Identification of the installation/facility :

Country: **Germany**
Location (city): **Braunschweig**
Name of the facility: **ACT/FHS Experimentals incl. Ground Station (ACT/FHS: Active Control Technologie / Flying Helicopter Simulator)**
Date of construction or of acquisition or of main refurbishment: **2002**
Owner: **DLR**
Contact point: **Martin Gestwa, Head of the FHS-Board, DLR Institute of Flight Systems (FT),**
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Internet site:
http://www.dlr.de/ft/en/desktopdefault.aspx/tabid-1387/1915_read-3374/

Technical characteristics:

1 - Type of infrastructure

Wind tunnel	☐
Propulsion bench	☐
Structures facility	☐
Material facility	☐
Simulator (ex. Flight simulator, tower, …)	☐
Flight test bed (aircraft, embedded facilities, …)	☒
Supercomputers	☐
Other	☐

2 - Main technical characteristics

The Active Control Technology / Flying Helicopter Simulator (ACT/FHS) is based on an EC135. The main feature is a combination of a full authority, quadruplex fly-by-wire/light control system with smart actuators and a simplex experimental system. It completely replaces the original flight control system and provides a high degree of flexibility. If the experimental system is engaged, it has full authority over all control surfaces. The experiment system offers unique capabilities to the researcher. Either software-based experiments are implemented (no certification required) or the experimental system is used as a simple interface to integrate external hardware like sensors, active inceptors, and display systems. All hardware modifications have to be certified, which is also done by DLR. In February 2008 the ACT/FHS was certified to land in experimental mode.

The ACT/FHS is equipped with a hierarchical flight control system (see Figure 2). The core system consists of the active control technology for the pilots. All components, hardware and software, are four times redundant (quadruplex). The connections between the pilot controls and the core interface computer are by wire and between the core interface computer and the actuator units by light. The functionality of the core system can be shortly described in the following way: The command inputs of the pilot (safety or evaluation pilot) are measured and transmitted as digital signals to the core interface computer. This computer monitors the control activities and the data communication, performs the safety analysis and limits safety critical control commands before these signals are

transferred to the smart actuators. Additionally, the ACT/FHS has a mechanical backup control system for the safety pilot. If the experimental system is engaged, the controls of the evaluation pilot are fed through the experimental system (see Figure 2) and fed back to the core system with full authority.

The experimental system consists of three computer systems, additional sensors, and two stations, one for the evaluation pilot and one for the flight test engineer (see Figure 3). The first computer system is the Data Management Computer, which acquires and stores data, distributes them to the other computer systems, and transmits them to the ground via telemetry. The second computer system is the Experiment Computer, which executes the experimental programs. It is connected to the core system. The third computer system is the Graphics Computer, which drives two displays for the evaluation pilot and the flight test engineer. The freely programmable displays may show instruments but also signal quick looks etc. The Data Management Computer accesses two attitude and heading reference systems, two air data systems, two full authority digital engine controls and a radar altimeter. In addition to these sensors of the basic helicopter the experimental system contains further sensors: an inertial navigation system, a differential global positioning system, nose boom air data sensors, accelerometers, rotor data sensors as well as main rotor and tail boom load sensors. In addition to the conventional controls the evaluation pilot's station contains a flat screen display as well as two active control sticks – one for cyclic and one for collective control. The station of the flight test engineer contains also a flat screen display. Both stations are equipped with control display units to operate the experimental system. Furthermore, experiment specific input devices, like touch panels, can be added to both stations.

The overall system of the ACT/FHS includes telemetry and experimenter ground station as well as a ground based system. The telemetry station receives the data from the ACT/FHS. There are several operator stations available for monitoring flight data. The transmitted data can comprise audio (intercom) and video data. This data transfer enables the experimenter to monitor and, if necessary, to communicate with the crew during the flight test. The telemetry station contains the essential infrastructure for the conduction of a flight test campaign. This is indispensable in remote flight test areas or campaigns outside the ACT/FHS home base. To be able to react on this requirement of flight operation a special small mobile telemetry station is available.

The system simulator is designed as a hard- and software-in-the-loop test facility for the ACT/FHS. The simulator replicates the environment of the helicopter with a cockpit and a large field-of-view visual system. The EC135 itself, the core system, and all relevant sensors are simulated. Pilot controls and the complete experimental system are the same as in the aircraft. Experiment specific software and parameter settings must be tested in the system simulator before flight. If necessary, experiment specific hardware has to be integrated, also. Subsequent to a successful integration the flight test will be prepared in the system simulator. Furthermore, the ground simulator can be used to familiarize pilots with the special handling of the ACT/FHS or to optimize the flight test program on the ground.

