PhD position @ ISAE-SUPAERO

Aeroacoustic study of twin supersonic jets using compressible Large Eddy Simulation

Project TWIST (TWIn Supersonic jeTs)

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Deadline for applying: 15 of March 2018, only for EU and Swiss nationals
Location: Aerodynamics, Energetics and Propulsion Department (DAEP), ISAE-Supaéro, Toulouse
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Scientific domain: Aeroacoustics
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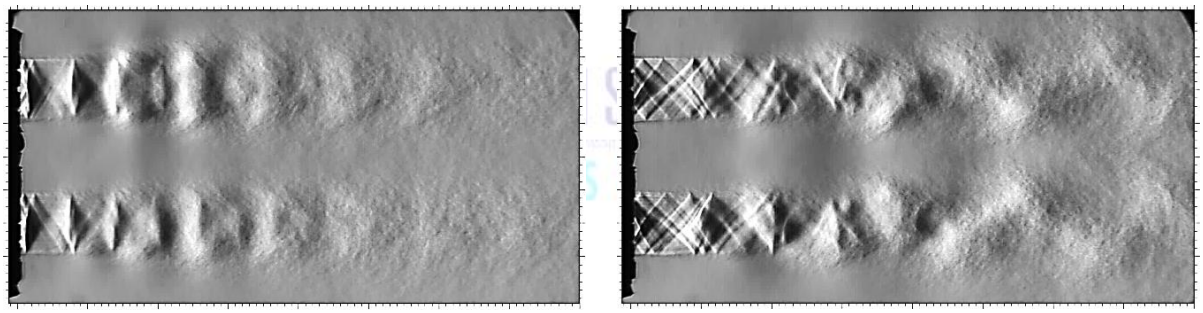
Summary:

Twin supersonic jets are commonly found on many transport aircrafts, such as space launchers, fighter aircraft and spacecraft. Coupling between such jets may result in global instability modes shaped either axisymmetrically or helically. Experimental evidence of such modes was found by Kuo et al. [1] for two supersonic round jets as shown on Fig. 1. They can produce intense acoustic radiation that may lead to fatigue damage of the nozzle and/or the airframe, as was the case for the F-15 for instance [2]. The understanding of the interactions between twin jets is therefore important in order to design future air- and space-craft.



Axisymetric mode *Helical mode*

Figure 1. Phase-averaged Schlieren technique applied to a pair of supersonic round jets: Phase averaged shadowgraphs at the tonal frequency.

Envisaged progression:

In the first part of the PhD thesis, compressible Large Eddy Simulations of twin supersonic jets will be carried out using an in-house compressible Navier-Stokes solver called IC3. This code has already been used to perform the Large Eddy simulation of a Shock-Boundary Layer interaction [3]. Thanks to its high scalability, it can be run in parallel on thousands of processors and is applicable to state-of-the-art simulations of twin turbulent supersonic jets. Large Eddy Simulations of such turbulent supersonic jets were previously performed by the PhD advisors using another solver [4], as illustrated in Figure 2.

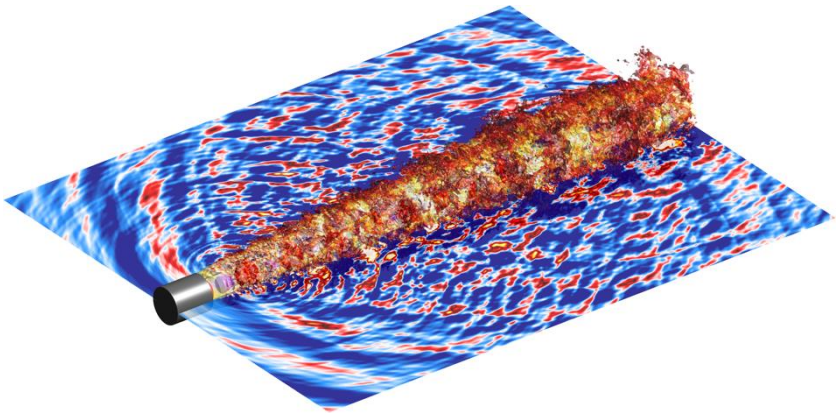


Figure 2 *Supersonic turbulent jet (M=1.56 - Re=50 000). Density contours are plotted for the aerodynamic field whereas pressure fluctuations in a meridian plane show the instantaneous radiated sound field [4].*

In the second part of the PhD thesis, the numerical results will be carefully analysed using advanced post-processing methodologies in order to investigate the key features of the interactions between the jets. Analytical modelling and/or a stability analysis will also be conducted, depending on the interaction mechanisms unveiled by the simulation data.

References

[1] Kuo, C. W., Cluts, J. & Samimy, M. (2016). An investigation of twin supersonic jet coupling. AIAA Paper 2016-1113.

[2] Seiner, J. M., Manning, J. C. & Ponton, M. K., Dynamic Pressure Loads Associated with Twin Supersonic Plume Resonance. AIAA Journal, Vol. 26, No. 8, 1988, pp. 954960.

[3] Grébert, A., Bodart, J., Jamme, S. & Joly, L., Simulations of shock wave/turbulent boundary layer interaction with upstream micro vortex generators. TSFP10, vol 2B-2.

[4] **Gojon, R.** & **Bogey, C**., Numerical study of the flow and the near acoustic fields of an underexpanded round free jet generating two screech tones, International Journal of Aeroacoustics, Vol. 16, No 7-8, pp. 603-625.