

Aerodynamic optimization of large-scale VAWT - elements of multi-parameter analysis

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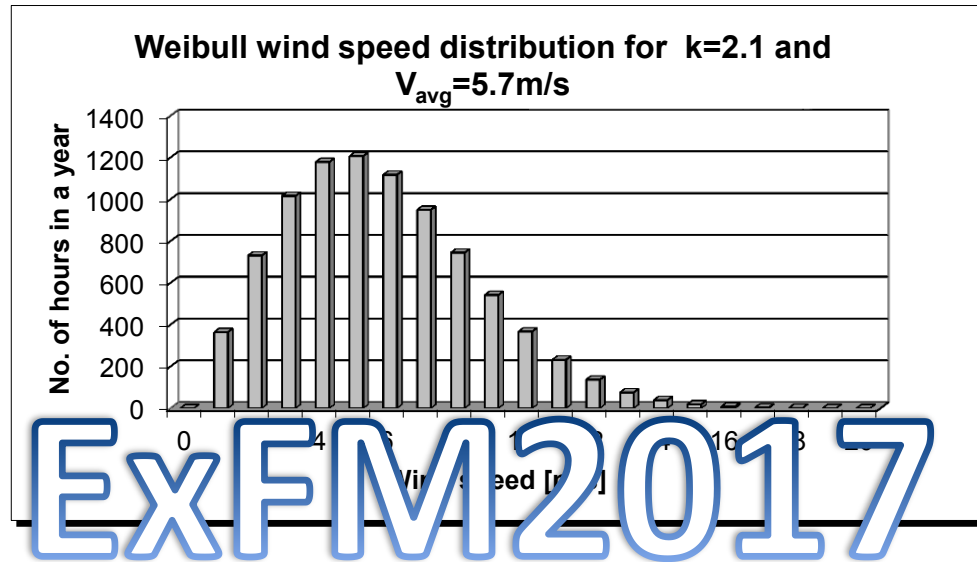
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CFD input

- 2D
- $k - \omega$ SST method
- 22.5m diameter
- 1.5m chord
- NACA0018
- 9m/s inflow speed

