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Molecular Tagging Velocimetry Study of High Reynolds Number Turbulent Pipe Flow in Cryogenic Helium HAMID SANAVANDI, Department of Mechanical Engineering, Florida State University, Tallahassee, Florida, SHIRAN BAO, National High Magnetic Field Laboratory, Tallahassee, Florida, YANG ZHANG, Florida Center for Advanced Aero-Propulsion, Tallahassee, Florida, WEI GUO, National High Magnetic Field Laboratory, Tallahassee, Florida, LOUIS CATTAFESTA, Florida Center for Advanced Aero-Propulsion, Tallahassee, Florida
— Cryogenic helium-4 has considerable potential in fluids research due to a very small kinematic viscosity, suitable to generate and study high Reynolds number turbulent flow within a compact laboratory apparatus. However, studying the flow in helium-4 has been challenging largely due to the lack of effective visualization and velocimetry techniques. Here we have assembled a novel instrumentation including a 335 cm long horizontal cryogenic helium channel with a square 4cm^2 cross-section. This allows us to generate fully-developed turbulent pipe flows with Reynolds numbers above 10^6. We implement a unique molecular tagging velocimetry (MTV) method based on tracking two parallel thin He_2^* molecular tracer lines created perpendicular to the pipe wall with an adjustable distance via femtosecond laser-field ionization. By observing the displacement and distortion of the tracer lines, we can measure the near-wall mean velocity profile, velocity fluctuation profile, as well as both the transverse and longitudinal spatial velocity correlations We also report the pressure drop data acquired from the experimental channel using a differential pressure transducer, then the friction factor coefficient can be determined.

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