

George Halaal

Curriculum Vitae as of Nov. 2018

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Career Objectives

I intend to pursue a Ph.D. in Experimental High Energy Physics. Upon graduation, I plan on pursuing a position as a professor at a research university.

Education

- 2015–2019 **Lehigh University**, Bethlehem, PA, USA, GPA: 3.96/4.00.
- B.S. in Physics (highest honors expected) – **Major GPA: 3.98/4.00**
 - Minor in Applied Mathematics
 - **Thesis in progress:** *"Machine Learning in Relativistic Heavy-Ion Collisions at RHIC: Applications to Jet Flavor Tagging, Centrality and Event Plane Determination, and the Trigger Definition"* (Advisor: Dr. Rosi Reed)
 - **Coursework includes:** 3 graduate physics courses, Nuclear and Elementary Particle Physics, and an independent study course in Quantum Field Theory.
- 2012–2015 **Eastwood International School**, Beirut, Lebanon,
GPA: 4.00/4.00, Valedictorian.

Computing Skills

- Platforms Linux, Microsoft Windows, Macintosh
- Languages C++, Python, Arduino, LabVIEW, Slurm, L^AT_EX
- Technical ROOT, PYTHIA, FastJet, JETSCAPE, DiffGeo
- Machine Learning Python: Keras (TensorFlow backend), scikit-learn
ROOT: TMultilayerPerceptron, TMLPAnalyzer
- Other AutoCAD, Microsoft Office

Laboratory Skills

- Electronics Oscilloscope, Function Generator, Multimeter, Lock-in Amplifier
- Machine Shop Metalworking & Soldering, Woodworking, 3D Printing

Languages

- Fluent English & Arabic
- Proficient French

Research Grants

- 2018 **Eckardt Scholar Research Project Grant.**
For conducting research at Yale University
- 2017 **CAS Undergraduate Research Grant.**
For conducting research at The Ohio State University
- 2017 **Summer Research Participation Fellowship.**
For conducting research at Lehigh University

Honors & Awards

- 2017 **Malcolm J. Gordon, Jr. Physics Prize, *Lehigh University*.**
A prize awarded to the top-ranking sophomore majoring in physics with some extracurricular activity.
- 2015–present **Eckardt Scholar, *Lehigh University*.**
A highly selective honors program at Lehigh University with special benefits.
- 2015–present **Dean's List, *Lehigh University*.**
- 2015–present **Merit Scholarship, *Lehigh University*.**

High Energy Physics Research Experience Highlights

Analysis Experience:

- 2018–present **Machine Learning for Heavy-Flavor Jet Tagging,**
Advisors: Helen Caines & John Harris, Yale University.
- Simulated proton-proton collisions at RHIC energies using PYTHIA, and clustered final state particles into jets using FastJet.
 - Trained an artificial neural network using Keras on a list of discriminators to be able to classify charm, bottom, and light jets.
 - Included STAR detector effects and tracking efficiency.
 - Developed a new jet tagging strategy for RHIC.
- 2018–present **Centrality & Event Plane (EP) Determination Using Machine Learning with the STAR Event Plane Detector (EPD),**
Advisors: Rosi Reed & Michael Lisa, Lehigh University & The Ohio State University.
- Trained an artificial neural network (ANN) to identify the centrality of a collision, based on which EPD tiles are hit during a given event.
 - Trained another ANN to identify the 2nd order EP of a collision by minimizing the difference between the EPs measured by the east and west EPDs.
 - Tried different machine learning packages in ROOT and Python to determine which performs the best.
 - Presented results at the 2018 STAR Collaboration Meeting at Lehigh University.
 - Plots I made were presented by Dr. Michael Lisa at the Workshop on Chirality, Vorticity and Magnetic Field in Heavy Ion Collisions in Florence, Italy.

2017–2018 **Performance Analysis of the STAR Event Plane Detector (EPD),**

Advisor: Rosi Reed, Lehigh University.

