# Career Development: Graduate Students

About Me

➢ Ph.D. in 2003 from University of Pennsylvania

➢ Now professor at Iowa State University

➢ Research experiences:
- ✓ CDF II at Fermilab: 1999– 2003
- ✓ Babar experiment at SLAC: 2003 – present
- ✓ ATLAS experiment at CERN: 2009 – 2021
- ✓ Belle II experiment at KEK: 2020 – present
- ✓ Others activities: phenomenology, detector R&D, CEPC, etc.

➢ Student and Postdoc supervisions
- ✓ 5 PhD (2 current, 3 graduated), 2 MS (1 current, 1 graduated)
- ✓ 8 Postdoc (2 current)
- ✓ Work directly with many other PhD students/postdocs at ISU and non-ISU institutes.
- ✓ Former students/postdocs in both academia (faculty, lab staff, postdoc) and private industry (Data scientist, software engineer, quantitative analyst in Finance)

Common Career Path

Desired Future Employment Sector of New Physics PhDs, Classes of 2015 & 2016 Combined

- Academia 42%
- Private Sector 38%
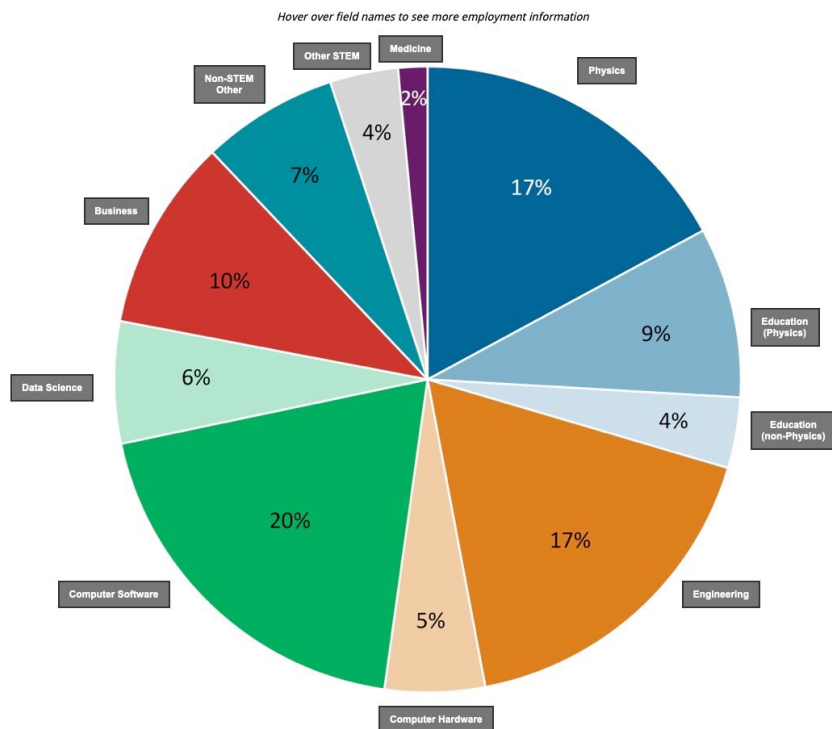- Government 15%
- Other 5%
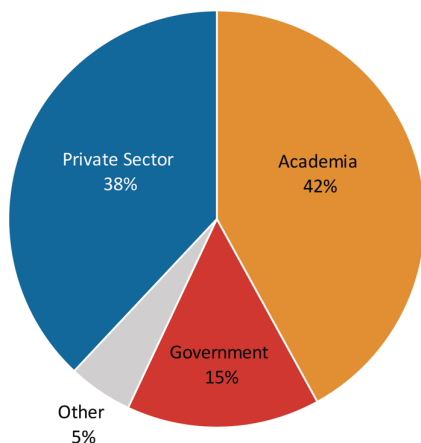
Note: "Other" includes nonprofit organizations, hospitals, and other unspecified employment sectors.

AIP | Statistics

aip.org/statistics

Employment fields for new physics PhD recipients in potentially permanent positions, classes of 2013 through 2018

Hover over field names to see more employment information

- Physics 17%
- Education (Physics) 9%
- Education (non-Physics) 4%
- Engineering 17%
- Computer Hardware 5%
- Computer Software 20%
- Data Science 6%
- Business 10%
- Non-STEM Other 7%
- Other STEM 4%
- Medicine 2%

➢ My talk focus on pursuit of academia (research) position in physics:
   ✓ Faculty in college/university, researchers in governmental labs.
➢ Many suggestions/comments equally applicable to industry positions

Academia Career Path

Get your PhD degree

⬇

Find a postdoc position

⬇

Look for a permanent position in Academia

Criteria to obtain a PhD degree

➢ No single answer

➢ What I told my students:

- ✓ Develop a high level of independent problem-solving skill
- ✓ Develop independent research and critical thinking capability
- ✓ Finishing an independent research work with creative component
- ✓ Publication of thesis work is not mandatory, but important
  - • Especially for pursuit of an academia position
  - • Also helpful for industry position

