

Mathieu Benoit

SCIENTIFIC ASSOCIATE · INSTRUMENTATION SPECIALIST IN NUCLEAR AND HIGH ENERGY PHYSICS

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Summary

Currently employed as Experimental High Energy / Nuclear Physicist - RD Staff in the Physics division of Oak Ridge National Laboratory (ORNL)

Research Interests

- Numerical simulation in semiconductors for High Energy Physics (HEP)
- Charge transport algorithms in semiconductors
- Detector development for nuclear medical imagery and HEP applications
- Low-noise semiconductor characterization
- Data acquisition system (DAQ) and data analysis
- Test-Beam characterization of semiconductor detectors in high energy particle beams
- Radiation damage in semiconductors: study, simulation and hardening methods
- CMOS detector technology for ionizing radiation detection

Work Experience and Education

Relativistic Nuclear Physics, Physics Division, Oak Ridge National Laboratory

Oak Ridge, TN, USA

EXPERIMENTAL HIGH ENERGY / NUCLEAR PHYSICIST - R&D STAFF

Oct. 2022 - present

- Management of CMS Endcap Timing Layer (ETL) sensor and bump bonding scope
- Support for Silicon layers of FOCAL
- Promote novel Silicon detector technologies, facilities, and synergy between ORNL projects.
- Support R&D on the CARIBOu system, a versatile system for control and data acquisition Silicon detectors used in R&D programs for a large user base (NASA, RD50, CLICdp, Medipix and more)

OMEGA Group, physics Department, Brookhaven National Laboratory

Upton, NY, USA

SCIENTIFIC ASSOCIATE

Apr. 2020 - Oct. 2022

- Development of Software for the Felix high-speed data acquisition system for the Phase I and II of the Upgrade of the ATLAS detector
- Control Account Management for the Felix Readout in the ATLAS-US project
- Operation system customization for the ATLAS Upgrade projects and CaRIBOu systems
- Characterization of Front-end electronic circuitry for the upgrade of the readout of the LAr calorimeter for performance and radiation hardness
- Development of the integration test bench and production tools for the upgrade of ATLAS Liquid Argon (LAr) calorimeter readout board
- R&D on the CARIBOu system, a versatile system for control and data acquisition Silicon detectors used in R&D programs for a large user base (NASA, RD50, CLICdp, Medipix and more)

Dept. of Particle and Nuclear Physics (DPNC), University of Geneva

Geneva, Switzerland

SENIOR RESEARCHER AND TEACHING COLLABORATOR

Sept. 2014 - Feb. 2020

- Co-Coordination of ATLAS CMOS demonstrator program since February 2017
- Management of the R&D program on CCPD and Monolithic CMOS sensors for ATLAS Inner Tracker Upgrade
- Supervision of PhD and Master students in their CMOS detector activities
- Coordination and development of clean room and test beam activities
- Development of new assembly and testing procedure using clean room equipment
- Teaching of Electrodynamics practical courses and supervision of undergrad internships
- Convener of the CLICdp collaboration Vertex and Tracker working group since May 2016

European Organization for Nuclear Research (CERN)

Geneva, Switzerland

FELLOW ASSIGNED TO CLIC VERTEX DETECTOR R&D PROGRAM

Sept. 2011 - Sept. 2014

- Conception and management of Ultra-Thin Silicon pixel sensor Timepix/CLICPix assembly production with Micron Semiconductor Ltd., IZM Franhofer and Advacam Ltd. for the needs of the Vertex Detector R&D for CLIC
- Conception and application of a calibration routine for Ultra-thin Timepix pixel assemblies
- Technology-Computer Assisted Design (TCAD) feasibility Study of Ultra-Thin Pixel sensors in CLIC Vertex detector conditions
- Integration of the Timepix detector readout to EUDET Telescope software and hardware and realization of a telescope test beam study campaign with the assemblies produced for the R&D program
- Participation in CLIC Vertex detector mechanical, electrical and functional design for the realization of an engineering model
- Conception, implementation, simulation (GEANT4) and calibration of a digitization model for Ultra-Thin Pixel detectors in intense magnetic field for CLIC Vertex simulation
- Conception and realization of a laboratory dedicated to Silicon detector characterization
- Evaluation of alternate technologies (HV-CMOS, Monolithic detectors) for application in CLIC Vertex detector R&D

