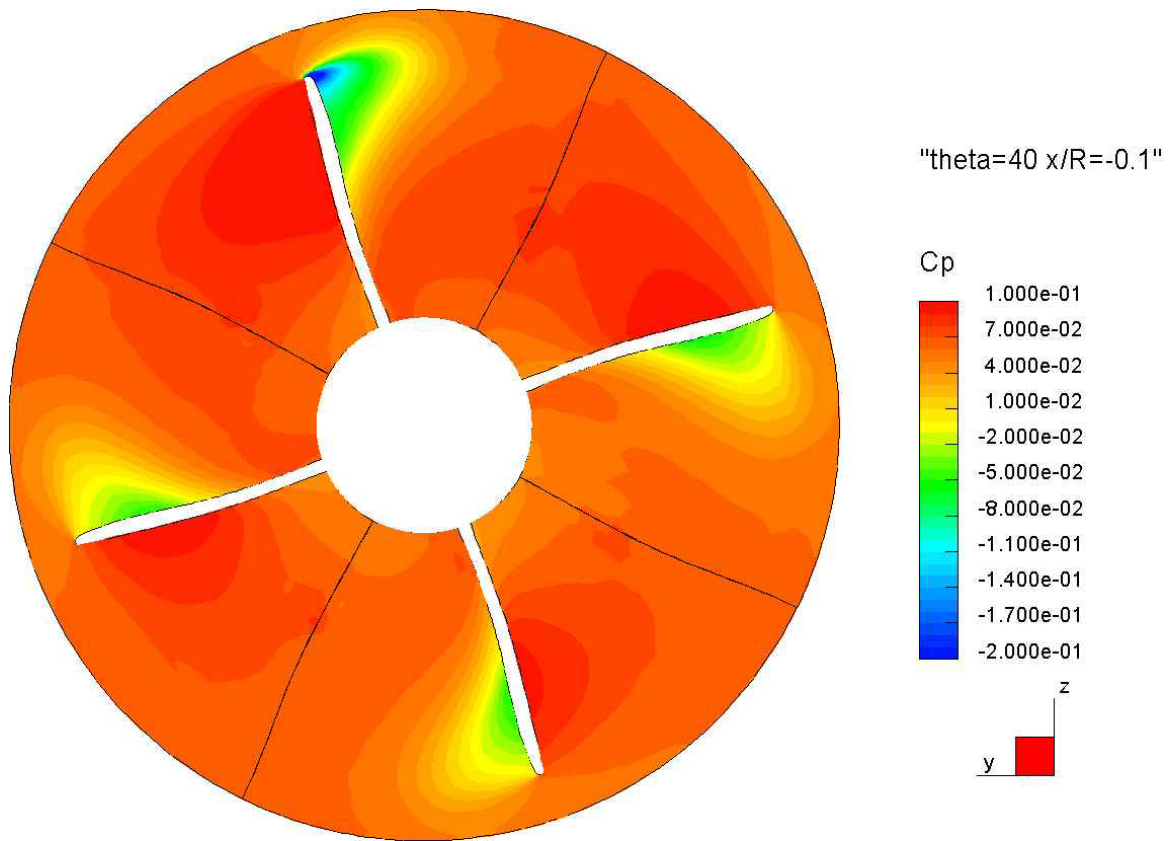


Abbildung 109 : Cp-Verteilung, Theta=40°, x/R= -0.1, oben W2, unten W1

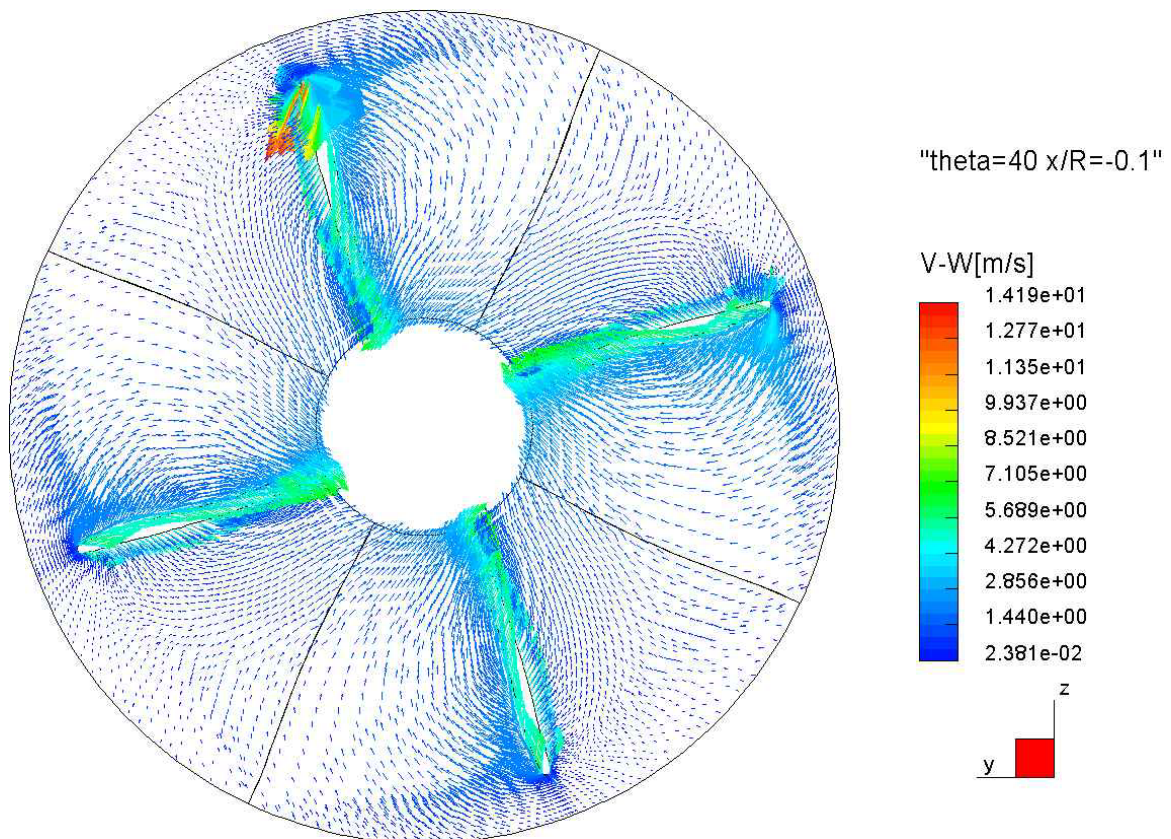
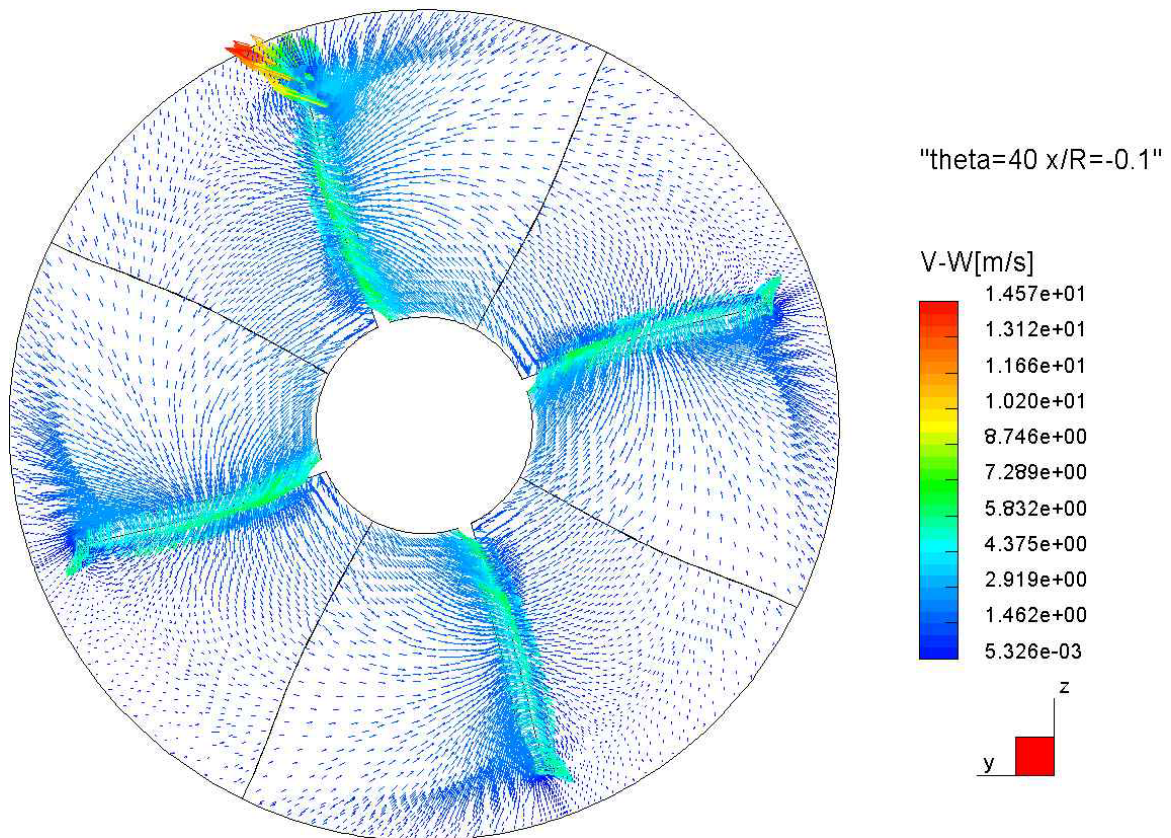


Abbildung 110 : Quergeschwindigkeit in der y-z-Ebene, Theta=40°, x/R= -0.1, oben W2, unten W1

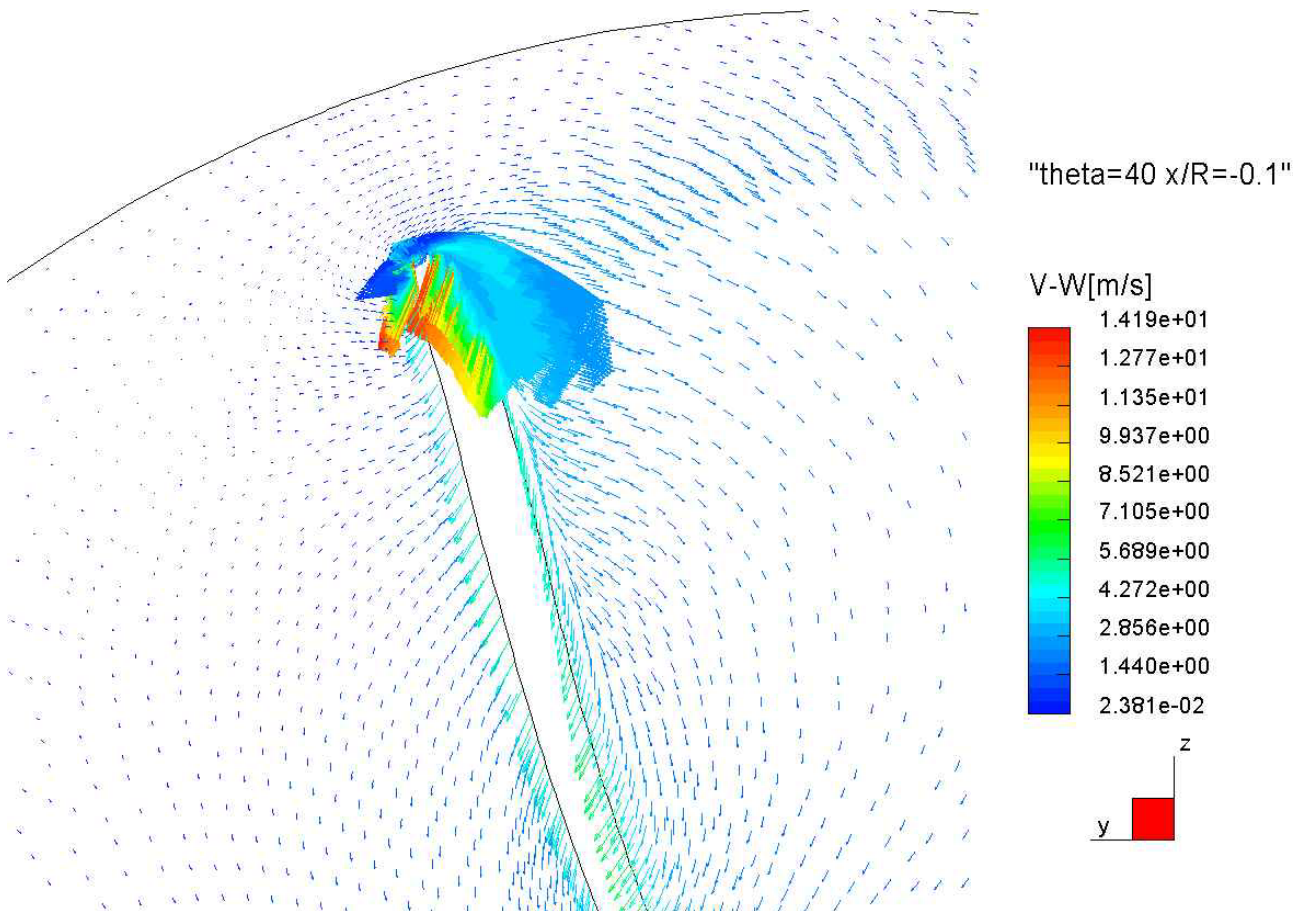
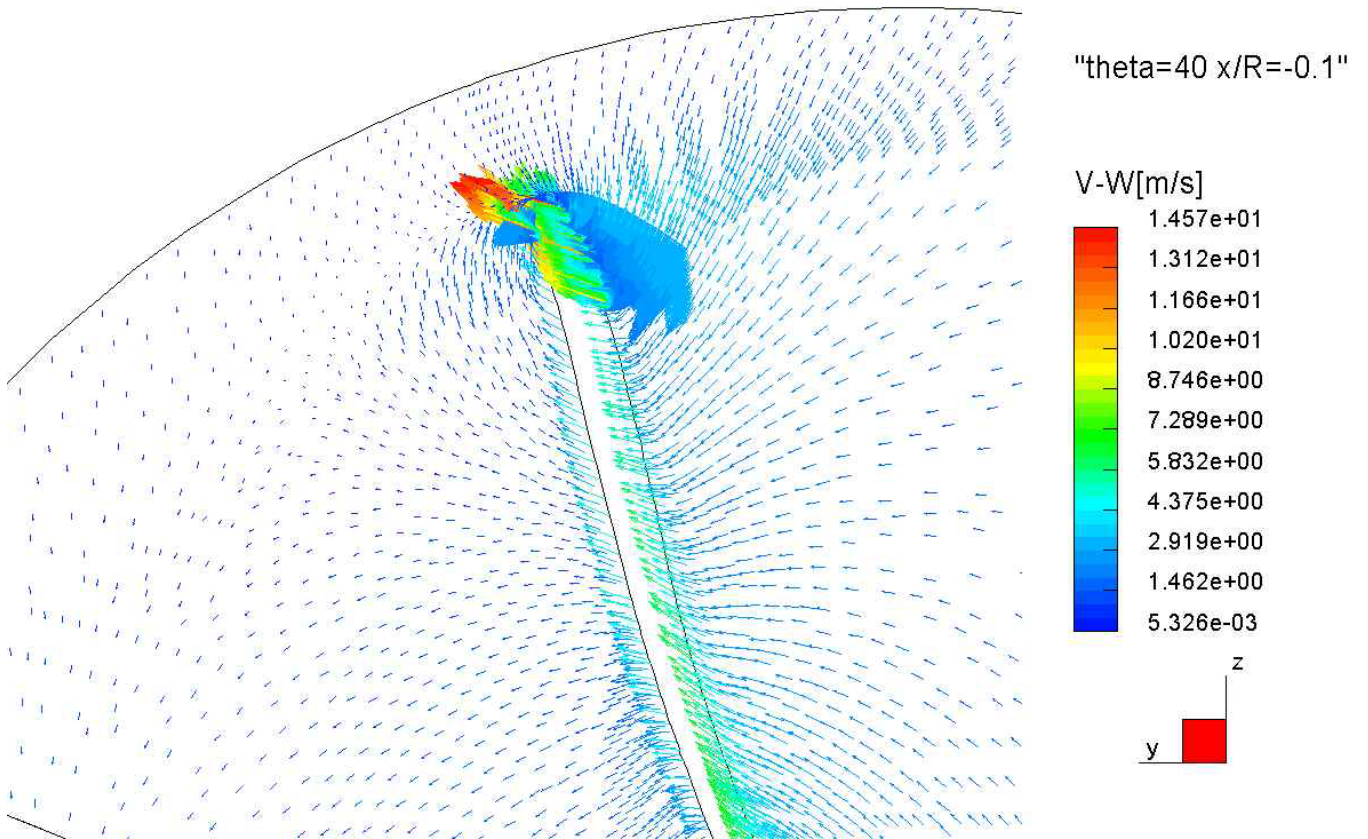


Abbildung 111 : Quergeschwindigkeit in der y-z-Ebene, Theta=40°, x/R= -0.1, oben W2, unten W1, Ausschnitt

