Guidelines on dual scanning lidar measurements for wind resource assessments

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Motivation

Aim

- Provide guidance in campaign planning, uncertainty assessment, documentation and decision making.
- Increase general acceptance of scanning lidars.

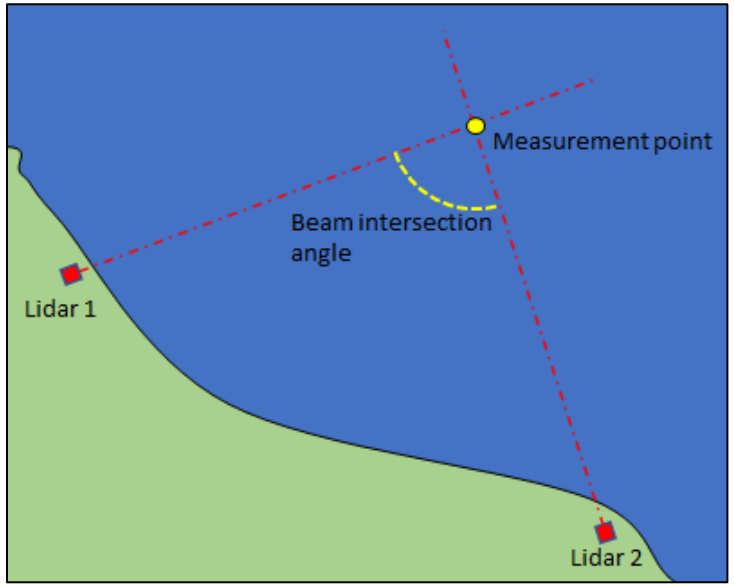
Motivation

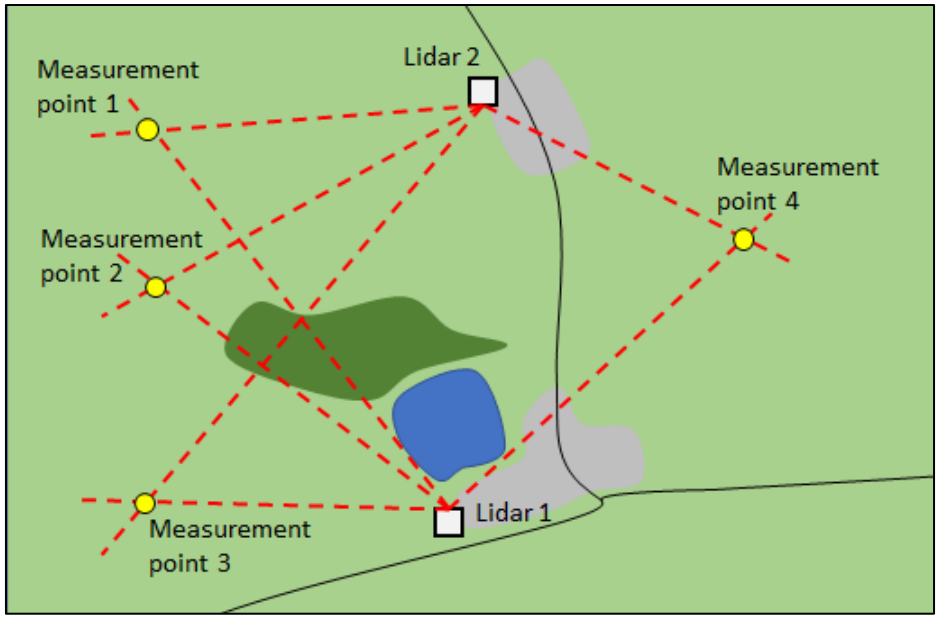
Background

- Scanning lidars are increasingly being used for wind resource assessments.
- Currently there is no international standard defining their use.
- There is a guideline from NEDO released in March 2023.
  - Focused on offshore wind resource measurements
  - No advice on uncertainty assessment
- Further standardization activities:
  - IEA Task 52: Recommended practice for the use of scanning lidar
  - IEC 61400-50-5

General advantage of DSL

- no (or simplified) permitting process for installation
- able to measure at multiple points with a single setup
- spatial distribution information regarding wind speed





Scope of the white paper

- scanning lidar in a dual staring mode setup
- application to wind resource assessment
  - reasonably uniform flows, e.g. near shore measurement sites
- lidar verification method (white box)
- LoS uncertainty assessment approach

