

Three tidal turbines in interaction: an experimental data-set on wake and performances

Additional informations and some processing results

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In this document, authors give some additional informations about the turbine first, with the complete definition of the blade geometry and a technical drawing, in sections **I** and **II** respectively. Then, the time-averaged velocity profiles of the normalized stream-wise component \bar{u}^* are presented in sections **III** and **IV**, for $I_\infty = 1.3\%$ and $I_\infty = 15\%$ respectively and the three configurations. The normalization of the velocity is performed using the first upstream velocity profile, especially using $U_\infty = 0.79m/s$ for $I_\infty = 1.3\%$ and $U_\infty = 0.83m/s$ for $I_\infty = 15\%$. In the same way, the first element of the Reynolds stress $u'^*u'^*$ are shown with profile plots in sections **V** and **VI**. All these profiles are presented again with coloured maps in sections **VII** and **VIII**, for the same turbulent rates and configurations. Finally, Power Spectral Density functions of the torque and the thrust, for the third downstream turbine, are plotted in section **IX**, for both the turbulent rates, the three configurations and all the Tip Speed Ratios.

I. DETAILED BLADE PROFILE DESCRIPTION

Table I

DETAILED BLADE GEOMETRICAL DESCRIPTION WITH CHORD (c), PITCH ANGLE AND THICKNESS (t) IN FUNCTION OF THE VARYING RADIUS r

| r/R | c/R | Pitch (deg) | t/c (%) |
|--------|--------|-------------|-----------|
| 0.1333 | 0.0567 | 29.5672 | 80.0 |
| 0.1500 | 0.0567 | 29.5672 | 100.0 |
| 0.1550 | 0.0567 | 29.5672 | 100.0 |
| 0.1983 | 0.1521 | 25.6273 | 36.0 |
| 0.2417 | 0.2474 | 22.1491 | 21.3 |
| 0.2850 | 0.2375 | 19.3031 | 21.4 |
| 0.3283 | 0.2259 | 16.9737 | 21.7 |
| 0.3717 | 0.2141 | 15.0538 | 22.0 |
| 0.4150 | 0.2029 | 13.4572 | 22.2 |
| 0.4583 | 0.1925 | 12.1169 | 22.4 |
| 0.5017 | 0.1829 | 10.9815 | 22.5 |
| 0.5450 | 0.1743 | 10.0114 | 22.5 |
| 0.5883 | 0.1665 | 9.1761 | 22.4 |
| 0.6317 | 0.1594 | 8.4516 | 22.2 |
| 0.6750 | 0.1529 | 7.8191 | 21.9 |
| 0.7183 | 0.1471 | 7.2638 | 21.5 |
| 0.7617 | 0.1418 | 6.7735 | 20.9 |
| 0.8050 | 0.1370 | 6.3387 | 20.2 |
| 0.8483 | 0.1325 | 5.9514 | 19.5 |
| 0.8917 | 0.1285 | 5.6050 | 18.6 |
| 0.9350 | 0.1247 | 5.2941 | 18.0 |
| 0.9783 | 0.1213 | 5.0143 | 18.0 |
| 1.0000 | 0.0655 | 4.8743 | 25.0 |

