Research Development Fund – Spring 2016

Application Title Hyperloop and Hypervelocity: A dual use facility for research at extreme speeds

Lead contact for RDF Application:

Name Adonios N. Karpetis
Department Aerospace Engineering
Email address karpetis@tamu.edu
Phone number (979) 458-4301

Key Participating Units: College of Engineering, College of Science, College of Veterinary Medicine & Biomedical Sciences, Texas A&M Institute for Preclinical Studies, 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 1-mile long, 3-foot diameter vacuum tube that will serve as a dual use facility for testing and research at extreme speeds. The facility will have two basic operational modes: a) it will be a test track for the Hyperloop concept, the only such facility that can test the concept at full transonic speeds, albeit at subscale size; b) it will be the longest shock tube in the world, where many experiments may be carried out at extreme (Hypervelocity) 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 a yearly 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) but also that of state and federal entities (e.g. DOT).

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 technological problems. Future air propulsion will probably rely on supersonic combustion ramjets, or scramjets, burning simple hydrocarbon fuels. The high-speed chemistry of those fuels can be studied in the proposed facility, along with the internal aerodynamics of scramjets. Operating at its maximum length the Hypervelocity will generate extreme nonequilibrium conditions akin to the deep space reentry of spacecraft returning from Mars. Important experiments that can be carried out range from the very fundamental, e.g. dissociation and ionization behind the reentry shock, to the very applied, e.g. invention of novel materials that can withstand such conditions. The proposed shock tube will offer an unprecedented scale where experiments can be accomplished at extreme conditions at full scale, or with modest down scaling of the test subject. 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. Varying the shock strength by utilizing the shock 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, or more severe conditions like automobile and airplane accidents. The Hypervelocity facility is expected to attract the interest of many 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.