

Academic and Scientific Curriculum Vitae of Gabriele Simi

Personal Information

Name: Gabriele Simi
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Academic background

04/2017 - now : **Associate Professor** at the Università' di Padova
04/2011 - 04/2017 : **Assistant Professor (“ricercatore confermato”)** at the Università' di Padova
03/2010 - 03/2011 : **Research Associate** at the Università' di Padova to carry on a “feasibility study of a system for photo-detection of scintillation light based on silicon photo-detectors”
2005/01 - 2010/01: **Research Associate** at University of Maryland, College Park, MD.
2001/09 - 2004/09: **Research Associate** at the Stanford Linear Accelerator Center, Menlo Park, CA
2001/10-2001/11: **Research Fellowship** for a collaboration with the university of Pisa for the characterization of micro-strip silicon detectors with integrated electronics
1996/08-1996/09: **Pre-doctoral Visiting Fellow** at the Stanford Linear Accelerator Center, Menlo Park, CA.

Education

November 2001: Defended the **Ph.D. Thesis** with title “Measurement of the D0 meson lifetime with the BaBar detector”, supervision of Prof. Marcello Giorgi.
August 2001: Attended the **SLAC Summer School** on “CP violation. In and beyond the standard model”.
1997 - 2000: Attended the **graduate school** at the University of **Pisa** succeeding all the required tests.
October 1997: **Graduated in Physics** at the University of **Pisa**. Thesis title: “Analysis of the direct CP violation in charged B decays in BaBar”, supervision of Prof. Marcello Giorgi, grade of 110/110 *cum laude*.
August 1996: Attended the **SLAC Summer School** on “The Strong Interaction, From Hadrons to Partons “.
1992 - 1997: Attended the **classes for physics major** and **physics master** at the University of **Pisa**.
June 1992: **High School diploma** in scientific studies at the “Liceo Scientifico A.Vallisneri” - Lucca (Italy) with grade 60/60.
1987 - 1992: Attended the High School “Liceo Scientifico A.Vallisneri” - Lucca (Italy).

Responsibilities and Coordination of International Research Groups

1. 2023- **Principal investigator** of the Padova group of the TwoCryst international experiment.
2. 2023- **Member** of the TwoCryst **international collaboration board**.

3. 2021- **Member of the INFN National Scientific Commission V** coordinating the INFN research activities in the fields of accelerator physics, medical physics, detector R&D, preservation of cultural and environmental heritage.
4. 2019-2023 **Principal investigator** of the LHCb group in Padova
5. 2019-2023 **Member** of the LHCb **international collaboration board**.
6. 2018-now **Principal investigator** of the TIMESPOT group in Padova
7. 2015-now: **Responsible** (in conjunction with Univ. of Edinburgh) for the characterization of the photon detectors for the upgraded LHCb RICH detector
8. 2015-now: **Responsible** for the design and construction of the mechanical structure and the cooling system of the upgraded LHCb RICH detector.
9. 2014-now: **Principal investigator** of the HPS group in Padova.
10. 2014-2019: **“team leader”** of the Upgraded LHCb RICH detector group in Padova.
11. 2013-2019: **“team leader”** of the LHCb RICH sub-detector group in Padova.
12. 2007-2008: **Coordinator** of the core **track reconstruction** group of the *BABAR* experiment.
13. 2001-2004: **Coordinator** of the **SVT detector** of the *BABAR* experiment.
14. 2004: **coordinator** of an international task force for the study of radiation damage to the silicon vertex tracker of BaBar.
15. 2002: **coordinator** for the SVT disassembly, reassembly, test and re-commissioning during the upgrade of the PEP II accelerator.

Referee Activity

- **Referee** for the **Scientific Commission V** for scientific and budgetary aspects of several experiments (4D_SHARE, ACROMASS, IBIS_NEXT, LITE_SLPD, APLOMB, NEIS)
- **Referee** for the **INFN Scientific Commission I** for scientific and budgetary aspects of the **PADME experiment** to be installed at the DAPHNE accelerator in the INFN Frascati Laboratory: 2015 - now
- Referee for IEEE Transactions of Nuclear Physics
- Referee (member of the evaluation committee) for “Resmini award 2013” for the selection of the best PhD thesis in applied and medical physics with the INFN.
- Member of the **evaluation committee** for the final PhD defense for the academic year 2013/2014; candidates Gozzelino Andrea, Hemmer Sabine, Pivato Giovanna.
- 2023 Member of the evaluation committee for the “Young Researchers grant” funded by the “Commissione Scientifica Nazionale 5” (CSN5) of the INFN

Scientific Responsibility in Funded Peer Reviewed Research Projects

- Scientific responsibility for a 2 year research fellowship position of the University of Padova funded under the Research grant - BIRD 2024 “Particle identification at the LHCb experiment”, **PI: G. Simi**
- Scientific responsibility for a 2 year research fellowship position of the University of Padova funded under the Research grant - BIRD 2018 “LHCb RICH Upgrade and data Analysis”, **PI: G. Simi**

- Scientific responsibility for a 2 year research fellowship position of the University of Padova funded under the Research grant - BIRD 2016 “LHCb RICH Upgrade and search for lepton universality violation in rare b-baryon decays”, **PI: G. Simi**
- Scientific responsibility for a one year research fellowship position of the University of Padova funded under the physics department ex-60% funds with title “Development and experimental characterization of detectors for the identification of charged particles”

