

# YIHUI LAI

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## EMPLOYMENT

### Postdoctoral Research Associate

Princeton University, Princeton, New Jersey, USA

Aug. 2024 – Present

## EDUCATION

### University of Maryland, College Park, Maryland, USA

Ph.D. in Physics

Aug. 2019 - Aug. 2024

### Shanghai Jiao Tong University, Shanghai, China

B.S. in Physics

Aug. 2015 - June 2019

## PUBLICATIONS

CMS Collaboration Author (2020 – present) on 200+ articles & preprints. ([Link](#))

### Selected publications:

- Constraints on the Higgs boson self-coupling with combination of single and double Higgs boson production. [arXiv:2407.13554](#). Submitted to *PLB*
- Search for Higgs boson pair production with one associated vector boson in proton-proton collisions at  $\sqrt{s} = 13$  TeV. [arXiv:2404.08462](#). Submitted to *JHEP*
- Luminosity measurement in proton-proton collisions at 13.6 TeV in 2022 at CMS. [CMS-PAS-LUM-22-001](#)
- Search for a resonance decaying to a W boson and a photon in proton-proton collisions at  $\sqrt{s} = 13$  TeV using leptonic W boson decays. [arXiv:2406.05737](#). Submitted to *JHEP*
- Measurement of simplified template cross sections of the Higgs boson produced in association with W or Z bosons in the  $H \rightarrow b\bar{b}$  decay channel in proton-proton collisions at  $\sqrt{s} = 13$  TeV. *Phys. Rev. D* 109, 092011 (2024), [doi:10.1103/PhysRevD.109.092011](#), [arXiv:2312.07562](#). (Selected as editor's suggestion)
- C. Papageorgakis *et al.*, Dose rate effects in radiation-induced changes to phenyl-based polymeric scintillators. *Nucl. Instrum. Meth. A* 1042, 167445 (2022), [doi:10.1016/j.nima.2022.167445](#), [arXiv:2203.15923](#)
- G. Bernardi *et al.* The Future Circular Collider: A Summary for the US 2021 Snowmass Process. March, 2022. [arXiv:2203.06520](#)
- A. Belloni *et al.* Test beam study of SiPM-on-tile configurations. *JINST* 16, P07022 (2021), [doi:10.1088/1748-0221/16/07/P07022](#), [arXiv:2102.08499](#)
- M. T. Lucchini *et al.* New perspectives on segmented crystal calorimeters for future colliders. *JINST* 15, P11005 (2020). [doi:10.1088/1748-0221/15/11/P11005](#), [arXiv:2008.00338](#)
- Q. Wang *et al.* An improved evaluation of the neutron background in the PandaX-II experiment. *Sci. China Phys. Mech. Astron.* 63, 231011 (2020). [doi:10.1007/s11433-019-9603-9](#), [arXiv:1907.00545](#)
- Kaixiang Ni, Yihui Lai *et al.* Searching for neutrino-less double beta decay of  $^{136}\text{Xe}$  with PandaX-II liquid xenon detector. *Chinese Phys. C* 43, 113001 (2019). [doi:10.1088/1674-](#)

[1137/43/11/113001](#), [arXiv:1906.11457](#) (Selected as The Most Influential Paper of 2020 by the Chinese Physical Society)

## RESEARCH EXPERIENCE

### Search for Higgs boson pair production with one associated vector boson

Feb. 2021 - Present (lead analyzer)

- Developed the overall analysis strategy to optimize simultaneously for the Higgs boson self-coupling  $\kappa_\lambda$  and the coupling of two Higgs bosons with two vector bosons  $\kappa_{2V}$
- Led studies in the lepton decay channels of vector boson
- Led studies in the boosted topology, demonstrated its importance to  $\kappa_{2V}$  sensitivity

### STXS measurement of the Higgs boson produced in association with W or Z bosons in the $H \rightarrow b\bar{b}$ decay channel

Aug. 2022 – Mar. 2024 (analyzer)

- Collaborated with the Princeton team on the mass-based analysis
- Performed comprehensive background model validation to avoid bias on signal strength
- Managed to update the effective field theory interpretation of this measurement

