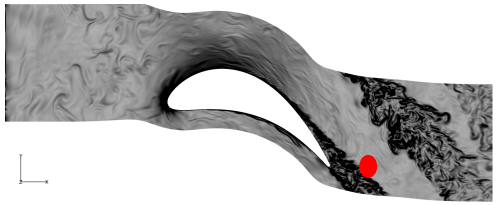
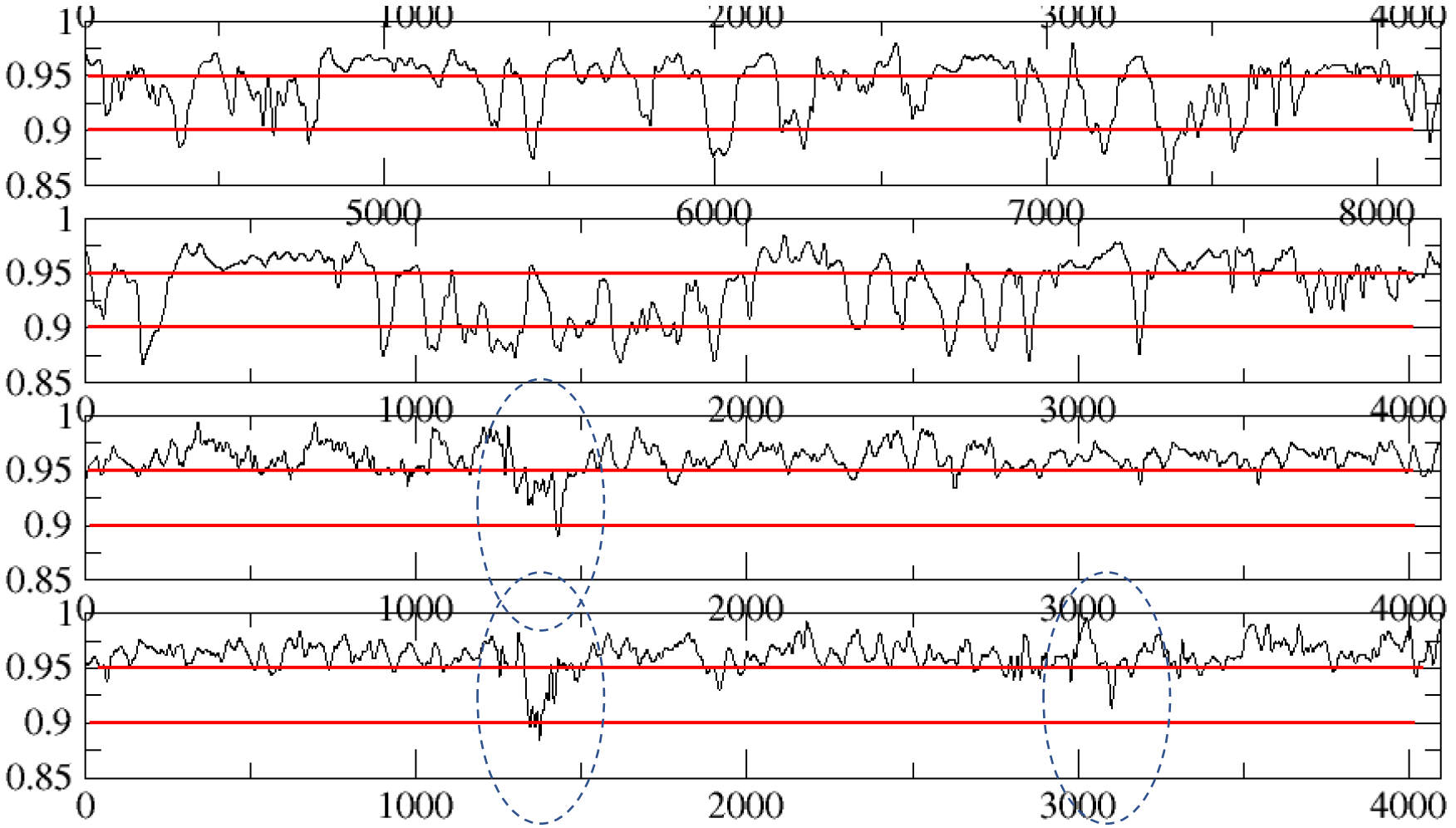
Four Different Time histories of Total Pressure at the Edge of the Wake





Level 2 Grid (Coarse)

Level 1 Grid (Fine)

- All data points has 4096 time-steps, and FFT is performed to analyze these data.
- For Level 1 (fine mesh), the wake is significantly stable, but still some “hiccup”s.