II. DETAILED DESCRIPTION OF THE TURBINE

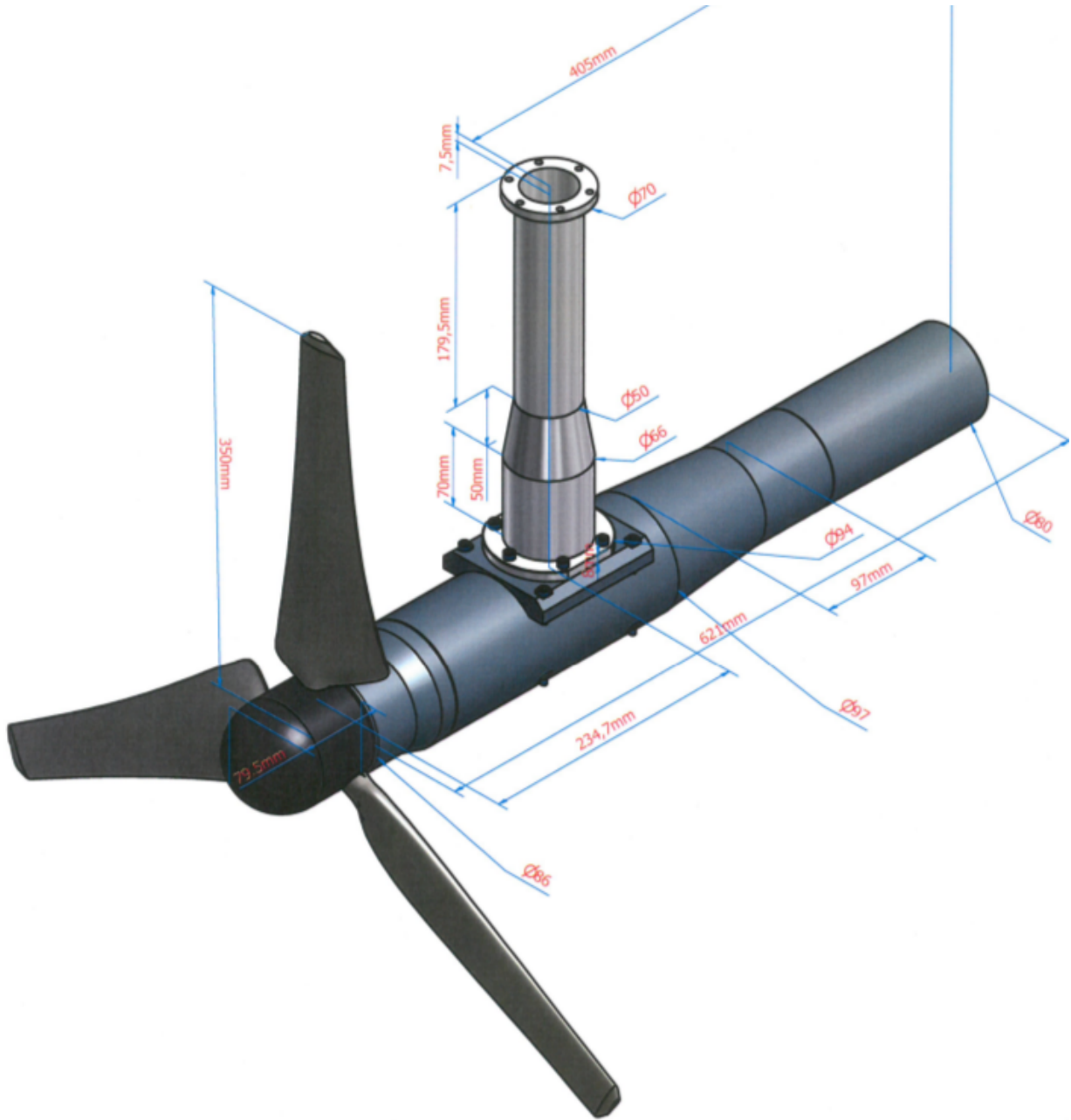


Figure 1. Geometrical characteristics of the turbines

III. WAKE PROFILES AT $I_\infty = 1.3\%$

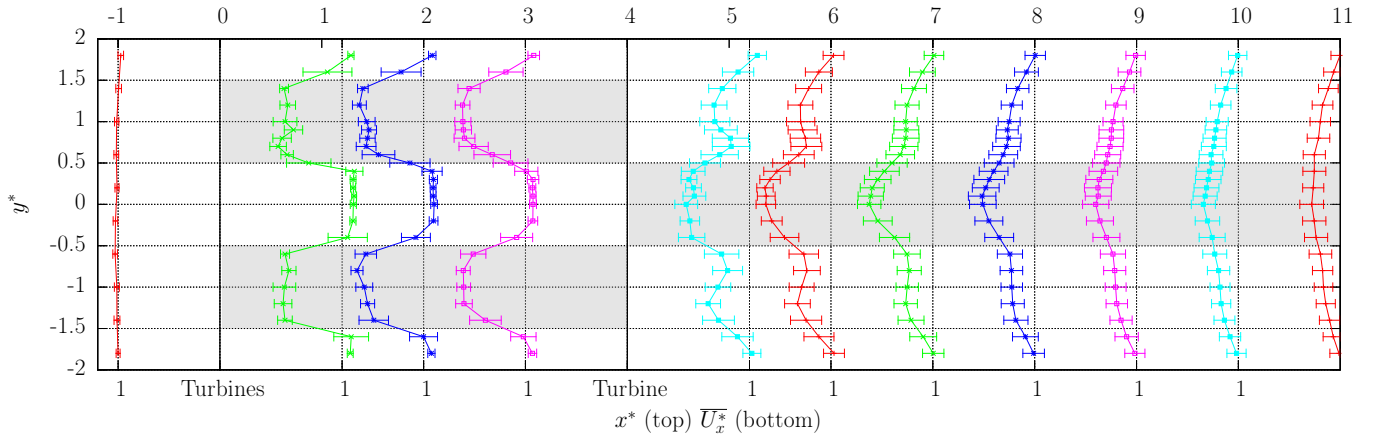


Figure 2. Axial velocity $\overline{u^*}$ profiles for configuration 1 and $I_\infty = 1.3\%$

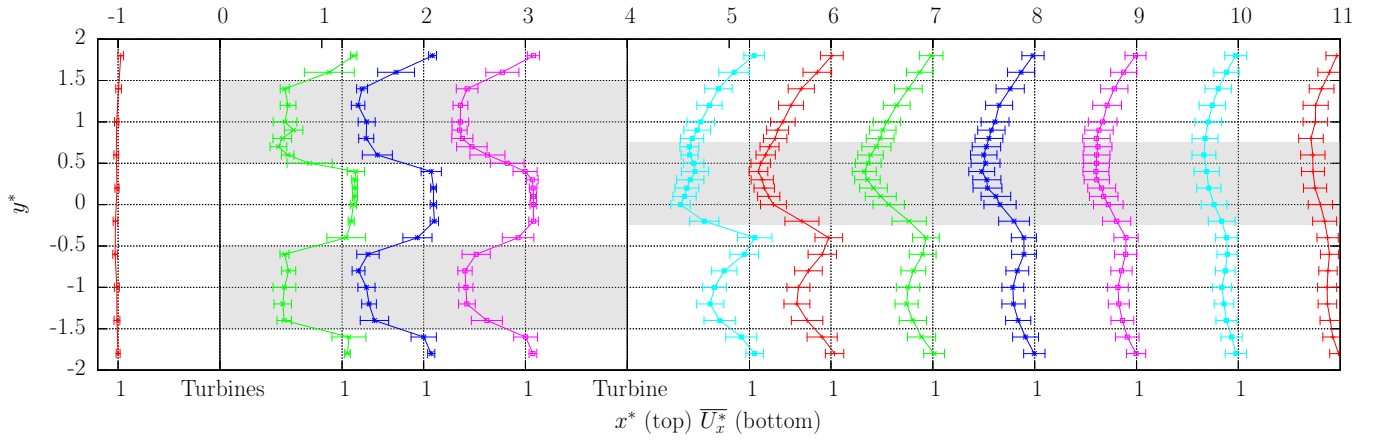


Figure 3. Axial velocity $\overline{u^*}$ profiles for configuration 2 and $I_\infty = 1.3\%$

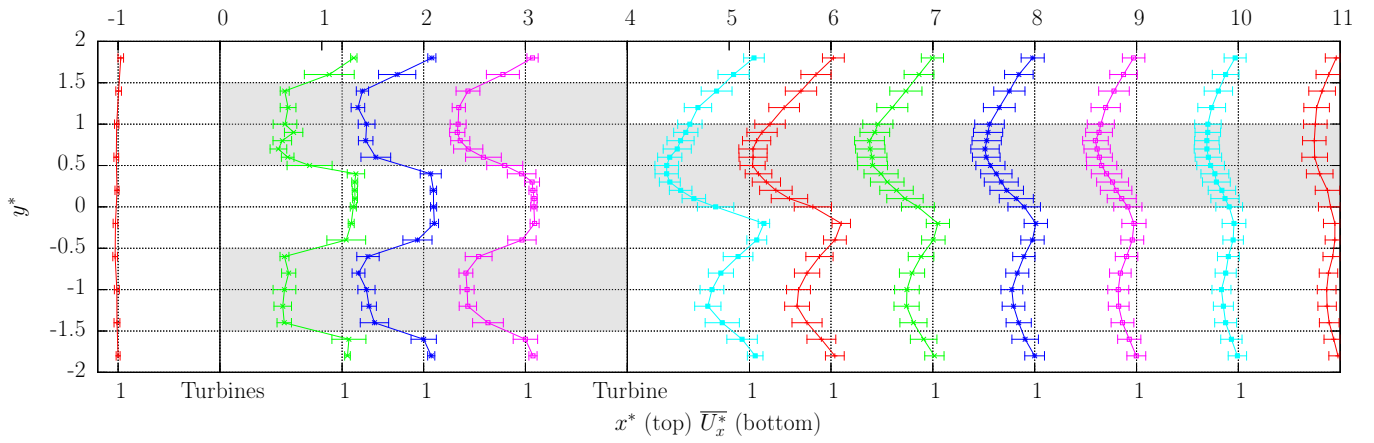


Figure 4. Axial velocity $\overline{u^*}$ profiles for configuration 3 and $I_\infty = 1.3\%$

