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Rendezvous with HALO – a report

5 March 2009

On 24 January 2009, HALO (High Altitude and Long Range Research Aircraft), the new member of the research fleet belonging to the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR), landed at its base airport in Oberpfaffenhofen. The aeroplane, a Gulfstream G550, had previously been converted from a business jet to a modern climate and atmospheric research aircraft. On 26 January 2009, the aeroplane took off on a two-hour flight in order to receive its German airworthiness certification. During the flight, all of the devices on board were checked once again. The previous flagship of the DLR's research fleet in Oberpfaffenhofen, the Falcon, rendezvoused with HALO high above the Zugspitze to welcome it as a member of DLR's research fleet.

HALO: First flight under DLR management (Credit: DLR)

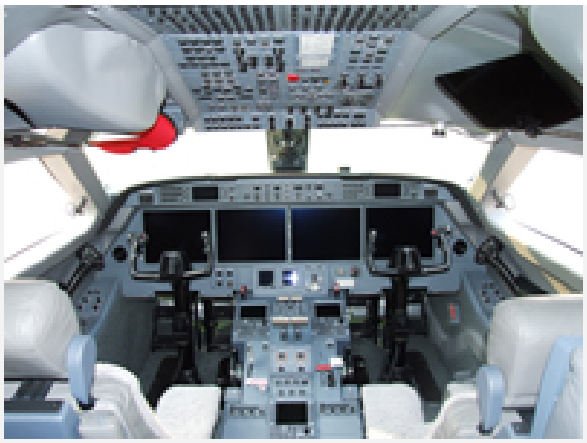
By Andrea Schaub

In attendance for the German airworthiness certification flight

The pilots and scientists of the 31 research institutes who supported the construction of the Euro 62 million jet have waited a long time for this day. Many of DLR’s employees are using their lunch break to watch the takeoff of the eagerly awaited aeroplane. While the technician on duty asks his colleagues to leave the apron, the film crew that has arrived for the airworthiness certification flight is allowed to enter the hangar and even survey HALO from the inside. The team is here to document the preparations for the flight and be present when HALO is tested and meets DLR’s Falcon research aircraft above the Alps for a special photo shoot. The new research aircraft, painted in brilliant white, is just about to commence its important first flight under the management of DLR.

12:30 - The preparations

The camera team enters the cabin and it immediately becomes clear that HALO has not only undergone significant changes on the outside, but also on the inside. The interior of the slender, elegant-looking research aircraft is well laid out. It smells 'new'. The smell of the blue soft plastic panelling designed by Steppmantel hangs in the air. It is attached to the cabin wall with press-studs. This allows the technicians from DLR’s Flight Operations team to access the cabling in the aircraft cabin, in accordance with the requirements of the plane’s mission. In the front part of the cabin there are 15 seats. Behind this, there is the small galley and at the back there is a small cargo compartment. In this part of the interior, the aeroplane still looks like a completely normal business jet. But when HALO begins researching the atmosphere in Summer 2009, the aeroplane will be brimming with more than 15 racks for scientific instruments. It can house twice as many devices as its predecessor, the over thirty-year-old Falcon. It is not only HALO's capacity that will present science with totally new opportunities. In its application as an atmospheric research aircraft it can achieve a range of more than 8000 kilometres and, with a maximum altitude of 15.5 kilometres, it can perform measurements in the stratosphere, the second storey of the Earth's atmosphere, and study remote areas around the globe.



Impressive: The complex instruments in HALO's cockpit

HALO pilot Roland Welser steps inside the aeroplane for a brief visit and looks at the inquisitive film crew somewhat critically. He answers the question as to whether HALO’s flight technology is also different from that of the Falcon with a shake of his head: "There is hardly any difference from the Falcon, at least not with respect to how it actually flies". He adds, "HALO is of course faster, is incredibly powerful and is has a higher performance level. The cockpit is different and the instruments are more complex than those in the Falcon". One glimpse inside the cockpit and we understand what he means – sitting down and taking off is not so easy, even for an experienced test pilot.

Background information

The conversion of the research aircraft began back in 2005. Since then, in accordance with the specifications of DLR's Flight Operations team, HALO has been converted in over 60,000 hours by aerospace company RUAG in Oberpfaffenhofen, modified in over 30,000 hours, and equipped and finally painted with the DLR’s design in many more than 300 dayshifts and nightshifts by aircraft manufacturer Gulfstream in the USA for its future missions. HALO has been tested for 130 hours by American and German test pilots prior to its handover to DLR. DLR’s test pilots have prepared themselves for the challenging missions with HALO for more than 200 hours in both simulator and aeroplane.