Statistics: Time histories of Total Pressure at the Edge of the Wake

Level 2	> 0.95	> 0.925	< 0.9	Wave-power
1	0.36	0.68	0.13	0.33
2	0.53	0.77	0.07	0.36
3	0.38	0.65	0.13	0.37
4	0.43	0.7	0.11	0.34
5	0.49	0.8	0.05	0.28
6	0.507	0.77	0.09	0.32
7	0.49	0.74	0.09	0.34
8	0.465	0.694	0.157	0.32
Level 1	> 0.95	> 0.925	< 0.9	Wave-power
1	0.85	0.98	0.005	0.27
2	0.88	0.98	0.006	0.19

- First, we check how often the total pressure indicates that the flow is in the freestream (> 0.95) or in the wake (<0.9)
- Also, “wave power” is the area of spectra profile (Large: more fluctuations)
- For both cases, we see that the statistic is fluctuating, but may be in a quasi-steady state.

Correlation between FFTs of the wake (Po) and FFT of other location (U)

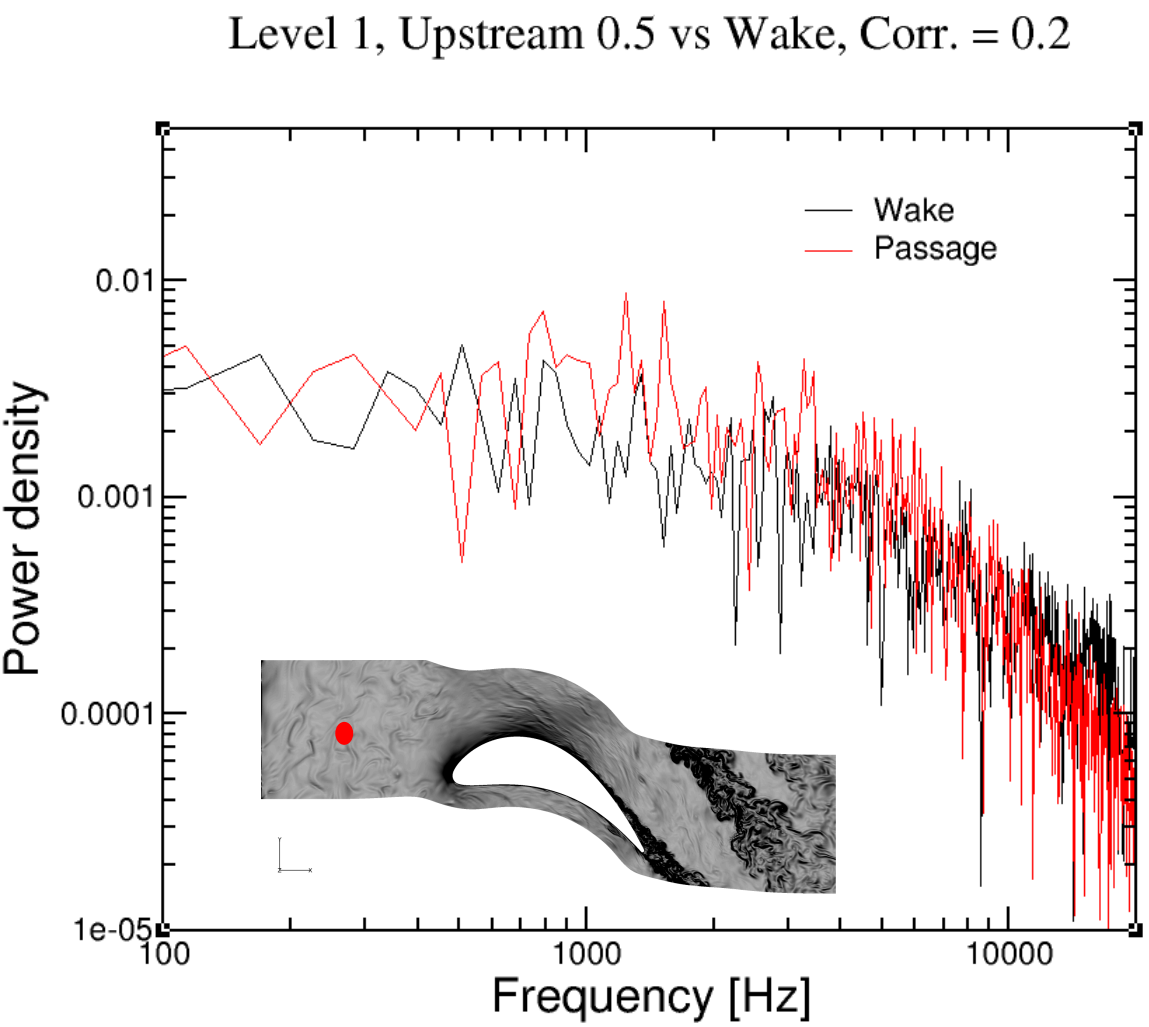
	Level2: Correlation with wake	Level1: Correlation with wake
Passage0_U.dat	0.28	0.43
UpM1_R	0.11	0.41
UpMp5_U	0.09	0.2
Sside_p95_U	0.25	0.43
Sside_p85_U	0.21	0.35
Sside_p8_U	0.41	0.36
Sside_p75_U	0.27	0.55
Sside_p7_U	0.1	0.31
Sside_p65_U	0.25	0.5
Sside_p6_U	0.33	0.42
Sside_p5_U	0.38	0.38
Sside_p4_U	0.36	0.5
Sside_p3_U	0.37	0.53
Sside_p2_U	0.44	0.5
Sside_p1_U	0.44	0.39
Pside_p1_U	0.35	0.62
Pside_p2_U	0.33	0.6
Pside_p3_U	0.37	0.533
Pside_p4_U	0.42	0.65
Pside_p5_U	0.45	0.46
Pside_p6_U	0.35	0.43
Pside_p8_U	0.22	0.52

