Fernando Torales Acosta

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APPOINTMENTS & EDUCATION

PostDoctoral Fellow
LAWRENCE BERKELEY NATIONAL LABORATORY   FEBRUARY 2022-PRESENT

NSSC Fellow
UNIVERSITY OF CALIFORNIA, BERKELEY   MAY 2017 - MARCH 2021
PhD, Physics
UNIVERSITY OF CALIFORNIA, BERKELEY   AUGUST 2016 - DECEMBER 2021

B.S. Physics Honors
STONY BROOK UNIVERSITY   AUGUST 2012 - MAY 2016

RESEARCH EXPERIENCE

Generative Models for Entire DIS Events at the Electron Ion Collider
Lawrence Berkeley National Lab | February 2022 - Present

- Point Cloud based diffusion models to generate entire events with all final state particles and their kinematics
- Adapted one of the first foundation models in HEP for this standalone new study on entire event generation
- Implemented a combination of novel point edge transformer architecture and point cloud datasets
- Generated Data on HPC infrastructure at LBNL, transformed data, and containerized pipeline
- Created notebook for theory collabaroters to constructe new observables from model outputs
- Organized small collaboration to ensure conference and funding deadlines were met.

AI Codesign for EIC - Generative Models for Calorimeter Simulation
Lawrence Berkeley National Lab | February 2022 - Present

- Used state of the art score based diffusion models to generate calorimeter showers.
- Investigated optimal representation of calorimeter data for machine learning.
- Compared models made up of CNNs trained on images to models consisting of DeepSets trained on Point Clouds.
- Chosen representation lead to 150x reduction in disk space, and a 300% reduction in sampling time, all while maintaining cutting-edge performance.
- Ground work to generate differentiable simulations for end-to-end differentiable detector design.

H1 - Machine Learning Assisted Unfolding for Lepton-Jet Asymmetry measurements
Lawrence Berkeley National Lab | February 2022 - Present
Postdoctoral Fellow | Lawrence Berkeley National Lab | February 2022 - Present

- Use ML-based unfolding in to measure moments defining properties of electron-proton collisions
- First measurement of moments of lepton-jet asymmetry angle, probes contribution of soft gluon radiation to asymmetry measurements. Vital reference for future TMD studies at the EIC.
- Iteratively re-weighted a set of simulated events with deep learning, correcting entire datasets for detector effects
- Contributor to OmniFold Python package, for unfolding collider data
- Repurposed a classifier as a likelihood-ratio estimator to reweight synthetic data to match real data
- Ran thousands of models in High Performance Computing environment, both for robustness of results and for visualizing progression of iterative models.

AI Codesign for EIC - Optimal Use of Detector Segmentation
Postdoctoral Fellow | Lawrence Berkeley National Lab | February 2022 - Present

- Lead researcher, designed experiments, synthesized training data, containerized pipeline and tutorials
- Optimized the design for a hadronic calorimeter and ZDC for the upcoming Electron Ion collider
- Achieved a 50% improvement in energy resolution for hadronic calorimeter
- Training surrogate models on detector simulation that are conditional on the parameters of the detector geometry
- Translated data into Point-Cloud representation for use in deep sets and graph neural network models
- Large scale production of simulation using High Performance computing infrastructure at Lawrence Berkeley and Lawrence Livermore national lab
- Distilled methods into easy to run Jupyter Notebooks for engaging students

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- Optimal reconstruction conditioned on detector parameter values for differentiable design process
- Influenced hadronic calorimeter after sharing results of optimal detector design

ALICE - Deep Photons for Photon-Jet Correlations
Graduate Researcher | July 2021 - December 2021 | University of California, Berkeley

- Developed deep neural network classifier to identify prompt vs. non-prompt photons in PbPb
- Trained model on PYTHIA embedded into PbPb data.
- Tuned neural network over wide parameter space using keras tuner.
- Experimented with convolution layers, dropout layers, and ResNet architecture.
- Analyze results, plotting ROC curves and obtained an accuracy of 70% or greater.
- Model currently outperforms standard σ^2_{long} variable based on cluster shower shape.

