## Francesca Benassi



Nationality: Italian

## RESEARCH AND ACA-DEMIC EXPERIENCE -

### [ 31/03/2022 – Current ] Postdoctoral Research Fellow

University of Bologna - DEI "Guglielmo Marconi"

Bologna, Italy

Research activity: "Project and characterization of material for radiofrequency epidermal antennas"- H2020 NANO-EH "NANOMATERIALS ENABLING SMART ENERGY HARVESTING FOR NEXT-GENERATION INTERNET-OF-THINGS".

The research activity currently carried out is focused on the design and experimental validation of a small and wearable mm-wave Bessel Beam launcher to be used for wearable applications **[8]**.

The design involves:

- accurate full-wave characterizations of the radiative structure to find the best tradeoff between miniaturization and radiation performance when operating at 30 GHz,
- detailed circuital/full-wave simulation and optimization of the feeding network (transmitting side),
- power budget estimation of the wireless link derived through a custom-made numerical method based on the Electromagnetic fields theory.
- nonlinear optimization of the rectification circuitry with focus on the maximization of the RF-to-dc power conversion efficiency.

The solution is developed in the framework of the Research Project of National Interest (PRIN) WPT4WID (Wireless Power Transfer for Wearable and Implantable Devices), coordinated by the University of Bologna.

### [ 31/10/2018 - 30/01/2022 ]

# PhD in Electronics, Telecommunications and Information Technologies Engineering

University of Bologna - DEI "Guglielmo Marconi"

Bologna, Italy

**PhD Thesis Title**: "*RF energy harvesting systems for electromagnetic harsh environments: from industrial plants to wearable/implantable devices*".

The research activity is carried out within the PRIN Project WPT4WID and it is focused on the design and experimental validations of wireless power transfer systems operating at millimeter-waves for wearable applications.

The research has also involved the design and experimental validations of a 2.45 GHz antennas for wireless power transfer operating in electromagnetically hostile environments, for industrial applications.

Additional research activities involve:

• design and realization of energy-autonomous microfluidic sensors for fluid detection [3], [18]

- exploitation and engineering of the RFID technology to implement systems for Item level tagging.
- design and realization of Radiofrequency Low-Energy Sensor Nodes dedicated to predictive maintenance in electromagnetically harsh environments [4], [15].
- design of Highly focused wearable antennas exploiting Bessel Beam launchers [12], [13].
- design and optimization of miniaturized circuitry for rotation-insensitive wireless power transfer receiver to be applied in implantable applications **[17]**.
- design of a modular wireless/wired WPT system to be applied in harsh industrial plants **[10]**.
- experience in the use of UHF RFID system for item localization [14] and customization of algorithms for data post-processing.

Final dissertation on July 5th 2022.

Final evaluation: Excellent cum laude.

#### [2020] Licensed Professional Engineer

Alma Mater Studiorum - University of Bologna

Qualification to the profession of Information Engineer (Section A).

#### [01/11/2021 - 31/01/2022] Visiting Researcher

James Watt School of Engineering - University of Glasgow

Glasgow, UK

The research activity titled " design and experimental validation of tissue-independent wearable antennas for wireless power transfer applications" has been carried out in the framework of the EuMA Internship award and it has been focused on the design of a 2.45 GHz wearable antenna boasting reduced dimensions, electrical decoupling and high radiation performance **[9]**.

#### [01/07/2018 - 31/10/2018] Research Fellow

University of Bologna - DEI "Guglielmo Marconi"

Bologna, Italy

Research activity: "Analysis of RFID tags for Item Level Tagging applications".

The research activity has been focused on the realization of a system able to localized item on smart shelf exploiting the RFID technology, together with the development of a custom software for the data processing.

#### [01/11/2017 - 30/06/2018] **Research Fellow**

University of Bologna - CIRI-ICT Bologna, Italy

Research activity: "Development and engineering of a wearable RF-ID tag operating at 2.45 GHz. Project POR-FESR 2014-2020 HABITAT ("Home Assistance Based on the Internet of Things for the AuTonomy of everybody").

My activity has been focused on the design and experimental characterization of a 2.45 GHz wearable antenna incorporated into a radio system for indoor localization in a home living environment **[5]**.