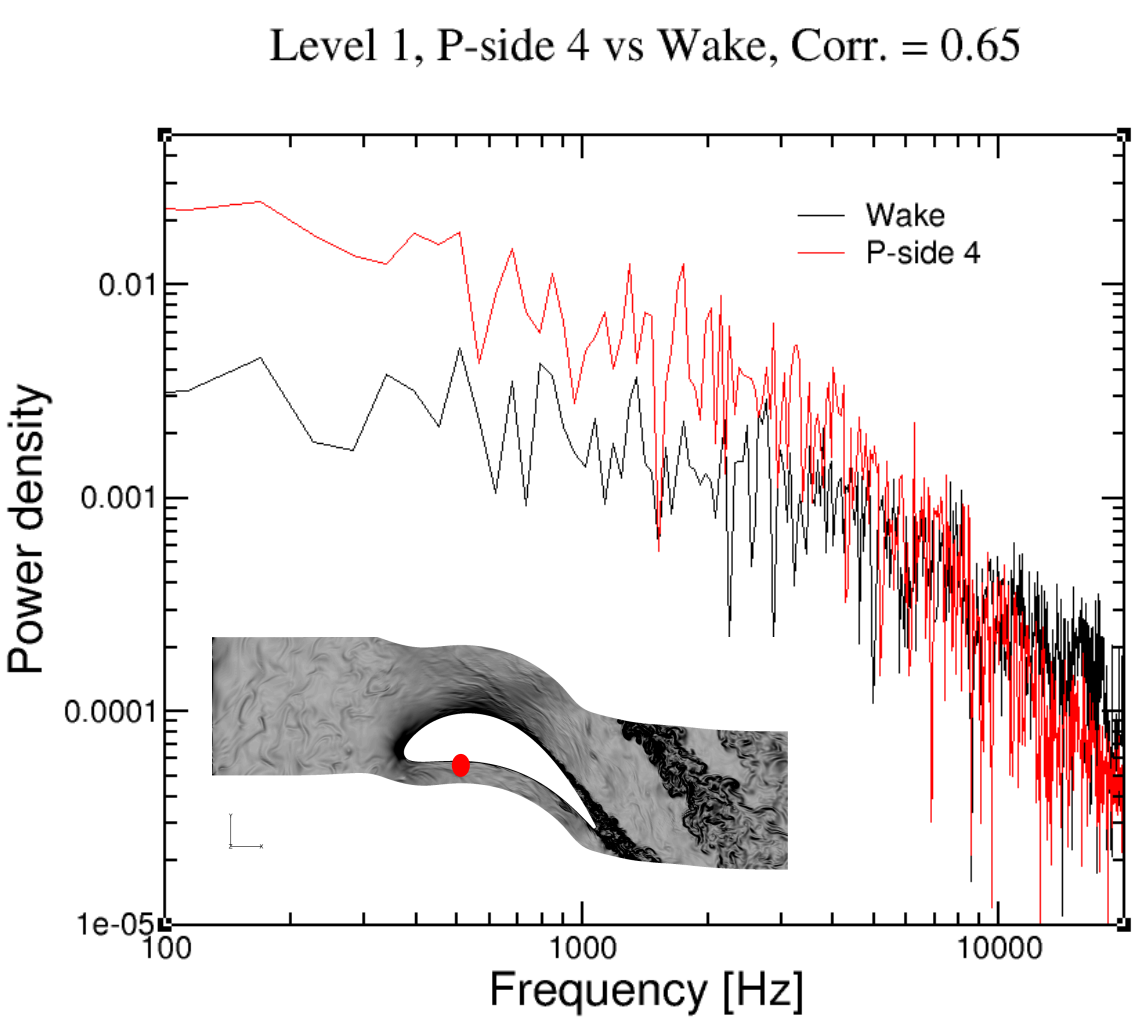
Please note that histories of properties at the wake and other locations have some time-lag, so it is not good to compare these profiles. BUT, FFT should be a better metric.

