VALIDATION OF WIND SPEED DISTURBANCES TO CUPS AT THE METEORLOCICAL MAST ON THE OFFSHORE PLATFORM FINO1 USING WIND-LIDAR MEASUREMENTS

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DOWNVInD EU-Project

FINO 1 2 3
Forschungs- und Entwicklungsplattformen in Nord- und Ostsee Nr. 3

FINO BMU-Project

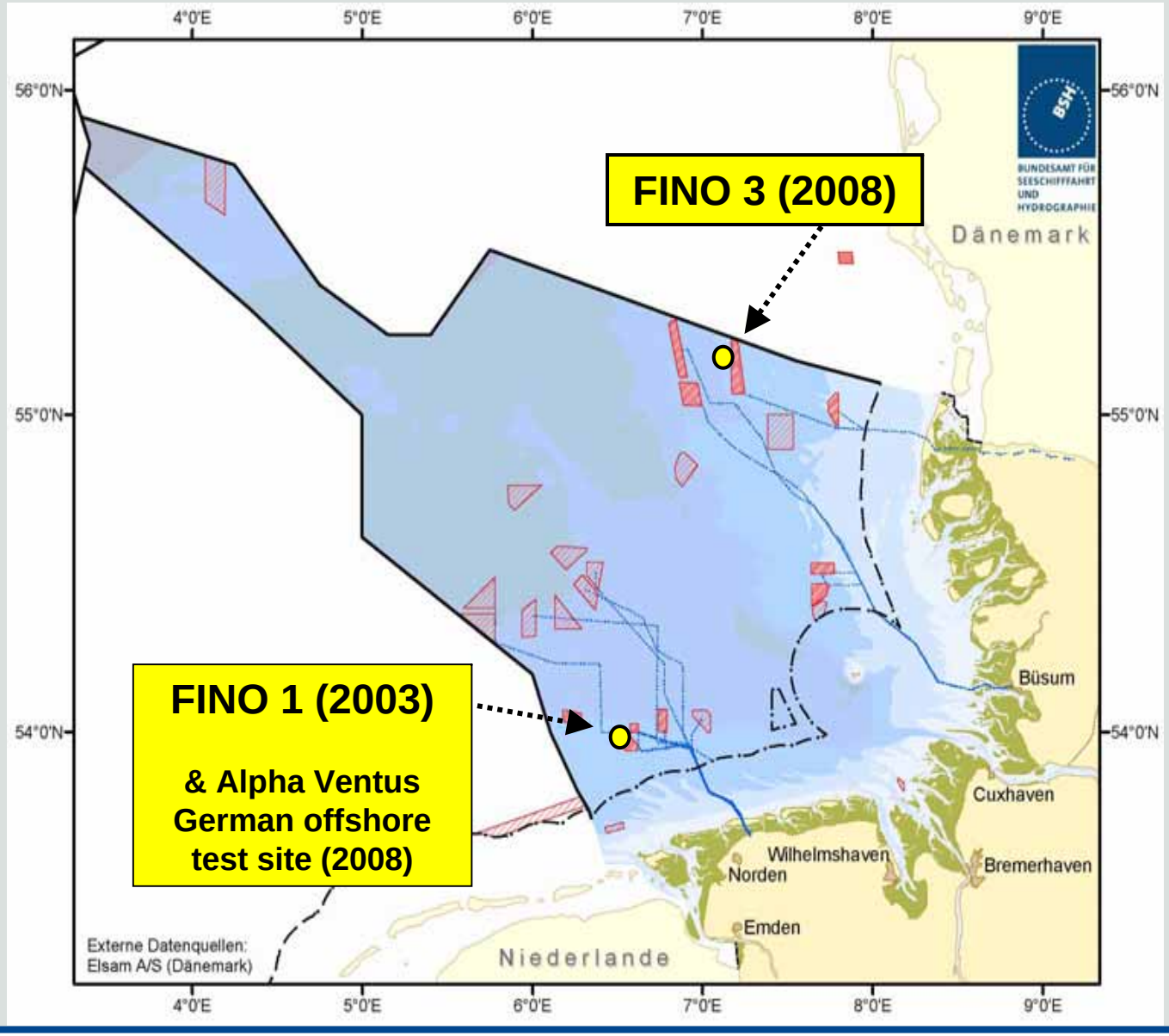
- Motivation
  Undisturbed wind measurements offshore
- North Sea research platforms FINO-1 & -3
- Assessment of a wind LiDAR system
  offshore on FINO-1
- **Investigation of the distorted wind flow by the met. mast structure on the FINO-1 platform**
  → using a wind LiDAR
- Application to future measurements on FINO-3