ALICE – Isolated Photon-Hadron Correlations
Graduate Researcher | June 2018 – May 2020 | University of California, Berkeley

- First photon-tagged fragmentation measurement at the LHC in p–Pb.
- Analyzed isolated, single photon-hadron correlations in ALICE pp and p-Pb data.
- Thorough comparison of proxy fragmentation functions in two collision systems.
- Showed no observable modification in p–Pb compared to pp, constraining cold nuclear matter effects on parton fragmentation.

EIC - Jet Resolution and Lepton Jet Correlations
Graduate Researcher | November 2020 - June 2021 | University of California, Berkeley

- Ran large scale electron-proton simulations using the PYTHIA and sPHENIX Fun4All framework inside a Singularity container at NERSC.
- Helped implement All-Sillicon tracker in Fun4All for GEANT4 full simulation.
- Created NTuple framework with full e-proton event information, including all jets and particles at truth and reconstructed level, vastly reducing the need to re-run simulation.
- Analyze simulation results: charged jet momentum response as well as momentum and angular resolutions.
- Produced Lepton Jet Correlations and Charged Jet fragmentation analysis, propagating uncertainties using relevant resolutions, and scaling statistical error bars according to expected EIC luminosity.

High Performance Computing for Event Mixing
Graduate Researcher & NSSC Fellow | June 2018 – Present | University of California, Berkeley

- Created novel event mixing framework for pairing similar collision events based on Gale-Shapely stable pairing algorithm often used in the field of economics. Alternative to k-nearest neighbors that ensures even use of events.
- Characterized detector acceptance affects and combinatorial background in ALICE γ-hadron and γ-jet analysis.
- Parallelized framework to run on NERSC KNL and Haswell high performance nodes with fast, random access I/O implemented with HDF5.
- Decreased required time of mixed event correlations from several days through the ALICE analysis train system to 30 minutes on a single high performance interactive node.

sPHENIX – Jet Energy Scale Calibration
NSSC Fellow & Lab Intern | June 2019 - March 2020 | Livermore National Lab

- Analyze simulation results to develop and optimize jet calibration methods in order to improve jet energy scale and accuracy to probe jet energy loss mechanisms in Quark Gluon Plasma.
- Contributed to NSSC meetings comprised of nuclear engineers, political scientists, data analysists, and physicists.
- Present results in jet substructure topical group on jet reconstruction performance.
- Run simulation on Livermore Computing clusters as well as RACF at BNL.
- Apply numerical inversion technique to correct reconstructed jet energy scale.

ALICE - Upgraded Pixel Detector Testing
Berkeley Lab Undergraduate Intern (BLUR) | June 2015 – Aug 2015 | Berkeley National Lab

- Characterized latch-up cross section of prototype next generation Monolithic Active Pixel Sensor for the upgrade to ALICE Inner Tracking System.
- Read data from data acquisition card and check linear energy transfer of ALPIDE silicon pixels .
- Took measurements of linear energy transfer in real time during beam test at 88" Cyclotron.

PHENIX - Muon-Piston Calorimeter Extension
Undergraduate Researcher | April 2013 - February 2015 | Stony Brook University

- Helped simulate electromagnetic showers from incident photons or π_0's in PHENIX, to help identify the impact of a pre-shower detector
- Assisted in the construction of a Tungsten-Silicon pre-shower detector with high position resolution to separate direct and π_0 decay photons.

