

# Attività scientifica

La mia attività di ricerca è stata dedicata essenzialmente a due temi: lo studio della fisica nucleare con ioni pesanti alle energie intermedie (10-100 MeV) e poi a cominciare da circa l'anno 2000 lo studio della fisica astroparticellare in particolare la rivelazione di neutrini di alta energia ( $E > 100$  GeV).

Dai i primi anni della mia carriera fino a circa il 2000, la mia attività si è svolta nell'ambito della fisica nucleare studiando le reazioni nucleari fra ioni pesanti alle energie intermedie. Tale sperimentazione è stata effettuata principalmente con il rivelatore MEDEA che ha lavorato con successo negli anni 1990-1993 presso il laboratorio francese Grand Accelerator National d'Ion Lourdes (GANIL, Francia) e poi in seguito accoppiato con i rivelatori MULTICS, SOLE e MACISTE presso i Laboratori Nazionali del Sud. Una parte delle mia attività è stata dedicata alla progettazione, realizzazione e messa in opera di questi apparati di rivelazione.

La mia attività di ricerca in fisica astroparticellare, i cui i primi approcci cominciarono nel 1998, è stata dedicata alla rivelazione di neutrini di alta energia ( $E > 100$  GeV) di origine astrofisica con apparati Cerenkov sottomarini.

Il principale scopo di questi apparati è quello di scoprire e studiare i siti extraterrestri di accelerazione di neutrini di alta energia. La misura dei neutrini di alta energia e la loro origine è anche un punto chiave per la comprensione dell'origine dei raggi cosmici di altissima energia che è ancora ignota.

I neutrini, essendo neutri, non sono deflessi dai campi magnetici come i protoni, principali costituenti dei raggi cosmici. Inoltre, interagendo debolmente, possono attraversare indisturbati grandi distanze e dense quantità di materia che può circondare le sorgenti di neutrini stesse. Queste caratteristiche fanno dei neutrini un'ottima sonda per esplorare zone ancora ignote dell'Universo e identificare in modo chiaro, come un telescopio, le sorgenti di neutrini.

Nei primi anni del 2000 si cominciò a definire la volontà di costruire un rivelatore di volume dell'ordine del  $\text{km}^3$  nel mar Mediterraneo e si costituì con questo scopo in Italia la collaborazione NEMO a cui io ho partecipato sin dalla suo inizio.

Già due grosse collaborazioni operavano nel Mediterraneo. La prima ANTARES con un piccolo rivelatore (dell'ordine di un centesimo di  $\text{km}^3$ ) che in quegli anni era in fase di costruzione al largo delle coste di Tolone ed un'altra NESTOR che ambiva a costruire un rivelatore al largo delle coste greche di Pylos. Negli stessi anni era stata avviata la costruzione del rivelatore IceCube al Polo Sud. A causa della sua posizione IceCube ha la visibilità, con basse soglie in energia, del solo cielo Nord. Un rivelatore posto nel mar Mediterraneo risulta invece complementare e può osservare gran parte del piano galattico con soglie basse in energie e quindi con ottima sensibilità.

Alla fine dello scorso decennio le tre collaborazioni NEMO, ANTARES e NESTOR sono confluite nella collaborazione europea KM3NeT. La mia attività è stata svolta all'interno delle collaborazioni ANTARES, NEMO e KM3NeT.

Attualmente sono coordinatrice all'interno della collaborazione KM3NeT del working group "Neutrino Astronomy". Questo working group ha il compito di valutare tramite simulazioni Monte Carlo le prestazioni del rivelatore per le principali sorgenti di neutrini e per flussi diffusi. Inoltre nel Dicembre 2015 sono stata nominata da KM3NeT coordinatrice del working group "DU Data Analysis" che si occupa dell'analisi dei dati di KM3NeT.

# *Curriculum vitae et studiorum*

Nata a Catania il 14 Febbraio 1961

- 12/1984 Consegue la laurea in Fisica indirizzo applicativo (orientamento nucleare) presso l'Università degli studi di Catania con voti 110/110 e lode discutendo la tesi "Studio dei frammenti del proiettile prodotti nella reazione  $^{40}\text{Ar} + ^{\text{nat}}\text{Ti}$  a 44 MeV/A" relatori Prof. Lo Nigro e Dott. G. Lanzaò.
- 1985-1986 Dal 1° Ottobre 1985 al 30 Giugno 1986 ha usufruito della borsa di studio presso il C.E.N. di Saclay (Francia)
- 1986-1988 Dal 1° Luglio 1986 al 30 Giugno 1988 è borsista dell'INFN presso i Laboratori Nazionali del Sud.
- 9/1988 Dal 15 Settembre 1988 è dipendente dell'INFN presso i Laboratori Nazionali del Sud
- 11/2003 Dichiarata vincitrice del concorso 9725/2003 per il profilo di primo ricercatore INFN - II livello professionale
- 2/2006 Inquadrata in prova nel profilo di Primo Ricercatore di II livello professionale con decorrenza dal 16-12-2005

## *Incarichi e responsabilità*

- 1994-1997 Responsabile locale presso i LNS della linea di ricerca DYNAMICS in seno alla commissione Scientifica Nazionale III
- 1999 Responsabile locale presso i LNS della linea di ricerca OUVERTURE in seno alla commissione Scientifica Nazionale III
- 2000- 2002 Responsabile locale presso i LNS della linea di ricerca FORWARD in seno alla commissione Scientifica Nazionale III
- 2003 Responsabile locale presso i LNS della linea di ricerca ISOSPIN in seno alla commissione Scientifica Nazionale III
- 2007-2013 Rappresentante del Personale ricercatore dipendente o dotato di incarico di ricerca in seno al Consiglio direttivo dei Laboratori Nazionali del Sud e membro del Consiglio di Laboratorio (LNS).
- 2007-2009 Membro della commissione per il conferimento degli assegni di ricerca presso i Laboratori Nazionali del Sud.
- 4/2007 Nominata membro della commissione esaminatrice del concorso INFN 6N/T3/STR per l'assunzione di personale a tempo determinato con profilo di Tecnologo di III livello
- 4/2007 Nominata membro della commissione esaminatrice del concorso INFN 7N/T3/MAC per l'assunzione di personale a tempo determinato con profilo di Tecnologo di III livello
- 2007 Responsabile Unico del Procedimento (R.U.P.) presso i Laboratori Nazionali del Sud
- 2008-2012 Responsabile locale presso i LNS della linea di ricerca ANTARES in seno alla commissione Scientifica Nazionale II
- 2008-2012 Membro dell'Institution Board della collaborazione ANTARES in rappresentanza dei LNS
- 11/2008 Nominata membro della commissione esaminatrice della selezione riservata al personale dei profili di tecnologo stabilizzante presso l'INFN
- 2009-2012 Membro del Publication Committee all'interno della collaborazione internazionale ANTARES
- 2010-2012 Membro del Comitato Unico di Garanzia dell'INFN. Dimessa dalla carica il 11-12-2012.
- 2012-2015 Eletta Physics Coordinator di KM3NeT-Italia
- 2012 Nominata dal management di KM3NeT coordinatrice del gruppo di lavoro "High Energy Astrophysics"
- 11/2012 Eletta chairperson dell'Institution Board della collaborazione ANTARES. L'incarico ha una durata triennale.

- 2012-2014 Responsabile del corso di formazione “Una nuova frontiera per la ricerca: gli osservatori sottomarini” Progetto di formazione specialistica per la creazione di figure professionali con competenze in ambito scientifico tecnico-scientifico e manageriale. PON Ricerca e Competitività 2007-2013 (bando MIUR 254/ric)
- 2014 Nominata dal management di KM3NeT coordinatrice dell’analisi dati del prototipo della stringa (PPM-DU) di KM3NeT
- 12/2015 Nominata dal management di KM3NeT coordinatrice dell’analisi dati di KM3NeT-ARCA
- 11/2015 Facente parte del progetto ASTERICS dal Novembre 2015 all’interno del WP3 OBELICS
- 2/2019 Responsabile scientifico locale del progetto ESCAPE (H2020)

### *Attività didattica e di tutoring*

- 1997-1998 Relatore della tesi del Dott. P. Ventura “Le emissioni di pre-equilibrio nelle collisioni tra ioni pesanti alle energie intermedie”
- 2001 Nominata dal consiglio di corso di laurea in Ingegneria elettrica dell’Università di Catania cultore della materia ed ha partecipato alla commissione per gli esami di profitto di Fisica I. Ha collaborato al corso integrativo di Fisica I per gli studenti del corso di laurea in Ingegneria Elettrica dell’Università di Catania
- 2001/2002 Ha collaborato al corso di Fisica Sperimentale I (laurea in Ingegneria Informatica presso l’Università degli studi di Catania.) tenendo il corso di esercitazioni.
- 2002/2003 Correlatore del lavoro di tesi di laurea del Dott. A. Rizzo dal titolo “Effetti delle caratteristiche del sito sulle prestazioni di un telescopio sottomarino per neutrini di alta energia”
- 2008-2011 Supervisore della tesi di dottorato del Dott.ssa V. Giordano dal titolo “Statistical methods for the search of high energy neutrinos from galactic sources in KM3NeT and ANTARES telescopes” XXIV ciclo dell’ International Ph.D in Nuclear and Particle Astrophysics” dell’Università di Catania Scuola superiore di Catania.
- 2004-2005 Correlatore del lavoro di tesi di laurea del Dott.ssa A. Calanna dal titolo “Studio delle prestazioni di un telescopio sottomarino per neutrini di energia dell’ordine del TeV”
- 2008-2009 Tutor della Dott. R. Calcagno contrattista consorzio COMETA
- 2008-2009 Correlatore del lavoro di tesi di laurea della Dott.ssa A. Trovato dal titolo “Ottimizzazione delle prestazioni del telescopio per neutrini KM3NeT”
- 2009-2011 Supervisore della tesi di Dottorato del Dott. D. Lattuada dal titolo “Discovering the dark side of the Universe with neutrinos”
- 2010-2013 Tutor della tesi di dottorato del Dott.ssa A. Trovato dal titolo “Development of a reconstruction algorithms for large volume neutrino telescope and their application to KM3NeT detector” XXVI ciclo dell’ International Ph.D in Nuclear and Particle Astrophysics” dell’Università di Catania - Scuola superiore di Catania.
- 2014-2015 Correlatore del lavoro di tesi di laurea della Dott.ssa G. Ferrara dal titolo “Evaluation of the discovery potential of neutrino fluxes from Active galactic Nuclei with the KM3NeT detector”
- 2015 Tutor del lavoro di tesi di dottorato della Dott.ssa M. Durocher. La Dott.ssa M. Durocher è un PhD student del GSSI dell’Aquila
- 2015 Facente parte del “GNN Prize Committee” commissione internazionale GNN (Global Neutrino Network) per l’assegnazione di un premio per la migliore tesi di dottorato
- 2013- 2016 Tutor del Dott. Vladimir Kulikovskiy vincitore di una borsa postdoc per fisici sperimentali per stranieri da svolgere presso i LNS nell’ambito della collaborazione KM3NeT
- 2016 Facente parte del “GNN Prize Committee” commissione internazionale GNN (Global Neutrino Network) per l’assegnazione di un premio per la migliore tesi di dottorato.

