UNIVERSITÀ DEGLI STUDI DI NAPOLI FEDERICO II

DOTTORATO DI RICERCA / PHD PROGRAM IN
INFORMATION TECHNOLOGY AND ELECTRICAL ENGINEERING

Activities and Publications Report

PhD Student: Vittorio Ferrentino

Student DR number: DR995870

PhD Cycle: XXXVII
PhD Cycle Chairman: Prof. Stefano Russo

PhD program student's start date: 01/01/2022
PhD program student's end date: 31/12/2024

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PhD scholarship funding entity: Student enrolled supernumerary under the UNINA-CERN agreements and CERN Doctoral Student Programme

General information

Vittorio Ferrentino received in 2020 the Master Science degree in Electrical Engineering from the University of Napoli Federico II. He attended a curriculum in Electrical Engineering within the PhD program in Information Technology and Electrical Engineering. He received a grant from European Organization for Nuclear Research (CERN).

Study activities

Attended Courses

Year	Course Title	Type	Credits	Lecturer	Organization
1st	Scientific writing	Eternal course	3	Prof. Raymond Boxman, University of Tel Aviv, Tel Aviv, Israel, Dr. Jonathan Boxman, Edith Boxman	CERN
1st	My first steps in French	External course	6	Prof. Emmanuel Bonato, Supercomm Group, Switzerland	CERN & Supercomm
1st	Metrology and Machine Learning for Brain Computer Interfaces	Ad hoc course	2.4	Prof. Pasquale Arpaia	DIETI
1st	CERN Accelerator School (CAS): Introduction to Accelerator Physics	External course	12	Dr. Frank Tecker, CERN, Geneva, Switzerland	CERN
2nd	Academic Entrepreneurship	Ad hoc course	4	Prof. Pierluigi Rippa, Department of Industrial Engineering, University of Naples Federico II, Naples, Italy	DIETI
2nd	Standard Model of Fundamental Interactions	Ad hoc course	3	Prof. Francesco Sannino, University of Naples Federico II, Naples, Italy; University of Southern Denmark, Odense, Denmark	DIETI and Scuola Superiore Meridionale (SSM), Naples, Italy
2nd	Introduction to Deep Learning	Ad hoc course	6	Prof. Giovanni Poggi, University of Naples Federico II, Naples,	DIETI and Scuola Superiore Meridionale (SSM), Naples, Italy

				Italy; Diego Gragnaniello, University of Salerno, Salerno, Italy	
2nd	Big Data Architecture and Analytics	Ad hoc course	5	Prof. Giancarlo Sperli', DIETI, University of Naples Federico II, Naples, Italy	DIETI
3rd	Numerical Methods for Thermal Analysis, Modelling and Simulation: Application to Electronic Devices and Systems	Ad hoc course	4	Prof. Antonio Pio Catalano, University of Naples Federico II, Naples, Italy	DIETI
3rd	Learn English with Confidence – Niveau B2+	External course	0	Dr. Rossa Pinar Escalante, Formations&Co, Nyon, Switzerland	CERN and Formations&Co

Attended PhD Schools

Year	School title	Location	Credits	Dates	Organization
1st	5th Future-IoT PhD School: IoT meets Autonomy 2022	Berlin, Germany	3	29.08.2022 - 02.09.2022	
2nd	2023 Spring School on Transferable Skill	Naples, Italy	2	24.05.2023 – 25.05.2023	Department of Pharmacy, University of Naples Federico II, Naples, Italy

Attended Seminars

Year	Seminar Title	Credits	Lecturer	Lecturer affiliation	Organization
1st	Project Vac: Can a Textto-speech Engine Generate Human	0.2	Prof V.K. Gubani	Illinois Institute of Technologies, US	Department of Physics Ettore Pancini and DIETI
1st	Global and cluster synchronization in complex network and beyond	0.2	Prof. Mattia Frasca	Department of Computer Science and Electronic Engineering, University of Catania	DIETI, University of Napoli Federico II
1st	Computational single-cell biology – From one-to-many cells	0.2	Dr. Oliver Stegle,	German Cancer Research Center (DFKZ), Heidelberg, Germany	DIETI, University of Napoli Federico II

