📞 15905187015   💬 chnzhangrui   ✉ rui.zhang@cern.ch

R U I   Z H A N G

EDUCATION & EMPLOYMENT

Nanjing University   **Nanjing**, *Jiangsu, China*
Associate professor in High Energy Physics   ***2024.12–Now***

University of Wisconsin-Madison   **(based in)** *Geneva, Switzerland*
Postdoc researcher in High Energy Physics   ***2019.07–2024.12***
Supervisor: Prof. Sau Lan Wu, Enrico Fermi Distinguished Professor, honoured with the named minor planet (177770) 'Saulanwu' (=2005 JE163)

University of Bonn   ***Bonn, Germany***
Ph.D. in HEP *(degree granted in 06.2019 with "magna cum laude")*   ***2013.10–2019.06***
Supervisor: Prof. Ian Brock, co-author of the book "Physics at the Terascale" (ISBN-13: 978-3527410019)
Thesis: Measurement of single top quark at ATLAS (inclusive & differential)
Won the Honours Branch (stipend) of Bonn-Cologne Graduate School in 2015-2016

University of Chinese Academy of Sciences   **Beijing, China**
Master of Science in High Energy Physics (*degree granted in 07.2013*) ***2010.09–2013.08***
Supervisor: Prof. Yangheng Zheng, Associate Dean of School of Physics, UCAS
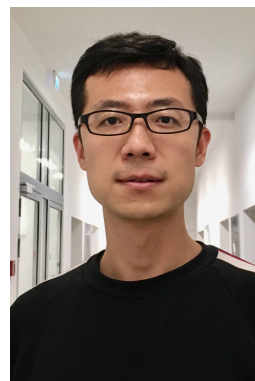*Thesis: Main Drift Chamber simulation improvement and FCNC search at BESIII*
Won the State Scholarship (研究生国家奖学金) in 2012

Tianjin University   ***Tianjin, China***
Bachelor in Applied Physics *(degree granted in 07.2010)*   ***2006.09–2010.07***
Thesis supervisor: Prof. Jiulin Du, topic: Monte-Carlo application in information flow

RESEARCH & ACHIEVEMENTS

I devote my time and research to perform most stringent test to the particle physics Standard Model, and search for New Physics in efficient ways. I am enthusiastic to bridge novel technologies from computer science and machine learning community to HEP, and pursue potential in quantum machine learning development for HEP.

Activities during my postdoc   *CERN, Switzerland*

1. Search for non-resonant di-Higgs production and establishing Higgs self-coupling as a crucial test of the Higgs mechanism.
   1.1. Searched for HH→bb+γγ final state. Improve 20% sensitivity to the Higgs self-coupling using optimised machine learning model.
   1.2. Searched for HH→bb+bb final state. Applied machine learning algorithms to classify signal and estimate background. Improved 30% sensitivity using machine learning.
   1.3. HH combination (6 channels). Co-leading the HH combination team. Produced most stringent Higgs self-coupling constraints to date (2022).
2. Search for BSM resonance production through di-Higgs final state.
   2.1. Searched for spin-0 scaler and spin-2 graviton in the HH→bb+bb final state. Mass reaches 5TeV for the first time; 5x results obtained than previous publication.
   2.2. Combination with heavy resonant search. Co-coordinating the team under my HH combination lead hat.
3. Exotics search using Anomaly Detection technique in machine learning.
   3.1. Searched for nine two-body final states simultaneously using anomaly detection technique. Sensitivity improves by around one order of magnitude. Co-leading the analysis team and serving as a paper editor.
4. Fast calorimeter simulation using generative adversarial network (GAN).
   4.1. Implemented GAN in ATLAS fast simulation environment. Improved performance by 2x and speed by 3x. Co-author of the official ATLAS FastCaloGAN to be used in Run 3. Participating the CaloChallenge 2022 [project hyperlink].
5. Developed algorithms and infrastructure to optimise the BSM parameter space search
   5.1. Realised an infrastructure as part of ATLAS distributed computing. Proposed a workflow to automatically and efficiently search for BSM parameter in high dimensional space. Demonstrated its efficiency using a dark photon search.

6. Quantum machine learning application in HEP analysis and beyond.
    6.1. Realised a quantum support vector machine application in $t\bar{t}H$ analysis. Archived compatible results from both quantum simulator and quantum computer hardware.
    6.2. Invited as one of the mentors of the project "Quantum GAN" in Google Summer of Code 2021 [project hyperlink]. Developed a fast and light quantum convolutional network using window sliding. Less qubits are required in this algorithm therefore leading to less training time and less memory footprint.
7. Developed Machine Learning workflow for High Lumi-LHC at ATLAS
    7.1. Integrated a service for machine learning and hyperparameter optimisation to the ATLAS distributed computing infrastructure. Sponsored by US-ATLAS HL-LHC R&D funding.
    7.2. Machine learning at High-Performance Computation. Brought Summit (2rd world leading supercomputer as of 2020), Theta (34th as of 2020), Perlmutter (7th as of 2022) to ATLAS machine learning use.

