

Kasaero GmbH
Press release
14.9.2020

Released for immediate publication!

Electric Long-Range Drone Celebrates its Premiere on Mengen Test Field (Germany)

New Unmanned Aircraft Detects Toxic Clouds from the Air and Provides Real-Time Data

Pioneering work for civil defence: German engineers take off for the first time with protex.one. The emission-free, self-controlling flight system is part of the ATHMOS project. In future, it will carry the miniature version of an infrared spectrometer into the sky and ensure enhanced safety.

Long ranges with electric propulsion, safe unmanned flight, the miniaturisation and automation of complex applications from a bird's eye view - these are undoubtedly the megatrends in aviation development. On the initiative of the Baden-Wuerttemberg Ministry of Economics and the University of Stuttgart, an experimental site for electric and autonomous aviation is currently under development at the regional airport Mengen-Hohentengen (EDTM). M&D Flugzeugbau GmbH & Co KG and Kasaero GmbH, a founding member of the operating association AREA BW, successfully completed the first test flight at the test and development site in mid-August 2020. They tested *protex.one*, a new, completely emission-free long-range drone (UAV) built for highly sensitive cargo: Within the ATHMOS project, the drone will carry sensors to enable precise measurement of toxic clouds in the air, after chemical accidents or major fires for instance. This will provide an accurate real-time picture of the situation to emergency services and fire brigades. What sounds simple is a complex engineering achievement "Made in Germany".

Complicated and heavy cargo like space researchers

"Infrared spectroscopy" is used in astronomy and other fields. IR spectrometers can be used to determine the chemical composition of distant celestial bodies. IR spectrometers are typically very large, heavy and sensitive to vibrations and until now, it was assumed that they were more suitable for stationary applications or required massive flying equipment.

An impressive example is the FIFI-LS spectrometer, developed under the direction of the University of Stuttgart. NASA has integrated it into the Boeing 747 ("Jumbo Jet")

of its SOFIA project. The four-engine 184-tonne aircraft carries the IR spectrometer into the air to generate thermal images from space.

Research funding enables ground-breaking development

Can it be smaller? As payload for *protex.one*, research is being done on a light-weight IR spectrometer. The resulting weight of the flying system thus becomes less than 40 kg. At the same time, UAV navigation is being revolutionised by integrating autonomous flight path planning. With various systems on board, the drone can adapt its course around the toxic cloud without touching it.

The "pilot seat" at *protex.one*, a sub-project of ATHMOS, holds Friedeburg-based M&D Flugzeugbau GmbH & Co KG. As an EASA-approved design and production organisation, M&D has achieved global recognition by type certification of the high-performance gliders JS-MD 1 and JS-MD 3 – these gliders are among the most powerful aircraft in their class. "With our long-term experience in aircraft design and fibre composite technology, we are expanding our activities into the innovative field of unmanned aerial systems," explains M&D's Managing Director Tim Markwald.

In the ATHMOS research project, all necessary components including IR spectrometer are designed. It is funded by the Federal Ministry of Education and Research (BMBF) within the scope of the "Research for Civil Security" programme with a grant of €1.6 million.

In addition to M&D, the project involves SIOS Meßtechnik GmbH, Gesellschaft für Bild- und Signalverarbeitung (GBS) mbH, Hamburg University of Applied Sciences and the Institute of Fire Service and Rescue Technology (IFR) of Dortmund's fire department. Kasaero GmbH in Stuttgart is development partner of M&D and manufactures the used UAV.

The algorithm for automatic flight control is being developed at M&D and Kasaero as part of a master's thesis. The challenge is the complexity between the sensor's line of sight and the drone's flight movement. The basis for an optimal measurement of the toxic substances is created by a multi-step approach which performs its tasks in real-time. The software algorithm can adapt the flight path of *protex.one* based on data received from the spectrometer.

The master's thesis is supervised by the Institute of Flight Mechanics and Flight Control (IFR) at the University of Stuttgart under the direction of Professor Walter Fichter.

