

# LIDAR Technology for Flight Safety



# Applications of LIDAR Technology

WINDEX-300 and WINDEX-5000 LIDAR Wind Profilers may be used in different industries which require provision of operative wind situation information as well as acquisition of statistical wind parameters data



## Wind Situation and Ceiling

Hazardous wind phenomena detection (wind shear and turbulence) as well as ceiling detection



## Wake Vortex

Detection of wake vortices behind aircraft in the terminal area



## Wind Profile

Vertical wind profile detection in heliport areas and landing grounds for other types of aircraft, including aerostatic ones

## Aerobatic Application

Receive information about wind parameters at given altitudes during training flights, stunt flying, championships of aerobatic, gliding, balloons, airships, etc.



## Green Application

Wind situation analysis in the ecologically hazardous objects to provide pre-disaster planning to protect environment from pollution



## Wind Energy

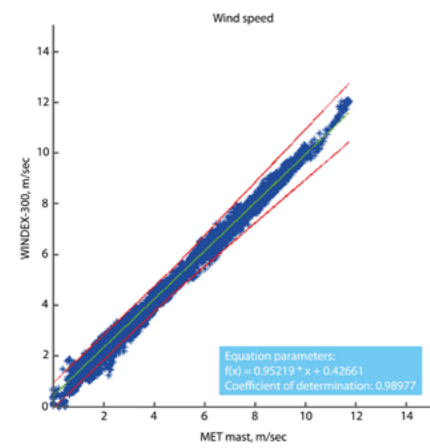
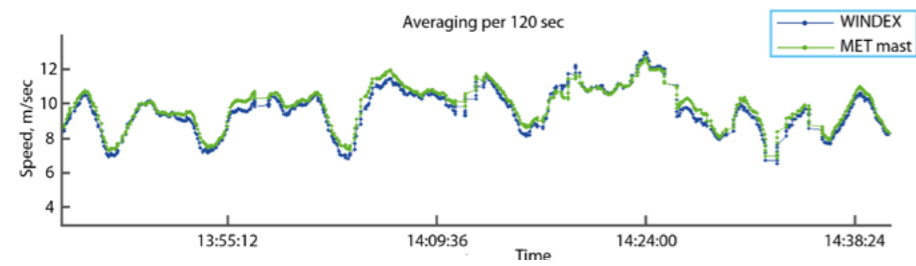
Wind situation analysis in the prospective construction sites for onshore/offshore wind power plants



# LIDAR Wind Profiler WINDEX-300

Comparison of measurements performed by WINDEX-300 and anemometers installed on the high-altitude weather mast (310 m) are shown on the charts.

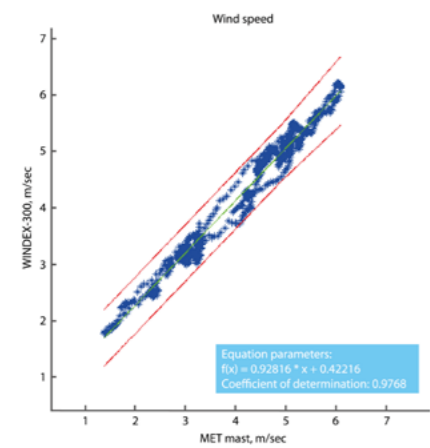
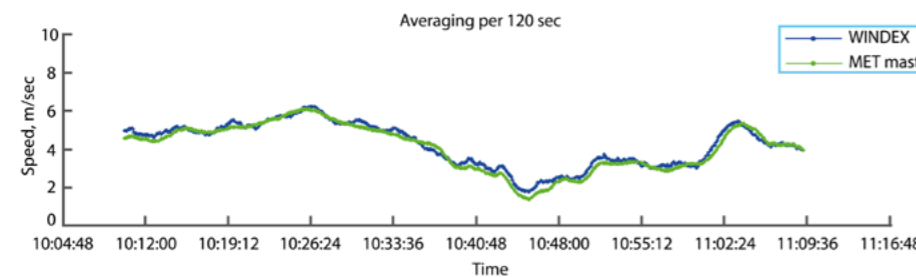
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## WEATHER CONDITIONS DURING MEASUREMENTS:

