The Green-Wake Project

UV Lidar for Wake Vortex Detection

An overview

presented by Steve Bowater
(Sula Systems Ltd)

Funded by the European Commission's
Framework Programme 7 under Grant Agreement 213254

GREENWAKE

February 2011

History

- GreenWake programme started in Nov 2008
- Coordinator went into liquidation March 2010
- Work on project stopped
  - Delay about 10 months
- New Coordinator (Sula Systems)
- New LIDAR Company (Hovemere)
- Work restarted Nov 2010

GREENWAKE

Green-Wake at a glance

- Funded by European Commission (FP 7)
- NOV 2008 – AUG 2012
- 11 Partners:

  - Sula Systems 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
  - Hovemere Ltd, UK
  - SimSoft Ltd, Bulgaria

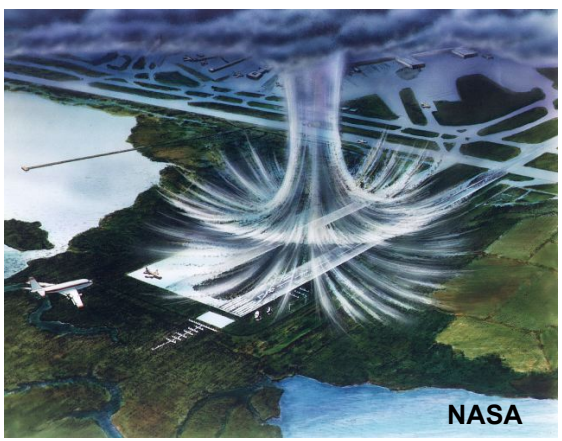
Funded by the European Commission's Framework Programme 7 under Grant Agreement 213254

GREENWAKE

Atmospheric threats

Wake vortices

Wind shear



GREENWAKE

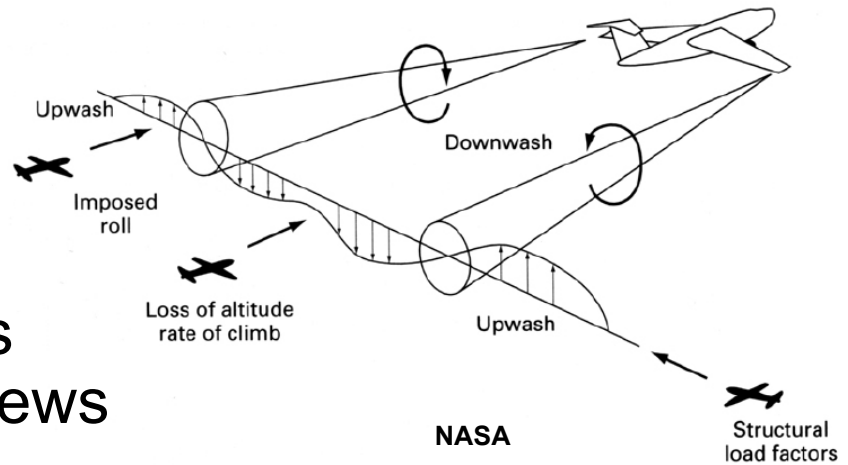
Risk

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

GREENWAKE

* ASN Safety Database

Green-Wake objectives

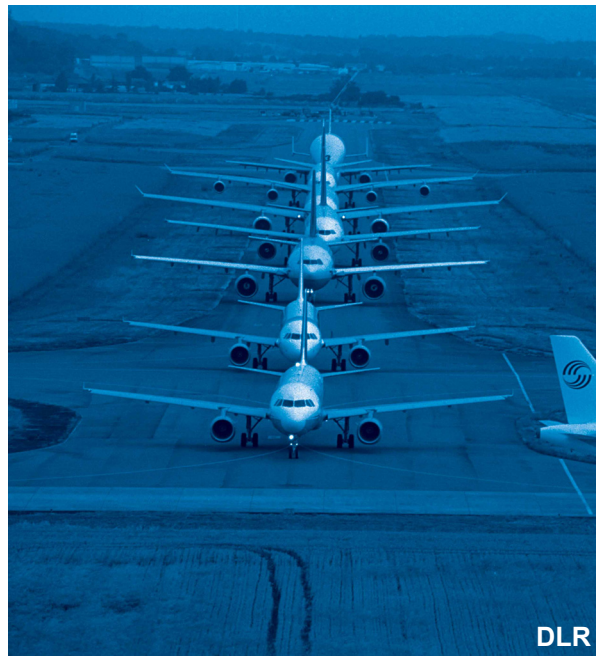
- Demonstrate an instrument which can:
  - Detect wake vortices and wind shear in a timely manner
  - Anticipate and mitigate effect of wake vortices and wind shear on the aircraft and occupants
- Investigate mitigation via flight controls
- Develop, demonstrate and validate innovative technologies: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

