Sadman Ahmed **Shanto**

Budding Physicist · Aspiring Mathematician · Ardent Programmer

2320 Portland St., Los Angeles, CA, USA

2137065806 | shanto@usc.edu | shanto268.github.io | shanto268 | sshanto

Education

University of Southern California (USC) — *Los Angeles, USA*

Doctor of Philosophy (PhD) in Physics — *2021 – 2026*

Texas Tech University (TTU) — *Texas, USA*

Bachelor of Science (BSc) in Applied Physics — *2017 – 2021*

- Minors: *Computer Science* and *Mathematics*
- Applied Physics Concentration: *Quantum Information and Computation*

Peer Review publications

1 Challenges of Microsimulation Calibration with Traffic Waves using Aggregate Measurements — *2021*

SA Shanto, G Gunter, DB Work, R Ramadan, B Seibold — *2021 Transportation Research Board Annual Meeting*

2 High-Resolution Muography Using a Prototype Portable Muon Telescope — *2020*

R Perez, SA Shanto, M Moosajee, & S Cano — *Journal of Undergraduate Reports in Physics*

3 Machine Learning Applications in Muon Tomography — *in prep.*

SA Shanto, S Cano, K Binu, M Howard, C Gabriel, C Moreno, V Bradley

4 Drive Like Ants: Design Autonomous Vehicle Behaviors in Heterogeneous Traffic Flow — *in prep.*

SA Shanto, J Li

Employment

University of Southern California — *Los Angeles, CA, USA*

Teaching Assistant — *Aug. 2021 - Present*

- Mentored and led over 18 undergraduate engineering students for the lab section for the *"Fundamentals of Physics II: Electricity and Magnetism"* course

Advanced Particle Detector Laboratory (APDL) — *Lubbock, TX, USA*

Undergraduate Research Assistant — *Nov. 2018 - Aug. 2021*

- Led a team of 3 Summer Interns to use Machine Learning to develop auto-focus, depth perception and non-linear Filtered Back Propagation algorithms in the field of Muon Tomography
- Developed a Neural Network Architecture (Asymmetric Deep Mixture Density NN) that predicts muon hit locations from photon time propagation with a 87% accuracy
- Designed a 3D reconstruction algorithm that uses CNN's to approximate a binary focus metric and dynamic k-means clustering with Image Segmentation and homomorphic transforms
- Designed and implemented Monte Carlo simulations (Geant4, ROOT) and wrote fully automated analysis programs (python) to test experimental data integrity, assess theorized designs and measure telescope efficiency
- Deployed a web based 3D interactive Event Display system for our muon telescope system (WebGL, JS)
- Conducted Monte Carlo studies on the scattering/absorption behaviour of muons and the consequent effects in image quality
- Refactored and deployed all software used by the lab on our university's High Performance Computing (HPC) Cluster
- Engineered the calibration and installation of 40 SiPM's (Phase 1) and 44 PMTs (Phase 2) on the telescopes
- Implemented a multi-thread sync mechanism (python and Arduino) in the DAQ system comprised of 40 Arduino's and CAMAC systems
- Facilitated the design of custom PCB's (kiCAD, LTspice) and assembled various components (soldering)
- Designed (CAD and CNC machines) custom Winston Cone light collectors for increased optical transmission from Scintillators to SiPM array
- Aided (welding and CAD designs) in the mechanical assembly of two prototype muon telescopes
- Trained new undergraduate members in the lab to use Geant4, ROOT, and our custom software base
- Coauthored the proposal for IRIS-HEP Fellows Program
- Supervisors: Shuichi Kunori, PhD. & Nural Akchurin, PhD.

Texas Tech University

Lubbock, TX, USA

Teaching Assistant, *"Introduction to Quantum Information and Computation (QIC)"* — *Aug. 2020 - Present*

- Delivered supplemental lecture notes and interactive jupyter notebooks to teach quantum computing through the use of IBM's qiskit
- Prepared bi-weekly computational assignments on the implementation of various Quantum Information and Computing topics
- Helped students with their problems during office hours each week
- Graded both computational and theoretical/mathematical assignments for the 25+ students enrolled in the course
- Assisted and collaborated with the students in their semester research project
- Materials covered: *qiskit API, single and multi qubit systems, statevector evolution, superposition and entanglement, quantum circuit model, quantum teleportation, Deutsch's algorithm, Deutsch-Jozsa Algorithm, Grover's Algorithm, Bernstein-Vazirani algorithm, VQE, and Jordan's Algorithm*
- Supervising Professor: Ismael Regis de-Farias, PhD.