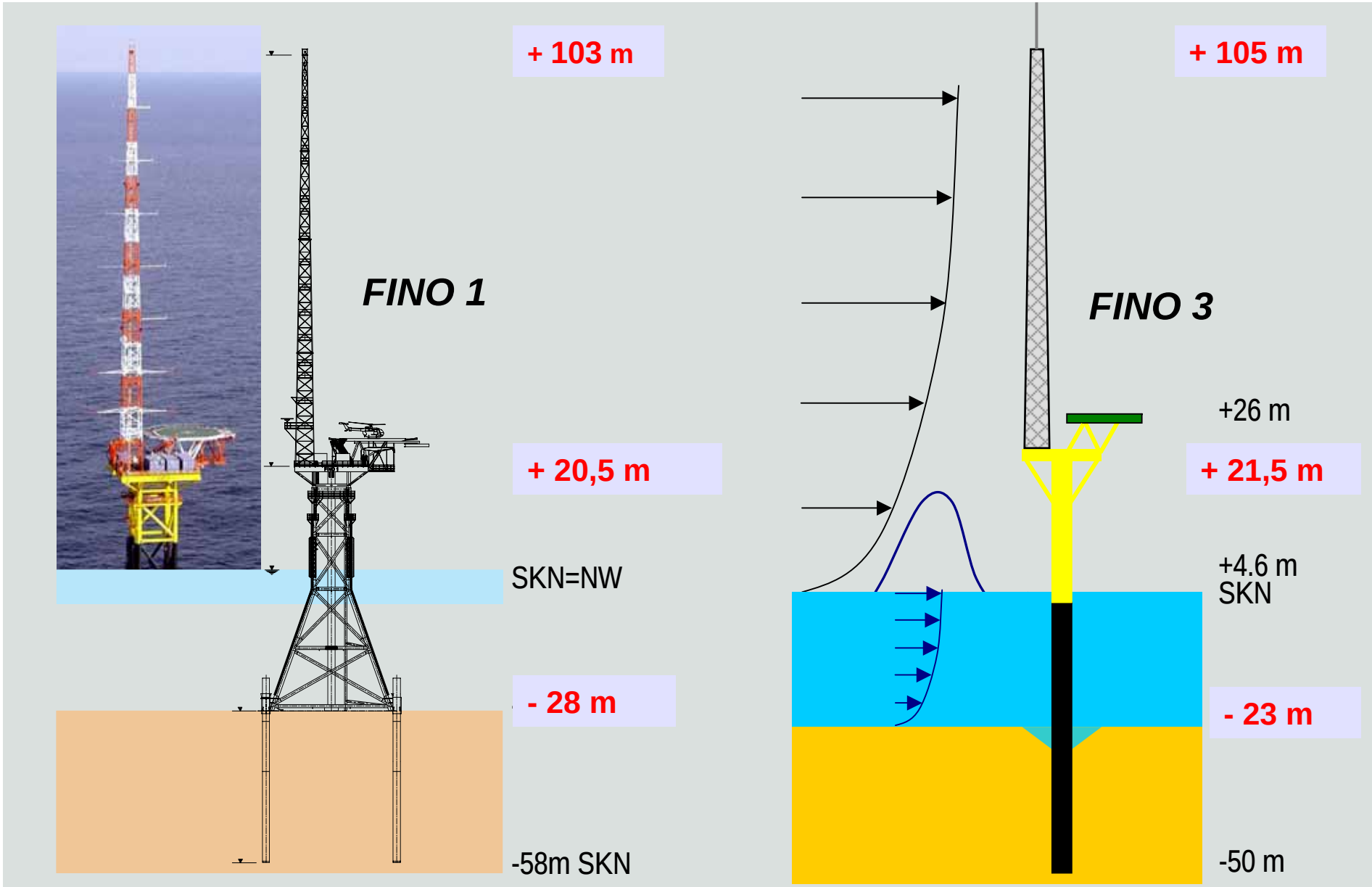
Outline

- **Wind speed measurements offshore masts**
  → wind statistic, speed and direction
  → wind speed profile
  → energy yield analysis

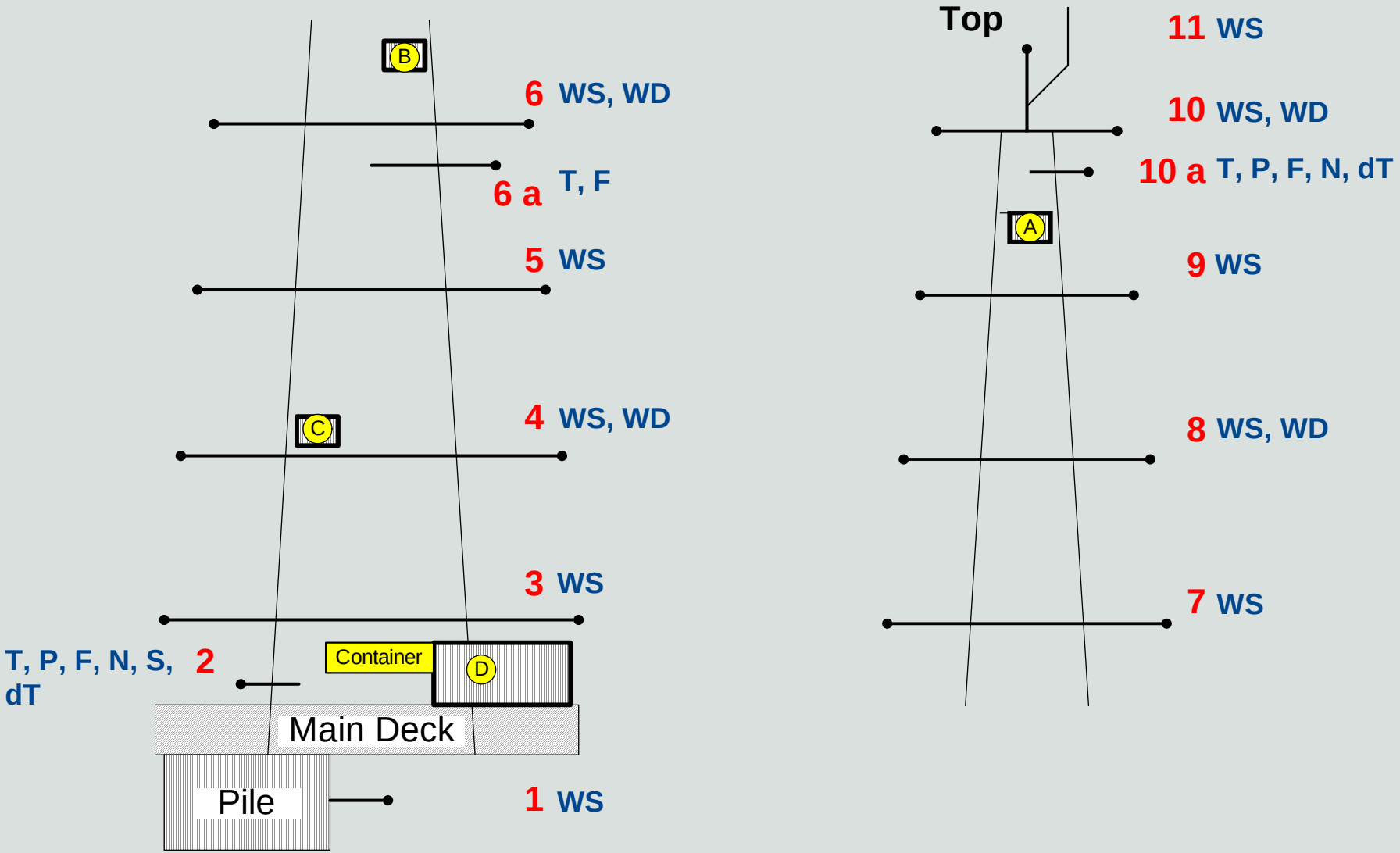
- **High quality data**
  → at all heights
  → for all wind directions