Some lessons learned for PhD students

- ➢ Data Analysis
  - ✓ Understand the detector principle and physics behind each objects
  - ✓ Knows details and always look for improvement/new ideas
  - ✓ Have a broad understanding/knowledge of the experiment (HEP)
    - • Pay attentions to other analysis in the experiments
    - • Reading literatures: eprint, etc.
    - • Attend the working group meetings and ask questions
- ➢ Team work
  - ✓ Collaborate with other people if you can
  - ✓ Know your limit, ask for help
    - • Not afraid of showing your ignorance
- ➢ Regular presentation in the group meetings
  - ✓ Communication skill, feedback on your research
  - ✓ Showcase your talent/work (let people/collaboration know you)
- ➢ Technical expertise and service work
  - ✓ Very important but often ignored
  - ✓ Become an expert on one specific area, a way to get to know big picture
- ➢ Multitasking skills

Looking for a postdoc position

➢ Think about what you want to do
- ✓ Same experiment or different
- ✓ Which physics: Higgs, flavor or even neutrino

➢ Start the application 3-4 months before your graduation
- ✓ Ready to give a talk about your own work
- ✓ Check websites for openings
  - HEP postdoc opening are year round

➢ Prepare Application materials
- ✓ Cover letters
- ✓ CV
- ✓ Research statement
- ✓ 3-4 Reference letters
  - Letters from junior/senior faculty who knows your work
  - Letters from senior postdoc OK, but sometime less desirable
  - Letters from different institutes

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> Length: as long as needed with details
> Name, contact information
> Education

> Research experience with details
> - ✓ Data analysis
> - ✓ Detector R&D
> - ✓ Service/technical works: software, detector performance etc.

> Award
> Leadership position
> Selected publication
> - ✓ You are one of the primary authors
> - ✓ Explanation of your contribution in research experience section

> Internal Belle II publications

> Selected presentation
> - ✓ Conference & workshop
> - ✓ Major talks at Belle II
> Others: software skills etc.

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EDUCATION

Huazhong University of Science and Technology — Wuhan, China
Bachelor of Physics — Aug. 2010 – May 2014

Iowa State University(ISU) — Iowa, U.S.
Ph.D. in Physics — Aug. 2015 – Nov. 2020

ATLAS EXPERIENCE

Physics analysis

Search for $H\gamma$ resonance, submitted to PRL, arXiv:2008.05928 — Aug.2018 - Aug.2020
- Many extensions of the standard model (SM) predict a new particle that decays into a SM Higgs boson and a photon. Since summer 2018, I had been working on an analysis as the main analyzer to search for new massive neutral bosons decaying to a photon and a Higgs boson with subsequent hadronic decay $H \to b\bar{b}$. The search uses $139\ fb^{-1}$ of pp collision data at $\sqrt{s} = 13$ TeV collected with the ATLAS detector during the Run 2 data taking period. We implement the newly proposed Center of Mass (CoM) Higgs tagger by ISU group in this analysis. This novel algorithm uses information about the jet constituents in the center-of-mass frame of the jet, which significantly improve our performance by more than 30% compared with the previous ALTAS and CMS search. I am the main analyzer of this analysis. I also serve as the contact person and I am the main contact editor of the analysis supporting note. This analysis constitutes my PhD thesis.

Search for lepton flavor violation $Z \to e\mu$ — Sep.2019 -
- In the SM, lepton flavor violating (LFV) processes are strongly suppressed. Thus, searches for LFV processes are good candidates for probing new physics. Since winter 2019, I have been working on searching for a SM Z boson decay to $e\mu$ as the main analyzer. The search uses $139\ fb^{-1}$ of pp collision data at $\sqrt{s} = 13$ TeV collected with the ATLAS detector during the Run 2 data taking period. Compared with run 1 $Z \to e\mu$ search, several improvements have been implemented, including a multivariable analysis based on the boosted decision tree algorithm. The analysis is currently under the internal review in the ATLAS Lepton+X(LPX) group for the unblinding approval. I am the contact person, the contact paper editor and main analysis note editor of the analysis.

Search for $V\gamma$ resonance — Aug.2018 -
- Many extensions of the standard model (SM) predict a new particle that decays into a SM Z/W boson and a photon. Since summer 2018, I have worked on this analysis and made significant contribution. The search uses $139\ fb^{-1}$ of pp collision data at $\sqrt{s} = 13$ TeV collected with the ATLAS detector during the Run 2 data taking period. The analysis is unblinded and currently under the ATLAS internal review for publication.

Performance study

Development of Quality Control Methods for ATLAS Phase II upgrade — Jul.2016 - Nov.2017
- A major component of the Phase II upgrade is the construction of the new all silicon tracker (ITk), which is comprise of barrel and endcap components. At ISU, I played one of the major roles in developing two quality control (QC) methods and their instrumentation to test for possible mechanical and structure defects of the stave cores: the thermal imaging method and the laser scanning method. The thermal imaging QC measurements of the stave cores are based on the visualization of the surface temperature of an actively cooled or heated stave core in ambient room temperature using an infrared camera. The laser scanning QC method measures precisely stave core surface height under a pressure to detect internal structure flaws. Both methods and the corresponding hardware implementations have been successfully designed and built. The ITk management has accepted them as standard QCs for the stave core production.

