Mustafa Mustafa

Specialties: Physics, Data Analysis, C++, ROOT, Linux
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Current Position

2013-Present

Postdoctoral Fellow
Lawrence Berkeley National Laboratory,
Relativistic Nuclear Collisions group (RNC), Nuclear Science Division.
Member of the Solenoidal Tracker at RHIC (STAR) experiment.
Advisor: Jim Thomas.

Focus:
I) Measurements of open heavy flavor hadrons production to study heavy quarks interactions and energy-loss in Heavy Ions Collisions.
II) Heavy Flavor Tracker alignment, simulations, data analysis software and data production.

Education

2009-2013

Ph.D. in High Energy Nuclear Physics
Purdue University, IN.
Advisor: Wei Xie.

2004-2008

B.Sc. in Physics
University of Jordan, Amman, Jordan.

Skills and Areas of Expertise

CS

Scientific Computing	C++	Linux Clusters
Monte Carlo Simulations	OOP	Linux Admin.
Data Analysis	Python	Open Source
ROOT	Mathematica	Vim

Online Courses

Machine Learning (Andrew Ng).
Statistical Learning (Hastie &Tibshirani).

Personal

Effective Communicator	Adaptable	Analytical
Good Team Player	Dependable	Innovative

Physics

Heavy-Ion Physics	Quark Gluon Plasma	Heavy Flavor Physics
Mathematical Physics	Mathematical Modeling	

Projects and Contributions

Ongoing:

2015-Present

$D^0/D^{\pm}$ Azimuthal Anisotropy and Spectra in Au+Au collisions using Heavy Flavor Tracker

Objective:	High precision measurement of open charm observables in heavy ion collisions using the newly installed Heavy Flavor Tracker.
Contributions:	Main author of Pico Heavy Flavor Analysis Library and Data Driven Fast Simulator.
Outcome:	First measurement of D^0 azimuthal anisotrpy and high precision measurement of nuclear modification factors. Results have been presented at Quark Matter 2015 conference. D^0 and $D^{\pm}$ spectra are being finalized for publication.

2015-Present **Data Driven Fast Simulator**

Objective:	Reliable simulation of the Heavy Flavor Tracker efficiency, acceptance and spatial resolution performance.
Contributions:	Developed a first of its kind and scale, data-driven simulation package.
Outcome:	The Fast Simulator. As opposed to ab-initio simulations, the Fast Simulator uses an input of +1M histograms extracted from data to simulate the HFT real performance. In addition to the superior accuracy of the data-driven approach, it cuts the computation time of traditional simulations by more than a 7000 times.
Skills:	Monte Carlo simulations. Understanding of Time Projection Chambers and Silicon Trackers, their calibration and alignment.

2016-Present **STAR data production at Cori (NERSC)**

Objective:	To process 3Pb of raw data that uses 70M CPU hours at Cori phase I facility.
Contributions:	Developing the workflow pipeline.
Outcome:	Currently stress testing the pipeline.
Technologies:	Docker/Shifter, MongoDb, Map/Reduce.

Selected completed projects:

2014-2016 **Heavy Ion Tea (HIT) seminars series (LBNL)**

Objective:	Organization of HIT seminars which are hosted by the (RNC) group at LBNL.
Contribution:	As a committee member I am involved in seminars program preparation and organization, identifying and inviting speakers.
Skills:	Staying current in High Energy Particle and Nuclear Physics. Effective communication with committee members and speakers candidates.
Outcome:	Fall 2014 - Spring 2016 diverse and active seminar series.

2015 **C++11 STAR coding guidelines committee**

Objective:	Revise STAR coding standard to provide guidance and recommendation for usage of C++11 new features.
Contribution:	As a member of the committee, I reviewed: Range-`for` statements. Override controls: `override` and `final`. Smart pointers. Move semantics/rvalue reference. Control of defaults: `default` and `delete`, move and copy. In-class members initialization.
Skills:	Knowledge of C++, STAR coding standards. Learning enough about C++11 standards to make informed recommendations.
Outcome:	Coding guidelines. Formatting guidelines

2015 **Time Projection Chamber (TPC) alignment and calibration (STAR experiment)**

Objective:	Carry R&D on alignment and calibration of STAR TPC (50% of my postdoc appointment at LBNL).
Contributions:	TPC gas $\omega\tau$ and field distortion correction coefficients measurement using lasers data and verification using Magboltz simulations. TPC alignment vetting using HFT and cosmic rays data.
Skills:	Knowledge of TPC operation, physics and design. TPC calibrations and alignment techniques. Expertise on STAR software infrastructure.

2012-2014 **Heavy Flavor Tracker - PXL simulators (STAR experiment)**

Objective:	Development and deployment of STAR Heavy Flavor Tracker (HFT) new silicon secondary vertex tracker (PXL) simulators.
Contributions:	Designed and implemented: 1) Simulation data containers 2) Simulators interface 3) Fast simulator 4) Pile up hits adder 5) STAR wrapper for DIGMAPS sensors response emulation tool. Maintaining the software package.

