Faculty Engineering Technology
Program Mechanical Engineering

UNIVERSITY OF TWENTE.

COLLOQUIUM

Group: **Engineering Fluid Dynamics**

As part of his MSc thesis assignment

S.K. Siemons

will give a presentation, entitled:

Aerodynamic Design of a Seeding Rake for Injecting Helium Filled Soap Bubbles Tracer Particles

Date: Friday April 29, 2016
Time: 13:00
Room: **Horst Building Room NH 124**

Summary:
In the past 20 years flow visualization techniques using tracer particles have developed to an accurate and reliable flow field measurement technique. Fog generators introduce particles into the flow with a typical diameter of 1 µm, which are illuminated and recorded using a high-intensity laser and high-speed cameras. Typical measurement scales are 100 cm^2 up to 1000 cm^2 for two-dimensional and 20 cm^3 to 52 cm^3 for three-dimensional recordings, both at frequencies up to 1 kHz.

The increased need to investigate turbulent flows around complex engineering systems within the aerospace, automotive and wind energy sector requires the development of larger scale and higher frequency measurements. This has led to the suggestion of utilizing helium-filled soap bubbles (HFSB) with a diameter of 100 µm as tracer particles. HFSB feature increased light scattering, while remaining neutrally buoyant. Recent feasibility studies on the application of HFSB showed measurement scales up to an unprecedented volume of 4000 cm^3, while recording frequencies are hypothesized up to 10 kHz at current measurement scales.

Typical designs for seeding rakes consist of multiple struts with injection of tracer particles at their trailing edge. The small diameter of traditional particles allows installation of the seeding rake upstream of the wind tunnel turbulence-reduction screens. However, the HFSB seeding rake is to be installed downstream of the turbulence-reduction screens in order to prevent shattering of the much larger HFSB. Without careful aerodynamic design such a configuration would compromise wind tunnel flow quality due to velocity deficits and fluctuations in the wake of the seeding rake.

In the present study the aerodynamic design of a two-dimensional single strut is investigated to retain wind tunnel flow quality. It was found that the boundary layer over the aft part of the strut must remain laminar in order to minimize velocity deficits and fluctuations. For the seeding rake two airfoils have been investigated, one featuring fully laminar flow and one featuring slot-suction. The aerodynamic performances have been investigated numerically and experimentally. The slot-suction airfoil showed a noteworthy drag reduction of 2 orders of magnitude, while providing excellent manufacturability and possibility for integration of the HFSB generator. For the seeding rake an airfoil with slot-suction is therefore proposed.

Assessment committee: **Chairman,**

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