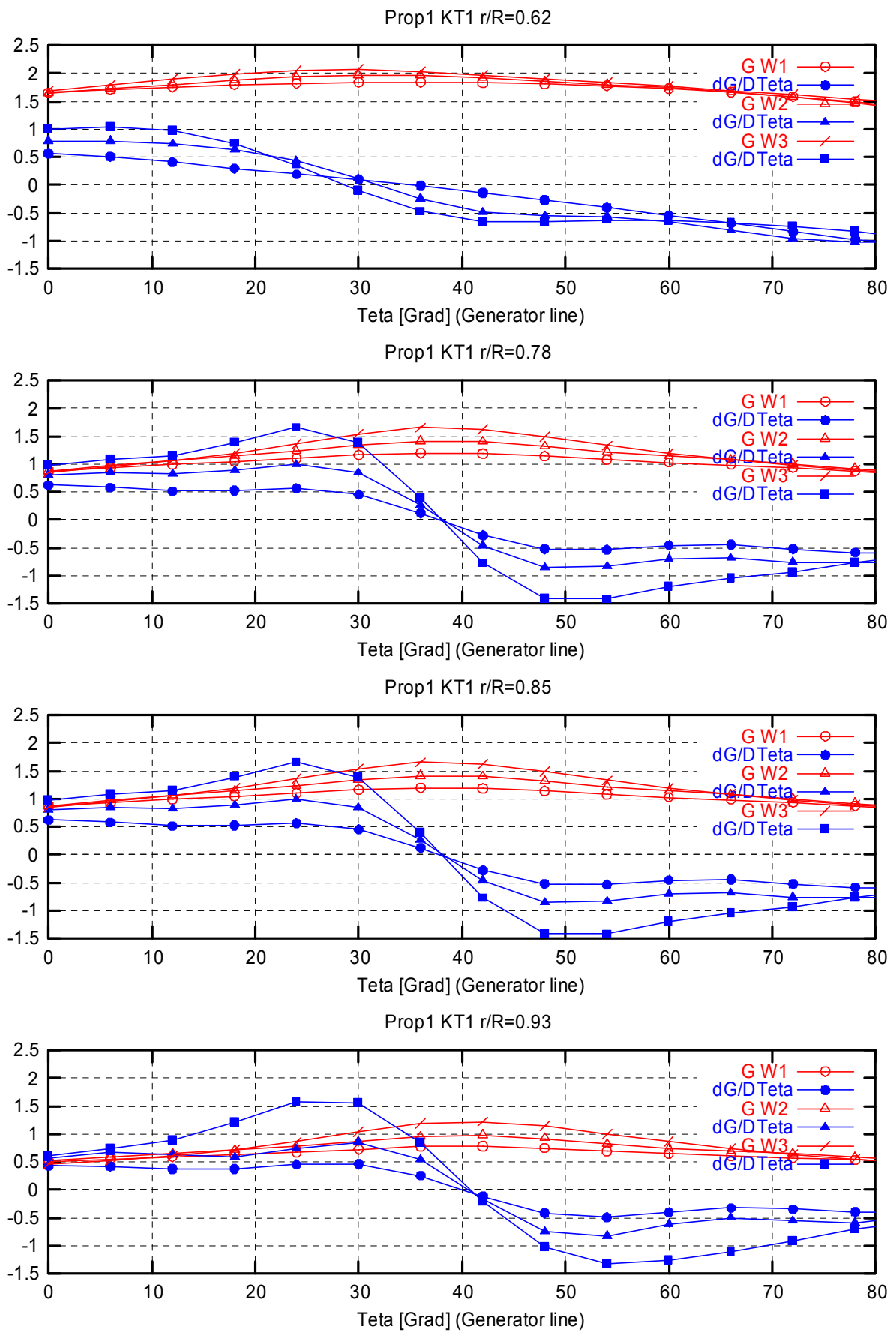


Abbildung 112 : Zirkulation  $\Gamma$  und  $d\Gamma/dt$ , E1-KT1-S2

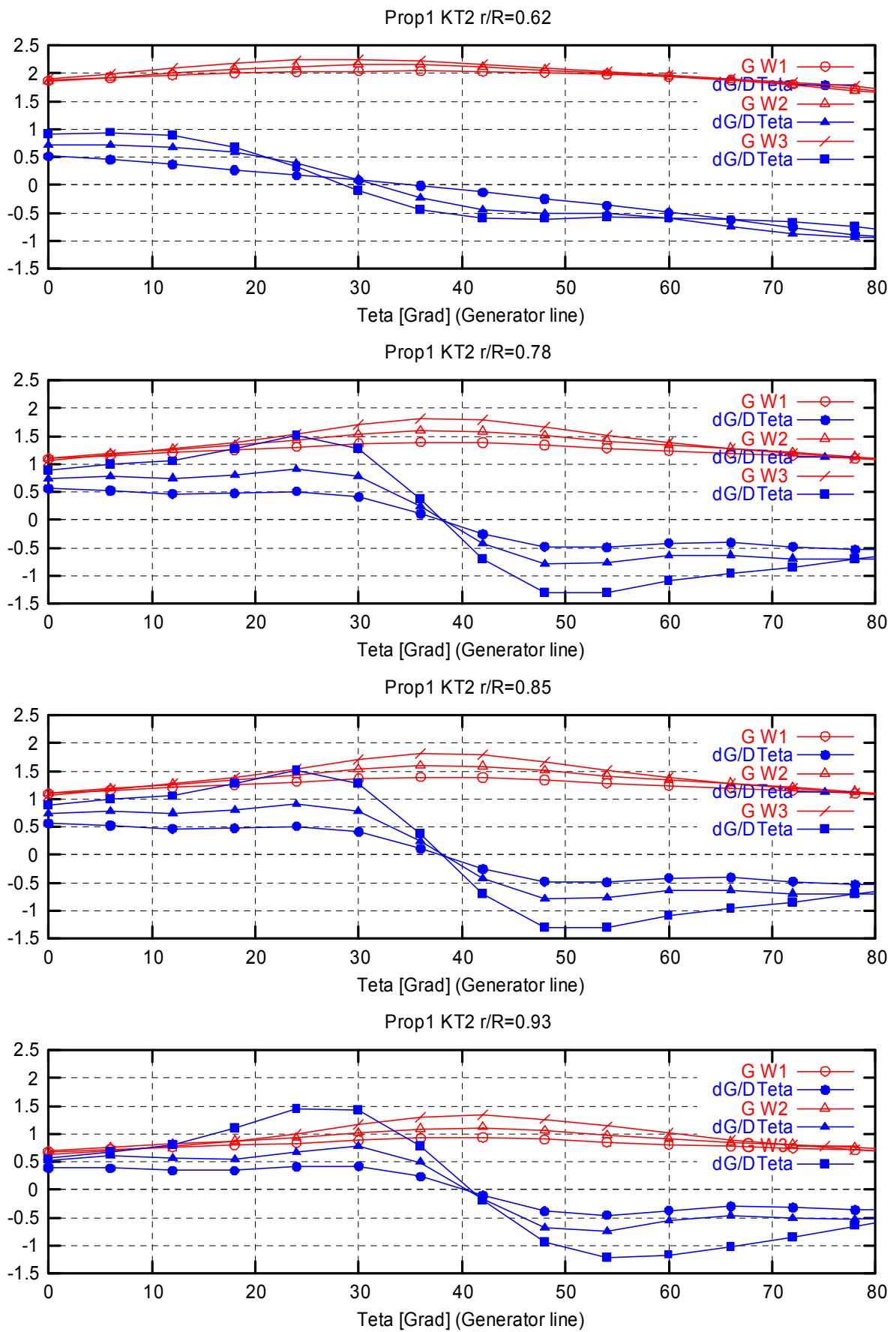


Abbildung 113 : Zirkulation  $\Gamma$  und  $d\Gamma/dt$ , E1-KT2-S2



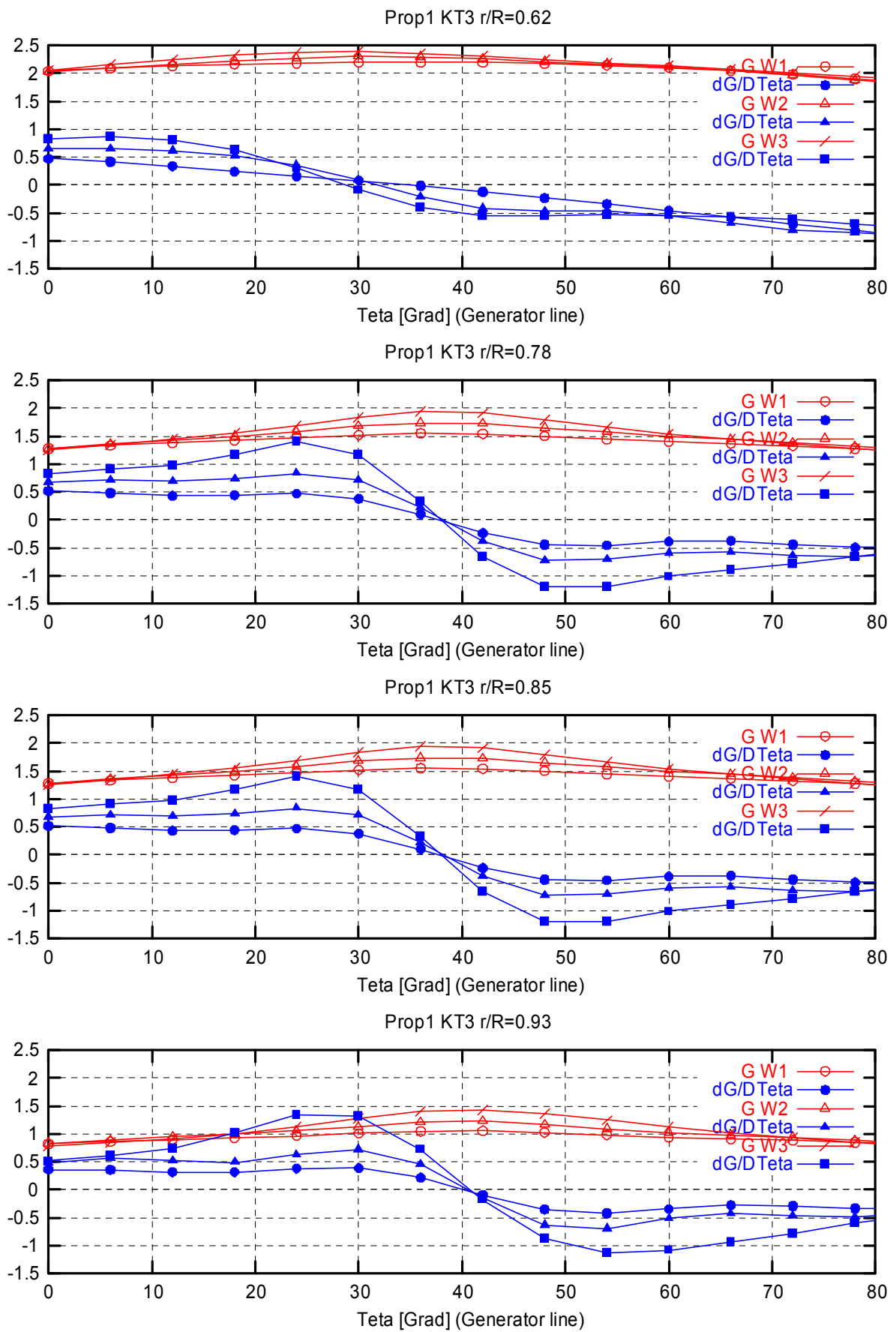


Abbildung 114 : Zirkulation  $\Gamma$  und  $d\Gamma/dt$ , E1-KT3-S2

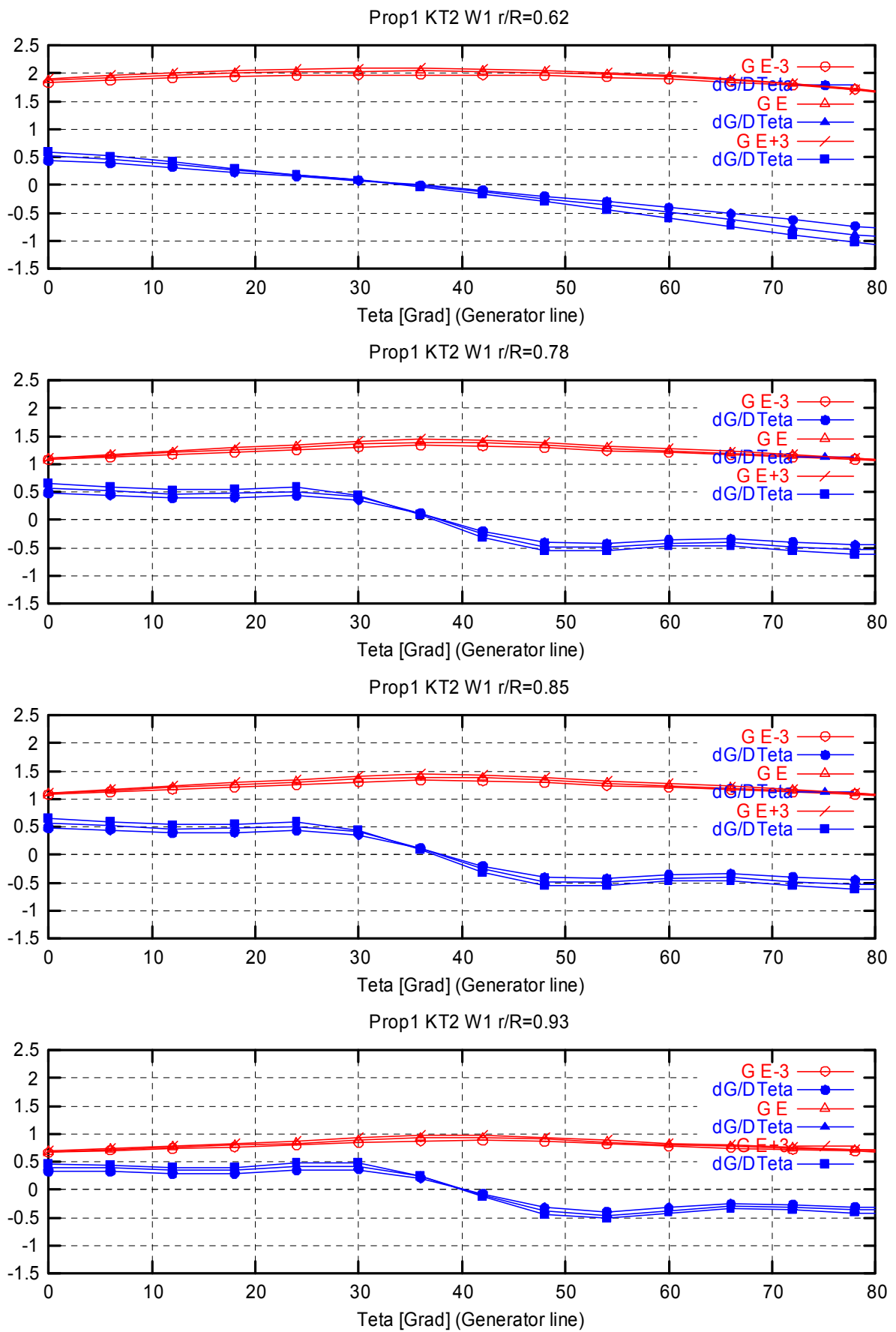


Abbildung 115 : Zirkulation  $\Gamma$  und  $d\Gamma/dt$ , KT2-S2-W1

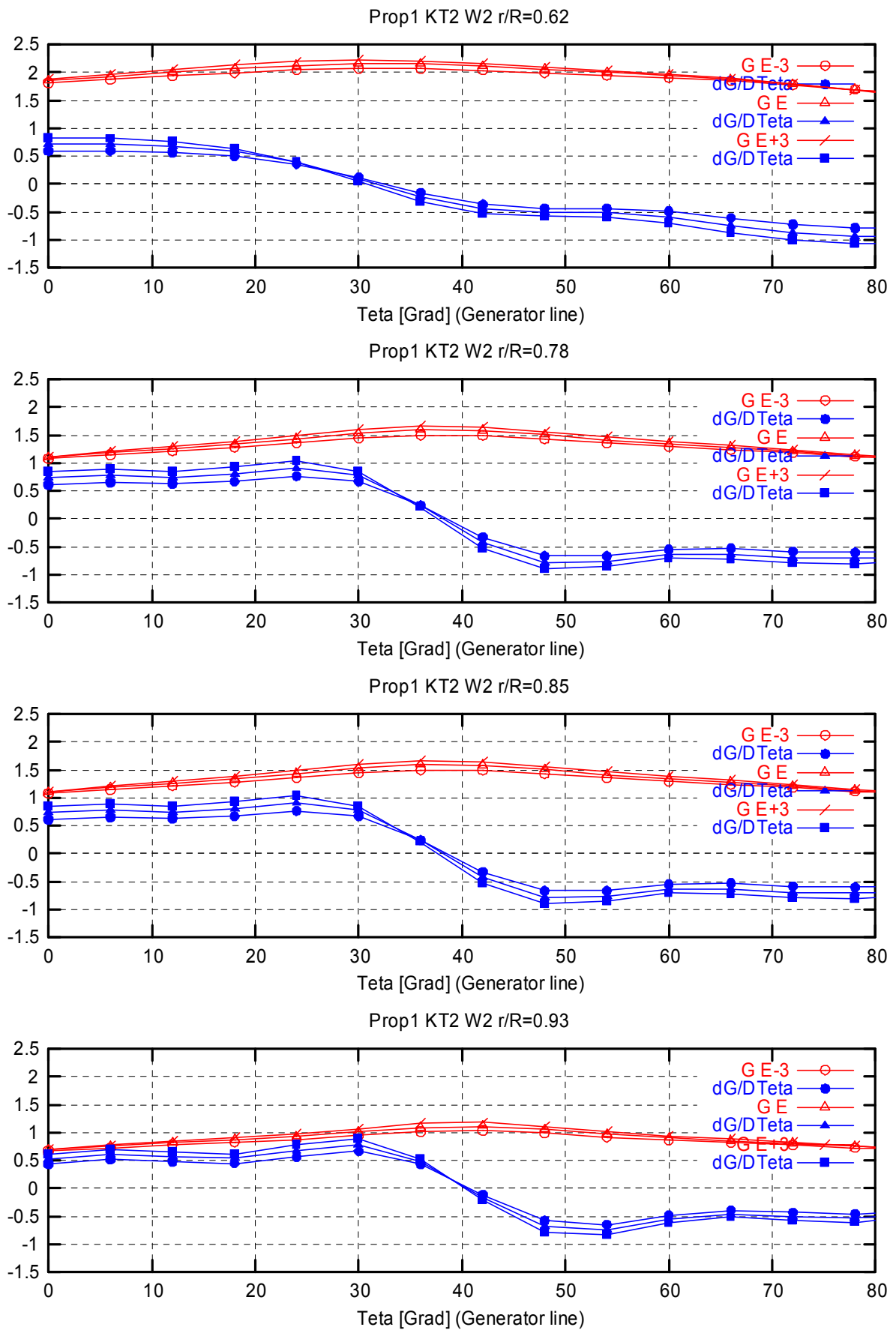


Abbildung 116 : Zirkulation  $\Gamma$  und  $d\Gamma/dt$ , KT2-S2-W2

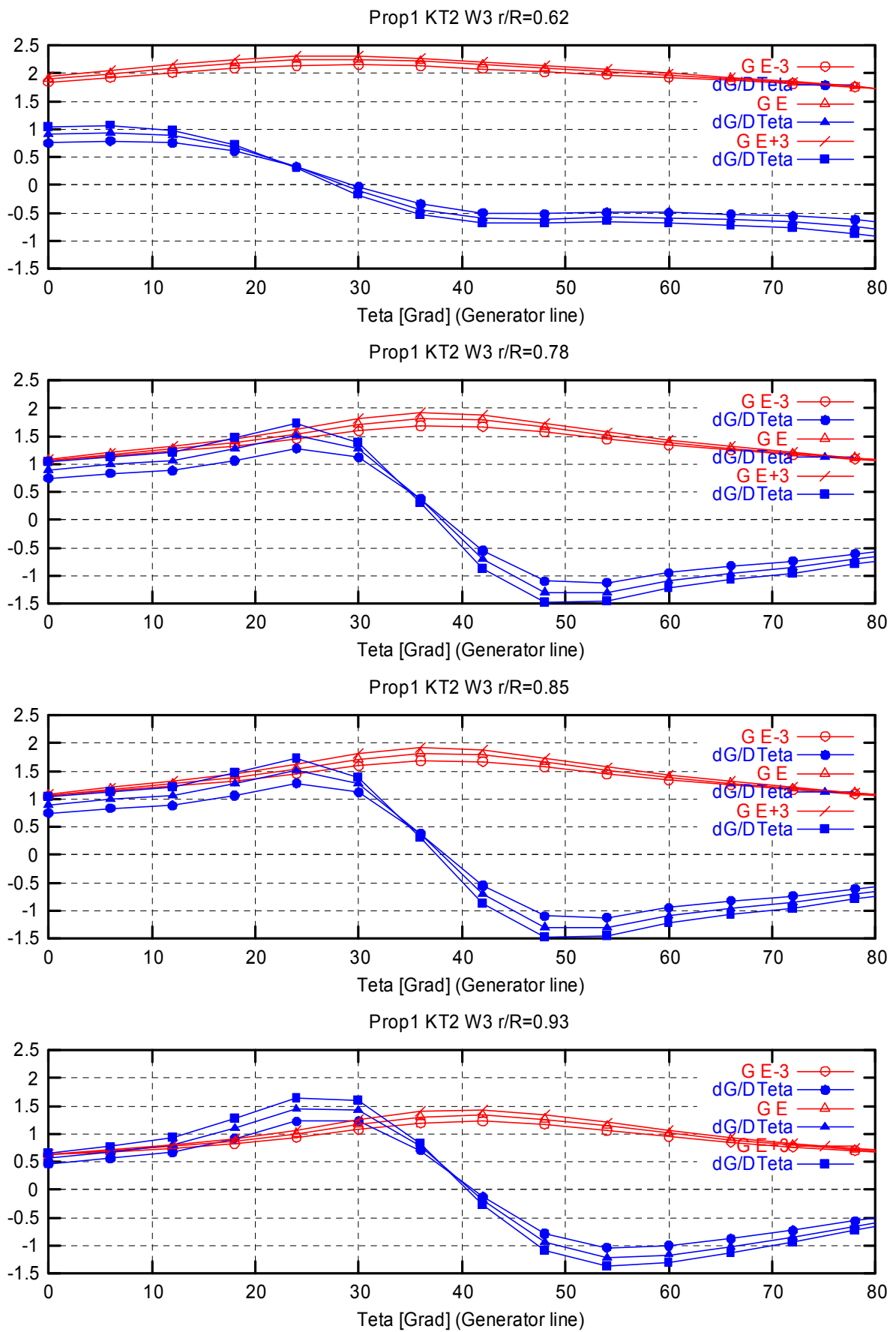


Abbildung 117 : Zirkulation  $\Gamma$  und  $d\Gamma/dt$ , KT2-S2-W3

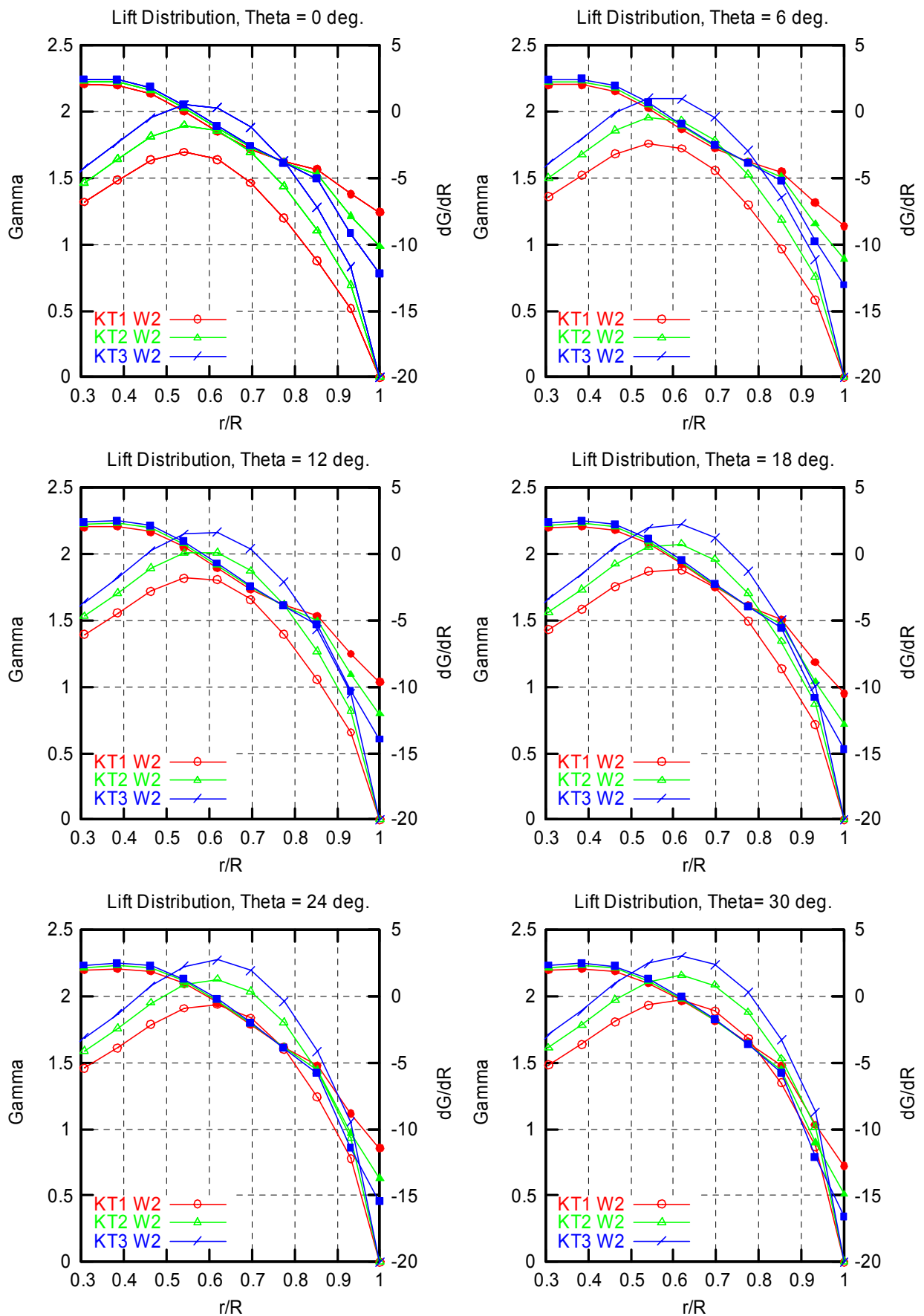


Abbildung 118 : Zirkulation  $\Gamma$  und  $d\Gamma/dr$ , KT1-KT3

