CURRICULUM VITAE

Andrea Pola

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ACADEMIC EXPERIENCE

December 2022 — Full Professor of "Nuclear Measurements and Instrumentation" (Academic Discipline ING-IND/20). On duty at the Department of Energy of Politecnico di Milano (Nuclear Engineering Division).

November 2020 — National scientific qualification as Full Professor in the Academic Recruiting Field 09/C2 - Thermal Sciences, Energy Technology, Building Physics and Nuclear Engineering ING, Academic Discipline ING-IND/20 - Nuclear Measurements and Instrumentation.

October 2014 — Associate Professor of "Nuclear Measurements and Instrumentation" (Academic Discipline ING-IND/20). On duty at the Department of Energy of Politecnico di Milano (Nuclear Engineering Division).

July 2006 — Assistant professor of "Nuclear Measurements and Instrumentation" (Academic Discipline ING-IND/20). Confirmed in the assistant professor position in 2009. On duty at the Department of Nuclear Engineering of Politecnico di Milano (Italy).

EDUCATION

May 2006 — Philosophy Doctor with honours in Radiation Science and Technology at Politecnico di Milano in 2006 with a thesis entitled "Semiconductor detectors for Neutron Spectrometry and Microdosimetry". The PhD thesis concerned the study and the development of detection systems based on monolithic silicon telescopes, semiconductor detectors designed in collaboration with ST-Microelectronics.

December 2002 Graduated with honours in Nuclear Engineering at the Politecnico di Milano in 2002 with a Master Thesis entitled "Spettrometria Neutronica con diodi PIN" ("Neutron spectrometry with PIN diodes"), mainly related to the study and the development of a recoil proton spectrometer based on a silicon diode in reverse-mode injection configuration coupled with a plastic converter.

SCIENTIFIC ACTIVITY

Andrea Pola carries out research activity since 2002. Main scientific interests are:

1) Dosimetry, Microdosimetry and Nanodosimetry;
2) Spectrometry of complex radiation fields;
3) Radiation risk assessment in medical diagnostics;
4) Commissioning and decommissioning of medical cyclotrons.

Since 2002 he is being associated to the Italian Institute of Nuclear Physics (INFN).

1) Dosimetry, Microdosimetry and Nanodosimetry

Andrea Pola has gained experience in the field of fundamental dosimetry in all its branches, i.e. dosimetry, microdosimetry and nanodosimetry. Early works concern the study and development of innovative solid state devices to be applied to the microdosimetric characterization of complex radiation fields, in particular to hadrontherapy beams. Thanks to the collaboration with the research group of doc. Paolo Colautti (INFN Legnaro National Laboratories), from 2013 his interests have been extended to the design and development of novel gas detectors for microdosimetry at the nanometric scale.

Main achievements in the two different research lines are:

I. design and development of a pixelated monolithic silicon telescope for solid state microdosimetry;
II. development of avalanche-confinement tissue equivalent proportional counters able to simulate site sizes from 500 nm down to 20 nm (nano-microdosiemeters);

The scientific work has been carried out in the framework of the following research projects approved and funded by national and international institutions (chronological order):

1a) *Project Name:* SISP – Single Event Spectrometry with Silicon Detectors
Framework: National
Funding Institution: Italian Institute of Nuclear Physics – INFN
Period: January 2004 – December 2007, 48 months
Results:
The main achievement of the SISP project was the development of a new solid state microdosimeter based on a ΔE-E telescope monolithic silicon device able to neglect field funnelling effects and to measure microdosimetric spectra of neutron fields at lineal energies higher than 20 keV μm^{-1}. The proposed device structure offered the possibility of performing an optimized event-by-event tissue-equivalent correction (suitably studied and developed).
Roles and achievements:
As a PhD student, Andrea Pola was in charge of the study, the design and the development of the whole detection system based on the new silicon microdosimeter, i.e. of the detector, the electronics and the acquisition system. Moreover, Andrea Pola studied and developed the analytical models through which

the minimization of the field funnelling effect was demonstrated and the associated correction procedures were applied.

1b) *Project Name:* MICRO-SI - Development of a Transportable Low-noise Silicon Microdosimeter
Framework: National
Funding Institution: Italian Institute of Nuclear Physics – INFN
Period: January 2008 – December 2010, 36 months
Results:
The MICRO-SI experiment aimed at improving microdosimetric performance of ΔE-E telescope devices by reducing the detection threshold down to a few keV μm^{-1}. The systems were thoroughly studied and tested for microdosimetry of hadrontherapy beams (proton and carbon ion beams). A prototype version constituted by a single cylindrical pixel and a custom ultra-low noise electronics was designed and developed to measure microdosimetric spectra with a detection threshold of about 0.6 keV μm^{-1} (presented at NEUDOS11 conference in 2009).
In the framework of the MICRO-SI experiment the ΔE-E telescope coupled to a plastic converter was also studied for spectrometry of low-energy neutron fields with the development of an extremely compact recoil-proton spectrometer able to measure spectra up to 8 MeV similar to that derive through Time-of-Flight techniques. An optimized neutron-gamma discrimination based on a real-time analysis of the ΔE-E scatter-plot was also developed to reduce the minimum detectable energy down to 0.2 MeV. The spectrometer was selected by the INFN Legnaro National Laboratories in 2011 and 2013 for the spectrometric characterization of neutron fields generated by thick beryllium targets at study for the new accelerator-driven Boron Neutron Capture Therapy (BNCT) facility.
Roles and achievements:
As participant Andrea Pola was in charge of the analytical study and the development of the whole silicon-based systems for microdosimetry and neutron spectrometry. Moreover, Andrea Pola developed the iterative multichannel unfolding code for neutron spectra derivation.

