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Hands-On with Degreane Horizon PCL-1300

Baptiste Domps*, J. Marmain, C. Melnotte and T. Pugliesi

Degreane Horizon – Radar and Scientific Applications Department

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Specialist Meeting on Electromagnetic Waves and Wind Turbines École Nationale de l'Aviation Civile, 5-6 Dec 2019



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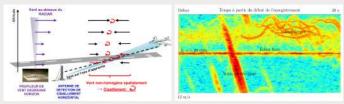
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Research Topics

Degreane Horizon Wind Profiler: measures wind speed and direction on a vertical axis (meterological agencies, airports)

Our 'usual' research topic: wind shear detection



Our 'wind energy' research topic: wind assessment using radar system

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- Early stages
- Marketing studies, requirements





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Degreane Horizon

- Based in Toulon (French Riviera)
- 70 people, sales: €10m

Our expertises





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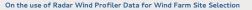
Our expertises





A full range of worldwide-trusted weather sensors, e.g.:









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- 70 people, sales: €10m

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Defence



Space surveillance radar

Air-droppable met system



Underwater acoustics





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- 70 people, sales: €10m

Our expertises





Energy/transport

Remote alarm systems, Data transmission, Remote control, Galvanic Isolation Devices

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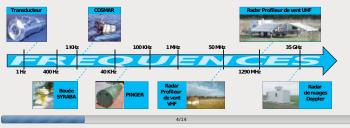
- Based in Toulon (French Riviera)
- 70 people, sales: €10m

Our expertises





A wideband knowledge



On the use of Radar Wind Profiler Data for Wind Farm Site Selection



Forward

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VINCI group

Global player in concessions and construction

Degreane Horizon is part of VINEL , itself part of VINCI group



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- Investor, builder and operator of buildings and infrastructure
- Worldwide business (≈ 100 countries)
- At the heart of today's challenges









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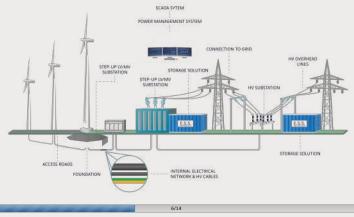
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Wind energy and VINCI Énergies

Dedicated brand for energy transition: **OMEXOM**

- 21k people, 33 countries
- Power (wind & solar), transmission, substations, distribution, territories





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Degreane Horizon Wind Profiler: measures wind speed and direction on a vertical axis

- L-band (pprox 1,3 GHz)
 - 3 to 5 arrays of dipoles
 - Range from 75 m to 5 km
 - 75 m max resolution
 - 2 min temporal resolution
- Deployed on > 50 sites worldwide, many references in the meteorological literature as a reliable instrument

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• Optional temperature profile with RASS system



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Setup example



(hard or mobile installation)

Remote Data Analysis

- Custom-setup: hard or mobile
- Turnkey solution (including civil engineering if needed)

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- Robust system with autonomous and continuous operation under all weather conditions
- Remote data analysis
- Life span > 10 years, low operating costs



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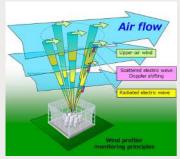
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Wind remote sensing with radar

Detection of irregularities of the refractive index of particle-free clear air

These irregularities are caused through variations in the temperature, pressure and moisture that affect the propagation of electromagnetic waves and backscattering



Japan Meteorological Agency

- Doppler Beam Swinging technique to compute wind vector
- Applications: Aeronautic safety, Meteorological forecasting, Study of atmosphere's dynamic, etc.





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Wind remote sensing with radar Case study: Wind Shear & Wind Barb display (3 min sampling, 7 hours data)

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Time vs Altitude





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Network Control **Profiler Signal** Profiler Profiler Processor Center Data Processor Coherent integration Fuzzy Logic ·FFT **Profiler Data** Processor InCoherent Integration Running .Ground Clutter **Data Archive** Consensus Rejection Multiple Peak Moments Calculation Statistical Dissemination OC. Weber-Wuertz OC Spectrum Wind, Temp. Date Humidity Profiles

• Own software tailored to customer's requirements

Local Site

• Full quality control functionality is provided at all stages of signal and data processing

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Wind, Temp, Humidity Profiles



Met Building



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Generalities about Wind Potential Assessment

- One of the first step when designing a Wind Farm Project
- Ensures economic viability of the farm:

Identification of wind site (mesoscale wind atlases);

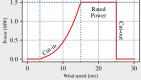
- 2 preliminary evaluation;
- assessment of site and micrositing.

Wind Potential depends on *w*:

$$P_W = \frac{1}{2}\rho A w^3$$

 $f(w) = \frac{k}{\lambda} \left(\frac{w}{\lambda}\right)^{k-1} \exp\left(-\frac{w}{\lambda}\right)^{k}$





Power Curve is non-linear

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Goal: Find the most realistic (λ ; k) parameters



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Masts

- 3 different Meteorological Towers:
 - Site Selection: 40 m, 2 years data, 1/site
 - Measures Wind direction & speed, humidity, temperature
 - Verify Wind Atlases Data
 - Wind at the rotor's height is **estimated** with the Wind profile power law
 - Ø Micrositing: 100 m, 2 months, 1/Wind Turbine
 - Validation of Wind Turbine position
 - Operation: 100 m, during all Wind Farm's life, 1/site
 - Met Monitoring

Expensive, Civil engineering required, No errors permitted, Height limitation



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There are even offshore met masts! FINO-1: 80 m

D. Muñoz-Esparza, F. Miceli





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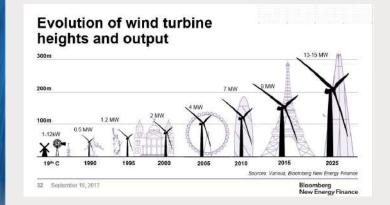
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Issues with classical instruments

Masts are becoming too short



• WTG's rotor is now outside the radar's blind zone



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Issues with classical instruments

Anemometer/Lidar/Radar

Anemometer mounted on Met Masts: sensitive to Aerodynamics Effects because of the mast

Pros for Lidar Very high radial resolution for low altitudes Cons for Lidar Expensive, Mechanical parts

Pros for Radar All-weather, Reliable, Temperature & Humidity with RASS

Cons for Radar Lower resolution, Blind zone near ground



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Wind Assessment with Wind Profiler

Reduce the blind zone:

- First gate at 75 m
- Ground noise and fixed-echoes issues

Ø Better resolution:

- Resolution depends on Pulse Width: $r = \frac{c\tau}{2}$
- Present shorter Pulse Width is au= 0.5 $\mu {
 m s}$
- Faster switching: less transmit power



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- Promising alternative to met masts
- Wind speed & direction but also temperature with RASS
- I would be happy to discuss further ^(C)



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