Other research activities have involved the study of a rotation-insensitive receiver operating in Near-field at 13.56 MHz to be applied in Wireless Power Transfer application for implantable devices [21],[22].

EDUCATION AND	
[ 01/11/2018 – 30/01/2022 ]	PhD in Electronics, Telecommunications and Information Technologies Engineering
	University of Bologna - DEI "Guglielmo Marconi"
	Final grade: Excellent cum Laude Thesis: "RF energy harvesting systems for electromagnetic harsh environments: from industrial plants to wearable/implantable devices"
[ 31/12/2014 - 04/10/2017 ]	Master Degree in Biomedical Engineering
	Alma Mater Studiorum - University of Bologna
	Address: School of Engineering and Architecture, Cesena, Italy Field(s) of study: Biomedical Engineering Final grade: 107/110 Thesis: Project of a 6.78 MHz wireless power transfer link for implantable applications
[ 31/08/2011 - 10/12/2014 ]	Bachelor Degree in Biomedical Engineering
	Alma Mater Studiorum - University of Bologna
	Address: School of Engineering and Architecture, Cesena, Italy Field(s) of study: Biomedical Engineering Final grade: 104/110 Thesis: Remote monitoring of implantable cardiac devices: the role of biomedical engineers in Cardiology The thesis has required a 3-month internship at the Electrophysiology ward of the Infermi Hospital in Rimini. The thesis topic concerns the role of a biomedical engineer within an hospital scenario, with focus on the remote monitoring of the cardiac devices implanted on patients, as CRT-D, pacemakers and loop recorders.
[ 31/07/2009 - 30/06/2010 ]	Certified Year of Study abroad
	Sauquoit Valley High School
	Address: 13456, Sauquoit, United States Participation ad an exchange student to the Long-term Youth Exchange Program in Saquoit, NY, USA where I attended the senior year of the Sauquoit Valley High School.
TEACHING AND EDUCA-	
[ 31/01/2022 – 30/09/2022 ]	Teaching Tutor
	University of Bologna - DEI "Guglielmo Marconi".
	Master Degree Course: "Technologies and Applications of Wireless Power Transfer (M)" - Master Degree in Telecommunications Engineering - University of Bologna.
	As tutor, I have been responsible for conducting lab activities on the use of AWR and CST software for the design energy harvesting rectennas and also for coordinating the

resulting final group project on energy harvesting system, designed on different substrates, and operating at different frequencies.

[ 17/01/2022 - 11/02/2022 ]

## Teaching Tutor of the "Scuola di alta formazione in Ingegneria dei Sistemi per la mobilità integrata"

https://eventi.unibo.it/safingegneriamobilitaintegrata

#### [ 31/01/2021 - 30/09/2021 ] Teaching Tutor

University of Bologna - DEI "Guglielmo Marconi".

Master Degree Course: "Technologies and Applications of Wireless Power Transfer (M)" - Master Degree in Telecommunications Engineering - University of Bologna.

#### [ 31/01/2020 – 29/09/2020 ] Teaching Tutor

University of Bologna - DEI "Guglielmo Marconi".

Master Degree Course: "Technologies and Applications of Wireless Power Transfer (M)" - Master Degree in Telecommunications Engineering - University of Bologna.

#### **Thesis Co-supervision activities**

- •Elisa Augello, "Precise Near-Field Focusing exploiting Bessel Beam Launchers for Wireless Power Transfer at millimeter waves"- Master Degree in Telecommunications Engineering. Supervisor Prof. Alessandra Costanzo (2022).
- Alessandra di Florio di Renzo, "*Electromagnetic characterization of coplanar ground planes effects on microstrip circuits*"- Bachelor Degree in Electronic and Telecommunications Engineering, University of Bologna. Supervisor Prof. Diego Masotti (2019).
- •"Design of omni-directional circularly polarized antenna"- Bachelor Degree in Electronic and Telecommunications Engineering, University of Bologna. Supervisor Prof. Diego Masotti (2019).
- •Nicola Zincarelli, "Design and realization of a wireless passive wearable sensor for biological fluids identification"- Master Degree in Biomedical Engineering, University of Bologna. Supervisor Prof. Alessandra Costanzo (2019).

#### [01/01/2019 – Current] **Teaching support activities**

Relator of seminars and laboratory activities.