1st	From basic principles in spintronics to some recent developments toward spin-orbitronics	0.2	Dr. Vincent Cros	Unité Mixte de Physique, CNRS, Thales, Université Paris-Saclay, 91767, Palaiseau – France	DIETI, University of Napoli Federico II
1st	Living well within planetary Limits: is it possible? And what can physicists contribute?	0.4	Prof Julia K. Steinberger	University of Lausanne, Lausanne, Switzerland	CERN
1st	Potential and challenges of next generation railway signaling systems: Moving Block and Virtual Coupling	0.2	Eng. Joelle Aoun	Faculty of Civil Engineering and Geosciences, Delf University of Technology, Netherlands	DIETI, University of Napoli Federico II
1st	Design Thinking Workshop	1	Dr. Samuel Simon	PhDnet, Center for Advanced Internet Studies (CAIS), Germany	PhDnet, Center for Advanced Internet Studies, Germany
1st	Towards a political philosophy of AI, Picariello Lectures on Data Science	0.4	Prof. Mark Coeckelbergh	University of Wien, Wien, Austria	DIETI, University of Napoli Federico
1st	Towards AI-Driven Cancer Precision Medicine	0.2	Dr. Olivier Elemento	Director Englander Institute for Precision Medicine, Associate Director Institute for Computational Biomedicine	DIETI, University of Napoli Federico
1st	Everything you always wanted to know about the Internet (but were afraid to ask)	0.8	Dr Eric Huizer, Dr. Job Snijders, Prof. Colin Perkins	GEANT, IEFT GROW, School of Computing, University of Glasgow; Dr Kent Lindstrom	CERN
1st	ITER, the magnets and the road to the first plasma	0.2	Dr. Neil Mitchell	ITER, Saint-Paul-les-Durance, France	CERN
1st	5G Academy: Fixed Wireless Access	1.2	Ing. Angela Deluga, Ing. Luca Mazza, Ing. Marco Fazzari,	Fastweb, Italy	CERN
1st	5G Academy: AR for remote use of measurement instrumentation	0.4	Prof. Annalisa Liccardo	DIETI, University of Napoli Federico	DIETI, University of Napoli Federico

1st	Vine robots: design challenges and unique opportunities	0.2	Dr. Nicholas Naclerio	Department of Mechanical Engineering, University of California Santa Barbara, Santa Barbara, US	DIETI, University of Napoli Federico
1st	PhD4PhD: A student's speaking - Thermoacoustics for renewable energies	0.2	Elio Di Giulio	Department of Industrial Engineering, University of Naples Federico II, Naples, Italy	DIETI, University of Napoli Federico
1st	Probing and infusing biomedical knowledge for pre-trained language models	0.4	Dr. Zaiqiao Meng	University of Glasgow, UK School of Computing Science, Glasgow, Scotland	DIETI, University of Napoli Federico
1st	PhD4PhD: A student's speaking ± Robotic assistance: pros and cons of a new technology	0.2	Dr. Michele Manigrasso	DIETI, University of Napoli Federico	DIETI, University of Napoli Federico
1st	5G Academy: Introduction to intellectual property management	0.4	Dr.Alessandro Morroni	Director of Transactions and External Alliances, Nokia	DIETI, University of Napoli Federico
1st	Cybercrime and Information Warfare: National and International Actors	0.4	Dr. Pierluigi Paganini	Cybhorus S.r.l, Italy	DIETI, University of Napoli Federico
1st	Privacy and Data Protection	0.4	Dr. Stefano Mele	Partner at Gianni & Origoni, Head of Cybersecurity Law Department, co-Head of Data Protection Department	DIETI, University of Napoli Federico
2nd	5G Academy – Open Digital Framework	0.6	Dr. Alberto Curcio	Manager&Head of TMT Portfolio, Valeria Crimaldi, Analyst Consultant, Capgemini Invent, Italy	DIETI, University of Napoli Federico
2nd	Multi-Robot Control of Heterogeneous Herds	0.2	Prof. Eduardo Montijano	Associate Professor, Department of Informatics and Systems	DIETI, University of Napoli Federico