Qualification task: Track-to-subjet association optimization — Aug.2017 - Oct.2018
- From summer in 2017 to winter in 2018, I had worked on the task to investigate and optimize the track-to-subjet association algorithm for variable radius and CoM jets of the advanced $H \to b\bar{b}$ taggers for the ATLAS Run2 data, and the expected performance with very high pileup condition in future HL-LHC. Besides physics studies, my qualification task involves extensive code development in order to adopt the CoM Higgs tagger into the existing analysis framework used by the Xbb subgroup.

ATLAS Tracking: Re-train Neural Network for pixel cluster splitting — Jan.2020 -

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CV

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- Since January 2020, I have worked on the task to optimize and re-train the pixel Neural Network to improve pixel cluster splitting. This pixel Neural Network is used to identify the number of tracks associated to the cluster and their hit position. I optimized the training strategy to improve the performance, did the k-fold validation to test the stability, and fix a few bugs for the previous training script. The re-training model will be implemented into the official ATLAS software.

Award
- Bowie Fellowship award in Iowa State University — 2015 - 2017
- APS April meeting student travel award from DPF — Apr 2019

Leadership
- Main analyzer of $H\gamma$ resonance and LFV $Z \to e\mu$ analysis
- Lead developer of pixel cluster splitting neural network

Selected Publication as the primary author

[1] ATLAS Collaboration, "Search for heavy resonances decaying into a photon and a hadronically decaying Higgs boson in pp collisions at $\sqrt{s} = 13$ Tev with the ATLAS detector", submitted to Physical Review Letters, arXiv:2008.05928

Selected ATLAS internal note

[1] "Search for $H\gamma$ resonances in boosted large-R jet plus photon final states with 140 fb^{-1} pp collision data at $\sqrt{s} = 13TeV$ collected by the ATLAS detector", ATL-COM-PHYS-2019-466

[2] "Search for the Lepton Flavor Violating decay $Z \to e\mu$ with the ATLAS detector in Run2", ATL-COM-PHYS-2018-499

[3] "Search for $Z\gamma$, $W^{\pm}\gamma$ resonances in boosted large-R jet plus photon final states with 140 fb^{-1} pp collision data at $\sqrt{s} = 13TeV$ collected by the ATLAS detector", ATL-COM-PHYS-2019-1263

[4] "Background Calibration of $H \to b\bar{b}$ Center-of-Mass Tagger", ATL-COM-PHYS-2019-490

[5] "B-tagging Calibration of $H \to b\bar{b}$ Center-of-Mass Tagger", ATL-COM-PHYS-2018-1142

[6] "Qualification task summary", ATL-COM-GEN-2018-021

Selected Presentation

[1] Status of Pixel cluster splitting update (MDN, NN retraining)
Inner Tracking CP Weekly during ATLAS Physics and Performance Weeks week — 16 Sep 2020

[2] $H\gamma$ resonance search paper meeting
Paper Approval Meeting and Paper Closure Meeting, CERN, Geneva, Switzerland

[3] $H\gamma$ resonance search update
HDBS Plenary during ATLAS Physics and Performance Weeks week — 11 Jun 2020

[4] Paper presentations for the $H\gamma$ resonance search
ATLAS Weekly, CERN, Geneva, Switzerland — 28 Apr 2020

[5] Summary of DBL analysis for Moriond
HDBS Plenary, CERN, Geneva, Switzerland — 30 Jan 2020

[6] Presentation for the analysis "Search for $H\gamma$ resonance"
APS April 2019 meeting, Denver, Colorado, US — 14 Apr 2019

ACTIVITY

USATLAS/FIRST-HEP Computing Bootcamp 2019 — Aug 2019, LBNL, U.S
Learn and practise the computing software including GitLab, Docker, CMake, etc.

Teaching experience
Teaching assistant in Iowa State University — Aug.2015 - Aug.2017

COMPUTER SKILLS

Programming Languages: C++, python, Fortran, LaTeX
Software: ROOT, Athena, Keras, Matlab, Mathmatica, Maple, Labview
Operation system: Linux: maintainer of Tier3 machine in Iowa State University

Interview and Offers

- ➢ What expected for onsite Interviews (less often nowadays)
  - ✓ Give a HEP seminar
    - Present your own work
    - Knows details on what you present
  - ✓ One-on-one interaction with group faculty/students/postdocs
    - Questions on technique details of your research experiences
    - Your career plan, research plan etc
  - ✓ Have lunch/dinner with hosts
    - Not to relax too much: it is a part of interview as well!

- ➢ What expected for zoom interview (more common nowadays)
  - ✓ Similar to above but much shorter
  - ✓ 20-30 minute talk on your work
    - Keep your slides/talk concise with lots of backup materials
  - ✓ Questions/discussion afterwards

- ➢ Decide on multiple offers