

VTT Technical Research Centre of Finland

VTT Icing wind tunnel 2.0

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VTT ICING WIND TUNNEL 2.0

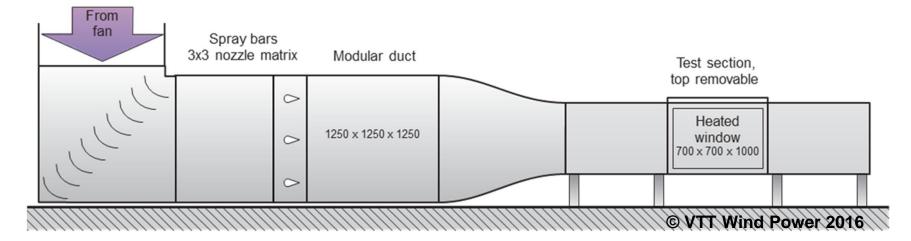
Winter Wind 2016 M. Tiihonen, T. Jokela, L. Makkonen & G. Bluemink VTT Technical Research Centre of Finland Ltd



NEED – Icing Wind Tunnel 2.0

- By 2012, 24% (69 GW) of global wind in Cold Climate (CC) /2/
- 2013-17 forecasts 10 GW/a in CC!! /2/
- Cold Climate solutions, especially the different anemometer, ice detector and coating markets in the wind power industry, resemble "the Wild West"
 - Missing standards and guidelines to verify the instruments and coatings for CC!
- Controlled laboratory environment is needed to solve the above mentioned challenge to accelerate R&D cycles and lower LCoE

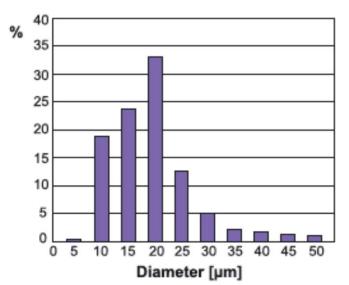




Performance of Icing Wind Tunnel:

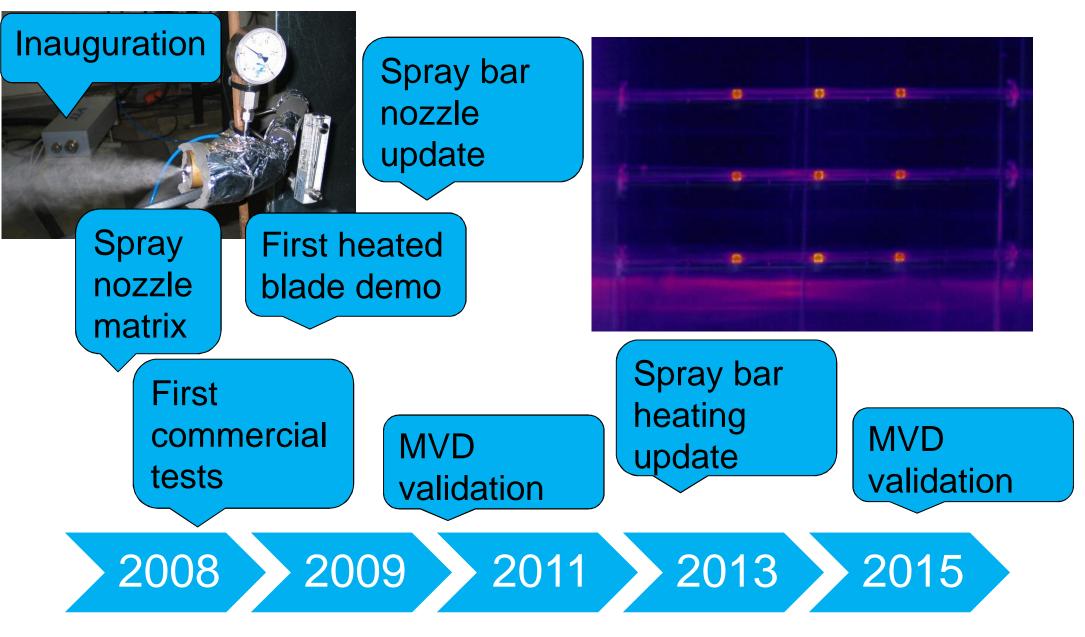
Property	Range in the facility	VTT's Reference conditions	
		In-cloud icing, stationary components	In-cloud icing, wind turbine rotor blades
Temperature [ºC]	-20+25	-5	-5
Wind speed [m/s]	050	7	40
Water content [g/m ³]	0.11.0	0.2	0.2
Droplet size, MVD [µm]	1735	20	20

Droplet size distribution:



10/02/2016

The journey of the VTT Icing Wind Tunnel





Approach – Icing Wind Tunnel 2.0



 <u>Controlled</u>, <u>calibrated</u> and <u>proven</u> laboratory environment provides repeatable in-cloud icing conditions in the VTT wind tunnel

glaze, rime and mixed ice can be formed on the surface of different test specimens



Approach – Icing Wind Tunnel 2.0

- For creating new ideas, testing prototypes and their functionalities, optimizing design and performing verification of different products in controlled testing environment
- Pre-certification test procedure & test conditions -5°C, 10 m/s:

LWC₁ = 0.1 g/m³; Light icing condition
LWC₂ = 0.2 g/m³; Standard icing condition
LWC₃ = 0.4 g/m³; Harsh icing condition
LWC₃ = 0.6 g/m³; Extreme icing condition

 VTT is an independent research institute that has globally unique capabilities to provide development services and pre-certification tests for different instruments, coatings, products and concepts for Cold Climate conditions.