Radiation Damage in Lead-Glass Calorimeter
SULI Intern | Summer 2014 | Thomas Jefferson National Accelerator Facility

- Worked to reduce radiation damage in lead glass by thermal annealing
- Modeled the optical transparency and the electrical conductivity of lead glass as a function of temperature, used to predict the impact of thermal annealing

Ring Imaging Cherenkov Detector
Undergraduate Researcher | February 2012- March 2013 | Stony Brook University

- Helped develop a prototype 1-meter long compact Ring Imaging Cherenkov detector (RICH).
- Tested and optimized the appropriate bias for a five layer stack of Gas Electron Multipliers, a 'quintuple GEM stack', used to detect the Cherenkov radiation at the end of the RICH.
- Successfully tested the detector using beam tests at Fermi National Accelerator Laboratory.

CONFERENCES & TALKS

NeurIPS
December 2024 | Vancouver, CA
- Point Cloud Diffusion models for entire EIC event generation

NeurIPS
December 2023 | New Orleans, USA
- Fast Generative Models for EIC calorimeters

AI4EIC
November 2023 | Washington D.C., USA
- Talk on Optimal Use of segmentation for sampling calorimeters

Center for Frontiers in Nuclear Science
November 2023 | Stony Brook, NY, USA
- Talk an Machine Learning for EIC. Surrogate models, AI-codesign for detectors, and fast simulation.

DIS2023
March 2023 | Michigan, USA
- ML Unfolding for Lepton-Jet Asymmetry, and implications for saturation at the EIC

Quark Matter
November 2019 | Wuhan, China
- Contribution on Isolated γ-hadron correlations in pp and p–Pb Collisions

ALICE Physics Week
July 2019 | Prague, Czech Republic
- Overview on Isolated γ-hadron analysis given to ALICE collaboration

APS Quarks to Cosmos
July 2019 | Boulder, CO
- Description of Isolated γ-hadron analysis in pp and p-Pb collisions

ALICE-USA Meeting March 2019 | Knoxville, TN
- Talk on Isolated γ-hadron analysis in pp and p-Pb collisions

Hard Probes
September 2018 | Savoie, France
- Isolated γ-hadron and γ-jet correlations preliminary [contribution]

NSSC University Program Review
June 2018 | Ann Arbor, MI
- Upgrade to the ALICE Inner Tracking System

Talking Science SCIENCE COMMUNICATION TO THE PUBLIC
Jan 2016 – May 2016 | Stony Brook, NY
- Discussion oriented school of journalism course on effectively communicating science to the public

RELEVANT PUBLICATIONS

POINT CLOUD-BASED DIFFUSION MODELS FOR THE ELECTRON-ION COLLIDER
https://arxiv.org/abs/2410.22421

COMPARISON OF POINT CLOUD AND IMAGE-BASED MODELS FOR CALORIMETER FAST SIMULATION
https://arxiv.org/abs/2307.04780

DESIGN OF A SiPM-ON-TILE ZDC FOR THE FUTURE EIC AND ITS PERFORMANCE WITH GRAPH NEURAL NETWORKS
https://arxiv.org/abs/2406.12877

ARTIFICIAL INTELLIGENCE FOR THE ELECTRON ION COLLIDER
https://arxiv.org/abs/2307.08593

THE OPTIMAL USE OF SEGMENTATION FOR SAMPLING CALORIMETERS
https://arxiv.org/abs/2310.04442

EIC PHYSICS FROM AN ALL-SILICON TRACKING DETECTOR
https://arxiv.org/abs/2102.08337

ISOLATED PHOTON HADRON CORRELATIONS IN 5.02 TeV pp AND p–Pb COLLISIONS AT ALICE
DOI:10.1103/PhysRevC.102.044908

PERFORMANCE OF A QUINTUPLE-GEM BASED RICH
DOI:10.1109/TNS.2015.2487999

AWARDS/APPOINTMENTS

LLBNL Posdoctoral Fellow	2022-2025
NSSC Fellow	2019-2021
NSSC Fellow	2017-2019
NSF Fellow Honorable Mention	2016
SUNY LSAMP Fellowship	2015-2017
NASA NY Undergraduate Space Grant	2014