

**EUROPEAN
CURRICULUM VITAE
FORMAT**



PERSONAL INFORMATION

Name
Address
Telephone
Fax
E-mail

LUCA SERAFINI

Nationality
Date of birth

Italian

WORK EXPERIENCE

- Dates (from – to)
- Name and address of employer
- Type of business or sector
- Occupation or position held
- Main activities and responsibilities

1981-2023

Istituto Nazionale di Fisica Nucleare – Milano

Research in Fundamental and Applied Physics – Particle Accelerators and Beams,
High Brilliance Radiation Sources

Research Director (2004-2023) Research staff (1981-2004)

Visiting Professor - U.C.L.A. Physics Department - 1996/1997

Faculty member - INFN National PhD School in Particle Accelerator Physics - 2015/2023

Scientific Coordinator of INFN SPARC Project
P.I. of SL-EXIN experiment at INFN-LNF
TDR Coordinator of ELI-NP-GBS from EuroGammaS
MariX CDR Coordinator
BrXSino TDR Coordinator
STAR Project P.I. for INFN

EDUCATION AND TRAINING

- Dates (from – to)
- Name and type of organisation providing education and training
- Principal subjects/occupational skills covered
- Title of qualification awarded
- Level in national classification (if appropriate)

25-11-1980

University of Milan

Physics degree

**PERSONAL SKILLS
AND COMPETENCES**

*Acquired in the course of life and career
but not necessarily covered by formal
certificates and diplomas.*

MOTHER TONGUE

ITALIAN

OTHER LANGUAGES

ENGLISH

very good

• Reading skills

very good

• Writing skills

very good

• Verbal skills

PORTUGUESE

very good

• Reading skills

good

• Writing skills

quite good

• Verbal skills

SOCIAL SKILLS

AND COMPETENCES

*Living and working with other people, in
multicultural environments, in positions
where communication is important and
situations where teamwork is essential
(for example culture and sports), etc.*

ORGANISATIONAL SKILLS

AND COMPETENCES

*Coordination and administration of
people, projects and budgets; at work, in
voluntary work (for example culture and
sports) and at home, etc.*

I) ADVANCING THE PHYSICS OF BEAMS AND RADIATION WITH NEW CONCEPTS

II) MANAGING NATIONAL TEAMS OF PHYSICISTS AND ENGINEERS FOR
ADVANCED PROJECTS OF NEW PARTICLE ACCELERATORS

III) CHAIRING INTERNATIONAL WORKSHOPS

IV) PARTICIPATING IN INTERNATIONAL SCIENTIFIC ADVISORY COMMITTEES

TECHNICAL SKILLS

AND COMPETENCES

*With computers, specific kinds of
equipment, machinery, etc.*

MASTERING THE THEORY OF HIGH BRIGHTNESS ELECTRON BEAMS AND ADVANCED RADIATION
SOURCES, INCLUDING FREE ELECTRON LASERS, INVERSE COMPTON SCATTERING SOURCES AND
EXOTIC SECONDARY BEAM SOURCES BASED ON ELECTRON-PHOTON BEAM INTERACTIONS

ARTISTIC SKILLS

AND COMPETENCES

Music, writing, design, etc.

OTHER SKILLS

AND COMPETENCES

Competences not mentioned above.

DRIVING LICENCE(S)

ADDITIONAL INFORMATION

Author of: RF Beam Transport Matrix (ref. 2), Laminar Beam Theory (ref.3), Velocity Bunching technique (ref.4), Petrillo-Serafini criterion (ref. 5), Two-way Acceleration Concept (ref.7), EXMP muon beam source (ref.10), Symmetric Compton Scattering (ref.11)

MAIN SCIENTIFIC ACHIEVEMENTS: 1) first derivation of the generalized beam transport matrix of RF Ponderomotive Focusing, 2) first derivation of the Invariant Envelope theory model to explain emittance reversible oscillations in high brightness electron beams in laminar regime, 3) conceivement, study and proposal of the Velocity Bunching technique, 4) first derivation of the Petrillo-Serafini criterion for maximum spectral density in Inverse Compton Sources of X and gamma-rays, 5) conceivement and analysis of the new concept of two-way acceleration in RF Super-Conducting Linacs, 6) first study of Symmetric Compton Scattering, conceived as a follow-up of study on deep recoil Inverse Compton Scattering

ANNEXES

AUTHORS OF ABOUT 400 PUBLICATIONS ON INTERNATIONAL REFEREED SCIENTIFIC JOURNALS AND CONFERENCE PAPERS, 112 INVITED TALKS AT INTERNATIONAL SCIENTIFIC CONFERENCES OR WORKSHOPS, 42 CONTRIBUTED TALKS AT INTERNATIONAL SCIENTIFIC CONFERENCES OR WORKSHOPS, 123 SEMINARS IN INTERNATIONAL LABORATORIES AND UNIVERSITIES

