Wind Tunnel in the Clasroom

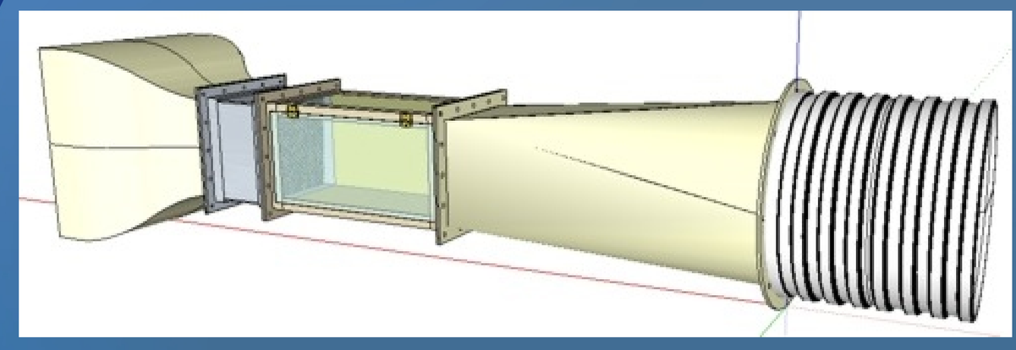
12th International Conference on Hands-on Science. "Brightening our future".

Msc. Prof. Joze Pernar
High School Krsko, Slovenia
Joze.pernar@guest.arnes.si

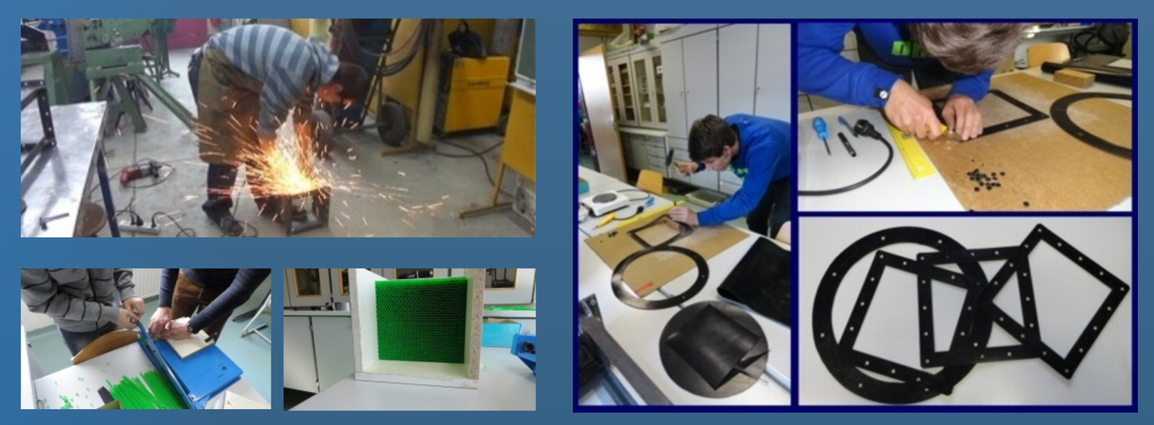
hsci2015
Funchal, Madeira Island Portugal
27 - 30 July