ExFM2017

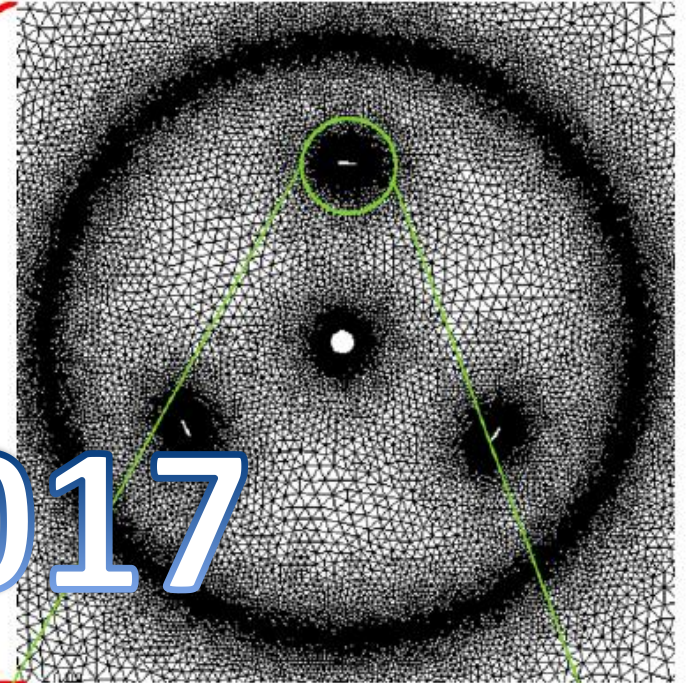
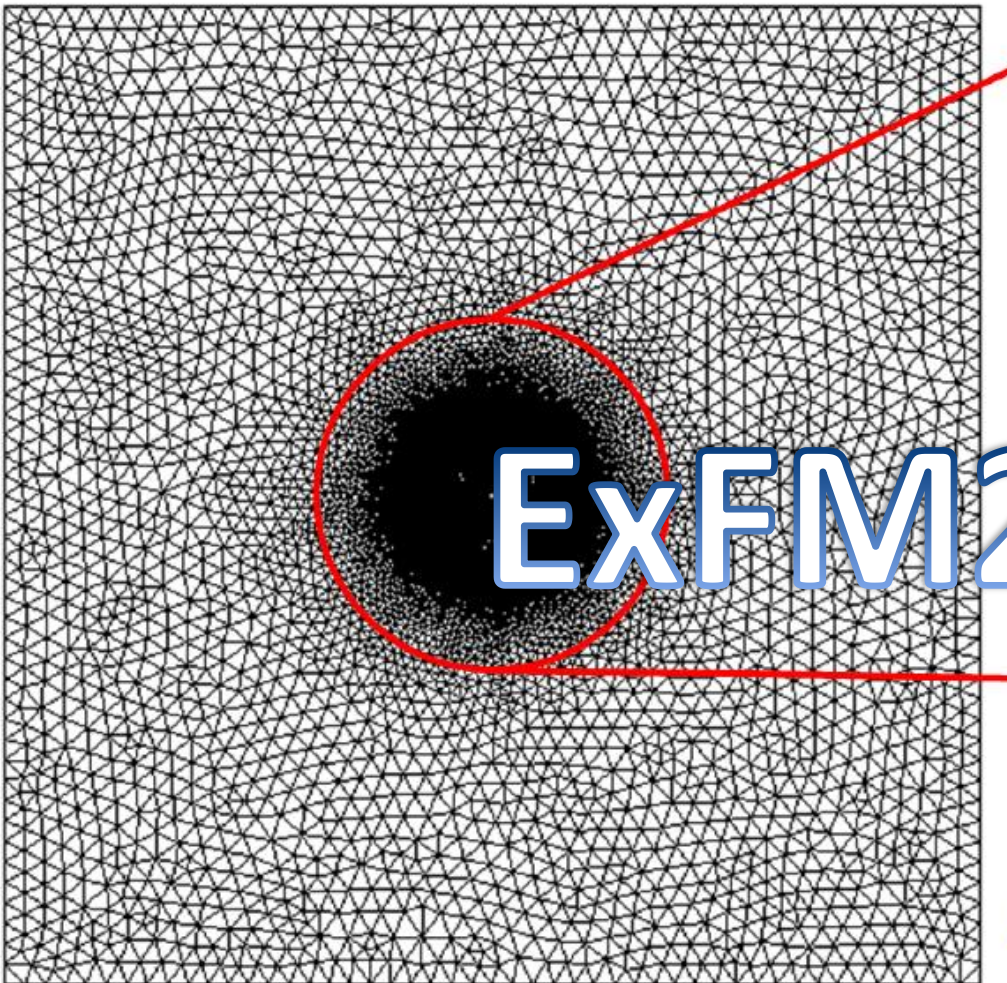
Inflow speed



