Chapter 1
Foreword to the Proceedings of the Final Workshop

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Flight testing is the final proof of maturity for a technology under the most representative levels of acceleration, aerodynamic load on structures and in the most representative flight environment (e.g. Reynolds number). Therefore, measurements performed during flight tests are particularly valuable. They are also scarce because a flight is costly, requires a long preparation time for the instrumentation while satisfying certification requirements to ensure safety.

A number of optical measurement techniques developed over the last decades have become mature and provide nowadays a good level of accuracy in laboratory environment while being non-intrusive. Many of them have the capacity to provide information over a 2D field in one measurement while classical probe techniques are limited to a point observation.

As a challenging goal, the FP6 research project 'Advanced In Flight Measurement Techniques' (AIM), coordinated by DLR, has set as an objective to test and demonstrate the possibility of using such techniques during flight. These are Quantitative Visualization (QVT), Image Pattern Correlation Technique (IPCT) to measure deformation, Background Oriented Schlieren Method (BOS) to measure density gradients, LIght Detection And Ranging (LIDAR), Particle Image Velocimetry (PIV) to measure velocity, Pressure Sensitive Paint (PSP) to measure pressure and Infrared Thermography (IRT) to measure temperature.

A number of challenges had to be overcome. To adapt the techniques so that they are compatible with certification requirements needed significant effort and resources that should not be underestimated. Also the required low levels of vibrations called for particular care in the installation of cameras and verification in the post-processing.

Developing seeding systems in an open field (the runway) with large production rates of environmentally and engine friendly particles was not straight forward and is key to the success for PIV or LIDAR measurements in take-off, landing or hovering conditions. In-flight, the use of water droplets in clouds as particles turned out to be

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a good solution. The use of BOS using natural backgrounds available in the vicinity of a runway works in principle but the difficulty is in the arrangement of a large laser sheet and the proper viewing distance and angle of the camera, which is constrained by some minimum distance from the runway required for safety reasons. The use of infrared thermography to monitor a region of a helicopter cabin in the vicinity of the engine hot exhaust turned out to be quite straight forward and to achieve readily good levels of accuracy. It has also been demonstrated that PSP is usable for in-flight measurement but more work is needed to achieve the required levels of accuracy.

The generation of visual patterns for IPCT, which allows accurate measurement of displacements of the wing seen from the aircraft window under a low angle and variable field depth, called for innovative solutions and processing algorithms. The synchronisation of the cameras with a rotating aircraft propeller of helicopter rotor added complexity in the measurement and post-processing but allowed to acquire accurate deformation data in the relative frame. As a highlight of the project, this IPCT technique proved to be very successful for both propeller and helicopter rotors as well as wing deformation measurements (tested among others on an A380 aircraft) with a high level of accuracy. It is definitely an interesting candidate to be used in 'industrial' flight tests.

Overall, the project has advanced significantly a number of measurement techniques capable of doing in-flight measurement, some of them being very close to be usable in 'industrial' flight testing. Within the presently running follow up project AIM^2 these techniques are going to be further developed towards industrial application.

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