## *Presentazioni a conferenze e seminari*

- 1/1992 Presenta nell'ambito del "XXX International Winter Meeting on Nuclear Physics" tenutosi a Bormio, il contributo orale dal titolo "MEDEA: a 4p Multi Element Detector Array for  $\gamma$ -rays and light charged particles at the LNS-Catania"
- 4/1993 Presenta nell'ambito di un workshop sulle emissioni di pre-equilibrio tenutosi a Milano, una relazione dal titolo "Studio del meccanismo di produzione di protoni veloci nelle reazioni indotte da fasci di  $^{40}\text{Ar}$  e  $^{132}\text{Xe}$  a 44 MeV/A"
- 10/1995 Presenta una relazione su invito al LXXXI Congresso Nazionale della Società Italiana di Fisica, tenutosi a Perugia, dal titolo "Emissione di pre-equilibrio in reazioni fra ioni pesanti alle energie intermedie"
- 1/1996 Presenta nell'ambito del workshop "LNShow" tenutosi presso i LNS, una relazione dal titolo "Emissione di pre-equilibrio in reazioni fra ioni pesanti"
- 10/1997 Presenta nell'ambito dell' "ECT\* Workshop on photons Probing Dynamics in Simple Systems (N-N and p-A Bremsstrahlung)" tenutosi a Trento, una relazione dal titolo "Emission of photons and protons with energies well above the kinematical limit in heavy-ion reaction at intermediate energie"
- 6/2000 Presenta una relazione su invito alla conferenza internazionale "Bologna 2000 – Structure of the nucleus at the dawn of the century" dal titolo "Energetic proton emission and reaction dynamics in heavy ion reactions close to the Fermi Energy"
- 7/2001 Presenta una relazione alla conferenza internazionale INPC 2001 tenutasi a Berkeley (U.S.A.) dal titolo "Hard gamma and energetic photons as probes of nuclear dynamics"
- 9/2001 E' stata invitata a tenere una relazione su invito dal titolo "Hard gammas and energetic photons as probes of nuclear dynamics" alla "IV latin American Symposium on Nuclear Physics" tenutasi a Città del Messico.
- 6/2002 Presenta una breve relazione su invito alla conferenza internazionale "Nuclear Chemistry Gordon Conference", tenutasi a New London (U.S.A.), dal titolo "Energetic proton production"
- 2/2005 Presenta una relazione all' "International Workshop on a Very Large Volume Neutrino Telescope for the Mediterranean (VLVnT02)" tenutosi a Catania dal titolo "Effects of architectural and environmental issues on a  $\text{km}^3$  detector"
- 2005 Nel comitato organizzatore locale dell' "International Workshop on a Very Large Volume Neutrino Telescope for the Mediterranean (VLVnT02)" tenutosi a Catania dall'8 all'11 Novembre 2005
- 9/2005 Presenta una relazione al "9th International Conference on Topics in Astroparticle and Underground Physics (TAUP2005)" tenutosi a Saragoza (Spain) dal titolo "Status Report on NEMO"
- 2006 Editore dei proceeding del "2nd International Workshop on very large Volume Neutrino Telescope (VLVnT02)" pubblicati su Nuclear Instrument and Method 567 Novembre 15, 2006.
- 9/2006 Presenta una relazione alla conferenza internazionale "Neutrino Oscillation Workshop (NOW2006)" tenutasi a Conca Specchiulla (Otranto, Lecce, Italy) dal titolo "Status of the NEMO project"
- 2/2007 Presenta una relazione al "Workshop on Nuclear and Neutrino Astrophysics (WNNA)" tenutosi a Catania dal titolo "Study of the performance of an underwater  $\text{km}^3$  neutrino telescope"
- 4/2008 Presenta una relazione alla conferenza internazionale "VLVnT08 International Workshop on a Very Large Volume Neutrino Telescope for the Mediterranean Sea" tenutasi a Tolone (France) dal titolo "KM3NeT: Optimization studies for a cubic kilometer neutrino detector"
- 1/2009 Invitata a tenere un seminario presso il Liceo Scientifico Boggiolera di Catania dal titolo "La fisica astroparticellare: un nuovo modo di guardare l'Universo"

- 10/2009 Presenta una relazione alla conferenza internazionale “VLVnT09 International Workshop on a Very Large Volume Neutrino Telescope for the Mediterranean Sea” tenutasi ad Atene (Grecia) dal titolo “Study of the sensitivity to point-like neutrino sources for a flexible-tower geometry for KM3NeT”
- 7/2010 Presenta una relazione alla conferenza internazionale “TeV Particle Astrophysics 2010” tenutasi a Parigi (Francia) dal titolo “KM3NeT: a project for an underwater cubic kilometre neutrino telescope”.
- 9/2010 Presenta una relazione alla conferenza internazionale “SciNeGHE 2010 8th Workshop on Science with the New Generation of High Energy Gamma-ray Experiments” tenutasi a Trieste dal titolo “First results of the ANTARES neutrino telescope”
- 4/2011 Presenta una relazione su invito al workshop “From Neutrino to multimessenger astronomy: status and perspectives” tenutasi a Marsiglia (Francia) dal titolo “KM3NeT:status and performance”
- 9/2011 Coordinatrice della sessione “Fermi Bubble/extended sources” al workshop MANTS2011 (Mediterranean Antarctic Neutrino Telescope Symposium) tenutosi a Uppsala (Svezia)
- 9/2011 Presenta una relazione al workshop Mediterranean Antarctic Neutrino Telescope Symposium (MANTS2011) tenutosi a Uppsala (Svezia) dal titolo “Fermi bubbles and extended sources”.
- 10/2011 Presenta una relazione al “Very Large Volume Neutrino Telescope Workshop (VLVnT11)” tenutosi a Erlangen (Germany) dal titolo “The KM3NeT high energy neutrino telescope and Fermi bubbles: some predictions”
- 11/2011 Tiene delle lezioni alla scuola nazionale “Methods of Analysis for Physics in Space, Earth and Sea (MAPSES)” tenutosi a Lecce (Italy) dal titolo “Tecniche di analisi per la ricerca di neutrini di alta energia di origine cosmica”
- 11/2011 Presenta una relazione al “International workshop on high energy geophysics: muon and neutrinos” tenutosi a Tokio (Giappone) dal titolo “ANTARES: the first operational neutrino telescope in the Mediterranean sea”.
- 7/2013 Presenta una relazione all’ “International Cosmic Ray Conference (ICRC2013)” tenutosi a Rio De Janeiro (Brasile) dal titolo “KM3NeT detection capability for high-energy neutrinos from the Fermi bubbles”
- 8/2013 Presenta una relazione al “Very Large Volume Neutrino Telescope Workshop (VLVnT13)” tenutosi a Stoccolma (Svezia) dal titolo “Sensitivity of the KM3NeT detector to a neutrino flux from the Fermi Bubbles”
- 9/2013 Presenta una relazione al “13th International Conference on Topics in Astroparticle and Undergrounds Physics (TAUP2013)” tenutosi a Asilomar California (U.S.A.) dal titolo “Status of the KM3NeT project”
- 10/2013 Presenta una relazione al workshop “Mediterranean Antarctic Neutrino Telescope Symposium (MANTS2013)” tenutosi a Wurzburg (Germania) dal titolo “KM3NeT and diffuse flux: preliminary results”
- 5/2014 Tiene una lezione alla scuola nazionale “XI Seminar on software for Nuclear, Subnuclear and Applied Physics” tenutosi ad Alghero dal titolo “Monte Carlo simulations and data analysis technics for high energy neutrino detectors”
- 9/2014 Presenta una relazione al “24<sup>th</sup> European Cosmic Ray Symposium (ECRS14)” tenutosi a Kiel (Germania) dal titolo “The KM3NeT project”.
- 10/2014 Nel comitato organizzatore locale della conferenza “The Roma International Conference on Astroparticle Physics (RICAP-14)” che si è tenuta a Noto dal 30 Settembre al 3 Ottobre.
- 10/2014 Invitata al workshop “Multiple Messengers and Challenges in Astroparticle Physics” organizzato nell’ambito del GSSI dell’ Università dell’Aquila che si è tenuto presso il Laboratorio Nazionale del Gran Sasso
- 9/2014 Fa parte del gruppo di lavoro “Figure of Merit” al workshop “Mediterranean Antarctic Neutrino Telescope Symposium (MANTS2014)” tenutosi al CERN (Germania) e presenta una relazione riassuntiva del lavoro del gruppo di lavoro dal titolo: “Figure of Merit: point-like sources”.
- 11/2014 Tiene un seminario dal titolo “Detectors for underwater experiments“ al IV Seminario Nazionale Rivelatori Innovativi tenutosi a Catania il 10-14 Novembre 2014

- 12/2014 Presenta una relazione dal titolo “KM3NeT” alla riunione di “What next: Oscillazioni di Neutrino” tenutasi a Padova il 1 e 2 Dicembre 2014
- 9/2015 Presenta la relazione su invito al “Very Large Volume Neutrino Telescope Workshop (VLVnT15)” tenutosi a Roma dal 14 al 16 Settembre dal titolo “KM3NeT-ARCA project status and plans”
- 9/2015 Coordinatrice della sessione “Physics results” alla conferenza Very Large Volume Neutrino Telescope Workshop (VLVnT15)” tenutosi a Roma dal 14 al 16 Settembre.
- 9/2016 Presenta una relazione al “25<sup>th</sup> European Cosmic Ray Symposium (ECRS16)” tenutosi a Torino (Italy) dal titolo “High-energy neutrino astronomy with KM3NeT/ARCA”.
- 9/2016 Fa parte del gruppo di organizzatore del workshop “Mediterranean Antarctic Neutrino Telescope Symposium (MANTS2016)” tenutosi al Mainz (Germania) e presenta una relazione dal titolo: “KM3NeT/ARCA prospect”.
- 11/2016 Tiene una relazione su invito dal titolo “KM3NeT muography project” al workshop “Mugraphers 2016” tenutosi a Tokyo Japan il 7 Novembre 2016
- 7/2017 Presenta una relazione dal titolo “The KM3NeT detection capability to a diffuse flux of cosmic neutinos” al 35<sup>th</sup> International Cosmic ray Conference (ICRC2017) tenutosi a Busan (Corea) il 12-20 Luglio 2017.
- 9/2017 Fa parte del gruppo di organizzatore del workshop “Mediterranean Antarctic Neutrino Telescope Symposium (MANTS2017)” tenutosi al Marseille (Germania).
- 9/2018 Tiene una relazione su invito dal titolo “First results and perspective of the KM3NeT/ARCA detector” al workshop “Neutrino Oscillation Workshop NOW2018” tenutosi a Ostuni Italy il 9 Settembre 2018

## Curriculum Vitae – David Mascali

### Personal Information

Name: **David Mascali**

Nationality: Italian

Date and place of birth: 23/07/1981, Catania - Italy;

Date of PhD: 12/02/2009

Email address: [davidmascali@lns.infn.it](mailto:davidmascali@lns.infn.it)

Residence: Via Felice Magri 49, 95123 Santa Maria di Licodia (CT)

### Professional record

- 01/02/2017 → Full Staff Researcher (Ricercatore a Tempo Indeterminato) at Istituto Nazionale di Fisica Nucleare – Laboratori Nazionali del Sud**
- 01/07/2015 – 31/01/2017 Temporary staff Researcher at INFN-LNS – RTD (until July 2017) at INFN-LNS, Catania in the framework of the ESS – European Spallation Source activities;**
- 02/06/2013 – 01/06/2015 Temporary staff Researcher at INFN-LNS – RTD, Catania in the framework of the ESS – European Spallation Source activities;**
- 03/09/2012 – 02/06/2013 Temporary staff Researcher at INFN-LNS – RTD, supported by EU funds in the framework of the European Collaboration ENSAR-ARES-JRA01; 01/01/2012**
- 03/09/2010 – 02/09/2012 Post-Doctorate fellow at INFN-LNS, Catania, Italy**
- 01/09/2009 – 31/08/2010 Post-Doctorate fellow at CSFNSM – Centro Siciliano di Fisica Nucleare e Struttura della Materia, Catania, Italy;**
- 01/02/2006 – 11/02/2009 PhD fellow University of Catania;**
- 24/01/2005 – 23/01/2006 Under-graduate fellow, supported by INFN;**

### Education

- **Feb. 2009** PhD in Physics “cum laude”, University of Catania. Tutor: Prof. S. Barbarino. Co-tutor: Dr. S. Gammino. Final dissertation title: “A new approach to the study of the ECR-Heating and Particle Dynamics in the plasma of Electron Cyclotron Resonance Ion Sources”.
- **Oct. 2005** Master Degree in Physics “cum laude”, University of Catania.