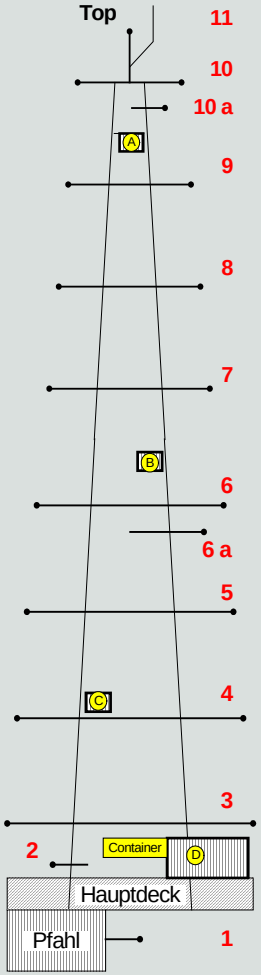
- **<u>Attention:</u>**
  wind flow distortion by mast structure itself
  (in certain wind directions)


FINO 3 (2008)
FINO 1 (2003)
& Alpha Ventus
German offshore
test site (2008)
Dänemark
Niederlande
Büsum
Cuxhaven
Wilhelmshaven
Norden
Bremerhaven
Emden
Externe Datenquellen:
Elsam A/S (Dänemark)
4°0'E
5°0'E
6°0'E
7°0'E
8°0'E
9°0'E
56°0'N
55°0'N
54°0'N



Layout FINO 1 vs. FINO 3


Top
11 WS
10 WS, WD
10 a T, P, F, N, dT
A
9 WS
8 WS, WD
7 WS
B
6 WS, WD
6 a T, F
5 WS
C
4 WS, WD
3 WS
T, P, F, N, S, dT
2
Container
D
Main Deck
Pile
1 WS

