David Rousso

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I am a DESY Research Fellow in fundamental physics, from phenomenology and collider searches for new particles beyond the standard model, all the way to designing new detectors to probe our understanding of nature. After stints in metasurface photonics, biosensing plasmonics, and cold atom physics, I went to Cambridge as a Gates Scholar to do my PhD as part of the ATLAS Collaboration at CERN. Since then I have collaborated across several sub-fields of particle physics at CERN and led an international team across 7 time zones. I particularly enjoy teaching, mentoring research students, outreach, and making physics accessible to students.

I am always eager to discuss and learn about cool new things from others who are excited about what they do, no matter the field.

Research Positions and Degrees

Deutsches Elektronen Synchotron (DESY) *Dec. 2023–Present*
DESY Particle Physics ***Research Fellow***
ATLAS Collaboration @ CERN / ALPS Group @ DESY

Studying Use of Machine Learning for Anomaly Detection Using the Underlying Event [Pheno]
Lead Contributor

- Leveraging the underlying event (the messy tracks in a collision we usually ignore) to enhance sensitivity to resonances (the signal for a new particle).
- Specifically using the Classifying Anomalies THrough Outer Density Estimation (CATHODE) method, which uses a normalizing flow to create a estimate of the background that can be used for a neural network/BDT to distinguish it from signal+background. We investigate a QCD' "quirks" model as our benchmark.
- Personally working on nearly all aspects of the paper from ML implementation and studies, MC validation, analysis design, limit setting, comparisons to cuts and fully supervised learning.
- Along with the PI, collaborating with a theorist who developed the model, and 4 machine learning experts who developed the CATHODE method. Also supervising a PhD student through tasks on this project.
- Paper being submitted to PRD [arxiv.org/abs/2506.11192]

Designing Membrane Resonator Detectors for High Frequency Gravitational Waves [ALPS]
Lead Contributor

- Interesting new physics lie at the higher frequencies of gravitational waves currently out of range of the current LIGO/VIRGO collaborations due to shot noise.
- I am designing a new class of detector that couples the optical signal to a mechanical resonator in the form of a nano-membrane to increase sensitivity.
- Personally working on all aspects of the paper from the COMSOL multiphysics simulations, membrane design/optimization, sensitivity calculations, to paper writing (the project comprises only myself and the PI).
- Also co-supervised a bachelors student on a brief project related to this project.
- Lead applicant on a successful PIER Seed Project grant on this project, for funds for bringing together the aspects of fabrication, characterization setup, and squeezed light readout.
- Paper draft in progress.

Searches for Long Lived Particles in ATLAS: DV+MET Analysis [ATLAS-Analysis: SUSY-2022-15]
Analysis Contact (Analysis Leader)

- *(Continued from the PhD.)*
- Contrary to the assumption made in most searches, investigates the case that the new particles we search for don't decay immediately after being produced in the collision, but live long enough to travel through the detector before decaying.
- Searching for a displaced vertex signature in the inner detector in events triggered by missing transverse energy (i.e. where objects are invisible to the detector).
- Led an international team of $\sim$20 people spread across 7 time zones in 6 countries in a student-driven analysis. Mentored several PhD students at various institutes on the analysis.
- Personally working on the 2-displaced-vertex signal region, specializing in the Higgs portal interpretation, and collaborating with others to develop a new type of data-driven background estimate necessary for our challenging phase space.
- Paper awaiting approval for ATLAS circulation [ATL-COM-PHYS-2024-1051]

Searching for Quantum Gravity Through 4-jet Event Planarity [ATLAS-Analysis: STDM-2023-37]
Contributor

- Some theories of quantum gravity predict a reduction in effective dimension at high energies instead of an increase
- Some cosmic ray experiments in the mid-20th Century have discovered an unusually large proportion of planar events at higher energies
- We therefore want to see if we also see a higher proportion of planar 4-jet events at the LHC, which could be evidence of dimensional reduction required of some quantum gravity theories.
- Personally working on the analysis design for the quantum gravity measurement portion in an analysis team of $\sim$10 people.

Electron/Photon Physics Validation Contact [ATLAS-Reconstruction]
e/gamma (Electron/Photon) Group

- Weekly/biweekly validation tasks of release/simulation changes to monitor effects on electron/photon reconstruction
- Also developing code to overhaul and modernize the way we do this at least on the electron/photon side.

Electron/Photon Physics Automated Release Testing Contact [ATLAS-Reconstruction]
e/gamma (Electron/Photon) Group

- Daily monitoring (and maintaining code for monitoring) nightly releases of Athena (central ATLAS software framework) for changes to electron/photon reconstruction
- Also developing code to simplify reporting of these monitoring results.

