

Potsdam Propeller Test Case (PPTC)

Velocity Field

Case 2.2

Lars Ole Lübke

Potsdam Model Basin (SVA)

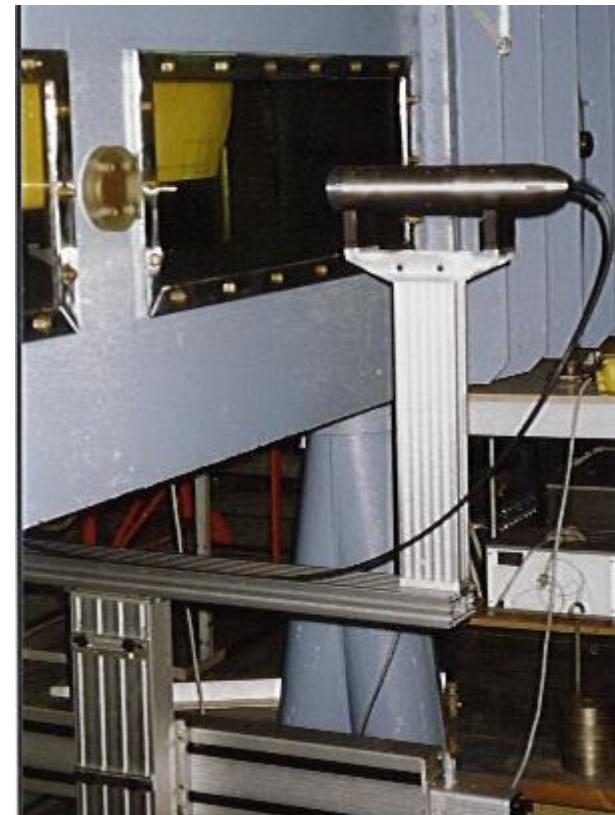


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10. Results $x/D = 0.2$
 - Case 2.2.1, $r/R = 0.70$
 - Case 2.2.2, $r/R = 0.97$
 - Case 2.2.3, $r/R = 1.00$
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11. Acknowledgement

LDV measurements

- LDV (Laser Doppler Velocimetry) measurements conducted in the cavitation tunnel
- SVA Propeller VP1304 in homogeneous inflow
- 2D LDV measuring system from TSI
- 4 beam standard probe
- 4 Watt Argon Laser
- All three velocity components measured
- Angular based measurements with an angular resolution of 0.25° (1440 angle classes)
- Probe mounted on traversing unit



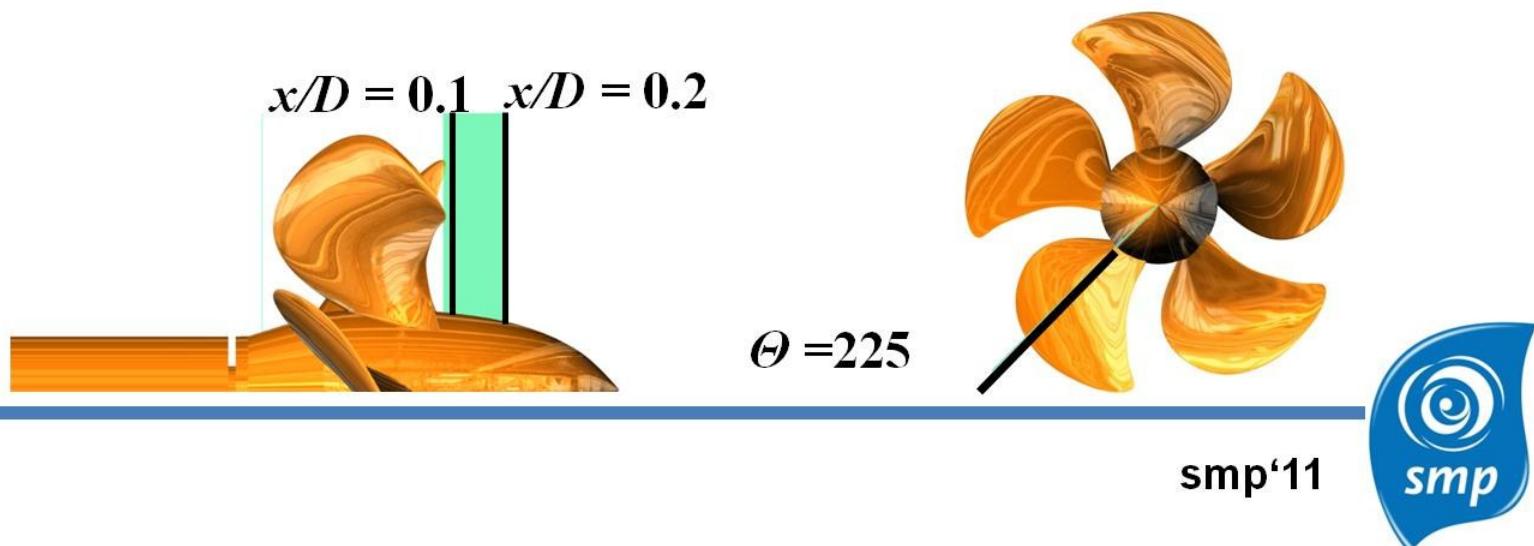
Measuring locations

Measuring planes

x-position	x/D	[–]	-0.200	0.094	0.100	0.110	0.130	0.160	0.200
x-position	x	[mm]	-50.0	23.5	25.0	27.5	32.5	40.0	50.0

Radial positions

Measuring planes	r/R	r/R	$\Delta r/R$	[mm]
$x/D = -0.20$	0.40	1.10	0.050	6.250
$x/D =$	0.40	0.70	0.050	6.250
$0.094, 0.10, 0.11, 0.13, 0.16, 0.20$	0.70	0.90	0.025	3.125
	0.90	0.95	0.010	1.250
	0.95	1.05	0.002	0.250
	1.05	1.10	0.025	3.125



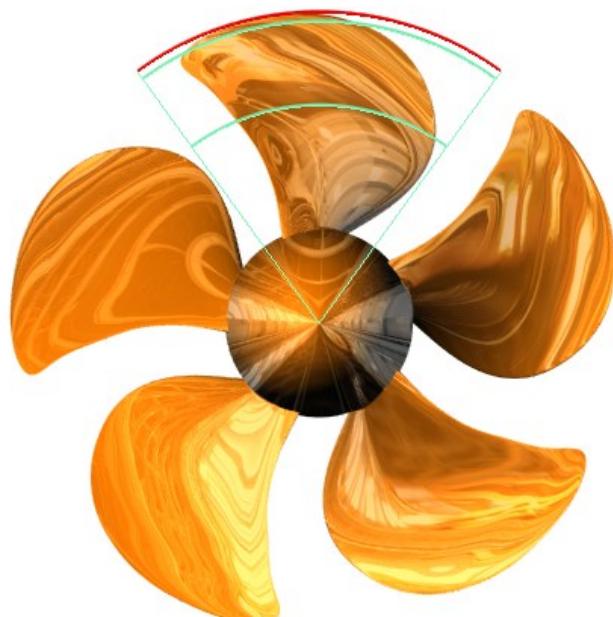
Working point and test condition

Inflow speed	V_A	[m/s]	7.204
Number of revolutions	n	[s ⁻¹]	23.000
Advance coefficient	J	[–]	1.253
Thrust coefficient	K_T	[–]	0.250
Torque coefficient	$10K_Q$	[–]	0.725
Water density	ρ	[kg/m ³]	997.100
Kinematic viscosity of water	ν	[m ² /s]	0.903E-6

- Thrust identity requested
- Ambient pressure (no cavitation)

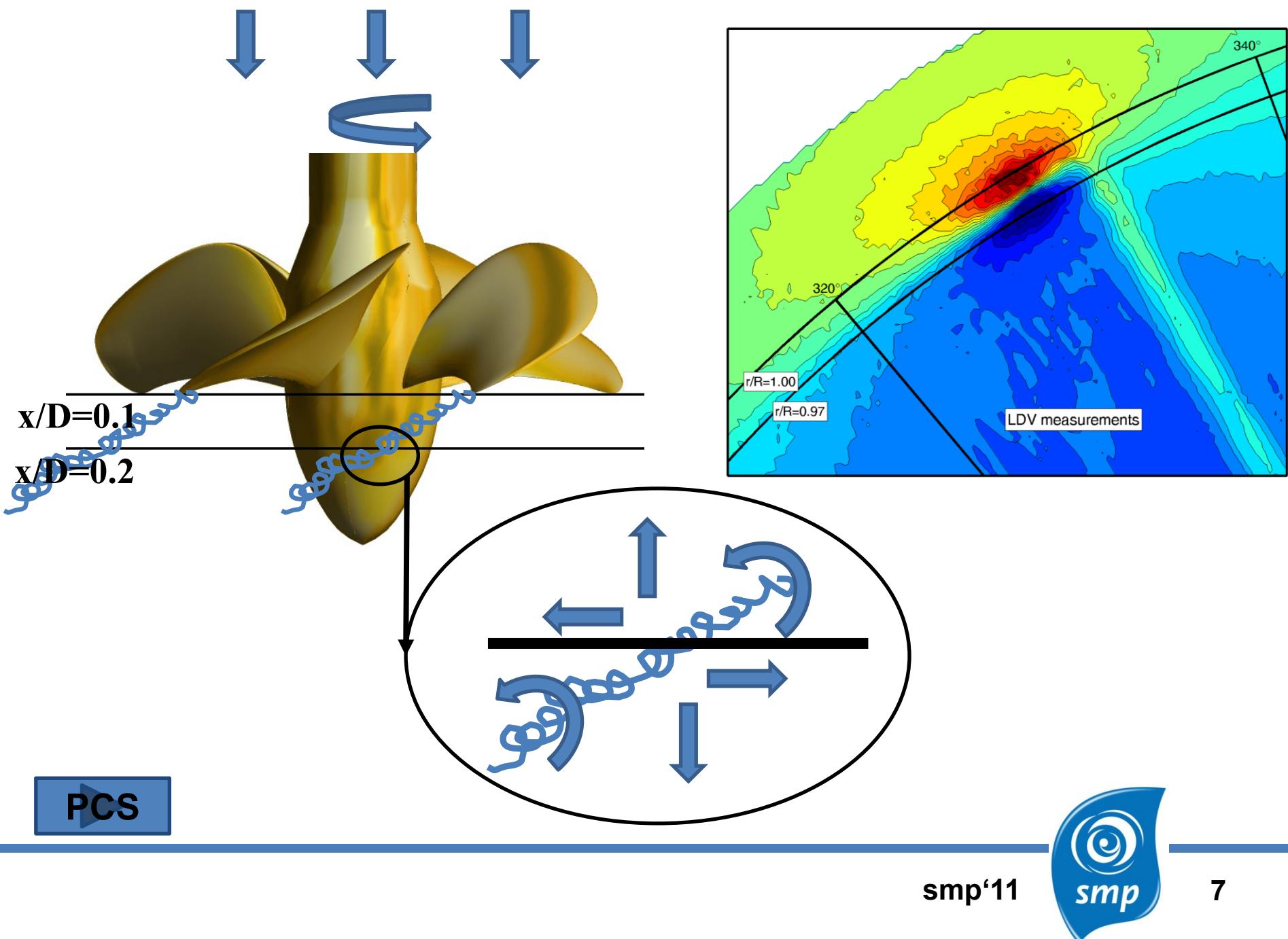
Requested Computations: Case 2.2

	r/R [-]	x/D [-]	θ [°]	Velocity
Case 2.2.1	0.70	0.1, 0.2	-50° - 22°	$I-V_x/V_A, V_t/V_A, V_r/V_A$.
Case 2.2.2	0.97	0.1, 0.2	-50° - 22°	$I-V_x/V_A, V_t/V_A, V_r/V_A$
Case 2.2.3	1.00	0.1, 0.2	-50° - 22°	$I-V_x/V_A, V_t/V_A, V_r/V_A$
Case 2.2.4	0.40 - 1.10	0.1, 0.2		$I-V_x/V_A, V_t/V_A, V_r/V_A$



- Velocities for the propeller being in the upright position
- Zero degree defined at the 12 O'clock position

Tip Vortex



Participants- Case 2.2

Group	Solver	Acronym
1 Berg-Propulsion	OpenFOAM	Berg-OpenFOAM
2 Cradle	SC/Tetra	Cradle-SC/Tetra
3 HSVA	FreSCO+	HSVA-FreSCO+
4	PPB	HSVA-PPB
5 INSEAN	PFC	INSEAN-PFC
6 MARIC	ANSYS Fluent	MARIC-Fluent
7 SSPA	ANSYS Fluent	SSPA-Fluent
8 TUHH	FreSCO+	TUHH-FreSCO
9 University of Genua	StarCCM+	UniGenua-StarCCM (ke or kw)
10 University of Triest	ANSYS CFX	UniTriest-CFX
11 VOITH	Comet	VOITH-Comet
12 VTT	FinFlo	VTT-FinFlo

11 different groups, 10 solvers, 13 results

Computational Mesh – Case 2.2

Group	Cells blade [Mil.]	Z	Tank, Radius	Cell Type	TipVortex refinement
1 Berg-Propulsion	2.76	5	Cyl.	Hybrid	✓
2 Cradle	4.60*	5	✓	Tet+Prism	✓(1 b.)
3 HSVA	1.06	5	Cyl., Area	Hex unstruct.	✓
4	≈0.005			Quad	
5 INSEAN	≈0.027			Quad	
6 MARIC		1	Cyl.*	Hex, block	
7 SSPA	1.50	1	Cyl.	Hex. block	
8 TUHH	0.94	5	Cyl., Area	Hex unstruct.	
9 University Genua	1.50	1	Cyl., Area	Polyhedral	
10 University Triest	2.62**	1	Cyl.	Hex. block	
11 VOITH		5	Cyl	Polyhedral	
12 VTT	4.27	1	Cyl., Area	Hex. block	

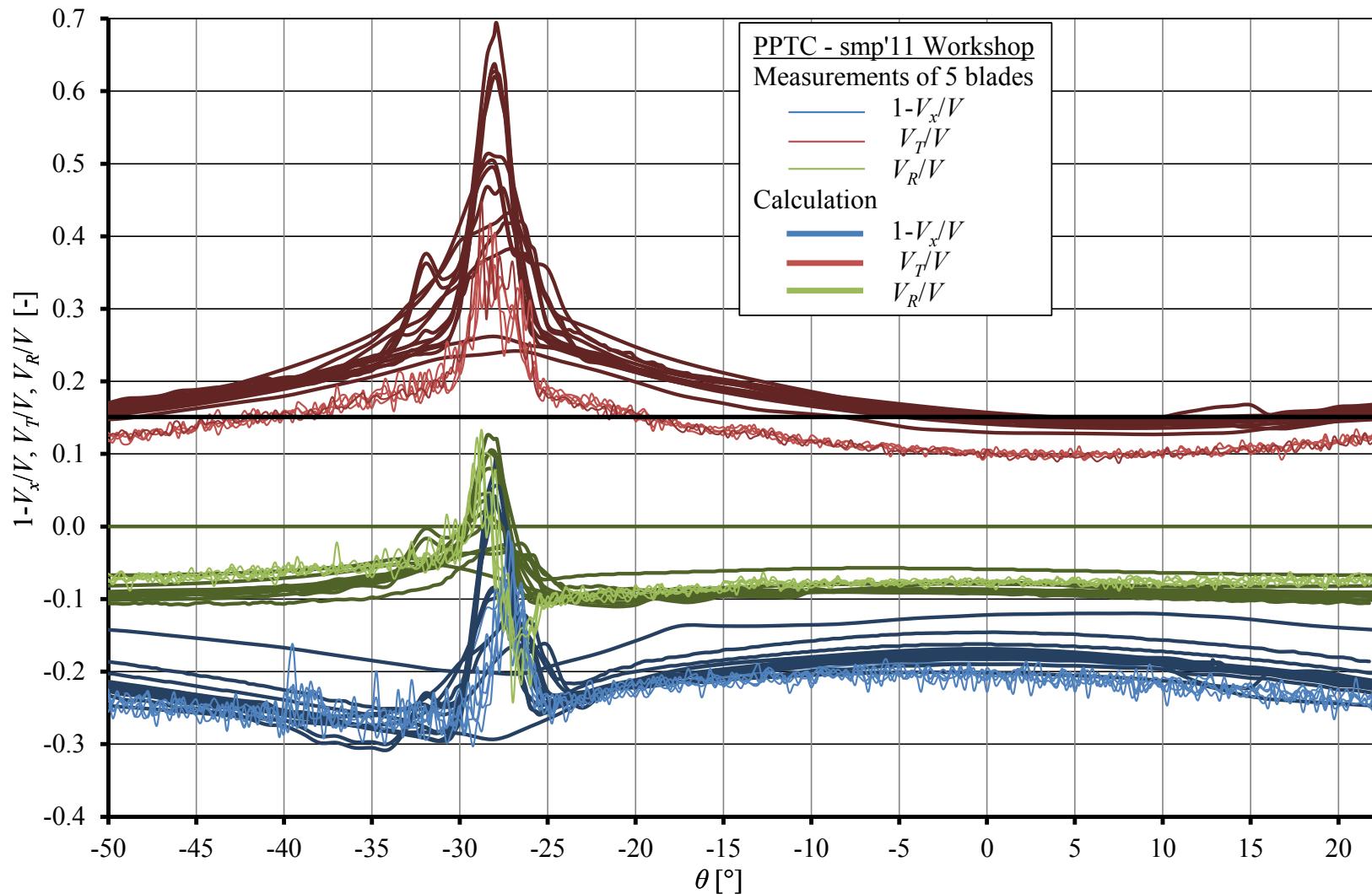
Computational Setup – Case 2.2

Group	Steady/unsteady	V_a/V_{ini}	KT_{num}/KT_{exp}
1 Berg-Propulsion	steady	0.998	1.000
2 Cradle	steady and unsteady	1.000	-
3 HSVA	unsteady	1.034	1.000
4	steady		
5 INSEAN	unsteady		
6 MARIC	steady		
7 SSPA	steady	0.993	1.000
8 TUHH	unsteady	1.000	-
9 University Genua	steady		1.000
10 University Triest	steady	1.000	0.998
11 VOITH	unsteady		1.000
12 VTT	steady	1.018	1.003

