Allegato B

ALESSANDRO CURCIO
Curriculum Vitae per la destinazione "ai fini della pubblicazione in ottemperanza del D. Lgs. 33/2013"

Date 02/12/2023

Part I – General Information

Full Name	Alessandro Curcio
Spoken Languages	Italian, English, Spanish, French, Polish

Part II – Education

Type	Year	Institution	Notes
University graduation	2012	University of Salerno	**Bachelor Degree in Physics.** Title of the thesis: Fractal structure of coherent states. Grade: 110/110 cum Laude
University graduation	2014	University of Pisa	**Master Degree in Physics.** Title of the thesis: High-brilliance X-gamma ray sources based on laser-matter interaction at high-intensity. Grade: 110/110
Post-graduate studies	2015	CERN	Joint Universities Accelerator School (**JUAS**). Grade: 15/20
PhD	2018	University of Rome La Sapienza	**PhD in Accelerator Physics.** Title of the thesis: Relativistic interaction of coherent pulsed light with plasmas for the electron acceleration and the production of secondary electromagnetic radiation. Grade: Ph.D. cum Laude
Habilitations	2023	MUR (Italy)	**To Associate Professor in FIS 02/A1-ASN21** (Experimental Physics of Fundamental Interactions) and FIS 02/B1-ASN21 (Experimental Physics of Matter)

Part III – Appointments

IIIA – **Academic Appointments**

Start	End	Institution	Position
07/01/2020	31/01/2021	Jagellonian University of Krakow	**Senior Scientist** at the **Polish Synchrotron Radiation Centre** (SOLARIS), which is a **special Department of the Jagellonian University of Krakow** (Poland). Experimental work on electron beam optimization: **electron bunch length diagnostics in the injector LINAC by coherent diffraction radiation, irradiations by electron beams for the generation of radioisotopes for medical applications**, diagnostics of the **electron transverse phase space from combined measurements of far/near field and polarization of synchrotron radiation**, study of the **spin-flip radiation.**
15/02/2021	28/02/2023	University of Salamanca-CLPU	**Senior Scientist at Laser-Accelerator Centre** (**CLPU**) of the University of Salamanca (Spain). Experimental and theoretical activity aimed at **particle beams transport, magnetic beamlines design in the framework of medical applications with protons and electron beams generated by lasers**. In parallel: **Mandatary** (by means of Contracts of Mandate, under

			payment) **for the Polish Synchrotron Radiation Centre of the Jagellonian University** in Krakow (Poland). Main task: **beam dynamics simulations** (by the **ASTRA, MADX and Elegant** codes) for the design of a new injector LINAC at the energy of 1.5 GeV. Other tasks: **design of electron beam diagnostics** (transverse and longitudinal), participation in writing the Conceptual Design Report (CDR) of the project.

IIIB – **Other Appointments**

Start	End	Institution	Position
01/11/2017	31/12/2019	CERN	**Senior Research Fellow at CERN** (European Organization for Nuclear Research), Geneva (Switzerland). Experimental and simulation work on **electron beam dynamics, in particular longitudinal dynamics for bunch compression and generation of coherent radiation** for beam diagnostics purposes and/or high-power high-frequency RF sources; **participation in experiments of electron irradiation for VHEE** (Very-High Energy Electrons)**/FLASH therapy studies**; representative of the CLEAR (CERN Linear Electron Accelerator for Research) at the Facilities Operation Meetings of CERN; **machine operator of CLEAR.**
01/01/2020	01/01/2021	CERN	**Visiting Scientist at CERN** (European Organization for Nuclear Research), Geneva (Switzerland). Due to COVID there was no occasion to be physically at CERN. However, the collaboration with the CLEAR (CERN Linear Electron Accelerator for Research) team continued remotely, leading to the finalization of the analysis and discussion of the data collected during the Fellowship period, subsequently published on peer-reviewed journals. In particular: **design and test of novel electron beam diagnostics** (both transverse and longitudinal, i.e. **beam position and bunch length monitors**) based on the mechanism of **Coherent Cherenkov-Diffraction Radiation**; study of the radiation suppression mechanisms in compact electron beam diagnostics (**electromagnetic shadowing effects**).
01/09/2020	31/01/2021	SOLARIS, **Polish Synchrotron Radiation Centre**	**Leader of the Electron Beam Operation and Optimization Section.** Achievements: development of an **online model for the injector LINAC, based on MADX; increase of the LINAC current** (through a better optics and phase adjustments); **increase of the injection rate from the injector LINAC to the storage ring** (from 20 mins to 2 mins for one injection); **increase of the stored current** from 200 mA to 450 mA; **generation/transport/injection of single bunches for single bunch operations.**
01/09/2020	31/01/2021	SOLARIS, **Polish Synchrotron Radiation Centre**	**Leader of the Electron and Photon Diagnostics and Electronics Section.** Achievements: **measurements and optimization of the emittance in the electron LINAC**; indirect **measurement of the bunch length in the electron LINAC with a personally developed reconstruction algorithm**; installation and **commissioning of a diagnostic beamline based on visible synchrotron radiation; measurements of beam emittance with visible synchrotron radiation; measurements of bunch length and filling pattern with a streak camera coupled to visible synchrotron radiation.**
01/03/2023		INFN	**Staff Scientist at National Laboratories of Frascati (LNF)** of the Italian Institute for Nuclear Physics (INFN), Frascati (Italy). Work on the **operation and optimization of the electron beam dynamics in RF and plasma accelerators** (laser and beam driven), in terms of delivered charge per bunch, delivered energy/spread, transverse

emittance and bunch duration. Main goal: **production of high-brightness electron beams for light sources.** In parallel: **Mandatary** (by means of Contracts of Mandate, under payment) **for the Polish Synchrotron Radiation Centre of the Jagellonian University** in Krakow (Poland). Main task: **beam dynamics simulations** (by the **ASTRA, MADX and Elegant** codes) for the design of a new injector LINAC at the energy of 1.5 GeV. Other tasks: **design of electron beam diagnostics** (transverse and longitudinal), participation in writing the Conceptual Design Report (CDR).

Part IV – Teaching experience

IVA – **University courses and lectures at summer schools**

Year	Institution	Lecture/Course
2023	University of Rome La Sapienza	Introduction to Betatron Radiation (Lecture for the Ph. D. students in Accelerator Physics, 3 h, 3 students)
2021	University of Salamanca	**Principles of Beam Dynamics** (Part of Academic Course, master's degree in physics, 15 h, 10 students)
2021	CLPU-University of Salamanca	Radiation Mechanisms in Ultrashort Laser-Plasma Interactions (Lecture at LaPlass Summer School, 45 min, 60 students)
2022	47th INSC (Nathiagali Summer School)	**Introduction to accelerators and plasma wake field acceleration** (Lecture, 2h, 60 students)
2022	47th INSC (Nathiagali Summer School)	Relativistic laser-matter interaction: plasma wakefield generation (Lecture, 2h, 60 students)
2022	47th INSC (Nathiagali Summer School)	Laser WakeField Acceleration and production of betatron radiation (Lecture, 2h, 60 students)
2022	47th INSC (Nathiagali Summer School)	**Applications of betatron radiation** (Lecture, 2h, 60 students)

IVB – **Ph. D, Master, Bachelor, and Apprenticeship student supervision**

Year	Institution	Thesis/Project	Student
2021-2024	University of Salamanca	Supervisor of the student Berkahoum Kebladj. Thesis: **Numerical methods for charged particle energy deposition in biological tissues for Cancer therapy applications.**	Ph. D.
2022	University of Salamanca	Supervisor of the student Carlos Sanchez Sanchez, Thesis: **Interaction of ultrashort ion beams with matter.**	Master's degree
2021	University of Salamanca	Supervisor of the student Carlos Sanchez Sanchez, Thesis: **Control of time-energy properties of laser-driven proton pulses for applications.**	Bachelor's degree
2021	University of Salamanca	Supervisor of the student José Miguel Pablos Marín. Project**: ASTRA simulations for laser-proton beam focusing via solenoid magnets.**	Apprenticeship
2020	Jagellonian University of Krakow	Supervisor of a group of 2 summer students. Project**: Emittance measurements in the SOLARIS injector LINAC.**	Apprenticeship

