Ayush Priyadarshi

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Research Profile

Integrated BS–MS Physics student at IIT Roorkee with experience in computational detector physics, scientific software development, Geant4-based Monte Carlo simulations, ROOT-based analysis, and gamma-ray spectroscopy. My current research develops and applies angle-resolved detector-response methods and reproducible software for coincidence-summing corrections in positron emitters.

I am interested in PhD research involving detector simulations, radiation detection, nuclear or particle instrumentation, scientific software, computational physics, and high-performance simulation workflows.

Research Interests

Computational Physics; Scientific Software Development; Monte Carlo Simulations; Geant4; Detector-Response Modelling; Radiation Detection; Gamma Spectroscopy; Coincidence Summing; Radioactive-Source Modelling; High-Performance Computing.

Education

Indian Institute of Technology Roorkee Roorkee, India
Integrated Bachelor of Science–Master of Science in Physics Nov. 2021 – Expected Apr./May 2027
Current CGPA: 4.542/10
Relevant Coursework: Programming, Computational Physics, Nuclear Physics, Optics, Electronics, Quantum Mechanics, Condensed Matter Physics, Laboratory Physics.

Master's Thesis: A Python-Assisted Geant4 Workflow for Automated Scintillation Detector Response Simulations
Supervisor: Prof. Anil Kumar Gourishetty
Thesis Performance: Stage I: 8/10; Stage II: 9/10

Research Experience

Angle-Resolved Annihilation-Photon Correlation Factors for an Annular NaI(Tl) Detector August 2026
Department of Physics, Indian Institute of Technology Roorkee
Role: First and Corresponding Author

Led the annular-detector study required before extending the coincidence-summing formalism to the soccer-ball array.

- Corrected an earlier unpublished derivation and developed a full-interval calculation of w_{L1}, w_{L2}, and w_G without assuming a direction-independent peak-to-total ratio.
- Led the one-million-event, angle-resolved Geant4 analysis, fitted detector-response coefficients, and validated the physics against NIST XCOM and physical/experimental checks.
- Obtained $w_{L1} = 1.260741$, $w_{L2} = 1.253825$, and $w_G = 1.269388$ for the stated ideal annular geometry.
- Released the BSD-licensed Angular Factors Calculator with ROOT analysis, coefficient-based calculation, numerical cross-checks, structured outputs, tests, and citation metadata.
- Prepared and submitted the complete first-author conference paper to the DAE Symposium on Nuclear Physics 2026.

Repository: github.com/ayushpriyadarshi-18/angular-factors-calculator

Coincidence-Summing Correction for β^+ Emitters in a Near-4π NaI(Tl) Detector Array July 2026–Present
Department of Physics, Indian Institute of Technology Roorkee
Supervisor: Prof. Anil Kumar Gourishetty

Extended the Geant4–Python platform developed during my thesis for an ongoing study of coincidence-summing corrections in beta-plus emitters. Prof. Gourishetty is developing the correction formalism; my work provides the detector and source modelling, geometry-dependent angular factors, and computational validation required to apply it.

- Reconstructed the published eight-block near-4π NaI(Tl) reference detector of Byun et al. and reproduced its angular factors within a maximum relative difference of 2.3%.
- Implemented custom Geant4 sources from nuclear decay schemes, including emission probabilities, characteristic gamma rays, and back-to-back 511 keV annihilation photons.

- Completed 10^8-event simulation campaigns for Na-22, O-14, and Sc-44 and calculated the detector-specific angular factors for the 32-element TIFR soccer-ball array.
- Benchmarked the detector model against published experimental measurements for the physical TIFR array and validated the correction procedure against separate coincidence-free monoenergetic simulations.
- Ongoing work toward a peer-reviewed journal manuscript; confirmed second author.

Master's Thesis Research and Software Development
A Python-Assisted Geant4 Workflow for Automated Scintillation Detector Response Simulations 2025–Present
Department of Physics, Indian Institute of Technology Roorkee
Supervisor: Prof. Anil Kumar Gourishetty

Developed an automated Geant4–Python workflow for campaign-level scintillation detector response simulations by integrating a Geant4 C++ backend with Python-based macro generation, simulation execution, ROOT-file validation, spectral analysis, count extraction, plotting, and table generation.

- Implemented and maintained a configurable Geant4 C++ simulation backend for scintillation detector studies.
- Developed Python automation scripts for macro generation, batch execution, ROOT-file validation, spectral analysis, and count-table generation.
- Supported monoenergetic gamma simulations, radioactive-decay simulations, beta-plus decay cases, material-dependent studies, detector-size studies, and geometry-dependent studies.
- Implemented and tested solid cylindrical, hollow annular, and custom near-4π soccer-ball detector geometries.
- Performed detector-response studies for NaI, LaBr3, CsI, BGO, GGAG, and PbWO4 scintillator materials.
- Processed ROOT outputs to generate deposited-energy spectra and extract photopeak, sum-peak, and total non-zero energy-deposition counts.
- Executed high-statistics Geant4 simulations on the PARAMGanga HPC facility, including 10^8-event validation runs.
- Consolidated the workflow into a public GitHub repository with reference macros, spectra, count tables, logs, ROOT outputs, and visualisation files.

Repository: github.com/ayushpriyadarshi-18/geant4-detector-simulation-pipeline
Related webpage: ayushpriyadarshi-18.github.io/software

Publications and Conference Presentations

A. Priyadarshi, R. Chauhan, A. Srivastava, and G. Anil Kumar, "Angle-resolved annihilation-photon correlation factors for an annular NaI(Tl) detector," submitted to the DAE Symposium on Nuclear Physics, 2026. Submission date: 8 September 2026.
Role: First and corresponding author.