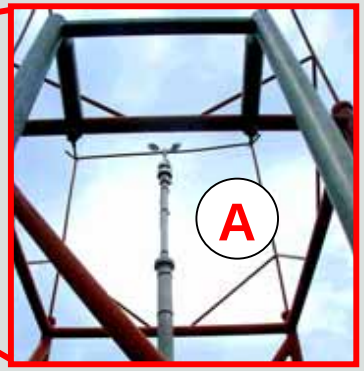


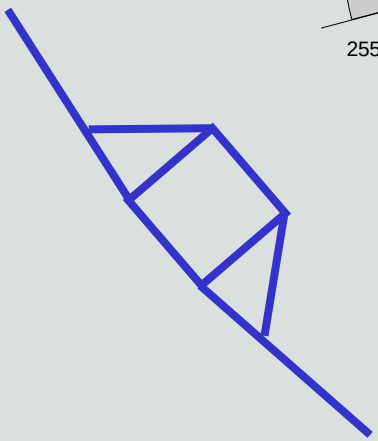
WS Cup 1 Hz

WD Vane 1Hz

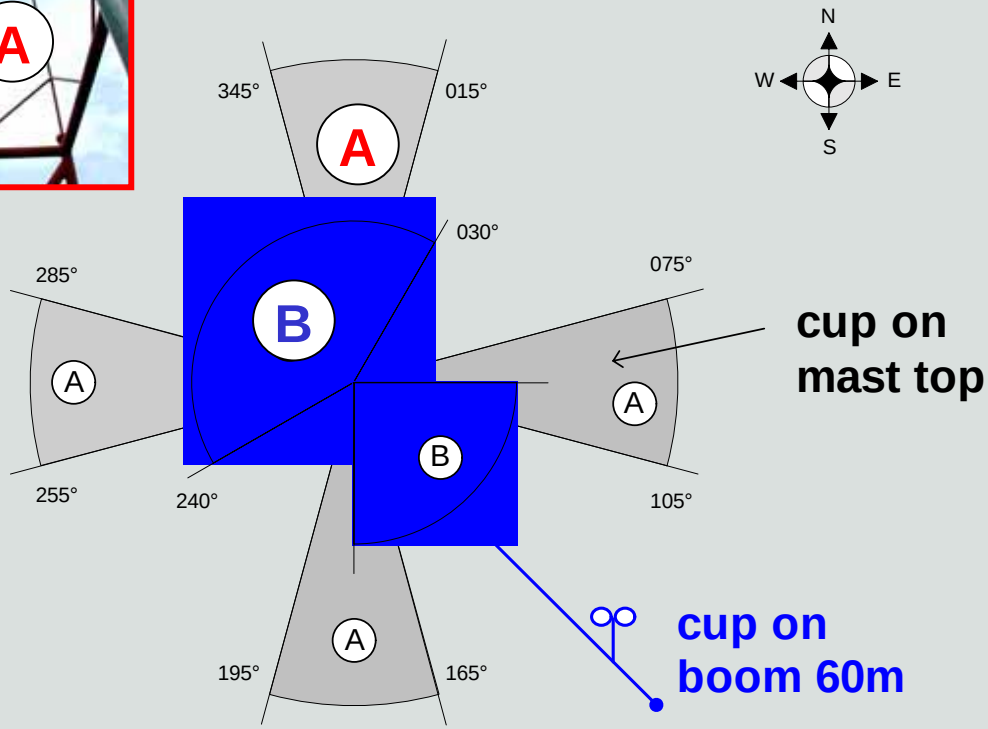
WS/WD SONIC
10 Hz

Square Mast Base



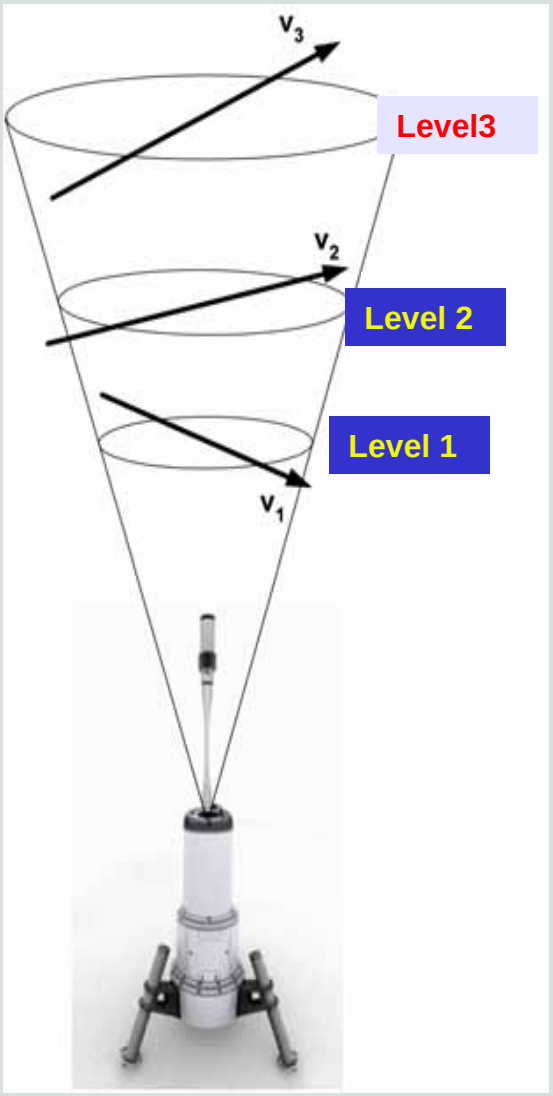


Disturbed Sectors

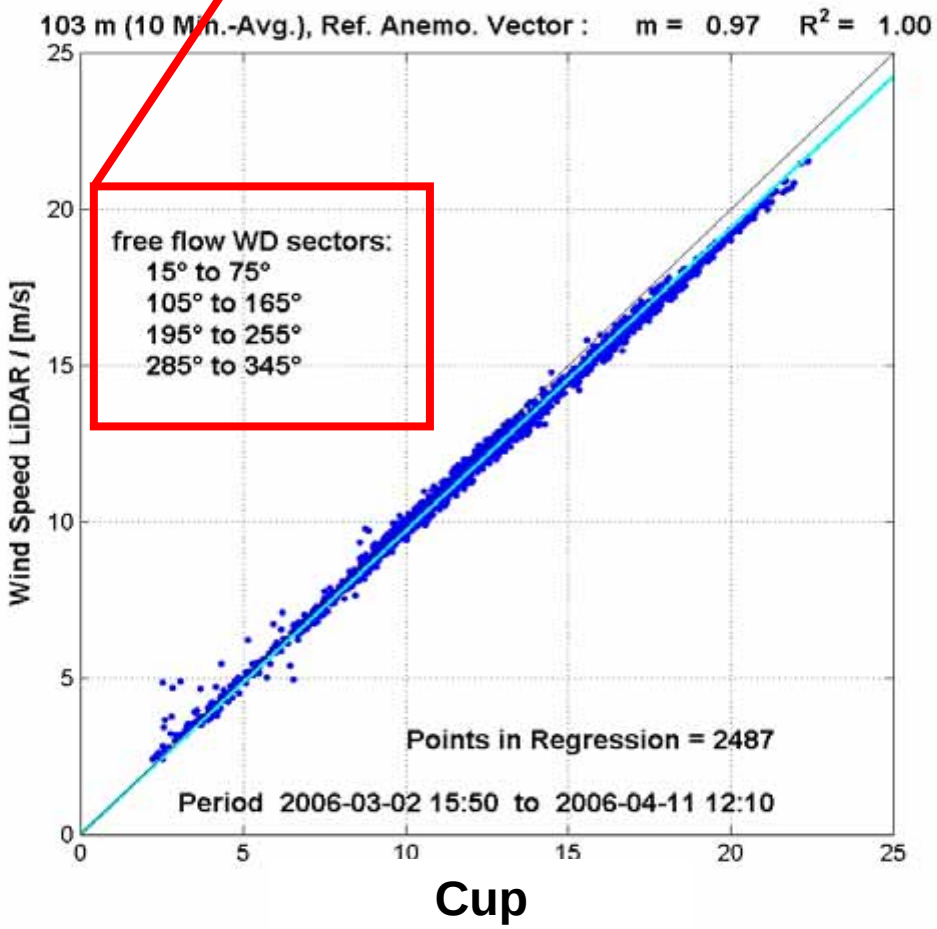


Comparison

- top level & 2 boom levels
- Cups, disturbed
- LiDAR, undisturbed



Undisturbed top sectors



Height:

103 (78) m

WS range:

2 to 23 m/s

Slope:

m = 0.97

Regr. coefficient:

R^2 = 0.99

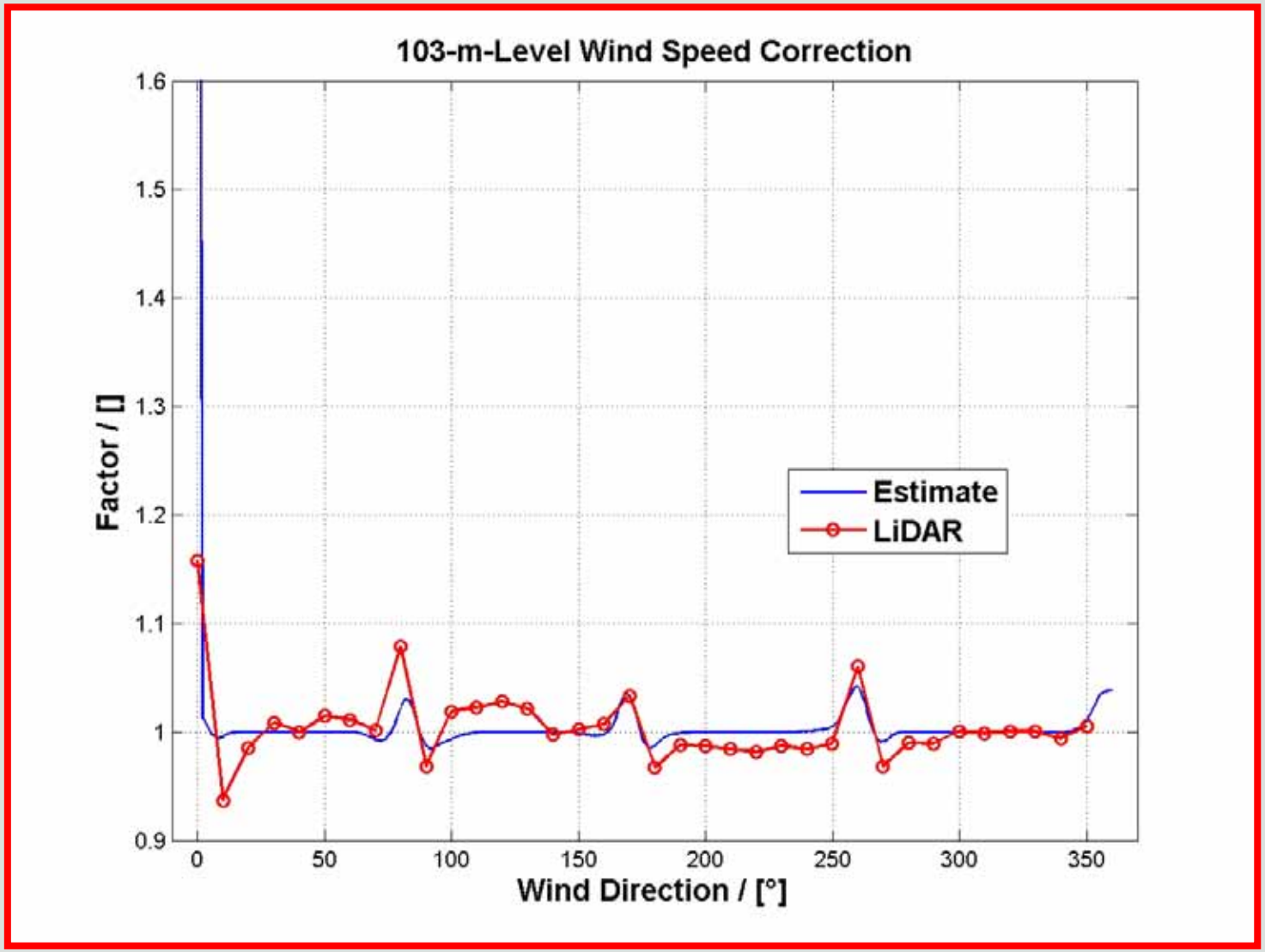
Analysis Sector	15°-75°, 105°-165°, 195°-255°, 295°-345°	30° to 90° and 180° to 240°	
	1st Period, 4 weeks		
	103 (78) m	**81 (56) m**	**61 (36) m**
10-min-avg. values	1965	/	/
Slope "m"	**0.97**	/	/
Regr. Coeff "R^2"	**0.99**	/	/
	2nd Period, 14 weeks		
	103 (78) m	**81 (56) m**	**61 (36) m**
10-min-avg. values	6005	2589	2749
Slope "m"	**0.98**	**0,97**	**0,98**
Regr. Coeff "R^2"	**0.99**	**0.99**	**1,00**

- **Use regression results from undisturbed sectors to correct LiDAR wind speeds**