Funded by the European Commission's
Framework Programme 7 under Grant Agreement 213254

GREENWAKE

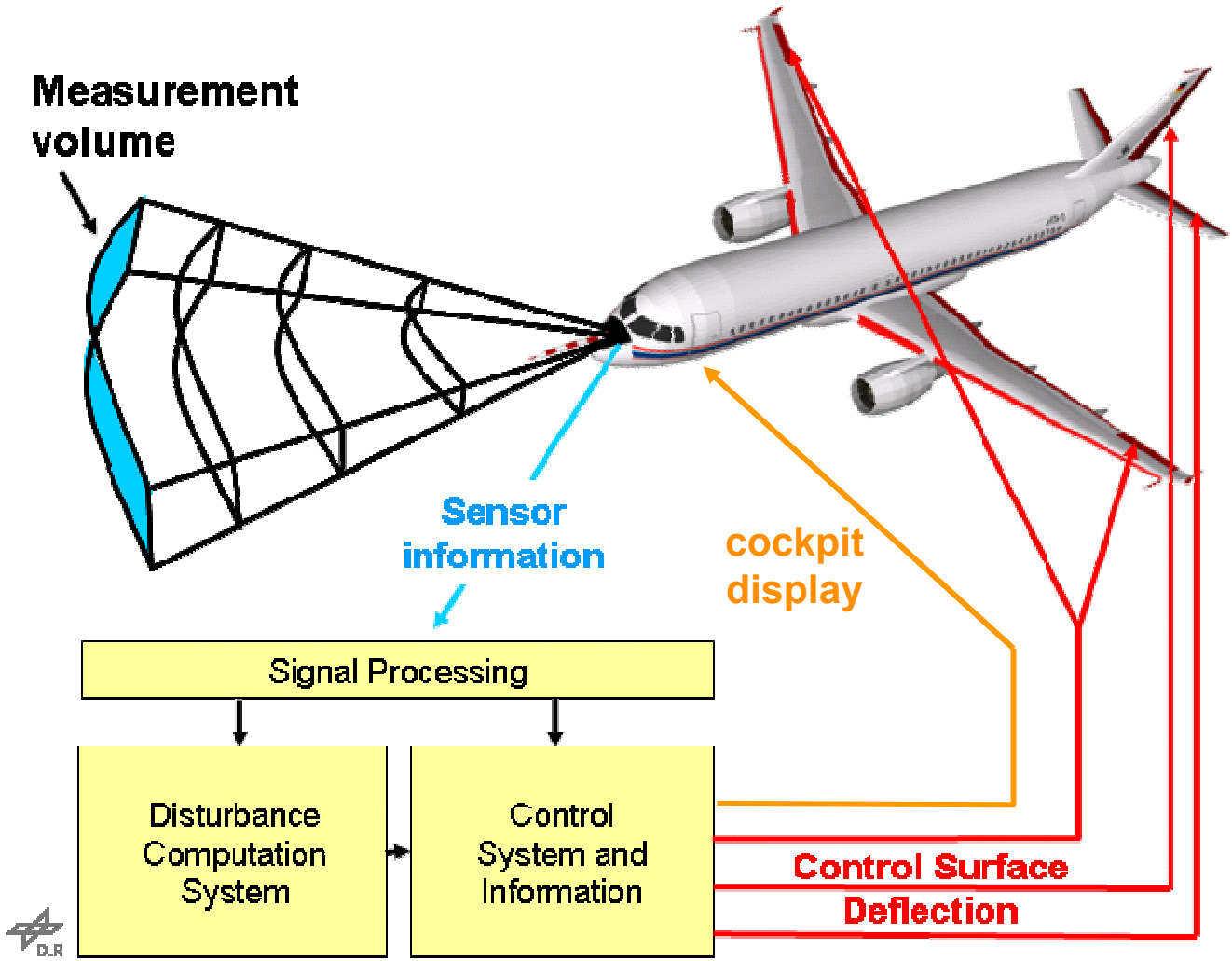
Targeted benefits

- Improved crew and passenger safety
- Increased airport ~~capacity~~ recovery via reduced air traffic separation
- Higher environmental hazard awareness



GREENWAKE

The Green-Wake concept
Airborne detection, control & warning



GREENWAKE

Green-Wake innovations

- Modelling and simulation of wake vortex and wind shear detection by imaging LIDAR system