## Research Topics

Plasma Based Ion sources; Microwave-plasma interaction; Electron Cyclotron Resonance Ion Sources; Plasma and ion beams diagnostics methods; laser-matter and laser plasma interaction, multidisciplinary applications of plasmas in nuclear physics, material analysis, energy. RF based plasma diagnostics methods, plasma immersed probes (Langmuir Probe) and plasma-emitted radiation diagnostics (OES, X/γ ray detectors, interferometers). Simulation and modelling: plasma dynamics (heating, confinement) by MATLAB and FEM solvers, PIC/MC methods.

## Prizes and Awards

- **2018**                    **“National Prize Aquila d’Argento”** (the Silver Eagle) from the City of Misterbianco (Catania) for contribution in the scientific culture;
- **2012**                    **International “Richard Geller Prize”, Sydney, Australia**, as the best young scientist (<41 years old) producing worldwide outstanding results in the field of ECR Ion Sources science and technology;
- **2010**                    **“Francesco Resmini National Prize”, Firenze, Italy**, awarded by the INFN to the best Italian PhD thesis in the Accelerator Physics and related technology;
- **2005**                    **Fellowship by CERN, Genève, Switzerland**, supporting the participation to the “CERN Accelerator School” held in Zeegse, The Netherlands, from 24/05/2005 to 02/06/2005.

## Institutional Responsibilities

- **Jan. 2016 to now**        **Head of the Ion Beams Production Service**  
*Accelerators Division of INFN-LNS*. [Budget: ~200 k€/year]
- **2016**                    **Referee of the 5th INFN National Committee**, with responsibility about the experiment: PLASMA4BEAM.
- **2014**                    **Member of the Public Engagement group of INFN-LNS**, co-organizer of the European Research Night, Catania, Sept. 2014
- **2013-2014**            **Referee of the 5th INFN National Committee**, with responsibility about the experiments: COOLBEAM and BEAM4FUSION.

## Project Leadership

- **2017-2018**            **National responsible of the PANDORA experiment** [~180 k€]  
Supported by V Nat. Comm. INFN;  
*Status: Started in Jan. 2017.*





**European Projects and/or Collaborations where I work as member/contact person of research groups include:**

- **2013-2015 ESS – European Spallation Source** 500 k€\*  
Role: responsible at LNS of the magnetic and RF system design of the Proton Source (PS-ESS); responsible about plasma modelling and diagnostics; experimental tests.  
*\*funded by Italian government under European contract – Italian Ministry of Education, University and Research.*
- **ENSAR-ARES collaboration EU – FP7/2007–2013** 150 k€  
Role: responsible at LNS of plasma modelling and correlation between X-ray diagnostics and plasma ionisation and ion beam formation (Task 2).

**Other funds:**

**F.A.I. Funds provided by INFN for international collaboration and invitation of foreign scientists: 6 k€ (proponent and responsible)**

The proposal for the grant has been done in October 2012, assigned in January 2013, until March 2014. Invitation of Prof. F. Volpe from Columbia University – New York, and Prof. K. Wiesemann, Emeritus at the Ruhr University in Bochum, Germany.

**Invited Talks**

- **2018** [I2] **Società Italiana di Fisica, 104° Congresso Nazionale, Cosenza 17-21 Settembre 2018;**  
Title: *“Physics and applications of compact plasma traps”*
- **2016** [I1] **The 2nd Sicily-East Asia Workshop on Low-energy Nuclear Physics, Tokyo (Wako) – RIKEN 26-28 June 2016.**  
Title: *“Compact traps for dense and hot plasmas: from ion sources to multidisciplinary research”*
- **2014** [I2] **Società Italiana di Fisica, 100° Congresso Nazionale, Pisa 22-26 Settembre 2014;**  
Title: *“Research and development about innovative high intensity proton sources: the INFN-LNS contribution to the construction of the European Spallation Source facility”*
- **2013** [I3] **ENSAR Town Meeting, June 17-20, 2013 - Warsaw, Poland;**  
Title: *“Investigation of plasma heating and multi-charged ions build-up in ECR plasmas”*  
  
[I4] **XXI CONGRESSO AIV, Catania, 15-17 May 2013;**  
Title: *“Application of plasma techniques to Archeometry, Polymers technology and Nuclear Physics”*
- **2012** [I5] **20th ECRIS Workshop, Australia, Sydney, September 26th 2012; “Geller Prize Ceremony”**  
Title: *“A “simple” model of ECRIS plasma”*

- **2011** [I6] **14<sup>th</sup> International Conference on Ion Sources (ICIS2011)**, Giardini Naxos (ME), Italy, September 12-16 2011;  
Title: *“Towards a better comprehension of Plasma formation and heating in Electron Cyclotron Resonance Ion Sources”*
- [I7] **19<sup>th</sup> Topical Conference on Radio Frequency Power in Plasmas and the US Japan RF Physics Workshop**  
June 1-3, 2011, Newport (RI), USA;  
Title: *“RF heating of Electron Cyclotron Resonance Ion Sources plasmas”*

## Oral Presentations

- **2018** [O1] **4<sup>th</sup> incontro Nazionale di Fisica Nucleare**  
November 2018, Laboratori Nazionali del Sud (Catania, Italy)  
Title: *“Magnetized Plasmas in Compact Traps for Astrophysics and Nuclear Astrophysics”*
- **2016** [O2] **Intense and powerful accelerator beams for industrial and energy application (IPAB 2016)**  
March 14- 15 2016, Laboratori Nazionali di Legnaro, Legnaro (PD)  
Title: *“Perspectives about the production of multiply-charged ions at high intensities: Innovative schemes of microwave-to-plasma matching”*
- **2015** [O3] **16<sup>th</sup> International Conference on Ion Sources (ICIS2015);**  
August 23-28, 2015 New York New York City – USA  
Title: *“Investigation of plasma heating and multi-charged ions build-up in ECR plasmas”*
- [O4] **Mini-workshop on Accelerators;**  
17 February 2015, INFN Laboratori Nazionali di Legnaro, Italy  
Title: *“INFN contribution to ESS project”*
- **2013** [O5] **XCIX Congress of the Italian Physical Society;**  
Trieste (Italy) September, 23-27, 2013  
Title: *“Innovative plasma heating methods in compact magnetic traps and expected applications in multidisciplinary fields: Archaeometry, Nuclear Physics, Polymers Chemistry”*
- [O6] **15<sup>th</sup> International Conference on Ion Sources (ICIS2013);**  
Chiba-Tokyo, Japan, 9th-13th September 2013  
Title: *“X-ray spectroscopy of warm and hot electron components in the CAPRICE source plasma at GSI testbench”*
- **2012** [O7] **European Conference on X-ray Spectroscopy (EXRS-2012);**  
18-22 June 2012, Vienna  
Title: *“Preliminary investigation of X-ray emission from an innovative trap based on Bernstein waves heating”*

- **2010**      **[O8] 19<sup>th</sup> International Workshop on ECR Ion Sources;**  
Grenoble, France, August 23-26, 2010  
Title: *“Some considerations about frequency tuning effect in ECRIS plasmas”*
- **2009**      **[O9] 4<sup>th</sup> Workshop Plasma Production by Laser Ablation (PPLA);**  
18-20 June 2009, Messina, Italy  
Title: *“Numerical simulations of the ion capture process for laser generated plasmas interacting with electron cyclotron resonance ion sources”*  
  
**[O10] Congress of the Italian Physical Society;**  
28 Sept.-03 Oct. 2009, Bari (Italy).  
Title: *“Alternative plasma heating methods in ECR ion sources”*
- **2007**      **[O11] 34<sup>th</sup> European Physical Society Conference on Plasma Physics;**  
Warsaw, Poland, July 2007.  
Title: *“Enhancement of the electron confinement and temperature by means of the Two Frequency Heating in ECR Ion Sources plasmas”*
- **2006**      **[O12] 22<sup>nd</sup> Symposium on Plasma Physics and Technology;**  
SPPT 2006. Prague, June 2006.  
Title: *“Microwave Technology for the boost of performances in ECR Ion Sources”*

## Invited Seminars/Lectures

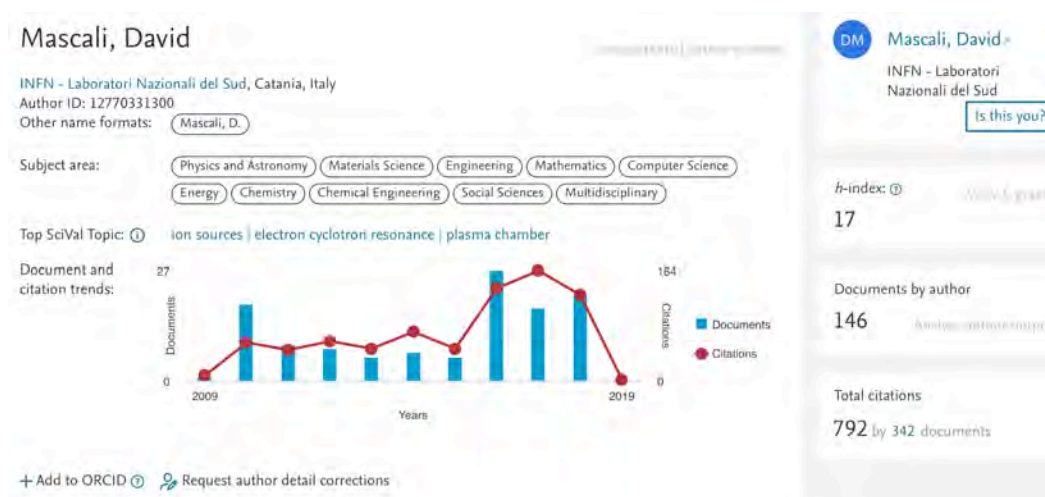
- **2019**      **Università degli Studi di Bologna, Italy**  
**“Aperitivo Scientifico”**  
February 1<sup>st</sup>, 2019  
Title: *“Magnetized Plasmas in Compact Traps for Astrophysics and Nuclear Astrophysics”*
- **2017**      **Telescopio Nazionale Galileo – La Palma (Canary Islands)**  
**TNG/NOT SEMINAR**  
May 24<sup>th</sup>, 2017  
Title: *“The PANDORA project: Plasmas for Astrophysics, Nuclear Decays Observation and Radiation for Archaeometry”*
- **2015**      **Goethe Universitat, Frankfurt (Germany)**  
November 20<sup>th</sup>, 2015  
Title: *“Non-invasive diagnostics tools for ECR plasmas: from microwave interferometry to X-ray spectroscopy and imaging”*
- **2012**      **IX Seminar on Software for Nuclear, Subnuclear and Applied Physics**  
28 May to 01 June 2012, Porto Conte, Alghero

Title: "Some strategies for modeling magnetically confined plasmas"

- **2013**                    **Università degli Studi di Catania, Electromagnetic Waves Propagation course, Telecommunication Engineering;**  
January 2013  
Title: "Plasma Physics bases in ECR Ion Sources and simulation strategies"
- **2009**                    **Michigan State University – National Superconducting Cyclotron Laboratory (MSU-NSCL);**  
March 19<sup>th</sup>, 2009  
Title: "A new approach to the study of the ECR heating and particle dynamics in the plasma of ECR Ion Sources"

## Publications

- **110 publications in refereed international journals:**
  - 80 without PhD supervisor;
  - 20 without PhD supervisor and PhD co-tutor;
  - 18 as first author, 20 as second/corresponding author;
  - almost 800 citations on Scopus;
  - over 1150 by Google Scholar.
- **70 contributions to conferences and workshop proceedings;**
- **h-index 17** according to SCOPUS, **h-index 19** according to Google Scholar.



