WAKENET-3 Europe / GREENWAKE WORKSHOP – 29/03/2010 LIDAR Airborne Aerodynamic Sensors Thales Avionics

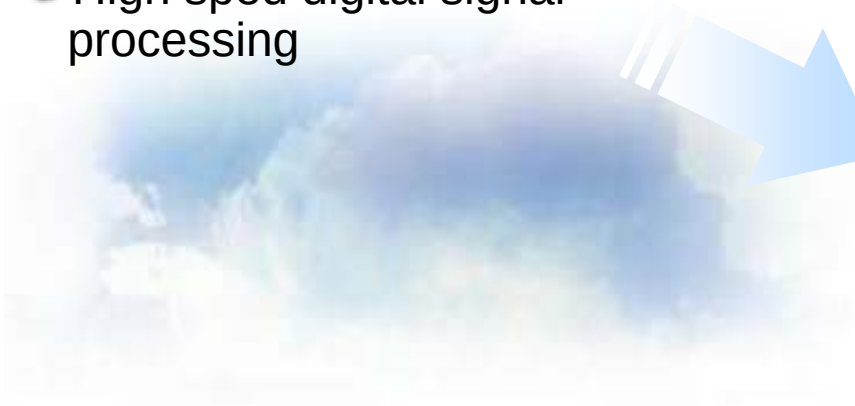
Aéronautique

Thales LIDAR Products and developments

- **1980's Trials on mirage, Caravelle and Puma**
- **1988 – 1990**
  ALEV 3 (10.6 µm) Anemometry reference for flight tests (AirbusA340, A320, A318, etc)
- **2001 –2004**
  DALHEC (1.55 µm) Demonstrator of laser anemometer for Helicopter
- **2003- 2005**
  DALAS (1.55 µm) Demonstrator of laser anemometer for military aircraft
- **2006 – 2007**
  DALEV (1.55 µm) Anemometry reference for flight tests (Airbus A380, A350, etc)
- **2006 – 2009**
  NESLIE: operational Laser anemometer for primary system, demonstrator development
- **2008 – 2011**
  DANIELA: operational Laser anemometer for primary system prototype product for flight tests
- **2009- 20012**
  DELICAT demonstration of medium range turbulence detection

Background and airborne applications

- Laser source
- Optical architecture
- Optical signal processing
- Detection
- Analogue signal processing
- High sped digital signal processing