While the Falcon appears quite confusing, with its many different aircraft instruments, HALO's cockpit looks very tidy, almost sterile. All of the flight and system-related information is displayed on four large monitors. What is impressive is the glass head-up display on which the artificial horizon is projected and which allows the pilot to safely navigate and land even in low visibility conditions. DLR's test pilots, Roland Welser and Stefan Grillenbeck, were required to complete comprehensive flight training over several months in order to be able to operate the high-tech cockpit. In addition, special training courses such as 'Surviving in Ice' and 'Surviving at Sea' are a basic requirement for flying a research aircraft.

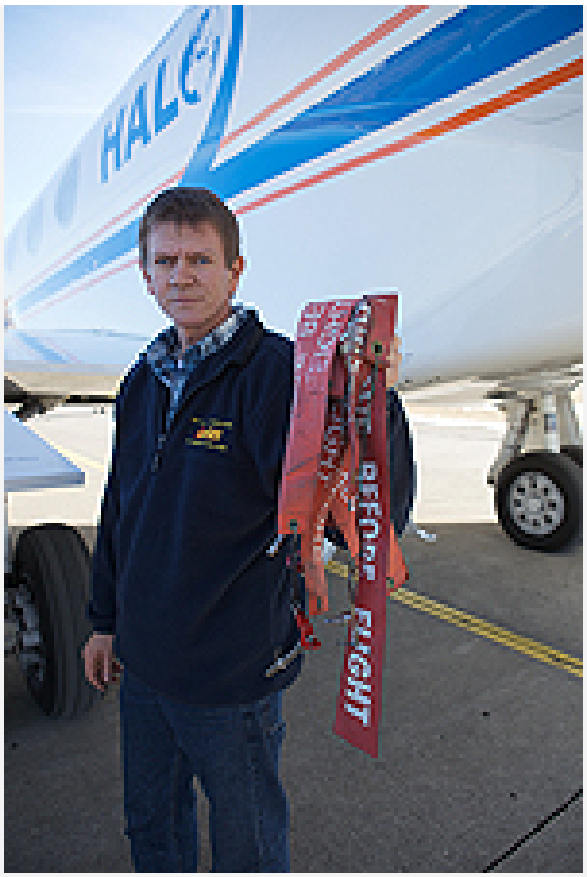
13:30 – Commencing the flight

HALO is towed out of the hangar onto the apron

The camera team is requested to leave HALO; the personnel of Flight Operations do not want to waste any time and they tow the aeroplane onto the apron. This is because there are still preparations to be made before it is ready for the two-hour airworthiness certification flight. Flight captain Roland Welser and his co-pilot, the American Gulfstream test pilot Kent Crenshaw, will again test the complex electronics on board during special approach procedures. The yellow aircraft tug pulls HALO out of the

new aircraft hangar very slowly. Christian Hinz, who has been working as an aircraft maintenance engineer at DLR for 14 years, approaches his work in an experienced and concentrated manner: “Every task has to be done correctly; if I make a mistake here, I can pack my bags”, he calls to the camera team. After a few minutes, HALO is in position and the mechanic jumps out of the aircraft tug with a smile.

"Let's take off", he calls and pats the shoulder of his American colleague Ed Spirko who, in his capacity as aircraft maintenance engineer from the company Gulfstream, will be assisting DLR for another two weeks during the transfer phase. On the apron, the HALO pilots Welser and Grillenbeck assume control of the aeroplane. They are accompanied by their American colleague, Crenshaw.



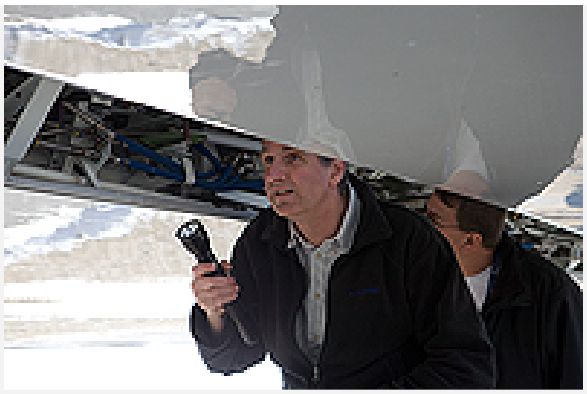
Every task needs to be done correctly: DLR aircraft engineering technician Christian Hinz

13:45 – Large engines, lots of power

HALO is now ready for takeoff. But still a fairly long time passes before it starts to move onto the runway of the adjacent private airport. "This is only the case because it is an airworthiness certification flight", stresses DLR pilot Roland Welser, who is making his routine external check equipped with a large torch. He meticulously checks the fuselage from all sides for possible damage.