1c) *Project Name:*
FAR118 - "Nuovo rivelatore di particelle nucleari telescopico monolitico e sue applicazioni".
(FAR 118 – "New telescopic and monolithic detector of nuclear particles and its applications")
Framework: National
Funding Institution: Ministry of Universities and Research
Period: January 2004 – December 2007, 48 months
Results:
In the framework of the FAR 118 project, the collaboration with ST-Microelectronics allowed to design and fabricate the first geometrically segmented monolithic silicon telescope. This innovative device, studied and characterized in the MICRO-SI project, has been used in different projects and experiments related to silicon microdosimetry (see in particular the ARDENT and BIOQUART European projects).
Roles and achievements:
Participant as PhD student, Andrea Pola studied, designed and tested the detectors produced by ST-Microelectronics.

1d) *Project Name:* ARDENT- Advanced Radiation Dosimetry European Network Training
Framework: European
Funding Institution: European Community - 7th Framework Programme – People
Period: 2012-2015, 48 months
Results:
The project aimed at training young researchers in advanced dosimetry. Besides the education results, Monte Carlo simulations of microdosimetric distribution of carbon ions at clinical energies were carried

out. A first microdosimetric characterization of clinical carbon beams of energy up to 400 MeV/u was also performed at Centro di Adroterapia Oncologica – CNAO (Pavia) with silicon microdosimeters based on the monolithic telescope structure.

Roles and achievements:

Andrea Pola was a member of the Early Stage Researcher (ESR) selection panel. He was a tutor at Politecnico di Milano of the ESR training on silicon microdosimetry for hadrontherapy beams.

1e) *Project Name:* BIOQUART - Biologically Weighted Quantities in Radiotherapy
Framework: European
Funding Institution: European Metrology Research Programme - EURAMET
Period: June 2012 – June 2015, 36 months
Results:

Many scientific results were obtained by the different JRP working groups. As far as the research unit of Politecnico di Milano is concerned, two prototypes of silicon microdosimeters based on the monolithic telescope were installed as trigger detectors in the nanodosimeter of PTB (Germany) for performing microdosimetry and nanodosimetry of ion tracks.

Roles and achievements:

Andrea Pola was a JRP-member and leader of the Politecnico di Milano research unit (PoliMi).
He was directly involved in Work Package 1 – Microdosimetry, 2 – Nanodosimetry, 6- Creating Impact, 7- Management and Coordination. He was responsible for i) the characterization of hadron beams through solid state microdosimeters and for ii) the coupling of silicon microdosimeters and nanodosimeters.

1f) *Project Name:* MITRA – Microdosimetria di Traccia (Track microdosimetry)
Framework: National
Funding Institution: Italian Institute of Nuclear Physics – INFN
Period: January 2013 – December 2015, 36 months
Results:

In order to study the link between microdosimetric and nanodosimetric data, a new gas microdosimeter able to simulate sites ranging from 1 um down to 25 nm in diameter was designed and developed at Politecnico di Milano. This gas detector, based on a avalanche-confinement structure, allows to perform microdosimetry at nanometric level for the study of the correlation between nanodosimetric cluster size distributions of ion tracks and the associated microdosimetric properties.

Roles and achievements:

Andrea Pola was the Leader of the Politecnico di Milano research unit (PoliMi).
He was responsible for: Work Package 2 – Microdosimetry at nanometric level; 4 – Silicon Microdosimetry of hadrontherapy beams.

1g) *Project Name:* NEPTUNE - Nuclear process-driven Enhancement of Proton Therapy UNravEled
Framework: National
Funding Institution: Italian Institute of Nuclear Physics – INFN
Period: January 2019 – December 2022, 48 months
Results:

The aim is to study the possibility of exploiting the fusion reactions p-^{11}B and p-^{19}F for enhancing the effectiveness of proton therapy. Research groups involved: Politecnico di Milano, University of Pavia, La Sapienza University, University of Campania, University of Naples, University of Trento, CNR and INFN (Southern National Laboratories, Legnaro National Laboratories, Milan sections).
The reaserch unit of Politecnico di Milano has the role of performing the microdosimetric assessment of the fusion reaction products.

Roles and achievements:

Andrea Pola participates to the project as a member of the Politecnico di Milano research unit (PoliMi).