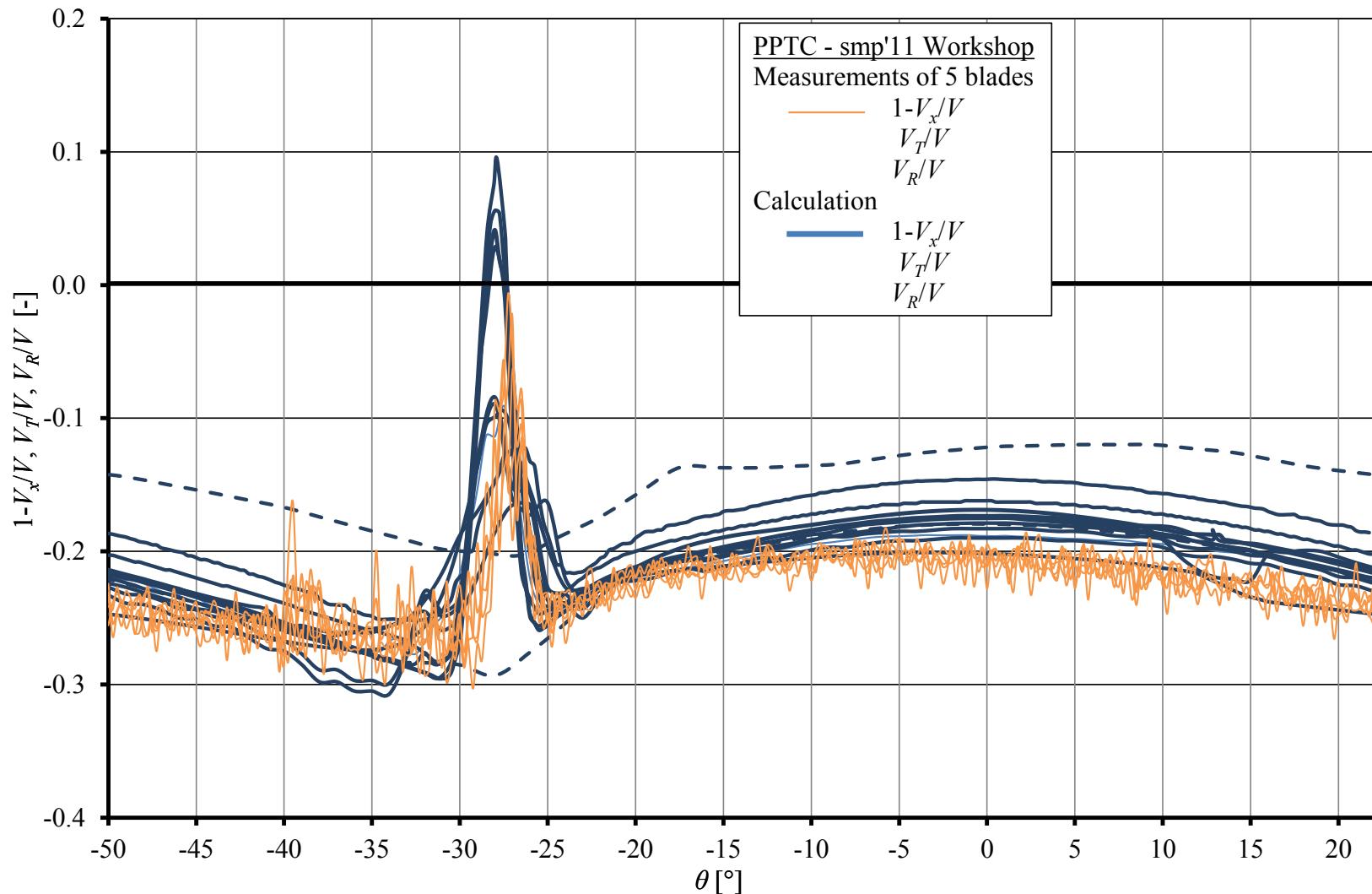
Evaluation

Case 2.2.1: $x/D=0.1, r/R=0.70$

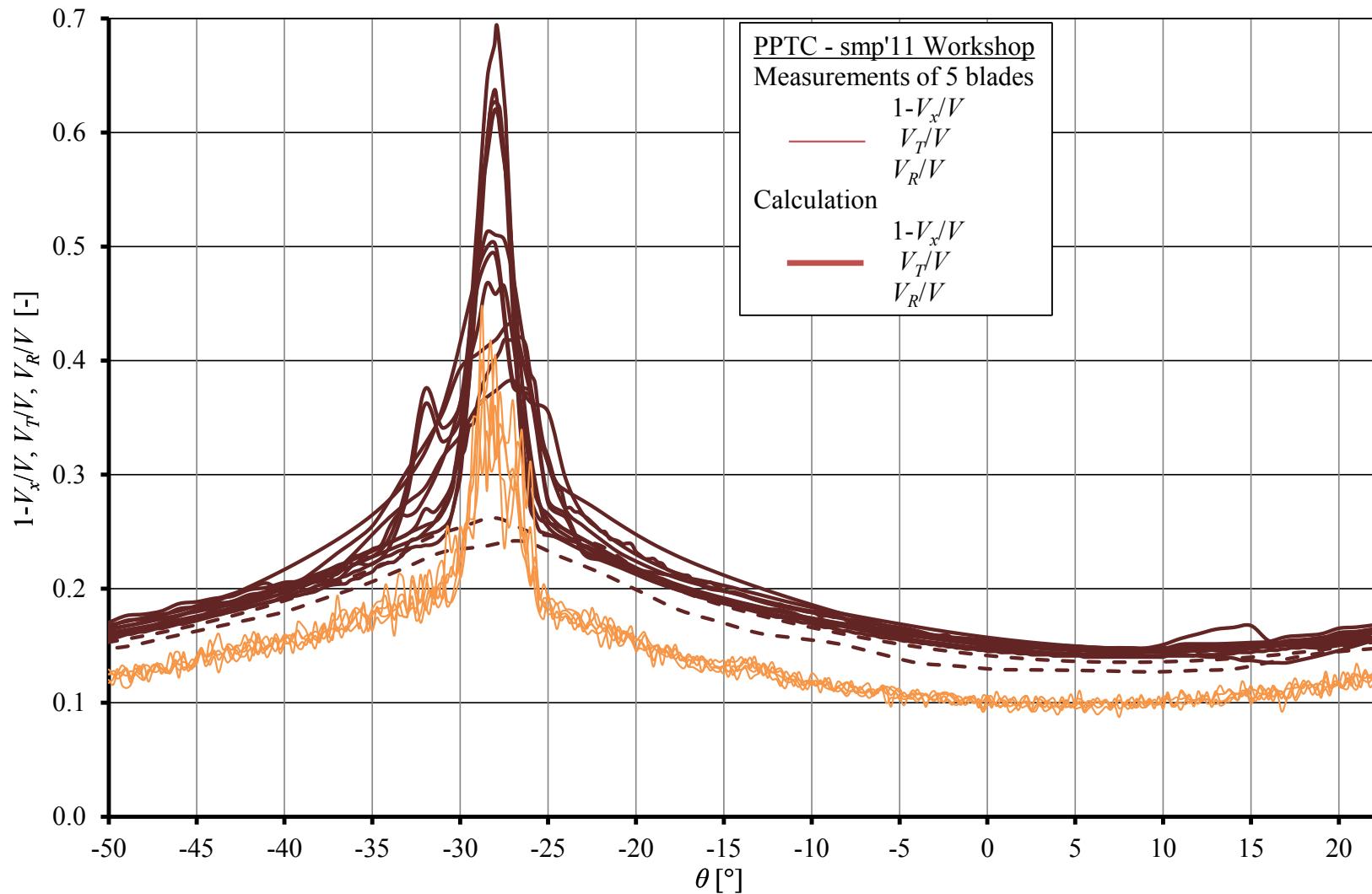
Case 2.2.1: $r/R=0.70$, $x/D=0.1$



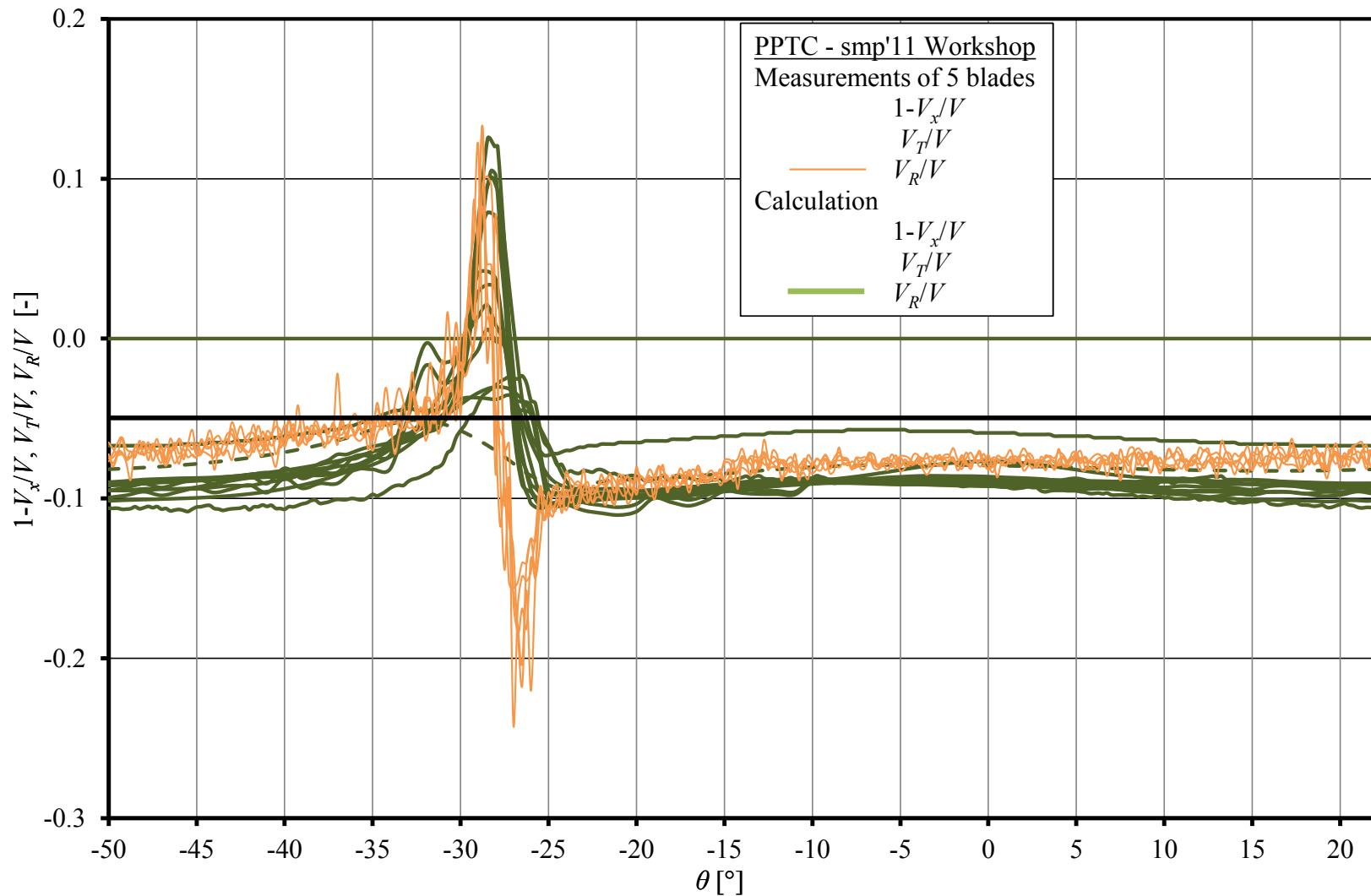
Case 2.2.1: $r/R=0.70$, $x/D=0.1$, axial velocities