He reaches under the fuselage, opens a flap at the rear, and pulls down a ladder. Then all but the legs of the tall man disappears into the aeroplane’s fuselage. "Too little pressure", he declares matter-of-factly. Aircraft maintenance engineer Christian Hinz knows what needs to be done: The pressure tank for the hydraulics needs to be filled. With one leap he jumps into the agile aircraft tug and drives back into the aircraft hangar. He returns after a few minutes, gas bottle in hand, and provides the aeroplane with the required nitrogen.

14:25 – As many holes as Swiss cheese



DLR pilot Roland Welser during the routine exterior check

In the meantime, the two employees of the aerospace company RUAG that have been commissioned by the German Federal Aviation Office (LBA) have appeared on the apron. DLR's aircraft maintenance manager, Wolfgang Schneider, is also there. In addition, the pilots Grillenbeck and Crenshaw arrive on the field. Everyone takes a last careful look at HALO before they climb into the aeroplane.

"Before and during an airworthiness certification flight the aeroplane is inspected with a fine-tooth comb, comparable to annual roadworthiness test for a car", Welser tells us and adds with a smile, "HALO has a lot of complex systems, that is why the check takes quite a lot of time". Believe it or not, 27 holes were cut in the aeroplane during the conversion, as the structure needed to be reinforced in order to attach additional measuring pods at certain points under the fuselage and under the wings. "HALO is like a Swiss cheese, and its scientific attachments can have a significant impact on the flight characteristics", explains Welser. “The most important thing now is for the Federal Aviation Office to issue us the final certification so that we can at last start to prepare for the first missions in Summer 2009."

Background information

Since the construction of the Euro 62 million jet was approved in 2005, German environmental and climate researchers have developed numerous mission proposals that can only be realised with HALO. The scientific steering committee selected 10 missions from more than 50 proposals as demonstration missions. In addition to these national research projects, there is also a range of missions that will be carried out by European partners. The scientific questions that are expected to be answered by HALO are manifold:

- How does the self-cleaning capacity of the troposphere change?
- How are trace elements from the troposphere transported to the stratosphere and what influence does air traffic have on the formation of cirrus clouds?

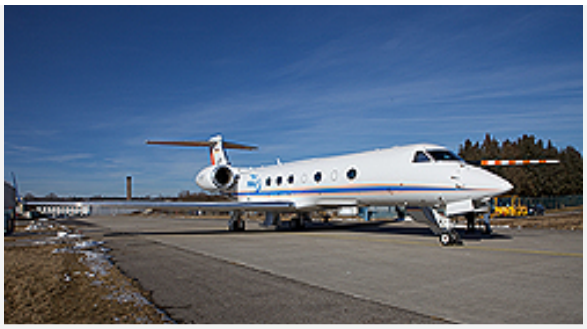
Its long range and extensive modifications also make HALO an ideal tool for research work in the area of remote Earth sensing.

15:00 – Ready for flight

The HALO testing team enters, and pilots Crenshaw, Welser and Grillenbeck also climb the steps. Just like business travel pilots, they are carrying black pilot's cases which contain notebooks, flight maps, checklists and a small but important accessory: a pair of sunglasses. Crenshaw smiles within the group. He has been working with the HALO project intensely right up to this day. As a trained test pilot he has accumulated around 4,000 flying hours on Gulfstream aeroplanes. He knows HALO like the back of his hand. Every noise, every signal on the complex display is familiar to him.

After the conversion phase in the USA, the aeroplane underwent extensive flight-testing with Crenshaw during over 130 flying hours and was then certified by the American certification authority, the FAA (Federal Aviation Administration). He will continue to assist the staff of DLR's Flight Operations team. In a friendly, calm and businesslike manner, he describes the necessary procedures for the pending acceptance flight.

