

SAMUELE MESCHINI

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[Google Scholar](#) ◊ [LinkedIn](#)

EDUCATION

- Doctorate** - *Politecnico di Torino (PoliTo), Torino, Italy* 2019 - 2023
PhD in energetics. Specialty: Nuclear engineering Grade: PhD awarded with honors
Thesis: *ARC-class tokamaks: Preliminary design, system modeling and safety assessment.*
Awards: Eni scholarship
Visiting student at MIT PSFC. Supervisors: S. Ferry, K. Woller, D. Whyte
- M. Sc. in Nuclear Engineering** - *Politecnico di Milano (PoliMi), Milano, Italy* 2017 - 2019
Joint International Program between PoliTo and PoliMi Grade: 110/110 cum laude
- M. Sc. in Energy and Nuclear Engineering** - *Politecnico di Torino* 2016 - 2019
Thesis: *Preliminary reactor design for nuclear thermal propulsion* Grade: 110/110 cum laude
H2politO, Internal Combustion Engine division.
- B. Sc. in Industrial Engineering** - *Politecnico di Torino, Torino, Italy* 2013 - 2016
Thesis: *Reactor design for biomedical applications* Grade: 110/110 cum laude

ACADEMIC AND PROFESSIONAL EXPERIENCE

- Research Scientist (RTDA)**, PoliTo, Torino, Italy 2024 - Present
Field: Fusion fuel cycles, Nuclear power plants, Tritium transport, Safety.
- Postdoctoral Associate**, MIT-PSFC, Cambridge, MA, USA 2023 - 2024
Field: Fusion fuel cycles, tritium transport, tritium systems.
- Leading the effort in developing an open-source fuel cycle model
 - LIBRA team: validation of fuel cycle models on tritium experiments
 - MIT Energy Initiative: The role of fusion energy in a decarbonized electricity system - Scientific Advisor
 - Tritium transport modeling and development of the open-source code FESTIM
 - Mentor for the Economics and Integration team (22.63 - Engineering Principles for Fusion Reactors)
- Research Fellow**, PoliTo, Torino, Italy 2022 - 2023
Field: Fuel cycle, Nuclear safety, Neutronics, CFD.
- Modeling and design of fuel cycles
 - Modeling and design of advanced neutron shields for compact fusion reactors
 - DTT S.c.a.r.l., DTT (SAM-TEN-85017) - Source term identification for the DTT facility
 - EUROfusion, DEMO (WPSAE.S-04.03-T005) - Safety analysis of the DEMO fuel cycle
 - Eni contract, HSE - Hazards identification in compact tokamaks
 - Eni contract (O.d.L. nr. 4310543787) - Tritium studies for fusion safety

- Teaching Assistant: *Nuclear Power Plants, Radiation Protection, Fuel cycle, waste, and de-commissioning, History of Energy*

Chief Information Officer, EyeWay

2019 - 2020

Building a startup (EyeWay) to support Autostrade per l'Italia (ASPI) within the program Innovation4Change. In collaboration with College des Ingenieurs Italia, CERN Ideasquare, and PoliTo. EyeWay developed an integrated smart sensors system for instantaneous crash detection to be implemented in Italian highways according to the innovation plan of the Italian Ministry of Infrastructure and Transport.

PROJECTS

Fuel cycle modeling and analysis, MIT, Cambridge, MA

2022-2024

The project involves the development of an open-source model for fuel cycle analysis of fusion power plants (FPPs). The model uses the state-of-the-art approach based on the resident time model, and is the first fuel cycle model to integrate tritium trapping and material damage dynamics. The model is used to inform component modeling and design, and FPP strategies to manage tritium inventories. One paper has been published in Nuclear Fusion and another is under review.

LIBRA - Validation of fuel cycle models, MIT, Cambridge, MA

2022-present

LIBRA (Liquid Immersion Blanket Robust Accountancy) is an experiment that aims at breeding tritium from molten salts to de-risk the liquid immersion blanket concept. LIBRA is also an effective test bench to validate fuel cycle models, being one of the few experimental setups operating with tritium and providing a robust tritium accountancy. I developed a plan to validate our fuel cycle model by exploiting the BABY-1L setup, currently under commissioning. The first results from the LIBRA team were presented in a series of contributed and invited talks at the *TOFE 2024* conference. Additionally, one paper has recently been submitted to a scientific journal and is awaiting peer review.

MITEI - MIT study on role of fusion energy in a decarbonized electricity system, MIT, Cambridge, MA

2023-2024

The project was developed over 1.5 years to assess the role of fusion energy in a decarbonized electricity system. We explored deployment factors such as costs and climate policy, using a multidisciplinary approach involving economic and grid modeling, policy analytics, and supply chain analysis. I served as Scientific Advisor for the Techno-Economic Analysis of fuel cycles, and fusion technologies. The project culminated in a report published by MITEI.