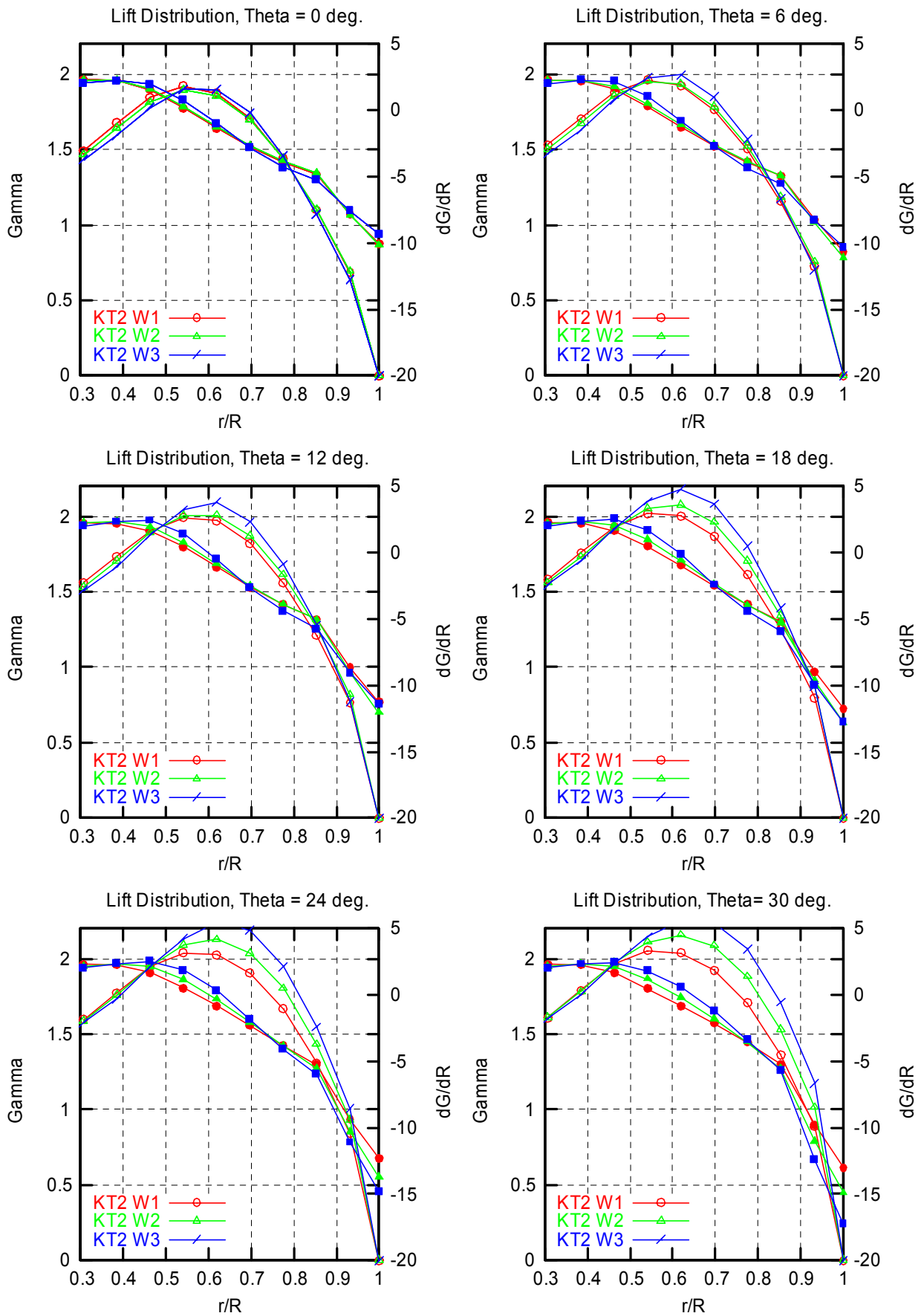


Abbildung 119 : Zirkulation  $\Gamma$  und  $d\Gamma/dr$ , W1-W3

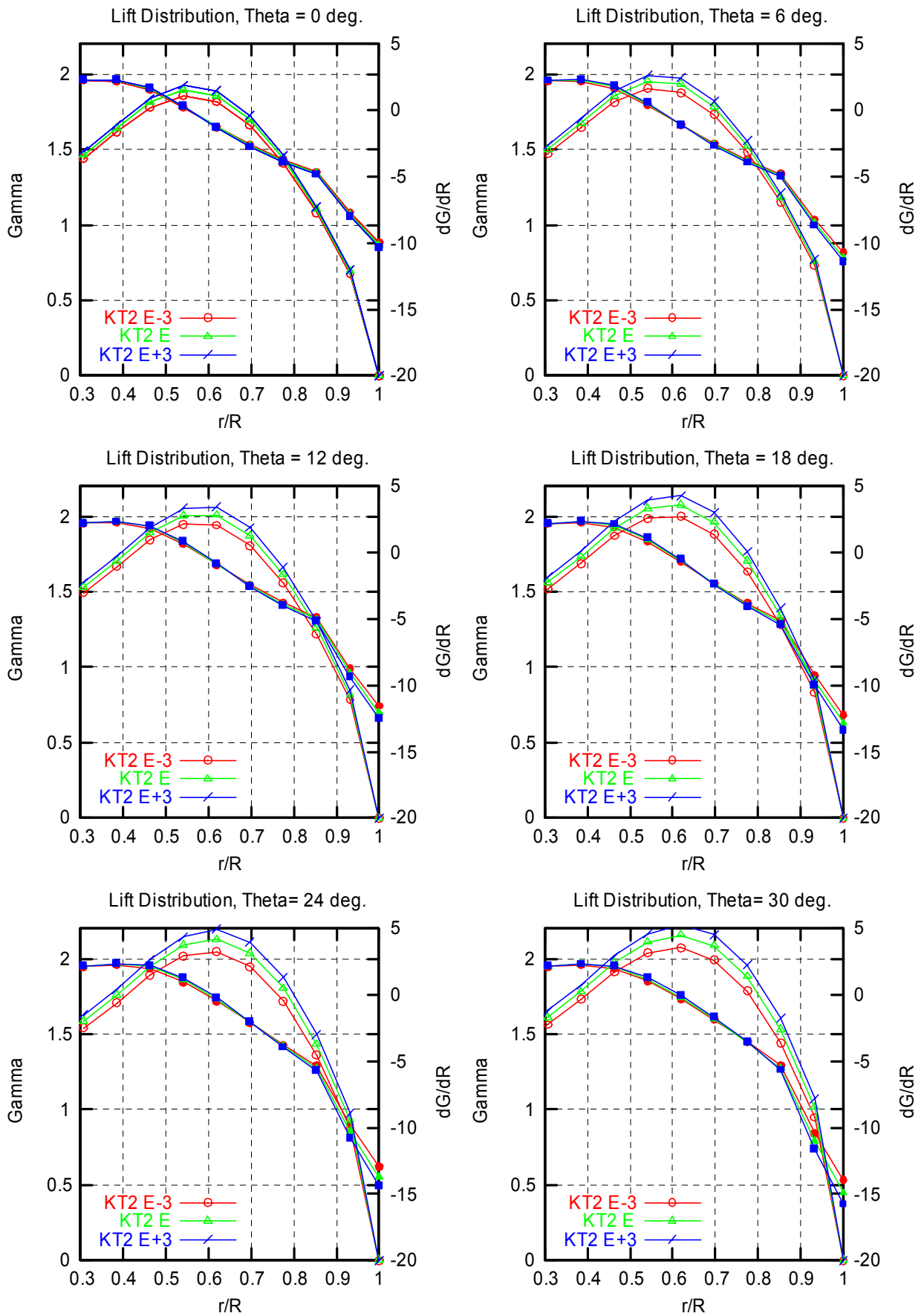


Abbildung 120 : Zirkulation  $\Gamma$  und  $d\Gamma/dr$ , E1-E3

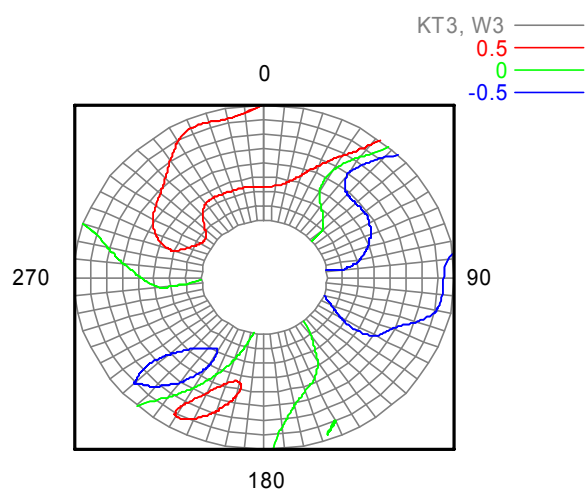
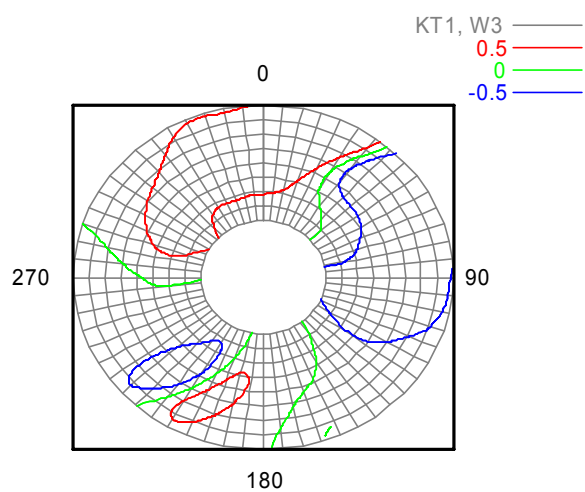
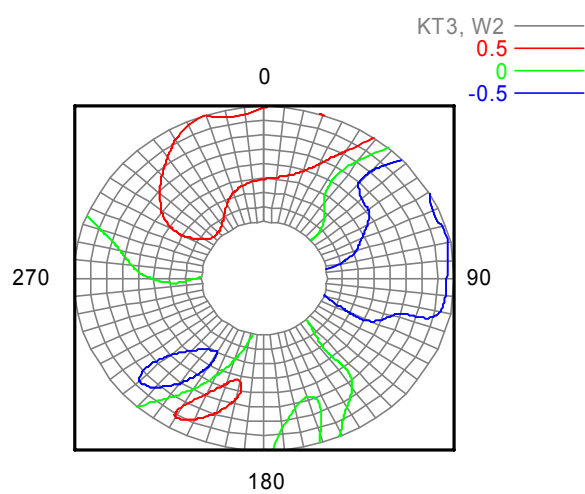
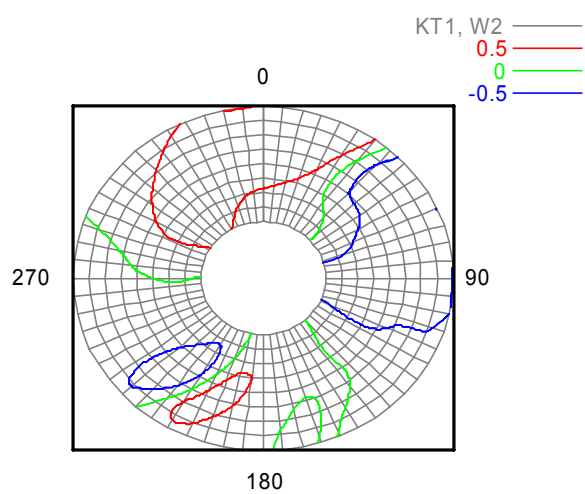
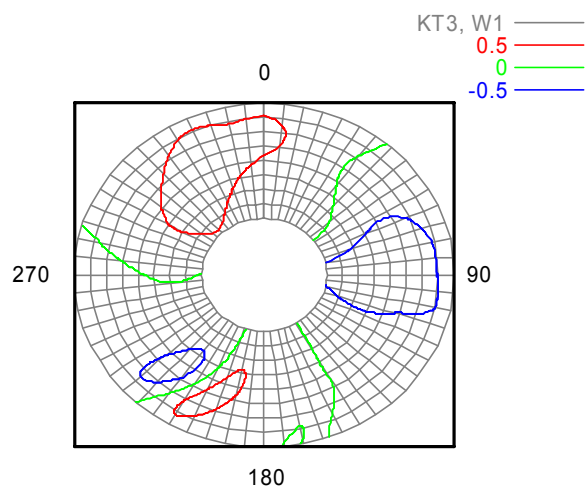
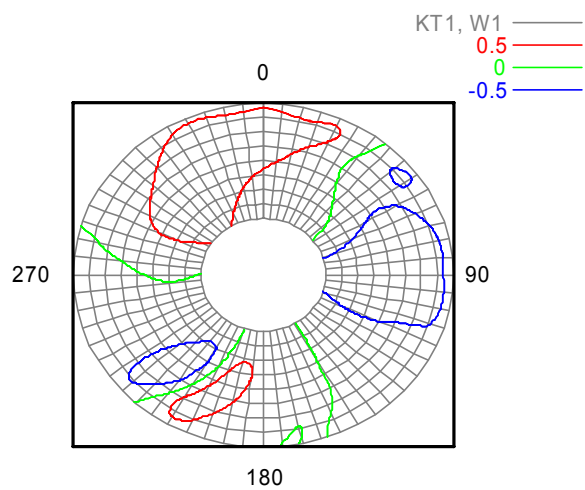


Abbildung 121 :  $d\Gamma/dt$ , E1



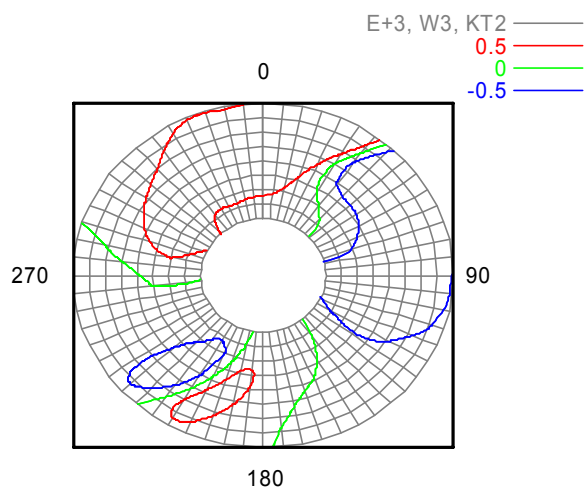
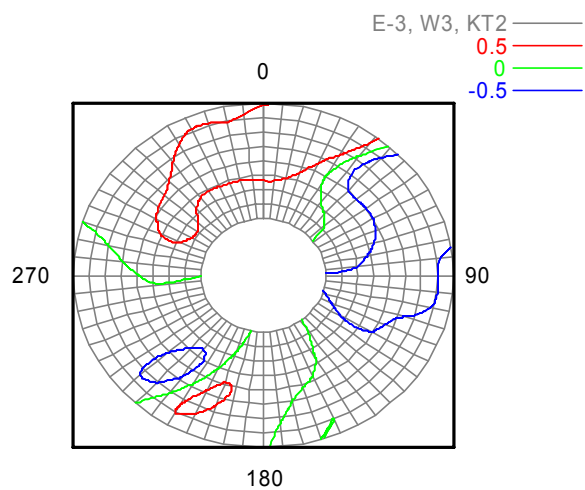
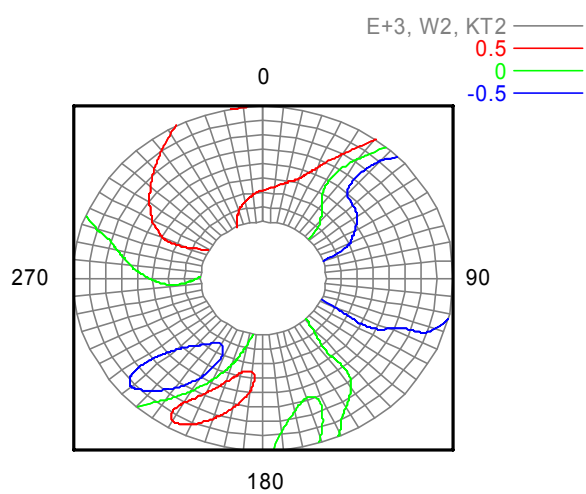
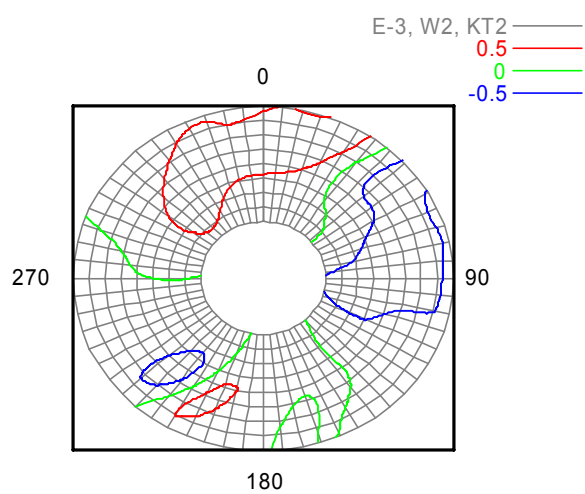
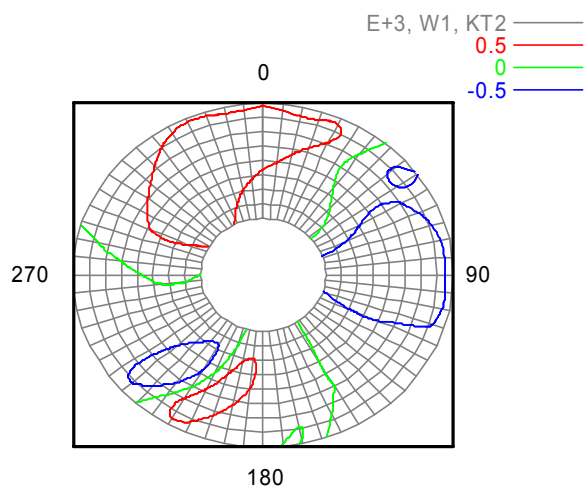
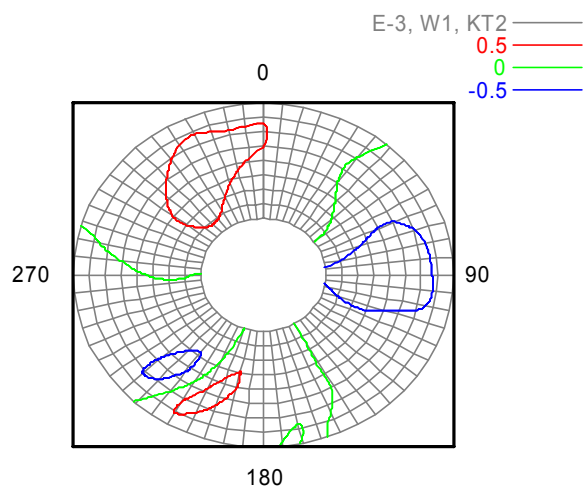