### Precision measurement of Higgs boson properties with combination

Aug. 2022 - Present (analyzer)

- Collaborating on the Run-II **single Higgs boson** combination and developing the combination tools
- Collaborating on the combined measurements of Run-II **double Higgs boson** production
- Collaborating on the combination of **single and double Higgs boson** production to constrain the Higgs boson self-coupling

### Search for new particles decaying into W boson and photon

July 2021 - Present (analysis contact)

- Leading the search for new particles in the  $W\gamma$  final state, with  $W$  boson decays leptonically
- Achieved the strongest exclusion limits on the cross-section of new particles decaying in the  $W\gamma$  final state within the search region

### Missing transverse momentum (MET) estimator developments

Feb. 2021 - Present

- Development of Graph Neural Network-based MET estimator (DeepMETv2), with 10% to 20% improvements in resolution compared to PF and Puppi MET
- Preparation of the training sample

### Other research within CMS

Sep. 2019 - Present

- **Analyzer** for the Run-III HF-based luminosity measurement. Working on the luminosity calibration, lookup table maintenance, and daily shifts

- **HCAL operation and detector performance study**
  - Optimized zero suppression thresholds for the Run-III operation via Monte Carlo simulation. Improved pulse shape simulation using HCAL phase scan
  - HCAL operation on-call, took the most shifts during the 2022 data-taking period
- **HGCAL scintillation tiles optical simulation**
  - Co-developed a Monte Carlo optical simulation framework to simulate the photoresponse of SiPM-on-tile configurations
  - Analyzed simulation data and compared it with test beam results to validate simulation models and optimize scintillation tile designs

### **Radiation damage study of plastic scintillators**

Feb. 2020 - Feb. 2022

- Investigated the scintillator light yields for different materials, under different radiation damage conditions
- Developed an experimental setup to study the recovery of damaged scintillators using LED lights

### **Study of homogeneous dual-readout calorimeter for future collider**

Feb. 2020 - July 2022

- Implemented and verified the optical simulation with a crystal calorimeter
- Developed Monte Carlo tools to guide experimental design and material selection

### **Searching for Neutrino-less Double Beta Decay of $^{136}\text{Xe}$**

Aug. 2018 - July 2019

- Lead analyzer for this first NLDBD result reported from a dual-phase xenon experiment
- Led the study of event selection criteria, developed the statistical fitting tool

## **PROFESSIONAL EXPERIENCE**

- **Combine Contact** for Higgs Group Sep. 2023 - Present
- **Monte Carlo Contact** for the Higgs to  $b\bar{b}$  Group July 2023 - Present

## **HONORS AND AWARDS**

Dean's Fellowship, UMD, <i>The highest honor awarded to entering graduate students</i>	2019 - 2020
Excellent Bachelor Thesis award of SJTU, <i>Top 1%</i>	2019
Outstanding Graduates Award of Shanghai, <i>Top 5%</i>	2019
Overseas Alumni Scholarship, SJTU	2017
International Summer school on TeV Experimental Physics "individual excellence award"	2017
Academic Excellence Scholarship of SJTU	2017
National Endeavor Scholarship, SJTU	2016

## **PRESENTATIONS AND POSTERS**

- Invited to the 73rd Lindau Nobel Laureate Meeting (only 650 Young Scientists from all over the world were invited), Lindau, Germany, June 2024

- *Latest combined Higgs boson measurements from CMS.* **Talk** presented at the Higgs 2023 conference, Beijing, China, Nov. 2023
- *Search for Higgs boson pair production with one associated vector boson in proton-proton collisions at  $\sqrt{s} = 13$  TeV on CMS.* **Poster** presented at the CMS 2023 collaboration meeting in Saint-Malo, Saint-Malo, France, April 2023
- *Combining Dual-Readout Crystals and Fibers in a Hybrid Calorimeter for Future  $e^+e^-$  Higgs Factories.* **Talk** presented at the 2022, 19<sup>th</sup> International Conference on Calorimetry in Particle Physics, University of Sussex, Brighton, UK, May 2022

## OUTREACH

- CERN Certifications: CMS underground visit guide
- Mentor: Maryland Physics Mentorship program