3 - Research domains which can be addressed (refer to ACARE taxonomy http://www.acare4europe.com/sites/acare4europe.org/files/document/ASD-Annex-final-211004-out-asd.pdf)

4 - *Main (or specific) associated measurement techniques*

The experimental system accesses the following sensors of the basic helicopter:

- 2 attitude and heading reference systems,
- 2 air data systems
- Central panel display system with access to 2 full authority digital engine controls (and other data),
- Radar altimeter.

The experimental system contains the following additional sensors:

- Inertial navigation system,
- Differential and satellite augmented global positioning systems,
- Noseboom air data sensors,
- Accelerometers,
- Main rotor and tail boom load monitor,
- Collision avoidance sensor,
- Obstacle and terrain sensors with laser radar, microwave radar, normal camera and infrared camera

The experimental system is highly configurable. The parameters are roughly divided into system and user parameters. They are used to configure the interfaces and devices, the signal database, and the administration of the experimental applications like the configuration of the data storage, the telemetry, and the Graphics Computer display pages. Each experimental application can have its own set of parameters for internal usage. Sets of application parameters can be predefined and activated as a whole during flight.

Sets of application parameters can be predefined and activated as a whole during flight. Parameters are specified before flight, verified in the system simulation, compiled into binary files, and copied to USB flash drives. These are read by the Data Management Computer during initialization. Data are stored during runs (which are started and stopped by the crew) and/or outside runs. The data to be stored in each mode can be configured individually. After the flight they can be converted into the data format defined by the customer.

5 - Operational status

- Fully operational (hours available in 2012 are 103 and in 2013 are 54)

6 – Pictures

Figure 1: Active Control Technology / Flying Helicopter Simulator (ACT/FHS)