Opted for electric drive from the very beginning - and on wings instead of rotors

"Our greatest challenge was to design a low-vibration, high-performance unmanned aerial vehicle for a compact, lightweight and completely new type of IR spectrometer," explains Karl Käser, CEO of Kasaero GmbH in Stuttgart. "Stability, safety, range and ease of operation - a quadrature that we have successfully solved together with our partners. We have relied on electric propulsion right from the start. In this way we can avoid the measuring environment being contaminated by exhaust gases. "

Käser is a pioneer of electric aviation, he has already been involved in the famous Solar Impulse project and played a key role in the development of the world-famous electric motor glider e-Genius from the Institute of Aircraft Design (IFB) at the University of Stuttgart. e-Genius is an experimental vehicle for flight performance measurements and the testing of novel aircraft configurations. An e-Genius version reduced to a third of the original size was the starting point for the development of *protex.one*. It is powered by a lithium-polymer battery pack weighing approximately 7 kg and has a range of around 120 km.

The UAV has a wingspan of 5.60 m, is only 2.70 m long and reaches speeds between 80 and 150 km/h. At present, only flights within the visual range of the operator are planned. Take-offs and landings will be performed manually. In cruise flight, it is possible to switch between manual and automatic operation.

The decision in favour of this model was made due to the requirements of being able to fly around extensive toxic clouds. This means not only efficient propulsion, but also endurance for the long distances. "This can be better achieved with a fixed-wing aircraft than with a multicopter," explains project engineer Kai Kemke. "Lower noise levels and low vibration values for the sensor can also be expected here. "

The manned e-Genius was presented at NASA's Green Flight Challenge 2011. It has a battery electric range of more than 400 km and holds numerous records in its class to date, flown by world record pilot Klaus Ohlmann. "I am very proud that our record performances have contributed to making the world a little bit safer in the future," said Ohlmann, who is delighted about *protex.one* as the platform for ATHMOS. "Most importantly, however, we must continue to push the limits in order promote flying with alternative propulsion systems, such as electricity and hydrogen." As a test and development pilot, Ohlmann works closely with M&D/Kasaero. Through a cooperation with the German Aerospace Centre (DLR), he has been able to gain important insights into atmospheric waves, especially in mountainous areas, which are a constant challenge for civil aviation. Such measurement flights in the high mountains can only be carried out by manned personnel. "The prospect of possibly being able to achieve altitude records autonomously with experience from projects such as *protex.one* is tempting."

M&D and Kasaero are in constant exchange with companies such as Airbus and TB-Copters, which are also active in the UAV sector. The know-how gained in the ATHMOS project can be used in future research and development projects.

Further development to life-saving deployment in civil defence units

At present *protex.one* is still a first demonstrator. The next step will be the integration of the IR spectrometer, automatic flight control and numerous safety systems containing passive and active components. For example, a FLARM collision warning device to create electronic visibility for other air traffic participants. Most general aviation pilots are using such a system and are thereby able to see the position of the UAV on a cockpit display. In addition, an acoustic alert sounds when the UAV approaches. Eye-catching warning markings are also attached to the aircraft. For safety reasons, individual and separately fused circuits supply the propulsion system, radio receiver, flight control system and payload with power. Important control surfaces (e.g. elevators) are double present and radio links are redundant. If the autopilot fails, the system automatically switches to manual control. The good glide ratio enables a safe landing in case of failure of the e-propulsion.

During the project period, measurement flights under realistic test conditions will be performed together with the Institute for Fire and Rescue Technology of the Dortmund fire department. For this purpose, flight operations will be extended to selected test sites in northern and central Germany. The acquisition costs for such an innovative UAV and its certification, depend on its complexity and can vary from a few tens of thousands to several hundred thousand euros.

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About Kasaero GmbH:

Kasaero GmbH is a versatile engineering company for aircraft development and fiber composite structures. Kasaero has been involved in innovative electric flight projects since its inception, such as NASA Green Flight Challenge with the the world-renowned e-Genius airplane or the purely solar-powered two-seater "Sunseeker Duo" from Solar Flight. Since

then, the company has been working on many different sustainable flight projects. An excerpt can be found on the reference page of www.kasaero.de

Kasaero was founded in 2008 by Karl Käser. With a background of dual training as an aircraft manufacturer at Glasfaser-Flugzeug-Service GmbH and a degree in aerospace engineering from the University of Stuttgart, in combination with years of experience as a glider pilot, Karl M. Käser offers an extraordinary range of expertise and an extremely high range of services Value to the aviation industry.

The rapidly increasing demand for services from Kasaero and the associated expansion of the team soon necessitated a new company structure and so Kasaero was renamed Kasaero GmbH in 2014 - with Karl Käser as managing director.