Participation in Funded Peer Reviewed Research Projects

- ex-60% 2015: title “Measurement of CKM matrix elements and real time events selection at LHCb experiment” (participant), PI Prof. D. Lucchesi, contribution: measurement of the gamma angle in B_s decays.
- ex-60% 2015: title “Allestimento di un laboratorio allargato per la fisica delle alte energie e astroparticellare” (participant), PI Prof. A. Garfagnini.
- ex-60% 2013: title “Rivelazione ed identificazione di particelle e ioni di energia molto bassa utilizzando radiazione indotta da collisioni atomiche di scambio carica” (participant), PI Dott. G. Collazuol, contribution: test beam.
- ex-60% 2012: title “Nuove applicazioni di tecniche di spettroscopia gamma alla datazione di materiale geologico tramite la misura diretta delle concentrazioni dei radionuclidi di origine cosmogenica.”, (participant), PI Prof. A. Garfagnini.
- Fiscal year 2009, grant from the Office of Science of the US DOE to the HEP group of the University of Maryland. PI Hassan Jawahery University of Maryland. Contribution: Analysis of CP violation and new physics effects with BaBar, simulation of the proposed SuperB experiment
- PRIN 2003-2005. Title: Development of monolithic pixel with integrated electronics (duration: 24 months, role: participant). PI Marcello Giorgi (University of Pisa). Contribution: investigation of radiation damage effects in silicon.
- University funded projects 1999. Title: “Feasibility study of detectors with micro-electrodes on a high resistivity silicon substrate” (duration: 24 months, role: participant). PI Marcello Giorgi (University of Pisa). Contribution: characterization of integrated J-FET on high resistivity substrate.

Organization of Workshops and Schools

- Organizer of the VII International Schoola “Detectors and Electronics for High Energy Physics, Astrophysics, Space Applications and Medical Physics”, INFN National Laboratories of Legnaro, 3-7 April 2017, web site Organizing Committee
- Organizer of the VIII International School “Detectors and Electronics for High Energy Physics, Astrophysics, Space Applications and Medical Physics”, INFN National Laboratories of Legnaro, 1-5 April 2019, web site , organizing committee
- Member of the Scientific Committe of the “Workshop ob Electronics for Physics Experiments and applications @INFN”, 5-7 Marzo 2025, Aula Magna del Politecnico di Torino, Torino’ web site

Outreach

- Oral presentation in the context of the International MasterClasses to present the experimental activities on physics of the fundamental interactions for high school students , 21/1/2025, web site

International Conference Presentations and Seminars

- 2025 Oral presentation at the “17th Vienna conference on instrumentation”, 17–21 Feb 2025 Vienna University of Technology, Vienna
“The LHCb RICH Upgrade”.
Abstract : The LHCb experiment was upgraded during the Long Shutdown 2 of the LHC (2019-2021) to collect data at five times the instantaneous luminosity of Runs 1 and 2 ($2 \times 10^{33} \text{ cm}^{-2} \text{ s}^{-1}$) using a triggerless data acquisition system. Upgrade I for the RICH system consists of new photon detectors and readout electronics together a new optical system for RICH1, with the purpose to continue to provide excellent particle identification at the new operating luminosity. The front-end readout system features an FPGA based programmable time-gate for allowing the suppression of backgrounds like scintillation, signal induced noise and out-of-time photons. The gate is currently operated at 6.25 ns, suppressing the backgrounds by a factor of four. After a vacuum incident affecting the operation of LHCb in 2023, this has been a productive year with the collection of over 9 fb⁻¹ in 2024. The key performance indicators of the LHCb RICH system will be presented together with the performance in particle identification. web site
- 2024 Oral presentation at the “Supersymmetry and Unification of Fundamental Interactions (SUSY 2024)”, 10-14 June 2024, Madrid, Spain,
”Recent Dark Matter searches at BaBar and implications on some SUSY models”.
Abstract: This talk presents the results from the BaBar experiment on the search for dark matter candidates produced from mesons decays in annihilations at 10.58 GeV. We focus on two searches: The search for exotic B meson decays into a baryon and a dark sector anti-baryon; and . These decays could simultaneously explain the presence of dark matter and the asymmetry between matter-antimatter in the universe. No significant signal is observed, and upper limits on the Branching fractions are placed. The model independent search for an additional, mostly sterile, Heavy Neutral Lepton (HNL), that mixes with the Standard Model neutrino. The mixing strength is denoted by . No significant signal is observed and limits on strength versus the mass hypothesis are presented. The results are also reinterpreted to provide limits on a super-symmetric model with R-parity violation and a light neutralino. web site
- 2022 - Oral plenary high profile presentation “10th Large Hadron Collider Physics Conference” 16-21 May 2022, Taipei, Taiwan
“Tests of Lepton Flavor Universality” <https://indico.cern.ch/event/1109611/>
- 2016 - Oral plenary review at the “VIII International Workshop on Charm Physics” September 5 - 9 2016, Bologna, Italy
“Leptonic, semileptonic and rare decays at BFactories” <http://charm2016.bo.infn.it/index.php/agenda/2016-02-20-09-25-28/>
- 2016 - Oral presentation at the “16th International Conference on B-physics at Frontier Machines (BEAUY 2016)”, Marseille, France, 2-6 May 2016
“The LHCb Upgrade” <https://indico.cern.ch/event/352928/contributions/1757300/>
- 2015 - Oral plenary review at the Internation “Workshop on High Energy Physics Phenomenology (WHEPP 2015)”, 4-14 December 2015, Kanpur, India
“Experimental Results on Flavor Physics” <http://www.iitk.ac.in/phy/activities/2015-2016/whepp/plenary.html>
- 2015 - Oral Seminar at the VI Scuola Nazionale “Rivelatori ed Elettronica per Fisica delle Alte Energie, Astrofisica, Applicazioni Spaziali e Fisica Medica”, Legnaro, 23-27 March 2015, “From the pn junction to the particle detector” <https://agenda.infn.it/contributionDisplay.py?contribId=37&confId=8834>.
- 2013 - Oral presentation at the 11th Internation Conference on “Flavor Physics and CP Violation (FPCP 2013)”, 19-24 May 2013, Rio de Janeiro, Brazil
“Precise Measurement of D0 mass and D* linewidth with BABAR” <http://fpcp2013.if.ufrj.br/>
- 2013 - Oral Presentation at the “Incontri di Fisica delle Alte Energia”, 3-5 April 2013, Cagliari, Italy
“Risultati recenti e prospettive ai colliders e+e-” <https://agenda.infn.it/conferenceDisplay.py?confId=5829>

