Paper Title:

Experimental investigation of harmonic surge motions on the far wake of a wind turbine model and analysis of a resulting subharmonic wake response

General summary:

The manuscript presents a wind tunnel experiment on the wake of a porous disk, subject to surge motions. The well documented methodology includes hot-wire and PIV measurements, by that combining temporal and spatial resolution. The post processing is adequate and the two main findings are i) the Strouhal number corresponding strongest wake response and ii) the occurrence of a subharmonic component in the wake dynamics. The paper is well structured and the results are presented in a comprehensible way. While the topic of investigation is a very narrow and specific case, (and further abstracted by the use of a porous disk instead of a model turbine), the processing chain can be inspiring for follow-up research. Please consider the following remarks to improve the manuscript.

Kind regards

General comments:

1. Comment on the following topics in the paper:
    - Porous disk vs. (model) turbine: limitations, i.e. wake rotation, tip vortices
    - Phase-averaged method: variance of individual cycles w.r.t. phase-averaged effects
    - The role of the dynamic inflow effect in view of the surge motion (consider time scales)
    - Sharpen the discussion of the involved wake meandering (both in introduction and discussion, following line 423ff)
2. The conclusion got too long and detailed, repeating much of the introduction and methods but also bringing up new thoughts. Besides, the detailed literature references are not needed here – they suit better in the previous discussion chapter. I recommend to considerably shorten and condense the conclusions. Apart from that, the paper is well structured and the dedicated discussion chapter is a good choice.

Specific Comments:

Abstract

1. Fine and informative.

Introduction

1. The first paragraph starts very fundamental with the reference to the 19th century. In my opinion you could shorten here and assume general awareness of the role of (offshore) wind turbines from a WES reader.
2. Line 100: "quasi-steady-state analysis with basic wake models". Please name and reference the wake models here. The generic formulation is fine for the abstract though.
3. Line 110ff: Please conclude the research gap more thoroughly. The literature review is very detailed, but the take-away could be formulated more clearly.
4. Line 114: Please mention here (or earlier in the introduction) the disc diameter of the experiment, so the reader already has an ap-front information of the involved dimensions.

Methodology

1. The measurement systems are generally well described.
2. Line 148ff, 165: Good that you describe the HW calibration. Please comment on the accuracy at such low wind speeds (<2m/s in the wake), which might be tough to handle for the hot-wires. What's the wind speed range used for calibration?
3. Line 169: Please sharpen: 1px is just the algorithm accuracy. Type B uncertainties considering camera orientation might be larger that that. That might rather impact the uncertainty of e.g. the wake centre than that of the absolute wind speed.
4. Line 190ff: Please comment: when calculating the difference in PSD w.r.t. a fixed case: in how far could a meandering motion of the fixed disk distort the result. Maybe generally comment on what to expect for the fixed case, e.g. comparing to (Muller et al., 2015).
   Update: I see that Fig. 5 actually shows this aspect well. Still, please comment on the background dynamics, either here or in section 3.1.
5. Line 193: It's intuitive that HW1 shows best response to wake motion. Still, do the other HWs agree with the amplitude peak at St = 0.24? please comment briefly here or in the results section.
   Update: as I read the results section, I see the aspect discussed. Please reference to that section here, because it sounds as if the other positions were not considered for the processing from the start.

Result analysis

1. Line 247: consider changing the formulation "thanks to".
2. Line 260ff: comment on the impact of the tower wake. It seems to impact, and its relevance in comparison to the disk wake might rise, especially at phase angles of low disk wake you mention, seemingly pulling down the wake centre. The different tower diameter (in comparison to the disk diameter) could mean different mixing dynamics (coupled to St) are on hand for the tower.
3. Fig 7: check phase labels
4. Fig. 9c . check legend
5. Please comment on the presence of systematic y_c variations. It seems unexpected in a symmetric setup and with no wake rotation.
6. Section 3.3.1: please introduce the coherence functions and phases
7. Fig. 14 fix legend
8. Section 3.3.2: (for later in discussion: why is the lateral mode considerably larger than the vertical one? Comment on the role of shear and the impact of the tower wake, please.
9. Line 343: Maybe "preferably" isn't the best term here.

Discussion

1. Line 360: please comment on the role of the downstream distance on the results. 8.xx D seems at the upper limit of what's seen in the field.
2. Line 362: could this finding relate to the introduced threshold in combination with a smeared-out tower footprint for the motion cases?
3. Line 382: add a discussion of the influence (model) turbine vs. porous disk on the wake dynamics here.
4. Line 394-401: this is a helpful and relevant interpretation. Also, the numerical example in the following is helpful. Would it be possible to refine on the transport velocity here (e.g. refining the simple assumption of a transport velocity averaged over downstream distance)?

References

1. Line 536: Incomplete reference