IV. WAKE PROFILES AT $I_\infty = 15\%$

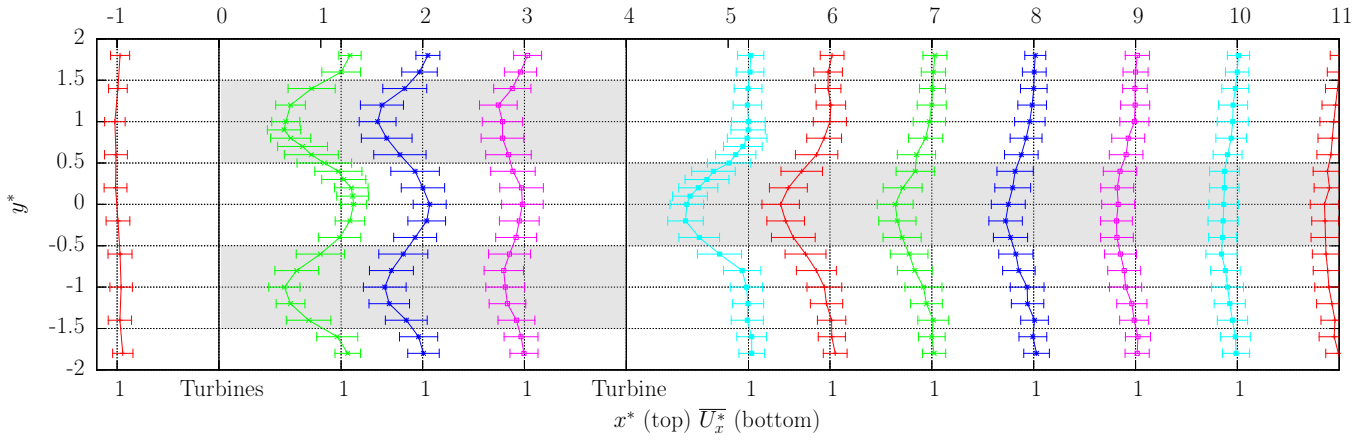


Figure 5. Axial velocity $\overline{u^*}$ profiles for configuration 1 and $I_\infty = 15\%$

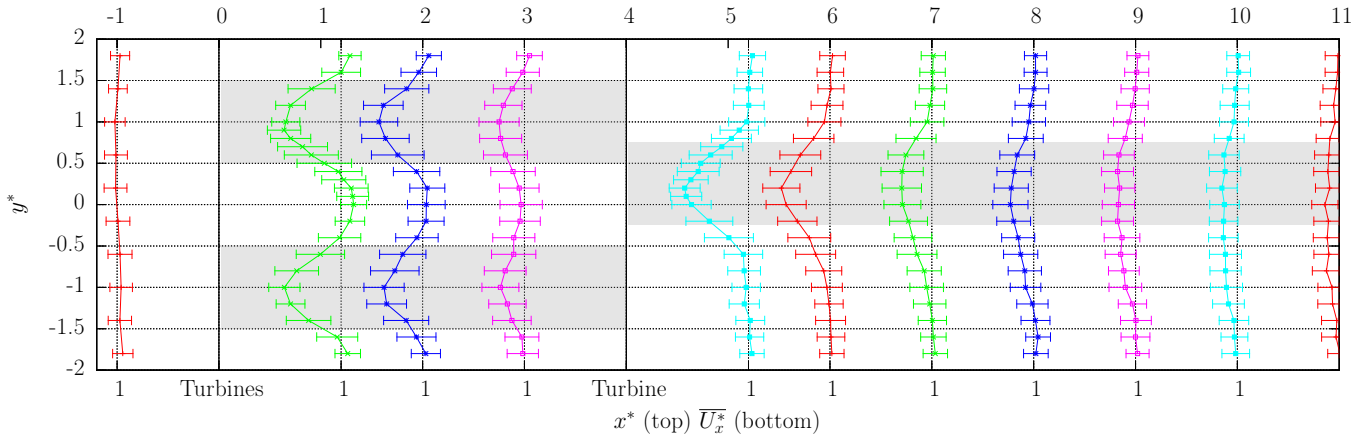


Figure 6. Axial velocity $\overline{u^*}$ profiles for configuration 2 and $I_\infty = 15\%$

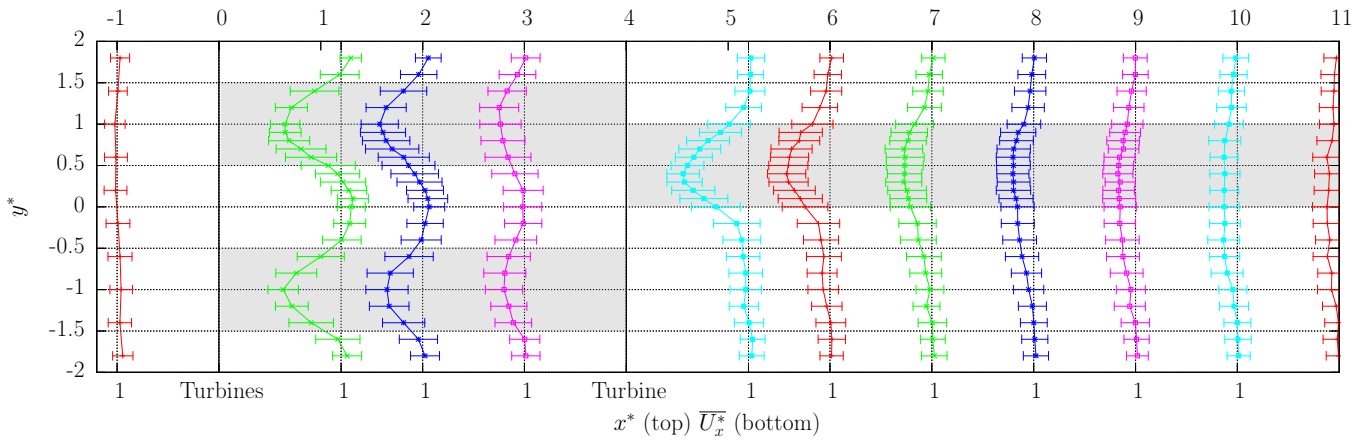


Figure 7. Axial velocity $\overline{u^*}$ profiles for configuration 3 and $I_\infty = 1\%$