- 2012 - Oral Presentation at the “International Conference on New Frontiers in Physics”, 10-16 June 2012, Kolymbari, Crete, Greece
“New sources of CP Violation at BaBar (CP violation in τ and 3 body B decays)” <https://indico.cern.ch/event/176361/contributions>
- 2010 - Oral Presentation at the international conference “Rencontres de Moriond QCD”, 13-20 March 2010, La Thuile, IT
“Quarkonium non-exotic decays at BaBar and Belle”
- 2009 - Oral Presentation at the international conference BEAUTY09, 7-11 September 2009, Heidelberg University, Germany:
“Bottomonium Spectroscopy (and Decay) at the B Factories”
<http://beauty2009.physi.uni-heidelberg.de/Programme/talks/thursday-session1/simi-bottomonium-beauty09.v4.pdf>
- 2009 - Oral Presentation at “15th International Symposium on Particles Strings and Cosmology”, 6-10 July 2009, DESY, Hamburg, Ge
“Rare Processes in B decays”
<http://pascos2009.desy.de/e39/e79/>
- 2008 - Seminar at University of Maryland, 7 May 2008, College Park, MD
“Penguin B Decays in BaBar” http://www.slac.stanford.edu/simi/umd/2008-05_peng_umd_seminar.pdf
- 2008 - Oral Presentation at the “XLIIIrd Rencontres de Moriond, Electroweak section”, 1-8 March 2008, La Thuile, IT
“BaBar Recent results on Penguin Decays”
<http://indico.in2p3.fr/materialDisplay.py?contribId=78&sessionId=5&materialId=slides&confId=420>
- 2006 - Oral Presentation at the 7th International Conference on Hyperons, Charm And Beauty Hadrons (BEACH 2006), 2-8 July 2006,
“EW Penguin Decays and New Physics, Experimental Overview for BaBar and Belle”,
<http://indico.cern.ch/materialDisplay.py?contribId=51&sessionId=21&materialId=slides&confId=a056809>
- 2004 - SCIPP experimental seminar, UC S. Cruz, 7 June 2004,
“The BaBar SVT: Radiation Damage and Operational Issues”,
<http://scipp.ucsc.edu/seminars/experimental/simi.pdf>
- 2003 - Oral presentation at the Nuclear Science Symposium, Portland, Oregon, October 20-24, 2003,
“Performance, Radiation Damage and Future Plans of the BaBar Silicon Vertex Tracker”,
<http://www.slac.stanford.edu/simi/presentations/IEEE2003/talk.pdf>,
G.Simi *et al.*, *IEEE Trans. Nucl. Sci.*, 51:2298– 2301, 2004.
- 2003 - Poster session at the conference on Frontier Detectors For Frontier Physics, La Biodola, Isola D’Elba, May 25-31 2003, “Sensor Performance of the BaBar Silicon Vertex Tracker after four years of data taking”,
G. Simi *et al.*, *Nucl. Instrum. Meth. A* **518**, 290-293 (2003)
http://www.slac.stanford.edu/simi/presentations/2003May_9thPisaMeet/poster.pdf
- 2003 - XXXI International Meeting on Fundamental Physics, February 24-28, 2003, Soto de Cangas (Asturias), Spain, “Radiative Penguin Decays in BaBar”,
http://www.slac.stanford.edu/simi/presentations/2003Feb_Asturia/final.pdf
- 2001 - 5th International Conference on Large Scale Applications and Radiation Hardness of Semiconductor Detectors , July 4-6, 2001, Firenze, Italy
“Design And Characterization Of Integrated Front-End Transistors In A Micro-Strip Detector Technology”,
G. Simi *et al.* *Nucl. Instrum. Meth. A* **485**, 193 (2002).
<http://www.fi.infn.it/conferenze/rd01/rd01preliminaryprogram.html>