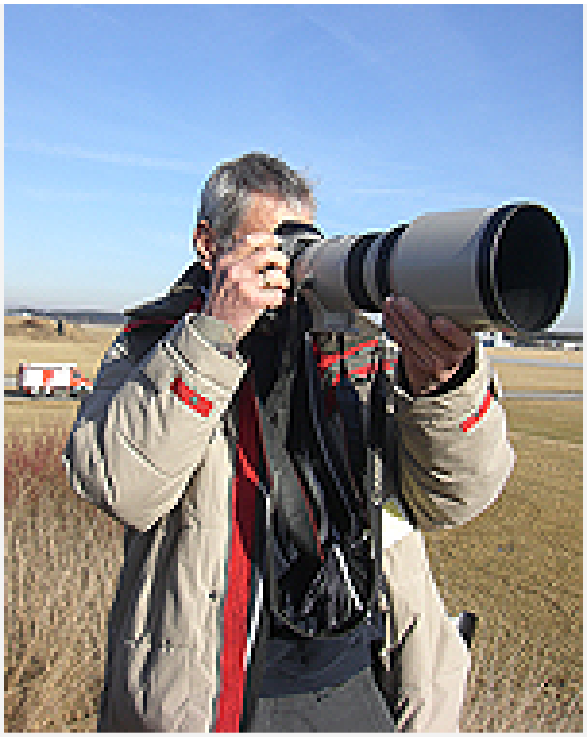
15:45 – The take-off flaps are extended



Ready for takeoff: HALO on the apron

HALO finally rolls towards the runway. On the 'shelter', a nearby grassy knoll which once served as a camouflaged bunker for military aircraft, the film and photo team waits anxiously for the aeroplane to take off. Although the aeroplane is rolling into position it is very quiet at the research airport. The sound of the 41-tonne colossus as it rolls is drowned in the slipstream. Suddenly a loud rumbling is heard – the film crew flinches and instantly turns around. This is immediately followed by expressions of relief – it is only the building cranes working on DLR's new robotics building. Their gaze immediately turns back to the viewfinders of their video and photographic cameras. "It must be about to start any minute", calls the photographer excitedly. The flaps are in the takeoff position, the jet engines can now be clearly heard and HALO is moving, at first slowly, then with increasing speed… It lifts off and flies up and away almost soundlessly, over the heads of the onlookers.

16:45 – The Falcon gives chase



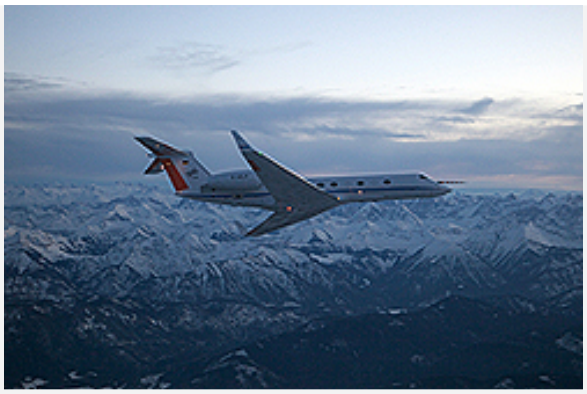
The photographer waits anxiously for HALO's takeoff

The cameramen, photographers and assistants now quickly enter the Falcon and prepare themselves for a rendezvous of a very special kind. Being on board the veteran research aircraft, they will be present when the Falcon meets HALO and symbolically welcomes it as a member of the DLR fleet. The crewmembers have found a romantic locale for this purpose: the highest mountain in Germany, the Zugspitze. In addition to DLR pilots Philipp Weber and Steffen Gemsa, technician Siegfried Judt is also a permanent member of Falcon's crew. He is sitting right at the front of the cabin in his grey overalls. With his legs casually stretched out in front of him, he is enjoying the trip to meet HALO above the Alps, which is unusual for him as well. The mountains on the horizon provide an impressive panorama. Twenty-five kilometres southwest of Munich, the Falcon is travelling in clear conditions, blue skies and sunshine over one of the most beautiful regions in Germany, the Fünfseenland lake region. Thanks to

the good weather, the aeroplane glides without turbulence towards the red evening sun.

