
The Green-Wake Project

UV Lidar for Wake Vortex Detection

An overview

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Green-Wake at a glance

- Funded by European Commission (FP 7)
- NOV 2008 – OCT 2011
- <http://www.greenwake.org>
- 12 Partners:
 - Lidar Technologies Ltd (coordinator), UK
 - EADS Deutschland GmbH, Germany
 - Université catholique de Louvain, Belgium
 - Technical University Sofia, Bulgaria
 - German Aerospace Center DLR, Germany
 - Aeronautical Research and Test Institute VZLU, Czech Republic
 - Active Space Technologies, Portugal
 - ADSE, Netherlands
 - Photonic Science Ltd, France
 - SensL Ltd, Ireland
 - Sula Systems Ltd, United Kingdom
 - SimSoftware Ltd, Bulgaria

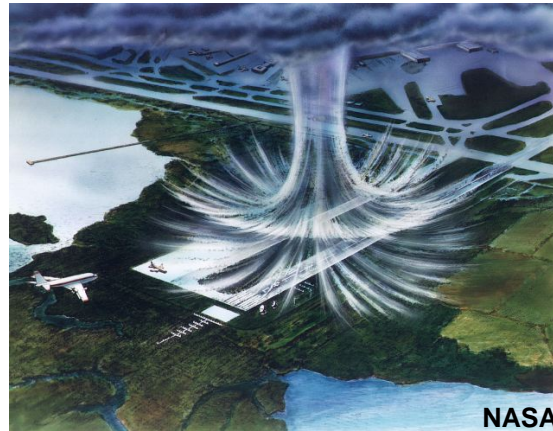


Atmospheric threats

Clear air turbulence (CAT)



Wind shear



Wake vortices



Risk

Probability

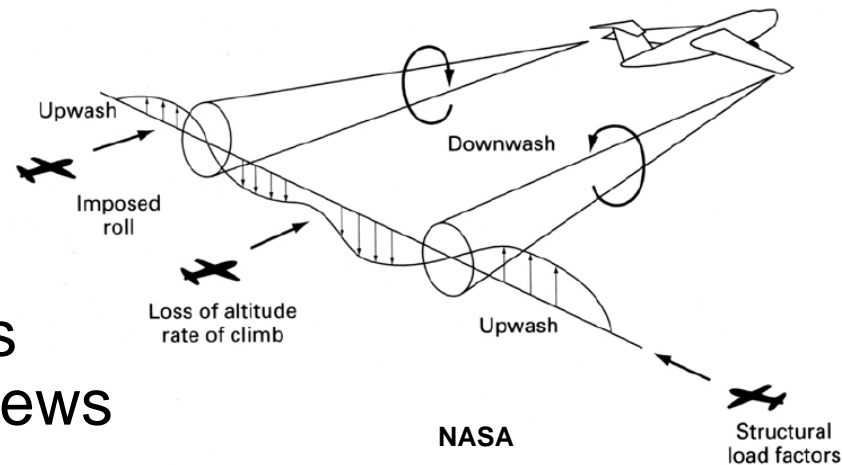


- Wake vortex : 12 accidents in 40 yrs*
- Wind shear : 72 accidents in 62 yrs*

Impact



- Unexpected aircraft movements
- Potential causes of accidents and injuries to passengers and crews
- Currently few options for protection
 - Reactive, procedural solutions



* ASN Safety Database



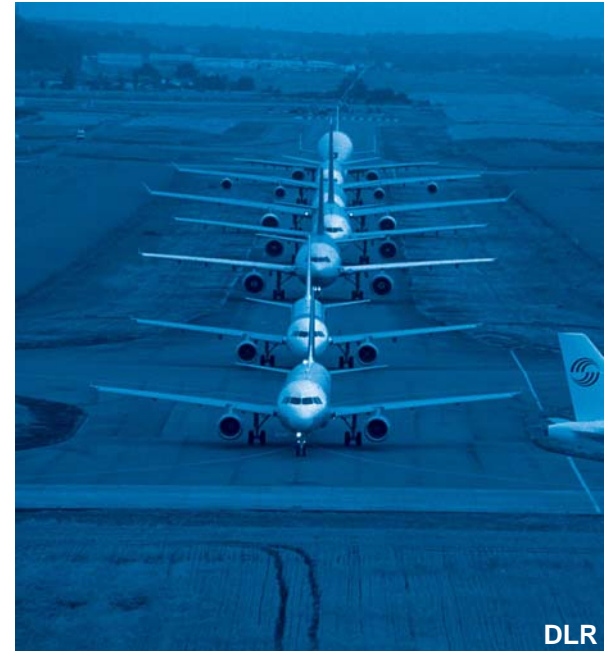
Green-Wake objectives

- Detect wake vortices and wind shear in a timely manner
- Anticipate and mitigate effect of wake vortices and wind shear on the aircraft and occupants
- Investigate mitigation via flight controls
- Develop and validate innovative technologies: UV LIDAR based
- Provide air traffic system wide benefits