ŠOLSKI CENTER KRŠKO-SEVNICA
Gimnazija Krško

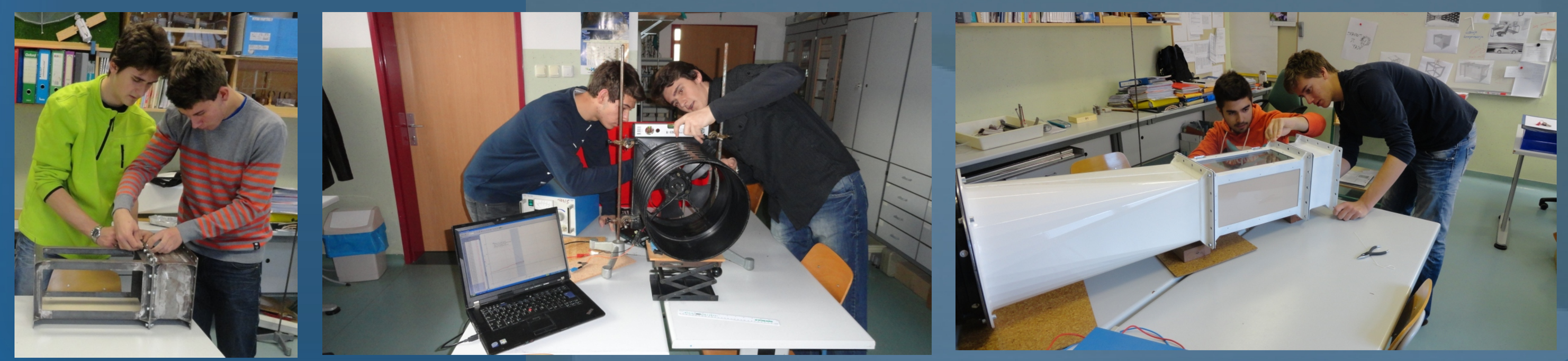
Produced in School



From concept and design to finished Lab - product.



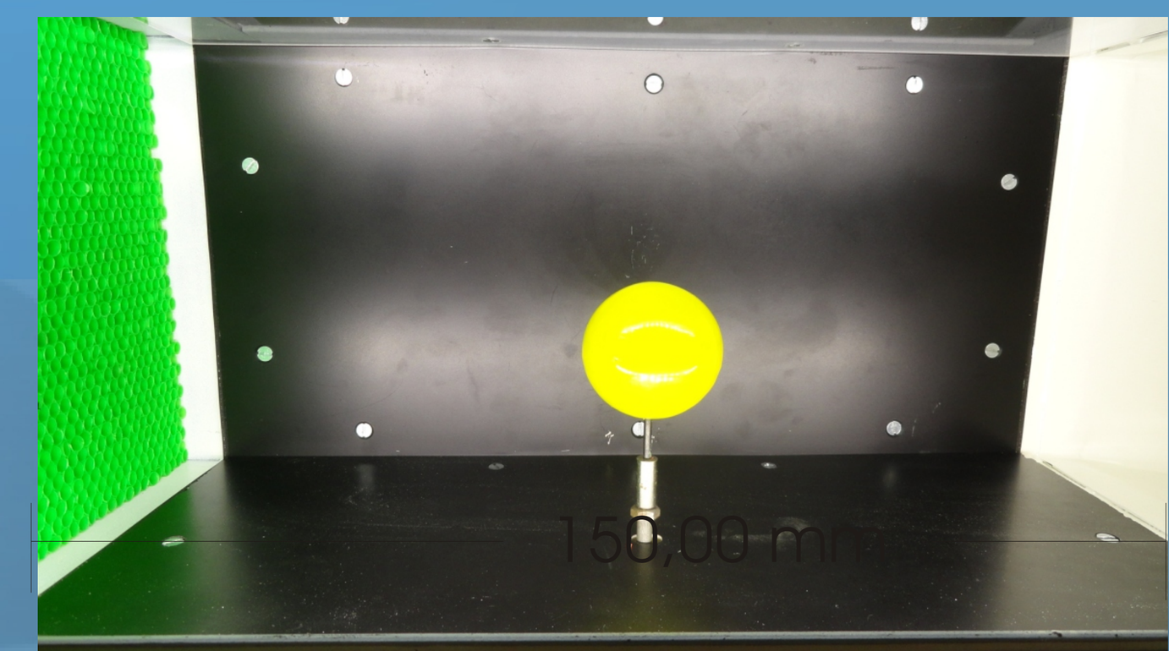
Complete work process of the wind tunnel brought together a large group of students. Some students were creating plans, others manual working in workroom, painting the components, making seals and in the end consist together. One group of students was making measurement between work process.