1h) *Project Name:* NECTAR – Neutron capture-enhanced treatment of neurotoxic amyloid aggregates
Framework: European
Funding Institution: European Union (H2020 programme, Future and Emerging Technologies - Open call – Grant Agreement N°964934)
Period: May 2021 – May 2024, 36 months
Project Objectives:
NECTAR aims at developing, testing and proving the feasibility, safety and effectiveness of a Capture-Enhanced Neutron Irradiation (CENI) of Aβ aggregates (oligomers considered the main culprit of Alzheimer's Disease) exploiting the synergy between an external beam of low energy neutrons which irradiate the whole brain and specifically engineered radiation enhancers capable of increasing the administered dose only in the Aβ aggregate site.
The project is ongoing. The role of Politecnico di Milano, defined in the consortium agreement as a sub-contractor of RAYLAB, is to study novel experimental solutions and tools for the microdosimetric and nanodosimetric characterization of the radiation field generated locally by the neutron capture of boron-doped or gadolinium-doped enhancers.
Roles and achievements:
Andrea Pola is the leader of the Politecnico di Milano research unit (PoliMi).

2) Spectrometry of complex radiation fields

The research activity concerning spectrometry has been carried out since 2002. Different techniques and solutions have been developed, mainly related to neutron fields. Innovative solutions for low and high resolution neutron spectrometry have been proposed to the scientific community and are now exploited by different research groups and institutions. Developments in this field allowed the issue of an international patent and triggered the activity of a spin-off company. Moreover, a novel spectrometric approach has been recently developed for X-ray spectrometry for Laser-based combined Proton Induced X-ray Emission (PIXE)/EDX spectroscopy.

Main achievements are:

I. Proton-recoil neutron spectrometer based on a monolithic silicon telescope;
II. Active-converter spectrometer for direct high-resolution neutron spectrometry;
III. DIAMON, the first Direction-Aware Isotropic and Active Neutron Monitor with spectrometric capabilities (patented design);
IV. First combined PIXE/EDX performed via Ultra-Intense and Ultra-High Contrast Lasers.

The scientific work has been carried out in the framework of the following research projects approved and funded by national and international institutions (chronological order):

2a) *Project Name:* SID – Silicon detectors
Framework: National
Funding Institution: Italian Institute of Nuclear Physics – INFN
Period: January 2002 – December 2003, 24 months
Results:
A new recoil-proton spectrometer based on a silicon diode was studied, assembled and developed. A pulse shape discrimination technique based on charge collection times, already discussed in literature

for heavy ions, was extended to low LET particles, i.e. electrons and protons, to carry out an effective gamma-neutron discrimination and neutron spectrometry at energies down to 800 keV.
Roles and achievements:
Participant as Master Student and PhD student.
In charge of the study, the design and the experimental characterization of the whole detection system, the discrimination techniques and the associated unfolding code.

2b) *Project Name:* NESCOFI @BTF – NEutron Spectrometry in COmplex FIelds
Framework: National
Funding Institution: Italian Institute of Nuclear Physics – INFN
Period: January 2011 – December 2013, 36 months
Results:
The NESCOFI@BTF project produced two new detection systems for neutron fields able to perform real-time spectrometry over 12 decades (meV - GeV). The systems are based on the moderation in high density polyethylene and on the thermalized neutron detection via multiple compact thermal neutron sensors, newly developed. The so-called CYSP e SP^2 detectors were conceived for diagnostics, monitoring and dosimetry applications and are able to measure neutron fields (continuous) characterized by fluence rates in the range 10^1 - 10^6 cm^{-2} s^{-1}. More specifically, the CYSP detector was design to have a marked directional response, therefore for directional neutron spectrometry. On the other hand, SP^2 was conceived to have an isotropic response for neutron spectrometry in workplaces.
Roles and achievements:
As participant Andrea Pola was responsible for the design, the development and the characterization of the active thermal neutron sensors to be embedded in CYSP e SP^2 neutron spectrometers (7 sensors for the former, 31 sensors for the latter). He was in charge of the development of whole multichannel acquisition systems. Moreover, Andrea Pola was responsible for the final design and implementation of the SP^2 device.

2c) *Project Name:* NEURAPID – NEUtron RAPId Diagnostics
Framework: National
Funding Institution: Italian Institute of Nuclear Physics – INFN
Period: January 2014 – December 2016, 36 months
Results:
Innovative thermal neutron sensors sensitive to very low neutron fields were developed. These detectors were successfully applied, in collaboration with the Helmoltz Zentrum (Munich), for monitoring cosmic neutron fields at the Schneefernerhaus Environmental Research Station (Summit of Zugspitze, Germany). On the other hand, an innovative detection system (called “Speedy”) was developed and characterized for ultra-fast (pulsed) neutron fields.
In the framework of this project a novel neutron irradiation configuration based on AmBe sources was studied and developed to have reference thermal neutron facilities fields for sensor characterization.
Roles and achievements:
Andrea Pola was the Leader of the research unit of Politecnico di Milano.
He was responsible for the study, the design, the development and the characterization of high sensitivity active thermal neutron sensors to be embedded in neutron spectrometers. He was responsible for the development of the acquisition system able to process ultra-fast pulsed neutron fields. He was in charge of the design and development of the thermal neutron irradiation facility (called ESTHER, Expanded Source of THERmal Neutron) now available at the neutron metrology facility of Politecnico di Milano.