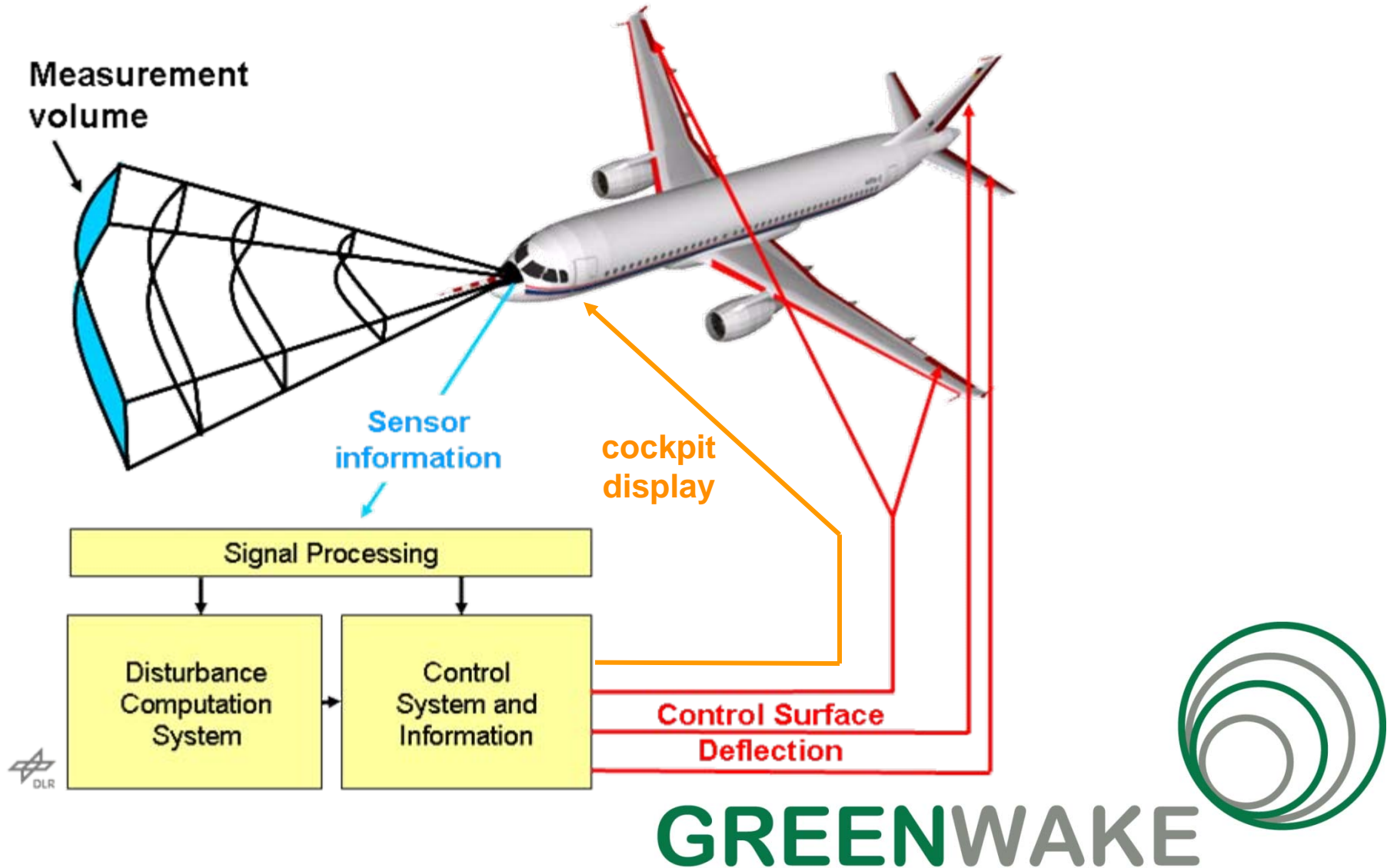
Targeted benefits

- Increased crew and passenger and safety
- Higher airport capacity via reduced air traffic separation
- Increased in-flight safety in dense airspace