ABSTRACT

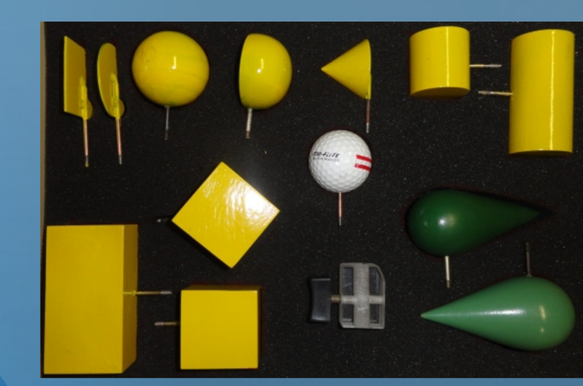
The absence of experimental work for students in all forms of science particularly in physics education brings about the loss of motivation and prevents deep understanding of real world phenomena. Combining natural phenomena and work in the classroom presents a considerable challenge for teachers and students alike.
Wind tunnels are an important form of testing and measurement for industry and laboratory research. That form of testing is essential in the automotive and aerospace industries, as well as for observing birds and some other physical bodies.
Building Wind tunnels brings fresh air into experimental education taking place at High School Krsko. Literally, we brought the air into the classroom. One year and a half we spent designing, drawing and making by hand primary parts of the equipment. We encountered many problems with shortage of tools, equipment, materials, technology processing of materials and particularly with space. With all these problems, students learned a lot.
Only then did we begin to learn something about aerodynamic physics. The project is an opportunity for students to use different sensors and IT technology. They can develop sophisticated measurements and methods, hardware and software components and solutions in order to exercise their engineering skills.

Physical models



Measurement force of resistance sphere model in wind tunnel chamber.

Experimental exercise.

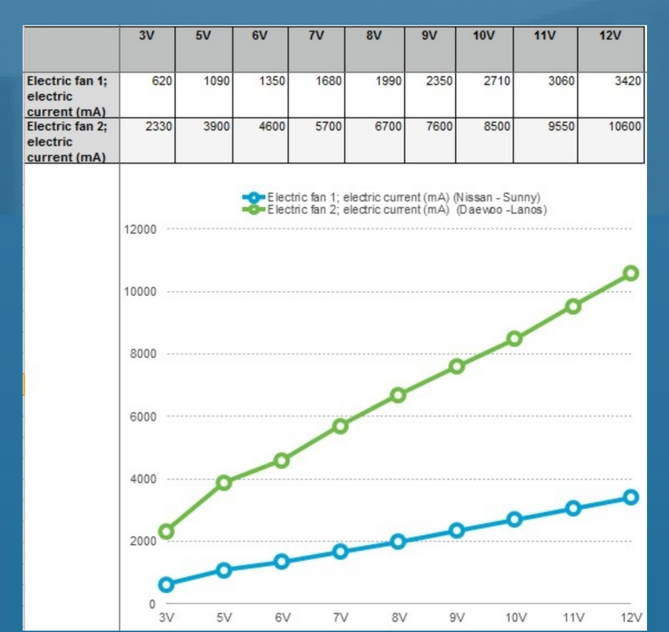


We made a few standard forms of bodies - models (wood) for basic physical measurement.

First measurements

For the first experiments and wind tunnel testing we had to choose the best propulsion currently available. We choose between equipments forced cooling system propulsions of cars Nissan Sunny and Daewoo Lanos.

The measurements have shown that Lanos propulsion performs better. At a voltage of 12 V it creates a power of 127,2 W. Measurements of flow rate are still needed to determine if our current propulsion will be strong enough to create high-speed airflow through the test section.



