b-IONIC Airfish

World launch!
A flying prototype demonstrating ionic jet- and plasma ray propulsion systems

Info

Ionic jet- and plasma ray propulsion systems

Ionic jet propulsion systems were originally conceived for space applications and work with high voltage DC-fields. The achievable thrust in vacuum is very small – in the milli-Newton range – which is sufficient to reach high speeds through constant discharge of high-mass ions during long interplanetary flights. The same principle can be used in the atmosphere to accelerate air ions and to attain high thrust for lighter than air vehicles.

Tail ionic jet propulsion engine

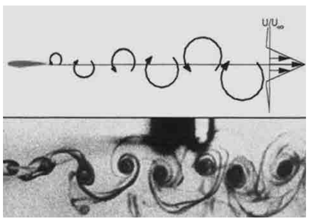
Plasma ray propulsion engine

Tail fin of b-IONIC Airfish

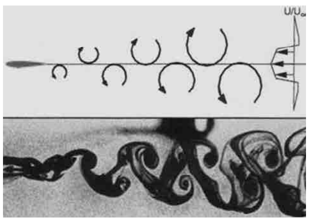
High-voltage electronics

The b-IONIC Airfish employs two atmospheric ionic jet propulsion systems:

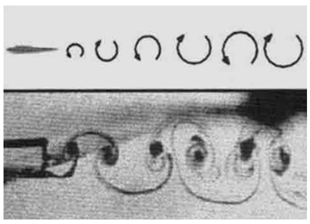
At the tail end Airfish uses the classic principle of an electrostatic ionic jet propulsion engine. High-voltage DC-fields (20-30 kV) along thin copper wires tear electrons away from air molecules. The positive ions thus created are then accelerated towards the negatively charged counter electrodes (ring-shaped aluminum foils) at high speeds (300-400 m/s), pulling along additional neutral air molecules. This creates an effective ion stream with speeds of up to 10 m/s.



1 Wake turbulence and thrust

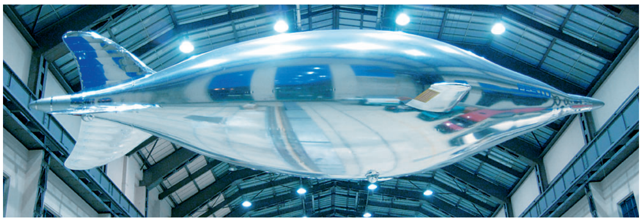


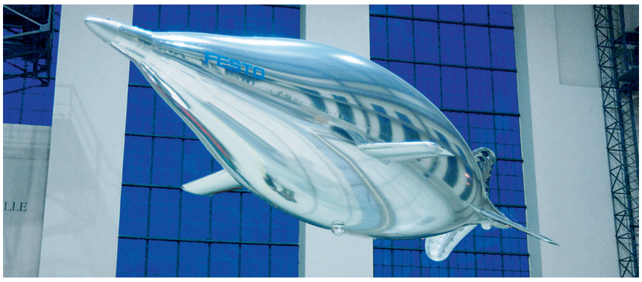
2 Wake turbulence and resistance



3 Wake turbulence at eliminated resistance (source: K.D. Jones)

The side wings of Airfish are equipped with a new bionic plasma-ray propulsion system, which mimics the wing based stroke principle used by birds, such as penguins, without actually applying movable mechanical parts. As is the case with the natural role model, the plasma-ray system accelerates air in a wavelike pattern while it is moving across the wings. Figures 1 and 2 illustrate the general working principle. Figure 1 depicts the trajectory turbulence caused by wing strokes under propulsion conditions. Inbound turbulence pushes air across the wing's surface before eventually drifting backwards. In figure 2,

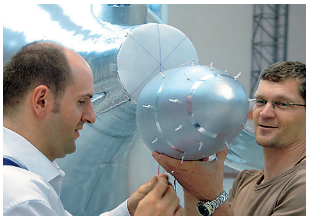




outbound turbulence decelerates the actual air stream – which basically means that friction is created along the trajectory turbulence. Under propulsion conditions, the plasma-ray system creates the same wake as a simplified mechanical wing when stroking (See depiction on plasma-ray system). With the former, ionization is based on the so-called dielectric barrier-discharge principle. That is, an AC (alternating current) field of high voltage and frequency (10 kV, 11 kHz) is generated between two lamellar electrodes separated only by an insulated barrier of 0.4 mm in thickness and made from Kapton or Teflon® materials. Depending on the field's polarity, this either emits or extracts electrons form the edges of the upper electrode, which in turn leads to the creation of cold plasma gleaming purple even under regular daylight conditions (See depiction on plasma-ray system). As a result, air-ions located in the plasma zones (which are neutral toward the outside) are accelerated by an alternating and moving low-frequency field (10-100 Hz) and on their way are dragging along additional neutral air molecules. When operated under high frequency conditions plasma ray systems produce a constant subtle but audible sound, whereas in pulse-modulated mode striking sounds can be heard like the ones typical for regular mechanical wings. What is new in terms of aerodynamics are ion-jet velocities of 10 to 100 m/s in the lower parts of the atmosphere and close to the Earth's surface. This allows for a new kind of electro-dynamic air transportation without movable parts, which are common to all aviation propulsion systems currently in use.

Future applications for atmospheric ionic propulsion systems, however, will not be about generating thrust rather than reducing or even eliminating friction (See figure 3). For example, penguins have created an air-coat around their bodies composed of numerous micro-bubbles embedded into their plumage. As such, the excellent drag-coefficient found with penguins is not only due to the peculiar geometry of their body shapes but also related to the positive influence the different physical conditions of gaseous and liquid matter have on the boundary layer. If the entire surface of an object could be used for propulsion purposes, development of additional propulsion support through a much bigger ion jet volume would be a promising option. In order to accomplish that, an object ought to be entirely enclosed by a plasma-bubble – a forth degree wrapping in terms of state of aggregation. This would make a b-IONIC Airfish capable of swimming in air like a penguin does in water.

After bringing an Airfish into reality by using pneumatic structures and looped propeller principles, the strategies mentioned above consequently carry forward the idea of influencing drag by applying micro-plasma discharges across the surface of entire objects. Accordingly, laminar ion jets could be harnessed specifically for drag reduction. Moreover, this also allows for estimating the potential to accelerate air without movable mechanical parts and, as a consequence, to evaluate further possibilities for air compression in general.



Technical data b-IONIC Airfish:

Length	7.50 m
Span	3.00 m
Shell diameter	1.83 m
Shell surface	26.8 m^2
Total weight Airfish	9.04 kg
Empty weight Airfish	2.71 kg
Total thrust c.	8 – 10 g
Helium volume	9.00 m^3
Minimum buoyancy	9.0 kg
Maximum buoyancy	9.3 kg
Weight generators in wing/tail	4.25 kg
Weight LiPo accumulator in wing/tail	2.08 kg
Maximum reserve weight	0.37 kg
Max. flight velocity	0.7 m/s
Max. flight time with tail actuation	60 min.
Max. flight time with wing actuation	30 min.
LiPo accumulators in tail	12 x 1,500 mAH, max. 8 A
LiPo accumulators per wing	9 x 3,200 mAH, max. 60 A
Performance for ionic beam drive in tail	2 x 40 W, max. 2 x 60 W
Performance for plasma wave drive per wing	266 W, max. 360 W

Project partners:

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