## Committees Membership and Organization

- **2018**                    **Member of the Organizing Committee of the 23<sup>rd</sup> International Workshop on ECR Ion Sources, Catania (Italy) September 10<sup>th</sup> – 14<sup>th</sup> 2018**
- **2017**                    **Member of the International Scientific and Program Committee at the 17<sup>th</sup> International Conference on Ion Sources, Geneva (Switzerland) October 15<sup>th</sup> – 19<sup>th</sup> 2017**

- **2015**            **Member of the International Scientific and Program Committee** at the **16<sup>th</sup> International Conference on Ion Sources, New York City (USA)** August 24<sup>th</sup> – 28<sup>th</sup> 2015  
  
Since Oct. 2015 → **Member of the European Spallation Source Editorial Board;**
- **2013**            **Member of the International Scientific and Program Committee** at the **15<sup>th</sup> International Conference on Ion Sources, Chiba-Tokyo (Japan)**, September 9<sup>th</sup> – 13<sup>th</sup>
- **2011**            **Scientific Secretariat** at the **14<sup>th</sup> International Conference on Ion Sources, Giardini Naxos (Italy)**, September 12<sup>th</sup> – 16<sup>th</sup> 2011, September 9<sup>th</sup> – 13<sup>th</sup>

## **Career Supervision and Coordination**

- Tutor of n. **6 PhD students in Physics**, University of Catania: 4 completed
  - Nadia Gambino, now at ETH – Zurich;
  - Rosalba Miracoli, now at ESS – Bilbao;
  - Giuseppe Castro, now post-doc fellow at INFN-LNS;
  - Carmen Altana, in progress at INFN-LNS;Two in progress: Eugenia Naselli, since 2017; Aref Eshkrafi (now starting)
- Tutor of n. **1 PhD students in Telecommunication Engineer**, University of Reggio Calabria;
  - Giuseppe Torrisi, now post-doc fellow at INFN-LNS;
- Co-tutor of n. **10 Master degree Thesis in Physics**: Catania University, Faculty of Natural, Mathematical and Physical Sciences, Department of Physics and Astronomy, AY (since) 2006/2007 (to) 2016/2017.
- Co-tutor of n. **20 Bachelor (10)/Master(3) degree Thesis in Engineer** (Telecommunications, Mechanics, Electronics, Informatics, Automation, Controls and Sensing): Catania University, Faculty of Engineer, AY (since) 2005/2006 (to) 2017/2018.
- Tutor of the Liceo Scientifico Capizzi, Bronte (Catania, Italy) for the “Beamline for School” organized by CERN, Geneva (2016/17).

## **Stages & Training**

- Tutor of **N. 7 students of the Catania University for the 240 hours stages** (n. 2 from TLC Eng., n.1 from Mechanics and Industrial Eng., n.1 from Management Eng., n.1 from Informatics Eng., n.2 from Sensing and Autom. Eng.)

### **Teaching Activity:**

- i) lecturer for the **class of “Electromagnetism”**, AY 2006/2007 in the framework of Degree Course in Physics, Catania University.
- ii) Lecturer at the **“Workshop Nazionale sul Calcolo Computazionale in Fisica Nucleare e Applicata”**, organized by INFN 31-May-2012, Alghero (Italy).
- iii) Lecturer at the **PhD school of the Messina University**, 23 Feb-2010, Physics Dpt., about Magnetically Confined plasmas.
- iv) Lecturer at the **“Accelerator Physics Course”**, Università degli Studi di Catania, 2014-2018.

### **International Cooperation [Contact Person]**

The prominent role played by INFN-LNS in the field of Accelerator/Ion Sources physics and technology has permitted to activate a number of international collaborations with European and American partners. The ones in which I played a major role are:

- **ESS-Bilbao – INFN-LNS MoU** under approval (contact person at INFN-LNS D. Mascali, at ESS-Bilbao I. Bustinduy;
- **Goethe Universitat, Frankfurt**, Germany, for beam dynamics issues and beam diagnostics [*K. Schulte, O Meusel*];
- Within the **ESS – European Spallation Source collaboration**, frequent contacts with European partners from CEA-Saclay (France) [*R. Gobin, O. Tuske*], ESS-Bilbao (Spain) [*R. Miracolì*], ESS-Lund (Sweden) [*A. Ponton*].
- Member of the **ENSAR-ARES collaboration** in the frame of European Union – Seventh Framework Programme FP7/2007–2013. Principal partners: **GSI – Darmstadt** [*K. Tinschert, F. Maimone, P. Spaedke*], Germany, **ATOMKI Debrecen** [*S. Biri, R. Racz*] (Hungary), **Jyvaskyla University** (Finland) [*H. Koivisto, O. Tarvainen*], **INFN-LNL** [*A. Galatà*];
- **Max Planck Institute**, Institute of Plasma Physics, **Greifswald** (Germany) [*Prof. H. Laqua*];
- **Ruhr University in Bochum** (Germany) [*Prof. K. Wiesemann*];
- School of Physical Sciences and **National Centre for Plasma Science and Technology, Dublin City University, Glasnevin, Dublin 9, Ireland**;
- **Columbia University, Institute of Applied Physics and Applied Mathematics**;

### **Editorial Activity**

**2019 – Guest Editor of Journal of Instrumentation**, edited by SISSA and IOP, for the book of proceeding at the ECRIS-Workshop 2018.

Refereeing for international journals:

- *Physical Review Letters*;
- *Physical Review - Special Topics on Accelerators and Beams*;
- *Plasma Sources Science and Technology*;
- *Nuclear Instruments and Methods in Physics Research*;
- *Review of Scientific Instruments*;
- *Heliyon – Elsevier*;
- *Indian Journal of Physics*.

## Track Record of the Research Activities

*[The 10 selected papers are cited in the activities description as P1, P2, .... Oral and Invited presentations listed above, are references as O1, O2..., I1, I2,....]*

### *General Overview*

The scientific activity has been focused on the **investigation about a better coupling between electromagnetic waves and plasmas inside Electron Cyclotron Resonance Ion Sources in order to increase the Particles Accelerator Performances**. High-performance plasma based ion sources will play a role of increasing importance in the next future, for feeding particle accelerators devoted to Nuclear Physics and Applied Research. The goals have been oriented **to obtain larger plasma densities, more rapid electron heating, then a fast production of singly or multi-charged ions** [O1].

The further development of these machines is nowadays limited by technological constraints (the use of microwave generators above 28 GHz for the plasma heating, and the design and construction of compact magnetic traps made of superconducting magnets). The idea of the entire research activity has been to increase the knowledge about the plasma physics underlying the ion beam generation mechanism, in order to make a significant step forward in terms of overall performances. This has allowed **to discover several interplays between the microscopical plasma parameters – especially the electron energy distribution function and the structural distribution of the plasma density – and the beam quality, namely the current, the average charge state, and the emittance**. The obtained results based on plasma diagnostics and plasma modeling are now allowing to optimize the performances of the existing devices (it is evident in the operations of the ion injectors of the LNS superconducting Cyclotron, where I'm serving as ion beam production service responsible), and of the ones that will be designed and constructed in the next future.

The results obtained in the scientific carrier have constantly supported the **R&D activities of INFN-LNS ion sources group, which plays a worldwide leading role in the design, construction and characterization of ion injectors for particles accelerators, and in the framework of international collaborations and research projects, such as the ENSAR-ARES collaboration (in the frame of the FP7/2007–2013) and the European Spallation Source. The gained know-how will be valuable in the perspective of the Superconducting Cyclotron upgrade at LNS**, in terms of intense ion beams production for the expected, challenging experimental activities (e.g. the NUMEN project, etc.).

More specifically, **the activities concern the following topics:**

- **Intense Beam production for Accelerator Physics and Technology;**
- **Improvement of ion beam currents and average charge states** extracted from plasma-based, highly performing ion sources (ECRIS-Electron Cyclotron Resonance Ion Sources);
- **Improvement of beam quality (emittance, brightness) and reduction of beam ripple and halos; improvement of the ion sources reliability;**
- **Propagation of electromagnetic waves** in the microwave range inside non-isotropic-nonhomogeneous media (**strongly magnetized plasmas**);
- Study of **microwave-based devices** (cavities, generators, amplifiers) of interest in the field of **R&D on plasma based Ion Sources;**
- **Plasma diagnostics:** electrostatic, electromagnetic (interferometry), X-rays spectroscopy;



- Non-linear interaction of electromagnetic waves with high density plasmas;
- **Laser matter interaction, laser generated plasmas** and studies on nuclear fusion reactions at moderate ion energies;

**The improvement of the ion beam formation mechanism from high density plasmas requires advanced plasma diagnostics tools explicitly designed for compact sources: among the others activities, this led to the VESPRI proposal – approved by the INFN 5<sup>th</sup> Nat. Comm. in 2014 – in which I served as PI, for the design and construction of the first microwave interferometer devoted to compact plasma-based ion sources.**

The activities concerning the development of advanced plasma heating and confinement methods, and of plasma diagnostics for the on-line monitoring of density, temperature and charge state distribution, have triggered the idea of **an innovative scenario for studying nuclear decays, especially the ones governed by the electroweak interaction. The proposal, called PANDORA (Plasma for Astrophysics, Nuclear Decays Observation and Radiation for Archaeometry), proposed as PI, has been evaluated very well by the INFN 3<sup>rd</sup> and 5<sup>th</sup> Nat. Comm. during 2016, and accepted by the 5<sup>th</sup> Nat. Comm. for the last evaluation step, in September 2016.** PANDORA will be a feasibility study of a future facility based on a high performance magnetic trap, in which the plasmas become the environment for measuring for the first time **nuclear decays rates in stellar-like conditions, such as <sup>7</sup>Be decay and beta- decay** involved in s-process nucleosynthesis, as a function of the ionization state of the ions. These studies are of paramount importance in both stellar and primordial nucleosynthesis, e.g. **the determination of solar neutrino flux and <sup>7</sup>Li cosmological problem.** Several interesting results are expected in other field of research, following a multidisciplinary approach, and especially in Astrophysics – e.g. spectropolarimetric observations in the visible, UV and X-ray domains, offering breaking-through advancements in observational astronomy –, and by making the plasma as an exceptional source of electromagnetic radiation, for applications in material science and Archaeometry.