<u>This is an interesting results!</u>

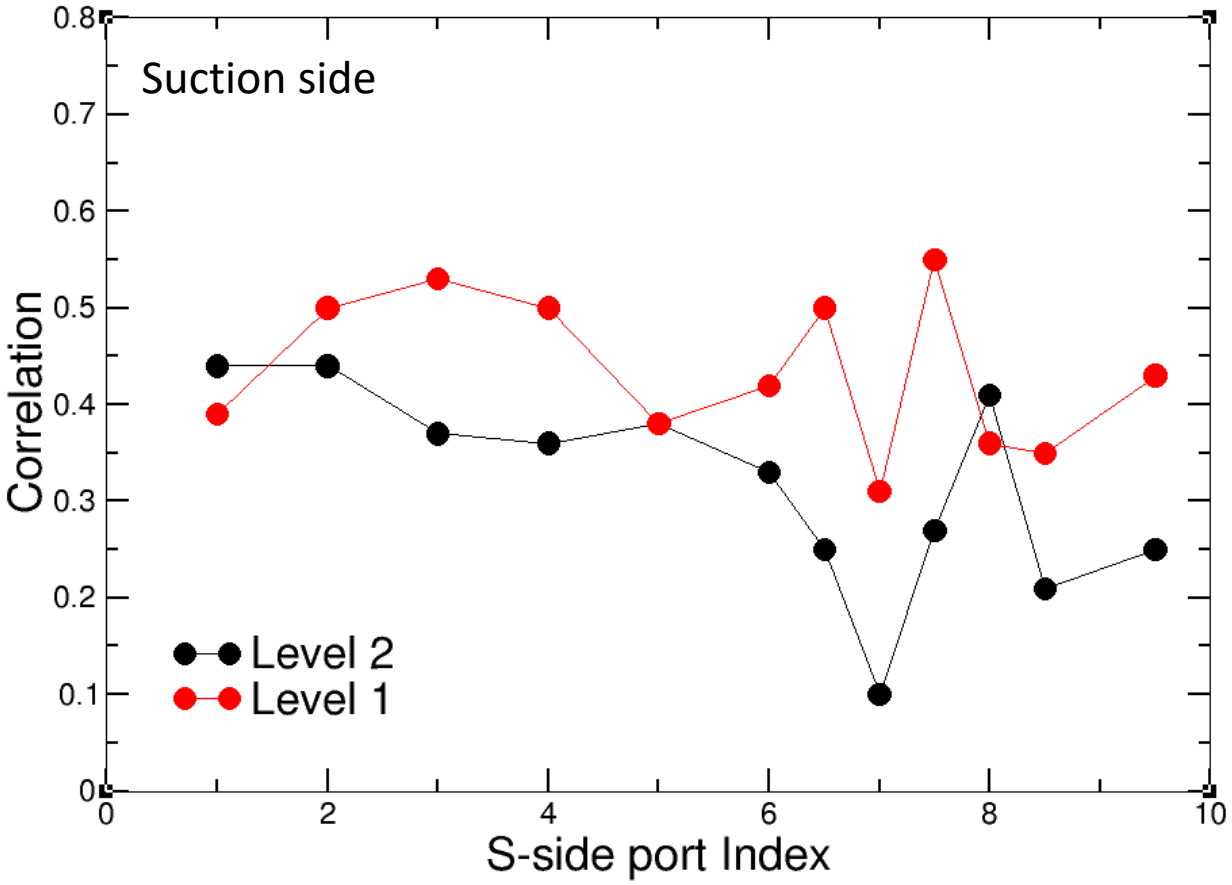
- For Level 2, the freestream turbulence is not synchronized with the wake.
- For Level 2, the separation bubble (X/C=0.8) and the pressure side oscillation are moderately correlated with the wake.
- For Level 1, the fluctuations at the leading edge and at the pressure side are strongly correlated with the wake. It suggests that the “rare” event of the broadening wake seems to be caused by some effects originating at the leading edge or pressure side?