Teaching activities

- Academic years: 2011/2012 → 2023/2024 - Professor in charge of the **second-year compulsory course “Complementi di fisica” (9CFU)** for the Bachelor’s degree in aerospace engineering and mechanical engineering, **University of Padua**. This course provides the students with the problem solving ability and the basic theory of electromagnetism, wave optics and an introduction to modern physics (special relativity and quantum mechanics). It consists of in class lectures (69 hours), laboratory experiences (6 hours) and demonstrations (6 hours).
- Academic year
 - 2016/2017Professor in charge of the “Flavour Physics and Standard Model” (3CFU) course for the Doctoral degree in Physics, **University of Padova**. In this course students learn the basic experimental analysis techniques and results in flavour and electroweak physics.
- Academic year 2015/2016 → 2023/2024 - Professor in charge of the **fourth year compulsory course “Laboratorio avanzato di fisica, modulo A” (2CFU)** for the Bachelor’s degree in Physics and Astronomy, **University of Padua**. This course is aimed at setting up an experiment to measure the lifetime, polarization and g-2 factor of muons from cosmic rays. Students learn to build and calibrate a muon detector, acquire the time difference data and analyze the resulting distributions to extract the parameters of the model.
- Academic years: 2020/2021→ 2023/2024 Professor in charge of the **fourth year compulsory course “Physics Laboratory”(4CFU on a total of 9 CFU)** for the Bachelor’s degree in Physics and Astronomy, **University of Padua**. Students in this course setup up three experiments using detectors, electronics, and analysis techniques typical of nuclear and accelerator physics experiments.
- Academic years: 2011/2012 → 2014/2015, 2017/2018 → 2018/2019 - Professor in charge of the **first year compulsory course “Mechanics and Thermodynamics” (9CFU)** for the Bachelor’s degree in civil and environmental engineering, **Ecole Nationale Supérieure des Travaux Publics, Yaoundé**. This course provides the students with the problem solving ability and the basic theory of classical mechanics of the point and rigid body, oscillations, gravity and thermodynamics. It consists of an intense period of in class lectures (72 hours).
- Academic year : 2013/2014 = Professor in charge of the **“techniques and materials for physics lab” (2CFU)** for the C290 class of the “special abilitation tracks” (PAS) for secondary school educators, **University of Padua**. This course provides the students with the ability to setup physics laboratory experiments and consists of 8 hours in the laboratory and 8 hours of online course.
- Academic year: 2012/2013 - Professor in charge of the **first year compulsory course “Fisica” (6CFU)** for the Bachelor’s degree in civil-architectural engineering, University of Padua. This course provides the students with the problem solving ability and the basic theory of classical mechanics of the point and rigid body and thermodynamics. It consists of in class lectures and tutoring (80 hours), laboratory experiences (6 hours) and demonstrations (2 hours).
- Academic year : 2011/2012 In class tutoring (14 hours) for the **first year compulsory course of “Fisica I”** for industrial and information engineering, **University of Padua**.
- Academic year 2007/2008: Lectures on **“accelerators and detectors for particle physics”** for the QuarkNet Teacher Training at the **University of Maryland, College Park, USA**
- Member of the **evaluation committee** for
 - the final exams for the above mentioned courses
 - for the final Bachelor’s degree in Physics and Astronomy (AA 2012/2013)
- Member of the **education committee (Consiglio di Corso di Studi)** of the Industrial Engineering department and Aerospace Engineering department (AA from 2011 to 2020)

Tutoring

- Academic year 2017/2018: Examiner **Controrelatore** for a thesis on “misura della sezione d’urto $\sigma_{pp} \rightarrow b\bar{b}X$ with CMS” by Enrico Lusiani.
- Academic year 2017/2018: Tutor (**Relatore**) for a bachelor degree thesis in Physics at the **University of Padova** by Pietro Argenton with title “Study of the decay $\Lambda_b^* \rightarrow \Lambda_c^* \pi \pi \pi$ with the LHCb detector”
- Academic year 2018: Proponent for a CERN summer student project with title “Photodetectors for RICH Upgrade” and tutor of the student V. Lukashenko **winner of the CERN Moritz Karbach Prize.**
- Academic year 2016: Tutor (**Relatore**) for a bachelor degree thesis in Energy Engineering at the **University of Padua** with title “Calcolo analitico e verifica sperimentale di un sistema di raffreddamento per rilevatori di fotoni”
- Academic years
 - 2013/2014
 - 2014/2015

Tutor for the **International Internship of Erasmus+ students** on the following projects:

- “preparation of a facility to measure the characteristics of a photo-multiplier”
 - “Preparation of an experiment to detect cosmic ray muons and measure their magnetic moment”
 - “Thermal simulations of the cooling system for the upgraded RICH detector of the LHCb experiment”
 - “Development of a database to store the photo-multiplier test data for the RICH detector of the LHCb experiment”
- Academic year 2016: Tutor for the **International Internship INFN-DOE (summer exchange program)** with the project “R&D for the Upgrade of the LHCb RICH Detector”.

Summary of the Scientific Activity

Dr. Simi joined the *BABAR* collaboration in 1996 with a fellowship position at SLAC as “visiting scientist” to work on the track reconstruction algorithms of the *BABAR* experiment.