Case 2.2.1: $r/R=0.70$, $x/D=0.1$, tang. velocities

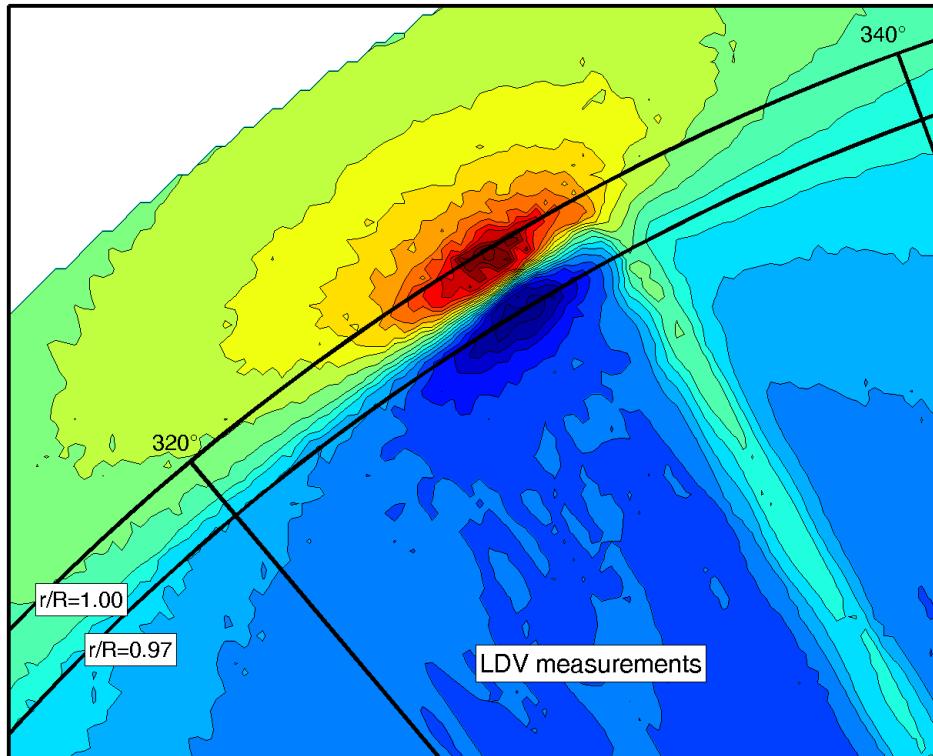


Case 2.2.1: $r/R=0.70$, $x/D=0.1$, radial velocities

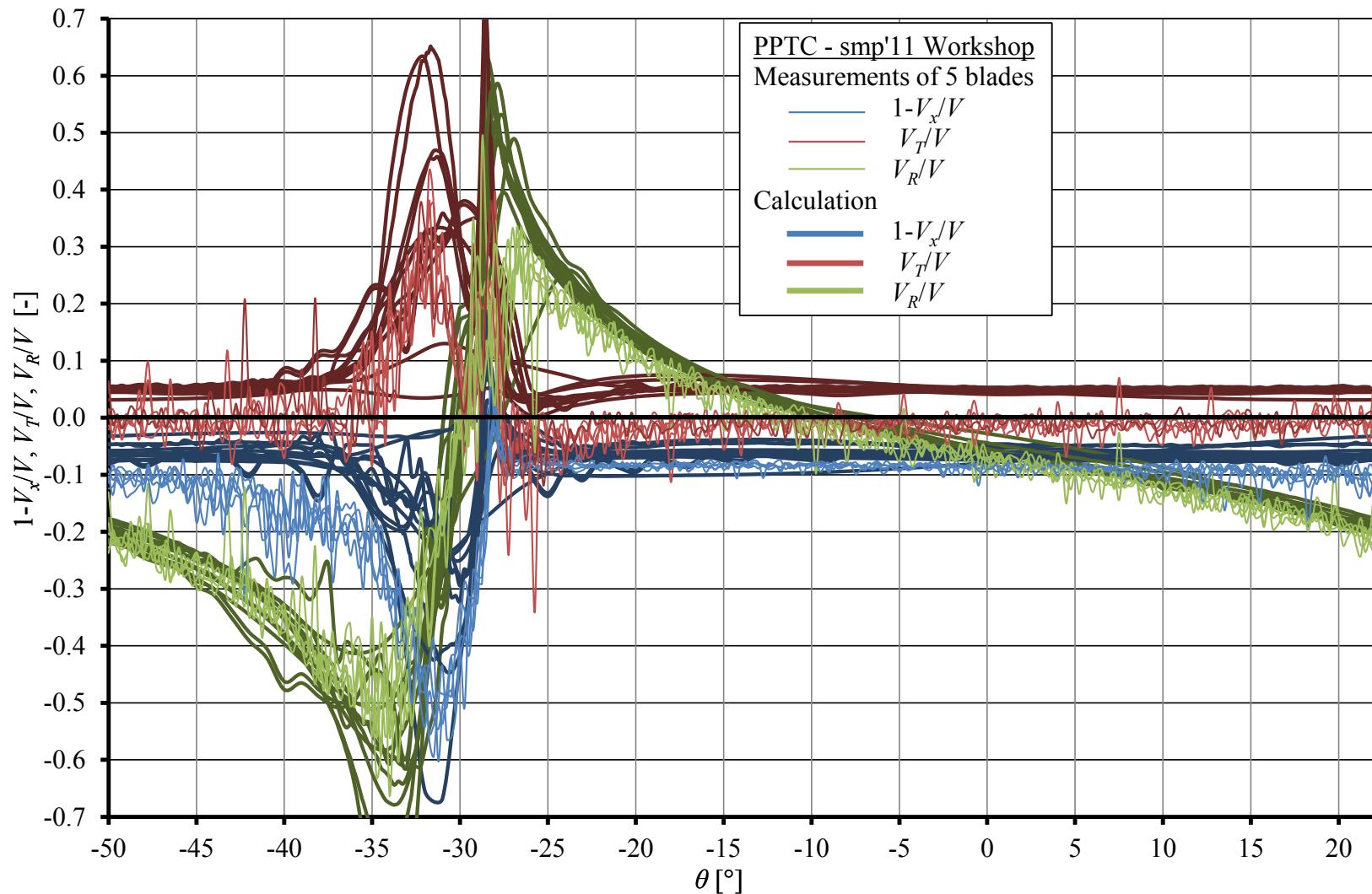


Evaluation

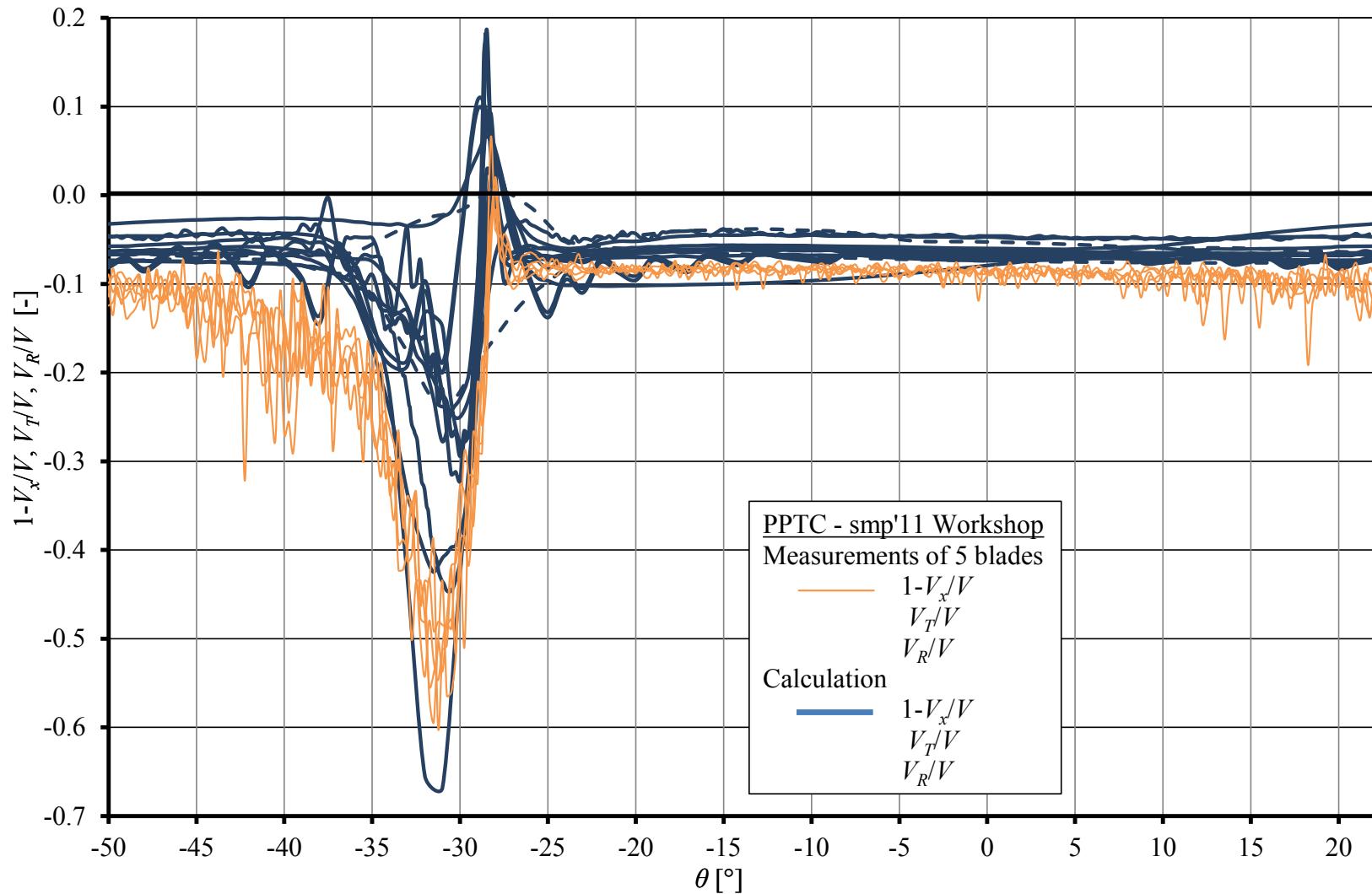
Case 2.2.2: $x/D=0.1, r/R=0.97$



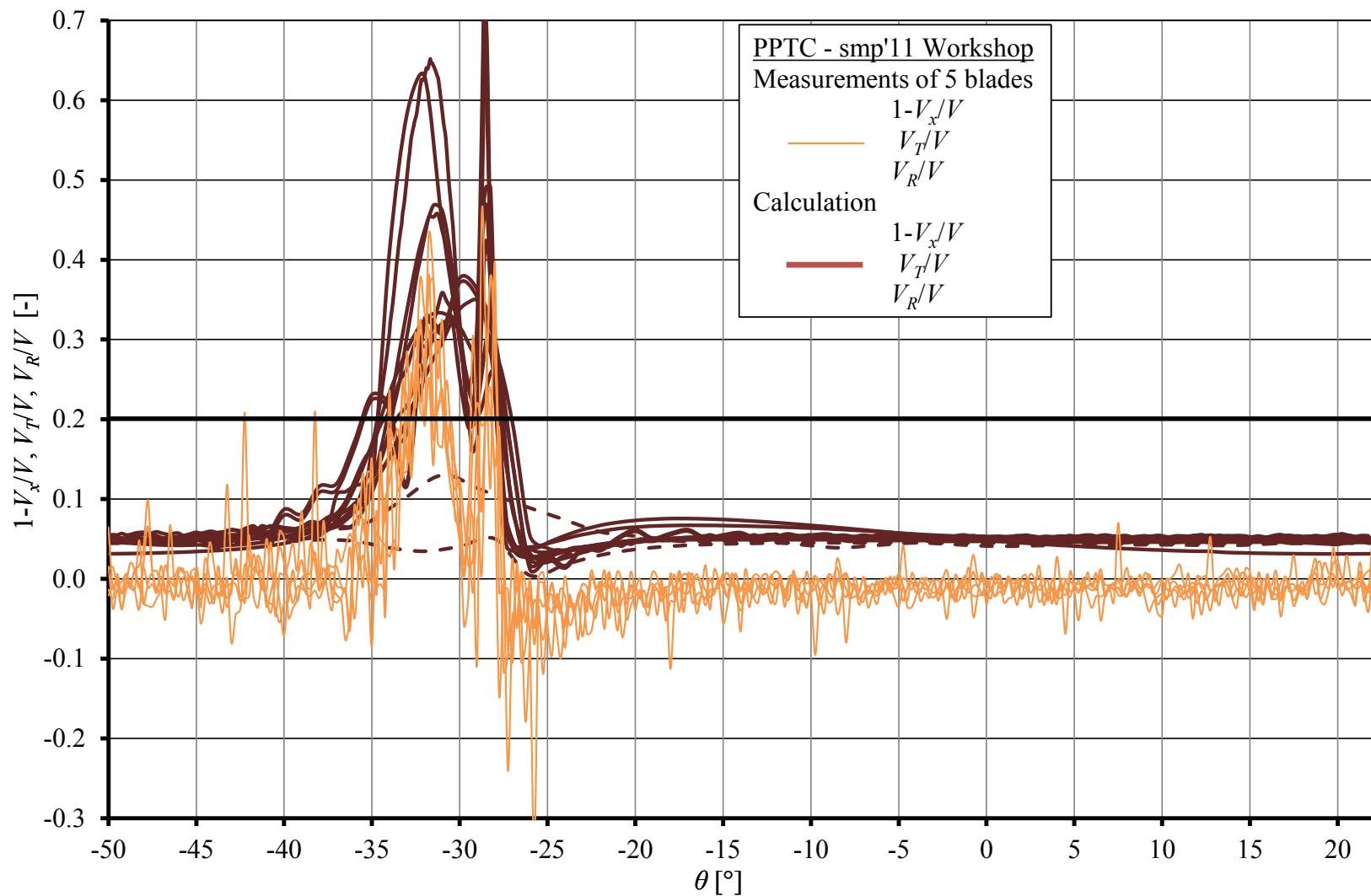
Case 2.2.2: $r/R=0.97$, $x/D=0.1$



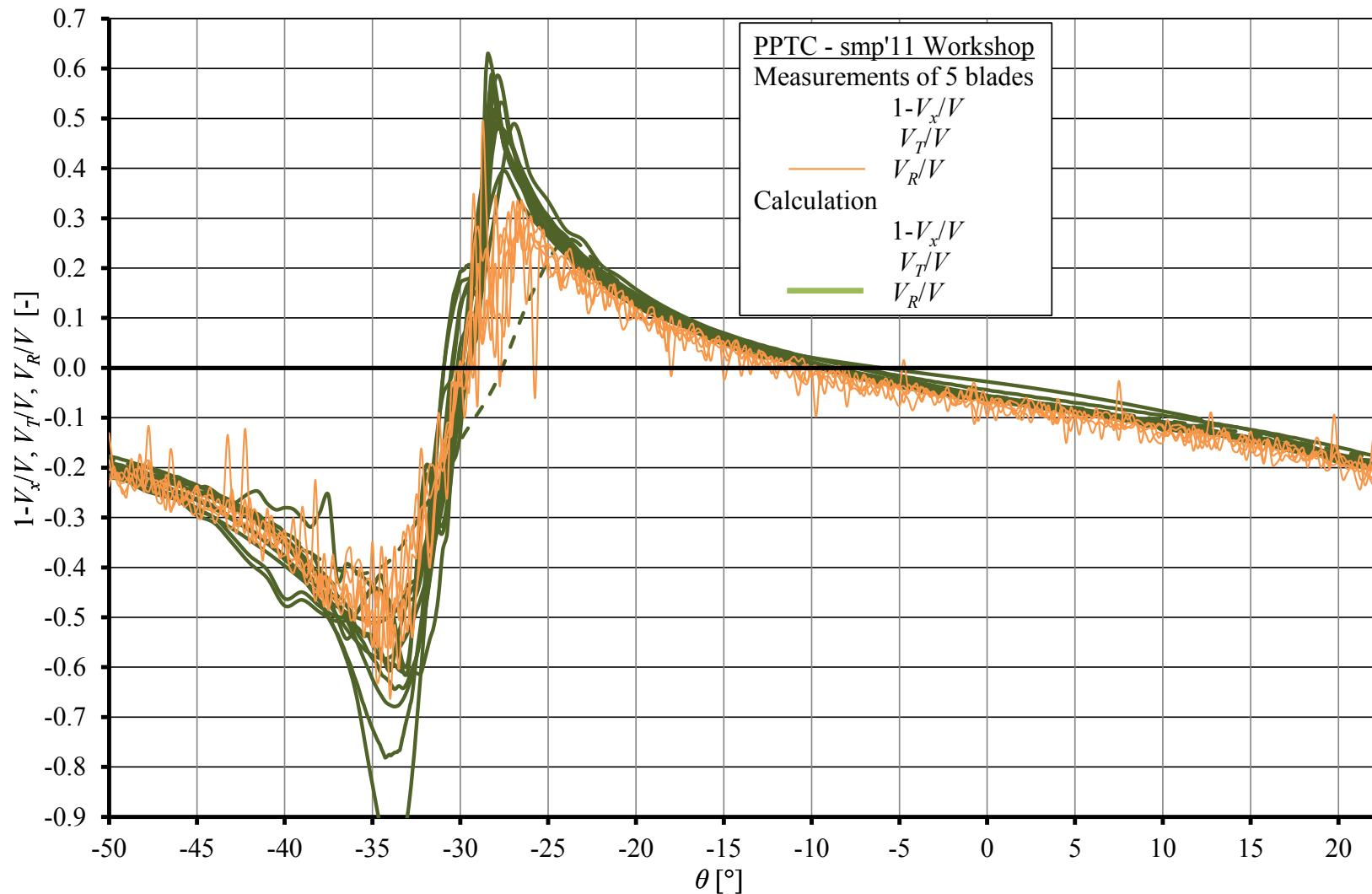
Case 2.2.2: $r/R=0.97$, $x/D=0.1$, axial velocities