Scope of the document

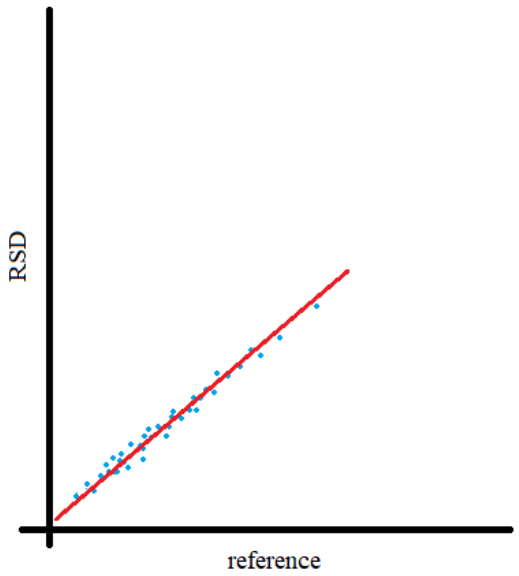
Structure and content

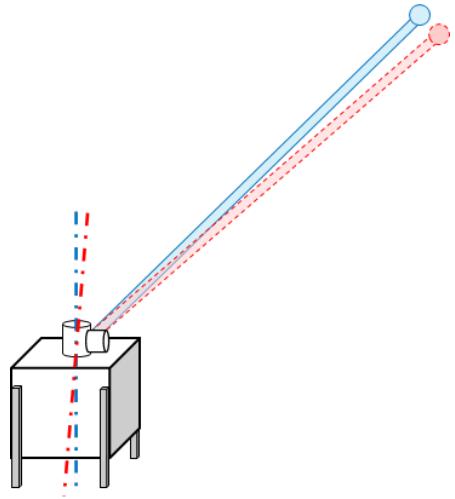
- detailed run through all phases of a measurement campaign
  1. campaign planning
  2. lidar verification
  3. installation and commissioning
  4. operation and monitoring
  5. data processing
  6. uncertainty evaluation
  7. decommissioning and post-campaign verification
- detailed look at documentation and reporting for each phase
- focus on strategies to minimise uncertainty in each phase
- sample calculations and recommended methods

Lidar verification

Aim

- determine the correct function of the measurement system
- assess the measurement accuracy / uncertainty
  - Are the measured wind speeds accurate?
  - Are the measurements taken in the correct location?
- identify systematic and random error sources
  - Are there factors that can be corrected for in the SMC?
  - Are there factors that cannot be corrected and must be accounted for as uncertainties?





Lidar verification

Verification campaign

- Site requirements
  - met mast with anemometers
  - terrain
  - lidar installation location
- Methodology
  - setup and configuration of the lidar and reference system
  - data set requirements
  - data processing and filtering
- Key performance indicators

Lidar verification

Pointing Accuracy

- System inherent factors
  - pointing resolution, range gate lengths
- Factors to be determined at the verification stage
  - pointing repeatability, range accuracy, backlash
- Factors that need to be assessed at each installation
  - inclination sensor alignment

