Turbulence decay in a von Kármán swirling flow

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In this study, we investigate the decay of high Reynolds number turbulence at the center of a large von Kármán swirling flow facility (2m height and 2m across). The facility consists of a dodecagonal with two counter-rotating impellers that produces stationary homogenous turbulence near the center of the tank with low mean velocity and intense fluctuations. To measure the decay rate, we run the impellers until the flow reaches a stationary state and then stop them and immediately start measuring the velocity field in a plane at the center of the tank using Stereoscopic Particle Image Velocimetry (S-PIV). We run the experiment for 3 different Reynolds numbers $Re_R = \frac{R^2\omega}{\nu} = 2.54\times10^5, 1.91\times10^5, 1.27\times10^5$ where R is the impeller radius, ω is the angular velocity of the impeller and ν is the kinematic viscosity of the flow. Over 30 runs for each Re_R were obtained to ensure reasonable convergence of the turbulent statistics. We calculate the spatially averaged kinetic energy over the field of view (FoV) from the PIV measurements and show that, after a proper normalization, the kinetic energy remains approximately constant for a short period after the impellers are stopped before transitioning to the expected power law decay. Our results consistently follow the power law $k \sim t^n$ with a decay exponent $n \simeq -1.6$.

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