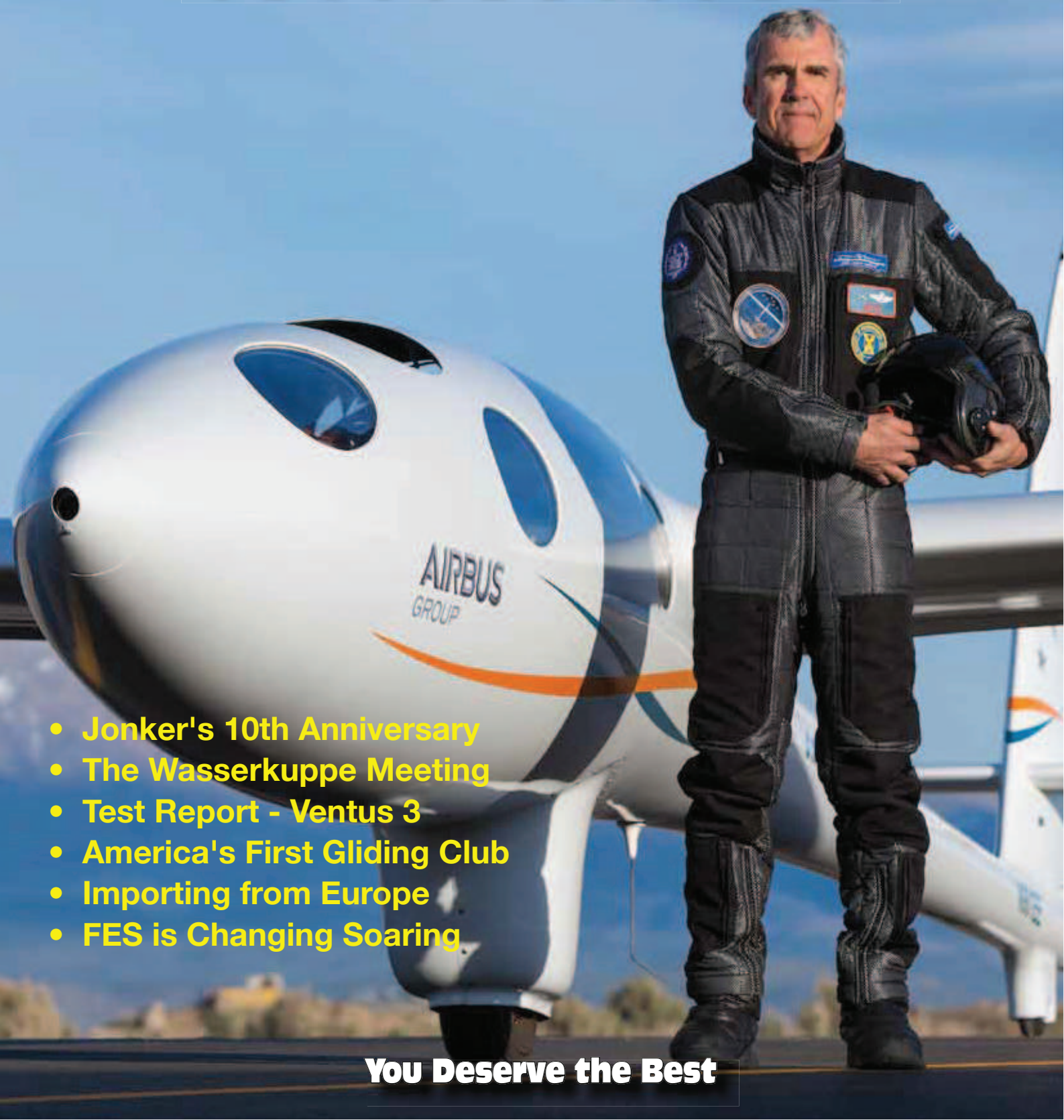
SEPTEMBER - OCTOBER 2016

GLIDING International



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You Deserve the Best

From Joseph King

FES is Changing Soaring as We Know it . . . .

Seven years have elapsed since Luka Znidarsic and Matija Znidarsic, both experienced sailplane pilots and mechanical engineers from Slovenia first introduced their Front Electric Sustainer (FES) to the soaring world. The first flight was on October 30, 2009 mounted on an 18 metre Lak 17. That power system provided a climb rate of 198 feet per minute. They ran into many problems getting to this stage. After evaluating available electric motors on the market, it was clear that there was no suitable electric motor which would fulfil their requirements. The weight of motor could be only about 7kg so that 30kg of batteries could compensate a nose-heavy moment. But its construction needed to be strong enough and suitable for installation.
They ultimately decided to design their own electric motor. After two years of work, many tests and a few development versions, they created a state of the art brushless DC electric motor. Their BLDC motor offers several advantages over brushed DC motors including higher efficiency and reliability, reduced noise, longer lifetime (no brush erosion), elimination of ionizing sparks from the commutation, more power, and an overall reduction of electromagnetic interference.