Airflow

Measurement with computer allows us to accurately measure the velocity of the air in the chamber. We moved anemometer in vertically and the horizontal plane of the measuring chamber. Created a honeycomb contributed to evenly air flow through the entire cross - section of the chamber.
Calculation of volumetric air flow: $\O V_{max} = S \cdot v = 0{,}2m \cdot 0{,}2m \cdot 9{,}8m/s = 0{,}392\ m^3/s$

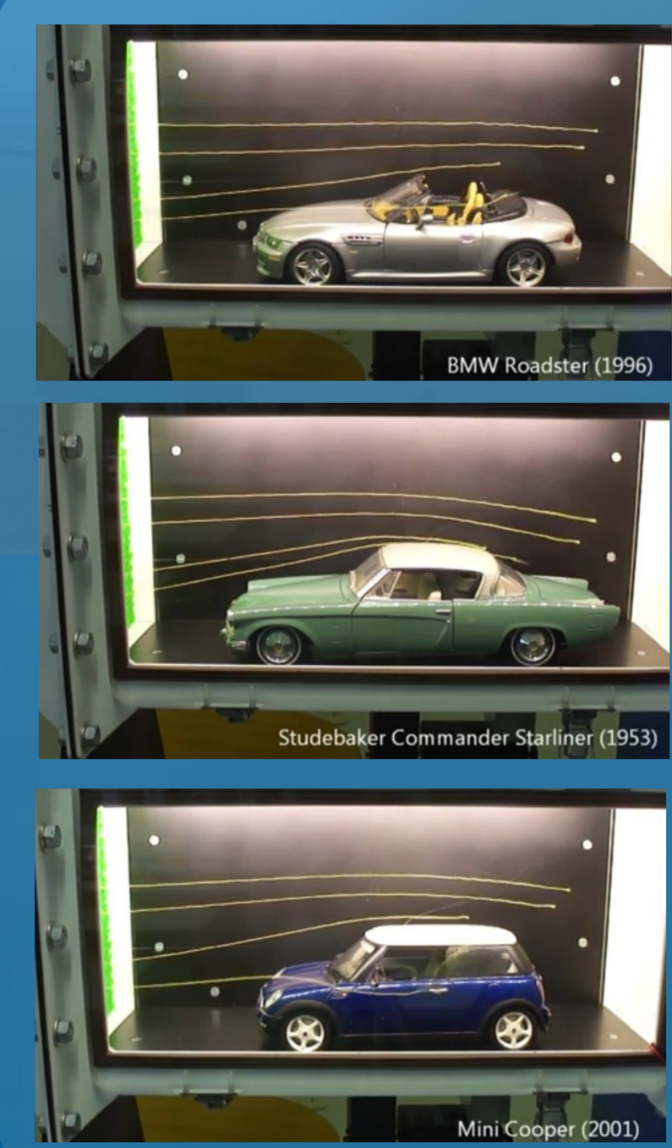
Workshops

Our students prepared several workshop for pupils of Primary Schools.

The transfer of knowledge from the students to the pupils. Making models from simple block styrodur and measuring resistance force.

Help in hand making models.