In 1997 dr. Simi graduated in Physics at the University of Pisa with a thesis on the feasibility of the measurement of direct CP asymmetry in B mesons decays with the *BABAR* detector at PEP-II at SLAC, under the supervision of Prof. Marcello Giorgi. This work was then included in “The BaBar Physics Book’: Physics at an asymmetric B-Factory”, chap. 6.8 [Harrison, P. F., e. and Quinn, Helen R., e. *SLAC-R-0504* (1998). **Papers from Workshop on Physics at an Asymmetric B Factory (BaBar Collaboration Meeting), Rome, Italy, 11-14 Nov 1996, Princeton, NJ, 17-20 Mar 1997, Orsay, France, 16-19 Jun 1997 and Pasadena, CA, 22-24 Sep 1997**]. Dr. Simi was then accepted in the graduate Ph.D. program at the physics department of the University of Pisa where he successfully completed all the required tests.

BABAR Silicon Vertex Tracker and PhD Thesis

During the Ph.D. Dr. Simi participated with Prof. G. Batignani and F. Forti (U.Pisa and INFN) to the development of micro-strip detectors with transistors integrated on a high resistivity substrate [Simi, G., Angelini, C., Batignani, G., Bettarini, S., Bondioli, M., et al. *Nucl. Instrum. Meth.* **A485**, 193–198 (2002)] and the realization of a photo-detector [Batignani, G. et al. *Nucl. Instrum. Meth.* **A530**, 98–104 (2004)] prototype, in particular he was responsible for the measurement of the characteristics of the integrated

transistors.

He also participated to the design and construction of the *BABAR* Silicon Vertex Tracker (SVT) [Bozzi, C. et al. *Nucl.Instrum.Meth.* **A447**, 15–25 (2000)] and the commissioning at SLAC, in particular to the construction of the modules of the external layers of the SVT.

From 2001 to 2004 Dr. Simi has been in charge of coordinating the group of physicists responsible for the operation of the *BABAR* SVT.

In 2002 Dr. Simi was also responsible for the SVT disassembly, reassembly, test and re-commissioning during the IR upgrade (internal BaBar note NOTE-0577).

During this period Dr. Simi also used the first *BABAR* data to calibrate the SVT alignment and vertexing algorithms with control samples (internal BaBar note BAD-183). This has been an important contribution to the determination of the systematic errors in the first observation of CP violation in the B^0 meson system [Aubert, B. et al. *Phys.Rev.Lett.* **87**, 091801 (2001)].

In 2002 Dr. Simi studied the radiation damage to the SVT [Re, V., Kirkby, D. P., Bruinsma, M., Berryhill, J., Burke, S. P., et al. *IEEE Trans.Nucl.Sci.* **51**, 2298–2301 (2004)] and determined the expected degradation of performance of the device through the end of the experiment (internal note BAD-707). Furthermore in 2004 Dr. Simi coordinated the task force studying the effect of the accumulation of static charge on the surface of the silicon wafers that caused a sudden increase in the detector dark current. In June 2004 Dr. Simi was also invited to give a seminar at the University of California Santa Cruz on “The BaBar SVT: Radiation Damage and Operational Prospects” to present the radiation damage studies on the SVT and the effects of the accumulation of charge in the passivation oxide.

Dr Simi graduated from the Ph.D. program in 2001 defending his thesis on “Measurement of the D^0 meson lifetime with the *BABAR* detector” [Simi, G. (2001). SLAC-R-937]. In the thesis he obtained the most precise determination of the D^0 meson lifetime and developed a method to search for the mixing in charm mesons using double Cabibbo suppressed decays. Charm mixing was indeed observed by *BABAR* in 2007 in $D^0 \rightarrow K\pi$ using this technique [Aubert, B. et al. *Phys.Rev.Lett.* **98**, 211802 (2007)]. This measurement had significant impact on the theoretical understanding of the D^0 mesons system and spurred numerous theoretical studies.

In January 2005 Dr. Simi was hired by University of Maryland as a “research associate”.

***BABAR* Tracking**

From 2006 to 2009 Dr. Simi has been responsible for coordinating the group developing the core track reconstruction software for the *BABAR* experiment. Under his coordination this group developed several important improvements to the tracking code which improved the quality of the analyses subsequently published by *BABAR*: 2-4% efficiency increase, 50% reduction of systematic errors related to tracking [Banerjee, Simi, G. et al. *J. Phys.: Conf. Ser.* **119**, 032007 (2008)] [Allmendinger, T., Bhuyan, B., Brown, D. N., Choi, H., Christ, S., Simi, G., et al. *Nucl.Instrum.Meth.* **A704**, 44–59 (2013)].

***BABAR* Analysis**

In 2005 Dr. Simi began the study of rare exclusive radiative B decays $B \rightarrow Xs + \gamma$. In particular Dr. Simi analyzed the clean decay mode $B^{0(+)} \rightarrow K_S^{r(+)} \phi \gamma$ improving the limit on the \mathcal{BR} of the neutral channel by 5 folds [Aubert, B. et al. *Phys.Rev.* **D75**, 051102 (2007)].