2d) *Project Name:* Neutron Facility @ PoliMi

Framework: Local
Funding Institution: Politecnico di Milano
Period: January 2016 – December 2018, 36 months
Results:
The project aimed at developing a neutron metrology facility at the Department of Energy of Politecnico di Milano. An irradiation bunker was equipped with a positioning system for fast irradiations with a AmBe source (1 Ci) in agreement with ISO standards. Moreover, an AmBe-based thermal neutron facility based on neutron streaming method was also studied, design and developed.
The facility is now fully operative and offers a calibration service at national level for external users.
Roles and achievements:
Andrea Pola was the Leader of the proposal. He is now the head of the metrology and calibration facility at Politecnico di Milano.

2e) *Project Name:* "Metodos innovadores para dosimetria y espectrometria de neutrones"
Framework: National (Spain)
Funding Institution: Programa estatal de fomento de la investigación científica y técnica de excelencia - subprograma estatal de generación de conocimiento (fis2015-64793-c2-1-p) (mineco/feder, spain).
Period: January 2016 – December 2018, 36 months
Results:
The project aimed at developing multi-sensor systems embedded in single moderators for real-time neutron spectrometry of radiation background and related dosimetry from thermal to GeV.
Roles and achievements:
Andrea Pola was a participant of the project. He was responsible for the multi-sensor system development. Leader: CIEMAT (Madrid). Other research groups: UAB (Barcellona) and INFN- Laboratori Nazionali di Frascati.

2f) *Project Name:* eLiBaNS – e-LINAC based neutron source
Framework: National
Funding Institution: Italian Institute of Nuclear Physics – INFN
Period: January 2016 – December 2018, 36 months
Results:
The project succeeded in developing an homogenous and intense neutron source based on a medical-type ELEKTA SL18 MV electron LINAC. This aim was achieved by studying and developing a beam delivery system, which material composition and size were optimized according to the purpose of producing thermal neutrons (E < 0.4 eV), or epithermal neutrons (eV < E < 100 keV). To have a well-defined and characterize neutron facility, new epithermal neutron detectors suited for monitoring the E_LIBANS epithermal field were also developed.
Roles and achievements:
Andrea Pola was the Leader of the research unit of Politecnico di Milano.
He was responsible for the study, the design, the development and the characterization of active thermal neutron sensors for intense neutron fields and high neutron fluences.

2g) *Project Name:* ERC ENSURE-Exploring the New Science and engineering unveiled by Ultraintense ultrashort Radiation Interaction with Matter
Framework: European
Funding Institution: European Research Council - Grant Agreement 647554
Period: January 2019 – September 2021.
Results:

The project aimed at studying ion acceleration processes induced by Ultraintense lasers, the production of targets and the development of diagnostic systems for fields generated by ultra-intense lasers (https://www.ensure.polimi.it/).

<u>*Role and achievements*</u>:

Andrea Pola participated to the project (Leader: prof Matteo Passoni) with the responsibility for the study and development of diagnostics of i) proton fields and ii) X-ray fields induced on a specified target. Results allowed the first integrated quantitative PIXE analysis and EDX spectroscopy using a laser-driven particle source.

Other developments in the research field

2h) Andrea Pola conceived and proposed a new recoil-proton spectrometer based on a monolithic silicon telescope for direct neutron spectrometry (Active-Converter Spectrometer – ACSpect). The system is characterized by a three-stage system: an active converter constituted by a plastic scintillator coupled to a monolithic silicon telescope. By positioning the two detectors at a proper distance in vacuum and by exploiting the neutron-gamma discrimination capability of the telescope a direct measurement of impinging neutron spectra can be performed with an overall resolution of about 200 keV FWHM. The system is now exploited by other research group for neutron characterization of novel moderator materials and structures.

3) Radiation risk assessment in medical diagnostics

The research activity related to patient risks from radiodiagnostic procedures started in 2010 in the framework of a regional initiative for the study of Computed Tomography (CT) use in paediatrics.

The framework of the work was provided by the project PREP- Procedure Radiodiagnostiche in Età Pediatrica (Radiodiagnostic procedures in paediatrics), approved and funded by the Regional Government of Lombardy (the most populated italian region with about 10 million inhabitants) for the period February 2011 – February 2013. PREP project involved 8 different institutes and hospitals and concerned the retrospective analysis and discussion of the radiation exposure in emergency and outpatient medical imaging. It was devoted to increase the appropriateness and the justification in radiodiagnostics, especially in paediatrics. From the scientific point of view, the project aimed at analysing radiation risk for patients starting from the analysis of organ doses and dose indexes defined for CT. Moreover, a regional system for dosimetric data collection and analysis was studied ad designed.

Andrea Pola was the leader of Work Package 2 – Retrospective data and radiation risk analysis and of Work Package 3 – Development of the prototype network.

