

Evaluation of infrasound in-situ calibration method on a 3-month measurement campaign

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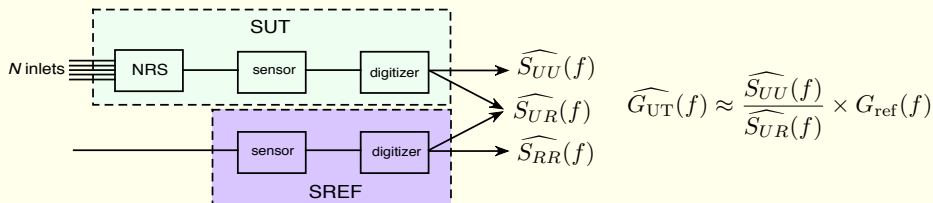
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IMS study

In the framework of the calibration program, a study was conducted with the following theoretical and practical results:

- determining closed form expression for the asymptotic distributions of the estimators;
- sizing a statistic for testing the magnitude square coherence (MSC) level;
- introducing a weighted estimator of the system under test (SUT) response based on the estimated value of the MSC;
- proposal of a filter bank analysis for the SUT estimation;
- providing a simple wind coherence model which explains an observed artefact of the noise reduction system (NRS), in relation with the wind velocity;
- **Evaluation on a 3-month campaign of measurement at station IS26. This presentation mainly focuses on the last item.**

Measurement

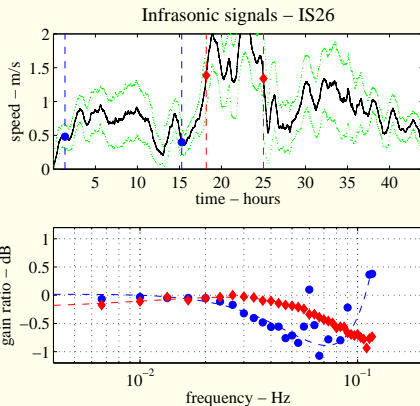


- objective: calibrate the system under test (SUT), i.e. NRS+sensor+digitizer, based on the knowledge of the reference system (SREF);
- 2 kinds of signals: acoustic and non acoustic (typically wind) with different ranges of velocity;
- non spatially coherent signals are called “noise”;
- acoustic signals is spatially coherent, in all frequency band of interest, regarding the size of the SUT.

NRS effect

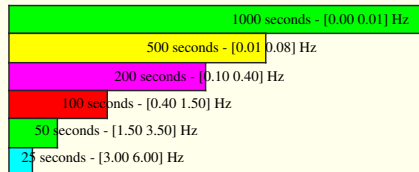
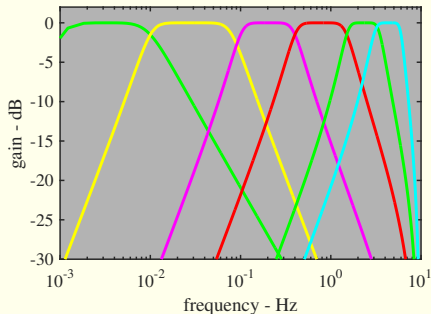
The ratio $\frac{v_{\text{wind}}}{f}$ can be viewed as a wavelength. Therefore

- **at very low frequency**, the wind appears as spatially coherent for all SUT/SREF elements. Therefore everything occurs as there is NO noise, and the MSC is almost 1,
- **at high frequency**, the wind appears as spatially NON coherent. Therefore the NRS plays its role to reduce the noise,
- **around 0.8 Hz**, a small part of the wind appears as spatially coherent for a few NRS inlets. Therefore a dip artefact is observed.