				Engineering, Universidad de Zaragoza, Spain	
2nd	Analysis and control of functional brain networks	0.2	Prof. Fabio Pasqualetti	Professor at Department of Mechanical Engineering, University of California at Riverside, USA	DIETI, University of Napoli Federico
2nd	High Power Targetry R&D Program with the RaDIATE Collaboration and target perspectives in framework of Snowmass	0.2	Dr. Frederique Pellemoine	Fermi National Accelerator Laboratory, Batavia, USA	CERN
2nd	Learning gene association networks using single-cell RNA-seq data: a graphical model approach	0.2	Prof. Davide Risso	University of Padua, Padua, Italy	DIETI, University of Napoli Federico
2nd	Accurate and Efficient Numerical Modelling Methods for Superconducting Circuit Quantum Information Processing Devices	0.2	Prof. Thomas E. Roth	Purdue University, Elmore Family School of Electrical and Computer Engineering, USA	DIETI, University of Napoli Federico
2nd	How to publish under the CARE-CRUI Open Access Agreement with IEEE	0.3	Prof. Nino Grizzuti, Eszter Lukacs, Dr. Stefano Bianco	CRUI-CARE and University of Naples Federico II, IEEE Client Services Manager, CRUI-CARE and INFN, Italy	DIETI, University of Napoli Federico
2nd	Bremsstrahlung Beam-Size Effects and FCC-ee Beam Lifetime	0.4	Prof. Krzysztof Piotrzkowski	AGH University of Science and Technology, Krakow, Poland	CERN
2nd	Nanoneuro: the power of nanoscience to explore the frontiers of neuroscience	0.2	Dr. Aitzol Garcia-Etxarri	Ikerbasque Resercher, Donostia International Physics Center, Donostia ± San Sebastian, Spain	DIETI, University of Napoli Federico
2nd	Optimization of a mobile clinic routing and scheduling problem in equitable vaccination outreach	0.2	Prof. Mingyao Qi	Shenzhen International Graduate School, Tsinghua University, Shenzhen, China	DIETI, University of Napoli Federico

2nd	Traffic Engineering with Segmented Routing: optimally addressing popular uses cases	0.2	Prof. Pascal Merindol	Department of Mathematics and Computer Science, University of Strasbourg, Strasbourg, France	DIETI, University of Napoli Federico
2nd	Slawosz Uznanski - A CERN staff member, now ESA astronaut	0.2	Dr. Slawosz Uznanski	ESA, Paris, France	CERN
2nd	"Rainbow´ Storage Ring Nuclear Transmutation with Spin Control Capability	0.2	Prof. Richard Talman	Cornwell University, Ithaca, USA	CERN
2nd	Optimization of the High-Brightness Beam Performance of CERN PSB with H-injection	0.2	Dr. Tirsi Prebibaj	CERN	CERN
2nd	Beam Physics Research in IOTA-FAST at Fermilab	0.2	Dr. Giulio Stancari	Fermilab, Batavia, Illinois, USA	CERN
2nd	Research in Energy Storage Systems for Automotive, Aerospace and Grid-connected Systems at the Ohio State University Center for Automotive Research	0.4	Dr. Matilde D'Arpino	Departments of Mechanical and Aerospace Engineering and Electrical and Computer Engineering, Ohio State University (OSU), Center for Automotive Research, Coulumbus, OH, USA	DIETI
2nd	The design of the ENUBET beamline	0.2	Dr. Elisabetta Giulia Parozzi	CERN	CERN
2nd	Reinforcement learning in CERN's accelerator & beyond	0.2	Dr. Michael Schenk	CERN	CERN
2nd	Neutrinos in the lab and in the cosmos (2/3)	0.3	Dr. Joachim Kopp	CERN, University of Mainz, Mainz, Germany	CERN
2nd	Mixed Reality human-robot interface for remote operations in accelerator facilities	0.2	Dr. Krzysztof Adam Szczurek	CERN	CERN
2nd	Picariello Lectures on Data Science – Robotics meets AI and 5G: Future is now	0.4	Prof. Bruno Siciliano	DIETI, University of Naples Federico II, Naples, Italy	DIETI, University of Napoli Federico II

