Do Floating LiDARs qualify for assessing offshore wind turbine power curves?

J. Gottschall, Chr. Redl, E. Patschke

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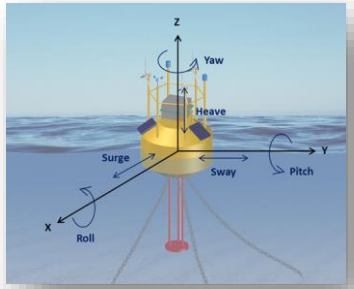
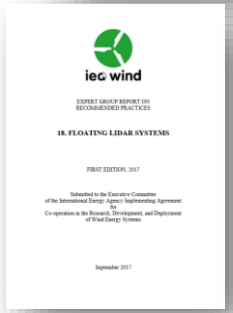
Outline

- Introduction – why power curve measurements with FLS
- Demonstration field measurement
- FLS technology
- Results for FLS power curve incl. discussion of uncertainties
- Conclusions

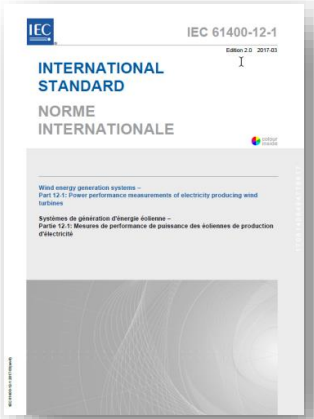
Introduction

Floating LiDAR (FLS)
(focus on Wind Resource Assessments)





Most recent standard for power curve assessments (acceptance by industry)



Combine both for cost-efficient offshore “FLS Power Curves”

→ maximal compliant with IEC 61400-12-1:2017 (except for stand alone application)

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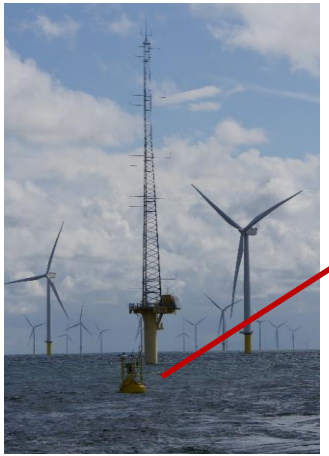
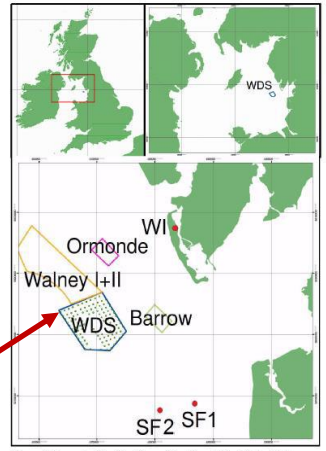
Demonstration field measurement

- **Idea:** Offshore power curve measurements for free-flow and wake conditions by FLS
- **Purpose:** Development and demonstration of concept
- **Benefit:** results can be put into standardisation
- **Measurement period:** 6 months
- **Partners**: Ørsted and Iberdrola





- **Project:** LeikLine
- **Funding:** German Federal Ministry for Economic Affairs and Energy (BMWi)

FLS technology

- Fraunhofer IWES Wind LiDAR Buoy
- Chosen measurement heights:
  - Met mast heights
  - Additional heigts for rotor area