Other

- ATLAS Control Room Shifts - Inner Detector Desk
- ATLAS ITk (inner tracker upgrade) test-beam shifts - Shifter
- Beamline for Schools (BL4S) - First Round Evaluator (team of judges creating shortlist of high school beamline proposals)
- CERN International Physics Masterclass - Moderator (moderate CERN zoom sessions at the end of the masterclass, and answer high school student questions about being a physicist)

University of Cambridge *2019-2023*
PhD Particle Physics *- Gates Cambridge Scholar*
ATLAS Collaboration @ CERN / Cavendish Laboratory - HEP

Searches for Long Lived Particles in ATLAS: DV+MET Analysis [ATLAS-Analysis: SUSY-2022-15]
Analysis Contact (Analysis Leader)
- *[See this section under DESY]*

Searches for Long Lived Particles in ATLAS: DV+Jets Analysis [ATLAS-Analysis: SUSY-2018-13]
Major Contributor
- Similar to the above, except searching for a displaced vertex signature in the inner detector in events triggered by multiple jets (i.e. collimated hadronic activity).
- Expert in backgrounds and truth studies, trying to understand how different types of displaced vertices can be produced in ATLAS with just the standard model that we need to account for. Responsible for background characterization and estimation, Higgs-DM portal reinterpretation. Also work in limit setting and MC production.
- Paper published in JHEP [JHEP 06 (2023) 200]

Developing Automated Strip Sensor Quality Control Evaluation [ATLAS-ITk: Qualification Task]
Lead Designer and Developer
- O(1000) strip sensors for the ATLAS inner tracker upgrade (ITk) each need to be individually tested for quality control (QC) by technicians before being approved for assembled, however there was not an automated way of making the pass/fail decision from the raw data.
- I therefore designed and developed software framework and reporting tool that technicians across 9 institutes use for QC automated decisions and batch reporting for ITk silicon strips sensors.
- The whole project, from understanding needs of the collaboration, designing the framework, developing it, collecting feedback, and adding new features, was done primarily on my own.
- Also performed QC tests themselves.
- First-authored proceedings published in NIMA [10.1016/j.nima.2022.167608]

Other
- Also did some ITk strips system tests work in SR1 working on comparing stave test results from different frameworks. Co-authored internal note in CDS [ATL-COM-UPGRADE-2022-013].
- ATLAS Control Room Shifts - Inner Detector Desk
- ATLAS and CERN visits service guide (for public, private/internal, and diplomatic tours)
- Various outreach activities (see the Outreach section) and teaching (see the Teaching section)
- Along with mentoring students on the DV+MET analysis, I also closely mentored a student in our own group for MC generation for Higgs portal interpretations of displaced vertex analyses.
- Started and chaired a students-only seminar series at CERN for UK PhD students

University of Waterloo *2014-2019*

BASc Nanotechnology Engineering

96.39% GPA, Ranked 1st, Dean's List

Combined internship/research program under Electrical Engineering, Chemical Engineering, and Chemistry departments with training in circuits, control systems, biochemistry, nanofabrication, numerical methods & multi-physics simulations, material & polymer science, statistical thermodynamics, nanotoxicology, and more.

Research positions and internships I held during this time are listed below:

University of Waterloo Nano Robotics Group

Advisor (2017-2019), ***Technical Director*** *(2017), Sub-team Lead (2015-2016), Member (2014-2015)*

- Directed an undergraduate-only research group of $\sim$25 people, and gave technical guidance to its sub-teams, designing microbots for competition.
- Also personally worked on setup experimentation and field & microbot microfabrication.

Paul Scherrer Institute (Swiss ETH Domain): Muon Group *2018*

Particle Physics Trainee

- Overall project aim was to drop muonium to see if antimatter falls up or down. At the time it comprised myself, a PhD student, and the PI.
- Specialized in G4Beamline simulations for designing setup for characterizing cold muonium extraction.
- Developed native quantum Monte Carlo/Bohmian trajectories and numerical wave-packet diffraction simulations for planning interferometry portion of experiment.
- Worked with the PI on salvaging and rebuilding a cryostat for the beamline experiment.

Microsoft Japan: Microsoft Office Team *2017*

Program Manager Intern

- User experience (UX) design and testing for consumer app.
- Developed team's workflow for backlog prioritization and dealing with customer feedback data, which involved the full process from interviews with the team to understand needs, to proposing and iterating designs with managers and engineering, to implementation.
- Did development work with natural language processing machine learning for classification and implementing convolutional neural networks for input recognition.