V. FIRST ELEMENT OF THE REYNOLDS STRESS PROFILES AT $I_\infty = 1.3\%$

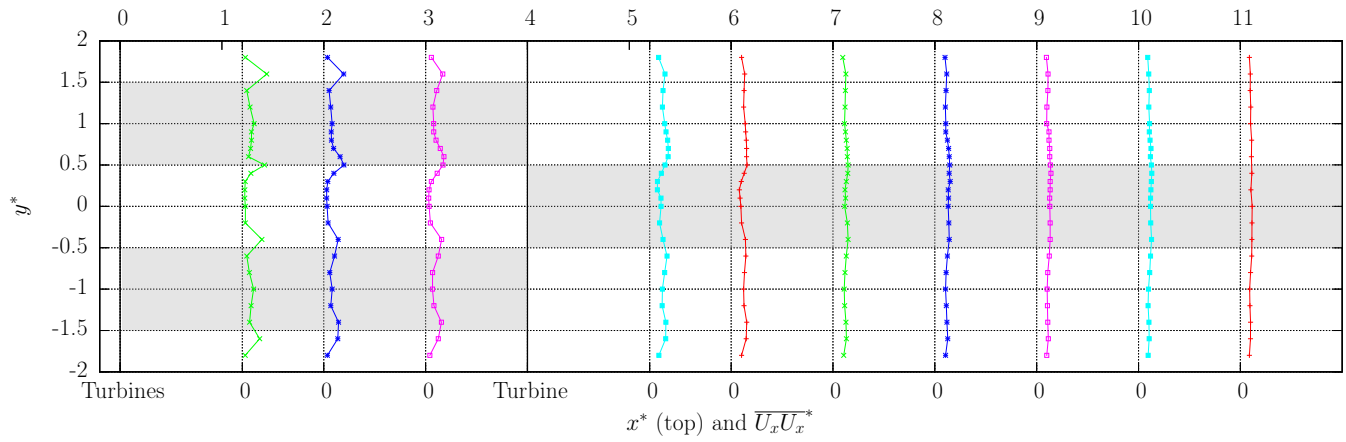


Figure 8. $\overline{u'^*u'^*}$ profiles for configuration 1 and $I_\infty = 1.3\%$

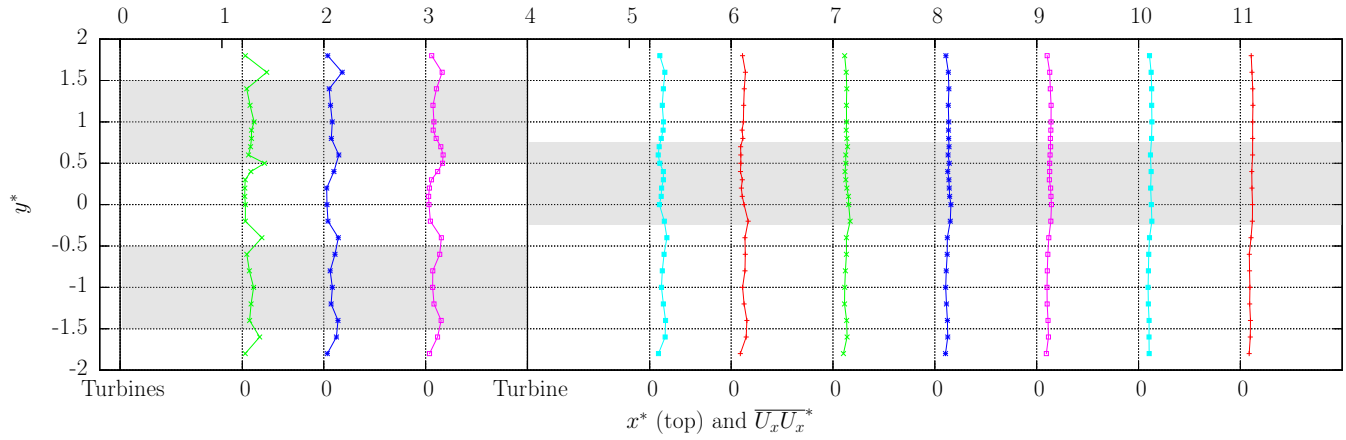


Figure 9. $\overline{u'^*u'^*}$ profiles for configuration 2 and $I_\infty = 1.3\%$

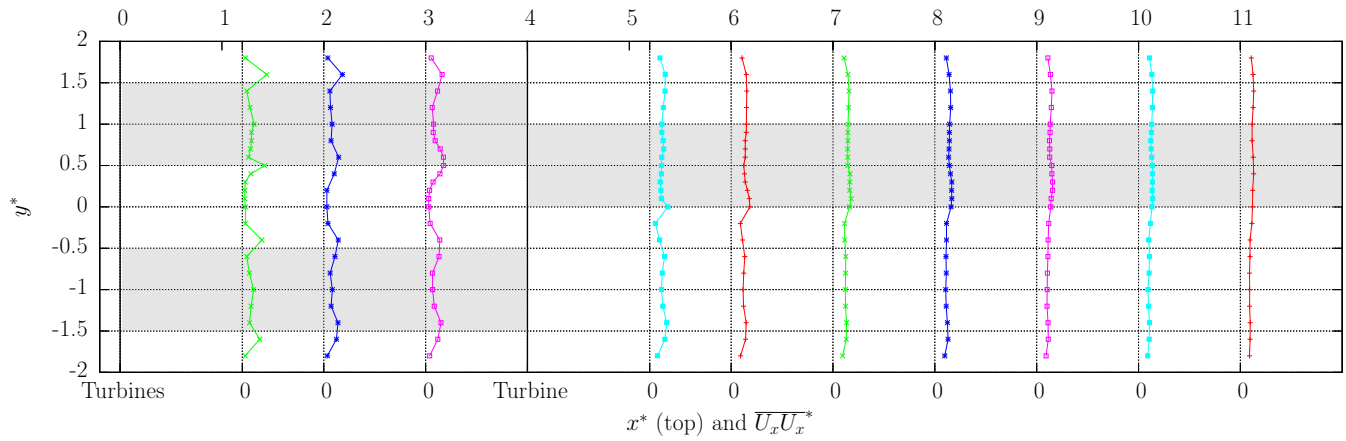


Figure 10. $\overline{u'^*u'^*}$ profiles for configuration 3 and $I_\infty = 1.3\%$