Part V - Society memberberships, Awards and Honors

Year	Title
2023	Member of the Italian Society of Synchrotron Light (SILS)
2022	Faculty Member of International Nathiagali Summer College (founded by Nobel Laur. Salam)
2020	European "Seal of Excellence" Award for the Horizon2020 MSCA project called "**Present and future of the SOLARIS injector at the National Synchrotron Radiation Center in Poland**"
2017	CERN Fellowship
2014	"Best Early-Stage Researcher" at the conference Channeling 2014
2013	Member of the Italian Physical Society (SIF)

Part VI - Funding Information [grants as PI-principal investigator or I-investigator]

Year	Title	Program	Grant value
2021-2023	**WP1 (Design) Leader** and Investigator in WP2 (Gun construction), WP3 (Optimization of a new cathode), WP4 (Reconditioning of the Clinac 2100), WP7 (Preliminary tests at the University Hospital) of the Hybrilin project.	Hybrilin Project (**Hybrid prototype based on laser enhancement of a LINAC to obtain an ultra-high dose rate in radiotherapy**), within the Spanish Plan de Recuperación, Transformación y Resiliencia. My role in the project was that of an expert scientist in the generation, characterization, and acceleration of laser electron beams. The project has been changed in progress, for difficulties of access to the Clinac 2100 of the University Hospital. However, the studies conducted have shown the **possibility to scale a laser-electron accelerator** to relatively low energies (lower than 10 MeV), with charge on the pC-level, such that a small laser-plasma cathode/injector may be thought (for a future project) to **exploit femtosecond bunches and study the difference in dose compared to relatively longer ones**.	Euro (cost of the project, where I was WP Leader, **not PI**)
2023-2026	**PI** of the sub-project **"Generation, transport and control of short proton pulses"** of the main project **APPLE.**	**Advanced Particle beams and Plasmas Experiments** (APPLE), within the call "Generacion de Conocimiento 2022", of the Spanish "Ministerio de Ciencia e Innovacion". The project proposes two alternative methods to "freeze" or compress the short bunch length of laser-produced ion beams. Ultrashort ion beams will be used for probing warm-dense matter. My task for the project is the "Generation, transport, and control of short proton pulses". In the past, when I used to work in Spain, I **directed the design work for an isochronous magnet for short proton pulses**, to be realized at the Laser Centre of the University of Salamanca (CLPU). Also, **I conducted preliminary studies for a magnetic bunch compressor by means of the ASTRA code**. The most promising solution is given by the isochronous magnet. **The results of these studies were used for the proposal of the project**. My contribution to the project after its acceptance and start, now that I moved to Italy, will be **taking part in the experiment with the goal of probing an ultrashort laser-produced warm dense matter.**	Euro (cost of the project, where I am **PI**)
04/2021-09/2021	PI (**Mandatary**)	**Mandate Contract for the development of a Conceptual Design for a new LINAC injector** at the SOLARIS centre of the Jagellonian University in Krakow. Since leaving the institute and Poland, I have maintained collaboration with SOLARIS, the Polish Synchrotron Accelerator Facility of the University of Krakow, to carry out some of the tasks I started during my stay	PLN (value of the contract, i.e.

		there, as well as to **exploit my expertise in machine design and simulation of beam dynamics.** Indeed, as mandatary, **I perform simulations of beam dynamics by ASTRA, Elegant and MADX for the design of a new LINAC injector** machine that will make it possible to have top-up injection at the National Polish synchrotron facility. Once the conceptual design is finished, the SOLARIS management also plans to ask me support in the **definition of the beam diagnostics along the machine.**	payment I received as **PI/Mandatary**)
10/2021-12/2021	PI (**Mandatary**)	**Mandate Contract for the development of a Conceptual Design for a new LINAC injector** at the SOLARIS center of the Jagellonian University in Krakow.	PLN (value of the contract, i.e. payment I received as **PI/Mandatary**)
02/2022-04/2022	PI (**Mandatary**)	**Mandate Contract for the development of a Conceptual Design for a new LINAC injector** at the SOLARIS center of the Jagellonian University in Krakow.	PLN (value of the contract, i.e. payment I received as **PI/Mandatary**)
05/2022-11/2022	PI (**Mandatary**)	**Mandate Contract for the development of a Conceptual Design for a new LINAC injector** at the SOLARIS center of the Jagellonian University in Krakow.	PLN (value of the contract, i.e. payment I received as **PI/Mandatary**)
01/2023-06/2023	PI (**Mandatary**)	**Mandate Contract for the development of a Conceptual Design for a new LINAC injector** at the SOLARIS center of the Jagellonian University in Krakow.	PLN (value of the contract, i.e. payment I received as **PI/Mandatary**)
12/2023-04/2024	PI (**Mandatary**)	**Mandate Contract for the development of a Conceptual Design for a new LINAC injector** at the SOLARIS center of the Jagellonian University in Krakow.	PLN (value of the contract, i.e. payment I received as **PI/Mandatary**)
04/2020-12/2021	**Investigator** for Polish Free Electron Laser project	During my stay at the Synchrotron Centre of the University of Krakow, I joined the Polish Free Electron Laser project. Specifically for the project, **I actively worked on beam dynamics simulations (mostly by means of the ASTRA code) for the design of the injector LINAC** that will be realized to pilot the first Free-Electron-Laser of Eastern Europe. I **gave support in designing the doglegs and compressors of the machine as well as in matching the beam parameters in the THz undulators.** Moreover, **I have helped to define the bunch length diagnostics** along the machine, based on Coherent Diffraction Radiation. Afterwards, even after leaving Poland, Icontinued **beam dynamics ASTRA simulations for the POLFEL project.** For the latter task **I developed a tool based on the beam envelope equation (including space-charge)** to speed the identification of the matching conditions in a space-charge regime.	PLN (cost of the project, where I was **I**nvestigator, **not PI**)
2023-2026	**Investigator** for EuPRAXIA Advanced Photon Source (EuAPS)	Since I have moved back to Italy, I am involved in the activities related to EuPRAXIA (European Plasma Research Accelerator with Excellence In Applications). **I took a leading part in the sub-project called EuAPS** which proposes the realization of a laser-plasma synchrotron-like source**. I participate as expert in electron plasma acceleration and beam optimization/diagnostics. An**	(cost of the project, where I am **I**nvestigator, **not PI**)

	optimized electron beam corresponds to an optimized photon pulse emitted as betatron radiation in a plasma accelerating cavity. In the past, I have demonstrated that such radiation can be used for electron emittance diagnostics, while for the EuAPS project, such X-ray radiation will be used for user applications.