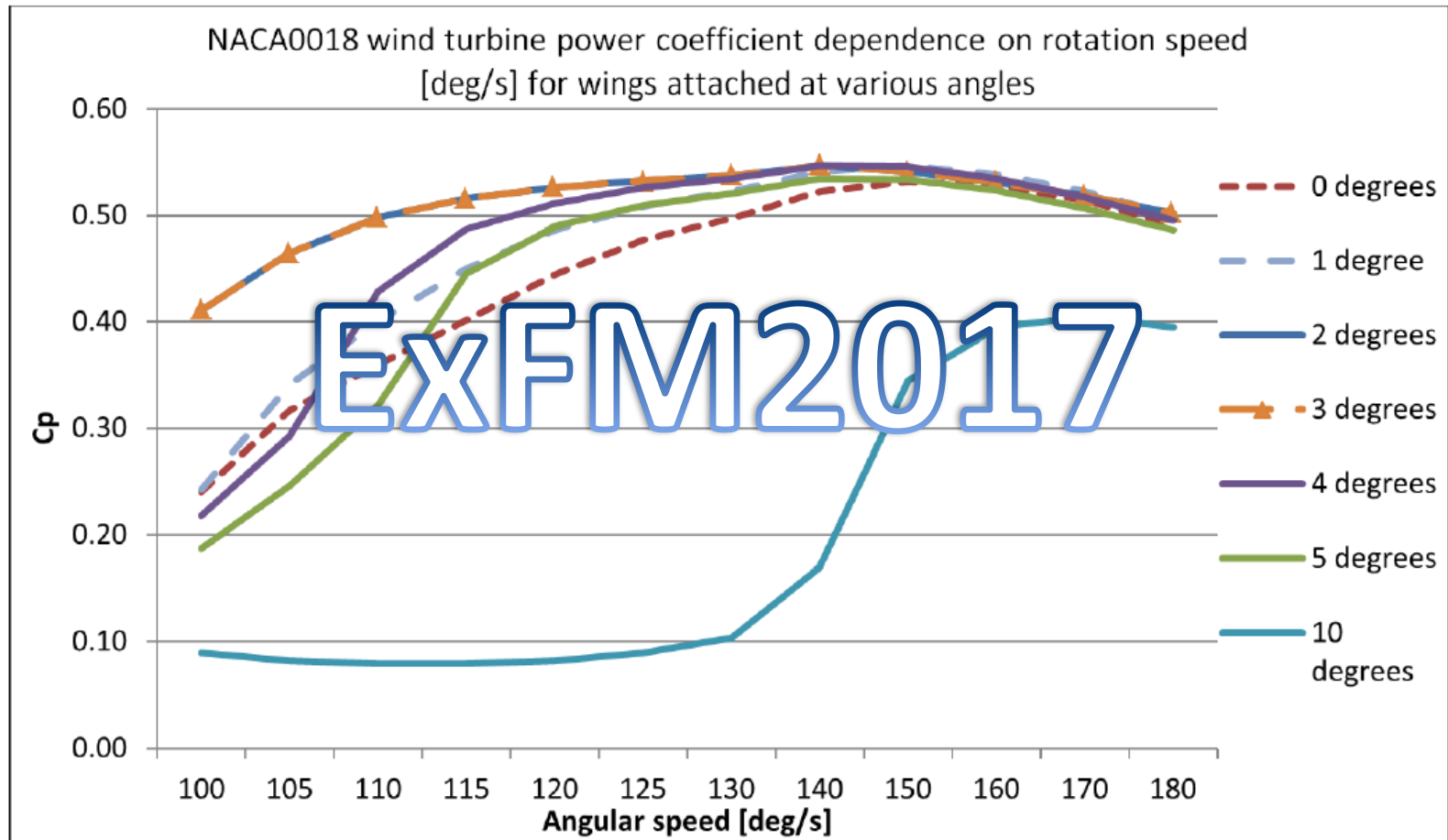
Middle of rotor height [m]	Optimal wind speed [m/s]			
	REPower	Vestas V44	Evolvegreen	Suntop
40	9	8	8	8
60	9	9	9	8
80	10	9	9	9
100	10	9	9	9