In the following sections, the most representative and original contributions in these fields are described and commented.

***The explanation of the Frequency Tuning Effect in ECR ion sources for the improvement of output current and charge states.***

After the participation to the data analysis of the experiments performed in Catania during the period 2004/2005, and then at GSI in 2006, highlighting for the first time the Frequency Tuning Effect (FTE), **a model to explain the sensitivity of ECRIS plasma to the pumping frequency tuning was proposed in the PhD thesis**, including other innovative techniques for the optimization of plasma heating.

The explanation of the FTE – **a method that has for instance permitted to increase of a factor 1.5 to 3 the performances of any source**, e.g. CAESAR and SERSE at LNS, Supernanogan at the CNAO (the national hadrontherapy facility), the sources of INFN-LNL, etc. – was based on a new model of the wave-to-plasma interaction in ECRIS, based on the persistence of standing waves inside the plasma chamber even in case of a dense plasma contained inside of it. This contribution was **recognised by INFN, awarding the Francesco Resmini national Prize** to the PhD thesis in Florence, February 2010. The main results were also presented to the scientific community at the EPS-Conference on Plasma Physics [O2] in 2007 and at the 19<sup>th</sup> ECRIS international workshop held in Grenoble in 2010 [O3].

### ***Studies about innovative heating methods***

In the meanwhile the studies about the coupling of microwaves with ECR heated plasma were progressing, **alternative heating schemes – based on the indirect excitation of plasma waves – were explored, starting from 2008. This topic still represent an “unicum” in the ECRIS community, since never in the past the generation of the plasma via inner-plasma modal conversion has been attempted in these machines. The advantages would be huge, especially in the boost of the plasma density, then of the ion beam current intensity.** This topic has a strict interplay with thermonuclear fusion research, since in that field the plasma density limitation is also an issue limiting the fulfillment of the Lawson criterion.

**In September of 2008 I was visiting the Max Planck Institute in Greifswald, Institute of Plasma Physics, where the research group on plasma heating was attempting to establish a O-X-B modal conversion scenario.** This technique consisted in the conversion of the incoming electromagnetic wave into a plasma (matter) wave named “Electron Bernstein Wave”, thus bypassing the intrinsic limit of the plasma density due to the well-known electromagnetic cutoff. The experiment was performed on the WEGA-Stellarator, a relatively small-size reactor for thermonuclear fusion research. **During the joint activities, coordinated by prof. H. Laqua, it was possible to test the different emission of X-rays from the plasma when operating in ECR or EBW heating mode.** In the years 2009-2010 a similar experiment was attempted at INFN-LNS, working with a small-size ECR ion source prototype called “Plasma Reactor” [P1]. The theoretical explanation of the frequency tuning effect, with particular regard to the influences on ions dynamics, as well as the correlation between the magnetic field profile and the generation of suprathermal electrons in third generation ECRIS, and finally the preliminary observation of **EBW-heating in a small-size reactor at INFN-LNS**, were the main topics of **two invited talks [I1, I2], in 2011**, presented at the Joint Meeting of the 19th Topical Conference on Radio Frequency Power in Plasmas and the US Japan RF Physics Workshop, **organized by the Princeton Plasma Physics Laboratories**, and held in Newport (RI), USA, in June, and **at the 14th International Conference on Ion Sources (ICIS2011), organized by INFN** and held in Giardini Naxos (ME), Italy, in September. In this last occasion, **an invited paper was published on Review of Scientific Instruments**, highlighting the perspectives of plasma heating in ECR ion sources in the next future [P2].

### ***Impact of the developed plasma modeling and diagnostics in ECRIS physics and technology***

The experiments performed about FTE and plasma waves generations were supported by numerical modeling of the wave-to-plasma interaction, which started already during the Master Degree thesis, then continuing in the PhD phase and in the following years. The relevance of the scientific results were **recognized in 2012 with the “International Richard Geller Prize”, assigned every two years to the best young scientist (<41 years old) who has produced an outstanding work for progresses in ECRIS science and technology.** The prize was awarded in Sydney, Australia, during the 20<sup>th</sup> International Workshop on ECRIS (ECRIS’12), and **a plenary lecture was given [I3]. In the prize motivations, the development of advanced numerical modeling of ion sources plasmas was explicitly mentioned.**

The activity on plasma dynamics investigation was further carried out by working on both theoretical modeling and experiments performed by means of on-purpose developed diagnostics tools. In the framework of the ENSAR-ARES collaboration a strict **synergy with European laboratories working in the field of plasma-based ion source was reinforced by joint experimental activities, in particular with GSI-Darmstadt (Germany) and ATOMKI-Debrecen**

**(Hungary) groups.** The results of the experiments proposed to both the laboratories, then accepted and performed in 2013 and 2014, were presented during the ENSAR-ARES town meeting [I4] in Warsaw (June 2013), and during the **15<sup>th</sup> and 16<sup>th</sup> International Conferences on Ion Sources** held in Chiba (Tokyo) – Japan, during September 2013, and New York City, USA, in August 2015 [O2, O5]. For the first time, the plasma X-ray emission in the 2-30 keV energy domain, that is ascribed to the so-called “warm electrons” (the responsible of the stepwise ionization), was characterized as plasma volumetric emission (at GSI in 2013, [P3] and as space resolved emission by means of an X-ray pin-hole camera (at ATOMKI, Hungary, in late 2014) versus the pumping wave frequency, the magnetic field strength and the input RF power [P4].

Several efforts were paid to the investigation of **plasma heating under different magnetic field profiles and RF field configurations [P5]** and to correlate the impact of the internal plasma structure with the properties of the ion beam, i.e. other than on the current and charge states, on the real space and phase space structure (the emittance, especially, *D. Mascali et al. Review of Scientific Instruments 81 (2), 02A334*).

**With the aim to improve the performances in terms of output beam currents and overall reliability, innovative methods of electrons injection into the plasma [P6]** developed in collaboration with INFN-Bologna and CNR-IMM Bologna colleagues have been studied.

The underlying idea in the above-mentioned research activities is that any further development of ECR ion sources in the next future will be based on a significant boost of the plasma density that can be attained by a very precise characterization of the plasma structure and temperature distribution. **The project VESPRI, led since early 2015, aimed just to measure in a non-invasive way the 1D profile of the plasma density. The first result worldwide of a plasma density measurement via microwave interferometry inside an ECR ion source has been obtained by VESPRI right in early 2016, and it is now under refereeing** (*D. Mascali et al. Letter to the Editor of Rev. Sci. Instrum., sbmitted*), while some papers have been already published by PhD students tutored in the frame of VESPRI, especially as concerns the conceptual and the design phase.

The expertise gained in the field of plasma modeling and plasma diagnostics in compact traps has additionally permitted to argue “non-classical” applications of these machines. In particular, the use of **ECR heated plasmas in compact magnetic traps as environment for investigating nuclear decays of astrophysical and cosmological interest has been proposed, under the Grant PANDORA submitted to the 5<sup>th</sup> Nat. Comm. of INFN.** The proposal has overcome the first selection phase.

Ideas concerning new diagnostics and **perspectives beyond the current scheme of operations for ECR ion sources have been recently included in a review paper published by IEEE-Transactions on Nuclear Science [P7].**

#### ***Additional impact of the plasma modeling and diagnostics: from Laser Generated Plasmas to Charge Breeding mechanism***

The plasma modeling activity, coordinated by involving several MS and PhD students in Physics and Engineering, has continued along the years, providing valuable results on the basis of a self-consistent approach [P8]. The versatility of this approach, and the relevance of the obtained results, are demonstrated by the several contexts in which the method has been applied. The quasi-PIC (Particle-In-Cell) approach has been applied in **laser generated plasmas also**, investigating the early stage of the plasma plume generation in case of plasmas produced by ablation of solid (metallic) targets interacting with ns pulses at  $10^{12} - 10^{14}$  W/cm<sup>2</sup>. The results have been published in a letter [P9]. Diagnostics of these kind of plasmas has been published in other

papers, giving valuable information on the plasma energy distribution function (e.g. *L. Torrisi, D. Mascali et al. Journal of Applied Physics 107 (12), 123303*).

In the same field of research, **a collaboration was activated with the Dublin University** (Dublin City Univ, Natl Ctr Plasma Sci & Technol, Dublin 9, Ireland) for investigating the dynamics of colliding plasma plumes expanding at supersonic velocities (*N. Gambino; P. Hayden; D. Mascali; et al. Applied Surface Science 272(69-75), 2013*). These plasmas have the potentiality to become an environment for investigating nuclear fusion reactions at extremely low temperatures (<1-2 keV) to be compared with stellar systems.

**The ECR plasma modeled on the basis of these simulations has been used as a “plasma target” for reproducing numerically the charge breeding mechanism**, such as the case of  $\text{Rb}^{1+}$  ions interacting with the plasma of an ECR ion source in an ISOL-like facility for exotic nuclei production [P10]. **These activities have been carried out in a strict synergy with INFN-LNL and in the framework of the European EMILIE collaboration. They are important for future developments of the SPES facility and also represent valuable results in the perspective of radioactive beams injection in magnetic traps such as the one we would like to develop in the framework of the PANDORA proposal.**

Experiments on **novel plasma heating schemes**– especially focused on the **production of intense beams of protons or other light ions** – have shown for the first time the **possibility to use EBW-heated plasmas as sources of electromagnetic radiation. Preliminary results have been presented at the European Conference on X-ray Spectrometry, EXRS-2012, held in Vienna (Austria), in June 2012 [O6].** Experimental techniques developed for plasma emitted radiation measurements have been preliminary applied for material characterization, in collaboration with the colleagues of INFN-LNS, CNR and Landis laboratory working on the **application of X-ray spectroscopic techniques to the Cultural Heritage Field** (*P. Romano, C. Caliri, ..., D. Mascali, ... et al., published on Analytical Chemistry, 86 (21), 10892-10899, 2013*).

### ***Impact of the plasma studies on the production of intense beams of protons***

Ideas concerning new diagnostics and **perspectives beyond the current scheme of operations for ECR ion sources were important for the design of the high performing proton injector of the European Spallation Source. For the first time (as discussed during the invited talk [I2], at the SIF congress in 2014), I proposed the use of a flexible magnetic system for a microwave discharge ion source, based on three different configurations:**

- **Flat-B field for off-resonance plasma heating;**
- **Simple mirror for the optimization of the proton fraction;**
- **Magnetic-beach for the boosting of the modal conversion, then of the plasma density;**

**The same scheme was adopted for the design of the Flexible Plasma Trap, then becoming a test-bench of the ESS proton injector. The FPT was designed in the framework of the INFN 5<sup>th</sup> Nat. Comm. experiment named UTOPIA, in which I played a major role in the proposal writing and experimental activities coordination.**

The modeling activities developed in parallel were very useful to explore the relative weight of the plasma heating parameters in the definition of the proton/ $\text{H}^{2+}$  abundances in the plasma.

**These results were helpful also in the framework of the Daedalus collaboration**, coordinated at LNS by Dr. Luciano Calabretta. The aim was to increase the intensity of beams accelerated by high

intensity cyclotrons, using the  $H^{2+}$  molecule. **A new plasma chamber was designed and tested by one of the coworkers in Canada**, at the Best Company facility in Vancouver (*G. Castro et al., accepted for publication on Rev. Sci. Instrum.*).

