# Elia Arturo Vallicelli

Date of birth: 12/11/1988 | **Nationality:** Italian | **Gender:** Male

## • BIOSKETCH

### CV Summary

Elia A. Vallicelli received the master's degree in Physics in 2017 and the PhD in Physics and astronomy in 2021 at the University of Milano - Bicocca where he is currently working as Research Fellow (RTD-A) within the Microelectronics Group. His main research interests are in the fields of medical physics, ionoacoustic particle range verification, photoacoustic imaging, brain-chip interfaces and integrated circuits. He is technical coordinator and responsible of different work packages within the INFN Proton Sound Detector project (ProSD) and he develops low noise electronics, ultrasound sensors and FPGA based digital circuits. He collaborates with several national and international research projects. In 2019 he received the Gold and Bronze Leaf Awards at the IEEE PRIME conference, in 2021 the Best Student Paper award at BIODEVICES conference. Since 2021 he is the PI of the paMELA (Photoacoustic Melanoma Detector, funded 23 k€) project with the goal of developing a low-cost high-resolution photoacoustic probe for early-stage melanoma detection.

### Keywords

Sensors, Analog and Digital Integrated Circuits, FPGA, Radiotherapy, Thermoacoustics, Signal processing, Proton Sound Detectors

## • WORK EXPERIENCE

01/2022 – CURRENT
**RESEARCH FELLOW (RTD-A) –** UNIVERSITÀ DEGLI STUDI DI MILANO - BICOCCA

Development of photoacoustic technology for environmental protection applications.

18/03/2021 – 12/2021
**POST-DOC RESEARCHER –** ITALIAN INSTITUTE FOR NUCLAR PHYSICS - INFN, SECTION OF MILANO BICOCCA

Architectural and behavioral analysis of an Incremental Analog-to- Digital Converter with radiation damage hardness

01/01/2021 – 17/03/2021
**POST-DOC RESEARCHER –** UNIVERSITÀ DEGLI STUDI DI MILANO - BICOCCA

## EDUCATION AND TRAINING

11/2017 – 10/2020
**PHD IN PHYSICS AND ASTRONOMY –** Università degli Studi di Milano - Bicocca

**Main Topic**: Design and development of a Proton Sound Detector for ionoacoustic detection of charged particles.
**Secondary Topics**: Denoising signal processing algorithms for neuron-silicon interfaces; characterization of Small-Diameter Muon Drift Tube Detector Fast-Tracker Front-End for ATLAS detector; characterization of integrated analog filters in scaled CMOS technologies

EQF level 8

02/2016 – 10/2017
**MASTER'S DEGREE IN PHYSICS –** Università degli Studi di Milano - Bicocca

**Thesis:** Neural Spikes Digital Detector and Sorting on FPGA

100/110 │ EQF level 7

09/2007 – 09/2014
**BACHELOR'S DEGREE IN PHYSICS –** Università degli Studi di Milano - Bicocca

**Thesis:** Cadence and Matlab Modelling of a Continuous-Time 4th-Order Multipath Analog Filter with 24MHz -3dB

97/110 │ EQF level 6

## PROJECTS AND MAJOR COLLABORATIONS

12/2020 – CURRENT
**paMELA - Photoacoustic Melanoma Detector**

**Project Description:**
Design and development of a low-cost photoacoustic probe for early-stage melanoma diagnosis. This project has been selected for crowdfunding (1st/24) within the BiUniCrowd - Bicocca Crowdfunding University initiative and raised 9245/8000€ during an online campaign (April-May 2021).

**Contribution:**
Principal investigator, team leader (4 people), spokeperson, analog designer. He promoted the project through national newspapers and magazines, radio and social networks. He currently leads the paMELA team towards the development and experimental validation of the probe, in collaboration with a network of dermatologists.

## Proton Sound Detector (ProSD) - CSN5 INFN Project

**Project Description:**
Design and development of low-noise detectors and electronics for ionoacoustic localization of the Bragg Peak of a proton beam interacting with a water absorber.
**Contribution:**
Technical coordinator and responsible of the following workpackages:
<u>2018</u>: Responsible of Beam Test Workpackage - Development and testing of an analog/digital system for low-noise real-time ionoacoustic signal acquisition and Bragg Peak localization. Experimental validation has been done during two measurements campaigns at LMU University Tandem Accelerator, Munich (GE).
<u>2019</u>: Responsible of Photoacoustic Setup Workpackage - Design and realization of a Photoacoustic Testbench capable of emulating the ionoacoustic signal of 20/30 MeV protons using a 70W 150 ns pulsed laser source. Development of a JFET-based Low-Noise Amplifier for thermoacoustic signals detection.
<u>2020/21</u>: Responsible of Beam Test Workpackage: Design and development of an experimental setup to localize in 2D the Bragg Peak of a 20/40 MeV proton beam using a multichannel sensor, a multichannel ASIC and real-time beamforming/imaging algorithms on FPGA. Experimental validation has been done during two measurements campaigns at Linearbeam proton accelerator, Ruvo di Puglia (IT).

