Paper 3.2

Experimental verification of novel spectral analysis algorithms for Laser Doppler Anemometry data.

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ABSTRACT

Two novel algorithms for estimating turbulence power spectra from Laser Doppler Anemometry (LDA) data, the *Refined sample and hold reconstruction (RR)* and the *Improved slot correlation (SC)*, have been tested on two test cases: grid turbulence and cylinder wake flow.
The algorithms were developed by Nobach et al. (1998), and van Maanen et al (1999) as a follow up on a benchmark comparison of some 15 algorithms reported by Benedict et al (1998). They were tested on simulated data generated from a known input spectrum, which was then used as a reference for evaluation of the algorithms.
In the present work, an experimental evaluation has been carried out, using reference spectra obtained with a Constant Temperature Anemometer (CTA), to evaluate spectra based on the RR, the SC and the traditional sample-and-hold reconstruction and resampling (S&H) algorithms.
It is shown, that RR and SC produce correct spectra up to frequencies above the data rate, whereas S&H, produces low-pass filtered spectra with a cut-off frequency corresponding to the data rate divided by 2π, the so-called the particle rate filter effect first reported by Adrian and Yao (1987). They recommended that data rates of 20 times the highest frequency of interest should be used for S&H.
The RR and SC thus have great relevance because they make it possible to obtain correct turbulence spectra at much lower data rates than with S&H. The practical implications of this are that less seeding is required, and that smaller lasers may be used.
Since RR is much faster than SC, and they produce very similar results, Dantec's LDA software has been extended with an on-line implementation of the RR algorithm.
The figure below compares the spectra obtained using CTA, and the RR, SC and S&H algorithms, for the cylinder wake flow.

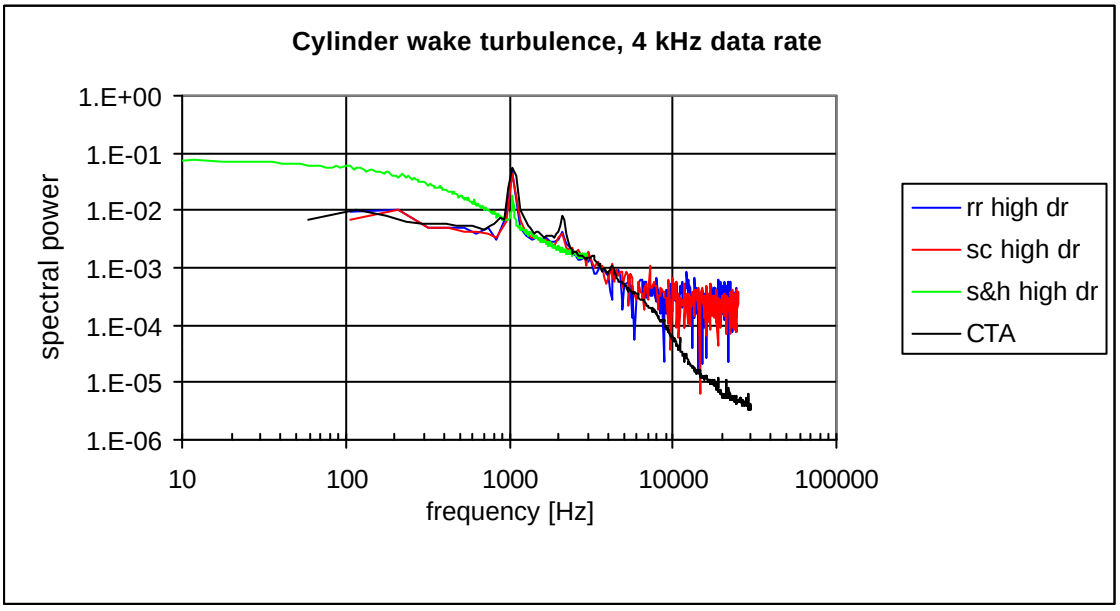

Fig. 1: Comparison of RR, SC and S&H LDA spectra with a reference CTA spectrum