THE "NORDIC WIND TUNNEL" – A PROPOSAL TO BUILD A VERY LARGE TURBULENCE RESEARCH FACILITY

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Turbulence is often cited as the last unsolved problem in classical mechanics. The lack of understanding has many adverse effects, from weather prediction to engineering design and practice. Scientists and engineers cope, but at a price in safety margins, wasted energy resources and limitations to innovation. Many "classical" ideas of turbulence theory date back to the 1930's and 40's. These ideas have evolved since, but it has never been possible to truly test them because of the absence of large *and* long enough, high quality (low background turbulence) research facilities.

Despite the increases in computational power and progress in numerical techniques, it is currently not possible to resolve the small scales at high Reynolds number. Even with computational power doubling every 18 months, it would take several decades before a DNS of the simplest flow case of non-decaying isotropic turbulence could be performed with the separation of scales (10^5) equivalent to the wind tunnel proposed here.

Experimental work in a large research wind tunnel is needed to solve a number of fundamental questions and enable scientists and engineers to further improve computations of turbulent flow. Simply put, the problem is how to achieve a separation of scales, energy/dissipation, of 10^5 or larger – and still be able to resolve the smallest scales with the smallest technically feasible probes (~10μm). Existing research wind tunnels are too small to reach high enough Reynolds numbers while still permitting resolved measurements of the smallest scales.

A wind tunnel which overcomes the shortcomings of current facilities has been proposed at Chalmers University of Technology. The "Nordic Wind Tunnel" would be

- *wide enough* to remove the effect of side walls on the energetic turbulence scales
- *fast enough and large enough* to get the necessary high Reynolds numbers, yet still resolve the dissipative scales
- *long enough* and with *low enough background disturbances* to obtain the necessary downstream development times

and will thus provide an experimental facility capable of resolving some of the oldest questions in turbulence while also testing conclusively new ideas, and producing high-quality turbulence data for model validation.

Based on the criterion that the smallest length scale that can be resolved is about 10μm, while still requiring high bulk Reynolds numbers, we arrive at the following dimensions: Test section length 40 m, cross section after contraction 3x3 m, maximum free stream speed 40 m/s and a free stream turbulence u'/U of 0.01%. The total dimensions of the facility are: Length: 80 m, width: 21 m, height 7 m. The estimated cost of construction is US$ 6 million. A picture of a model is shown below.

Who will use this unique facility? Possibilities for fundamental studies are tremendous. It is envisioned that researchers from around the world will participate both in proposing ideas and conducting research. Letters of support are encouraged and should be addressed to R. I. Karlsson (rolf.karlsson@vattenfall.com) or W. K. George (wkgeorge@tfd.chalmers.se) .

A 1:100 scale model of the planned Nordic Wind Tunnel.

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