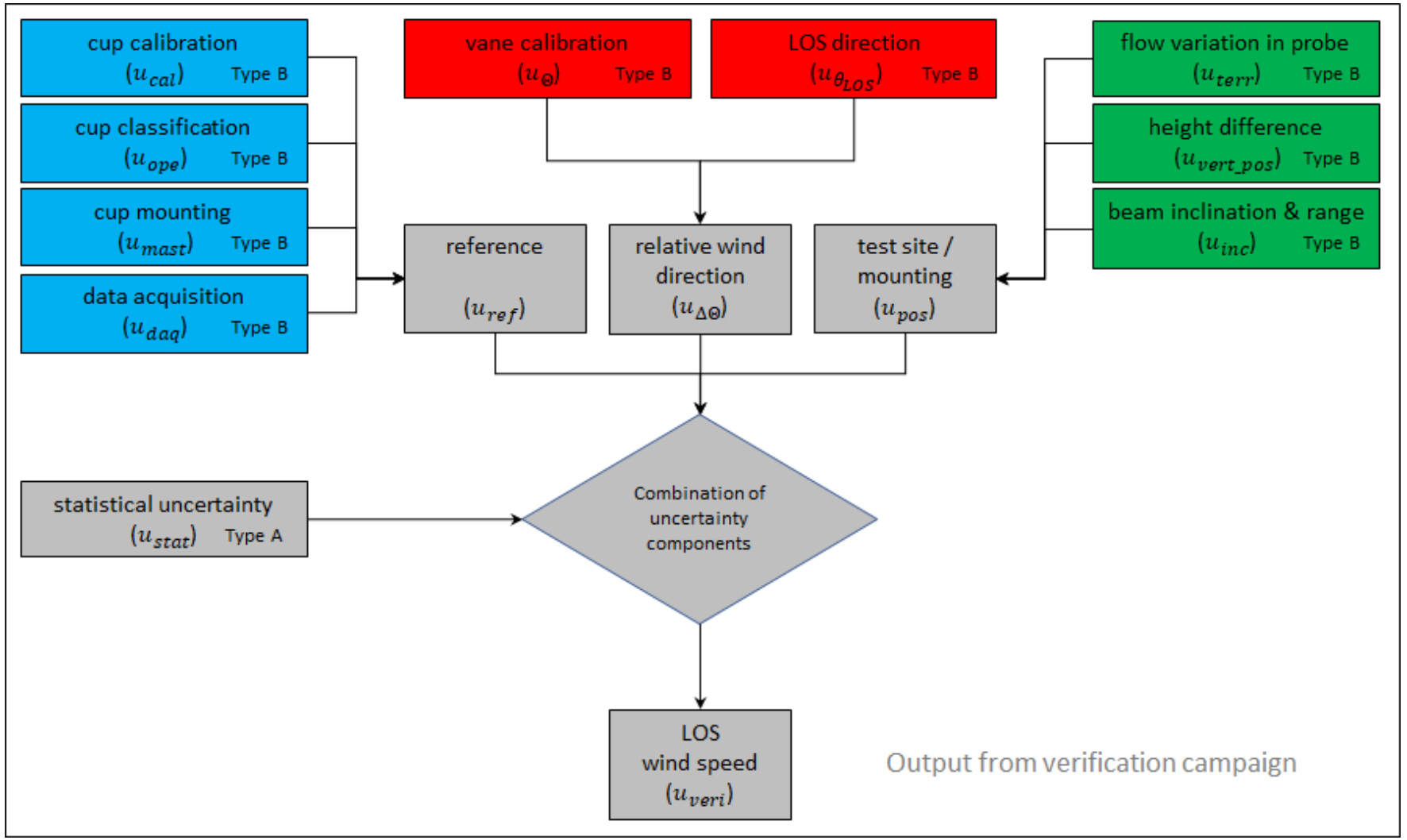
LOS Wind Speed Accuracy

- Projection of reference to LOS
- Wind direction and wind speed limits
- Focus on white-box approach (61400-50-3 modified for scanning lidars)

Uncertainty assessment

	white-box approach (line-of-sight wind speed)	**black-box approach** (horizontal wind speed)
pros	generic (device specific and setup agnostic/adaptable)	direct comparison to a reference
cons	very complicated!! Not a direct comparison.	geometry specific, so difficult to transfer from verification to specific measurement campaign geometry

Uncertainty assessment



Uncertainty Assessment

An example is given that guides the user through the process:

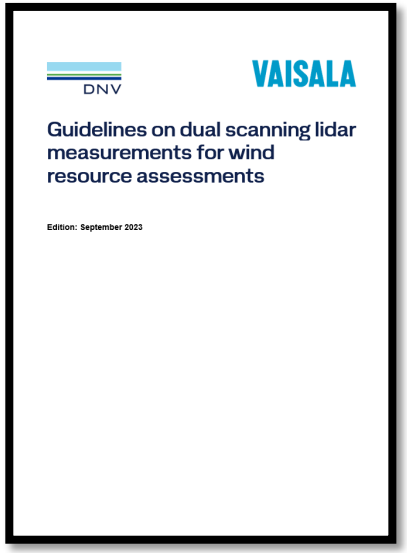
1. Assess the uncertainty of the reference
2. Assess the uncertainty components of the comparison (e.g. distance between reference and RSD measurement locations)
3. Assess the uncertainty of the LoS wind speed
4. Assess the uncertainty of the reconstructed wind speed for the given measurement geometry

Conclusion

- Guidelines are developed for dual scanning lidar wind resource assessment measurements.

- The document serves to provide best practice guidance in:
  - campaign planning
  - verification and measurement campaign
  - uncertainty assessment
  - reporting and documentation
  - decisions making

- Document currently under review and will be published soon (Q4 2023).



Please get in touch!

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