Flight test Air data LIDAR

100m or more in order to be out of aircraft perturbation

ALEV 3

DALEV

Operational Air data LIDAR

Helicopters: Short distance, 15-20 m in order to get out of rotor blast

Aircraft: 1 m to minimize necessary power and allowing reduce size and cost

NESLIE & DANIELA demonstrators

Atmospheric hazards LIDAR systems

DETAC

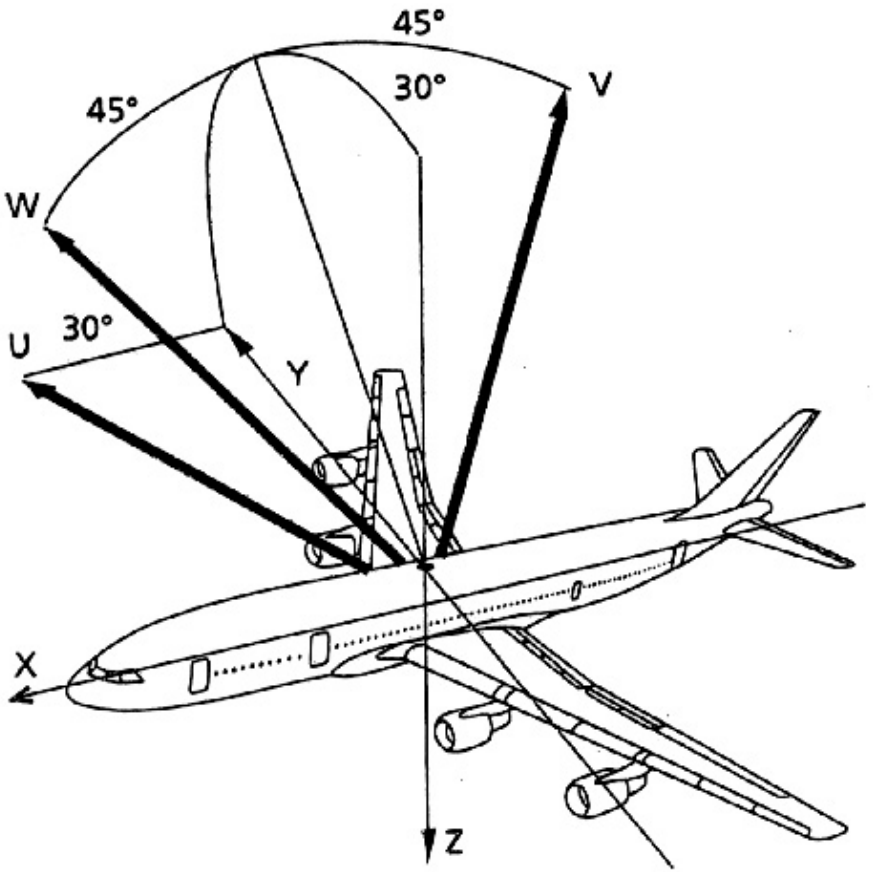
Flysafe

DELICAT

THALES

FLIGHT TEST APPLICATIONS

Reference air velocity measurement



Measurement is made far enough to be out of the aircraft perturbation

The measurement principle avoid bias

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1st generation: ALEV3

2nd generation: DALEV

DALEV is an air data reference system based on air velocity measurement using Doppler effect on signal back-scattered from particles contained in air at a distance free from aircraft aerodynamic perturbation
Following ALEV3, DALEV is the second generation of such air data reference system produced by Thales

Measurement performances: 1 σ < 0.25 kt

AIR DATA SYSTEM FOR HELICOPTERS

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Helicopter low speed issue

At low speed (<25 kts) the probes are not free from rotor blast, making the airspeed measurement impossible

Medium range anemometry for Helicopter:

Thanks to remote measurement, provide unique solution for long awaited function

Air data measurement over full flight envelope, providing not only TAS module but TAS vector

