Hyperloop and Hypervelocity: A facility for research at extreme speeds in the nexus of Defense, Science, and Transportation

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Key Participating Units: College of Engineering, College of Science, Health Science Center, College of Medicine, College of Veterinary Medicine & Biomedical Sciences, Texas A&M Transportation Institute
Anticipated Request Amount ($): 3,000,000

Executive summary of this application to utilize Research Development Funds:

We propose the construction of a unique user facility at the nexus of Defense, Science, and Transportation. The facility will be a 1-mile long vacuum tube with a diameter of 3 feet, separated in two main compartments that offer many different functionalities and experimental capabilities, broadly grouped along the following two operational modes:

a) A test track where vehicles may be launched at very high accelerations to nearly sonic speeds at various ambient pressures. This mode allows for research in the aerodynamics of cars, planes, jet engines, and projectiles, but will be designed particularly for testing the Hyperloop transportation system, the only such facility that can currently test the concept at full transonic speeds. Operating as a Hyperloop test track the facility will allow for testing of pods at realistic speeds, and thus explore the main scientific issues that hold back practical implementation of the "fifth mode of transportation". It will also enable the organization of an annual international competition - similar to the very successful one that took place recently at Texas A&M - where university and industrial teams will research the aerodynamics, materials, levitation, breaking, communications, and system dynamics of their pods. More broadly, the facility will allow for research in linear induction motors, train and freight, and general transportation issues. We anticipate that the Hyperloop facility will attract strong industrial interest and collaboration (e.g. SpaceX, P&W, GE, Boeing) but also that of state and federal entities (e.g. DOT, DOD);

b) A shock tube where many experiments may be carried out at extreme speeds (Hypervelocity). The proposed Hypervelocity shock tube facility will allow for fundamental chemical kinetic studies in conditions that are inaccessible anywhere in the world. Experiments will be conducted at timescales that are 5-10 times longer than the ones currently available worldwide. This in turn will open up the study of long-lived pollutant species, such as nitrogen oxides, and their low temperature generation. Due to its modular nature the facility will enable studies at various supersonic and hypersonic conditions relevant to many important scientific and technological problems, ranging from the fast chemistry and aerodynamics in supersonic combustion scramjets, to the generation of extreme nonequilibrium conditions akin to the deep space reentry of spacecraft returning from Mars. The large scale of the facility will allow for experiments with biological materials and even animal studies to be conducted with relative ease and quick access. Porcine models may be developed in place of the current murine ones used in human trauma research. Varying the shock strength by utilizing the tube modularity will enable studies of shock impact on biological tissue at different conditions. In this manner the facility can be used to simulate "modest" impact effects like traumatic brain injury, chronic traumatic encephalopathy and aortic dissection, or more severe conditions that obtain in automobile and airplane accidents and warzone explosions. The Hypervelocity facility is expected to attract the interest of various funding sources, from the fundamental (NSF, DOE) to the more applied (NASA, AFOSR, AFRL) but also from diverse entities such as automobile, aircraft, health industries and NIH.