- Maximum permissible visibility 20 km
- Clear sky
- Temperature 21 °C
- No precipitation
- Humidity 43 %

2



## WEATHER CONDITIONS DURING MEASUREMENTS:

- Maximum permissible visibility 3 km
- Mostly cloudy, fractonimbus
- Temperature 14.5 °C
- Cloudburst
- Moderate and light rain intensity 3.3-5.1 mm/hour
- Humidity 93%



WINDEX-300 is a LIDAR wind profiler providing measurement of horizontal wind speed and direction, as well as vertical wind speed component, at given altitudes with arbitrary assigned increment step.

## PRINCIPLE OF OPERATION

At dissemination of laser (probing) signal in the atmosphere it reflects with a certain frequency from airborne particles dragged with wind flow (i.e. aerosol, molecule), that results to a change of return signal frequency - Doppler effect.

## PARAMETERS

- Weight 70 kg
- Dimensions 1.25 \* 0.7 \* 0.45 m
- Continuous operation mode
- Wave length 1.56 micron (eye-safe)
- Does not require calibration
- Range 3-300 m
- Detects wind direction
- Measurement time 4 sec (at one altitude)
- Vertical wind profile measurement interval ≈60 sec (refocus increment size is 20 m)
- Range of measured speed 0-55 m/s
- Range of wind direction measurements 0-360°
- Maximum permissible relative errors of wind speed measurements with two-minute averaging is no more that 10% wind speed
- Maximum permissible error of wind direction measurements is 10°
- Power voltage 220 V
- Option of autonomous operation from embedded DC power supply is foreseen
- Power consumption:
  - 450 W (including a thermostabilization

system) - 200 W (without a thermostabilization system)

Communication interface with computer via Ethernet, RS-485, CAN, Wi-Fi, and Modbus Remote access (control) and software upgrade is foreseen

Data Storage

Range of operation conditions:

- Temperature -50+60 °C
  - Humidity 20-98 %
  - Maximum permissible visibility 0,2-20 km
  - Resistant to influence of environment: rain, dew, rime ice, icing, dust, etc.
- Delivery by any transport (without any additional alignment)  
On-site repair if required

## WINDEX-300 CERTIFICATION

WINDEX is a certified equipment. It has a Type Certificate issued by the Interstate Aviation Committee and ROSSTANDART Certificate on Instrumentation Pattern Approval. WINDEX was developed in compliance with GOST (Russian State Standards) and IEC 60825-1 (Class 1 Laser Product). It operates in the range sightless with human eyes. The fact that WINDEX is a safe laser device was proven by ROSPOTREBNADZOR Conformance Certificate and the Opinion Letter.

## WINDEX-300 VERIFICATION

WINDEX has passed a range of tests including all-season on-site tests with correlation of measurement data with anemometers installed on the high-altitude weather mast (310 m) and experimental research in the wind tunnel as well.

# Wind Shear Avoidance System



**INCREASE OF THE SAFETY LEVEL** at increasing the volume of air transportation requires ground based technical tools applied for remote monitoring of meteorological conditions near a runway to be developed.

One of the tools is a WINDEX LIDAR Wind Profiler that performs remote measurements and receives information as follows:

1. Wind speed and direction at different altitudes;
2. Wind shear;
3. Vertical gusts;
4. Ambient turbulence.

It should be installed near the runway and the inner marker beacon to control the airspace around the glide path at altitudes up to 300 m. Configuration of LIDAR system for a specific aerodrome is selected individually.

Inclusion of WINDEX-5000 in LLWAS provides additional geo-referenced and runway referenced 3D information about gust front altitude position.