Furthermore in 2006 Dr. Simi measured the time dependent CP violation and the \mathcal{BR} of the $B \rightarrow K^0 \pi^0$ decay channel. This transition is dominated by a $b \rightarrow s d \bar{d}$ penguin diagram which is sensitive to the virtual contributions of new physics in the loop diagrams (ICHEP 2006 hep-ex/0607096, [Aubert,

B. et al. *Phys.Rev.* **D77**, 012003 (2008)]. An updated measurement has been published by Dr. Simi in 2009 [Aubert, B. et al. *Phys.Rev.* **D79**, 052003 (2009)] together with the measurements of the time dependent CP violation in the main $b \rightarrow sq\bar{q}$ channels accessible to *BABAR*, and a detailed description of the methodology used.

Finally in 2007 Dr. G. Simi studied the time dependent CP violation also in the channel $B^0 \rightarrow K_S\pi^0\gamma$ where the left handed nature of the weak interaction can be tested through the measurement of time dependent CP violation [Aubert, B. et al. *Phys.Rev.* **D78**, 071102 (2008)].

In 2008 Dr. Simi studied the decay of $\Upsilon(1S)$ to open charm mesons observing this process for the first time and measuring the inclusive $\mathcal{BR}[\Upsilon(1S) \rightarrow D^{*\pm} + X]$ and the D^* momentum distribution which is helpful to test Non Relativistic QCD [Aubert, B. et al. *Phys.Rev.* **D81**, 011102 (2010)].

Applied Physics

In 2010 Dr. Simi participated to a research project at University of Padova to develop in collaboration with the Concast Technologies Srl a sensor for the liquid steel level in continuous iron casting plants. He applied gamma detection techniques and data analysis techniques widely used in particle physics to improve the measurement of the liquid steel level and most importantly to measure at the same time the amount of lubricating material present on the steel surface. He realized and tested the detector on a real steel factory. This device has been shown ([Stahl Und Eisen, 135 (2015), Nr. 1, S. 39]) to improve the quality of the casted steel and a European patent (EP 2 492 650 B1) has been obtained by the Concast Technologies Srl as a result of this work.

Design of the SuperB experiment

Dr. Simi participated to the proposal for the SuperB experiment, a flavor physics experiment at the “precision frontier” using high luminosity colliders to search for new physics. It is based on an innovative design for an e^+e^- collider with a luminosity two orders of magnitude higher than the one available at the B-Factories, the possibility to collide polarized beams and to run at the ψ' resonance as a charm factory. The SuperB had the ambitious goal to test the Standard model using precision measurements, through the observation of the interference effects of New Physics amplitudes with the SM model ones. The main decay channels are rare decays dominated by loop diagrams and lepton number violating decays, where this experiment had the potentiality to obtain limits comparable to dedicated experiments.

Dr. Simi contributed to the definition of the physics opportunities at a SuperB factory as acknowledged in the 2009 presentation to the High Energy Physics Advisory Panel [http://science.energy.gov/ /media/hep/pdf/files/pdfs/hepap_may_2009_jawahery_hepap_may21.pdf](http://science.energy.gov/media/hep/pdf/files/pdfs/hepap_may_2009_jawahery_hepap_may21.pdf)

Dr. Simi developed a fast simulation of the SuperB detector (together with collaborators from LBL, Caltech, U. Cincinnati and LNF in Rome) which was used for detector optimization studies and sensitivity studies of benchmark physics measurements (VII SuperB Workshop at “Isola d’Elba”, 2008 and [Andreassen, R., Sokoloff, M., Arnaud, N., Burmistrov, L., Brown, D., et al. *J. Phys. Conf. Series* **331**, 032038 (2011)]). This simulation has also been used for the mu2e experiment at Fermilab.

Dr. Simi used the fast simulation to study the optimization of the silicon vertex detector using the decay channel $B^0 \rightarrow K_S\pi^0$ (VIII SuperB workshop, Orsay (Fr) 2/2009). Due to the reduced boost of the CM the vertex detector has to be re-optimized with the addition of a layer close to the interaction region.

Secondary neutron background affects several SuperB analyses, especially those with missing energy, and can cause damage to the detector elements and electronics, affecting its performance. To study its effect Dr. Simi connected the detailed accelerator simulation and a GEANT4 description of the detector with the simulation of the physics events (IX SuperB Workshop, Perugia (It) 6/2009).

One of the SuperB sub-detectors that is most affected by the increase of the background related to the luminosity is the particle identification system. Previous designs (BaBar) employed a large water tank that makes it sensitive to secondary neutron background. Therefore Dr. Simi participated to the design and test of a new concept of Detector of Internally Reflected Cerenkov Light (DIRC) with a focusing optics to reduce this volume by ten times (Focusing DIRC or FDIR [Va'vra, J., Arnaud, N., Barnyakov, A. Y., Barnyakov, M. Y., Beigbeder, C., et al. *Nucl.Instrum.Meth.* **A718**, 541–545 (2013)] [Gargano, F., Arnaud, N., Barnyakov, A. Y., Barnyakov, M. Y., Beigbeder, C., et al. *Nucl.Instrum.Meth.* **A718**, 563–565 (2013)] [Arnaud, N., Barnyakov, A. Y., Barnyakov, M. Y., Beigbeder, C., Benettoni, M., et al. *Nucl.Instrum.Meth.* **A718**, 557–559 (2013)] [Beigbeder, C., Breton, D., Arnaud, N., Barnyakov, A. Y., Barnyakov, M. Y., et al. *Nucl.Instrum.Meth.* **A718**, 186–188 (2013)],). In addition the use of fast photo-detectors and electronics (with resolutions of the order of 50ps) allows to reduce the background by another factor of ten.