2nd	Diffusive models and chaos indicators for non-linear betatron motion	0.2	Dr. Carlo Emilio Montanari	CERN	CERN
2nd	Ensuring Electronic Reliability Against CERN's Radiation Environment	0.2	Dr. Salvatore Danzeca	CERN	DIETI, University of Napoli Federico II
2nd	Picariello Lectures on Data Science - Artificial Intelligence for Ocean Dynamics	0.2	Dr. Bruno Buongiorno Nardelli	CNR, Italy	DIETI, University of Napoli Federico II
2nd	ICALEPCS 2023 Summary & ATS Flash Presentation Seminar	0.8	Dr. Chris Roderick, Dr. Enrique Blanco Vinuela, Dr. Manuel Gonzalez Berges, Dr. Peter Sollander, Dr. Alessandro Masi	CERN	CERN
3rd	Resource management and orchestration for mixed-criticality cloud/distributed systems	0.2	Dr. Ing. Gautam Gala	Post Doctoral Researcher, Technical University of Kaiserslautern, Kaiserslautern, Germany	DIETI, University of Napoli Federico II
3rd	From ACE Technologies to Sustainable, Accessible and Equitable Urban Mobility: An Optimization Journey	0.4	Prof. Mauro Salazar	Eindhoven University of Technology, Eindhoven, Netherlands	DIETI, University of Napoli Federico II
3rd	Asset Management Structure for the Full Remote Alignment System	0.2	Dr. Mamta Shrikrishna Dandekar	CERN	CERN
3rd	IPAC-Linac Conferences Flash Presentations	0.6	Dr. Richards Scrivens	CERN	CERN

Research activities

Vittorio Ferrentino participated in the research of the magnetic and optics modelling of the CERN Proton Synchrotron (PS) Main Unit (MU) magnets, and their validation with beam-based measurements. To predict the field harmonics within the magnet aperture, he has developed a new, accurate and time-efficient 3D model of the PS-MU in Opera. Field harmonics, properly converted in magnet strengths, have been used as input for beam-dynamics simulations with the Methodical

Accelerator Design – X tool (MAD-X). Beam-based measurements have been carried out to benchmark the models' predictions. The development of the PS-MU models, along with the accuracy of their predictions, has led to various insights into operational applications. For the first time after 60 years of operation, it has been shown that magnetic models of the PS-MU main magnets can accurately predict changes in tune and chromaticity as energy increases.
With the Optics Measurements and Corrections (OMC) team, Vittorio has actively participated to the 2022, 2023 and 2024 Proton Optics Commissioning, and the 2023 and 2024 Ion Optics Commissioning of the CERN Large Hadron Collider (LHC).
Vittorio joined the 2024 International Particle Accelerator Conference (IPAC) in Nashville, Tennessee, US, presenting two papers as main author. He his first author and co-author of many journal and conference papers.

Tutoring and supplementary teaching activities

Credits summary

PhD Year	Courses	Seminars	Research	Tutoring / Supplementary Teaching
1st	26.4	7.8	30.8	0
2nd	20	6.8	42.2	0
3rd	4	1.4	60	0

Research periods in institutions abroad and/or in companies

This research has been supported by the PhD scholarship "CERN Doctoral student programme", funded by the European Organization for Nuclear Research (CERN). The student has been enrolled supernumerary in the XXXVII cycle under the UNINA-CERN agreements. Research activities have been conducted at CERN from 01.03.2022 – 31.12.2024.

PhD Year	Institution / Company	Hosting tutor	Period	Activities
1st - 3rd	European Organization for Nuclear Research (CERN)	Dr. Ewen Hamish Maclean, Staff member	01.03.2022 - 31.12.2024	Research on the magnetic and optics modelling of the CERN Proton Synchrotron (PS) Main Units magnets (MU); Validation of the models through beam-based measurements; Optics measurements in the Large Hadron Collider (LHC); Scientific papers preparation for international journals and conferences;

PhD Thesis

In the PhD Thesis, Vittorio Ferrentino investigates the possibility of predicting the beam dynamics within particle accelerators starting from magnetic and optics models of the main magnetic units in the machine.
Digital twins of accelerator magnets play a vital role in the design, operation, and development of particle accelerators, as well as in optimizing beam performance. This involves the development of accurate magnetic models to predict the field distribution within the magnet aperture, along with optics models to predict the beam dynamics within the machine. Connection between magnetic field predictions and beam dynamics simulations is often complex, requiring sophisticated models to bridge the gap and deliver precise predictions outcomes.
In this context, the CERN Proton Synchrotron (PS) accelerator is featured with 100 combined-function Main Unit (MU) magnets, generating the main magnetic field in the machine. The modelling of these magnetic unit is a unique challenge, aiming to capture the multipolar field distribution within the aperture and the non-linearities, due to the presence of air gaps between consecutive iron blocks within the same unit, and their impact on the beam.
Over the past decades, various efforts have aimed to create accurate digital twins of the PS-MU, striving to incorporate the complexities of their magnetic and optics behaviour. While the operation and optics modelling of the PS-MUs have been historically carried out with empirical beam-based studies, the thesis proposes to evaluate whether, starting from a proper magnetic model and using the predicted harmonics as input to optics simulations, it is possible to accurately predict the beam dynamics in the PS. The predictions from the combined magnetic and optics models are later benchmarked with dedicated beam-based measurements.
This work also explores the implications of magnetic length saturation effects on momentum computation, providing valuable operational insights into the interplay between magnetic and beam optics modelling. The results underline the potential of the developed digital twins to optimize machine performance.