11 Selected Publications:

1)

Particle Accelerators, 1995, Vol. 49, pp. 253–271
Reprints available directly from the publisher
Photocopying permitted by license only

© 1995 OPA (Overseas Publishers Association)
Amsterdam B.V. Published under license by
Gordon and Breach Science Publishers SA
Printed in Malaysia

ANALYTICAL DESCRIPTION OF PARTICLE MOTION IN RADIO-FREQUENCY PHOTO-INJECTORS

LUCA SERAFINI

*INFN and Università di Milano
Via Celoria 16 – 20133 Milano, Italy*

(Received 9 June 1994; in final form 25 January 1995)

2)

PHYSICAL REVIEW E

VOLUME 49, NUMBER 2

FEBRUARY 1994

Transverse particle motion in radio-frequency linear accelerators

J. Rosenzweig

Department of Physics, University of California—Los Angeles, Los Angeles, California 90024

L. Serafini

*Istituto Nazionale di Fisica Nucleare and Università di Milano, Via Celoria 16, 20133 Milano, Italy
(Received 18 October 1993)*

The transverse motion of a relativistic charged particle in a radio-frequency linear accelerator (rf linac) is examined. The spatially averaged equations of motion are derived for a particle in a periodic accelerating cavity system, and solved exactly in the ultrarelativistic limit. These solutions, along with an impulse treatment of the transients at the entrance and exit of the linac cavities, allow derivation of a linear transport matrix through the cavity. This generalized matrix is improved over previously derived results in that it is applicable to both traveling- and standing-wave structures, allows for arbitrary injection phase and spatial-harmonic content of the rf fields, and is more accurate in approximating the exact charged-particle motion.

PACS number(s): 41.75.−i, 41.85.−p, 29.17.+w, 29.27.Eg

3)

PHYSICAL REVIEW E

VOLUME 55, NUMBER 6

JUNE 1997

Envelope analysis of intense relativistic quasilaminar beams in rf photoinjectors: A theory of emittance compensation

Luca Serafini

Istituto Nazionale di Fisica Nucleare, Milano, Via Celoria 16, 20133 Milano, Italy

James B. Rosenzweig

Department of Physics and Astronomy, University of California, Los Angeles, 405 Hilgard Avenue, Los Angeles, California 90095-1547

(Received 11 November 1996)

In this paper we provide an analytical description for the transverse dynamics of relativistic, space-charge-dominated beams undergoing strong acceleration, such as those typically produced by rf photoinjectors. These beams are chiefly characterized by a fast transition, due to strong acceleration, from the nonrelativistic to the relativistic regime in which the initially strong collective plasma effects are greatly diminished. However, plasma oscillations in the transverse plane are still effective in significantly perturbing the evolution of the transverse phase space distribution, introducing distortions and longitudinal-transverse correlations that cause an increase in the rms transverse emittance of the beam as a whole. The beam envelope evolution is dominated by such effects and not by the thermal emittance, and so the beam flow can be considered quasilaminar. The model adopted is based on the rms envelope equation, for which we find an exact particular analytical solution taking into account the effects of linear space-charge forces, external focusing due to applied as well as ponderomotive RF forces, acceleration, and adiabatic damping, in the limit that the weak nonlaminarity due to the thermal emittance may be neglected. This solution represents a special mode for beam propagation that assures a secularly diminishing normalized rms emittance and it represents the fundamental operating condition of a space-charge-compensated RF photoinjector. The conditions for obtaining emittance compensation in a long, integrated photoinjector, in which the gun and linac sections are joined, as well as in the case of a short gun followed by a drift and a booster linac, are examined. [S1063-651X(97)10706-1]

PACS number(s): 41.75.-i, 41.85.-p, 29.17.+w, 29.25.Bx

4)

Velocity bunching in photo-injectors

AIP Conference Proceedings **581**, 87 (2001); <https://doi.org/10.1063/1.1401564>L. Serafini⁰ and M. Ferrario¹

5)

JOURNAL OF APPLIED PHYSICS **113**, 194508 (2013)

Electron Linac design to drive bright Compton back-scattering gamma-ray sources

A. Bacchi,¹ D. Alesini,² P. Antici,³ M. Bellaveglia,² R. Boni,² E. Chiadroni,² A. Cianchi,⁴ C. Curatolo,^{1,5} G. Di Pirro,² A. Esposito,² M. Ferrario,² A. Gallo,⁵ G. Gatti,² A. Ghigo,² M. Migliorati,³ A. Mostacci,³ L. Palumbo,³ V. Petrillo,^{1,6} R. Pompili,^{2,4} C. Ronsivalle,⁶ A. R. Rossi,¹ L. Serafini,¹ B. Spataro,² P. Tomassini,⁵ and C. Vaccarezza²