- Development of an imaging Doppler LIDAR and fast scanning system
- Development of detector and data processing
  - Two detector technologies being assessed
- Integration and demonstration of the performance of the system
- Creation of 3-d visualisation of the air movement (hazard map)

GREENWAKE

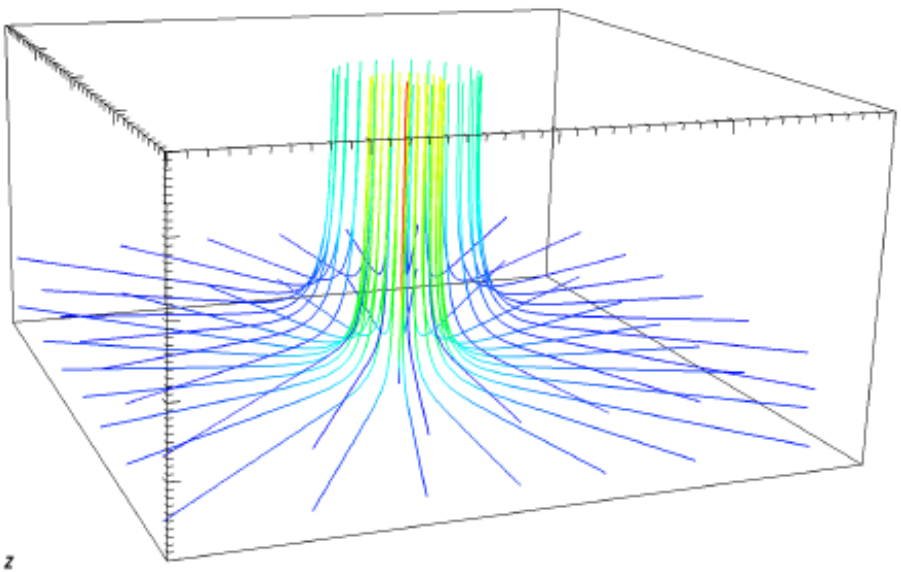
Primary Technical Challenges

- Scanning System
- Detectors (small number of photons)
  - CCD
  - SiPM
- Data throughput
- Data processing