Exam and thesis co-supervision for the courses of "Bioelectromagnetism", "Sistemi a RF energeticamente autonomi" and "Technologies and Applications of Wireless Power Transfer (M)".

#### LANGUAGE SKILLS

Mother tongue(s): Italian

Other language(s):

#### English

LISTENING C2 READING C2 WRITING C1

SPOKEN PRODUCTION C2 SPOKEN INTERACTION C2

#### French

LISTENING B1 READING B1 WRITING B1

SPOKEN PRODUCTION B1 SPOKEN INTERACTION B1

## HONOURS AND

AWARDS

- [ 12/01/2021 ] Awardee of the MTT-S Graduate Fellowship Award Awarding institution: MTT-S
- [ 12/04/2021 ] Awardee of the EuMA Internship Abroad Awarding institution: EuMA European Microwave Association

## **CERTIFICATIONS AND**

#### **OTHER ACTIVITIES** -

#### [ 2022 – Current ] Member of the URSI Chapter "Women in RadioScience (WIRS) ITALY

[ 2022 – Current ]

## Associate Editor in Wearable Antennas - Frontiers in Antennas and Propagation

#### [ 26/09/2022 ] Organizer and Co-Chair of the 3-Minute Thesis Competition

Organizer and Co-Chair of the 3-Minute Thesis Competition within the 25th Edition of the European Microwave Week Conference.

#### [25/09/2022] Workshop Organizer and Co-Chair

Organizer and Co-Chair of the Workshop titled "*Electromagnetic Waves in Daily Life: Research Insights from Young Professionals*" within the 25th Edition of the European Microwave Week Conference.

#### [ 13/09/2022 ] Session Chair

Chair of the Special Session titled "*Wireless Power Transfer Enabling the IoT Energy Harvesting*" within the 2022 IEEE International Conference on RFID Technology and Applications (IEEE RFID-TA).

#### [ 01/01/2020 - Current ] Member of the European Microwave Association (EuMA)

#### [ 21/07/2020 ] Wireless power transfer: technologies and applications

Co-Relator within the PhD School titled "Wireless power transfer: technologies and applications" organized by the University of Pisa.

Topic of the presentation: design rules to implement an energy harvesting system, both on the theoretical side and with a practical case involving the software CST Microwave Studio and AWR Microwave Office.

#### [ 2018 – Current ] Peer reviewer

Peer reviewer for Transactions on Microwave Theory and Techniques (IEEE MTT-S), IEEE Transactions on Antennas and Propagation (TAP), IEEE Transactions on Wireless Communication (TWC), IEEE Journal of Electromagnetics, RF and Microwaves in Medicine and Biology (J-ERM), Wireless Power Transfer (Cambridge University Press), International Journal of Microwave and Wireless Technologies (Cambridge University Press), Microwave and Optical Technology Letters (Wiley), Electrical Engineering (Springer), and IEEE International Conferences.

[ 2019 – Current ]

# Member and Vice-president of the IEEE Student Branch of the University of Bologna.

#### [15/05/2019] UHF RFID Technologies: Principles and Applications

Relator of the course titled "UHF RFID Technologies: Principles and Applications" within the Master Degree In Telecommunications Engineering at the University of Bologna.

The topic involved the definition of the RFID technology, together with the basis principles and applications examples.

- [ 2018 Current ] Institute of Electrical and Electronics Engineers (IEEE) Member.
- [ 2018 Current ] IEEE Microwave Theory and Techniques Society (MTT-S) Member.
- [ 2018 Current ] Italian Society of Electromagnetism (SIEm) Student Member.

#### Foreign Languages Certifications

Cambridge IELTS C1 (Overall score 7.5)

### **TECHNICAL SKILLS -**

#### [ 2018 – Current ] Expertises and Professional skills

- Proficient knowledge of CST microwave Studio, Advance Design Studio, AWR Design Environment and KiCad software for antennae and circuit design.
- Good knowledge of programming languages as Java for Android App development and C# for RFID interfaces.
- Good knowledge in the use of measuring instruments (spectrum analyzer, vector network analyzer, RF generators).
- Basic knowledge of 3D printing software interfaces.
- Basic knowledge of Matlab and Python.