Study of planar pixel sensors hardened to radiation damage for the upgrade of the ATLAS vertex detector for operation at high luminosity

- TCAD Simulation and conception of novel guard ring structures for planar pixel sensors for high voltage operation with slimmed edges for the production of the sensor candidates for the ATLAS insertable b-layer detector upgrade (IBL)
- Elaboration of the first simulation model to include radiation damage and reproduce the charge multiplication phenomenon observed experimentally in highly irradiated sensors, and inclusion of these models in MC simulation
- Conception and installation of a clean room for characterization of silicon pixel detectors and simulation model calibration:
 - [+] Low noise probe station for high bias voltage DC characterization (IV, CV, WV) of silicon detectors under different temperature
 - [+] Test bench for laser stimulation of pixel sensors for dynamical and geometrical studies of pixel sensors
- Contribution to installation, operation, development of reconstruction and analysis code and analysis of collected data for ATLAS Planar Pixel Sensor and IBL Test beam campaign

Université de Montréal

Montréal, Québec, Canada

MASTER CANDIDATE IN PHYSICS

2007-2008

Modeling of CdZnTe-based detectors for γ spectroscopy and imagery

- Use of finite-element method modeling, GEANT4 simulation and custom made C++ code to simulate the behavior of CdZnTe detectors
- Conception of a theoretical model of repulsion and its coupling to diffusion in semiconductor detectors
- Optimization of single-sided cross strip pixel sensors for γ spectroscopy and imagery using the developed simulation tools

Université de Montréal

Montréal, Québec, Canada

BACHELOR DEGREE IN PHYSICS

Sep. 2003, Dec. 2007

Student Supervision

2019	Mateus Vicente, PhD Thesis , HV-CMOS detector development for future experiments, in redaction	Uni. of Geneva
2019	Francesco di Bello, PhD Thesis , Search for scalar and axial resonances decaying into a pairs of b quarks using the ATLAS detector at the LHC and studies on CMOS pixel sensor for HL-LHC, in redaction	Uni. of Geneva
2018	Lingxin Meng, PhD Thesis , Development of CMOS Sensors for High-Luminosity ATLAS Detectors	Uni. of Geneva & Uni. of Liverpool
2018	Matthew Buckland, PhD Thesis , Simulation and evaluation of HV-CMOS pixel sensors for the CLIC vertex detector	Uni. of Liverpool & CERN (CLICdp)
2018	Branislav Ristic, PhD Thesis , Novel Pixel Sensors in HV-CMOS Technology and Testbeam Infrastructure for Upgrades of the ATLAS Inner Tracking System	University of Geneva
2017	Niloufar Alipour, PhD Thesis , Test-beam measurements and simulation studies of thin pixel sensors for the CLIC vertex detector	ETH Zurich & CERN (CLICdp)
2016	Javier de Bilbao, PhD Thesis , Production, integration and commissioning of the ATLAS Insertable B-Layer and test beam studies of new pixel technologies for the HL-LHC	Uni. of Geneva
2019	Le Li, Msc Thesis , TCAD and Monte-Carlo simulation of the ATLASPix prototype	Uni. of Geneva
2018	Nicolas Terasson, Msc Thesis , Monte-Carlo simulation of the FEI4 Telescope	Uni. of Geneva
2016	Francesco di Bello, Msc Thesis , Simulation, reconstruction and analysis of HV-CMOS pixel detector prototype data with the FEI4 Telescope	Uni. of Geneva
2016	Misael Caloz, Msc Thesis , Equalisation algorithms for the CCPdv4 HV-CMOS pixel sensor prototype	Uni. of Geneva
2015	Niloufar Alipour, Msc Thesis , Simulation of novel planar pixel sensors with active-edge for Timepix	ETH Zurich & CERN (CLICdp)

Software Proficiency

General Programmation	C/C++, Fortran, Java, Python, Go
Monte-Carlo Simulation	GEANT4, GATE, Allpix & Allpix ²
Data Acquisition	Labview, LabWindows CVI, MATLAB, openVISA
Engineering Tools	Cadence Allegro PCB Design, Xilinx ISE, Xilinx XPS & Vivado, Zynq SoC, Yocto linux
Symbolic Mathematics	Mathematica, Maple, Scipy, SymPy
Numerical Analysis	ROOT, Matlab, Mathematica, Numpy
TCAD & FEM Simulation	SILVACO, Synopsis Sentaurus, COMSOL Multi-Physics
Management and Productivity	Zotero, Microsoft Project, Latex