Manage the stationarity

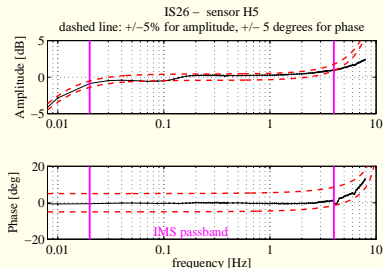
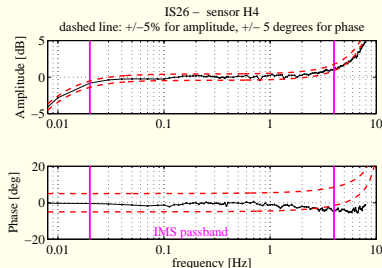
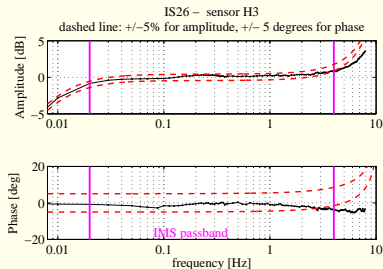
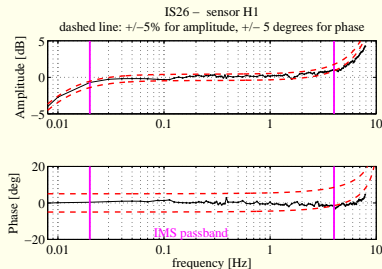
Spectrum analysis requires stationarity. In high frequencies the duration where we can expect stationarity can be considered smaller. Hence the idea to use a filter bank. The example below is used in the following processing.



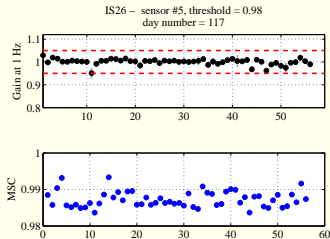
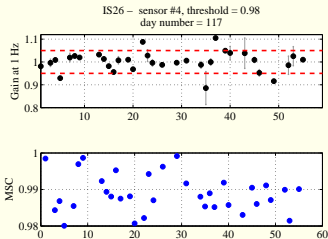
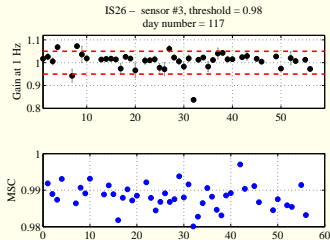
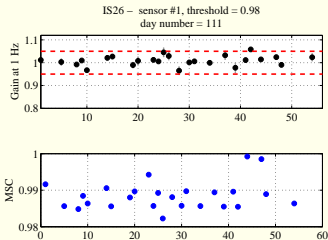
Deployment

- 8 SUTs with 18 meter wind noise reduction system, each of them with 96 inlets;
- 8 SREFs have been deployed on May 2015;
- each reference sensor has been calibrated in the lab;
- capability of wind measurement on H1;

Results



Temporal variability at the 1 Hz frequency value



Conclusions

PTS specifications are:

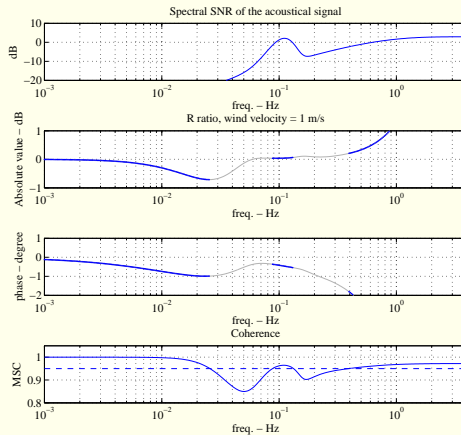
- bandwidth $[0.02 - 4]$ Hz;
- $\pm 5\%$ on the response magnitude;
- no requirement on the phase but ... $\pm 5^\circ$ has been considered.

Conclusions:

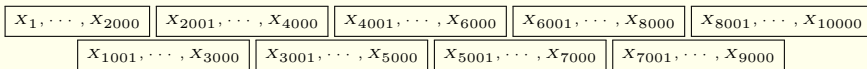
- The experimental results obtained averaging over 4 months fully validate the calibration method;
- The experimental results obtained by couples of 2 days show a permanence (without outliers) in full agreement with the PTS requirements;

THANKS FOR YOUR ATTENTION

NRS effect simulation



Rks



- If we have $N = 2000$ samples the resolution is $F_s/N = 0.01$ Hz. Therefore there is a possibility to decimate if the bandwidth is $B < 0.01$. But for sake of simplicity, we keep the common value F_s to all filters of the bank (no decimation).
- For each frequency bin, an averaging is applied on the $L = 9$ segments. If a few number of bins is required the fft algorithm is not needed.