Great recirculation wind tunnel
SZ.3.1. Force acting on a human body in various poses

The knowledge on aerodynamic drag acting on a human body and its dependence on the pose, on clothing, and on the interaction among people standing or moving close to one another is of importance in certain sports (e.g. parachuting, running, skiing), in safety fixing of people working on high equipments, and in design of parachutist wind tunnels.

Assignment: investigation on i) the details of flow past a single human body, ii) drag force, iii) dependence of the drag coefficient on Reynolds number, pose (e.g. whether Von Karman vortex street develops past our horizontally kept arm), clothing (skiing clothes, inflating wind jacket), iv) interaction among two and three persons running various distances, separated from each other at various distances.

Before the tests, the cross-section of the individuals is to be recorded by a camera, to be used as reference cross-section necessary for calculation of the drag coefficient.

In the 45 min of the measurement, the following activities are to be carried out:

a) Calibration of the balance (in 2-3 points, using weights),
b) Investigation on the flow characteristics past a single person, at normal incidence, at various wind speeds, at given clothing and pose: i) by visualization using oil smoke and taking photographs, ii) by force measurements for determination of Reynolds number dependence of drag coefficient,
c) Study b) (only the force measurements as appropriate) is to be repeated at various poses. It is to be visualized using oil smoke whether Von Karman vortex street develops past i) arms kept away from the body, ii) legs at straddle-stand.
d) Study b) is to be repeated with 2 and 3 persons, standing on a podium of height equal to the scales, standing at various distances from one another (mean velocities related to 400, 1500 and 5000 m distance running: 9,1, 7,1 and 6,4 m/s, respectively); measuring the force acting on the person being the first, second and third one in the queue.

Availabilities:

- Balance located in the wind tunnel measurement section, capable for measurement of longitudinal force,
- Pitot-static probe for wind velocity measurements,
- Oil smoke generator,
- Pipe and probe for introduction of the oil smoke,
- Manometer.

A camera is to be provided by the measurement group. Possibility is given for investigation on the effect of customized accessories obtained or produced by the measurement group (e.g. rucksack, helmet).

Background information (chapters from Lajos, T.: Fundamentals of Fluid Mechanics, 2004, 3rd Edition):
2.1.1. Pathline, streakline, streamline, 2.1.3. Flow visualization, 3.3.3. Static, dynamic, total pressure, 3.4.1. Euler component equations in the natural coordinate system, 3.4.2. Applications, 6.2.4. Instruments based on the deformation of a flexible body, 6.2.5. Practical pressure measurement problems, 6.3.1. Determination of velocity based on the measurement of dynamic pressure, 8.5.2. Preconditions for similarity of flows, 9.1.1. Characteristics of boundary layers, 9.2.2. Development of the boundary layer in streamwise direction, 9.3.1. Development of shear stresses in the boundary layer, 9.3.2. Boundary layer separation, 9.3.3. Flow past a cylinder, 9.3.5. Control and elimination of boundary layer separation, 10.1.2. Dimensional analysis, 10.1.3. Application of dimensional analysis, 11.1.1. Development of aerodynamic forces, 11.1.2. Aerodynamic force acting on a cylinder, 11.2.2. Aerodynamic force acting on bluff bodies. **Further recommendations: From 4th Edition**: 6.4.1. The aim of application of wind tunnels, 6.4.2. Types of wind tunnels, considering velocity and layout, 6.4.3. Structural elements of wind tunnels, layouts for measurement sections, 6.4.4. Practice of wind tunnel measurements, and/or Bradshaw, P., Mehta, R.: Wind tunnel design www-htgl.stanford.edu/bradshaw/tunnel/