Noteworthy Scientific Communications

INVITED SEMINARS

- Feb. 2019 **Overview of simulation methods for modeling of radiation damage in silicon detectors**, Geneva, Switzerland
Inter-experiment workshop on Radiation Effects in LHC Experiments, CERN
- Apr. 2017 **CMOS pixel development for the ATLAS experiment at the HL-LHC and CLIC Vertex and tracker**, Argonne Chicago, IL, USA
National Laboratory, HEP Division seminar
- Sept. 2016 **Simulation of Silicon detectors using TCAD and Monte-Carlo methods**, DESY Detector seminar Hamburg, Germany
- June 2016 **Simulation of Silicon detectors using TCAD and Monte-Carlo methods**, CERN Detector seminar Geneva, Switzerland
- Feb. 2013 **Research and development on vertex detector technology for the Compact Linear Collider (CLIC)**, LAL Orsay, France
- May 2012 **TCAD Simulation of irradiated Silicon radiation detector using commercial simulation products**, 20th Bari, Italy
RD50 Collaboration meeting
- Feb. 2011 **Technology-Computer Assisted Design (TCAD) and Monte-Carlo (MC) simulation of semiconductor detectors for high energy and nuclear physics applications**, Gottingen II. Institute of Physics Gottingen, Germany
- Jan. 2010 **Mise à jour du détecteur interne d'ATLAS pour son opération à haute luminosité**, Particle Physics Montreal, QC, Canada
Laboratory Seminar, University of Montreal
- June 2009 **Formation aux outils de simulation Silvaco TCAD Omni**, Centre de développement des technologies Algiers, Algeria
avancées de Alger (CTDA)
- June 2008 **Modélisation des signaux et du partage de charge dans les dispositifs de détection à base de CZT par une méthode hybride de simulation Monte-Carlo/elements finis**, LAL Orsay, France

INVITED PRESENTATION IN INTERNATIONAL CONFERENCES

- Au. 2021 **Development of the ATLAS Liquid Argon Calorimeter Readout Electronics for the HL-LHC**, ICNFP Krematos, Greece
- Feb. 2019 **Characterization of the 180nm HV-CMOS ATLASPix large-fill factor Monolithic prototype**, TREDI2019 Trento, Italy
- Dec. 2018 **Pixel-detector R&D for CLIC**, PIXEL2018 Taipei, Taiwan
- May 2017 **The Phase-2 ATLAS ITk Pixel Upgrade**, TIPP 2017 Beijing, China
- Aug. 2015 **HV and HR-CMOS sensor technology R&D for ATLAS ITk**, Vertex 2015 Santa Fe, NM, USA
- Feb. 2015 **TCAD Simulation of CCPD family of HVCMOS sensors**, Trento Workshop on advanced Silicon detectors Trento, Italy
- Sept. 2013 **TCAD Simulation of Silicon Radiation Detectors using commercial simulation products**, Vertex 2013 Lake Starnberg, Germany
- Sept. 2012 **Vertex detectors for the future linear colliders**, PIXEL2012 Conference Inawashiro, Japan

OTHER PRESENTATIONS

- Feb. 2019 **Characterization of the 180nm HV-CMOS ATLASPix large-fill factor Monolithic prototype**, TREDI19 Trento, Italy
- Aug. 2014 **Test-beam characterization, calibration and simulation for hybrid-pixel readout assemblies with ultra-thin sensors**, PIXEL2014 Niagara Falls, On, Canada
- Feb. 2014 **Test beam characterization of Ultra-Thin hybrid pixel Timepix assemblies for CLIC Vertex R&D**, Trento Genova, Italy
Workshop on advanced Silicon detectors
- Nov. 2013 **Vertex detector R&D for CLIC**, LCWS13 Tokyo, Japan
- Nov. 2010 **Simulation of charge multiplication and trap-assisted tunneling in irradiated n-in-p planar pixel sensors**, IEEE NSS 2010 Knoxville, TN, USA
- Feb. 2010 **Simulation of charge multiplication and trap-assisted tunneling in irradiated n-in-n planar pixel detectors**, 5th Trento Workshop on Advanced silicon detectors Manchester, UK
- Feb. 2009 **Simulation of multi guard ring structure in p-type pixel sensor for ATLAS inner tracker upgrade**, 4th Trento, Italy
Trento Workshop on Advanced silicon detectors
- Sept. 2008 **Simulation of guard ring influence on the performance of ATLAS pixel detectors for inner layer replacement**, PIXEL2008 Chicago, IL, USA
- June 2008 **CdZnTe for γ ray imagery: Simulation of pixel size influence on charge-sharing by hybrid Monte-Carlo and finite element method**, NDIP08 Aix-Les-Bains, France