FESTIM - An open-source tritium transport code, MIT, Cambridge, MA

2022-Present

Ongoing project aimed at developing an open-source code (FESTIM) and an open-source ecosystem for hydrogen transport. The code is already available on GitHub, and we are working at its second version. I am among the first contributors to the code development and implementation of numerical techniques, as well as co-author of the grant for the POSE (Pathways to Enable Open-Source Ecosystems) proposal of the U.S. National Science Foundation to support an open-source ecosystem for FESTIM. One paper on FESTIM has already been published on International Journal of Hydrogen Energy.

Hazards identification in compact tokamaks, PoliTo, Torino, Italy

2023

The project provided a comprehensive identification of the nuclear hazards in an FPP based on compact tokamaks, within an Eni open contract and in collaboration with the HSE (Health, safety,

and environment) team. All the relevant phases were considered: Construction; Commissioning; Operations; Decommissioning. I served as safety expert and co-author of the report.

Tritium studies for fusion safety, PoliTo, Torino, Italy *2022-2023*

The goals of the project involved the estimation of tritium inventories within an ARC-class FPP fuel cycle, identification of an operating region for the fuel cycle, and sensitivity analysis accounting for uncertainties in tritium transport parameters in fusion materials and fluids. The project was developed within the Eni contract O.d.L. 4310543787. I was the scientific responsible for this project, carrying out the fuel cycle analysis and coordinating the sensitivity analysis and report writing.

Source Terms Identification in the DTT facility, PoliTo, Torino, Italy *2021 - 2023*

The objective of the project was to identify radiological source terms in the Divertor Test Tokamak (DTT) facility based on the initiating events identified by the HSEQ team within the work package SAM-TEN-85017. The analysis included quantification of activated dust production and tritium retention. I was the main contributor of the project, developing the models for the analysis and writing the final report.

Full Accident Analysis of PIE(s) in the DEMO Fuel Cycle, *2021-2023*
PoliTo, Torino, Italy

The project aimed to quantify the tritium release from accidental scenarios involving the IR/PR (Isotope Rebalancing/Protium Removal) system in DEMO fuel cycle within the EUROfusion work package WPSAE. We investigated multiple solutions to limit tritium releases and prevent hydrogen explosions, including glovebox, envelopes, and detritiation systems. I carried out all the analyses for PoliTo and co-authored the final report.

ARC-class tokamaks: Preliminary design, system modeling, and safety assessment (PhD research project), PoliTo/MIT PSFC, Torino, Italy *2019 - 2023*

The PhD project was aimed at developing a preliminary design of ARC-class fusion pilot plant main systems (blanket, primary cooling circuit, fuel cycle) and carrying out a preliminary safety assessment in parallel with the design process. I also investigated new methodologies for safety assessment by integrating deterministic and probabilistic approaches with machine learning algorithms. Main results: estimation of source terms at component, system and plant level, shielding design, 1D system level model of FLiBe loop (thermal-hydraulics + tritium transport) coupled with an MC failure injection engine for accidental scenarios simulations, dynamics fuel cycle model to assess tritium inventories and tritium self-sufficiency. During the PhD I spent 5 months as a visiting student at MIT-PSFC, developing the fuel cycle model. The results were published in two papers in Fusion Engineering and Design and one in Nuclear Fusion.

University Projects, PoliTo and PoliMi *2013-2019*
Other projects carried out at university:

- Preliminary reactor design for nuclear thermal propulsion
- Reactor design for biomedical applications
- H2politO Team: CFD analysis of the internal combustion engine. Sensoristics and ECU design
- Sensitivity analysis through adjoint perturbation technique applied on TRIGA reactor kinetics parameters
- Thermal-hydraulics and thermomechanical analysis of a fast reactor fuel assembly

- Thermal-hydraulics analysis of the hot channel of an AP1000 reactor

TEACHING AND MENTORING EXPERIENCE

Co-Instructor, MIT, Cambridge, MA 2024
Co-Instructor for the MIT Nuclear Science and Engineering 22.63 course: *Engineering Principles for Fusion Reactors*. Mentor of the *Design integration and economics* team.

Teaching Assistant, PoliTo, Turin, Italy 2021-2023
TA in the *Nuclear Power Plants, Radiation Protection, and Fuel Cycle, Waste, and Decommissioning* courses for graduate students, and *History of Energy* for undergraduate students. Classes involve both theoretical lectures and exercise sessions prepared by the TA. The TA was also involved in the written and oral examinations. Main topics managed by the TA: design of a passive heat removal loop for Gen-III PWRs, thermomechanical verification of a fuel pin according to ASME codes, radiation shielding of a spent fuel pool, non-proliferation investigation of radioactive materials according to IAEA regulation, fuel cycle analysis, history and development of energy sources.

Research Advisor, PoliTo, Turin, Italy 2019-2022
Supervised 8 Master thesis in the fields of fusion neutronics, material activation, tritium systems, CFD and tritium transport modeling of liquid immersion blankets, power cycle for fusion reactors, D-³He fusion.