Can provide warning against hazardous rotor vortex conditions

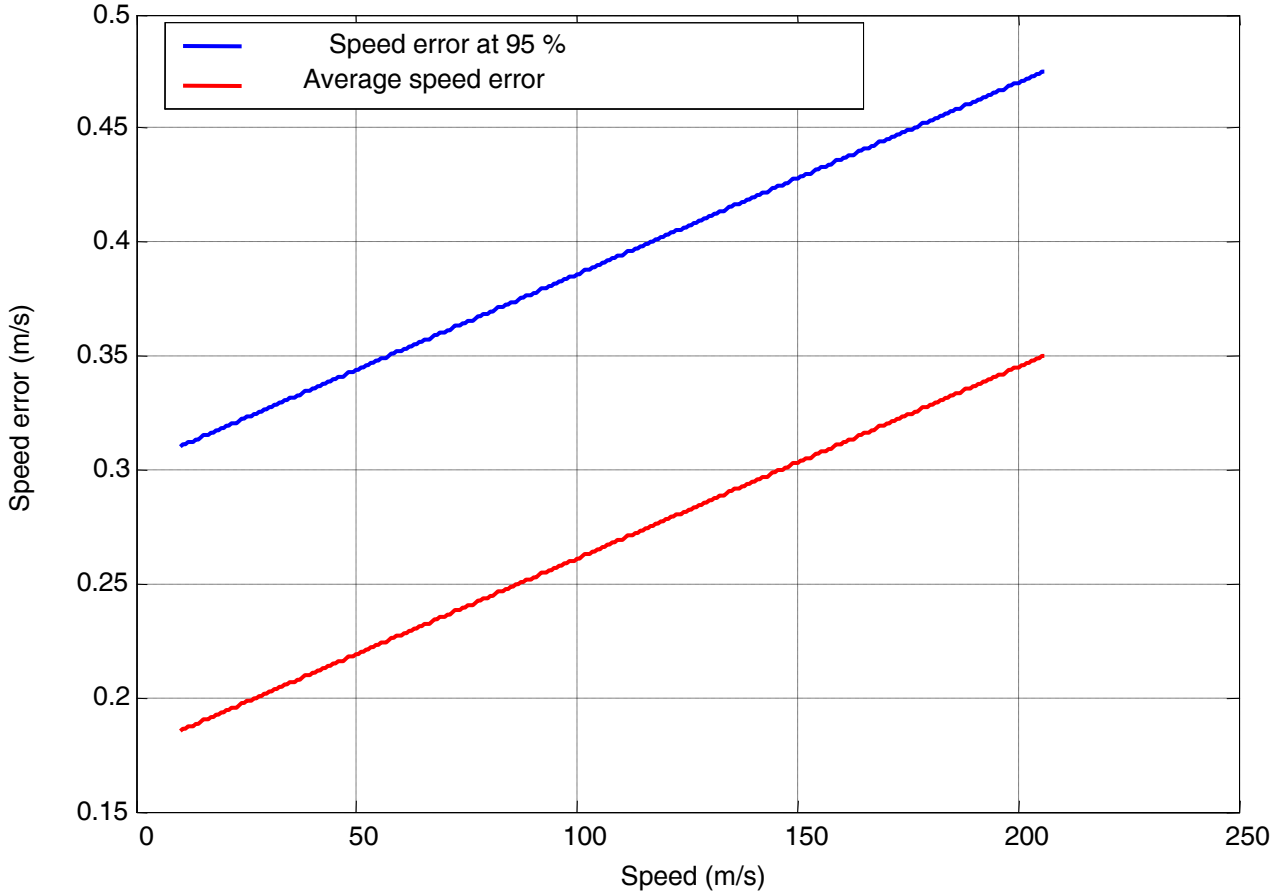
SOURCE : Solid state Laser 1.54 µm

- Ocular safety
- Very good spectral and spatial qualities
- Excellent atmospheric transmission
- Compact and reliable

OPTICAL FIBER ARCHITECTURE :

- Compact and reliable
- Availability of high performance components developed for telecoms
- Easy to use and to adjust

Laser anemometry performances



- **Speed errors calculated for DALHEC system and an orthogonal trihedron**
- **Typical Angle Of Attack and Angle Of Sideslip errors are in the range 0.15° to 0.18°**