Input Parameters

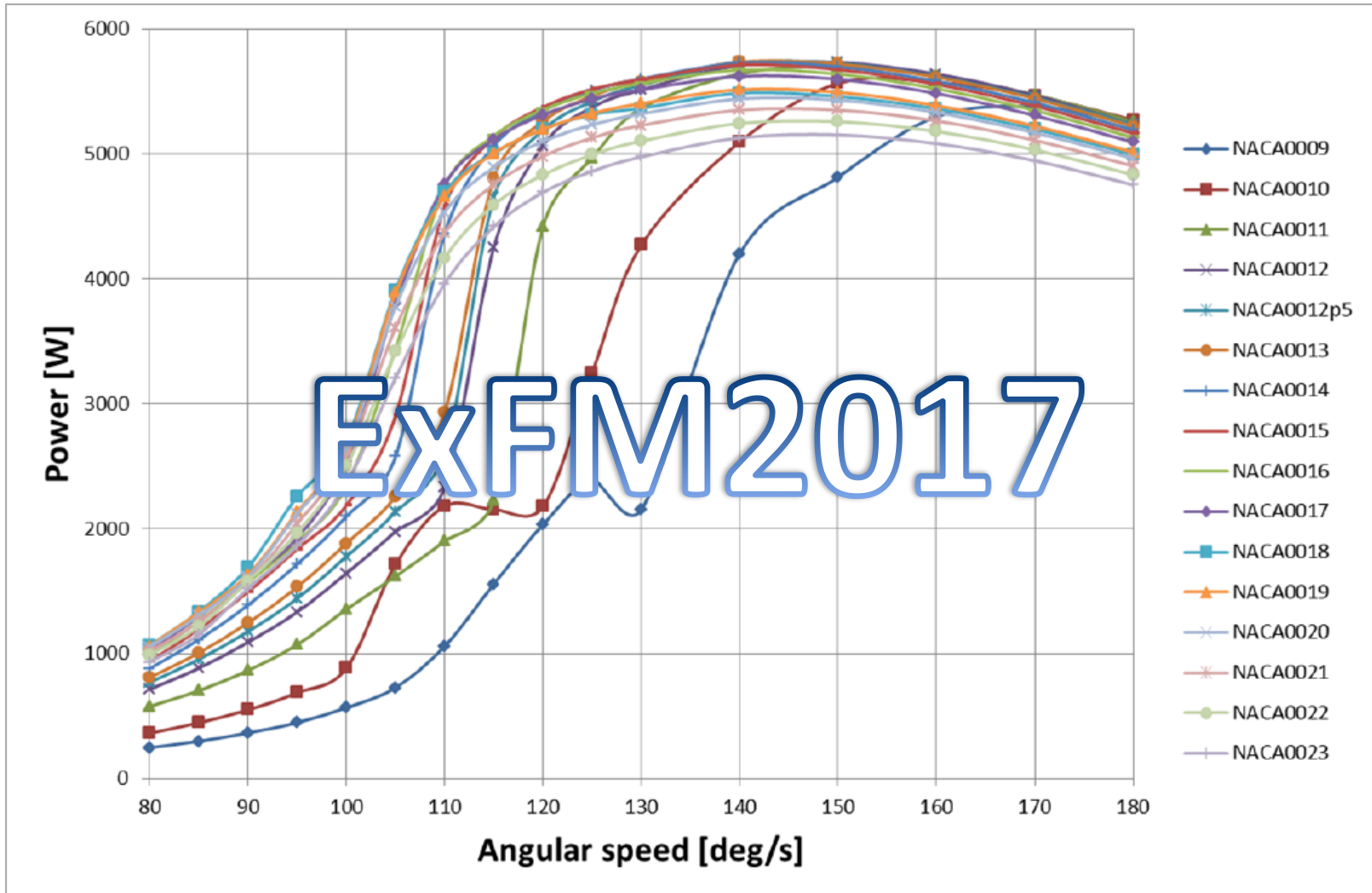
ExFM2017



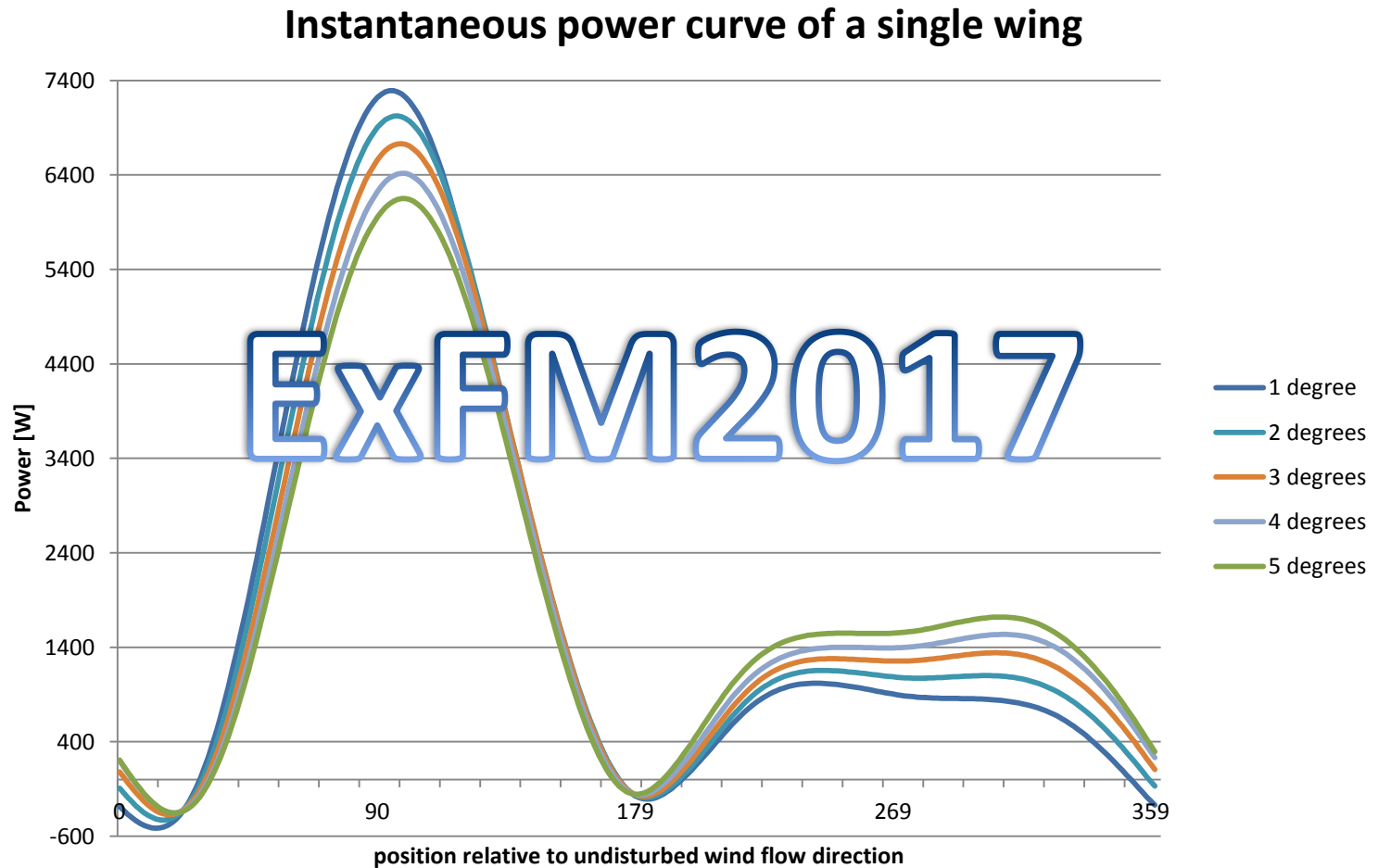
Angle of attachment for NACA0018



Effect of profile thickness on power



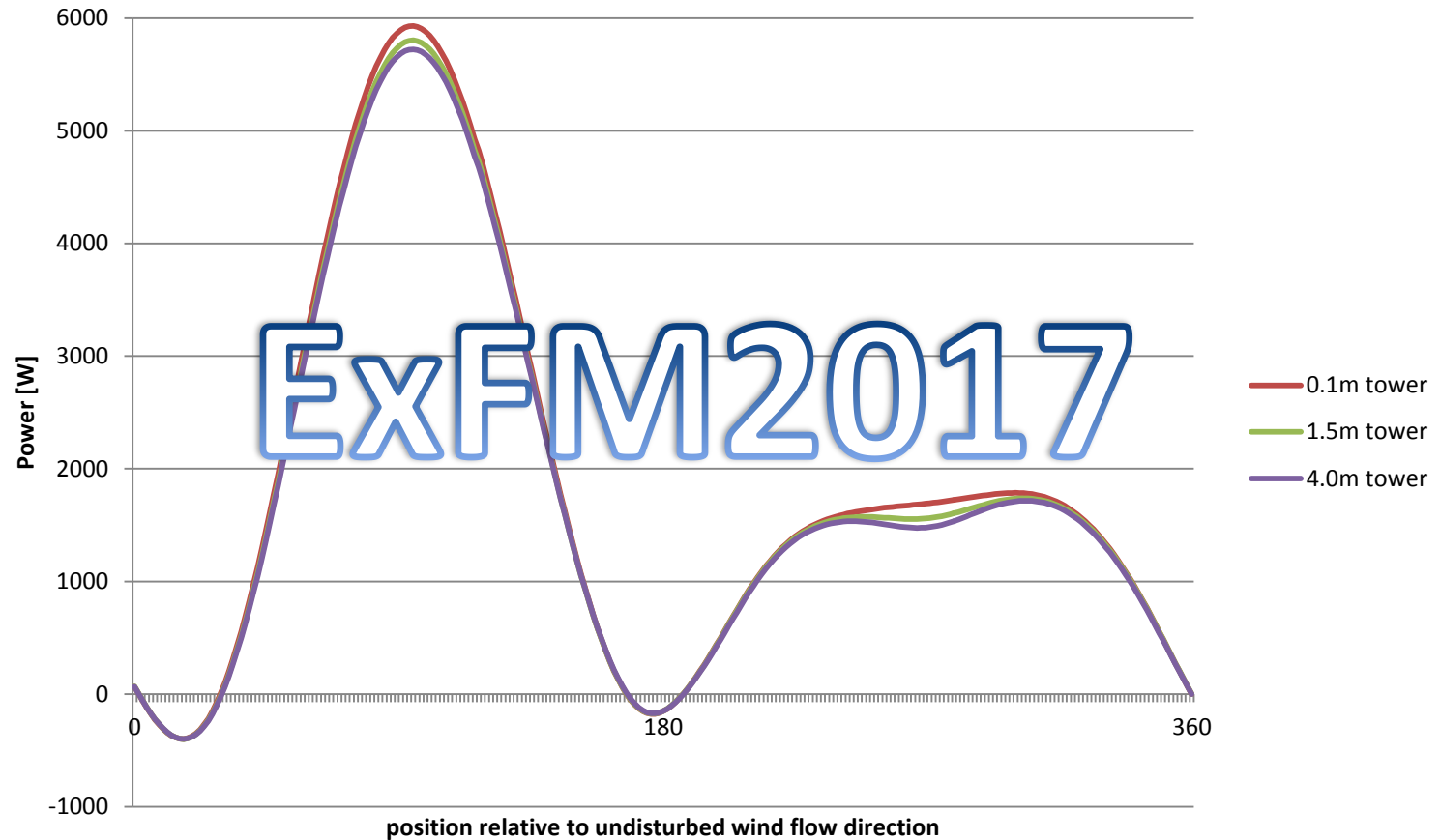
Angle of attachment for optimal airfoil



ExFM2017

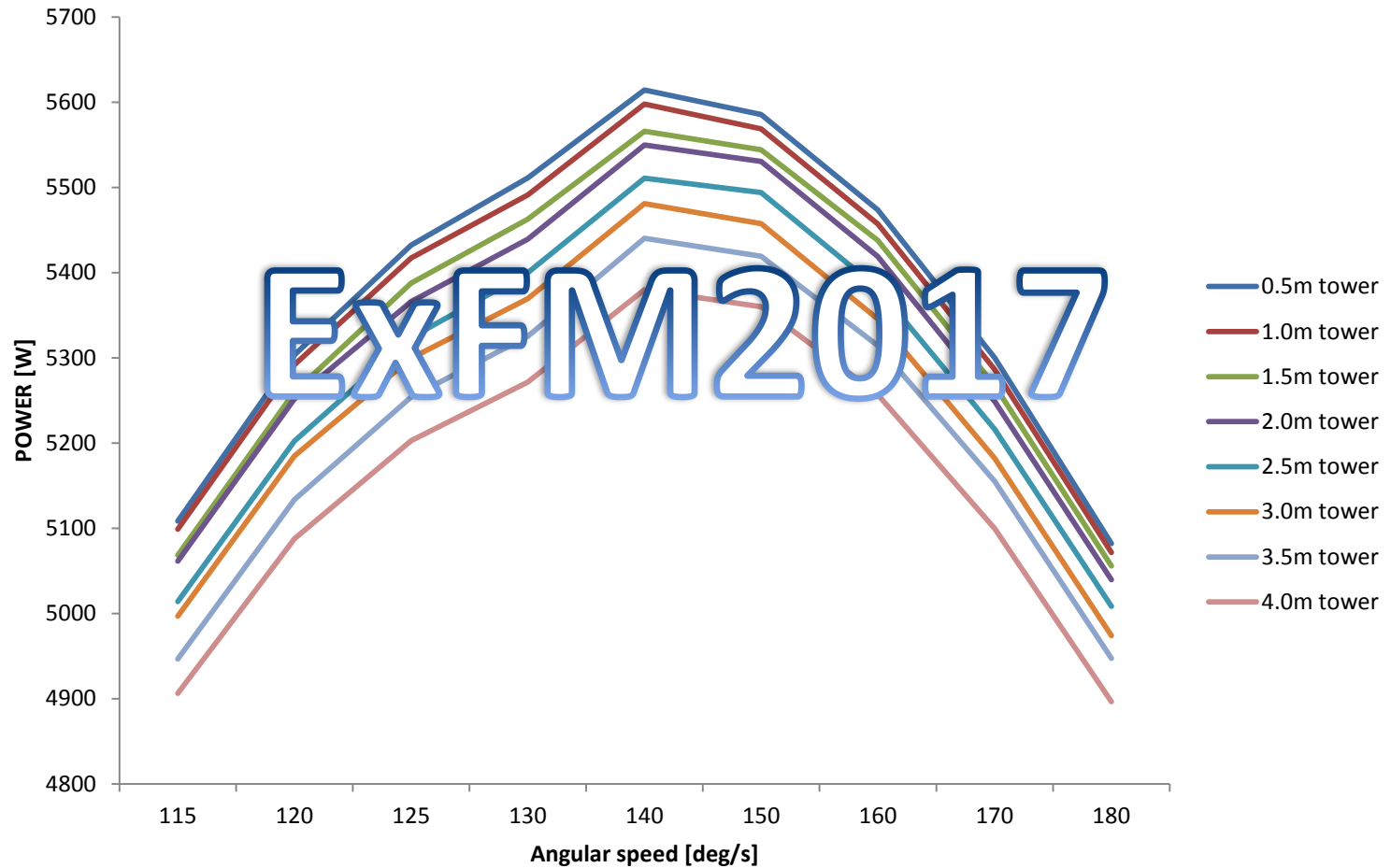
Tower diameter

Instantaneous power curve of a single wing

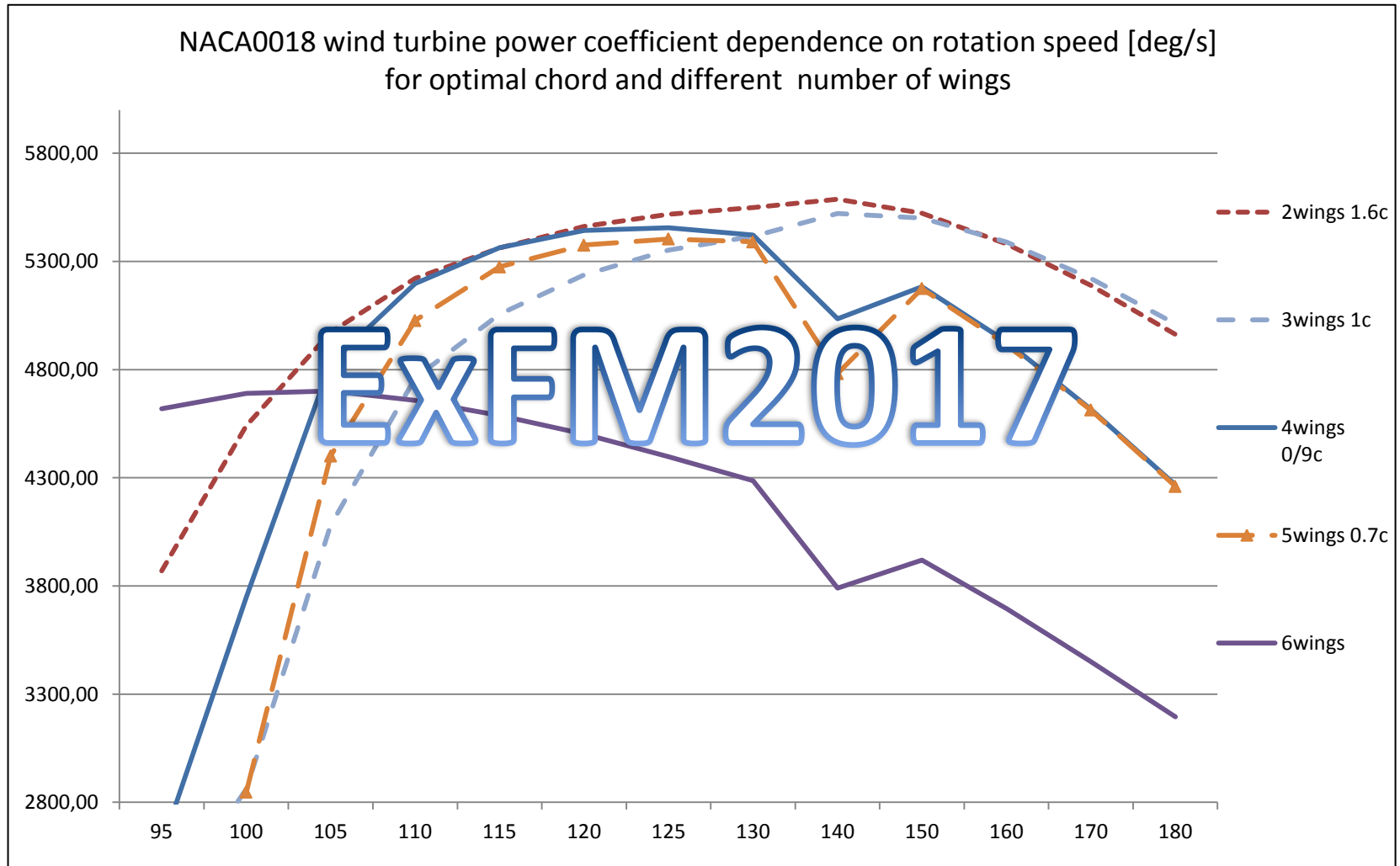


Tower diameter