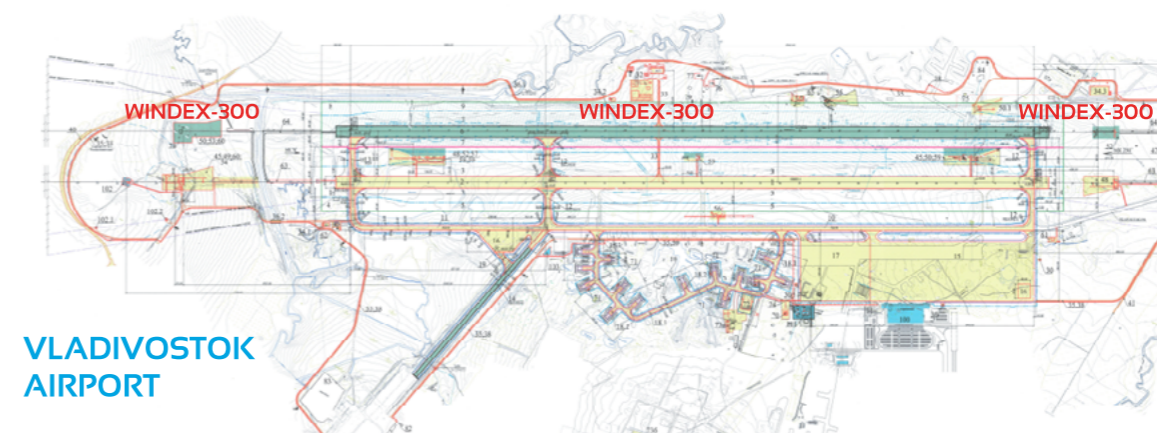
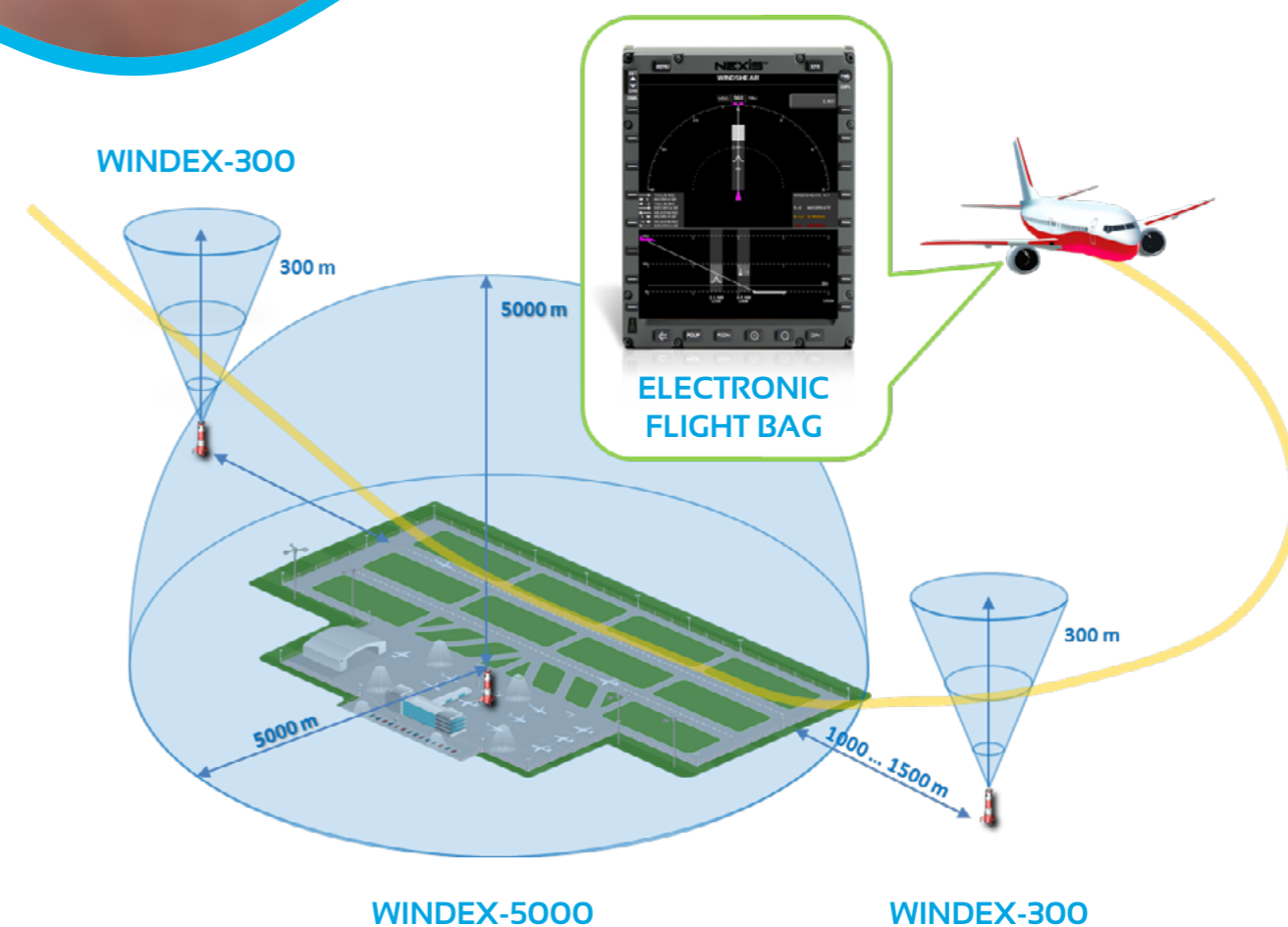
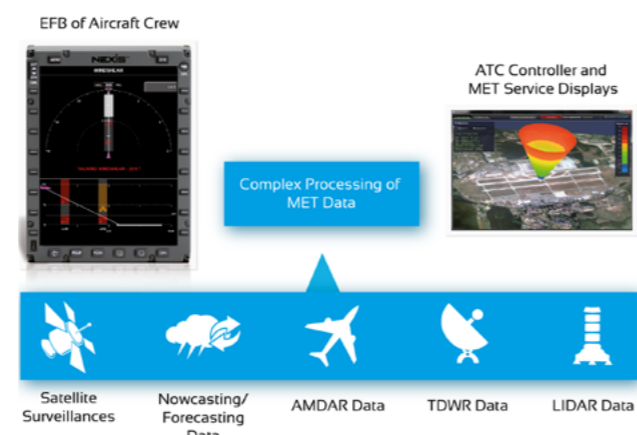
When a dangerous meteorological event such as wind shear or severe turbulence is detected WINDEX automatically transmits warnings to the airport MET and ATC service as well as to the aircraft flight crew to be displayed in the flight desk via Electronic Flight Bag both in graphic and textual formats.