The Green-Wake concept

Airborne detection, control & warning



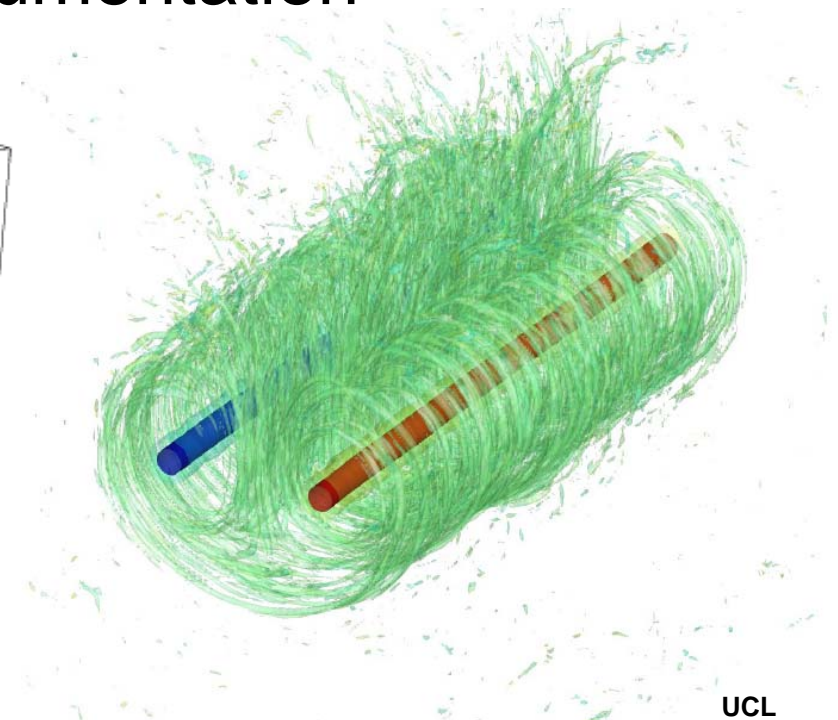
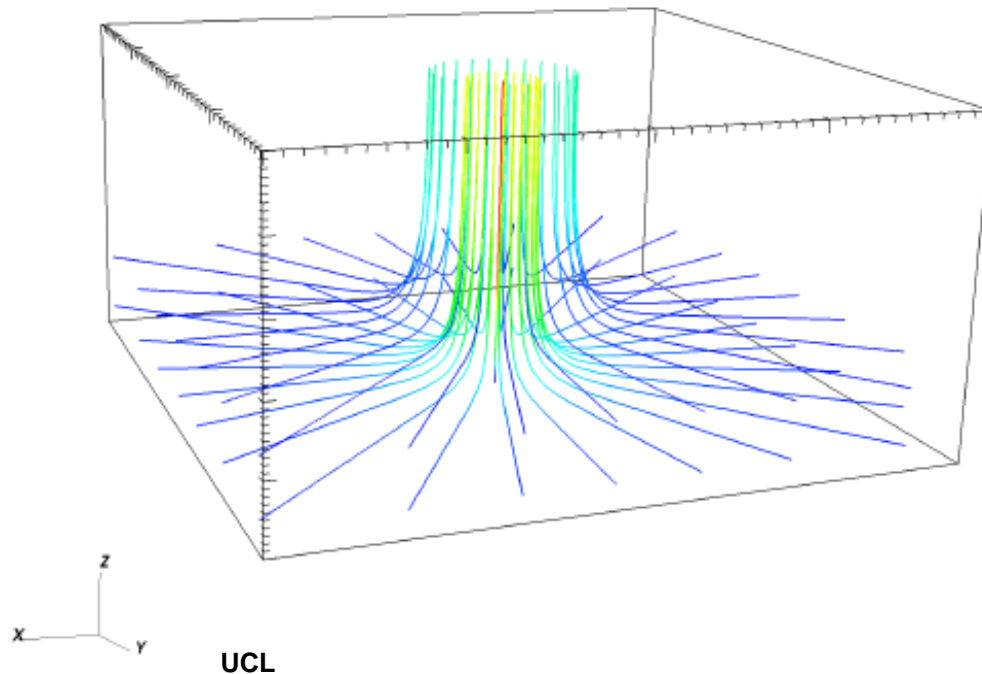
Green-Wake innovations

