Brian Moser

Experimental Particle Physicist
(+31) 683 010 535 | brian.moser@physik.uni-freiburg.de
https://orcid.org/0000-0001-6750-5060

Research Interests

I am an experimental particle physicist collaborating on the ATLAS Experiment at the CERN Large Hadron Collider (LHC) in Geneva, Switzerland. My main research fields are:

- Measurements of Higgs boson decays to heavy-flavour quarks
- Measurements of Higgs boson production at high transverse momentum
- Searches for Higgs boson pair production in the $b\bar{b}\tau^+\tau^-$ final state
- Flavour tagging algorithms and their calibrations
- Machine learning applications to high energy physics data analysis
- Characterisation and construction of silicon pixel detectors
- Higgs boson physics at Future Colliders

Professional History

Juniorprofessor for Experimental Particle Physics 01/2025 - present
University of Freiburg, DE

Schmidt AI in Science Fellow at the University of Oxford 04/2024 - 12/2024
Associate Research Fellow at Reuben College
Oxford, UK

CERN Senior Research Fellow 02/2022 - 03/2024
Geneva, CH

Education

PhD in Physics 11/2017 - 03/2022
Nikhef and University of Amsterdam, NL

- Advisor: Prof. Dr. W. Verkerke; co-advisor: Prof. Dr. T. A. du Pree
- Thesis: "The Beauty and the Boost: a Higgs Boson Tale - Measurements of Higgs Boson Production at High Energy in Decays to Bottom Quarks and Their Interpretations with the ATLAS Experiment at the LHC" [16]
- PhD awarded with the highest 'cum laude' distinction (top 5% of theses in the field)

CERN Summer Student 06/2016 - 09/2016
Geneva, CH

BSc and MSc in Physics 10/2012 - 11/2017
University of Freiburg, DE

Recognition and Awards

- Newton International Fellowship (2024, $\sim$ £ 300k, declined)
- Eric and Wendy Schmidt AI in Science Fellowship (2023, $\sim$ £ 80k)
- PhD thesis selected for publication in Springer Theses (2023)
- ATLAS Thesis Award (2023)
- Thesis selected as one of the top 3 Dutch Physics PhD theses of 2022 (2023)
- CERN Senior Research Fellowship (2021, $\sim$ CHF 150k)

Scientific Leadership

Convener of the ATLAS flavour tagging calibration group 10/2023 - 09/2025

- Responsible for providing central calibrations to the entire ATLAS collaboration, coordinating and supervising the work for a fixed term of 2 years
- The subgroup consists of $\sim$ 50 active members from over 20 institutes

Analysis coordinator of the search for Higgs boson pair production in the $b\bar{b}\,\tau^+\tau^-$ final state 05/2023 - present

- Coordination of the Run 2 analysis with an international analysis team of 55 members from 28 institutes
- Re-appointed to lead the currently ongoing Run 3 efforts with a larger team of $\sim$ 80 members from 33 institutes

Analysis coordinator of the resolved + boosted $VH, H \to b\bar{b}$ combination 06/2021 - 09/2021

- Coordination of an analysis team of about 5 active members

Contact physicist for EFT interpretations of $H \to b\bar{b}$ analyses 2020 - present

Contact physicist for analysis combinations involving $H \to b\bar{b}$ analyses 2020 - present

Research Experience

My past and current research is performed within the international ATLAS collaboration. Below you can find details on highlighted contributions to the collaboration.