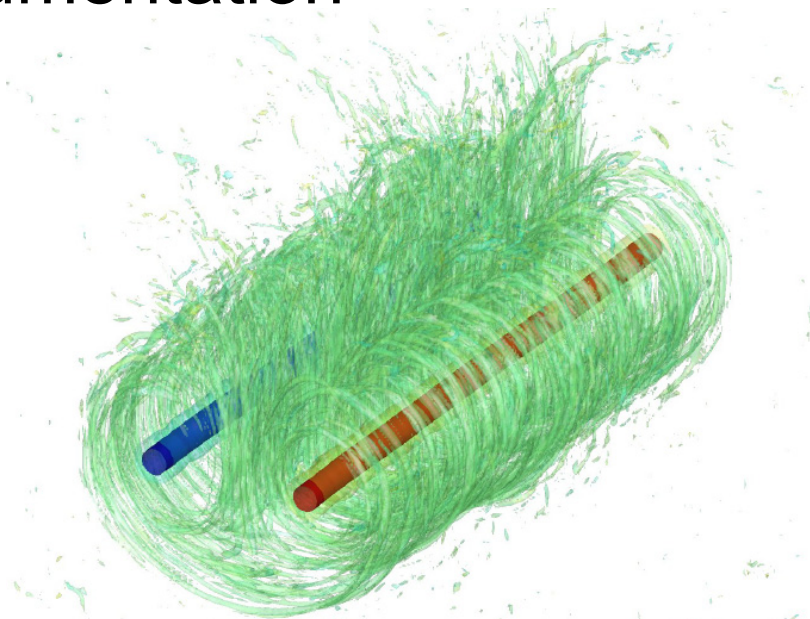
GREENWAKE

Fluid phenomena models/ data

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



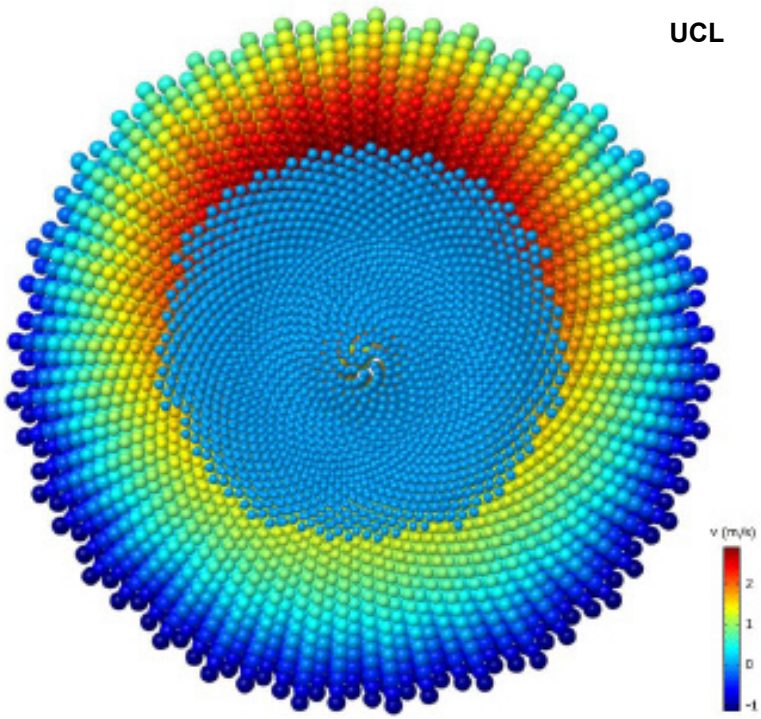
UCL



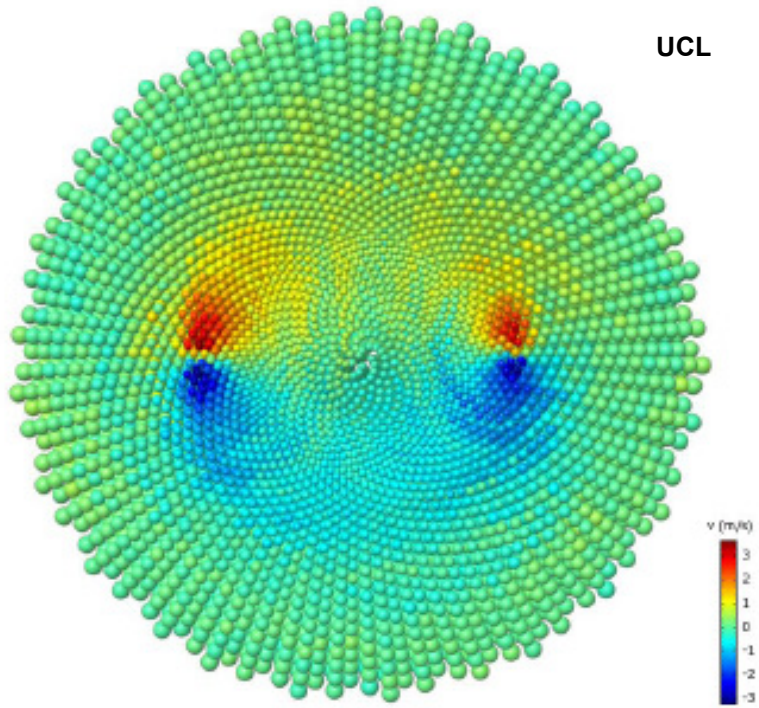
UCL

GREENWAKE

Ideal sensor investigations



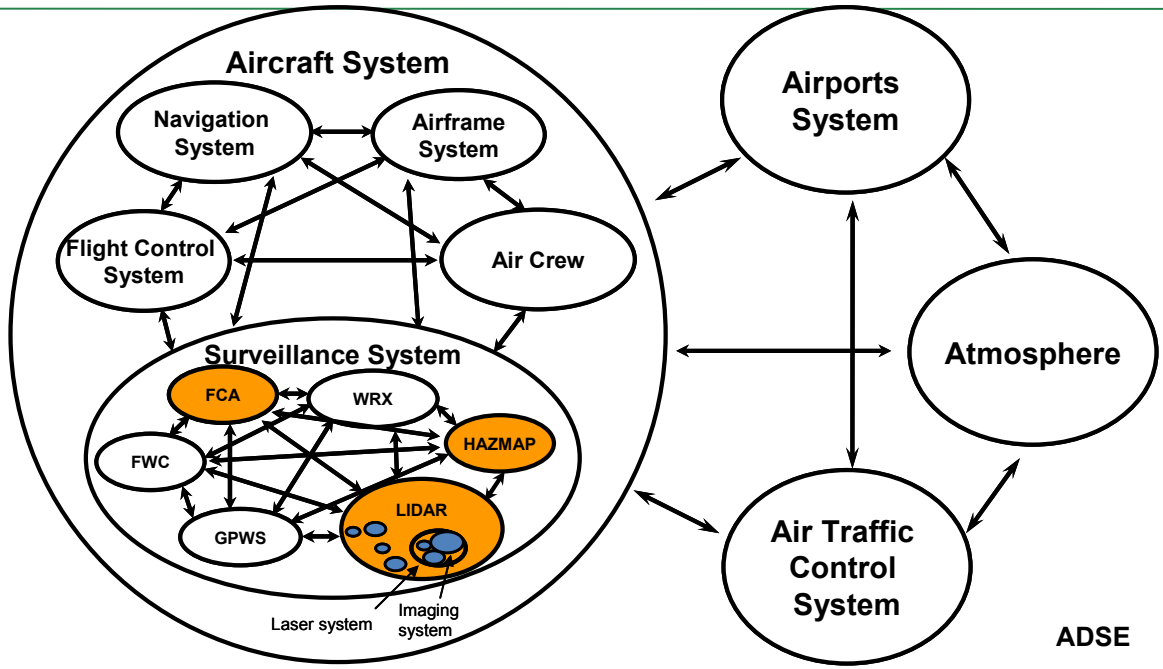
Windshear, front-view



Wake vortex, front-view

GREENWAKE

Requirements

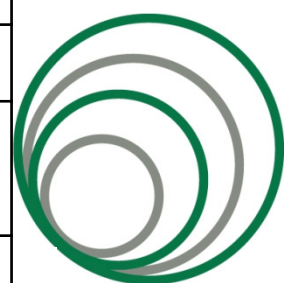


1. Air Transport Level Requirements
   - Stakeholder analysis of turbulence work domain
   - Overview of concepts
   - GREEN-WAKE concept requirements
2. Aircraft level requirements
3. GREEN-WAKE System requirements

GREENWAKE

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	5 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