In particular Dr. Simi studied the time resolution of traditional multi-anode photo-multipliers designed a time calibration system based on charge injected through the PMT dynodes and investigated the possibility to improve its particle separation power by using novel photo-detectors such as pixelated G-APD. These studies were included in the technical design report for the SuperB detector [SuperB Collaboration. *SLAC-R-1003* (2013)].

HPS Experiment

In July 2013 Dr. Simi started a collaboration with the SLAC National Accelerator Laboratory joining the HPS experiment. Several observed anomalies such as the high energy excess in the positrons flux measured by the Pamela experiment and the g-2 discrepancy could be naturally explained by the presence of a hidden sector of particles uncharged under the standard model which can be related to a new U(1) gauge symmetry and a new A' gauge boson. The HPS experiment at the Jefferson Laboratory in Virginia (USA) is designed to produce the A' boson in fixed target collisions using the CEBAF electron beam. and search for the decay of the A' decaying into a pair of leptons. HPS plans to exclude a significant part of the sensitivity plane by adding a vertex detector to a more standard e.m. calorimeter detector in order to separate long lived particles from the enormous background. Dr. Simi has contributed to the effort of the Italian group working on the vertexing and tracking software. In particular Dr. Simi worked on the alignment of the vertex detector, one of the most critical aspects of the tracking system, using a Generalized Broken Lines tracking algorithm in conjunction with Millepede.

The HPS experiment took data during an engineering run in 2015 recording 30mC on target at a beam energy of 1.05 GeV of which 10mC with the Vertex Detector. The engineering run was used to calibrate the detector and understand the operation of the Vertex Detector. Dr. Simi participated to the data taking and the commissioning of the Vertex detector. The HPS experiment took data again in 2016 at a beam energy of 2.3 GeV collecting 6.3×10^9 events. This data is currently being analyzed to search for an electron-positron pairs invariant mass peak using the information of the calorimeter with and without the information from the vertex detector. The expected sensitivity on the A' gauge boson mixing parameter ϵ^2 is 10^{-6} .

LHCb experiment

After the cancellation of the SuperB project Dr. Simi joined the LHCb collaboration. The LHCb detector will be upgraded to make more efficient use of the available luminosity at the LHC in Run III and extend its potential for discovery. Dr. Simi joined the effort for the preparation of the LHCb upgrade foreseen during the 2018 LHC shutdown. In particular Dr. Simi contributed to the design of the new Ring Imaging Cerenkov detectors which are key components of the LHCb detector for particle identification.

Dr. Simi has been the “team leader” of the LHCb RICH group group in Padova which is working on both the operation and maintenance of the LHCb detector and the design and construction of the LHCb-Upgrade1 detector (LHCb-TDR-014).

Dr. Simi's group had the responsibility for the design and construction of the mechanical support structure for the photo-multipliers of the RICH2 subsystem as well as the RICH2 cooling system. The mechanical structure has to support the photon detector and front-end electronics in a close packed environment while maintaining easy access to the detectors for maintenance and repair. The cooling system has to remove the heat generated by the electronics systems maintaining a uniform temperature for the photon detectors below 35 degrees to avoid quick aging. These structures have been designed and simulated in Padova and prototypes have been built to measure and optimize their performances. The system has passed the engineering design review (Jul 2016) and Dr. Simi's group has successfully assembled and installed these structures at the LHCb-Upgrade1 detector.

Dr. Simi's group had also the responsibility for the characterization of the photon detectors that are being installed in the experiment. An automated test facility has been built in collaboration with Univ. of Edinburgh and with the help of a grant fellowship of the G.Galilei Physics and Astronomy Department of Padova obtained by Dr. Simi's group. The facility has been validated and used to determine the quality, and measure their characteristic parameters, of the PMTs which have been installed in the LHCb-Upgrade1 detector.

Dr. Simi's group also participated to the test of the photon detection system for the LHCb RICH Upgrade in a charged particle beam, carried out to assess the prototypes of the upgraded opto-electronic chain from the Multi-Anode PMT photo-sensor to the readout and data acquisition system. [Baszczyk, M. K. et al. (2016)].

Dr Simi is analyzing the LHCb data to search for new physics in semileptonic decays where one of the most puzzling hints of deviations from the standard model in flavor physics has been found: the measured ratio of $R_{D^{(*)}} = BR(B \rightarrow D^{(*)\pm}\tau\nu)/BR(B \rightarrow D^{(*)\pm}\mu\nu)$ which is incompatible with the Standard model prediction at the 3.9σ level [Phys.Rev.Lett. 115 (2015) 11]. Dr. Simi and his group is investigating the analogous quantity $R_{\Lambda_c^*}$ from semileptonic decays of the Λ_b baryon into excited charmed baryons. LHCb is the only running or past experiment that can access this decay modes. The Run1+Run2 data are expected to yield $O(10^3)$ events with an expected sensitivity of 20%.

A necessary ingredient for the measurement of $R_{\Lambda_c^*}$ is a) the knowledge of the form factors of the semileptonic decay $\Lambda_b \rightarrow \Lambda_c^* \mu \nu_{mu}$ and b) the measurement of the abundance of the physical background $\Lambda_b \rightarrow \Lambda_c^* D_s^{(*)}$. Dr. Simi's group is currently finalizing the analysis for a) and b).