## Materia Oscura a Bolle (MoscaB) - CSN2 INFN Project

**Project Description:**
Development of a super-heated $C_3F_8$ bubble chamber detector prototype for acoustic detection of WIMPs and neutrons at INFN Gran Sasso National Laboratory (LNGS).
**Contribution:**
Development of piezoelectric-based sensors and Low-Noise Amplifiers for the acquisition and charaterization of acoustic signatures of particle-induced bubbles.

## In-Vivo Brain-to-Bit System for Neuroelectronics - Unimib

**Project:**
Development of analog and digital circuits for brain-silicon interfaces.
**Contribution:**
Development and validation of hardware implemented (FPGA) algorithms for real-time neural spikes detection.

## Brain28nm Project - MIUR

**Project Description:**
Design and development of an Autonomous In-vivo Brain-Machine-Interface in 28nm-CMOS technology with Ultrasound-based Power-Harvester and Communication-Link (Brain28nm) Project.
**Contribution:**
Development and validation of hardware implemented (FPGA) algorithms for neural spikes detection. Digital algorithms characterization and optimization.

**ATLAS Small-Diameter Muon Drift Tube Detector Fast-Tracker Front-End**

**Project Description**:
Design and development of a multichannel front-end for ATLAS Small-Diameter Muon Drift Tube Detector, in collaboration with Max Planck Institut for Physics - Munich.
**Contribution:**
Electrical characterization of the CMOS 65nm ASIC Fast-Tracker Front-End prototype. ASIC electrical testbench design, ASIC time and frequency domain characterization.

**Advanced Nanometer IC Technologies for Next Generation Transceivers (ANIThiNG) - PRIN2017, MIUR**

**Project Description:**
Design of analog circuits in scaled CMOS technologies (28nm node) for telecommunications.
**Contribution:**
Test and electrical characterization of integrated circuits in time and frequency domain. Evaluation of frequency response, power consumption, distortion, linearity.

## HONOURS AND AWARDS

### Best Student Paper Award - BIODEVICES 2021

Paper title:
Vallicelli, E. A., Cosmi, M. O., Baschirotto, A., & De Matteis, M. (2021). Front-end Design Optimization for Ionoacoustic 200 MeV Protons Beam Monitoring with Sub-millimeter Precision for Hadron Therapy Applications. In *BIODEVICES* (pp. 77-87).

### Gold Leaf Award - Best 10% Paper at IEEE PRIME 2019 Conference

Paper title:
 Vallicelli, E. A., Gelmi, L., Bertoni, R., Fulgione, W., Tambaro, M., Baschirotto, A., & De Matteis, M. (2019, July). A 0.3 nV/$\sqrt{}$ Hz Input-Referred-Noise Analog Front-End for Weakly-Interacting-Massive-Particles (WIMPs) Acoustic Sensing in Bubbles-Chamber Detectors. In *2019 15th Conference on Ph. D Research in Microelectronics and Electronics (PRIME)* (pp. 197-200). IEEE.

### Bronze Leaf Award - Best 30% Paper at IEEE PRIME 2019, as co-supervisor of a Master's Student

Paper title:
Tambaro, M., Vallicelli, E. A., Tomasella, D., Baschirotto, A., Vassanelli, S., Maschietto, M., & De Matteis, M. (2019, July). Real-Time Neural (RT-Neu) Spikes Imaging by a 9375 sample/(sec pixel) 32× 32 pixels Electrolyte-Oxide-Semiconductor Biosensor. In *2019 15th Conference on Ph. D Research in Microelectronics and Electronics (PRIME)* (pp. 233-236). IEEE.