Texas Tech Multidisciplinary Research in Transportation (TechMRT)

Lubbock, TX, USA

Undergraduate Research Assistant — *Jan. 2019 - Jun. 2020*

- Developed an open source analysis and simulation software for studying various heterogeneous traffic flow of Human Driven (HVs) and Autonomous Vehicles (AVs)
- Designed and tested various AV models for efficient shared lane mobility in multi-lane networks using a novel approach based on the Nagel-Schreckenberg Cellular Automaton Model
- Observed and explained intelligent herding phenomena in certain regimes of heterogeneous traffic flow in a journal paper
- Incorporated Reinforcement Learning functionality to the simulation and analysis software
- Supervisor: Jia Li, PhD.

TECHniques Center

Lubbock, TX, USA

STEM Peer Tutor — *Jan. 2018 - May 2019*

- Provided course-specific tutoring to undergraduate students with documented evidence of learning disabilities
- Received Level 2 International Tutor Certification from College Reading & Learning Association (CRLA)
- Documented over 670 hours of student tutoring while maintaining federal confidentiality guidelines
- Courses tutored: *Physics I and II, Calculus I and II, Circuits I, Object Oriented Programming, Wind Energy, Linear Algebra, Advanced Calculus, Differential Equations, Combinatorics and Statistics*

TexPREP (Prefreshman Engineering Program) Lubbock

Lubbock, TX, USA

Course Instructor — *May 2019 - Jul. 2019*

- Taught advanced programming principles - data types, variables, control flow theory, compilers, loops, animation, game design, booleans, discrete numerical analysis - to middle school students on MIT's Scratch IDE.
- Administered the after-school tutoring program by leading and training a group of Assistants.

Internships

Institute for Software Integrated Systems (ISIS), Vanderbilt University

Nashville, TN, USA

Summer Research Intern — *Jun. – Aug. 2020*

- Designed computationally efficient models for various microscopic traffic simulations using a system written in C++, Python, Bash and XML
- Contributed to developing a computational framework (Flow by UC Berkeley) for deep RL and control experiments for traffic microsimulation
- Established an objected oriented system for calibrating results from stochastic simulations under multi-objective methods using gradient free algorithms
- Incorporated Ray to the software package to parallelize the simulations resulting in massive speedup of running simulation experiments
- Developed scripts to convert microscopic data from the Intelligent Driver Model (IDM) to RDS/radar style data
- Implemented various non-trivial optimization routines to fit simulation data to macroscopic RDS data sets
- Studied the various challenges of Microsimulation Calibration with Traffic Waves using Aggregate Measurements and co-authored a conference paper
- Supervisors: Daniel Work, PhD. & George Gunter (PhD Candidate)

Virtual-Thermal-Fluids LLC

Lubbock, TX, USA

Business Development Intern — *Aug.– Dec. 2019*

- Conducted primary market research for commercialization of our consultation services for a National Science Foundation-funded program
- Developed data-driven strategies to explore emerging markets by implementing Web Scraping algorithms in Python with BeautifulSoup and creating visualizations using Tableu
- Prepared and led presentations to pitch our company raising $50000 in series A funding