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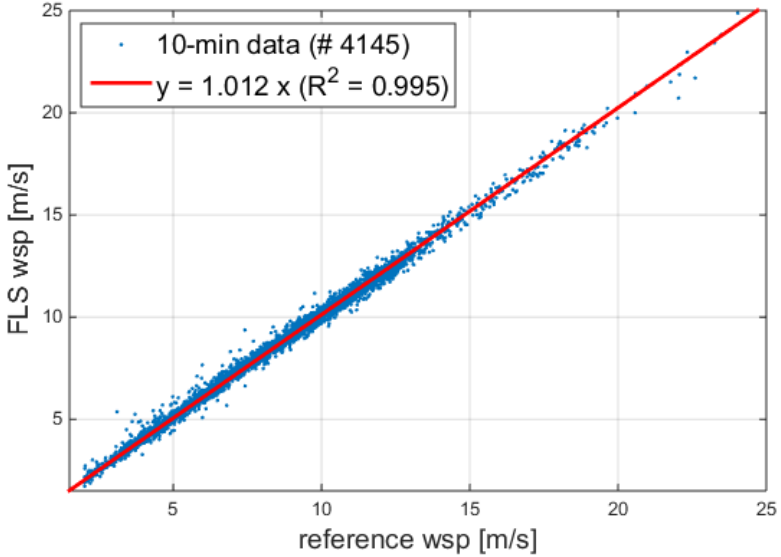
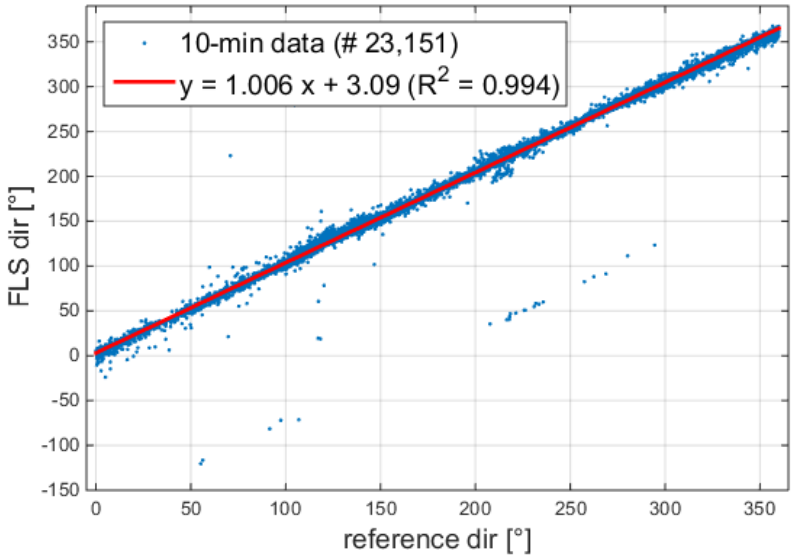
FLS technology → offshore verification

- Fraunhofer IWES Wind LiDAR Buoy (@ 60 m)





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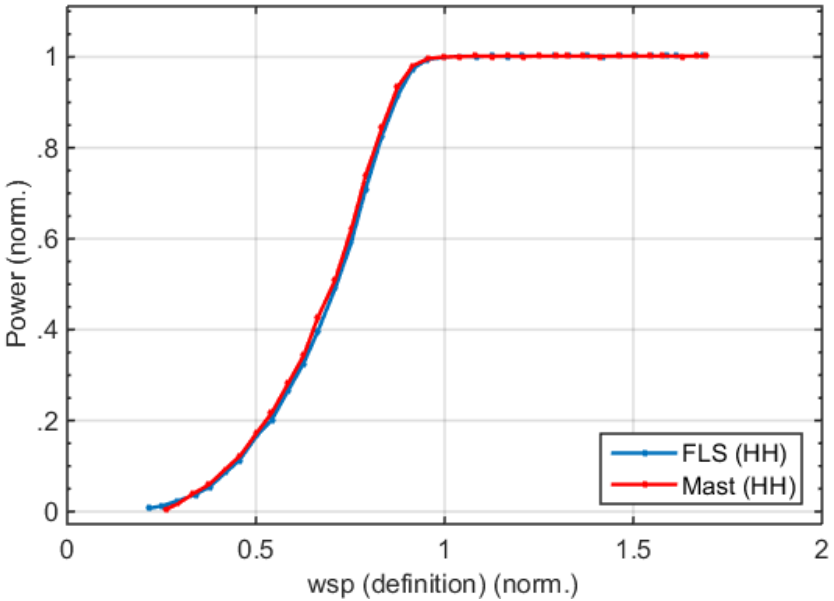
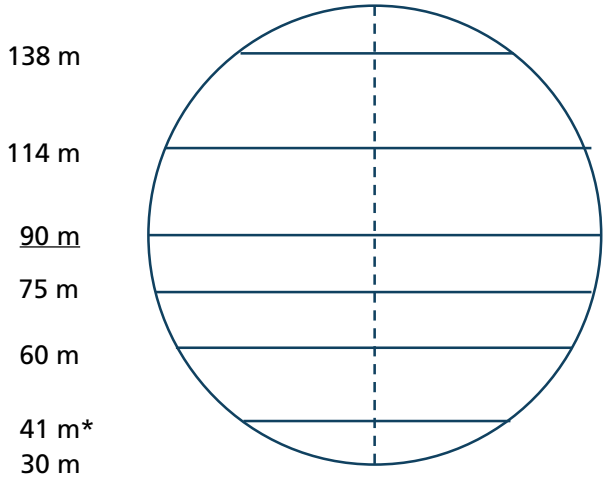
Results for FLS Power Curve (PC)