- Modeling and simulation of wake vortex and wind shear detection by imaging LIDAR instruments
- Development of an imaging Doppler LIDAR and fast scanning system
- Detector and data processing
- Test and demonstration of the performance of the system
- Hazard map



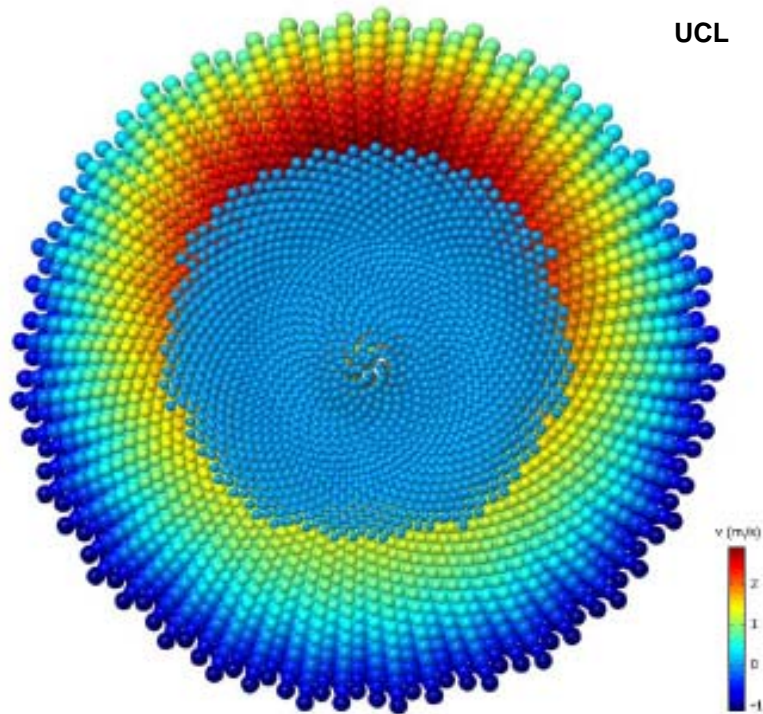
Fluid phenomena models/ data

- simple WS model, simple WV model and database of complex (LES) WV simulations available including documentation