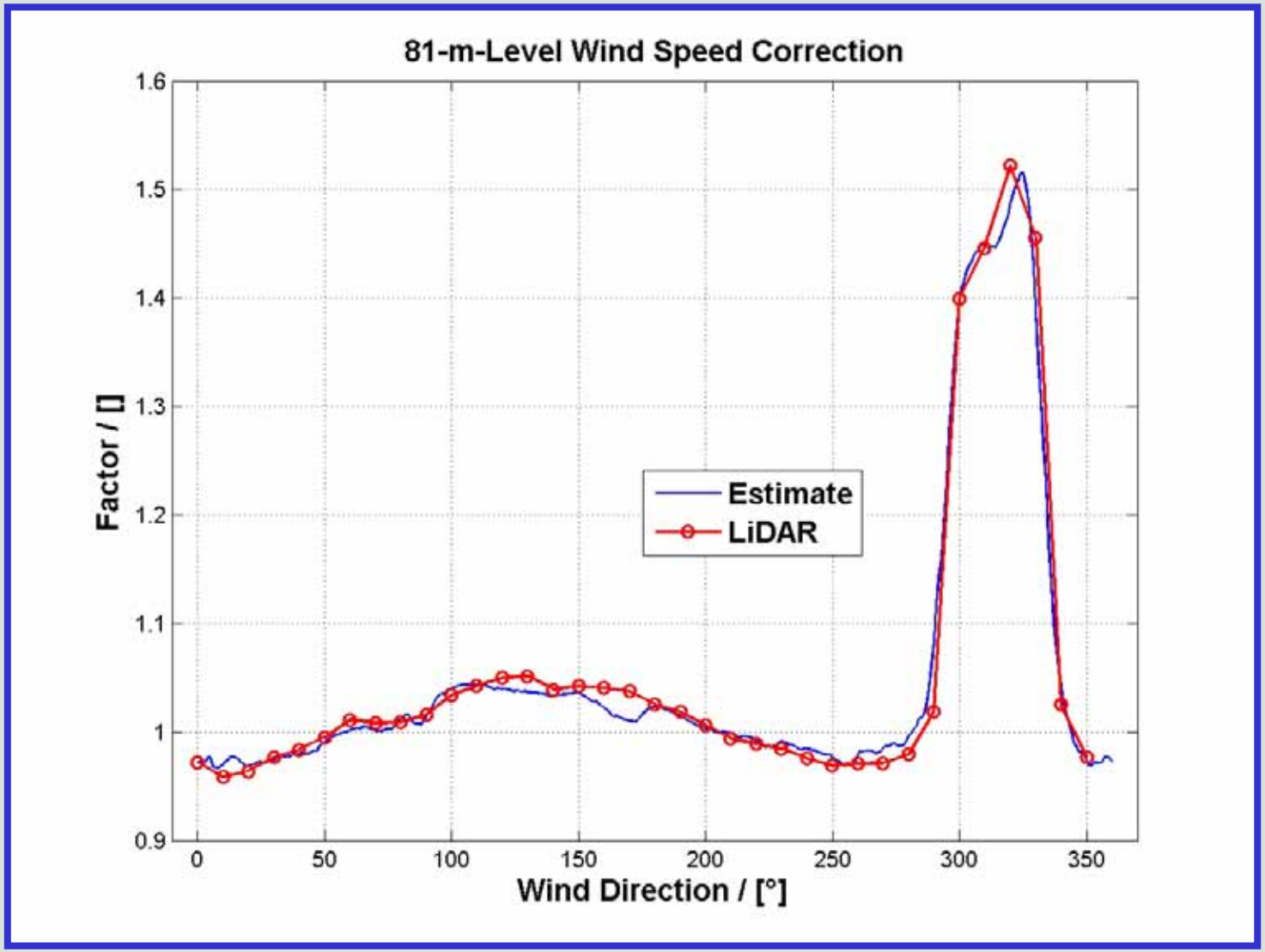
- **Use corrected LiDAR wind speeds as undisturbed equivalent of cup wind speeds for all wind directions, i.e. as well in disturbed sectors**