⇒ almost identical with Mast PC (for Hub Height wind speed definition)

… but only with FLS REWS (Rotor Equivalent Wind Speed) for whole rotor area (↓)



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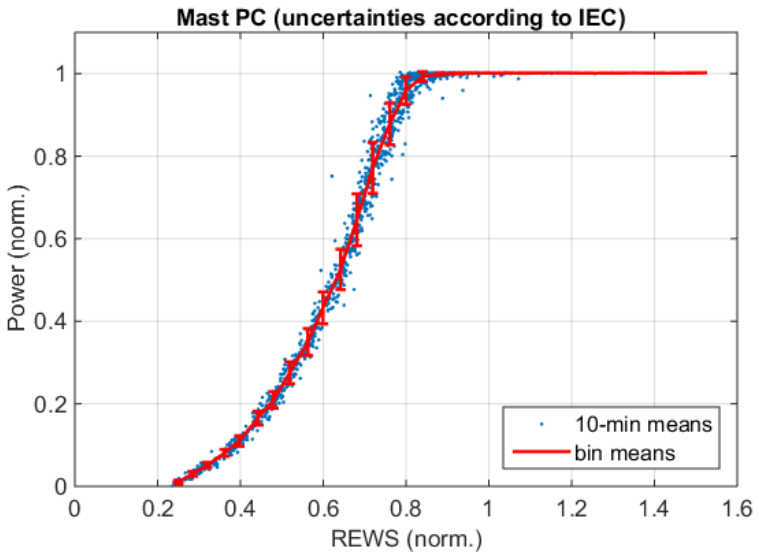
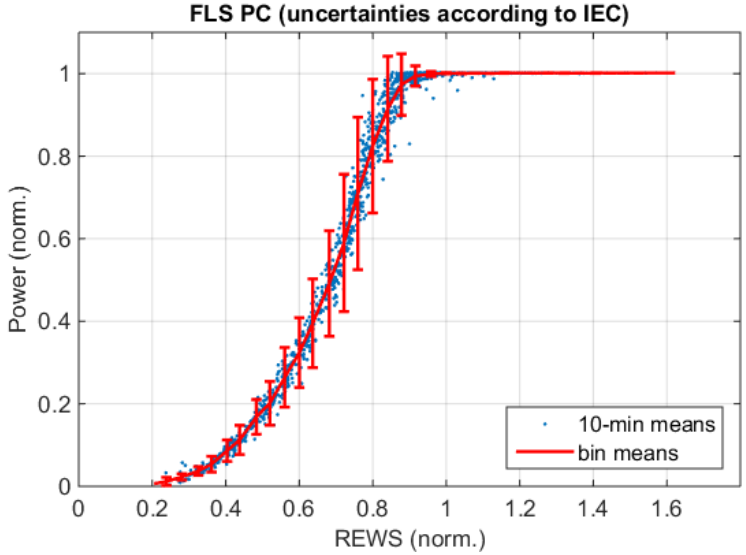
Results for FLS Power Curve – IEC uncertainties