VI. FIRST ELEMENT OF THE REYNOLDS STRESS PROFILES AT $I_\infty = 15\%$

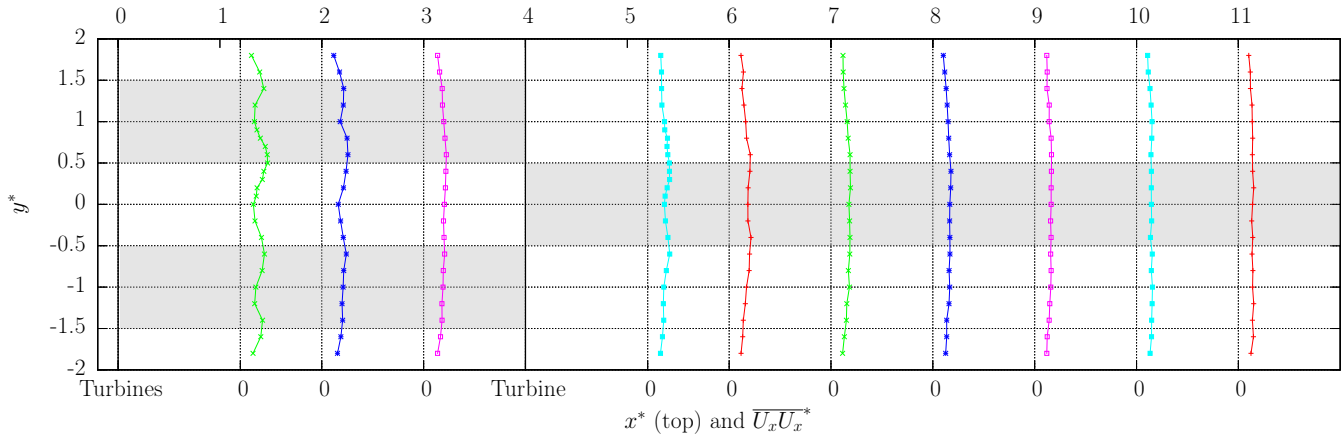


Figure 11. $\overline{u'^*u'^*}$ profiles for configuration 1 and $I_\infty = 15\%$

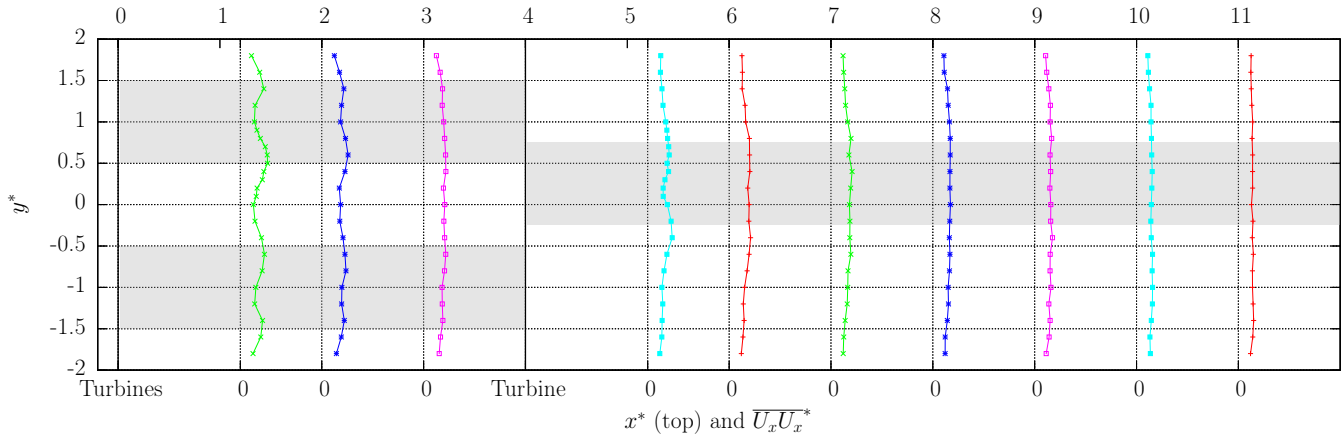


Figure 12. $\overline{u'^*u'^*}$ profiles for configuration 2 and $I_\infty = 15\%$

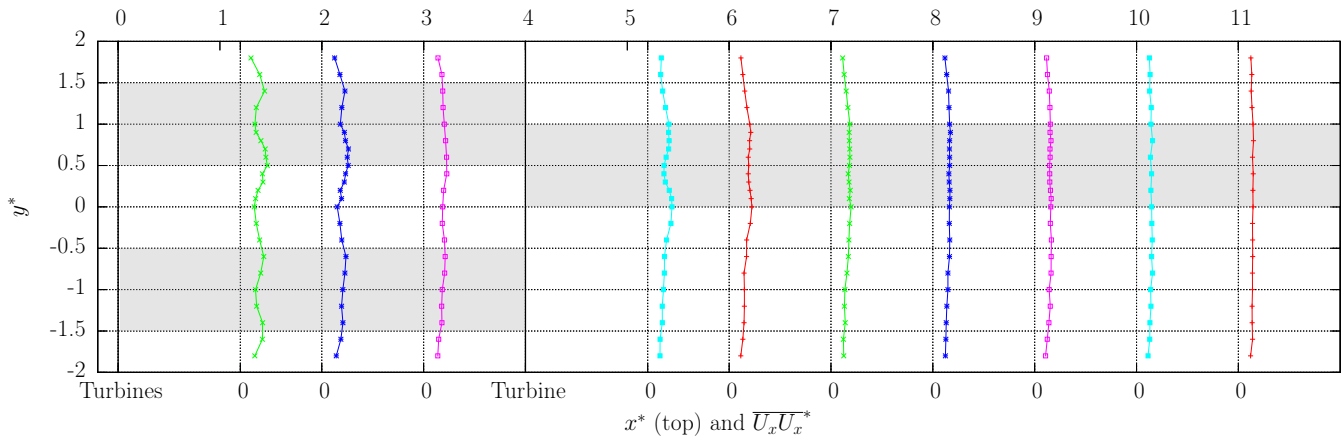


Figure 13. $\overline{u'^*u'^*}$ profiles for configuration 3 and $I_\infty = 15\%$