#### ***Impact of the research activity in the future design of plasma based ion sources***

The results obtained in the last five years especially, have opened the road to a new approach in the design of future ion sources. The single-pass RF energy absorption efficiency at the Electron Cyclotron Resonance Layer is rather poor, and it is still difficult to drive energy deposition to specific parts of electron population in the phase space. **A "microwave absorption optimization-oriented" design, based on the control of the electromagnetic radiation by a dedicated RF launcher, must be implemented. One of these launchers has been designed by Telecommunication Engineering colleagues under my supervision for driving modal conversion for the first time in a compact ECR ion source**, namely the Flexible Plasma Trap at LNS (*G. Torrasi et al. accepted for publication on Microwave Optical Letters*).

Along with new schemes of waves' launching, very innovative concepts of ion beams production from high temperature/high density plasmas have been explored. One of the tutored MS degree students in Physics moved in 2013 to **Columbia University in New York City, USA**, with a post-degree fellow. **The collaborative activities were fruitfully dedicated to the conceptual design study of a toroidal ECR ion source** as a new paradigm of multiply-charged ion production for particles accelerators. The beam extraction issues were also explored (*C. Caliri, D. Mascali, F. Volpe, NIM-A, 790 (57-63) – 2015*).

#### ***Team coordination, Training of students, Tutoring***

**The several laboratory and modeling activities have involved a number of students in Physics and Engineering. I served as tutor or co-tutor of more than twenty Bachelor, MS, PhD thesis.** The activities of VESPRI have been carried out with the valuable contribution of MS and PhD students from the Catania and Reggio Calabria University, Faculty of Telecommunication and Electronics Engineering.

The modeling efforts have been also supported by students coming from Computer Science and Informatics Faculty of the Catania University.

The mechanics and the control systems of the different designed devices have been supported by stages and training periods of students coming from Mechanics Engineering and Automation and Sensing Engineering Faculty of the Catania University.

The main achievements of the valuable team-working activity have been presented during the last International Conference on Ion Sources, held in New York City in August 2015. A total of thirteen contribution were presented, most of them by PhD/post-doc students coordinated in the framework of the VESPRI Grant, then published after peer review on *Rev. of Scientific Instruments*. It is worth mentioning the multi-field approach with papers covering a variety of topics such as:

- **advanced X-ray plasma diagnostics** (*D. Mascali et al, Review of Scientific Instruments 87(2):02A510*), in collaboration with colleagues of the Hungarian Academy of Sciences;
- **microwave interferometry** (*G. Torrasi, D. Mascali et al., Review of Scientific Instruments 87(2):02B909*);
- **non linear wave-plasma interaction** (*G. Castro, D. Mascali et al. Review of Scientific Instruments 87(2):02A507*);
- **ion beam diagnostics** (*D. Nicolosi, L. Cosentino, D. Mascali et al. Review of Scientific Instruments 87*);



***Detailed Personal contribution to National or International Grants and Collaborations***

<p>2006 - 2008 <b>INES</b> Experiment of the 5<sup>th</sup> Nat. Comm. of INFN.</p>	<p>I coordinated the activities about electromagnetic wave interaction with the strongly magnetized plasma of an Electron Cyclotron Resonance Ion Source. In particular, I promoted the <b>development of a MATLAB based numerical code in order to investigate the impact of resonant modes established into the plasma chamber on the electron heating process</b>. The major inputs to these activities came from the direct experience gathered in preparing lectures for "Electromagnetic Field", given at the Catania University Science Faculty, Degree course in Physics.</p>
<p>2009 - 2011 <b>HELIOS</b> Experiment, <i>in the framework of the Strategic Project NTA-INFN (Nuove Tecnologie di Accelerazione).</i></p>	<p>I coordinated the task concerning experimental and theoretical activities about new mechanisms of plasma heating, based on the inner plasma conversion of an electromagnetic wave into a plasma wave. In this framework in September 2008 at the <b>Max Planck Institute for Plasma Physics, Greifswald, Germany</b>, I attended to the <b>already mentioned joint experiment</b> about microwave coupling to toroidal plasmas contained in a Stellarator-like machine named WEGA. <b>Another experiment was carried out at the Michigan State University</b>, National Superconducting Laboratory, in December 2009. The latter put the basis for a more deep understanding of non-linear wave-to-plasma interaction under specific profiles of the confining magnetic field. Another output of these activities, to be finalized within the UTOPIA experiment is the design of a complex setup of microwave amplifier to optimize the microwave to plasma coupling under the so-called TCFH - Two Close Frequency Heating scheme.</p>
<p>2009 - 2011 <b>CANTES</b> Experiment of 5<sup>th</sup> Nat. Comm.</p>	<p>The experiment aimed to plasma density increase inside ECRIS by means of auxiliary electrons launched by carbon nanotubes based electron guns. <b>The activities concerning the modeling of electron capture and plasma diffusion modification due to the CNT emitted electron beams were under my responsibility</b>. I proposed an original model to explain the plasma density increase and the damping of plasma turbulence (due to non-linear plasma-wave coupling) as a consequence of the anisotropic plasma diffusion rates modification under the effect of auxiliary electron currents flowing along the metallic walls of the plasma chamber <b>[P6]</b>.</p>
<p><b>INFN-MED</b> Strategic Project of INFN</p>	<p><b>This project supported my idea of an experiment at Michigan State University, National Superconducting Cyclotron Laboratory</b>, about the investigation of the plasma X-ray emission under slightly different gradients of the magnetic field at the ECR layer. <b>The results of such measurements were of paramount importance in the design of the AISHa – Advanced Ion Source for Hadrontherapy</b>, supported by regional funds under the PO-FESR European Program.</p>
<p>2012-2015 <b>UTOPIA (then, RDH)</b> National Experiment of</p>	<p>In this framework I coordinated the activities concerning the design of microwaves antennas able to improve the coupling of the incoming electromagnetic waves to high energy plasma waves which can sustain plasmas above the critical density. I also designed microwave</p>

<p><i>the 5<sup>th</sup> Nat. Comm. of INFN.</i></p>	<p>diagnostics in order to electromagnetically characterize the resonant cavity working as plasma chamber, and to detect evidences of mode conversion via the introduction of small antennas inside the plasma.</p>
<p><b>2012-2014</b> <b>ESOPO</b> <i>National Experiment of the 5<sup>th</sup> Nat. Comm. of INFN</i> <b>LNS Responsible</b></p>	<p><b>I served as the coordinator of the ESOPO experiment at INFN-LNS.</b> The activity was specifically focused to the design of a plasma based "electrostatic lens" able to focalize high intensity ion beams along the so-called LEBT (Low Energy Beam Transport line). <b>A collaboration was activated with Goethe University in Frankfurt</b>, for the use of electron beams as boosters of the electron density in Gabor lenses. The idea that I proposed to the colleagues of the Goethe University was to inject such auxiliary electrons by breaking the azimuthal symmetry of the lens magnetic field. <b>The test-phase has been completed and an experiment is expected soon in Frankfurt, funded by the Institute of Applied Physics of the Goethe University, under the EDEN activities. I'm now playing the role of contact person.</b></p>
<p><b>2014-2016</b> <b>VESPRI - National Experiment of the 5<sup>th</sup> Nat. Comm. of INFN</b> <b>National Responsible</b></p>	<p>In this experiment I played the role of National Responsible (PI). The experiment was aimed to the design, simulation, installation and test of a novel microwave interferometer based on the "frequency sweep" method for the measurement of plasma density in ECR ion sources. <b>The experiment has permitted to design and realize the first interferometer worldwide for plasma density measurements in compact Electron Cyclotron Resonance Ion Sources (D. Mascali et al. Letter to the Editor of Rev. Sci. Instrum, submitted).</b></p>
<p><b>2016-2018</b> <b>PANDORA - Nati Exp. of the 5<sup>th</sup> Nat. Comm. of INFN</b> <b>National Responsible</b></p>	<p>The proposal, regarding the <b>study of nuclear decays in magnetized plasmas</b>, with relevant impacts in stellar and primordial nucleosynthesis of light elements, has been approved by the V Nat. Comm. Activities started on Jan. 2017. The project involves INFN-LNS and LNL, and includes a <b>strict synergy with INAF and European partners such as GANIL and Grenoble-LSPC in France, the Hungarian Academy of Science – ATOMKI laboratories in Debrecen, Hungary (which have already sent an official Lol), the PSI in Switzerland, the University of Michigan – USA, the University of Cambridge, UK.</b></p>
<p><b>ENSAR – ARES</b> <b>UE FP7 2007-2013</b> <b>European collaboration</b></p>	<p>Activities were focused on Task 1: M-JRA01-1.1.1, in the frame of which I proposed and managed two experiments (in 2013 and 2014) in synergy with the European partners of GSI – Darmstadt, Germany, JYFL – University of Jyväskylä, Finland, and Hungarian Academy of Science, ATOMKI – Debrecen, concerning the correlation of X-rays emission measurements and electron heating study and relationship between the data obtained and the charge state distributions inside the ECR ion sources.</p>
<p><b>2013 to now</b> <b>ESS – European Spallation Source.</b></p>	<p>The activities, supported by temporary staff (RTD) contracts, were focused on the theoretical and numerical modelling of magnetized plasmas in Microwave Discharge Ion Sources finalized to the design of high-performance proton sources (high currents, low emittance). <b>I was in charge of the construction and commissioning of the ESS</b></p>

	<b>test-bench at LNS named FPT – Flexible Plasma Trap, devoted to the investigation of wave-plasma interaction by means of innovative waves’ launching schemes, and to the development of advanced plasma diagnostics methods.</b>
<b>2013 to now</b> <b>AISHa – Advanced Ion Source for Hadrontherapy</b>	<b>The activities in this frame were devoted especially to the conceptual design of the magnetic trap, which presents a relevant flexibility for the tailoring of the electron energy distribution function.</b> A contribution has been also given to the design of the RF system, which will be able to implement the heating schemes such as the Frequency Tuning and the Two Close Frequency Heating.

