



Flight Calibration Services

Company Profile





Flight Inspection Experts

FCS Flight Calibration Services GmbH is a joint venture of DFS Deutsche Flugsicherung GmbH, Austro Control and skyguide, the ANSPs of Germany, Austria and Switzerland. FCS owns and operates two King Air 350 aircraft and employs subchartered Learjet 35 aircraft

for radar flight testing. With 37 permanent staff, FCS currently provides over 2500 flight inspection hours annually, as one of Europe's largest flight inspection providers.

Scope of Services Overview

Flight Inspection

- ILS CAT I to III, PAR, (D)VOR, DME, TACAN, NDB, P-RNAV (DME-DME)
- GBAS
- VHF and UHF radio direction finders and COM systems
- PAPI and visual aids/air-field lighting
- Special flight inspections
- Associated services:
 - Site surveys and geodetic surveys
 - Training and qualification

Flight Validation

- RNP (GPS RNAV and conventional procedures), LPV/APV SBAS precision approaches
- ARINC 424 and FMS database validation

Flight Testing of Surveillance Systems

- Primary radar
- Secondary radar (SSR/MSSR)
- Multilateration (MLAT/WAM)
- ADS-B
- Associated services:
 - SASS-C radar data quality evaluation
 - 1030/1090 MHz channel occupancy and interference measurements

R&D Services, Studies and Simulations

- Coverage simulations and electromagnetic simulations





Approvals, Certifications, Management System

FCS flight inspection systems are approved by the Bundesaufsichtsamt für Flugsicherung (BAF, Federal Supervisory Authority for Air Navigation Services, Germany) against certification requirements issued by BAF/DFS, based on ICAO Annex 10 and Doc 8071. Further FCS reference documents include:

- ICAO Doc 9906 Vol. 5 and Vol. 6 (Flight Validation)
- NATO STANAG A Et P-1
- Flight inspection guidelines of DFS, skyguide and Austro Control

FCS is fully compliant with current EASA requirements for aerial work both with respect to aircraft maintenance performed under the responsibility of the

FCS CAMO (Continuing Airworthiness Maintenance Organisation) and flight operations, according to our EU-OPS1 compliant Operations Manual, aligned with EASA Specialized Operations (Part-SPO) requirements.

FCS is ISO9001-certified and fully compliant with the Standards and Recommended Practices (SARPs) of ICASC, the International Committee on Airspace Standards and Calibration, the ICAO-recognized body that deals with all aspects of Flight Inspection and Flight Validation. The FCS Integrated Management System covers all company activities including flight inspection, aircraft maintenance, quality and safety management, and naturally also covers risk management and occupational health aspects.





Advanced Infrastructure

Aircraft

FCS employs two Beechcraft King Air 350 aircraft for flight inspection and flight validation. The aircraft is proven in terms of performance, reliability and economics for these tasks. Superior engine performance of the PT6A turbines, benign runway lengths requirements, RVSM certification for fast ferry flights at high flight levels, as well as low noise emission are some of this aircraft's features, as well as EGPWS, TCAS-II and ADS-B. A comprehensive support center at Braunschweig airport carries out all maintenance work under

the control of the FCS inhouse CAMO, ensuring a perfect condition of FCS aircraft with short turnarounds.

FCS King Airs with their state-of-the art Proline 21/FUSION "glass cockpit" avionics (including the FMS3000 flight management system) with latest WAAS/EGNOS/SBAS-enabled avionics and up-to-date firmware supporting current ARINC levels including RNP "RF" leg types, are ideally suited to perform all tasks related to flight inspection and flight validation.

Aerodata Flight Inspection System

FCS aircraft D-CFMD, D-CFME (and in future D-CFMF) are equipped with an advanced industry-grade Aerodata AFIS 220 Flight Inspection System (FIS) including features such as:

- High integrity and accuracy of the multi-sensor hybrid positioning reference system with an accuracy of <10cm for phase based DGPS, respectively 0.01° in azimuth and elevation and 20 cm in range for the fully automatic backup laser tracker for ILS and LPV, and submeter Wide Area DGPS precision for RNAV
- Capability to combine ILS, VOR, NDB, TACAN, multi-DME and flight validation patterns; simultaneous checking of 4 DMEs in real time and up to 10 DMEs in scanning mode
- EASA certified FIS-autopilot coupling, reducing pilot fatigue, improved efficiency (shorter mission durations) and repeatability, as well as the precision required for noise abatement in high traffic TMAs
- Fast radio up- and downlinks using advanced military tactical components; flight inspection parameters and graphics can be downlinked to the ground for effective ILS commissioning
- calibrated 3D antenna patterns processed in real time compliant with ICAO 8071 requirements for field strength measurement accuracy, vital for ILS, GBAS or L-band (DME/TAC) commissioning flights.
- Fixed installed cockpit and outside camera system for documentation of flight validation tasks.