In 2014 Lombardy Regional Government approved and funded the second phase of the PREP project. In the framework of the PREP Project – phase 2, Andrea Pola was the leader of Work Package 1 devoted to the study of protocols and radiation risk models for radiodiagnostic procedures of the whole regional population.

Main achievements of the research activity in the field are:

I. First experimental evidence of concerns about the exposure of teenagers and young adults in emergency CT use,
II. New national recommendation on dental procedures;
III. Implementation of a multicentre cloud-based CT dosimetric database;
IV. Review of main software for patient organ and effective dose estimation in CT.

4) Commissioning and decommissioning of medical cyclotrons

The works related to commission and decommissioning of medical cyclotrons have been carried out in the framework of research collaboration and contracts with public and private entities. Since 2016, Andrea Pola have been responsible of studies and the designs of medical facilities based on cyclotrons, together with analysis and management of the decommissioning of medical facility.

Main achievements are:

I. first decommissioning of a medical cyclotron in Italy at the National Cancer Institute of Milan;
II. shielding study and design and radiological assessment of the New Nuclear Medicine Ward "Al Sadr Teaching Hospital" at Basra (Iraq);
III. shielding design of the new protontherapy facility of European Institute of Oncology of Milan.

The activity was carried out as the responsible for the following research contracts:

5a) *Programme Title: Study of the decommissioning of medical cyclotrons*
Framework: National
Funding: Nucleco Spa
Period: January 2016 – January 2017.
Objectives:
The research aimed at studying scientific and technical issues of the decommissioning of medical cyclotrons at national level. As part of the activity, the analysis of conditions of italian medical cyclotrons and the related management was performed. Moreover, strategies for the management of radioactive waste generated by the decommissioning of medical cyclotrons at national level were also identified and proposed.

5b) *Programme Title: Decommissioning of the medical cyclotron of National Cancer Institute of Milan*
Framework: Local
Funding: National Cancer Institute of Milan
Period: March 2016 – March 2017.
Objectives:
The study concerned the issues associated with the decommissioning of the medical cyclotron of the institute, the radiometric characterization of the accelerator and its vault, the proposal of decommissioning strategies. The activity allows to successfully manage the first decommissioning of a medical cyclotron in Italy.

5c) *Programme Title: Application of the international standards UNI ISO 11929:2015 to measurements for clearance of materials and structures*
Framework: National
Funding: Nucleco Spa
Period: January 2017 – January 2018.
Objectives:
The research aimed at studying and defining characterization protocols for materials where neutron-induced activation occurred. Moreover, robust criteria for the analysis of radioactive waste and the corresponding disposal scenarios were identified and proposed.

5d) *Programme Title: Decommissioning of the cyclotron bunker at the National Cancer Institute of Naples*
Framework: Local
Funding: Progetti Plant srl

Period: October 2019 – July 2020.
Objectives:
The study concerned the analysis of issues associated with the management of the decommissioning of the medical cyclotron vault, the radiometric characterization of related materials, the proposal of decommissioning strategies.

5e) *Programme Title: New Nuclear Medicine Ward "Al Sadr Teaching Hospital" at Basra (Iraq)*
Framework: International
Funding: Progetti Plant srl
Period: January 2020 – July 2020
Objectives:
The activity aimed at designing the radiation shielding of the whole new center. The center hosts a medical cyclotron for radioisotopes production, hot labs for radiotracers preparation, PET scanners, CT scanners and a radiometabolic therapy area. Analytical and Monte Carlo-based assessments were carried out for radiation protection and risks analysis.

5f) *Programme Title: Study and characterization of radiation shielding of the new protontherapy facility at European Institute of Oncology of Milan*
Framework: Local
Funding: European Institute of Oncology
Period: June 2020 – June 2023
Objectives:
The activity aimed at designing and verifying numerically the radiation shielding of the new protontherapy center of the funding Institution. The center consists in a cyclotron-based facility with a beam system able to deliver proton beams of energies up to 250 MeV via a gantry. Analytical and Monte Carlo-based assessments have been carried out for shielding design and radiological risks analysis.

5) Activity in other research programmes

The scientific activity carried out in other research programmes is describe in the following:

5a) Andrea Pola was the leader of the project "Study of the relation between ionization and energy deposition process at the micro scale: comparison of the response of microdosimeters", approved and funded in 2013 by the SPIRIT project - Support of Public and Industrial Research using Ion beam Technology (7th European Framework Programme – Capacities). The aim of the project was to investigate the relation of ionization and energy absorption at the micro scale. This was carried out by comparing microdosimetric distributions measured with a silicon micro-telescope developed by the Politecnico di Milano (main applicant) with those derived by micro-calorimeters based on an Inductive Superconductive Transition Edge Detector, developed by the National Physical Laboratory in collaboration with the University of Surrey and the Royal Surrey County Hospital. The former detector derives information about the energy deposition indirectly by measuring the ionization, while the latter provides a direct measurement of energy deposition at the micrometer scale. The two different detection systems were irradiated with micro-beams of protons and carbon ions at different energies at the Surrey Ion Beam Centre by adopting a common suitable set-up. A dedicated numerical study based on Monte Carlo simulations was also carried out in order to analyze in-depth the experimental results and the correlation between the response of the two different detectors.

