Meera Patel

February 22, 2026
Prof. Dr. Vreeswijk and Prof. Dr. Verkerke
Nikhef, University of Amsterdam

Dear Dr. Vreeswijk and Dr. Verkerke,

I am writing to apply for the PhD position on "When Higgs bosons meet Top quarks" within the Nikhef ATLAS group. I am currently completing my Master's in Physics and Astronomy at the University of Amsterdam, working on my thesis at Nikhef under Dr. Tina Pollmann. The challenge of disentangling the gg->HZ process from the dominant qq->HZ background, and using modern deep learning techniques to probe the poorly constrained top Higgs interaction, is a compelling problem that sits at the intersection of my interests in data analysis, computational physics, and machine learning. While my research experience to date has been in detector R&D and muon physics rather than collider analysis, I believe my strong computational and data analysis skills, combined with my familiarity with the Nikhef environment, make me well suited to contribute to this project.

I have built a solid foundation in computational methods throughout my studies. During my Bachelor's at Boston University, I worked as a research assistant on the Fermilab g-2 experiment, where I developed particle extrapolation algorithms in C++ using CERN's GEANE package and ROOT for data visualization. This was my first real research programming project, and I was able to bring it to completion after it had been started by previous students, ultimately achieving a 4x improvement in speed through careful optimization. This experience gave me hands on familiarity with the C++ and ROOT ecosystem that is used in ATLAS analysis work. Since then, I have continued to develop my programming skills in Python, Fortran, and Linux/Bash, and have completed coursework in machine learning for physics at UvA. Although I have not yet applied deep learning methods in a research context, I am eager to develop expertise in techniques such as Transformer networks, which I understand are in development for the analysis work to be done in these positions.

In my current master's thesis work on the VULCAN experiment at Nikhef, I am measuring photoluminescence lifetimes of wavelength-shifting materials for liquid noble gas dark matter detectors. While the physics context differs from collider physics, the data analysis challenges share common ground. I have implemented matched filtering techniques to recover signals buried in noise, refactored our analysis pipeline to improve efficiency by over an order of magnitude, and designed hardware upgrades for the experimental setup. This work has sharpened my ability to think critically about systematic effects and signal extraction, skills that are directly relevant to the careful treatment of backgrounds and systematic uncertainties that measurements at the LHC demand. Working at Nikhef has also given me an appreciation for the collaborative and open research environment here, and I have enjoyed supervising bachelor's students on the VULCAN experiment and other practical courses.

I am particularly drawn to the prospect of using the gg->HZ process to separately probe top-Higgs interactions, especially since no independent cross section measurement of this process exists yet. The idea that modern deep learning architectures can exploit the structure of the Lagrangian itself to achieve sensitivity to anomalous couplings is very exciting, and I would

welcome the opportunity to contribute to both the physics analysis and the further development of these methods. More broadly, the chance to work within the ATLAS collaboration, with the possibility of extended stays at CERN, aligns with my long term goal of pursuing a career in experimental particle physics research.

Thank you for considering my application. I would welcome the opportunity to discuss how my background and skills could contribute to your research program.

Sincerely,
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