Flight Validation

Flight validation of new Instrument Flight Procedures (IFPs) is a core competency of FCS, based on our experience of more than 18 years in this field. The analysis of all procedure type (Standard Arrivals STAR, Approaches and Standard Instrument Departures SID) is fully supported by the FCS aircraft's flight management system (FMS) and comprehensive integration of FIS and cockpit. Both conventional nav aids-based procedures as well as RNP procedures can be validated. In the RNP domain, both GNSS-based procedures (like LPV, APV SBAS or GBAS) as well as DME/DME based procedures can be evaluated. Beyond the validation flight, performed by specially qualified FCS flight validation pilots and used to evaluate flyability and RNP containment criteria, flight validation includes preparation on the ground, desktop analysis of the new procedures and a database check. The validation flight is performed with a dedicated test (preproduction) database coded in the regular industry processing chain but for FCS use only. FCS employs its dedicated "FIDIT" (Flight Inspection

Database Integrity Tool) to validate both ARINC424 and FMS databases against data published in the AIP. Results are documented in flight validation and flight inspection reports.

Helicopter Procedures

In a partnership with the Swiss air ambulance operator REGA, FCS provides flight validation and flight inspection of GPS RNAV, LPV helicopter procedures and point in space procedures with a Leonardo AW109 SP helicopter equipped with a mobile flight inspection system.

GBAS

With our GBAS-equipped and enabled D-CFME aircraft FCS has flight checked the majority of operational and certified GBAS CAT I systems in Europe. D-CFME will be equipped for GBAS CAT III flight inspection.





Radar Flight Testing

Surveillance systems (radar, MLAT/ WAM, ADS-B) are safety-critical and expensive infrastructure investments forming the backbone of ATM with a life span often exceeding 20 years. Therefore, the commissioning flight check is one of the most important milestones in the system life cycle, and confirms that the system is within the required specifications and fit for its operational use, as governed by ICAO or EUROCONTROL specifications. Flight testing of a surveillance system by FCS typically comprises:

- supply of critical quality figures such as probability of detection (PD) and resolution
- coverage evaluation on test radial and arrival and departure routes
- system optimization, e.g. tilt
- general certification of system performance.

Learjet 35A Flight Testing Aircraft

FCS, in cooperation with our partner GFD of Hohn, Germany, employs specially equipped Learjet 35A aircraft for surveillance flight testing. The Learjet features excellent performance figures, including high altitude capabilities up to FL 450, a small radar cross-section and extremely fast deployment times, at favourable operation cost. Flight testing equipment comprises

- aviation-certified GPS data logging system for position recording in the meter or sub-meter range as required, using Wide Area DGPS.
- transponder system, switchable to lower output power consistent with ICAO minimum specifications, whilst maintaining full TCAS functionality.

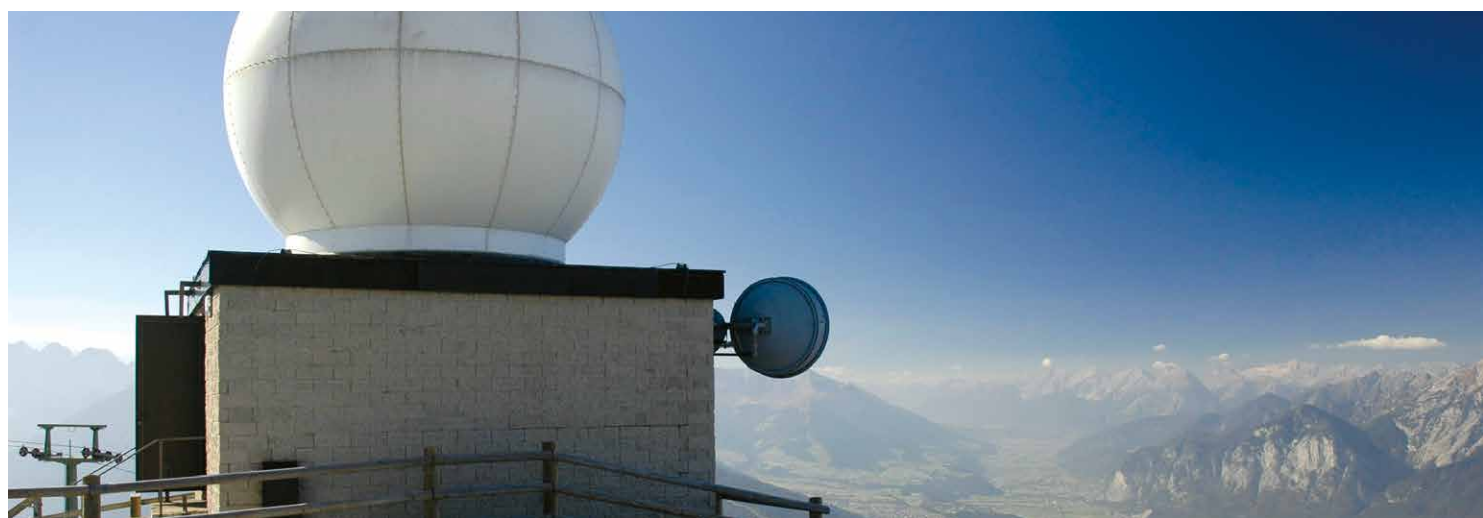
Calibration of the transponder system includes the associated antennas far field performance for accurate results.