5b) From 2010 to 2013 Andrea Pola participated to the LILIA project (LILIA- Laser-Induced Ion Acceleration), an experiment approved and funded by INFN related to light ions acceleration through laser interaction with thin metal targets. The main aim of LILIA was to study, design and verify a scheme which foresees the production, the characterization and the transport of a proton beam toward a stage of post

acceleration (high frequency compact Linac). To do this, a comprehensive study was carried out about the radiation fields produced by bombarding different targets with lasers characterized by ultra-high powers (10^{20}-10^{21} W cm^{-2}), ultra-short pulses (20-30 fs) and ultra-high contrasts (>10^{10}). In the framework of the LILIA project, Andrea Pola was involved in the feasibility study of active detection techniques able to characterize the ion beams, mainly protons, generated by lasers pulses over ultra-short times and energies of tens of MeV.

5c) Since 2020 Andrea Pola is the leader of the project "Non Destructive Testing @ Polimi", an initiative funded by the national programme "Departments of excellence" promoted by the Italian Minister of University and Research. The aim of the project is to develop an X-ray tomography facility for the non-destructive testing of large samples (tens of cm). The facility, under development, will allow to perform the static and dynamic 3D characterization of complex objects. First scientific objectives are the analysis of degradation of lithium and post-lithium batteries, together with the study of chemical alterations in fuel cells.

SCIENTIFIC ROLES AND CONTRIBUTIONS

Roles in the scientific community

Organizer and member of the scientific committee of the 1st National Conference on Design, Management and Decommissioning of a Medical Cyclotron ("Progettazione, gestione e decommissioning di un ciclotrone medicale"), National Cancer Institute of Milan, 19th November 2019

Chairman of the session "Radiation Detection and Measurement" at 12th International Conference on Radiation Shielding – 17th Topical Meeting of the Radiation Protection and Shielding, Nara, Japan Sep. 2012.

Reviewer of several ISI journals, e.g. "Radiation Measurements", "Nuclear Instruments and Methods in Physics Research A" and "Applied Radiation and Isotopes".

Proposing author, together with S. Agosteo, of an intercomparison problem in the CONRAD-A Coordinated Action for Radiation Dosimetry, funded by the European Union's 7h Framework Program.

Contributions at national and international conferences

Andrea Pola was lecturer at the following national and international conferences and workshops:

OR1. "Microdosimetria allo stato solido" ("Solid state microdismetry"), presented at the National Conference of the Italian Association of Radiation Protection (AIRP), Catania, 15th-17th September 2005;

OR2. "A solid state microdosimeter based on a monolithic silicon telescope" presented at the 14th International Symposium on Microdosimetry MICROS, Venezia, 13th-18th November 2005;

OR3. “Spettrometria neutronica con dispositivi al silicio” (“Neutron spectrometry with silicon devices”) the National Conference of the Italian Radiation Protection Association (AIRP), Torino, 20th-23th September 2006;
OR4. “A silicon microdosimeter for high-LET radiation” presented at the Discussion Seminar on Radiation Quality Assessment, Legnaro (Pd), 30th-31th October 2006;
OR5. “A pixelated silicon telescope for solid state microdosimetry” presented at the 15th International Conference on Solid State Dosimetry - SSD, Delft (NL), 8th -13th July 2007;
OR6. “Study of a solid state microdosimeter based on micrometric size diodes coupled to a residual energy stage”, presented at the 11th International Conference on Radiation Shielding - ICRS, Pine Mountain (GE, USA) 13th-18th April 2008;
OR7. “Studio di rivelatori al silicio per la caratterizzazione di fasci adroterapici” (“Study of silicon devices for the characterization of hadrontherapy beams”), presented the National Conference of the Italian Association of Radiation Protection (AIRP), Pisa, 4th-6th June 2008;
OR8. *Invited talk*: “Development of a solid state microdosimeter based on a monolithic silicon telescope" presented at the International Workshop on Current Challenges to the Metrology of Ionizing Radiation in Sub-Micrometer Dimensions", PTB, Braunschweig (D), 8th-10th June 2009;
OR9. “Study of a silicon microdosimeter for hadrontherapy applications: measurements at the therapeutic proton beam line of CATANA”, presented at the 11th Symposium on Neutron and Ion Dosimetry - NEUDOS, Cape Town (SA), 12th-16th October 2009;
OR10. *Co-author of invited talk:* “Silicon Microdosimetry” presented at the 15th International Symposium on Microdosimetry - MICROS, Verona, 25th-30th October 2009;
OR11. “Study of a monolithic silicon telescope for solid state microdosimetry: response to a 100 MeV proton beam” presented at the 16th International Conference on Solid State Dosimetry - SSD, Sydney, (AU) 19th-24th September 2010;
OR12. “A monolithic silicon telescope for hadron beams: numerical and experimental study of the effect of ΔE detector geometry on microdosimetric distributions” presented at the 12th International Conference on Radiation Shielding (ICRS12), Nara, Japan, 2nd-7th September 2012;
OR13. *Invited talk:* “Principle of Silicon-based microdosimetry” presented at the Second Annual ARDENT workshop, Milano, 17 Ottobre 2013.
OR14. “The extended energy neutron spectrometer SP2: development and characterization with reference monochromatic neutron beams” presented at the 13th Symposium on Neutron and Ion Dosimetry - NEUDOS, Krakow (Poland), 14th-19th May 2017;
OR15. “DIAMON: a portable, real-time and direction-aware neutron spectrometer”, presented at the Neutron User Club Meeting - NUC, National Physical Laboratory (UK), 9th October 2019;
OR16. “Alzheimer Disease and NECTAR project: characterization of a neutron facility for brain cell irradiations” presented at the 14th Symposium on Neutron and Ion Dosimetry - NEUDOS, Krakow (Poland), 25th-29th April 2022;