Power/Angular speed for different tower diameters



Number of wings



Scale

Table 2. Aerodynamic efficiency of 3-wing turbine at different scales for a range of Wing Speed Ratios

WSR	Aerodynamic efficiency [%]					
	scale					
	1:40	1:10	1:4	1	4	10
1,75	0,3%	2,3%	5,3%	10,6%	15,7%	18,6%
1,85	0,5%	3,1%	7,1%	13,3%	19,0%	23,0%
1,96	0,8%	4,2%	9,1%	16,8%	24,5%	29,0%
2,07	1,2%	5,6%	11,3%	22,5%	29,6%	38,5%
2,18	1,9%	8,3%	13,7%	27,9%	43,1%	49,8%
2,29	2,7%	11,7%	19,6%	37,9%	50,6%	53,7%
2,40	3,7%	12,7%	27,1%	46,7%	53,6%	55,8%
2,51	5,4%	17,8%	37,2%	49,8%	55,3%	57,1%
2,62	7,0%	25,7%	42,7%	51,7%	56,4%	57,9%
2,73	9,7%	31,9%	45,6%	52,9%	57,1%	58,4%
2,84	15,1%	36,1%	47,3%	53,4%	57,5%	58,6%
3,05	25,5%	40,3%	49,6%	54,6%	58,0%	59,0%
3,27	29,0%	42,0%	50,1%	54,3%	57,5%	58,5%
3,49	29,2%	41,9%	49,5%	53,4%	56,4%	57,5%
3,71	28,0%	41,1%	48,2%	51,8%	54,9%	56,1%
3,93	26,0%	39,3%	46,1%	49,7%	53,0%	54,3%