Physics analyses

- Analysis coordinator for the $HH \to b\bar{b}\tau^+\tau^-$ analysis using a combination of Run 2 and Run 3 data
- Coordinator for the sensitivity projections of the $HH \to b\bar{b}\tau^+\tau^-$ analysis from Run 2 to the HL-LHC and expert support for their integration in the ATLAS-wide HH combination [12, 13]
- Principle analyser (and later analysis coordinator) for the $HH \to b\bar{b}\tau^+\tau^-$ analysis using Run 2 data [1]

- Studies on the feasibility of searches for HHH production and their complementarity to searches for HH production [2]
- Principle analyser for the boosted $VH, H \to b\bar{b}$ analysis [3] and its combination with the resolved $VH, H \to b\bar{b}$ analysis [4, 9, 5]
- Effective Higgs boson coupling interpretation of the $VH, H \to b\bar{b}$ and $VH, H \to c\bar{c}$ analyses [6]
- Expert support for the combination and integration of the $VH, H \to b\bar{b}$ and $VH, H \to c\bar{c}$ analyses in the ATLAS-wide combination of Higgs boson measurements [5, 10, 11]

Flavour tagging

- Calibration of the b-tagging efficiency in dense jet environments to study the effect of close-by jets [16]

Offline software

- Developer for the CxAODFramework and the WSMaker, one of the few common analysis frameworks and statistical analysis frameworks within the collaboration

Detector development and operations

- Designed and performed a measurement of the radiation length of a planar hybrid pixel detector module using multiple scattering of low energy positrons at the CERN Proton Synchrotron; this included the construction of a low-material beam telescope using thin monolithic pixel detectors as reference planes [8]
- Quality testing of modules with standard electrical scans and radioactive sources
- Construction of a prototype for the ATLAS Outer Barrel pixel detector upgrade, mainly focusing on the data acquisition part [14]
- Performed and analysed 3D measurements of carbon fibre support structure rings to check for cooling-induced deformations
- Frequent control room shifts for the Inner Detector during Run 2 and as Shift Leader during Run 3 data taking ($\sim$ 25 shifts each); on-call shifts for the ATLAS readout system during Run 2 ($\sim$ 20 shifts)

Services to the collaboration

- Regular member of collaboration-internal editorial review boards, sign-off reader and expert reviewer for the ATLAS Higgs and Di-Higgs group

Selected Talks and Seminars

Talks at conferences

2023	**Higgs 2023**, Search for Higgs Boson Pairs in the $b\bar{b}\tau^+\tau^-$ Final State with the ATLAS Experiment (parallel talk)	Beijing, CN
2023	**VERTEX 2023**, Material Measurement of an ATLAS Pixel Module via Multiple Scattering (poster + pitch talk)	Sestri Levante, IT
2022	**ICNFP 2022**, Celebrating 10 years of Higgs boson physics at ATLAS (plenary talk)	Crete, EL
2022	**ICHEP 2022**, Development and evaluation of prototypes for the ATLAS ITk pixel detector (poster)	Bologna, IT
2021	**Physics@Veldhoven**, The beauty and the boost: A Higgs boson tale (parallel talk)	online
2020	**Higgs 2020**, EFT interpretations of Higgs measurements in ATLAS (parallel talk)	online
2020	**ICHEP 2020**, Measurement of $VH, H \to b\bar{b}$ at high vector boson transverse momentum (poster + pitch talk)	online

Seminars and colloquia

2023	**IPHC Strasbourg**, Particles and Pixels (invited seminar)	Strasbourg, FR
2020	**IIHE Brussels**, Measurement of boosted $VH, H \to b\bar{b}$ (invited seminar)	online
2020	**MIT**, Measurement of boosted $VH, H \to b\bar{b}$ (invited talk in the group of Prof. Harris)	online
2020	**Nikhef**, SMEFT for $VH, H \to b\bar{b}$ (colloquium)	online

ATLAS-internal talks

2023	System test results with full chain of services; talk at the ITk Pixel Off-detector Services Final Design Review	CERN, CH
2022	Comparison of ATLAS and CMS measurements of $VH, H \to bb$; presented in the ATLAS Higgs group and the physics coordination meeting	CERN, CH
2022	Limiting factors of Run-2 analyses; talk at the ATLAS workshop on Higgs and diboson searches	Uppsala, SE
2022	Pixel Outer Barrel - pre-demonstrator tests; talk at the ATLAS ITk week	CERN, CH

