Letter of Intent

Funding Opportunity Announcement (FOA) Number: DE-FOA-0001604

Research in Elementary Particle Physics

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A Renewal Proposal
Period: 3 years

Research areas:
Energy Frontier, Intensity Frontier, Detector Research and Development

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Introduction

The High Energy Physics Group at the University of Texas at Arlington proposes a three-year program of research in the Energy and Intensity Frontiers, and in Detector Research and Development. We will continue our long term strong role in the ATLAS experiment, to ramp up our Intensity Frontier effort, to prepare for long term participation in the International Linear Collider, and to increase our detector R&D efforts in pursuit of new innovations.

Energy Frontier: ATLAS (PIs: De, Brandt, Farbin, Hadavand, White)

The ATLAS group at UTA has added a junior faculty Haleh Hadavand, and new responsibilities in HL-LHC. We propose to continue our physics studies in the areas of Higgs and SUSY. We have significant detector responsibilities, including TileCal management in support of UTA-built sub-detectors and components, Phase I commissioning and operations, and HL-LHC R&D and construction projects. We have new responsibility for the construction of more than 1000 newly developed Low Voltage Power Supplies, while continuing R&D work on the TileCal Trigger/DAQ Preprocessor Boards. We will maintain our leading roles in ATLAS Distributed Computing (ADC) software development and operations, leadership in U.S. ATLAS computing, operation of the SouthWest Tier-2 center, and analysis support. We also propose a new effort in the High-level Trigger core software for Run 3, for the transition to a multi-threaded framework by Run 3.

SUSY is the most compelling model of new physics at the LHC. Since early Run 1, UTA has been deeply involved in squark and gluino searches, with two UTA postdocs contributing to a large number of searches as sub-group conveners. Recently, UTA applied the most generalized recursive jig-saw Razor technique to extend the all hadronic final state squark and gluino searches. We propose to leverage our expertise in this challenging technique and considerable experience with Matrix Element Method and Deep Neural Networks to broaden BSM searches. We also have a long history of third generation searches at the Tevatron and the LHC, resulting in multiple Ph.D. theses. Our TMVA based (machine learning) analysis increased the range of traditional cut based analysis for stop searches. We are currently extending TMVA techniques to Run 2 data, using machine learning techniques to search for new strongly produced particles.

We also propose to search for BSM physics through our leading role in the search for charged Higgs and Higgs decays to invisible particles. A key question for the Higgs boson is whether it couples to the dark matter. We will continue to explore this possibility by searching for evidence of Higgs decays to invisible particle(s) in Vector-Boson Fusion processes. Run 2 data will allow us to probe this process with significantly increased sensitivity over our Run 1 results. We propose to search for charged Higgs in the hadronic tau nu final state and produce the first results in the intermediate mass region close to the top mass. As the charged Higgs convener, Hadavand has opened the door to additional charged Higgs final states for ATLAS. We propose to leverage our expertise on tau leptons to expand our searches for BSM phenomena to searches with the signature Z boson + X which include di-tau leptons in the final state.

Energy Frontier: International Linear Collider (PI: White)

The full exploration of the Higgs sector, the role of the top quark in the Standard Model, and the search for new physics, require high precision measurements of an e+e- collider in combination with the energy reach of the LHC. We propose to continue our leadership role in the SiD Detector Consortium: detector design, specification of subsystems, physics studies (particularly in response to new results from the LHC), machine-detector interface issues, and detector simulation. Activities at UTA will include the design and specification of the scintillator/steel hadron calorimeter and its full simulation, as well as service on national and ILC committees.

Intensity Frontier (PIs: Yu, Asaadi)

The Intensity Frontier group at UTA has added a junior faculty member, Jonathan Asaadi, who has responsibilities across the neutrino program. Yu will transition fully to the Intensity Frontier in this proposal. We plan to contribute to the Fermilab Short-Baseline Neutrino (SBN) program as well as the Long-Baseline Neutrino (LBN) program. The LBN program has chosen the liquid argon time projection chamber (LArTPC) detector as its technology of choice to be used in the Deep Underground Neutrino Experiment (DUNE). DUNE (Asaadi, Yu) aims to address the questions of the neutrino mass hierarchy and CP-violation in the lepton sector. The SBN program aims to conclusively address the experimental hints of sterile neutrinos through the utilization of three LArTPC detectors: the Short-Baseline Near Detector (SBND) (Asaadi, Yu), the Micro-Booster Neutrino Experiment (Asaadi), and the ICARUS Experiment (Asaadi, Yu). All three of these SBN experiments as well as DUNE are strategically selected to leverage the UTA expertise in LArTPC technology across them.

Asaadi is playing a leading role in the operations of MicroBooNE experiment. Asaadi and Yu will play key roles in the construction, commissioning, and operation of SBND through contributions to cold electronics testing, APA assembly, and operations of the detector. These efforts build on our experience in commissioning of the LArIAT and MicroBooNE experiments. UTA is actively involved in the ICARUS experiment where Yu is currently the IB representative and a post-doc is helping the refurbishment of the light detectors at CERN. UTA is also playing key roles in the construction of protoDUNE detectors, template DUNE far detectors. Asaadi is involved in quality assurance and construction of the single phase (SP) protoDUNE. Yu is leading the DUNE BSM physics group and is involved in design and construction of dual phase protoDUNE field cage whose design shares large portion of the SP protoDUNE field cage. These activities aim to ensure synergy between the SBN and LBN efforts and an optimized use of resources.

Detector R&D (PIs: Brandt, Asaadi, Nygren, Jones)

The main thrust of Brandt's research has been characterization and development of long-life microchannel plate (MCP) photomultiplier tubes (PMTs), capable of high rates. We propose to continue the ongoing work that seeks to optimize lifetime testing methods including the efficacy of multiple lifetime measurements per device, expedited lifetime measurements, and after-pulsing studies that seek to correlate lifetime with the amount of specific heavy ions. The continued operation of UTA's Picosecond Test Facility will be a useful community resource and can be used to perform independent study of other devices such as large area MCP-PMT produced by the LAPPD collaboration. Equipment from this facility will also be used by Nygren and new faculty Jones and Asaadi in projects to develop large area light detecting plates using wavelength shifters and SiPMs that can be deployed in noble gas or liquid TPCs. These devices will be tested within an existing high purity xenon gas system and within liquid argon to understand the energy resolution and position dependent response. Applications include any TPC-related experiments where good light collection efficiency is needed, ranging from high priority neutrino physics experiments to neutrinoless double beta decay experiments.