VII. MAP OF THE FIRST ELEMENT OF THE REYNOLDS STRESS PROFILES AT $I_\infty = 1.3\%$

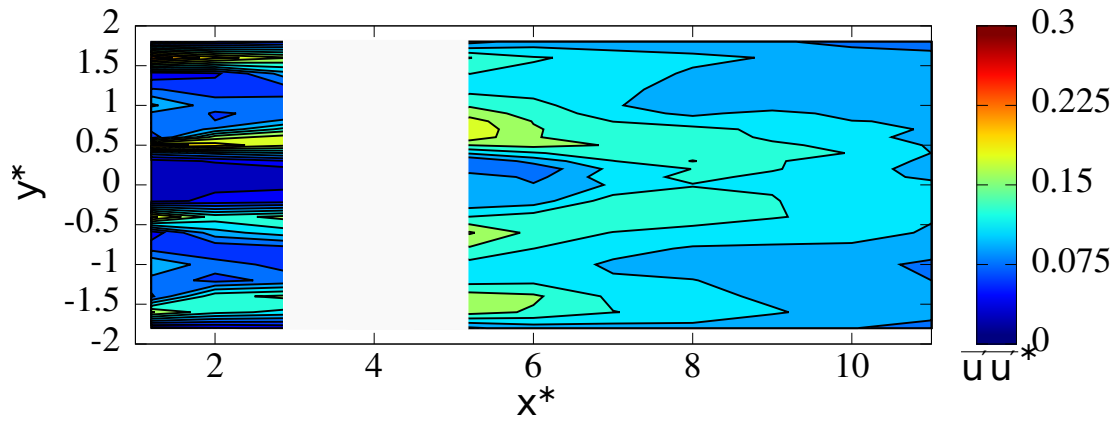


Figure 14. Map of $\overline{u'u'^*}$ for configuration 1 and $I_\infty = 1.3\%$

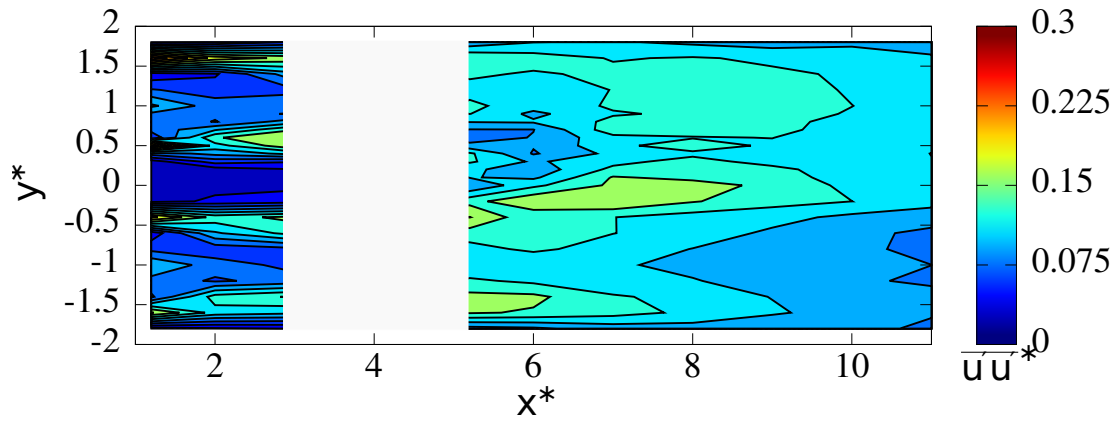


Figure 15. Map of $\overline{u'u'^*}$ for configuration 2 and $I_\infty = 1.3\%$

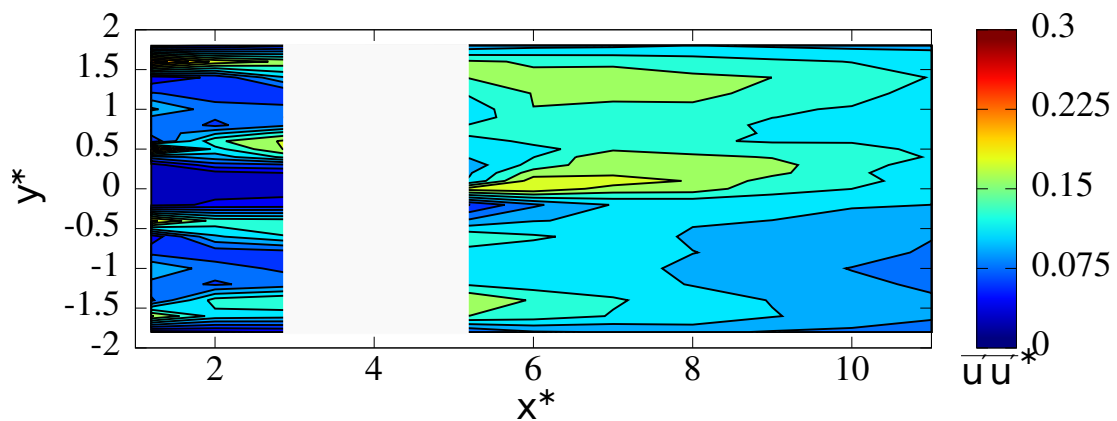


Figure 16. Map of $\overline{u'u'^*}$ for configuration 3 and $I_\infty = 1.3\%$

VIII. MAP OF THE FIRST ELEMENT OF THE REYNOLDS STRESS PROFILES AT $I_\infty = 15\%$

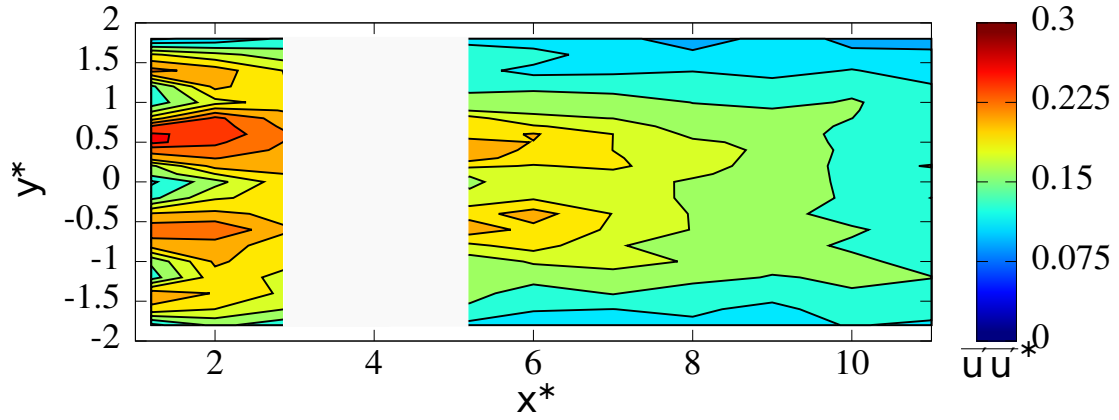


Figure 17. Map of $\overline{u'^*u'^*}$ for configuration 1 and $I_\infty = 15\%$

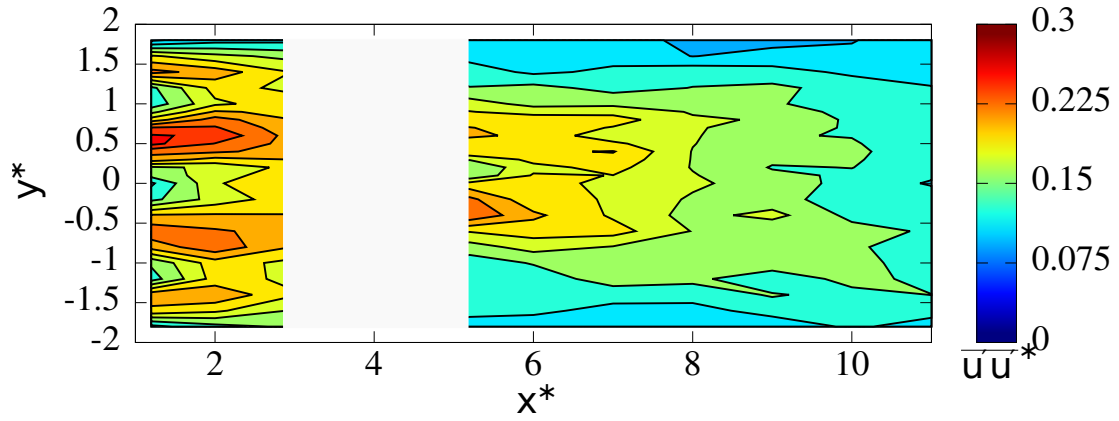


Figure 18. Map of $\overline{u'^*u'^*}$ for configuration 2 and $I_\infty = 15\%$