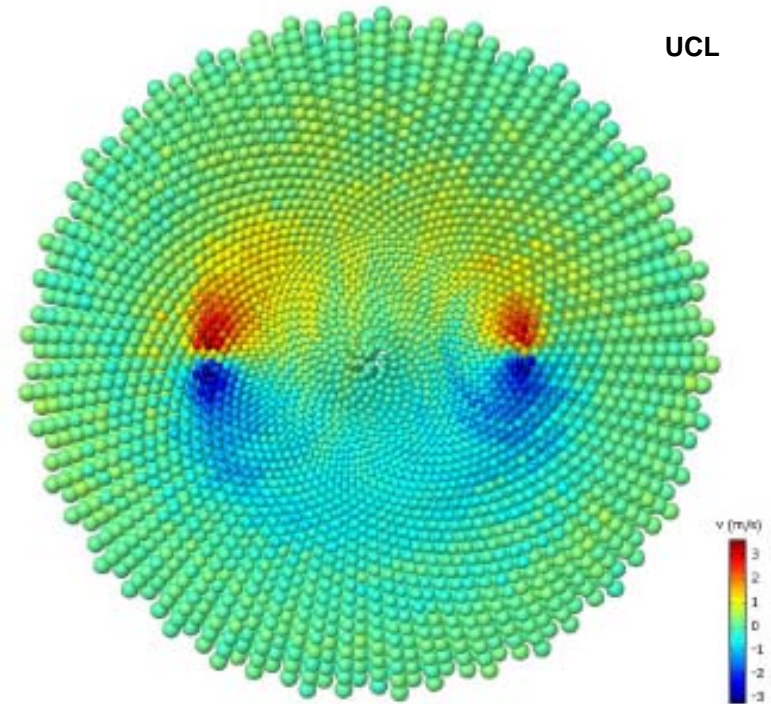


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Ideal sensor investigations



Windshear, front-view

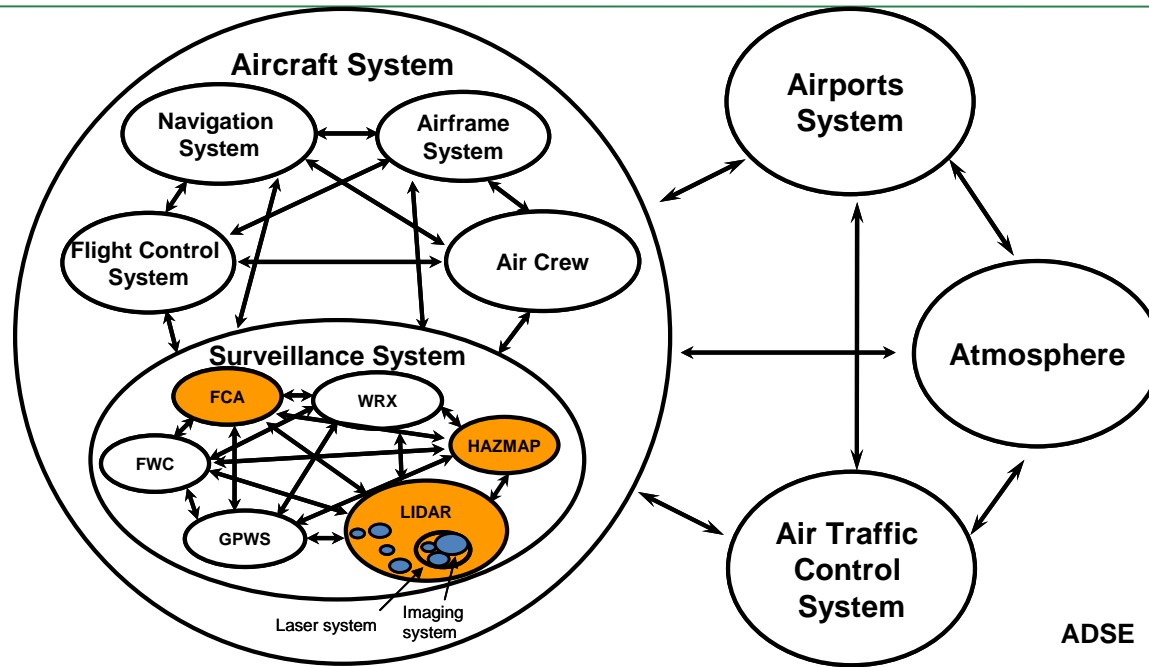


Wake vortex, front-view

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Requirements



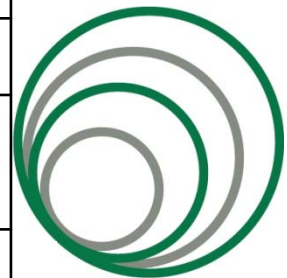
1. Air Transport Level Requirements
 - Stakeholder analysis of turbulence work domain
 - Overview of concepts
 - GREEN-WAKE concept requirements
2. Aircraft level requirements
3. GREEN-WAKE System requirements

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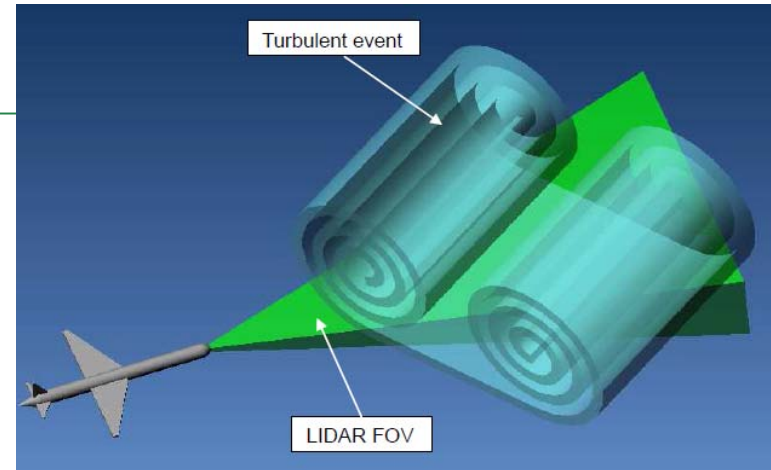
System requirements

