

TIMESTEP Astronomical Software Engineering Internship

Workforce Development for Undergraduate Majors in the Physical Sciences at the University of Arizona

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The Astronomical Software Engineering (Astro SE) Internship places Astronomy and Physics juniors and seniors into software development teams working on cutting-edge scientific software challenges in Astrophysics. Students are trained through technical workshops focused on modern software engineering principles, including: code optimization, documentation, collaborative development practices, and how to understand and use emerging AI tools. The program prepares students for the technical realities of pursuing careers in industry and advanced scientific research as emerging technologies (AI/ML) fundamentally alter the computational landscape.

The 2025-2026 Program: Preparing UA Astronomy Majors for High-Tech Careers Through Software Engineering



Interns: Ram Muthukumarasamy, Nayera Abdessalam, Rohin Sant, Hayden Marchinek and Graduate Coordinator, Hayden Foote.

Piloted in 2025, this first year of the Astro SE program funded four UA Astronomy and Physics undergraduates to build a new student software engineering team (*left*) for the Event Horizon Telescope (EHT) Collaboration. The team focused on software optimization for massive EHT data sets that hold information about the material around the super massive blackholes at the centers of galaxies.

Interns were supported by a graduate student (Hayden Foote, PhD Astronomy) and a faculty lead (Dr. Chi-Kwan Chan, Astronomy).

This program has enabled new partnerships between Astronomy/Physics and **Software Engineering** and **Planetary Sciences** at UA. Current partners include Dr. Diana Diazh and Sharon ONeal in ECE and Michael Phillips in LPL.

Goal 1: To Build a Valued Program that Advances Student Career Goals

Interns reported high satisfaction in the program and with its impact on their career aspirations.

- **100%** of the interns would recommend the program to their peers
- **100%** of the interns agreed that this program supported them in achieving/working toward their career goals.
- **100%** of the interns agreed that this internship helped clarify their career goals

2025-2026 Interns Report:

"My career goals have become broader through this internship. . . I see software engineering as a strong option. Working on real code and systems showed me I enjoy building tools and solving engineering problems as much as doing physics."

"This project has definitely encouraged me to heavily incorporate a computational component into my career goals"

"This internship has been very valuable in preparing me for my career goals. Just having coursework, or even department specific research, did not prepare me for what it was like to work in an industry setting, which is what I hope to be doing upon finishing my PhD."

Goal 2: To Prepare Students to Meet Expectations of their Future Careers in Industry or Advanced Education

High-tech careers in industry and academia demand high computational proficiency owing to rapid technological advances in AI/ML. Students need advanced computational training; however, technological advancement is outpacing curriculum reform. The Astro SE program addresses major gaps in computational training in the Astronomy and Physics major curriculum, namely in Software Engineering concepts and the usage of AI Agents to build software.

“This [program] is a great bridge between research and software engineering in industry because it is run in an academic setting but develops skills that are useful in both research and a software engineering position. It is a truly unique experience and you will learn more than you would ever expect.” - 25-26 Intern

Through weekly skills workshops (26 total), this internship offers UA students core training in software engineering and industry best practices. 100% of interns reported increased confidence in their ability to code at industry standard levels after the internship. Workshop topics (not covered in Astronomy/Physics major courses) include:

Technical Skills (Software Engineering)

- Code documentation
- Writing and running tests
- Database schemes
- Automation strategies for large-scale data analysis
- Software Optimization
- Continuous Integration / Continuous Delivery
- Docker, Kubernetes, and distributed computing

Durable Skills / Soft skills:

- Version control-Git, GitHub, Git Client
- Debugging
- Coding with AI Agents like Github Copilot
- Software Engineering Best Practices
- Team communication modes/Agile: standup meetings, product demos, code review



(Left) The Intern team participating in a weekly Agile Standup Meeting. (Right) The intern team participating in a workshop on code documentation, led by Astronomy graduate student Sóley Hyman.

Key Outcomes Related to AI Training: Interns were introduced to AI tools towards the latter half of the program, after having established fundamentals in software engineering. One intern reported that “using AI to support the development of the coding saved us 7 months of work.” However, students were quick to add that this progress **would not have been the same if they had used AI tools earlier as they would not have known what would / would not work.** Student feedback and outcomes validate the Astro SE workshop/program design. As one student said, “I liked how AI was dealt with in the program. I wanted to get experience on my own before using AI.” Student interns were featured in an OpenAI documentary related to their experience with this internship.

Goal 3: For Students to Meaningfully Contribute Software for a Cutting-Edge Astronomical Research Collaboration



The student team developed the `hallmark` software (*outlined below*) and demoed the software to the Event Horizon Telescope (EHT) team in a presentation, where they articulated the skills they have learned (*image on left*). EHT team members requested to use the software after the demo.

hallmark

Reproducibility is the [hallmark](#) of the scientific method.

Modern science has become so complex that many science projects rely on multiple software packages to work in unison, resulting in networks of data products along the analyses. Versioning and managing these data products are essential in making modern data- and computation-intensive science reproducible.

Motivated by the [Event Horizon Telescope \(EHT\)](#)'s observational data calibration pipelines and theory data analyses tools, [hallmark](#) is a lightweight package designed to version control and manage data products in a complex workflow. It provides a simple abstraction and a uniform Application Programming Interface (API) on top of different backend technologies such as [POSIX file system](#), [object storage](#), [globus](#), [iRODS](#), [stream](#), etc. By using [hallmark](#) with other packages such as [yukon](#) and [banyan](#) in [Project Laniakea](#), researchers can utilize computing infrastructures in a global scale to accelerate their science.

Interns reported feeling proud of building a valued product to advance Astronomy research. The faculty lead affirmed the value of the program as an effective way to create cutting-edge software that is high quality and maintainable.

"I feel most proud that our team built something that actually works and is useful for real research. We improved the code, made it more structured and reliable, and worked together to solve problems and push the project forward" – 25-26 Intern

"We have a `hallmark` release on the Python package index, so people can now install the software and use it, and this is great. If other PIs allow students to work on their projects, they will get better quality software." – Dr. Chi-Kwan Chan

Goal 4: To Give Students the Skills and Experience to Secure Competitive Positions After the Internship

Student career outcomes after completion of the Astro SE Internship are strong:

- 100% of participating seniors (2) received **multiple graduate school offers in Astronomy and Physics Depts.**
- 100% of participating juniors (2) secured **nationally competitive summer positions**, including an NSF REU and an IBM Internship, highlighting the potential for this program to build partnerships with tech companies.
- Graduate Coordinator, Hayden Foote, received a College of Science Graduate Student Teaching Award

Astro SE Student Intern Spotlight: *Nayera Abdessalam*



UA undergraduate major in the Department of Astronomy and Department of Physics, expected graduation May 2027

"The TIMESTEP Astro Software Engineering Internship has given me the opportunity to combine my interests in astronomy and coding—allowing me to do what I really want to do, support black hole research through software engineering. No classwork directly supported this project. This program taught me skills that I wouldn't have learned anywhere else and set me up for an IBM internship in software engineering this summer." – Nayera Abdessalam

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