Abbildung 122 :  $d\Gamma/dt$ , KT2

Entwurf

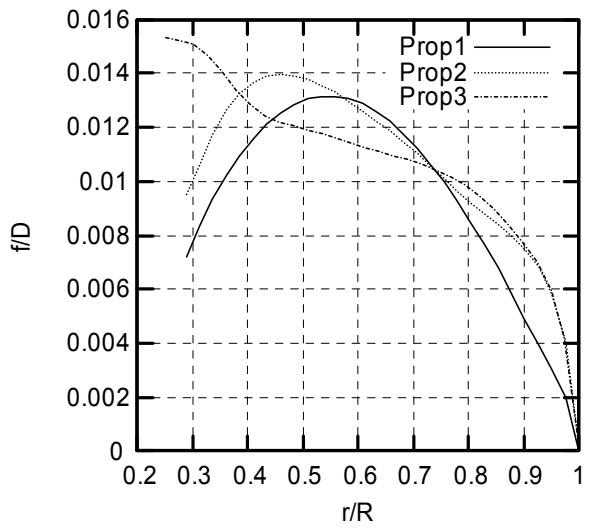
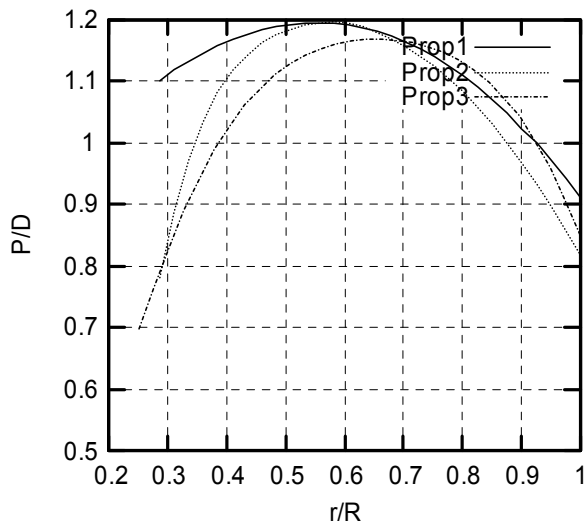
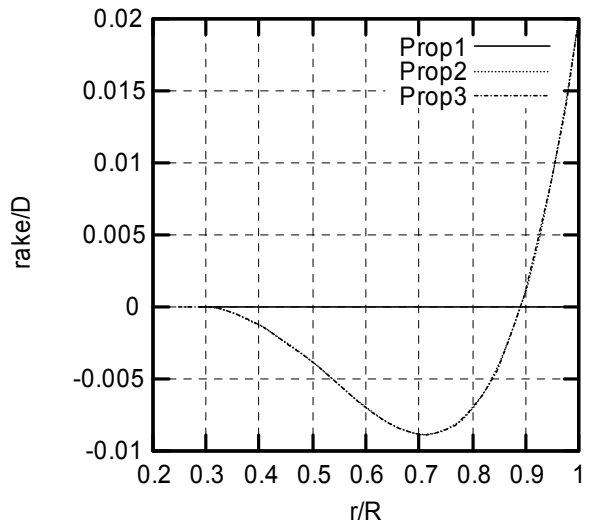
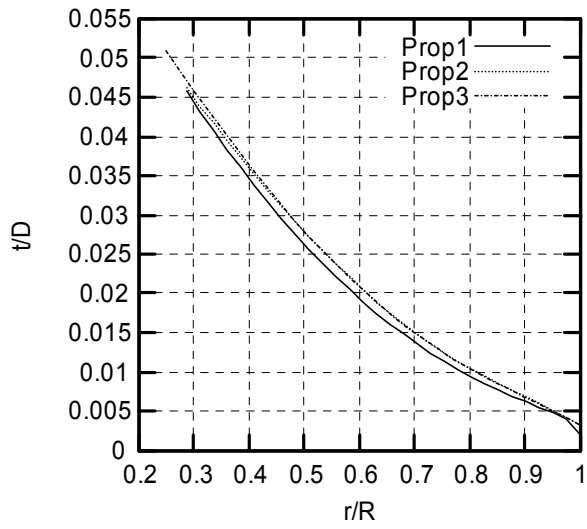
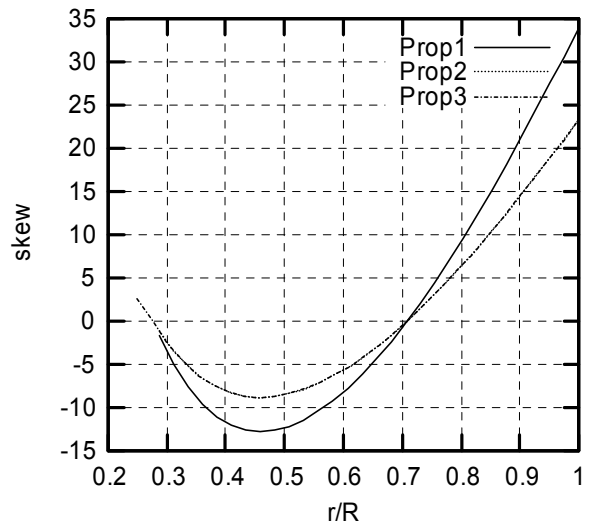
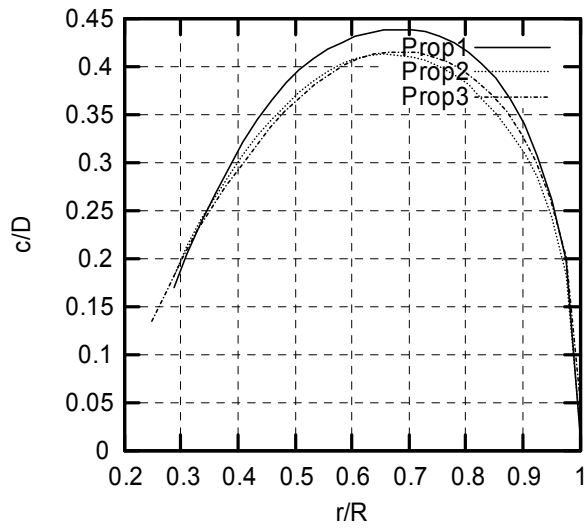
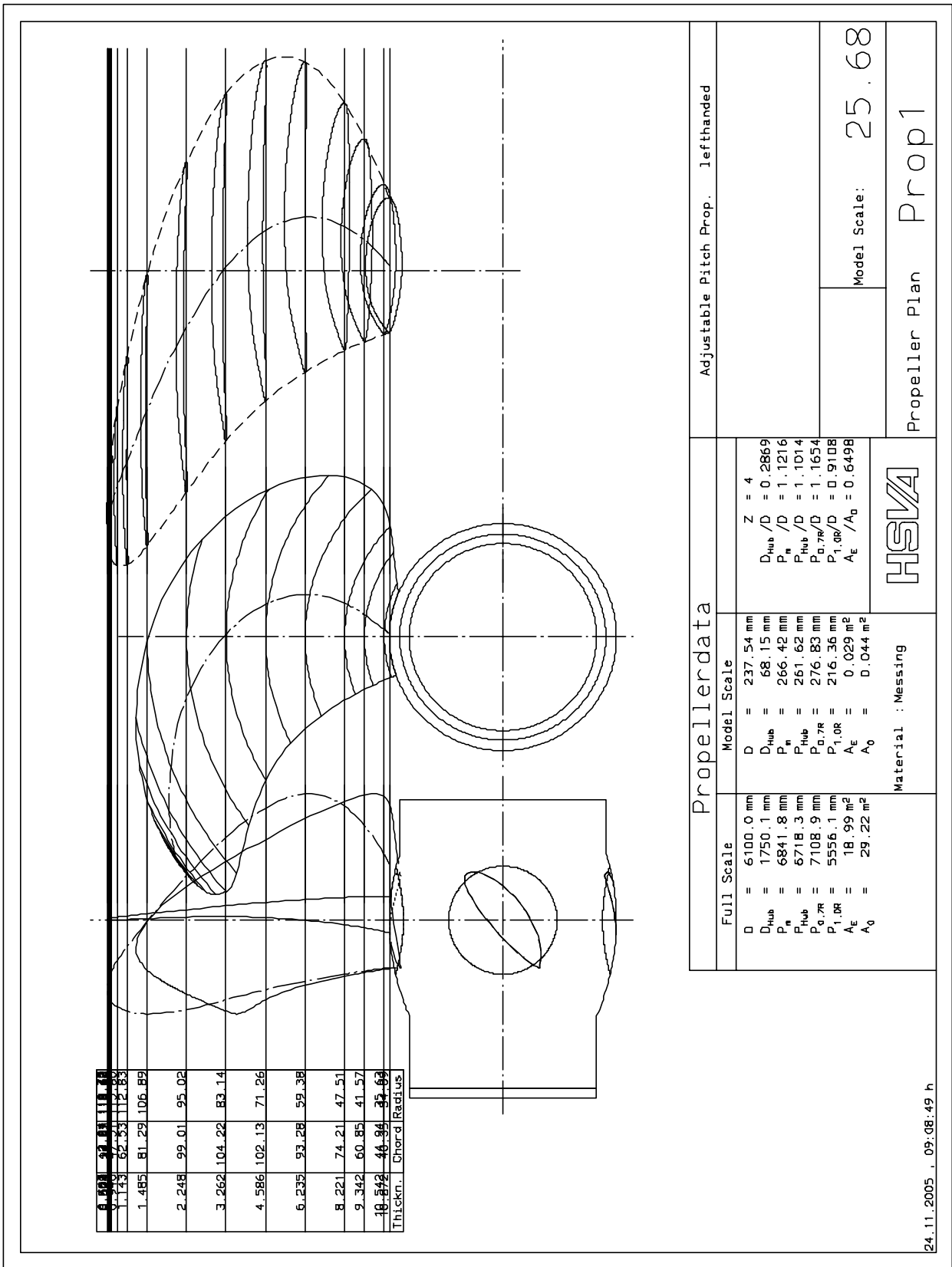
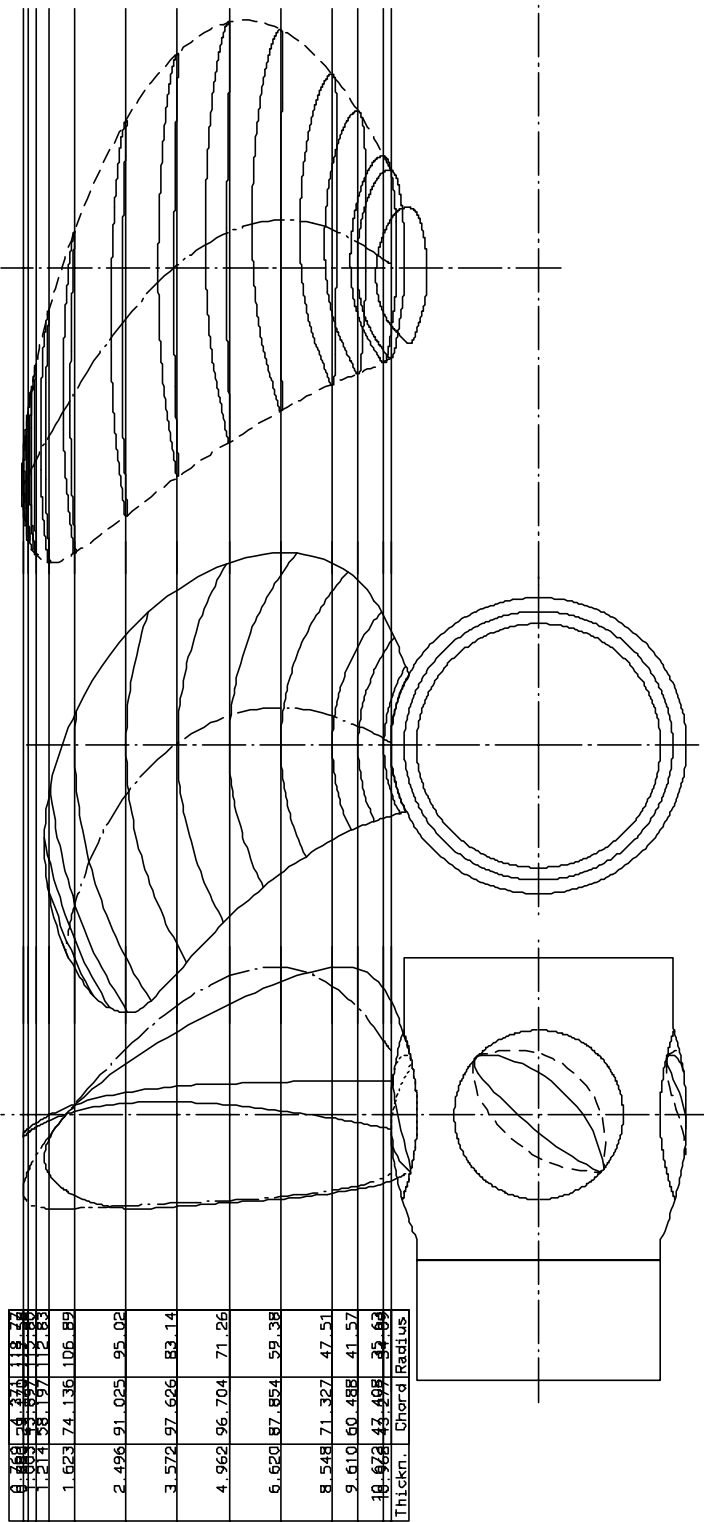


Abbildung 123 : Radiale Verteilung der Hauptparameter



24.11.2005 . 09:08:49 h

Abbildung 124 : Formplan Propeller 1

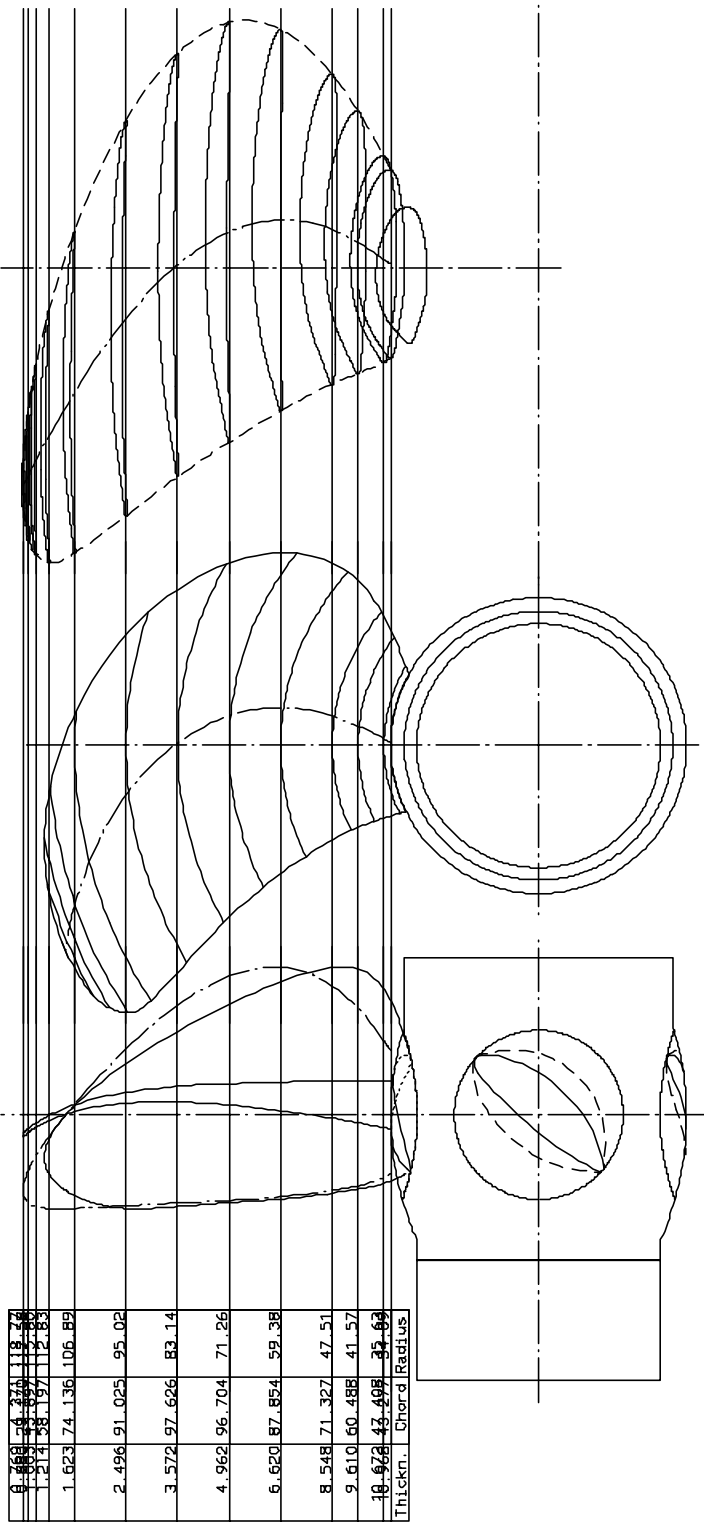


Propellerdata		Adjustable Pitch Prop.	Left-handed																		
<table border="1"> <tr><td>Full Scale</td></tr> <tr><td>D = 6100.0 mm</td></tr> <tr><td>D<sub>hub</sub> = 1749.9 mm</td></tr> <tr><td>P<sub>n</sub> = 6651.4 mm</td></tr> <tr><td>P<sub>hub</sub> = 4767.9 mm</td></tr> <tr><td>P<sub>0.7R</sub> = 7061.4 mm</td></tr> <tr><td>P<sub>1.0R</sub> = 4986.1 mm</td></tr> <tr><td>A<sub>E</sub> = 17.84 m<sup>2</sup></td></tr> <tr><td>A<sub>0</sub> = 29.22 m<sup>2</sup></td></tr> </table>	Full Scale	D = 6100.0 mm	D <sub>hub</sub> = 1749.9 mm	P <sub>n</sub> = 6651.4 mm	P <sub>hub</sub> = 4767.9 mm	P <sub>0.7R</sub> = 7061.4 mm	P <sub>1.0R</sub> = 4986.1 mm	A <sub>E</sub> = 17.84 m <sup>2</sup>	A <sub>0</sub> = 29.22 m <sup>2</sup>	<table border="1"> <tr><td>Model Scale</td></tr> <tr><td>D = 237.54 mm</td></tr> <tr><td>D<sub>hub</sub> = 68.14 mm</td></tr> <tr><td>P<sub>n</sub> = 259.01 mm</td></tr> <tr><td>P<sub>hub</sub> = 185.66 mm</td></tr> <tr><td>P<sub>0.7R</sub> = 274.98 mm</td></tr> <tr><td>P<sub>1.0R</sub> = 194.16 mm</td></tr> <tr><td>A<sub>E</sub> = 0.027 m<sup>2</sup></td></tr> <tr><td>A<sub>0</sub> = 0.044 m<sup>2</sup></td></tr> </table>	Model Scale	D = 237.54 mm	D <sub>hub</sub> = 68.14 mm	P <sub>n</sub> = 259.01 mm	P <sub>hub</sub> = 185.66 mm	P <sub>0.7R</sub> = 274.98 mm	P <sub>1.0R</sub> = 194.16 mm	A <sub>E</sub> = 0.027 m <sup>2</sup>	A <sub>0</sub> = 0.044 m <sup>2</sup>	Design of H S V A for BMBF/ProTip	
Full Scale																					
D = 6100.0 mm																					
D <sub>hub</sub> = 1749.9 mm																					
P <sub>n</sub> = 6651.4 mm																					
P <sub>hub</sub> = 4767.9 mm																					
P <sub>0.7R</sub> = 7061.4 mm																					
P <sub>1.0R</sub> = 4986.1 mm																					
A <sub>E</sub> = 17.84 m <sup>2</sup>																					
A <sub>0</sub> = 29.22 m <sup>2</sup>																					
Model Scale																					
D = 237.54 mm																					
D <sub>hub</sub> = 68.14 mm																					
P <sub>n</sub> = 259.01 mm																					
P <sub>hub</sub> = 185.66 mm																					
P <sub>0.7R</sub> = 274.98 mm																					
P <sub>1.0R</sub> = 194.16 mm																					
A <sub>E</sub> = 0.027 m <sup>2</sup>																					
A <sub>0</sub> = 0.044 m <sup>2</sup>																					
<table border="1"> <tr><td>Z = 4</td></tr> <tr><td>D<sub>hub</sub> / D = 0.2869</td></tr> <tr><td>P<sub>n</sub> / D = 1.0904</td></tr> <tr><td>P<sub>hub</sub> / D = 0.7816</td></tr> <tr><td>P<sub>0.7R</sub> / D = 1.1576</td></tr> <tr><td>P<sub>1.0R</sub> / D = 0.8174</td></tr> <tr><td>A<sub>E</sub> / A<sub>0</sub> = 0.6103</td></tr> </table>		Z = 4	D <sub>hub</sub> / D = 0.2869	P <sub>n</sub> / D = 1.0904	P <sub>hub</sub> / D = 0.7816	P <sub>0.7R</sub> / D = 1.1576	P <sub>1.0R</sub> / D = 0.8174	A <sub>E</sub> / A <sub>0</sub> = 0.6103	Model Scale: 25.68												
Z = 4																					
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P <sub>n</sub> / D = 1.0904																					
P <sub>hub</sub> / D = 0.7816																					
P <sub>0.7R</sub> / D = 1.1576																					
P <sub>1.0R</sub> / D = 0.8174																					
A <sub>E</sub> / A <sub>0</sub> = 0.6103																					
Material : Messing		Propeller Plan Prop2																			