Streamlines on models

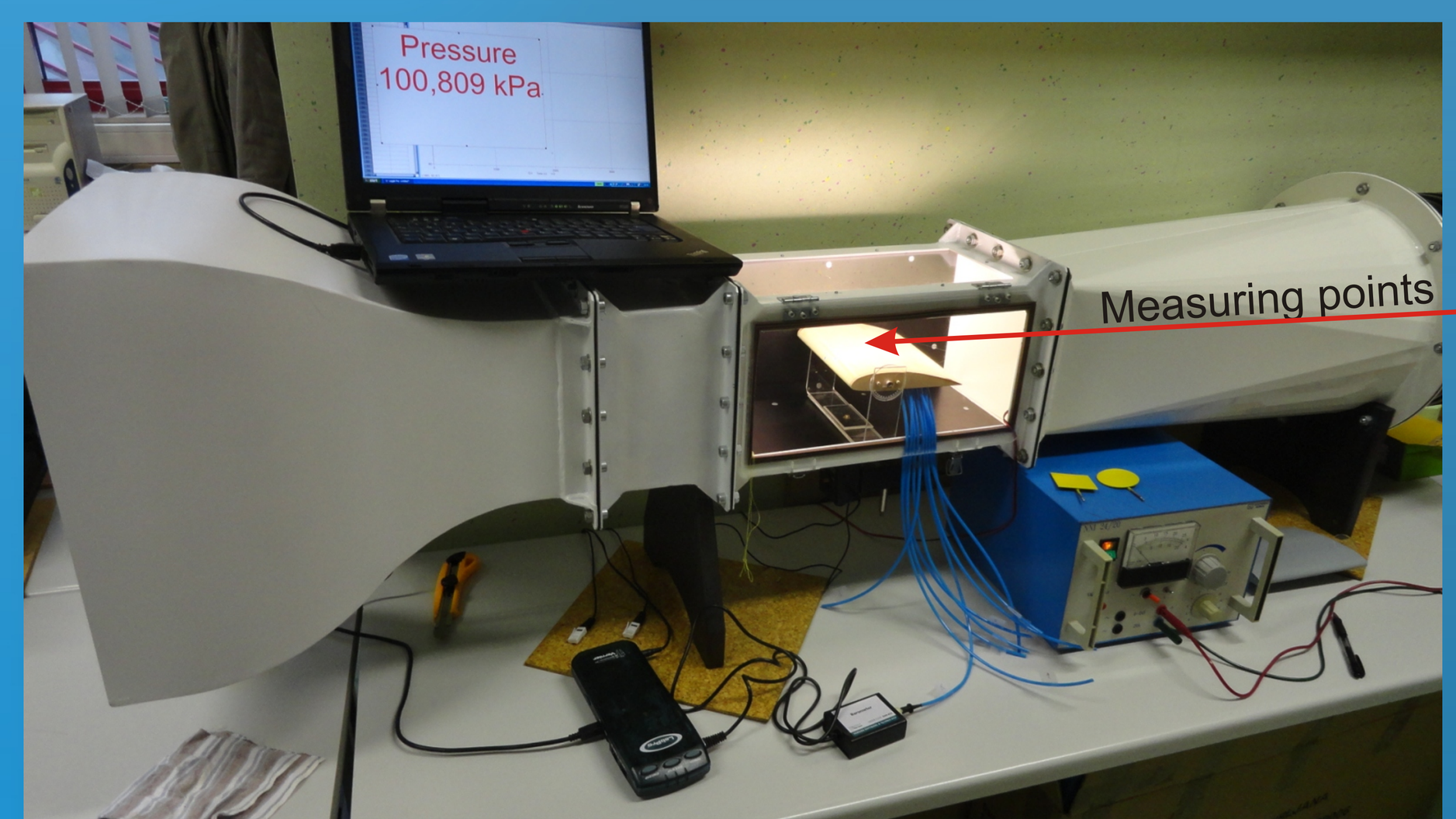


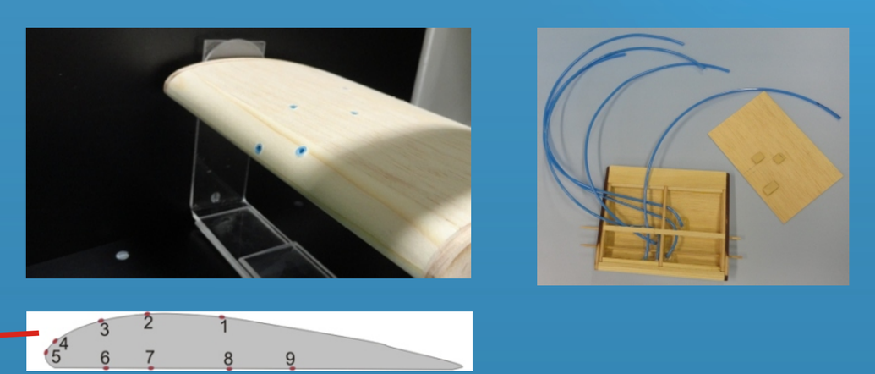
The first wind tunnel experiments have shown circulating turbulent and extremely fast rotation of air through the measuring chamber. The phenomenon was most pronounced in the mean values speed. By installing the router - spoiler, we achieved targeted air movement air mass, which represented laminar flow. This is evidenced by the first tests with the use of textile floss.
They discovered some interesting comparisons between different car models (1/18).