	Skills:	Simulation. Software architecture. Knowledge of STAR software architecture. OOP, C++, software design.
	Outcome:	STAR PXL simulation software. github, STAR documentation.

2014 **MTD simulation software code review (STAR experiment)**

Objective:	Verify compliance of StMtdSimMaker code with the STAR coding guidelines and C++ standards.
Technical skills:	Knowledge of C++ and STAR coding standards.

2013 **FGT point maker code review (STAR experiment)**

Objective:	Verify compliance of StFgPointMaker code with the STAR coding guidelines and C++ standards.
Technical skills:	Knowledge of C++ and STAR coding standards.

2014-2015 **Measurement of non-photonic electrons in *U*+*U* collisions (STAR experiment)**

Objective:	Measurement of non-photonic electrons production in *U*+*U* collisions at $\sqrt{s}$=193 GeV.
Contribution:	Mentoring Masters student Katarína Gajdošová (Czech Technical University, Prague).
Skills:	Teaching and mentorship.
Outcome:	Preliminary results will be presented at the 53rd International Winter Meeting on Nuclear Physics, Borimo, Italy. (Jan/2015).

2013-2014 **Charm production in *p*+*p* collision at $\sqrt{s}$ = 200 GeV (STAR experiment)**

Objective:	Measurement of charm production at mid-rapidity by direct reconstruction of $D^0 \rightarrow K\pi$ and $D^* \rightarrow D^0\pi \rightarrow K\pi\pi$ from RHIC year 2012 run.
Contribution:	Hao Qiu and I carried out the entire analysis.
Technical skills:	Large data analysis. PYTHIA. ROOT, OOP, C++, computer clusters.
Outcome:	Preliminary results were presented at Quark Matter 2014 (PDF).

2013-2015 **Measurement of non-photonic electrons in *p*+*p* collisions (STAR experiment)**

Objective:	Measurement of non-photonic electrons production in *p*+*p* collisions at $\sqrt{s}$=200 GeV from RHIC year 2012 run.
Contribution:	Mentoring Ph.D. student Xiaozhi Bei (UIC and CCNU).
Skills:	Teaching and mentorship.
Outcome:	Poster at Quark Matter 2014. Paper in preparation.

2011-2013 **Measurement of non-photonic electrons production and azimuthal anisotropy (STAR experiment)**

Objective:	Measurement of non-photonic electrons production and azimuthal anisotropy in *Au*+*Au* collisions at $\sqrt{s_{NN}}$=200, 62.4 and 39 GeV.
Contribution:	PicoDst production. Data quality assurance. Electrons identification. Data analysis for spectra part. Embedding and efficiency studies.
Technical skills:	Large data analysis. Statistical methods. Simulation. PYTHIA. OOP, C++, ROOT, scripting.
Outcome:	Ph.D. thesis. arXiv:1210.5199. arXiv:1405.6348. Two more papers in the pipeline.

2012-2013 **Embedding Deputy (STAR experiment)**

Objective:	Train and follow-up with Embedding Helpers on embedding productions. Quality assurance of production physics and detector performance in simulation vs. data. Follow-up on issues and bugs with the core Software and Computation team.
Skills:	Effective communication. Team management. Knowledge of STAR data simulation and reconstruction code base. C++, scripting.

	Outcome:	Identified and helped in solving several software bugs. Helped in restructuring the embedding work-flow and thus refactoring submission and production management scripts.

2010-2012 **Embedding Helper (STAR experiment)**

Objective:	Organize, prepare and submit Heavy Flavor (HF) embedding productions. Quality assurance of the production. Communicate the needs of the HF working group to the embedding team.
Skills:	Effective communication. Computational resources management and planning. C++, scripting.
Achievement Highlight:	The embedding team and I finished more than 25 HF embedding requests (17m events) for Quark Matter 2012 within sixth months. This required 6500 CPU weeks and 30TB of disk space.

2011 **D^* reconstruction with HFT (STAR experiment)**

Objective:	Study topological reconstruction of D^* using STAR Heavy Flavor Tracker in full GEANT simulations.
Contribution:	Carried out the entire study.
Technical skills:	Simulations. Data analysis. PYTHIA. ROOT, C++, computer clusters.
Outcome:	Optimized topological cuts and signal significance estimates for RHIC projected luminosities for year 2014 run. PDF.

2010-2011 **D^0 production in p+p collision at $\sqrt{s}$ = 200 GeV (STAR experiment)**

Objective:	Measurement of charm cross-section at mid-rapidity by direct reconstruction of $D^0 \rightarrow K\pi$.
Contribution:	Studying event-mixing techniques in p+p collisions. Cross-checking signal reconstruction. STAR documents.
Technical skills:	Large data analysis. PYTHIA. ROOT, C++, computer clusters.
Outcome:	Phys. Rev. D 86, 072013 (2012). arXiv:1204.4244.

2008 **Theoretical Physics Lab. Linux Cluster (University of Jordan)**

Objective:	Constructing the first Linux Cluster in the University of Jordan for computation physics research.
Contribution:	Organized and lead a group of physicists and engineers to carry the task.
Skills:	Leadership. Linux administration, networking, cluster infrastructure.
Outcome:	We completed the construction of two clusters.