24.11.2005 . 08:49:40 h

Abbildung 125 : Formplan Propeller 2



Propellerdata		Adjustable Pitch Prop.	Left-handed
Full Scale	Model Scale	Design of H S V A for BMBF/ProTip	
$D = 6100.0 \text{ mm}$ $D_{\text{Hub}} = 1749.9 \text{ mm}$ $P_n = 6651.4 \text{ mm}$ $P_{\text{Hub}} = 4767.9 \text{ mm}$ $P_{0.7R} = 7061.4 \text{ mm}$ $P_{1.0R} = 4986.1 \text{ mm}$ $A_E = 17.84 \text{ m}^2$ $A_0 = 29.22 \text{ m}^2$	$Z = 4$ $D_{\text{Hub}}/D = 0.2869$ $P_n/D = 1.0904$ $P_{\text{Hub}}/D = 0.7816$ $P_{0.7R}/D = 1.1576$ $P_{1.0R}/D = 0.8174$ $A_E/A_0 = 0.6103$	Model Scale: 25.68	
Material : Messing		Propeller Plan Prop3	
<b>HSVA</b>			

24.11.2005 . 08:49:40 h

Abbildung 126 : Formplan Propeller 3

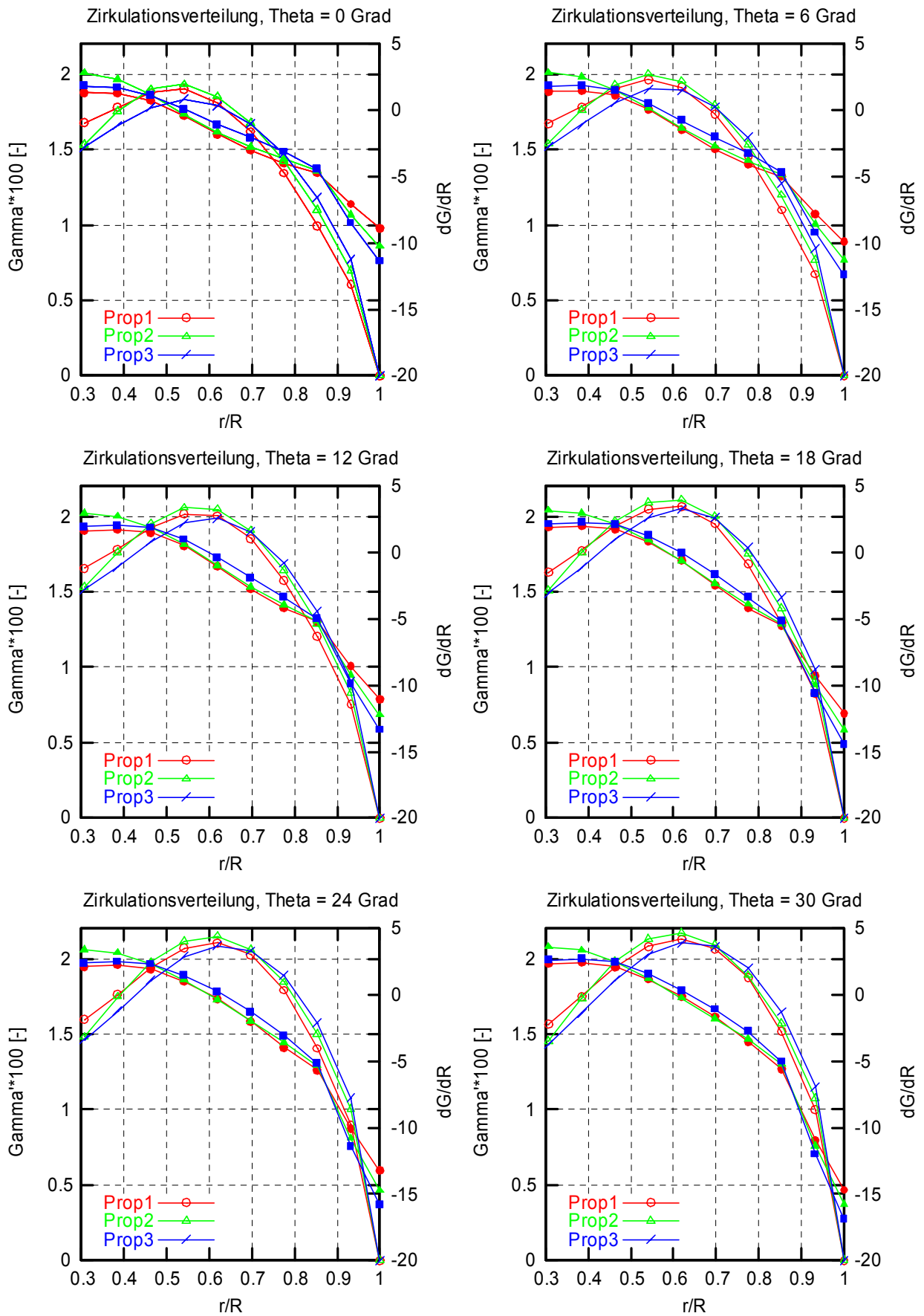


Abbildung 127 : Vergleich der radialen Zirkulationsverteilungen im Entwurfsunkt

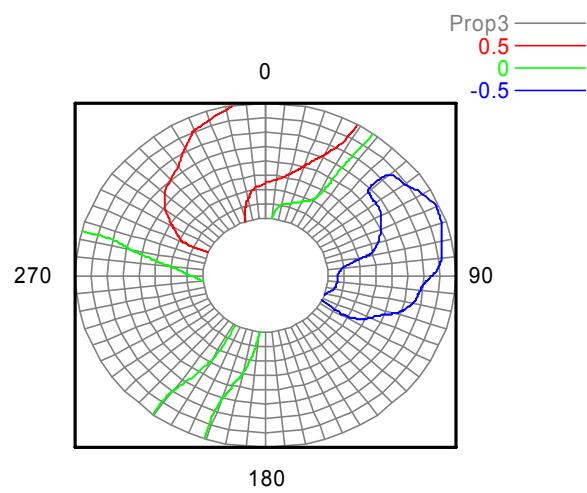
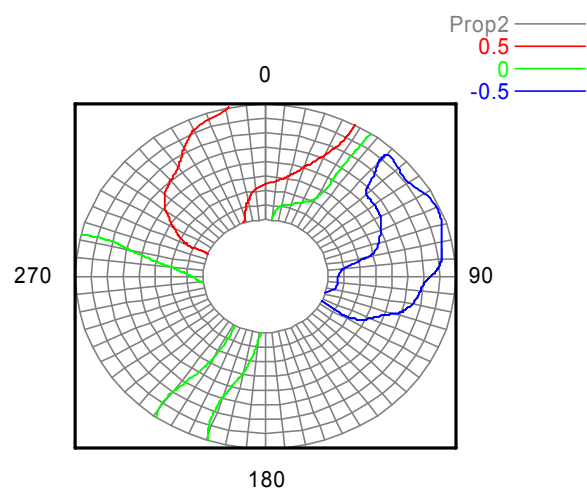
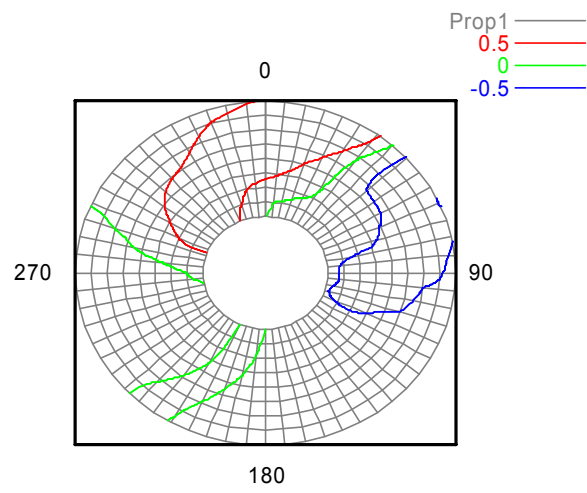


Abbildung 128 : Zeitliche Ableitung der Zirkulationsverteilung  $d\Gamma/dt$



Freifahrt Charakteristik, Modellwerte

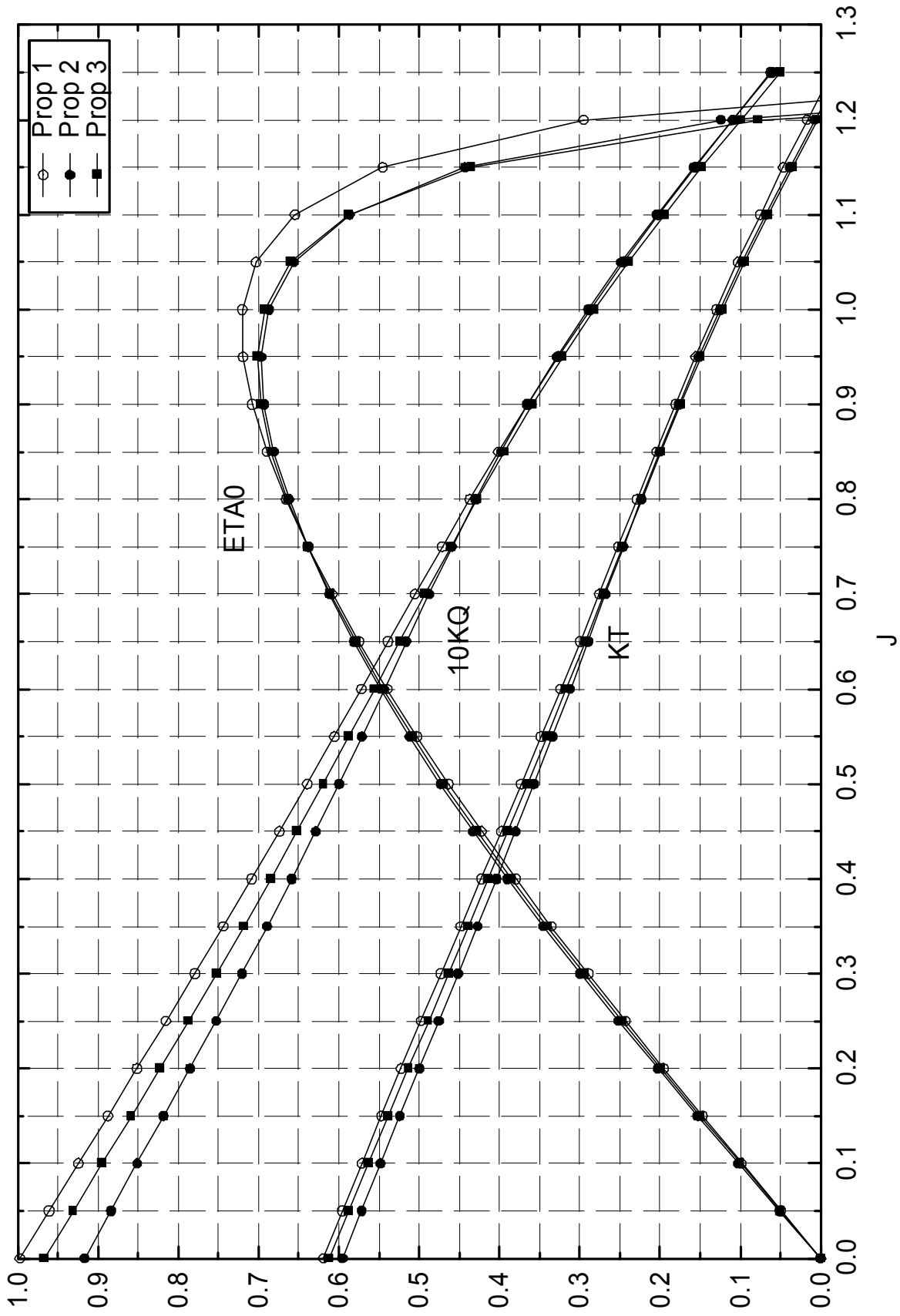


Abbildung 129 : Freifahrtcharakteristik, Modellwerte

Freifahrt Charakteristik, Grossausführungswerte

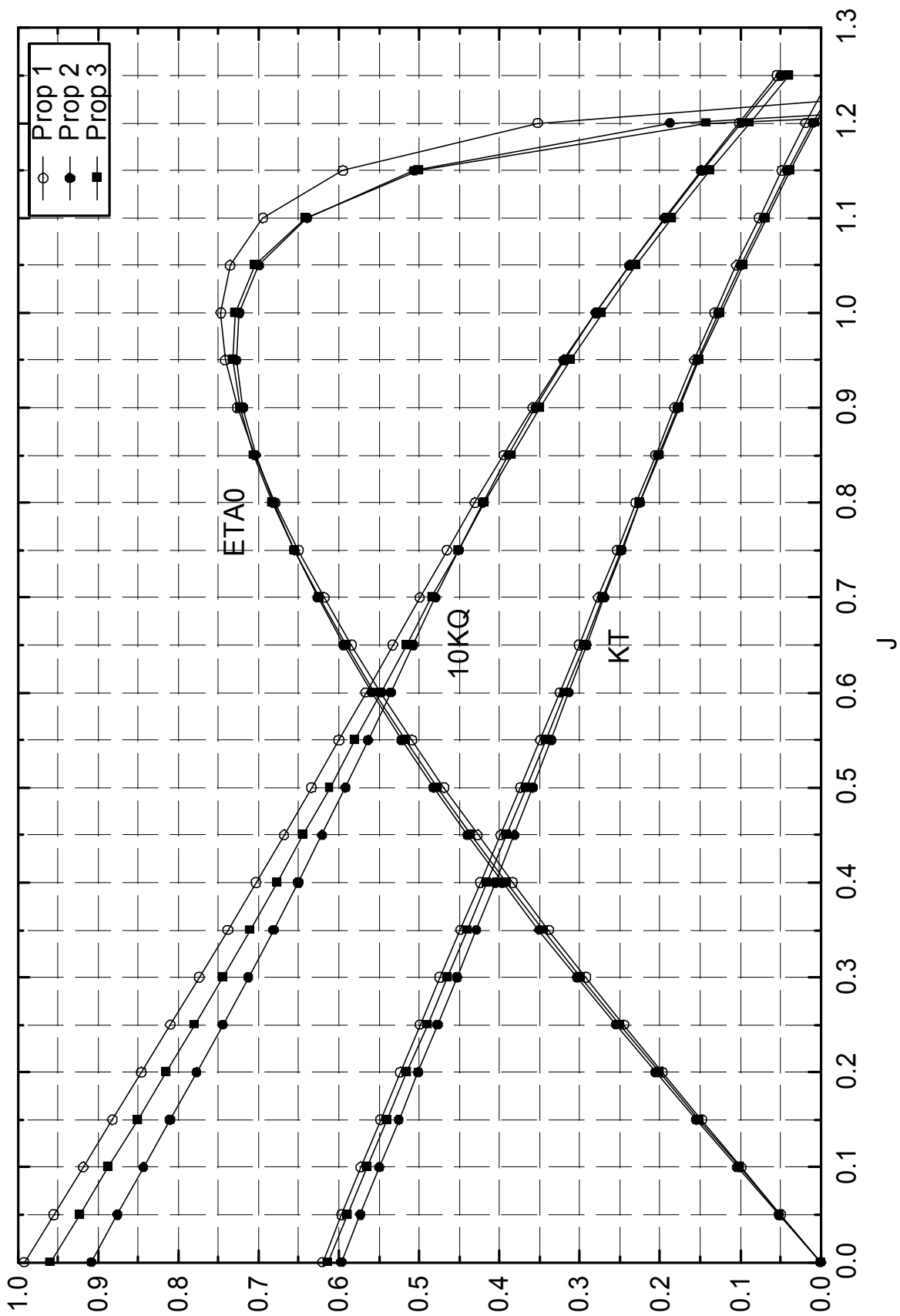
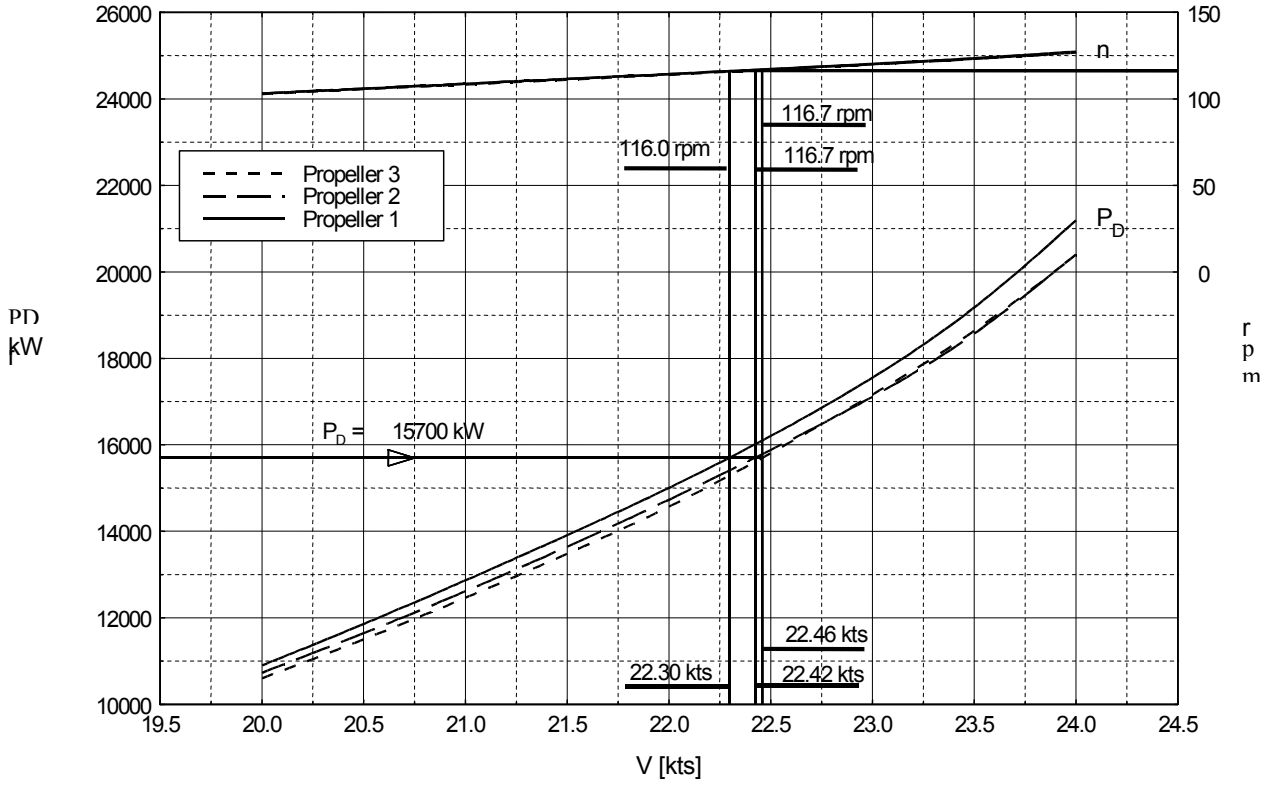