Video
https://www.youtube.com/watch?v=xqwTSjqnQyE

Force sensor: measuring air resistance.

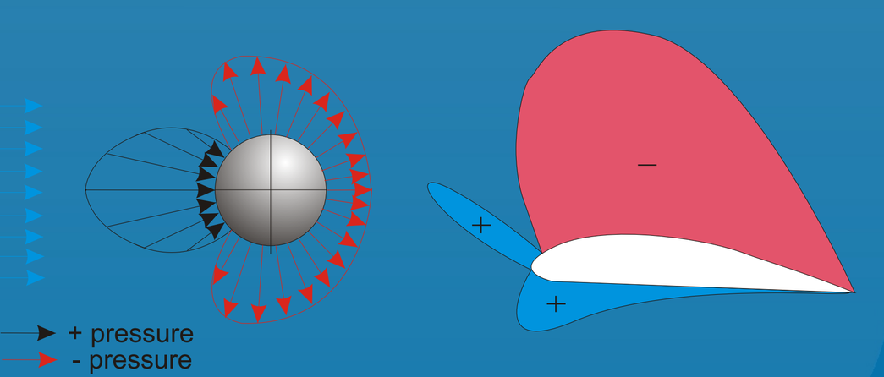
Measuring presure on air wings



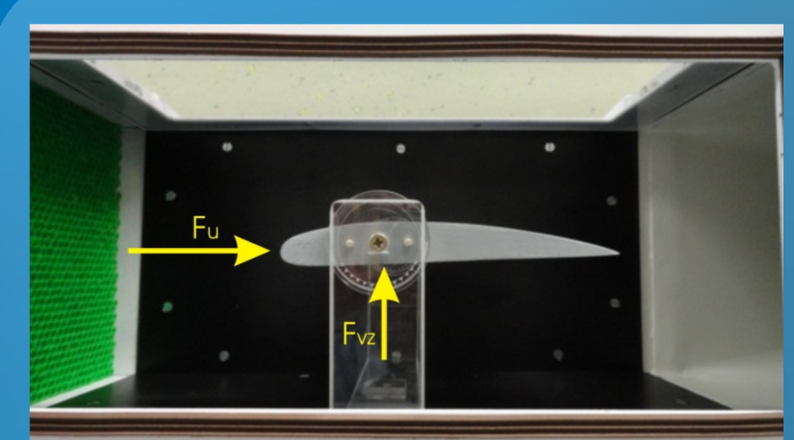


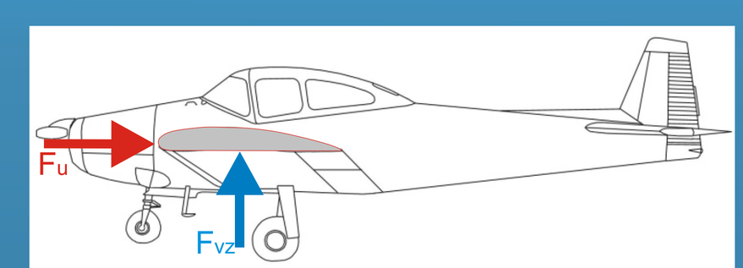
We made a special pressure wing with tubs for research the pressure differences on the wing. We can measure the pressure on nine points.

The different speeds at the surface of the leaf create the difference in pressures. This is the reason for lift force F_{vz}. With this data we made pressure diagram on the wing.
Comparing the diagram of sphere and wing.



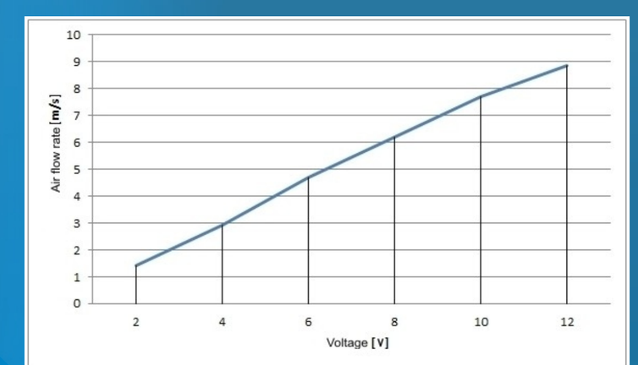
Measuring forces on air wings





We can measure air resistance force F_u and lifting force F_{vz}.