- **High-Voltage CMOS Active Pixel Sensor**, I. Peric, M. Benoit et al. , IEEE Journal of Solid-State Circuits, Vol. 56, No. 8, Aug. 2021, DOI 10.1109/JSSC.2021.3061760
- **Roadmap toward the 10 ps time-of-flight PET challenge : Perspectives on using silicon pixel detectors for fast timing applications**, M. Benoit, Physics in Medicine & Biology, 2020, DOI 10.1088/1361-6560/ab9500
- **Development of FELIX based readout system for HV-CMOS sensor testbeam**, M. Benoit et al., J. Inst. Vol 14 issue 01 (2019), DOI 10.1088/1748-0221/14/01/P01013
- **Electrical characterization of AMS aH18 HV-CMOS after neutrons and protons irradiation**, M. Benoit et al., J. Inst. PIXEL18 proceedings (2019), arXiv:1902.05914
- **Allpix²: A Modular Simulation Framework for Silicon Detectors**, M. Benoit et al., NIMA Vol 901 p164-172 (2018), DOI 10.1016/j.nima.2018.06.020
- **Charge collection characterisation with the Transient Current Technique of the ams H35DEMO CMOS detector after proton irradiation**, J. Anders et al., J. Inst. Vol. 13 (2018), DOI 10.1088/1748-0221/13/10/P10004
- **Test beam measurement of ams H35 HV-CMOS capacitively coupled pixel sensor prototypes with high-resistivity substrate**, M. Benoit et al., J. Inst. Vol 13 (2018), arXiv:1712.08338
- **Testbeam results of irradiated ams H18 HV-CMOS pixel sensor prototypes**, M. Benoit et al., J. Inst. Vol 13 (2018), arXiv:1611.02669
- **The FE-I4 telescope for particle tracking in testbeam experiments**, M. Benoit et al., J. Inst, Vol. 11 No. 7 (2016), DOI 10.1088/1748-0221/11/07/p07003
- **Results of the 2015 testbeam of a 180 nm AMS High-Voltage CMOS sensor prototype**, M. Benoit et al., J. Inst. Vol. 11 No. 07 (2016), DOI 10.1088/1748-0221/11/07/p07019
- **100 ps time resolution with thin silicon pixel detectors and a SiGe HBT amplifier**, M. Benoit et al., J. Inst. Vol. 11 No 03 (2016), DOI 10.1088/1748-0221/11/03/P03011
- **Test beam analysis of ultra-thin hybrid pixel detector assemblies with Timepix readout ASICs**, M. Benoit et al., CLICdp-Note-2016-001 (2016), <http://cds.cern.ch/record/2133128>
- **Capacitively coupled hybrid pixel assemblies for the CLIC vertex detector**, N. Alipour et al., NIMA Vol 823 (2016), DOI 10.1016/j.nima.2016.03.072
- **Prototyping of an HV-CMOS demonstrator for the High Luminosity-LHC upgrade**, E. Villa et al., J. Inst. Vol. 11 No. 1 (2016), DOI 10.1088/1748-0221/11/01/C01012
- **Vertex-Detector R&D for CLIC** , D. Dannheim, M. Benoit et al. , PoS Vol. 31 Vertex2012 (2013)
- **A prototype hybrid pixel detector ASIC for the CLIC experiment**, P. Valerio, M. Benoit, J. Inst (TWEPP 2013) Vol. 9 No. 01. (2014), DOI 1748-0221-9-01-C01012
- **A wireless beta-microprobe based on pixelated silicon for in vivo brain studies in freely moving rats**, J. Mark, M. Benoit et al., Phys. Med. Biol., Vol. 58 No.13 (2013), pp. 4483-500, DOI 10.1088/0031-9155/58/13/4483
- **High-voltage pixel detectors in commercial CMOS technologies for ATLAS, CLIC and Mu3e experiments**, I. Peric, M. Benoit et al., NIMA Vol. 731 pp. 131-136 (2013), DOI 10.1016/j.nima.2013.05.006
- **Planar pixel sensors for the ATLAS upgrade: beam tests results**, J. Weingarten, M. Benoit et al. , J. Inst. Vol. 7 No. 10 (2012), DOI 10.1088/1748-0221/7/10/P10028
- **New concept of a submillimetric pixellated Silicon detector for intracerebral application**, M. Benoit et al., NIMA Vol. 659 No. 1. pp. 499-503 (2011), DOI 10.1016/j.nima.2011.08.027
- **Simulation of charge multiplication and trap-assisted tunneling in irradiated planar pixel sensors**, M. Benoit , No. ATL-UPGRADE-INT-2010-002, IEEE Transactions on Nuclear Science NSS-MIC proceedings (2010), DOI 10.1109/NSSMIC.2010.5873832
- **Simulations of planar pixel sensors for the ATLAS high luminosity**, G. Calderini, M. Benoit et al. , NIMA Vol. 636 issue 1 pp. S37-S41 (2011), DOI 10.1016/j.nima.2010.04.082
- **TCAD Simulations of ATLAS Pixel Guard Ring and Edge Structure for SLHC Upgrade**, M. Benoit et al., ATLAS Upgrade Note ATL-UPGRADE-PUB-2010-001
- **Simulation of Radiation Damage Effects on Planar Pixel Guard ring Structure for ATLAS Inner Detector Upgrade**, IEEE Transactions on Nuclear Science, Vol. 56, No. 6 (2009), DOI 10.1109/TNS.2009.2034002
- **Simulation of guard ring influence on the performance of ATLAS pixel detectors for inner layer replacement**, M. Benoit et al. , J. Inst. Vol. 4 No. 03 (2009), DOI 10.1088/1748-0221/4/03/P03025
- **Simulation of charge collection process in semiconductor-based gamma- ray detectors**, L.A. Hamel et M. Benoit, NIMA Vol. 606 No. 3. (2009), DOI 10.1016/j.nima.2009.04.019
- **Optimization of Single-Sided Charge-Sharing Strip Detectors**, L.A. Hamel, M. Benoit et al., IEEE NSS Conference proceedings (2006), DOI 10.1109/NSSMIC.2006.353811