Moreover, Andrea Pola is co-author of more than 30 oral presentations at international conferences.

Andrea Pola is author and co-author of more than 30 posters at international conferences.

TEACHING ACTIVITY

Institutional teaching activity

Since 2014: Professor of the course “Laboratory of Physics of the Nucleus” at Politecnico di Milano. The course concerns the introduction to experimental methods for nuclear physics, analysis of main nuclear processes and training on radiation spectrometry. The course provides also an introduction to radiation physics and radiation protection.

Since 2009: Professor of the course “Radioactivity” at Politecnico di Milano. The course concerns fundamentals of special relativity, quantum mechanics, nuclear structure and models, main radioactive processes.

Other teaching activity

2021-2022: Expert lecturer of the “I Level Specializing Master in Nuclear Safeguards” (https://www.nuclearsafeguards.polimi.it/) organized by the Department of Energy – Politecnico di Milano and the European Nuclear Education Network (ENEN), in collaboration with European Joint research center (EU JRC), Academic institution participating in the European Nuclear Education Network, ESARDA partners and several International organizations (IAEA and others). The Master is part of the European Safeguards Training and Education (SaTE) project.

Since 2019: Lecturer of the course “Fisica e Ingegneria Nucleare” (“Nuclear Physics and Engineering”) offered by the School of Engineering of Politecnico di Milano in the framework of the “Policollege” initiative. The course is offered annually (2-3 times) to outstanding undergraduate students selected via a national call with the aim of providing a viable introduction to nuclear physics and engineering.

April 2014: Expert lecturer at the 7th Framework Programme TRANSNUSAFE “EUROCOURSE 3: Economic Relevance of Safety Culture in Medical Applications”, a course for senior and safety managers of medical radiation facilities.

Sept 2013: Lecturer of the seminar “Silicon Microdosimetry” at the National Physical Laboratories (NPL), Teddington, London.

May 2013: Lecturer of the seminar “Radiation Risks in Paediatric Radiology” at the Niguarda Ca’ Granda Hospital, Milano.

2002-2012: Assistant of the course “Medical Application of Radiation” at Politecnico di Milano.

2009: Lecturer at the INFN school “"Rivelatori ed Elettronica per Fisica delle Alte Energie, Astrofisica, Applicazioni Spaziali e Fisica Medica" (“Detectors and Electronics for High

Energy Physics, Astrophysics, Space Applications and Medical Physics") organized by Laboratori Nazionali di Legnaro (LNL) of the National Institute of Nuclear Physics.

2008: Lecturer of training seminars concerning the radiation protection in paediatrics at Melegnano Hospital. Moreover, Andrea Pola is co-author of an on-line course and of the associated guidelines about the Radiological Risk in Pediatric Radiodiagnostics proposed by Regione Lombardia in the framework of the "Continuous Education in Medicine" (ECM credits).

Since 2006 Andrea Pola is being supervisor of 15 master thesis in Nuclear Engineering and 5 PhD thesis concerning topics relevant to Microdosimetry and Spectrometry.

Since 2013 Andrea Pola gives lectures in the course "Radiation Protection and Instrumentation in Nuclear Systems" (Coordinator: S. Agosteo) of the PhD Programme in Energy and Nuclear Science and Technology at Politecnico di Milano.

INSTITUTIONAL RESPONSIBILITIES AND COMMITMENTS

Sept 2021 – Dec 2021 – Andrea Pola is an invited lecturer at the "Seminar on National Repository of Radioactive Waste", a national phase of the institutional path that will lead to the creation of the first italian repository of radioactive waste. The initiative involved several institutional representatives and consisted of nine meetings live-streamed aimed at presenting to the public and to regional administrations technical aspects of the National Repository for radioactive waste and Technological Park project.

Since 2020 Andrea Pola is member of the Board of Professors of the PhD Programme in Energy and Nuclear Science and Technology (STEN) of Politecnico di Milano.

Since January 2020 Andrea Pola is member of the executive board of the Department of Energy of Politecnico di Milano.

Since January 2020 Andrea Pola is coordinator of the Nuclear Engineering Division of the Department of Energy of Politecnico di Milano.