## PUBLICATIONS

### Invited Journal Publications

1. Vallicelli, E. A., Turossi, D., Gelmi, L., & De Matteis, M. A 0.3nV/√Hz Input-Referred-Noise Analog Front-End for Radiation-Induced Thermo-Acoustic Pulses. *Integration: The VLSI Journal.*
2. Vallicelli, E. A., Baschirotto, A., Lehrack, S., ... & De Matteis, M. 22 dB Signal-to-Noise-Ratio Real-Time Proton Sound Detector for Experimental Beam Range Verification. *IEEE Transactions on Circuits and Systems I*
3. Vallicelli, E. A., Baschirotto, A., Lehrack, S., ... & De Matteis, M. 50-Channels Ionoacoustic Sensor for 60 MeV Proton Beam Characterization in Hadron Therapy Applications. Submitted at Springer Nature Computer Science

### Journal Publications

1. Stevenazzi, L., Baschirotto, A., Zanotto, G., Vallicelli, E. A., & De Matteis, M. (2022). Noise Power Minimization in CMOS Brain-Chip Interfaces. *Bioengineering*, *9*(2), 42.
2. De Matteis, M., Baschirotto, A., & Vallicelli, E. (2021). Acoustic Analog Signal Processing for 20 MeV-200 MeV Proton Sound Detectors. *IEEE Transactions on Radiation and Plasma Medical Sciences*.
3. M. De Matteis, A. Baschirotto, E. Vallicelli and E. Zanini, "Proton Induced Thermoacoustic Process as Linear Time Invariant System," in *IEEE Transactions on Radiation and Plasma Medical Sciences*
4. M. De Matteis, N. Galante, F. Fary, E. Vallicelli and A. Baschirotto, "64 dB Dynamic-Range 810 µW 90 MHz Fully-Differential Flipped-Source-Follower Analog Filter in 28nm-CMOS," in *IEEE Transactions on Circuits and Systems II: Express Briefs*
5. De Matteis, M., Baschirotto, A., & Vallicelli, E. (2021). Acoustic Analog Signal Processing for 20 MeV-200 MeV Proton Sound Detectors. *IEEE Transactions on Radiation and Plasma Medical Sciences*.
6. De Matteis, M., Fary, F., Vallicelli, E. A., & Baschirotto, A. (2021). A 28 nm CMOS 100 MHz 67 dB-Dynamic-Range 968 µW Flipped-Source-Follower Analog Filter. *Journal of Low Power Electronics and Applications*, *11*(2), 15.
7. Vallicelli, E. A., & De Matteis, M. (2021). Analog Filters Design for Improving Precision in Proton Sound Detectors. *Journal of Low Power Electronics and Applications*, *11*(1), 12.
8. Saggese, G., Tambaro, M., Vallicelli, E. A., Strollo, A. G., Vassanelli, S., Baschirotto, A., & Matteis, M. D. (2021). Comparison of Sneo-Based Neural Spike Detection Algorithms for Implantable Multi-Transistor Array Biosensors. *Electronics*, *10*(4), 410.
9. Vallicelli, E. A., Reato, M., Maschietto, M., Vassanelli, S., Guarrera, D., Rocchi, F., ... & De Matteis, M. (2018). Neural Spike Digital Detector on FPGA. *Electronics*, *7*(12), 392.
10. Ardid, M., Baschirotto, A., Burgio, N., Corcione, M., Cretara, L., De Matteis, M., ... & Santagata, A. (2019). Effects of the thermodynamic conditions on the acoustic signature of bubble nucleation in superheated liquids used in dark matter search experiments. *The European Physical Journal C*, *79*(11), 961.
11. Riva, M., Vallicelli, E. A., Baschirotto, A., & De Matteis, M. (2018). Acoustic Analog Front End for Proton Range Detection in Hadron Therapy. *IEEE transactions on biomedical circuits and systems*, *12*(4), 954-962.
12. De Matteis, M., De Blasi, M., Vallicelli, E. A., Zannoni, M., Gervasi, M., Bau, A., ... & Baschirotto, A. (2017). A CMOS application-specified-integrated-circuit for 40 GHz high-electron-mobility-transistors automatic biasing. *Review of Scientific Instruments*, *88*(2), 024702.
13. Tambaro, M.; Vallicelli, E.A.; Saggese, G.; Strollo, A.; Baschirotto, A.; Vassanelli, S. Evaluation of In Vivo Spike Detection Algorithms for Implantable MTA Brain—Silicon Interfaces. *J. Low Power Electron. Appl.* **2020**, *10*, 26.

### Invited Conference Contributions

1. Vallicelli, E.; Chirico, G.; Cosmi, O.; Stevenazzi, L. and Tambaro, M. (2022). paMELA - Photoacoustic Melanoma Detector Design for Real-Time Imaging of Melanin with 18 db SNR and 10 µm Precision. In Proceedings of the 15th International Joint Conference on Biomedical Engineering Systems and Technologies - Volume 1: BIODEVICES, ISBN 978-989-758-552-4, ISSN 2184-4305, pages 102-108.