#### PUBLICATIONS

#### Journals and Magazines:

#### [1]

M. Wagih *et al.*, "Microwave-Enabled Wearables: Underpinning Technologies, Integration Platforms, and Next-Generation Roadmap," in *IEEE Journal of Microwaves*, 2022 (Accepted for publication).

## [2]

A. Costanzo, F. Benassi and G. Monti, "Wearable, Energy-Autonomous RF Microwave Systems: Chipless and Energy-Harvesting-Based Wireless Systems for Low-Power, Low-Cost Localization and Sensing," in IEEE Microwave Magazine, vol. 23, no. 3, pp. 24-38, March 2022.

## [3]

F. Benassi, G. Paolini, D. Masotti and A. Costanzo, "A Wearable Flexible Energy-Autonomous Filtenna for Ethanol Detection at 2.45 GHz," in *IEEE Transactions on Microwave Theory and Techniques*, vol. 69, no. 9, pp. 4093-4106, Sept. 2021.

### [4]

Paolini, G.; Guermandi, M.; Masotti, D.; Shanawani, M.; Benassi, F.; Benini, L.; Costanzo, A. RF-Powered Low-Energy Sensor Nodes for Predictive Maintenance in Electromagnetically Harsh Industrial Environments. *Sensors* 2021, *21*, 386.

## [5]

Borelli, E.; Paolini, G.; Antoniazzi, F.; Barbiroli, M.; Benassi, F.; Chesani, F.; Chiari, L.; Fantini, M.; Fuschini, F.; Galassi, A.; Giacobone, G.A.; Imbesi, S.; Licciardello, M.; Loreti, D.; Marchi, M.; Masotti, D.; Mello, P.; Mellone, S.; Mincolelli, G.; Raffaelli, C.; Roffa, L.; Salmon Cinotti, T.; Tacconi, C.; Tamburini, P.; Zoli, M.; Costanzo, A. HABITAT: An IoT Solution for Independent Elderly. *Sensors* 2019.

## National and International Conferences:

### [6]

Z. He, S. Trovarello, F. Benassi, D. Masotti, C. Liu and A. Costanzo, "Analysis of Rectifiers Under Various Multitone Excitations and Using Different Diodes in Low-Power Conditions," 2022 IEEE 12th International Conference on RFID Technology and Applications (RFID-TA), 2022, pp. 157-160.

## [7]

F. Benassi, G. Paolini, D. Masotti and A. Costanzo, "Circuit Techniques for Efficient SWIPT," 2022 IEEE 12th International Conference on RFID Technology and Applications (RFID-TA), 2022, pp. 165-167.

## [8]

E. Negri *et al.*, "Effective TE-Polarized Bessel-Beam Excitation for Wireless Power Transfer Near-Field Links," *2022 52nd European Microwave Conference (EuMC)*, 2022, pp. 230-233.

## [9]

F. Benassi, M. Ur Rehman, M. A. Jamshed, D. Masotti and A. Costanzo, "A novel Hexagonal Excitation for a Multi-Layer Wearable Miniaturized Antenna," *2022 Microwave Mediterranean Symposium (MMS)*, 2022, pp. 1-4.

## [10]

A. B. Gok, F. Benassi, G. Paolini, D. Masotti and A. Costanzo, "A Wireless/Wired UHF Modular System Combining Energy and Data Transfer," *2022 Wireless Power Week (WPW)*, 2022, pp. 231-234.

## [11]

A. Costanzo *et al.*, "Wireless Power Transfer for Wearable and Implantable Devices: a Review Focusing on the WPT4WID Research Project of National Relevance," 2021 XXXIVth General Assembly and Scientific Symposium of the International Union of Radio Science (URSI GASS), 2021.

## [12]

F. Benassi, W. Fuscaldo, D. Masotti, A. Galli and A. Costanzo, "Wireless Power Transfer in the Radiative Near-field Through Resonant Bessel-Beam Launchers at Millimeter Waves," 2021 IEEE Wireless Power Transfer Conference (WPTC), 2021, pp. 1-4.

## [13]

F. Benassi *et al.*, "Comparison between Hybrid- and TM-polarized Bessel-Beam Launchers for Wireless Power Transfer in the Radiative Near-field at Millimeter Waves," *2021 51st European Microwave Conference (EuMC)*, 2022, pp. 829-832.