- **Derive correction factors in WD ranges, i.e. as well in disturbed sectors**

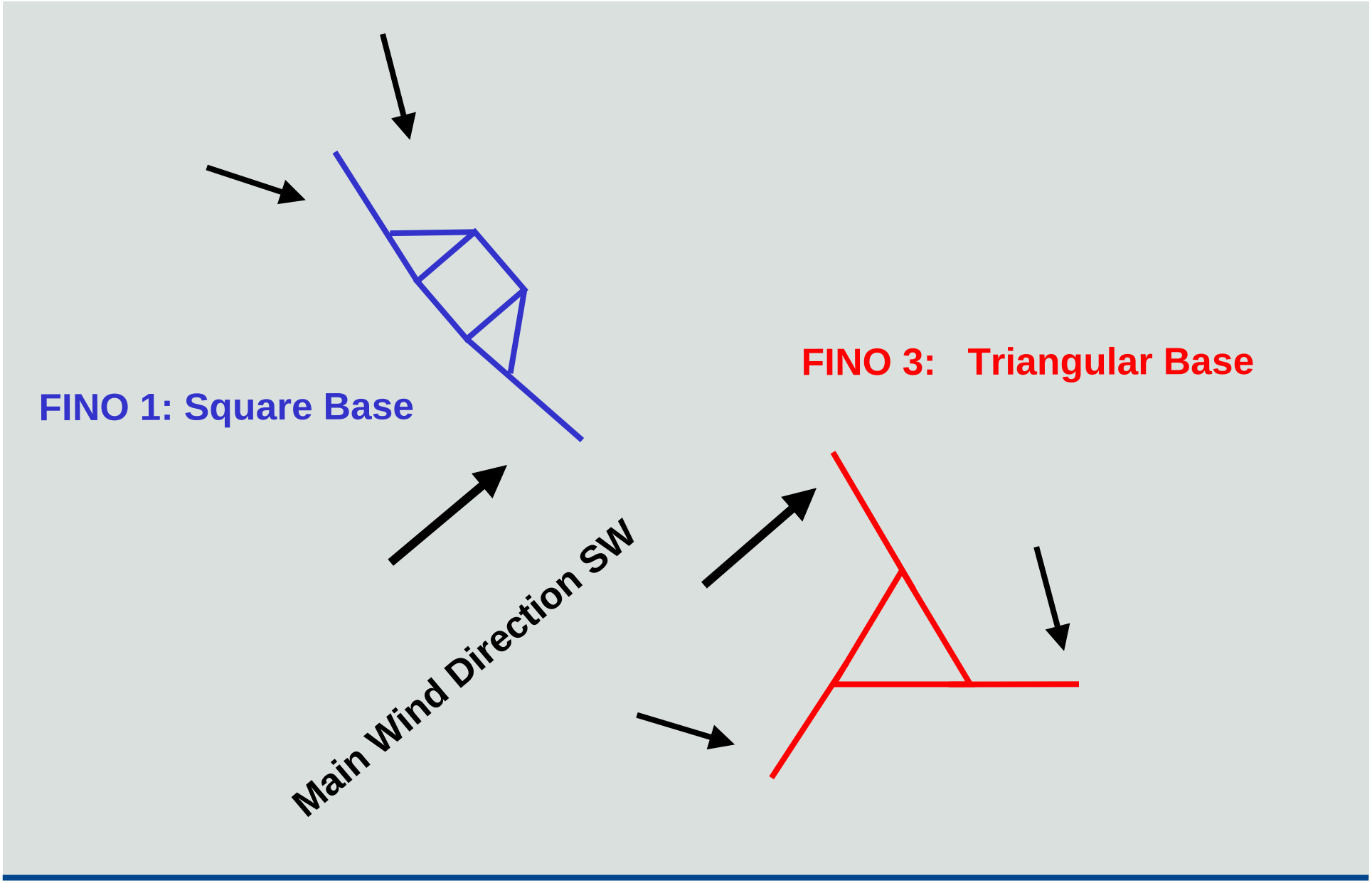
  …to be applied to the full time series