2021	Approval talk of the $VH, H \to bb$ and $VH, H \to cc$ combination within the ATLAS Higgs group	online
2020	Approval talk of the boosted $VH, H \to bb$ analysis within the ATLAS Higgs group	CERN, CH
2019	Summary of b-tagging calibration status at the ATLAS flavor tagging workshop	Hamburg, DE
2019	Analysis overview talk of the boosted $VH, H \to bb$ analysis at the ATLAS $H \to bb$ workshop	Genova, IT
2018	Higgs physics - Highlights and Prospects; summary talk at the Nikhef end-of-the-year Jamboree	Utrecht, NL

Outreach Activities

- Supervision of a high school student during her two week internship at CERN via the German outreach network (Netzwerk Teilchenwelt); project topic: Impact of the quartic Higgs coupling on di-Higgs processes at the LHC [7]
- Official CERN tour guide for university students and the general public ($\sim$ 2 tours per month during my time at CERN)
- Lectured and assisted in introductory masterclasses on particle physics and the ATLAS experiment for both high-school students and teachers

Supervision and Teaching Experience

Day-to-day supervision of students

- Co-supervision of two bachelor students, five master students, three summer students and two PhD students on topics related to my own research; mainly responsible for the technical day-to-day supervision

Courses

- Replacement lecturer for three lectures in the nuclear and particle physics course for bachelor students during the winter term 2025, University of Freiburg (DE)

Teaching at graduate schools

- Coordinator of the experimental session for the particle physics school in the Maria Laach abbey, DE (2023)

Experience as a teaching assistant

- **Machine Learning for Physics**, 2021, master level, co-designed and graded weekly exercise sheets, supervised hands-on sessions
- **C++ programming**, 2020 and 2021, master level, supervised hands-on sessions and graded the exercise sheets
- Assisted in multiple **introductory Physics- and lab courses** at bachelor level from 2015 to 2017

Skills

Languages:	German (native), English (proficient), Dutch, French (both intermediate)
Programming:	C++ (10 years of experience), Python (8 years of experience), experienced with git version control and continuous integration
Machine Learning:	TMVA, Keras, TensorFlow, PyTorch
Data analysis:	ROOT, Mathematica
Additional:	Scientific management in large collaborations

List of Publications

As part of the ATLAS collaboration I am listed as an author on all publications of the collaboration. Listed below are publications to which I contributed significantly. My individual contributions to these publications are listed in the CV.

Journal articles

[1] The ATLAS Collaboration,
"Search for the nonresonant production of Higgs boson pairs via gluon fusion and vector-boson fusion in the $b\bar{b}\tau^+\tau^-$ final state in proton-proton collisions at $\sqrt{s} = 13\,\text{TeV}$ with the ATLAS detector", in: *Phys. Rev. D* 110.3 (2024), p. 032012, DOI: 10.1103/PhysRevD.110.032012, arXiv: 2404.12660 [hep-ex]

[2] Abouabid, Hamza at al. (including Moser, Brian),
"HHH whitepaper", in: *Eur. Phys. J. C* 84 (2024), p. 1183, DOI: 10.1140/epjc/s10052-024-13376-3, arXiv: 2407.03015 [hep-ph]

[3] The ATLAS Collaboration,
"Measurement of the associated production of a Higgs boson decaying into b-quarks with a vector boson at high transverse momentum in pp collisions at $\sqrt{s} = 13$ TeV with the ATLAS detector", in: *Phys. Lett. B* 816 (2021), DOI: 10.1016/j.physletb.2021.136204, arXiv: 2008.02508 [hep-ex]

[4] The ATLAS Collaboration,
"Measurements of WH and ZH production in the $H \to b\bar{b}$ decay channel in pp collisions at 13 TeV with the ATLAS detector", in: *Eur. Phys. J. C* 81.2 (2021), DOI: 10.1140/epjc/s10052-020-08677-2, arXiv: 2007.02873 [hep-ex]