Research products

Research results appear in *3* papers published in international journals and *9* contributions to international conferences. 2 journal papers are into the internal review process.

List of scientific publications

International journal papers

V. Ferrentino, P. Arpaia, A. Gilardi, M. Karppinen, C. Kokkinos, E. Ravaioli,
Analysis of Powering and Quench Protection of the SIGRUM Superconducting Combined-Function Dipole Magnet,
IEEE Transactions on Applied Superconductivity
Vol. 33, number 7, pp. 1-8, 2023, DOI: 10.1109/TASC.2023.3296281.

J. Dilly, V. Ferrentino, M. Le Garrec, E. H. Maclean, L. Malina, T. Persson, T. Pugnat, L. van Riesen-Haupt, F. Soubelet, and R. Tomás,
First operational dodecapole correction in the LHC,
Physical Review Accelerators and Beams (PRAB),
Vol. 26, pp. 121001, Dec. 2023, DOI: {10.1103/PhysRevAccelBeams.26.121001}.

R. Tomás, F. Carlier, F. Chudoba, L. Deniau, J. Dilly, V. Ferrentino, S. Horney, M. Hostettler, J. Keintzel, S. Kostoglou, M. Le Garrec, E.H. Maclean, T. Nissinen, K. Paraschou, T. Persson, M. Solfaroli, F. Soubelet, A. Wegscheider and J. Wenninger,
Optics for Landau damping with minimized octupolar resonances in the LHC,
Journal of Instrumentation (JINST),
Vol. 19, pp. T05010, May 2024, DOI: 10.1088/1748-0221/19/05/T05010.

V. Ferrentino, P. Arpaia, D.G. Cotte, V. Di Capua, A. Gilardi, A. Huschauer, M. Karppinen, E.H. Maclean, M. Pentella, T. Persson, R. Tomas Garcia, and L. Von Freeden,
Optics energy dependence within the CERN Proton Synchrotron Main Units,
Physical Review Accelerators and Beams (PRAB),
(in internal review)

E.H. Maclean, V.Ferrentino, M. Le Garrec, W. Van Goethem, S. Horney, K.Paraschou, R. Tomas
Measurement and correction of forced RDTs to improve machine models and performance
Physical Review Accelerators and Beams (PRAB),
(in internal review)

International conference papers

T. Persson, J.Cardona, F. Carlier, A. Costa Ojeda, J. Dilly, H. García Morales, V. Ferrentino, E. Fol, M. Hofer, E.J Høydalsvik, J. Keintzel, M. Le Garrec, E.H. Maclean, L. Malina, F. Soubelet, R. Tomás, L. Van Riesen-Haupt, and A. Wegscheider,
Optics Correction Strategy for Run 3 of the LHC,
13th International Particle Accelerator Conference (IPAC),
Bangkok, Thailand, 12 - 17 Jun 2022, pp.1687-1690, Publisher JACoW IPAC 2022, DOI: http://dx.doi.org/10.18429/JACoW-IPAC2022-WEPOST008,

F. Carlier, A. Costa Ojeda, J. Dilly, V. Ferrentino, E. Fol, M. Hofer, J. Keintzel, M. Le Garrec, T. Levens, E. H. Maclean, T. H. B. Persson, F. Soubelet, R. Tomás Garcia, L. Van RiesenHaupt, A. Wegscheider,
Challenges of K-modulation measurements in the LHC Run 3,
14th International Particle Accelerator Conference (IPAC),
Venice, Italy, 7 - 12 May 2023, pp. 531-534, JACoW Publishing, Geneva, Switzerland, DOI: 10.18429/JACoW-IPAC2023-MOPL014

F. Carlier, J. Cardona, A. Costa Ojeda, R. De Maria, J. Dilly, V. Ferrentino, E. Fol, M. Hofer, J. Keintzel, M. Le Garrec, E. H. Maclean, T. H. B. Persson, F. Soubelet, G. Trad, R. Tomás Garcia, L. Van Riesen-Haupt, A. Wegscheider,
LHC Run 3 optics corrections,
14th International Particle Accelerator Conference (IPAC),

Venice, Italy, 7 - 12 May 2023, pp. 535-538, JACoW Publishing, Geneva, DOI: 10.18429/JACoW-IPAC2023-MOPL015.