I have just completed a test flight of the Discus 2c FES at Hahnweide, Germany. The system is grossly under-rated and will change gliding as we know it . . . . . .

(This from Jens Tradbolt, Editor of Nordic Gliding).

Basic data of the standard FES electric motor:

- Out runner BLDC brushless synchronous permanent magnet motor with electronically controlled commuta tion system - 3 phase
- 20kW continuous power at 118V
- Up to 23kW for a shorter time
- Rotor rink diameter 180mm
- Length 100mm
- Weight of motor is only 7,3 kg
- Efficiency up to 95%.
- Rotor position by hall sensors

BLDC motors need special controllers for their operation. The controller is mounted on a cooling rib on top of the sailplane's wheel box, and is cooled by three ventilators.
The FES Control Unit instrument (FCU) was designed for a simple system operation. It fits into standard hole of 57mm diameter. It is equipped with sunlight readable high resolution colour display. The screen is really bright, in fact brighter than most displays, and is readable in the strongest of sunlight! It indicates important parameters like RPM, Power, Voltage, Current, Battery Capacity, Remaining Time and Temperatures. In the case that one of the parameters is out of limit, an alarm is activated together with a sound signal. FCU also count total engine running time, and some other parameters.

There is only one switch to turn ON the instrument and a knob with rotary encoder which acts as throttle and propeller brake. A press on the throttle knob, has also some additional functions like message confirmations.

The "Power Switch" is located on the right side of the cockpit (as a key or a toggle switch under red safety cap) which powers up the motor controller electronic and connects the Battery packs to the controller. The FCU instrument was specifically developed for the FES system in cooperation with a leading producer of gliding instruments LXNAV, who is also producing it for LZ design.

FES FOLDABLE PROPELLER

The designers have developed a special very light carbon fibre foldable propeller. The propeller opens quickly using centrifugal force when rotation starts. It is 1.0m in diameter and each blade weighs only 240 grams. The blades are slightly bent to take the shape of the front surface of the fuselage. During propeller folding, the pitch of the blades is automatically reduced when rotation is closer to the fuselage. Additional drag of the folded propeller is really minimal as proved by accurate Idaflieg flight performance measurement tests. The propeller is stopped by electronic braking, and is automatically positioned in the horizontal position. The composite spinner has recesses for the middle section of propeller blades and a central hole for cockpit ventilation for the air cooling of the electric motor. The ventilator can be closed during soaring flight but must be opened when the motor is running. The Pitot measurement point is on top of vertical stabiliser, and works fine also during powered flight. The nose cone holding bracket in its trailer needs to be slightly modified, so as not to be pressing against the propeller blades.

FES BATTERY PACKS

The battery pack for the FES consists of 28 high quality Lithium Polymer cells produced by the world leading LiPo battery producer Kokam, using special high power cells with the capacity of 43 Ah each. They have packed cells into special composite boxes of their own. Cells are wired in series and operate at a voltage range of 90-118V. There is a total of 4.2kWh of energy available in the two battery packs, each weighing 15.5kg. They are positioned in a reinforced fuselage area behind the wings. The batteries fully compensate the weight of motor and propeller in front.

The latest GEN2 Battery packs have integrated BMS (Battery Management System) and RADSOK high power quick connectors! The batteries are also used to supply power for all instrumentation on board through a DC/DC converter. No other battery on board is required anymore.

Power consumption of all instrumentation is very small (5W to max about 30W) compared to the motor consumption at full power. So you will have enough power for your radio, flight computer, PDA and transponder. If batteries are discharged during flight using the motor, they still have plenty of power for instrumentation. It is easy to take them out of the fuselage, for charging.

CHARGING OF FES BATTERY PACKS

An external 1200W programmable Li-Po charger (or two 600W chargers) is used for charging. Inside of each Battery pack (GEN2) is an integrated advanced Battery Management System - BMS unit. BMS monitors the voltage levels of each cells, and their condition by calculating internal resistance of each cell in the pack. At the end of the charging cycle it balances the cells to equal voltage within a precision of 2mV, using advanced balancing algorithms. Charging current, starting and stopping of charging is controlled by BMS.

Charging time of one battery pack with the 1200W charger is about 150 minutes (+balancing time which depends on differences between cell voltages) if it is fully discharged. If you have used only 50% of available energy, than charging time is also 50% shorter. LiPo cells do not have any memory effect, so you can charge them even though they are not fully discharged! The charging process can be monitored on a PC using dedicated

FES BMS control software.

A quick onboard 3000W charger is optionally available. Both packs fully discharged can be charged simultaneously in less than two hours. It is essential that a 16A fuse is used on the grid supply.

Unlike lead acid batteries, Li-Po batteries can be stored for months without significantly losing charge. Self discharge rate is less then 1% per month at room temperature! The cell manufacturer claims that at discharging with 1C rating (horizontal flight) the life expectancy of the batteries is around 1500 cycles. After that the battery will still have 80% of its original capacity.