Collaboration Membership and Coordination Tasks

CLIC Detector & Physics

MEMBER OF CLIC DETECTOR & PHYSICS STUDIES, CO-CONVENER OF THE WORKING GROUP ON VERTEX AND TRACKING TECHNOLOGIES
<https://clidp.web.cern.ch/>

Sept. 2011 - PRESENT

Timepix/Medipix Collaboration

ACTIVE MEMBER OF THE MEDIPIX/TIMEPIX COLLABORATION
<https://medipix.web.cern.ch/>

Sept. 2011 - PRESENT

ATLAS Collaboration

MEMBER, ATLAS COLLABORATION
MEMBER, ATLAS PLANAR PIXEL SENSOR UPGRADE CERN R&D
MEMBER, ATLAS PLANAR PIXEL AND IBL TESTBEAM GROUP
<https://atlas.cern/>

Jan. 2008 - PRESENT

ATLAS CMOS Collaboration

CO-COORDINATOR, ATLAS CMOS COLLABORATION ON CMOS SENSOR DESIGN FOR THE OUTERMOST LAYER OF THE ATLAS INNER TRACKER REPLACEMENT

Jan. 2017 - Oct. 2020

Medical Nuclear Physics

MEMBER, ANR-PIXSIC INTRA-CEREBRAL β MICRO-PROBE
<http://pixsic.in2p3.fr>

2009 - 2012

Allpix & Allpix²

CO-DEVELOPER OF THE ALLPIX AND ALLPIX² SIMULATION FRAMEWORK FOR THE SIMULATION OF PIXEL DETECTORS
<https://cern.ch/allpix-squared>

2009 - PRESENT

References

Prof. Giuseppe Iacobucci

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24 Quai Ernest Ansermet	
CH-1206, Genève, Switzerland	Email: Giuseppe.Iacobucci@unige.ch

Lucie Linssen

Head of PH-LCD & Spokesperson of CLICdp	Phone: +41 22 76 72910
CERN, Route de Meyrin,	Fax: +41 22 76 68468
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Michael Campbell

Spokesperson of the Medipix Collaboration	Phone: +41 22 76 74866
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More references available upon request.