Part VII – Research Activities

Keywords	Brief Description
Accelerator Physics	I have been working on accelerator physics since the start of my career as **master's degree student when I was involved in studies of electron and ion acceleration** in laser-plasma interactions within a collaboration between the **University of Pisa and the ENEA** of Frascati. Afterwards, I won a **Ph.D. in Accelerator Physics at the University of Rome La Sapienza.** The main topic of my thesis, mostly developed at INFN-LNF, was **the electron acceleration in laser-plasma cavities and the emission of high-brightness secondary radiation.** I focused on the study of the **electron beam dynamics for finding the key-parameters to optimize the emission of radiation.** I also **conceived a method to measure the electron beam emittance in plasma accelerators** exploiting betatron radiation (see Curcio, Alessandro, et al. "Trace-space reconstruction of low-emittance electron beams through betatron radiation in laser-plasma accelerators." *Physical Review Accelerators and Beams* 20.1 (2017): 012801. and Curcio, A., et al. "Single-shot non-intercepting profile monitor of plasma-accelerated electron beams with nanometric resolution." *Applied Physics Letters* 111.13 (2017).). The latter method has also been considered for the AWAKE project, see the citation and acknowledgment in Williamson, Barney, et al. "Betatron radiation diagnostics for AWAKE Run 2." *Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment* 971 (2020): 164076. **I have always tried to have both theoretical and experimental control of the topics related to my studies.** In the last period of my Ph.D. studies, **I was also involved** in activities devoted to the **production of THz radiation by laser and/or particle beams.** For example, I demonstrated the use of Cherenkov THz radiation for longitudinal bunch diagnostics in radiofrequency and plasma accelerators (Curcio, A., et al. "Electro-optical detection of coherent radiation induced by relativistic electron bunches in the near and far fields." *Physical Review Applied* 9.2 (2018): 024004.). Afterwards, I **won a Senior Research Fellowship at CERN**. I **joined the CERN Linear Electron Accelerator for Research (CLEAR),** with the main aim of **developing innovative beam diagnostics based on the emission of coherent radiation**, and of maximizing the emission of radiation for the realization of high-frequency **power sources for high-gradient compact accelerators** (for example in the dielectric-acceleration or plasma-acceleration scheme, as in Curcio, A., et al. "Resonant plasma excitation by single-cycle THz pulses." *Scientific reports* 8.1 (2018): 1052.). Among the **main achievements of the CERN period**, there are the development of a **bunch length diagnostic station based on Coherent Diffraction Radiation** (see Curcio, A., et al. "Beam-based sub-THz source at the CERN linac electron accelerator for research facility." *Physical Review Accelerators and Beams* 22.2 (2019): 020402), and the development of an optimized **Cherenkov-Diffraction dielectric target/pickup to demonstrate the simultaneous diagnostics of beam position and length** (see Curcio, A., et al. "Noninvasive bunch length measurements exploiting Cherenkov diffraction radiation." *Physical Review Accelerators and Beams* 23.2 (2020): 022802.). These results have been again seminal for the AWAKE project (see citation in Pakuza, Collette, et al. "A beam position monitor for electron bunch detection in the presence of a more intense proton bunch for the AWAKE Experiment." *Journal of Physics: Conference Series*. Vol. 2420. No. 1. IOP Publishing, 2023.). At CERN I also had the occasion to make research on the phenomenon called "Electromagnetic Shadowing" (see Curcio, A., et al. "Diffractive shadowing of coherent polarization radiation." *Physics Letters A* 391 (2021): 127135.).

After the CERN experience, I **joined the team of the Polish Synchrotron Radiation Centre (SOLARIS)**. After short I was nominated **Leader** of two sections, i.e., the **Electron Beam Operation and Optimization Section and the Electron and Photon Beam Diagnostics Section.** Among the main achievements of that period, there is the **conceivement of a diagnostic method for the bunch length measurement in the SOLARIS injector LINAC** (see Curcio, A., et al. "Liouville theory for fully analytic studies of longitudinal beam dynamics and bunch profile reconstruction in dispersive lines." *Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment* 986 (2021): 164755.) and the **commissioning of a new diagnostic beamline in the storage ring** (see my invited talk at the International Beam Instrumentation Conference, IBIC 2020). My work was seminal for the SOLARIS team in the years after (see for example Wawrzyniak, A. I., Curcio, A., et al. (2021). Solaris Storage Ring Performance After 6 Years of Operation. or Panaś, R., Curcio, A., & Wawrzyniak, A. (2021, August). and LUMOS: A Visible Diagnostic Beamline for the Solaris Storage Ring. In *12th International Particle Accelerator Conference (IPAC'21), Campinas, SP, Brazil, 24-28 May 2021* (pp. 3901-3903). JACOW Publishing, Geneva, Switzerland.). Before joining SOLARIS, I had **submitted a Horizon2020 Marie Curie project for an Individual Fellowship, proposing the design of a new injector LINAC for SOLARIS,** for top-up injection. The project won **the European Seal of Excellence** but was not funded by Europe. Winner projects could be funded by the host countries. The Polish Ministry of Science and Education confirmed the will to fund my project only after the decision, due to COVID and family reasons, to leave Poland to move to Spain. I couldn't accept the fundings, but **I committed myself in participating in the project with a key-role in beam dynamics simulation and diagnostics design.** Since then, **I work as Mandatary for the Jagellonian University**. In Spain, I joined the **Laser Centre of the University of Salamanca (CLPU), which is an electron and ion laser-accelerator facility.** In that period, **I had the opportunity to get even closer to the University reality**. **I was lecturer for a part of an Academic course**, named **"Principles of Beam Dynamics".** Moreover, **I was supervisor of a several students,** with thesis and projects always related to **beam dynamics. I supervised a group of post-docs to design and test a beamline based on permanent magnets to transport laser-proton beams for medical applications** (see Curcio, Alessandro, et al. "Liouville Theory for Fully Analytic Studies of Transverse Beam Dynamics in Laser-Plasma Ion Accelerators." *Symmetry* 14.9 (2022): 1875.). At the beginning of 2023 I moved back to my home country, Italy, joining **INFN-LNF** as a **Staff Scientist.** There, **I continue my activity on electron accelerators**. I joined both the **activities of the SPARC radiofrequency injector** (both for plasma acceleration studies and not) and I have a **key-role in the development of a laser-plasma electron accelerator** for the realization of a compact X-ray source for medical and other applications. **My passion and expertise for Accelerator Physics continue to grow, to the same extent as regards the experimental and theoretical aspects, which is a key-feature that defines me as researcher.**

Beam Dynamics

Beam dynamics is a building block of accelerator physics, but it deserves an its own space **in my CV.** I naively **approached the beam dynamics as a master's degree student,** when I **developed a particle tracker** to follow the **electron trajectories in a plasma bubbl**e, to finally evaluate the betatron radiation emitted by plasma accelerated electron beams. Afterwards, **during the Ph.D. in Accelerator Physics**, I had the opportunity to **refine many concepts and become a professional**, for instance through my participation in the JUAS accelerator school. Specifically, I learned more about the **transverse and longitudinal beam dynamics**, as well as about the topics of **wakefields and space-charge fields/forces**. For my Ph.D. work **I massively used the concept of normalized transverse beam emittance, up to the point that the methodology invented to measure the electron beam emittance in plasma accelerators has become one of my main achievements** (see Curcio, Alessandro, et al. "Trace-space reconstruction of low-emittance electron beams through betatron radiation in laser-