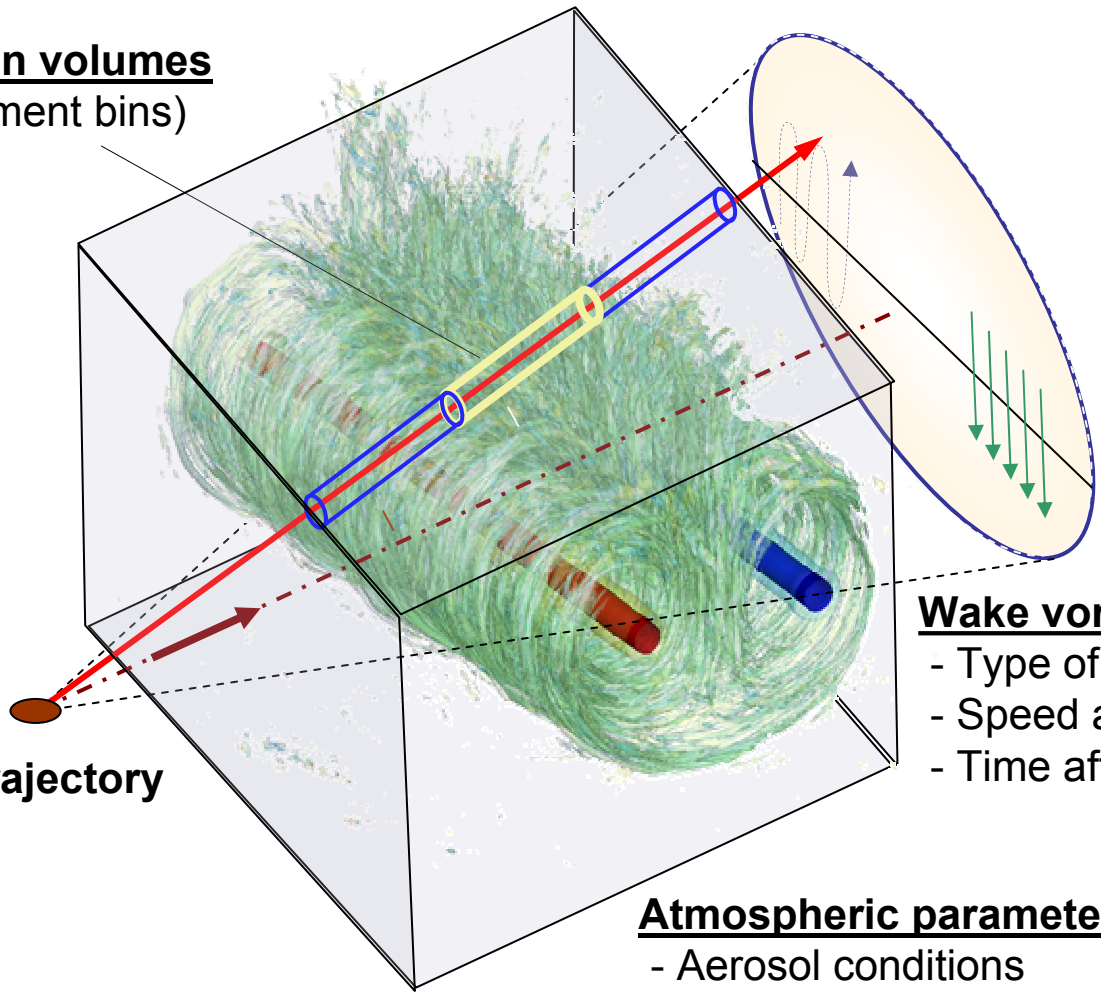
System concept

- System design underpinned by modelling & simulation
- Pulsed UV Laser with 50mm beam
- Optical system for focussing outbound and return signals
- One mechanical scanning system for outbound laser and return signal
- Range gated detectors
- 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?

