PhD Thesis proposal

- Title : **Control of flow detachment around A-pillars of long-haul tractor**
- Location : **Laboratoire de Mécanique des Fluides et d'Acoustique**, UMR CNRS 5509, Ecole Centrale de Lyon, 69134 Ecully Cedex
- Supervisors :
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- Starting date : October 2017
- **FUI funding** - research program FALCON
  3-year fixed-term contract by Ecole Centrale de Lyon ; gross salary : 2020 euros (net salary : 1630 euros)

Context

The present thesis concerns long-haul trucks aerodynamics, in the frame of the collaborative FUI program FALCON - Flexible and Aerodynamic truck for Low CONsumption. In the program consortium, one finds academic partners as well as industrial partners in the field of road transportation, including Renault Trucks - member of Volvo group - as project leader. The need for reduction of fuel consumption together with new regulations related to a decrease of greenhouse gases emission make unavoidable the increase of aerodynamic performances of the truck tractor, including the cabin. The FALCON program will give the opportunity to evaluate the benefits of different technological concepts on a full-scale dedicated vehicle from the aerodynamic view-point.

The thesis is more specifically linked with aerodynamic changes due the future use of cameras to replace the large rear-view mirrors. In this case, two opposite effects should be evaluated :

- the rear-view mirrors used nowadays being quite large, their wake generates aerodynamic drag. A much smaller camera, possibly integrated in the cabin, should lead to an aerodynamic gain.
- with this design for the rear-view mirrors, the flow detachment around the A-pillar (i.e. the pillar linking the windshield to the lateral window) of the cabin is limited thanks to the rear-view mirror. Without these features, a massive flow detachment is visible in the flow field (Figure 1), which is associated with a drag penalty.

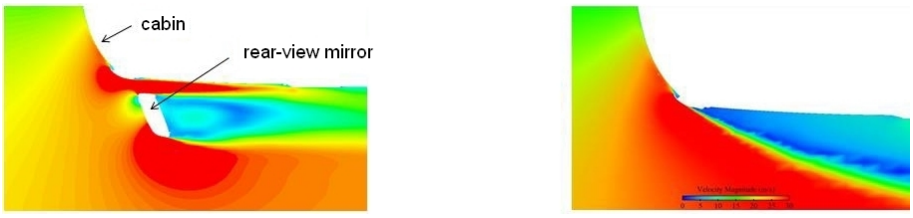

Figure 1 : Influence of a rear-view mirror on the velocity flow field around a typical cabin of long-haul vehicle (top view) ; with (left) and without (right) rear-view mirror. RANS simulation - Renault Trucks

Objectives of the thesis

As an objective for the thesis, one wishes to explore experimentally control devices, be it active or passive, aiming at reducing or suppressing flow detachment on the A-pillar of the cabin. Three phases are proposed for the thesis :

- at first, the flow detachment on the A-pillar at full-scale will be deeply analyzed by use of the available references on the subject. Of particular interest will be the identification of the influence on flow detachment of physical parameters such as upstream turbulence or lateral wind. Moreover, wall pressure measurements at full-scale with and without rear-view mirror will be carried out together with Renault Trucks. From these measurements, the main features of the flow detachment process (for instance stability of the detachment point, typical frequencies of the local Kelvin-Helmholtz or more global instabilities) will de determined.
- then, a simplified model at reduced scale will be defined to allow for dedicated experiments in the Lab wind-tunnel so that the major characteristics of the real flow detachment process will be reproduced. The benefits of different control strategies, either passive (for instance micro-slots or cavities) or active (unsteady micro-jets), will be evaluated using this model together with pertinent measurement tools (PIV at high frame rate, unsteady wall pressure, wall friction). Some of these strategies are derived from previous experimental work carried out at LMFA. The influence of physical parameters like the boundary layer thickness over the A-pillar upstream the flow detachment and external upstream turbulence will be investigated. The pertinence of the identified solutions will be confirmed at larger scale, i.e. for higher Reynolds numbers closer to those of the final application, in an industrial wind tunnel.
- finally, the best candidate from the solutions tested during the previous step will be evaluated over a real full-scale vehicle.

Applicant Profile

The applicant must have strong skills in the field of aerodynamics and turbulence, as well as in experimental methods and signal processing. The resume should highlight his (her) interest for experimental activities, for instance during training periods. A first experience in the use of measurement tools such as PIV, hot wire anemometry and/or pressure measurements will be acknowledged ; a previous application of flow control strategies would be appreciated. This PhD work will require a frequent use and thus reinforced knownledge of Labview and Matlab softwares. Fluent English and good writing skills are mandatory to ensure proper dissemination of the results for seminar attendance and papers publication. The attendant will work in close cooperation with other partners of the FALCON program, a good team spirit is thus mandatory.