A. Priyadarshi, G. A. Kumar, K. Madhan, and V. Ranga, "A Python-based Tool for Automated Geant4 Simulations of Scintillation Detectors," accepted for poster presentation at IEEE Nuclear Science Symposium, 2026.
Status: Accepted for poster presentation.

Research Software

Angular Factors Calculator
Role: Developer and Maintainer
Repository: github.com/ayushpriyadarshi-18/angular-factors-calculator

Python package and command-line tool for fitting angle-resolved Geant4 responses and calculating annular-detector annihilation-photon correlation factors from ROOT events or supplied mass coefficients. Includes independent numerical checks, JSON/CSV outputs, tests, continuous integration, and citation metadata.

Geant4 Detector Simulation Pipeline
Role: Developer and Maintainer
Repository: github.com/ayushpriyadarshi-18/geant4-detector-simulation-pipeline

Python-assisted Geant4 simulation pipeline for automated scintillation detector response studies. The software integrates Geant4 C++ detector simulations with Python tools for macro generation, campaign execution, ROOT-file validation, spectrum generation, peak-count extraction, total-count extraction, plotting, and output organisation.

- Automates Geant4 macro generation and campaign execution.
- Validates ROOT outputs and extracts deposited-energy quantities.
- Generates reproducible spectra, count tables, logs, and reference outputs.

- Supports monoenergetic gamma and radioactive-decay simulations.
- Includes solid cylindrical, hollow annular, and near-4π soccer-ball detector geometries.
- Supports NaI, LaBr3, CsI, BGO, GGAG, and PbWO4 scintillator materials.
- Provides public Cs-137 reference demonstrations across multiple detector geometries.
- Forms the software basis of my master's thesis and first-author IEEE NSS 2026 poster presentation.
- Privately extended for ongoing beta-plus-emitter research; unpublished code and research outputs are withheld until approved for public release by the supervisor.

Technical Skills

Programming: Python, C++, SQL, Bash, Fortran, HTML/CSS
Scientific Software: Geant4, ROOT, Monte Carlo simulations, detector-response modelling
Research Automation: Macro generation, campaign execution, ROOT validation, spectral analysis, plotting, CSV/table generation
Tools: Git, Linux, Docker, Qt, MySQL
High-Performance Computing: PARAMGanga, batch simulation workflows, high-statistics Geant4 simulations
Embedded Systems: Raspberry Pi, Arduino, ESP8266, microcontrollers, FPGA, relay circuits
Systems and Networking: Linux administration, Docker services, Samba/NFS, reverse proxy, DNS filtering, network gateway configuration

Laboratory and Instrumentation Skills

Radiation Detection: NaI(Tl) and LaBr3 scintillation detectors, gamma spectroscopy, radioactive sources, detector signal acquisition
Nuclear Electronics: NIM/VME modules, pulse processing, counting systems, oscilloscopes
Instrumentation: FPGA-based systems, microcontrollers, Arduino, ESP8266, Raspberry Pi, relay circuits
Optics: Lasers, optical alignment, interference, diffraction, spectrometers, optical benches
General Physics Laboratories: Condensed matter, atmospheric physics, thermal physics, electronics, optics, and nuclear physics experiments

Engineering and Instrumentation Projects

Radio Telescope Control and Embedded Linux Support
Physics and Astronomy Club, IIT Roorkee
Role: Assisting contributor

Contributed to Raspberry Pi-based embedded Linux and hardware-control support for a student-led radio telescope project.

- Assisted in developing a custom Raspberry Pi image for the radio telescope system.
- Modified boot configuration for reliable startup under lower-voltage portable power conditions.
- Enabled networking over the power/data port for a single-cable portable Linux setup.
- Built support for an initially unsupported Wi-Fi module.
- Assisted with hardware-control integration for telescope operation.

Raspberry Pi Home Server and Network Gateway
Independent systems engineering project

Designed and maintain a Raspberry Pi-based home server for self-hosted services, network management, and automation.

- Deployed Docker-based services including Jellyfin, Home Assistant, Samba/NFS file sharing, reverse proxy services, DNS filtering, and network gateway functionality.
- Gained practical experience in Linux administration, networking, Docker, service deployment, and home automation.

WiFi IP Mouse
First Prize, Syntax Error Hackathon, SDS Labs, IIT Roorkee, 2022
Repository: github.com/ayushpriyadarshi-18/MyPi.git

Built a WiFi-based IP mouse system using Raspberry Pi during the Syntax Error Hackathon.

- Developed a Raspberry Pi-based wireless mouse/control system.
- Implemented network-based communication between the Raspberry Pi and host device.

- Built the project under hackathon time constraints.

IoT Smart Switch with Alexa Integration
Independent embedded systems project, 2020

Built a Wi-Fi-enabled smart switch using an ESP8266 microcontroller and relay-based switching to control household lights and fans through Alexa voice commands.

Python and MySQL Travel Agency Management System
Class XII computer science project, 2021

Developed a terminal-based travel agency management system using Python and MySQL with user authentication, database-backed records, and reporting features.

Awards

- Category Winner, Solar Decathlon India Net-Zero Building Competition – Rs. 1,00,000 cash prize.
- First Prize, Syntax Error Hackathon, SDS Labs, IIT Roorkee, 2022 – Built a Raspberry Pi-based WiFi IP Mouse.

References

Prof. Anil Kumar Gourishetty
Professor, Department of Physics, Indian Institute of Technology Roorkee
Research Supervisor and former Master's Thesis Supervisor
Current research: Beta-plus-emitter coincidence-summing correction study
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