Abbildung 130 : Freifahrtcharakteristik, Großausführungswerte

BMBF  
 RoRo Ship  
 Trial Prediction - Headwind Bft 3



eg05287.dat eg05288.dat eg05289.dat  
 c:\tmp\hugo

Report WP, Diagr. 1

Abbildung 131 : Propulsionsergebnisse

# **KYKAT Versuche**

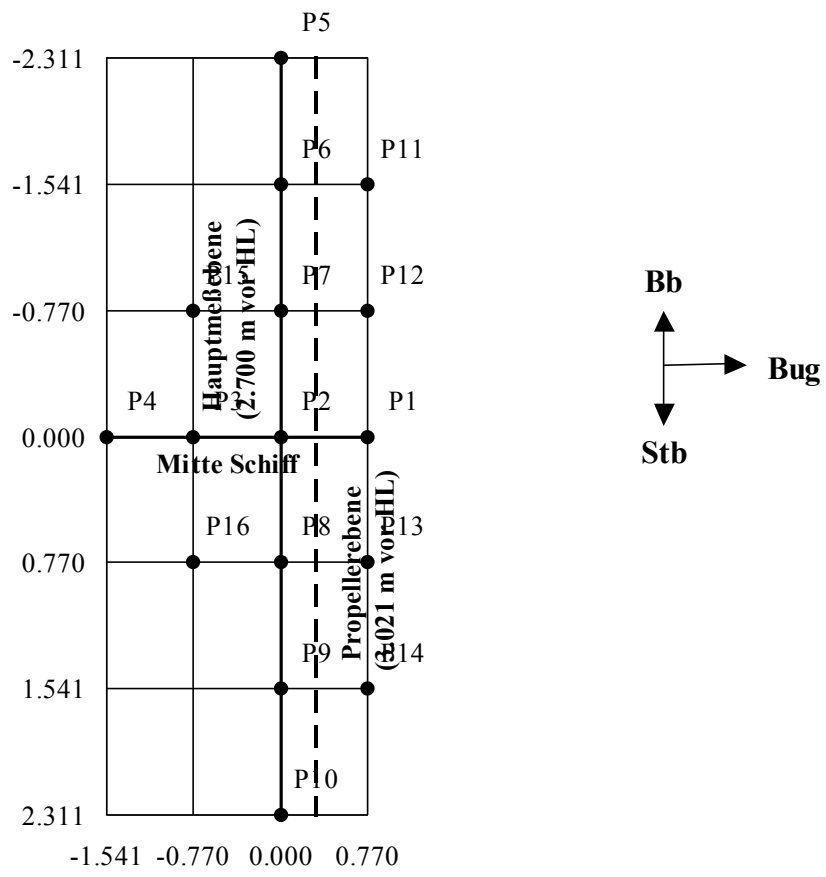
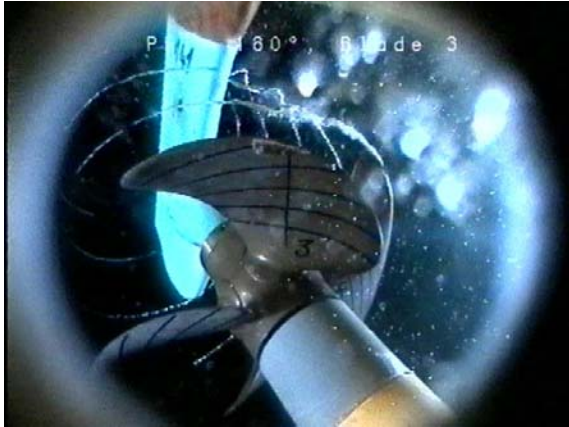
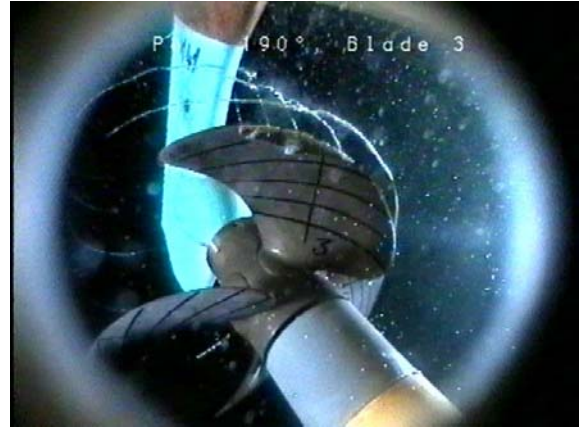


Abbildung 132 : Lage der Druckmessdosen in Metern (Großausführung)



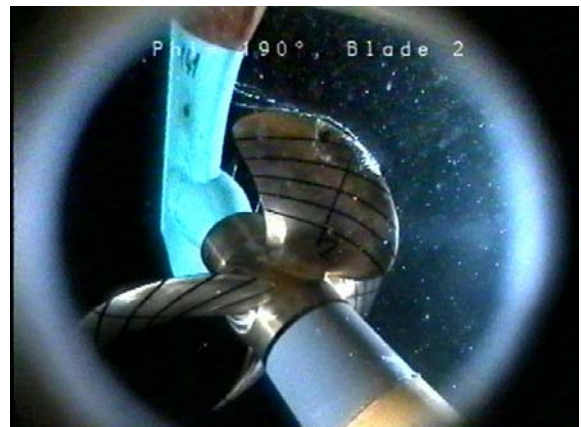
Propeller 1



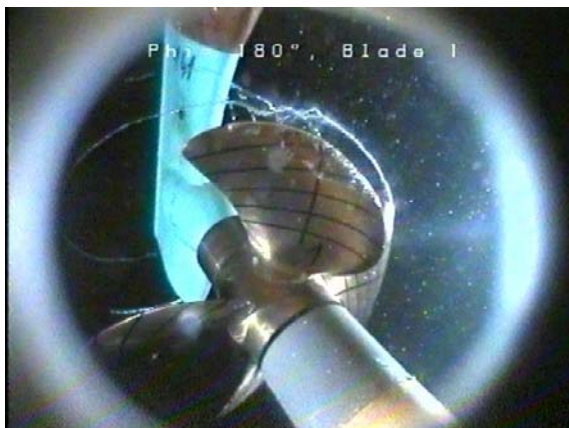
Propeller 1



Propeller 2



Propeller 2

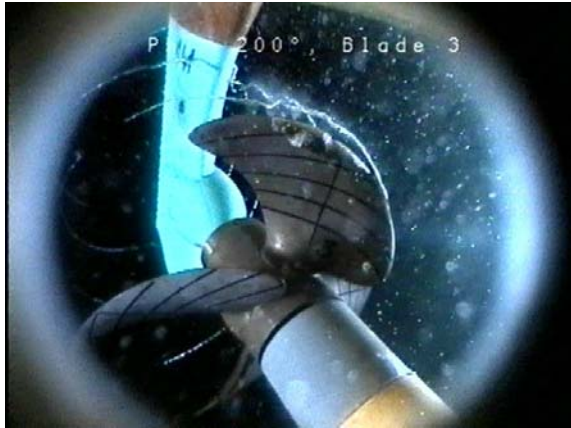


Propeller 3

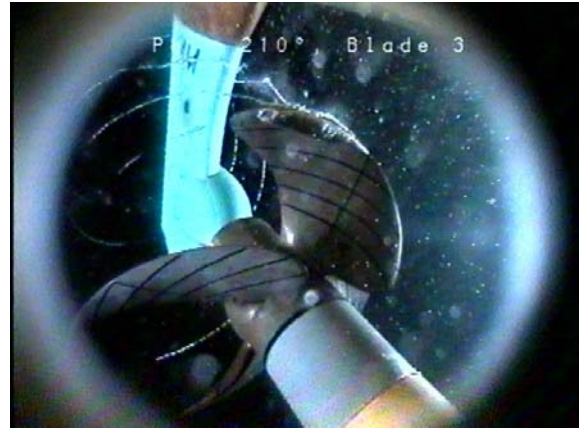


Propeller 3

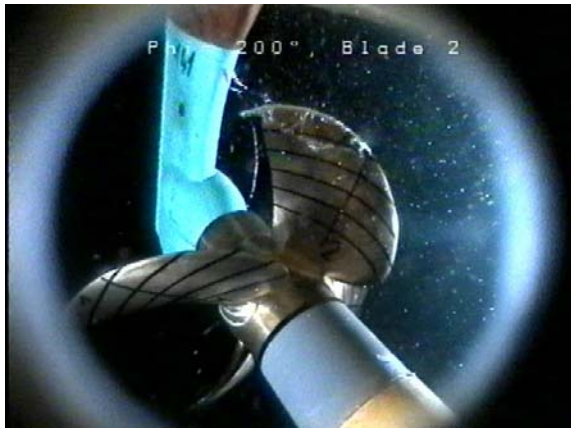
Abbildung 133 : Kavitationverhalten Prop1-3,  $\phi=180^\circ-190^\circ$



Propeller 1



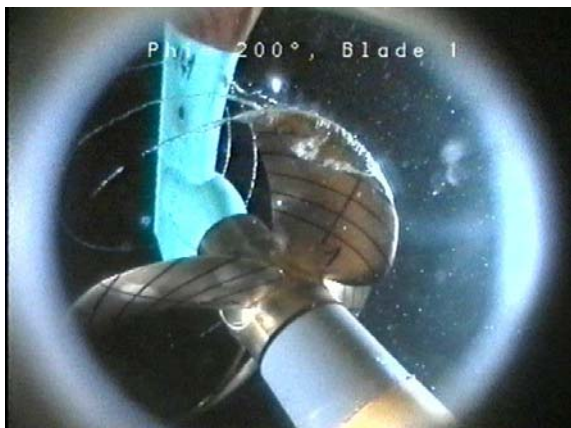
Propeller 1



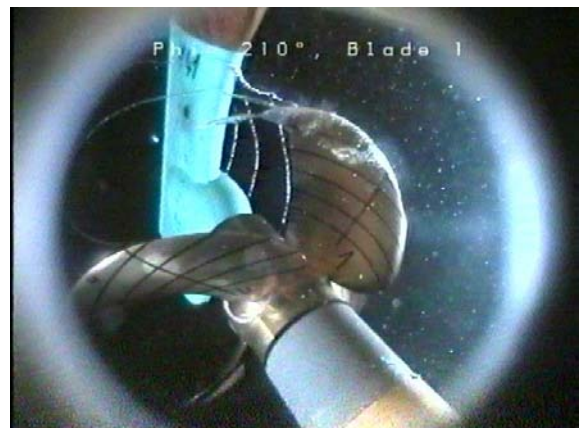
Propeller 2



Propeller 2

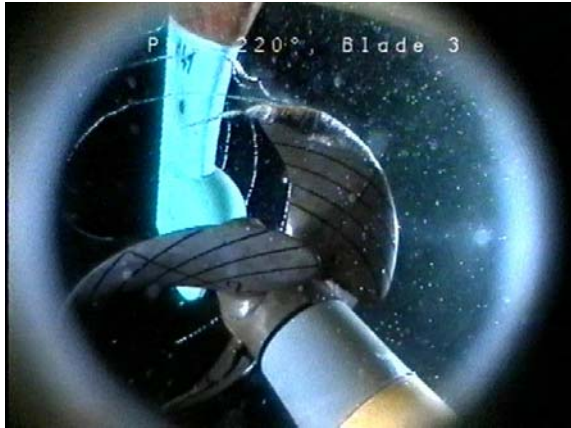


Propeller 3

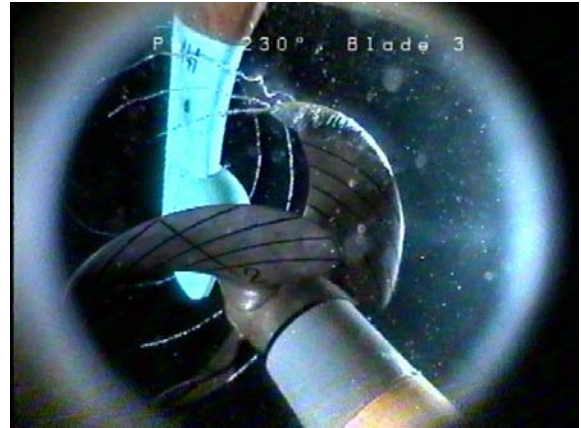


Propeller 3

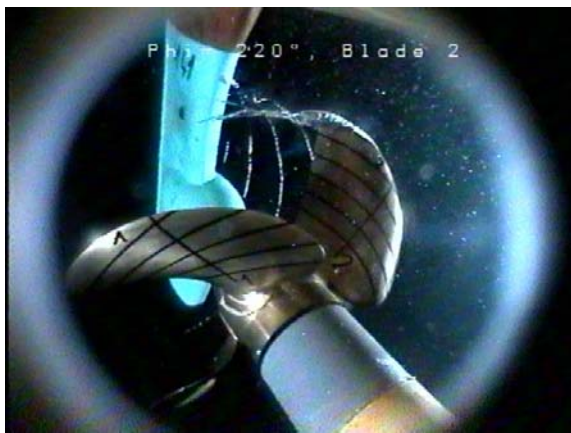
Abbildung 134 : Kavitationverhalten Prop1-3,  $\phi=200^\circ-210^\circ$



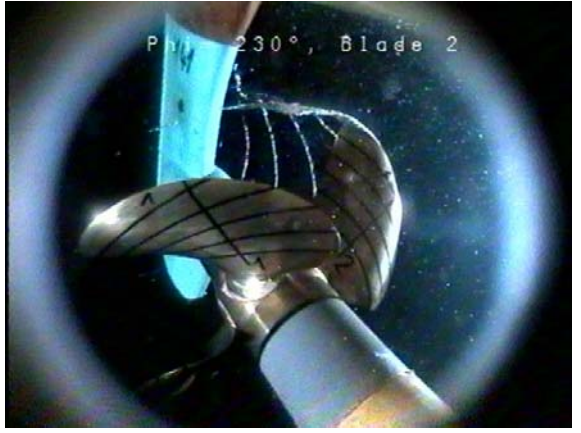
Propeller 1



Propeller 1



Propeller 2



Propeller 2



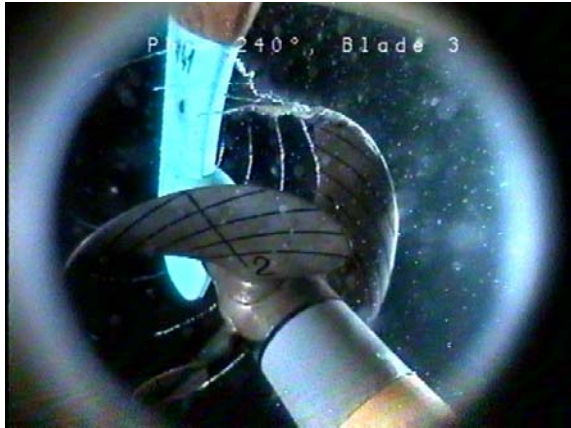
Propeller 3



Propeller 3

Abbildung 135 : Kavitationverhalten Prop1-3,  $\phi=220^{\circ}230^{\circ}$





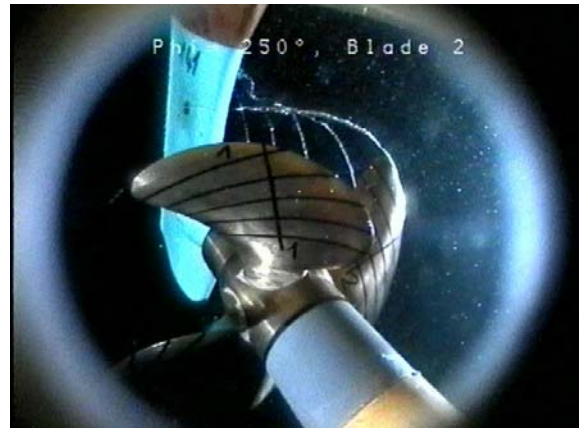
Propeller 1



Propeller 1



Propeller 2



Propeller 2

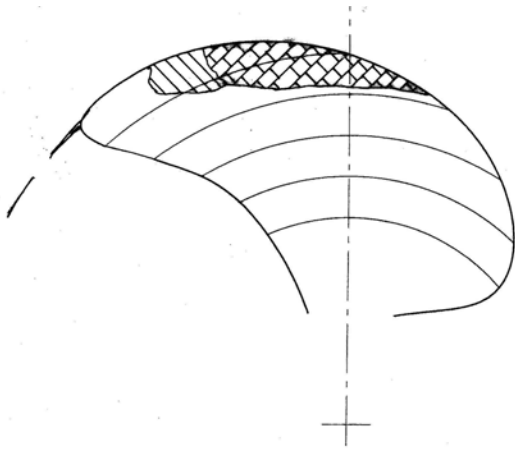


Propeller 3

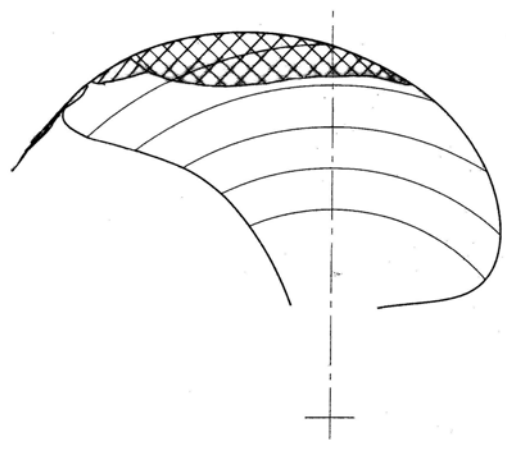


Propeller 3

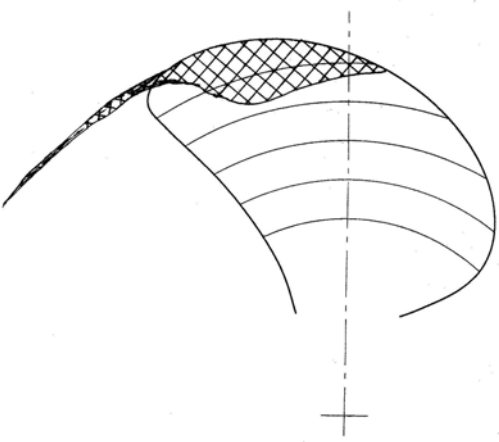
Abbildung 136 : Kavitationverhalten Prop1-3,  $\phi=240^\circ-250^\circ$



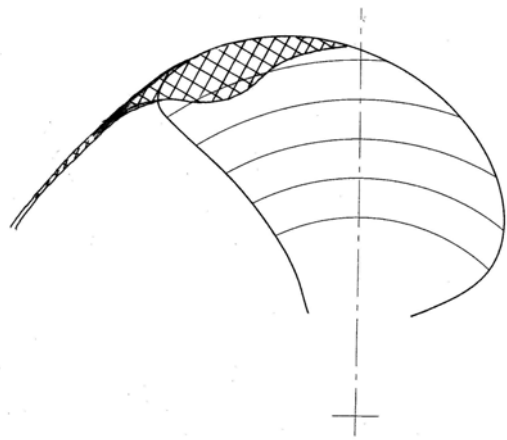
Propeller 1,  $\Phi=200^\circ$



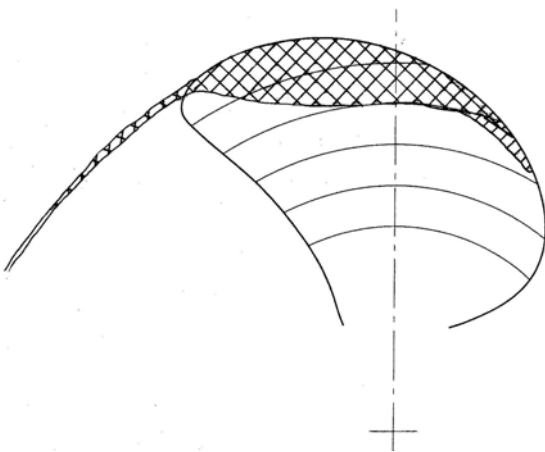
Propeller 1,  $\Phi=210^\circ$



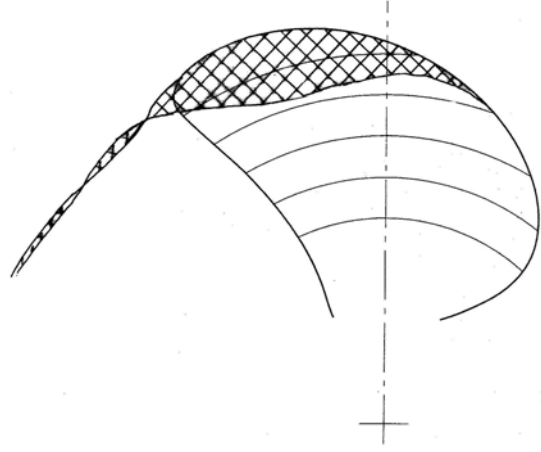
Propeller 2,  $\Phi=200^\circ$



Propeller 2,  $\Phi=210^\circ$

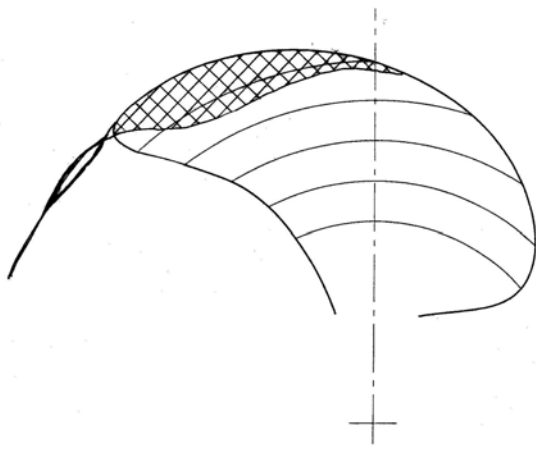


Propeller 3,  $\Phi=200^\circ$

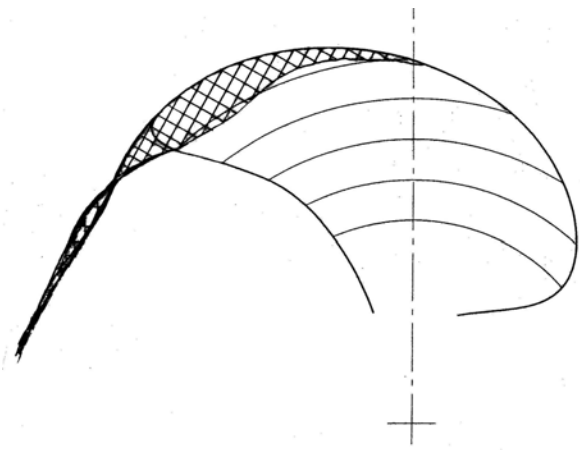


Propeller 3,  $\Phi=210^\circ$

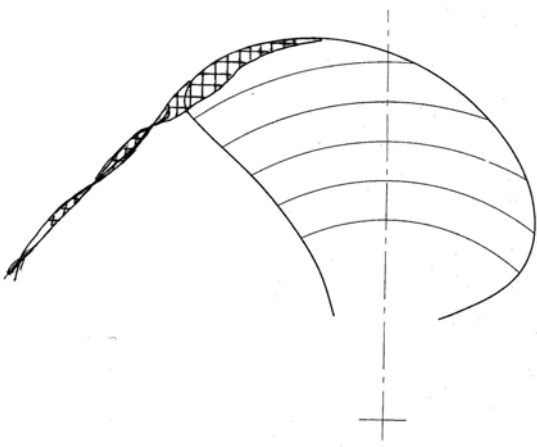
Abbildung 137 : Kavitationsskizzen Prop1-3,  $\phi=200^\circ-210^\circ$