Case 2.2.2: $r/R=0.97$, $x/D=0.1$, tang. velocities

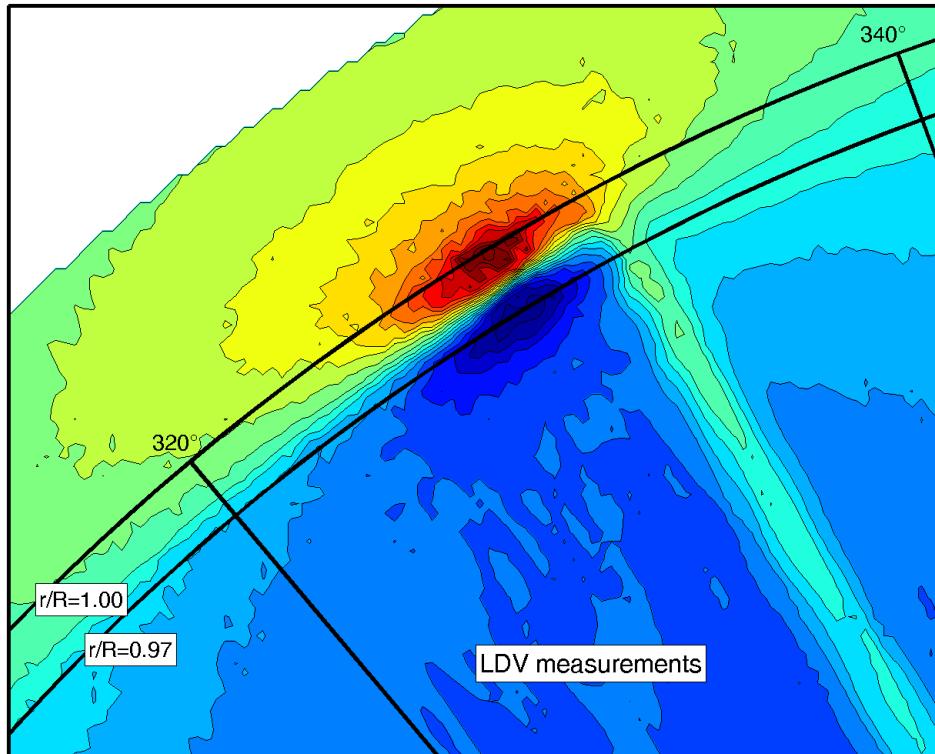


Case 2.2.2: $r/R=0.97$, $x/D=0.1$, radial velocities

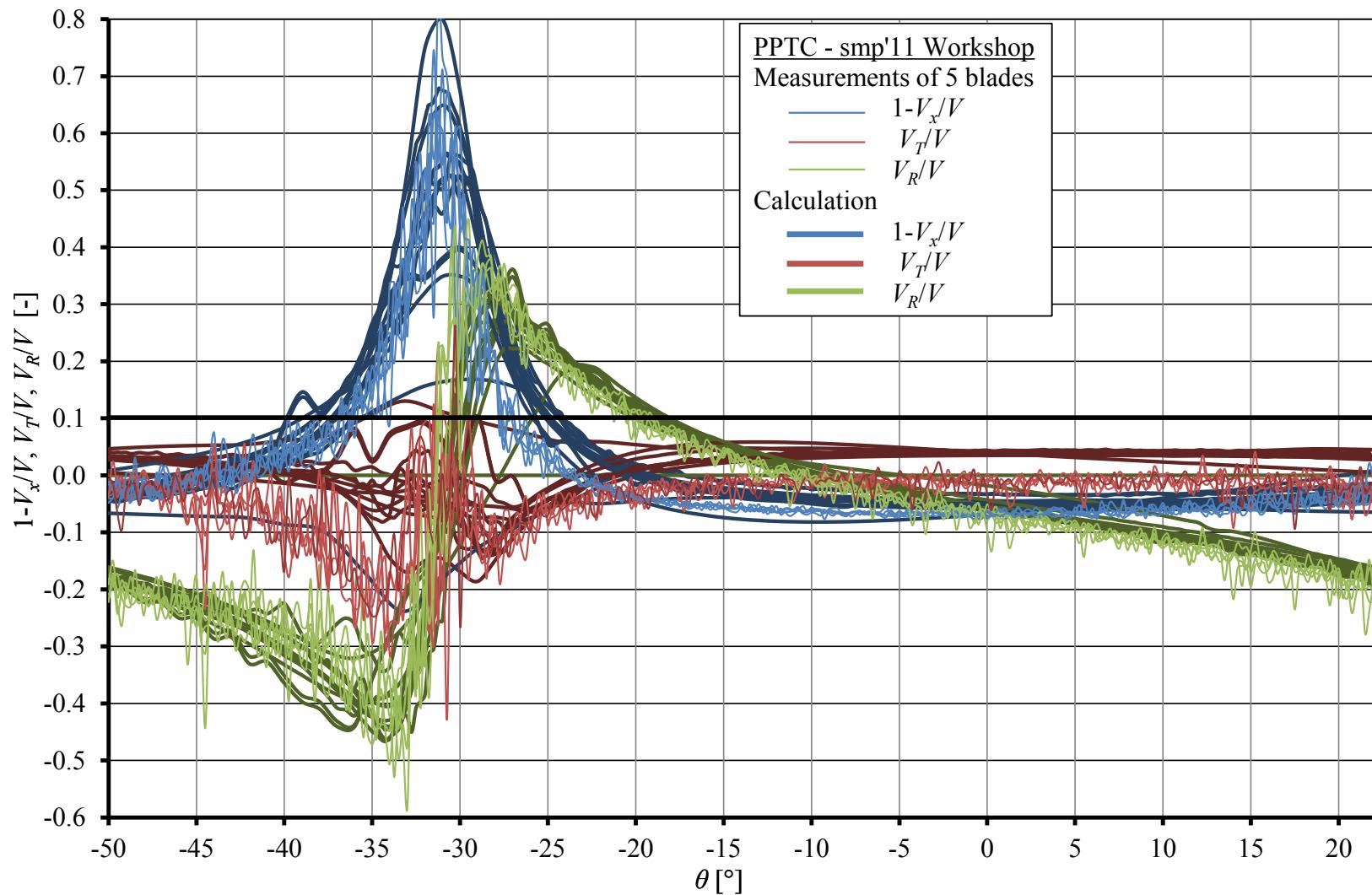


Evaluation

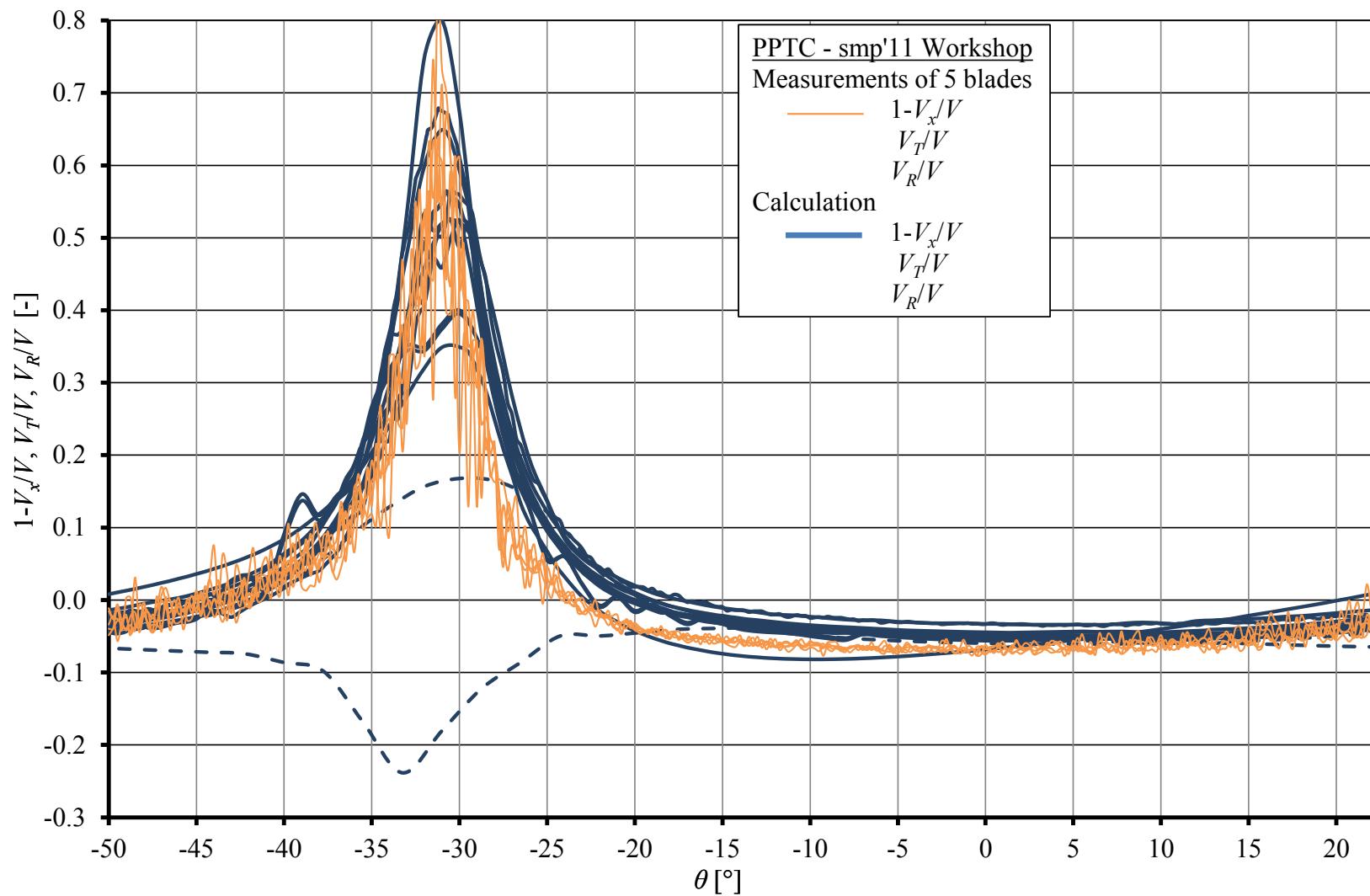
Case 2.2.3: $x/D=0.1, r/R=1.00$



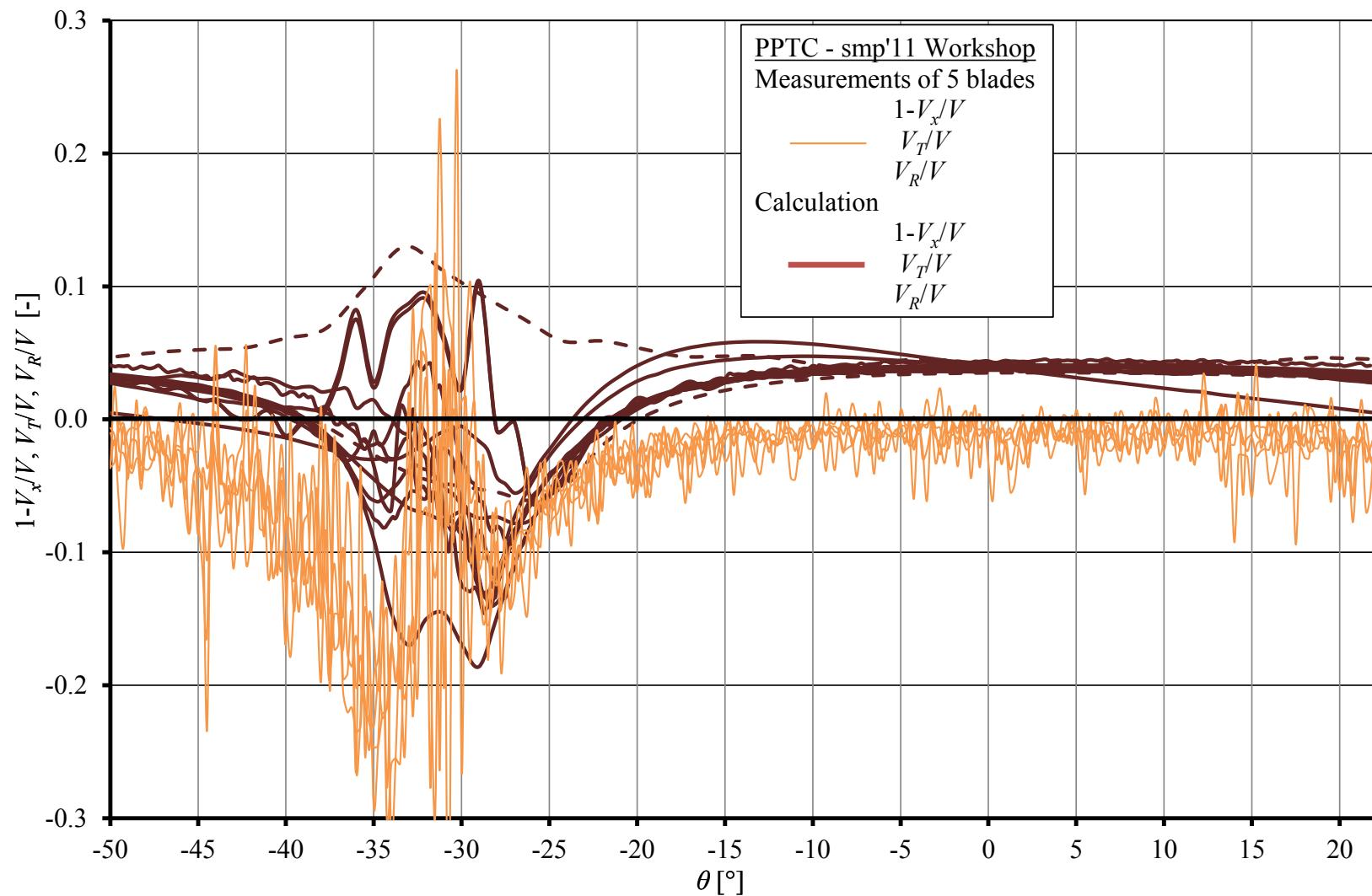
Case 2.2.3: $r/R=1.00$, $x/D=0.1$



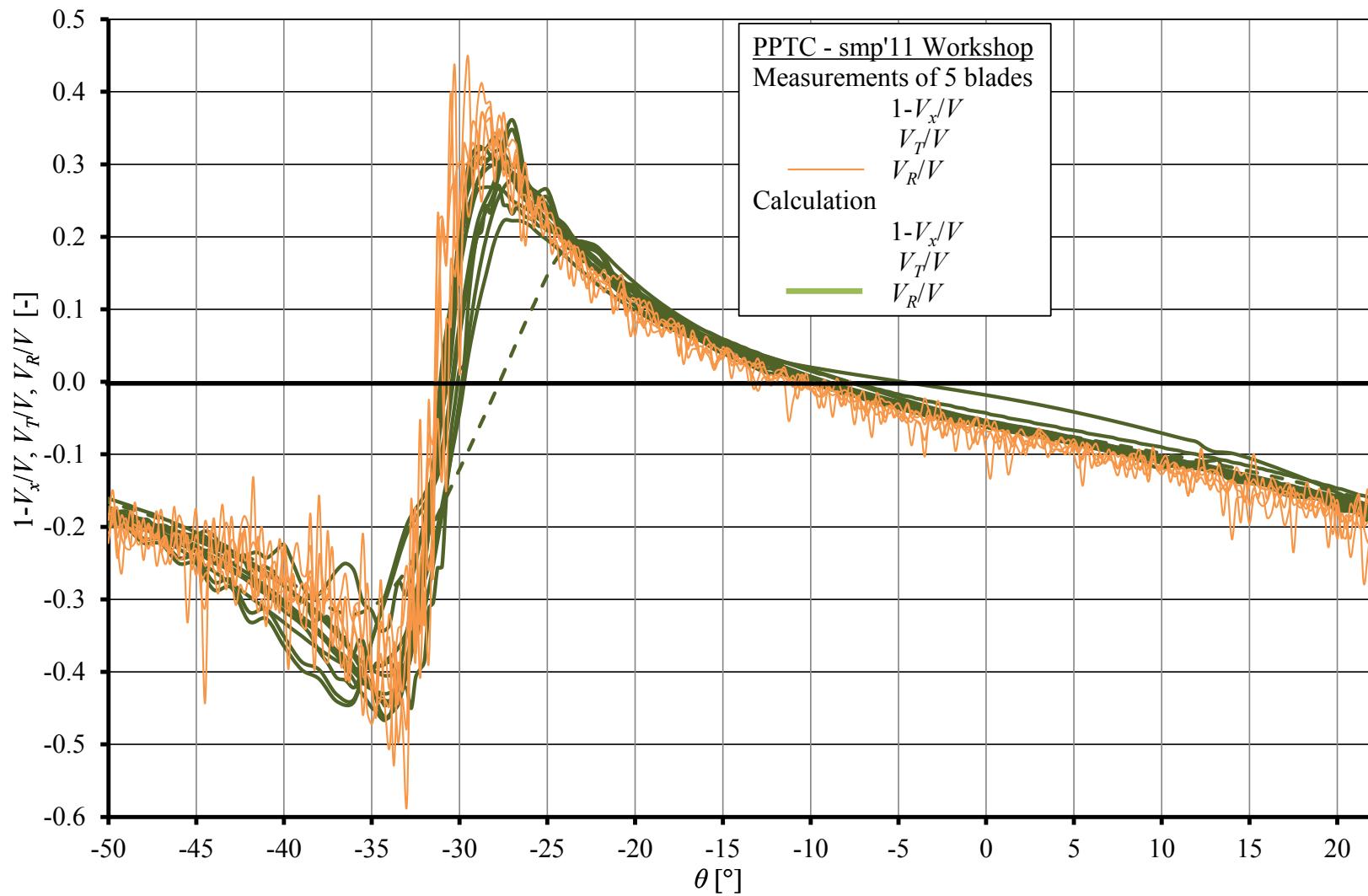
Case 2.2.3: $r/R=1.00$, $x/D=0.1$, axial velocities



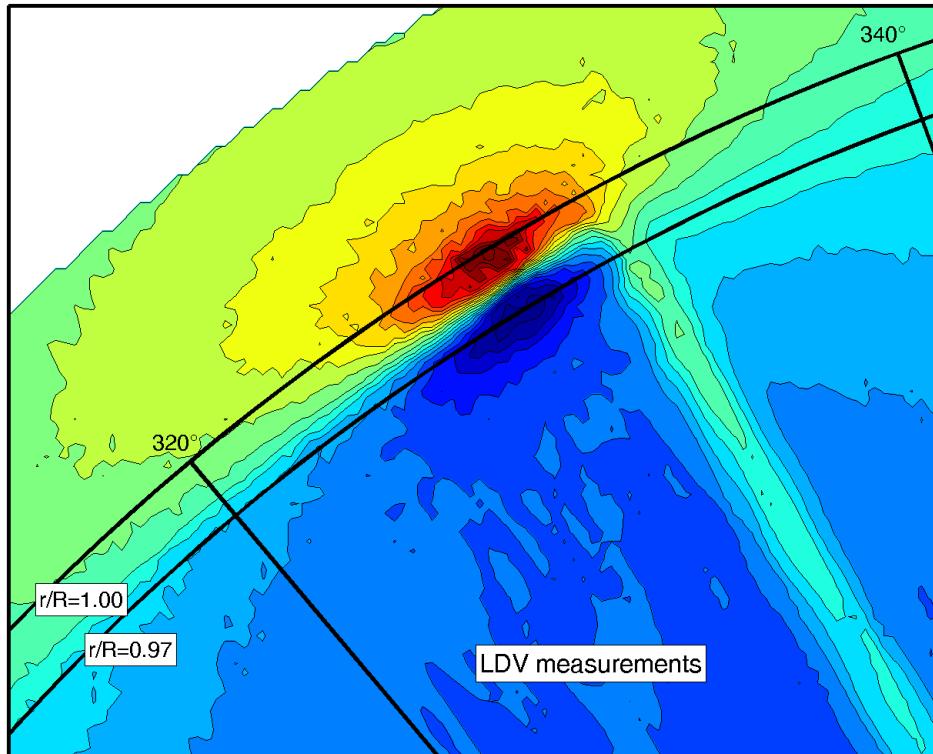
Case 2.2.3: $r/R=1.00$, $x/D=0.1$, tang. velocities



Case 2.2.3: $r/R=1.00$, $x/D=0.1$, radial velocities



Case 2.2.4: $x/D=0.1$

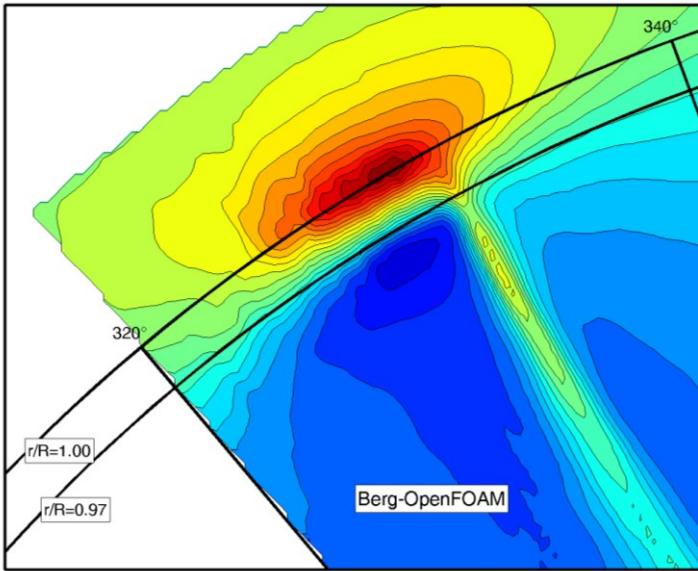
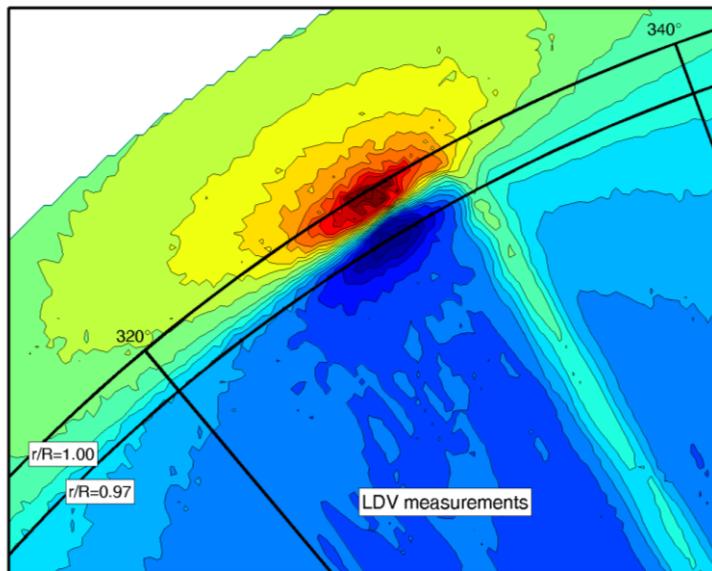


Case 2.2.4: Submitted data sets

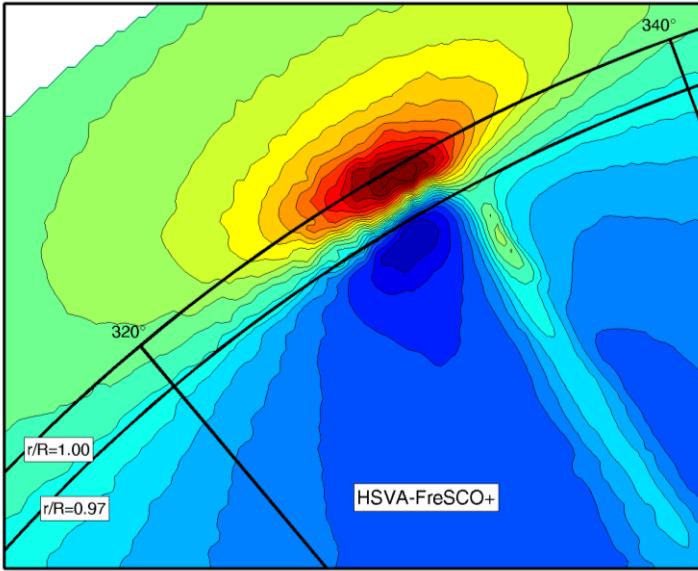
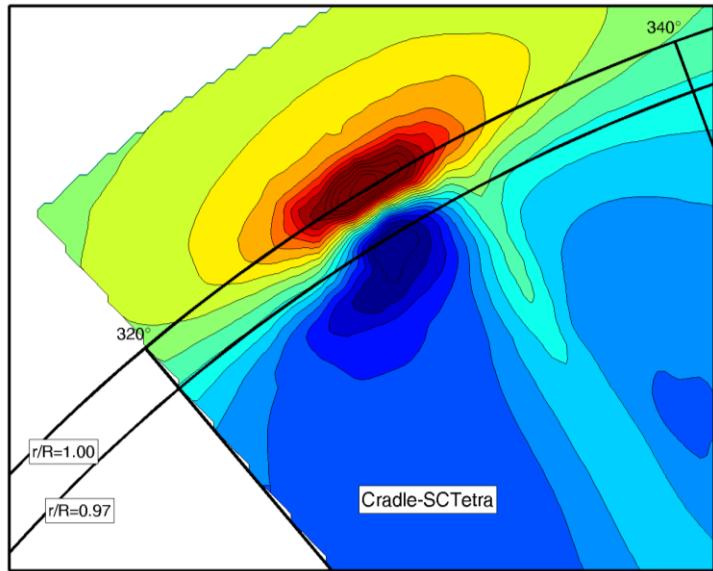
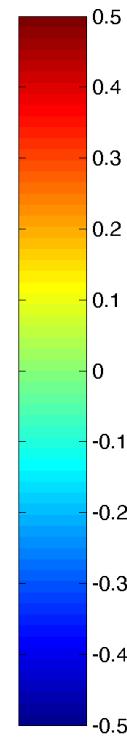
Group	nrad	ntheta	$\Delta r/R$ between $0.95 < r/R < 1.05$
1 Berg-Propulsion	36	161	0.0200
2 Cradle	15	73	0.0250
3 HSVA	74	288	0.0100
4			
5 INSEAN	29	180	0.0250
6			
7 SSPA	10	145	0.0200 (...0.9,0.95,0.97,1.0,1.1)
8 TUHH	71	289	0.0100
9 University of Genua	15	73	0.0500
10 University of Triest	14	50	0.0100
11 VOITH	36	145	0.0200
12 VTT	161	289	0.0024

- Exp.: between $0.95 < r/R < 1.05$ $\Delta r/R = 0.002$
- Data may not reflect the quality of the computations !!!

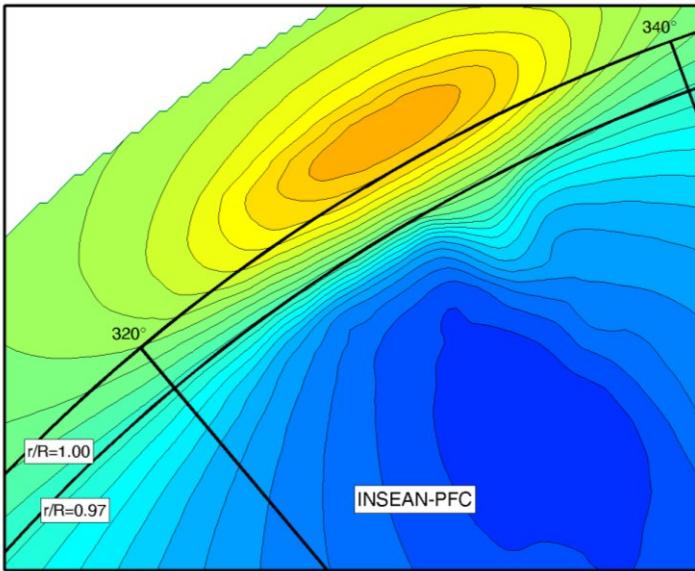
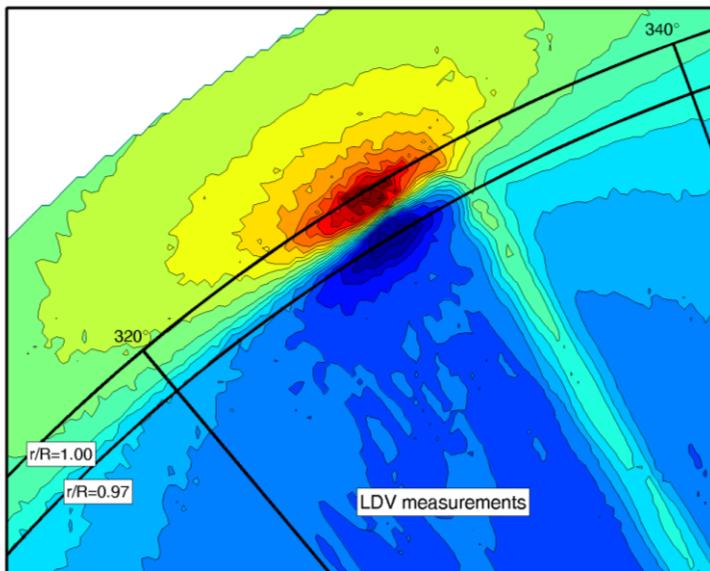
Case 2.2.4, $x/D=0.1$



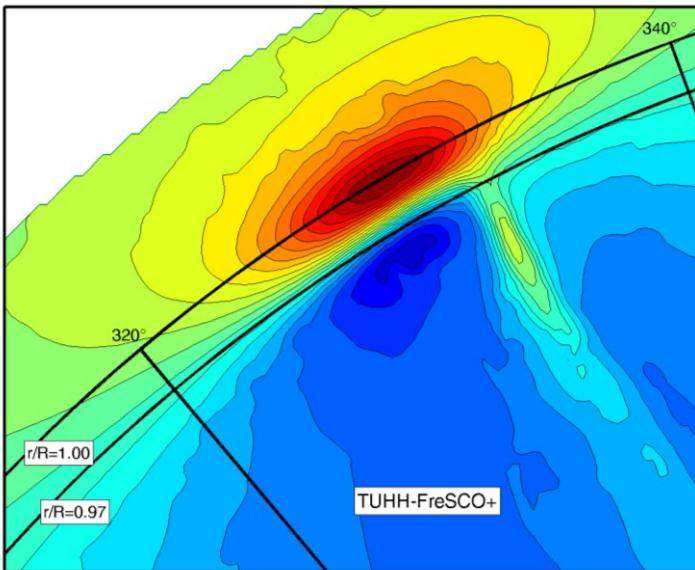
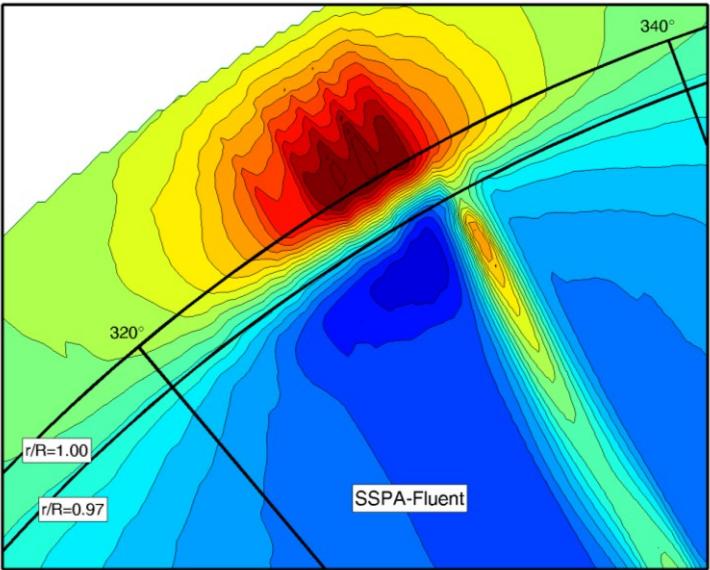
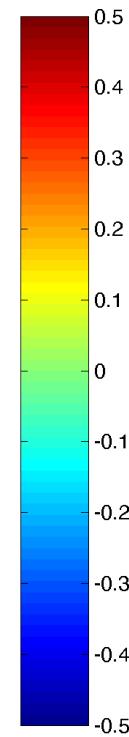
$$1-V_x/V_A$$



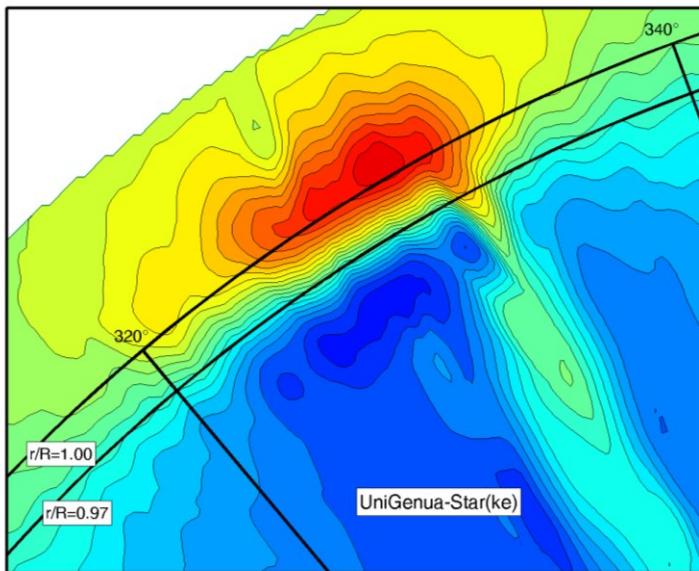
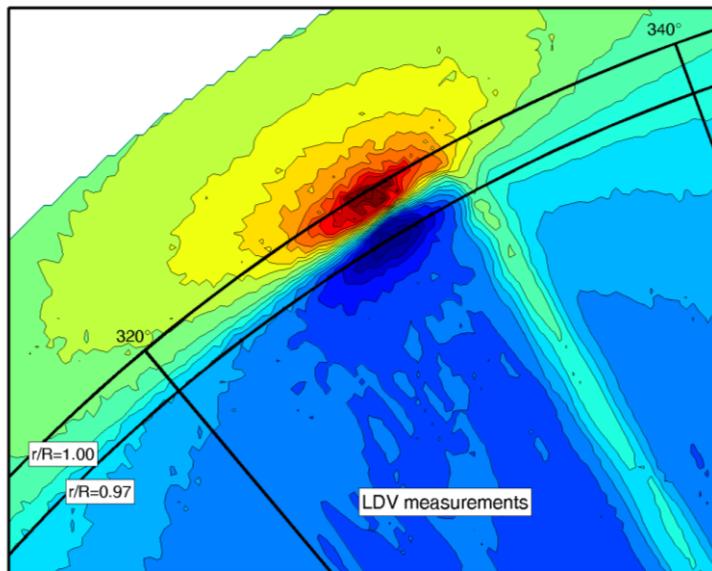
Case 2.2.4, $x/D=0.1$