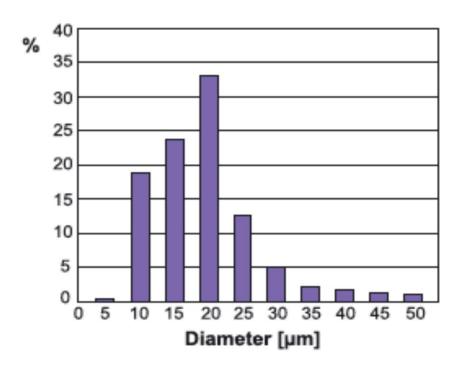


Validation of MVD

- Validated by FMI with CAPS (Cloud, Aerosol and Precipitation Spectrometer Probe)
- MVD was just right, not what we feared ^(C)



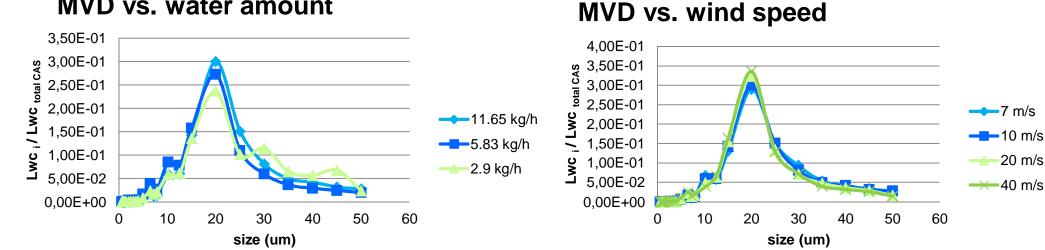
Droplets size distribution:



Validation of MVD

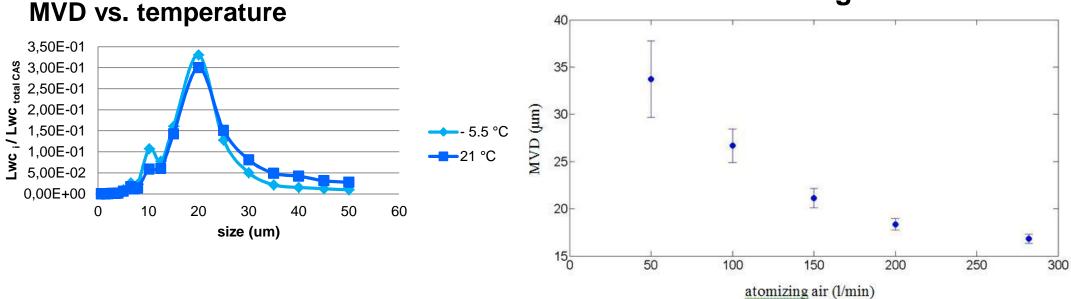


20 m/s



MVD vs. water amount





Benefit – VTT Icing Wind Tunnel 2.0



- What is the benefit for the customer?
- End user: developer or turbine OEM
 - Know what you are buying!
 - Know ice detector performance and application options!
- Sensor manufacturer
 - Faster R&D cycles
 - Increase sales & confidence with pre-certification report

Benefit – VTT Icing Wind Tunnel 2.0 Applications

- New advanced VTT <u>ice adhesion test method</u> with high accuracy and repeatability compared to the rotational ice adhesion testing method_{/3/}
 - Multiple, simultaneous coating specimens for faster and more comparative results /4/
- Coating tests can be performed on blade section /4/
 - Coating durability tests also possible



VTT Icing Wind Tunnel 2.0 Applications



VTT basic ice adhesion tester /4/

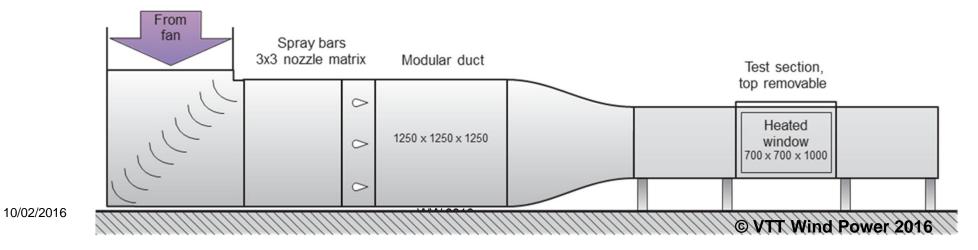




Summary

 VTT Icing Wind Tunnel facility has a unique potential for creating new ideas, testing prototypes and their functionalities, optimizing design and performing verification of different products in controlled testing environment

 Droplet size distribution (MVD) is <u>validated</u> by Finnish Meteorological Institute (2015) /1/



References



- Droplets Size Distributions Measurement by Finnish Meteorological Institute (FMI), Atmospheric Composition Research with CAPS (Cloud, Aerosol and Precipitation Spectrometer Probe) at VTT Icing Wind Tunnel 2015.
- A BTM Wind Report. 7 Special Chapter: Cold Climate Turbines ("CCTs"). Navigant Research. World Market Update 2012. International Wind Energy Development Forecast 2013-2017. 26th March 2013.
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- 4. Makkonen, L., 2014: TopNANO Final Seminar. Designing and testing coatings for easy ice release. VTT Technical Research Centre of Finland. 6.5.2014. Power Point presentation.

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