plasma accelerators." *Physical Review Accelerators and Beams* 20.1 (2017): 012801.). **The wakefield concept was significantly used for the conception of a compact plasma accelerator driven by an intense THz pulse**, in a middle realm between RF accelerators and IR-laser plasma accelerators (see in Curcio, A., et al. "Resonant plasma excitation by single-cycle THz pulses." *Scientific reports* 8.1 (2018): 1052.). I also **demonstrated that plasma wakefields simultaneously excited at harmonic frequencies** in laser-plasma accelerators **have a strong influence on the beam dynamics and radiation** (Curcio, Alessandro, et al. "Numerical and analytical models to study the laser-driven plasma perturbation in a dielectric gas-filled capillary waveguide." *Optics letters* 41.18 (2016): 4233-4236. and Curcio, A., Danilo Giulietti, and M. Petrarca. "Tuning of betatron radiation in laser-plasma accelerators via multimodal laser propagation through capillary waveguides." *Physics of Plasmas* 24.2 (2017): 023104.). **At CERN, I refined my experimental and theoretical skills on bunch compression** by means of velocity bunching. Indeed, being responsible for the beam-based generation of THz radiation, I also intensively worked on the preparation of ultra-short (100-200 fs) high-charge (up to 1 nC) electron beams. **At CERN I learned in depth and used the MADX and ASTRA codes** to help myself in setting the CLEAR machine. Such **acquired skills in beam dynamics** was also used to **propose new schemes for a new LINAC injector at the Synchrotron Centre in Poland,** which was **awarded with the European Seal of Excellence** for Horizon 2020 MSCA projects. **At SOLARIS, as Section Leader in Beam Operation and Optimization, as well as in the Electron and Photon Beam Diagnostics and Electronics,** I **developed an online model of the LINAC** injector (a 550 MeV machine), based on **MADX. I formed a group of summer students on the transverse dynamics and the emittance concept and measurement.** Moreover, **I realized an ASTRA model of the same machine,** based on a previous model made in Elegant. This was the starting point for **simulations of a new machine for top-up injection at 1.5 GeV.** At the same time, **I was involved in ASTRA simulation studies for bunch transport and compression in the doglegs and magnetic chicanes** of the machine designed for the Polish Free Electron Laser project (**POLFEL**). After leaving Poland, **I continued my simulation work for the new LINAC injector at SOLARIS, by means of Contracts of Mandate under payment**, both during my stay at CLPU and at INFN LNF. I started exploring a solution based on S-band sections This brought, for reasons of space limitation, to the necessity to explore a hybrid solution based on S and C-band sections. Moreover, the new machine will foresee a magnetic chicane for bunch compression, for possible irradiation studies with short bunch lengths and/or to drive a FEL. This design is already present in the CDR draft of the project. **A summary of my simulation work is given in Curcio, A., Panaś, J, W., & Wawrzyniak, A. (2023). Simulation study towards a new injector linac for the solaris synchrotron facility. In 14th international particle accelerator conf.(ipac'23), venice, italy.** I would also like to mention **my work as Lecturer at the University of Salamanca during 2021**, where I proposed and **given a course named "Principles of Beam Dynamics**". Furthermore, **I supervised a group of post-docs** to simulate (by **ASTRA and other particle trackers based on Python**) the **transport of laser-ion beams through a series of permanent magnets** that have been realized and tested in an experiment of laser-plasma acceleration (see Curcio, Alessandro, et al. "Liouville Theory for Fully Analytic Studies of Transverse Beam Dynamics in Laser-Plasma Ion Accelerators." *Symmetry* 14.9 (2022): 1875.). **I supervised an Apprenticeship student in ASTRA simulations of laser-proton beam focusing**; **I supervised a bachelor's degree student on the use of the Beam Envelope Equation to track a proton beam propagating within a isochronous magnet**, comparing the results with other codes (to be noticed that the beam envelope equation was adapted to dispersive beamlines). **I supervised a master's degree in the modelling of particle propagation and absorption in the dense matter for the case of ultra-short particle bunches. The interaction of ultra-intense beams with dense matter continues to be one of my main lines of research today, combining all the experience I have accumulated in accelerator physics and beam dynamics, with nonlinear optics and electromagnetic interactions.** I supervised and I am still **supervisor of a Ph.D. student**

for a thesis on proton and ion beam transport in laser-plasma accelerators for medical applications. In **Frascati, I am involved in the electron beam operation and optimization,** both for the activities on the radiofrequency injector and on the laser-plasma accelerator. Finally, from a theoretical point of view and from a few years, **study the use of analytic solution of the Liouville equation for alternative approaches for beam dynamics in particle accelerators** (see Curcio, Alessandro, et al. "Liouville Theory for Fully Analytic Studies of Transverse Beam Dynamics in Laser-Plasma Ion Accelerators." *Symmetry* 14.9 (2022): 1875. and Curcio, A., et al. "Liouville theory for fully analytic studies of longitudinal beam dynamics and bunch profile reconstruction in dispersive lines." *Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment* 986 (2021): 164755. and Curcio, A. (2021). Recirculated Wave Undulators for Compact FELs. *Applied Sciences*, *11*(13), 5936.).

Radiation Sources

Radiation sources based on particle accelerators can also be considered part of Accelerator Physics, sharing a lot of topics and contexts. **In my career, the development of novel and high-brightness radiation sources has been always a key-point**. In fact, **most the work on the optimization of the beam dynamics has been devoted to find the best beam parameters and/or machine settings such to maximize radiation processes.** Since the time of my **master's degree thesis, I have been working on Compton and betatron sources** for X-gamma rays. Currently, I have a **contract under payment with the IOP Publising, to write two volumes on Compton Backscattering sources**, and I **work on a large european project (EuPRAXIA), specifically on the sub-project EuAPS (EuPRAXIA Advanced Photon Source), with the aim to realize a laser-plasma betatrons** (see my invited talks at PAHBB 2023, SILS 2023, SIF 2023). In general, I **have been mostly working on X-ray sources based on plasma accelerators and on THz-sources based on high-brightness LINAC**s. Specifically, **regarding X-ray sources, I was involved in first tests of betatron radiation measurements** at INFN LNF during my Ph.D. (Curcio, Alessandro, et al. "First measurements of betatron radiation at FLAME laser facility." *Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms* 402 (2017): 388-392.) and, nowadays, I have a **key-role in the EuAPS project,** where I lead **the laser-plasma accelerator to produce and characterize the electron beams responsible for the generation of radiation** (see my invited talks at PAHBB2023, SILS2023, SIF2023). Moreover, I was **Section Leader of the Electron Beam Operation and Optimization at the Polish Synchrotron Radiation facility**, to prepare the beams for the X-ray user applications (see Wawrzyniak, A. I., Panaś, R., Curcio, A., Knafel, M., Kowalski, G., & Marendziak, A. (2021). Solaris synchrotron performance and operational status. Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms, 493, 19-27.). **Concerning THz sources, I have been actively working both on particle and laser-based sources of coherent radiation from ultra-short drive pulses** (see Curcio, A., et al. "Beam-based sub-THz source at the CERN linac electron accelerator for research facility." *Physical Review Accelerators and Beams* 22.2 (2019): 020402 and Curcio, A., et al. "Noninvasive bunch length measurements exploiting Cherenkov diffraction radiation." *Physical Review Accelerators and Beams* 23.2 (2020): 022802., Curcio, A., and M. Petrarca. "Saturation regime of THz generation in nonlinear crystals by pumps with arbitrary spectral modulations." *Optics Letters* 45.7 (2020): 1619-1622. and Curcio, A., Mou, S., Palumbo, L., Lupi, S., & Petrarca, M. (2021). Selection rules for the orbital angular momentum of optically produced THz radiation. *Optics Letters*, *46*(7), 1514-1517.). Furthermore, I was **involved in the ASTRA simulations campaigns for the design of matching conditions of electron beams in THz undulators for the Polish Free Electron Laser Project.** About **Free Electron Lasers, I worked on theoretical models to ease the predictions of the beam dynamics and radiation in such machines** (see Curcio, A., et al. "Free electron laser oscillator efficiency." *Optics Communications* 425 (2018): 29-37. And Curcio, A., et al. "Free electron laser saturation: Exact solutions and logistic equation." *Journal of Applied*

Physics 134.13 (2023)). At the **University of Salamanca, I continued the research on X-ray sources** when I **produced high-brightness electron beams**, optimizing the size of the plasma accelerating cavity, **by a laser-plasma accelerator to collide on crystalline structures to study the X-ray scattering** of monochromatic radiation, the Parametric X-ray Radiation (Curcio, A., et al. "Observation of tunable parametric X-ray radiation emitted by laser-plasma electron beams interacting with crystalline structures." *Physical Review Accelerators and Beams* 25.6 (2022): 063403.). Finally, in Spain I continued **my activity on plasma synchrotron-like sources** (Curcio, A., and G. Gatti. "Time-domain study of the synchrotron radiation emitted from electron beams in plasma focusing channels." *Physical Review E* 105.2 (2022): 025201. and Curcio, Alessandro, et al. "Performance Study on a Soft X-ray Betatron Radiation Source Realized in the Self-Injection Regime of Laser-Plasma Wakefield Acceleration." *Applied Sciences* 12.23 (2022): 12471.)