FES UNITS INSTALLED

Extensive on going development has continued since that first flight in 2009 and by mid 2016 over 80 units are now flying providing sustainer security many thought not possible. The largest number of sailplanes fitted with the FES is the Italian Silent 2. In this particular sailplane the unit is powerful enough to provide self launching, a big bonus in anyone's language.

But the recent publicity provided by a FES being fitted to and successfully flown in a Ventus 2C (as well as the Discus 2c) by Schempp-Hirth has renewed interest ten fold and many commentators are just discovering and openly declaring that the FES is very under-rated and will now change the future of gliding as

we know it. Simply put, off-field landings are no longer a worry making the sport even more enjoyable. The promises of a Discus 2c FES as a foolproof sustainer is clearly superior to the turbo in the climb performance.

Actually the Schempp-Hirth Discus 2 is an old acquaintance. The maiden flight of this standard class aircraft was made in 1994. Later, the c-version followed with wing tip extensions for an 18 metre wingspan. We have looked closely at pilot reports and learnt more about this aircraft - much more than we expected.

The FES variant proved not only a rock-solid combination of proven systems, it proved to be markedly different from the Discus 2cT with its alternate combustion engine and five-bladed propeller.

The simplicity and ease of use is probably the main reason for the now rapid spread of the system. There are only two movements to bring the FES to life: safety switch on, a twist of the potentiometer, and bingo - comes the purr of the electric motor. Power full on, the Discus climbs at around 2 m / s. Our pilot report goes on to say that after several experiments with turning it on and off he quickly gained immense confidence in the system and had no concerns that it would reliably take him to to a safe level above a potential outlanding. But in just two and a half minutes he had climbed over 300 metres - sufficient to get back to his missed thermals. With a substantially reduced output, the display indicated he was drawing at five kilowatts. Switching off he got a very secure feeling to see the display telling him that he still had almost an hour's flight time still in the battery.

USAGE IN ALL FACETS

For a flight home the FES should always have sufficient power for a less or no thermal flight. Noise is as far as the noise can ever be classified, only that generated by the propeller. Quite unlike the turbos the FES is almost free of vibrations.

Our pilot continues - At first he tended to fly the Discus 2c a little too fast, flying the stretched nose was disceiving but he got used to it. More attention to airspeed was necessary so as not to fly too fast.

In gliding mode, the cooling air flow through the engine can be turned off. At 2000 metres there was only one degree centigrade of frost into the cockpit. In his first flight with the FES our pilot was quickly convinced of the many pluses and its ease of handling. He concluded his report with the comment "the system is fool proof and there is now no excuse not to take a cross-country flight".

Finally this treatise on the FES cannot end without reference to the Alisport factory in Cremella, Italy. A small company of like-minded people, all with an individual passion for soaring! Alisport SRL has been in business for over 22 years and were the manufacturing pioneers in the sailplane installation and development of the FES - fitting it to their 13.5 metre Silent. It was a dramatic success but not because they were first with a new concept in sustainer electric units, but because they discovered that the FES unit had sufficient power to make the Silent (now Silent 2) a self launcher.

The first real “show-case” for the Silent two was the first Italian FAI 13.5m

Championship, held at Alzate Brianza, near Lake Como in April/May 2014. The competition was dedicated to Leonardo Brigliadori, former world champion and strong supporter of the FAI 13.5m Class. It was a competition and trial for the FES that exceeded all expectations, both in terms of the competition itself and in the performance of the gliders. Weather conditions were variable. Tasks varied between170km and 320km and there were seven Electros in the competition. It was indeed impressive to see these aircraft self-launch, all within seconds of one another, to seek out their first thermals of the day. (It was to emerge later that there had been a unofficial competition between the pilots, to see who could preserve the most battery power).

Another remarkable aspect of the event was undoubtedly the performance of this nimble new breed of sailplane. The average speeds achieved over the five competition days were very respectable, even as high as 114km/h.

Amongst those that have flown and tested the Silent 2 is G Dale of England whose report reads:

My first impression was that, although the glider is small, it has plenty of room in the cockpit. Controls are light as you would expect. The motor is incredibly simple. At the first sign of a thermal, crank it into a turn and shutdown the motor. Once in the glide the Silent 2 is light and nimble. It’s just great to fly, feeling very agile and willing to turn tight in thermals. Much more pleasant to fly than other self-launchers I have flown, including some very costly two-seaters. There’s no engine up and down nonsense, the batteries come out of the fuselage quickly and easily, are light to carry around and the chargers can be stowed in the cockpit.

Of all the aircraft to appear in the last few years – including the ones with blisteringly high performance, and all the high-cost self-launchers and turbos – I find this the most interesting. It offers the prospect of simple, safe, moderate performance and self-launch soaring. It’s the sort of glider you can take to the hills, the mountain or the desert and really get stuck into some serious flying – with almost no support.

I just loved it.

Photos Right
From the top down -

- ***The "tell-all" panel mounted instrument***
- ***The simple on-off switch***
- ***The battery pack with built in cooling fans***
- ***The closed hatch cover to the battery compartment***