A jetting grid driven by temporally and spatially coherent 4-D gradient noise

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We present a newly constructed turbulence generator for the Twente Water Tunnel facility. It consists of a rectangular array of 112 individually computer-controlled water jets that are aligned streamwise to the measurement section of our 8 meter tall vertically recirculating water tunnel. The maximum exit velocity of each jet is designed to be 8 m/s.

This so-called 'jetting grid' replaces the older turbulent active grid that relied on 24 independently rotating axes with agitator wings. The jetting grid allows for higher turbulence intensities and Taylor-Reynolds numbers inside of the measurement section than the previous grid, while preserving lateral homogeneity and near isotropy in the core of the measurement section.

Many different turbulence generators with spatial and temporal control can be found in the literature, notably and recently, the individually controllable winglets grid by Griffin *et al.*[1], the synthetic jet array by Bellani and Variano[2], and the V-ONSET jet array by Masuk *et al.*[3]. The latter has served as a basis for our current design in pleasant communication with these authors.

Novel to our jetting grid is the full stainless-steel design and the protocol that we use to drive the individual jets. The protocol is based on 4-dimensional OpenSimplex noise: a type of gradient noise that features temporal and spatial coherence. We will show how we use these noise characteristics to try tailor the generated turbulence farther downstream of the grid as measured by Laser-Doppler Anemometry.

a) b)

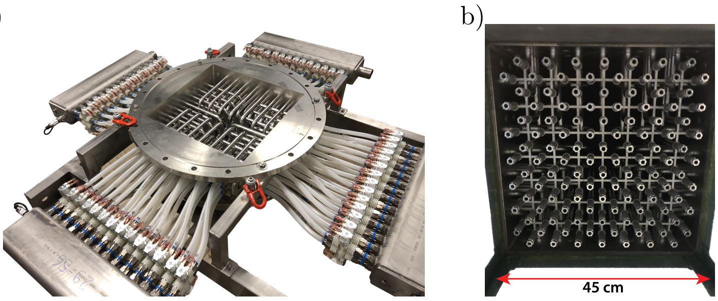

Figure 1: The jetting grid (a) before installation in the tunnel, (b) inside of the tunnel viewed head-on through the measurement section of cross-section 0.45 m by 0.45 m.

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[1] Griffin et al., *Exp Fluids* **60**, 55 (2019).

[2] Bellani and Variano, *Exp Fluids* **55**, 1646 (2014).

[3] Masuk et al., *Rev. Sci. Instrum.* **90**, 085105 (2019).