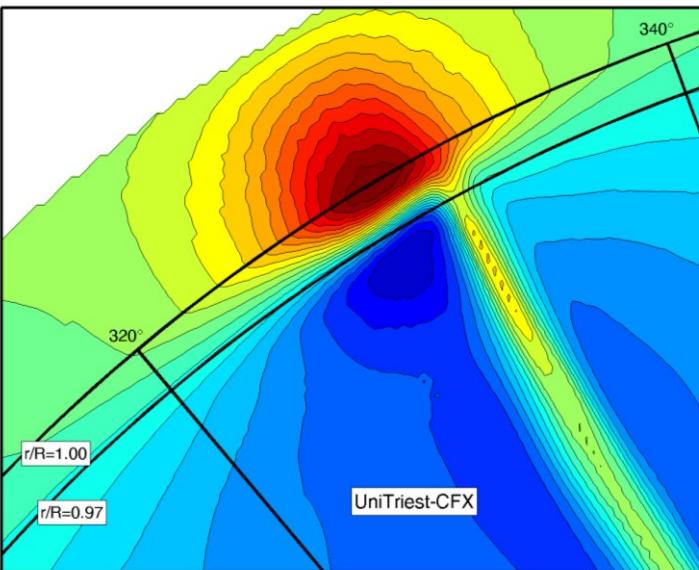
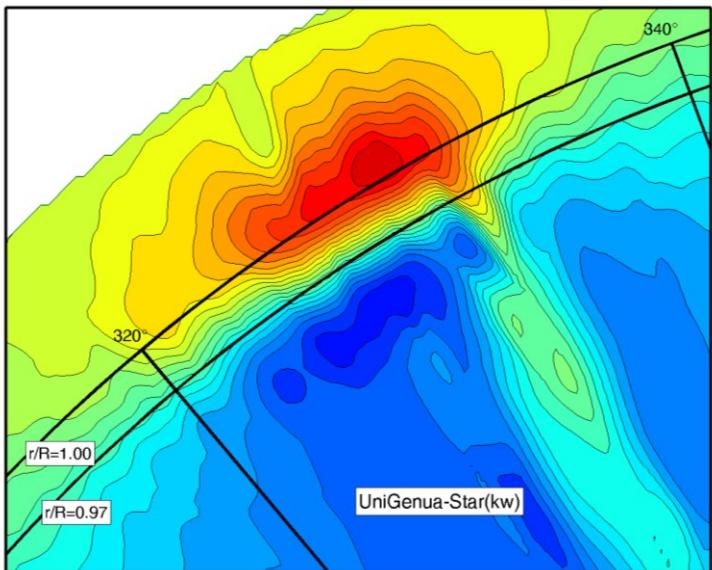
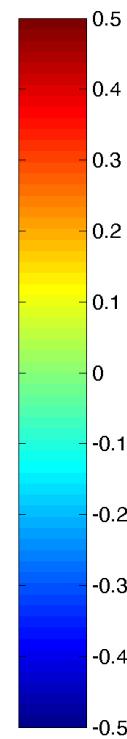
$$1 - V_x/V_A$$



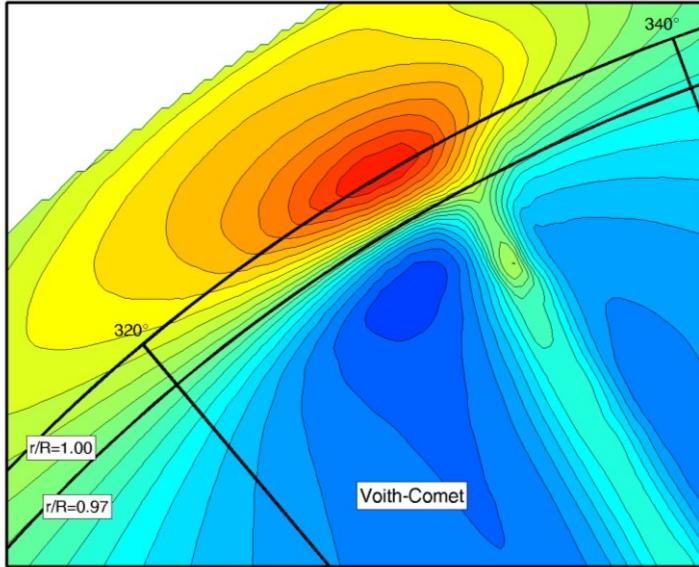
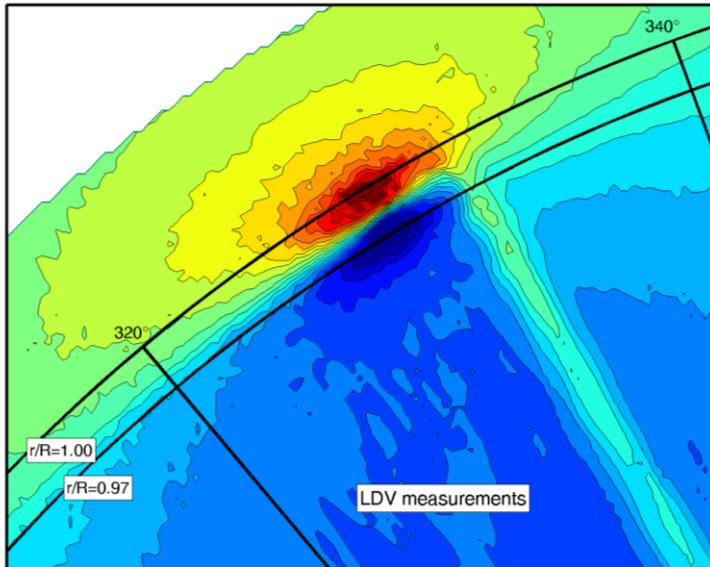
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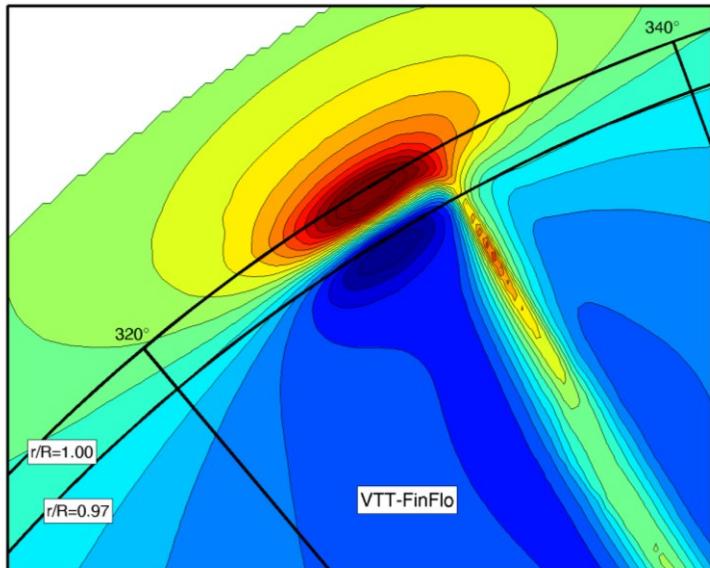
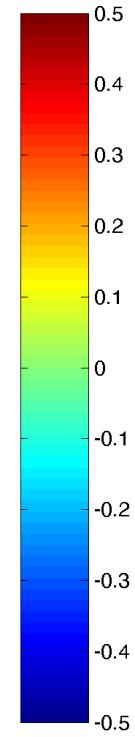
$1 - V_x/V_A$



Case 2.2.4, $x/D=0.1$

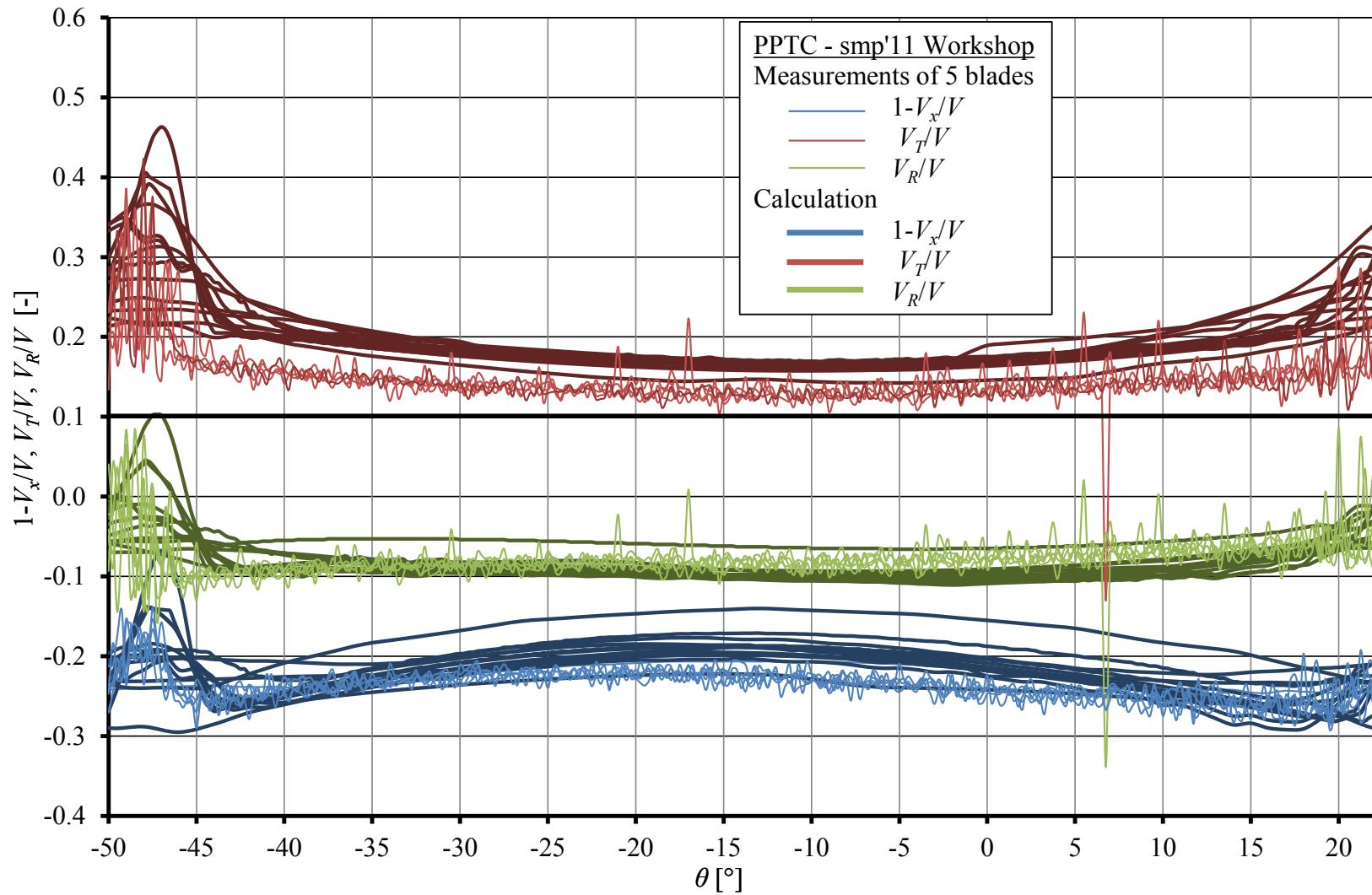


$1-V_x/V_A$

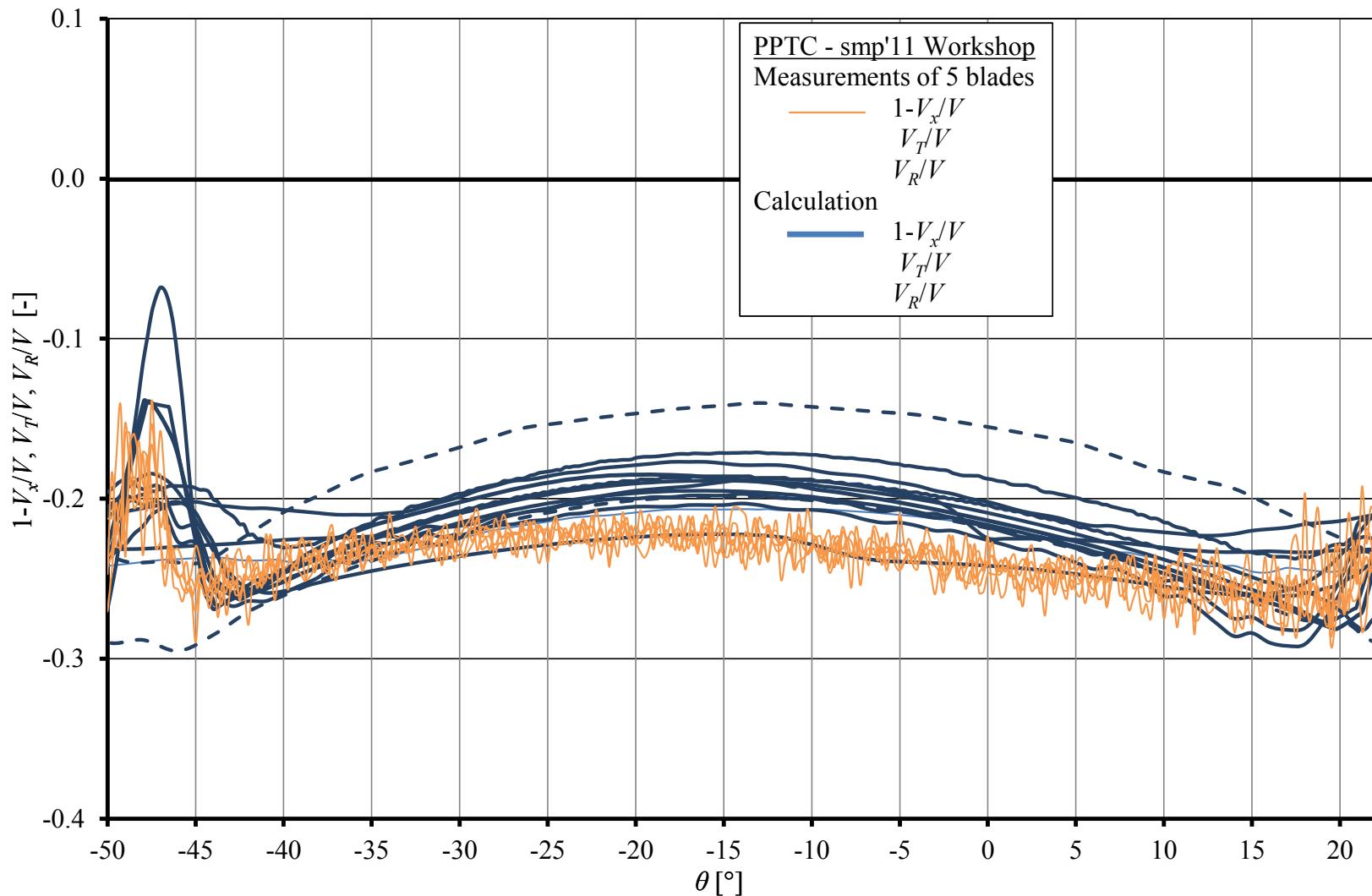


Case 2.2.1: $x/D=0.2, r/R=0.70$

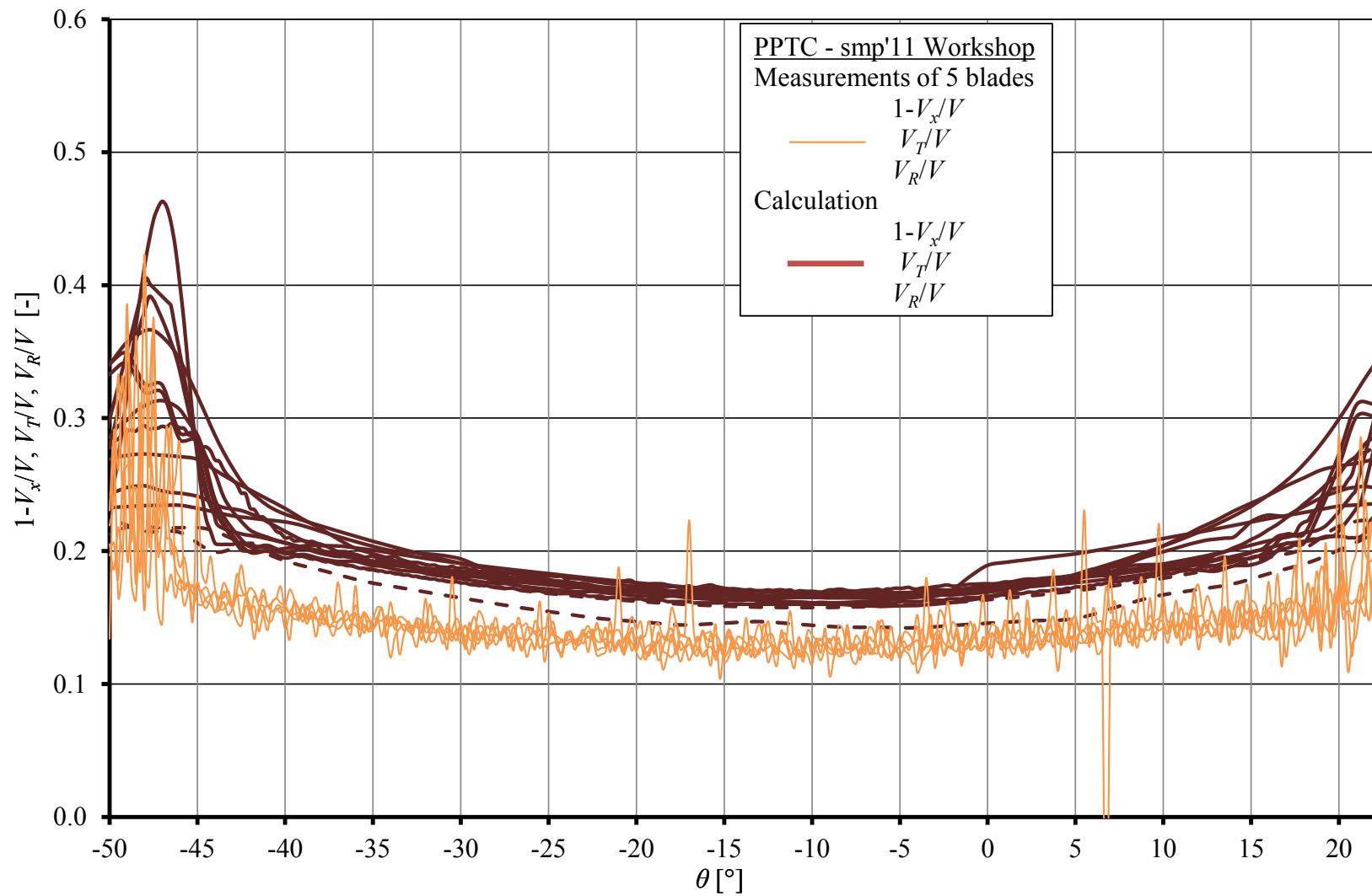
Case 2.2.1: $r/R=0.70$, $x/D=0.2$



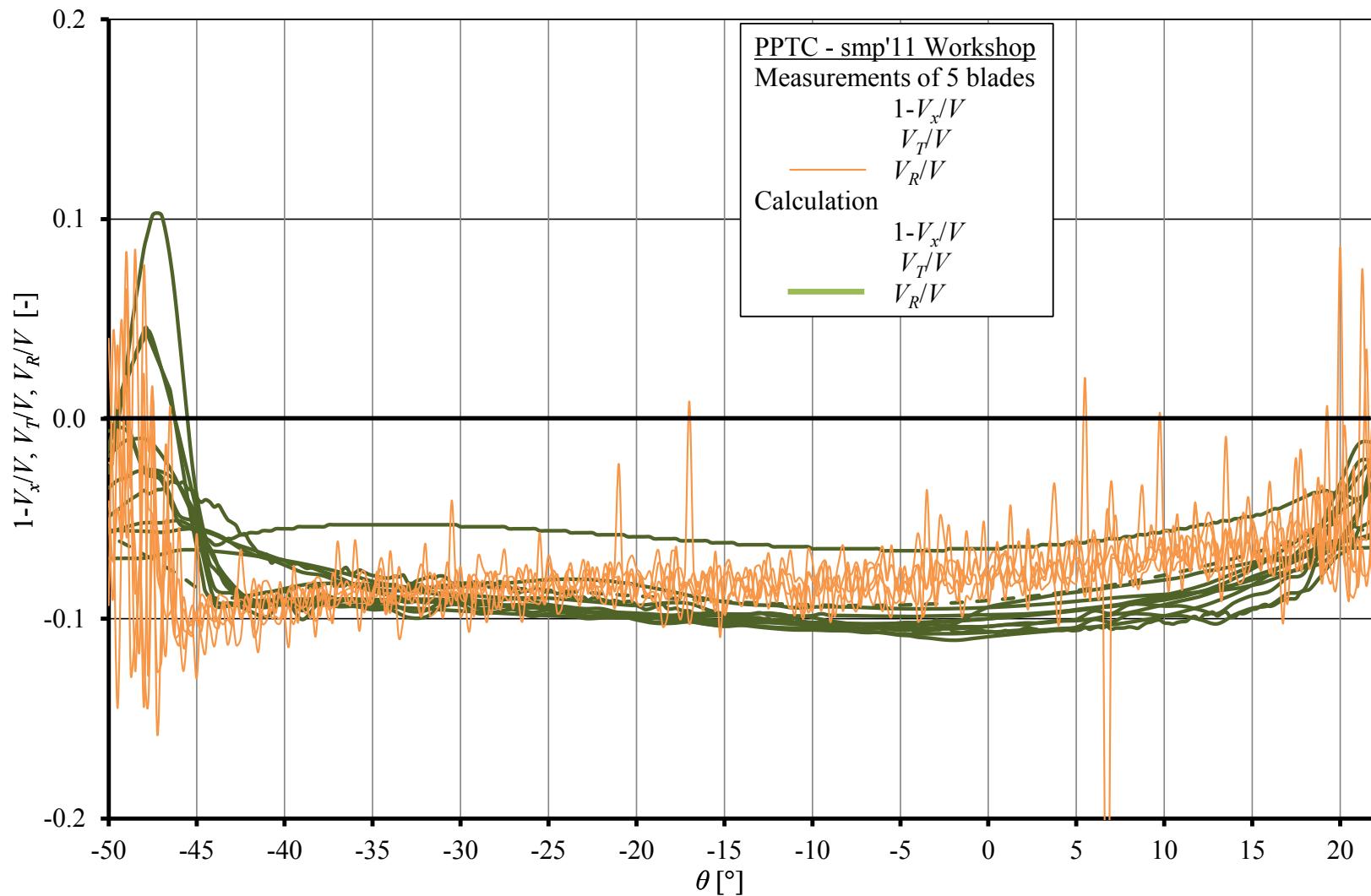
Case 2.2.1: $r/R=0.70$, $x/D=0.2$, axial velocities