M. Le Garrec, K. Paraschou, F.S. Carlier, V. Ferrentino, E.H. Maclean, J. Dilly, R. Tomas,
Measurement and modelling of decapole errors in the LHC from beam-based studies,
14th International Particle Accelerator Conference (IPAC),
Venice, Italy, 7 - 12 May 2023, pp. 567-570, JACoW Publishing, Geneva, Switzerland, DOI: 10.18429/JACoW-IPAC2023-MOPL024.

V. Ferrentino, P. Arpaia, D.G. Cotte, A. Gilardi, A. Huschauer, M. Karppinen, E.H. Maclean, T. Persson, R.Tomás Garcia, L. Von Freeden,
Energy dependence of PS Main Unit Harmonics,
15th International Particle Accelerator Conference (IPAC);
Nashville, TN, US, 19 - 24 May 2024, pp. 1036-1039, JACoW Publishing, Geneva, Switzerland, DOI: 10.18429/JACoW-IPAC2024-TUPC15.

V. Ferrentino, P. Arpaia, A. B. Carazo, J. Cardona, F. S. Carlier, J. Dilly, E. Fol, A. Gilardi, M. Hofer, S. J. Horney, J. Keintzel, M. Le Garrec, E. H. Maclean, T. Nissinen, T. Persson, F. Soubelet, R. Tomás Garcia, W. Van Goethem, A. Wegscheider,
LHC 2023 Ion Optics Commissioning,
15th International Particle Accelerator Conference (IPAC)
Nashville, TN, US, 19 - 24 May 2024, pp. 99-102, JACoW Publishing, Geneva, Switzerland, DOI: 10.18429/JACoW-IPAC2024-MOPC20.

T. Persson, A. B. Carazo, F. Carlier, J. Cardona, F. Chudoba, J. Dilly, R. De Maria, S. Fartoukh, V. Ferrentino, E. Fol, S. J. Horney, U. Kar, J. Keintzel, M. Le Garrec, E. H. Maclean, T. Nissinen, F. Soubelet, K. Skoufaris, G. Trad, R. Tomás, L. Van Riesen-Haupt, W. Van Goethem, A. Wegscheider,
LHC Optics Commissioning in 2023 and 2024,
15th International Particle Accelerator Conference (IPAC),
Nashville, TN, US, 19 - 24 May 2024, pp. 67-70, JACoW Publishing, Geneva, Switzerland, DOI: 10.18429/JACoW-IPAC2024-MOPC12.

S. J. Horney, E. Maclean1, P. Burrows, F. Carlier, J. Dilly, L. Deniau, V. Ferrentin, E. Fol, M. Hofer, J. Keintzel, M. Le Garrec, T. Persson, L. van Riesen-Haupt, F. Soubelet, R. Tomás, A. Wegscheider,
Sextupole RDTs in the LHC at Injection and in the Ramp,
15th International Particle Accelerator Conference (IPAC),
Nashville, TN, US, 19 - 24 May 2024, pp. 71-74, JACoW Publishing, Geneva, Switzerland, DOI: 10.18429/JACoW-IPAC2024-MOPC13.

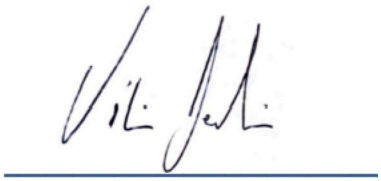
R. Bruce, A. Carazo, F. Carlier, M. D'Andrea, J. Dilly, I. Efthymiopoulos, S. Fartoukh, V. Ferrentino, S. Horney, M. le Garrec, E. Maclean, D. Mirarchi, T. Nissien, T. Persson, S. Redaelli, M. Solfaroli Camillocci, R. Tomás García, F. F. Van der Veken, A. Wegscheider,
Evolution of Special LHC Optics Configurations Run 3 Update,

15th International Particle Accelerator Conference (IPAC),
Nashville, TN, US, 19 - 24 May 2024, pp. 83-86, JACoW Publishing, Geneva, Switzerland, DOI: 10.18429/JACoW-IPAC2024-MOPC16

Patents and/or spin offs

Awards and Prizes

Date: 10.12.2024

PhD student signature 

Supervisor signature