Chord for 1:10 scale

Table 3. Aerodynamic efficiency of 1:10 scale 3-wing turbine with modified chord length for a range of Wing Speed Ratios

WSR	Aerodynamic efficiency [%]					
	Chord					
	1	1.1	1.2	1.3	1.4	1.5
1.75	2.3%	3.4%	4.2%	5.1%	5.6%	6.3%
1.85	3.1%	4.5%	5.5%	5.9%	6.8%	10.0%
1.96	4.2%	5.8%	6.7%	7.7%	10.4%	14.5%
2.07	5.6%	7.0%	8.9%	11.4%	14.3%	15.9%
2.18	7.3%	5%	2.5%	15.1%	18.5%	24.6%
2.29	9.7%	11.8%	6.1%	21.1%	27.8%	34.3%
2.40	12.7%	17.6%	23.9%	31.2%	36.4%	39.7%
2.51	17.8%	26.2%	32.5%	37.5%	40.9%	42.5%
2.62	25.7%	33.2%	38.0%	40.9%	42.8%	43.5%
2.73	31.9%	37.6%	40.9%	42.7%	43.6%	43.7%
2.84	36.1%	40.1%	42.3%	43.4%	43.8%	43.4%
3.05	40.3%	42.9%	43.8%	43.9%	43.3%	42.2%
3.27	42.0%	43.4%	43.3%	42.6%	41.5%	39.6%
3.49	41.9%	42.4%	41.8%	40.3%	38.3%	35.7%
3.71	41.1%	40.8%	39.2%	36.9%	34.3%	31.3%
3.93	39.3%	38.1%	35.9%	33.2%	29.6%	26.0%

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