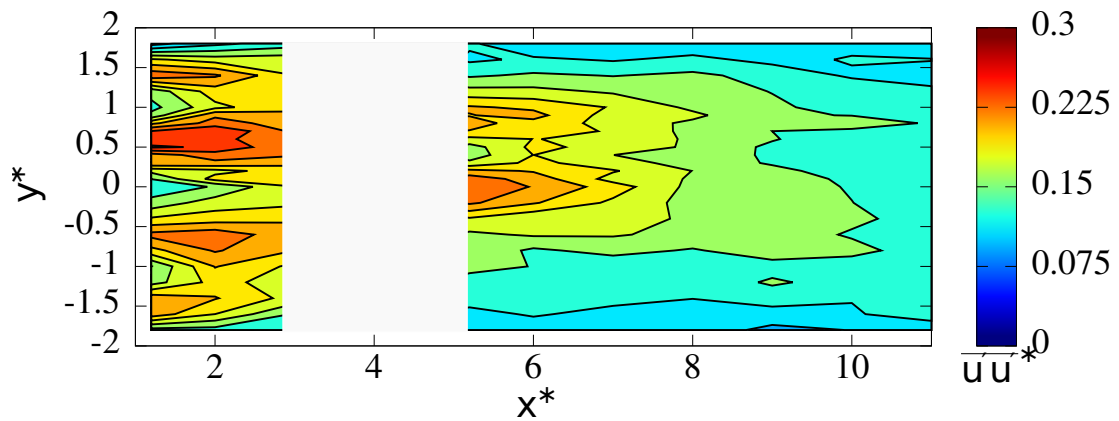
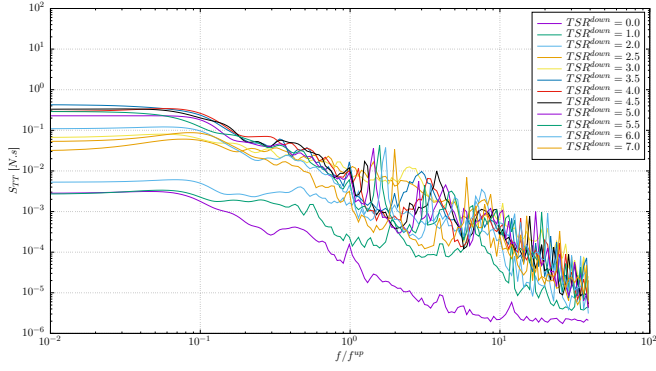
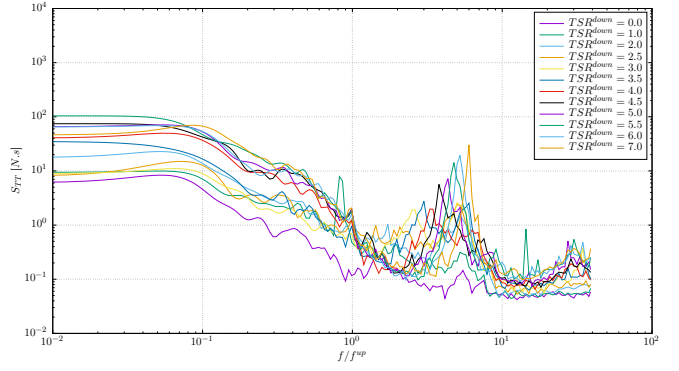


Figure 19. Map of $\overline{u'^*u'^*}$ for configuration 3 and $I_\infty = 15\%$