Seminars, Poster Presentations & Conference Talks

2021	**American Physical Society April Meeting**, *Machine Learning in Muon Tomography Talk*	*Online*
	Physics Departmental Colloquium, *Dancing in the "Muon" light*	*Lubbock, USA*
	University Research Conference, TTU, *Economic Impact of Quantum Computers*	*Virtual*
	SPS and Women In Physics (WiP) Programming Principles, *speaker*	*Lubbock, USA*
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2020	**SPS and Women In Physics (WiP) Introduction to Programming**, *speaker*	*Lubbock, USA*
	Departmental Poster Competition, Department of Physics and Astronomy, TTU	*Lubbock, USA*
	Quantum 2020 (Institute Of Physics) Virtual Conference, *Analysis of VQE Regimes in NISQ Era*	*Virtual*
	Summer Showcase! at the Institute for Software Integrated Systems	*Tennessee, USA*
	International Symposium on Transportation Data and Modeling (ISTDM), *postponed*	*Michigan, USA*
	TTU Undergraduate Research Conference, *Muon Tomography Talk*	*Virtual Conference*
	TTU Undergraduate Research Conference, *Autonomous Vehicle Model Poster*	*Virtual Conference*
2019	**Far West Section of American Physical Society (FWSAPS), Stanford University**	*Stanford, USA*
	Texas Section of American Physical Society (TSAPS)	*Lubbock, USA*
	Departmental Poster Competition, Department of Physics and Astronomy, TTU	*Lubbock, USA*
	International Conference for Physics Students 2019, University of Köln	*Köln, Germany*
2018	**Undergraduate Colloquium: Programming Principles**, *SPS TTU*	*Lubbock, USA*

Honors & Awards

2021 – 2026	**University of Southern California Dornsife College of Arts, Sciences and Letters Graduate Fellowship**	*Los Angeles, CA, USA*
2017 – 2021	**Texas Tech University Presidential Scholarship**	*Lubbock, TX, USA*
2017 – 2021	**Dean's Honor List**, *TTU*	*Lubbock, TX, USA*
2021	**Best Talk in *Economic* Impact**, *Undergraduate Research Conference, TTU*	*Lubbock, TX, USA*
2021	**Best Virtual Presentation in *Economic* Impact**, *Undergraduate Research Conference, TTU*	*Lubbock, TX, USA*
2020	**Certification of Quantum Excellence**, *IBM Qiskit*	*International*
2020	**TrUE Undergraduate Scholar Project Fund**, *Center for Transformative Undergraduate Experiences, TTU*	*Lubbock, TX, USA*
2020	**Second Place for Best Undergraduate Presenter**, *Department of Physics and Astronomy, TTU*	*Lubbock, TX, USA*
2020	**C.C. Schmidt and Alma K. Schmidt Award in Physics**, *Physics and Astronomy Department, TTU*	*Lubbock, TX, USA*
2018-2019	**Bucy Undergraduate Scholarship Physics Award**, *Physics and Astronomy Department, TTU*	*Lubbock, TX, USA*
2018-2019	**Raiders Who Rock: Pursuit of Excellence Award**, *Office of Engagement and Transition, TTU*	*Lubbock, TX, USA*
2019	**Outstanding Student Presenter**, *Texas Section of APS*	*Texas, USA*
2019	**Best Poster Presenter**, *Department of Physics and Astronomy, TTU*	*Lubbock, TX, USA*
2019	**Certified Tutor, Level II**, *College Readiness and Learning Association (CRLA)*	*International*
2019	**Honorable Mention: Best Undergraduate Poster Presenter**, *Far West Section of APS, Stanford University*	*Stanford, CA, USA*
2019	**TrUE Undergraduate Scholar Project Fund**, *Center for Transformative Undergraduate Experiences, TTU*	*Lubbock, TX, USA*
2019	**TrUE Travel Funds Award**, *Center for Transformative Undergraduate Experiences, TTU*	*Lubbock, TX, USA*
2018	**Silver Medal**, *University Physics Competition (UPhysC)*	*International*
2017	**Gangapadhaya Physics Scholarship Award**, *Department of Physics and Astronomy, TTU*	*Lubbock, TX, USA*
2017	**Glen Mann Physics Scholarship Award**, *Department of Physics and Astronomy, TTU*	*Lubbock, TX, USA*

Projects

Senior Capstone Project: Quantum Optimization Algorithms

Lubbock, TX, USA

Research Project *Apr. 2020 – May 2021*

- Conducting research work done under the supervision of Dr. Ismael Regis de-Farias in collaboration with National Laboratory of Scientific Computing (LNCC) of Brazil
- Implemented methods to calculate Hilbert-Schmidt-Product and decompose any given square matrix into sum of Pauli matrices
- Created a computational framework for testing Variational Quantum Eigensolver (VQE) Algorithms
- Initiated a study to explore the dynamics of changing each component - *Hermitian matrix type, variational form, circuit depth* and *optimizer* - used in the VQE routine by conducting sensitivity analyses on two performance metrics – time taken to solve the problem and accuracy of the solution
- Contributed to the development efforts of NEBLINA - a Quantum Random Walk Simulator Software Suite