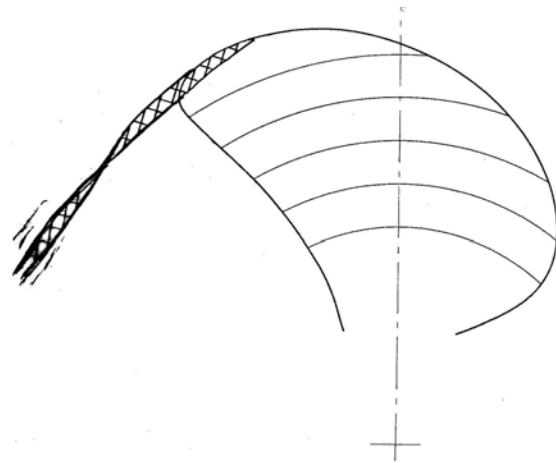
Propeller 1,  $\Phi=220^\circ$



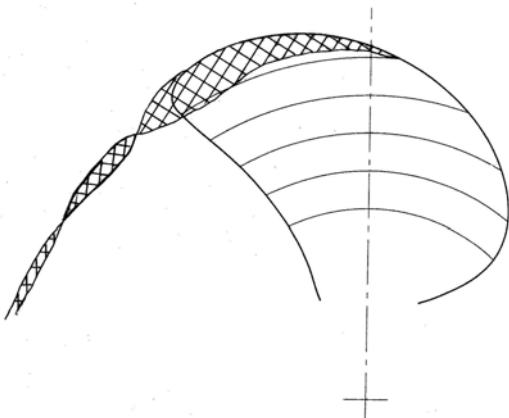
Propeller 1,  $\Phi=230^\circ$



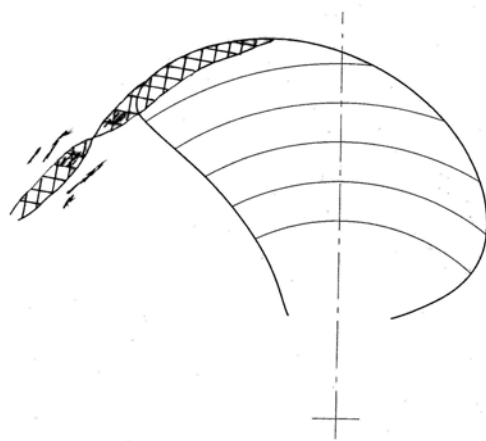
Propeller 2,  $\Phi=220^\circ$



Propeller 2,  $\Phi=230^\circ$

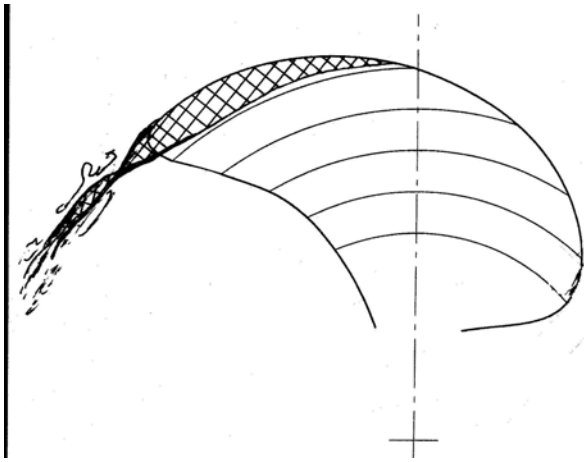


Propeller 3,  $\Phi=220^\circ$

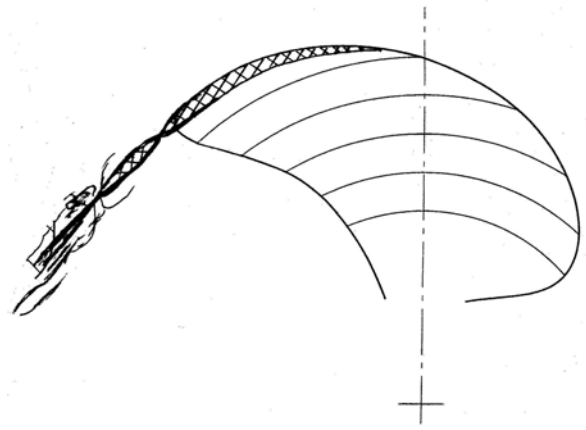


Propeller 3,  $\Phi=230^\circ$

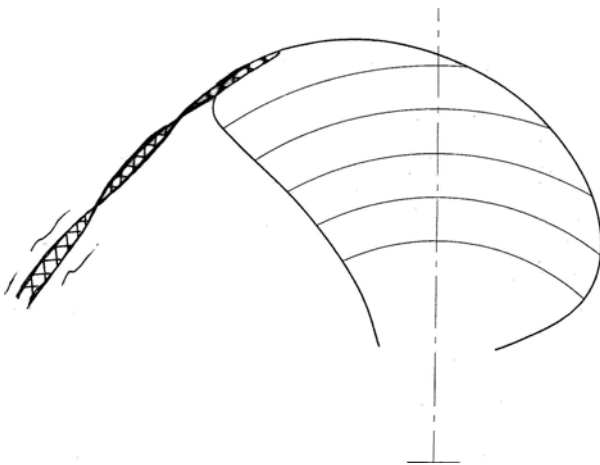
Abbildung 138 : Kavitationskizzen Prop1-3,  $\phi=220^\circ$ - $230^\circ$



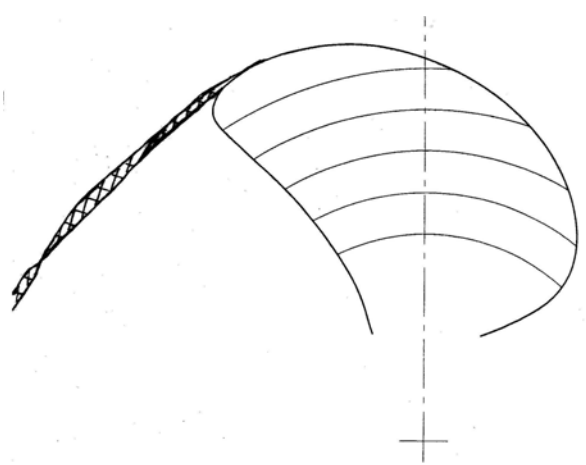
Propeller 1,  $\Phi=240^\circ$



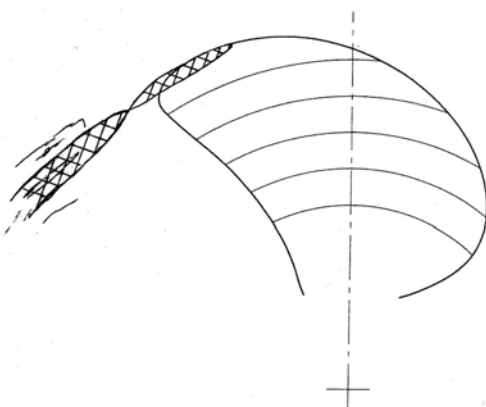
Propeller 1,  $\Phi=250^\circ$



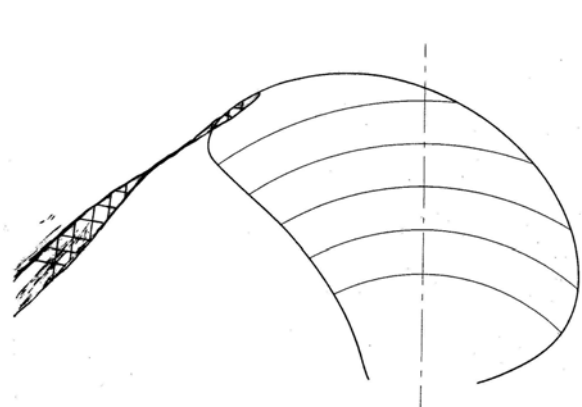
Propeller 2,  $\Phi=240^\circ$



Propeller 2,  $\Phi=250^\circ$



Propeller 3,  $\Phi=240^\circ$



Propeller 3,  $\Phi=250^\circ$

Abbildung 139 : Kavitationsskizzen Prop1-3,  $\phi=240^\circ$ - $250^\circ$

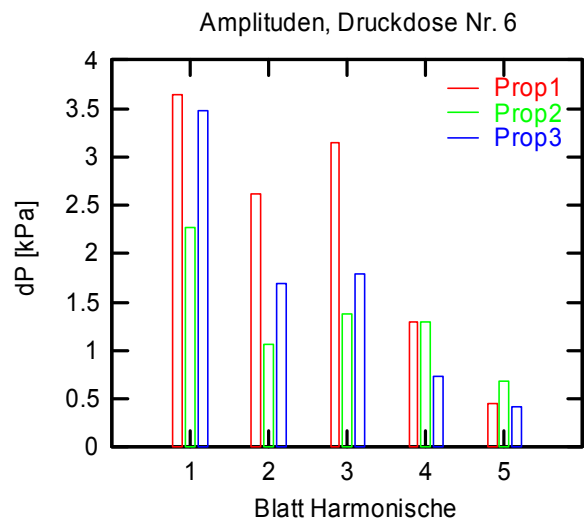
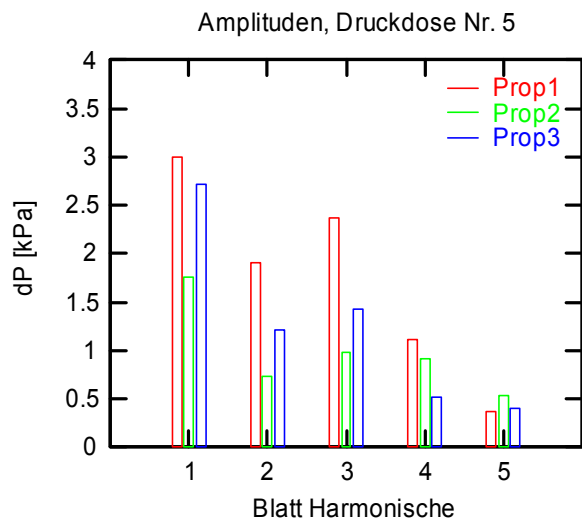
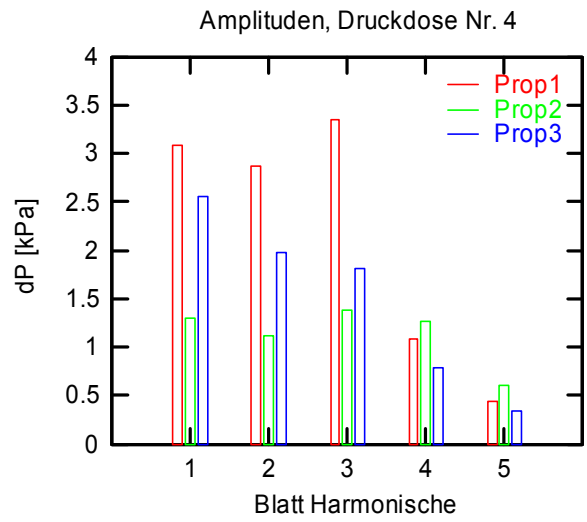
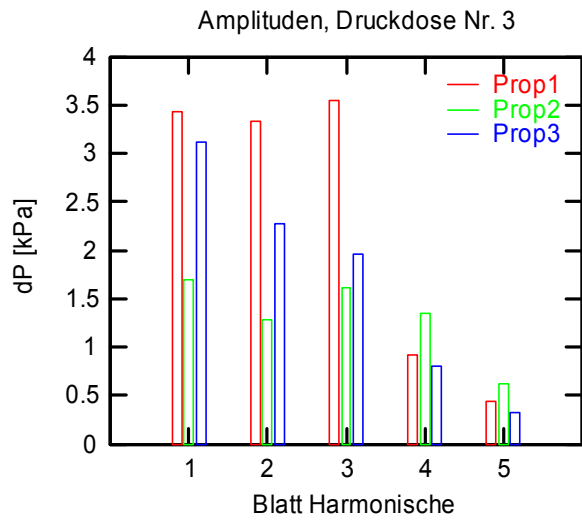
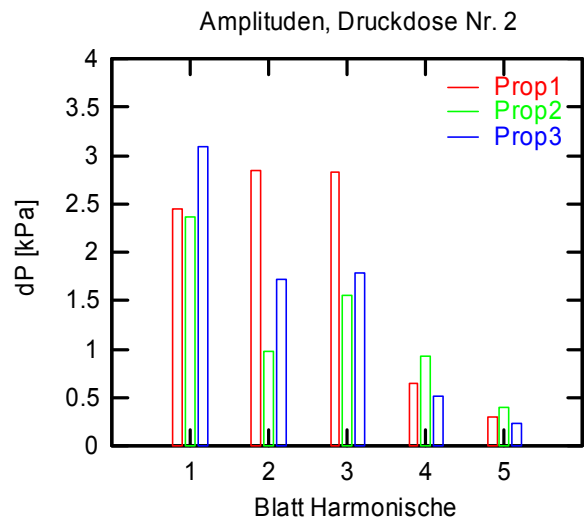
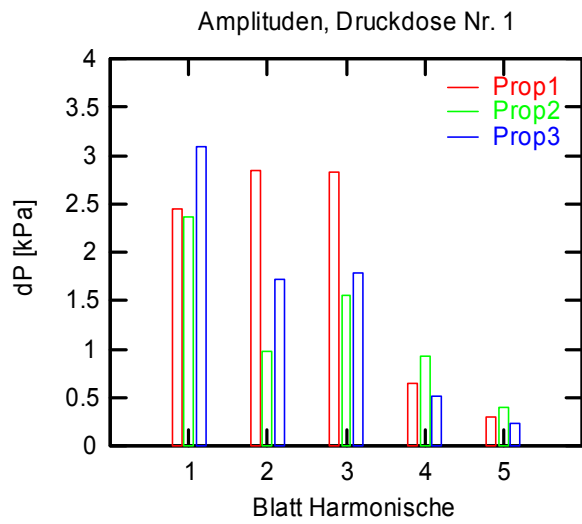


Abbildung 140 : Amplituden der Harmonischen Blattfrequenz

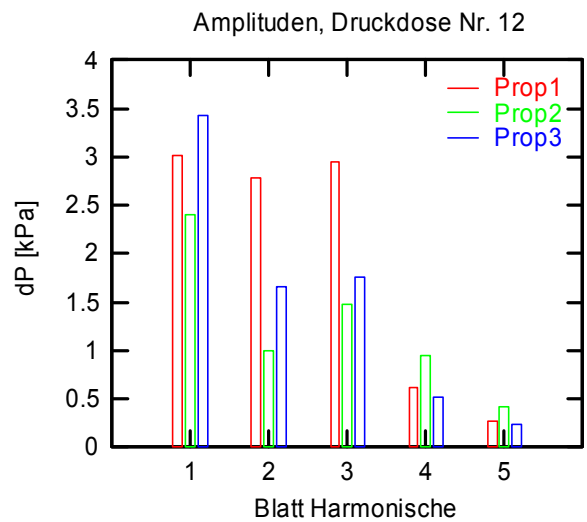
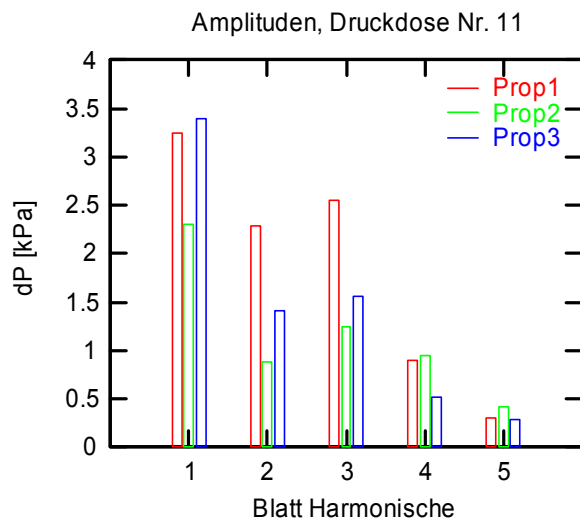
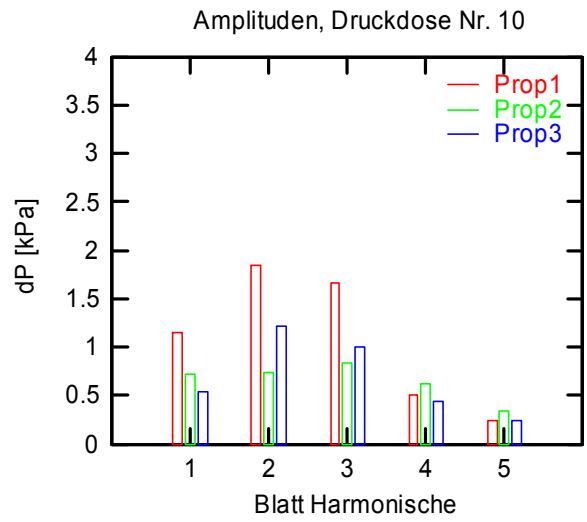
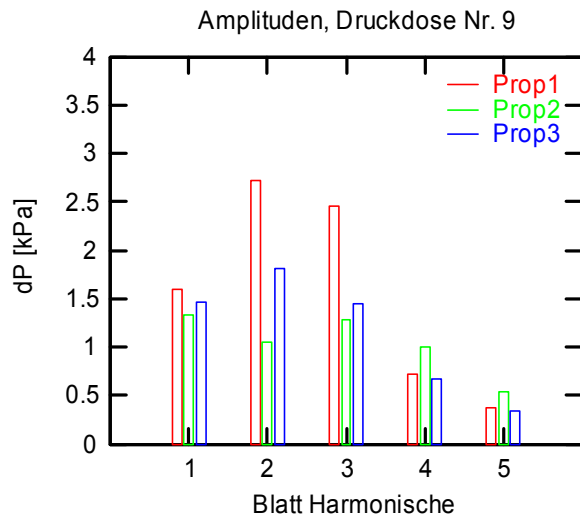
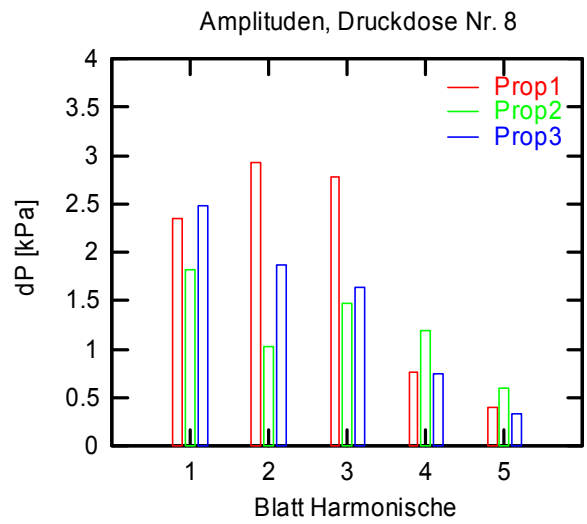
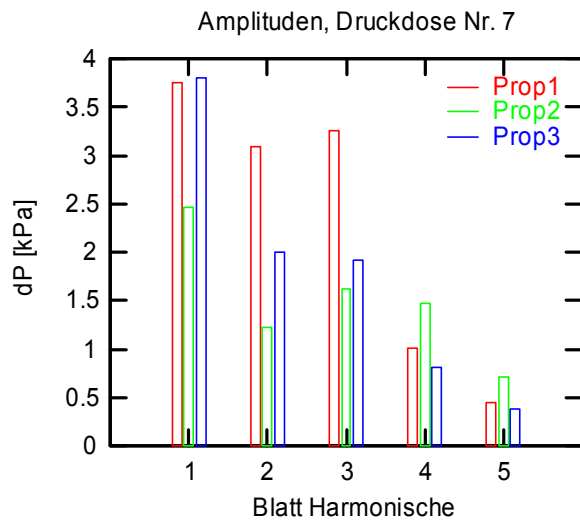