Case 2.2.1: $r/R=0.70$, $x/D=0.2$, tang. velocities

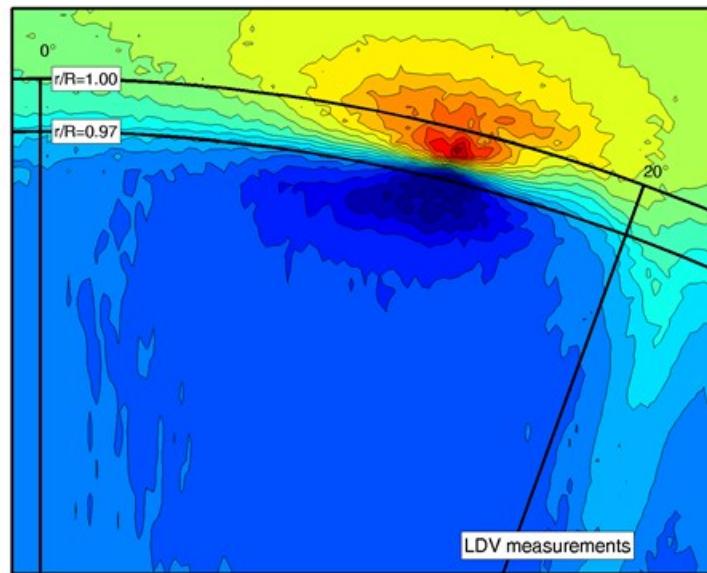


Case 2.2.1: $r/R=0.70$, $x/D=0.2$, radial velocities

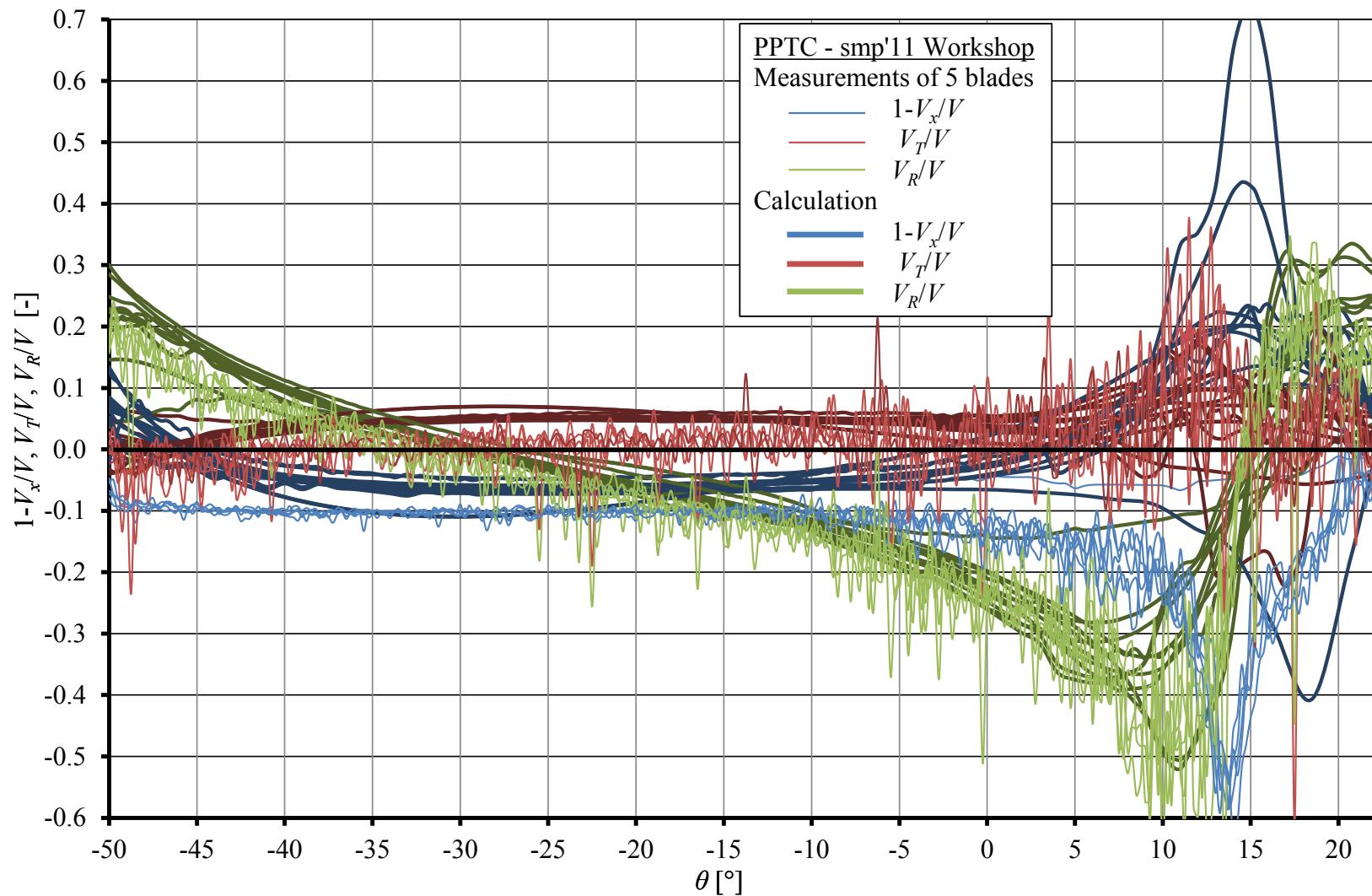


Evaluation

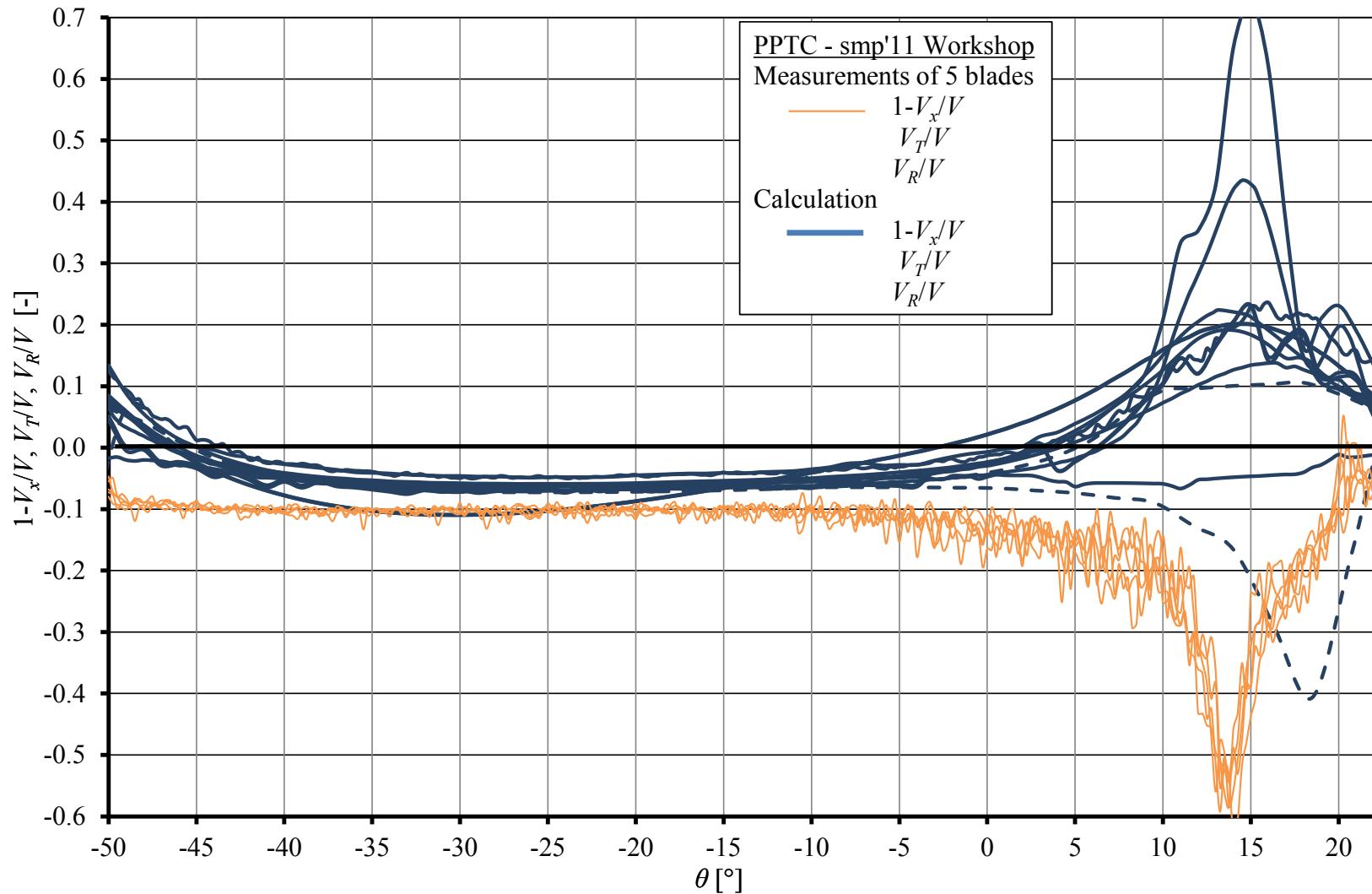
Case 2.2.2: $x/D=0.2, r/R=0.97$



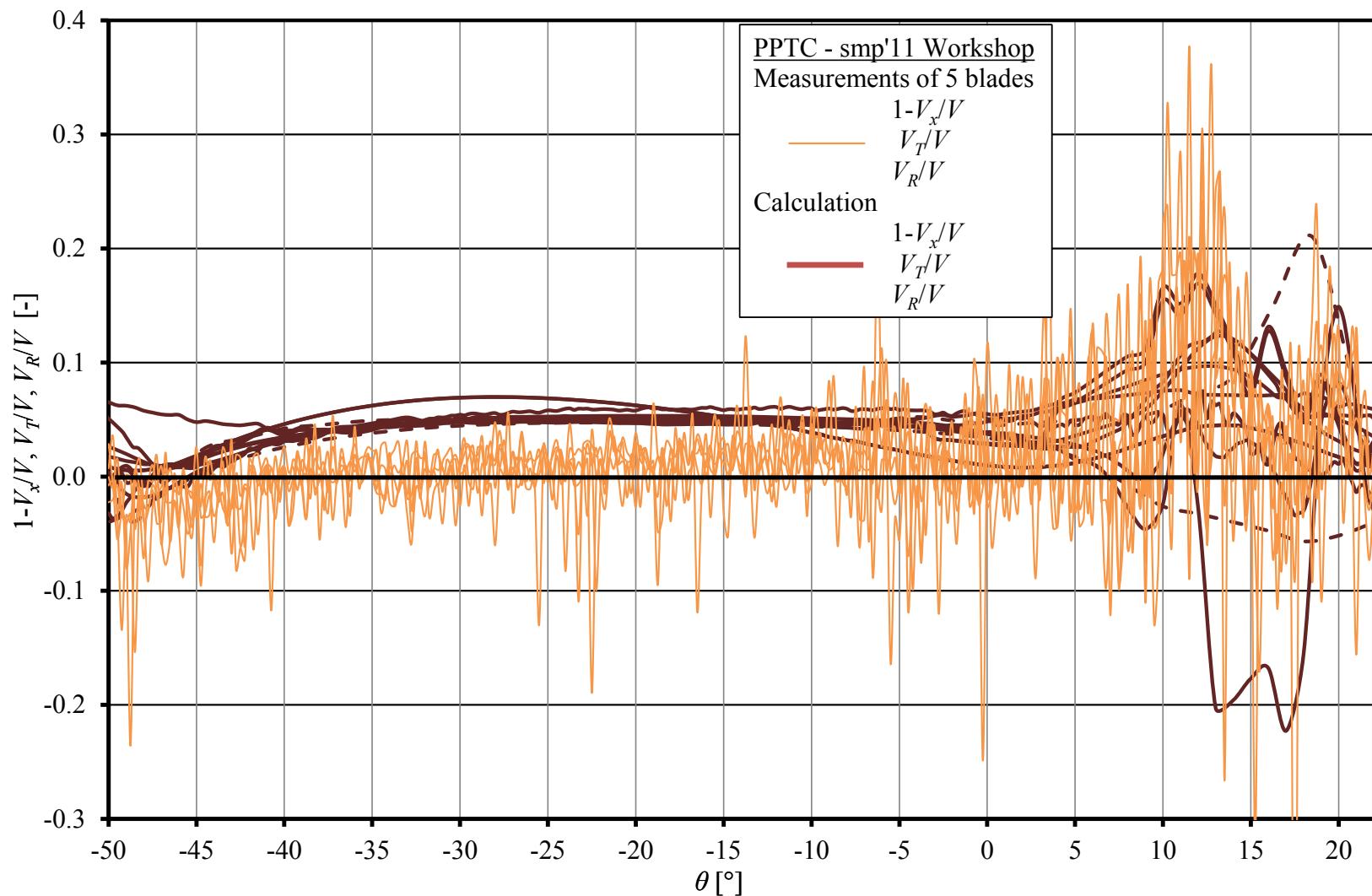
Case 2.2.2: $r/R=0.97$, $x/D=0.2$



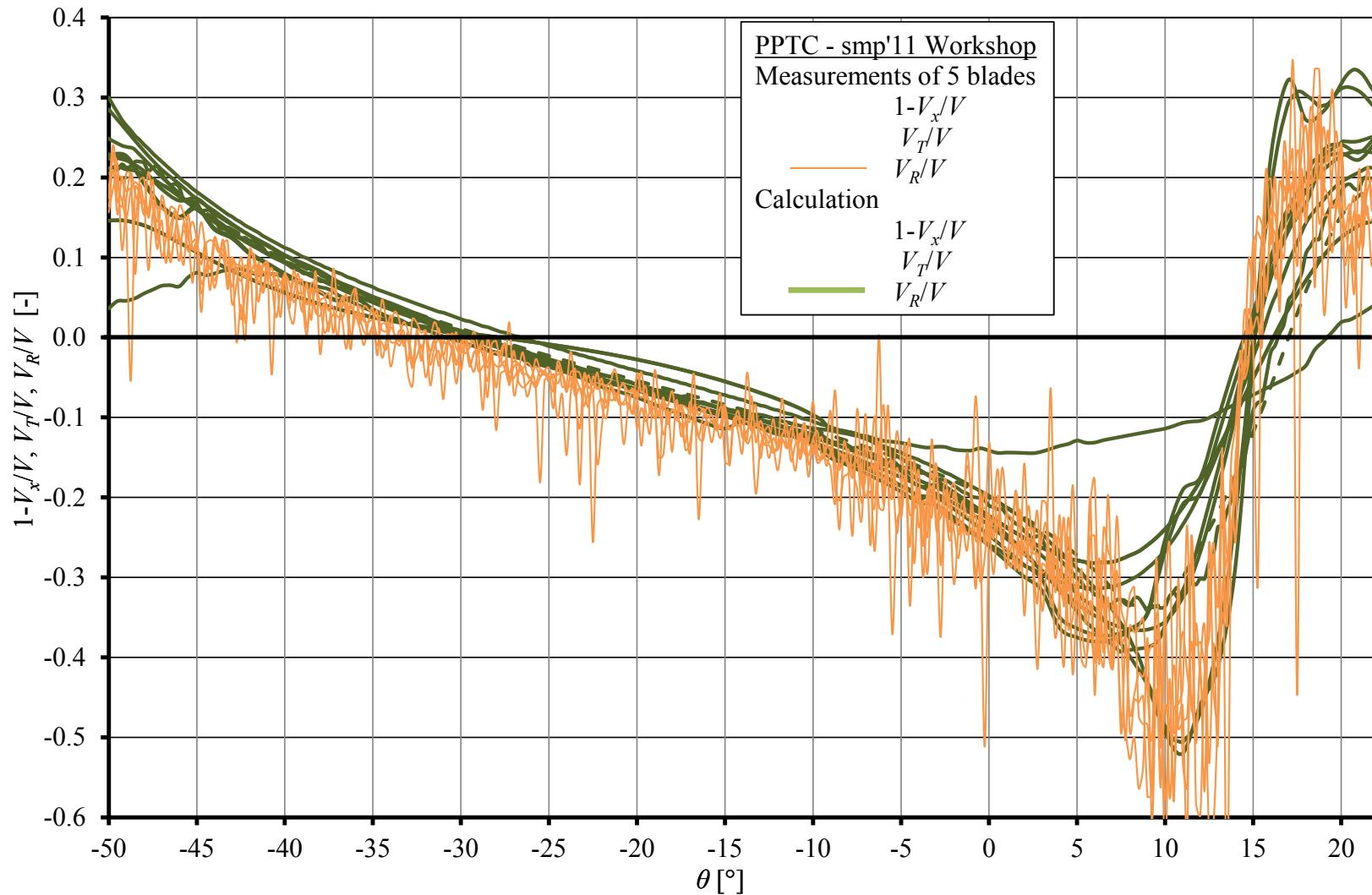
Case 2.2.2: $r/R=0.97$, $x/D=0.2$, axial velocities



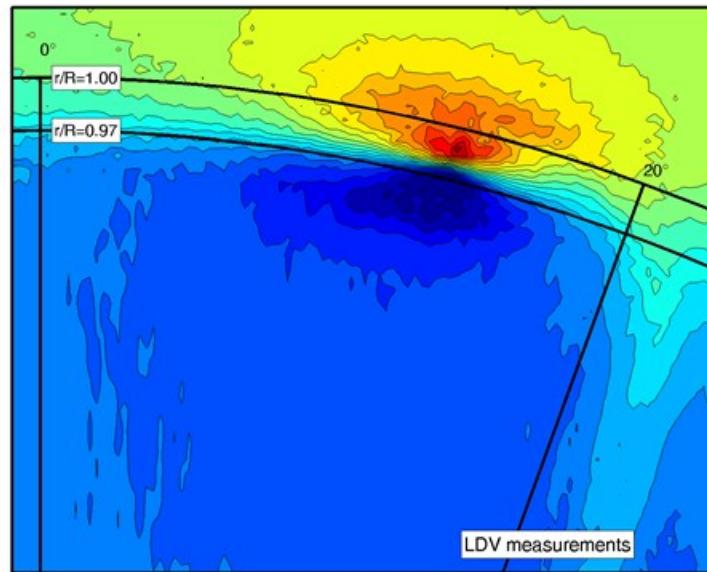
Case 2.2.2: $r/R=0.97$, $x/D=0.2$, tang. velocities