AIR DATA SYSTEM FOR AIRCRAFT

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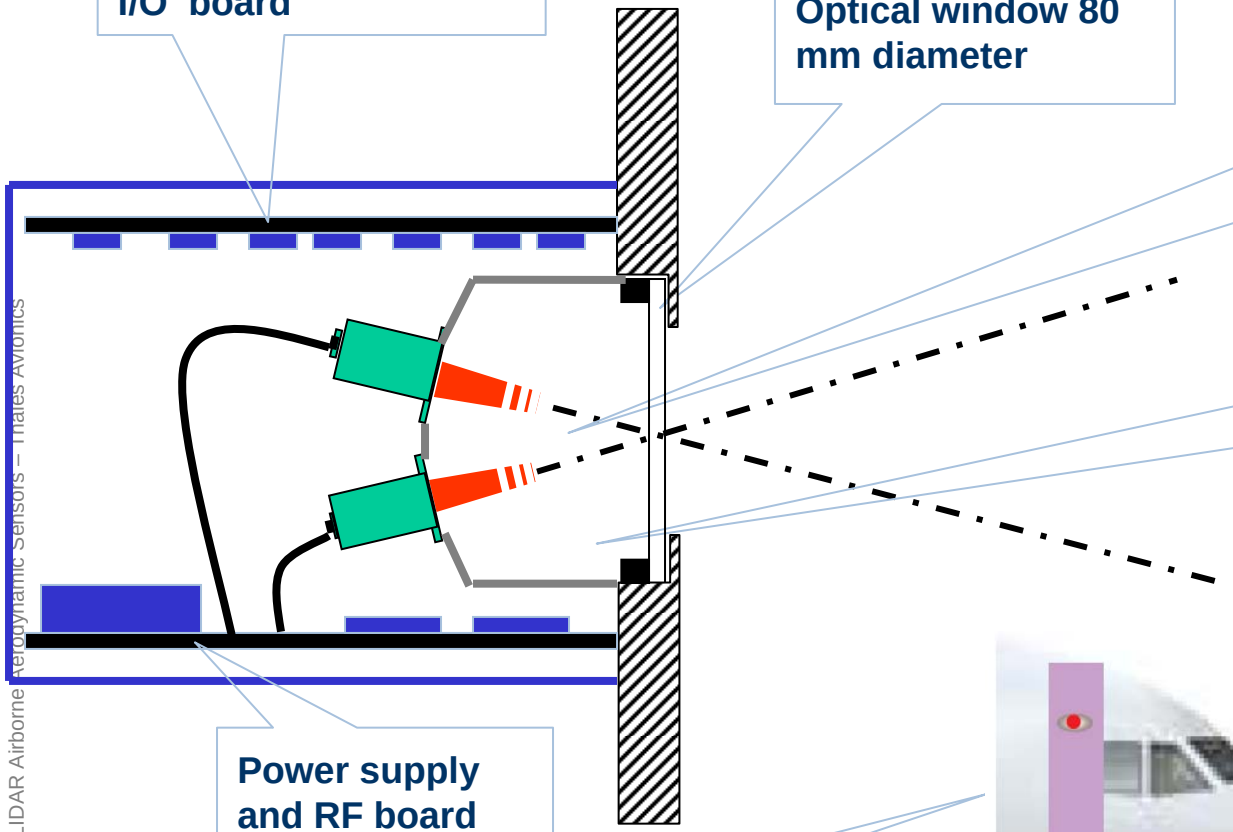
Benefit provided to ADS by LIDAR

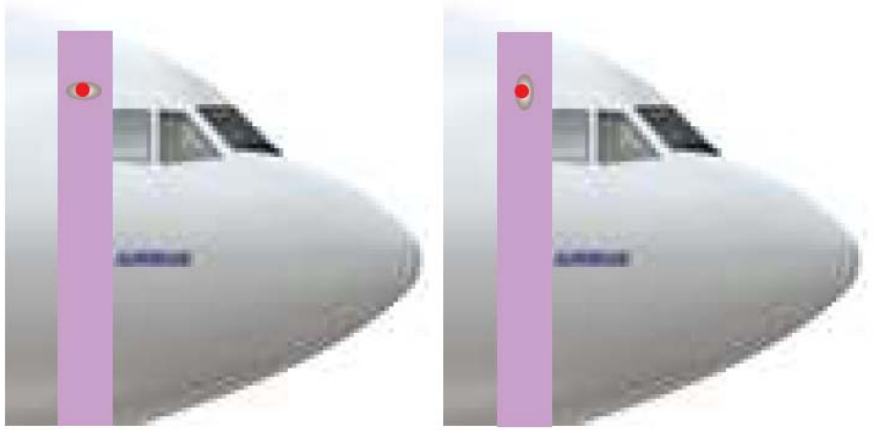
- Robustness against external aggression bird collision, passenger stairs mishandling or hailstone
- Less dependency on aerodynamic compensation
- No de-icing power : a classical ADS require around 4 KW
- Improved MTBF thanks to fully static equipments well protected inside the aircraft
- Improved integrity due to dissymmetric system
- Reduced maintenance costs

Though satisfying in terms of performances, classical pressure ADS suffered from lack of reliability and robustness against hailstone or bird collision

How to survive such an event?