## [14]

G. Paolini, F. Benassi, D. Masotti and A. Costanzo, "Recent Developments of RFID and WPT Technologies for Biomedical and Industrial Applications at the University of Bologna," 202 1 IEEE International Conference on RFID Technology and Applications (RFID-TA), 2021, pp. 238-240.

## [15]

G. Paolini, M. Shanawani, A. Costanzo, F. Benassi and D. Masotti, "RF Energy On-Demand for Automotive Applications," 2020 IEEE/MTT-S International Microwave Symposium (IMS), 2020, pp. 1191-1194.

## [16]

M. Shanawani, D. Masotti, G. Paolini, F. Benassi and A. Costanzo, "Efficient Simulation Method for Wireless Power Transfer," 2019 IEEE International Conference on RFID Technology and Applications (RFID-TA), 2019, pp. 71-75.

## [17]

F. Benassi, D. Masotti and A. Costanzo, "Engineered and miniaturized 13.56 MHz omnidirectional WPT system for medical applications," 2019 IEEE International Conference on RFID Technology and Applications (RFID-TA), 2019, pp. 306-309.

## [18]

F. Benassi, N. Zincarelli, D. Masotti and A. Costanzo, "A wearable passive microwave fluid sensor wirelessly activated," 2019 IEEE Wireless Power Transfer Conference (WPTC), 2019, pp. 236-240.

## [19]

Alessandra Costanzo, Alex Pacini, Francesca Benassi, Diego Masotti, <u>Circuit and system</u> <u>design of moving WPT</u>, in: Proceedings of 2018 IEEE MTT-S International Microwave and RF Conference (IMaRC), New York (NJ), IEEE, 2018, pp. 1 - 4 (atti di: 2018 IEEE MTT-S International Microwave and RF Conference (IMaRC), Kolkata (India), 28-30 Novembre 2018)

## [20]

G. Paolini, F. Benassi, D. Masotti and A. Costanzo, "Wearable Tag at 2.45 GHz for Continuous Tracking of Patients Activities in Indoor Environments," 2018 EMF-Med 1st World Conference on Biomedical Applications of Electromagnetic Fields (EMF-Med), 2018, pp. 1-2.

## [21]

A. Pacini, F. Benassi, D. Masotti and A. Costanzo, "Design of a RF-to-dc Link for in-body IR-WPT with a Capsule-shaped Rotation-insensitive Receiver," 2018 IEEE/MTT-S International Microwave Symposium - IMS, 2018, pp. 1289-1292.

## [22]

A. Pacini, F. Benassi, D. Masotti and A. Costanzo, "Design of a Miniaturized Omni-Directional RF-to-dc IR-WPT," 2018 IEEE Wireless Power Transfer Conference (WPTC), 2018, pp. 1-4.

## **PhD Thesis**

Benassi, F. "RF energy harvesting solutions for electromagnetic harsh environments: from industrial plants to wearable/implantable devices." (2022).

CONFERENCES AND	
[ 25/09/2022 - 30/09/2022 ]	2022 European Microwave Conference (EuMC) Milan, IT
	Presented research work titled "WPT and Energy Harvesting Solutions for Biomedical and Industrial Applications" as a speaker.
[ 12/09/2022 - 14/09/2022 ]	
	2022 IEEE International Conference on RFID Technology and Applications (RFID-TA)
	Cagliari, IT
	Presented research work titled "Circuit Techniques for Efficient SWIPT" as a speaker.

# 2022 IEEE International Conference on RFID Technology and Applications (RFID-TA)

Cagliari, IT

Presented research work titled "Analysis of Rectifiers Under Various Multitone Excitations and Using Different Diodes in Low-Power Conditions" as a speaker.

[ 09/05/2022 – 13/05/2022 ] Mediterranean Microwave Symposium (MMS) Pizzo Calabro, IT

Presented research work titled "A novel Hexagonal Excitation for a Multi-Layer Wearable Miniaturized Antenna" as a speaker.

[02/04/2022 – 07/04/2022 ] 2021 European Microwave Conference (EuMC) London, UK

Presented research work titled "Comparison between Hybrid- and TM-polarized Bessel-Beam Launchers for Wireless Power Transfer in the Radiative Near-field at Millimeter Waves" as a speaker.