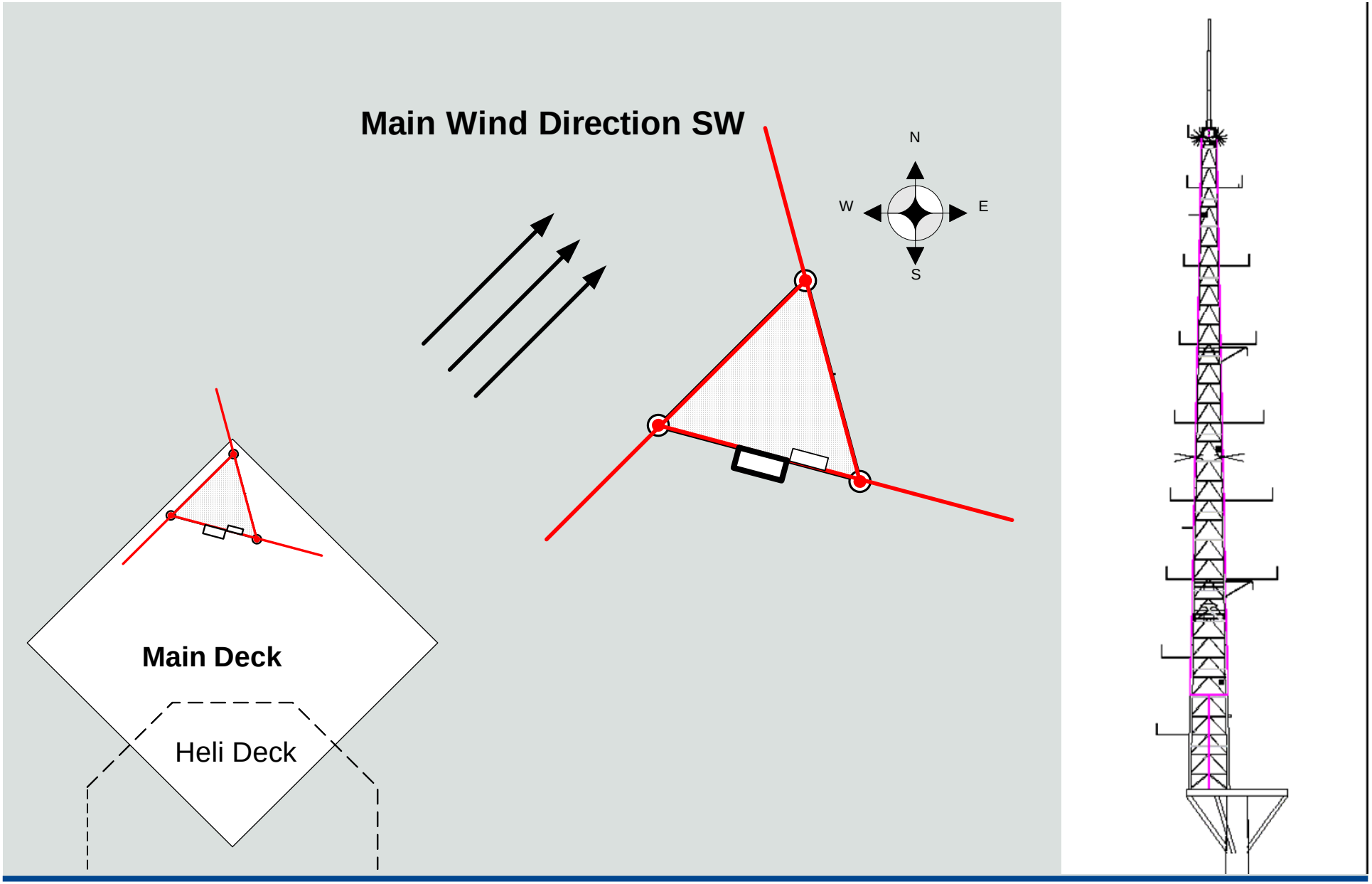


Top WS corrections 103 m



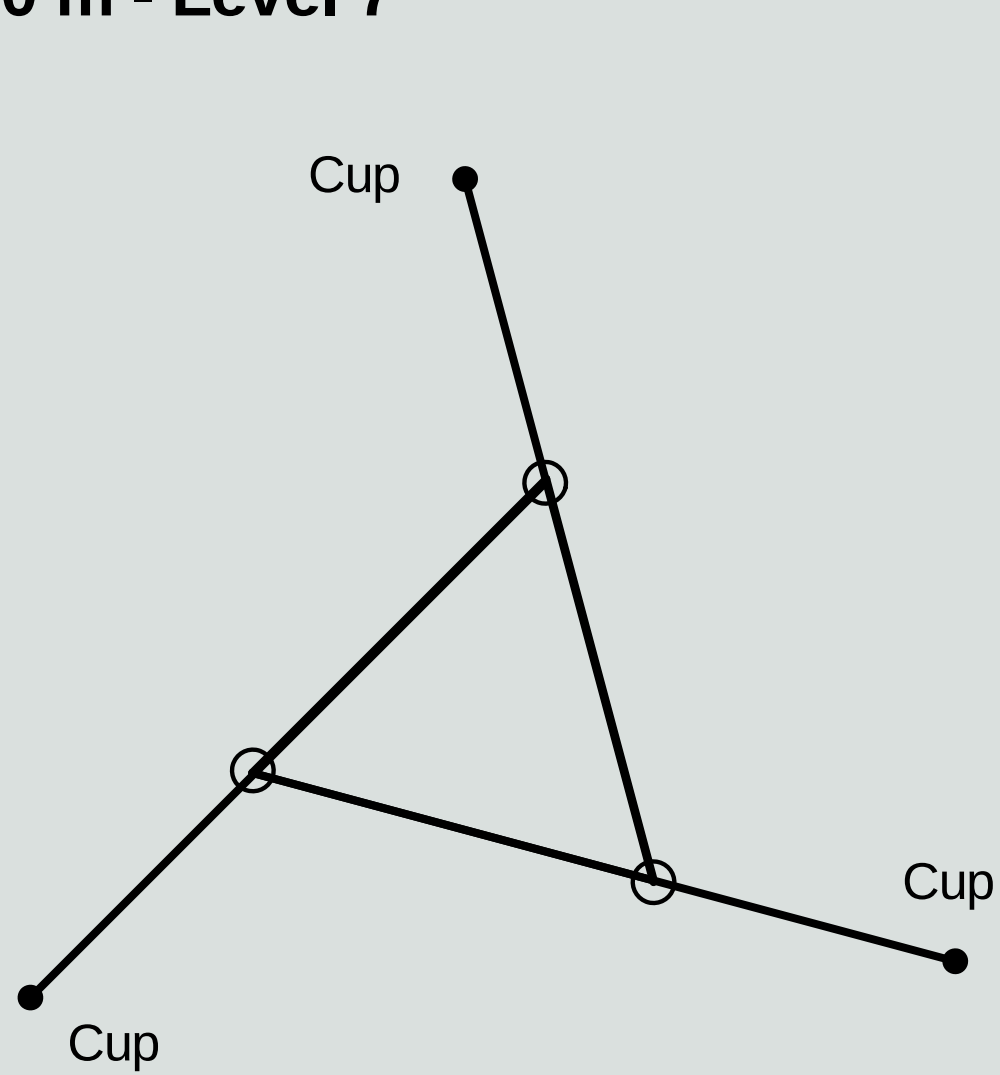
Boom WS Corrections 81 m

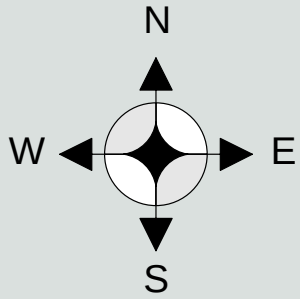

FINO 1: Square Base
FINO 3: Triangular Base
Main Wind Direction SW



FINO 3 – Mast & Boom Orientation

70 m - Level 7





- **Cup vs. LiDAR comparison campaign on FINO1**
  → LiDAR proved high quality and good availability
  → allowed an analysis of mast disturbance effects
- **Heavy disturbances of wind flow from mast structure**
  → need pre-cautions
  - slim mast structure
  - triangular mast shape → three boom directions
  - sufficient boom length
- **Consequences for FINO3**
  → triangular shaped, slim met. mast layout
  → final boom layout still to be defined
- **Outlook:**

  LiDAR as stand alone offshore wind monitoring tool
  → on smaller support structures (maybe floating…)
  → on existing offshore structures …
  … e.g. like oil & gas platforms
  … *research project*


Thanks