## WINDEX AS A COMPONENT OF AN OPERATIONAL MET SUPPORT SYSTEM

The system provides integrated processing of Information received from various sources including weather forecast data, results of LIDAR and weather RADAR remote atmosphere sensing as well as AMDAR data downlinked from the aircraft.

The main purpose of the system in airport application is integration of procedures, providing all air navigation users, including the ATM system, with timely and precise MET information at all flight phases.

Based on information complex processing the system identifies areas with hazardous meteorological phenomena and performs nowcasting and forecasting of their dynamics.



**VLADIVOSTOK AIRPORT**

## WINDEX-5000 (Next Generation 3D LIDAR)

WINDEX-5000 is a Next Generation 3D LIDAR with new operational functionality and advantages.

WINDEX-5000 operates in following modes:

- Circular Scanning at given bearing angles range with arbitrary elevation angles from 0 to 85°;
- Vertical Scanning at given range of elevation angles with arbitrary azimuth value;
- Profiler Mode in an arbitrary direction
- Laser Knife Mode that is used to detect aircraft wake vortices.

WINDEX-5000 could provide:

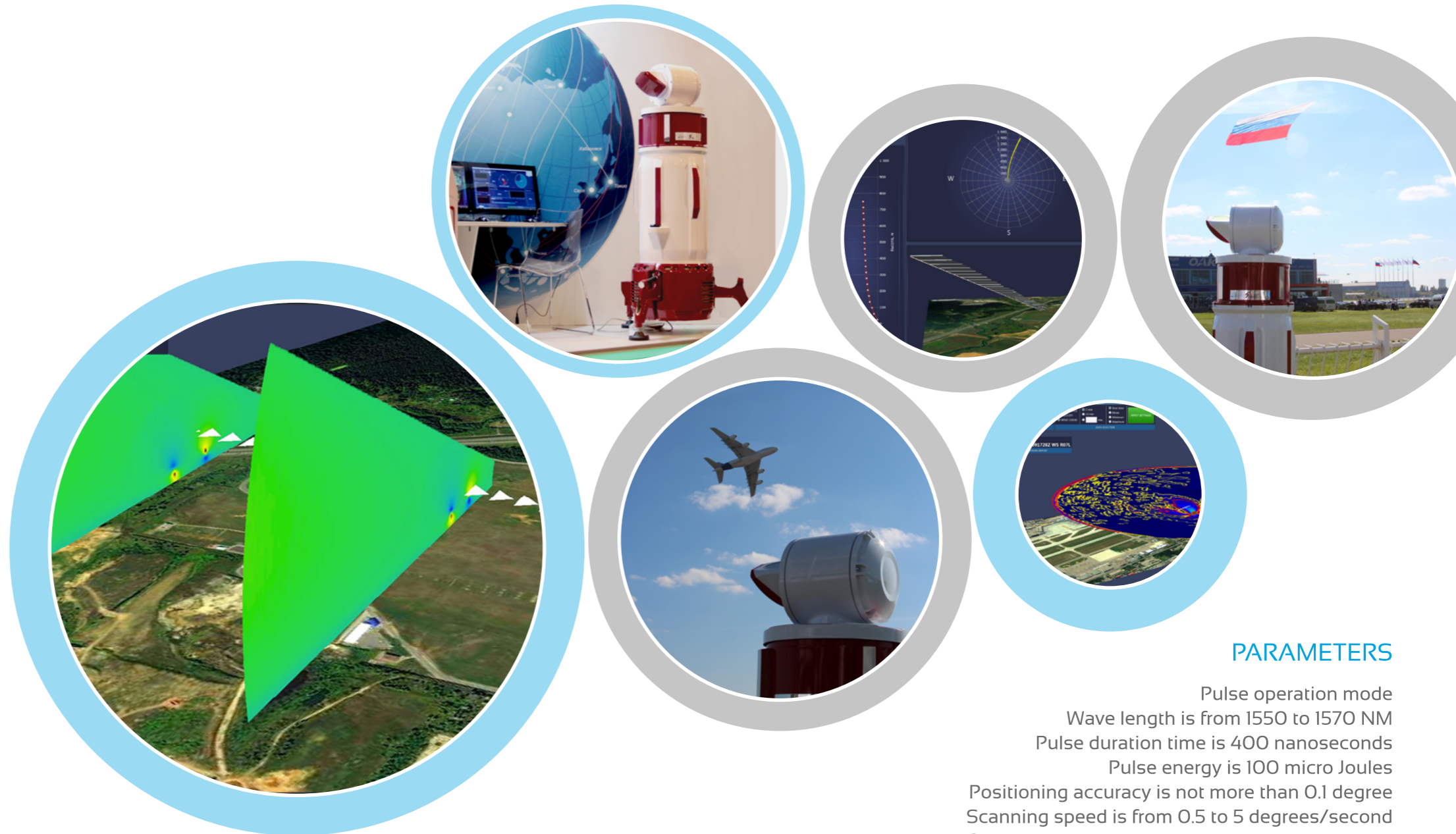
Multifunctional wind lidar scanner is developed to detect the following wind parameters:

- Wind speed and atmospheric turbulence component;
- High altitude wind profile;
- Identification of vortex situation;
- Identification of hazardous weather phenomena such as wind shear, high turbulence, ascending and descending gusts;
- Ceiling detection.

WINDEX-5000 is an impulse wind LIDAR.

It is low-sensitive to cloud coverage except very dense and low clouds.