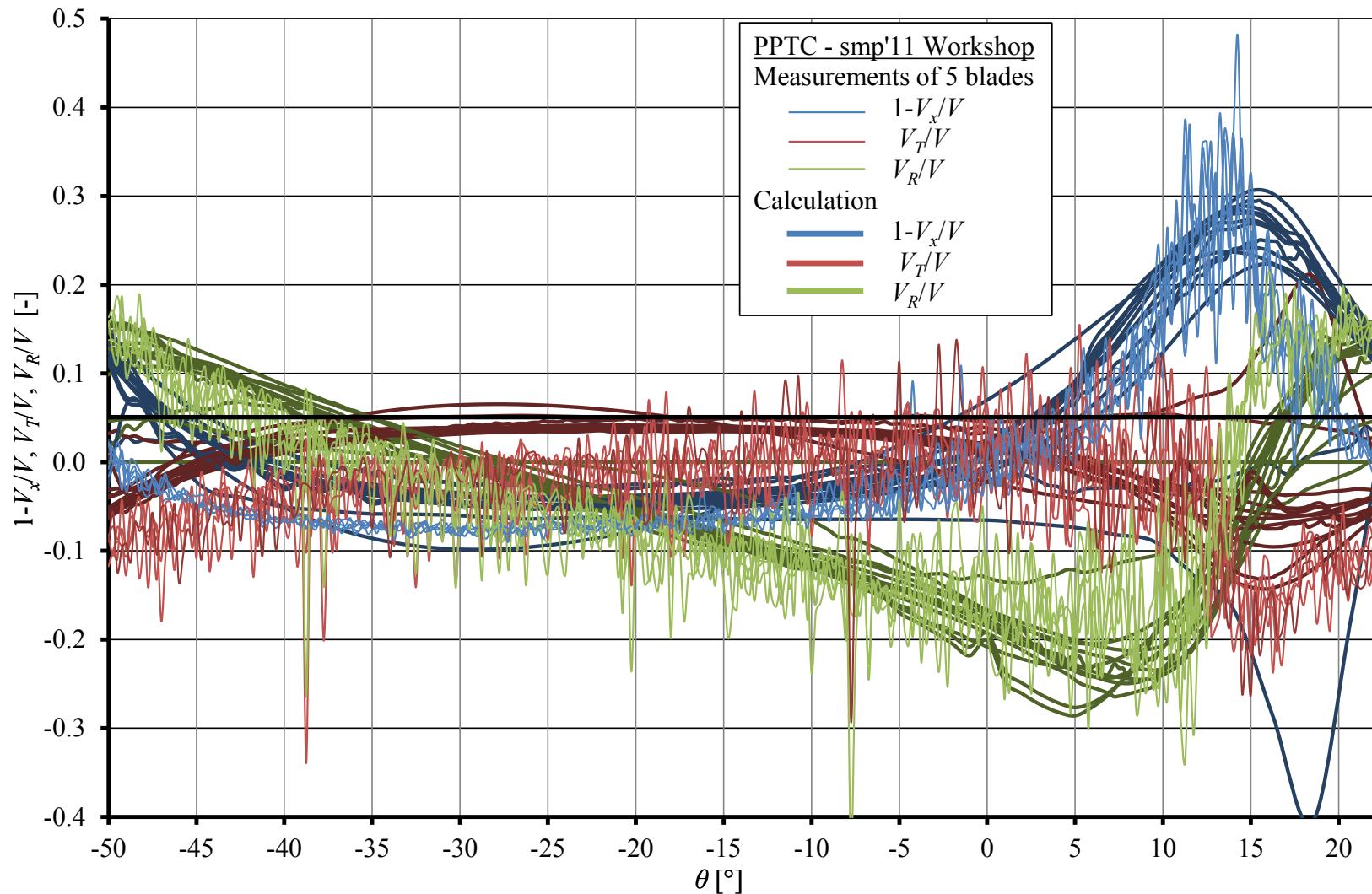
Case 2.2.2: $r/R=0.97$, $x/D=0.2$, radial velocities



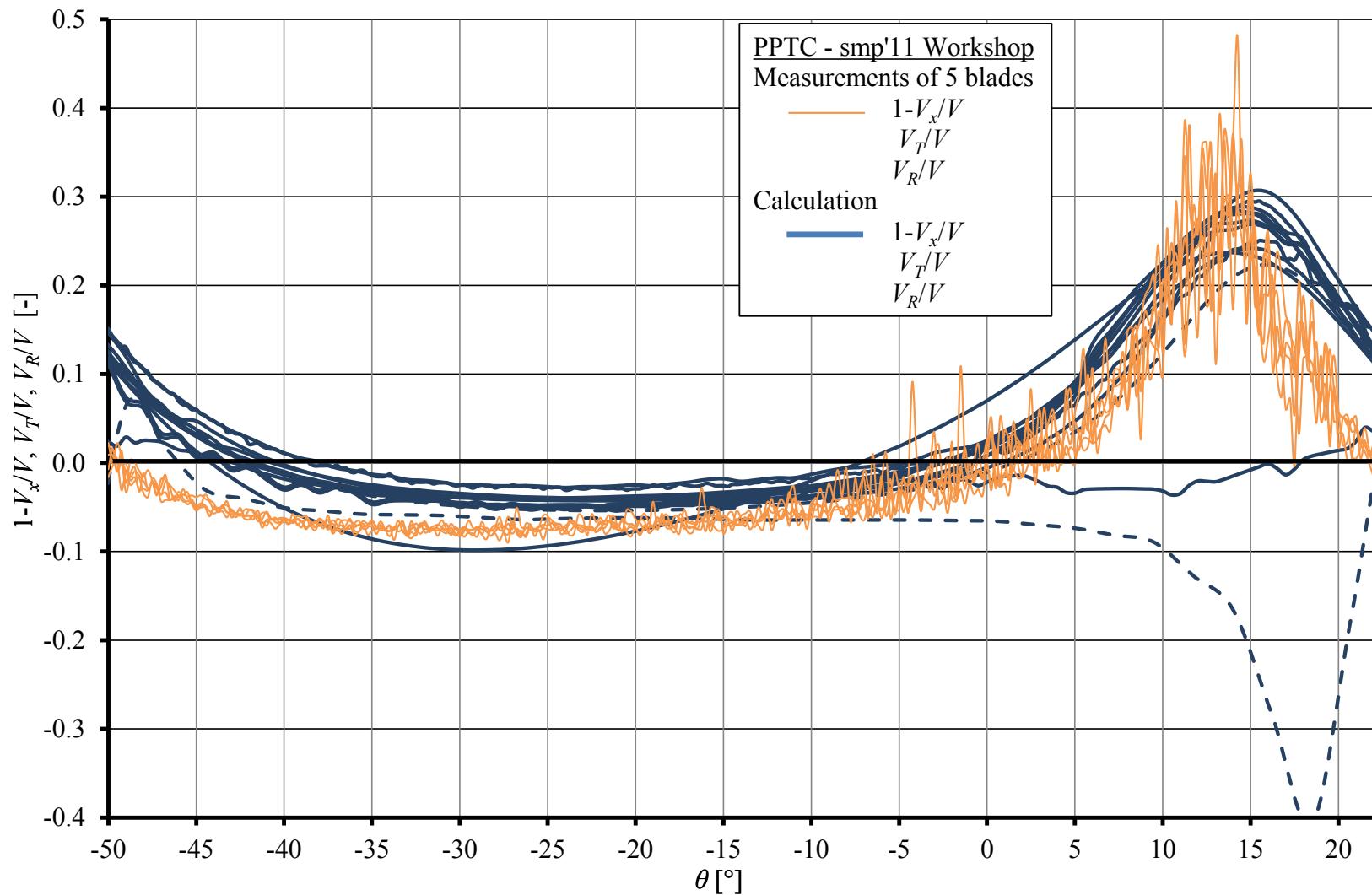
Case 2.2.3: $x/D=0.2, r/R=1.00$



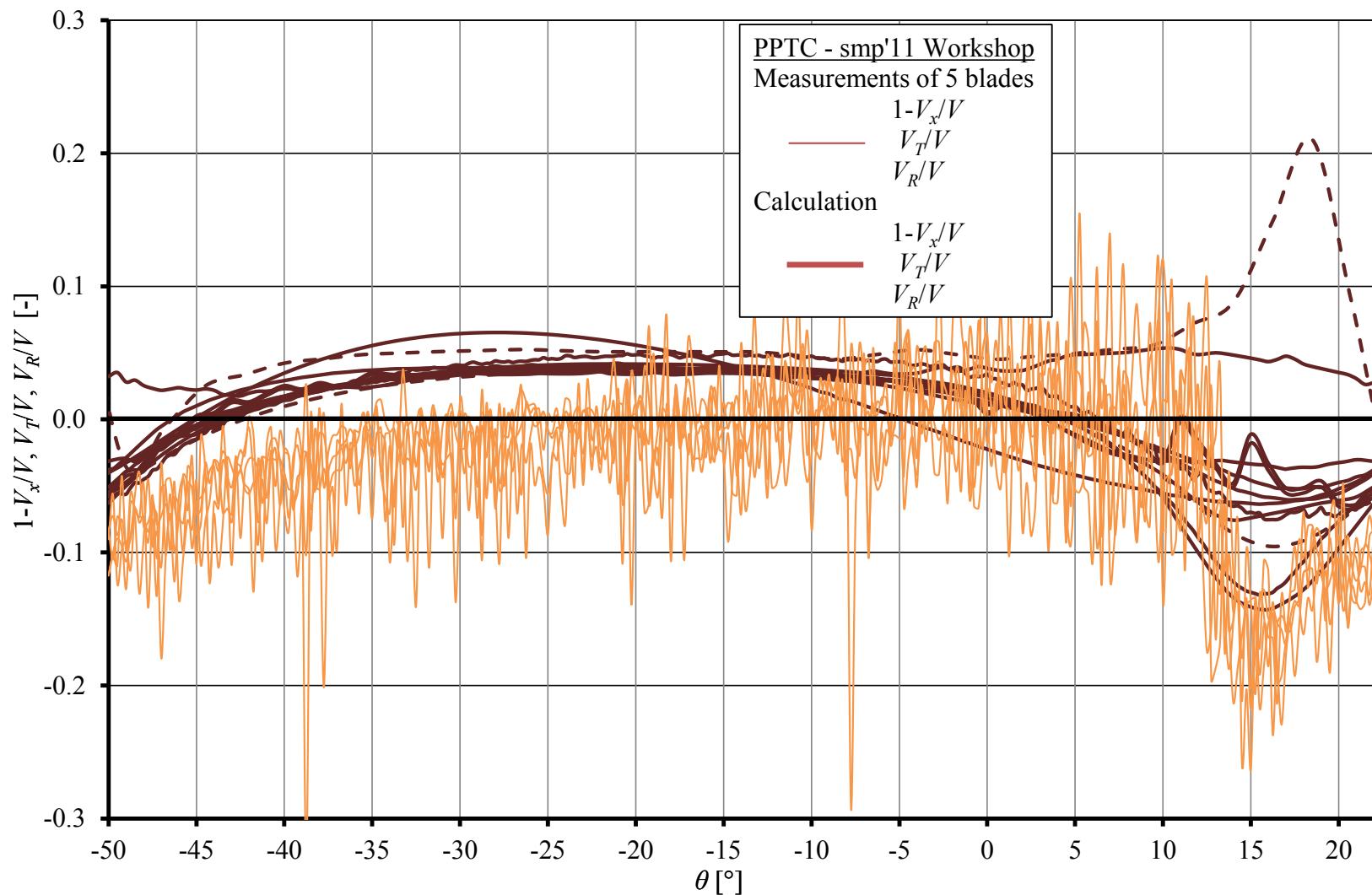
Case 2.2.3: $r/R=1.00$, $x/D=0.2$



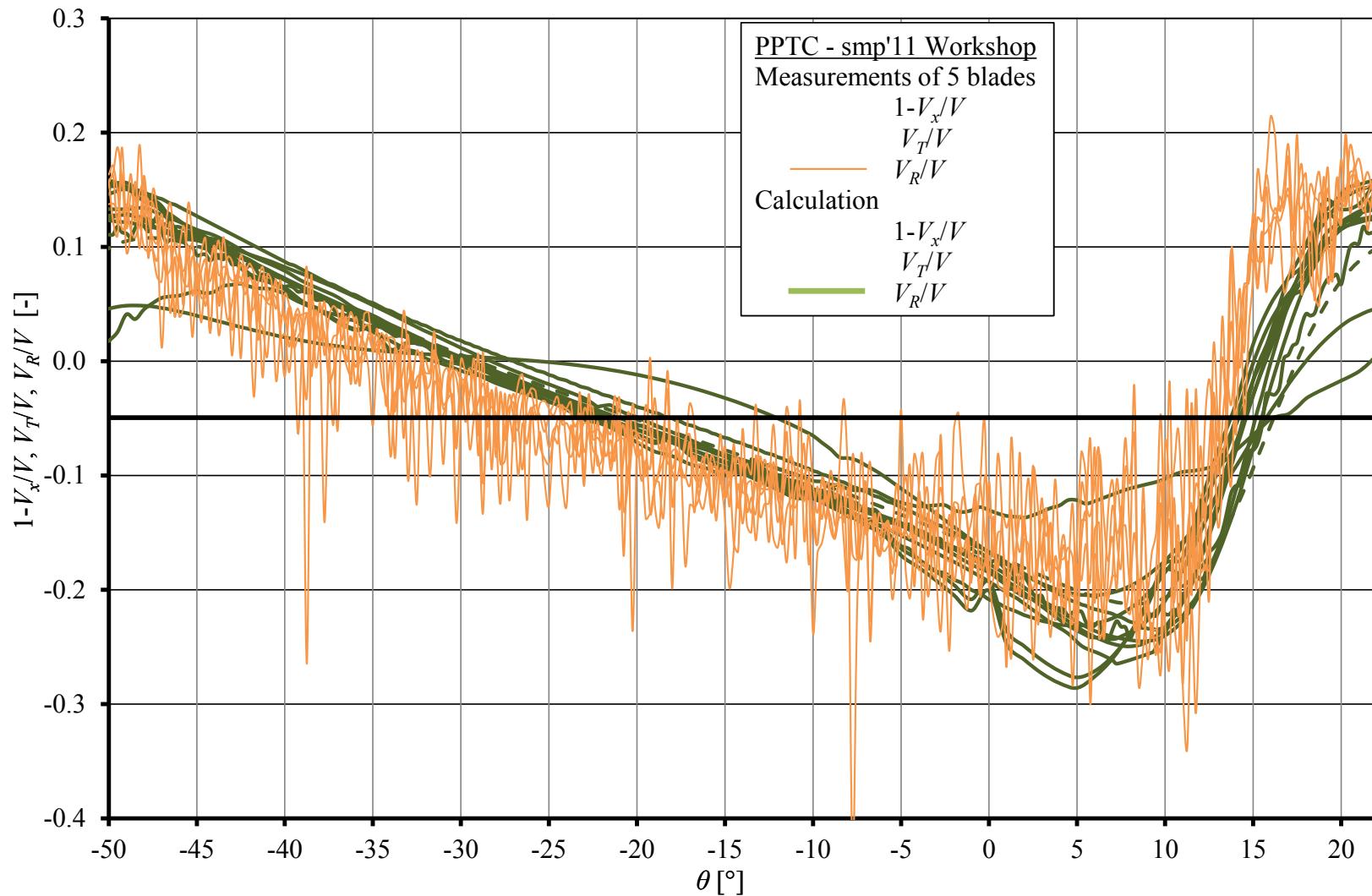
Case 2.2.3: $r/R=1.00$, $x/D=0.2$, axial velocities



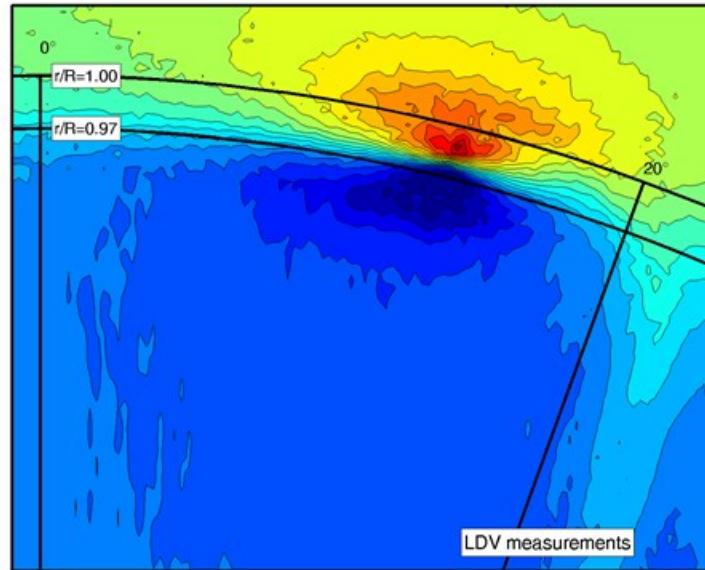
Case 2.2.3: $r/R=1.00$, $x/D=0.2$, tang. velocities



Case 2.2.3: $r/R=1.00$, $x/D=0.2$, radial velocities



Case 2.2.4: $x/D=0.2$

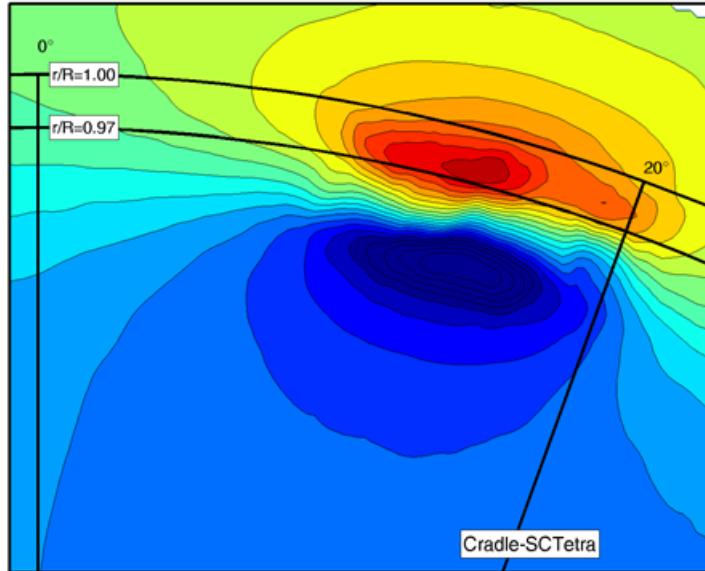
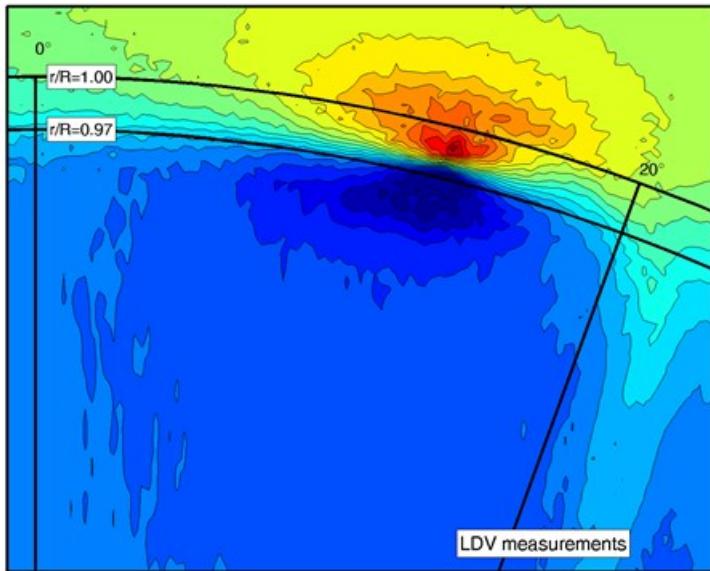


Case 2.2.4: Submitted data sets

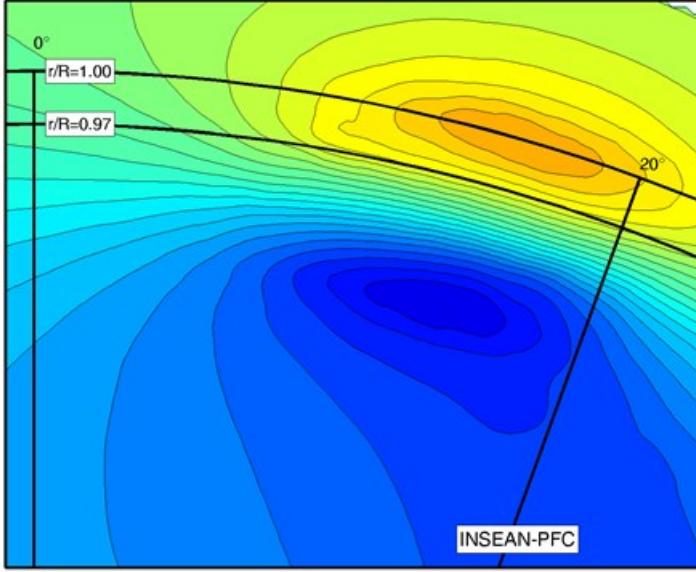
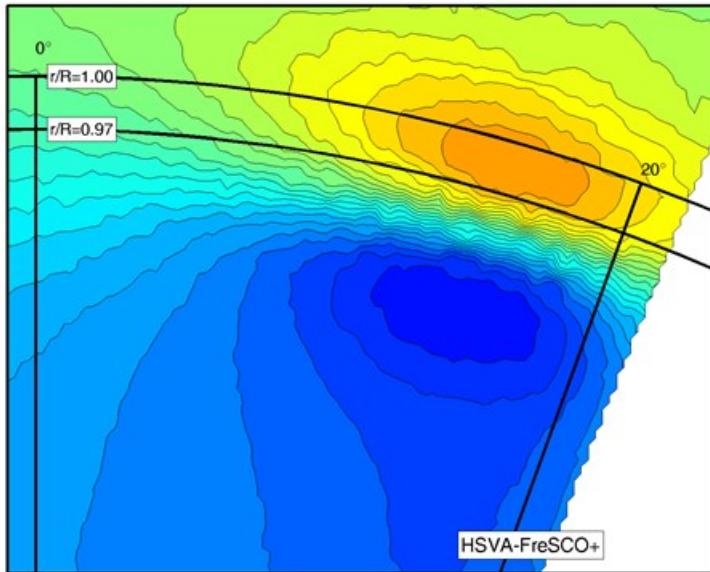
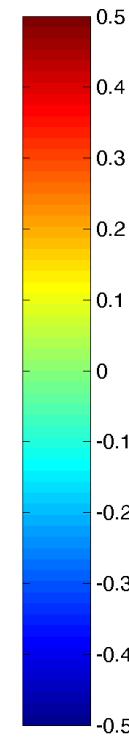
Group	nrad	ntheta	$\Delta r/R$ between $0.95 < r/R < 1.05$
1 Berg-Propulsion	36	161	0.0200
2 Cradle	15	73	0.0250
3 HSVA	74	288	0.0100
4			
5 INSEAN	29	180	0.0250
6			
7 SSPA	10	145	0.0200 (...0.9,0.95,0.97,1.0,1.1)
8 TUHH	71	289	0.0100
9 University of Genua	15	73	0.0500
10 University of Triest	14	50	0.0100
11 VOITH	36	145	0.0200
12 VTT	161	289	0.0024

- Exp.: between $0.95 < r/R < 1.05$ $\Delta r/R = 0.002$
- Data may not reflect the quality of the computations !!!