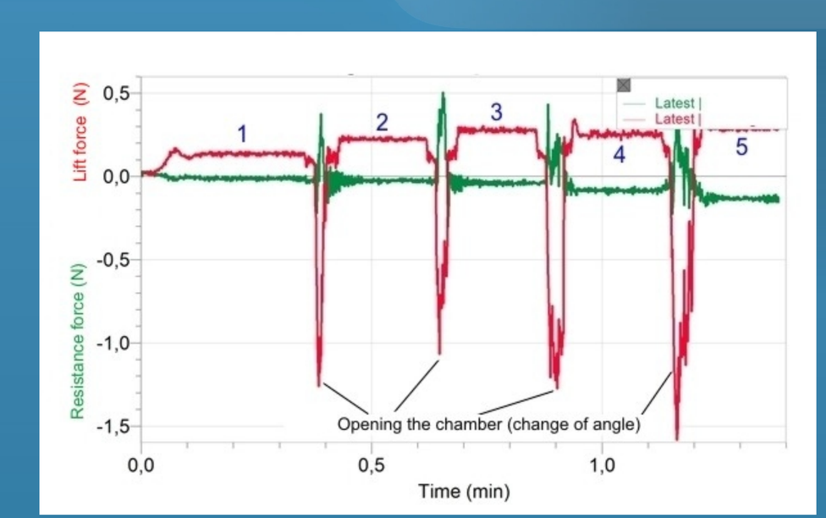
Both of these forces are depends of the air speed through chamber. The speed is depends from electric voltage.



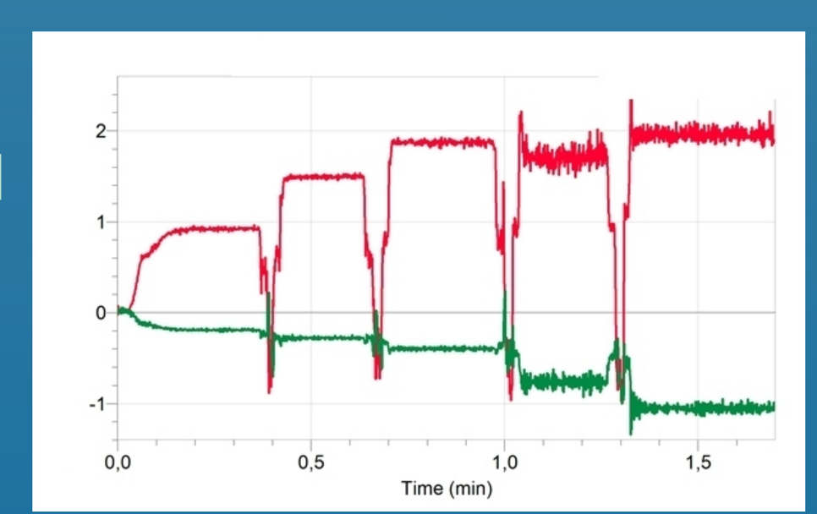
Air resistance force F_u and lifting force F_{vz} on the wings with angle tilt -10°, 0°,+10°.

The forces are also depend on the speed of the air in addition to the tilt.

Different shape of air wing.



Speed *v = 10 km/h*, the positive angles (continue measurements)



Speed *v = 30 km/h*

The web site has been created from the beginning to the last measurement

http://www2.arnes.si/~sssknm4/vetrovnik_ang/index.html

Goals and ideas for the future

- Increasing the speed from 10 m/s to 25 m/s.
- Design and produce gyroscopic measuring mechanism.
- Closed air circulation system.