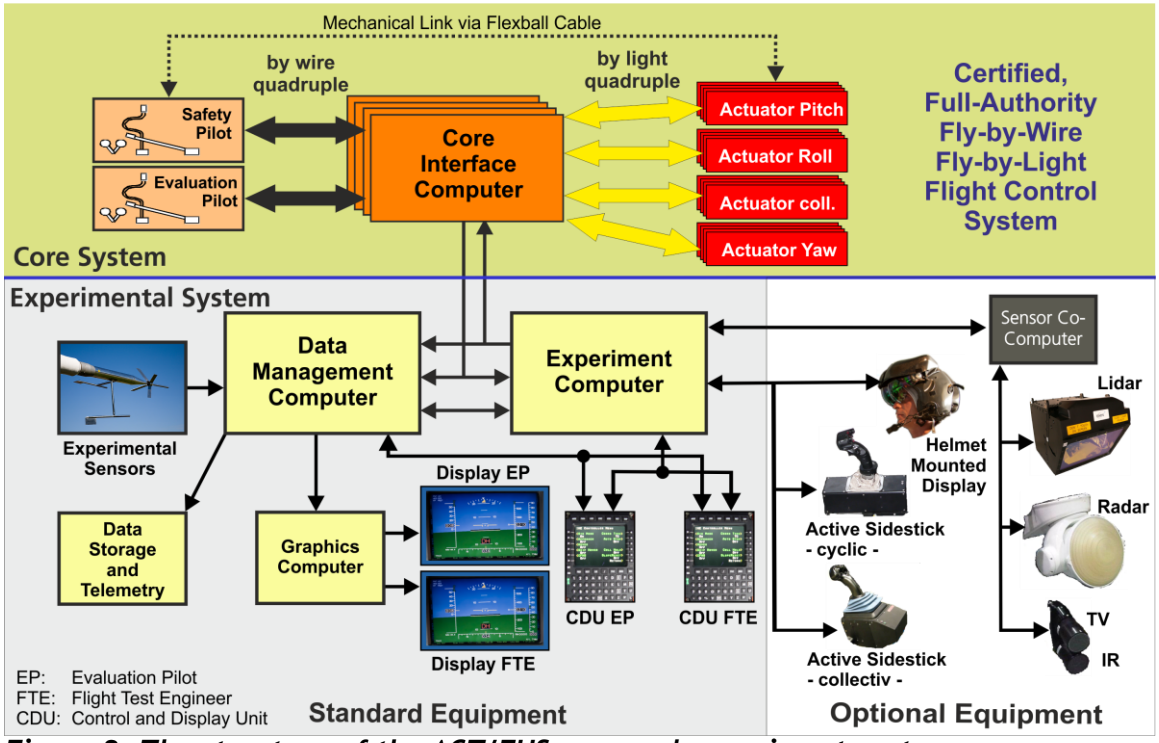

Figure 2: The structure of the ACT/FHS core and experiment systems

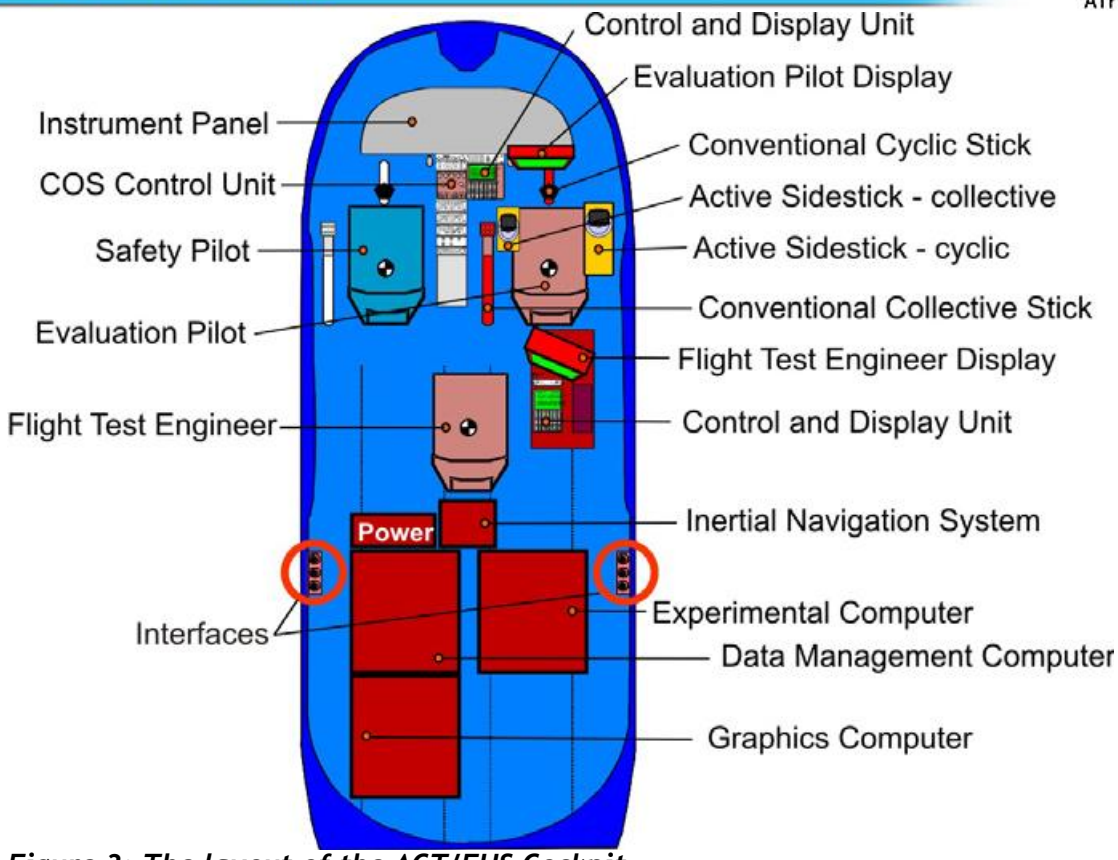

Figure 3: The layout of the ACT/FHS Cockpit

Financial elements:

Replacement cost (M€uros)

Less than 10	☐
10 to 30	☐
30 to 60	☐
60 to 100	☒
More than 100	☐

Practices concerning:

Access policy contract

Support regional, national, European and International

Comments:

The ACT/FHS Experimental System incl. the corresponding Ground Station – which are both described here – are operated in connexion with their carrying aircraft, an Eurocopter helicopter EC135. Yet, the EC135 itself is being treated as a separate device on its own and described in its own AirTN Questionnaire.

Origin of information ('signature'): author and date

Martin Gestwa (19 August 2014)