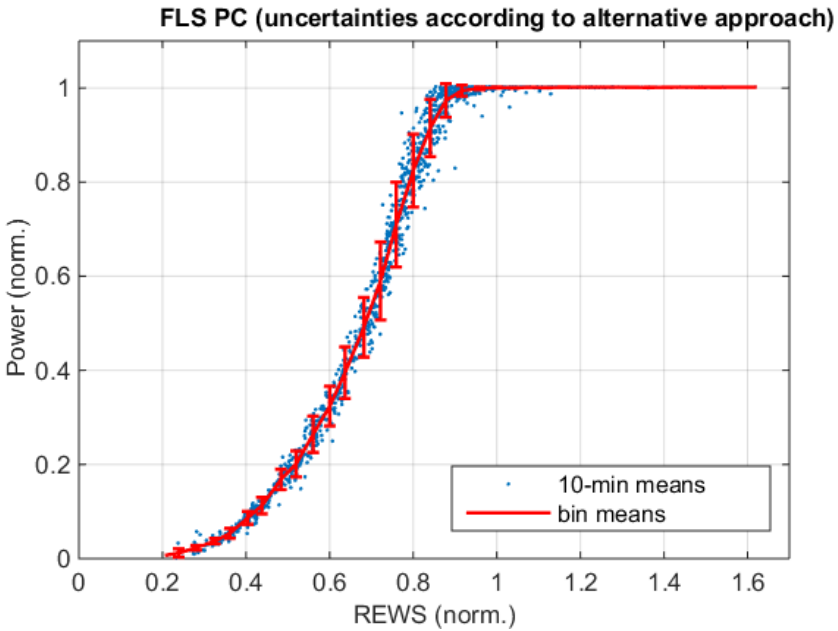
⇒ Deficit of REWS based on mast data (no full rotor coverage) only small impact, additional uncertainties for FLS PC much higher (when following IEC 61400-12-1:2017)

Discussion of IEC uncertainties

Why are uncertainties of FLS Power Curve so high?

- cf. OWA LUSR* project results → IEC too conservative assessment of …
  - LiDAR / FLS verification uncertainty (incl. consideration of distance to mast)
  - uncertainty due to terrain and flow complexity
  - mounting uncertainty

⇒ Proposed alternative approach for uncertainty assessment



* OWA Report 2017-001 "Lidar Uncertainty Standard Review Methodology Review and Recommendations", June 2018 (https://www.carbontrust.com/media/676998/owa-w-lusr_nov-2018.pdf)

Do FLS qualify for assessing offshore wind turbine power curves?

Yes, they do…

- FLS shows excellent agreement with met mast
- FLS approach makes full use of concept of REWS
  → lowest “method shear / veer” uncertainty components
- FLS can be considered as almost “ground-based”
  → compliance with IEC 61400-12-1:2017
- Practical advantages of FLS
  → turbine-independent wind measurements
  → easy re-deployment

Do FLS qualify for assessing offshore wind turbine power curves?

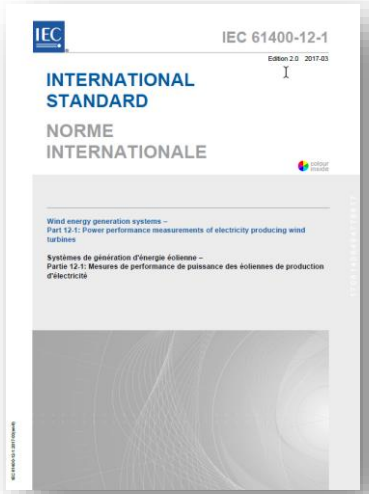
…but further standardisation necessary

- Uncertainties estimated according to standard are much too high

  → require alternative approach (as suggested within OWA LUSR project).

- Stand-alone application of lidars for power curve assessment – as deviation from standard – particularly for offshore

  → next revision of IEC standard



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Thanks a lot for your attention!

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