Since 2019 Dr. Simi is the principal investigator of the LHCb Padova group. In addition to the upgrade of the RICH detector for the LHCb experiment (mechanics, photon detectors, commissioning [LHCb-PUB-2016-015]), the group is involved in the upgrade of the calorimeter, the future upgrade of the vertex detector, several data analyses including the search for violation of the lepton universality in semitauonic decays of b-baryons $\Lambda_{b-} \rightarrow \Lambda_{c-} \tau \nu_{\tau}$, the search for new resonances in b-quark and c-quark jets, the application of innovative algorithms to the analysis of large amounts of data (deep neural networks and quantum algorithms).

TIMESPOT project

During the high luminosity runs of the LHC collider the detectors will face great challenges due to the increase in the particle density. Precise time information will be fundamental to maintain a good detector performance.

In 2017 G. Simi obtained fundings, together with other collaborators, for a research project (TIMESPOT) aimed at the design and construction of a pixel detector for tracking with precise measurement of the time of passage of the track capable of withstanding a radiation dose equivalent to a fluence of $10^{15} - 10^{16} n_{equiv}/cm^2$.

Dr. Simi group has participated to the design of the basic sensitive element of the pixel detector and measured the static characteristics of test devices. In particular the group studied the characteristics of an innovative 3D-trench pixel sensor with precise time measurement developed at the FBK in Trento by the TIMESPOT collaboration. The detector should be capable of 20ps time resolution, withstanding high radiation doses.

First we measured the static characteristics of the pixel sensor and studied its time resolution with a

laser system. Next, we tested the sensor with a 2MeV proton beam in Legnaro. The time resolution has been extracted using an innovative time tag system, based on a thin layer of organic scintillator deposited above the detector. The uniformity of the time response in the pixel active area has been studied with a precision of a few μm . Finally, we measured the time resolution with 250GeV pion beam at the SPS, obtaining a stunning 10ps resolution for the devices [Borgato, F. et al. *Front. in Phys.* **11**, 1117575 (2023)].

TwoCryst experiment

In recent years CERN put significant effort in searching for complementary methods to high-energy-frontier colliders to investigate the physics of elementary particles and forces. In this context it has been proposed to set new constraints to extensions of the Standard Model of particle physics by searching for the Electric Dipole Moment (EDM) of charmed baryons at the LHCb experiment or using a dedicated experiment.

The EDM of charmed baryons can be probed by studying the precession of its spin in an intense magnetic field. However the experimental observation is challenging because of the relatively short lifetime of charmed baryons. Nevertheless this limitation can be overcome using the combination of a fixed target and a bent crystal; baryons produced in the target are channeled into the crystal and undergo spin precession induced by the intense electromagnetic field of the crystal atoms. In fact an intense static electric field is transformed into an intense magnetic field in the moving frame of the charmed baryons.

Several technological advances are needed to perform this measurement but the prerequisite is a proof of principle of the extraction of the LHC beam using a short bent crystal and the subsequent production of charmed baryons in a target and channeling in a second long bent crystal.

The TwoCryst experiment is a proof of principle (POP) for the extraction of the LHC beam with two crystals in order to measure the efficiency and the background level.

G. Simi is the PI of the Padova group participating in the POP. The Padova group is responsible for the design and construction of the tracking detector and participates in the development of the DAQ system.

0.1 Aladdin Experiment

The ALADDIN experiment is a proposed setup at the LHC designed to measure the Magnetic and Electric Dipole Moments (MDM & EDM) of charmed baryons, specifically the Λ_c^+ . The experiment aims to bridge the gap between the short lifetimes of these particles and the need for a strong magnetic field to induce measurable spin precession.

The goal of the experiment is to measure the MDM and EDM of Λ_c^+ baryons to gain insights into baryon internal quark dynamics and test physics beyond the Standard Model.

It uses a fixed-target experiment within the LHC, utilizing a tungsten target to create Λ_c^+ particles from 7 TeV protons.

Instead of conventional magnets, ALADDIN plans to use bent silicon crystals to induce spin precession in the Λ_c^+ particles. These crystals can generate the equivalent of a 2300T magnetic field.

The experiment uses a splitting crystal to channel the beam halo and direct it towards a precession crystal (TCCP).

A detector system consisting of trackers, a Ring-Imaging Cherenkov Detector (RICH), and a dipole magnet is used to identify the decay products of the Λ_c^+ and reconstruct their trajectories.

The experiment is proposed for the free space in LHC IR3.

The experiment faces challenges related to the performance of the TCCP at TeV energies, achieving sufficient statistics, and operating two high-precision devices simultaneously.

The TWOCRYST project serves as a proof-of-principle test stand for the ALADDIN concept, operated in 2025.

G. Simi is the PI of the Padova group participating in the Aladdin international Experiment. The Padova group proposed to design and build the RICH detector and design the mechanics for the tracker.

Scientific Impact of The Research

On October 16th 2023, source WEB OF SCIENCE

- 1152 publications on international refereed journals and conference proceedings.
- Total number of citations without self-citations: 38553.
- Average citation per item: 38
- H-index: 106

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