¹INFN-MI, Milano, Italy²INFN-LNF, Frascati, Roma, Italy³University La Sapienza, Roma, Italy⁴University of Tor Vergata, Roma, Italy⁵University of Milano, Milano, Italy⁶Enea, Frascati, Roma, Italy

(Received 29 January 2013; accepted 1 May 2013; published online 20 May 2013)

The technological development in the field of high brightness linear accelerators and high energy/high quality lasers enables today designing high brilliance Compton-X and Gamma-photon beams suitable for a wide range of applications in the innovative field of nuclear photonics. The challenging requirements of this kind of source comprise: tunable energy (1–20 MeV), very narrow bandwidth (0.3%), and high spectral density (10^4 photons/s/eV). We present here a study focused on the design and the optimization of an electron Linac aimed to meet the source specifications of the European Extreme Light Infrastructure—Nuclear Physics project, currently funded and seeking for an innovative machine design in order to outperform state-of-the-art facilities. We show that the phase space density of the electron beam, at the collision point against the laser pulse, is the main quality factor characterizing the Linac. © 2013 AIP Publishing LLC. [<http://dx.doi.org/10.1063/1.4805071>]

6)

Technical Design Report EuroGammaS proposal for the ELI-NP Gamma beam System

O. Adriani, S. Albergo, D. Alesini, M. Anania, D. Angal-Kalinin, P. Antici, A. Bacci, R. Bedogni, M. Bellaveglia, C. Biscari, N. Bliss, R. Boni, M. Boscolo, F. Broggi, P. Cardarelli, K. Cassou, M. Castellano, L. Catani, I. Chaikovska, E. Chiadroni, R. Chiche, A. Cianchi, J. Clarke, A. Clozza, M. Coppola, A. Courjaud, C. Curatolo, O. Dadoun, N. Delerue, C. De Martinis, G. Di Domenico, E. Di Pasquale, G. Di Pirro, A. Drago, F. Druon, K. Dupraz, F. Egal, A. Esposito, F. Falcoz, B. Fell, M. Ferrario, L. Ficcadenti, P. Fichot, A. Gallo, M. Gambaccini, G. Gatti, P. Georges, A. Ghigo, A. Goulden, G. Graziani, D. Guibout, O. Guilbaud, M. Hanna, J. Herbert, T. Hovsepian, E. Iarocci, P. Iorio, S. Jamison, S. Kazamias, F. Labaye, L. Lancia, F. Marcellini, A. Martens, C. Maroli, B. Martlew, M. Marziani, G. Mazzitelli, P. McIntosh, M. Migliorati, A. Mostacci, A. Mueller, V. Nardone, E. Pace, D.T. Palmer, L. Palumbo, A. Pelorosso, F.X. Perin, G. Passaleva, L. Pellegrino, V. Petrillo, M. Pittman, G. Riboulet, R. Ricci, C. Ronsivalle, D. Ros, A. Rossi, L. Serafini, M. Serio, F. Sgamma, R. Smith, S. Smith, V. Soskov, B. Spataro, M. Statera, A. Stecchi, A. Stella, A. Stocchi, S. Tocci, P. Tomassini, S. Tomassini, A. Tricomi, C. Vaccarezza, A. Variola, M. Veltri, S. Vescovi, F. Villa, F. Wang, E. Yildiz, F. Zomer (collapse list)

Submitted on 14 Jul 2014

The machine described in this document is an advanced Source of up to 20 MeV Gamma Rays based on Compton back-scattering, i.e. collision of an intense high power laser beam and a high brightness electron beam with maximum kinetic energy of about 720 MeV. Fully equipped with collimation and characterization systems, in order to generate, form and fully measure the physical characteristics of the produced Gamma Ray beam. The quality, i.e. phase space density, of the two colliding beams will be such that the emitted Gamma ray beam is characterized by energy tunability, spectral density, bandwidth, polarization, divergence and brilliance compatible with the requested performances of the ELI-NP user facility, to be built in Romania as the Nuclear Physics oriented Pillar of the European Extreme Light Infrastructure. This document illustrates the Technical Design finally produced by the EuroGammaS Collaboration, after a thorough investigation of the machine expected performances within the constraints imposed by the ELI-NP tender for the Gamma Beam System (ELI-NP-GBS), in terms of available budget, deadlines for machine completion and performance achievement, compatibility with lay-out and characteristics of the planned civil engineering.