### *Institutional Responsibilities*

<b>January 2016 to now</b> <b>Head of Ion Beams Production Service at INFN-LNS</b>	Since January 2016 I was nominated as <b>responsible of the LNS ion beams production service.</b> The responsibilities cover the <b>management of the two injectors of the Tandem-Van der Graff accelerator (two “sputtering” ion sources), and of the two ECR ion sources</b> (named CAESAR – with room temperature coils, and SERSE – equipped with superconducting coils) feeding the K800 Superconducting Cyclotron. <b>R&amp;D activities</b> have been also started, with the design of a <b>compact proton source</b> supporting the CS during eye cancer treatments (CATANA project) and, in perspective, for the <b>development of noble gases negative ion beams (<math>^3\text{He}^-</math> and <math>\text{Ne}^-</math>) for the Tandem accelerator.</b>
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### Selection of n.10 Peer Reviewed Papers

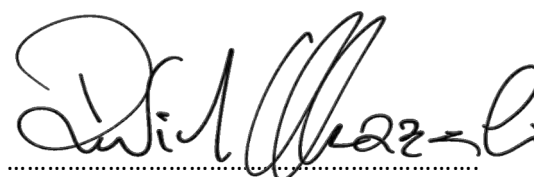
- [P1] **D. Mascali**, L. Celona, S. Gammino, R. Miracoli, G. Castro, N. Gambino, G. Ciavola, *Electrostatic wave heating and possible formation of self-generated high electric fields in a magnetized plasma*, Nucl. Instr. & Meth. A 653 (1) 11-16, 2011;  
<http://dx.doi.org/10.1016/j.nima.2011.02.048>
- [P2] **D. Mascali**, S. Gammino, L. Celona, G. Ciavola, *Towards a better comprehension of plasma formation and heating in high performance ECRIS*, Rev. Sci. Instrum. **83**, 02A336 (2012);  
<http://dx.doi.org/10.1063/1.3672107>
- [P3] **D. Mascali**, L. Celona, F. Maimone, J. Maeder, G. Castro, F.P. Romano, A. Musumarra, C. Altana, C. Caliri, G. Torrasi, L. Neri, S. Gammino, K. Tinschert, K. P. Spaedtke, J. Rossbach, R. Lang and G. Ciavola. *X-ray spectroscopy of warm and hot electron components in the CAPRICE source plasma at EIS testbench at GSI.* Rev. Sci. Instrum. **85**, 02A956 (2014);  
<http://dx.doi.org/10.1063/1.4858115>
- [P4] **D. Mascali**, G. Castro, S. Biri, R. Racz, J. Palinkas, C. Caliri, L. Celona, L. Neri, F.P. Romano, G. Torrasi, S. Gammino *Electron cyclotron resonance ion source plasma characterization by X-ray spectroscopy and X-ray imaging*, Review of Scientific Instruments 87(2):02A510, Feb. 2016  
<http://dx.doi.org/10.1063/1.4939201>
- [P5] **D. Mascali**, L. Celona, S. Gammino, G. Castro, R. Miracoli, L. Malferrari, F. Odorici, G. P. Veronese, R. Rizzoli, T. Serafino, *An investigation on the formation of suprathermal electrons in a B-min*



- ECR machine and a novel method for their damping*, Plasma Sources Sci. Technol. 22 (2013) 065006;  
doi:10.1088/0963-0252/22/6/065006
- [P6] S. Gammino, L. Celona, **D. Mascali** *Perspectives of Electron Cyclotron Resonance Ion Sources Beyond the Scaling Laws – Review Paper*, IEEE Transactions on Nuclear Science 63(2):1-9 · April 2016 DOI: 10.1109/TNS.2016.2514981
- [P7] **D. Mascali** , G. Torrisi, L. Neri , G. Sorbello, G. Castro, L. Celona, and S. Gammino. *3D-full wave and kinetics Numerical modelling of Electron Cyclotron Resonance Ion Sources plasma: steps towards self-consistency*, Eur. Phys. J. D (2015) 69: 27; doi:10.1140/epjd/e2014-50168-5
- [P8] **D. Mascali**, S. Tudisco, N. Gambino, A. Pluchino, A. Anzalone, F. Musumeci, A. Rapisarda, A. Spitaleri. *Prompt electrons driving ion acceleration and formation of a two temperatures plasma in nanosecond laser-ablation domain*. EuroPhysics Letters 100 (4) , art. no. 45003.  
<http://stacks.iop.org/0295-5075/100/i=4/a=45003>  
0295-5075-100-4-45003
- [P9] A. Galatà, **D. Mascali**, L. Neri, L. Celona, *A new numerical description of the interaction of an ion beam with a magnetized plasma in an ECR-based charge breeding device*, Plasma Sources Science and Technology 25(4) · August 2016 DOI: 10.1088/0963-0252/25/4/045007  
<http://dx.doi.org/10.1088/0963-0252/25/4/045007>
- [P10] **D. Mascali**, A. Musumarra, F. Leone, F. P. Romano, G. Galatà, S. Gammino, C. Massimi et al. Eur. Phys. J. A (2017) 53: 145 DOI: 10.1140/epja/i2017-12335-1

Catania, 19/07/2017

Signature<sup>1</sup>:

A handwritten signature in black ink, appearing to read 'David Mascali', written over a horizontal dotted line.

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<sup>1</sup> Il sottoscritto dichiara di essere informato, ai sensi del decreto legislativo 196/2003, che i dati verranno utilizzati nell'ambito del procedimento per il quale la presente dichiarazione viene resa.

### **Full List of Peer Reviewed Papers**

1. R. Miracoli, G. Castro, L. Celona, S. Gammino, **D. Mascali**, M. Mazzaglia, E. Naselli, G. Torrissi: Characterization of ECR plasma by means of radial and axial X-ray diagnostics. *Journal of Instrumentation* 01/2019; 14(01):C01016-C01016., DOI:10.1088/1748-0221/14/01/C01016
2. G. Torrissi, **D. Mascali**, A. Galatà, G. Sorbello, G. Castro, L. Celona, G. Mauro, M. Mazzaglia, E. Naselli, S. Gammino: Plasma heating and innovative microwave launching in ECRIS: models and experiments. *Journal of Instrumentation* 01/2019; 14(01):C01004-C01004., DOI:10.1088/1748-0221/14/01/C01004
3. E. Naselli, **D. Mascali**, G. Torrissi, G. Castro, L. Celona, S. Gammino, M. Mazzaglia, G. Sorbello: The first measurement of plasma density by means of an interfero-polarimetric setup in a compact ECR-plasma trap. *Journal of Instrumentation* 12/2018; 13(12):C12020-C12020., DOI:10.1088/1748-0221/13/12/C12020
4. R. Rácz, S. Biri, Z. Perduk, J. Pálinkás, **D. Mascali**, M. Mazzaglia, E. Naselli, G. Torrissi, G. Castro, L. Cellona, S. Gammino, A. Galata: Effect of the two-close-frequency heating to the extracted ion beam and to the X-ray flux emitted by the ECR plasma. *Journal of Instrumentation* 12/2018; 13(12):C12012-C12012., DOI:10.1088/1748-0221/13/12/C12012
5. G. Torrissi, **D. Mascali**, G. Sorbello, G. Castro, L. Celona, S. Gammino: Numerical and Experimental Characterization of RF Waves Propagation in Ion Sources Magnetoplasmas. *IEEE Transactions on Antennas and Propagation* 12/2018; PP(99):1-1., DOI:10.1109/TAP.2018.2884807
6. Bruno Ando, Salvatore Baglio, Ruben Crispino, Salvatore Graziani, Vincenzo Marletta, Alfio Mazzaglia, Valentina Sinatra, David Mascali, Giuseppe Torrissi: A Fluxgate-Based Approach for Ion Beam Current Measurement in ECRIS Beamline: Design and Preliminary Investigations. *IEEE Transactions on Instrumentation and Measurement* 11/2018;., DOI:10.1109/TIM.2018.2878612
7. M. Giarrusso, G. Avila, G. Del Zanna, E. Landi, F. Leone, M. Munari, G. Castro, L. Celona, S. Gammino, **D. Mascali**, M. Mazzaglia, E. Naselli: High resolution spectropolarimetry: from Astrophysics to ECR plasmas. *Journal of Instrumentation* 11/2018; 13(11):C11020-C11020., DOI:10.1088/1748-0221/13/11/C11020
8. G.G. Rapisarda, V.P. Bonanno, R. Catalano, G.A.P. Cirrone, G. Cosentino, G. Cuttone, **D. Mascali**, M.S. Musumeci, G. Petringa, S.M.R. Puglia, S. Tudisco, D. Rifuggiato: An irradiation test facility at INFN-LNS: status and perspectives. *Journal of Instrumentation* 11/2018; 13(11):C11018-C11018., DOI:10.1088/1748-0221/13/11/C11018
9. S. Biri, J. Pálinkás, Z. Perduk, R. Rácz, C. Caliri, G. Castro, L. Celona, S. Gammino, **D. Mascali**, M. Mazzaglia, E. Naselli, P. Romano, G. Torrissi, A. Galatà: Multi-diagnostic setup to investigate the two-close-frequency phenomena. *Journal of Instrumentation* 11/2018; 13(11):C11016-C11016., DOI:10.1088/1748-0221/13/11/C11016
10. M. Mazzaglia, G. Castro, **D. Mascali**, S. Briefi, U. Fantz, L. Celona, R. Miracoli, E. Naselli, R. Reitano, G. Torrissi, S. Gammino: Study of the influence of magnetic field profile on plasma parameters in a simple mirror trap. *Journal of Instrumentation* 11/2018; 13(11):C11014-C11014., DOI:10.1088/1748-0221/13/11/C11014
11. A. Galatà, **D. Mascali**, G. Torrissi, C.S. Gallo: Numerical simulations of magnetically confined plasmas. *Journal of Instrumentation* 11/2018; 13(11):C11013-C11013., DOI:10.1088/1748-0221/13/11/C11013

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13. A Caruso, A Longhitano, G Torrisci, L Neri, O Leonardi, G Castro, L Celona, D Mascali, L Allegra, G Gallo, S Passarello, G Sorbello, S Gammino: Experimental performance of the chopper for the ESS LINAC. *Journal of Physics Conference Series* 09/2018; 1067(4):042015., DOI:10.1088/1742-6596/1067/4/042015
14. G. Lanzalone, A. Muoio, C. Altana, M. Frassetto, L. Malferrari, D. Mascali, F. Odorici, S. Tudisco, L. A. Gizzi, L. Labate, S. M. R. Puglia, A. Trifirò: Nuclear Reactions Studies in Laser-Plasmas at the forthcoming ELI-NP facilities. *Journal of Physics Conference Series* 05/2018; 1014(1):012006., DOI:10.1088/1742-6596/1014/1/012006
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16. G. Torrisci, E. Naselli, **D. Mascali**, G. Castro, L. Celona, G. Sorbello, S. Gammino: A new interferometric/polarimetric setup for plasma density measurements in compact microwave-based Ion Sources. *Journal of Instrumentation* 10/2017; 12(10):C10003-C10003., DOI:10.1088/1748-0221/12/10/C10003
17. Leonida Antonio Gizzi, Dario Giove, Carmen Altana, Fernando Brandi, Pablo Cirrone, Gabriele Cristoforetti, Alberto Fazzi, Paolo Ferrara, Lorenzo Fulgentini, Petra Koester, Luca Labate, Gaetano Lanzalone, Pasquale Londrillo, **David Mascali**, Annamaria Muoio, Daniele Palla, Francesco Schillaci, Stefano Sinigardi, Salvatore Tudisco, Giorgio Turchetti: A New Line for Laser-Driven Light Ions Acceleration and Related TNSA Studies. *Applied Sciences* 09/2017; 7(10):984., DOI:10.3390/app7100984
18. S. Gammino, L. Celona, **D. Mascali**, G. Castro, G. Torrisci, L. Neri, M. Mazzaglia, G. Sorbello, O. Leonardi, L. Allegra, G. Calabrese, F. Chines, G. Gallo, S. Passarello: The Flexible Plasma Trap (FPT) for the production of overdense plasmas. *Journal of Instrumentation* 07/2017; 12(07):P07027-P07027., DOI:10.1088/1748-0221/12/07/P07027
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24. C. Altana, S. Tudisco, G. Lanzalone, **D. Mascali**, A. Muoio, F. Brandi, G. Cristoforetti, P. Ferrara, L. Fulgentini, P. Koester, L. Labate, D. Palla, L. Gizzi: Experimental investigation of ion production and acceleration mechanism in laser-produced plasma at moderate intensity for nuclear studies @ ELI-NP. Journal of Instrumentation 04/2017; 12(04):C04011-C04011., DOI:10.1088/1748-0221/12/04/C04011
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26. Muoio, C. Altana, M. Frassetto, G. Lanzalone, L. Malferrari, **D. Mascali**, F. Odorici, S. Tudisco: Nanostructured targets irradiation by ns-laser for nuclear astrophysics applications: first results. Journal of Instrumentation 03/2017; 12(03):C03076-C03076., DOI:10.1088/1748-0221/12/03/C03076
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28. **D. Mascali**, A Musumarra, F Leone, A Galatà, F P Romano, S Gammino: *Plasmas in compact traps: From ion sources to multidisciplinary research*. Il Nuovo Cimento C 02/2017; 39(5)., DOI:10.1393/ncc/i2016-16365-y
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215. **D. Mascali**, L. Celona, F. Consoli, S. Gammino, G. Ciavola. *Analysis of Microwave spectra emitted from TWT and Klystron-based generators used for the ECRIS at LNS*. LNS INTERNAL REPORT, February 2006.
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219. S. Gammino, G. Ciavola, L. Torrisi, L. Celona, L. Andò, F. Consoli, S. Passarello, M. Presti, S. Manciangli, D. Margarone, F. Chines, S. Marletta, G. Manno, E. Zappalà, **D. Mascali**, A. Scuderi, A.M. Mezzasalma, C. Gentile, E. Amato, F. Neri, A. Picciotto, F. Caridi, J. Beltrano, A. Mangione, A. Galatà, M. Winkler, P. Spadtke, K. Tinschert, R. Gobin, S. Barbarino, G. Sorbello, L. Laska, J. Krasa, M. Pfeifer, K. Rohlena, J. Wolowski, P. Parys, L. Ryc, V. Nassisi, A. Lorussoi, F. Belloni, D. Doria, J. Sherman, XZh. Zhang, *Research and developments of ion sources*, Report LNS (2004).