Medical physics

Medical physics has always been one of my greatest interests, and I fortunately **had a several occasions to use my expertise on machine operation and beam dynamics to take part in experiments in such a field.** During my stay at **CERN, as operator of the CLEAR machine**, I was **supporting the experimental tests towards therapy by Very High Energy Electrons (VHEE) electrons and by FLASH effect**. The support I gave in those occasions, was to **prepare the beams in terms of charge, size and stability and alignment for irradiations.** Indeed, I was **supporting 3 main experiments**: one with the **hospital of Lausanne CHUV (a test for the FLASH effect in zebra fishes**), which didn't bring to any publication, and **two experiments of electron beam focusing in water with a setup for tight focusing, to explore the possibility of deep irradiations in a dose voxel** (Kokurewicz, Karolina, et al. "An experimental study of focused very high energy electron beams for radiotherapy." *Communications Physics* 4.1 (2021): 33. and Lagzda, Agnese, et al. "Influence of heterogeneous media on Very High Energy Electron (VHEE) dose penetration and a Monte Carlo-based comparison with existing radiotherapy modalities." *Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms* 482 (2020): 70-81, where I only appear in the general acknowledgments to the CLEAR team). At the **Jagellonian University of Krakow,** as **responsible for beam operation** at the **SOLARIS accelerator facility**, I was **involved in a collaboration to produce radioisotopes relevant to nuclear medicine by electron irradiations**. I was in charge to **produce electron beams of controllable parameters for irradiating heavy materials** (Ahmed, A. A., Wrońska, A., Magiera, A., Curcio, A., Jaglarz, M., & Wawrzyniak, A. (2020). Study of M99o and long-lived impurities produced in the Mnato (γ, x) reactions using an electron beam. *Radiation Physics and Chemistry*, *177*, 109095.). At the **Laser Centre of the University of Salamanca, I was involved as Working Package Leader (Design) in a project to readapt a radiofrequency LINAC for radiotherapy**, owned by the University Hospital, to host a photocathode and/or a plasma cathode (Hybrilin project). The **main achievement of the project was the individuation of the electron energies and beam quality to be produced by means of a plasma gun which could be assembled to the medical LINAC** of the Hospital, and the achievement of such parameters by a modest-power laser. At CLPU, I have got a **leading role in beam dynamics simulations for the development of an ion beamline for medical applications**. I also was supervisor of a Ph.D. student, whose thesis will be on the **beam transport and dose desposition issues in laser-ion sources for medical applications**. In Spain, I also continued my activity on X-ray betatron sources. **Secondary sources of high-energy photons are also in the strategic interest of CLPU as user facility, mostly for medical and/or biological applications** (Curcio, Alessandro, et al. "Performance Study on a Soft X-ray Betatron Radiation Source Realized in the Self-Injection Regime of Laser-Plasma Wakefield Acceleration." *Applied Sciences* 12.23 (2022): 12471.). Currently, **I work on the EuAPS project, for the realization of a compact plasma X-ray source** for applications, **including medical imaging.**

Non-linear optics	Due to my **involvement in novel and compact high-gradient accelerators,** I approached **non-linear optics** quite soon in my career. Non-linear optics, indeed, gives the **theoretical backbone to mechanisms as the laser wakefield acceleration**, made by high-power infrared laser propagating in underdense plasmas. In the past, **I found convenient models for studying the formation of the accelerating conditions in laser-plasma waveguides** (see Curcio, Alessandro, et al. "Numerical and analytical models to study the laser-driven plasma perturbation in a dielectric gas-filled capillary waveguide." *Optics letters* 41.18 (2016): 4233-4236.), by means of non-linear optics. Non-linear optics has also given the theoretical frame for **novel acceleration schemes based on high-intensity THz radiation and plasmas** (Curcio, A., et al. "Resonant plasma excitation by single-cycle THz pulses." *Scientific reports* 8.1 (2018): 1052.). I have been working on **laser and beam-based THz sources for the generation of high-power to feed compact accelerators** (possibly dielectric or plasma). For the laser-based schemes of high-power THz generation, **I studied the Optical Rectification and the Difference Frequency of infrared lasers in non-linear crystals** (see Curcio, A., and M. Petrarca. "Saturation regime of THz generation in nonlinear crystals by pumps with arbitrary spectral modulations." *Optics Letters* 45.7 (2020): 1619-1622.). I also demonstrated the possibility to **make diagnositcs of plasma accelerators with high-power THz radiation** produced in non-linear crystals (see Curcio, A., and M. Petrarca. "Diagnosing plasmas with wideband terahertz pulses." *Optics letters* 44.4 (2019): 1011-1014.). Moreover, I developed **novel diagnostics for ultra-short pump lasers (used to drive laser-plasma accelerators) based on THz radiation emitted by Optical Rectification** (see Curcio, A., et al. "Terahertz-based retrieval of the spectral phase and amplitude of ultrashort laser pulses." *Optics letters* 43.4 (2018): 783-786.). Finally, one of my last works concerning non-linear optics touched on the **generation of THz radiation with Orbital Angular Momentum, for example to drive exotic modes in compact accelerating cavities** (see Curcio, Alessandro, et al. "Selection rules for the orbital angular momentum of optically produced THz radiation." *Optics Letters* 46.7 (2021): 1514-1517.)

Part VIII – Summary of Scientific Achievements

VIIIA – **Summary Tables**

Product type	Number	Data Base	Start	End
Papers	85	Scopus	2014	2023
Books	1	Aracne Editrice Website	2014	2023

Total Impact factor	165 (Journal Citation Report-Clarivate and MUR-Cineca)
Total Citations	845 (Google Scholar), 654 (Scopus), 851 (Research Gate)
Average Citations per Product	12
Hirsch (H) index	15 (Scopus), 17 (Research Gate)
Normalized H index*	2.5 (Scopus), 2.8 (Research Gate)

*****H index divided by the academic seniority.

VIIIB – **Habilitations**

Sector - Call	Title
FIS 02/A1-ASN21	**Associate Professor in Experimental Physics of Fundamental Interactions**
FIS 02/B1-ASN21	Associate Professor in Experimental Physics of Matter

Part IX– Selected Publications

1) **Curcio, A**., & Gatti, G. (2022). **Time-domain study of the synchrotron radiation emitted fromelectron beams in plasma focusing channels**. Physical Review E, 105(2), 025201. **IF: 2.707, Citations: 2** (Journal Citation Report-Clarivate, Google Scholar)

   In this work, **synchrotron-type radiation emitted by high-brightness electron beams during the acceleration process in a plasma cavity is studied**. **My contribution was to develop the first theory for the temporal description of such radiation pulses, also called betatron pulses**. The starting point was the study of the dynamics of electrons in a plasma accelerator, followed by the calculation of the electromagnetic field radiated in the time domain. Betatron radiation has never been characterized temporally until now, due to the experimental difficulties involved in measuring ultrashort X-ray pulses. **This work paves the way for an entirely new diagnostic use of betatron radiation, to measure the longitudinal dynamics of electron beams accelerated in a plasma channel.** Finally, **the existence of coherent betatron radiation is highlighted, relevant not only for diagnostic applications but also for compact energy sources in the THz/IR, to power new generation high-gradient accelerators**.

2) **Curcio, A.** (2021). Recirculated wave undulators for compact fels. Applied Sciences, 11(13), 5936. **IF: 2.838, Citations: 2** (Journal Citation Report-Clarivate, Google Scholar)

   In this work, a **start-to-end simulation study is performed for the electron beam dynamics and radiation in a compact Free Electron Laser (FEL) based on a wave-undulator**, i.e. an infrared laser recirculated in an optical cavity. **Being a single author paper, all the results were derived and obtained individually.** A machine design is presented, with a **particular focus on the electron beam dynamics**, since the laser dynamics of the same machine was studied in a previous paper (*Curcio, et al. (2017). An optical cavity design for a compact wave-undulator based-fel. Optics Communications, 405, 197–200.*). **The used approach is fully analytic, using cutting edge techniques and models.** For example, the analytical solution of the **Liouville equation in terms of the evolution operator** allows **tracking an electron beam from one undulator section to another in a compact and analytical way**, also allowing the study of the **evolution of the micro-bunching** along the transfer-lines of the designed machine. **The FEL radiation is also calculated in terms of a highly predictive model,** which I contributed to develop in the past years until the last version published in 2023 (*Curcio, A. et al. (2023). Free electron laser saturation: Exact solutions and logistic equation. Journal of Applied Physics, 134(13), 133103. doi:10.1063/5.0166336.).*

3) Kokurewicz, K., Brunetti, E., **Curcio, A**., Gamba, D., Garolfi, L., Gilardi, A., Senes, E., Sjobak, K. N., Farabolini, W., Corsini, R., & Jaroszynski, D. A. (2021). **An experimental study of focused very high energy electron beams for radiotherapy.** *Communications Physics*, *4*(1), 33. **IF: 6.497, Citations: 36** (Journal Citation Report-Clarivate, Google Scholar)