SASS-C Recording

FCS performs the essential recording and radar data quality analysis work on the ground with the EUROCONTROL SASS-C toolset through special partner-ships, thus ensuring complete and concise evaluation reports in accordance with the pertinent standards.

Project Management and Mission Planning

Commissioning flight tests are frequently carried out in difficult project environments under high time pressure involving many technical and operational stressors. FCS radar flight inspectors, with their dual background of both Air Traffic Controller and radar specialist and their long experience in coordinating radar flight checks, ensure a perfect coordination of the project.



Research and Development, Simulation and Studies

Signal-in-Space Monitoring (SISMOS)

Avoiding the shortcomings of FIS-integrated aviation-certified receivers, FCS developed its generic SISMOS platform. This is designed to analyze and record raw NAV, PSR and SSR signals to make radio wave propagation transparent. It uses dedicated RF frontends, signal-specific correlation algorithms, high sampling rates and offers parallel multi-channel processing and recording. FCS reference projects include ILS LOC/GP and DME/TACAN multipath interference studies, analysis of P-RNAV (DME/DME) coverage and quality figures for the EUROCONTROL/P-RNAV implementation program, and 1030/1090 MHz SSR, WAM and ADS-B radio field studies, including the "MOSTDONT" SSR Mode S radar / transponder interoperability study for EASA. Under EU Regulation No 1207/2011, member states must assure that SSR transponders are not subject to excessive interrogations by June 2020. FCS has working equipment to measure SSR hotspots using a multicoper UAS equipped with SISMOS technology.

Assessment of Electromagnetic Interference caused by Wind Turbines using Drones

With our signal-in-space analysis, receiver design and simulation competence, FCS is a key partner in the "WERAN plus" project, which is funded by the German government. WERAN investigates the potential of wind turbines (WT) to interfere with navigation and radar systems used by ATC and the weather services, using an UAS measu-

* WERAN, FKZ 0325644A-D, a collaborative project sponsored by the Federal Ministry for Economic Affairs and Energy (BMWi) by resolution of the German Federal Parliament

rement platform. For the first time ever, the WT multipath wave propagation impact was demonstrated on the signal-in-space basis. This technology is now integrated in a UAS, designed to carry out near-ground measurements of ILS, (D)VOR, GBAS, primary and secondary radar installations.

Electromagnetic Simulation

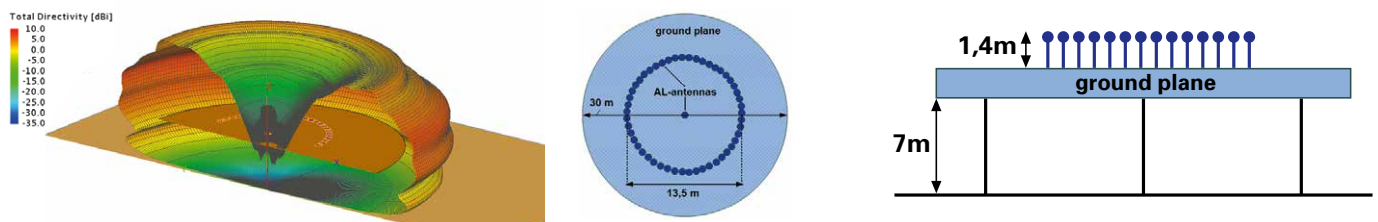
Using state-of-the-art electromagnetic solver software, FCS provides simulations of NAV (e.g. ILS/VOR) or surveillance (e.g. WAM) configurations and interference scenarios at airports, applying calibrated measured RF data and measured reflection properties of materials to the simulation model for best results.

Design Support for Industry

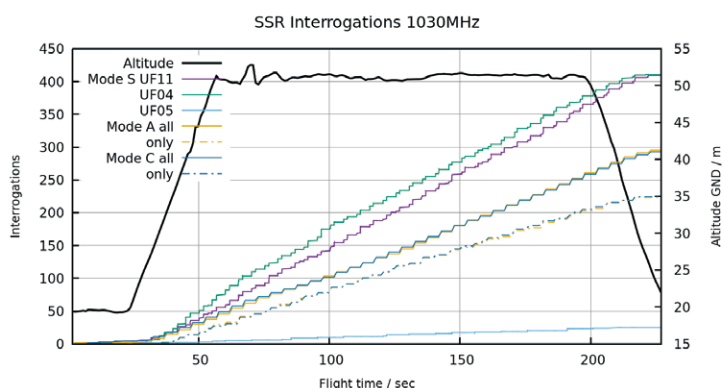
Based on our receiver design experience, FCS provides support to the industry. References include NAV test equipment, SSR 1030/1090MHz receivers including the first ADS-B receiver in space (PROBA-V) and general SSR receivers.

Patented Knowhow and Expert Studies

Over 80 publications, as well as several patents granted by the German patent office are evidence of the R&D competence and experience of FCS Flight Calibration Services GmbH. Prof. J. Bredemeyer provides expert studies in his function of a publicly certified expert in "Navigation- and Radar Systems in Air Traffic Control".



Figurexx: Number of various SSR interrogations across drone flight time



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