Abbildung 141 : Amplituden der Harmonischen Blattfrequenz

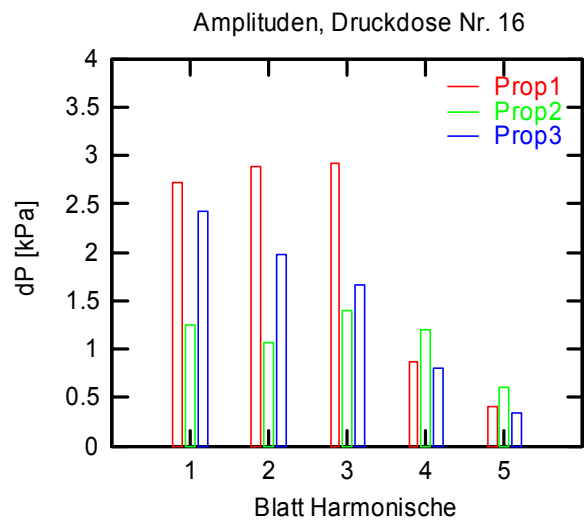
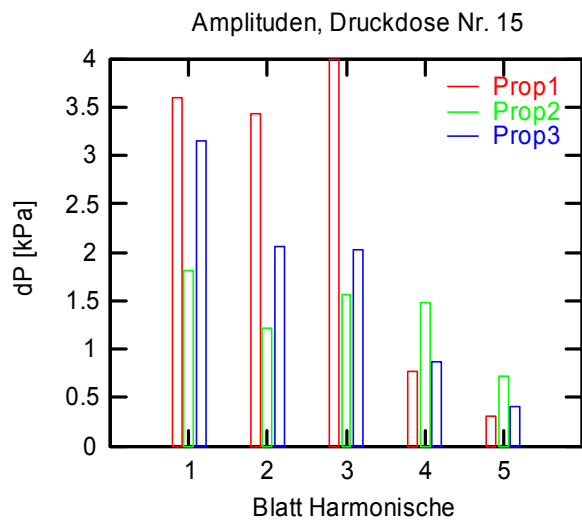
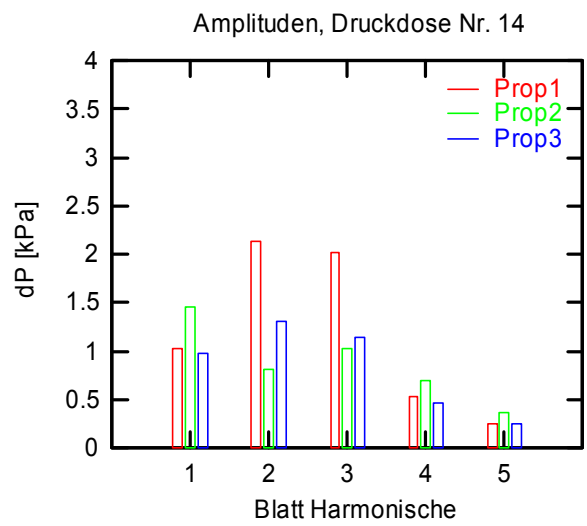
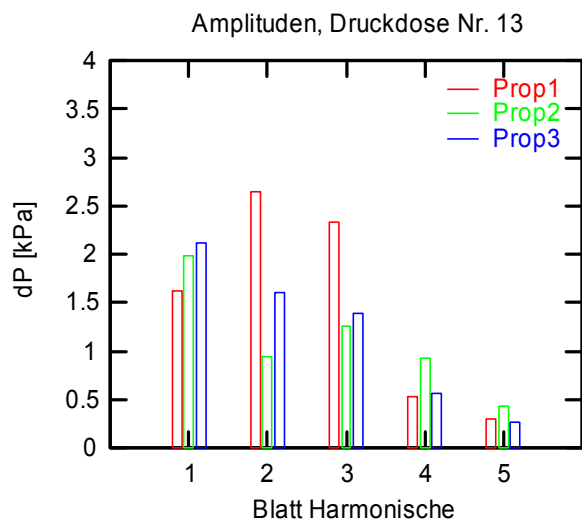


Abbildung 142 : Amplituden der Harmonischen Blattfrequenz

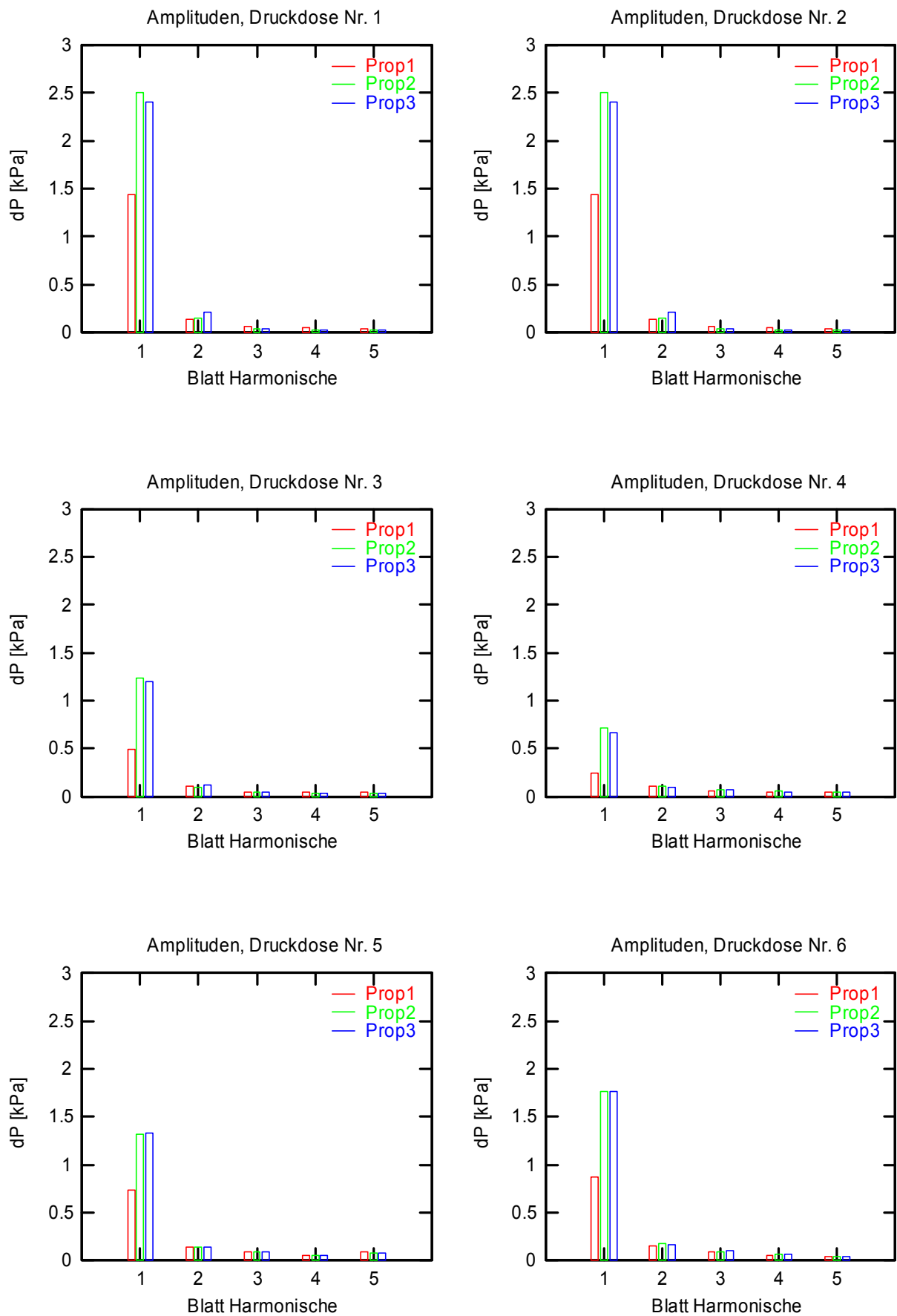


Abbildung 143 : Amplituden der Harmonischen Blattfrequenz, kavitationfreier Zustand



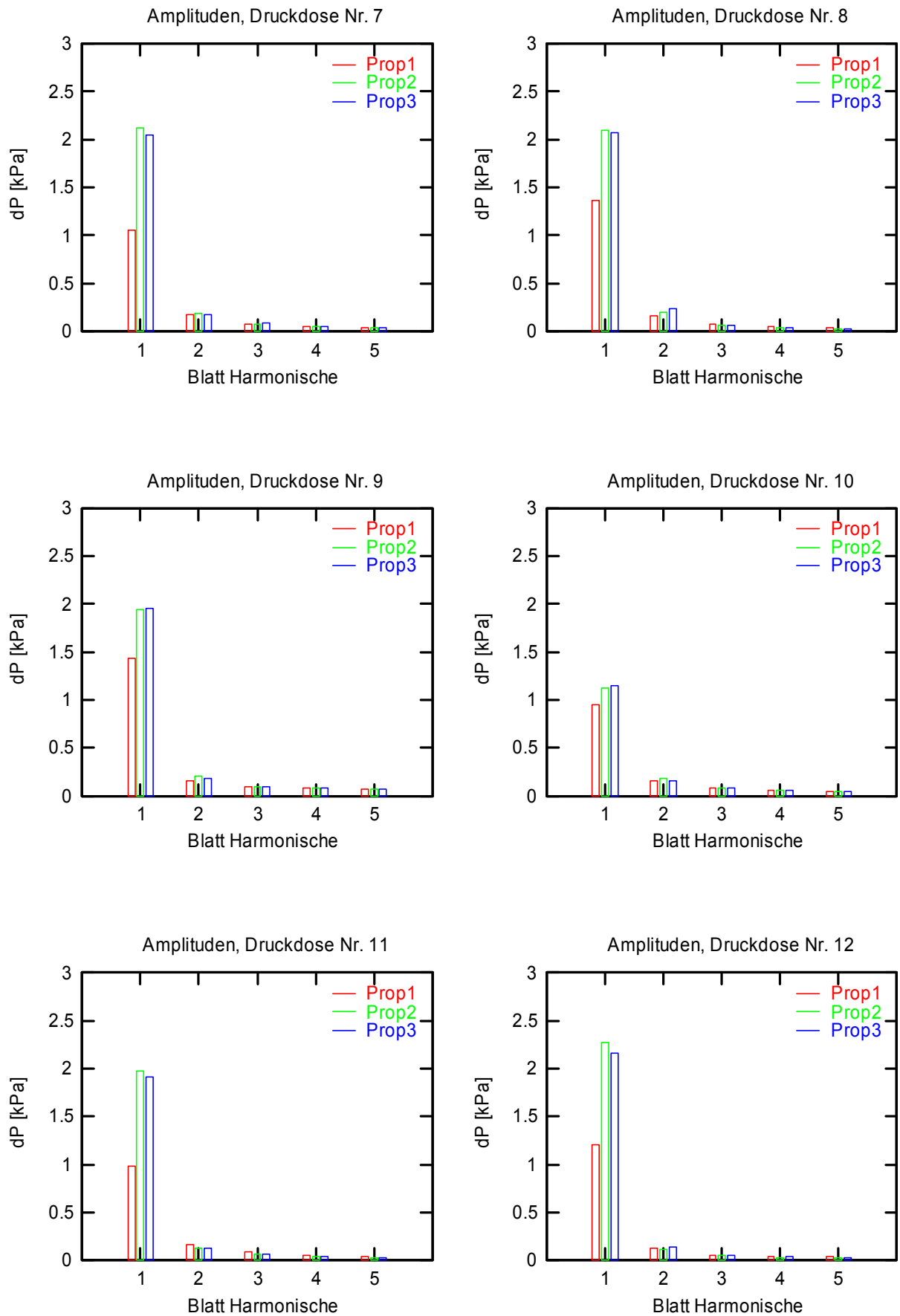


Abbildung 144 : Amplituden der Harmonischen Blattfrequenz, kavitationsfreier Zustand

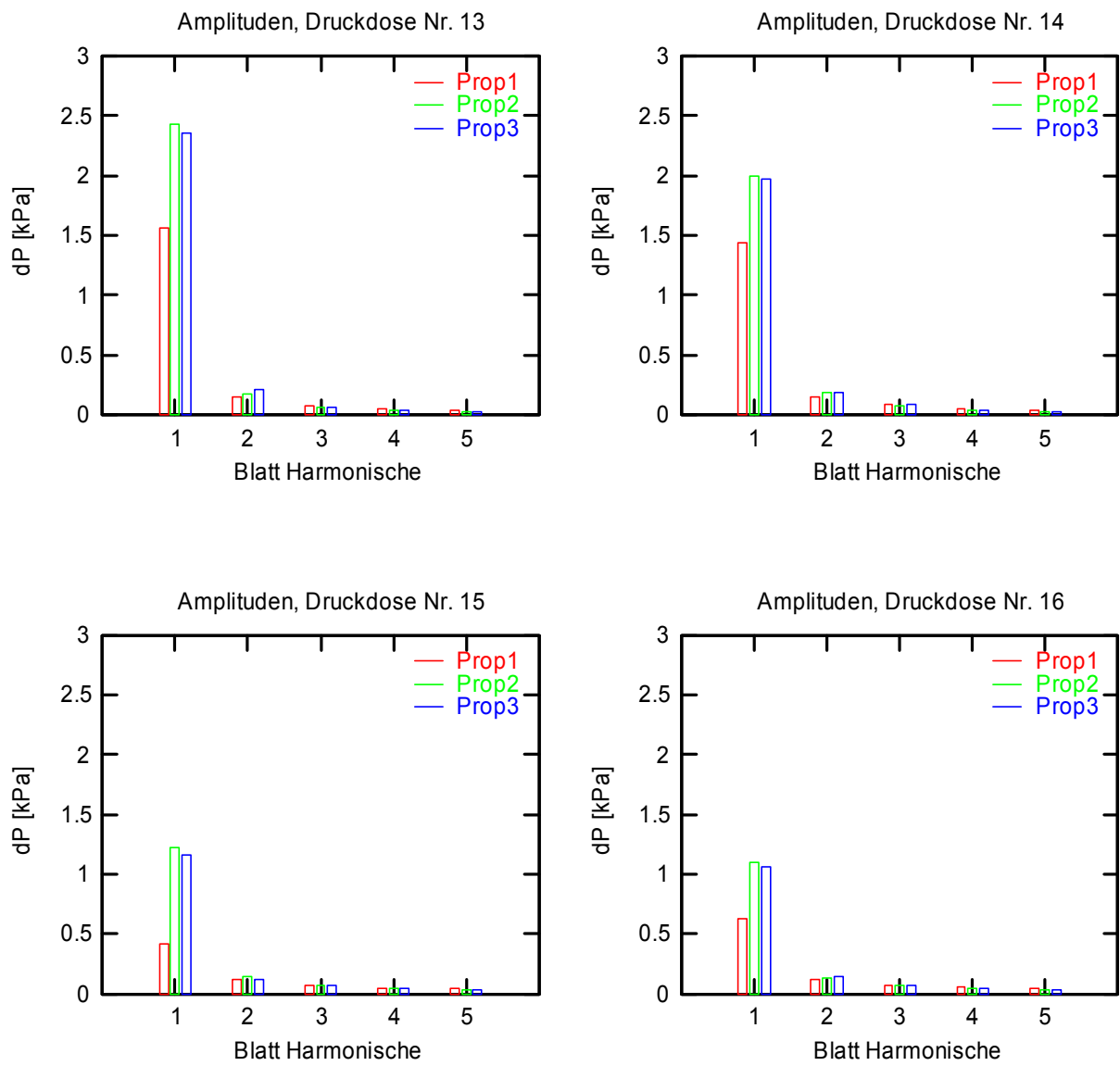
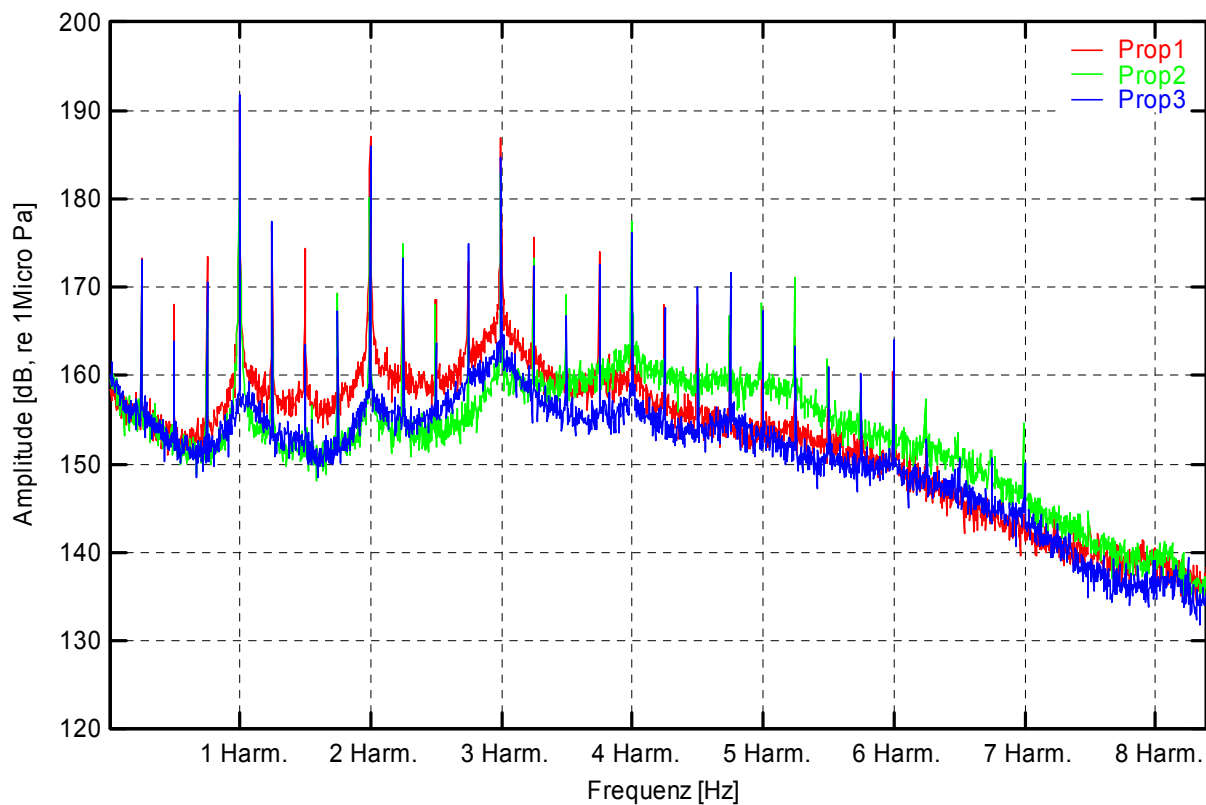


Abbildung 145 : Amplituden der Harmonischen Blattfrequenz, kavitationsfreier Zustand

Dose 7



Kavitationsfreier Zustand, Dose 7

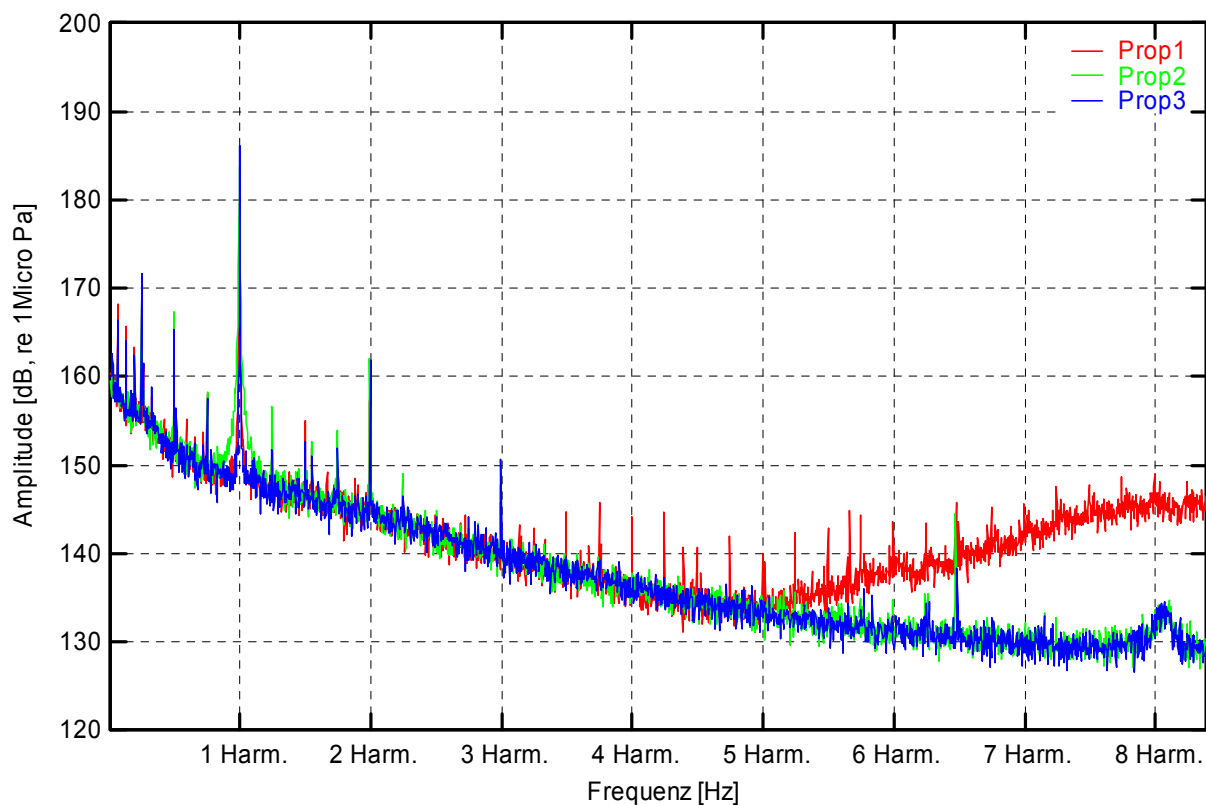


Abbildung 146 : FFT-Spektren Prop1-3