Since 2017 Andrea Pola is member of the management board of the "Energy for Motion" project (E4M), an initiative funded by the "Department of Excellence" call of Italian minister of university and research (MUR). The board was appointed by the council of the Department of Energy of Politecnico di Milano, after the successful work carried out in developing the project proposal. E4M manages a budget of 9.35 M€ for academic recruitment, infrastructure investments and teaching activity development.

Since 2017 Andrea Pola is member of the study plan commission of the Master Science Course in Nuclear Engineering of Politecnico di Milano.

In 2021 Andrea Pola was member of the evaluation board of the final exam for PhD thesis dissertation of the Faculty of Science of the University of Basel (CH). In 2014, he was member of the evaluation board of the final exam for PhD thesis dissertation of the Faculty of Science of the University of Bern (CH). In 2013, he was member of the evaluation commission of the final exam of the "PhD programme in Nuclear Engineering and Industrial Safety" at the University of Pisa.

TECHNOLOGY TRANSFER RESULTS

Andrea Pola is the leader of the industrial initiative "RAYLAB", accredited on October 2017 as a Spin-off company of Politecnico di Milano (Academic Senate Approval n. 201710230470, 23/10/2017, Administration Board Approval n. 201710310708 ,31/10/2017). The aim of RAYLAB is the development of innovative instrumentation in the radiation detection and measurement field. The flagship product of RAYLAB is the "DIAMON" spectrometer, the first active, portable, direction-aware neutron spectrometer. DIAMON is presently adopted by several institutions and companies, e.g. IRSN- Institut de radioprotection et de sûreté nucléaire (Paris, France), ISIS Neutron and Muon Source (Oxford, UK), INFN (Italy), ORANO (France), EDF (France), Swedish Radiation Safety Authority (Sweden), University of Bern. Andrea Pola is a shareholder of Raylab srl. Raylab website: www.raylab.solutions.

Main inventor of the patent "ACTIVE NEUTRON SPECTROMETER". The technology transfer initiative was filed on March 22th, 2018. On April 7th, 2020 the patent was registered in Italy from UIBM. It is currently in the international extension phase through the "ACTIVE NEUTRON SPECTROMETER" PCT procedure with reference PCT / EP2019 / 055507. On January 3rd, 2022, the patent was issued by the US Patent and Trademark Office (Pub. No. US 2020/0379134 A1).

LANGUAGE SKILLS

Andrea Pola has a certified level of proficiency in written and spoken English equivalent to the Common European Framework of Reference for Languages (CEF) level C1, i.e. "highly proficient in spoken and written English".

LIST OF PUBLICATIONS

Publications on International Journals

1. Braccini, Saverio, Casolaro, Pierluigi, Dellepiane, Gaia, Mateu, Isidre, Mercolli, Lorenzo, Pola, Andrea, Rastelli, Dario, Scampoli, Paola (2022). A novel experimental approach to characterize neutron fields at high- and low-energy particle accelerators. SCIENTIFIC REPORTS, vol. 12, p. 16886-16896, ISSN: 2045-2322, doi: 10.1038/s41598-022-21113-7

2. Caracciolo, Anita, Di Vita, Davide, Buonanno, Luca, Carminati, Marco, Protti, Nicoletta, Altieri, Saverio, Pola, Andrea, Bortot, Davide, Fiorini, Carlo (2022). Experimental validation of a spectroscopic gamma-ray detector based on a LaBr3 scintillator towards real-time dose monitoring in BNCT. NUCLEAR INSTRUMENTS & METHODS IN PHYSICS RESEARCH. SECTION A, ACCELERATORS, SPECTROMETERS, DETECTORS AND ASSOCIATED EQUIPMENT, vol. 1041, p. 1-8, ISSN: 0168-9002, doi: 10.1016/j.nima.2022.167409

3. Bortot, D., Mazzucconi, D., Fazzi, A., Agosteo, S., Pola, A., Colautti, P., Selva, A., Conte, V. (2022). From micro to nanodosimetry with an avalanche-confinement TEPC: characterization with He-4 and Li-7 ions. RADIATION PHYSICS AND CHEMISTRY, vol 198, p. 110225. doi:org/10.1016/j.radphyschem.2022.110225.

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22. Calderoni F., Campanaro F., Colombo P. E., Campoleoni M., De Mattia C., Rottoli F., Galetta G., Zucconi F., Pola A., Righini A., Triulzi F., Vanzulli A., Torresin A. (2019). Analysis of a multicentre cloud-based CT dosimetric database: preliminary results. EUROPEAN RADIOLOGY EXPERIMENTAL, vol. 3, p. 27-39, ISSN: 2509-9280, doi: 10.1186/s41747-019-0105-6

23. Mazzucconi D., Bortot D., Pola A., Fazzi A., Colautti P., Conte V., Petringa G., Cirrone G. A. P., Agosteo S. (2019). Nano-microdosimetric investigation at the therapeutic proton irradiation line of CATANA. RADIATION MEASUREMENTS, vol. 123, p. 26-33, ISSN: 1350-4487, doi:10.1016/j.radmeas.2019.02.012

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