   In this work, **volumetric dose deposition in water using ultra-intense electron beams was studied**. The electron beams were tightly focused (short focal length) by expanding the beam at the entrance of an electromagnetic quadrupole triplet. The beam passed into the triplet after passing a vacuum-air interface. In fact, the beam propagating and focusing in the air was then sent into a tank filled with water (water phantom) and a series of gafchromic films to monitor the evolution of the dose. **The aim of the experiment was to demonstrate the possibility of creating a voxel dose, i.e. of being able to penetrate deeply with relativistic electrons (Very High Energy Electrons, VHEE) in radiotherapeutic applications,** limiting collateral damage to the tissues in front and behind the point of interest. **My contribution, as a CLEAR operator** (CERN's electron LINAC), **was above all to set the electron beams for the experiment in terms of charge per bunch and energy, and to adjust the optics of the machine in such a way as to maximize the dose within the voxel in water.**

4) **Curcio, A**., Bergamaschi, M., Corsini, R., Farabolini, W., Gamba, D., Garolfi, L., Kieffer, R., Lefevre, T., Mazzoni, S., Fedorov, K., gardelle, J., Gilardi, A., Karatev, P., Lekomtsev, K., Pacey, T., Saveliev, Y., Potylitsin, A., & Senes, E. (2020). **Noninvasive bunch length measurements exploiting Cherenkov diffraction radiation.** *Physical Review Accelerators and Beams*, *23*(2), 022802. **IF: 1.639, Citations: 45** (Journal Citation Report-Clarivate, Google Scholar)

   In this work, **I coordinated the international collaboration on THz activity at the CLEAR electron LINAC located at CERN**. Coordination took place both in the design phase of the experiment and in the data analysis and discussion phase. Furthermore**, I was the beam operator myself who prepared the machine for experimental tests and installed and operated the measuring device.** All this made me the **Principal Investigator** of this work as first author. The possibility of producing **THz radiation from ultrarelativistic, high-brightness electron beams via the Cherenkov diffraction mechanism was demonstrated**. This radiation was **used for single-shot, non-intercepting temporal diagnostics of ultrashort (hundreds of femtoseconds) electron beams**, **as well as for measuring their position (Beam Position Monitor).** Note: These studies were pioneering for CERN, which is considering, within the AWAKE project, to install an advanced prototype of the aforementioned monitor based on Cherenkov diffraction radiation.

5) **Curcio, A**., Bergamaschi, M., Corsini, R., Gamba, D., Farabolini, W., Lefevre, T., Mazzoni, S., Dolci, V., Petrarca, M., & Lupi, S. (2019). **Beam-based sub-THz source at the CERN linac electron accelerator for research facility.** *Physical Review Accelerators and Beams*, *22*(2), 020402. **IF: 1.623, Citations: 22** (Journal Citation Report-Clarivate, Google Scholar)

   In this work, **I coordinated the international collaboration on THz activity at the CLEAR electron LINAC located at CERN**. Furthermore**, I was the beam operator myself who prepared the machine for the experimental tests and installed and operated the measurement setup.** All this made me the **Principal Investigator** of this work as first author. We demonstrated the possibility of **producing THz radiation from ultra-relativistic electron beams through several mechanisms including diffraction radiation and Cherenkov-diffraction radiation.** Radiation was diagnosed using several techniques (time-resolved, frequency-resolved measurements, near-field imaging, far-field imaging, polarization). **This radiation was used for the temporal diagnostics of ultrashort electron beams.** Furthermore, peak power levels in the MW range were achieved, which could be used for the **generation of electromagnetic modes in dielectric or plasma waveguides, within the context of new high-gradient accelerator technologies**.

6) **Curcio, A**., Bisesto, F., Costa, G., Biagioni, A., Anania, M., Pompili, R., . . . Petrarca, M. (2019). **Modeling and diagnostics for plasma discharge capillaries**. Physical Review E, 100(5), 053202. **IF: 2.296, Citations: 12** (Journal Citation Report-Clarivate, Google Scholar)

   In this work, **a discharge plasma source designed for generating plasma waves, i.e. cavity of a plasma accelerator, is modeled through an RLC circuit**, where the plasma acts as a load (resistor). **My contribution was to derive the expression of the various resistivity terms that make up the final resistance of the plasma to the discharge circuit, such as electron-atom, electron-ion collision terms, terms related to radiative recombination and terms related to the heat exchange between plasma and external environment** (the walls of the dielectric capillary that contains the plasma). Furthermore, **I also developed a simplified analytical model (valid at thermodynamic equilibrium) and analyzed experimental measurements that were provided to me by the LNF collaborators, to test the predictivity of the model on real data,** in terms of density of the generated plasma, peak current intensity, etc. Finally, the results of the work allow us to **calculate the intensity and profile of the magnetic field in the discharge capillary for plasma lens-type applications**, where the electron beams are focused by the discharge currents generated in the plasmas.

7) **Curcio, A**., & Petrarca, M. (2019). **Diagnosing plasmas with wideband terahertz pulses.** Optics letters, 44(4), 1011–1014. **IF: 3.714, Citations: 13** (Journal Citation Report-Clarivate, Google Scholar)

   In this work, **an innovative diagnostic method is presented for the characterization of a plasma source of the kind used in compact accelerators of new generation by means of single-cycle (wideband) THz pulses**. My contribution was to develop the model and perform the simulations to demonstrate the validity and the capabilities of the method. **Specifically, it is shown how the electron plasma density and temperature can be measured in a single-shot fashion by exploiting reflected and transmitted THz light from a probe pulse. The diagnostics is also compatible for very-high rep. rate plasma sources.** The method uses the fact that the **electron plasma density used in plasma accelerators is such to make the plasmas underdense (transparent) for some frequencies of the THz spectrum and overdense (opaque) for some others.** At the transition point, where the plasma is resonantly absorptive, the electron plasma density can be identified (related to the plasma frequency), but also the electron temperature can be retrieved from the width of the absorption resonance.

8) **Curcio, A**., Anania, M., Bisesto, F., Botton, M., Castellano, M., Chiadroni, E., Cianchi, A., Ferrario, M. Galletti, M., Giulietti, D., Henis, Z., Petrarca, M., Pompili, R., Schleifer, E., & Zigler, A. (2018). **Electro-optical detection of coherent radiation induced by relativistic electron bunches in the near and far fields.** *Physical Review Applied*, *9*(2), 024004. **IF: 4.532, Citations: 16** (Journal Citation Report-Clarivate, Google Scholar)

   In this work, **the functioning is studied of a non-intercepting longitudinal diagnostic for ultrashort electron beams**, namely Electro-Optical Sampling **(EOS**) in spatial decoding mode. **My contribution** was to **prepare the experimental setup, collect and analyze electro-optical sampling data of accelerated electrons both with the SPARCLAB LINAC and with the ultraintense FLAME laser**. The theoretical interpretation of these data led to the important conclusion that electro-optical sampling is intimately linked to the emission of near-field **Cherenkov radiation** in the case of high-energy electrons (about 200 MeV) accelerated with a radio-frequency LINAC, while to the far-field Cherenkov one in the case of electrons of a few MeV such as those accelerated during the interaction of a very intense laser with a solid target.