Remote sensing data may be transmitted to authorized MET centres to be assimilated in weather forecast models.



### PARAMETERS

- Pulse operation mode
- Wave length is from 1550 to 1570 NM
- Pulse duration time is 400 nanoseconds
- Pulse energy is 100 micro Joules
- Positioning accuracy is not more than 0.1 degree
- Scanning speed is from 0.5 to 5 degrees/second
- Transfer time (without changes) is 45 degrees/second
- Averaging time is from 0.1 to 15 seconds
- Minimum range is not more than 100 meters (meteorological range of visibility >500 m)
- Spatial resolution is not more than 75 m
- Maximum measured wind speed is not less than 60 m/sec, minimum measured wind speed is not more than 1m/sec
- Wind speed measurement error is  $\pm 0.25$  m/sec
- Direction measurement error is  $\pm 5^\circ$
- Operational temperatures are from  $-50^\circ$  to  $+50^\circ$ C
- Relative air humidity can be up to 98% at the temperature of  $35^\circ$ C
- Environmental resistance class is IP65
- Dimensions: 1700x1000x880mm
- Mass 145 kg
- Power consumption is 200V AC/50Hz (27V DC) 800W (with regard to heating and cooling system)

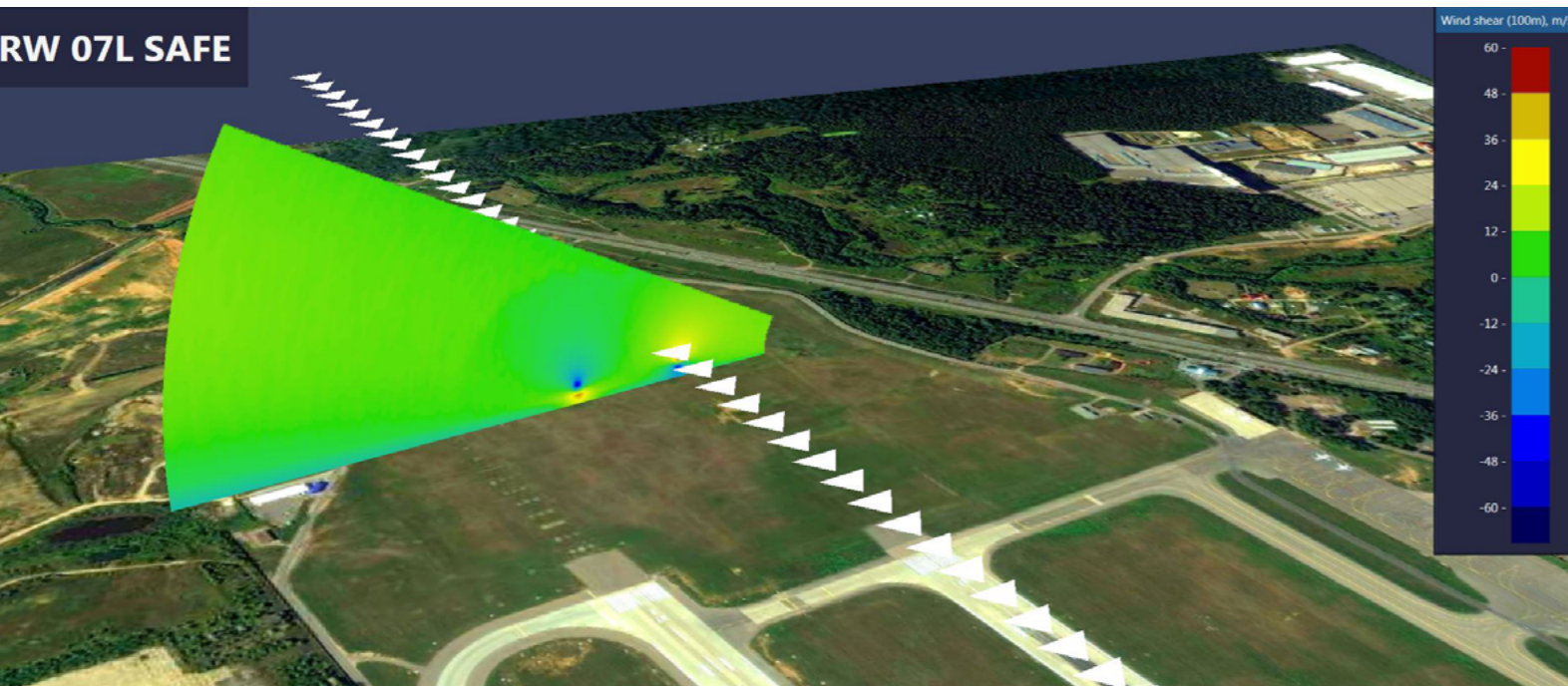
# Wake Vortices Scanner

WINDEX-5000 is able to work as a scanner of aircraft wake vortices. It could be integrated with ATM system and provide information about wake vortex situation directly to air traffic controllers in real-time mode.

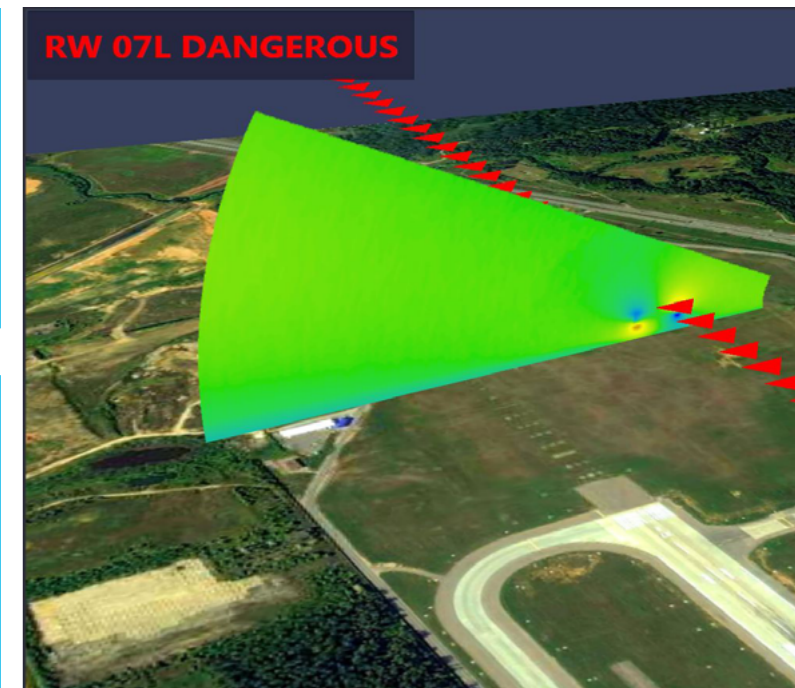
WINDEX-5000 detects wake vortices by scanning in a vertical plane, on an orthogonal glidepath, in the range of 0-300 angles.

WINDEX-5000 provides for the detection and measurement of wake vortices parameters (circulation and position of vortex cores centers) behind Heavy and Medium aircraft categories.

WINDEX-5000 provides for the automatic alert messages creation in the event when the wake vortex of a flying over aircraft is within given glidepath.



**WINDEX-5000** is a key ground-based component of the Integrated Wake Vortex Flight Safety System.



Alert messages are being generated considering the degree of the wake vortex danger for aircraft of various weight categories.

Spatial resolution of the wake vortex scanner is ~22 m. Scanning range is 1000 m.

WINDEX-5000 may be integrated with ATC systems in order to transmit automatically marks of the glidepath occupancy for aircraft of various weight categories as well as to forecast the time of the glidepath clearing considering the dynamics of aircraft performing an in-trail glidepath descent if ADS-B data about its flight parameters is available.

WINDEX-5000 provides for possible integration of wake vortex data placing two scanners along the glidepath, thus allowing to forecast the time of the glidepath clearing for aircraft of various weight categories.

WINDEX-5000 provides optimum use of airspace based on the current traffic and weather conditions.



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