*Il sottoscritto dichiara di essere informato, ai sensi del decreto legislativo 196/2003, che i dati verranno utilizzati nell'ambito del procedimento per il quale la presente dichiarazione viene resa.*

Catania, 19/07/2017

Signature:



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## Curriculum Vitae

### **Rosario Pizzone**

7 Aprile 1975, Catania

Nationalita: Italiana

Lingue Italiano (Madrelingua), English (fluent), German (elementary)

### **Researcher Unique Identifiers:**

-ORCID: **0000-0003-2436-6640** -Researcher **ID I-4527-2015**

#### • **Formazione**

Gennaio 2002\_ **PhD in Fisica** (cum laude), Università di Catania, Tesi: "Electron screening in fusion reactions" Advisor: Prof. C. Spitaleri

Luglio 1998\_ **Laurea in Fisica (Ind. Astrofisico)** (110/110 cum laude), Università di Catania, Tesi: "Studio della reazione  $6\text{Li}(d,\alpha)4\text{He}$  nel contesto dell'inhomogenous Big Bang" Advisor: Prof. C. Spitaleri & prof. R.A. Zappalà

#### • **Posizione attualmente Ricoperta**

**2005-today** Ricercatore (INFN, National Institute for Nuclear Physics), Italy

**Responsabile Nazionale** Esperimento ASFIN2 INFN ( 30 ricercatori)

#### • **Borse, Contratti in Istituzioni Scientifiche Nazionali**

Ott. 2012-2017\_ Professore a contratto di Fisica Medica, Facoltà Medicina, CDL Dietistica, University of Catania

Ott. 2014-Set 2015\_ Professore a contratto di Fisica Generale, Facoltà Agraria, University of Catania

Ott. 2005-Set 2009\_ Professore a contratto di Fisica Applicata, Facoltà Ingegneria, University of Catania

Nov 2002-Dec 2005\_ Assegno di Ricerca, INFN, Italy

Nov 2001-Nov. 2002 Post-doctoral Fellowship, CSFNSM, Italy

Nov.2001\_vincitore Borsa PhD Università di Catania, Italy (vince anche Univ. Messina e Palermo)

Nov.1997-Nov.1998\_ Borsa per Laureandi (INFN) Nov.1998

### **Fellowship presso Istituzioni Estere di Ricerca:**

March 2016 - oggi Visiting Research Scientist, University of Texas Austin, TX USA: work on reactions at astrophysical plasma induced by laser

May 2013 Visiting Research Scientist, Texas A&M University, Commerce, TX USA: work on primordial nucleosynthesis

February 2011 – June 2012 Visiting Research Scientist Texas A&M University, College Station, TX, USA (research and tutoring of undergraduate students): set-up, commissioning, experiments with TECSA detector Array and MarS exotic beams

Mar-Apr 2009 Visiting Scientist Cyclotron Institute, Texas A&M University, College Station, TX, USA: DWBA calculation

Giu 2005-Lug 2005 Visiting Scientist CNS Riken, Tokyo Japan: CNS CRIB exotic beams test

### **Abilitazioni Nazionali**

Nov. 2014: Abilitazione all'insegnamento universitario in fascia 1 Bando 2013 DD n.161/2013 per Fisica Sperimentale delle Interazioni fondamentali (settore 02/A1)

Dic 2013 Abilitazione all'insegnamento universitario in fascia 2 Bando 2012 DD n.222/2012 per Astrofisica (Settore 02/C1)

Dic 2013 Abilitazione all'insegnamento universitario in fascia 2 Bando 2012 DD n.222/2012 per Fisica Sperimentale delle Interazioni fondamentali (settore 02/A1)

Nov. 2014: Abilitazione all'insegnamento universitario in fascia 1 Bando 2013 DD n.161/2013 per Fisica Sperimentale delle Interazioni fondamentali (settore 02/A1)

### **Premi e Riconoscimenti**

2002 SIF Premio per giovani fisici, 2001 Accademia Gioenia Premio per giovani Ricercatori , 2001 SIF Premio per giovani fisici

### **Attività DIDATTICA presso Istituzioni Nazionali**

2012-2016 Professore a contratto e coordinamento del corso di Fisica Medica, CdL Dietistica, Facoltà di Medicina, Università di Catania (4 anni accademici, 4 CFU)

2014-2015 Professore a contratto e coordinamento del corso di Fisica, CDL Scienze e tecnologie alimentari, Fac. Agraria (1 anno accademico, 7 CFU)

2014 Tiene il modulo di nucleosintesi primordiale del corso di Astrofisica Nucleare, Facoltà Scienze MMFFNN, CDL Fisica, Università di Catania

2005 - 2009 Fisica Applicata – Onde ed Oscillazioni (Professore a contratto e coordinamento del corso), Facoltà di Ingegneria, Università di Catania (4 anni accademici, 4 CFU)

1998-2005 Svolge il corso di Esercitazioni di Fisica Generale ed assistenza agli esami per Ingegneria

Edile, Fac. Ingegneria, Università di Catania

### **Attività DIDATTICA presso Istituzioni Internazionali**

2015 Lecturer (Invited) “European Summer School on Experimental Nuclear Astrophysics”

2013 Lecturer (Invited) at the Russbach school on nuclear astrophysics

2012 Lecturer (Invited) “Carpathian Summer on Nuclear and Particle Astrophysics”,

2011 Lecturer (Invited) “European Summer School on Experimental Nuclear Astrophysics”

2010 Lecturer (Invited) “Russbach school on nuclear astrophysics”

2007 Lecturer (Invited) “Carpathian Summer on Nuclear and Particle Astrophysics”,

### **Attività di Coordinamento Studenti e gestione tesi di laurea o dottorato**

Tutor of a Post-doctoral fellowship for foreign researchers at INFN LNS (A. Cvetinovic)

Co-Supervisor of a PhD thesis on the “Measurement of the  $^{19}\text{F}(\alpha, p)^{20}\text{Ne}$  reaction by means of the THM”, by G. D’Agata, Department of Physics and Astronomy, University of Catania, Italy

Correlatore di due tesi di Laurea Magistrale, CdL Fisica, Facoltà Scienze MMFFNN, Univ. Catania

- A.A. 2007/2008 Studio dei canali di reazione  $^3\text{H}(\mathbf{d}, \mathbf{p})^3\text{H}$  e  $^3\text{H}(\mathbf{d}, \mathbf{n})^3\text{He}$  ad energie di interesse astrofisico attraverso il Metodo del Cavallo di Troia
- A.A. 2013/2014 Misura della sezione d’urto  $^{19}\text{F}(\mathbf{a}, \mathbf{p})^{22}\text{Ne}$  con il metodo del Cavallo di Troia nel contesto astrofisico

2011 Responsabile per l’attività di uno borsista REU (REsearch for Undergraduate) presso Cyclotron Institute – Texas A&M University.

### **PUBBLICAZIONI**

Publicati 222 articoli in riviste peer-reviewed (ISI), primo autore in 30 di essi. In NASA ADS database circa 260 articoli. h-index totale =38 (fonte ISI web of Science)

### **TALK su INVITO, SEMINARI E CONFERENZE**

circa 40 contributi orali a conferenze Internazionali; 15 invited talks a conferenze e workshop (di cui 5 invited lecture presso scuole internazionali), 8 Seminari e “Colloquia” in istituzioni accademiche nazionali ed internazionali (e.g. Università di Pisa, Texas A&M University, University of Tokyo).

### **Organizzazione e coordinamento di conferenze, scuole ed eventi scientifici**

2001-2009 Membro del Local Organizing Committee della European Summer school on Experimental nuclear Astrophysics -Italy

2009-2015 Chair del Local Organizing Committee della European Summer school on Experimental

nuclear Astrophysics -Italy

2009-2015 Membro dello Scientific Advisory Committee della Russbach school on Nuclear Astrophysics - Austria

2009 Member del Local Organizing Committee del First Eurisol topical Meeting , INFN LNS Catania

2010 Member del Local Organizing Committee del VII Meeting of Italian groups of Experimental and Theoretical Nuclear Astrophysics - Italy

2007 Responsabile Scientifico della “Settimana della Ricerca Scientifica” ai LNS

2014 Responsabile Scientifico della “European Researchers’ night” ai LNS

### **Editor di pubblicazioni peer-review**

2007 co-editor della EAS publications series n. 27, proceedings of the Third European Summer School on Experimental Nuclear Astrophysics, ed. M. Busso, R.G. Pizzone, C. Rolfs, C. Spitaleri, A. Tumino, EDP sciences,

2010 co-editor della AIP publication series n. 1213 of the Fifth European Summer School on Experimental Nuclear Astrophysics, ed. C. Spitaleri, C. Rolfs, R.G. Pizzone, AIP, 2010

2013 co-editor della AIP publication series n. 1595 of the Seventh European Summer School on Experimental Nuclear Astrophysics, ed. C. Spitaleri, L. Lamia, R.G. Pizzone, AIP, 2014

### **Attività di Referaggio su riviste Scientifiche, Enti Pubblici di Ricerca o Panel**

Referee: European Journal of Physics A, Journal of Physics G, Journal of Environmental Radioactivity, International Journal of Phys. E. , AIP publications of conference proceedings, Physical Science International Journal.

Referee of PEGASUS, FIRB grants for the Italian Science Ministry, VQR MIUR National Center of Science and Technology Evaluation (Rep. Kazakhstan).

### **Gestione e coordinamento Progetti di Ricerca:**

2011- 2018 Responsabile Nazionale Esperimento Asfin2 INFN (responsabile locale 2011-2015) per LNS): gestione fondi ricerca per un totale di circa 600 k€ in tutto il periodo