9) **Curcio, A**., Marocchino, A., Dolci, V., Lupi, S., & Petrarca, M. (2018). **Resonant plasma excitation by single-cycle THz pulses.** *Scientific reports*, *8*(1), 1052. **IF: 4.011, Citations: 22** (Journal Citation Report-Clarivate, Google Scholar)

   In this work, **the possibility of exciting a plasma wave by THz pulses is studied**, corresponding to an accelerating field of up to hundreds of MegaVolts per meter. **My contribution** was **to coordinate the research and calculation activity on the generation of plasma wakefields by intense single-cycle THz pulses** (energy per pulse of the order of mJ and duration of the order of a few hundred femtoseconds). Specifically, I analyzed the results of the PIC simulations and corroborated the results by numerical and analytical arguments. The importance of the work, awaiting experimental realization, was to demonstrate the **greater efficiency in the excitation of electron plasma waves** (designed for the acceleration of externally injected electron beams) **by intense THz pulses compared to other power sources.**

10) **Curcio, A**., Anania, M., Bisesto, F., Chiadroni, E., Cianchi, A., Ferrario, M., Filippi, F., Giulietti, D., Marocchino, A., Mira, F., Petrarca, M., Shpakov, V. & Zigler, A. (2017). **Single-shot non-intercepting profile monitor of plasma-accelerated electron beams with nanometric resolution.** *Applied Physics Letters*, *111*(13). **IF: 3.495, Citations: 11** (Journal Citation Report-Clarivate, Google Scholar)

    In this work, a prototype of a **non-intercepting Beam Profile Monitor for high-brightness electron beams accelerated with plasma acceleration techniques is studied and demonstrated**. **My contribution** was **to develop the method for the complete and two-**

dimensional reconstruction of the transverse profile of electrons accelerated in a plasma cavity. The method consists in the simultaneous measurement of the spectral-angular distribution of the betatron radiation and the energy spectrum of the bunches of accelerated electrons. The method does not assume any radial symmetry, **allowing a realistic reconstruction of the bidimensional beam profile and transverse dimensions inside a plasma accelerator** up to values such as a few tens of nanometers.

11) Curcio, A., Anania, M., Bisesto, F., Chiadroni, E., Cianchi, A., Ferrario, M., Filippi, F., Giulietti, D., Marocchino, A., Petrarca, M., Shpakov, V. & Zigler, A. (2017). **Trace-space reconstruction of low-emittance electron beams through betatron radiation in laser-plasma accelerators.** *Physical Review Accelerators and Beams*, *20*(1), 012801. **IF: 1.413, Citations: 34** (Journal Citation Report-Clarivate, Google Scholar)

In this work, a methodology is studied and demonstrated for **the single-shot and non-intercepting measurement of transverse emittance** (one-dimensional, radially symmetric) of electron beams accelerated with plasma acceleration techniques. **My contribution** was **to carry out both the theory and the experiment for the reconstruction of the transverse phase space of electrons accelerated in a plasma cavity.** The method consists in the simultaneous measurement of the spectral distribution of the betatron radiation and the energy spectrum of the bunch of accelerated electrons to reconstruct the beam properties such as the transverse profile, the angular distribution, and the correlation function in the transverse phase space. The method allows the measurement of the radially symmetric rms transverse emittance up to values such as a few tens of nanometers, i.e. for **high-brightness beams.**

12) **Curcio, A**., Petrarca, M., Giulietti, D., & Ferrario, M. (2016). **Numerical and analytical models to study the laser-driven plasma perturbation in a dielectric gas-filled capillary waveguide.** *Optics letters*, *41*(18), 4233-4236. **IF: 3.416, Citations: 9** (Journal Citation Report-Clarivate, Google Scholar)

In this work, a complete theoretical treatment is provided for the study of **plasma wakefields generated by lasers in capillary dielectric waveguides**, which also act as plasma cells/containers. **My contribution** was **to develop a simulation code also accompanied by a simplified analytical model for wakefields**, with predictive capabilities like those of the numerical model. The model describes the possible simultaneous generation of various electromagnetic field modes in the case in which one starts from a non-ionized gas and/or from a pump pulse not perfectly matched to the guide. The beatings between the modes and their attenuation during propagation are studied. The importance of this work was **to provide rapid computational methods for studying the generation of plasma wakefields in dielectric capillary waveguides for the design of acceleration experiments of externally injected electron bunches into plasma waves**.

Part X– List of all Publications

XA – **Medical Physics Articles**

- Curcio, A., Cianchi, A., Costa, G., Demurtas, F., Ehret, M., Ferrario, M., . . . Gatti, G. (2022). Performance study on a soft x-ray betatron radiation source realized in the self-injection regime of laser-plasma wakefield acceleration. Applied Sciences, 12(23), 12471.

- Kokurewicz, K., Brunetti, E., Curcio, A., Gamba, D., Garolfi, L., Gilardi, A., . . . Corsini, R. et al. (2021). An experimental study of focused very high energy electron beams for radiotherapy. Communications Physics, 4(1), 1–7.

- Ahmed, A. A., Wrońska, A., Magiera, A., Curcio, A., Jaglarz, M., & Wawrzyniak, A. (2020). Study of m99o and long-lived impurities produced in the natmo (γ, x) reactions using an electron beam. Radiation Physics and Chemistry, 177, 109095

XB – **Accelerator Physics Articles**

- Galletti, M., Cianchi, A., Curcio, A., Dipace, F., Ferrario, M., & Pompili, R. (2023). Direct visualization of relativistic coulomb field in the near and far field ranges. New Journal of Physics.

- Curcio, A., Apiñaniz Aginako, J. I., Cebriano Ramírez, T., Ehret, M., Kebladj, B., Morabito, A., . . Gatti, G. (2022). Liouville theory for fully analytic studies of transverse beam dynamics in laser-plasma ion accelerators. Symmetry, 14(9), 1875.

- Puyuelo-Valdes, P., de Luis, D., Hernandez, J., Apiñaniz, J., Curcio, A., Henares, J., . . . Gatti, G. et al. (2022). Implementation of a thin, flat water target capable of high-repetition-rate mev-range proton acceleration in a high-power laser at the clpu. Plasma Physics and Controlled Fusion, 64(5), 054003.

- Curcio, A., Bergamaschi, M., Corsini, R., Gamba, D., Farabolini, W., Kieffer, R., . . . Petrarca, M. et al. (2021). Diffractive shadowing of coherent polarization radiation. Physics Letters A, 391, 127135.

- Curcio, A., Panas, R., Knafel, M., & Wawrzyniak, A. (2021). Liouville theory for fully analytic studies of longitudinal beam dynamics and bunch profile reconstruction in dispersive lines. Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment, 986, 164755.

- Pompili, R., Chiadroni, E., Cianchi, A., Curcio, A., Del Dotto, A., Ferrario, M., . . . Shpakov, V. et al. (2021). Time-resolved study of nonlinear photoemission in radiofrequency photoinjectors. Optics Letters, 46(12), 2844–2847.

- Wawrzyniak, A. I., Panaś, R., Curcio, A., Knafel, M., Kowalski, G., & Marendziak, A. (2021). Solaris synchrotron performance and operational status. Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms, 493, 19–27.

- Curcio, A., Bergamaschi, M., Corsini, R., Farabolini, W., Gamba, D., Garolfi, L., . . . Fedorov, K. et al. (2020). Noninvasive bunch length measurements exploiting cherenkov diffraction radiation. Physical Review Accelerators and Beams, 23(2), 022802.

- Curcio, A., Bergamaschi, M., Corsini, R., Gamba, D., Farabolini, W., Lefevre, T., . . . Lupi, S. (2019). Beam-based sub-thz source at the cern linac electron accelerator for research facility. Physical Review Accelerators and Beams, 22(2), 020402.

- Curcio, A., Bisesto, F., Costa, G., Biagioni, A., Anania, M., Pompili, R., . . . Petrarca, M. (2019). Modeling and diagnostics for plasma discharge capillaries. Physical Review E, 100(5), 053202.

- Curcio, A., & Volpe, L. (2019). A quasi-static model for hot-electron interaction with self-generated magnetic fields. Plasma Physics and Controlled Fusion, 61(5), 055013.

- Malko, S., Vaisseau, X., Perez, F., Batani, D., Curcio, A., Ehret, M., . . . Santos, J. J. et al. (2019). Enhanced relativistic-electron beam collimation using two consecutive laser pulses. Scientific Reports, 9(1), 1–7.

- Cianchi, A., Anania, M., Bisesto, F., Chiadroni, E., Curcio, A., Ferrario, M., . . . Scifo, J. et al. (2018). Frontiers of beam diagnostics in plasma accelerators: Measuring the ultra-fast and ultra-cold. Physics of Plasmas, 25(5), 056704.

