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Design and Analysis of A Spin-Stabilized Projectile Experimental Apparatus NOAH SIEGEL, US Military Academy at West Point, GREGORY RODEBAUGH, Armament Research, Development and Engineering Center, CHRISTOPHER ELKINS, Stanford University, BRET VAN POPPEL, MICHAEL BENSON, MICHAEL CREMINS, AUSTIN LACHANCE, RAYMOND ORTEGA, DOUGLAS VANDERYACHT, US Military Academy at West Point — Spinning objects experience an effect termed 'The Magnus Moment' due to an uneven pressure distribution based on rotation within a crossflow. Unlike the Magnus force, which is often small for spin-stabilized projectiles, the Magnus moment can have a strong detrimental effect on aerodynamic flight stability. Simulations often fail to accurately predict the Magnus moment in the subsonic flight regime. In an effort to characterize the conditions that cause the Magnus moment, researchers in this work employed Magnetic Resonance Velocimetry (MRV) techniques to measure three dimensional, three component, sub-millimeter resolution fluid velocity fields around a scaled model of a spinning projectile in flight. The team designed, built, and tested using a novel water channel apparatus that was fully MRI-compliant water-tight and non-ferrous and capable of spinning a projectile at a constant rotational speed. A supporting numerical simulation effort informed the design process of the scaled projectile to thicken the hydrodynamic boundary layer near the outer surface of the projectile. Preliminary testing produced two-dimensional and three-dimensional velocity data and revealed an asymmetric boundary layer around the projectile, which is indicative of the Magnus effect.

BRET VAN POPPEL
US Military Academy

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