Setting Up *Kim* Lab and FDTD Analysis of Silicon Carbide (SiC) Permittivity

Lubbock, TX, USA

Research Project *Nov. 2019 – Apr. 2020*

- Collaborated with University of Texas, Rio Grande Valley to conduct experiments and record the permeability value of SiC
- Verified the recorded data by simulating a 2D FDTD implementation of the experimental condition
- Volunteered in setting up *Kim* lab for Infrared optics & polarimetry for novel quantum system and nanostructures
- Supervisor: Myoung-Hwan Kim, PhD.

Geometric Optics: Modelling Scalar Irradiance of light sources under water

Lubbock, TX, USA

Research Project *Aug. 2018 – May. 2019*

- Assisted Masud (Math PhD candidate) with his thesis by accepting to take on one of his problems as my project
- Created a mathematical model for the downwards scalar irradiance of light from first principles
- Discovered that the derived model is exponentially more accurate than the traditional model of Lambert-Beer at optical densities greater than 0.4 in the context of water bodies.

Web Application for a Health Care System

Lubbock, TX, USA

Academic Project: ***Software Engineering 1*** *Sept. 2020 – Present*

- Developed the static model for the healthcare system
- Documented the interaction model that depicts objects participating in each use case and the sequence of interactions among the objects
- Designed database tables to store information about appointments, patient charts, payments, and reports in the healthcare system.
- Implemented the program in JAVA using XXX libraries

Design and Implementation of AI used in Bang! The Dice Game

Lubbock, TX, USA

Academic Project: ***Object Oriented Programming*** *Apr. 2020 - May 2020*

- Utilized ideas of Probabilistic State Vectors and Unitary Evolutions from Quantum Mechanics to model AI behavior for Bang! the Dice Game
- Implemented concepts Markov Decision Processes (MDP) to simulate AI gameplay with a Human user
- Documented, debugged and conducted various test cases to ensure AI reliability and robustness

Dynamics of a laser propelled nanocraft on a fly by mission to Proxima Centauri B

Lubbock, TX, USA

Physics Competition Project *Nov. 2018*

- Modelled the design and trajectory needed for a light sail propelled nanocraft to the nearest star system Alpha Centauri in order to perform a flyby of Proxima Centauri b subject to various constraints defined by the University Physics Competition Committee
- Co-authored a research paper addressing the problem uder 48 hours as per the guidelines of the competition
- Won the Silver Medal for our efforts

Technological Skills and Languages

Human Spoken Languages	Bengali (native), English (bilingual), Hindi (intermediate), Urdu (intermediate)
Programming	Python, C++, C, JAVA, Mathematica, Matlab, R, Julia, Bash, TEX, Dart, Swift
Operating System	MAC OS, Linux, Raspbian, Windows 10
Data Analysis	Numpy, Scipy, SymPy, Matplotlib, Ray, Vaex, Modin, Pandas, StatsModels, Seaborn, BeautifulSoup
Machine Learning	Tensorflow, Keras, SciKit Learn, Pytorch, Open AI Gym
Quantum Computing	Qiskit, PyQuil, PennyLane, Microsoft QDK, Forest SDK
High-Energy/Particle Physics	CERN Geant4, CERN Root, PyROOT, CAMAC System Analysis
Digital Electronics	LTspice, Vivado Design Suite, KiCad
Microcontrollers	Arduino, Raspberry Pi, Basys 3, Iconikal Rockchip RK3328
3D Modelling	Inventor, Blender
Database	SQLite, MySQL
Management	Git, Yarn/NPM, Apache
Web	HTML, CSS, JavaScript, nodeJS, *Flask*

Leadership & Involvement

Sigma Pi Sigma Physics Honor Society — *North America*
Member — *2020-Present*

American Physical Society (APS) — *North America*
Member — *2019-Present*

PrivaC Female Only Virtual Hackathon — *Bangladesh*
Team Mentor — *2020*

RaiderHacks — *Texas, USA*
Member and Representative — *2019*

National Science Foundation (NSD) Regional Innovation Corporations (I-Corps) Program — *Texas, USA*
Entrepreurial Lead — *2019*