Activities during my Master (BESIII) & Ph.D. in brief   *UCAS, China & Uni Bonn, Germany*

1. Inclusive and differential measurements of single top quark production.
2. Adversarial neural network application to reduce systematic uncertainty.
3. Single vector-like quark search.
4. Particle-flow algorithm improvement and maintenance for jet reconstruction.
5. Flavour-Changing-Neutral-Current search through $D0 \rightarrow \pi 0 v v^-$ at BESIII.
6. Main Drift Chamber Monte-Carlo simulation improvement at BESIII.
7. Study the performance of Track Segment Finder in BESIII tracking.

PUBLICATIONS

Peer-reviewed papers with my significant contributions (from ATLAS Glance)

1. Search for non resonant pair production of HH→4b at 13 TeV. Submitted to PRD.
2. Constraining Higgs self-coupling from single and double Higgs combination. **Accepted** by PLB, arXiv:2211.01216. Cited by 2.
3. Search for resonant pair production of HH→4b at 13 TeV. **Accepted**, Phys. Rev. D 105 (2022) 092002, arXiv:2202.07288. Cited by 17.
4. Search for Higgs pair production in bbγγ at 13 TeV. **Accepted**, Phys. Rev. D 106 (2022) 052001, arXiv:2112.11876. Cited by 35.
5. Measurement of differential cross section of a single top quark production with a Wboson. **Accepted**, Eur. Phys. J. C 78 (2018) 186, arXiv:1712.01602. Cited by 42.
6. Measurement of cross section for single top production with a W boson. **Accepted**, JHEP 01 (2018) 63, arXiv:1612.07231. Cited by 165.
7. Search for the production of single vector-like and excited quarks in Wt final state at ATLAS. **Accepted**, JHEP 02 (2016) 110, arXiv:1510.02664. Cited by 114.

Peer-reviewed papers outside of ATLAS

8. Application of Quantum Machine Learning using the Quantum Kernel Algorithm on High Energy Physics Analysis at the LHC. Accepted, Phys. Rev. Research 3, 033221 (2021), arXiv:2104.05059. Cited by 31.
9. Improvement of Main Drift Chamber Monte-Carlo tuning model at BESIII. Accepted, arXiv: 1304.6149, Chinese Physics C, 38(2), 026201. Cited by 31.

PUBLIC NOTES

ATLAS reviewed notes (without overlaps with papers)

1. Combination of searches for non-resonant and resonant Higgs pair production in bbγγ, bbττ, bbbb final states. ATLAS-CONF-2021-052.
2. HL-LHC prospects for the measurement of Higgs boson pair production in the bbbb final state. ATL-PHYS-PUB-2022-053.
3. 2HDM reinterpretations and hMSSM summary results. ATL-PHYS-PUB-2022-043.
4. Higgs Effective Field Theory interpretation of Higgs pair production in bbγγ, bbττ, and their combination. ATL-PHYS-PUB-2022-019.
5. HL-LHC prospects for the Higgs pair production combination. ATL-PHYS-PUB-2022-005.

SCHOOL ACTIVITIES

(During Ph.D. candidature)

Teaching assistant (master level)

High Energy Collider Physics	*~50 students, 1 semester in 2018*
Particle Physics	~50 student, 2 semesters in 2017 & 2018
C++ Programming in High Energy Physics	~30 students, 1 semester in 2017
Statistical Methods in High Energy Physics	~80 students, 1 semester in 2015
Determination of the Orbit of the Asteroid 2004_BL86	2 distinct students, 1 week in 2015 (in Warsaw)
Advanced Topics in High-Energy Particle Physics	~20 students, 1 semester in 2014

IT administration for Bonn HEP Tier 3 cluster   2016-2018

Bonn-Cologne Graduate School of Physics and Astronomy (Excellence Initiative from 2007 to 2019)

Admission Academy Mentor   2016

CONFERENCES TALKS

Plenary:

- Higgs Pairs Production: ATLAS overview (45'). Higgs Pairs Workshop, Dubrovnik, Croatia, 2022.

Parallel:

- Application of Quantum Machine Learning to HEP Analysis (20'). International Conference on New Frontiers in Physics, Crete, Greece, 2022.
- Most recent FCNC searches at the LHC (20'). Standard Model at the LHC, CERN, 2022.
- Measurements of single top quark production cross sections with the ATLAS detector at the LHC (15'). European Physical Society conference, DESY, 2021.
- Hyperparameter optimisation for Machine Learning using iDDS (15'). IRIS-HEP Blueprint Workshop: Future Analysis Systems and Facilities, online, 2020.
- Hyperparameter tuning for FastCaloGan (20'). Machine learning for simulation, CERN, 2020.
- Searches for new phenomena in high-pT lepton final states and jets using the ATLAS detector (20').
- International Conference on Supersymmetry, Melbourne, Australia, 2016.

Poster:

- Search for resonant pair production of Higgs bosons in the 4b final state. Annual Large Hadron
- Collider Physics Conference. online, 2022.
- AtlFast3: Fast Simulation in ATLAS for Run 3 and beyond. International Workshop on Advanced Computing and Analysis Techniques in Physics, Bari, Italy, 2022.
- Hyperparameter Optimisation for Machine Learning using Grid computing and HPC. Accelerated
- Artificial Intelligence for Big-Data Experiments Conference, online, 2020.
- Measurement of differential single top-quark production cross-sections. International Workshop on Top Quark Physics, Braga, Portugal, 2017.