Meera Patel

February 22, 2026
Prof. Dr. Björn Penning
University of Zurich

Dear Dr. Penning,

I am writing to apply for the PhD position in cryogenic dark matter searches within your group at the University of Zurich. I am currently completing my Master's in Physics and Astronomy at the University of Amsterdam, working on my thesis at Nikhef on detector R&D for liquid noble gas dark matter experiments. The opportunity to contribute to TESSERACT and pushing sensitivity to light dark matter candidates with superconducting quantum sensors is a natural and exciting next step from my current work, and I am hopeful to bring my experience in detector hardware, data analysis, and signal processing to this effort.

My master's thesis on the VULCAN experiment at Nikhef is directly relevant to this position. VULCAN measures photoluminescence properties of wavelength-shifting materials at VUV wavelengths, with the goal of characterizing and mitigating background sources in noble gas dark matter detectors, such as XENONnT. I contribute to both the hardware and analysis sides of the experiment. On the hardware side, I have designed upgrades for the vacuum setup using CAD, including a new cooling system for the SiPMs to reduce dark count rates, and I am planning the installation of an optical chopper to measure photoluminescence time decay form and constants. On the analysis side, I have refactored the data processing pipeline to improve efficiency by over an order of magnitude, and implemented matched filtering to recover sensitivity lost to noise, which is relevant to signal extraction in cryogenic detectors where backgrounds and noise are challenges. I also enjoy supervising bachelor's students working in the lab. Additionally, I received the Olga Igonkina Foundation Travel Grant to visit AstroCENT in Poland, where I will conduct VUV photoluminescence measurements in a liquid argon cooled setup and fabricating calibrated wavelength shifters. This work has given me a thorough understanding of the interplay between detector hardware, background mitigation, and data quality that is central to rare event searches.

Prior to my master's, I worked as a research assistant on the Fermilab g-2 experiment at Boston University, where I developed particle extrapolation algorithms in C++ using CERN's GEANE package and ROOT, achieving a 4x performance improvement through optimization. I am experienced in C/C++, Python, Fortran, and Linux/Bash, and have worked on computing clusters at Fermilab, Nikhef, and the national Snellius supercomputer. I have also completed coursework in machine learning for physics using PyTorch, and in astroparticle physics, which introduced me to the landscape of dark matter detection strategies including cryogenic approaches.

While I do not have direct experience with superconducting sensors or dilution refrigerator systems, my laboratory detector R&D work, through hardware design, cryogenic cooling, photon detection, and low level signal analysis, provides a strong foundation to build on. I am particularly drawn to developing expertise in superconducting detector technologies, and especially for light dark matter searches which is my primary research interest. The broader

scope of your group's involvement in LZ and XLZD also works well with my existing connection to the liquid xenon dark matter program through my work at Nikhef.

Thank you for considering my application. I would welcome the opportunity to discuss how my background in detector R&D and data analysis could contribute to your group's research.

Sincerely,
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