University of Cambridge: Cavendish - AMOP: Hadzibabic Group *2016*

Visiting Student

- Overall project aim was to develop setup to rapidly switch a Bose Einstein condensate (BEC)'s scattering length to investigate the weak collapse phenomenon. At the time, comprised myself and a post-doc only.
- Simulated, designed, ordered, built, and tested Raman process infrared optical table setup with acoustic-optical modulators (AOMs) for doing the above.
- Did analytical and numerical simulations for investigation of the Bloch-Siegart effect for another project.

Harvard University – Wyss Institute: Aizenberg Group *2016*

UG Research Fellow

- Designed and fabricated photonic nanotechnology for Harvard Business School-based start-up.
- Experience with hydrogels, colloidal crystals, plasmonic systems, photonic crystals, actuating microfins, cleanroom micro- and nano- fabrication, metrology characterization techniques
- Experience in photonic simulations both natively and in Lumerical FDTD.

Harvard University – SEAS: Capasso Group *2015*
UG Research Assistant

- Worked on several projects revolved around photonic metasurfaces for various applications such as flat multi-chromatic holographic lenses, achromatic flat-lenses, and chiral separating flat-lenses
- Designed and optimized these photonic metasurface structures with Lumerical FDTD and MATLAB
- Improved code base for simulation analysis and exporting devices to fabrication.
- Results published in 10.1364/OE.24.018024, 10.1021/acs.nanolett.6b01897, and 10.1021/acs.nanolett.5b01727

Awards/Awarded Funding

- **PIER Seed Grant** *2025*
  Awarded 39'500 EUR in funding as lead applicant of a 6 person collaboration for the high-frequency gravitational waves project to do membrane fabrication, characterization, and implement squeezed light readout.
- **DESY Particle Physics Fellowship** *2023-2025*
  Awarded funding via fellowship to pursue my own choice of research at DESY in the High Energy Physics group
- **Zuckerman Fellowship** *[Declined to take DESY Fellowship]* *2023-2025*
  Awarded funding via fellowship to pursue research at Tel Aviv University
- **Gates Cambridge Scholarship** *2019-2023*
  Awarded funding to complete a research postgraduate course at Cambridge by demonstrating "leadership and a commitment to improving the lives of others through one's research".
- **Clarendon Scholarship** *[Declined to take Gates Scholarship]* *2019-2023*
  Awarded funding to complete a research postgraduate course at Oxford by demonstrating "outstanding merit and potential".
- **Governor General's Silver Medal for Academic Excellence** *2019*
  Canada-wide award, awarded to the undergraduate who achieves the highest academic standing in each university upon graduation (awarded at the University of Waterloo)
- **Sanford Fleming Foundation Academic Achievement Award** *2019*
  Highest Standing in Course Over Degree (awarded at the University of Waterloo)
- **Ontario Professional Engineers Foundation Undergraduate Scholarship** *2018*
  Scholarship based on academic achievement, demonstrated "leadership through participation in professional affairs, volunteer and/or extracurricular activities" (awarded while at the University of Waterloo).

Teaching (as Teaching Assistant ("Supervisor") at Cambridge)

- Part II (3rd Year Undergrad) **Particle and Nuclear Physics** *Lent 2022, Lent 2023*
- Part III (Masters) **Particle Physics** *Michaelmas 2020*
- Part IB (2nd Year Undergrad) **Maths Methods for Physicists** *Michaelmas 2019*

Select Positions of Responsibility

- **DV+MET Analysis** – Analysis Contact (analysis leader) *2022-Present*
- **CERN LTA Student-Only Seminar Series** – Founder/Organizer/Chair *2022*
- **University of Waterloo Nano Robotics Group** – Advisor, Technical Director *2017-2019*
- **University of Waterloo Design Nanoscale Assembly Team (BIOMOD)** – Technical Director *2015*
- **Churchill College Boat Club | City of Cambridge Rowing Club** – Coxswain *2020-2021, 2023 | 2021*
- **Gates Scholars Council** – Technology Officer *2020*

Volunteering and Outreach

- **Königsberger Bridges Institute (KBI) Hong Kong** *2025*
  Invited workshop speaker. Introducing secondary students to CERN, data science, and ML.
- **Beamline for Schools** –First Round Evaluator *2022, 2023, 2024, 2025*
- **CERN International Physics Masterclass** – Moderator *2022, 2023, 2024*
- **Cambridge Physics Masterclass** *2023*
  Workshop presenter for cosmic rays, helper for particle tracks
- **Congrès des Deux Infinis** *2022*
  Presenter for outreach for high school students in La Réunion
- **Hong Kong Academy for Gifted Education** *2021-2022*
  Mentor for high school student, for both a research project and advice on universities
- **Tel Aviv University Future Scientists CERN Program** – Speaker, Tour Guide *2022*
- **CERN Visits Service/ATLAS Secretariat** *2021-Present*
  English and French Language Tour Guide [internal, general public, and officials]
- **Gates Cambridge Teach-a-Thon** – Teacher *2021, 2022*
- **Intel ISEF** – Volunteer, Interpreter [Team France], Extra Chaperone [Team Hong Kong] *2019*
- **Hong Kong New Gen. Cultural Assc. Science Innovation Centre** – Volunteer, Mock Judge *2017*