Laboratory Assistant, PoliTo, Turin, Italy 2015 - 2016
Laboratory assistant for the class *Electrotechnics and Electrical Machines*. Preparation of practical sessions where the students build electronics circuits and perform measurements.

CONFERENCES, WORKSHOPS & SEMINARS

PPPL, NTSX-U seminar - **Invited talk** 2024
PoliTo, Fuel cycle seminar - **Invited talk** 2024
26th Technology of Fusion Energy (TOFE 2024) - **Contributed talk** 2024
HBS-MIT Sloan Fusion workshop - Commercialization Pathways for Fusion Energy 2024
30th Symposium On Fusion Energy (SOFE 2023) - Poster presentation 2023
Fusion Fuel Cycles and Blankets Workshop 2023 - Invited contribution 2023
IAEA International Conference on Topical Issues in Nuclear Installation Safety: 2022
Strengthening Safety of Evolutionary and Innovative Reactor Designs - **Contributed Talk**
8-bit PhD Event 2021 Fusenet EUROfusion - **Contributed talk** 2021
29th Symposium On Fusion Energy (SOFE 2021) - Poster presentation 2021
31st Symposium on Fusion Technology (SOFT 2020) - Poster presentation 2020
24th Technology of Fusion Energy (TOFE 2020) - **Contributed talk** 2020
Mediterranean Scientific Association of Environmental Protection 2020
Symposium (MESAEP 2020) - Poster presentation

REFEREE FOR INTERNATIONAL JOURNALS

Referee for: Nuclear Fusion, Fusion Engineering and Design, Acta Astronautica, Science and Technology of Nuclear Installation, Superconductor Science and Technology, Energies

OUTREACH ACTIVITIES

“Esperto in classe” (Expert in classroom) 2021-2022
Group classes for scientific dissemination events
Biennale Tecnologia 2021-2023
Invited talk at scientific dissemination events in Torino
“Cervelli in città” (Brains in town) 2021
Talk at scientific dissemination event in public libraries (for ADI Torino association)

The future of nuclear energy	2021
Invited talk at scientific dissemination event (for RUN PoliTo association)	
Stand-up for nuclear	2020 - 2023
National public event for scientific dissemination on nuclear energy	
Energy mix and nuclear energy	2022
Invited talk at Rotary Club Torino	
Principles and applications of nuclear fusion	2021
Invited talk at PoliEnergy	

SKILLS

Languages	Italian (native speaker), English (fluent), French (basic) German (basic)
Numerical Methods	Monte Carlo, Finite Elements
Operating Systems	Windows, Linux, iOS
Programming Languages	Python, C, MATLAB
Numerical tools	MATLAB, FESTIM, OpenMC, Serpent, Fispack-II, COMSOL Multiphysics, EcosimPro, SRIM
Design & CAD	SolidWorks, Inventor
Other tools	Microsoft Office, GitHub, LaTeX
Hardware	Basic electronics, Internal Combustion Engines

SELECTED PUBLICATIONS

- [1] R. Delaporte-Mathurin, J. Dark, G. Ferrero, E. A. Hodille, V. Kulagin, and **S. Meschini**, “FESTIM: An open-source code for hydrogen transport simulations,” *International Journal of Hydrogen Energy*, vol. 63, pp. 786–802, 2024.
- [2] **S. Meschini**, S. E. Ferry, R. Delaporte-Mathurin, and D. G. Whyte, “Modeling and analysis of the tritium fuel cycle for arc-and step-class dt fusion power plants,” *Nuclear Fusion*, vol. 63, no. 12, p. 126 005, 2023.
- [3] **S. Meschini**, F. Laviano, F. Ledda, *et al.*, “Review of commercial nuclear fusion projects,” *Frontiers in Energy Research*, vol. 11, p. 1 157 394, 2023.
- [4] D. Whyte, R. Delaporte-Mathurin, S. Ferry, and **S. Meschini**, “Tritium burn efficiency in deuterium–tritium magnetic fusion,” *Nuclear Fusion*, vol. 63, no. 12, p. 126 019, 2023.
- [5] S. Segantin, **S. Meschini**, R. Testoni, and M. Zucchetti, “Preliminary investigation of neutron shielding compounds for arc-class tokamaks,” *Fusion Engineering and Design*, vol. 185, p. 113 335, 2022.
- [6] G. Ferrero, **S. Meschini**, and R. Testoni, “A preliminary cfd and tritium transport analysis for arc blanket,” *Fusion Science and Technology*, vol. 78, no. 8, pp. 617–630, 2022.
- [7] **S. Meschini**, R. Testoni, S. Segantin, and M. Zucchetti, “Arc reactor: A preliminary tritium environmental impact study,” *Fusion Engineering and Design*, vol. 167, p. 112 340, 2021.