- Analyzed data collected by the eighth of the EPD that was installed for the RHIC 2017 run, colliding protons at $\sqrt{s} = 510$ GeV and gold ions at $\sqrt{s_{NN}} = 54.4$ GeV, to optimize its final design.
- Compared the EPD to the other detectors at the STAR experiment to verify that they are measuring the same collisions at the same time and that the electronics work properly.
- Analyzed the charged particle multiplicity distribution in the EPD as a function of pseudorapidity and compared it to the results from the RHIC PHOBOS experiment and to Monte Carlo simulations.
- Studied the ADC distributions of the tiles in the EPD to quantify the number of minimum ionizing particles (MIP) hitting the detector.
- Studied whether it is useful to have a maximum ADC cap for each tile in the EPD in order to suppress the effects of large Landau fluctuations and what that value is.

Hardware Experience:

2016–2018 **Building an Event Plane & Centrality Detector (EPD) for the STAR Experiment,**

Advisor: Rosi Reed, Lehigh University.

- Helped build and test one of the detector upgrades proposed for the second phase of the Relativistic Heavy Ion Collider (RHIC) Beam Energy Scan (BES). The EPD increases precision in triggering on events and in measuring the event plane and centrality of collisions with significant timing resolution. It is designed such that when a minimum ionizing particle (MIP) hits one of the optically-isolated tiles of this detector, which are made of special plastic material, photons are generated through scintillation. The photons then travel through a wavelength-shifting fiber embedded in the tile to a clear optical fiber to be detected by silicon photo-multipliers.

2017 **Cosmic Ray & Radioactive Source Testing of the Event Plane Detector (EPD),**

Advisors: Michael Lisa & Rosi Reed, The Ohio State University.

- Helped build two test stands that use cosmic rays and a radioactive source to quantify the quality and uniformity of the EPD sectors.
- Connected different electronics boards to each other and to silicon photo-multipliers to digitize the signals detected.
- Performed different calculations, such as the distance an electron from the radioactive source can travel through different materials before stopping.
- Analyzed data collected from both tests using ROOT.

Peer-Reviewed Publications

- In Progress **"An Event Plane Detector for STAR,"** *Nuclear Instruments and Methods in Physics Research*
- In Progress **"Upper Limit on Jet Flavor Tagging at RHIC Energies Using Machine Learning,"** *Journal of High Energy Physics*

Research Communication Experience

Professional Conferences:

- 2018 **Halal, G.**, 2018, "Machine Learning and Optimization with the Event Plane Detector", *The STAR Collaboration Meeting*, Oral Presentation
- 2017 **Halal, G.**, 2017, "A Centrality and Event Plane Detector for STAR to Complete the Phase Diagram of Quantum Chromodynamics", *APS Division of Nuclear Physics Meeting*, Poster Presentation Section EA.075

Seminars & Symposiums:

- 2018 **"Feasibility of Jet Flavor Tagging at RHIC"**, *Lehigh Astro-Particle-Nuclear Physics Seminar*, Lehigh University, Bethlehem, PA
- 2018 **"Machine Learning for Heavy Flavor Jet Tagging"**, *Yale Wright Laboratory Undergraduate Summer Research Symposium*, Yale University, New Haven, CT
- 2018 **"An Event Plane Detector to Better Understand the Strong Force"**, *Lehigh Astro-Particle-Nuclear Physics Undergraduate Research Symposium*, Lehigh University, Bethlehem, PA
- 2018 **"Introduction to Machine Learning in Physics"**, *Lehigh Astro-Particle-Nuclear Physics Seminar*, Lehigh University, Bethlehem, PA
- 2017 **"An Event Plane Detector to Understand the Structure of Quantum Chromodynamics"**, *Lehigh Physics Undergraduate Research Symposium*, Lehigh University, Bethlehem, PA

Other:

- 2017–2018 Presentations for the STAR EPD meetings, *BlueJeans Webinar*
- 2017–2018 Presentations on weekly research progress for the Lehigh Relativistic Heavy Ion Group (RHIG), *Lehigh University, Bethlehem, PA*

Work Experience

- 2018 **Peer Tutor for Introductory Physics II (Electricity & Magnetism)**, *Lehigh University*
- 2016 **Structural Engineering Intern**, *GGICO PSC Engineering, UAE*

References

Dr. Helen Caines, *Associate Professor of Physics*, Yale University.

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Dr. Michael Lisa, *Professor of Physics*, The Ohio State University.

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Dr. Rosi Reed, *Assistant Professor of Physics*, Lehigh University.

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