Subjects: Accelerator Physics (physics.acc-ph)

Cite as: arXiv:1407.3669 [physics.acc-ph]
(or arXiv:1407.3669v1 [physics.acc-ph] for this version)


7)

PHYSICAL REVIEW ACCELERATORS AND BEAMS 22, 111304 (2019)

Two-pass two-way acceleration in a superconducting continuous wave linac to drive low jitter x-ray free electron lasers

A. Bacci^{1,*}, M. Rossetti Conti¹, A. Bosotti¹, S. Cialdi^{2,1}, S. Di Mitri³, I. Drebot¹, L. Faillace¹, G. Ghiringhelli⁴, P. Michelato¹, L. Monaco¹, M. Oromolla^{1,2}, R. Paparella¹, V. Petrillo^{1,2}, M. Placidi⁵, E. Puppin^{1,4}, A. R. Rossi¹, G. Rossi², D. Sertore¹ and L. Serafini¹

¹INFN—Sezione di Milano, Via Celoria 16, 20133, Milano and LASA, Via F. Cervi 201, 20090 Segrate (MI), Italy
²Università degli Studi di Milano, Via Festa del Perdono 7, 20100 Milano, Italy
³Elettra—Sincrotrone Trieste S.C.p.A., 34149 Basovizza, Trieste, Italy
⁴Politecnico di Milano, Piazza Leonardo da Vinci, 32 20133 Milano, Italy
⁵LBNL, Lawrence Berkeley National Laboratory, Berkeley, California 94720, USA

 (Received 27 June 2019; published 13 November 2019)

8) MariX: Multi-disciplinary Advanced Research Infrastructure for the generation and application of X-Rays. Conceptual Design Report, available online: <https://marix.mi.infn.it>

9) BriXSino Technical Design Report, available online: <https://marix.mi.infn.it/brixsino-docs/>

Article

Electrons and X-rays to Muon Pairs (EXMP)

Camilla Curatolo * and Luca Serafini 

INFN Sezione di Milano, via Celoria 16, 20133 Milan, Italy; luca.serafini@mi.infn.it

* Correspondence: camilla.curatolo@mi.infn.it

Abstract: One of the challenges of future muon colliders involves the production of muon beams carrying high phase space densities. In particular, the muon beam normalised transverse emittance is a relevant figure of merit used to meet luminosity requests. A typical issue impacting the achieved transverse emittance in muon collider schemes, thus far considered, is the phase space dilution caused by the Coulomb interaction of primary particles propagating into the target where muons were generated. In this study, we present a new scheme (named electrons and X-rays to muon pairs) for muon beam generation occurring in a vacuum via interactions of electron and photon beams. Setting the center of mass energy at about twice the threshold (i.e., around 350 MeV), the normalised emittance of the muon beam generated via muon pair production reaction ($e^- + \gamma \rightarrow e^- + \mu^+ + \mu^-$) is largely independent on the emittance of the colliding electron beam and is set basically by the excess of transverse momentum in the muon pair creation. In absence of any other mechanism for emittance dilution, the resulting muon beam, with energy in the range of a few tens of GeV, is characterised by an ultra-low normalised transverse RMS emittance of a few nm rad, corresponding to a geometrical emittance below 10π pm rad. This opens up the way to a new muon collider paradigm based on muon sources conceived with primary colliding beams delivered by 100 GeV-class energy recovery LINACs interacting with hard-X ray free electron lasers. The challenge is to achieve the requested luminosity of the muon collider adopting a strategy of low muon fluxes/currents combined to ultra-low emittances, to largely reduce the levels of muon beam-induced backgrounds.

Keywords: muon collider; high efficiency XFEL; FELs for colliders; low emittance muon beam photoproduction



Citation: Curatolo, C.; Serafini, L. Electrons and X-rays to Muon Pairs (EXMP). *Appl. Sci.* **2022**, *12*, 3149. <https://doi.org/10.3390/app12063149>

Academic Editor: Wolfram Helm

Received: 5 February 2022

Accepted: 16 March 2022

Published: 19 March 2022

1. Introduction

Muon beam generation for muon colliders has been traditionally conceived using hadronic interactions that go through a pion production channel with consequent decay into the muons. The total cross section for these reactions is quite large, assuring a wealth of muon populations when intense proton beams are impinging on targets made of proper material [1]. Unfortunately, the coulomb interactions of primary and secondary beams



Contents lists available at ScienceDirect

Fundamental Plasma Physics

journal homepage: www.elsevier.com/locate/fpp

Original research article

Symmetric Compton Scattering: A way towards plasma heating and tunable mono-chromatic gamma-rays

L. Serafini ^{a,b}, A. Bacci ^{a,b}, C. Curatolo ^{a,b}, I. Drebot ^{a,b}, V. Petrillo ^{a,c}, A. Puppini ^{a,c},
M. Rossetti Conti ^{a,b,*}, S. Samsam ^{a,b}

^a INFN-Section of Milan, Via G. Celoria 16, Milan, 20133, Italy^b INFN-LASA, Via F. Cervi 201, Segrate, 20090, Italy^c University of Milan, Via G. Celoria 16, Milan, 20133, Italy