Parameter	Value
Minimum range	50 m
Maximum range	200 m
Minimum Number of measurement points	100 (WV) < 10 (WS)
Scanning area	120 x 50 m
Range resolution (bin length)	3 – 30 m
Full FOV Update	10 Hz
Required LOS velocity accuracy in a single integration	1 m/s
Operating altitude (max)	Flight level 400
Maximum atmospheric density	All conditions
Range of velocities	+/-25 m/s for WV +/-20 m/s for WS
Beam diameter	50 mm



System concept

- Simulation model developed
- Scanning system (mirrors/ prisms)
- Scanning pattern
- Focus regarding wake vortices on approach/ landing and takeoff/ departure rather than cruise flight
- Key questions
 - What is the optimum scanning regime (size and number of points)?
 - What is the optimum bin length (LOS sample size)?
 - What is the required laser power?



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Simulation setup

Integration volumes (measurement bins)

Instrument

- FOV
- Scanning trajectory
- Spatial sampling

Wake vortex parameters

- Type of the plane causing the event
- Speed and direction of the plane
- Time after initiation of the event

Atmospheric parameters

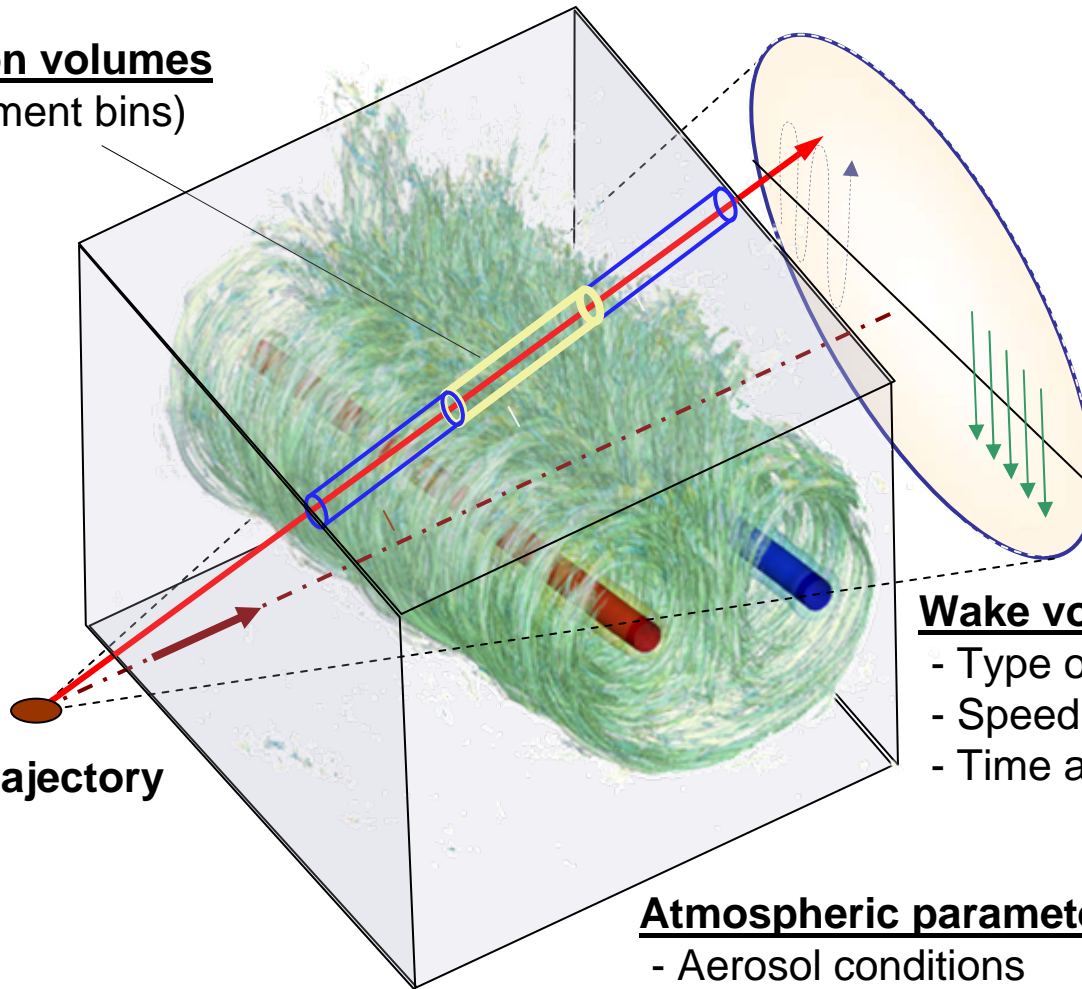
- Aerosol conditions

Platform trajectory

- Speed
- Direction
- Position

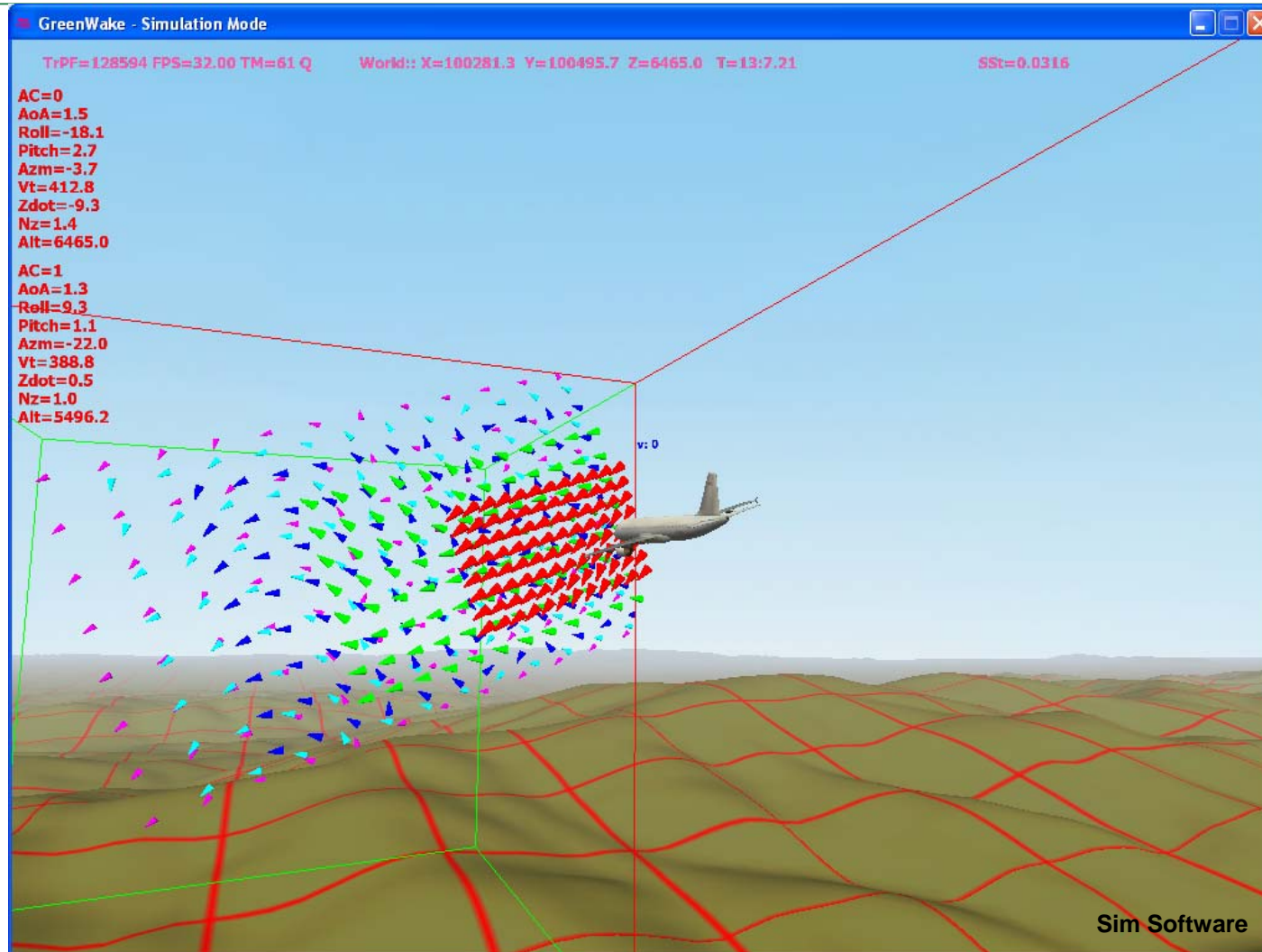
Simulation volume

Up to 300mx300mx300m



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Visualization 3D simulation environment