Talks

Conference talks:

2015/10 **Overview of resent results from the STAR experiment**,
Quark Matter 2015 International Conference
Kobe, Japan. PDF.

2013/11 **Measurement of non-photonic electrons in STAR experiment**,
EMMI workshop on Heavy Flavor & QCD Phase Structure in High Energy Collisions.
LBL, Berkeley, CA. PDF.

2012/08 **Measurements of non-photonic electrons at STAR experiment**,
parallel talk at *Quark Matter 2012 International Conference*,
Washington D.C. PDF.

Invited talks:

2014/06 **Recent open heavy flavor results from STAR experiment**,
RHIC & AGS Annual Users' Meeting,

BNL, NY. PDF.

2013/06 **Recent open heavy flavor results at RHIC**,
RHIC & AGS Annual Users' Meeting,
BNL, NY. PDF.

2012/10 **Measurements of non-photonic electron in STAR experiment**,
International Workshop on Heavy Quark Production in Heavy-Ion Collisions,
Utrecht, Netherlands. PDF.

2012/08 **Measurements of non-photonic electron in STAR experiment**,
Workshop on Heavy Flavor Production in High-Energy Nuclear Collisions,
UIC, Chicago, IL. PDF.

Seminars:

2014/08 **Measurements of electrons from heavy-flavor hadrons decays in STAR experiment**,
University of Illinois at Chicago,
Chicago, IL. PDF.

Publications

59+ publications. Full list available at Google Scholar or INSPIRE.

Selected experimental physics publications:

2015 *Overview of resent results from the STAR experiment.*
Mustafa Mustafa (for the STAR Collaboration). Nuclear Physics A. arXiv:1512.09329.

2013 *Measurements of non-photonic electron production and azimuthal anisotropy in* $\sqrt{s_{NN}} = 39, 62.4$ *and* 200 *GeV Au+Au collisions from STAR at RHIC.*
Mustafa Mustafa (for the STAR Collaboration). Nuclear Physics A 904-905, 665 (2013). arXiv:1210.5199.

2012 *Measurements of* D^0 *and* D^* *production in* $p + p$ *Collisions at* $\sqrt{s} = 200$ *GeV*.
L. Adamczyk et al. (STAR Collaboration). Phys. Rev. D 86, 072013 (2012). arXiv:1204.4244.

Mathematical physics publications:

2011 *Supersymmetry identifies molecular Stark states whose eigenproperties can be obtained analytically*.
M. Lemeshko, M. Mustafa, S. Kais, B. Friedrich. New J. Phys. 13, 063036 (2011). arXiv:1106.4402.

2011 *Supersymmetric factorization yields exact solutions to the molecular Stark effect problem for "stretched" state*.
M. Lemeshko, M. Mustafa, S.Kais, B. Friedrich. Phys. Rev. A. 83, 043415 (2011). arXiv:1105.5262.

2009 *A Venn diagram for supersymmetric, exactly solvable, shape invariant, and Infeld-Hull factorizable potential*. M. Mustafa, S. Kais. arXiv:0911.4206.

2009 *Effective polar potential in the central force Schrödinger equation*.
M. S. Shikakhwa and M. Mustafa. Eur. J. Phys. 31, 151 (2010). arXiv:1001.3693.

Book chapters:

2009 *General Physics, Electromagnetism Laboratory Manual, 3rd Edition.*
M. S. Shikakhwa, M. Mustafa, R. Al-Rfou', A. Ecevit, M. Ozbakan.
Middle East Technical University, North Cyprus Campus.

Work History:

Research:

2010-2013 **Graduate Research Assistant. High-Energy Nuclear Physics Group.**
Purdue University, IN.
The primary focus of my research was heavy quarks interaction with the strongly interacting partonic medium created in heavy-ion collisions so-called Quark Gluon Plasma.

2008-2009 **Research Assistant. Remote collaboration with Prof. Sabre Kais.**
Purdue University, IN.
Applications of Supersymmetric Quantum Mechanics techniques to problems in Atomic and Molecular Physics. This work has been initiated during my Dec. 2008 research visit to Max Planck Institute for Physics of Complex Systems, Dresden, Germany.

2008 **Research Assistant. Prof. Jameel Khalifeh's group.**
University of Jordan, Amman, Jordan.
Worked on analytical evaluations of lattice Green's functions for isotropic and anisotropic FCC, BCC and SC lattices, where these are applied to evaluate resistance of networks of resistors.

2007 **DAAD Intern.**
Ilmenau Technical University, Ilmenau, Germany.
Developed a Mathematica™ visualization package to be used with an Ada implementation of a Kinetic Monte Carlo simulation of thin film growth package.

Teaching:

2009-2010 **Astronomy Laboratory Teaching Assistant, ASTR 263, ASTR 264.**
Purdue University, IN.

2008-2009 **Physics Laboratory Instructor.**
Middle East Technical University, North Cyprus Campus.
General Physics, Electromagnetism (PHYS 106).
General Physics, Classical Mechanics (PHYS 105).

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