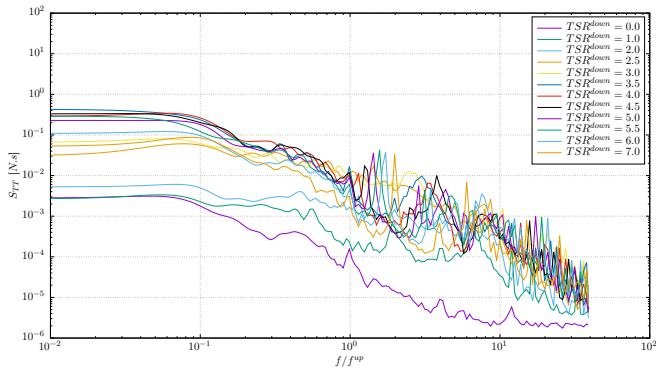
IX. POWER SPECTRAL DENSITY FUNCTIONS OF THE TORQUE AND THRUST



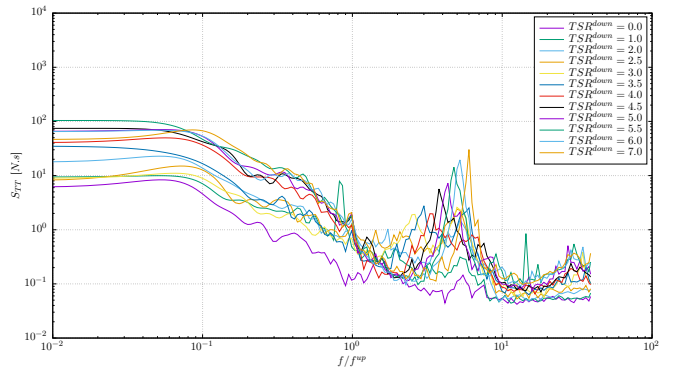
(a) S_{QQ} configuration 1



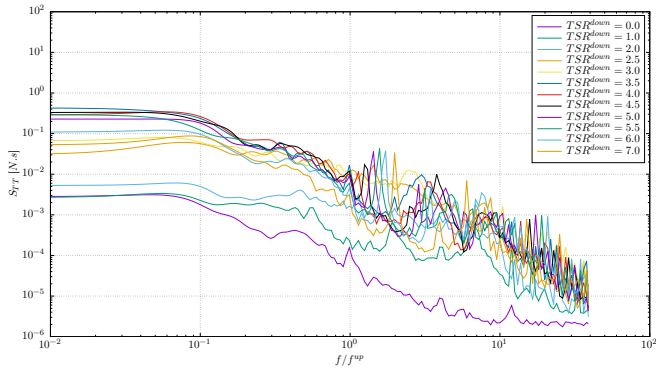
(b) S_{TT} configuration 1



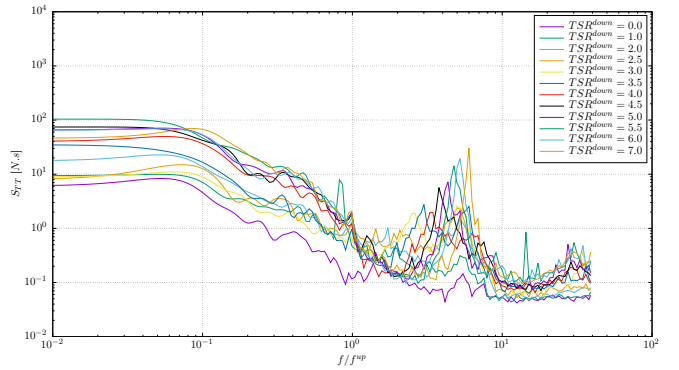
(c) S_{QQ} configuration 2



(d) S_{TT} configuration 2

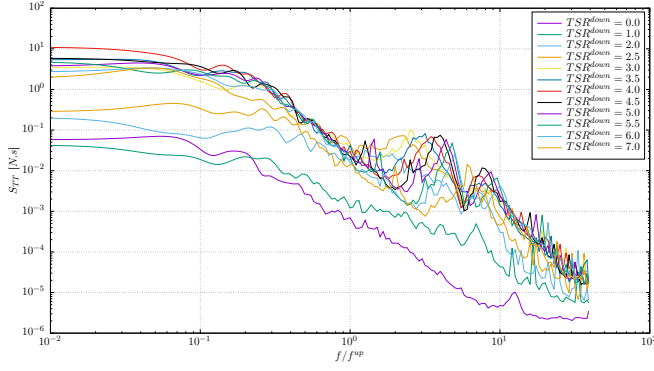


(e) S_{QQ} configuration 3

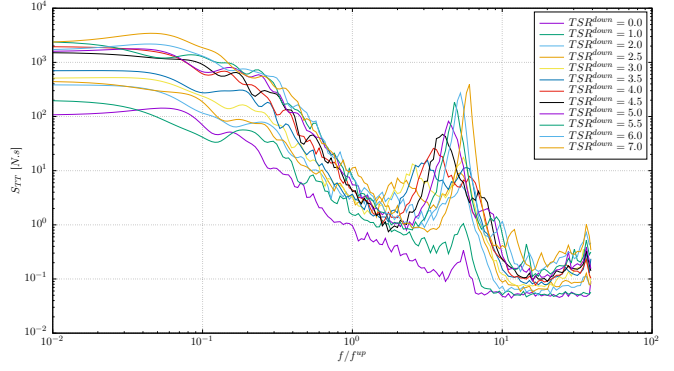


(f) S_{TT} configuration 3

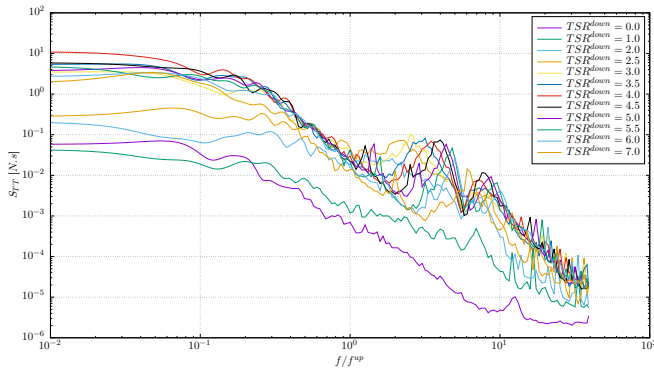
Figure 20. Spectral density functions of the torque S_{QQ} and the thrust S_{TT} for all downstream turbine TSR -values and the three configurations, for $I_\infty = 1.3\%$



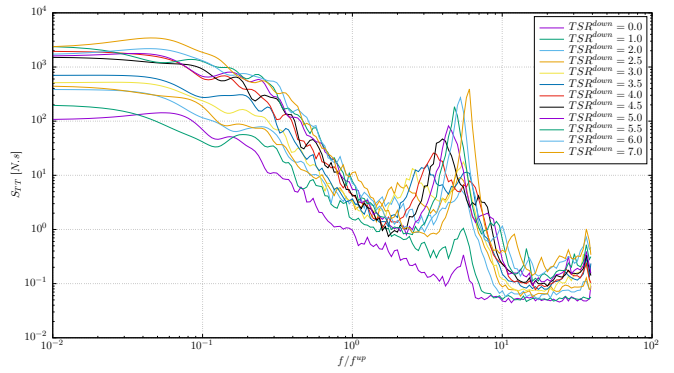
(a) S_{QQ} configuration 1



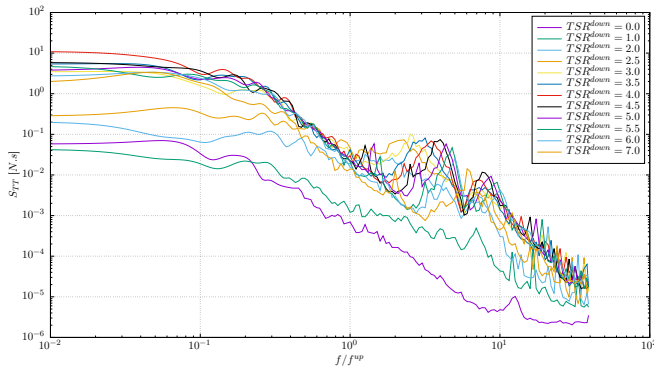
(b) S_{TT} configuration 1



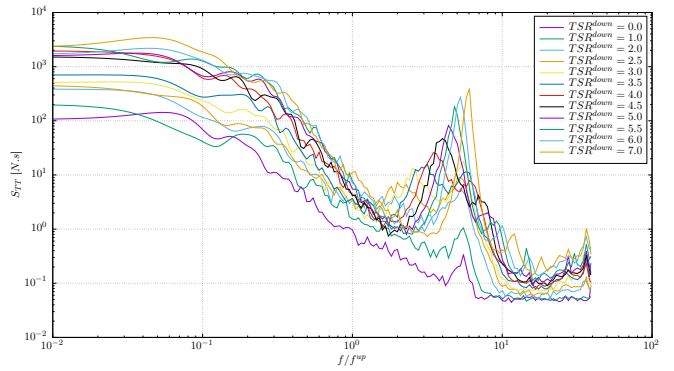
(c) S_{QQ} configuration 2



(d) S_{TT} configuration 2



(e) S_{QQ} configuration 3



(f) S_{TT} configuration 3

Figure 21. Spectral density functions of the torque S_{QQ} and the thrust S_{TT} for all downstream turbine TSR -values and the three configurations, for $I_\infty = 15\%$