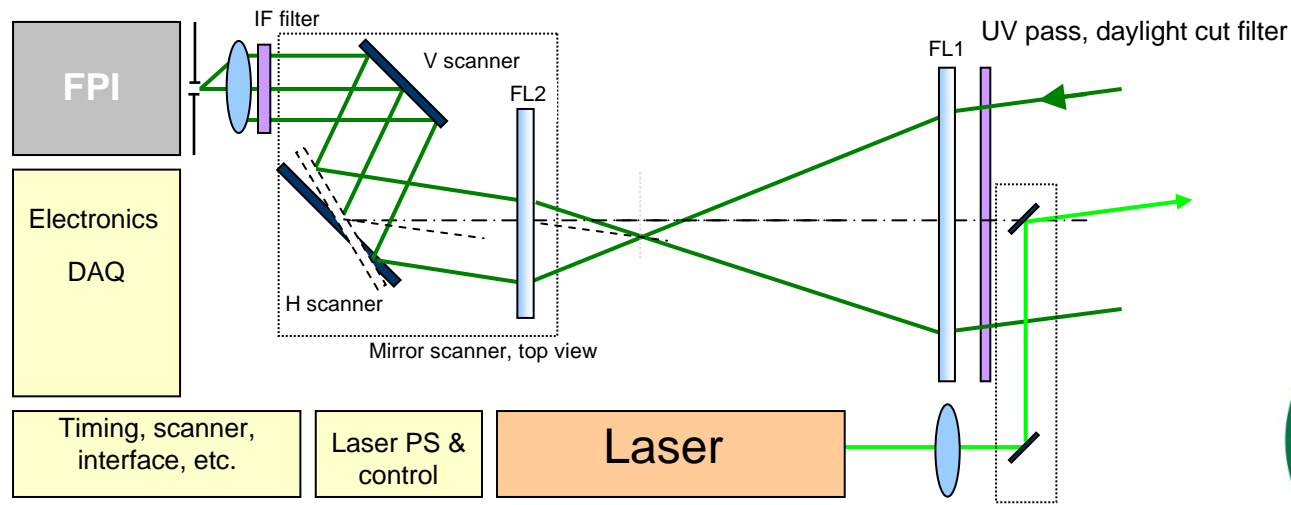


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System design

- system scans 2 range bins (~50 m - ~200 m)
 - flight control action
 - characterisation/ detection of turbulence event for warnings



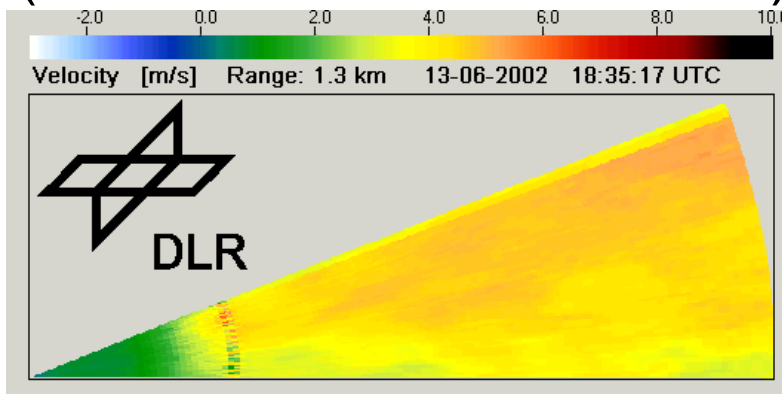
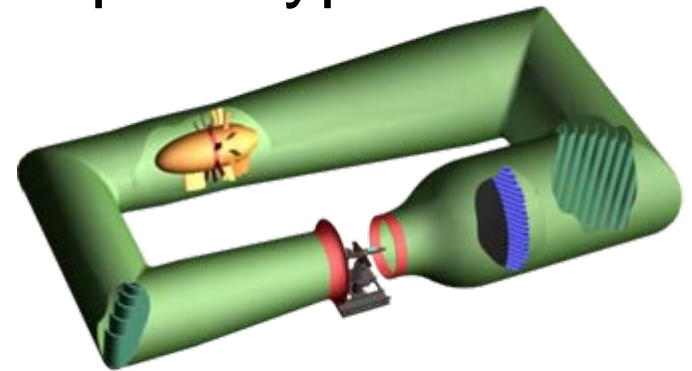
schematic concept design

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Outlook

- final design review
- ground-based demonstrator/ prototype
- testing/ validation
 - wind tunnel
 - airport
(with DLR coherent LIDAR)



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