Free Market Institute — *Texas, USA*
McLane Political Economy Scholar — *2018 - 2019*

College of Arts & Sciences, TTU — *Lubbock, USA*
Student Ambassador — *2018-2019*

Society of Physics Students (SPS) — *Lubbock, USA*
Public Relations Officer (TTU Chapter) & Member — *2017-2019*

The Quark Newsletter, SPS — *Lubbock, USA*
Officer in Charge — *2018-2019*

Alpha Lambda Delta & Phi Eta Sigma Honor Society (ALD/PES) — *Lubbock, USA*
Social Coordinator Officer (TTU Chapter) — *2018-2019*

Undergraduate Colloquium Series, SPS — *Lubbock, USA*
Initiator and Organizer — *2018*

Red Raider Orientation, TTU — *Lubbock, USA*
Orientation Crew Leader — *2018*

Society for Advancement of Chicanos/Hispanics and Native Americans in Science (SACNAS) — *Lubbock, USA*
Vice President (TTU Chapter), Recruitment Chair & Member — *2017-2018*

Training

Summer schools

Sept. 2020	**Summer School on Machine Learning and Big Data with Quantum Computing (SMBQ)**, University of Porto & Polytechnic Institute of Porto	*Virtual*
Jun. - Aug. 2020	**Lunch and Learn Lecture Series**, Cyber-Phyical Systems Virtual Organisation (CPS VO)	*Tennessee, USA*
Jul. 2020	**Qiskit Global Summer School**, IBM	*International*

Workshops

In Process	**ALD Leads Certified: Leadership Program**, Alpha Lambda Delta Honor Society	*Virtual*
Nov. 2020	**Quantum Week of Fun**, Cambridge Quantum Computing	*Virtual*
Sept. 2020	**Introduction to Parallel Computing**, TTU High Performance Computing Center (HPCC)	*Texas, USA*
Sept. 2020	**Basic Programming for Quantum Machine Learning**, National Institute for Theoretical Physics	*Virtual*
Virtual	**A Progress Report from the Wolfram Physics Frontier**, Neural Engineering Research Venture (NERV)	
Jul. 2020 Jun. 2020	**Cybersecurity Basics Training**, TTU	*Texas, USA*
Nov. 2019	**Career in Physics Workshop**, Stanford University	*California, USA*
Oct. 2020	**Customer Discovery and the Business Model Canvas for STEM innovations**, TTU Innovation Hub	*Texas, USA*
Oct. 2018	**Red Raider Startup Program**, TTU Innovation Hub	*Texas, USA*

Outreach & Community Service

2020 - Present	**Training and Professional Development Workshops**, WiP	*Lubbock, TX, USA*
2018 - Present	**Volunteering for Wheelchair Dodgeball Events**, South Plains Adaptive Recreation Club	*Lubbock, TX, USA*
2018-2019	**Trick or Treat: Science Demonstration**, SPS	*Lubbock, TX, USA*
2019	**Physics Department Annual Banquet Organizing**, SPS	*Lubbock, TX, USA*
2019	**Physics Department Representation at Major and Minor Fair**	*Lubbock, TX, USA*
2019	**Research Carnival Presentation**, APDL	*Lubbock, TX, USA*
2019	**College of Arts & Sciences Events**, Student Ambassador	*Lubbock, TX, USA*
2017 - 2019	**Multiple Fund Raisers**, SPS	*Lubbock, TX, USA*
2018-2019	**Multible Member Social Events**, ALD/PES	*Lubbock, TX, USA*
2018-2019	**Study Hall Monitoring and Organizing**, ALD/PES	*Lubbock, TX, USA*
2017 - 2018	**Volunteering at the Science Spectrum and OMNI Theatre**, SACNAS	*Lubbock, TX, USA*
2017 - 2018	**Astronomy Day at the Moody Planetarium**, SPS	*Lubbock, TX, USA*
2018	**Fund Raiser at Top Tier Catering**, SACNAS	*Lubbock, TX, USA*
2018	**Undergraduate Colloquium Organizing**, SPS	*Lubbock, TX, USA*
2018	**Grad Students 2 Undergrad Research Party Organizing**, SACNAS	*Lubbock, TX, USA*