## Conference Contributions - Speaker

1. Vallicelli, E. A., Corona, M., Dell'Acqua, M., Baschirotto, A., & De Matteis, M. (2021, October). Denoising for Enhancing Signal-to-Noise Ratio in Proton Sound Detectors. In *2021 IEEE Biomedical Circuits and Systems Conference (BioCAS)* (pp. 1-4). IEEE.
2. Vallicelli, E. A., Cosmi, M. O., Baschirotto, A., & De Matteis, M. (2021). Front-end Design Optimization for Ionoacoustic 200 MeV Protons Beam Monitoring with Sub-millimeter Precision for Hadron Therapy Applications. In *BIODEVICES* (pp. 77-87). **Best student paper award**
3. Vallicelli, Elia A., et al. "Photoacoustic Sensing Instrumentation using 70 W 905 nm Pulsed Laser Source for Proton-Induced Thermoacoustic Effect Emulation." *2020 IEEE Sensors*. IEEE, 2020.
4. Vallicelli, E. A., Gelmi, L., Bertoni, R., Fulgione, W., Tambaro, M., Baschirotto, A., & De Matteis, M. (2019, July). A 0.3 nV/√ Hz Input-Referred-Noise Analog Front-End for Weakly-Interacting-Massive-Particles (WIMPs) Acoustic Sensing in Bubbles-Chamber Detectors. In *2019 15th Conference on Ph. D Research in Microelectronics and Electronics (PRIME)* (pp. 197-200). IEEE. **Gold leaf award – best 10% paper.**
5. Tambaro, M., Vallicelli, E. A., Tomasella, D., Baschirotto, A., Vassanelli, S., Maschietto, M., & De Matteis, M. (2019, July). Real-Time Neural (RT-Neu) Spikes Imaging by a 9375 sample/(sec pixel) 32× 32 pixels Electrolyte-Oxide-Semiconductor Biosensor. In *2019 15th Conference on Ph. D Research in Microelectronics and Electronics (PRIME)* (pp. 233-236). IEEE. **Bronze leaf award – best 30% paper**
6. Riva, M., Vallicelli, E. A., Baschirotto, A., & De Matteis, M. (2019). Modeling the Acoustic Field Generated by a Pulsed Beam for Experimental Proton Range Verification. In *EPJ Web of Conferences* (Vol. 216, p. 03005). EDP Sciences.
7. Vallicelli, E. A., Riva, M., Zannoni, M., Baschirotto, A., & De Matteis, M. (2019). Analog and Digital Signal Processing for Pressure Source Imaging at 190 MeV Proton Beam. In *EPJ Web of Conferences* (Vol. 216, p. 04003). EDP Sciences.
8. Vallicelli, E. A., Baschirotto, A., Lehrack, S., & De Matteis, M. (2019). Mixed-Signal Ionoacoustic Analog Front-End for Proton Range Verification with 24 µm Precision at 0.8 Gy Bragg Peak Dose. In *2019 International Conference on Electronics Circuits and Systems (ICECS)*. IEEE.
9. Vallicelli, E. A., Baschirotto, A., De Matteis, M. (2019). 10 MHz -3 dB Bandwidth 360 µW Power Source-Follower Low-Pass Filter for Multi-Channel Acoustic Analog Front-End in CMOS 0.18 µm. In *2019 International Conference on Electronics Circuits and Systems (ICECS)*. IEEE.

## Conference Contribution - Poster

1. Riva, M., Vallicelli, E., Baschirotto, A., & De Matteis, M. (2017, October). Acoustic analog front-end for Bragg-peak detection in hadron therapy. In *2017 IEEE Biomedical Circuits and Systems Conference (BioCAS)* (pp. 1-4). IEEE.
2. Vallicelli, E. A., De Matteis, M., Baschirotto, A., Rescati, M., Reato, M., Maschietto, M., ... & Zeiter, R. (2017, October). Neural spikes digital detector/sorting on FPGA. In *2017 IEEE Biomedical Circuits and Systems Conference (BioCAS)* (pp. 1-4). IEEE.

## Other Conference Contributions

1. Vallicelli, E. A., Fary, F., Baschirotto, A., De Matteis, M., Reato, M., Maschietto, M., ... & Zeitler, R. (2018, June). Real-time digital implementation of a principal component analysis algorithm for neurons spike detection. In *2018 International Conference on IC Design & Technology (ICICDT)* (pp. 33-36). IEEE.
2. Fary, F., Mangiagalli, L., Vallicelli, E., De Matteis, M., & Baschirotto, A. (2019, September). A 28nm bulk-CMOS 50MHz 18 dBm-IIP3 Active-RC Analog Filter based on 7 GHz UGB OTA. In *ESSCIRC 2019-IEEE 45th European Solid State Circuits Conference (ESSCIRC)* (pp. 253-256). IEEE.
3. Fary, F., Vallicelli, E. A., De Matteis, M., & Baschirotto, A. (2018, June). About figure-of-merit for continuous-time analog filters. In *2018 International Conference on IC Design & Technology (ICICDT)* (pp. 57-60). IEEE.
4. Tambaro, Mattia, et al. "A 10 MSample/Sec Digital Neural Spike Detection for a 1024 Pixels Multi Transistor Array Sensor." *2019 26th IEEE International Conference on Electronics, Circuits and Systems (ICECS)*. IEEE, 2019.