Peer-Reviewed Articles

- ATLAS Collaboration, **Search for long-lived, massive particles in events with displaced vertices and multiple jets in pp collisions at $\sqrt{s}$=13 TeV with the ATLAS detector**. *Journal of High Energy Physics*, 2023(6), 1-49.
- Rousso, D. et al. **Test and extraction methods for the QC parameters of silicon strip sensors for ATLAS upgrade tracker**. *Nuclear Inst. and Methods in Physics Research, A*, 1045 (2023) 167608
- Zhang, S., Kim, M.H., Aieta, F., She, A., Mansuripur, T., Gabay, I., Khorasaninejad, M., Rousso, D., Wang, X., Troccoli, M. and Yu, N., 2016. **High efficiency near diffraction-limited mid-infrared flat lenses based on metasurface reflectarrays**. *Optics express*, 24(16), pp.18024-18034.
- Khorasaninejad, M., Chen, W.T., Zhu, A.Y., Oh, J., Devlin, R.C., Rousso, D. and Capasso, F., 2016. **Multispectral chiral imaging with a metalens**. *Nano letters*, 16(7), pp.4595-4600.
- Khorasaninejad, M., Aieta, F., Kanhaiya, P., Kats, M.A., Genevet, P., Rousso, D. and Capasso, F., 2015. **Achromatic metasurface lens at telecommunication wavelengths**. *Nano letters*, 15(8), pp.5358-5362.

Other Non-Analysis Internal Documents or Public Results

- Le Boulicaut, E.M., Sharma, P., Trischuk, D.A., Morii, M., Rousso, D., Sanyal, S., Jones, E.K., Arnaez, O., **ITk Strips System Tests**. *ATL-COM-UPGRADE-2022-013*.
- Ritjoho, N., Antognini, A., Crivelli, P., Kirch, K., Taqqu, D., Bartkowiak, M., Papa, A., Knecht, A., Soter, A., Rousso, D., Scheuermann, R., Volder, M., Phillips, T. and Kaplan, D., **The Development of a High Brightness Muonium Beam**. In *Annual Meeting of the Swiss Physical Society, Lausanne, 2018*.
- Zhang, J., Eigen, C., Lopes, R., Garratt, S., Rousso, D., Smith, R.P., Hadzibabic, Z. and Navon, N., 2017, April. **Bloch-Siegert shift in an interacting Bose-Einstein condensate**. In *APS Division of Atomic, Molecular and Optical Physics Meeting Abstracts*.
- Khorasaninejad, M., Chen, W. T., Devlin, R. C., Zhu, A. Y., Oh, J., Rousso, D., and Capasso, F. **Macro to nanoscale imaging using planar lenses at visible wavelengths**. *SPIE Newsroom, doi, 10(2.1201608), 006633*.

Conferences, Talks, and Posters

- **ATLAS e/gamma Workshop** – [Talk] *2025*
- **13th LLP Workshop (Long Lived Particles)** – [Talk] *2023*
- **IOP APP HEPP** – [Talk] *2023*
  (UK Institute of Physics Astroparticle Physics and High Energy Particle Physics Conference)
- **4th World Summit on Exploring the Dark Side of the Universe** – [ECS Talk] ***EDSU2022***
  Search for Long-Lived particles in ATLAS with Displaced Vertex Signatures in Multi-Jet-Triggered Events
- **2022 International Workshop on Baryon and Lepton Number Violation** ***BLV2022***
  [Collaboration talk, presenting results on behalf of the LHC collaborations]
  Long lived particles at LHC (not HNL)
- **15th Pisa Meeting on Advanced Detectors** –[Poster] ***PM2021 (2022)***
  Test and extraction methods for the QC parameters of silicon strip sensors for ATLAS upgrade tracker
- **ALICE Coffee Series** – [Talk] *2022*
- **UK CERN Long-Term Attachment PhD Student Summer Seminar Series** – [Talk] *2022*
- **ATLAS SUSY Workshop** – [Talk] *2021, 2022*
- **ATLAS UK** – [Poster] *2022*
- **LHCC Meeting (Large Hadron Collider Committee)** – [Poster] *Nov. 2022*
- **ATLAS Week** – [Poster] *June 2022*
- **ATLAS Idea Day** – [Talk] *2021*