[ 28/08/2021 - 04/10/2021 ] URSI GASS 2021 Rome, IT

Presented research work titled "*Resonant Bessel-Beam Launchers for Wireless Power Transfer at Millimeter Waves*" as a speaker during a poster session.

[01/06/2021 – 04/06/2021] Wireless Power Transfer Conference (WPTC) 2021 San Diego, USA - Remote

Presented research work titled "Wireless Power Transfer in the Radiative Near-field Through Resonant Bessel-Beam Launchers at Millimeter Waves" as a speaker.

- [ 25/11/2020 26/11/2020 ] **RiNEm 2020 Riunione Nazionale di Elettromagnetismo** Rome, IT Remote Presented research work titled " 2.45 GHz Energy-autonomous wearable sensor for Ethanol detection" as a speaker.
- [01/12/2019 04/12/2019] 5G Italy Conference Rome, IT

Attendee of the 5G Italy Conference.

[ 24/09/2019 - 26/09/2019 ]

2019 IEEE International Conference on RFID Technology and Applications (RFID-TA)

Pisa, IT

Presented research work titled "Engineered and miniaturized 13.56 MHz omnidirectional WPT system for medical applications" as a speaker.

[ 24/09/2019 - 26/09/2019 ]

2019 IEEE International Conference on RFID Technology and Applications (RFID-TA)

Pisa, IT

Presented research work titled "*Efficient Simulation Method for Wireless Power Transfer*" as a speaker.

[16/06/2019 – 20/06/2019] Wireless Power Transfer Conference (WPTC) 2019 London, UK

Presented research work titled "A wearable passive microwave fluid sensor wirelessly activated" as a speaker.

[ 02/09/2018 – 05/09/2018 ] XXII Riunione Nazionale di Elettromagnetismo, Cagliari, IT

Presented research work titled "*Rotation-Insensitive RF-To-DC Link for IPT Implants*" as a speaker.

09/06/2018 - 14/06/2018 ]	2018 Internationa	I Microwave Symposyum	(IMS)	Philadelphia, USA
---------------------------	-------------------	-----------------------	-------	-------------------

Presented research work titled "Design of a RF-to-dc Link for in-body IR-WPT with a Capsuleshaped Rotation-insensitive Receiver" as a speaker.

#### **DOCTORAL SCHOOLS** [ 26/04/2021 - 29/04/2021 ]

## ESoA Course: Leaky Waves and Periodic Structures for Antennas Applications (6th Edition)

(Rome, IT - Remote)

Participation to the ESoA Course on Leaky Waves and Periodic Structures for Antennas Applications (6th Edition).

### [11/11/2020] Introduction to Quantum Information

(Bologna, IT- Remote)

Participation to the doctoral course titled "Introduction to Quantum Information"

#### [09/04/2019 – 11/04/2019] An overview of UHF RFID Technology: Past, Present and Future

(Pisa, IT)

Participation to the doctoral course titled "An overview of UHF RFID Technology: Past, Present and Future", University of Pisa.

### [01/12/2019 – 04/12/2019] **5G PhD School and 5G Italy Conference**

(Rome, IT)

Participation to the 5G PhD School.

### [ 02/12/2018 - 06/12/2018 ] PhD Creativity and Entrepreneurship

(Bologna, IT)

Participation to the Winter School on Creativity and Entrepreneurship.

### [ 28/08/2017 - 31/08/2017 ] Summer School on Cyber-Physical Systems

(Cambridge, UK)

Participation to the Summer School on Cyber-Physical Systems.

### VOLUNTEERING -

[09/06/2018 – 14/06/2018] **Student Volunteer at IMS 2018** Philadelphia, USA

Enrolled as student volunteer within the Conference IMS 2018 in Philadelphia Link: https://2018.ims-ieee.org/

#### [26/08/2021 – 03/09/2021] Student Volunteer at URSI GASS 2021 Rome, IT

Enrolled as student volunteer in the organizing staff within the Conference URSI GASS 2021 held in Rome.

DIGITAL SKILLS

Adobe Photoshop | Written and Verbal skills | Good listener and communicator | Organizational and planning skills | Team-work oriented | Presenting | Microsoft Office

DRIVING LICENCE -

Cars: B