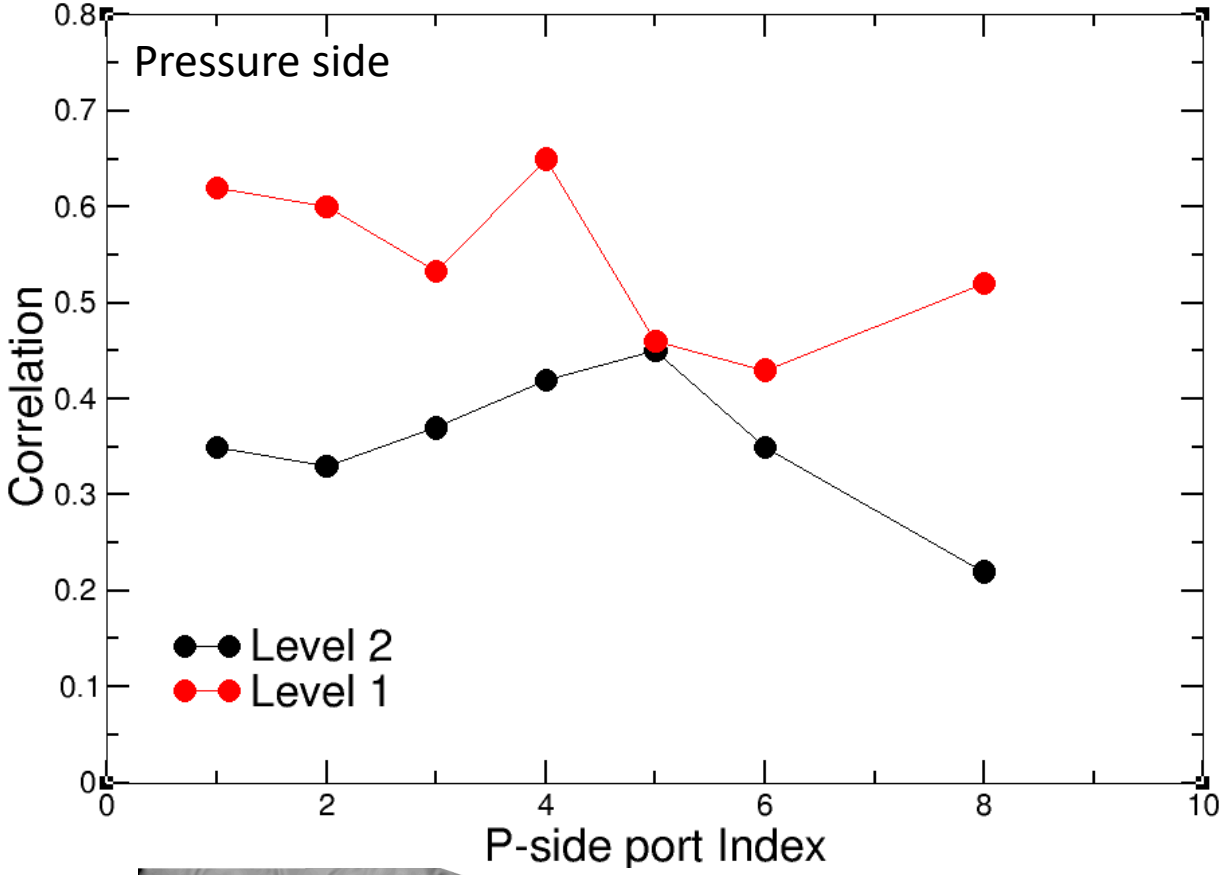
Key FFT Comparisons



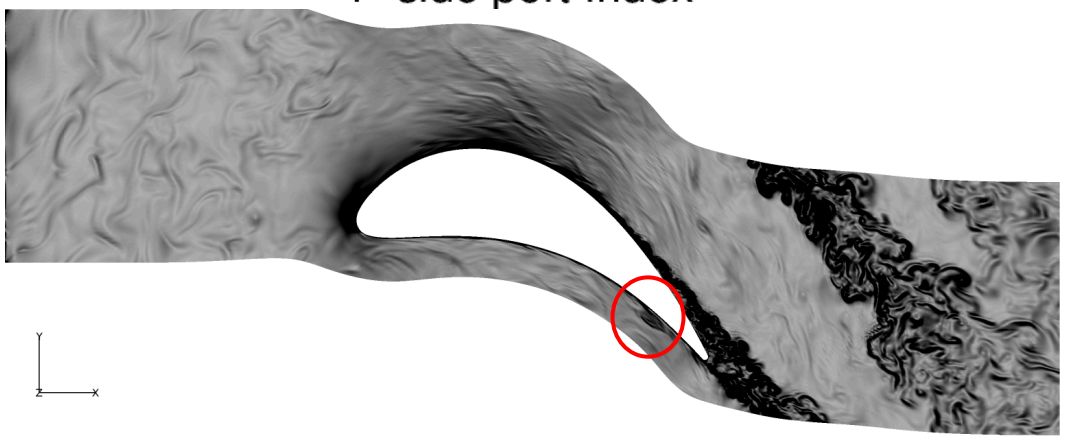


Correlation: Pressure side and Suction side for Level 1 and Level 2

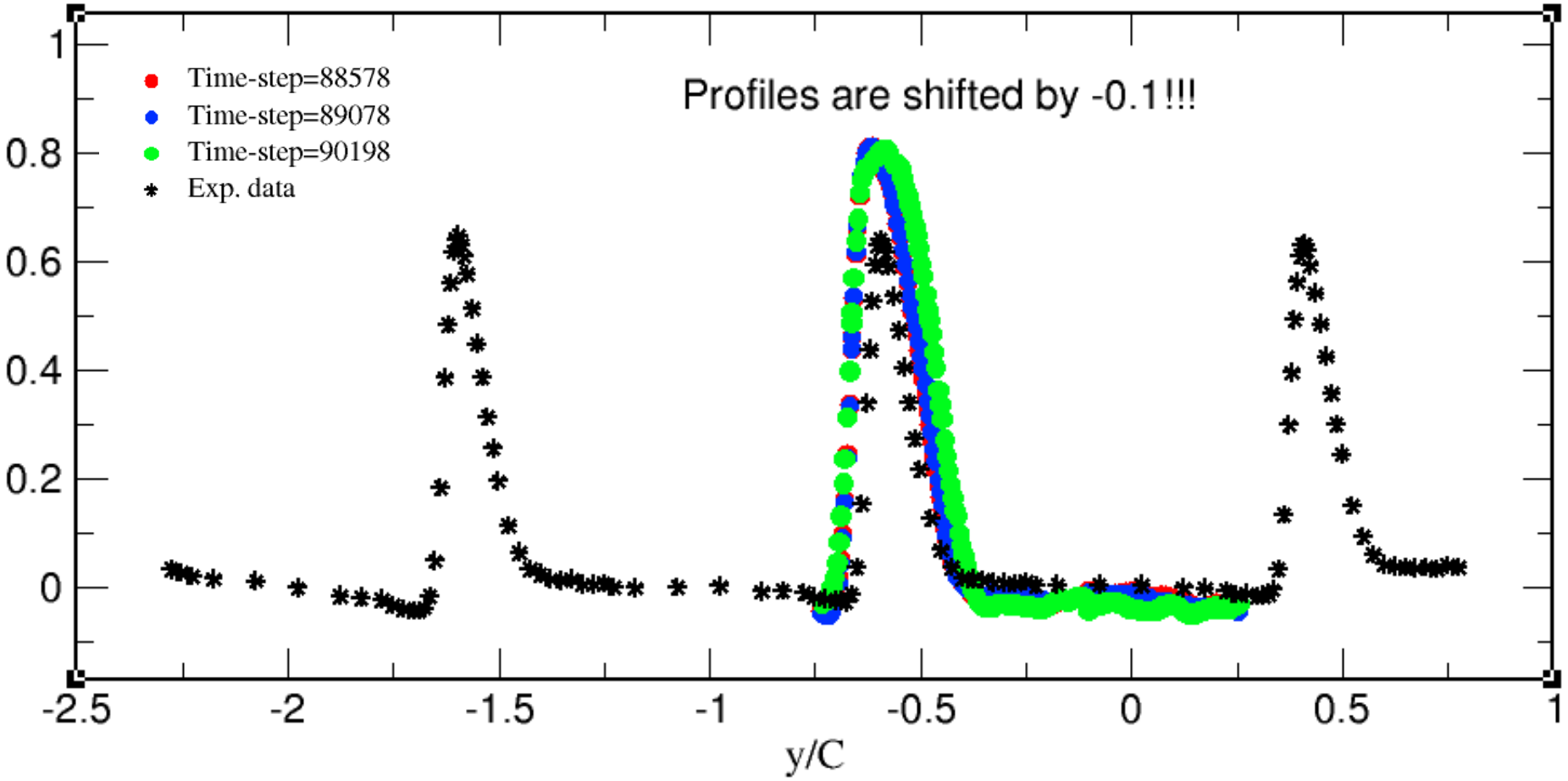




- For Level 1 it is surprising that the velocity fluctuations at pressure side are closely synchronized with the wake fluctuations. WHY???
- We know there are occasionally some eddies traveling along the pressure side…does it cause the wake to fluctuate?



Level 1: Wake Profiles



- Profiles are SHIFTED by y/C=-0.1
- Blue and Red stay top each other (these are token when the wake is stable), but once the wake gets broaden, the profile becomes wilder (green).
- The peaks are much higher. One possible reason is that the freestream/upstream Po is slightly higher than unity.