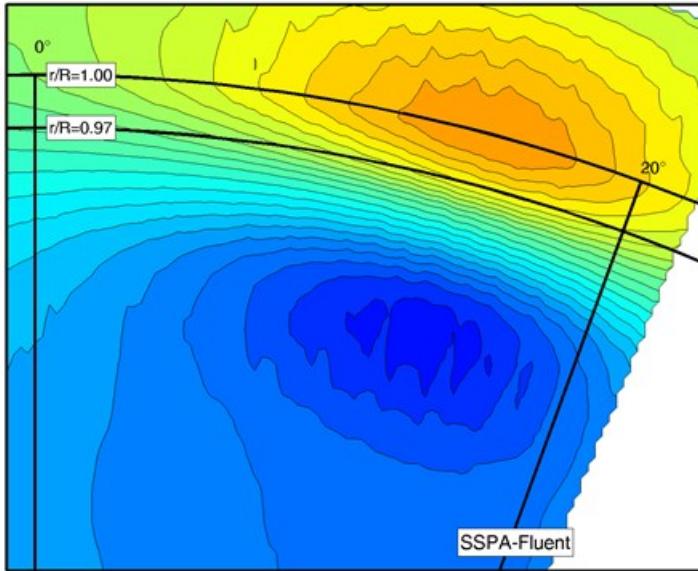
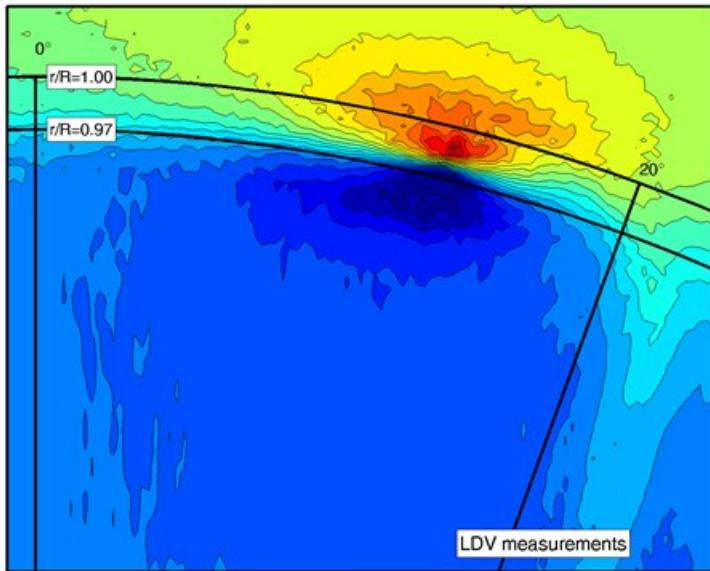
Case 2.2.4, $x/D=0.2$



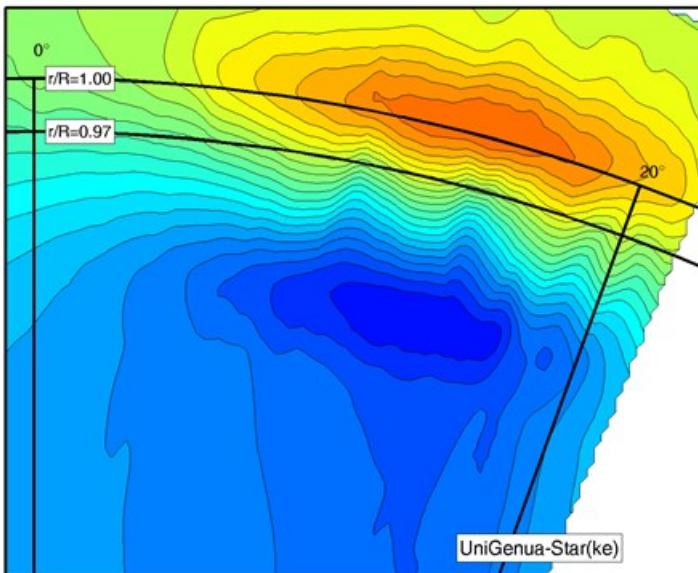
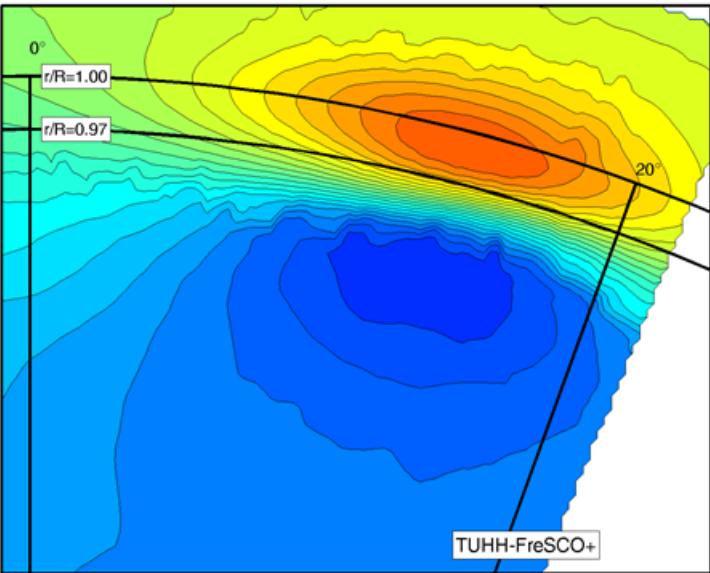
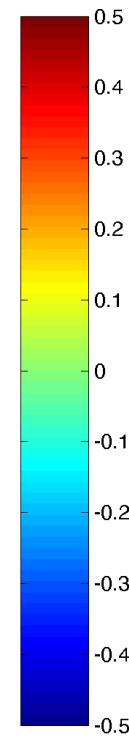
$1-V_x/V_A$



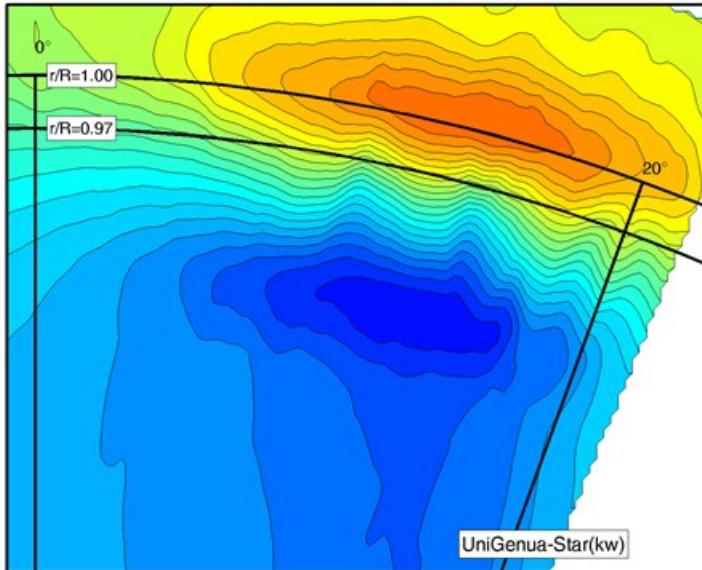
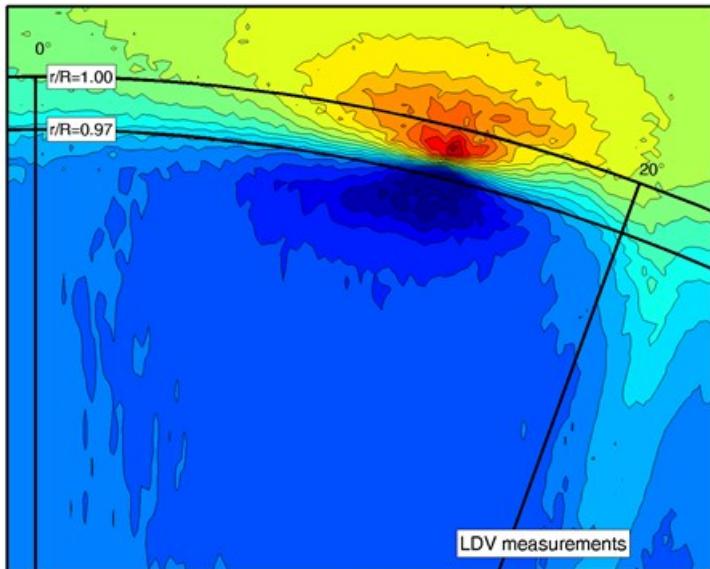
Case 2.2.4, $x/D=0.2$



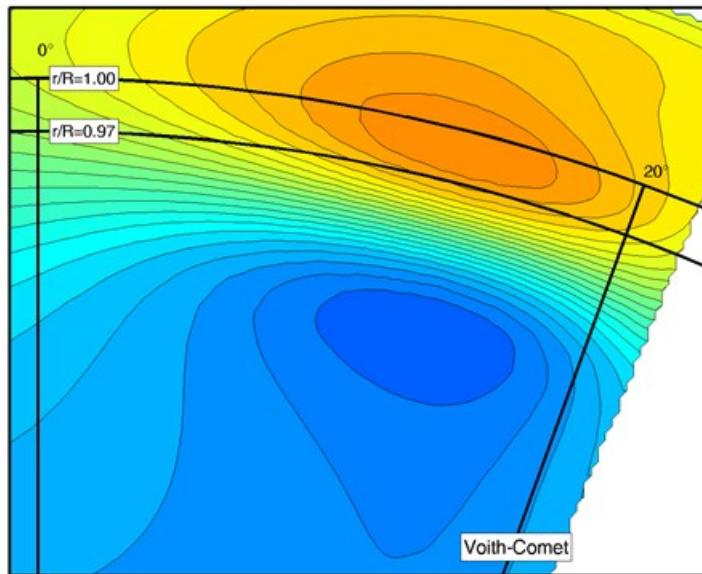
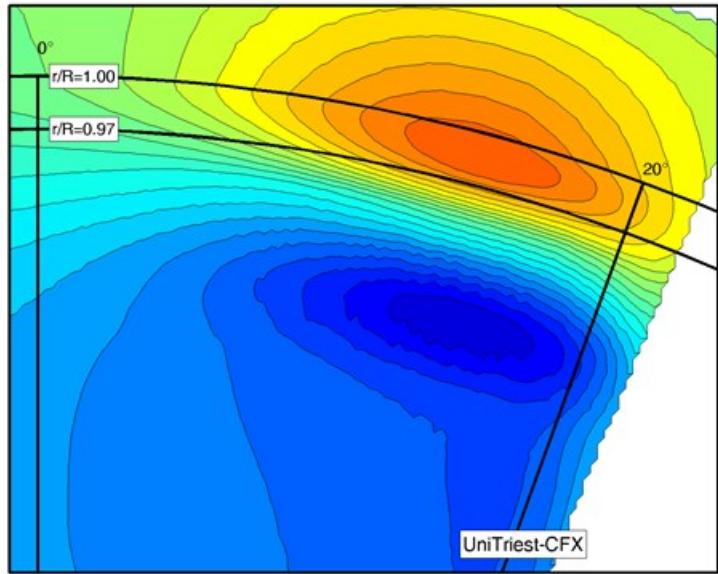
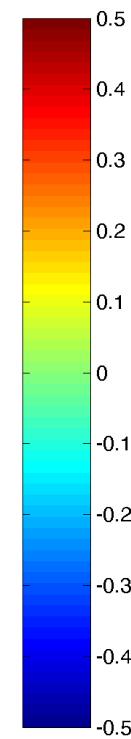
$1-V_x/V_A$



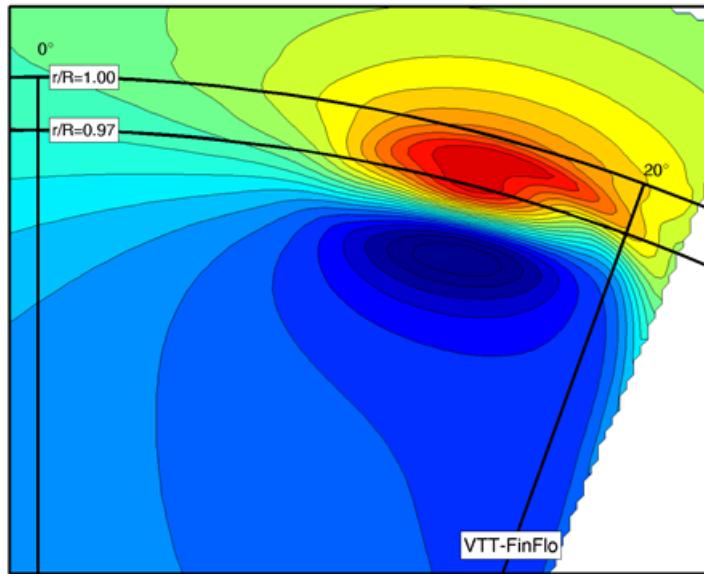
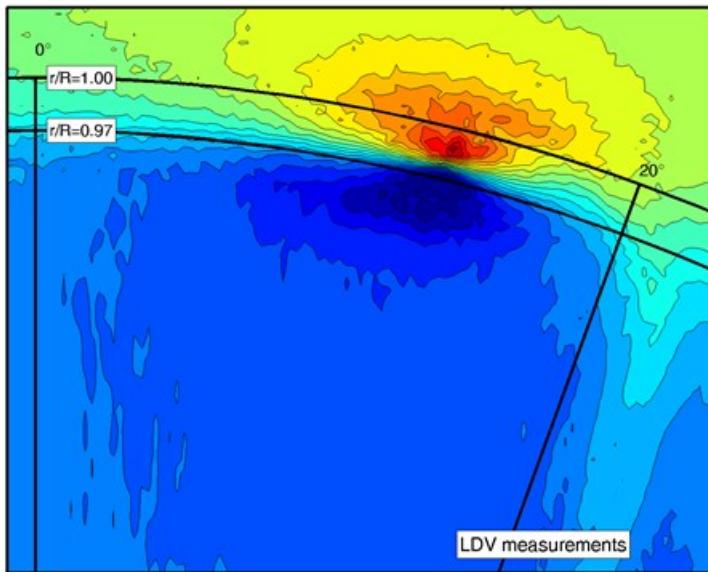
Case 2.2.4, $x/D=0.2$



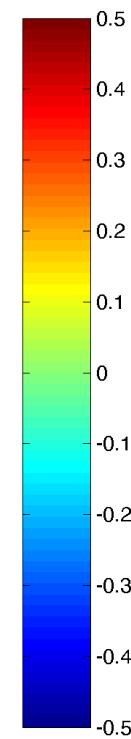
$1-V_x/V_A$



Case 2.2.4, $x/D=0.2$



$$1 - V_x/V_A$$

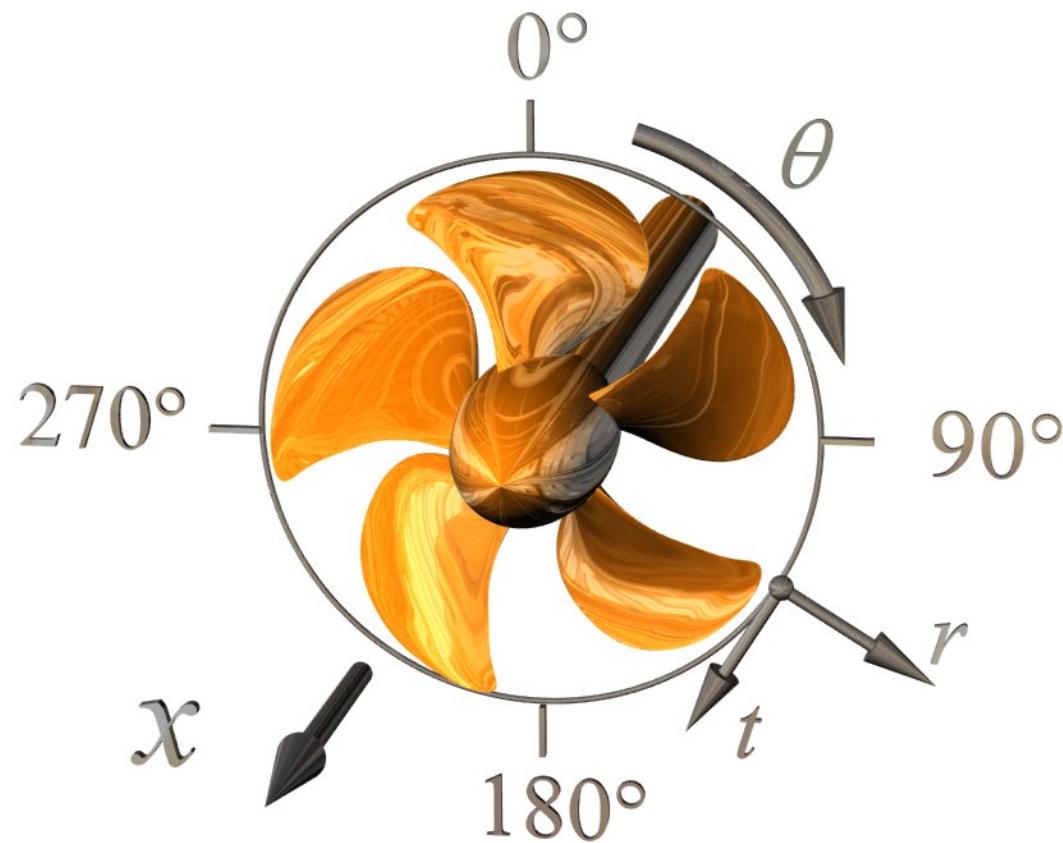


Acknowledgement

The PPTC working group wishes to acknowledge the support for the Propeller Performance Workshop given by the organisation committee of the smp'11

Special thanks also to the participants without whom the workshop could not have taken place

Coordinate System



- Axial velocities positive in flow direction
- Radial velocities positive outwards
- Tangential velocities positive in direction of rotation