[5] The ATLAS Collaboration,
"A detailed map of Higgs boson interactions by the ATLAS experiment ten years after the discovery", in: *Nature* 607.7917 (2022), pp. 52–59, DOI: 10.1038/s41586-022-04893-w, arXiv: 2207.00092 [hep-ex]

[6] The ATLAS Collaboration,
"Direct constraint on the Higgs-charm coupling from a search for Higgs boson decays into charm quarks with the ATLAS detector", in: *Eur. Phys. J. C* 82 (2022), DOI: 10.1140/epjc/s10052-022-10588-3, arXiv: 2201.11428 [hep-ex]

[7] Bizoń, Wojciech et al. (including Moser, Brian),
"Addendum to: Constraints on the quartic Higgs self-coupling from double-Higgs production at future hadron colliders [JHEP 10 (2019) 267]", in: *JHEP* 02 (2024), p. 170, arXiv: 2402.03463 [hep-ph]

Pre-prints submitted to journals

[8] Koch, Simon, Moser, Brian et al.,
"Measuring the ATLAS ITk Pixel Detector Material via Multiple Scattering of Positrons at the CERN PS", in: *Eur. Phys. J. C* (2024), arXiv: 2412.04686 [physics.ins-det]

Conference notes

Conference notes are results prepared by the ATLAS Collaboration in light of an upcoming conference. While they are not sent to a peer-reviewed journal, they have undergone a complete review process within the collaboration.

[9] The ATLAS Collaboration,
"Combination of measurements of Higgs boson production in association with a W or Z boson in the $b\bar{b}$ decay channel with the ATLAS experiment at $\sqrt{s} = 13$ TeV", ATLAS-CONF-2021-051, 2021, URL: http://cds.cern.ch/record/2782535

[10] The ATLAS Collaboration,
"A combination of measurements of Higgs boson production and decay using up to 139 fb^{-1} of proton–proton collision data at $\sqrt{s} = 13$ TeV collected with the ATLAS experiment", ATLAS-CONF-2020-027, 2020, URL: http://cds.cern.ch/record/2725733

[11] The ATLAS Collaboration,
"Combined measurements of Higgs boson production and decay using up to 139 fb^{-1} of proton-proton collision data at $\sqrt{s} = 13$ TeV collected with the ATLAS experiment", ATLAS-CONF-2021-053, 2021, URL: http://cds.cern.ch/record/2789544

Public notes

Public notes are a collection of results, mainly limited to studies performed on simulated collision events, that have been made public by the ATLAS Collaboration. They pass through an internal review process.

[12] The ATLAS Collaboration,
"Projected sensitivity of measurements of Higgs boson pair production with the ATLAS experiment at the HL-LHC", ATL-PHYS-PUB-2025-006, 2025, URL: https://cds.cern.ch/record/2925853

[13] The ATLAS Collaboration,
"Updated projection of the sensitivity of searches for Higgs boson pair production in the $b\bar{b}\tau^+\tau^-$ final state from LHC Run 2 to the High Luminosity LHC with the ATLAS detector", ATL-PHYS-PUB-2024-016, 2024, URL: https://cds.cern.ch/record/2910850

Conference proceedings

[14] Brian Moser,
"Development and evaluation of prototypes for the ATLAS ITk pixel detector", in: *PoS* ICHEP2022 (2022), p. 1016, DOI: 10.22323/1.414.1016

[15] Brian Moser,
"Measurement of Higgs boson production at high transverse momentum in the $VH, H \to b\bar{b}$ channel with the ATLAS detector", in: *PoS* ICHEP2020 (2021), DOI: 10.22323/1.390.0101

Books

[16] Moser, Brian,
"The Beauty and the Boost: A Higgs Boson Tale - Measurements of Higgs Boson Production at High Energy in Decays to Bottom Quarks and Their Interpretations with the ATLAS Experiment at the LHC", 20 September 2023, Springer Cham, ISBN: 978-3-031-39441-6