GREENWAKE

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

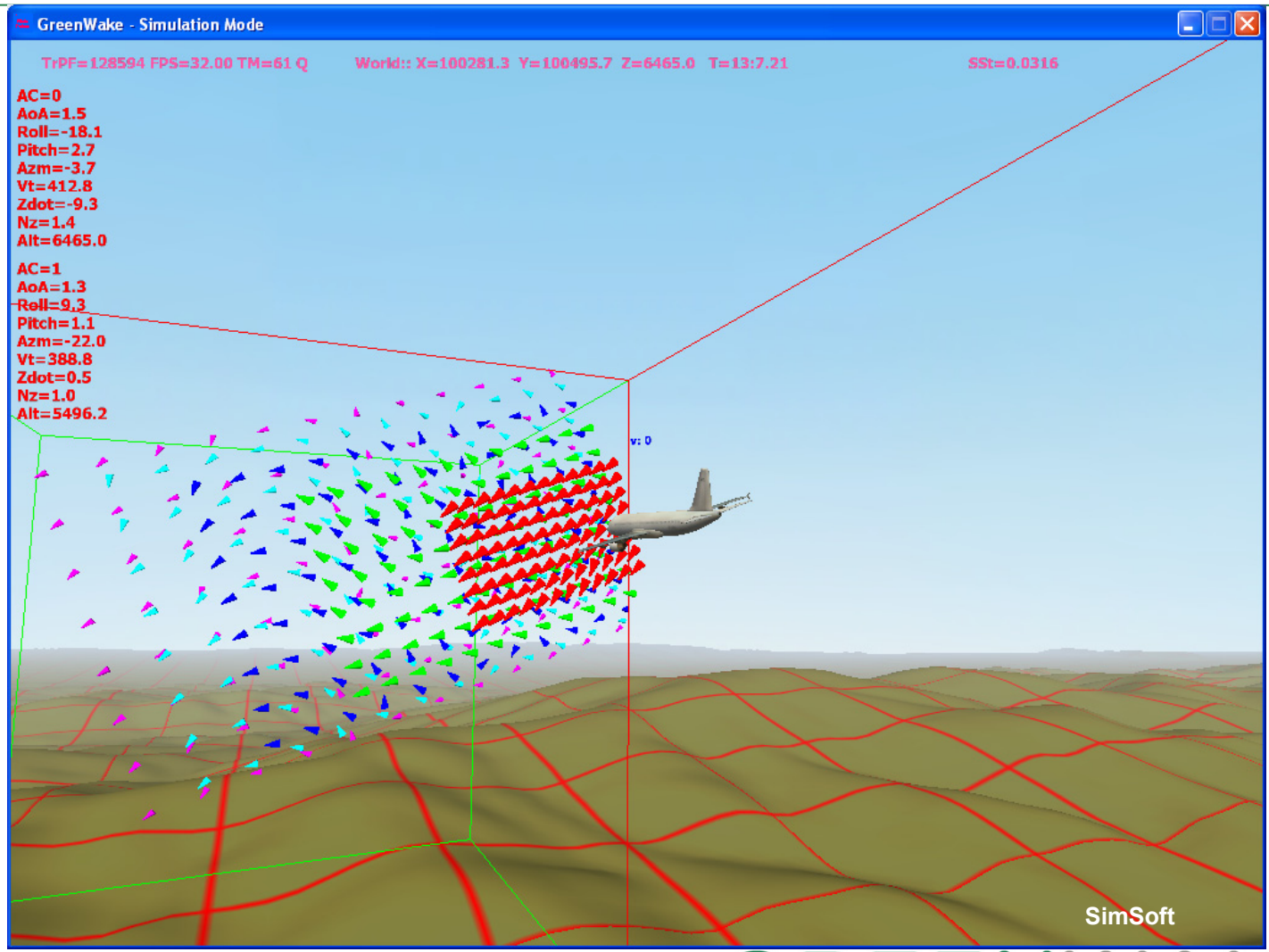
Platform trajectory
- Speed
- Direction
- Position

Atmospheric parameters
- Aerosol conditions

Simulation volume
Up to 300mx300mx300m

GREENWAKE

Visualization
3D simulation environment



GREENWAKE

Scanning System

- Two oscillating mirrors (~200mm diameter)
  - One operating at 2.5Hz
  - One operating at 20Hz
- Meets requirement for full FOV scan at 5Hz
- Generates Lissajous scan pattern
- Scans outbound laser and return signal