Dr Andreas Giez, responsible for HALO's measuring and sensor technology, is also on board for this rare occasion. He too knows HALO well, having been present throughout the making of the external modifications and installation of internal equipment. When the actual research flights begin, he will provide the scientists with all of the measurement data relevant to the mission. He is no doubt looking forward to the extraordinary view of HALO in flight that is about to be experienced. Armed with a reflex camera, he says with a smile, "The pictures taken now have to keep for 30 years", alluding to the Falcon, which performed its airworthiness certification flight in 1976.

17:30 – The encounter above the Zugspitze



Breathtaking: HALO above the Alps

Giez suddenly starts rhapsodising. "We are now at exactly 3000 metres, the view of the Zugspitze is breathtaking". The last rays of sun are shining through the Alps. HALO is still not in sight. The autopilot steers the aeroplane and the two Falcon pilots sitting in the cockpit appear relaxed, but impressions are deceptive. They are busy continuously monitoring the airspace. Not only to detect HALO early enough, but also to keep an eye on the air traffic. "We don’t have any air traffic controllers to guide us", emphasises Gemsa. “We must remain in constant contact with HALO's crew and ensure that no aircraft cross our path, because amateur pilots love the Zugspitze", he adds.

17:50 – The encounter in the air

Suddenly Weber's voice is heard over the cabin loudspeaker. "HALO at level 95". This term stands for 9,500 feet, which corresponds to 2,800 metres. The pilots now prepare both aeroplanes for what is known as a 'close up', during which the planes will come especially close to each other and HALO will pose in front of the incredible panorama. At first, there is a vertical distance of 1,000 feet between the two research aircraft, that is, a height difference of almost 300 metres. For the Falcon this means a flying altitude of level 85. Then the manoeuvre known as ‘closing’ begins: HALO pilot Welser gives the command for the manoeuvre via radio. The Falcon pilots immediately bring their aeroplane to the same level as HALO.

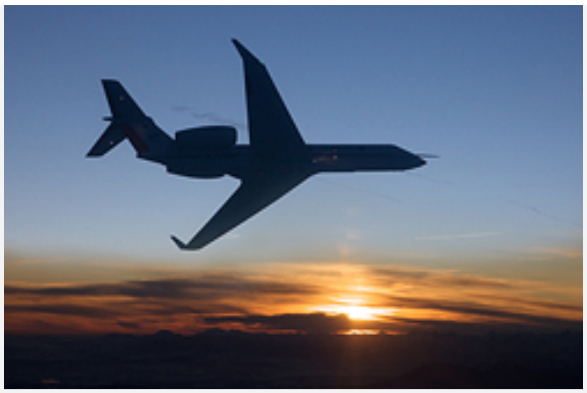
Rendezvous above the Alps: Falcon and HALO

Elegantly and graciously, the 31-metre-long new fleet member shows the film crew what it can offer the camera lens: silver-coloured, slightly angled wings, a gorgeous white fuselage and the four large letters spelling 'HALO'. In the flurry of camera flashes from the Falcon's crew, HALO proudly displays the orange-and-white striped rod that has been attached to the aircraft nose for measuring wind and flow

speeds, among other things, and the large engines, using which HALO can reach a speed of up to 88 per cent of the speed of sound (Mach 0.88).

After 20 minutes, the evening sun has disappeared and it is night. HALO finishes the rendezvous with a 'left turn'. We return to the research airport in Oberpfaffenhofen, where HALO will be rolled into the newly built hangar.

18:30 – HALO can fly superbly



HALO with the sunset over the Alps

HALO's crew leaves the new atmospheric research aircraft looking visibly satisfied, and Grillenbeck, who today accompanied the flight only in the cabin, also leaves the hangar. "HALO flies perfectly, both the fly-by-wire controls and the electronic onboard systems function perfectly", he reports happily. He triumphs in knowing that the airworthiness certification flight was a complete success. Before the crew are released to enjoy a well-earned rest, a debriefing takes place during which the pilots and mechanics once again o over all of the tests and events of the day.

The employees of DLR's Flight Operations team do not waste any time while this is taking place. After the successful airworthiness certification flight, the work on HALO is far from over. Further tests must be passed before the aeroplane is able to commence scientific flight operations in the summer of 2009. This includes a six-week ground vibration test. Colleagues from the DLR's Institute for Aeroelastics will arrive from Göttingen as early as the following day to prepare HALO for these complex tests. The camera team and the editor will long be back in their familiar surroundings and their HALO project will be complete. For others, the work is just beginning.

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