Mirror Measures Vortex Drag

July 28 2004

Airplanes generate trailing wake vortices which can be dangerous for following aircraft, especially on takeoff and landing. An onboard laser measuring device scans the air space in front of the plane, recognizes turbulence and will inform the pilot.

The volume of air traffic is constantly rising – many air routes are already overloaded. Frequent delays are encountered when machines are taking off and landing at major airports. The frequency of aircraft cannot be increased because they have to maintain a safety distance of up to six miles (11.1 kilometers). It is to ensure that the following airplane is not endangered by the vortex drag of the machine in front. This across-the-board safety distance is often more generous than required. If the position and the actual extent of the air vortex could be directly measured, the safety distance could be adjusted to the actual circumstances and shortened. Airports could then use their capacity to better effect.

“In the EU project I-Wake we are cooperating with eight teams from four different countries to develop a sensor which can determine whether the air is calm enough for a safe takeoff," explains Thomas Peschel from the Fraunhofer Institute for Applied Optics and Precision Engineering IOF in Jena. "The optical scanner can recognize any turbulence and in future could deliver rapid and reliable measured results on board commercial aircraft. A prototype is currently being tested on a small Cessna plane." The measurement principle is relatively simple: A laser sends pulses into the air space in front of the aircraft. The light is scattered on aerosol or dust particles and registered by a detector. As a result of the Doppler effect, the wavelength of the incoming laser pulses is shifted according to whether the airborne particles are moving towards or away from the beam. From the difference relative to the incident wavelength, a software system calculates the strength of air turbulences within fractions of a second.

Core parts of the device are two precision mirrors, measuring 11 by 15 centimeters. One of the challenges which had to be overcome was to scan the air space at a relatively high frequency of around seven times per second. To keep forces of inertia and slight subsequent deformations as low as possible, the mirrors have to be lightweight but stiff. The aluminum plate they were manufactured from was perforated to minimize its mass. The perforations run parallel to the surface on the inside in order not to deteriorate mechanical and optical properties. At the same time, the reverse side of the mirrors were retained as a closed surface in order to provide even more rigidity.

Source: Fraunhofer-Gesellschaft