GREENWAKE

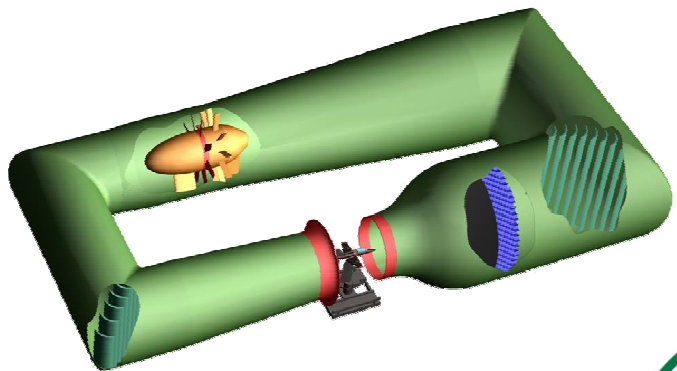
Scan Mechanism

Adobe Acrobat
Document

GREENWAKE

Risk Reduction & Final Trials

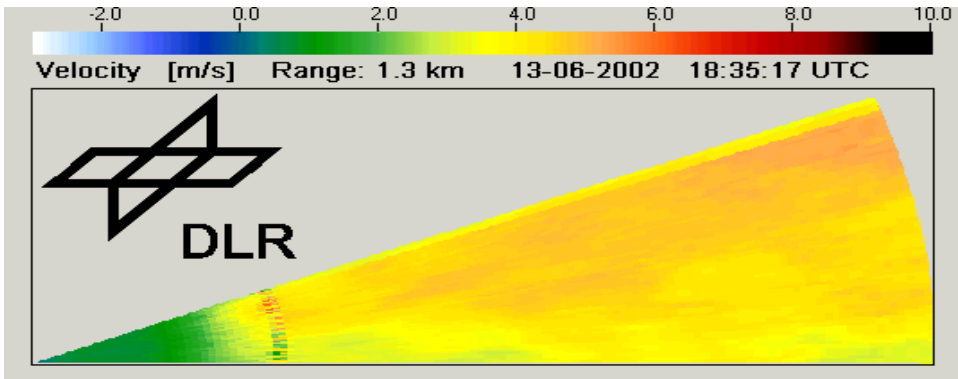
- Trials at Hovemere premises (March 2011)
  - To test basic operation using existing LIDAR
- Wind tunnel trial (Prague, July 2011)
  - GreenWake system without scanning mechanism
  - To test detection of
    - Wake vortices
    - Wind shear
    - Gusts



GREENWAKE

Risk Reduction & Final Trials

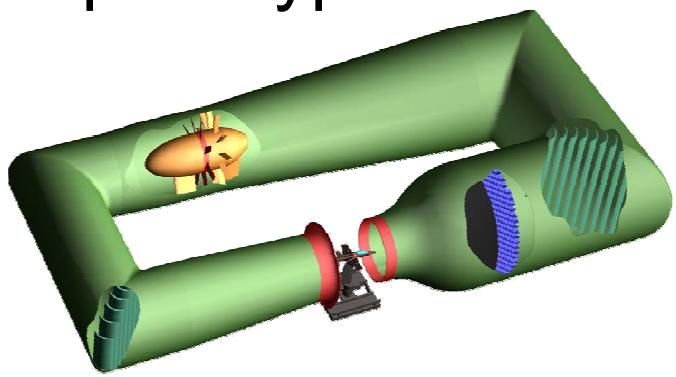
- Airfield trials (TBD, March 2012)
  - Full GreenWake system
  - Validated with DLR coherent LIDAR

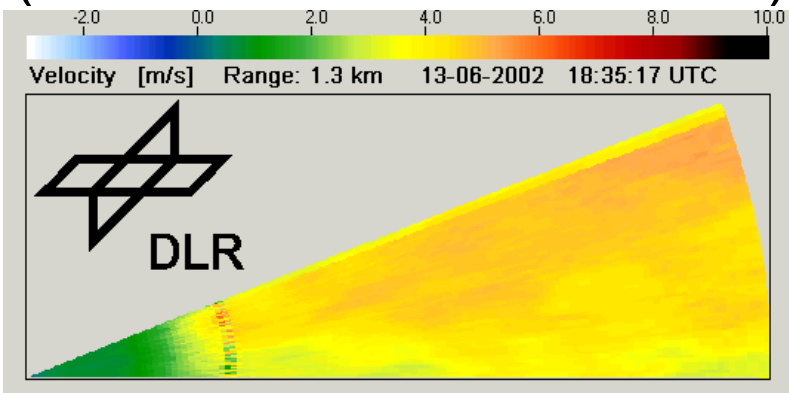


GREENWAKE

Outlook

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





GREENWAKE

Research Requirements

- Novel detector configurations
- Lighter, faster scanning mechanisms
- Integration into flight control system
- Human Factors Integration

GREENWAKE

Thank you for your attention

Any Questions?

GREENWAKE