LIDAR installation on aircraft





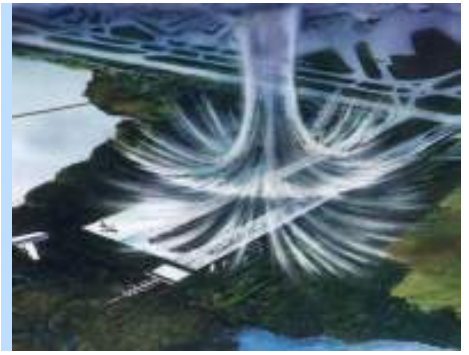
THALES

ATMOSPHERIC HAZARDS

Atmospheric hazards detection : The most difficult application because of complexity

Turbulence

Wake Vortex



Wind Shear

Turbulence description

From Advisory Circular AC 120-88A (FAA, 01/2006)

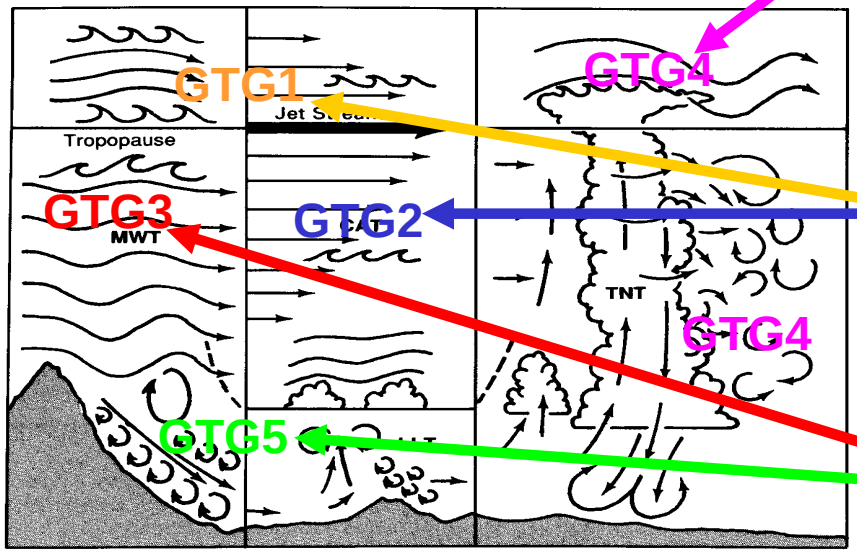


Figure 1-16. Aviation turbulence classifications. This figure is a pictorial summary of the turbulence-producing phenomena that may occur in each turbulence classification.

GTG = Graphical Turbulence Guidance

Thunderstorm Turbulence

Turbulence associated within and in the vicinity of thunderstorms or cumulonimbus clouds

⇒ RADAR preferred domain

Clear Air Turbulence

High level turbulence (above 15000 ft) not normally associated with cumuliform cloudiness. Typically windshear turbulence even when in cirrus clouds

Mountain wave Turbulence.

Turbulence as a result of air being blown over a mountain range or a sharp bluff causing a series of up and down drafts

⇒ LIDAR preferred domain

Turbulences mitigation and avoidance

Turbulence effect can be managed through 3 different ways

Avoidance	Mitigation	
Long-range detection	**Mitigation at passenger level**	**Mitigation at aircraft level**
Not achievable with foreseeable LIDAR technology	**Detection** medium range	**Measurement** short range
	DETAC / DELICAT	**SFWA**
	Autonomous single axis <u>detection</u> LIDAR	**Redundant and tightly coupled with flight control <u>measurement</u> LIDAR**