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XF-**Books**

- Curcio, A., & Giulietti, D. (2019). Laser-plasma acceleration and secondary em radiation (Aracne, Ed.).

- Curcio, A., Dattoli, G., & DiPalma, E. (Under preparation, Proposal Accepted, foreseen by 2025). Physics and applications of compton backscattering sources Vol. 1 (IOP, Ed.).

- Curcio, A., Dattoli, G., & DiPalma, E. (Under preparation, Proposal Accepted, foreseen by 2025). Physics and applications of compton backscattering sources Vol. 2 (IOP, Ed.).

XG-**Periodicals**

- D. Gamba, A. Curcio, R. Corsini. (2018). First experimental results from the clear facility at cern. Accelerating News-CERN Courier. Retrieved from https://acceleratingnews-d7-archive.web.cern.ch/taxonomy/term/222.html

Part XI– Contributions to conferences

XIA-**Invited Talks**

- Congresso Nazionale SIF (Società Italiana di Fisica), 2023 Salerno, Italy. Presentation title: Betatron radiation: The EuAPS PNRR project;

- SILS (Società Italiana Luce di Sincrotrone) Conference 2023, Rome (Italy) 30 August-01 September 2023. Presentation title: A compact plasma-based betatron X-ray source: the EuPRAXIA Advanced Photon Sources (EuAPS) project;

- PIERS (PhotonIcs and Electromagnetics Research Symposium, also known as Progress In Electromagnetics Research Symposium) Conference, Prague (Czech Republic) 03-06 July 2023. Presentation title: On the THz Radiation Mechanisms at the Base of On-axis Emission in Relativistic Laser-plasma Interactions;

- Physics and Applications of High Brightness Beams (PAHBB 2023) Conference, San Sebastian (Spain) 19-23 June 2023. Presentation title: EuPRAXIA Advanced Photon Sources (EuAPS): a plasma-based betatron source;

- STAMPLASS (Standardization of Metrology Procedures for Lasers and Secondary Sources) Conference, Magurele (Romania) 21-23 March 2023. Presentation title: Advanced Electron Metrology for laser plasmas;

- Ultrafast Science & Technology Spain 2022 (USTS2022) Conference, Malaga (Spain) 16- 18 November 2022. Presentation title: Observation of tunable parametric X-ray radiation emitted by laser-plasma electron beams interacting with crystalline structures;

- ICFDT6 (International Conference on Frontier in Diagnostic Technologies), 2022 Frascati, Italy. Presentation title: Observation of tunable parametric X-ray radiation emitted by laser-plasma electron beams interacting with crystalline structures;

- ECLIM2022 (European Conference on Laser Interaction with Matter), Frascati, Italy 19- 23 September 2022. Presentation title: Observation of tunable parametric X-ray radiation emitted by laser-plasma electron beams interacting with crystalline structures;

- IBIC 2020 (International Beam Instrumentation Conference), 2020, Remote Conference (due to COVID19). Presentation title: Novel trends in bunch length diagnostics based on coherent polarization radiation;

- AFAD2019 (Asian Forum for Accelerators and Detectors), 2019, Nuova Deli, India. Pre- sentation title: THz studies for high-intensity sources and beam diagnostics at CLEAR;

- WCPST (World Congress on Plasma Science & Technology), 2018, Stoccolma, Svezia. Presentation title: Laser-plasma acceleration and production of secondary X-gamma radiation sources;

- ICFDT5 (International Conference on Frontier in Diagnostic Technologies), 2018 Frascati, Italy. Presentation title: Emittance measurement through betatron radiation in laser- plasma accelerator;

- Congresso Nazionale SIF (Società Italiana di Fisica), 2014 Pisa, Italy. Presentation title: Radiazione di betatrone in esperimenti di interazione laser-plasma.

XIB-**Oral Presentations**

- EAAC (European Advanced Accelerator Concepts), 2019 Isola d'Elba, Italy. Presentation title: Coherent radiation studies for beam diagnostics and high-intensity THz sources at CLEAR;

- CLIC Project Meeting #30, Ginevra, Svizzera. Presentation title: CLEAR: status and results;

- CLIC Workshop 2018, Ginevra, Svizzera. Presentation title: THz@CLEAR: source and diagnostics for the electron acceleration;

- Channeling 2018 Ischia, Italy. Presentation title: Proton-boron fusion reactions in solid matter, laser-plasmas and quantum plasmas. PPLA (Plasma Physics by Laser and Applications), 2017 Messina, Italy. Presentation title: Relativistic self-focusing in gas-jets: theory and experiments;

- EAAC (European Advanced Accelerator Concepts), 2017 Isola d'Elba, Italy. Presentation title: Betatron Radiation as Emittance Diagnostics for plasma acceleration experiments;

- Workshop "Trends in Free Electron Laser Physics", 2016 Erice, Italy. Presentation title: Betatron radiation as bright hard X-ray source and effective diagnostic for laser-plasma acceleration experiments;

- CALIFES Workshop, 2016 CERN-Ginevra, Svizzera. Presentation title: THz shaping;

- Channeling 2016 Ischia, Italy. Presentation title: Betatron radiation from electrons accelerated in laser-produced plasma channels.

- PPLA (Plasma Physics by Laser and Applications), 2015 Frascati, Italy. Presentation title: Fast ions emission and parametric instabilities in laser-solid target interactions;

- Congresso Nazionale SIF (Società Italiana di Fisica), 2015 Rome, Italy. Presentation title: Betatron Radiation in Capillaries for Plasma Acceleration Experiments;

- RAIN (Radiazione per l'INnovazione), 2015 Frascati, Italy. Presentation title: Nanosecond and Femtosecond X-ray Thomson Sources within the Frascati Area;

- Channeling 2014, Capri-Napoli, Italy. Presentation title: Innovative X-gamma ray sources based on laser-produced plasmas, winner of the award: BEST EARLY-STAGE RESEARCHER.

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XIC-**Posters**

- IPAC 2023 Venice, Italy. Presentation title: Simulation study towards a new injector LINAC for the SOLARIS synchrotron facility;

- IPAC 2021 Campinas, Brazil. Presentation title: Bunch Length Characterizations for the Solaris Injector LINAC;

- Channeling 2018 Ischia, Italy. Presentation title: Radiation studies on mm-waves at CLEAR;

- DDIFW13 (Direct Drive Fast Ignition Workshop), 2017 Salamanca, Spain. Presentation title: Non collisional hot electron transport in the femtosecond regime: analytic calculations of magnetic fields;

- CHILI (Conference on HIgh Intensity Lasers and attosecond science in Israele), 2016 Tel Aviv, Israele. Presentation title: X-ray emission from plasma filaments in air;

- EAAC (European Advanced Accelerator Concepts), 2015 Isola d'Elba, Italy. Presentation title: Advanced diagnostics for Laser Plasma Acceleration experiments.

XID-**Organization**

- Member of the Scientific Committee of the International Beam Instrumentation Conference (IBIC) 2022, Krakow (Poland);

- Member of the Local Organizing Committee of the European Conference on Plasma Diagnostics (ECPD) 2021, Salamanca (Spain).

Part XII– Reviewing and Editing

XIIA- Role of Referee for peer-review journals

- APS Journals (PRL, PRA, PRE, PRR, PRSTAB);

- AIP Journals (Applied Physics Letters, Physics of Plasmas);

- Optica Publishing Group (Optics Letters, Optics Express);

- MDPI Journals (Physics, Applied Sciences, Instruments, Symmetry, Electronics, Particles);

- Elsevier Journals (NIM A, NIM B, Optics and Lasers in Engineering);

- Springer Nature Journals (Scientific Reports, Applied Physics B).

XIIB- **Guest Editor for Special Issues**

- Applied Sciences, Special Issue Oscillator-Amplifier Free Electron Lasers an Outlook to Their Feasibility and Performances. Link: https: //www.mdpi.com/journal/applsci/special_issues/ Oscillator − Amplifier_Free_Electron_Lasers.

- Symmetry, Special Issue Recent Advances in Plasma Physics 2021. Link: https: //www.mdpi.com/journal/symmetry/special_issues/ recent_advances_plasma_physics_2021.