## Invited Talks

1. "Un laser per la diagnosi precoce del melanoma?" at AIDA (Associazione Italiana Dermatologi Ambulatoriali) 2022 congress, Rimini.

## INTERNSHIPS

06/2009 – 07/2009
**Internship at Elettra Sincrotrone Trieste, Trieste (IT)**

Activity: Modelling and optimization of a PID temperature controller for an X-ray diffraction crystallography experimental setup.
Supervisor: Dr. Andrea Lausi

06/2006 – 06/2006
**Internship at Elettra Sincrotrone Trieste, Trieste (IT)**

Activity: Labview control of stepper motors for an X-ray diffraction crystallography experimental setup.
Supervisor: Dr. Andrea Lausi

## ACADEMIC ACTIVITY

2017 – CURRENT
**Students Co-Supervisor**

Tutor and co-supervisor of 5 Master's students in Computer Science, 2 Master's students in Physics, 16 Bachelor's students in Physics

2019 – 2021
**"Digital Filters on FPGA", "Real-time Digital Signal Processing on FPGA", "FIR and IIR filters design on FPGA" Seminaries**

Seminaries held during the course "Informatics for Industrial Applications", Master's degree in Informatics, University of Milano - Bicocca

2020
**"Thermoacoustic Signals - An overview" Seminary**

Seminary held within Unimib Microelectronics and Biophysics groups.

## SKILLS

**Technical skills**

- Matlab modelling of analog/digital circuits, sensors and physical/cross-domain systems
- Analog circuits design, Low-Noise Amplifiers
- Design of digital circuits on FPGA for real-time systems
- Ionoacoustic/Photoacoustic experimental setups design and characterization
- Multichannel acoustic detector design, acoustic imaging algorithms optimization
- Cadence Schematic and Layout
- Design of PCB for ASIC testbench

**Management and leadership skills**

- Good management skills gained thanks to the work on the ProSD project workpackages under my responsibility.
- Good leadership skills gained in coordinating the individual work of thesis students towards a common goal within a research project.

## Communication and interpersonal skills

- ○ Good communication skills gained by presenting the results of research works in international journals and as a conference speakers.
- ○ Good teamwork skills developed thanks to the collaboration with various researchers and research groups in Italy and abroad.

## LANGUAGE SKILLS

Mother tongue(s):  **ITALIAN**

Other language(s):

|  | UNDERSTANDING | | SPEAKING | | WRITING |
|---|---|---|---|---|---|
|  | Listening | Reading | Spoken production | Spoken interaction |  |
| **ENGLISH** | C1 | C2 | C1 | C1 | C1 |
| **GERMAN** | A1 | A1 | A1 | A1 | A1 |

*Levels: A1 and A2: Basic user; B1 and B2: Independent user; C1 and C2: Proficient user*

## OTHER INFORMATION

### Bibliometric Indexes

Elia A. Vallicelli is author of 13 Journal papers and 15 conference papers (28 documents).
Scopus h-index: 4
Total citations: 56
Author profile: https://www.scopus.com/authid/detail.uri?authorId=57193208541

### Reviewer Activity

Journal of Circuits, Systems and Computer (14 reviews)
MDPI Brain Sciences (1 review)
MDPI Processes (1 review)
MDPI Sensors (1 review)
Phisica Medica (1 review)
International Journal of Circuit Theory and Applications (2 reviews)

### Research collaborations

Ludwig-Maximilians University Medical Physics Group
Linearbeam SRL
Venneos GmbH
INFN Laboratori Nazionali del Sud, Laboratori Nazionali del Gran Sasso
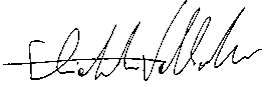Neurochip Lab, University of Padova

### Other activities

Session Chair at INSTICC BIOSTEC 2022 Conference, "Biomechanical Devices" Session

## TRATTAMENTO DATI PERSONALI

### General Data Protection Regulation

According to law 679/2016 of the Regulation of the European Parliament of 27th April 2016, I hereby express my consent to process and use my data provided in this CV.

### Signature